XMM Optical Monitor

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XMM-OM USER MANUAL (FM) - PART 2
Experiment Operations Procedures

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CHANGE RECORD

Issue	**Date**	**Changes**
0	31-Oct-98	First version—draft

Contents

List of Tables

1 Introduction

This is the Experiment Operations Procedures manual for ^{XMM}OM .

2 Reference Documents

- **XMM-OM/MSSL/ML/0010** ^{XMM}OM User Manual Part 3: Telecomand and Telemetry Specification
- **XMM-OM/MSSL/SP/0194** ^{XMM}OM (FM) Integrated Functional Test Procedure
- **XMM-OM/MSSL/ML/0011** ^{XMM}OM User Manual Part 4: ICU-DPU protocol definitions

3 Overview

An overview will be written one day.

4 Terms and abbreviations

4.1 Clarification

4.1.1 Window Table and Detector Table

4.1.2 Guide Starts and Tracking Stars

4.1.3 Science Windows, Memory Windows and Detector Windows

4.2 Abbreviations

XMM	X-ray Multi Mirror Mission
OM	Optical Monitor
HK	Housekeeping
KAL	Keep Alive
IFT	Integrated Functional Test
ICU	Instrument Control Unit
DPU	Digital Processing Unit
HV	High Voltage
LUT	Lookup Table
tc	Telecommand
tm	Telemetry
MSSL	Mullard Space Science Lab (University College London)
ESA	European Space Agency
SOC	Science Operations Centre
MCP	Microchannel Plate(s)
FAQ	Field Acquisition
s/c	spacecraft
GS	guide star(s)
TMPSU	Telescope module power supply unit
RBI	Remote Bus Interface

5 Typographical Conventions used in this document

- Running text shall appear in this normal Roman font.
- *Italic font* will indicate special emphasis.
- A `"typewriter" font` will be used to indicate MSSL EGSE VxWorks commands.
- A **"bold" font** will be used to indicate database entries.

6 Note: Alerts

Please note the following ...

The ground system should always monitor the telemetry stream for exception packets of (type, subtype):

- (3,2) Unsuccessful Command Acceptance
- (3,4) Unsuccessful Command Execution
- (4,2) Exception Report
- (4,3) Major Anomaly Report

as these indicate an error has occured and should only be expected when a intentional bad command is sent as a test.

7 Initial Procedures

7.1 Telescope Door

Opening the ^{XMM}OM telescope door will be a spacecraft procedure. The OM telescope door should be opened as late as possible to reduce contamination.

7.2 Initial switch on procedure

1. Perform "nominal switch on procedure" (see section 8.1)

7.2.1 Basic Mode tests

1. (Do a Basic mode IFT??)

7.2.2 Operational mode tests

1. Upload ICU operational mode software using modified MSSL-supplied load memory packets (the sequence count and checksum need modifying)
   `<load_icu`.

2. Mode change to full safe
   tc h9001
   `tc_mode 1`

3. expect **tm 92100** "Cathode OK" **param h7000=13h** within 20 s of mode change

4. expect **tm 92100** "MCP 1 OK" **param h7000=14h** within 20 s of mode change.

5. expect **tm 92100** "MCP 2,3 OK" **param h7000=15h** within 20 s of mode change.

6. expect **tm 92600** "fw at req. posn" **param 7010=60h** within 20 s of mode change.

7. Check HK: expect **tm 90000 h5405="Operational"** every 10 s.

8. (thermal control starts automatically)

9. Load DPU using modified MSSL-supplied load packets
   `<load_dpu`.

10. Switch to the DPU loadable code
    h7202
    `tc_load_dpuos`

11. Enable red dsp
    h7207 param h522="Red" h16="Enabled"
    `tc_enbl_dsp red,1`
12. sleep (10)
13. Enable blue1 dsp
    tc h7207 param h522="Blue1" h16="Enabled"
    `tc_enbl_dsp blue1,1`
14. sleep (10)
15. Enable blue1 dsp
    tc h7207 param h522="Blue2" h16="Enabled"
    `tc_enbl_dsp blue2,1`
16. sleep (10)
17. Sync clock **tc h7214 pref h600=20**
    `tc_synch_clk 20`
18. **??do we get anything here?? Matt, Howard**
19. sleep (3)
20. Initialize DPU
    tc h7248
    `tc_init_dpu`
21. wait for event DA_EOT_INIT_DPU
    tm 92210
    `tm_wait_for_alert DA_EOT_INIT_DPU`
22. Send a tc packet with an invalid type (15,3)
23. Check for **tm 91202 param h6015=15 h6020=3**
24. Send a tc packet with an invalid subtype (5,15)
25. Check for **tm 91203 param h6015=5 h6020=15**
26. Send a tc packet with the wrong checksum
27. Check for **tm 91201 param h6005=*expected_crc* h6010=*found_crc***
28. Prepare for heater switching: disable standard control algorithm
    tc H6670
    `tc_heater_stop`
29. Examine HK
    tm 90000 Pref H5240 = "offoffoffoff"

30. Measure S/C +28V voltage and current. Compare with Table 1.

31. Start heater contingency task
    tc h5660
    `tc_heater_config_start`

32. Switch on heater 1 (Main I/F)
    tc H7660 Pref H380 = "onoffoffoff"
    `tc_heater_config 8`

33. Examine HK
    tm 90000 Pref H5240 = "onoffoffoff"

34. Measure S/C +28V voltage and current. Compare with Table1

35. Switch off heater 1
    tc H7660 Pref H380 = "offoffoffoff"
    `tc_heater_config 0`

36. Examine HK
    tm 90000 Pref H5240 = "offoffoffoff"

37. Switch on heater 2 (forward tube)
    tc H7660 Pref H380 = "offonoffoff"
    `tc_heater_config 4`

38. Examine HK
    tm 90000 Pref H5240 = "offonoffoff"

39. Measure S/C +28V voltage and current: Compare with Table1

40. Switchoff heater 2
    tc H7660 Pref H380 = "offoffoffoff"
    `tc_heater_config 0`

41. Examine HK
    tm 90000 Pref H5240 = "offoffoffoff"

42. Switch on heater 3 (metering rods)
    tc H7660 Pref H380 = "offoffonoff"
    `tc_heater_config 2`

43. Examine HK
    tm 90000 Pref H5240 = "offoffonoff"

44. Measure S/C +28V voltage and current: Compare with Table1

45. Switchoff heater 3
    tc H7660 Pref H380 = "offoffoffoff"
    `tc_heater_config 0`

Table 1: Heater Switching Current Profile

Heater	+28 V Current
1 (Main Interface)	1440mA ± 100 mA
2 (Forward tube)	1740mA ± 100 mA
3 (Metering Rods)	1060mA ± 100 mA
4 (Secondary Mirror)	950mA ± 100 mA
Disable Heater Algorithm	810mA ± 100 mA

46. Examine HK
    tm 90000 Pref H5240 = "offoffoffoff"

47. Switch on heater 4 (secondary mirror)
    tc H7660 Pref H380 = "offoffoffon"
    `tc_heater_config 1`

48. Examine HK
    tm 90000 Pref H5240 = "offoffoffon"

49. Measure S/C +28V voltage and current: Compare with Table1

50. Switchoff heater 4
    tc H7660 Pref H380 = "offoffoffoff"
    `tc_heater_config 0`

51. Examine HK
    tm 90000 Pref H5240 = "offoffoffoff"

52. Disable heater switching: stop heater contingency task
    tc h6660
    `tc_heater_config_stop`

53. Enable standard control algorithm
    tc H5670
    `tc_heater_start`

54. Specify next move of the filter wheel to the datum position
    tc h7608
    `tc_fw_to_datum`

55. Command the filter wheel to move
    tc h5600
    `tc_fw_move`

56. Wait for TMPSU event
    tm 92600 param h7010="fw @ req pos"

57. Examine HK
    tm 90000 params h5150="seen", h5265=0
58. Command the filter wheel away from datum
    tc h7606 param h290=1000
    `tc_fw_rel_steps 1000`
59. Wait for TMPSU event
    tm 92600 param h7010="fw @ req pos"
60. Examine HK
    tm 90000 params h5150="seen", h5250="not seen"
61. Command the filter wheel to move to the coarse sensor position
    tc h7609
    `tc_fw_to_coarse`
62. Command the filter wheel to move
    tc h5600
    `tc_fw_move`
63. Wait for TMPSU event
    tm 92600 param h7010="fw @ req pos"
64. Command the filter wheel to move back to the datum position
    tc h7608
    `tc_fw_to_datum`
65. Command the filter wheel to move
    tc h5600
    `tc_fw_move`
66. Wait for TMPSU event
    tm 92600 param h7010="fw @ req pos"
67. Examine HK
    tm 90000 params h5150="seen", h5265=0

7.2.3 Switch on high voltages

The high volatges can be used 48 hours after launch.

1. Specify V_{mcp23} ramp parameters
   tc h7140 params h510="mcp23", h160=1500, h175="off"
   `tc_det_load_hv_ramp_params 3,1500,25,0`
2. Perform ramp
   tc h5140
   `tc_det_start_hv_ramp`

3. Wait for event
   tm 92100 param h7000="mcp23 ok"
4. Specify V_{mcp1} ramp parameters
   tc h7140 params h510="mcp1", h160=500, h175="off"
   `tc_det_load_hv_ramp_params 2,500,25,0`
5. Wait for event
   tm 92100 param h7000="mcp1 ok"
6. Perform ramp
   tc h5140
   `tc_det_start_hv_ramp`
7. Specify $V_{cathode}$ ramp parameters
   tc h7140 params h510="cathode", h160=2, h175="off"
   `tc_det_load_hv_ramp_params 1,2,25,0`
8. Perform ramp
   tc h5140
   `tc_det_start_hv_ramp`
9. Wait for event
   tm 92100 param h7000="cathode ok"
10. Specify $V_{cathode}$ ramp parameters
    tc h7140 params h510="cathode", h160=390, h175="off"
    `tc_det_load_hv_ramp_params 1,390,25,0`
11. Perform ramp
    tc h5140
    `tc_det_start_hv_ramp`
12. Wait for event
    tm 92100 param h7000="cathode ok"
13. Specify V_{mcp1} ramp parameters
    tc h7140 params h510="mcp1", h160=550, h175="off"
    `tc_det_load_hv_ramp_params 2,550,25,0`
14. Perform ramp
    tc h5140
    `tc_det_start_hv_ramp`
15. Wait for event
    tm 92100 param h7000="mcp1 ok"
16. Specify V_{mcp23} ramp parameters
    tc h7140 params h510="mcp23", h160=1850, h175="off"
    `tc_det_load_hv_ramp_params 3,1850,25,0`

17. Perform ramp
    tc h5140
    `tc_det_start_hv_ramp`

18. Wait for event
    tm 92100 param h7000="mcp23 ok"

??Do IFT 5.7 Image acquisition test - full frame - eng4
????MSSL may provide the following tests:

1. dark current

2. phd

3. LUT update

4. flatfield/fullframe

5. flatfield/BPE binned

6. if time left, do raw data modes during commissioning

7. set instrument into intermediate safe mode (used for perigee passage)

8 Nominal Procedures

8.1 Nominal Switch On

1. Spacecraft procedure: Switch off substitution heater.

2. Spacecraft procedure: Switch on 28V.

3. After not more than 20 s, expect a bootstrap report
   tm 92703 "bootstrap report event packet".

4. Check the HK: expect a HK packet every 10 s
   tm 90000

5. In the HK packets, look for mode and heater status
   tm 90000 params h5395="Initial" h5240="OnOnOffOff" h5255="Disabled"

8.2 Nominal Switch Off

N.B. High voltages must be ramped down slowly and safely before switching off main power

1. Specify $V_{cathode}$ ramp parameters
   tc h7140 params h510="cathode", h160=0, h175="off"
   `tc_det_load_hv_ramp_params 1,0,25,0`

2. Perform ramp
   tc h5140
   `tc_det_start_hv_ramp`

3. Wait for event
   tm 92100 param h7000="cathode ok"

4. Specify V_{mcp1} ramp parameters
   tc h7140 params h510="mcp1", h160=0, h175="off"
   `tc_det_load_hv_ramp_params 2,0,25,0`

5. Perform ramp
   tc h5140
   `tc_det_start_hv_ramp`

6. Wait for event
   tm 92100 param h7000="mcp1 ok"

7. Specify V_{mcp23} ramp parameters
   tc h7140 params h510="mcp23, h160=0, h175="off"
   `tc_det_load_hv_ramp_params 3,0,25,0`

8. Perform ramp
   tc h5140
   `tc_det_start_hv_ramp`

9. Wait for event
   tm 92100 param h7000="mcp23 ok"

10. Send an RBI suspend
    Spacecraft command **D???? Matt**
    `suspend`

11. Spacecraft procedure: switch off +28 V.

8.3 Transition to Safe Mode

This is a spacecraft procedure or initiated by a **tc h9001**.

8.4 Example Observation

The example observation shown in Table 2 consists of an acquisition phase followed by 2 exposures. In turn, each exposure consists of a choose guide star phase followed by an accumulation and tracking phase. Science data is not available for downlinking until the end of the first exposure. The status of science data, filter wheel and detector during the course of the observation is summarized Table 2. This example can be generalized to a n-exposure sequence by repeating the "between exposures" and "Exposure 2" (with suitable changes in the uplinked configuration) phases as often as required.

8.5 Overall Flow Diagram

The overall flow diagram is shown in Figure 1.

8.6 Acquisition

1. Set acquisition mode
   tc h7130 param="low res win"
   `tc_det_acq_mode 0`

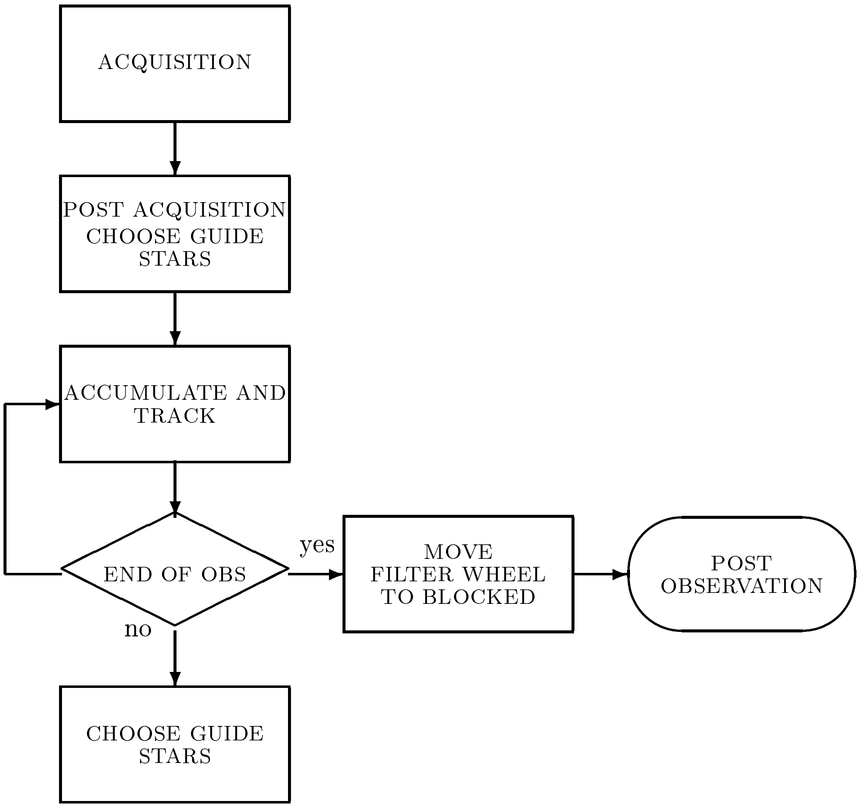
2. Load window table parameters (see table TBD??)
   tc h7110
   `????`

3. Start load window table task
   tc h5110
   `tc_det_load_windows 1`

Table 2: Example Observation

Observation Phase	Associated Command Sequences	Detector Status		Filter Wheel Position	Science Data Status	
		Windows	Resolution		Priority	Regular
Acquisition	Acquisition	Four abutting windows covering the whole detector	Low	V Filter	–	–
Exposure 1	Post Acquisition Choose Guide Stars			Observer Requested	Exposure 1 Downloading	–
	Accumulate and Track	Observer requested + guiding	High			
Between Exposures	–	HV on Data not sent to DPU		Last Observer Request	–	Exposure 1 Downloading
Exposure2	Choose Guide Stars	Four abutting windows covering the whole detector	Low	Observer Requested	Exposure2 Downloading	
	Accumulate and Trtack	Observer requested + guiding	High			
Post Observation	Post Observation	HV On Data not sent to DPU		Blocked	–	Exposure2 Downloading

Figure 1: Overall Flow Diagram



4. Wait for detector event
   tm 92100 param="win tab load"

5. Set filter wheel number for the V filter
   tc h7604 param h280="V"
   `tc_fw_filter 1`

6. Move the filter wheel
   tc h5600
   `tc_fw_move`

7. Wait for TMPSU event
   tm 92600 param h7010="FW @ req pos"

8. Set the exposure id
   tc h7238 param h530= *exposure_number*
   `tc_set_exp_no` *exposure_id*

9. Load the reference stars
   tc h7240 params=*Table 3*
   `tc_prog_ref_stars`

Table 3: Reference Stars

Description	PREF
Verification	h10
Number of reference stars	h1160
X co-ordinate of reference star 1	h1095
Y co-ordinate of reference star 1	h1096
X co-ordinate of reference star 2	h1097
Y co-ordinate of reference star 3	h1098
.	.
.	.
.	.
X co-ordinate of reference star 31	h1155
Y co-ordinate of reference star 31	h1156
X co-ordinate of reference star 32	h1157
Y co-ordinate of reference star 32	h1158

10. Set the DPU frame time
    tc h7236 param h710=*frame_time*
    `tc_set_frame_time` *frame_time*

11. Prepare the DPU for acquiring low resolution data
    tc h7249
    `tc_init_exp`

12. Start the detector integration
    tc h5130
    `tc_det_start_int`

13. Initiate acquire field
    tc h7250
    `tc_????`

    sleep ???

14. Stop detector integration task
    tc h6130
    `tc_det_stop_int`

15. Set filter wheel number (filter for exposure 1)
    tc h7604 param=*filter*
    `tc_fw_filter` *filter*

16. Move the filter wheel
    tc h5600
    `tc_fw_move`

17. Wait for TMPSU event
    tm 92600 param h7010="FW @ req pos"

    sleep??

18. Wait for end of acquire field event report
    tm 92211

19. Receive priority science data (acquisition data)
    tm 97402

8.7 Post Acquisition Choose Guide Stars

1. Set the DPU frame time (units in 0.001 seconds)
   tc h7236 param=*frame_time*
   `tc_set_frame_time` *frame_time*

2. Set the exposure id
   tc h7238 param h530=*exposure_number*
   `tc_set_exp_no` *exposure_id*

3. Load the memory windows
   tc h7242 params=*table ???*
   `tc_????`

4. Load the science windows
   tc h7243 params=*table ???*
   `tc_????`

5. Set the exposure duration (units = frames)
   tc h7237 param h720=*number_of_frames*
   `tc_????`

6. Start the detector integration task
   tc h5130
   `tc_det_start_int`

7. Enable choose guide stars task
   tc h7251
   `tc_send_command IC_CHOOSE_GS`

8. Wait for DPU event report DA_EOT_CHOOSE_GS
   tm 92212 `tm_wait_for_alert DA_EOT_CHOOSE_GS`

9. Stop the detector integration task
   tc h6130
   `tc_det_stop`

   sleep??

10. Wait for priority science data (window data)
    tm 97401

11. Wait for window table loaded event
    tm 92100 param = "win tab load"

8.8 Accumulate and Track

1. Set the acquisition mode to high resolution windowed
   tc h7130 param="Hi Res Win"
   `tc_det_acq_mode 2`

2. Start the detector integration task
   tc h5130
   `tc_det_start_int`

3. Enable track guide stars task
   tc h7252
   `tc_send_command IC_TRACK_GS`

   sleep??

4. Wait for DPU event report end of exposure
   tm 92205
   `tm_wait_for_alert DA_COMPLETE_EXP`

8.9 Post Perigee Procedure

1. *The "Nominal Switch On" procedure should already have been performed (see Section 8.1) if not, do it now.*

2. Memory dump of ICU's loadable code.

   Alter each MSSL-supplied ICU memory load packet to become a memory dump request packet and send. Compare the memory dump report tm packets with the memory load packets. Reload full code if a difference is found (see Section 7.2.2).

3. Transition from intermediate safe to idle mode
   tc h9002
   `tc_mode 2`

4. Specify V_{mcp23} ramp parameters
   tc h7140 params h510="mcp23", h160=1500, h175="off"
   `tc_det_load_hv_ramp_params 3,1500,25,0`

5. Perform ramp
   tc h5140
   `tc_det_start_hv_ramp`

6. Wait for event
   tm 92100 param h7000="mcp23 ok"

7. Specify V_{mcp1} ramp parameters
   tc h7140 params h510="mcp1", h160=500, h175="off"
   `tc_det_load_hv_ramp_params 2,500,25,0`

8. Wait for event
   tm 92100 param h7000="mcp1 ok"

9. Perform ramp
   tc h5140
   `tc_det_start_hv_ramp`

10. Specify $V_{cathode}$ ramp parameters
    tc h7140 params h510="cathode", h160=2, h175="off"
    `tc_det_load_hv_ramp_params 1,2,25,0`

11. Perform ramp
    tc h5140
    `tc_det_start_hv_ramp`

12. Wait for event
    tm 92100 param h7000="cathode ok"

13. Specify $V_{cathode}$ ramp parameters
    tc h7140 params h510="cathode", h160=390, h175="off"
    `tc_det_load_hv_ramp_params 1,390,25,0`

14. Perform ramp
    tc h5140
    `tc_det_start_hv_ramp`
15. Wait for event
    tm 92100 param h7000="cathode ok"
16. Specify V$_{mcp1}$ ramp parameters
    tc h7140 params h510="mcp1", h160=550, h175="off"
    `tc_det_load_hv_ramp_params 2,550,25,0`
17. Perform ramp
    tc h5140
    `tc_det_start_hv_ramp`
18. Wait for event
    tm 92100 param h7000="mcp1 ok"
19. Specify V$_{mcp23}$ ramp parameters
    tc h7140 params h510="mcp23", h160=1850, h175="off"
    `tc_det_load_hv_ramp_params 3,1850,25,0`
20. Perform ramp
    tc h5140
    `tc_det_start_hv_ramp`
21. Wait for event
    tm 92100 param h7000="mcp23 ok"
22. Memory dump of DPU's loadable code.

    Alter each MSSL-supplied DPU memory load packet to become a memory dump request packet and send. Compare the memory dump report tm packets with the memory load packets. Reload full code if a difference is found (see Section 7.2.2).
23. Switch to the DPU loadable code
    h7202
    `tc_load_dpuos`
24. Enable red dsp
    h7207 param h522="Red" h16="Enabled"
    `tc_enbl_dsp red,1`
25. sleep (10)
26. Enable blue1 dsp
    tc h7207 param h522="Blue1" h16="Enabled"
    `tc_enbl_dsp blue1,1`
27. sleep (10)

28. Enable blue1 dsp
tc h7207 param h522="Blue2" h16="Enabled"
`tc_enbl_dsp blue2,1`

29. sleep (10)

30. Sync clock **tc h7214 pref h600=20**
`tc_synch_clk 20`

31. **??do we get anything here?? Matt, Howard**

32. sleep (3)

33. Initialize DPU
tc h7248
`tc_init_dpu`

34. wait for event DA_EOT_INIT_DPU
tm 92210
`tm_wait_for_alert DA_EOT_INIT_DPU`

35. LUT update (assumes one iteration only as baseline)

36. Load centroid table boundaries
tc h7100 with parameters set according to table 4

37. wait for event **92100 pref 7000=10h**

38. time verification??

8.10 Choose Guide Stars

1. Set the filter wheel number for exposure 2
tc h7604 param h280=*filter_number*
`tc_fw_filter ????`

2. Move the filter wheel
tc h5600
`tc_fw_move`

3. Wait for TMPSU event report
tm 92600 param h7010="fw @ req pos"

4. Set the acquisition mode to low resolution windowed
tc h7130 param h110="Lo Res Win"
`tc_det_acq_mode 0`

5. Load the window table parameters
tc h7110 params=*Table ???*

Table 4: Centroid Table Boundaries

Description	**Pref**	**Value**
Verification	h10	"enable"
X Centroid Table Boundary 0	h20	-1000
X Centroid Table Boundary 1	h21	-750
X Centroid Table Boundary 2	h22	-500
X Centroid Table Boundary 3	h23	-250
X Centroid Table Boundary 4	h24	0
X Centroid Table Boundary 5	h25	250
X Centroid Table Boundary 6	h26	500
X Centroid Table Boundary 7	h27	750
X Centroid Table Boundary 8	h28	1000
Y Centroid Table Boundary 0	h30	-1000
Y Centroid Table Boundary 1	h31	-750
Y Centroid Table Boundary 2	h32	-500
Y Centroid Table Boundary 3	h33	-250
Y Centroid Table Boundary 4	h34	0
Y Centroid Table Boundary 5	h35	250
Y Centroid Table Boundary 6	h36	500
Y Centroid Table Boundary 7	h37	750
Y Centroid Table Boundary 8	h38	1000

6. Start the load window table task
   tc h5110
   `tc_det_load_windows 1`

7. Wait for detector event report
   tm 92100 param="win tab load"

8. Prepare the DPU to acquire low resolution data
   tc h7249
   `tc_init_exp`

9. Set the DPU frame time (units in 0.001 seconds)
   tc h7236 param=*frame_time*
   `tc_set_frame_time` *frame_time*

10. Set the exposure id
    tc h7238 param h530=*exposure_number*
    `tc_set_exp_no` *exposure_number*

11. Load the memory windows
    tc h7242 params=*table ???*
    `tc_????`

12. Load the science windows
    tc h7243 params=*table ???*
    `tc_????`

13. Set the exposure duration (units = frames)
    tc h7237 param h720=*number_of_frames*
    `tc_set_exposure_time` *exposure_time*

14. Start the detector integration task
    tc h5130
    `tc_det_start_int`

15. Enable choose guide stars task
    tc h7251
    `tc_send_command IC_CHOOSE_GS`

16. Wait for DPU event report DA_EOT_CHOOSE_GS
    tm 92212

    sleep??

17. Wait for priority science data (window data)
    tm 97401

18. Wait for window table loaded event
    tm 92100 param h7000="win tab load"

8.11 Post Observation

1. Request flushing of the science telemetry queue
   tc h7255
   `tc_send_command ic_flush_cmprs`

2. Set the filter wheel to blocked
   tc h7604 param h280="Blocked"
   `tc_fw_filter 0`

3. Move the filter wheel
   tc h5600
   `tc_fw_move`

4. Wait for TMPSU event report
   tm 92600 param h7010="fw @ req pos"

8.12 Flat fielding

1. Switch to mode 4
   tc h9004
   `tc_mode 4`

2. Set exposure id
   tc h7238 param h530=exposure_id
   `tc_set_exp_no` *exposure_number*

3. Send IC_INIT_EXP
   tc h7249
   `tc_send_command IC_INIT_EXP`

4. ??Until the SID for DA_EOT_INIT_EXP is enabled,
   sleep 20 instead

5. **Howard do we need these two??**

6. `tc_det_enbl_frame_tag 1`

7. `tc_det_event_threshold 30`

8. Start sending events from mic
   matt
   tc h5130
   `tc_det_start_int`

9. Howard is this right for flatfield??

10. Load flatfield window table
    tc h7110 with parameters set according to Table 5

11. Load windows
    tc h5110 `tc_det_load_windows 1`

12. Wait for event **tm 92100 param h7000="win tab load"**

Table 5: Flatfield Window Table

Description	**Pref**	**Value**	
		Prime	**Redundant**
Verification	h10	"enable"	"enable"
Number of windows	h40	1	1
Window 1 Xlow	h50	52	0
Window 1 Ylow	h51	27	0
Window 1 Xsize	h52	256	256
Window 1 Ysize	h53	256	256

13. Turn off tracking
    h7256 param h1040="on"
    `tc_set_trk 0`

14. Set BPE binning
    h7257 param h540="binning"
    `tc_set_bpe 1`

15. Set up reporting options. These are probably already defaulted to 1 do we need them **howard**??
    ```
    tc_report_tracking 1
    tc_enbl_verbose 0,1
    tc_enbl_verbose 3,1
    ```

16. Set frame time in units of millisecond
    tc h7236 param h710=250000
    `tc_set_frame_time 25 000`

17. Set exposure time, in units of frames
    tc h7237 param h720=40
    `tc_set_exposure_time 40`

18. Reference frame processing, done by invoking the choose_guide_stars task on the DPU
    tc h7251
    `tc_send_command IC_CHOOSE_GS`

19. Wait for alert DA_EOT_CHOOSE_GS
    tm 92212
    `tm_wait_for_alert DA_EOT_CHOOSE_GS`

20. Set acquisition mode
    tc h7130 param h110="hi res win"
    `tc_det_acq_mode 3`

21. Start the exposure.
    tc h7252
    `tc_send_command IC_TRACK_GS`

22. Wait for alert DA_COMPLETE_EXP. This will take approximately ((frame time in second) $\times$ (exposure time in second) + 60) second.
    tm 92209
    `tm_wait_for_alert DA_COMPLETE_EXP`

23. Flush the compression queue
    tc h7255
    `tc_send_command IC_FLUSH_CMPRS`

24. Wait for alert DA_EOT_FLUSH_CMPRS
    tm 92217
    `tm_wait_for_alert DA_EOT_FLUSH_CMPRS`

25. Wait finite time for the data to come out??

8.13 Procedure for the end of science data acquisition period

At the end of science data acquisition period of an orbit care has to be taken that the science data of the last exposure of the last observation are compressed and are made available for downlinking. This can be ensured by forcing the flush compression queue.

1. Flush the compression queue
   tc h7255
   `tc_send_command IC_FLUSH_CMPRS`

2. If you need to turn off the detector and BPE, do it here??

3. Wait for alert DA_EOT_FLUSH_CMPRS
   tm 92217
   `tm_wait_for_alert DA_EOT_FLUSH_CMPRS`

4. Wait finite time for the data to come out??

8.14 Procedure for the prepartion for perigee passage

The procedure will be invoked at the time: LOS+1h+time needed for OM science data downlink period of remaining science data in compressed data buffer. Initially this will happen at 40 000 km altitude.

A time tagged "goto intermediate safe mode" command is needed to ensure HV ramp down for the case that unexpected LOS occurs. This command will be scheduled at the instrument activiation period of an orbit and will be removed as part of the preparation for perigee passage procedure.

1. Transit into intermediate safe mode
   tc h9005
   `tc_mode 5`

2. Expect a Vcathode reached tm packet
   tm 92100 h7000=13h ("Vcathode reached")

3. Spacecraft procedure: remove time tagged command by MOC.

8.15 Procedure for the preparation for eclipse

Before transition into eclipse OM has to be switched off by invoking the Switch off Prime (power supply) procedure. The remaining data in the compressed data queue buffer have been already sent down in the buffer interval allocated in the ??PSF??.

See "Nominal switch-off procedure" (Section 8.2).

8.16 Procedure for activation after eclipse

OM will be switched off during eclipse. The MCP HV requires a stabilization period of several hours. For the sake of observation efficiency it is desirable to switch on OM and command it into intermediate safe state before perigee passage for the case that eclipse occurs before perigee and that there is s/c contact before perigee. This approach would require different post eclipse procedures depending on the orbital phase eclipse occurs, treating the case where there is a s/c contact after eclipse and before perigee differently to all other cases. In the latter cases the full procedure would be invoked after perigee, otherwise only the transition to intermediate safe mode is commanded and normal activation after perigee will occur.

1. Perform "nominal switch on" (see Section 8.1).
2. Wait until ready for "post perigee procedure".
3. Perform "post perigee procedure" (see Section 8.9).

Action 1.13: Kate will investigate the possibililty of different OM operation for eclipse with s/c contact before perigee.

8.17 Pre apogee gap procedure

1. Go to idle mode
   tc h9002
   `tc_mode 2`

8.18 Procedure for activation after the apogee gap

Normal operation.

8.19 Procedure for starting a science observation

The science observation will start with the field acquisition. An unsuccessful field aquisition will result in 4 iterations where less than 12 guide stars were found. The offsets dx, dy and sin(theta) are set to zero. Currently 16 GS can be uplinked for the FAQ by TC, the DPU code supports up to 32 guide stars. Once larger areas of the detector are degraded 32 GS should be uplinked (the unsuccessful criteria would be less than 20 GS out of 32 identified). If the tracking GS algorithm fails, ...

1. Switch to mode 4
   h9004
   `tc_mode 4`
2. Set exposure id
   h7238 pref h530=exposure_id
   `tc_set_exp_no` *exposure_number*

3. Prepare BPE for image acquisition
   h7131 pref h120=threshold
   `tc_det_event_threshold` *threshold*

4. Send an init exposure to the DPU
   tc h7249
   `tc_send_command IC_INIT_EXP`

5. Wait for alert DA_EOT_INIT_EXP alert
   tm 92213
   `tm_wait_for_alert DA_EOT_INIT_EXP`

6. Load window table
   tc h7110 with parameters set according to Table 6

7. Load windows
   tc h5110
   `tc_det_load_windows 1`

8. Wait for event **tm 92100 param h7000="win tab load"**

Table 6: Window Table

Description	**PREF**
Verification	h10
Number of windows	h40
Window 1 Xlow	h50
Window 1 Ylow	h51
Window 1 Xsize	h52
Window 1 Ysize	h53
Window 2 Xlow	h54
Window 2 Ylow	h55
Window 2 Xsize	h56
Window 2 Ysize	h57
.	.
.	.
.	.
Window 14 Xlow	h102
Window 14 Ylow	h103
Window 14 Xsize	h104
Window 14 Ysize	h105
Window 15 Xlow	h106
Window 15 Ylow	h107
Window 15 Xsize	h108
Window 15 Ysize	h109

9. Ensure frame tags are disabled
   h7135 param h16="disabled"
   `tc_det_enbl_frame_tag 0`

10. ??start faq (as defined in example command sequence used until issue of user manual 5/98)

8.20 Procedure for start of exposure with user defined configuration

1. Set exposure id
   tc h7238 pref h530=*exposure_id*
   `tc_set_exp_no` *exposure_number*

2. Move filter
   h7604 h280=*filter*
   `tc_fw_filter` *filter_number*

3. Move filter wheel
   h5600
   `tc_fw_move`

4. Await event **92600 with param h7010="fw @ req pos"**

5. Select tracking GS

6. Wait 2 min (TBC)

7. Load window configuration

8. Exposure as in command sequence ?? see ??

8.21 Procedure for start of exposure of the default configuration INSTRUMENT image or image/fast

The procedure will be identical to the user defined configuration. The GO has to specify the filter element to be used and the duration of the exposure. The time needed allocated to the default configurations will be 5 times the specified exposure duration.

See "science user defined" (Section ??).

There is currently no field foreseen in the RPS to specify the position of the fast mode window located at the prime instrument boresight. There is no link implemented between the pointing direction of the prime instrument and the fast mode window position neither in the RPS nor in the SGs.

Action 1.14: Kate and Rudi will investigate possibilities how the position of central window can be defined in the RPS.

TBD

8.22 End of Observation Procedure

1. Filter wheel to blocked
   h7604 h280="blocked"
   `tc_fw_filter` *filter_number*

2. Move filter wheel
   h5600
   `tc_fw_move`

3. Await event "fw at req posn"
   tm 92600 param h7010="fw @ req pos"

9 Maintenance Procedures

9.1 Clock resynchronisation

1. Spacecraft procedure: command cdmu to synch clock
2. Spacecraft procedure: command cdmu to read time
3. Both cdmu and icu send down timepacket
4. Compare on ground
5. DPU can be synchronised against the ICU

9.2 Procedure to change heater configuration

The procedure for changing the heater configuration can be used for the heater control test or for contingency. For the heater checkout one would cycle through on/off of all heaters individually. (see XMM-OM/MSSL/ML/0010: User Manual Part 3: Telecommand and Telemetry Specification, Section 2.2.4.4.3, page 27–28).

1. Switch off heater control task
   h6670
   `tc_heater_stop`
2. Check hk **tm packet 90000** with **h5240="offoffoffoff"**
3. Load up heater configuration
   Send one of **h7671** to **h7678** with correct parameters set (see XMM-OM/MSSL/ML/0010: User Manual Part 3: Telecommand and Telemetry Specification, Section 2.2.4.4.3.2)
4. Start heater control again
   h5670
   `tc_heater_start`

9.3 Dichroic Reconfiguration

9.3.1 Selecting the Prime Chain

1. Change to idle mode
   tc h9002
   `tc_mode 2`
2. Change to engineering mode
   tc h9004
   `tc_mode 4`

3. Request dichroic move to the prime position
   tc h7650 params h370=-1 h375=0
   `tc_dm_direction -1,0`
4. Move dichroic
   tc h5650
   `tc_dm_move`
5. Wait for TMPSU event
   tm 92600 param h7010="dich @ req pos"
6. Examine HK
   tm 90000 param h5275=-31
7. Return to idle mode
   tc h9002
   `tc_mode 2`

9.3.2 Selecting the Redundant Chain

1. Change to idle mode
   tc h9002
   `tc_mode 2`
2. Change to engineering mode
   tc h9004
   `tc_mode 4`
3. Request dichroic move to the redundant position
   tc h7650 params h370=1 h375=0
   `tc_dm_direction 1,0`
4. Move dichroic
   tc h5650
   `tc_dm_move`
5. Wait for TMPSU event
   tm 92600 param h7010="dich @ req pos"
6. Examine HK
   tm 90000 param h5275=32
7. Return to idle mode
   tc h9002
   `tc_mode 2`

9.4 Engineering mode 0

1. Change to engineering mode
   tc h9004
   `tc_mode 4`

2. Set frame time to 10 000 ms
   tc h7236 param h710=10000
   `tc_set_frame_time 10000`

3. Set exposure id
   tc h7238 param h530=exposure_id
   `tc_set_exp_no` *exposure_number*

4. Send IC_INIT_EXP
   tc h7249
   `tc_send_command IC_INIT_EXP`

5. ??Until the SID for DA_EOT_INIT_EXP is enabled,
   sleep 20 instead

6. Load window table
   tc h7110 with parameters set according to Table 6

7. Load windows
   tc h5110
   `tc_det_load_windows 1`

8. Wait for event **tm 92100 param h7000="win tab load"**

9. Ensure frame tags are enabled
   h7135 param h16="enabled"
   `tc_det_enbl_frame_tag 1`

10. Prepare BPE for image acquisition
    h7131 pref h120=threshold
    `tc_det_event_threshold` *threshold*

11. Set acquisition mode
    tc h7130 param h110="hi res win"
    `tc_det_acq_mode 3`

12. Start sending events from mic
    tc h5130
    `tc_det_start_int`

13. Choose engineering mode 0
    h7254 param h880="both blue"
    `tc_enbl_eng 1, 0`

14. Wait for end of exposure
tm 92209
`tm_wait_for_alert DA_COMPLETE_EXP`

15. Wait for telemetry to finish
sleep ??

9.5 Engineering mode 1

1. Change to engineering mode
tc h9004
`tc_mode 4`

2. Set frame time to 10 000 ms
tc h7236 param h710=10000
`tc_set_frame_time 10 000`

3. Set exposure id
tc h7238 param h530=exposure_id
`tc_set_exp_no` *exposure_number*

4. Send IC_INIT_EXP
tc h7249
`tc_send_command IC_INIT_EXP`

5. ??Until the SID for DA_EOT_INIT_EXP is enabled,
sleep 20 instead

6. Load window table
tc h7110 with parameters set according to Table 6

7. Load windows
tc h5110
`tc_det_load_windows 1`

8. Wait for event **tm 92100 param h7000="win tab load"**

9. Ensure frame tags are enabled
h7135 param h16="enabled"
`tc_det_enbl_frame_tag 1`

10. Prepare BPE for image acquisition
h7131 pref h120=threshold
`tc_det_event_threshold` *threshold*

11. Set acquisition mode
tc h7130 param h110="hi res win"
`tc_det_acq_mode 3`

12. Start sending events from mic
    tc h5130
    `tc_det_start_int`

13. Choose engineering mode 1
    h7254 param h880="blue1"
    `tc_enbl_eng 1, 1`

14. Wait for end of exposure
    tm 92209
    `tm_wait_for_alert DA_COMPLETE_EXP`

15. Wait for telemetry to finish
    sleep ??

9.6 Engineering mode 2

1. Change to engineering mode
   tc h9004
   `tc_mode 4`

2. Set frame time to 10 000 ms
   tc h7236 param h710=10000
   `tc_set_frame_time 10 000`

3. Set exposure id
   tc h7238 param h530=exposure_id
   `tc_set_exp_no` *exposure_number*

4. Send IC_INIT_EXP
   tc h7249
   `tc_send_command IC_INIT_EXP`

5. ??Until the SID for DA_EOT_INIT_EXP is enabled,
   sleep 20 instead

6. Load window table
   tc h7110 with parameters set according to Table 6

7. Load windows
   tc h5110
   `tc_det_load_windows 1`

8. Wait for event **tm 92100 param h7000="win tab load"**

9. Ensure frame tags are enabled
   h7135 param h16="enabled"
   `tc_det_enbl_frame_tag 1`

10. Prepare BPE for image acquisition
    h7131 pref h120=threshold
    `tc_det_event_threshold` *threshold*

11. Set acquisition mode
    tc h7130 param h110="hi res win"
    `tc_det_acq_mode 3`

12. Start sending events from mic
    tc h5130
    `tc_det_start_int`

13. Choose engineering mode 2
    h7254 param h880="blue2"
    `tc_enbl_eng 1, 2`

14. Wait for end of exposure
    tm 92209
    `tm_wait_for_alert DA_COMPLETE_EXP`

15. Wait for telemetry to finish
    sleep ??

9.7 Engineering mode 3: Channel Boundary Data

1. Change to engineering mode
   tc h9004
   `tc_mode 4`

2. Set frame time to 10 000 ms
   tc h7236 param h710=10000
   `tc_set_frame_time 10 000`

3. Set exposure id
   tc h7238 param h530=exposure_id
   `tc_set_exp_no` *exposure_number*

4. Send IC_INIT_EXP
   tc h7249
   `tc_send_command IC_INIT_EXP`

5. ??Until the SID for DA_EOT_INIT_EXP is enabled,
   sleep 20 instead

6. Load window table
   tc h7110 with parameters set according to Table 6

7. Load windows
   tc h5110
   `tc_det_load_windows 1`

8. Wait for event **tm 92100 param h7000="win tab load"**

9. Ensure frame tags are enabled
   h7135 param h16="enabled"
   `tc_det_enbl_frame_tag 1`

10. Prepare BPE for image acquisition
    h7131 pref h120=threshold
    `tc_det_event_threshold` *threshold*

11. Set acquisition mode
    tc h7130 param h110="hi res win"
    `tc_det_acq_mode 3`

12. Start sending events from mic
    tc h5130
    `tc_det_start_int`

13. Choose engineering mode 3
    h7254 param h880="??channel boundaries"
    `tc_enbl_eng 1, 3`

14. Wait for end of exposure
    tm 92209
    `tm_wait_for_alert DA_COMPLETE_EXP`

15. Wait for telemetry to finish
    sleep ??

9.8 Engineering mode 5: Centroiding Confirmation

1. Change to engineering mode
   tc h9004
   `tc_mode 4`

2. Set frame time to 10 000 ms
   tc h7236 param h710=10000
   `tc_set_frame_time 10 000`

3. Set exposure id
   tc h7238 param h530=exposure_id
   `tc_set_exp_no` *exposure_number*

4. Send IC_INIT_EXP
   tc h7249
   `tc_send_command IC_INIT_EXP`

5. ??Until the SID for DA_EOT_INIT_EXP is enabled,
   sleep 20 instead

6. Load window table
   tc h7110 with parameters set according to Table 6

7. Load windows
   tc h5110
   `tc_det_load_windows 1`

8. Wait for event **tm 92100 param h7000="win tab load"**

9. Ensure frame tags are enabled
   h7135 param h16="enabled"
   `tc_det_enbl_frame_tag 1`

10. Prepare BPE for image acquisition
    h7131 pref h120=threshold
    `tc_det_event_threshold` *threshold*

11. Set acquisition mode
    tc h7130 param h110="hi res win"
    `tc_det_acq_mode 3`

12. Start sending events from mic
    tc h5130
    `tc_det_start_int`

13. Choose engineering mode 5
    h7254 param h880="??centroiding
    `tc_enbl_eng 1, 5`

14. Wait for end of exposure
    tm 92209
    `tm_wait_for_alert DA_COMPLETE_EXP`

15. Wait for telemetry to finish
    sleep ??

9.9 Engineering mode 6: Intensifier Characteristics

1. Change to engineering mode
   tc h9004
   `tc_mode 4`

2. Set frame time to 10 000 ms
   tc h7236 param h710=10000
   `tc_set_frame_time 10 000`

3. Set exposure id
   tc h7238 param h530=exposure_id
   `tc_set_exp_no` *exposure_number*

4. Send IC_INIT_EXP
   tc h7249
   `tc_send_command IC_INIT_EXP`
5. ??Until the SID for DA_EOT_INIT_EXP is enabled,
   sleep 20 instead
6. Load window table
   tc h7110 with parameters set according to Table 6
7. Load windows
   tc h5110
   `tc_det_load_windows 1`
8. Wait for event **tm 92100 param h7000="win tab load"**
9. Ensure frame tags are enabled
   h7135 param h16="enabled"
   `tc_det_enbl_frame_tag 1`
10. Prepare BPE for image acquisition
    h7131 pref h120=threshold
    `tc_det_event_threshold` *threshold*
11. Set acquisition mode
    tc h7130 param h110="hi res win"
    `tc_det_acq_mode 3`
12. Start sending events from mic
    tc h5130
    `tc_det_start_int`
13. Choose engineering mode 6
    h7254 param h880="??intensifier
    `tc_enbl_eng 1, 6`
14. Wait for end of exposure
    tm 92209
    `tm_wait_for_alert DA_COMPLETE_EXP`
15. Wait for telemetry to finish
    sleep ??

9.10 Engineering mode 7: M,N Images

1. Change to engineering mode
   tc h9004
   `tc_mode 4`

2. Set frame time to 10 000 ms
   tc h7236 param h710=10000
   `tc_set_frame_time 10 000`

3. Set exposure id
   tc h7238 param h530=exposure_id
   `tc_set_exp_no` *exposure_number*

4. Send IC_INIT_EXP
   tc h7249
   `tc_send_command IC_INIT_EXP`

5. ??Until the SID for DA_EOT_INIT_EXP is enabled,
   sleep 20 instead

6. Load window table
   tc h7110 with parameters set according to Table 6

7. Load windows
   tc h5110
   `tc_det_load_windows 1`

8. Wait for event **tm 92100 param h7000="win tab load"**

9. Ensure frame tags are enabled
   h7135 param h16="enabled"
   `tc_det_enbl_frame_tag 1`

10. Prepare BPE for image acquisition
    h7131 pref h120=threshold
    `tc_det_event_threshold` *threshold*

11. Set acquisition mode
    tc h7130 param h110="hi res win"
    `tc_det_acq_mode 3`

12. Start sending events from mic
    tc h5130
    `tc_det_start_int`

13. Choose engineering mode 7
    h7254 param h880="M,N??
    `tc_enbl_eng 1, 7`

14. Wait for end of exposure
    tm 92209
    `tm_wait_for_alert DA_COMPLETE_EXP`

15. Wait for telemetry to finish
    sleep ??

10 Calibration and PV

10.1 Focus

Focussing tests using the magnifier. The heaters will be switched on/off.

1. Focues heater
   tc h7677 param h200=*ontime* h210=*cycle_time* h240=*focus_direction*
   `matt??`

2. ??acquisition of a fullframe image to assess the boresight alignment.
   This observation will be performed without FAQ.

3. ??switch on for IST, intial functional checkout