Allen Telescope Array

Harvard-Smithsonian

April 3, 2001

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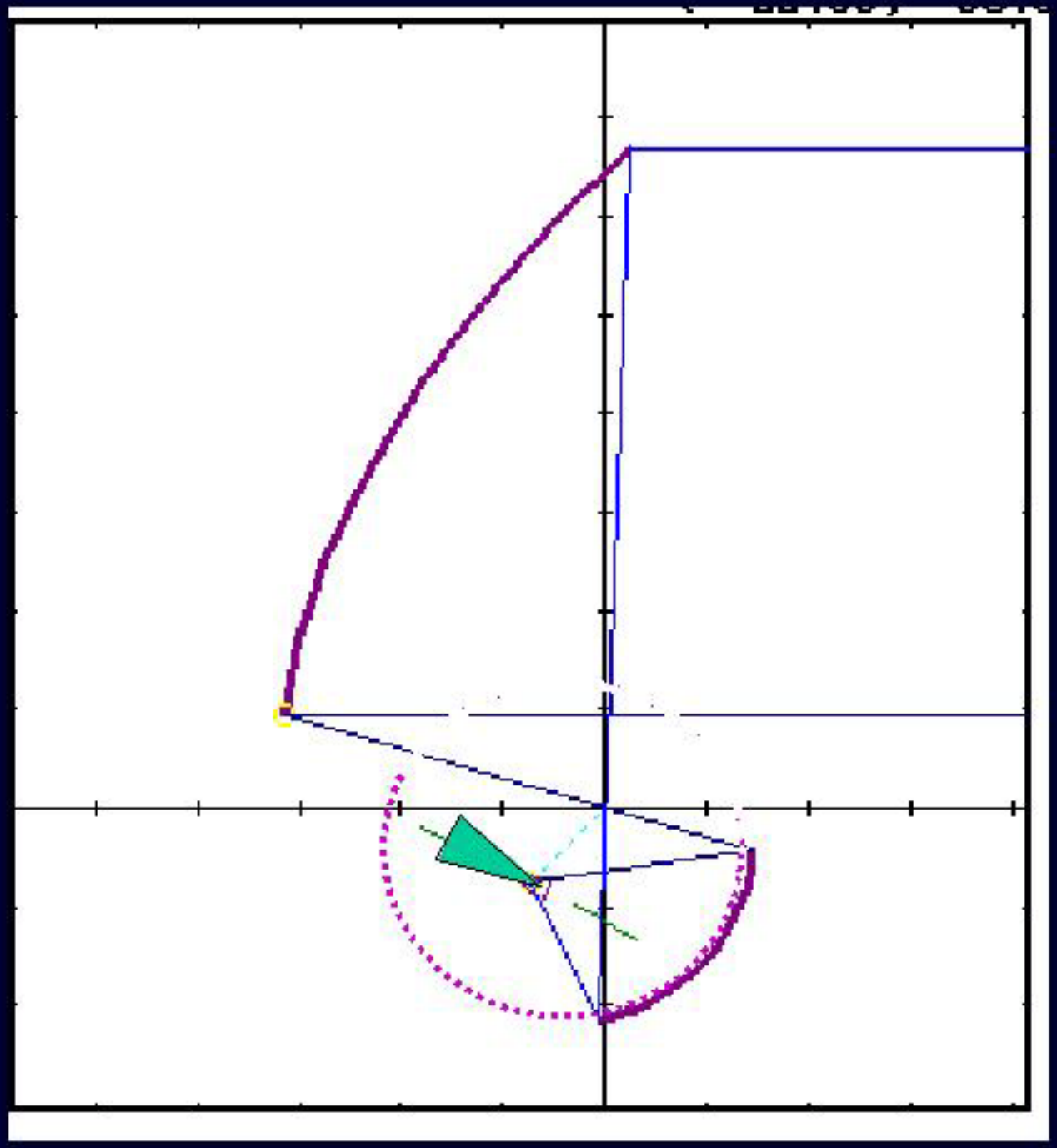
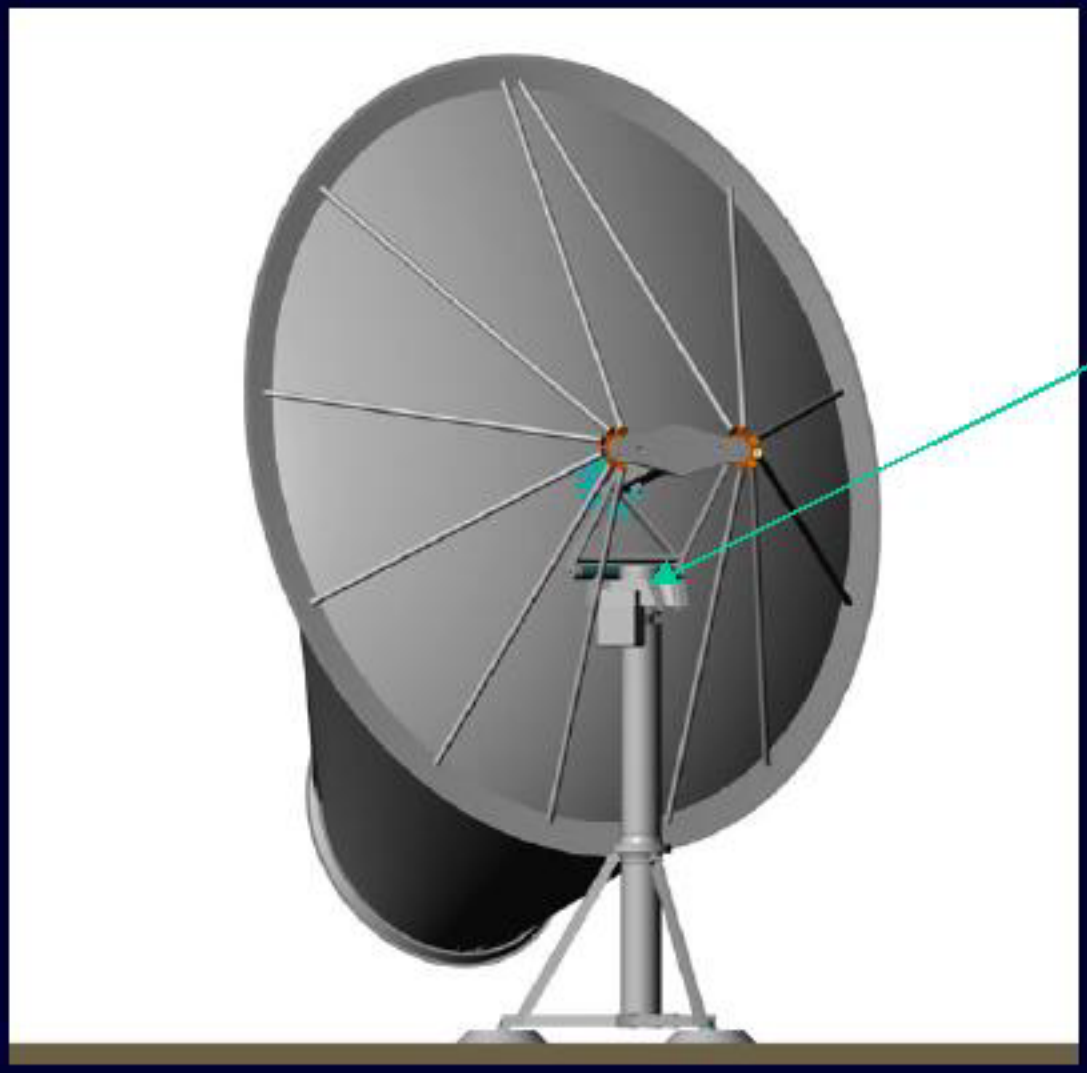
Director, SETI Research
Bernard M. Oliver Chair
SETI Institute



Selected Mount with 4.2m Anderson Dish

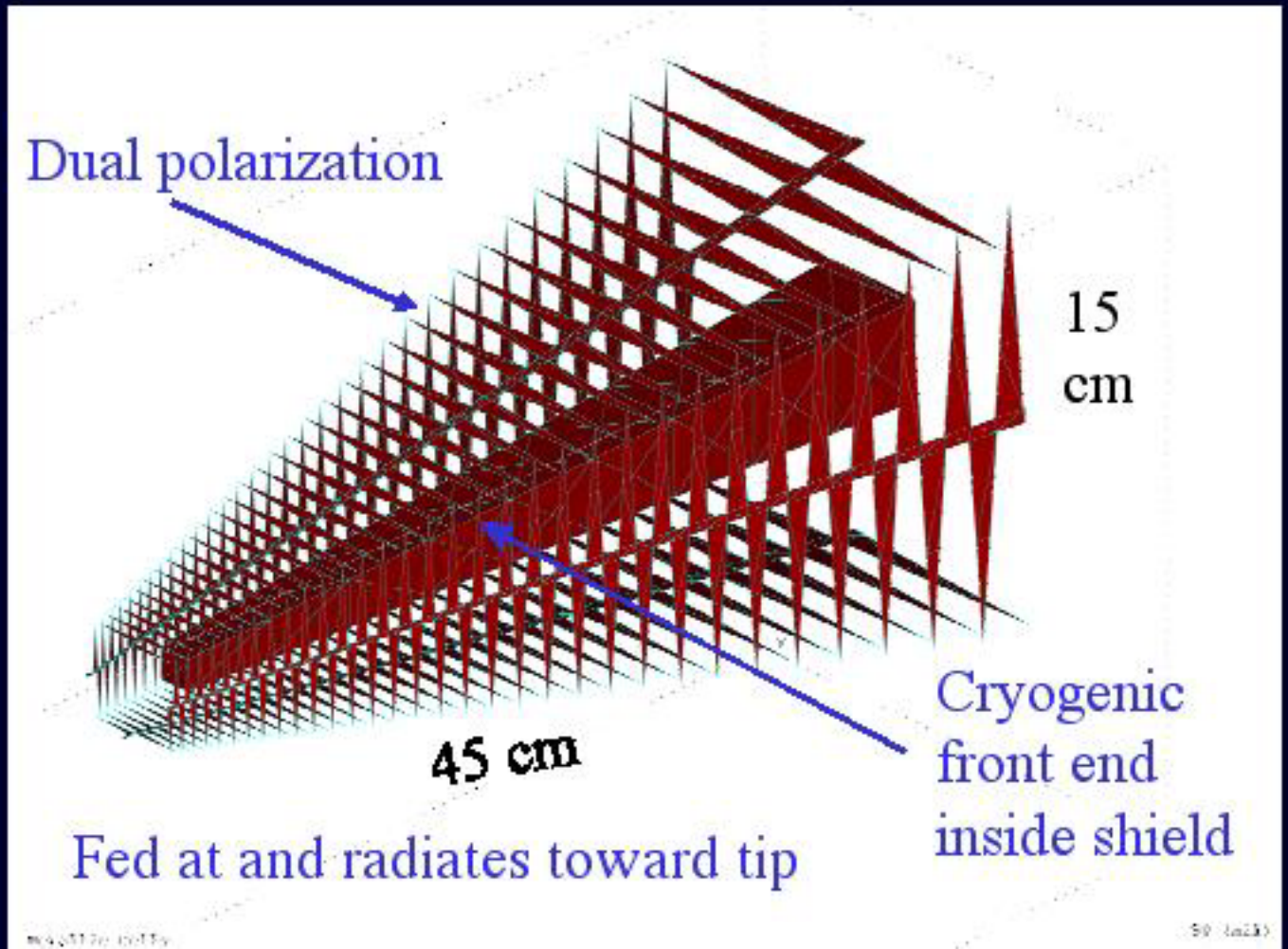
Mount and Antenna



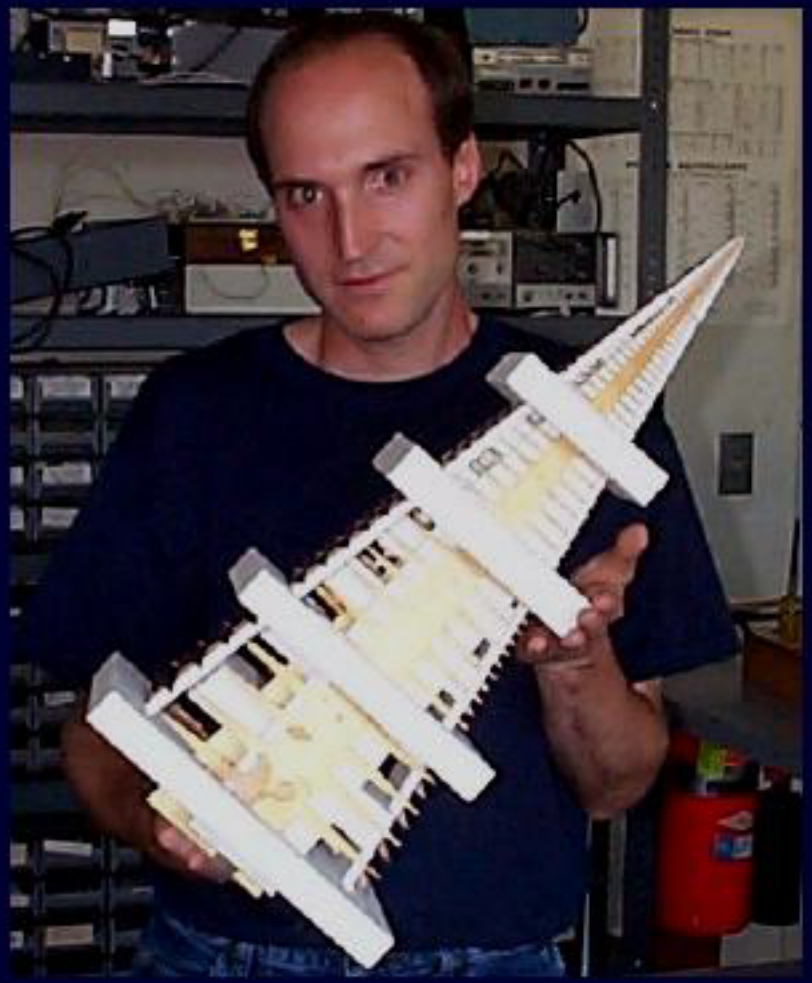
Enabling Technologies

- Inexpensive parabolic dishes
- Decade bandwidth feed
- Low noise amplifiers based on InP
- Commodity priced 80K cryogenics
- Wideband fiber optic links
- MMICs
- Cheap DSP/computing
- GPS for calibration
- Distributed control systems

Ultrawideband Log Periodic Feed

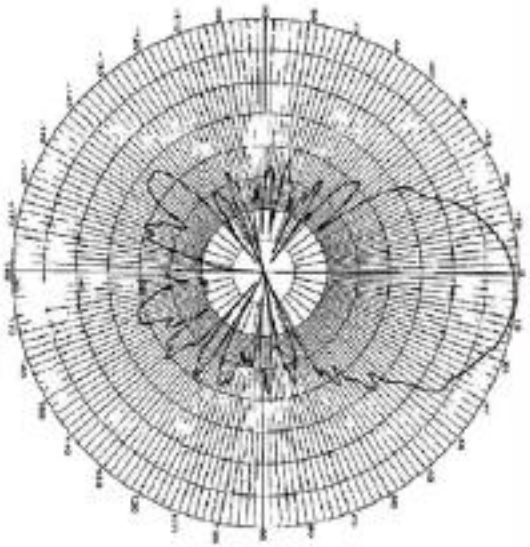


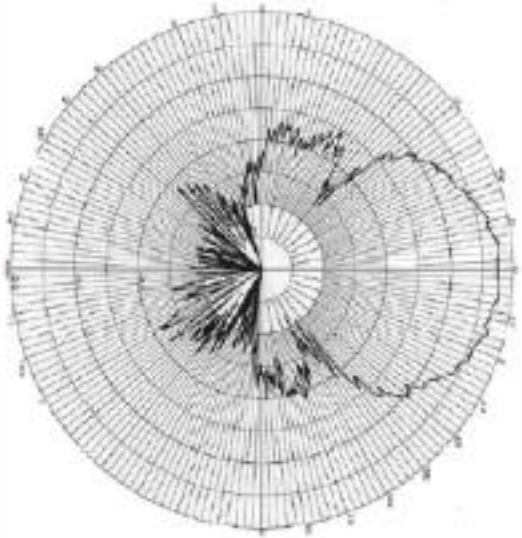
Prototype Feed for Tests



Feed Tests

- Excellent (20 dB) match
- Agrees with EM calcs on
  - Impedance
  - Gain
  - Internal Loss
- Range Tested (preliminary)
- Optimizing with ridge





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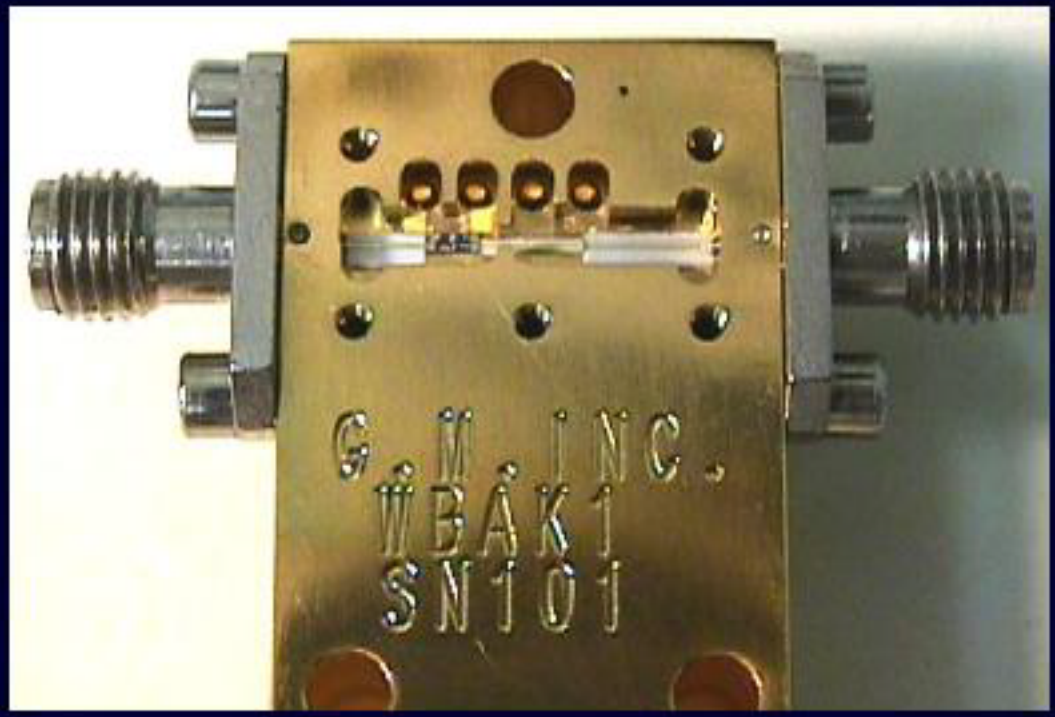
Prototype InP MMIC LNA

MMIC
- In-P PHEMT
- 0.18 microns
- Weinreb

Model T_{in} ~ 10 K

First try
- works fine
- T_{in} ~ 20 K



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SETI 2020

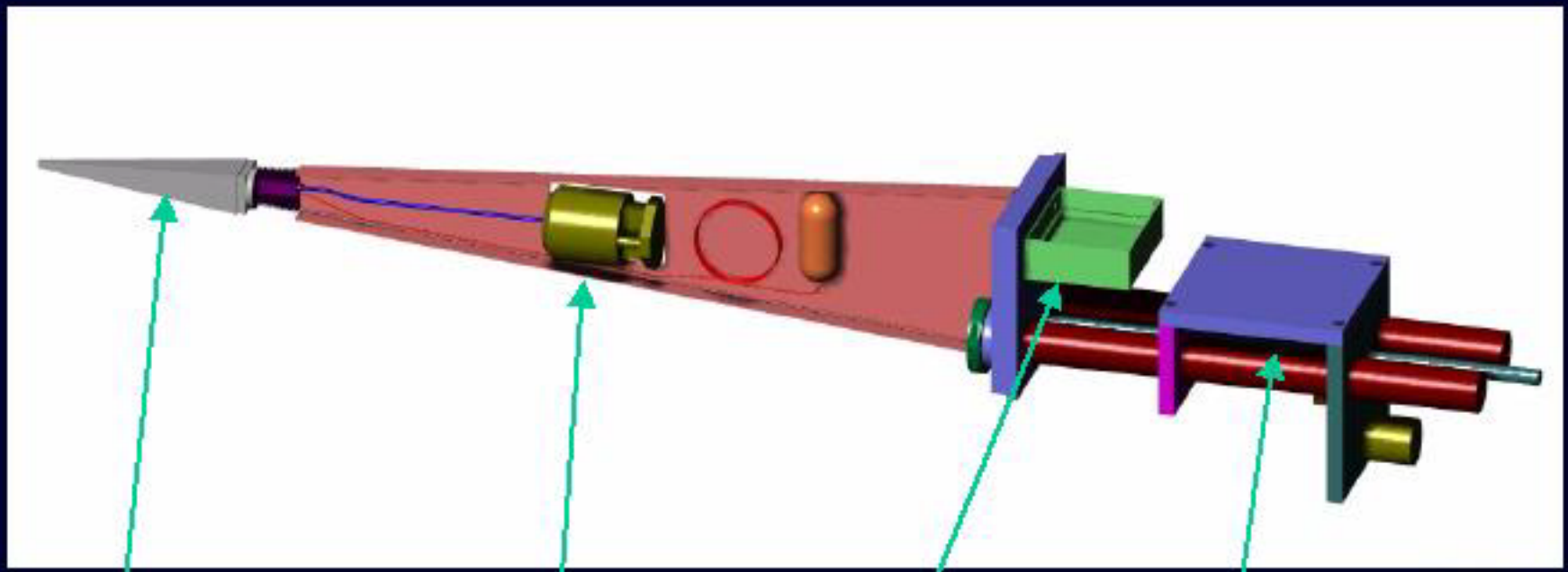
- Dedicated telescope for microwave SETI with 10^4 m^2 collecting area – One Hectare Telescope (→ Allen Telescope Array
- Optical SETI
- Omni-directional Sky Survey Telescope

80 K Cryogenics

- Must be
  - Small (to fit inside shield)
  - Reliable (> 10 yr MTBF)
  - Cheap (< few K$)
- In-house solution
  - Clearance seal compressor with voice coil motor
  - "vacuum tube" style dewar with getter
  - Pulse tube cooler (no moving parts) NIST

- Commercial solution also possible

Cryogenics Inside Feed



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0.5-11 GHz Analog F/O Links

- Off the shelf units too expensive now
- Reduced component costs soon due to recent massive investments by industry
- Laser progress "Real Soon Now"
  - Cheaper DFB, e.g. Ortel "Daytona"
  - 1310 nm VCSEL (Gore, Novalux, Cielo, Agilent, Infineon)
- External modulators as fallback

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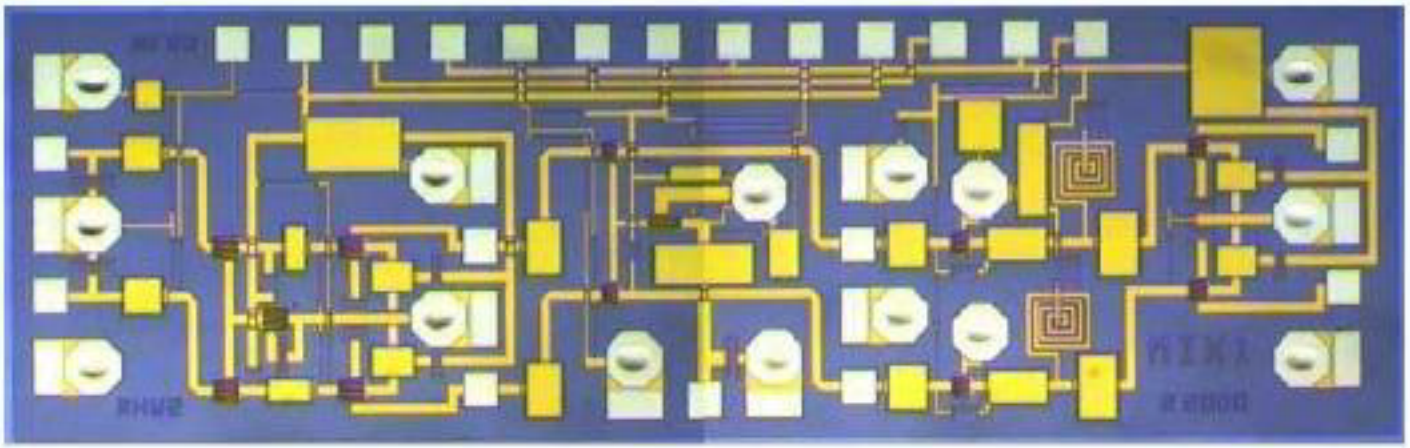
Micro Photograph of Mixer



Test Version

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Signal Processing

- Up/down converter
- DSP architecture in preliminary design
- Cross correlator (imager) with BW set by $$
- Backends for synthesized beams
  - SETI
  - Pulsars
  - Spectral line
- RFI mitigation and removal designed in

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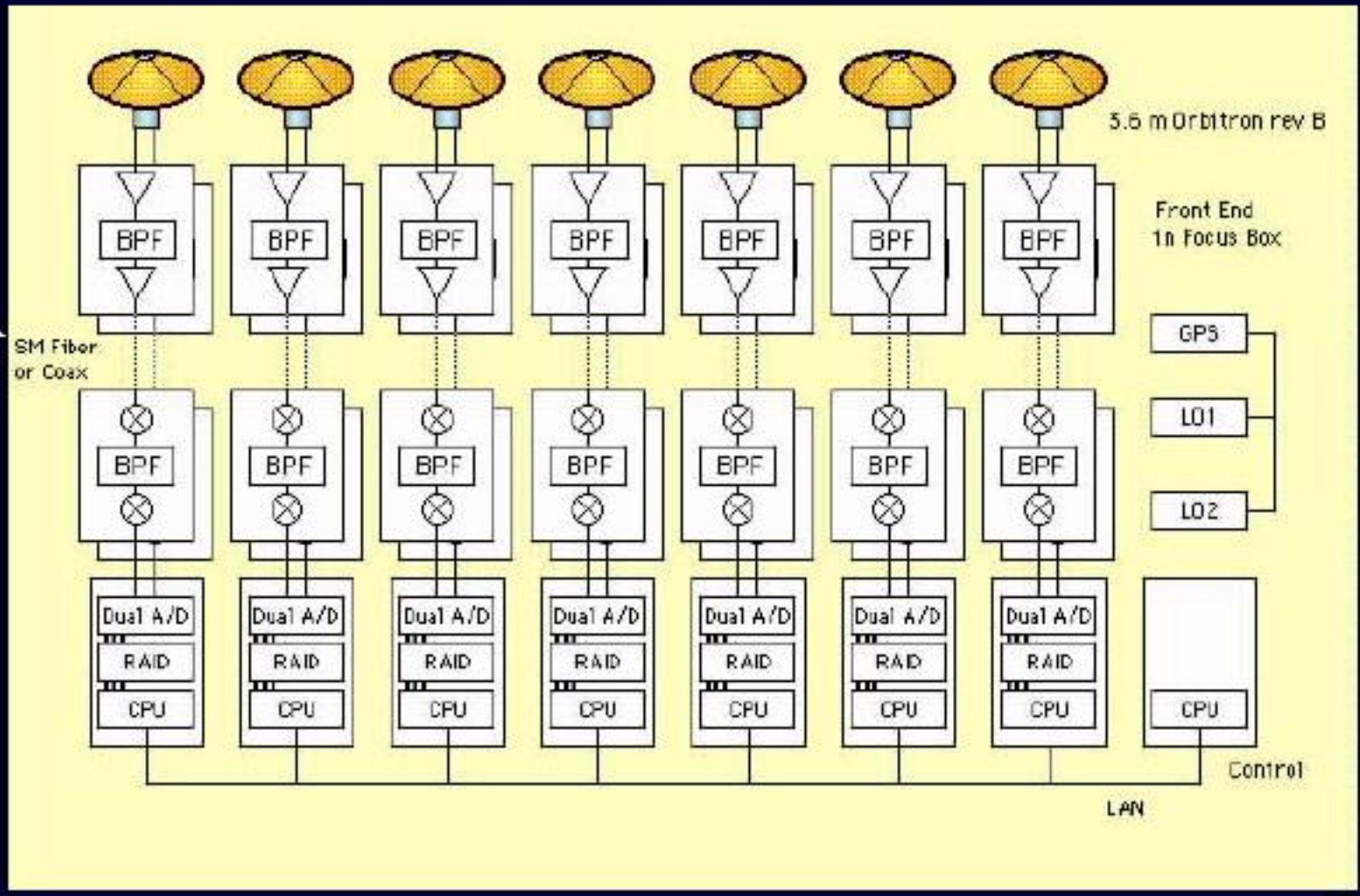
RPA - Rapid Prototyping Array

Russell Reservation in Lafayette CA



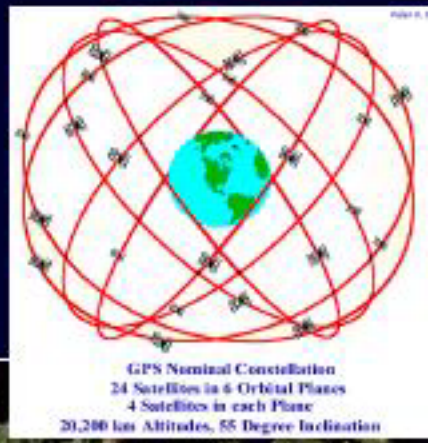
The Allen Telescope Array (ATA)

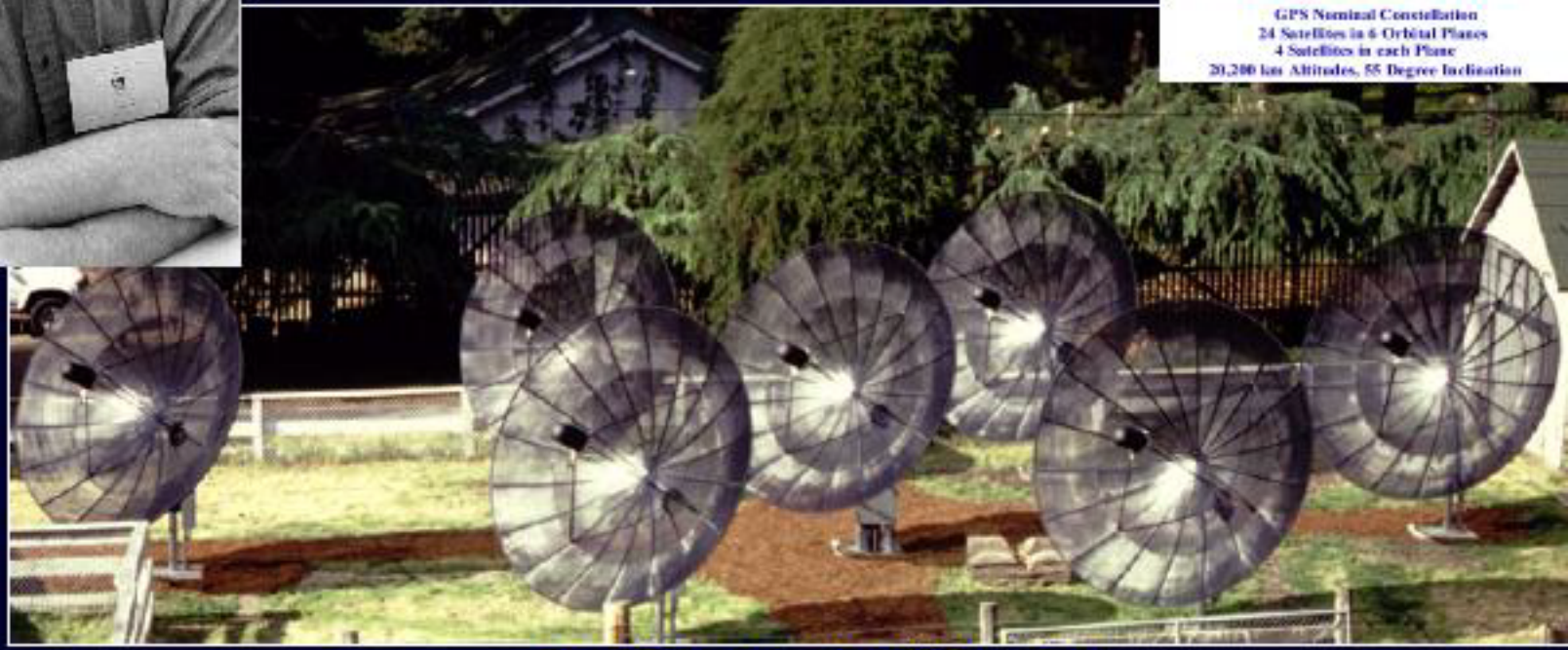
- Large, massively parallel array of "TV" dishes
  - ***350 elements*** each 6.1 m in diameter
  - total collecting area ***larger than 100 m dish***
  - 0.5 - 11 GHz ***simultaneously***
  - ***multiple*** beams
- Must be ***much*** cheaper than existing arrays
- Joint project of SETI Institute and UCB
- Private $ from Allen, Myhrvold, stakeholders, and others

Rapid Prototype Array (RPA)

John Dreher

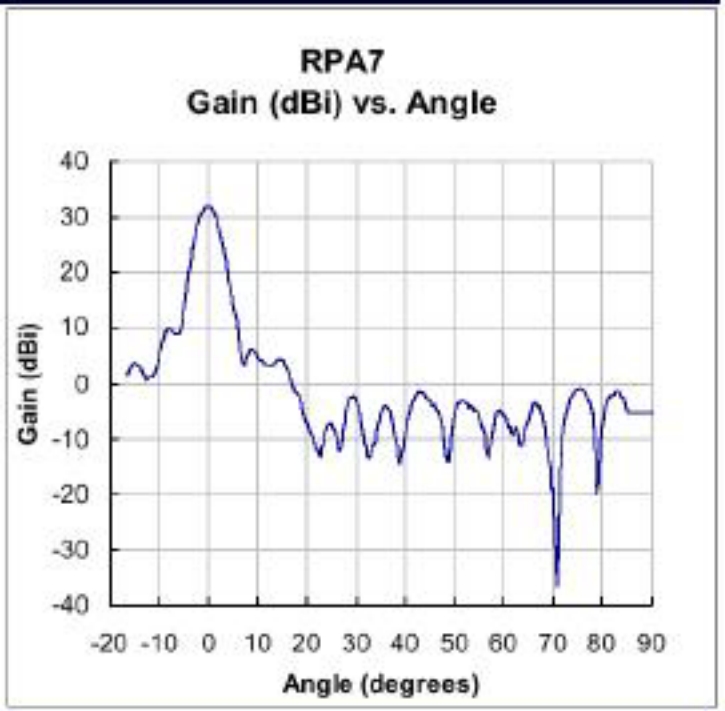
- RFI Mitigation Experiments
- Calibration with GPS
- Software Development





Lafayette, California

Antenna Gain Calibration



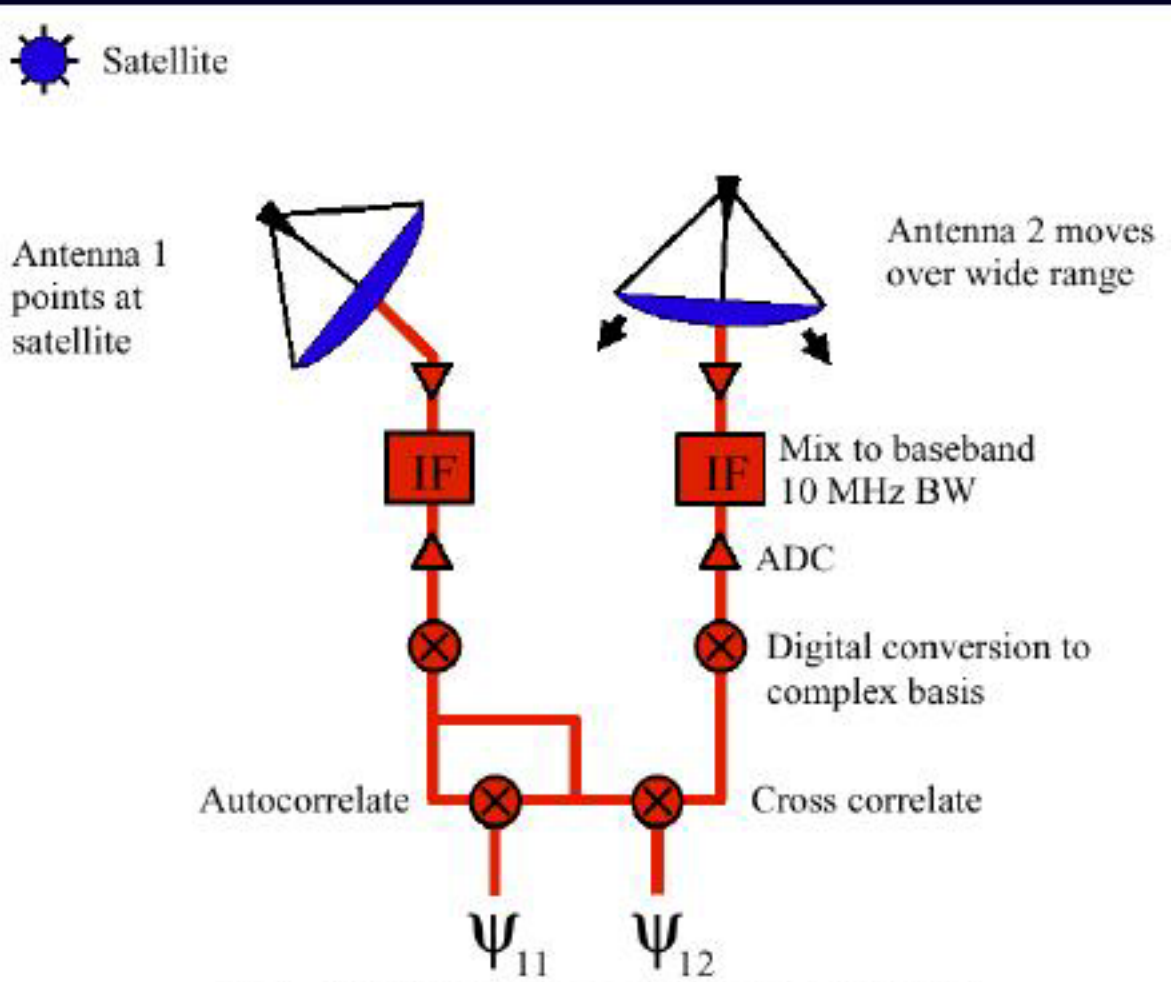
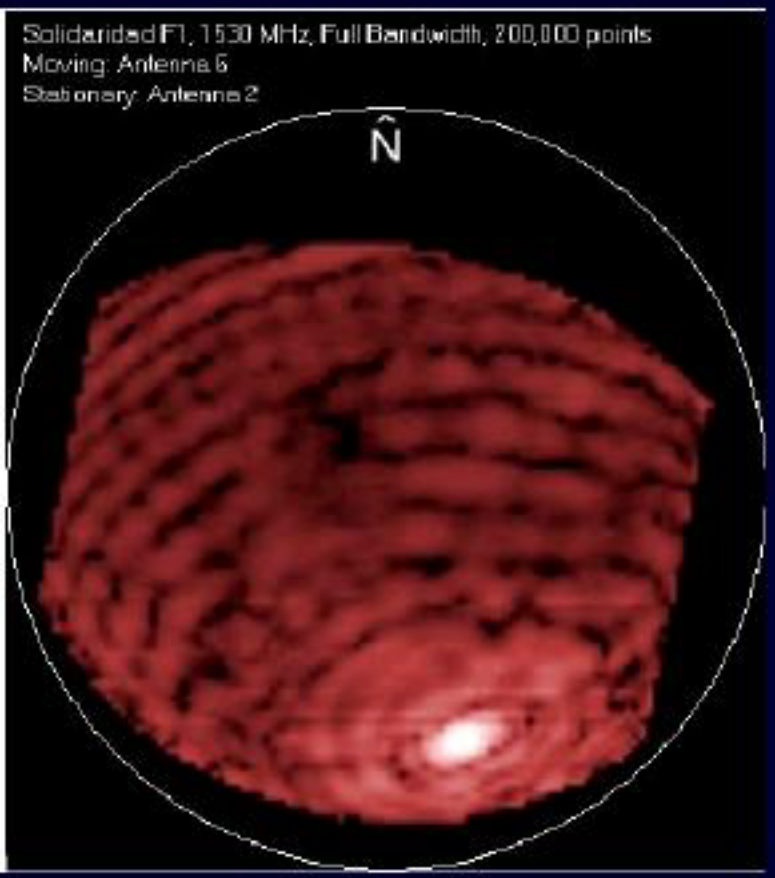
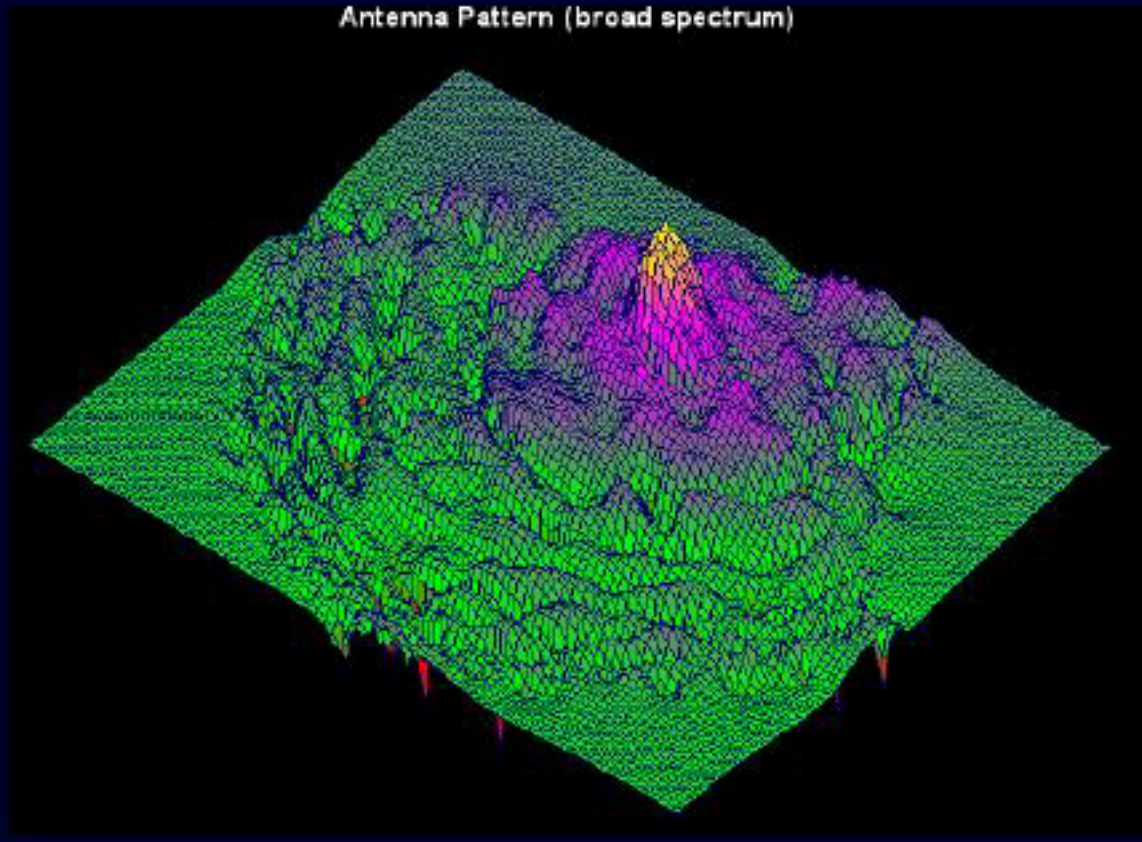


Fig. 1. Block diagram of the experimental measurements.

Antenna Gain





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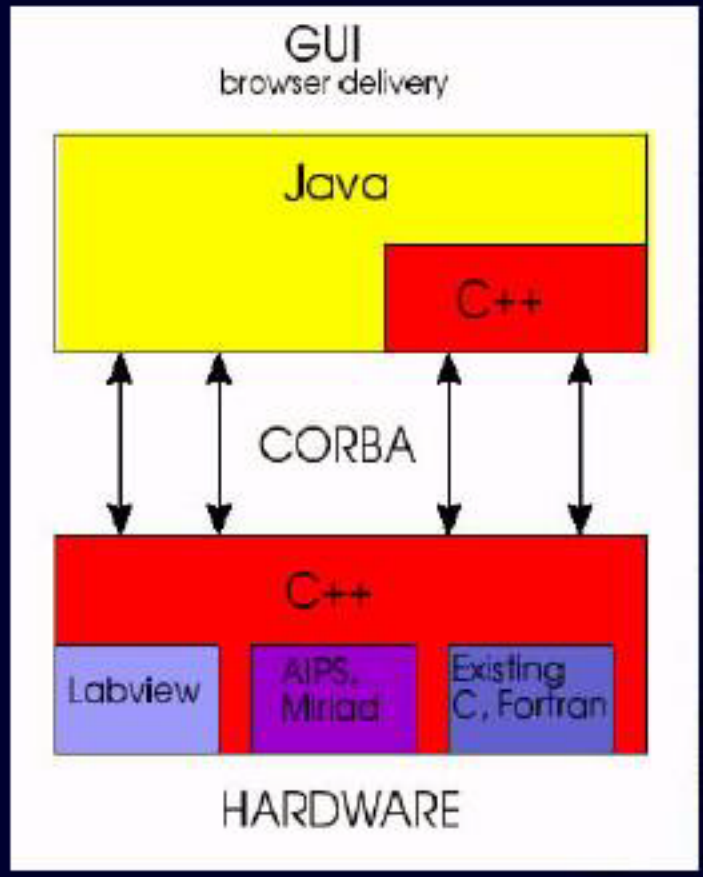
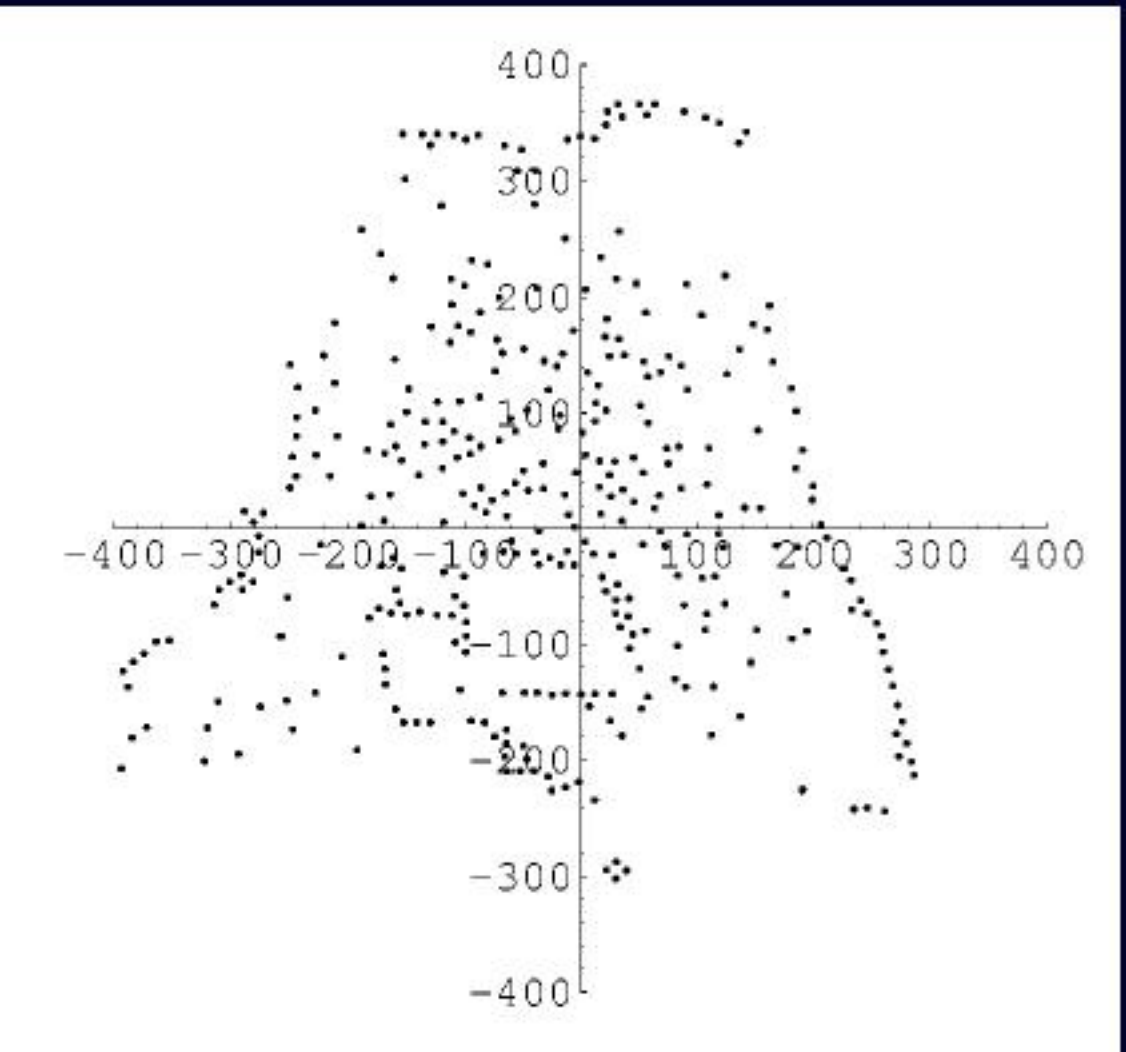
Software Technology

- OO design
  - C++
  - Java
- Use standard tools and products (where possible)
- Distributed, multiplatform design (where appropriate)




7 13'00

Selected Configuration for ATA



Nearly circular beam
76 arcsec
Near-in sidelobes
peak at 1%
Far-out sidelobes
~ 1/N

Timeline for ATA

1999-2000

- R&D Phase
- Rapid Prototype Array of 7 antennas built
  - calibration, beam forming, RFI excision, telescope control
- Selected site, began approval processes
- PDRs : most done
- Design staffing complete

Timeline for ATA

2001-2002

- CDR
- Build Production Test Array
- Operational tests begin
- Develop tools

Timeline for ATA

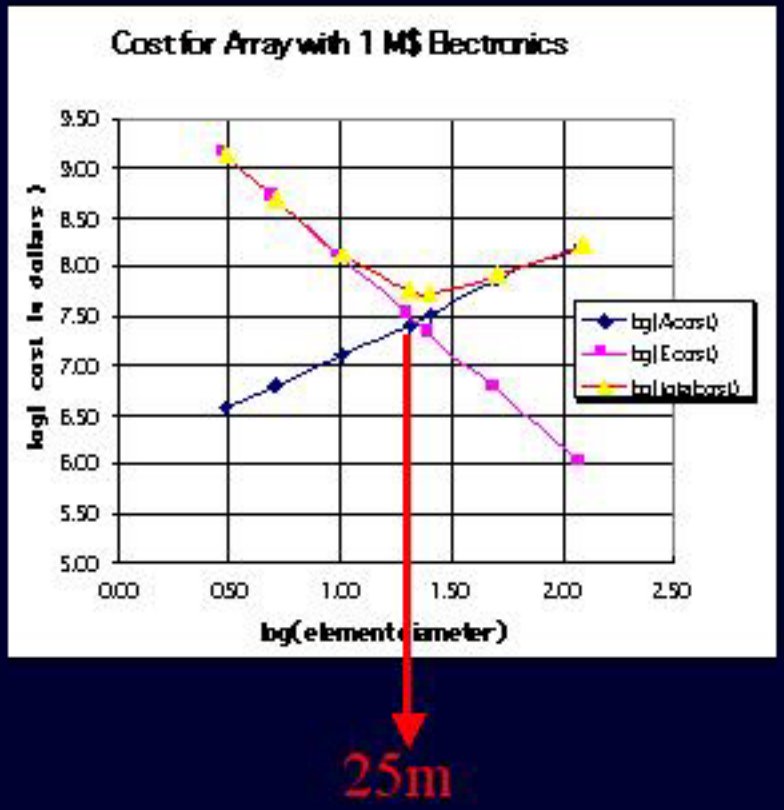
2003-2004

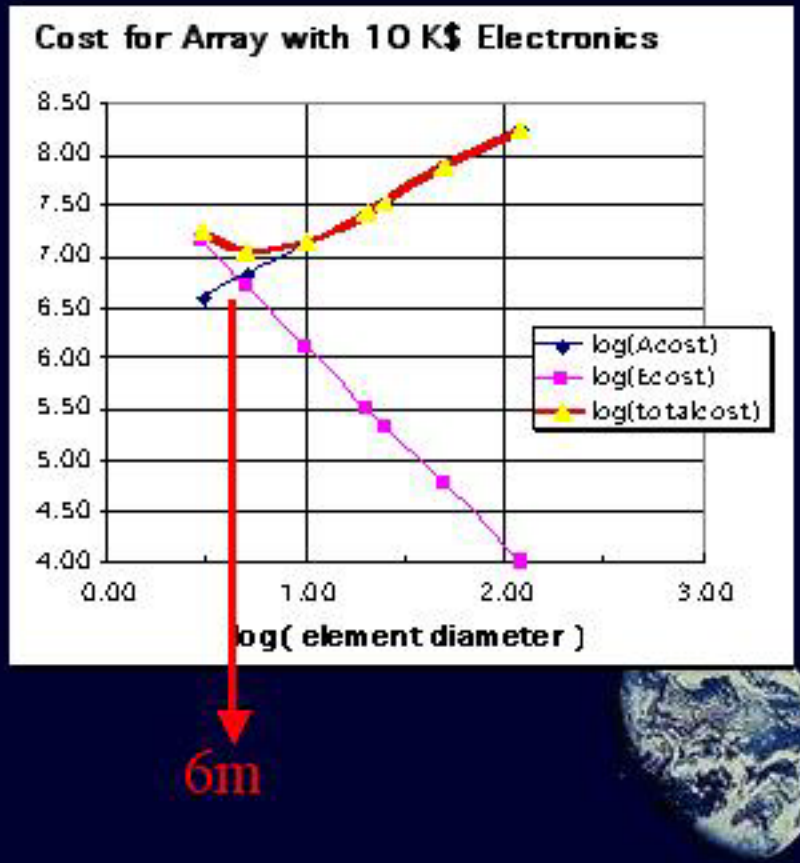
- Begin construction
- First use of partial array

2005

- Array complete - extensions begin
- Feed into SKA technology decision point

Economies Of Cheap Electonics



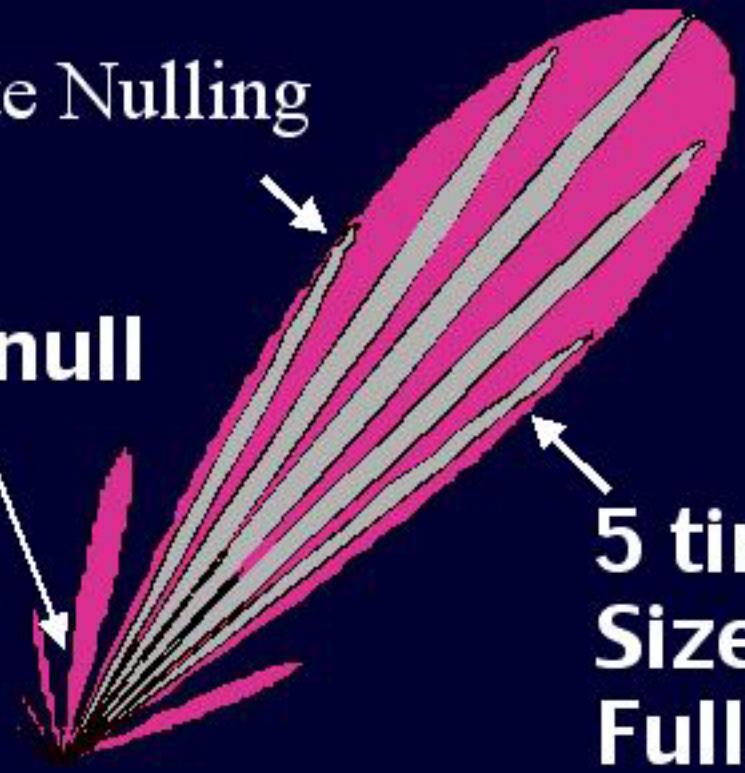



"The
Stay tuned!
www.seti.org
the
is zero."
Cocconi and Morris , Nature (1959)

The ATA at Hat Creek

It's Not Just Cheaper, It's Better!

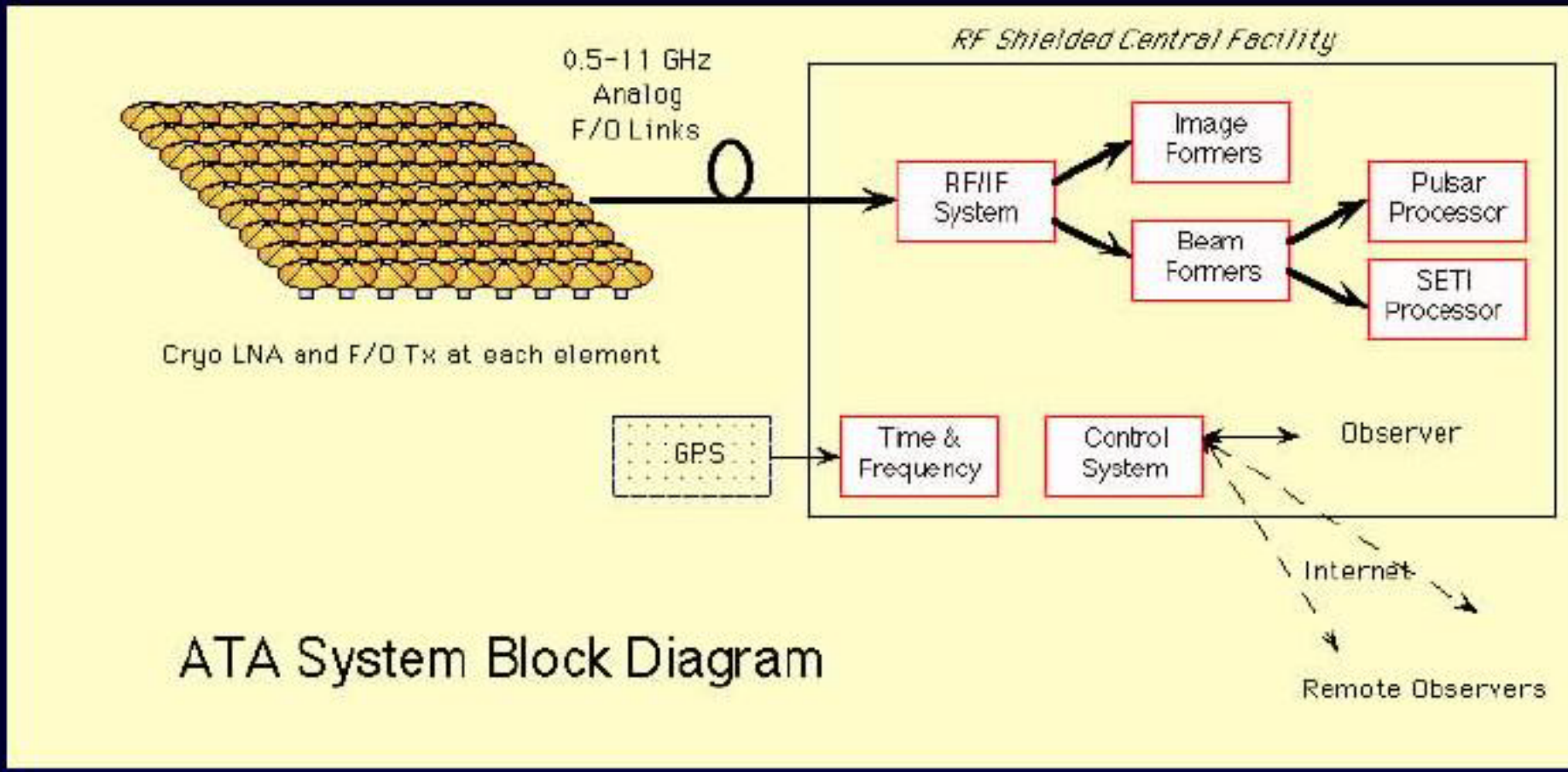
- Exploits Large Primary FOV
- Enables Simultaneous SETI and RA
- Satellite Nulling



Steer the null beam

5 times Size of Full moon

The Design


RF Shielded Central Facility
0.5-11 GHz
Analog
F/O Links
Cryo LNA and F/O Tx at each element
RF/IF
System
Image
Formers
Beam
Formers
Pulsar
Processor
SETI
Processor
GPS
Time &
Frequency
Control
System
Observer
Internet
Remote Observers
ATA System Block Diagram

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6m Offset Gregorian Antenna

6m x 7m primary

Shroud

Log-periodic Feed
with Actuator

2.4m secondary