



ngVLA Project Update

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David Halstead – NRAO Head of IT

South American-African Astronomy
Coordination Committee, 08/2023



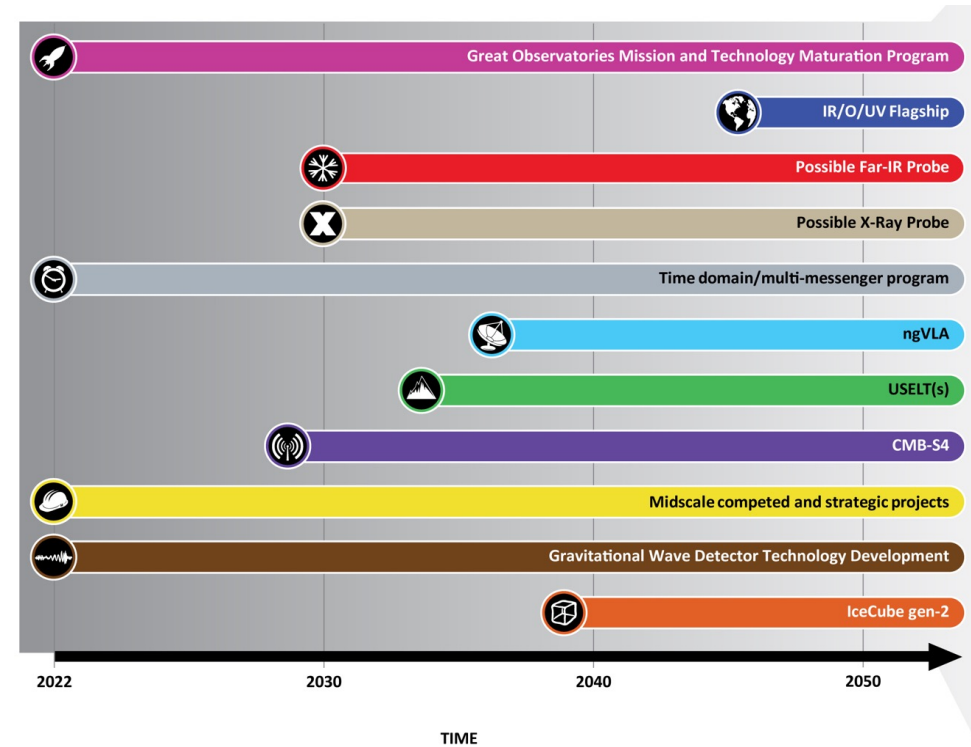
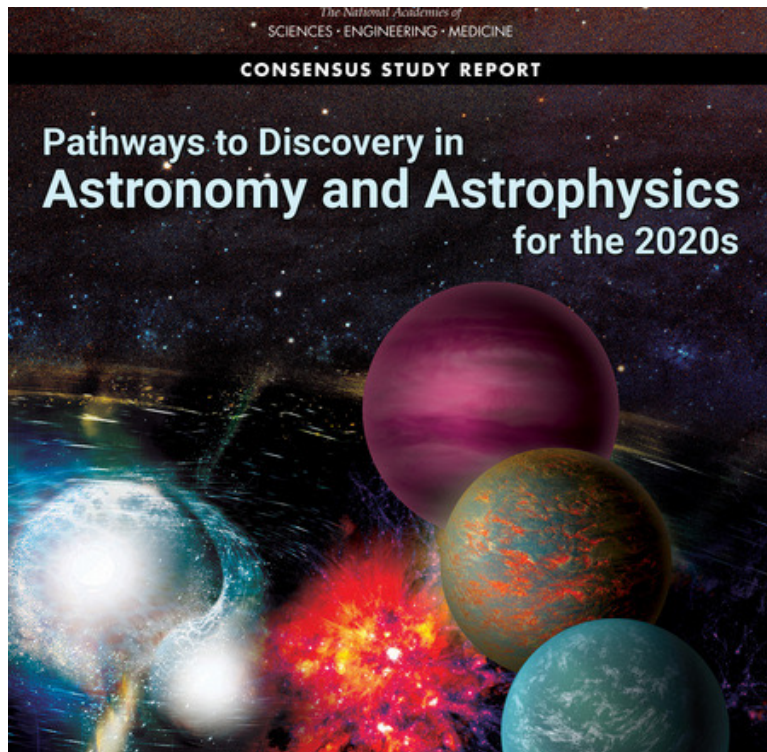


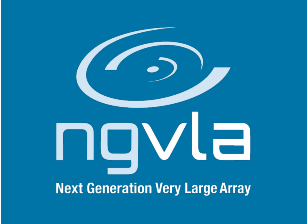
A next generation VLA

- Scientific Frontier: thermal imaging at milli-arcsecond resolution
 - 10x Sensitivity, 10-100x Resolution of VLA
 - Frequency range: 1.2-116 GHz
- Bridge SKA – ALMA
- Proposal driven, pointed telescope
 - Deep single fields, small area mapping.
- Centered on present location of VLA in Southwest USA
- Under evaluation as part of the Astro2020 Decadal Survey.



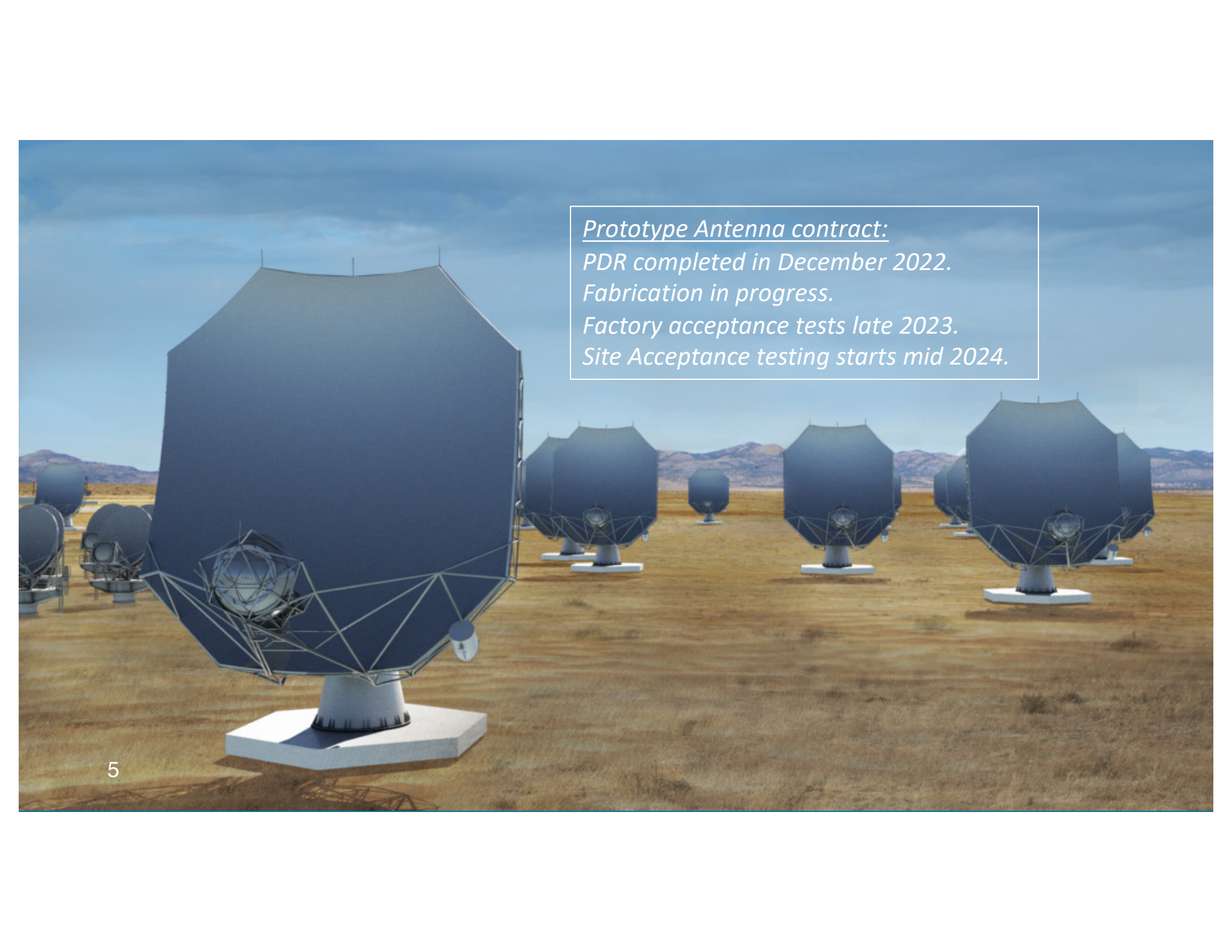
Astro2020 identified the ngVLA as a high-priority large, ground-based facility whose construction should start this decade.





Vancouver, British Columbia, Canada
May 2023



A photograph showing a large array of satellite antennas in a field. The antennas are large, dark, and mounted on white bases. They are arranged in a grid pattern across a dry, brown field. In the background, there are mountains under a blue sky with some clouds. The antennas in the foreground are more detailed, showing a complex metal structure supporting the dish. The overall scene is a wide, open landscape.

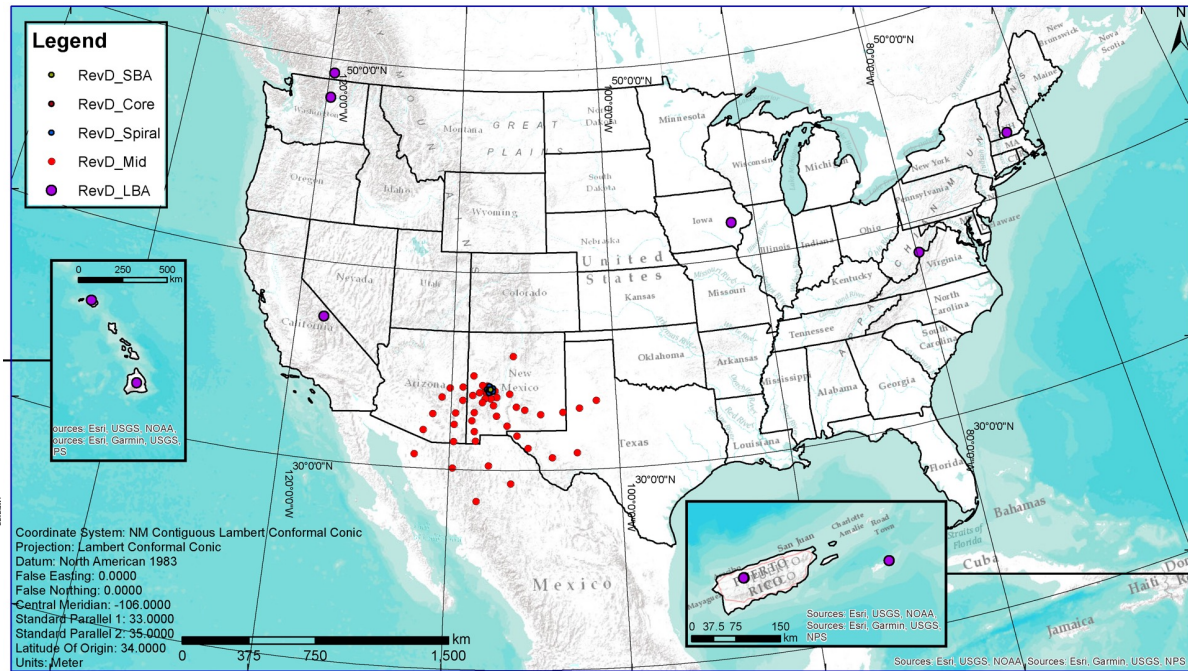
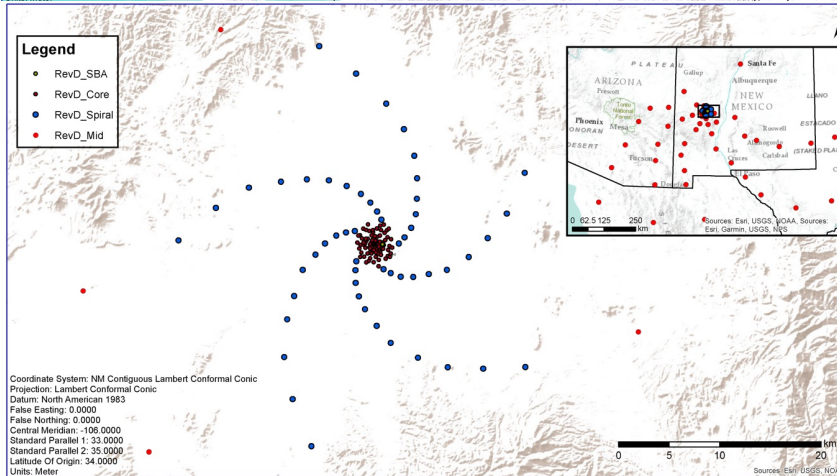
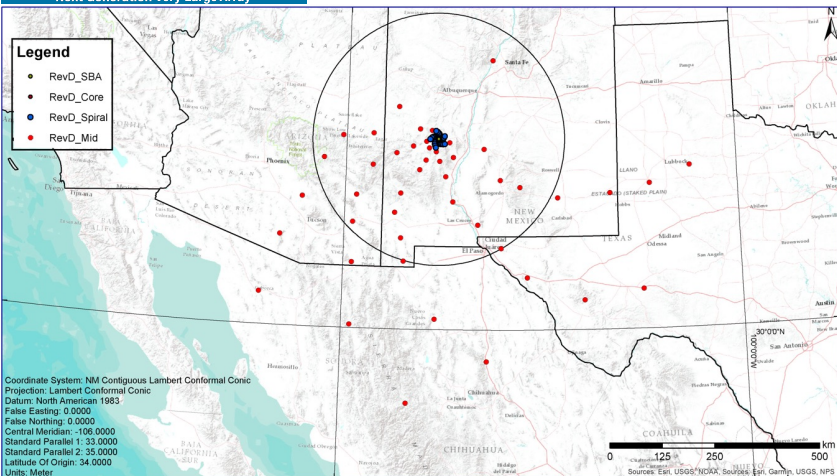
Prototype Antenna contract:
PDR completed in December 2022.
Fabrication in progress.
Factory acceptance tests late 2023.
Site Acceptance testing starts mid 2024.



- **1.2 - 116 GHz** Frequency Coverage
- **Main Array:** 214 x 18m offset Gregorian Antennas
 - Fixed antenna locations across NM, TX, AZ, MX.
- **Short Baseline Array:** 19 x 6m offset Greg. Antenna
 - Use 4 x 18m in TP mode to fill in (u, v) hole
- **Long Baseline Array:** 30 x 18m antennas located across continent for baselines up to 8860km

Band #	Dewar	f_L GHz	f_M GHz	f_H GHz	$f_H: f_L$	BW GHz
1	A	1.2	2.35	3.5	2.91	2.3
2	B	3.5	7.90	12.3	3.51	8.8
3	B	12.3	16.4	20.5	1.67	8.2
4	B	20.5	27.3	34.0	1.66	13.5
5	B	30.5	40.5	50.5	1.66	20.0
6	B	70.0	93.0	116	1.66	46.0

Distribution of Antennas



Long Baseline Antenna Locations

Qty	Location	Notes	Qty	Location	Notes
3	Puerto Rico	Arecibo Site	3	Green Bank, WV	GBO
3	St. Croix	VLBA Site	3	Brewster, WA	VLBA Site
3	Kauai, HI	Kokee Park Obs.	3	Penticton, BC	DRAO
3	Hawaii, HI	Not MK Site	3	North Liberty, IA	VLBA site
3	Hancock, NH	VLBA Site	3	Owens Valley, CA	VLBA site

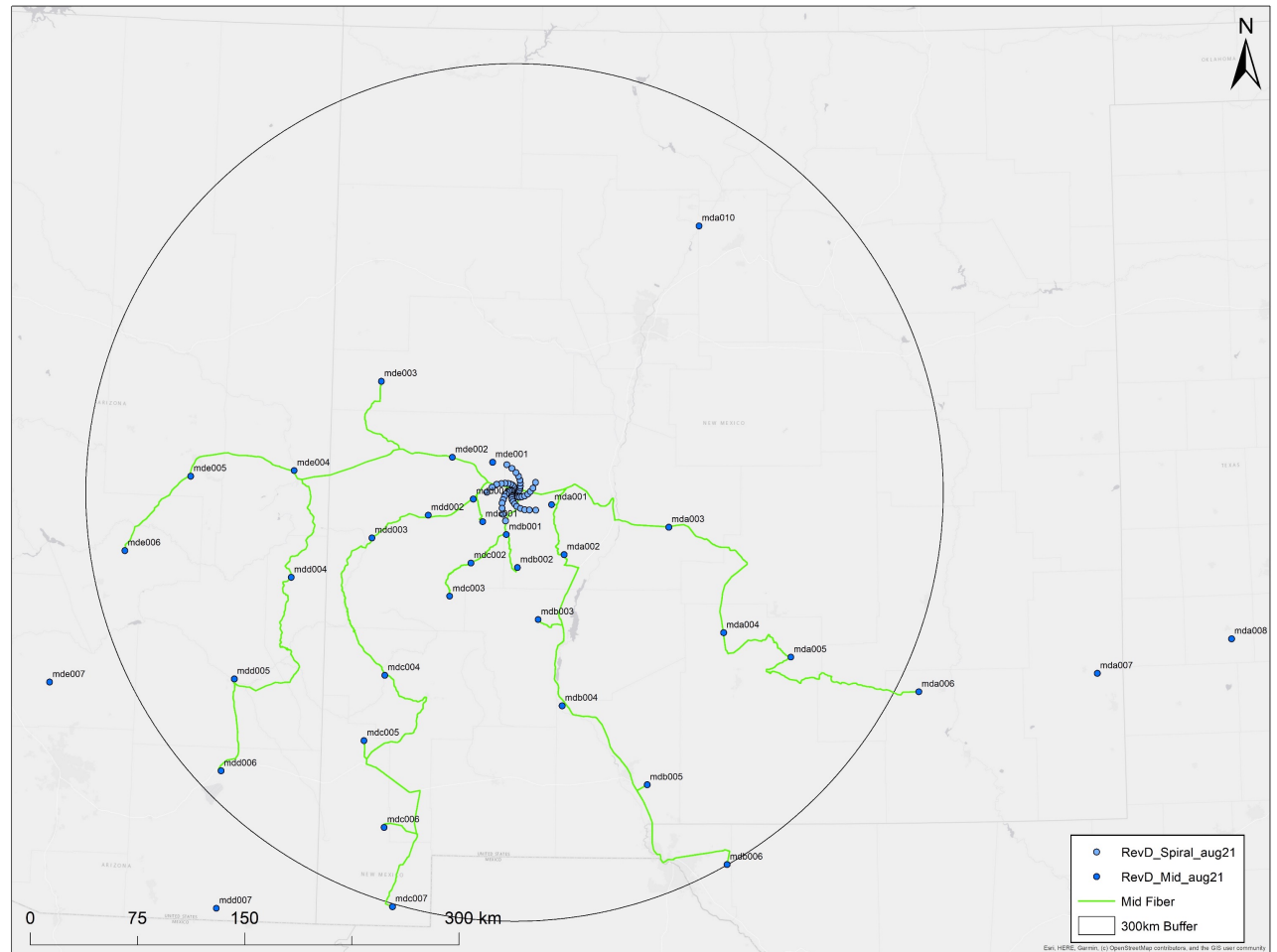


Antenna Data Rates

- Real-time correlation of all 244 18m array elements.
- Up to 20 GHz of instantaneous bandwidth per polarization.
- 8-bit digitization at all bands.
- 723 Gbps per antenna, over 8x100 / 2x400 Gbps links on ngVLA installed fiber.
- Requantized and formatted for data transmission on packet-switched networks
- ~3 antenna LBA sites = ~1 Tbps link (goal, TBC)

Main Array Fiber Optic Network

- Dedicated point-to-point fiber links for ~196 antennas in NM within ~300 km radius of core.
- ISP connected elements beyond inner stations.
- ISP connections to LBA sites.
- Leased fiber vs spectrum vs bandwidth (TBD)



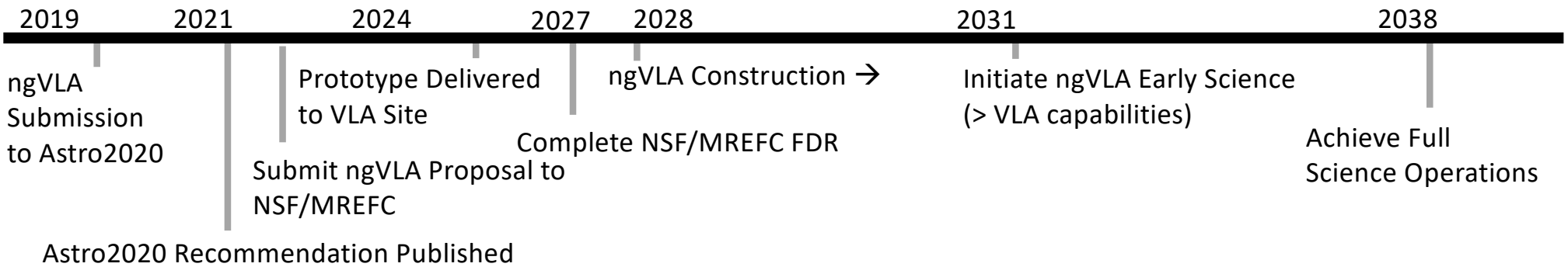
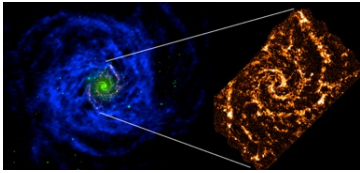
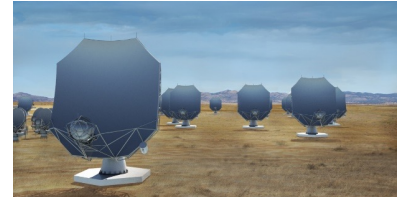
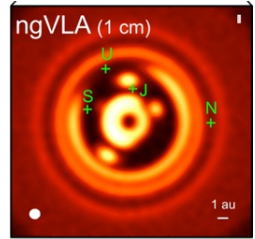
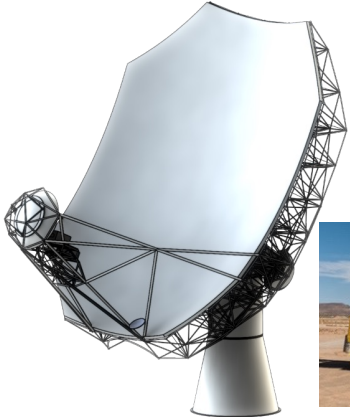
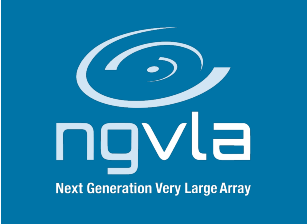
Data Processing

- **Post Processing:** storing the raw visibilities will be possible.
 - Data processing is post-facto, with system sized for average throughput.
 - Data Rates:
 - Average – 8 GB/s.
 - Peak - 128 GB/s.
- **Computing:** Challenging, but feasible with current technology.
 - Sized by time resolution, spectral resolution, and multi-faceting in imaging.
 - ~60 PFLOPS/s (inc. efficiency factors) matches average data throughput.

Serving Data to Users

- “Science Ready Data Products” Operations Model
- Process-in-place for data to most PIs.
- Data products requested in proposal; Pipeline interaction possible.
- Low-level data products (visibilities, flagging tables)
- High-level data products for Standard Observing Modes (e.g, calibrated image cubes)
- Archive reprocessing interface for users.
- Data Reduction S/W; Data Analysis S/W
- Distributed archive and re-processing capacity amongst international partners? (ALMA-like model)

Project Timeline





ngvla

Next Generation Very Large Array