Fluid Science Laboratory

B.USOC – Operations and achievements

09 October 2026

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Outline

2013

July - Announcement FSL operations would be handed over from MARS to B.USOC

2014

October - Arrival of the FSL EM at B.USOC

2015

March - First 3 B.USOC OPS certified for FSL operations

May – successful E2E test FSL FM

June – CEM and VMU SW update

2016

November - Start of Geoflow-2C science campaign

2018

July –

VMU Mk2 installation, FSL ASW update, VMU Mk2 commissioning

SMD installation and commissioning

SMD-CompGran-1

2018-2026

FSL ON – Mission 1 and Mission 2

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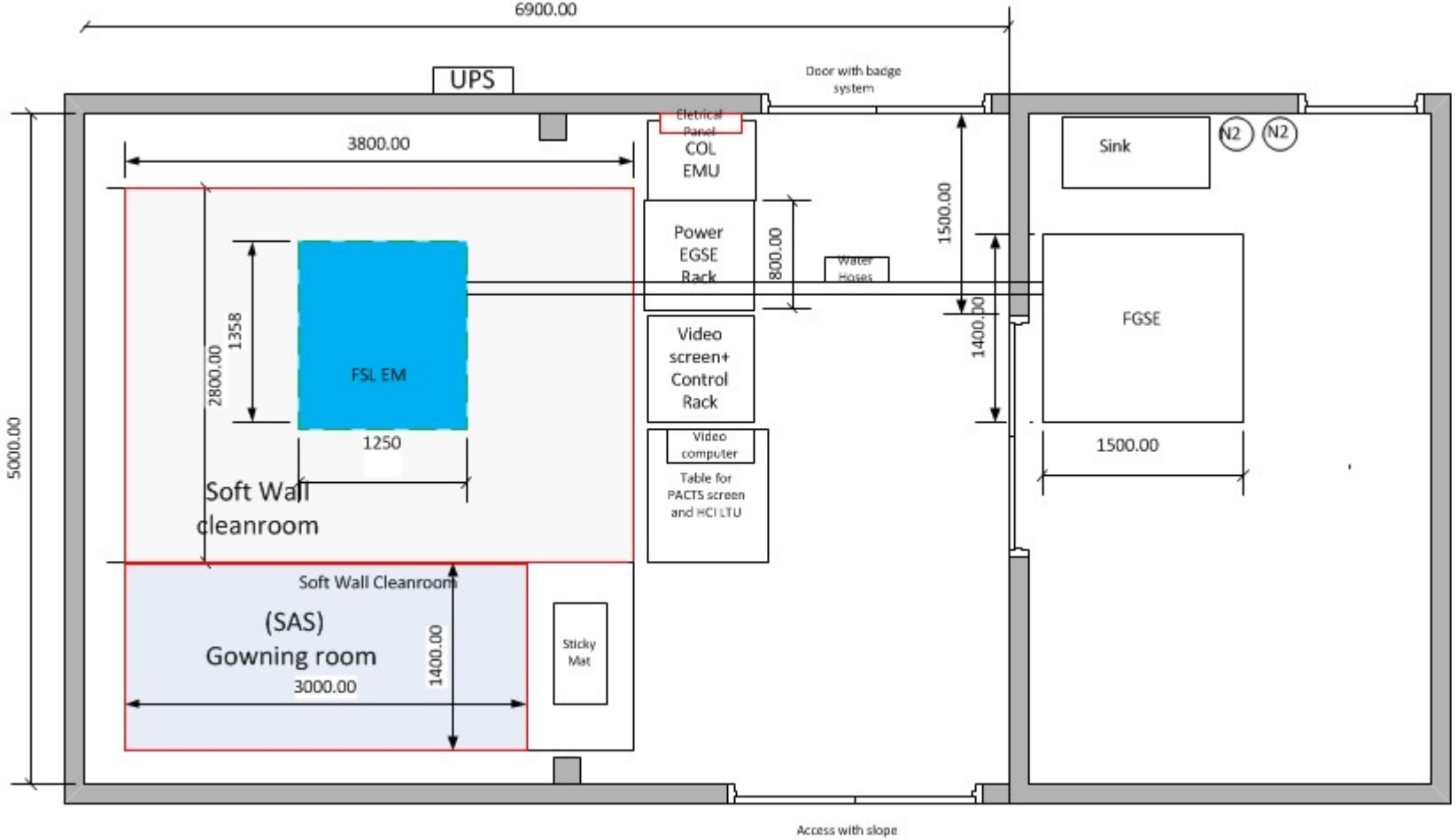
2013-2014: FSL handover to B.USOC

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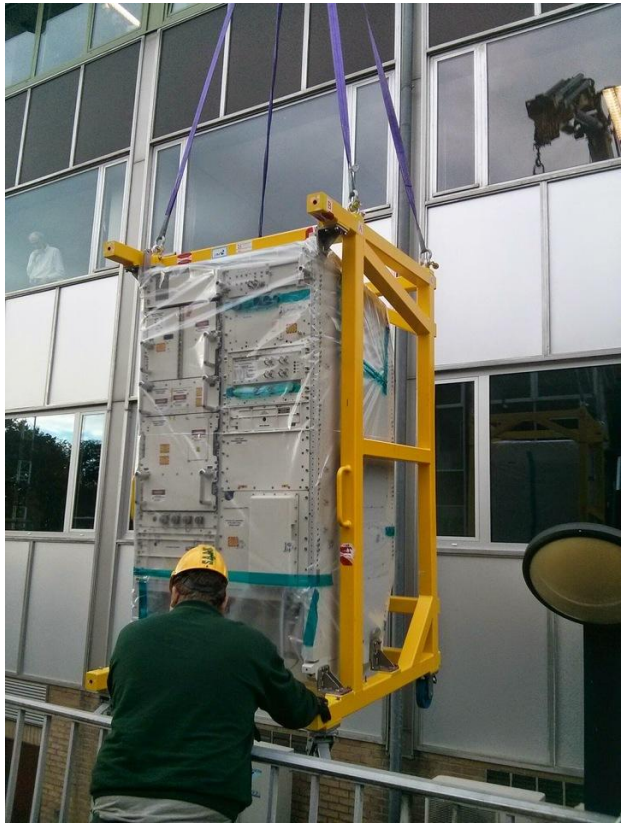
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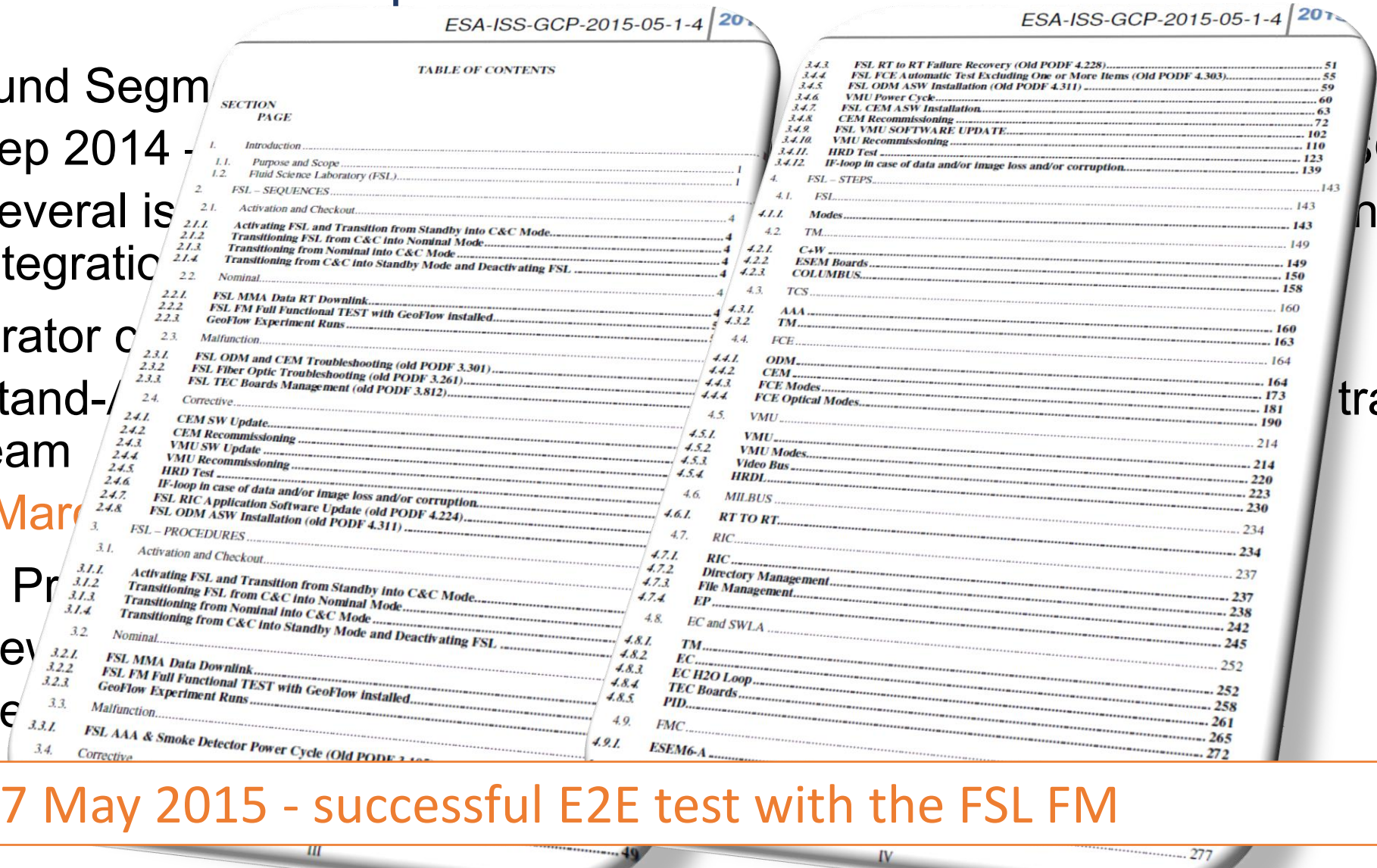
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- July 2013 - Announcement FSL operations would be handed over from MARS to B.USOC
- Setup of the FSL Lab, including clean room
- October 2014 - Installation of the FSL EM and GSE
- Training and certification
  - Familiarization at EAC and hands-on training on the FSL TM.
  - Familiarization lessons provided by the Payload Developer at B.USOC
  - FSL Operations training at B.USOC provided by MARS
  - FSL Dry Runs at B.USOC supported by MARS for hand-on use of the FSL EM.

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2015: Readiness to operations

- Ground Segm
  - Sep 2014 -
  - Several is
    integratic
- Operator c
  - Stand-/
    team
  - → Mar
- Ops Pr
  - Nev
  - De



→ 27 May 2015 - successful E2E test with the FSL FM

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2015: Readiness to operations



Some known issues…

- Degraded VMU
  - Recording functionality lost (2013)
  - Unstable HRD transfer (WO: multiple VMU reboots or even an FSL reboot)
- Recurrent issues with work-around
  - Failure of the 40-minute “Automatic Test” when transitioning to nominal mode
  - EC spurious reboot
  - EC to RIC serial line hang-up
  - TEC-board trips
- Tests on FSL EM with returned FASES FM suggested some possible degradation of the FSL FM

→ June 2015:

- CEM ASW update – resolving the errors during the Automatic Test
- VMU SW update – gaining diagnostics on the HRD issue

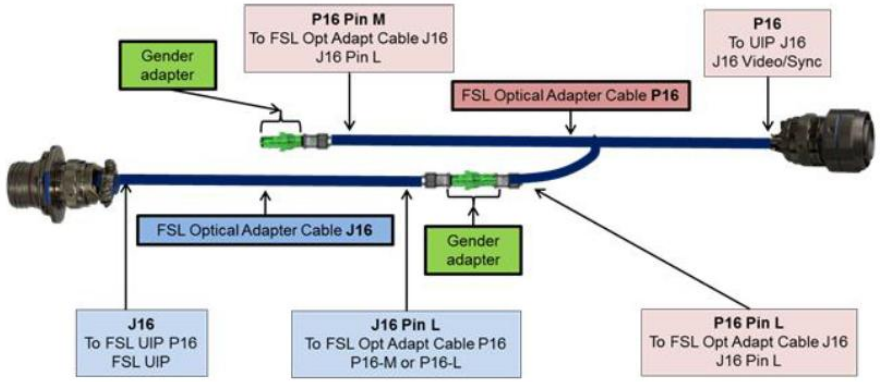
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2015-2016: Understanding the HRD troubles (SPR-1226)

HRD throughput characterization,

1. by using the O1 UIP connector as a knob

2. by using a "FSL Optical Adapter Cable",
   - either connect FSL HRD cable to the second optic fiber pin on the O1 or O2 UIP connector
   - or connect the HRD cable of the well working EDR rack to the O1 UIP connector



3.600 FSL Rack Optical Fibre Connector Troubleshooting
(FSL Rack/Inc45-ALL/FIN-1) Page 6 of 7 pages

COL1OA1 3. UN-TIGHTENING THE CONNECTOR BY 45° (LOOP 2 to 6)

NOTE

The P16 plug has 4 flat faces and by identifying them drawing a unique amount of dots on each of them will allow the ground to match your pictures with each of the turns. Whenever a new flat face comes into view while implementing the loops of step 3, it has to be identified uniquely (e.g. 3 dots for the 3rd and 0 dots for the 4th, see Figure 5).

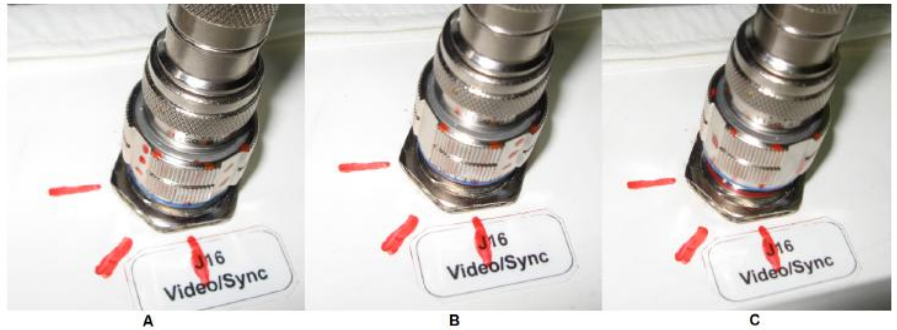


Figure 5. view every two 45° turns (turn 2 (A), turn 4 (B) and turn 6 (C)) and 1-dotted flat face appearing again aligned with the horizontal mark on the UIP (C)

Conclusion: FSL HRD cable and/or FSL TAXI convertor declared broken

→ Important information for the VMU2 project: inclusion of dedicated front mounted HRD cable + TAXI convertor

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2016-2017: First science

How to perform FSL experiments without a functional VMU?



- Use the analogue S-video output connector on the VMU
- Route the signal to an analogue to digital video convertor attached to a laptop
- Control the laptop from ground through KU-IP services (MPCC demo 2)

→ Geoflow-2c science campaign Nov 2016- Feb 2017

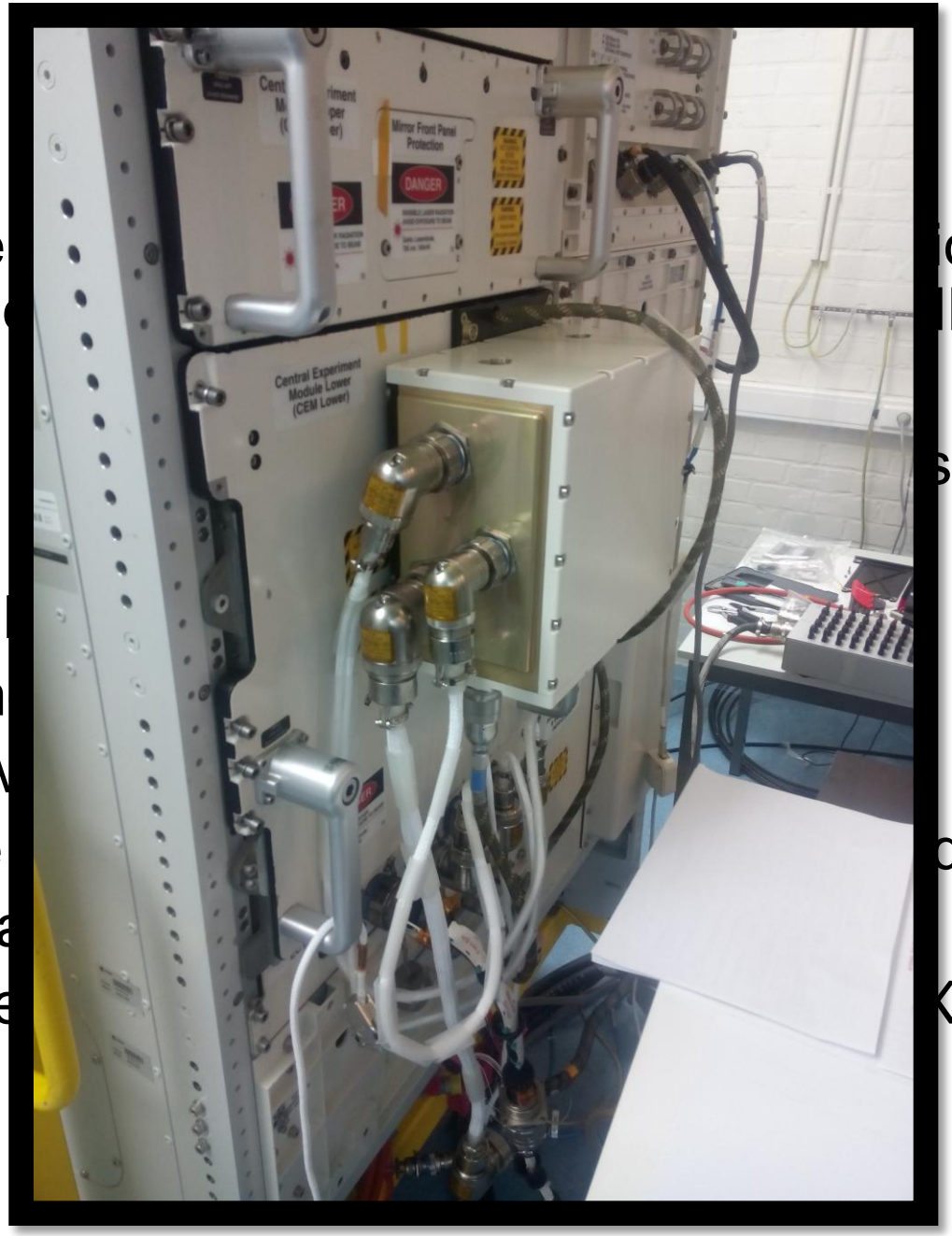


- MVIS commissioning phase 3: Oct 2017- Nov 2017

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2017: FSL ON!

- Objective: ensure ion across FSL, the VMU MkII, and th ID and Multiscale Boiling ECs)
- Joint effort Airbus se coordination with B.USOC
- Aging parts of FS
  - ~~ODM~~ (optics m
  - CEM – only MM
  - VMU – replace design)
  - → FSL ASW upda
  - → Experiments re X)



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2017: FSL ON!

- Aggressive schedule to finish the development and verification of the FSL ASW, VMU MkII, SMD EC and Multiscale Boiling EC, all in parallel by the respective teams and industrial contractors.

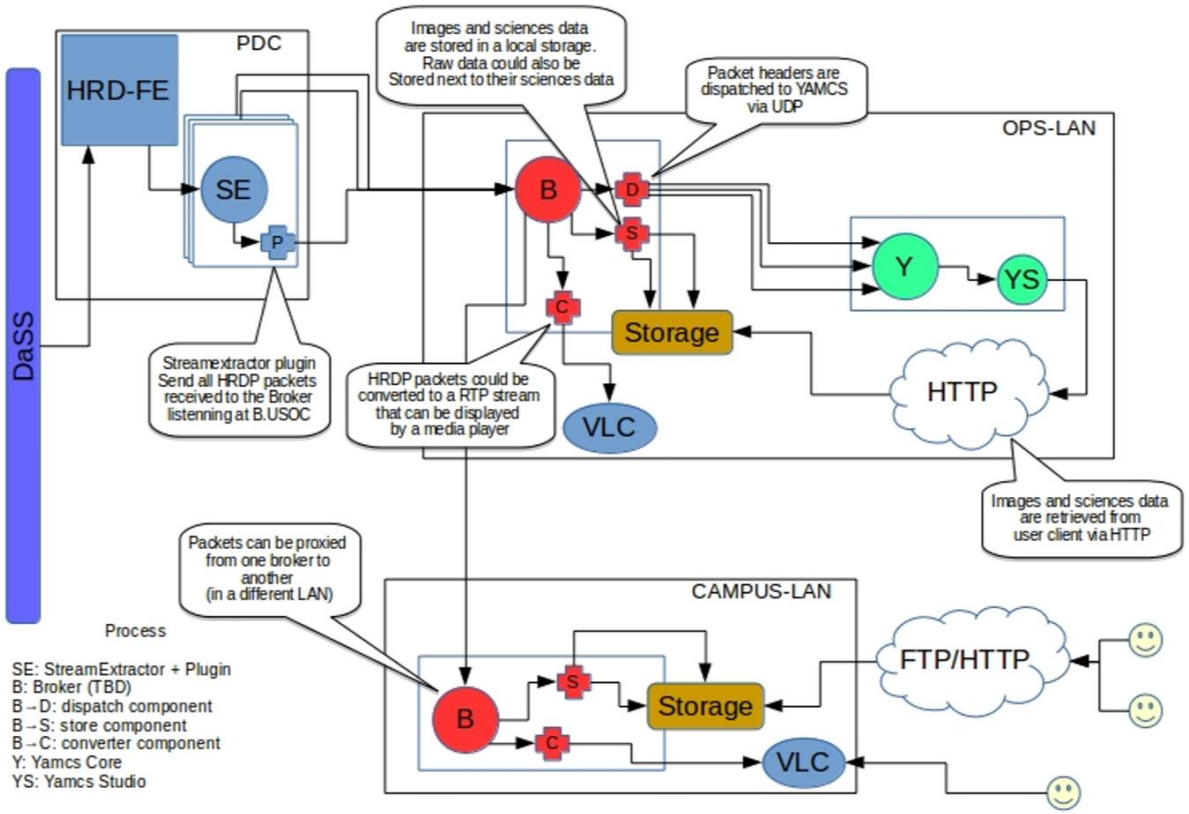
→ Test-as-you-build approach

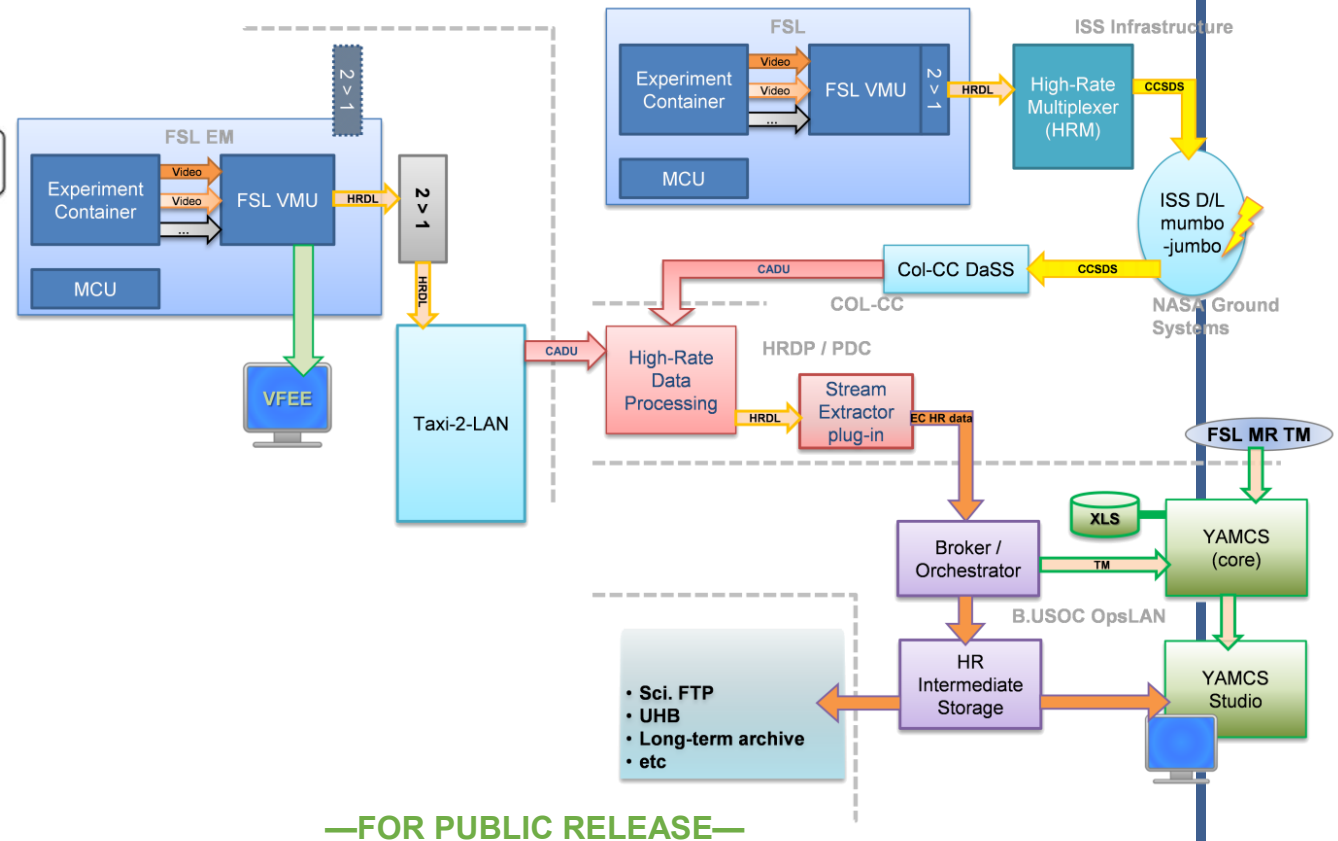
→ Intensive use of the FSL EM at B.USOC for development in parallel with Ops preparation

→ Upgrade of the B.USOC ground segment introducing the High Rate Data Broker (aka Hadock)

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2017: FSL ON!





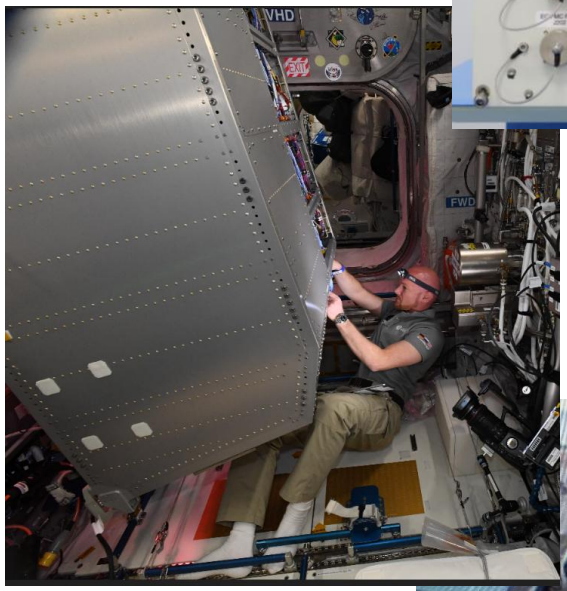
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2018: Installation of VMU Mk2 and ASW

Performed by Alexander Gerst in July 2018









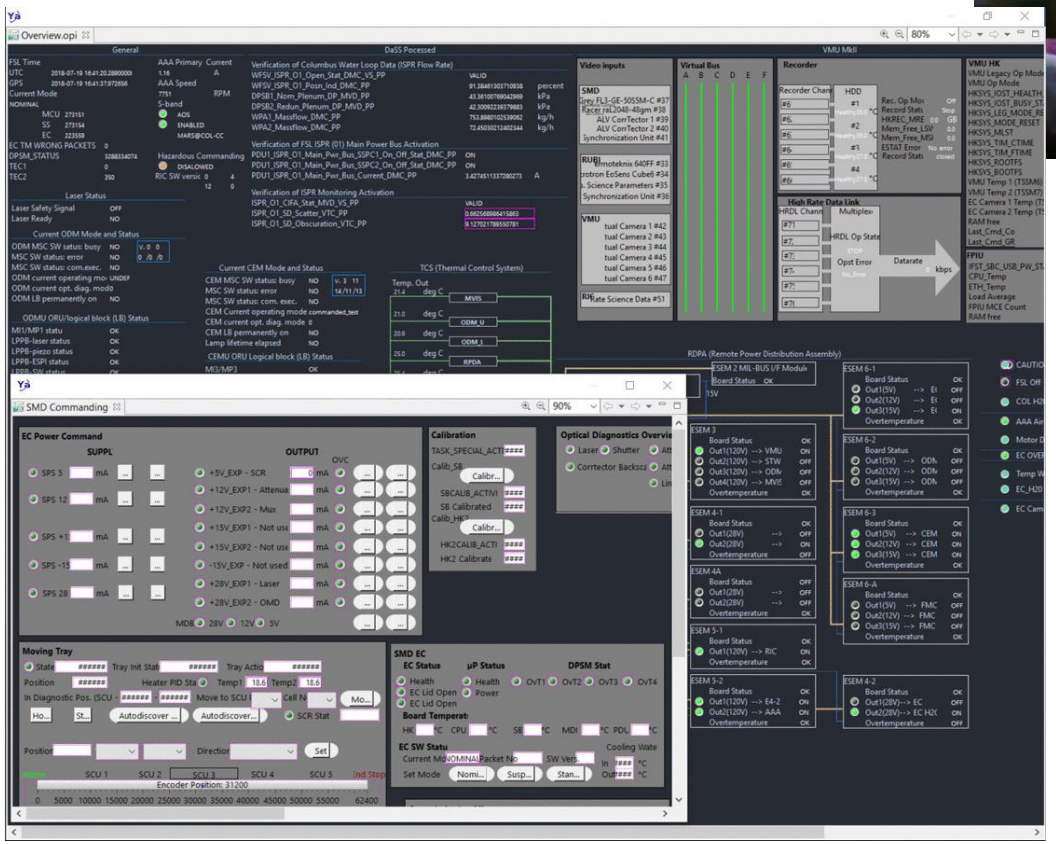
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2018: Installation and commissioning of SMD with CompGran samples

Performed by Alexander Gerst,

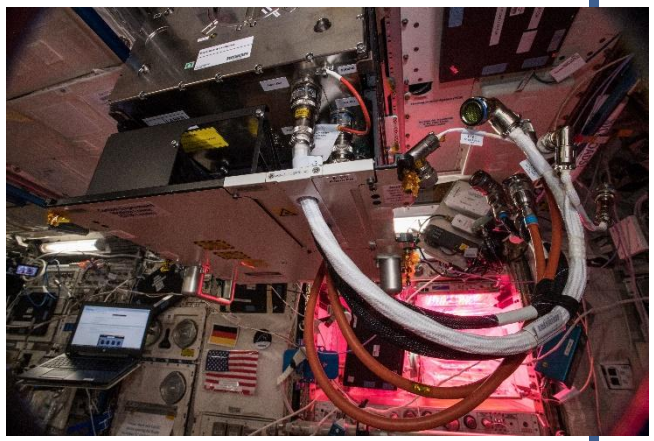
July 2018











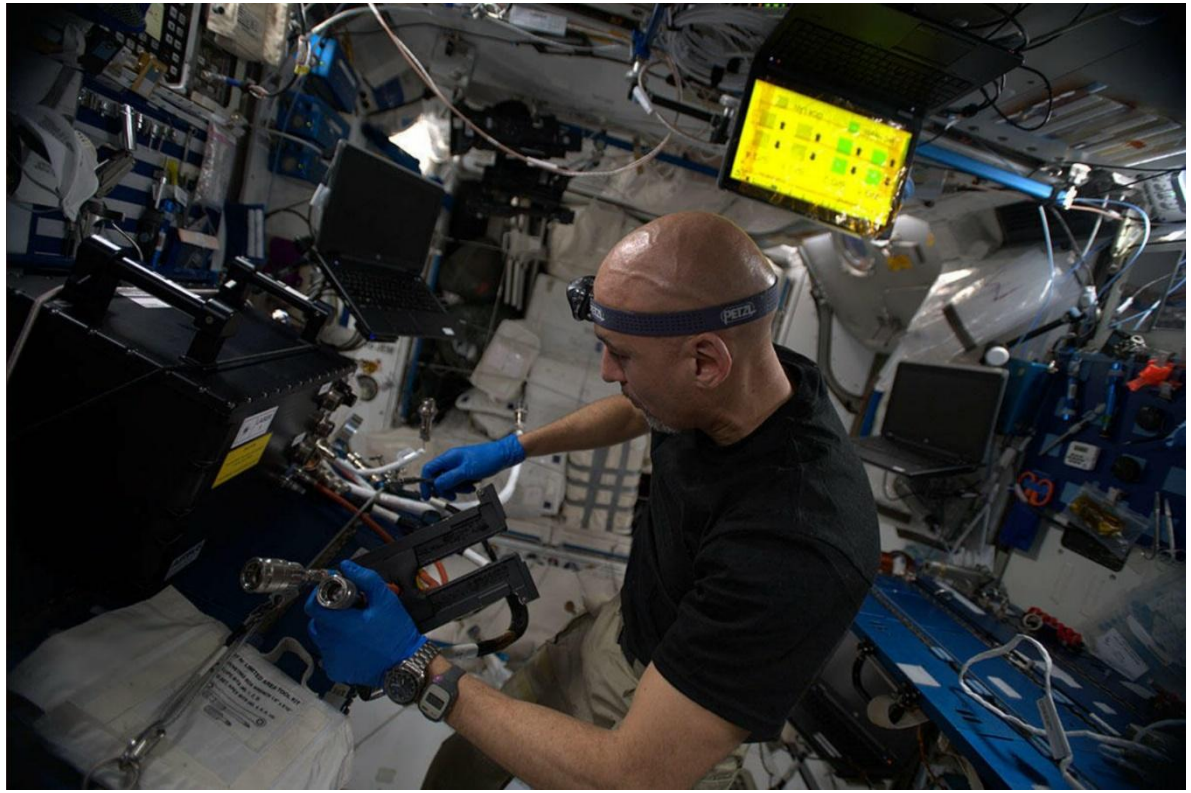
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2019: Multiscale Boiling

Installation performed by Luca Parmitano,

August 2019





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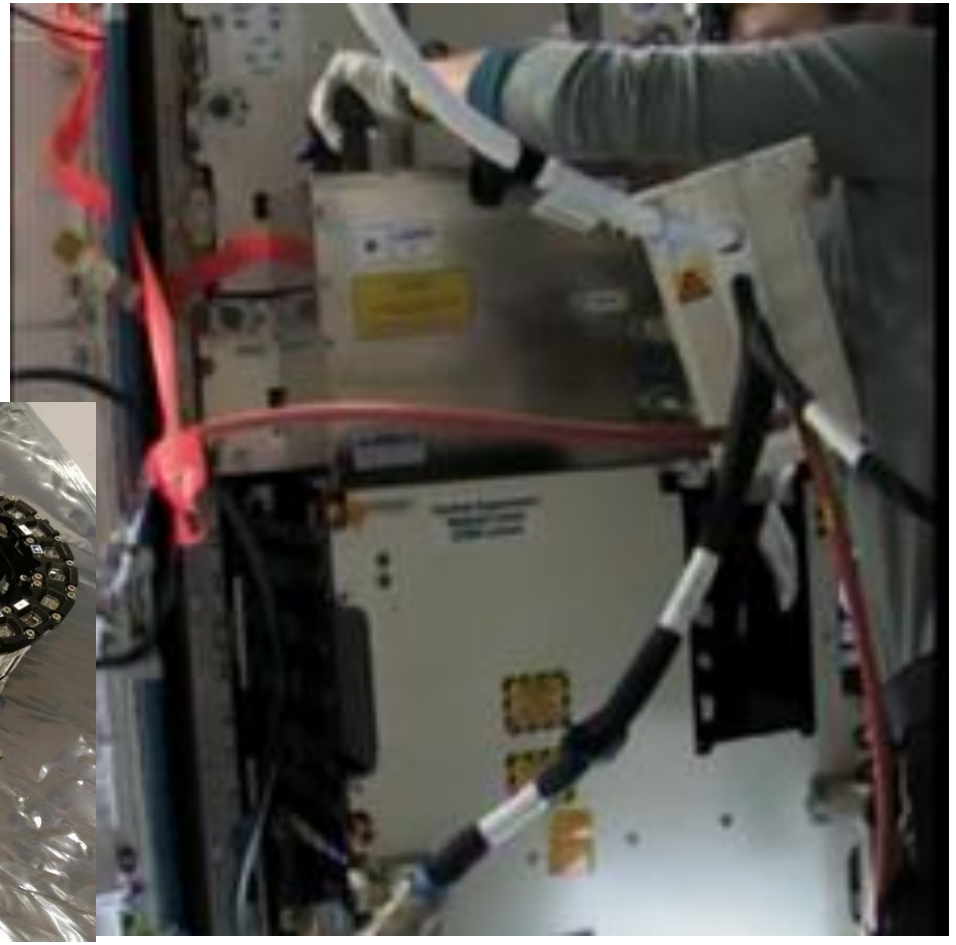
2020: Installation and commissioning of FOAM-C in SMD

Installation by Jessica Meir,

March 2020

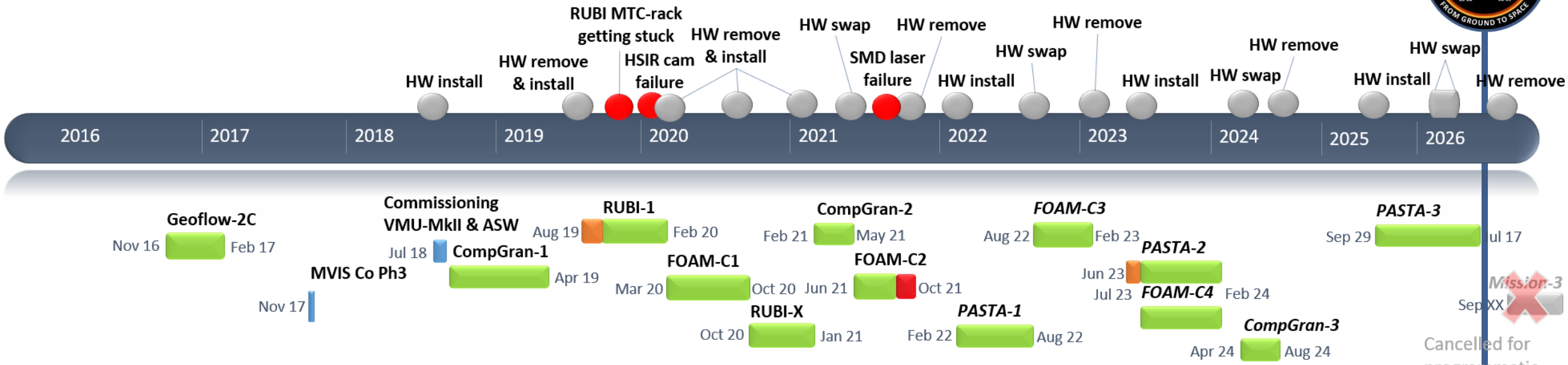






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Overview

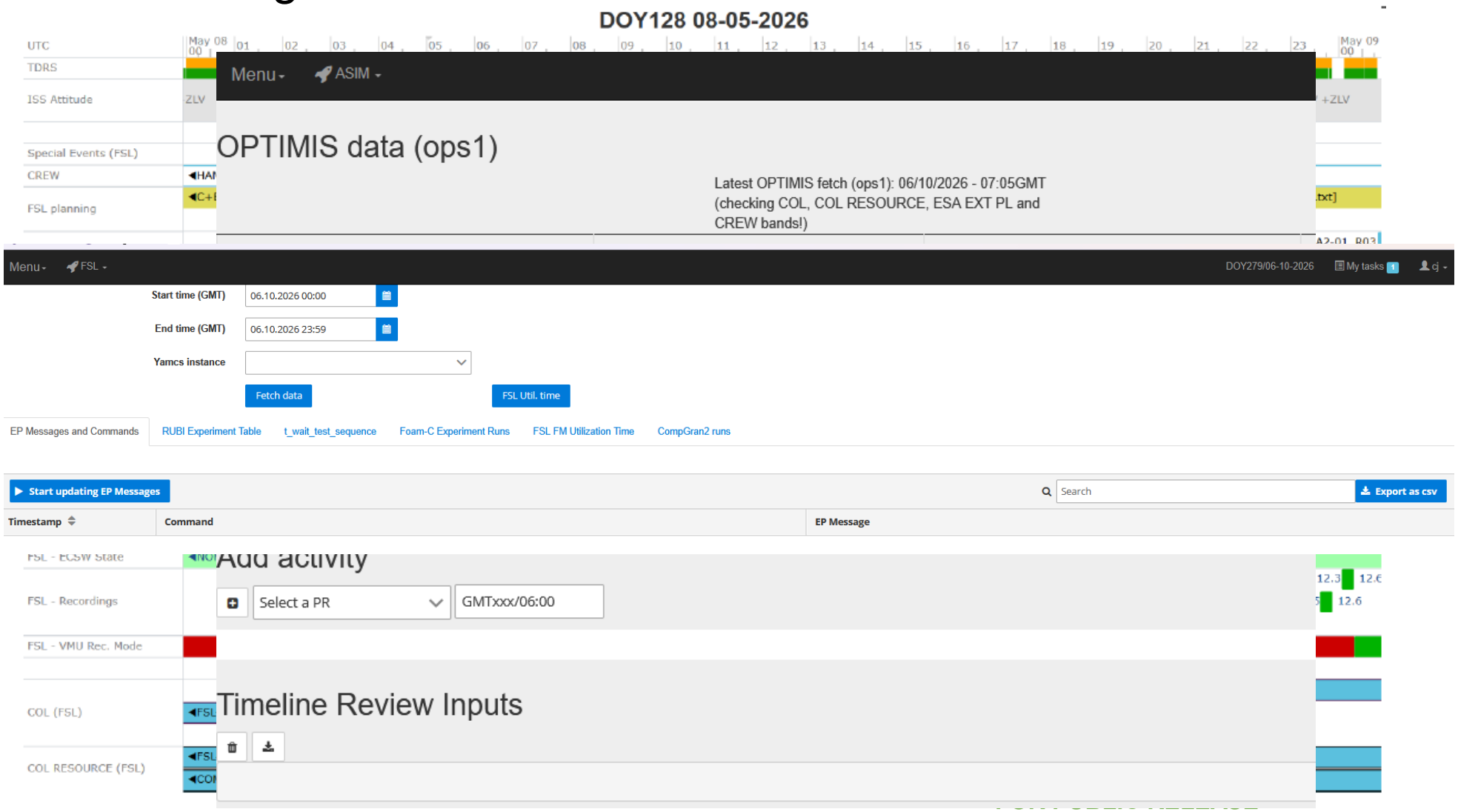


- SMD
  - CompGran -1, -2, -3
  - FOAM-C -1, -2, -3 and -4
  - PASTA -1, -2 and -3
- MultiScale Boiling
  - RUBI-1
  - RUBI-X

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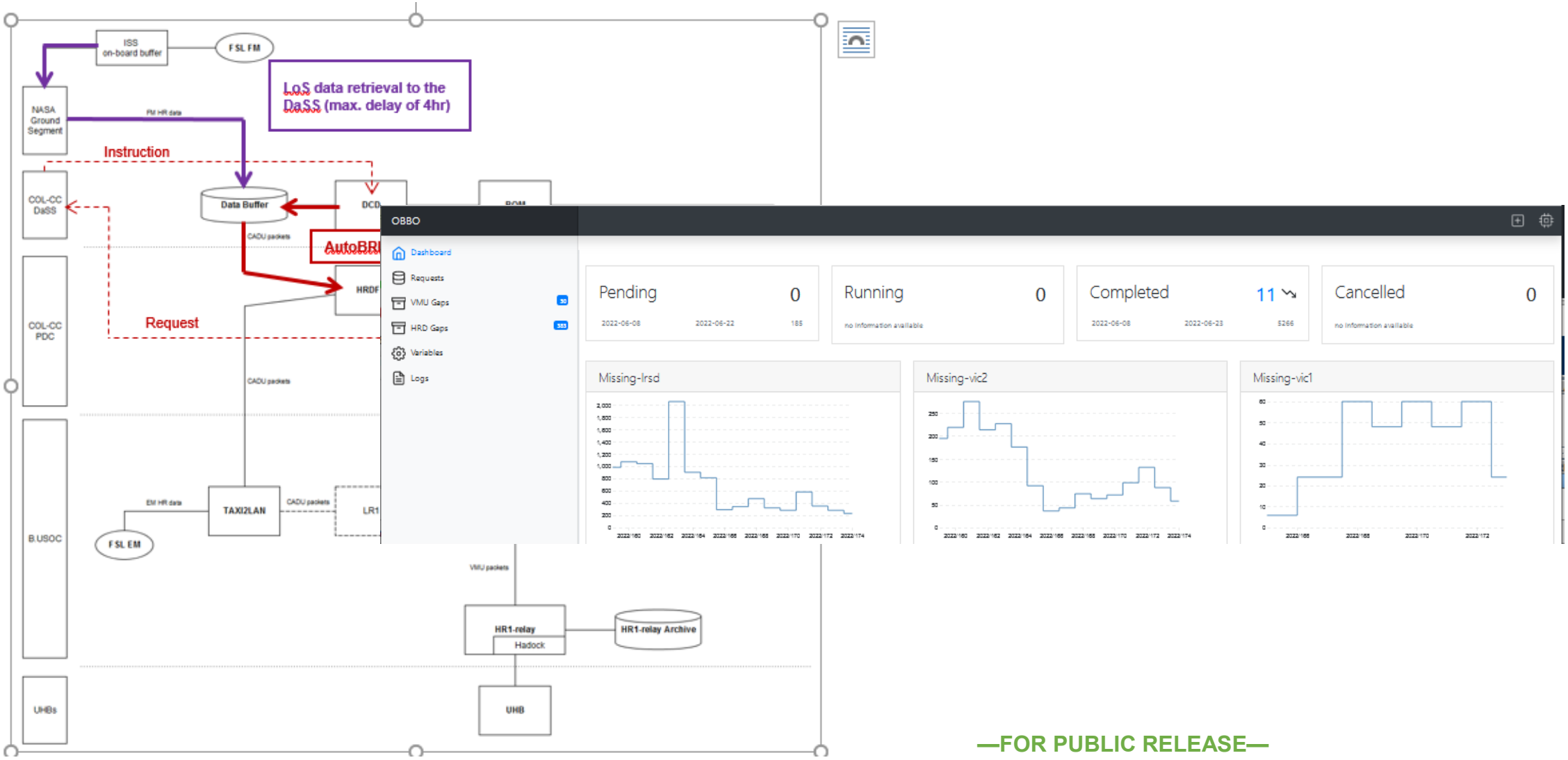
Ops Support Tools

Generic Planning Tool



Ops Support Tools

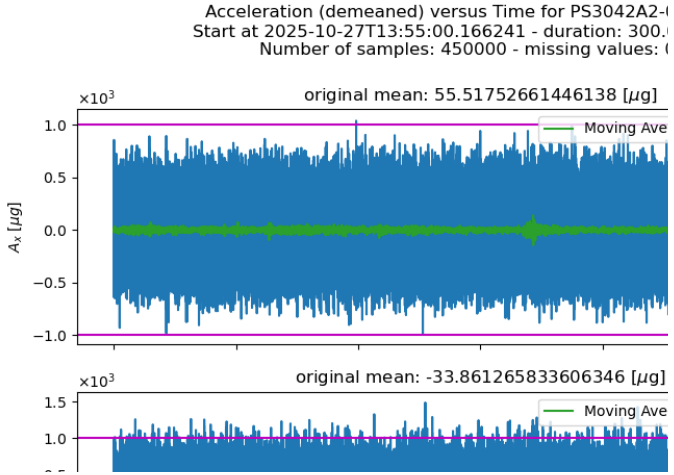
High Rate Data archive consolidation with AutoBRM and OBBO webinterface

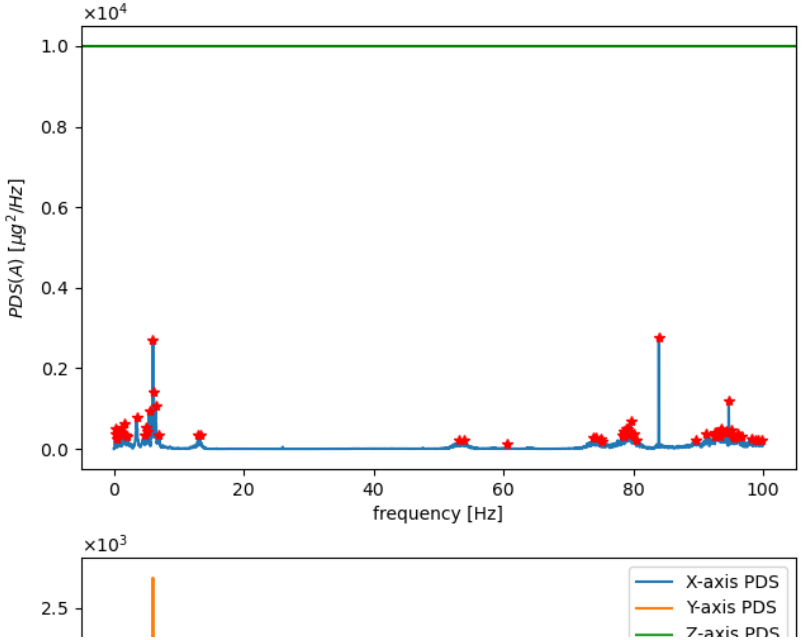


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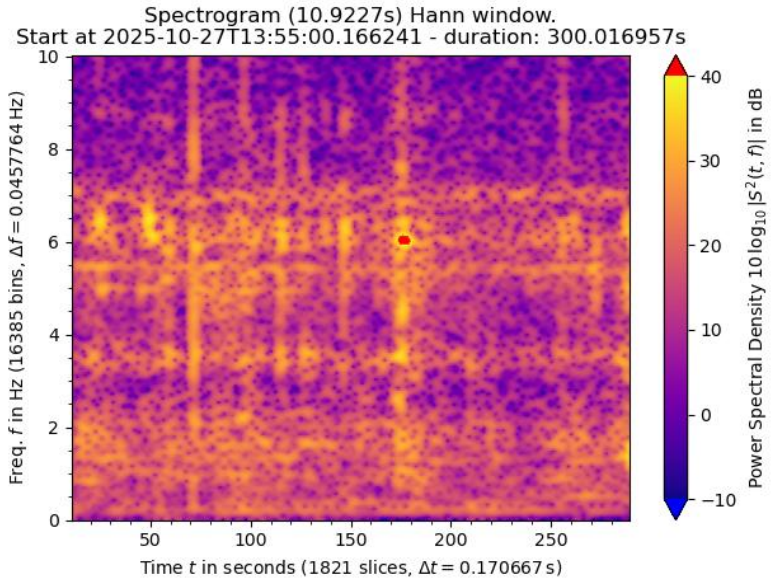
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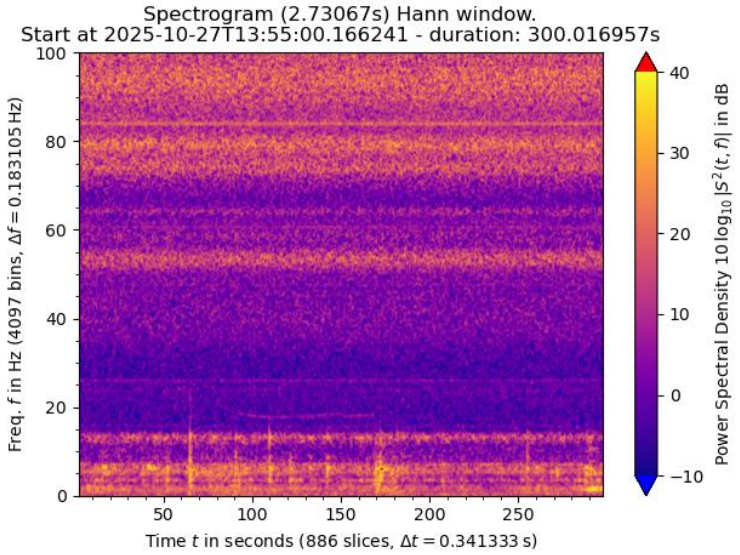
MMA Data Analysis

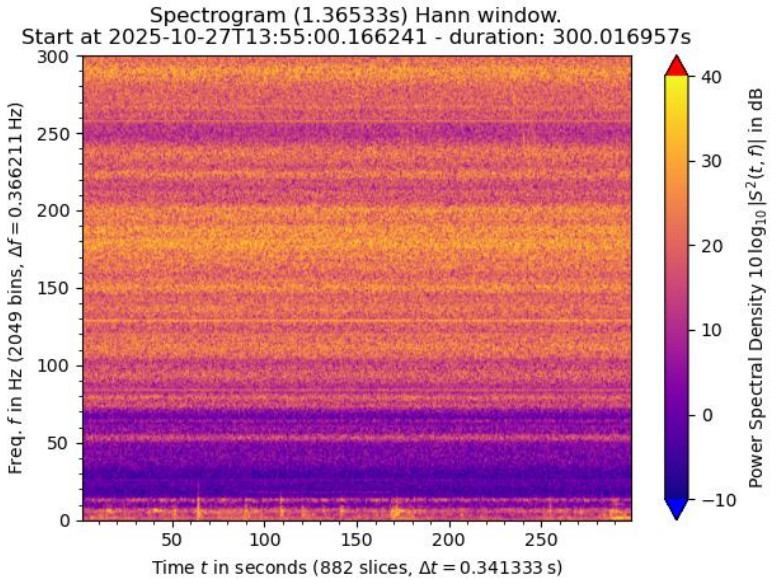




freq [Hz]	RSS PDS
0.18	494.83
0.37	369.65
0.5	244.47
1.03	383.26
1.33	539.2
1.65	646.38
1.83	364.42
2.01	333.17
3.5	773.36
4.74	337.91
4.94	549.4
5.24	435.4
5.45	953.83
6.02	2721.64
6.11	1426.79
6.43	1058.64
6.96	333.85
13.02	334.08
13.3	338.14
53.12	217.39
53.86	219.7
60.61	144.57
73.81	271.23
74.25	273.95
74.94	242.13
75.19	181.19
78.28	354.49
78.44	330.42
78.53	435.86
78.67	393.97
78.9	509.91
79.15	511.66
79.31	450.97







Concluding remarks

- B.USOC accepted the challenge!
- Enabling factors for success
  - Integrated teams
  - Early involvement of operation during the development → expertise; implementing user proposed improvements
  - Learn as you go – implement lessons learnt from encountered anomalies in ops products and software after each mission
  - Dedication and infinite flexibility

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- Van Hoof, D.; Jacobs, C. (2023). The Operational Challenges of the Multiscale Boiling Investigation on the International Space Station. , SpaceOps 2023: 17th International Conference on Space Operations, Dubai, United Arab Emirates, 6-10 March 2023, ID#585,
- Van Hoof D., Jacobs, C., Arijs, Y. (2025). Dealing with the ageing Fluid Science Laboratory facility: the successful integrated approach for payload development and operations preparations for FSL mission extension on the ISS., SpaceOps 2025: 18th International Conference on Space Operations, Montreal, Canada, 26 - 30 May 2025, ID#502

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THANK YOU!



Credits: Gemini

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