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RadioNet

National Radio Astronomy Observatory

Atacama Large Millimeter/submillimeter Array
Expanded Very Large Array
Robert C. Byrd Green Bank Telescope
Very Long Baseline Array

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National Science Foundation

Associated Universities, Inc.

GBT Focal Plane Array
K band 7 Pixel

Steven White
Program Manager

Personnel

- Jay Lockman, Project Scientist
- Steven White, Project Manager
- Matt Morgan, Project Engineer
- Galen Watts, M&C Design
- Glen Langston, Scientist
- Sivasankaran Srikanth, EM component
- Bob Simon, Mechanical Design
- Eric Byerton, Noise Calibration
- Gary Anderson, LO Design
- Roger Norrod, System Specifications
- Bob Garwood, Amy Shelton, Joe Masters: Pipeline Software
- Mark Whitehead and Patrick Brandt: M&C Software.
- Dennis Egan, Component Construction

K-Band FPA Development

- Developed science case in series of GBT science workshops.
- Weather limitations requires efficiency improvements.
  - Large proposal back log.
- Technical feasibility and experience with components.
  - Feed, Phase Shifter, OMT, HEMT Amplifier
- True measure of a successful program for the GBT:
  - Competitive instrumentation installed on short time scales and in production use by external observers.
- Instrumentation must be complete with analysis software capable of producing image cubes. (ie data pipeline).

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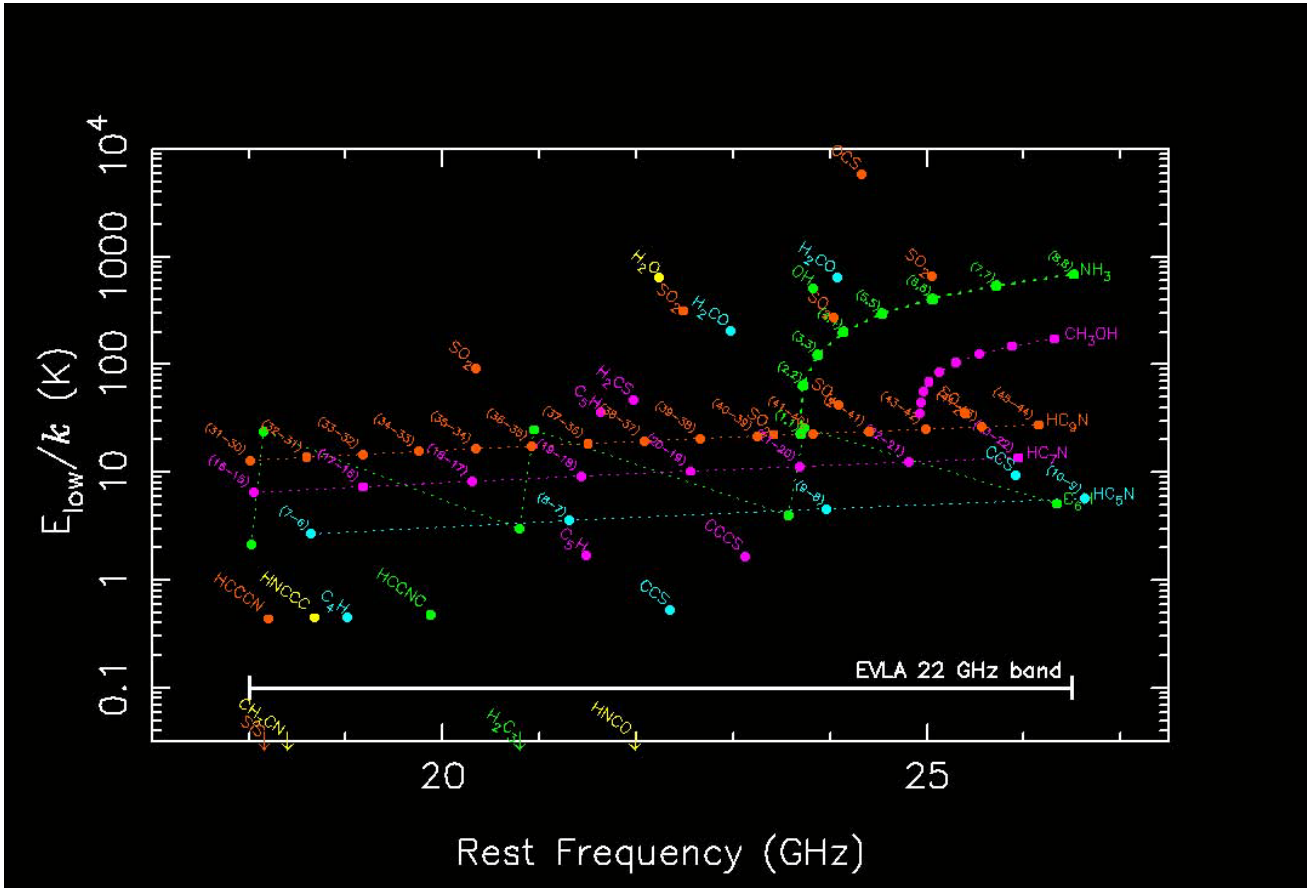
SEVENTH FRAMEWORK PROGRAMME



Science Driver : NH_3 Mapping, Molecular Chemistry

Accurate method for determining temperature in star forming regions

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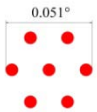


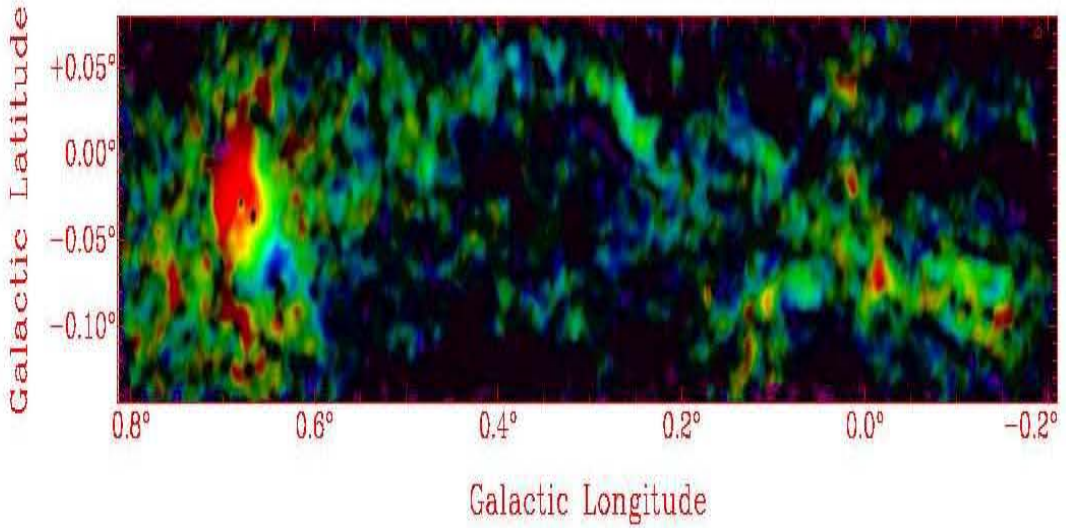
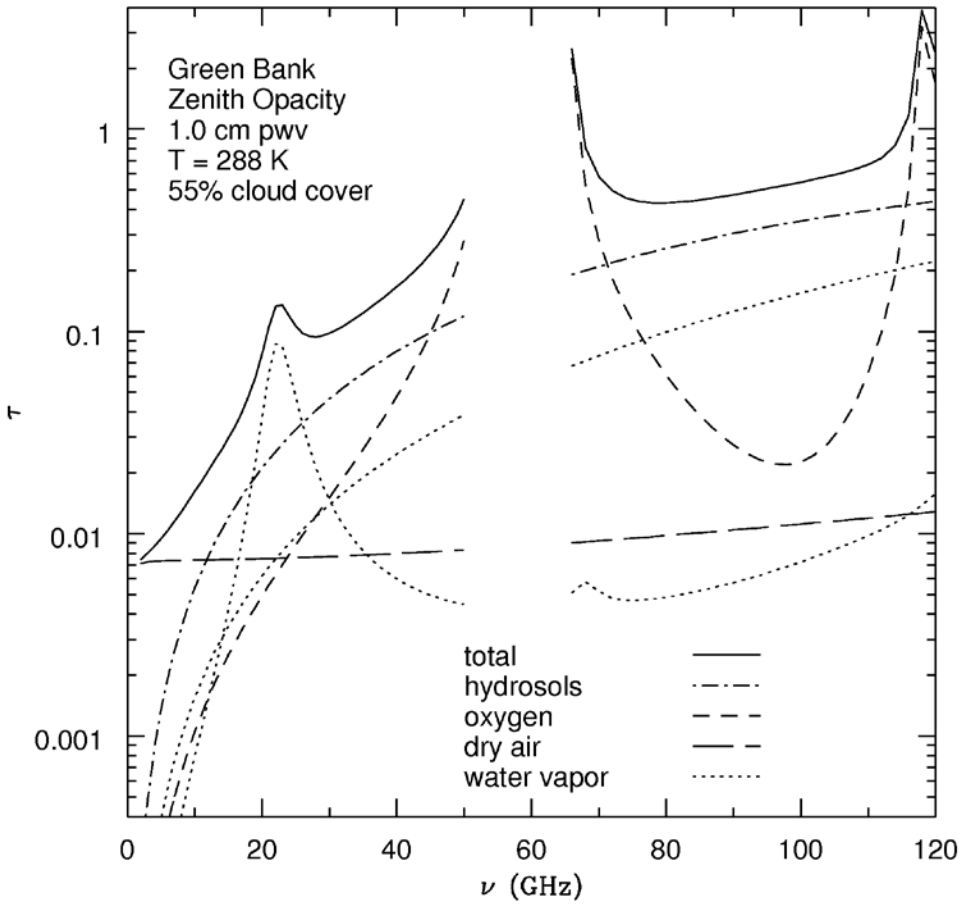


Figure 1: Kinetic temperature map of cold gas via NH_3 (1,1) and (2,2) transition observations in the Galactic Center Sgr A* to Sgr B2 region. Image courtesy J.Ott

Green Bank Atmosphere



From 2004 to 2007 statistically 20% K band Observing and 30% 3 mm Observing

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Schedule and Cost

- Proposed a ~60 pixel focal plane array.
- November, 2008 received funds as part of the Lockheed Martin track settlement.
  - $1.2 M Total
  - $0.19 M Parts
  - $0.2 M Contingency
  - $0.83 M Labor
- Compromised to seven pixels with GBT IF system limitations (8 fiber optic links)
- Develop with eye toward expansion while working with schedule and cost constraints
- Seven pixel array construction complete December, 2009
- Production use by November, 2010.

K-band FPA Deliverables

- Frontend
  - Cryogenic Package for Seven Pixel Instrument
  - Seven Dual Circular Polarization K band Pixels
  - Modular Noise Calibration for each Pixel
  - Modular Downconverter for each Channel (14)
  - Monitor and Control Electronics
  - LO Distribution with Doubler for LO1A (synthesizer lacked range)

- Software
  - Package for Engineering M&C
  - Observing Software Manager
  - Data Analysis Pipeline

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Cost Break Down

- Total for Parts (Dewar, EM parts, Isolator, HEMT Amp, WG parts, Noise Mod, IDM).
  - $245,000 vs estimated $190,000
  - Band flatness added cryogenic isolators at output ($ 20K)

- Labor for Machining: Dewar Hardware, Feed, Phase Shifter, OMT, Thermal Transitions
  - 2.5 FTE years : Machinist

- Engineering Development
  - 1 FTE year Systems Engineering
  - 1 FTE year Electronics Technician
  - 0.2 FTE year Noise Module Design Engineering
  - 0.4 FTE years Integrated Downconverter Design Engineering
  - 0.2 FTE year EM parts (Feed, Phase Shifter, OMT).
  - 0.2 FTE M&C Module Design

- Software Development
  - 0.5 FTE year Software Engineering Monitor and Control.
  - 2 FTE years Pipeline Development
- Scientist
  - 1 FTE year

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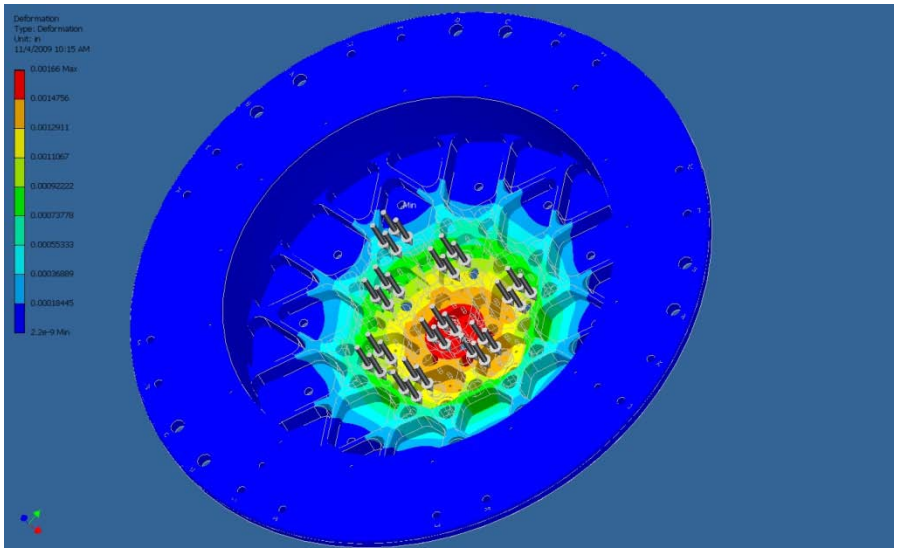
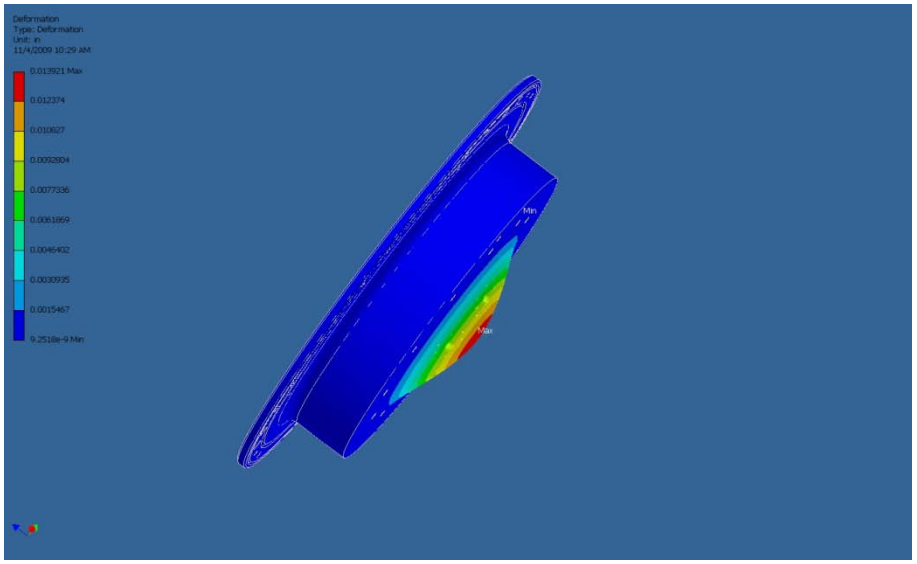
Lesson Learned

- Absolutely need a defined science case!
- Identify stakeholders.
- Fix the design and specifications early to control cost and schedule
- Be flexible with specifications if benefits are justifiable
- Be cautiously bold and confident in abilities.
- Be aware of development costs.
- Build what you know when possible.

Mechanical and Thermal Design

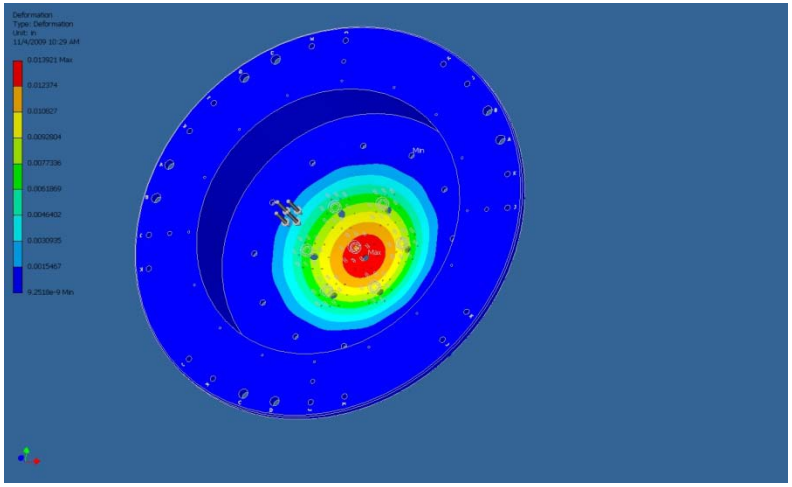
- Solve as many issues as possible to allow expansion.
- Compromised with small dewar to maximize receiver turret options.
- Two thermal gaps reduce thermal loading.
- Sliding waveguide compensates for thermal expansion.
- Reduction of metal for weight control.
- Integrate dewar top plate and mounting bracket.
- Ribbed top plate for strength: expandable to large diameter.





Ribbed design
Red: 0.00166” max

Inventor Stress Analysis



Flat plate design
Red 0.0139” max

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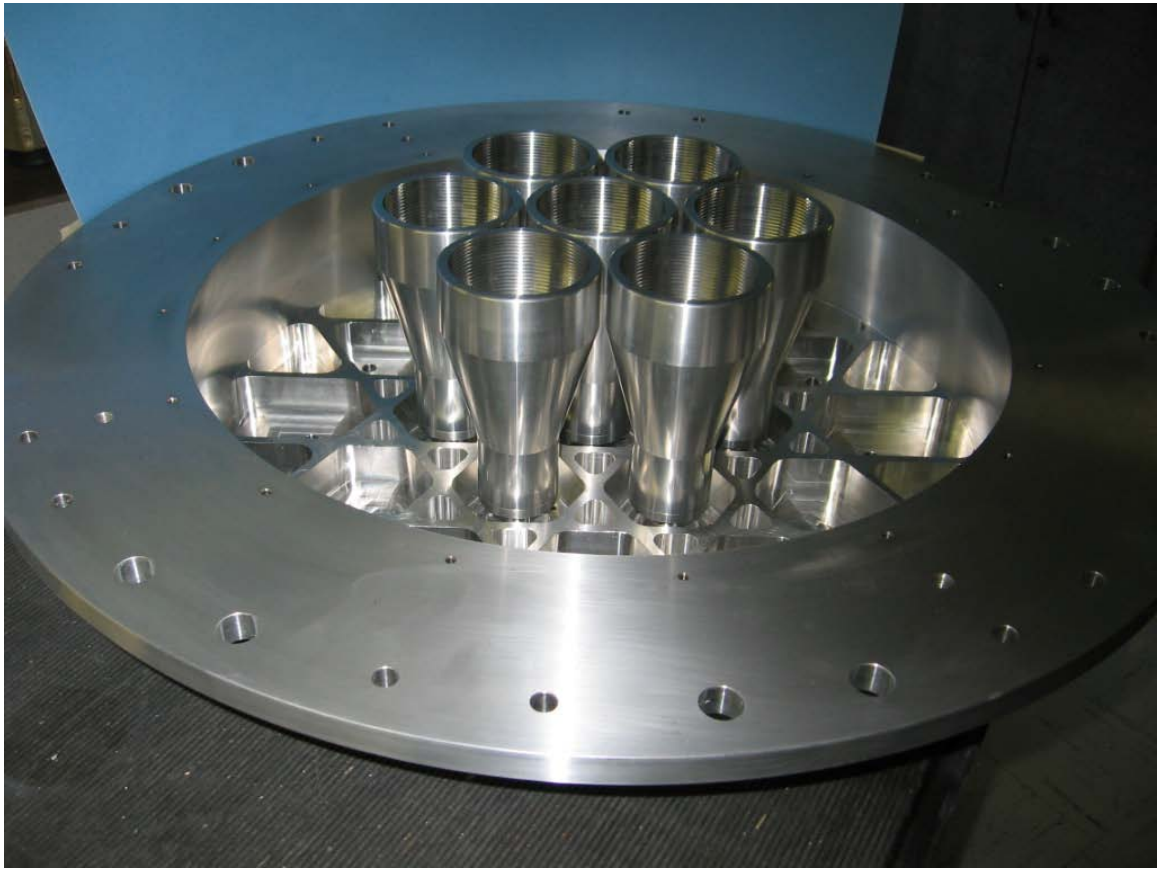

Top Plate with Feeds

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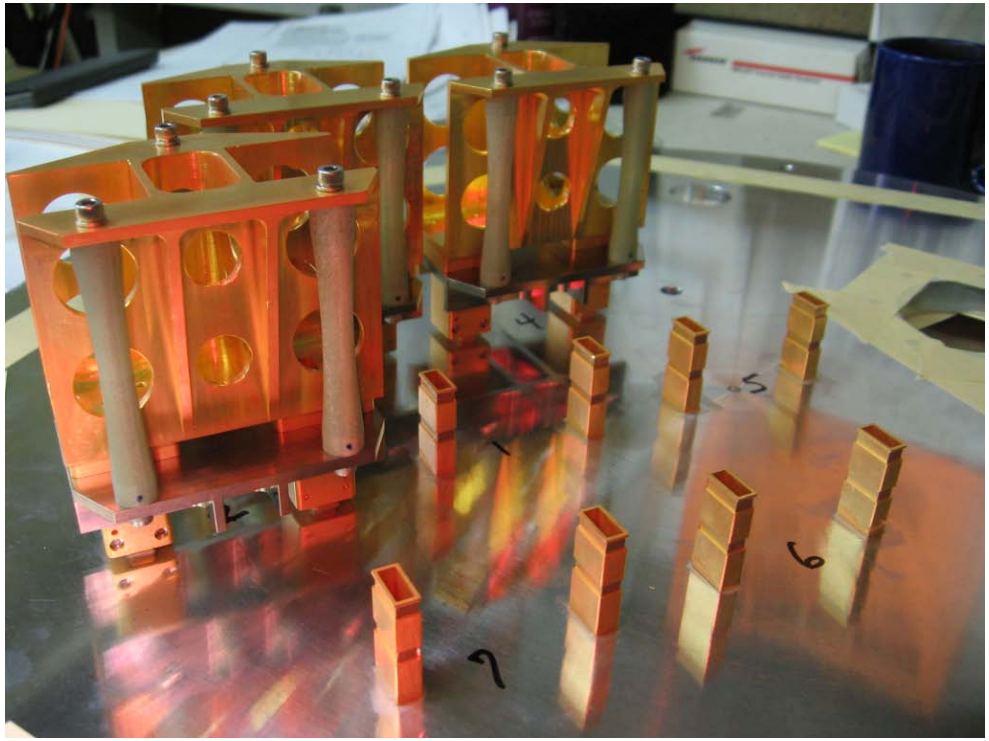
Sliding Waveguide/Thermal Gap Assembly



Thermal Gap and 20 cm SS waveguide: 1.7 Watts 1st Stage Load.
30 cm SS coax: 0.54 Watts 1st Stage Load.
Total: 1st Stage 7.7 W; 2nd Stage 3 W.

Contraction from 300K to 15K is ~ 4.1 mm of total 6.35 mm.

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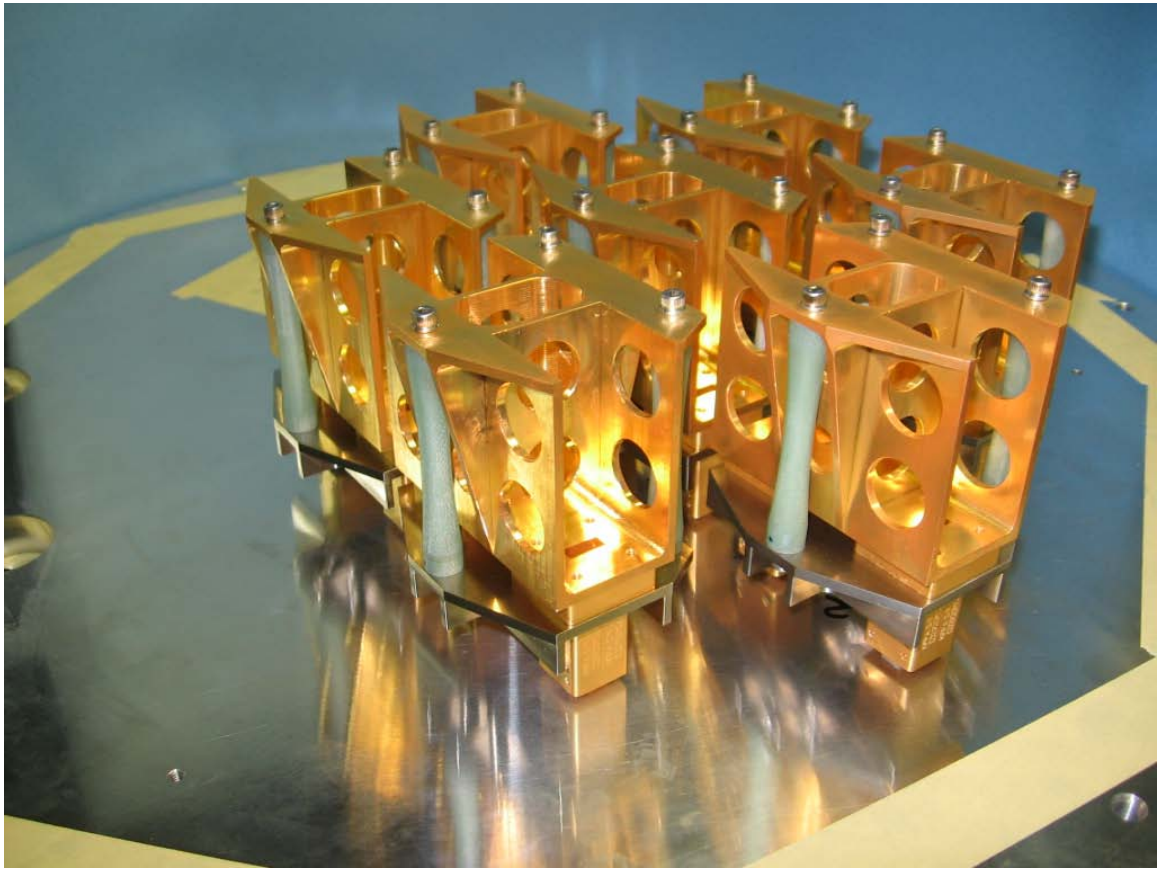


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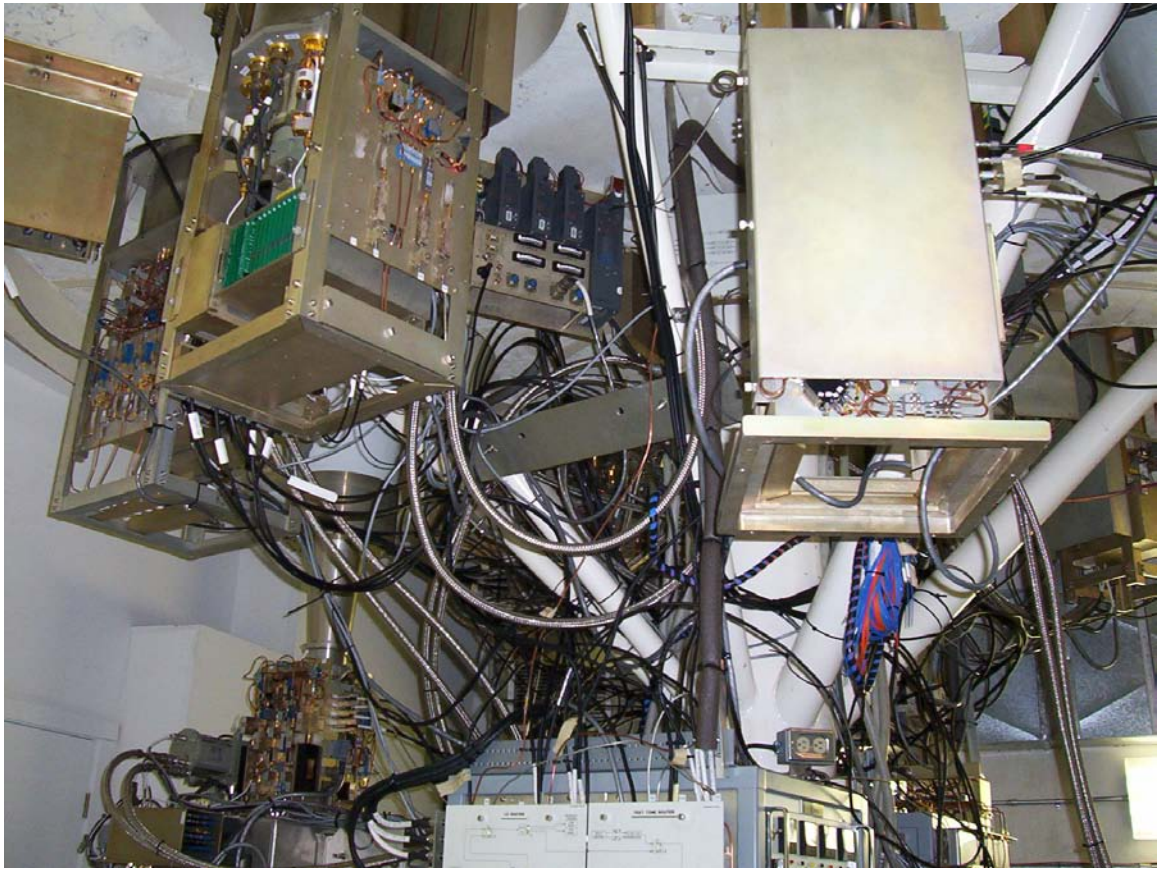
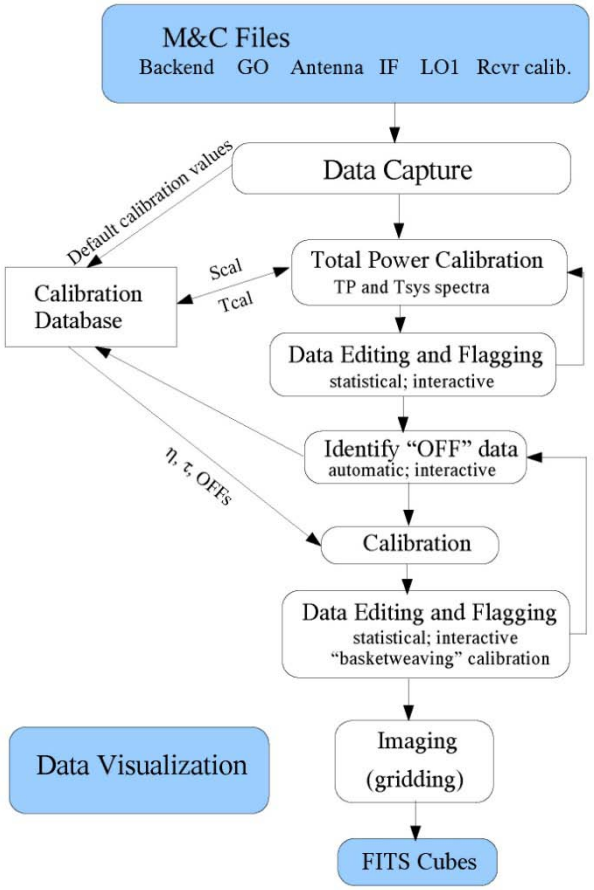
Receiver Turret

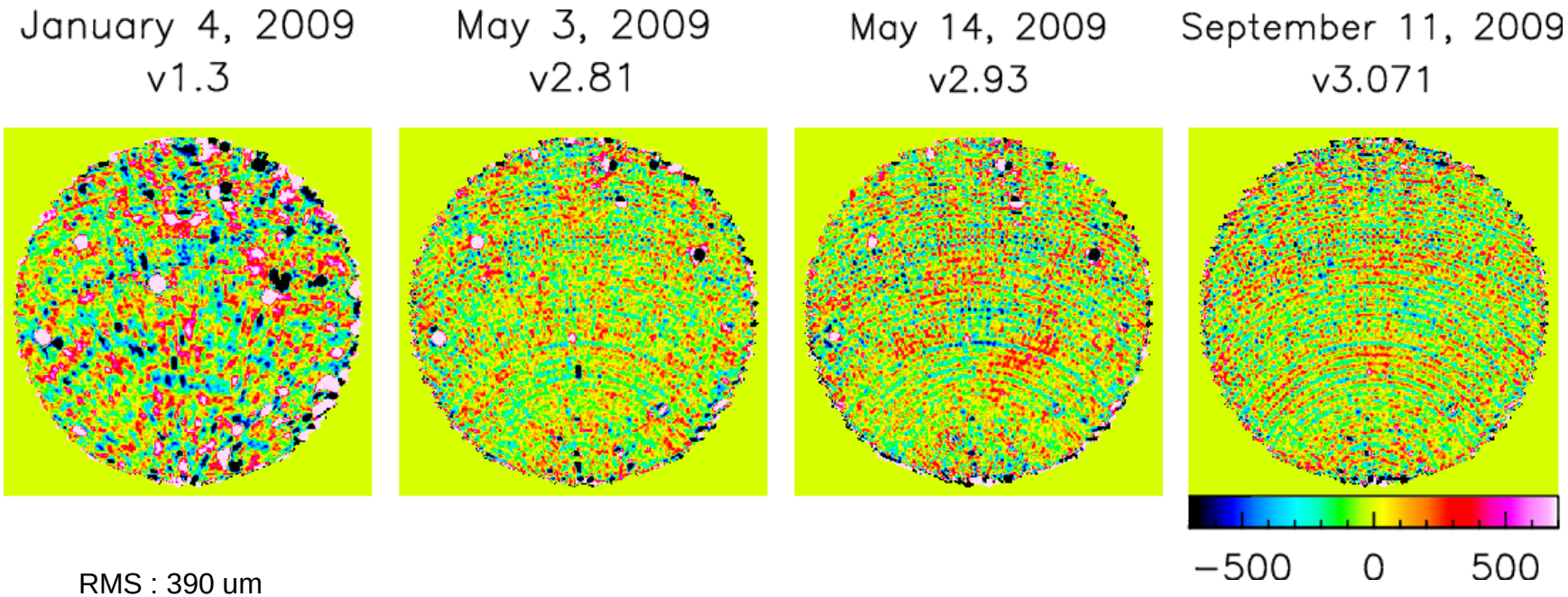


Inside Receiver Room

KFPA Pipeline



Surface Improvements



RMS : 390 um

RMS: ~200 um @ D < 60 m

What's next for the GBT?

- A W band focal plane array (Conceptual Stage for Prototype).
- Science Case is strong and under development (Full Time Scientist).
- Surface has improved to acceptable efficiencies (Very near goal).
- Precision Telescope Control System program is improving the servo system.
- Needs.
  - Digital IF system
  - Backend (CICADA)
  - Funding (Collaborators)

Thank you for your attention.

Questions?