

SPIRE-AST-REP-002639

TP-TR40-0793
TEST PROTOCOL
EMC Test on Herschel CCV

Issue 1, Revision 1

Ottobrunn, Dec. 19th, 2005

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PROJECT / CONTRACT INFORMATION

CUSTOMER: EADS ASTRIUM GmbH
CM Power Electronics
88039 Friedrichshafen

CONTRACT NO.: LTA

IABG ORDER NO.: 352 1911 04

TEST PERIOD: November 14th – 18th, 2005 (HIFI)
November 21st – 25th, 2005 (PACS)
November 28th – December 2nd, 2005 (SPIRE)
December 12th – Dember 14th, 2005 (SPIRE)

TEST ARTICLE: HERSCHEL CCV

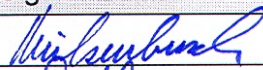

TYPE OF TEST: EMC, Radiated and Conducted Susceptibility

TEST FACILITY: ASTRIUM Preparation - Facility

TEST PROCEDURE: HP-2-ASED-PR-0033, Issue 1
SRON-U/HIFI/PR/2004-001, Issue 1.3

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Released	Bartlang		20.12.2005

DOCUMENT CHANGE RECORD

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1	0	19.12.2005	all	First Draft	
1	1	06.02.2006	all	Comments included Errors corrected	Hü

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ACCREDITATION / CERTIFICATION



Accreditation DIN ISO IEC 17025
DAR Reg.Nr.: TTI-P-G076/95-02



Compliance with ESA PSS-01-203
REF.: ESTEC/SoC/94-02



Certified according to
ISO 9001:2000 by TÜV-Cert
Cert.Reg.: 12 100 14515 TMS

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1. SUMMARY

The Herschel CCV was tested in the ASTRIUM Preparation Facility on November 14th to December 2nd and December 12th to 14th 2005. A pre-calibration of the required magnetic and electric fields was performed in the IABG's EMC Test Facility.

For the Radiated Susceptibility tests a transmitting licence (Versuchsfunkgenehmigung) from the German authorities (Bundesnetzagentur) was granted.

The EMC requirements and setups are described in the documents HP-2-ASED-PR-0033, Issue 1 and SRON-U/HIFI/PR/2004-001, Issue 1.3.

The tests were executed on the instruments HIFI, PACS and SPIRE.

This document specifies the applied electrical parameters during the EMC tests, the used equipment with calibration status and the antenna setup in specific positions.

Susceptibility related to the pass/fail criteria are not described in this document but in the corresponding customer's report.

2. PERFORMED TESTS

Instrument HIFI

Radiated Susceptibility Magnetic Field
Radiated Susceptibility Electric Field
Conducted Susceptibility Differential Mode FD
Conducted Susceptibility Common Mode FD
Conducted Susceptibility Differential Mode TD
Conducted Susceptibility Common Mode TD

Instrument PACS

Radiated Susceptibility Magnetic Field
Radiated Susceptibility Electric Field

Instrument SPIRE

Radiated Susceptibility Magnetic Field
Radiated Susceptibility Electric Field

3. CALIBRATIONS

3.1 Calibration of Currents for Conducted Susceptibility

3.1.1 Sweep Parameters

Frequency Domain

Frequency Range:	30 Hz – 50 kHz 50 kHz – 50 MHz
Step Width:	10 % log
Dwell Time:	1 sec or manually
Level:	30 Hz – 50 kHz forward power to reach voltage level TP fig. 5.4-1 50 kHz – 50 MHz forward power to reach voltage level TP fig. 5.4-1

Time Domain

Pulse Width:	2 msec and 10 μ s
PRF:	5 – 10 Hz

For detailed and applied sweep parameters see the corresponding chapter of the instrument.

3.1.2 Equipment List

CS-Test, Frequency and Time Domain

IDENT-No	SUBUNIT	TYP	LAST SERVICE	NEXT SERVICE
02.01.10	PULSE GENERATOR	6254-5S (SOLAR)		pre test
05.08.05	ARBITRARY GENERATOR	FC300 (YOKOGAWA)		pre test
02.03.11	BIPOLAR OPERATIONAL AMPLIFIER	BOP (KEPCO)		pre test
02.01.15	AMPLIFIER	SMX-100 (IFI)		pre test
02.01.28	SIGNAL GENERATOR	SMT06 (R&S)	08.2005	08.2006
03.02.15	CURRENT PROBE	F-61 (FISHER)	09.2004	09.2007
03.02.34	CURRENT INJECTION PROBE	F-140 (FISHER)		pre test
04.02.05	OSCILLOSCOPE	TDS544A (TEKTRONICS)	10.2005	10.2006

3.2 Calibration of Magnetic Field

3.2.1 Sweep Parameters

Frequency Range:	30 Hz – 50 kHz
Step Width:	5 % and 10 % or discrete frequencies
Dwell Time:	10 sec to 30 sec
Level:	30 Hz – 20 kHz 120 dBpT (=122 dB μ A/m) 20 kHz – 50 kHz 110 dBpT (=112 dB μ A/m)
Antenna Distance:	1 m

For detailed and applied sweep parameters see the corresponding chapter of the instrument.

3.2.2 Equipment List

IDENT-No	SUBUNIT	TYP	LAST SERVICE	NEXT SERVICE
04.03.09	EM-Field Analyzer	EFA-3 (W&G)	04.2004	04.2006
04.03.09.01	B-Field Probe 100 cm ²	2245/90.10 (W&G)	04.2004	04.2006
--	RADIATING LOOP ANTENNA	-- (IABG)		pre test
02.01.05	SYNTHESIZER	HP3325A (HP)	09.2005	09.2006
02.02.01	4-QUADR.AMPLIFIER	PAS2000/NT2000 (SPITZENBERGER & SPIESS)		pre test
05.01	SUSCEPTIBILITY SOFTWARE	RSUS V.2.133 (NeWeTec)		pre test

3.2.3 Test Setup



FIG 1: Calibration of Magnetic Field in IABG Anechoic Chamber

3.2.4 Field Calibration

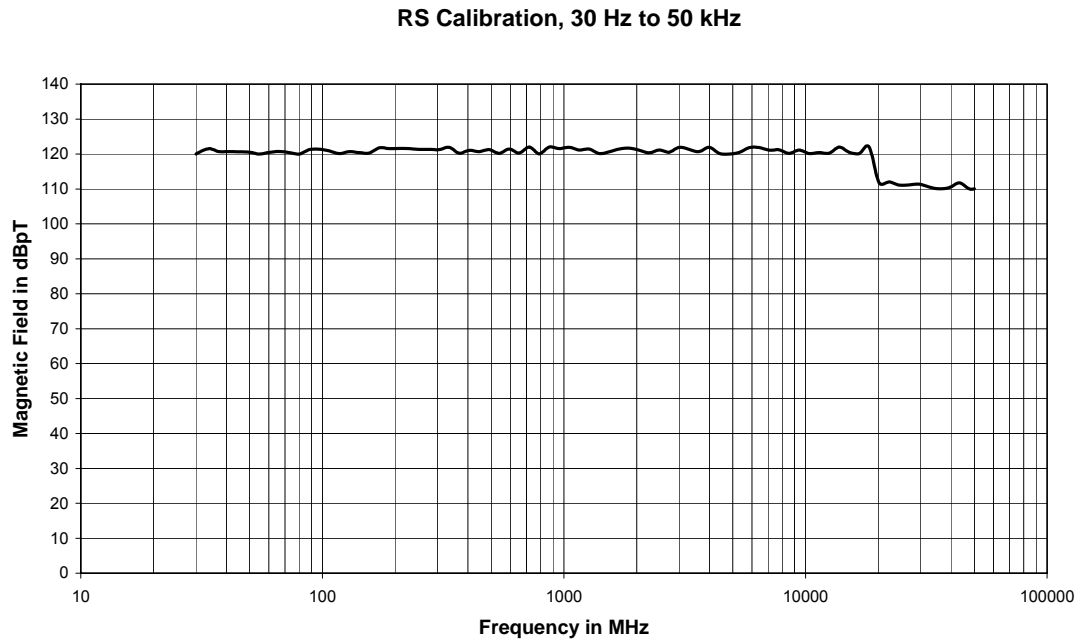


FIG 2: Recorded Magnet Field during Calibration

3.3 Calibration of Electric Field

3.3.1 Sweep Parameters

Frequency Range:	14 kHz – 18 GHz
Step Width:	5 % and 10 % or discrete frequencies (see ch. instruments)
Dwell Time:	10 sec to 30 sec
Level:	14 kHz – 18 GHz 2 (V/m) _{RMS} , 8.45 GHz – 8.50 MHz 10(V/m) _{RMS}
Antenna Distance:	1 m

3.3.2 Equipment List

General Equipment

IDENT-No	SUBUNIT	TYP	LAST SERVICE	NEXT SERVICE
03.07.06	COAX N/N/9m	SUCOFLEX 106 (SUHNER)		pre test
04.05.04.01	POSITIONING CONTROLLER	HCC (R&S)		pre test
04.05.04.02	HIGHT ADJUSTABLE MAST	(R&S)		pre test
05.01	SUSCEPTIBILITY SOFTWARE	RSUS V.2.133 (NeWeTec)		pre test

RS-Test, Frequency Range 14 kHz – 1 GHz:

IDENT-No	SUBUNIT	TYP	LAST SERVICE	NEXT SERVICE
02.01.28	SIGNAL GENERATOR	SMT06 (R&S)	08.2005	08.2006
	AMPLIFIER	SMX-100 (IFI)		pre test
03.01.34	BROADBAND ANTENNA **)	BDLP-20/1000A (ROLF HEINE)		pre test
03.01.19	E-FIELD GENERATOR *)	AT3000 (AR)		pre test
04.03.10	EM RADIATION METER	EMR-300 (W&G)	04.2004	04.2006
04.03.10.01	E-FIELD SENSOR 3 GHz +)	TYP-8 (10k-3GHz) (W&G)	04.2004	04.2006
04.03.10.02	E-FIELD SENSOR 60 GHz ++)	2244/90.22 (W&G)	04.2004	04.2006

*) from 14 kHz to 30 MHz **) from 30 MHz to 1 GHz
+) from 14 kHz to 1 GHz ++) from 1 GHz to 18 GHz

RS-Test, Frequency Range 1 GHz – 18 GHz

IDENT-No	SUBUNIT	TYP	LAST SERVICE	NEXT SERVICE
02.01.16	SWEEP GENERATOR	68169A (HP)	11.2005	11.2006
--	AMPLIFIER 2W *)	APT 18659 (ADVANTEK)		pre test
02.01.05	SYNTHESIZER	HP3325A (HP)	09.2005	09.2006
02.01.15	PULSE GENERATOR	PM5786B (PHILIPS)		pre test
03.01.32	STD GAIN HORN **)	SGH-4 (ROLF HEINE)		pre test
03.01.17	HORN ANTENNA	RGA-180/2 (EMCO)		pre test
03.01.19	BROADBAND ANTENNA	AT3000 (AR)		pre test
04.03.10	EM RADIATION METER	EMR-300 (W&G)	04.2004	04.2006
04.03.10.02	E-FIELD SENSOR 60 GHz	2244/90.22 (W&G)	04.2004	04.2006

*) from 6 GHz to 18 GHz only,

***) for notch frequency 8.4 – 8.45 GHz only

3.3.3 Test Setup



FIG 3: Calibration Setup 14 kHz – 30 MHz with AT-3000



FIG 4: Calibration Setup 30 MHz – 1 GHz with BDLP vertical

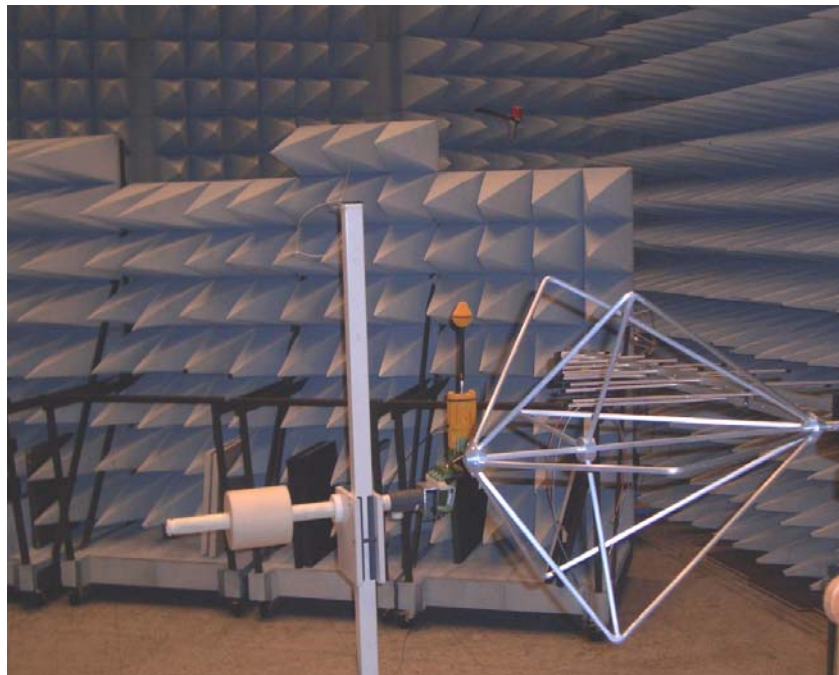


FIG 5: Calibration Setup 30 MHz – 1 GHz with BDLP horizontal

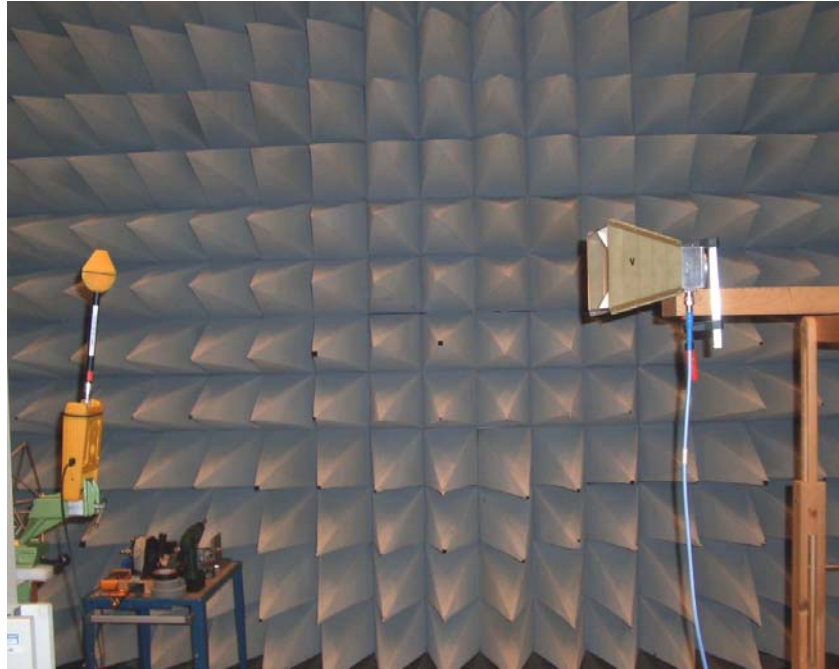


FIG 6: Calibration Setup 1 GHz – 18 GHz 2 V/m with RGA-180

3.3.4 Field Calibration

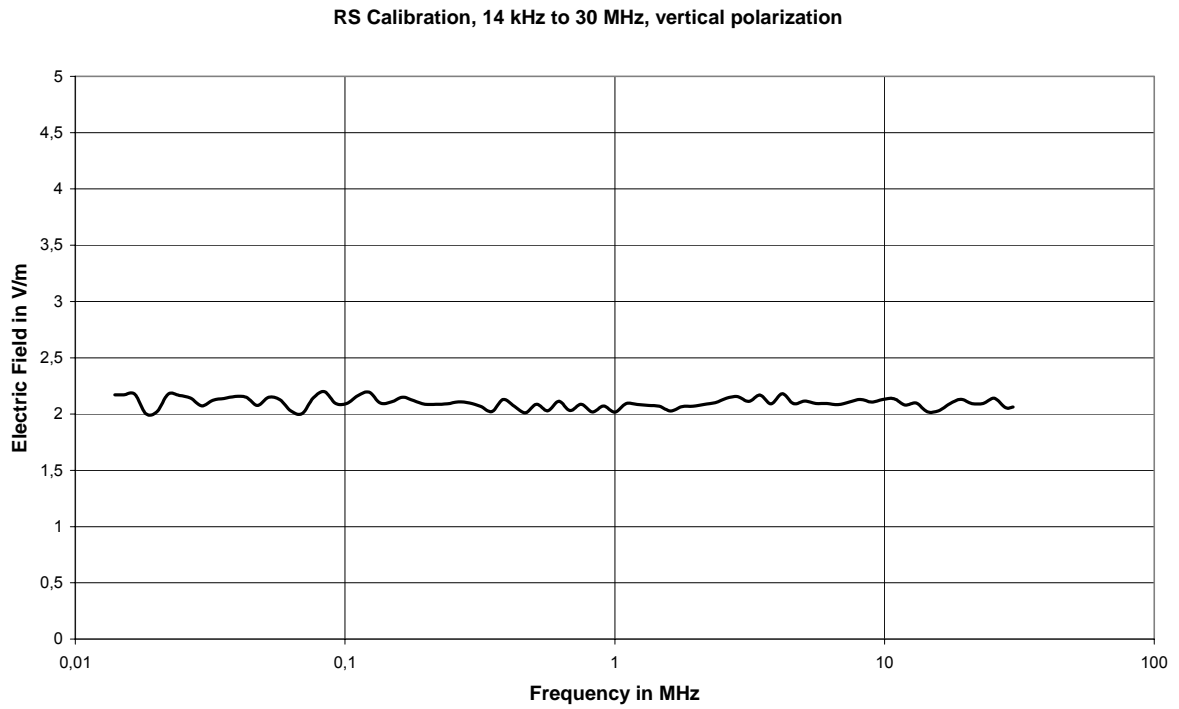


FIG 7: Vertical Field 14 kHz – 30 MHz, Recorded Field during Calibration

RS Calibration, 30 MHz to 1 GHz, vertical polarization

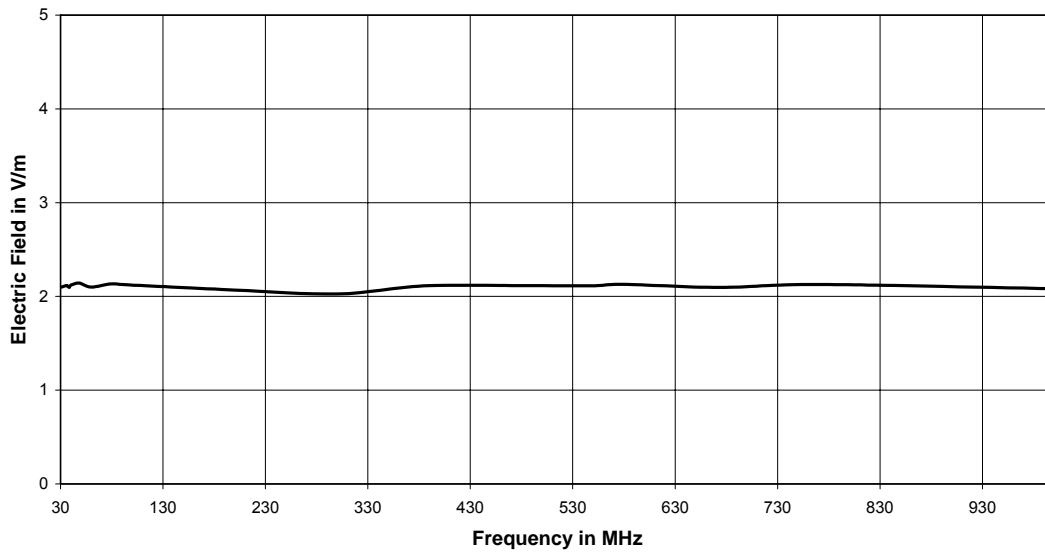


FIG 8: Vertical Field 30 MHz – 1 GHz, Recorded Field during Calibration

RS Calibration, 30 MHz to 1 GHz, vertical polarization

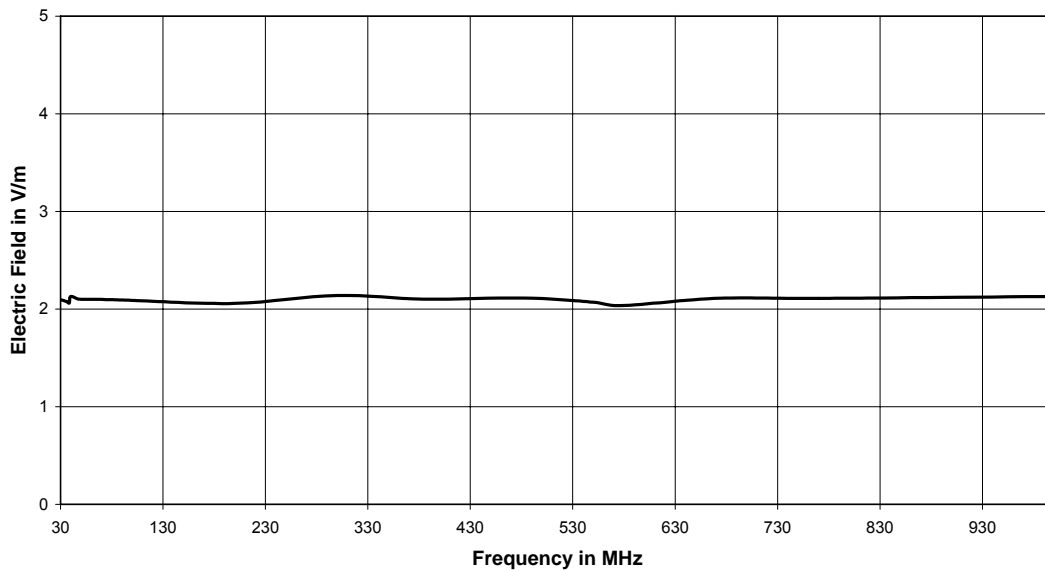


FIG 9: Horizontal Field 30 MHz – 1 GHz, Recorded Field during Calibration

RS Calibration, 1 GHz to 6 GHz

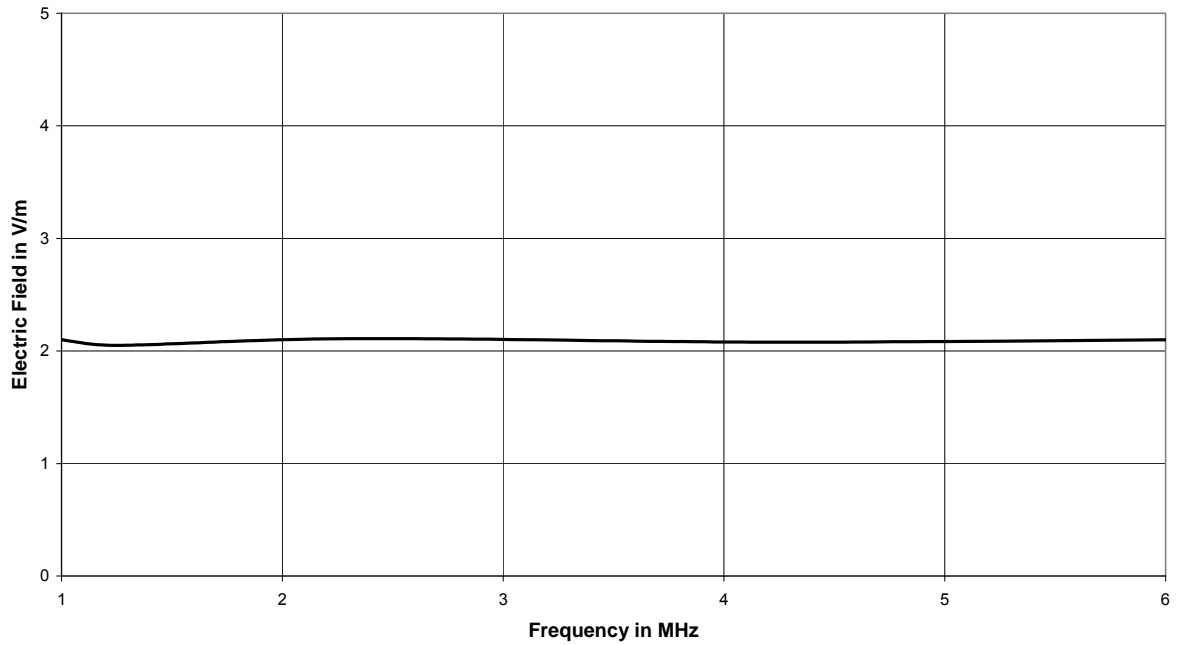


FIG 10:Field 1 GHz - 6 GHz, Recorded Field during Calibration

RS Calibration, 6 GHz to 18 GHz

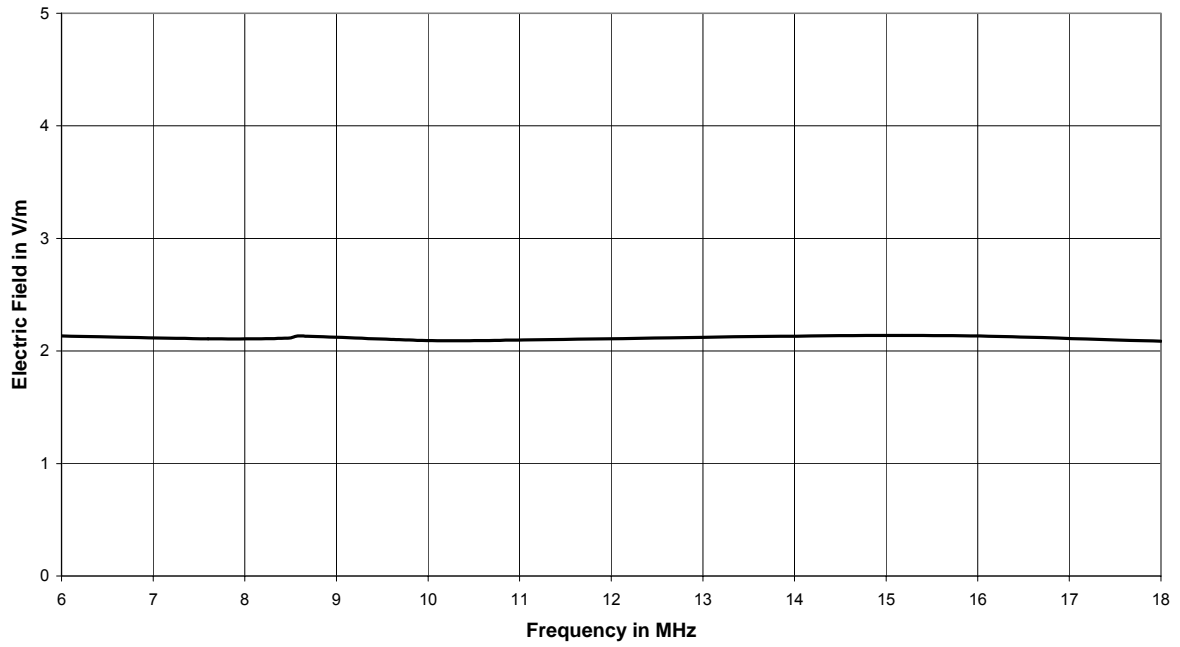


FIG 11:Field 6 GHz - 18 GHz, Recorded Field during Calibration

RS Calibration, 8 GHz Notch Band

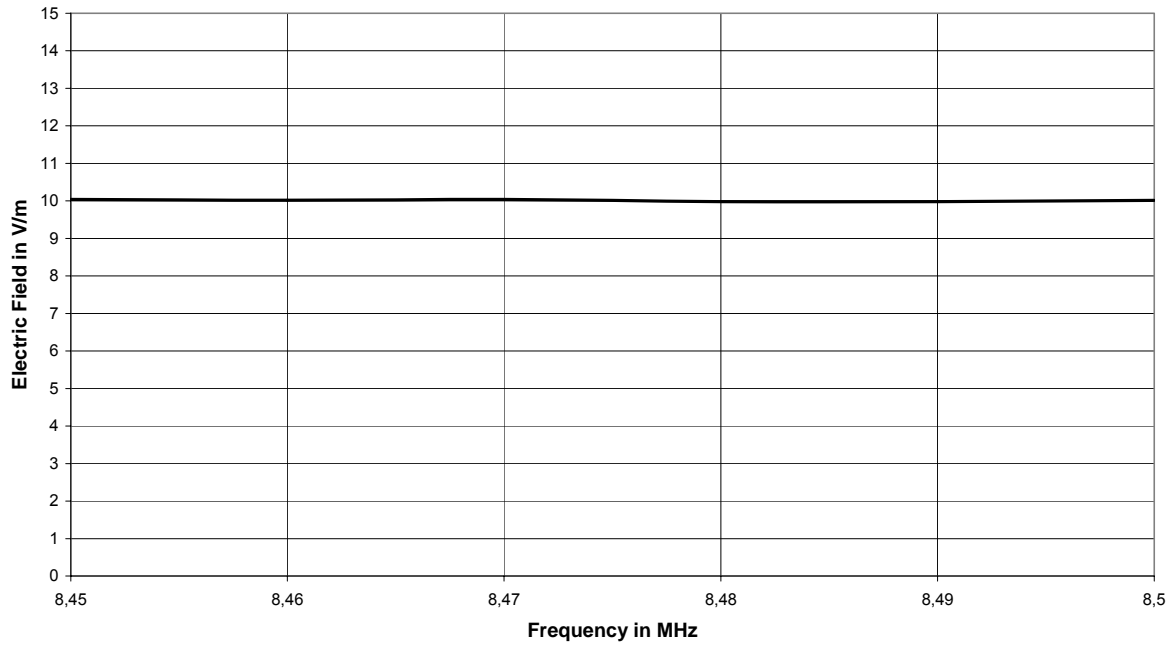


FIG 12: Field Notch Band 8,45 GHz – 8,5 GHz, Recorded Field during Calibration

4. SUSCEPTIBILITY TESTS

4.1 Radiated Susceptibility Magnetic Field on Instrument HIFI

4.1.1 Test Parameters

Test Procedure:	SRON-U/HIFI/PR/2004-001, Issue 1.3
Frequency Range:	30 Hz – 1230 Hz and 1230 Hz – 50 kHz
Step Width:	10 %
Dwell Time:	10 sec
Level:	30 Hz – 20 kHz 120 dBpT (=122 dB μ A/m) 20 kHz – 50 kHz 110 dBpT (=112 dB μ A/m)
Positions:	1
Antenna Distance:	1 m

4.1.2 Test Setup



FIG 13: Setup RS H-Field on HIFI front view



FIG 14: Setup RS H-Field on HIFI side view

4.2 Radiated Susceptibility Electric Field on Instrument HIFI

4.2.1 Test Parameters

Test Procedure:	SRON-U/HIFI/PR/2004-001, Issue 1.3
Frequency Range:	14 kHz – 600 kHz 600 kHz – 30 MHz 30 MHz – 1 GHz 1 GHz – 6 GHz 6 GHz – 18 GHz 8,45 GHz – 8,50 GHz
Step Width:	10 % log
Dwell Time:	10 sec
Modulation:	1 kHz sqwv AM 30%
Level:	2 V/m (14 kHz – 18 GHz) and 10 V/m (8,45 GHz – 8,50 GHz)
Positions:	Position 1 – 4
Polarisation:	14 kHz – 30 MHz vertical only 30 MHz – 18 GHz vertical and horizontal
Antenna Distance:	1 m

4.2.2 Test Setup



FIG 15: Setup RS E-Field 14 kHz – 30 MHz on HIFI in upper position



FIG 16: Setup RS E-Field 30 MHz – 1 GHz vertical on HIFI in upper position

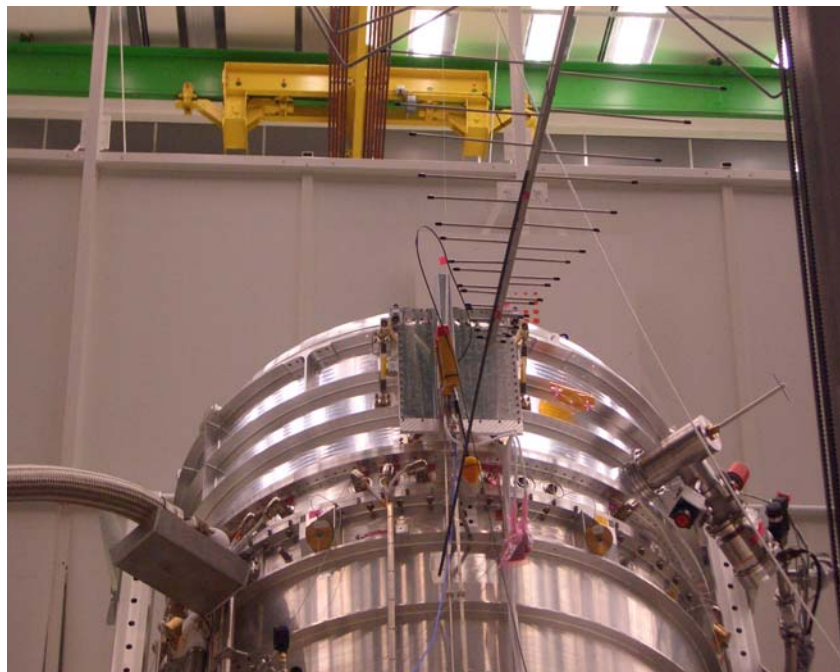


FIG 17: Setup RS E-Field 30 MHz – 1 GHz horizontal on HIFI in upper position

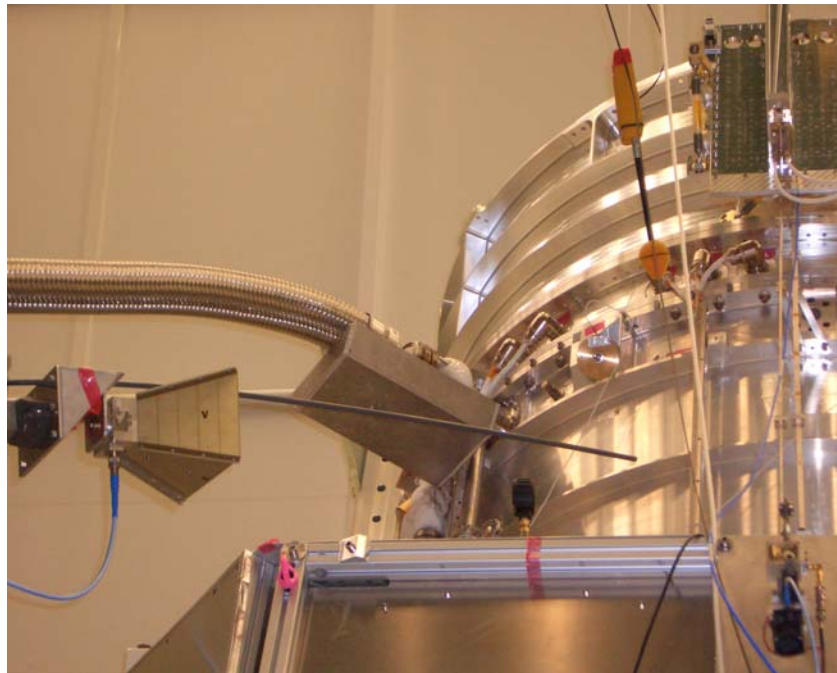


FIG 18: Setup RS E-Field 1 GHz – 6 GHz vertical on HIFI in lower position

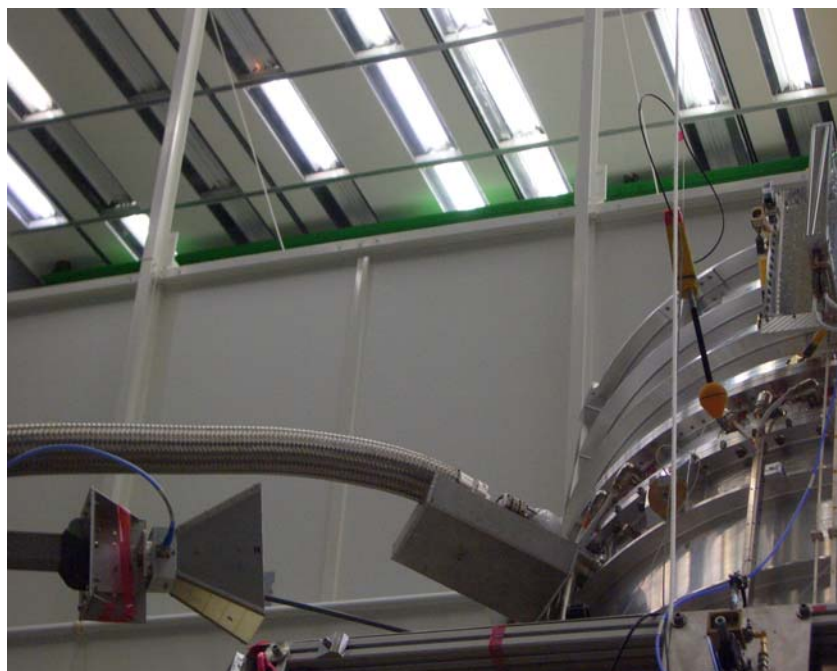


FIG 19: Setup RS E-Field 1 GHz – 6 GHz horizontal on HIFI in lower position

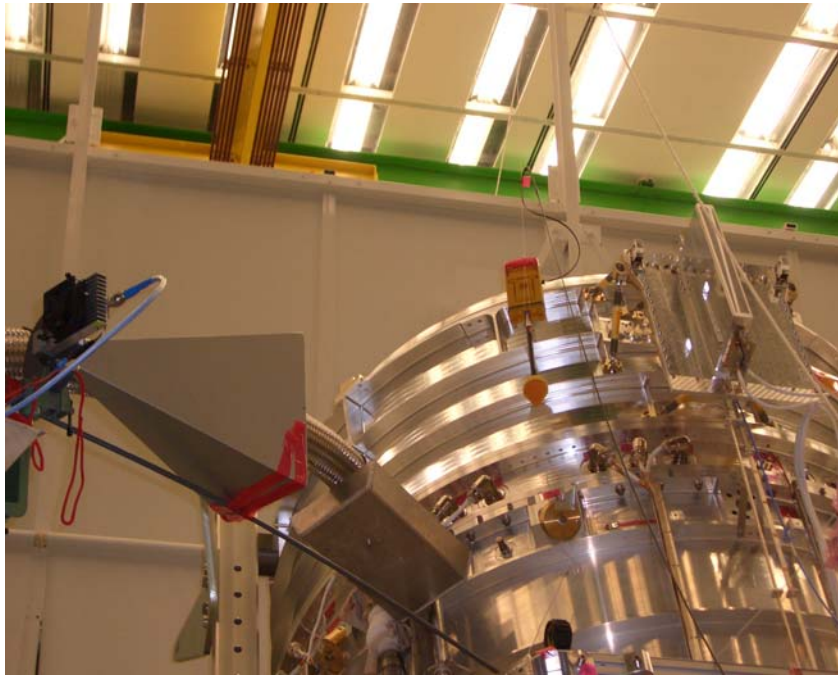


FIG 20: Setup RS E-Field 8,45 GHz – 8,50 GHz horizontal on HIFI in lower position

4.3 Conducted Susceptibility on Instrument HIFI

4.3.1 Test Parameters for Frequency Domain

Test Procedure:	SRON-U/HIFI/PR/2004-001, Issue 1.3, ch. 5.4.1+2
Frequency Range:	30 Hz – 50 kHz 50 kHz – 50 MHz
Modes:	Differential from 30 Hz to 50 MHz Common from 10 kHz to 50 MHz
Step Width:	10 %
Dwell Time:	1 sec or manually
Modulation:	1 kHz sqwv AM 30%
Level:	30 Hz – 50 kHz TP fig. 5.4-1 or 1 A _{rms} 50 kHz – 50 MHz TP fig. 5.4-1 or 1 W into 50 Ω
Lines:	FHICU Main, FHLCU Main

4.3.2 Test Setup Frequency Domain

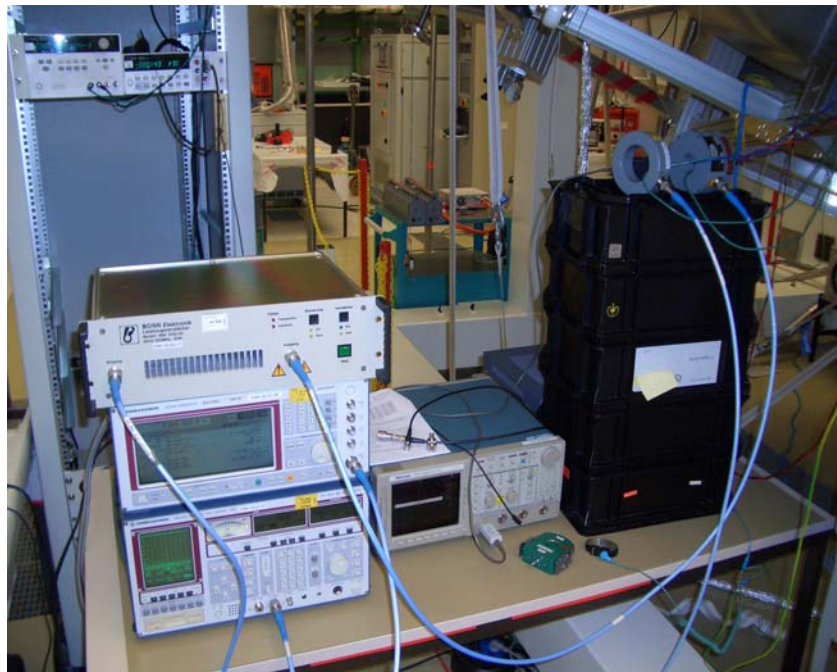


FIG 21: Test Setup Conducted Susceptibility in Frequency Domain on HIFI

4.3.3 Test Parameters for Time Domain

Test Procedure: SRON-U/HIFI/PR/2004-001, Issue 1.3, ch. 5.4.3
Pulse Width: Time constant 2 msec for differential mode
10 μ sec for common mode
Level: $\pm 2,5$ V for 2 msec transient
 ± 28 V for 10 μ sec transient
PRF: 10 Hz
Test Time: 5 min

4.3.4 Test Setup Time Domain



FIG 22: Test Setup for 10 μ sec Transient

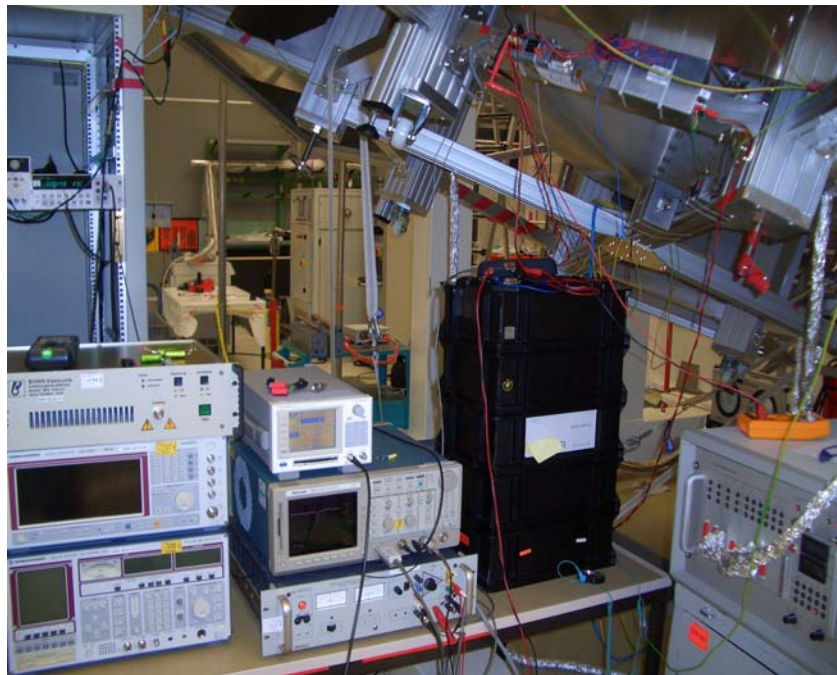


FIG 23:Test Setup for 2 msec Transient

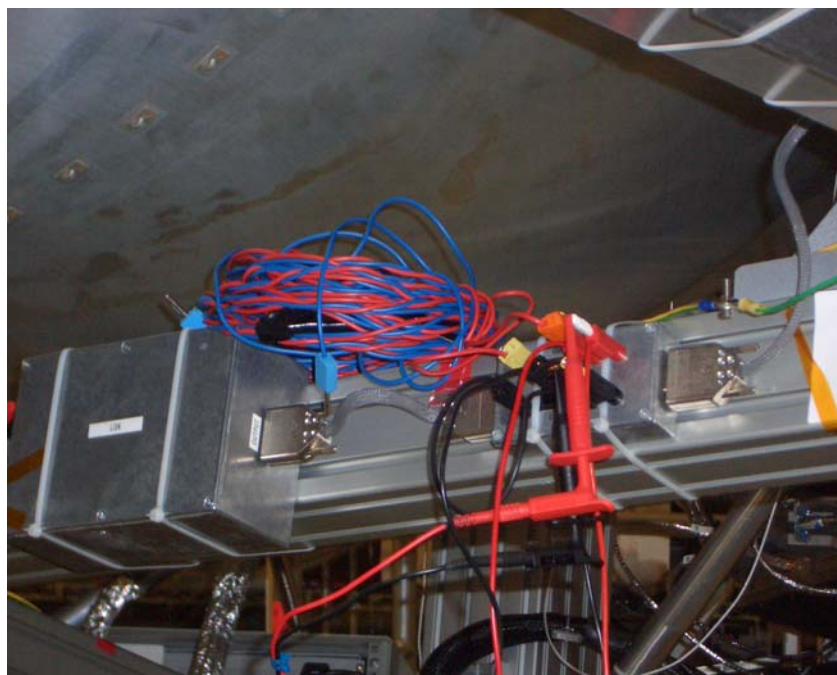


FIG 24:Injection Point of 2 msec Transient

4.3.5 Plots

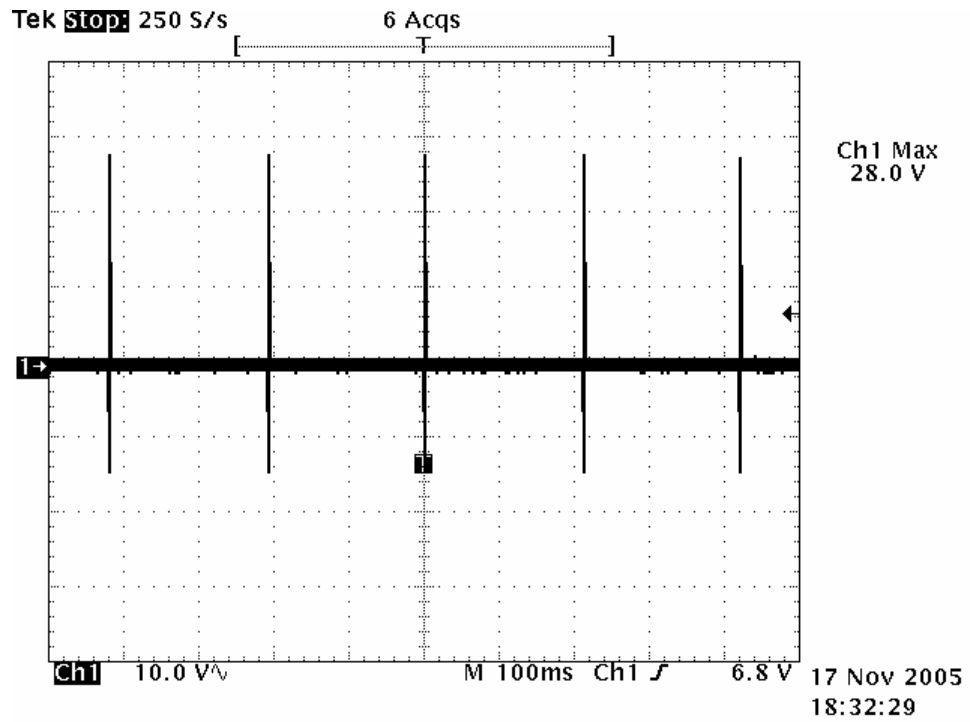


FIG 25:PRF 5 Hz

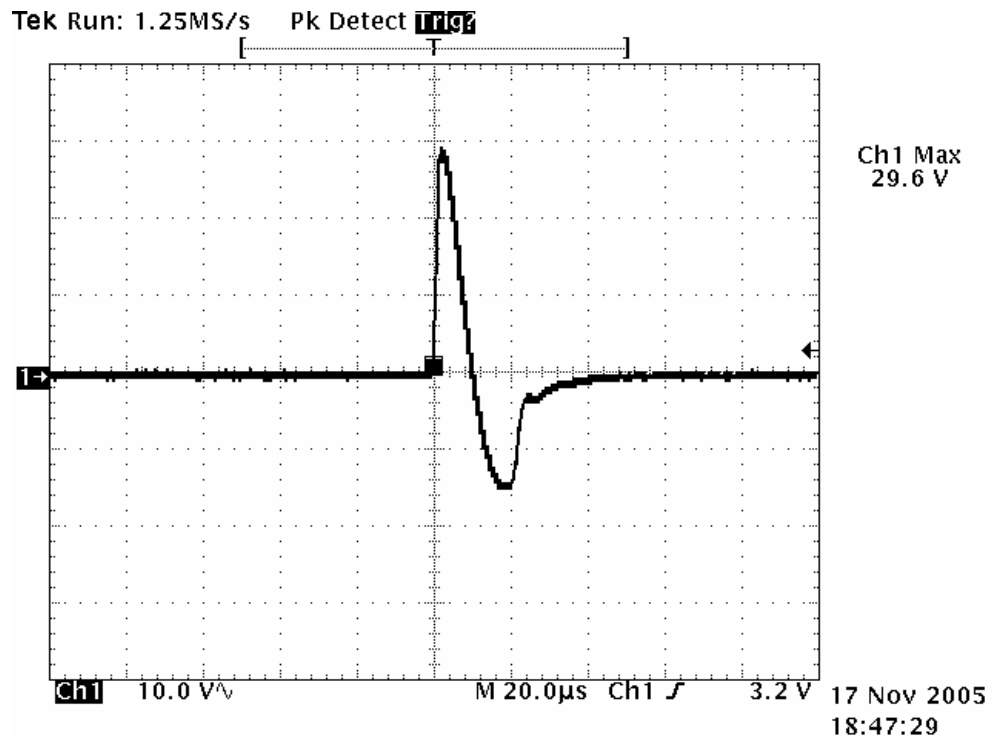


FIG 26:Positive Transient 10 µsec During Injection

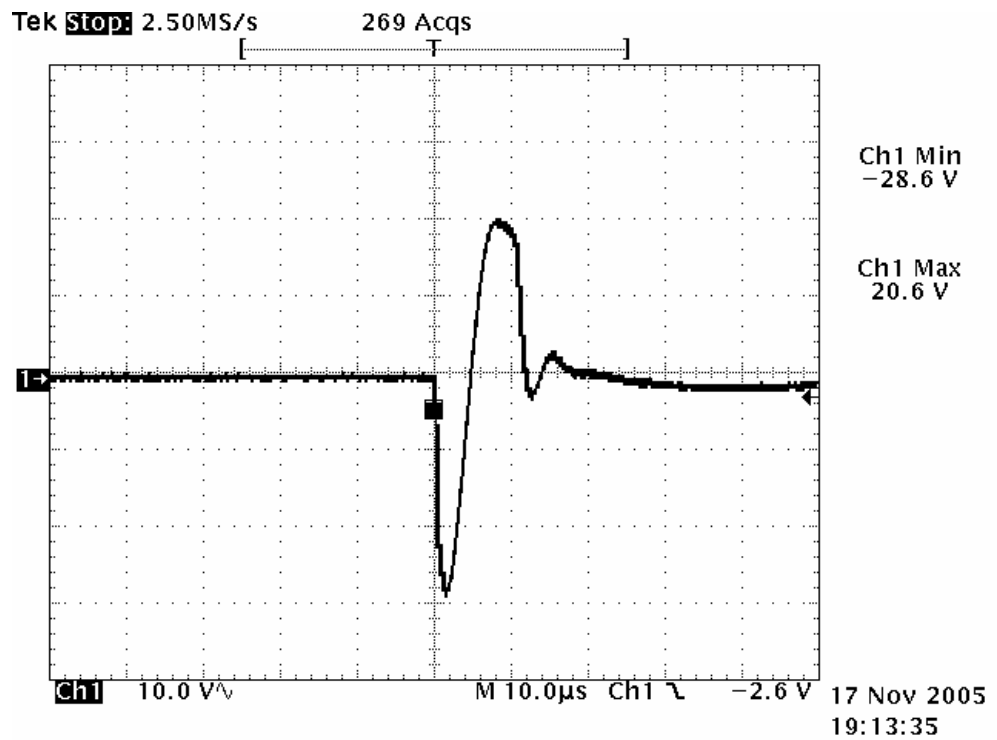


FIG 27: Negative Transient 10 µsec During Injection

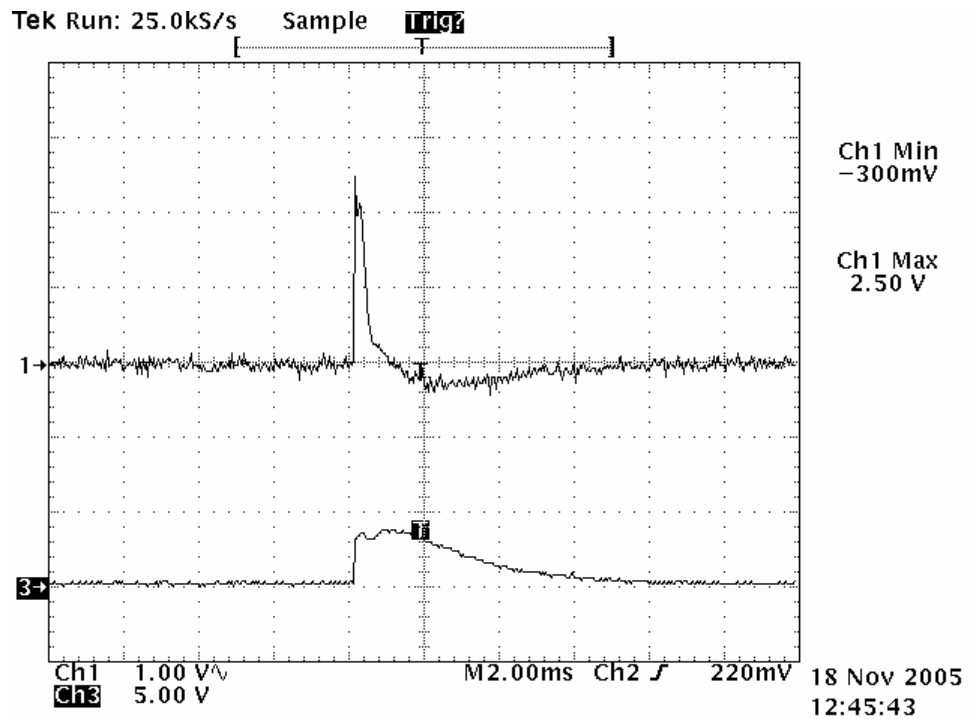


FIG 28: Positive Transient 2 msec, CH1 Injection Point, CH2 Generator Output

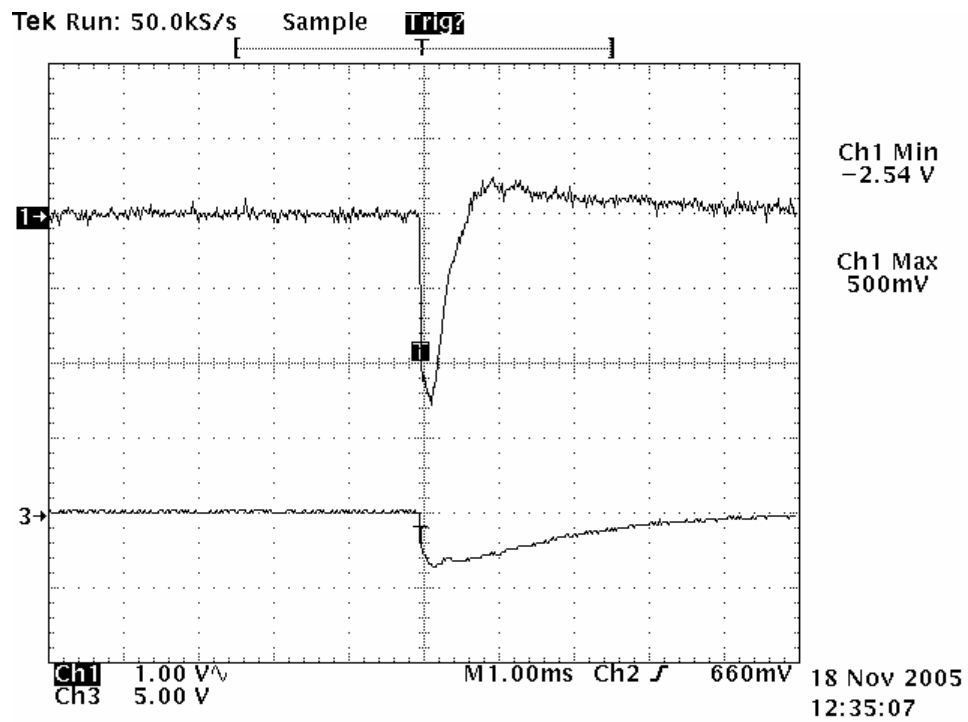


FIG 29:Negative Transient 2 msec, CH1 Injection Point, CH2 Generator Output

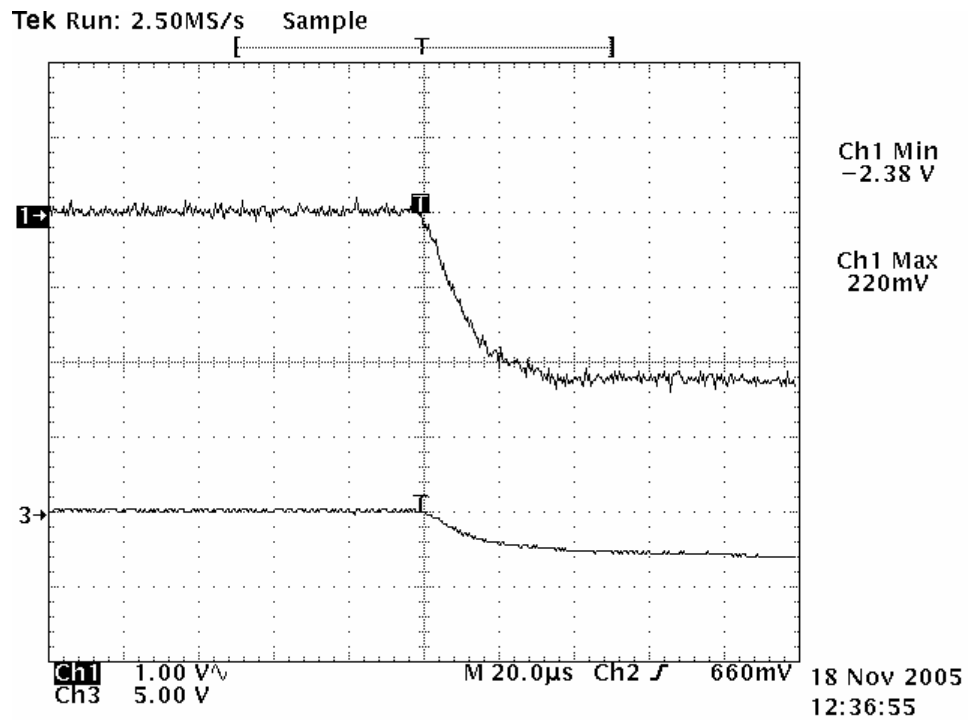


FIG 30:Rise Time of Negative 2 msec Transient

4.4 Radiated Susceptibility Magnetic Field on Instrument PACS

4.4.1 Test Parameters

Test Procedure:	HP-2-ASED-PR-0033
Frequency Range:	30 Hz – 1230 Hz and 1230 Hz – 50 kHz For discrete frequencies see HP-2-ASED-PR-0033 ch. 8.5
Step Width:	10 %
Dwell Time:	10 sec
Level:	30 Hz – 20 kHz 120 dBpT (=122 dB μ A/m) 20 kHz – 50 kHz 110 dBpT (=112 dB μ A/m)
Positions:	Position 1 (upper) and 2 (lower)
Antenna Distance:	1 m

4.4.2 Test Setup

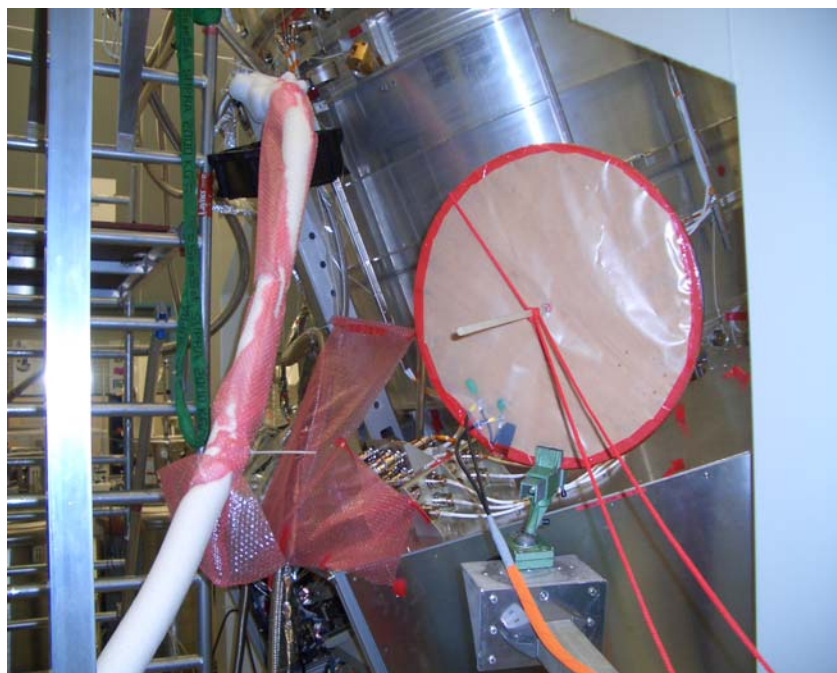


FIG 31: Setup RS H-Field on PACS in lower position

4.5 Radiated Susceptibility Electric Field on Instrument PACS

4.5.1 Test Parameters

Test Procedure:	HP-2-ASED-PR-0033
Frequency Range:	14 kHz – 30 MHz 30 MHz – 1 GHz 1 GHz – 6 GHz 6 GHz – 18 GHz 8,45 GHz – 8,50 GHz
	For discrete frequencies see HP-2-ASED-PR-0033 ch. 8.6
Step Width:	10 %
Dwell Time:	30 sec
Modulation:	1 kHz sqwv AM 30%
Level:	2 V/m (14 kHz – 18 GHz) and 10 V/m (8,45 GHz – 8,50 GHz)
Positions:	Position 1 – 4
Polarisation:	14 kHz – 30 MHz vertical only 30 MHz – 18 GHz vertical and horizontal
Antenna Distance:	1 m

4.5.2 Test Setup

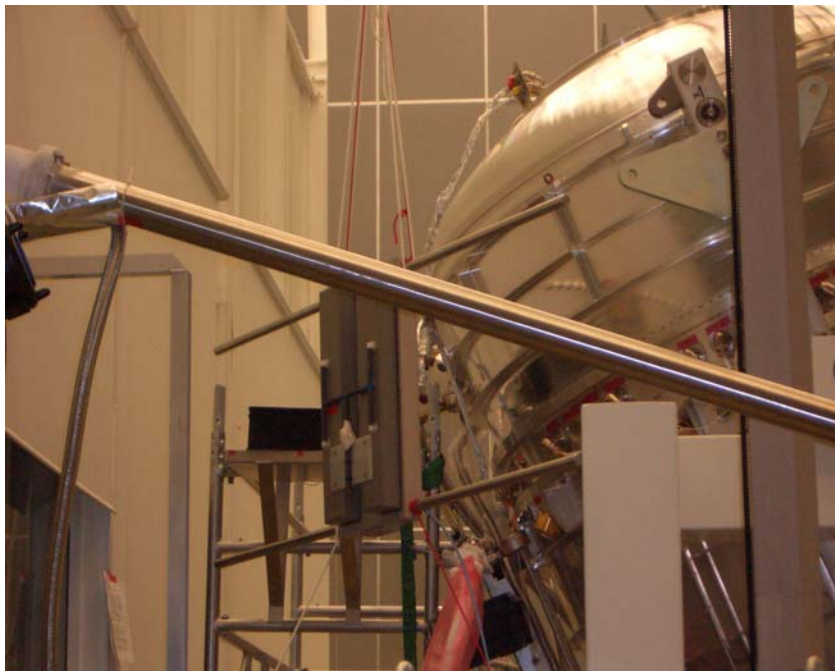


FIG 32: Setup RS E-Field 14 kHz – 30 MHz vertical on PACS in position 1

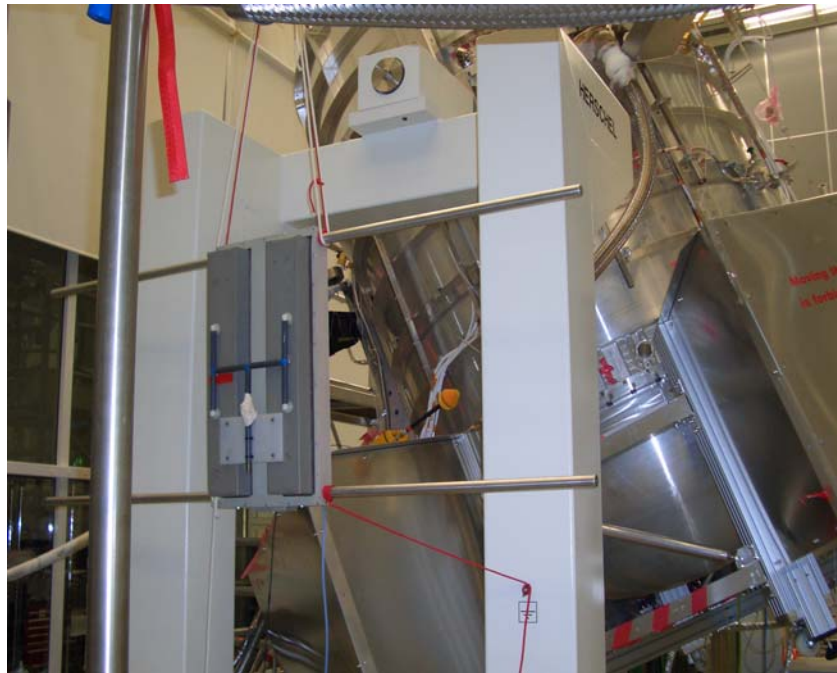


FIG 33: Setup RS E-Field 14 kHz – 30 MHz vertical on PACS in position 2



FIG 34: Setup RS E-Field 30 MHz – 1 GHz vertical on PACS in position 1

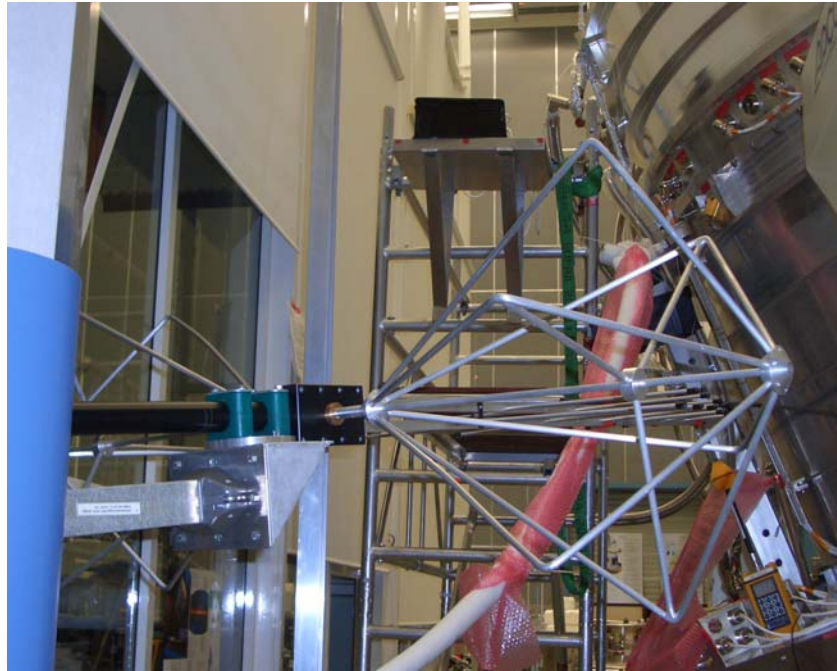


FIG 35: Setup RS E-Field 30 MHz – 1 GHz vertical on PACS in position 2

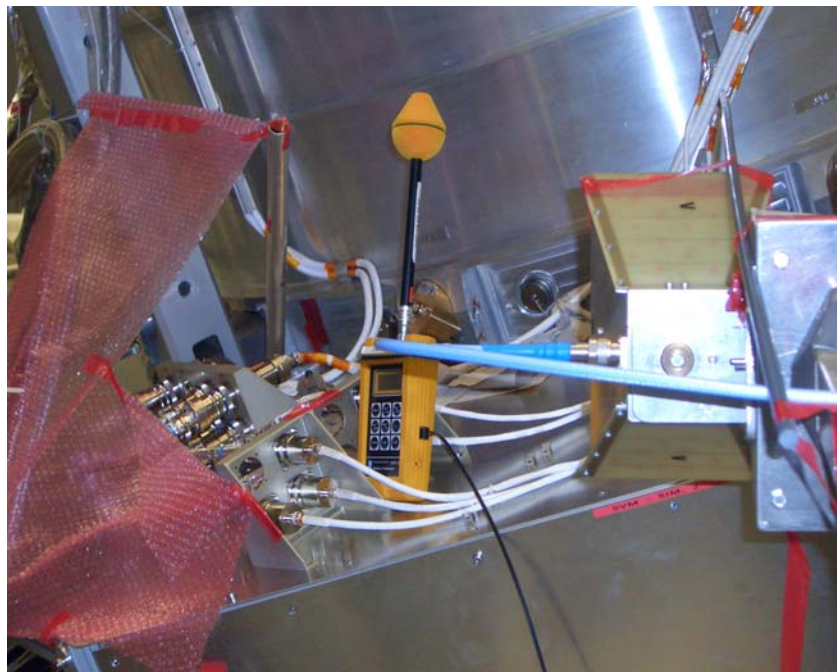


FIG 36: Setup RS E-Field 1 GHz - 6 GHz horizontal on PACS in position 1

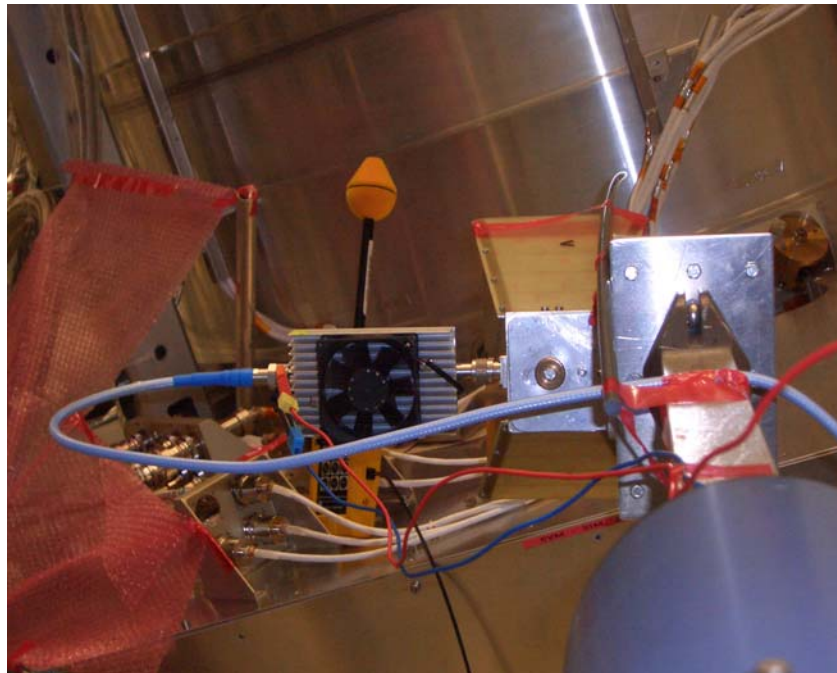


FIG 37: Setup RS E-Field 6 GHz - 18 GHz horizontal on PACS in position 1

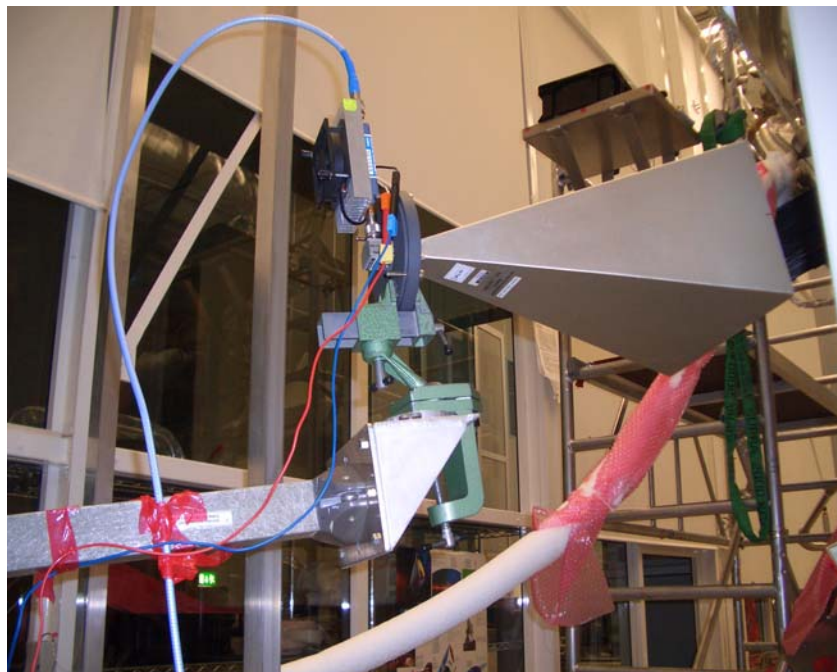


FIG 38: Setup RS E-Field 8,45 GHz – 8,50 GHz vertical on PACS in position 1

4.6 Radiated Susceptibility Magnetic Field on Instrument SPIRE

4.6.1 Test Parameters

Test Procedure:	HP-2-ASED-PR-0033
Frequency Range:	30 Hz – 50 kHz
Step Width:	5 % log
Dwell Time:	180 sec
Modulation:	Pulse 100 %, 800 msec on, 140 msec off
Level:	30 Hz – 20 kHz 120 dBpT (=122 dB μ A/m) 20 kHz – 50 kHz 110 dBpT (=112 dB μ A/m)
Positions:	Position 1 (upper) and 2 (lower)
Antenna Distance:	1 m

4.6.2 Test Setup

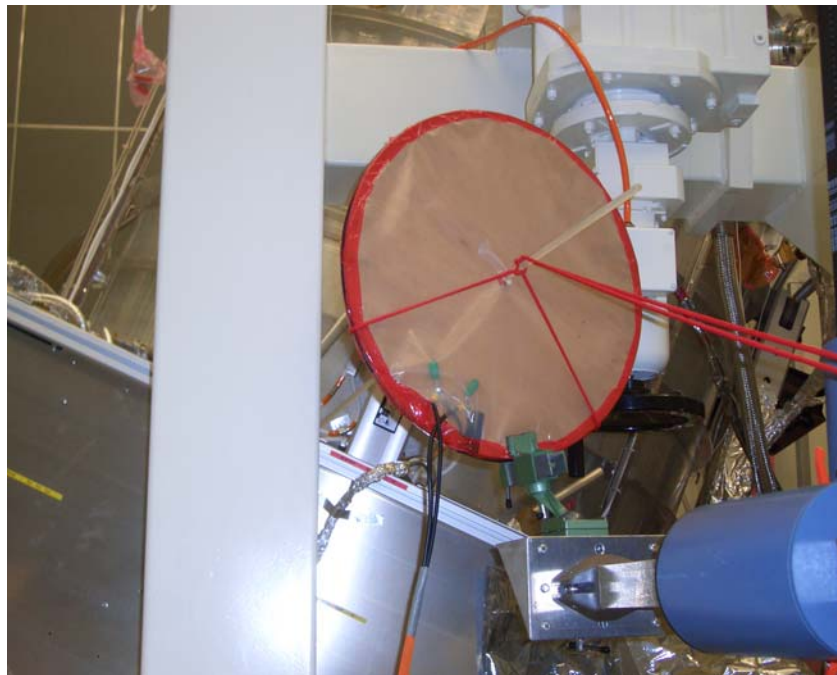


FIG 39: Setup RS H-Field on SPIRE in position 2

4.7 Radiated Susceptibility Electric Field on Instrument SPIRE

4.7.1 Test Parameters

Test Procedure:	HP-2-ASED-PR-0033
Frequency Range:	14 kHz – 30 MHz 30 MHz – 1 GHz 1 GHz – 6 GHz 6 GHz – 18 GHz 8,45 GHz – 8,50 GHz
	For discrete frequencies see HP-2-ASED-PR-0033 ch. 8.6
Step Width:	10 % log
Dwell Time:	defined during test
Modulation:	1 kHz sqwv AM 30% additional Pulse 100 % 800 msec on 200 msec off
Level:	2 V/m (14 kHz – 18 GHz) and 10 V/m (8,45 GHz – 8,50 GHz)
Positions:	Position 1 – 4
Polarisation:	14 kHz – 30 MHz vertical only 30 MHz – 18 GHz vertical and horizontal
Antenna Distance:	1 m

4.7.2 Test Setup

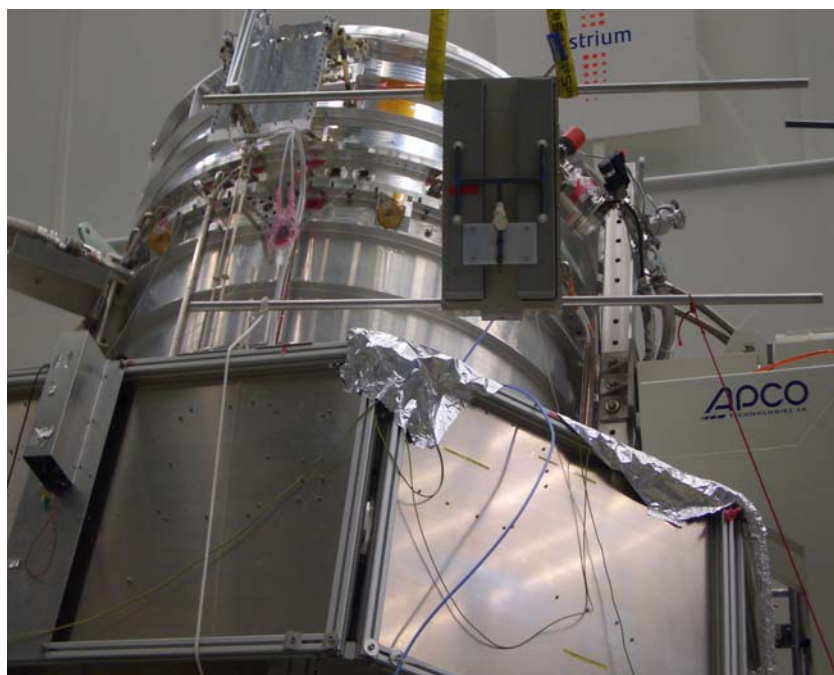


FIG 40: Setup RS E-Field 14 kHz – 30 MHz vertical on SPIRE in position 1

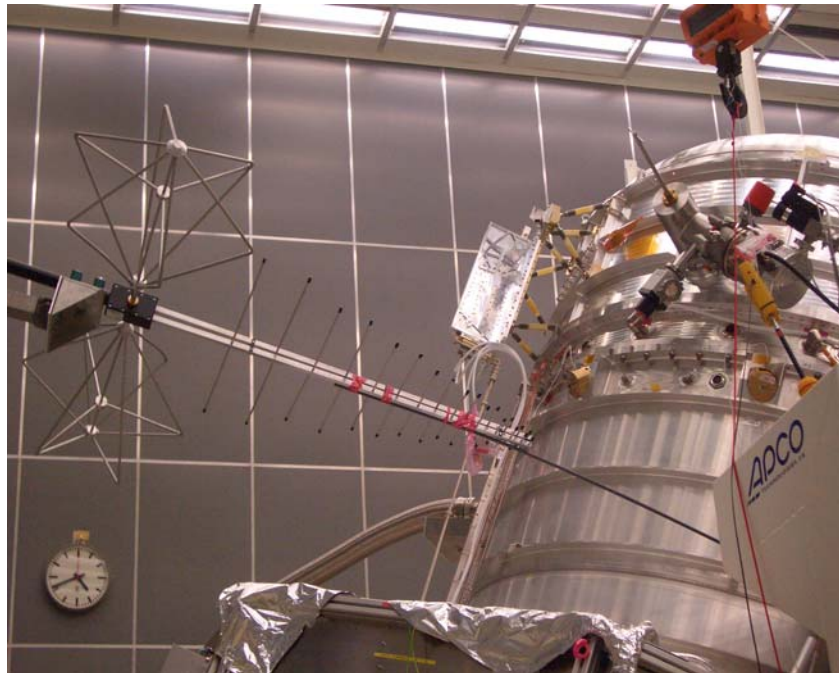


FIG 41: Setup RS E-Field 30 MHz – 1 GHz horizontal on SPIRE in position 1

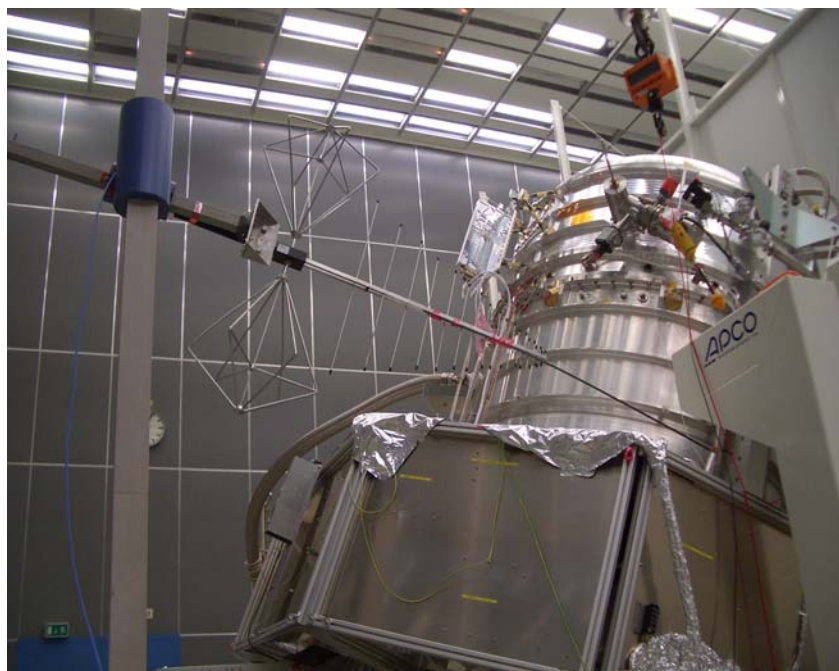


FIG 42: Setup RS E-Field 30 MHz – 1 GHz vertical on SPIRE in position 1



FIG 43: Setup RS E-Field 1 GHz -6 GHz vertical on SPIRE in position 1

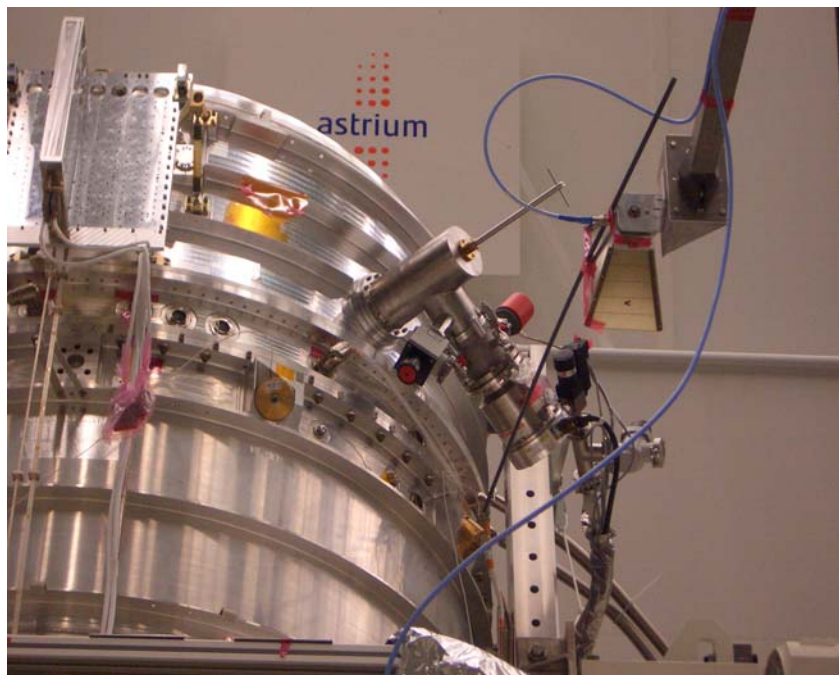


FIG 44: Setup RS E-Field 1 GHz -6 GHz horizontal on SPIRE in position 1

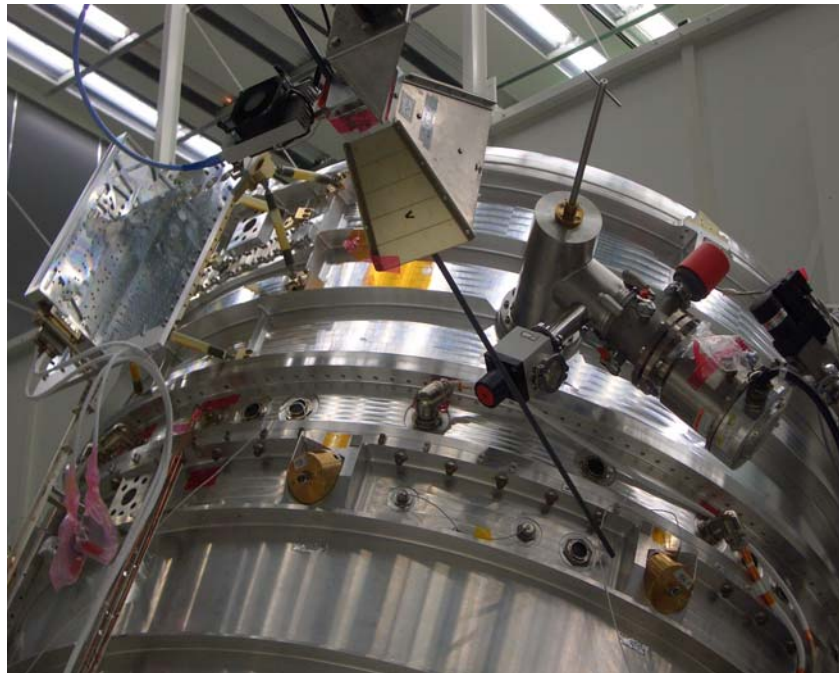


FIG 45: Setup RS E-Field 6 GHz - 18 GHz horizontal on SPIRE in position 1

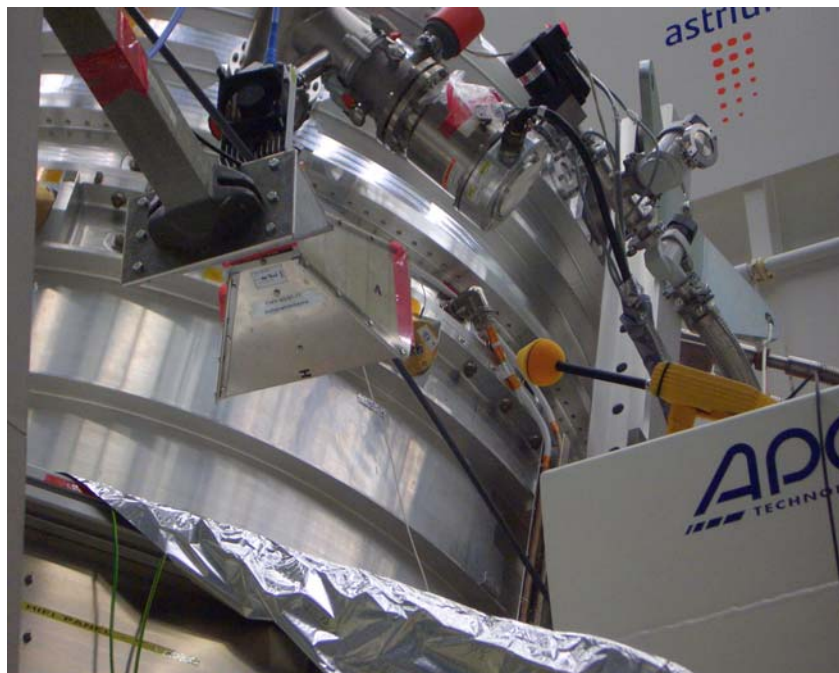


FIG 46: Setup RS E-Field 6 GHz - 18 GHz vertical on SPIRE in position 2

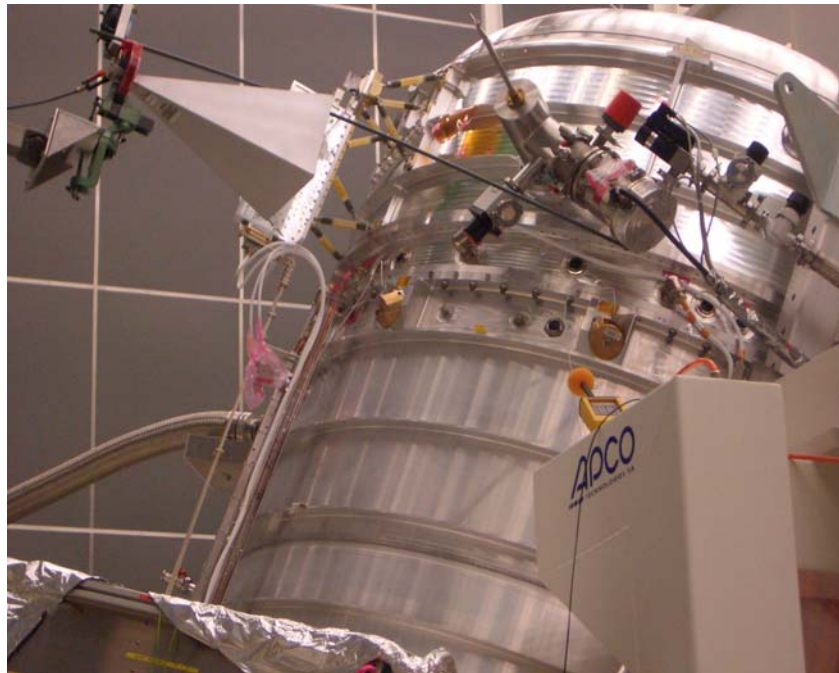


FIG 47: Setup RS E-Field 8,45 – 8,50 GHz vertical on SPIRE in position 1

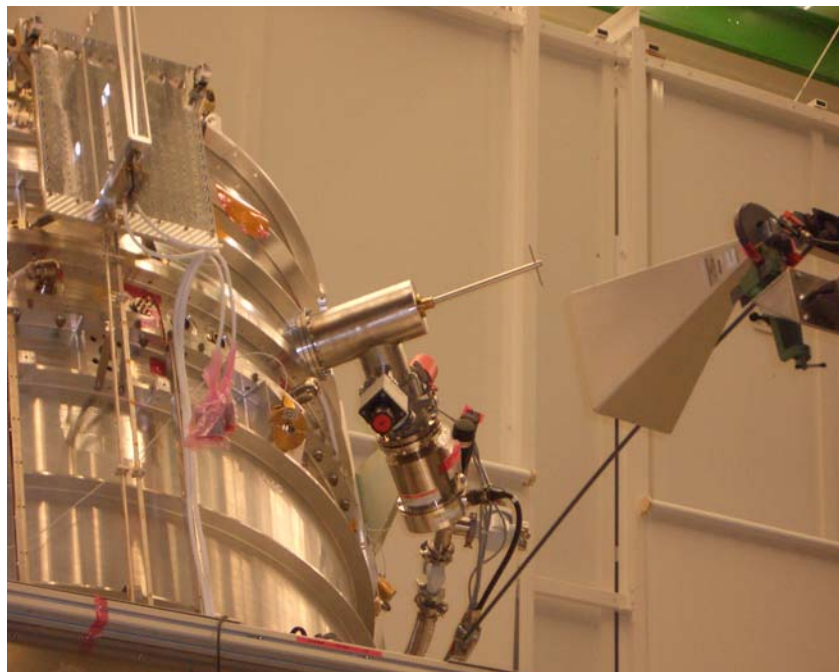


FIG 48: Setup RS E-Field 8,45 – 8,50 GHz horizontal on SPIRE in position 1