



SPECTRUMX

SpectrumX Updates

Randall Berry

WinnForum International Spectrum Sharing Workshop

May 2025

SpectrumX - An NSF Spectrum Innovation Center



30
Member
Institutions

66
Researchers
and Staff

20
Collaborating
Organizations

87
Students

8
Working
Groups

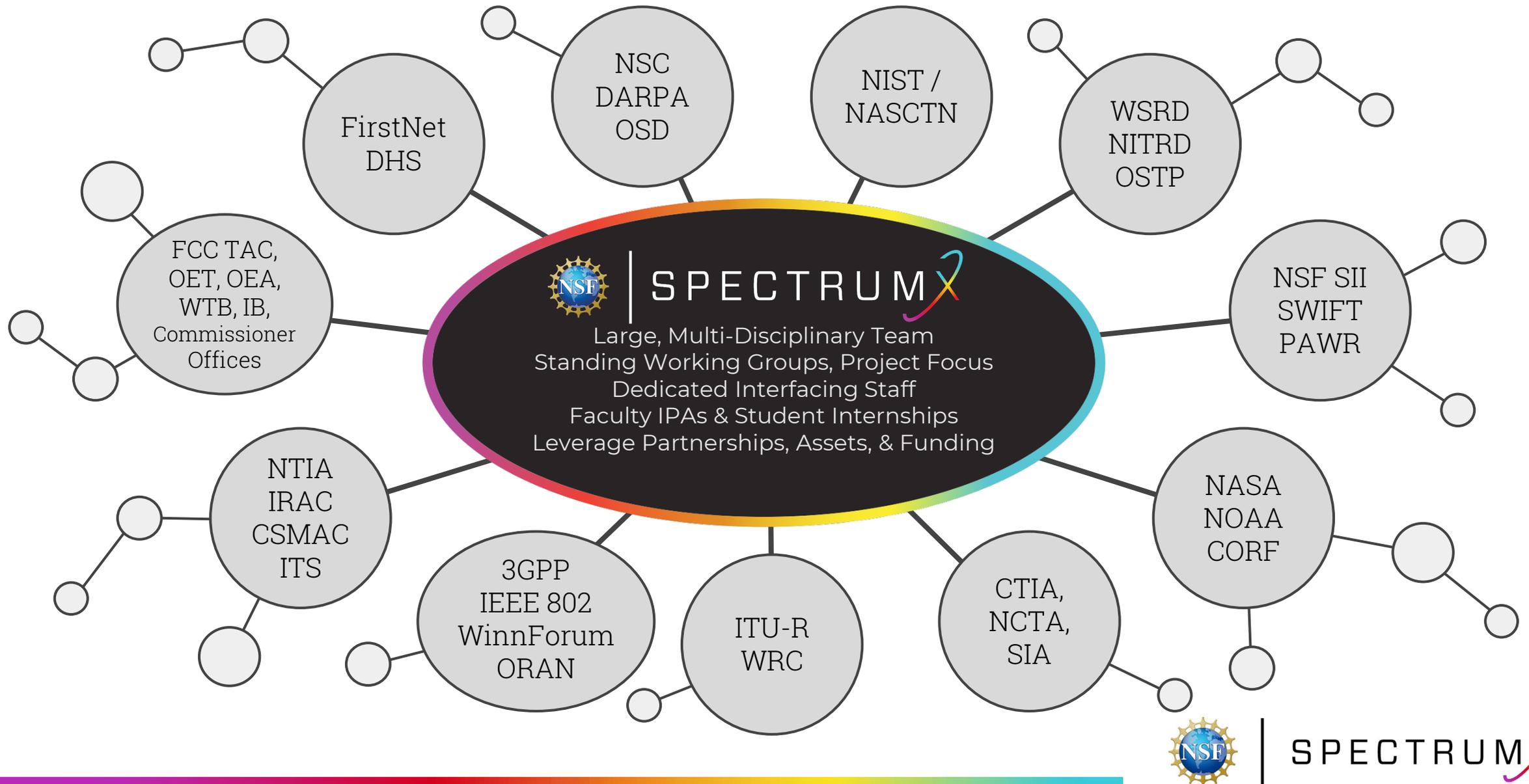
14
External
Advisors

- 5-year, \$25M award from the NSF Spectrum Innovation Initiative (SII), launched September 2021
- Part of unique partnership among NTIA, FCC, & NSF
- Pursuing sustainability with additional \$3.6M from current Industry & Government Collaborations

As of December 2024



Academic Hub in the Radio Spectrum Ecosystem



Working Groups

Strategic Coordination WG
Director: N. Laneman

NSF Program Officers
FCC, NTIA Observers
External Advisory Board (EAB)

Research Program Managers
Research Community

Research WG
Director: R. Berry

Policy Outreach WG
Director: M. Ghosh

FCC, NTIA Staff
OSTP, Congress
ITU WGs,
Delegation

Middle- & High-Schools
Undergraduate Institutions
Graduate Institutions

Education & Workforce
Development WG
Director: A. Yener

Broadening Participation WG
Director: M. Habashi

Public Awareness
Student Engagement
Professional
Advancement

Collaboration Advisory Board (CAB)
Industry Partners
Govt Agency Partners

Collaboration WG
Deputy Director: C. Shen

Facilities WG
Director: S. Palo

National Labs
Testbeds

Admin WG
Director: Emily Case

Member Research Administration Offices
NSF Administration



Some Notable Accomplishments



Advanced Spectrum Sensing & Coexistence Experimentation Platforms

Extremes of Software-Defined Radios (SDRs)
Scalable Data Management
AI/ML Acceleration



Engineers & Economists Collaborating to Explore Spectrum Rights & Incentives



Congressional Hearing Testimony on Spectrum Issues



Workforce Development

Grades 6-12 Curriculum
Summer School
REU+ Program



Funded Agency Collaborations

NTIA Liaison Projects
DoD Spectrum Taxonomy Project
National Spectrum Strategy Listening Session



Growing Spectrum Research Capacity

Engaging over 150 leading & developing researchers
Organizing NSF Spectrum Week 2023 & 2024



Research Activities

- **Flagship Projects (FPs)** - coordinated research with cross Center teams, multiple work elements, and structured management. Policy relevance, the potential for significant impact, and integrated workforce training experiences
- **Research Communities (RCs)** - community coordination that fosters collaboration and engagement within and outside the Center including policy engagement
- **Seed Projects:** develop novel ideas via small efforts and enable engagement with new members
- **Liaisons/supplemental funding:** focused research efforts in collaboration with key Federal agencies.



2
Flagship
Projects

30+
Researchers
Engaged in
Flagships

301
Publications
(Conf+Journal)

16
Seed Projects

42
Graduate
Students

14
Flagship
Research
Memos

7
Liaison Projects

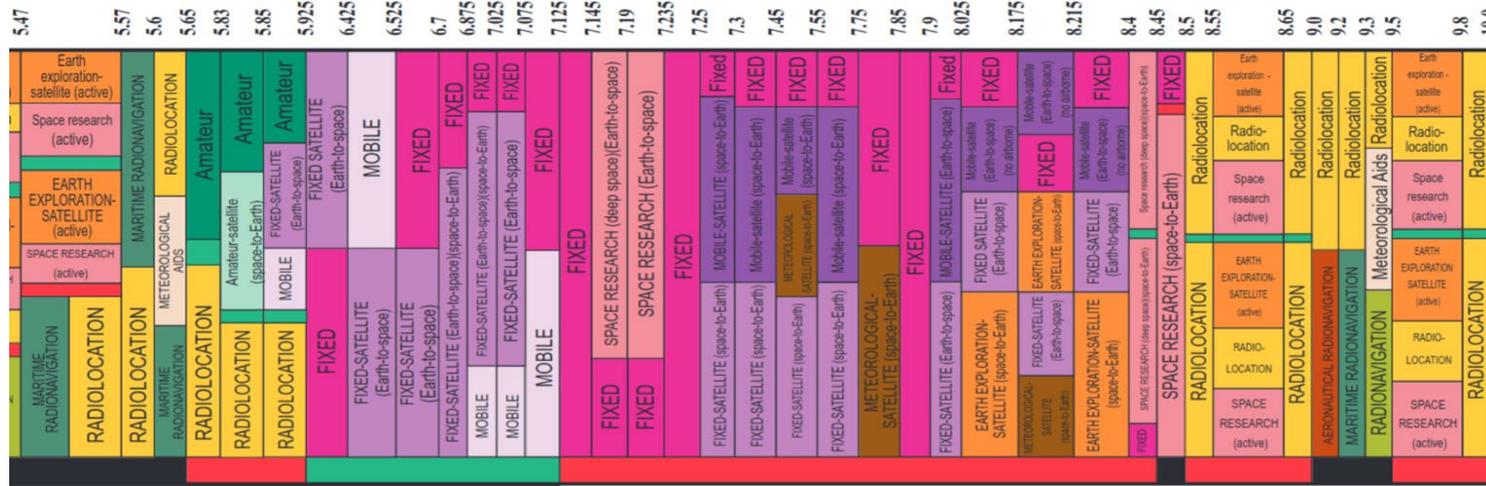
24
Measurement
Platforms

6
Public GitHub
Repositories

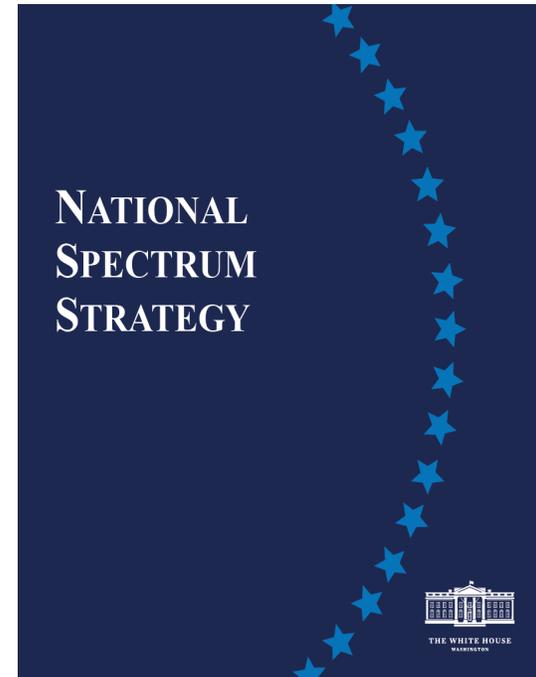
Flagship 1: Spectrum Awareness

Enable Next Generation Sensing, Awareness, and Understanding at Scale

Focus on 7 to 8.4 GHz



NASA
and
NOAA
Satcom



Create a “Demonstration of the Possible” for Coexistence by combining

- Sensing, Models, AI / ML, and Visualization
- Training and Field Experiments
- Exploration of Coexistence Scenarios
- Development of Concepts, Capabilities, and Infrastructure

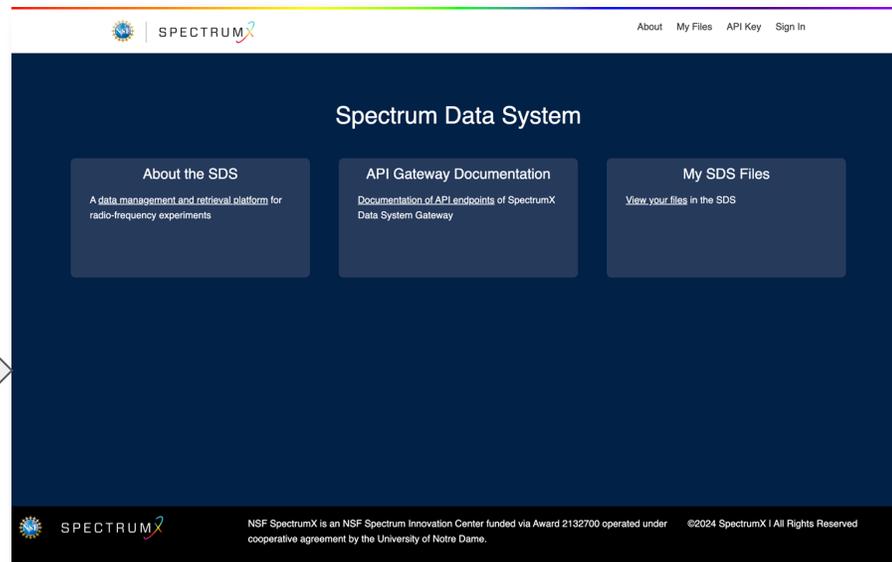
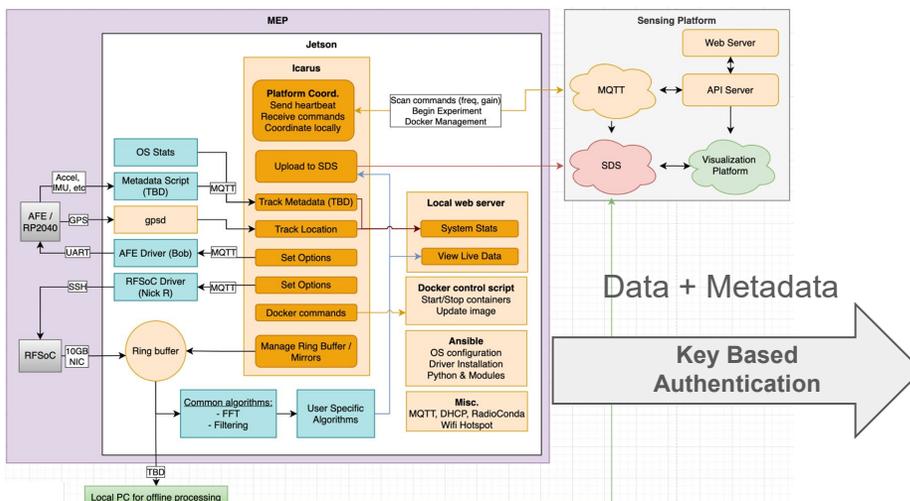
Unique Student Experiences
Focused Measurements
Active and Passive Coexistence



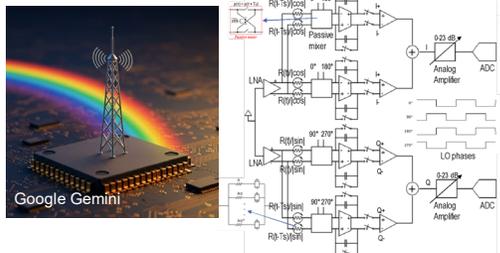
FP1 Highlight - Spectrum Sensing at Scale



MEP and Radio Hound
Coming Soon : Radio Hound-X



Ultra-Low SWAP



Federated Spectrum Data Repository

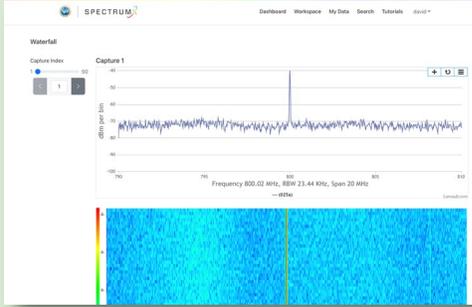


Researcher






SpectrumX Search, Visualization, and Control Interfaces



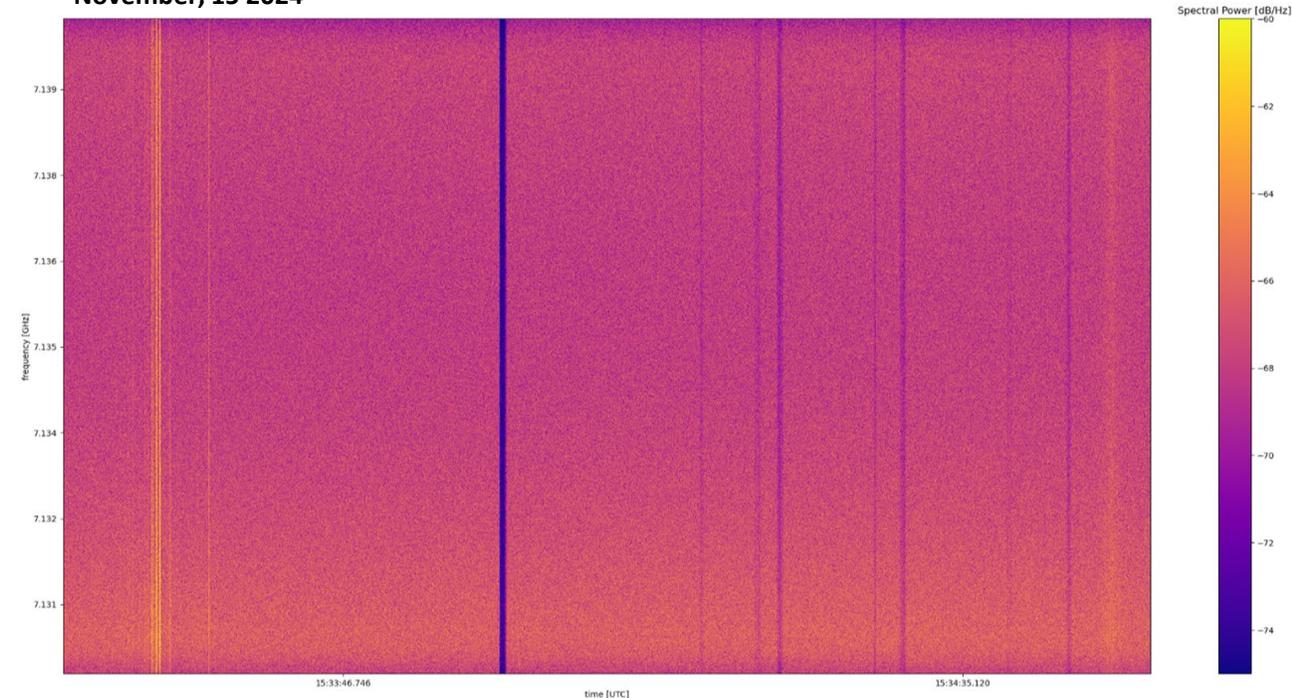
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1915143-64ct0943a794-2021-04-26_183504.json	application/json	625.5 KB	2025-01-30 16:30:23
1915150-64ct0943a794-2021-04-26_194415.json	application/json	625.5 KB	2025-01-30 16:30:23
1915146-64ct0943a794-2021-04-26_184608.json	application/json	625.5 KB	2025-01-30 16:30:23
1915145-64ct0943a794-2021-04-26_184408.json	application/json	625.5 KB	2025-01-30 16:30:23
1915152-64ct0943a794-2021-04-26_213446.json	application/json	625.5 KB	2025-01-30 16:30:22
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1915144-64ct0943a794-2021-04-26_184208.json	application/json	625.5 KB	2025-01-30 16:30:22
1915140-64ct0943a794-2021-04-26_172353.json	application/json	625.5 KB	2025-01-30 16:30:21
1915141-64ct0943a794-2021-04-26_172819.json	application/json	625.5 KB	2025-01-30 16:30:21
1915151-64ct0943a794-2021-04-26_213247.json	application/json	625.5 KB	2025-01-30 16:30:21
1926846-64ct0943a794-2021-04-26_213040.json	application/json	625.5 KB	2025-01-30 16:30:20
1915147-64ct0943a794-2021-04-26_184808.json	application/json	625.5 KB	2025-01-30 16:30:20

FP1 Flagship Experiment Overview

- Student training workshop - **Nov. 2024**
 - Initial MEP build and student training.
- East coast propagation experiment - **Late Spring 2025**
 - NTIA organized for DoD
 - SpectrumX members invited to participate
 - Participation TBD depending on MEP availability
- **POWDER - Early Summer 2025** (under discussion)
 - Coexistence Waveforms with POWDER in Utah
 - Possible dry run for VLA experiment
- **VLA field campaign - Summer 2025 / week of July 7**
 - Passive band survey
 - Active 5G waveform and beacon experiment
 - Data workshop with MEPs in advance (early June)
- **Student competition - Summer to Fall 2025**
 - Student Team Experiments with PI Guidance
 - Multiple Prize Categories
- **NRDZ Hat Creek experiment - Fall 2025**
- **Flagship experiment - Spring 2026**
 - Field experiment notionally with NASA and NOAA
 - Emphasis on spectrum sharing experiments
 - Details/date in development; notional at this point



November, 15 2024



FP1 : Next Generation Wireless in 7-8GHz.

Understand and Engage on approaches for sharing 7-8.4 GHz

- Characterize incumbents and potential entrant in band.
- Characterize different co-existence approaches.
- Define coexistence experiments
- Interface with National Spectrum Strategy Process and Issues

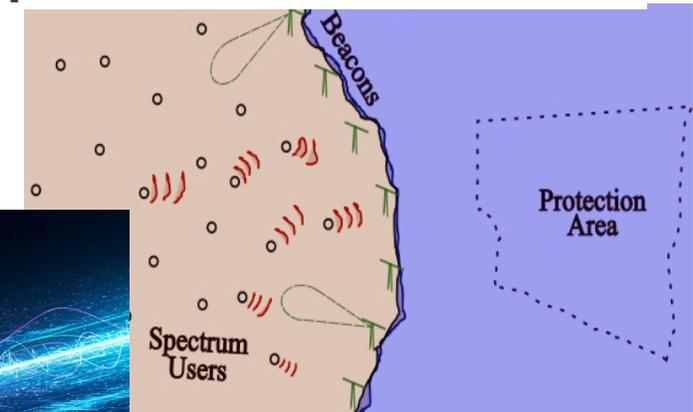
Coexistence frameworks

- Beacon assisted approaches
- Dynamic sharing
- Indoor/outdoor sharing
- Overlay rights



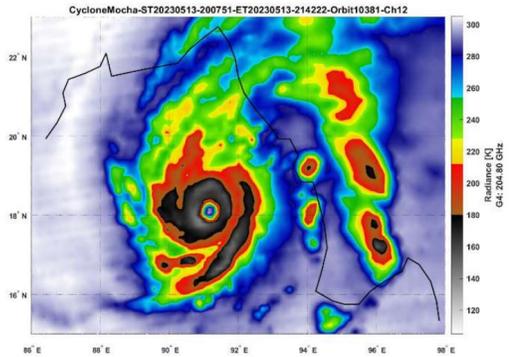
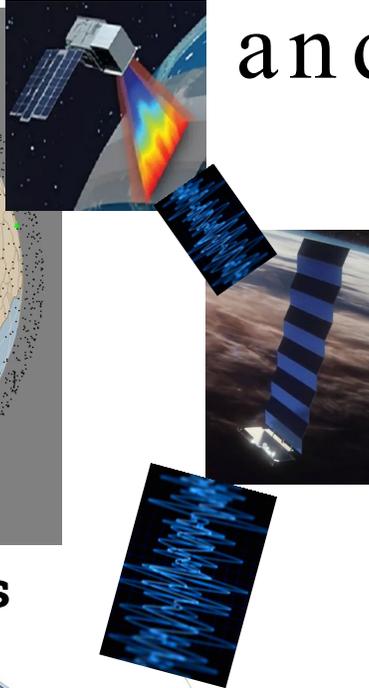
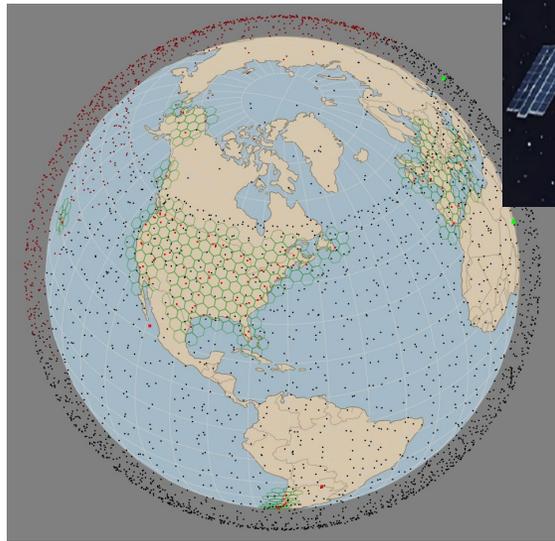
The Future of Commercial Spectrum

Spectrum & Wi-Fi



Flagship 2 : Scientific Coexistence and the High Frontier

Critical Weather, Climate, and Scientific Systems



Coexistence Methods and Tools



Astronomy Coexistence

Mega Constellations

Very Sensitive Systems
Highly Visible RFI (looking up and down)

Lack of Prediction Capability
Inadequate Rights and Coexistence Mechanisms
Unknown Impacts on Systems and Weather Models

The Scale of the Systems Involves Matters
We Need to Look at both Benefits and Challenges



FP2 Work Elements

Develop Radio Science Coexistence Simulator

Direct and aggregate interference

Scientific System Coexistence and Data Impacts

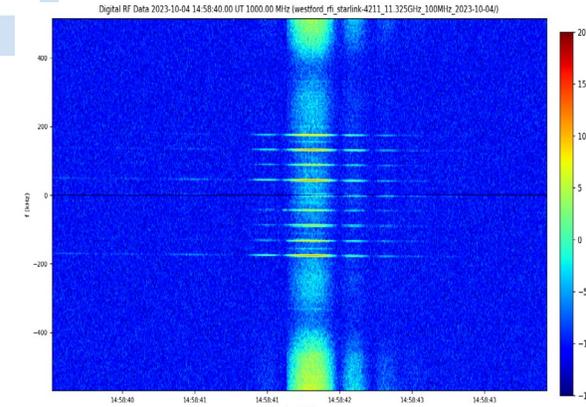
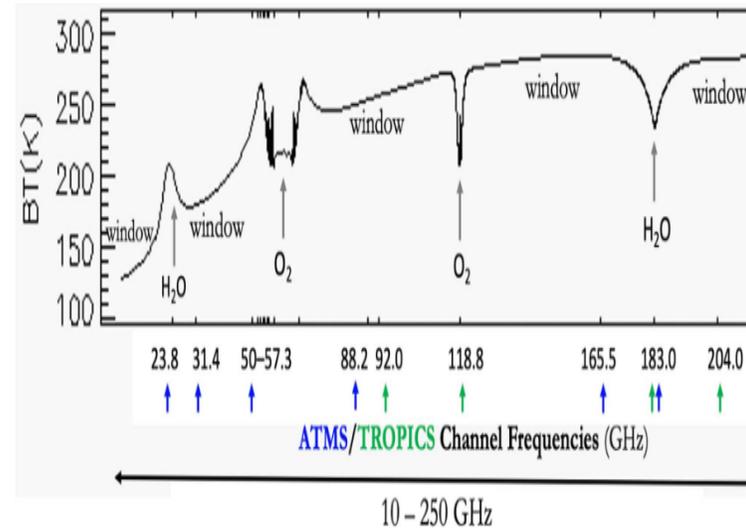
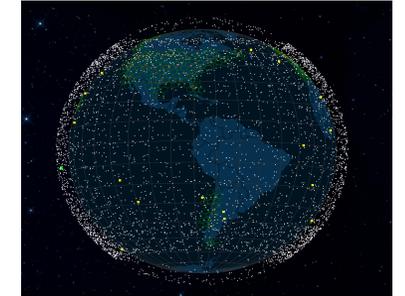
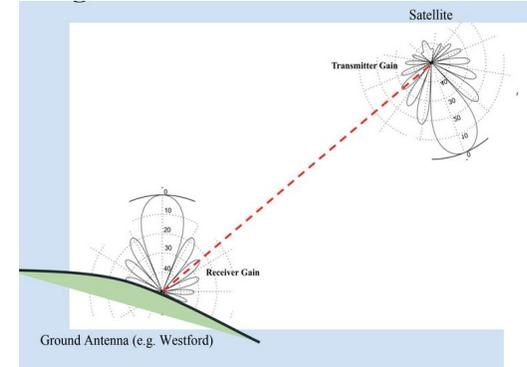
Weather modeling and Astronomy

Signature Collection with Scientific Platforms

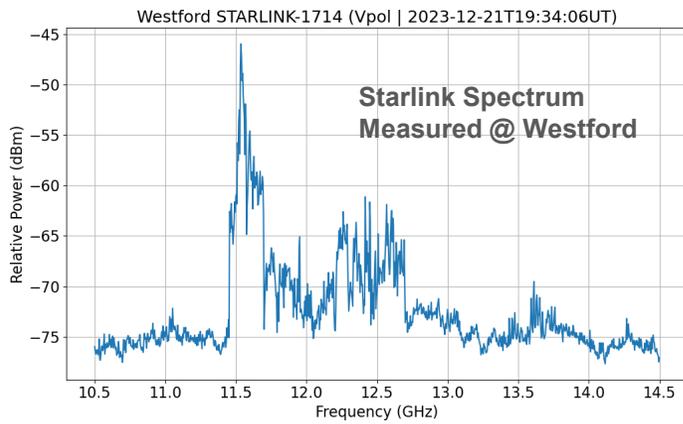
incl. harmonics and unwanted emissions

Scientific Rights, Incentives, and Policy

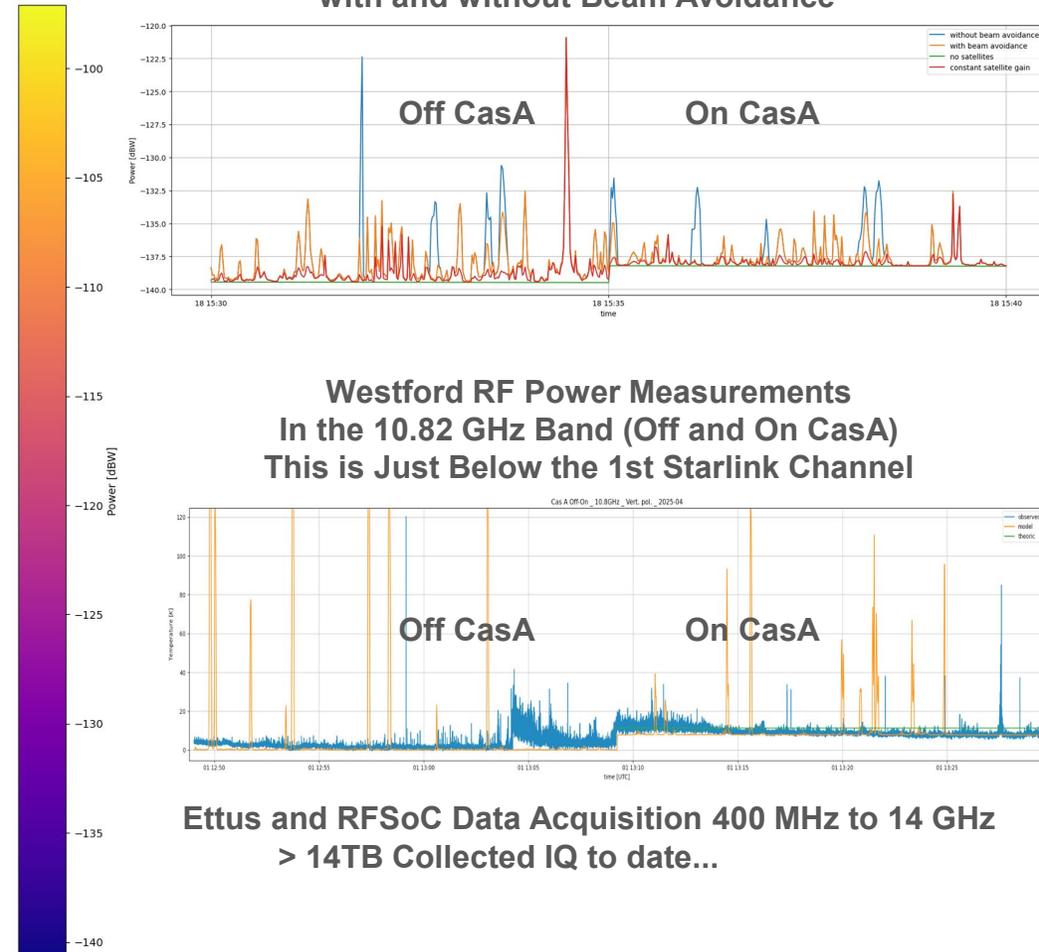
Role of markets?



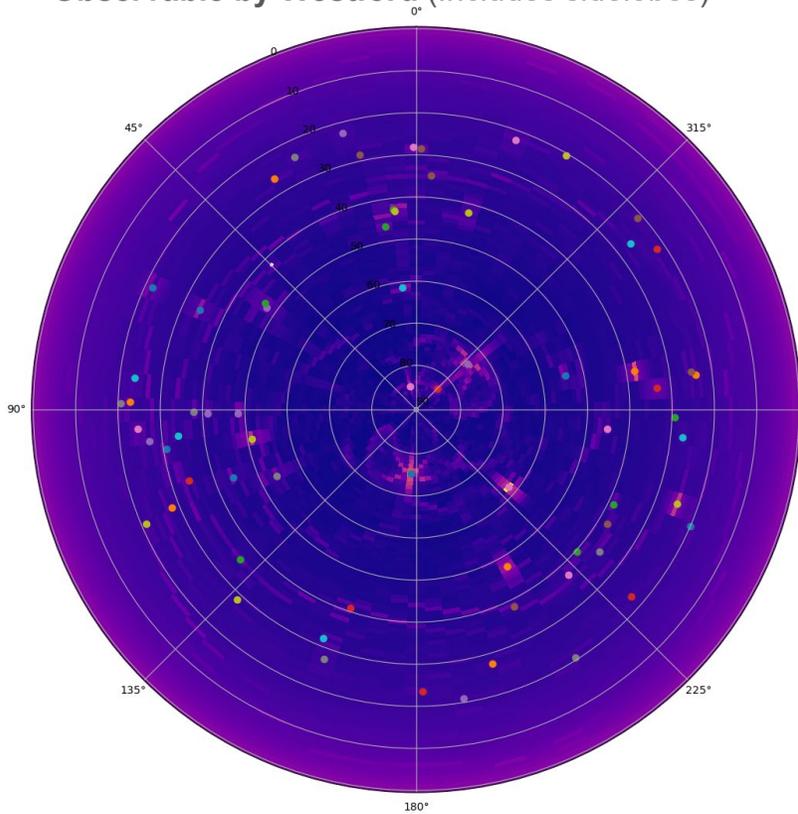
FP2 Highlight - Starlink Modeling and Measurement



Model Prediction of Starlink Signals at Westford with and without Beam Avoidance



Model Prediction of the Starlink Signals Observable by Westford (Includes sidelobes)



Research Communities

RC - Economics,
Rights, & Policy

RC - Technology &
Measurements

RC - Models,
Algorithms, & AI/ML

Research
Communities (RC)



Access rights; comparative analyses;
incentives and mechanisms; empirical
studies



Devices, sensors; interfaces;
data collection/storage/curation



Propagation;
Interference modeling and mitigation;
Dynamic resource allocation

- Monthly meetings to share ideas and present ongoing research
- Vision papers (e.g. data-driven policy, AI/ML in spectrum)
- Briefings on policy activities
- Entry point for new affiliates (academic, industry, government)



Research Seed Projects

- Six proposals funded in Y4 (plus 5 others in Y3)

Title	Investigator(s)	Institution
FR3 Agile RF Front-Ends with Analog and Propagation Interference Suppression	Laila Marzall & Zoya Popovic	University of Colorado Boulder
Operator Self-Identification for Spectrum Sharing	Donging Guo & Igor Kadota	Northwestern University
Byzantine Fault Tolerance in Spectrum Sharing Regimes	Prashant Krishnamurthy & Amy Babay	University of Pittsburgh
SpectrumX Chatbot	Cong Shen & Nick Laneman	University of Virginia & University of Notre Dame
Multi-spectral transmitter characterization	Mariya Zheleva	University of Albany SUNY
Enhancing Spectrum Research through an Open, Scalable SigCap Data Platform	Monisha Ghosh & Caleb Reinking	University of Notre Dame

- Opportunities for stakeholders to suggest and influence projects



NTIA OSM & ITS Liaisons



Randy Berry – NWU
Paul Ransom – NTIA
Value Based Spectrum
Management



Cong Shen – UVA
Alan Rosner – NTIA
AI/ML for Spectrum
Management



Monish Ghosh – ND
Nick LaSorte – NTIA
5G Sharing



Nick Laneman – ND
Chris Anderson – NTIA
Education & Workforce
Development, DSS Testbed



Jon Chisum – ND
Charles Dietlein – NTIA
Spectrum Cartography



Kobus Van der Merwe – Utah
Daniel Galanos – NTIA
Table Mountain Open ZMS

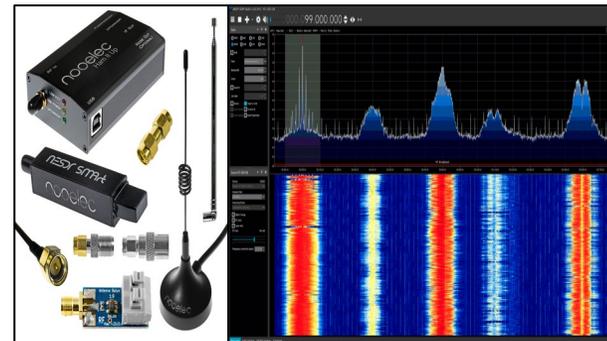
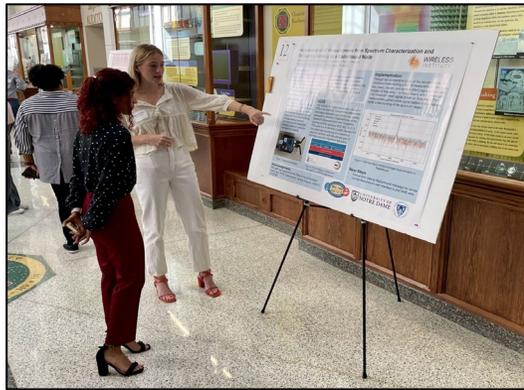


Lisa LeFevre – NJC
Adam Hicks – NTIA
Tropospheric Propagation



Education & Workforce Activities

Courseware for Grades 6-12, Higher Education
Multi-Institution Summer Schools
Enhanced Research Experiences for Undergraduates
Citizen Science Project



20
Grade 6-12
Lessons
Published

928
K-12
Students
Engaged

48
REU(+)
Projects

4
Higher-Ed
Courses in
Development

4
Summer
School
Sites

50
Citizen
Science Kits
Distributed



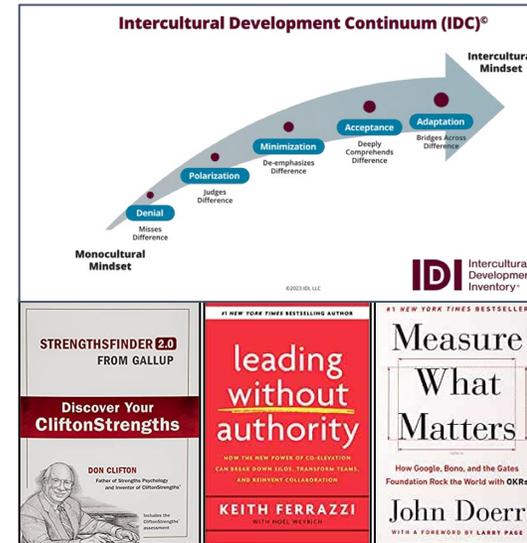
Broadening Participation Activities

- Institution & Community Outreach (ASEE By the Numbers, Professional Organizations)
- Professional Skills Assessments & Development
- Research Onboarding



Career Opportunities Talk Tour

Professional Dev Tools



Broadband Mapping US

25
New Affiliates
(since launch)

9
New Subawards
(since launch)

40
Professional
Assessments



Coordination & Collaboration Activities

- External Advisory Board (EAB)
- Collaboration Advisory Board (CAB)
- NSF, NTIA, FCC Observers
- Engagement in External Working Groups (NextG, PATHSS, ...)

14
EAB
Members

4
Federal Agency
Exchanges



12
CAB
Members

4
Testbed Facility
Exchanges



10
Educational
Collaborators

3
Supplemental
Funded
Programs



Policy Engagement Activities

- Sharing Regulatory Proceedings
- Translating Research Insights into Policy Options and Regulatory Comments
- Prioritizing Policy-Relevant Conferences
- Engaging with Policymakers



4
Congressional
Testimonies

> 15
US Regulatory
Proceedings
Tracked

~30
Policy Speaker
& Panelist Roles

10
Regulatory
Comments Filed

~ 10
International
Consultations
Tracked

~5
External
Engagements



USNC-URSI National Radio Science Meeting



Administrative Activities

- Brand Identify and Management, SWAG
- Communication Channels - Website, LinkedIn, YouTube, Mailing list
- Meeting Planning and Facilitation
- Subaward Management
- Reporting to Sponsors

2,300+
Unique
Website
Visitors

14
Recurring
Meetings
(Biweekly)

1,930
LinkedIn
Followers

13
Center + EAB
Meetings
Organized

1,100+
Mailing List
Participants

~20
Subawards

