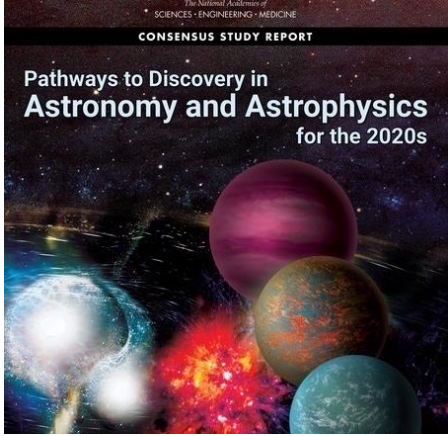
ngVLA Project Update

Eric J. Murphy – Project Scientist

ngVLA.nrao.edu

Big Picture - Overview



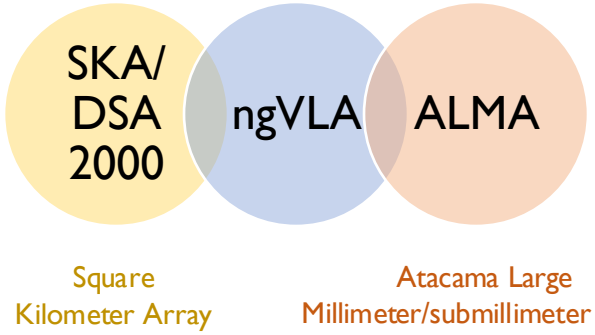
The ngVLA will be a single interferometric array that replaces the NSF Jansky Very Large Array and the NSF Very Long Baseline Array.

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

ngVLA concept

- Frequency span 1.2 – 116 GHz
- Resolution span 0.1 milliarcsec – 10 arcsec
- 10 x sensitivity of the Jansky VLA and ALMA
- 244 x 18m + 19 x 6m offset Gregorian antennas
  - At fixed locations in the U.S. and Mexico
  - Concentrated in the U.S. Southwest

ngVLA science bridges SKA/ALMA



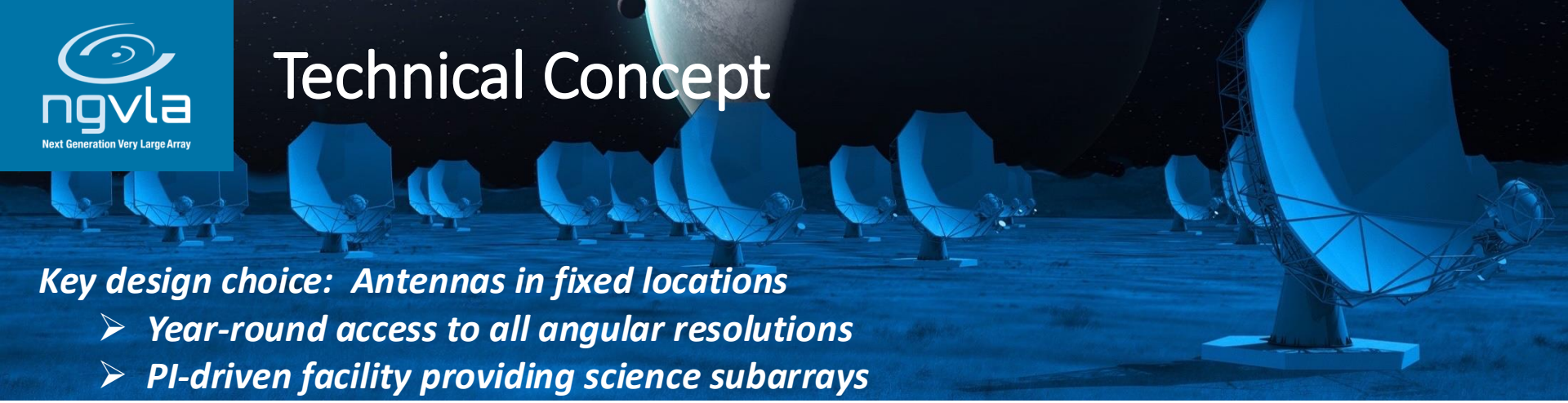
ngVLA Key Science Goals (ngVLA memos #19 & 125)

1. *Unveiling the Formation of Solar System Analogues on Terrestrial Scales*
2. *Probing the Initial Conditions for Planetary Systems and Life with Astrochemistry*
3. *Charting the Assembly, Structure, and Evolution of Galaxies Over Cosmic Time*
4. *Science at the Extremes: Pulsars as Laboratories for Fundamental Physics*
5. *Understanding the Formation and Evolution of Stellar and Supermassive Black holes in the Era of Multi-Messenger Astronomy*

Science requirements

Technical concept

Technical Concept



Key design choice: Antennas in fixed locations

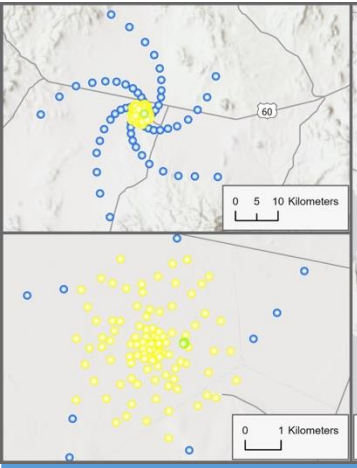
- ***Year-round access to all angular resolutions***
- ***PI-driven facility providing science subarrays***

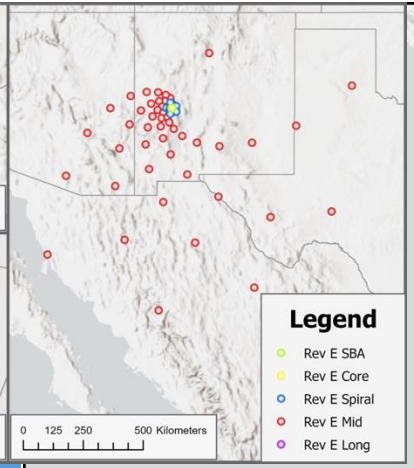
- **Frequency Range**: 1.2 - 116 GHz
- **Main Array**: 244 x 18m offset Gregorian Antennas
  - **Core**: 114 antennas; B_{max} = 4.3 km
  - **Spiral**: 54 antennas; B_{max} = 39 km
  - **Mid**: 46 antennas in NM, AZ, TX, MX; B_{max}=1070 km
  - **Long**: 30 antennas across continent; B_{max}= 8860 km
- **Short Baseline Array**: 19 x 6m offset Greg. Antennas
  - Use 4 x 18m in **Total Power mode** to fill (*u,v*) hole

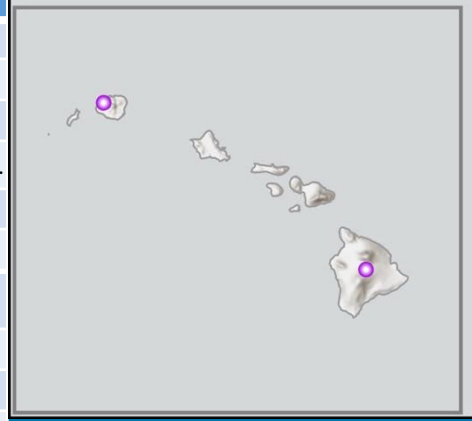
Band #	Freq. Range (GHz)
1	1.2 - 3.5
2	3.5 - 12.3
3	12.3 - 20.5
4	20.5 - 34
5	30.5 - 50.5
6	70 - 116

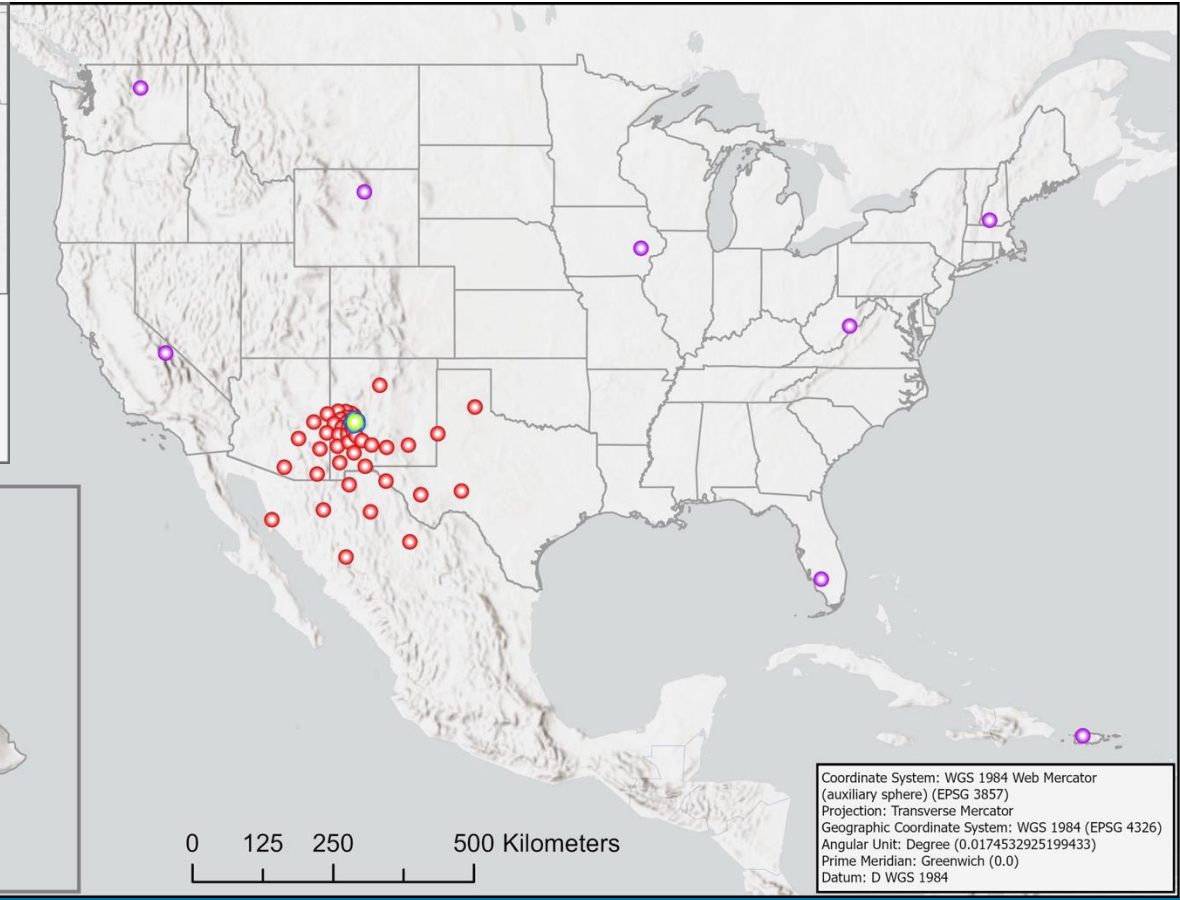
Correlator / Beamformer	Requirement (design)
digital efficiency	>95%
narrowest channel	<1 kHz
total # channels	>240,000
sub-band width	<250MHz (218.75)
total bandwidth	>14GHz/pol (20)
# formed beams	10

Distribution of Antennas





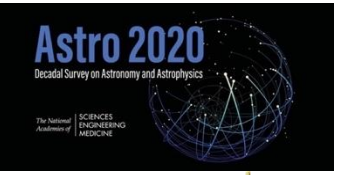


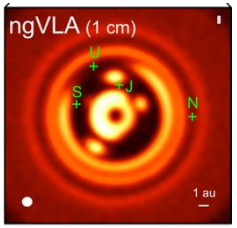


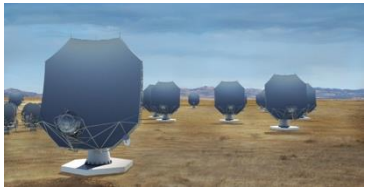
Long Antenna Sites

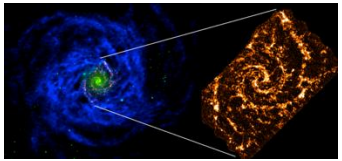
Qty	Location	Notes
3	Puerto Rico	Arecibo Site
3	Immokalee, FL	UF IFAS Site
3	Kauai, HI	Kokee Park Obs.
3	Hawaii, HI	Not MK Site
3	Hancock, NH	VLBA Site
3	Green Bank, WV	GBO
3	Brewster, WA	VLBA Site
3	High Park, WY	New Site
3	North Liberty, IA	VLBA site
3	Owens Valley, CA	VLBA site

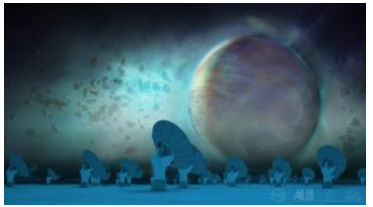
Big Picture - Timeline











2019 — ngVLA Submission to Astro2020

2021 — Astro2020 Recommendation Published

2024 — Prototype Delivered to VLA Site; ngVLA Proposal to NSF/MREFC

MREFC Design Candidate!

2028 — Complete NSF/MREFC FDR; ngVLA Construction →

2031 — Initiate ngVLA Early Science (> VLA capabilities)

2037 — Achieve Full Science Operations

ngVLA Community

Proactively engaged the worldwide scientific and technical communities since 2015

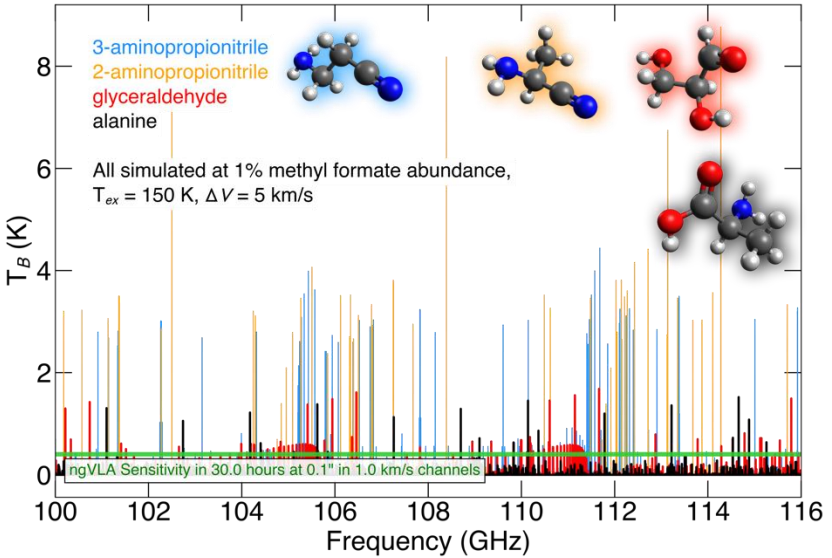
- Science Advisory Council offers expertise, guidance and feedback, and leads Science Working Groups with 300+ subscribers
- Technical Advisory Council offers expertise, guidance and feedback on engineering and computing topics
- Sought use cases, Science Book chapters, white papers
- Supported 50+ Community Studies
- Showcased 50+ scientific papers in NRAO eNews
- Supported 30+ scientific and technical conferences
- ngVLA mentioned in 1200+ community publications

Recent Highlights

- Completed NSF-run CDR September 3 – 6, 2024
  - Panel recommended project move to PDR
  - Panel recommended project Design be fully funded
- ngVLA Science Advisory Council updated Key Science Goals
  - Document also identifies expected data products and computing needs
- Strong recommendation in a Kavli-IAU report
- Supported a Focus Meeting at IAU GA in Cape Town
  - Continue to build international community
- Held 2024 ngVLA Science Meeting in MX
  - Morelia; broad range of science using ~100+km baselines
- Prototype Antenna Progress
  - Nearly completed antenna construction.

2025 Scope & Plans

- Continue with System Design Work
  - Focus on being PDR-ready in FY26
  - Secure International Partnerships
  - Identify Possible Science and Data Center Locations
- Prepare for Prototype Antenna Handover
  - Scientific testing in this spring
- Continue work for possible 2nd (Long) Prototype
  - To be sited in at GBO
- Start to organize 2025 ngVLA Science Meeting
  - Astrochemistry in Portland ME in October




ngvla
Next Generation Very Large Array