Allen Telescope Array

The Allen Telescope Array

A CUTTING EDGE DESIGN FOR THE SPECTRUM CONGESTION OF TODAY AND TOMORROW

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We want to observe from DC to Light (0.5 to 11.2 GHz). How?

- Choose a quiet site, then *keep* it quiet
- Use a clean, unblocked antenna design
- Give the front end headroom to spare
- Maintain linearity, stay flexible
- Be aware of (and schedule around) strong satellites
- Participate in spectrum protection

When things get tough, use active interference mitigation:

- Use many small antennas ('large N')
- Be prepared to form complex, dynamic spatial and frequency nulls
- Design the correlator and other back ends to accommodate fast dump rates
- Don't spend too much on the first generation; be prepared to replace it

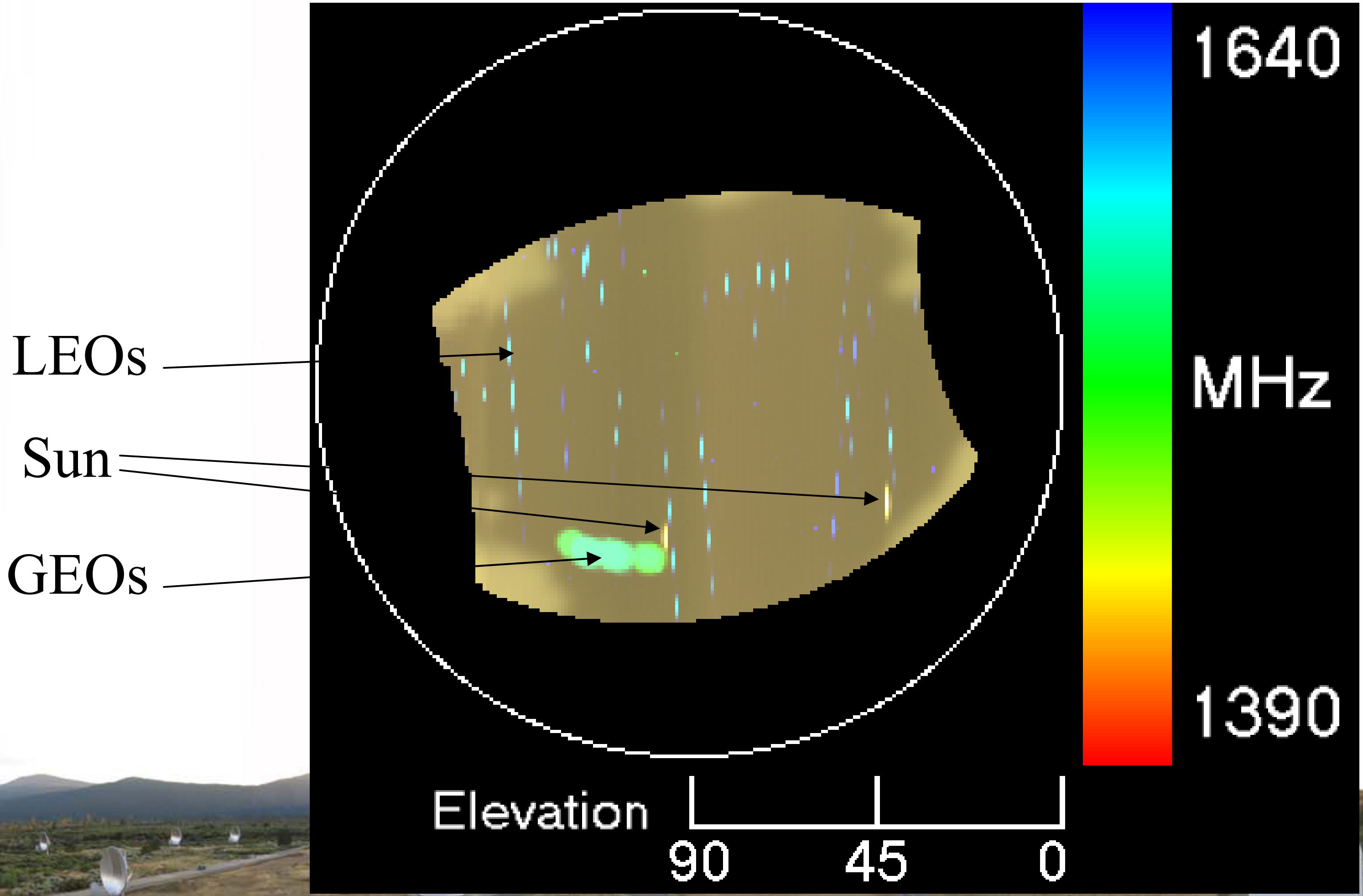
The Site – Hat Creek, CA

- High desert valley in the Southern Cascade region of Northern California
  - Lava beds, Agricultural, little local development since the site was selected by UC Berkeley in 1958
  - The major change during this time is common to all sites: Satellites

RFI Survey at the RPA

G. R. Harp and R. F. Ackermann

48 hours continuous scanning



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Clean, Unblocked Aperture

Keeping the Site Quiet

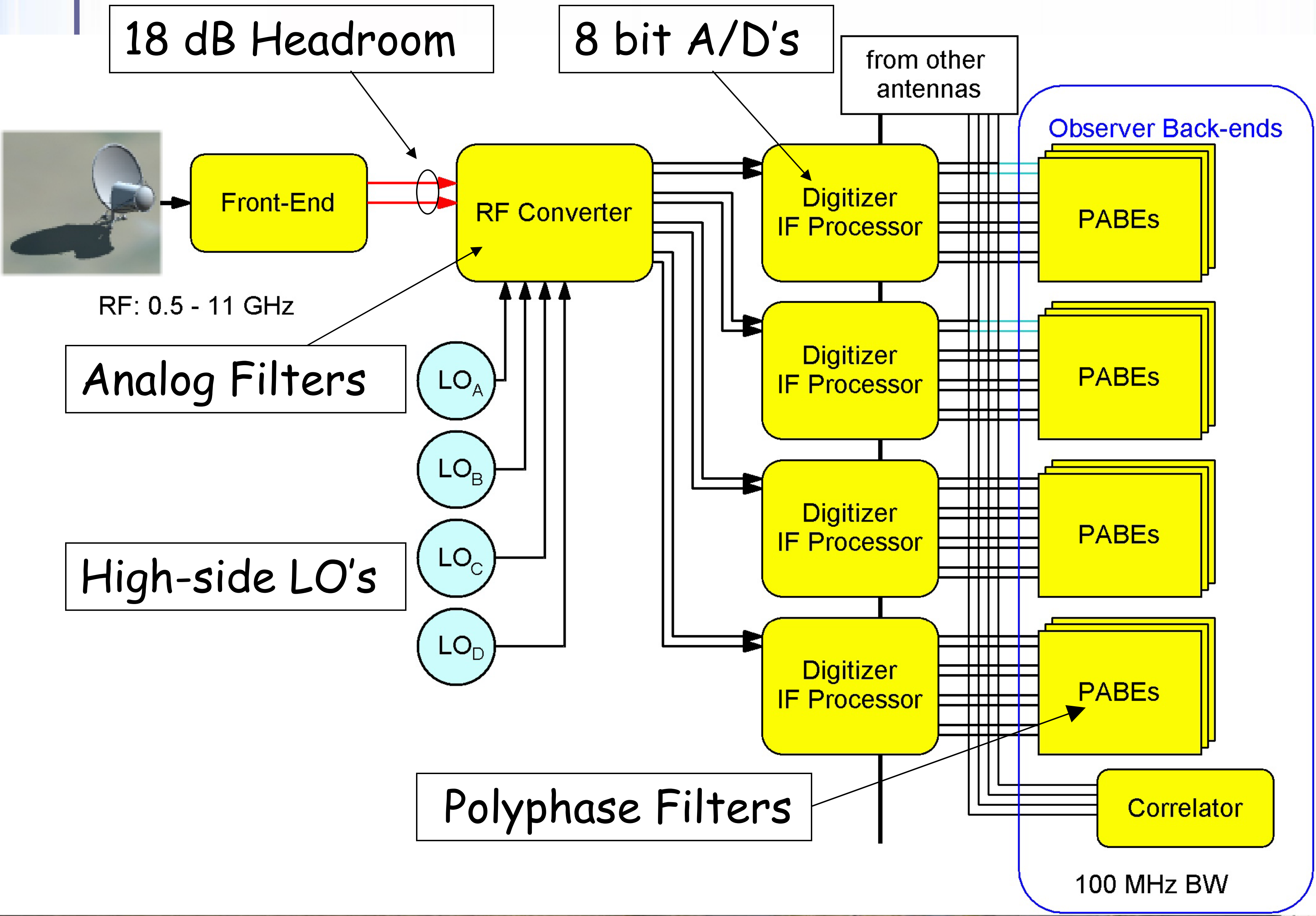
- No local oscillators at the antennas
- Direct fiber optic transmission of the entire RF band to a shielded building with separate analog and digital rooms
- Control of other local sources of RFI
- Good relations with the community

Headroom, Linearity, Filters

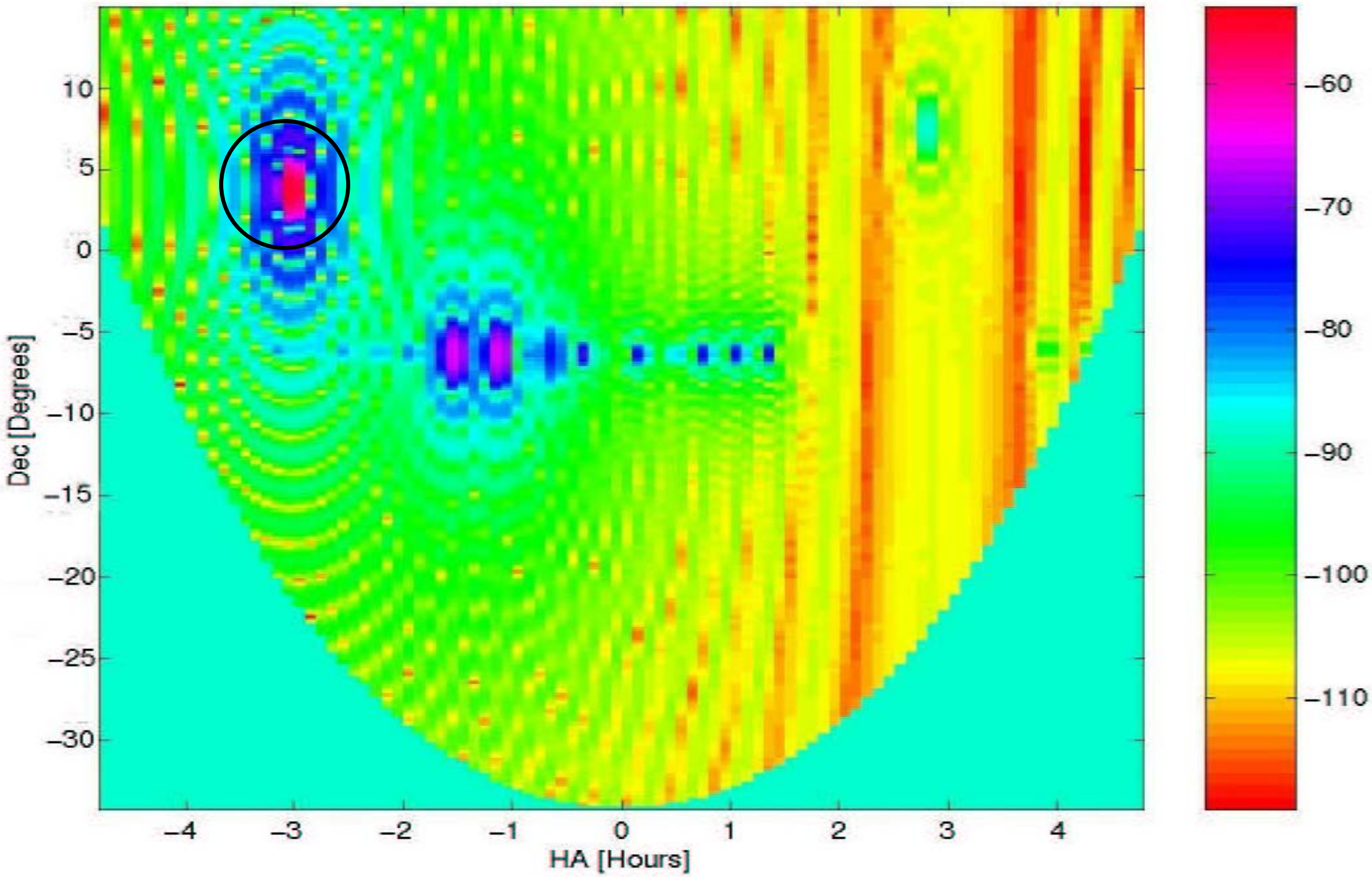
Characteristics of radio astronomy receivers relevant to the rejection of emissions in adjacent and nearby bands

Radio astronomy receivers must be extremely ***sensitive***, in order to detect faint naturally occurring astronomical signals. In addition to this, they must have ***headroom*** … adequate to handle signal level variations. Finally, it is essential to maintain ***linearity*** in radio astronomy receivers, in order to avoid generating intermodulation products in the spectrum, and to maintain calibration accuracy. Combinations of ***analog and digital filters*** can be used for these purposes.

ITU, 7D29, 18 April 2001


18 dB Headroom
8 bit A/D's
from other antennas
Observer Back-ends
Front-End
RF Converter
Digitizer IF Processor
PABEs
RF: 0.5 - 11 GHz
Analog Filters
LO$_A$
LO$_B$
LO$_C$
LO$_D$
High-side LO's
Digitizer IF Processor
PABEs
Digitizer IF Processor
PABEs
Digitizer IF Processor
PABEs
Polyphase Filters
Correlator
100 MHz BW

Satellite 'Horizons' in Schedule



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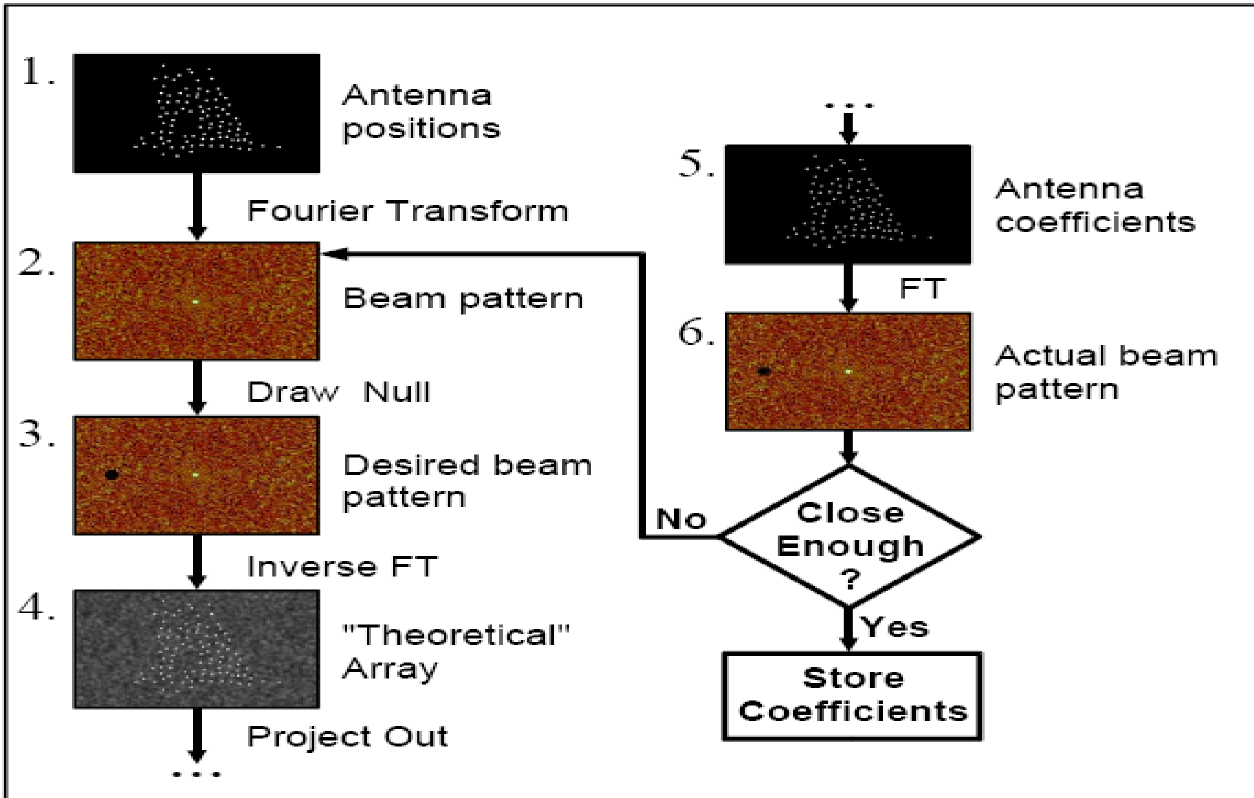
350 Antennas Allow Flexible Nulling (700 Degrees of Freedom for Each Frequency Bin)



Demands on Signal Processing

- The update rate for complex weighting is much higher (~1 kHz) than normal sidereal tracking
- The dump rate is also much higher, if RFI excision is required (~10 msec)
- Large N makes heavy demands on imaging software and hardware, but gives exquisite image fidelity

Keep up with Moore's Law

- Be prepared to upgrade the digital electronics every three to five years
- Apply the RFI lessons learned to the next generation
- Maintain flexibility and creativity with an 'open telescope' approach to data access

Spectrum Protection

- ATA Personnel are involved in CORF, ITU, IUCAF, URSI
- ATA can be used for special spectrum monitoring and measurements
  - For example, measure IRIDIUM, GPS and GLONASS down to Rec. 769 levels in radio astronomy and remote sensing bands
  - Check new satellite systems on launch