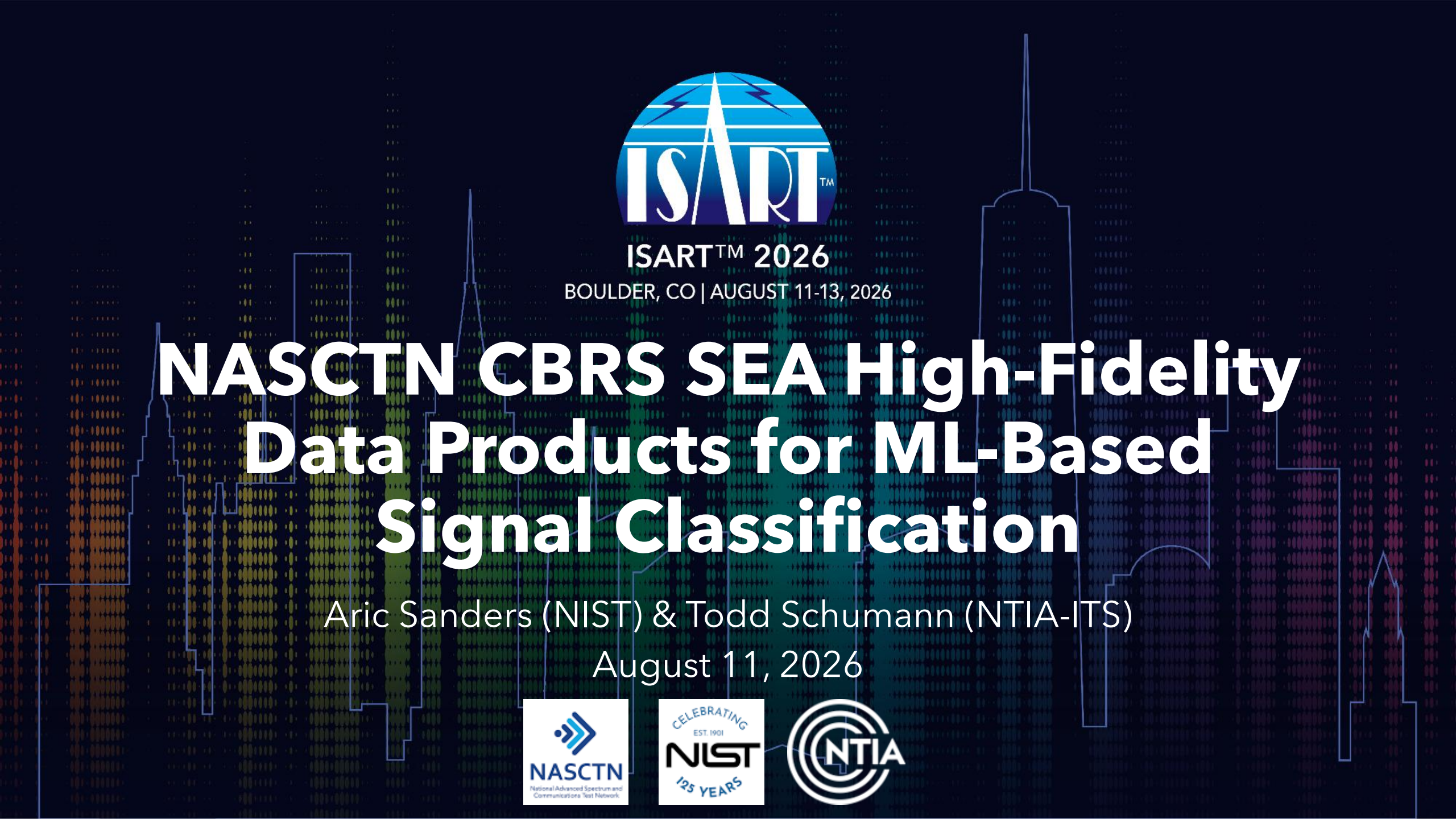


NASCTN CBRS SEA High-Fidelity Data Products for ML-Based Signal Classification

Aric Sanders (NIST) & Todd Schumann (NTIA-ITS)

August 11, 2026

Disclaimer

This presentation does not imply the endorsement or approval by the United States Government or the National Telecommunications and Information Administration (NTIA) and does not represent the views of the U.S. Government or NTIA.

All material in this presentation is Uncontrolled Unclassified Information.

BLUF

- Subject Matter Expert Feature Extraction (Data Products) Computed on the Edge Allows for Reduced Data Footprint
- The NASCTN CBRS SEA has >20 Sensor Years' Worth of This Type of Data on the CBRS Ecosystem
- Demonstration of Novel Simple Classifier for Broad Categorization
- Example Machine Learning Application for Classification of Multiple Signal Types

Outline

- What is NASCTN
- SEA Sensor and Data Products
- Simple Classifier
- Machine Learning Classifier
- Summary

What is NASCTN

NASCTN Mission

To provide, through its partners, **robust test processes** and **validated measurement data** necessary to develop, evaluate and deploy spectrum sharing technologies that can ***thoughtfully*** **improve access to the spectrum** by both federal agencies and non-federal spectrum users.

Develop scientifically rigorous test plans and new methodologies with independent technical experts

Coordinate access to key test facilities, and commercial and federal equipment and capabilities

Provide validated data and models for use within the spectrum community

Operates as a trusted agent and protect proprietary, sensitive, and classified information

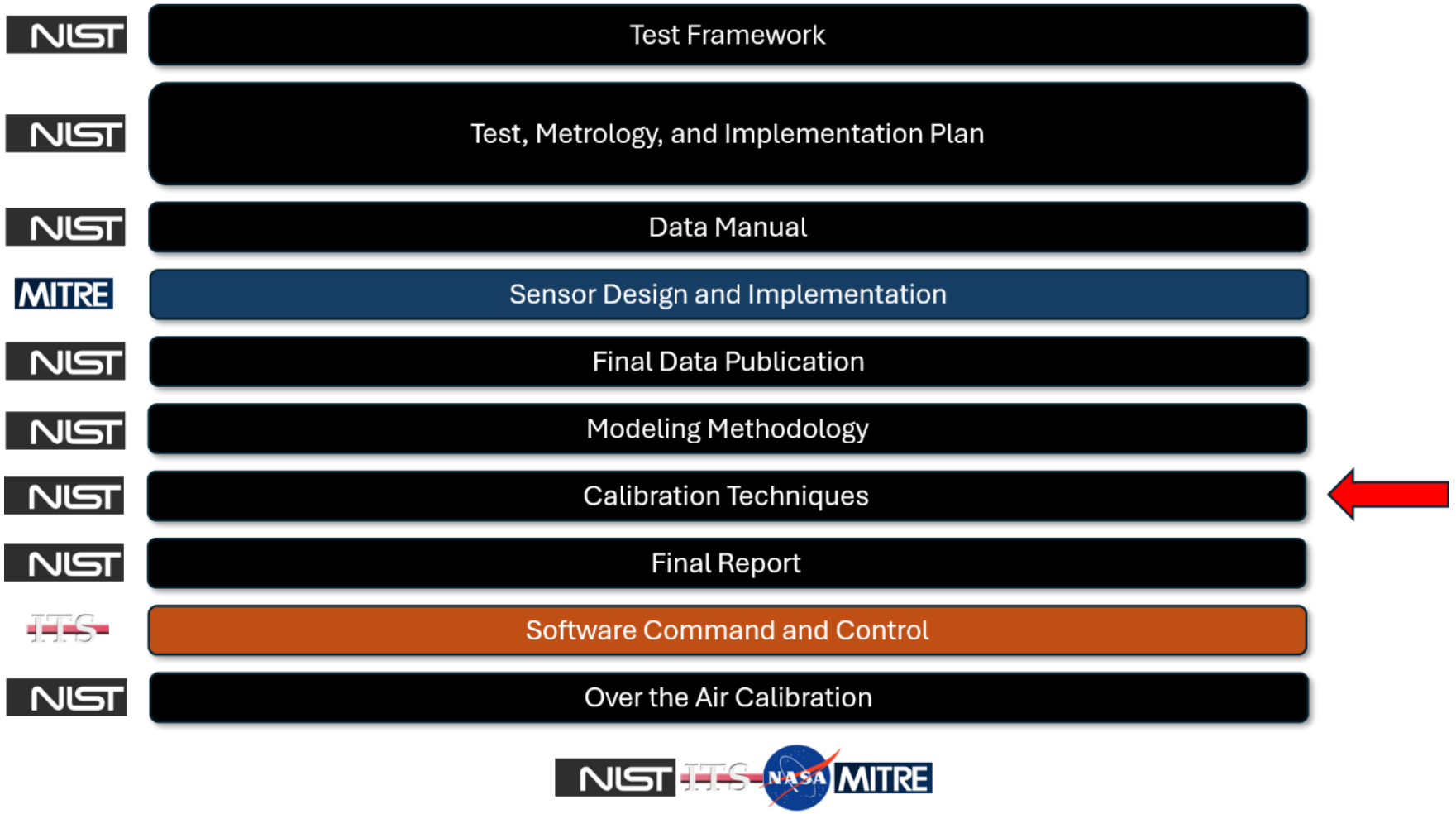
NASCTN CBRS SEA

Collect data required for DISA PEO Spectrum to ascertain the effectiveness of the sharing ecosystem between CBRS systems as managed by Spectrum Access Systems (SASs), and DoD systems as monitored by Environmental Sensing Capabilities (ESCs). Provide insight into the sharing ecosystem's effectiveness, and track changes in the spectrum environment over time.

Anticipated Outcomes that Align with National Spectrum Priorities:

- American Spectrum Sharing – can spectrum be shared effectively and can it be quantified
- Advancing American Led Standards – towards WInnForum CBRS 2+, SCOS, ANSI C63.26
- Trusted Data sets for AI / ML applications – applications being implemented by Stakeholder
- Spectrum Science R&D
  - Quantifying the importance of ground truth data in interference modeling and prediction
  - Aggregate emissions considerations in protecting Federal Incumbents
  - Advancing measurement practices in spectrum monitoring
  - Intercomparisons across spectrum monitoring nodes and networks

Publication Plan



Presentations and Outreach

Cyclostationary Channel Power Measurements for CBRS Coexistence Assessment

2024 URSI NRSM

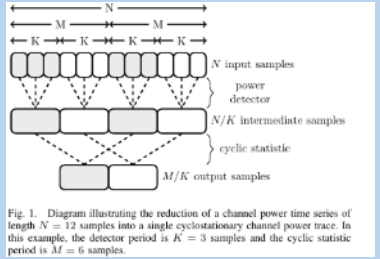


Fig. 1. Diagram illustrating the reduction of a channel power time series of length $N = 12$ samples into a single cyclostationary channel power trace. In this example, the detector period is $K = 3$ samples and the cyclic statistic period is $M = 6$ samples.

Spectrum Monitoring System Deployment Site Analysis Using Realistic Radiation Patterns

EuCAP 2025

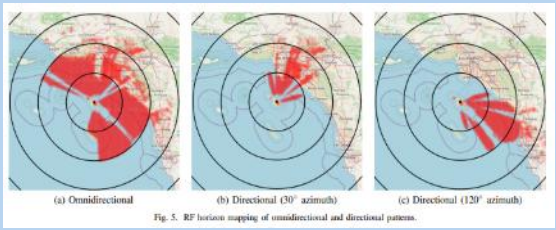
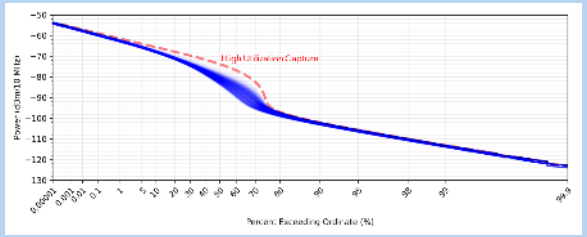


Fig. 5. RF horizon mapping of omnidirectional and directional patterns.

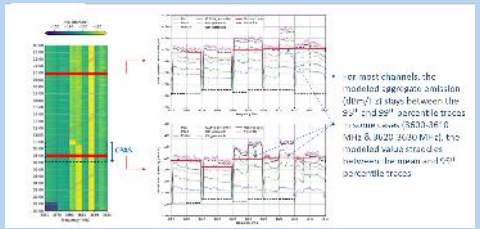
Advanced Interference Analysis Measurements of Real-World Spectrum Sharing Environments

IEEE EMC 2025



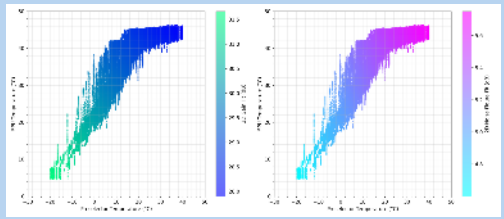
Modeling and Measurement of NASCTN SEA Sensors in CBRS Ecosystem

2026 URSI NRSM



Long-Term Calibration Trends and Observations from Deployed NASCTN SEA Sensors

2026 URSI NRSM

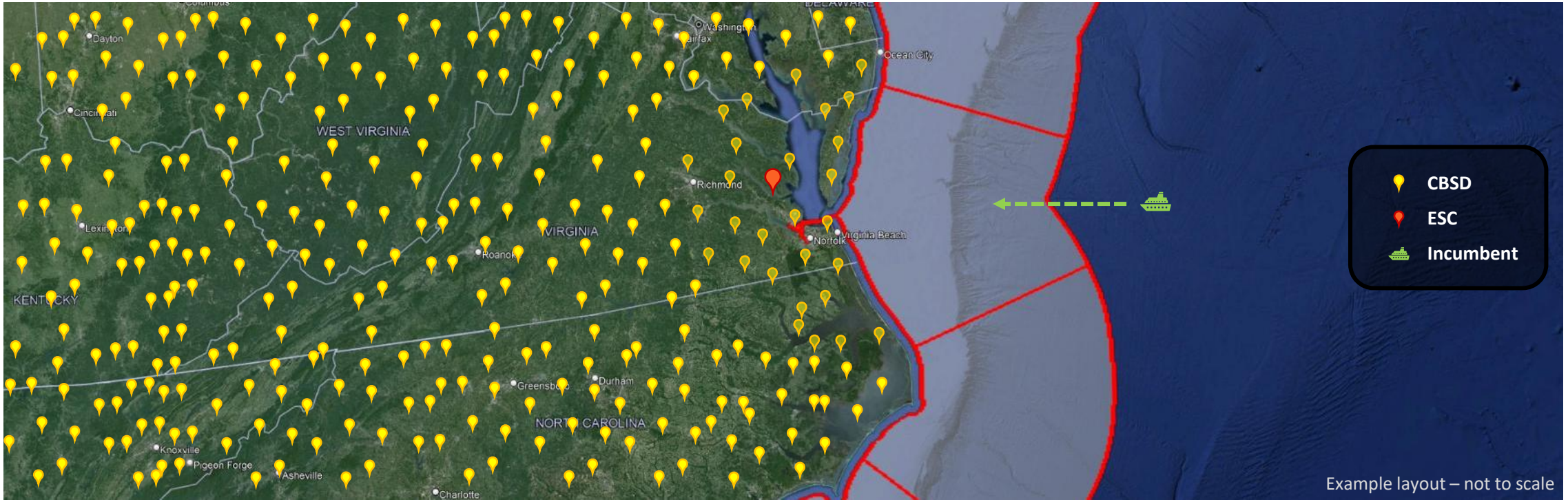


Additional WInnForum briefs, Test Plan briefs, and casual references in other presentations

SEA Sensor and Data Products

CBRS Overview

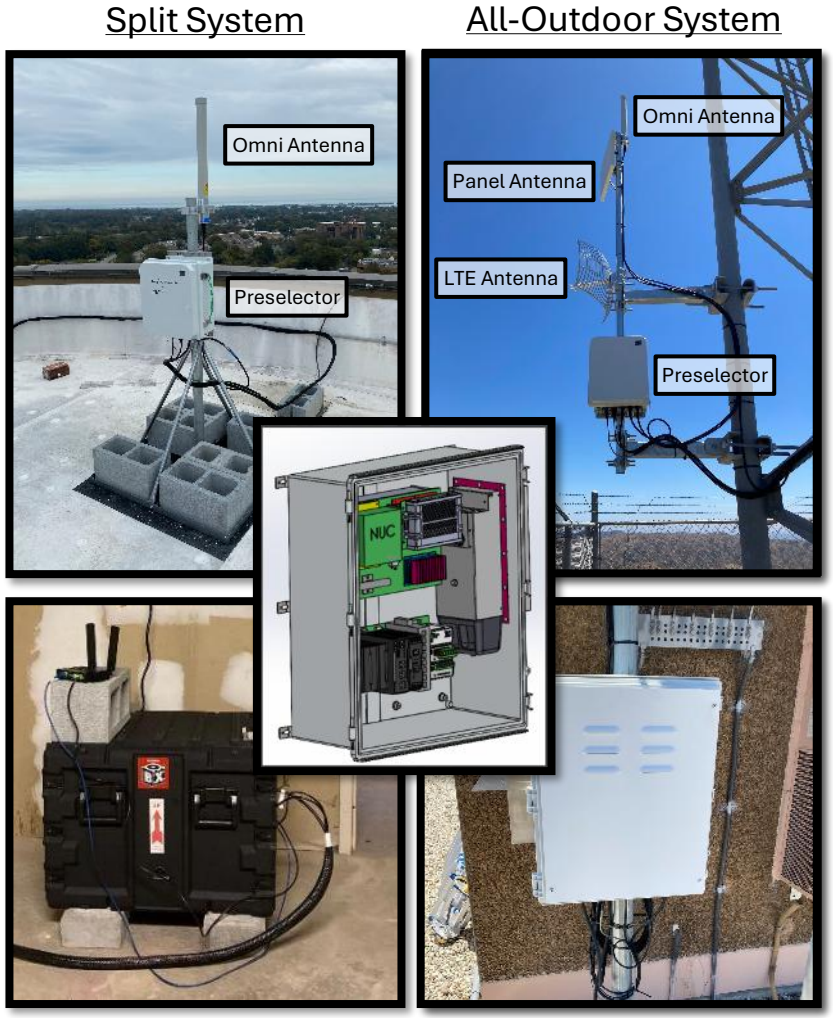
Vacate CBSDs to prevent interference



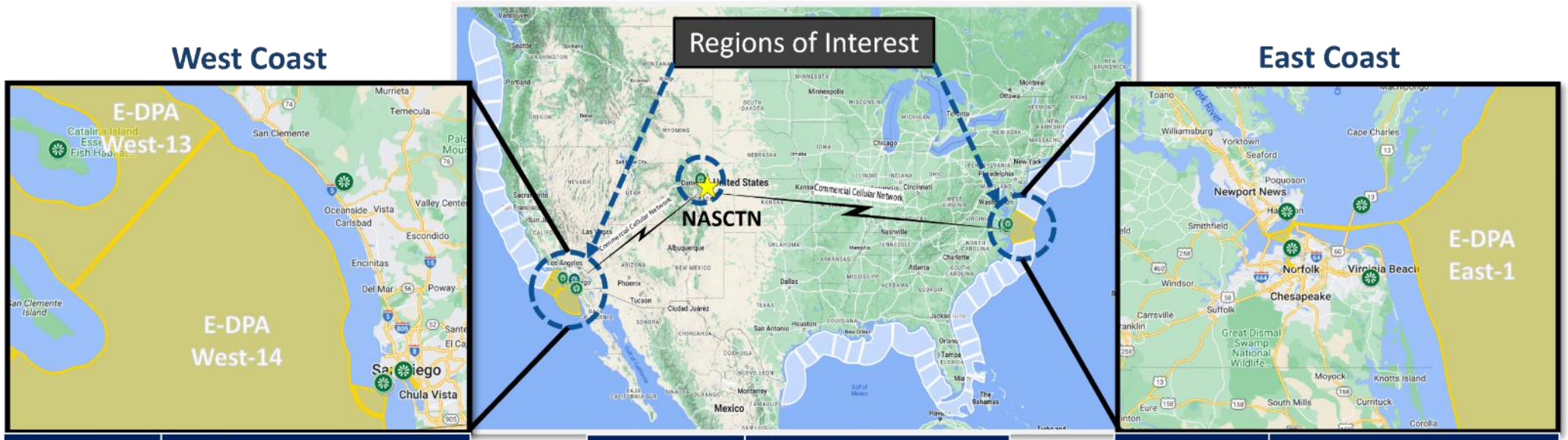
- Detect and vacate scheme – geographic, temporal, and spectral sharing
- Dependent upon **sensing** the incumbent
- Minimize the overhead of sharing

SEA Sensors at a Glance

- Measurement Range: 3530–3710 MHz
- Configurable noise figure: ~5 dB+
- Omni and/or directional antenna
- Wireless backhaul
- Hourly calibrations



SEA Sensor Locations



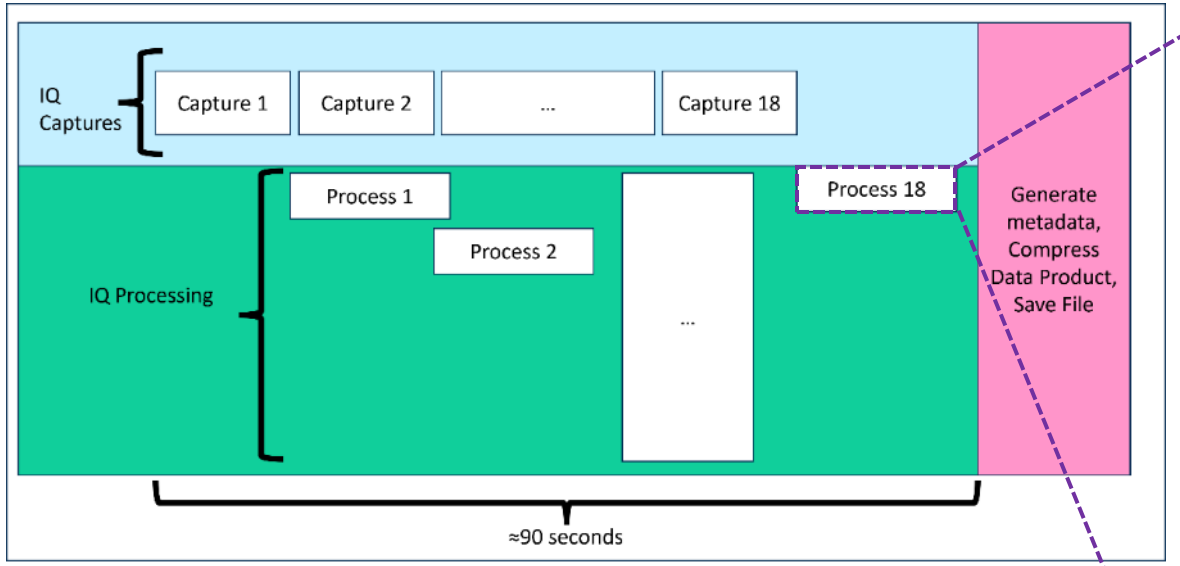
Sensor Name	Location
Catalina	US Coast Guard Tower, Catalina, CA
Pendleton	USMC Camp Pendleton, CA
Midway	USS Midway Museum, San Diego, CA
PtLoma	US Coast Guard Rescue 21, Point Loma, San Diego, CA

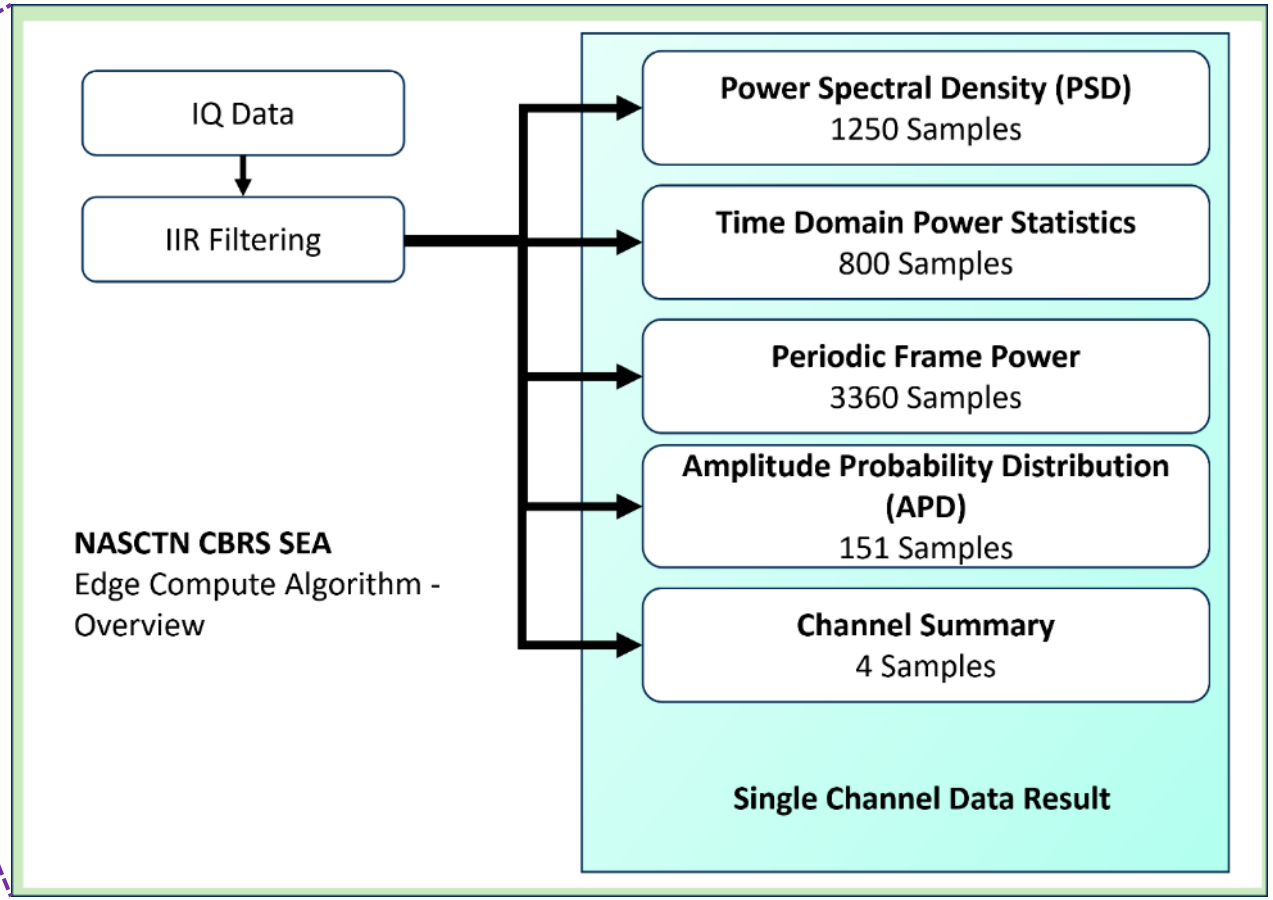
Sensor Name	Location
GMM	Green Mountain Mesa, Boulder, CO

Operates as a control sensor in a non-DPA-controlled region

Sensor Name	Location
NIT	Norfolk International Terminal, Norfolk, VA
HU	Hampton University Tower, Hampton, VA
CBBT	Chesapeake Bay Bridge Tunnel, Chesapeake Bay, VA
Oceana	Naval Air Station Oceana, Virginia Beach, VA

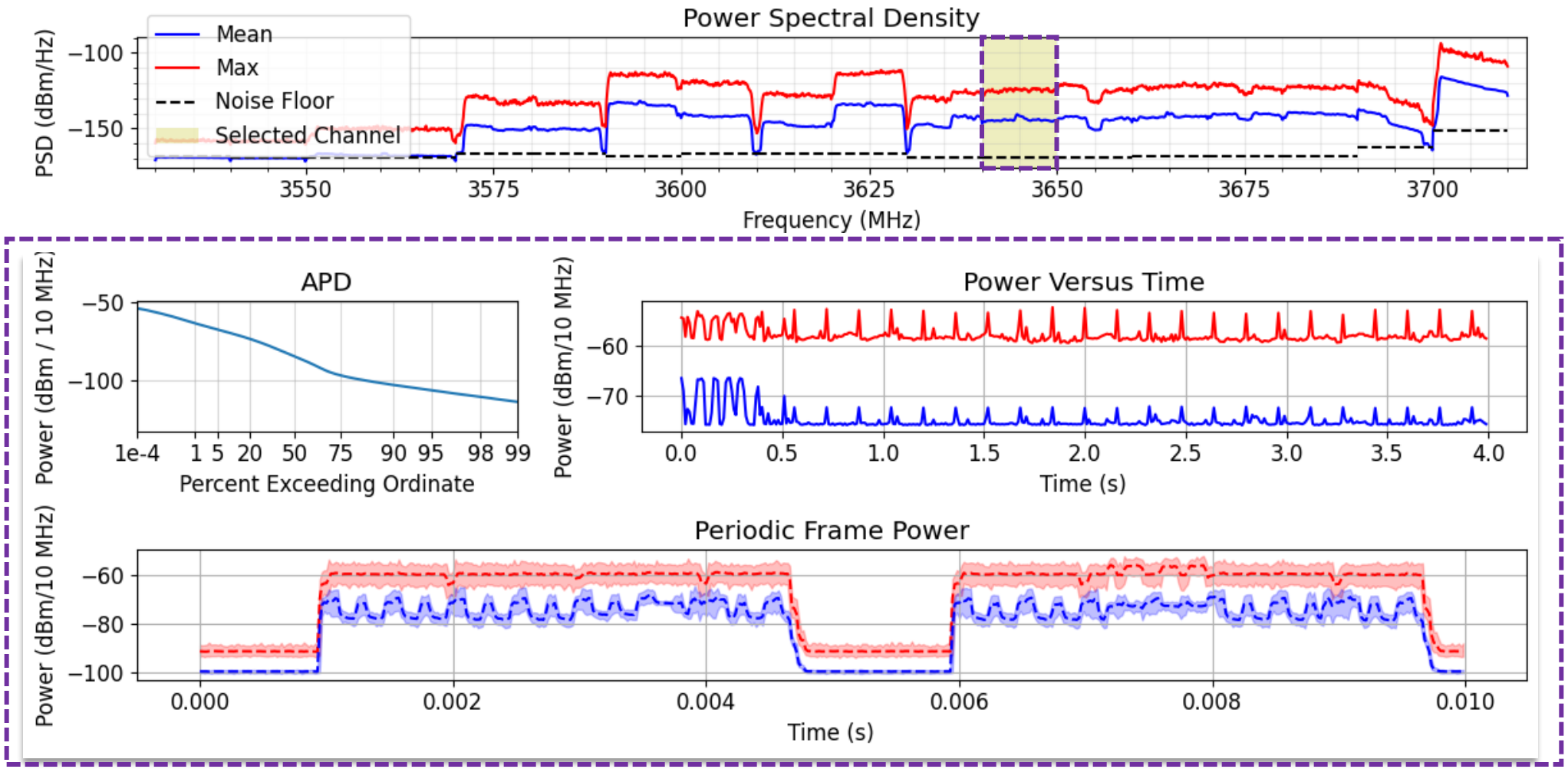
SEA Data Products





- 10 MHz channels with 4 second dwell times
- Multi-processed IQ-derived data products
- Channel revisit time of ~90 seconds
- >10,000x data reduction

SEA Data Products per Channel



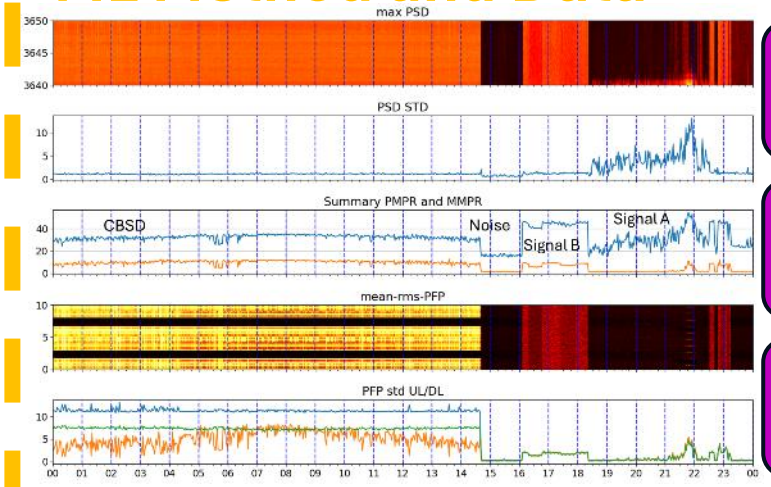
Simple Classifier

Classifier Approach

Data Product

Feature Extraction and Classification *

ML Method and Data*

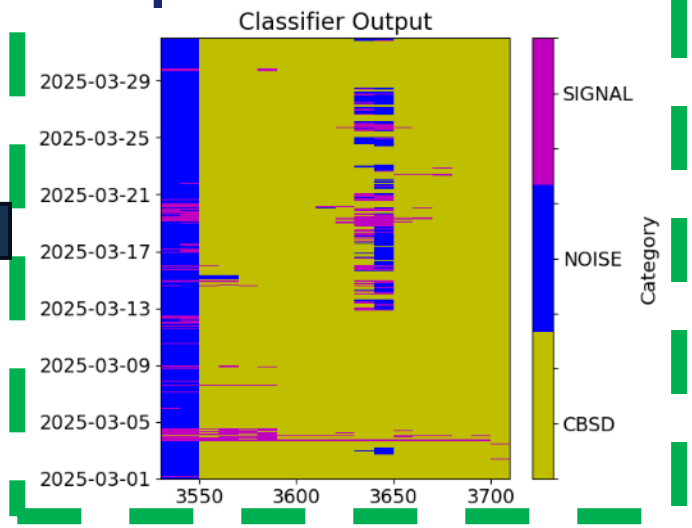


Signal-A

Signal-B

Signal-C

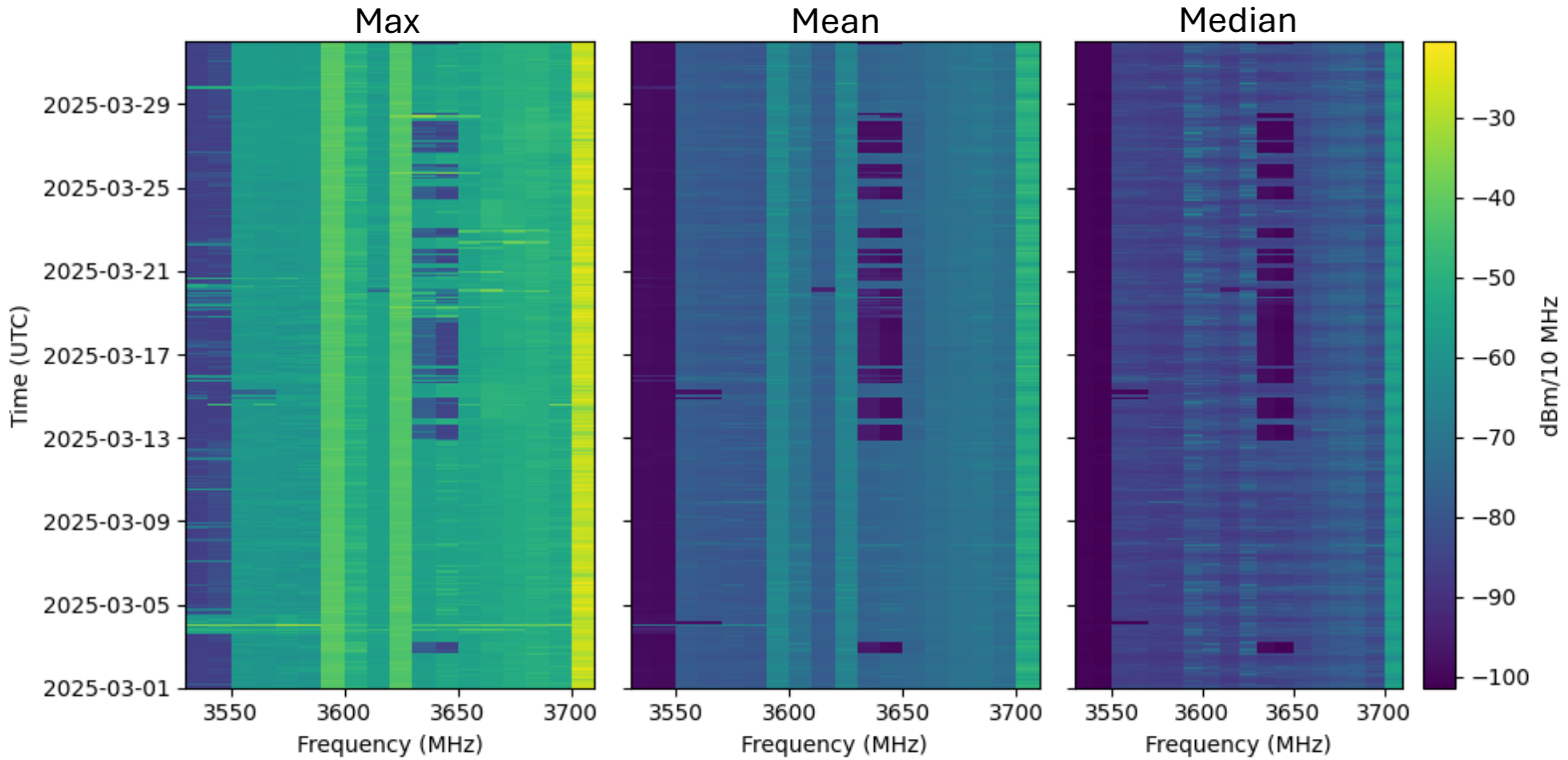
Simple



***Direct identification of any system increases sensitivity**

The Most Compressive Example

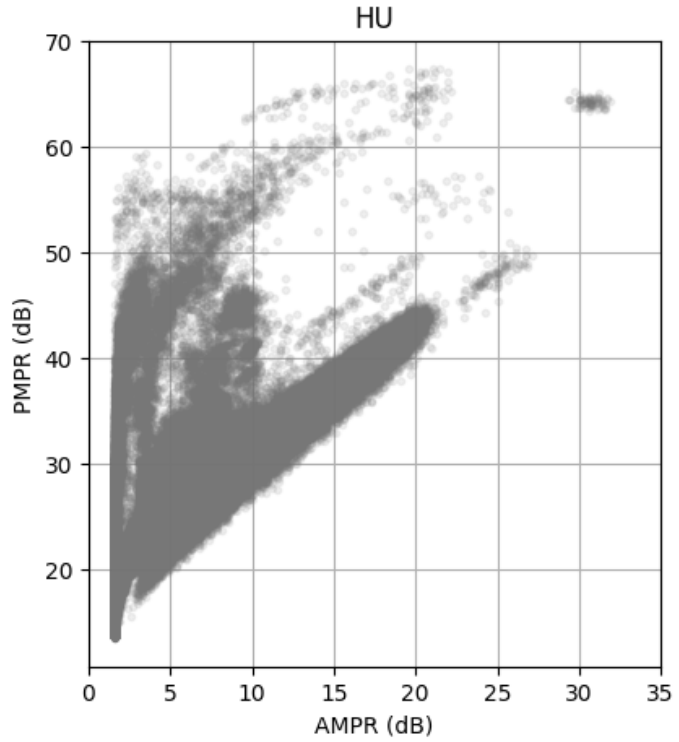
Peak to Median and Average to Median Ratio

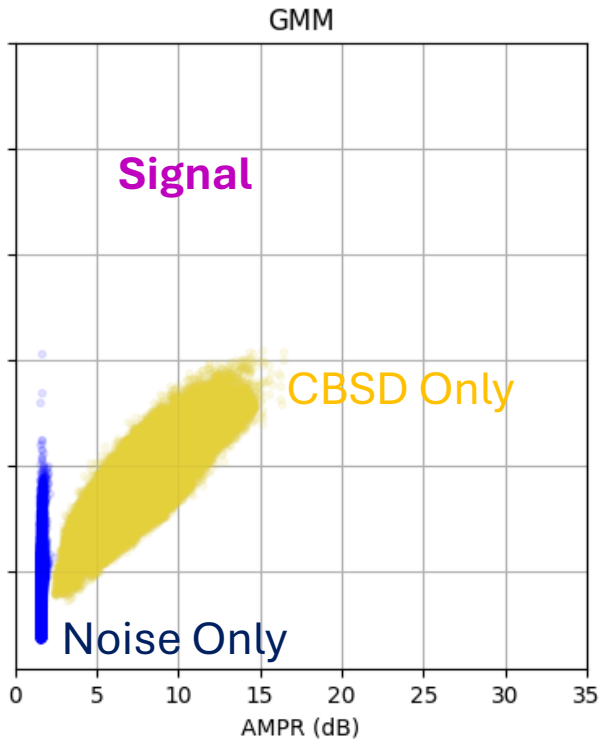


CBSD **Noise** **Signal**

The Most Compressive Example
Peak to Median and Average to Median Ratio

Incumbents Possible



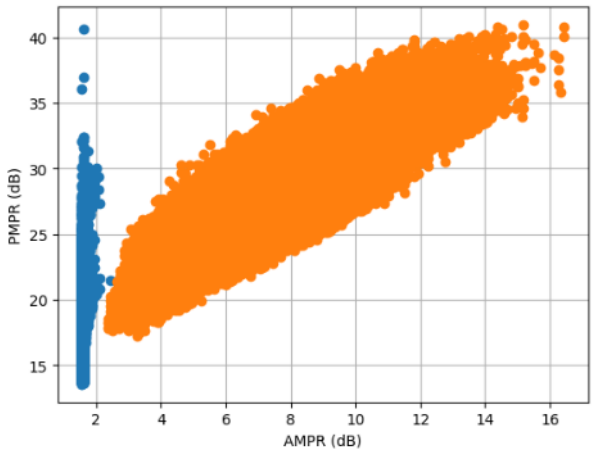


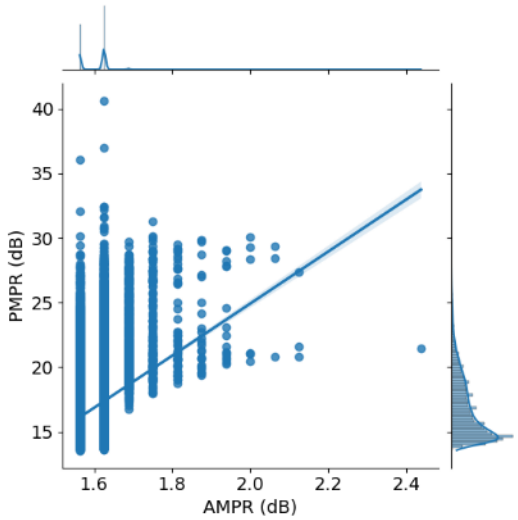
No Incumbent

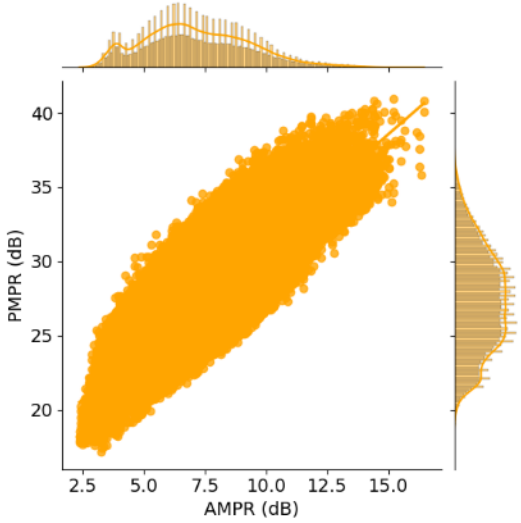
CBSD | Noise | Signal

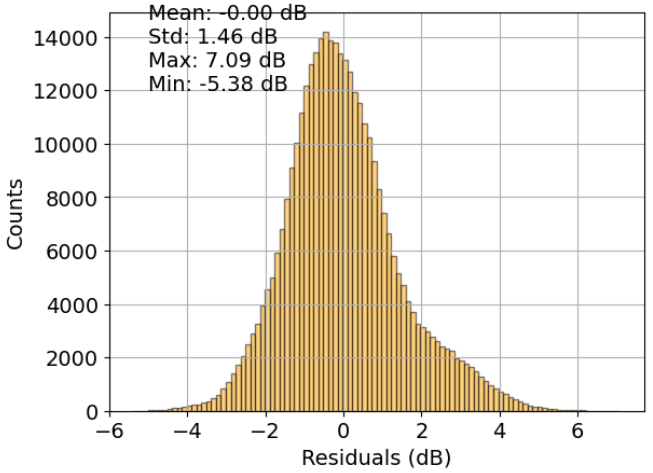
Process to Create Simple Classifier

- Isolate Channels of Noise – (GMM March 2025, 3530–3550 MHz)
- Isolate Channels of CBSD Activity-(GMM March 2025, 3550–3700 MHz).
- Find statistics of noise box (min, max, mean, and std) and identify ranges of interest.
- Linear fit to CBSD activity, characterizing the residuals.

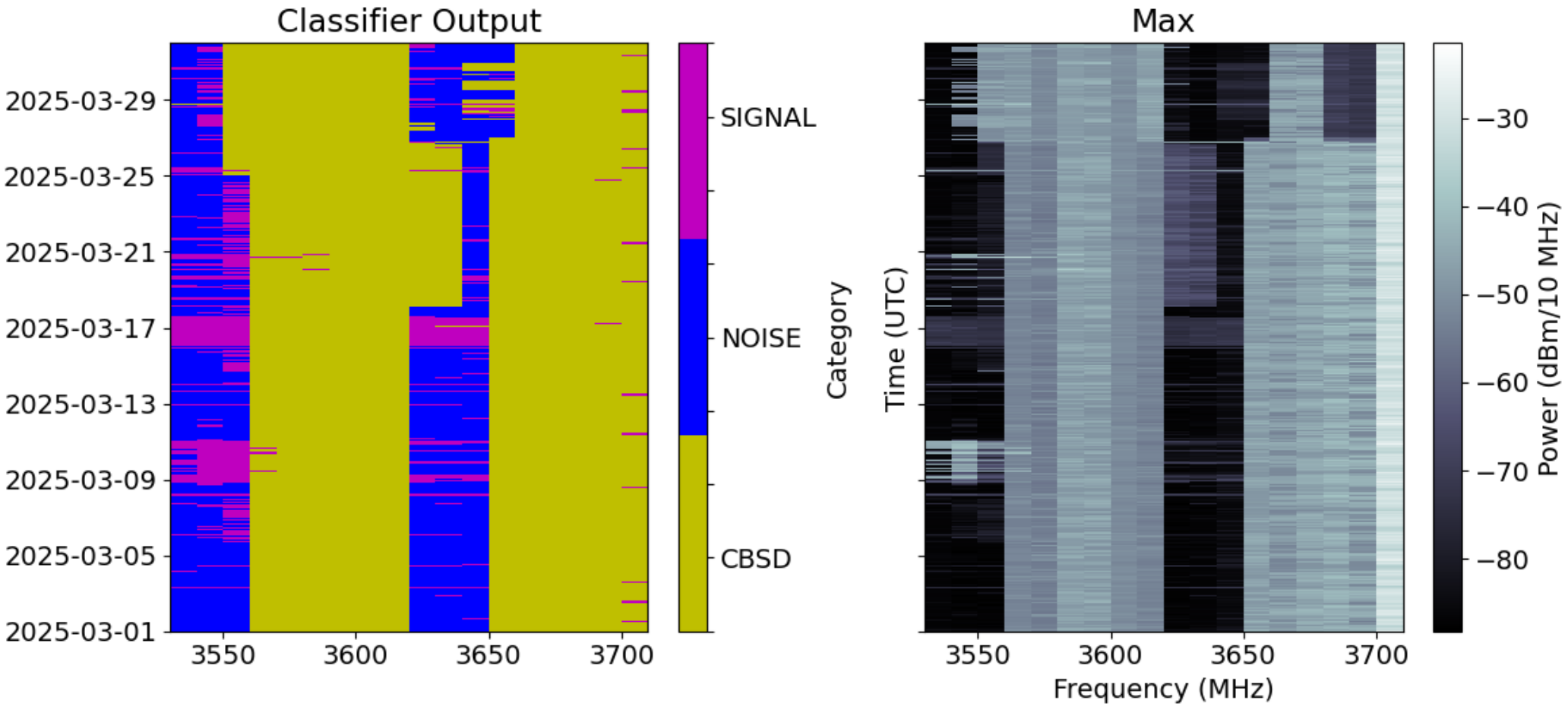






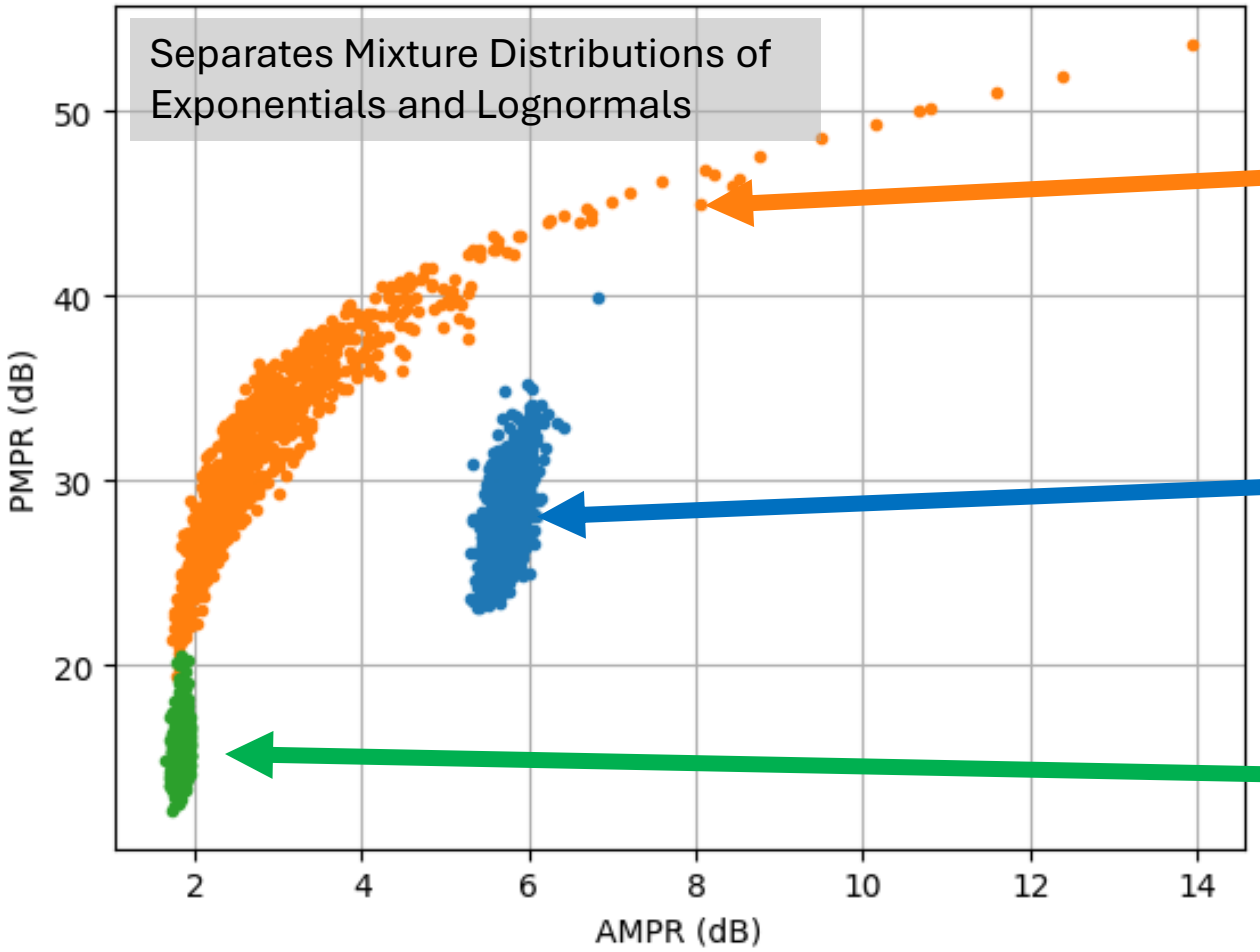


Example Classifier Output – Midway

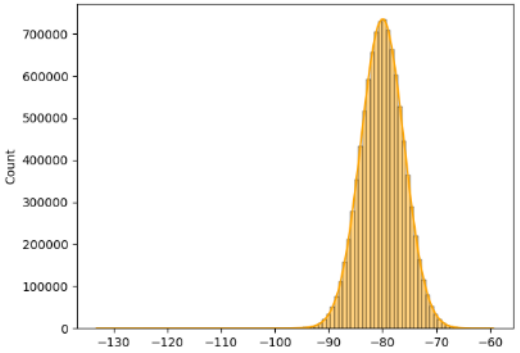


Why It Works – Statistical Test

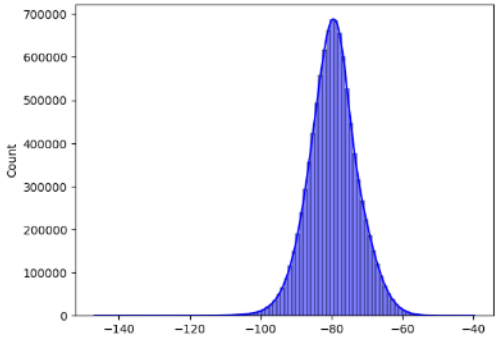
Separates Mixture Distributions of Exponentials and Lognormals



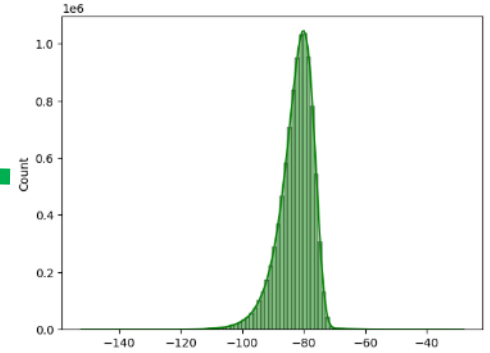
Mostly Lognormal



70/30 Exponential /Lognormal

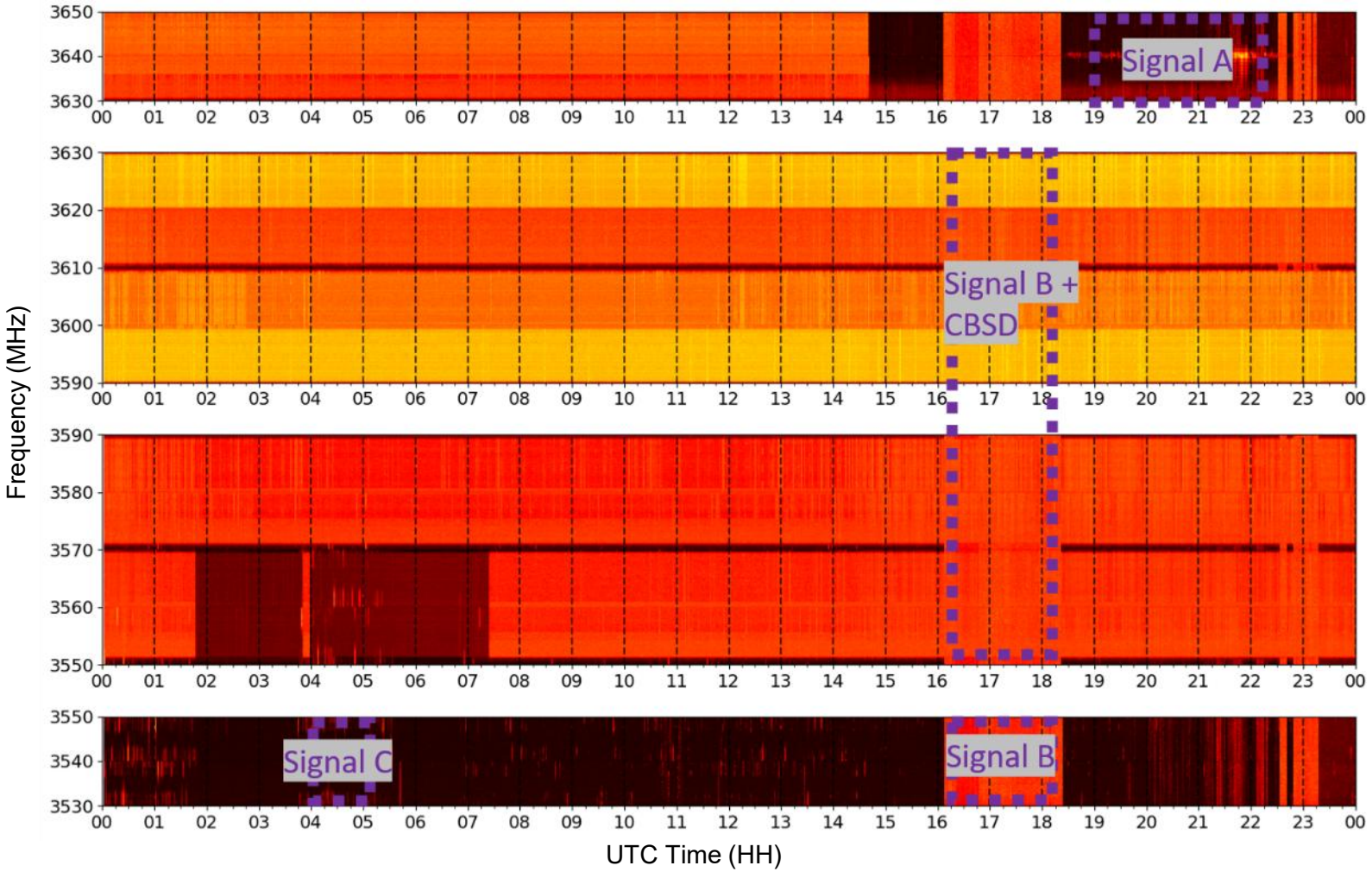


Mostly Exponential



Machine Learning Classifier

Reduced Dimensionality Signal Classification



Reduced Dimensionality Signal Classification

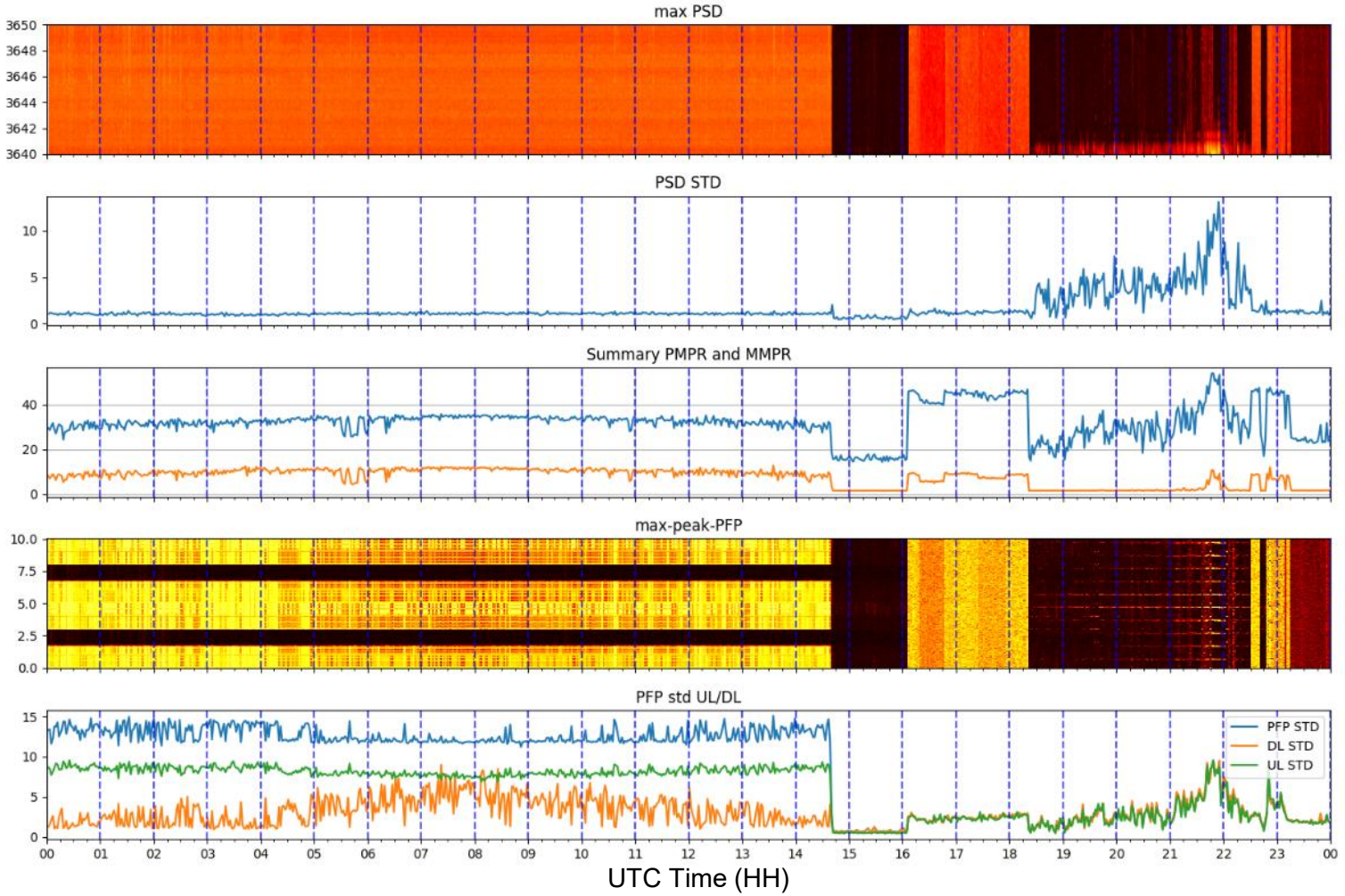
Original Data Product: *MAX PSD*

Derived Data: **Standard Deviation along frequency**

Derived Data: **Peak-to-Median and Mean-to-Median Power Ratios**

Original Data Product: *MAX-PEAK PFP*

Derived Data: **Variation over full frame and separated uplink/downlink**

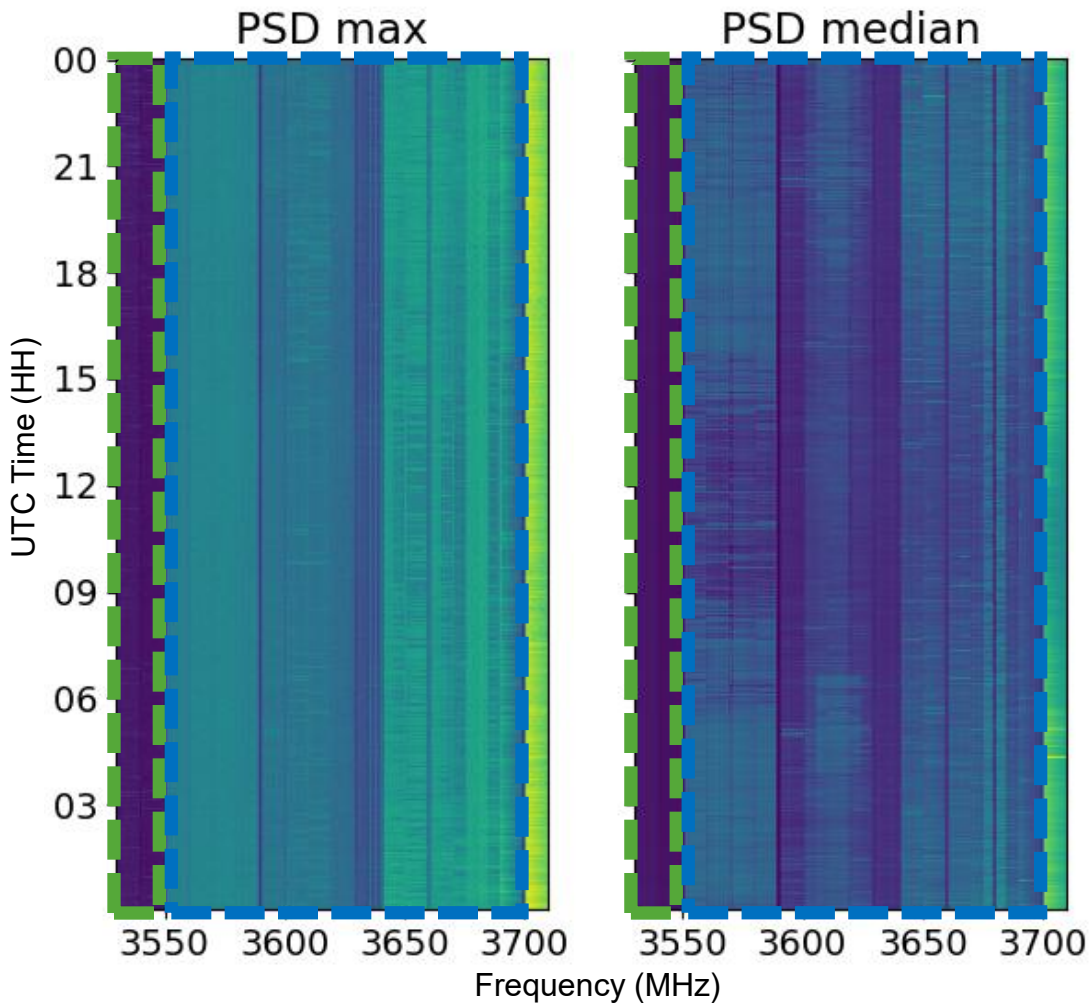


Noise and CBSD Training Set

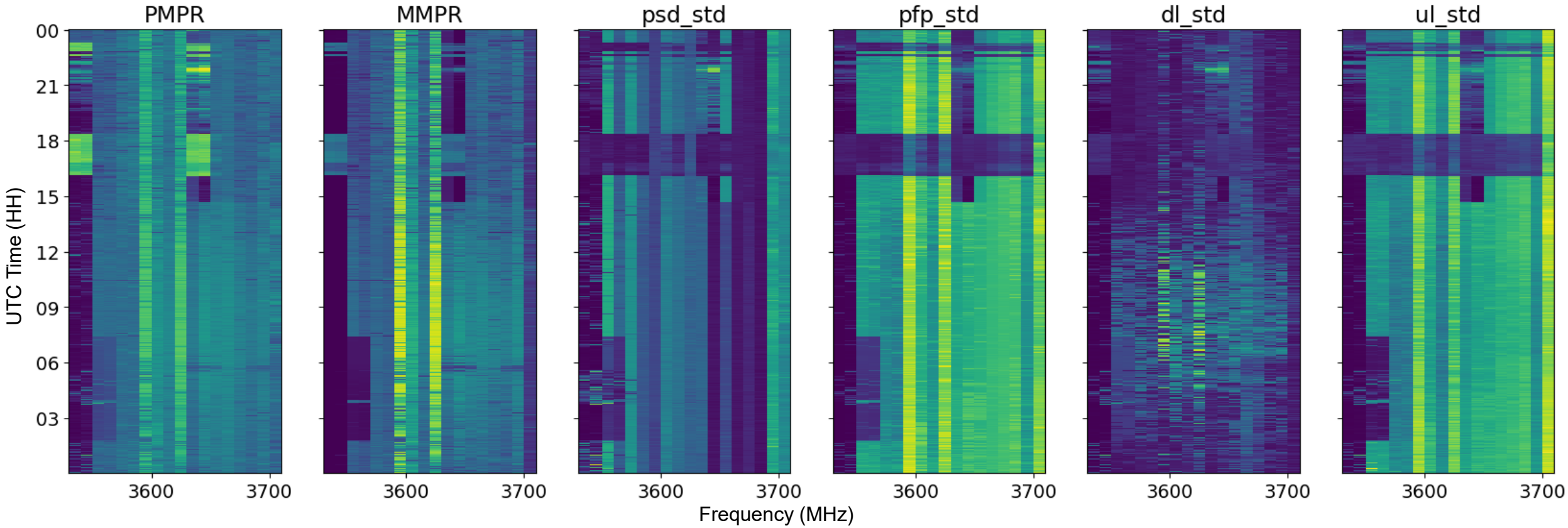
Training for Noise is GMM for Center Frequencies of 3535 and 3545 MHz

Training for CBSD is GMM for Frequencies of 3550–3700 MHz

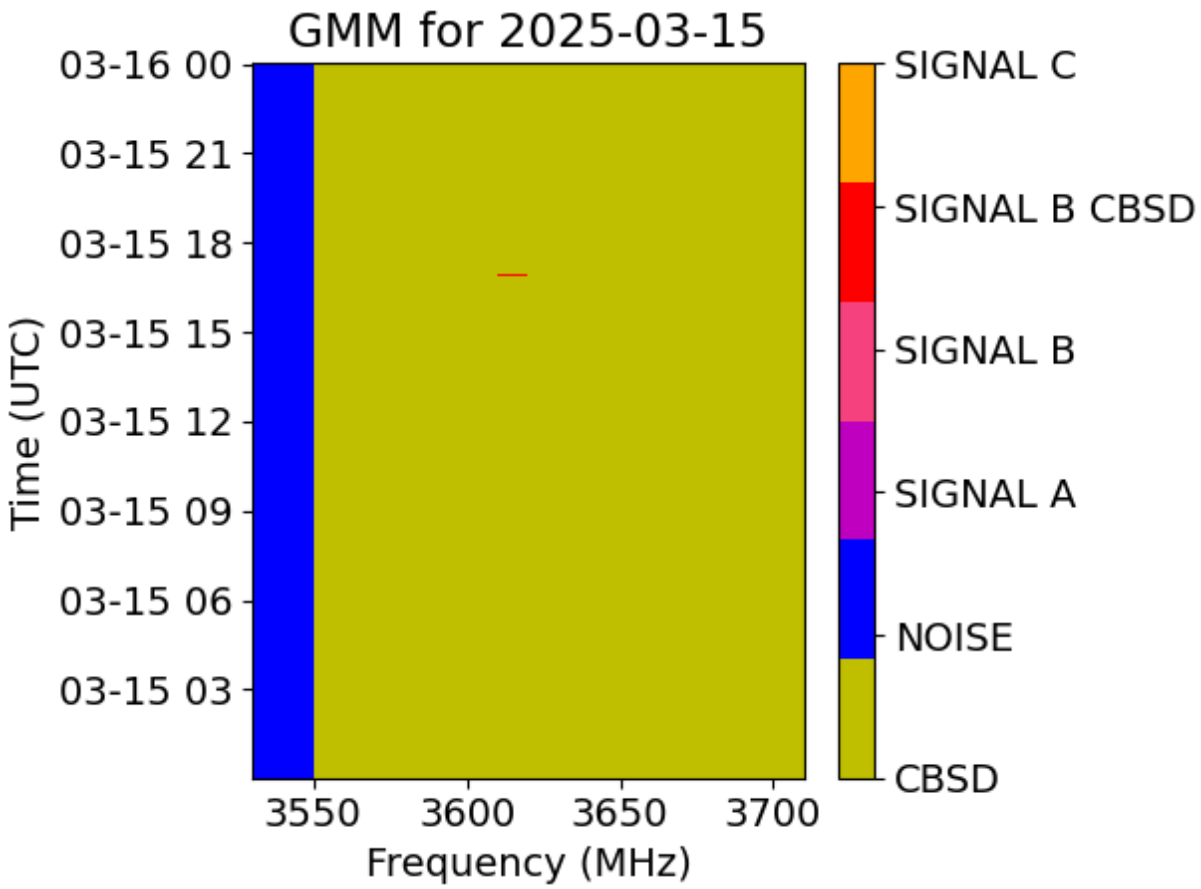
Classifier is **Histogram-based Gradient Boosting Classification Tree**

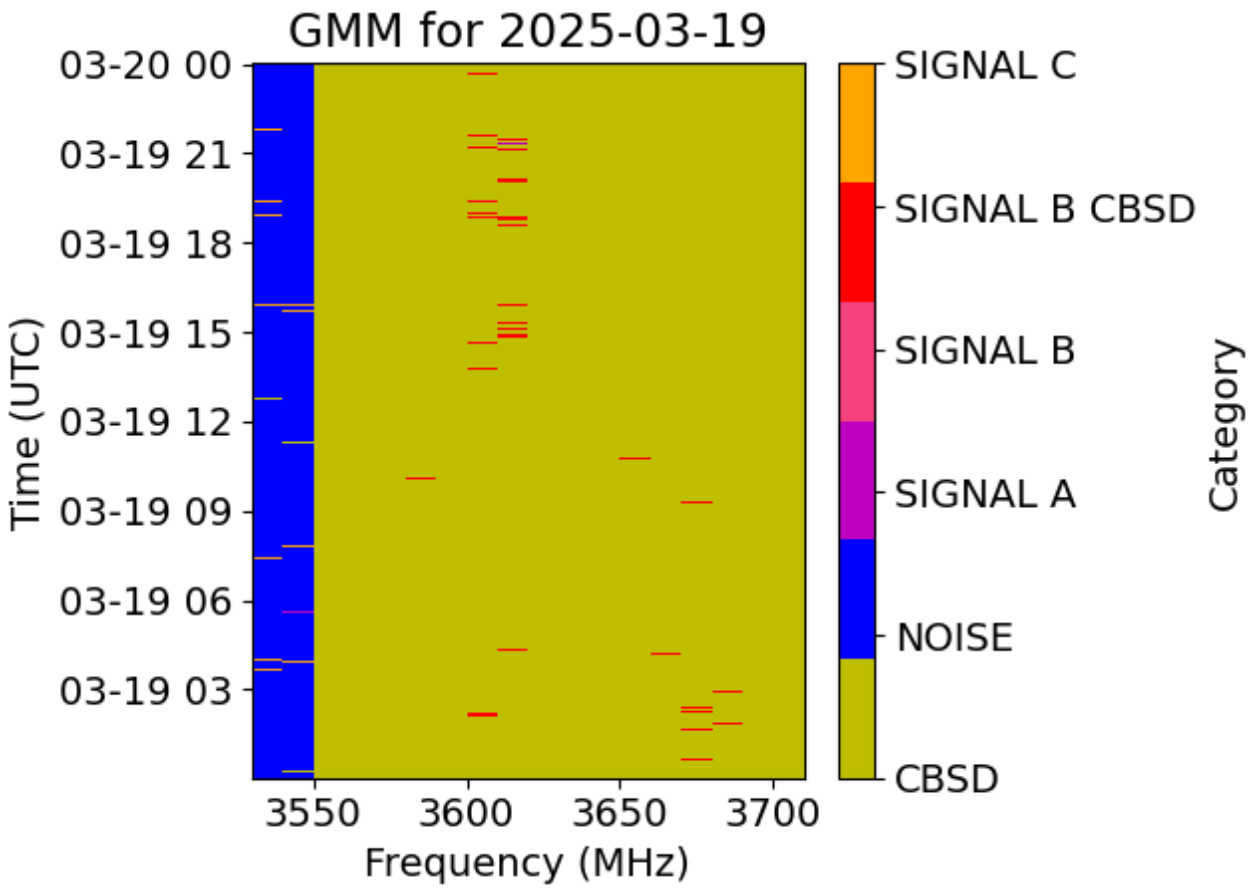


What the Classifier "Sees"

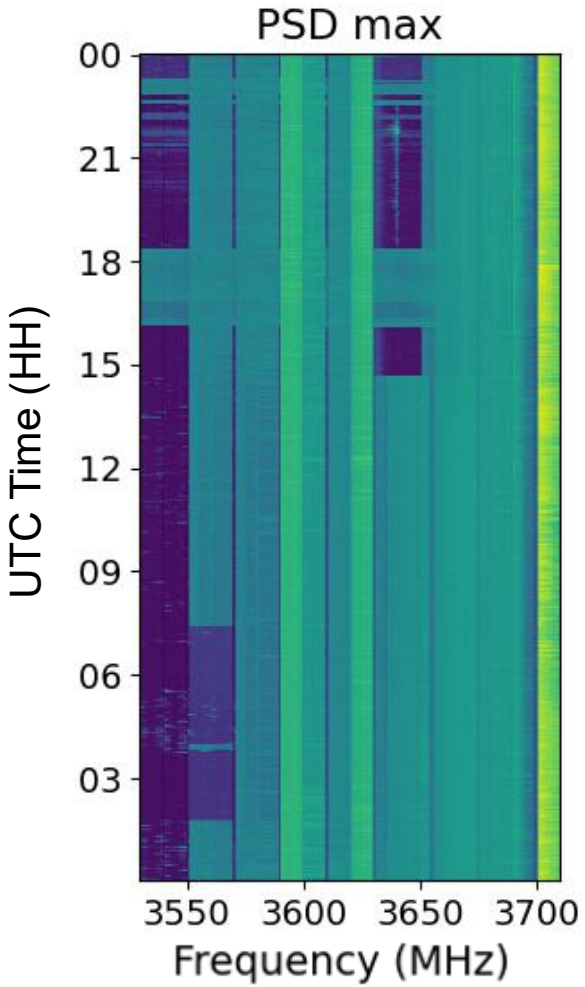


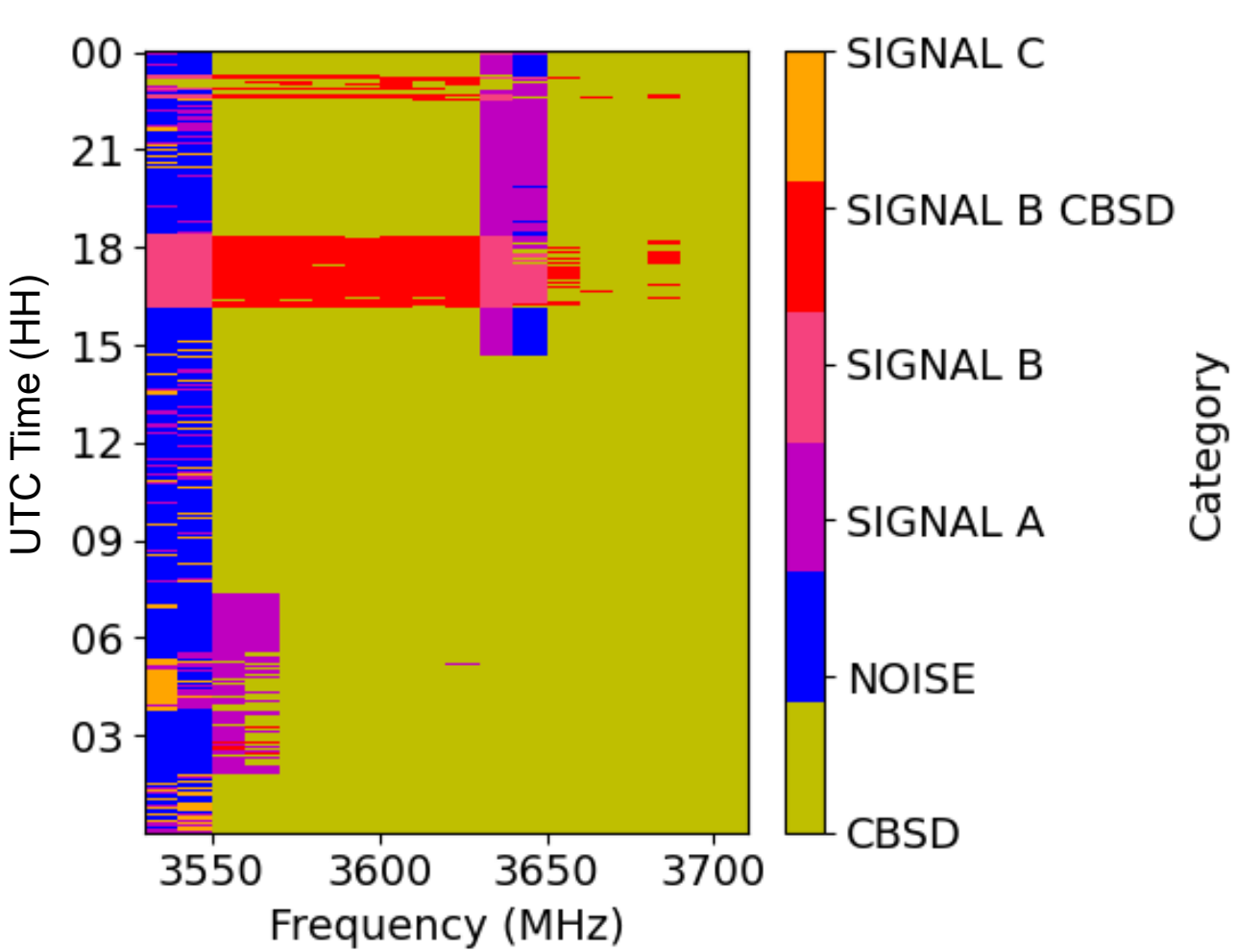
Classifier Results - Control GMM





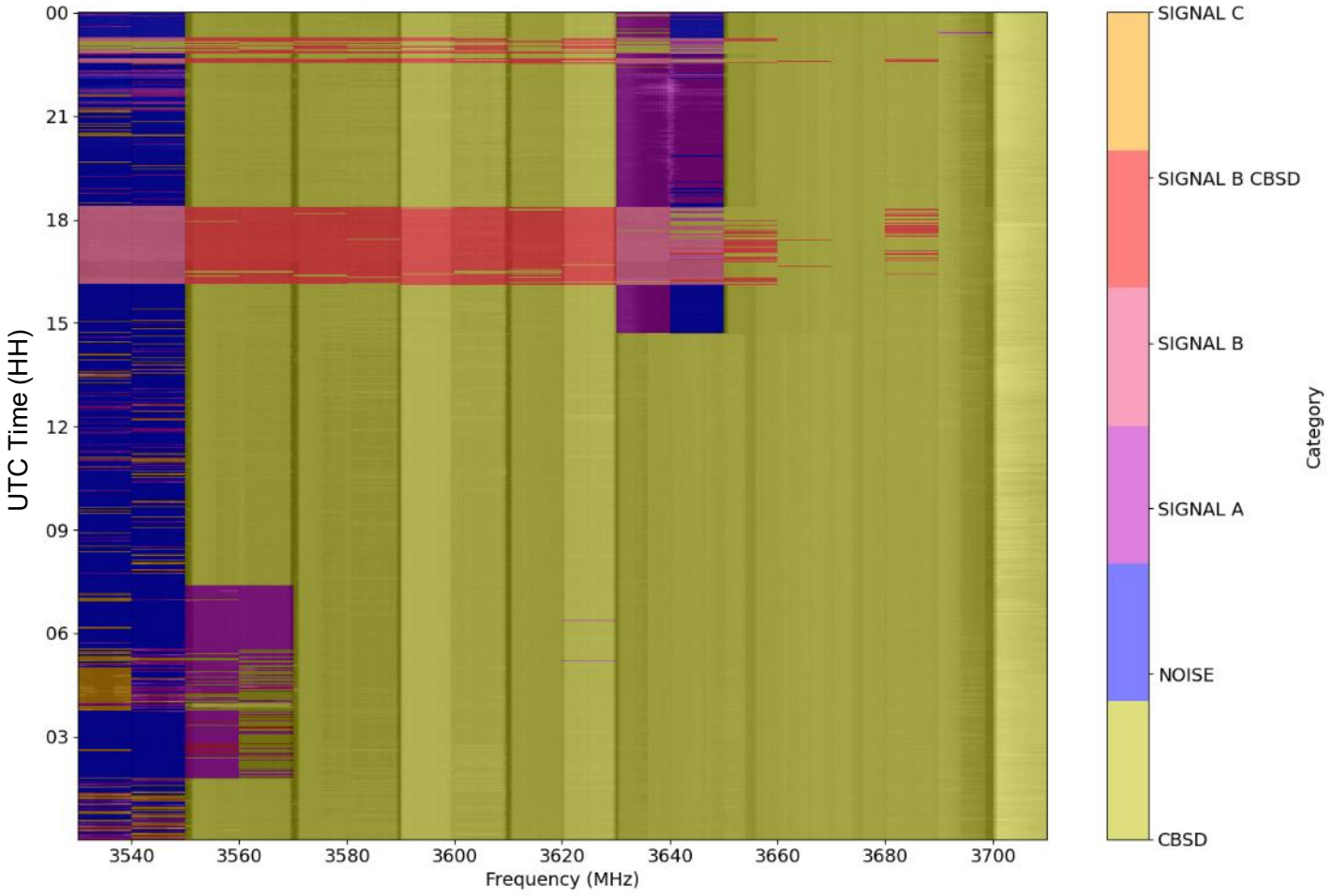
Classifier Results – East Coast





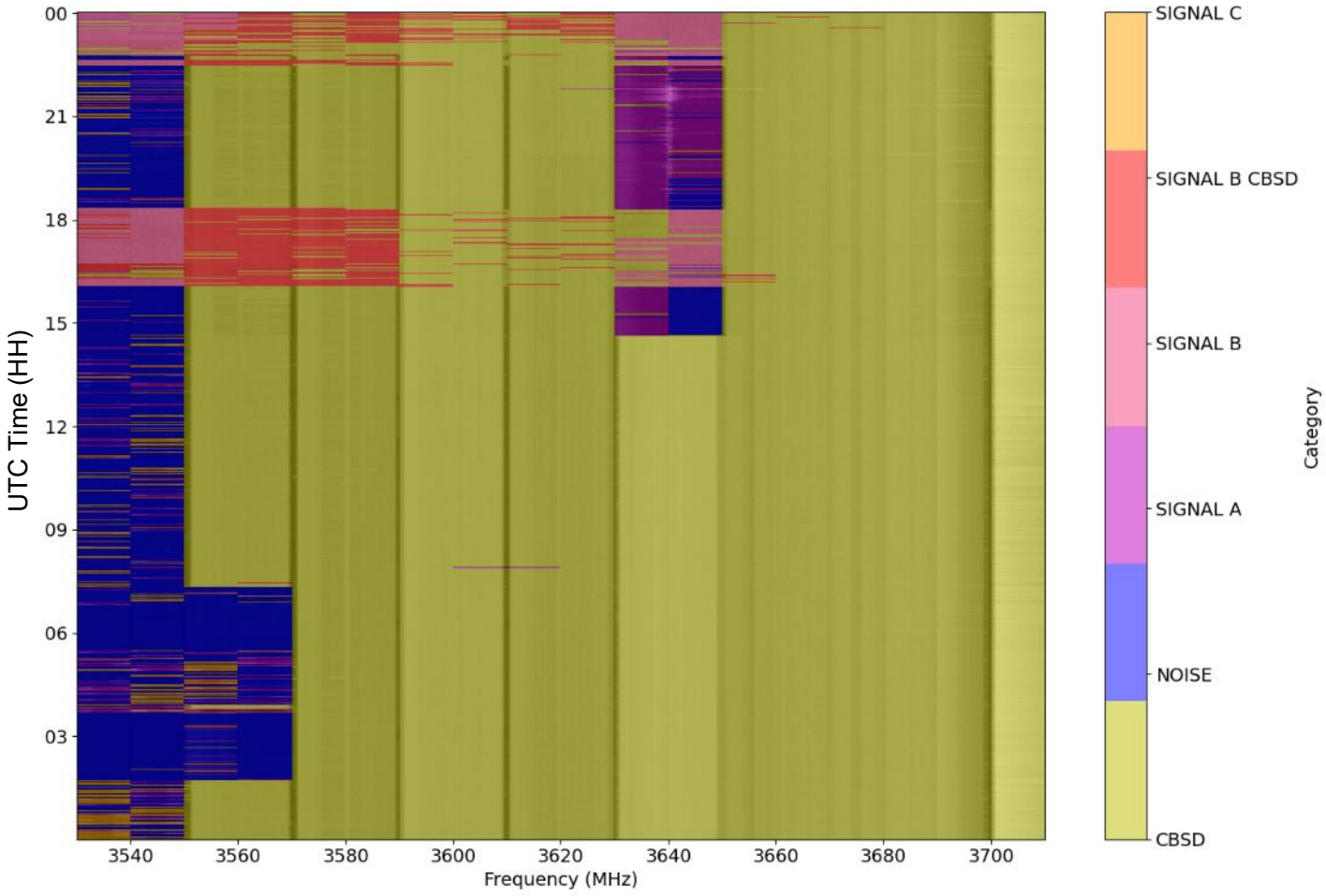
Classifier Results – Blended Map

Blended PSD and Classification Map



Classifier Results – Second Sensor

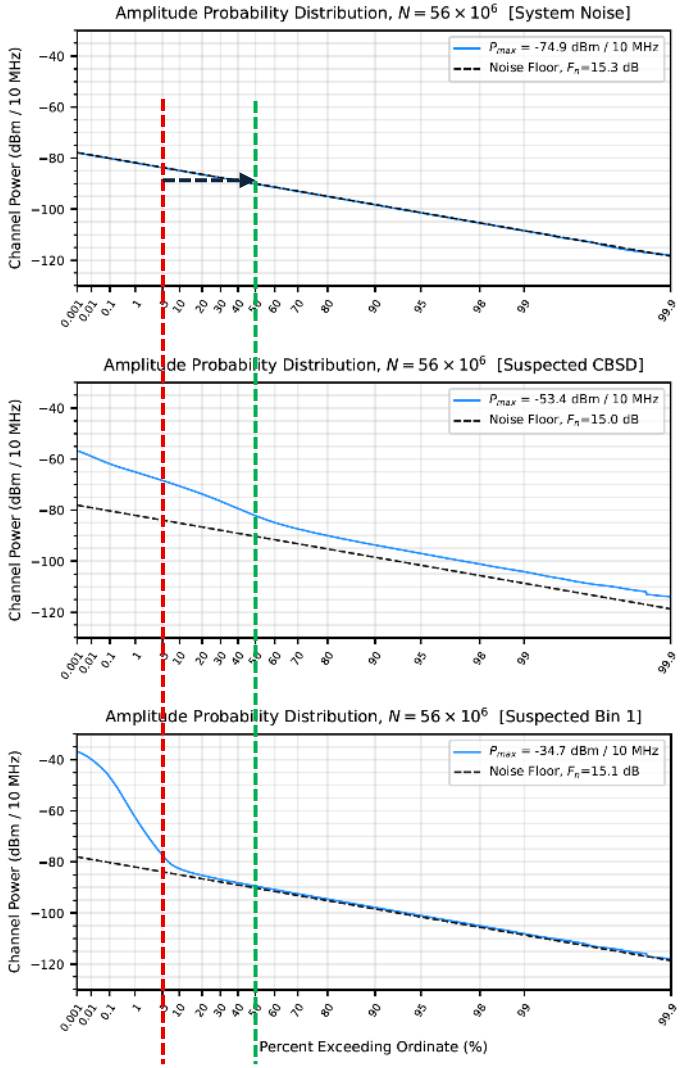
Blended PSD and Classification Map For Second Sensor

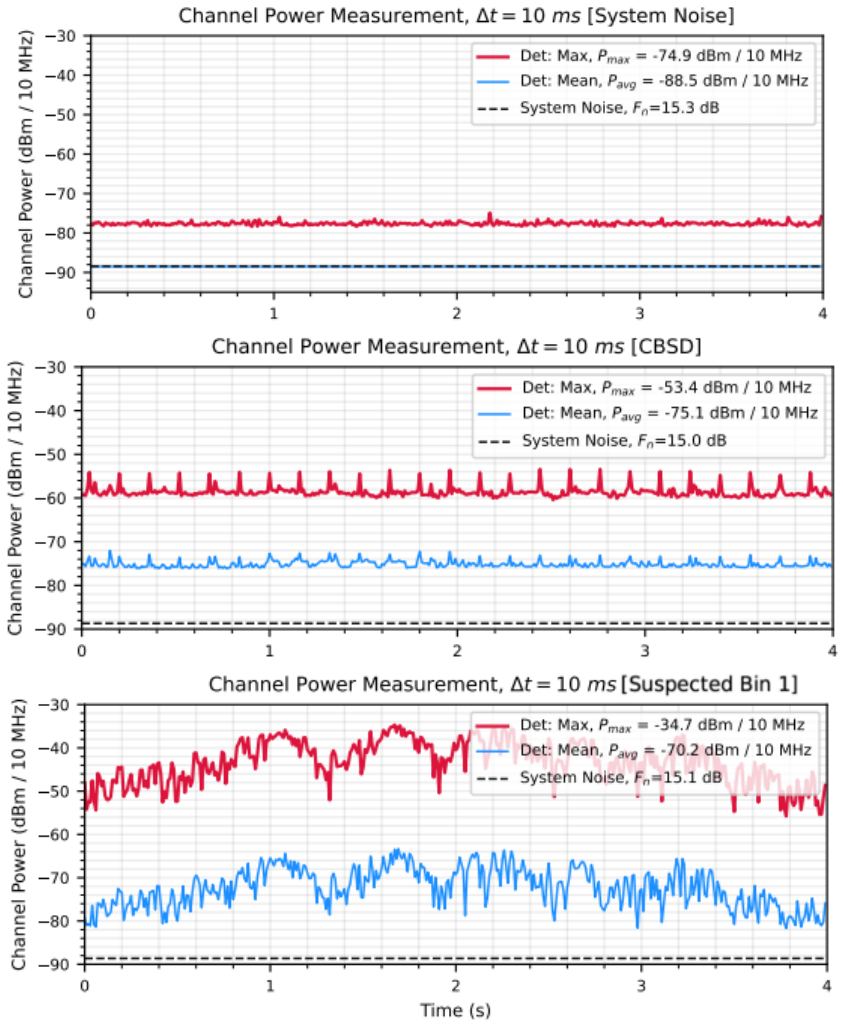


Summary

Additional Metrics Available

Amplitude Probability Distribution

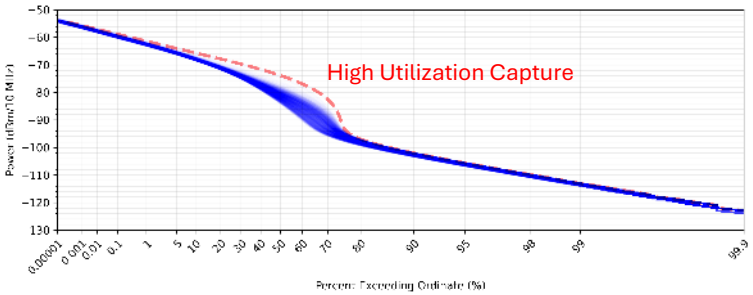


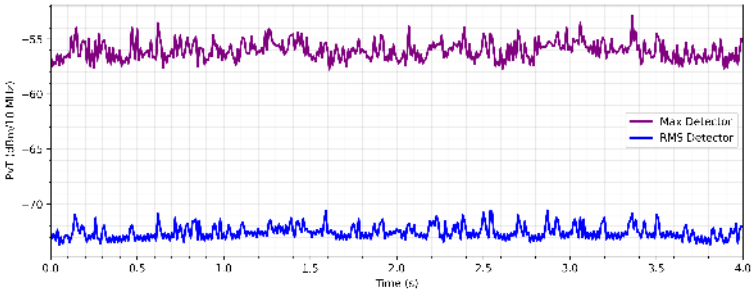


Power vs Time

Additional Analyses – CBSD Behavior

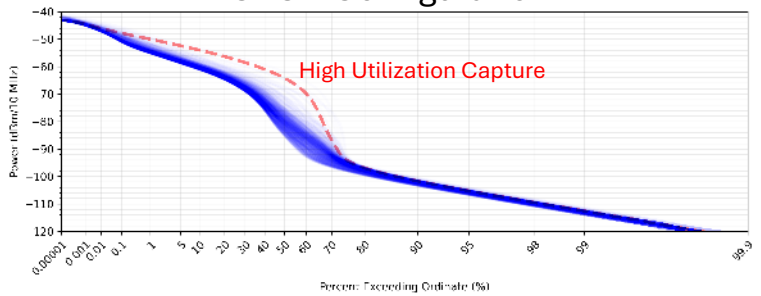
CBSD Configuration 1

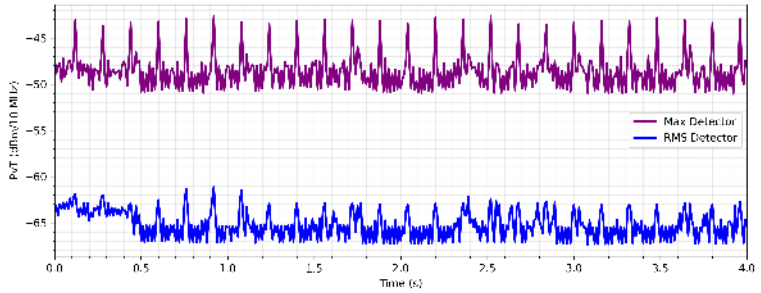


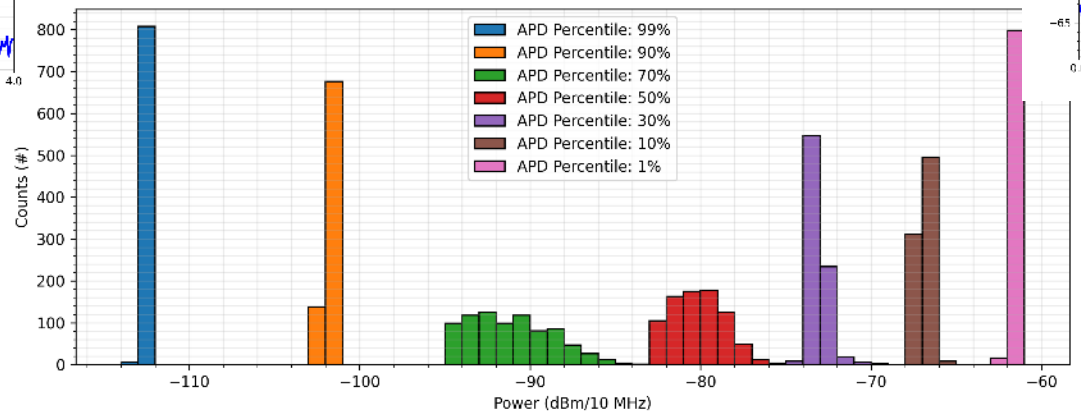


Further classify within the CBSD group to view different CBSD configurations

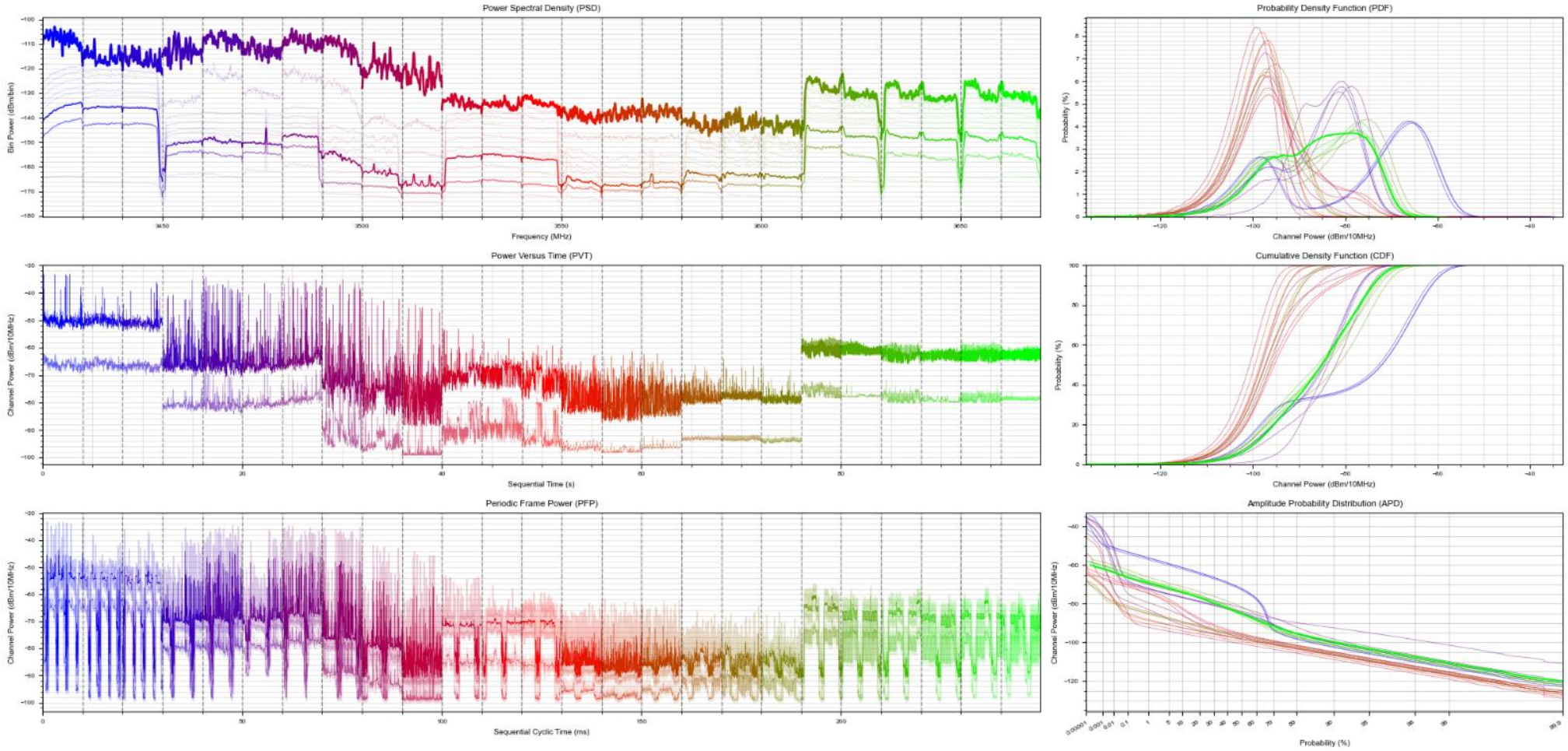
CBSD Configuration 2







Full Data Product



Summary

- Deployed sensor network longitudinally with over 95% reliability in key regions:
  - Norfolk VA (DPA: EAST-1), San Diego CA (DPAs: West-13 & West-14)
  - USMC Camp Pendleton (Always On DPA)
- Provided a mechanism for stakeholders to get access to pre-decisional sensor data sets. Data is updated weekly.
- Implemented *WinnForum Reference models using CBRS 1.0 and CBRS 2.0* assumptions to corroborate expected received aggregate emissions using industry-provided, obfuscated, and real Spectrum Access System – "Full-Activity-Dump" data sets.
- Devised a simulation for modelling informed sensor fielding.
- Provided corroboration to CBRS response in the first of its kind active measurement campaigns of coordinated Federal Incumbent systems exercising Harbor DPAs in Norfolk, VA, and San Diego, CA.
- Measured end-to-end CBRS vacate response to Federal incumbent systems.
- UAS-based wide area Sensor Validation Technique.

Enabling Agencies and Partners

- Test Teaming:
  - NIST CTL, NTIA-ITS, NASA Langley Research Center, MITRE Corporation
- Special thank you to core partners that have enabled, contributed, and strengthened the test campaigns:
  - DOW CIO, DON CIO, USMC IC4, NSWC DD
  - Working Groups:
    - Government and Industry members of the CBRS I-JWG, WInnForum
  - Sensor Hosts:
    - Hampton University, Port of Norfolk, NAS Oceana, Virginia DOT
    - USMC Camp Pendleton, US Coast Guard Rescue 21 Program, US Navy Point Loma, USS Midway Museum

Q&A

Data Access

https://pages.nist.gov/SEA-DATA/

Data Manual

https://nvlpubs.nist.gov/nistpubs/TechnicalNotes/NIST.TN.2359.pdf

Sensor Documentation

https://www.mitre.org/sites/default/files/2026-01/PR-25-3159-spectrum-monitoring-sensor-radio-service-assessment.pdf