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DOCUMENT

Herschel Post Helium Tests And Spacecraft Disposal Plan

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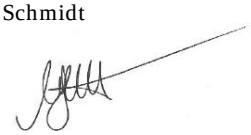
M. Schmidt  2013.03.27 14:45:22 +01'00'	27/03/2013

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1 INTRODUCTION

1.1 Purpose and Scope

This document schedules the Herschel operations activities starting with the end of Herschel routine phase until final disposal of the S/C.

These activities include technology experiments, disposal Delta-V, etc. until the last contact.

1.2 Applicable Documents

Applicable documents are those which either supersede or form an intrinsic part of this document.

[AD-1] Herschel MOC Project Closure Plan
PT-HMOC-OPS-PL-6221-OPS-OAH, Draft 1, 18/02/2013

1.3 Reference Documents

Reference documents are intended to provide background and supplementary information.

[RD-1] Herschel SVT-5 Test Plan
PT-PMOC-OPS-PL-6229-OPS-OAH, Issue 1.0, 25/02/2013

1.4 Acronyms

AOS	Acquisition of Signal
AVM	Avionics Model
CCU	Cryostat Control Unit
CDMS	Central Data Management Subsystem
CRP	Contingency Recovery Procedure
DTCP	Daily Telecommunication Period
EoHe	End of Helium
EPOS	Enhanced Planned Observation Sequence
FCT	Flight Control Team
FD	Flight Dynamics
HSC	Herschel Science Centre
ICC	Instrument Control Centre
LGA	Low gain Antenna
MTL	Mission Timeline
OD	Operational Day

PM	Processor Module
POS	Planned Observation Sequence
RWB	Reaction Wheel Bias
RWL	Reaction Wheel
S/C	Spacecraft
SCM	Science Mode
SOI	Special Operations Instruction
SVM	Service Module
SVT	System Validation Test
TC	Telecommand
TM	Telemetry
TX	Transmitter

2 OVERVIEW ABOUT ACTIVITIES

2.1 Detection of EoHe

The end of Herschel Routine phase is defined by running out of Helium, which prevents the continuation of science activities.

DTCP-X = DTCP when SPACON detects EoHe ([1])
T_0 = Date of DTCP-X

EoHe will be detected when two or more of the following parameters show hard OOL (CCU-A assumed to be in use):

KD200302 C100_0_T102 > 2.0 K

KD201302 C100_0_T105 > 2.0 K

KD204302 C100_2_T106 > 2.0 K

KD204303 C100_2_T107 > 2.0 K

2.2 Impact of EoHe

EoHe will cause the loss of external disturbance torque, which has following effects:

- Risk that autonomous RWB will be performed. If this happens during the last long slew in OD-(X-1) to DTCP-X attitude, it would interrupt the slew, probably leaving the S/C in a non-DTCP attitude at AOS.
  - The No-TM CRP would handle this situation by switching to TX-2 using the LGA.
  - To avoid this No-TM situation at all, HSC will place a repetition of this DTCP slew into each POS files at the end of ODs. Should the initial slew be executed nominally, the repeated slew will be a "null-slew", which does not cause harm; but should the initial slew fail, the repeated command will slew the S/C to DTCP attitude (resulting only in a late AOS of some minutes)
- Higher frequency of RWB may be required. FD needs one OD (i.e. OD-X) to assess external disturbance torque. Should more than one RWB per OD be required, the EoHe Mission Re-Planning (see 2.6) must start from PSF level in order to introduce additional SOPS windows.

2.3 Preparation for EoHe

FD:

- FD to provide alternative EPOS files, for OD 1401 – 1434 (covering the period from mid March to mid April). These EPOS files shall contain slews to maintain Earth pointing attitude (and other regular ACMS maintenance, like RWB, OBDB updates, etc.). The slews will be performed just after each DTCP.

[1] Probably end of March 2013: DTCP time early afternoon (via NNO station)

FCT:

- Mission planner to generate alternative MTLs from FD EPOS
- Naming convention: From "H_1404A___EoH_..." to "H_1432B___EoH_..."

SVM:

- Last slot reserved for station keeping (on 15/03/2013) will be used for the so-called "Departure Manoeuvre" (see 2.8.1)

HIFI:

- Nothing special to do

PACS:

- Nothing special to do

SPIRE:

- Disable SPIRE instrument internal monitoring prior to last block of SPIRE observation:
  - DTCP-1405: Manually send command SC007500 (STOP_MONITORING)
  - SPIRE ICC plans to monitor its execution (no R/T Science required)

2.4 Special Activities in DTCP-X

Following special activities shall be performed in DTCP-X. An SOI (see 4) shall be prepared for this event.

If EoHe occurs during the DTCP (CASE 1 EoHe):

- SPACON to inform SOM
- SPACON to continue standard DTCP activities
- All other special EoHe activities shall be performed in DTCP-(X+1)

If EoHe is detected at AOS (CASE 2 EoHe), these are DTCP-X activities; if EoHe occurred during last DTCP (CASE 1 EoHe), these are DTCP-(X+1) activities:

- SPACON to inform SOM (SOM will inform On-Call SOE and On-Call FD)
- FD to provide TPFs for RWB and slew to Earth pointing attitude
- On-Call SOE to execute the TPFs for this DTCP
- Instruments shall be put into a "safe" mode (if not already):
  - PACS: Disable sub-schedule and switch off
  - HIFI: Disable sub-schedule and command to Dissipative-II (band 5b) (HIFI will most likely already be in Diss-II (band 5b) at EoHe) Disable stdby-0 autonomy, LCU comm. autonomy and LCU checksum autonomy
  - SPIRE: Disable sub-schedule and

- Scenario 1: EoHe is discovered while SPIRE is in REDY mode
  - No further actions
- Scenario 2: EoHe is discovered while the SPIRE cooler recycle is in progress (CREC mode)
  - No further actions (cooler recycle will timeout and fail without any side effects)
- Scenario 3: EoHe is discovered while SPIRE is observing
  - Trigger OBCP 1105h "DB_OBCP_H_SPIRE_STANDBY" manually (via TC DC5ST185) to put SPIRE back into REDY mode

- Further ACMS slews by MTL shall be avoided as well; therefore to simplify sub-schedule operations, following actions shall be performed:
  - Disable all sub-schedules
  - Delete MTL
  - Re-enable all sub-schedules again
- Upload alternative MTL, starting execution after this DTCP

2.5 Period between DTCP-X and End of OD-(X+6)

DTCP activities:

- For DTCPs following DTCP-X (until the re-planned HSC POS-(X+7) takes over) the alternative MTLs can do all basic stuff. If additional RWBs are necessary, FD will provide additional TPFs for manual execution during DTCPs.
- Continuation of manual SPIRE and HIFI checks

Station request:

- When T_0 and X are known, option for SPIRE Test A (requires ~6h) shall be selected: Is extension of DTCP-(X+15) possible or is an additional pass within OD-(X+15) required?

Test schedule update:

- SOM and ACMS SOE to decide in which DTCPs (X+1...14) the STR-2 CCD dump and the RWL initial test shall be performed

2.6 Mission Re-planning triggered by EoHe

No urgency is required for this re-planning process, therefore weekend work shall be avoided. When SOM is informed about EoHe in DTCP-X by SPACON, SOM will contact FD and HSC to trigger re-planning starting from OD-(X+7).

FD will need one OD to assess the external disturbance torque. If necessary FD will provide new PSFs for the re-planning.

2.7 Technology Tests

2.7.1 HIFI Tests

2.7.1.1 HIFI Zig-Zag Test

- Duration: 1 day
- MTL driven (provided by HSC POS file)

2.7.1.2 HIFI WBS Test

- Duration: 7 days
- MTL driven (provided by HSC POS file)
- DTCPs will remain empty (of POS commands)

2.7.1.3 HIFI Switch off

HIFI ICC needs time to confirm that tests are successful; when confirmed, HIFI shall be switched off.

2.7.2 SPIRE Tests

SPIRE tests shall be performed once the instrument is warm and relatively stable, as the objective is to compare results with the warm tests performed on ground before launch.

2.7.2.1 SPIRE Test A: Warm Functional Tests

- Duration: ~6h.
- All tests will be run manually from REDY mode using MOIS procedures already delivered to MOC.
- Tests will be done in one extended DTCP or split between the nominal DTCP and a second pass within the same OD.

#	Test Procedure Name	FOP Procedure (H_COP_SPI_XXXX)	Purpose	Duration [min]
1	SPIRE-CP-FUNC-PCAL-01-P	PCAC	PCAL Characterisation Test PRIME (TBC)	10
2	SPIRE-CP-FUNC-SCAL-01-P	SCAC	SCAL Characterisation Test PRIME (TBC)	20
3	SPIRE-CP-FUNC-BSM-01-P	BSSC	BSM Chop/Jiggle Sensors check PRIME	10
4	SPIRE-CP-FUNC-BSM-03-P	BS03	BSM Open Loop Dynamics Check PRIME	10
5	SPIRE-CP-FUNC-BSM-05A-P	BS5A	BSM Open Loop Chop Test PRIME	10
6	SPIRE-CP-BSM-INIT	BSMI	BSM Initialisation Test PRIME	10
7	SPIRE-CP-FUNC-BSM-05B-P	BS5B	BSM Close Loop Chop Test PRIME	10
8	SPIRE-CP-FUNC-BSM-06-P	BS06	BSM Close Loop Operational Mode Chop Test PRIME	10
9	SPIRE-CP-BSM-0FF-P	BSMF	BSM switch OFF PRIME	10
10	SPIRE-CP-FUNC-SMEC-01-LVDT-P	LSCP	SMEC LVDT check PRIME	10
11	SPIRE-CP-FUNC-SMEC-03	SMEP	SMEC Encoders Levels Check	10

12	SPIRE-CP-FUNC-SMEC-04A	SMPP	SMEC Open Loop Positioning Test	30
13	SPIRE-CP-FUNC-SMEC-09	SMOS	SMEC Open Loop Scan Check	20
14	SPIRE-CP-SMEC-OFF-P	MSMF	SMEC switch OFF PRIME	10
15	SPIRE-CP-BASIC-REDY	REDB	Put SPIRE in REDY mode	10

2.7.2.2 SPIRE Test B

Following analysis of the functional test data, it is expected that a new calibration MC will be delivered to the HSC, together with the (existing) AORs below which will be performed from the MTL.

Min. 1 week shall be scheduled between Test A and B to prepare/update MTLs.

- Duration: 1 OD
- MTL driven
  - Photometer
    - SpirePhoto_Cal_JfetVssTestCGen - Standard photometer JFET Vss test (No Pointing) – 2120 seconds
    - SpireEngREDYtoPHOT_STBY (No Pointing) – 454 seconds
    - SpirePhoto_Cal_StdLoadCurve – Standard Load Curve pointing at Dark Sky – 1094 seconds
    - SpireEngPHOT_STBYtoREDY (No Pointing) – 164 seconds
  - Spectrometer
    - SpireSpectro_Cal_JfetVssTestCGen - Standard spectrometer JFET Vss test (No Pointing) – 1264 seconds
    - SpireEngREDYtoSPEC_STBY (No Pointing) – 611 seconds
    - SpireSpectro_Cal_StdLoadCurve – Standard Load Curve pointing at Dark Sky – 1059 seconds
    - SpireEngSPEC_STBYtoREDY – 193 seconds
    - SpireEngSmecScan – two AORs (Low and High Res scans) – 208 and 328 seconds respectively.

2.7.2.3 SPIRE Test C

The final set of tests will be of the DPU EEPROM, on both the nominal and redundant side, to check the integrity of the primary and secondary partitions.

Min. 1 day shall be scheduled between Test B and C.

- Duration: 2 ODs

- Part 1 (MTL driven): On the primary EEPROM partition NOMINAL side (which contains the faulty EEPROM page since before launch):
  - 1.1 - PM Full Dump
  - 1.2 - DM Full Dump
  - 1.3 - EEPROM Full Dump
  - 2.1 - Write to EEPROM Primary Side WITHOUT ANY PAGE SKIP
  - 2.2 - Write to EEPROM Secondary Side WITHOUT ANY PAGE SKIP
  - 2.3 - EEPROM Full Dump
  - 2.4 - It is assumed that the TC at 2.1&2 is correctly executed
  - 2.5 - wait 10 minutes
  - 2.6 - EEPROM Full Dump
  - 3.1 - Write to EEPROM Primary Side WITH PAGE SKIP
  - 3.2 - Write to EEPROM Primary Side WITH PAGE SKIP
  - 3.3 - EEPROM Full Dump
  - 3.4 - It is assumed that the TCs at 3.1& 3.2 are correctly executed
  - 3.5 - wait 10 minutes
  - 3.6 - EEPROM Full Dump
  - 3.7 - wait 1 hour
  - 3.8 - EEPROM Full Dump
  - 3.9 - wait ~ 6 hours
  - 3.10 - EEPROM Full Dump
  - 4.1 - DPU Switch OFF
  - 4.2 - Wait the shortest time possible (i.e. a few minutes)
  - 4.3 - DPU Switch ON – NOMINAL Side
  - 4.4 - PM Full Dump
  - 4.5 - DM Full Dump
  - 4.6 - EEPROM Full Dump
- Part 2 (manual)
  - 5.1 - SPIRE NOMINAL Side Switch OFF
  - 5.2 - DPU REDUNDANT Side Switch On
- Part 3 (MTL driven)
  - Repeat steps 1-4 on the DPU REDUNDANT side.

2.7.2.4 SPIRE Switch off

SPIRE ICC needs time to confirm that tests are successful; when confirmed, SPIRE shall be switched off.

2.7.3 ACMS Tests

2.7.3.1 Long staring Pointings Test

- Test proposed by PACS ICC
- Duration: 1 day

- MTL driven (provided by HSC POS file, no specific requirement on FD for support)
- PACS instrument is off. Pointing test only.
- 2 long stares of about 10 hours, each on two different targets.

2.7.3.2 Interlacing staring and Line scan Test

- Test proposed by PACS ICC
- Duration: 1 day
- MTL driven (provided by HSC POS file)
- PACS instrument is off. Pointing test only.
- Long staring observations (2hr staring observation of target -- then 2hr observation on target with different control loop and interlacing (must be a target where interlacing enabled)-- set by MOC. Repeat last two observations without interlacing and time tagged by MOC. Can be done on the MTL provided by HSC POS file. Do two degree line scans with interlacing on at different scan speeds [back and forth] ~2hrs total for tests.
- Some tests should be done with and without interlacing switched on. HSC to inform MOC/FDS of the times for when interlacing should NOT be enabled (i.e. departure from standard operational procedure).
- MOC will use the timeline based on the EPOS and only the change of the control loop gains will be done via time-tagged manual commanding (and this will be done with time tagged commands by Dave).

2.7.3.3 RWL at low speeds Test

2.7.3.3.1 Test Objectives

In order to exercise the Reaction Wheels (RWL) in a similar way to the Euclid scientific observations, an in-flight experiment has been proposed by TAS-I and agreed by ESA as part of the Herschel end-of-life technological tests.

Opposite to what is done in Herschel where the RWL's are always operated at relatively high speed, the specific interest exists in preparation of other scientific missions for observing the behaviour of the RWL's at low speed and in presence of frequent start-stop events. The main purpose of this test is to characterize the RWL's stiction and friction and their evolution.

2.7.3.3.2 Test Overview

- Test proposed by TAS-I
- Duration: 1+11 days
- MTL driven
- Doing a sequence of SCM TC's (raster, RWL-bias, raster, RWL-bias...)

- Industry agreed to remain in SCM using only MTL TC's. Simulation by ESOC is recommended to confirm that RWL bias in SCM brings all 4 wheels to zero. Initial RWL Run-in in OCM is anyhow needed for optimal distribution of lubricant and initial friction estimation.

- Risk of damaging RWL in-flight to be minimized: The sequence could be split in few hours the first day, followed by performance assessment. Then a continuous sequence for the remaining 11 days. Confirmed by Industry. First day: OCM Initial run-in for lubricant distribution and initial friction determination; then Sequence (SCM-raster; SCM-bias-to0) for one hour; Raster number of points (x, y) distance (d0, d1) between points TBD by TAS-I. Any attitude having 9 stars is acceptable.
  - Industry: We assume no new DTM is needed. Activation of DTM containing RWL-Tacho at 4 Hz is desired but not mandatory

2.7.3.3.3 Test Details

In-Flight Activities of DAY-1:

- Initial RWL Run-in performed in Orbit Correction Mode (OCM) (|HRWL| > 10Nms) in order to:
  - Ensure optimal RWL lubricant distribution
  - Determine the initial value of the RWL friction.
- Transition to OCM Fine
- Command RWL Momentum biasing (H=0) in Orbit Control Mode (OCM)
- Transition to Science Mode (SCM)
- Command RWL Momentum biasing (H=0; NullSpaceBias=0) in SCM
- Command Raster Pointing in SCM with parameters defined in Raster_Euclid:
- Command RWL Momentum biasing (H=0; NullSpaceBias=0) in SCM
- Command Raster Pointing in SCM with parameters defined in Raster_Euclid:
- Final RWL Run-in performed in Orbit Correction Mode (OCM) (|HRWL| > 10Nms) in order to:
  - Ensure optimal RWL lubricant distribution
  - Determine the final value of the RWL friction.

Ground activities in the following days:

- Assessment of the ACMS performance (RWL friction and stiction, disturbing torques)
- Timing optimization of the sequence to be repeated in the following days.

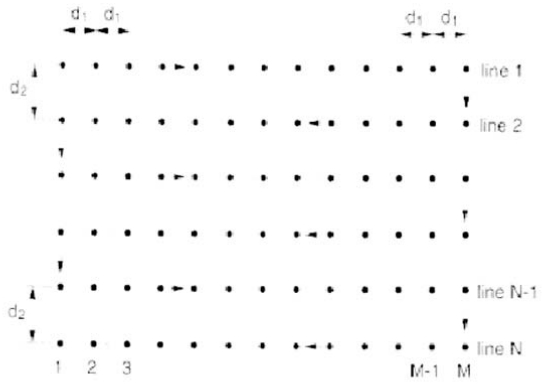
In-Flight Activities of DAY-2 to DAY-12:

- Initial RWL Run-in performed in Orbit Correction Mode (OCM) (|HRWL| > 10Nms) in order to:
  - Ensure optimal RWL lubricant distribution
  - Determine the initial value of the RWL friction.
- Transition to OCM Fine
- Command RWL Momentum biasing (H=0) in Orbit Control Mode (OCM)
- Transition to Science Mode (SCM)
- Continuous repetition of the sequence of commands in SCM:
  - Command RWL Momentum biasing (H=0; NullSpaceBias=0) in SCM
  - Command Raster Pointing in SCM with parameters defined in Raster_Euclid
- Final RWL Run-in performed in Orbit Correction Mode (OCM) (|HRWL| > 10Nms) in order to:
  - Ensure optimal RWL lubricant distribution
  - Determine the final value of the RWL friction

Parameters for the Raster_Euclid:

The ACMS shall compute and execute autonomously all the manoeuvres needed to perform the raster based on the following parameters:

- the quaternion q_{rast} of the 1st raster point (to be computed by ESOC-FD: Compatible with Attitude Pointing Domain; Availability of 9 guide stars in the STR FoV)
- angle φ defining the rotation of the pattern axes with respect to the ACMS reference frame (φ is in the range 0° - 180° with resolution of 0.1°): (to be decided by ESOC-FD)
- the number of pointings per line M (M is in the range 2 - 32): (TASI proposal: M=4)
- the number of lines N (N is in the range 1 - 32): (TASI proposal: N=4)
- the spherical angular distance between successive steps d_1 (d_1 is in the range 2 arcsec - 8 arcmin with resolution 0.5 arcsec); (TASI proposal: d_1=100arcsec)
- the spherical angular distance between successive lines steps d_2 (d_2 is in the range 2 arcsec - 8 arcmin or 0 with resolution 0.5 arcsec. The condition d_2 = 0, means that it shall be possible to scan N times the points of a single line) (TASI proposal: d_2=8arcmin (max length)
- the duration of stable pointing at any position t (t will be between 10 seconds and 30 minutes with the resolution of 1 second) (TASI proposal: t=60sec)



2.7.3.4 AAD Performance Test

2.7.3.4.1 Test Objectives

Check AAD/SAS degradation at the edge of the safe zone, and performance of Level 4. The extra degradation may affect all Sun Sensors in L2, so useful for later missions. Useful to test the TNO hypothesis, because if true the degradation at the edge of the AAD should be less. It will also verify the correctness of the Level 4 concept.

2.7.3.4.2 Test Overview

- Test proposed by industry
- Duration: 1 extended DTCP (5h)
- Manual activity: Disable on-board pointing target limit check and command a slew to an attitude violating the limits. AAD should trigger ACMS level 4 FDIR.
  - Diagnostic packet used to measure AAD current with higher frequency (1 Hz)
  - Or better (TBD): Line scan to step in slower to the limit?

2.7.3.5 STR-2 CCD Dump

2.7.3.5.1 Test Objectives

To compare CCDs between both STRs.

2.7.3.5.2 Test Overview

- Test proposed by industry
- Manual activity, requires 2 hours during a DTCP

2.8 Disposal Delta-V Campaign

2.8.1 Departure Manoeuvre

The last foreseen orbit maintenance slot shall be used for the "departure manoeuvre". This manoeuvre will ensure that, in the event that the spacecraft is disabled during the post operations ACMS tests, an escape away from the Earth Moon system is assured.

- Date: 15/03/2013 (end of OD-1401, start on 2013-03-15 at 12:08:05z)
- Duration: 40min
- Delta-V = 10.51 m/s in escape direction

2.8.2 Disposal Manoeuvre

Enough Delta-V (the “big” manoeuvre) to ensure a disposal orbit, but enough margin left to ensure a stable attitude for CDMU patch.

- Date: 13/05/2013 (Start during DTCP)
- Duration: 10h
- Delta-V = 130 m/s

MGA attitude constraints are not guaranteed during the manoeuvre, therefore a switch over to the LGA will be performed before slewing to manoeuvre attitude.

This Delta-V will result in a significant drop in tank pressure, therefore the thrust related RCS control parameters shall be updated before starting the manoeuvre: RCS control parameters (table in UM for SAM but valid for OCM too) shall be updated to values valid for the middle of manoeuvre.

2.8.3 Draining Manoeuvre

Using up remaining fuel. This part of the Disposal Delta-V Campaign needs to be preceded by the CDMS patch.

- Date: 16/05/2013 (during DTCP)
- Duration: Assumed ~90min
- Delta-V = 18 m/s

MGA attitude constraints are not guaranteed during the manoeuvre, therefore a switch over to the LGA will be performed before slewing to manoeuvre attitude.

See “Passivation” (2.10) as well, both activities are linked.

2.9 CDMS Patch

The CDMS patch shall be applied prior to the Draining Delta-V. Patching all 4 CDMS EEPROMs to prevent autonomous transmitter switch-on by S/C.

Requires one 3h DTCP.

Patch was validated with AVM (H-SVT-5, see [RD-1]).

Any PM reboot using the patched OBSW will result in an entire disabled RF chain (TX+EPC+TWT off).

2.10 Passivation

When fuel runs out during the Draining Manoeuvre, the resulting uncontrolled drift/rotation of the S/C can be monitored, which should result in a loss of solar power, discharge of battery and finally triggering of DoD.

Should the unpredictable drift/rotation result in a periodic charge/discharge of the battery (instead of a quick DoD), a manual CDMU PM reboot shall be performed to activate the patched OBSW, which will switch the entire RF chain (TX+EPC+TWT) off.

As an insurance a CDMU PM reboot TC will be inserted into the MTL (execution time 150min after start of the Draining Manoeuvre). Should Herschel “decide not to die” and should the TC uplink be lost, the PM reboot is done automatically.

To allow uninterrupted monitoring of TM, the LGA and non-coherent TM will be used, and the CDMU event action on AIR will be disabled.

3 SCHEDULE

3.1 Overview

Date	OD	Activities	MTL
15/03/2013	1401	Last "regular" Delta-V: "Departure Manoeuvre"	Nominal
18/03/2013	1405	DTCP: Stop SPIRE on-board monitoring	Nominal
T_0 = Date of DTCP End of March ?	X	SPACON discovers EoHe	Nominal MTL deleted. Replaced by alternative ESOC MTL (based on FD EPOS) starting after DTCP-X
	X+1→6	Manual instrument commanding: ▪ Continue daily SPIRE manual checks ▪ HIFI manual checks according to SOI-87	
		Use one empty DTCP of (X+1) - (X+14): STR-B CCD dump	
		Use one empty DTCP of (X+1) - (X+14): ACMS test: RWL at low speeds – initial test (1 day)	
T_1	X+7	HIFI test: Zig-Zag (1 day) DTCPs empty	HSC MTL (based on HSC POS)
T_2	X+8→14	HIFI test: WBS (7 days) DTCPs empty	
T_3	X+15	SPIRE tests: Part A (1 extended DTCP or requesting a second pass within the same OD)	ESOC MTL (based on FD EPOS)
T_4	X+16→26	ACMS test: RWL at low speeds (11 days)	
T_5	X+27	SPIRE tests: Part B (1 day)	HSC MTL (based on HSC POS)
T_6	X+28	ACMS test: Long staring pointings (1 day)	
T_7	X+29	ACMS test: Interlacing staring and line scan (1 day)	
T_8	X+30→31	SPIRE tests: Part C (2 days)	
End of April / Begin of May	X+32→ 1460	Waiting for Disposal Delta-V: ▪ Slot to repeat HIFI or SPIRE tests	ESOC MTL (based on FD EPOS)
T_9 = 13/05/2013 (Monday)	1461	Delta-V: "Disposal Manoeuvre"	
T_{10} = 14/05/2013 (Tuesday)	1462	CDMS patch	
T_{11} = 15/05/2013 (Wednesday)	1463	ACMS test: AAD Performance (comprising ACMS level 4)	
T_{12} = 16/05/2013 (Thursday)	1464	Delta-V: "Draining Manoeuvre" Passivation	

3.2 Detailed Schedule

Date	OD	Activities
15/03/2013	1401	Last "regular" Delta-V: "Departure Manoeuvre" ▪ 10.51 m/s ▪ MTL driven (at end of OD-1401) ▪ DELTAV_BEG_TIME = 2013-03-15T12:08:04.99999990 (UTC) ▪ Additional pass before start of Delta-V to monitor RWB and slew: ▪ MLG: 10:30z – 11:59z
18/03/2013	1405	Stop SPIRE on-board monitoring **DTCP activities:** ▪ Manually send command SC007500 (STOP_MONITORING) ▪ SPIRE ICC plans to monitor its execution (no R/T Science required)
End of March ? T_0 = Date of DTCP	X	SPACON discovers EoHe **DTCP activities:** ▪ Perhaps late AOS (because of aborted slew by autonomous RWB) ▪ DTCP-X activities described in SOI-83 (see 4) **Other activities:** ▪ SOM to contact HSC to kick off re-planning, starting for OD-(X+7) ▪ Ground station request: Select option for SPIRE Test A (requires ~6h): Is extension of DTCP-(X+15) possible or is an additional pass within OD-(X+15) required? ▪ SOM and ACMS SOE to decide in which DTCPs (X+1…14) the STR-2 CCD dump and the RWL initial test shall be performed ▪ MCS database update (to disable some OOLs, e.g. for CCU)
	X+1	**DTCP activities:** If CASE 1 EoHe (SOI-83, see 4): ▪ DTCP-X activities postponed to here Else: ▪ Nominal DTCP activities (continue uplink of alternative MTLs) ▪ Execute additional TPFs for RWB if necessary ▪ Manual SPIRE and HIFI (SOI-87) checks ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds – initial test (1 day)
	X+2	**DTCP activities:** ▪ Nominal DTCP activities (continue uplink of alternative MTLs) ▪ Execute additional TPFs for RWB if necessary ▪ Manual SPIRE and HIFI (SOI-87) checks ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds – initial test (1 day)

Date	OD	Activities
	X+3	**DTCP activities:** ▪ Nominal DTCP activities (continue uplink of alternative MTLs) ▪ Execute additional TPFs for RWB if necessary ▪ Manual SPIRE and HIFI (SOI-87) checks ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds – initial test (1 day)
	X+4	**DTCP activities:** ▪ Nominal DTCP activities (continue uplink of alternative MTLs) ▪ Execute additional TPFs for RWB if necessary ▪ Manual SPIRE and HIFI (SOI-87) checks ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds – initial test (1 day)
	X+5	**DTCP activities:** ▪ Nominal DTCP activities ▪ Uplink of last alternative MTL: MTL-(X+6) part A ▪ Uplink of first re-planned MTL: MTL-(X+6) part B (containing DTCP-(X+7)) ▪ Execute additional TPFs for RWB if necessary ▪ Manual SPIRE and HIFI (SOI-87) checks ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds - initial test (1 day)
	X+6	**DTCP activities:** ▪ Nominal DTCP activities ▪ Execute additional TPFs for RWB if necessary ▪ Manual SPIRE and HIFI (SOI-87) checks ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds - initial test (1 day)
T_1	X+7	HIFI test: Zig-Zag (day 1): ▪ MTL driven (HSC) **DTCP activities:** ▪ Nominal DTCP activities ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds - initial test (1 day)
T_2	X+8	HIFI test: WBS (day 1): ▪ MTL driven (HSC, DTCPs empty) **DTCP activities:** ▪ Nominal DTCP activities ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds - initial test (1 day)

Date	OD	Activities
	X+9	HIFI test: WBS (day 2): ▪ MTL driven (HSC, DTCPs empty) **DTCP activities:** ▪ Nominal DTCP activities ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds - initial test (1 day)
	X+10	HIFI test: WBS (day 3): ▪ MTL driven (HSC, DTCPs empty) **DTCP activities:** ▪ Nominal DTCP activities ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds - initial test (1 day)
	X+11	HIFI test: WBS (day 4): ▪ MTL driven (HSC, DTCPs empty) **DTCP activities:** ▪ Nominal DTCP activities ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds - initial test (1 day)
	X+12	HIFI test: WBS (day 5): ▪ MTL driven (HSC, DTCPs empty) **DTCP activities:** ▪ Nominal DTCP activities ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds - initial test (1 day)
	X+13	HIFI test: WBS (day 6): ▪ MTL driven (HSC, DTCPs empty) **DTCP activities:** ▪ Nominal DTCP activities ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds - initial test (1 day)
	X+14	HIFI test: WBS (day 7): ▪ MTL driven (HSC, DTCPs empty) **DTCP activities:** ▪ Nominal DTCP activities ▪ TBD: STR-2 CCD dump? ▪ TBD: ACMS test: RWL at low speeds - initial test (1 day)
		HIFI ICC to confirm that HIFI tests were successful: If OK: HIFI switch off If not OK: Check if possible and when to repeat tests

Date	OD	Activities
T_3	X+15	SPIRE test: Test A (day 1) ▪ Manual activities **DTCP activities:** ▪ Nominal DTCP activities ▪ Extend DTCP or schedule a second pass within this OD ▪ Dump SPIRE tables to check health and recover if necessary ▪ Manual test activities
		Following analysis of the functional test data, it is expected that a new calibration MC will be delivered to the HSC. Probably a re-planning for the MTL driven SPIRE tests B and C must be performed.
	Before DTCP-(X+30)	Mission Planning without HSC: ▪ FD to generate EPOS directly from PSF, starting with OD-(X+32)
T_4	X+16	ACMS test: RWL at low speeds (day 2): ▪ MTL driven (FD) **DTCP activities:** ▪ Nominal DTCP activities
	X+17	ACMS test: RWL at low speeds (day 3): ▪ MTL driven (FD) **DTCP activities:** ▪ Nominal DTCP activities
	X+18	ACMS test: RWL at low speeds (day 4): ▪ MTL driven (FD) **DTCP activities:** ▪ Nominal DTCP activities
	X+19	ACMS test: RWL at low speeds (day 5): ▪ MTL driven (FD) **DTCP activities:** ▪ Nominal DTCP activities
	X+20	ACMS test: RWL at low speeds (day 6): ▪ MTL driven (FD) **DTCP activities:** ▪ Nominal DTCP activities
	X+21	ACMS test: RWL at low speeds (day 7): ▪ MTL driven (FD) **DTCP activities:** ▪ Nominal DTCP activities

Date	OD	Activities
	X+22	ACMS test: RWL at low speeds (day 8): ▪ MTL driven (FD) **DTCP activities:** ▪ Nominal DTCP activities
	X+23	ACMS test: RWL at low speeds (day 9): ▪ MTL driven (FD) **DTCP activities:** ▪ Nominal DTCP activities
	X+24	ACMS test: RWL at low speeds (day 10): ▪ MTL driven (FD) **DTCP activities:** ▪ Nominal DTCP activities
	X+25	ACMS test: RWL at low speeds (day 11): ▪ MTL driven (FD) **DTCP activities:** ▪ Nominal DTCP activities
	X+26	ACMS test: RWL at low speeds (day 12): ▪ MTL driven (FD) **DTCP activities:** ▪ Nominal DTCP activities
T_5	X+27	SPIRE test: Test B (day 1) ▪ MTL driven **DTCP activities:** ▪ Nominal DTCP activities ▪ Dump SPIRE tables to check health and recover if necessary
T_6	X+28	ACMS test: Long staring pointings (day 1): ▪ MTL driven (HSC) **DTCP activities:** ▪ VC-3 contains HIFI science ▪ Nominal DTCP activities ▪ Preparation for tomorrow's ACMS test: ▪ H_FCP_AOC_DPAC: ACMS SOE to insert time-tagged gain factor changes into MTL

Date	OD	Activities
T_7	X+29	ACMS test: Interlacing staring and line scan (day 1): ▪ MTL driven (HSC) ▪ Plus manually inserted time-tagged gain factor changes **DTCP activities:** ▪ VC-3 empty ▪ Nominal DTCP activities
T_8	X+30	SPIRE test: Test C (day 1) ▪ MTL driven (HSC) **DTCP activities:** ▪ Uplink of HSC POS based MTL-(X+31) part A ▪ Uplink of FD EPOS based MTL-(X+31) part B (containing DTCP-(X+32)) ▪ Dump SPIRE tables to check health and recover if necessary
	X+31	SPIRE test: Test C (day 2) ▪ MTL driven (HSC) ▪ Manual part in this DTCP **DTCP activities:** ▪ Dump SPIRE tables to check health and recover if necessary ▪ Manual part of Test C ▪ SPIRE NOMINAL Side Switch OFF ▪ DPU REDUNDANT Side Switch On
	X+32	From this OD onwards MTLs based on FD EPOS only **DTCP activities:** ▪ Nominal DTCP activities ▪ VC-3 contains last SPIRE science
		SPIRE ICC to confirm that SPIRE tests were successful: If OK: SPIRE switch off If not OK: Check if possible and when to repeat tests
	X+32 until 1460	Waiting for Disposal Delta-V: ▪ Slot to repeat HIFI or SPIRE tests ▪ Mission planning based on FD EPOS (without HSC)
		When all instruments are switched off: ▪ VC-3 empty ▪ H/K generation reduced to SVM H/K only (max. 9 kbps). Dump of packet store 2 (with 24h of data) will only require ~9 min (or ~90 min if in medium TM rate)

Date	OD	Activities
T_9 = 13/05/2013 (Monday)	1461	Disposal Delta-V: ▪ Duration 10h (130 m/s) ▪ DTCP extended (12h): ▪ NNO: 14:40z – 21:40z ▪ CEB: 21:30z – 04:40z ▪ (MLG not booked, but TC coverage from 22:52z until 10:40z) **DTCP activities:** ▪ Switch to LGA (Delta-V attitude perhaps outside MGA constraints) ▪ Update of thrust related RCS control parameters (using values valid for middle of manoeuvre): H_FCP_AOC_D5SM with TPF AETLP_00 ▪ Start Delta-V ▪ Wait for Delta-V completion (and slew back to DTCP attitude) ▪ Switch back to MGA
T_{10} = 14/05/2013 (Tuesday)	1462	CDMS patch: To prevent autonomous RF chain switch-on by S/C **DTCP activities:** ▪ H_FCP_DHS_EOL: Patch PM-A EEPROM-1 and 2 ▪ H_CRP_SYS_PMSC: PM switchover to PM-B (active PM-B still running on old software) ▪ H_FCP_DHS_EOL: Patch PM-B EEPROM-1 and 2 Comment: From now on any PM reboot will result in RF chain off
T_{11} = 15/05/2013 (Wednesday)	1463	ACMS test: AAD Performance (comprising ACMS level 4) ▪ DTCP extended (5h): NNO, 15:00z – 20:00z **DTCP activities:** ▪ Switch to LGA ▪ H_FCP_AOC_D3FD: Enable 1Hz TM acquisition for AAD ▪ H_CRP_DHS_1008: Disable CDMU event action on AIR ▪ H_FCP_AOC_DAAD: Disable TC-Check on Target within Operational Range ▪ Slewing to attitude violating constraints (perhaps via line scan) to trigger AAD, resulting in ACMS level 4 ▪ H_CRP_SYS_ANOM: Recover from ACMS SM ▪ H_FCP_AOC_DAAD: Re-enable TC-Check on Target within Operational Range ▪ Stay on LGA, leave CDMU event action on AIR disabled

Date	OD	Activities
T_{12} = 16/05/2013 (Thursday)	1464	Draining Delta-V and Passivation: ▪ Expected duration of Delta-V until end of fuel: ~90min ▪ Expected Delta-V: 18 m/s **DTCP activities:** ▪ Switch to LGA ▪ H_CRP_DHS_1008: Disable CDMU event action on AIR ▪ Switch TX to non-coherent ▪ Insert CDMU reboot TC as time-tagged into MTL (execution time 150min after start of Delta-V) ▪ Start Draining Delta-V ▪ Monitoring of last TM: ▪ Running out of fuel -> S/C drifting/rotating -> AAD will trigger ACMS level 4 -> AIR ignored by CDMU -> Loss of solar power -> Battery discharge -> TM available until DoD (CDMU reboot) -> new CDMU OBSW in use -> TX off ▪ Passivation (optional): If DoD does not trigger after a while (i.e. discharge and recharge of batteries while S/C is drifting/rotating), forcing manual CDMU reboot (or wait until MTL executes the inserted CDMU reboot TC)

4 SPECIAL OPERATIONS INSTRUCTION FOR DTCP-X

Herschel Special Operations Instruction

ID	Title
83	End of Helium Instructions
Objective	
This SOI explains how to detect "End of Helium" and which special activities shall be executed in this DTCP.	
Execution Time	
X Once In DTCP: Unknown	□ Repeating Interval: Until:
Description	

End of Helium is detected by:

- Two or more of the following parameters showing hard OOL (CCU-A assumed to be in use):
  a. KD200302 C100_0_T102 > 2.0 K
  b. KD201302 C100_0_T105 > 2.0 K
  c. KD204302 C100_2_T106 > 2.0 K
  d. KD204303 C100_2_T107 > 2.0 K

Communication:

- In order to allow ESA communications office to release a communication note to the outside world, the occurrence of End-Of-Helium shall not be announced to anybody outside the Herschel Flight Control Team once it is noticed on Acquisition of Signal or during a DTCP.
- Under no circumstances shall any information be provide to anybody else than the below specified contact persons. Only upon go-ahead from the SOM the information about Herschel End of Scientific Life may be communicated outside the Herschel Flight Control Team.
- DTCP report (big distribution list): If "news embargo" is still in place, SOM or On-Call SOE shall write DTCP report

SPACON Actions:

If End-of-Helium occurs during DTCP (CASE 1 EoHe):

1. Contact SOM
   a. Micha Schmidt under +49-170-2969126 or +49-6254-959372
   b. If not reachable, contact Frank Keck under +49-176-34595934
2. Continue standard DTCP activities
3. (Special activities will be done in next DTCP)

If End-of-Helium is detected at AOS (CASE 2 EoHe), or if this is the DTCP following a CASE 1 EoHe:

1. Contact SOM
   a. Micha Schmidt under +49-170-2969126 or +49-6254-959372
   b. If not reachable, contact Frank Keck under +49-176-34595934
2. Insert command DC76F170 (disable all sub-schedules) into DTCP stack after AD connection test command
3. Wait after releasing the AD connection test until HIFI H/K TM is available again (about 10min after AOS, e.g. HIFI mode TM parameter shows green again); then release the prepared command DC76F170. Should HIFI be off: TM check is obsolete, release the command.
4. Continue standard DTCP activities but do not uplink standard MTL

SOM Actions:

1. Inform On-Call FD
2. Inform On-Call SOE
3. Inform other persons according to "Manager/VIP Flowchart"
4. Trigger Mission Re-planning, starting from OD-(X+7) onwards

On-Call SOE Actions (CASE 2 EoHe, or for DTCP following CASE 1):

1. Come in to ESOC immediately
2. Sub-schedules should have been disabled by SPACON
3. H_FCP_PAC_NSOF: Switch off PACS
4. If SPIRE mode ≠ REDY or CREC: Trigger OBCP 0x1105 via DC5ST185
   - SM00M500 "MODE" ≠ REDY or CREC
5. H_FCP_HIF_2D5B: Command HIFI to Dissipative-II (band 5b), if not already (use OBS ID = 0x999)
   - HM258194 "HL_MODE_S" = dissipative
   - HM003194 "HL_Channel_S" = 5b
6. H_FCP_HIF_S0DI: Disable HIFI stdby-0 autonomy
7. H_FCP_HIF_LCDI: Disable HIFI LCU comm. autonomy
8. H_FCP_HIF_CCDI: Disable HIFI LCU checksum autonomy
9. Delete all remaining MTL TCs and re-enable all sub-schedules again:
   a. H_FCP_DHS_3023: One TC to clear the whole MTL
   b. H_FCP_DHS_3025: Follow the 'Rebuild + Release' branch (step 8). TC sequences are HFD3025E and HFD3025H
10. Instruct SPACON to uplink alternative MTLs (named "H_1$$$$___EoH_*"): MTL-X part A and B, MTL-(X+1) part A and B
11. Wait for On-Call FD to provide TPFs for Earth pointing slew and RWB; execute these TPFs
    - TPFs come together with printouts (FD sends them to DCR printer)

Approval	
Requester (date, signature)	SOM (date, signature)