Merging the Gaia, XMM-Newton and INTEGRAL Spacon teams

Marcus Kirsch
XMM-Newton
Spacecraft Operations Manager

menu

- history

- operations concept
- estimated effect on science performance
- implementation of merged SPACON team
- counter measures against science loss

- future activities –regain of science performance

history

- Decision 2016 by OPS-O and SRE-O to merge the SPACON teams accepting a decrease in science performance on XMM/INT

- **proposal:** reduction of Spacon team from currently 6(XMM/INT)+3(Gaia)
  to 6+1(day SPACON called OPS-Analyst) → saving of 2 FTE

  → Reduction of workload, knowledge and training for XMM/INT required
  - **Workload:** missions identified situations which do not require immediate recovery and can be carried out when time allows or next day/shift + Low priority routine tasks to be de-scoped or automated
  - **Knowledge:** full knowledge for all 3 missions can't be provided by 1 person,
    → reduce the knowledge on instruments such that only instrument safety is guaranteed
  - **Training:** the knowledge reduction would reduce the training time by 6 weeks to allow training for Gaia

main principles of the shared SPACON team

1. **Spacecraft health and safety shall not be put at risk** for any of the three missions. (e.g. no significant increase of risk of ESAM entry for XMM/Integral, no significant increase of risk of safe mode for Gaia).

2. **Gaia performance (as still in prime mission phase) shall not be adversely affected**.

3. It is fully accepted that **XMM/Integral instrument performance and science data return may be reduced** due to conflicting activities (e.g. if the SPACON cannot run a recovery and has to wait for an on-call engineer (or next working day) to perform a recovery).

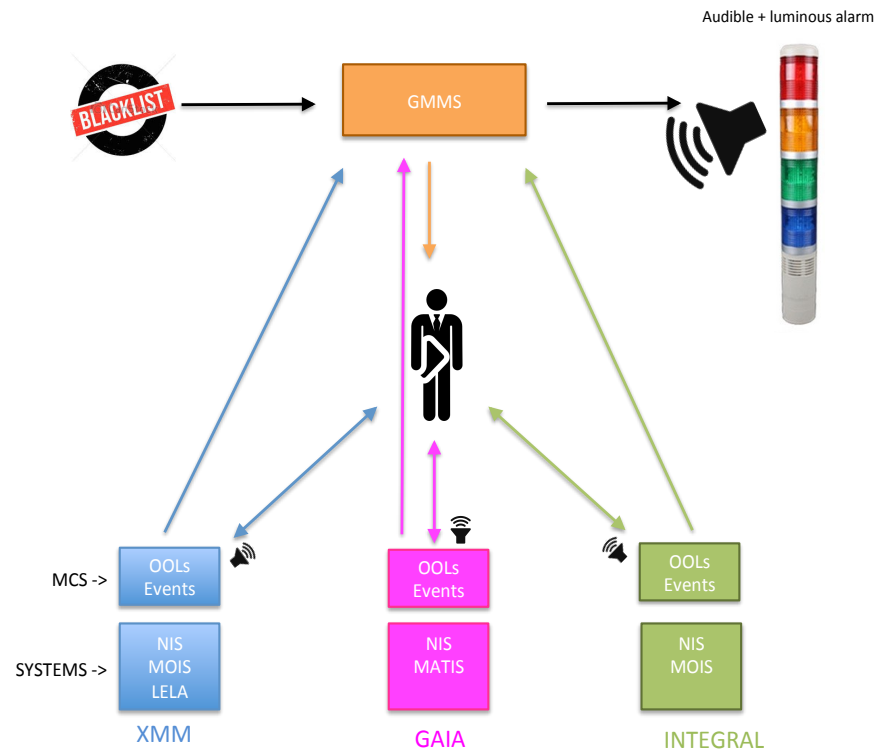4. In case of conflict between XMM and Integral, XMM has priority.

consequences for design

- Response to contingencies on XMM/INT needed review due to higher Gaia priority
  - **Small subset requiring immediate action → SUPER ALARMS**
  - Recurring anomalies when time / manpower allows or during working hours by OPS analyst.
  - Other anomalies, contact engineering on-call
- MCS alarms review (S/C & ground)
  - reduce number of OOL to a manageable but still safe number
  - new class of alarms, requiring immediate attention → **SUPER ALARMS**
  - X-reference review and re-design + SPACON high level X-ref needed
- Gaia integration in SPACON shift planning
- SPACONs need to be cross-trained

→ Changes to Ground Segment
- **De-conflicting Software**
- **Visualization Software**
- **Super Alarm Software**

merged operations concept

Audible + luminous alarm

BLACKLIST

GMMS

MCS ->

OOLs
Events

OOLs
Events

OOLs
Events

SYSTEMS ->

NIS
MOIS
LELA

NIS
MATIS

NIS
MOIS

XMM

GAIA

INTEGRAL

- **one single SPACON** takes care of GAIA, XMM-Newton and INTEGRAL (in order of priority).

- During the daily **2 hours of dedicated GAIA activities, the SPACON will concentrate on Gaia nominal operations, but will react to super alarms from the other two missions (safety)**

- A new mechanism has been defined for super alarms - integrated in **GMMS** (Global Monitoring and Management System). These contain safety critical alarms from all three missions.

- For Gaia there are 5 dedicated alarms.

- For XMM/Integrall the "Super Alarms" list is a subset of the MCS (mission control system) alarms plus some super critical alarms. To remove unwanted MCS alarms from GMMS a Black List is defined, which contains the MCS alarms that GMMS shall ignore.

- In case of GMMS "Super Alarms" there is an additional visible luminous and loud audio alarm to amplify the distinction to MCS alarms.

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estimated XMM science loss

- Impact of SPACON reduced responsibility
  - Analysis by MOC only, based on Digilog information from 32 revolutions in 2015 (non-eclipse)
    - Considered the SPACON reaction to 44 separate events (Radiation alerts, RM crash, OM crash, PFM problems, Ground segment problems). Average 1.4 Events/Revolution
    - Actual Lost science was : PN/MOS = 1.0% / 1.5%
    - If the SPACON had not been trained for recovery (delay action to next working day) then lost science for same period would have been: PN /MOS = 9% / 6%
    - This is an increase of 5% to 8%

- Impact of Gaia activity taking priority over XMM critical windows
  - Analysis by MOC of overlapping windows between XMM and Gaia, based on 125 revolutions (incl. 30 Eclipse rev.)
    - Considered the actual overlaps in any 8 hour shift
    - Then calculated a probability of a Clash Event occurring: this was 0.9 per revolution
    - Since this is similar order of magnitude to events/revolution above, the lost science model from Digilog is simply scaled according to ratio 0.9/1.4
    - Lost science is 3% to 5%

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implementation process

30.08.2016 kick off meeting

12/2016 requirements documents ready

ESA-XMM-FOS-RS-0001 - INT / XMM / Gaia SPACON Team Merger Software URD

ESA-XMM-FOS-TN-0001 - XMM-Newton - INTEGRAL - Gaia SPACON merger assumptions and concept

ESA-XMM-FOS-TN-0002 - XMM-Newton - INTEGRAL Cross Reference review and Super Alarms classification criteria

13/01: Implementation kick off

19/04: conceptual end to end demonstration took place successfully

16/05: all main hardware components at ESOC

23/05: full end to end demonstration on DevLan

29/09: all hardware in house and installed

04/10: super alarm system connected to OPSLAN

27/10: official V1 of super alarm S/W delivered, De-conflicting tool V1 available on web for testing

21/11: D/B for XMM/INT with merger relevant features operational

29/11: INT end to end test demonstration on OPS-LAN

30/11: Test and Validation plan available

15/01-23/02: validation testing

16/01: blacklist under configuration control

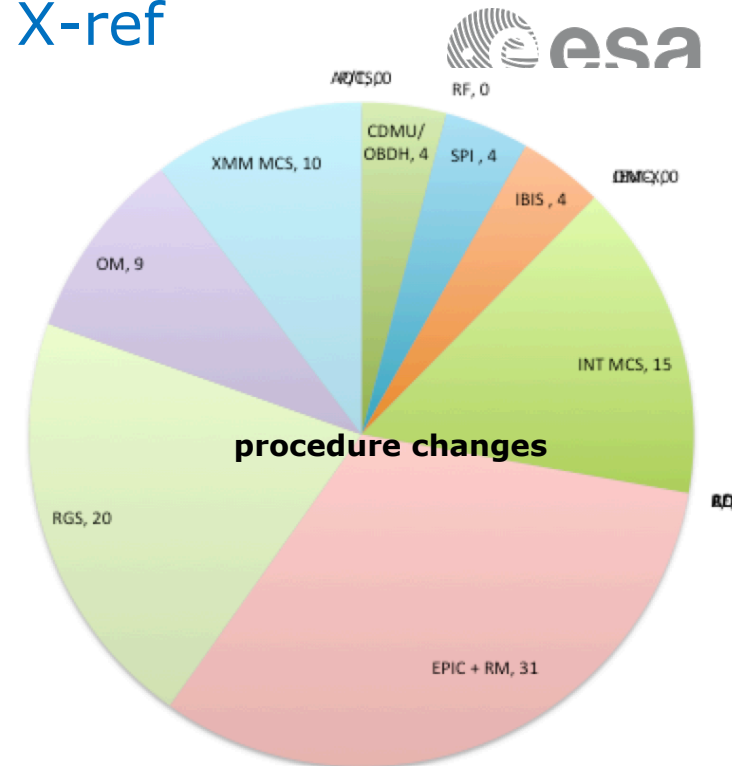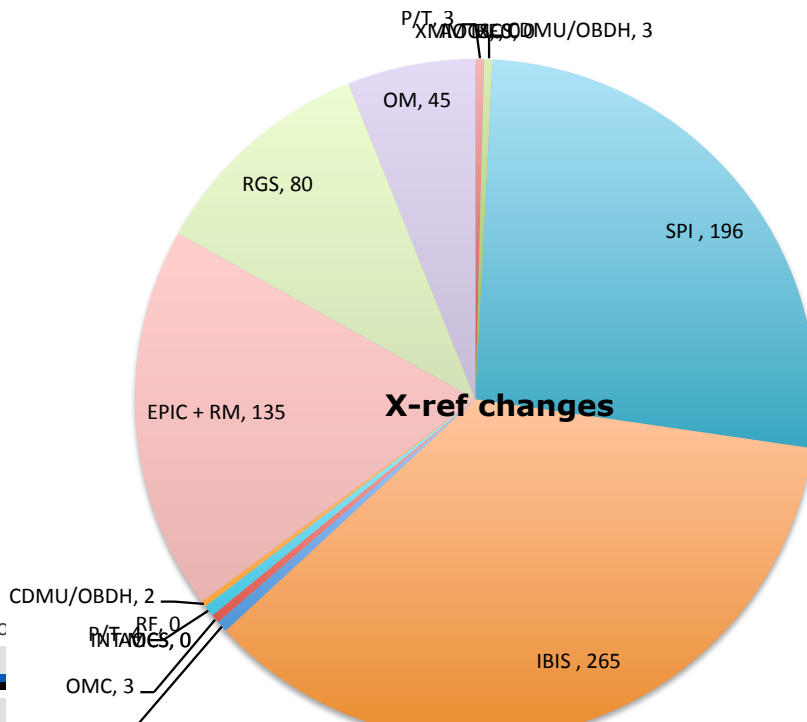06/03: system under configuration control

11/04: merged SPACON team fully operational

performed activities – procedures, X-ref

- **review of procedures** and **X-ref** (XMM/INT):
  - 90 new/refined procedures
  - 500 changes to XREF
  - new SPACON only X-ref for XMM instruments

X-ref changes pie chart: SPI, 196; IBIS, 265; EPIC + RM, 135; RGS, 80; OM, 45; P/T, 3; CDMU/OBDH, 3; CDMU/OBDH, 2; RF, 0; INT MCS, 0; OMC, 3

procedure changes pie chart: XMM MCS, 10; CDMU/OBDH, 4; SPI, 4; IBIS, 4; INT MCS, 15; EPIC + RM, 31; RGS, 20; OM, 9; RF, 0

performed activities: alarm review

- **XMM**

OOLs in database (total 3118):

- SOFT OOL: 1500
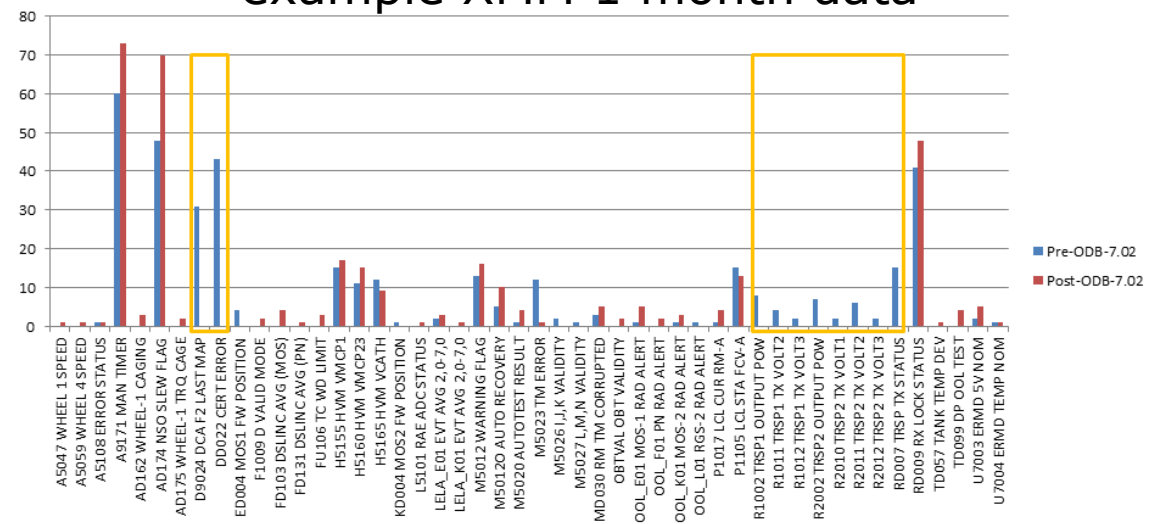- HARD OOL: 1433
- SCC OOL: 163
- others (events): 22

- **INT**

OOLs in database (total 5633):

- SOFT OOL: 1779
- HARD OOL: 3435
- SCC OOL: 418
- others (events): 1

→ modified and removed OOL: XMM:60, INT:65
→ **on average 30% reduction of alarms**

example XMM 1 month data

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performed activities – super alarms

new SUPER alarms

• super critical alarms for known very critical issues (white list)

• XMM/INT back list approach for all the rest:
→take out what is not important to not forget something

- • **Gaia**
  - • NoTC
  - • NoTM
  - • Safe Mode Entry
  - • TTC Safe Mode (LGA)
  - • Science downlink interruption
- • **XMM**
  - • ESAM first actions
  - • CDMU Crash
  - • G/S outage
  - • MCS server issue
  - • PN camera thermal control problem
  - • No LELA
  - • No Autocommand
  - • OM UNSAFE
  - • Target Of Opportunity
  - • OSL unsafe with current wheel speeds
  - • LCL trip on critical AOCS sensors: FSS-A and STR-A
- • **Integral**
  - • ESAM first actions
  - • CDMU Crash
  - • DPE Crash (or switch-off, i.e. LCL SEU or similar)
  - • G/S outage
  - • MCS server issue
  - • LCL trip on critical AOCS sensors: FSS-A and STR-A

control room setup

INTEGRAL

XMM

Gaia

automated super alarm monitoring

nominal operations flow

Multi Mission Nominal Operations

- FOP Volume 2.1 EPO — INTEGRAL
- FCP-SY-0001 — GAIA
- XMM_SPA_0010 FCP_SYS_5010 — XMM
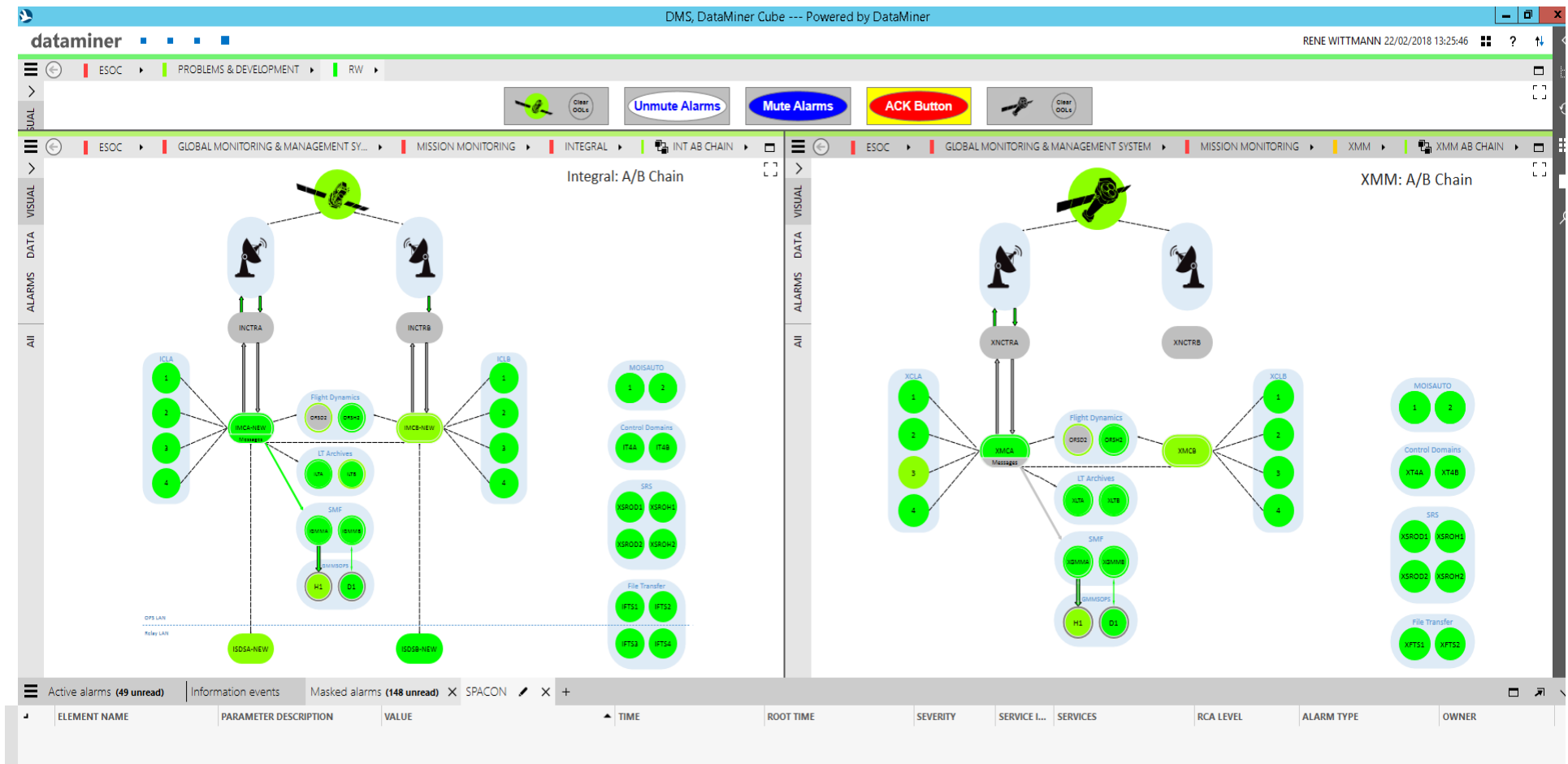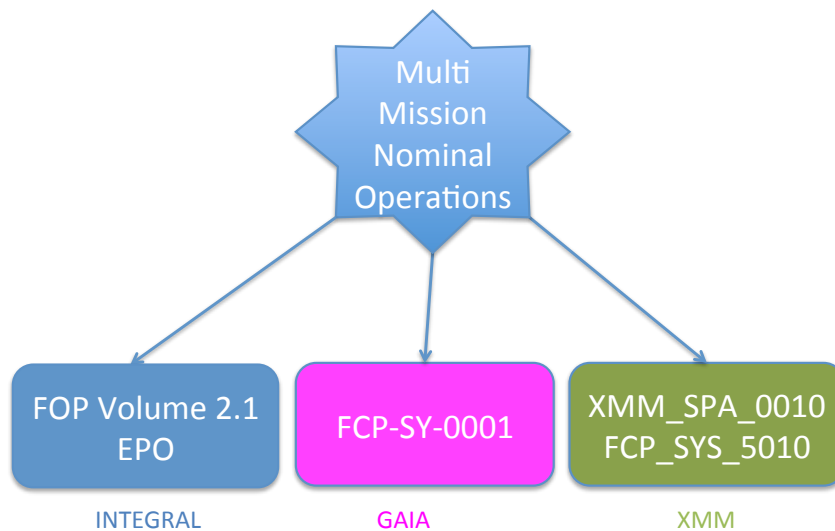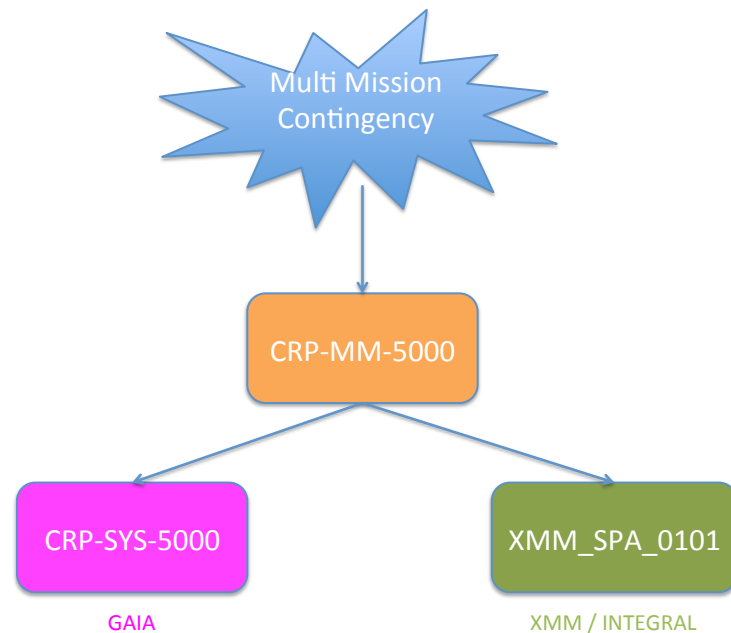
- Six SPACONs will operate all 3 spacecraft in parallel on shifts.

- The output from the De-conflicting tool called the "IXG Daily Overview" is informing the SPACON when to execute activities for all three missions.

contingency flow

Multi Mission Contingency

CRP-MM-5000

CRP-SYS-5000

GAIA

XMM_SPA_0101

XMM / INTEGRAL

- Multi mission contingency operations will be guided by **CRP-MM-5000**.

- Flowing down from this multi-mission procedure, in case of an anomaly the **SPACON will react using the relevant mission FOP** (including X-references) as entry point for action, pointing to contingency recovery procedures

- Specifically for XMM/Integral the procedure **XMM_SPA_0101** will guide the SPACON to the correct XMM/Integral X-reference. Reaction to any "Super Alarm" is included in this top-level procedure.

- **In case of an XMM/INT instrument anomaly not mentioned in the XMM_SPA_0101 procedure, the SPACON will only command the instruments into a safe status. The recovery will be done at the next working day by the OPS-Analyst**

- Back up for OPS-Analyst during leave and sickness shall be the individual XMM/INT instrument SubSystem engineer on best effort basis. Analysts are not trained for this.

- The OPS-Analyst may occasionally support special OPS as SPACON (eclipse, earth observation, galactic plane scan).

- The SPACON can perform exceptionally XMM/Integral instrument recovery under guidance of instrument SOEs during leave and sickness periods of the OPS Analyst.

mission planning – "de-conflicting"
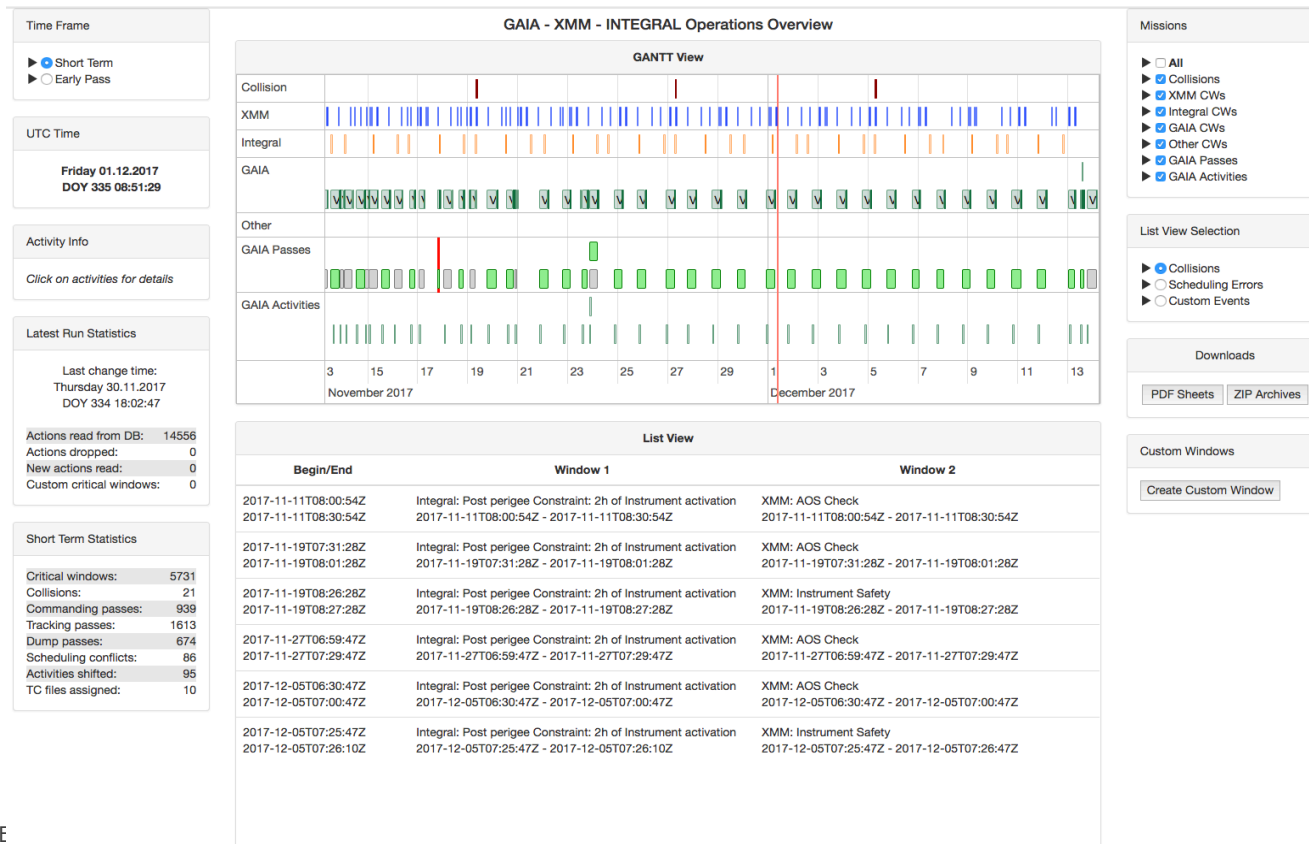
- **De-conflicting tool is used at planning level and makes sure that GAIA uplink activities happen outside the critical XMM/INT windows**

- XMM/INT nominal mission planning is not affected; In case of conflict with XMM/INT critical windows only the GAIA uplink activities might be shifted inside the GAIA pass window. Exception to this is a conflict with the Integral Cable Unwrap Handover window that has an impact on INT mission planning.

counter measures regarding estimated XMM science loss in 2016

- Impact of Gaia activity taking priority over XMM critical windows
  (estimated increase was 3% to 5%)

  → so far fully recovered by de-conflicting tool + OPS analyst support
  no actual science loss

- Impact of SPACON reduced responsibility
  (estimated increase was 5% to 8%)
  → Radiation monitor recovery automated
  → Most of OM recoveries automated
  → pn/MOS automatically re-enabled with a new observation

statistics on delayed recoveries from 1st month
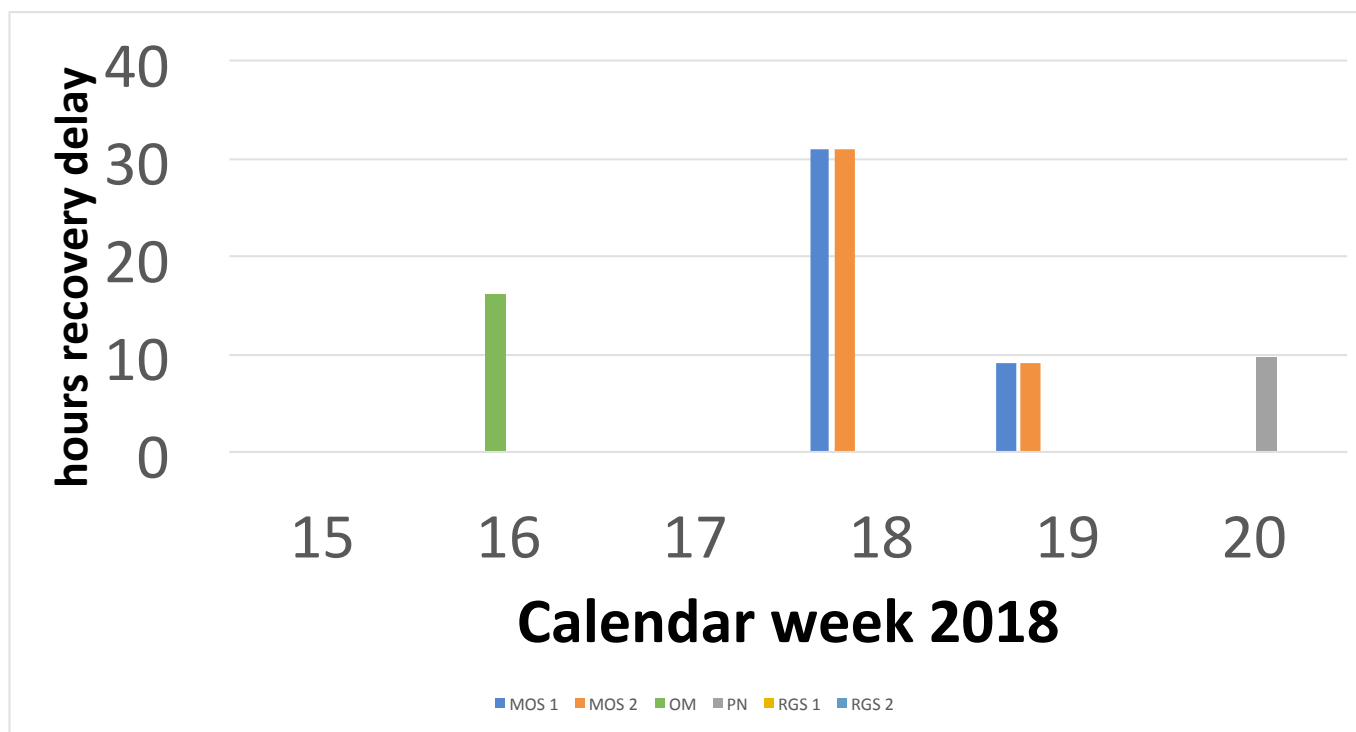
rough estimate **MOS1:**

- 40h/14 revolutions: ~ 7 %
  → 5-6% additional loss

- (in agreement with estimates, but still **small numbers of statistics** and details need to be provided by SOC in numbers of "real science loss")

- note: delayed recoveries caused by human error is not part of this analysis

TOO observations

- TOO observations are handled as before with an improved TOO procedure

- If a TOO happens during a Gaia uplink activity (2h/24h) this might introduce a delay in TOO start of <1h in the worst case

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future improvements

- Ground station hand over will be automated via MOIS
  → less conflicts with Gaia

- XMM Antenna hand over will be automated via MOIS
  → less conflicts with Gaia

- Instrument recoveries might be operated by the SPACON if sufficiently automated or eventually fully automated …
  (especially important for very long observations during weekends)
  → potential science re-gain

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