Compatibility between Amateur Services and RNSS in E6 Band

ICG Working Group A
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J. López-Salcedo, M. Paonni
M. Bavaro, J. Fortuny
European Commission
JRC.G.5

D. Hayes
European Commission
ENTR.H.3

Joint Research Centre

The European Commission's in-house science service

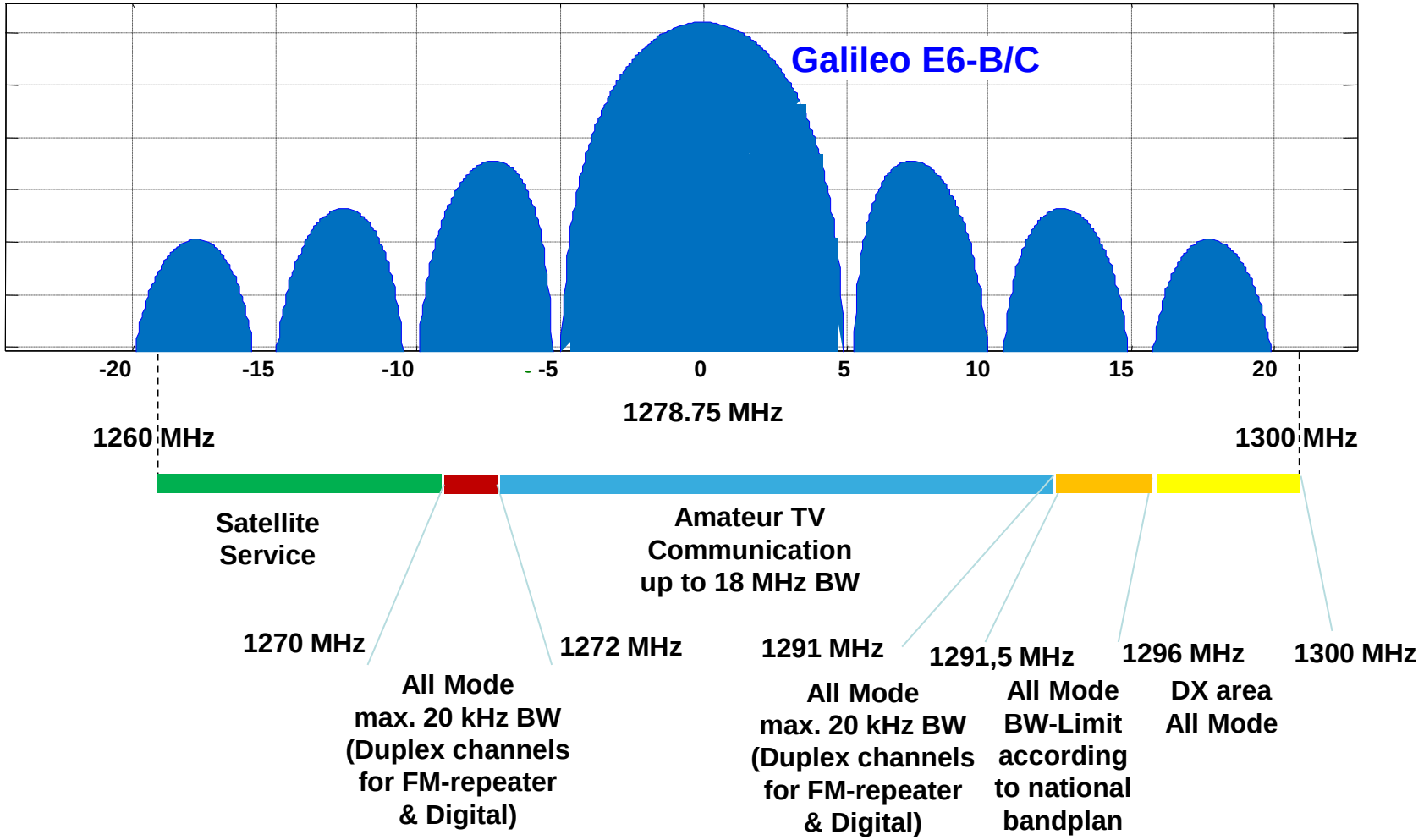
Regulatory Framework

- The band **1260-1300 MHz** is allocated to **RNSS** on a **primary basis**
  - ✓ The band is currently used by **Galileo**, **Beidou** and **QZSS**
- **Amateur Services (AS)** are allocated on a **secondary basis** in the **1240-1300 MHz** band (also known as 23 cm band)
  - ✓ The ARS allocation is used for many diversified services, the most relevant being Amateur TV

Amateur Services in 23 cm band

- The 23cm band has sufficient bandwidth to support TV as well as voice/data systems
  - ✓ FM Voice Repeaters
  - ✓ Digital Voice Repeaters
  - ✓ Digital Data Repeaters/links
  - ✓ Amateur Television Repeaters (analog and digital)
- The 23cm band is probably the most popular band currently for ATV, other bands are available and graduated migration may be feasible

IARU band plan for AS in E6 (ITU R1)



Shutdown of ATV repeater in Germany

- In March 2014, the Galileo receiver located at the Galileo Control Center (GCC) in Oberpfaffenhofen did report interference
- The German authority (BNetzA) determined the ATV repeater DB0QI in Munich as the source of interference
- BNetzA instructed the operator of DB0QI to shut down the repeater on 1278 MHz (analog ATV) and 1291 MHz (digital ATV)
- TV repeater operations nearby are now terminated
- Distance between GCC and DB0QI is 18 km

Ongoing European Initiatives

- Already since 2013 quite high attention on possible compatibility issues between Galileo and AS
- The 2014 case of the Munich repeater increased the concern within Europe
- Several initiatives started in 2014:
  - ✓ Preliminary studies conducted by Member States
  - ✓ Dialogue with IARU representatives
  - ✓ Extensive compatibility analysis performed by JRC

JRC Activity on Galileo-AS Compatibility

Activities have been initiated at JRC at three different levels:

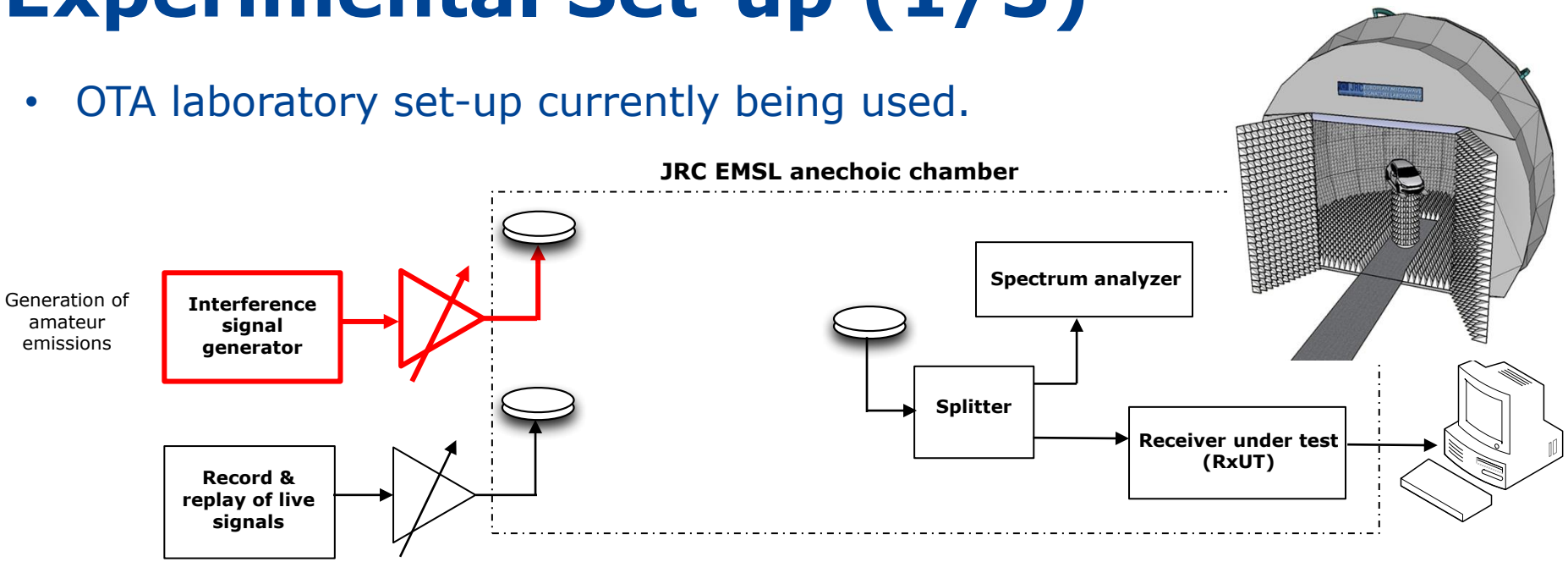
- Good cooperation and coordination with IARU and amateur societies
- Experimental assessment at the JRC European Microwave Signature Laboratory (EMSL) using Galileo-E6 prototype receivers and recorded live signals
- Analytical assessment based on computer simulations, using a Galileo-E6 software receiver

Coordination with IARU

- JRC is in contact with a delegation of IARU members from Germany, UK and Italy amateur societies.
- Meetings have been held to agree on the approach for the compatibility analysis and the definition of a representative test plan:
  - **Test #1.** CW signal with a power sweep. Key frequency placements were selected (i.e. maxima of Galileo E6 spectral lobes and spectral nulls).
  - **Test #2.** The same as test #1 but using different amateur signals and different bandwidths (i.e. amateur TV, data, voice, etc.).
  - **Test #3**. Impact of high-power "out-of-band" emissions in 1240-1260 MHz.

Experimental Set-up (1/3)

- OTA laboratory set-up currently being used.



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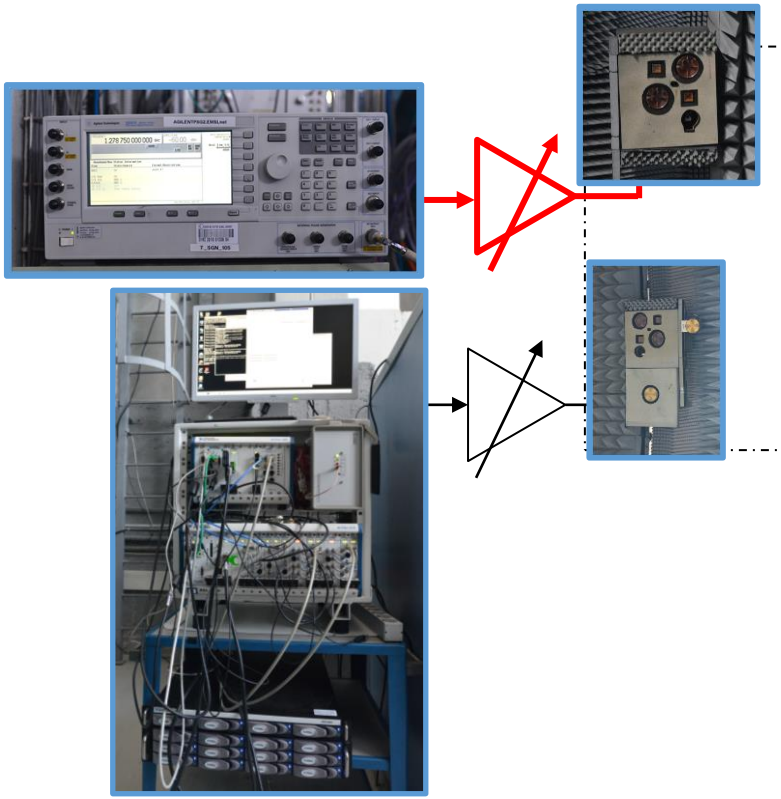
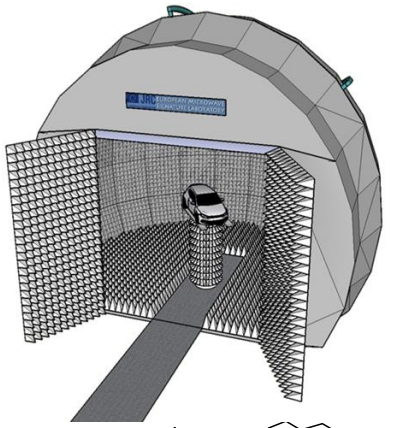
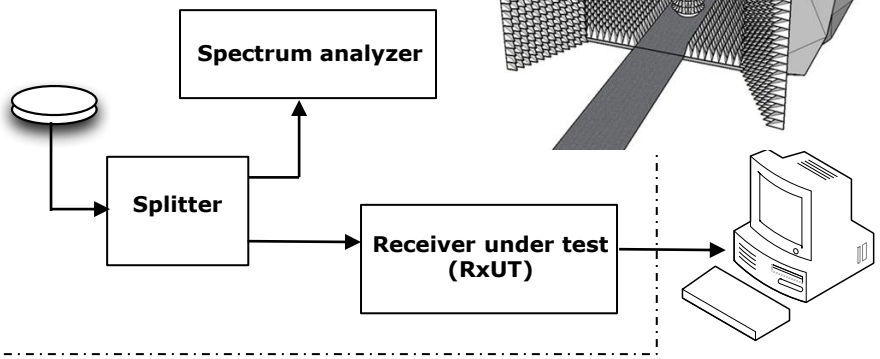
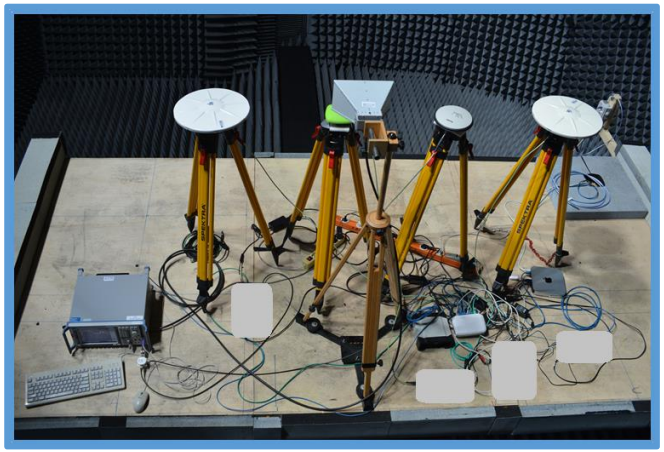
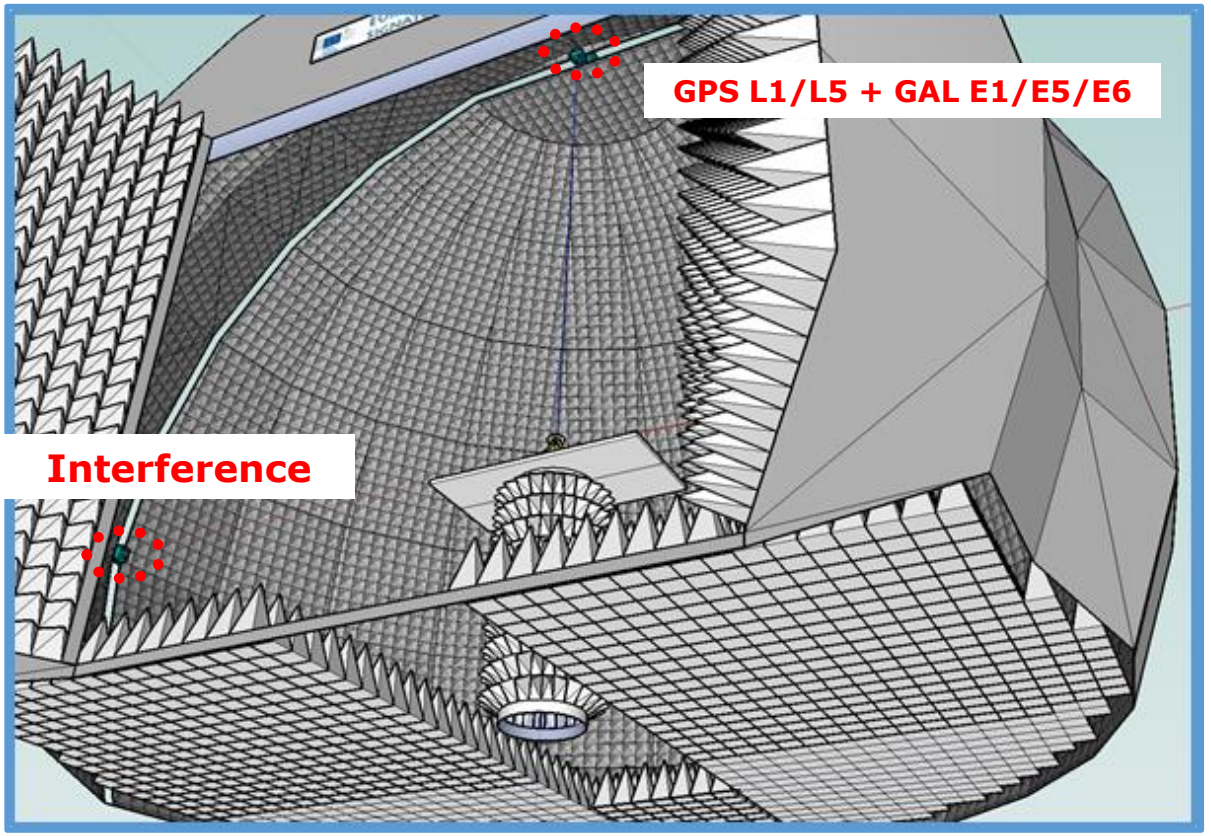






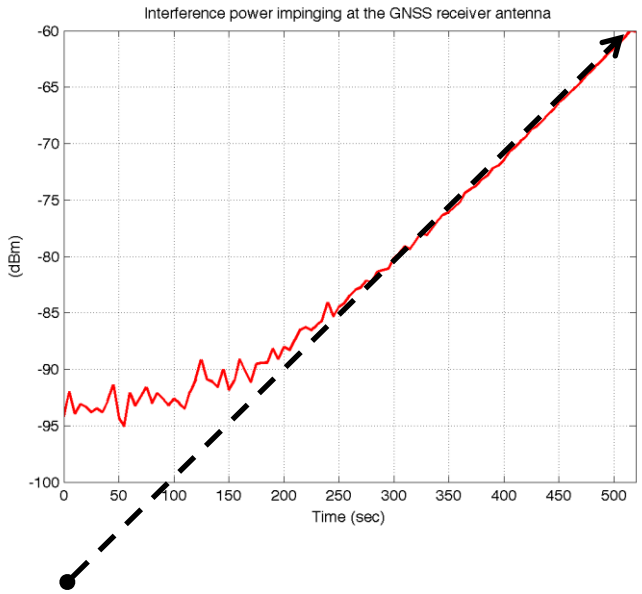


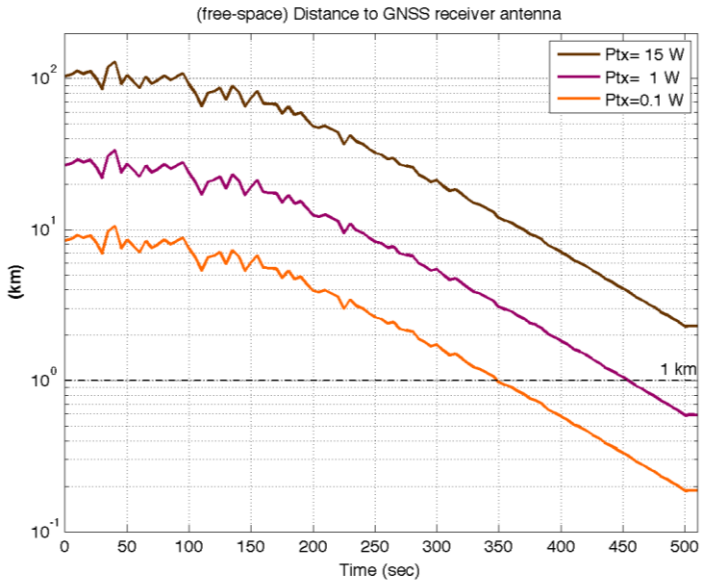
Experimental Set-up (2/3)



Experimental Set-up (3/3)

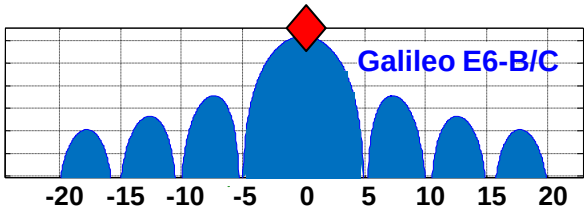
- Three E6-enabled Galileo high-end receivers tested
- A recorded set of Galileo signals is re-broadcasted inside the EMSL
- The interference signal is transmitted in the same horizontal plane where the antenna is placed (i.e. 0º elevation)
- The interference power is gradually increased up to -60dBm at the GNSS antenna input

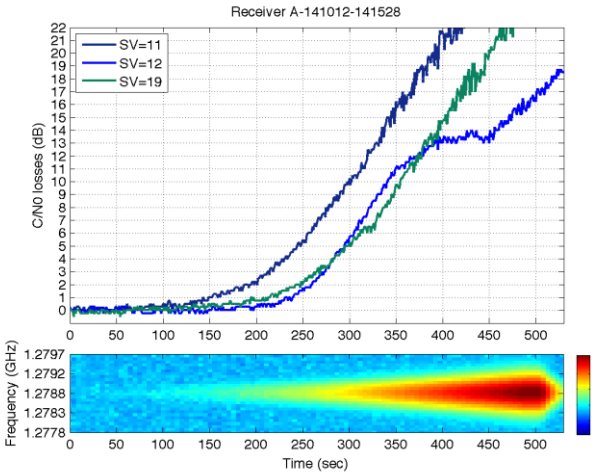




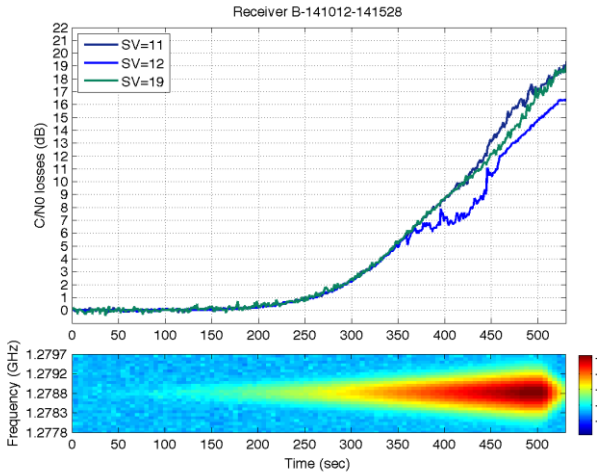
Some Preliminary Results (1/3)

- Continuous Wave AS interfering signal at 1278.75 MHz
- Measured C/N_0 Degradation (vs. time)

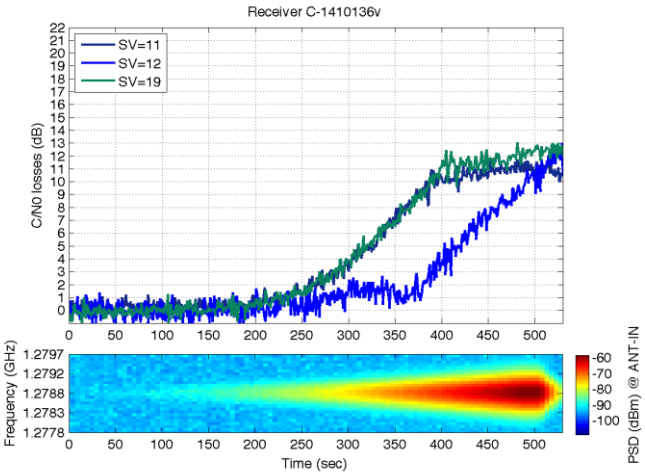




Rx-A



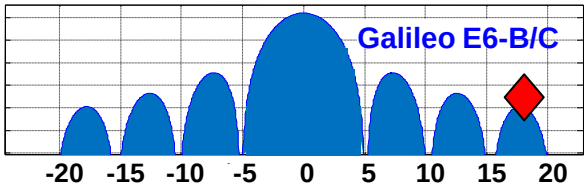
Rx-B

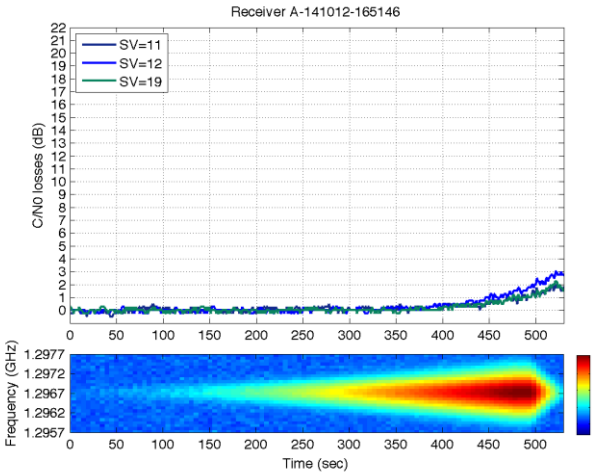


Rx-C

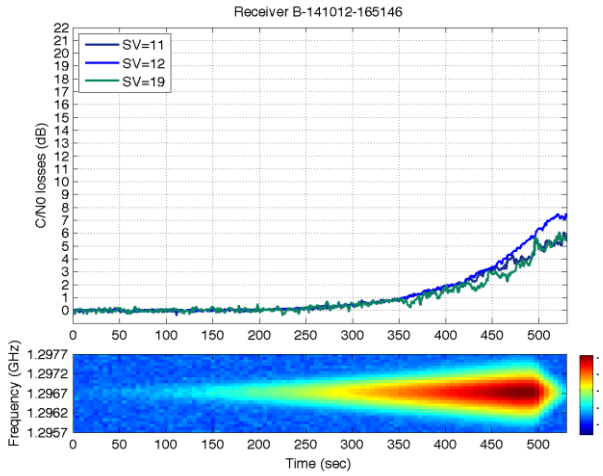
Some Preliminary Results (2/3)

- Continuous Wave AS interfering signal at 1296.6525 MHz
- Measured C/N_0 Degradation (vs. time)

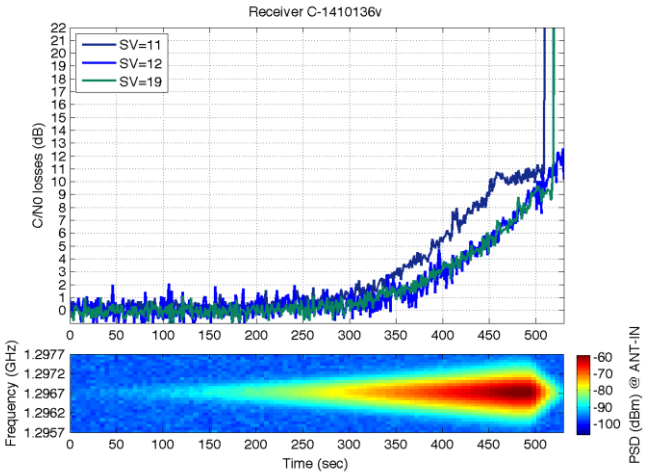




Rx-A



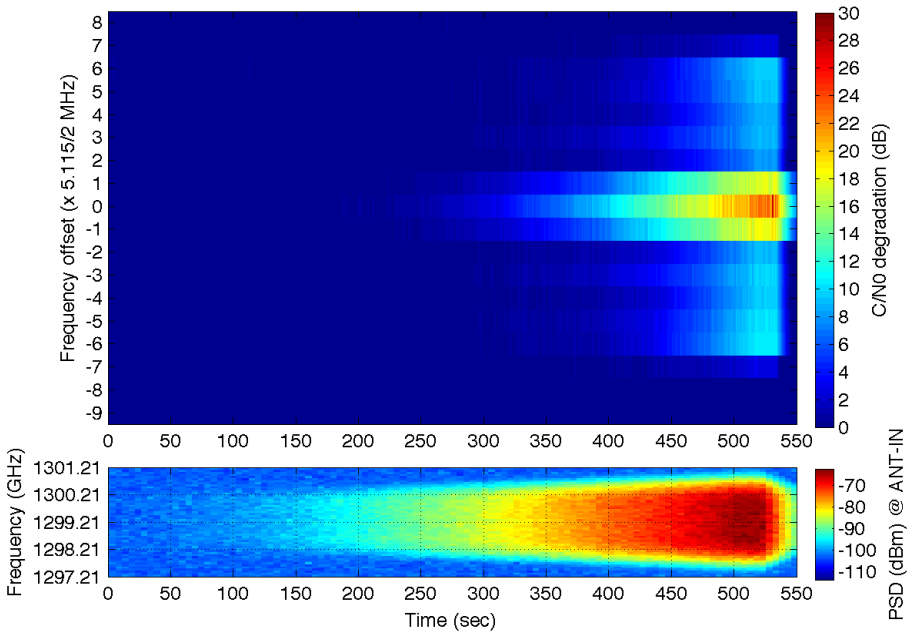
Rx-B



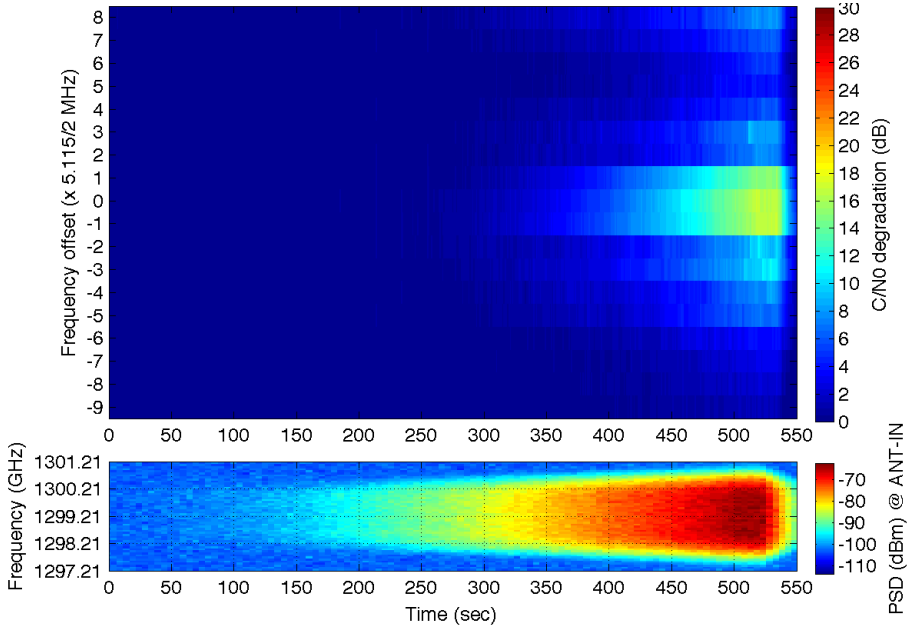
Rx-C

Some Preliminary Results (3/3)

- AS 2 Msps DVB-S interfering signal
- Measured C/N_0 Degradation (vs. Frequency Offset and time)



Rx-A



Rx-B

Preliminary Conclusions of JRC Work

- Coexistence scenarios defined in agreement with IARU
- First round of measurements for the first coexistence scenario (18 fixed frequency beacons) successfully completed
- Three high-end E6-enabled receivers have been used in the tests
- A versatile and highly realistic OTA test-bed has been put in place
- As a start, C/N_0 degradation used as metric and protection distances from the amateur station have been estimated
- Remaining coexistence scenarios to be analyzed in the coming weeks (awaiting for precise definition of the waveforms to be used from IARU)

Way Forward

- Initial results suggest definite potential for AS impacts on RNSS
  - ➢ Both RNSS and AS recognise this
- Collaborative work continues with the AS community to fully understand the nature of the impacts
- Joint report of the results to be written, from which submissions to CEPT are expected, and possible ITU inputs
- Although AS is secondary, Galileo is keen to minimise disruption to AS if possible
- Galileo and AS will work to identify ways to allow RNSS to operate ubiquitously in E6 without interference, whilst recognising:
  - May require AS to limit use in portions of 1240-1300MHz
  - AS priority to preserve key frequencies used for bespoke applications like Moon-bounce using high gain antennas
- Investigate the possibility to extend the secondary AS allocation above 1300 to 1320MHz (WRC-19 agenda item?)
  - Similar or same (successful) sharing scenarios with radar