In [1]:
```
import os
import matplotlib.pyplot as plt
from mpl_toolkits.mplot3d import Axes3D
import numpy as np
import pandas as pd
%matplotlib inline

from time import time

from sklearn import metrics
from sklearn.cluster import KMeans
from sklearn import metrics
from sklearn.cluster import DBSCAN
from sklearn.preprocessing import StandardScaler, MaxAbsScaler, Normalizer
from sklearn.model_selection import RandomizedSearchCV

from trackml.dataset import load_event, load_dataset
from trackml.score import score_event



from scipy import spatial
```

In [2]:
```
path_to_train = "/home/cameron/Documents/Computational_Physics/train_1"
```

In [3]:
```
event_prefix = "event000001000"
```

In [4]:
```
hits, cells, particles, truth = load_event(os.path.join(path_to_train, event_prefix))
```

In [5]:
```
hits.head()
```

	hit_id	x	y	z	volume_id	layer_id	module_id
0	1	-64.409897	-7.163700	-1502.5	7	2	1
1	2	-55.336102	0.635342	-1502.5	7	2	1
2	3	-83.830498	-1.143010	-1502.5	7	2	1
3	4	-96.109100	-8.241030	-1502.5	7	2	1
4	5	-62.673599	-9.371200	-1502.5	7	2	1

In [6]:

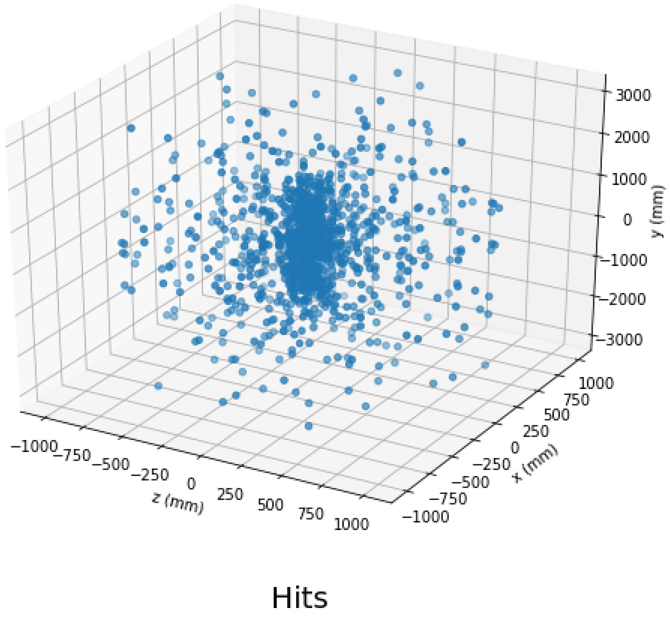
```
fig = plt.figure(figsize=(20,7))
ax = fig.add_subplot(122,projection='3d')

x = hits['x']
x1 = x[::100]
y = hits['y']
y1 = y[::100]
z = hits['z']
z1 = z[::100]

ax.scatter(x1,y1,z1)

ax.set_xlabel('z (mm)')
ax.set_ylabel('x (mm)')
ax.set_zlabel('y (mm)')
ax.set_title("Hits", y=-.15, size=20)

plt.show()
```



In [7]:

```
cells.head()
```

	hit_id	ch0	ch1	value
0	1	209	617	0.013832
1	1	210	617	0.079887
2	1	209	618	0.211723
3	2	68	446	0.334087
4	3	58	954	0.034005

In [8]:

```
particles.head()
```

	particle_id	vx	vy	vz	px	py	pz	q	nhits
0	4503668346847232	-0.009288	0.009861	-0.077879	-0.055269	0.323272	-0.203492	-1	8
1	4503737066323968	-0.009288	0.009861	-0.077879	-0.948125	0.470892	2.010060	1	11
2	4503805785800704	-0.009288	0.009861	-0.077879	-0.886484	0.105749	0.683881	-1	0
3	4503874505277440	-0.009288	0.009861	-0.077879	0.257539	-0.676718	0.991616	1	12
4	4503943224754176	-0.009288	0.009861	-0.077879	16.439400	-15.548900	-39.824902	1	3

In [9]:

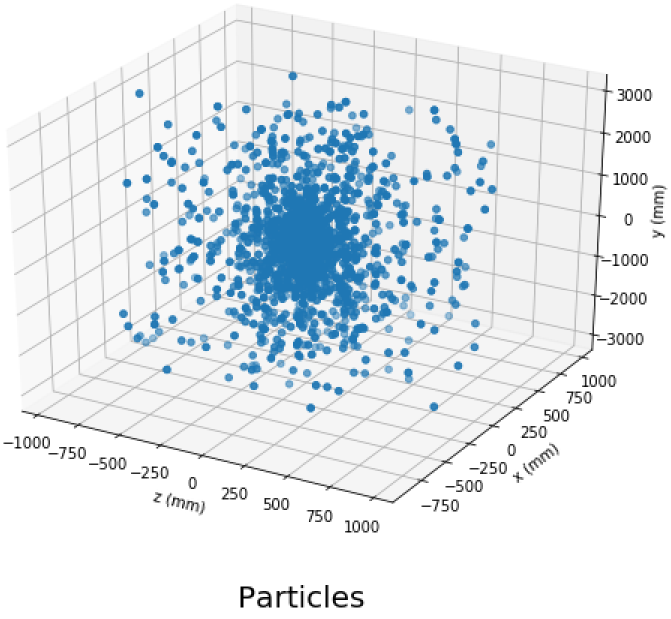
```
fig = plt.figure(figsize=(20,7))
ax = fig.add_subplot(122,projection='3d')

x = particles['vx']
x1 = x[::10]
y = particles['vy']
y1 = y[::10]
z = particles['vz']
z1 = z[::10]

ax.scatter(x,y,z)

ax.set_xlabel('z (mm)')
ax.set_ylabel('x (mm)')
ax.set_zlabel('y (mm)')
ax.set_title("Particles", y=-.15, size=20)

plt.show()
```



In [10]:

```
truth.head()
```

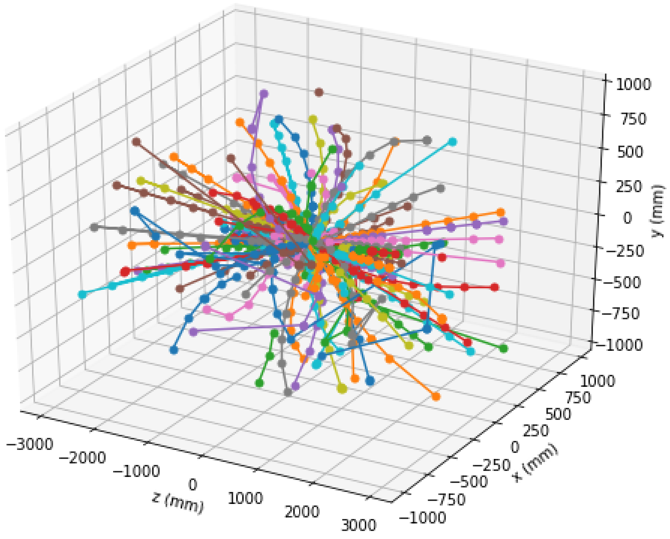
	hit_id	particle_id	tx	ty	tz	tpx	tpy	tpz	weight
0	1	0	-64.411598	-7.164120	-1502.5	250710.000000	-149908.000000	-956385.00000	0.000000
1	2	22525763437723648	-55.338501	0.630805	-1502.5	-0.570605	0.028390	-15.49220	0.000010
2	3	0	-83.828003	-1.145580	-1502.5	626295.000000	-169767.000000	-760877.00000	0.000000
3	4	297237712845406208	-96.122902	-8.230360	-1502.5	-0.225235	-0.050968	-3.70232	0.000008
4	5	418835796137607168	-62.659401	-9.375040	-1502.5	-0.281806	-0.023487	-6.57318	0.000009

In [11]:
```
#Plot from Joshua Bonatt
tracks = truth.particle_id.unique()[1::100]
fig = plt.figure(figsize=(20,7))

ax2 = fig.add_subplot(122,projection='3d')
for track in tracks:
    hit_ids = truth[truth['particle_id'] == track]['hit_id']
    t = hits[hits['hit_id'].isin(hit_ids)][['x', 'y', 'z']]
    ax2.plot3D(t.z, t.x, t.y, '.-', ms=10)

ax2.set_xlabel('z (mm)')
ax2.set_ylabel('x (mm)')
ax2.set_zlabel('y (mm)')
ax2.set_title("Particle Tracks", y=-.15, size=20)

plt.show()
```



Particle Tracks

In [12]:

```
#Based of of code from Mikhail Hushchyn
class Clusterer(object):

    def __init__(self, eps):
        self.eps = eps


    def _preprocess(self, hits):

        x = hits.x.values
        y = hits.y.values
        z = hits.z.values

        r = np.sqrt(x**2 + y**2 + z**2)
        hits['x2'] = x/r
        hits['y2'] = y/r

        r = np.sqrt(x**2 + y**2)
        hits['z2'] = z/r

        ss = StandardScaler()
        X = ss.fit_transform(hits[['x2', 'y2', 'z2']].values)

        return X


    def predict(self, hits):

        X = self._preprocess(hits)

        clf = DBSCAN(eps=self.eps, min_samples=1, algorithm='auto', n_jobs=-1)
        labels = clf.fit_predict(X)

        return labels
```

In [13]:

```
model = Clusterer(eps=0.00738)
labels = model.predict(hits)
```

In [ ]:

In [14]:

```
def create_one_event_submission(event_id, hits, labels):
    sub_data = np.column_stack(([event_id]*len(hits), hits.hit_id.values, labels))
    submission = pd.DataFrame(data=sub_data, columns=["event_id", "hit_id", "track_id"])
.astype(int)
    return submission
```

In [15]:

```
submission = create_one_event_submission(0, hits, labels)
```

In [16]:

```
#Alternative scoring function from CPMP
def score_event_fast(truth, submission):
    truth = truth[['hit_id', 'particle_id', 'weight']].merge(submission, how='left', on='hit_id')
    df = truth.groupby(['track_id', 'particle_id']).hit_id.count().to_frame('count_both').reset_index()
    truth = truth.merge(df, how='left', on=['track_id', 'particle_id'])

    df1 = df.groupby(['particle_id']).count_both.sum().to_frame('count_particle').reset_index()
    truth = truth.merge(df1, how='left', on='particle_id')
    df1 = df.groupby(['track_id']).count_both.sum().to_frame('count_track').reset_index()
    truth = truth.merge(df1, how='left', on='track_id')
    truth.count_both *= 2
    score = truth[(truth.count_both > truth.count_particle) & (truth.count_both > truth.count_track)].weight.sum()
    return score
```

In [17]:

```
score = score_event_fast(truth, submission)
print("Your score: ", score)
```

```
Your score:  0.20306711
```