
Coherent Dedispersion Backends: CGSR2 and GASP

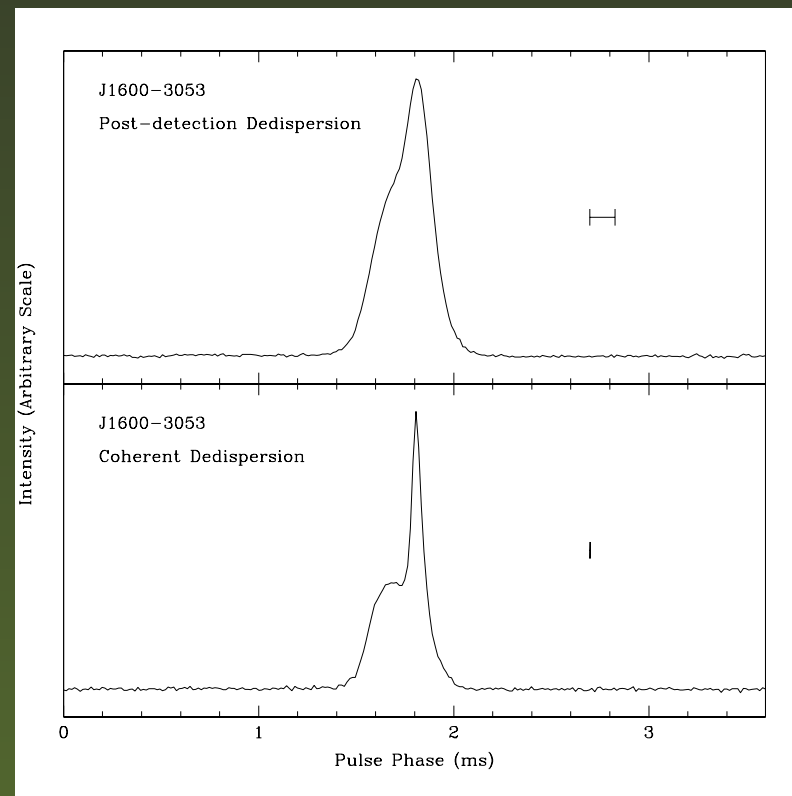
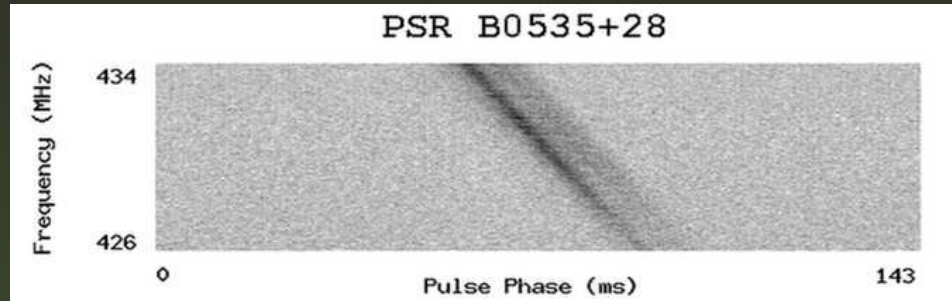
Bryan Jacoby (NRL/NRC)

Motivation

Challenge: Coherent dedispersion offers very high time resolution for precision timing and other applications. However, wide-bandwidth voltage recorders produce impractically large data volumes.

Solution: Integrate computing power with backend to process data at time and place of observation, eliminating need for large-scale data storage and transport.

Dedispersion Techniques

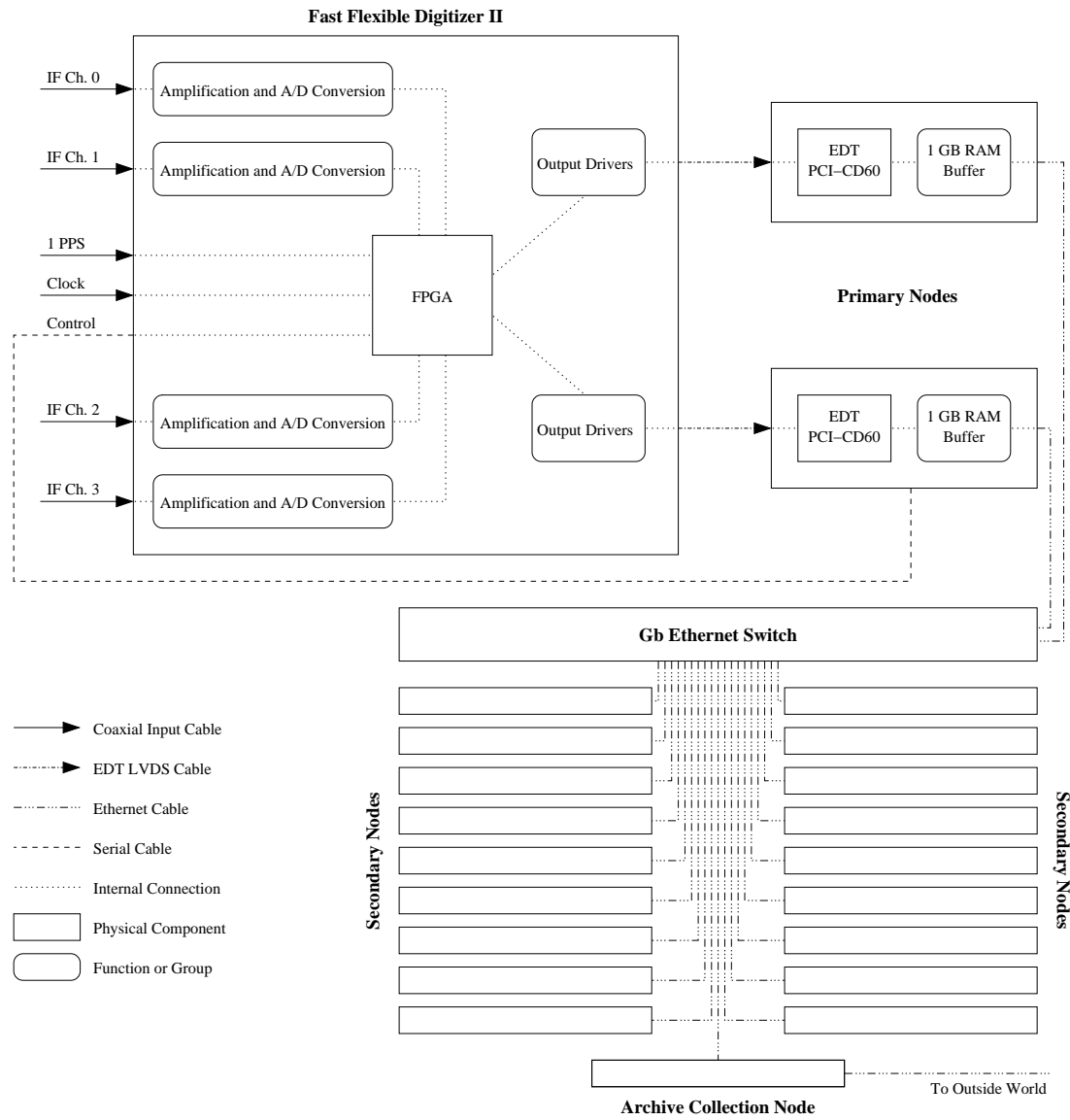


CGSR2 Overview

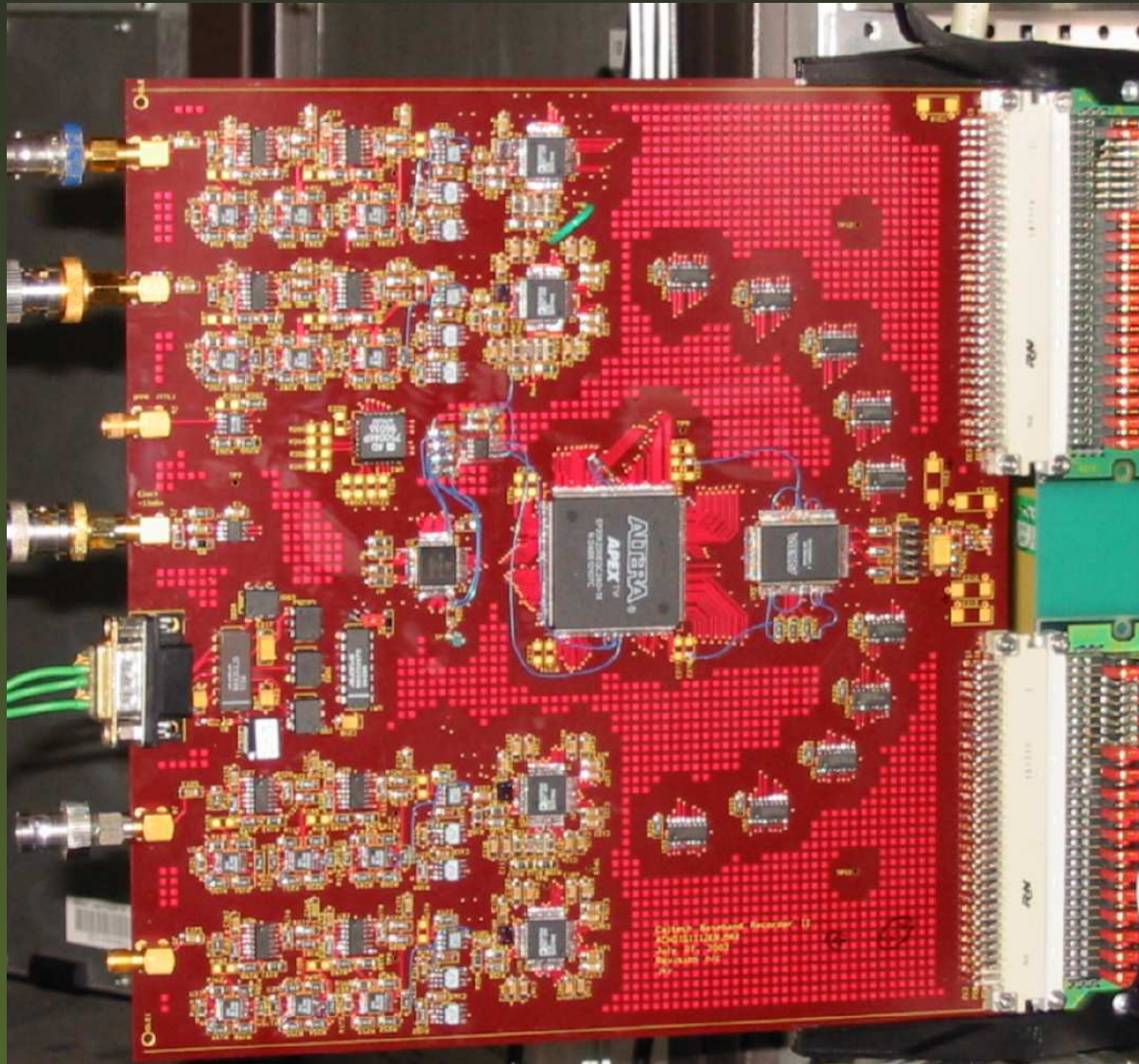
Wide-bandwidth voltage sampler and (semi-)real-time coherent dedispersion engine

- One custom Fast Flexible Digitizer (FFD) board
- Inputs: 4×64 MHz analog channels, sampler clock, 1 PPS, serial control
- Outputs: 4×2 -bit or 2×4 -bit, real sampled, to $2 \times$ EDT PCI CD60
- On-board gain control, bit packing, etc.
- 21-node computer cluster linked by Gb Ethernet:
 - $2 \times$ primary (data acquisition) nodes
 - $18 \times$ secondary (data processing) nodes
 - $1 \times$ gateway / archiver node

Schematic



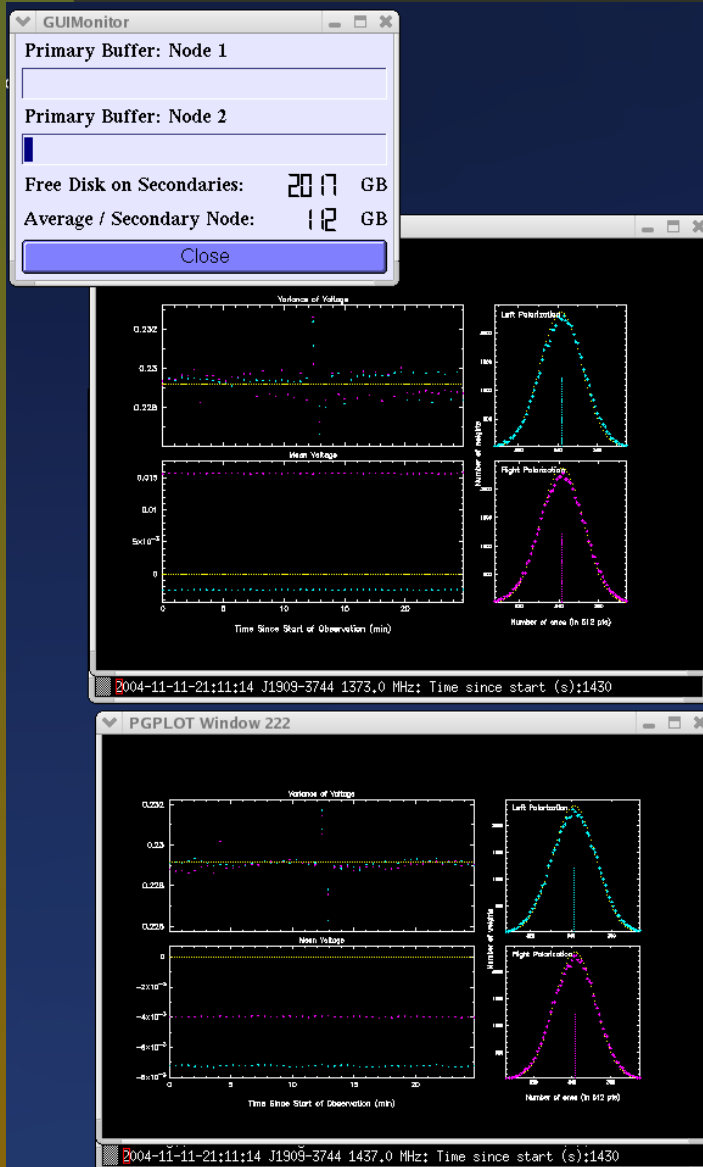
Fast Flexible Digitizer



Crate and Cluster



Observing



GUIMonitor

Control | Targets | Summary | Primary Nodes | # 3 | # 4 | # 5 | # 6 | # 7 | # 8

	Disk (MB)	Load	Status	Gigabit	Time (s)
Node # 1	203716	0.53	PRIMARY	█	0
Node # 2	204134	0.61	PRIMARY	█	0
Node # 3	77489	0.74	ONLINE	█	16.6
Node # 4	193974	0.58	ONLINE	█	16.6
Node # 5	57390	2.24	ONLINE	█	16.6
Node # 6	128085	1.84	ONLINE	█	17.6
Node # 7	48918	1.63	ONLINE	█	16.6
Node # 8	156775	1.41	ONLINE	█	15.3
Node # 9	51344	2.2	ONLINE	█	16.4
Node # 10	153402	1.07	ONLINE	█	16.4
Node # 11	69170	2.04	ONLINE	█	15.3
Node # 12	188314	1.56	ONLINE	█	16.4
Node # 13	54201	1.38	RECEIVING	█	16.6
Node # 14	137434	0.72	RECEIVING	█	15.8
Node # 15	73406	1.67	ONLINE	█	16.6
Node # 16	172618	1.25	ONLINE	█	16.3
Node # 17	50667	0.8	ONLINE	█	16.6
Node # 18	145429	0.89	ONLINE	█	16.4
Node # 19	119019	0.79	ONLINE	█	16.6
Node # 20	187827	1.17	ONLINE	█	16.5

Quit Vital Statistics

The screenshot shows the 'Summary' tab of the GUIMonitor software. It displays a table of 20 nodes with columns for Disk (MB), Load, Status, Gigabit, and Time (s). Each node has a corresponding green progress bar. The status bar at the bottom includes 'Quit' and 'Vital Statistics' buttons.

Data Processing

- Usual mode: dedispersion/folding with PSRDISP
- Of order real time for reasonable DM at L-band
- Secondary analysis: PSRCHIVE
- Other packages exist or can be implemented for searching, single pulse work, etc.
- Versatile, modular: can do anything with the voltage sampled data.

Processing

The screenshot displays a software interface with several windows:

- GUIManager**: A window with a menu bar (Baseband Data, Node Info, # 3, # 4, # 5, # 6, # 7, # 8, # 9, # 10, #) and a table of Baseband Data. The table has columns for Observation ID, Observation Mode, Source, and Priority. The entry for 2004-11-11-21:11:14 PSR is selected. Below the table are buttons for Delete, Info, List Files, reduce, psrdisp, Clear ProcQ, and a list of checkboxes: Safety Override, Delete Processed, Show ToolTips, Auto reduce, and Move Archives. A Quit button is at the bottom.
- GUIMonitor**: A window showing buffer and disk information:
 - Primary Buffer: Node 1
 - Primary Buffer: Node 2
 - Free Disk on Secondaries: 1992 GB
 - Average / Secondary Node: 110 GB
 - Close button
- PGPLOT Window 987**: Two vertically stacked plots showing spectral data. The top plot has a y-axis from 0 to 8x10⁻³ and an x-axis from 0 to 0.7. It shows a sharp peak at approximately 0.55. Metadata: all_gafb, 13.8 arr, 20cm/64 Uncalibrated, 1909-3744 (7.5min) Weight = 7424.0 (6000). The bottom plot has a y-axis from 0 to 0.03 and an x-axis from 0 to 0.9. It shows a sharp peak at approximately 0.55. Metadata: all_gafb, 172.2 arr, 20cm/64 Uncalibrated, 1909-3744 (8.5min) Weight = 9725.0 (8000).
- xterm**: A terminal window showing "SSH Connection to open9 established".

The Future

- Scalability: can do more bandwidth by adding more nodes, software is already written.
- BUT: big clusters are a lot of work to maintain.
- Question: cluster or FPGA approach for the next generation backend?