

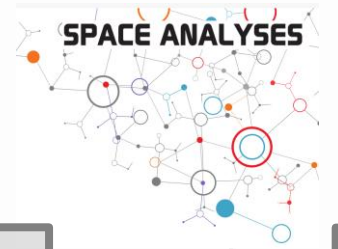
Satellite Conjunctions in the RF Spectrum: Learning out From an RF Measurement Campaign of LEO Objects



02.09.25
26th ISRMM, Athens, Greece

RF Space Domain Downlink Settings

Main Stakeholders and Measurement Setting



OneWeb



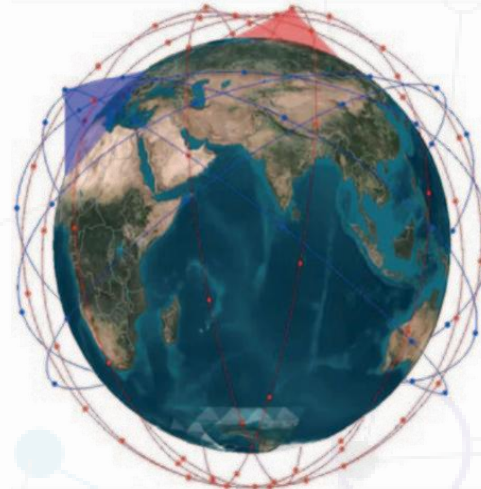
Ku

Starlink



Ku
Ka

Telesat



Ka

	Details	20.03.2025 12:44:45	49281 - ONEWEB-0349	receiving measurements [43/92]
	Details	20.03.2025 12:00:53	50850 - STARLINK-3312	receiving measurements [43/92]
	Details	20.03.2025 11:43:53	56714 - ONEWEB-0678	receiving measurements [43/92]
	Details	20.03.2025 11:15:11	46035 - STARLINK-1558	receiving measurements [68/91]
	Details	20.03.2025 10:45:44	54651 - ONEWEB-0584	receiving measurements [68/91]
	Details	20.03.2025 10:43:25	54658 - ONEWEB-0592	receiving measurements [68/91]
	Details	20.03.2025 10:39:20	58545 - STARLINK-31057	receiving measurements [68/91]
	Details	20.03.2025 09:52:54	47357 - STARLINK-2050	receiving measurements [68/91]



Moving targets

Measurement strategies

Cataloguing

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

Targeting

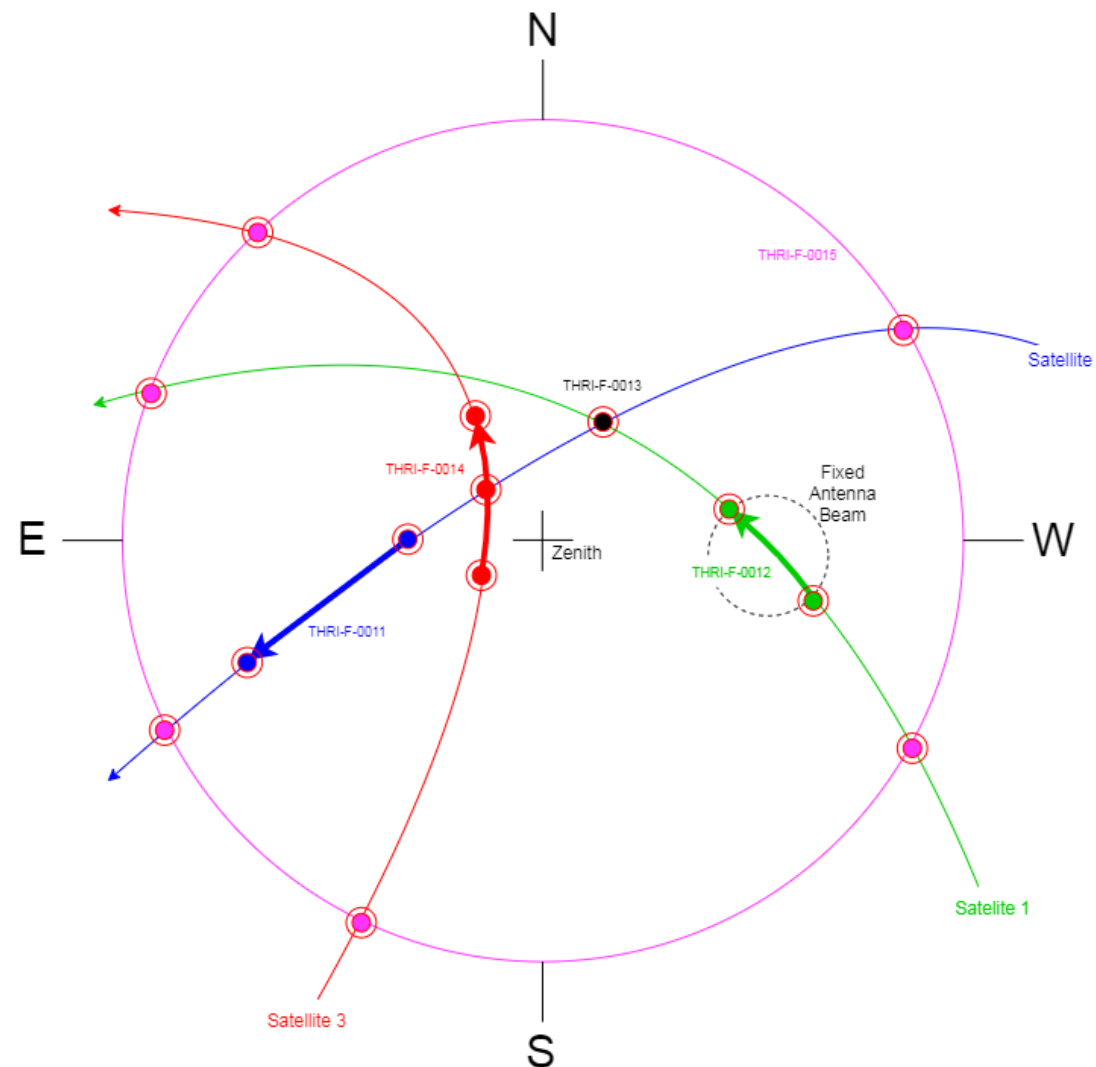
- Event based, triggered measurements of objects
 - Foreground measurements
 - Selection of objects of specific interest

Scanning

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

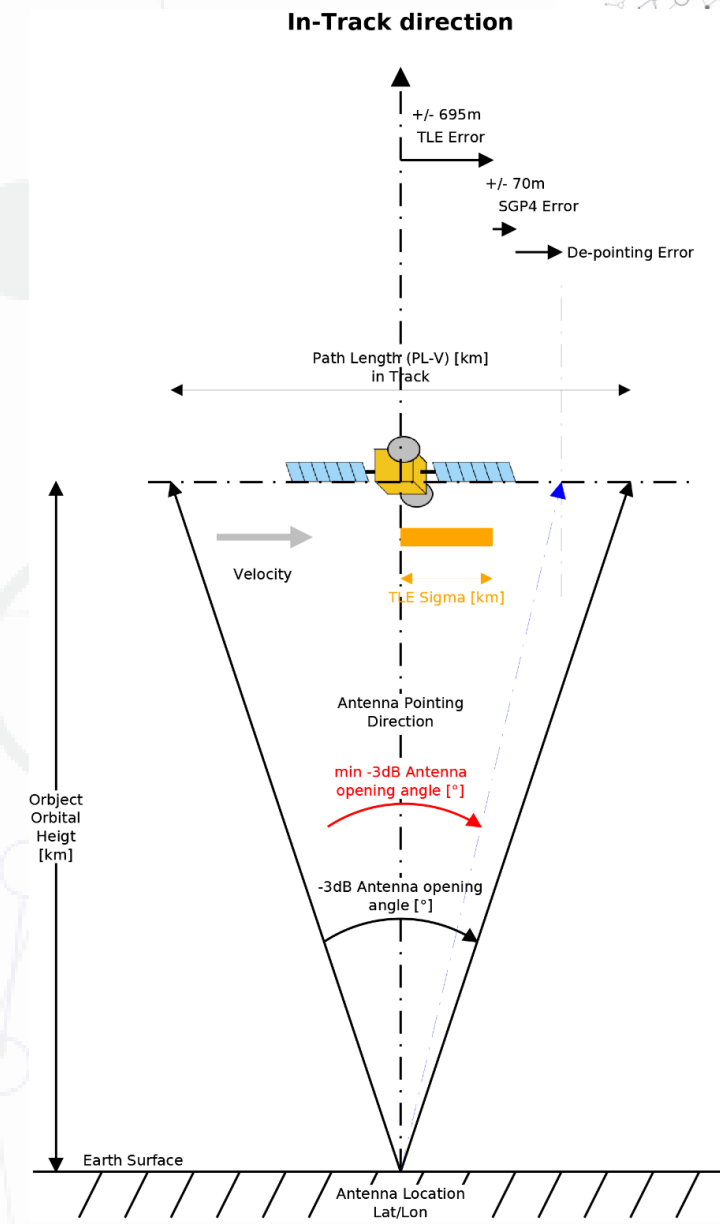
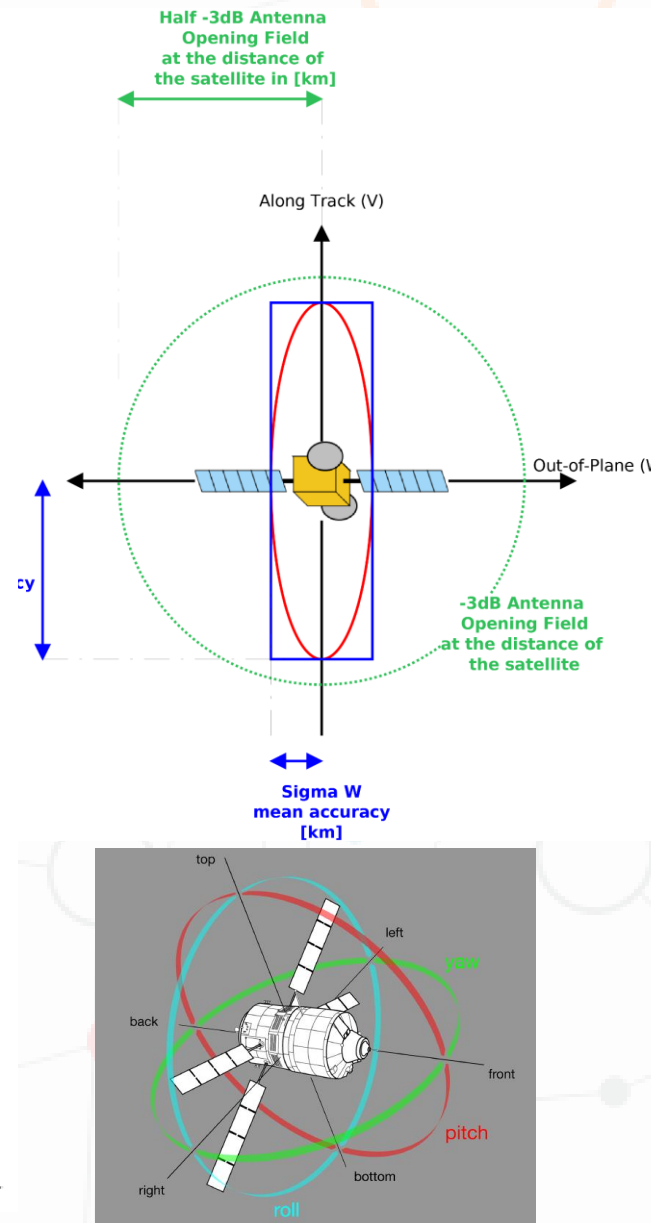
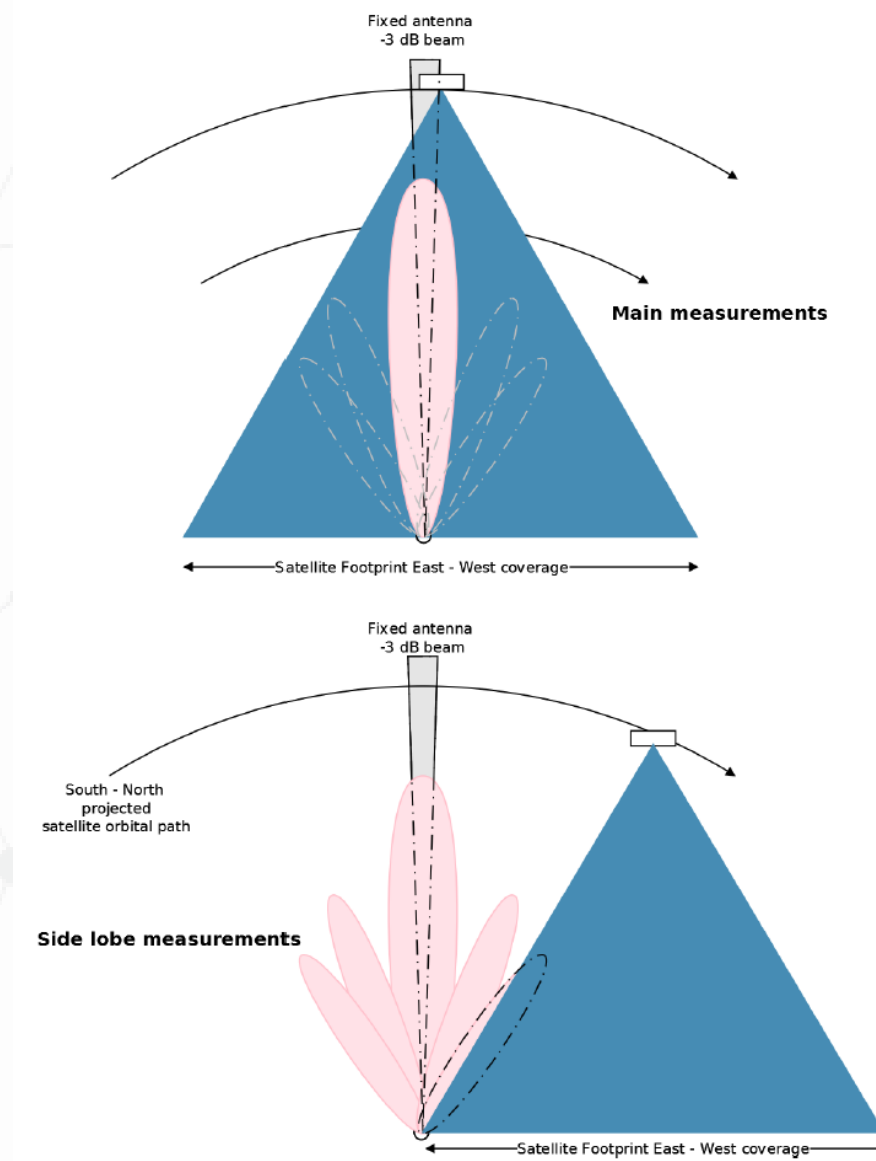
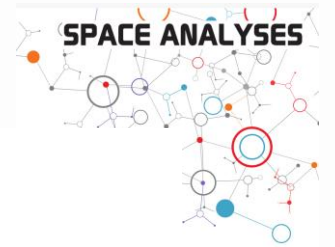
Tracking

- 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

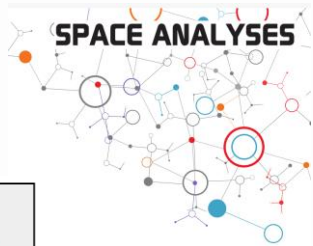


In the best case: the object transmits something

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



THRIMOS

Manual Forum Space Analyses Impressum About Logout

Home Builder Activate Processing Processing Monitor Result Explorer Measurement Explorer Ground Object Catalogue

FOREGROUND/BACKGROUND

Foreground Background

SCENARIO BUILDER

Load Scenario Save Scenario Send to Activate Processing

THEMATIC ANALYSIS

Fixed RF recording for under-flights

INFRASTRUCTURE

Find & Select Space Objects Find & Select Ground Station

SCENARIO TIMEFRAME (UTC)

Set Recurrency: 21.03.2025 - 22.03.2025, Every day from 01:00 to 09:00

CRITICALITY

Alarms

SETTINGS

Center Frequency [GHz] 11725 Bandwidth [MHz] 2050 Measurement time offset [s] 4

TITLE & DESCRIPTION

Enter Title: Bonn 2025 Enter Description: Have a good ESA Space Debris Conference

THRIMOS

Manual Forum Space Analyses Impressum About Logout

Home Builder Activate Processing Processing Monitor Result Explorer Measurement Explorer Ground Object Catalogue

Foreground/Background Thematic Analyses

Status: Done Receiving measurements Active Files provided

Scenario Timeframe: From Date 00 To Date 00

Title Contains Description Contains Creator Contains

Created At From Date 00 Created At To Date 00

Apply Filters to load Objects

Page 1 of 3 Previous Next 100 Showing Entries 1 to 100 - Total Entries: 251

Column Visibility

Info	Results	Title	Description	Timeframe (UTC)	# of
i	Results	FG control msg 250320 PRC	Commercial Communications. PL. PRC. ...	20.03.2025 13:45 - 21.03.2025 12:00	3
i	Results	afternoon underflights 250319	Strl + OW	20.03.2025 - 22.03.2025, Every day ...	10
i	Results	morning underflights 250319	Strl + OW	20.03.2025 - 22.03.2025, Every day ...	10
i	Results	night underflights 250319	Strl + OW	19.03.2025 - 22.03.2025, Every day ...	12
i	Results	evening underflights 250319	Strl + OW	19.03.2025 - 22.03.2025, Every day ...	12
i	Results	afternoon ctrl measurements 250319	Starlink, Oneweb, Qianfan, gobalstar	20.03.2025 - 22.03.2025, Every day ...	92
i	Results	morning ctrl measurements 250319	Starlink, Oneweb, Qianfan, gobalstar	20.03.2025 - 22.03.2025, Every day ...	91

Contacts

Generate Shareable Link

Page 1 of 1 Previous Next 100 Showing Entries 1 to 93 - Total Entries: 93

Column Visibility

Thumbnail	Details	Recorded at	Satellite Id	Status	Scenario Name
		20.03.2025 05:01:28	60062 - STARLINK-11166	receiving measurements [69/93]	afternoon ctrl measure...
		20.03.2025 04:50:33	54054 - STARLINK-5163	receiving measurements [69/93]	afternoon ctrl measure...
		20.03.2025 04:46:52	62244 - QIANFAN-43	receiving measurements [69/93]	afternoon ctrl measure...
		20.03.2025 04:45:25	62238 - QIANFAN-37	receiving measurements [69/93]	afternoon ctrl measure...
		20.03.2025 04:31:23	60923 - STARLINK-32373	receiving measurements [69/93]	afternoon ctrl measure...
		20.03.2025 04:29:55	50494 - ONEWEB-0419	receiving measurements [69/93]	afternoon ctrl measure...
		20.03.2025 04:28:18	57852 - STARLINK-30431	receiving measurements [69/93]	afternoon ctrl measure...
		20.03.2025 04:27:08	52855 - STARLINK-4209	receiving measurements [69/93]	afternoon ctrl measure...

Measurement Details

Generate Shareable Link

62772 - STARLINK-33600

Adjacent Object: 47287 - ONEWEB-0141

Contact Pass Time

Duration: 14.921 seconds | Start: 15.03.2025 05:54:53.225 (UTC) | End: 15.03.2025 05:55:08.146 (UTC)

Azimuth: 310.925 to 349.867 | Elevation: 86.327 to 86.796

Fixed RF recording for under-flights

Name: morning underflights 250308 | Description: Strl + OW

Creator: Valentin Eder | Created at: 08.03.2025 15:26:14

Scenario Timeframe: 09.03.2025 - 15.03.2025, Every day from 05:30 to 11:30 - Contact calculation at (UTC).

Parameters: Center Frequency [GHz]: 11725 | Bandwidth [MHz]: 2050 | Measurement time offset [s]: 6

Infrastructure

View on Map Show measurements View full OMM Data

Ground Station

Name: Netview Lat: 50.86585 Lon: -2.153583 Altitude: 119m

Antenna: Mode: fixed Diameter: 0.75m Az: 328° El: 87° Pol: 0°

Space Object

NORAD ID: 62772 Name: STARLINK-33600 Type: PAYLOAD

Country Code: US Operator: One Web Mission: Commercial Communications

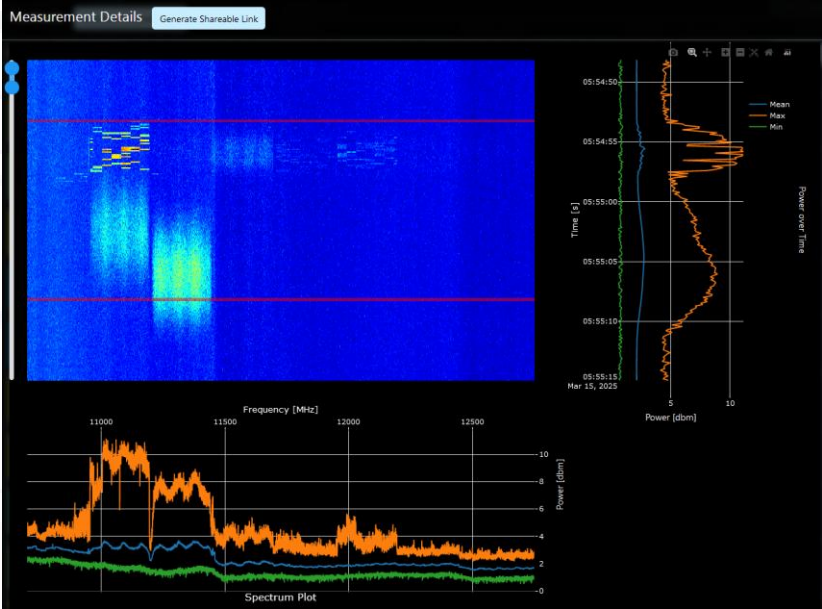
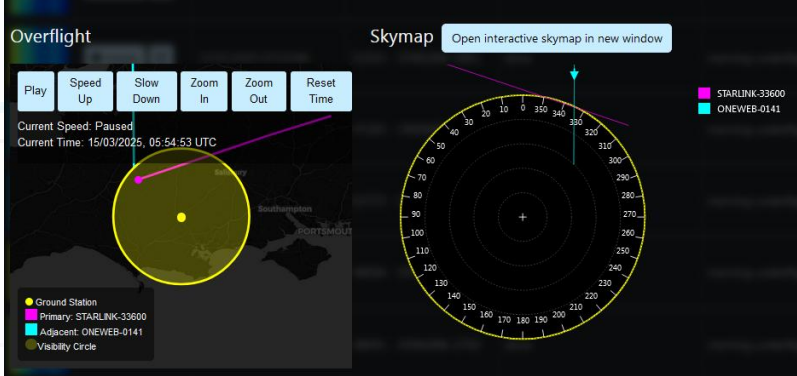
Apoapsis: 476.399 Periapsis: 474.184 Launch Date: 21.01.2025

Adjacent Object

NORAD ID: 47287 Name: ONEWEB-0141 Type: PAYLOAD

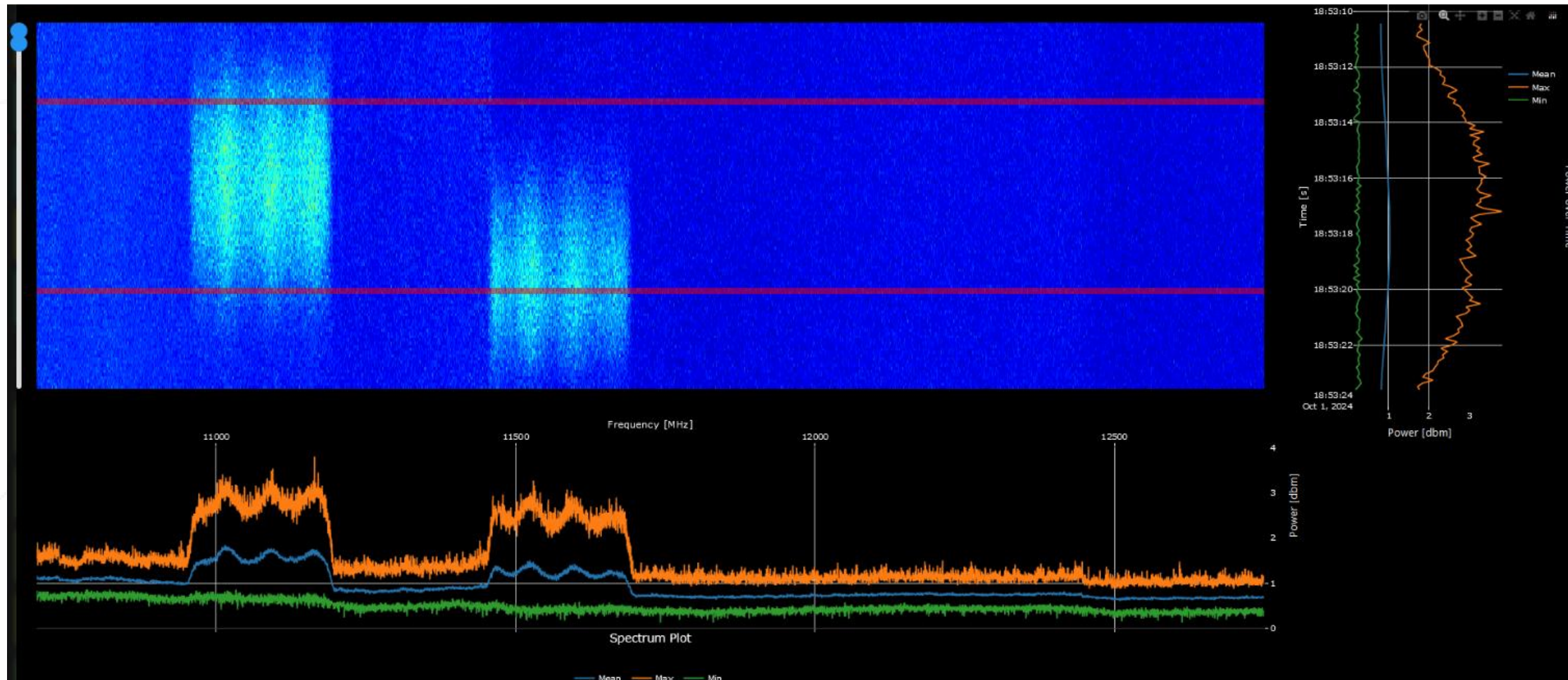
Country Code: UK Operator: One Web Mission: Commercial Communications

Apoapsis: 1215.113 Periapsis: 1212.305 Launch Date: 18.12.2020



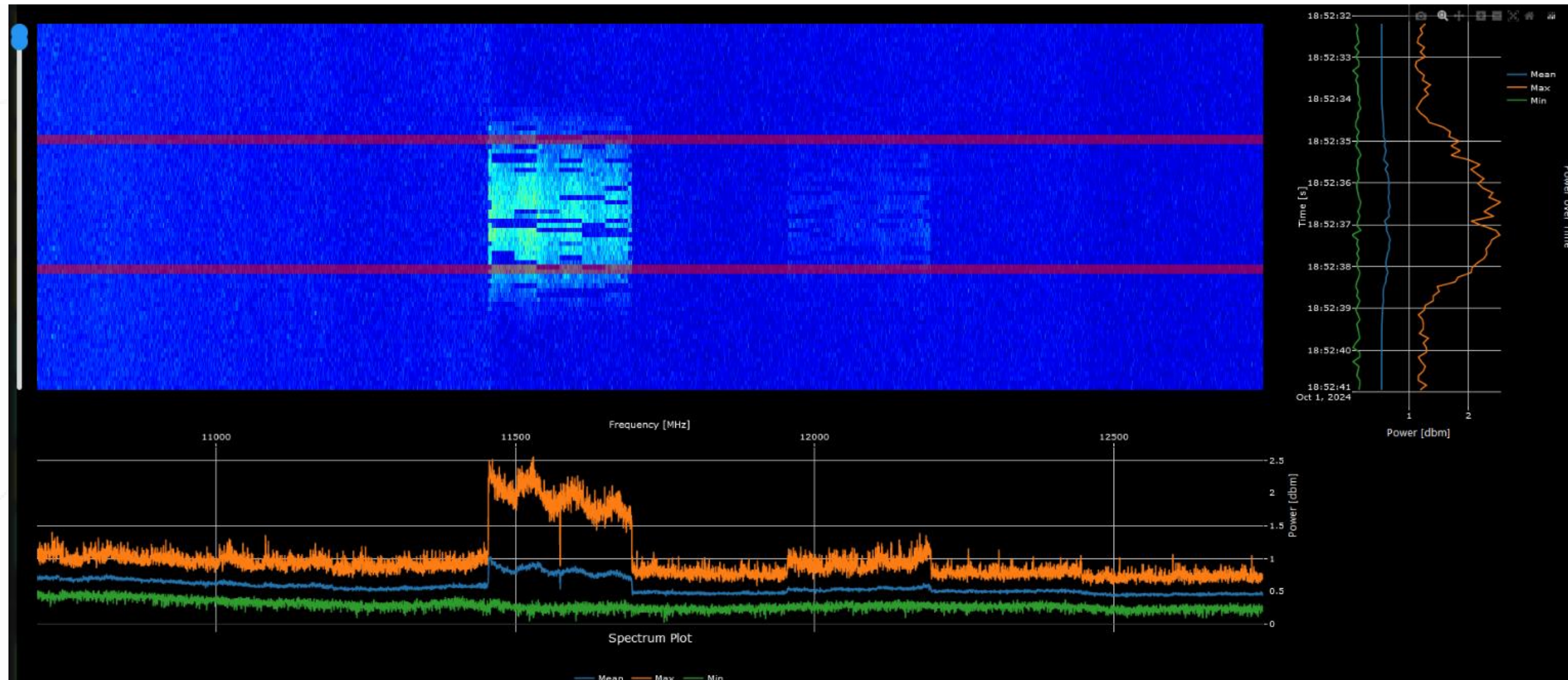
The OneWeb RF 'Footprint'

The Wave-Twins



The Starlink RF 'Footprint'

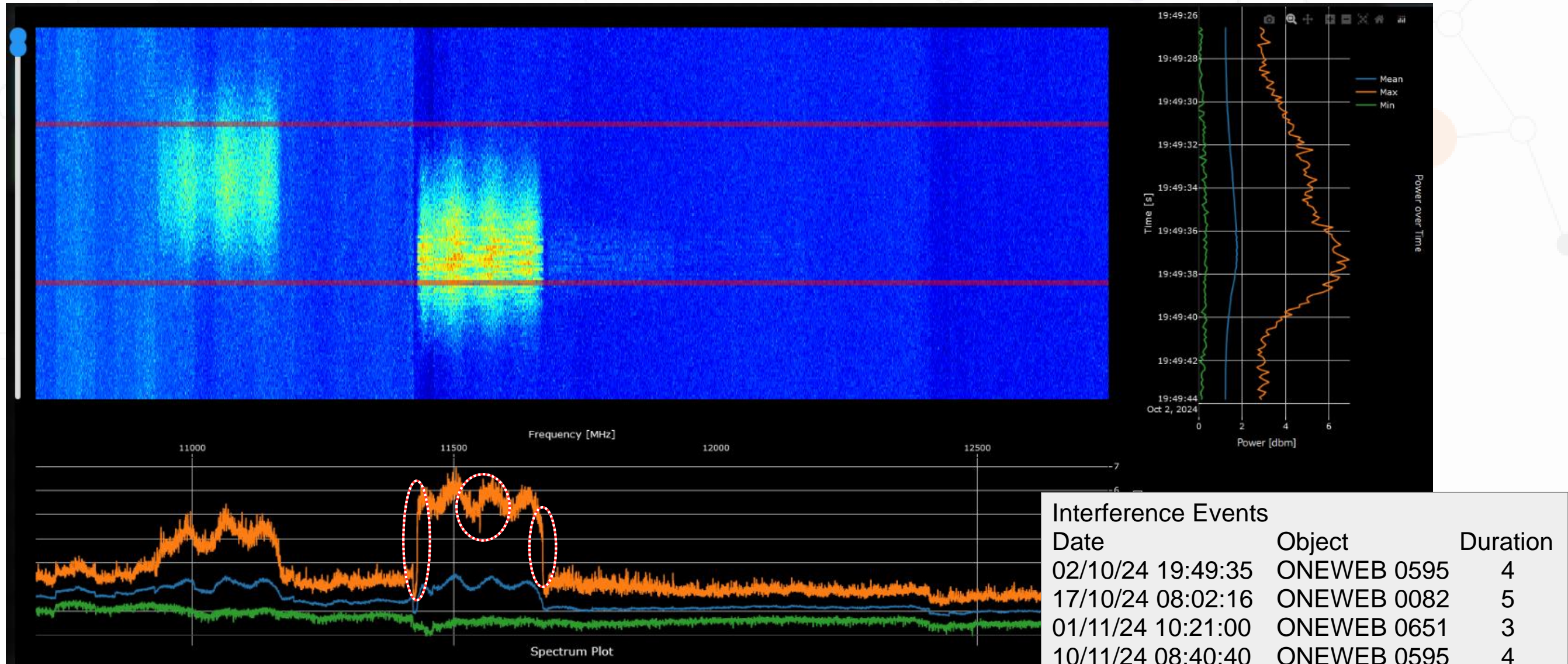
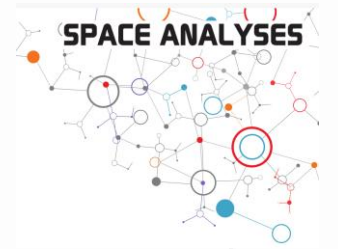
The patchwork cut-outs with the 'split'



Interference / One Signal over the Other

Two signals at the same time in the same band in the antenna beam

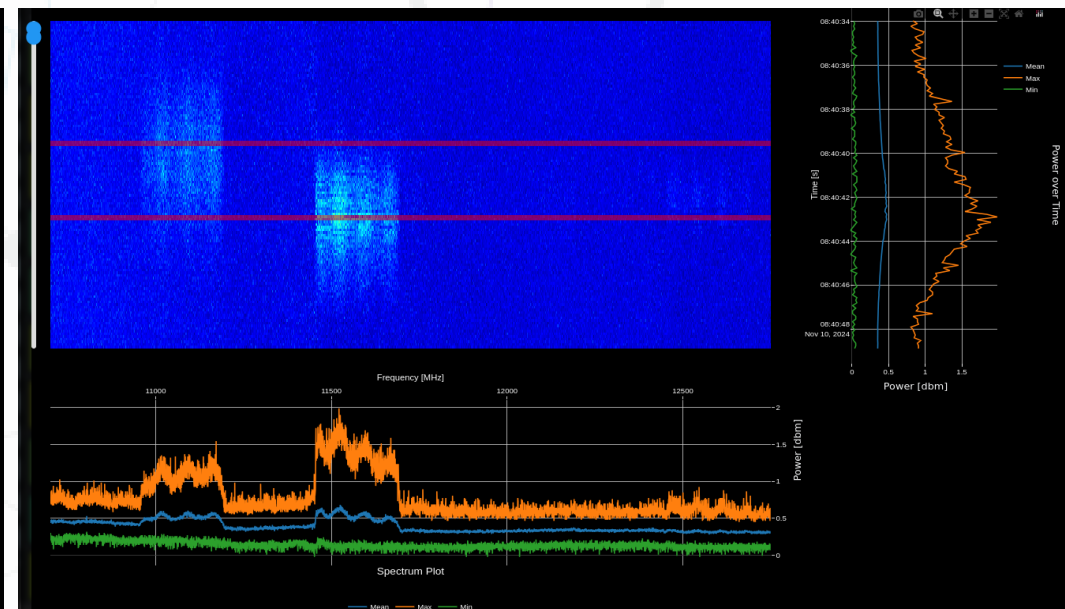
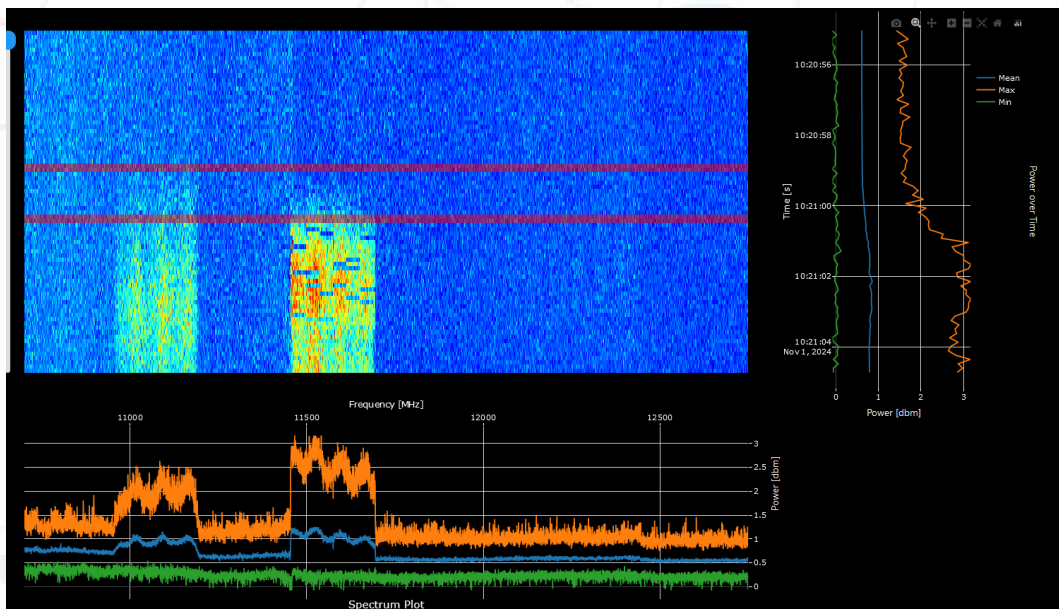
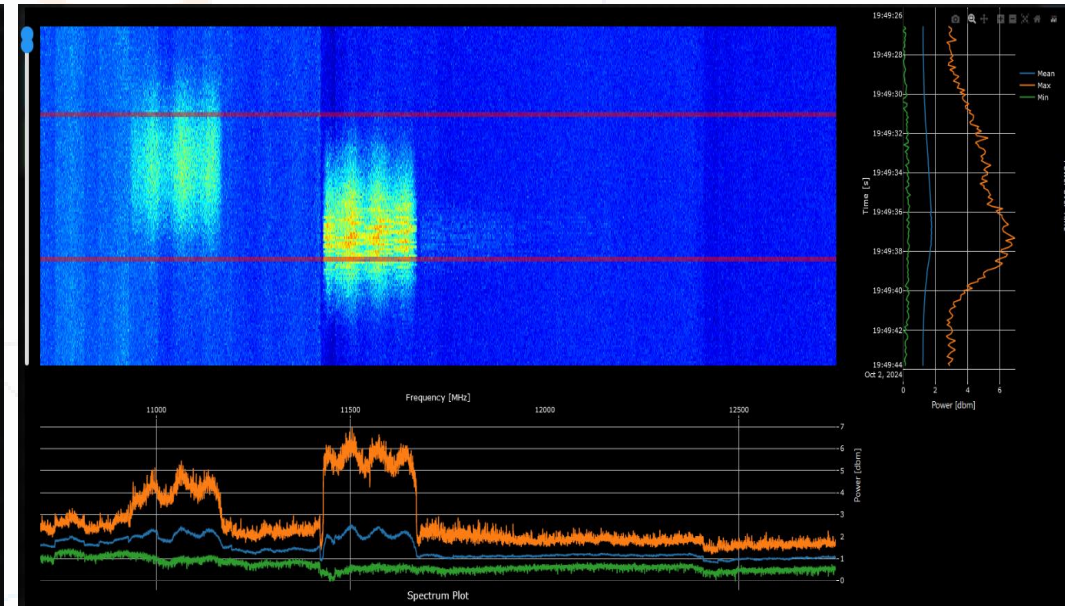
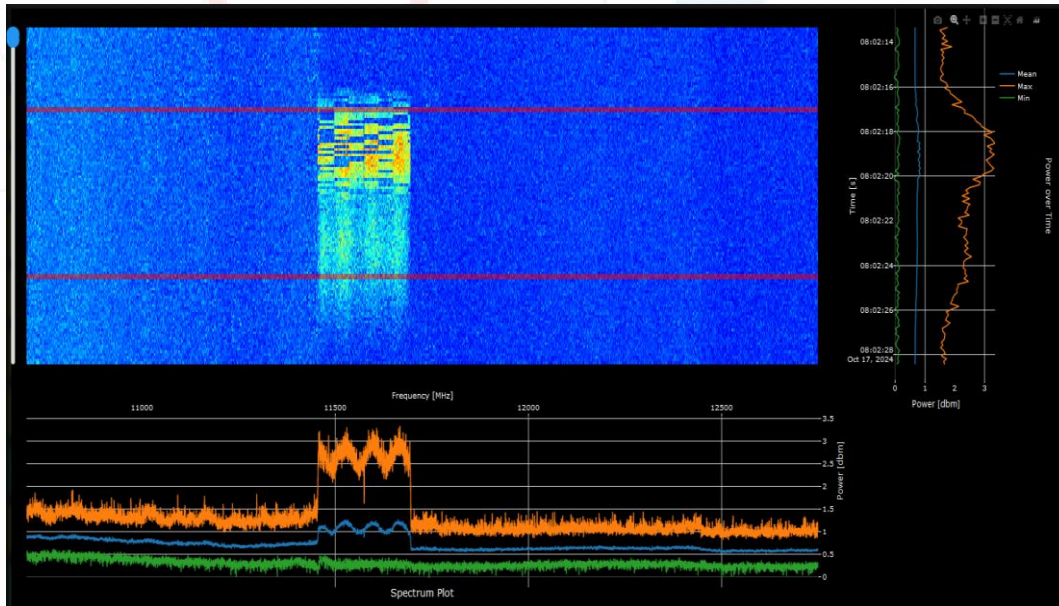
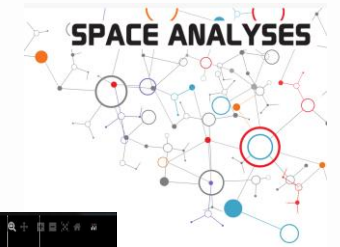
The 'wave-patchwork'



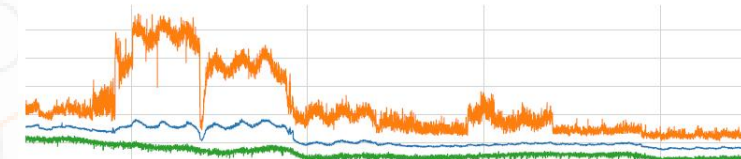
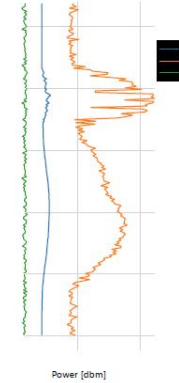
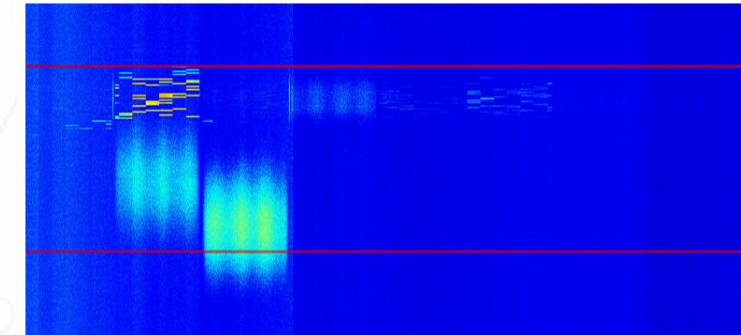
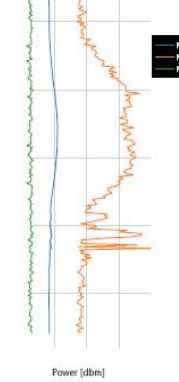
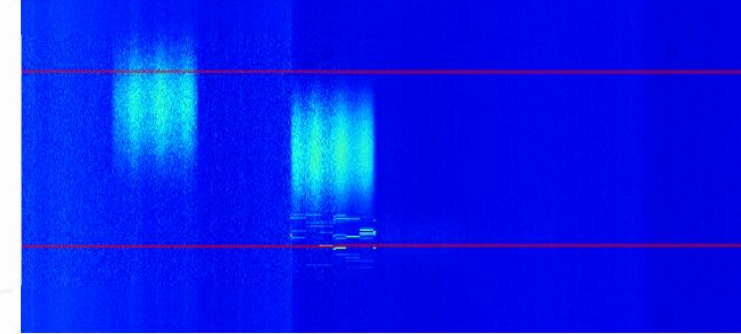
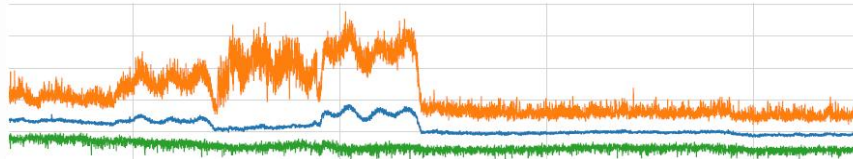
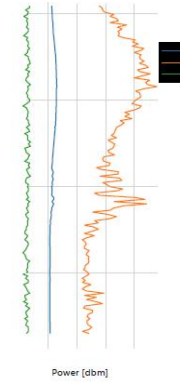
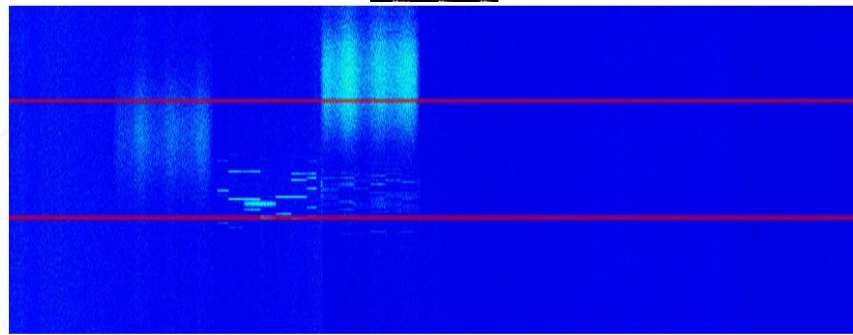
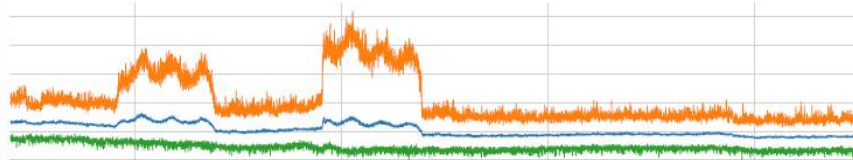
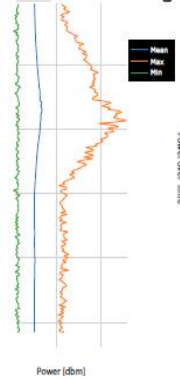
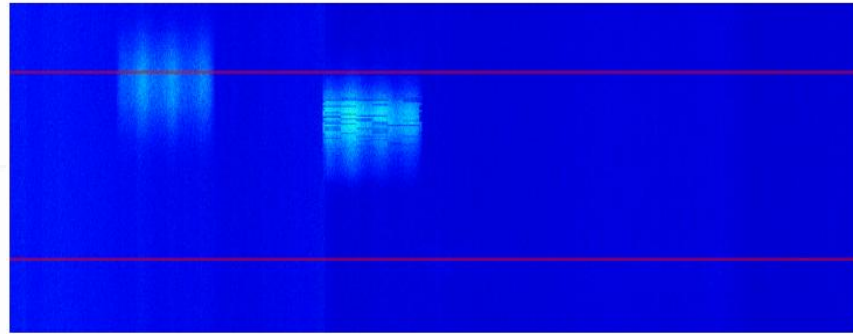
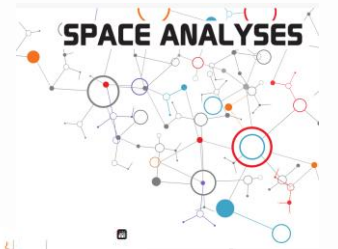
Interference Events

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

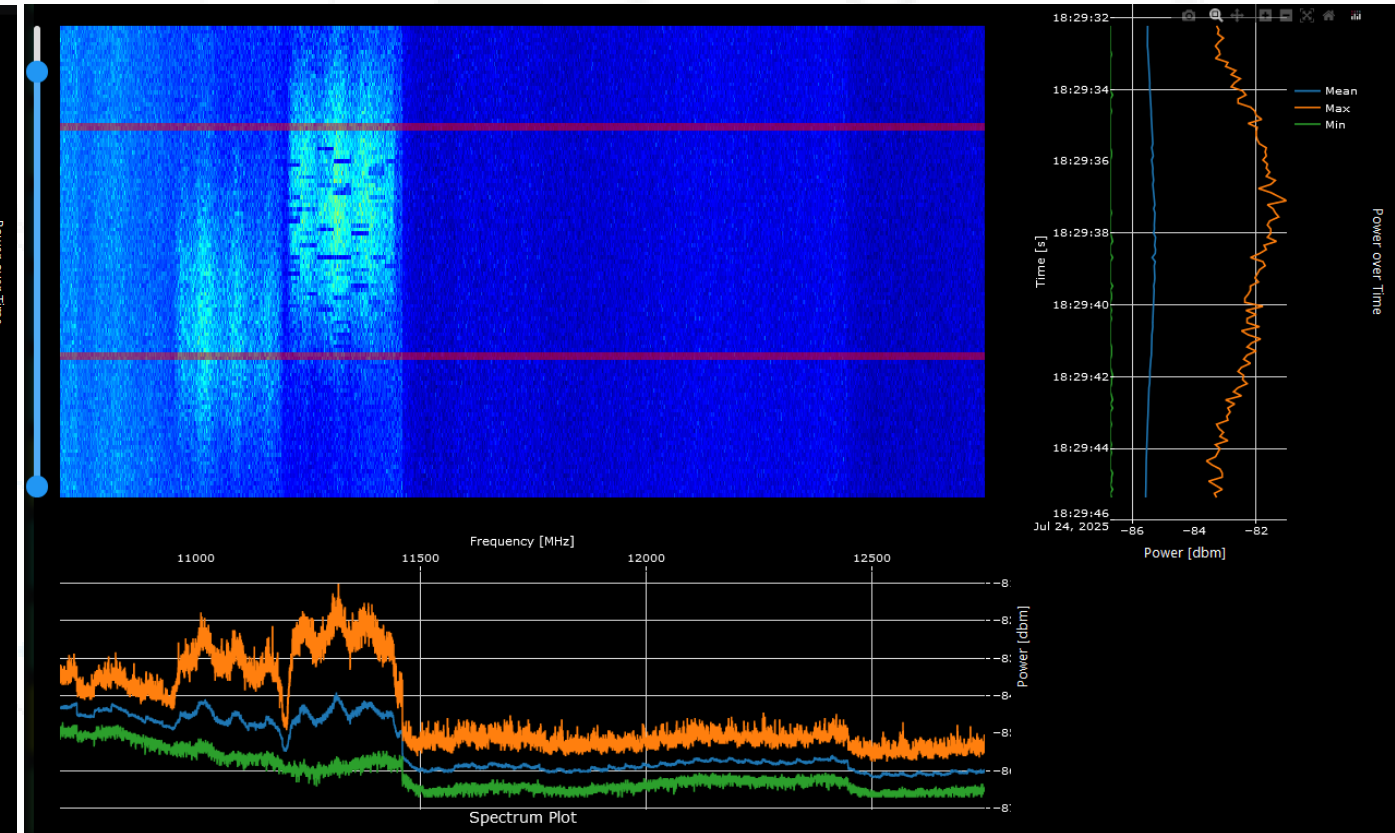
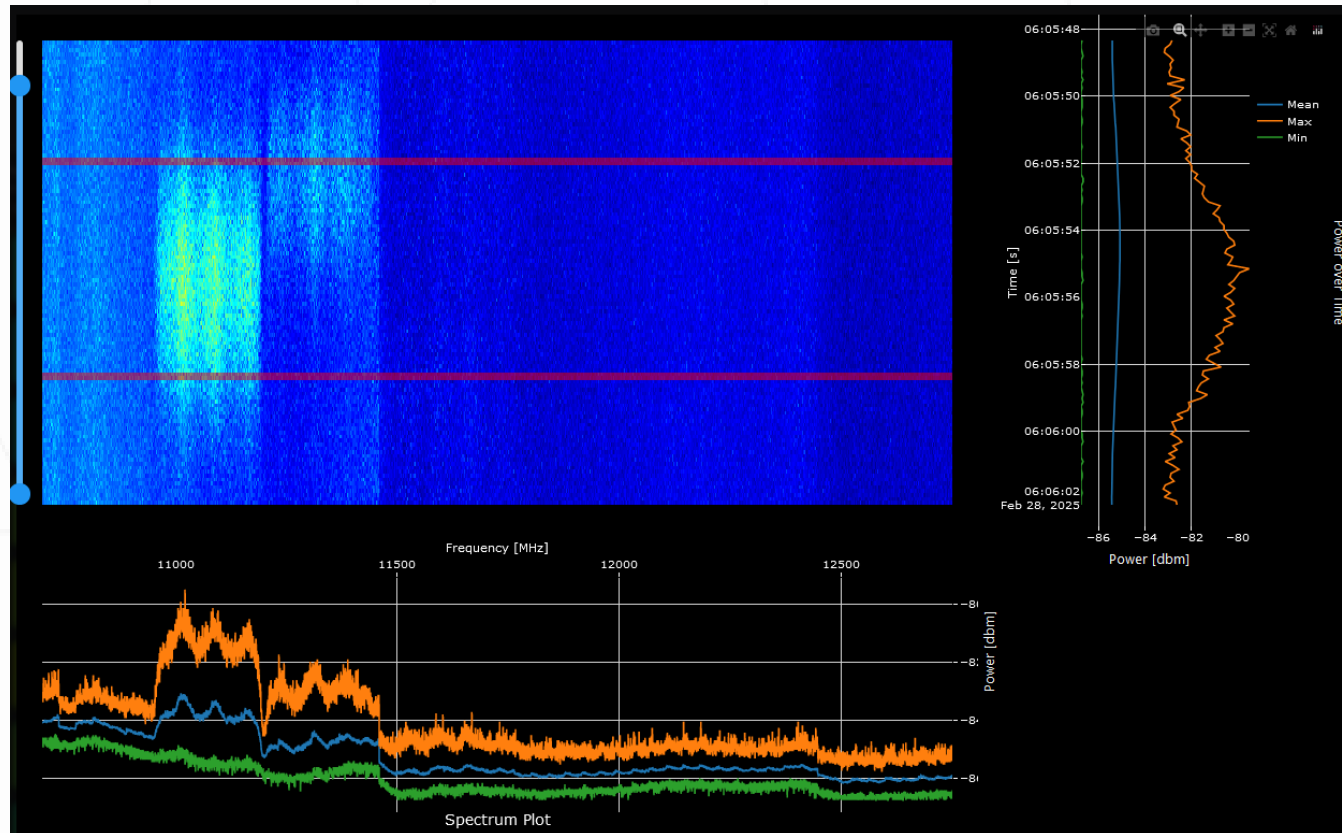


Change of coding reports



28.02.2025 06:05:51

24.07.2025 18:29:34



Results and Statistics

Numbers and System

Conclusion

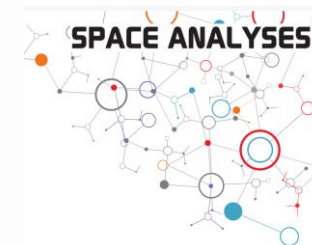
- .Automated & Systematic NON-GSO RF Monitoring is operational
- .State of the art Mobile-Network RF-Signal Recording is precondition
- .TLE/OMM input is reasonable
- .RF-Conjunction is predictable but not necessarily the interference
- .The measurement campaign proofed evidence of interference between 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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