Focal Plane Arrays, Data Transmission, Pulsars, and Spectral Line Backends

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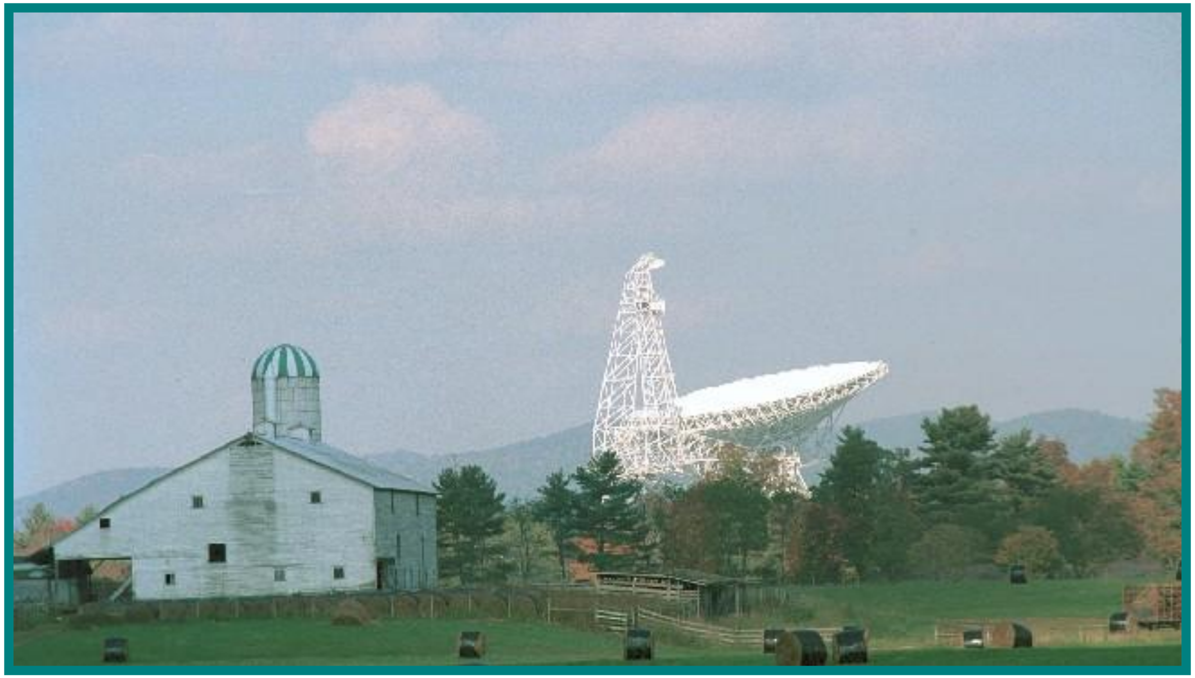

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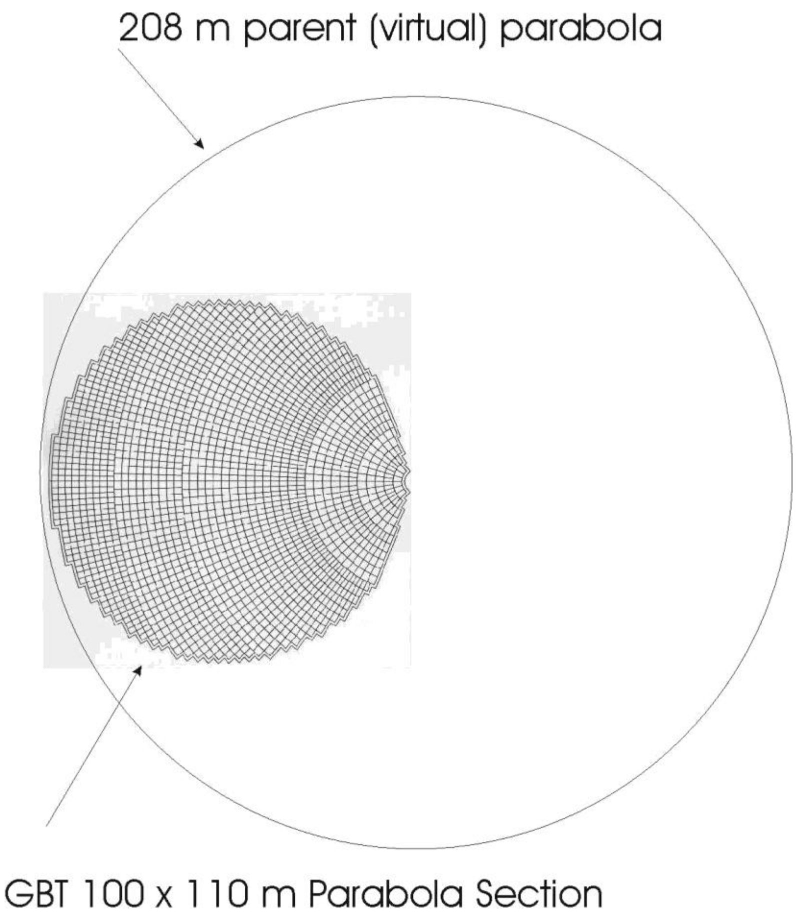
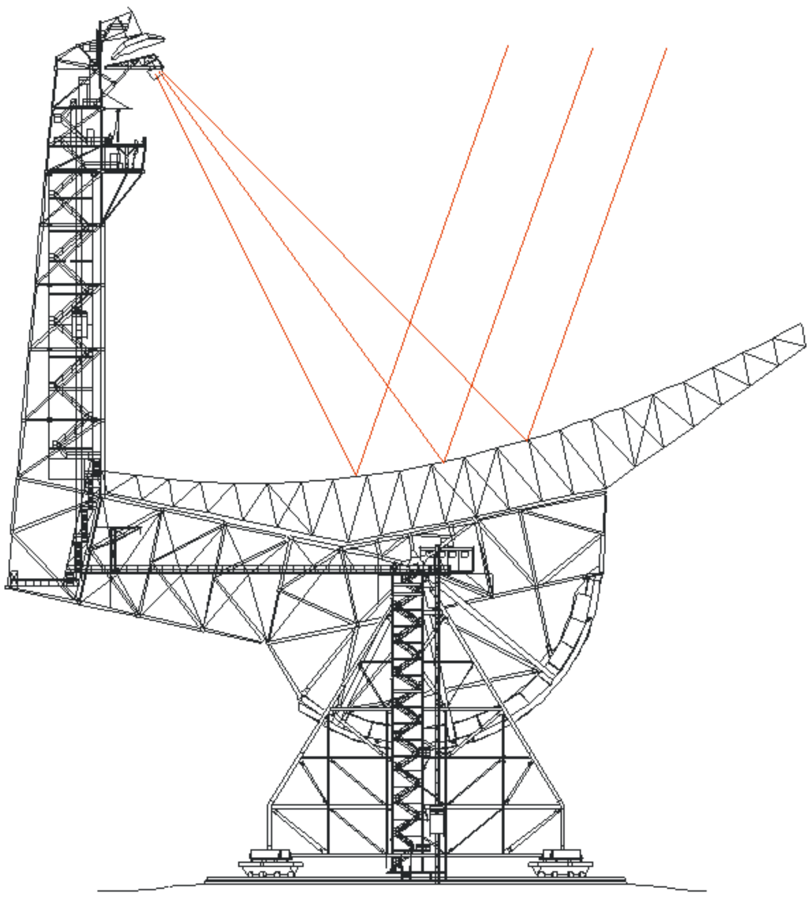
GBT Design

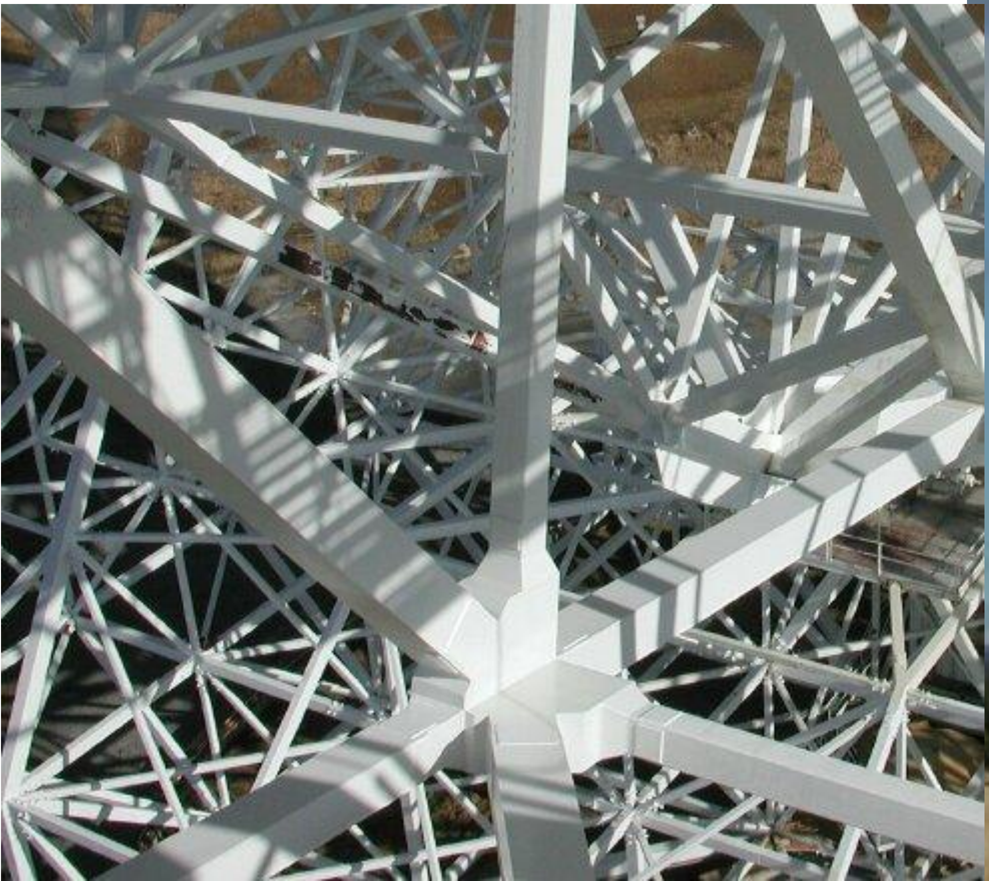
- 100 x 110 m section of a parent parabola 208 m in diameter
- Cantilevered feed arm is at focus of the parent parabola



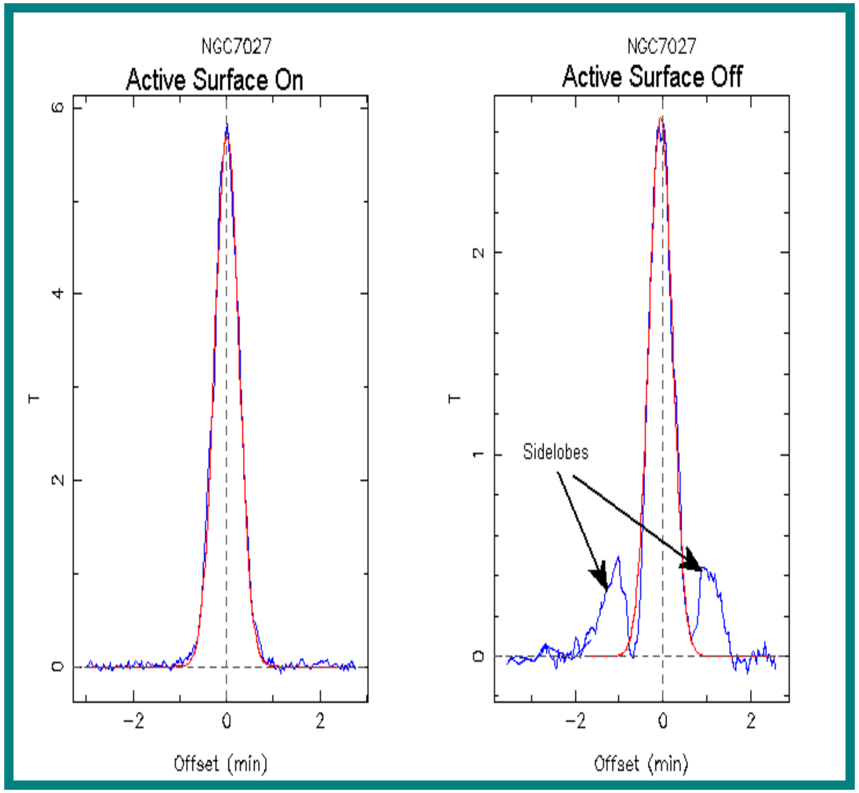


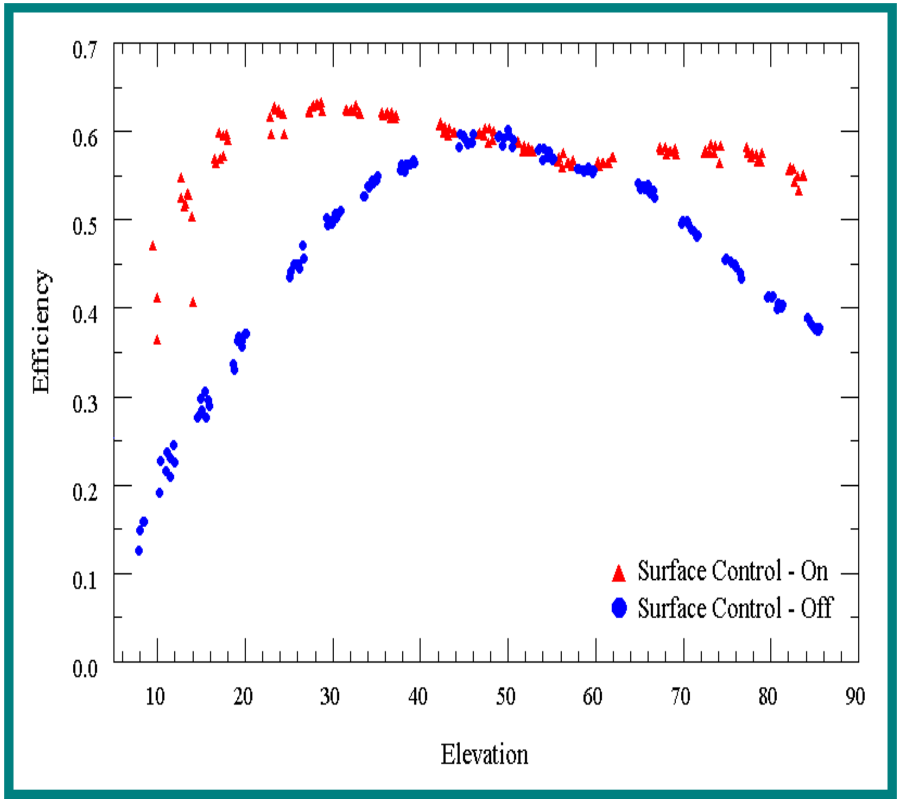
GBT Structure

- *Welded, Optimized Structure*
- *Homologous design*
- *Active surface*



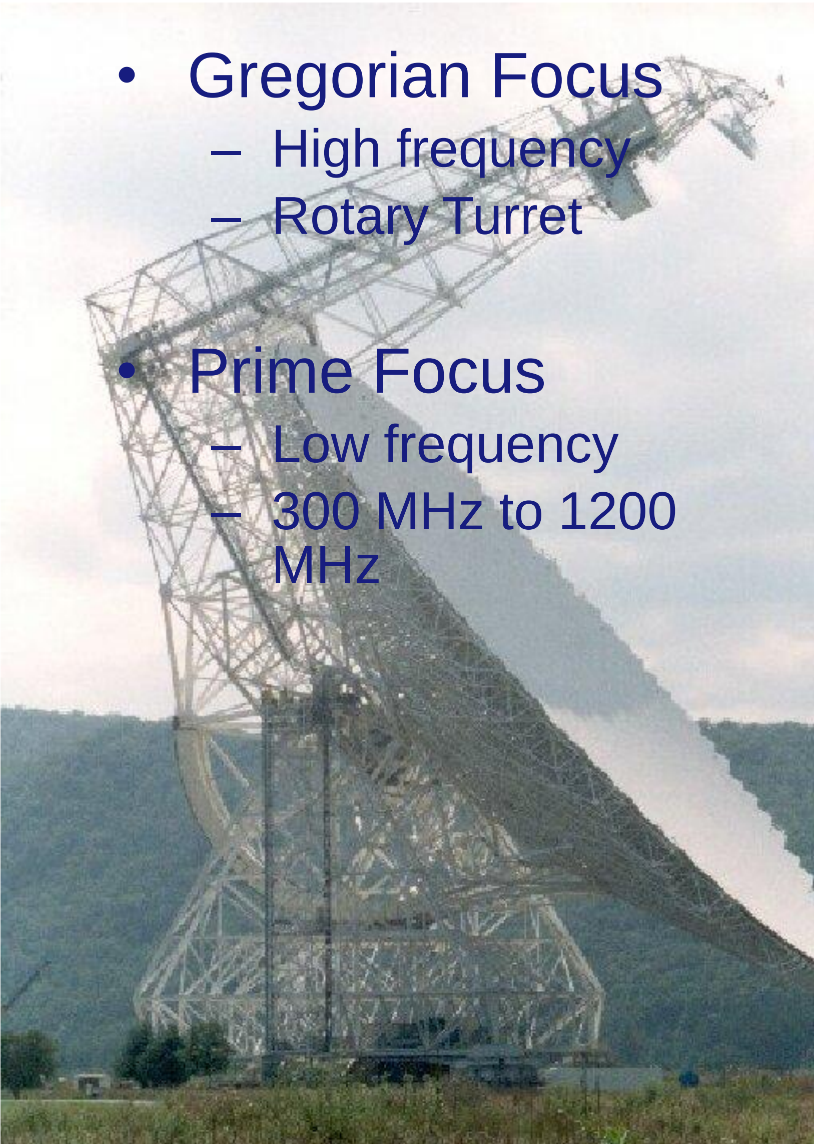
Active surface performance at 20 GHz





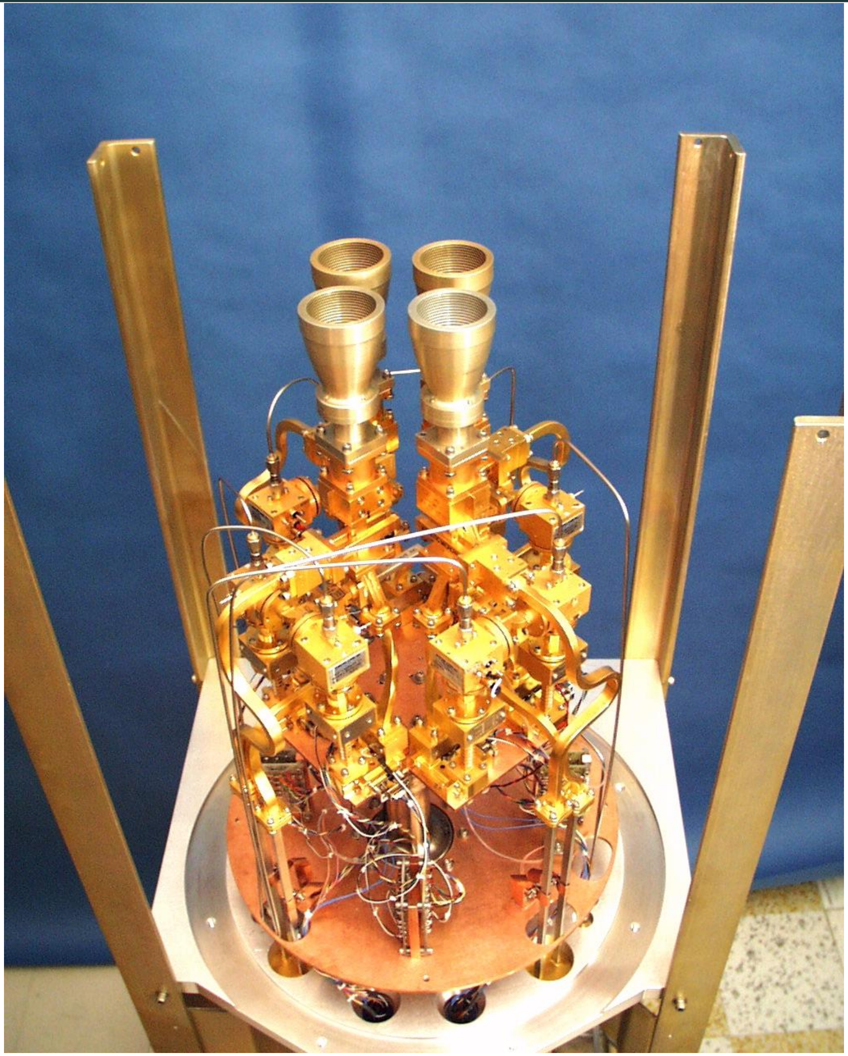
Receivers

- Gregorian Focus
  - High frequency
  - Rotary Turret
- Prime Focus
  - Low frequency
  - 300 MHz to 1200 MHz



GBT Turret Top

Q-band Receiver



Raw Data Transmission Bit Rates

Data Rate, GB/S	IF's	Pols	Bits / samp	BW, GHz	Data Rate, Gb/S	# links @ 10 Gb/S	# links 100 Gb/S	Equiv. EVLA's
800	100	1	4	8	6400	640	64	2.47
1600	***100***	***2***	***4***	***8***	***12800***	***1280***	***128***	***4.94***
1600	100	1	8	8	12800	1280	128	4.94
3200	100	2	8	8	25600	2560	256	9.88
400	100	1	2	8	3200	320	32	1.23
800	100	2	2	8	6400	640	64	2.47
112	***7***	***2***	***4***	***8***	***896***	***89.6***	***8.96***	***0.35***
28	***7***	***2***	***4***	***2***	***224***	***22.4***	***2.24***	***0.09***

Spectrometers

- Output data rate is proportional to:
  - # spectral channels
  - # IF's
  - # switching signal bins
  - # bits of precision kept
  - Inversely proportional to accumulation time

Output Date Rate Examples

Output Data Rate, GB/S	IF's	Pols	Bits	Total Channels/ IF	Bins	Tint	Cross Terms ?	Equiv GBT Spectro-meters
1.31	100	2	32	16384	1	0.01	0	156.25
2.62	100	2	32	16384	2	0.01	0	312.5
5.24	100	2	32	16384	4	0.01	0	625
2.62	100	2	32	16384	1	0.01	1	312.5
5.24	100	2	32	16384	2	0.01	1	625
10.49	100	2	32	16384	4	0.01	1	1250

Existing GBT Spectrometer Data Rate

0.000262	8	1	32	2048	4	1	0	800 MHz
0.008389	16	1	32	16384	4	1	1	50 MHz

Pulsars

- *Pulsar Search*
  - *Up to 200 MB/s data rate*
  - *Raw time series spectra recorded*
  - *Search is done off-line*
    - *Parameter search over DM, period.*
    - *Acceleration searches for binary pulsars*
    - *~2 days to search 2 minutes of data on one core*
  - *Requires lots of storage for the data.*
- *Pulsar Timing*
  - *Coherent dedispersion for best timing residuals*
  - *Requires real-time fast convolution over ~128 channels at 1.6 GS/s.*
  - *Almost 100% data reduction. Output data is folded and combined.*
  - *Using GPU's to run the fast convolutions*

Spectral line pipeline

- Pleasingly parallel for most steps
  - data from each sampler(beam/feed/polarization) is treated independently. So long as one processor can keep up with the data from one sampler, just buy enough processors to keep up with the data rate. Divide and conquer.
- Except when it isn't
  - Statistical flagging might involve comparisons between multiple samplers.
  - The same (or nearly the same) region on the sky will often be sampled by more than one sampler. That should be used to improve the relative calibration of all of the samplers (multi-feed equivalent to basketweaving).
- The sooner you can reduce the data volume, the easier it is to keep up with the data rates. It's important in each science use case to make it clear when it's OK to smooth, average, etc to reduce the data volume.

Data archiving

- What gets archived?
  - How do we tell what's good data and what can be tossed (data quality measures)?
  - How far down the pipeline can the data be automatically processed before you need to archive it (how much data reduction can be done)?
  - Keep raw data local for some period, archive for the long term some processed data (at perhaps several steps in the pipeline). How long would the raw data need to be kept around (size of local archive)?