

alfaburst

Jayanth Chennamangalam
University of Oxford

Aris Karastergiou · David MacMahon · Wes Armour · Jeff Cobb · Duncan Lorimer · Kaustubh Rajwade
Andrew Siemion · Dan Werthimer · Christopher Williams



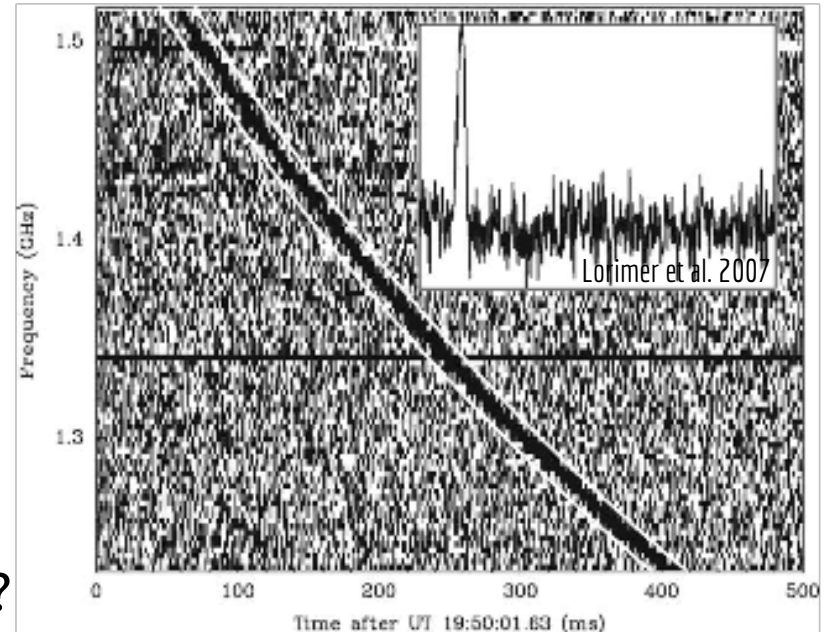


outline

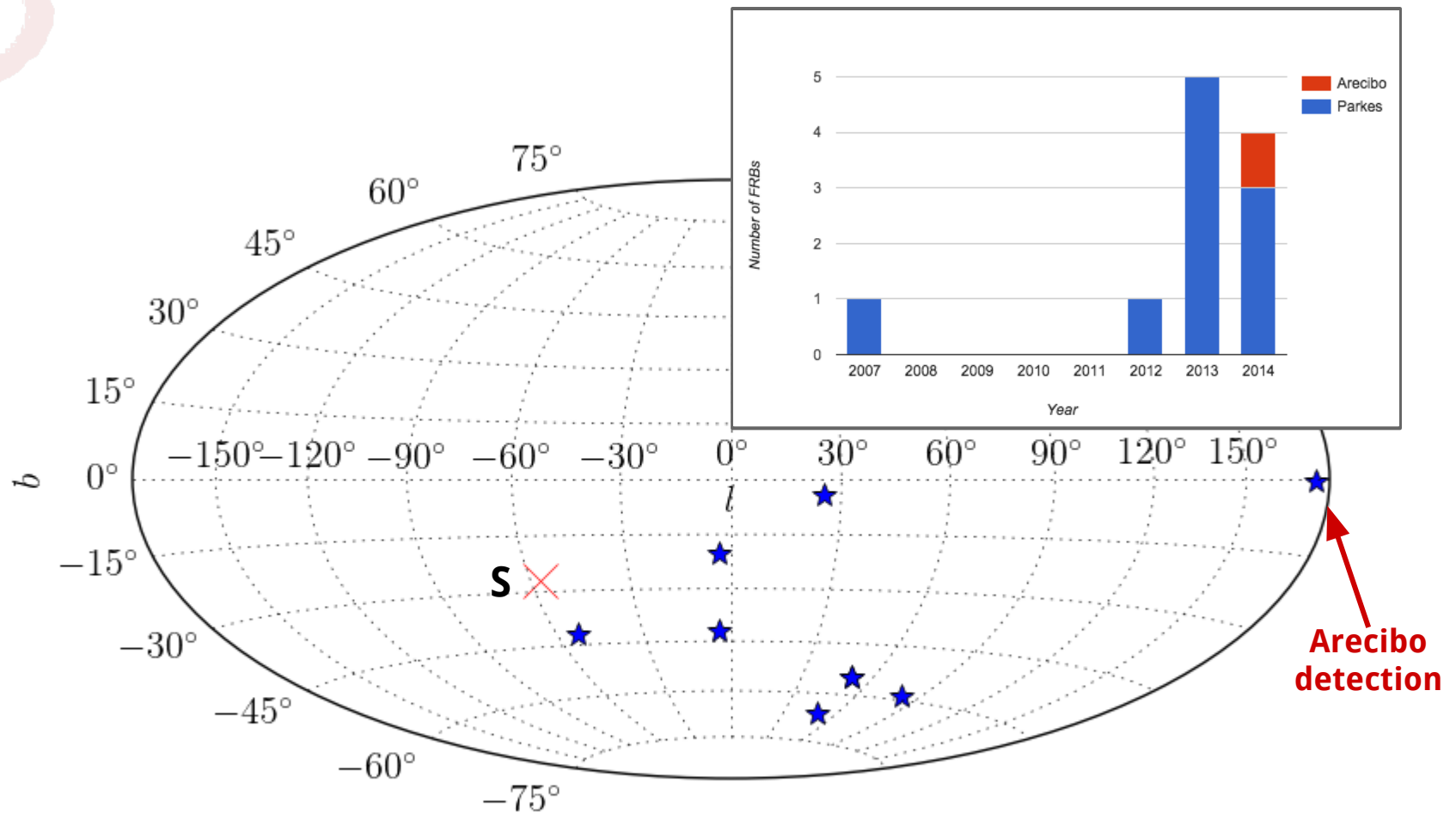
- Motivation: Realtime detection of FRBs
- ALFABURST architecture
- ALFABURST data flow
- ARTEMIS
 - RFI excision
 - Dedispersion
 - Matched filtering
 - Candidate extraction
- AMPP
- Deployment
- Commissioning tests
- Commensal survey
- Future work

motivation

- Fast Radio Bursts
 - ◆ Broad-band
 - ◆ Pulse widths: ~ms
 - ◆ $DM > DM_{\text{Galactic}}$
- > 11 known FRBs (10 at Parkes, 1 at Arecibo)
- Origin:
 - ◆ Flaring magnetars?
 - ◆ Binary neutron star mergers?
 - ◆ Gravitational collapse of neutron stars to black holes?
 - ◆ Nearby flare stars?
 - ◆ ...

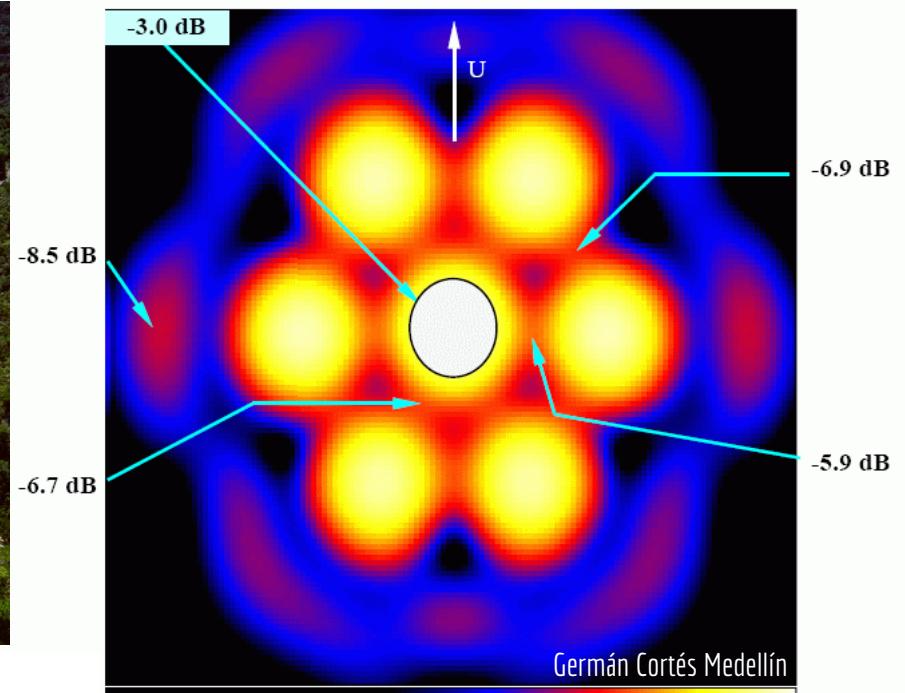
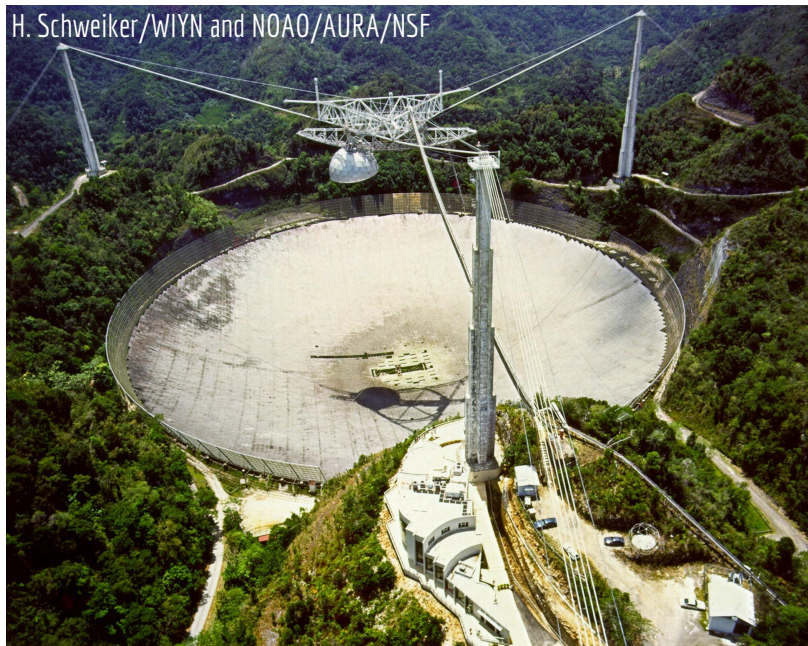


motivation



- > 11 known FRBs (> 10 at Parkes, 1 at Arecibo)
- Estimated rates @ 1.4 GHz: $3.3 \times 10^3 \text{ sky}^{-1} \text{ day}^{-1}$ (for flux density above $\sim 0.1 \text{ Jy}$; Rane et al. 2015)

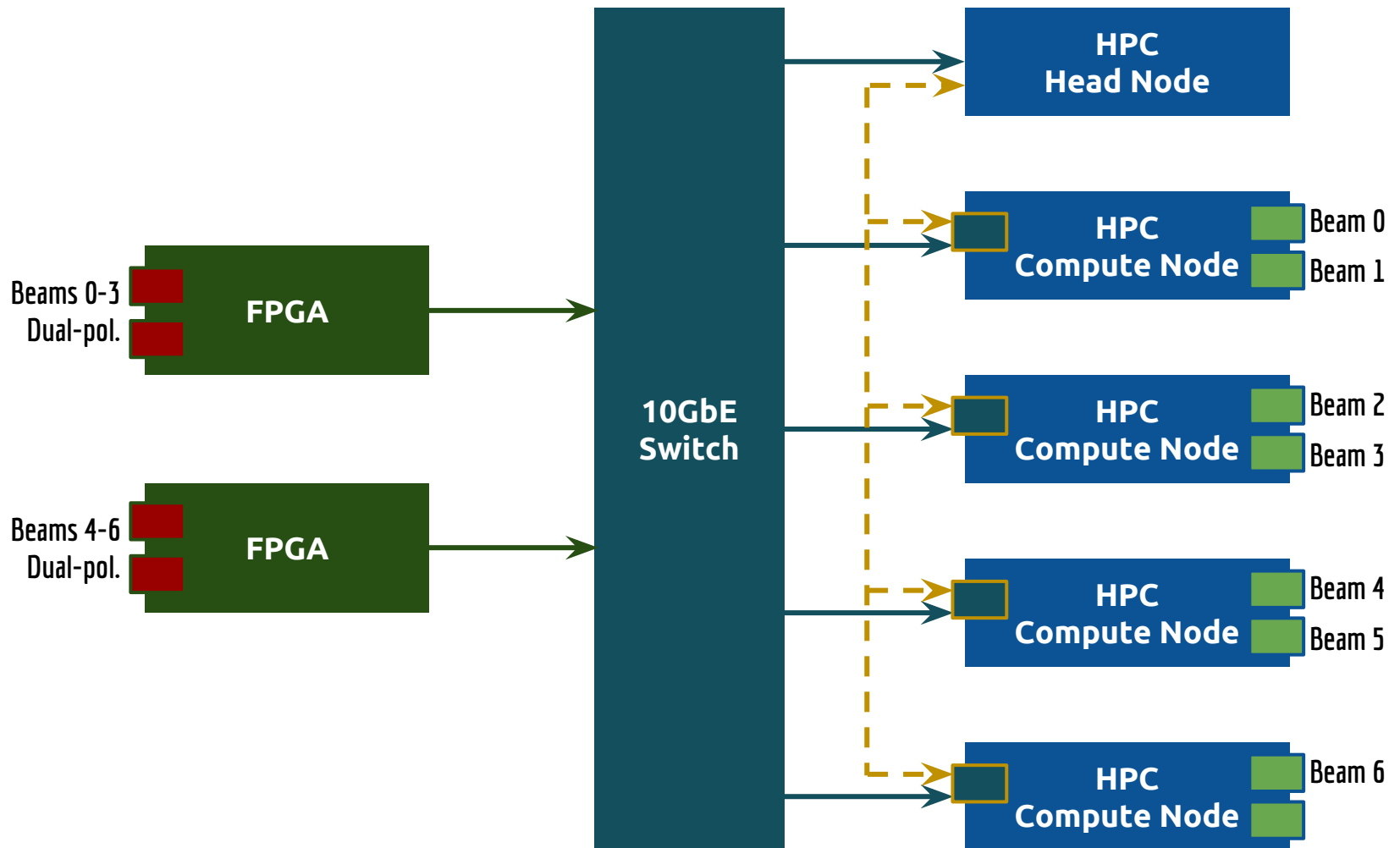
- Commensal, automated, real-time FRB monitor
- ALFA: Arecibo L-band Feed Array, 7 beams (each $\sim 3.5'$ at ~ 1400 MHz), 300 MHz bandwidth, $T_{\text{sys}} \sim 30$ K



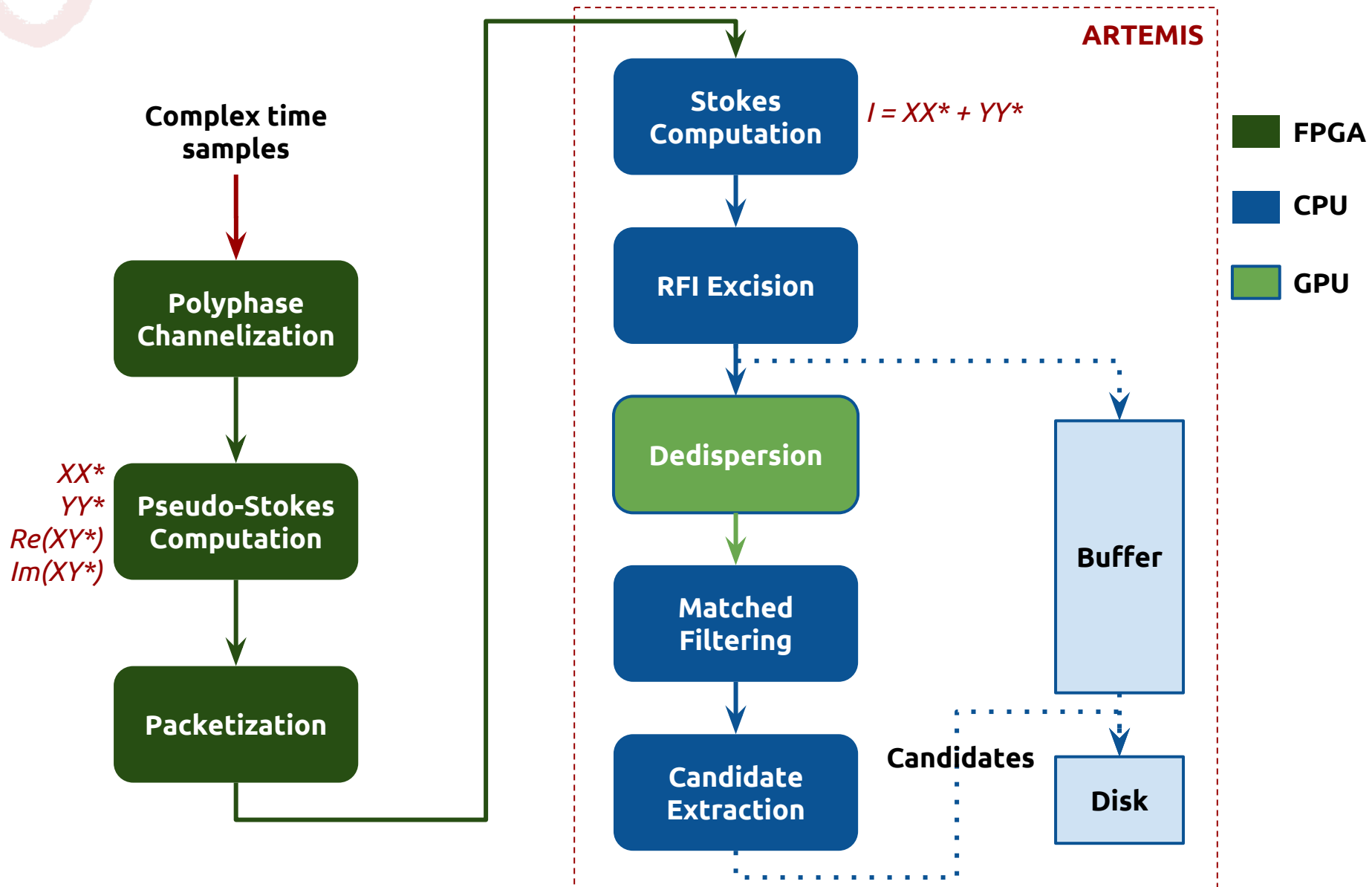
- SERENDIP VI commensal data processing infrastructure
- ARTEMIS development



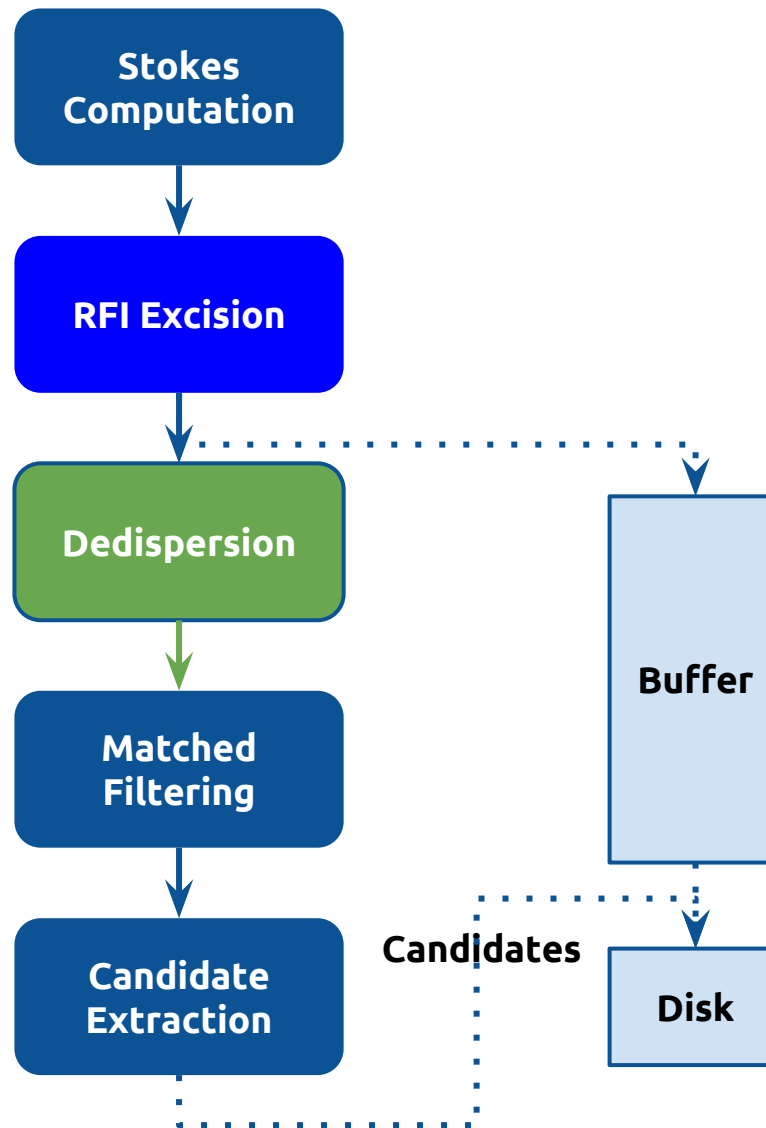
alfaburst architecture



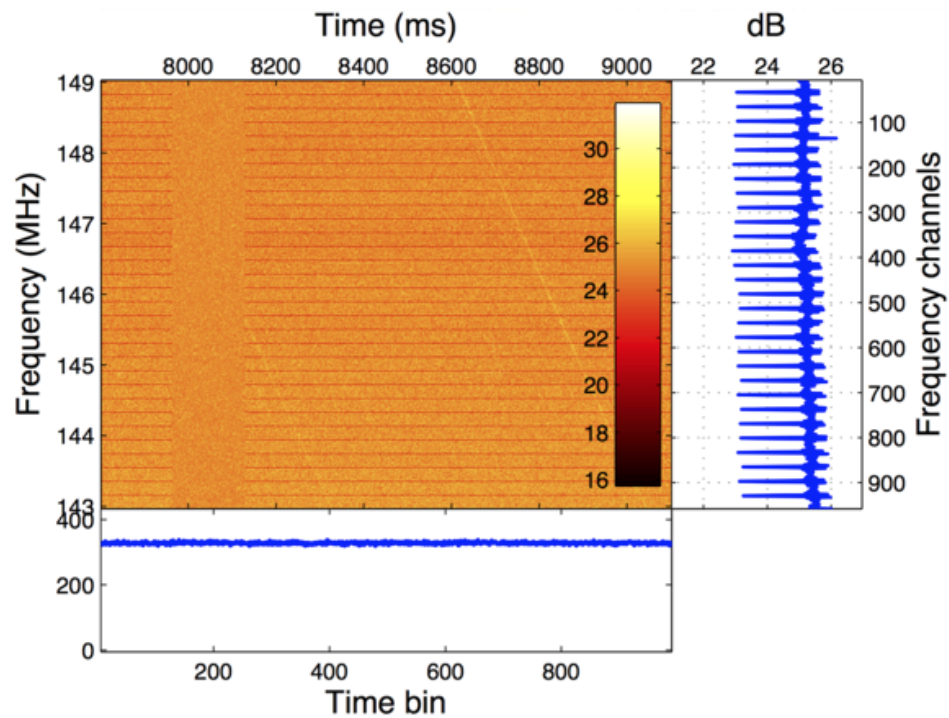
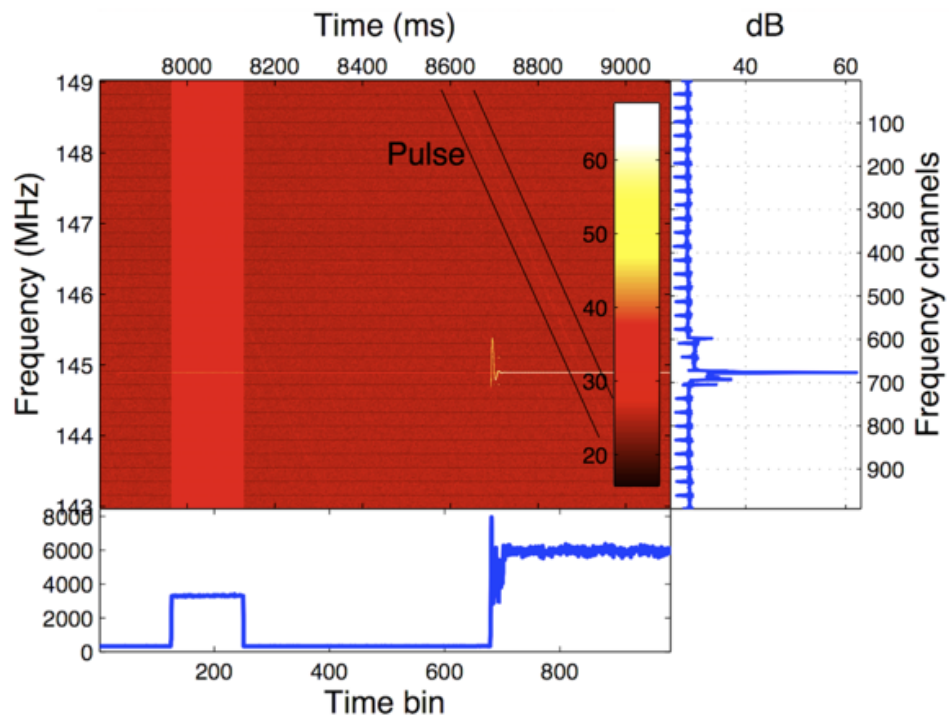
alfaburst data flow

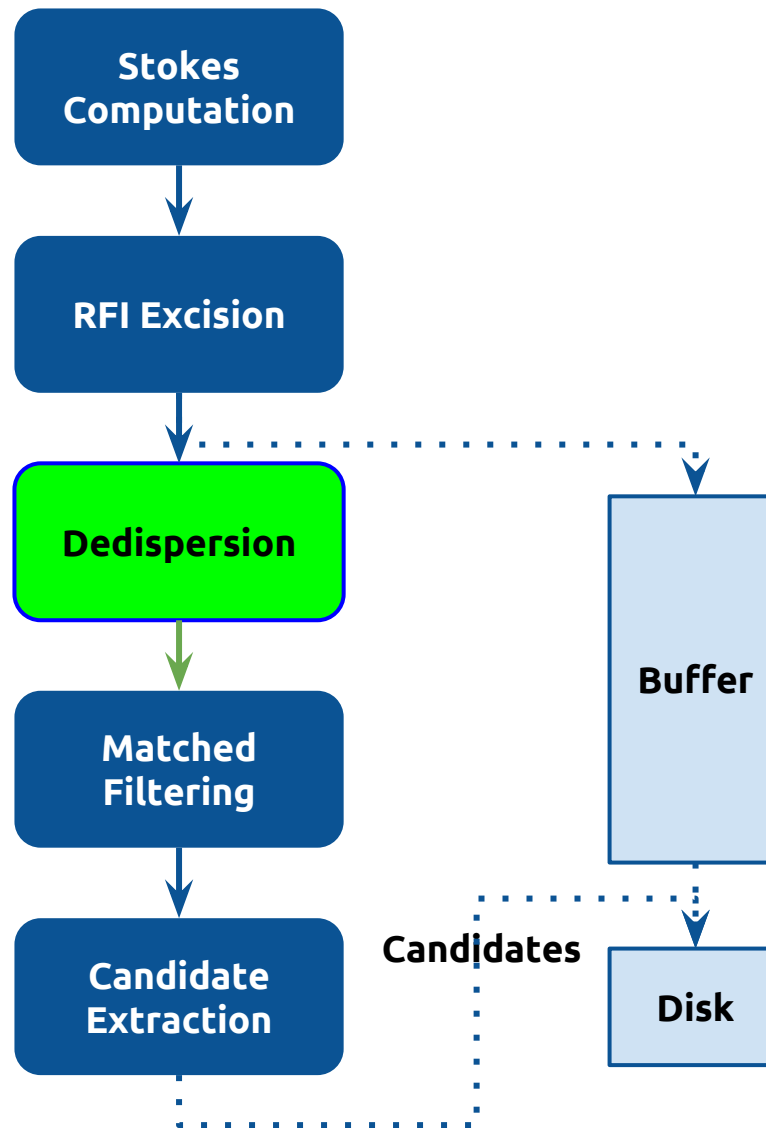


- **A**dvanced **R**adio **T**ransient **E**vent **M**onitor and **I**dentification **S**ystem
- Realtime incoherent dedispersion search
 - Modular architecture - extensible, scalable
 - Industry-standard software tools/methodologies
 - ⇒ Fast deployment/easy maintenance ⇒ More science

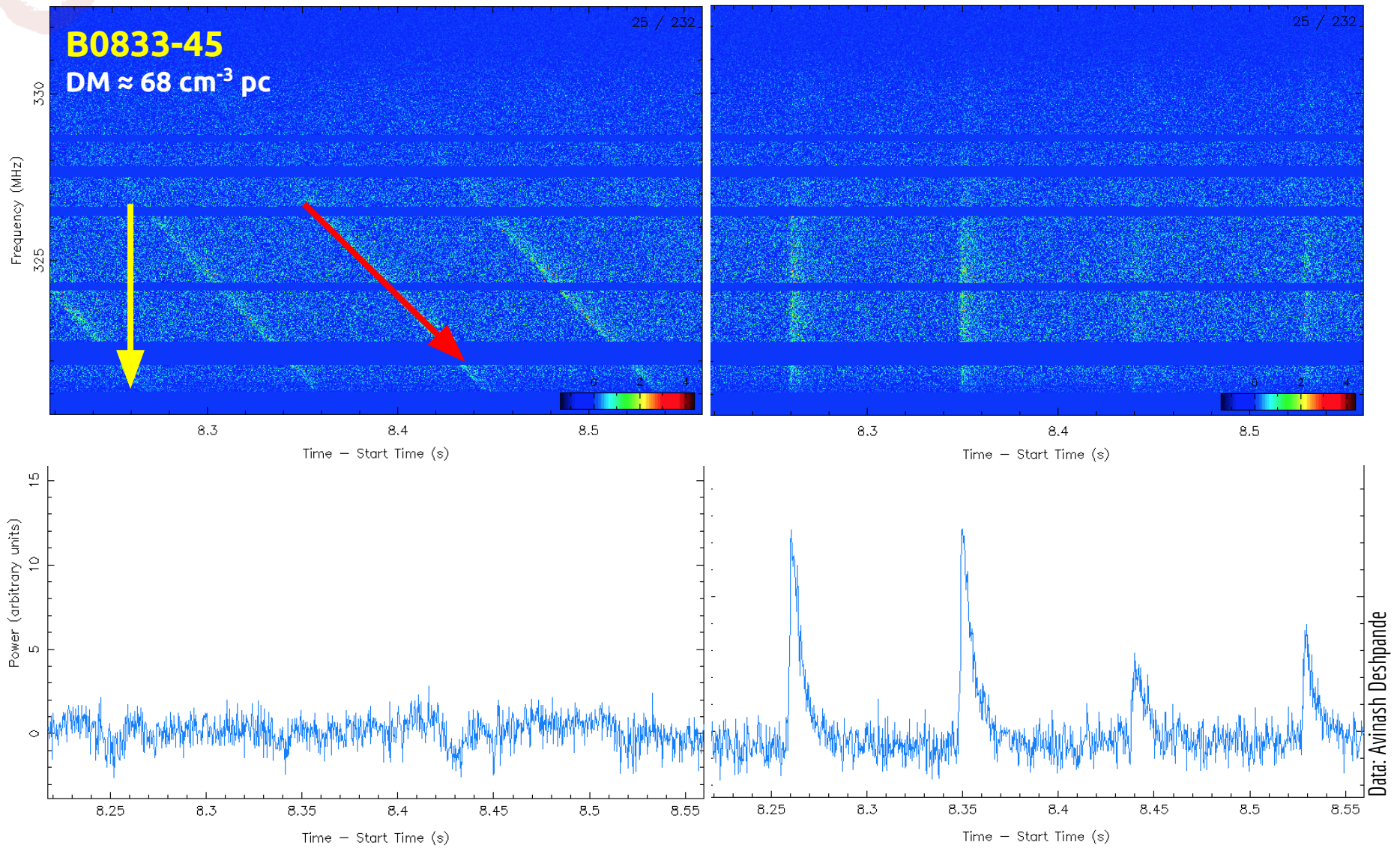


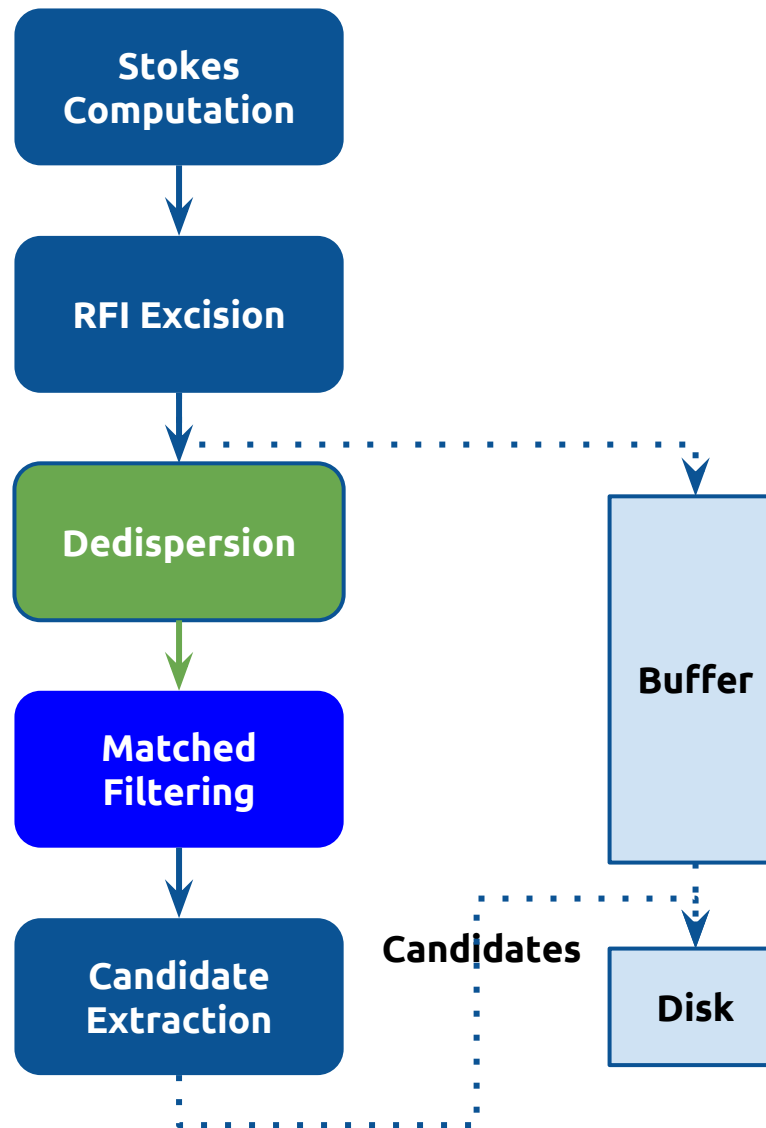
rfi excision





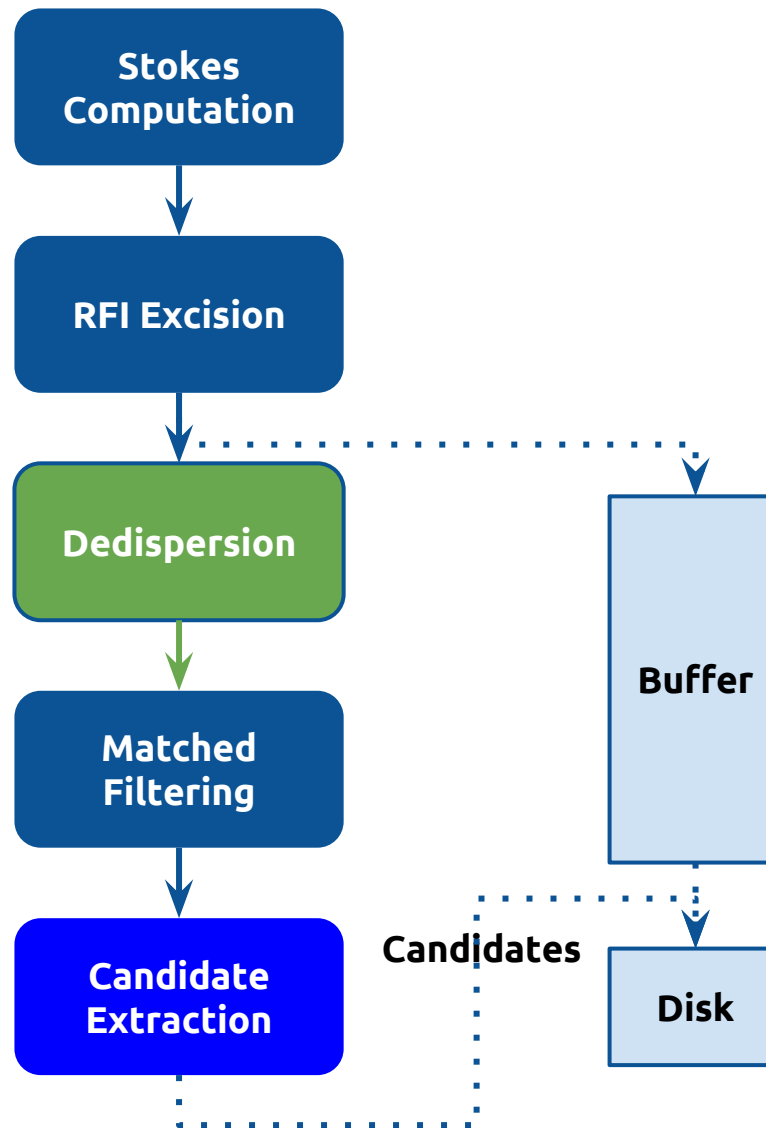
dedispersion





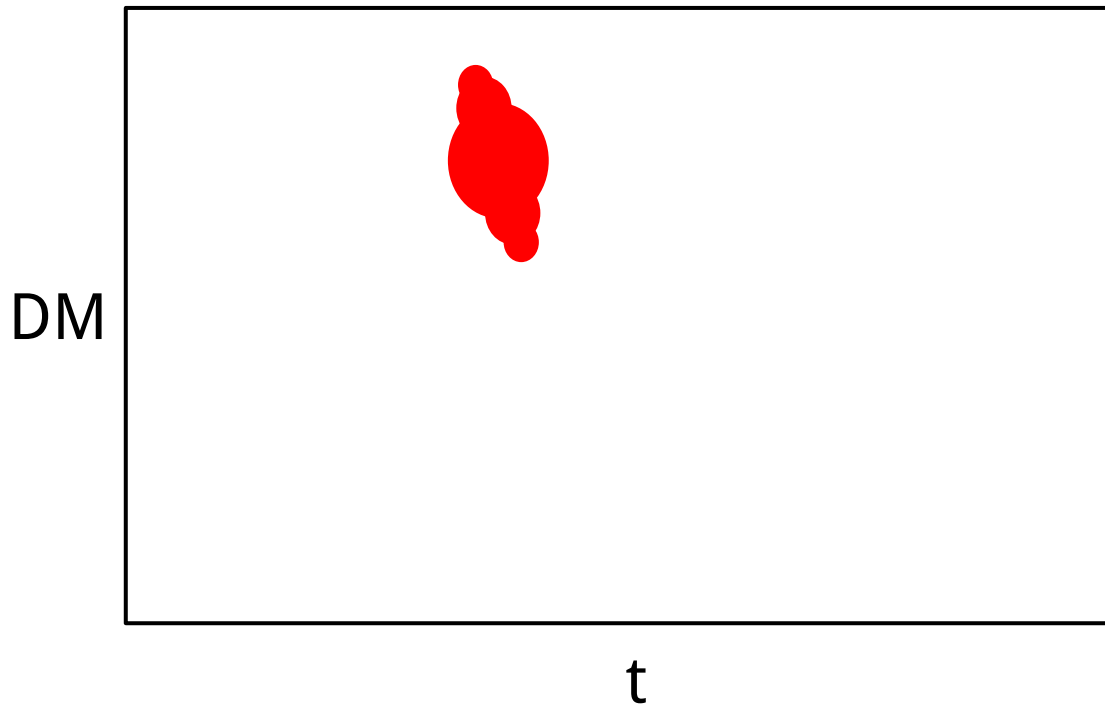
matched filtering

- Each time series (DM channel) is decimated/smoothed:
Effective sampling time equals detected pulse width
⇒ Maximize S/N
 - Decimation factors: 2, 4, 8, 16, 26, 64



candidate extraction

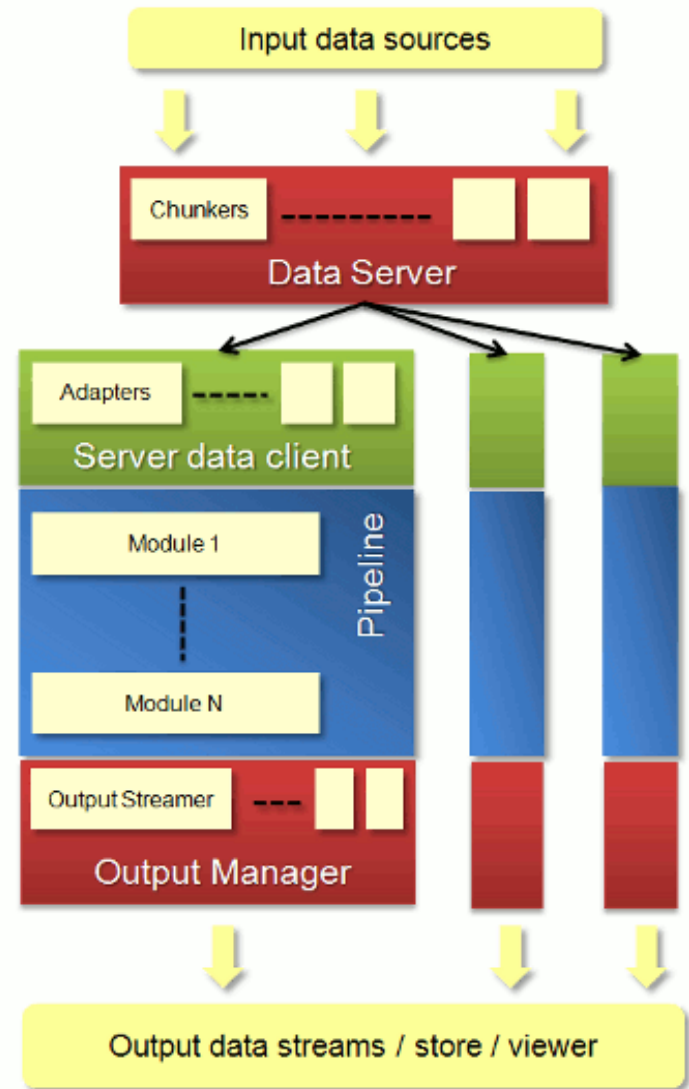
- Thresholding: $N\sigma$
- Diagnostic plots:

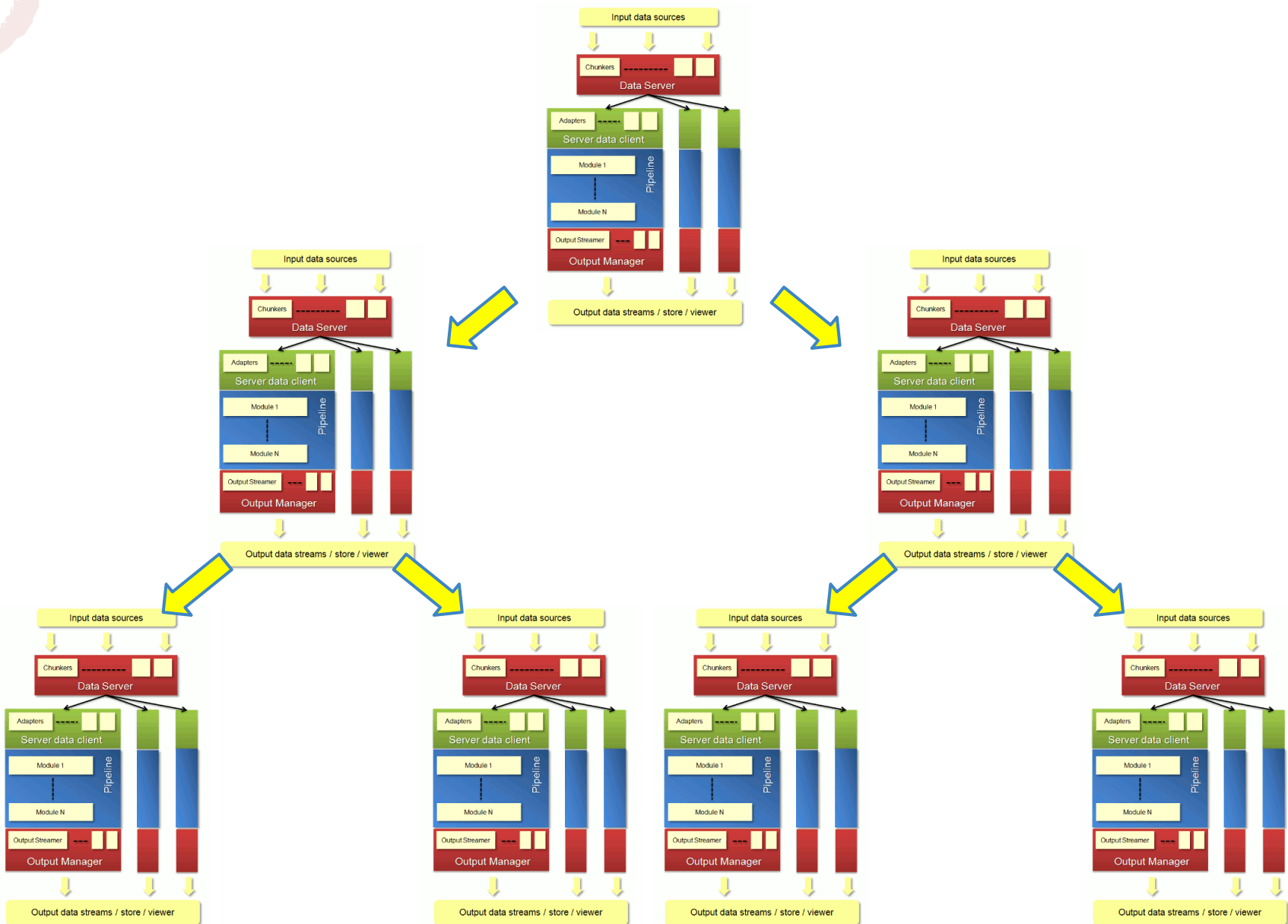


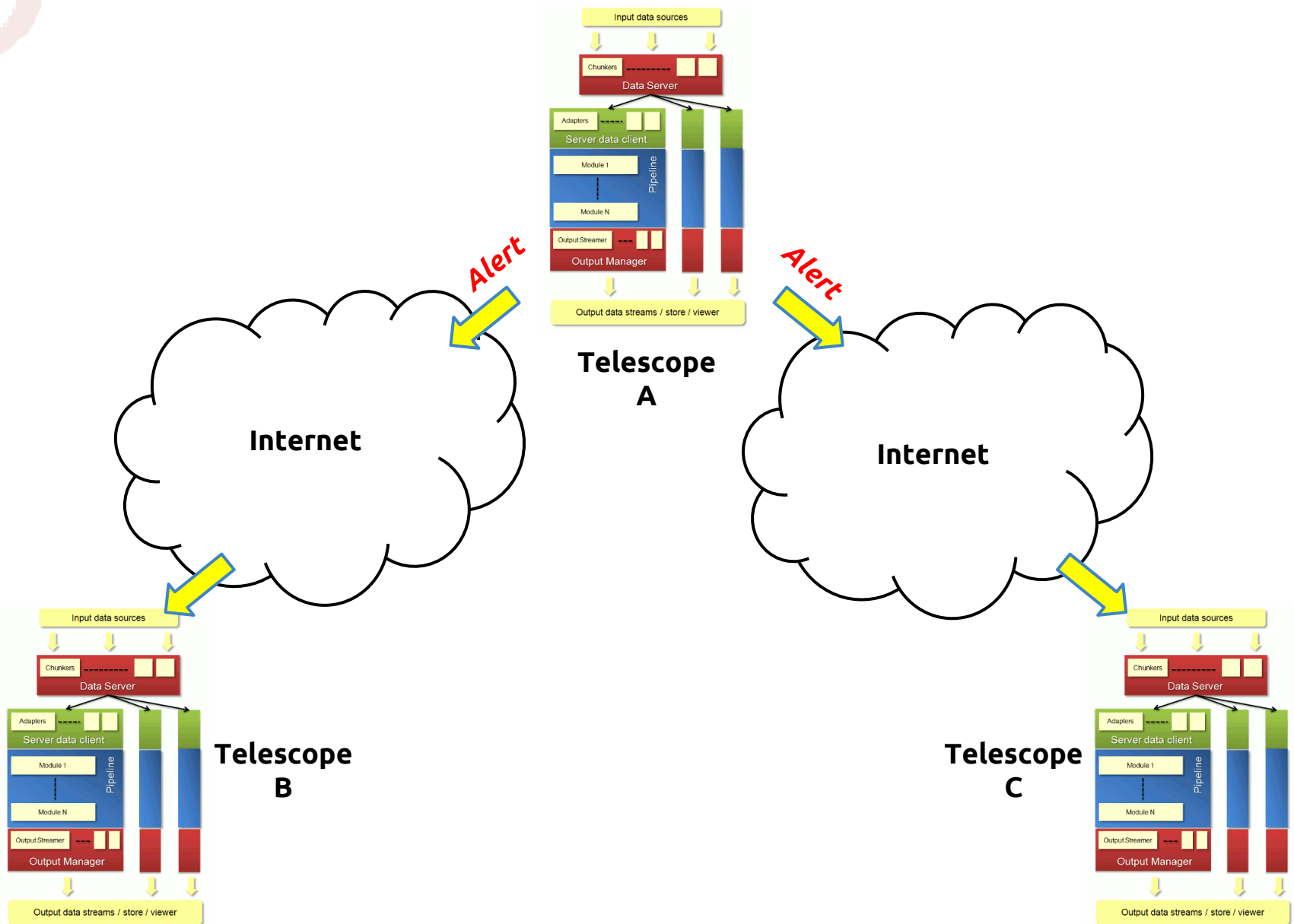
alfaburst is an ampp

→ ARTEMIS Modular PELICAN Pipeline

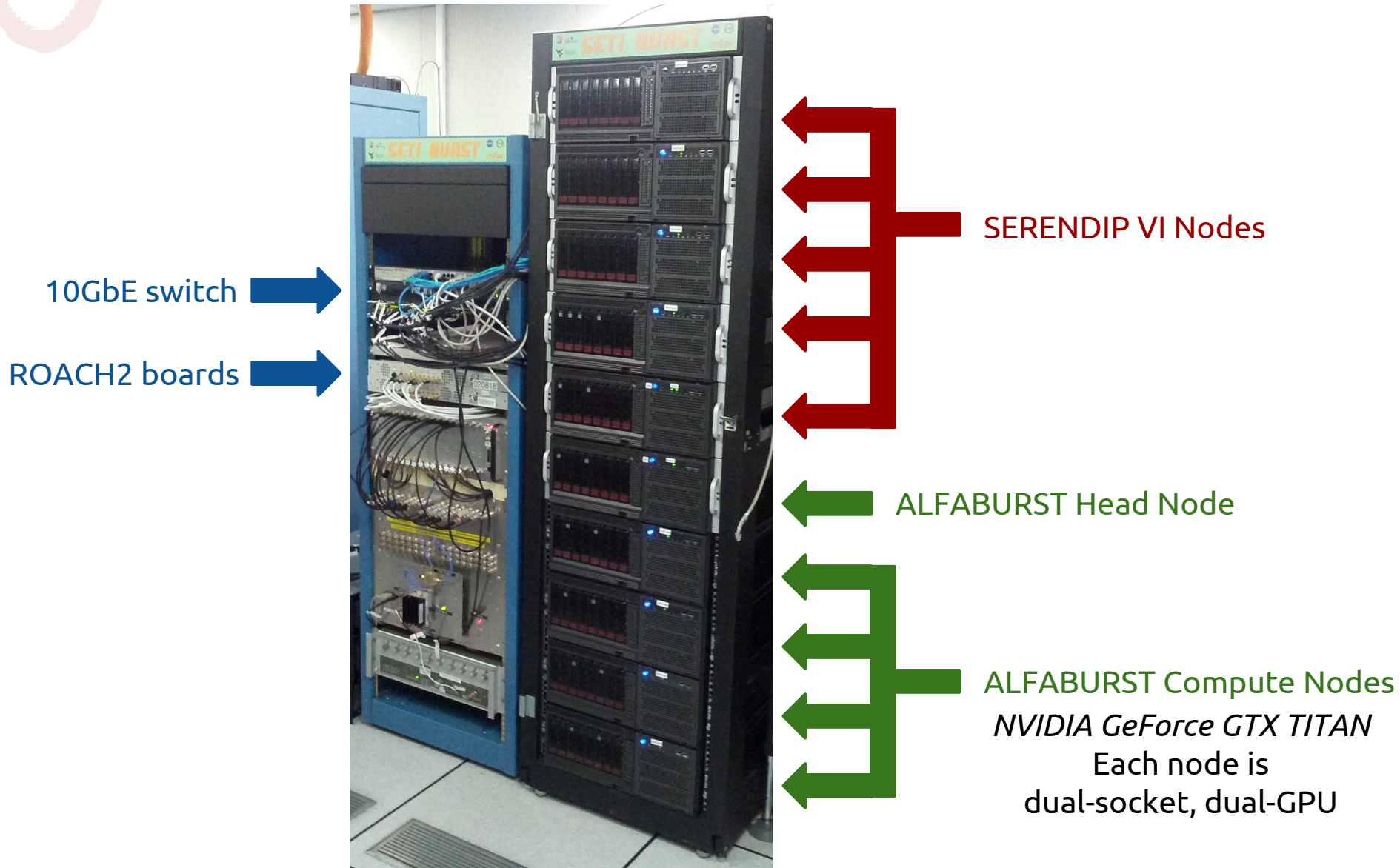
- PELICAN: C++ framework with client-server architecture
- Distributes incoming data across processing nodes
- Modular - extensible, scalable







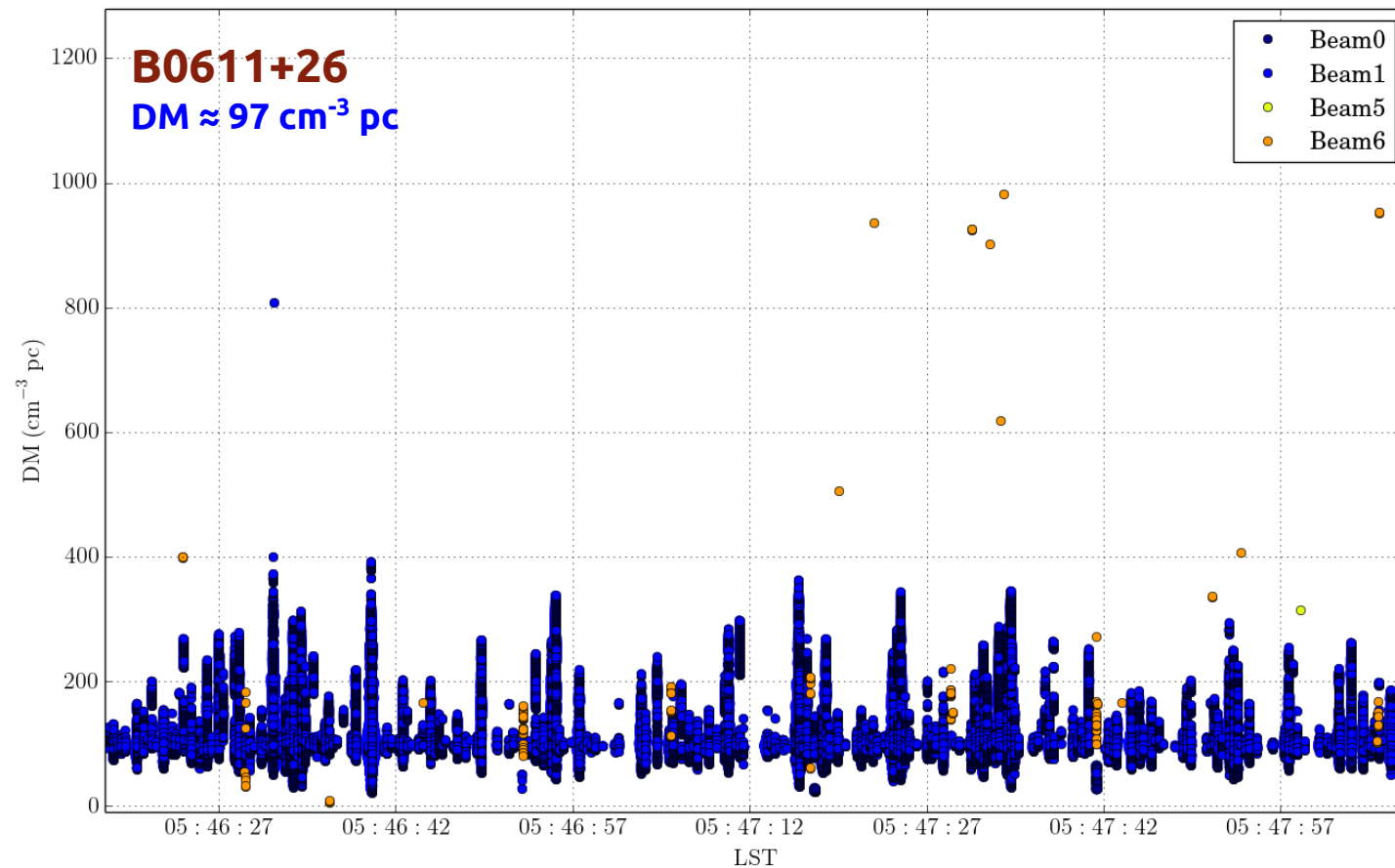
deployment



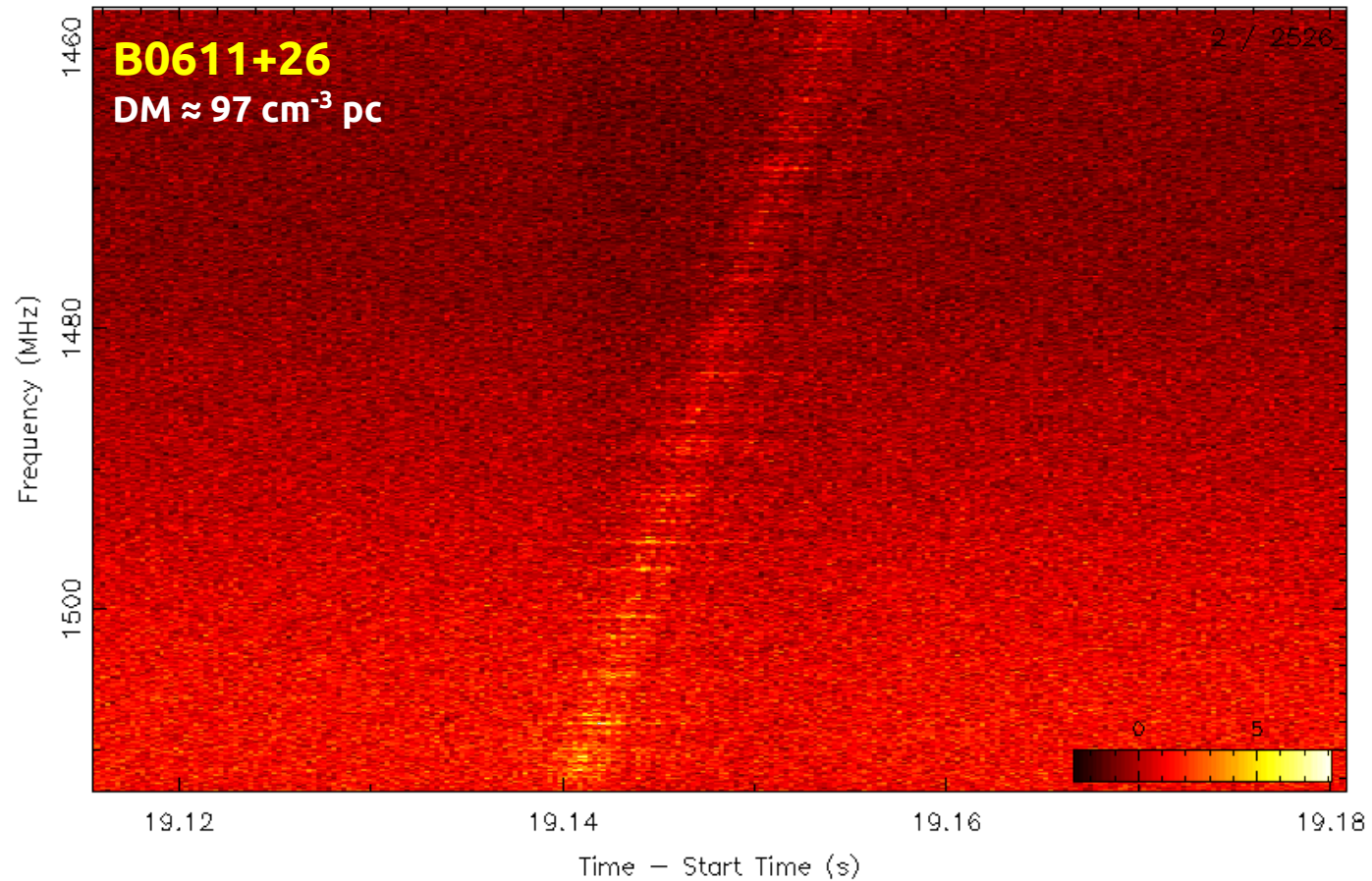
deployment

- Current configuration:
- Bandwidth: 56 MHz (out of 300 MHz max.)
 - $t_s = 256 \mu\text{s}$ (native 128 μs)
 - DM limit: $2560 \text{ cm}^{-3} \text{ pc}$
 - Only Stokes I

commissioning tests



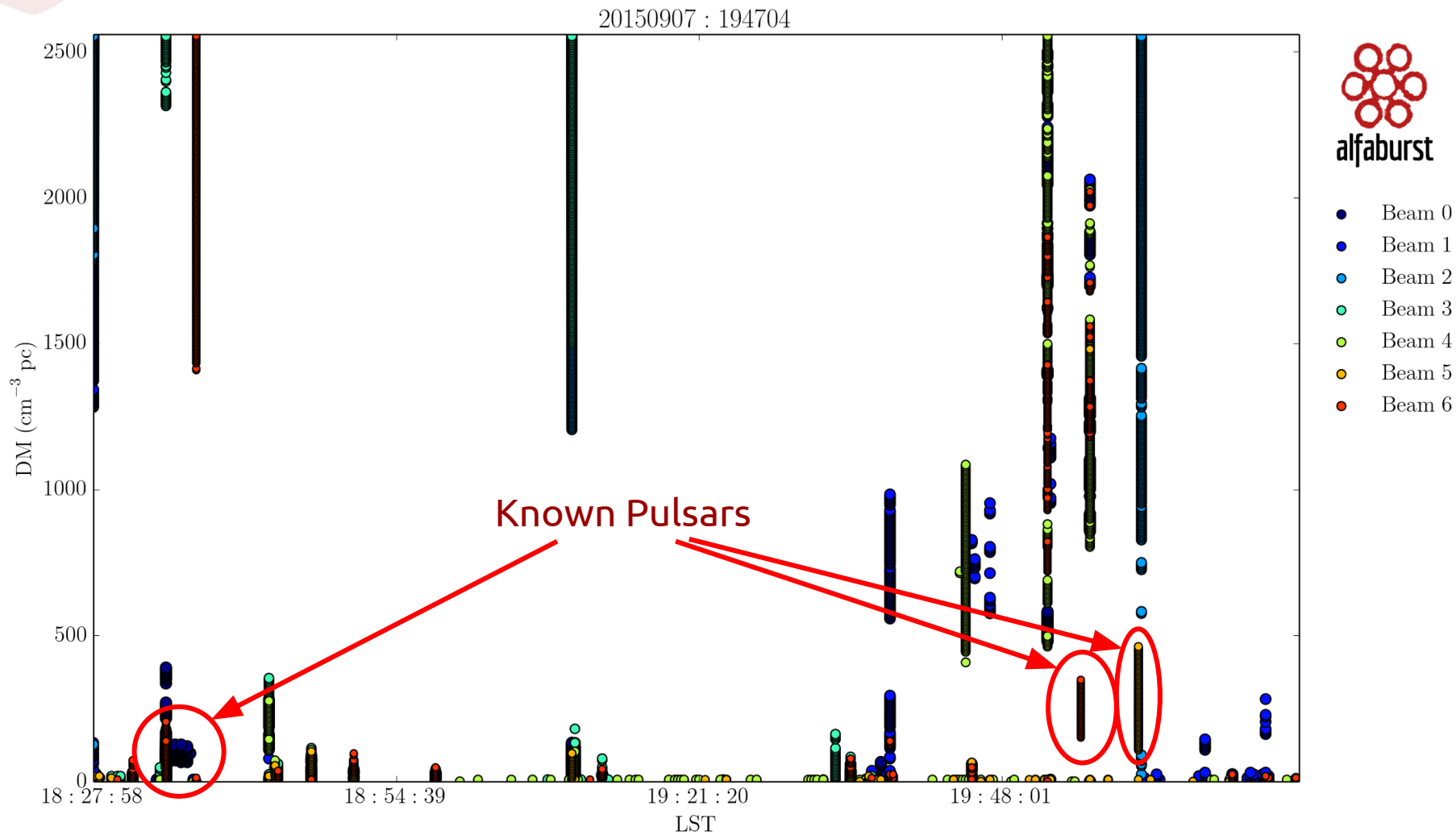
commissioning tests



commensal survey

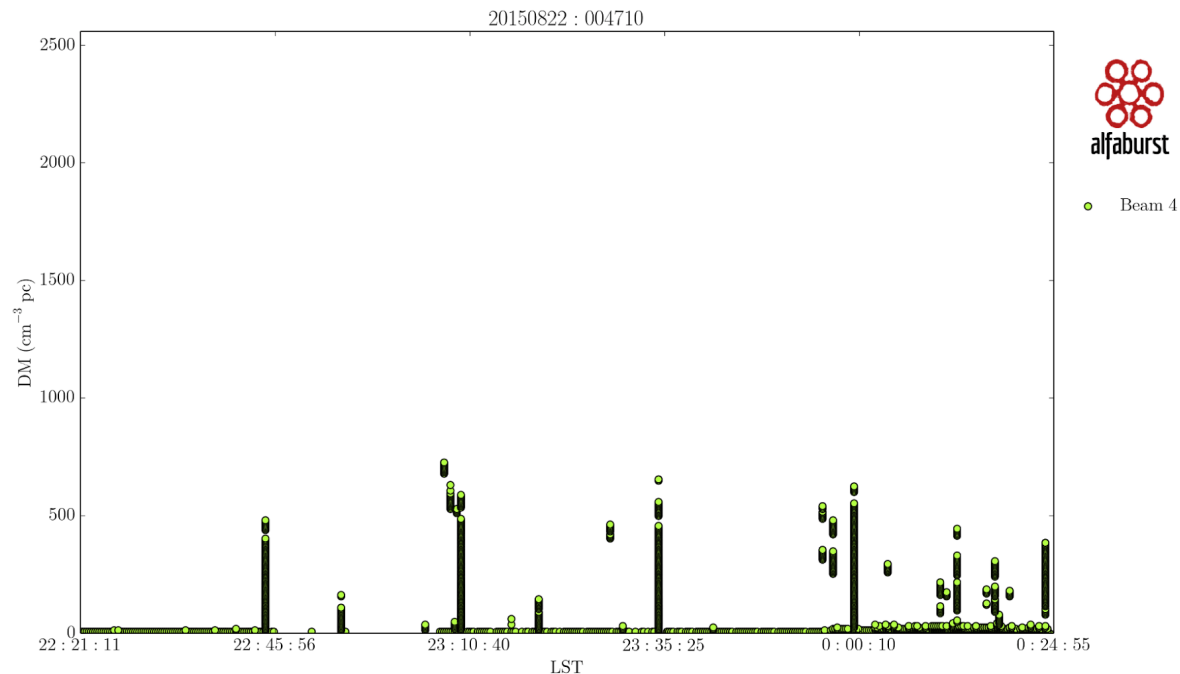
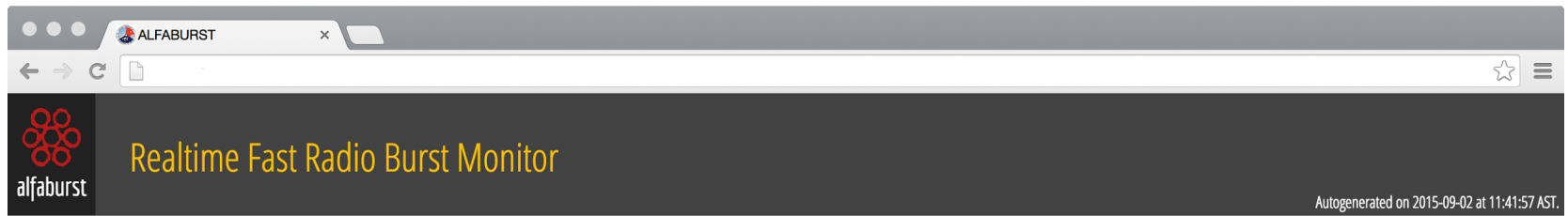
- ALFA usage: 500-1000 hours over the next year
 - Spitler et al. (2014) inferred event rate:
 $3.1 \times 10^4 \text{ sky}^{-1} \text{ day}^{-1}$ above 350 mJy
 - Instantaneous FoV (including sidelobes): 0.109 sq. deg.
- ⇒ 2-3 FRBs over the next year

commensal survey



commensal survey

→ Web-based monitoring interface



ALFABURST is a collaboration between the University of Oxford, the University of California Berkeley, West Virginia University, and the Arecibo Observatory.

future work

- Increase DM search limit from $2560 \text{ cm}^{-3} \text{ pc}$ to $\sim 10000 \text{ cm}^{-3} \text{ pc}$
- Move from PELICAN to PANDA
- Increase bandwidth from 56 MHz to 300 MHz
- Full Stokes recording
- Better web-based monitoring interface
- Automated realtime classification
- Triggering



thank you