



Considerations of a Planetary Radar System for the GBT

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Outline

- Motivation
 - Why consider this?
- Preliminary Technical Investigations
 - What to design and build?
 - What obstacles are in the way?
 - What do we know as of now?
- Conclusions

Motivation

- Why a Radar transmitter on the GBT?
 - Extra observing time and easier scheduling possible with another Planetary Radar Transmitter to complement Goldstone and Arecibo
 - Good sky coverage and long tracks with the GBT
 - Reaches down to -45 declination
 - Access to 85 % of the sky
 - Excellent surface and receivers give good A_e/T_{sys}
 - Frequency diversity with higher frequency possible than at Goldstone or Arecibo
 - Would require development of new Klystron?
 - No large efficient bistatic partner antennas?

Antenna Specifications and Performance

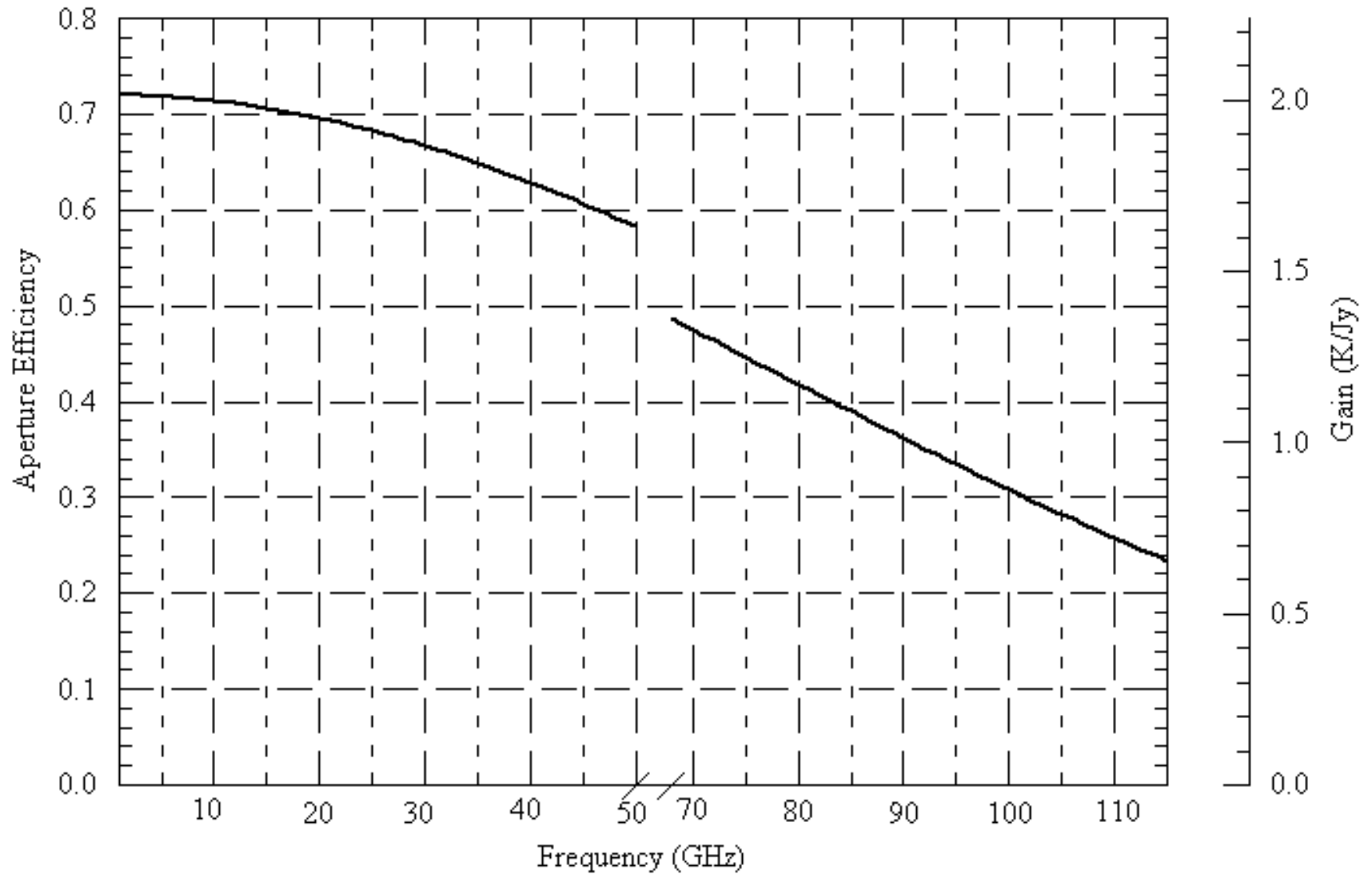
Coordinates	Longitude: 79d 50' 23.406" West (NAD83) Latitude: 38d 25' 59.236" North (NAD83)
Optics	Off-axis feed, Prime and Gregorian foci f/D (prime) = 0.29 (referred to the 208 m parent parabola) f/D (Gregorian) = 1.9 (referred to the 100 m effective aperture)
FWHM beamwidth	$720''/\nu$ [GHz] = $12.4' / \nu$ [GHz]
Declination limits	- 45° to 90°
Elevation Limits	5° to 90°
Slew rates	35° / min azimuth 17° / min elevation
Surface RMS	~ 250 μm; average accuracy of individual panels: 68 μm
Pointing accuracy RMS (rss of both axes)	4" (blind) 2.7" (offset)
Tracking accuracy	~1" over a half-hour (benign night-time conditions)
Field of View	~ 7 beams Prime Focus 100s – 1000s (10' FOV) Gregorian.

GBT Characteristics

High gain, good sensitivity

- 100 meter unblocked aperture
 - 88 dB gain at 30 GHz
 - 83 dB @ 17 GHz
 - 77 dB @ 8.5 GHz
- Good sensitivity at X, Ku, and Ka bands
 - Tsys of ~25K at X and Ku bands
 - Tsys of 30K at 30 GHz
- Active surface:
 - Overall surface accuracy about 240 microns RMS, individual panels ~ 70 microns
 - Good aperture efficiency: X, Ku ~ 70%, Ka ~65%

GBT Aperture Efficiency (R. Maddalena, 2009)

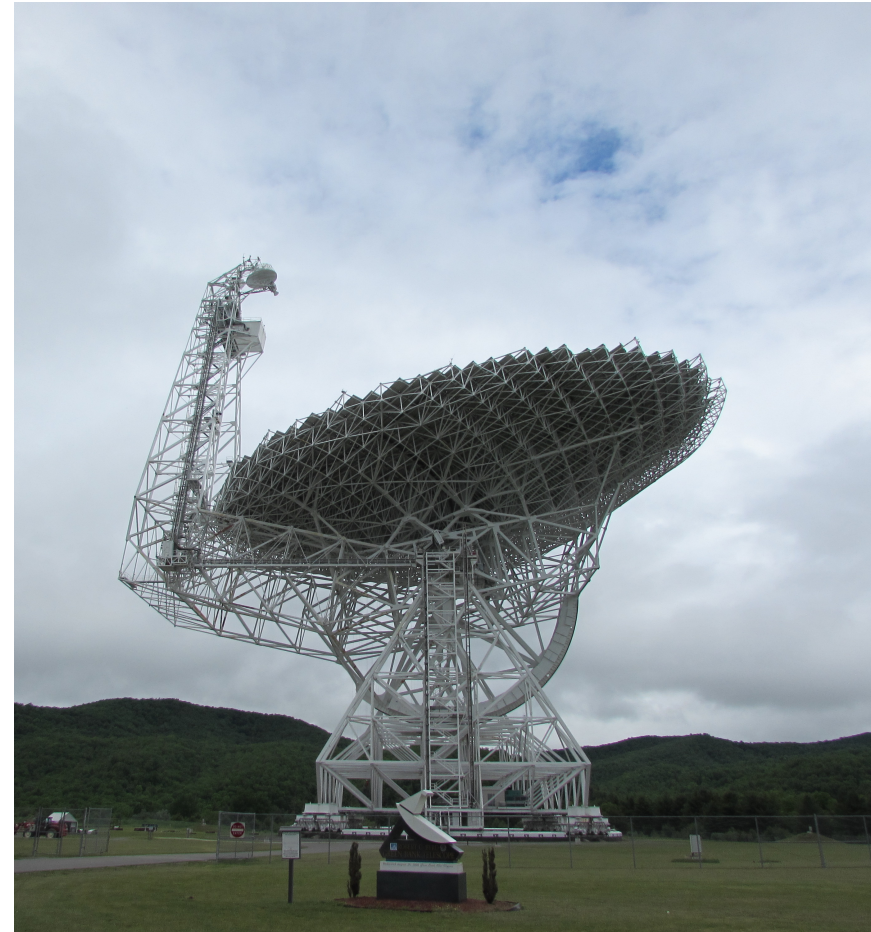


Active Surface



GBT Construction

- Offset paraboloid
 - No center blockage
 - Good access to the focus cabin
 - Self-supporting cantilevered feedarm imposes limits on weight capacity
- Large structure!



Strawman Design Parameters

- Assume X, Ku, or Ka band
 - Transmitter assembly is about the same size and weight (~2 tons)
- Assume 500 and 1000 KW power output for comparison
- Choose modular dry cooling system
- Power supply on the rotating structure

- Given the above, what would the plan be?



Transmitter Assembly Position

- Limited to 2 tons
- Near feed to reduce waveguide losses
- Needs environmentally controlled space
- Accessible for maintenance

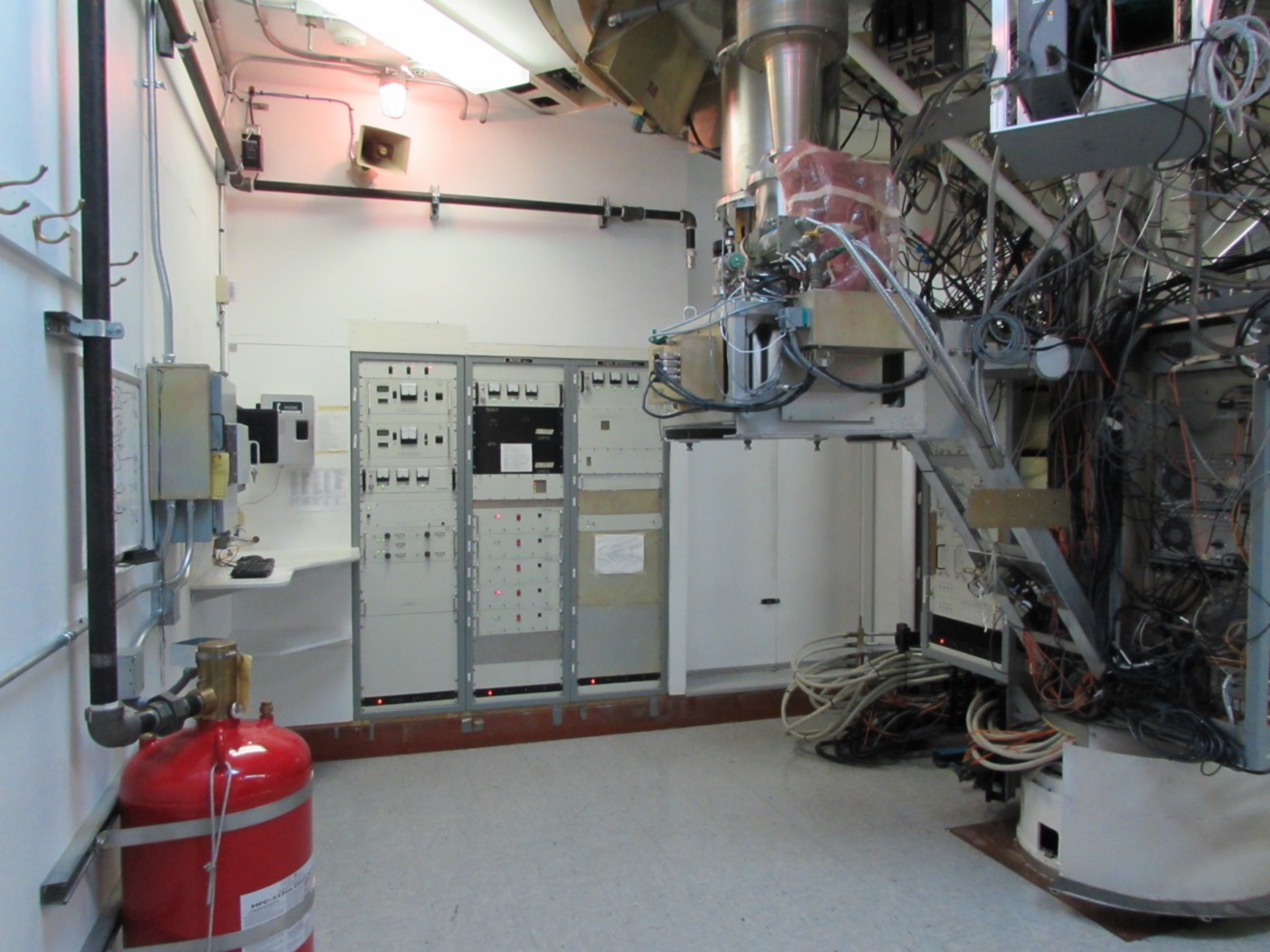
















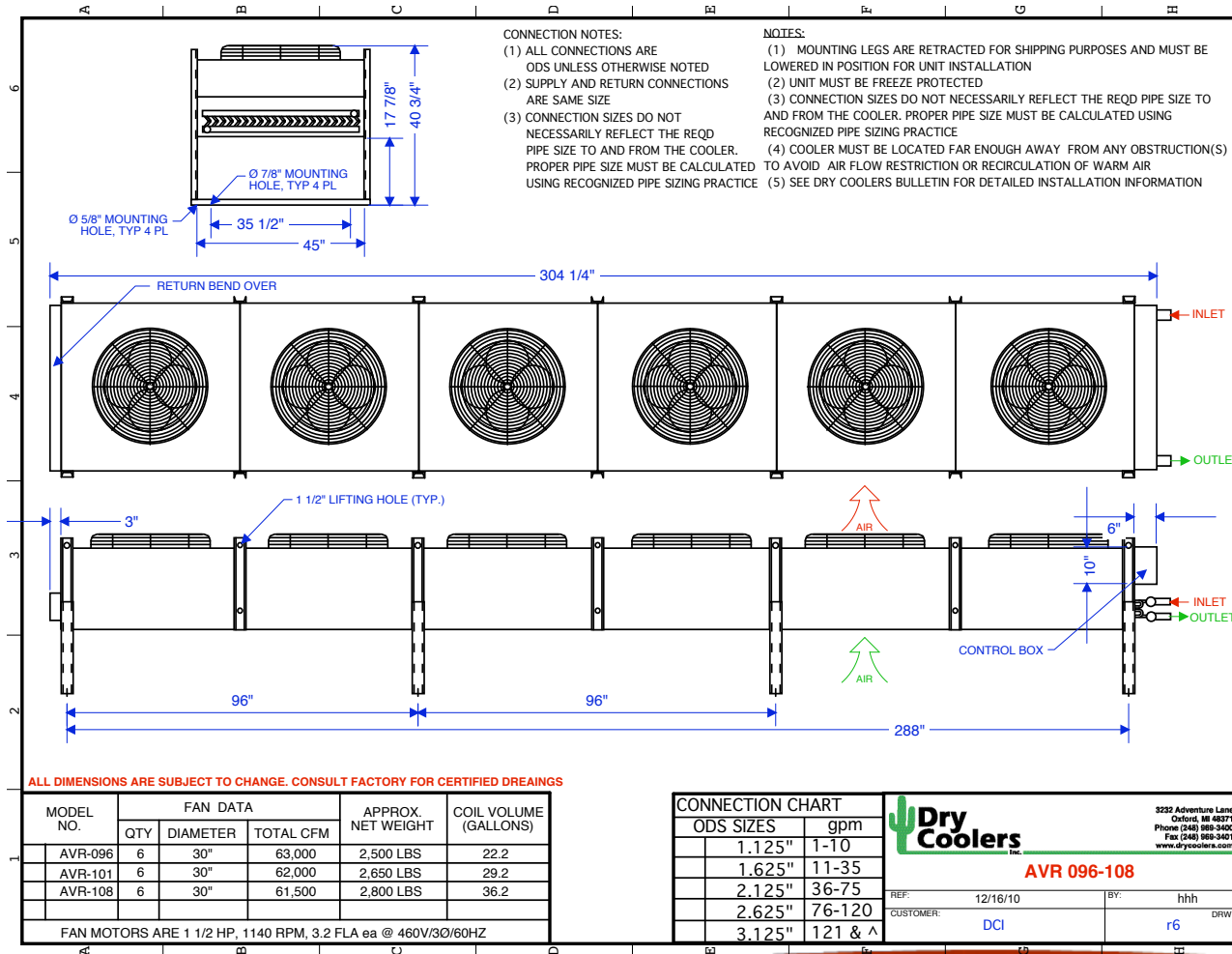




Cooling System

Sized for 500 KW system, provides 1.34 MW dissipation

- 2 units
- 185 GPM each
- 62C inlet temp
- 47C outlet temp
- 85 deg ambient
- Place near transmitter for efficiency?



Cooling System

Pump, controls and reservoir
(2 each)







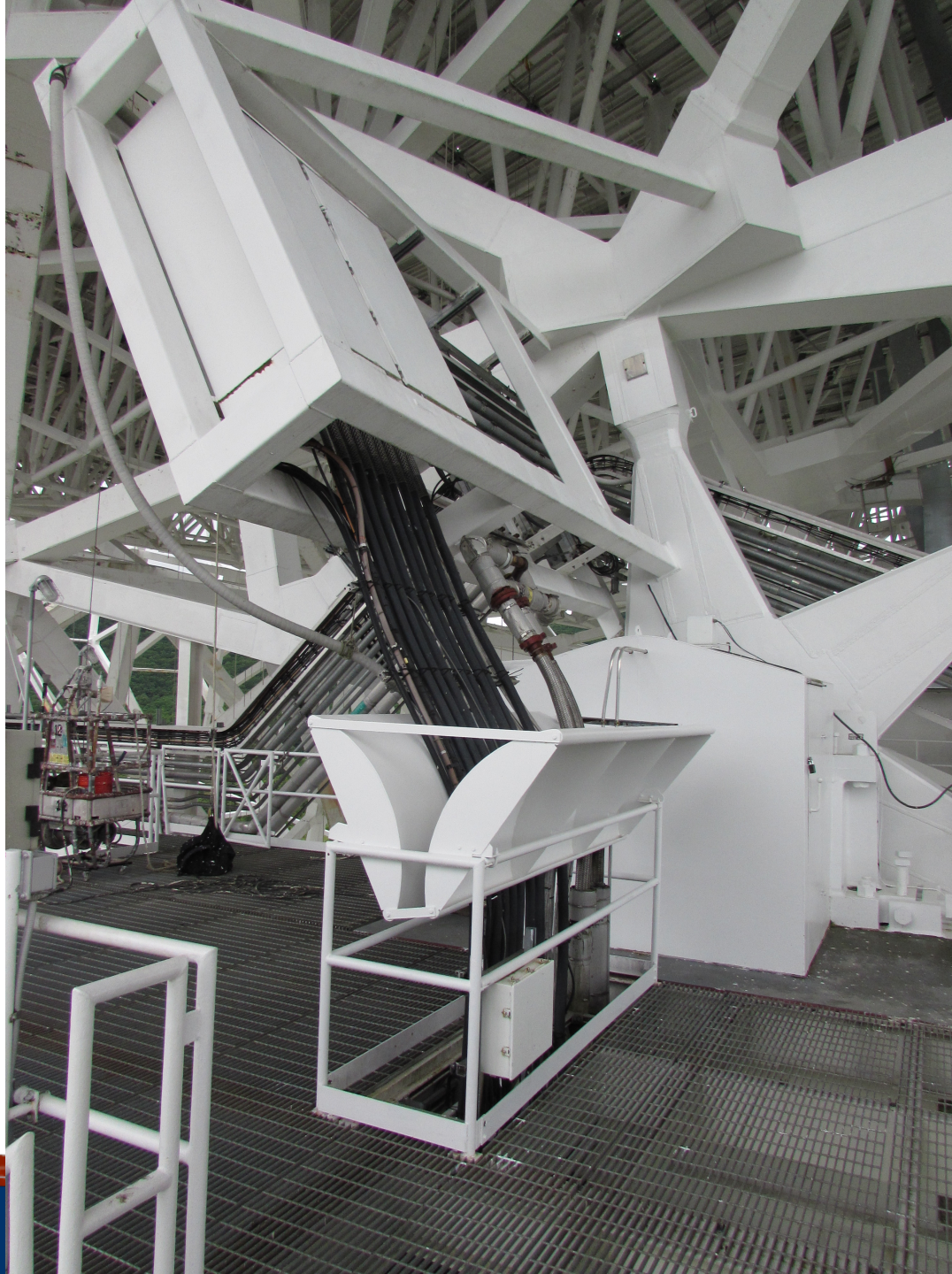


Power supply

- Placed on Alidade platform in new room
 - Solid state power supply (no crowbar needed)
 - One wrap to go around < 90 degrees
 - New 4160V feed from substation
 - New power feed from Commercial power line









Conclusions

- A 500 KW X band system is feasible
- A 1 MW X band system is probably feasible
- A large Ku or Ka band system is feasible, but no Klystrons exist. Large (MW!) 95 GHz Gyrotrons exist, however, so it is possible to build them.
- From the discussions yesterday, a high-frequency radar is probably desired by most users, to diversify and complement existing radar system capability



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