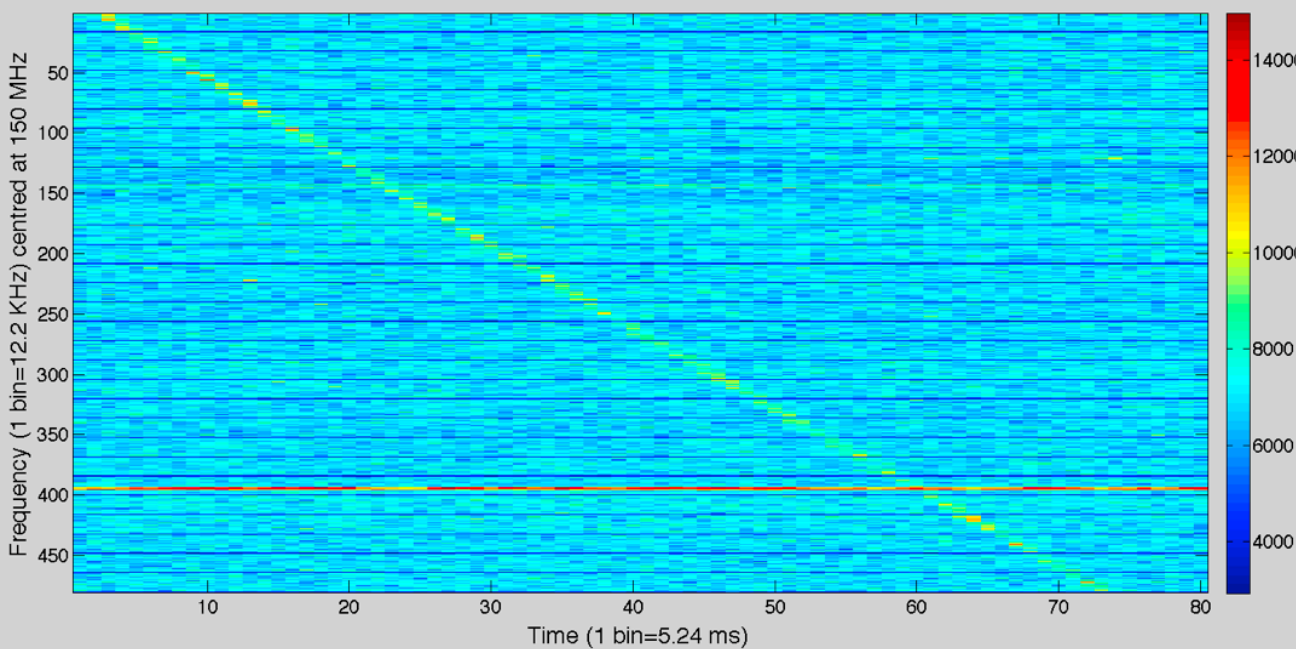




SKA Non Imaging Processing Concept description: GPU processing for real-time isolated radio pulse detection

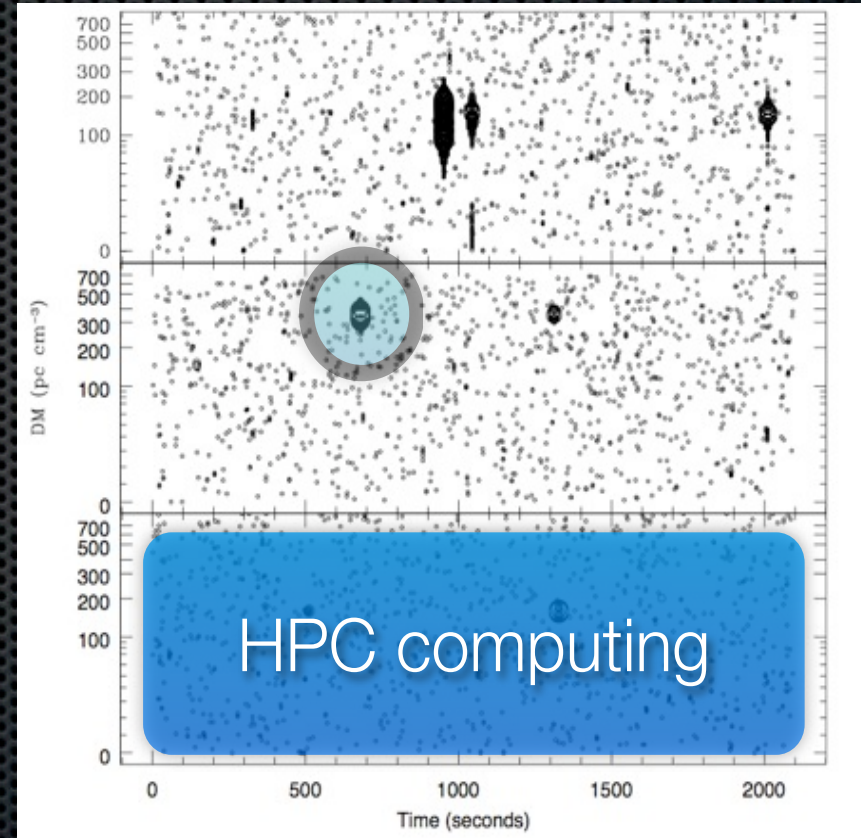
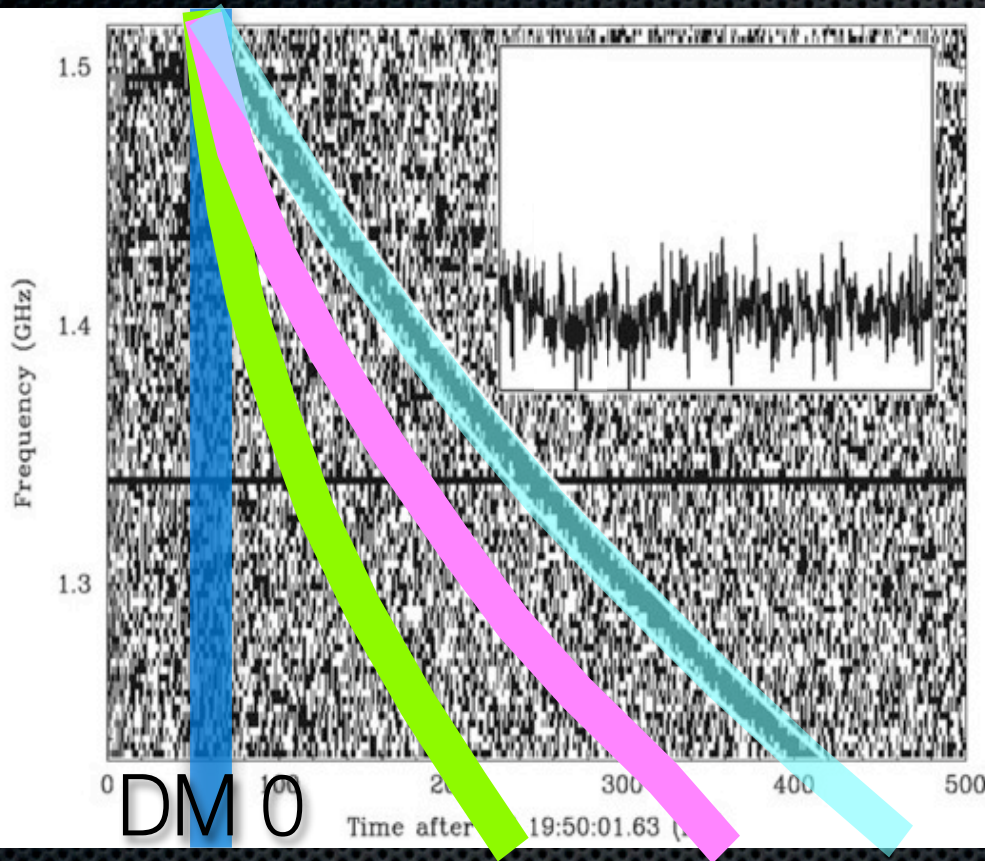
The problem



- Poorly sampled parameter space for fast, dispersed pulses.
- Classes of neutron stars -such as RRATs- better found through searches of Individual Radio Pulses

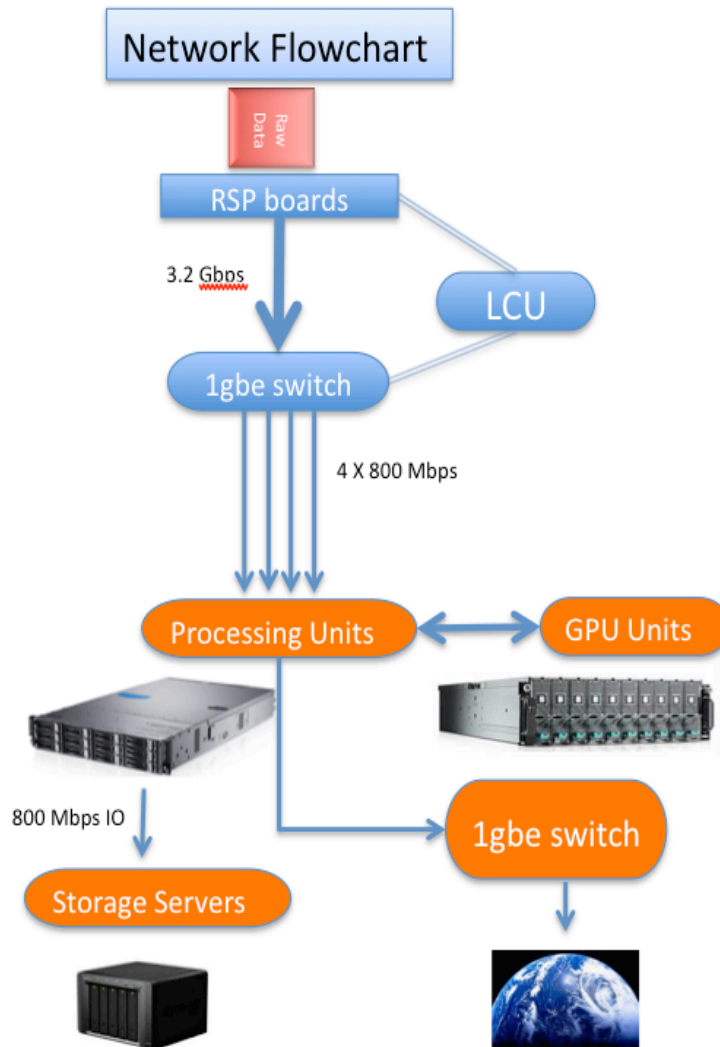
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Dispersion searches



N^2 or $N \log N$ process per DM per time sample
($N > 1000$) (10000 DMs) (10000+ samples/sec)

Hardware description



Specifications	
LBA frequency range	30 – 90 MHz
HBA frequency range	110 – 240 MHz
elevation range	30° - 90°
Number of usable <u>subbands</u>	244
Maximum number of beams	244 (1 <u>subband</u> /beam)
Sampling rate	200 or 160 MHz
<u>Subband</u> time resolution	5.12 or 6.4 μ s
<u>Subband</u> frequency resolution	195.3 or 156.2 kHz
Maximum sky bandwidth	47.6 MHz

Station Beam FWHM				
Size (°)	9.9	4.0	2.5	1.2
Frequency (MHz)	30	75	120	240

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International LOFAR stations as testbeds

Monday, 11 April 2011

GPU hardware



Tesla S1070 1U System

end of line, £5500



<i>Processors</i>	4 x Tesla T10P
<i>Number of cores</i>	960
<i>Core Clock</i>	1.5 GHz
<i>Performance</i>	4 Teraflops
<i>Total system memory</i>	16.0 GB (4.0 GB per T10P)
<i>Memory bandwidth</i>	408 GB/sec peak (102 GB/sec per T10P)
<i>Memory I/O</i>	2048-bit, 800MHz GDDR3 (512-bit per T10P)
<i>Form factor</i>	1U (EIA 19" rack)
<i>System I/O</i>	2 PCIe x16 Gen2
<i>Typical power</i>	700 W

NVIDIA Confidential

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GPU hardware



NVIDIA Tesla M2050
Fermi

double precision, £1500



3 or 6 GB on-board memory

nominal 250W during operation

NVIDIA GeForce GTX series

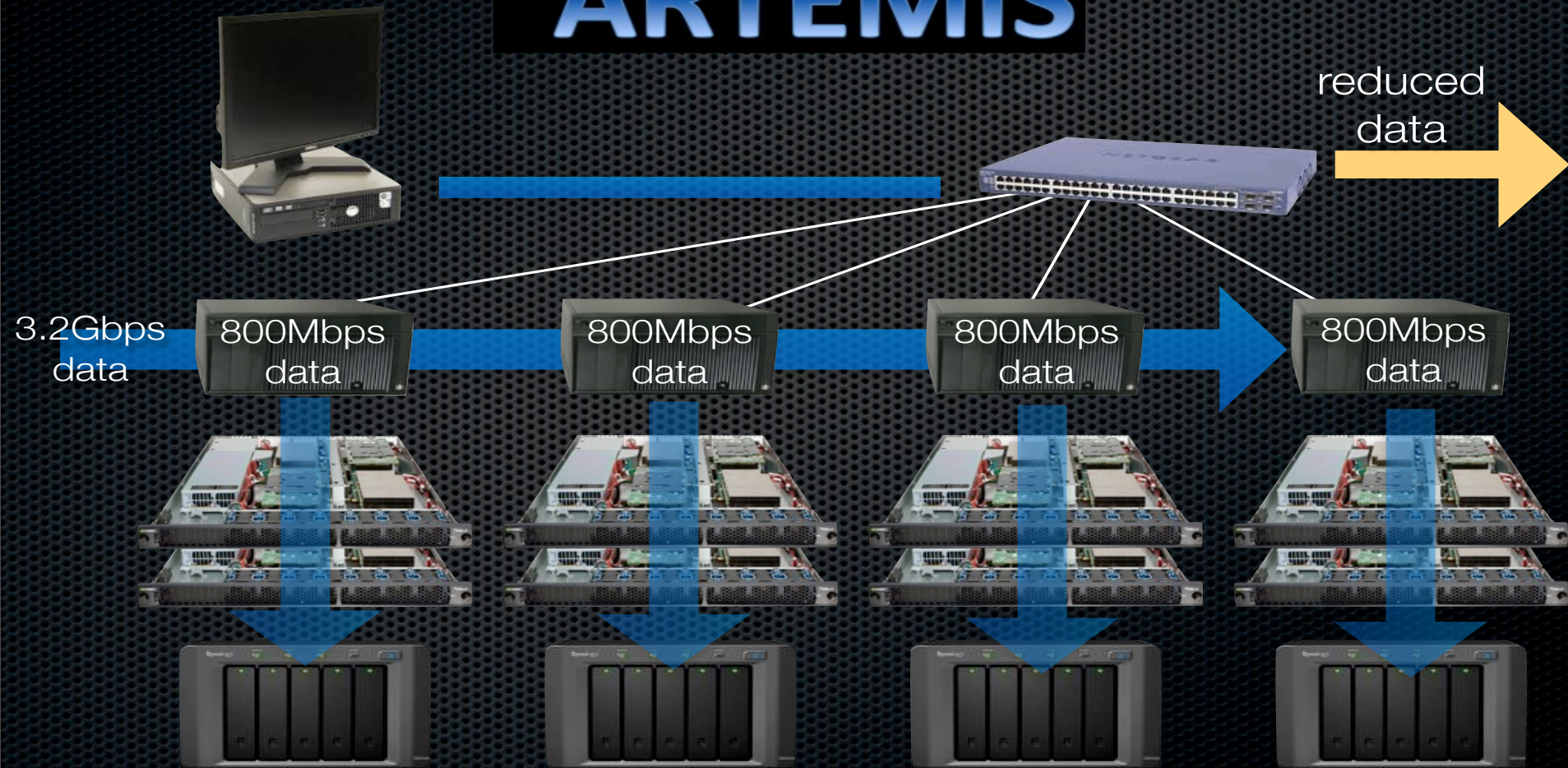
single precision,
slower data transfers, £400



> 1.5 GB on-board memory

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Hardware layout for ILS



Software layout for ILS



pelican server

Collecting the data

pelican module

Flagging for interference

pelican module

Channelisation

pelican module

Voltage to Power (Stokes)

pelican module

dispersion search

Fred Dulwich



Chris Williams



Stef Salvini



Ben Mort

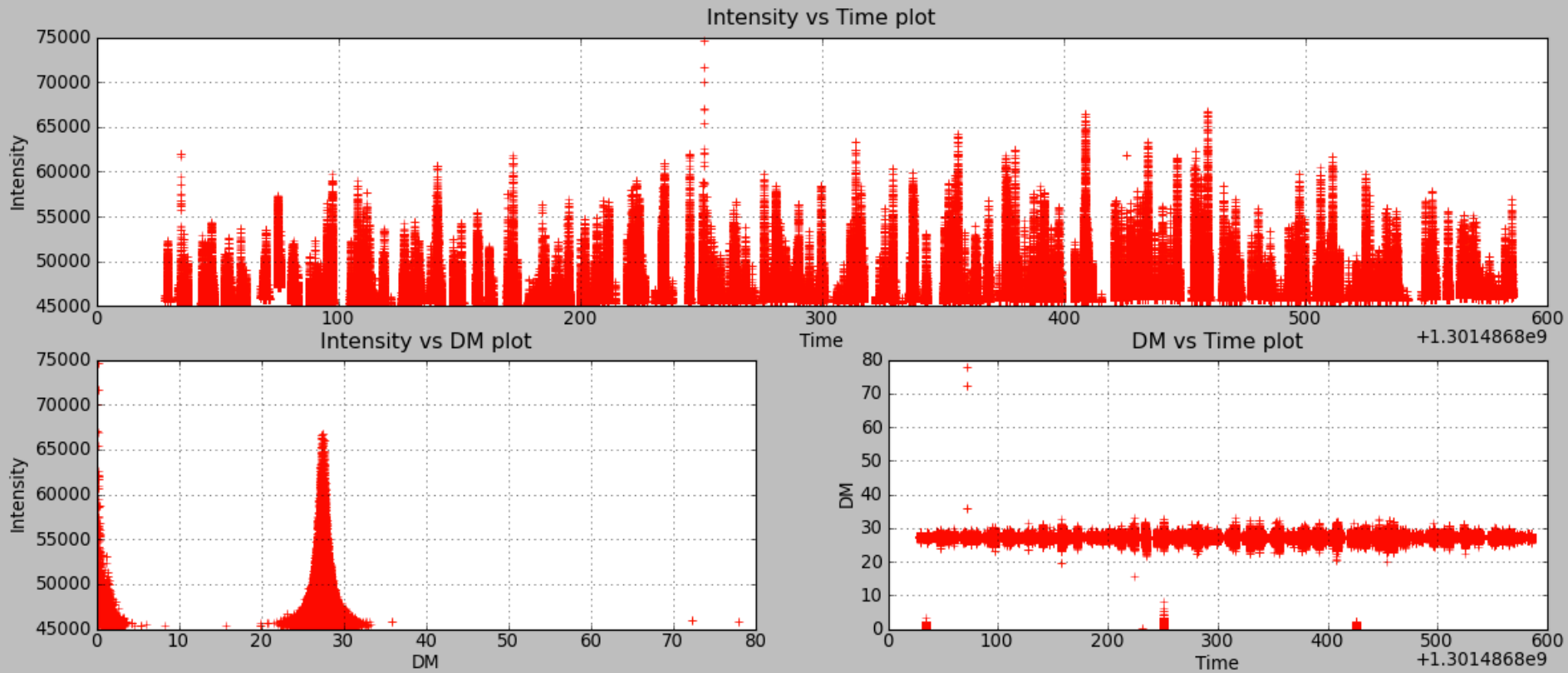


Alessio Magro



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Live testing on known pulsars

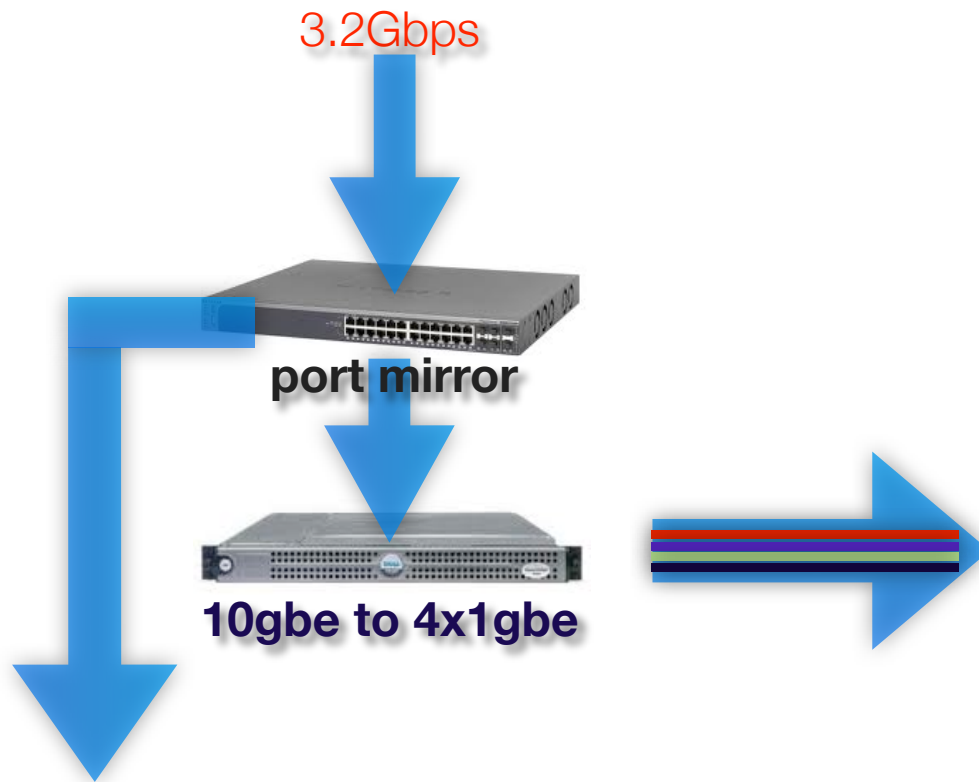


Test survey 1:

$T_{res} = 164\mu s$ $\nu = 146 \text{ MHz}$ $\Delta\nu = 6 \text{ kHz}$ $N_{DMs} = 1200$

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Live testing on known pulsars



Compact solution
Dell C6100 (4 servers in 2U)
Dell C410x PCIe expansion (3U)



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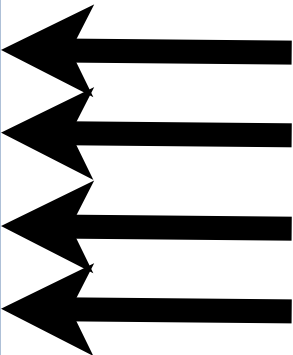
Live testing on known pulsars



Power Consumption

Refresh

Status	Probe Name	Reading	Warning Threshold		Failure Threshold	
			Minimum	Maximum	Minimum	Maximum
✓	GPU 1 Watt	82 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 2 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 3 Watt	80 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 4 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 5 Watt	82 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 6 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 7 Watt	84 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 8 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 9 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 10 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 11 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 12 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 13 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 14 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 15 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts
✓	GPU 16 Watt	0 Watts	0Watts	240Watts	0Watts	252Watts



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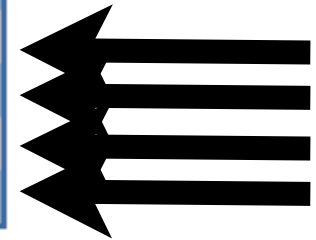
Live testing on known pulsars



Temperatures

Refresh

Status	Probe Name	Reading	Warning Threshold		Failure Threshold	
			Minimum	Maximum	Minimum	Maximum
✓	FB Temp	20.0 C	0.0C	45.0C	0.0C	50.0C
✓	Board Temp 1	28.0 C	0.0C	70.0C	0.0C	75.0C
✓	Board Temp 2	26.0 C	0.0C	70.0C	0.0C	75.0C
✓	Board Temp 3	25.0 C	0.0C	70.0C	0.0C	75.0C
✓	Board Temp 4	25.0 C	0.0C	70.0C	0.0C	75.0C
✓	Board Temp 5	27.0 C	0.0C	70.0C	0.0C	75.0C
✓	Board Temp 6	25.0 C	0.0C	70.0C	0.0C	75.0C
✓	GPU 1 Temp	31.0 C	0.0C	85.0C	0.0C	90.0C
✓	GPU 3 Temp	27.0 C	0.0C	85.0C	0.0C	90.0C
✓	GPU 5 Temp	28.0 C	0.0C	85.0C	0.0C	90.0C
✓	GPU 7 Temp	28.0 C	0.0C	85.0C	0.0C	90.0C



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Conclusions



- €5000 for incoherent dispersion search of 800 Mbps of beamformed data
 - €3500 for CPU server + €1500 for GPU
 - <1kW, possibly even <500W
 - isolated radio pulse search of 2000+ DMs with current, unoptimised kernels at LOFAR high band frequencies
- Algorithmic development on dedispersion kernel is pushing requirements down
- CPU buffering can be used for additional processing, e.g. folding.