“Traditional” Holography

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GBT PTCS Conceptual Design Review
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Hardware

- **Gregorian “Signal” receiver**
  - Prime focus mount not suitable for holography
  - Combines the errors from primary and secondary
  - Special purpose 12 GHz receiver

- **“Reference” receiver mounted at the tip of the feed horn**
  - Except for gain, a clone of signal receiver
  - Special cables to keep relative phases stable
  - 30-cm diameter feed horn provides sufficient collecting area

- **Special-purpose correlator**
  - Used in 1992 for measuring the OVLBI antenna
What Do We Observe

Ku-Band (12 GHz) Geostationary

HBO

Reference

Signal

45°
How Do We Observe?

Wavelength / D
or
Beamwidth / 2

(1) Point
(2) Focus
(3) Calibration
(4) Do some strips
(5) Calibration
(6) Do some strips
(7) Calibration
(8) etc.

Repeat Point and Focus whenever needed.

Far Field Plane
Map Size

GBT: For 1-m resolution, 
N and M = 100,
beamwidth = 100"
size = 1.5 degrees

Far Field Plane

1.5 degrees
Products

Amplitude Map
- Reflectivity of Antenna
- Feed Amplitude response

Phase Map
- Surface rms
- Feed phase response
- Astigmatism
- Gravitational deformations

Focus/Pointing Fit
- Pointing Offset
- Focus Errors
- Optical Alignments
Experiment to Determine Panel-to-Panel Errors

- 200 µm rms surface accuracy ➤ 50 µm rms measurement accuracy.
- Elevation = 45°
  - Where the best 12 Ghz geostationary satellites are located.
  - Near the rigging angle
- ½ m resolution
  - 200 x 200 pixel, 3° x 3° map
  - About 1 dozen pixels per panel
- Mapping time ~ 4 hours, including overhead
  - 50 msec sampling time (6x oversampling)
  - 3° / min slew rates
Experiment to Determine Large-Scale Errors

- 50 \( \mu \text{m} \) rms measurement accuracy.
- Wide range of elevations
  - Methanol masers (\( \sim 1\text{kJy} \times 15 \text{kHz} \))
  - Same receiver and hardware as for panel setting
- 5m resolution
  - 20 x 20 pixel, 20' x 20' map
  - 7 panels per pixel
- Mapping time \( \sim 30 \text{ min} \)
  - 0.5 sec sampling (6x oversampling)
  - 0.3 deg/min slew rate
What Has Been Tested?

- Correlator – OVLBI Holography experiment in 1992
- M&C Software – 140-ft experiment in 1999
- Analysis Software – Various experiments
- GBT Holography receiver – April 2002
  - Miscellaneous problems including I.F. saturation
  - Sufficient signal-to-noise and long-term phase stability
Next Step...

- When do we start:
  - May 2003

- Map types
  - Panel-to-panel, high resolution maps
  - Some large-scale maps

- Expected Problems
  - Pointing & feed arm sway
  - Temperature changes during a map

- Problem Mitigation
  - Multiple maps to beat down the introduced pointing “noise”
  - Extra overhead to allow time for feed arm to damp out
  - Observe on calm, overcast nights
Saturation
Pointing
Phase Stability