MANCHESTER 1824
The University of Manchester

SP-1879: Create set of PSS test vectors for the SPS pipeline

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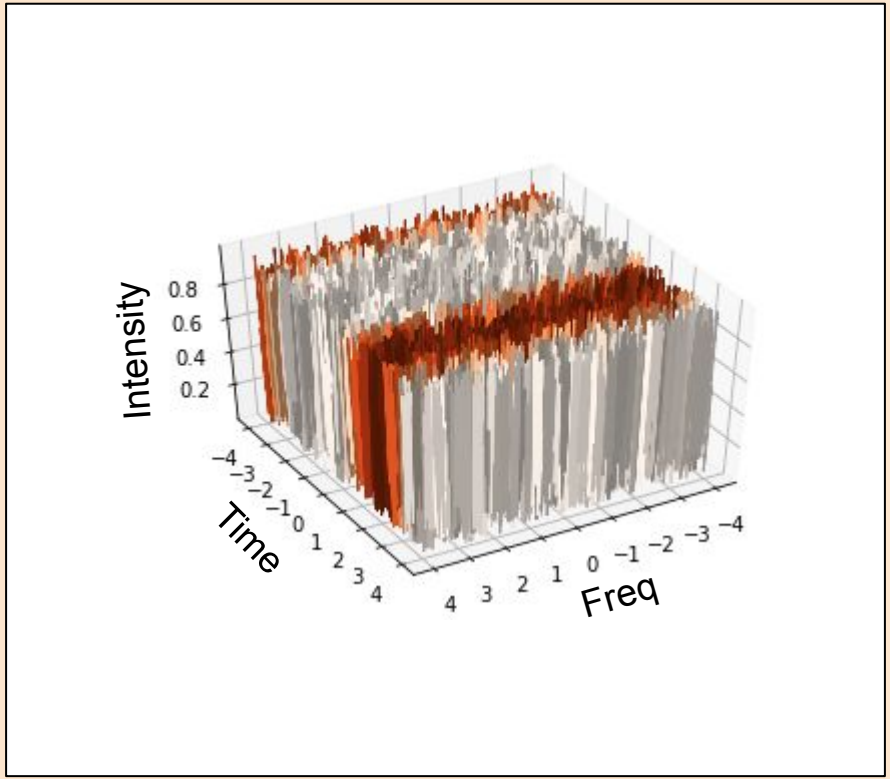
Test Vectors

- 4-D Data cube - signal intensity vs time, frequency, polarisation.
- Examples of real astrophysical signals (periodic (pulsars) and transient (FRBs, GP, RRATs)).
- SKA sized test vectors are up to 36GB based on current requirements.
- Crucial for
  - demonstrating pipeline performance
  - demonstrating compliance to system requirements
  - ad-hoc/unit/system/pipeline testing



Define SPS test vector parameters

Pulse parameters for the SPS test vector set:

- 2 pulse periods: 5, 8 s
- 10 DMs: 1, 100, 370, 500, 740, 1000, 1480, 2000, 2950, 3000 pc/cm^3
- 5 pulse widths: 100 μs, 1 ms, 10 ms, 100 ms, 1 s
- 3 S/N values: 20, 30, 50

Relevant requirements:

SKAO-CSP_Mid_PSS_REQ-13: CSP_Mid.PSS Single Pulse search
CSP_Mid.PSS shall, as part of the Pulsar Search, search for individual pulses with dispersion measures from 0 to 3000 pc cm^{-3} and with widths from 100 microseconds to 1 second.

SKAO-CSP_Low_PSS_REQ-14: CSP_Low.PSS Single Pulse search
CSP_Low.PSS shall, as part of the Pulsar Search, search for individual pulses with dispersion measures from 0 to 3000 pc cm^{-3} and with widths from 100 microseconds to 1 second.

Create SPS test vector set

```
[llevin@dokimi plots]$ ls -1 /skatvnas3/doc_root/testvectors/SPS-MID/
latest
SPS-MID_747e95f_0.125_0.000125_1000.0_0.0_Gaussian_20.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_1000.0_0.0_Gaussian_30.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_1000.0_0.0_Gaussian_50.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_100.0_0.0_Gaussian_20.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_100.0_0.0_Gaussian_30.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_100.0_0.0_Gaussian_50.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_1.0_0.0_Gaussian_20.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_1.0_0.0_Gaussian_30.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_1.0_0.0_Gaussian_50.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_1480.0_0.0_Gaussian_20.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_1480.0_0.0_Gaussian_30.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_1480.0_0.0_Gaussian_50.0_123123123.fil
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SPS-MID_747e95f_0.125_0.000125_2000.0_0.0_Gaussian_30.0_123123123.fil
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SPS-MID_747e95f_0.125_0.000125_2950.0_0.0_Gaussian_20.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_2950.0_0.0_Gaussian_30.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_2950.0_0.0_Gaussian_50.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_3000.0_0.0_Gaussian_20.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_3000.0_0.0_Gaussian_30.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_3000.0_0.0_Gaussian_50.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_370.0_0.0_Gaussian_20.0_123123123.fil
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SPS-MID_747e95f_0.125_0.000125_370.0_0.0_Gaussian_50.0_123123123.fil
SPS-MID_747e95f_0.125_0.000125_500.0_0.0_Gaussian_20.0_123123123.fil
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SPS-MID_747e95f_0.125_0.00125_1000.0_0.0_Gaussian_50.0_123123123.fil
SPS-MID_747e95f_0.125_0.00125_100.0_0.0_Gaussian_20.0_123123123.fil
```
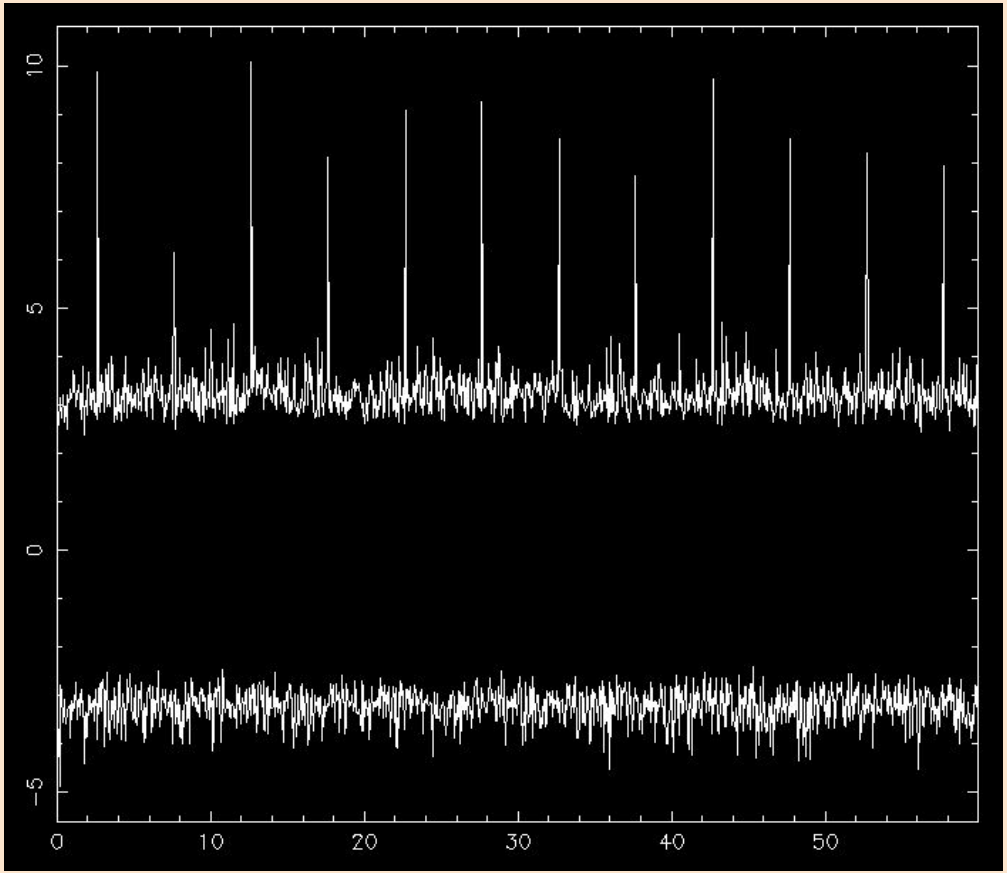

The SPS test vector set:

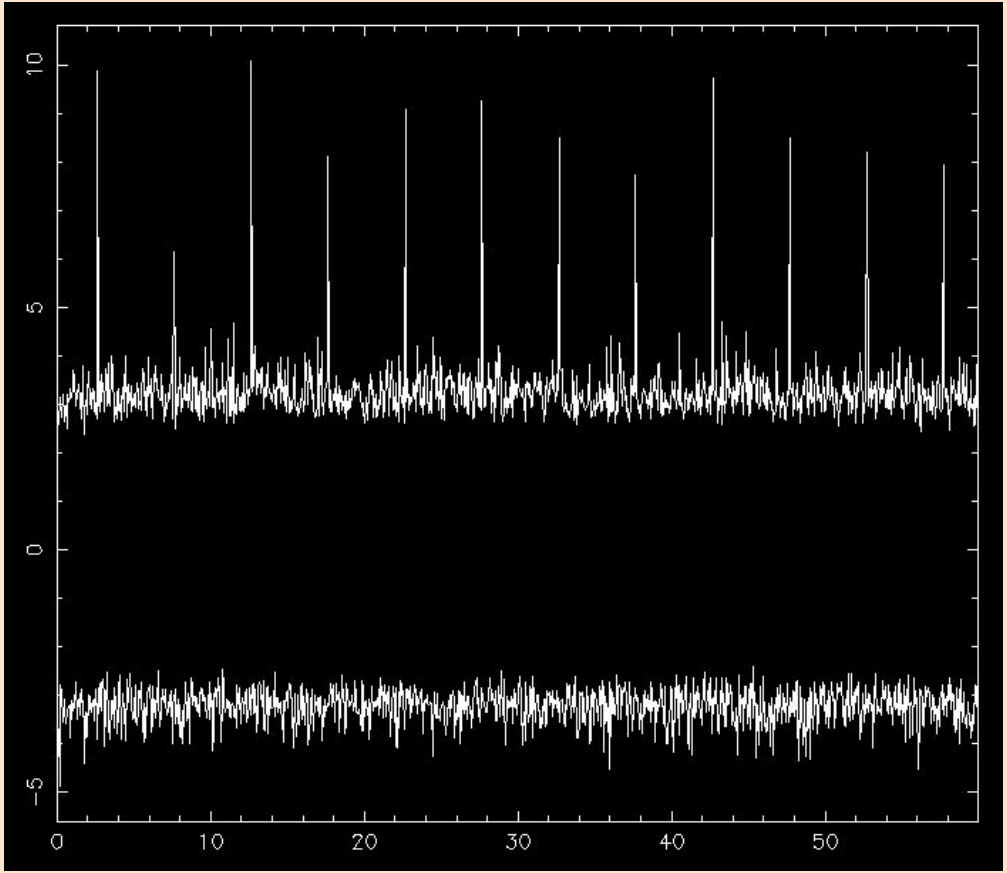
- 300 test vectors:
  - 60 second integration time
  - 4096 frequency channels
  - 64 µs time resolution
  - 8-bit samples.
- 3.84 GB/file = 1.152 TB

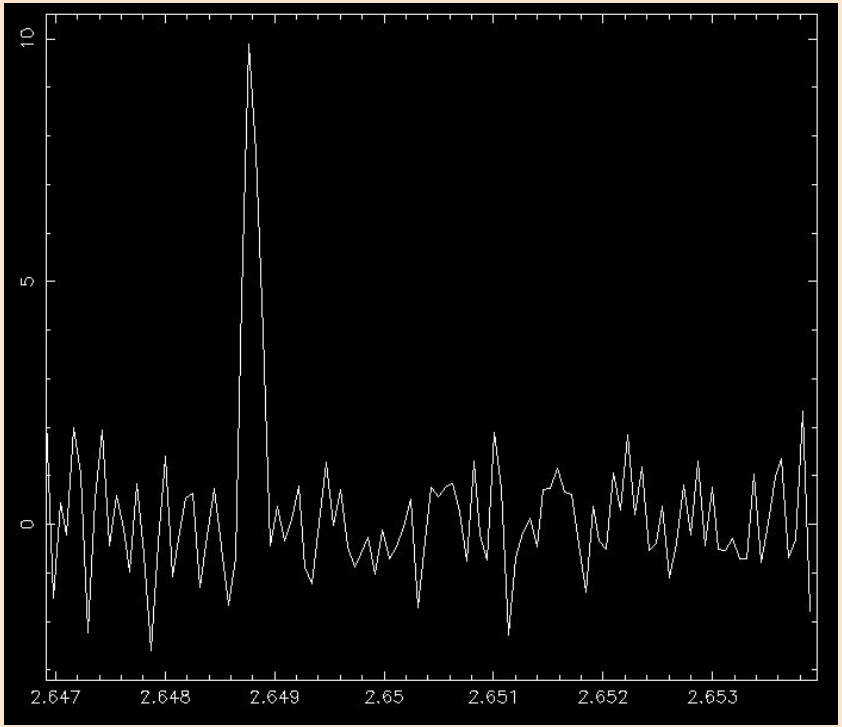
Test Vector Generator:
https://gitlab.com/ska-telescope/pss-test-vector-generator/



Input parameters for vector:

- DM = 100 pc/cm^3
- Period = 5 s
- Pulse width = 1 μs
  => <2 bins
- S/N = 50
  => single pulse S/N ~14


10
5
0
-5
0
10
20
30
40
50


10
5
0
2.647
2.648
2.649
2.65
2.651
2.652
2.653

Validate SPS test vectors

Validation steps:

- Run SPS parts of PSS Gold Standard matlab code
  - RCPT: read in test vector data
  - RFIM: remove interference (mask channels)
  - DDTR: de-disperse data at given DM steps
  - SPDT: search each time series for single pulses
  - SPSIFT: remove duplicate single pulse detections
- Compare output detection lists with input parameters

PSS Gold Standard MatLab model:
https://gitlab.com/SKA-TDT/tdt-matlab-models

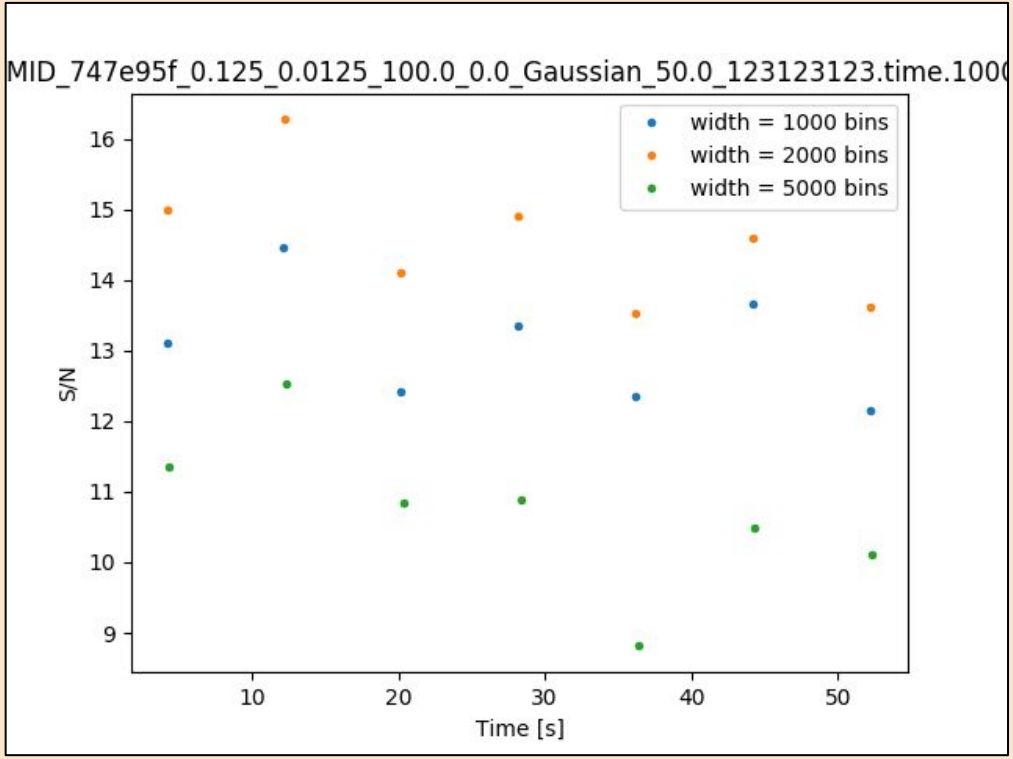
PSS Signal Model document:
https://www.dropbox.com/s/sv86txc0zkwmx7f/SKA-TEL-CSP-0000085_5_PSSSignalModel_Mickaliger_2018-09-04%20-%20signed.pdf?dl=0

Validate SPS test vectors

Input parameters for vector:

- DM = 100 pc/cm^3
- Period = 8 s
- Pulse width = 100 ms
  => 1563 bins
- S/N = 50
  => single pulse S/N ~18

Summary document
https://www.overleaf.com/read/xmrjnskdjfqg



Future work

- We have a plan for how to implement the end-to-end testing framework, with many features already identified.

- Next steps:
  - Implement reverse proxy on University of Manchester machines to enable test vectors to be accessed remotely
  - End-to-end testing will be using pytest, need to develop classes for running Cheetah and parse the output
  - Set up and implement SPS tests in pss-pipeline
  - Further down the line we will also implement tests for FDAS pipeline