



RPW Consortium Meeting #23

EMC Tests status

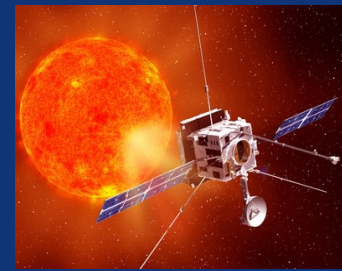
30/09 & 01/10 2019,
Meudon



SOLO EMC TRB – July 26th, 2019

RPW autocompatibility





ARA E-field measurements during RPW autocompatibility

SOLO EMC TRB – July 26th, 2019



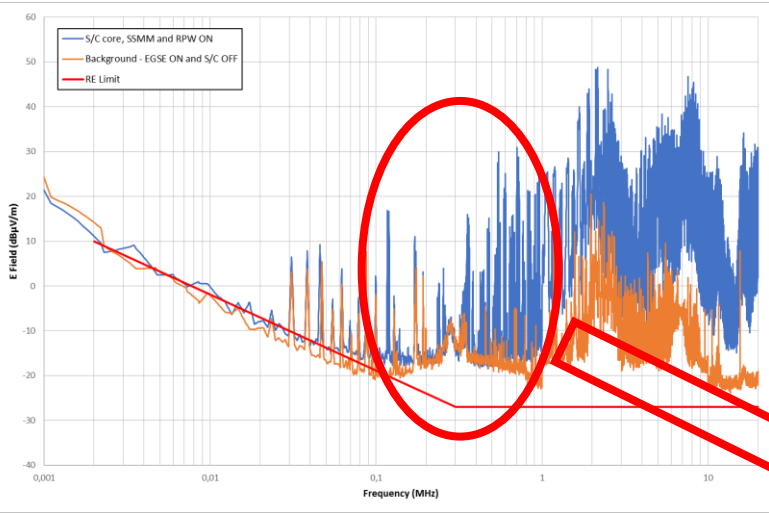
RPW + dummy antenna calibration (April 2019)

- **Calibration to evaluate dummy antenna gain when connected to RPW antenna**
 - S21 calibration antenna / RPW QM antenna (with and without dummy)
- **Scan E-field to assess empty EMC chamber background**
 - RPW QM antenna (with and without dummy)
 - ARA antenna
- **Scan B-field to assess empty EMC chamber background**
 - Search coils

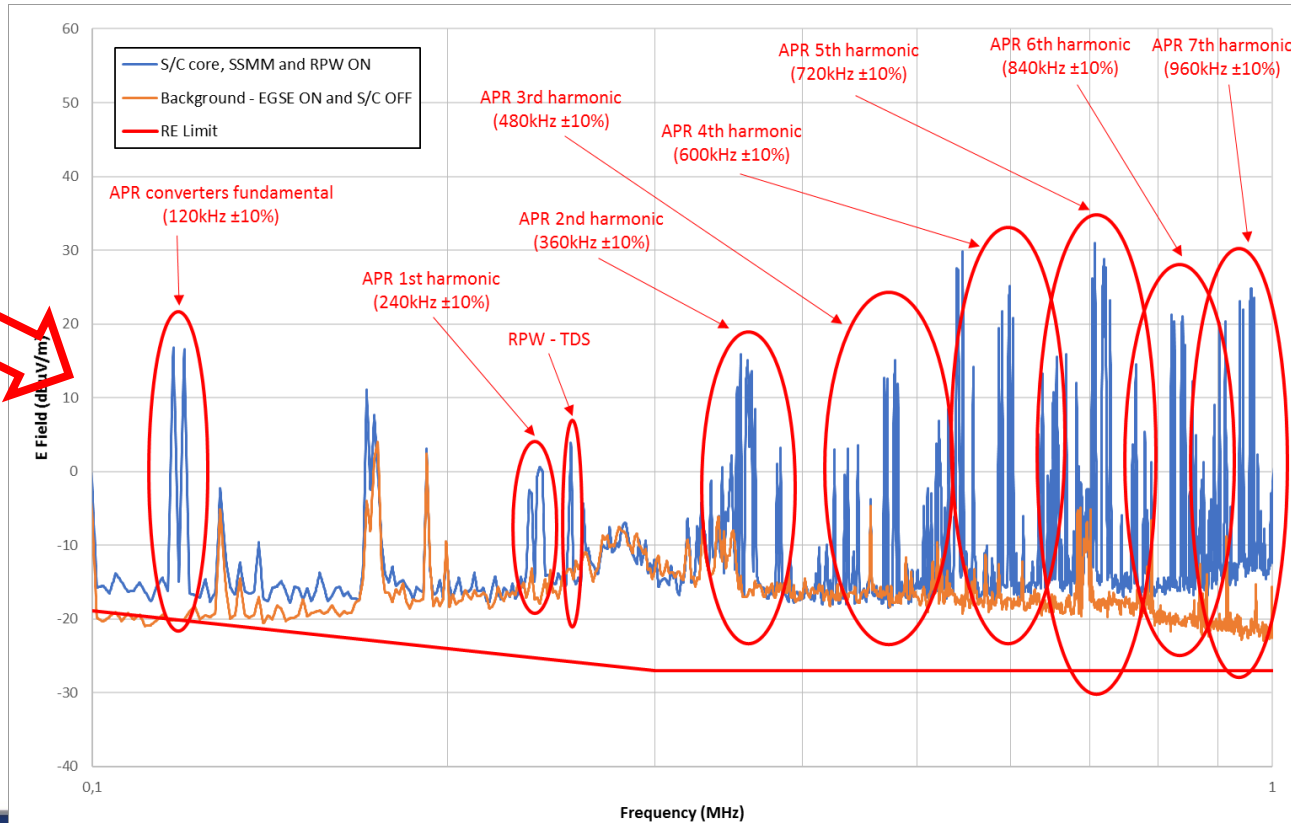


Background measurement

- Noisy background due to APR converters (120kHz) and its harmonics



Spikes amplified by EGSE cable, should not be seen during flight



Main contributors seen with ARA antenna

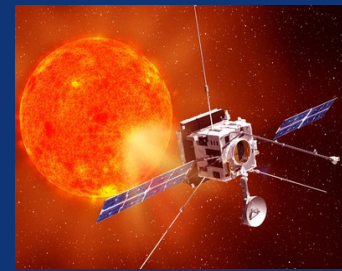
Unit	Components / Function	Frequency	Level over background
PCDU	APR converters	120kHz + harmonics	5 to 40dB
RW + WDE	DC-DC converter	80kHz + harmonics	5 to 15dB
SADE	AD conversion rate, burst	23.81kHz	2dB
METIS	DC-DC switching frequency	130k – 140kHz	3dB

ARA measurements conclusion

- **Noisy background** → some frequencies might have been missed:
 - **Uncertainties due to APR frequency** width ($\pm 10\%$)
 - **Not possible to conclude on frequencies hidden by APR**
- **Frequencies identified:**
 - APR converters: due to EGSE cable, **should not be seen during flight**
 - WDE converter: **harmonics measured, expected compliant by ADS in flight**
 - SADE conversion rate: **small exceedances**
 - METIS switching frequency: **small exceedances**



Complete compliance to be confirmed in flight



RPW MEB measurements during RPW autocompatibility

SOLO EMC TRB – July 26th, 2019

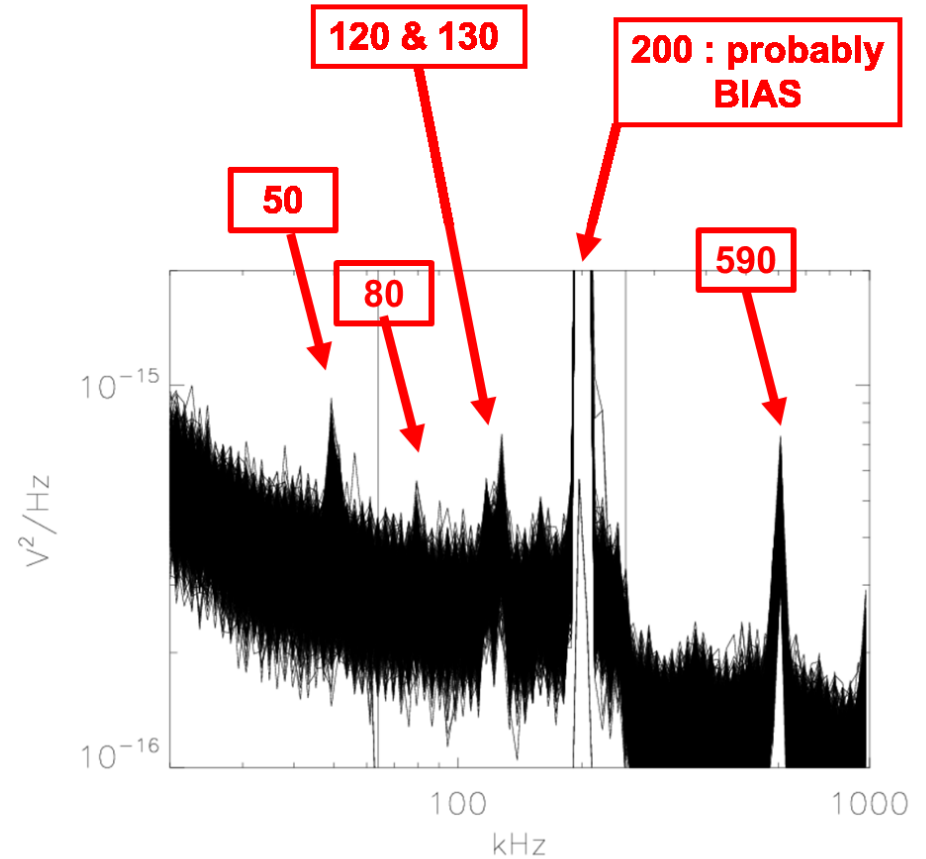
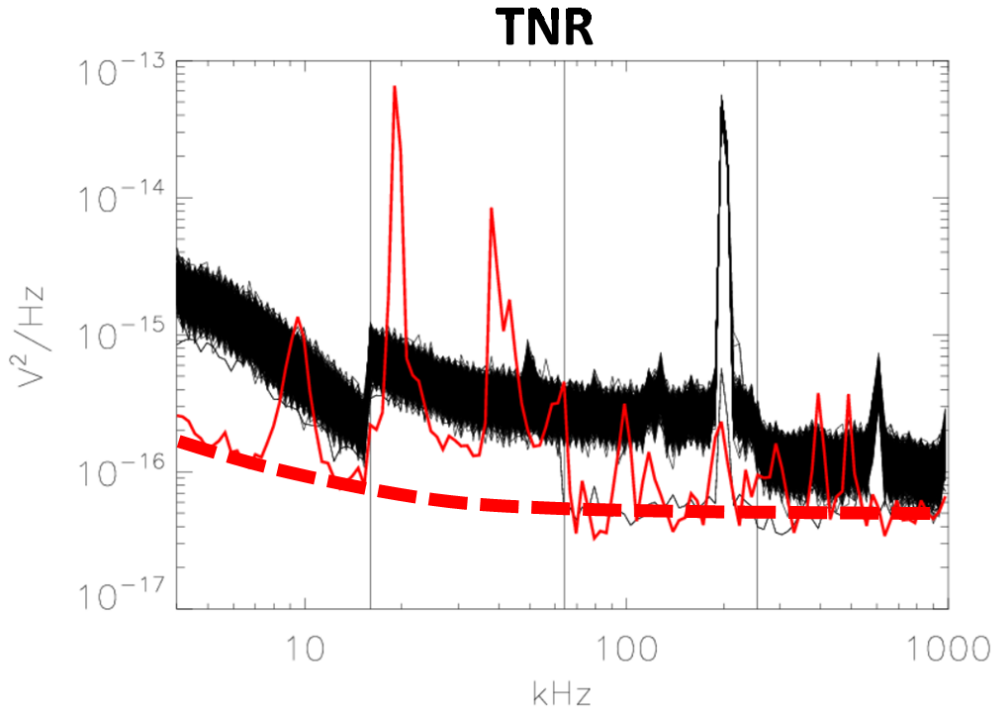


Problems encountered during the RPW data production

- Compared to the previous RPW data analysis the full L0 → L1 → L2 is used for the current EMC tests
- A few bugs have been detected and corrected for the production of RPW L1 data
- Data for the two HFR bands (HF1 and HF2) are not as expected → **due to a wrong setting by the TNR-HFR team. Now corrected for the future.**
- The TNR configuration used during the EMC tests does not correspond to the configuration prepared by the TNR-HFR team (ex. B measurements on HFR not required). **An error has been introduced at some point. Action for ADS see email from E. Lorfèvre en 11/07/2019)**

Electric field measurement

All spectra for V1 between
06:00:10.597971 & 17:50:16.846937
on 22 May 2019



Electric field measurement

Detected spurious frequencies (kHz) for each sensor

V1	V2	V3
	715	715
590	550	550
200	200	200
130	160	160
120	120	120
80	80	80
50	60	60
	40	40
	7	

Antenna configuration during the IABG EMC tests

Serial #	Antenna	Panel	Measurement	Dummy Antenna
FM01	ANT 1	PZ	V1	Connected
FM02	ANT 2	PY	V2	Connected
FM03	ANT 3	MY	V3	Non-connected

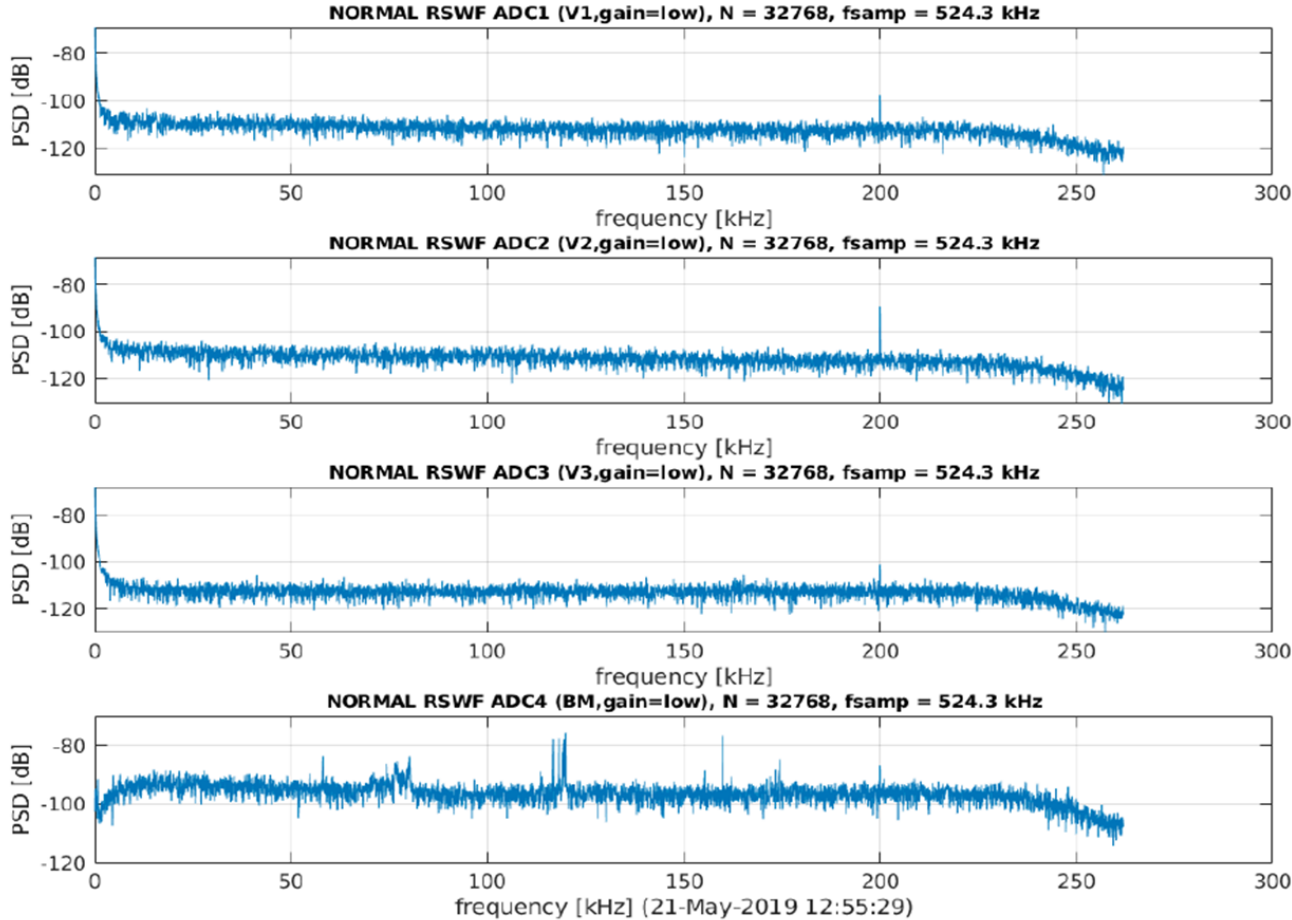
V3 seems the same perturbations as V2. How is this possible ?

Timeline

TC#	Test Case (TC)	S/C Equipment Active	Time [CEST]	Time [HTML]
1	EGSE ON S/C OFF	None	20/05/2019 10:00	N/A
2	EGSE OFF S/C OFF	None	13:40	N/A
3	EGSE ON S/C OFF	None	14:15	N/A
4	EGSE ON SAS Dummy Load ON	SAS Dummy Load	16:30	N/A
5	Core ON	PCDU, OBC, RIU, DST Rx, SSMM, RPW	21/05/2019 09:17	21/05/2019 07:17
6	MAG (Normal Mode)	Core ON + MAG	12:10	10:10
7	MAG (Burst Mode)	Core ON + MAG	12:18	10:18
8	STR	Core ON + MAG, STR	12:33	10:33
9	RWA 1	Core ON + MAG, STR, RWA 1	14:05	12:05
10	RWA 2	Core ON + MAG, STR, RWA 1, RWA 2	14:26	12:26
11	RWA 3	Core ON + MAG, STR, RWA 1, RWA 2, RWA 3	14:58	12:58
12	RWA 4	Core ON + MAG, STR, RWA 1, RWA 2, RWA 3, RWA 4,	15:18	13:18
13	IMU	Core ON + MAG, STR, RWA 1, RWA 2, RWA 3, RWA 4, IMU	15:32	13:32
14	SADE	Core ON + MAG, STR, RWA 1, RWA 2, RWA 3, RWA 4, IMU, SADE	15:41	13:41

TC#	Test Case (TC)	S/C Equipment Active	Time [CEST]	Time [HTML]
24	SWA DPU	Platform ON (-TWTA) + EPD HET-1, EPD HET-2, EPD SIS, EPD STEP, SWA DPU	09:34	07:34
25	SWA EAS	Platform ON (-TWTA) + EPD HET-1, EPD HET-2, EPD SIS, EPD STEP, SWA DPU, SWA EAS	10:02	08:02
26	SWA PAS	Platform ON (-TWTA) + EPD HET-1, EPD HET-2, EPD SIS, EPD STEP, SWA DPU, SWA EAS, SWA PAS	10:28	08:28
27	SWA PAS (Run 2)	Platform ON (-TWTA) + EPD HET-1, EPD HET-2, EPD SIS, EPD STEP, SWA DPU, SWA EAS, SWA PAS	10:34	08:34
28	SWA HIS (Burst mode)	Platform ON (-TWTA) + EPD HET-1, EPD HET-2, EPD SIS, EPD STEP, SWA DPU, SWA EAS, SWA PAS, SWA HIS	11:09	09:09
29	SWA HIS (Normal mode) (Key Point = In Situ ON)	Platform ON (-TWTA) + EPD HET-1, EPD HET-2, EPD SIS, EPD STEP, SWA DPU, SWA EAS, SWA PAS, SWA HIS	11:18	09:18
30	Platform ON	Platform ON (-TWTA) + EUI (Safe)	14:08	12:08
31	EUI (EMC Mode 2)	Platform ON (-TWTA) + EUI	14:16	12:16
32	EUI (EMC Mode 2)	Platform ON (-TWTA) + EUI	14:26	12:26
33	EUI (EMC Mode 1b)	Platform ON (-TWTA) + EUI	14:44	12:44
34	PHI (Obs Idle)	Platform ON (-TWTA) + PHI	15:13	13:13
35	PHI (Obs Idle)	Platform ON (-TWTA) + PHI	15:21	13:21

E-field above 1kHz



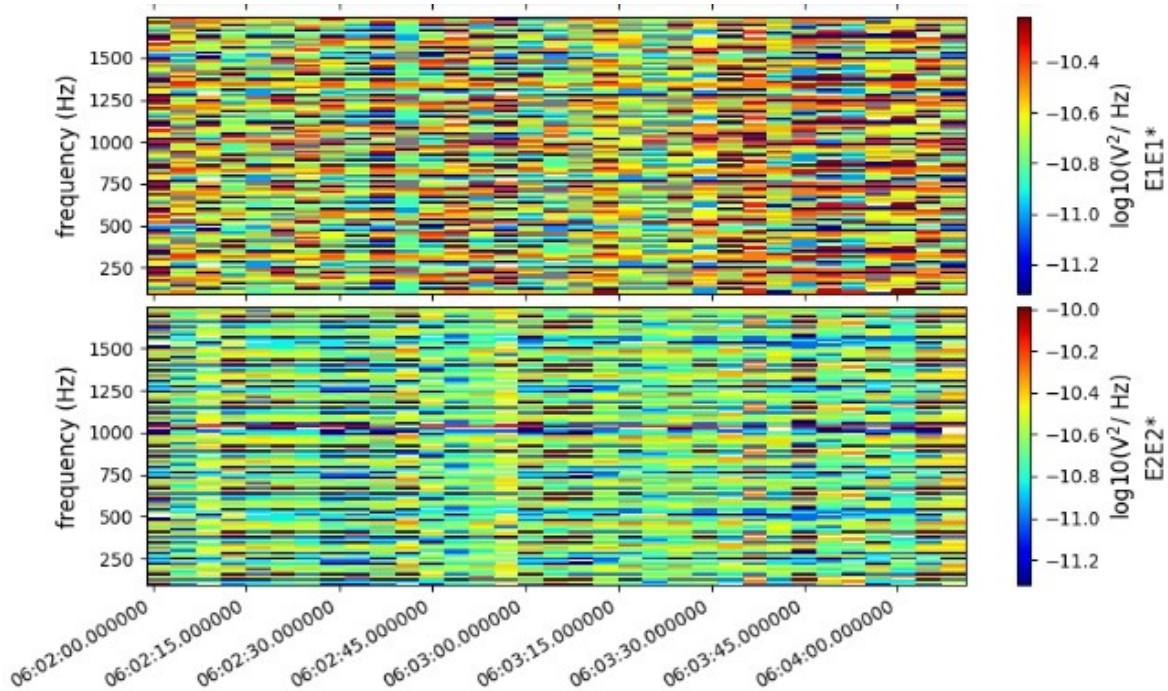
Only the RPW internal interference at 200 kHz (BIAS DC/DC)

Otherwise, E-field is very clean at high frequencies.

Noise floor unchanged since calibration.

TDS

E-field

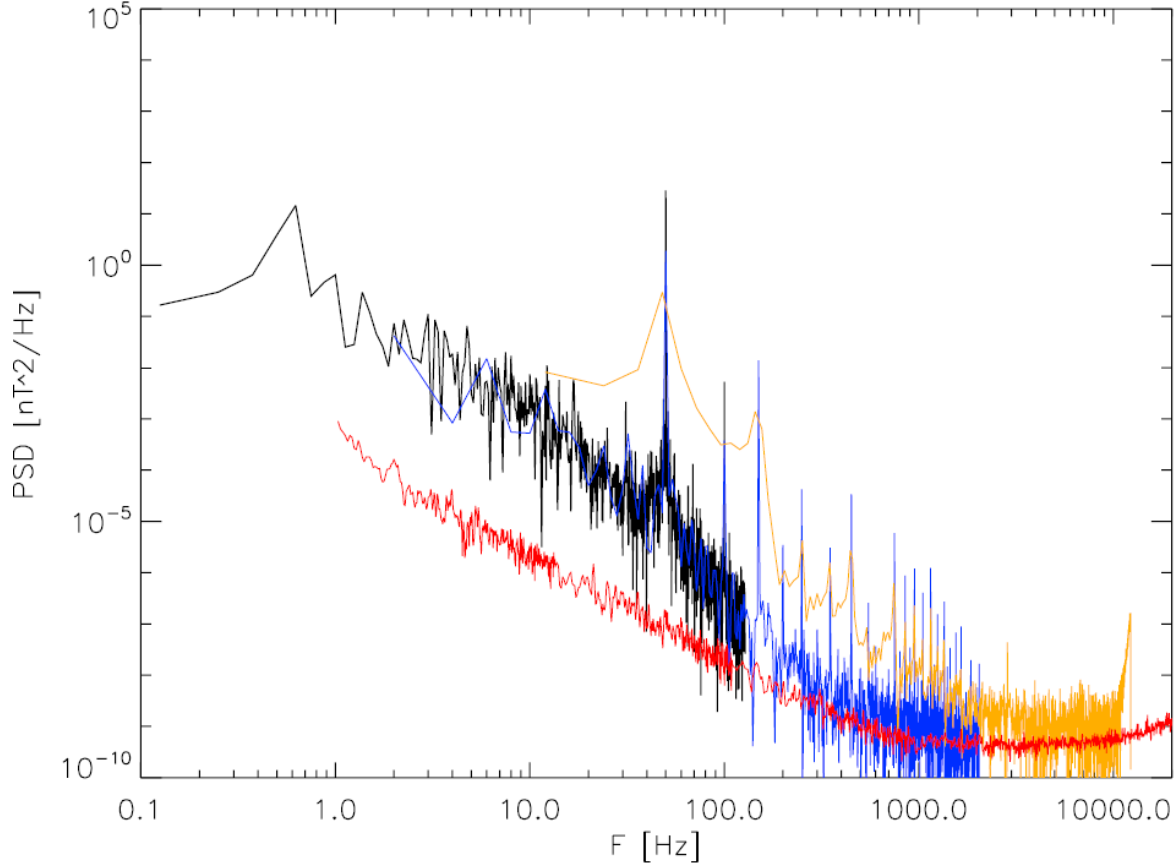


- **LFR spectral products** : In electric we see the sensitivity level of the LFR
- There are no electric counterpart of the radiated magnetic 50 Hz. This is very suspicious !
- Also the LFR team discovered BIAS is possibly in calibration mode (need to recheck the ROC pipeline). Were the electric antennas really connected ?

LFR

Magnetic field measurement

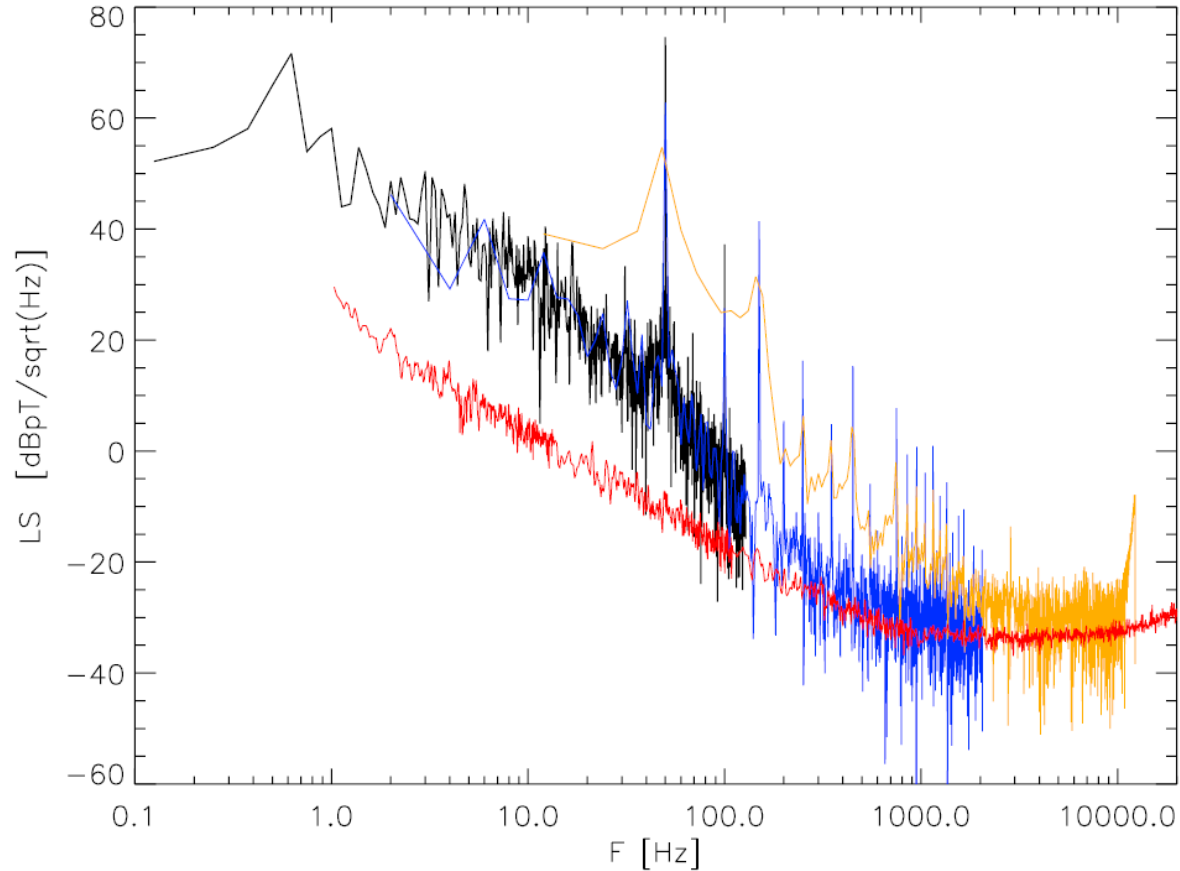
LF3X 20190522 15:43:48.9993



- **Black, blue & orange are spectra obtained in the IABG chamber @ f2, f1 et f0 LFR filters**
- **Red is the SCM requirement**
 - **No reaction wheels**
 - **Strong 50 Hz perturbation and harmonics**
 - **The EMC chamber background is about 20 dB above the RPW requirement below 200 Hz**

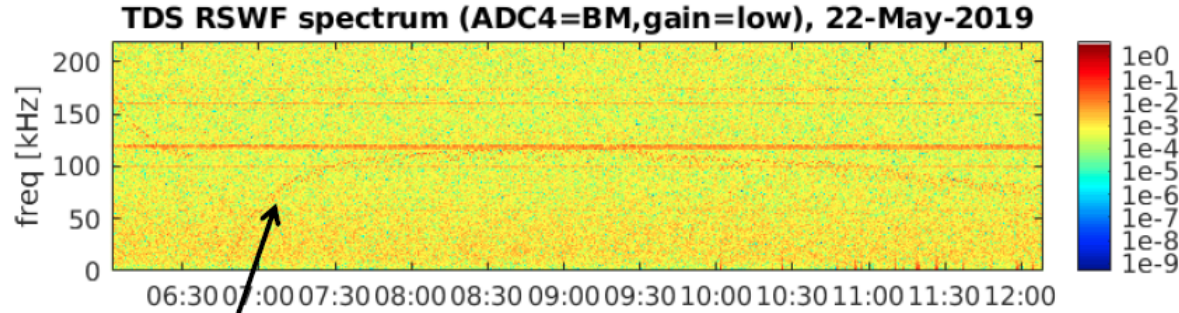
Magnetic field measurement

LF3X 20190522 15:43:48.9993



- Same in dBpT/sqrt(Hz) for comparison with the ADS report

B-field above 1kHz



There is a number of spikes in HF magnetic field, but the amplitude is reasonable (max 15 dB above noise).

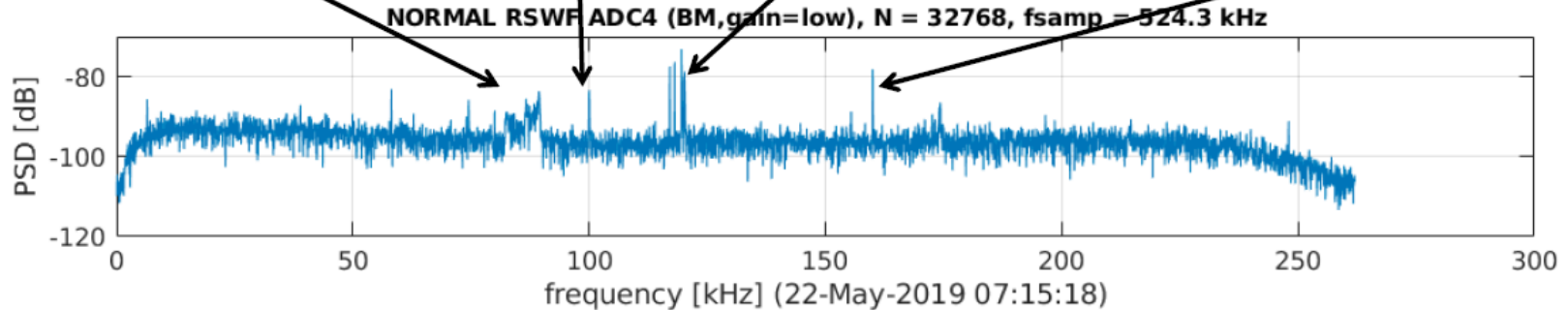
Noise floor same as during calibration.

Drifting spike. Moves in frequency, present most of the time.

100 kHz (not there on May 21)

EGSE (~120 kHz). All the time

Constant 160 kHz. Started on 21/5 12:15 UT



Preliminary conclusions (1/2)

- **These EMC tests have been very useful to test the RPW data pipeline production**
- **There is still work to be done to fully understand these data**
 - Wrong TNR-HFR configuration needs to be understood
 - The detailed timeline and absolute times needs to be understood
- **Impact on the RPW Electric measurements**
 - TNR sees some spurious perturbations which are almost the same on all 3 antennas. This is in contradiction with the antennas setup (V3 not connected).
 - LFR & TDS electric data are very clean !
 - There are no electric counterpart of the radiated magnetic 50 Hz. This is very suspicious !
 - Also the LFR team discovered BIAS is possibly in calibration mode (need to recheck the ROC pipeline). Were the electric antennas really connected ?
 - Were the RPW V1 & V2 dummy antennas really connected ?
 - TNR could see conducted emissions
 - Maybe connected but BIAS in the wrong mode



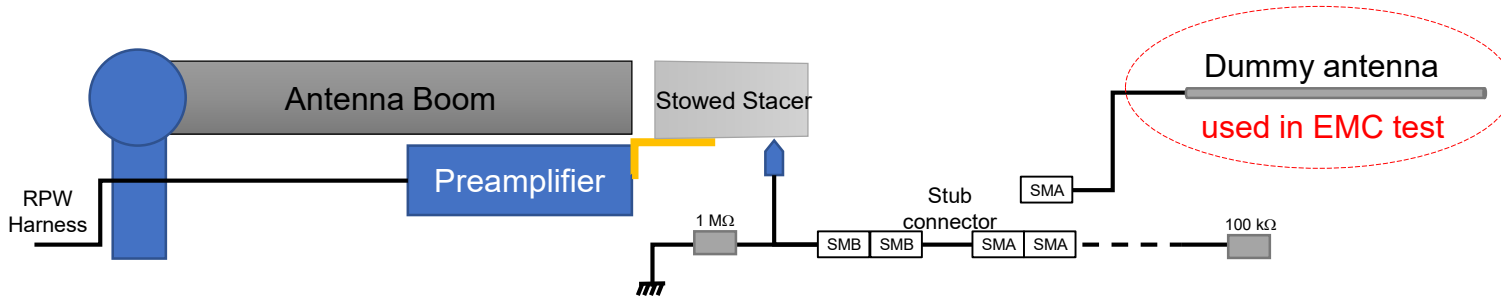
**Electric RPW behavior
under investigation**

Preliminary conclusions (2/2)

- **Impact on the RPW Magnetic measurements**
 - RPW does not see the reaction wheels (similar to MAG)
 - RPW sees a strong 50Hz perturbation (and harmonics) which saturates our instrument and creates artificial DC offsets
 - The EMC chamber background is about 20dB above the RPW requirement below 200Hz. We cannot therefore assess whether some spurious are present below 200Hz.

Connection Issue on PY/V2 antenna 1/3

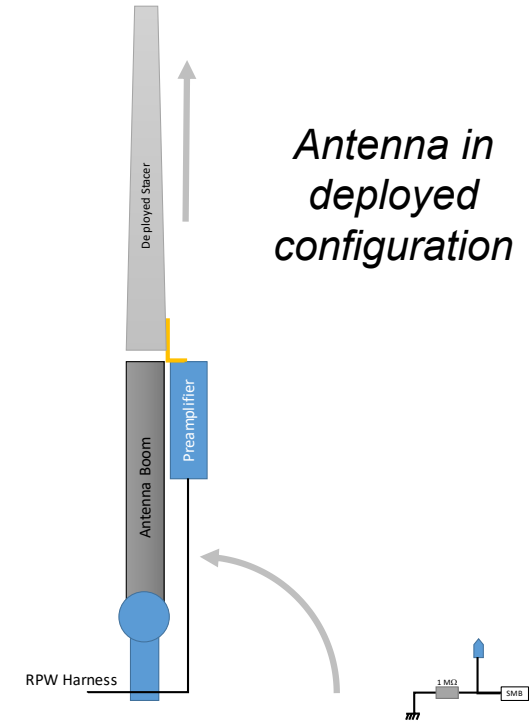
- A connection issue is suspected on PY/V2 antenna.



Antenna in stowed configuration

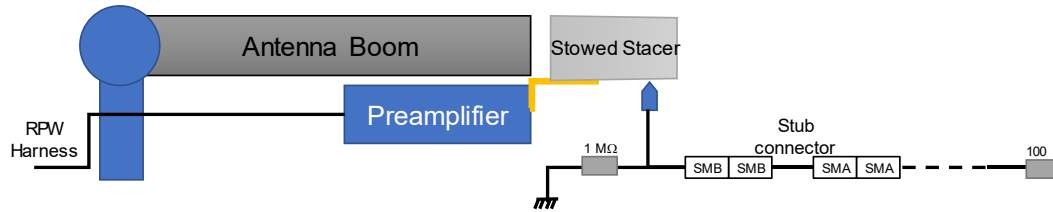
- Possible issues

- ✓ Hardware issue at MEB level,
- ✓ Connection issue at RPW harness level (i.e. between MEB and PY antenna PA),
- ✓ Unexpected path to ground from the stacer (i.e. potential interference with MLI)
- ✓ Hardware issue at Pre-amplifier level
- ✓ Connection issue at PY antenna internal connections level (between PA input, antenna stacer, grounding pin until the SMB connector).



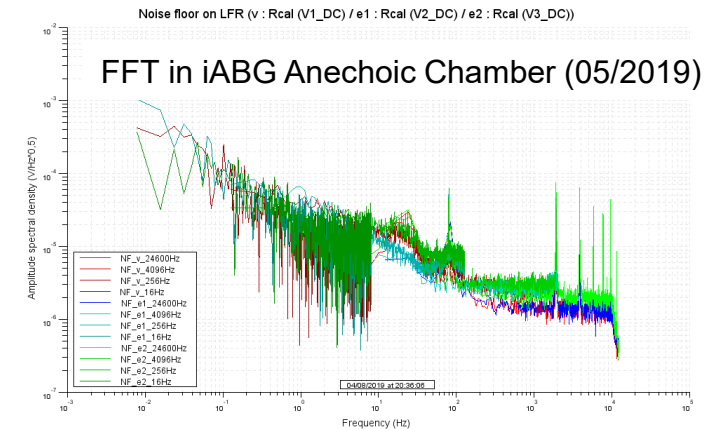
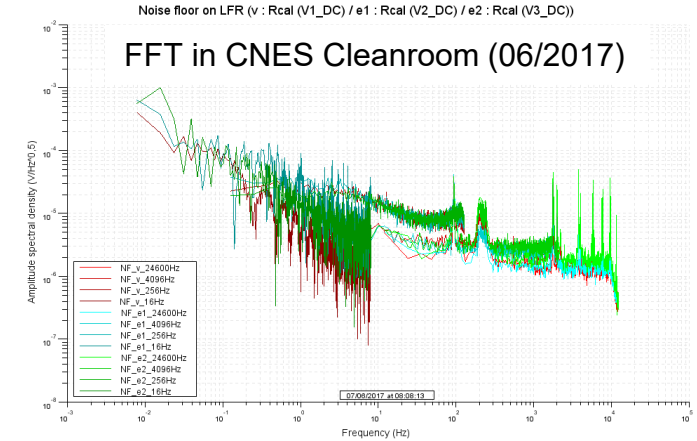
Connection Issue on PY/V2 antenna 2/3

- Further analysis shows that the internal connections until preamplifier are not in cause (i.e. MEB, RPW harness between MEB and PY antenna preamplifier).
- Indeed on test #40, the NF on LFR performed when antenna PAs are on the internal R_cal load give similar results for the three antenna PAs. This confirms that the electrical paths until R_cal are ok.
→ No HW or connection issue between MEB and Preamplifier



Antenna in stowed configuration

Setup N°4 (10 MΩ on PA_ANT inputs) - Waveform generator settings : OFF												
# 40	600 s	R cal	PA_HF	Normal	12	BIAS1 : V1_DC (R cal) BIAS2 : V2_DC (R cal) BIAS3 : V3_DC (R cal) BIAS4 : V12_AC BIAS5 : V23_AC	1	v : V1_DC (R cal) e1 : V2_DC (R cal) e2 : V3_DC (R cal) b1 : B_LF1 b2 : B_LF2 b3 : B_LF3	0	CH1 : V1 (HF) - LG CH2 : V2 (HF) - LG CH3 : V3 (HF) - LG CH4 : B_MF - LG	0	TNR Sensor CH1 : B_MF Sensor CH2 : B_MF



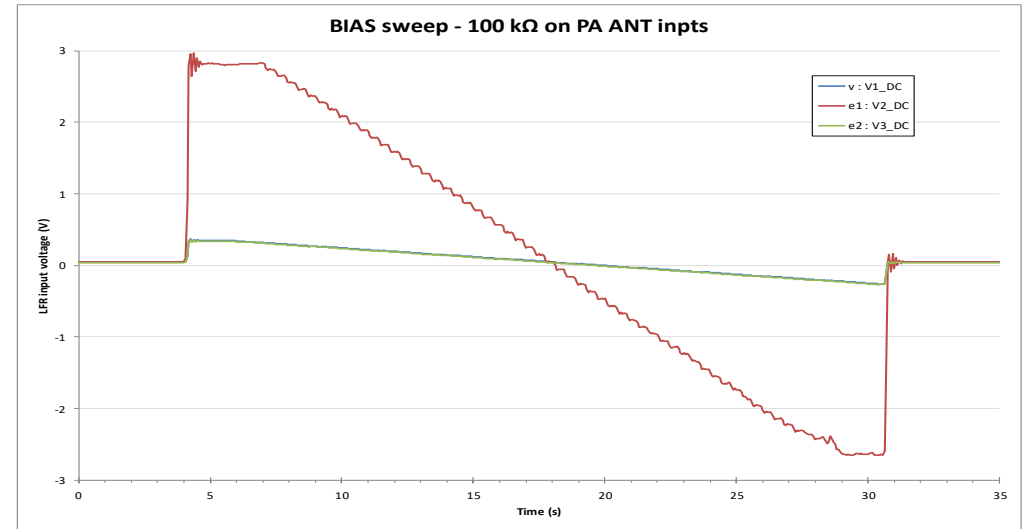
→ Similar results are obtained during both FFTs

Connection Issue on PY/V2 antenna 3/3

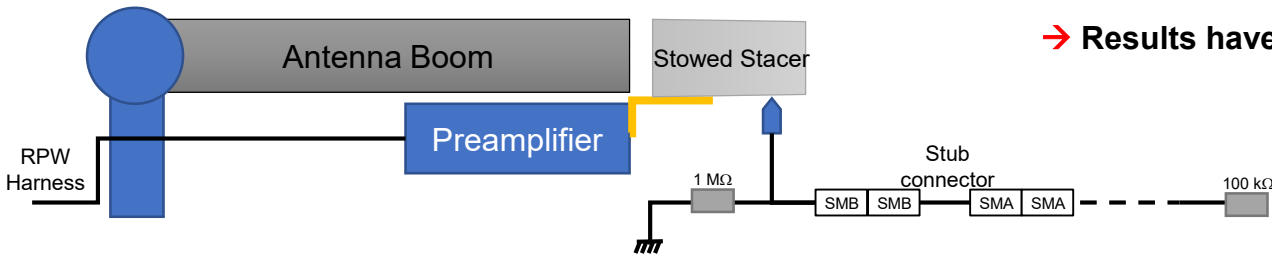
- Moreover, BIAS sweeps show that the PY/V2 antenna impedance is 10x higher than for the two other antennas (connected to a 100 kOhms load). Then the V2 antenna would be loaded by ~1MOhms.

This load corresponds to the case where no additional load is connected to the SMB connector (floating case) and confirm the integrity of the internal PY/V2 antenna connections until this point.

→ No connection issue between MEB and grounding pin/ 1 Mohms load

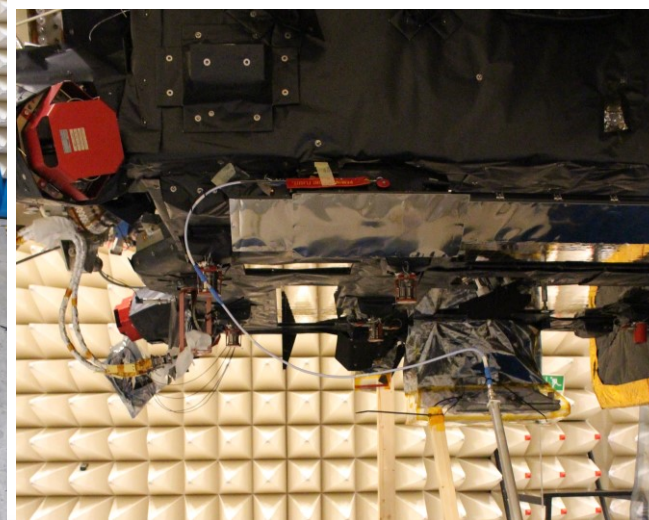
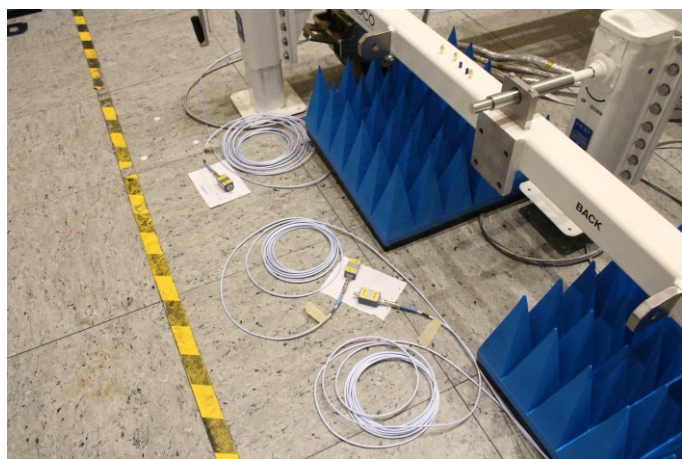
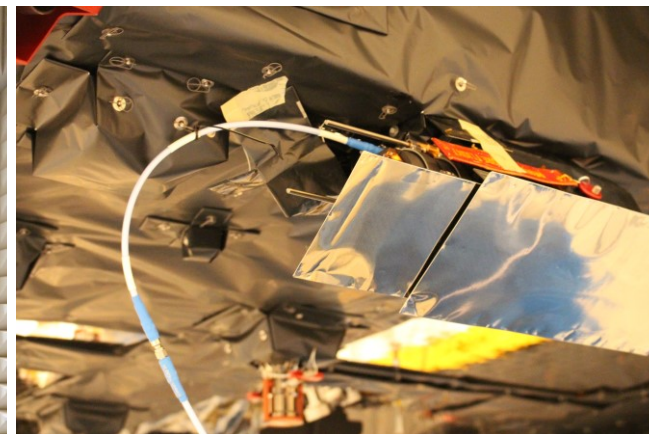
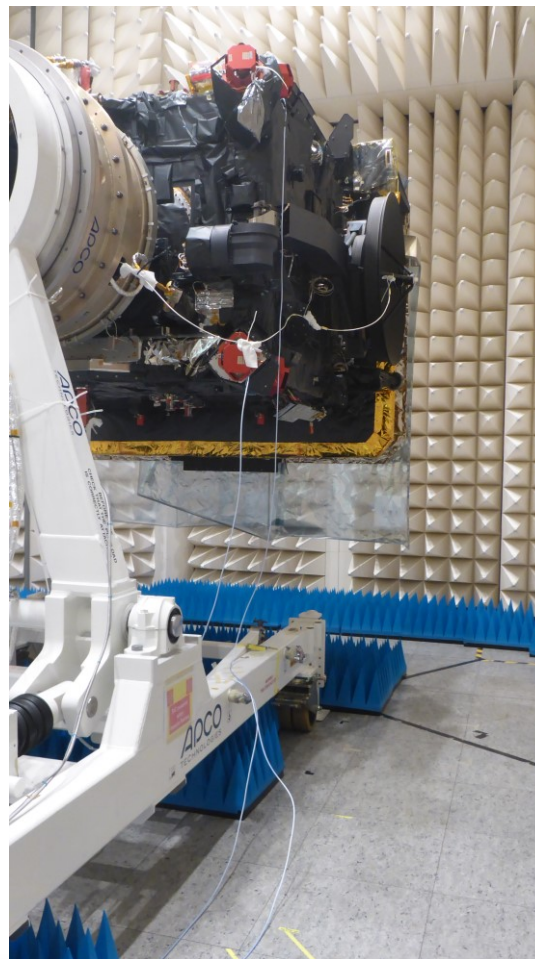
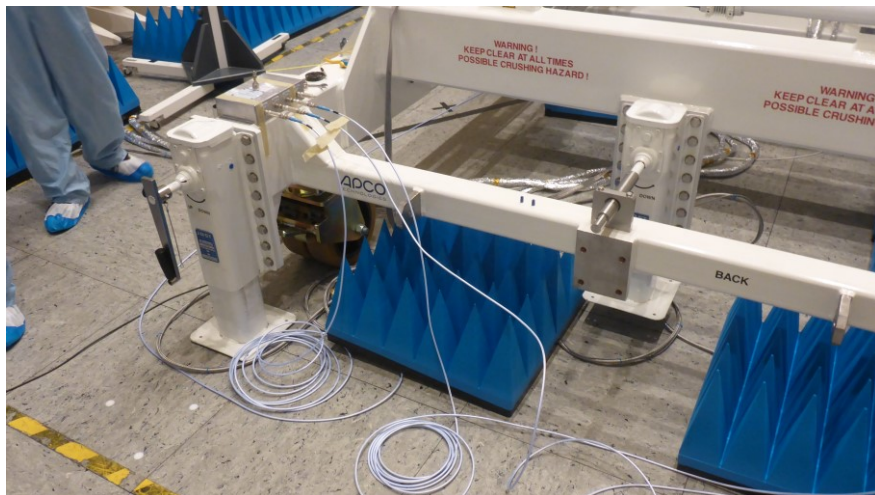


Antenna in stowed configuration



→ Results have been confirmed by BIAS team (email on the 05/09/19)

Additional Information



□ The magnetic data are ok

- *We see the instrument background above 100 Hz. The background below 100 Hz is not due to the S/C (see ADS search coil data)*
- *We do not see the reaction wheels nor other S/C related perturbation*
- *We see a strong 50 Hz perturbation form the chamber*

- ❑ **The electric data have several issues**
 - *The environment as seen by the ARA antenna is very noisy*
 - *ANT3 was not intended to be connected and ANT 2 was badly connected (ADS team mistake)*
 - *LFR/BIAS was not in the proper configuration (Signal with a gain of 1/17) → no LFR exploitable electric data and therefore no electric counterpart to the 50 Hz magnetic signal seen by SCM*
 - *HFR was not in the proper mode (THR team mistake) and electric data were not directed to it (ADS mistake) → no HFR exploitable electric data*
 - *TDS & TNR background are ok*
 - *TDS & TNR do not see the ARA environment. Could be due to the spectrum analyser small bandwidth used with the ARA antenna*
 - *Strong need to perform very good space interference campaign*