



ngVLA Project Update

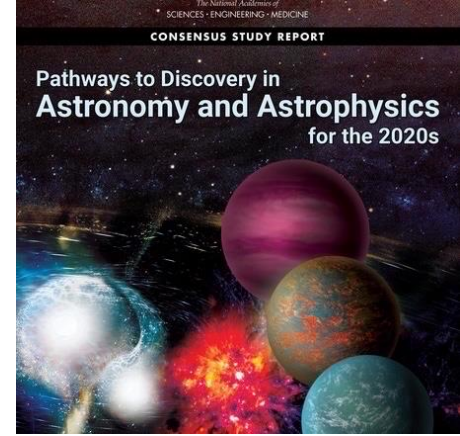
Eric J. Murphy – Project Scientist



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.

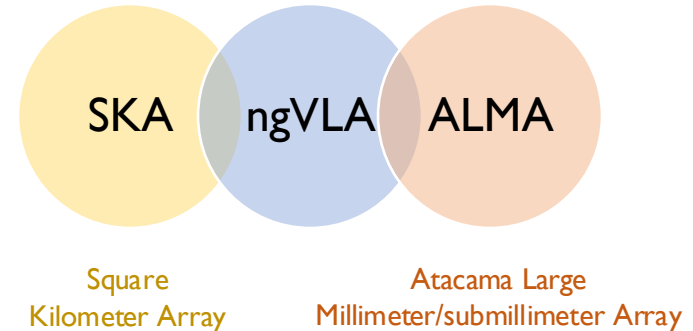
Astro2020 identified the ngVLA as a high-priority, ground-based large facility whose construction should start this decade.



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)

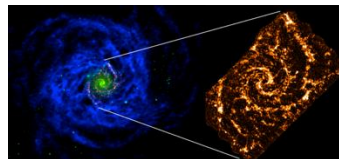
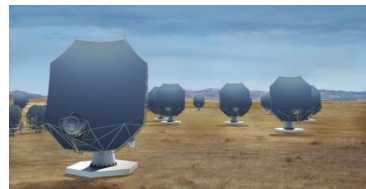
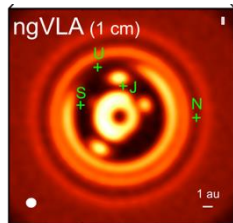
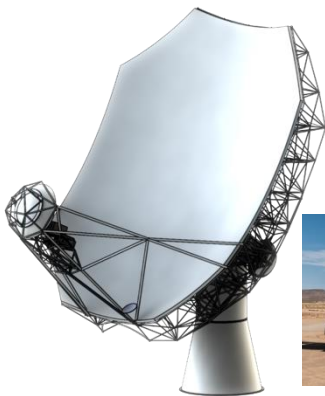
1. *Unveiling the Formation of Solar System Analogues on Terrestrial Scales*
2. *Probing the Initial Conditions for Planetary Systems and Life with Astrochemistry*
3. *Charting the Assembly, Structure, and Evolution of Galaxies Over Cosmic Time*
4. *Science at the Extremes: Pulsars as Laboratories for 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

Big Picture - Timeline



2019

2021

2024

2028

2031

2037

ngVLA
Submission
to Astro2020

Prototype Delivered
to VLA Site

Submit ngVLA Proposal to
NSF/MREFC

Complete NSF/MREFC FDR

ngVLA Construction → Initiate ngVLA Early Science
(> VLA capabilities)

Achieve Full
Science Operations

Astro2020 Recommendation Published

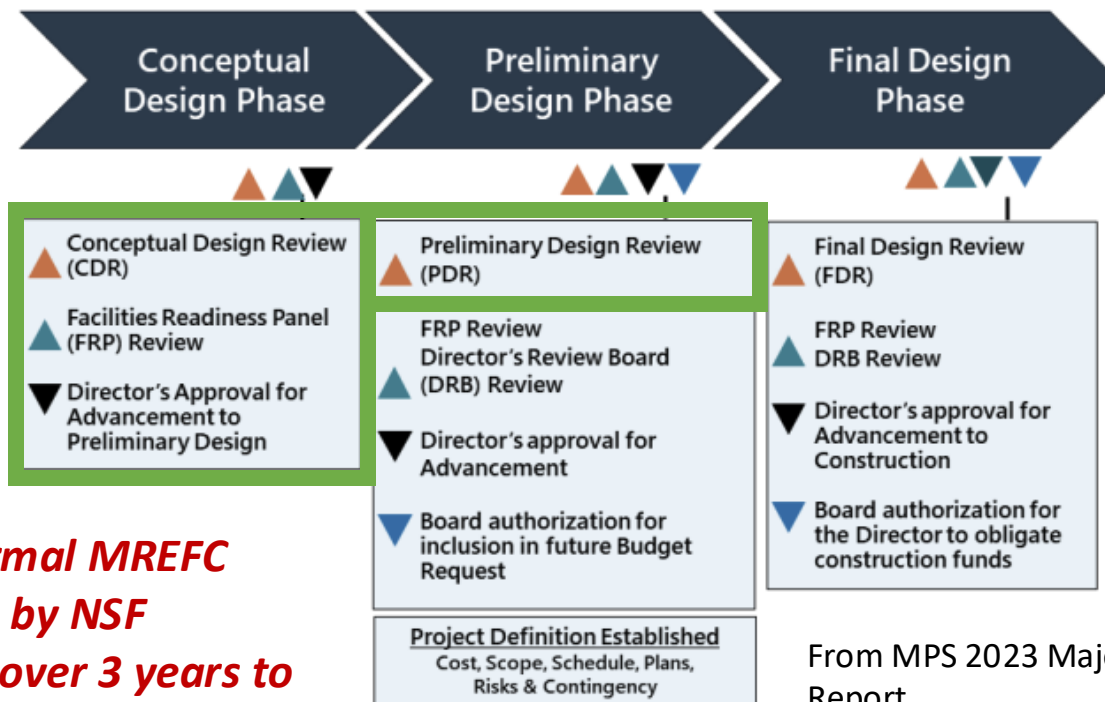
NSF RIG: MREFC Design Queue

Technical Baseline
July 2022

NSF CDR
September 2024

NSF PDR
Early 2026

**Identified as a formal MREFC
Design Candidate by NSF
Awarded (\$21M) over 3 years to
Support PDR**



**Partially
Funded**

From MPS 2023 Major Facility Report

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



Technical Concept

Key design choice: Antennas in fixed locations

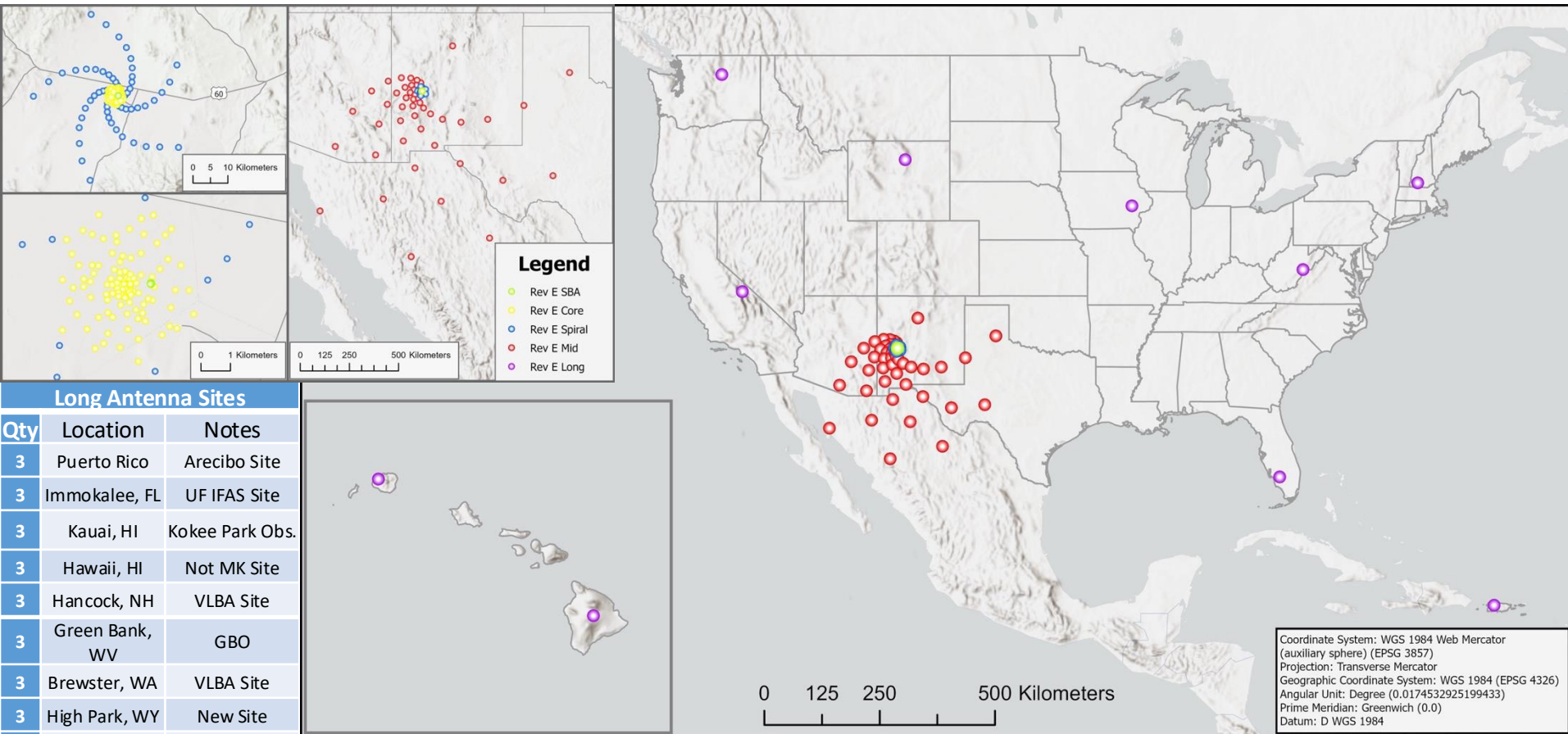
- *Year-round access to all angular resolutions*
- *PI-driven facility providing science subarrays*

- **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

Coordinate System: WGS 1984 Web Mercator (auxiliary sphere) (EPSG 3857)
 Projection: Transverse Mercator
 Geographic Coordinate System: WGS 1984 (EPSG 4326)
 Angular Unit: Degree (0.0174532925199433)
 Prime Meridian: Greenwich (0.0)
 Datum: D WGS 1984

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.



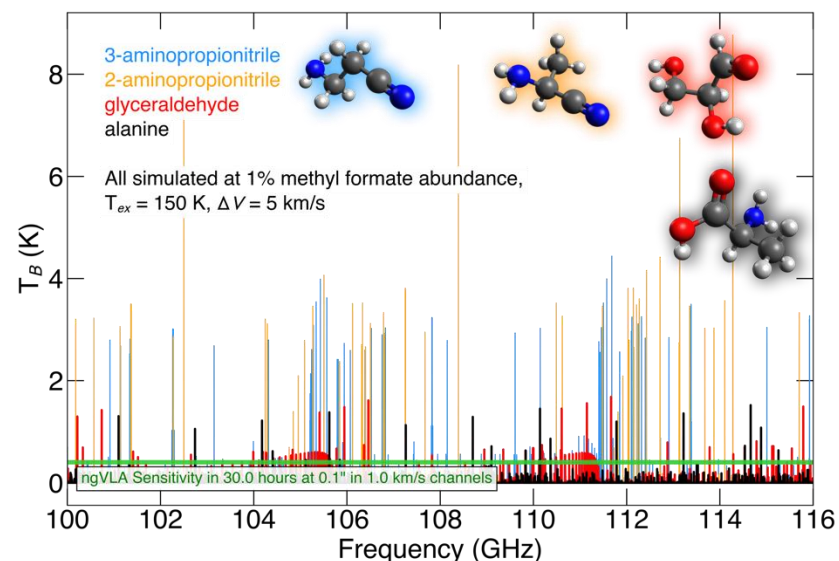
International Engagement

- International involvement via SAC, TAC, Community Studies
 - Canada, Mexico, Japan, Germany, Netherlands, Taiwan
- NAOJ-ngVLA workshop, Mitaka (2019) – *1st international science meeting*
- ngVLA currently a candidate being considered as part of Japanese Master Plan
- ngVLA identified as a high priority future project in Canadian LRP (6% partner)
- Signed MOU with UNAM (11/4/22) for their participation in ngVLA design.
- German ngVLA workshop held in Bonn (12/14/22) – *~100 attendees!*
- Science Meeting + mtex Open House held in Leipzig (9/23).
- **Mexican-led ngVLA Science Meeting in Morelia (9/23 & 11/24)**
- **MX-US Cooperation in Astronomy (US Consulate in MX: 11/24)**



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

ngvla.nrao.edu

