Satellite Conjunctions in the RF Spectrum: Learning out From an RF Measurement Campaign of LEO Objects

02.09.25

26th ISRMM, Athens, Greece

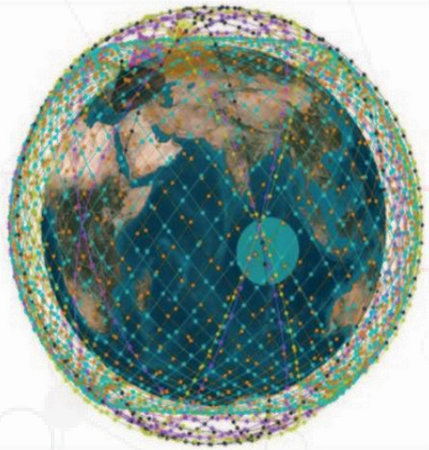
RF Space Domain Downlink Settings

Main Stakeholders and Measurement Setting

OneWeb

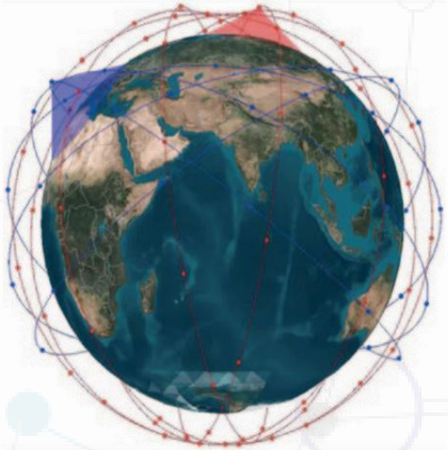
Ku

Starlink

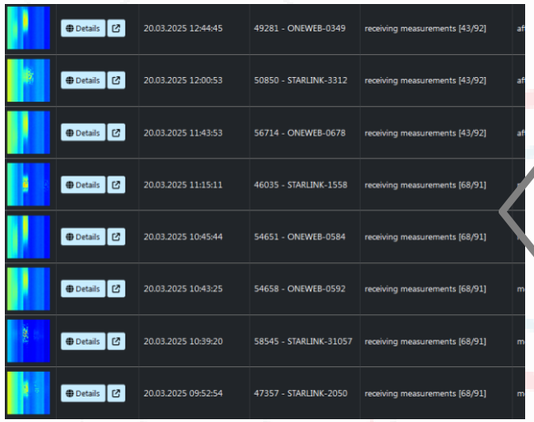


Ku
Ka

Telesat



Ka



Moving targets

Measurement strategies

Cataloguing

- Automated and systematic NON-GSO RF monitoring
→ everything scanning
→ RF properties to ‘every object’
→ Background process

Targeting

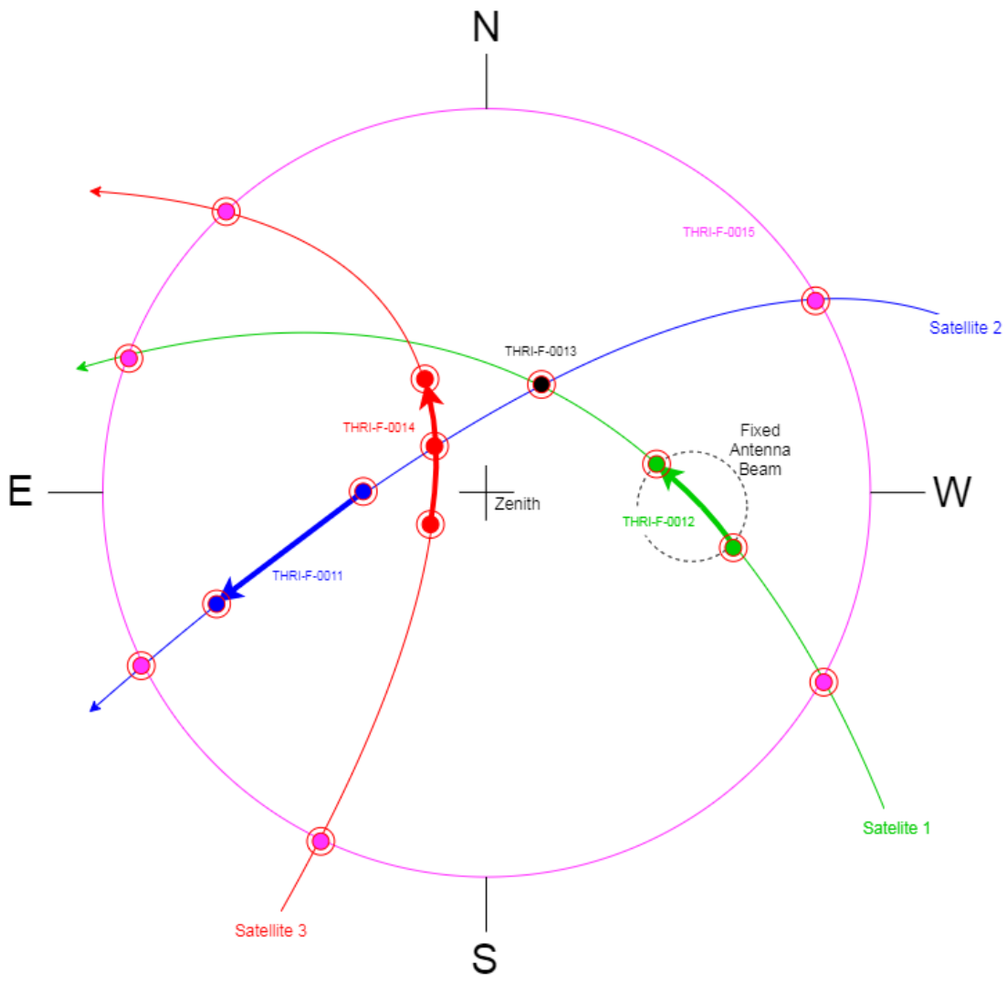
- Event based, triggered measurements of objects
→ Foreground measurements
→ Selection of objects of specific interest

Scanning

- RF-measurements with fixed antenna
→ simple, arrays possible (Fly-Eye)
→ short measurement cycles

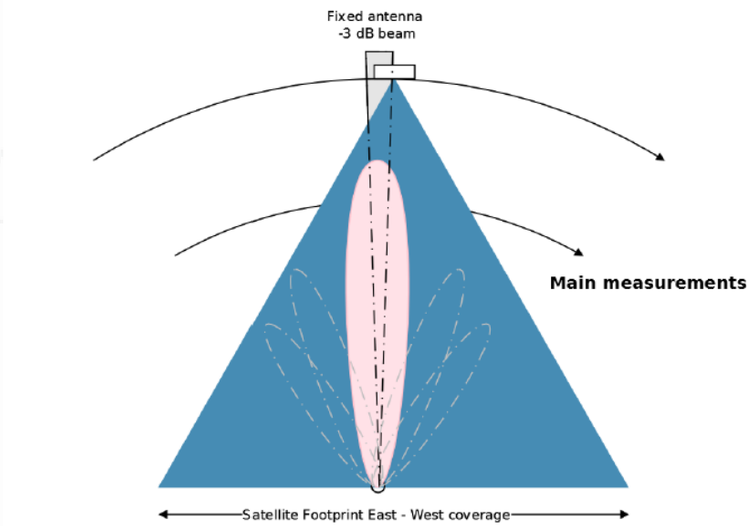
Tracking

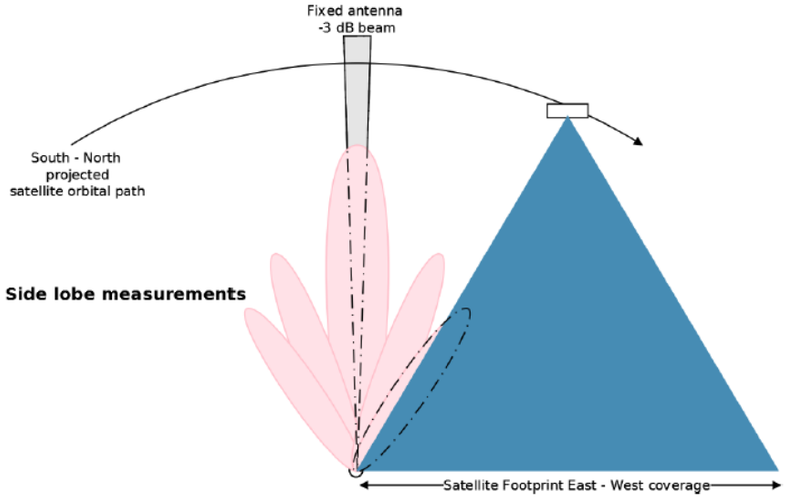
- RF-measurements with tracking (full motion) antenna
→ one-fits-all solution, channelling in SW and HW operations
→ long measurement cycles
→ satellite antenna pattern measurements possible (min Tx elevation)

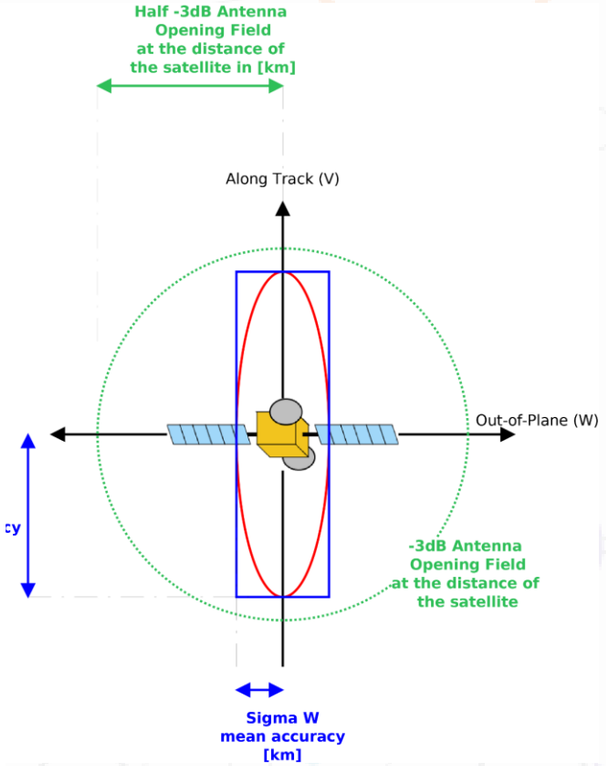


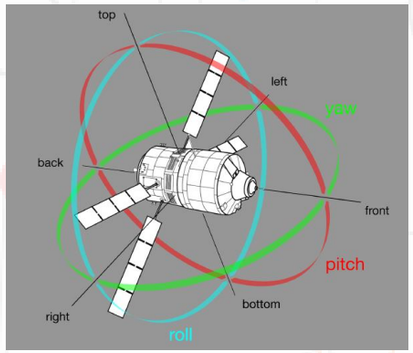
Objects are flying through an Antenna Rx Beam

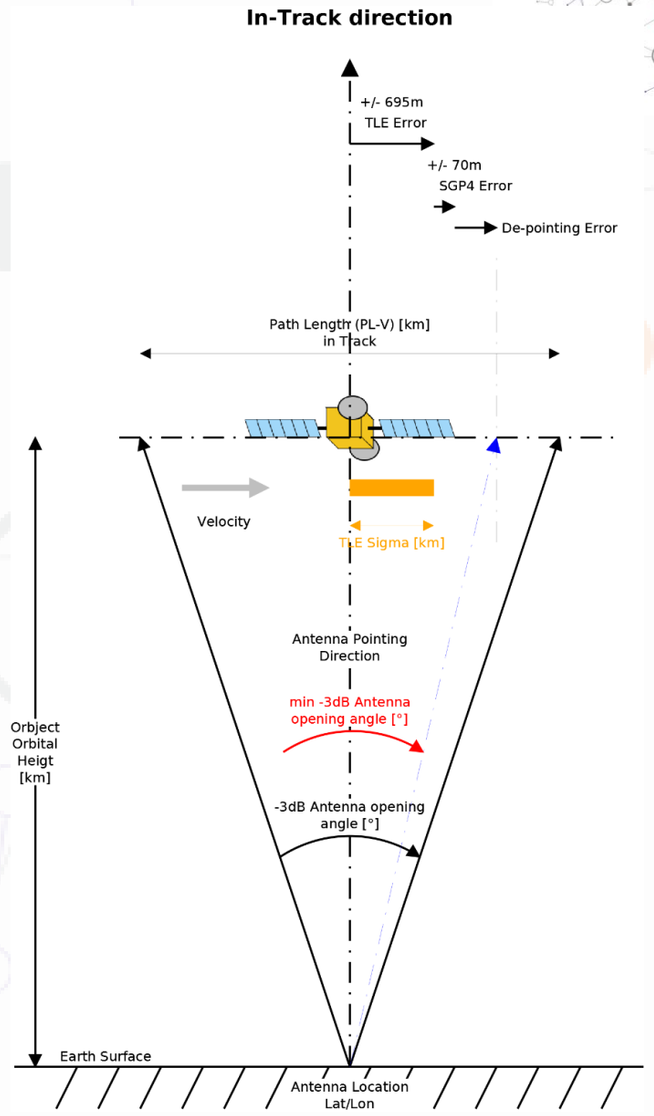
Uncertainties











In the best case: the object transmits something

In the worst case: the object transmits something

Results and Statistics

Numbers and System

Ground Infrastructure

Number of Ground Stations in the System:	13
Active in the Last 30 Days:	1

Space Objects

Total Objects in Catalogue:	30591
Payload:	15453
Debris:	11438
Rocket Bodies:	2269
Unknown:	1431
Decayed Objects:	1859
Payload:	981
Debris:	622
Rocket Bodies:	88
Unknown:	168
Active Objects:	28732
Payload:	14472
Debris:	10816
Rocket Bodies:	2181
Unknown:	1263
Catalogue Last Update:	24.07.2025 11:00 (UTC)
Catalogue Next Update:	24.07.2025 17:00 (UTC)

Measurements

Total in the System		53264
With Carriers		23187
	ordered	received
Last 7 Days:	2300	1895
Last 24 Hours:	413	288

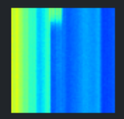
Repeated Measurements

Total	6234
Last 7 Days:	181
Last 24 Hours:	1

Objects with measurements

Total	6956
With Carriers	4416

Latest Measurement

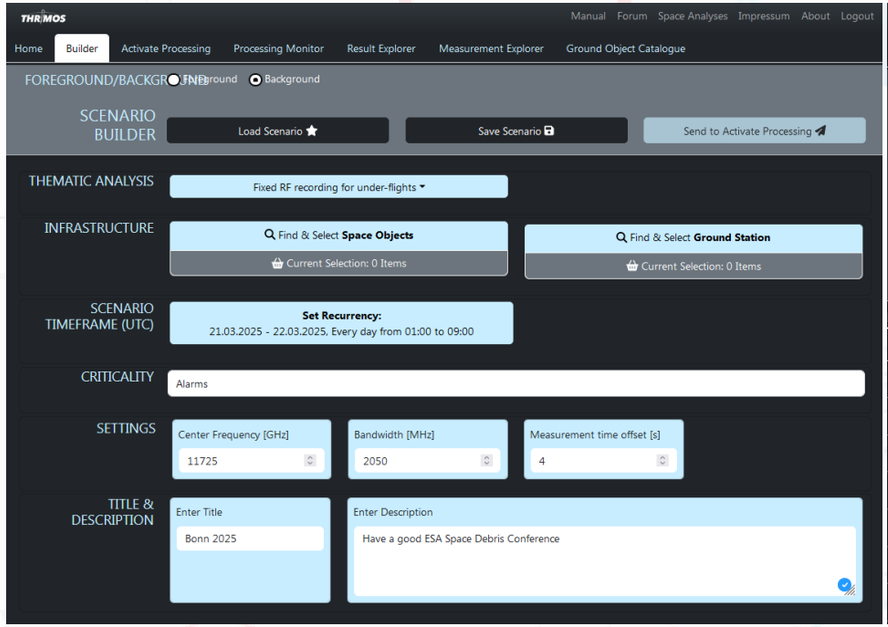


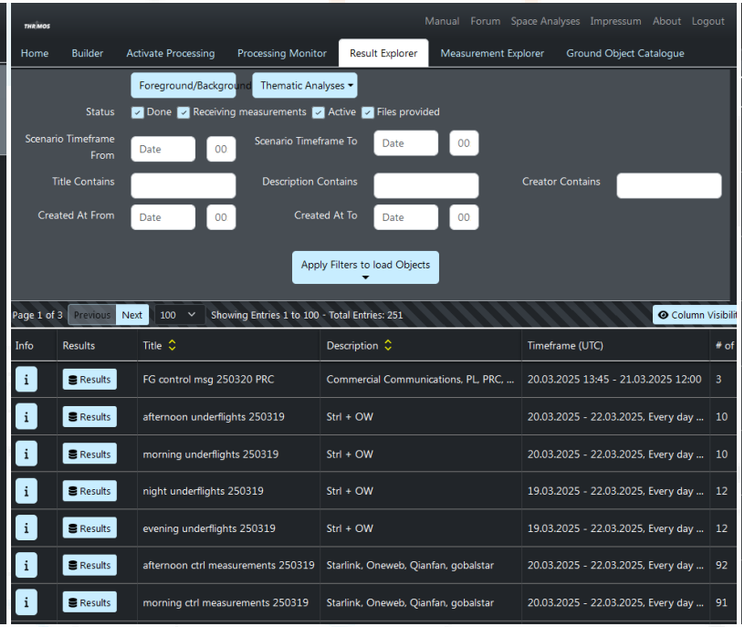
Object Name:	STARLINK-3726
Antenna ID:	KU2
Processing Status:	carrier detected
saved at:	24.7.2025 13:04:17.345

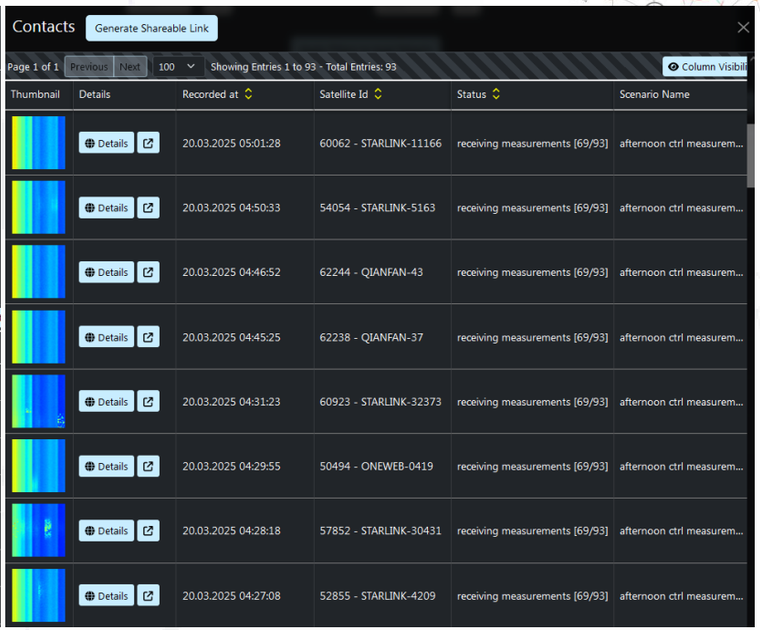
Frequency Band [MHz]	Carrier Counts	Precent
10830	261	1.50%
11075	2662	15.28%
11325	3967	22.77%
11575	5168	29.67%
11825	2666	15.31%
12075	741	4.25%
12325	856	4.91%
12575	1098	6.30%
Total	**17419**	

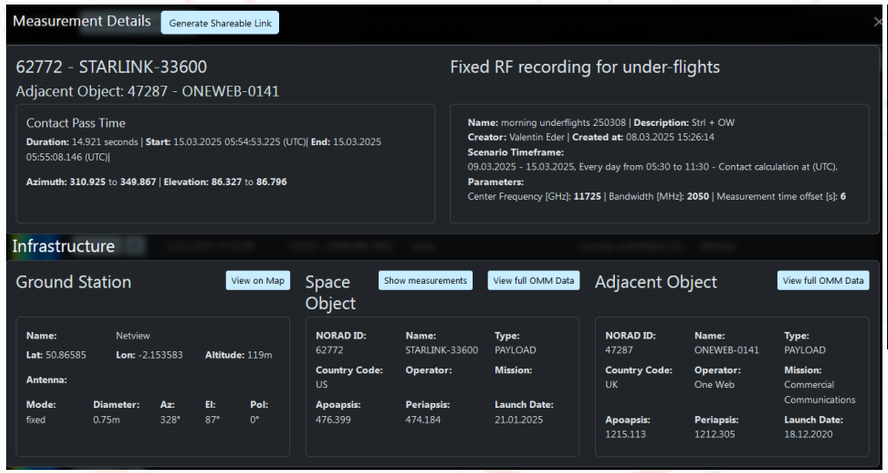
Measurement operating Time frame:
Report Start Time: 2024-11-01
Report End Time: 2025-03-20
Duration: 139 days

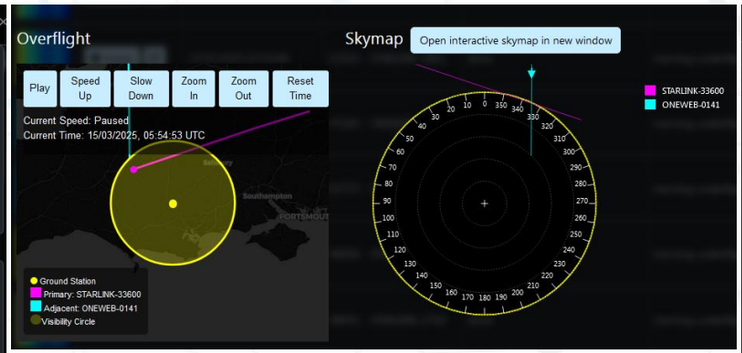
From the 'Scenario' to the Measurement Results

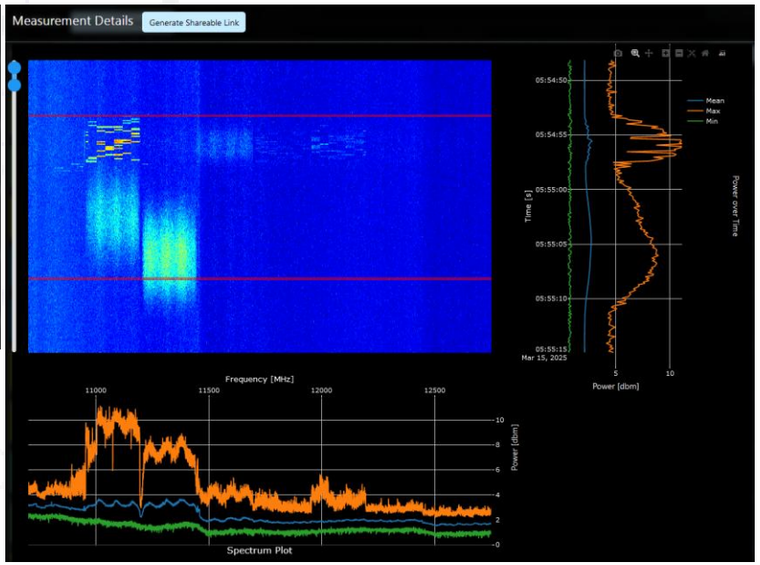






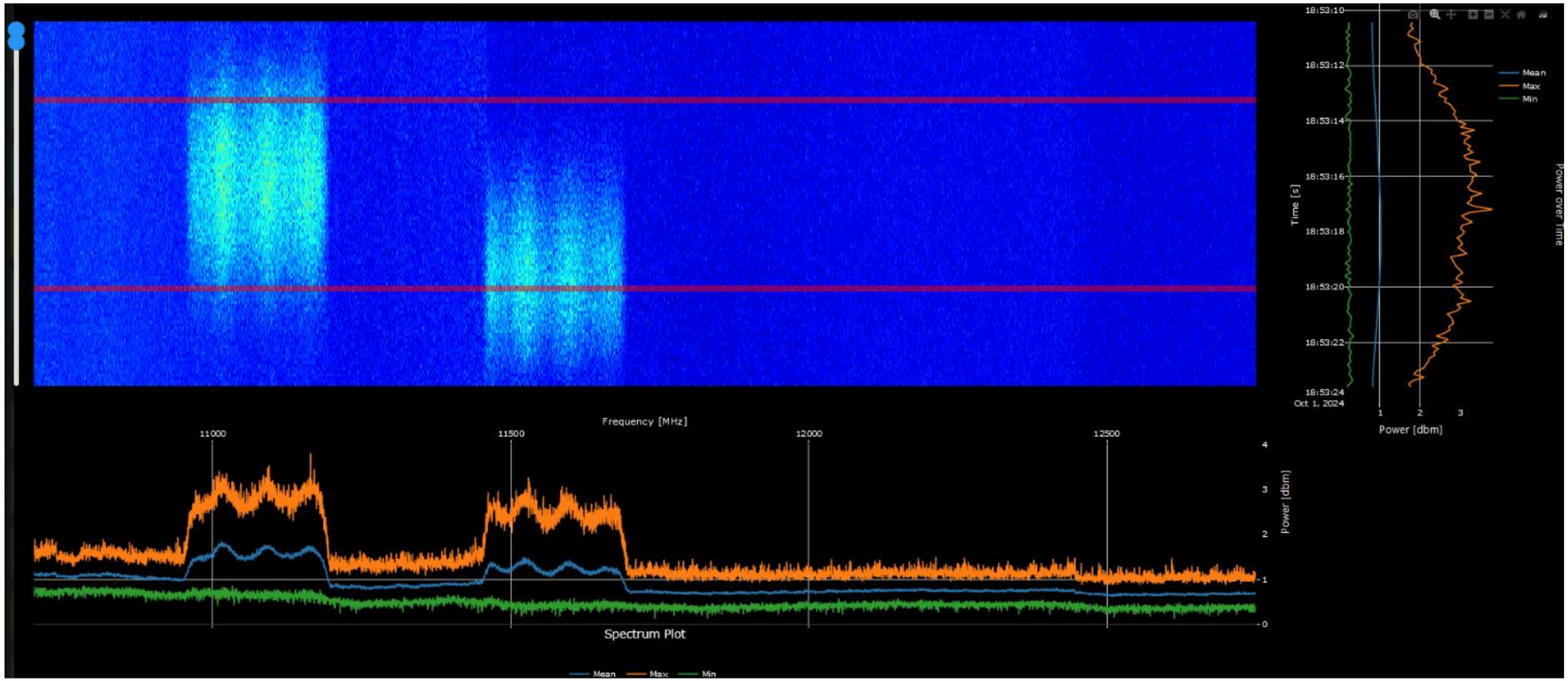






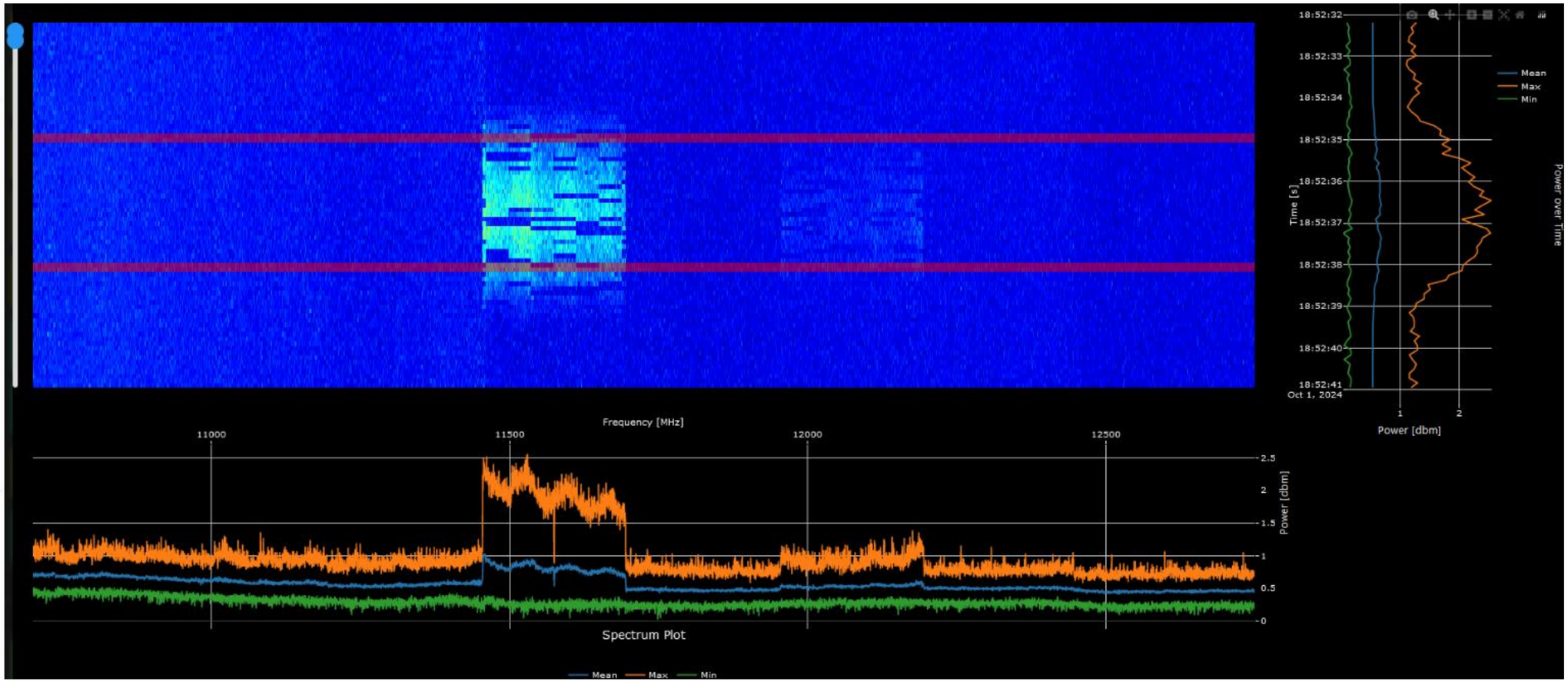
The OneWeb RF 'Footprint'

The Wave-Twins



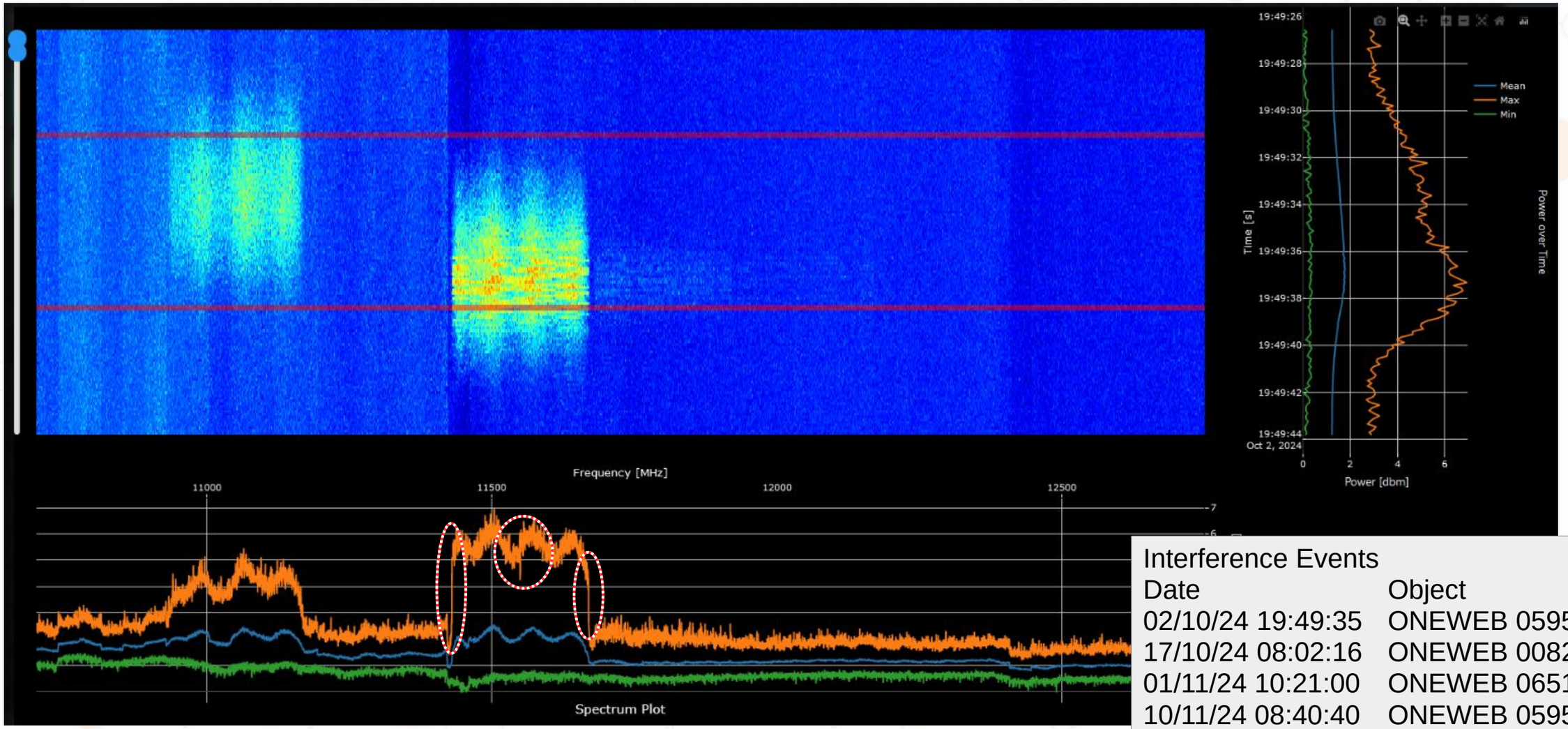
The Starlink RF 'Footprint'

The patchwork cut-outs with the 'split'



Interference / One Signal over the Other

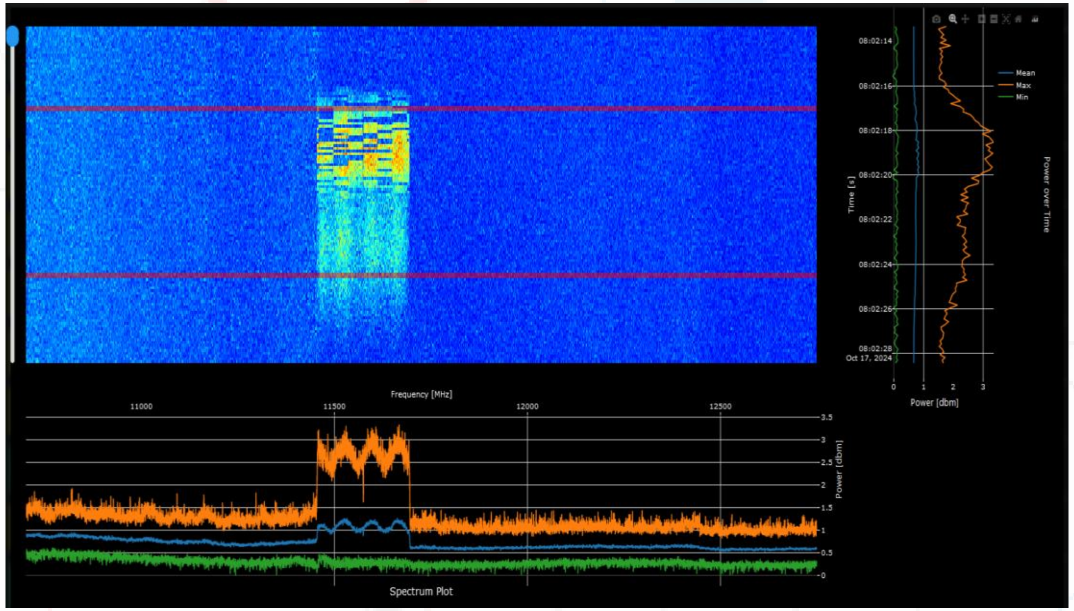
Two signals at the same time in the same band in the antenna beam
The 'wave-patchwork'

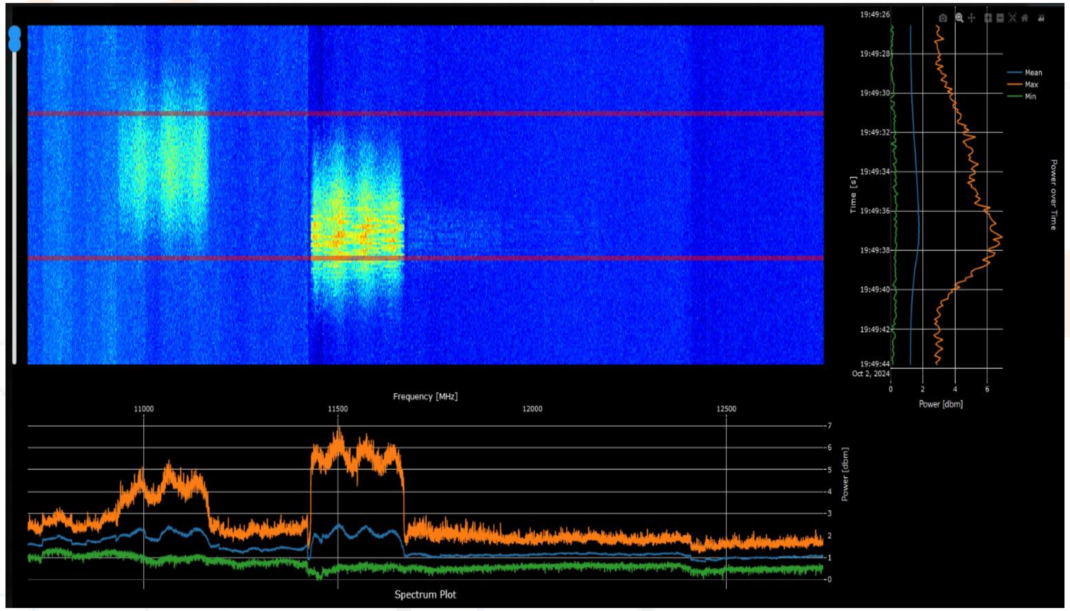


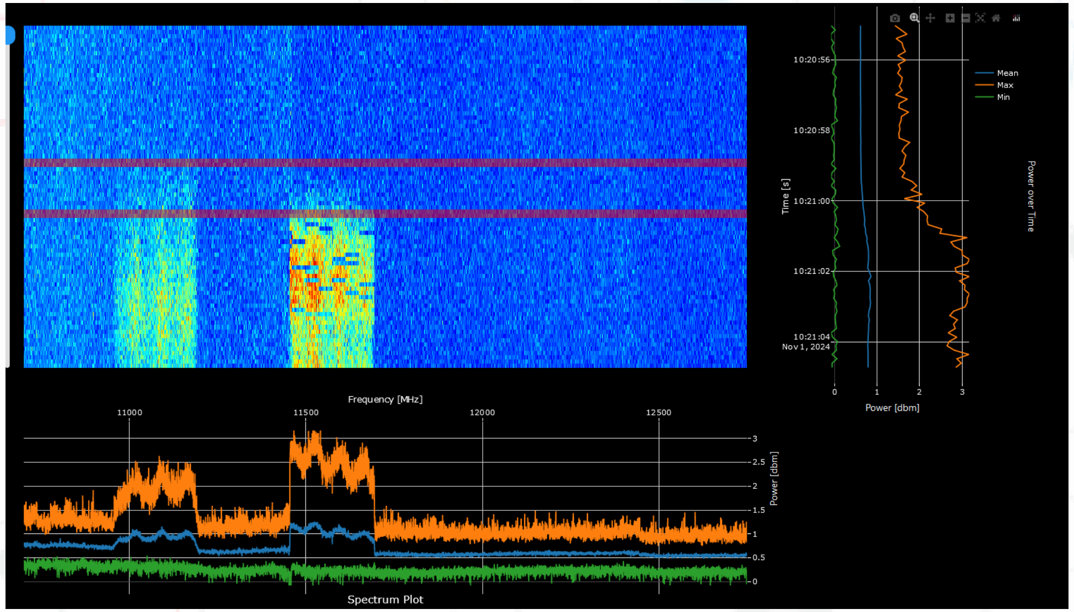
Interference Events

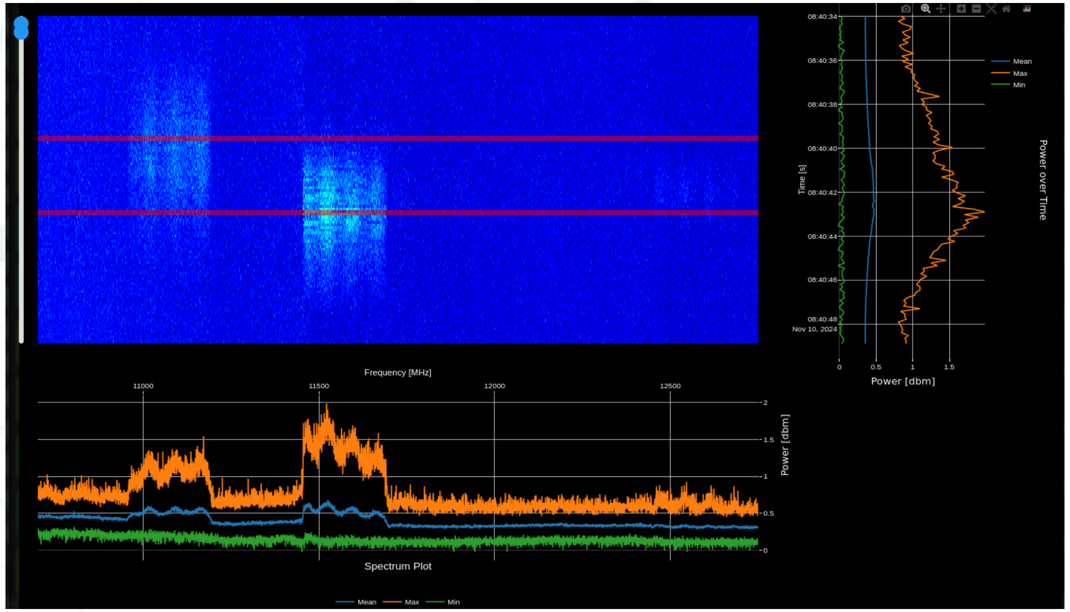
Date	Object	Duration
02/10/24 19:49:35	ONEWEB 0595	4
17/10/24 08:02:16	ONEWEB 0082	5
01/11/24 10:21:00	ONEWEB 0651	3
10/11/24 08:40:40	ONEWEB 0595	4
10/11/24 19:38:53	ONEWEB-0676	5

Interference has various formats and events

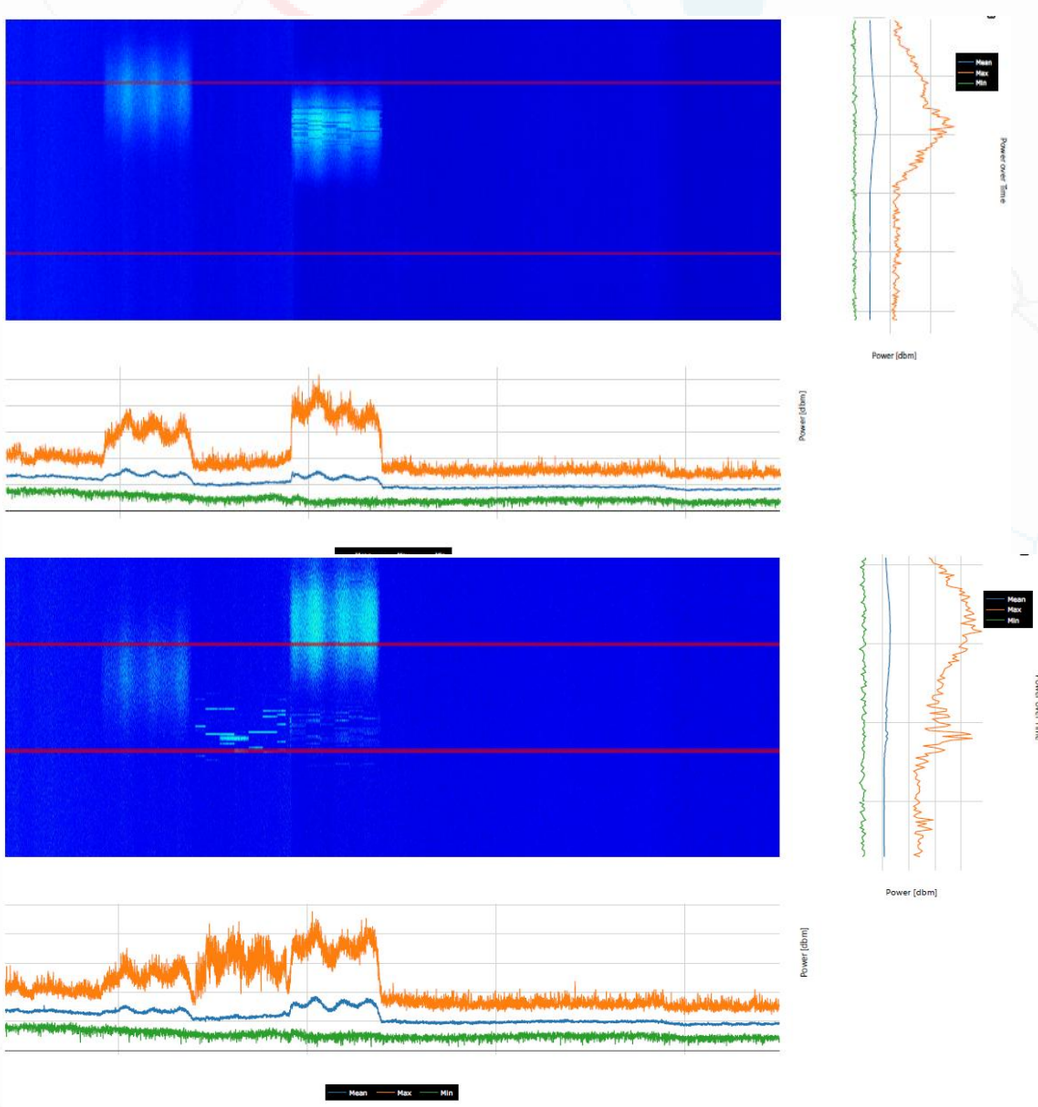


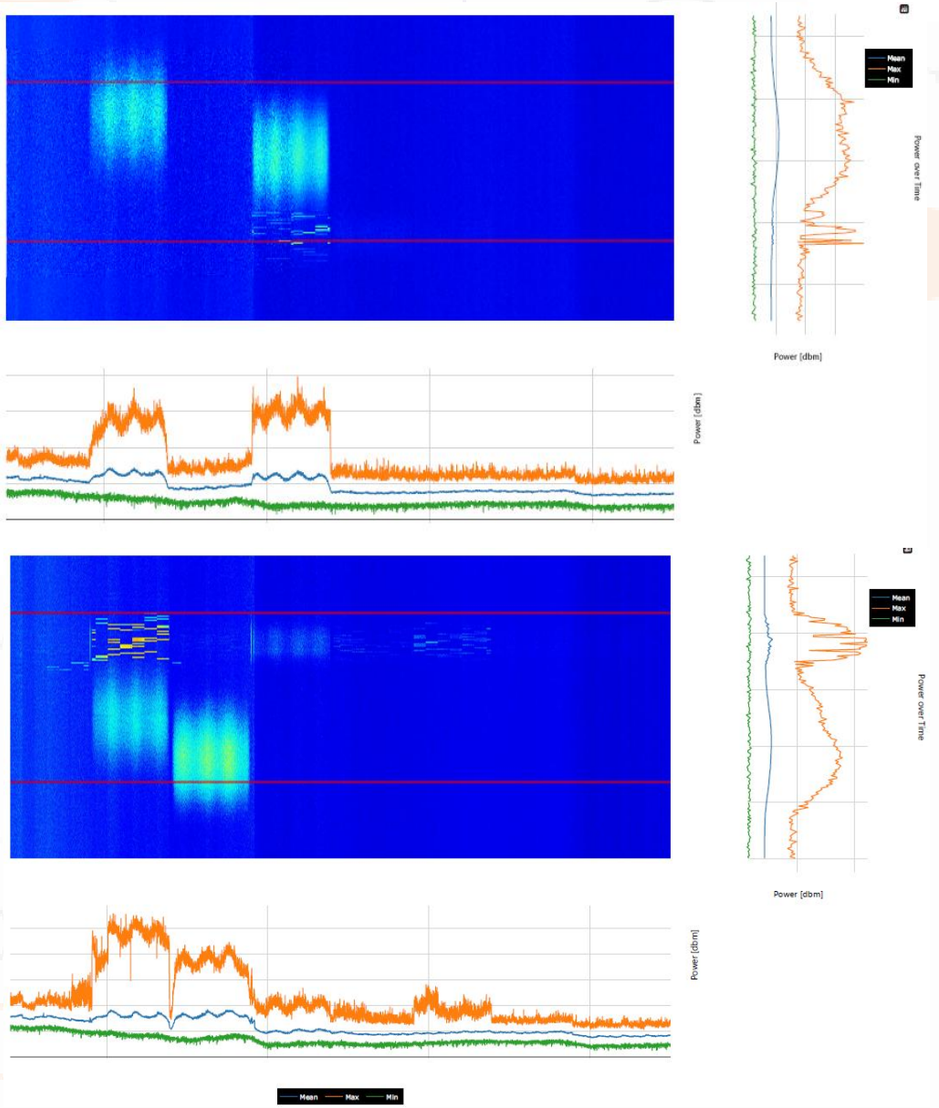






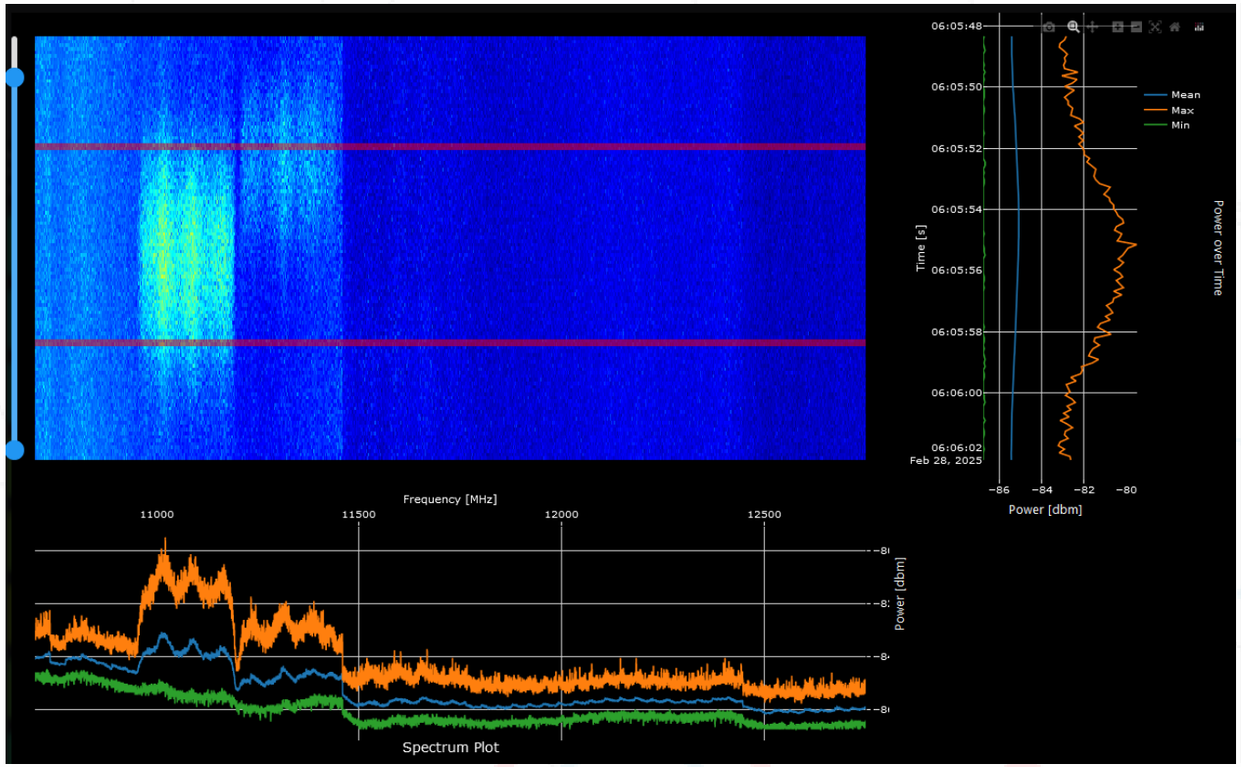
Interference has various formats and events





Change of coding reports

28.02.2025 06:05:51



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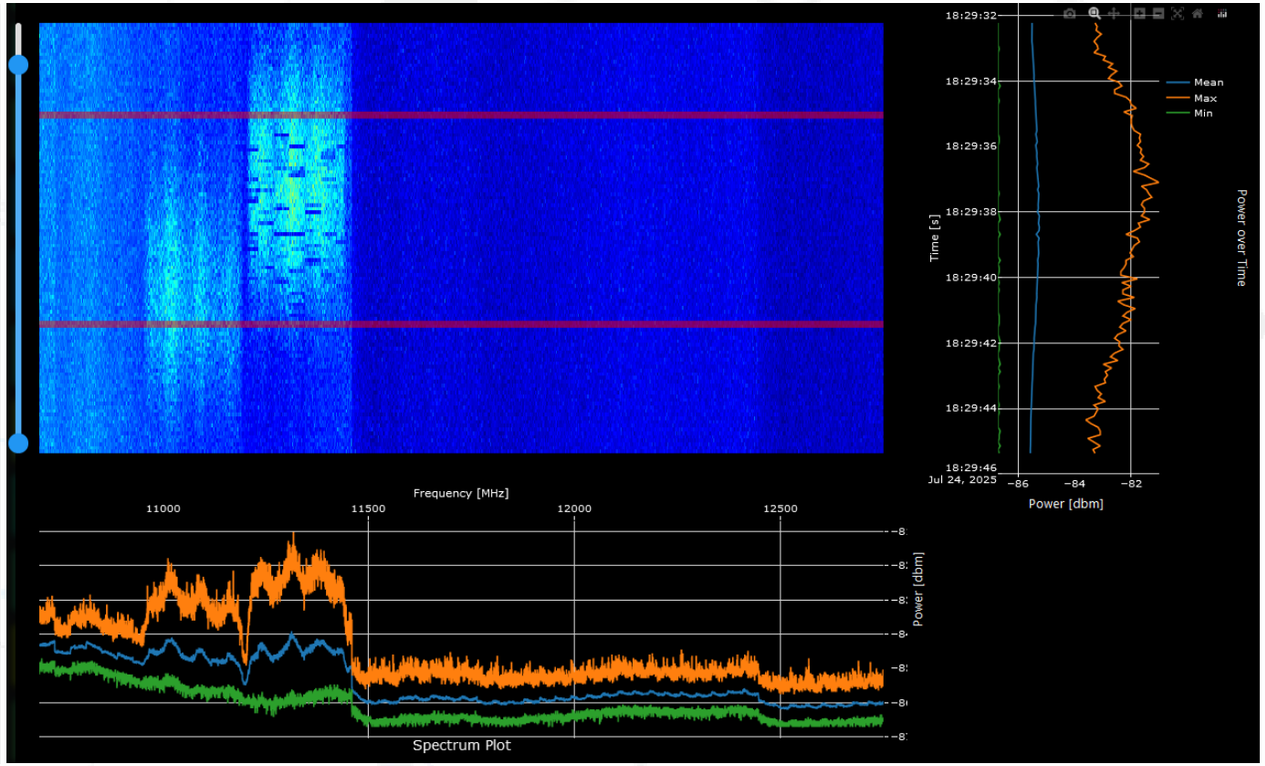

Results and Statistics

Numbers and System

Conclusion

- Automated & Systematic NON-GSO RF Monitoring is operational
- State of the art Mobile-Network RF-Signal Recording is precondition
- TLE/OMM input is reasonable
- RF-Conjunction is predictable but not necessarily the interference
- The measurement campaign proofed evidence of interference between NON-GSO fleets with significant impact (<99.5% availability)
- Spacecraft manoeuvres are measurable

Outlook

- Integration of consumer terminal – Rx Phased Array – to THRIMOS
- Extension to S, X, Ka, and TT&C bands
- Extension to wide LAT areas (equatorial areas to protect GEOs)
- Integration as 'in-house – stand-alone' version
- RF catalogue as source
- RF-timing-calibration for TLE timing correction

Contact

You can’t manage what you don’t know.

You can’t know what you don’t measure.

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