In [1]:
```
import os
import pathlib
import time
import re
import pickle
import numpy as np
import pandas as pd
import matplotlib
import matplotlib.pyplot as plt
import seaborn as sns
import tensorflow as tf
from tensorflow import keras
from tensorflow.keras import layers
print(tf.__version__)

# plotting style options
font = {'size': 18}
matplotlib.rc('font', **font)
sns.set_theme()
sns.set(font_scale = 1.2)
%matplotlib inline
```

```
2.7.0
```

# Contents

The notebook is structured as follows:

# 1. Introduction

## 1.1. Problem statement

- Two opposing robots, R1 and R2, apply pressure onto a metal sheet to deform it.
- Each robot can move in $x, y, z$, and (roll, pitch, yaw) $a, b, c$.
- R1 (the "forming robot") pushes into the sheet ($z$) while moving along a path in $x$/$y$-plane, parallel to the sheet metal surface.
- R2 (the opposing "support robot") pushes into the sheet from the other side.
- Both robots experience forces at the tool-tip in $x$, $y$, and $z$ directions.
- Positions, angles, and tool-tip forces are captured for each robot.

**Deliverables**:

- Develop a model to predict forces experienced by tool-tips for any path traveled by the robot arms
- Provide a Jupyter notebook that includes all the steps

## 1.2. Proposed solution

The problem is to find a function $G$ to predict tool-tip forces from position coordinates:

$$\vec{f} = G(x, y, z, a, b, c)$$

Models like these could be solved using a parametrized dynamical model with Lagrange or Newton-Euler methods assuming rigid body motion. However, instead of doing that, I'm going to **approximate $G$ with a neural network**.

Here are a few sources I looked at for inspiration:

- http://www.scholarpedia.org/article/Robot_dynamics
- https://ethz.ch/content/dam/ethz/special-interest/mavt/robotics-n-intelligent-systems/rsl-dam/documents/RobotDynamics2016/6-dynamics.pdf
- https://towardsdatascience.com/approximating-dynamic-models-of-industrial-robots-with-neural-networks-2474d1a2eecd
- https://www.nature.com/articles/s41598-021-97003-1.pdf

- https://www.tensorflow.org/tutorials/keras/regression
- https://www.tensorflow.org/guide/keras/rnn

# 2. Exploration of the dataset

Before training a model, it is always good to look at the data. Let's have a look at time series plots, histograms, and correlations.

## Import the datasets into pd.DataFrame

In [124…

```
workdir = pathlib.Path("./")


# create a timestamp for tagging saved models
timestamp = time.strftime("%Y%m%d_%H%M")

# output directory for saved models, plots, etc.
output_dir = workdir / 'olsson_solution_{}'.format(timestamp)
output_dir.mkdir(parents=True, exist_ok=True)

dataset_filenames = ["Test1", "Test2", "Test4"]

# list of dataframes
datasets = list()
print("loading datasets:")
for filename in dataset_filenames:
    print("-", workdir / str(filename+'.csv'))
    datasets.append(pd.read_csv(workdir / str(filename+'.csv')))
```

```
loading datasets:
- Test1.csv
- Test2.csv
- Test4.csv
```

## Look at a summary of what's in the dataframe

In [3]:

```
print("First five entries: \n", datasets[0].head(5).T)
```

```
First five entries:
                      0             1             2             3             4
t         1.636580e+09  1.636580e+09  1.636580e+09  1.636580e+09  1.636580e+09
a_enc_1  -4.951100e+00 -4.951100e+00 -4.951100e+00 -4.951100e+00 -4.951100e+00
b_enc_1   1.830000e-02  1.830000e-02  1.830000e-02  1.830000e-02  1.830000e-02
c_enc_1  -7.190000e-02 -7.190000e-02 -7.190000e-02 -7.190000e-02 -7.190000e-02
x_enc_1   2.136337e+02  2.136337e+02  2.136337e+02  2.136337e+02  2.136337e+02
y_enc_1   3.241015e+02  3.241015e+02  3.241015e+02  3.241015e+02  3.241015e+02
z_enc_1   8.953528e+02  8.953528e+02  8.953528e+02  8.953528e+02  8.953528e+02
a_enc_2  -1.549772e+02 -1.549772e+02 -1.549772e+02 -1.549772e+02 -1.549772e+02
b_enc_2   2.023000e-01  2.024000e-01  2.024000e-01  2.024000e-01  2.024000e-01
c_enc_2  -1.798798e+02 -1.798798e+02 -1.798798e+02 -1.798798e+02 -1.798798e+02
x_enc_2   2.232210e+01  2.232040e+01  2.232040e+01  2.232040e+01  2.232040e+01
y_enc_2   7.831761e+02  7.831754e+02  7.831754e+02  7.831754e+02  7.831754e+02
z_enc_2  -7.725771e+02 -7.725771e+02 -7.725771e+02 -7.725771e+02 -7.725771e+02
fx_1     -2.326357e+00 -2.192611e+00 -2.103594e+00 -1.869649e+00 -2.336206e+00
fy_1      9.639795e+00  9.531656e+00  9.776526e+00  9.100982e+00  9.058406e+00
fz_1     -3.264595e+01 -3.307391e+01 -3.143578e+01 -3.171914e+01 -3.232948e+01
```

```
fx_2     1.180561e+01  1.169716e+01  1.166217e+01  1.141468e+01  1.122329e+01
fy_2     1.865609e+01  1.846252e+01  1.860119e+01  1.848982e+01  1.795298e+01
fz_2    -1.283101e+01 -1.225022e+01 -1.145559e+01 -1.253816e+01 -1.042543e+01
```

In [4]:

```
print("\ndescribe():\n", datasets[0].describe().T[['count', 'mean', 'std', 'min'
```

```
describe():
            count          mean          std           min           max
t         20091.0  1.636590e+09  5800.523780  1.636580e+09  1.636600e+09
a_enc_1   20091.0 -8.924334e+01     7.811876 -9.001034e+01 -4.951004e+00
b_enc_1   20091.0  8.760533e-04     0.002961 -1.604445e-02  2.338158e-02
c_enc_1   20091.0  1.884124e-03     0.007390 -7.199558e-02  2.159353e-02
x_enc_1   20091.0  4.578387e+02   197.669145  8.937531e+01  8.306894e+02
y_enc_1   20091.0  1.965825e+02   103.805836 -1.773652e+00  3.672685e+02
z_enc_1   20091.0 -6.500421e+01   100.980291 -1.767849e+02  8.953528e+02
a_enc_2   20091.0  8.804365e+01    22.349876 -1.783886e+02  1.789519e+02
b_enc_2   20091.0  1.449096e-03     0.029150 -2.199676e+00  1.164570e+00
c_enc_2   20091.0 -4.858466e+01   173.319815 -1.800000e+02  1.800000e+02
x_enc_2   20091.0  4.560382e+02   202.637762  2.231891e+01  8.318730e+02
y_enc_2   20091.0  1.995663e+02   120.025141 -3.800164e+00  7.831773e+02
z_enc_2   20091.0 -7.605120e+01    81.255998 -7.725771e+02 -6.817898e-01
fx_1      20091.0  3.084250e+01   681.262919 -1.919500e+03  1.876367e+03
fy_1      20091.0  9.071373e+01  1192.944410 -1.841587e+03  2.238735e+03
fz_1      20091.0  2.518588e+03   582.206105 -7.799607e+01  3.374799e+03
fx_2      20091.0 -2.917874e+01   441.132354 -1.488688e+03  1.233724e+03
fy_2      20091.0 -1.031784e+02   729.100519 -1.584797e+03  1.303751e+03
fz_2      20091.0 -7.406174e+02   302.882751 -2.315789e+03 -5.323892e+00
```

### Make separate lists of input features (position coordinates and euler angles) and outputs (forces)

In [5]:

```
#features = [k for k in datasets[0].keys() if not re.search('^f', k) and 't' not
#outputs = [k for k in datasets[0].keys() if re.search('^f', k)]

features_1 = [i+'_enc_1' for i in 'xyzabc']
features_2 = [i+'_enc_2' for i in 'xyzabc']
outputs_1 = ['fx_1', 'fy_1', 'fz_1']
outputs_2 = ['fx_2', 'fy_2', 'fz_2']
features = features_1 + features_2
outputs = outputs_1 + outputs_2

print('features:', features)
print('outputs:', outputs)
```

```
features: ['x_enc_1', 'y_enc_1', 'z_enc_1', 'a_enc_1', 'b_enc_1', 'c_enc_1', 'x_
enc_2', 'y_enc_2', 'z_enc_2', 'a_enc_2', 'b_enc_2', 'c_enc_2']
outputs: ['fx_1', 'fy_1', 'fz_1', 'fx_2', 'fy_2', 'fz_2']
```

# 2.1. Correlations

### First look at correlations for R1 and R2 separately, for simplicity

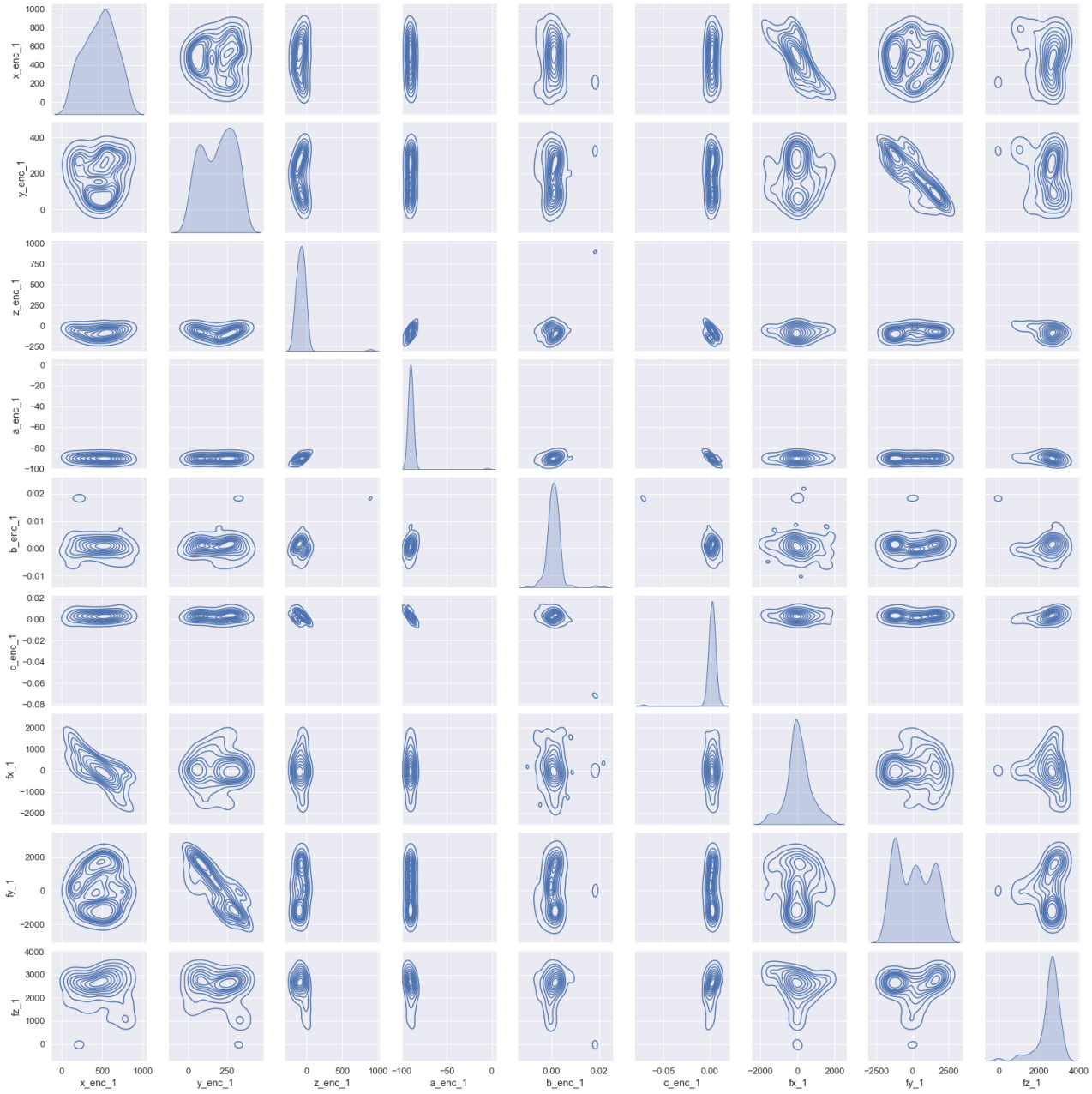
seaborn.pairplot can be helpful to get an idea of correlations

In [6]:

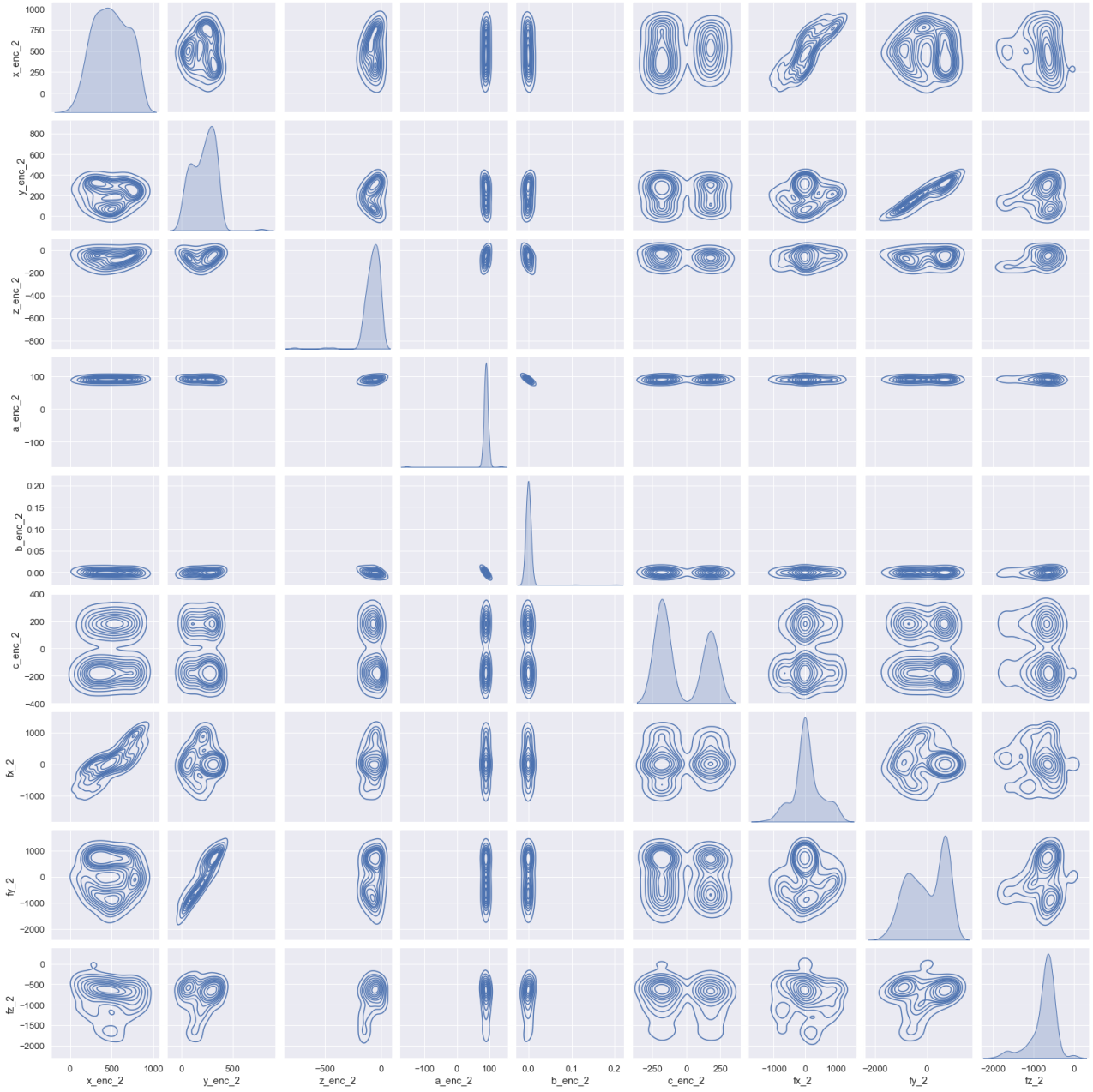
```
# pair plots (slow...)
labels = [features_1+outputs_1, features_2+outputs_2]
for robot_idx in range(2):
    fig = plt.figure(figsize=(20, 20))
```

```
    sns.pairplot(datasets[0].sample(200)[labels[robot_idx]], kind='kde')
    plt.savefig(output_dir/'pairplot_robot{}.pdf'.format(robot_idx+1))
```

```
<Figure size 1440x1440 with 0 Axes>
```



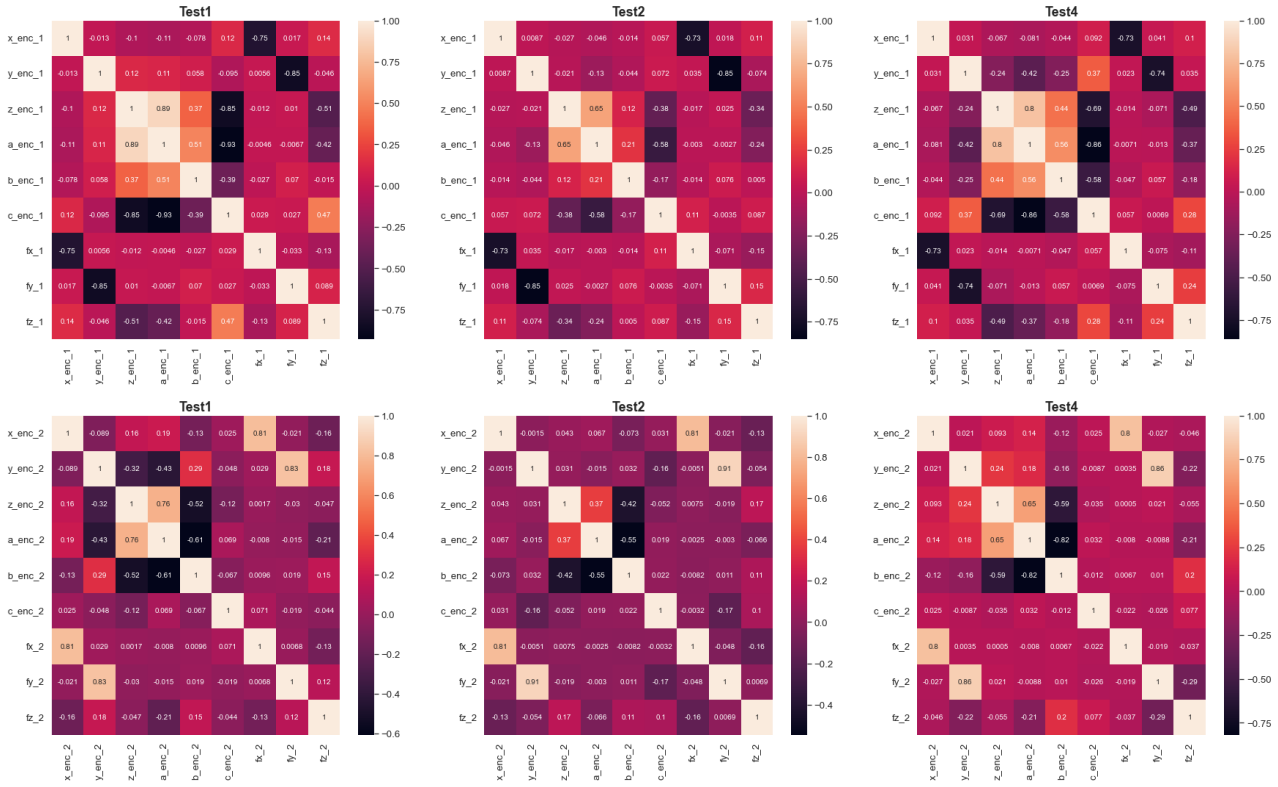

```
<Figure size 1440x1440 with 0 Axes>
```




## Plot correlation matrices

In [7]:

```
sns.set_style("whitegrid")
labels = [features_1+outputs_1, features_2+outputs_2]
for robot_idx in range(2):
    fig = plt.figure(figsize=(10*len(datasets), 8))
    for i,df in enumerate(datasets):
        corr = df[labels[robot_idx]].corr()
        ax = fig.add_subplot(1, len(datasets), i+1)
        ax.set_title(dataset_filenames[i], weight='bold').set_fontsize('18')
        sns.heatmap(corr, annot=True)
    plt.savefig(output_dir/'corr_robot{}.pdf'.format(robot_idx+1))
```



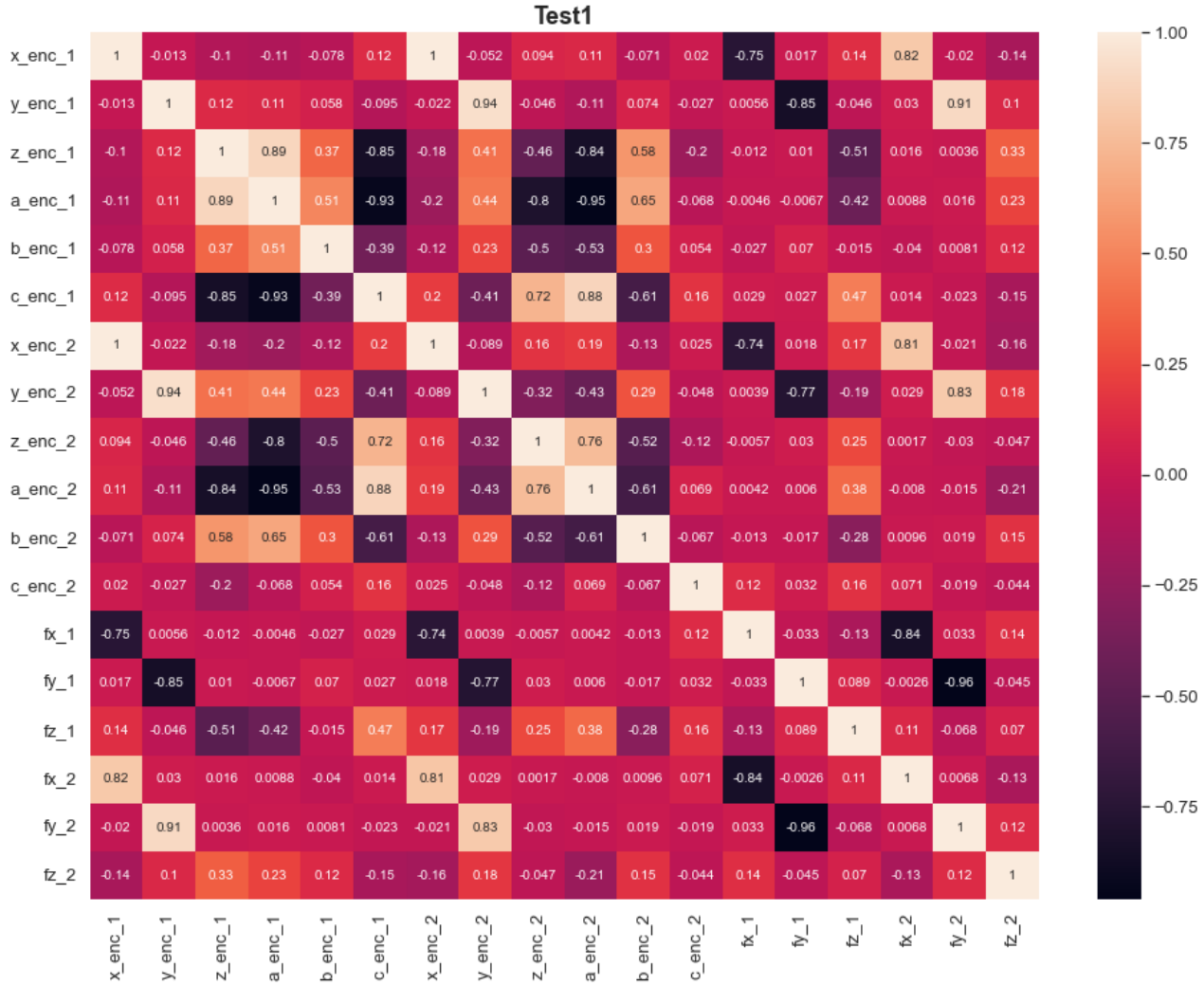

**Observations:**

- Forces $f_x$ and $f_y$ are strongly correlated with positions $x$ and $y$ respectively and relatively weakly related to anything else.
- $f_z$ is mainly correlated to $z$, but also quite strongly correlated with $a$ (roll) and $c$ (yaw), especially for R1.

## Now let's look at correlations between R1 and R2

In [8]:

```
dataset_idx = 0 # Test1
labels = features_1+features_2+outputs_1+outputs_2
fig = plt.figure(figsize=(16, 12))
corr = datasets[dataset_idx][labels].corr()
ax = fig.add_subplot(111)
ax.set_title(dataset_filenames[dataset_idx], weight='bold').set_fontsize('18')
sns.set_style("whitegrid")
sns.heatmap(corr, annot=True)
plt.savefig(output_dir/'corr_{}_both_robots.pdf'.format(dataset_filenames[datase
```




**Observations:**

- Strong correlations between $x_1$, $x_2$, $f_{x_1}$, and $f_{x_2}$ and between $y_1$, $y_2$, $f_{y_1}$, and $f_{y_2}$ which seems reasonable given the motion of the two robots.
- Relatively weak correlation between $f_{z_1}$ and $f_{z_2}$. Forces in $z$ have quite strong correlation to $a$, $b$, and $c$.

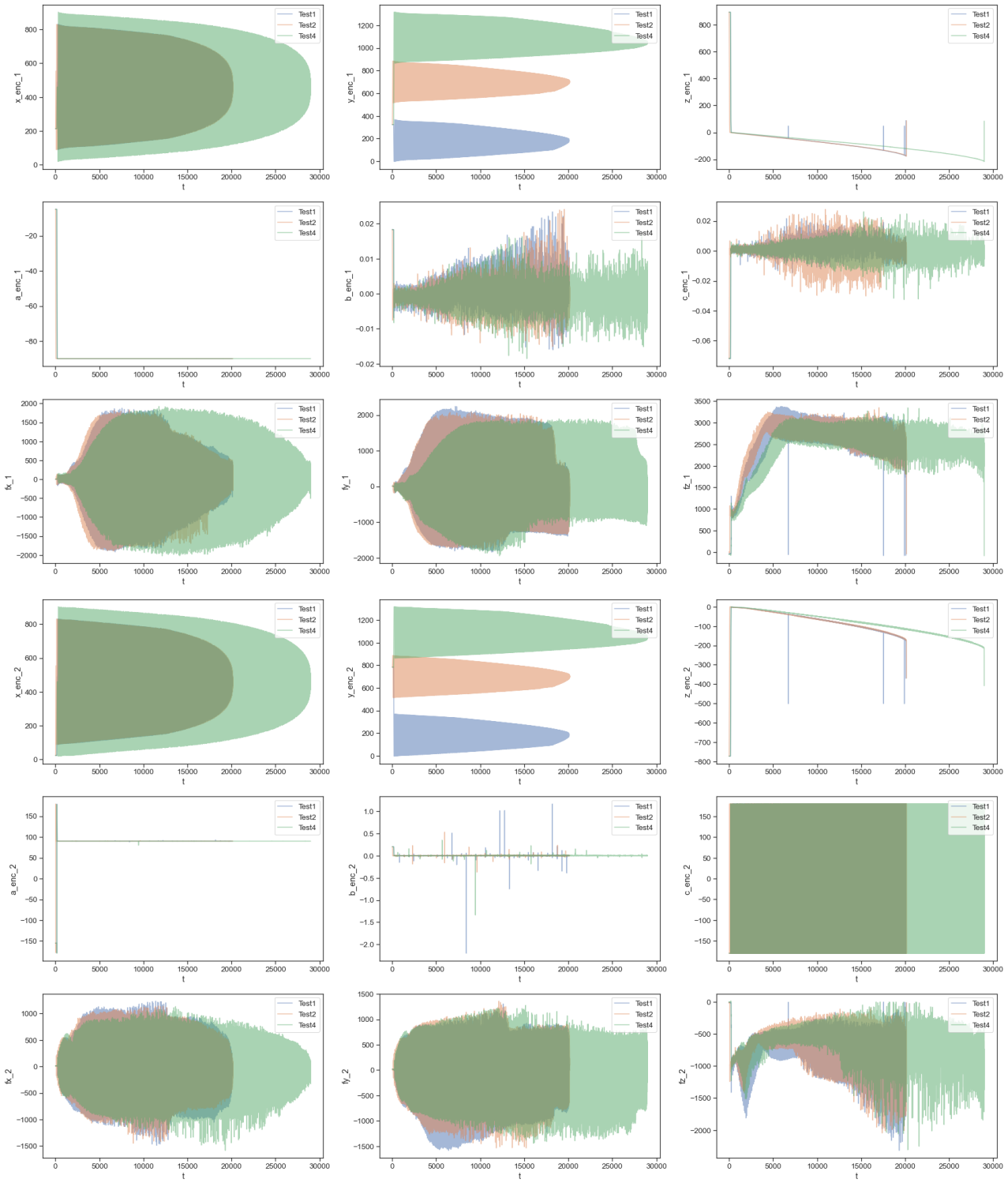
# 2.2. Time series plots

## Plot varables in dataset to see what things look like

In [9]:

```
sns.set_style("ticks")
variables_to_plot = [i+'_enc' for i in 'xyzabc'] + ['fx', 'fy', 'fz']
for robot_idx in range(2):
    fig = plt.figure(figsize=(30,18))
    for i,k in enumerate(variables_to_plot):
        k += '_{}'.format(robot_idx+1)
        ax = fig.add_subplot(3,3, i+1)
        for j in range(len(datasets)):
            # shift 't' to start at 0 for each dataset
            ax.plot(datasets[j]['t']-min(datasets[j]['t']), datasets[j][k], labe
        ax.set_xlabel('t', y=0.5)
        ax.set_ylabel(k, y=0.5)
```

```
        ax.legend(loc=1)
    fig.savefig(output_dir/'1d_plot_variables_vs_time_robot{}.pdf'.format(robot_
```

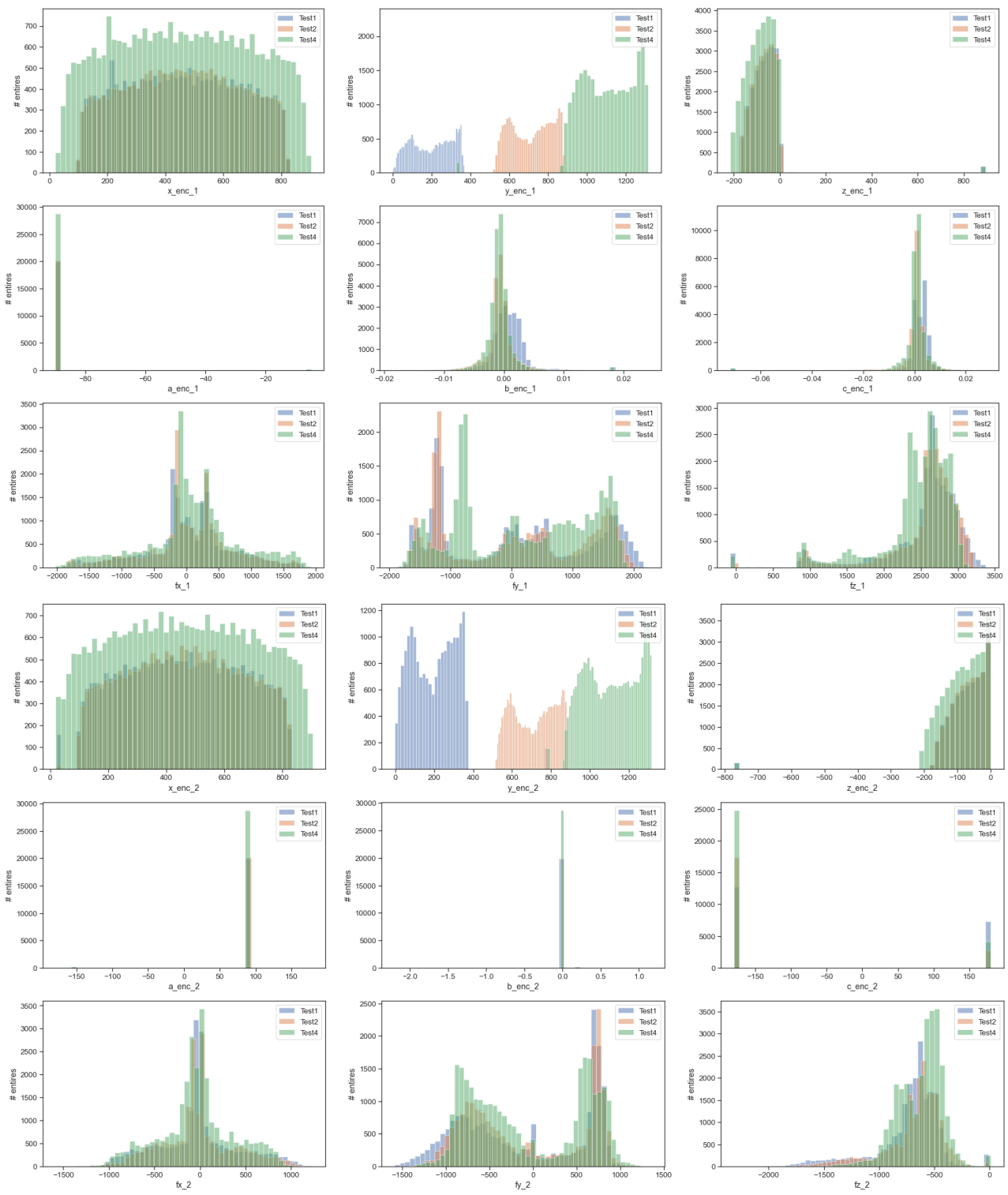



# 2.3. Histograms

## Make histograms of varables in dataset

In [10]:
```
sns.set_style("ticks")
variables_to_plot = [i+'_enc' for i in 'xyzabc'] + ['fx', 'fy', 'fz']
for robot_idx in range(2):
    fig = plt.figure(figsize=(30,18))
```

```
    for i,k in enumerate(variables_to_plot):
        k += '_{}'.format(robot_idx+1)
        ax = fig.add_subplot(3,3, i+1)
        for j in range(len(datasets)):
            ax.hist(datasets[j][k], label=dataset_filenames[j], bins=50, alpha=0
        ax.set_xlabel(k, y=0.5)
        ax.set_ylabel('# entires', y=0.5)
        ax.legend(loc=1)
    fig.savefig(output_dir/'1d_hist_variables_vs_time_robot{}.pdf'.format(robot_
```




# 3. Pre-processing

# 3.1. Addition of higher-order derivatives of input features

I noticed that the models could more accurately predict forces from motion in datasets not seen during training when adding higher-order derivatives of the position coordinates as input features.

First (velocity) and second (acceleration) order derivatives had a notable effect on the performance (more about that in section 4). I also tried to include up to 6th order derivatives (3rd=jerk, 4th=snap, 5th=crackle, 6th=pop) [1]. These had a smaller impact but did help in some cases.

[1] https://en.wikipedia.org/wiki/Fourth,_fifth,_and_sixth_derivatives_of_position

In [11]:
```
# differentiate variables in dataframe
def add_gradients(df, keys_to_diff, nth_order=1):
    for k in keys_to_diff:
        df['d'+str(nth_order)+'_'+re.sub('d\d_','', k)] = np.gradient(df[k])
```

In [12]:
```
# add derivatives of position and euler angles:
# 1=velocity, 2=acceleration, 3=jerk, 4=snap, 5=crackle, 6=pop
nth_order = 6
features_to_diff = features
for n in range(1, nth_order+1):
    for df in datasets:
        add_gradients(df, features_to_diff, n)
    features_to_diff = [k for k in datasets[0].keys() if re.search('^d{:d}'.form
```

## Create feature lists

In [13]:
```
# x-axis only
features_x1 = ['x_enc_1'] + ["d{:d}_x_enc_1".format(i) for i in range(1,7)]
features_x2 = ['x_enc_2'] + ["d{:d}_x_enc_2".format(i) for i in range(1,7)]
outputs_x1 = ['fx_1']
outputs_x2 = ['fx_2']
```

In [14]:
```
def generate_feature_list(arm_idx, nth_order=6):
    features = []
    for i in 'xyzabc':
        features.append('{}_enc_{}'.format(i, arm_idx))
    for i in 'xyzabc':
        for j in range(1,nth_order+1):
            features.append('d{}_{}_enc_{}'.format(j, i, arm_idx))
    return features
```

In [15]:
```
# up to 6th order derivatives (velocity, acceleration, jerk, snap, crackle, pop)
features_1_nth = generate_feature_list(1, nth_order)
features_2_nth = generate_feature_list(2, nth_order)

# up to 2nd order derivatives (velocity, acceleration)
features_1_2nd = generate_feature_list(1, 2)
```

```
features_2_2nd = generate_feature_list(2, 2)

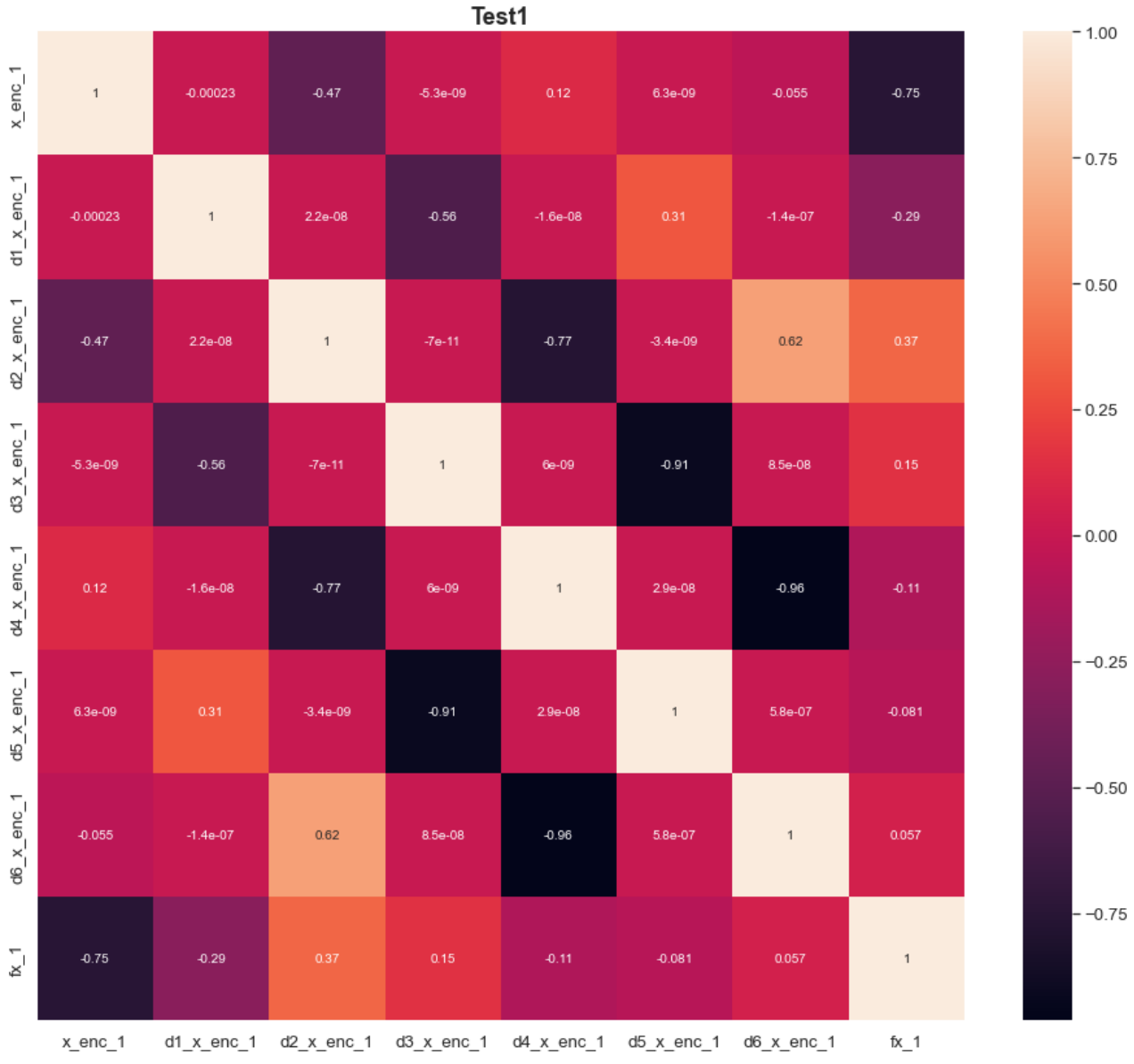
outputs_1 = ['fx_1', 'fy_1', 'fz_1']
outputs_2 = ['fx_2', 'fy_2', 'fz_2']
```

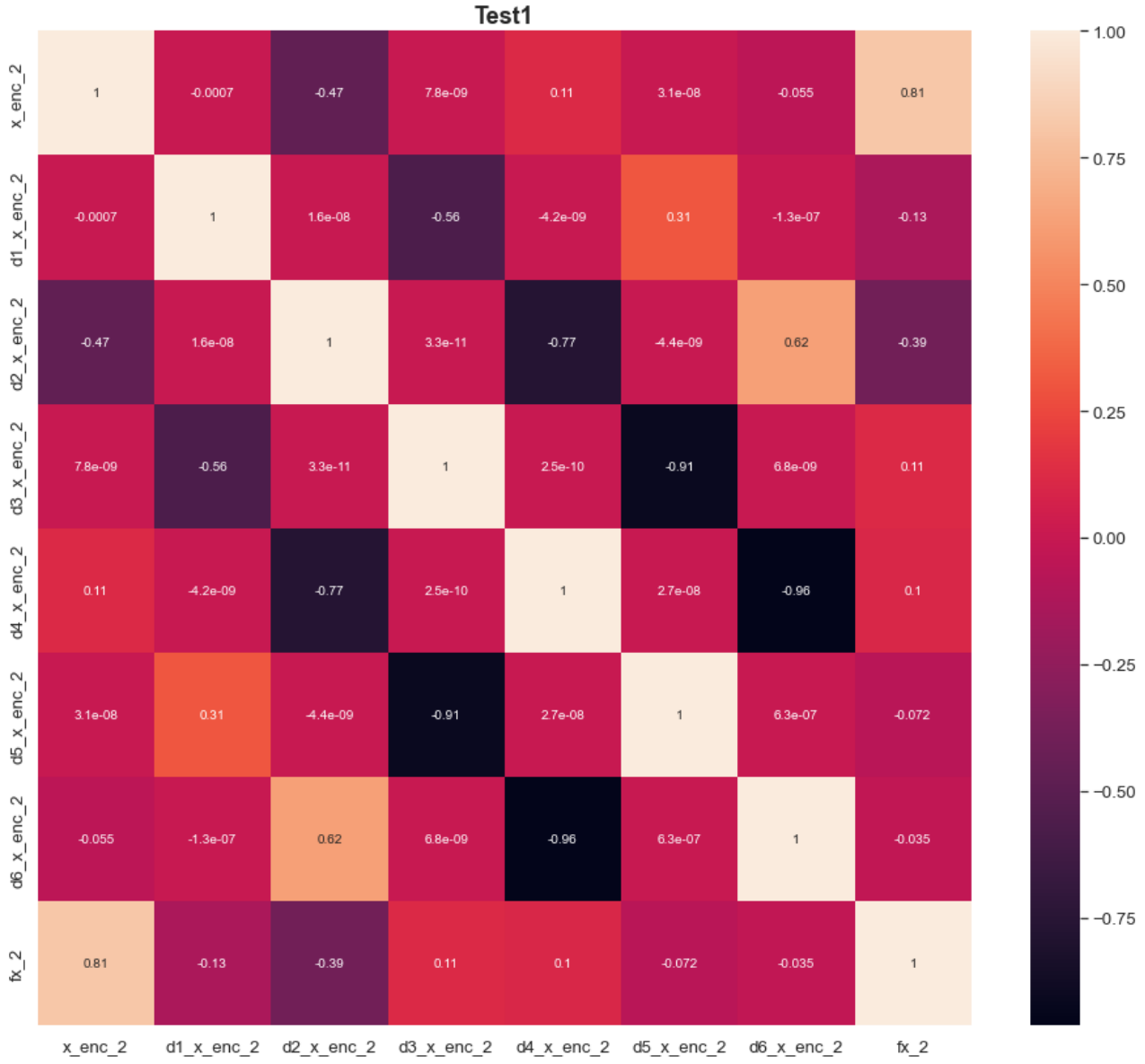
## Correlations to higher order derivatives

### $x$-axis only

In [16]:

```
idx = 0 # Test1
labels = [features_x1+outputs_x1, features_x2+outputs_x2]
sns.set_style("whitegrid")
for robot_idx in range(2):
    fig = plt.figure(figsize=(16, 14))
    corr = datasets[idx][labels[robot_idx]].corr()
    ax = fig.add_subplot(111)
    ax.set_title(dataset_filenames[idx], weight='bold').set_fontsize('18')
    sns.heatmap(corr, annot=True)
    plt.savefig(output_dir/'corr_derivatives_x_robot{}.pdf'.format(robot_idx+1))
```

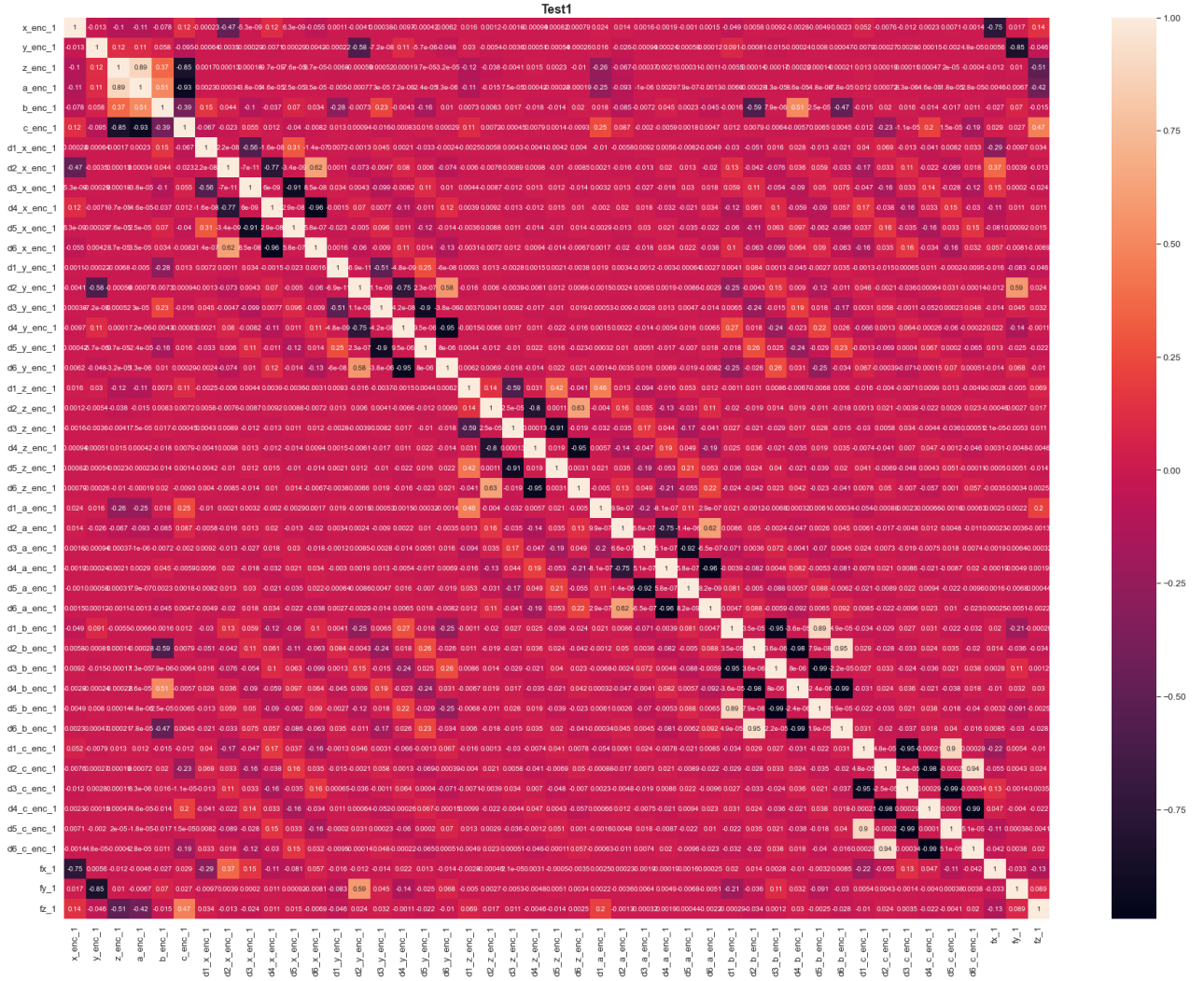


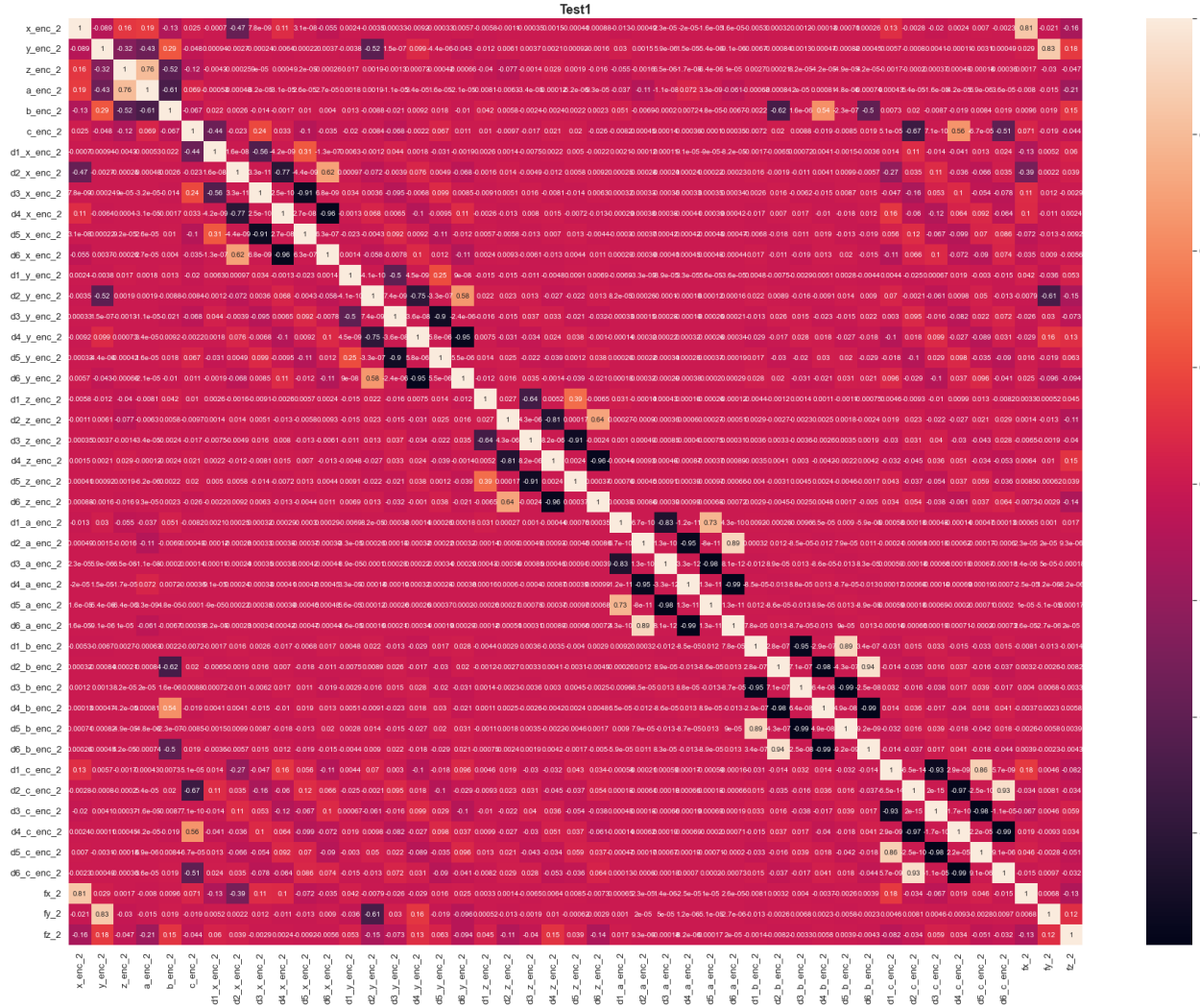



## All coordinates

In [17]:

```
idx = 0 # Test1
labels = [features_1_nth+outputs_1, features_2_nth+outputs_2]
sns.set_style("whitegrid")
for robot_idx in range(2):
    fig = plt.figure(figsize=(32, 24))
    corr = datasets[idx][labels[robot_idx]].corr()
    ax = fig.add_subplot(111)
    ax.set_title(dataset_filenames[idx], weight='bold').set_fontsize('18')
    sns.heatmap(corr, annot=True)
    plt.savefig(output_dir/'corr_derivatives_all_robot{}.pdf'.format(robot_idx+1
```


Test1
x_enc_1
y_enc_1
z_enc_1
a_enc_1
b_enc_1
c_enc_1
d1_x_enc_1
d2_x_enc_1
d3_x_enc_1
d4_x_enc_1
d5_x_enc_1
d6_x_enc_1
d1_y_enc_1
d2_y_enc_1
d3_y_enc_1
d4_y_enc_1
d5_y_enc_1
d6_y_enc_1
d1_z_enc_1
d2_z_enc_1
d3_z_enc_1
d4_z_enc_1
d5_z_enc_1
d6_z_enc_1
d1_a_enc_1
d2_a_enc_1
d3_a_enc_1
d4_a_enc_1
d5_a_enc_1
d6_a_enc_1
d1_b_enc_1
d2_b_enc_1
d3_b_enc_1
d4_b_enc_1
d5_b_enc_1
d6_b_enc_1
d1_c_enc_1
d2_c_enc_1
d3_c_enc_1
d4_c_enc_1
d5_c_enc_1
d6_c_enc_1
fx_1
fy_1
fz_1
1.00
0.75
0.50
0.25
0.00
−0.25
−0.50
−0.75




# 3.2. Scaling of input features and outputs

## Specify which datasets to use

Hold out 'Test2' for testing of model trained on data from 'Test1' and 'Test4'.

In [18]:
```
df1 = datasets[0] # Test1
df2 = datasets[1] # Test2
df4 = datasets[2] # Test4
df = df1.copy()
#df = df.append(datasets[1])
df = df.append(datasets[2])
```

## Split dataframe into X (features) and Y (outputs)

In [19]:
```
features_nth = features_1_nth + features_2_nth
features_2nd = features_1_2nd + features_2_2nd
X = df[features_nth].to_numpy()
Y = df[outputs].to_numpy()
print(X.shape, Y.shape)
```

```
(49078, 84) (49078, 6)
```

### Feature scaling

Both MinMaxScaler and StandardScaler were tried, the former gave slightly more robust performance.

In [20]:
```
from sklearn.preprocessing import StandardScaler, MinMaxScaler
#scaler_x = StandardScaler()
#scaler_y = StandardScaler()
scaler_x = MinMaxScaler()
scaler_y = MinMaxScaler()
X_normed = scaler_x.fit_transform(X)
Y_normed = scaler_y.fit_transform(Y)
```

In [21]:
```
# sanity check
print(X[0:5,0])
print(X_normed[0:5,0])
print(scaler_x.inverse_transform(X_normed)[0:4,0])
```

```
[213.6337 213.6337 213.6337 213.6337 213.6337]
[0.21954808 0.21954808 0.21954808 0.21954808 0.21954808]
[213.6337 213.6337 213.6337 213.6337]
```

## 3.3. Preparing input features for RNN training

Including multiple time steps of the input features and training an RNN to predict forces improved the performance over using a DNN. After some experimentation, I concluded that about 20 timesteps worked pretty well.

In [22]:
```
def split_sequences(X, Y, n_steps):
    X_seq, Y_seq = list(), list()
    for i in range(len(X)):
        end_i = i + n_steps
        if end_i > len(X):
            break
        Xi, yi = X[i:end_i, :], Y[end_i-1, :]
        X_seq.append(Xi)
        Y_seq.append(yi)
    return (np.array(X_seq), np.array(Y_seq))
```

In [23]:
```
# prepare sequences for RNN with 20 time steps
n_steps = 20
X_seq, Y_seq = split_sequences(X_normed, Y_normed, n_steps)
print(X_seq.shape, Y_seq.shape)
```

```
(49059, 20, 84) (49059, 6)
```

## 3.4. Splitting of data into train/validation/test sets

In [24]:
```
from sklearn.model_selection import train_test_split
# if False: keep last events for testing
shuffle = True
# 70-10-20 train-validation-test split
```

```
train_frac = 0.7
val_frac = 0.1

# for dnn
X_train, X_val_test, Y_train, Y_val_test = train_test_split(X_normed, Y_normed,
X_val, X_test, Y_val, Y_test = train_test_split(X_val_test, Y_val_test, test_siz

print(X_train.shape, Y_train.shape)
print(X_val.shape, Y_val.shape)
print(X_test.shape, Y_test.shape)

# for rnn
X_seq_train, X_seq_val_test, Y_seq_train, Y_seq_val_test = train_test_split(X_se
X_seq_val, X_seq_test, Y_seq_val, Y_seq_test = train_test_split(X_seq_val_test,

print(X_seq_train.shape, Y_seq_train.shape)
print(X_seq_val.shape, Y_seq_val.shape)
print(X_seq_test.shape, Y_seq_test.shape)
```

```
(34354, 84) (34354, 6)
(4907, 84) (4907, 6)
(9817, 84) (9817, 6)
(34341, 20, 84) (34341, 6)
(4905, 20, 84) (4905, 6)
(9813, 20, 84) (9813, 6)
```

## Create train/val/test sets with 12 (positions and angles) and 36 input features (positions, angles, and up to 2nd order derivatives)

In [25]:

```
# sanity check
print(features)
print(features_2nd)
print(outputs)
```

```
['x_enc_1', 'y_enc_1', 'z_enc_1', 'a_enc_1', 'b_enc_1', 'c_enc_1', 'x_enc_2', 'y
_enc_2', 'z_enc_2', 'a_enc_2', 'b_enc_2', 'c_enc_2']
['x_enc_1', 'y_enc_1', 'z_enc_1', 'a_enc_1', 'b_enc_1', 'c_enc_1', 'd1_x_enc_1',
'd2_x_enc_1', 'd1_y_enc_1', 'd2_y_enc_1', 'd1_z_enc_1', 'd2_z_enc_1', 'd1_a_enc_
1', 'd2_a_enc_1', 'd1_b_enc_1', 'd2_b_enc_1', 'd1_c_enc_1', 'd2_c_enc_1', 'x_enc
_2', 'y_enc_2', 'z_enc_2', 'a_enc_2', 'b_enc_2', 'c_enc_2', 'd1_x_enc_2', 'd2_x_
enc_2', 'd1_y_enc_2', 'd2_y_enc_2', 'd1_z_enc_2', 'd2_z_enc_2', 'd1_a_enc_2', 'd
2_a_enc_2', 'd1_b_enc_2', 'd2_b_enc_2', 'd1_c_enc_2', 'd2_c_enc_2']
['fx_1', 'fy_1', 'fz_1', 'fx_2', 'fy_2', 'fz_2']
```

In [26]:

```
# indices of 12 position input features
feature_idx = [df[features_nth].columns.get_loc(col) for col in features]
# indices of position, velocity, and acceleration input features
feature_idx_2nd = [df[features_nth].columns.get_loc(col) for col in features_2nd
# indices of all features
feature_idx_nth = [df[features_nth].columns.get_loc(col) for col in features_nth
```

In [27]:

```
# sanity check
print(df[features][4000:4001].to_numpy())
print(scaler_x.inverse_transform(X_normed)[:,feature_idx][4000:4001,:])
```

```
[[ 7.01138030e+02  9.05163185e+01 -2.66579203e+01 -8.99984769e+01
  -4.16576996e-04  2.06331677e-03  7.04664055e+02  8.46991898e+01
  -2.02531592e+01  8.99942266e+01 -2.56791472e-04 -1.79998530e+02]]
```

```
[[ 7.01138030e+02  9.05163185e+01 -2.66579203e+01 -8.99984769e+01
  -4.16576996e-04  2.06331677e-03  7.04664055e+02  8.46991898e+01
  -2.02531593e+01  8.99942266e+01 -2.56791472e-04 -1.79998530e+02]]
```

In [28]:

```
# select 12 input features: x,y,z,a,b,c for robots 1 and 2
X_train_12 = X_train[:,feature_idx]
X_val_12 = X_val[:,feature_idx]
X_test_12 = X_test[:,feature_idx]

X_seq_train_12 = X_seq_train[:,:,feature_idx]
X_seq_val_12 = X_seq_val[:,:,feature_idx]
X_seq_test_12 = X_seq_test[:,:,feature_idx]

# select 36 input features: x,y,z,a,b,c + 1st and 2nd order derivatives for robo
X_train_36 = X_train[:,feature_idx_2nd]
X_val_36 = X_val[:,feature_idx_2nd]
X_test_36 = X_test[:,feature_idx_2nd]

X_seq_train_36 = X_seq_train[:,:,feature_idx_2nd]
X_seq_val_36 = X_seq_val[:,:, feature_idx_2nd]
X_seq_test_36 = X_seq_test[:,:,feature_idx_2nd]
```

In [29]:

```
# sanity check
print(X_train_12.shape)
print(X_seq_train_12.shape)

print(X_train_36.shape)
print(X_seq_train_36.shape)
```

```
(34354, 12)
(34341, 20, 12)
(34354, 36)
(34341, 20, 36)
```

# 4. Modeling

Finally, we're getting to the exciting part of training some neural nets.

In [165…

```
# function to plot loss, to be used several times below
def plot_loss(history, name, title=''):
    fig = plt.figure(figsize=(24,10))
    fig.suptitle(title)

    # full range
    ax = fig.add_subplot(121)
    ax.plot(history.history['loss'], label='loss')
    ax.plot(history.history['val_loss'], label='val_loss')
    ax.set_xlabel('Epoch')
    ax.set_ylabel('Error')
    ax.legend()
    ax.grid(True)

    # last 30 percent of epochs
    zoom_frac = 0.7
    nepochs = len(history.history['loss'])
    ax = fig.add_subplot(122)
```

```
    ax.plot(history.history['loss'], label='loss')
    ax.plot(history.history['val_loss'], label='val_loss')
    xmin = int(zoom_frac*nepochs)
    xmax = nepochs
    ax.set_xlim([xmin, xmax])
    ymin = 0.99*np.min(history.history['loss'][int(zoom_frac*nepochs):]
                       + history.history['val_loss'][int(zoom_frac*nepochs):])
    ymax = 1.01*np.max(history.history['loss'][int(zoom_frac*nepochs):]
                       + history.history['val_loss'][int(zoom_frac*nepochs):])
    ax.set_ylim([ymin, ymax])
    ax.set_xlabel('Epoch')
    ax.set_ylabel('Error')
    ax.legend()
    ax.grid(True)

    plt.savefig(output_dir/name)
```

In [142…

```
# for comparing test results of different models
test_results = dict()
```

# 4.1. Linear Regression

Let's start with a simple linear regression.

## Predict $f_{x_1}$ from $x_1$

In [32]:

```
x1_train = X_train[:,0].reshape(len(X_train),1)
fx1_train = Y_train[:,0].reshape(len(Y_train),1)
x1_val = X_val[:,0].reshape(len(X_val),1)
fx1_val = Y_val[:,0].reshape(len(Y_val),1)
x1_test = X_test[:,0].reshape(len(X_test),1)
fx1_test = Y_test[:,0].reshape(len(Y_test),1)
```

In [33]:

```
linear_model_x1 = keras.experimental.LinearModel()
linear_model_x1.compile(optimizer='adam', loss='mean_squared_error')
history_linear_x1 = linear_model_x1.fit(
    x1_train, fx1_train,
    validation_data=(x1_val, fx1_val),
    batch_size = 32,
    epochs=40)
with open(output_dir/'history_linear_x1.pickle', 'wb') as f:
    pickle.dump(history_linear_x1.history, f)
```

```
Epoch 1/40
1074/1074 [==============================] - 2s 932us/step - loss: 0.0849 - val_
loss: 0.0388
Epoch 2/40
1074/1074 [==============================] - 1s 908us/step - loss: 0.0279 - val_
loss: 0.0192
Epoch 3/40
1074/1074 [==============================] - 1s 897us/step - loss: 0.0166 - val_
loss: 0.0152
Epoch 4/40
1074/1074 [==============================] - 1s 922us/step - loss: 0.0150 - val_
```

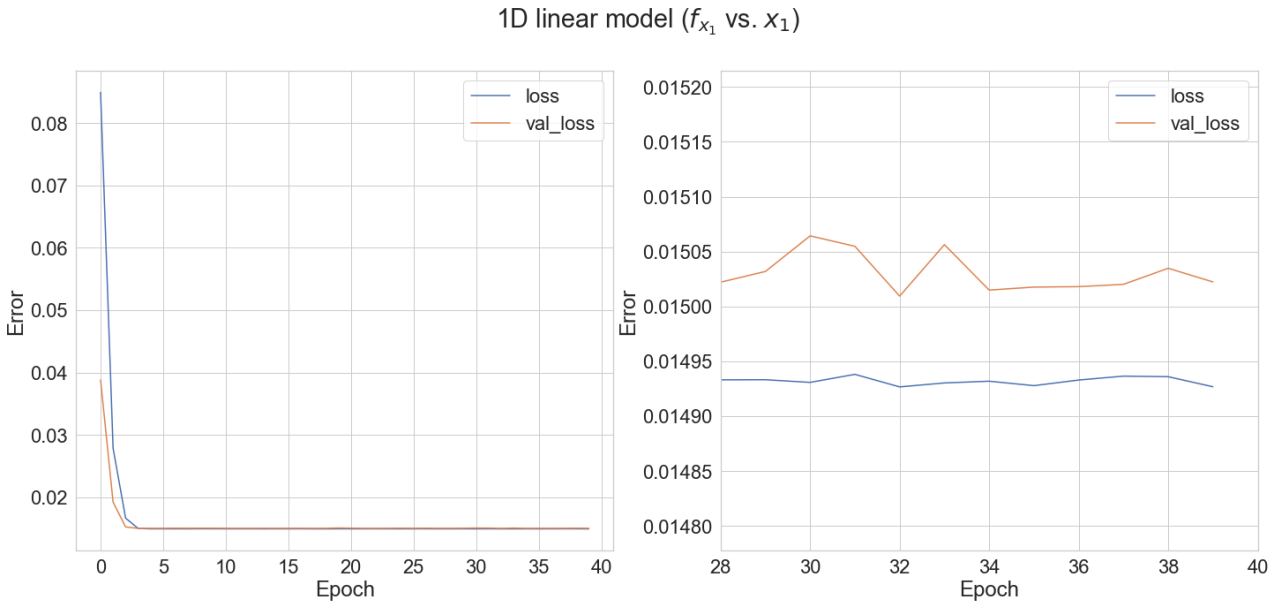
```
loss: 0.0150
Epoch 5/40
1074/1074 [==============================] - 1s 844us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 6/40
1074/1074 [==============================] - 1s 754us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 7/40
1074/1074 [==============================] - 1s 771us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 8/40
1074/1074 [==============================] - 1s 797us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 9/40
1074/1074 [==============================] - 1s 860us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 10/40
1074/1074 [==============================] - 1s 870us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 11/40
1074/1074 [==============================] - 1s 826us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 12/40
1074/1074 [==============================] - 1s 792us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 13/40
1074/1074 [==============================] - 1s 945us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 14/40
1074/1074 [==============================] - 1s 926us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 15/40
1074/1074 [==============================] - 1s 900us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 16/40
1074/1074 [==============================] - 1s 888us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 17/40
1074/1074 [==============================] - 1s 818us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 18/40
1074/1074 [==============================] - 1s 844us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 19/40
1074/1074 [==============================] - 1s 839us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 20/40
1074/1074 [==============================] - 1s 872us/step - loss: 0.0149 - val_
loss: 0.0151
Epoch 21/40
1074/1074 [==============================] - 1s 890us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 22/40
1074/1074 [==============================] - 1s 858us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 23/40
1074/1074 [==============================] - 1s 853us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 24/40
1074/1074 [==============================] - 1s 867us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 25/40
1074/1074 [==============================] - 1s 849us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 26/40
```

```
1074/1074 [==============================] - 1s 850us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 27/40
1074/1074 [==============================] - 1s 867us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 28/40
1074/1074 [==============================] - 1s 823us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 29/40
1074/1074 [==============================] - 1s 861us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 30/40
1074/1074 [==============================] - 1s 856us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 31/40
1074/1074 [==============================] - 1s 867us/step - loss: 0.0149 - val_
loss: 0.0151
Epoch 32/40
1074/1074 [==============================] - 1s 888us/step - loss: 0.0149 - val_
loss: 0.0151
Epoch 33/40
1074/1074 [==============================] - 1s 865us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 34/40
1074/1074 [==============================] - 1s 854us/step - loss: 0.0149 - val_
loss: 0.0151
Epoch 35/40
1074/1074 [==============================] - 1s 858us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 36/40
1074/1074 [==============================] - 1s 866us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 37/40
1074/1074 [==============================] - 1s 850us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 38/40
1074/1074 [==============================] - 1s 864us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 39/40
1074/1074 [==============================] - 1s 831us/step - loss: 0.0149 - val_
loss: 0.0150
Epoch 40/40
1074/1074 [==============================] - 1s 642us/step - loss: 0.0149 - val_
loss: 0.0150
```

## Plot loss vs. epoch

In [166…

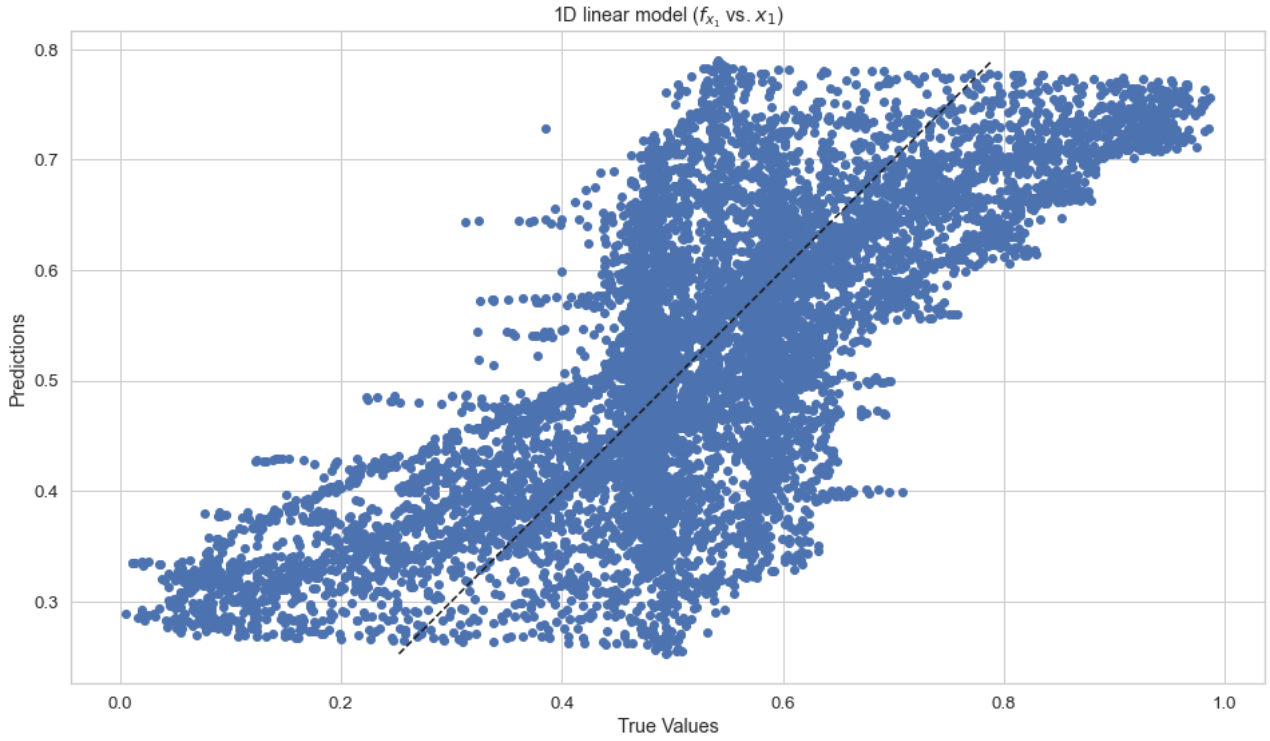
```
plot_loss(history_linear_x1, 'loss_linear_x1.pdf', '1D linear model ($f_{x_1}$ v
```




In [35]:
```
# save model loss on test set for evaluation section below
test_results['linear_x1'] = linear_model_x1.evaluate(x1_test, fx1_test, verbose=
```

## Plot predictions vs. true values

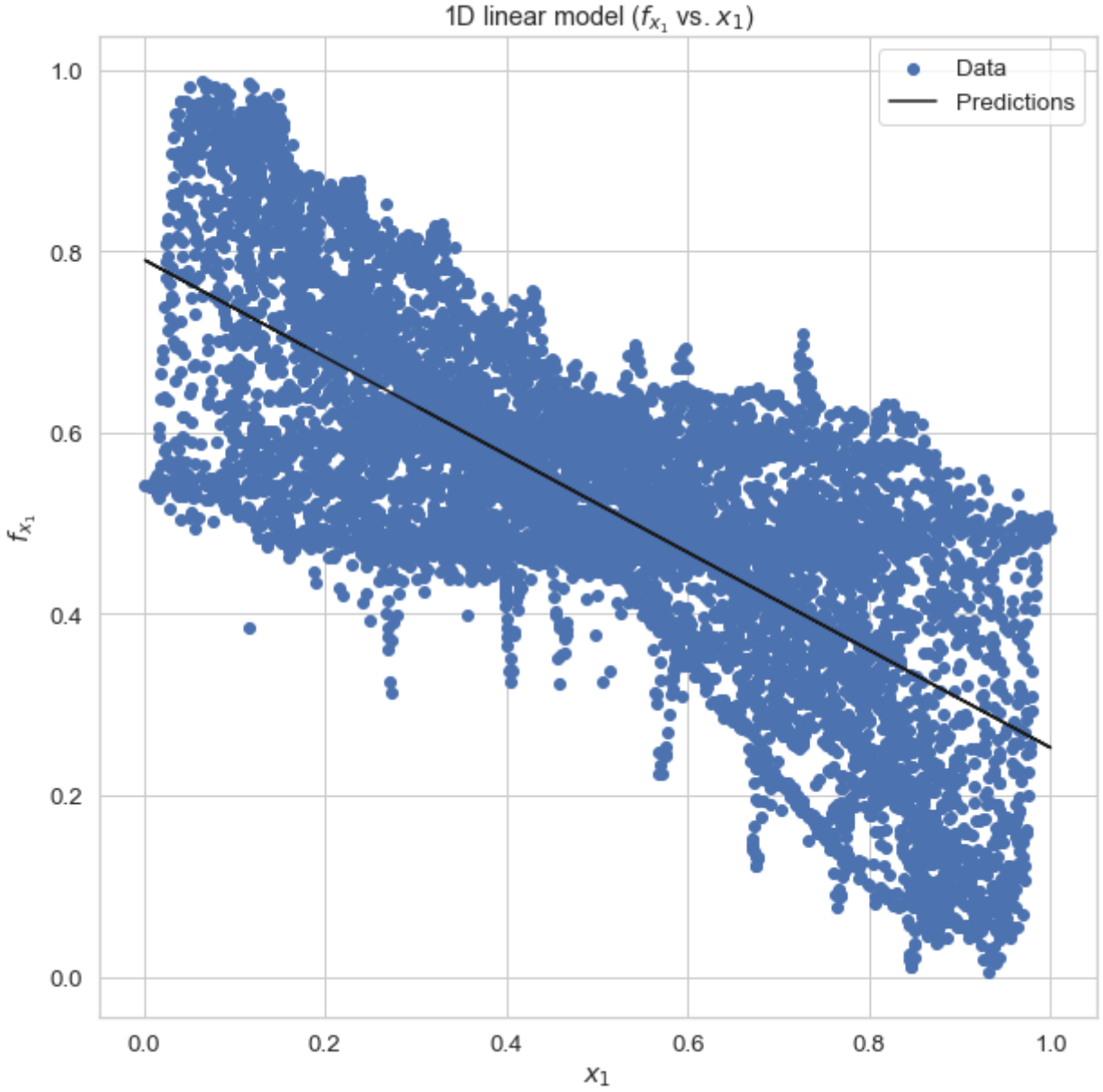
In [36]:
```
fx1_test_pred = linear_model_x1.predict(x1_test)
fig = plt.figure(figsize=(16,10))
ax = fig.add_subplot(111, aspect='equal')
ax.scatter(fx1_test, fx1_test_pred)
ax.plot([np.min(fx1_test_pred), np.max(fx1_test_pred)], [np.min(fx1_test_pred),
#ax.plot([0.2, 0.8], [0.2, 0.8], linestyle='dashed', label='Predictions', color=
ax.set_xlabel('True Values')
ax.set_ylabel('Predictions')
ax.set_title('1D linear model ($f_{x_1}$ vs. $x_1$)')
plt.savefig(output_dir/'pred_vs_true_linear_x1.pdf')
```




## Plot $f_{x_1}$ vs. $x_1$ (scaled)

In [37]:

```
fig = plt.figure(figsize=(16,10))
ax = fig.add_subplot(111, aspect='equal')
ax.scatter(x1_test, fx1_test, label='Data')
ax.plot(x1_test, fx1_test_pred, label='Predictions', color='k')
ax.set_xlabel('$x_{1}$')
ax.set_ylabel('$f_{x{_1}}$')
ax.set_title('1D linear model ($f_{x_1}$ vs. $x_1$)')
ax.legend()
plt.savefig(output_dir/'linear_fx1_vs_x1.pdf')
```




## Predict all 6 forces from 12 input features

In [38]:

```
linear_model_12 = keras.experimental.LinearModel(units=6)
linear_model_12.compile(optimizer='adam', loss='mean_squared_error')
history_linear_12 = linear_model_12.fit(
    X_train_12, Y_train,
    validation_data=(X_val_12, Y_val),
    batch_size = 32,
    epochs=200)
with open(output_dir/'history_linear_12.pickle', 'wb') as f:
    pickle.dump(history_linear_12.history, f)
```

```
Epoch 1/200
1074/1074 [==============================] - 1s 874us/step - loss: 0.0454 - val_
loss: 0.0302
Epoch 2/200
1074/1074 [==============================] - 1s 792us/step - loss: 0.0295 - val_
loss: 0.0295
Epoch 3/200
1074/1074 [==============================] - 1s 807us/step - loss: 0.0292 - val_
```

```
loss: 0.0292
Epoch 4/200
1074/1074 [==============================] - 1s 863us/step - loss: 0.0290 - val_
loss: 0.0290
Epoch 5/200
1074/1074 [==============================] - 1s 803us/step - loss: 0.0289 - val_
loss: 0.0291
Epoch 6/200
1074/1074 [==============================] - 1s 822us/step - loss: 0.0289 - val_
loss: 0.0290
Epoch 7/200
1074/1074 [==============================] - 1s 817us/step - loss: 0.0288 - val_
loss: 0.0289
Epoch 8/200
1074/1074 [==============================] - 1s 842us/step - loss: 0.0288 - val_
loss: 0.0290
Epoch 9/200
1074/1074 [==============================] - 1s 804us/step - loss: 0.0288 - val_
loss: 0.0289
Epoch 10/200
1074/1074 [==============================] - 1s 814us/step - loss: 0.0288 - val_
loss: 0.0289
Epoch 11/200
1074/1074 [==============================] - 1s 822us/step - loss: 0.0288 - val_
loss: 0.0288
Epoch 12/200
1074/1074 [==============================] - 1s 847us/step - loss: 0.0287 - val_
loss: 0.0289
Epoch 13/200
1074/1074 [==============================] - 1s 840us/step - loss: 0.0287 - val_
loss: 0.0289
Epoch 14/200
1074/1074 [==============================] - 1s 812us/step - loss: 0.0287 - val_
loss: 0.0288
Epoch 15/200
1074/1074 [==============================] - 1s 798us/step - loss: 0.0287 - val_
loss: 0.0287
Epoch 16/200
1074/1074 [==============================] - 1s 826us/step - loss: 0.0287 - val_
loss: 0.0287
Epoch 17/200
1074/1074 [==============================] - 1s 808us/step - loss: 0.0286 - val_
loss: 0.0287
Epoch 18/200
1074/1074 [==============================] - 1s 811us/step - loss: 0.0286 - val_
loss: 0.0287
Epoch 19/200
1074/1074 [==============================] - 1s 807us/step - loss: 0.0286 - val_
loss: 0.0287
Epoch 20/200
1074/1074 [==============================] - 1s 847us/step - loss: 0.0286 - val_
loss: 0.0288
Epoch 21/200
1074/1074 [==============================] - 1s 810us/step - loss: 0.0286 - val_
loss: 0.0287
Epoch 22/200
1074/1074 [==============================] - 1s 818us/step - loss: 0.0286 - val_
loss: 0.0287
Epoch 23/200
1074/1074 [==============================] - 1s 770us/step - loss: 0.0286 - val_
loss: 0.0287
Epoch 24/200
1074/1074 [==============================] - 1s 805us/step - loss: 0.0285 - val_
loss: 0.0288
Epoch 25/200
```

```
1074/1074 [==============================] - 1s 810us/step - loss: 0.0285 - val_
loss: 0.0287
Epoch 26/200
1074/1074 [==============================] - 1s 888us/step - loss: 0.0285 - val_
loss: 0.0286
Epoch 27/200
1074/1074 [==============================] - 1s 814us/step - loss: 0.0285 - val_
loss: 0.0286
Epoch 28/200
1074/1074 [==============================] - 1s 814us/step - loss: 0.0285 - val_
loss: 0.0286
Epoch 29/200
1074/1074 [==============================] - 1s 983us/step - loss: 0.0285 - val_
loss: 0.0286
Epoch 30/200
1074/1074 [==============================] - 1s 922us/step - loss: 0.0285 - val_
loss: 0.0286
Epoch 31/200
1074/1074 [==============================] - 1s 967us/step - loss: 0.0285 - val_
loss: 0.0286
Epoch 32/200
1074/1074 [==============================] - 1s 1ms/step - loss: 0.0285 - val_lo
ss: 0.0285
Epoch 33/200
1074/1074 [==============================] - 1s 999us/step - loss: 0.0284 - val_
loss: 0.0287
Epoch 34/200
1074/1074 [==============================] - 1s 893us/step - loss: 0.0284 - val_
loss: 0.0285
Epoch 35/200
1074/1074 [==============================] - 1s 861us/step - loss: 0.0284 - val_
loss: 0.0285
Epoch 36/200
1074/1074 [==============================] - 1s 871us/step - loss: 0.0284 - val_
loss: 0.0285
Epoch 37/200
1074/1074 [==============================] - 1s 870us/step - loss: 0.0284 - val_
loss: 0.0285
Epoch 38/200
1074/1074 [==============================] - 1s 873us/step - loss: 0.0284 - val_
loss: 0.0290
Epoch 39/200
1074/1074 [==============================] - 1s 912us/step - loss: 0.0284 - val_
loss: 0.0286
Epoch 40/200
1074/1074 [==============================] - 1s 889us/step - loss: 0.0284 - val_
loss: 0.0284
Epoch 41/200
1074/1074 [==============================] - 1s 900us/step - loss: 0.0283 - val_
loss: 0.0285
Epoch 42/200
1074/1074 [==============================] - 1s 895us/step - loss: 0.0283 - val_
loss: 0.0284
Epoch 43/200
1074/1074 [==============================] - 1s 919us/step - loss: 0.0283 - val_
loss: 0.0285
Epoch 44/200
1074/1074 [==============================] - 1s 892us/step - loss: 0.0283 - val_
loss: 0.0284
Epoch 45/200
1074/1074 [==============================] - 1s 875us/step - loss: 0.0283 - val_
loss: 0.0287
Epoch 46/200
1074/1074 [==============================] - 1s 892us/step - loss: 0.0283 - val_
loss: 0.0285
```

```
Epoch 47/200
1074/1074 [==============================] - 1s 907us/step - loss: 0.0283 - val_
loss: 0.0287
Epoch 48/200
1074/1074 [==============================] - 1s 889us/step - loss: 0.0283 - val_
loss: 0.0286
Epoch 49/200
1074/1074 [==============================] - 1s 873us/step - loss: 0.0283 - val_
loss: 0.0284
Epoch 50/200
1074/1074 [==============================] - 1s 873us/step - loss: 0.0283 - val_
loss: 0.0283
Epoch 51/200
1074/1074 [==============================] - 1s 897us/step - loss: 0.0283 - val_
loss: 0.0284
Epoch 52/200
1074/1074 [==============================] - 1s 872us/step - loss: 0.0282 - val_
loss: 0.0283
Epoch 53/200
1074/1074 [==============================] - 1s 899us/step - loss: 0.0282 - val_
loss: 0.0283
Epoch 54/200
1074/1074 [==============================] - 1s 893us/step - loss: 0.0282 - val_
loss: 0.0283
Epoch 55/200
1074/1074 [==============================] - 1s 847us/step - loss: 0.0282 - val_
loss: 0.0284
Epoch 56/200
1074/1074 [==============================] - 1s 843us/step - loss: 0.0282 - val_
loss: 0.0284
Epoch 57/200
1074/1074 [==============================] - 1s 845us/step - loss: 0.0282 - val_
loss: 0.0283
Epoch 58/200
1074/1074 [==============================] - 1s 839us/step - loss: 0.0282 - val_
loss: 0.0283
Epoch 59/200
1074/1074 [==============================] - 1s 871us/step - loss: 0.0282 - val_
loss: 0.0283
Epoch 60/200
1074/1074 [==============================] - 1s 844us/step - loss: 0.0282 - val_
loss: 0.0282
Epoch 61/200
1074/1074 [==============================] - 1s 843us/step - loss: 0.0282 - val_
loss: 0.0282
Epoch 62/200
1074/1074 [==============================] - 1s 846us/step - loss: 0.0282 - val_
loss: 0.0283
Epoch 63/200
1074/1074 [==============================] - 1s 826us/step - loss: 0.0281 - val_
loss: 0.0284
Epoch 64/200
1074/1074 [==============================] - 1s 842us/step - loss: 0.0281 - val_
loss: 0.0282
Epoch 65/200
1074/1074 [==============================] - 1s 961us/step - loss: 0.0281 - val_
loss: 0.0282
Epoch 66/200
1074/1074 [==============================] - 1s 844us/step - loss: 0.0281 - val_
loss: 0.0282
Epoch 67/200
1074/1074 [==============================] - 1s 846us/step - loss: 0.0281 - val_
loss: 0.0282
Epoch 68/200
1074/1074 [==============================] - 1s 842us/step - loss: 0.0281 - val_
```

```
loss: 0.0282
Epoch 69/200
1074/1074 [==============================] - 1s 847us/step - loss: 0.0281 - val_
loss: 0.0282
Epoch 70/200
1074/1074 [==============================] - 1s 853us/step - loss: 0.0281 - val_
loss: 0.0282
Epoch 71/200
1074/1074 [==============================] - 1s 892us/step - loss: 0.0281 - val_
loss: 0.0282
Epoch 72/200
1074/1074 [==============================] - 1s 850us/step - loss: 0.0281 - val_
loss: 0.0282
Epoch 73/200
1074/1074 [==============================] - 1s 840us/step - loss: 0.0280 - val_
loss: 0.0281
Epoch 74/200
1074/1074 [==============================] - 1s 849us/step - loss: 0.0281 - val_
loss: 0.0282
Epoch 75/200
1074/1074 [==============================] - 1s 845us/step - loss: 0.0281 - val_
loss: 0.0281
Epoch 76/200
1074/1074 [==============================] - 1s 917us/step - loss: 0.0280 - val_
loss: 0.0281
Epoch 77/200
1074/1074 [==============================] - 1s 855us/step - loss: 0.0280 - val_
loss: 0.0281
Epoch 78/200
1074/1074 [==============================] - 1s 761us/step - loss: 0.0280 - val_
loss: 0.0282
Epoch 79/200
1074/1074 [==============================] - 1s 755us/step - loss: 0.0280 - val_
loss: 0.0282
Epoch 80/200
1074/1074 [==============================] - 1s 791us/step - loss: 0.0280 - val_
loss: 0.0281
Epoch 81/200
1074/1074 [==============================] - 1s 775us/step - loss: 0.0280 - val_
loss: 0.0280
Epoch 82/200
1074/1074 [==============================] - 1s 798us/step - loss: 0.0280 - val_
loss: 0.0281
Epoch 83/200
1074/1074 [==============================] - 1s 803us/step - loss: 0.0280 - val_
loss: 0.0281
Epoch 84/200
1074/1074 [==============================] - 1s 812us/step - loss: 0.0280 - val_
loss: 0.0280
Epoch 85/200
1074/1074 [==============================] - 1s 819us/step - loss: 0.0280 - val_
loss: 0.0281
Epoch 86/200
1074/1074 [==============================] - 1s 823us/step - loss: 0.0279 - val_
loss: 0.0281
Epoch 87/200
1074/1074 [==============================] - 1s 820us/step - loss: 0.0280 - val_
loss: 0.0280
Epoch 88/200
1074/1074 [==============================] - 1s 818us/step - loss: 0.0279 - val_
loss: 0.0281
Epoch 89/200
1074/1074 [==============================] - 1s 817us/step - loss: 0.0279 - val_
loss: 0.0280
Epoch 90/200
```

```
1074/1074 [==============================] - 1s 817us/step - loss: 0.0279 - val_
loss: 0.0281
Epoch 91/200
1074/1074 [==============================] - 1s 839us/step - loss: 0.0279 - val_
loss: 0.0280
Epoch 92/200
1074/1074 [==============================] - 1s 831us/step - loss: 0.0279 - val_
loss: 0.0281
Epoch 93/200
1074/1074 [==============================] - 1s 848us/step - loss: 0.0279 - val_
loss: 0.0281
Epoch 94/200
1074/1074 [==============================] - 1s 793us/step - loss: 0.0279 - val_
loss: 0.0280
Epoch 95/200
1074/1074 [==============================] - 1s 792us/step - loss: 0.0279 - val_
loss: 0.0280
Epoch 96/200
1074/1074 [==============================] - 1s 796us/step - loss: 0.0279 - val_
loss: 0.0280
Epoch 97/200
1074/1074 [==============================] - 1s 809us/step - loss: 0.0279 - val_
loss: 0.0279
Epoch 98/200
1074/1074 [==============================] - 1s 816us/step - loss: 0.0279 - val_
loss: 0.0280
Epoch 99/200
1074/1074 [==============================] - 1s 812us/step - loss: 0.0278 - val_
loss: 0.0280
Epoch 100/200
1074/1074 [==============================] - 1s 814us/step - loss: 0.0278 - val_
loss: 0.0280
Epoch 101/200
1074/1074 [==============================] - 1s 682us/step - loss: 0.0278 - val_
loss: 0.0280
Epoch 102/200
1074/1074 [==============================] - 1s 615us/step - loss: 0.0278 - val_
loss: 0.0281
Epoch 103/200
1074/1074 [==============================] - 1s 607us/step - loss: 0.0278 - val_
loss: 0.0279
Epoch 104/200
1074/1074 [==============================] - 1s 607us/step - loss: 0.0278 - val_
loss: 0.0281
Epoch 105/200
1074/1074 [==============================] - 1s 642us/step - loss: 0.0278 - val_
loss: 0.0279
Epoch 106/200
1074/1074 [==============================] - 1s 614us/step - loss: 0.0278 - val_
loss: 0.0279
Epoch 107/200
1074/1074 [==============================] - 1s 767us/step - loss: 0.0278 - val_
loss: 0.0279
Epoch 108/200
1074/1074 [==============================] - 1s 817us/step - loss: 0.0278 - val_
loss: 0.0279
Epoch 109/200
1074/1074 [==============================] - 1s 810us/step - loss: 0.0278 - val_
loss: 0.0278
Epoch 110/200
1074/1074 [==============================] - 1s 814us/step - loss: 0.0278 - val_
loss: 0.0278
Epoch 111/200
1074/1074 [==============================] - 1s 832us/step - loss: 0.0278 - val_
loss: 0.0278
```

```
Epoch 112/200
1074/1074 [==============================] - 1s 818us/step - loss: 0.0277 - val_
loss: 0.0280
Epoch 113/200
1074/1074 [==============================] - 1s 811us/step - loss: 0.0277 - val_
loss: 0.0279
Epoch 114/200
1074/1074 [==============================] - 1s 852us/step - loss: 0.0277 - val_
loss: 0.0278
Epoch 115/200
1074/1074 [==============================] - 1s 829us/step - loss: 0.0277 - val_
loss: 0.0278
Epoch 116/200
1074/1074 [==============================] - 1s 812us/step - loss: 0.0277 - val_
loss: 0.0279
Epoch 117/200
1074/1074 [==============================] - 1s 814us/step - loss: 0.0277 - val_
loss: 0.0278
Epoch 118/200
1074/1074 [==============================] - 1s 800us/step - loss: 0.0277 - val_
loss: 0.0278
Epoch 119/200
1074/1074 [==============================] - 1s 817us/step - loss: 0.0277 - val_
loss: 0.0279
Epoch 120/200
1074/1074 [==============================] - 1s 814us/step - loss: 0.0277 - val_
loss: 0.0278
Epoch 121/200
1074/1074 [==============================] - 1s 811us/step - loss: 0.0277 - val_
loss: 0.0277
Epoch 122/200
1074/1074 [==============================] - 1s 813us/step - loss: 0.0277 - val_
loss: 0.0277
Epoch 123/200
1074/1074 [==============================] - 1s 858us/step - loss: 0.0277 - val_
loss: 0.0278
Epoch 124/200
1074/1074 [==============================] - 1s 809us/step - loss: 0.0277 - val_
loss: 0.0279
Epoch 125/200
1074/1074 [==============================] - 1s 805us/step - loss: 0.0277 - val_
loss: 0.0277
Epoch 126/200
1074/1074 [==============================] - 1s 801us/step - loss: 0.0276 - val_
loss: 0.0277
Epoch 127/200
1074/1074 [==============================] - 1s 601us/step - loss: 0.0276 - val_
loss: 0.0278
Epoch 128/200
1074/1074 [==============================] - 1s 614us/step - loss: 0.0276 - val_
loss: 0.0278
Epoch 129/200
1074/1074 [==============================] - 1s 633us/step - loss: 0.0276 - val_
loss: 0.0277
Epoch 130/200
1074/1074 [==============================] - 1s 822us/step - loss: 0.0276 - val_
loss: 0.0276
Epoch 131/200
1074/1074 [==============================] - 1s 842us/step - loss: 0.0276 - val_
loss: 0.0277
Epoch 132/200
1074/1074 [==============================] - 1s 814us/step - loss: 0.0276 - val_
loss: 0.0278
Epoch 133/200
1074/1074 [==============================] - 1s 815us/step - loss: 0.0276 - val_
```

```
loss: 0.0276
Epoch 134/200
1074/1074 [==============================] - 1s 815us/step - loss: 0.0276 - val_
loss: 0.0276
Epoch 135/200
1074/1074 [==============================] - 1s 844us/step - loss: 0.0276 - val_
loss: 0.0277
Epoch 136/200
1074/1074 [==============================] - 1s 817us/step - loss: 0.0276 - val_
loss: 0.0279
Epoch 137/200
1074/1074 [==============================] - 1s 848us/step - loss: 0.0276 - val_
loss: 0.0278
Epoch 138/200
1074/1074 [==============================] - 1s 846us/step - loss: 0.0276 - val_
loss: 0.0277
Epoch 139/200
1074/1074 [==============================] - 1s 842us/step - loss: 0.0275 - val_
loss: 0.0276
Epoch 140/200
1074/1074 [==============================] - 1s 824us/step - loss: 0.0276 - val_
loss: 0.0276
Epoch 141/200
1074/1074 [==============================] - 1s 835us/step - loss: 0.0275 - val_
loss: 0.0277
Epoch 142/200
1074/1074 [==============================] - 1s 820us/step - loss: 0.0275 - val_
loss: 0.0277
Epoch 143/200
1074/1074 [==============================] - 1s 858us/step - loss: 0.0275 - val_
loss: 0.0276
Epoch 144/200
1074/1074 [==============================] - 1s 818us/step - loss: 0.0275 - val_
loss: 0.0276
Epoch 145/200
1074/1074 [==============================] - 1s 819us/step - loss: 0.0275 - val_
loss: 0.0276
Epoch 146/200
1074/1074 [==============================] - 1s 842us/step - loss: 0.0275 - val_
loss: 0.0276
Epoch 147/200
1074/1074 [==============================] - 1s 821us/step - loss: 0.0275 - val_
loss: 0.0276
Epoch 148/200
1074/1074 [==============================] - 1s 821us/step - loss: 0.0275 - val_
loss: 0.0276
Epoch 149/200
1074/1074 [==============================] - 1s 857us/step - loss: 0.0275 - val_
loss: 0.0276
Epoch 150/200
1074/1074 [==============================] - 1s 855us/step - loss: 0.0275 - val_
loss: 0.0277
Epoch 151/200
1074/1074 [==============================] - 1s 841us/step - loss: 0.0275 - val_
loss: 0.0275
Epoch 152/200
1074/1074 [==============================] - 1s 842us/step - loss: 0.0275 - val_
loss: 0.0276
Epoch 153/200
1074/1074 [==============================] - 1s 821us/step - loss: 0.0275 - val_
loss: 0.0275
Epoch 154/200
1074/1074 [==============================] - 1s 852us/step - loss: 0.0274 - val_
loss: 0.0275
Epoch 155/200
```

```
1074/1074 [==============================] - 1s 799us/step - loss: 0.0274 - val_
loss: 0.0276
Epoch 156/200
1074/1074 [==============================] - 1s 792us/step - loss: 0.0274 - val_
loss: 0.0276
Epoch 157/200
1074/1074 [==============================] - 1s 824us/step - loss: 0.0274 - val_
loss: 0.0275
Epoch 158/200
1074/1074 [==============================] - 1s 800us/step - loss: 0.0274 - val_
loss: 0.0276
Epoch 159/200
1074/1074 [==============================] - 1s 793us/step - loss: 0.0274 - val_
loss: 0.0275
Epoch 160/200
1074/1074 [==============================] - 1s 800us/step - loss: 0.0274 - val_
loss: 0.0276
Epoch 161/200
1074/1074 [==============================] - 1s 791us/step - loss: 0.0274 - val_
loss: 0.0276
Epoch 162/200
1074/1074 [==============================] - 1s 820us/step - loss: 0.0274 - val_
loss: 0.0274
Epoch 163/200
1074/1074 [==============================] - 1s 623us/step - loss: 0.0274 - val_
loss: 0.0274
Epoch 164/200
1074/1074 [==============================] - 1s 607us/step - loss: 0.0274 - val_
loss: 0.0274
Epoch 165/200
1074/1074 [==============================] - 1s 613us/step - loss: 0.0274 - val_
loss: 0.0274
Epoch 166/200
1074/1074 [==============================] - 1s 599us/step - loss: 0.0273 - val_
loss: 0.0275
Epoch 167/200
1074/1074 [==============================] - 1s 618us/step - loss: 0.0273 - val_
loss: 0.0274
Epoch 168/200
1074/1074 [==============================] - 1s 604us/step - loss: 0.0273 - val_
loss: 0.0274
Epoch 169/200
1074/1074 [==============================] - 1s 699us/step - loss: 0.0273 - val_
loss: 0.0277
Epoch 170/200
1074/1074 [==============================] - 1s 848us/step - loss: 0.0273 - val_
loss: 0.0275
Epoch 171/200
1074/1074 [==============================] - 1s 805us/step - loss: 0.0273 - val_
loss: 0.0274
Epoch 172/200
1074/1074 [==============================] - 1s 813us/step - loss: 0.0273 - val_
loss: 0.0274
Epoch 173/200
1074/1074 [==============================] - 1s 803us/step - loss: 0.0273 - val_
loss: 0.0274
Epoch 174/200
1074/1074 [==============================] - 1s 811us/step - loss: 0.0273 - val_
loss: 0.0275
Epoch 175/200
1074/1074 [==============================] - 1s 799us/step - loss: 0.0273 - val_
loss: 0.0274
Epoch 176/200
1074/1074 [==============================] - 1s 847us/step - loss: 0.0273 - val_
loss: 0.0274
```

```
Epoch 177/200
1074/1074 [==============================] - 1s 814us/step - loss: 0.0273 - val_
loss: 0.0274
Epoch 178/200
1074/1074 [==============================] - 1s 803us/step - loss: 0.0273 - val_
loss: 0.0276
Epoch 179/200
1074/1074 [==============================] - 1s 812us/step - loss: 0.0273 - val_
loss: 0.0274
Epoch 180/200
1074/1074 [==============================] - 1s 799us/step - loss: 0.0272 - val_
loss: 0.0273
Epoch 181/200
1074/1074 [==============================] - 1s 839us/step - loss: 0.0272 - val_
loss: 0.0273
Epoch 182/200
1074/1074 [==============================] - 1s 844us/step - loss: 0.0273 - val_
loss: 0.0273
Epoch 183/200
1074/1074 [==============================] - 1s 804us/step - loss: 0.0272 - val_
loss: 0.0273
Epoch 184/200
1074/1074 [==============================] - 1s 801us/step - loss: 0.0272 - val_
loss: 0.0273
Epoch 185/200
1074/1074 [==============================] - 1s 814us/step - loss: 0.0272 - val_
loss: 0.0273
Epoch 186/200
1074/1074 [==============================] - 1s 807us/step - loss: 0.0272 - val_
loss: 0.0273
Epoch 187/200
1074/1074 [==============================] - 1s 811us/step - loss: 0.0272 - val_
loss: 0.0273
Epoch 188/200
1074/1074 [==============================] - 1s 850us/step - loss: 0.0272 - val_
loss: 0.0273
Epoch 189/200
1074/1074 [==============================] - 1s 836us/step - loss: 0.0272 - val_
loss: 0.0273
Epoch 190/200
1074/1074 [==============================] - 1s 817us/step - loss: 0.0272 - val_
loss: 0.0273
Epoch 191/200
1074/1074 [==============================] - 1s 801us/step - loss: 0.0272 - val_
loss: 0.0272
Epoch 192/200
1074/1074 [==============================] - 1s 818us/step - loss: 0.0272 - val_
loss: 0.0276
Epoch 193/200
1074/1074 [==============================] - 1s 840us/step - loss: 0.0272 - val_
loss: 0.0272
Epoch 194/200
1074/1074 [==============================] - 1s 814us/step - loss: 0.0272 - val_
loss: 0.0273
Epoch 195/200
1074/1074 [==============================] - 1s 808us/step - loss: 0.0272 - val_
loss: 0.0272
Epoch 196/200
1074/1074 [==============================] - 1s 812us/step - loss: 0.0272 - val_
loss: 0.0272
Epoch 197/200
1074/1074 [==============================] - 1s 810us/step - loss: 0.0271 - val_
loss: 0.0272
Epoch 198/200
1074/1074 [==============================] - 1s 832us/step - loss: 0.0271 - val_
```

```
loss: 0.0272
Epoch 199/200
1074/1074 [==============================] - 1s 807us/step - loss: 0.0271 - val_
loss: 0.0271
Epoch 200/200
1074/1074 [==============================] - 1s 860us/step - loss: 0.0271 - val_
loss: 0.0271
```

## Plot loss vs. epoch

In [167…

```
plot_loss(history_linear_12, 'loss_linear_12.pdf', 'Full linear model (predict 6
```


In [40]:

```
# save model loss on test set for evaluation section below
test_results['linear_12'] = linear_model_12.evaluate(X_test_12, Y_test, verbose=
```

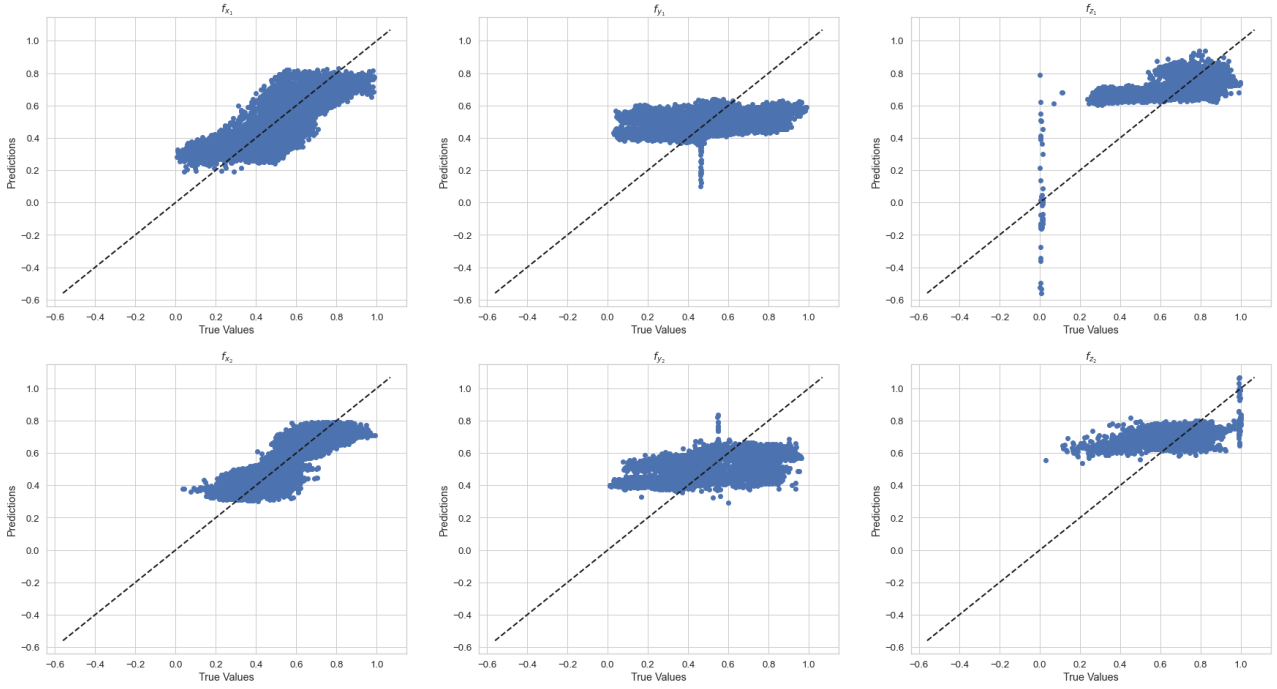
## Plot predictions vs. true values

In [41]:

```
def plot_pred_vs_true(pred, true, name, titles=None):
    fig = plt.figure(figsize=(30,16))
    for i in range(len(pred.T)):
        ax = fig.add_subplot(2,3,i+1)
        ax.scatter(true.T[i], pred.T[i])
        ax.plot([np.min(pred), np.max(pred)],[np.min(pred), np.max(pred)], lines
        ax.set_xlabel('True Values')
        ax.set_ylabel('Predictions')
        if len(titles)>=len(pred.T):
            ax.set_title(titles[i])
    plt.savefig(output_dir/'pred_vs_true_{}.pdf'.format(name))
```

In [42]:

```
Y_test_pred_linear_12 = linear_model_12.predict(X_test_12)
plot_pred_vs_true(Y_test_pred_linear_12, Y_test, 'pred_vs_true_linear_12', title
```




## 4.2. DNN regression

I experimented by varying the number of layers, dropout rate, learning rate, batch size, and adding batch normalization layers—the model below achieves pretty good performance.

In [43]:
```
# The Sequential model will do just fine here
# (functional API is more flexible though)

def setup_dnn_model(n_outputs):
  model = keras.Sequential([
      #layers.BatchNormalization(),
      layers.Dense(200, activation='relu'),
      layers.Dropout(0.05),
      layers.Dense(200, activation='relu'),
      layers.Dropout(0.05),
      layers.Dense(200, activation='relu'),
      layers.Dropout(0.05),
      layers.Dense(100, activation='relu'),
      layers.Dropout(0.05),
      layers.Dense(100, activation='relu'),
      layers.Dense(n_outputs)
  ])

  model.compile(loss='mean_squared_error',
                optimizer=tf.keras.optimizers.Adam(learning_rate=1e-3, decay=5e-
  return model
```

In [44]:
```
# dnn config
dnn_tag = "dnn_200x3_100x2_05dropout"
dnn_epochs = 1000
dnn_batch_size = 32
```

## Predict all 6 forces from 12 input features

In [45]:
```
dnn_model_12 = setup_dnn_model(Y_train.shape[-1])
dnn_model_12_tag = "{}_12features".format(dnn_tag)
```

In [46]:
```
\%%time

early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=20)
save_every_epoch = tf.keras.callbacks.ModelCheckpoint(output_dir/'dnn_12_tmp.h5'

history_dnn_12 = dnn_model_12.fit(
    X_train_12, Y_train,
    validation_data=(X_val_12, Y_val),
    batch_size = dnn_batch_size,
    epochs=dnn_epochs,
    callbacks=[save_every_epoch]
    #callbacks=[early_stop, save_every_epoch]
    #verbose=0,
    )
dnn_model_12.summary()
with open(output_dir/'history_dnn_12.pickle', 'wb') as f:
    pickle.dump(history_dnn_12.history, f)
```

```
Epoch 1/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 0.0176 - val_lo
ss: 0.0060
Epoch 2/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0062 - val_lo
ss: 0.0035
Epoch 3/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0043 - val_lo
ss: 0.0029
Epoch 4/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0037 - val_lo
ss: 0.0024
Epoch 5/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0032 - val_lo
ss: 0.0024
Epoch 6/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0031 - val_lo
ss: 0.0023
Epoch 7/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0029 - val_lo
ss: 0.0024
Epoch 8/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0029 - val_lo
ss: 0.0022
Epoch 9/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0027 - val_lo
ss: 0.0023
Epoch 10/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0027 - val_lo
ss: 0.0021
Epoch 11/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 0.0026 - val_lo
ss: 0.0023
Epoch 12/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0026 - val_lo
ss: 0.0019
Epoch 13/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0025 - val_lo
ss: 0.0019
Epoch 14/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 0.0024 - val_lo
ss: 0.0019
Epoch 15/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0024 - val_lo
ss: 0.0040
Epoch 16/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0023 - val_lo
ss: 0.0020
Epoch 17/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0024 - val_lo
ss: 0.0020
Epoch 18/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0024 - val_lo
ss: 0.0018
Epoch 19/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0023 - val_lo
ss: 0.0017
Epoch 20/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0022 - val_lo
ss: 0.0019
Epoch 21/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0022 - val_lo
ss: 0.0022
Epoch 22/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0022 - val_lo
ss: 0.0015
Epoch 23/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0021 - val_lo
ss: 0.0015
Epoch 24/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0021 - val_lo
ss: 0.0015
Epoch 25/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0021 - val_lo
ss: 0.0015
Epoch 26/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0021 - val_lo
ss: 0.0016
Epoch 27/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0020 - val_lo
ss: 0.0015
Epoch 28/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0020 - val_lo
ss: 0.0016
Epoch 29/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0021
Epoch 30/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0016
Epoch 31/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0015
Epoch 32/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0020 - val_lo
ss: 0.0014
Epoch 33/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0021
Epoch 34/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0015
Epoch 35/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0015
```

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Epoch 36/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0019
Epoch 37/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0022
Epoch 38/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0017
Epoch 39/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0013
Epoch 40/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0017
Epoch 41/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0022
Epoch 42/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0023
Epoch 43/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0013
Epoch 44/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0015
Epoch 45/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0017
Epoch 46/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0015
Epoch 47/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0014
Epoch 48/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0016
Epoch 49/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0014
Epoch 50/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0013
Epoch 51/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0014
Epoch 52/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0017
Epoch 53/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0013
Epoch 54/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0016
Epoch 55/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0018
Epoch 56/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0013
Epoch 57/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
```

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ss: 0.0021
Epoch 58/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0013
Epoch 59/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0013
Epoch 60/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0013
Epoch 61/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0021
Epoch 62/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0013
Epoch 63/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0013
Epoch 64/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0014
Epoch 65/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0013
Epoch 66/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0014
Epoch 67/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0015
Epoch 68/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0013
Epoch 69/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0012
Epoch 70/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0012
Epoch 71/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0012
Epoch 72/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0013
Epoch 73/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0013
Epoch 74/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0013
Epoch 75/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0012
Epoch 76/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0014
Epoch 77/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0018
Epoch 78/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0013
Epoch 79/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0014
Epoch 80/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0015
Epoch 81/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0012
Epoch 82/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0012
Epoch 83/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0012
Epoch 84/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0012
Epoch 85/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0012
Epoch 86/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0012
Epoch 87/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0012
Epoch 88/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0012
Epoch 89/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0018
Epoch 90/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0013
Epoch 91/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
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Epoch 92/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0013
Epoch 93/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0012
Epoch 94/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0012
Epoch 95/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0013
Epoch 96/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0013
Epoch 97/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0013
Epoch 98/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0012
Epoch 99/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0013
Epoch 100/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0012
```

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Epoch 101/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0017
Epoch 102/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0012
Epoch 103/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0012
Epoch 104/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0013
Epoch 105/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0013
Epoch 106/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0011
Epoch 107/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0012
Epoch 108/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
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Epoch 109/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0014
Epoch 110/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0012
Epoch 111/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
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Epoch 112/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 113/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0014
Epoch 114/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0013
Epoch 115/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0018
Epoch 116/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 0.0012
Epoch 117/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
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Epoch 118/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0013
Epoch 119/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0011
Epoch 120/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0012
Epoch 121/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 0.0011
Epoch 122/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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ss: 0.0013
Epoch 123/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 124/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 0.0013
Epoch 125/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
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Epoch 126/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 127/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
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Epoch 128/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 129/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
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Epoch 130/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 131/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 132/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 133/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 134/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 135/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 136/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 137/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 138/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 139/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 140/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 141/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 142/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 143/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 144/1000
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1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 145/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 146/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 147/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 148/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 149/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 150/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 151/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 0.0013 - val_lo
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Epoch 152/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 153/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 154/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 155/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 156/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 0.0013 - val_lo
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Epoch 157/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 0.0012 - val_lo
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Epoch 158/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 159/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 160/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 161/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 162/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 163/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 164/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 165/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 0.0011
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Epoch 166/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 0.0012
Epoch 167/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 168/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 169/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 170/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 171/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 172/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 173/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 174/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 175/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 176/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 177/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 178/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 179/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 180/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 181/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 182/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 183/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
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Epoch 184/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 185/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 186/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 0.0013
Epoch 187/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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ss: 0.0011
Epoch 188/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 189/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 190/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 191/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 192/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
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Epoch 193/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 194/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
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Epoch 195/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
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Epoch 196/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
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Epoch 197/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 198/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 199/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
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Epoch 200/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 201/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
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Epoch 202/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
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Epoch 203/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 204/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 205/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
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Epoch 206/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
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Epoch 207/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 208/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 209/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0012
Epoch 210/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 211/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 212/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 213/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0014
Epoch 214/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0012
Epoch 215/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 216/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 0.0011
Epoch 217/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0012
Epoch 218/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 219/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 220/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 221/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 222/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 223/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.8458e-04
Epoch 224/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 225/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 226/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 227/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0015
Epoch 228/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 229/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0012
Epoch 230/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
```

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Epoch 231/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.9672e-04
Epoch 232/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 233/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 234/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 235/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.9076e-04
Epoch 236/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 237/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 238/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 239/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 240/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 241/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 242/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 243/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0013
Epoch 244/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 245/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 246/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 247/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 248/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.9647e-04
Epoch 249/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 250/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 251/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 252/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
```

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ss: 0.0011
Epoch 253/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 254/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 255/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 256/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.8882e-04
Epoch 257/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 258/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 259/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 260/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.6183e-04
Epoch 261/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 262/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 263/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 264/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 265/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 266/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 267/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 268/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 269/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 270/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 271/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 272/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 273/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 274/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 275/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 276/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0012
Epoch 277/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 278/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 279/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 280/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 281/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 282/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 283/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 284/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 285/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0011
Epoch 286/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 287/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 288/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 289/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 290/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 291/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 292/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 293/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.7782e-04
Epoch 294/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 295/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.8400e-04
```

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Epoch 296/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.6978e-04
Epoch 297/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 298/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 299/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 300/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0011
Epoch 301/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 302/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.8731e-04
Epoch 303/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 304/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9672e-04 - va
l_loss: 9.9718e-04
Epoch 305/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0010
Epoch 306/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.7480e-04
Epoch 307/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.9402e-04
Epoch 308/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.9452e-04
Epoch 309/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0011
Epoch 310/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0012
Epoch 311/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0011
Epoch 312/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.9203e-04
Epoch 313/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.5612e-04
Epoch 314/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9206e-04 - va
l_loss: 0.0010
Epoch 315/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.9558e-04
Epoch 316/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9827e-04 - va
l_loss: 9.8650e-04
Epoch 317/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
```

```
ss: 0.0011
Epoch 318/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9265e-04 - va
l_loss: 9.6848e-04
Epoch 319/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.9657e-04
Epoch 320/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0011
Epoch 321/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0011
Epoch 322/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0011
Epoch 323/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0011
Epoch 324/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.9358e-04
Epoch 325/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8036e-04 - va
l_loss: 0.0010
Epoch 326/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 327/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 328/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 329/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8851e-04 - va
l_loss: 0.0011
Epoch 330/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9269e-04 - va
l_loss: 0.0011
Epoch 331/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.9262e-04
Epoch 332/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9687e-04 - va
l_loss: 0.0011
Epoch 333/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.7146e-04
Epoch 334/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0010
Epoch 335/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8864e-04 - va
l_loss: 9.8240e-04
Epoch 336/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8793e-04 - va
l_loss: 0.0010
Epoch 337/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8313e-04 - va
l_loss: 9.6162e-04
Epoch 338/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8347e-04 - va
l_loss: 9.7727e-04
Epoch 339/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 9.9385e-04 - va
l_loss: 0.0010
Epoch 340/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8833e-04 - va
l_loss: 0.0010
Epoch 341/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8342e-04 - va
l_loss: 9.9632e-04
Epoch 342/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9494e-04 - va
l_loss: 9.5941e-04
Epoch 343/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9590e-04 - va
l_loss: 0.0011
Epoch 344/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9736e-04 - va
l_loss: 9.7819e-04
Epoch 345/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7754e-04 - va
l_loss: 9.4274e-04
Epoch 346/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7894e-04 - va
l_loss: 0.0011
Epoch 347/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7955e-04 - va
l_loss: 0.0010
Epoch 348/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7379e-04 - va
l_loss: 9.4402e-04
Epoch 349/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8438e-04 - va
l_loss: 0.0017
Epoch 350/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9843e-04 - va
l_loss: 0.0010
Epoch 351/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6998e-04 - va
l_loss: 9.7052e-04
Epoch 352/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7468e-04 - va
l_loss: 9.7223e-04
Epoch 353/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7270e-04 - va
l_loss: 0.0010
Epoch 354/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8251e-04 - va
l_loss: 9.6324e-04
Epoch 355/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0011
Epoch 356/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7485e-04 - va
l_loss: 0.0010
Epoch 357/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8318e-04 - va
l_loss: 0.0010
Epoch 358/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7333e-04 - va
l_loss: 9.6637e-04
Epoch 359/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8603e-04 - va
l_loss: 9.2282e-04
Epoch 360/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6303e-04 - va
l_loss: 0.0010
```

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Epoch 361/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7925e-04 - va
l_loss: 9.9539e-04
Epoch 362/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6551e-04 - va
l_loss: 9.4437e-04
Epoch 363/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7167e-04 - va
l_loss: 9.5361e-04
Epoch 364/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6057e-04 - va
l_loss: 9.5960e-04
Epoch 365/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7813e-04 - va
l_loss: 0.0010
Epoch 366/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6050e-04 - va
l_loss: 9.4996e-04
Epoch 367/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6231e-04 - va
l_loss: 9.7675e-04
Epoch 368/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4388e-04 - va
l_loss: 0.0012
Epoch 369/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4629e-04 - va
l_loss: 9.7911e-04
Epoch 370/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7697e-04 - va
l_loss: 9.9116e-04
Epoch 371/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6491e-04 - va
l_loss: 9.2483e-04
Epoch 372/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9819e-04 - va
l_loss: 9.4071e-04
Epoch 373/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6503e-04 - va
l_loss: 9.9711e-04
Epoch 374/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7562e-04 - va
l_loss: 9.8164e-04
Epoch 375/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8286e-04 - va
l_loss: 9.8278e-04
Epoch 376/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7955e-04 - va
l_loss: 9.3772e-04
Epoch 377/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6653e-04 - va
l_loss: 0.0010
Epoch 378/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5907e-04 - va
l_loss: 9.5457e-04
Epoch 379/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5610e-04 - va
l_loss: 9.6036e-04
Epoch 380/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4730e-04 - va
l_loss: 0.0010
Epoch 381/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5247e-04 - va
l_loss: 9.4087e-04
Epoch 382/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7441e-04 - va
```

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l_loss: 9.9430e-04
Epoch 383/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4599e-04 - va
l_loss: 9.4847e-04
Epoch 384/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7107e-04 - va
l_loss: 9.9437e-04
Epoch 385/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2505e-04 - va
l_loss: 9.9356e-04
Epoch 386/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4985e-04 - va
l_loss: 9.7205e-04
Epoch 387/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7225e-04 - va
l_loss: 0.0013
Epoch 388/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5568e-04 - va
l_loss: 9.6233e-04
Epoch 389/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6892e-04 - va
l_loss: 0.0011
Epoch 390/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6697e-04 - va
l_loss: 9.5910e-04
Epoch 391/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4864e-04 - va
l_loss: 0.0011
Epoch 392/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5417e-04 - va
l_loss: 9.1369e-04
Epoch 393/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5954e-04 - va
l_loss: 9.9765e-04
Epoch 394/1000
1074/1074 [==============================] - 4s 3ms/step - loss: 9.3909e-04 - va
l_loss: 9.9416e-04
Epoch 395/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6089e-04 - va
l_loss: 0.0011
Epoch 396/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 9.4271e-04 - va
l_loss: 0.0010
Epoch 397/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 9.3770e-04 - va
l_loss: 9.1084e-04
Epoch 398/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4763e-04 - va
l_loss: 0.0013
Epoch 399/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 9.4491e-04 - va
l_loss: 9.7206e-04
Epoch 400/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4005e-04 - va
l_loss: 9.5211e-04
Epoch 401/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4770e-04 - va
l_loss: 9.9165e-04
Epoch 402/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5568e-04 - va
l_loss: 0.0011
Epoch 403/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4090e-04 - va
l_loss: 9.7028e-04
Epoch 404/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 9.3915e-04 - va
l_loss: 0.0010
Epoch 405/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6091e-04 - va
l_loss: 9.3106e-04
Epoch 406/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4457e-04 - va
l_loss: 0.0011
Epoch 407/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5826e-04 - va
l_loss: 9.4252e-04
Epoch 408/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3937e-04 - va
l_loss: 9.7306e-04
Epoch 409/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3354e-04 - va
l_loss: 9.3638e-04
Epoch 410/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4264e-04 - va
l_loss: 0.0010
Epoch 411/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4031e-04 - va
l_loss: 0.0011
Epoch 412/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4167e-04 - va
l_loss: 9.9645e-04
Epoch 413/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2419e-04 - va
l_loss: 9.8100e-04
Epoch 414/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3293e-04 - va
l_loss: 9.8027e-04
Epoch 415/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2077e-04 - va
l_loss: 9.3777e-04
Epoch 416/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3614e-04 - va
l_loss: 0.0010
Epoch 417/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4462e-04 - va
l_loss: 9.9699e-04
Epoch 418/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5761e-04 - va
l_loss: 0.0013
Epoch 419/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2406e-04 - va
l_loss: 9.4496e-04
Epoch 420/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5993e-04 - va
l_loss: 9.4656e-04
Epoch 421/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3711e-04 - va
l_loss: 0.0010
Epoch 422/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0623e-04 - va
l_loss: 0.0010
Epoch 423/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3412e-04 - va
l_loss: 0.0011
Epoch 424/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4113e-04 - va
l_loss: 9.1990e-04
Epoch 425/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3671e-04 - va
l_loss: 9.7110e-04
```

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Epoch 426/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2735e-04 - va
l_loss: 9.7011e-04
Epoch 427/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5127e-04 - va
l_loss: 0.0012
Epoch 428/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3624e-04 - va
l_loss: 9.6013e-04
Epoch 429/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2485e-04 - va
l_loss: 9.7699e-04
Epoch 430/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3177e-04 - va
l_loss: 9.3412e-04
Epoch 431/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3489e-04 - va
l_loss: 0.0011
Epoch 432/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3989e-04 - va
l_loss: 0.0011
Epoch 433/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3947e-04 - va
l_loss: 9.6678e-04
Epoch 434/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3907e-04 - va
l_loss: 9.6711e-04
Epoch 435/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3383e-04 - va
l_loss: 0.0010
Epoch 436/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2948e-04 - va
l_loss: 9.4596e-04
Epoch 437/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1693e-04 - va
l_loss: 9.5664e-04
Epoch 438/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2067e-04 - va
l_loss: 9.4547e-04
Epoch 439/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1545e-04 - va
l_loss: 9.4954e-04
Epoch 440/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2832e-04 - va
l_loss: 0.0011
Epoch 441/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1794e-04 - va
l_loss: 9.7189e-04
Epoch 442/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2491e-04 - va
l_loss: 9.5288e-04
Epoch 443/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4142e-04 - va
l_loss: 0.0010
Epoch 444/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1831e-04 - va
l_loss: 0.0011
Epoch 445/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2011e-04 - va
l_loss: 0.0011
Epoch 446/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2102e-04 - va
l_loss: 9.5616e-04
Epoch 447/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2461e-04 - va
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l_loss: 9.6851e-04
Epoch 448/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1691e-04 - va
l_loss: 0.0011
Epoch 449/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2165e-04 - va
l_loss: 9.7989e-04
Epoch 450/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9105e-04 - va
l_loss: 9.1835e-04
Epoch 451/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3074e-04 - va
l_loss: 0.0010
Epoch 452/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2051e-04 - va
l_loss: 0.0011
Epoch 453/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1282e-04 - va
l_loss: 9.9978e-04
Epoch 454/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4402e-04 - va
l_loss: 0.0011
Epoch 455/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1654e-04 - va
l_loss: 9.0172e-04
Epoch 456/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1538e-04 - va
l_loss: 9.4191e-04
Epoch 457/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1732e-04 - va
l_loss: 9.3868e-04
Epoch 458/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0557e-04 - va
l_loss: 9.4236e-04
Epoch 459/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1887e-04 - va
l_loss: 0.0010
Epoch 460/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0378e-04 - va
l_loss: 9.7286e-04
Epoch 461/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1499e-04 - va
l_loss: 9.2364e-04
Epoch 462/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0945e-04 - va
l_loss: 9.4203e-04
Epoch 463/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3606e-04 - va
l_loss: 9.9412e-04
Epoch 464/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2044e-04 - va
l_loss: 9.7739e-04
Epoch 465/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9166e-04 - va
l_loss: 0.0011
Epoch 466/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1529e-04 - va
l_loss: 9.8560e-04
Epoch 467/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1078e-04 - va
l_loss: 9.7958e-04
Epoch 468/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3555e-04 - va
l_loss: 9.0172e-04
Epoch 469/1000
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1074/1074 [==============================] - 2s 2ms/step - loss: 9.0192e-04 - va
l_loss: 9.4375e-04
Epoch 470/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0533e-04 - va
l_loss: 9.7443e-04
Epoch 471/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0769e-04 - va
l_loss: 9.9062e-04
Epoch 472/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1180e-04 - va
l_loss: 0.0010
Epoch 473/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9166e-04 - va
l_loss: 9.1968e-04
Epoch 474/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9250e-04 - va
l_loss: 0.0010
Epoch 475/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0930e-04 - va
l_loss: 0.0010
Epoch 476/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8386e-04 - va
l_loss: 9.4754e-04
Epoch 477/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9925e-04 - va
l_loss: 0.0012
Epoch 478/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1595e-04 - va
l_loss: 9.8091e-04
Epoch 479/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1626e-04 - va
l_loss: 0.0010
Epoch 480/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0998e-04 - va
l_loss: 9.6098e-04
Epoch 481/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0661e-04 - va
l_loss: 9.2774e-04
Epoch 482/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8152e-04 - va
l_loss: 9.4760e-04
Epoch 483/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1286e-04 - va
l_loss: 0.0011
Epoch 484/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0812e-04 - va
l_loss: 9.7406e-04
Epoch 485/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8680e-04 - va
l_loss: 0.0010
Epoch 486/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9563e-04 - va
l_loss: 9.0961e-04
Epoch 487/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9864e-04 - va
l_loss: 9.5592e-04
Epoch 488/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0903e-04 - va
l_loss: 9.1630e-04
Epoch 489/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9668e-04 - va
l_loss: 9.6223e-04
Epoch 490/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8811e-04 - va
l_loss: 9.2042e-04
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Epoch 491/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8911e-04 - va
l_loss: 9.7175e-04
Epoch 492/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0876e-04 - va
l_loss: 8.8552e-04
Epoch 493/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9133e-04 - va
l_loss: 0.0010
Epoch 494/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8202e-04 - va
l_loss: 9.1483e-04
Epoch 495/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9598e-04 - va
l_loss: 9.3866e-04
Epoch 496/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1017e-04 - va
l_loss: 9.1608e-04
Epoch 497/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9348e-04 - va
l_loss: 9.8123e-04
Epoch 498/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9717e-04 - va
l_loss: 9.8010e-04
Epoch 499/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1209e-04 - va
l_loss: 8.9807e-04
Epoch 500/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8850e-04 - va
l_loss: 0.0010
Epoch 501/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8435e-04 - va
l_loss: 9.7036e-04
Epoch 502/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9594e-04 - va
l_loss: 9.5810e-04
Epoch 503/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0328e-04 - va
l_loss: 0.0010
Epoch 504/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8886e-04 - va
l_loss: 0.0010
Epoch 505/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0921e-04 - va
l_loss: 9.4790e-04
Epoch 506/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0329e-04 - va
l_loss: 9.5533e-04
Epoch 507/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7950e-04 - va
l_loss: 0.0010
Epoch 508/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9037e-04 - va
l_loss: 0.0010
Epoch 509/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9555e-04 - va
l_loss: 9.1140e-04
Epoch 510/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7462e-04 - va
l_loss: 9.2839e-04
Epoch 511/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8150e-04 - va
l_loss: 9.1913e-04
Epoch 512/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8789e-04 - va
```

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l_loss: 9.8004e-04
Epoch 513/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1074e-04 - va
l_loss: 9.3390e-04
Epoch 514/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8409e-04 - va
l_loss: 9.6550e-04
Epoch 515/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9347e-04 - va
l_loss: 9.4743e-04
Epoch 516/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7863e-04 - va
l_loss: 9.4862e-04
Epoch 517/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8053e-04 - va
l_loss: 0.0010
Epoch 518/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9041e-04 - va
l_loss: 0.0010
Epoch 519/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8636e-04 - va
l_loss: 9.8040e-04
Epoch 520/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6645e-04 - va
l_loss: 0.0010
Epoch 521/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8775e-04 - va
l_loss: 9.2917e-04
Epoch 522/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9746e-04 - va
l_loss: 9.7084e-04
Epoch 523/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8897e-04 - va
l_loss: 9.6868e-04
Epoch 524/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8445e-04 - va
l_loss: 9.5743e-04
Epoch 525/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7299e-04 - va
l_loss: 9.5911e-04
Epoch 526/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8888e-04 - va
l_loss: 0.0010
Epoch 527/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0279e-04 - va
l_loss: 9.2186e-04
Epoch 528/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8308e-04 - va
l_loss: 9.2634e-04
Epoch 529/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9721e-04 - va
l_loss: 9.5456e-04
Epoch 530/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8759e-04 - va
l_loss: 9.6341e-04
Epoch 531/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7349e-04 - va
l_loss: 9.6490e-04
Epoch 532/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7536e-04 - va
l_loss: 9.0468e-04
Epoch 533/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8241e-04 - va
l_loss: 9.6784e-04
Epoch 534/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 8.7021e-04 - va
l_loss: 9.5393e-04
Epoch 535/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7866e-04 - va
l_loss: 9.5905e-04
Epoch 536/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8772e-04 - va
l_loss: 0.0010
Epoch 537/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8395e-04 - va
l_loss: 9.8613e-04
Epoch 538/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6753e-04 - va
l_loss: 9.9044e-04
Epoch 539/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6606e-04 - va
l_loss: 9.3492e-04
Epoch 540/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8194e-04 - va
l_loss: 9.6546e-04
Epoch 541/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7741e-04 - va
l_loss: 0.0011
Epoch 542/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9152e-04 - va
l_loss: 9.4046e-04
Epoch 543/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6823e-04 - va
l_loss: 9.2488e-04
Epoch 544/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7460e-04 - va
l_loss: 9.3075e-04
Epoch 545/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7081e-04 - va
l_loss: 9.2307e-04
Epoch 546/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8201e-04 - va
l_loss: 0.0010
Epoch 547/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6931e-04 - va
l_loss: 9.2407e-04
Epoch 548/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7406e-04 - va
l_loss: 9.4437e-04
Epoch 549/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6713e-04 - va
l_loss: 9.2220e-04
Epoch 550/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7236e-04 - va
l_loss: 0.0010
Epoch 551/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6539e-04 - va
l_loss: 9.7807e-04
Epoch 552/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7592e-04 - va
l_loss: 0.0011
Epoch 553/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7083e-04 - va
l_loss: 0.0010
Epoch 554/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7996e-04 - va
l_loss: 0.0011
Epoch 555/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6483e-04 - va
l_loss: 9.9170e-04
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Epoch 556/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7801e-04 - va
l_loss: 0.0011
Epoch 557/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5050e-04 - va
l_loss: 9.7398e-04
Epoch 558/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7624e-04 - va
l_loss: 9.7688e-04
Epoch 559/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7098e-04 - va
l_loss: 9.9570e-04
Epoch 560/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7507e-04 - va
l_loss: 8.9676e-04
Epoch 561/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7880e-04 - va
l_loss: 9.3832e-04
Epoch 562/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7070e-04 - va
l_loss: 9.4873e-04
Epoch 563/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8104e-04 - va
l_loss: 9.7742e-04
Epoch 564/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6734e-04 - va
l_loss: 0.0010
Epoch 565/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5676e-04 - va
l_loss: 0.0010
Epoch 566/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6800e-04 - va
l_loss: 9.3357e-04
Epoch 567/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0043e-04 - va
l_loss: 9.1553e-04
Epoch 568/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6431e-04 - va
l_loss: 9.5999e-04
Epoch 569/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5460e-04 - va
l_loss: 8.9874e-04
Epoch 570/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7109e-04 - va
l_loss: 0.0010
Epoch 571/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5316e-04 - va
l_loss: 9.9390e-04
Epoch 572/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7361e-04 - va
l_loss: 9.0964e-04
Epoch 573/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6330e-04 - va
l_loss: 9.8174e-04
Epoch 574/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5389e-04 - va
l_loss: 9.7601e-04
Epoch 575/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6801e-04 - va
l_loss: 9.2478e-04
Epoch 576/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5708e-04 - va
l_loss: 9.7329e-04
Epoch 577/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7169e-04 - va
```

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l_loss: 9.2760e-04
Epoch 578/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5508e-04 - va
l_loss: 0.0010
Epoch 579/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5828e-04 - va
l_loss: 9.6591e-04
Epoch 580/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5141e-04 - va
l_loss: 9.9216e-04
Epoch 581/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5735e-04 - va
l_loss: 9.3843e-04
Epoch 582/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7188e-04 - va
l_loss: 0.0010
Epoch 583/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4637e-04 - va
l_loss: 9.4624e-04
Epoch 584/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5886e-04 - va
l_loss: 9.8820e-04
Epoch 585/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5318e-04 - va
l_loss: 9.4806e-04
Epoch 586/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6583e-04 - va
l_loss: 0.0011
Epoch 587/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6275e-04 - va
l_loss: 9.5303e-04
Epoch 588/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4769e-04 - va
l_loss: 9.7632e-04
Epoch 589/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5705e-04 - va
l_loss: 9.6968e-04
Epoch 590/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6499e-04 - va
l_loss: 9.4918e-04
Epoch 591/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4626e-04 - va
l_loss: 9.4744e-04
Epoch 592/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5923e-04 - va
l_loss: 0.0010
Epoch 593/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7316e-04 - va
l_loss: 9.4447e-04
Epoch 594/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4094e-04 - va
l_loss: 9.4079e-04
Epoch 595/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6391e-04 - va
l_loss: 0.0010
Epoch 596/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6191e-04 - va
l_loss: 9.2801e-04
Epoch 597/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4936e-04 - va
l_loss: 9.6789e-04
Epoch 598/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4492e-04 - va
l_loss: 8.7498e-04
Epoch 599/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 8.5885e-04 - va
l_loss: 0.0011
Epoch 600/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6161e-04 - va
l_loss: 9.6359e-04
Epoch 601/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3957e-04 - va
l_loss: 9.3062e-04
Epoch 602/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6248e-04 - va
l_loss: 9.8657e-04
Epoch 603/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4416e-04 - va
l_loss: 9.0377e-04
Epoch 604/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6230e-04 - va
l_loss: 9.5728e-04
Epoch 605/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4533e-04 - va
l_loss: 0.0010
Epoch 606/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5309e-04 - va
l_loss: 9.7953e-04
Epoch 607/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4098e-04 - va
l_loss: 9.6571e-04
Epoch 608/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4003e-04 - va
l_loss: 9.0251e-04
Epoch 609/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5769e-04 - va
l_loss: 9.9724e-04
Epoch 610/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3907e-04 - va
l_loss: 9.5918e-04
Epoch 611/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5152e-04 - va
l_loss: 9.3990e-04
Epoch 612/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6614e-04 - va
l_loss: 9.0045e-04
Epoch 613/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5280e-04 - va
l_loss: 9.5541e-04
Epoch 614/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3465e-04 - va
l_loss: 0.0010
Epoch 615/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5052e-04 - va
l_loss: 9.6653e-04
Epoch 616/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4329e-04 - va
l_loss: 0.0011
Epoch 617/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4785e-04 - va
l_loss: 0.0010
Epoch 618/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4783e-04 - va
l_loss: 9.6284e-04
Epoch 619/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4144e-04 - va
l_loss: 9.7420e-04
Epoch 620/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4852e-04 - va
l_loss: 0.0012
```

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Epoch 621/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3824e-04 - va
l_loss: 9.8667e-04
Epoch 622/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3890e-04 - va
l_loss: 9.2577e-04
Epoch 623/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3978e-04 - va
l_loss: 0.0010
Epoch 624/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3568e-04 - va
l_loss: 0.0010
Epoch 625/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4856e-04 - va
l_loss: 9.8685e-04
Epoch 626/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3949e-04 - va
l_loss: 0.0010
Epoch 627/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4613e-04 - va
l_loss: 9.4852e-04
Epoch 628/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4918e-04 - va
l_loss: 9.5410e-04
Epoch 629/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4040e-04 - va
l_loss: 9.0208e-04
Epoch 630/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4275e-04 - va
l_loss: 9.7679e-04
Epoch 631/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5040e-04 - va
l_loss: 8.9939e-04
Epoch 632/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3661e-04 - va
l_loss: 9.3009e-04
Epoch 633/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3553e-04 - va
l_loss: 9.2309e-04
Epoch 634/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4690e-04 - va
l_loss: 0.0010
Epoch 635/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4212e-04 - va
l_loss: 9.8792e-04
Epoch 636/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2937e-04 - va
l_loss: 9.0824e-04
Epoch 637/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4338e-04 - va
l_loss: 9.5445e-04
Epoch 638/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4397e-04 - va
l_loss: 9.2001e-04
Epoch 639/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3802e-04 - va
l_loss: 9.6866e-04
Epoch 640/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4226e-04 - va
l_loss: 9.8081e-04
Epoch 641/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3860e-04 - va
l_loss: 8.8598e-04
Epoch 642/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4176e-04 - va
```

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l_loss: 9.0458e-04
Epoch 643/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4720e-04 - va
l_loss: 9.7188e-04
Epoch 644/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3802e-04 - va
l_loss: 0.0011
Epoch 645/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4323e-04 - va
l_loss: 9.1175e-04
Epoch 646/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4462e-04 - va
l_loss: 9.4210e-04
Epoch 647/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4187e-04 - va
l_loss: 9.5395e-04
Epoch 648/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3346e-04 - va
l_loss: 0.0010
Epoch 649/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4740e-04 - va
l_loss: 9.4236e-04
Epoch 650/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3912e-04 - va
l_loss: 0.0011
Epoch 651/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4650e-04 - va
l_loss: 9.2677e-04
Epoch 652/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2877e-04 - va
l_loss: 9.5591e-04
Epoch 653/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5329e-04 - va
l_loss: 9.6145e-04
Epoch 654/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2620e-04 - va
l_loss: 0.0010
Epoch 655/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3768e-04 - va
l_loss: 9.2105e-04
Epoch 656/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4081e-04 - va
l_loss: 9.7030e-04
Epoch 657/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3882e-04 - va
l_loss: 9.0467e-04
Epoch 658/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3006e-04 - va
l_loss: 8.9451e-04
Epoch 659/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3569e-04 - va
l_loss: 9.2884e-04
Epoch 660/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3738e-04 - va
l_loss: 9.5552e-04
Epoch 661/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3315e-04 - va
l_loss: 9.1129e-04
Epoch 662/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3682e-04 - va
l_loss: 9.4540e-04
Epoch 663/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4279e-04 - va
l_loss: 9.4882e-04
Epoch 664/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 8.4550e-04 - va
l_loss: 9.8872e-04
Epoch 665/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3231e-04 - va
l_loss: 0.0011
Epoch 666/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5353e-04 - va
l_loss: 8.9260e-04
Epoch 667/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1942e-04 - va
l_loss: 9.0065e-04
Epoch 668/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3771e-04 - va
l_loss: 9.5349e-04
Epoch 669/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3756e-04 - va
l_loss: 0.0011
Epoch 670/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3818e-04 - va
l_loss: 9.0785e-04
Epoch 671/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4504e-04 - va
l_loss: 9.3543e-04
Epoch 672/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2566e-04 - va
l_loss: 9.5704e-04
Epoch 673/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3192e-04 - va
l_loss: 9.0574e-04
Epoch 674/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3046e-04 - va
l_loss: 9.4938e-04
Epoch 675/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3492e-04 - va
l_loss: 9.1061e-04
Epoch 676/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3549e-04 - va
l_loss: 9.3788e-04
Epoch 677/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2824e-04 - va
l_loss: 9.6595e-04
Epoch 678/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2910e-04 - va
l_loss: 0.0011
Epoch 679/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2213e-04 - va
l_loss: 0.0010
Epoch 680/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3543e-04 - va
l_loss: 9.1837e-04
Epoch 681/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2094e-04 - va
l_loss: 9.4356e-04
Epoch 682/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3157e-04 - va
l_loss: 9.4118e-04
Epoch 683/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2390e-04 - va
l_loss: 9.7423e-04
Epoch 684/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2811e-04 - va
l_loss: 8.8509e-04
Epoch 685/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3586e-04 - va
l_loss: 0.0011
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Epoch 686/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3540e-04 - va
l_loss: 9.1694e-04
Epoch 687/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2513e-04 - va
l_loss: 0.0010
Epoch 688/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3217e-04 - va
l_loss: 9.2554e-04
Epoch 689/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2333e-04 - va
l_loss: 9.3373e-04
Epoch 690/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2754e-04 - va
l_loss: 9.6007e-04
Epoch 691/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3969e-04 - va
l_loss: 9.1042e-04
Epoch 692/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2351e-04 - va
l_loss: 9.3276e-04
Epoch 693/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2514e-04 - va
l_loss: 9.7471e-04
Epoch 694/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1847e-04 - va
l_loss: 9.0415e-04
Epoch 695/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2599e-04 - va
l_loss: 9.2613e-04
Epoch 696/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2549e-04 - va
l_loss: 9.3497e-04
Epoch 697/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2188e-04 - va
l_loss: 9.6737e-04
Epoch 698/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3287e-04 - va
l_loss: 9.3698e-04
Epoch 699/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1640e-04 - va
l_loss: 9.0879e-04
Epoch 700/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2554e-04 - va
l_loss: 9.4617e-04
Epoch 701/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2871e-04 - va
l_loss: 9.4674e-04
Epoch 702/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2952e-04 - va
l_loss: 8.9135e-04
Epoch 703/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3687e-04 - va
l_loss: 9.2742e-04
Epoch 704/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0794e-04 - va
l_loss: 9.0211e-04
Epoch 705/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2755e-04 - va
l_loss: 9.9490e-04
Epoch 706/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3286e-04 - va
l_loss: 9.8187e-04
Epoch 707/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2071e-04 - va
```

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l_loss: 9.3501e-04
Epoch 708/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1894e-04 - va
l_loss: 9.0865e-04
Epoch 709/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1741e-04 - va
l_loss: 9.0269e-04
Epoch 710/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2114e-04 - va
l_loss: 9.6884e-04
Epoch 711/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0291e-04 - va
l_loss: 9.0277e-04
Epoch 712/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2415e-04 - va
l_loss: 9.6147e-04
Epoch 713/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2529e-04 - va
l_loss: 9.6497e-04
Epoch 714/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1942e-04 - va
l_loss: 9.4148e-04
Epoch 715/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2535e-04 - va
l_loss: 9.4380e-04
Epoch 716/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2331e-04 - va
l_loss: 0.0010
Epoch 717/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1682e-04 - va
l_loss: 9.5503e-04
Epoch 718/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0803e-04 - va
l_loss: 9.0113e-04
Epoch 719/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2503e-04 - va
l_loss: 9.3199e-04
Epoch 720/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1399e-04 - va
l_loss: 0.0010
Epoch 721/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1884e-04 - va
l_loss: 9.3026e-04
Epoch 722/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1167e-04 - va
l_loss: 9.8037e-04
Epoch 723/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1890e-04 - va
l_loss: 9.8517e-04
Epoch 724/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2295e-04 - va
l_loss: 8.9908e-04
Epoch 725/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2206e-04 - va
l_loss: 9.8522e-04
Epoch 726/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1970e-04 - va
l_loss: 8.8738e-04
Epoch 727/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2689e-04 - va
l_loss: 9.2857e-04
Epoch 728/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1842e-04 - va
l_loss: 0.0010
Epoch 729/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 8.2223e-04 - va
l_loss: 9.6273e-04
Epoch 730/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1968e-04 - va
l_loss: 9.6114e-04
Epoch 731/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2734e-04 - va
l_loss: 8.9166e-04
Epoch 732/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0599e-04 - va
l_loss: 8.9755e-04
Epoch 733/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1578e-04 - va
l_loss: 9.3657e-04
Epoch 734/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1143e-04 - va
l_loss: 9.5036e-04
Epoch 735/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1902e-04 - va
l_loss: 9.9990e-04
Epoch 736/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1685e-04 - va
l_loss: 0.0010
Epoch 737/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0479e-04 - va
l_loss: 9.4232e-04
Epoch 738/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1869e-04 - va
l_loss: 9.1927e-04
Epoch 739/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2500e-04 - va
l_loss: 9.4647e-04
Epoch 740/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1604e-04 - va
l_loss: 9.7288e-04
Epoch 741/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1031e-04 - va
l_loss: 8.7314e-04
Epoch 742/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9909e-04 - va
l_loss: 9.0620e-04
Epoch 743/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1581e-04 - va
l_loss: 8.9547e-04
Epoch 744/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0810e-04 - va
l_loss: 9.0302e-04
Epoch 745/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0866e-04 - va
l_loss: 0.0010
Epoch 746/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1162e-04 - va
l_loss: 9.5121e-04
Epoch 747/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1711e-04 - va
l_loss: 9.1077e-04
Epoch 748/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2400e-04 - va
l_loss: 9.0109e-04
Epoch 749/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1023e-04 - va
l_loss: 9.0972e-04
Epoch 750/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0398e-04 - va
l_loss: 9.1981e-04
```

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Epoch 751/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0512e-04 - va
l_loss: 9.8091e-04
Epoch 752/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1333e-04 - va
l_loss: 8.8660e-04
Epoch 753/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0482e-04 - va
l_loss: 9.9413e-04
Epoch 754/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0269e-04 - va
l_loss: 8.9213e-04
Epoch 755/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1740e-04 - va
l_loss: 9.2030e-04
Epoch 756/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1920e-04 - va
l_loss: 8.8654e-04
Epoch 757/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1041e-04 - va
l_loss: 9.2043e-04
Epoch 758/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2783e-04 - va
l_loss: 9.3424e-04
Epoch 759/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0299e-04 - va
l_loss: 9.0175e-04
Epoch 760/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0247e-04 - va
l_loss: 9.4531e-04
Epoch 761/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0732e-04 - va
l_loss: 0.0011
Epoch 762/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1573e-04 - va
l_loss: 9.0940e-04
Epoch 763/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0624e-04 - va
l_loss: 9.2126e-04
Epoch 764/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0248e-04 - va
l_loss: 9.3352e-04
Epoch 765/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9859e-04 - va
l_loss: 8.9115e-04
Epoch 766/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9856e-04 - va
l_loss: 8.7878e-04
Epoch 767/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9368e-04 - va
l_loss: 0.0010
Epoch 768/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1227e-04 - va
l_loss: 8.9531e-04
Epoch 769/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1379e-04 - va
l_loss: 9.5258e-04
Epoch 770/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1572e-04 - va
l_loss: 8.9206e-04
Epoch 771/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9363e-04 - va
l_loss: 8.8598e-04
Epoch 772/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9843e-04 - va
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l_loss: 9.5404e-04
Epoch 773/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0811e-04 - va
l_loss: 9.2562e-04
Epoch 774/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1437e-04 - va
l_loss: 0.0011
Epoch 775/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0724e-04 - va
l_loss: 8.9264e-04
Epoch 776/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0401e-04 - va
l_loss: 9.5186e-04
Epoch 777/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0542e-04 - va
l_loss: 9.0623e-04
Epoch 778/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1672e-04 - va
l_loss: 9.2024e-04
Epoch 779/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0610e-04 - va
l_loss: 9.1457e-04
Epoch 780/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9753e-04 - va
l_loss: 9.2977e-04
Epoch 781/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9461e-04 - va
l_loss: 9.7844e-04
Epoch 782/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9861e-04 - va
l_loss: 9.8275e-04
Epoch 783/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0173e-04 - va
l_loss: 9.7106e-04
Epoch 784/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0399e-04 - va
l_loss: 9.2996e-04
Epoch 785/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9622e-04 - va
l_loss: 8.9876e-04
Epoch 786/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1254e-04 - va
l_loss: 9.2495e-04
Epoch 787/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8855e-04 - va
l_loss: 9.0772e-04
Epoch 788/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9464e-04 - va
l_loss: 9.1324e-04
Epoch 789/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9017e-04 - va
l_loss: 8.9687e-04
Epoch 790/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1114e-04 - va
l_loss: 9.4310e-04
Epoch 791/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9866e-04 - va
l_loss: 9.0834e-04
Epoch 792/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9993e-04 - va
l_loss: 8.7675e-04
Epoch 793/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0141e-04 - va
l_loss: 9.5523e-04
Epoch 794/1000
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1074/1074 [==============================] - 2s 2ms/step - loss: 8.1108e-04 - va
l_loss: 0.0010
Epoch 795/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0877e-04 - va
l_loss: 8.9254e-04
Epoch 796/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8948e-04 - va
l_loss: 8.9873e-04
Epoch 797/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9759e-04 - va
l_loss: 9.5962e-04
Epoch 798/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9786e-04 - va
l_loss: 9.2747e-04
Epoch 799/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9835e-04 - va
l_loss: 9.5125e-04
Epoch 800/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0174e-04 - va
l_loss: 9.4981e-04
Epoch 801/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0110e-04 - va
l_loss: 9.5158e-04
Epoch 802/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9889e-04 - va
l_loss: 9.0005e-04
Epoch 803/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9988e-04 - va
l_loss: 8.8007e-04
Epoch 804/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0276e-04 - va
l_loss: 9.2272e-04
Epoch 805/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9538e-04 - va
l_loss: 9.1204e-04
Epoch 806/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9124e-04 - va
l_loss: 9.2047e-04
Epoch 807/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9961e-04 - va
l_loss: 9.4630e-04
Epoch 808/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9064e-04 - va
l_loss: 9.6814e-04
Epoch 809/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9408e-04 - va
l_loss: 8.9043e-04
Epoch 810/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0179e-04 - va
l_loss: 9.4366e-04
Epoch 811/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9861e-04 - va
l_loss: 9.1308e-04
Epoch 812/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9111e-04 - va
l_loss: 9.4626e-04
Epoch 813/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9538e-04 - va
l_loss: 8.9722e-04
Epoch 814/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9999e-04 - va
l_loss: 9.6369e-04
Epoch 815/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8929e-04 - va
l_loss: 9.2068e-04
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Epoch 816/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9997e-04 - va
l_loss: 9.1202e-04
Epoch 817/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9496e-04 - va
l_loss: 9.3320e-04
Epoch 818/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0482e-04 - va
l_loss: 9.2190e-04
Epoch 819/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0242e-04 - va
l_loss: 9.0498e-04
Epoch 820/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8626e-04 - va
l_loss: 9.0223e-04
Epoch 821/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8849e-04 - va
l_loss: 9.1764e-04
Epoch 822/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8683e-04 - va
l_loss: 8.9930e-04
Epoch 823/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9249e-04 - va
l_loss: 9.5918e-04
Epoch 824/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9293e-04 - va
l_loss: 8.9091e-04
Epoch 825/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9950e-04 - va
l_loss: 0.0010
Epoch 826/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9738e-04 - va
l_loss: 8.6419e-04
Epoch 827/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8752e-04 - va
l_loss: 9.1267e-04
Epoch 828/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8080e-04 - va
l_loss: 9.8390e-04
Epoch 829/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9459e-04 - va
l_loss: 0.0012
Epoch 830/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8911e-04 - va
l_loss: 9.1611e-04
Epoch 831/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9463e-04 - va
l_loss: 9.4349e-04
Epoch 832/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8909e-04 - va
l_loss: 9.0748e-04
Epoch 833/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9548e-04 - va
l_loss: 8.8218e-04
Epoch 834/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8504e-04 - va
l_loss: 8.7041e-04
Epoch 835/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9495e-04 - va
l_loss: 8.9801e-04
Epoch 836/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9566e-04 - va
l_loss: 0.0010
Epoch 837/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9185e-04 - va
```

```
l_loss: 9.4503e-04
Epoch 838/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9955e-04 - va
l_loss: 9.3536e-04
Epoch 839/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8553e-04 - va
l_loss: 9.4162e-04
Epoch 840/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9671e-04 - va
l_loss: 9.2942e-04
Epoch 841/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9208e-04 - va
l_loss: 9.3865e-04
Epoch 842/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8579e-04 - va
l_loss: 9.7705e-04
Epoch 843/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8597e-04 - va
l_loss: 9.0868e-04
Epoch 844/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9493e-04 - va
l_loss: 9.4390e-04
Epoch 845/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8715e-04 - va
l_loss: 9.0339e-04
Epoch 846/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8374e-04 - va
l_loss: 8.9061e-04
Epoch 847/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8898e-04 - va
l_loss: 9.6115e-04
Epoch 848/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9680e-04 - va
l_loss: 9.2516e-04
Epoch 849/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7759e-04 - va
l_loss: 8.4139e-04
Epoch 850/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9529e-04 - va
l_loss: 9.4101e-04
Epoch 851/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0014e-04 - va
l_loss: 8.7970e-04
Epoch 852/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8069e-04 - va
l_loss: 9.7651e-04
Epoch 853/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8701e-04 - va
l_loss: 9.3467e-04
Epoch 854/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9149e-04 - va
l_loss: 8.8931e-04
Epoch 855/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9233e-04 - va
l_loss: 9.0002e-04
Epoch 856/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9196e-04 - va
l_loss: 9.1909e-04
Epoch 857/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8540e-04 - va
l_loss: 9.4833e-04
Epoch 858/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8613e-04 - va
l_loss: 9.2023e-04
Epoch 859/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 7.8459e-04 - va
l_loss: 9.0866e-04
Epoch 860/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8447e-04 - va
l_loss: 9.3039e-04
Epoch 861/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8702e-04 - va
l_loss: 9.2241e-04
Epoch 862/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9487e-04 - va
l_loss: 9.2941e-04
Epoch 863/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9369e-04 - va
l_loss: 8.9070e-04
Epoch 864/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9695e-04 - va
l_loss: 9.7155e-04
Epoch 865/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8292e-04 - va
l_loss: 9.7219e-04
Epoch 866/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9588e-04 - va
l_loss: 8.6741e-04
Epoch 867/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7434e-04 - va
l_loss: 9.1193e-04
Epoch 868/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8293e-04 - va
l_loss: 9.2347e-04
Epoch 869/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8225e-04 - va
l_loss: 8.8244e-04
Epoch 870/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8689e-04 - va
l_loss: 9.3581e-04
Epoch 871/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9281e-04 - va
l_loss: 9.5739e-04
Epoch 872/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9202e-04 - va
l_loss: 9.5244e-04
Epoch 873/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8603e-04 - va
l_loss: 9.4169e-04
Epoch 874/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9311e-04 - va
l_loss: 9.3981e-04
Epoch 875/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8494e-04 - va
l_loss: 0.0010
Epoch 876/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8087e-04 - va
l_loss: 9.6808e-04
Epoch 877/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8360e-04 - va
l_loss: 8.5005e-04
Epoch 878/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8520e-04 - va
l_loss: 9.2952e-04
Epoch 879/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8070e-04 - va
l_loss: 9.1811e-04
Epoch 880/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8464e-04 - va
l_loss: 9.1720e-04
```

```
Epoch 881/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9037e-04 - va
l_loss: 9.2929e-04
Epoch 882/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7936e-04 - va
l_loss: 9.8367e-04
Epoch 883/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9091e-04 - va
l_loss: 9.1074e-04
Epoch 884/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8940e-04 - va
l_loss: 9.6274e-04
Epoch 885/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8732e-04 - va
l_loss: 8.8341e-04
Epoch 886/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7714e-04 - va
l_loss: 9.5597e-04
Epoch 887/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8175e-04 - va
l_loss: 8.9984e-04
Epoch 888/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8767e-04 - va
l_loss: 9.1687e-04
Epoch 889/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9260e-04 - va
l_loss: 9.0856e-04
Epoch 890/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8135e-04 - va
l_loss: 9.4970e-04
Epoch 891/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8270e-04 - va
l_loss: 9.2978e-04
Epoch 892/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9071e-04 - va
l_loss: 9.6502e-04
Epoch 893/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7753e-04 - va
l_loss: 8.5529e-04
Epoch 894/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8126e-04 - va
l_loss: 8.7840e-04
Epoch 895/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8557e-04 - va
l_loss: 0.0011
Epoch 896/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7322e-04 - va
l_loss: 9.3656e-04
Epoch 897/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8171e-04 - va
l_loss: 8.6223e-04
Epoch 898/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8581e-04 - va
l_loss: 9.2325e-04
Epoch 899/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8655e-04 - va
l_loss: 9.3488e-04
Epoch 900/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7290e-04 - va
l_loss: 9.0842e-04
Epoch 901/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7399e-04 - va
l_loss: 9.0080e-04
Epoch 902/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8007e-04 - va
```

```
l_loss: 9.5704e-04
Epoch 903/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8062e-04 - va
l_loss: 0.0010
Epoch 904/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8025e-04 - va
l_loss: 8.8409e-04
Epoch 905/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7945e-04 - va
l_loss: 8.8503e-04
Epoch 906/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7821e-04 - va
l_loss: 8.9379e-04
Epoch 907/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8924e-04 - va
l_loss: 9.6975e-04
Epoch 908/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7554e-04 - va
l_loss: 9.4904e-04
Epoch 909/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7312e-04 - va
l_loss: 9.1016e-04
Epoch 910/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8177e-04 - va
l_loss: 8.9749e-04
Epoch 911/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7098e-04 - va
l_loss: 8.9949e-04
Epoch 912/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9047e-04 - va
l_loss: 8.8018e-04
Epoch 913/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7627e-04 - va
l_loss: 9.6375e-04
Epoch 914/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5918e-04 - va
l_loss: 8.6263e-04
Epoch 915/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6044e-04 - va
l_loss: 8.5418e-04
Epoch 916/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7030e-04 - va
l_loss: 9.0123e-04
Epoch 917/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7944e-04 - va
l_loss: 9.5382e-04
Epoch 918/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7392e-04 - va
l_loss: 9.2379e-04
Epoch 919/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7477e-04 - va
l_loss: 8.6728e-04
Epoch 920/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8148e-04 - va
l_loss: 8.6980e-04
Epoch 921/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6895e-04 - va
l_loss: 9.4128e-04
Epoch 922/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7993e-04 - va
l_loss: 9.1415e-04
Epoch 923/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7177e-04 - va
l_loss: 8.9996e-04
Epoch 924/1000
```

```
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7380e-04 - va
l_loss: 8.8294e-04
Epoch 925/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8083e-04 - va
l_loss: 0.0011
Epoch 926/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7814e-04 - va
l_loss: 8.8950e-04
Epoch 927/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8059e-04 - va
l_loss: 9.4386e-04
Epoch 928/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8679e-04 - va
l_loss: 9.5077e-04
Epoch 929/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9175e-04 - va
l_loss: 8.6807e-04
Epoch 930/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6824e-04 - va
l_loss: 9.1028e-04
Epoch 931/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6610e-04 - va
l_loss: 9.1002e-04
Epoch 932/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7649e-04 - va
l_loss: 9.5445e-04
Epoch 933/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7652e-04 - va
l_loss: 9.1394e-04
Epoch 934/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9112e-04 - va
l_loss: 9.1134e-04
Epoch 935/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7340e-04 - va
l_loss: 9.1944e-04
Epoch 936/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7606e-04 - va
l_loss: 9.1309e-04
Epoch 937/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7933e-04 - va
l_loss: 9.1253e-04
Epoch 938/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6964e-04 - va
l_loss: 9.4980e-04
Epoch 939/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7789e-04 - va
l_loss: 9.0997e-04
Epoch 940/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6936e-04 - va
l_loss: 9.4306e-04
Epoch 941/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7778e-04 - va
l_loss: 9.6080e-04
Epoch 942/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6352e-04 - va
l_loss: 9.1160e-04
Epoch 943/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7672e-04 - va
l_loss: 9.5701e-04
Epoch 944/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7605e-04 - va
l_loss: 9.0684e-04
Epoch 945/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8103e-04 - va
l_loss: 9.2032e-04
```

```
Epoch 946/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6315e-04 - va
l_loss: 9.6716e-04
Epoch 947/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6175e-04 - va
l_loss: 9.3241e-04
Epoch 948/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8725e-04 - va
l_loss: 8.7011e-04
Epoch 949/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6376e-04 - va
l_loss: 8.3876e-04
Epoch 950/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6648e-04 - va
l_loss: 9.6003e-04
Epoch 951/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7104e-04 - va
l_loss: 8.8040e-04
Epoch 952/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6102e-04 - va
l_loss: 8.7961e-04
Epoch 953/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6839e-04 - va
l_loss: 8.7142e-04
Epoch 954/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7251e-04 - va
l_loss: 9.7555e-04
Epoch 955/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6731e-04 - va
l_loss: 0.0010
Epoch 956/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7153e-04 - va
l_loss: 9.3505e-04
Epoch 957/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7004e-04 - va
l_loss: 9.4164e-04
Epoch 958/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6921e-04 - va
l_loss: 8.6198e-04
Epoch 959/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7057e-04 - va
l_loss: 9.3051e-04
Epoch 960/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5388e-04 - va
l_loss: 9.8321e-04
Epoch 961/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7547e-04 - va
l_loss: 9.1704e-04
Epoch 962/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6974e-04 - va
l_loss: 9.0780e-04
Epoch 963/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6295e-04 - va
l_loss: 8.7472e-04
Epoch 964/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7224e-04 - va
l_loss: 9.2440e-04
Epoch 965/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6687e-04 - va
l_loss: 8.3570e-04
Epoch 966/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6924e-04 - va
l_loss: 9.2598e-04
Epoch 967/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6660e-04 - va
```

```
l_loss: 9.2070e-04
Epoch 968/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7380e-04 - va
l_loss: 8.4487e-04
Epoch 969/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6060e-04 - va
l_loss: 8.9568e-04
Epoch 970/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5934e-04 - va
l_loss: 9.8816e-04
Epoch 971/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7158e-04 - va
l_loss: 9.5102e-04
Epoch 972/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7030e-04 - va
l_loss: 9.5312e-04
Epoch 973/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6114e-04 - va
l_loss: 8.8437e-04
Epoch 974/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6392e-04 - va
l_loss: 8.4503e-04
Epoch 975/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6001e-04 - va
l_loss: 9.0198e-04
Epoch 976/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6306e-04 - va
l_loss: 8.8854e-04
Epoch 977/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6372e-04 - va
l_loss: 9.0375e-04
Epoch 978/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6708e-04 - va
l_loss: 8.8047e-04
Epoch 979/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8267e-04 - va
l_loss: 9.1784e-04
Epoch 980/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6823e-04 - va
l_loss: 9.3025e-04
Epoch 981/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5641e-04 - va
l_loss: 0.0010
Epoch 982/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7112e-04 - va
l_loss: 9.1690e-04
Epoch 983/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7412e-04 - va
l_loss: 9.4293e-04
Epoch 984/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6673e-04 - va
l_loss: 9.1218e-04
Epoch 985/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5886e-04 - va
l_loss: 9.4548e-04
Epoch 986/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6337e-04 - va
l_loss: 9.4118e-04
Epoch 987/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6214e-04 - va
l_loss: 9.4002e-04
Epoch 988/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7209e-04 - va
l_loss: 8.5063e-04
Epoch 989/1000
```

```
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6267e-04 - va
l_loss: 9.5025e-04
Epoch 990/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7188e-04 - va
l_loss: 9.3111e-04
Epoch 991/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6617e-04 - va
l_loss: 9.4429e-04
Epoch 992/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5996e-04 - va
l_loss: 8.3807e-04
Epoch 993/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6634e-04 - va
l_loss: 9.0566e-04
Epoch 994/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6265e-04 - va
l_loss: 9.0445e-04
Epoch 995/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6349e-04 - va
l_loss: 9.5535e-04
Epoch 996/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6452e-04 - va
l_loss: 8.6927e-04
Epoch 997/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7106e-04 - va
l_loss: 8.5391e-04
Epoch 998/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6998e-04 - va
l_loss: 9.2541e-04
Epoch 999/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6056e-04 - va
l_loss: 9.1517e-04
Epoch 1000/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5942e-04 - va
l_loss: 9.2650e-04
Model: "sequential"
_________________________________________________________________
 Layer (type)                Output Shape              Param #
=================================================================
 dense (Dense)               (None, 200)               2600

 dropout (Dropout)           (None, 200)               0

 dense_1 (Dense)             (None, 200)               40200

 dropout_1 (Dropout)         (None, 200)               0

 dense_2 (Dense)             (None, 200)               40200

 dropout_2 (Dropout)         (None, 200)               0

 dense_3 (Dense)             (None, 100)               20100

 dropout_3 (Dropout)         (None, 100)               0

 dense_4 (Dense)             (None, 100)               10100

 dense_5 (Dense)             (None, 6)                 606

=================================================================
Total params: 113,806
Trainable params: 113,806
Non-trainable params: 0
_________________________________________________________________
```

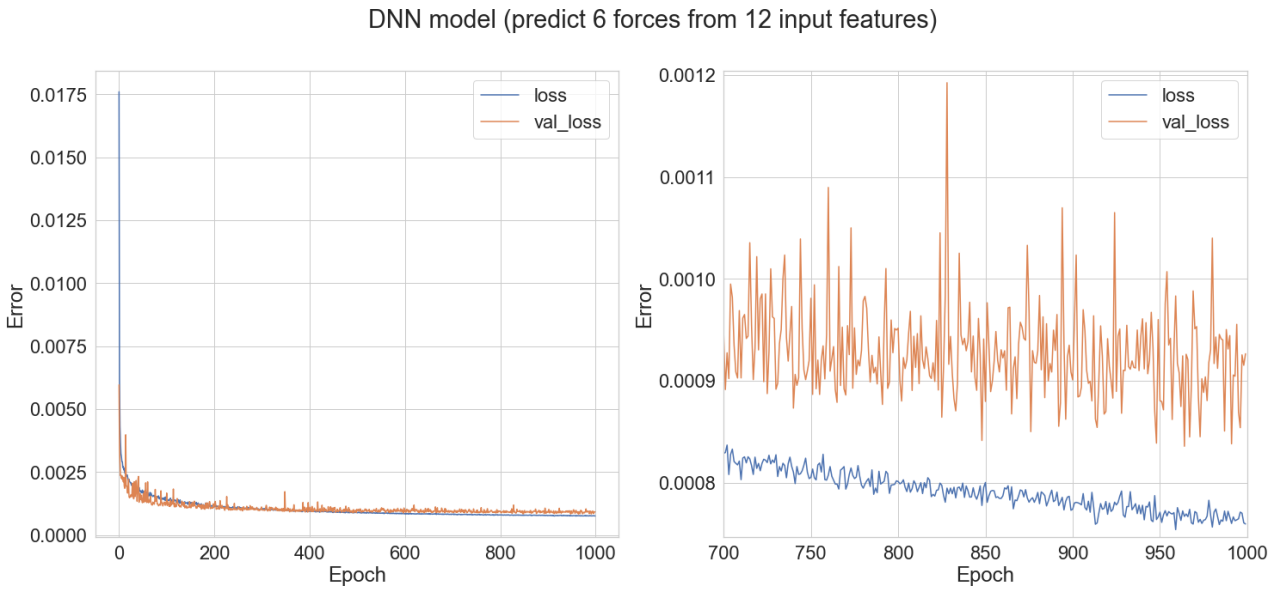
```
CPU times: user 1h 4min 14s, sys: 26min 52s, total: 1h 31min 7s
Wall time: 34min 3s
```

## Save DNN model

In [47]:
```
dnn_model_12.save(output_dir/"{}_{}.h5".format(dnn_model_12_tag, timestamp))
```

## Plot loss vs. epoch

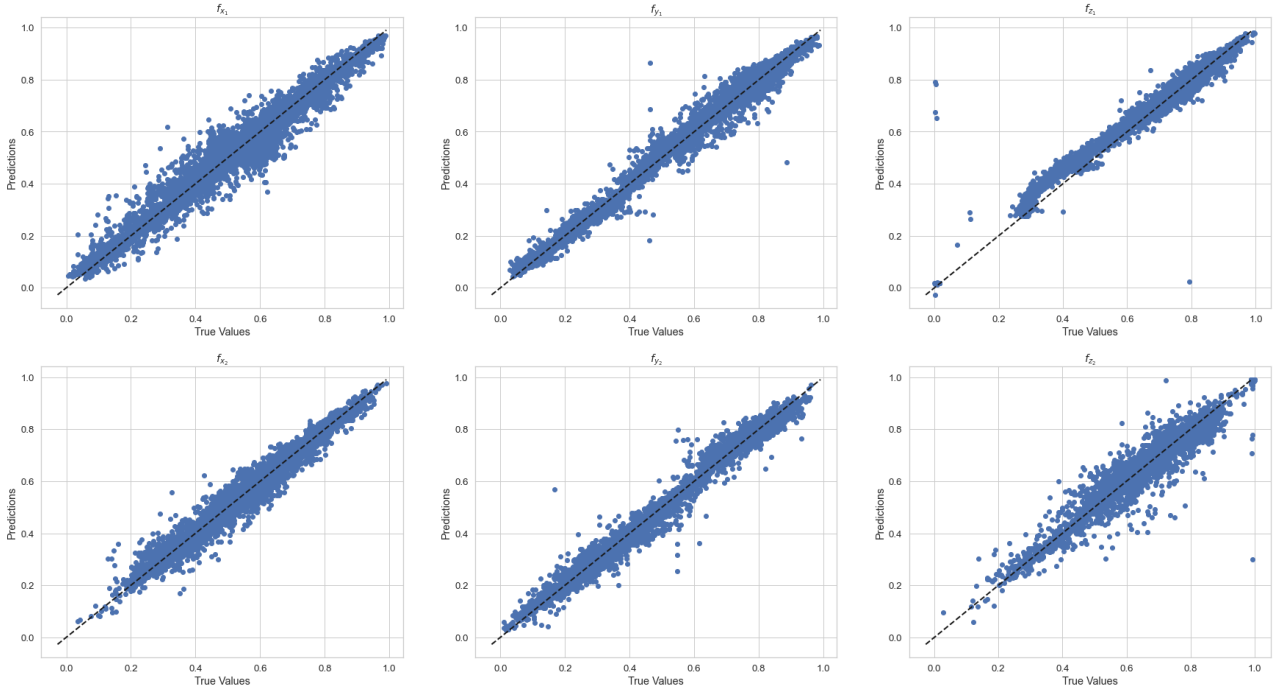
In [168…
```
plot_loss(history_dnn_12, 'loss_{}.pdf'.format(dnn_model_12_tag), 'DNN model (pr
```




In [49]:
```
# save model loss on test set for evaluation section below
test_results['dnn_12'] = dnn_model_12.evaluate(X_test_12, Y_test, verbose=0)
```

## Compare prediction vs. true values for the test set

In [50]:
```
Y_test_pred_dnn_12 = dnn_model_12.predict(X_test_12)
plot_pred_vs_true(Y_test_pred_dnn_12, Y_test, 'pred_vs_true_{}'.format(dnn_model
```




# Predict all 6 forces from 36 input features (12+2x12)

Up to 2nd order derivatives for 12 input features.

In [51]:
```
dnn_model_36 = setup_dnn_model(Y_train.shape[-1])
dnn_model_36_tag = "{}_36features".format(dnn_tag)
```

In [52]:
```
%%time

early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=20)
save_every_epoch = tf.keras.callbacks.ModelCheckpoint(output_dir/'dnn_36_tmp.h5'

history_dnn_36 = dnn_model_36.fit(
    X_train_36, Y_train,
    validation_data=(X_val_36, Y_val),
    batch_size = dnn_batch_size,
    epochs=dnn_epochs,
    callbacks=[save_every_epoch]
    #callbacks=[early_stop, save_every_epoch]
    #verbose=0,
    )
dnn_model_36.summary()
with open(output_dir/'history_dnn_36.pickle', 'wb') as f:
    pickle.dump(history_dnn_36.history, f)
```

```
Epoch 1/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 0.0194 - val_lo
ss: 0.0080
Epoch 2/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0074 - val_lo
ss: 0.0086
Epoch 3/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0052 - val_lo
ss: 0.0029
Epoch 4/1000
```

```
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0041 - val_lo
ss: 0.0025
Epoch 5/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0035 - val_lo
ss: 0.0028
Epoch 6/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0030 - val_lo
ss: 0.0030
Epoch 7/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0028 - val_lo
ss: 0.0017
Epoch 8/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0026 - val_lo
ss: 0.0025
Epoch 9/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0025 - val_lo
ss: 0.0016
Epoch 10/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0024 - val_lo
ss: 0.0014
Epoch 11/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0021 - val_lo
ss: 0.0013
Epoch 12/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0021 - val_lo
ss: 0.0012
Epoch 13/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0023 - val_lo
ss: 0.0047
Epoch 14/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0020 - val_lo
ss: 0.0027
Epoch 15/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0021 - val_lo
ss: 0.0029
Epoch 16/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0011
Epoch 17/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0011
Epoch 18/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0020 - val_lo
ss: 0.0013
Epoch 19/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0011
Epoch 20/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0012
Epoch 21/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0012
Epoch 22/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0011
Epoch 23/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 9.5742e-04
Epoch 24/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0013
Epoch 25/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 9.2908e-04
```

```
Epoch 26/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0010
Epoch 27/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0010
Epoch 28/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 9.1709e-04
Epoch 29/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 9.2764e-04
Epoch 30/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0017
Epoch 31/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 8.7558e-04
Epoch 32/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 9.5999e-04
Epoch 33/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 9.1137e-04
Epoch 34/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 7.9356e-04
Epoch 35/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 8.5856e-04
Epoch 36/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 8.4388e-04
Epoch 37/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 8.6082e-04
Epoch 38/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 8.6063e-04
Epoch 39/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0012
Epoch 40/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 0.0015
Epoch 41/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 9.6825e-04
Epoch 42/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 8.0688e-04
Epoch 43/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 8.7040e-04
Epoch 44/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 6.6290e-04
Epoch 45/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 0.0013
Epoch 46/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 7.5597e-04
Epoch 47/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
```

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ss: 7.7197e-04
Epoch 48/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.1111e-04
Epoch 49/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 7.1723e-04
Epoch 50/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 7.0959e-04
Epoch 51/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 0.0016
Epoch 52/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 7.8587e-04
Epoch 53/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 7.8243e-04
Epoch 54/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.7229e-04
Epoch 55/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.5028e-04
Epoch 56/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.4211e-04
Epoch 57/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 7.8195e-04
Epoch 58/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.2912e-04
Epoch 59/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 7.6904e-04
Epoch 60/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.6583e-04
Epoch 61/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 7.6859e-04
Epoch 62/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 8.7405e-04
Epoch 63/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.4790e-04
Epoch 64/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 6.9312e-04
Epoch 65/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 7.2359e-04
Epoch 66/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8808e-04 - va
l_loss: 6.8154e-04
Epoch 67/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.7375e-04
Epoch 68/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 6.6916e-04
Epoch 69/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 7.0302e-04
Epoch 70/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.0861e-04
Epoch 71/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 6.3480e-04
Epoch 72/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3944e-04 - va
l_loss: 6.6047e-04
Epoch 73/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.1253e-04
Epoch 74/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.0751e-04
Epoch 75/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 7.9162e-04
Epoch 76/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6959e-04 - va
l_loss: 8.6828e-04
Epoch 77/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.2489e-04
Epoch 78/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 6.7421e-04
Epoch 79/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2467e-04 - va
l_loss: 6.3645e-04
Epoch 80/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 8.6188e-04
Epoch 81/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2931e-04 - va
l_loss: 0.0014
Epoch 82/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 6.0532e-04
Epoch 83/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6026e-04 - va
l_loss: 7.0217e-04
Epoch 84/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7967e-04 - va
l_loss: 6.1708e-04
Epoch 85/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4030e-04 - va
l_loss: 7.2395e-04
Epoch 86/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7758e-04 - va
l_loss: 5.9675e-04
Epoch 87/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2594e-04 - va
l_loss: 7.4021e-04
Epoch 88/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4915e-04 - va
l_loss: 6.8115e-04
Epoch 89/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3478e-04 - va
l_loss: 8.1955e-04
Epoch 90/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6318e-04 - va
l_loss: 5.6247e-04
```

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Epoch 91/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 6.3205e-04
Epoch 92/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2303e-04 - va
l_loss: 6.0630e-04
Epoch 93/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2197e-04 - va
l_loss: 6.3379e-04
Epoch 94/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7591e-04 - va
l_loss: 6.3844e-04
Epoch 95/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5311e-04 - va
l_loss: 7.3128e-04
Epoch 96/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0594e-04 - va
l_loss: 8.3055e-04
Epoch 97/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5950e-04 - va
l_loss: 6.5864e-04
Epoch 98/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8517e-04 - va
l_loss: 9.0228e-04
Epoch 99/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6363e-04 - va
l_loss: 5.6437e-04
Epoch 100/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5966e-04 - va
l_loss: 6.1666e-04
Epoch 101/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2059e-04 - va
l_loss: 5.7837e-04
Epoch 102/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0535e-04 - va
l_loss: 5.8361e-04
Epoch 103/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8903e-04 - va
l_loss: 6.8746e-04
Epoch 104/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5450e-04 - va
l_loss: 0.0037
Epoch 105/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2852e-04 - va
l_loss: 6.5022e-04
Epoch 106/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2091e-04 - va
l_loss: 5.9692e-04
Epoch 107/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1470e-04 - va
l_loss: 8.1819e-04
Epoch 108/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5383e-04 - va
l_loss: 7.8870e-04
Epoch 109/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1744e-04 - va
l_loss: 5.5650e-04
Epoch 110/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1300e-04 - va
l_loss: 5.9412e-04
Epoch 111/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3586e-04 - va
l_loss: 9.4603e-04
Epoch 112/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1492e-04 - va
```

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l_loss: 8.1574e-04
Epoch 113/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5491e-04 - va
l_loss: 5.4704e-04
Epoch 114/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7815e-04 - va
l_loss: 6.0167e-04
Epoch 115/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7815e-04 - va
l_loss: 6.0183e-04
Epoch 116/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3518e-04 - va
l_loss: 6.8867e-04
Epoch 117/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2575e-04 - va
l_loss: 5.9121e-04
Epoch 118/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9392e-04 - va
l_loss: 6.9245e-04
Epoch 119/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5562e-04 - va
l_loss: 7.2403e-04
Epoch 120/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8169e-04 - va
l_loss: 8.6593e-04
Epoch 121/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9999e-04 - va
l_loss: 5.0927e-04
Epoch 122/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6313e-04 - va
l_loss: 5.7534e-04
Epoch 123/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3076e-04 - va
l_loss: 5.7497e-04
Epoch 124/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7116e-04 - va
l_loss: 6.1593e-04
Epoch 125/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7310e-04 - va
l_loss: 5.7118e-04
Epoch 126/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4660e-04 - va
l_loss: 5.4860e-04
Epoch 127/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2485e-04 - va
l_loss: 5.7291e-04
Epoch 128/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1039e-04 - va
l_loss: 5.8325e-04
Epoch 129/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8392e-04 - va
l_loss: 9.0334e-04
Epoch 130/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0071e-04 - va
l_loss: 5.3214e-04
Epoch 131/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8669e-04 - va
l_loss: 6.2772e-04
Epoch 132/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7680e-04 - va
l_loss: 6.3310e-04
Epoch 133/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0259e-04 - va
l_loss: 6.5339e-04
Epoch 134/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 8.1819e-04 - va
l_loss: 6.9535e-04
Epoch 135/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5967e-04 - va
l_loss: 5.4810e-04
Epoch 136/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5758e-04 - va
l_loss: 5.3169e-04
Epoch 137/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5909e-04 - va
l_loss: 5.4228e-04
Epoch 138/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9636e-04 - va
l_loss: 7.3784e-04
Epoch 139/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7450e-04 - va
l_loss: 5.4866e-04
Epoch 140/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2723e-04 - va
l_loss: 6.1039e-04
Epoch 141/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6959e-04 - va
l_loss: 6.2385e-04
Epoch 142/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5769e-04 - va
l_loss: 5.2376e-04
Epoch 143/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4723e-04 - va
l_loss: 5.5838e-04
Epoch 144/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6245e-04 - va
l_loss: 5.4079e-04
Epoch 145/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1730e-04 - va
l_loss: 7.6099e-04
Epoch 146/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.3079e-04 - va
l_loss: 5.4546e-04
Epoch 147/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4833e-04 - va
l_loss: 6.0461e-04
Epoch 148/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6771e-04 - va
l_loss: 5.5281e-04
Epoch 149/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7234e-04 - va
l_loss: 5.7318e-04
Epoch 150/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9164e-04 - va
l_loss: 5.1061e-04
Epoch 151/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5896e-04 - va
l_loss: 6.8358e-04
Epoch 152/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.3250e-04 - va
l_loss: 4.7411e-04
Epoch 153/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.8070e-04 - va
l_loss: 7.0373e-04
Epoch 154/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6910e-04 - va
l_loss: 4.9133e-04
Epoch 155/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3084e-04 - va
l_loss: 5.0086e-04
```

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Epoch 156/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9809e-04 - va
l_loss: 5.1139e-04
Epoch 157/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4323e-04 - va
l_loss: 8.8061e-04
Epoch 158/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.3153e-04 - va
l_loss: 5.8858e-04
Epoch 159/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2968e-04 - va
l_loss: 6.8790e-04
Epoch 160/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5019e-04 - va
l_loss: 8.9638e-04
Epoch 161/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5644e-04 - va
l_loss: 5.3762e-04
Epoch 162/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7633e-04 - va
l_loss: 5.4804e-04
Epoch 163/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.1522e-04 - va
l_loss: 5.2867e-04
Epoch 164/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0733e-04 - va
l_loss: 4.7593e-04
Epoch 165/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.1970e-04 - va
l_loss: 5.1296e-04
Epoch 166/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2244e-04 - va
l_loss: 5.7866e-04
Epoch 167/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5696e-04 - va
l_loss: 4.8376e-04
Epoch 168/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6591e-04 - va
l_loss: 4.6124e-04
Epoch 169/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7764e-04 - va
l_loss: 4.8823e-04
Epoch 170/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.1669e-04 - va
l_loss: 4.9697e-04
Epoch 171/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.8428e-04 - va
l_loss: 5.0673e-04
Epoch 172/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8972e-04 - va
l_loss: 5.6534e-04
Epoch 173/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.1487e-04 - va
l_loss: 4.8170e-04
Epoch 174/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0852e-04 - va
l_loss: 4.9943e-04
Epoch 175/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2281e-04 - va
l_loss: 5.6248e-04
Epoch 176/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9390e-04 - va
l_loss: 5.0296e-04
Epoch 177/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6436e-04 - va
```

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l_loss: 5.1809e-04
Epoch 178/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5370e-04 - va
l_loss: 5.5072e-04
Epoch 179/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7201e-04 - va
l_loss: 4.4466e-04
Epoch 180/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7324e-04 - va
l_loss: 5.3724e-04
Epoch 181/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7313e-04 - va
l_loss: 9.2743e-04
Epoch 182/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.8300e-04 - va
l_loss: 6.7960e-04
Epoch 183/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2887e-04 - va
l_loss: 4.4567e-04
Epoch 184/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4710e-04 - va
l_loss: 5.0462e-04
Epoch 185/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0483e-04 - va
l_loss: 5.0835e-04
Epoch 186/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.8309e-04 - va
l_loss: 5.7608e-04
Epoch 187/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9970e-04 - va
l_loss: 4.9755e-04
Epoch 188/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5338e-04 - va
l_loss: 4.4138e-04
Epoch 189/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5707e-04 - va
l_loss: 5.2775e-04
Epoch 190/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6967e-04 - va
l_loss: 5.1782e-04
Epoch 191/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4068e-04 - va
l_loss: 6.6816e-04
Epoch 192/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6785e-04 - va
l_loss: 5.9548e-04
Epoch 193/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7760e-04 - va
l_loss: 7.6558e-04
Epoch 194/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4132e-04 - va
l_loss: 5.2225e-04
Epoch 195/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5500e-04 - va
l_loss: 5.2824e-04
Epoch 196/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5022e-04 - va
l_loss: 4.6985e-04
Epoch 197/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7325e-04 - va
l_loss: 4.8658e-04
Epoch 198/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5587e-04 - va
l_loss: 6.2058e-04
Epoch 199/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 6.4329e-04 - va
l_loss: 4.8841e-04
Epoch 200/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6856e-04 - va
l_loss: 4.5727e-04
Epoch 201/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6583e-04 - va
l_loss: 9.8540e-04
Epoch 202/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.8814e-04 - va
l_loss: 6.0061e-04
Epoch 203/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3485e-04 - va
l_loss: 6.0925e-04
Epoch 204/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2271e-04 - va
l_loss: 4.5322e-04
Epoch 205/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2092e-04 - va
l_loss: 4.6165e-04
Epoch 206/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0557e-04 - va
l_loss: 4.6387e-04
Epoch 207/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5245e-04 - va
l_loss: 4.6304e-04
Epoch 208/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7367e-04 - va
l_loss: 5.1369e-04
Epoch 209/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1990e-04 - va
l_loss: 5.5172e-04
Epoch 210/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6131e-04 - va
l_loss: 5.1813e-04
Epoch 211/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5833e-04 - va
l_loss: 5.0829e-04
Epoch 212/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0015e-04 - va
l_loss: 4.8125e-04
Epoch 213/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2067e-04 - va
l_loss: 5.4956e-04
Epoch 214/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.3046e-04 - va
l_loss: 5.1314e-04
Epoch 215/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4332e-04 - va
l_loss: 4.7734e-04
Epoch 216/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0163e-04 - va
l_loss: 4.3318e-04
Epoch 217/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3238e-04 - va
l_loss: 4.8449e-04
Epoch 218/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3159e-04 - va
l_loss: 4.9731e-04
Epoch 219/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4199e-04 - va
l_loss: 4.6352e-04
Epoch 220/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0474e-04 - va
l_loss: 5.9265e-04
```

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Epoch 221/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1504e-04 - va
l_loss: 4.5641e-04
Epoch 222/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4215e-04 - va
l_loss: 5.1903e-04
Epoch 223/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1454e-04 - va
l_loss: 4.5625e-04
Epoch 224/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2565e-04 - va
l_loss: 4.6130e-04
Epoch 225/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1515e-04 - va
l_loss: 4.7104e-04
Epoch 226/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0276e-04 - va
l_loss: 4.3434e-04
Epoch 227/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9577e-04 - va
l_loss: 4.6112e-04
Epoch 228/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1390e-04 - va
l_loss: 4.7052e-04
Epoch 229/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1580e-04 - va
l_loss: 4.6812e-04
Epoch 230/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2380e-04 - va
l_loss: 4.3041e-04
Epoch 231/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9710e-04 - va
l_loss: 4.2753e-04
Epoch 232/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1176e-04 - va
l_loss: 4.5262e-04
Epoch 233/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4117e-04 - va
l_loss: 5.4229e-04
Epoch 234/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0257e-04 - va
l_loss: 4.2519e-04
Epoch 235/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9490e-04 - va
l_loss: 4.7901e-04
Epoch 236/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8578e-04 - va
l_loss: 4.8797e-04
Epoch 237/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0914e-04 - va
l_loss: 4.9011e-04
Epoch 238/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9151e-04 - va
l_loss: 5.1336e-04
Epoch 239/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2429e-04 - va
l_loss: 4.6215e-04
Epoch 240/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8801e-04 - va
l_loss: 5.2327e-04
Epoch 241/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1382e-04 - va
l_loss: 4.9764e-04
Epoch 242/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9308e-04 - va
```

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l_loss: 4.6337e-04
Epoch 243/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9999e-04 - va
l_loss: 4.8501e-04
Epoch 244/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8321e-04 - va
l_loss: 4.6182e-04
Epoch 245/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9834e-04 - va
l_loss: 5.0060e-04
Epoch 246/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4489e-04 - va
l_loss: 5.7211e-04
Epoch 247/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0222e-04 - va
l_loss: 5.0348e-04
Epoch 248/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0779e-04 - va
l_loss: 5.0783e-04
Epoch 249/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9442e-04 - va
l_loss: 4.6747e-04
Epoch 250/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7855e-04 - va
l_loss: 4.9413e-04
Epoch 251/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8726e-04 - va
l_loss: 4.8799e-04
Epoch 252/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8983e-04 - va
l_loss: 4.4748e-04
Epoch 253/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1336e-04 - va
l_loss: 5.5425e-04
Epoch 254/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7695e-04 - va
l_loss: 4.7833e-04
Epoch 255/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8127e-04 - va
l_loss: 4.8501e-04
Epoch 256/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7356e-04 - va
l_loss: 5.1892e-04
Epoch 257/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9676e-04 - va
l_loss: 4.8643e-04
Epoch 258/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9400e-04 - va
l_loss: 5.9345e-04
Epoch 259/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8796e-04 - va
l_loss: 4.7784e-04
Epoch 260/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9557e-04 - va
l_loss: 4.8079e-04
Epoch 261/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7646e-04 - va
l_loss: 4.4990e-04
Epoch 262/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5444e-04 - va
l_loss: 4.3615e-04
Epoch 263/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8387e-04 - va
l_loss: 4.9813e-04
Epoch 264/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 6.0117e-04 - va
l_loss: 6.6819e-04
Epoch 265/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0501e-04 - va
l_loss: 4.6115e-04
Epoch 266/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7700e-04 - va
l_loss: 4.7895e-04
Epoch 267/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5746e-04 - va
l_loss: 4.2126e-04
Epoch 268/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6609e-04 - va
l_loss: 4.7670e-04
Epoch 269/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8464e-04 - va
l_loss: 7.4872e-04
Epoch 270/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9381e-04 - va
l_loss: 4.9130e-04
Epoch 271/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6421e-04 - va
l_loss: 5.3379e-04
Epoch 272/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5873e-04 - va
l_loss: 4.2544e-04
Epoch 273/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4183e-04 - va
l_loss: 4.2949e-04
Epoch 274/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9949e-04 - va
l_loss: 7.3922e-04
Epoch 275/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7077e-04 - va
l_loss: 5.5463e-04
Epoch 276/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6109e-04 - va
l_loss: 4.3216e-04
Epoch 277/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4593e-04 - va
l_loss: 4.4131e-04
Epoch 278/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7393e-04 - va
l_loss: 5.4592e-04
Epoch 279/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5656e-04 - va
l_loss: 4.7630e-04
Epoch 280/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0709e-04 - va
l_loss: 5.1205e-04
Epoch 281/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5229e-04 - va
l_loss: 5.0632e-04
Epoch 282/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5818e-04 - va
l_loss: 6.6209e-04
Epoch 283/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8844e-04 - va
l_loss: 4.9487e-04
Epoch 284/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7302e-04 - va
l_loss: 5.7150e-04
Epoch 285/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5629e-04 - va
l_loss: 5.6228e-04
```

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Epoch 286/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5561e-04 - va
l_loss: 5.3271e-04
Epoch 287/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7548e-04 - va
l_loss: 4.5762e-04
Epoch 288/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5847e-04 - va
l_loss: 4.3832e-04
Epoch 289/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9378e-04 - va
l_loss: 5.1047e-04
Epoch 290/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5380e-04 - va
l_loss: 4.9241e-04
Epoch 291/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6557e-04 - va
l_loss: 4.4644e-04
Epoch 292/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3913e-04 - va
l_loss: 4.6128e-04
Epoch 293/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5036e-04 - va
l_loss: 5.0266e-04
Epoch 294/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4956e-04 - va
l_loss: 4.4754e-04
Epoch 295/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4766e-04 - va
l_loss: 4.2698e-04
Epoch 296/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7783e-04 - va
l_loss: 5.3037e-04
Epoch 297/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2146e-04 - va
l_loss: 5.4622e-04
Epoch 298/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5164e-04 - va
l_loss: 4.7851e-04
Epoch 299/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4602e-04 - va
l_loss: 4.7031e-04
Epoch 300/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2684e-04 - va
l_loss: 4.8022e-04
Epoch 301/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5334e-04 - va
l_loss: 5.0211e-04
Epoch 302/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5886e-04 - va
l_loss: 6.4590e-04
Epoch 303/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8237e-04 - va
l_loss: 4.9591e-04
Epoch 304/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3503e-04 - va
l_loss: 5.1775e-04
Epoch 305/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2752e-04 - va
l_loss: 4.6486e-04
Epoch 306/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5437e-04 - va
l_loss: 4.9640e-04
Epoch 307/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2625e-04 - va
```

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l_loss: 5.0048e-04
Epoch 308/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2200e-04 - va
l_loss: 4.7033e-04
Epoch 309/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7289e-04 - va
l_loss: 4.7849e-04
Epoch 310/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3548e-04 - va
l_loss: 4.3951e-04
Epoch 311/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1775e-04 - va
l_loss: 4.3925e-04
Epoch 312/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1589e-04 - va
l_loss: 5.5028e-04
Epoch 313/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2559e-04 - va
l_loss: 4.9065e-04
Epoch 314/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2550e-04 - va
l_loss: 4.7303e-04
Epoch 315/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2782e-04 - va
l_loss: 4.6100e-04
Epoch 316/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3266e-04 - va
l_loss: 5.3859e-04
Epoch 317/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1768e-04 - va
l_loss: 5.6827e-04
Epoch 318/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3132e-04 - va
l_loss: 4.2505e-04
Epoch 319/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5148e-04 - va
l_loss: 5.1878e-04
Epoch 320/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6456e-04 - va
l_loss: 5.4883e-04
Epoch 321/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3079e-04 - va
l_loss: 5.2122e-04
Epoch 322/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2326e-04 - va
l_loss: 4.2490e-04
Epoch 323/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1698e-04 - va
l_loss: 5.1052e-04
Epoch 324/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3961e-04 - va
l_loss: 6.0807e-04
Epoch 325/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4452e-04 - va
l_loss: 3.9603e-04
Epoch 326/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1137e-04 - va
l_loss: 4.0207e-04
Epoch 327/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1177e-04 - va
l_loss: 4.0610e-04
Epoch 328/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2546e-04 - va
l_loss: 4.0923e-04
Epoch 329/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 5.1928e-04 - va
l_loss: 4.1799e-04
Epoch 330/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0789e-04 - va
l_loss: 5.2415e-04
Epoch 331/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3680e-04 - va
l_loss: 4.3818e-04
Epoch 332/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0461e-04 - va
l_loss: 4.0753e-04
Epoch 333/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0827e-04 - va
l_loss: 4.3226e-04
Epoch 334/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2618e-04 - va
l_loss: 4.6200e-04
Epoch 335/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1667e-04 - va
l_loss: 3.9453e-04
Epoch 336/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1683e-04 - va
l_loss: 5.1134e-04
Epoch 337/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3881e-04 - va
l_loss: 4.9502e-04
Epoch 338/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2715e-04 - va
l_loss: 4.1411e-04
Epoch 339/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0298e-04 - va
l_loss: 4.7509e-04
Epoch 340/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2223e-04 - va
l_loss: 4.2209e-04
Epoch 341/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1779e-04 - va
l_loss: 4.1761e-04
Epoch 342/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3161e-04 - va
l_loss: 4.5884e-04
Epoch 343/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2401e-04 - va
l_loss: 4.3682e-04
Epoch 344/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0258e-04 - va
l_loss: 4.6780e-04
Epoch 345/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0358e-04 - va
l_loss: 3.8754e-04
Epoch 346/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0135e-04 - va
l_loss: 4.3436e-04
Epoch 347/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0948e-04 - va
l_loss: 5.4952e-04
Epoch 348/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9730e-04 - va
l_loss: 4.8513e-04
Epoch 349/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3241e-04 - va
l_loss: 4.6185e-04
Epoch 350/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0776e-04 - va
l_loss: 4.2826e-04
```

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Epoch 351/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1847e-04 - va
l_loss: 4.3360e-04
Epoch 352/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0002e-04 - va
l_loss: 3.9262e-04
Epoch 353/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9911e-04 - va
l_loss: 4.2365e-04
Epoch 354/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8723e-04 - va
l_loss: 4.3357e-04
Epoch 355/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0108e-04 - va
l_loss: 4.3514e-04
Epoch 356/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2856e-04 - va
l_loss: 6.6686e-04
Epoch 357/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4867e-04 - va
l_loss: 4.4035e-04
Epoch 358/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.9069e-04 - va
l_loss: 4.8550e-04
Epoch 359/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8261e-04 - va
l_loss: 4.4631e-04
Epoch 360/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0700e-04 - va
l_loss: 4.3618e-04
Epoch 361/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0977e-04 - va
l_loss: 4.3444e-04
Epoch 362/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9601e-04 - va
l_loss: 4.5507e-04
Epoch 363/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8332e-04 - va
l_loss: 4.2958e-04
Epoch 364/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9824e-04 - va
l_loss: 4.5003e-04
Epoch 365/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8885e-04 - va
l_loss: 4.1506e-04
Epoch 366/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0702e-04 - va
l_loss: 4.0699e-04
Epoch 367/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8948e-04 - va
l_loss: 4.3185e-04
Epoch 368/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0089e-04 - va
l_loss: 4.2977e-04
Epoch 369/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8139e-04 - va
l_loss: 4.5624e-04
Epoch 370/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8711e-04 - va
l_loss: 4.8550e-04
Epoch 371/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8365e-04 - va
l_loss: 4.5061e-04
Epoch 372/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9873e-04 - va
```

```
l_loss: 4.7621e-04
Epoch 373/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7650e-04 - va
l_loss: 4.6144e-04
Epoch 374/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9373e-04 - va
l_loss: 4.1662e-04
Epoch 375/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8659e-04 - va
l_loss: 4.9648e-04
Epoch 376/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0138e-04 - va
l_loss: 4.2195e-04
Epoch 377/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9726e-04 - va
l_loss: 9.2309e-04
Epoch 378/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8488e-04 - va
l_loss: 3.8792e-04
Epoch 379/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9281e-04 - va
l_loss: 5.5006e-04
Epoch 380/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7921e-04 - va
l_loss: 3.9847e-04
Epoch 381/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7385e-04 - va
l_loss: 4.2214e-04
Epoch 382/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9116e-04 - va
l_loss: 4.2670e-04
Epoch 383/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0955e-04 - va
l_loss: 4.1923e-04
Epoch 384/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0433e-04 - va
l_loss: 4.0892e-04
Epoch 385/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9909e-04 - va
l_loss: 4.3276e-04
Epoch 386/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8280e-04 - va
l_loss: 4.1279e-04
Epoch 387/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6089e-04 - va
l_loss: 3.8868e-04
Epoch 388/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7665e-04 - va
l_loss: 4.5679e-04
Epoch 389/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9404e-04 - va
l_loss: 3.9539e-04
Epoch 390/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7760e-04 - va
l_loss: 4.4544e-04
Epoch 391/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6804e-04 - va
l_loss: 4.6052e-04
Epoch 392/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1169e-04 - va
l_loss: 4.0331e-04
Epoch 393/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5844e-04 - va
l_loss: 4.2891e-04
Epoch 394/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 4.8505e-04 - va
l_loss: 4.1362e-04
Epoch 395/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6853e-04 - va
l_loss: 4.3482e-04
Epoch 396/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7568e-04 - va
l_loss: 4.6183e-04
Epoch 397/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7450e-04 - va
l_loss: 4.6656e-04
Epoch 398/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8894e-04 - va
l_loss: 4.2076e-04
Epoch 399/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6204e-04 - va
l_loss: 4.1379e-04
Epoch 400/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8159e-04 - va
l_loss: 4.3087e-04
Epoch 401/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7203e-04 - va
l_loss: 4.6181e-04
Epoch 402/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7584e-04 - va
l_loss: 4.5240e-04
Epoch 403/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6887e-04 - va
l_loss: 3.9268e-04
Epoch 404/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6992e-04 - va
l_loss: 3.9310e-04
Epoch 405/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8739e-04 - va
l_loss: 3.8375e-04
Epoch 406/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5748e-04 - va
l_loss: 4.1539e-04
Epoch 407/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6021e-04 - va
l_loss: 4.6197e-04
Epoch 408/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6397e-04 - va
l_loss: 4.2783e-04
Epoch 409/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6059e-04 - va
l_loss: 4.0459e-04
Epoch 410/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7385e-04 - va
l_loss: 4.3333e-04
Epoch 411/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6599e-04 - va
l_loss: 3.7780e-04
Epoch 412/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8492e-04 - va
l_loss: 4.0228e-04
Epoch 413/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8247e-04 - va
l_loss: 4.1698e-04
Epoch 414/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4914e-04 - va
l_loss: 4.0202e-04
Epoch 415/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6606e-04 - va
l_loss: 4.3763e-04
```

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Epoch 416/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6343e-04 - va
l_loss: 4.2102e-04
Epoch 417/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5812e-04 - va
l_loss: 4.1371e-04
Epoch 418/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5326e-04 - va
l_loss: 4.0778e-04
Epoch 419/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6595e-04 - va
l_loss: 4.4451e-04
Epoch 420/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6568e-04 - va
l_loss: 4.1518e-04
Epoch 421/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4997e-04 - va
l_loss: 4.5243e-04
Epoch 422/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5844e-04 - va
l_loss: 5.3830e-04
Epoch 423/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5729e-04 - va
l_loss: 3.9424e-04
Epoch 424/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5719e-04 - va
l_loss: 4.0812e-04
Epoch 425/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5100e-04 - va
l_loss: 4.4899e-04
Epoch 426/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9206e-04 - va
l_loss: 4.0856e-04
Epoch 427/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5734e-04 - va
l_loss: 4.5382e-04
Epoch 428/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8087e-04 - va
l_loss: 3.9370e-04
Epoch 429/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5870e-04 - va
l_loss: 3.8515e-04
Epoch 430/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4856e-04 - va
l_loss: 4.1182e-04
Epoch 431/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4734e-04 - va
l_loss: 4.0885e-04
Epoch 432/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7821e-04 - va
l_loss: 4.1443e-04
Epoch 433/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4671e-04 - va
l_loss: 4.1607e-04
Epoch 434/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4735e-04 - va
l_loss: 3.8693e-04
Epoch 435/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5173e-04 - va
l_loss: 5.2717e-04
Epoch 436/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5828e-04 - va
l_loss: 4.2738e-04
Epoch 437/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5293e-04 - va
```

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l_loss: 5.0037e-04
Epoch 438/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6733e-04 - va
l_loss: 3.8580e-04
Epoch 439/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5143e-04 - va
l_loss: 3.7743e-04
Epoch 440/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5155e-04 - va
l_loss: 4.1403e-04
Epoch 441/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5751e-04 - va
l_loss: 4.0854e-04
Epoch 442/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5893e-04 - va
l_loss: 3.9533e-04
Epoch 443/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4759e-04 - va
l_loss: 3.9825e-04
Epoch 444/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6057e-04 - va
l_loss: 3.9567e-04
Epoch 445/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.6581e-04 - va
l_loss: 4.2357e-04
Epoch 446/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4923e-04 - va
l_loss: 4.0404e-04
Epoch 447/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4566e-04 - va
l_loss: 4.2698e-04
Epoch 448/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.4397e-04 - va
l_loss: 4.2028e-04
Epoch 449/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6153e-04 - va
l_loss: 4.1794e-04
Epoch 450/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3740e-04 - va
l_loss: 4.2902e-04
Epoch 451/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4746e-04 - va
l_loss: 3.8561e-04
Epoch 452/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4667e-04 - va
l_loss: 4.1271e-04
Epoch 453/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6693e-04 - va
l_loss: 4.0236e-04
Epoch 454/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3818e-04 - va
l_loss: 4.1138e-04
Epoch 455/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5600e-04 - va
l_loss: 3.9929e-04
Epoch 456/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3112e-04 - va
l_loss: 4.0079e-04
Epoch 457/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5105e-04 - va
l_loss: 4.8531e-04
Epoch 458/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4626e-04 - va
l_loss: 4.0746e-04
Epoch 459/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 4.6080e-04 - va
l_loss: 3.9714e-04
Epoch 460/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4098e-04 - va
l_loss: 4.2692e-04
Epoch 461/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6902e-04 - va
l_loss: 3.7470e-04
Epoch 462/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4111e-04 - va
l_loss: 4.8717e-04
Epoch 463/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3308e-04 - va
l_loss: 4.3775e-04
Epoch 464/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3553e-04 - va
l_loss: 4.5891e-04
Epoch 465/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5175e-04 - va
l_loss: 4.3418e-04
Epoch 466/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3928e-04 - va
l_loss: 4.0059e-04
Epoch 467/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4006e-04 - va
l_loss: 4.2228e-04
Epoch 468/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5936e-04 - va
l_loss: 4.7629e-04
Epoch 469/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3103e-04 - va
l_loss: 3.7496e-04
Epoch 470/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3397e-04 - va
l_loss: 3.8479e-04
Epoch 471/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3029e-04 - va
l_loss: 4.8695e-04
Epoch 472/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5075e-04 - va
l_loss: 3.8654e-04
Epoch 473/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4642e-04 - va
l_loss: 3.8714e-04
Epoch 474/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5586e-04 - va
l_loss: 3.9257e-04
Epoch 475/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 4.3924e-04 - va
l_loss: 3.9373e-04
Epoch 476/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.3633e-04 - va
l_loss: 3.8891e-04
Epoch 477/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.4178e-04 - va
l_loss: 4.7974e-04
Epoch 478/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3860e-04 - va
l_loss: 4.2782e-04
Epoch 479/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3964e-04 - va
l_loss: 3.9462e-04
Epoch 480/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4671e-04 - va
l_loss: 3.9379e-04
```

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Epoch 481/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3727e-04 - va
l_loss: 6.6559e-04
Epoch 482/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4780e-04 - va
l_loss: 4.4163e-04
Epoch 483/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2695e-04 - va
l_loss: 3.8111e-04
Epoch 484/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2809e-04 - va
l_loss: 3.8285e-04
Epoch 485/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3539e-04 - va
l_loss: 3.8700e-04
Epoch 486/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2874e-04 - va
l_loss: 3.8629e-04
Epoch 487/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3412e-04 - va
l_loss: 4.3629e-04
Epoch 488/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3513e-04 - va
l_loss: 3.9160e-04
Epoch 489/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2457e-04 - va
l_loss: 4.0476e-04
Epoch 490/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3574e-04 - va
l_loss: 4.0337e-04
Epoch 491/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3281e-04 - va
l_loss: 3.9423e-04
Epoch 492/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3819e-04 - va
l_loss: 4.1034e-04
Epoch 493/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3357e-04 - va
l_loss: 4.1039e-04
Epoch 494/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3644e-04 - va
l_loss: 4.7649e-04
Epoch 495/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4092e-04 - va
l_loss: 3.9134e-04
Epoch 496/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2735e-04 - va
l_loss: 3.8085e-04
Epoch 497/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1905e-04 - va
l_loss: 3.9768e-04
Epoch 498/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2317e-04 - va
l_loss: 3.9529e-04
Epoch 499/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3741e-04 - va
l_loss: 4.4019e-04
Epoch 500/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3094e-04 - va
l_loss: 3.9473e-04
Epoch 501/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2165e-04 - va
l_loss: 4.2395e-04
Epoch 502/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2897e-04 - va
```

```
l_loss: 4.0017e-04
Epoch 503/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2071e-04 - va
l_loss: 4.2168e-04
Epoch 504/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 4.2779e-04 - va
l_loss: 4.5101e-04
Epoch 505/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2786e-04 - va
l_loss: 3.8777e-04
Epoch 506/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3536e-04 - va
l_loss: 3.9106e-04
Epoch 507/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2582e-04 - va
l_loss: 4.6503e-04
Epoch 508/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3120e-04 - va
l_loss: 3.7541e-04
Epoch 509/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2866e-04 - va
l_loss: 4.4415e-04
Epoch 510/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2657e-04 - va
l_loss: 4.0723e-04
Epoch 511/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2559e-04 - va
l_loss: 3.7320e-04
Epoch 512/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2385e-04 - va
l_loss: 4.5389e-04
Epoch 513/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3615e-04 - va
l_loss: 4.1649e-04
Epoch 514/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3143e-04 - va
l_loss: 3.8475e-04
Epoch 515/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2096e-04 - va
l_loss: 3.9684e-04
Epoch 516/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1809e-04 - va
l_loss: 3.8824e-04
Epoch 517/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2626e-04 - va
l_loss: 4.1030e-04
Epoch 518/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1485e-04 - va
l_loss: 4.7858e-04
Epoch 519/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3724e-04 - va
l_loss: 3.9380e-04
Epoch 520/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1680e-04 - va
l_loss: 4.2352e-04
Epoch 521/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2013e-04 - va
l_loss: 3.9900e-04
Epoch 522/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2464e-04 - va
l_loss: 3.6475e-04
Epoch 523/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1891e-04 - va
l_loss: 4.0477e-04
Epoch 524/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 4.3056e-04 - va
l_loss: 4.0565e-04
Epoch 525/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3093e-04 - va
l_loss: 4.5878e-04
Epoch 526/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2095e-04 - va
l_loss: 4.6532e-04
Epoch 527/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2022e-04 - va
l_loss: 4.0972e-04
Epoch 528/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3001e-04 - va
l_loss: 3.6756e-04
Epoch 529/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3017e-04 - va
l_loss: 4.1507e-04
Epoch 530/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.2301e-04 - va
l_loss: 4.2397e-04
Epoch 531/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1028e-04 - va
l_loss: 3.8328e-04
Epoch 532/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2071e-04 - va
l_loss: 4.0723e-04
Epoch 533/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0815e-04 - va
l_loss: 3.9541e-04
Epoch 534/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0967e-04 - va
l_loss: 4.0259e-04
Epoch 535/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1583e-04 - va
l_loss: 4.0218e-04
Epoch 536/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1421e-04 - va
l_loss: 3.8677e-04
Epoch 537/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1690e-04 - va
l_loss: 4.9144e-04
Epoch 538/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3009e-04 - va
l_loss: 3.6246e-04
Epoch 539/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1701e-04 - va
l_loss: 4.0083e-04
Epoch 540/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1064e-04 - va
l_loss: 3.6671e-04
Epoch 541/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2211e-04 - va
l_loss: 3.9515e-04
Epoch 542/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2732e-04 - va
l_loss: 3.6853e-04
Epoch 543/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1681e-04 - va
l_loss: 3.7028e-04
Epoch 544/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1194e-04 - va
l_loss: 4.2912e-04
Epoch 545/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3161e-04 - va
l_loss: 4.7165e-04
```

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Epoch 546/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1613e-04 - va
l_loss: 3.8022e-04
Epoch 547/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1572e-04 - va
l_loss: 3.9631e-04
Epoch 548/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0961e-04 - va
l_loss: 3.6198e-04
Epoch 549/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0944e-04 - va
l_loss: 4.2117e-04
Epoch 550/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1783e-04 - va
l_loss: 3.8793e-04
Epoch 551/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1372e-04 - va
l_loss: 4.2622e-04
Epoch 552/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0950e-04 - va
l_loss: 3.8323e-04
Epoch 553/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1155e-04 - va
l_loss: 4.4381e-04
Epoch 554/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.2450e-04 - va
l_loss: 3.6427e-04
Epoch 555/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1099e-04 - va
l_loss: 4.1254e-04
Epoch 556/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0771e-04 - va
l_loss: 4.1947e-04
Epoch 557/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 4.1442e-04 - va
l_loss: 3.6397e-04
Epoch 558/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 4.3052e-04 - va
l_loss: 4.0793e-04
Epoch 559/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.2363e-04 - va
l_loss: 3.9027e-04
Epoch 560/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1319e-04 - va
l_loss: 4.2598e-04
Epoch 561/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0284e-04 - va
l_loss: 3.7568e-04
Epoch 562/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0456e-04 - va
l_loss: 3.7859e-04
Epoch 563/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2409e-04 - va
l_loss: 4.6960e-04
Epoch 564/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0743e-04 - va
l_loss: 3.7843e-04
Epoch 565/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1444e-04 - va
l_loss: 3.7460e-04
Epoch 566/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0521e-04 - va
l_loss: 3.8540e-04
Epoch 567/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0365e-04 - va
```

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l_loss: 5.1976e-04
Epoch 568/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2291e-04 - va
l_loss: 4.0496e-04
Epoch 569/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1082e-04 - va
l_loss: 4.0390e-04
Epoch 570/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0355e-04 - va
l_loss: 4.5220e-04
Epoch 571/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1075e-04 - va
l_loss: 4.1243e-04
Epoch 572/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1701e-04 - va
l_loss: 3.7961e-04
Epoch 573/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0439e-04 - va
l_loss: 3.6301e-04
Epoch 574/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1789e-04 - va
l_loss: 3.8231e-04
Epoch 575/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9791e-04 - va
l_loss: 3.5567e-04
Epoch 576/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0403e-04 - va
l_loss: 3.7001e-04
Epoch 577/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1343e-04 - va
l_loss: 3.7613e-04
Epoch 578/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0377e-04 - va
l_loss: 3.8350e-04
Epoch 579/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0754e-04 - va
l_loss: 3.8537e-04
Epoch 580/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1835e-04 - va
l_loss: 4.5674e-04
Epoch 581/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0647e-04 - va
l_loss: 4.5744e-04
Epoch 582/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9778e-04 - va
l_loss: 3.8620e-04
Epoch 583/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.1561e-04 - va
l_loss: 3.8805e-04
Epoch 584/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 4.0914e-04 - va
l_loss: 3.9773e-04
Epoch 585/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0187e-04 - va
l_loss: 3.6091e-04
Epoch 586/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0609e-04 - va
l_loss: 4.1562e-04
Epoch 587/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0952e-04 - va
l_loss: 3.6207e-04
Epoch 588/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9793e-04 - va
l_loss: 3.7862e-04
Epoch 589/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 3.9297e-04 - va
l_loss: 3.8586e-04
Epoch 590/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2071e-04 - va
l_loss: 3.7879e-04
Epoch 591/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0116e-04 - va
l_loss: 3.4933e-04
Epoch 592/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0424e-04 - va
l_loss: 3.4998e-04
Epoch 593/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0293e-04 - va
l_loss: 3.9416e-04
Epoch 594/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9466e-04 - va
l_loss: 3.7507e-04
Epoch 595/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1492e-04 - va
l_loss: 3.7445e-04
Epoch 596/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1037e-04 - va
l_loss: 3.9917e-04
Epoch 597/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9197e-04 - va
l_loss: 4.0686e-04
Epoch 598/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1099e-04 - va
l_loss: 3.7587e-04
Epoch 599/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9742e-04 - va
l_loss: 3.6910e-04
Epoch 600/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0421e-04 - va
l_loss: 3.8811e-04
Epoch 601/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9312e-04 - va
l_loss: 3.6393e-04
Epoch 602/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0623e-04 - va
l_loss: 3.8111e-04
Epoch 603/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9376e-04 - va
l_loss: 3.7565e-04
Epoch 604/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0517e-04 - va
l_loss: 3.7022e-04
Epoch 605/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1380e-04 - va
l_loss: 3.9696e-04
Epoch 606/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9366e-04 - va
l_loss: 3.8211e-04
Epoch 607/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9051e-04 - va
l_loss: 3.8583e-04
Epoch 608/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0329e-04 - va
l_loss: 4.1096e-04
Epoch 609/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9714e-04 - va
l_loss: 3.8306e-04
Epoch 610/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9839e-04 - va
l_loss: 3.5548e-04
```

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Epoch 611/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9574e-04 - va
l_loss: 4.0134e-04
Epoch 612/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0254e-04 - va
l_loss: 4.1701e-04
Epoch 613/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0737e-04 - va
l_loss: 4.4589e-04
Epoch 614/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8775e-04 - va
l_loss: 4.1830e-04
Epoch 615/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9983e-04 - va
l_loss: 3.9428e-04
Epoch 616/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0144e-04 - va
l_loss: 3.8408e-04
Epoch 617/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9618e-04 - va
l_loss: 3.7894e-04
Epoch 618/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0527e-04 - va
l_loss: 3.5972e-04
Epoch 619/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9346e-04 - va
l_loss: 3.8676e-04
Epoch 620/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9449e-04 - va
l_loss: 3.9200e-04
Epoch 621/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9167e-04 - va
l_loss: 3.6638e-04
Epoch 622/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0459e-04 - va
l_loss: 4.0994e-04
Epoch 623/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9209e-04 - va
l_loss: 3.9465e-04
Epoch 624/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9248e-04 - va
l_loss: 3.7131e-04
Epoch 625/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9899e-04 - va
l_loss: 3.6791e-04
Epoch 626/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9001e-04 - va
l_loss: 3.8245e-04
Epoch 627/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9672e-04 - va
l_loss: 3.9176e-04
Epoch 628/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0394e-04 - va
l_loss: 3.7598e-04
Epoch 629/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8693e-04 - va
l_loss: 3.7316e-04
Epoch 630/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9528e-04 - va
l_loss: 3.6792e-04
Epoch 631/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8684e-04 - va
l_loss: 3.7731e-04
Epoch 632/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9550e-04 - va
```

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l_loss: 3.6087e-04
Epoch 633/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9030e-04 - va
l_loss: 3.8912e-04
Epoch 634/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9276e-04 - va
l_loss: 3.7091e-04
Epoch 635/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9599e-04 - va
l_loss: 3.7639e-04
Epoch 636/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9419e-04 - va
l_loss: 3.7790e-04
Epoch 637/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8818e-04 - va
l_loss: 3.9215e-04
Epoch 638/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9830e-04 - va
l_loss: 3.6391e-04
Epoch 639/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9509e-04 - va
l_loss: 5.0569e-04
Epoch 640/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9272e-04 - va
l_loss: 3.4410e-04
Epoch 641/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8512e-04 - va
l_loss: 4.0867e-04
Epoch 642/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9050e-04 - va
l_loss: 4.0416e-04
Epoch 643/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8949e-04 - va
l_loss: 4.1658e-04
Epoch 644/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0448e-04 - va
l_loss: 5.3265e-04
Epoch 645/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 3.9785e-04 - va
l_loss: 3.7360e-04
Epoch 646/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 3.8359e-04 - va
l_loss: 3.8585e-04
Epoch 647/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8912e-04 - va
l_loss: 3.9241e-04
Epoch 648/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9386e-04 - va
l_loss: 3.8663e-04
Epoch 649/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8514e-04 - va
l_loss: 3.6139e-04
Epoch 650/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8562e-04 - va
l_loss: 3.8448e-04
Epoch 651/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9428e-04 - va
l_loss: 3.8539e-04
Epoch 652/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9172e-04 - va
l_loss: 3.6214e-04
Epoch 653/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8149e-04 - va
l_loss: 3.7285e-04
Epoch 654/1000
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1074/1074 [==============================] - 2s 2ms/step - loss: 3.8816e-04 - va
l_loss: 3.4657e-04
Epoch 655/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.0580e-04 - va
l_loss: 3.7874e-04
Epoch 656/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7776e-04 - va
l_loss: 4.2368e-04
Epoch 657/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8366e-04 - va
l_loss: 3.3580e-04
Epoch 658/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9387e-04 - va
l_loss: 3.4978e-04
Epoch 659/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8619e-04 - va
l_loss: 3.5499e-04
Epoch 660/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8297e-04 - va
l_loss: 3.9568e-04
Epoch 661/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9032e-04 - va
l_loss: 3.9140e-04
Epoch 662/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8533e-04 - va
l_loss: 3.6346e-04
Epoch 663/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8668e-04 - va
l_loss: 3.7328e-04
Epoch 664/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7451e-04 - va
l_loss: 3.5200e-04
Epoch 665/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8110e-04 - va
l_loss: 3.8627e-04
Epoch 666/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8255e-04 - va
l_loss: 3.6860e-04
Epoch 667/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9716e-04 - va
l_loss: 3.6670e-04
Epoch 668/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8892e-04 - va
l_loss: 3.6266e-04
Epoch 669/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7832e-04 - va
l_loss: 3.9121e-04
Epoch 670/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8552e-04 - va
l_loss: 3.7221e-04
Epoch 671/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8442e-04 - va
l_loss: 3.5751e-04
Epoch 672/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 3.7112e-04 - va
l_loss: 3.6429e-04
Epoch 673/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 3.7817e-04 - va
l_loss: 3.6151e-04
Epoch 674/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9171e-04 - va
l_loss: 3.4119e-04
Epoch 675/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8653e-04 - va
l_loss: 3.7169e-04
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Epoch 676/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8804e-04 - va
l_loss: 3.6641e-04
Epoch 677/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7483e-04 - va
l_loss: 3.6140e-04
Epoch 678/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8286e-04 - va
l_loss: 3.6096e-04
Epoch 679/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7708e-04 - va
l_loss: 3.9606e-04
Epoch 680/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8143e-04 - va
l_loss: 3.6498e-04
Epoch 681/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8322e-04 - va
l_loss: 3.6340e-04
Epoch 682/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8735e-04 - va
l_loss: 3.8627e-04
Epoch 683/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8564e-04 - va
l_loss: 3.6805e-04
Epoch 684/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9565e-04 - va
l_loss: 3.5512e-04
Epoch 685/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8812e-04 - va
l_loss: 3.8471e-04
Epoch 686/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9658e-04 - va
l_loss: 3.4843e-04
Epoch 687/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8082e-04 - va
l_loss: 3.5975e-04
Epoch 688/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7380e-04 - va
l_loss: 3.8160e-04
Epoch 689/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7442e-04 - va
l_loss: 3.6790e-04
Epoch 690/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8703e-04 - va
l_loss: 3.7786e-04
Epoch 691/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7324e-04 - va
l_loss: 3.5558e-04
Epoch 692/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8669e-04 - va
l_loss: 4.0286e-04
Epoch 693/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7716e-04 - va
l_loss: 3.6029e-04
Epoch 694/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9224e-04 - va
l_loss: 3.8748e-04
Epoch 695/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7250e-04 - va
l_loss: 3.7965e-04
Epoch 696/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8209e-04 - va
l_loss: 3.6856e-04
Epoch 697/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9385e-04 - va
```

```
l_loss: 3.8363e-04
Epoch 698/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7689e-04 - va
l_loss: 3.8211e-04
Epoch 699/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7932e-04 - va
l_loss: 3.6483e-04
Epoch 700/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7631e-04 - va
l_loss: 3.4724e-04
Epoch 701/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 3.7477e-04 - va
l_loss: 4.3021e-04
Epoch 702/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 3.7580e-04 - va
l_loss: 3.5619e-04
Epoch 703/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7322e-04 - va
l_loss: 3.8949e-04
Epoch 704/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7694e-04 - va
l_loss: 3.8528e-04
Epoch 705/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8817e-04 - va
l_loss: 3.5085e-04
Epoch 706/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7394e-04 - va
l_loss: 3.5290e-04
Epoch 707/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7539e-04 - va
l_loss: 3.5773e-04
Epoch 708/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7854e-04 - va
l_loss: 3.4270e-04
Epoch 709/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9324e-04 - va
l_loss: 4.2624e-04
Epoch 710/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7160e-04 - va
l_loss: 4.0981e-04
Epoch 711/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7264e-04 - va
l_loss: 3.8678e-04
Epoch 712/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.9985e-04 - va
l_loss: 4.2807e-04
Epoch 713/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7045e-04 - va
l_loss: 3.4665e-04
Epoch 714/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7271e-04 - va
l_loss: 3.6581e-04
Epoch 715/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7886e-04 - va
l_loss: 3.4877e-04
Epoch 716/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7004e-04 - va
l_loss: 3.7347e-04
Epoch 717/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7855e-04 - va
l_loss: 3.9895e-04
Epoch 718/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6563e-04 - va
l_loss: 3.6337e-04
Epoch 719/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 3.7329e-04 - va
l_loss: 3.7585e-04
Epoch 720/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7201e-04 - va
l_loss: 3.6641e-04
Epoch 721/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7069e-04 - va
l_loss: 3.4487e-04
Epoch 722/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8025e-04 - va
l_loss: 3.7288e-04
Epoch 723/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7388e-04 - va
l_loss: 3.6704e-04
Epoch 724/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8037e-04 - va
l_loss: 3.6266e-04
Epoch 725/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8283e-04 - va
l_loss: 3.6602e-04
Epoch 726/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7506e-04 - va
l_loss: 3.6954e-04
Epoch 727/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7947e-04 - va
l_loss: 3.5749e-04
Epoch 728/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7418e-04 - va
l_loss: 3.6543e-04
Epoch 729/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7368e-04 - va
l_loss: 3.7004e-04
Epoch 730/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7503e-04 - va
l_loss: 3.6021e-04
Epoch 731/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7913e-04 - va
l_loss: 3.4490e-04
Epoch 732/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7661e-04 - va
l_loss: 3.6527e-04
Epoch 733/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7777e-04 - va
l_loss: 3.3964e-04
Epoch 734/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7349e-04 - va
l_loss: 3.5550e-04
Epoch 735/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6824e-04 - va
l_loss: 4.3468e-04
Epoch 736/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8634e-04 - va
l_loss: 3.6882e-04
Epoch 737/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6638e-04 - va
l_loss: 3.6226e-04
Epoch 738/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7222e-04 - va
l_loss: 4.1242e-04
Epoch 739/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6716e-04 - va
l_loss: 3.7215e-04
Epoch 740/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6850e-04 - va
l_loss: 3.3696e-04
```

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Epoch 741/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7193e-04 - va
l_loss: 3.5163e-04
Epoch 742/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6588e-04 - va
l_loss: 3.5132e-04
Epoch 743/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6792e-04 - va
l_loss: 3.3239e-04
Epoch 744/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6707e-04 - va
l_loss: 3.8041e-04
Epoch 745/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7344e-04 - va
l_loss: 3.6252e-04
Epoch 746/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 3.6960e-04 - va
l_loss: 3.4771e-04
Epoch 747/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7983e-04 - va
l_loss: 3.6048e-04
Epoch 748/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7814e-04 - va
l_loss: 3.6260e-04
Epoch 749/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6561e-04 - va
l_loss: 3.3490e-04
Epoch 750/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 3.6816e-04 - va
l_loss: 3.4214e-04
Epoch 751/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7279e-04 - va
l_loss: 3.7562e-04
Epoch 752/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7068e-04 - va
l_loss: 3.6540e-04
Epoch 753/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7935e-04 - va
l_loss: 3.4922e-04
Epoch 754/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6670e-04 - va
l_loss: 3.4360e-04
Epoch 755/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6913e-04 - va
l_loss: 3.8998e-04
Epoch 756/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7011e-04 - va
l_loss: 3.6920e-04
Epoch 757/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6446e-04 - va
l_loss: 3.5098e-04
Epoch 758/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7555e-04 - va
l_loss: 3.6534e-04
Epoch 759/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6684e-04 - va
l_loss: 3.5325e-04
Epoch 760/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6787e-04 - va
l_loss: 3.6338e-04
Epoch 761/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7281e-04 - va
l_loss: 3.6513e-04
Epoch 762/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6842e-04 - va
```

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l_loss: 3.6347e-04
Epoch 763/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6160e-04 - va
l_loss: 3.7532e-04
Epoch 764/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7557e-04 - va
l_loss: 3.6803e-04
Epoch 765/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7065e-04 - va
l_loss: 3.8829e-04
Epoch 766/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6829e-04 - va
l_loss: 4.3211e-04
Epoch 767/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5745e-04 - va
l_loss: 4.0144e-04
Epoch 768/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6472e-04 - va
l_loss: 3.6844e-04
Epoch 769/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6682e-04 - va
l_loss: 3.4249e-04
Epoch 770/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7042e-04 - va
l_loss: 3.7072e-04
Epoch 771/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6482e-04 - va
l_loss: 3.8300e-04
Epoch 772/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5871e-04 - va
l_loss: 3.5433e-04
Epoch 773/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6280e-04 - va
l_loss: 3.8526e-04
Epoch 774/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6746e-04 - va
l_loss: 4.0371e-04
Epoch 775/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6566e-04 - va
l_loss: 3.4729e-04
Epoch 776/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6663e-04 - va
l_loss: 3.4858e-04
Epoch 777/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7066e-04 - va
l_loss: 3.9635e-04
Epoch 778/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7034e-04 - va
l_loss: 3.7240e-04
Epoch 779/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6268e-04 - va
l_loss: 3.5781e-04
Epoch 780/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6239e-04 - va
l_loss: 3.8232e-04
Epoch 781/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6943e-04 - va
l_loss: 3.4595e-04
Epoch 782/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6973e-04 - va
l_loss: 3.9162e-04
Epoch 783/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6973e-04 - va
l_loss: 3.5047e-04
Epoch 784/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 3.5976e-04 - va
l_loss: 3.4346e-04
Epoch 785/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5703e-04 - va
l_loss: 3.6423e-04
Epoch 786/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6581e-04 - va
l_loss: 3.7797e-04
Epoch 787/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6032e-04 - va
l_loss: 3.6096e-04
Epoch 788/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5715e-04 - va
l_loss: 4.5811e-04
Epoch 789/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6528e-04 - va
l_loss: 3.9012e-04
Epoch 790/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6062e-04 - va
l_loss: 3.4364e-04
Epoch 791/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6338e-04 - va
l_loss: 3.3476e-04
Epoch 792/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5117e-04 - va
l_loss: 3.7685e-04
Epoch 793/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6711e-04 - va
l_loss: 3.6687e-04
Epoch 794/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 3.5785e-04 - va
l_loss: 3.8149e-04
Epoch 795/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5456e-04 - va
l_loss: 3.4829e-04
Epoch 796/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5691e-04 - va
l_loss: 3.5828e-04
Epoch 797/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6712e-04 - va
l_loss: 3.5325e-04
Epoch 798/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6912e-04 - va
l_loss: 3.4028e-04
Epoch 799/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5833e-04 - va
l_loss: 3.5689e-04
Epoch 800/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6562e-04 - va
l_loss: 3.4975e-04
Epoch 801/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5399e-04 - va
l_loss: 3.5586e-04
Epoch 802/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5573e-04 - va
l_loss: 3.8094e-04
Epoch 803/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6981e-04 - va
l_loss: 3.5082e-04
Epoch 804/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6129e-04 - va
l_loss: 3.6948e-04
Epoch 805/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5614e-04 - va
l_loss: 3.2620e-04
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Epoch 806/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6072e-04 - va
l_loss: 3.4965e-04
Epoch 807/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6185e-04 - va
l_loss: 3.6130e-04
Epoch 808/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5183e-04 - va
l_loss: 3.4977e-04
Epoch 809/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5514e-04 - va
l_loss: 3.6304e-04
Epoch 810/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5713e-04 - va
l_loss: 3.4531e-04
Epoch 811/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5972e-04 - va
l_loss: 3.4352e-04
Epoch 812/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5484e-04 - va
l_loss: 3.3074e-04
Epoch 813/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6597e-04 - va
l_loss: 3.6242e-04
Epoch 814/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6033e-04 - va
l_loss: 3.7399e-04
Epoch 815/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5465e-04 - va
l_loss: 3.5154e-04
Epoch 816/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5257e-04 - va
l_loss: 3.6638e-04
Epoch 817/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.7236e-04 - va
l_loss: 4.2297e-04
Epoch 818/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5461e-04 - va
l_loss: 3.2560e-04
Epoch 819/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5942e-04 - va
l_loss: 3.3356e-04
Epoch 820/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5959e-04 - va
l_loss: 3.4572e-04
Epoch 821/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5058e-04 - va
l_loss: 3.8157e-04
Epoch 822/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5876e-04 - va
l_loss: 4.0473e-04
Epoch 823/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5631e-04 - va
l_loss: 3.5619e-04
Epoch 824/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5376e-04 - va
l_loss: 3.7010e-04
Epoch 825/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6123e-04 - va
l_loss: 3.6078e-04
Epoch 826/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5279e-04 - va
l_loss: 3.2591e-04
Epoch 827/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5670e-04 - va
```

```
l_loss: 3.3677e-04
Epoch 828/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5751e-04 - va
l_loss: 3.6976e-04
Epoch 829/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6383e-04 - va
l_loss: 3.4050e-04
Epoch 830/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.8023e-04 - va
l_loss: 3.4897e-04
Epoch 831/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5912e-04 - va
l_loss: 3.4215e-04
Epoch 832/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4821e-04 - va
l_loss: 3.5203e-04
Epoch 833/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5838e-04 - va
l_loss: 3.5821e-04
Epoch 834/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5993e-04 - va
l_loss: 3.2732e-04
Epoch 835/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5675e-04 - va
l_loss: 4.2306e-04
Epoch 836/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6400e-04 - va
l_loss: 3.3154e-04
Epoch 837/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4971e-04 - va
l_loss: 3.6072e-04
Epoch 838/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4686e-04 - va
l_loss: 3.4744e-04
Epoch 839/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5344e-04 - va
l_loss: 3.7028e-04
Epoch 840/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5239e-04 - va
l_loss: 3.6195e-04
Epoch 841/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5213e-04 - va
l_loss: 3.4860e-04
Epoch 842/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5785e-04 - va
l_loss: 3.3996e-04
Epoch 843/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6039e-04 - va
l_loss: 3.5527e-04
Epoch 844/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5687e-04 - va
l_loss: 3.4967e-04
Epoch 845/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4700e-04 - va
l_loss: 3.8390e-04
Epoch 846/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4585e-04 - va
l_loss: 3.5127e-04
Epoch 847/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4651e-04 - va
l_loss: 3.6235e-04
Epoch 848/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5310e-04 - va
l_loss: 3.6875e-04
Epoch 849/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 3.5366e-04 - va
l_loss: 3.4083e-04
Epoch 850/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5074e-04 - va
l_loss: 3.2920e-04
Epoch 851/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6368e-04 - va
l_loss: 3.3646e-04
Epoch 852/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5481e-04 - va
l_loss: 3.4582e-04
Epoch 853/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6099e-04 - va
l_loss: 3.6692e-04
Epoch 854/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6021e-04 - va
l_loss: 3.8437e-04
Epoch 855/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4504e-04 - va
l_loss: 3.7124e-04
Epoch 856/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6334e-04 - va
l_loss: 3.3834e-04
Epoch 857/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4541e-04 - va
l_loss: 3.5147e-04
Epoch 858/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4436e-04 - va
l_loss: 3.7006e-04
Epoch 859/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5142e-04 - va
l_loss: 3.3824e-04
Epoch 860/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5014e-04 - va
l_loss: 4.1138e-04
Epoch 861/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6025e-04 - va
l_loss: 3.8117e-04
Epoch 862/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6430e-04 - va
l_loss: 3.6751e-04
Epoch 863/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4924e-04 - va
l_loss: 3.6577e-04
Epoch 864/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4644e-04 - va
l_loss: 4.2463e-04
Epoch 865/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4607e-04 - va
l_loss: 3.5386e-04
Epoch 866/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5172e-04 - va
l_loss: 3.6377e-04
Epoch 867/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4662e-04 - va
l_loss: 3.8074e-04
Epoch 868/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4287e-04 - va
l_loss: 3.3214e-04
Epoch 869/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5335e-04 - va
l_loss: 3.2442e-04
Epoch 870/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5665e-04 - va
l_loss: 3.3188e-04
```

```
Epoch 871/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4437e-04 - va
l_loss: 3.8456e-04
Epoch 872/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4932e-04 - va
l_loss: 3.5361e-04
Epoch 873/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4799e-04 - va
l_loss: 3.3428e-04
Epoch 874/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5269e-04 - va
l_loss: 3.4635e-04
Epoch 875/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6541e-04 - va
l_loss: 3.7214e-04
Epoch 876/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4474e-04 - va
l_loss: 3.5022e-04
Epoch 877/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5471e-04 - va
l_loss: 3.5307e-04
Epoch 878/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5137e-04 - va
l_loss: 3.4779e-04
Epoch 879/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6228e-04 - va
l_loss: 3.8475e-04
Epoch 880/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5788e-04 - va
l_loss: 3.6806e-04
Epoch 881/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4977e-04 - va
l_loss: 3.5407e-04
Epoch 882/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4668e-04 - va
l_loss: 3.7003e-04
Epoch 883/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5282e-04 - va
l_loss: 3.7177e-04
Epoch 884/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4427e-04 - va
l_loss: 3.7238e-04
Epoch 885/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.6172e-04 - va
l_loss: 3.7227e-04
Epoch 886/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4890e-04 - va
l_loss: 3.7312e-04
Epoch 887/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4879e-04 - va
l_loss: 3.4320e-04
Epoch 888/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5102e-04 - va
l_loss: 3.6761e-04
Epoch 889/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5480e-04 - va
l_loss: 3.3362e-04
Epoch 890/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4324e-04 - va
l_loss: 3.2769e-04
Epoch 891/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5090e-04 - va
l_loss: 3.5469e-04
Epoch 892/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4362e-04 - va
```

```
l_loss: 3.3434e-04
Epoch 893/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4766e-04 - va
l_loss: 3.7050e-04
Epoch 894/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4506e-04 - va
l_loss: 3.2943e-04
Epoch 895/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5580e-04 - va
l_loss: 3.3311e-04
Epoch 896/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5110e-04 - va
l_loss: 4.2154e-04
Epoch 897/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5380e-04 - va
l_loss: 3.4978e-04
Epoch 898/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4421e-04 - va
l_loss: 3.7158e-04
Epoch 899/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4460e-04 - va
l_loss: 3.3146e-04
Epoch 900/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4436e-04 - va
l_loss: 3.5688e-04
Epoch 901/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4942e-04 - va
l_loss: 3.7932e-04
Epoch 902/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4782e-04 - va
l_loss: 3.3312e-04
Epoch 903/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5679e-04 - va
l_loss: 3.8534e-04
Epoch 904/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4447e-04 - va
l_loss: 3.4316e-04
Epoch 905/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4984e-04 - va
l_loss: 3.6972e-04
Epoch 906/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4692e-04 - va
l_loss: 3.6762e-04
Epoch 907/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4683e-04 - va
l_loss: 3.4438e-04
Epoch 908/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4515e-04 - va
l_loss: 3.5644e-04
Epoch 909/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4145e-04 - va
l_loss: 3.4440e-04
Epoch 910/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5433e-04 - va
l_loss: 3.5931e-04
Epoch 911/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4137e-04 - va
l_loss: 3.2803e-04
Epoch 912/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5200e-04 - va
l_loss: 3.6050e-04
Epoch 913/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4336e-04 - va
l_loss: 3.5711e-04
Epoch 914/1000
```

```
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4531e-04 - va
l_loss: 3.4519e-04
Epoch 915/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4739e-04 - va
l_loss: 3.2492e-04
Epoch 916/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4121e-04 - va
l_loss: 3.8266e-04
Epoch 917/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4440e-04 - va
l_loss: 3.6934e-04
Epoch 918/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4859e-04 - va
l_loss: 3.4810e-04
Epoch 919/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4307e-04 - va
l_loss: 3.6211e-04
Epoch 920/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4740e-04 - va
l_loss: 3.6386e-04
Epoch 921/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4783e-04 - va
l_loss: 3.2821e-04
Epoch 922/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4168e-04 - va
l_loss: 3.2884e-04
Epoch 923/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3338e-04 - va
l_loss: 4.3463e-04
Epoch 924/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3880e-04 - va
l_loss: 4.0180e-04
Epoch 925/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4635e-04 - va
l_loss: 3.4945e-04
Epoch 926/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4511e-04 - va
l_loss: 3.5816e-04
Epoch 927/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4779e-04 - va
l_loss: 3.6126e-04
Epoch 928/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4771e-04 - va
l_loss: 3.3929e-04
Epoch 929/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4627e-04 - va
l_loss: 3.4914e-04
Epoch 930/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4345e-04 - va
l_loss: 3.2772e-04
Epoch 931/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3907e-04 - va
l_loss: 3.7198e-04
Epoch 932/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4665e-04 - va
l_loss: 3.0860e-04
Epoch 933/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4181e-04 - va
l_loss: 3.7659e-04
Epoch 934/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4475e-04 - va
l_loss: 3.3769e-04
Epoch 935/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4203e-04 - va
l_loss: 3.6017e-04
```

```
Epoch 936/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4886e-04 - va
l_loss: 3.5669e-04
Epoch 937/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3860e-04 - va
l_loss: 3.2070e-04
Epoch 938/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3908e-04 - va
l_loss: 3.5678e-04
Epoch 939/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4822e-04 - va
l_loss: 3.3918e-04
Epoch 940/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4669e-04 - va
l_loss: 3.4157e-04
Epoch 941/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3792e-04 - va
l_loss: 3.3243e-04
Epoch 942/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4044e-04 - va
l_loss: 3.4837e-04
Epoch 943/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4211e-04 - va
l_loss: 3.4913e-04
Epoch 944/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4535e-04 - va
l_loss: 3.3565e-04
Epoch 945/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4283e-04 - va
l_loss: 3.4556e-04
Epoch 946/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3702e-04 - va
l_loss: 3.4410e-04
Epoch 947/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3888e-04 - va
l_loss: 3.3736e-04
Epoch 948/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4469e-04 - va
l_loss: 3.4208e-04
Epoch 949/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3609e-04 - va
l_loss: 3.2620e-04
Epoch 950/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3676e-04 - va
l_loss: 3.4120e-04
Epoch 951/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4073e-04 - va
l_loss: 3.7542e-04
Epoch 952/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4055e-04 - va
l_loss: 3.2551e-04
Epoch 953/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4095e-04 - va
l_loss: 3.4990e-04
Epoch 954/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3974e-04 - va
l_loss: 3.2383e-04
Epoch 955/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4537e-04 - va
l_loss: 5.0290e-04
Epoch 956/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4034e-04 - va
l_loss: 3.4912e-04
Epoch 957/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3626e-04 - va
```

```
l_loss: 3.7723e-04
Epoch 958/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3904e-04 - va
l_loss: 3.6863e-04
Epoch 959/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3373e-04 - va
l_loss: 3.5259e-04
Epoch 960/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4050e-04 - va
l_loss: 3.4839e-04
Epoch 961/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3566e-04 - va
l_loss: 3.4176e-04
Epoch 962/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3944e-04 - va
l_loss: 3.3011e-04
Epoch 963/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4569e-04 - va
l_loss: 3.3353e-04
Epoch 964/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4182e-04 - va
l_loss: 3.1372e-04
Epoch 965/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3307e-04 - va
l_loss: 3.6908e-04
Epoch 966/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3998e-04 - va
l_loss: 3.3524e-04
Epoch 967/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4112e-04 - va
l_loss: 3.5092e-04
Epoch 968/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4003e-04 - va
l_loss: 3.5097e-04
Epoch 969/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4062e-04 - va
l_loss: 3.5798e-04
Epoch 970/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4253e-04 - va
l_loss: 3.5296e-04
Epoch 971/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3775e-04 - va
l_loss: 3.2527e-04
Epoch 972/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3360e-04 - va
l_loss: 3.5082e-04
Epoch 973/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3921e-04 - va
l_loss: 3.4778e-04
Epoch 974/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3927e-04 - va
l_loss: 3.4735e-04
Epoch 975/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4667e-04 - va
l_loss: 3.3248e-04
Epoch 976/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3777e-04 - va
l_loss: 3.5589e-04
Epoch 977/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4349e-04 - va
l_loss: 3.4788e-04
Epoch 978/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4019e-04 - va
l_loss: 3.8088e-04
Epoch 979/1000
```

```
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4267e-04 - va
l_loss: 3.4996e-04
Epoch 980/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3457e-04 - va
l_loss: 3.6023e-04
Epoch 981/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4331e-04 - va
l_loss: 3.3237e-04
Epoch 982/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3601e-04 - va
l_loss: 3.5746e-04
Epoch 983/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3687e-04 - va
l_loss: 3.2193e-04
Epoch 984/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3548e-04 - va
l_loss: 3.4794e-04
Epoch 985/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3764e-04 - va
l_loss: 3.5151e-04
Epoch 986/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3984e-04 - va
l_loss: 3.2758e-04
Epoch 987/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3693e-04 - va
l_loss: 3.2723e-04
Epoch 988/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4318e-04 - va
l_loss: 3.5631e-04
Epoch 989/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3061e-04 - va
l_loss: 3.0576e-04
Epoch 990/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3398e-04 - va
l_loss: 3.3314e-04
Epoch 991/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3909e-04 - va
l_loss: 3.3064e-04
Epoch 992/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3926e-04 - va
l_loss: 3.4767e-04
Epoch 993/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4109e-04 - va
l_loss: 3.5436e-04
Epoch 994/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.5116e-04 - va
l_loss: 3.8458e-04
Epoch 995/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.2572e-04 - va
l_loss: 3.2416e-04
Epoch 996/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.2906e-04 - va
l_loss: 3.3718e-04
Epoch 997/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3980e-04 - va
l_loss: 3.3999e-04
Epoch 998/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3308e-04 - va
l_loss: 3.2166e-04
Epoch 999/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.3036e-04 - va
l_loss: 3.4935e-04
Epoch 1000/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 3.4566e-04 - va
l_loss: 3.8959e-04
```

```
Model: "sequential_1"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 dense_6 (Dense)              (None, 200)               7400

 dropout_4 (Dropout)          (None, 200)               0

 dense_7 (Dense)              (None, 200)               40200

 dropout_5 (Dropout)          (None, 200)               0

 dense_8 (Dense)              (None, 200)               40200

 dropout_6 (Dropout)          (None, 200)               0

 dense_9 (Dense)              (None, 100)               20100

 dropout_7 (Dropout)          (None, 100)               0

 dense_10 (Dense)             (None, 100)               10100

 dense_11 (Dense)             (None, 6)                 606

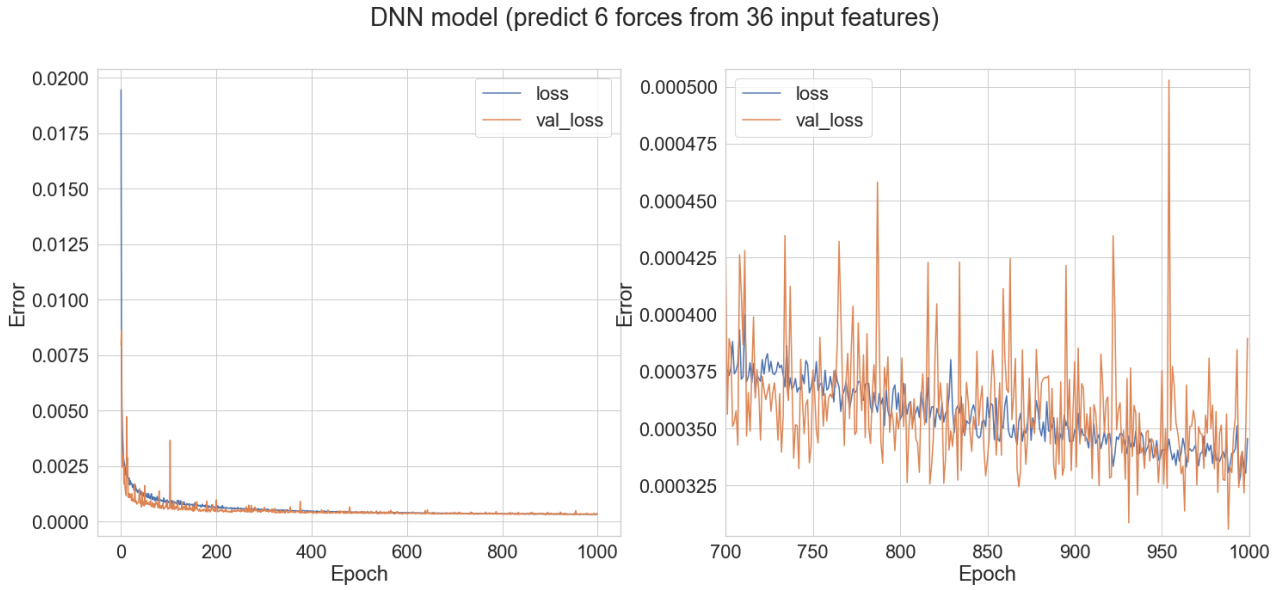
=================================================================
Total params: 118,606
Trainable params: 118,606
Non-trainable params: 0
_________________________________________________________________
CPU times: user 1h 6min 19s, sys: 28min 27s, total: 1h 34min 46s
Wall time: 35min 26s
```

## Save DNN model

In [53]:
```
dnn_model_36.save(output_dir/"{}_{}.h5".format(dnn_model_36_tag, timestamp))
```

## Plot loss vs. epoch

In [169…
```
plot_loss(history_dnn_36, 'loss_{}.pdf'.format(dnn_model_36_tag), 'DNN model (pr
```

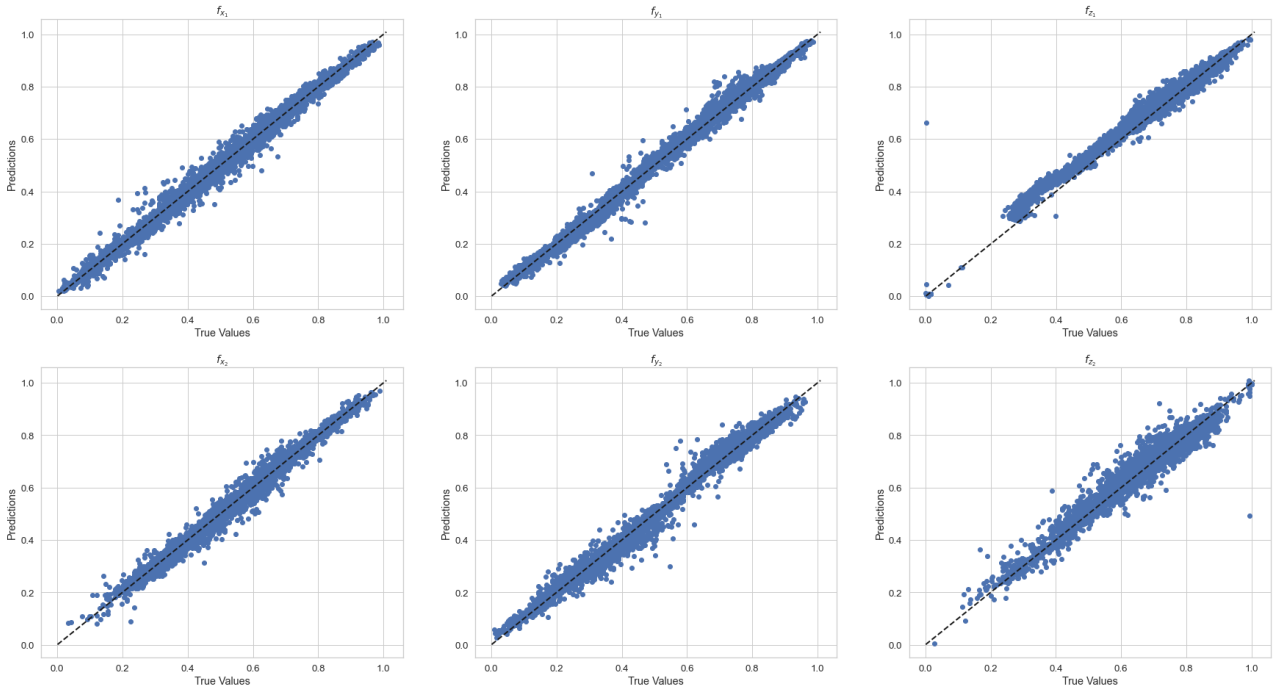



In [55]:

```
# save model loss on test set for evaluation section below
test_results['dnn_36'] = dnn_model_36.evaluate(X_test_36, Y_test, verbose=0)
```

### Compare prediction vs. true values for the test set

In [56]:
```
Y_test_pred_dnn_36 = dnn_model_36.predict(X_test_36)
plot_pred_vs_true(Y_test_pred_dnn_36, Y_test, 'pred_vs_true_{}'.format(dnn_model
```




# Predict all 6 forces from 84 input features (12+6x12)

Up to 6th order derivatives for 12 input features.

In [57]:
```
dnn_model_84 = setup_dnn_model(Y_train.shape[-1])
dnn_model_84_tag = "{}_84features".format(dnn_tag)
```

In [58]:
```
%%time

early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=20)
save_every_epoch = tf.keras.callbacks.ModelCheckpoint(output_dir/'dnn_84_tmp.h5'

history_dnn_84 = dnn_model_84.fit(
    X_train, Y_train,
    validation_data=(X_val, Y_val),
    batch_size = dnn_batch_size,
    epochs=dnn_epochs,
    callbacks=[save_every_epoch]
    #callbacks=[early_stop, save_every_epoch]
    #verbose=0,
    )
dnn_model_84.summary()
with open(output_dir/'history_dnn_84.pickle', 'wb') as f:
    pickle.dump(history_dnn_84.history, f)
```

```
Epoch 1/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 0.0219 - val_lo
ss: 0.0087
Epoch 2/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 0.0099 - val_lo
ss: 0.0075
Epoch 3/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0081 - val_lo
ss: 0.0067
Epoch 4/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0066 - val_lo
ss: 0.0052
Epoch 5/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0058 - val_lo
ss: 0.0042
Epoch 6/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0051 - val_lo
ss: 0.0040
Epoch 7/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0044 - val_lo
ss: 0.0043
Epoch 8/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0045 - val_lo
ss: 0.0025
Epoch 9/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0039 - val_lo
ss: 0.0048
Epoch 10/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0034 - val_lo
ss: 0.0026
Epoch 11/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0034 - val_lo
ss: 0.0023
Epoch 12/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0033 - val_lo
ss: 0.0018
Epoch 13/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0034 - val_lo
ss: 0.0023
Epoch 14/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0032 - val_lo
ss: 0.0019
Epoch 15/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0028 - val_lo
ss: 0.0041
Epoch 16/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0027 - val_lo
ss: 0.0018
Epoch 17/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0031 - val_lo
ss: 0.0019
Epoch 18/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0024 - val_lo
ss: 0.0018
Epoch 19/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0028 - val_lo
ss: 0.0014
Epoch 20/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0027 - val_lo
ss: 0.0031
Epoch 21/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0029 - val_lo
ss: 0.0024
Epoch 22/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0026 - val_lo
```

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ss: 0.0013
Epoch 23/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0023 - val_lo
ss: 0.0018
Epoch 24/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0028 - val_lo
ss: 0.0013
Epoch 25/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0027 - val_lo
ss: 0.0022
Epoch 26/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0023 - val_lo
ss: 0.0013
Epoch 27/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0026 - val_lo
ss: 0.0028
Epoch 28/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0023 - val_lo
ss: 0.0022
Epoch 29/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0028 - val_lo
ss: 0.0013
Epoch 30/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0022 - val_lo
ss: 0.0023
Epoch 31/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0021 - val_lo
ss: 0.0012
Epoch 32/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0022 - val_lo
ss: 0.0015
Epoch 33/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0024 - val_lo
ss: 0.0012
Epoch 34/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0023 - val_lo
ss: 0.0022
Epoch 35/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0021 - val_lo
ss: 0.0014
Epoch 36/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0020 - val_lo
ss: 0.0024
Epoch 37/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0022 - val_lo
ss: 0.0014
Epoch 38/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0012
Epoch 39/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0023 - val_lo
ss: 0.0012
Epoch 40/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0020 - val_lo
ss: 0.0013
Epoch 41/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0013
Epoch 42/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0020 - val_lo
ss: 0.0015
Epoch 43/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0013
Epoch 44/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0010
Epoch 45/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0020 - val_lo
ss: 0.0013
Epoch 46/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0020 - val_lo
ss: 0.0028
Epoch 47/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0010
Epoch 48/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0019 - val_lo
ss: 0.0011
Epoch 49/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0012
Epoch 50/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0013
Epoch 51/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0020 - val_lo
ss: 0.0011
Epoch 52/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0014
Epoch 53/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0011
Epoch 54/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0020
Epoch 55/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0013
Epoch 56/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0014
Epoch 57/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 9.5612e-04
Epoch 58/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0018 - val_lo
ss: 0.0011
Epoch 59/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0010
Epoch 60/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0035
Epoch 61/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0023
Epoch 62/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0011
Epoch 63/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0015
Epoch 64/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0014
Epoch 65/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0013
```

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Epoch 66/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0010
Epoch 67/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 9.0314e-04
Epoch 68/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0011
Epoch 69/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 8.6111e-04
Epoch 70/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 0.0011
Epoch 71/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 9.8855e-04
Epoch 72/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0017
Epoch 73/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0017 - val_lo
ss: 0.0016
Epoch 74/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0011
Epoch 75/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 0.0010
Epoch 76/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0011
Epoch 77/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0016 - val_lo
ss: 9.1063e-04
Epoch 78/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 8.6335e-04
Epoch 79/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 9.0884e-04
Epoch 80/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 8.3081e-04
Epoch 81/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0015 - val_lo
ss: 0.0010
Epoch 82/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 9.2659e-04
Epoch 83/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0018
Epoch 84/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 8.5173e-04
Epoch 85/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 9.0842e-04
Epoch 86/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 0.0011
Epoch 87/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
```

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ss: 8.7407e-04
Epoch 88/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 8.7798e-04
Epoch 89/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 9.6556e-04
Epoch 90/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 8.6595e-04
Epoch 91/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 8.3817e-04
Epoch 92/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 9.5477e-04
Epoch 93/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0013
Epoch 94/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.3526e-04
Epoch 95/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 0.0014
Epoch 96/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 8.6447e-04
Epoch 97/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0011
Epoch 98/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 8.8648e-04
Epoch 99/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 8.9497e-04
Epoch 100/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 9.5131e-04
Epoch 101/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 9.5735e-04
Epoch 102/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.5962e-04
Epoch 103/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 7.6230e-04
Epoch 104/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 7.3930e-04
Epoch 105/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 9.4030e-04
Epoch 106/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0014 - val_lo
ss: 0.0011
Epoch 107/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 9.0767e-04
Epoch 108/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 8.2854e-04
Epoch 109/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.7433e-04
Epoch 110/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 7.6795e-04
Epoch 111/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0013 - val_lo
ss: 0.0015
Epoch 112/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.4961e-04
Epoch 113/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 9.9987e-04
Epoch 114/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 0.0011
Epoch 115/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.2639e-04
Epoch 116/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.0432e-04
Epoch 117/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0013
Epoch 118/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 9.2043e-04
Epoch 119/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 6.9609e-04
Epoch 120/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.1964e-04
Epoch 121/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 0.0011
Epoch 122/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.9347e-04
Epoch 123/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 0.0013
Epoch 124/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 7.6510e-04
Epoch 125/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 7.4422e-04
Epoch 126/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.0125e-04
Epoch 127/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 7.1635e-04
Epoch 128/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 7.9316e-04
Epoch 129/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0012 - val_lo
ss: 8.0182e-04
Epoch 130/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 7.2773e-04
```

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Epoch 131/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8024e-04 - va
l_loss: 7.8228e-04
Epoch 132/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 8.3666e-04
Epoch 133/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.0076e-04
Epoch 134/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0013
Epoch 135/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 6.7599e-04
Epoch 136/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 7.4810e-04
Epoch 137/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 7.6094e-04
Epoch 138/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 7.4513e-04
Epoch 139/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 7.6557e-04
Epoch 140/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 7.4784e-04
Epoch 141/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 9.3355e-04
Epoch 142/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0011
Epoch 143/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 9.4055e-04
Epoch 144/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7641e-04 - va
l_loss: 8.3985e-04
Epoch 145/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4895e-04 - va
l_loss: 0.0011
Epoch 146/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8956e-04 - va
l_loss: 7.6132e-04
Epoch 147/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0011 - val_lo
ss: 0.0015
Epoch 148/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8139e-04 - va
l_loss: 8.1839e-04
Epoch 149/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8897e-04 - va
l_loss: 6.7309e-04
Epoch 150/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9131e-04 - va
l_loss: 7.7124e-04
Epoch 151/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9927e-04 - va
l_loss: 6.1070e-04
Epoch 152/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
```

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ss: 9.5172e-04
Epoch 153/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4939e-04 - va
l_loss: 7.5742e-04
Epoch 154/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 6.8510e-04
Epoch 155/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9180e-04 - va
l_loss: 6.5048e-04
Epoch 156/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.8918e-04 - va
l_loss: 8.4828e-04
Epoch 157/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3375e-04 - va
l_loss: 7.1854e-04
Epoch 158/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.6392e-04 - va
l_loss: 9.1165e-04
Epoch 159/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5569e-04 - va
l_loss: 8.2345e-04
Epoch 160/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3226e-04 - va
l_loss: 6.4322e-04
Epoch 161/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 7.7015e-04
Epoch 162/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5203e-04 - va
l_loss: 6.9937e-04
Epoch 163/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 6.5060e-04
Epoch 164/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8141e-04 - va
l_loss: 8.6447e-04
Epoch 165/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7805e-04 - va
l_loss: 0.0011
Epoch 166/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 8.9293e-04
Epoch 167/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7843e-04 - va
l_loss: 6.9462e-04
Epoch 168/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8313e-04 - va
l_loss: 0.0011
Epoch 169/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7705e-04 - va
l_loss: 0.0010
Epoch 170/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.4910e-04 - va
l_loss: 7.7669e-04
Epoch 171/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 7.3192e-04
Epoch 172/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2705e-04 - va
l_loss: 8.0162e-04
Epoch 173/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.9354e-04 - va
l_loss: 7.0136e-04
Epoch 174/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 8.9052e-04 - va
l_loss: 7.0871e-04
Epoch 175/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.8769e-04 - va
l_loss: 0.0014
Epoch 176/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2890e-04 - va
l_loss: 9.6783e-04
Epoch 177/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2911e-04 - va
l_loss: 7.4075e-04
Epoch 178/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 7.0198e-04
Epoch 179/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5481e-04 - va
l_loss: 7.6343e-04
Epoch 180/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2165e-04 - va
l_loss: 9.1247e-04
Epoch 181/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.7111e-04 - va
l_loss: 6.5582e-04
Epoch 182/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 0.0010 - val_lo
ss: 7.3929e-04
Epoch 183/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9399e-04 - va
l_loss: 8.5975e-04
Epoch 184/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3794e-04 - va
l_loss: 6.7963e-04
Epoch 185/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4992e-04 - va
l_loss: 6.6632e-04
Epoch 186/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1126e-04 - va
l_loss: 6.8889e-04
Epoch 187/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3758e-04 - va
l_loss: 6.8716e-04
Epoch 188/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9543e-04 - va
l_loss: 6.5351e-04
Epoch 189/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9004e-04 - va
l_loss: 5.8320e-04
Epoch 190/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6187e-04 - va
l_loss: 5.9470e-04
Epoch 191/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3146e-04 - va
l_loss: 6.2851e-04
Epoch 192/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.6540e-04 - va
l_loss: 6.3405e-04
Epoch 193/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9650e-04 - va
l_loss: 6.7774e-04
Epoch 194/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.0850e-04 - va
l_loss: 8.5584e-04
Epoch 195/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9927e-04 - va
l_loss: 9.3437e-04
```

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Epoch 196/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.2075e-04 - va
l_loss: 5.9140e-04
Epoch 197/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2306e-04 - va
l_loss: 6.1035e-04
Epoch 198/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9186e-04 - va
l_loss: 8.4956e-04
Epoch 199/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9718e-04 - va
l_loss: 6.1330e-04
Epoch 200/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7769e-04 - va
l_loss: 7.4891e-04
Epoch 201/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3855e-04 - va
l_loss: 5.7886e-04
Epoch 202/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.9969e-04 - va
l_loss: 7.2559e-04
Epoch 203/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5183e-04 - va
l_loss: 6.3697e-04
Epoch 204/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3671e-04 - va
l_loss: 6.2620e-04
Epoch 205/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1244e-04 - va
l_loss: 6.3117e-04
Epoch 206/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1453e-04 - va
l_loss: 6.1464e-04
Epoch 207/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4702e-04 - va
l_loss: 8.5012e-04
Epoch 208/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3928e-04 - va
l_loss: 6.2635e-04
Epoch 209/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1735e-04 - va
l_loss: 6.0872e-04
Epoch 210/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3170e-04 - va
l_loss: 5.6758e-04
Epoch 211/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0287e-04 - va
l_loss: 5.8999e-04
Epoch 212/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3239e-04 - va
l_loss: 6.2724e-04
Epoch 213/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.4623e-04 - va
l_loss: 0.0011
Epoch 214/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2035e-04 - va
l_loss: 5.7958e-04
Epoch 215/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1518e-04 - va
l_loss: 6.3154e-04
Epoch 216/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.5424e-04 - va
l_loss: 7.2175e-04
Epoch 217/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8079e-04 - va
```

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l_loss: 8.0955e-04
Epoch 218/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.7357e-04 - va
l_loss: 8.4425e-04
Epoch 219/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0921e-04 - va
l_loss: 6.9521e-04
Epoch 220/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8148e-04 - va
l_loss: 6.4125e-04
Epoch 221/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3015e-04 - va
l_loss: 7.2940e-04
Epoch 222/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3184e-04 - va
l_loss: 6.8889e-04
Epoch 223/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.1212e-04 - va
l_loss: 7.8100e-04
Epoch 224/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7088e-04 - va
l_loss: 6.5947e-04
Epoch 225/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7367e-04 - va
l_loss: 6.3826e-04
Epoch 226/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 9.3065e-04 - va
l_loss: 8.3424e-04
Epoch 227/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3737e-04 - va
l_loss: 5.4603e-04
Epoch 228/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.5121e-04 - va
l_loss: 6.5523e-04
Epoch 229/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3177e-04 - va
l_loss: 5.6449e-04
Epoch 230/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1166e-04 - va
l_loss: 7.4712e-04
Epoch 231/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1612e-04 - va
l_loss: 6.2941e-04
Epoch 232/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7484e-04 - va
l_loss: 5.5642e-04
Epoch 233/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7662e-04 - va
l_loss: 7.6652e-04
Epoch 234/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7687e-04 - va
l_loss: 5.2238e-04
Epoch 235/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0758e-04 - va
l_loss: 6.0414e-04
Epoch 236/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6840e-04 - va
l_loss: 8.2707e-04
Epoch 237/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2115e-04 - va
l_loss: 7.2581e-04
Epoch 238/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9189e-04 - va
l_loss: 5.9844e-04
Epoch 239/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 8.9164e-04 - va
l_loss: 5.8475e-04
Epoch 240/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9118e-04 - va
l_loss: 5.9717e-04
Epoch 241/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4755e-04 - va
l_loss: 6.2680e-04
Epoch 242/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0091e-04 - va
l_loss: 6.5762e-04
Epoch 243/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.0206e-04 - va
l_loss: 6.4786e-04
Epoch 244/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2152e-04 - va
l_loss: 6.4584e-04
Epoch 245/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2480e-04 - va
l_loss: 6.4950e-04
Epoch 246/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5460e-04 - va
l_loss: 5.3462e-04
Epoch 247/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4165e-04 - va
l_loss: 7.3025e-04
Epoch 248/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.1293e-04 - va
l_loss: 6.2521e-04
Epoch 249/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6165e-04 - va
l_loss: 6.4274e-04
Epoch 250/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5684e-04 - va
l_loss: 5.6579e-04
Epoch 251/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8792e-04 - va
l_loss: 6.7990e-04
Epoch 252/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.3102e-04 - va
l_loss: 7.1353e-04
Epoch 253/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8761e-04 - va
l_loss: 5.6376e-04
Epoch 254/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4077e-04 - va
l_loss: 5.7011e-04
Epoch 255/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4622e-04 - va
l_loss: 9.8024e-04
Epoch 256/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8429e-04 - va
l_loss: 5.7876e-04
Epoch 257/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4485e-04 - va
l_loss: 7.6871e-04
Epoch 258/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.3868e-04 - va
l_loss: 0.0010
Epoch 259/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9455e-04 - va
l_loss: 5.5536e-04
Epoch 260/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.1232e-04 - va
l_loss: 5.7896e-04
```

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Epoch 261/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9353e-04 - va
l_loss: 6.0783e-04
Epoch 262/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.7091e-04 - va
l_loss: 5.4812e-04
Epoch 263/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.3825e-04 - va
l_loss: 7.2178e-04
Epoch 264/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2516e-04 - va
l_loss: 5.6494e-04
Epoch 265/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 8.2117e-04 - va
l_loss: 6.5113e-04
Epoch 266/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2291e-04 - va
l_loss: 6.0132e-04
Epoch 267/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8400e-04 - va
l_loss: 6.3067e-04
Epoch 268/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2971e-04 - va
l_loss: 6.9786e-04
Epoch 269/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.3394e-04 - va
l_loss: 5.2564e-04
Epoch 270/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.8647e-04 - va
l_loss: 7.5796e-04
Epoch 271/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4718e-04 - va
l_loss: 5.5968e-04
Epoch 272/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.1717e-04 - va
l_loss: 6.8588e-04
Epoch 273/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2649e-04 - va
l_loss: 6.3542e-04
Epoch 274/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4795e-04 - va
l_loss: 5.6834e-04
Epoch 275/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0810e-04 - va
l_loss: 5.5339e-04
Epoch 276/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9749e-04 - va
l_loss: 5.5927e-04
Epoch 277/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2217e-04 - va
l_loss: 5.5254e-04
Epoch 278/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6156e-04 - va
l_loss: 5.7053e-04
Epoch 279/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.1069e-04 - va
l_loss: 6.9661e-04
Epoch 280/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2571e-04 - va
l_loss: 6.6182e-04
Epoch 281/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.1820e-04 - va
l_loss: 5.3009e-04
Epoch 282/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5385e-04 - va
```

```
l_loss: 7.4962e-04
Epoch 283/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2060e-04 - va
l_loss: 5.2470e-04
Epoch 284/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.3036e-04 - va
l_loss: 5.6975e-04
Epoch 285/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2398e-04 - va
l_loss: 5.7213e-04
Epoch 286/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.9209e-04 - va
l_loss: 6.9725e-04
Epoch 287/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0671e-04 - va
l_loss: 5.8549e-04
Epoch 288/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9956e-04 - va
l_loss: 5.5479e-04
Epoch 289/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.6522e-04 - va
l_loss: 5.1799e-04
Epoch 290/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0453e-04 - va
l_loss: 5.6031e-04
Epoch 291/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0831e-04 - va
l_loss: 5.5240e-04
Epoch 292/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2189e-04 - va
l_loss: 5.7167e-04
Epoch 293/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5522e-04 - va
l_loss: 5.6451e-04
Epoch 294/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9295e-04 - va
l_loss: 5.9507e-04
Epoch 295/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9695e-04 - va
l_loss: 5.3247e-04
Epoch 296/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5019e-04 - va
l_loss: 6.8172e-04
Epoch 297/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0205e-04 - va
l_loss: 5.8075e-04
Epoch 298/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.5591e-04 - va
l_loss: 5.3483e-04
Epoch 299/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4636e-04 - va
l_loss: 6.2464e-04
Epoch 300/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0479e-04 - va
l_loss: 6.3029e-04
Epoch 301/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9884e-04 - va
l_loss: 4.9955e-04
Epoch 302/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0281e-04 - va
l_loss: 5.7195e-04
Epoch 303/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.8662e-04 - va
l_loss: 5.5825e-04
Epoch 304/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 7.3148e-04 - va
l_loss: 5.4538e-04
Epoch 305/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7899e-04 - va
l_loss: 5.7394e-04
Epoch 306/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7189e-04 - va
l_loss: 6.0914e-04
Epoch 307/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7972e-04 - va
l_loss: 5.6330e-04
Epoch 308/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0372e-04 - va
l_loss: 5.5027e-04
Epoch 309/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9527e-04 - va
l_loss: 5.7542e-04
Epoch 310/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7369e-04 - va
l_loss: 5.6567e-04
Epoch 311/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.1015e-04 - va
l_loss: 6.5376e-04
Epoch 312/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6758e-04 - va
l_loss: 5.3450e-04
Epoch 313/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2541e-04 - va
l_loss: 5.4492e-04
Epoch 314/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0729e-04 - va
l_loss: 8.1774e-04
Epoch 315/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.4885e-04 - va
l_loss: 5.3604e-04
Epoch 316/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7097e-04 - va
l_loss: 5.9334e-04
Epoch 317/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7974e-04 - va
l_loss: 6.6290e-04
Epoch 318/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6451e-04 - va
l_loss: 5.8993e-04
Epoch 319/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6717e-04 - va
l_loss: 5.7886e-04
Epoch 320/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.8907e-04 - va
l_loss: 6.7382e-04
Epoch 321/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7512e-04 - va
l_loss: 6.0121e-04
Epoch 322/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.8866e-04 - va
l_loss: 5.7446e-04
Epoch 323/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0454e-04 - va
l_loss: 5.8319e-04
Epoch 324/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9956e-04 - va
l_loss: 5.6680e-04
Epoch 325/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6392e-04 - va
l_loss: 5.4211e-04
```

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Epoch 326/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.2507e-04 - va
l_loss: 7.5074e-04
Epoch 327/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.1395e-04 - va
l_loss: 5.7592e-04
Epoch 328/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5577e-04 - va
l_loss: 5.1938e-04
Epoch 329/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0737e-04 - va
l_loss: 5.2459e-04
Epoch 330/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6176e-04 - va
l_loss: 5.3865e-04
Epoch 331/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5500e-04 - va
l_loss: 6.9773e-04
Epoch 332/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6670e-04 - va
l_loss: 5.7883e-04
Epoch 333/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6158e-04 - va
l_loss: 6.3256e-04
Epoch 334/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7802e-04 - va
l_loss: 5.1391e-04
Epoch 335/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4844e-04 - va
l_loss: 8.2481e-04
Epoch 336/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9220e-04 - va
l_loss: 5.1850e-04
Epoch 337/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.8365e-04 - va
l_loss: 5.0610e-04
Epoch 338/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5501e-04 - va
l_loss: 5.2551e-04
Epoch 339/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5870e-04 - va
l_loss: 7.6519e-04
Epoch 340/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.8594e-04 - va
l_loss: 5.1189e-04
Epoch 341/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.1408e-04 - va
l_loss: 5.3122e-04
Epoch 342/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9848e-04 - va
l_loss: 5.6882e-04
Epoch 343/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4439e-04 - va
l_loss: 5.5634e-04
Epoch 344/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3468e-04 - va
l_loss: 5.6551e-04
Epoch 345/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6761e-04 - va
l_loss: 8.4218e-04
Epoch 346/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4844e-04 - va
l_loss: 5.0387e-04
Epoch 347/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2857e-04 - va
```

```
l_loss: 5.7527e-04
Epoch 348/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4495e-04 - va
l_loss: 5.1115e-04
Epoch 349/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3703e-04 - va
l_loss: 5.2789e-04
Epoch 350/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4552e-04 - va
l_loss: 5.8756e-04
Epoch 351/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7414e-04 - va
l_loss: 5.3167e-04
Epoch 352/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3213e-04 - va
l_loss: 5.7149e-04
Epoch 353/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7133e-04 - va
l_loss: 5.7166e-04
Epoch 354/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5446e-04 - va
l_loss: 5.2398e-04
Epoch 355/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6312e-04 - va
l_loss: 5.4855e-04
Epoch 356/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4137e-04 - va
l_loss: 4.9858e-04
Epoch 357/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3214e-04 - va
l_loss: 5.1116e-04
Epoch 358/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.9391e-04 - va
l_loss: 6.4957e-04
Epoch 359/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6473e-04 - va
l_loss: 5.6219e-04
Epoch 360/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4927e-04 - va
l_loss: 5.0147e-04
Epoch 361/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1862e-04 - va
l_loss: 5.1735e-04
Epoch 362/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4426e-04 - va
l_loss: 4.9204e-04
Epoch 363/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2870e-04 - va
l_loss: 5.0002e-04
Epoch 364/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 7.0462e-04 - va
l_loss: 7.3471e-04
Epoch 365/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5446e-04 - va
l_loss: 5.2606e-04
Epoch 366/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2791e-04 - va
l_loss: 5.7059e-04
Epoch 367/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4055e-04 - va
l_loss: 5.3527e-04
Epoch 368/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2550e-04 - va
l_loss: 5.1561e-04
Epoch 369/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 6.3355e-04 - va
l_loss: 6.1218e-04
Epoch 370/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.8167e-04 - va
l_loss: 5.9073e-04
Epoch 371/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7622e-04 - va
l_loss: 5.4072e-04
Epoch 372/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0213e-04 - va
l_loss: 6.0968e-04
Epoch 373/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3986e-04 - va
l_loss: 4.7207e-04
Epoch 374/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4388e-04 - va
l_loss: 4.6776e-04
Epoch 375/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.6837e-04 - va
l_loss: 5.3816e-04
Epoch 376/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4401e-04 - va
l_loss: 5.1303e-04
Epoch 377/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4100e-04 - va
l_loss: 5.3718e-04
Epoch 378/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2289e-04 - va
l_loss: 5.5937e-04
Epoch 379/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2377e-04 - va
l_loss: 5.6204e-04
Epoch 380/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3338e-04 - va
l_loss: 5.0712e-04
Epoch 381/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3644e-04 - va
l_loss: 5.6734e-04
Epoch 382/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3093e-04 - va
l_loss: 5.3918e-04
Epoch 383/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2836e-04 - va
l_loss: 6.2793e-04
Epoch 384/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3898e-04 - va
l_loss: 4.8502e-04
Epoch 385/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9958e-04 - va
l_loss: 5.0492e-04
Epoch 386/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3334e-04 - va
l_loss: 4.8592e-04
Epoch 387/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1311e-04 - va
l_loss: 5.1493e-04
Epoch 388/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2814e-04 - va
l_loss: 5.0023e-04
Epoch 389/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2440e-04 - va
l_loss: 5.1052e-04
Epoch 390/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9262e-04 - va
l_loss: 5.8073e-04
```

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Epoch 391/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1195e-04 - va
l_loss: 5.4828e-04
Epoch 392/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.7978e-04 - va
l_loss: 6.6040e-04
Epoch 393/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1481e-04 - va
l_loss: 6.3779e-04
Epoch 394/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2600e-04 - va
l_loss: 5.9209e-04
Epoch 395/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9821e-04 - va
l_loss: 5.8055e-04
Epoch 396/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3898e-04 - va
l_loss: 5.8336e-04
Epoch 397/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3618e-04 - va
l_loss: 5.1842e-04
Epoch 398/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9749e-04 - va
l_loss: 5.4423e-04
Epoch 399/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8465e-04 - va
l_loss: 5.0513e-04
Epoch 400/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1305e-04 - va
l_loss: 5.1424e-04
Epoch 401/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1534e-04 - va
l_loss: 5.9578e-04
Epoch 402/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0796e-04 - va
l_loss: 7.3115e-04
Epoch 403/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3855e-04 - va
l_loss: 5.7215e-04
Epoch 404/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0295e-04 - va
l_loss: 5.1117e-04
Epoch 405/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3032e-04 - va
l_loss: 4.9628e-04
Epoch 406/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5101e-04 - va
l_loss: 5.4347e-04
Epoch 407/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9981e-04 - va
l_loss: 5.0569e-04
Epoch 408/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2124e-04 - va
l_loss: 5.1467e-04
Epoch 409/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.3371e-04 - va
l_loss: 5.0687e-04
Epoch 410/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1683e-04 - va
l_loss: 5.3028e-04
Epoch 411/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9404e-04 - va
l_loss: 5.1793e-04
Epoch 412/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0244e-04 - va
```

```
l_loss: 5.4761e-04
Epoch 413/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0323e-04 - va
l_loss: 4.9409e-04
Epoch 414/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0412e-04 - va
l_loss: 5.1596e-04
Epoch 415/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.4041e-04 - va
l_loss: 7.7654e-04
Epoch 416/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9779e-04 - va
l_loss: 5.3362e-04
Epoch 417/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9330e-04 - va
l_loss: 7.3408e-04
Epoch 418/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0627e-04 - va
l_loss: 5.2773e-04
Epoch 419/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1000e-04 - va
l_loss: 5.3697e-04
Epoch 420/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8010e-04 - va
l_loss: 5.2896e-04
Epoch 421/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9563e-04 - va
l_loss: 4.9952e-04
Epoch 422/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.5862e-04 - va
l_loss: 5.3963e-04
Epoch 423/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8961e-04 - va
l_loss: 5.1888e-04
Epoch 424/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1613e-04 - va
l_loss: 5.7811e-04
Epoch 425/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7029e-04 - va
l_loss: 5.1952e-04
Epoch 426/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1035e-04 - va
l_loss: 6.8207e-04
Epoch 427/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0331e-04 - va
l_loss: 5.0166e-04
Epoch 428/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9891e-04 - va
l_loss: 5.1345e-04
Epoch 429/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0068e-04 - va
l_loss: 5.3638e-04
Epoch 430/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8734e-04 - va
l_loss: 5.1739e-04
Epoch 431/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8332e-04 - va
l_loss: 6.2929e-04
Epoch 432/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0273e-04 - va
l_loss: 5.1964e-04
Epoch 433/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8314e-04 - va
l_loss: 5.4264e-04
Epoch 434/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 6.0701e-04 - va
l_loss: 5.3569e-04
Epoch 435/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9117e-04 - va
l_loss: 5.3861e-04
Epoch 436/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9182e-04 - va
l_loss: 5.5191e-04
Epoch 437/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0631e-04 - va
l_loss: 5.1523e-04
Epoch 438/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8634e-04 - va
l_loss: 6.7380e-04
Epoch 439/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1390e-04 - va
l_loss: 4.8849e-04
Epoch 440/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9511e-04 - va
l_loss: 5.0897e-04
Epoch 441/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9258e-04 - va
l_loss: 5.2938e-04
Epoch 442/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8877e-04 - va
l_loss: 5.5556e-04
Epoch 443/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6615e-04 - va
l_loss: 5.3489e-04
Epoch 444/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0640e-04 - va
l_loss: 5.6722e-04
Epoch 445/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8023e-04 - va
l_loss: 5.0716e-04
Epoch 446/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8122e-04 - va
l_loss: 5.8448e-04
Epoch 447/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9113e-04 - va
l_loss: 5.6632e-04
Epoch 448/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7553e-04 - va
l_loss: 5.3427e-04
Epoch 449/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9464e-04 - va
l_loss: 4.7712e-04
Epoch 450/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.2922e-04 - va
l_loss: 6.5392e-04
Epoch 451/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5271e-04 - va
l_loss: 4.8302e-04
Epoch 452/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7949e-04 - va
l_loss: 5.1112e-04
Epoch 453/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9018e-04 - va
l_loss: 4.9534e-04
Epoch 454/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8766e-04 - va
l_loss: 5.1252e-04
Epoch 455/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0605e-04 - va
l_loss: 5.7210e-04
```

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Epoch 456/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6456e-04 - va
l_loss: 5.5898e-04
Epoch 457/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4676e-04 - va
l_loss: 5.2174e-04
Epoch 458/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7555e-04 - va
l_loss: 5.1669e-04
Epoch 459/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1404e-04 - va
l_loss: 5.8964e-04
Epoch 460/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8738e-04 - va
l_loss: 5.1224e-04
Epoch 461/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5243e-04 - va
l_loss: 4.6907e-04
Epoch 462/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5003e-04 - va
l_loss: 5.2606e-04
Epoch 463/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6250e-04 - va
l_loss: 6.1243e-04
Epoch 464/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9291e-04 - va
l_loss: 5.3776e-04
Epoch 465/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7755e-04 - va
l_loss: 5.9044e-04
Epoch 466/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0472e-04 - va
l_loss: 5.1423e-04
Epoch 467/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6692e-04 - va
l_loss: 4.6944e-04
Epoch 468/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4755e-04 - va
l_loss: 4.6785e-04
Epoch 469/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5745e-04 - va
l_loss: 5.1720e-04
Epoch 470/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7298e-04 - va
l_loss: 5.1193e-04
Epoch 471/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4882e-04 - va
l_loss: 5.6512e-04
Epoch 472/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.1512e-04 - va
l_loss: 5.8271e-04
Epoch 473/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6964e-04 - va
l_loss: 5.1424e-04
Epoch 474/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7023e-04 - va
l_loss: 5.6646e-04
Epoch 475/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7572e-04 - va
l_loss: 5.3841e-04
Epoch 476/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 5.5554e-04 - va
l_loss: 5.1274e-04
Epoch 477/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7321e-04 - va
```

```
l_loss: 5.2366e-04
Epoch 478/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7676e-04 - va
l_loss: 5.6050e-04
Epoch 479/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.9337e-04 - va
l_loss: 5.8200e-04
Epoch 480/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6329e-04 - va
l_loss: 4.9594e-04
Epoch 481/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4772e-04 - va
l_loss: 4.9285e-04
Epoch 482/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8225e-04 - va
l_loss: 5.5788e-04
Epoch 483/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6179e-04 - va
l_loss: 4.9668e-04
Epoch 484/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8107e-04 - va
l_loss: 4.5776e-04
Epoch 485/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7159e-04 - va
l_loss: 4.8406e-04
Epoch 486/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7135e-04 - va
l_loss: 5.0374e-04
Epoch 487/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4733e-04 - va
l_loss: 4.9362e-04
Epoch 488/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5049e-04 - va
l_loss: 4.9469e-04
Epoch 489/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5791e-04 - va
l_loss: 5.3974e-04
Epoch 490/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7310e-04 - va
l_loss: 4.7604e-04
Epoch 491/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5504e-04 - va
l_loss: 5.8118e-04
Epoch 492/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7805e-04 - va
l_loss: 5.3126e-04
Epoch 493/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6883e-04 - va
l_loss: 4.8646e-04
Epoch 494/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4703e-04 - va
l_loss: 4.7820e-04
Epoch 495/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4405e-04 - va
l_loss: 4.9412e-04
Epoch 496/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 6.0489e-04 - va
l_loss: 5.5090e-04
Epoch 497/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5826e-04 - va
l_loss: 5.0492e-04
Epoch 498/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5713e-04 - va
l_loss: 5.1324e-04
Epoch 499/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 5.6264e-04 - va
l_loss: 5.8734e-04
Epoch 500/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4765e-04 - va
l_loss: 4.9085e-04
Epoch 501/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5103e-04 - va
l_loss: 5.1973e-04
Epoch 502/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4658e-04 - va
l_loss: 4.8447e-04
Epoch 503/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4446e-04 - va
l_loss: 5.0815e-04
Epoch 504/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7249e-04 - va
l_loss: 5.3123e-04
Epoch 505/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4626e-04 - va
l_loss: 5.2450e-04
Epoch 506/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3760e-04 - va
l_loss: 5.0235e-04
Epoch 507/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3726e-04 - va
l_loss: 4.9939e-04
Epoch 508/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6020e-04 - va
l_loss: 5.1888e-04
Epoch 509/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4463e-04 - va
l_loss: 5.1111e-04
Epoch 510/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6502e-04 - va
l_loss: 5.5733e-04
Epoch 511/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6949e-04 - va
l_loss: 5.0136e-04
Epoch 512/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6887e-04 - va
l_loss: 5.0363e-04
Epoch 513/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4006e-04 - va
l_loss: 5.8994e-04
Epoch 514/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6022e-04 - va
l_loss: 5.5382e-04
Epoch 515/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4065e-04 - va
l_loss: 4.7353e-04
Epoch 516/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8162e-04 - va
l_loss: 4.9877e-04
Epoch 517/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3403e-04 - va
l_loss: 5.0913e-04
Epoch 518/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3551e-04 - va
l_loss: 4.8007e-04
Epoch 519/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5551e-04 - va
l_loss: 4.9933e-04
Epoch 520/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3698e-04 - va
l_loss: 6.1786e-04
```

```
Epoch 521/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4255e-04 - va
l_loss: 5.0493e-04
Epoch 522/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8383e-04 - va
l_loss: 5.2547e-04
Epoch 523/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3770e-04 - va
l_loss: 5.4170e-04
Epoch 524/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4671e-04 - va
l_loss: 5.1312e-04
Epoch 525/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8332e-04 - va
l_loss: 4.7554e-04
Epoch 526/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2933e-04 - va
l_loss: 5.2047e-04
Epoch 527/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4477e-04 - va
l_loss: 5.1687e-04
Epoch 528/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5287e-04 - va
l_loss: 6.4663e-04
Epoch 529/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3681e-04 - va
l_loss: 5.0265e-04
Epoch 530/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4018e-04 - va
l_loss: 5.7287e-04
Epoch 531/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6860e-04 - va
l_loss: 4.6770e-04
Epoch 532/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3696e-04 - va
l_loss: 5.1996e-04
Epoch 533/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4547e-04 - va
l_loss: 5.0830e-04
Epoch 534/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5290e-04 - va
l_loss: 5.3795e-04
Epoch 535/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5505e-04 - va
l_loss: 4.9763e-04
Epoch 536/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4767e-04 - va
l_loss: 4.8919e-04
Epoch 537/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2803e-04 - va
l_loss: 5.1072e-04
Epoch 538/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5168e-04 - va
l_loss: 4.8013e-04
Epoch 539/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4198e-04 - va
l_loss: 5.0592e-04
Epoch 540/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3212e-04 - va
l_loss: 4.9800e-04
Epoch 541/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3372e-04 - va
l_loss: 5.5042e-04
Epoch 542/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2968e-04 - va
```

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l_loss: 5.0247e-04
Epoch 543/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3409e-04 - va
l_loss: 5.2251e-04
Epoch 544/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3135e-04 - va
l_loss: 5.7358e-04
Epoch 545/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2331e-04 - va
l_loss: 5.3323e-04
Epoch 546/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5377e-04 - va
l_loss: 5.3171e-04
Epoch 547/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2536e-04 - va
l_loss: 5.1891e-04
Epoch 548/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5021e-04 - va
l_loss: 7.0221e-04
Epoch 549/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.7813e-04 - va
l_loss: 4.8404e-04
Epoch 550/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3330e-04 - va
l_loss: 4.2641e-04
Epoch 551/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1833e-04 - va
l_loss: 4.7631e-04
Epoch 552/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3871e-04 - va
l_loss: 5.6377e-04
Epoch 553/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4195e-04 - va
l_loss: 4.4805e-04
Epoch 554/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4127e-04 - va
l_loss: 5.4408e-04
Epoch 555/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4344e-04 - va
l_loss: 4.9693e-04
Epoch 556/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.5305e-04 - va
l_loss: 5.3061e-04
Epoch 557/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4442e-04 - va
l_loss: 4.7707e-04
Epoch 558/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1913e-04 - va
l_loss: 5.3002e-04
Epoch 559/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3411e-04 - va
l_loss: 4.8857e-04
Epoch 560/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6792e-04 - va
l_loss: 4.9524e-04
Epoch 561/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1779e-04 - va
l_loss: 5.5336e-04
Epoch 562/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1363e-04 - va
l_loss: 7.2523e-04
Epoch 563/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3343e-04 - va
l_loss: 4.4820e-04
Epoch 564/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 5.3338e-04 - va
l_loss: 5.1090e-04
Epoch 565/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2774e-04 - va
l_loss: 5.2675e-04
Epoch 566/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3469e-04 - va
l_loss: 4.5554e-04
Epoch 567/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4363e-04 - va
l_loss: 4.8619e-04
Epoch 568/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3087e-04 - va
l_loss: 5.2391e-04
Epoch 569/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0554e-04 - va
l_loss: 5.3773e-04
Epoch 570/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3426e-04 - va
l_loss: 5.9749e-04
Epoch 571/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2067e-04 - va
l_loss: 4.7663e-04
Epoch 572/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2560e-04 - va
l_loss: 5.0265e-04
Epoch 573/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3765e-04 - va
l_loss: 5.3232e-04
Epoch 574/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2016e-04 - va
l_loss: 5.0870e-04
Epoch 575/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3349e-04 - va
l_loss: 6.2142e-04
Epoch 576/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.8035e-04 - va
l_loss: 4.9721e-04
Epoch 577/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2203e-04 - va
l_loss: 5.2908e-04
Epoch 578/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3839e-04 - va
l_loss: 7.2259e-04
Epoch 579/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4528e-04 - va
l_loss: 4.8475e-04
Epoch 580/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1483e-04 - va
l_loss: 5.0512e-04
Epoch 581/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3043e-04 - va
l_loss: 4.8591e-04
Epoch 582/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1731e-04 - va
l_loss: 5.3424e-04
Epoch 583/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1507e-04 - va
l_loss: 4.6036e-04
Epoch 584/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2228e-04 - va
l_loss: 4.9741e-04
Epoch 585/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3669e-04 - va
l_loss: 5.1728e-04
```

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Epoch 586/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1443e-04 - va
l_loss: 4.7684e-04
Epoch 587/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2410e-04 - va
l_loss: 4.9687e-04
Epoch 588/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2231e-04 - va
l_loss: 5.5360e-04
Epoch 589/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2070e-04 - va
l_loss: 4.9043e-04
Epoch 590/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0677e-04 - va
l_loss: 4.6669e-04
Epoch 591/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2819e-04 - va
l_loss: 5.0946e-04
Epoch 592/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4739e-04 - va
l_loss: 4.9428e-04
Epoch 593/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1259e-04 - va
l_loss: 4.5647e-04
Epoch 594/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2977e-04 - va
l_loss: 4.9742e-04
Epoch 595/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2501e-04 - va
l_loss: 4.7983e-04
Epoch 596/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1271e-04 - va
l_loss: 4.8905e-04
Epoch 597/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1985e-04 - va
l_loss: 5.4609e-04
Epoch 598/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2847e-04 - va
l_loss: 4.6551e-04
Epoch 599/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0630e-04 - va
l_loss: 4.8001e-04
Epoch 600/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2949e-04 - va
l_loss: 4.9679e-04
Epoch 601/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3951e-04 - va
l_loss: 4.8730e-04
Epoch 602/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3346e-04 - va
l_loss: 4.6126e-04
Epoch 603/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2281e-04 - va
l_loss: 4.8037e-04
Epoch 604/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0819e-04 - va
l_loss: 6.1513e-04
Epoch 605/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9857e-04 - va
l_loss: 5.2005e-04
Epoch 606/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1336e-04 - va
l_loss: 4.8550e-04
Epoch 607/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1636e-04 - va
```

```
l_loss: 5.2565e-04
Epoch 608/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1109e-04 - va
l_loss: 5.5892e-04
Epoch 609/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.6207e-04 - va
l_loss: 4.9635e-04
Epoch 610/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1718e-04 - va
l_loss: 5.1945e-04
Epoch 611/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0445e-04 - va
l_loss: 5.1167e-04
Epoch 612/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1725e-04 - va
l_loss: 5.0368e-04
Epoch 613/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1550e-04 - va
l_loss: 5.4038e-04
Epoch 614/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9802e-04 - va
l_loss: 5.9000e-04
Epoch 615/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2797e-04 - va
l_loss: 5.6871e-04
Epoch 616/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1573e-04 - va
l_loss: 4.9590e-04
Epoch 617/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0121e-04 - va
l_loss: 4.7486e-04
Epoch 618/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1565e-04 - va
l_loss: 4.8962e-04
Epoch 619/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9593e-04 - va
l_loss: 6.8755e-04
Epoch 620/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1683e-04 - va
l_loss: 0.0011
Epoch 621/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3899e-04 - va
l_loss: 4.7809e-04
Epoch 622/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0127e-04 - va
l_loss: 4.6379e-04
Epoch 623/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0436e-04 - va
l_loss: 5.0510e-04
Epoch 624/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0590e-04 - va
l_loss: 5.0018e-04
Epoch 625/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9871e-04 - va
l_loss: 5.3080e-04
Epoch 626/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9569e-04 - va
l_loss: 5.0981e-04
Epoch 627/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1446e-04 - va
l_loss: 5.0992e-04
Epoch 628/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2474e-04 - va
l_loss: 4.9452e-04
Epoch 629/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 5.1153e-04 - va
l_loss: 4.9367e-04
Epoch 630/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.3012e-04 - va
l_loss: 4.5074e-04
Epoch 631/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8766e-04 - va
l_loss: 5.0631e-04
Epoch 632/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2057e-04 - va
l_loss: 4.7854e-04
Epoch 633/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2512e-04 - va
l_loss: 4.8448e-04
Epoch 634/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.2381e-04 - va
l_loss: 4.9833e-04
Epoch 635/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9711e-04 - va
l_loss: 4.6462e-04
Epoch 636/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0554e-04 - va
l_loss: 5.5599e-04
Epoch 637/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1139e-04 - va
l_loss: 4.8825e-04
Epoch 638/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1866e-04 - va
l_loss: 5.2736e-04
Epoch 639/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1127e-04 - va
l_loss: 4.9024e-04
Epoch 640/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8906e-04 - va
l_loss: 4.6171e-04
Epoch 641/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9441e-04 - va
l_loss: 5.0435e-04
Epoch 642/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0380e-04 - va
l_loss: 4.4156e-04
Epoch 643/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0695e-04 - va
l_loss: 4.8189e-04
Epoch 644/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8369e-04 - va
l_loss: 4.7814e-04
Epoch 645/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.4018e-04 - va
l_loss: 6.5696e-04
Epoch 646/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9277e-04 - va
l_loss: 6.3093e-04
Epoch 647/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9147e-04 - va
l_loss: 5.2865e-04
Epoch 648/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9233e-04 - va
l_loss: 4.9195e-04
Epoch 649/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0715e-04 - va
l_loss: 5.0036e-04
Epoch 650/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9215e-04 - va
l_loss: 4.8077e-04
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Epoch 651/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0486e-04 - va
l_loss: 5.1260e-04
Epoch 652/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8636e-04 - va
l_loss: 4.9580e-04
Epoch 653/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9937e-04 - va
l_loss: 5.1035e-04
Epoch 654/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8850e-04 - va
l_loss: 5.0618e-04
Epoch 655/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0609e-04 - va
l_loss: 4.8393e-04
Epoch 656/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0287e-04 - va
l_loss: 4.9376e-04
Epoch 657/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0324e-04 - va
l_loss: 4.7333e-04
Epoch 658/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7887e-04 - va
l_loss: 4.5385e-04
Epoch 659/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0247e-04 - va
l_loss: 4.8572e-04
Epoch 660/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8360e-04 - va
l_loss: 4.7840e-04
Epoch 661/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0478e-04 - va
l_loss: 4.9653e-04
Epoch 662/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8445e-04 - va
l_loss: 4.5551e-04
Epoch 663/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.1851e-04 - va
l_loss: 5.4013e-04
Epoch 664/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0778e-04 - va
l_loss: 4.7503e-04
Epoch 665/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9127e-04 - va
l_loss: 5.0302e-04
Epoch 666/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9316e-04 - va
l_loss: 4.9546e-04
Epoch 667/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8739e-04 - va
l_loss: 4.6649e-04
Epoch 668/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0361e-04 - va
l_loss: 4.8102e-04
Epoch 669/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9490e-04 - va
l_loss: 5.1964e-04
Epoch 670/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0561e-04 - va
l_loss: 4.6677e-04
Epoch 671/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8067e-04 - va
l_loss: 5.4865e-04
Epoch 672/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8066e-04 - va
```

```
l_loss: 5.1177e-04
Epoch 673/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9057e-04 - va
l_loss: 5.5469e-04
Epoch 674/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0113e-04 - va
l_loss: 4.6449e-04
Epoch 675/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8731e-04 - va
l_loss: 4.7063e-04
Epoch 676/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9265e-04 - va
l_loss: 4.7203e-04
Epoch 677/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8118e-04 - va
l_loss: 5.7208e-04
Epoch 678/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8625e-04 - va
l_loss: 4.6976e-04
Epoch 679/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0109e-04 - va
l_loss: 4.8954e-04
Epoch 680/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7362e-04 - va
l_loss: 4.9962e-04
Epoch 681/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8819e-04 - va
l_loss: 4.6187e-04
Epoch 682/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0465e-04 - va
l_loss: 4.8152e-04
Epoch 683/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7499e-04 - va
l_loss: 5.6940e-04
Epoch 684/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9204e-04 - va
l_loss: 4.8064e-04
Epoch 685/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8332e-04 - va
l_loss: 4.4930e-04
Epoch 686/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8489e-04 - va
l_loss: 4.7953e-04
Epoch 687/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0986e-04 - va
l_loss: 4.7825e-04
Epoch 688/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7118e-04 - va
l_loss: 4.7047e-04
Epoch 689/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9449e-04 - va
l_loss: 4.8650e-04
Epoch 690/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9802e-04 - va
l_loss: 5.5162e-04
Epoch 691/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 5.0081e-04 - va
l_loss: 4.9408e-04
Epoch 692/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7585e-04 - va
l_loss: 5.3924e-04
Epoch 693/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.8942e-04 - va
l_loss: 4.8424e-04
Epoch 694/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 4.7976e-04 - va
l_loss: 4.6579e-04
Epoch 695/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9441e-04 - va
l_loss: 4.8196e-04
Epoch 696/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7720e-04 - va
l_loss: 4.5608e-04
Epoch 697/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8021e-04 - va
l_loss: 4.7685e-04
Epoch 698/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7744e-04 - va
l_loss: 4.9457e-04
Epoch 699/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7874e-04 - va
l_loss: 4.9946e-04
Epoch 700/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8940e-04 - va
l_loss: 4.6710e-04
Epoch 701/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8505e-04 - va
l_loss: 5.3725e-04
Epoch 702/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8279e-04 - va
l_loss: 5.0645e-04
Epoch 703/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9653e-04 - va
l_loss: 4.7457e-04
Epoch 704/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9839e-04 - va
l_loss: 5.1789e-04
Epoch 705/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0349e-04 - va
l_loss: 6.0567e-04
Epoch 706/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7764e-04 - va
l_loss: 4.9147e-04
Epoch 707/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7184e-04 - va
l_loss: 4.7870e-04
Epoch 708/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7850e-04 - va
l_loss: 5.0417e-04
Epoch 709/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8563e-04 - va
l_loss: 4.5421e-04
Epoch 710/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9889e-04 - va
l_loss: 4.5186e-04
Epoch 711/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7338e-04 - va
l_loss: 5.1122e-04
Epoch 712/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8658e-04 - va
l_loss: 5.0042e-04
Epoch 713/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7268e-04 - va
l_loss: 4.8244e-04
Epoch 714/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8078e-04 - va
l_loss: 4.8375e-04
Epoch 715/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5984e-04 - va
l_loss: 4.6096e-04
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Epoch 716/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8453e-04 - va
l_loss: 4.6676e-04
Epoch 717/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7541e-04 - va
l_loss: 4.5154e-04
Epoch 718/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7123e-04 - va
l_loss: 5.0617e-04
Epoch 719/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5313e-04 - va
l_loss: 5.0192e-04
Epoch 720/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0739e-04 - va
l_loss: 6.0620e-04
Epoch 721/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7490e-04 - va
l_loss: 5.0170e-04
Epoch 722/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8252e-04 - va
l_loss: 4.7272e-04
Epoch 723/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0168e-04 - va
l_loss: 4.4805e-04
Epoch 724/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7436e-04 - va
l_loss: 4.6212e-04
Epoch 725/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7186e-04 - va
l_loss: 4.4367e-04
Epoch 726/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7142e-04 - va
l_loss: 5.1621e-04
Epoch 727/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7601e-04 - va
l_loss: 4.6582e-04
Epoch 728/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7347e-04 - va
l_loss: 4.7127e-04
Epoch 729/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6611e-04 - va
l_loss: 4.6622e-04
Epoch 730/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6772e-04 - va
l_loss: 5.0833e-04
Epoch 731/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6159e-04 - va
l_loss: 4.7052e-04
Epoch 732/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6545e-04 - va
l_loss: 4.5688e-04
Epoch 733/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0972e-04 - va
l_loss: 4.7738e-04
Epoch 734/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 5.0466e-04 - va
l_loss: 4.5477e-04
Epoch 735/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8471e-04 - va
l_loss: 4.5977e-04
Epoch 736/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6365e-04 - va
l_loss: 4.8572e-04
Epoch 737/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8264e-04 - va
```

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l_loss: 5.1208e-04
Epoch 738/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6408e-04 - va
l_loss: 5.5741e-04
Epoch 739/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8003e-04 - va
l_loss: 4.7201e-04
Epoch 740/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7007e-04 - va
l_loss: 4.8882e-04
Epoch 741/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8107e-04 - va
l_loss: 5.1970e-04
Epoch 742/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7638e-04 - va
l_loss: 4.8365e-04
Epoch 743/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7799e-04 - va
l_loss: 5.1775e-04
Epoch 744/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6731e-04 - va
l_loss: 4.7710e-04
Epoch 745/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6264e-04 - va
l_loss: 4.8997e-04
Epoch 746/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5867e-04 - va
l_loss: 4.7958e-04
Epoch 747/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8531e-04 - va
l_loss: 4.8442e-04
Epoch 748/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7944e-04 - va
l_loss: 4.8860e-04
Epoch 749/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5662e-04 - va
l_loss: 5.0835e-04
Epoch 750/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9134e-04 - va
l_loss: 4.9369e-04
Epoch 751/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6236e-04 - va
l_loss: 4.7497e-04
Epoch 752/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5727e-04 - va
l_loss: 4.6505e-04
Epoch 753/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8877e-04 - va
l_loss: 4.7589e-04
Epoch 754/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7614e-04 - va
l_loss: 4.7325e-04
Epoch 755/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8011e-04 - va
l_loss: 5.0638e-04
Epoch 756/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6532e-04 - va
l_loss: 4.7938e-04
Epoch 757/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6130e-04 - va
l_loss: 4.5313e-04
Epoch 758/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6644e-04 - va
l_loss: 4.5774e-04
Epoch 759/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 4.7388e-04 - va
l_loss: 5.0170e-04
Epoch 760/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6896e-04 - va
l_loss: 4.2891e-04
Epoch 761/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6980e-04 - va
l_loss: 5.2735e-04
Epoch 762/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8614e-04 - va
l_loss: 4.7352e-04
Epoch 763/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6189e-04 - va
l_loss: 4.8490e-04
Epoch 764/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5964e-04 - va
l_loss: 4.8588e-04
Epoch 765/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7847e-04 - va
l_loss: 4.5391e-04
Epoch 766/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5403e-04 - va
l_loss: 4.5298e-04
Epoch 767/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6697e-04 - va
l_loss: 4.7029e-04
Epoch 768/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7649e-04 - va
l_loss: 4.7541e-04
Epoch 769/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6091e-04 - va
l_loss: 4.9943e-04
Epoch 770/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7333e-04 - va
l_loss: 4.4752e-04
Epoch 771/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6197e-04 - va
l_loss: 4.7872e-04
Epoch 772/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6781e-04 - va
l_loss: 4.7829e-04
Epoch 773/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7032e-04 - va
l_loss: 4.9955e-04
Epoch 774/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5333e-04 - va
l_loss: 5.3168e-04
Epoch 775/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9088e-04 - va
l_loss: 5.4615e-04
Epoch 776/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5695e-04 - va
l_loss: 4.5914e-04
Epoch 777/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7313e-04 - va
l_loss: 4.3761e-04
Epoch 778/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6813e-04 - va
l_loss: 4.8601e-04
Epoch 779/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6139e-04 - va
l_loss: 4.9868e-04
Epoch 780/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7345e-04 - va
l_loss: 5.0111e-04
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Epoch 781/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5812e-04 - va
l_loss: 4.9954e-04
Epoch 782/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5780e-04 - va
l_loss: 4.9586e-04
Epoch 783/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6117e-04 - va
l_loss: 5.2043e-04
Epoch 784/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7481e-04 - va
l_loss: 4.5825e-04
Epoch 785/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5308e-04 - va
l_loss: 4.5695e-04
Epoch 786/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6610e-04 - va
l_loss: 4.7117e-04
Epoch 787/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4876e-04 - va
l_loss: 4.6174e-04
Epoch 788/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5155e-04 - va
l_loss: 5.6672e-04
Epoch 789/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9026e-04 - va
l_loss: 5.0752e-04
Epoch 790/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7702e-04 - va
l_loss: 4.7889e-04
Epoch 791/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5969e-04 - va
l_loss: 4.5494e-04
Epoch 792/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4755e-04 - va
l_loss: 4.6797e-04
Epoch 793/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5858e-04 - va
l_loss: 4.6387e-04
Epoch 794/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6113e-04 - va
l_loss: 4.5212e-04
Epoch 795/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5468e-04 - va
l_loss: 4.5908e-04
Epoch 796/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5380e-04 - va
l_loss: 4.7149e-04
Epoch 797/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7272e-04 - va
l_loss: 4.7600e-04
Epoch 798/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6774e-04 - va
l_loss: 4.5614e-04
Epoch 799/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6378e-04 - va
l_loss: 4.6605e-04
Epoch 800/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5857e-04 - va
l_loss: 4.5877e-04
Epoch 801/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5745e-04 - va
l_loss: 4.6793e-04
Epoch 802/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4893e-04 - va
```

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l_loss: 5.1978e-04
Epoch 803/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6785e-04 - va
l_loss: 5.3758e-04
Epoch 804/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5905e-04 - va
l_loss: 4.7752e-04
Epoch 805/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5895e-04 - va
l_loss: 4.6675e-04
Epoch 806/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6906e-04 - va
l_loss: 5.1346e-04
Epoch 807/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6594e-04 - va
l_loss: 4.3044e-04
Epoch 808/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4894e-04 - va
l_loss: 4.4313e-04
Epoch 809/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6450e-04 - va
l_loss: 4.9192e-04
Epoch 810/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6584e-04 - va
l_loss: 4.8479e-04
Epoch 811/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6359e-04 - va
l_loss: 4.5674e-04
Epoch 812/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5536e-04 - va
l_loss: 4.6796e-04
Epoch 813/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5100e-04 - va
l_loss: 5.4919e-04
Epoch 814/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6661e-04 - va
l_loss: 4.4380e-04
Epoch 815/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7845e-04 - va
l_loss: 4.5933e-04
Epoch 816/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4979e-04 - va
l_loss: 4.9947e-04
Epoch 817/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7896e-04 - va
l_loss: 5.3320e-04
Epoch 818/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6096e-04 - va
l_loss: 4.7933e-04
Epoch 819/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6444e-04 - va
l_loss: 4.4227e-04
Epoch 820/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6690e-04 - va
l_loss: 4.8325e-04
Epoch 821/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5756e-04 - va
l_loss: 4.5560e-04
Epoch 822/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6838e-04 - va
l_loss: 5.0337e-04
Epoch 823/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6054e-04 - va
l_loss: 4.5956e-04
Epoch 824/1000
```

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1074/1074 [==============================] - 2s 2ms/step - loss: 4.4657e-04 - va
l_loss: 4.6410e-04
Epoch 825/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4641e-04 - va
l_loss: 4.1233e-04
Epoch 826/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5494e-04 - va
l_loss: 4.4761e-04
Epoch 827/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5793e-04 - va
l_loss: 4.8390e-04
Epoch 828/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5190e-04 - va
l_loss: 4.7715e-04
Epoch 829/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6860e-04 - va
l_loss: 4.7689e-04
Epoch 830/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4949e-04 - va
l_loss: 4.7170e-04
Epoch 831/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7490e-04 - va
l_loss: 4.7816e-04
Epoch 832/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5783e-04 - va
l_loss: 4.4985e-04
Epoch 833/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5379e-04 - va
l_loss: 4.6382e-04
Epoch 834/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4617e-04 - va
l_loss: 4.8290e-04
Epoch 835/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5380e-04 - va
l_loss: 4.8203e-04
Epoch 836/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3578e-04 - va
l_loss: 4.7117e-04
Epoch 837/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6062e-04 - va
l_loss: 4.2995e-04
Epoch 838/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5184e-04 - va
l_loss: 4.3475e-04
Epoch 839/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5974e-04 - va
l_loss: 4.7904e-04
Epoch 840/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 4.6490e-04 - va
l_loss: 4.8187e-04
Epoch 841/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5205e-04 - va
l_loss: 4.6427e-04
Epoch 842/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5163e-04 - va
l_loss: 5.0049e-04
Epoch 843/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5645e-04 - va
l_loss: 4.3253e-04
Epoch 844/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3898e-04 - va
l_loss: 5.0374e-04
Epoch 845/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5308e-04 - va
l_loss: 4.8496e-04
```

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Epoch 846/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.7989e-04 - va
l_loss: 4.8214e-04
Epoch 847/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6026e-04 - va
l_loss: 4.7368e-04
Epoch 848/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4624e-04 - va
l_loss: 4.8111e-04
Epoch 849/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4908e-04 - va
l_loss: 4.9177e-04
Epoch 850/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4972e-04 - va
l_loss: 4.5824e-04
Epoch 851/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 4.4351e-04 - va
l_loss: 4.9469e-04
Epoch 852/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 4.6801e-04 - va
l_loss: 4.6157e-04
Epoch 853/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 4.6414e-04 - va
l_loss: 5.0343e-04
Epoch 854/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 4.4970e-04 - va
l_loss: 4.5455e-04
Epoch 855/1000
1074/1074 [==============================] - 3s 3ms/step - loss: 4.4189e-04 - va
l_loss: 4.6846e-04
Epoch 856/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4315e-04 - va
l_loss: 4.5607e-04
Epoch 857/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6911e-04 - va
l_loss: 4.3557e-04
Epoch 858/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4215e-04 - va
l_loss: 4.4716e-04
Epoch 859/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4829e-04 - va
l_loss: 4.5065e-04
Epoch 860/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5622e-04 - va
l_loss: 4.4855e-04
Epoch 861/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5756e-04 - va
l_loss: 4.8254e-04
Epoch 862/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.6631e-04 - va
l_loss: 4.6571e-04
Epoch 863/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5811e-04 - va
l_loss: 4.4158e-04
Epoch 864/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6481e-04 - va
l_loss: 4.3399e-04
Epoch 865/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4470e-04 - va
l_loss: 4.5150e-04
Epoch 866/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5597e-04 - va
l_loss: 5.0560e-04
Epoch 867/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4870e-04 - va
```

```
l_loss: 4.5404e-04
Epoch 868/1000
1074/1074 [==============================] - ETA: 0s - loss: 4.5207e-0 - 2s 2ms/
step - loss: 4.5248e-04 - val_loss: 4.7415e-04
Epoch 869/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5265e-04 - va
l_loss: 4.7461e-04
Epoch 870/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4555e-04 - va
l_loss: 4.9644e-04
Epoch 871/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3971e-04 - va
l_loss: 4.6045e-04
Epoch 872/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4877e-04 - va
l_loss: 4.3616e-04
Epoch 873/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6326e-04 - va
l_loss: 5.0995e-04
Epoch 874/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.9179e-04 - va
l_loss: 4.8949e-04
Epoch 875/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4562e-04 - va
l_loss: 4.8289e-04
Epoch 876/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3685e-04 - va
l_loss: 4.7636e-04
Epoch 877/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3188e-04 - va
l_loss: 4.5653e-04
Epoch 878/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8997e-04 - va
l_loss: 4.3325e-04
Epoch 879/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4305e-04 - va
l_loss: 4.8532e-04
Epoch 880/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5344e-04 - va
l_loss: 6.1190e-04
Epoch 881/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3375e-04 - va
l_loss: 5.2057e-04
Epoch 882/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5474e-04 - va
l_loss: 4.7546e-04
Epoch 883/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4898e-04 - va
l_loss: 4.6538e-04
Epoch 884/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5375e-04 - va
l_loss: 4.3714e-04
Epoch 885/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3402e-04 - va
l_loss: 5.1475e-04
Epoch 886/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4143e-04 - va
l_loss: 4.4852e-04
Epoch 887/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3594e-04 - va
l_loss: 4.5698e-04
Epoch 888/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4988e-04 - va
l_loss: 4.5616e-04
Epoch 889/1000
```

```
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3694e-04 - va
l_loss: 4.5640e-04
Epoch 890/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3285e-04 - va
l_loss: 4.3146e-04
Epoch 891/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3783e-04 - va
l_loss: 4.6891e-04
Epoch 892/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4843e-04 - va
l_loss: 4.9356e-04
Epoch 893/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3942e-04 - va
l_loss: 4.6602e-04
Epoch 894/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5871e-04 - va
l_loss: 4.3771e-04
Epoch 895/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3227e-04 - va
l_loss: 4.5874e-04
Epoch 896/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3556e-04 - va
l_loss: 4.5530e-04
Epoch 897/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3732e-04 - va
l_loss: 5.1872e-04
Epoch 898/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4378e-04 - va
l_loss: 4.6062e-04
Epoch 899/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4278e-04 - va
l_loss: 4.8776e-04
Epoch 900/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5058e-04 - va
l_loss: 4.3762e-04
Epoch 901/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3296e-04 - va
l_loss: 4.6696e-04
Epoch 902/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3532e-04 - va
l_loss: 4.9162e-04
Epoch 903/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3691e-04 - va
l_loss: 4.4040e-04
Epoch 904/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3276e-04 - va
l_loss: 4.4650e-04
Epoch 905/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4678e-04 - va
l_loss: 4.6248e-04
Epoch 906/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3795e-04 - va
l_loss: 4.8704e-04
Epoch 907/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2843e-04 - va
l_loss: 4.4732e-04
Epoch 908/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2938e-04 - va
l_loss: 4.8418e-04
Epoch 909/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4997e-04 - va
l_loss: 4.5248e-04
Epoch 910/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4340e-04 - va
l_loss: 4.4887e-04
```

```
Epoch 911/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2703e-04 - va
l_loss: 4.3401e-04
Epoch 912/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4948e-04 - va
l_loss: 4.7618e-04
Epoch 913/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4172e-04 - va
l_loss: 4.4920e-04
Epoch 914/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2918e-04 - va
l_loss: 5.4876e-04
Epoch 915/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2541e-04 - va
l_loss: 4.6043e-04
Epoch 916/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3872e-04 - va
l_loss: 4.4705e-04
Epoch 917/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3648e-04 - va
l_loss: 4.4028e-04
Epoch 918/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5930e-04 - va
l_loss: 4.7775e-04
Epoch 919/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3161e-04 - va
l_loss: 4.8283e-04
Epoch 920/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5587e-04 - va
l_loss: 4.3817e-04
Epoch 921/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3808e-04 - va
l_loss: 4.4528e-04
Epoch 922/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4640e-04 - va
l_loss: 4.5780e-04
Epoch 923/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3721e-04 - va
l_loss: 4.1864e-04
Epoch 924/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2936e-04 - va
l_loss: 4.5455e-04
Epoch 925/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.8838e-04 - va
l_loss: 4.4433e-04
Epoch 926/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2593e-04 - va
l_loss: 4.3602e-04
Epoch 927/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3236e-04 - va
l_loss: 4.4244e-04
Epoch 928/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3893e-04 - va
l_loss: 4.3746e-04
Epoch 929/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3796e-04 - va
l_loss: 4.0367e-04
Epoch 930/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4735e-04 - va
l_loss: 4.5682e-04
Epoch 931/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3045e-04 - va
l_loss: 4.3502e-04
Epoch 932/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4162e-04 - va
```

```
l_loss: 4.8841e-04
Epoch 933/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.4805e-04 - va
l_loss: 4.5915e-04
Epoch 934/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4085e-04 - va
l_loss: 4.6231e-04
Epoch 935/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2777e-04 - va
l_loss: 4.5084e-04
Epoch 936/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2374e-04 - va
l_loss: 4.5147e-04
Epoch 937/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5422e-04 - va
l_loss: 4.6238e-04
Epoch 938/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1717e-04 - va
l_loss: 4.5798e-04
Epoch 939/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2650e-04 - va
l_loss: 4.5617e-04
Epoch 940/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3886e-04 - va
l_loss: 4.9377e-04
Epoch 941/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4085e-04 - va
l_loss: 4.2833e-04
Epoch 942/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6419e-04 - va
l_loss: 4.2841e-04
Epoch 943/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1883e-04 - va
l_loss: 4.3495e-04
Epoch 944/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3230e-04 - va
l_loss: 4.4785e-04
Epoch 945/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2730e-04 - va
l_loss: 4.3390e-04
Epoch 946/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3186e-04 - va
l_loss: 4.6922e-04
Epoch 947/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3148e-04 - va
l_loss: 4.8631e-04
Epoch 948/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4268e-04 - va
l_loss: 4.7228e-04
Epoch 949/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3135e-04 - va
l_loss: 4.3428e-04
Epoch 950/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3763e-04 - va
l_loss: 4.4012e-04
Epoch 951/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3140e-04 - va
l_loss: 4.5671e-04
Epoch 952/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3998e-04 - va
l_loss: 4.5773e-04
Epoch 953/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.6630e-04 - va
l_loss: 4.6500e-04
Epoch 954/1000
```

```
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2838e-04 - va
l_loss: 4.6858e-04
Epoch 955/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2919e-04 - va
l_loss: 4.4601e-04
Epoch 956/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2794e-04 - va
l_loss: 4.5488e-04
Epoch 957/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3770e-04 - va
l_loss: 4.6096e-04
Epoch 958/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3921e-04 - va
l_loss: 4.5291e-04
Epoch 959/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3395e-04 - va
l_loss: 4.4410e-04
Epoch 960/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2668e-04 - va
l_loss: 4.8657e-04
Epoch 961/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3232e-04 - va
l_loss: 4.6232e-04
Epoch 962/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4316e-04 - va
l_loss: 4.2703e-04
Epoch 963/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2203e-04 - va
l_loss: 4.6759e-04
Epoch 964/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2890e-04 - va
l_loss: 4.7031e-04
Epoch 965/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2421e-04 - va
l_loss: 4.2658e-04
Epoch 966/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2705e-04 - va
l_loss: 4.9686e-04
Epoch 967/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2468e-04 - va
l_loss: 4.7614e-04
Epoch 968/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3810e-04 - va
l_loss: 4.7425e-04
Epoch 969/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.3560e-04 - va
l_loss: 4.5379e-04
Epoch 970/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3885e-04 - va
l_loss: 4.4175e-04
Epoch 971/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.3883e-04 - va
l_loss: 4.6829e-04
Epoch 972/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.4819e-04 - va
l_loss: 4.5629e-04
Epoch 973/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4122e-04 - va
l_loss: 4.9025e-04
Epoch 974/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1414e-04 - va
l_loss: 4.6034e-04
Epoch 975/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3386e-04 - va
l_loss: 4.7546e-04
```

```
Epoch 976/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2081e-04 - va
l_loss: 4.5525e-04
Epoch 977/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2374e-04 - va
l_loss: 4.8132e-04
Epoch 978/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4061e-04 - va
l_loss: 4.7673e-04
Epoch 979/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.4760e-04 - va
l_loss: 4.6990e-04
Epoch 980/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.1642e-04 - va
l_loss: 4.8649e-04
Epoch 981/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5197e-04 - va
l_loss: 4.8600e-04
Epoch 982/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2925e-04 - va
l_loss: 5.5370e-04
Epoch 983/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.5716e-04 - va
l_loss: 4.5952e-04
Epoch 984/1000
1074/1074 [==============================] - 3s 2ms/step - loss: 4.2020e-04 - va
l_loss: 4.6142e-04
Epoch 985/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3435e-04 - va
l_loss: 4.4013e-04
Epoch 986/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3428e-04 - va
l_loss: 4.7055e-04
Epoch 987/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1849e-04 - va
l_loss: 4.8970e-04
Epoch 988/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2651e-04 - va
l_loss: 4.6644e-04
Epoch 989/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1902e-04 - va
l_loss: 4.4157e-04
Epoch 990/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2027e-04 - va
l_loss: 4.3197e-04
Epoch 991/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3040e-04 - va
l_loss: 4.5478e-04
Epoch 992/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2446e-04 - va
l_loss: 4.7516e-04
Epoch 993/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1569e-04 - va
l_loss: 4.4557e-04
Epoch 994/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3169e-04 - va
l_loss: 4.4710e-04
Epoch 995/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3095e-04 - va
l_loss: 4.4813e-04
Epoch 996/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2796e-04 - va
l_loss: 4.8094e-04
Epoch 997/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2262e-04 - va
```

```
l_loss: 4.7526e-04
Epoch 998/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.1401e-04 - va
l_loss: 4.6309e-04
Epoch 999/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.2859e-04 - va
l_loss: 4.5703e-04
Epoch 1000/1000
1074/1074 [==============================] - 2s 2ms/step - loss: 4.3420e-04 - va
l_loss: 4.7985e-04
Model: "sequential_2"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 dense_12 (Dense)             (None, 200)               17000

 dropout_8 (Dropout)          (None, 200)               0

 dense_13 (Dense)             (None, 200)               40200

 dropout_9 (Dropout)          (None, 200)               0

 dense_14 (Dense)             (None, 200)               40200

 dropout_10 (Dropout)         (None, 200)               0

 dense_15 (Dense)             (None, 100)               20100

 dropout_11 (Dropout)         (None, 100)               0

 dense_16 (Dense)             (None, 100)               10100

 dense_17 (Dense)             (None, 6)                 606

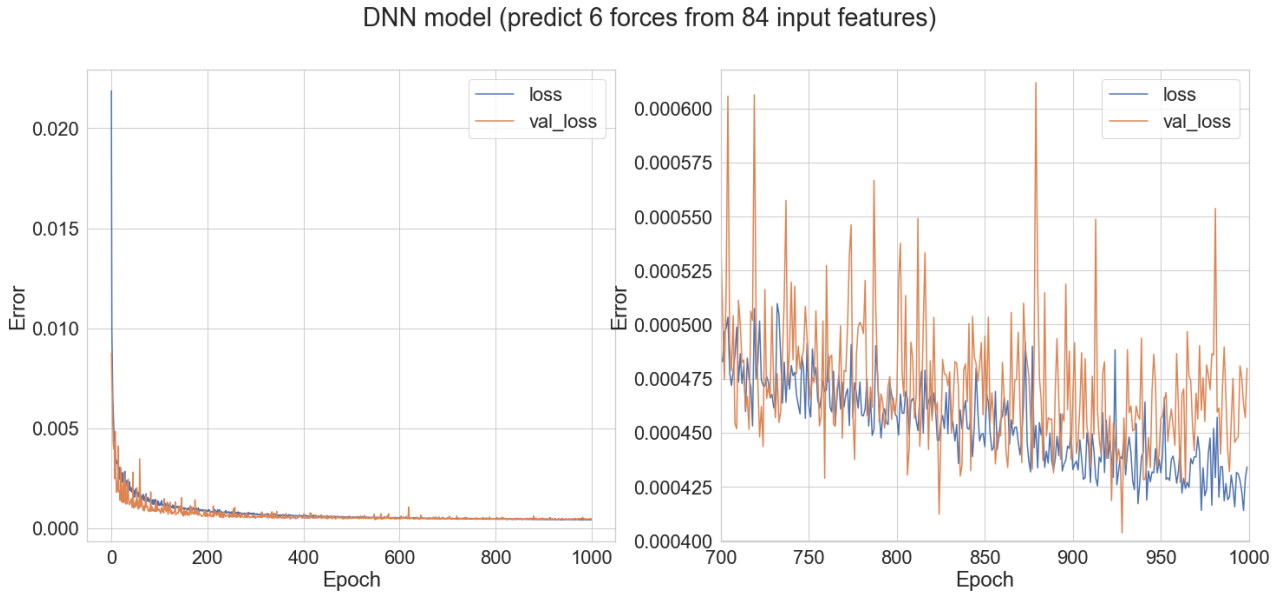
=================================================================
Total params: 128,206
Trainable params: 128,206
Non-trainable params: 0
_________________________________________________________________
CPU times: user 1h 6min 27s, sys: 27min 37s, total: 1h 34min 5s
Wall time: 35min 49s
```

## Save DNN model

In [59]:
```
dnn_model_84.save(output_dir/"{}_{}.h5".format(dnn_model_84_tag, timestamp))
```

## Plot loss vs. epoch

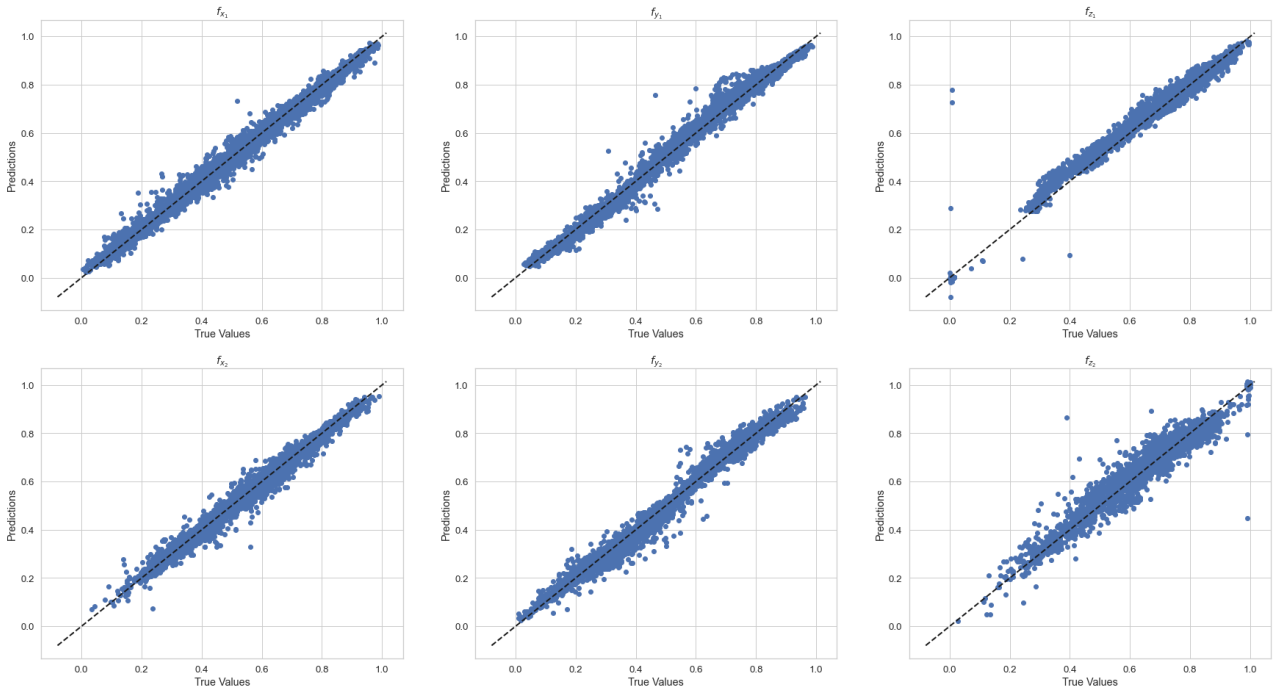
In [170…
```
plot_loss(history_dnn_84, 'loss_{}.pdf'.format(dnn_model_84_tag), 'DNN model (pr
```




In [61]:
```
# save model loss on test set for evaluation section below
test_results['dnn_84'] = dnn_model_84.evaluate(X_test, Y_test, verbose=0)
```

## Compare prediction vs. true values for the test set

In [62]:
```
Y_test_pred_dnn_84 = dnn_model_84.predict(X_test)
plot_pred_vs_true(Y_test_pred_dnn_84, Y_test, 'pred_vs_true_{}'.format(dnn_model
```




# 4.3 RNN regression

I experimented with LSTM, GRU, and SimpleRNN layers. Performance was relatively similar, but the LSTM seemed to do slightly better.

As is shown in section 5, an RNN did a significantly better job predicted unseen data than a DNN, especially for the dataset not seen during training.

In [63]:
```
def setup_rnn_model(n_outputs):
  model = keras.Sequential([
      #layers.BatchNormalization(),
      layers.LSTM(100, activation='relu', return_sequences=True),
      #layers.SimpleRNN(100, activation='relu', return_sequences=True),
      #layers.GRU(100, activation='relu', return_sequences=True),
      layers.Dropout(0.05),
      layers.LSTM(100, activation='relu', return_sequences=False),
      #layers.SimpleRNN(100, activation='relu', return_sequences=False),
      #layers.GRU(100, activation='relu', return_sequences=False),
      layers.Dropout(0.05),
      layers.Dense(100, activation='relu'),
      layers.Dense(n_outputs)
  ])

  model.compile(loss='mean_squared_error',
                optimizer=tf.keras.optimizers.Adam(learning_rate=1e-3, decay=5e-
  return model
```

In [64]:
```
# rnn config
rnn_tag = "rnn_lstm200x2_dense100x1_0p5drop"
rnn_epochs = 300
rnn_batch_size = 32
```

In [65]:
```
rnn_model_12 = setup_rnn_model(Y_seq_train.shape[-1])
rnn_model_12_tag = "{}_12features".format(rnn_tag)
```

In [66]:
```
rnn_model_36 = setup_rnn_model(Y_seq_train.shape[-1])
rnn_model_36_tag = "{}_36features".format(rnn_tag)
```

In [67]:
```
rnn_model_84 = setup_rnn_model(Y_seq_train.shape[-1])
rnn_model_84_tag = "{}_84features".format(rnn_tag)
```

In [68]:
```
%%time

early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=20)
save_every_epoch = tf.keras.callbacks.ModelCheckpoint(output_dir/'rnn_12_tmp.h5'

history_rnn_12 = rnn_model_12.fit(
    X_seq_train_12, Y_seq_train,
    validation_data=(X_seq_val_12, Y_seq_val),
    batch_size = rnn_batch_size,
    epochs=rnn_epochs,
    callbacks=[save_every_epoch]
    #callbacks=[early_stop, save_every_epoch]
    #verbose=0,
    )
rnn_model_12.summary()
```

```
with open(output_dir/'history_rnn_12.pickle', 'wb') as f:
    pickle.dump(history_rnn_12.history, f)
```

```
Epoch 1/300
1074/1074 [==============================] - 21s 18ms/step - loss: 0.0202 - val_
loss: 0.0076
Epoch 2/300
1074/1074 [==============================] - 19s 18ms/step - loss: 0.0069 - val_
loss: 0.0050
Epoch 3/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0048 - val_
loss: 0.0044
Epoch 4/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0039 - val_
loss: 0.0035
Epoch 5/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0035 - val_
loss: 0.0029
Epoch 6/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0031 - val_
loss: 0.0027
Epoch 7/300
1074/1074 [==============================] - 19s 18ms/step - loss: 0.0028 - val_
loss: 0.0027
Epoch 8/300
1074/1074 [==============================] - 19s 18ms/step - loss: 0.0027 - val_
loss: 0.0025
Epoch 9/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0025 - val_
loss: 0.0020
Epoch 10/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0023 - val_
loss: 0.0023
Epoch 11/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0022 - val_
loss: 0.0019
Epoch 12/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0021 - val_
loss: 0.0016
Epoch 13/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0020 - val_
loss: 0.0031
Epoch 14/300
1074/1074 [==============================] - 19s 18ms/step - loss: 0.0020 - val_
loss: 0.0017
Epoch 15/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0018 - val_
loss: 0.0015
Epoch 16/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0018 - val_
loss: 0.0021
Epoch 17/300
1074/1074 [==============================] - 19s 17ms/step - loss: 0.0017 - val_
loss: 0.0013
Epoch 18/300
1074/1074 [==============================] - 20s 18ms/step - loss: 0.0016 - val_
loss: 0.0014
Epoch 19/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0016 - val_
loss: 0.0013
Epoch 20/300
1074/1074 [==============================] - 21s 19ms/step - loss: 0.0015 - val_
loss: 0.0012
Epoch 21/300
```

```
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0015 - val_
loss: 0.0012
Epoch 22/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0015 - val_
loss: 0.0011
Epoch 23/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0014 - val_
loss: 0.0015
Epoch 24/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0014 - val_
loss: 0.0013
Epoch 25/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0013 - val_
loss: 0.0011
Epoch 26/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0013 - val_
loss: 0.0010
Epoch 27/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0013 - val_
loss: 0.0015
Epoch 28/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0013 - val_
loss: 0.0011
Epoch 29/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0013 - val_
loss: 0.0011
Epoch 30/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0012 - val_
loss: 9.5102e-04
Epoch 31/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0012 - val_
loss: 0.0010
Epoch 32/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0012 - val_
loss: 0.0014
Epoch 33/300
1074/1074 [==============================] - 22s 20ms/step - loss: 0.0011 - val_
loss: 0.0011
Epoch 34/300
1074/1074 [==============================] - 20s 18ms/step - loss: 0.0011 - val_
loss: 8.4230e-04
Epoch 35/300
1074/1074 [==============================] - 19s 18ms/step - loss: 0.0011 - val_
loss: 9.5012e-04
Epoch 36/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0011 - val_
loss: 8.8001e-04
Epoch 37/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0011 - val_
loss: 0.0011
Epoch 38/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0011 - val_
loss: 9.8858e-04
Epoch 39/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0010 - val_
loss: 9.0438e-04
Epoch 40/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0010 - val_
loss: 8.8918e-04
Epoch 41/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0010 - val_
loss: 7.8806e-04
Epoch 42/300
1074/1074 [==============================] - 17s 16ms/step - loss: 9.9302e-04 -
val_loss: 9.3320e-04
```

```
Epoch 43/300
1074/1074 [==============================] - 18s 16ms/step - loss: 9.9309e-04 -
val_loss: 8.0055e-04
Epoch 44/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0010 - val_
loss: 9.4246e-04
Epoch 45/300
1074/1074 [==============================] - 18s 16ms/step - loss: 9.6038e-04 -
val_loss: 8.2075e-04
Epoch 46/300
1074/1074 [==============================] - 17s 16ms/step - loss: 9.4395e-04 -
val_loss: 9.0383e-04
Epoch 47/300
1074/1074 [==============================] - 18s 17ms/step - loss: 9.3182e-04 -
val_loss: 7.8554e-04
Epoch 48/300
1074/1074 [==============================] - 17s 16ms/step - loss: 9.5321e-04 -
val_loss: 9.7262e-04
Epoch 49/300
1074/1074 [==============================] - 17s 16ms/step - loss: 8.9330e-04 -
val_loss: 8.5736e-04
Epoch 50/300
1074/1074 [==============================] - 17s 16ms/step - loss: 9.3348e-04 -
val_loss: 0.0013
Epoch 51/300
1074/1074 [==============================] - 17s 16ms/step - loss: 8.9831e-04 -
val_loss: 7.7642e-04
Epoch 52/300
1074/1074 [==============================] - 17s 16ms/step - loss: 8.9596e-04 -
val_loss: 9.9285e-04
Epoch 53/300
1074/1074 [==============================] - 17s 16ms/step - loss: 8.6902e-04 -
val_loss: 7.1372e-04
Epoch 54/300
1074/1074 [==============================] - 17s 16ms/step - loss: 8.6247e-04 -
val_loss: 7.3714e-04
Epoch 55/300
1074/1074 [==============================] - 17s 16ms/step - loss: 8.6065e-04 -
val_loss: 7.3530e-04
Epoch 56/300
1074/1074 [==============================] - 18s 16ms/step - loss: 8.7246e-04 -
val_loss: 7.1475e-04
Epoch 57/300
1074/1074 [==============================] - 18s 17ms/step - loss: 8.5633e-04 -
val_loss: 7.1641e-04
Epoch 58/300
1074/1074 [==============================] - 17s 16ms/step - loss: 8.6577e-04 -
val_loss: 7.3774e-04
Epoch 59/300
1074/1074 [==============================] - 18s 16ms/step - loss: 8.1993e-04 -
val_loss: 8.3861e-04
Epoch 60/300
1074/1074 [==============================] - 18s 17ms/step - loss: 8.4368e-04 -
val_loss: 8.5905e-04
Epoch 61/300
1074/1074 [==============================] - 17s 16ms/step - loss: 8.1242e-04 -
val_loss: 8.5391e-04
Epoch 62/300
1074/1074 [==============================] - 18s 16ms/step - loss: 8.2292e-04 -
val_loss: 6.8574e-04
Epoch 63/300
1074/1074 [==============================] - 20s 19ms/step - loss: 8.1516e-04 -
val_loss: 9.7254e-04
Epoch 64/300
1074/1074 [==============================] - 18s 17ms/step - loss: 7.8609e-04 -
```

```
val_loss: 6.8333e-04
Epoch 65/300
1074/1074 [==============================] - 18s 17ms/step - loss: 8.1694e-04 -
val_loss: 7.1373e-04
Epoch 66/300
1074/1074 [==============================] - 19s 17ms/step - loss: 7.9413e-04 -
val_loss: 8.7675e-04
Epoch 67/300
1074/1074 [==============================] - 19s 17ms/step - loss: 7.9427e-04 -
val_loss: 8.4678e-04
Epoch 68/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.7210e-04 -
val_loss: 7.1641e-04
Epoch 69/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.6577e-04 -
val_loss: 9.9984e-04
Epoch 70/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.5934e-04 -
val_loss: 7.3712e-04
Epoch 71/300
1074/1074 [==============================] - 18s 16ms/step - loss: 7.5499e-04 -
val_loss: 6.8764e-04
Epoch 72/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.5120e-04 -
val_loss: 8.3547e-04
Epoch 73/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.4893e-04 -
val_loss: 6.9053e-04
Epoch 74/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.3573e-04 -
val_loss: 0.0018
Epoch 75/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.6013e-04 -
val_loss: 8.0014e-04
Epoch 76/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.1654e-04 -
val_loss: 7.7888e-04
Epoch 77/300
1074/1074 [==============================] - 17s 15ms/step - loss: 7.6911e-04 -
val_loss: 8.2755e-04
Epoch 78/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.1343e-04 -
val_loss: 6.4415e-04
Epoch 79/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.1607e-04 -
val_loss: 6.5078e-04
Epoch 80/300
1074/1074 [==============================] - 17s 15ms/step - loss: 7.1533e-04 -
val_loss: 6.1989e-04
Epoch 81/300
1074/1074 [==============================] - 16s 15ms/step - loss: 7.2518e-04 -
val_loss: 6.5011e-04
Epoch 82/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.1422e-04 -
val_loss: 7.9746e-04
Epoch 83/300
1074/1074 [==============================] - 17s 15ms/step - loss: 6.9424e-04 -
val_loss: 6.6001e-04
Epoch 84/300
1074/1074 [==============================] - 17s 15ms/step - loss: 6.9526e-04 -
val_loss: 6.6730e-04
Epoch 85/300
1074/1074 [==============================] - 17s 16ms/step - loss: 7.0165e-04 -
val_loss: 6.1002e-04
Epoch 86/300
```

```
1074/1074 [==============================] - 16s 15ms/step - loss: 6.6947e-04 -
val_loss: 5.5193e-04
Epoch 87/300
1074/1074 [==============================] - 17s 15ms/step - loss: 6.8902e-04 -
val_loss: 6.4306e-04
Epoch 88/300
1074/1074 [==============================] - 17s 15ms/step - loss: 6.6527e-04 -
val_loss: 6.4533e-04
Epoch 89/300
1074/1074 [==============================] - 17s 16ms/step - loss: 6.9403e-04 -
val_loss: 6.1338e-04
Epoch 90/300
1074/1074 [==============================] - 17s 16ms/step - loss: 6.6556e-04 -
val_loss: 5.9472e-04
Epoch 91/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.6246e-04 -
val_loss: 5.8884e-04
Epoch 92/300
1074/1074 [==============================] - 20s 19ms/step - loss: 6.5485e-04 -
val_loss: 5.8659e-04
Epoch 93/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.7686e-04 -
val_loss: 6.0377e-04
Epoch 94/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.6595e-04 -
val_loss: 6.3790e-04
Epoch 95/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.6263e-04 -
val_loss: 6.8631e-04
Epoch 96/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.7642e-04 -
val_loss: 7.5732e-04
Epoch 97/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.4694e-04 -
val_loss: 6.0775e-04
Epoch 98/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.2973e-04 -
val_loss: 5.6125e-04
Epoch 99/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.4806e-04 -
val_loss: 5.9015e-04
Epoch 100/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.4884e-04 -
val_loss: 5.7771e-04
Epoch 101/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.3591e-04 -
val_loss: 5.9910e-04
Epoch 102/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.3895e-04 -
val_loss: 5.4847e-04
Epoch 103/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.2660e-04 -
val_loss: 8.3098e-04
Epoch 104/300
1074/1074 [==============================] - 20s 19ms/step - loss: 6.2918e-04 -
val_loss: 5.7079e-04
Epoch 105/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.3742e-04 -
val_loss: 8.1997e-04
Epoch 106/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.0087e-04 -
val_loss: 6.8207e-04
Epoch 107/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.2643e-04 -
val_loss: 6.5292e-04
```

```
Epoch 108/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.1873e-04 -
val_loss: 6.1612e-04
Epoch 109/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.2998e-04 -
val_loss: 6.1583e-04
Epoch 110/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.0628e-04 -
val_loss: 5.8405e-04
Epoch 111/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.0189e-04 -
val_loss: 5.7406e-04
Epoch 112/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.9826e-04 -
val_loss: 6.8647e-04
Epoch 113/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.1886e-04 -
val_loss: 6.1749e-04
Epoch 114/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.9853e-04 -
val_loss: 5.5870e-04
Epoch 115/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.9932e-04 -
val_loss: 7.5066e-04
Epoch 116/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.1361e-04 -
val_loss: 6.7686e-04
Epoch 117/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.9100e-04 -
val_loss: 5.6189e-04
Epoch 118/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.9848e-04 -
val_loss: 5.9534e-04
Epoch 119/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.8095e-04 -
val_loss: 5.5182e-04
Epoch 120/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.8151e-04 -
val_loss: 5.7776e-04
Epoch 121/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.8687e-04 -
val_loss: 5.8013e-04
Epoch 122/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.8164e-04 -
val_loss: 5.8633e-04
Epoch 123/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.8931e-04 -
val_loss: 5.6230e-04
Epoch 124/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.7310e-04 -
val_loss: 5.3180e-04
Epoch 125/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.7720e-04 -
val_loss: 6.1266e-04
Epoch 126/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.7795e-04 -
val_loss: 5.2894e-04
Epoch 127/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.6166e-04 -
val_loss: 5.1399e-04
Epoch 128/300
1074/1074 [==============================] - 20s 18ms/step - loss: 5.6074e-04 -
val_loss: 5.6594e-04
Epoch 129/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.6118e-04 -
```

```
val_loss: 5.4146e-04
Epoch 130/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.5288e-04 -
val_loss: 5.4651e-04
Epoch 131/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.7038e-04 -
val_loss: 6.4186e-04
Epoch 132/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.5485e-04 -
val_loss: 5.9011e-04
Epoch 133/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.4926e-04 -
val_loss: 5.6248e-04
Epoch 134/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.4996e-04 -
val_loss: 5.4048e-04
Epoch 135/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.7217e-04 -
val_loss: 6.1157e-04
Epoch 136/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.5498e-04 -
val_loss: 5.3622e-04
Epoch 137/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.4109e-04 -
val_loss: 5.6737e-04
Epoch 138/300
1074/1074 [==============================] - 20s 18ms/step - loss: 5.3760e-04 -
val_loss: 6.5598e-04
Epoch 139/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.5969e-04 -
val_loss: 6.4009e-04
Epoch 140/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.5465e-04 -
val_loss: 9.2043e-04
Epoch 141/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.4375e-04 -
val_loss: 5.3951e-04
Epoch 142/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.3452e-04 -
val_loss: 5.6943e-04
Epoch 143/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.3299e-04 -
val_loss: 6.1092e-04
Epoch 144/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.2985e-04 -
val_loss: 5.0735e-04
Epoch 145/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.3624e-04 -
val_loss: 5.2742e-04
Epoch 146/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.4280e-04 -
val_loss: 7.9784e-04
Epoch 147/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.2697e-04 -
val_loss: 5.3795e-04
Epoch 148/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.3205e-04 -
val_loss: 5.3278e-04
Epoch 149/300
1074/1074 [==============================] - 18s 16ms/step - loss: 5.1163e-04 -
val_loss: 5.9996e-04
Epoch 150/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.2591e-04 -
val_loss: 6.1352e-04
Epoch 151/300
```

```
1074/1074 [==============================] - 18s 17ms/step - loss: 5.2992e-04 -
val_loss: 5.0720e-04
Epoch 152/300
1074/1074 [==============================] - 18s 16ms/step - loss: 5.3525e-04 -
val_loss: 4.9406e-04
Epoch 153/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.0806e-04 -
val_loss: 4.9322e-04
Epoch 154/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.2629e-04 -
val_loss: 4.8780e-04
Epoch 155/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.0843e-04 -
val_loss: 5.3587e-04
Epoch 156/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.1871e-04 -
val_loss: 5.1896e-04
Epoch 157/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.2167e-04 -
val_loss: 5.6231e-04
Epoch 158/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.1767e-04 -
val_loss: 5.3957e-04
Epoch 159/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.1092e-04 -
val_loss: 4.9499e-04
Epoch 160/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.1715e-04 -
val_loss: 5.1669e-04
Epoch 161/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.1952e-04 -
val_loss: 5.4766e-04
Epoch 162/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.0758e-04 -
val_loss: 4.9972e-04
Epoch 163/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.0053e-04 -
val_loss: 4.7562e-04
Epoch 164/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.0300e-04 -
val_loss: 4.8585e-04
Epoch 165/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.1052e-04 -
val_loss: 5.3419e-04
Epoch 166/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.1202e-04 -
val_loss: 5.6595e-04
Epoch 167/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.9867e-04 -
val_loss: 4.9311e-04
Epoch 168/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.0106e-04 -
val_loss: 5.7811e-04
Epoch 169/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.9786e-04 -
val_loss: 4.9577e-04
Epoch 170/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.9049e-04 -
val_loss: 5.4724e-04
Epoch 171/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.0454e-04 -
val_loss: 5.8841e-04
Epoch 172/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.9265e-04 -
val_loss: 5.0909e-04
```

```
Epoch 173/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.9903e-04 -
val_loss: 5.1054e-04
Epoch 174/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.9371e-04 -
val_loss: 5.0101e-04
Epoch 175/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7214e-04 -
val_loss: 5.6800e-04
Epoch 176/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.8637e-04 -
val_loss: 4.7121e-04
Epoch 177/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.9482e-04 -
val_loss: 5.5380e-04
Epoch 178/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.8797e-04 -
val_loss: 5.1891e-04
Epoch 179/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7690e-04 -
val_loss: 5.0491e-04
Epoch 180/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.9247e-04 -
val_loss: 4.6079e-04
Epoch 181/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7343e-04 -
val_loss: 5.8746e-04
Epoch 182/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7545e-04 -
val_loss: 5.4903e-04
Epoch 183/300
1074/1074 [==============================] - 19s 18ms/step - loss: 4.8192e-04 -
val_loss: 5.0815e-04
Epoch 184/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7602e-04 -
val_loss: 4.8350e-04
Epoch 185/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.8441e-04 -
val_loss: 6.1862e-04
Epoch 186/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7145e-04 -
val_loss: 4.7913e-04
Epoch 187/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6786e-04 -
val_loss: 6.2310e-04
Epoch 188/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.8900e-04 -
val_loss: 5.1920e-04
Epoch 189/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.8878e-04 -
val_loss: 5.3453e-04
Epoch 190/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.7095e-04 -
val_loss: 5.4666e-04
Epoch 191/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6429e-04 -
val_loss: 4.6835e-04
Epoch 192/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7074e-04 -
val_loss: 6.4143e-04
Epoch 193/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.7621e-04 -
val_loss: 5.1034e-04
Epoch 194/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6342e-04 -
```

```
val_loss: 5.1096e-04
Epoch 195/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6923e-04 -
val_loss: 4.7249e-04
Epoch 196/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6348e-04 -
val_loss: 4.7889e-04
Epoch 197/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6091e-04 -
val_loss: 5.2509e-04
Epoch 198/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6336e-04 -
val_loss: 4.8491e-04
Epoch 199/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.5338e-04 -
val_loss: 4.8424e-04
Epoch 200/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.6562e-04 -
val_loss: 5.1011e-04
Epoch 201/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.5766e-04 -
val_loss: 5.1797e-04
Epoch 202/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7555e-04 -
val_loss: 5.4242e-04
Epoch 203/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.5304e-04 -
val_loss: 4.6168e-04
Epoch 204/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.5387e-04 -
val_loss: 4.6866e-04
Epoch 205/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.5430e-04 -
val_loss: 4.6195e-04
Epoch 206/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.4892e-04 -
val_loss: 4.9425e-04
Epoch 207/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.5475e-04 -
val_loss: 4.6290e-04
Epoch 208/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.5499e-04 -
val_loss: 4.9469e-04
Epoch 209/300
1074/1074 [==============================] - 19s 18ms/step - loss: 4.6023e-04 -
val_loss: 4.9021e-04
Epoch 210/300
1074/1074 [==============================] - 19s 18ms/step - loss: 4.4629e-04 -
val_loss: 4.6067e-04
Epoch 211/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.5165e-04 -
val_loss: 4.8381e-04
Epoch 212/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.4609e-04 -
val_loss: 4.7380e-04
Epoch 213/300
1074/1074 [==============================] - 19s 18ms/step - loss: 4.5384e-04 -
val_loss: 5.4504e-04
Epoch 214/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.4647e-04 -
val_loss: 4.6252e-04
Epoch 215/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.4013e-04 -
val_loss: 4.6368e-04
Epoch 216/300
```

```
1074/1074 [==============================] - 19s 18ms/step - loss: 4.6343e-04 -
val_loss: 4.7995e-04
Epoch 217/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3823e-04 -
val_loss: 4.9282e-04
Epoch 218/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.4912e-04 -
val_loss: 4.7412e-04
Epoch 219/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3737e-04 -
val_loss: 5.2138e-04
Epoch 220/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.4052e-04 -
val_loss: 4.6754e-04
Epoch 221/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3998e-04 -
val_loss: 4.6920e-04
Epoch 222/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.2757e-04 -
val_loss: 4.5936e-04
Epoch 223/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.4676e-04 -
val_loss: 4.6970e-04
Epoch 224/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3534e-04 -
val_loss: 5.7388e-04
Epoch 225/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3112e-04 -
val_loss: 5.2172e-04
Epoch 226/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3770e-04 -
val_loss: 4.5862e-04
Epoch 227/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3137e-04 -
val_loss: 4.4890e-04
Epoch 228/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.4012e-04 -
val_loss: 5.2980e-04
Epoch 229/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2989e-04 -
val_loss: 5.1679e-04
Epoch 230/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.2412e-04 -
val_loss: 4.5126e-04
Epoch 231/300
1074/1074 [==============================] - 19s 18ms/step - loss: 4.4646e-04 -
val_loss: 4.5522e-04
Epoch 232/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2224e-04 -
val_loss: 4.8170e-04
Epoch 233/300
1074/1074 [==============================] - 20s 18ms/step - loss: 4.2477e-04 -
val_loss: 5.4525e-04
Epoch 234/300
1074/1074 [==============================] - 19s 18ms/step - loss: 4.3013e-04 -
val_loss: 4.4605e-04
Epoch 235/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.2675e-04 -
val_loss: 4.5496e-04
Epoch 236/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2230e-04 -
val_loss: 4.8172e-04
Epoch 237/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3104e-04 -
val_loss: 4.4060e-04
```

```
Epoch 238/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0903e-04 -
val_loss: 4.2442e-04
Epoch 239/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2452e-04 -
val_loss: 5.0123e-04
Epoch 240/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2780e-04 -
val_loss: 4.8625e-04
Epoch 241/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1323e-04 -
val_loss: 4.8198e-04
Epoch 242/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2629e-04 -
val_loss: 4.6680e-04
Epoch 243/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2391e-04 -
val_loss: 4.9039e-04
Epoch 244/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2238e-04 -
val_loss: 4.5190e-04
Epoch 245/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0957e-04 -
val_loss: 4.4630e-04
Epoch 246/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3003e-04 -
val_loss: 4.4488e-04
Epoch 247/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1553e-04 -
val_loss: 4.6762e-04
Epoch 248/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2586e-04 -
val_loss: 4.7120e-04
Epoch 249/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1850e-04 -
val_loss: 4.8001e-04
Epoch 250/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0502e-04 -
val_loss: 4.5469e-04
Epoch 251/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.1646e-04 -
val_loss: 4.4847e-04
Epoch 252/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.0949e-04 -
val_loss: 5.2868e-04
Epoch 253/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1683e-04 -
val_loss: 4.5840e-04
Epoch 254/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1000e-04 -
val_loss: 4.6655e-04
Epoch 255/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.1048e-04 -
val_loss: 4.6312e-04
Epoch 256/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0303e-04 -
val_loss: 4.4663e-04
Epoch 257/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0781e-04 -
val_loss: 4.8446e-04
Epoch 258/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1753e-04 -
val_loss: 4.7725e-04
Epoch 259/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0398e-04 -
```

```
val_loss: 4.4968e-04
Epoch 260/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1383e-04 -
val_loss: 4.3528e-04
Epoch 261/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9829e-04 -
val_loss: 4.8809e-04
Epoch 262/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.0195e-04 -
val_loss: 4.7913e-04
Epoch 263/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9970e-04 -
val_loss: 4.6129e-04
Epoch 264/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0516e-04 -
val_loss: 4.3347e-04
Epoch 265/300
1074/1074 [==============================] - 19s 18ms/step - loss: 4.0315e-04 -
val_loss: 5.4273e-04
Epoch 266/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.0250e-04 -
val_loss: 4.5348e-04
Epoch 267/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.0449e-04 -
val_loss: 4.4170e-04
Epoch 268/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9504e-04 -
val_loss: 4.4889e-04
Epoch 269/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0623e-04 -
val_loss: 4.5490e-04
Epoch 270/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9403e-04 -
val_loss: 5.3867e-04
Epoch 271/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0014e-04 -
val_loss: 4.2025e-04
Epoch 272/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.0318e-04 -
val_loss: 4.3837e-04
Epoch 273/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9514e-04 -
val_loss: 4.0682e-04
Epoch 274/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9387e-04 -
val_loss: 4.0945e-04
Epoch 275/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.0004e-04 -
val_loss: 4.5050e-04
Epoch 276/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9374e-04 -
val_loss: 4.3418e-04
Epoch 277/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9344e-04 -
val_loss: 4.4277e-04
Epoch 278/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.8638e-04 -
val_loss: 4.2483e-04
Epoch 279/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9288e-04 -
val_loss: 4.3595e-04
Epoch 280/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9835e-04 -
val_loss: 4.4796e-04
Epoch 281/300
```

```
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9177e-04 -
val_loss: 5.1772e-04
Epoch 282/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9701e-04 -
val_loss: 4.7596e-04
Epoch 283/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.8539e-04 -
val_loss: 4.2447e-04
Epoch 284/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9905e-04 -
val_loss: 4.3386e-04
Epoch 285/300
1074/1074 [==============================] - 19s 18ms/step - loss: 3.8647e-04 -
val_loss: 4.4400e-04
Epoch 286/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.7965e-04 -
val_loss: 4.3484e-04
Epoch 287/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.8613e-04 -
val_loss: 5.0365e-04
Epoch 288/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9180e-04 -
val_loss: 4.1898e-04
Epoch 289/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.8169e-04 -
val_loss: 4.2963e-04
Epoch 290/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9448e-04 -
val_loss: 4.7071e-04
Epoch 291/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8239e-04 -
val_loss: 4.3133e-04
Epoch 292/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8521e-04 -
val_loss: 4.3249e-04
Epoch 293/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.8257e-04 -
val_loss: 4.4053e-04
Epoch 294/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.7424e-04 -
val_loss: 4.2335e-04
Epoch 295/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8982e-04 -
val_loss: 4.6866e-04
Epoch 296/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.8401e-04 -
val_loss: 4.5627e-04
Epoch 297/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.7862e-04 -
val_loss: 4.2434e-04
Epoch 298/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8028e-04 -
val_loss: 4.4587e-04
Epoch 299/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8026e-04 -
val_loss: 4.7789e-04
Epoch 300/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7995e-04 -
val_loss: 4.1412e-04
Model: "sequential_3"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 lstm (LSTM)                  (None, 20, 100)           45200
```

```
dropout_12 (Dropout)         (None, 20, 100)           0

lstm_1 (LSTM)                (None, 100)               80400

dropout_13 (Dropout)         (None, 100)               0

dense_18 (Dense)             (None, 100)               10100

dense_19 (Dense)             (None, 6)                 606

=================================================================
Total params: 136,306
Trainable params: 136,306
Non-trainable params: 0
_________________________________________________________________
CPU times: user 4h 5min 55s, sys: 57min 20s, total: 5h 3min 16s
Wall time: 1h 30min 53s
```

In [69]:

```
%%time

early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=20)
save_every_epoch = tf.keras.callbacks.ModelCheckpoint(output_dir/'rnn_36_tmp.h5'

history_rnn_36 = rnn_model_36.fit(
    X_seq_train_36, Y_seq_train,
    validation_data=(X_seq_val_36, Y_seq_val),
    batch_size = rnn_batch_size,
    epochs=rnn_epochs,
    callbacks=[save_every_epoch]
    #callbacks=[early_stop, save_every_epoch]
    #verbose=0,
    )
rnn_model_36.summary()
with open(output_dir/'history_rnn_36.pickle', 'wb') as f:
    pickle.dump(history_rnn_36.history, f)
```

```
Epoch 1/300
1074/1074 [==============================] - 20s 17ms/step - loss: 0.0171 - val_
loss: 0.0094
Epoch 2/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0068 - val_
loss: 0.0046
Epoch 3/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0044 - val_
loss: 0.0038
Epoch 4/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0033 - val_
loss: 0.0033
Epoch 5/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0028 - val_
loss: 0.0030
Epoch 6/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0026 - val_
loss: 0.0026
Epoch 7/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0024 - val_
loss: 0.0027
Epoch 8/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0022 - val_
loss: 0.0047
Epoch 9/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0021 - val_
loss: 0.0016
```

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Epoch 10/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0018 - val_
loss: 0.0015
Epoch 11/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0018 - val_
loss: 0.0015
Epoch 12/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0017 - val_
loss: 0.0015
Epoch 13/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0017 - val_
loss: 0.0023
Epoch 14/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0016 - val_
loss: 0.0014
Epoch 15/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0016 - val_
loss: 0.0012
Epoch 16/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0014 - val_
loss: 0.0012
Epoch 17/300
1074/1074 [==============================] - 17s 16ms/step - loss: 0.0014 - val_
loss: 0.0011
Epoch 18/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0013 - val_
loss: 0.0011
Epoch 19/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0014 - val_
loss: 0.0010
Epoch 20/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0012 - val_
loss: 9.7564e-04
Epoch 21/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0012 - val_
loss: 0.0010
Epoch 22/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0012 - val_
loss: 8.4779e-04
Epoch 23/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0011 - val_
loss: 9.4212e-04
Epoch 24/300
1074/1074 [==============================] - 18s 16ms/step - loss: 0.0011 - val_
loss: 9.6103e-04
Epoch 25/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0010 - val_
loss: 0.0013
Epoch 26/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0010 - val_
loss: 0.0013
Epoch 27/300
1074/1074 [==============================] - 18s 16ms/step - loss: 9.5598e-04 -
val_loss: 0.0015
Epoch 28/300
1074/1074 [==============================] - 18s 17ms/step - loss: 9.7852e-04 -
val_loss: 8.7361e-04
Epoch 29/300
1074/1074 [==============================] - 18s 17ms/step - loss: 9.2261e-04 -
val_loss: 7.4076e-04
Epoch 30/300
1074/1074 [==============================] - 18s 16ms/step - loss: 9.8934e-04 -
val_loss: 7.1053e-04
Epoch 31/300
1074/1074 [==============================] - 18s 16ms/step - loss: 9.4710e-04 -
```

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val_loss: 0.0011
Epoch 32/300
1074/1074 [==============================] - 18s 17ms/step - loss: 8.8613e-04 -
val_loss: 0.0013
Epoch 33/300
1074/1074 [==============================] - 18s 17ms/step - loss: 8.8353e-04 -
val_loss: 8.8054e-04
Epoch 34/300
1074/1074 [==============================] - 18s 16ms/step - loss: 8.6680e-04 -
val_loss: 6.3769e-04
Epoch 35/300
1074/1074 [==============================] - 18s 17ms/step - loss: 8.3696e-04 -
val_loss: 8.9115e-04
Epoch 36/300
1074/1074 [==============================] - 18s 16ms/step - loss: 8.5547e-04 -
val_loss: 9.2447e-04
Epoch 37/300
1074/1074 [==============================] - 18s 16ms/step - loss: 8.1975e-04 -
val_loss: 7.0634e-04
Epoch 38/300
1074/1074 [==============================] - 18s 17ms/step - loss: 7.7249e-04 -
val_loss: 6.7383e-04
Epoch 39/300
1074/1074 [==============================] - 18s 16ms/step - loss: 8.1927e-04 -
val_loss: 9.8428e-04
Epoch 40/300
1074/1074 [==============================] - 18s 17ms/step - loss: 7.4018e-04 -
val_loss: 6.3090e-04
Epoch 41/300
1074/1074 [==============================] - 18s 16ms/step - loss: 8.0606e-04 -
val_loss: 5.9785e-04
Epoch 42/300
1074/1074 [==============================] - 18s 16ms/step - loss: 8.0581e-04 -
val_loss: 0.0012
Epoch 43/300
1074/1074 [==============================] - 18s 17ms/step - loss: 7.3756e-04 -
val_loss: 7.8855e-04
Epoch 44/300
1074/1074 [==============================] - 18s 17ms/step - loss: 7.2865e-04 -
val_loss: 5.2185e-04
Epoch 45/300
1074/1074 [==============================] - 18s 17ms/step - loss: 7.6790e-04 -
val_loss: 6.0003e-04
Epoch 46/300
1074/1074 [==============================] - 18s 16ms/step - loss: 6.6962e-04 -
val_loss: 5.9698e-04
Epoch 47/300
1074/1074 [==============================] - 18s 16ms/step - loss: 7.4170e-04 -
val_loss: 5.3282e-04
Epoch 48/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.8807e-04 -
val_loss: 6.0760e-04
Epoch 49/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.8286e-04 -
val_loss: 5.9254e-04
Epoch 50/300
1074/1074 [==============================] - 18s 16ms/step - loss: 6.6675e-04 -
val_loss: 6.5320e-04
Epoch 51/300
1074/1074 [==============================] - 18s 16ms/step - loss: 6.9559e-04 -
val_loss: 5.4442e-04
Epoch 52/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.5276e-04 -
val_loss: 5.8548e-04
Epoch 53/300
```

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1074/1074 [==============================] - 18s 16ms/step - loss: 6.6685e-04 -
val_loss: 5.3712e-04
Epoch 54/300
1074/1074 [==============================] - 18s 16ms/step - loss: 7.3792e-04 -
val_loss: 5.4564e-04
Epoch 55/300
1074/1074 [==============================] - 18s 16ms/step - loss: 6.7026e-04 -
val_loss: 5.3939e-04
Epoch 56/300
1074/1074 [==============================] - 18s 16ms/step - loss: 6.3176e-04 -
val_loss: 5.0228e-04
Epoch 57/300
1074/1074 [==============================] - 18s 16ms/step - loss: 6.3531e-04 -
val_loss: 5.0178e-04
Epoch 58/300
1074/1074 [==============================] - 18s 16ms/step - loss: 6.7246e-04 -
val_loss: 5.7214e-04
Epoch 59/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.7861e-04 -
val_loss: 5.0005e-04
Epoch 60/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.0694e-04 -
val_loss: 5.1319e-04
Epoch 61/300
1074/1074 [==============================] - 18s 16ms/step - loss: 6.0258e-04 -
val_loss: 4.8018e-04
Epoch 62/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.0157e-04 -
val_loss: 4.7658e-04
Epoch 63/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.8875e-04 -
val_loss: 7.6435e-04
Epoch 64/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.9579e-04 -
val_loss: 5.1160e-04
Epoch 65/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.7647e-04 -
val_loss: 4.7658e-04
Epoch 66/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.0224e-04 -
val_loss: 6.5257e-04
Epoch 67/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.6630e-04 -
val_loss: 5.6712e-04
Epoch 68/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.0986e-04 -
val_loss: 5.7126e-04
Epoch 69/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.3643e-04 -
val_loss: 4.4553e-04
Epoch 70/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.7145e-04 -
val_loss: 8.1703e-04
Epoch 71/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.5177e-04 -
val_loss: 4.5036e-04
Epoch 72/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.5902e-04 -
val_loss: 5.5271e-04
Epoch 73/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.3859e-04 -
val_loss: 4.7943e-04
Epoch 74/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.3995e-04 -
val_loss: 4.5644e-04
```

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Epoch 75/300
1074/1074 [==============================] - 17s 16ms/step - loss: 5.5902e-04 -
val_loss: 6.8044e-04
Epoch 76/300
1074/1074 [==============================] - 17s 16ms/step - loss: 5.2194e-04 -
val_loss: 4.3259e-04
Epoch 77/300
1074/1074 [==============================] - 17s 16ms/step - loss: 5.1758e-04 -
val_loss: 4.7240e-04
Epoch 78/300
1074/1074 [==============================] - 17s 16ms/step - loss: 5.3657e-04 -
val_loss: 7.4981e-04
Epoch 79/300
1074/1074 [==============================] - 18s 16ms/step - loss: 5.2792e-04 -
val_loss: 4.3214e-04
Epoch 80/300
1074/1074 [==============================] - 17s 16ms/step - loss: 5.6859e-04 -
val_loss: 4.3085e-04
Epoch 81/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.9580e-04 -
val_loss: 4.7299e-04
Epoch 82/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.9543e-04 -
val_loss: 4.0326e-04
Epoch 83/300
1074/1074 [==============================] - 17s 16ms/step - loss: 5.0920e-04 -
val_loss: 4.6598e-04
Epoch 84/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.9809e-04 -
val_loss: 4.8511e-04
Epoch 85/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.9935e-04 -
val_loss: 5.1469e-04
Epoch 86/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.9731e-04 -
val_loss: 4.4929e-04
Epoch 87/300
1074/1074 [==============================] - 17s 16ms/step - loss: 5.0692e-04 -
val_loss: 4.0856e-04
Epoch 88/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.8340e-04 -
val_loss: 5.0373e-04
Epoch 89/300
1074/1074 [==============================] - 18s 16ms/step - loss: 5.0760e-04 -
val_loss: 6.8855e-04
Epoch 90/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.8550e-04 -
val_loss: 4.0220e-04
Epoch 91/300
1074/1074 [==============================] - 17s 16ms/step - loss: 5.0247e-04 -
val_loss: 4.5720e-04
Epoch 92/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.6267e-04 -
val_loss: 4.4964e-04
Epoch 93/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.8802e-04 -
val_loss: 5.9274e-04
Epoch 94/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.7667e-04 -
val_loss: 5.4291e-04
Epoch 95/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.5460e-04 -
val_loss: 4.7538e-04
Epoch 96/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.2815e-04 -
```

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val_loss: 4.8149e-04
Epoch 97/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.5937e-04 -
val_loss: 4.8701e-04
Epoch 98/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.7928e-04 -
val_loss: 4.1197e-04
Epoch 99/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.8201e-04 -
val_loss: 4.2620e-04
Epoch 100/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.4784e-04 -
val_loss: 4.0776e-04
Epoch 101/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.4325e-04 -
val_loss: 4.4665e-04
Epoch 102/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.5119e-04 -
val_loss: 4.1097e-04
Epoch 103/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.5146e-04 -
val_loss: 4.1023e-04
Epoch 104/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.5497e-04 -
val_loss: 4.2961e-04
Epoch 105/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.2986e-04 -
val_loss: 3.8642e-04
Epoch 106/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.6009e-04 -
val_loss: 3.8102e-04
Epoch 107/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.3755e-04 -
val_loss: 4.7567e-04
Epoch 108/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.3242e-04 -
val_loss: 4.9961e-04
Epoch 109/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.4622e-04 -
val_loss: 4.4248e-04
Epoch 110/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.3009e-04 -
val_loss: 4.1593e-04
Epoch 111/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.2216e-04 -
val_loss: 7.0543e-04
Epoch 112/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.3839e-04 -
val_loss: 3.5631e-04
Epoch 113/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3703e-04 -
val_loss: 3.5449e-04
Epoch 114/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.3106e-04 -
val_loss: 3.9565e-04
Epoch 115/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.2486e-04 -
val_loss: 4.3420e-04
Epoch 116/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.3258e-04 -
val_loss: 3.9147e-04
Epoch 117/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3446e-04 -
val_loss: 3.6801e-04
Epoch 118/300
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1074/1074 [==============================] - 18s 16ms/step - loss: 4.0873e-04 -
val_loss: 4.9778e-04
Epoch 119/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.1947e-04 -
val_loss: 4.0966e-04
Epoch 120/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0419e-04 -
val_loss: 3.6059e-04
Epoch 121/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.0002e-04 -
val_loss: 3.6220e-04
Epoch 122/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.2194e-04 -
val_loss: 4.4894e-04
Epoch 123/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1935e-04 -
val_loss: 3.6613e-04
Epoch 124/300
1074/1074 [==============================] - 17s 16ms/step - loss: 4.1036e-04 -
val_loss: 5.5353e-04
Epoch 125/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9651e-04 -
val_loss: 3.6253e-04
Epoch 126/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.0643e-04 -
val_loss: 3.5822e-04
Epoch 127/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9938e-04 -
val_loss: 3.8173e-04
Epoch 128/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.1127e-04 -
val_loss: 4.9891e-04
Epoch 129/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.0533e-04 -
val_loss: 4.3877e-04
Epoch 130/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9960e-04 -
val_loss: 4.8582e-04
Epoch 131/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.0093e-04 -
val_loss: 3.8120e-04
Epoch 132/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.7897e-04 -
val_loss: 3.3611e-04
Epoch 133/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.7631e-04 -
val_loss: 3.3180e-04
Epoch 134/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0217e-04 -
val_loss: 3.8190e-04
Epoch 135/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1218e-04 -
val_loss: 4.1992e-04
Epoch 136/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.9252e-04 -
val_loss: 3.6806e-04
Epoch 137/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8492e-04 -
val_loss: 4.2570e-04
Epoch 138/300
1074/1074 [==============================] - 18s 16ms/step - loss: 4.1811e-04 -
val_loss: 3.8126e-04
Epoch 139/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.8236e-04 -
val_loss: 4.2223e-04
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Epoch 140/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9370e-04 -
val_loss: 3.5108e-04
Epoch 141/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.7154e-04 -
val_loss: 3.4554e-04
Epoch 142/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.8026e-04 -
val_loss: 3.4944e-04
Epoch 143/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7837e-04 -
val_loss: 3.8456e-04
Epoch 144/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.6221e-04 -
val_loss: 3.4847e-04
Epoch 145/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7529e-04 -
val_loss: 3.1479e-04
Epoch 146/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.9518e-04 -
val_loss: 3.9958e-04
Epoch 147/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.6526e-04 -
val_loss: 3.3589e-04
Epoch 148/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.5465e-04 -
val_loss: 3.7143e-04
Epoch 149/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.6282e-04 -
val_loss: 5.2815e-04
Epoch 150/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.6862e-04 -
val_loss: 4.5892e-04
Epoch 151/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.6215e-04 -
val_loss: 4.6983e-04
Epoch 152/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.6386e-04 -
val_loss: 3.1409e-04
Epoch 153/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.6263e-04 -
val_loss: 4.4883e-04
Epoch 154/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.6625e-04 -
val_loss: 3.6774e-04
Epoch 155/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.6052e-04 -
val_loss: 3.3408e-04
Epoch 156/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.6809e-04 -
val_loss: 3.9737e-04
Epoch 157/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.5723e-04 -
val_loss: 3.3015e-04
Epoch 158/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.5388e-04 -
val_loss: 3.6091e-04
Epoch 159/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.4955e-04 -
val_loss: 7.4742e-04
Epoch 160/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.6528e-04 -
val_loss: 3.3808e-04
Epoch 161/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.5115e-04 -
```

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val_loss: 3.4754e-04
Epoch 162/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.4981e-04 -
val_loss: 6.2387e-04
Epoch 163/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.6586e-04 -
val_loss: 3.3129e-04
Epoch 164/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.4584e-04 -
val_loss: 3.0952e-04
Epoch 165/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.4359e-04 -
val_loss: 3.9166e-04
Epoch 166/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.5910e-04 -
val_loss: 3.6995e-04
Epoch 167/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.4866e-04 -
val_loss: 3.6752e-04
Epoch 168/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.3740e-04 -
val_loss: 4.8594e-04
Epoch 169/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.5087e-04 -
val_loss: 3.5983e-04
Epoch 170/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.4251e-04 -
val_loss: 3.3016e-04
Epoch 171/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.3974e-04 -
val_loss: 3.5960e-04
Epoch 172/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.4782e-04 -
val_loss: 5.0070e-04
Epoch 173/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.4089e-04 -
val_loss: 3.4288e-04
Epoch 174/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.4034e-04 -
val_loss: 3.2649e-04
Epoch 175/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.3910e-04 -
val_loss: 3.3540e-04
Epoch 176/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.4060e-04 -
val_loss: 3.7163e-04
Epoch 177/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.3943e-04 -
val_loss: 3.7301e-04
Epoch 178/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.2697e-04 -
val_loss: 3.0198e-04
Epoch 179/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.2855e-04 -
val_loss: 3.0211e-04
Epoch 180/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.4524e-04 -
val_loss: 3.2062e-04
Epoch 181/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.3442e-04 -
val_loss: 3.2511e-04
Epoch 182/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.4986e-04 -
val_loss: 4.4666e-04
Epoch 183/300
```

```
1074/1074 [==============================] - 17s 16ms/step - loss: 3.4025e-04 -
val_loss: 3.5646e-04
Epoch 184/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.3623e-04 -
val_loss: 3.0442e-04
Epoch 185/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.2758e-04 -
val_loss: 3.1216e-04
Epoch 186/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.4390e-04 -
val_loss: 3.4722e-04
Epoch 187/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.3695e-04 -
val_loss: 3.1112e-04
Epoch 188/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.2291e-04 -
val_loss: 4.5938e-04
Epoch 189/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.3867e-04 -
val_loss: 3.4895e-04
Epoch 190/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.1253e-04 -
val_loss: 4.1379e-04
Epoch 191/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.2883e-04 -
val_loss: 4.1369e-04
Epoch 192/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.3508e-04 -
val_loss: 2.9761e-04
Epoch 193/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.2483e-04 -
val_loss: 3.9106e-04
Epoch 194/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.2969e-04 -
val_loss: 3.0918e-04
Epoch 195/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.1268e-04 -
val_loss: 3.2873e-04
Epoch 196/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.3492e-04 -
val_loss: 2.9723e-04
Epoch 197/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.2088e-04 -
val_loss: 3.1755e-04
Epoch 198/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.2416e-04 -
val_loss: 3.2687e-04
Epoch 199/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.1399e-04 -
val_loss: 3.0203e-04
Epoch 200/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.1206e-04 -
val_loss: 4.0367e-04
Epoch 201/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.1909e-04 -
val_loss: 3.1026e-04
Epoch 202/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.1195e-04 -
val_loss: 3.9472e-04
Epoch 203/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.2146e-04 -
val_loss: 3.2217e-04
Epoch 204/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.0652e-04 -
val_loss: 2.9793e-04
```

```
Epoch 205/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.0881e-04 -
val_loss: 3.2260e-04
Epoch 206/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.1809e-04 -
val_loss: 3.4951e-04
Epoch 207/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.0363e-04 -
val_loss: 3.1330e-04
Epoch 208/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.0864e-04 -
val_loss: 3.0329e-04
Epoch 209/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.0844e-04 -
val_loss: 3.0156e-04
Epoch 210/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.2018e-04 -
val_loss: 3.6480e-04
Epoch 211/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.0894e-04 -
val_loss: 2.9924e-04
Epoch 212/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.0372e-04 -
val_loss: 2.9274e-04
Epoch 213/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.1578e-04 -
val_loss: 3.2916e-04
Epoch 214/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.0235e-04 -
val_loss: 3.1975e-04
Epoch 215/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.1699e-04 -
val_loss: 3.0738e-04
Epoch 216/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.1615e-04 -
val_loss: 5.2356e-04
Epoch 217/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.1104e-04 -
val_loss: 3.1056e-04
Epoch 218/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.0251e-04 -
val_loss: 3.5447e-04
Epoch 219/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.9886e-04 -
val_loss: 3.1898e-04
Epoch 220/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.0442e-04 -
val_loss: 2.9624e-04
Epoch 221/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.0562e-04 -
val_loss: 3.0139e-04
Epoch 222/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.9998e-04 -
val_loss: 4.2856e-04
Epoch 223/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.9473e-04 -
val_loss: 3.2009e-04
Epoch 224/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.0307e-04 -
val_loss: 4.0242e-04
Epoch 225/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.0973e-04 -
val_loss: 3.1877e-04
Epoch 226/300
1074/1074 [==============================] - 17s 16ms/step - loss: 2.9177e-04 -
```

```
val_loss: 3.0901e-04
Epoch 227/300
1074/1074 [==============================] - 17s 16ms/step - loss: 3.0399e-04 -
val_loss: 3.0242e-04
Epoch 228/300
1074/1074 [==============================] - 17s 16ms/step - loss: 2.9374e-04 -
val_loss: 3.1426e-04
Epoch 229/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.9302e-04 -
val_loss: 2.9340e-04
Epoch 230/300
1074/1074 [==============================] - 19s 18ms/step - loss: 2.8811e-04 -
val_loss: 3.7914e-04
Epoch 231/300
1074/1074 [==============================] - 20s 18ms/step - loss: 2.9275e-04 -
val_loss: 2.9822e-04
Epoch 232/300
1074/1074 [==============================] - 20s 18ms/step - loss: 3.0468e-04 -
val_loss: 4.3580e-04
Epoch 233/300
1074/1074 [==============================] - 20s 18ms/step - loss: 2.9474e-04 -
val_loss: 2.8607e-04
Epoch 234/300
1074/1074 [==============================] - 20s 18ms/step - loss: 2.8494e-04 -
val_loss: 2.7861e-04
Epoch 235/300
1074/1074 [==============================] - 20s 19ms/step - loss: 2.9465e-04 -
val_loss: 2.8745e-04
Epoch 236/300
1074/1074 [==============================] - 20s 19ms/step - loss: 3.0131e-04 -
val_loss: 3.0864e-04
Epoch 237/300
1074/1074 [==============================] - 20s 19ms/step - loss: 2.9694e-04 -
val_loss: 3.3503e-04
Epoch 238/300
1074/1074 [==============================] - 20s 19ms/step - loss: 3.0771e-04 -
val_loss: 3.6866e-04
Epoch 239/300
1074/1074 [==============================] - 20s 19ms/step - loss: 2.8496e-04 -
val_loss: 2.9335e-04
Epoch 240/300
1074/1074 [==============================] - 20s 18ms/step - loss: 2.9638e-04 -
val_loss: 3.2088e-04
Epoch 241/300
1074/1074 [==============================] - 20s 19ms/step - loss: 2.8484e-04 -
val_loss: 3.6484e-04
Epoch 242/300
1074/1074 [==============================] - 20s 18ms/step - loss: 2.9077e-04 -
val_loss: 3.1828e-04
Epoch 243/300
1074/1074 [==============================] - 20s 18ms/step - loss: 2.8069e-04 -
val_loss: 6.2958e-04
Epoch 244/300
1074/1074 [==============================] - 20s 19ms/step - loss: 2.8831e-04 -
val_loss: 2.7502e-04
Epoch 245/300
1074/1074 [==============================] - 20s 18ms/step - loss: 2.8170e-04 -
val_loss: 3.0374e-04
Epoch 246/300
1074/1074 [==============================] - 20s 19ms/step - loss: 2.9095e-04 -
val_loss: 3.0557e-04
Epoch 247/300
1074/1074 [==============================] - 21s 19ms/step - loss: 2.8270e-04 -
val_loss: 3.7817e-04
Epoch 248/300
```

```
1074/1074 [==============================] - 20s 18ms/step - loss: 2.8376e-04 -
val_loss: 3.2313e-04
Epoch 249/300
1074/1074 [==============================] - 20s 19ms/step - loss: 2.8068e-04 -
val_loss: 3.0700e-04
Epoch 250/300
1074/1074 [==============================] - 20s 19ms/step - loss: 2.8636e-04 -
val_loss: 2.8628e-04
Epoch 251/300
1074/1074 [==============================] - 20s 18ms/step - loss: 2.7735e-04 -
val_loss: 2.7108e-04
Epoch 252/300
1074/1074 [==============================] - 20s 18ms/step - loss: 2.8556e-04 -
val_loss: 4.2837e-04
Epoch 253/300
1074/1074 [==============================] - 20s 19ms/step - loss: 2.8688e-04 -
val_loss: 3.4571e-04
Epoch 254/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7604e-04 -
val_loss: 3.3680e-04
Epoch 255/300
1074/1074 [==============================] - 17s 16ms/step - loss: 2.8165e-04 -
val_loss: 2.9827e-04
Epoch 256/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7997e-04 -
val_loss: 3.0207e-04
Epoch 257/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7815e-04 -
val_loss: 3.3716e-04
Epoch 258/300
1074/1074 [==============================] - 17s 16ms/step - loss: 2.8004e-04 -
val_loss: 2.8055e-04
Epoch 259/300
1074/1074 [==============================] - 17s 16ms/step - loss: 2.7970e-04 -
val_loss: 2.8684e-04
Epoch 260/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.8139e-04 -
val_loss: 3.2305e-04
Epoch 261/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.8022e-04 -
val_loss: 4.1291e-04
Epoch 262/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7544e-04 -
val_loss: 3.4109e-04
Epoch 263/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.7791e-04 -
val_loss: 3.6522e-04
Epoch 264/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7249e-04 -
val_loss: 3.2929e-04
Epoch 265/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7558e-04 -
val_loss: 3.0878e-04
Epoch 266/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6680e-04 -
val_loss: 2.8670e-04
Epoch 267/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.7344e-04 -
val_loss: 2.9321e-04
Epoch 268/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6382e-04 -
val_loss: 2.9939e-04
Epoch 269/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.7048e-04 -
val_loss: 3.3446e-04
```

```
Epoch 270/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.7926e-04 -
val_loss: 3.3164e-04
Epoch 271/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7264e-04 -
val_loss: 4.3591e-04
Epoch 272/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7707e-04 -
val_loss: 2.7520e-04
Epoch 273/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7693e-04 -
val_loss: 3.0178e-04
Epoch 274/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.7139e-04 -
val_loss: 3.0095e-04
Epoch 275/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7156e-04 -
val_loss: 2.9777e-04
Epoch 276/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7598e-04 -
val_loss: 3.6209e-04
Epoch 277/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6524e-04 -
val_loss: 2.7808e-04
Epoch 278/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6791e-04 -
val_loss: 4.1092e-04
Epoch 279/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.8022e-04 -
val_loss: 2.7202e-04
Epoch 280/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.8040e-04 -
val_loss: 3.0277e-04
Epoch 281/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.6420e-04 -
val_loss: 5.3401e-04
Epoch 282/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.7593e-04 -
val_loss: 2.7230e-04
Epoch 283/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.6762e-04 -
val_loss: 3.4293e-04
Epoch 284/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6277e-04 -
val_loss: 2.8616e-04
Epoch 285/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.7550e-04 -
val_loss: 3.0908e-04
Epoch 286/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6282e-04 -
val_loss: 3.9594e-04
Epoch 287/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6435e-04 -
val_loss: 3.4124e-04
Epoch 288/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6766e-04 -
val_loss: 2.9571e-04
Epoch 289/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6343e-04 -
val_loss: 3.5964e-04
Epoch 290/300
1074/1074 [==============================] - 19s 17ms/step - loss: 2.6951e-04 -
val_loss: 3.0937e-04
Epoch 291/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6419e-04 -
```

```
val_loss: 2.9235e-04
Epoch 292/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6069e-04 -
val_loss: 3.0082e-04
Epoch 293/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6264e-04 -
val_loss: 3.3003e-04
Epoch 294/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6386e-04 -
val_loss: 3.1733e-04
Epoch 295/300
1074/1074 [==============================] - 18s 16ms/step - loss: 2.5697e-04 -
val_loss: 3.3751e-04
Epoch 296/300
1074/1074 [==============================] - 17s 16ms/step - loss: 2.7905e-04 -
val_loss: 2.8409e-04
Epoch 297/300
1074/1074 [==============================] - 19s 17ms/step - loss: 2.5475e-04 -
val_loss: 2.9780e-04
Epoch 298/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.6043e-04 -
val_loss: 3.1433e-04
Epoch 299/300
1074/1074 [==============================] - 17s 16ms/step - loss: 2.6849e-04 -
val_loss: 3.2881e-04
Epoch 300/300
1074/1074 [==============================] - 18s 17ms/step - loss: 2.5034e-04 -
val_loss: 2.7966e-04
Model: "sequential_4"
_________________________________________________________________
 Layer (type)                 Output Shape              Param #
=================================================================
 lstm_2 (LSTM)                (None, 20, 100)           54800

 dropout_14 (Dropout)         (None, 20, 100)           0

 lstm_3 (LSTM)                (None, 100)               80400

 dropout_15 (Dropout)         (None, 100)               0

 dense_20 (Dense)             (None, 100)               10100

 dense_21 (Dense)             (None, 6)                 606

=================================================================
Total params: 145,906
Trainable params: 145,906
Non-trainable params: 0
_________________________________________________________________
CPU times: user 4h 7min 58s, sys: 56min 32s, total: 5h 4min 31s
Wall time: 1h 29min 17s
```

In [70]:

```
%%time

early_stop = tf.keras.callbacks.EarlyStopping(monitor='val_loss', patience=20)
save_every_epoch = tf.keras.callbacks.ModelCheckpoint(output_dir/'rnn_84_tmp.h5'

history_rnn_84 = rnn_model_84.fit(
    X_seq_train, Y_seq_train,
    validation_data=(X_seq_val, Y_seq_val),
    batch_size = rnn_batch_size,
    epochs=rnn_epochs,
    callbacks=[save_every_epoch]
```

```
    #callbacks=[early_stop, save_every_epoch]
    #verbose=0,
    )
rnn_model_84.summary()
with open(output_dir/'history_rnn_84.pickle', 'wb') as f:
    pickle.dump(history_rnn_84.history, f)
```

```
Epoch 1/300
1074/1074 [==============================] - 20s 17ms/step - loss: 0.0185 - val_
loss: 0.0110
Epoch 2/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0083 - val_
loss: 0.0058
Epoch 3/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0054 - val_
loss: 0.0082
Epoch 4/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0047 - val_
loss: 0.0033
Epoch 5/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0038 - val_
loss: 0.0030
Epoch 6/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0034 - val_
loss: 0.0042
Epoch 7/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0031 - val_
loss: 0.0085
Epoch 8/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0027 - val_
loss: 0.0021
Epoch 9/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0025 - val_
loss: 0.0035
Epoch 10/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0024 - val_
loss: 0.0039
Epoch 11/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0024 - val_
loss: 0.0025
Epoch 12/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0020 - val_
loss: 0.0016
Epoch 13/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0019 - val_
loss: 0.0019
Epoch 14/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0020 - val_
loss: 0.0016
Epoch 15/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0020 - val_
loss: 0.0014
Epoch 16/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0020 - val_
loss: 0.0017
Epoch 17/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0018 - val_
loss: 0.0020
Epoch 18/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0017 - val_
loss: 0.0015
Epoch 19/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0016 - val_
loss: 0.0013
```

```
Epoch 20/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0016 - val_
loss: 0.0012
Epoch 21/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0016 - val_
loss: 0.0014
Epoch 22/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0015 - val_
loss: 0.0012
Epoch 23/300
1074/1074 [==============================] - 19s 17ms/step - loss: 0.0015 - val_
loss: 0.0012
Epoch 24/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0014 - val_
loss: 0.0014
Epoch 25/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0014 - val_
loss: 0.0012
Epoch 26/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0014 - val_
loss: 0.0011
Epoch 27/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0014 - val_
loss: 9.9421e-04
Epoch 28/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0015 - val_
loss: 0.0016
Epoch 29/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0013 - val_
loss: 9.5047e-04
Epoch 30/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0012 - val_
loss: 9.2328e-04
Epoch 31/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0012 - val_
loss: 0.0011
Epoch 32/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0012 - val_
loss: 0.0016
Epoch 33/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0011 - val_
loss: 8.0975e-04
Epoch 34/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0012 - val_
loss: 8.3571e-04
Epoch 35/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0011 - val_
loss: 7.7807e-04
Epoch 36/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0012 - val_
loss: 7.5977e-04
Epoch 37/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0011 - val_
loss: 8.4549e-04
Epoch 38/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0011 - val_
loss: 8.3697e-04
Epoch 39/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0010 - val_
loss: 0.0017
Epoch 40/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0010 - val_
loss: 0.0012
Epoch 41/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0011 - val_
```

```
loss: 8.0639e-04
Epoch 42/300
1074/1074 [==============================] - 18s 17ms/step - loss: 9.8903e-04 -
val_loss: 0.0052
Epoch 43/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0011 - val_
loss: 7.6488e-04
Epoch 44/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0010 - val_
loss: 0.0012
Epoch 45/300
1074/1074 [==============================] - 18s 17ms/step - loss: 0.0010 - val_
loss: 6.9760e-04
Epoch 46/300
1074/1074 [==============================] - 18s 17ms/step - loss: 9.1657e-04 -
val_loss: 0.0018
Epoch 47/300
1074/1074 [==============================] - 18s 17ms/step - loss: 9.0142e-04 -
val_loss: 7.7446e-04
Epoch 48/300
1074/1074 [==============================] - 20s 19ms/step - loss: 9.0158e-04 -
val_loss: 7.5985e-04
Epoch 49/300
1074/1074 [==============================] - 20s 19ms/step - loss: 9.2222e-04 -
val_loss: 9.3784e-04
Epoch 50/300
1074/1074 [==============================] - 19s 18ms/step - loss: 8.8561e-04 -
val_loss: 0.0012
Epoch 51/300
1074/1074 [==============================] - 19s 18ms/step - loss: 8.8007e-04 -
val_loss: 6.7388e-04
Epoch 52/300
1074/1074 [==============================] - 19s 18ms/step - loss: 9.3094e-04 -
val_loss: 8.0873e-04
Epoch 53/300
1074/1074 [==============================] - 19s 18ms/step - loss: 8.2848e-04 -
val_loss: 6.9909e-04
Epoch 54/300
1074/1074 [==============================] - 19s 18ms/step - loss: 8.4910e-04 -
val_loss: 7.6867e-04
Epoch 55/300
1074/1074 [==============================] - 19s 18ms/step - loss: 8.9716e-04 -
val_loss: 0.0016
Epoch 56/300
1074/1074 [==============================] - 19s 18ms/step - loss: 8.8283e-04 -
val_loss: 9.5373e-04
Epoch 57/300
1074/1074 [==============================] - 19s 18ms/step - loss: 8.0390e-04 -
val_loss: 5.9665e-04
Epoch 58/300
1074/1074 [==============================] - 21s 19ms/step - loss: 8.3606e-04 -
val_loss: 0.0015
Epoch 59/300
1074/1074 [==============================] - 20s 18ms/step - loss: 9.3143e-04 -
val_loss: 0.0019
Epoch 60/300
1074/1074 [==============================] - 19s 18ms/step - loss: 8.3622e-04 -
val_loss: 6.7212e-04
Epoch 61/300
1074/1074 [==============================] - 19s 18ms/step - loss: 7.9123e-04 -
val_loss: 6.9955e-04
Epoch 62/300
1074/1074 [==============================] - 19s 18ms/step - loss: 7.7866e-04 -
val_loss: 7.5570e-04
Epoch 63/300
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1074/1074 [==============================] - 19s 18ms/step - loss: 7.7623e-04 -
val_loss: 6.0547e-04
Epoch 64/300
1074/1074 [==============================] - 19s 18ms/step - loss: 7.4391e-04 -
val_loss: 0.0011
Epoch 65/300
1074/1074 [==============================] - 20s 18ms/step - loss: 8.2398e-04 -
val_loss: 7.1976e-04
Epoch 66/300
1074/1074 [==============================] - 19s 18ms/step - loss: 7.9055e-04 -
val_loss: 5.7308e-04
Epoch 67/300
1074/1074 [==============================] - 19s 18ms/step - loss: 7.3522e-04 -
val_loss: 6.6763e-04
Epoch 68/300
1074/1074 [==============================] - 19s 18ms/step - loss: 7.7277e-04 -
val_loss: 7.4603e-04
Epoch 69/300
1074/1074 [==============================] - 19s 18ms/step - loss: 7.3243e-04 -
val_loss: 6.2913e-04
Epoch 70/300
1074/1074 [==============================] - 19s 18ms/step - loss: 7.4717e-04 -
val_loss: 6.6798e-04
Epoch 71/300
1074/1074 [==============================] - 19s 18ms/step - loss: 8.1956e-04 -
val_loss: 5.1393e-04
Epoch 72/300
1074/1074 [==============================] - 19s 18ms/step - loss: 7.2869e-04 -
val_loss: 5.2713e-04
Epoch 73/300
1074/1074 [==============================] - 19s 18ms/step - loss: 7.4901e-04 -
val_loss: 9.0424e-04
Epoch 74/300
1074/1074 [==============================] - 20s 18ms/step - loss: 7.2292e-04 -
val_loss: 6.2707e-04
Epoch 75/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.6834e-04 -
val_loss: 5.9321e-04
Epoch 76/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.6918e-04 -
val_loss: 7.9918e-04
Epoch 77/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.9393e-04 -
val_loss: 5.2042e-04
Epoch 78/300
1074/1074 [==============================] - 18s 17ms/step - loss: 7.0354e-04 -
val_loss: 5.1253e-04
Epoch 79/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.7468e-04 -
val_loss: 9.5659e-04
Epoch 80/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.6551e-04 -
val_loss: 5.0816e-04
Epoch 81/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.9431e-04 -
val_loss: 7.5679e-04
Epoch 82/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.7167e-04 -
val_loss: 5.4897e-04
Epoch 83/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.5725e-04 -
val_loss: 5.8101e-04
Epoch 84/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.5200e-04 -
val_loss: 5.2693e-04
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Epoch 85/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.5595e-04 -
val_loss: 6.8314e-04
Epoch 86/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.6670e-04 -
val_loss: 7.2662e-04
Epoch 87/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.5896e-04 -
val_loss: 5.6436e-04
Epoch 88/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.7130e-04 -
val_loss: 4.6343e-04
Epoch 89/300
1074/1074 [==============================] - 18s 17ms/step - loss: 6.1096e-04 -
val_loss: 4.8416e-04
Epoch 90/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.6208e-04 -
val_loss: 4.4724e-04
Epoch 91/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.4827e-04 -
val_loss: 5.8953e-04
Epoch 92/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.1552e-04 -
val_loss: 0.0033
Epoch 93/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.6442e-04 -
val_loss: 4.9387e-04
Epoch 94/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.9173e-04 -
val_loss: 6.0315e-04
Epoch 95/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.2786e-04 -
val_loss: 4.5620e-04
Epoch 96/300
1074/1074 [==============================] - 19s 17ms/step - loss: 6.2217e-04 -
val_loss: 7.0626e-04
Epoch 97/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.6807e-04 -
val_loss: 4.6684e-04
Epoch 98/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.0467e-04 -
val_loss: 5.3211e-04
Epoch 99/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.7162e-04 -
val_loss: 5.0400e-04
Epoch 100/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.2328e-04 -
val_loss: 5.8032e-04
Epoch 101/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.2942e-04 -
val_loss: 4.8641e-04
Epoch 102/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.7230e-04 -
val_loss: 5.6387e-04
Epoch 103/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.8967e-04 -
val_loss: 6.0163e-04
Epoch 104/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.6953e-04 -
val_loss: 6.1696e-04
Epoch 105/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.7211e-04 -
val_loss: 0.0027
Epoch 106/300
1074/1074 [==============================] - 19s 18ms/step - loss: 6.3767e-04 -
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val_loss: 5.2899e-04
Epoch 107/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.8733e-04 -
val_loss: 4.3668e-04
Epoch 108/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.8764e-04 -
val_loss: 6.8402e-04
Epoch 109/300
1074/1074 [==============================] - 20s 19ms/step - loss: 5.7041e-04 -
val_loss: 9.3930e-04
Epoch 110/300
1074/1074 [==============================] - 20s 18ms/step - loss: 5.3707e-04 -
val_loss: 5.4404e-04
Epoch 111/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.8022e-04 -
val_loss: 4.6224e-04
Epoch 112/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.6963e-04 -
val_loss: 5.5088e-04
Epoch 113/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.7198e-04 -
val_loss: 4.2651e-04
Epoch 114/300
1074/1074 [==============================] - 20s 18ms/step - loss: 5.6844e-04 -
val_loss: 6.3290e-04
Epoch 115/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.5753e-04 -
val_loss: 4.7665e-04
Epoch 116/300
1074/1074 [==============================] - 20s 18ms/step - loss: 5.6005e-04 -
val_loss: 4.6921e-04
Epoch 117/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.5825e-04 -
val_loss: 7.5932e-04
Epoch 118/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.3487e-04 -
val_loss: 4.3144e-04
Epoch 119/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.6064e-04 -
val_loss: 5.5349e-04
Epoch 120/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.1716e-04 -
val_loss: 4.6723e-04
Epoch 121/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.3491e-04 -
val_loss: 4.8742e-04
Epoch 122/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.3180e-04 -
val_loss: 9.0151e-04
Epoch 123/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.0652e-04 -
val_loss: 4.2963e-04
Epoch 124/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.3564e-04 -
val_loss: 5.3344e-04
Epoch 125/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.3042e-04 -
val_loss: 4.5385e-04
Epoch 126/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.4185e-04 -
val_loss: 5.5588e-04
Epoch 127/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.7317e-04 -
val_loss: 4.4133e-04
Epoch 128/300
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1074/1074 [==============================] - 19s 18ms/step - loss: 4.9603e-04 -
val_loss: 4.1820e-04
Epoch 129/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.5219e-04 -
val_loss: 4.6013e-04
Epoch 130/300
1074/1074 [==============================] - 19s 18ms/step - loss: 4.9297e-04 -
val_loss: 4.3298e-04
Epoch 131/300
1074/1074 [==============================] - 19s 18ms/step - loss: 5.1615e-04 -
val_loss: 5.3784e-04
Epoch 132/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.8913e-04 -
val_loss: 4.5093e-04
Epoch 133/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.1579e-04 -
val_loss: 5.0725e-04
Epoch 134/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.1985e-04 -
val_loss: 5.1672e-04
Epoch 135/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.0320e-04 -
val_loss: 5.7447e-04
Epoch 136/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.2768e-04 -
val_loss: 4.3644e-04
Epoch 137/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.1329e-04 -
val_loss: 7.0698e-04
Epoch 138/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.9808e-04 -
val_loss: 4.4093e-04
Epoch 139/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.8682e-04 -
val_loss: 3.8655e-04
Epoch 140/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.3360e-04 -
val_loss: 4.4063e-04
Epoch 141/300
1074/1074 [==============================] - 19s 18ms/step - loss: 4.9850e-04 -
val_loss: 4.2660e-04
Epoch 142/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.6296e-04 -
val_loss: 5.0464e-04
Epoch 143/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.1031e-04 -
val_loss: 4.1748e-04
Epoch 144/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.6398e-04 -
val_loss: 3.9401e-04
Epoch 145/300
1074/1074 [==============================] - 19s 17ms/step - loss: 5.1747e-04 -
val_loss: 5.1280e-04
Epoch 146/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.8504e-04 -
val_loss: 3.8179e-04
Epoch 147/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.8597e-04 -
val_loss: 3.9366e-04
Epoch 148/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7430e-04 -
val_loss: 8.3642e-04
Epoch 149/300
1074/1074 [==============================] - 18s 17ms/step - loss: 5.0219e-04 -
val_loss: 4.1293e-04
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Epoch 150/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7034e-04 -
val_loss: 4.5023e-04
Epoch 151/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.4843e-04 -
val_loss: 4.8017e-04
Epoch 152/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.8476e-04 -
val_loss: 3.7373e-04
Epoch 153/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.9080e-04 -
val_loss: 4.1534e-04
Epoch 154/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7344e-04 -
val_loss: 4.2208e-04
Epoch 155/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.9261e-04 -
val_loss: 6.1455e-04
Epoch 156/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7424e-04 -
val_loss: 3.8863e-04
Epoch 157/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6797e-04 -
val_loss: 5.0949e-04
Epoch 158/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6621e-04 -
val_loss: 5.2586e-04
Epoch 159/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6837e-04 -
val_loss: 4.1202e-04
Epoch 160/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.5965e-04 -
val_loss: 3.7584e-04
Epoch 161/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.6660e-04 -
val_loss: 4.2800e-04
Epoch 162/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.4945e-04 -
val_loss: 3.7953e-04
Epoch 163/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6314e-04 -
val_loss: 3.7125e-04
Epoch 164/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.5252e-04 -
val_loss: 3.7839e-04
Epoch 165/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.4439e-04 -
val_loss: 6.5117e-04
Epoch 166/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6859e-04 -
val_loss: 4.5572e-04
Epoch 167/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.4802e-04 -
val_loss: 4.9065e-04
Epoch 168/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.5822e-04 -
val_loss: 4.5618e-04
Epoch 169/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.6464e-04 -
val_loss: 4.2303e-04
Epoch 170/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.5288e-04 -
val_loss: 5.5509e-04
Epoch 171/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.4744e-04 -
```

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val_loss: 5.6286e-04
Epoch 172/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.5269e-04 -
val_loss: 3.8986e-04
Epoch 173/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7305e-04 -
val_loss: 4.2242e-04
Epoch 174/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.5369e-04 -
val_loss: 3.7615e-04
Epoch 175/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3549e-04 -
val_loss: 4.9872e-04
Epoch 176/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.7386e-04 -
val_loss: 4.3258e-04
Epoch 177/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3000e-04 -
val_loss: 0.0030
Epoch 178/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.9696e-04 -
val_loss: 3.7470e-04
Epoch 179/300
1074/1074 [==============================] - 19s 18ms/step - loss: 4.4023e-04 -
val_loss: 3.9355e-04
Epoch 180/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2067e-04 -
val_loss: 4.0569e-04
Epoch 181/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.5671e-04 -
val_loss: 3.6220e-04
Epoch 182/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1870e-04 -
val_loss: 3.6918e-04
Epoch 183/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3903e-04 -
val_loss: 3.6436e-04
Epoch 184/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2931e-04 -
val_loss: 3.6310e-04
Epoch 185/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2964e-04 -
val_loss: 3.7121e-04
Epoch 186/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3010e-04 -
val_loss: 3.7364e-04
Epoch 187/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.4875e-04 -
val_loss: 4.1475e-04
Epoch 188/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1212e-04 -
val_loss: 3.4722e-04
Epoch 189/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0913e-04 -
val_loss: 3.4424e-04
Epoch 190/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1974e-04 -
val_loss: 5.1696e-04
Epoch 191/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.3612e-04 -
val_loss: 3.9290e-04
Epoch 192/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2259e-04 -
val_loss: 6.7331e-04
Epoch 193/300
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1074/1074 [==============================] - 18s 17ms/step - loss: 4.2159e-04 -
val_loss: 3.7723e-04
Epoch 194/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.1129e-04 -
val_loss: 3.7140e-04
Epoch 195/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.1328e-04 -
val_loss: 3.7299e-04
Epoch 196/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0923e-04 -
val_loss: 3.5940e-04
Epoch 197/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.1072e-04 -
val_loss: 3.3917e-04
Epoch 198/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0960e-04 -
val_loss: 4.9170e-04
Epoch 199/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.0807e-04 -
val_loss: 3.6784e-04
Epoch 200/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.1649e-04 -
val_loss: 3.6175e-04
Epoch 201/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0682e-04 -
val_loss: 6.2109e-04
Epoch 202/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.2206e-04 -
val_loss: 3.6473e-04
Epoch 203/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.4387e-04 -
val_loss: 5.4312e-04
Epoch 204/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9857e-04 -
val_loss: 3.3695e-04
Epoch 205/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0508e-04 -
val_loss: 3.8047e-04
Epoch 206/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9549e-04 -
val_loss: 4.4425e-04
Epoch 207/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.1499e-04 -
val_loss: 6.1601e-04
Epoch 208/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8586e-04 -
val_loss: 4.7474e-04
Epoch 209/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0226e-04 -
val_loss: 4.1521e-04
Epoch 210/300
1074/1074 [==============================] - 19s 17ms/step - loss: 4.0040e-04 -
val_loss: 5.8141e-04
Epoch 211/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0082e-04 -
val_loss: 4.5608e-04
Epoch 212/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9973e-04 -
val_loss: 3.4553e-04
Epoch 213/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.8540e-04 -
val_loss: 4.9446e-04
Epoch 214/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9863e-04 -
val_loss: 3.3368e-04
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Epoch 215/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9068e-04 -
val_loss: 3.5631e-04
Epoch 216/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9361e-04 -
val_loss: 3.4110e-04
Epoch 217/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.9380e-04 -
val_loss: 3.6490e-04
Epoch 218/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9644e-04 -
val_loss: 3.4883e-04
Epoch 219/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0278e-04 -
val_loss: 3.2957e-04
Epoch 220/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9341e-04 -
val_loss: 4.2799e-04
Epoch 221/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8764e-04 -
val_loss: 4.4054e-04
Epoch 222/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9818e-04 -
val_loss: 3.2500e-04
Epoch 223/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8357e-04 -
val_loss: 3.3161e-04
Epoch 224/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8726e-04 -
val_loss: 4.8841e-04
Epoch 225/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9223e-04 -
val_loss: 4.6660e-04
Epoch 226/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7012e-04 -
val_loss: 3.3367e-04
Epoch 227/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7705e-04 -
val_loss: 4.9727e-04
Epoch 228/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8785e-04 -
val_loss: 4.6724e-04
Epoch 229/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8824e-04 -
val_loss: 3.4931e-04
Epoch 230/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7477e-04 -
val_loss: 3.1034e-04
Epoch 231/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7509e-04 -
val_loss: 5.3348e-04
Epoch 232/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8483e-04 -
val_loss: 4.8173e-04
Epoch 233/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7978e-04 -
val_loss: 3.6726e-04
Epoch 234/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9241e-04 -
val_loss: 3.3872e-04
Epoch 235/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.6707e-04 -
val_loss: 3.3103e-04
Epoch 236/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.6896e-04 -
```

```
val_loss: 3.1745e-04
Epoch 237/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7924e-04 -
val_loss: 3.1178e-04
Epoch 238/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7496e-04 -
val_loss: 4.8041e-04
Epoch 239/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.9049e-04 -
val_loss: 3.3152e-04
Epoch 240/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.5432e-04 -
val_loss: 3.3925e-04
Epoch 241/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8617e-04 -
val_loss: 3.3674e-04
Epoch 242/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.6235e-04 -
val_loss: 3.4419e-04
Epoch 243/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.5768e-04 -
val_loss: 3.6075e-04
Epoch 244/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.8484e-04 -
val_loss: 3.1646e-04
Epoch 245/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.6921e-04 -
val_loss: 3.1919e-04
Epoch 246/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7764e-04 -
val_loss: 3.3364e-04
Epoch 247/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.5990e-04 -
val_loss: 3.2193e-04
Epoch 248/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.6704e-04 -
val_loss: 3.2476e-04
Epoch 249/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.6690e-04 -
val_loss: 4.1392e-04
Epoch 250/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7071e-04 -
val_loss: 3.2417e-04
Epoch 251/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.7490e-04 -
val_loss: 3.3869e-04
Epoch 252/300
1074/1074 [==============================] - 19s 18ms/step - loss: 3.5926e-04 -
val_loss: 3.8042e-04
Epoch 253/300
1074/1074 [==============================] - 19s 18ms/step - loss: 3.5120e-04 -
val_loss: 4.0974e-04
Epoch 254/300
1074/1074 [==============================] - 19s 18ms/step - loss: 3.5692e-04 -
val_loss: 3.2376e-04
Epoch 255/300
1074/1074 [==============================] - 20s 18ms/step - loss: 3.6642e-04 -
val_loss: 3.2220e-04
Epoch 256/300
1074/1074 [==============================] - 20s 18ms/step - loss: 3.7831e-04 -
val_loss: 4.7888e-04
Epoch 257/300
1074/1074 [==============================] - 20s 18ms/step - loss: 3.5547e-04 -
val_loss: 3.3280e-04
Epoch 258/300
```

```
1074/1074 [==============================] - 20s 18ms/step - loss: 3.8131e-04 -
val_loss: 4.2039e-04
Epoch 259/300
1074/1074 [==============================] - 20s 18ms/step - loss: 3.4808e-04 -
val_loss: 3.1429e-04
Epoch 260/300
1074/1074 [==============================] - 19s 18ms/step - loss: 3.5839e-04 -
val_loss: 3.4274e-04
Epoch 261/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.6618e-04 -
val_loss: 3.2722e-04
Epoch 262/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.6108e-04 -
val_loss: 3.0638e-04
Epoch 263/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.8792e-04 -
val_loss: 0.0010
Epoch 264/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.6260e-04 -
val_loss: 3.0172e-04
Epoch 265/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.5356e-04 -
val_loss: 3.3030e-04
Epoch 266/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.5785e-04 -
val_loss: 3.1638e-04
Epoch 267/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.6040e-04 -
val_loss: 3.4358e-04
Epoch 268/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.5242e-04 -
val_loss: 3.7313e-04
Epoch 269/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.6510e-04 -
val_loss: 3.5251e-04
Epoch 270/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.5674e-04 -
val_loss: 3.0192e-04
Epoch 271/300
1074/1074 [==============================] - 19s 18ms/step - loss: 3.5432e-04 -
val_loss: 3.3355e-04
Epoch 272/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.3897e-04 -
val_loss: 3.1197e-04
Epoch 273/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.5100e-04 -
val_loss: 3.6977e-04
Epoch 274/300
1074/1074 [==============================] - 18s 16ms/step - loss: 3.4903e-04 -
val_loss: 3.4840e-04
Epoch 275/300
1074/1074 [==============================] - 19s 18ms/step - loss: 3.4790e-04 -
val_loss: 5.1002e-04
Epoch 276/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.5692e-04 -
val_loss: 4.3563e-04
Epoch 277/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.4891e-04 -
val_loss: 3.9057e-04
Epoch 278/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.4766e-04 -
val_loss: 3.6534e-04
Epoch 279/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.4788e-04 -
val_loss: 3.1635e-04
```

```
Epoch 280/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.4375e-04 -
val_loss: 3.0661e-04
Epoch 281/300
1074/1074 [==============================] - 19s 18ms/step - loss: 3.3585e-04 -
val_loss: 2.9904e-04
Epoch 282/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.5170e-04 -
val_loss: 5.2426e-04
Epoch 283/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.5016e-04 -
val_loss: 3.1220e-04
Epoch 284/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.5126e-04 -
val_loss: 3.0976e-04
Epoch 285/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.3903e-04 -
val_loss: 2.9671e-04
Epoch 286/300
1074/1074 [==============================] - 19s 18ms/step - loss: 3.5041e-04 -
val_loss: 2.8876e-04
Epoch 287/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.2750e-04 -
val_loss: 3.2305e-04
Epoch 288/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.6276e-04 -
val_loss: 3.5906e-04
Epoch 289/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.3655e-04 -
val_loss: 3.1125e-04
Epoch 290/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.4295e-04 -
val_loss: 3.2457e-04
Epoch 291/300
1074/1074 [==============================] - 19s 17ms/step - loss: 3.3137e-04 -
val_loss: 3.0604e-04
Epoch 292/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.6438e-04 -
val_loss: 3.8535e-04
Epoch 293/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.4629e-04 -
val_loss: 3.1418e-04
Epoch 294/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.3425e-04 -
val_loss: 3.0500e-04
Epoch 295/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.4192e-04 -
val_loss: 3.6850e-04
Epoch 296/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.3095e-04 -
val_loss: 3.4243e-04
Epoch 297/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.3362e-04 -
val_loss: 3.0202e-04
Epoch 298/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.2846e-04 -
val_loss: 2.9990e-04
Epoch 299/300
1074/1074 [==============================] - 18s 17ms/step - loss: 3.4338e-04 -
val_loss: 0.0019
Epoch 300/300
1074/1074 [==============================] - 18s 17ms/step - loss: 4.0307e-04 -
val_loss: 4.0146e-04
Model: "sequential_5"
_________________________________________________________________
```

```
 Layer (type)                 Output Shape              Param #
=================================================================
 lstm_4 (LSTM)                (None, 20, 100)           74000

 dropout_16 (Dropout)         (None, 20, 100)           0

 lstm_5 (LSTM)                (None, 100)               80400

 dropout_17 (Dropout)         (None, 100)               0

 dense_22 (Dense)             (None, 100)               10100

 dense_23 (Dense)             (None, 6)                 606

=================================================================
Total params: 165,106
Trainable params: 165,106
Non-trainable params: 0
_________________________________________________________________
CPU times: user 4h 22min 8s, sys: 1h 27s, total: 5h 22min 35s
Wall time: 1h 32min 51s
```

## Save RNN model

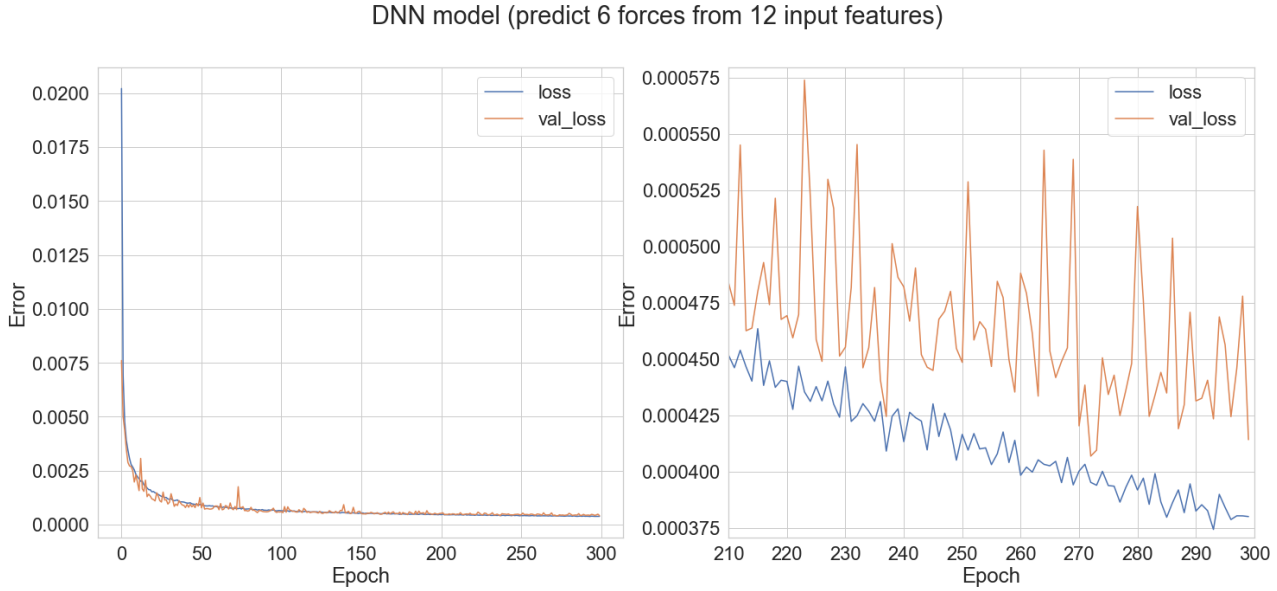
In [71]:
```
rnn_model_12.save(output_dir/"{}_{}.h5".format(rnn_model_12_tag, timestamp), sav
```

In [72]:
```
rnn_model_36.save(output_dir/"{}_{}.h5".format(rnn_model_36_tag, timestamp), sav
```

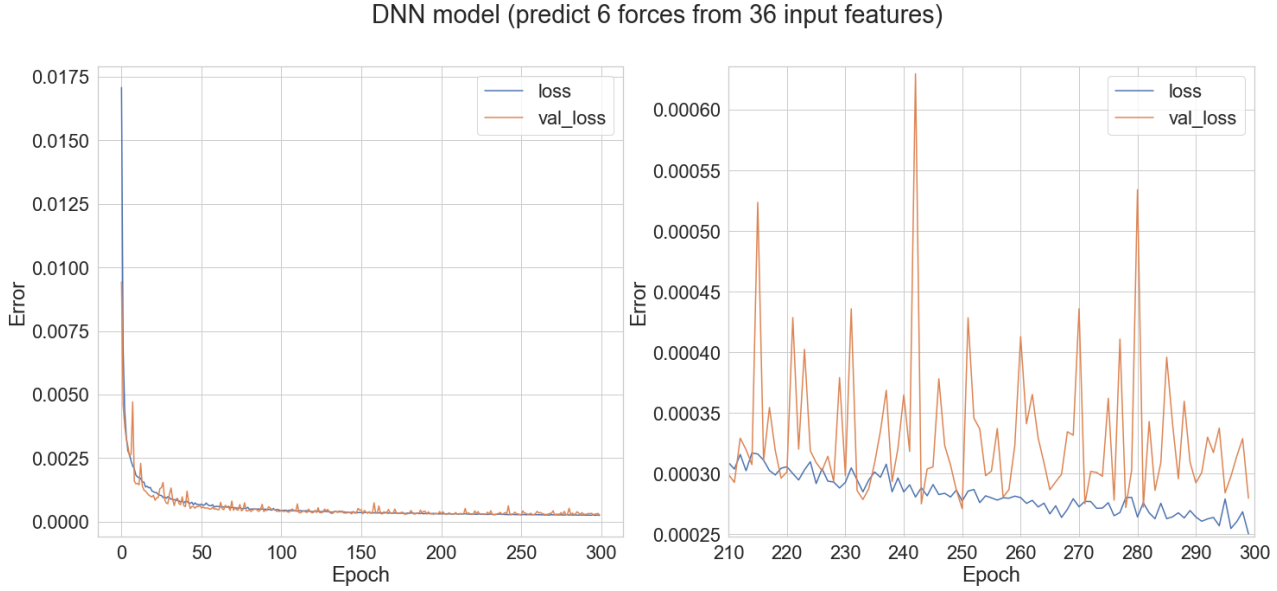
In [73]:
```
rnn_model_84.save(output_dir/"{}_{}.h5".format(rnn_model_84_tag, timestamp), sav
```

## Plot loss vs. epoch

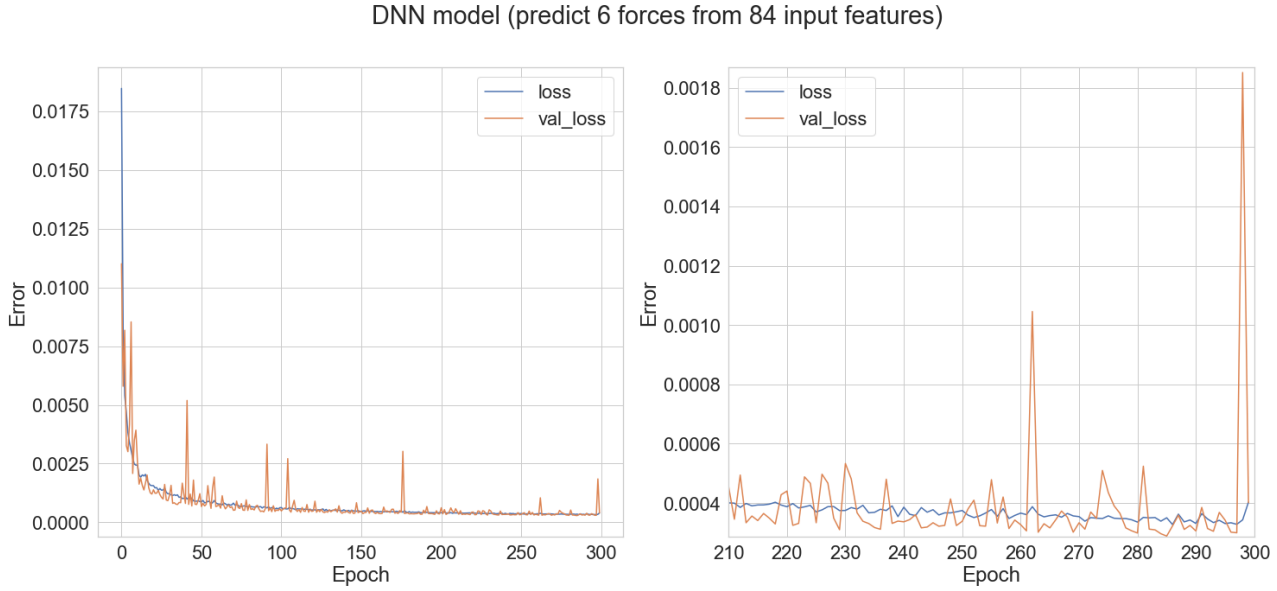
In [171…
```
plot_loss(history_rnn_12, 'error_vs_epoch_{}.pdf'.format(rnn_model_12_tag), 'DNN
```




In [172…
```
plot_loss(history_rnn_36, 'error_vs_epoch_{}.pdf'.format(rnn_model_36_tag), 'DNN
```




In [173…
```
plot_loss(history_rnn_84, 'error_vs_epoch_{}.pdf'.format(rnn_model_84_tag), 'DNN
```



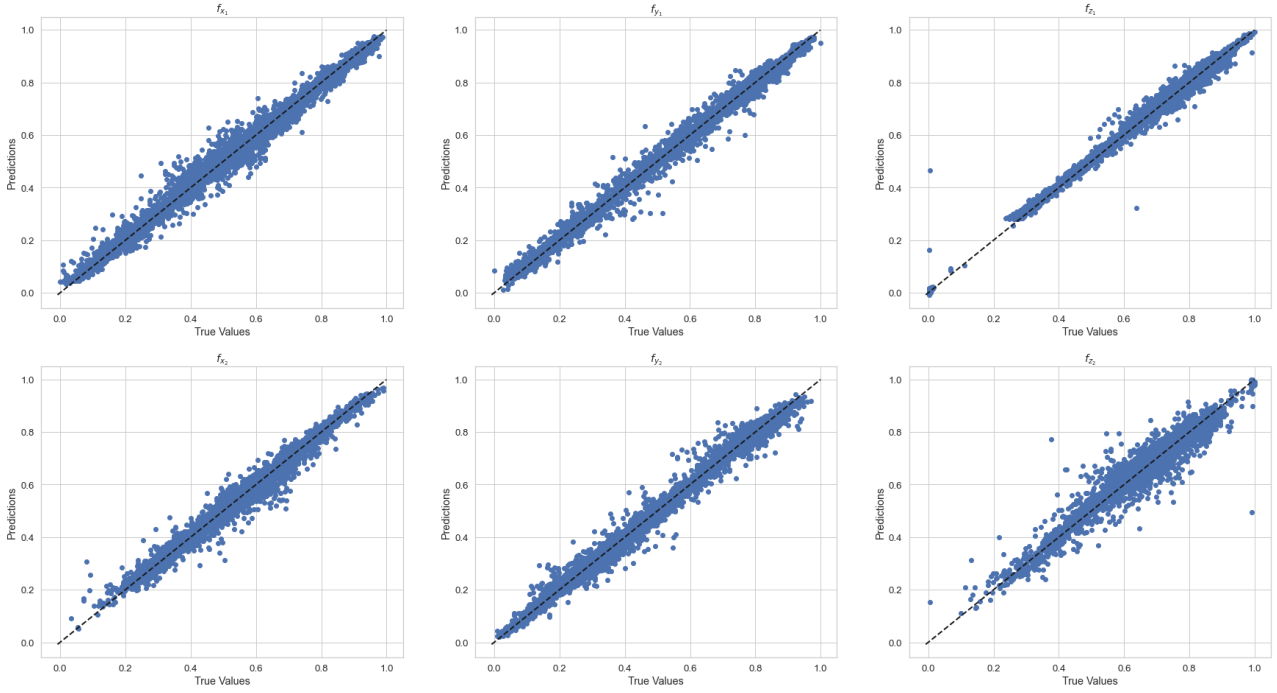

In [174…
```
# save model loss on test set for evaluation section below
test_results['rnn_12'] = rnn_model_12.evaluate(X_seq_test_12, Y_seq_test, verbos
```

In [175…
```
# save model loss on test set for evaluation section below
test_results['rnn_36'] = rnn_model_36.evaluate(X_seq_test_36, Y_seq_test, verbos
```

In [176…
```
# save model loss on test set for evaluation section below
test_results['rnn_84'] = rnn_model_84.evaluate(X_seq_test, Y_seq_test, verbose=0
```

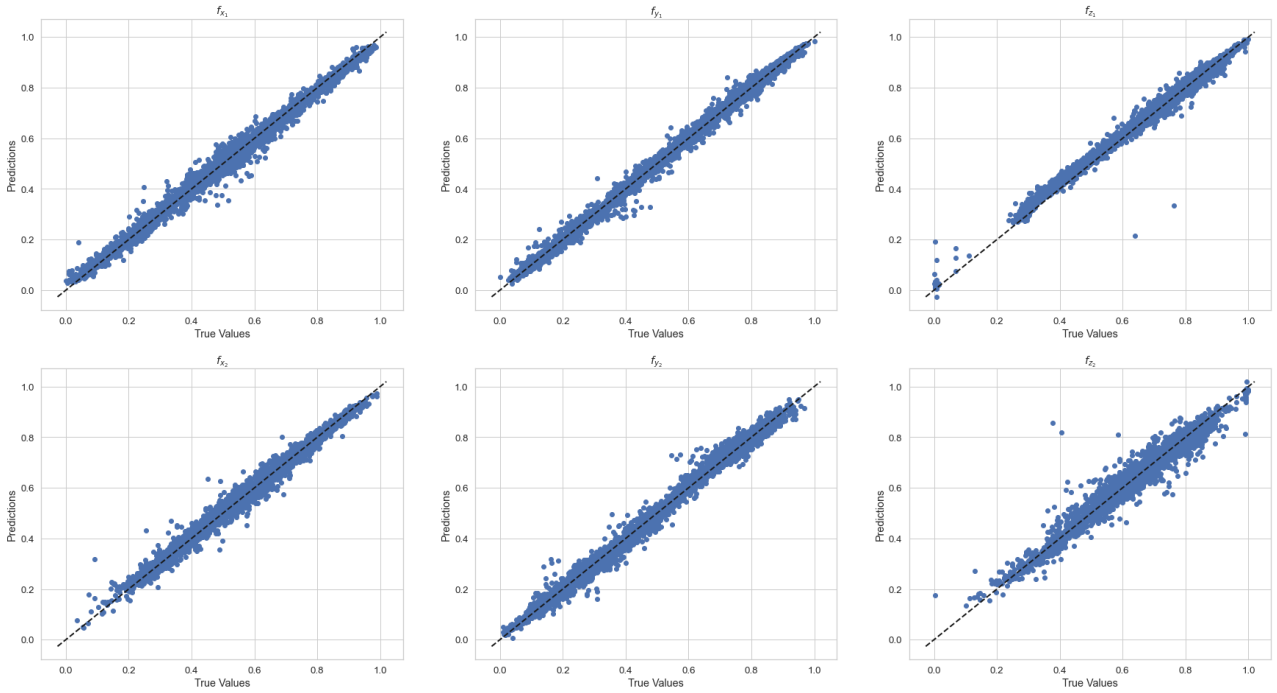
## Compare prediction vs. true values for the test set

In [80]:
```
Y_seq_test_pred_12 = rnn_model_12.predict(X_seq_test_12)
plot_pred_vs_true(Y_seq_test_pred_12, Y_seq_test, 'pred_vs_true_{}'.format(rnn_m
```



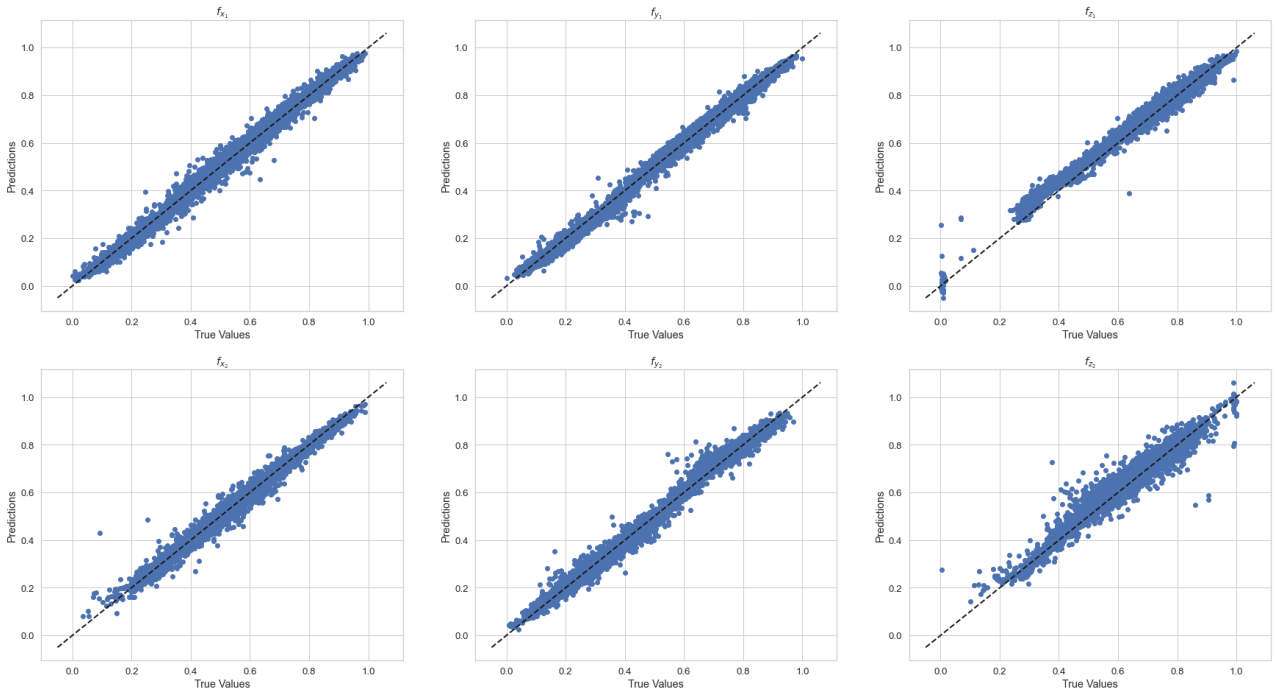

In [82]:

```
Y_seq_test_pred_36 = rnn_model_36.predict(X_seq_test_36)
plot_pred_vs_true(Y_seq_test_pred_36, Y_seq_test, 'pred_vs_true_{}'.format(rnn_m
```




In [83]:

```
Y_seq_test_pred = rnn_model_84.predict(X_seq_test)
plot_pred_vs_true(Y_seq_test_pred, Y_seq_test, 'pred_vs_true_{}'.format(rnn_mode
```




# 5. Evaluation

## 5.1 Loss on test sets

In [84]:

```
print("loss on test sets:")
for key,val in test_results.items():
    print("- {}: {:.2e}".format(key,val))
```

```
loss on test sets:
- linear_x1: 1.47e-02
- linear_12: 2.69e-02
- dnn_12: 8.80e-04
- dnn_36: 3.78e-04
- dnn_84: 4.47e-04
- rnn_12: 3.96e-04
- rnn_36: 2.87e-04
- rnn_84: 3.88e-04
```

Loss after 1000 and 300 epochs for DNN and RNN respectively:

- linear_x1: 1.47e-02
- linear_12: 2.69e-02
- dnn_12: 8.80e-04
- dnn_36: 3.78e-04
- dnn_84: 4.47e-04
- rnn_12: 3.96e-04
- rnn_36: 2.87e-04
- rnn_84: 3.88e-04

## Loss on Test1, Test2, Test4 (no data from Test2 was included in the training)

In [85]:
```
def create_separate_test_sets(df, features, outputs, n_steps=20, feature_idx=Non

    # select relevant features and outputs
    X = df[features].to_numpy()
    Y = df[outputs].to_numpy()

    # apply scaling
    X_normed = scaler_x.transform(X)
    Y_normed = scaler_y.transform(Y)

    # handle sequences
    X_seq, Y_seq = split_sequences(X_normed, Y_normed, n_steps)


    # select indices corresponding to desired feature
    if feature_idx:
        X = X[:,feature_idx]
        X_normed = X_normed[:,feature_idx]
        X_seq = X_seq[:,:,feature_idx]

    outputs = {
        'X': X, 'Y': Y,
        'X_normed': X_normed, 'Y_normed': Y_normed,
        'X_seq_normed': X_seq, 'Y_seq_normed': Y_seq,
        'Y_seq': scaler_y.inverse_transform(Y_seq)
        }

    # calculate model predictions
    if dnn_model:
        Y_pred_normed = dnn_model.predict(X_normed)
        Y_pred = scaler_y.inverse_transform(Y_pred_normed)
        outputs['Y_pred_normed'] = Y_pred_normed
        outputs['Y_pred'] = Y_pred
    if rnn_model:
        Y_seq_pred_normed = rnn_model.predict(X_seq)
        outputs['Y_seq_pred_normed'] = Y_seq_pred_normed
        Y_seq_pred = scaler_y.inverse_transform(Y_seq_pred_normed)
        outputs['Y_seq_pred'] = Y_seq_pred

    return outputs
```

In [86]:
```
tests_12 = dict()
for i,df in enumerate(datasets):
    tests_12[dataset_filenames[i]] = create_separate_test_sets(
        df, features_nth, outputs, n_steps, feature_idx=feature_idx,
        dnn_model=dnn_model_12, rnn_model=rnn_model_12)
```

In [87]:
```
tests_36 = dict()
for i,df in enumerate(datasets):
    tests_36[dataset_filenames[i]] = create_separate_test_sets(
        df, features_nth, outputs, n_steps, feature_idx=feature_idx_2nd,
        dnn_model=dnn_model_36, rnn_model=rnn_model_36)
```

In [88]:
```
tests_84 = dict()
for i,df in enumerate(datasets):
    tests_84[dataset_filenames[i]] = create_separate_test_sets(
```

```
        df, features_nth, outputs, n_steps, feature_idx=None,
        dnn_model=dnn_model_84, rnn_model=rnn_model_84)
```

In [89]:

```
print("Loss on full Test1, Test2, Test4 datasets:")
for filename in dataset_filenames:
    loss_dnn12 = dnn_model_12.evaluate(
        tests_12[filename]['X_normed'], tests_12[filename]['Y_normed'], verbose=
    loss_dnn36 = dnn_model_36.evaluate(
        tests_36[filename]['X_normed'], tests_36[filename]['Y_normed'], verbose=
    loss_dnn84 = dnn_model_84.evaluate(
        tests_84[filename]['X_normed'], tests_84[filename]['Y_normed'], verbose=
    loss_rnn12 = rnn_model_12.evaluate(
        tests_12[filename]['X_seq_normed'], tests_12[filename]['Y_seq_normed'],
    loss_rnn36 = rnn_model_36.evaluate(
        tests_36[filename]['X_seq_normed'], tests_36[filename]['Y_seq_normed'],
    loss_rnn84 = rnn_model_84.evaluate(
        tests_84[filename]['X_seq_normed'], tests_84[filename]['Y_seq_normed'],
    print("- {}:\n DNN-12: {:.2e}\n DNN-36: {:.2e}\n DNN-84: {:.2e}\n RNN-12: {:
        filename, loss_dnn12, loss_dnn36, loss_dnn84, loss_rnn12, loss_rnn36, lo
```

```
Loss on full Test1, Test2, Test4 datasets:
- Test1:
 DNN-12: 5.62e-04
 DNN-36: 2.34e-04
 DNN-84: 3.00e-04
 RNN-12: 1.76e-04
 RNN-36: 1.53e-04
 RNN-84: 2.54e-04
- Test2:
 DNN-12: 7.01e-02
 DNN-36: 3.22e-02
 DNN-84: 3.06e-02
 RNN-12: 3.60e-02
 RNN-36: 4.03e-03
 RNN-84: 4.52e-03
- Test4:
 DNN-12: 8.17e-04
 DNN-36: 3.62e-04
 DNN-84: 4.27e-04
 RNN-12: 3.73e-04
 RNN-36: 2.46e-04
 RNN-84: 3.68e-04
```

## >> Note that no part of Test2 was included during training <<

**Observations:**

- The RNN does significantly better than any of the DNNs for all datasets. It has about an order of magnitude lower loss on Test2.
- DNN/RNN-84 does a bit worse than DNN/RNN-36, indicating that adding higher-order derivatives beyond acceleration makes learning harder. It may also not be worth it adding the additional derivatives. Perhaps training for more epochs could help.
- Comparing the loss on Test1 and Test4 (70 percent of Test1+Test4 was seen during training) w.r.t. loss on Test2, it is clear that all models struggled to generalize well to Test2. **There is room for improvement here.**

# 5.2. Prediction error

## Model predictions on the different test sets

In [90]:

```
tmin = 0
tmax = -1
bins=50
linewidth=3

sns.set(font_scale = 2)
sns.color_palette()
sns.set_style("whitegrid")
for filename in dataset_filenames:

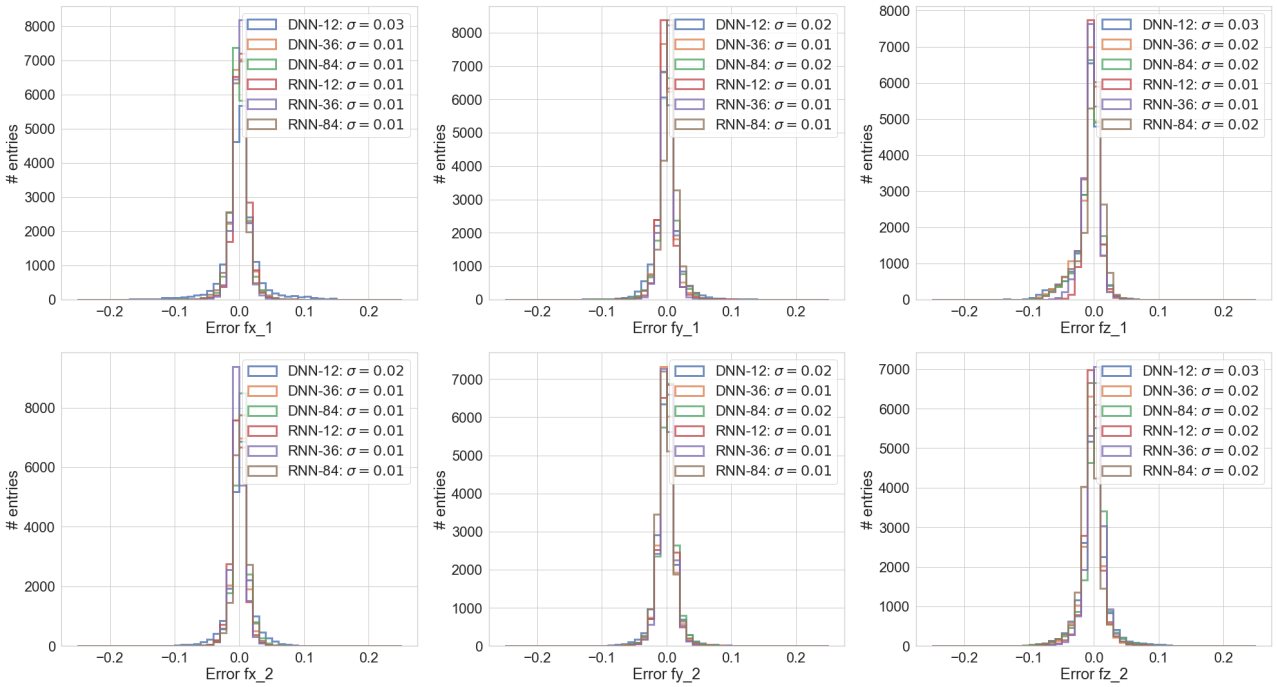
    Y_err_12 = tests_12[filename]['Y_normed'] - tests_12[filename]['Y_pred_norme
    Y_err_36 = tests_36[filename]['Y_normed'] - tests_36[filename]['Y_pred_norme
    Y_err_84 = tests_84[filename]['Y_normed'] - tests_84[filename]['Y_pred_norme
    Y_seq_err_12 = tests_12[filename]['Y_seq_normed'] - tests_12[filename]['Y_se
    Y_seq_err_36 = tests_36[filename]['Y_seq_normed'] - tests_36[filename]['Y_se
    Y_seq_err_84 = tests_84[filename]['Y_seq_normed'] - tests_84[filename]['Y_se

    fig = plt.figure(figsize=(28,16))
    fig.suptitle(filename, weight='bold').set_fontsize('24')
    for i in range(len(outputs)):

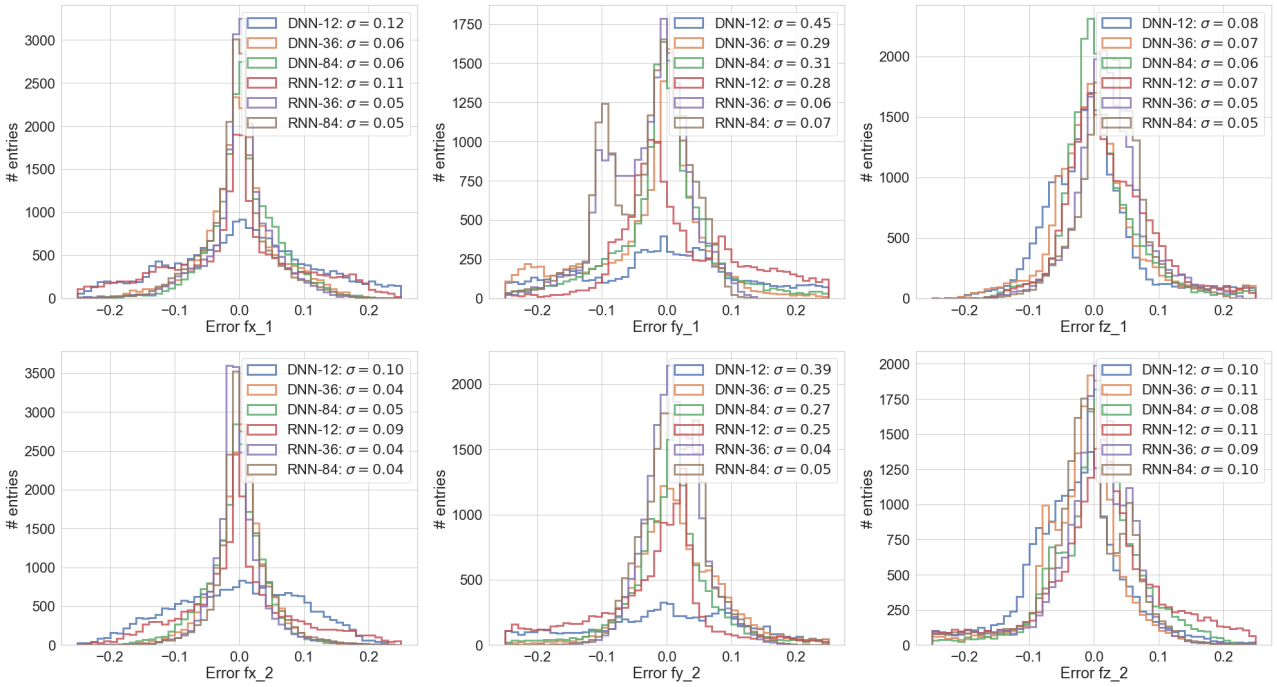
        label_dnn12 = "DNN-12: $\sigma={:.2f}$".format(np.std(Y_err_12[:,i]))
        label_dnn36 = "DNN-36: $\sigma={:.2f}$".format(np.std(Y_err_36[:,i]))
        label_dnn84 = "DNN-84: $\sigma={:.2f}$".format(np.std(Y_err_84[:,i]))
        label_rnn12 = "RNN-12: $\sigma={:.2f}$".format(np.std(Y_seq_err_12[:,i])
        label_rnn36 = "RNN-36: $\sigma={:.2f}$".format(np.std(Y_seq_err_36[:,i])
        label_rnn84 = "RNN-84: $\sigma={:.2f}$".format(np.std(Y_seq_err_84[:,i])

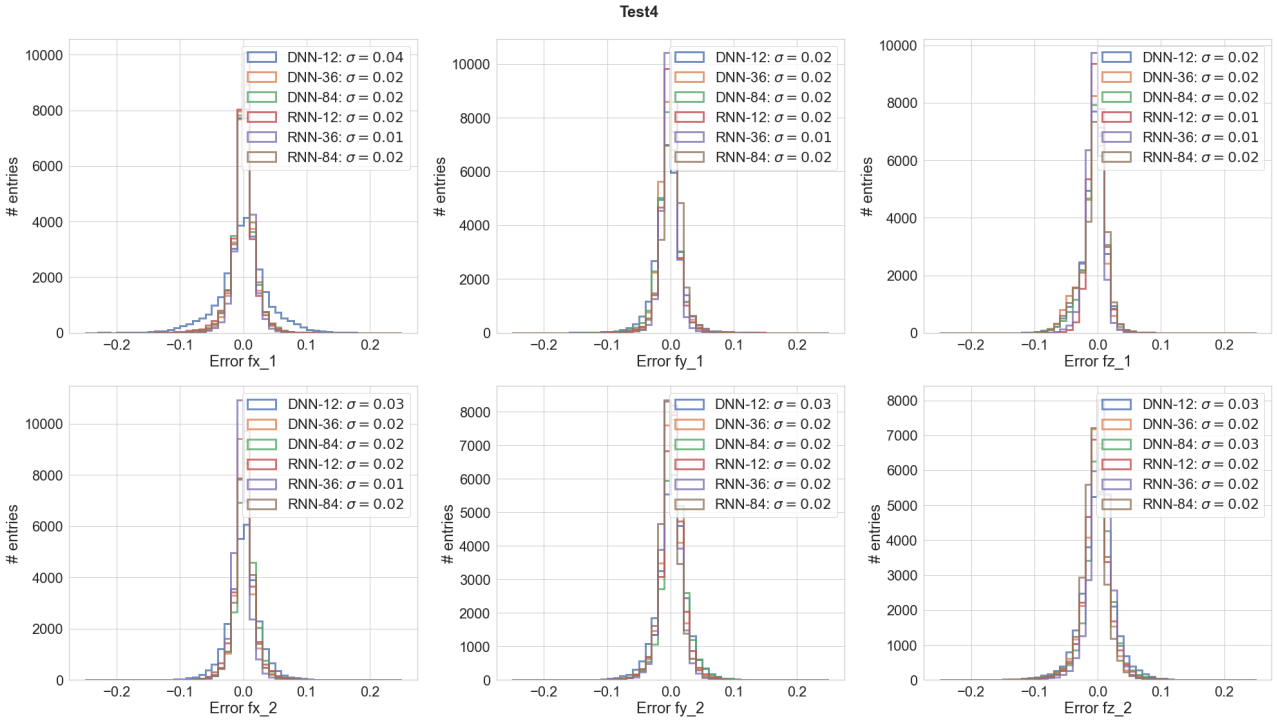
        ax = fig.add_subplot(2,3,i+1)
        ax.hist(Y_err_12[:,i], bins=bins, range=(-0.25, 0.25), alpha=0.8, histty
        ax.hist(Y_err_36[:,i], bins=bins, range=(-0.25, 0.25), alpha=0.8, histty
        ax.hist(Y_err_84[:,i], bins=bins, range=(-0.25, 0.25), alpha=0.8, histty
        ax.hist(Y_seq_err_12[:,i], bins=bins, range=(-0.25, 0.25), alpha=0.8, hi
        ax.hist(Y_seq_err_36[:,i], bins=bins, range=(-0.25, 0.25), alpha=0.8, hi
        ax.hist(Y_seq_err_84[:,i], bins=bins, range=(-0.25, 0.25), alpha=0.8, hi
        ax.set_xlabel('Error {}'.format(outputs[i]))
        ax.set_ylabel('# entries')
        ax.legend()
    plt.tight_layout()
    plt.savefig(output_dir/'{}_error.pdf'.format(filename))
```

**Test1**


DNN-12: σ = 0.03
DNN-36: σ = 0.01
DNN-84: σ = 0.01
RNN-12: σ = 0.01
RNN-36: σ = 0.01
RNN-84: σ = 0.01
# entries
Error fx_1
DNN-12: σ = 0.02
DNN-36: σ = 0.01
DNN-84: σ = 0.02
RNN-12: σ = 0.01
RNN-36: σ = 0.01
RNN-84: σ = 0.01
# entries
Error fy_1
DNN-12: σ = 0.03
DNN-36: σ = 0.02
DNN-84: σ = 0.02
RNN-12: σ = 0.01
RNN-36: σ = 0.01
RNN-84: σ = 0.02
# entries
Error fz_1
DNN-12: σ = 0.02
DNN-36: σ = 0.01
DNN-84: σ = 0.01
RNN-12: σ = 0.01
RNN-36: σ = 0.01
RNN-84: σ = 0.01
# entries
Error fx_2
DNN-12: σ = 0.02
DNN-36: σ = 0.01
DNN-84: σ = 0.02
RNN-12: σ = 0.01
RNN-36: σ = 0.01
RNN-84: σ = 0.01
# entries
Error fy_2
DNN-12: σ = 0.03
DNN-36: σ = 0.02
DNN-84: σ = 0.02
RNN-12: σ = 0.02
RNN-36: σ = 0.02
RNN-84: σ = 0.02
# entries
Error fz_2

**Test2**


DNN-12: σ = 0.12
DNN-36: σ = 0.06
DNN-84: σ = 0.06
RNN-12: σ = 0.11
RNN-36: σ = 0.05
RNN-84: σ = 0.05
# entries
Error fx_1
DNN-12: σ = 0.45
DNN-36: σ = 0.29
DNN-84: σ = 0.31
RNN-12: σ = 0.28
RNN-36: σ = 0.06
RNN-84: σ = 0.07
# entries
Error fy_1
DNN-12: σ = 0.08
DNN-36: σ = 0.07
DNN-84: σ = 0.06
RNN-12: σ = 0.07
RNN-36: σ = 0.05
RNN-84: σ = 0.05
# entries
Error fz_1
DNN-12: σ = 0.10
DNN-36: σ = 0.04
DNN-84: σ = 0.05
RNN-12: σ = 0.09
RNN-36: σ = 0.04
RNN-84: σ = 0.04
# entries
Error fx_2
DNN-12: σ = 0.39
DNN-36: σ = 0.25
DNN-84: σ = 0.27
RNN-12: σ = 0.25
RNN-36: σ = 0.04
RNN-84: σ = 0.05
# entries
Error fy_2
DNN-12: σ = 0.10
DNN-36: σ = 0.11
DNN-84: σ = 0.08
RNN-12: σ = 0.11
RNN-36: σ = 0.09
RNN-84: σ = 0.10
# entries
Error fz_2




**Observations:**

- The RNN models outperforms the DNN models.
- The error is low (1-2% for RNN-36/84) on Test1 and Test4 (70% of Test1+Test4 was seen during training).
- The error is significantly higher (4-10%) for RNN-36/84 on Test2 (not seen during training).

## R2 score

In [91]:
```
from sklearn.metrics import r2_score

print("R2 score on Test1, Test2, Test4 datasets:")
print("(" + " ".join(outputs) + ")")
for filename in dataset_filenames:

    r2_dnn12 = ['DNN-12:']
    r2_dnn36 = ['DNN-36:']
    r2_dnn84 = ['DNN-84:']
    r2_rnn12 = ['RNN-12:']
    r2_rnn36 = ['RNN-36:']
    r2_rnn84 = ['RNN-84:']
    for i in range(len(outputs)):
        r2_dnn12.append("{:.2f}".format(r2_score(tests_12[filename]['Y_normed'][
        r2_dnn36.append("{:.2f}".format(r2_score(tests_36[filename]['Y_normed'][
        r2_dnn84.append("{:.2f}".format(r2_score(tests_84[filename]['Y_normed'][
        r2_rnn12.append("{:.2f}".format(r2_score(tests_12[filename]['Y_seq_norme
        r2_rnn36.append("{:.2f}".format(r2_score(tests_36[filename]['Y_seq_norme
        r2_rnn84.append("{:.2f}".format(r2_score(tests_84[filename]['Y_seq_norme

    print("- {}:".format(filename))
    print("\t"+"\t".join(r2_dnn12))
    print("\t"+"\t".join(r2_dnn36))
    print("\t"+"\t".join(r2_dnn84))
    print("\t"+"\t".join(r2_rnn12))
```

```
    print("\t"+"\t".join(r2_rnn36))
    print("\t"+"\t".join(r2_rnn84))
```

```
R2 score on Test1, Test2, Test4 datasets:
(fx_1 fy_1 fz_1 fx_2 fy_2 fz_2)
- Test1:
        DNN-12: 0.97    0.99    0.97    0.98    0.99    0.96
        DNN-36: 1.00    1.00    0.98    0.99    1.00    0.98
        DNN-84: 0.99    1.00    0.98    0.99    1.00    0.97
        RNN-12: 0.99    1.00    0.99    0.99    1.00    0.98
        RNN-36: 1.00    1.00    0.99    1.00    1.00    0.98
        RNN-84: 0.99    1.00    0.99    0.99    1.00    0.98
- Test2:
        DNN-12: 0.50    -1.78   0.68    0.54    -1.85   0.07
        DNN-36: 0.88    -0.26   0.76    0.91    -0.26   0.04
        DNN-84: 0.89    -0.22   0.82    0.88    -0.30   0.57
        RNN-12: 0.62    -0.27   0.76    0.61    -0.42   0.09
        RNN-36: 0.90    0.94    0.83    0.92    0.96    0.34
        RNN-84: 0.90    0.93    0.85    0.91    0.96    0.18
- Test4:
        DNN-12: 0.95    0.99    0.98    0.97    0.99    0.90
        DNN-36: 0.99    1.00    0.98    0.99    0.99    0.94
        DNN-84: 0.99    0.99    0.98    0.98    0.99    0.92
        RNN-12: 0.99    1.00    0.99    0.98    0.99    0.93
        RNN-36: 0.99    1.00    0.99    0.99    0.99    0.95
        RNN-84: 0.99    1.00    0.98    0.99    0.99    0.93
```

The coefficient of determination (R2) is the proportion of the variation in the dependent variable (e.g., predicted forces) that is predictable from the independent variables (e.g., measured forces). The range is from negative infinity to +1.

- An R2 score of +1 indicates that the predictions match the observations perfectly.
- An R2 score of 0 indicates that the predictions are as good as random guesses around the mean of the observations.
- Negative R2 indicates that the predictions are worse than random.

**Observations:**

- All models do pretty well on Test1 and Test4, of which a significant fraction (70%) was seen during training.
- The RNN models does significantly better on Test2, which was not seen during training.
- Although it did better than the DNN models, even the RNN struggled to predict forces in the $z$-direction on the Test2 dataset (especially for R2).

## Pearson corrrelation coefficient

In [92]:
```
def pearson(x, y):
   corr = np.corrcoef(x, y)
   return corr[0,1]
```

In [93]:
```
print("Pearson correlations for Test1, Test2, Test4 datasets:")
print("(" + " ".join(outputs) + ")")
for filename in dataset_filenames:

    pearson_dnn12 = ['DNN-12:']
```

```
    pearson_dnn36 = ['DNN-36:']
    pearson_dnn84 = ['DNN-84:']
    pearson_rnn12 = ['RNN-12:']
    pearson_rnn36 = ['RNN-36:']
    pearson_rnn84 = ['RNN-84:']
    for i in range(len(outputs)):
        pearson_dnn12.append("{:.2f}".format(pearson(tests_12[filename]['Y_norme
        pearson_dnn36.append("{:.2f}".format(pearson(tests_36[filename]['Y_norme
        pearson_dnn84.append("{:.2f}".format(pearson(tests_84[filename]['Y_norme
        pearson_rnn12.append("{:.2f}".format(pearson(tests_12[filename]['Y_seq_n
        pearson_rnn36.append("{:.2f}".format(pearson(tests_36[filename]['Y_seq_n
        pearson_rnn84.append("{:.2f}".format(pearson(tests_84[filename]['Y_seq_n

    print("- {}:".format(filename))
    print("\t"+"\t".join(pearson_dnn12))
    print("\t"+"\t".join(pearson_dnn36))
    print("\t"+"\t".join(pearson_dnn84))
    print("\t"+"\t".join(pearson_rnn12))
    print("\t"+"\t".join(pearson_rnn36))
    print("\t"+"\t".join(pearson_rnn84))
```

```
Pearson correlations for Test1, Test2, Test4 datasets:
(fx_1 fy_1 fz_1 fx_2 fy_2 fz_2)
- Test1:
        DNN-12: 0.99    1.00    0.99    0.99    1.00    0.98
        DNN-36: 1.00    1.00    1.00    1.00    1.00    0.99
        DNN-84: 1.00    1.00    0.99    1.00    1.00    0.99
        RNN-12: 1.00    1.00    1.00    1.00    1.00    0.99
        RNN-36: 1.00    1.00    1.00    1.00    1.00    0.99
        RNN-84: 1.00    1.00    0.99    1.00    1.00    0.99
- Test2:
        DNN-12: 0.75    -0.43   0.84    0.75    -0.51   0.49
        DNN-36: 0.94    0.40    0.88    0.95    0.38    0.44
        DNN-84: 0.95    0.31    0.91    0.95    0.29    0.76
        RNN-12: 0.79    0.36    0.89    0.78    0.31    0.42
        RNN-36: 0.95    0.97    0.93    0.96    0.98    0.60
        RNN-84: 0.95    0.97    0.94    0.96    0.98    0.52
- Test4:
        DNN-12: 0.98    1.00    0.99    0.98    0.99    0.95
        DNN-36: 1.00    1.00    0.99    0.99    1.00    0.97
        DNN-84: 0.99    1.00    0.99    0.99    1.00    0.96
        RNN-12: 0.99    1.00    1.00    0.99    1.00    0.96
        RNN-36: 1.00    1.00    1.00    1.00    1.00    0.98
        RNN-84: 1.00    1.00    0.99    0.99    1.00    0.97
```

The Pearson correlation coefficient ($r$) can range from -1 to +1.

- An $r$ of -1 indicates a perfect negative linear correlation.
- An $r$ of 0 indicates no correlation.
- An $r$ of +1 indicates a perfect positive linear correlation.

**Observations:**

- Similar to the observations for the R2 score.

# 5.3. Time series plots of prediction vs. ground truth

In [114…

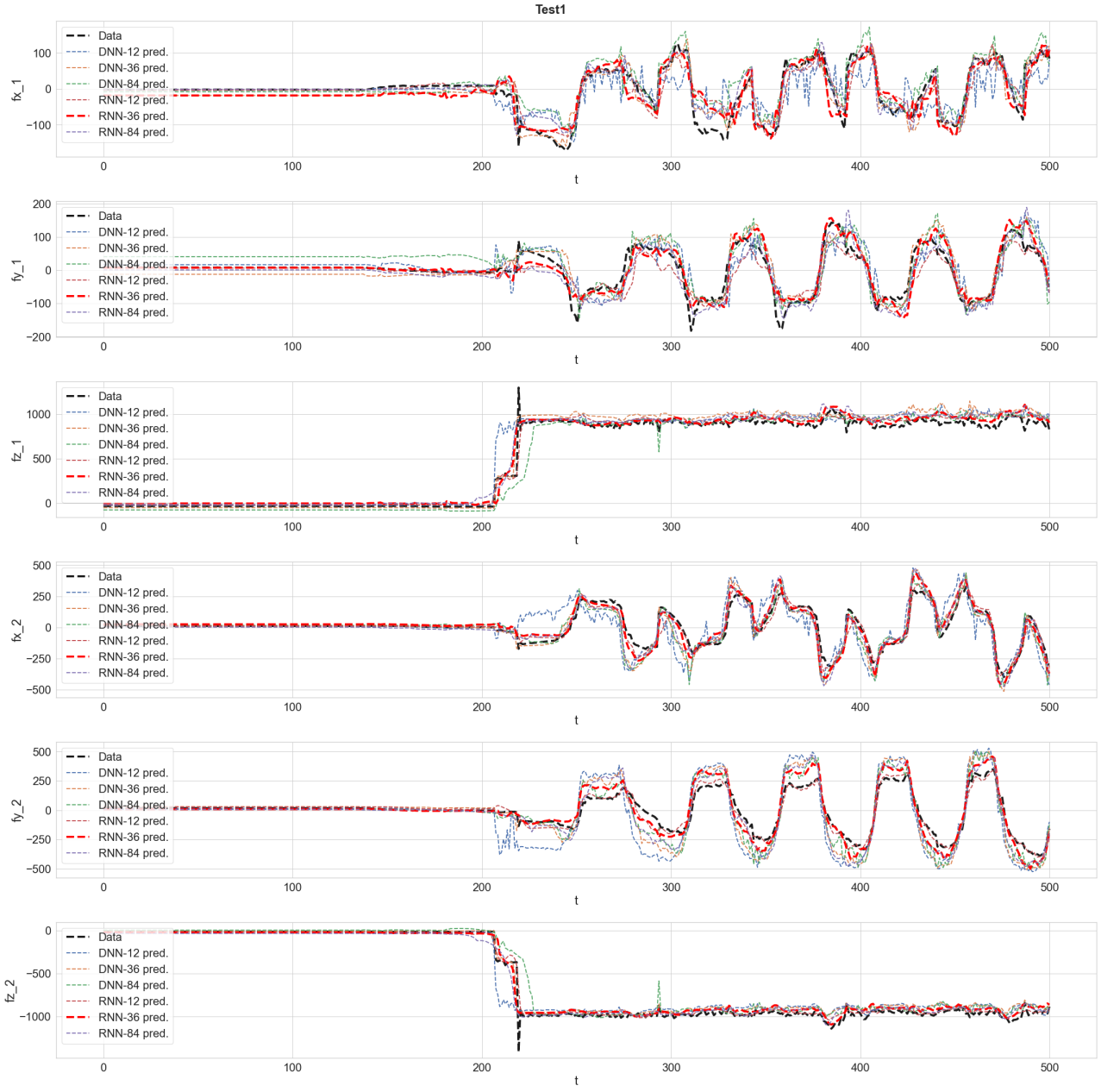
```
def plot_timeseries(tmin = 12000, tmax = 12500, linewidth=4):
```

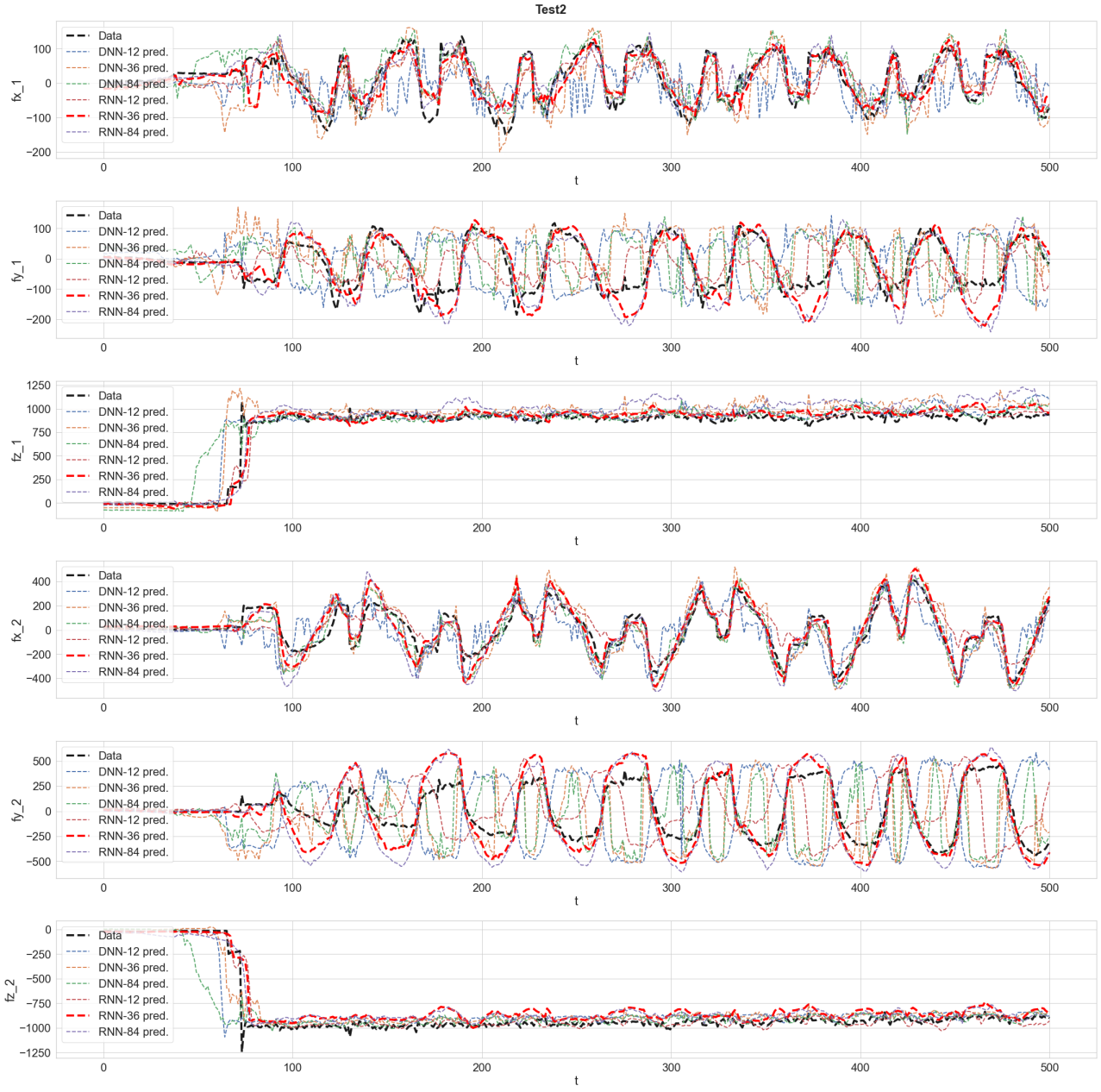
```
    t = np.linspace(tmin, tmax, tmax-tmin)
    sns.set(font_scale = 2)
    sns.color_palette()
    sns.set_style("whitegrid")
    for filename in dataset_filenames:

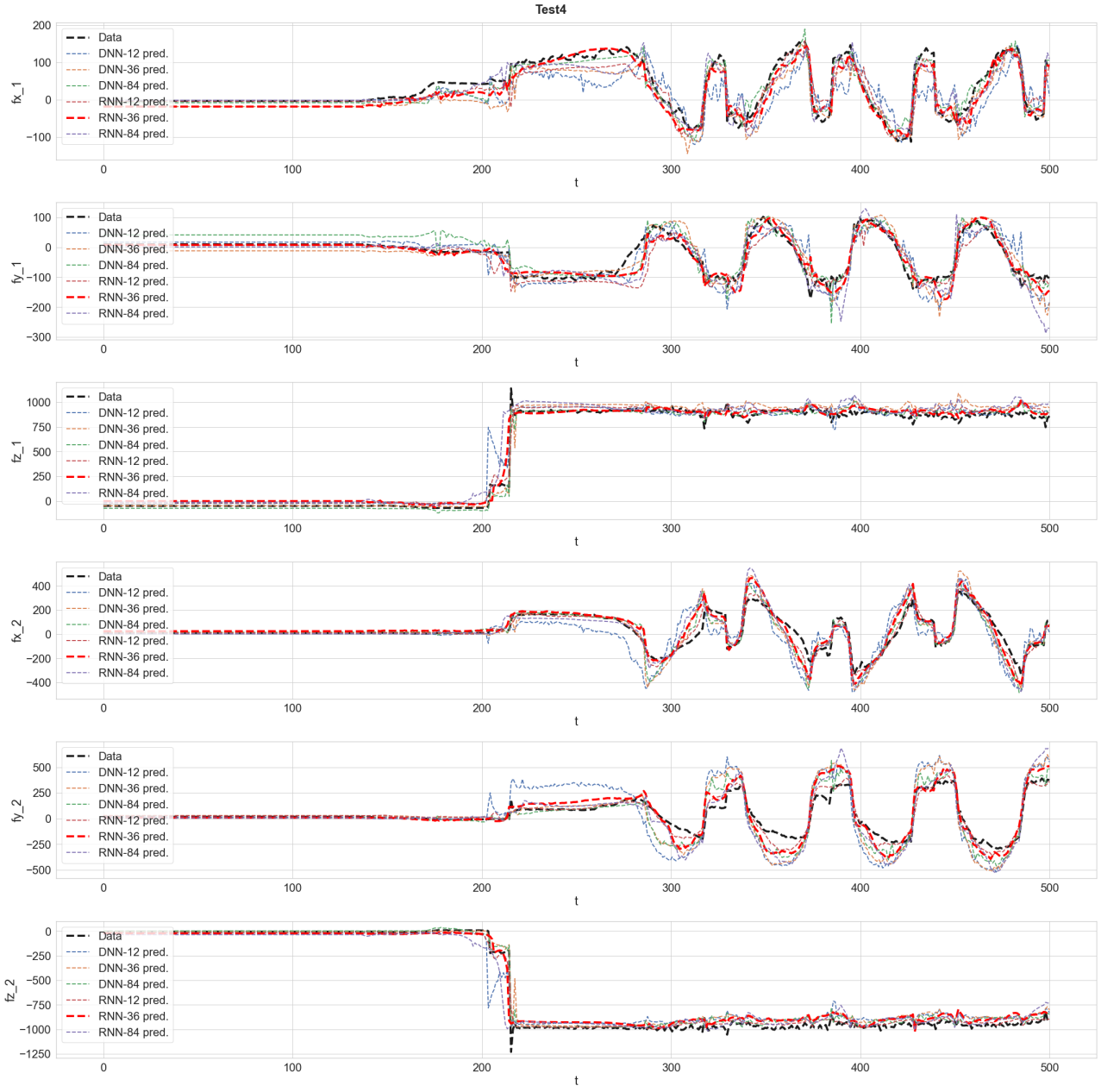
        fig = plt.figure(figsize=(30,30))
        fig.suptitle(filename, weight='bold').set_fontsize('24')
        for i in range(6):
            ax = fig.add_subplot(6, 1, i+1)
            ax.plot(t, tests_12[filename]['Y'].T[i][tmin+n_steps-1:tmax+n_steps-
            ax.plot(t, tests_12[filename]['Y_pred'].T[i][tmin+n_steps-1:tmax+n_s
            ax.plot(t, tests_36[filename]['Y_pred'].T[i][tmin+n_steps-1:tmax+n_s
            ax.plot(t, tests_84[filename]['Y_pred'].T[i][tmin+n_steps-1:tmax+n_s
            ax.plot(t, tests_12[filename]['Y_seq_pred'].T[i][tmin:tmax], label='
            ax.plot(t, tests_36[filename]['Y_seq_pred'].T[i][tmin:tmax], label='
            ax.plot(t, tests_84[filename]['Y_seq_pred'].T[i][tmin:tmax], label='
            ax.set_xlabel('t')
            ax.set_ylabel(outputs[i])
            ax.legend(loc=2)
        plt.tight_layout()
        plt.savefig(output_dir/'{}_timeseries_t{}to{}.pdf'.format(filename, tmin
```

In [115…

```
plot_timeseries(tmin=0, tmax=500)
```

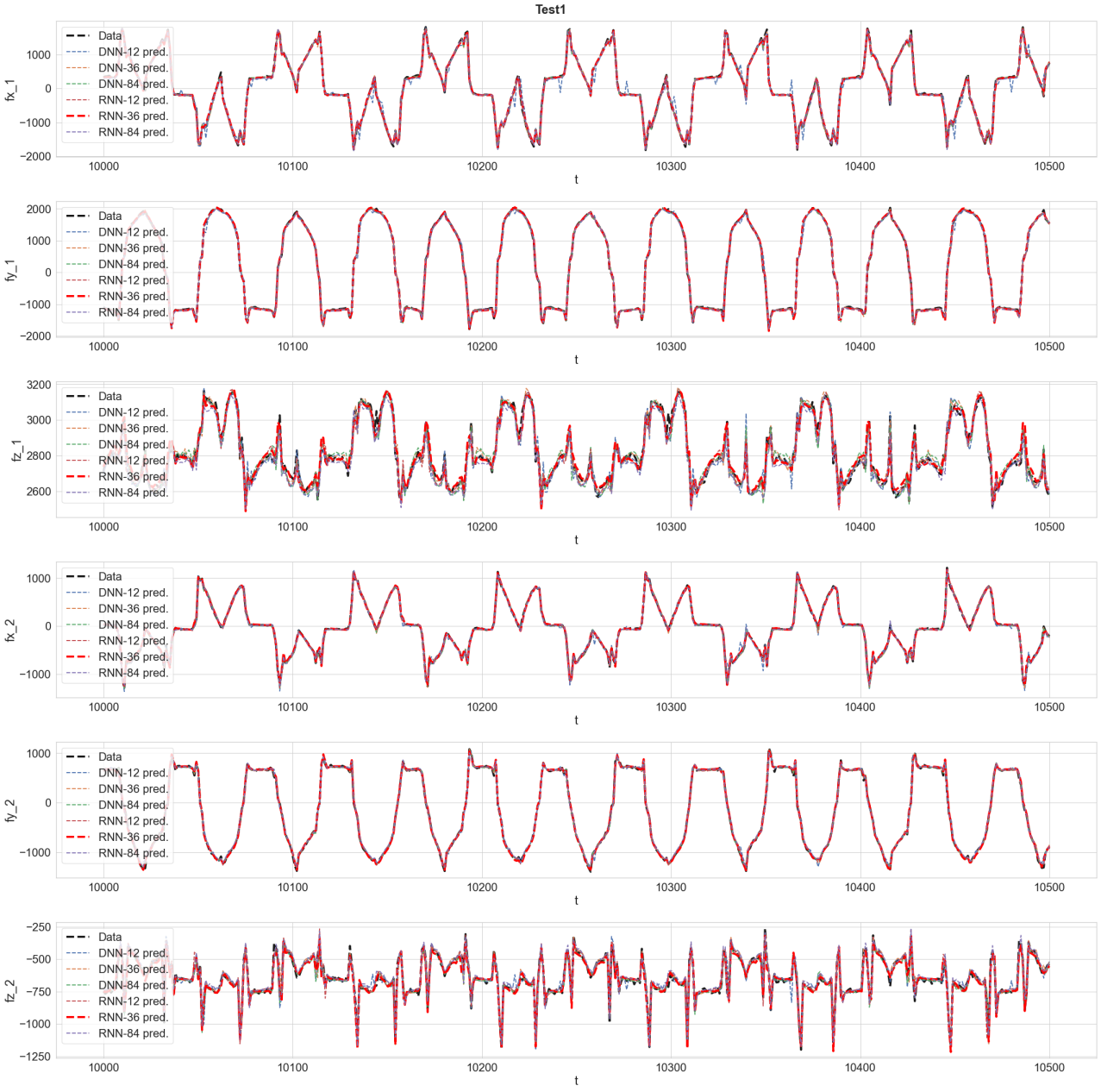

Test1
Data
DNN-12 pred.
DNN-36 pred.
DNN-84 pred.
RNN-12 pred.
RNN-36 pred.
RNN-84 pred.
fx_1
fy_1
fz_1
fx_2
fy_2
fz_2
t

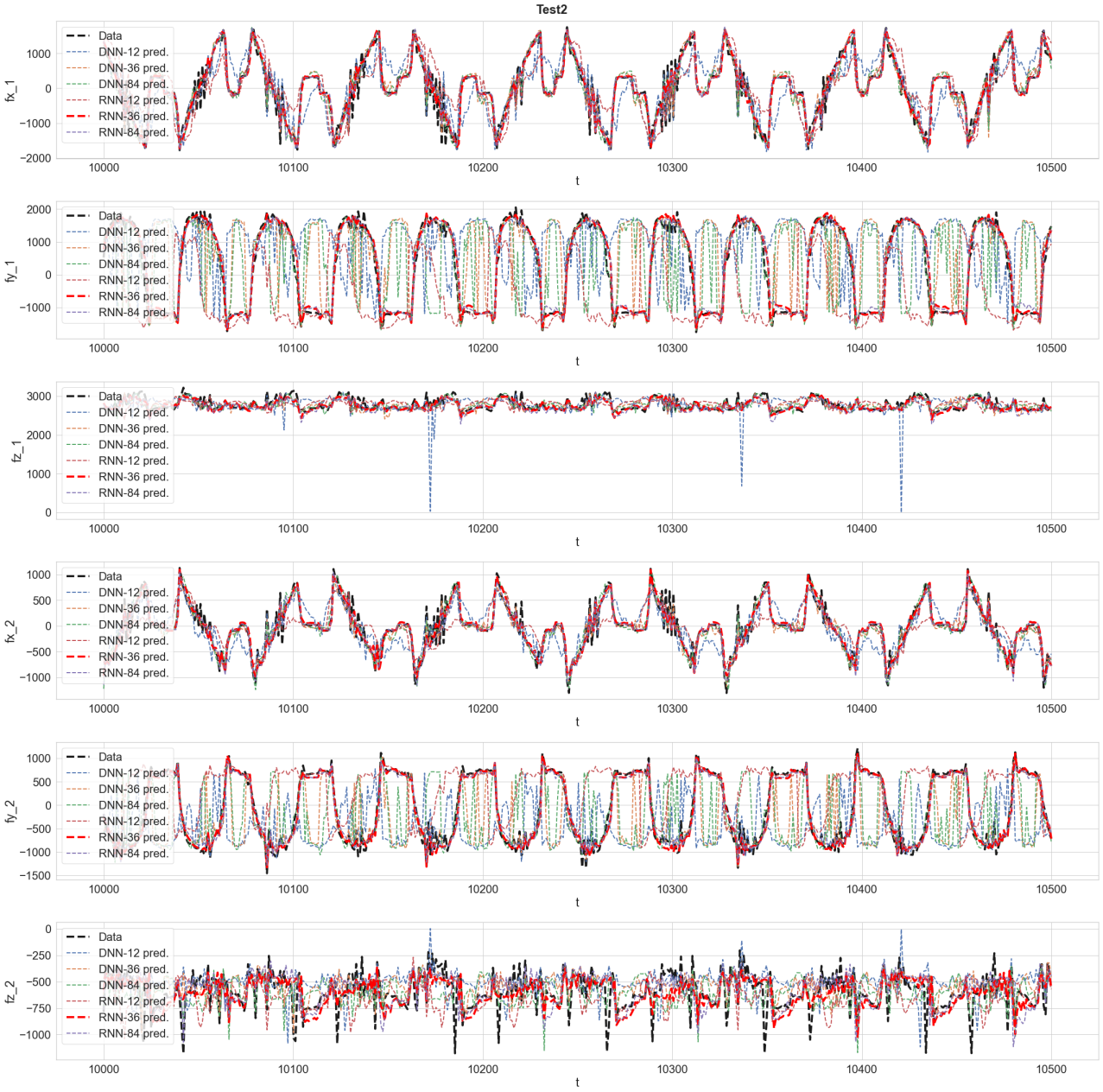

Test2
Data
DNN-12 pred.
DNN-36 pred.
DNN-84 pred.
RNN-12 pred.
RNN-36 pred.
RNN-84 pred.
fx_1
fy_1
fz_1
fx_2
fy_2
fz_2
t

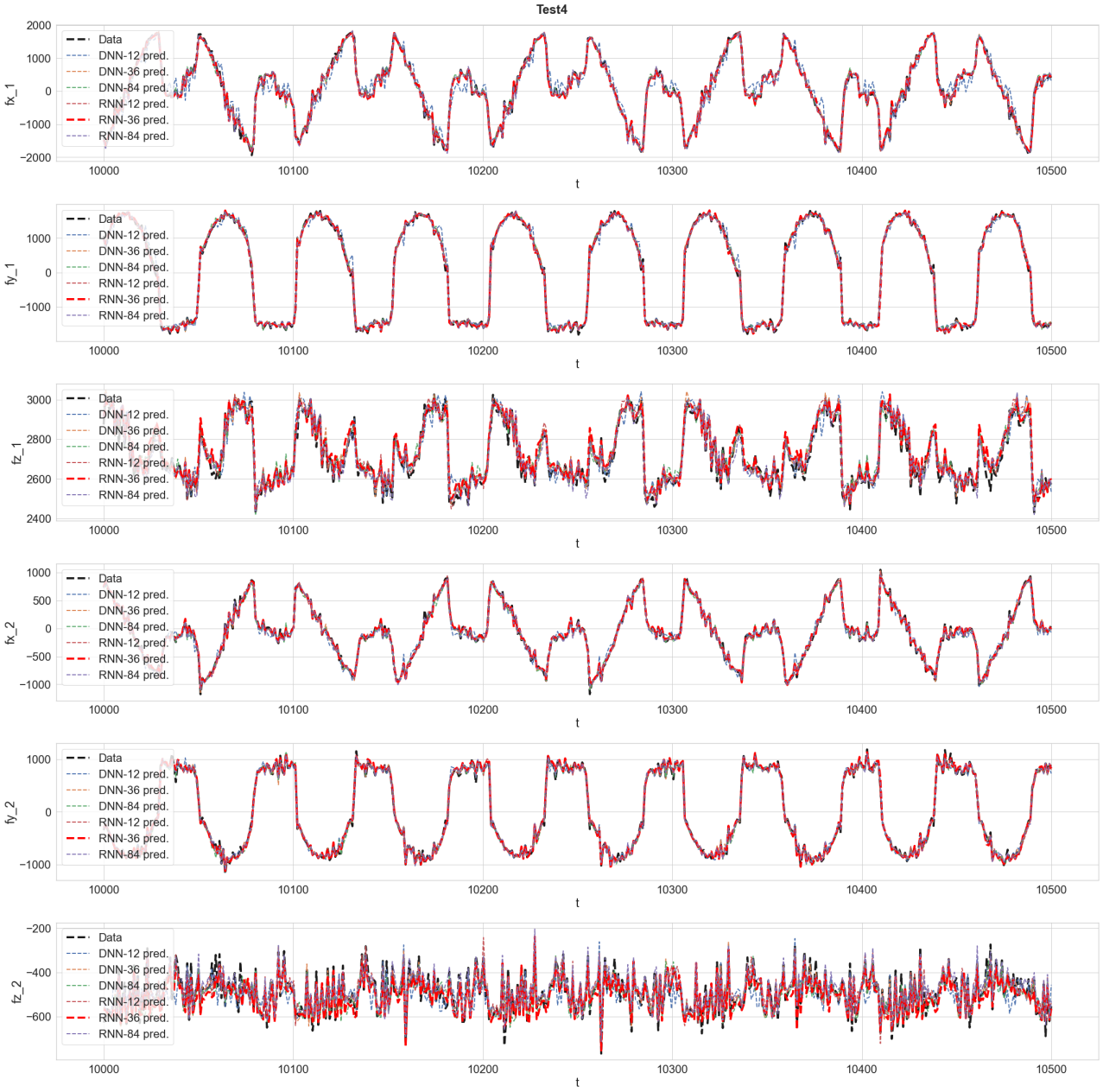



In [116…

```
plot_timeseries(tmin=10000, tmax=10500)
```

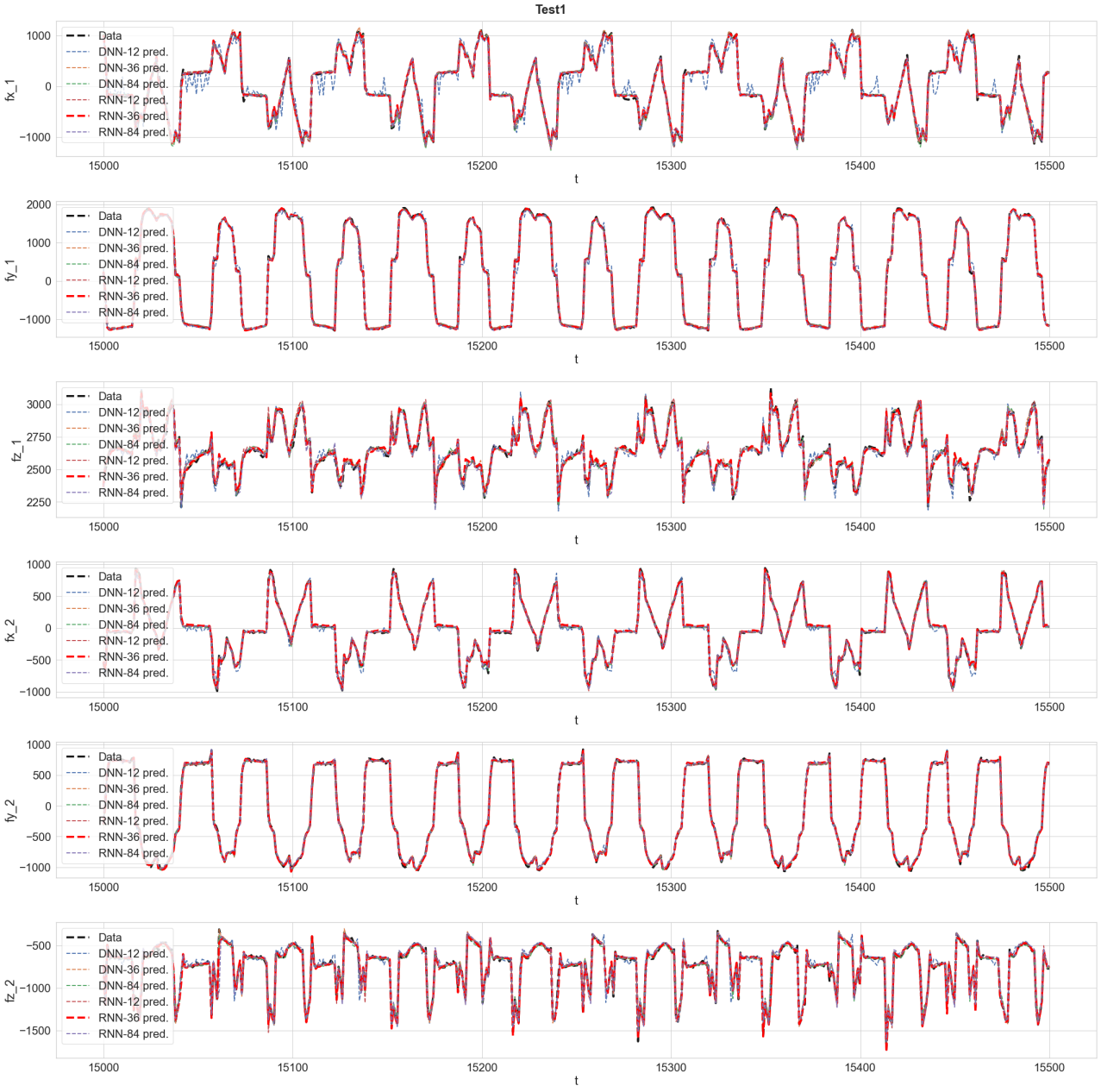

Test1
Data
DNN-12 pred.
DNN-36 pred.
DNN-84 pred.
RNN-12 pred.
RNN-36 pred.
RNN-84 pred.
fx_1
fy_1
fz_1
fx_2
fy_2
fz_2
t

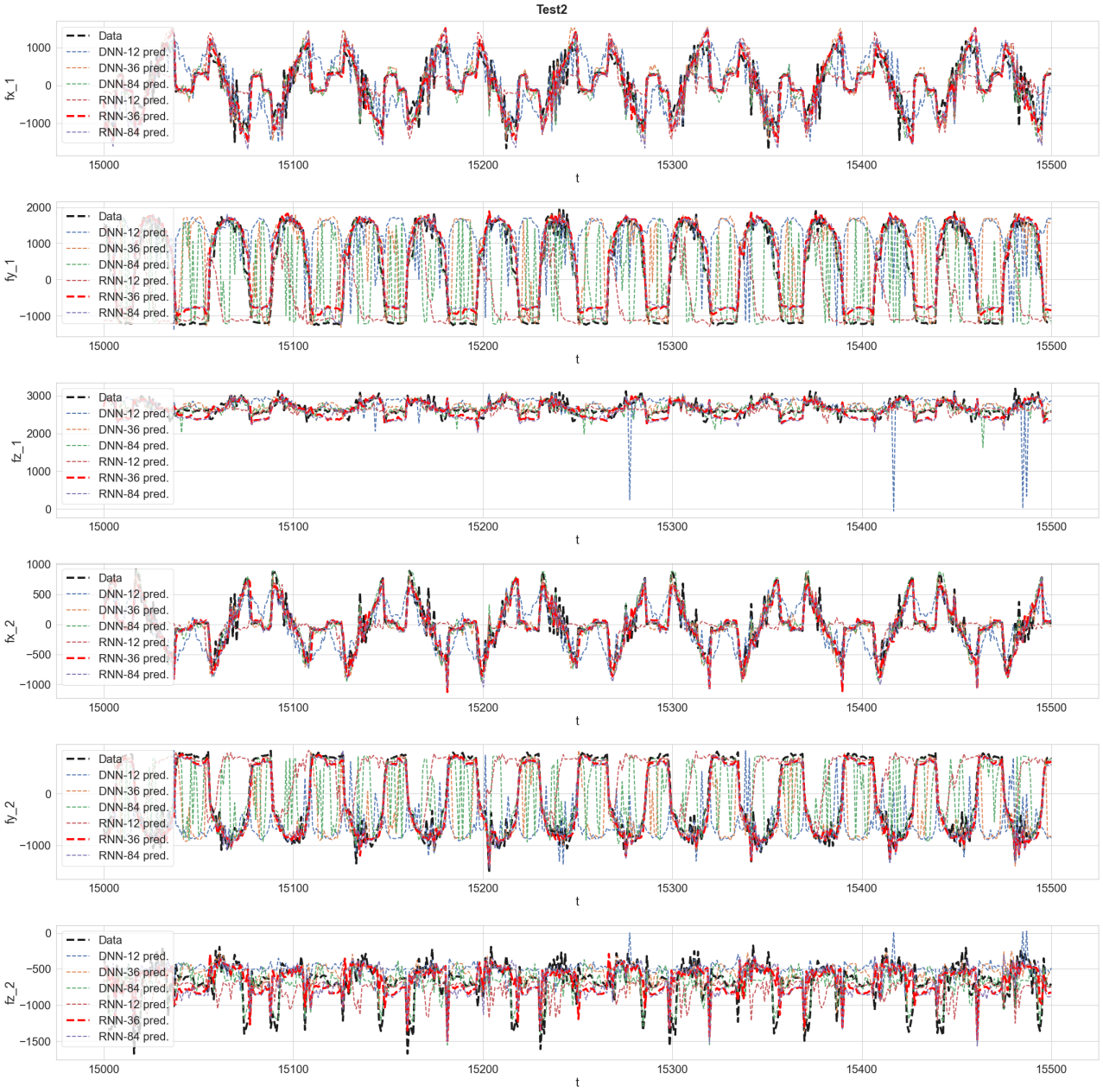

Test2
Data
DNN-12 pred.
DNN-36 pred.
DNN-84 pred.
RNN-12 pred.
RNN-36 pred.
RNN-84 pred.
fx_1
fy_1
fz_1
fx_2
fy_2
fz_2
t

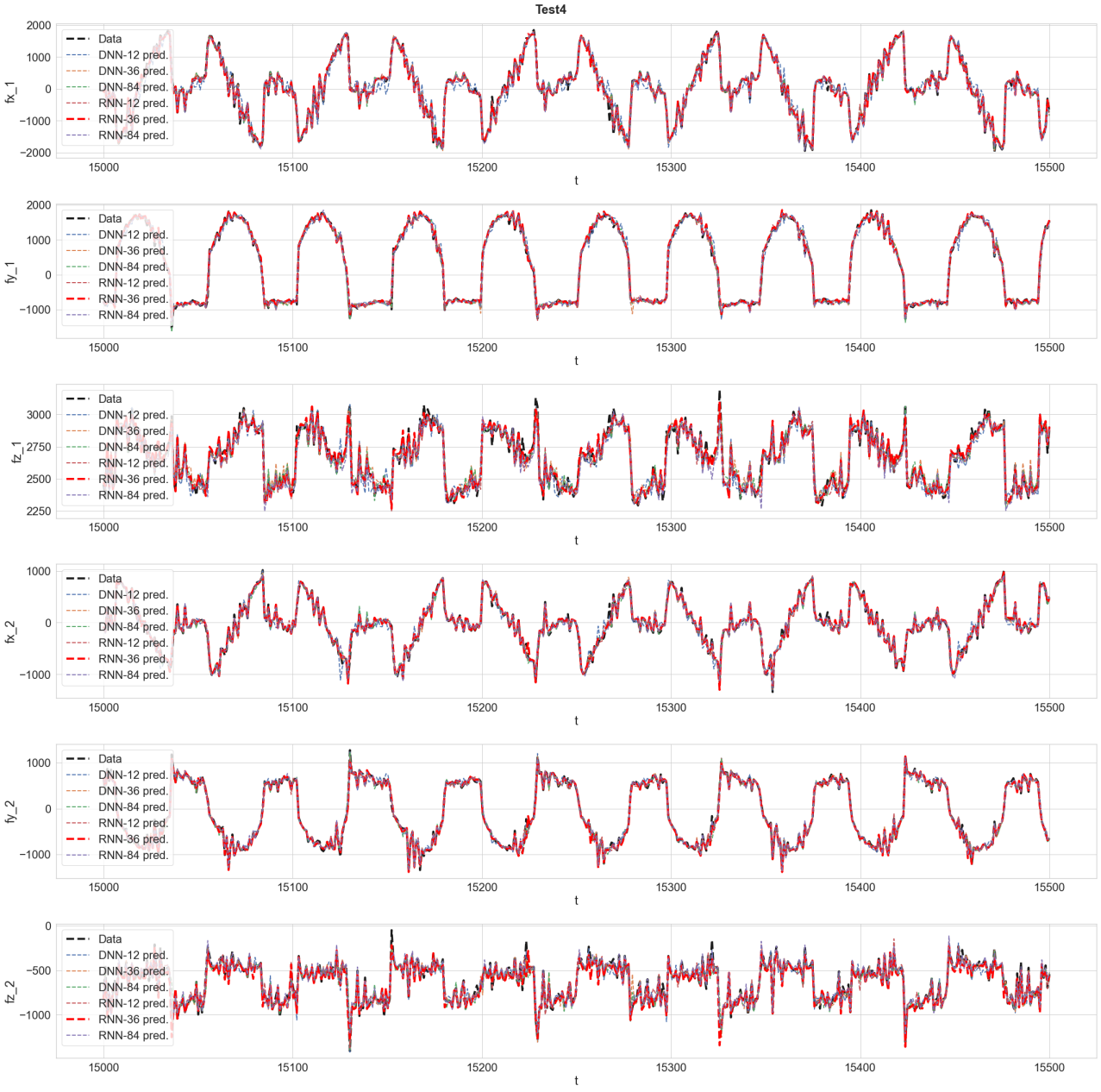



In [117…

```
plot_timeseries(tmin=15000, tmax=15500)
```

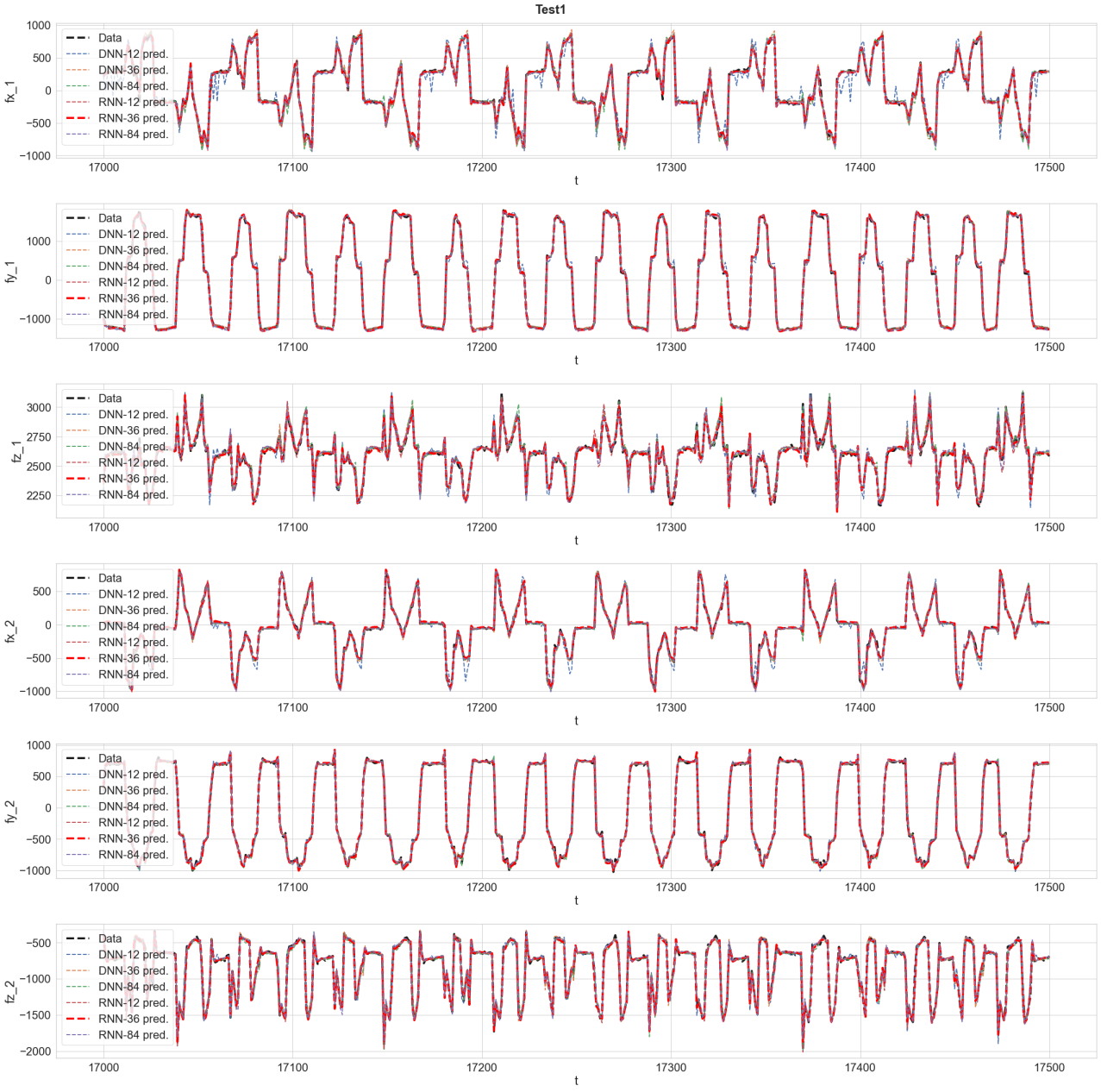

Test1
Data
DNN-12 pred.
DNN-36 pred.
DNN-84 pred.
RNN-12 pred.
RNN-36 pred.
RNN-84 pred.
fx_1
fy_1
fz_1
fx_2
fy_2
fz_2
t

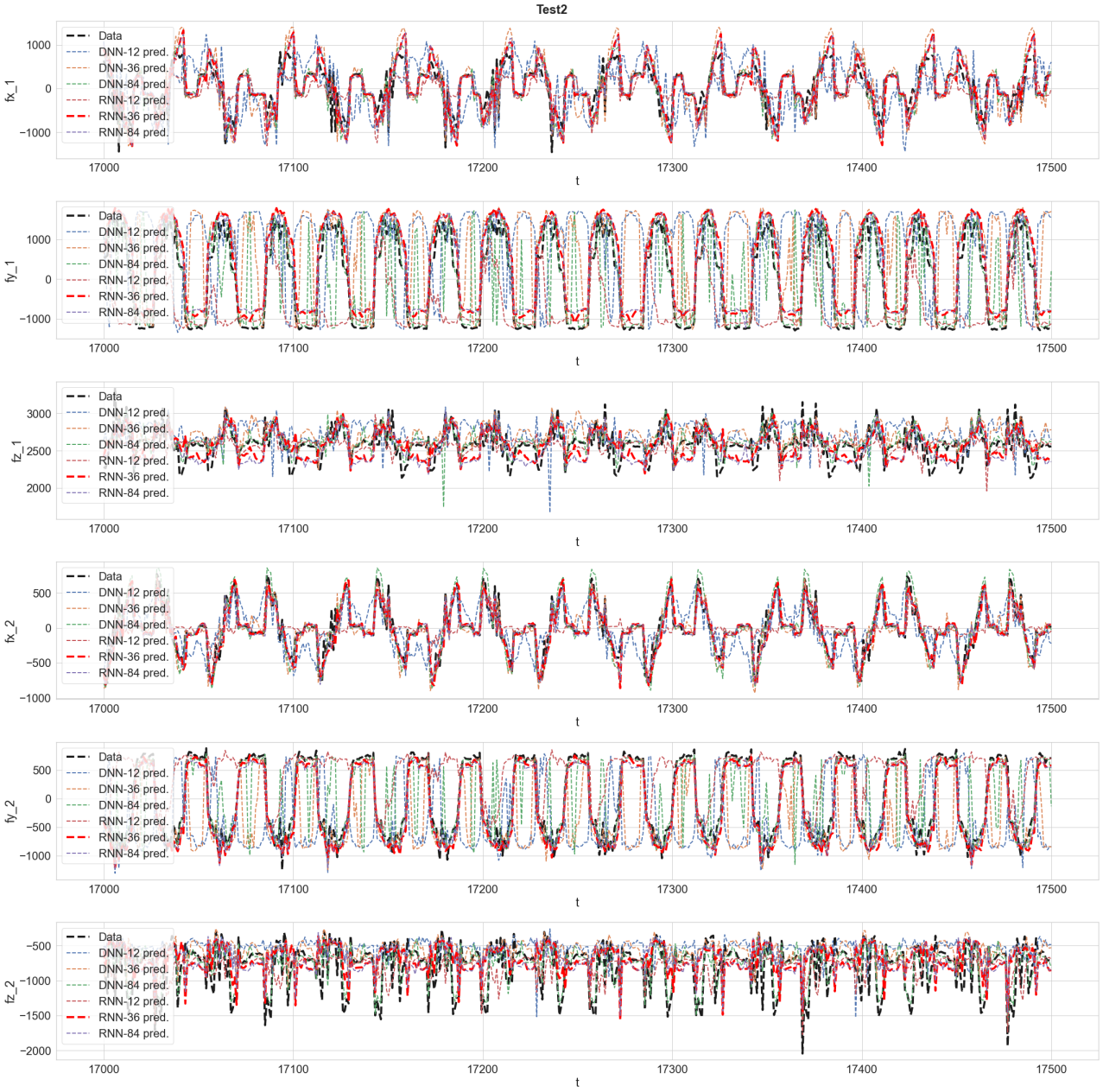

Test2
Data
DNN-12 pred.
DNN-36 pred.
DNN-84 pred.
RNN-12 pred.
RNN-36 pred.
RNN-84 pred.
fx_1
fy_1
fz_1
fx_2
fy_2
fz_2
t
15000
15100
15200
15300
15400
15500

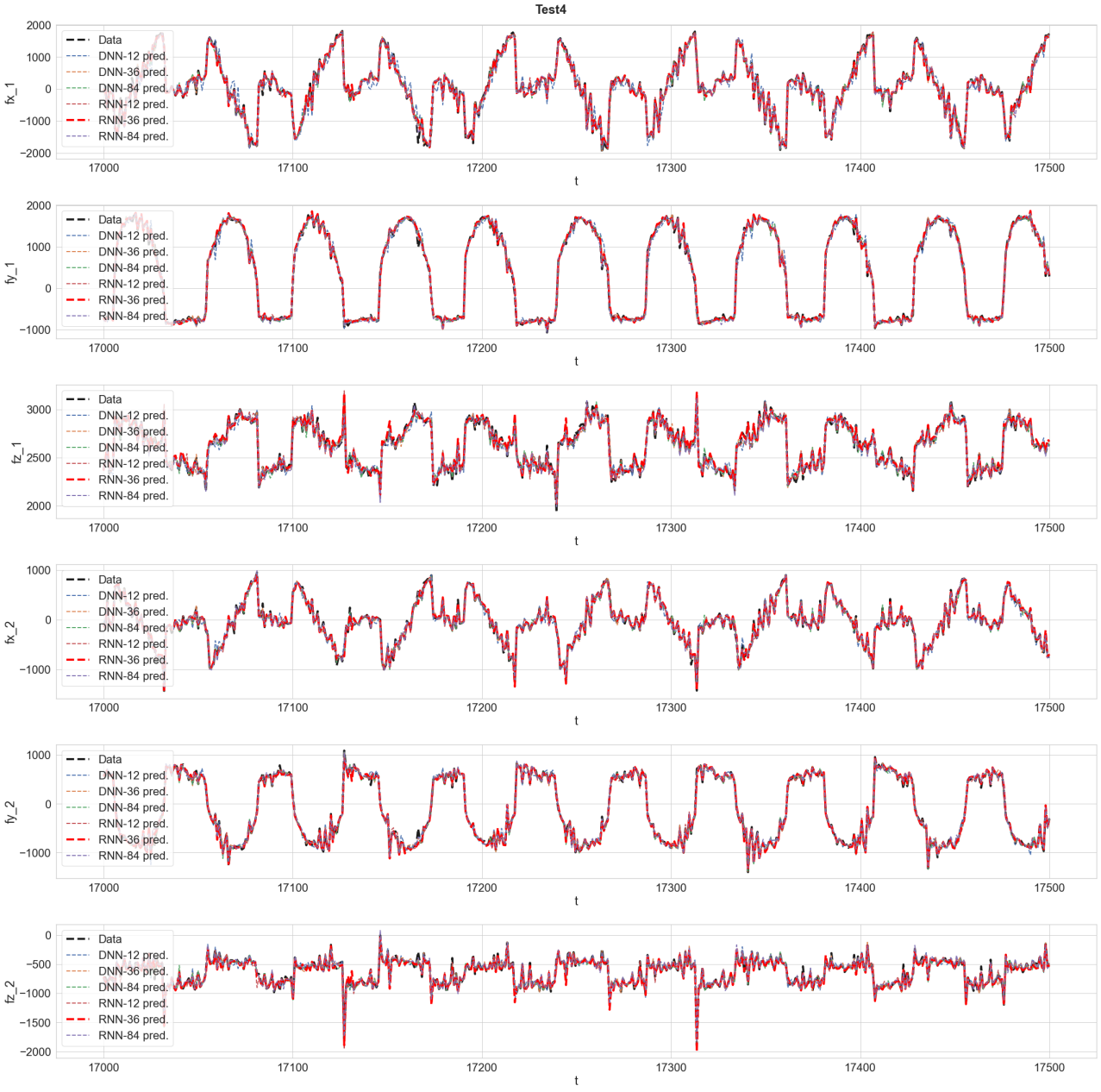



In [118…

```
plot_timeseries(tmin=17000, tmax=17500)
```

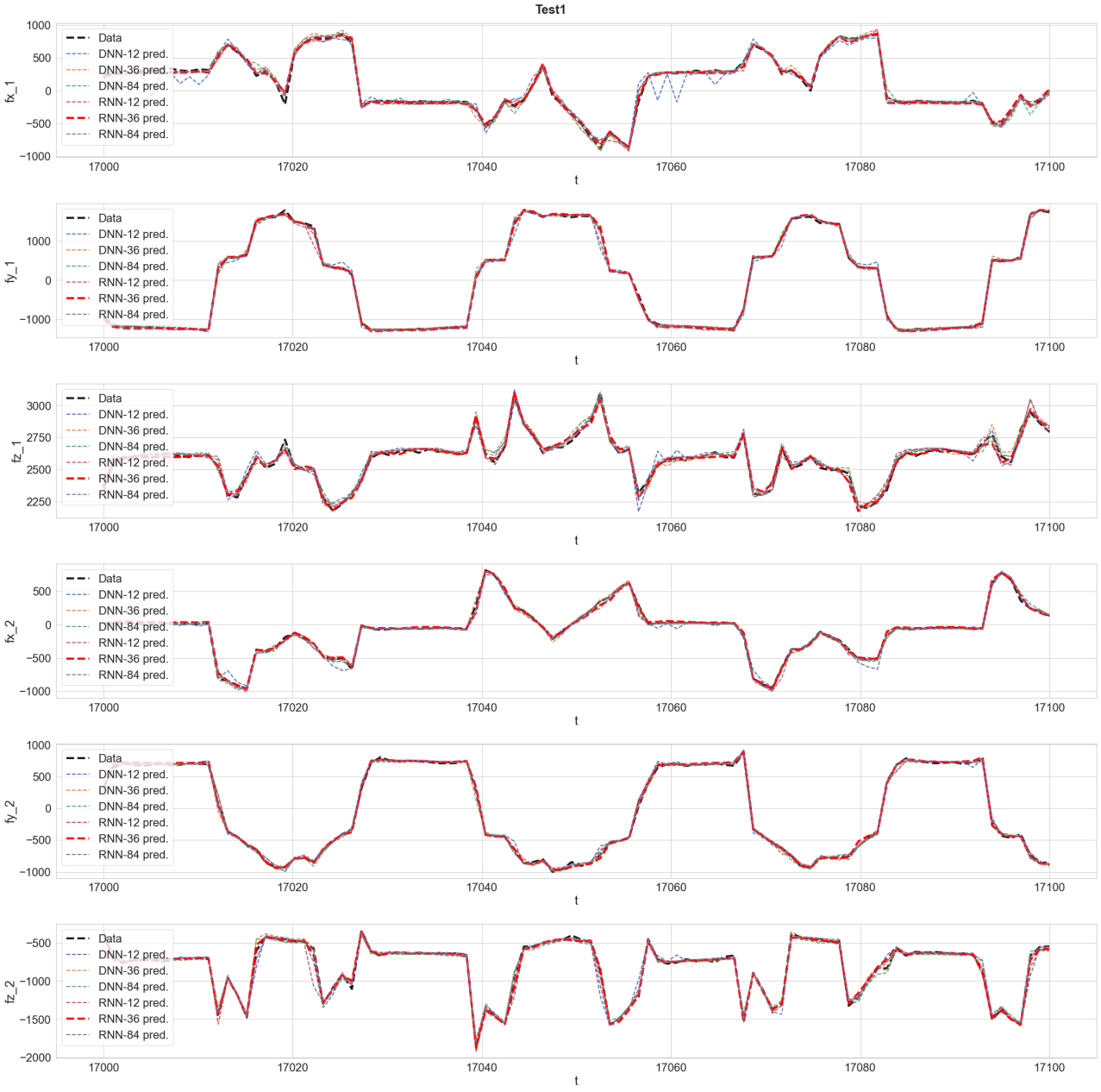

Test1
fx_1
fy_1
fz_1
fx_2
fy_2
fz_2
t
Data
DNN-12 pred.
DNN-36 pred.
DNN-84 pred.
RNN-12 pred.
RNN-36 pred.
RNN-84 pred.

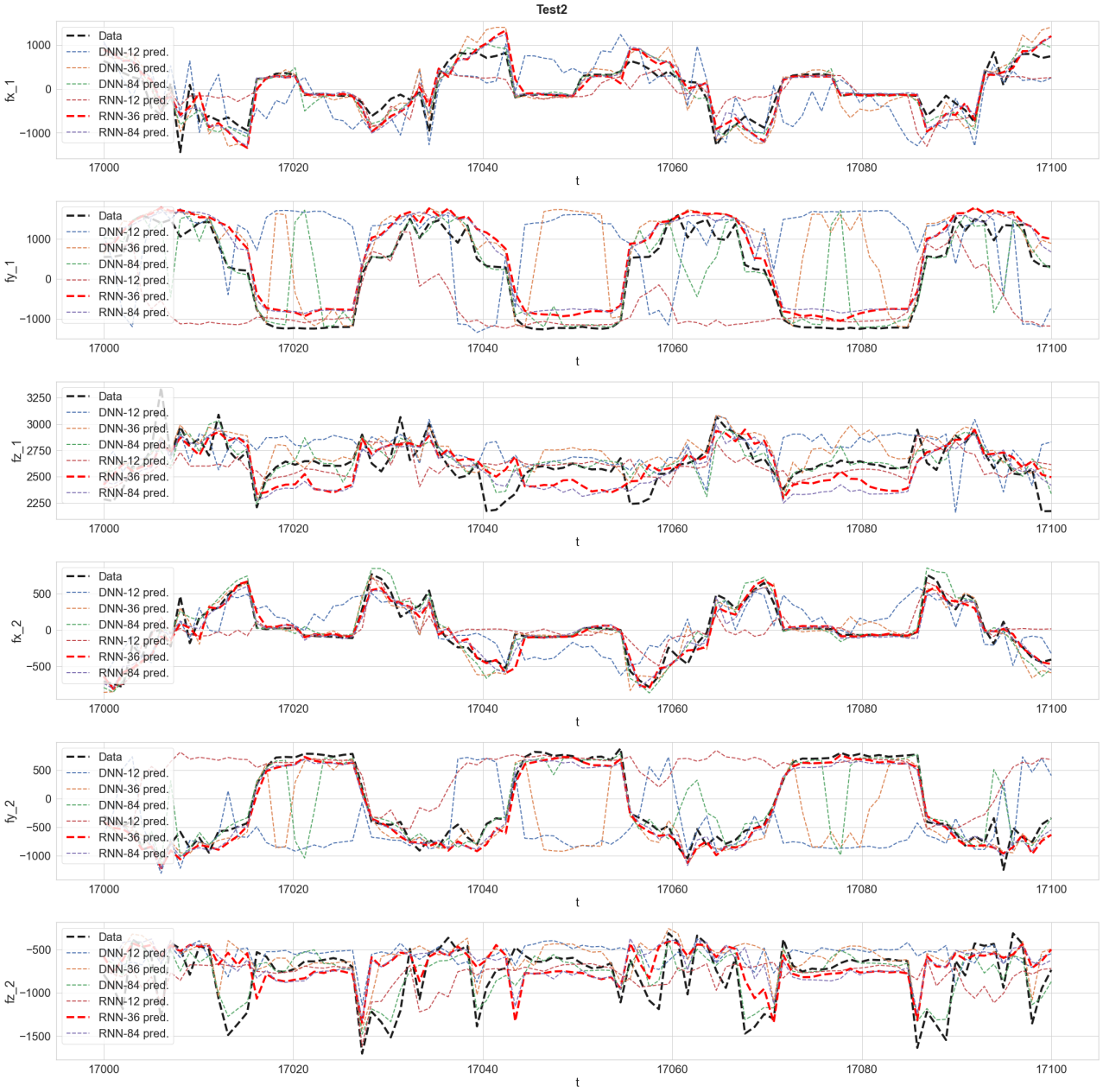

Test2
Data
DNN-12 pred.
DNN-36 pred.
DNN-84 pred.
RNN-12 pred.
RNN-36 pred.
RNN-84 pred.
fx_1
fy_1
fz_1
fx_2
fy_2
fz_2
t
17000
17100
17200
17300
17400
17500

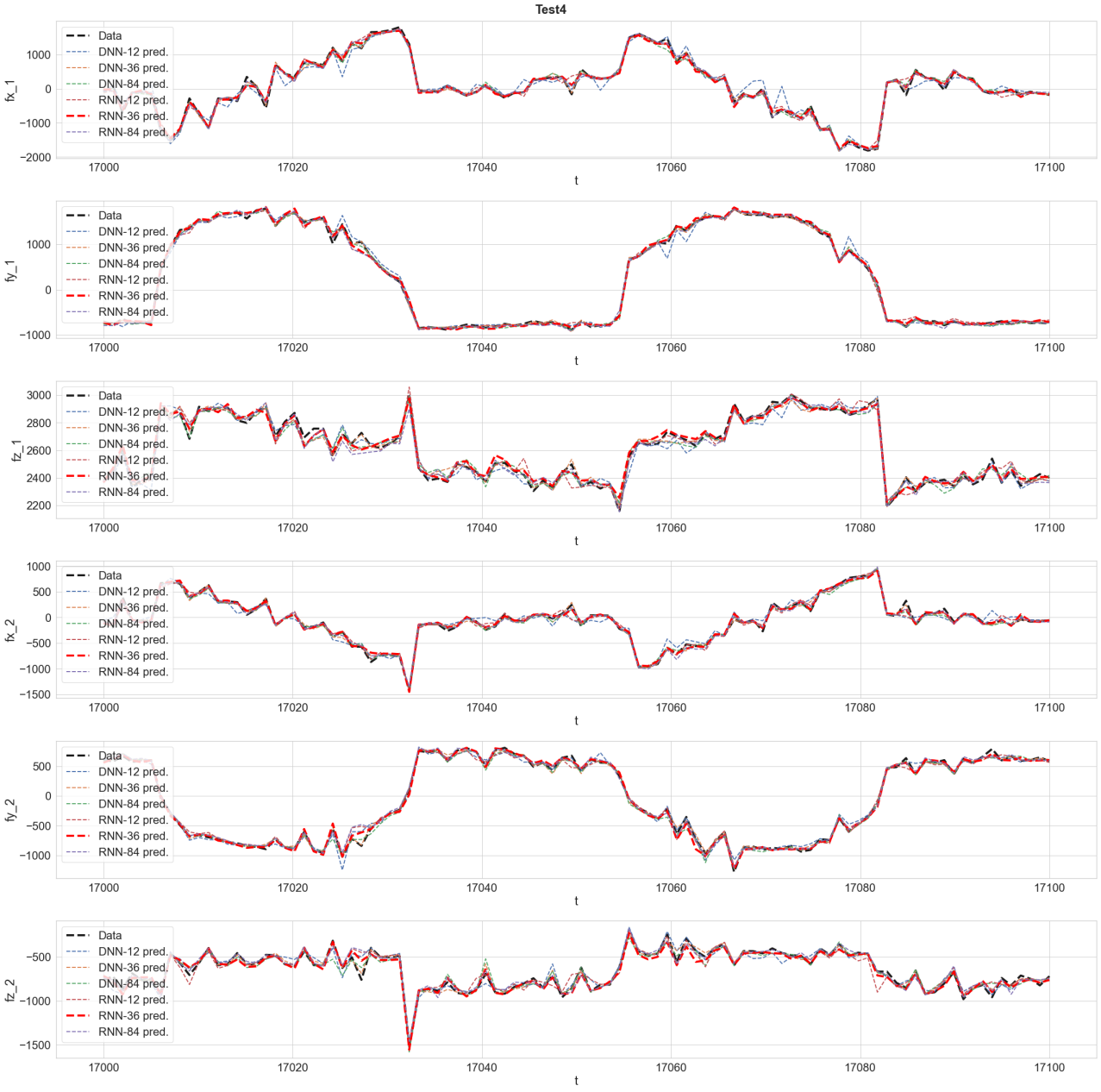



In [123…

```
plot_timeseries(tmin=17000, tmax=17100)
```


Test1
fx_1
fy_1
fz_1
fx_2
fy_2
fz_2
t
Data
DNN-12 pred.
DNN-36 pred.
DNN-84 pred.
RNN-12 pred.
RNN-36 pred.
RNN-84 pred.


Test2
Data
DNN-12 pred.
DNN-36 pred.
DNN-84 pred.
RNN-12 pred.
RNN-36 pred.
RNN-84 pred.
fx_1
fy_1
fz_1
fx_2
fy_2
fz_2
t
17000
17020
17040
17060
17080
17100

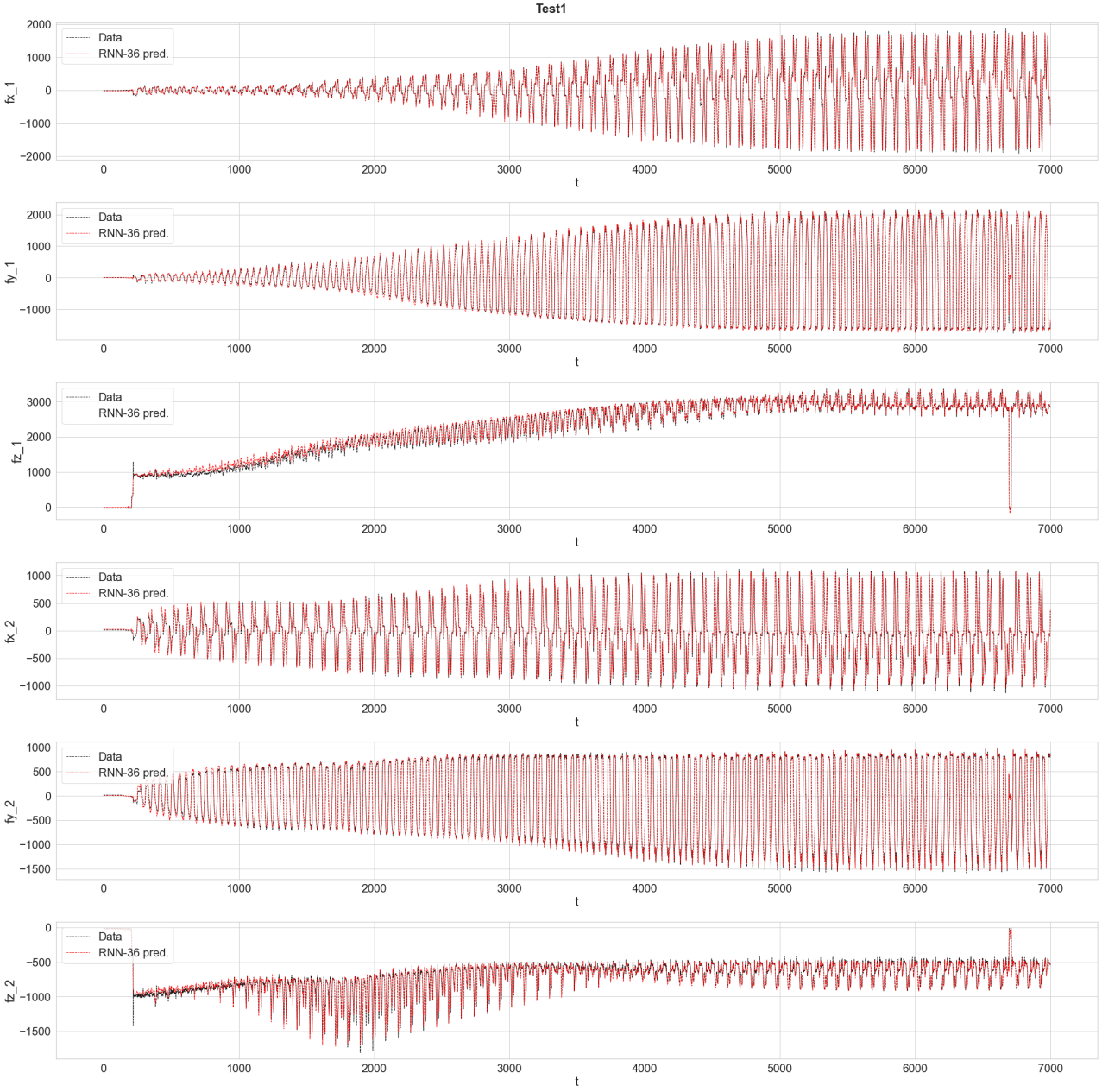


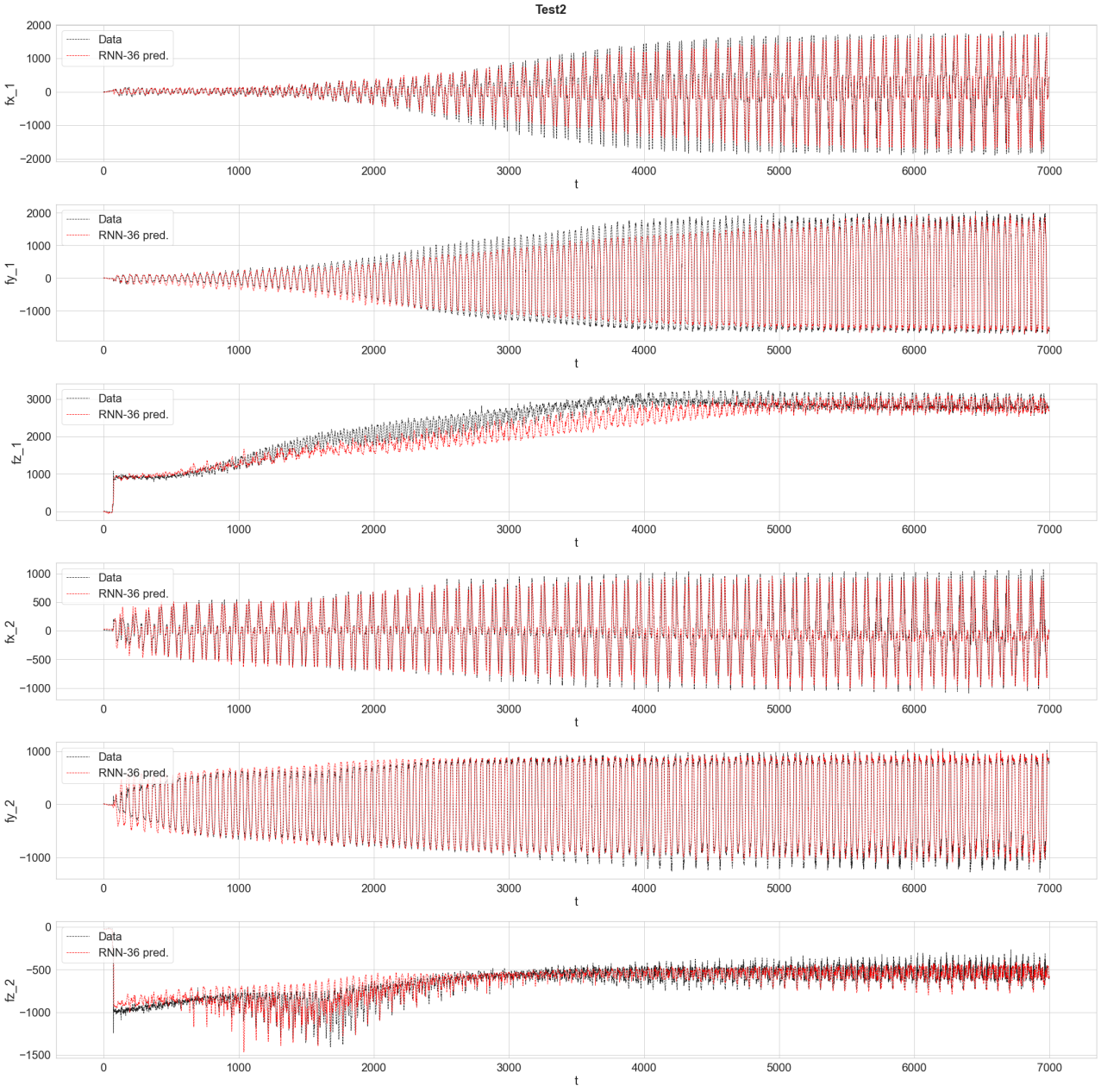

In [177…

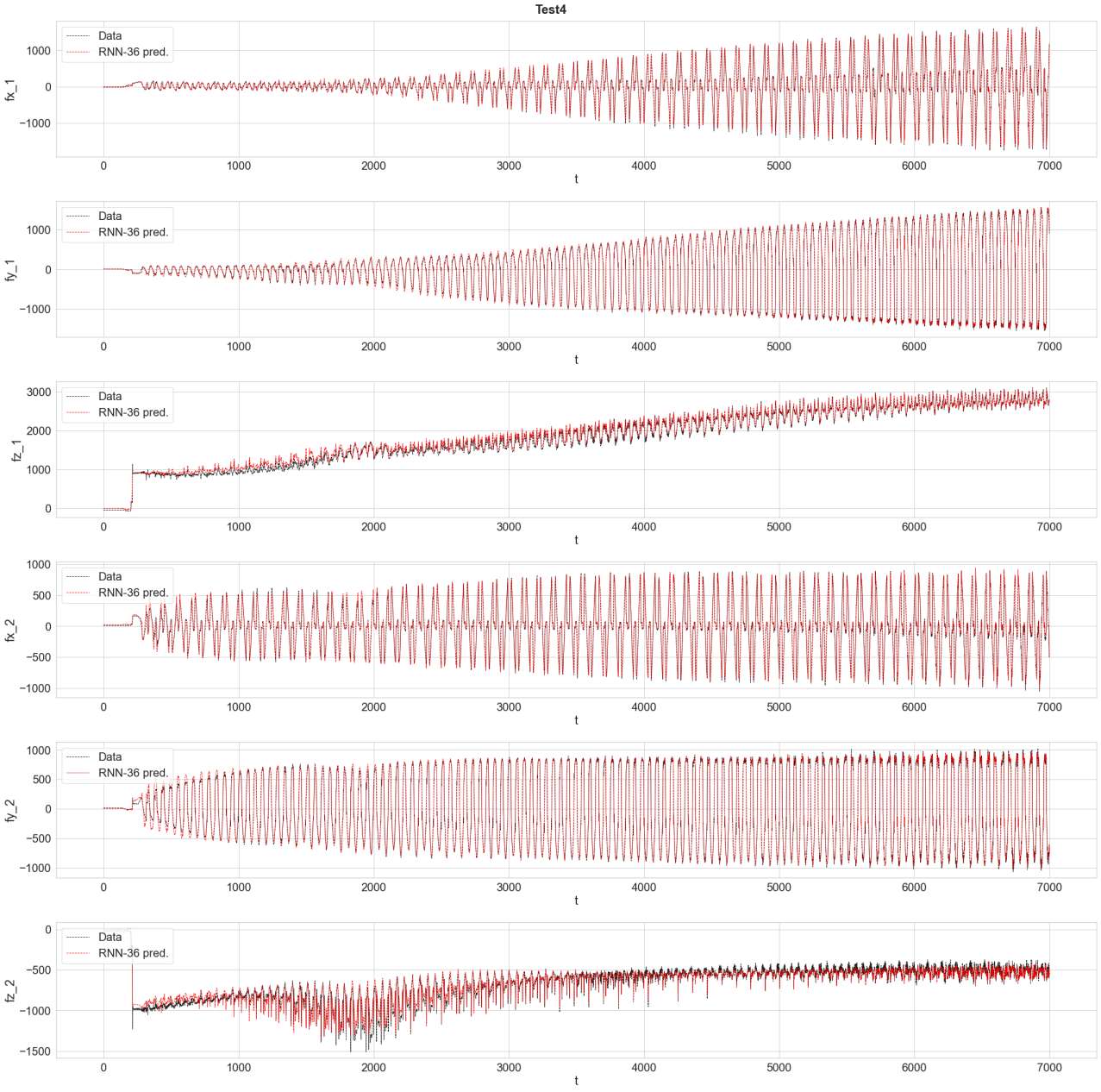
```
# plot large range for best model
tmin = 0
tmax = 7000
t = np.linspace(tmin, tmax, tmax-tmin)
sns.set(font_scale = 2)
sns.color_palette()
sns.set_style("whitegrid")
linewidth=1
for filename in dataset_filenames:

    fig = plt.figure(figsize=(30,30))
    fig.suptitle(filename, weight='bold').set_fontsize('24')
    for i in range(6):
        ax = fig.add_subplot(6, 1, i+1)
        ax.plot(t, tests_12[filename]['Y'].T[i][tmin+n_steps-1:tmax+n_steps-1],
        #ax.plot(t, tests_12[filename]['Y_pred'].T[i][tmin+n_steps-1:tmax+n_step
        #ax.plot(t, tests_36[filename]['Y_pred'].T[i][tmin+n_steps-1:tmax+n_step
        #ax.plot(t, tests_84[filename]['Y_pred'].T[i][tmin+n_steps-1:tmax+n_step
        #ax.plot(t, tests_12[filename]['Y_seq_pred'].T[i][tmin:tmax], label='RNN
```

```
        ax.plot(t, tests_36[filename]['Y_seq_pred'].T[i][tmin:tmax], label='RNN-
        #ax.plot(t, tests_84[filename]['Y_seq_pred'].T[i][tmin:tmax], label='RNN
        ax.set_xlabel('t')
        ax.set_ylabel(outputs[i])
        ax.legend(loc=2)
    plt.tight_layout()
    plt.savefig(output_dir/'{}_timeseries_t{}to{}.pdf'.format(filename, tmin, tm
```




Test2
Data
RNN-36 pred.
fx_1
fy_1
fz_1
fx_2
fy_2
fz_2
t




# 6. Summary and prospects

Six neural networks (three DNNs and three RNNs) were trained to predict tool-tip forces from input positions and angles (and their higher-order derivatives). The models were trained on 70% of the combined Test1 and Test4 datasets. Test2 was left out of the training entirely to evaluate the performance of the models on unseen runs of the robots.

The RNN models clearly outperformed the DNN models. This is especially clear from looking at the predicted tool-tip forces as a function of time for the Test2 dataset (unseen during training) above.

Adding the first-order (velocity) and second-order (acceleration) derivatives of the positions and angles as additional input features reduced the loss and significantly improved performance. Adding up to 6th order derivatives seemed helpful in some earlier DNN models (with fewer layers) that I trained (not shown in this notebook). However, the performance

comparisons between DNN-84 and DNN-36 in this notebook indicate that the impact is marginal.

Although the RNN did a decent job, all models struggled in generalizing to Test2. A more comprehensive hyperparameter optimization could be done to improve the performance. Adding training data from more runs with robots would probably help a lot.

You would probably want to further optimize and tailor the model to the application. A deeper (and recurrent) model will likely perform better if the goal is to achieve optimal accuracy. However, if the goal is to run fast inference on resource-constrained hardware, you'd want to optimize a smaller model that is *good enough* for the job.