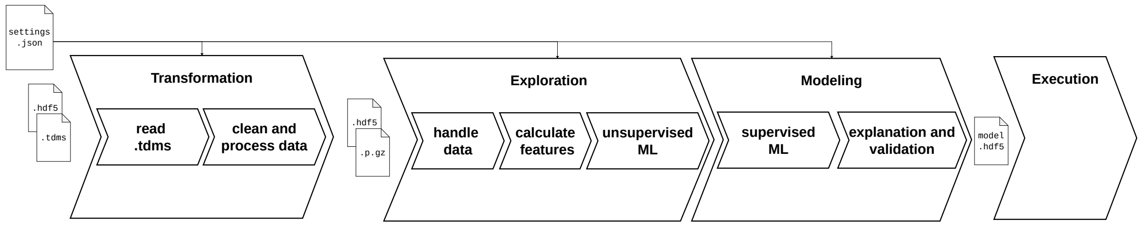
CERN

Transformation ML Framework

on basis of the XBox2 Data Set

Lorenz Fischl

Introduction



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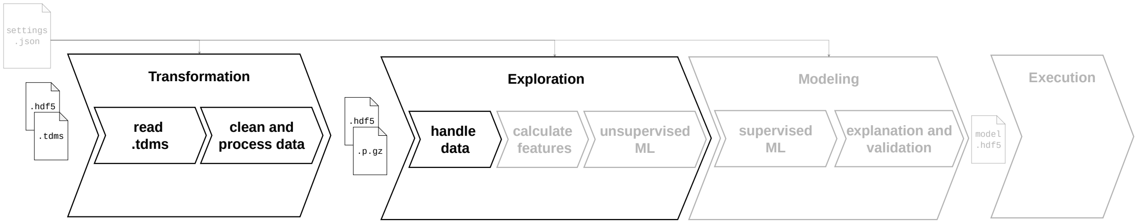

Table of Contents

Table of Contents

Table of Contents

.tdms files

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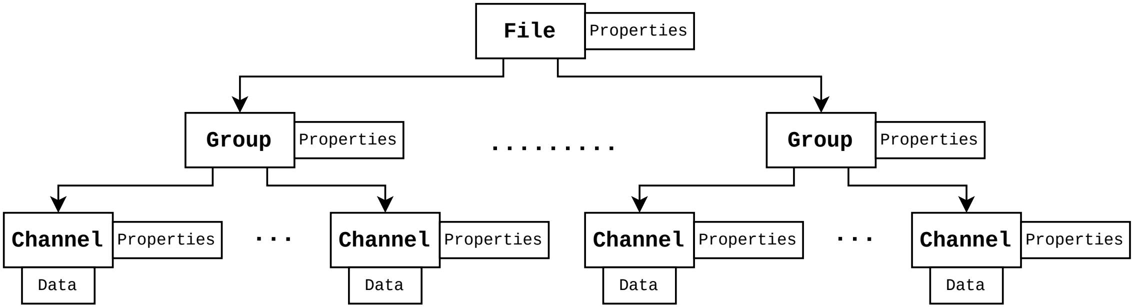

Table of Contents

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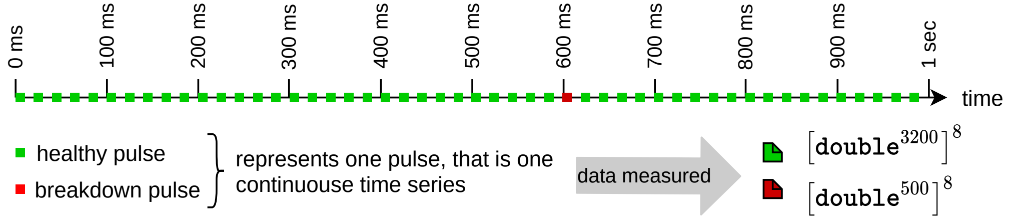
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400 ms
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700 ms
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time
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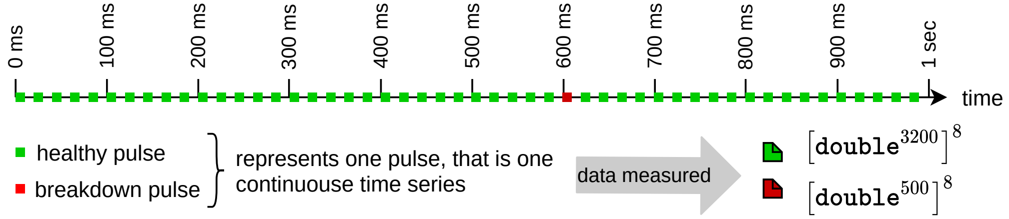

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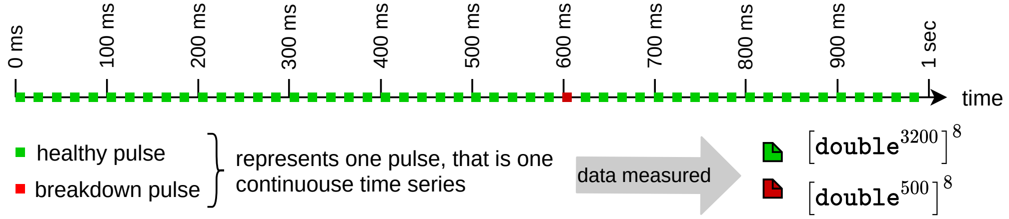
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temporary log files with 16 channels of 3200 and 500 sample points.
storing all EventData would take up $\sim$ 1TB.

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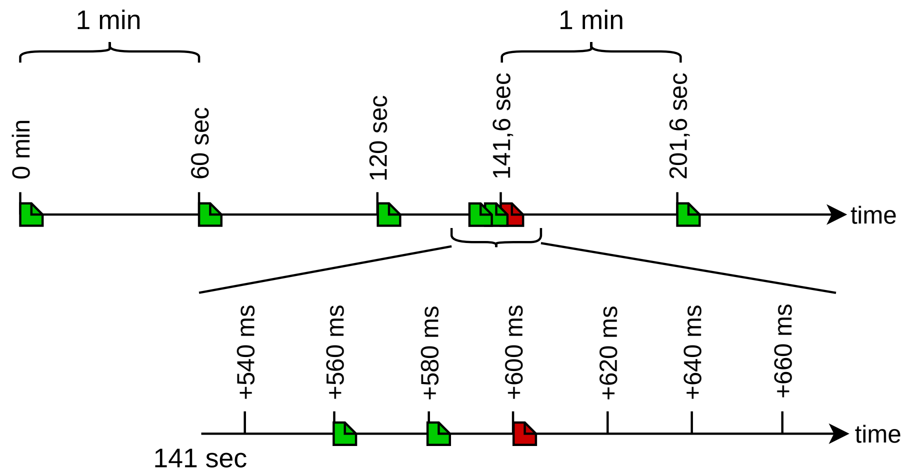

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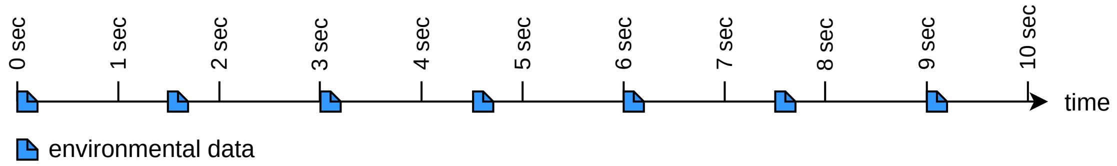

Table of Contents

Table of Contents

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- outputs `numpy` arrays for machine learning

Table of Contents

nptdms

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- very space inefficient (ex. TrendData: 20,5 GB in .tdms $\rightarrow$ 2.8 GB of data)

Table of Contents

Transformation

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`.tdms` file gets read with the `nptdms` package

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- *EventData*: For each channel form all groups in one file, there is a single column pd df of vectors (channel wise reading).

Transformation

`.tdms` $\longrightarrow$ `pd df/ dictionary`

data is stored in a `pandas` DataFrames (=pd df) and a python dictionary

- *EventData*: For each channel form all groups in one file, there is a single column pd df of vectors (channel wise reading).
- *ContextData*: for each event (= group in the EventData) the prior TrendData and some context data (eg. pulse length/amplitude) is stored in a dictionary together with the EventData names.

Transformation

$$\texttt{.tdms} \longrightarrow \texttt{pd df/ dictionary} \longrightarrow \texttt{pickle} \longrightarrow \texttt{.gzip}$$

data is serialized and compressed with the `compress_pickle` package

read .tdms

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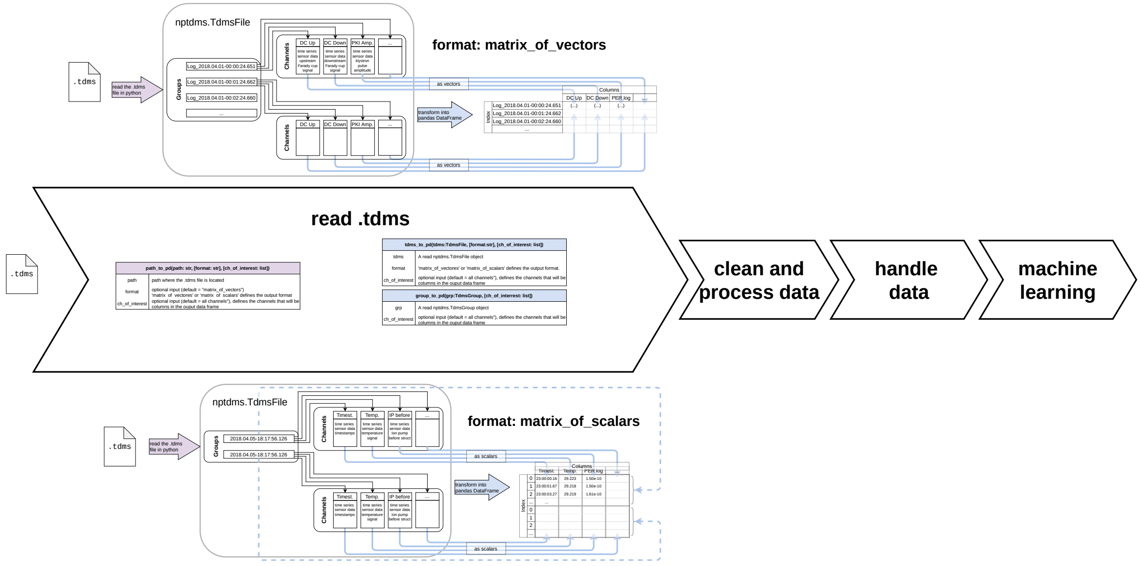

.tdms
read the .tdms file in python
nptdms.TdmsFile
Groups
Channels
Log_2018.04.01-00:00:24.651
Log_2018.04.01-00:01:24.662
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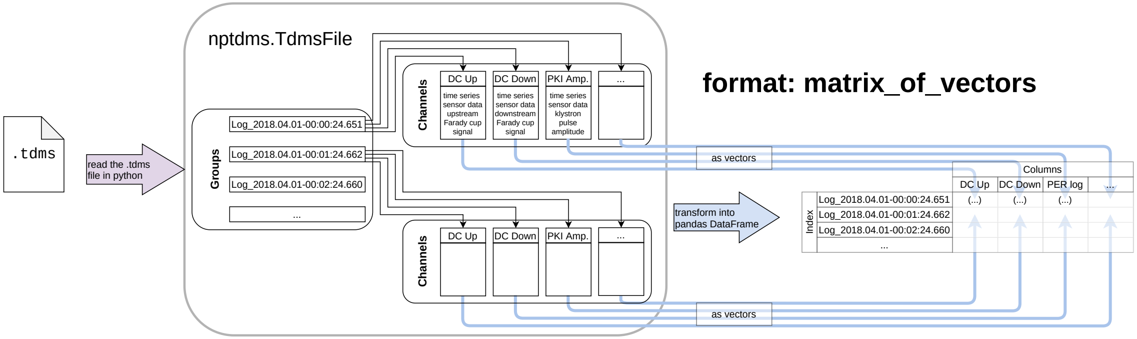
...
DC Up
DC Down
PKI Amp.
time series sensor data upstream Faraday cup signal
time series sensor data downstream Faraday cup signal
time series sensor data klystron pulse amplitude
format: matrix_of_vectors
as vectors
transform into pandas DataFrame
Columns
DC Up
DC Down
PER log
Index
(...)
read .tdms
clean and process data
handle data
machine learning
nptdms.TdmsFile
2018.04.05-18:17:56.126
Timest.
Temp.
IP before
time series sensor data timestamps
time series sensor data temperature signal
time series sensor data Ion pump before struct
format: matrix_of_scalars
as scalars
Timest.
Temp.
PER log
23:00:00.16
29.223
1.50e-10
23:00:01.67
29.218
1.50e-10
23:00:03.27
29.219
1.61e-10

path_to_pd(path: str, [format: str], [ch_of_interest: list])	
path	path where the .tdms file is located
format	optional input (default = "matrix_of_vectors") 'matrix of vectores' or 'matrix of scalars' defines the output format
ch_of_interest	optional input (default = all channels"), defines the channels that will be columns in the ouput data frame

tdms_to_pd(tdms:TdmsFile, [format:str], [ch_of_interest: list])	
tdms	A read nptdms.TdmsFile object
format	'matrix_of_vectores' or 'matrix_of_scalars' defines the output format.
ch_of_interest	optional input (default = all channels"), defines the channels that will be columns in the ouput data frame

group_to_pd(grp:TdmsGroup, [ch_of_interrest: list])	
grp	A read nptdms.TdmsGroup object
ch_of_interest	optional input (default = all channels"), defines the channels that will be columns in the ouput data frame

format: matrix_of_vectors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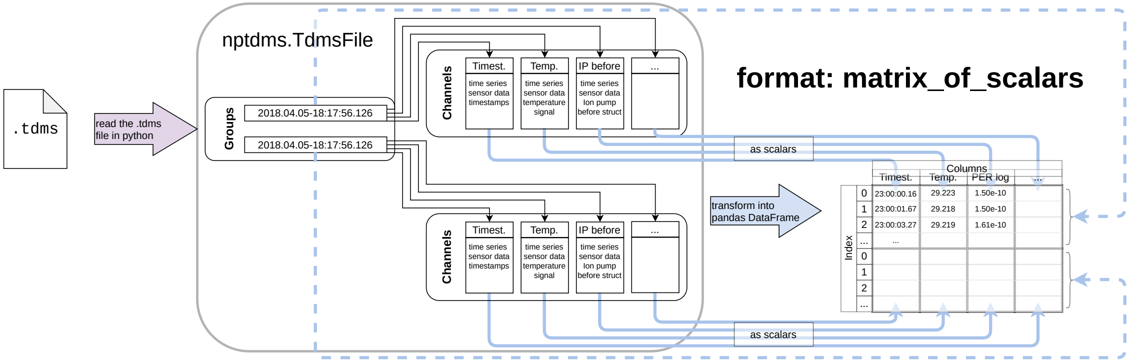

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- *EventData*: unzipped and unpickled with the `compress_pickle` package. (channel wise reading)
- *ContextData*: the dictionary is also unzipped and unpickled and then transformed into a `pandas` DataFrame.

Clean and Process data with classes

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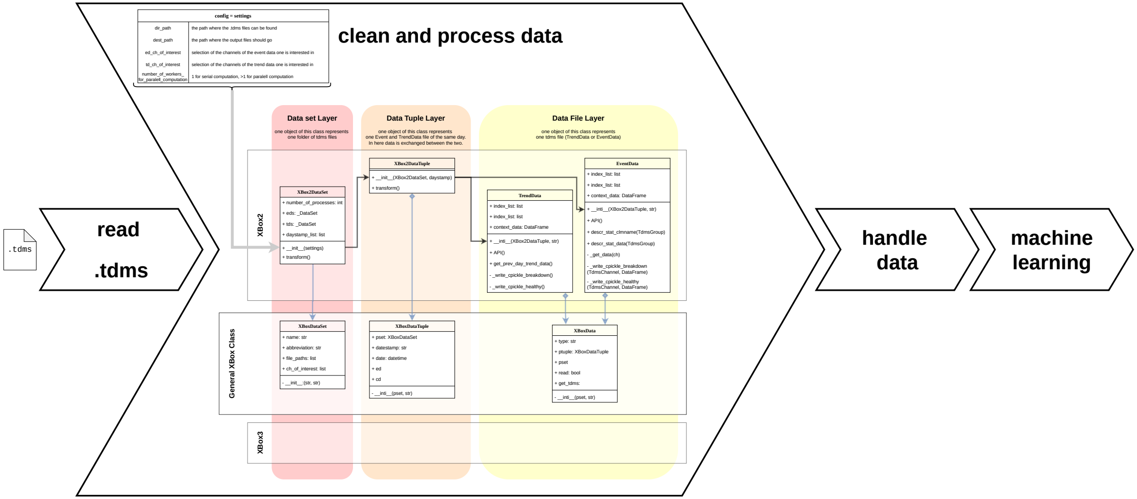
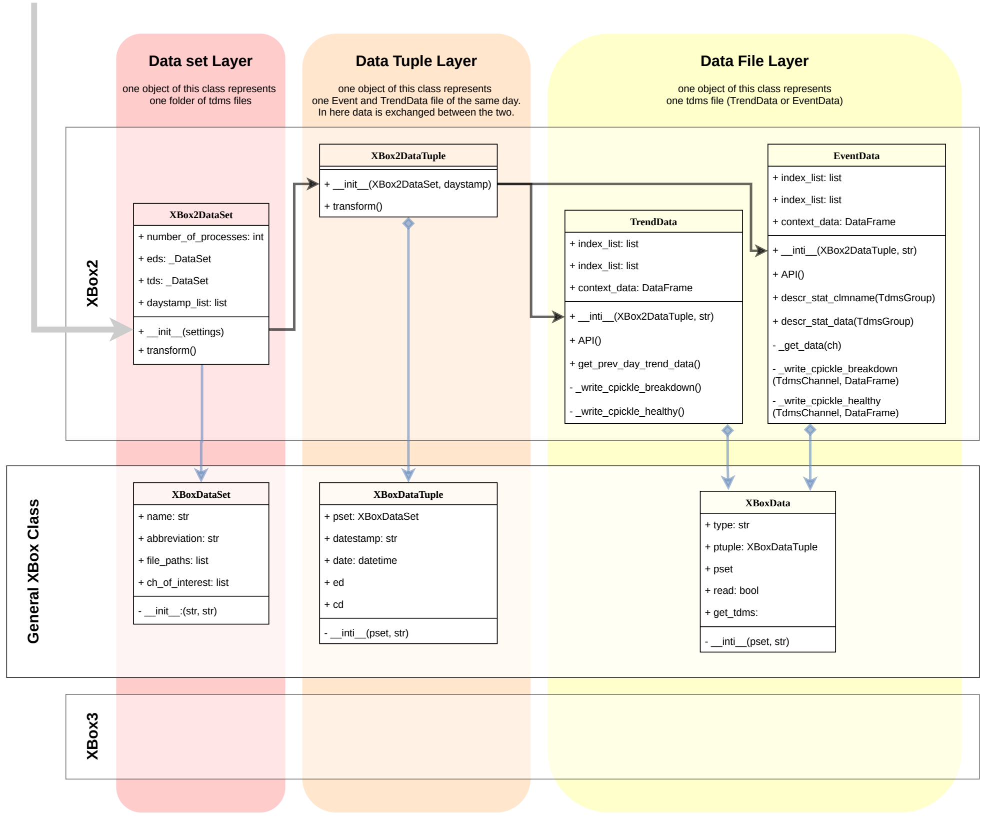


config = settings	
dir_path	the path where the .tdms files can be found
dest_path	the path where the output files should go
ed_ch_of_interest	selection of the channels of the event data one is interested in
td_ch_of_interest	selection of the channels of the trend data one is interested in
number_of_workers_ for_paralell_computation	1 for serial computation, >1 for paralell computation

.tdms
read
.tdms
clean and process data
Data set Layer
one object of this class represents one folder of tdms files
Data Tuple Layer
one object of this class represents one Event and TrendData file of the same day. In here data is exchanged between the two.
Data File Layer
one object of this class represents one tdms file (TrendData or EventData)
XBox2
XBox2DataSet
+ number_of_processes: int
+ eds: _DataSet
+ tds: _DataSet
+ daystamp_list: list
+ __init__(settings)
+ transform()
XBox2DataTuple
+ __init__(XBox2DataSet, daystamp)
+ transform()
TrendData
+ index_list: list
+ index_list: list
+ context_data: DataFrame
+ __inti__(XBox2DataTuple, str)
+ API()
+ get_prev_day_trend_data()
- _write_cpickle_breakdown()
- _write_cpickle_healthy()
EventData
+ index_list: list
+ index_list: list
+ context_data: DataFrame
+ __inti__(XBox2DataTuple, str)
+ API()
+ descr_stat_clmname(TdmsGroup)
+ descr_stat_data(TdmsGroup)
- _get_data(ch)
- _write_cpickle_breakdown (TdmsChannel, DataFrame)
- _write_cpickle_healthy (TdmsChannel, DataFrame)
General XBox Class
XBoxDataSet
+ name: str
+ abbreviation: str
+ file_paths: list
+ ch_of_interest: list
- __init__:(str, str)
XBoxDataTuple
+ pset: XBoxDataSet
+ datestamp: str
+ date: datetime
+ ed
+ cd
- __inti__(pset, str)
XBoxData
+ type: str
+ ptuple: XBoxDataTuple
+ pset
+ read: bool
+ get_tdms:
- __inti__(pset, str)
XBox3
handle data
machine learning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+ cd
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XBoxData
+ type: str
+ ptuple: XBoxDataTuple
+ pset
+ read: bool
+ get_tdms:
- __inti__(pset, str)
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- data was changed in place in notebooks in retrospect

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`.hdf5`

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- build for data management and storage
- keys work like pointers to the memory, channel wise reading possible
- in `nptdms` the function `to_hdf()` exists
- no data is lost in the Transformation, also properties are stored

Current Results with `.hdf5`

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- converted TrendData (20.5GB $\rightarrow$ 2.8GB) into the `.hdf5` files locally with 8 cores (using the `nptdms` function `tmds.to_hdf()`)

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	`nptdms`	`pd.df+cpickle`		`.hdf5`	
		w/o zip	w zip	w/o zip	w/ zip
space (GByte)	20.5GB	2.8GB	1GB	2.8GB	1GB
read (TD 1 channel)	$\sim$ 60min	4sec	12sec	0.5 sec	
read (TD 3 channels)	$\sim$ 60min	4sec	12sec	1 sec	
read (TD 15 channels)	$\sim$ 60min	4sec	12sec	4 sec	
feature calc. (ED)	$>$ 15min		7sec	8 sec	

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