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WRC-27 agenda item 1.16

Studies of technical and regulatory provisions necessary to protect radio astronomy operating in specific Radio Quiet Zones and, in radio astronomy service primary allocated frequency bands globally, from aggregate radio-frequency interference caused by systems in the non-geostationary-satellite orbit

Dr Balthasar Indermuehle
Chair WP7D

Mr Jonathan Williams
Chair WG7D-1

AI 1.16 Introduction of panelists

- APT: Dr Wahyudi Hasbi
- ASMG: Dr Ramzi Halimouche
- ATU: Ms Tebogo Mashile
- CEPT: Mr Karsten Buckwitz
- CITEL: Mr Damon Ladson
- RCC: Mr Anton Stepanov

AI 1.16 Brief recap: Resolution 681

…to consider studies on the technical and regulatory provisions necessary to protect radio astronomy operating in specific Radio Quiet Zones and, in frequency bands allocated to the radio astronomy service on a primary basis globally, from aggregate radio-frequency interference caused by non-geostationary-satellite orbit systems, in accordance with Resolution **681 (WRC-23)**;

AI 1.16 Brief recap: Considering

considering

...

j) that a small number of remote RAS stations are of the utmost importance as they are designed to make observations of significance, resulting in new knowledge of astronomical phenomena, which may require observations of objects not previously studied, or observing objects with increased precision;

k) that, for the purpose of this Resolution, the facilities which fall into the category defined in *considering j)* are:

- the Square Kilometre Array Observatory in South Africa;
- the Atacama Large Millimeter/submillimeter Array (ALMA) in Chile;

...

AI 1.16 Brief recap: Resolves

1) studies on how the interference from unwanted emissions from a single non-GSO satellite system operating in the adjacent and nearby frequency bands in Table 1 affects the operation of RAS stations in frequency bands allocated to the RAS on a primary basis in Table 1;
2) studies on how the aggregate interference from unwanted emissions from multiple non-GSO satellite systems operating in the adjacent and nearby frequency bands in Table 1 affect the operation of RAS stations in frequency bands allocated to the RAS on a primary basis in Table 1;

AI 1.16 Brief recap: Resolves Table 1

TABLE 1

RAS frequency bands to be studied and corresponding active services to be included

Radio astronomy frequency band	Active space service operating in adjacent or nearby frequency band	Active space service (space-to-Earth)	Scope
10.6-10.7 GHz	10.7-10.95 GHz	FSS	*Resolves etc.* 1 and 2
42.5-43.5 GHz	42-42.5 GHz	FSS	*Resolves etc.* 2
76-77.5 GHz	74-76 GHz	FSS, MSS	*Resolves etc.* 2
94.1-95 GHz	95-100 GHz	RNSS, MSS	*Resolves etc.* 2
100-102 GHz	95-100 GHz	RNSS, MSS	*Resolves etc.* 1 and 2
114.25-116 GHz	116-119.98 GHz	ISS	*Resolves etc.* 1 and 2
130-134 GHz	123-130 GHz	FSS, MSS, RNSS	*Resolves etc.* 2

AI 1.16 Brief recap: Resolves

3) studies on the possible recognition of the RQZs specified in *considering k)* above, based on their characteristics and existing ITU-R studies;
4) studies on how the aggregate interference from single and multiple non-GSO satellite systems affects the operation of RAS stations in the RQZs specified in *considering k)*;
5) studies on new coexistence measures between non-GSO satellite systems and RAS stations in the RQZs specified in *considering k)*;
6) studies of methods to calculate the necessary separation distances between gateways of non-GSO systems operating in bands adjacent to or near RAS allocations and RAS stations protected by the RQZs specified in *considering k)*,

AI 1.16: How did we get here?

- RAS receivers are roughly a quadrillion times more sensitive than a mobile phone and thus are extremely vulnerable to RFI.
  - To grasp the magnitude of a quadrillion, imagine 1 byte vs. 1 Petabyte (= 1000 Terabytes)
- RAS is critically dependent on observing throughout the radio spectrum where physical processes emit to meet its science goals.
  - RFI in this context is any anthropogenic signal, regardless of allocation status.
  - Physics takes place throughout the electromagnetic spectrum, not just in the few protected bands allocated to the RAS. Astronomers cannot ask the universe to “change channels”.
- This is not a choice radio astronomers have made just to be difficult.

AI 1.16: How did we get here?

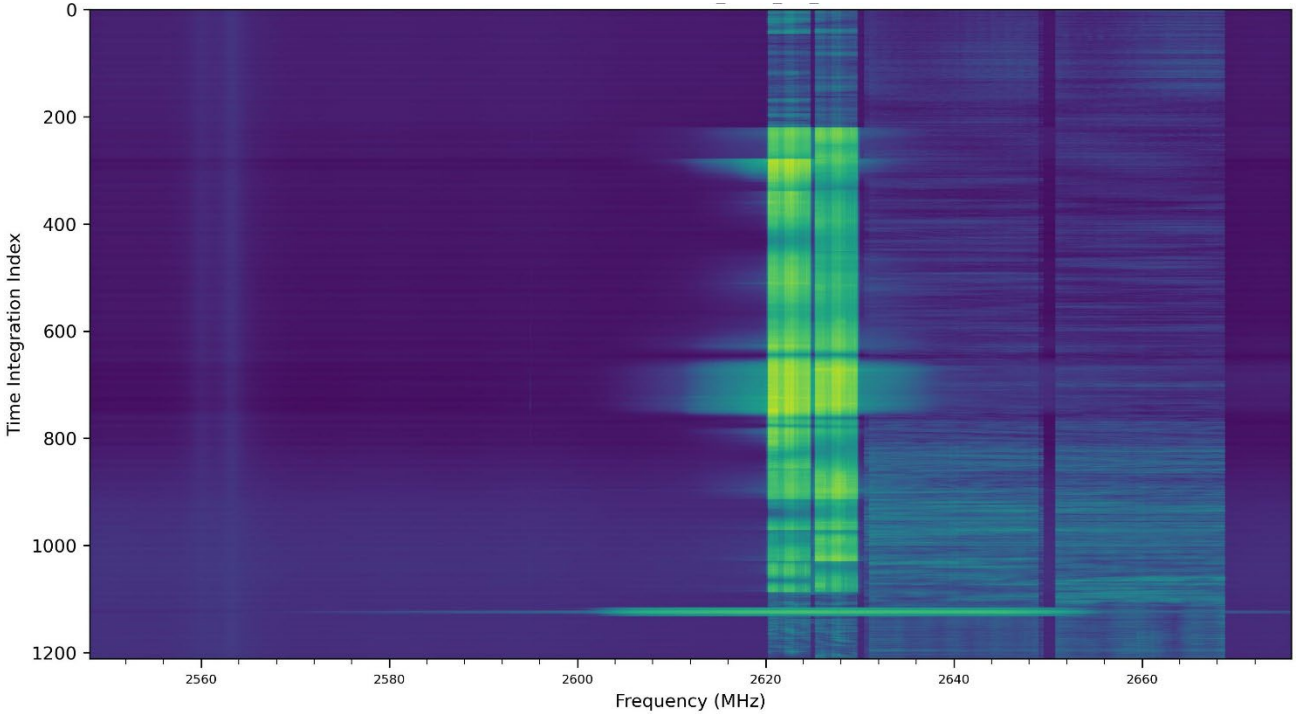
- While RAS needs access to large amounts of the spectrum, this typically takes place at a very few, discrete locations, sometimes located in defined Radio Quiet Zones.
- RQZs have traditionally been in the purview of national administrations, which can address terrestrial issues on their territories.
- This approach has its limits for satellites operating in space, particularly on large scales and with ubiquitous emissions.
- Satellite orbits, radio emissions, and radio radiation are international by definition, and fall squarely within the mandate of ITU-R.

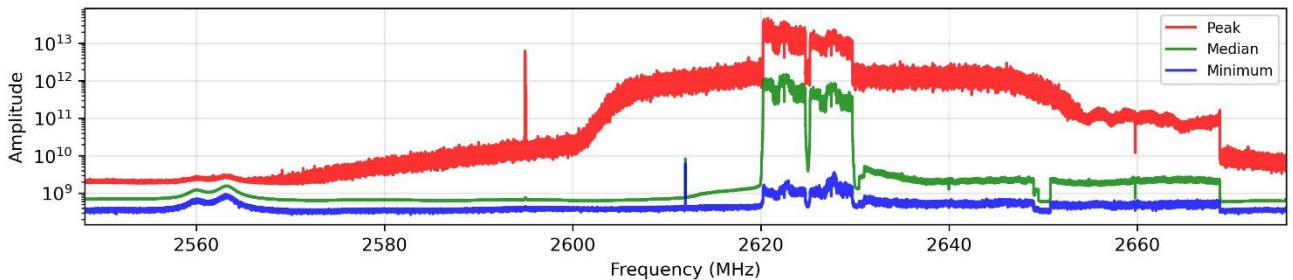
AI 1.16: How did we get here?

- The unprecedented proliferation of NGSOs and their intended and unwanted emissions as well as radiation from the platform electrics and electronics present a profoundly changed electromagnetic environment for all, and pose an existential threat to terrestrial RAS.
- Astronomers have frequently worked with satellite providers on one-to-one basis to resolve issues. This approach also has limits.
- This AI attempts to find solutions (technical and regulatory, as well as advancing the state of the art of knowledge) for ITU-R and administrations to address this new and increasingly urgent challenge on a large scale.

AI 1.16: One example for illustration

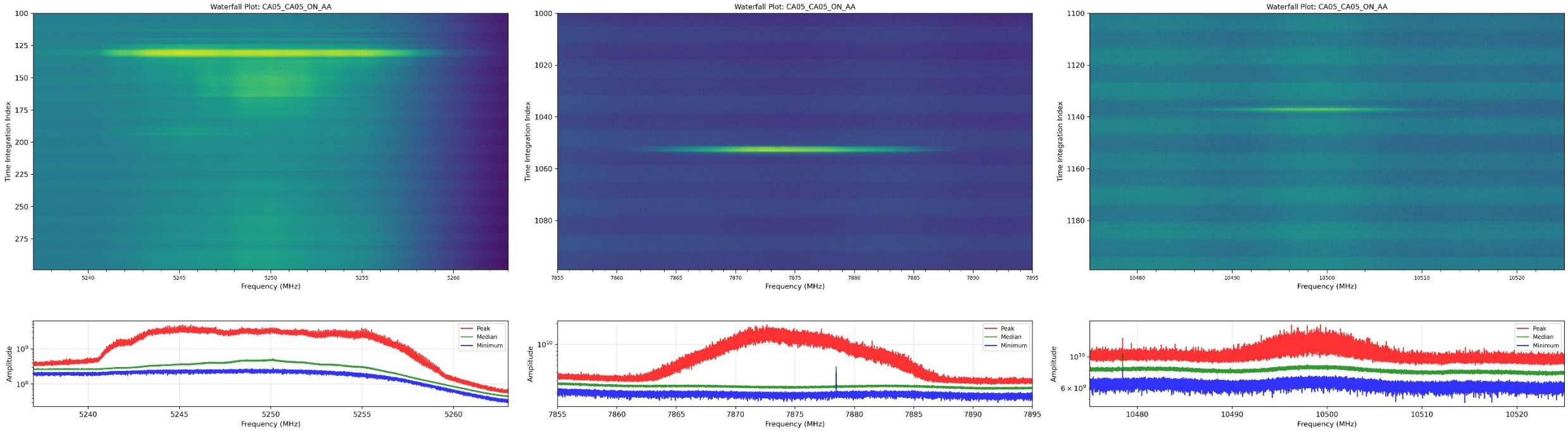
- 5 minute RAS observation of the sky that includes the DTC band 2620-2630 MHz.
- Enormous powers compared to terrestrial interferers 2630-2670 MHZ
- 4+ magnitudes above terrestrial
- Enormous shoulder emissions
- Drives LNAs and/or (16-bit!) sampler non-linear





AI 1.16: One example for illustration

2nd, 3rd, and 4th order harmonics of the same DTC emission, spurious domain!



AI 1.16: Status

- Resolves 1 and 2
  - Largely on track. WP7D has worked well with WPs 4A and 4C to find agreement on aggregate interference calculations.
  - Last NGSO system parameters were provided two weeks ago.
- Resolves 3 to 6 do not currently enjoy much consensus, aside from repeated communications between WP 7D and other working parties expressing a desire for no technical or regulatory constraints on other services as an outcome. However, inputs have been received towards better understanding of challenges.
- WD draft CPM Text in 7D/235 Annex 25 (subject to approval by next plenary). **More inputs are needed.**

	Method 1	Method 2
***Resolves* 1 & 2 (Issue A)**	NOC 114.25 - 116 GHz Band is not adjacent to active services under study for this AI	Mandatory thresholds in RR Footnotes for two bands adjacent to RAS bands under study (10.7-10.95 GHz; 95-100 GHz), and Appendix 4 mods reflecting commitment to observe ePFD for these bands at RAS sites
***Resolves* 3 – 6 (Issue B)**	NOC	None Yet

Status as of November 2025