

# **RPW PFM : First analysis of EMC on performances**

RPW Consortium Meeting  
KTH  
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## EMC « menu »

### RPW EMC tests in Toulouse with MEB PFM, ANT PFM and SCM FM

- EMC Status and Non Conformities
- Conducted Emissions
- Conducted Susceptibility
- Radiated Mode
- RPW Self Compatibility

### EMC Results of the Other Instruments and SOLO Platform

- E-Field measurements and analysis
- H-Field measurements and analysis
- Synthesis : EMC Quiet State for RPW
- Annex : All the results on each instrument



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## **RPW EMC tests in Toulouse with MEB PFM, ANT PFM and SCM FM**

# EMC Status and Non Conformities

Test Request	Requirement	RPW	MEB	ANT	SCM	Status	NC
			MEB				
Measure the equivalent magnetic dipole (magnetic moment)	EIDA R-817 EIDA R-680 EIDA R-796	N	Y	Y	Y	✓ PASS (expected 16mA.m²)	/
Grounding and isolation, Bonding and Case shielding	EIDA R-308 309 / 777 / 778 / 779	N	Y	Y	Y	✗ Grounding Failed on SpW link on EGSE side and on test harness dedicated for Conducted Mode. Isolation Failed due to TCS common mode filter	NC301
CE on power lines, differential mode, Frequency Domain	EIDA R-313	Y	Y	N	N	✓ Pass	/
CE on power and signal lines, common mode, frequency domain	EIDA R-314	Y	Y	N	N	✓ Pass	NC 183 can be closed
CE on power lines, differential mode, time domain	EIDA R-315 EIDA R-316	Y	Y	N	N	✗ Current out of the specification due to 96Hz, Voltage out of specification due to 200kHz => If LFR not active and Bandwidth <64Hz, compliant	NC184
CE on power lines, common mode, time domain	EIDA R-317	Y	Y	N	N	✓ Pass	/
CE on power lines, Inrush current	EIDA R-318	Y	Y	N	N	✗ Not fully compliant (di/dt) of very first peak with no energy => ✓	NC 317 can be closed
CE Common mode on signal lines	EIDA R-708	Y	Y	Y	Y	✓ Pass	NC 180 can be closed
CS on power lines, differential mode, frequency domain	EIDA R-320	Y	Y	N	N	✗ Not compliant with EIDA specification but acceptable with ETB results ✓	NC186 NC 187 can be close due to ETB results
CS on power lines, common mode, frequency domain	EIDA R-321	Y	Y	N	N	✗ Not compliant with EIDA specification but acceptable with ETB results ✓	NC 185, NC 205 can be closed due to ETB results
CS on power lines, differential mode, transient	EIDA R-322	Y	Y	N	N	✓ Pass (tested on EM2, only peaks are detected no failure)	
RE electric field	EIDA R-324	Y	N	N	N	✓ Pass no peaks on X-band (other frequencies tested on EM2)	/
RS electric field	EIDA R-325 EIDA R-846	Y	N	Y	Y	✓ Pass no susceptibility on X-band (other levels tested on EM2)	/
ESD Susceptibility, Radiated	EIDA R-327	Y	N	Y	N	✓ Pass (tested on EM2, only peaks are detected no failure)	/
ESD Susceptibility, conducted	EIDA R-328	Y	N	Y	N	✓ Pass (tested on EM2, only peaks are detected no failure)	/
RE DC magnetic field (Magnetic stability)	EIDA R-681 683/684/685	Y	Y	Y	Y	✓ Pass TBC (tested with ESA)	/
RE AC Magnetic Field	EIDA R-703 704/705/783 /784	Y	N	Y	Y	✗ On going analysis : 96Hz Harmonics are out of specification, not detected by RPW !	NC309
RE AC Electric Field	EIDA R-706 785/707	Y	N	Y	Y	✗ on going analysis: in Science mode with BIAS converter active DC/DC converter is seen (x peaks), also detected by RPW itself, in science Mode with BIAS not active, only one peak due to DPU	TBC (waiting Intespace report)



# EMC Status and Non Conformities

## Non Conformities

- Grounding and isolation

- ◆ Due to TCS filter towards SCM heaters that are directly plugged on primary power lines
- ◆ => Acceptable for SOLO,
- ◆ => induce more spurious that can path through RPW input impedance

- Current and Voltage Ripple

- ◆ Due to BIAS Activity (voltage, 200kHz)) and LFR (Current, 96Hz)
- ◆ => Acceptable no impact on MAG

- RPW is more susceptible than “standard” instrument

- ◆ Analysis to be done particularly concerning the use of heaters

- RPW is not fully “self compatible”

- ◆ To define the modes to be use in order to characterize the Galaxy



# Conducted Emissions



# Conducted Emissions

All tested harness are compliant in frequency domain

In time domain (ripple and spike)

- DM Current compliant if bandwidth <90Hz => due to LFR
- In full band, 200kHz is mainly responsible of the Voltage level (460mVpp)
- Science Mode with stable current mode is better than Burst Mode

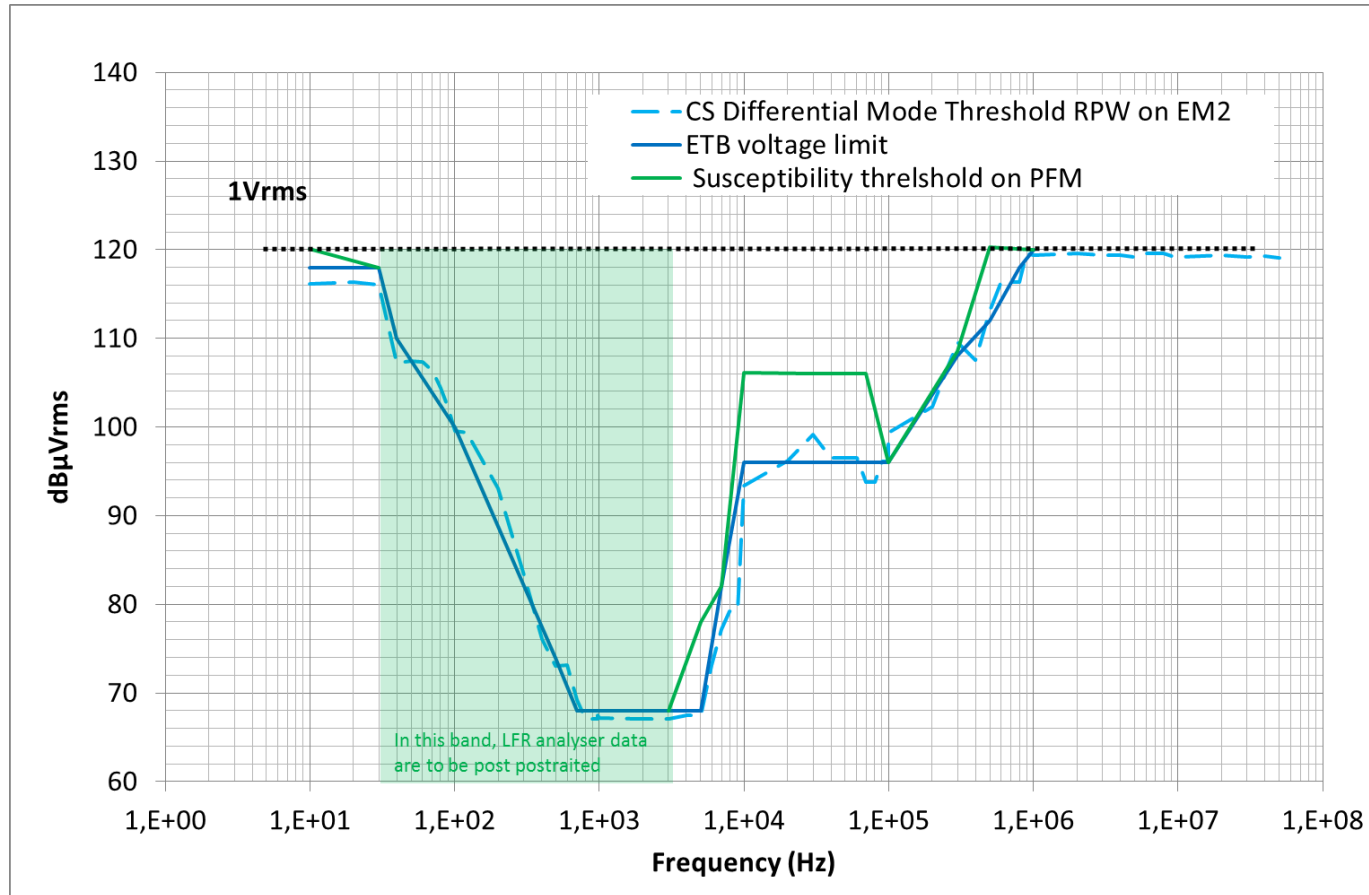
Configuration	Frequency (Hz)	DM Voltage Ripple or Spike (mVpp)	DM Current ripple (mApp)	CM Current ripple (mApp)	Comment
Mode Science	<100k	512	93 (Burst Mode) 54 (Stable mode)	<5	>150mVpp, >20mApp,<5mApp
	<96Hz	168	25	<5	#150mVpp, #20mApp,<5mApp
	200k	464	22	<5	>280mVpp , > 20mApp, <5mApp

Inrush are acceptable



# Conducted Susceptibility

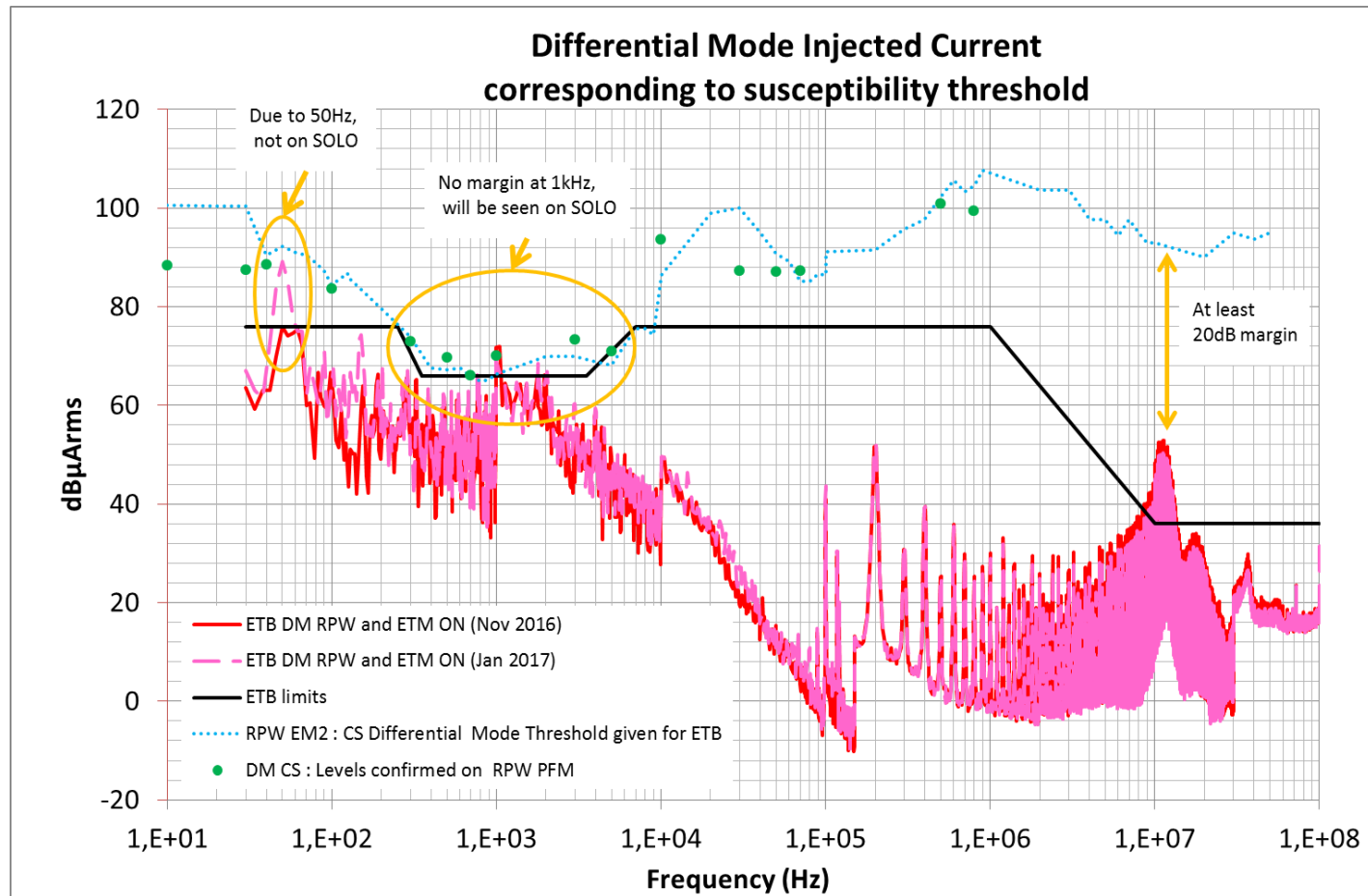
Differential Mode Susceptibility Voltage Threshold was given for ETB.  
Levels are confirmed





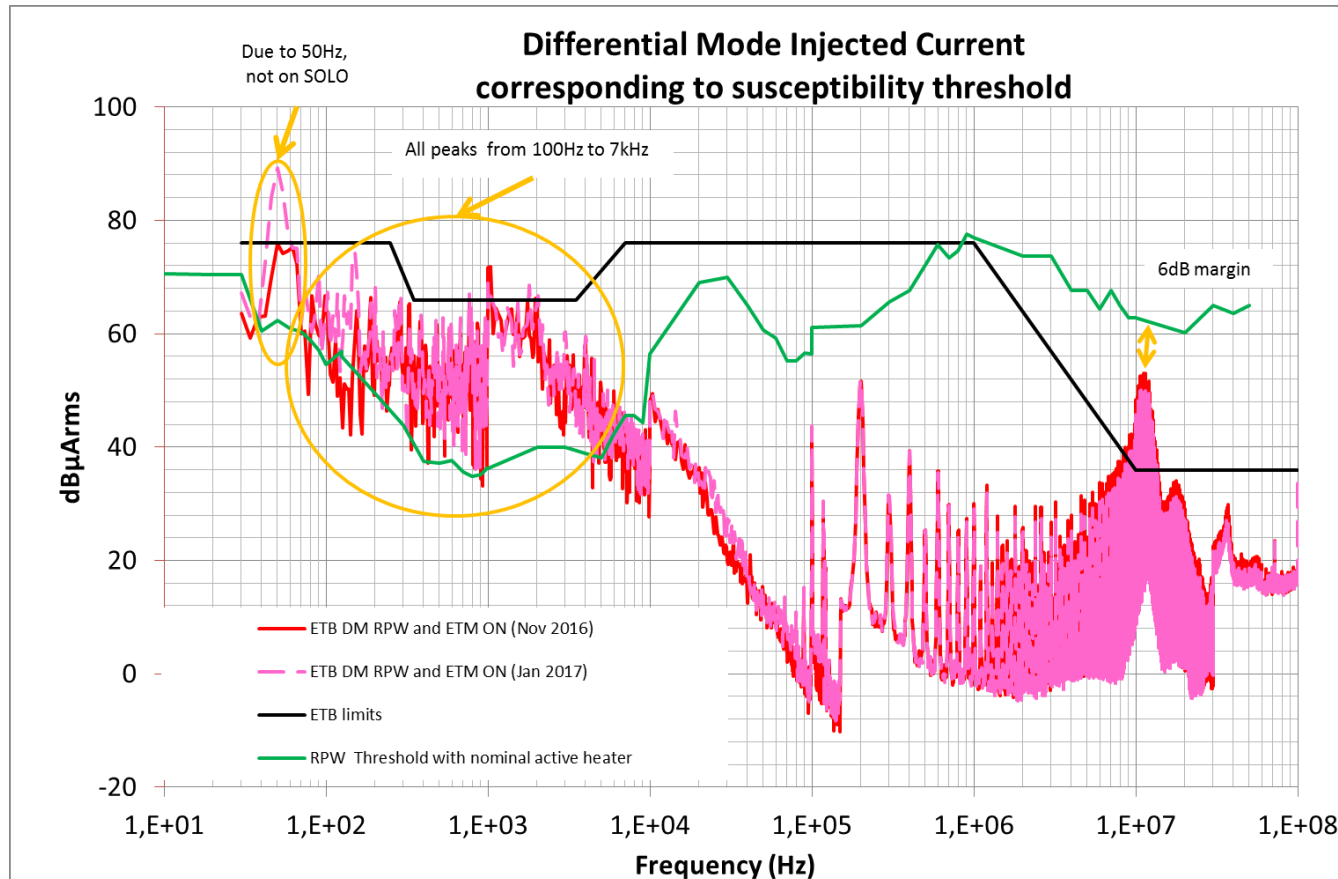
# Conducted Susceptibility

Differential Mode : 1kHz and 2kHz are without margin. Elsewhere, no susceptibility is expected on RPW => When SCM heaters are not active



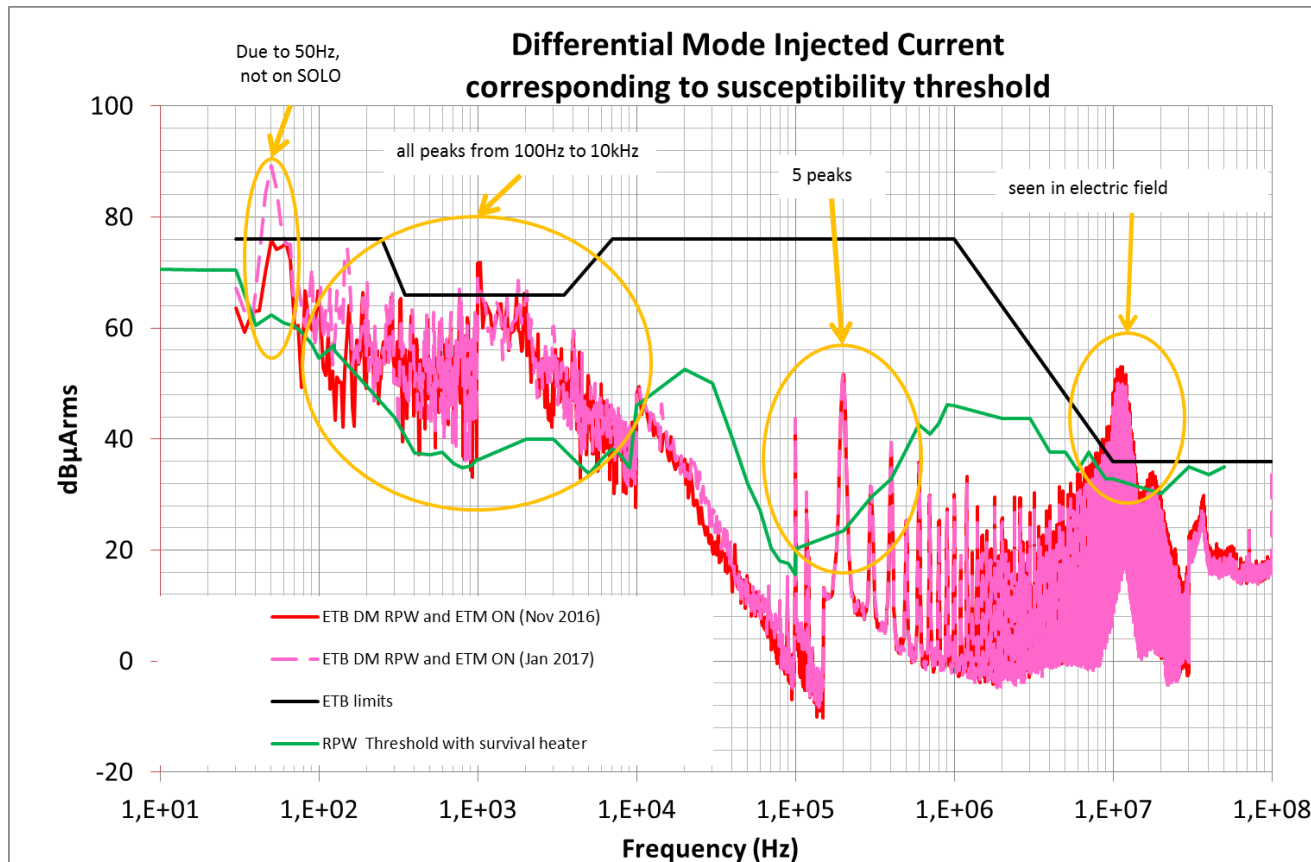
# Conducted Susceptibility

Differential Mode : 100Hz and 7kHz are out of margin. Elsewhere, no susceptibility is expected on RPW => When SCM heaters are active



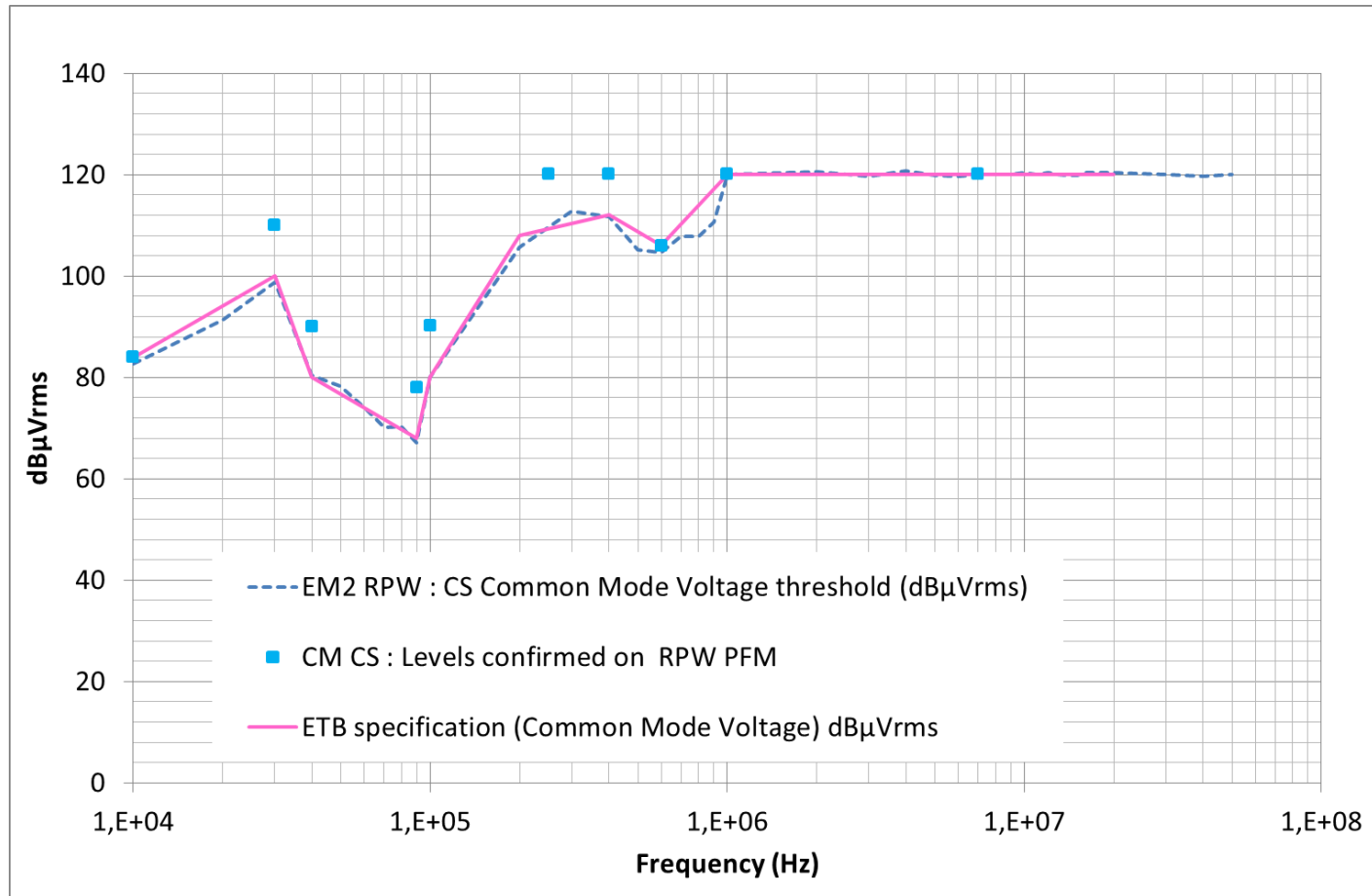
# Conducted Susceptibility

Differential Mode : 100Hz and 10kHz are out of margin, idem between 100kHz to 500kHz and 10MHz could be detected by antennas => When survival heaters on SCM



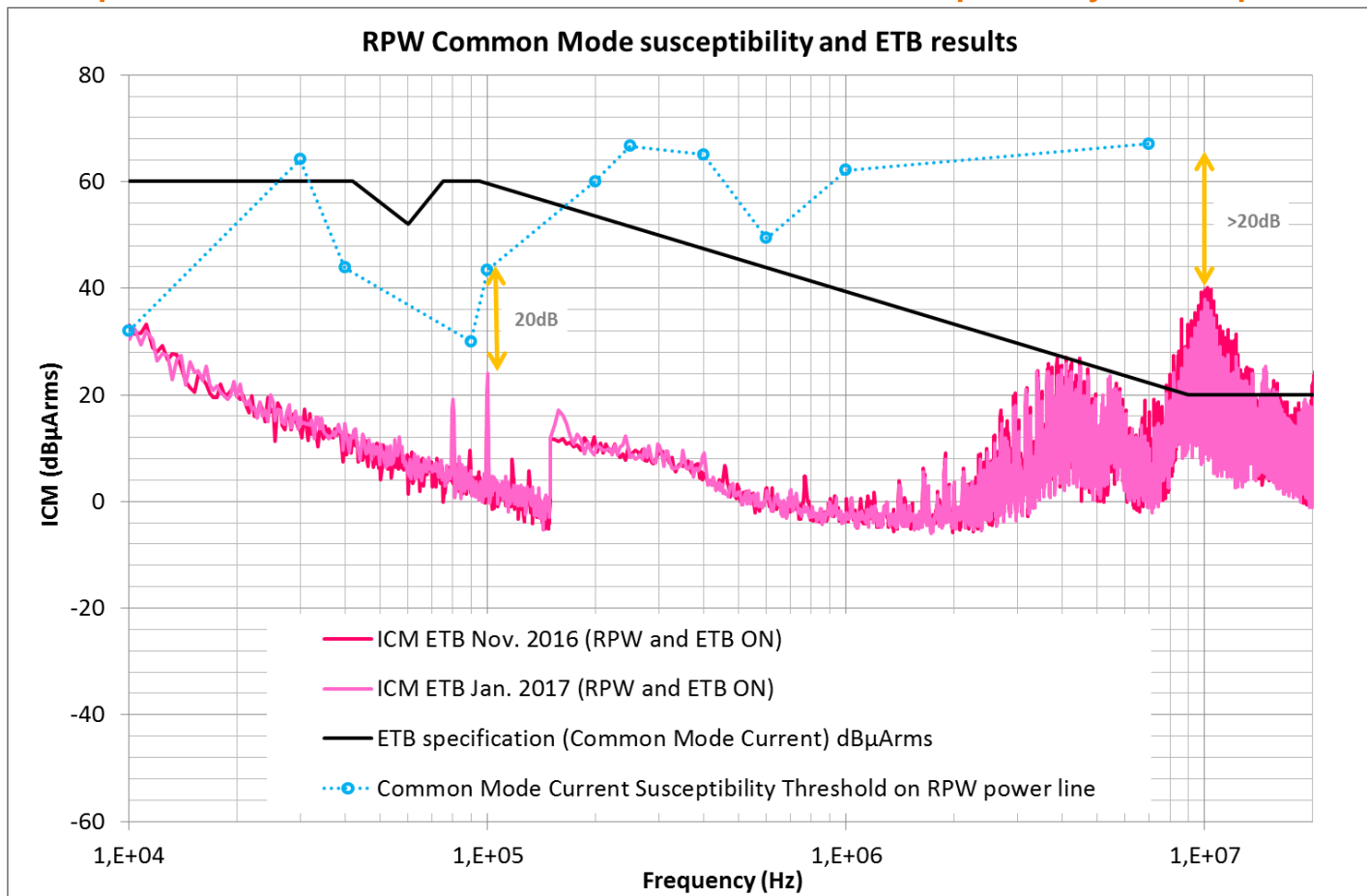
# Conducted Susceptibility

Common Mode Susceptibility Voltage Threshold was given for ETB : these levels are tested on PFM : no susceptibility was observed.



# Conducted Susceptibility

Using PFM impedance, current on Common Mode CS on RPW PFM can be compared with current on ETB : no susceptibility is expected on SOLO



# Conducted Susceptibility

## Transients

- Tests done on EM2 : compliant, no switch off

## ESD (Radiated and Conducted)

- Tests done on EM2 : compliant : no damages
- Spurious are detected : not science data

# Conducted Susceptibility

## Differential Mode Conclusion:

- When SCM heater are not active : 50% of science time
  - ◆ No coupling with the spacecraft spurious, except 2 peaks at 1kHz and 2kHz (0dB margin)
- When SCM heater are active 50% of science time:
  - ◆ Too many peaks from 100Hz to 10kHz => possibility to take into account the heaters operating TM in order to synchronize (on board of afterwards) science between heating windows

## Common Mode Heaters

- No susceptibility is expected (with margin) if all harnesses sharing path with RPW are compliant in emission



# Conducted Susceptibility

## To keep in mind

- For self compatibility : no heaters on SCM
- ANT heaters ?
  - ◆ Coupling characterization will be done in July on QM ANT at Intespace

## Some information's of the emissions of the other harnesses

- SOLO-HI Not compliant to CE Power lines
  - ◆ => to be check the rooting of harnesses into the payload (acceptable on RPW)
- SWA-HIS
  - ◆ No margin on CM CE, SpaceWire Not compliant (but acceptable on RPW)
- Can be easily verified during SOLO compatibility test

## Radiated Mode

Global test (RS from 30Mhz to 18GHz) was not done because :  
compliant on EM2

PFM RE on X-band ; compliant no peak (6dB margin)

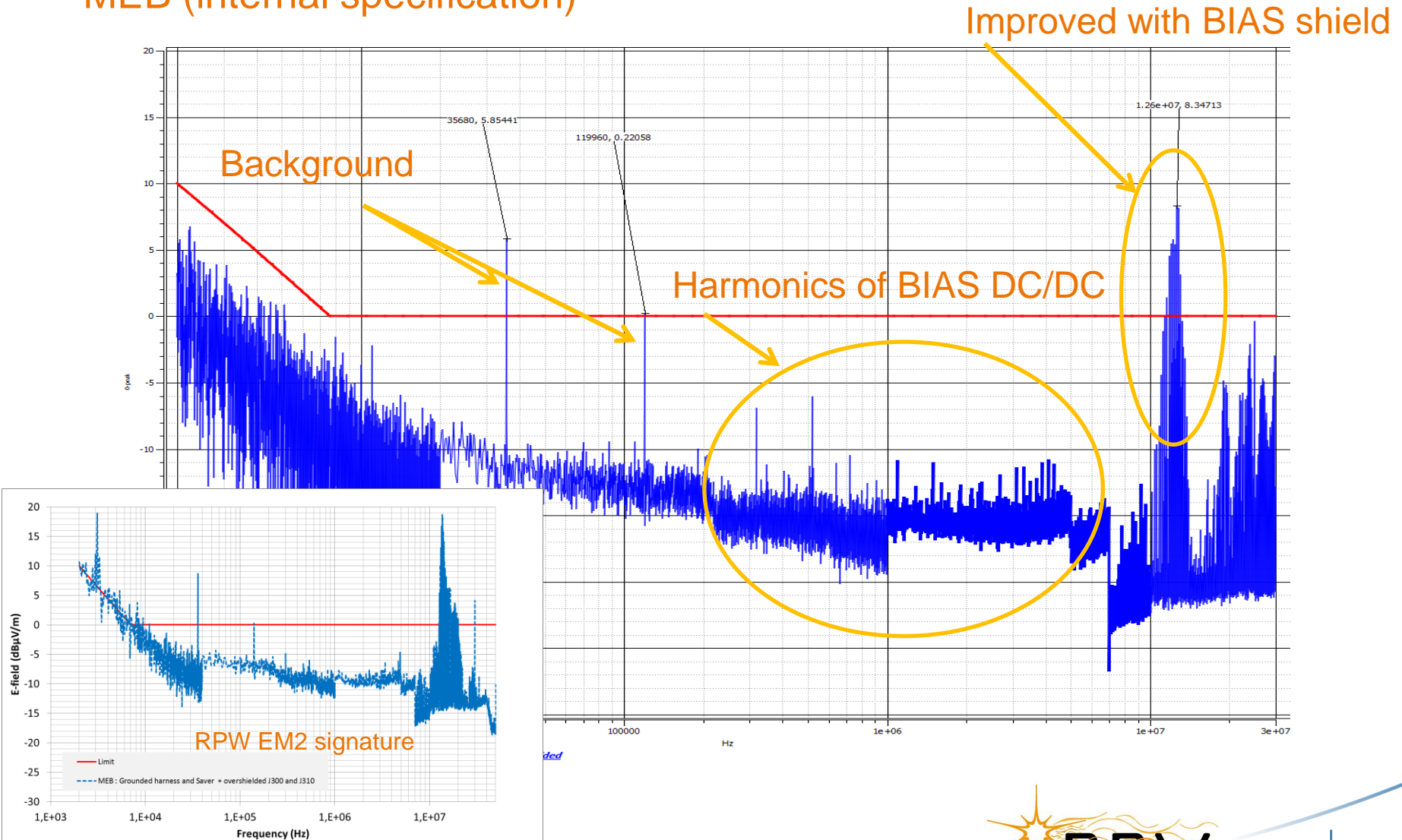
PFM RS on X band : compliant

- no damage, no saturation, some peaks detected
- No science during HGA emissions



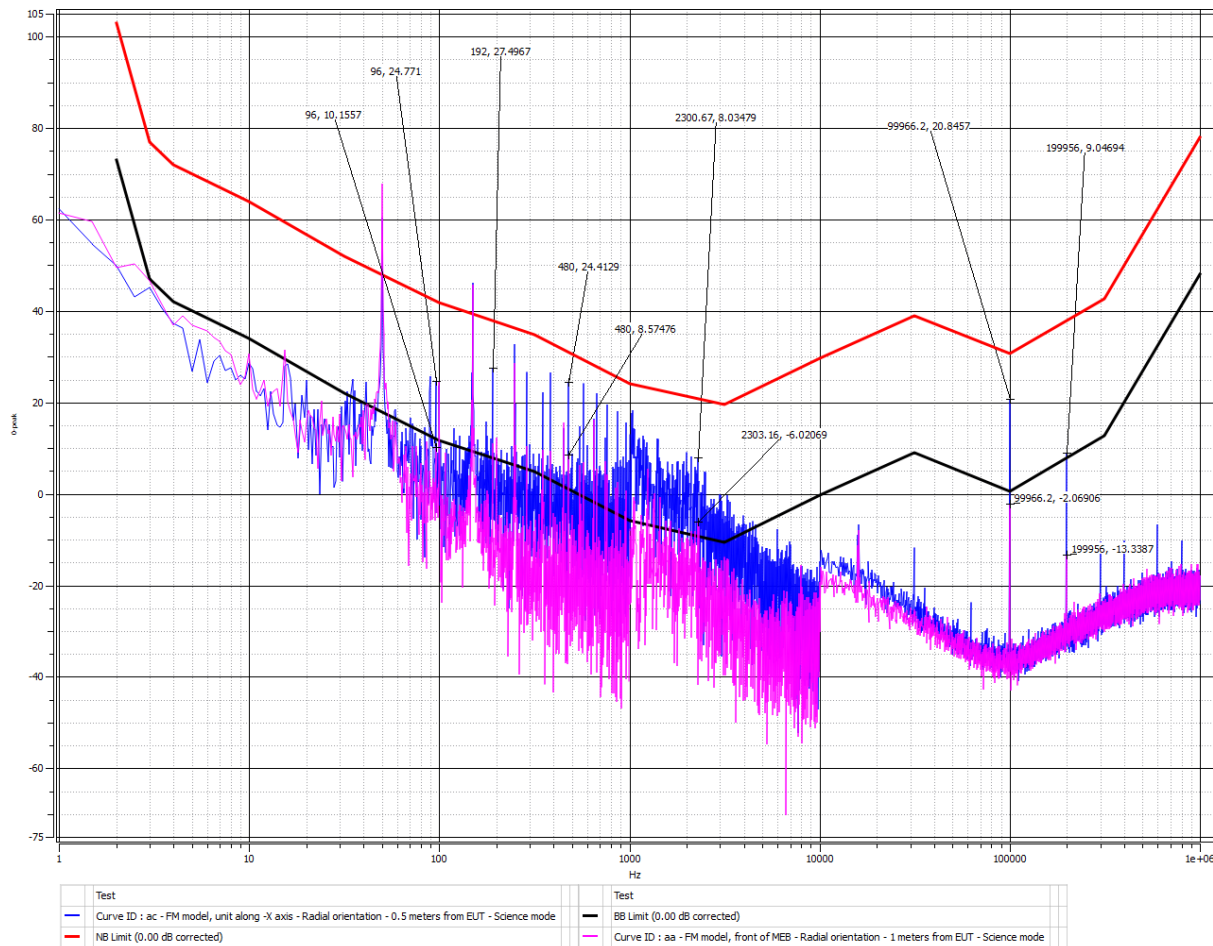
# Radiated Mode

## MEB (internal specification)



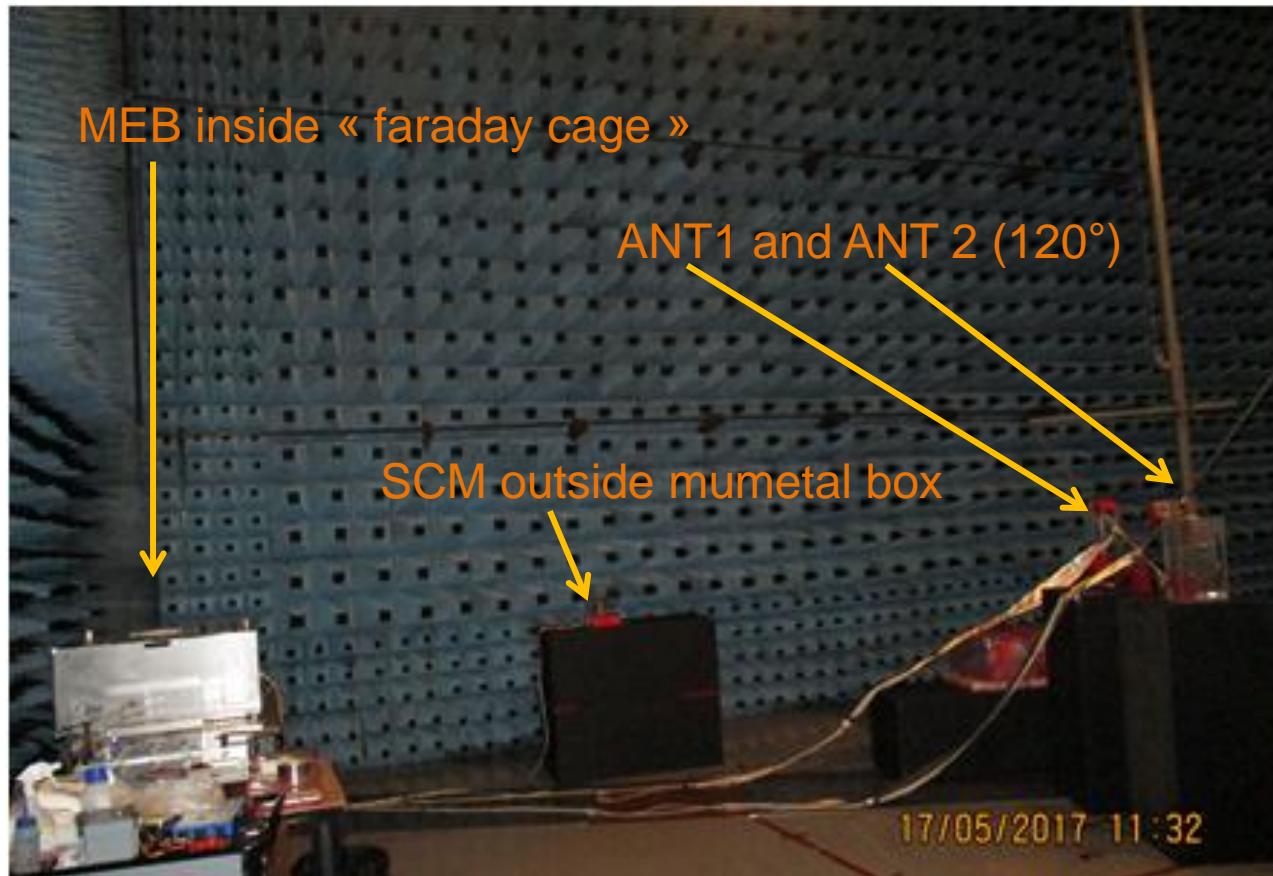
# Radiated Mode

96Hz is detected with Intespace Setup and not with RPW  
NC 309



# RPW Self Compatibility

## Setup



# RPW Self Compatibility

## Not true antennas

- Only 1.2m long, long monopole are “short-circuited” by the Faraday cage : the coupling through the cavity wall are too high to do analysis
- No plasma ! but  $510\text{k}\Omega$  is placed with a capacitance representative of the length of the monopole
- Grounding is not representative
- Only 2 antennas are deployed

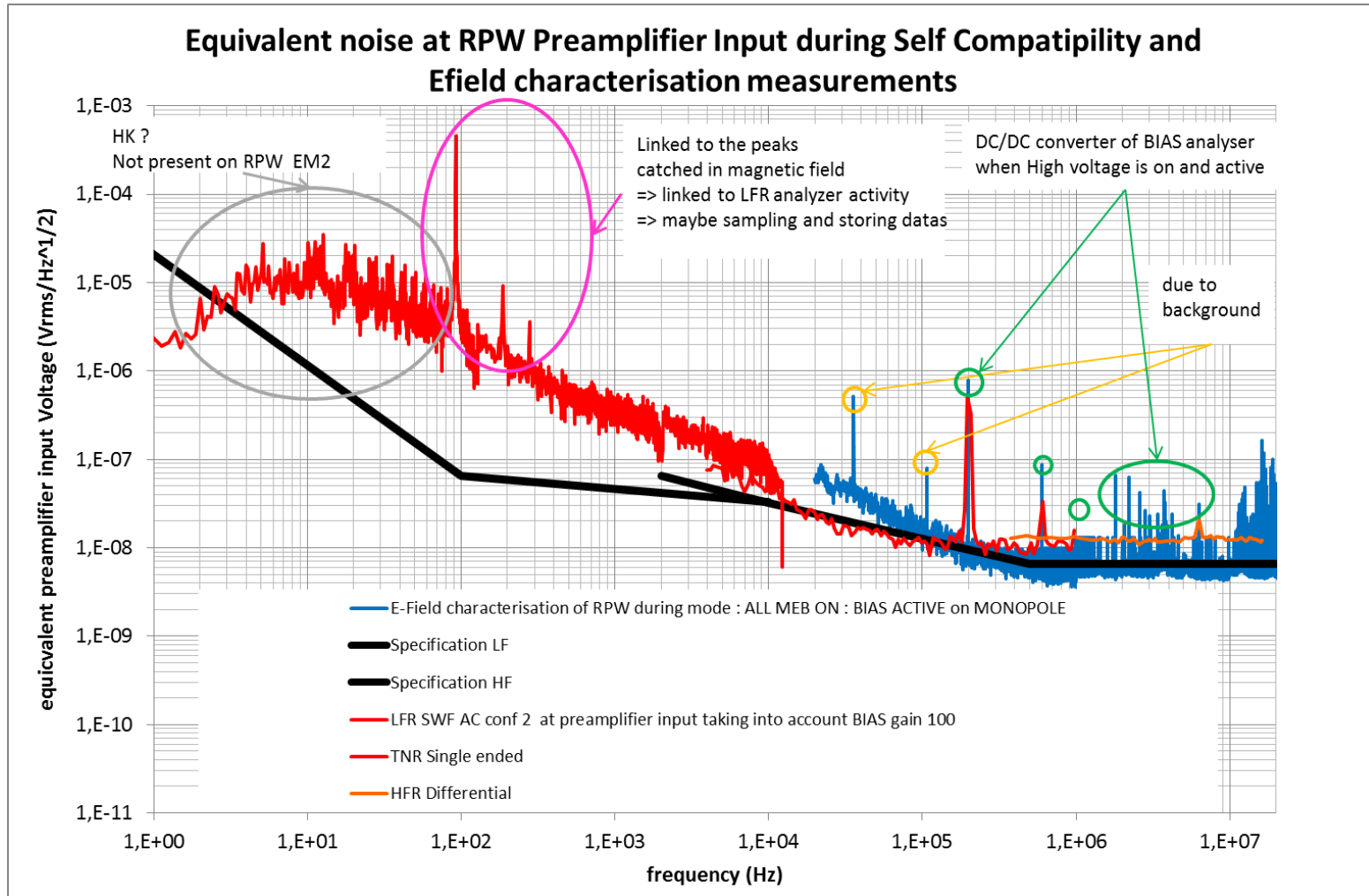
SCM is out of its mumetal box and “sees” 50Hz

MEB is « hidden » inside a faraday cage



# RPW Self Compatibility

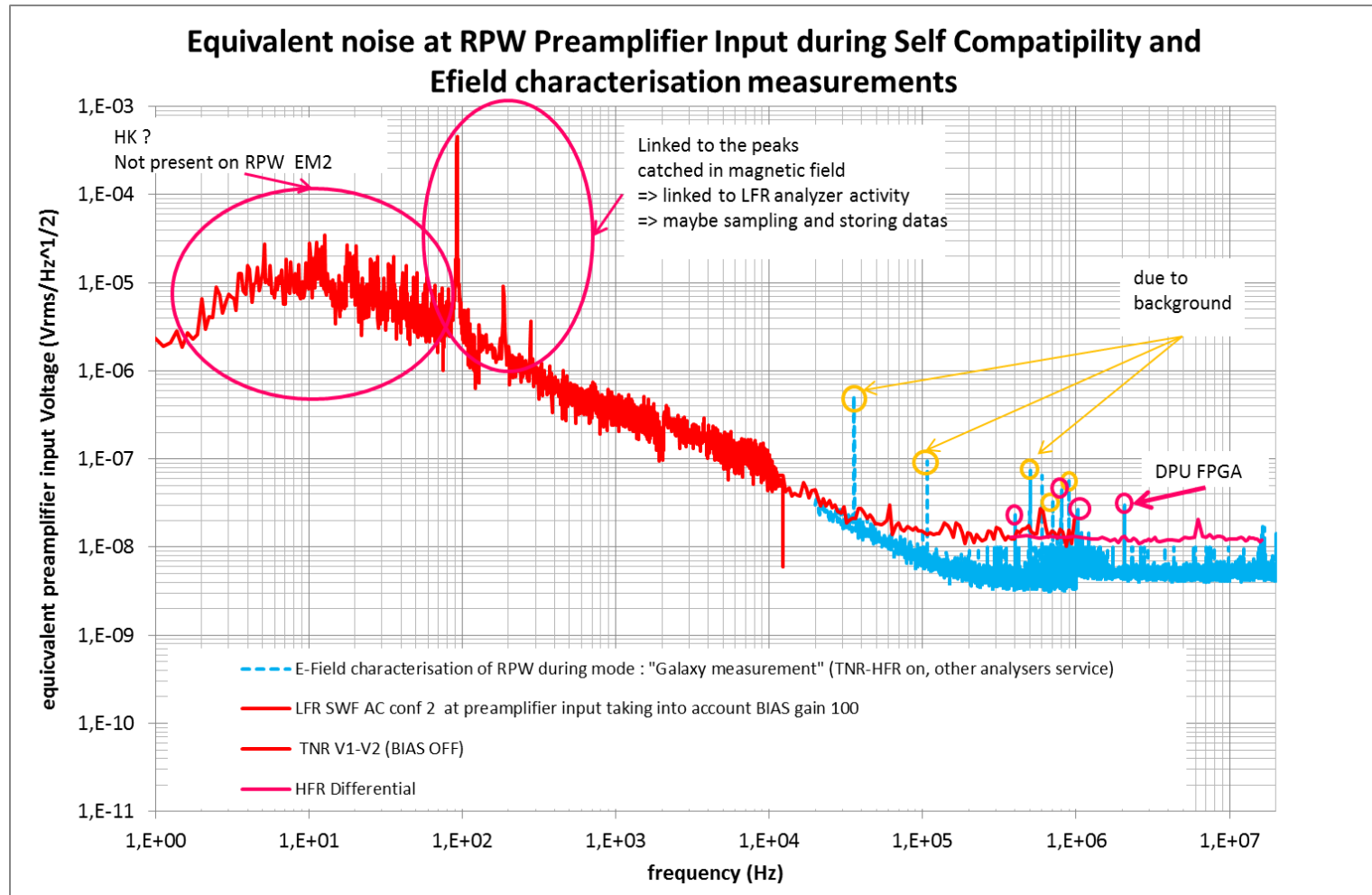
## E-field MEB Science Mode : BIAS active





# RPW Self Compatibility

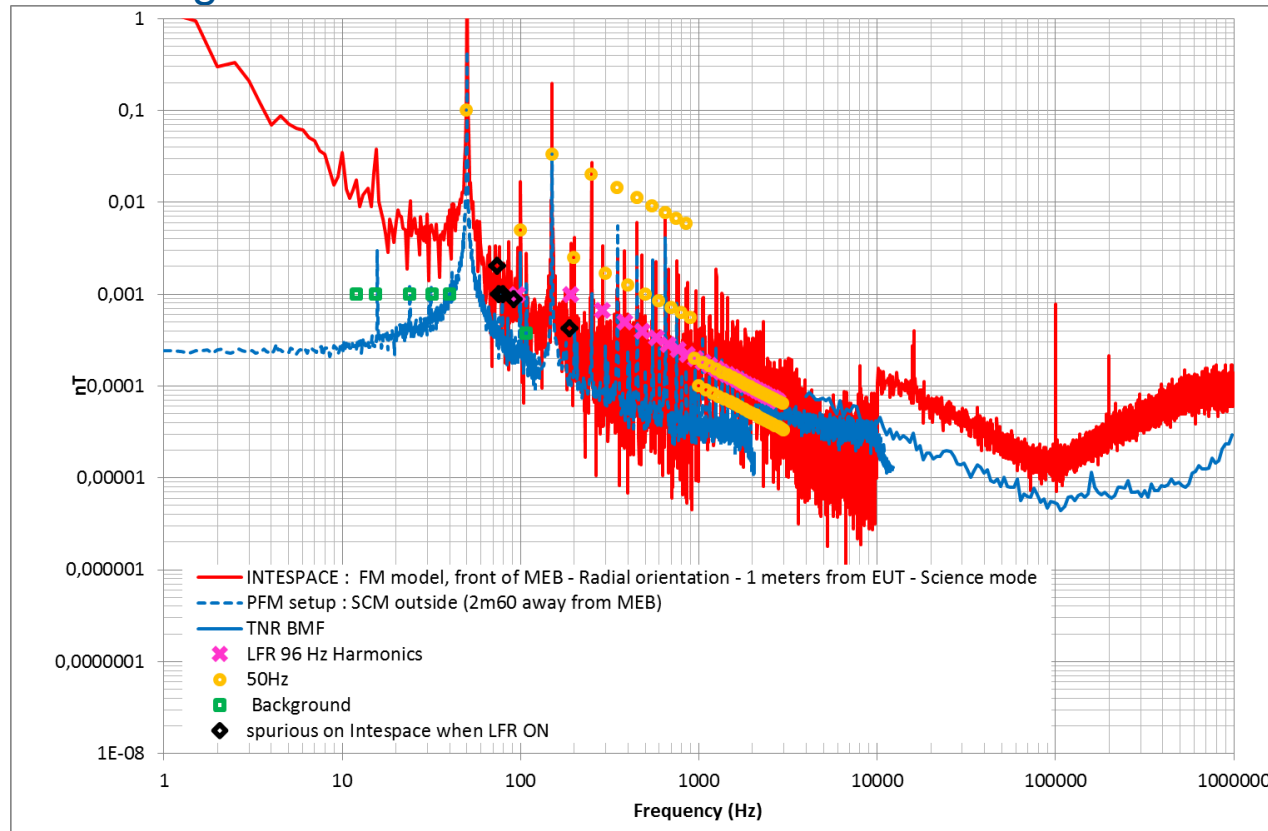
## E-field MEB Science Mode : BIAS not active



# RPW Self Compatibility

## H-field MEB Science Mode : BIAS not active

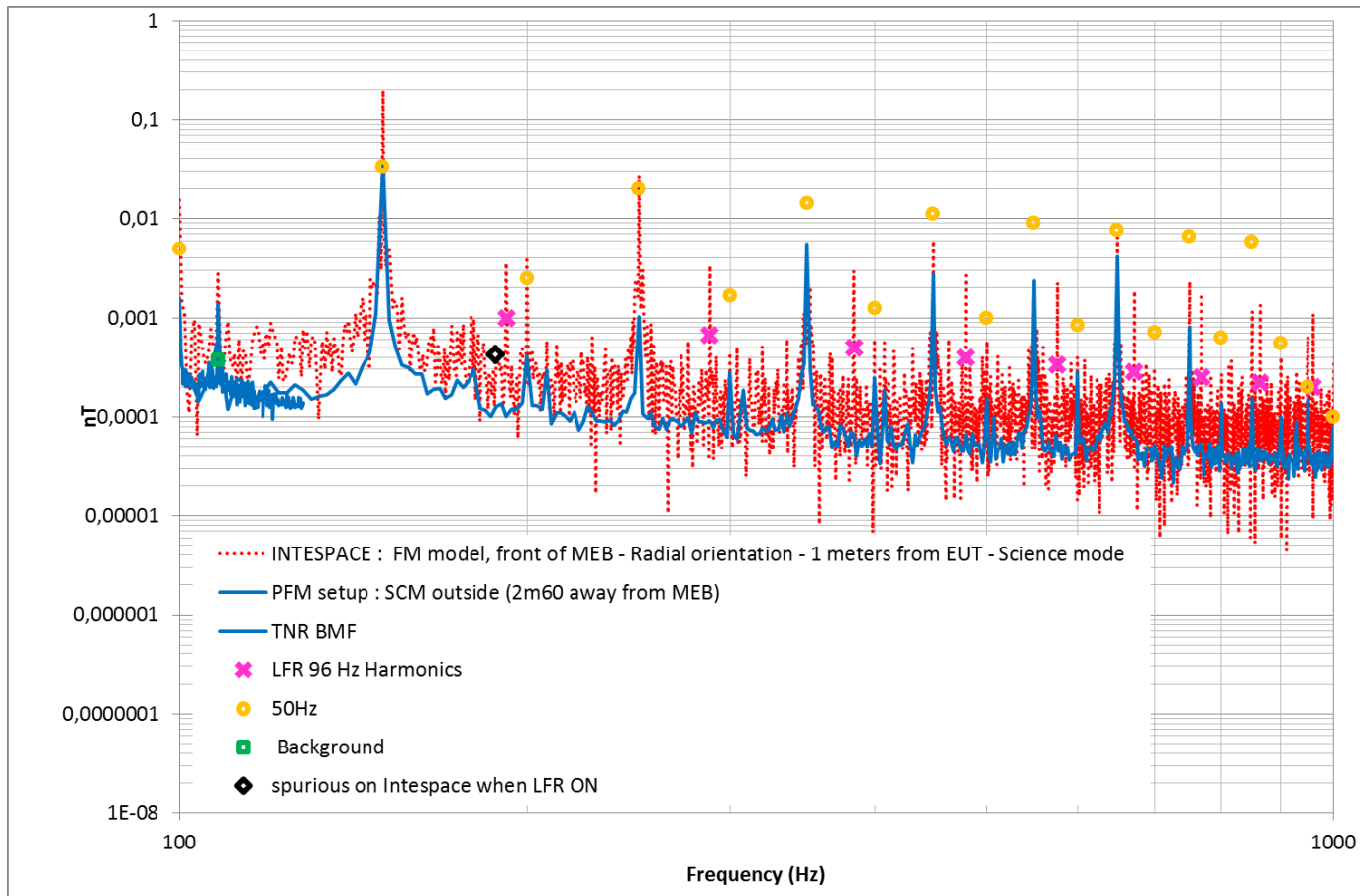
- 96Hz (present on LFR) present in from of ANT and also 100k and 200kHz
- (MEB faraday cage is not magnetic)
- Investigation to be done.



# RPW Self Compatibility

## H-field MEB Science Mode : BIAS not active

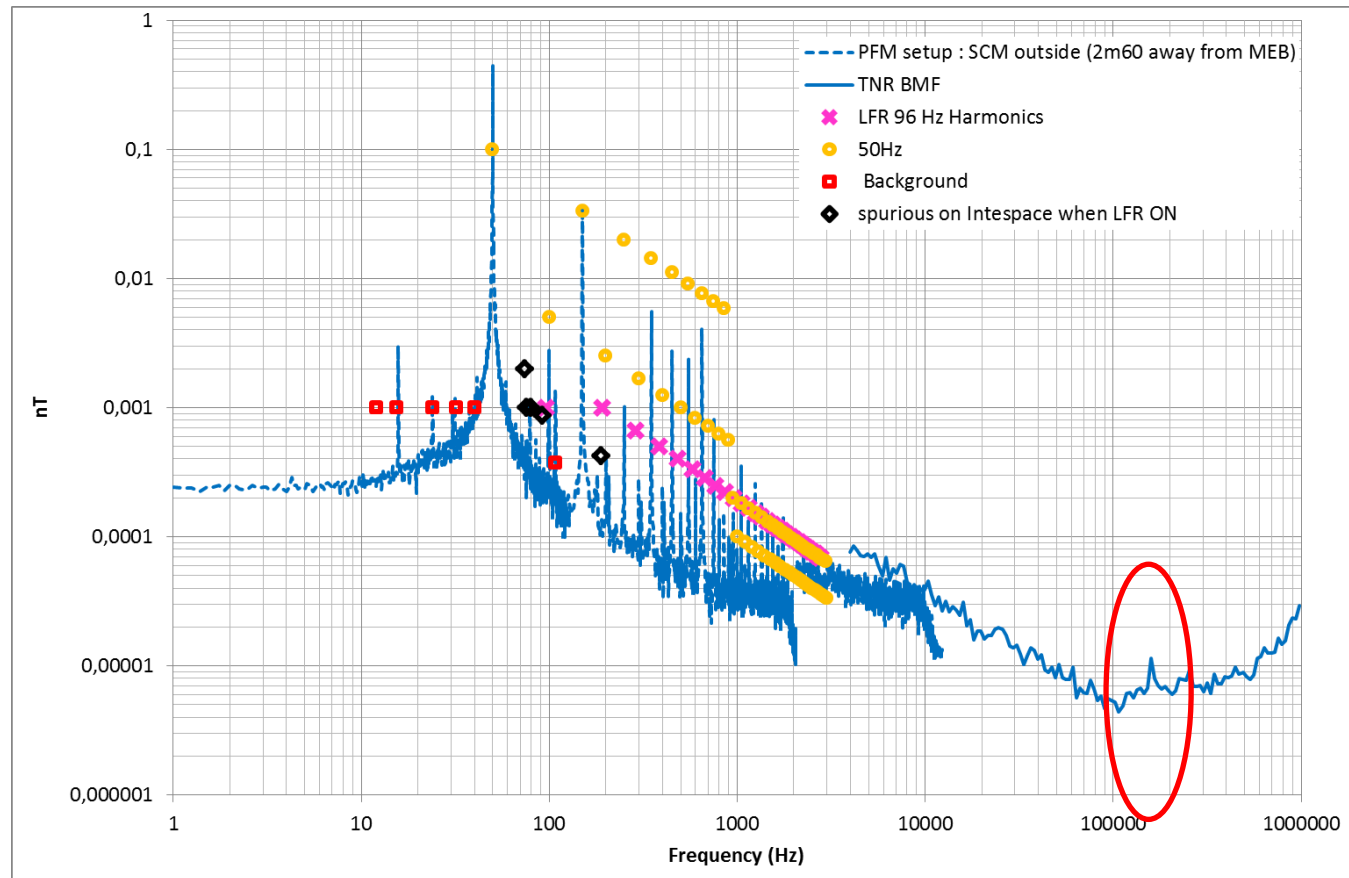
- 96Hz « family » not detected by RPW: LFR band



# RPW Self Compatibility

## H-field MEB Science Mode : BIAS not active

- 100kHz and 200kHz are not present on RPW science but there is a moving frequency



# RPW Self Compatibility

« Galaxy configuration » with BIAS not active,

- 200kHz should not be seen anymore
- only 3 peaks on LFR bandwidth (92, 184, 276Hz)
- Only 1 peak at 2MHz DPU FPGA frequency
- 4Hz HK ?

Science Mode with BIAS active

- DC/DC harmonics of BIAS are added from 1 to 15MHz

Magnetic field

- A moving frequency from 220kHz (at starting) to 120kHz (a few hours later)



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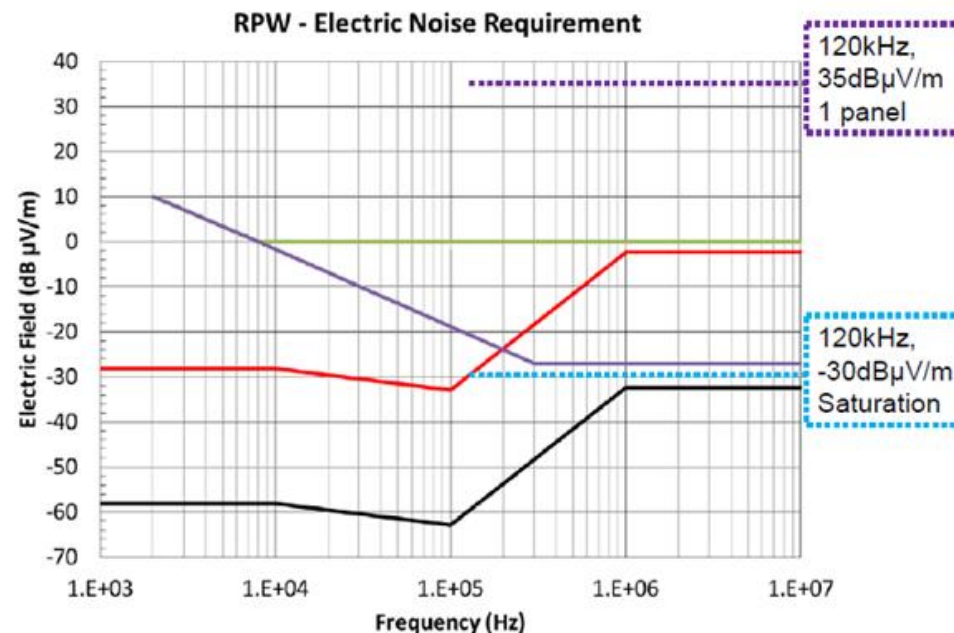
## EMC Results of the Other Instruments and SOLO Platform

# E-Field measurements and analysis

Measurement of E-field is possible in anechoic room from 2kHz

- No data for lower frequencies
- The level is comparable to RPW requirement from 200kHz

Solar Array Power Regulator Emissions – AC E-Field Emissions



- 2 levels
  - ◆ green for boxes inside the spacecraft
  - ◆ purple for boxes outside the spacecraft





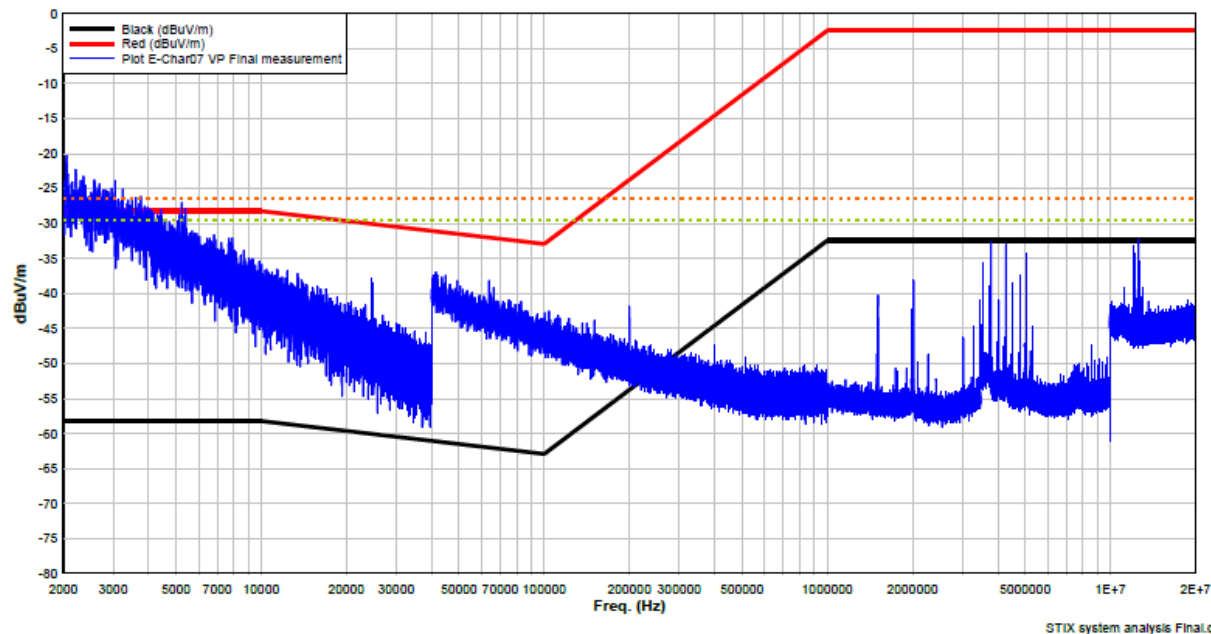
# E-Field measurements and analysis

One example of a measurement of one acceptable unit (STIX)

- Sometimes the results is shown with RPW requirement taking into account the scaling due to the distance and Spacecraft panel shielding
- Sometimes no post traitement



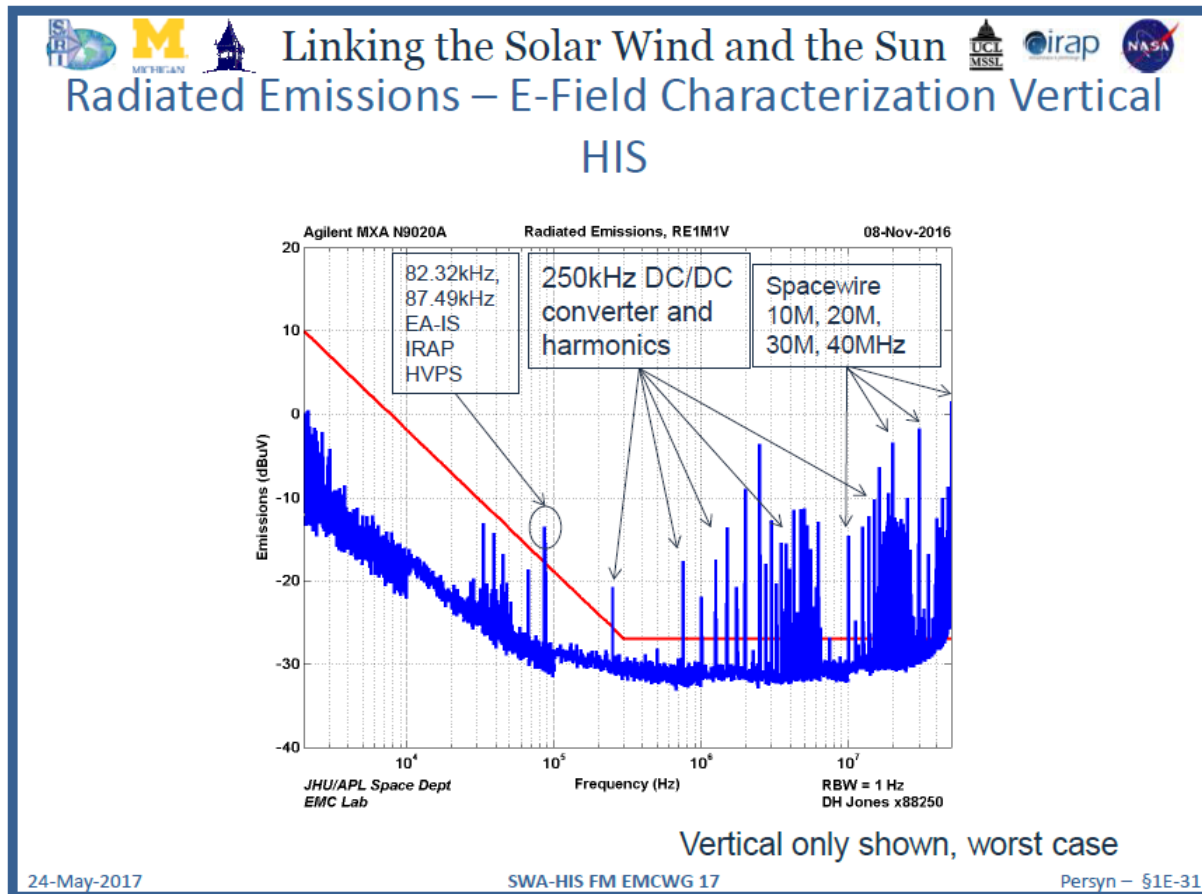
RPW E Field System / Science Analysis  
STIX FM - Solar Flare Mode



# E-Field measurements and analysis

One example of a measurement of one not acceptable unit (HIS)

- Should be OFF during RPW measurements



# E-Field measurements and analysis

## The synthesis at platform level

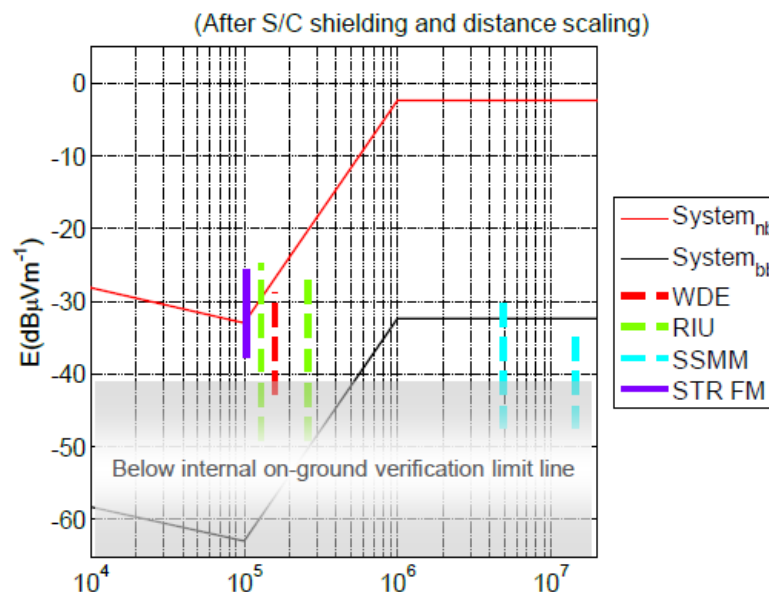
- On this figure the “uncertainty” on Solar panel is not shown :

Platform EMC Status

Confidential

### Equipment Frequency Summary of Exceedances (E-Field)

Freq. (kHz)	Unit	Stability
104	STR	Not Crystal
130.425	RIU	Crystal
160	WDE	Crystal
260.875	RIU	Crystal
4893	SSMM	Stable (SpW)
No Exceedance	OBC	N/A
	DST	
	RWAB	
	PCDU	
	PT	
	IMU	



- Dashed lines are stable spikes
- STR shielding mitigation study continues (best FM result to date shown, PFM is 5dB better)
- RIU shows emissions levels before test set-up improvements
- APM spikes removed since unit is switched off in EMC quiet periods

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# E-Field measurements and analysis

## The first synthesis of Instruments

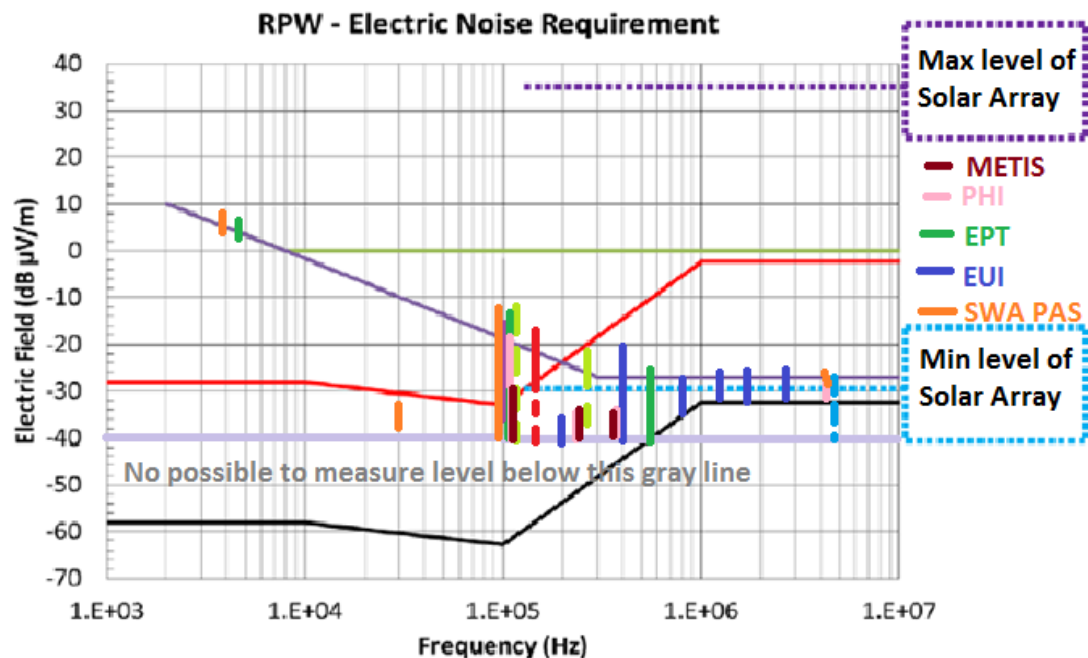
- EPT : 125kHz, 625kHz and 4,5kHz
- EUI : 10 peaks
- PHI : 10 peaks
- SOLO HI : > 30 peaks to be switched OFF
- SWA-HIS : >40 peaks to be switched OFF
- MAG : ELB 6 peaks, heaters to be switched OFF
- SWA-PAS : 16 peaks
- STIX : 1 peaks at 200kHz
- METIS : heaters to be switched off



# E-Field measurements and analysis

The synthesis of all contributors (not all peaks are shown on the figure)

- The list of frequencies to be confirmed and discussed with ESA
- Solar Panels emissions => still not clearly evaluated
- SOLO HI, SWA HIS OFF
- Heaters off on MAG, METIS, RPW



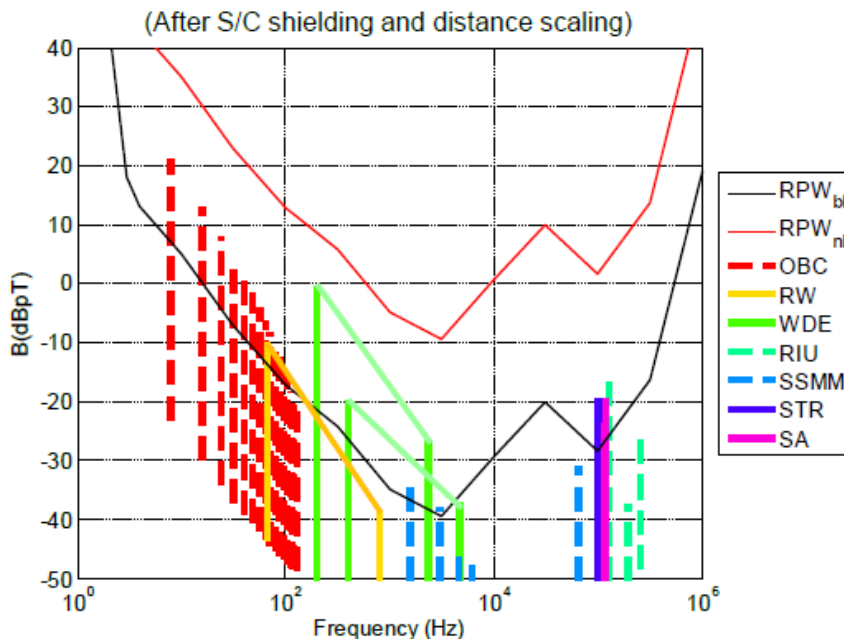
# H-Field measurements and analysis

Measurement of H-field is comparable to RPW requirement (with 50Hz)

Synthesis of Platform Contributor : It is “alive”

## Equipment Frequency Summary of Exceedances (H-Field)

Freq. (Hz)	Unit	Stability
8, 16, 24...	OBC	Crystal
70-800	RW	Varies: frequency=8x wheel rotation rate
200-2400	WDE	Varies: frequency=24x wheel rotation rate
400-4800	WDE	
1600, 3200	SSMM	Stable
104,000	STR	Not Crystal (measured)
120,000	PCDU/SA	Not Crystal (measured)
130,425	RIU	Crystal
No Exceedance	DST	N/A
	IMU	
	TWTA	
	RWAB	
	SADE	
	PT	
	I-BOOM	



- Dashed lines are stable spikes that will not vary in time
- RW levels are after external mu-metal shielding
- STR likely to reduce when extra shield is considered
- WDE varies, but is sufficiently stable over 1 hour

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# Synthesis : EMC Quiet State for RPW

## The synthesis of Instruments (adding H-field results)

- EPT : ok
- EUI : heaters off
- PHI : heating frequency from 1200 to 406 Hz => remains 3 peaks
- SOLO HI : no peaks (but already OFF)
- SWA-HIS : no peaks (but already OFF)
- MAG : heaters off
- SWA-PAS : no peaks
- STIX : no peaks
- METIS : heaters frequency lowered by 4Hz

## Platform

- OBC activity and solar array

The figure with all frequency is to be done and discussed





# Synthesis : EMC Quiet State for RPW

## Activities to be done

- EMC ANT Characterization with its own heaters
- EMC Tests on Solar Orbiter : to be defined on next EMC WG
- To define the operations to take into account RPW sensitivity



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## **Annex : some extracts of the measurements done in RPW bandwidth**

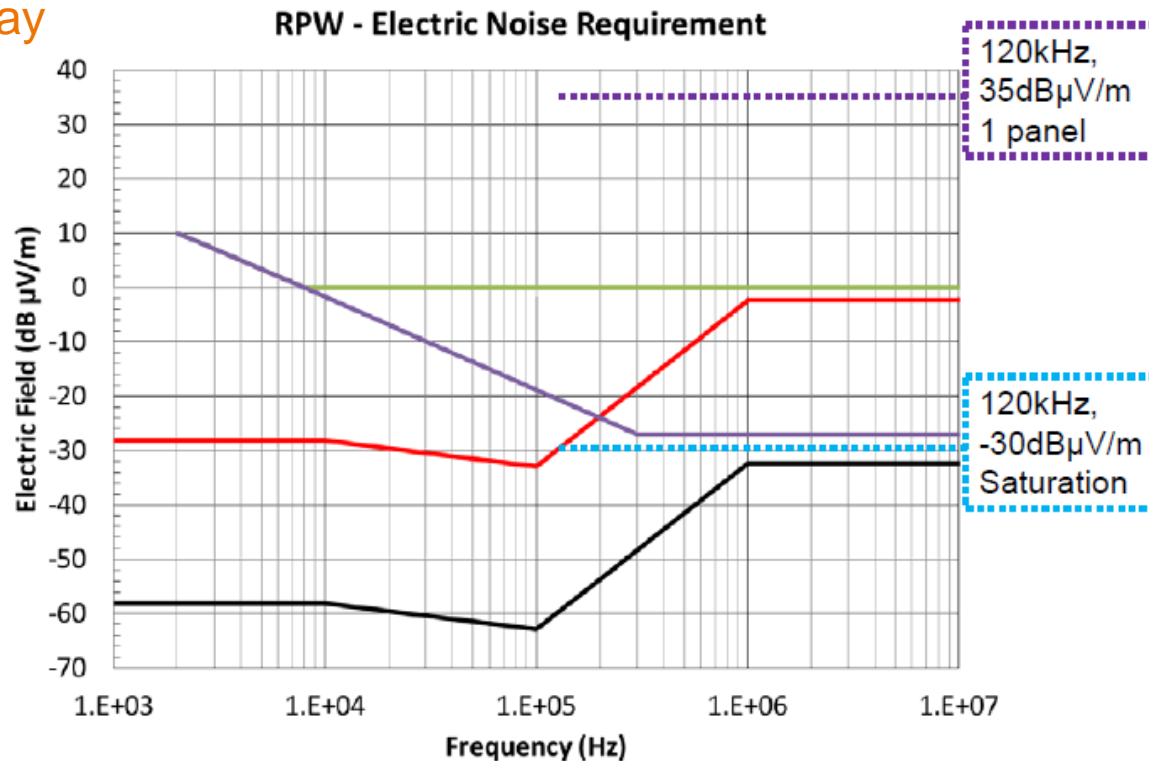
# Annex : All the results on each instrument

Platform EMC Status

Confidential

## Solar Array Power Regulator Emissions – AC E-Field Emissions

### Solar Array



23rd May 2017

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**RPW**

**cnes**

# H-Field measurements and analysis

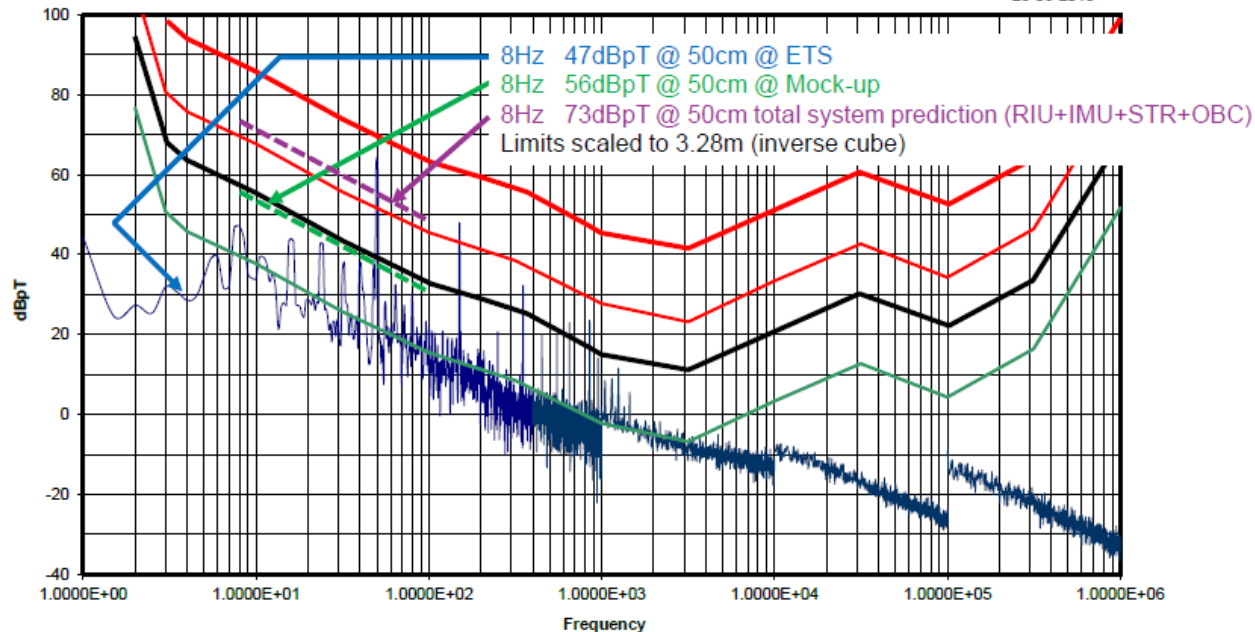
Platform EMC Status

Confidential

## OBC H-Field Results (EGSE ON, EUT ON, 50cm)

Plot Char RE-H16

25-06-2015



- RIU – 2.35m – 40dB requirement relaxation
- IMU – 2.77m – 45dB requirement relaxation
- STR – 2.16m – 38dB requirement relaxation
- OBC – 3.28m – 49dB requirement relaxation

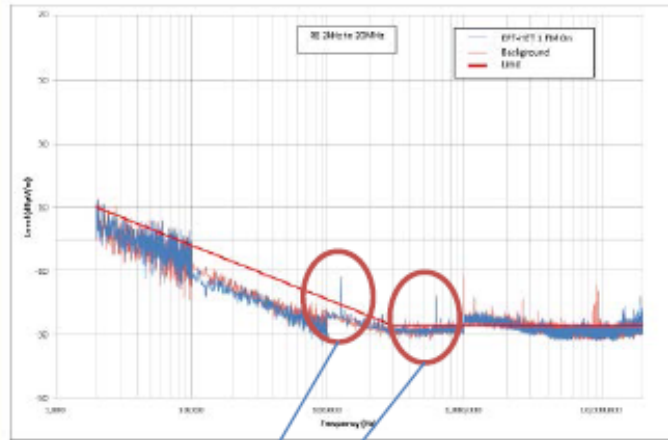
This analysis closes  
PO action: 795

11



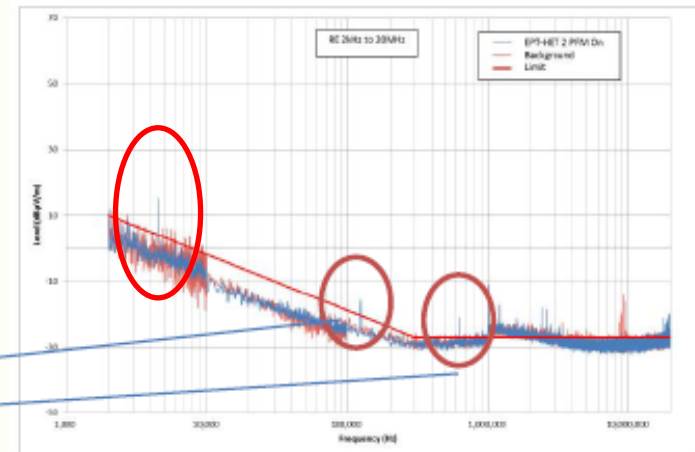
## Annex : All the results on each instrument

### EPT-HET 1& 2 E-Field Test



EPT-HET 1 FM

EPT



EPT-HET 2 FM

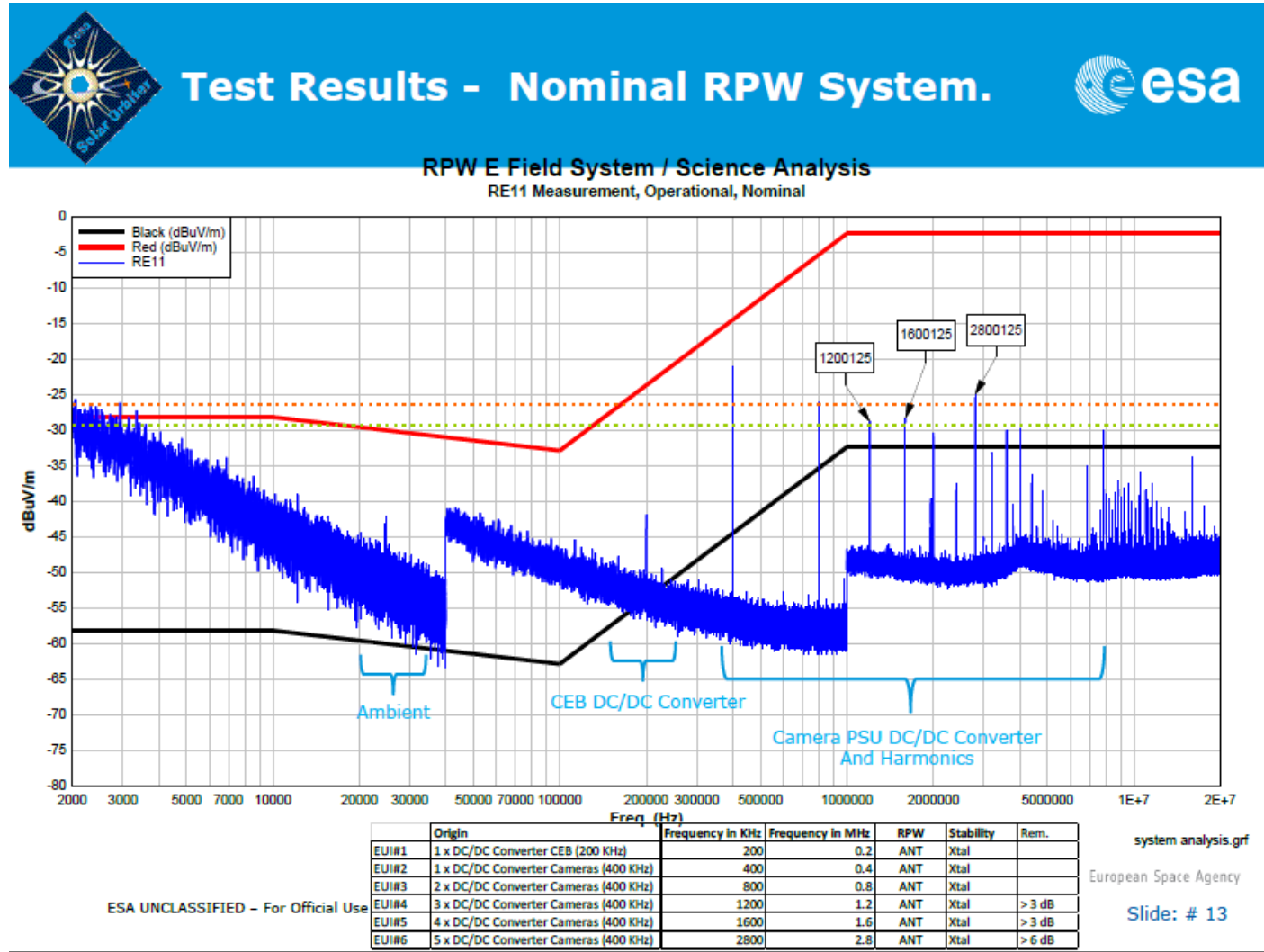
No Emission above Background Noise except two Harmonics from DC/DC switching frequency. These frequencies are crystal controlled.

Stevenage EMC WG#16, 8-9 November 2016

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# Annex : All the results on each instrument

EUI



# Annex : All the results on each instrument



## E Characterization - Test Results Analysis.



The PFM instrument redesign wrt. Camera PSU DC/DC Converter following the EMQ characterization confirm the expected improvements:

- Frequencies are crystal controlled.
- Number of fundamental frequencies has reduced from 6 to 1.
- Only two stable frequencies coming from the cameras are identified in the 100 KHz to 1 MHz band.

The following list of frequencies are identified:

- 2 KHz – 1 MHz band (3 Frequencies)
  - CEB DC/DC converter switching frequency: **200 KHz**, Below the characterization line. It is crystal controlled.
  - Camera PSU DC/DC Converter, **400 KHz** and first harmonic. Crystal controlled.
- 1 MHz – 20 MHz band (7 Frequencies)
  - Harmonics of **400 KHz** Camera PSU DC/DC Converter. Crystal controlled.
    - 1200 KHz
    - 1600 KHz
    - 2000 KHz
    - 2800 KHz
    - 3600 KHz
    - 4000 KHz
    - 7838 KHz (Source is TBD)

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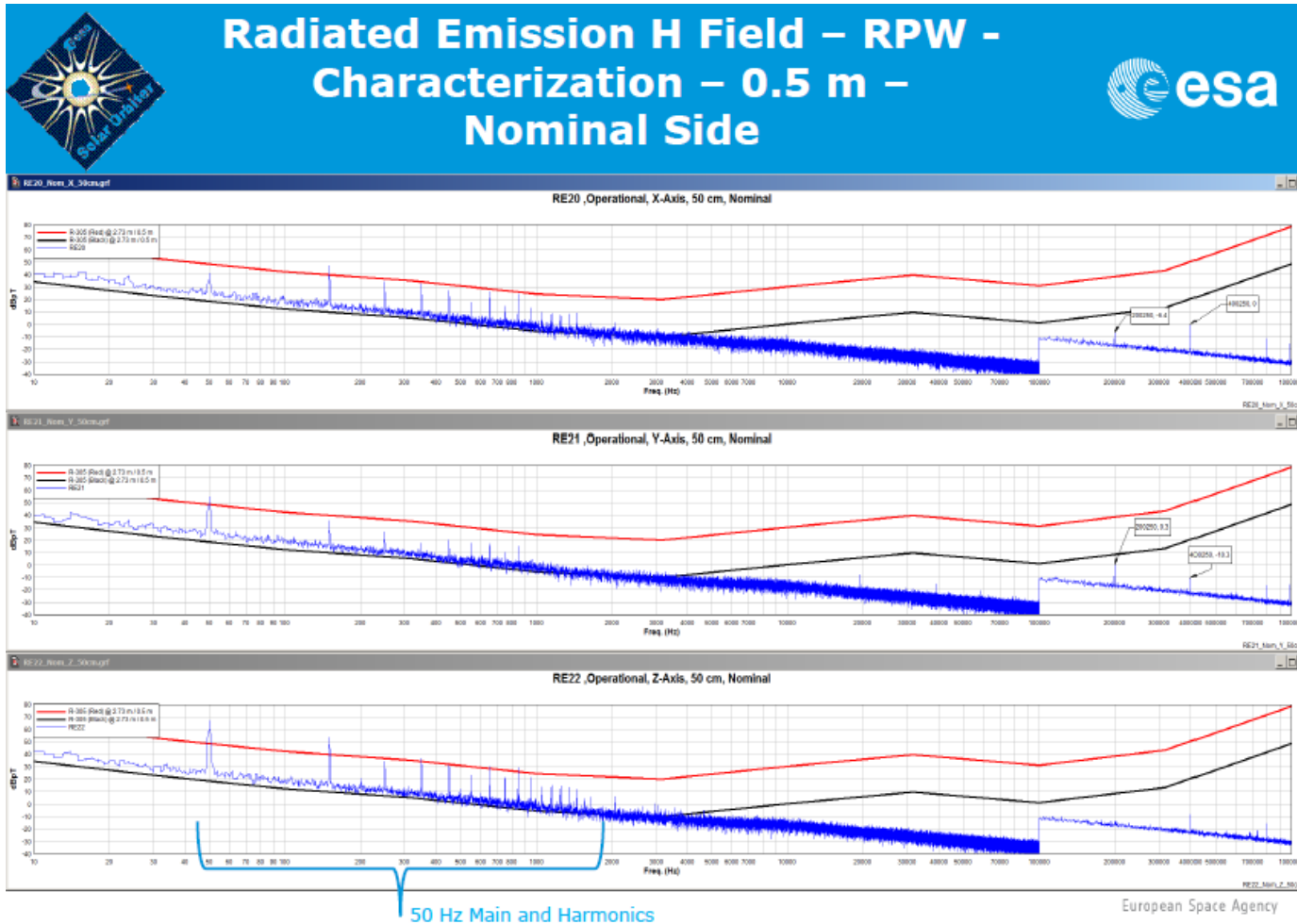
European Space Agency

Slide: # 12

EUI

# Annex : All the results on each instrument

## EUI without heaters



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European Space Agency

Slide: # 6



# Annex : All the results on each instrument

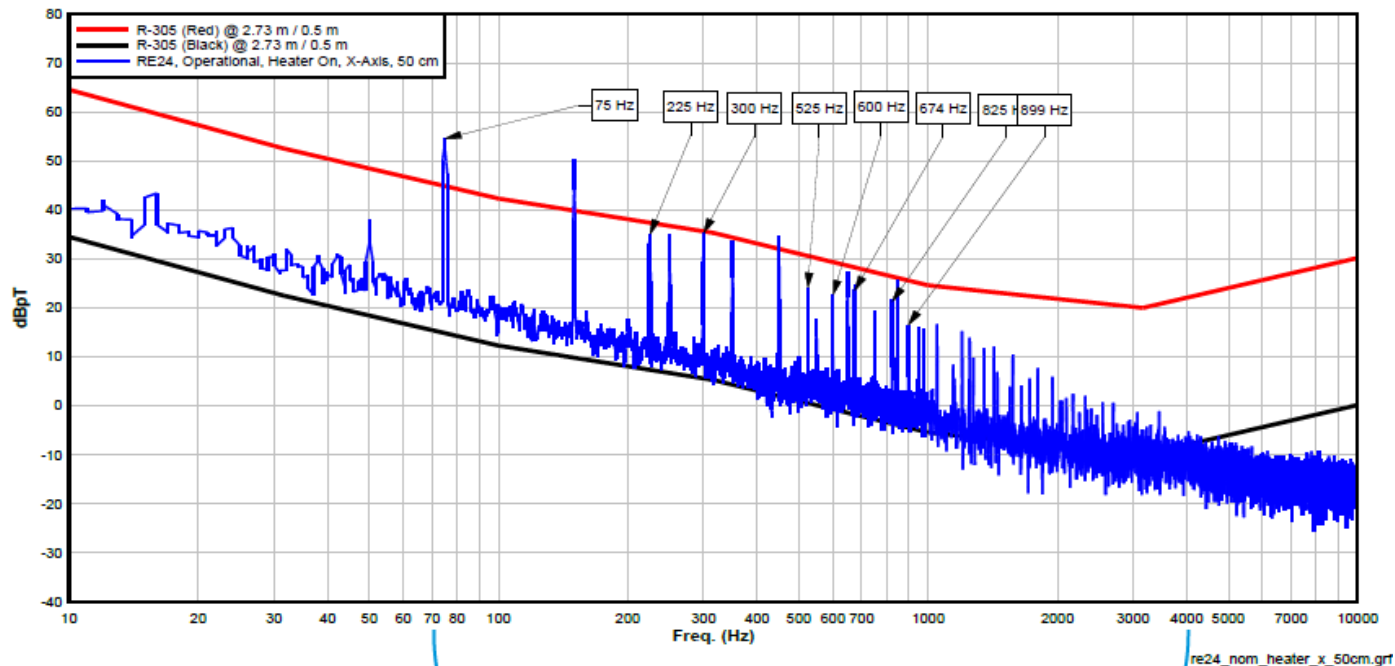
## EUI with heater



### Radiated Emission H Field – RPW – Characterization – 0.5 m – Annealing Heater



RE24 ,Operational Heater, X-Axis, 50 cm, Nominal



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75 Hz Annealing Heater and Harmonics

European Space Agency

Slide: # 7

# Annex : All the results on each instrument



## - H Characterization - - Test Results Analysis -



### EUI

- None of the frequency generated by EUI instrument will be detected by RPW – SCM, when annealing heater is OFF.
- All Instrument's tones are below the Black line.
- Annealing Heater Operation is not EMC quiet (Cf. Slide 7).
  - MAG instrument will be affected when frequency < 64 Hz affect, non compliance to R-842, periodic transient was already anticipated during the R-842 2 times the allocated 250 pT @ 1 m.
  - Annealing operation will be under the control of the operation's team with a clear timing operation and duration with respect to the EMC quiet phases.
  - However under the assumption that the heater is operated at a very low frequency eg. 0.1 Hz and that the telemetry reports the ON/OFF status with an accuracy of 1 s, the heater operation could be considered as a step function so EMC quiet. This is under clarification with the instrument team. Such Frequency will not affect RPW SCM. Open for discussion with SOC and MAG.

European Space Agency

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Slide: # 8



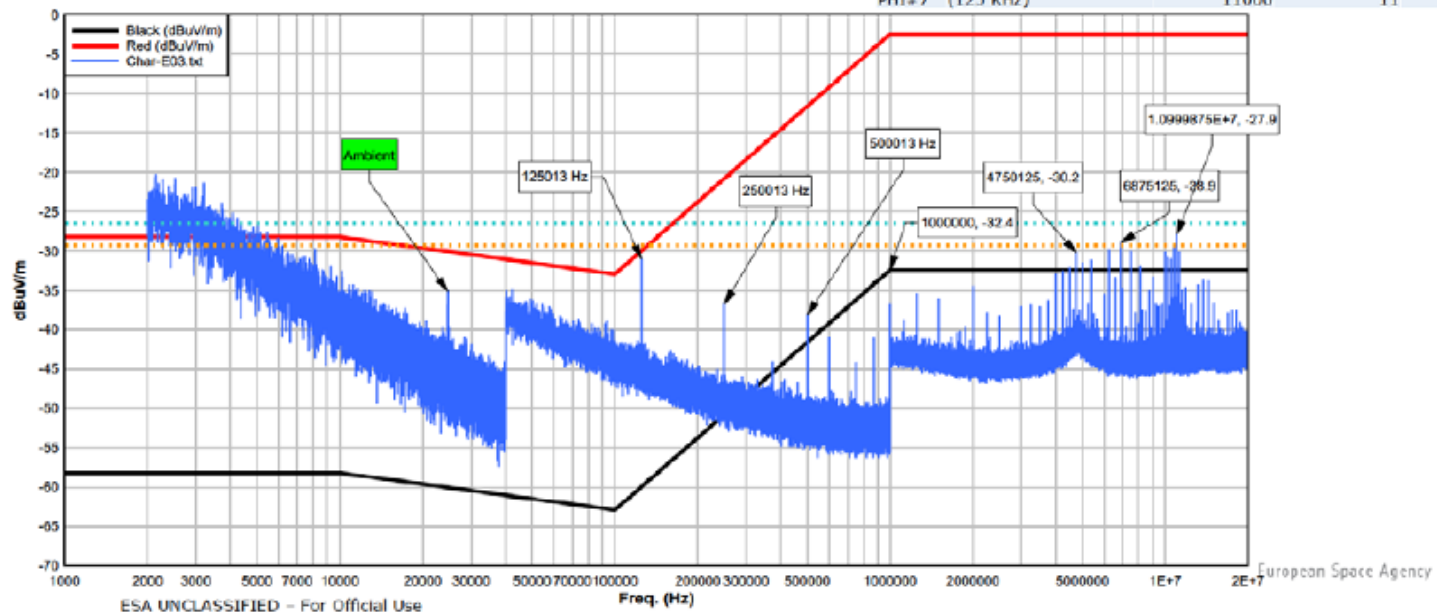
# Annex : All the results on each instrument



## Radiated Emission E Field – RPW – Frequencies Identification <sup>1</sup>

System Analysis - RPW Limits  
Test CHAR-E03  
Nominal - Science Mode

PHI#1	1 x Heater	0.2	0.0002	SCM
PHI#2	3 x Heater	0.6	0.0006	SCM
PHI#3	1 x DC/DC Converter (125 KHz)	125	0.125	ANT
PHI#4	2 x DC/DC Converter (125 KHz)	250	0.25	ANT
PHI#5	4 x DC/DC Converter (125 KHz)	500	0.5	ANT
PHI#6	55 x DC/DC Converter (125 KHz)	6875	6.875	ANT
PHI#7	88 x DC/DC Converter (125 KHz)	11000	11	ANT



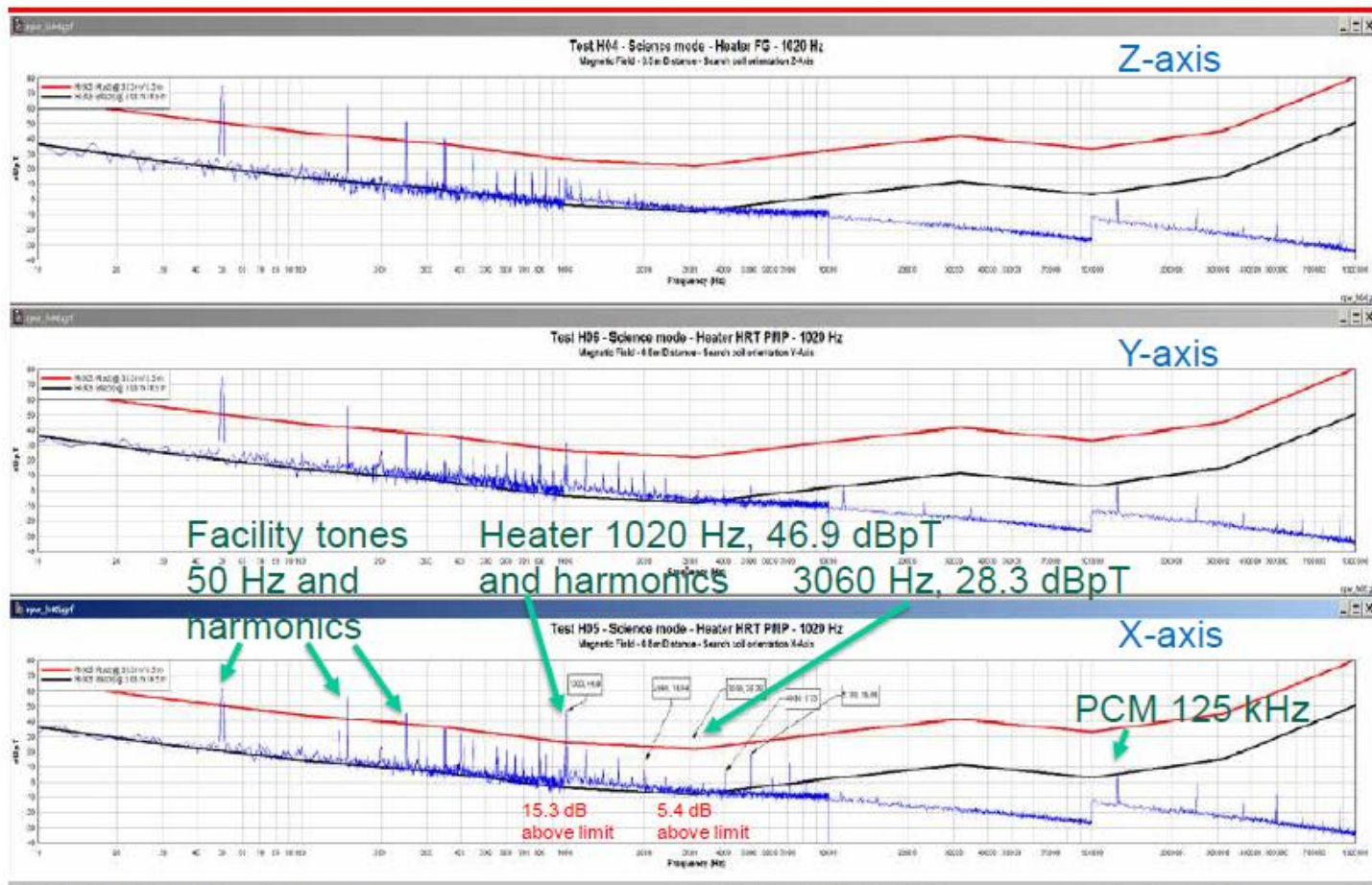
<sup>1</sup> ESA (Ph. Laget) 170511 PHI FM EMC Performance Summary – RPW E and H Characterization Analyses

# Annex : All the results on each instrument

PHI



## Radiated Emission H Field - RPW Characterization – 0.5 m



SO/PHI EMC Test Results Summary

Solo EMC WG Mtg #17

23-24. May 2017

8



# Annex : All the results on each instrument

## PHI : Mitigation on heating frequency



### Radiated Emission H Field – RPW

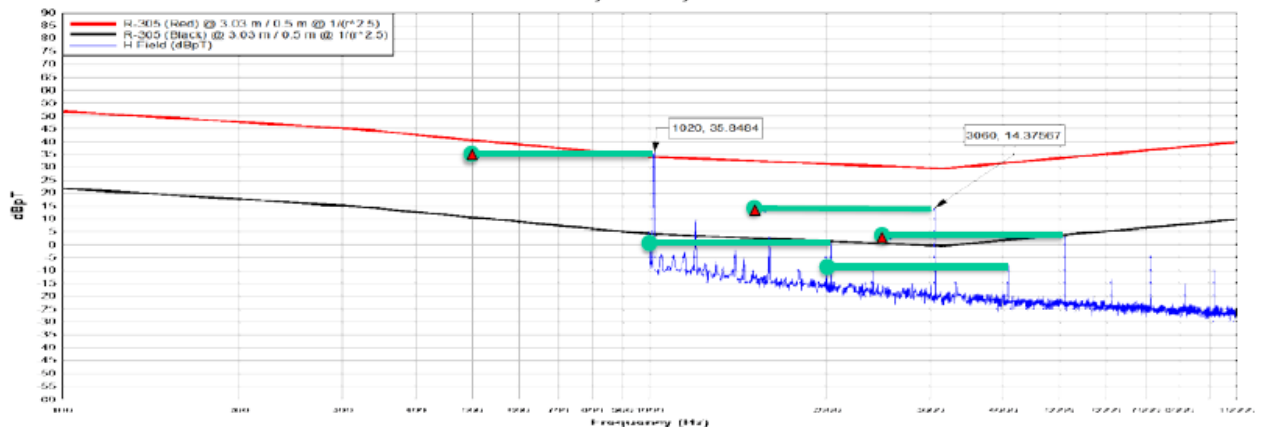
#### Conclusion <sup>1</sup> page 2 of 2

As a mitigation measure the drive frequency of the heater can be changed in orbit in the range between 406 Hz to 1200 Hz in order to move the fundamental in a less sensitive area of SCM.

Below is the illustration when the heater is set to 500 Hz. One extra tone will be detected by RPW-SCM, however all tones are below the RED line with a minimum 6 dB margin, in worst case test conditions.

#### test conditions

Test H05 - Science mode - Heater HRT PMP - 1020 Hz  
Magnetic Field - 0.5 m Distance - Search coil orientation X Axis  
System Analysis



<sup>1</sup> ESA (Ph. Laget) 170303 PHI FM EMC Performance Summary – RPW E and H Characterization Analyses



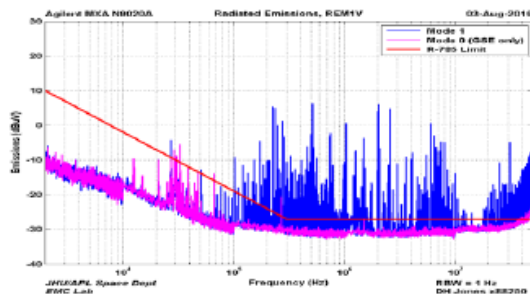


# Annex : All the results on each instrument



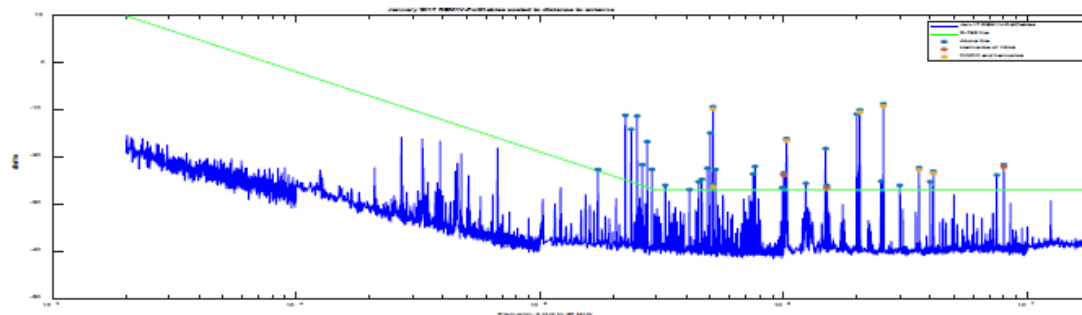
## EIDA R-785 Re-Test

- EIDA R-785:** The PI shall characterise the radiated E-field emissions of each unit using the frequency ranges and background noise as in Figure 9.1-2.



After review of the data there was a concern that the data included peaks from sources other than the instrument. A re-test was scheduled to include opto-isolation of the spacewire signals to verify the characterization of the instrument.

Re-test was completed under NCR-104.  
No Waivers for Magnetics Testing



SOLO-HI

SoloHi EMC WG#17

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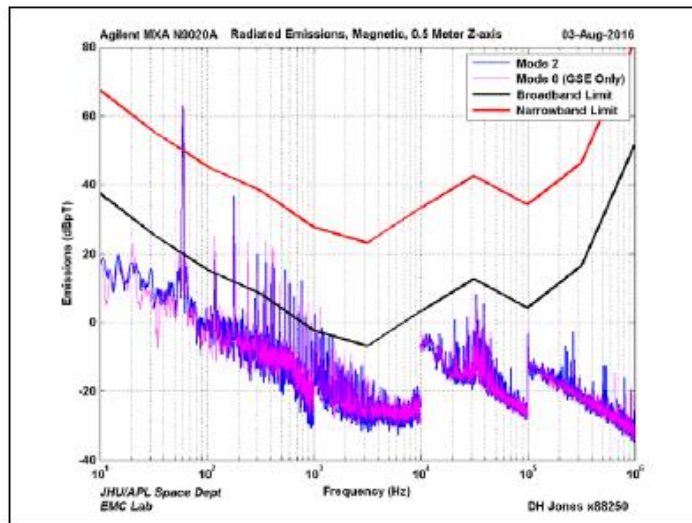
## Annex : All the results on each instrument



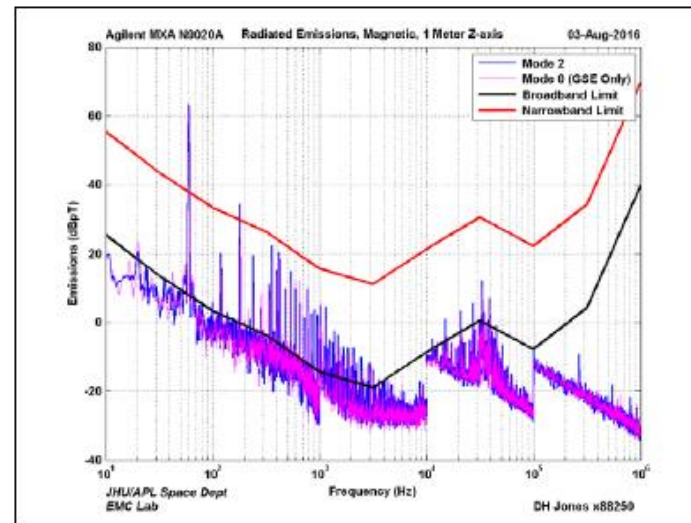
### EIDA-R-703, R-704, and R-784 Mode 2 Z-Axis

SOLO-HI

0.5 Meter Distance



1 Meter Distance



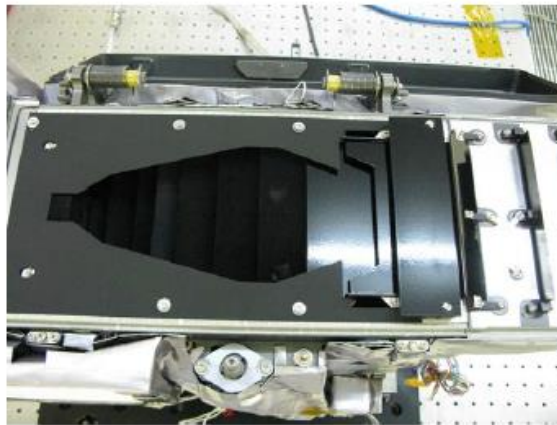
## Annex : All the results on each instrument



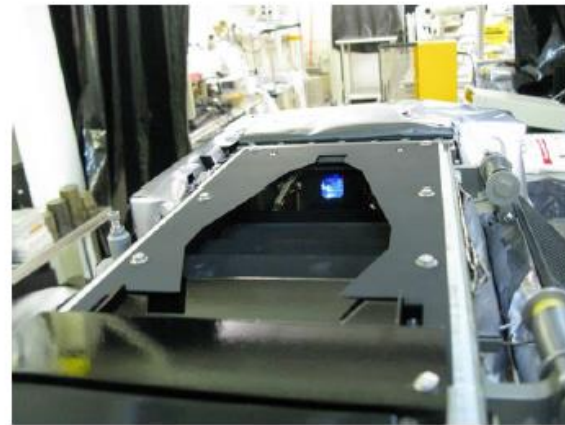
### Changes since PER

- Change made to the coating of the Peripheral Baffle (PB)
  - Original PB had non-conductive coating
  - Electrostatic analysis by ESA showed a potential charging issue
  - Modeling of a change to Z307 (conductive Black) showed significant improvement

SOLO-HI



SoloHI EMC WG#17

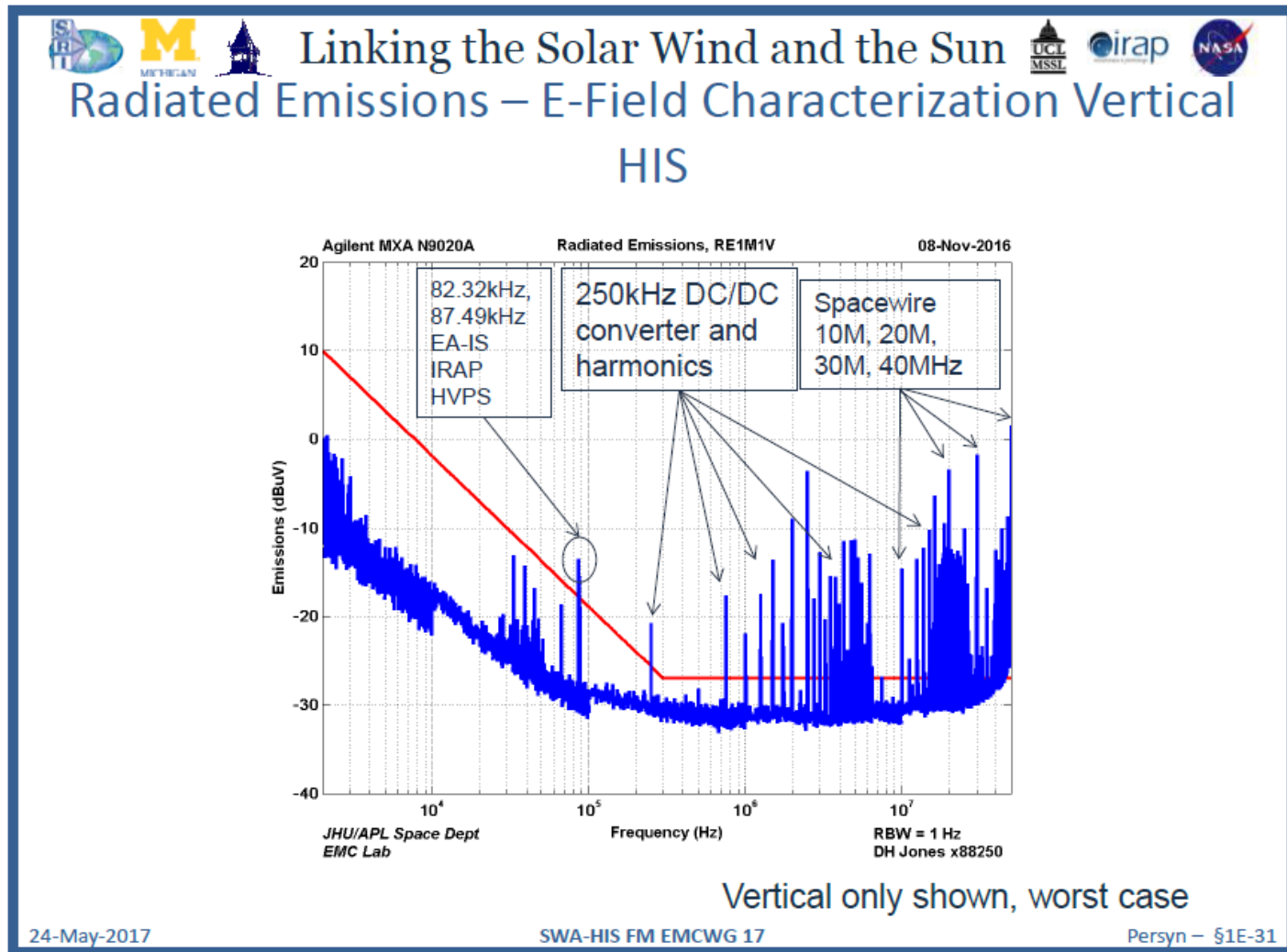


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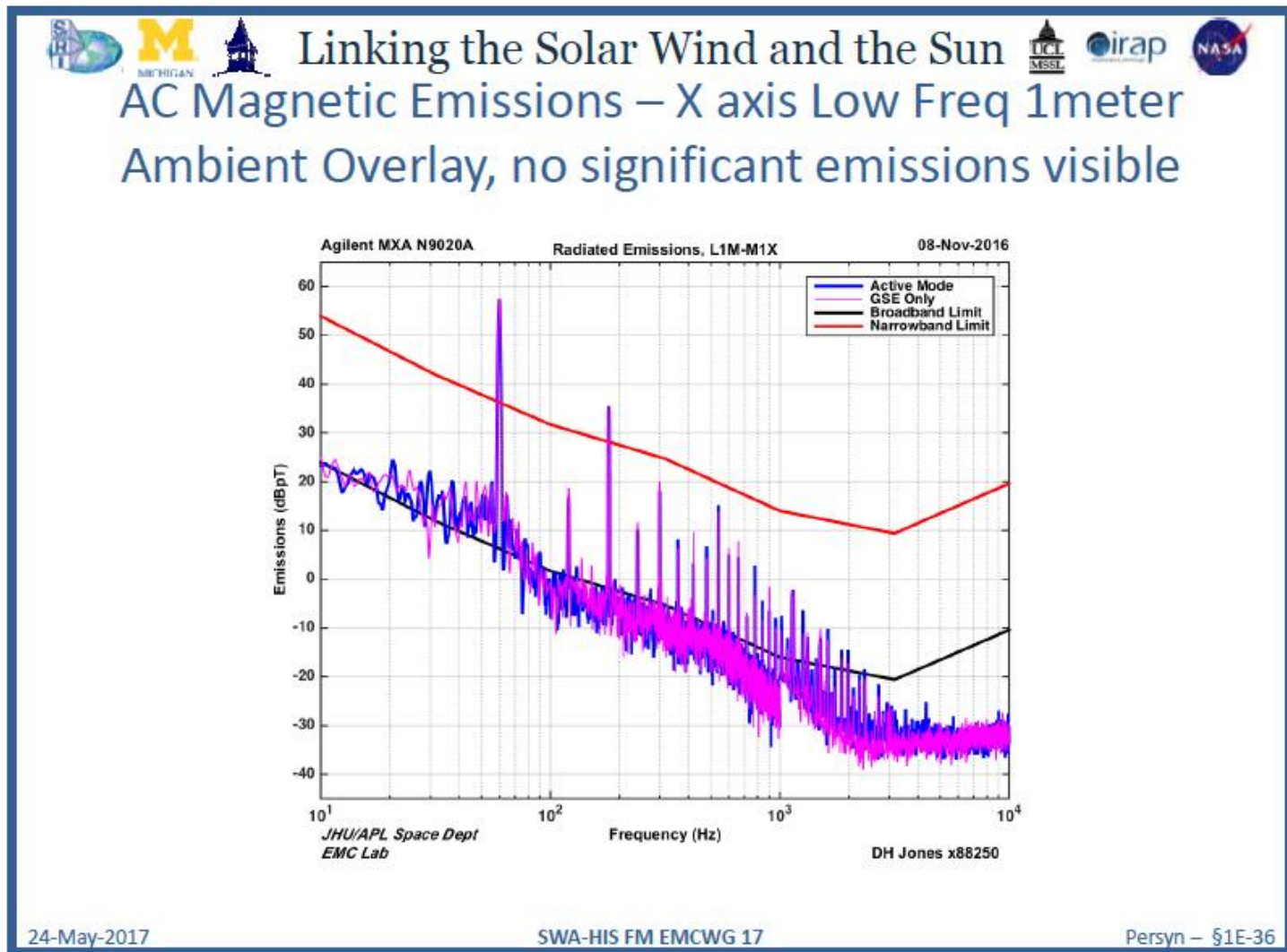
## Annex : All the results on each instrument

HIS



## Annex : All the results on each instrument

HIS

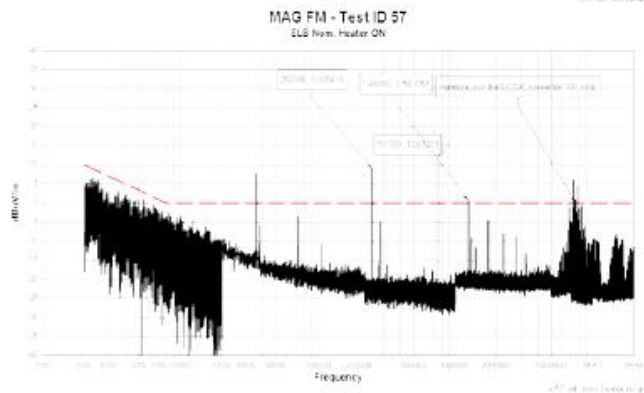
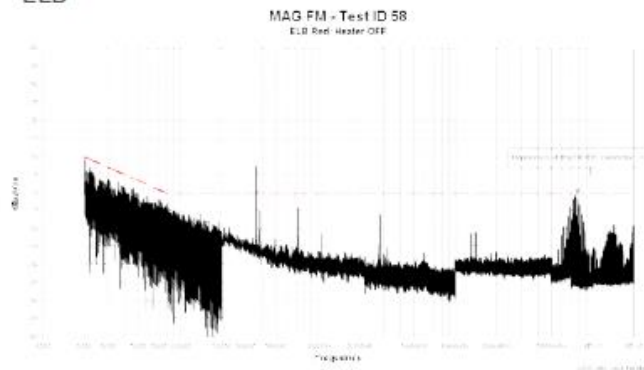


# Annex : All the results on each instrument

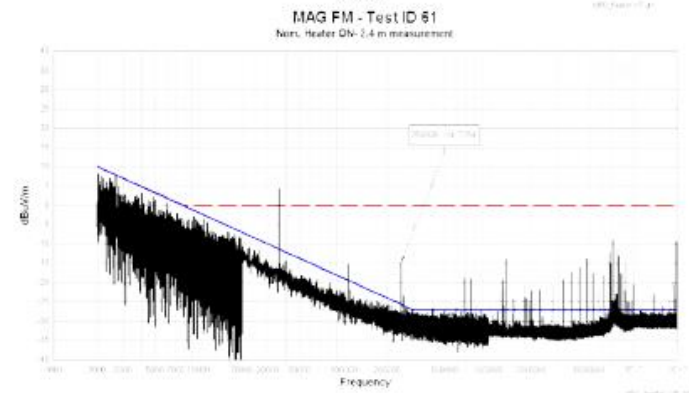
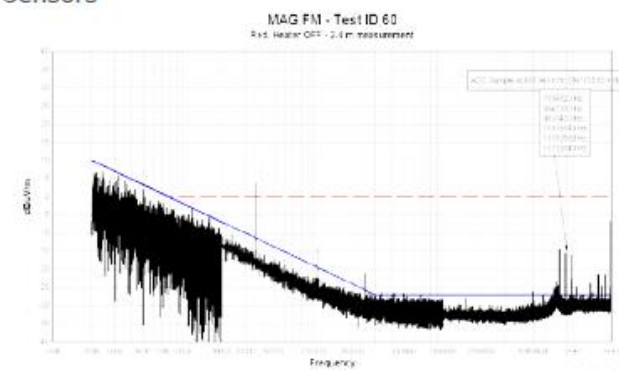


MAG

ELB



Sensors



Slide: # 4

## Annex : All the results on each instrument



### R785 RADIATED Electric fields vs RPW ANT requirements



MAG

- The MAGELB meets the specification when the heaters are off.
- The MAG sensors meet the specification except for 6 harmonics of the ADC sample frequency between 7.8MHz and 15.8MHz
- For both the MAGELB and MAG sensors the heaters exceed the limits between 250kHz and 10MHz.
- Operationally: Workaround to be implemented to not operate heater during EMC quiet times



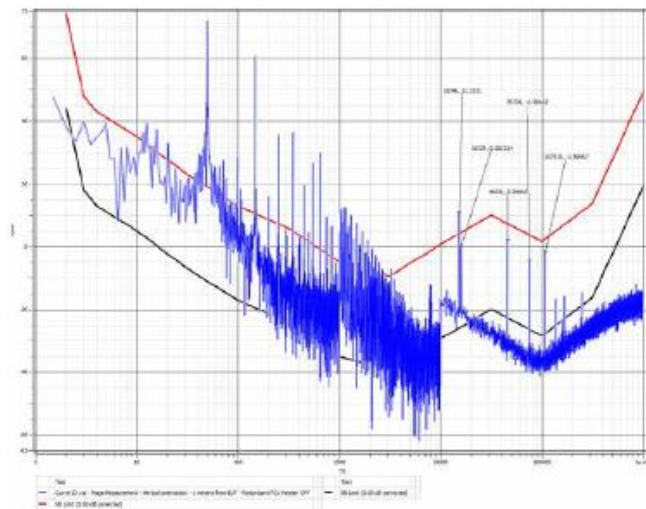
# Annex : All the results on each instrument



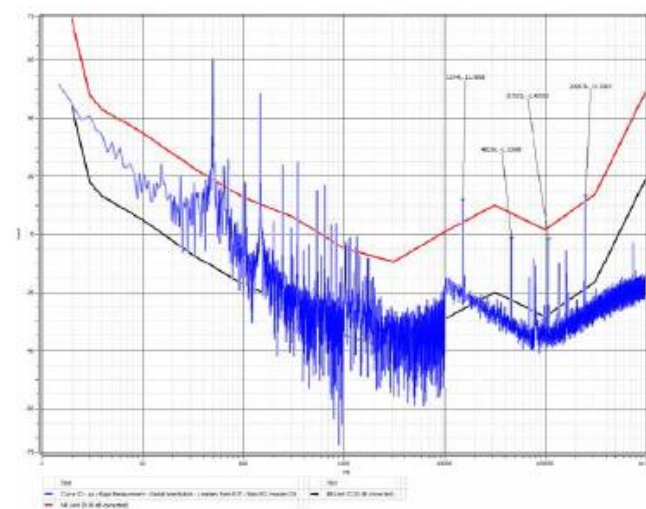
## R703, R704, R705 Radiated Magnetic fields vs RPW SCM requirements



SENSORS, HEATERS OFF REDUNDANT  
VERTICAL



SENSORS HEATERS ON MAIN  
RADIAL



MAG

Slide # 8





## Annex : All the results on each instrument



### R703, R704, R705 Radiated Magnetic fields vs RPW SCM requirements



- Largest amplitudes of magnetic field of the MAG instrument originate from the MAG sensors in the boom configuration
- 2 frequencies exceed maximum level as specified in the requirement these are 15360Hz of the MAG drive and 250kHz of the MAG heater
- Operationally: Workaround to be implemented to not operate heater during EMC quiet times

## MAG

### Compliance statement

EIDA Requirement	Compliance
R-703	Compliant
R-704	Partial Compliance, All below requirement except for drive frequency (15 360Hz) and the first 11 odd harmonics SOL-MAG-RFD-023_MAG_HField
R-705	Compliant
R-783	Compliant
R-784	Compliant

### Frequencies which will be seen by SCM

Frequency in Hz	Source
15 360	Fluxgate drive frequency
46 080	3 <sup>rd</sup> harmonic of drive
76 800	5 <sup>th</sup> harmonic of drive
107 520	7 <sup>th</sup> harmonic of drive
138 240	9 <sup>th</sup> harmonic of drive
168 960	11 <sup>th</sup> harmonic of drive
250 000	Heater frequency

## Annex : All the results on each instrument

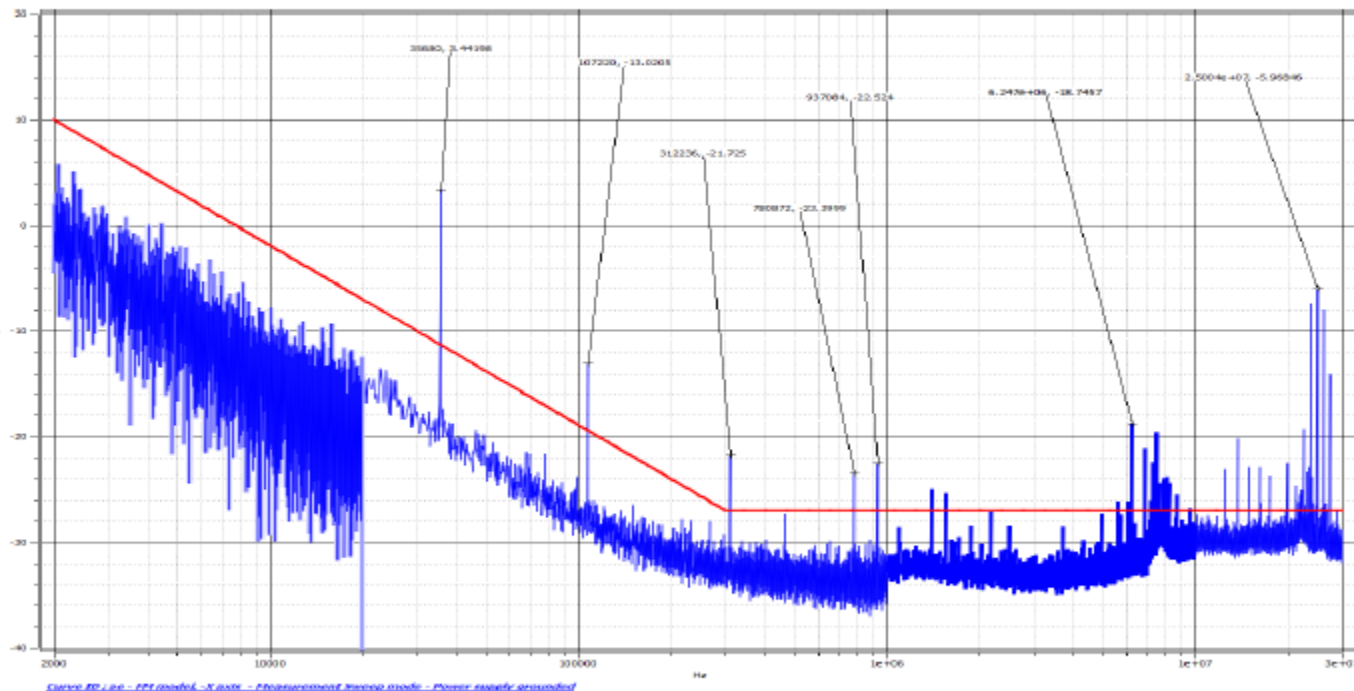


### Radiated E-field Characterization (2kHz – 30MHz)



Vertical scale  
in dB $\mu$ V/m

SWA-PAS



(ae) – EGSE ON – PAS ON SWEEP mode - Orientation -X (3/3/2017) –  
Primary return connected to ground plane

21-Mar-2017

SOLAR ORBITER EMC WG17 – SWA PAS EMC Test Results

8

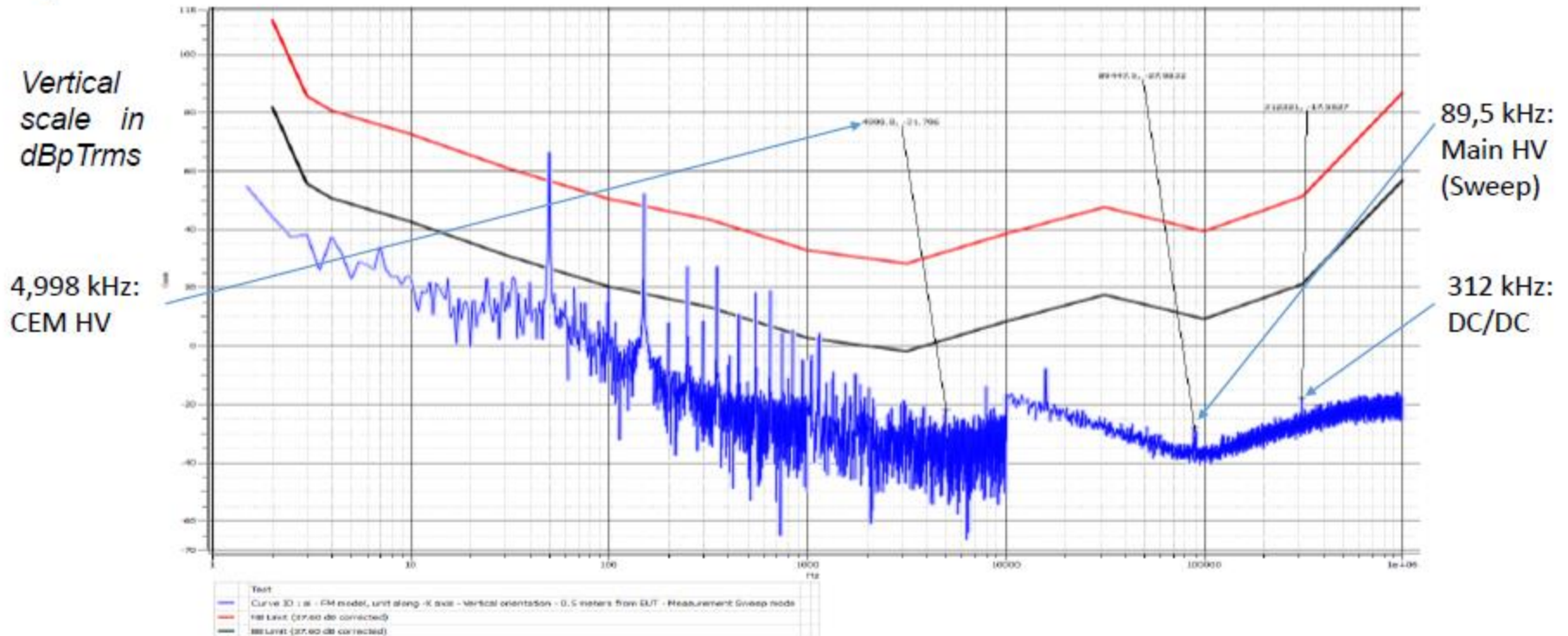


# Annex : All the results on each instrument



SWA-PAS

AC Magnetic Field



EGSE ON, PAS ON (SWEEP) -X, Vertical orientation 0.5m, 1<sup>st</sup> March 2017

24-May-2017

SOLAR ORBITER EMC WG17 – SWA PAS EMC Test Results

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## Annex : All the results on each instrument

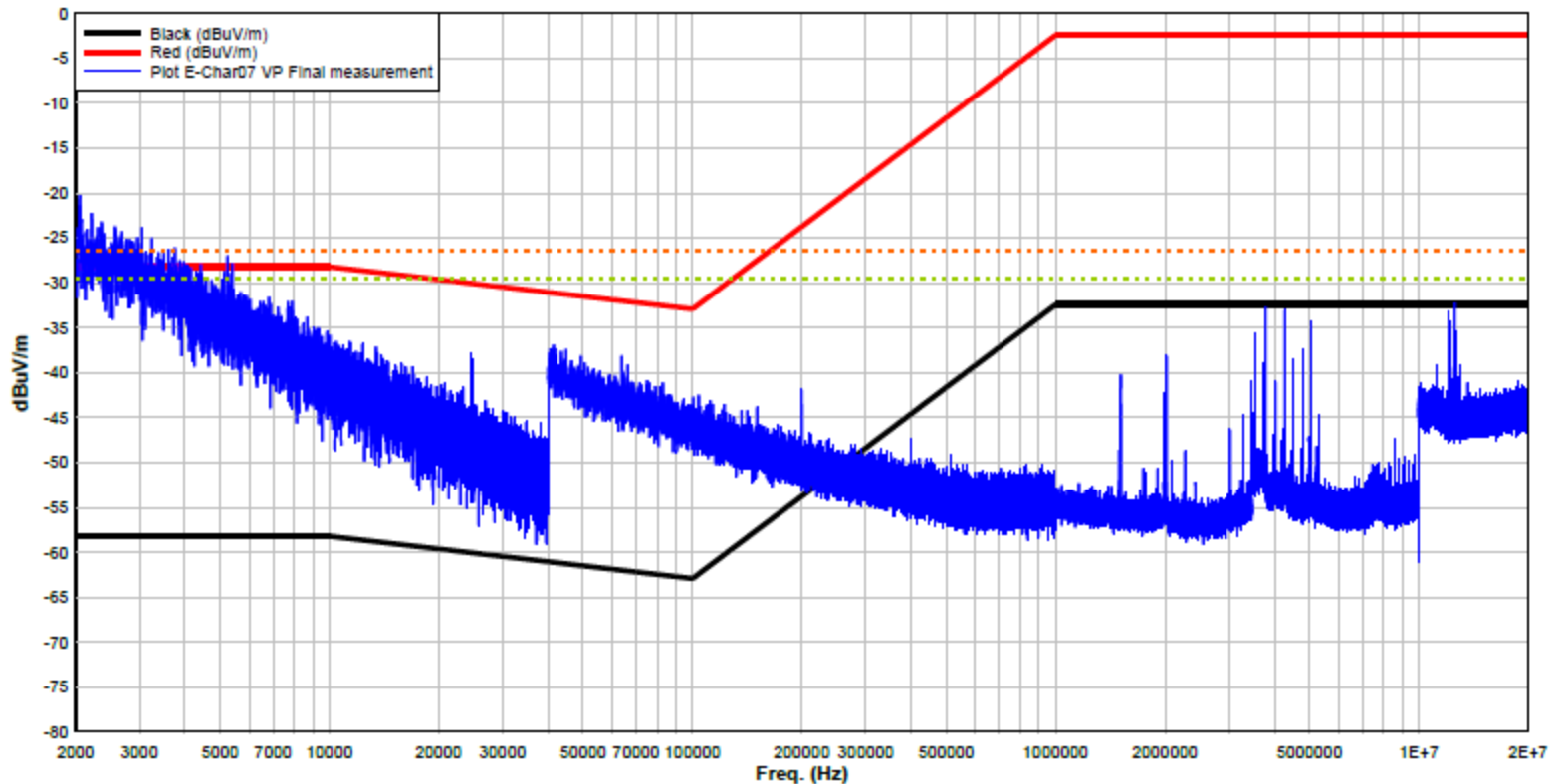


Test Results - Nominal and Redundant.



### RPW E Field System / Science Analysis

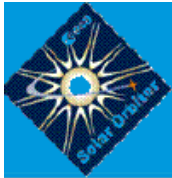
STIX FM - Solar Flare Mode



STIX system analysis Final.grf

STIX

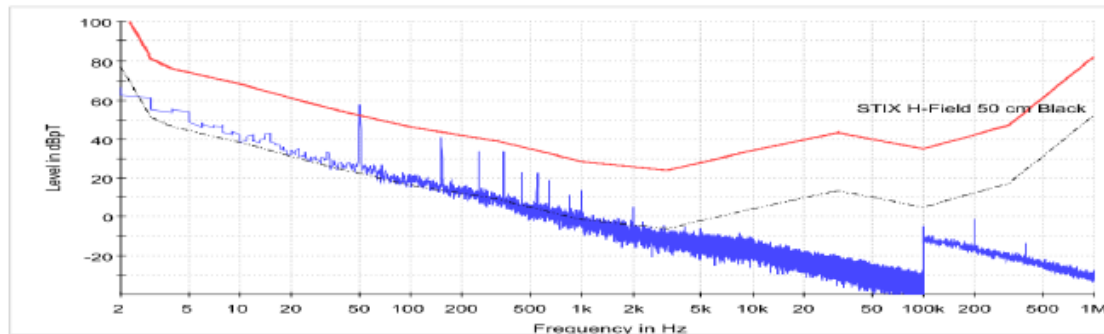
# Annex : All the results on each instrument



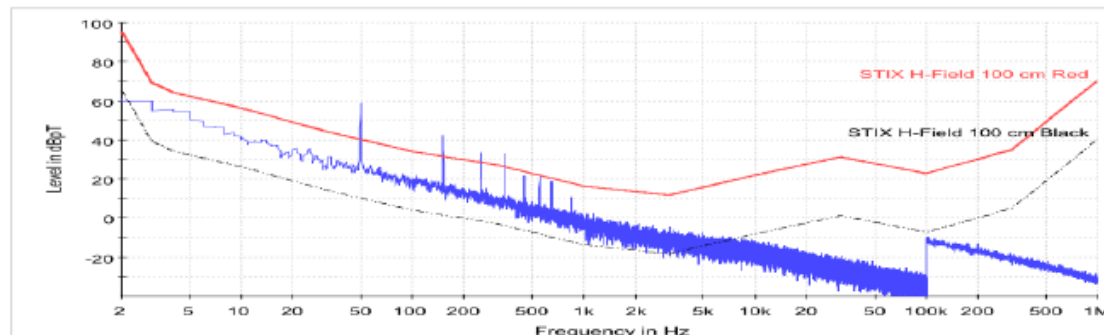
## Radiated Emission H Field – RPW - Characterization – 0.5 and 1 m X Orientation – Worst Case



REH Char 01 50 cm distance loop orientation 1 (see picture )  
Solar Flare mode, Command cable disconnected



REH Char 06 100 cm distance loop orientation 1 (X see picture )  
Solar Flare mode, Command cable disconnected Nominal power interface



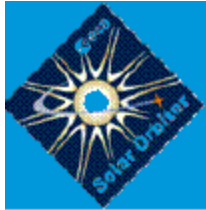
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European Space Agency

Slide: # 4

STIX

# Annex : All the results on each instrument



## E Characterization - Test Results – 1 MHz to 10 MHz.

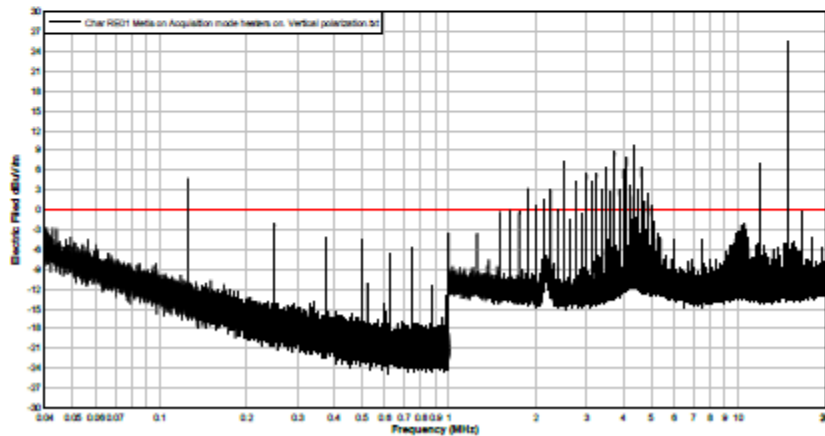


### From 1 MHz to 10 MHz:

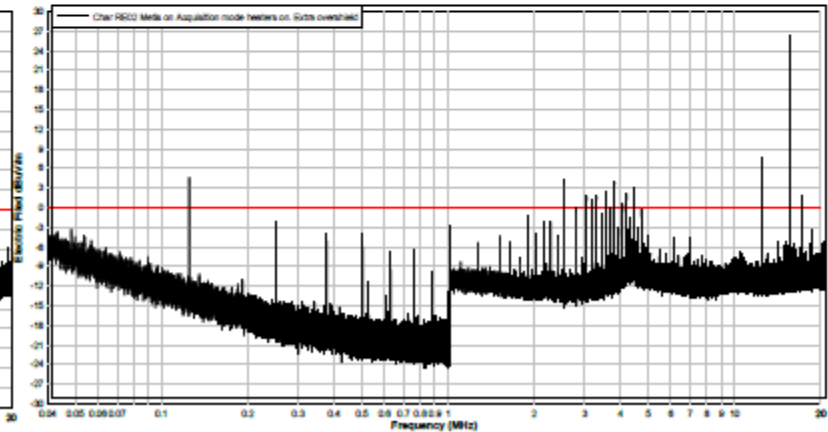
some DC/DC switching frequency harmonics are detected with some above the RED line.  
Investigation have demonstrated that these emission are coming from the power harness. (see Figures below).

### METIS

RE02 Metis on Acquisition mode heaters on. Vertical polarization extra over shield



RE02 Metis on Acquisition mode heaters on. Vertical polarization extra over shield



# Annex : All the results on each instrument

The Characterization results are scaled vs. RPW instrument's performances taking into account the distance wrt. the closest antenna (MY, 1.93m) and spacecraft shielding.

The Figure 2 shows the effect of the harness contribution. Flight performance is expected to be as good as Figure 2 with the following 5 frequencies above the Black line:

- 125 / 250 / 375 KHz, DC/DC switching frequency and harmonics.
- 12 MHz: UVDA ADC clock, Crystal Controlled
- 15 MHz: LVDA ADC Clock, Crystal Controlled

METIS

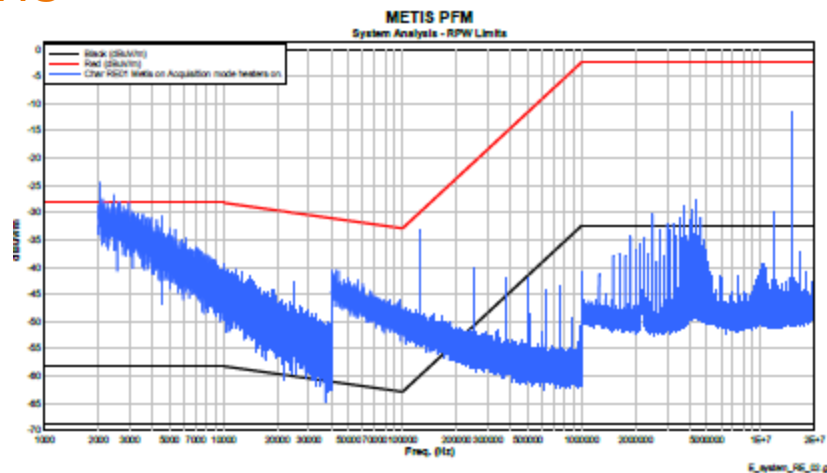


Figure 1

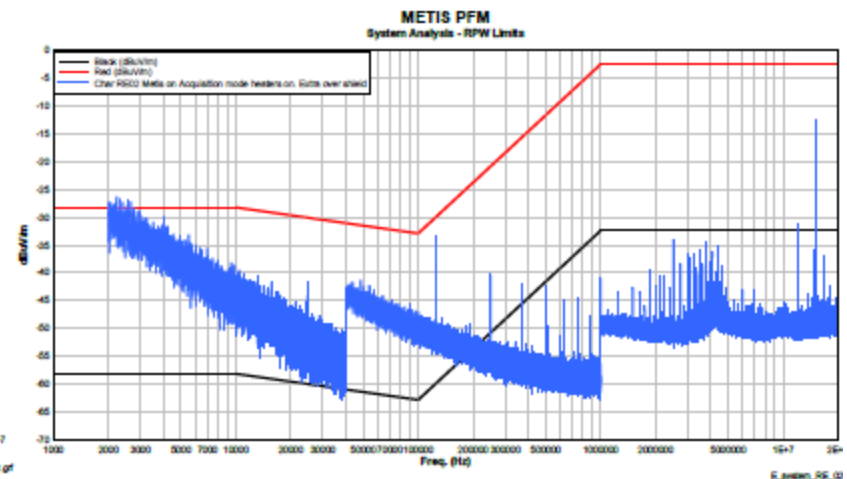
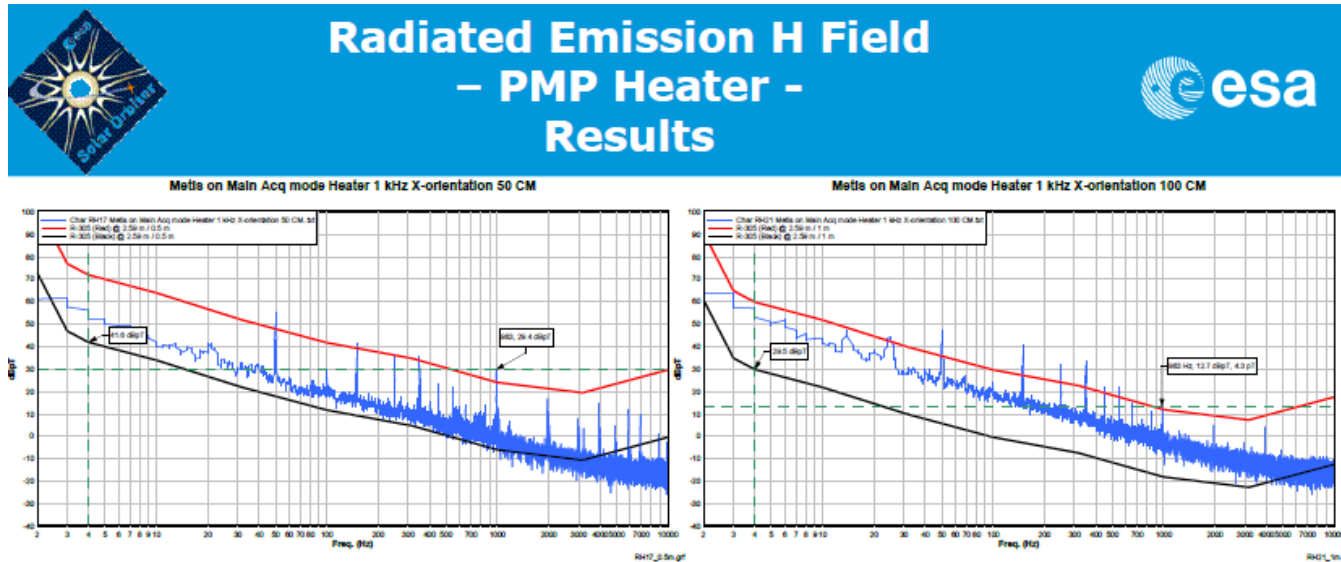


Figure 2

European Space Agency

# Annex : All the results on each instrument

METIS



## RPW:

At 983 Hz, the tone is above or touching the RED line.  
 When the frequency is shifted down to 4 Hz or below, the tone and harmonics are below the BLACK line with a margin > 10 dB.

## MAG:

At 983 Hz, the tone is outside MAG's maximum frequency (64 Hz).  
 When the frequency is shifted down to 4 Hz or below, the measured 4.3 pT measured at 983 Hz at 1 m distance is far below the allowed periodic transient of 120 pT @ 1 m (R-842).  
 This level rescaled with MAGOBS distance is 0.31 pT @ 4 Hz. This level below the sensitivity level of MAG.

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