The Green Bank Array's Contribution To Very Long Baseline Interferometry

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Green Bank Observatory

What Is The Green Bank Array?

The Green Bank Array is a concept for a versatile instrument that will be used for:

- VLBI observations (VLBA, High Sensitivity Array, Global Millimeter VLBI Array, etc.)
- Pulsar timing for gravitational wave detection
- Fast Radio Burst searches and follow-up observations
- Transient searches and follow-up observations
- Co-observation transient searches with other observatories (LSST, CHIME, etc.)
- Radar and other remote sensing observations

Array Design

The Green Bank Observatory has readily available infrastructure (power, optical fiber, machine shop, electronics shop, etc.)

The GBA would use the ngVLA antenna design (this saves on design costs and allows the GBA cost to be scaled from ngVLA costs). The array would cover 1.1-115 GHz.

Antennae would be located within 1 km of GBT (2 km maximum baseline).

Shadowing of GBA antennas is avoided for all antennae located more than 300 m from the GBT for observations above 30 degrees elevation.

The science requirements for the timing of pulsars requires the GBA to consist of at least 10 antennae.

Comments Welcome

We are interested in identifying new science cases and improving current science cases for the Green Bank Array. If you have any suggestions for projects, requirements, etc, for the GBA then please contact any of the Green Bank Observatory staff.

Also please see our iPoster (number 170.05) titled “The Green Bank Array - An Overview “ in the “Instrumentation: Ground Based or Airborne” session.

Sensitivity of the GBA

Table 1 shows the sensitivity and mapping speed of the GBA.

Frequency (GHz)	Point Source RMS [μJy/beam/minute]	Spectral Line RMS [μJy/beam/minute in 10 km/s]	Mapping Speed (deg² to 0.25 mJy RMS)
2	106	20	37
6.6	61	12	10
15.9	56	7	2
26.4	57	7	0.7
39.2	78	10	0.17
90.1	200	16	0.0046

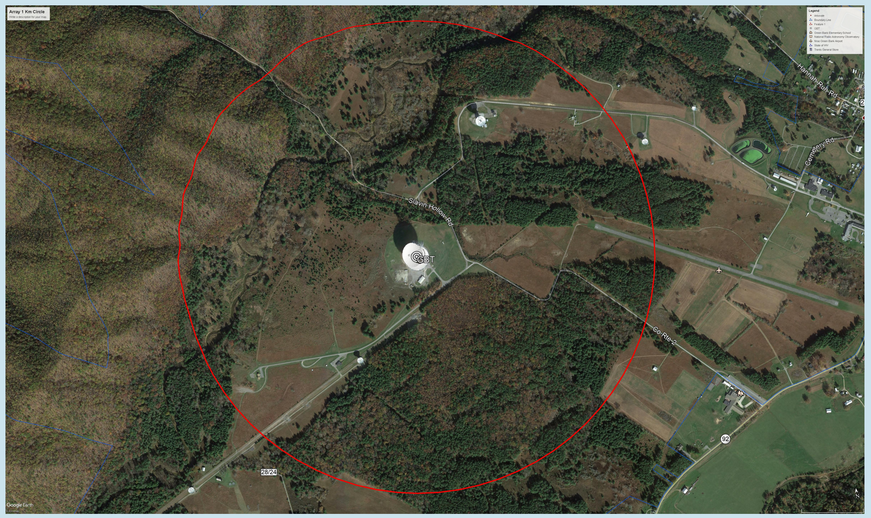
Table 1 Green Bank Array sensitivity and mapping speed.

The system equivalent flux density (SEFD) of the GBA would be 64 Jy at 2 GHz and 456 Jy at 90.1 GHz.

The GBT can be used as an element in a larger interferometer (GBA+GBT) for enhanced sensitivity.

The GBA+GBT would have an SEFD of 83.5 Jy at 90.1 GHz. For comparison, the current SEFD for the LMT is 857.1 Jy and the GBA+GBT SEFD would be comparable with the ALMA SEFD of 68.2 Jy.

A sub-array of the GBA could be used to make frequent phase referencing observations.



A 1 km radius around the GBT is shown above. The image is oriented such that north is up and east is right. Everything east of Deer Creek (roughly flowing from the upper center to the lower left corner of the image) is fairly level. Terrain west of Deer Creek is mountainous. Power and optical fiber is easily accessible east of Deer Creek.

A detailed study of antenna locations is currently being performed.

Global Millimeter VLBI Array (GMVA) Sensitivity with GBA

Future 3mm Very Long Baseline Interferometry (VLBI) observations will be dominated by the GBA+GBT, ALMA and the ngVLA.

	GBA+GBT	LMT	VLBA BR	VLBA FD	VLBA KP	VLBA LA	VLBA MK	VLBA NL	VLBA OV	VLBA PT	ngVLA
ALMA50	4	11	21.6	22.5	22.4	20	27.2	28.8	21.9	17.9	2.2
GBA+GBT		14.3	28.1	29.1	29	26	35.2	37.3	28.4	23.1	2.9
LMT			76.7	79.6	79.4	71	96.4	102.1	77.8	63.3	7.82
VLBA_BR				157	156.6	140.1	190.1	201.4	153.4	124.9	15.4
VLBA_FD					162.5	145.3	197.3	209	159.2	129.6	16.0
VLBA_KP						145	196.8	208.5	158.8	129.3	16.0
VLBA_LA							176	186.5	142	115.6	14.3
VLBA_MK								253.1	192.8	157	19.4
VLBA_NL									204.3	166.3	20.6
VLBA_OV										126.7	15.7
VLBA_PT											12.7

Table 2 shows the 7σ sensitivity of each baseline in mJy/beam for a 10 second integration.

The GMVA array sensitivity (7σ) for current North American observatories is currently 5.87 mJy/beam in 10 seconds.

With the addition of the ngVLA and GBA the GMVA array sensitivity (7σ) would be reduced to 1.44 mJy/beam in 10 seconds.

This provides a spectral line sensitivity of 0.18 K / km/s in 10 seconds for structures that fill the synthesized beam. The ALMA to GBA+GBT baseline would provide a resolution of 89 μ arcseconds.

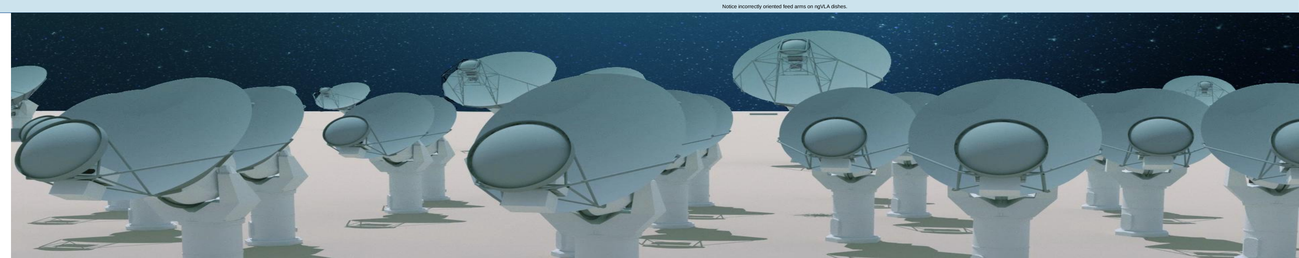
GMVA Science with the GBA

With a resolution of 89 μ arcseconds the North American observatories participating in GMVA observations would allow for any Jupiter sized planet to be resolved out to a distance of 5.2 pc. The 0.18 K/ km/s in 10 seconds sensitivity would allow for spectral line studies of any Jupiter sized planets nearby the Sun.

At the same resolution, a solar radius is resolved out to a distance of 50 pc. This would allow the study of stellar surfaces and dynamics for nearby stars.

This resolution allows structures that are an AU in size to be resolved out to a distance of 11 kpc. This would allow a significant number of stellar/planetary formation disks in the star forming regions of the Milky Way to be studied with unprecedented resolution.

Notice incorrectly oriented feed arms on ngVLA dishes.



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