

Updates on observations

- Pointing calibration for all antennas (4 were “new”) done last weekend
- Verification of the pointing model this weekend
- Moon on/off observation (moon position will not permit for the next 2 weeks)
- (Pranav) Back to daily pulsar observations + FRB/magnetar recording.
- SETI backend with RFSoC boards to commission starting next week

Beamformer updates

- Team: Jack, Ross, Luigi, Wael
- Tasks:
 - Jack: deliver firmware with whole sample + subsample delay and phase offset. Upgrade 4-bit to 8-bit complex output
 - Ross: deliver RX/ingest software + user interface
 - Luigi: deliver GPU-based software package
 - Wael: deliver delay engine (for RFSoc and beamformer) + calibration and beamformer on-sky tests

Firmware update (Jack)

- Currently 4-bit firmware exists, 4k PFB channels
- Whole ADC-sample delay included in current firmware, no fractional delay compensation exist
- Deliverable:
8-bit firmware, 16 output @ (at least) 650 MHz + time-shift register delay compensation + fractional delay + phase offsets.
API for delay engine

Network ingest (Ross)

- Data ingest from NICs + packet unpacking.
4-bit mode network + disk-writing “stress-test” last week was a success.
- User/observer interface with backend (start/stop, post processing, etc...)
- Deliverable:

Ingest 8-bit complex output at the rate of ~ 7.5 GB/s per interface + interface with GPU beamformer + write beam-formed data to disk.

(longer term) Data prep for real-time, 8-bit correlator.

Beamforming GPU-library (Luigi)

- GPU-Library exists.
It includes tests against a CPU-based beam former with simulated voltages + phasors
- Form up to 16 ATA beams on sky
- API for interfacing with our networking threads (not tested)
- Deliverable:
Data transport in and out of GPU device memory + beam-forming + ordering data for

Calibrations + on sky tests (Wael)

- Delay + delay slope code (showed in previous meeting)
- Delay phasor calculator for beamformer (i.e. steer from boresight) is still to be written.
- Offline correlator exists for calibration
- Tests on sky sources

Beamformer Calibration Strategy

- Calibrating the beamformer requires correlating antennas with a reference antenna. Our offline correlator can do the trick (but real-time correlator is still a goal)

$$c(\nu) = \sum_{t_i}^T V_a(t_i, \nu) \times V_b^\dagger(t_i, \nu),$$

- Fixed fiber delays and phase offsets can be calculated using the above.
- Important question: How often should we re-calibrate phase? Barott et al. (2011) say phase stability over 2 hours. We should re-measure this
- 2 strategies for frequency-dependent phase:
 - Either compute phase-solution model, for entire RF-band, at an (e.g.) weekly cadence. Apply solution for every tuning frequency for the week
 - Re-calibrate on a sky-source every time we change LO frequency
- All depends on phase stability (as a function of time and frequency)

Beamformer Testing Strategy

- Summarized by a single number: “beam former efficiency”
- 2 astrophysical sources:
 - Bright pulsars (J0332+5434, J1935+1616)
 - OH masers (W3OH)
- 2 Strategies (under perfect gain calibration / weighing scheme)
 - Measure S/N of coherent beam + compare to incoherent beam. The increase in S/N should scale with $\sqrt{N_{\text{ants}}}$
 - Measure S/N while progressively adding antennas to beam former. The S/N vs antenna curve should follow a linear trend, under perfect efficiency
- What about on/off measurements? Beam pattern is an important consideration. Target sources must not be resolved by synthesized beams (moon / Cassiopeia A / bright supernova remnants CANNOT be used, otherwise detailed beam-pattern calculations). Unresolved quasar sources (3c273, 3c48).

Timeline

- 8-bit mode with all antennas (no delay engine) - October 15th
- Network ingest test + write-to-disk tests - October 22nd
- Interface with GPU-beamforming library - October 31st.
- 8-bit mode + delay firmware - November 7th
- Calibration runs, phase stability, beam forming efficiency - November 22nd
- Real-time beam forming operations - December 15th