

CAU input to EPT-HET STM DRB



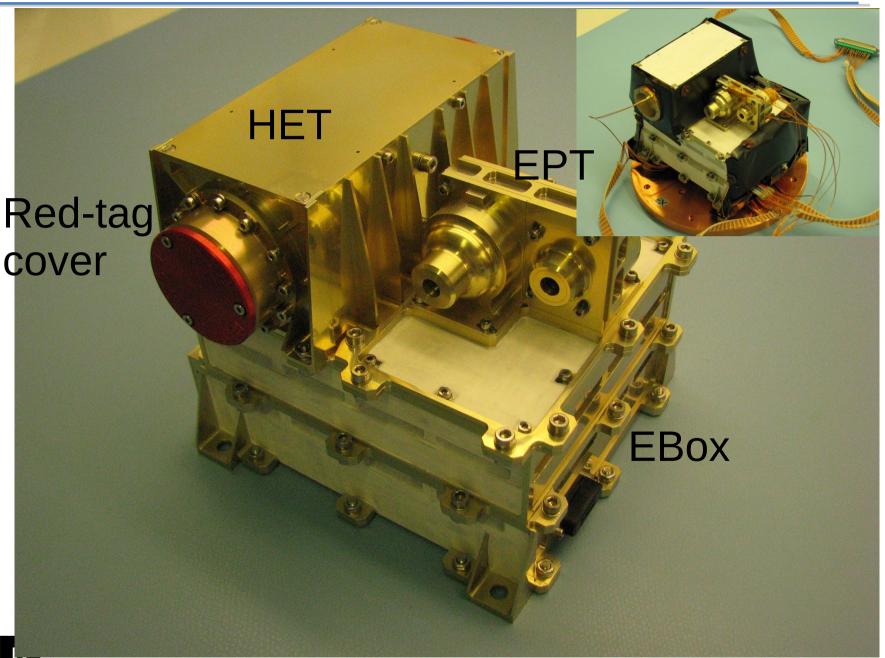
Plan for the review:

- Introduction: Fidelity of EPT-HET STM
- Go through ESA agenda point by point
- Visit clean room to inspect STM



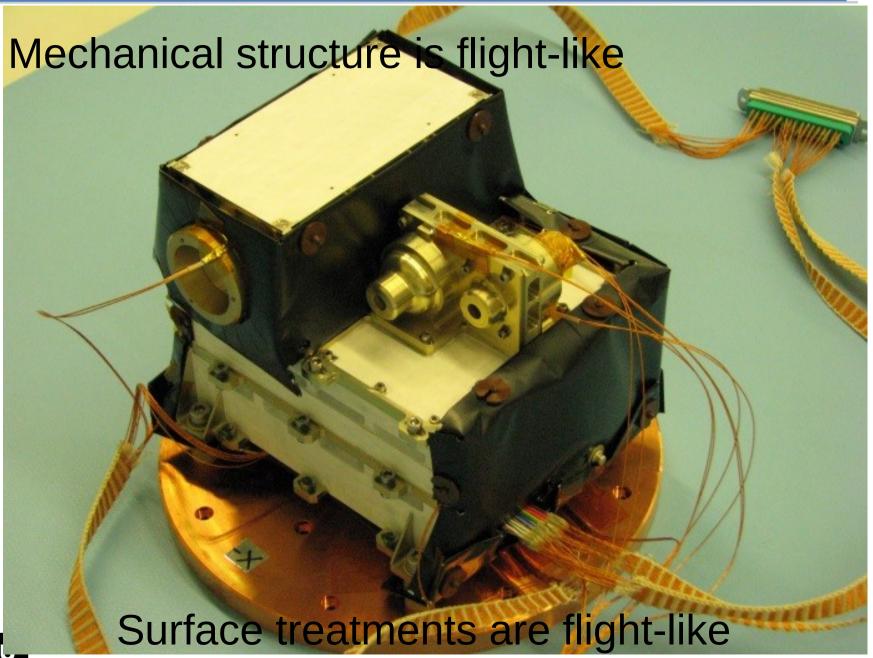






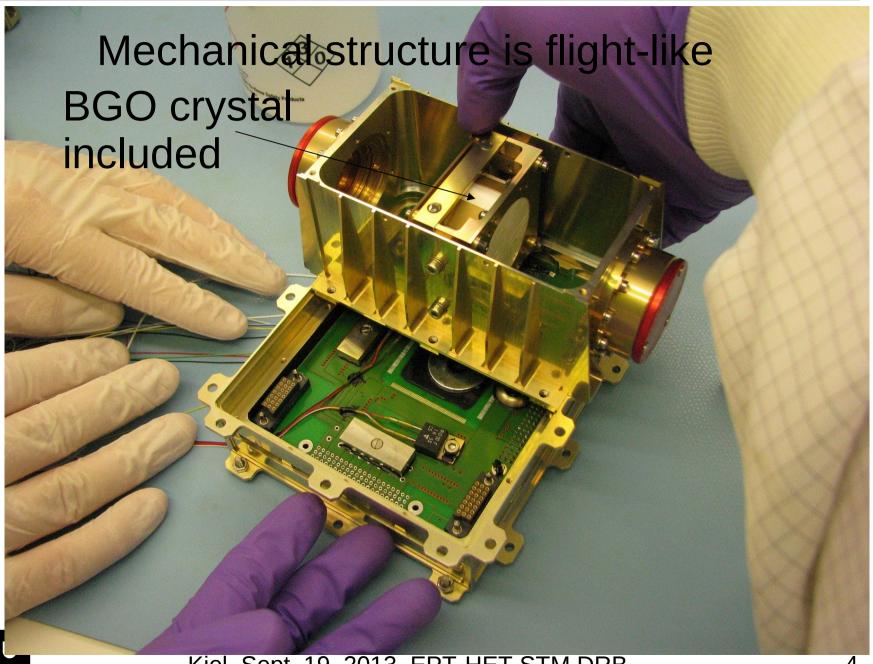






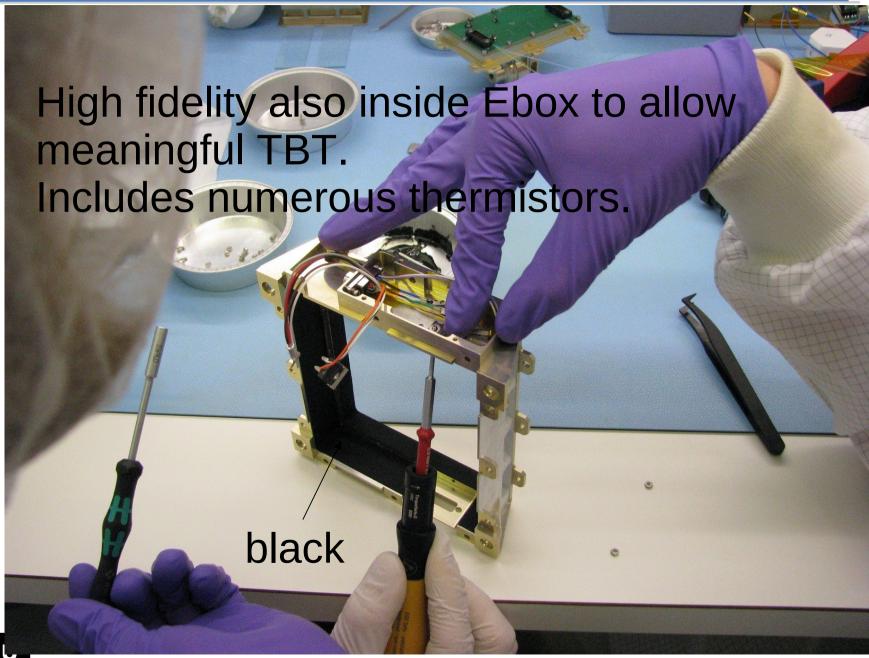






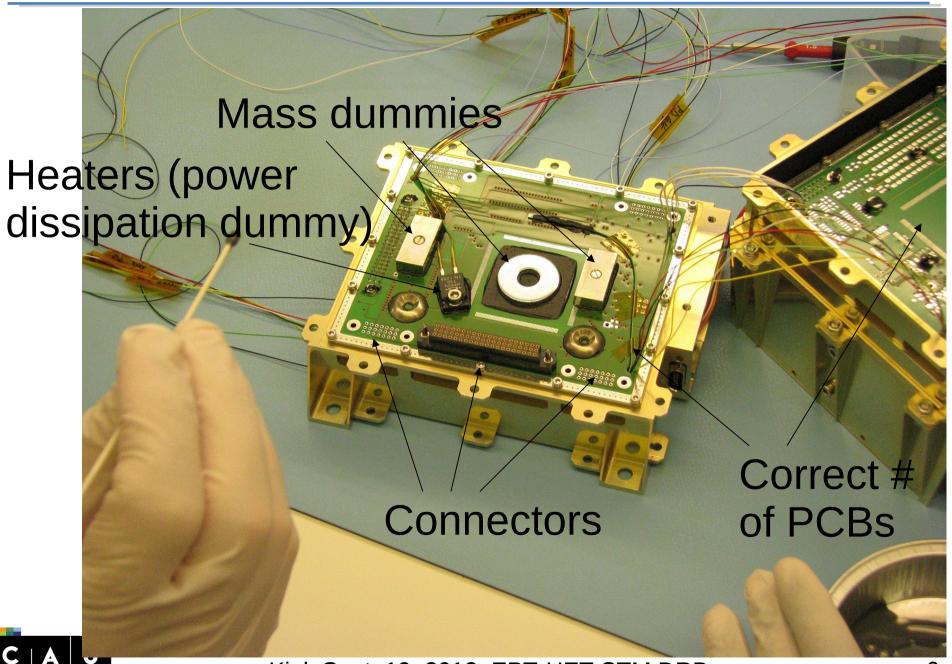








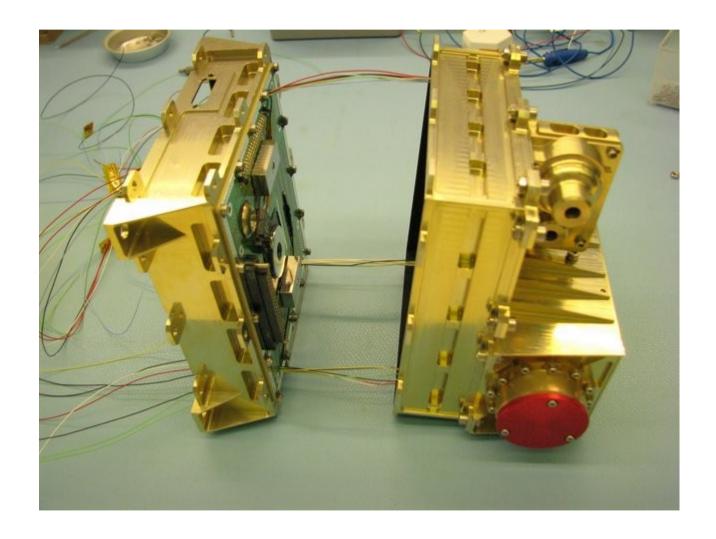








All this complexity is in the STM and was shaken and baken.





Purpose of the Delivery Review



To accept the instrument by ESA and at the same time by the Prime Contractor

To assess if the instrument configured HW, SW, GSE and EIDP can be accepted for delivery

To authorise the instrument HW, SW and GSE shipment to the Prime Contractor

Apart from shipping infrastructure EPT-HET STM has **no** SW and **no** GSE (heaters and flying leads are considered to be part of STM).

We are considering only EPT-HET STM. STEP has no CAU-provided STM.





Criteria for successful Pre-Shipment & FAR



- 1) The configured HW conforms to the EID-A and related NRs requirements and to an approved design configuration
 (→ Presentation)
- 2) The configured HW is fully tested and all tests subjected to successful TRB(s) (→ *Presentation*)
- 3) The configured HW is free from material and workmanship deficiencies (→ *Presentation, go to clean room (point 6)*)
- 4) Non-conformances are closed-out (or open ones are compatible with the delivery) (\rightarrow *Presentation, discussion*)
- 5) Relevant EIDP and shipping documents are complete, detailed and accurate (→ *Presentation*)
- 6) The configured HW and shipping "GSE" are made accessible for inspection and test before packing. (\rightarrow Go to clean room)



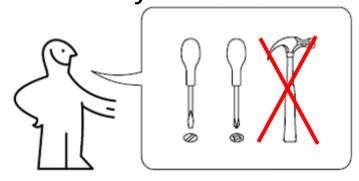


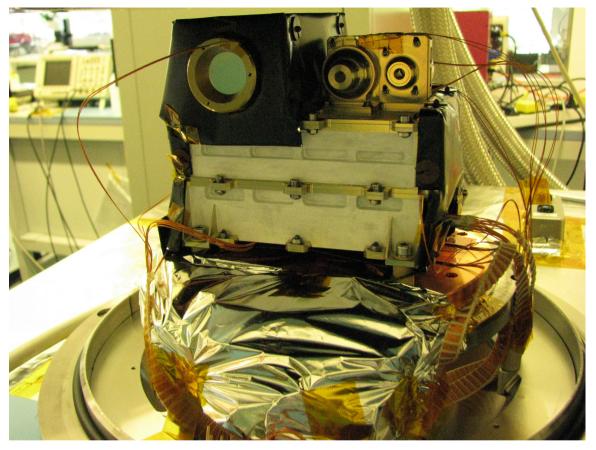
Identification of items under delivery (including loose items & spares)



What is being delivered?

One EPT-HET STM incl.:
Heaters and flying leads
One separate set of MLI
Assembly instructions





STM delivered w/o additional mounting hardware. All (M5) mounting screws, washers, nuts need to be provided by ASUK. See

SO-EPD-KIE-LI-0004-iss1_rev1-EPT-HET_STM_Shipping_list.pdf for details.





Applicable requirements



From EID-A:

See compliance and verification matrix: SO-EPD-KIE-TM-0002 iss1 rev0 EPT-HET STM verification-matrix.xls and following slides 12-14

Internal CAU requirements:

- Retire or at least more clearly identify structural and thermal risks (This was fully achieved, we found a problem (crystal holder), and redesigned and reworked it. It is much better to find such problems with the STM than with a later model...)
- Develop manufacturing details and improve design for FM development.
- Develop assembly and integration procedures for the sensor heads and the whole instrument.
- Fit check electronics components and test el. connectivity as input for parallel FM-board development.
- Fit check and verify MLI performace and design.





Applicable requirements (EID-A) Structural tests



Qualification sine vibration

EIDA R-497: The PI shall ensure that units mounted on the spacecraft panels are designed to withstand without degradation the sinusoidal environment as defined in table below at unit/structure interface.

Axis	Frequency (Hz)	Qualification
Out of plane	5-20	15 mm
	20-100	24 g
In plane	5-20	9.9 mm
	20-100	16 g
		2 Oct/min

Qualification random vibration

EIDA R-499: The PI shall ensure that each unit is designed to withstand without degradation the random environment as defined in the table below at unit/structure interface.

Axis	Frequency (Hz)	Qualification*
Perpendicular to mounting plane	20-100	+12 dB/Oct
(1 axis)	100-500	1 g ² /Hz
	500-2000	-8 dB/Oct
		26.3 g rms
Parallel to mounting plane	20-100	+4 dB/Oct
	100-500	0.1 g2/Hz
	500-2000	-3 dB/Oct
	10	10.7 g rms





Applicable requirements (EID-A) Thermal balance test



EIDA R-517: The PI shall verify the thermal design and functionalities of each unit by dedicated thermal vacuum tests and by thermal balance tests.

In particular:

Thermal balance (TB) test(s) at STM level and at FM level

Thermal vacuum (TV) cycling test at FM level

EIDA R-520: The PI shall ensure that the equipment is tested in a thermal vacuum environment having a pressure of 0.0013 Pa (10⁻⁵ Torr) or less.

EIDA R-521: The PI shall perform the TB test(s) using adequate test instrumentation and test set-up (e.g. number and position of temperature sensors, heaters) to provide accurate data (e.g. temperatures, voltages, unit dissipations)

EIDA R-522: The PI shall ensure that the TB test(s) conditions are clearly defined and reproducible, so that accurate and reliable input for thermal model correlation can be provided.

EIDA R-523: The PI shall ensure that the TB test(s) consist of at least a hot and a cold steady-state phase and several transient phases that simulate boundary conditions experienced during the mission, including actual Sun exposure (when applicable).

EIDA R-524: The PI shall ensure that the TB test(s) conditions encompass, as far as possible, the worst thermal conditions expected throughout all mission phases (including simulation of radiative and conductive external interfaces)

EIDA R-525: The PI shall ensure that the test item is a fully thermally representative configuration. In particular the thermal hardware shall be flight representative as far as any critical interface.

EIDA R-526: The PI shall assume that each steady state phase is reached when the temperatures of the unit does not vary by more than 1C/3 hour.





Applicable requirements (EID-A) Test tolerances



EIDA R-440: The PI shall respect the following test tolerances, unless otherwise specified.

Structural test

Sinusoidal vibration:

- -Acceleration, amplitude ± 10%
- -Frequency above 50 Hz ± 2%

Random vibration:

Power spectrum density (50 Hz or narrower)

20 to 500 Hz \pm 1.5 dB

500 to 2000 Hz ± 3.0 dB

Overall g rms \pm 1.5 dB

Thermal balance test

Temperature:

-Tmax: 0 to +3°C

-Tmin: 0 to -3°C

-Within the temperature range: -55°C to +150°C

Pressure:

- -Equal or above 0.1 mbar 10%
- -Below 0.1 mbar 50%





Requests for waivers and deviations



		Descriptio	Delivered	Status
Filename	on	n	Delivered	
SO-EPD-KIE-RD- 0001_iss1_rev1_RfD _for_mass_propertie s.pdf	SO-EPD- KIE-RD- 0001	RFD for mass properties	24.05.2013	Accepted, Closed
SO-EPD-KIE-RD- 0002_iss1_rev1_RfD _for_qualification_le vel_sine_vibration.p df	SO-EPD- KIE-RD- 0002	RFD for qualification level sine vibration	24.05.2013	Accepted, Closed



Request for waivers and deviations



1. RfD mass properties, SO-EPD-KIE-RD-0001 (Accepted)

Description:

We request to verify the two mass properties tolerances, Center of Gravity (CoG) and Moments of Inertia (MoI), by calculated values and not measured ones. (EIDA R-539)

1. Note: This RFD is applied to STM

2. RfD qualification level sine vibration, SO-EPD-KIE-RD-0002 (Accepted)

Description:

We request to reduce the qualification sine vibration amplitude from 15mm to 12mm for out of plane axis in frequency range of 5 to 20 Hz. (EIDA R-497)

Note: This RFD will be applied to PQM. In fact, STM was tested in the original qualification level mentioned in EIDA.





Approved as-design (CIDL)



See SO-EPD-KIE-LI-0002-iss1_rev2-STM-CIDL-ABCL.pdf (part of EIDP)



Status of change proposals



CAU did not *propose* changes, we have *made* changes to design:

Rework of the crystal holder (discussed in detail in NCR docs)

The redesigned and reworked STM was reshaken.

EPD As-built (ABCL) / Discrepancies asdesigned vs. as-built



Also covers "Identification of discrepancies build standard vs. flight design baseline"

ABCL is the evolution of CIDL and EPD has one single doc for both as agreed with the EPD PA manager. No answer from ESA so far, EPD assumes it is ok.

Status	Description	STM	FM
Approved*	EPT-Detectors	Not included.	Full functional detector stacks.
Approved*	HET-Detectors	Only det carriers.	Full functional detectors.
Approved*	EPT Collimators	No internal blackening.	
Approved*	PCBs, EEEs	Stainless steel mass dummies.	Full electronics components.
Ongoing design work	Choice of radiator surfaces	Reflective white paint on radiative surfaces.	SSM under consideration.
Ongoing design work	MLI design	MLI on HET head's side walls.	Under consideration: Free HET off MLI, use op heaters. (Sun illumination issue)
Ongoing design work	Mounting surface structure of ebox	Ebox wall surface structure uneven.	Under consideration: SSM (see above) might require flat mounting surface.
Approved*	Survival heaters	Heaters with "TO-220" housing.	Certified foil heaters. (Most probably RICA)



* per outcome of TRR, July 18th 2013 in Kiel





	CAU NO	CR Stat	us List	, Iss	ue 1, Date 03.07.2013
NCR No	Classi ficatio n	Issue / Date			Description of Non- Conformance
SO-EPD- KIE-NC- 0001	Minor		EPT- HET STM		Following Y-axis vibration, an electrical function test was carried out. Open circuit was found for photo-diode #2
SO-EPD- KIE-NC- 0002	Major	25.06 .2013	EPT- HET STM	Op en	Nonconformance in step 85 and step 100 of the test procedure.
					There is more than 10% change in resonance amplitudes before
					and after qualification-level random vibration.





1st vibration test (July 25, 2013) was unsuccessful. Large change in frequency and in amplitude after y-axis qualification run.

Was considered major NC Three actions required:

- identify root cause
 (ppt: EPT -HET STM vibration test failure Investigations, 20.08.2013)
- define rework
 (doc: Rework Plan and Report of STM of EPT-HET, SO-EPD-KIE-PL-0003, 1/0, 23.08.2013)
- rework and retest
 (doc: EPT-HET STM Random-Sine vibration test report, SO-EPD-KIE-TR-0005, 12.09.2013)

All three actions were performed. Retest was successful.





Certificate of Conformance





Certificate of conformity

Solar Orbiter Energetic Particles Detector (EPD) Reference: SO-EPD-KIE-CE-0001 Issue: 1 Rev: 0 (Draft) Date: 2013-09-16 Page: 1

IT	EM

Doc No SO-EPD-KIE-CE-001	Project Solar	Orbiter	Log
Item Name EPT-HET	Item part no. T0080046-01	Item serial no. STM	Customer code
Customer	Contract no.	Intended use S/C leve	el AIT

REFERENCE OF HARDWARE CONFORMITY

Contract requirements		Operational documents		Deliverable documents	
Document no.	Iss/rev	Document no.	Iss/rev	Document no.	Iss/rev
EID-A		None		EPT-HET STM EIDP	
EID-B					

STATEMENT OF CONFORMITY

It is hereby certified that apart from the deviations or waivers noted in the "Remarks" box below, the whole of the supplies detailed above conform in all respects to the specification(s), drawing(s) and condition(s) or requirements(s) with respect to the specification(s), drawing(s) and condition(s) or requirements(s) of the contract.

PI:	Date:	
SO-EPD-KIE-RD-0001: Verification of physical properties COG SO-EPD-KIE-RD-0002: Reduce sine vibration qualification ampli		



Certificate of conformity

Solar Orbiter Energetic Particles Detector (EPD)

Reference: SO-EPD-KIE-CE-0001 Issue: 1 Rev: 0 (Draft) Date: 2013-09-16 Page: 2

	Μ

Document No.	Project Solar O	rbiter	Log	
Item Name EPT-HET	Item part no. T0080046-01 Item serial no. STM		Customer code	
Customer	Contract no.	Intended use S/C leve	l AIT	

REFERENCE OF CLEANLINESS CONFORMITY

Contract requirements		Operational documents		Deliverable documents	
Document no.	Iss/rev	Document no.	Iss/rev	Document no.	Iss/rev
EID-A		None		EPT-HET EIDP	
EID-B					
SO-EPD-PO-PL-0005	1/1				

STATEMENT OF CONFORMITY

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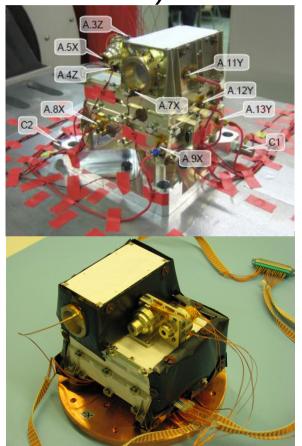
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PI: _		Date:
PA.	Michael 1. Richard	Date: 16 Sept 2013



EPDStatus wrt. Test flow and review of Test Reports

CAU Test matrix: (excerpt from EPD test matrix)



Test reports:

	STM						
Modelsand applicable units			M		MC		1/FS
riodese la oppidese al le	BT-HET	STEP	EPT-HET	STEP	EPT-HET	STEP	BT-HEI
FUNCTIONAL & PERFORMANCES TEST							
Visual Inspection	X	' Х	Х	X	Х	Х	Х
Functional Test		Χ	Х	X	X	Х	Х
Performance Verification (Calibration)		Χ	Х	X	X	Х	Х
Physical Properies (Mass, CoG, MOI, Dimensions)	Х			X	X	Х	Х
Mechanical Interfaces Check	Х			X	X	Х	Х
Electrical Characteristics & I/F	Х	Х	Х	X	X	Х	Х
STRUCTURALTEST							
Sine Vibration Test	Q			Q	Q	Q/A	Q/A
Random Vibration	Q			Q	Q	Q/A	Q/A
Acoustic Noise Test							
Shock Test				Q(TBC)	Q(TBC)		
THERMALTEST							-
Thermal Vacuum Cycling Test				Q	Q	Q/A	Q/A
Thermal Balance Test	Q			Q	Q		
ELECTROMAGNETIC COMPATIBILITY TEST (EMC)							
Bonding, Isolation, Conductivity and Grounding		Х	Х	Х	Х	Х	Х
Conducted Emission		Х	Х	Х	Х	Х	Х
Conducted Susceptibility		Х	Х	Х	Х		
Radiated Emission				Х	Х		
Radiated Susceptibility				Х	Х		
Electrostatic Discharge (ESD)				Х	Х		
DC Magnetic Properties Test				Х	Х	Х	Х
S/WTEST							
S/W Validation Tests	NA						
PURGING RATE							
Purging Rate Verification	NA						
NOTE:							
A = Acceptance Level							
Q= Qualification Level Q/A= Qualification Level for Acceptance duration							

12.09.2013

26.07.2013

26.07.2013

EPT-HET STM Random-Sine Vibration Test Report SO-EPD-KIE-TR-0005

EPT-HET STM Thermal Balance Test Report SO-EPD-KIE-TR-0006

EPT-HET STM Physical Properties Test Report SO-EPD-KIE-TR-0007



Status wrt. Verification and Qualification (Verification Matrix, Qualification Status list), including also approval status of materials, processes and EEE parts



Verification: See previous slide

Qualification: Parts under CPPA control, sensors, see previous slide

DMPL:

Status as per MPCB meeting July 10 2013, Alcala (Ref. SOL-EST-MN-5052).

Outcome: Delta MPCB review required to be held by telecon.

All actions considered to be normal work.

EEE parts:

Under CPPA control, but N/A for STM





Log-book contents, e.g.: Mate/Demate Cycles Records, Limited Life



Item Records, Temporary Installation Records, Operational

Cycles



Electron Proton Telescope and High Energy Telescope (EPT-HET)

Logbook of the Structural and Thermal Model

Page | 1 Compiled by: J. Steinhagen & S.R. Kulkarni

Similar log books will be kept for PQM, FM, and FS.

Mate/demate was performed on both, 15-and 25-pin, connectors for TBT only:

Mate: 02.07.2013

De-mate: 17.07.2013

STM has no limited life items.

MLI was installed for TBT and removed for subsequent rework.

STM has no real "operational cycles".

LOGBOOK

of the EPT-HET - Structural and Thermal Model (STM)

EPT-HET/Solar Orbiter



File name: SO-EPD-KIE-LB-0002_iss1_rev0_EPT-HET-STM-Logbook.doc

This document describes the Structural and Thermal Model (STM) development for the Electron Proton Telescope and High Energy Telescope (EPT-HET) at a low level.

IEAP, Christian-Albrechts-Universität Kiel, Leibnizstrasse 11, 24118 Kiel, Germany



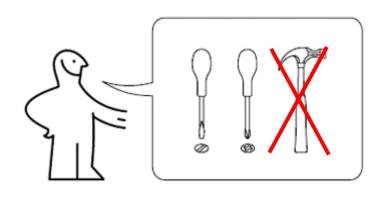


Integration, Operation and Maintenance Manual, including any operational limitation and safety precautions



See SO-EPD-KIE-IF-0001-iss1_rev5-EPT-HET_STM_Interface_Control Document.pdf

MLI and STM to be hand carried to ASUK in two separate boxes (because of cabin baggage size limitations)







EPDPacking, Unpacking, Storage, Transport and Handling procedures (including cleaning procedures)



Packing, storing, transport, and handling is described in:

SO-EPD-KIE-PR-0001-iss1_rev1-EPT-HET_STM_Packing-storing-transport-handling_procedure.pdf







Compatibility with rules, regulations and standards in receiving country (e.g. CE declaration of conformity).



CAU does **not** know rules, regulations and standards in receiving country.

CAU does **not** plan to find out about all possible rules in receiving country.

CAU will **not** provide a CE declaration of conformity

CAU considers STM to be a (sophisticated) "piece of metal".





Proof-load certificates for hoisting devices.



N/A for CAU-shipped parts.

CAU not responsible for hoisting devices in receiving institution.

EPD Final SAR (for FM); Residual Hazard Sheets (for STM and EM)



N/A for STM





PD Reports from mass properties measurements



No mass and physical properties measurements performed as per the following waivers.

Filename	EPD codification	Description	Deliver ed	Status
SO-EPD-KIE-RD- 0001_iss1_rev1_RfD _for_mass_propertie s.pdf	SO-EPD- KIE-RD-0001	RFD for mass properties		Closed
SO-EPD-KIE-RD- 0002_iss1_rev1_RfD _for_qualification_le vel_sine_vibration.p df	SO-EPD- KIE-RD-0002	RFD for qualification level sine vibration	24.05.2 013	Closed





EPD Reports from metrology measurements (e.g. mechanical I/Fs)



CAU Manufacturing Process:

Design/Engineering

Manufacturing

3d CAD-file

Vault: version control & backups

Get 3d file from vault

Machine from 3d cad-file



Verification of relevant dims. (MICD)

Fit check with mating parts

Results

	Ref Drawing	Manufactured	Allowed Tolerance	Measured	Pass	Fail
_	D1	115 mm	115mm +/- 0,1mm	115,04 mm	YES	
	D1	116 mm	116mm +/- 0,1mm	115,96 mm	YES	
	82	dA 5,5 mm	+/- 0,1 mm	5,42 mm	YES	
	D2	dA 11 mm	+/- 0,2 mm	10,99 mm	YES	

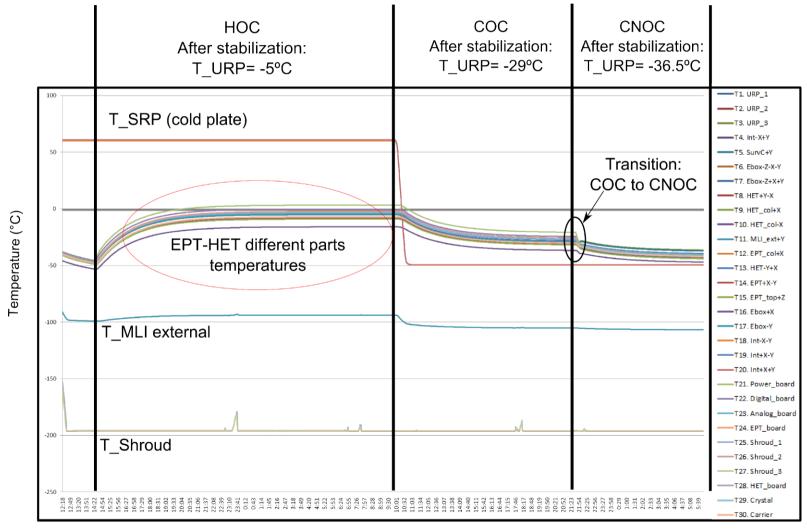


EPDReports from cleanliness measurements and bakeouts verification



STM to be visibly clean (Can be verified by visual inspection)

EPT-HET STM Logbook SO-EPD-KIE-LB-0002 (issue1/rev.1)







with CAU responses.

Feed-back from the review of other sections of EIDP, e.g.: interface control drawings, electrical circuit diagram



See separate spreadsheet EPD EIDP Review ASU to EPD v1 FINAL.xlsx

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Visual inspection of the hardware with magnifier, white and UV light for overall status and cleanliness (pictures/reports to be added to the data package)



To be seen in Point 6 of the agenda:

"The configured HW and GSE are made accessible for inspection and test before packing."

N/A for STM



PD Packing list (including list of loose items & spares)



SO-EPD-KIE-LI-0004-iss1_rev1-EPT-HET_STM_Shipping_list.pdf Loose items & spares: Thermal washers EPT-HET STM ships in two containers:

1st container:

- STM (with 2 thermocouples at URP with 15 m leads)
- supporting docs

2nd container

- MLI
- 15 m cables with one end connectors and other end flying leads (two sets, one for survival another for internal heaters)
- 1 set of documents (handing procedure doc, pictures, proforma invoice, MLI export Licence)
- some pairs of gloves (optional)



EPD Status of shipping documents / Logistics details for shipping operations



Proforma invoice is being prepared, according to all parties this is the only needed document.

Logistics details:

CAU will hand carry STM to ASUK in 2 shipping containers

SO-EPD-KIE-LI-0004-iss1_rev1-EPT-HET_STM_Shipping_list.pdf gives all details







Flying leads need to be re-made.





At the time of preparing this presentation, there was no "AOB".

Should there be some after this meeting, list AOB here online:

- _
- _
- _



Conclusions



Criteria for successful Pre-Shipment & FAR

- 1) The configured HW conforms to the EID-A and related NRs requirements and to an approved design configuration (yes)
- 2) The configured HW is fully tested and all tests subjected to successful TRB(s) (yes)
- 3) The configured HW is free from material and workmanship deficiencies (yes)
- 4) Non-conformances are closed-out (or open ones are compatible with the delivery) (yes)
- 5) Relevant EIDP and shipping documents are complete, detailed and accurate (yes)
- 6) The configured HW and shipping "GSE" are made accessible for inspection and test before packing. (yes)







Backup slides



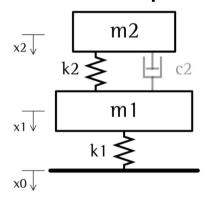


What went wrong in STM vibe?

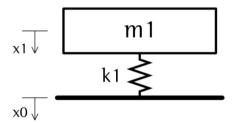


A medium mass must have 'settled down':

System w. 2 coupled masses



Single mass



Such a system is governed by set of two coupled differential eqs.:

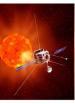
$$m_1 \ddot{x_1} + 2b_1 \dot{x_1} + D_1 x_1 + D_{12} (x_1 - x_2) = k \sin \omega t$$

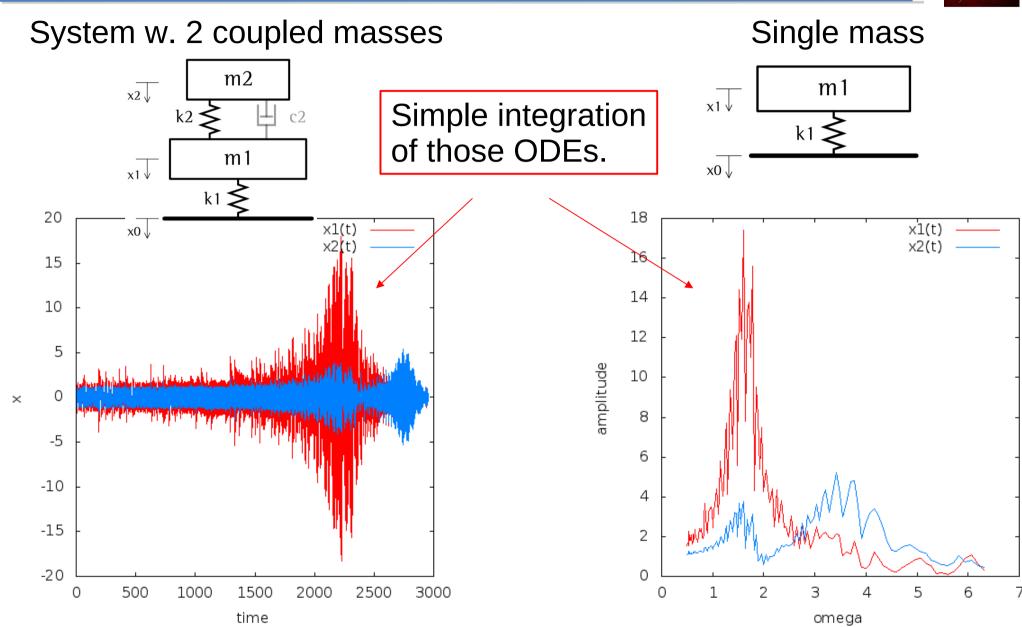
$$m_2 \ddot{x_2} + 2b_2 \dot{x_2} + D_2 x_2 + D_{12} (x_2 - x_1) = k \sin \omega t$$

Which has a characteristic class of solutions, as shown on next slide.

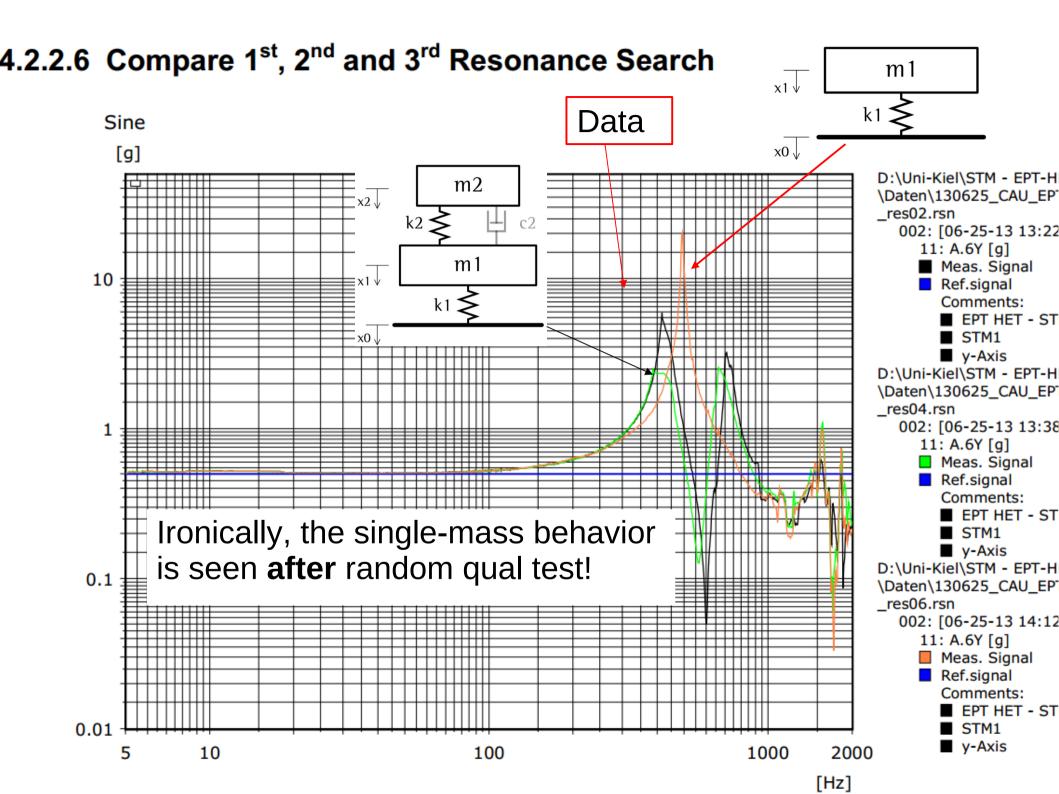


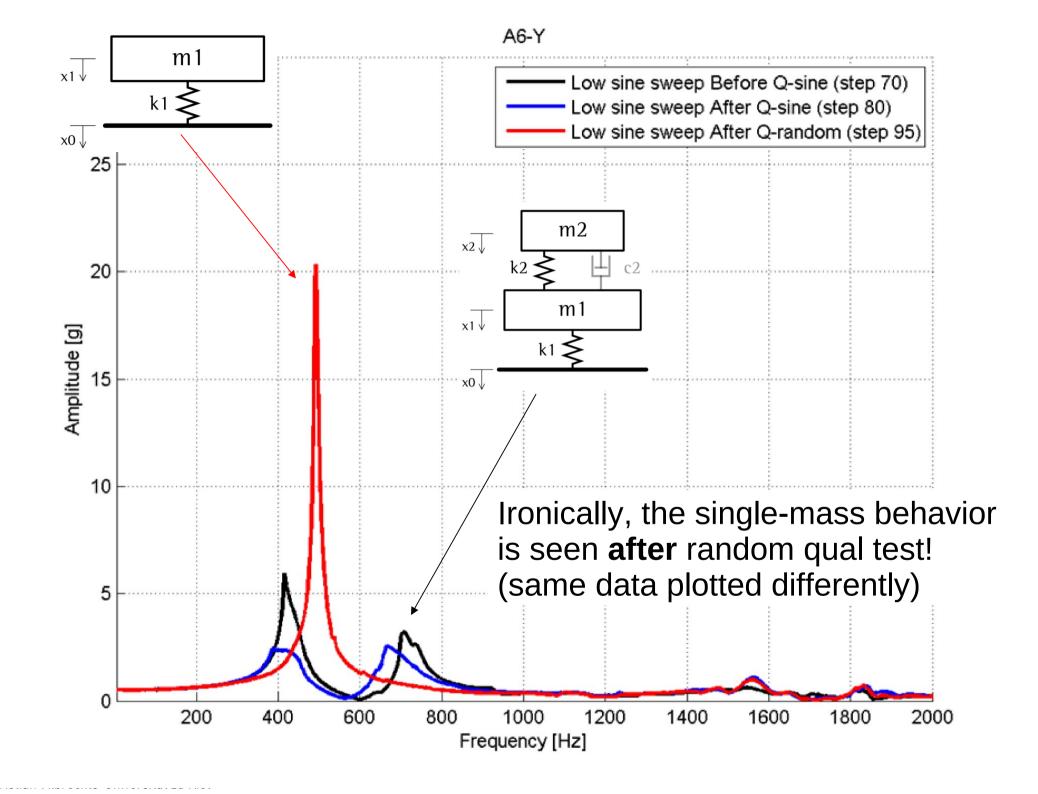
What went wrong in STM vibe?













EPT-HET STM TBT

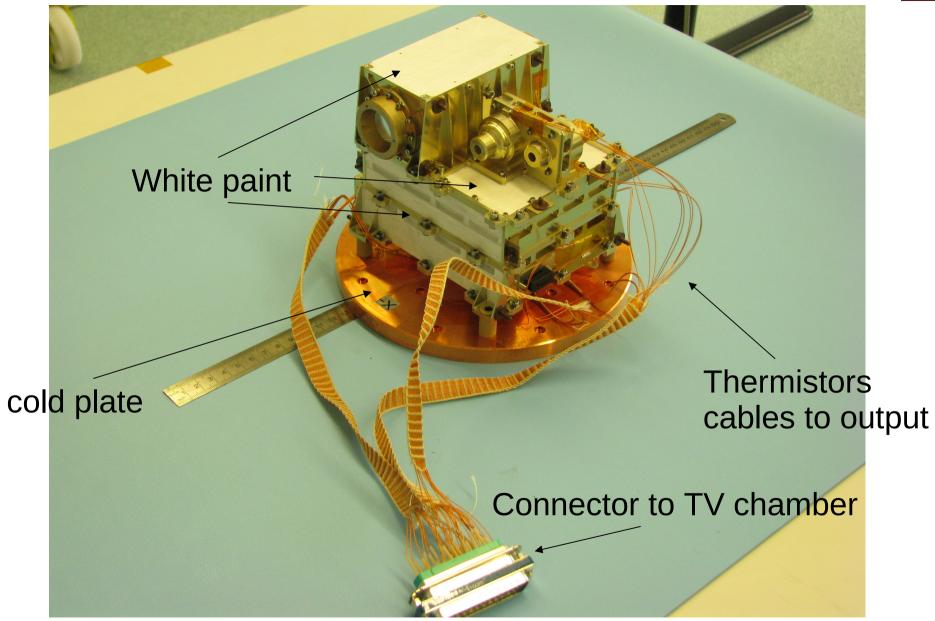






EPT-HET STM TBT Test

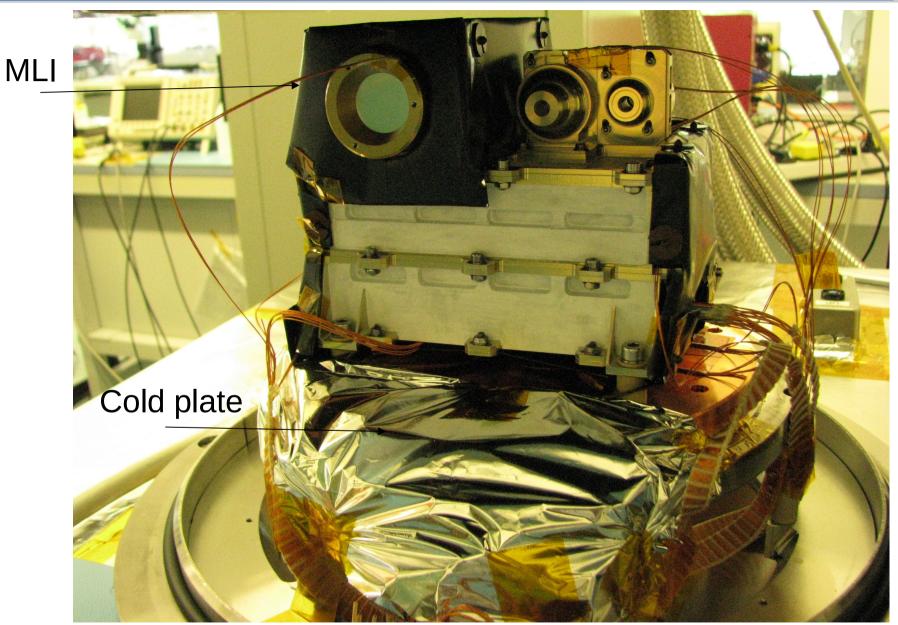






EPT-HET STM before closeout

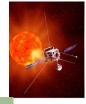


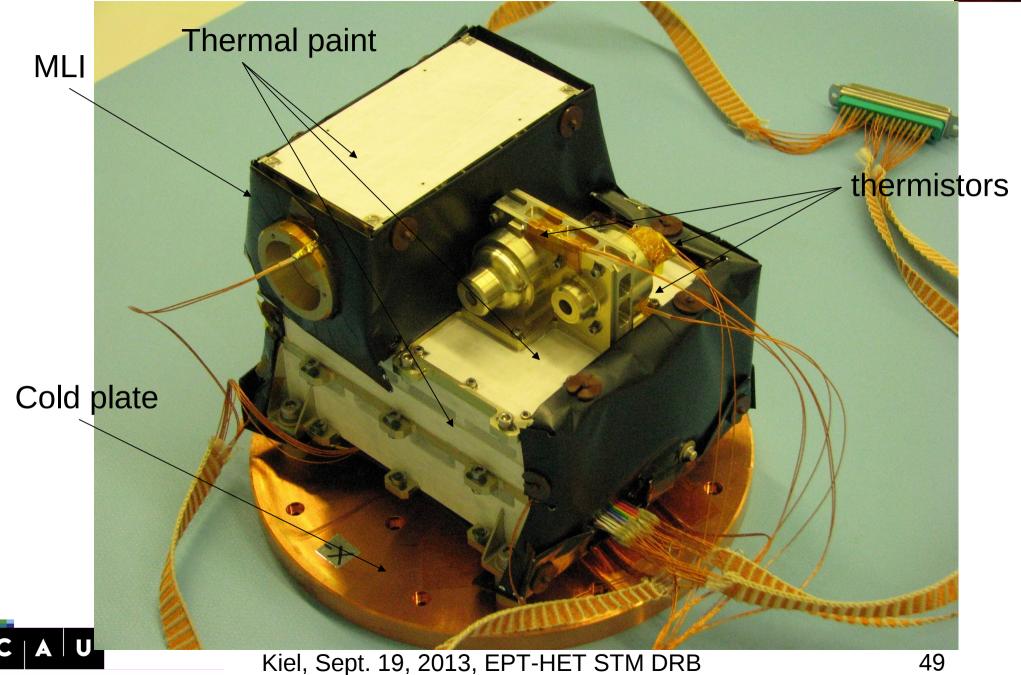






EPT-HET STM before closeout







EPT-HET STM TBT Test



Test ran successfully and data were submitted to IDR/UPM and discussed with them. This input was critical for the validation of the TMM and RTMM.

Test report EPT-HET STM Thermal Balance Test Report

was submitted.

(SO-EPD-KIE-TR-0006)

26.07.2013

