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CENTRE NATIONAL D'ÉTUDES SPATIALES

BIRD DEMONSTRATOR
DVB-S2 RF RESULTS

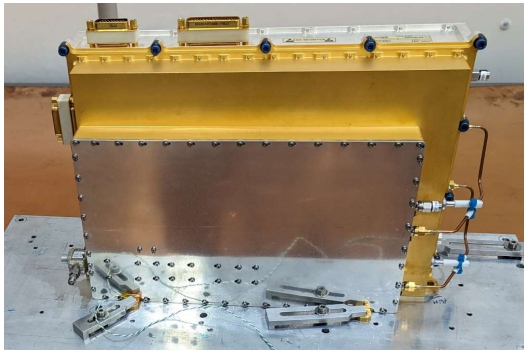
CCSDS FALL 2024 LONDON
05/11/2024

SUMMARY

BIRD PRESENTATION

- HDRTM (High Data Rate TeleMetry) chain demonstrator in X-band
- Will flight on IOD/IOV satellite (In orbit demonstration/ in orbit validation) from European Commission, on a Redwire platform
- Heritage from a CNES project started in 2011, called OTOS
- Objective of an average data rate of 1 Gbps (Peak data rate at 1.3 Gbps, so 2.6 Gbps with two transmitters)
- Three main innovations:
  - Variable Coding and Modulation (VCM): adapt the data rate to the satellite elevation (distance variation from satellite to ground station over one pass)
  - Antenna Pointing System (APS): high gain antenna pointed with precision thanks to an automated three-arm mechanism
  - Dual polarization transmissions: two transmitters on the same frequency band, with orthogonal polarizations

BIRD EQUIPMENT



X-BAND TRANSMITTER

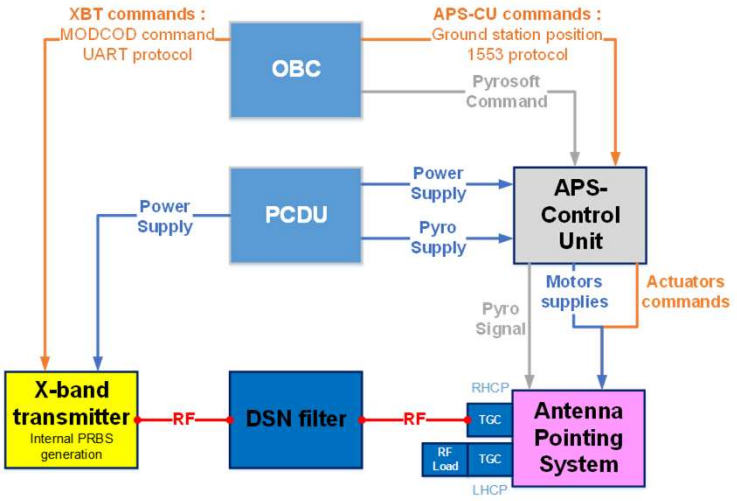
TAS

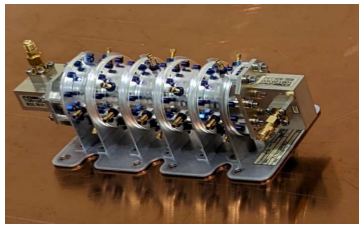
300 Mbauds in X-Band

VCM

ECSS Class 1

3.7 kg , 60 W





DSN FILTER

TAS

High rejection in DSN frequency band

APS- CONTROL UNIT

EREMS

1.5 kg

APS-CU + APS: 40 W

ANTENNA POINTING SYSTEM

COMAT 8.5 kg

Bipolar, 20.5 dBi gain

Pointing performances:

360° in azimut

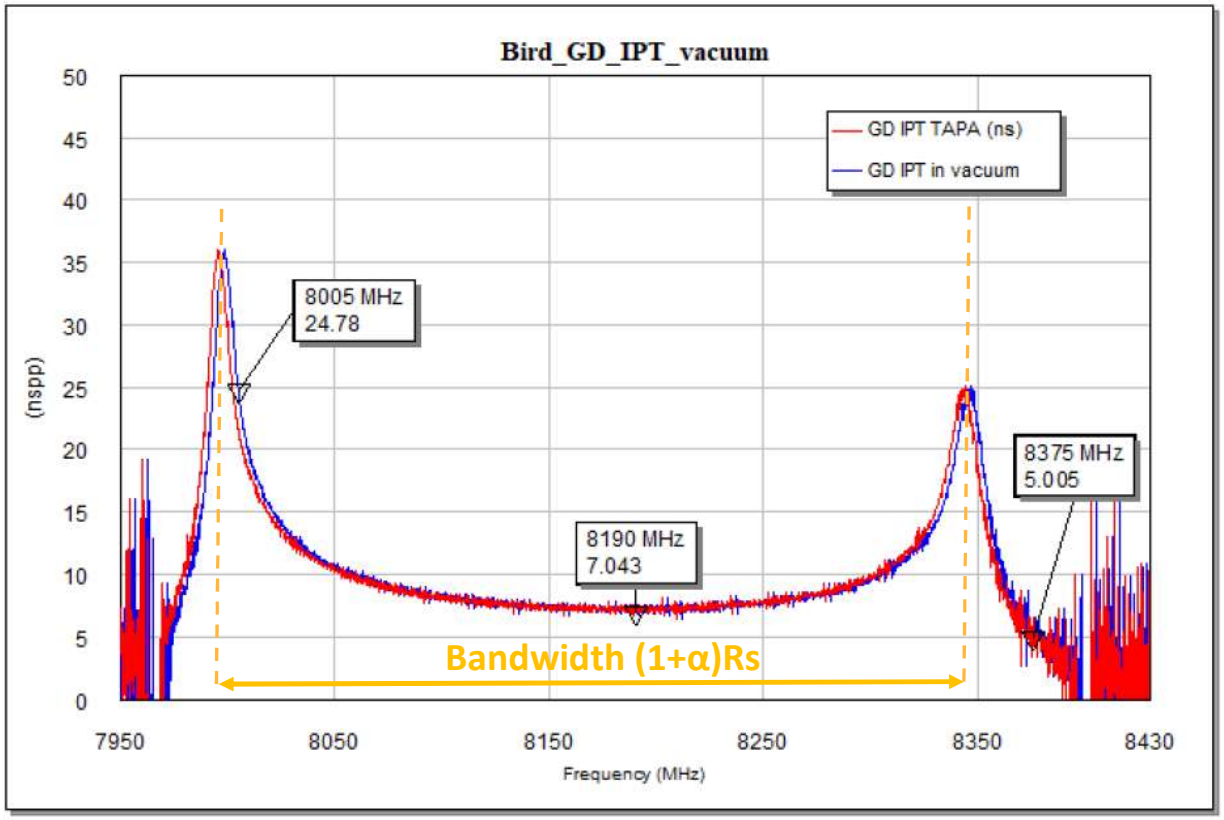
74° in elevation

RF FILTER SPECIFICATIONS

Several constraints for DSN filter specifications:

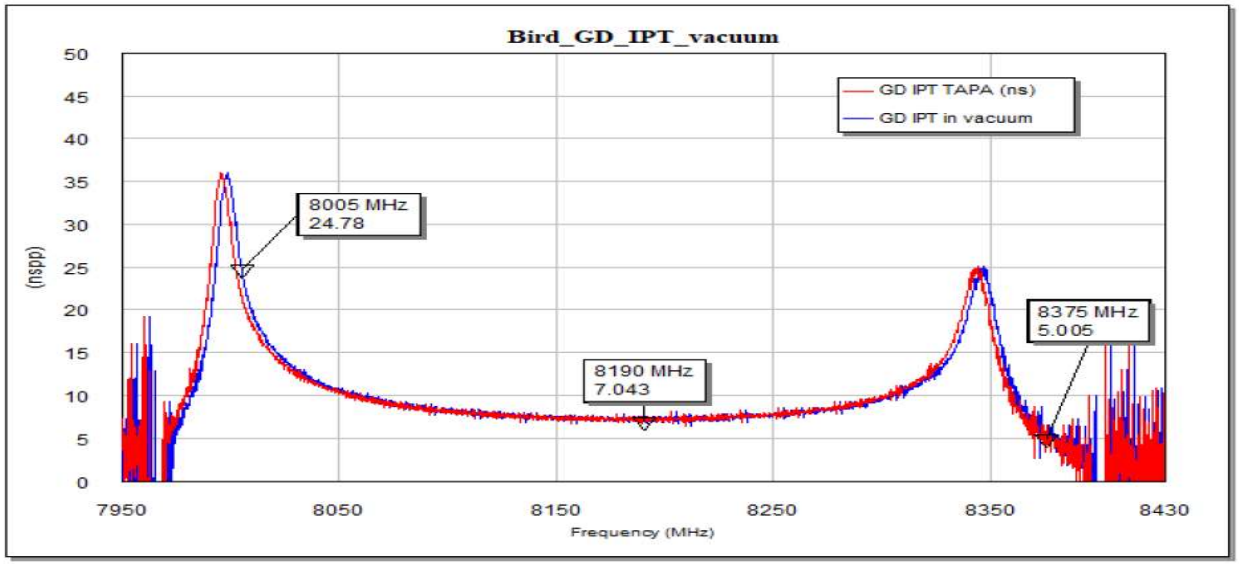
- High EIRP so high rejection at 8.4 GHz (ITU)
- 300 Mbaud so wide bandwidth (CNES)
- Small volume on satellite (Redwire)

BIRD filter group delay measurement during acceptance tests



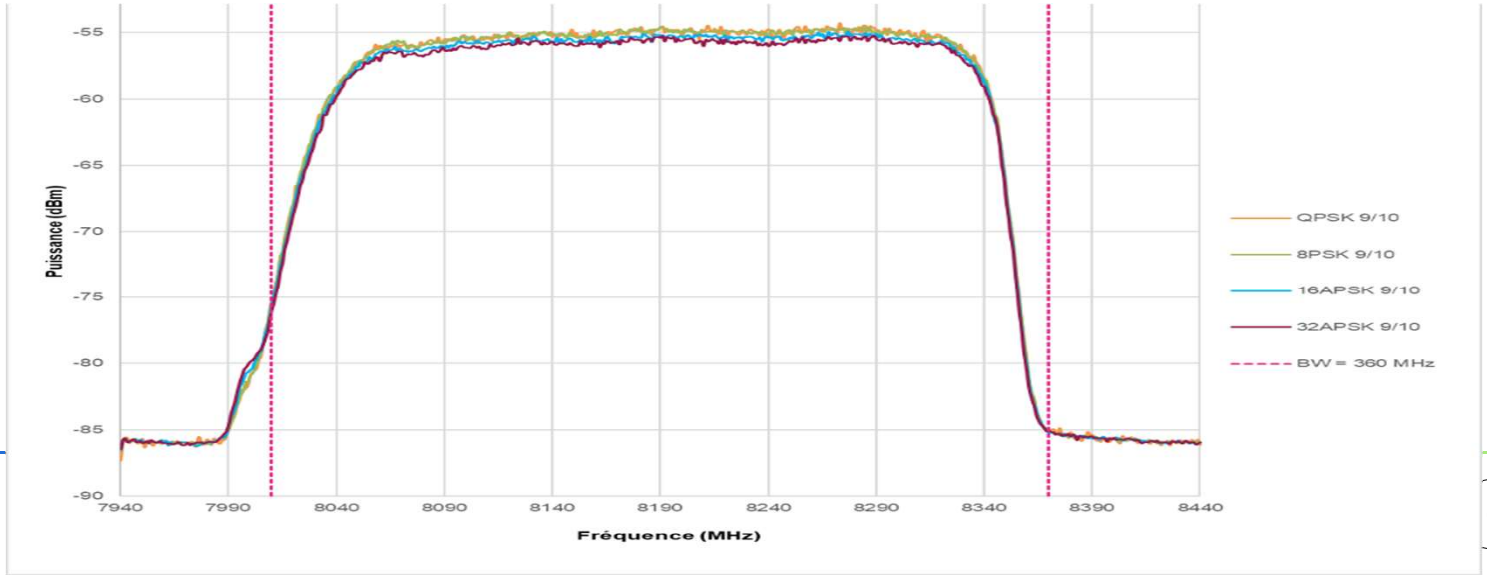
Telecom laboratory results in DVB-S2 projects showed that even with delta group delay = 12xTs (in the bandwidth (1+α)Rs) results remains acceptable.

RF FILTER GROUP DELAY

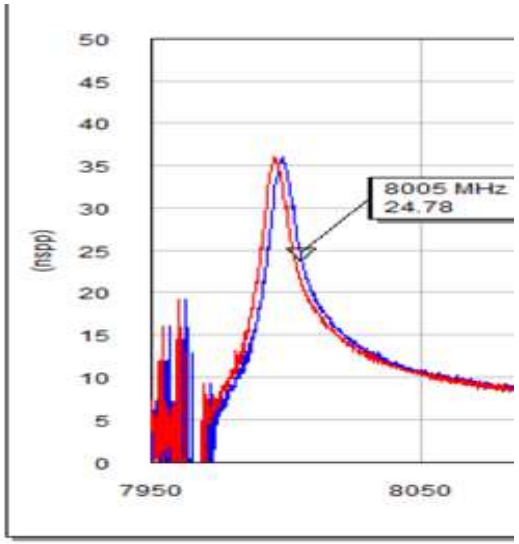


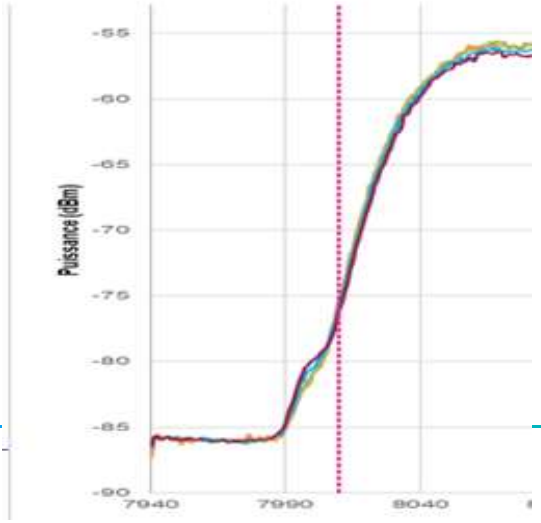
BIRD spectrum measurement during RF tests at CNES (X-Band transmitter + filter+ antenna)

In pink: (1+α)Rs bandwidth



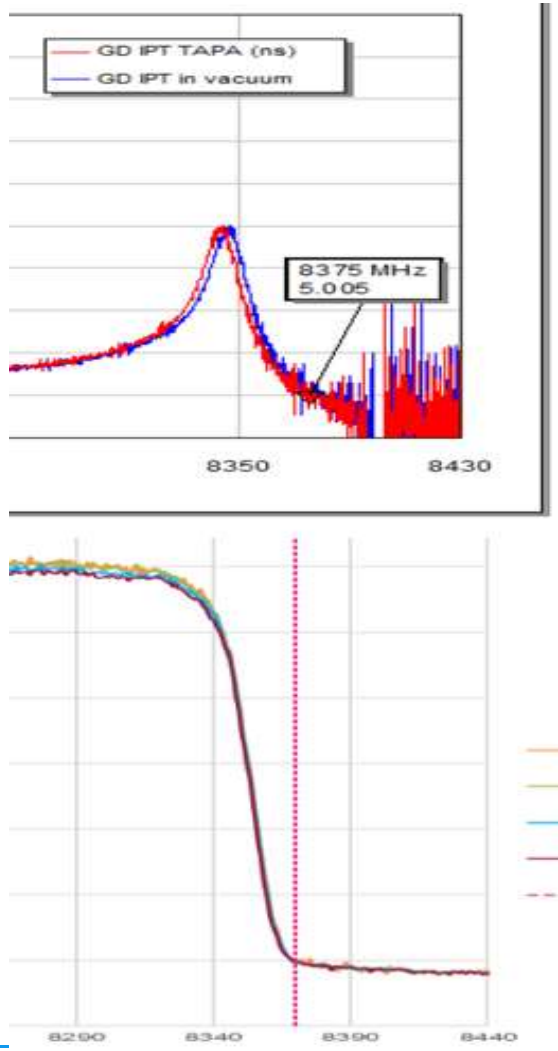
RF FILTER GROUP DELAY: ZOOM ON LEFT SIDE





Delta group delay = 24.78-7.043
= 17.7ns = $17.7*10^{-9}*(300*10^{6})$
= 5.3 Ts < 12 Ts **OK**

RF FILTER GROUP DELAY: ZOOM ON RIGHT SIDE



Delta Group delay = 25-5.005 ns
= $19.9*10^{-9}*(300*10^{6})$
= 5.9 Ts < 12 Ts **OK in theory**

But the whole variation (up and down) of group delay is inside the (1+α)Rs bandwidth

What will be the consequences on the RF chain performances ?

CARRIER SUPPRESSION

- CCSDS spring 2024: High Order Modulations for Space Research Category A (Recommendation 2.4.17A): SLS-RFM_24-02: changing the carrier suppression limit to -35 dBc for SRRC-32APSK and SRRC-64APSK

- X-Band BIRD transmitter :

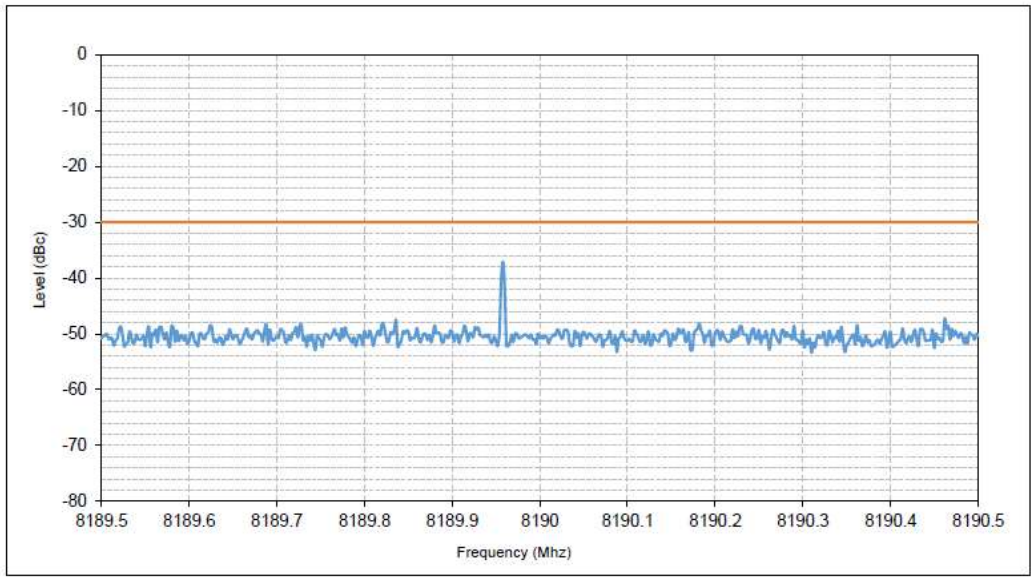
carrier suppression < -35 dBc

Temperature	Carrier rejection measure (dBc)
25 °C	-42.36
50°C	-37.11
-15°C	-43.04

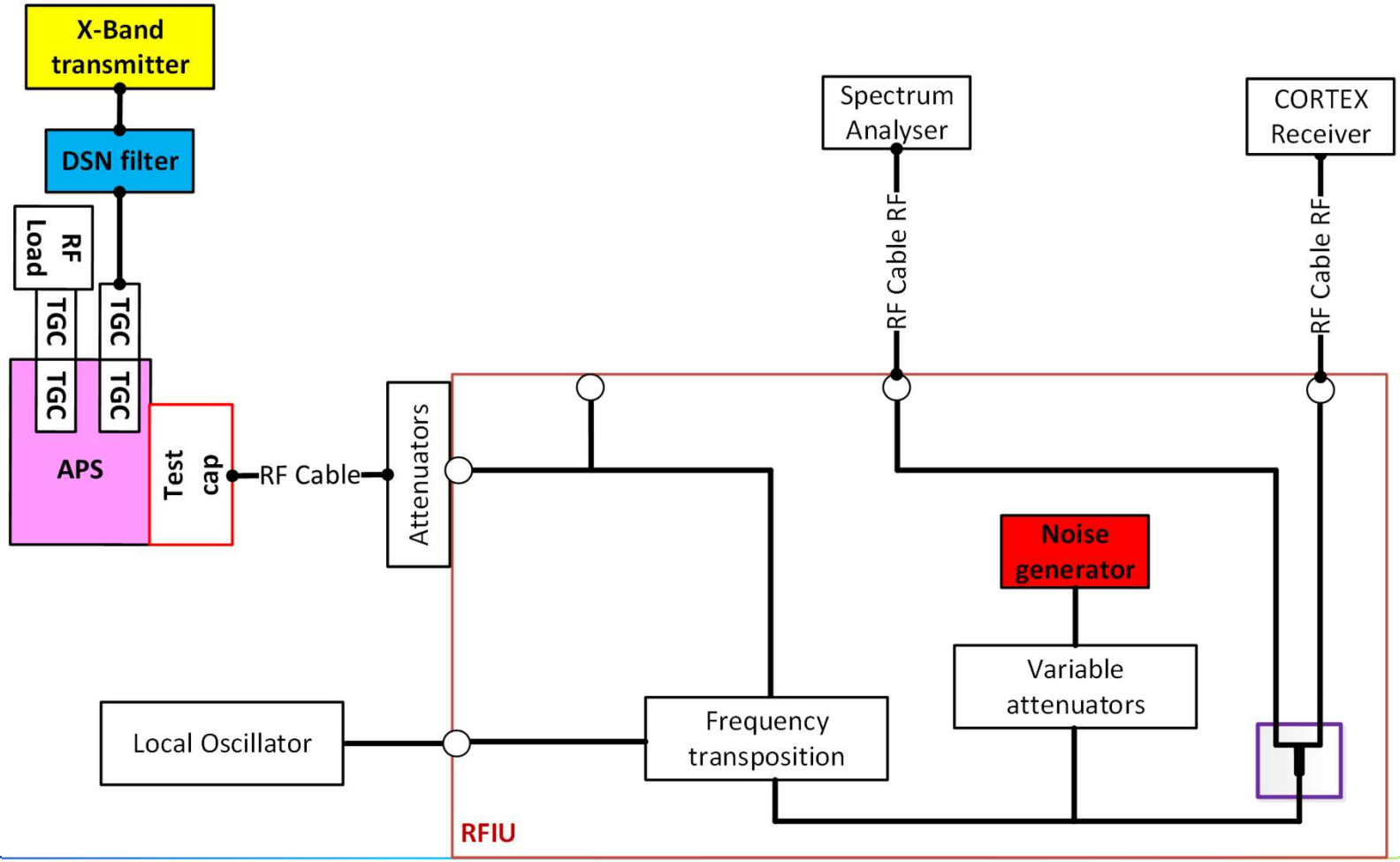
Carrier Rejection

DUT Parameters :
Vbus voltage: 28.0V
CW mode

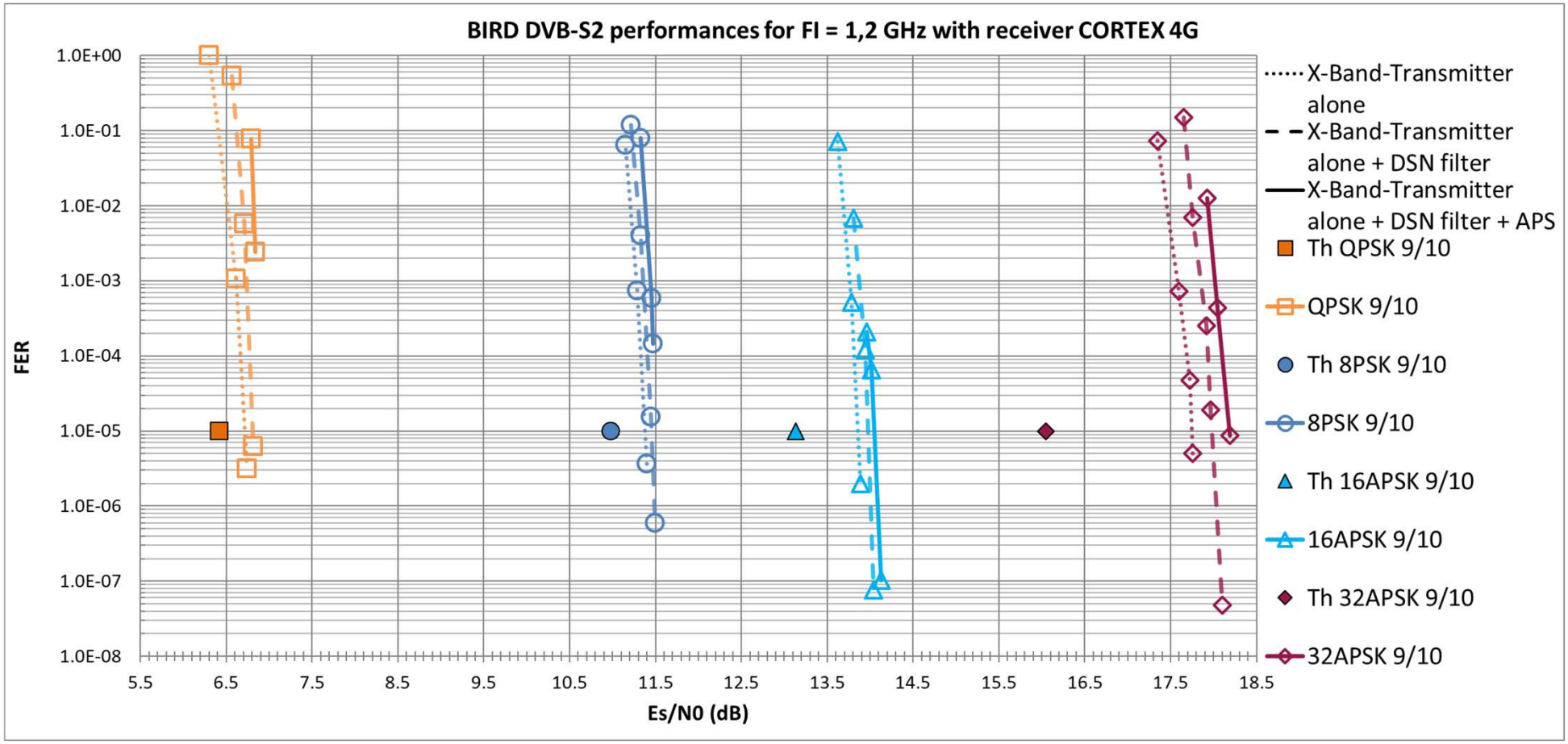
Spectrum analyser parameters :
Spectrum trace strart frequency (MHz): 8189.5
Spectrum trace stop frequency (MHz): 8190.5
Spectrum span frequency (MHz): 1
Spectrum resolution bandwidth (Hz): 3000
Spectrum video bandwidth (Hz): 3000
Spectrum average value: 10

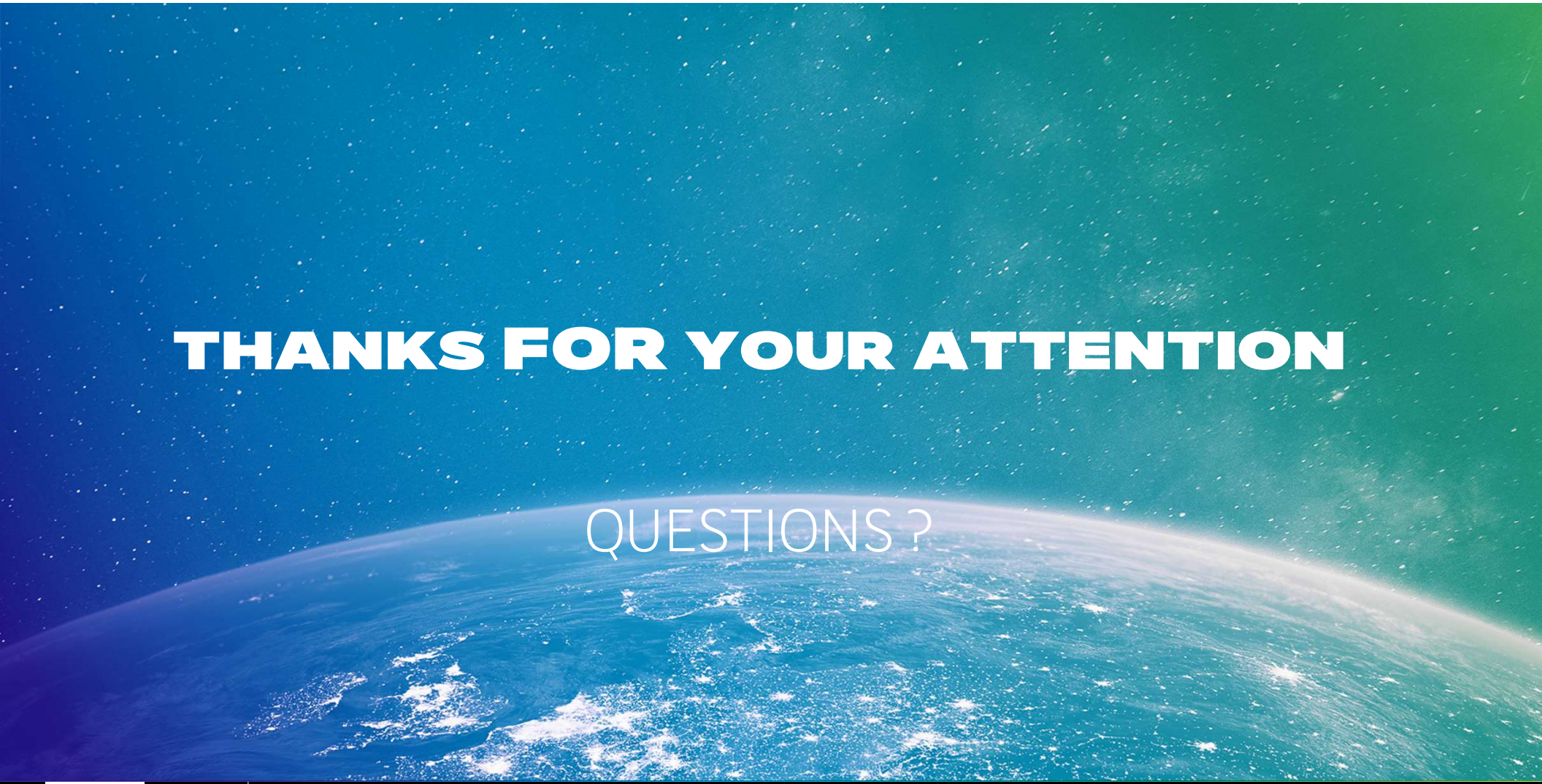


TEST SET UP


X-Band transmitter
DSN filter
RF Load
TGC
TGC
TGC
TGC
APS
Test cap
RF Cable
Attenuators
Spectrum Analyser
RF Cable RF
CORTEX Receiver
RF Cable RF
Noise generator
Variable attenuators
Local Oscillator
Frequency transposition
RFIU

RF RESULTS IN DVB-S2




THANKS FOR YOUR ATTENTION
QUESTIONS ?