Fundamental Physics and New Messengers

AAS Session 194: Jan 15, 2:00-3:30pm

Chair: Alexander van der Horst (GWU)
Welcome: Megan DeCesar (GMU)

- **Paul Demorest** (National Radio Astronomy Observatory), *Sgr A* and Its Neighbors: Fundamental Physics with Galactic Center Pulsars*
- **Thankful Cromartie** (Cornell University), *Probing the Extremes of Physical Laws with Pulsars*
- **Joe Lazio** (Jet Propulsion Laboratory), *Ground- and Space-Based Long Baseline Interferometry*
- **Jessie Runnoe** (Vanderbilt University), *Nanohertz Gravitational Waves and Their Electromagnetic Counterparts*

ngvla
Next Generation Very Large Array

Fundamental Physics and New Messengers

Megan DeCesar, *George Mason University*

Co-Chair, ngVLA Science Working Group 4

ngVLA.nrao.edu

GEORGE MASON UNIVERSITY

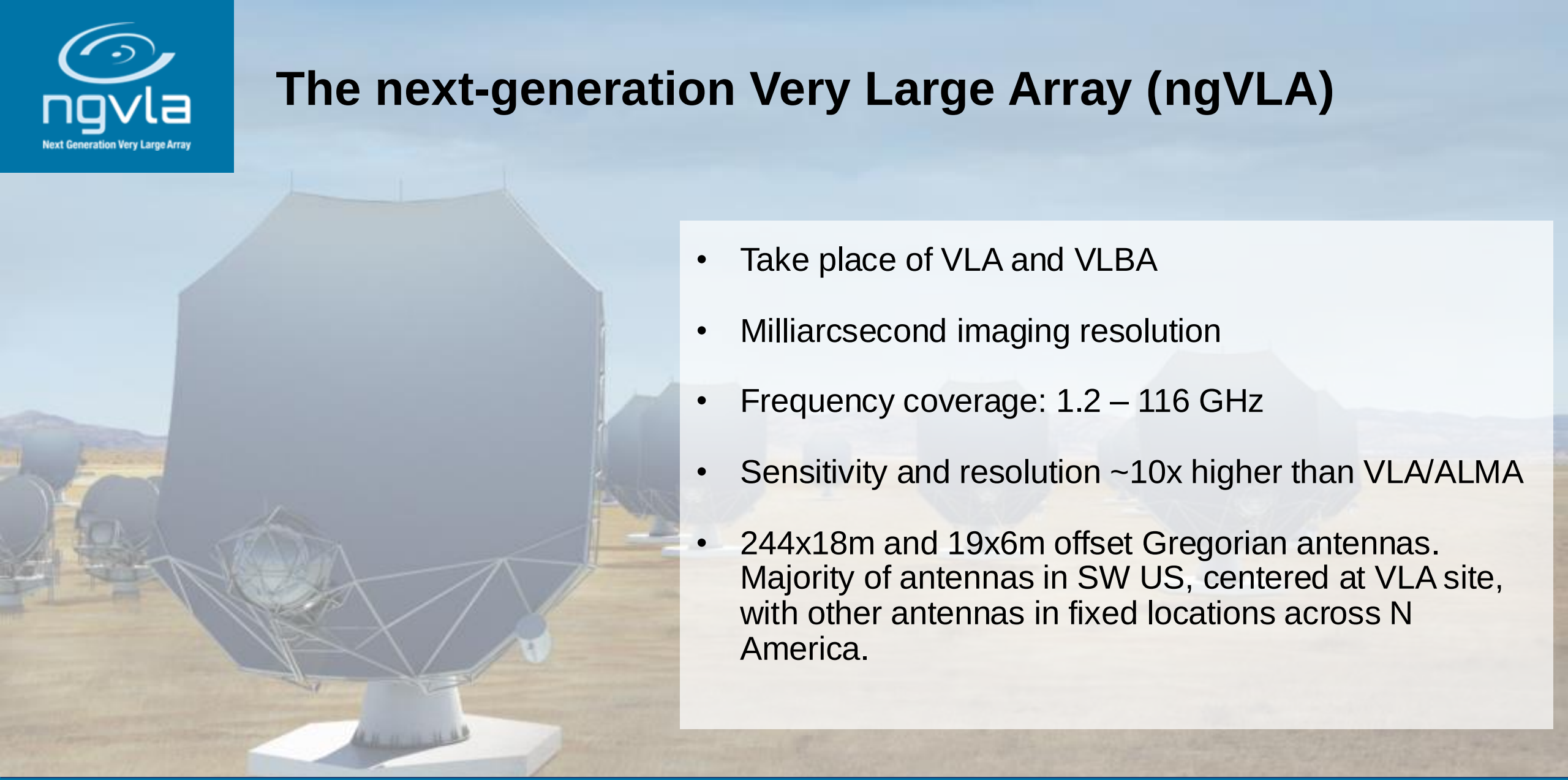
NANOGrav Physics Frontiers Center

NSF

AUI

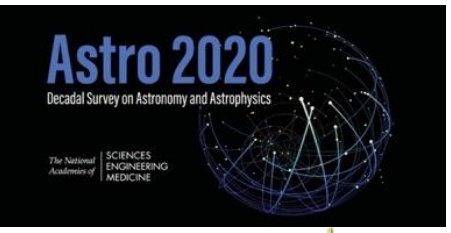
NRAO National Radio Astronomy Observatory

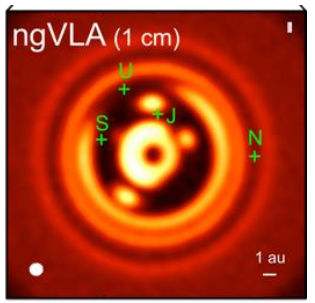
The next-generation Very Large Array (ngVLA)

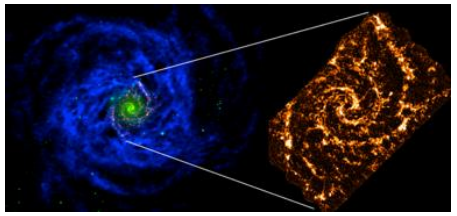


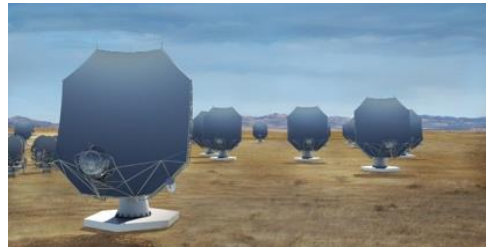
- Take place of VLA and VLBA
- Milliarcsecond imaging resolution
- Frequency coverage: 1.2 – 116 GHz
- Sensitivity and resolution ~10x higher than VLA/ALMA
- 244x18m and 19x6m offset Gregorian antennas. Majority of antennas in SW US, centered at VLA site, with other antennas in fixed locations across N America.

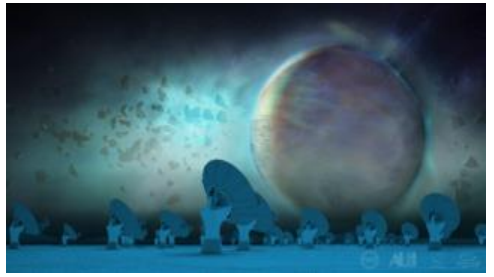
Project Timeline











2019 2021 2024 2026 2028 2031 2037

ngVLA Submission to Astro2020

Astro2020 Recommendation Published

ngVLA Proposal to NSF/MREFC
MREFC Design Candidate!

Prototype Delivered to VLA Site

Complete NSF/MREFC FDR

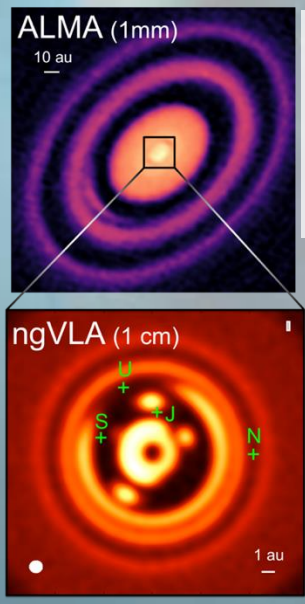
Construction →

Initiate ngVLA Early Science (> VLA capabilities)

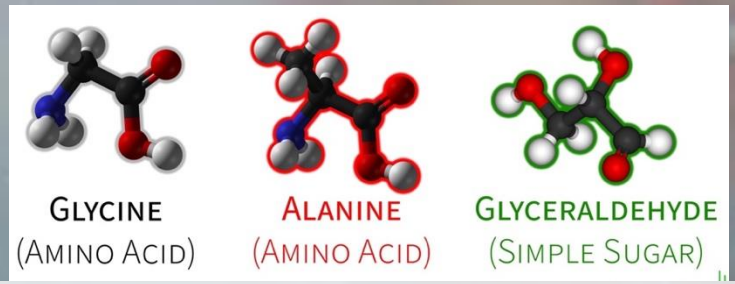
Achieve Full Science Operations

Slide: Eric Murphy

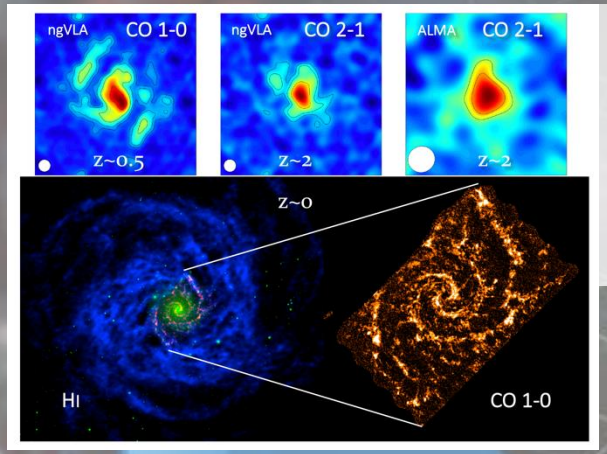
ngVLA Key Science Goals (KSGs)



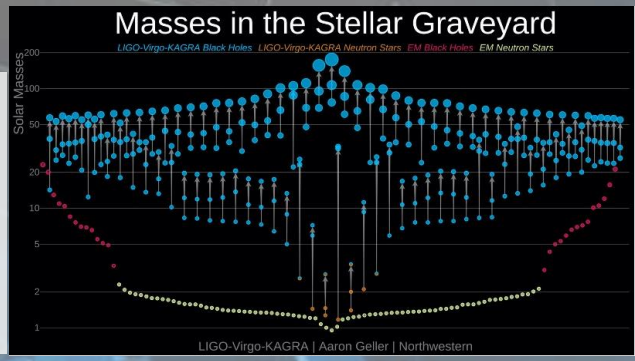
KSG1: Unveiling the Formation of Solar System Analogues on Terrestrial Scales



KSG2: Probing Initial Conditions for Planetary Systems & Life with Astrochemistry



KSG3: Understanding the Formation and Evolution of Stellar and Supermassive Black Holes in the Era of Multi-Messenger Astronomy



KSG5: Charting the Assembly, Structure, and Evolution of Galaxies over Cosmic Time

There are five Science Working Groups (SWGs), with one KSG per SWG. Join us!

Join at https://listmgr.nrao.edu/mailman/listinfo/ngvla-swg1 [or swg2, 3, 4, or 5]

KSG4: Science at the Extremes: Pulsars as Laboratories for Fundamental Physics

- **ngVLA memo #125** on updated KSGs (Wilner+ 2004, **arXiv:2408.14497**)
- GR tests with pulsars orbiting Sgr A* and in other binary/multiple systems (Bower+ 2018, ngVLA Science Book)
- Galactic Center pulsar population (~1000 expected; Pfahl & Loeb 2004), interstellar medium properties, magnetic field, star formation history, GeV excess
- Distant and/or extreme pulsar systems to probe gravity and dense matter
- Gravitational waves w/ pulsar timing arrays (Chatterjee+ 2018, ngVLA Science Book)
- Cosmology with Extragalactic Proper Motions (Darling+ 2018, ngVLA Science Book)

Summary and FYI's

- With 10x the sensitivity and angular resolution of VLA and ALMA, the ngVLA will be a transformative new facility across many sub-fields of astronomy and astrophysics
- Key Science Goals include planet formation, astrochemistry, galaxy formation and evolution, pulsars and fundamental physics, and black holes and multi-messenger astrophysics
- Construction beginning in 2029; early science 2031; full capabilities 2037
- **Join one or more Science Working Groups:**
  - https://listmgr.nrao.edu/mailman/listinfo/ngvla-swg1 *[or swg2, 3, 4, or 5]*
- **Submit new science case:** ngvla.nrao.edu/page/scicase
- **Community studies (funded!):** https://ngvla.nrao.edu/page/commstudiesprogram