Introduction to the ATA, Signal Paths,& Control

Hackathon at the Allen Telescope Array

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A Quick Overview

- Welcome to the ATA!
- Major Signal Path Subsystems You'll Encounter Here
- A Few Of The Basics Of Operation
- Plugging In And Doing Experiments

First, A Quick Reminder

You and Your Cool Phone, Normally

At A Radio Telescope

- **Please:** Try to achieve “zero emissions” during your visit
- Cell phones in *airplane mode*
- No wifi devices of any kind
- Bluetooth devices disabled
- Wired KB/Mouse Only
- The List Goes On

A First Thought: Bandwidth Challenge

- Some of you mentioned “wider bandwidths” or “more throughput”
- 1 MHz?
- 10 MHz?
- 100 MHz?

- ***Let’s think about: 42 x 2 x 15 GHz: 1.2 THz of instantaneous data***

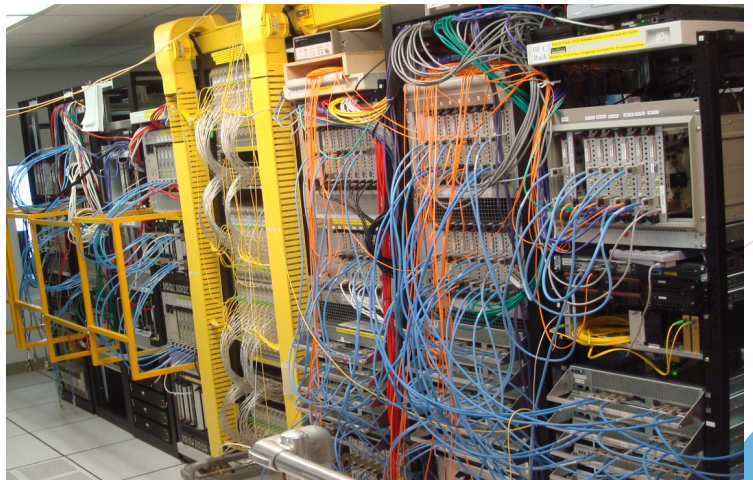
A Few Starter Notes

- Fun, Fun, Fun!
- Telescopes move without notice.
- We’re in the wild. Watch where you step.
- Feeds can be destroyed by transmitters. *Make Sure Your TX are Off!*

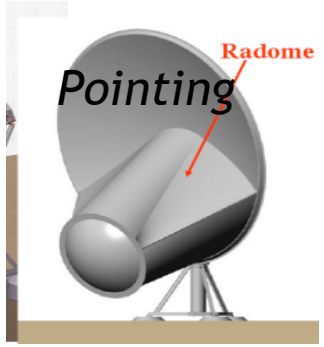
Names and Subsystems (Big Stuff)

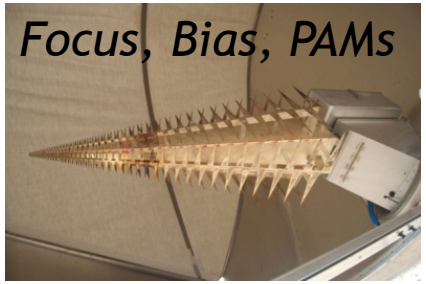
- The “Array” (or “field”):
  - The collection of 42 antennas
- The “Antenna”:
  - A single offset-fed Gregorian 6m; includes electronics for feed
- Nodes and Names:
  - Antennas divided into five nodes (1..5) and named by node number and letter (e.g., 1a, 1b, 3f, 3g).

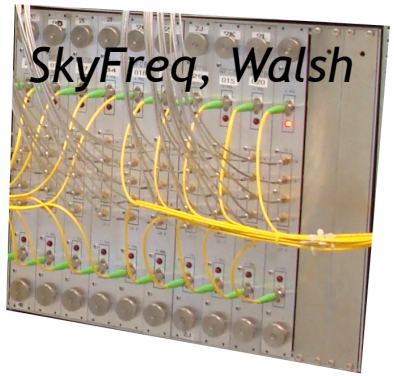
- The “SPR”:
  - Signal processing room (inside) containing all receiver electronics
- The “RFCBs”:
  - RF Converter Boards; convert fiber-line signal to band-limited IF
- The “Back Ends”:
  - Instruments that obtain, digitize, and process/archive the IF outputs



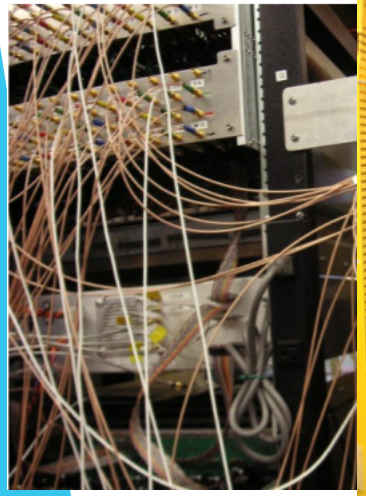
The Signal Path



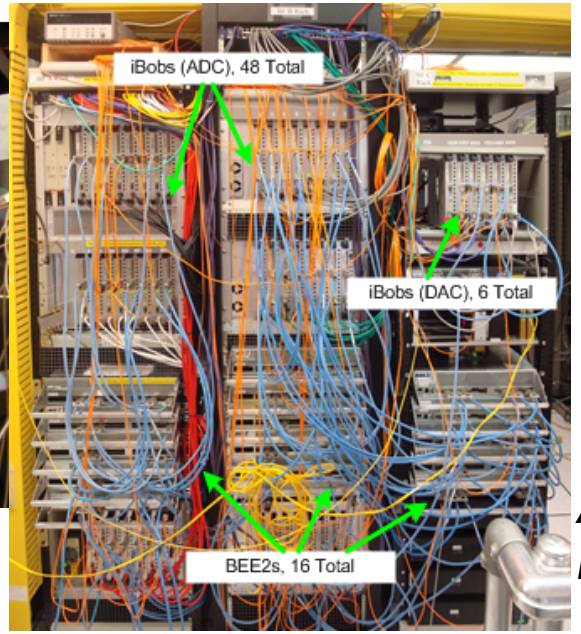




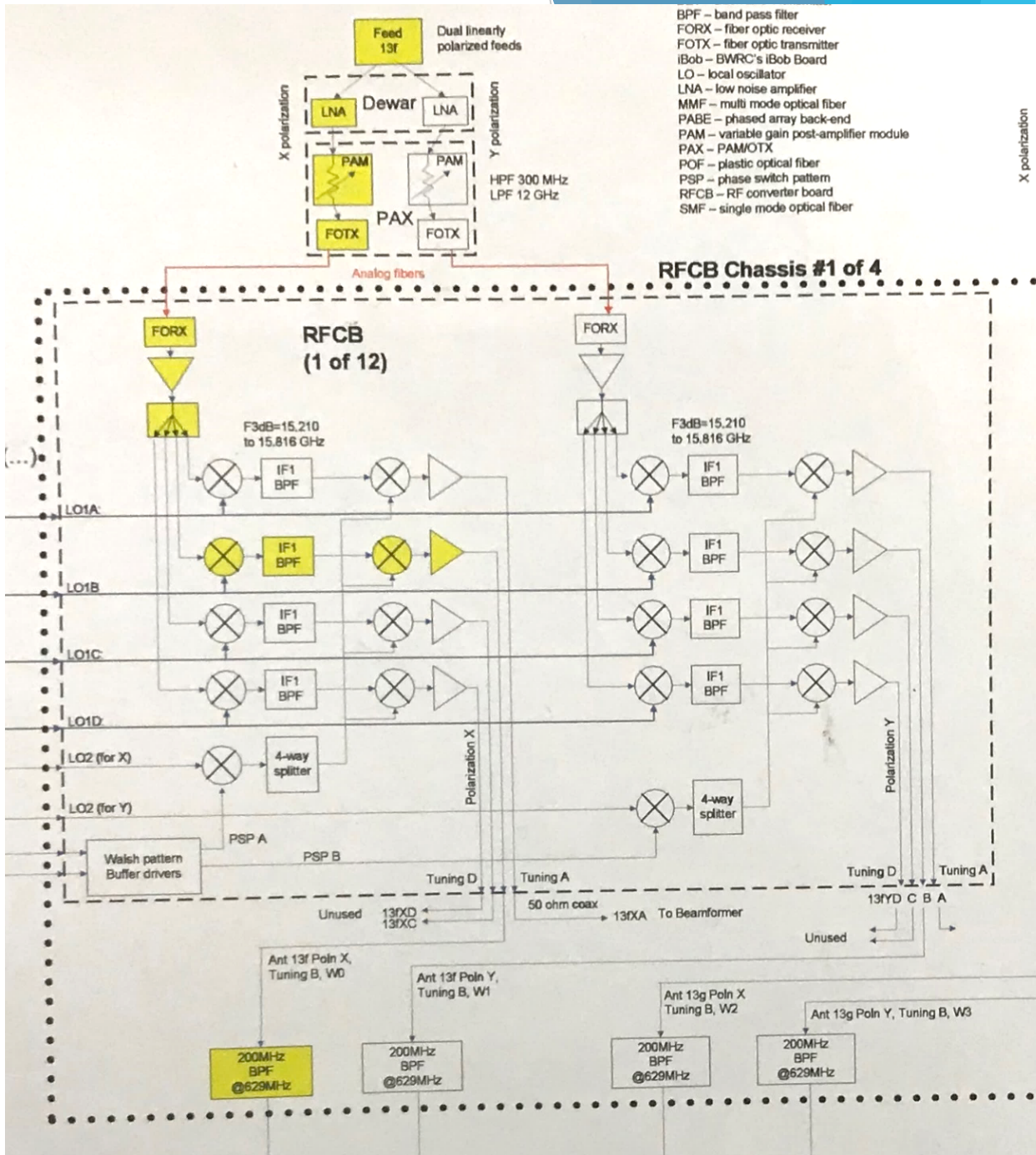
Above: Analog @ RF. Below: IF and Digital



IF Patch Panel

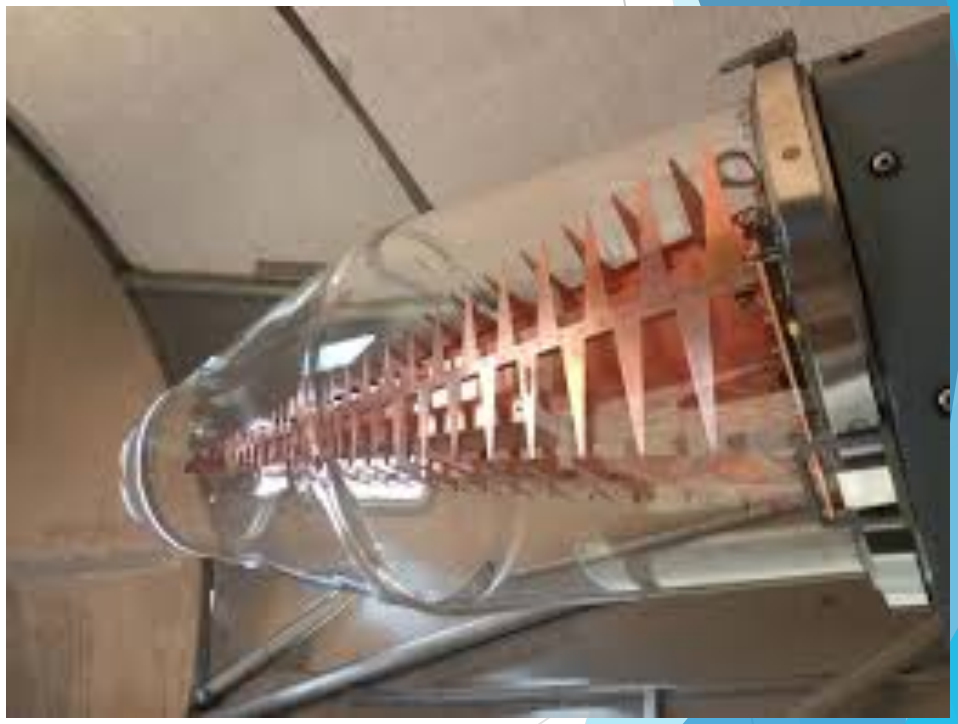


Above: Foxtrot
Left: ADCs & BEEs



Step 1: Turning Things On (At The Antennas)

- *Usually:* The array should be left in a usable state. Good practice to verify LNAs are on and that PAMs are at reasonable level
  - *atagetlna [antenna]*
  - *atalnaon [antenna]*
  - *ata{set/get}pams [antenna]*
  - *atasetfocus [antenna] [frequency]*
  - **### NEVER change the LNA bias settings other than “on” if it’s off ###**



The ATA/SETI/UCB staff are here to help and will execute ata commands for teams.

Step 2: Point Somewhere!

Teams / groups can be assigned subarrays

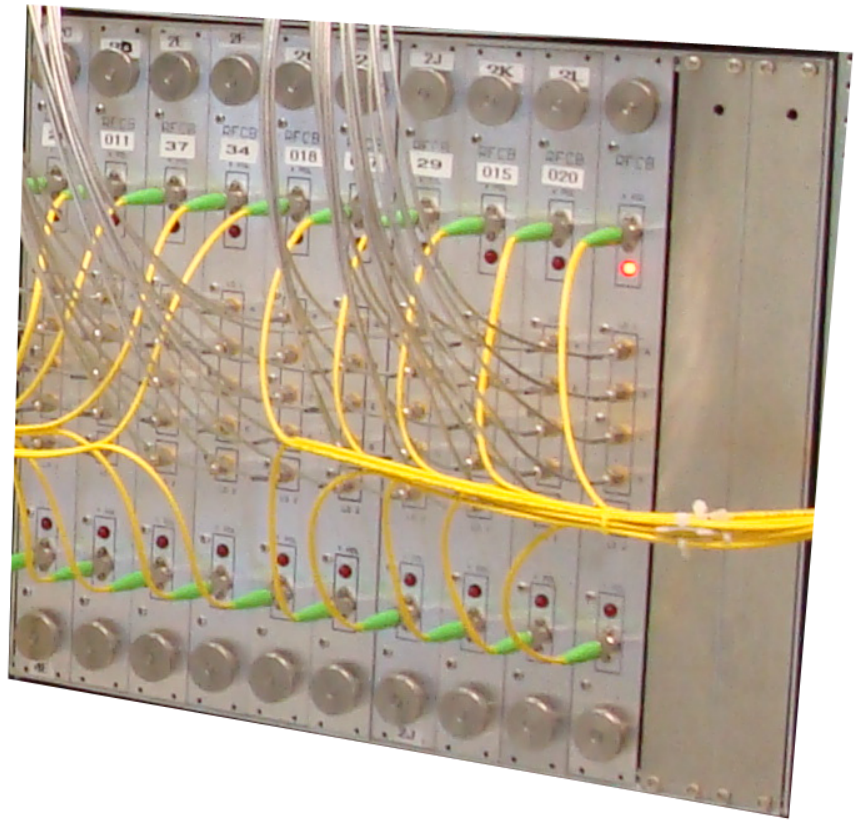
- Set position of antennas directly
  - atasetazel [antennas] [az] [el]
- Provide a trajectory (ephemeris) to track
  - atatrackephem [antennas] [ephemeris]
  - ataasciistatus -l → Watch what's happening
- Generating ephemeris
  - ataephem and variants can produce properly-formatted files of catalog objects
  - Make your own: Text files with [TAINS] [AZDEG] [ELDEG] [IRKM]
  - Mind the "Gotchas": we use TAI for pointing, and slew rates are limited

Three of the antennas *Can* run into each other. We won't be using those.

Step #3: Tune the RFCBs

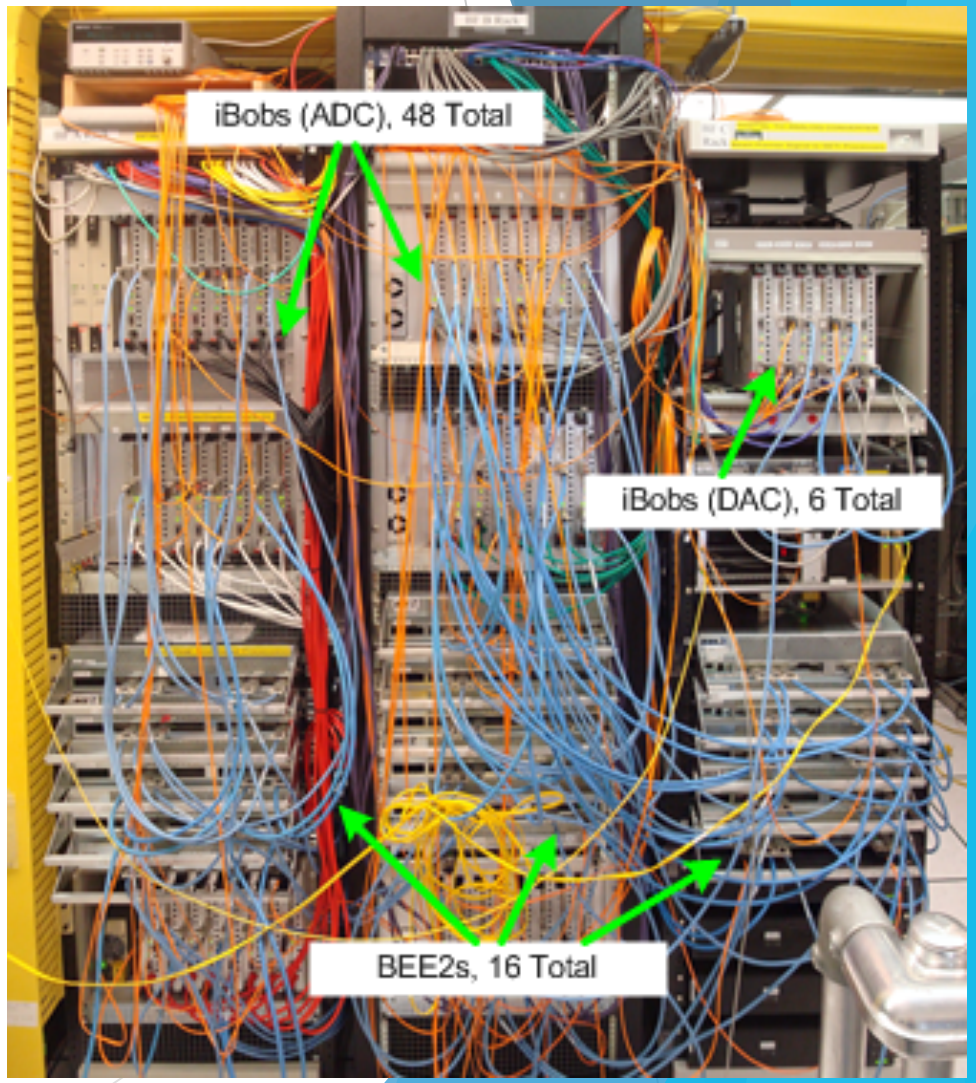
Teams / groups can be assigned tunings

- Tuning the receivers places the **sky frequency** of interest at the common IF band used by the back-end instruments
  - atasetskyfreq [IF] [FMHZ]
  - atagetskyfreq [IF]
  - “atasetskyfreq c 1420”
- In ATA nomenclature, the “tuning frequency” is the “sky frequency” that appears at the 629.1456 MHz RFCB output. Others will be higher/lower.
- IF may be conjugated here.
- The software automatically selects the proper value of LO2 to satisfy your frequency request



Step #4: Configure an Instrument

- Your best (and most fun) results might come directly from connecting your instruments to individual antennas.
- *However,* Beamformer and Foxtrot modes can be available for teams that are interested. These are mutually-exclusive
- **Beamformer:** Requires setup, calibration, and pointing; phases/delays input streams to align beam at requested part of the sky
  - Outputs: XAUI, 10GbE, analog DAC [not used in a while…]
- **Foxtrot:** Requires setup and choice of limited IF band; directs FFT of input streams to disk for later reconstruction
  - Outputs: 10GbE to disk; some procedure required to render usable data from it



Where To Plug In?

- **Ask Us First!** Many things are possible, but we need to be sure it goes back together with no leftover parts at the end of the week.
- **At The Feed:** *Can* (doesn't mean should) interrupt RF line between feed and PAX. Pro: Full bandwidth *if your instrument soaks it*. Con: Difficult, RFI risk.
- **At The Fiber:** *Can* use an OTX module separate of the RFCBs to convert fiber to RF and pull directly *if your instrument soaks it*. Con: Few OTX available.
- **At the RFCB Output:** Plug your ADCs into the back side of the RFCBs; 629 MHz IF with few 100 MHz bandwidth (last filters). Very straightforward!
- **At the DAC Output:** Patch Beamformer DAC to your ADC input, but requires running in beamformer mode.
- **On a Digital Stream**: 10 GbE native beamformer output or antennas output; requires having a receiver on the network that can soak packet rate

Most Importantly Have Fun!!!

https://github.com/SETIatHCRO/grhack/wiki

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#gnu_radio_and_seti