SCHLUSSBERICHT

FKZ 50 QP 9711 3

Das Experiment COSIMA auf ROSETTA

Herwig Höfner
Max-Planck-Institut für extraterrestrische Physik
85741 Garching

Das Experiment COSIMA auf ROSETTA

COSIMA ist ein Instrument, das als Flugzeit – Massenspektrometer für Sekundärionen eines der wissenschaftlichen Hauptgeräte der ESA – Kometen Mission ROSETTA ist. Es baut auf Vorentwicklungen und Erfahrungen auf, die für das Instrument CoMA der 1992 eingestellten NASA Mission CRAF gewonnen wurden.

Nach der Ankunft von ROSETTA am Kometen Churyumov – Gerasimenko im Jahr 2014 besteht die Aufgabe von COSIMA darin, kometare Staubteilchen aus der nahen Umgebung des Kometen aufzusammeln und deren Zusammensetzung mittels Massenspektroskopie entschlüsseln zu helfen. Das Fördervorhaben umfasste die Entwicklung, die Fertigung und die Qualifikation des Flugmodelles mit allen seinen vom Projekt geforderten Qualifikationsmodellen, sowie eines zum Flugmodell äquivalenten Referenzmodelles, das die in Zukunft geplanten Aktivitäten mit dem Flugmodell bereits vorab im Labor zu testen gestattet.

Das COSIMA Instrument entstand als gemeinsame Arbeit mehrerer europäischer Forschergruppen. So stammen die Flüssig-Indium-Ionenquellen vom Österreichischen Forschungszentrum ÖFZ Seibersdorf, deren Versorgungselektronik vom Institut für Weltraumforschung IWF in Graz, und die Primärionenstrahlquelle ist ein Beitrag des Instituts LPCE des Centre National de la Recherche Scientifique CNRS in Orleans. Die Mikroskop-Kamera zur optischen Untersuchung der Staubteilchen wurde vom Institut IAS der Universität Paris in Orsay beigestellt und die COSIMA Software sowie die Bodenbetriebsgeräte sind Entwicklungen des Finnish Meteorological Institute FMI. Die Kosten für die genannten Beiträge wurden ausnahmslos von den nationalen Weltraumagenturen der Heimatländer dieser Gruppen getragen.

Das Max-Planck-Institut für extraterrestrische Physik in Garching (MPE) hatte ab 1997 die wissenschaftliche und technische Projektleitung in der Entwicklungs- und Bauphase. Am MPE wurde die gesamte mechanische Struktur des Experiments konstruiert, gefertigt und qualifiziert, insbesondere auch die Target Manipulator Unit TMU, ein Mechanismus welcher die Probenhalter für den Kometenstaub zu den diversen Analysepositionen bewegt. Der Großteil der Elektronik von COSIMA wurde vom Hauptauftragnehmer, der von Hoerner und Sulger GmbH in Schwetzingen, entwickelt und gebaut. Diese Firma war auch für die Schnittstellendefinition und die endgültige Integration aller beigestellten Teile verantwortlich. Die Gewährleistung der physikalischen Funktion des Instruments und die abschließende Kalibrierung waren wiederum Aufgaben des MPE.

Die Betreuung von COSIMA während seiner langen Reise zum Kometen sind 2003 vom MPE an das Max-Planck-Institut für Sonnensystemforschung in Katlenburg - Lindau (MPS) übertragen worden. Dieses Institut wird nach der Ankunft von ROSETTA am Kometen auch für den Betrieb und die wissenschaftliche Datenauswertung von COSIMA verantwortlich sein. Dabei verbleiben die technische Schnittstelle zur Bodenkontrollstation ESOC einschließlich der Rohdatenaufbereitung auch weiterhin als Aufgabe in Verantwortung des FMI.

Der technische Ablauf des Vorhabens wird anhand der wesentlichen Meilensteine deutlich:

- April 1998: Bewilligung der Durchführung des Gesamtvorhabens

- Juni 1999: Abgabe des Struktur-Thermal-Modells STM an ESTEC

- Mai 2000: Abgabe des elektrischen Qualifikationsmodells EQM an ESTEC

- August 2001: Abgabe des ersten Flugmodelles FM; dieses Modell wies aber noch erhebliche funktionelle Defizite auf, sodass ein zweites, verbessertes Flugmodell gebaut werden musste

- Juli 2002: mit dem Nachweis der vollen Funktionstüchtigkeit des zweiten Flugmodelles XM und nach dessen Qualifikation wurde das COSIMA FM auf ROSETTA durch das XM ersetzt

- Januar 2003: wegen Problemen mit der Startrakete musste der Start von ROSETTA verschoben werden; ein neuer Zielkomet musste identifiziert werden

- Juni 2003: bedingt durch die Startverzögerung war eine zusätzliche Überprüfung der Funktionsfähigkeit der Primärionenemitter des XM notwendig geworden, die in Kourou durchgeführt wurde

- Dezember 2003: das COSIMA Referenzmodell RM konnte in der Vakuumkammer der Firma vH&S in Betrieb genommen werden

- März 2004: erfolgreicher Start von ROSETTA mit einer Ariane5-Rakete

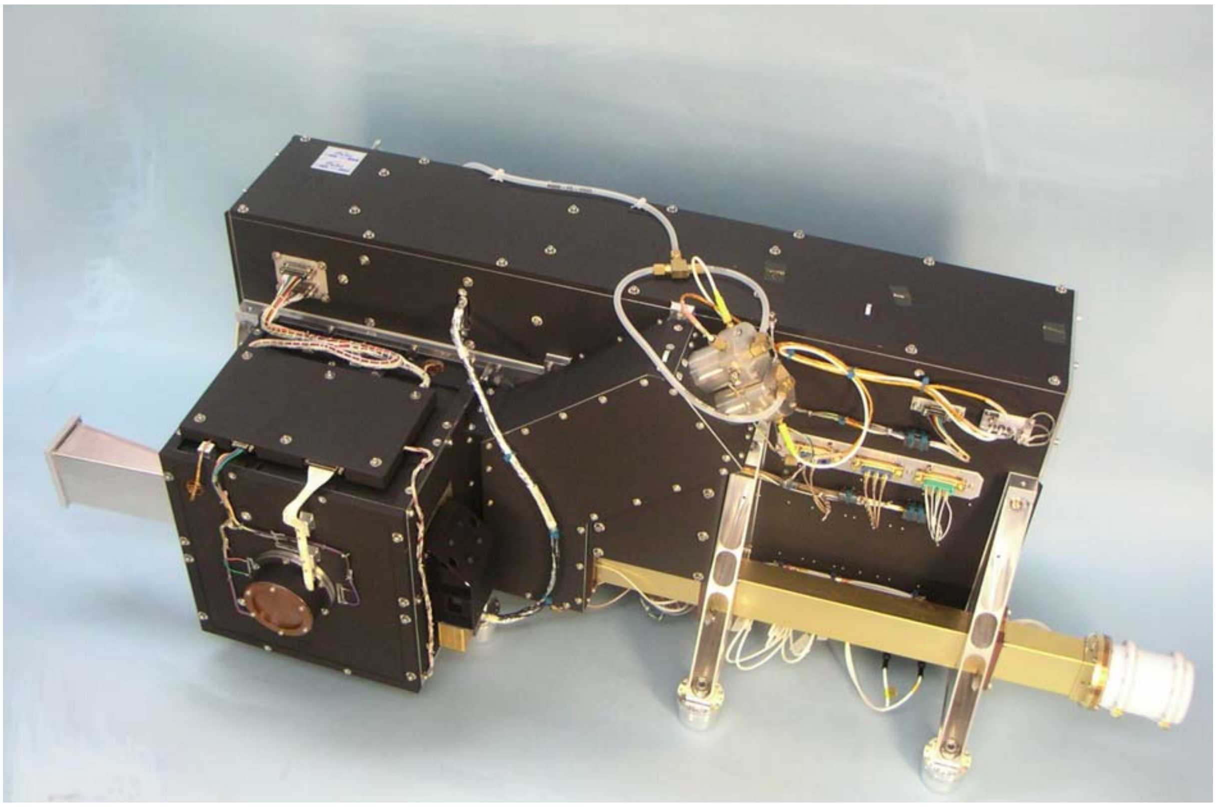
- Juli 2004: als letzte Aktivität im Rahmen des Fördervorhabens wurde das COSIMA Referenzmodell RM ans MPI für Sonnensystemforschung, der neuen Heimat von COSIMA, verbracht und dort in Betrieb genommen

- Oktober 2004: erfolgreicher Abschluss der Indienststellungsphase von COSIMA auf ROSETTA

Die Indienststellungsphase von COSIMA war unterteilt in zwei Phasen. Zunächst, kurz nach dem Start von ROSETTA, wurden die elektronischen und mechanischen Einheiten getestet. Aus Sorge vor eventuellen elektrischen Überschlägen wurden erst nach einer halbjährigen Ausgasungsphase im Weltraum dann auch die Hochspannungsversorgungen in Betrieb genommen. Es hat sich gezeigt, dass COSIMA im Weltraum wie erwartet funktioniert: Ionenemission konnte bei beiden Emittern erreicht werden und mehrere Massenspektren wurden erzeugt und zur Bodenstation übertragen. Die dabei erzielte Massenauflösung (z.B. 2030 beim Silberisotop Ag107) entspricht, wie erwartet, den vorher in den Labormessungen erreichten Werten. Ein detaillierter Bericht über die Erfahrungen in der Indienststellungsphase findet sich im Anhang.

Bis zur Ankunft am Kometen im Jahr 2014 wird COSIMA in einem etwa halbjährlichen Turnus eingeschaltet und einer so genannten ‚maintenance procedure' unterzogen werden, welche die Funktionsfähigkeit der Ionenemitter und der Mechanismen des Targetmanipulators auf Dauer gewährleisten soll.

Parallel zu den Aktivitäten für das Fluggerät werden Messungen am Referenzmodell gemacht, welche die Interpretation der später gewonnen Daten über Kometenmaterial vorbereiten. Aus den bisherigen Messungen an Kometen mit den Einschlagsspektrometern PIA und PUMA bei 1P/Halley und CIDA bei 92P/Wild 2 wissen wir, daß speziell der organische Anteil des Kometenstaubes sehr komplex zusammengesetzt ist. Mit einer so empfindlichen Methode wie SIMS sind komplizierte Erkennungsalgorithmen zur Identifikation chemischer Substanzklassen notwendig. Dazu wurden und werden an einem ähnlichen Gerät der Kollegen in Orléans Rohdaten aufgenommen und von einem CoI in Wien dann chemometrisch ausgewertet. Die ersten Ergebnisse sind sehr viel versprechend.



Das COSIMA Flugmodell XM kurz vor seiner Integration auf ROSETTA

Anhang:
COSIMA commissioning report

COSIMA Commissioning Report
Issue XM1

Jochen Kissel
COSIMA P.I.

COSIMA is a time-of-flight Secondary Ion Mass Spectrometer (TOF SIMS) for the in situ analysis of cometary dust collected on one of its many substrates. As such it can only be fully tested when it is outgassed and in a good vacuum. Due to operational constraints the instrument was tested in three time blocks. During the first block (covered by the report part 1 below) the target manipulator unit was heated and both of its solid-state ion emitters were heated to degas them. All of these actions were successful.

During the second part of the commissioning (covered by the report part 2 below) ion emission was obtained from both emitters and several mass spectra were received on ground and showed the good performance of the instrument as expected from the last laboratory measurements before delivery.

However, a word of caution is needed: Both emitters show features, which are common to the on/off operation of these types of ion sources, which include higher than normal voltages needed to get them started, as well as unexpected return to normal conditions without obvious reasons.

At the end of the commissioning the emitter 'C', which previously was hard to turn ON worked flawlessly, while the emitter 'A' which previously worked excellently caused problems. This problem will need special attention in the future maintenance operations, which are planned roughly every 9 months into the mission.

All in All, COSIMA is expected fit and performing to specification and therefore ready for the comet.

The COSIMA team is having a post-commissioning workshop 22. – 25. November 2004. New findings from this workshop can obviously not be presented here.

A powerpoint file with 4-6 slides will be prepared for the review after the COSIMA workshop

COSIMA commissioning report
Part 1

Maria Genzer
Finnish Meteorological Institute

1 COSIMA commissioning objectives

The objectives of the 1st part of COSIMA commissioning in March 2004 were:

- Self-check of all hardware sub-systems with low voltage levels
- Science simulation to check the telemetry delivery path
- Unlocking the grip of the Target Manipulator Unit (TMU)
- Removing the cover from the dust outlet and moving it into storage
- Heating both emitters (A and C) for 2 hours each to help the outgassing

The commissioning steps involving high voltages (like starting the ion beam and making a test measurement) will be carried out in September during the Commissioning slot 3, after sufficient outgassing time has passed.

2 Commissioning steps

All times in UTC.

7.3.2004 23:58 COSIMA switch-on.

Switch on procedure successful. Several out-of-limits received. All values acceptable, the reason for the OOLs is that some of the limits are set wrong in the RSDB. The RSDB is to be updated.

At first, COSIMA internal temperature reading was much lower than the S/C reading. It was later discovered that the COSIMA team had wrong S/C HK values on the display. The correct temperatures matched the internal readings of COSIMA.

8.3.2004 00:04 Command to start task 16, Self-diagnosis with low voltages.

It was reported by the Spacecraft Analyst that the reading of TM parameter NCSA0043 (DOSE) went very high for a moment, and then returned to normal value.

The explanation for this is, that DOSE value is measured only once every 20 minutes. The high value is the real measurement, and the others are false readings. The limits for this parameter in the RSDB are to be updated.

00:41 Task 16 stopped as expected. All diagnosis passed. Most of the results are within 3% of the expected values, which is very good.

00:51 Command to start task 6, science simulation.

Instead of expected 8 minutes, the science simulation took much longer. The reason for the wrong expectation was, that the science simulation task was always tested on ground with much higher telemetry rate than that available onboard the spacecraft. At 01:35 it was decided to abort the task, because sufficient amount of data had already been produced by the instrument.

01:48 Attempt to abort the task with low-level abortion command.

Because the aborted task would not result in 'Task stop' event, it was decided to test whether the abortion had succeeded, by sending another command that goes to the same execution stack.

01:57 Request for TMU state event.

The 'TMU state' event should have been received immediately, but it wasn't.
01:58:45 'Task stop' event received, and the 'TMU state' event immediately after that.

This proved that the abortion of the Science simulation task did not work, but the task finished later by itself.

Later analysis of the instrument's software showed that the abortion of the task was attempted with a wrong parameter. This was due to an error in the COSIMA Commands Reference Document. The document was updated immediately.

02:03 Command to unlock the TMU grip.

The unlocking procedure was successful, resulting in the initial position for the TMU (TMU relay reading 0x3209).

02:24 Command to grasp target 0xD8 (cover).

Grasping successful, operation ended at 02:37.

02:39 Command to move the grasped target to the storage.

Operation successful, ended at 02:50.

02:52 Command to move the TMU to the initial position.

Operation successful, ended at 03:06. TMU relay reading is 0x3209.

All TMU operations went smoothly. The context file was updated after this.

At this point the PI decided that it would be enough to heat each ion source emitter for 40 minutes instead of 2 hours.

03:14 Commands to heat PIS Emitter A.

Emitter heated at 03:28, maintaining temperature until heater shutdown.

03:33 TMU state event requested, because the last TMU operation (TMU to the initial position) is considered to be a high-level task, and those do not produce TMU state events automatically.

03:57 Command to shut down the emitter heater.

04:00 Commands to heat PIS Emitter C.

At this point it was decided to make an extra test with the Cosiscope camera, while waiting for the emitter heating. The Cosiscope testing was originally left out of the commissioning plan, but since we had some time to spare, the Cosiscope was tested anyway.

04:17 Command to get image from Cosiscope (ZCS21602). No target in front of the camera.

Received 5 Cosiscope error warnings, which is a known feature of the Cosima – Cosiscope interface.

Download of the Cosiscope image began.

Emitter heater current showed an unexpected drop to ≈ 8.8 V (for emitter A it was ≈ 12V). This was interpreted to be due to a good connection between the heater and the structure.

Heating of the emitter C was continued until all Cosiscope data was down.

05:05 Cosiscope image down.

05:10 Command to shut down the heater.

Ground analysis of the Cosiscope image. The analysis shows that parts of the image are missing (black).

05:26 Another command to get Cosiscope image.

10 Cosiscope error warnings received, this is within nominal limits.

06:05 Cosiscope image down.

The image is complete.

06:13 COSIMA shutdown.

The first Cosiscope image was analyzed again and found also complete. The missing parts found before were due to the EGSE software, which is currently not designed for off-line data analysis.

3 Summary of anomalies

Anomaly	Reason	Action
OOLs for several TM parameters.	Wrong limits in the RSDB.	RSDB to be updated.
Very high reading of TM parameter NCSA0043.	The high value is the actual measured value, the others are false values.	RSDB to be updated.
Science simulation task lasted much longer than expected.	The task was always tested on ground with a higher TM rate than available onboard the S/C.	No action. It is not planned to use this task in the future.
Abortion of the science simulation task failed.	Wrong parameter used due to an error in COSIMA Commands Reference Document.	The document was updated immediately.
Emitter heater current drop when heating emitter C.	A good connection between the heater and the structure.	No action.
Parts of the first Cosiscope image missing.	EGSE software problem, the image was actually OK.	EGSE software will be updated to better support off-line analysis.

4 Commissioning results

The commissioning of COSIMA was successful. All sub-systems were proven to function well with low voltages. The Cosiscope was also tested, although this was not part of the original commissioning plan. The instrument is now switched off for the outgassing period. The commissioning will be resumed in September with the steps involving high voltages.

5 Appendices: Screenshots from Cosima EGSE software

All screenshots are taken off-line after commissioning.

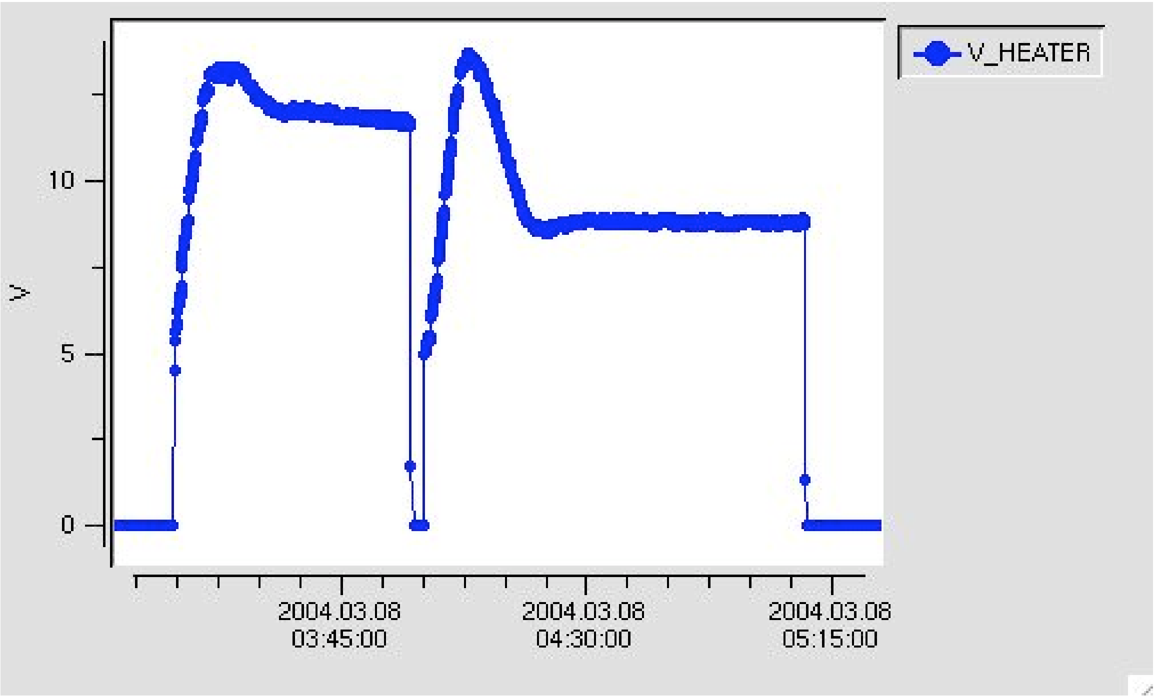


Figure 1. Heater voltage during heating emitters A and C.

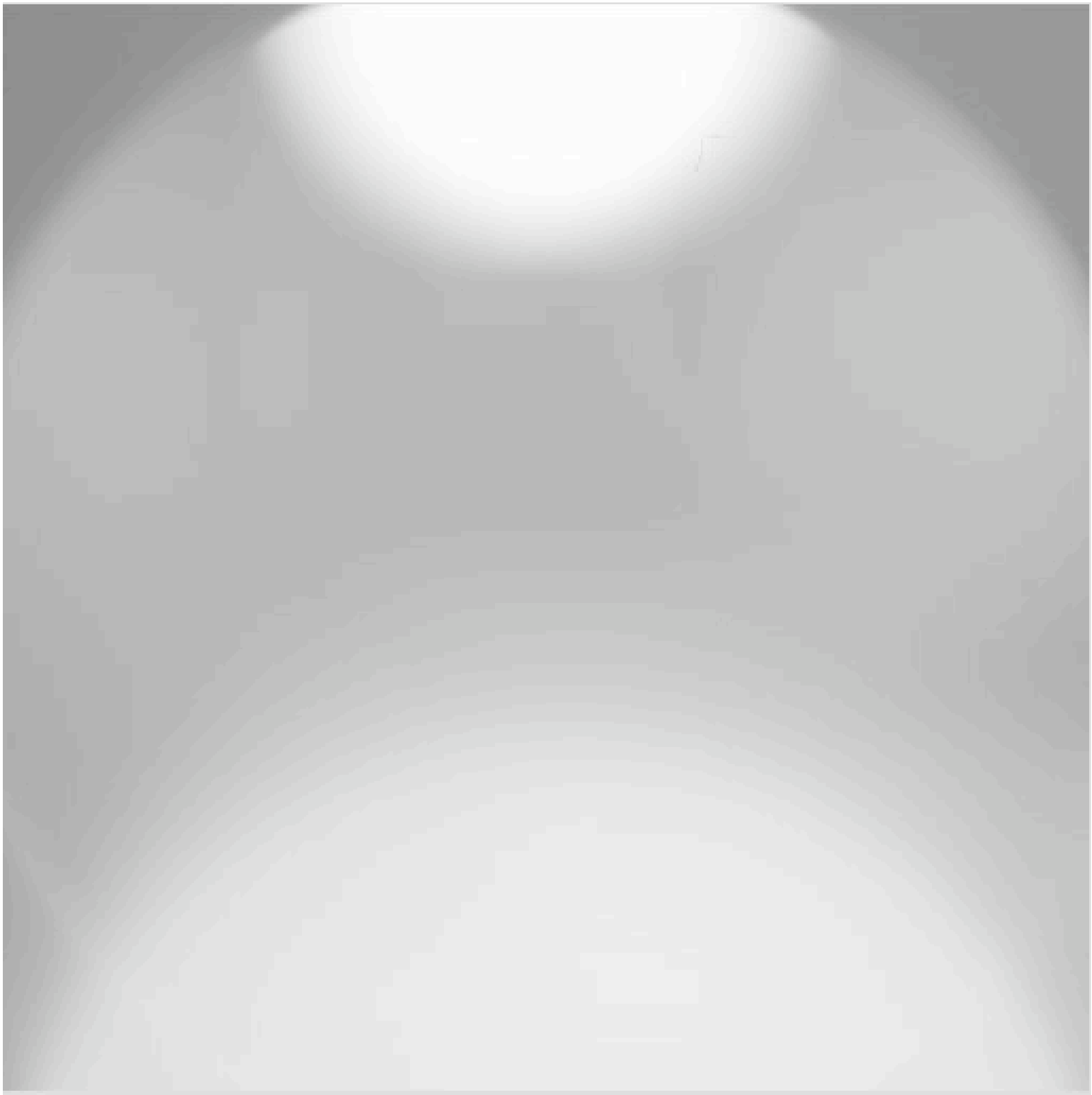


Figure 2. The first image taken by Cosiscope.

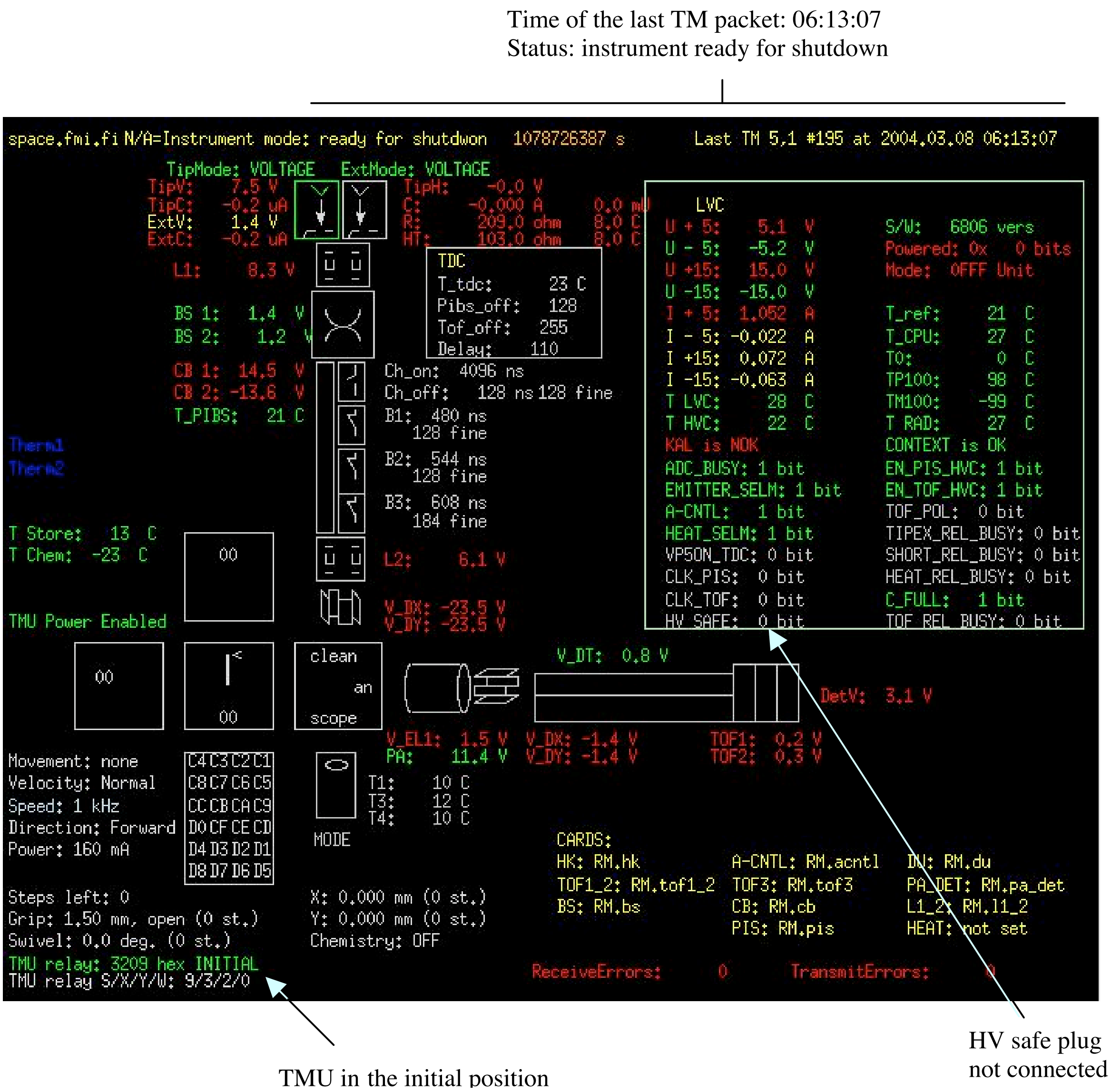


Figure 3. Cosima status just before shutdown.

COSIMA Commissioning Report, Part 2

Maria Genzer
Finnish Meteorological Institute

1 COSIMA commissioning objectives

The objectives of the 2nd part of COSIMA commissioning in September 2004 were:

- Updating COSIMA software to version 8-0-0
- Checkout of high-voltage subsystems
- Testing Cosiscope with –X led
- Activation and stabilization of both ion emitters (A and C)
- Making test measurements (spectra) with emitter A
- Optimisation of instrument performance (deflector optimization scan)

2 Steps of Commissioning part 2

All times are command execution/telemetry generation times in UTC. (One-way travel time for the signal was at that time ≈ 4 min.)

3.9.2004 19:09 COSIMA switch-on with SW patch OBCP

Several out-of-limits received. All values acceptable, the reason for the OOLs is that some of the limits are still set wrong in the RSDB. The RSDB is to be updated.

19:30 Start SW upload from the spacecraft.

20:18 Booting procedure completed. SW version 8-0-0 running in RAM.

20:31 SW version 8-0-0 burned to COSIMA EEPROM.

20:44 Cosima switch-off to test the EEPROM.

20:48 Cosima switch-on. SW version 8-0-0 loaded from the EEPROM. Everything OK.

20:50 Start task 8, self-diagnosis with high voltages.

21:27 Task 8 stopped as expected. All tests passed.

21:38 Commands to heat PIS emitter A. Heater HK (SID 2) enabled.

22:02 HK1 rate reduced to 10 minutes.

22:13 Emitter HK packet (SID 2) disabled. Emitter heating left on for the weekend.

6.9.2004 All HK values from the weekend OK.

19:12 PIS setup: change U_tip_set to 2925 raw ≈ 9.8 kV. This is now the maximum voltage the tip can reach with extractor shorted.

19:30 Set HK1 interval to 2 s.

19:31 Commands to start and immediately shut down emitter A in nominal mode (the first ignition). Ignition successful.

The HK rate did not change until 10 min after the last HK packet was received (nominal behavior of the software), so no detailed HK data was available during the ignition. The events confirm, however, that the ignition was successful.

19:40 HK1 interval set to 60 s.

19:59 Stop heater. Select emitter C and start heating it.

20:14 Start task 4, Picture with Cosiscope, target 0x2D8 (dust cover).

All TMU movements successful. Received 8 Cosiscope error warning events, which is nominal.

20:40 Task 4 completed.

20:51 Cosiscope setup for taking images with –X led (for SW testing purposes).

Start task 4, Picture with Cosiscope, target 0x2D8.

Received 4 Cosiscope error warning events, which is nominal.

20:59 Task 4 completed.

21:09 TMU state event request.

21:35 The first Cosiscope image on ground. Image OK.

21:44 Return Cosiscope parameters to default values (image with +X led).

21:48 Start task 4, image with Cosiscope, target 0x1C2 (silver target with a hole in the middle).

21:52 Reduce HK1 rate to 10 min.

Second image on ground. Image OK.

22:31 Task 4 completed. All TMU movements successful.

23:13 Image of target 0x1C2 on ground. Image OK.

Emitter C left heated until the next pass.

7.9.2004 All HK produced between the passes OK.

20:02 HK1 rate to 1 min.

20:12 HK1 rate to 2 s.
Enable Emitter HK (SID 3).

20:13 Start task 20, stabilize emitter A, with parameters x = 0, y = 300

20:30 Emitter A heated, PIS ignition successful, immediate shutdown as expected ("the first puff").

Wait 300 s.

20:38 PIS ignition.
OOL for NCSA0047 (the limit is not correct in the RSDB).
Emitter current stable.

20:43 PIS shutdown. End task. Emitter A stabilized.

20:57 Setup slot 0 for test spectrum:
Positive spectrum, Scalar measurement, 300 000 shots, IRQ measurements, FIFO + peak list returned.

Start task 19, Test measurement: target 0x1C2, x = 8000, y = 5000.

21:00 PIS test ignition successful. Cosiscope grain information taken. All TMU movements OK.

21:26 PIS ignition successful. Spectrum measured.

21:34 Automatic soft cleaning of the tip after the measurement is completed.

21:36 Task 19 completed.

The resulted spectrum was fine.

21:49 HK1 rate reduced to 1 min.

22:31 Setup slot 102 for deflector optimization scan in y direction.

Start task 3942, Measurement with slot 102: target 0x1C2, x = 8000, y = 5000.

22:34 PIS ignition successful.

22:41 Task 3942 completed. Deflector setup optimized.

23:03 Start heating emitter C.

23:20 Increase heater max. temperature (R_oper = 225 raw).
This was done because previous experience has shown that emitter C needs higher temperature than emitter A.

23:26 Attempt to start emitter C in nominal mode (the first ignition).
No ignition.

COSIMA produced an error event that was not recognized by the system. This was because the subtype for this event was set wrong in the database.

23:45 Attempt to start emitter C in tip startup mode (extractor shorted).
No ignition. The same error event not recognized by the system was produced again.

Starting emitter C failed.

23:55 Decrease heater max. temperature back to nominal (R_oper = 215 raw).

Set HK1 rate to 10 min.

Emitter C left heated until the next pass.

8.9.2004 19:30 HK1 rate set to 1 min.
TMU state event request.

TDC parameters set to the ones used during Cosima XM testing in 2002.
[0x0080, 0x0458, 0x0F9C, 0x11DB, 0x1418, 64, 255]
The default parameters in the software are incorrect. The new parameters are now in the keepalive as long as the keepalive power is on (just as the other parameters saved in the keepalive).

Setup slot 110 for relative TMU scan, x ± 1 mm
Setup slot 111 for relative TMU scan, y ± 1 mm
Setup slot 115 for Positive spectrum, scalar, 90000 shots
Setup slot 116 for Negative spectrum, scalar, 90000 shots

All task commands for measurements sent at once.

19:40 Enable emitter HK (SID 3).

Start task 3950 (measurement with slot 110): target 0x1C2, x = 3375, y = 5200

20:08 PIS ignition. Emitter current not stable, continuously dropping.

20:10 Automatic hard clean procedure of the tip.

Several automatic attempts to start the beam. Always resulting in hard clean.

20:22 HK1 rate increased to 2 s.

Several automatic attempts to start the beam. Always resulting in hard clean.

20:29 Emitter temperature increased (R_oper = 218 raw).

Several automatic attempts to start the beam. Always resulting in hard clean.

20:48 New PIS clean setup:
Extractor threshold for soft cleaning = 2.1 kV
Extractor threshold for hard cleaning = 1.75 kV
Extractor threshold for measurement abort = 1.5 kV
Extractor current for soft cleaning = 30 microA
Extractor current for hard cleaning = 60 microA
Soft cleaning length = 20 s (previously 30 s, default)
Hard cleaning length = 20 s (previously 5 s, default)

20:51 Automatic hard clean with the new settings. Doesn't help.

21:02 Another automatic hard clean. Doesn't help.

21:13 Aborting all operations on-board with low-level commands.

21:15 Hard clean length increased to 60 s.

21:18 Emitter temperature increased (R_oper = 220 raw).

21:22 Start task 20: Stabilize emitter A, x = 60, y = 2

The first ignition with extractor shorted, V_tip > 10 kV (too high…)

Nominal startup => soft clean => hard clean => nominal startup => soft clean

21:41 Task 20 ended. Stabilisation of emitter A was not achieved.

21:55 Cleaning thresholds decreased in order to try to obtain a negative spectrum. PIS clean setup:
Extractor threshold for soft cleaning = 1.2 kV
Extractor threshold for hard cleaning = 1 kV
Extractor threshold for measurement abort = 850 V
Extractor current for soft cleaning = 30 microA
Extractor current for hard cleaning = 60 microA
Soft cleaning length = 20 s
Hard cleaning length = 60 s

Start task 3956 (measurement with slot 116): target 0x1C2, x = 8000, y = 5000

22:01 PIS ignition.
Automatic hard clean.
New ignition.
Extractor voltage drops under measurement abort threshold.
Task aborted automatically.

22:13 Task stop.
The resulting spectrum contained only a little of noise because of the bad beam.

22:24 Start heating emitter C.
Move TMU to initial position.

22:40 Emitter C heated.
Emitter temperature increased still (R_oper = 230 raw).

22:48 TMU in initial position (relay = 0x3209). TMU state event.

23:02 New PIS setup: U_tip_set increased to 3200 raw ≈ 10.6 kV. This is now the maximum voltage the tip can reach with extractor shorted. Extractor voltage threshold for soft clean and the current for the hard clean simultaneously returned to default values.

23:02 Attempt to start emitter C. => Ignition successful!

23:22 Emitter temperature decreased back to nominal (R_oper = 215 raw).

HK1 rate to 10 min.

Emitter C left heated until the next pass.

The nominal commissioning slot reserved for COSIMA ended. The operations of the next pass were carried out by MissionTimeLine and analyzed off-line. Also an extra commissioning slot was requested from the project to investigate emitter A behavior.

9.9.2004 Operations by Mission Time Line.

21:00 HK 1 rate to 1 min.

Emitter temperature increased (R_oper = 230 raw).

22:00 New PIS clean setup:
Extractor threshold for soft cleaning = 2.0 kV
Extractor threshold for hard cleaning = 1.5 kV
Extractor threshold for measurement abort = 1.0 kV
Extractor current for soft cleaning = 30 microA
Extractor current for hard cleaning = 60 microA
Soft cleaning length = 20 s
Hard cleaning length = 60 s

22:01 Start task 21, Stabilize emitter C, x = 0, y = 300

The first ignition successful ("the first puff").
Wait 300 s.
Ignition in nominal mode successful.
Emitter C stabilized.

22:16 Task 21 ended.
HK1 rate to 1 min.
Instrument setup dumped.

22:17 COSIMA shutdown.
COSIMA team was given an extra commissioning slot on 11/12 October for investigating problems with the emitter A.

8.10.2004 Operations by Mission Time Line

19:00 Cosima switch on

Start task 22, TMU maintenance. Successful.

Start heating emitter A.
Emitter was heated to a higher temperature (R_oper = 230 raw) than intended by the operators (nominal = 215 raw), because R_oper parameter had not been changed since using emitter C.

HK1 rate changed to 10 min.

Emitter left heated for the weekend.

11.10.2004 "On-line" operations.

8:14 HK1 rate to 1 min.

8:23 HK1 rate to 2 s.

8:24 Start task 20, Stabilize emitter A, x = 0, y = 300.

Emitter current is not stable. Hard cleaning cycles again and again.

Periodic OOLs for NCSA0047 (extractor current), because the database is not yet updated.

09:11 Task 20 finished. Stabilization did not succeed.

09:33 Start task 3, Grains with Cosiscope, target 0x1C2

Task successful.

10:15 Setup slot 115 for positive spectrum, scalar, 450.000 shots (≈ 5 min of measurement).

PIS clean setup with really low threshold values for cleaning:

Extractor threshold for soft cleaning = 200 V
Extractor threshold for hard cleaning = 150 V
Extractor threshold for measurement abort = 88 V
Extractor current for soft cleaning = 30 microA
Extractor current for hard cleaning = 60 microA
Soft cleaning length = 20 s
Hard cleaning length = 60 s

Start task 3965 (slot 115): target 0x1C2, x = 8000, y = 5000.

Ignition successful. Emitter current not stable. No cleaning cycles because of the very low thresholds.

10:57 Task finished.

11:55 Emitter temperature decreased back to nominal (=215 raw).

Start task 3965 (slot 115): target 0x1C2, x = 8000, y = 5000.

Ignition successful. Emitter current not stable. No cleaning cycles because of the very low thresholds.

12:12 Task finished.

Setup slot 116 for negative spectrum, scalar, 450.000 shots (≈ 5 min of measurement).

12:22 Start task 3966 (slot 116): target 0x1C2, x = 8000, y = 5000.

Ignition successful. Emitter current not stable. No cleaning cycles because of the very low thresholds.

12:38 Task finished.

13:10 PIS setup changed for special test with tip current:
Threshold for soft cleaning = 200 V
Extractor current for hard cleaning = 5 microA

13:13 Low-level test commands enabled for tip current test

Beam started in cleaning (tip) mode with medium level command.

13:16 Ignition successful. HK1 rate to 2 s.

13:20 Tip current levels changed every 15 seconds with low-level test command. The levels used are: 10 microA, 15 microA, 20 microA, 25 microA, 20 microA, 15 microA, 10 microA, 5 microA

13:22 PIS beam shutdown. Low-level test commands disabled.
14:09 HK1 rate to 60 s.

New PIS setup for testing emitter C:
Extractor voltage threshold for soft cleaning = 2 kV
Extractor current for hard cleaning = 80 microA
Max. extractor voltage = 10.6 kV

PIS clean setup - same values as during previous emitter C stabilization:
Extractor threshold for soft cleaning = 2 kV
Extractor threshold for hard cleaning = 1.5 kV
Extractor threshold for measurement abort = 1 kV
Extractor current for soft cleaning = 30 microA
Extractor current for hard cleaning = 60 microA
Soft cleaning length = 20 s
Hard cleaning length = 60 s

Select emitter C.

Start PIS heater.

14:29 HK1 rate to 10 min.

Emitter C left heated for the night.

12.10.2004 08:12 HK1 rate to 1 min.
Heater temperature increased (R_oper = 230 raw).

08:22 HK1 rate to 2 s.

08:42 Start task 21: Stabilize emitter C, x = 0, y = 300

08:43 Ignition in tip mode ("the first puff"). Shutdown as expected.

Wait 300 s.

08:52 Ignition in nominal mode. Current stable.

08:57 Task ended. Emitter C stabilized.

09:19 PIS clean setup with really low threshold values for cleaning:
Extractor threshold for soft cleaning = 200 V
Extractor threshold for hard cleaning = 150 V
Extractor threshold for measurement abort = 88 V
Extractor current for soft cleaning = 30 microA
Extractor current for hard cleaning = 60 microA
Soft cleaning length = 20 s
Hard cleaning length = 60 s

Setup slot 117: backup (emitter C) positive spectrum, scalar measurement, 450.000 shots (≈5min of measurement)

Setup slot 118: backup (emitter C) negative spectrum, scalar measurement, 450.000 shots (≈5min of measurement)

Start task 3957 (slot 117), target 0x1C2, x = 8000, y = 5000.

Ignition successful. Emitter current stable.

09:35 Task finished. Produced good spectrum.

Start task 3958 (slot 118), target 0x1C2, x = 8000, y = 5000.

Ignition successful. Emitter current stable.

09:46 Task finished. Produced good spectrum.

11:21 PIS heater shutdown.

TMU state request.

TMU moved back to initial position.

11:29 TMU in initial (relay 0x3209).

TMU state request.

PIS heater temperature set back to nominal (R_oper = 215 raw).

PIS clean setup:

Extractor threshold for soft cleaning = 2 kV
Extractor threshold for hard cleaning = 1.5 kV
Extractor threshold for measurement abort = 1 kV
Extractor current for soft cleaning = 30 microA
Extractor current for hard cleaning = 60 microA
Soft cleaning length = 20 s
Hard cleaning length = 60 s

Dump instrument setup.
Dump slots 115, 116, 117, 118.
Dump context file.

11:53 Cosima Power off OBCP.
COSIMA OFF.

3 Summary of anomalies

Anomaly	Reason	Action
OOLs for several TM parameters.	Wrong limits in the RSDB.	Update RSDB.
Some events were not recognized by the ground system.	Wrong event types in the RSDB.	Update RSDB.
Emitter C did not ignite the first time tried. Stabilization failed.	Probably emitter temperature was not sufficient. Stabilization worked next time with higher temperature.	Heater temperature for emitter C operation should be set to 230 raw.
Emitter A very unstable since 8.9.2004. Difficult to produce spectra with emitter A.	Unknown.	Emitter C can be used for science measurements. Tests with emitter A will continue in the future.

4 Commissioning results

Commissioning of COSIMA was successful with the exception of unstable behavior of emitter A. All other sub-systems performed well.
The automatic maintenance procedure for the emitters has to be modified based on results of the commissioning phase. New procedures will be delivered to RSOC well before the first automatic maintenance slot.
COSIMA scientific objectives can still be achieved using emitter C also for scientific measurements (backup mode).

5 Appendices: Screenshots from Cosima EGSE software

All screenshots are taken off-line after commissioning.

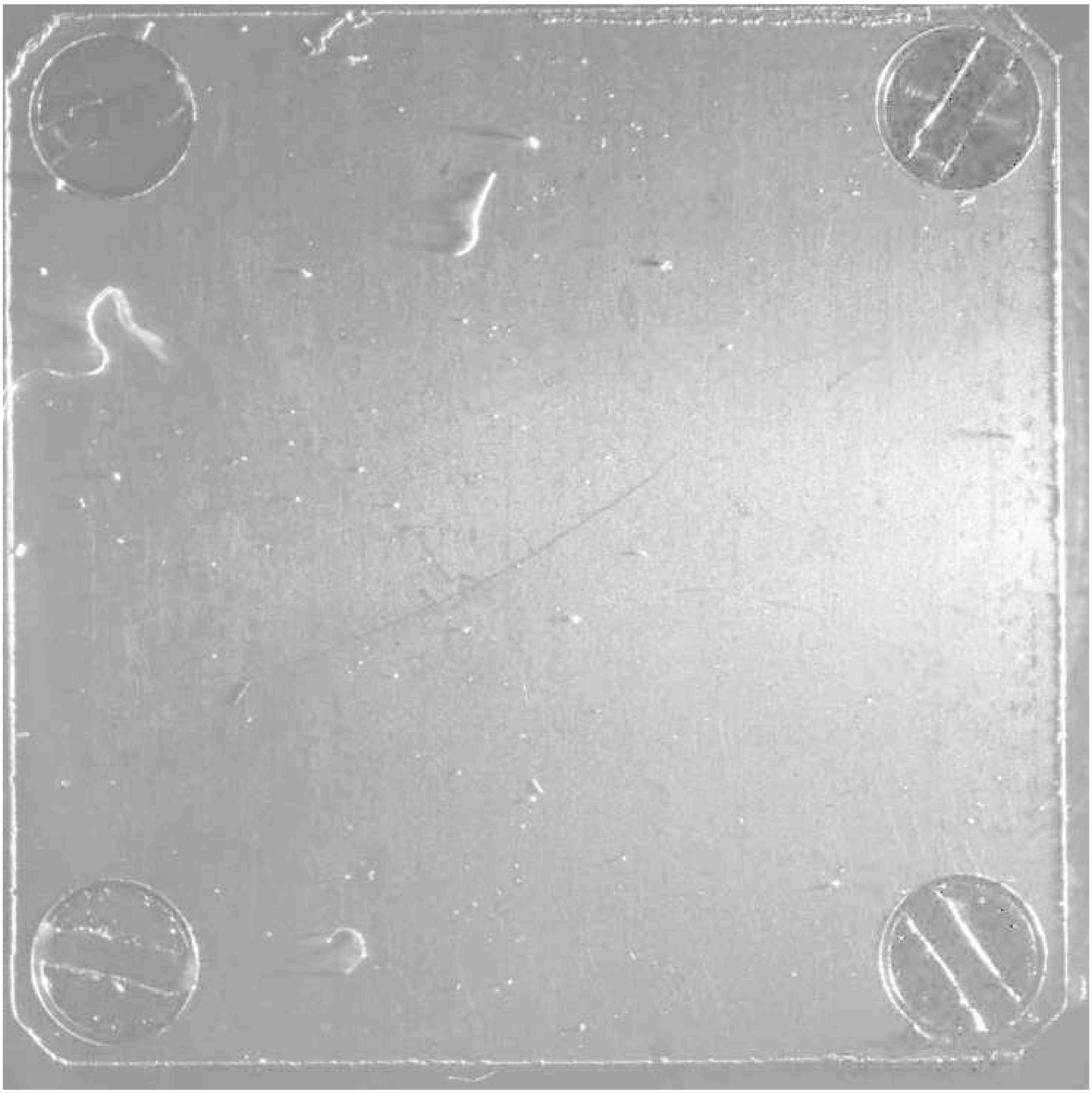


Figure 4. Cosiscope picture of target 2D8 (dust outlet cover).

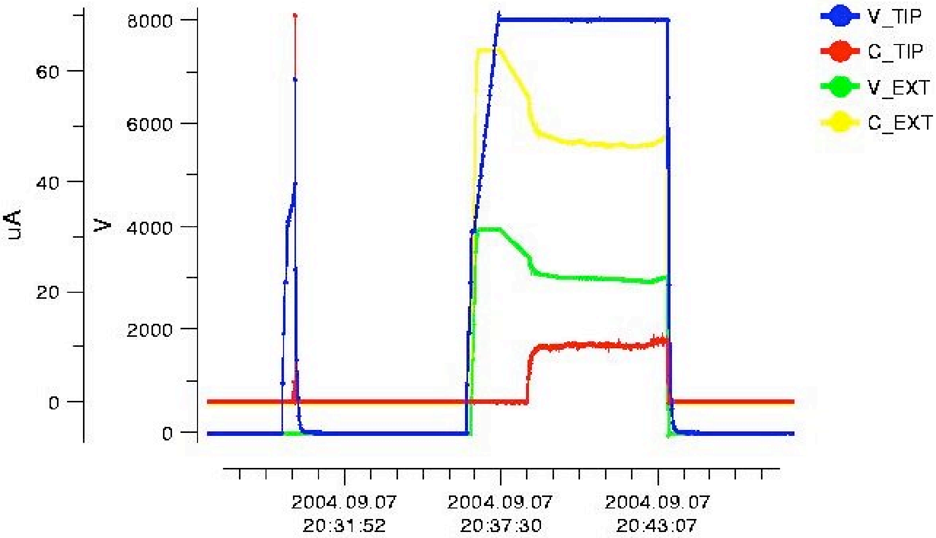


Figure 5. Tip and extractor currents and voltages during the first (successful) stabilization of Emitter A.

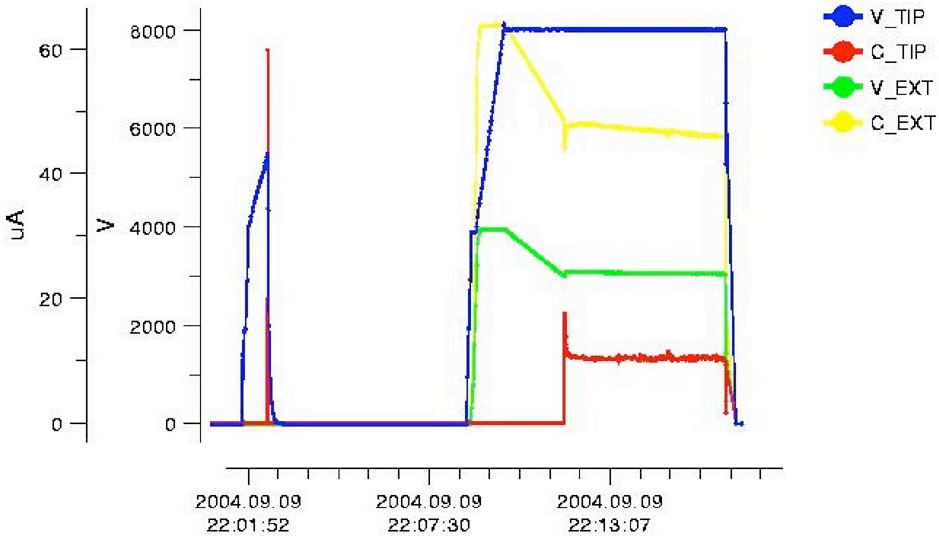


Figure 6. Tip and extractor currents and voltages during the second (successful) stabilization of Emitter C.

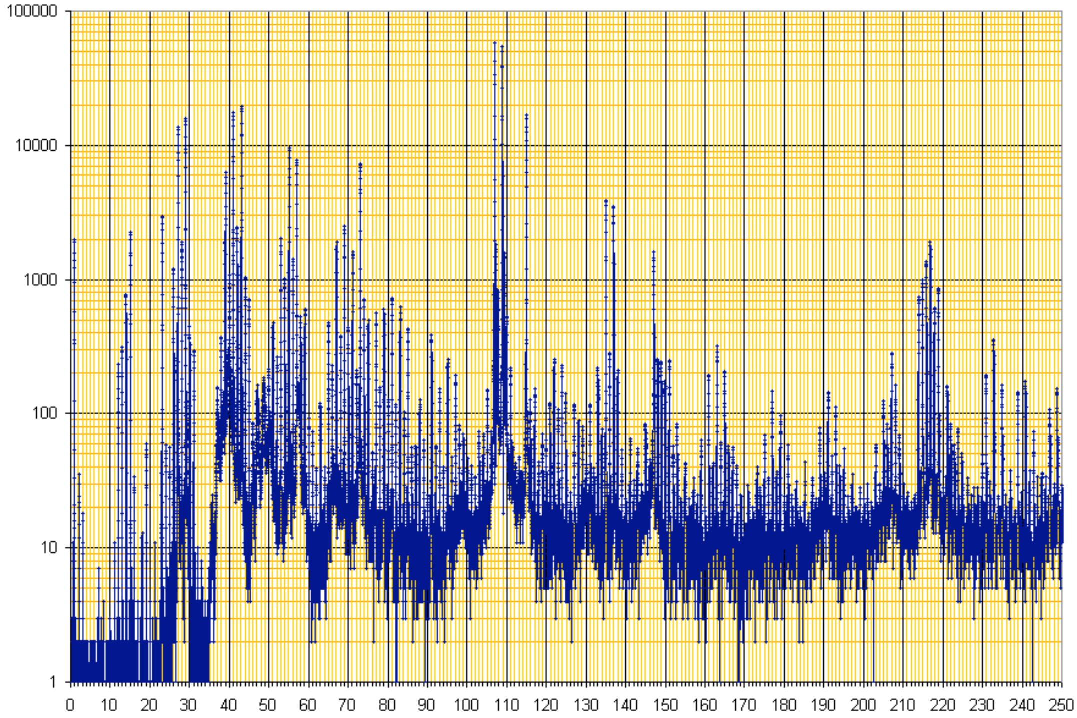


Figure 7. The first spectrum produced by COSIMA in space (Emitter A, when it was still working fine).

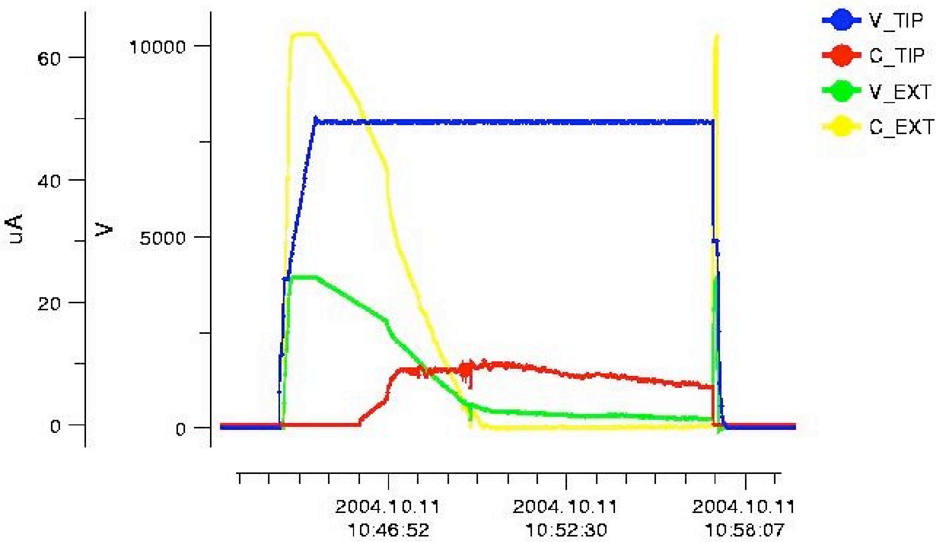


Figure 8. Tip and extractor currents and voltages during unstable behavior of Emitter A.

Draft Summary Report of the COSIMA Interference Test 1

Jouni Rynö
Finnish Meteorological Institute

COSIMA interference 1 report from 20.-21.9.2004

Summary:

Only the Target Manipulator Unit (TMU) generated possible interference.

A software bug prevented COSIMA to operate the Time To Digital Card. The same bug prevented COSIMA to measure any possible noise from other instruments.

Note:
If the interference test is to be repeated, an additional calibration command needs to be inserted before the TDC measurement command as the time to measure must be shorted in order to avoid the auto-calibration of the TDC which happens due to temperature change in the TDC boards and as a side effect zeroes the measurement timer.

Detailed operations:

A bug in the COSIMA operational code 8.0 prevented TDC measurement to continue the requested time. Instead it was stopped almost immediately after a calibration cycle.

Each TMU operation generates from the the time stamp:
- 2 s pause
- 5 s motor operation
- 1 s pause
- 5 s motor operation

For the X motor, the motor operates at 8 kHz, for the S motor 4 kHz.

2004-09-20T10:12:24	operational HV levels
2004-09-20T10:12:25	TDC on
	science packets lost
2004-09-20T10:40:02	TDC and HVs off
2004-09-20T21:31:02	TMU X-motor operation
2004-09-20T21:31:19	TMU S-motor operation
2004-09-20T21:32:02	TMU X-motor operation
2004-09-20T21:32:19	TMU S-motor operation
2004-09-20T21:33:02	TMU X-motor operation
2004-09-20T21:33:19	TMU S-motor operation
2004-09-20T21:34:02	TMU X-motor operation
2004-09-20T21:34:19	TMU S-motor operation
2004-09-20T21:35:02	TMU X-motor operation
2004-09-20T21:35:19	TMU S-motor operation
2004-09-20T21:36:02	TMU X-motor operation
2004-09-20T21:36:19	TMU S-motor operation
2004-09-20T21:37:01	TMU X-motor operation
2004-09-20T21:37:18	TMU S-motor operation
2004-09-20T21:38:02	TMU X-motor operation
2004-09-20T21:38:19	TMU S-motor operation

2004-09-20T21:41:14	operational HV levels
2004-09-20T21:42:03	TDC on
	science packets lost
2004-09-20T22:31:14	TDC and HVs off
2004-09-20T22:32:02	operational HVs and TDC on
2004-09-21T01:20:02	TDC and HVs off
2004-09-21T01:21:00	TMU X-motor operation
2004-09-21T01:21:17	TMU S-motor operation
2004-09-21T01:21:34	TMU X-motor operation
2004-09-21T01:21:51	TMU S-motor operation
2004-09-21T01:22:09	TMU X-motor operation
2004-09-21T01:22:26	TMU S-motor operation
2004-09-21T01:22:45	TMU X-motor operation
2004-09-21T01:23:02	TMU S-motor operation
2004-09-21T01:23:19	TMU X-motor operation
2004-09-21T01:23:37	TMU S-motor operation
2004-09-21T01:23:53	TMU X-motor operation
2004-09-21T01:24:10	TMU S-motor operation
2004-09-21T02:00:03	COSIMA shutdown
2004-09-21T17:01:00	COSIMA power on
2004-09-21T17:32:24	Operational HV levels
2004-09-21T17:32:25	TDC on
	science data unsable for analysis
2004-09-22T02:00:01	TDC off
2004-09-22T02:00:17	COSIMA off

As of 09. November 2004, there was no attempt for a interference Test 2 which includes COSIMA.
In case of a future test, the ACSS001C would need the command ZCS21401 \ # tdc/calibrate added before the ZCS21406 tdc/measure -command.