FUSION FOR ENERGY

ISFNT15

INTERNATIONAL SYMPOSIUM ON FUSION NUCLEAR TECHNOLOGY

F4E Remote Handling procurement for ITER

Emilio Ruiz - Project Manager – Remote Handling Project Team

(on behalf of Carlo Damiani)

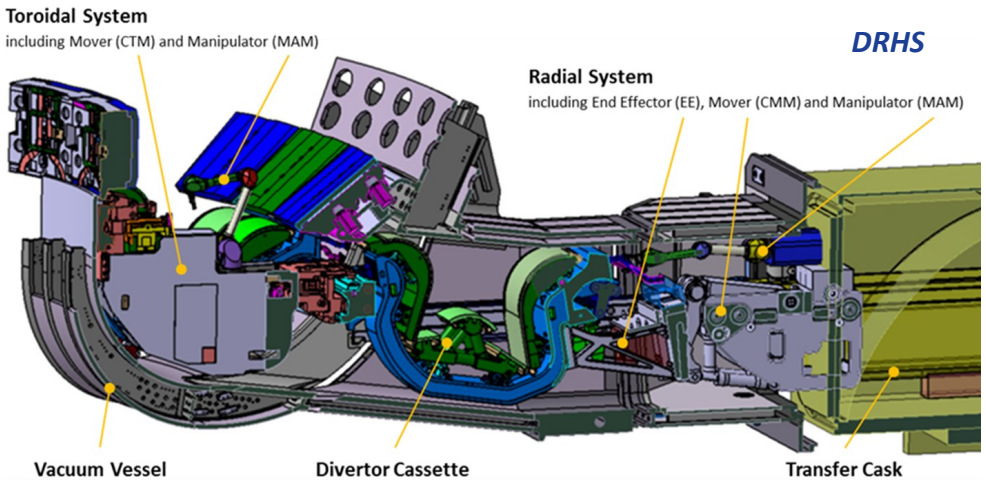
12th September 2023

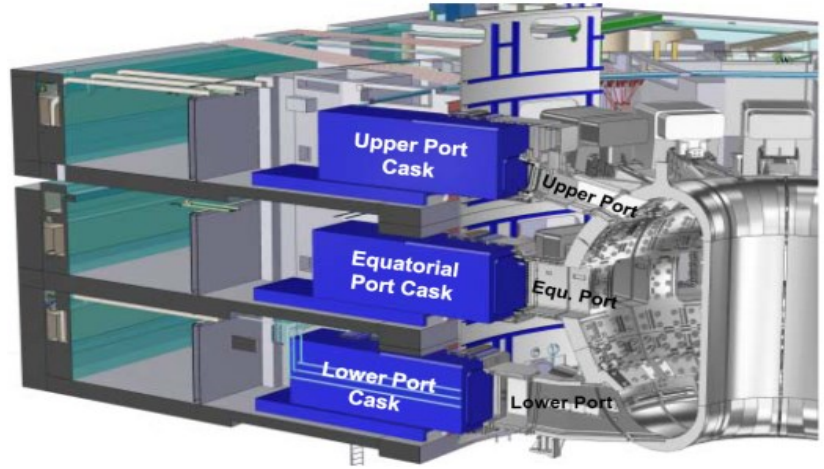
Bringing the power of the sun to earth

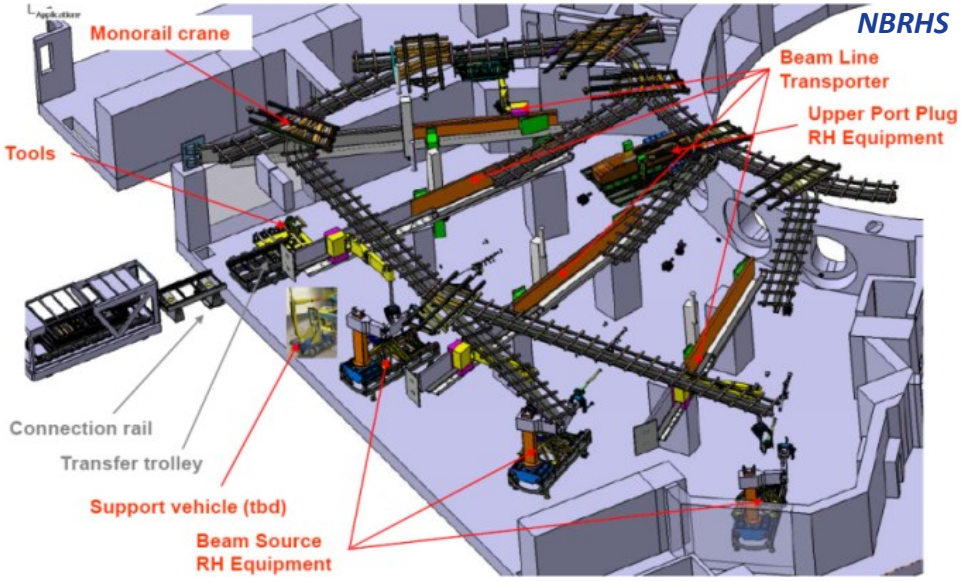
Outline

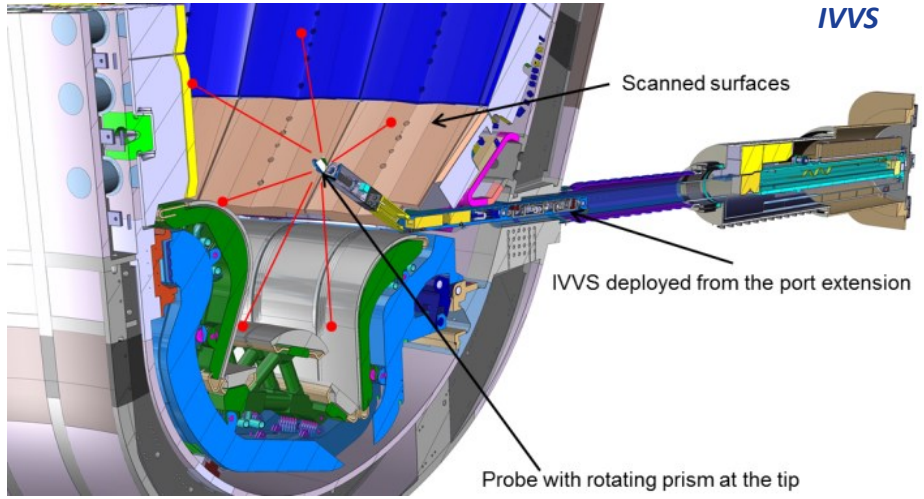
- Introduction to the European contribution to ITER RH and quick tour on recent developments and achievements
- Current status of our procurements
- Outlook to long term
- Business Opportunities
- Q&A

Introduction – F4E Remote Handling (RH) Scope





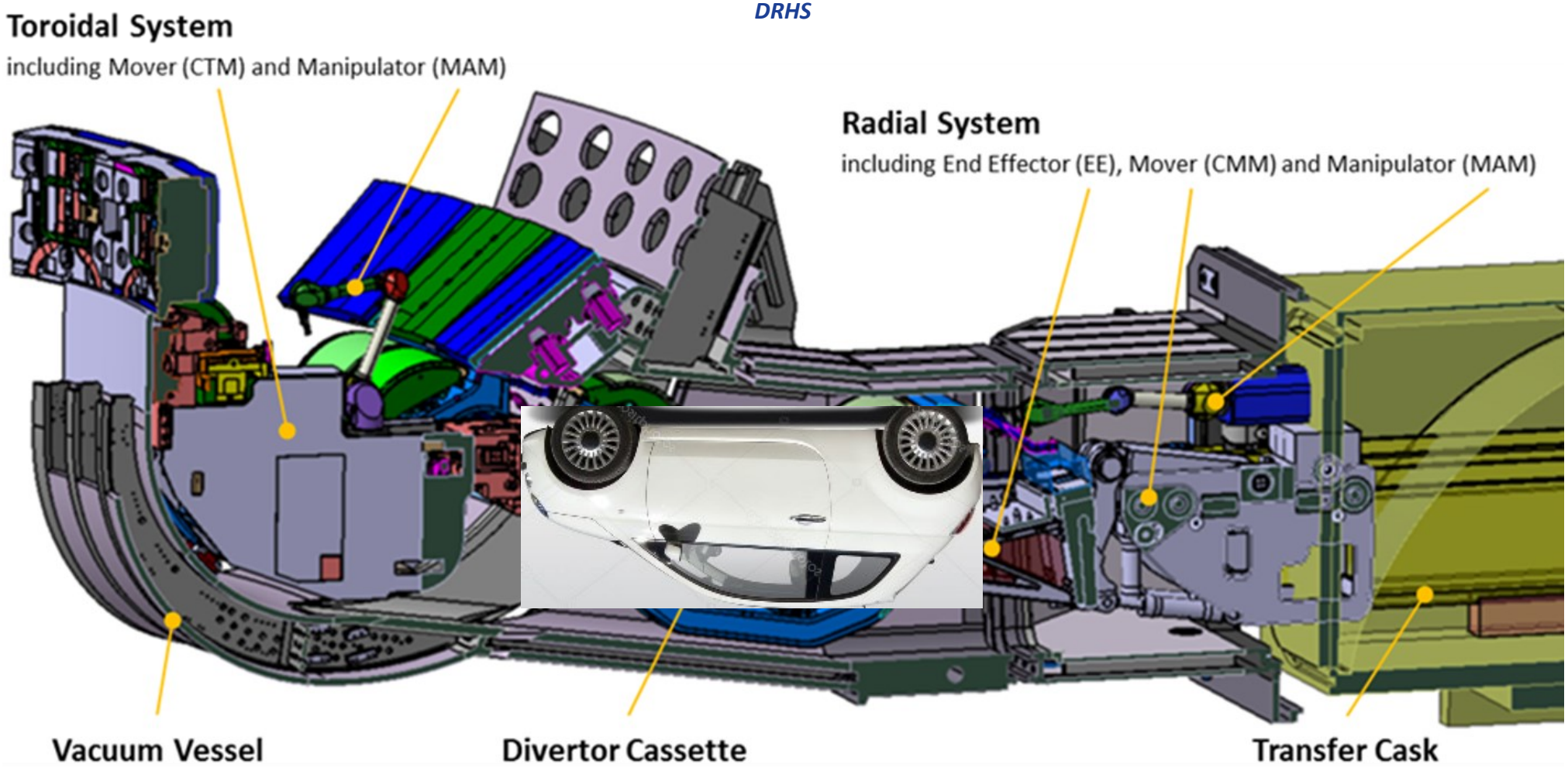




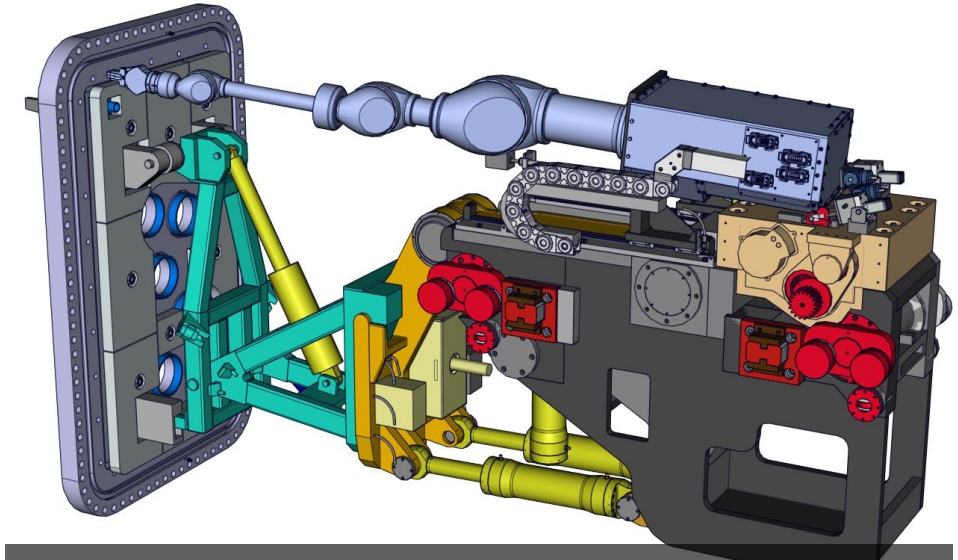
F4E is in charge of the procurement in kind of 4 packages

F4E RH Scope - Divertor RH System (DRHS)

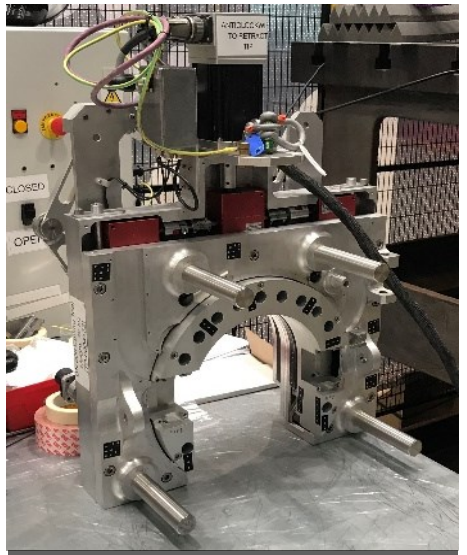
DRHS



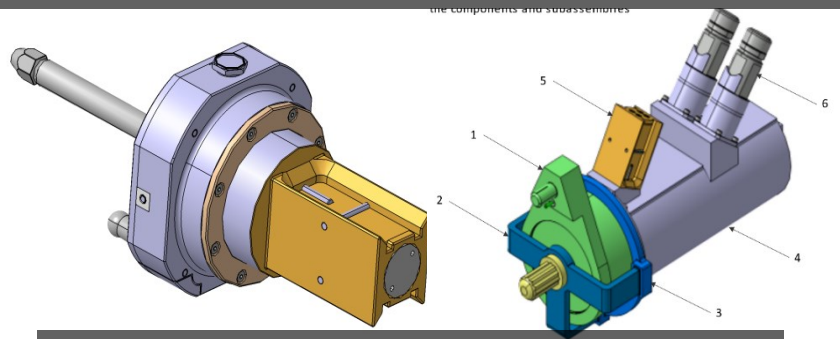
Status of the DRHS



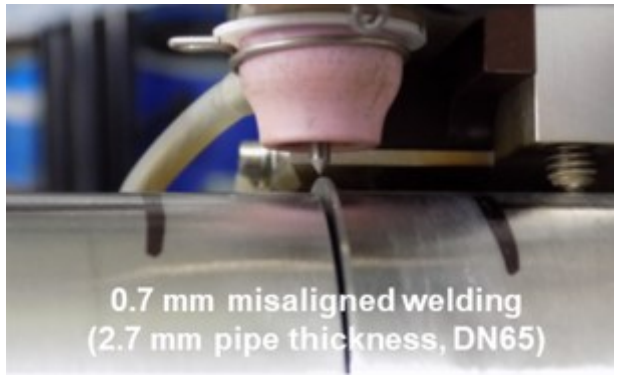
DRHS – Final Design of the Cassette Multifunctional Movers
The manipulator arm and the end effector are handling the Primary Closure Plate (VV lower port closure)

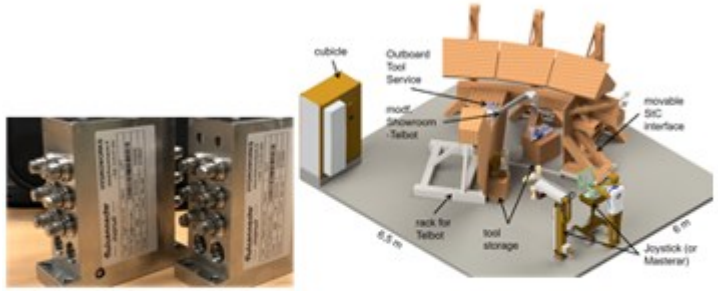


NBRHS cutting tool for 200 mm pipes



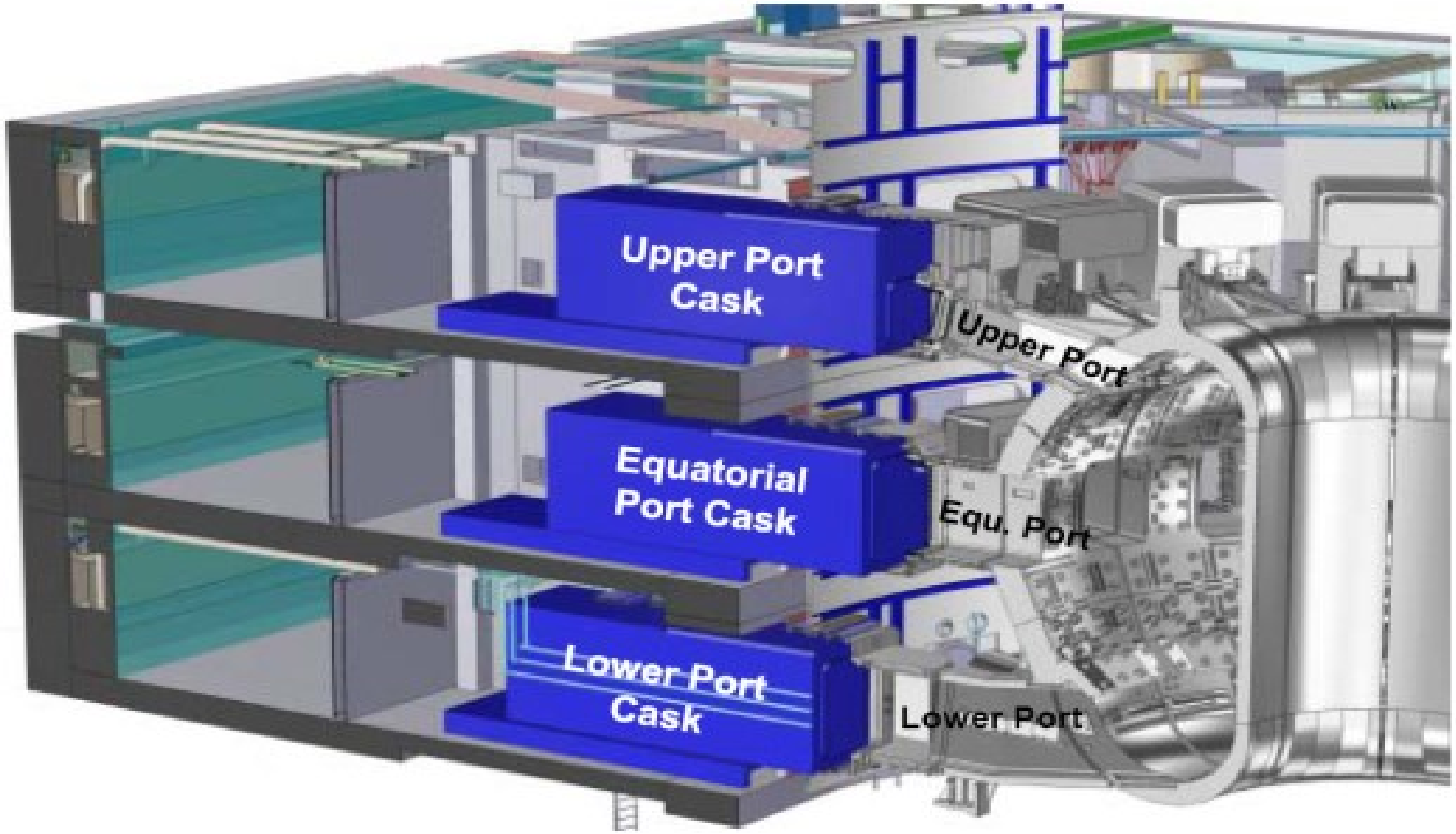
DRHS – Final Design of the tools for the divertor cassette locking system
These tools are operated by the manipulator arm (grappling the yellow handle)



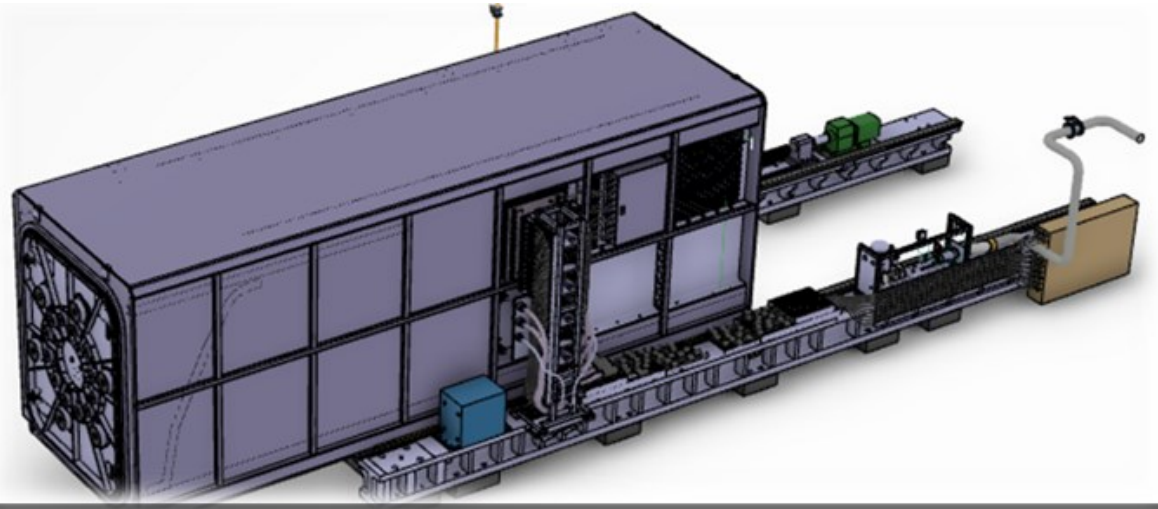


DRHS new digital valves (left) and manipulator arm test bed

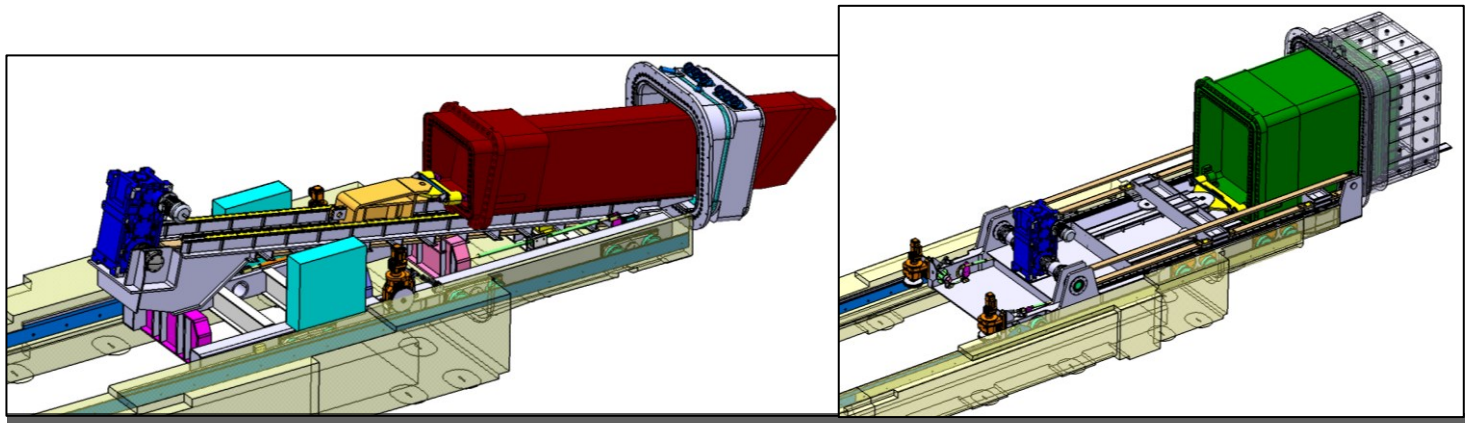
F4E RH Scope – Cask & Plug RH System (CPRHS)



Status of the CPRHS



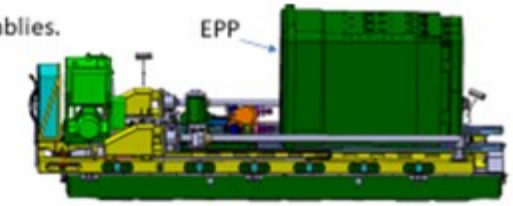
CPRHS: cask docking system prelim design (cask envelope shown)

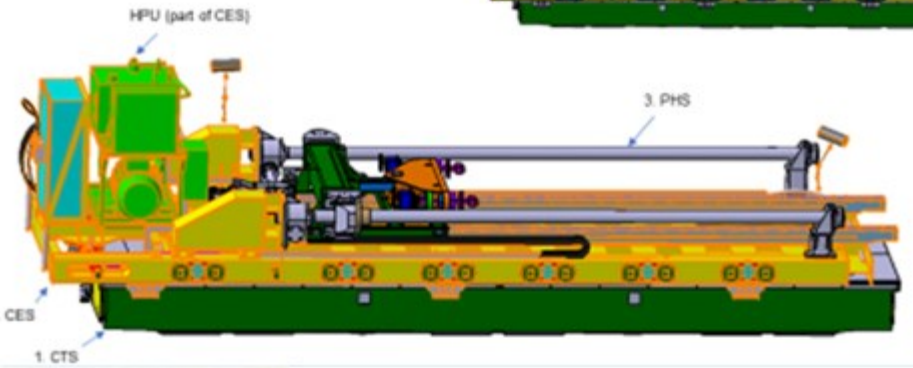


1st assembly Upper and Equatorial Port Plug Casks in Final Design Phase
("real" RH equatorial cask on the right)

The CPRHS MA-1 consists of 3 main sub-assemblies.

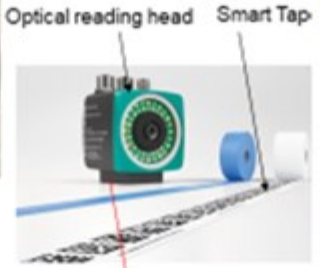
1. Cask Transfer System (CTS)
2. Cask Envelope System (CES)
3. Plug Handling System (PHS)

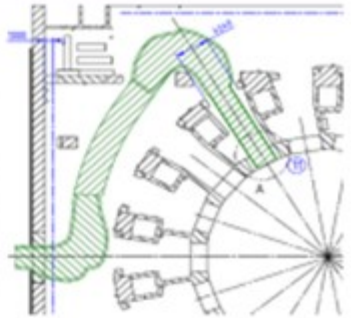


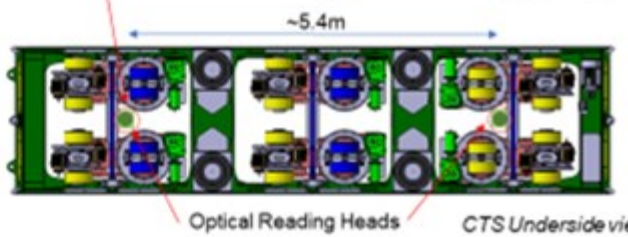


Typical Remote Control Console

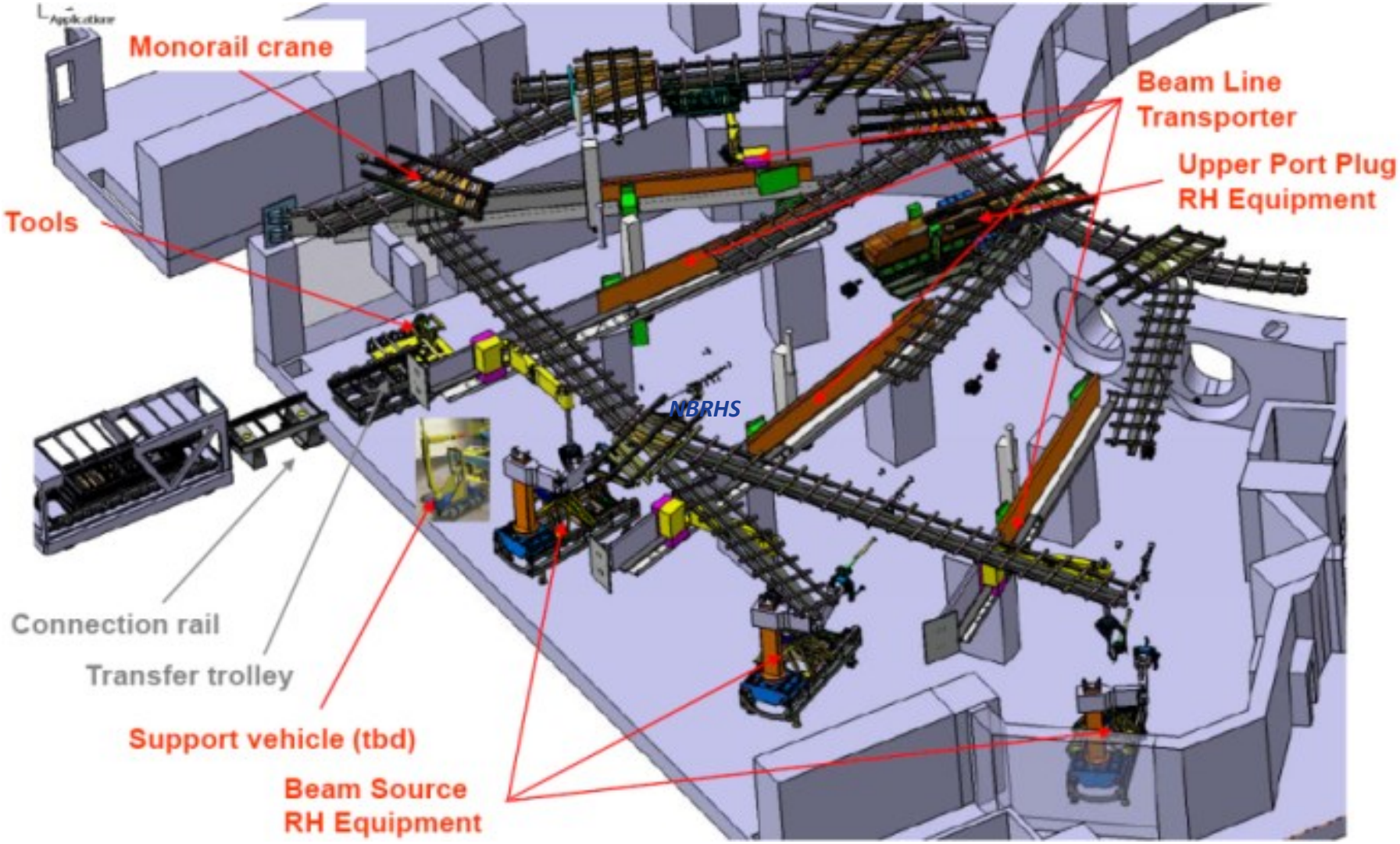
Wired Manual Control Device







F4E RH Scope – Neutral Beam RH System (NBRHS)



Status of the NBRHS

crane trolley structure before and after painting

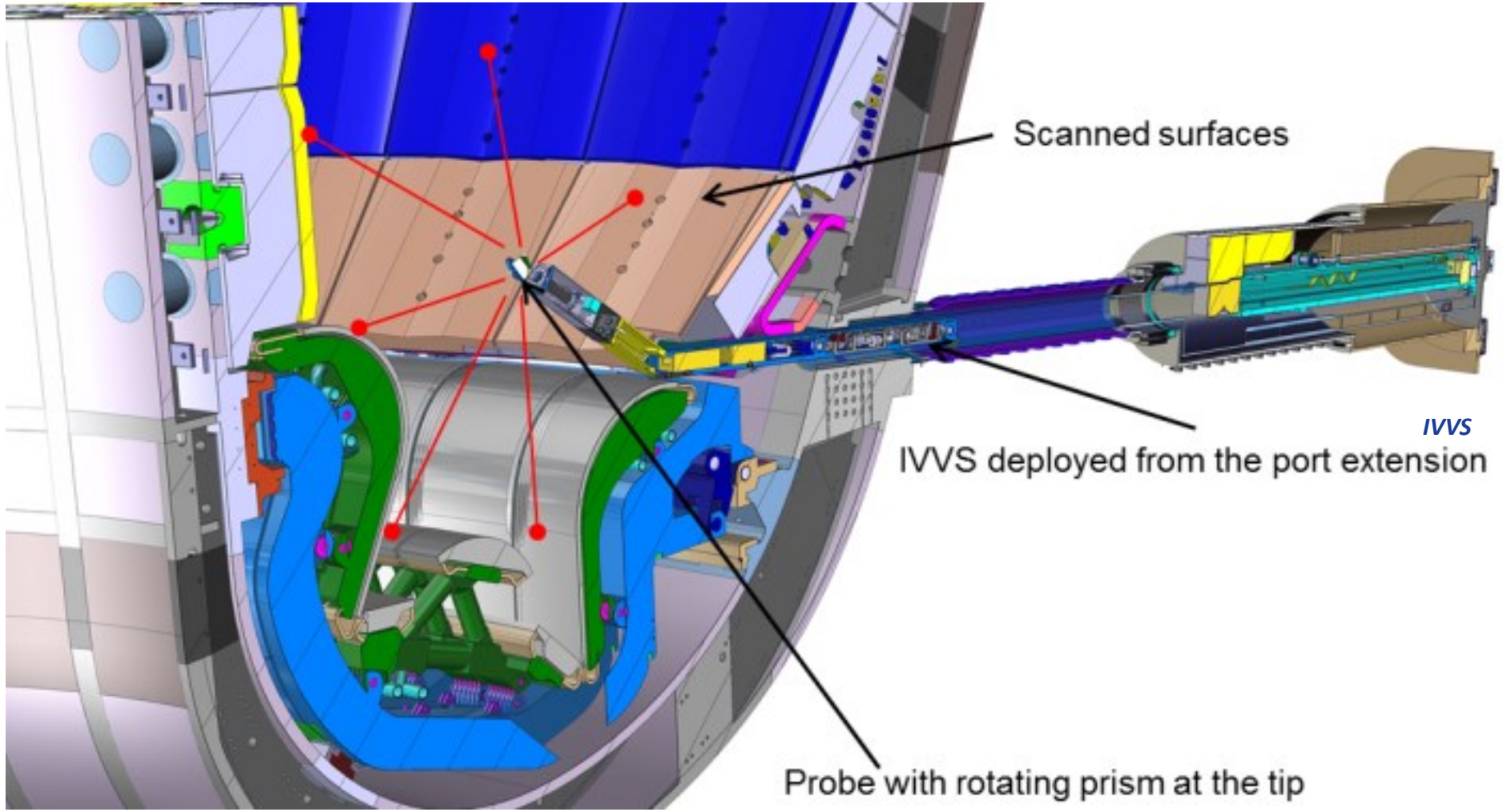
NBRHS monorail crane prototype manufacturing

with counterweight (ye
near rail bend (blue)

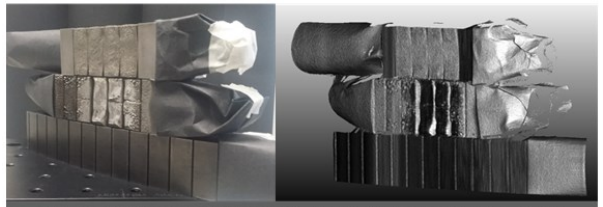
NBRHS - Joint visit from IO and F4E RH in the final day of the successful test campaign of the crane prototype at supplier premises

Completion of test campaign on NBRHS crane prototype at Reel premises (France).
Extreme offset loading configurations and induced ±4 mm rail misalignments trialled

F4E RH Scope – In-Vessel Viewing System (IVVS)

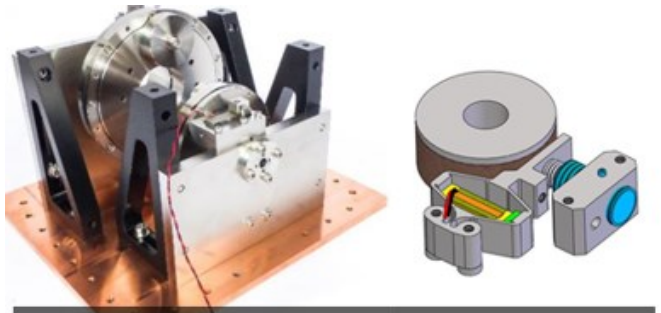


Status of the IVVS

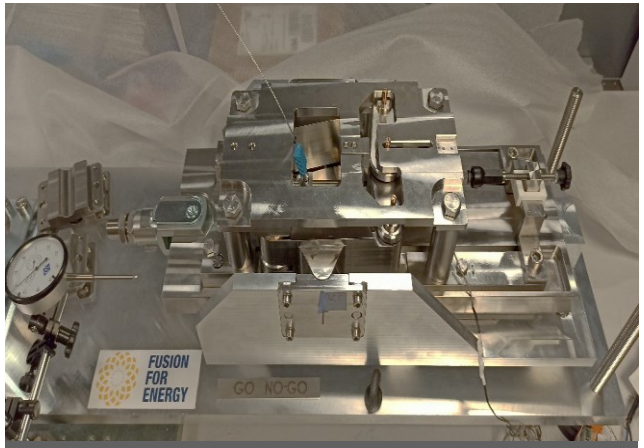


Camera image (left) and IVVS 3D reconstruction (right) during lab test on ITER Divertor PFC

Special encoder for IVVS scanning head developed

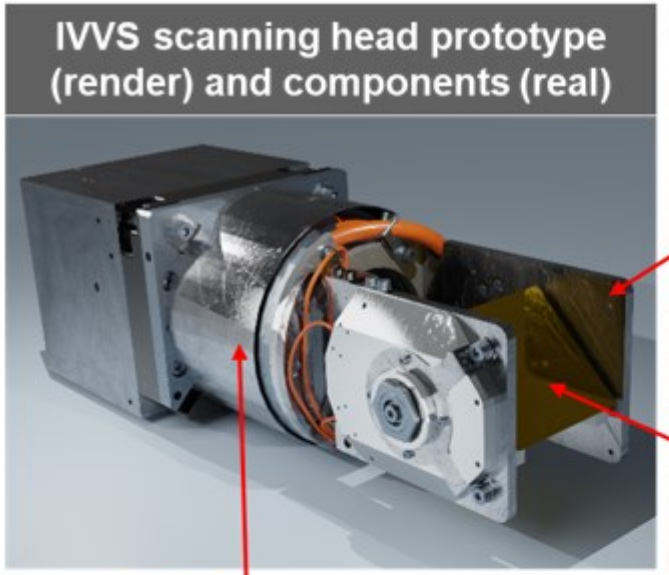


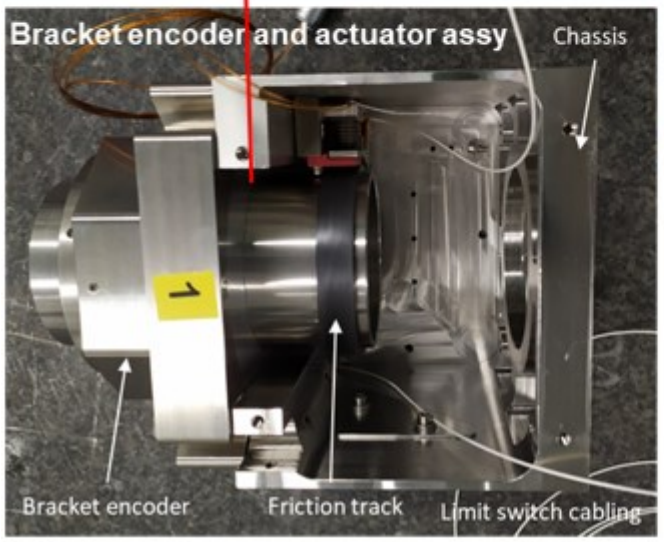
Test on IVVS piezo actuator for laser scanning prism rotation

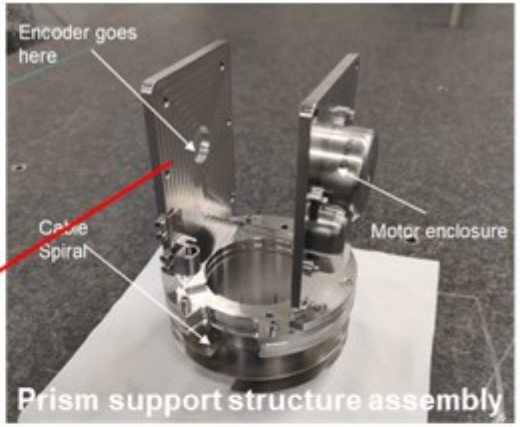


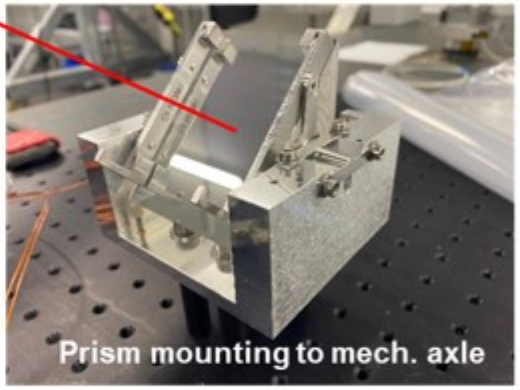
IVVS – Full-scale prototype of the Traverse Latch – it is the seismic-resistant, magnetic field compatible and radiation tolerant device that locks the IVVS in position during a scan

IVVS – Full-scale prototype of the Remote-handing Compatible Connector – it is the high-density electrical/optical connector assembly that services the IVVS Cartridge when installed; it must be connected/disconnected via remote tooling located in the CPRHS









F4E RH Scope – RH Control System integration

- **6 main layers:**
- Field equipment
- Cabling, connectors, junction boxes
- LLCS cubicles
- RH Networks
- HLCS - operators interfaces
- Supervisor

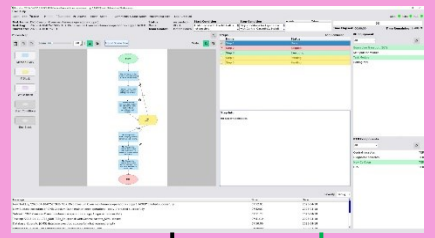
ITER remote maintenance is a complex, integrated and diffused system embedded in the nuclear plant (it includes many subsystems) and spread across various buildings

Status of Control System Technologies - Operators Interfaces (High Level Control System)

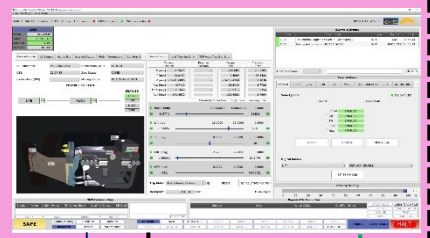
FUSION FOR ENERGY

HIGH LEVEL CONTROL SYSTEM

Operation Management System (OMS) to manage step by step operations sequences of RH tasks. GUIs for building, executing and analyzing RH tasks.



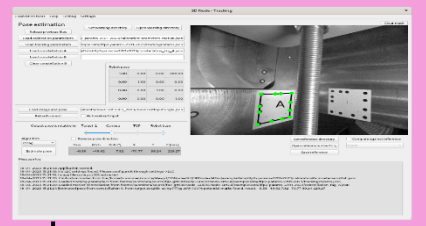
Command and Control (C&C): the primary operator GUI to remotely control and monitor RH devices through RH networks; interfaced to a Joystick for manually driven motion.



Virtual Reality (VR): to complement the Viewing System, to simulate **structural deformations**, to enable the anticipated detection of collision, to **assist Teleoperation**

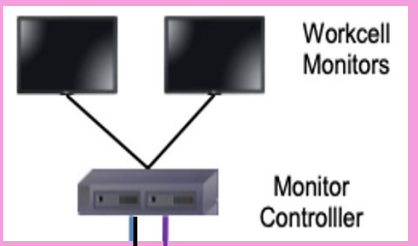
VIRTUAL REALITY SYSTEM

3DNode Machine Vision: to assist RH operations and Tele-operation.



RH OPERATIONS ASSISTANCE TOOLS

Viewing System (VS) for displaying camera views on the monitor displays of the RH workcell.



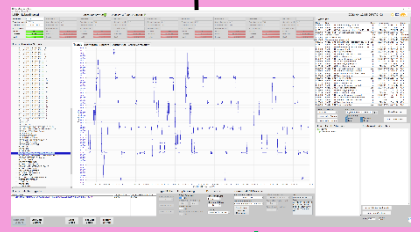
File Network

Master Haptic Arm to tele-operate the MAM slave arm with force feedback.

Emergency Stop button

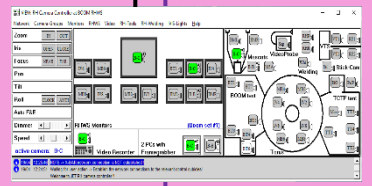
Joystick

TASK SUPERVISOR



Remote Diagnostic System (RDS) enabling the monitoring of the equipment health status to detect and diagnose equipment degradation, before failure occur.

REMOTE DIAGNOSTICS



VIEWING SYSTEM

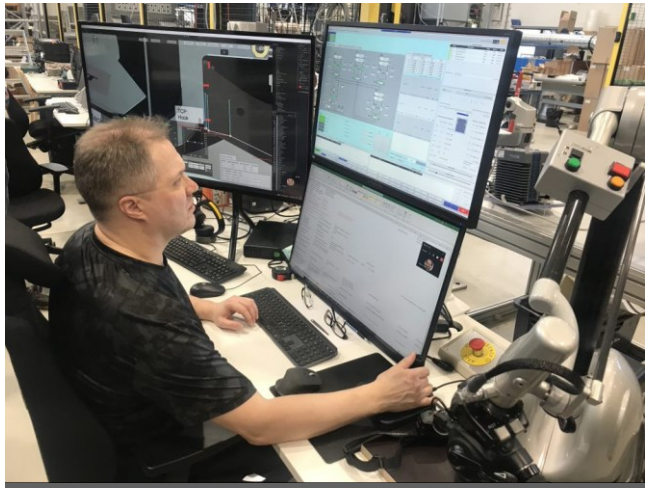
RH Control and Diagnostic Network

RH Real-Time Network

RH Audio-Video Network

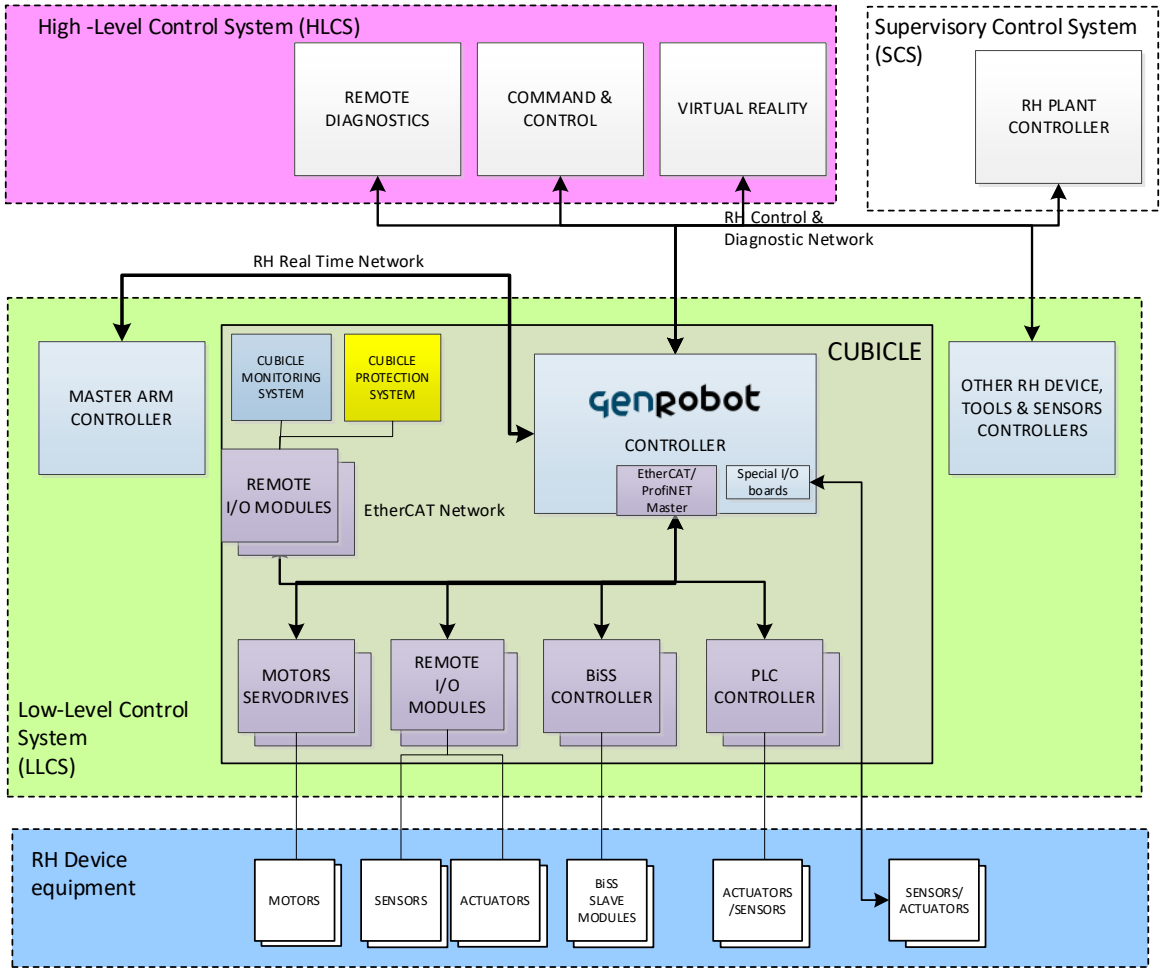
RH Estop Network

Status of Control System Technologies – GENROBOT, 3DMarkers and Integration @ DTP2

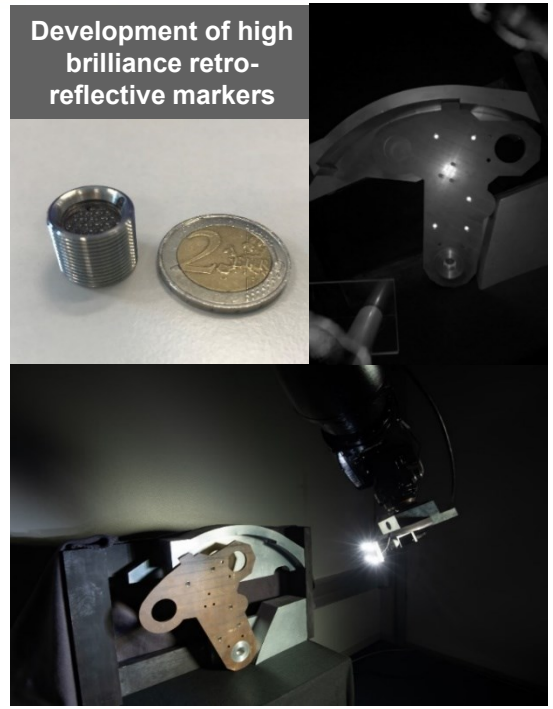


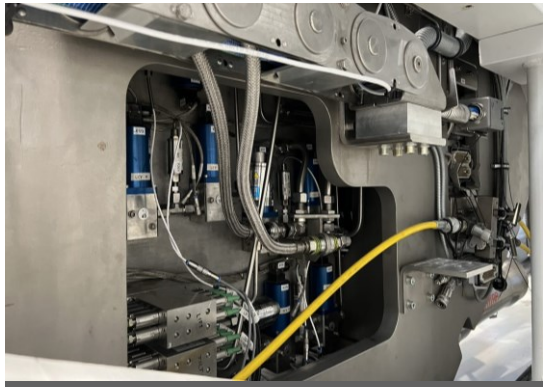
Tests at DTP2 on central cassette removal with new technologies on board of CMM: Genrobot control software and digital valves for hydraulic actuators

DTP2 lab during central cassette handling tests



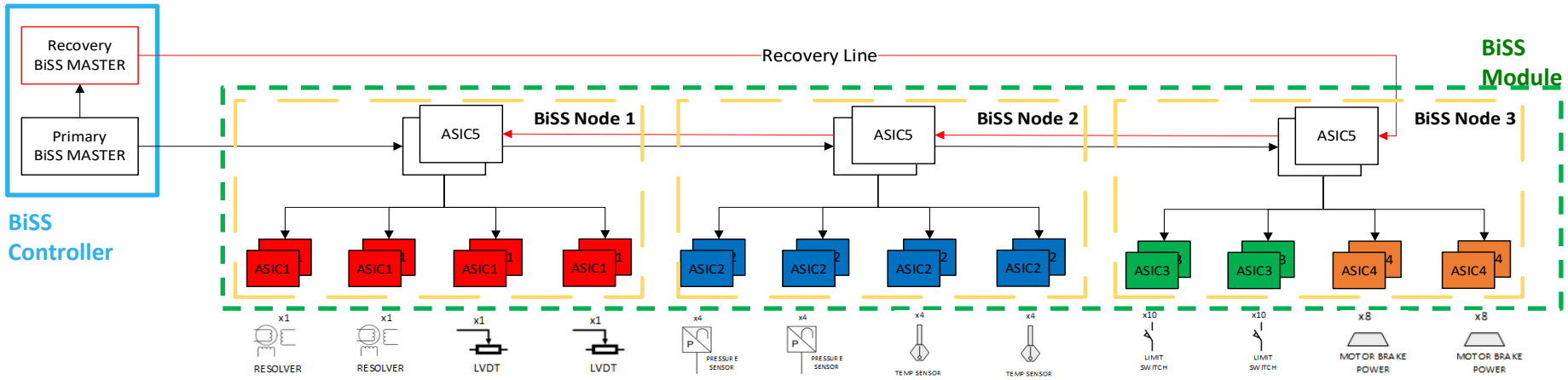
Development of high brilliance retro-reflective markers

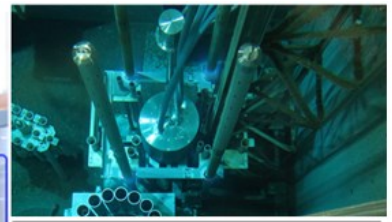




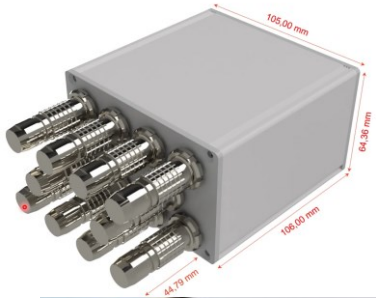
DTP2 – upgraded CMM hydraulics with digital valves on board

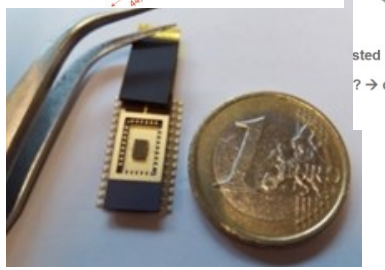
Status Control System Technologies – 1MGy Radhard BiSS Multiplexers

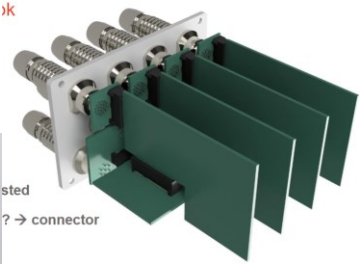


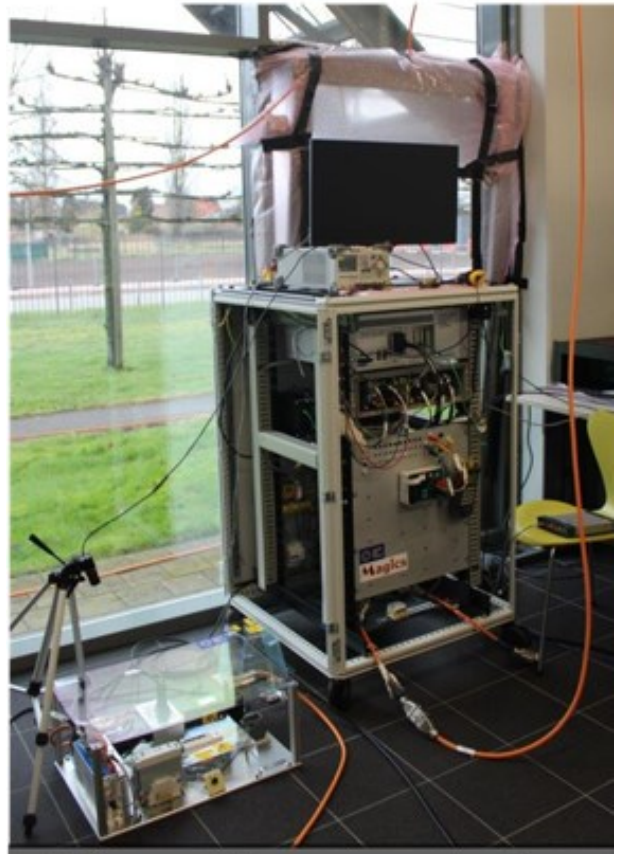


Set up (left) and execution (above) of gamma ray tests at 1 MGy on electronics for multiplexers for RH application





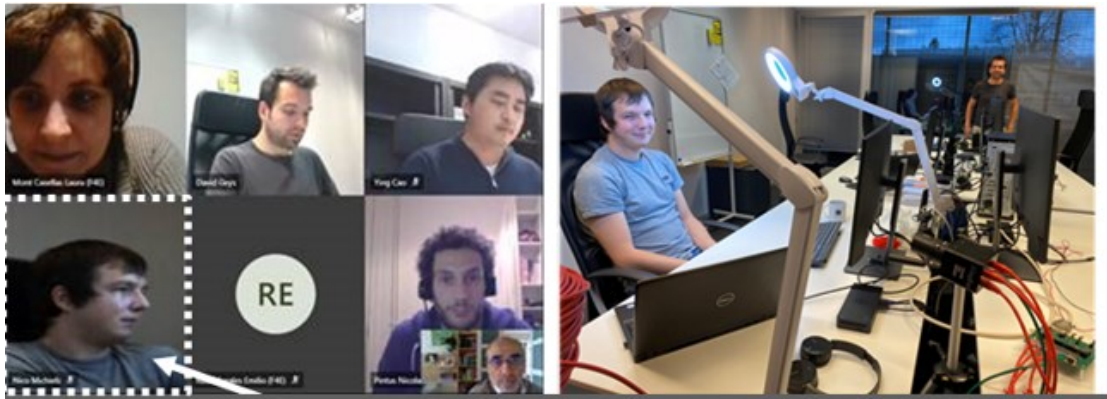




150-m cable communication tests for BISS module and irradiated ASICs (5 typologies)

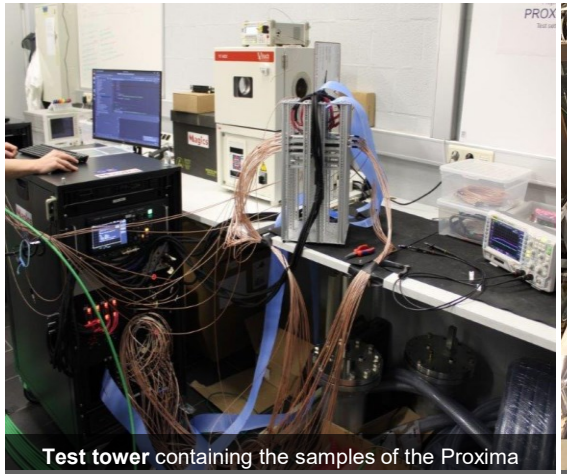
Status of Control System Technologies – 1MGy Radhard Cameras

Lab tests on 1-MGy-rated camera sensor (left) and sample image taken after 1MGy γ-irradiation (right)

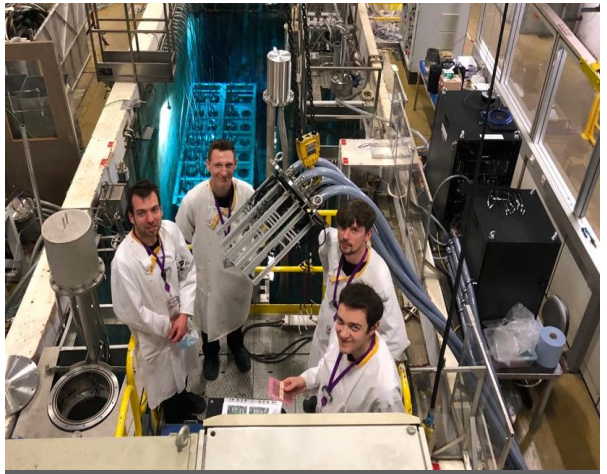


Camera demo with novel rad-hard chips in use for videoconf.

Rad-Tol – Test on camera serializer
Image sent via the 1MGy-rated serializer and displayed on the PC



Test tower containing the samples of the Proxima chip (i.e. camera serializer) **being characterized** at different T and V levels before irradiation experiment.



Team from **MAGICS** supervising the test tower being lifted down to **gamma irradiation facility RITA** at **SCK-CEN.**

Status of our procurements

We have held DRHS Preliminary Design Review (January 2019), NBRHS crane and IVVS PDR (January 2020), CPRHS 1st assembly units FDR (April 2023). We have entered the final design phase, too.

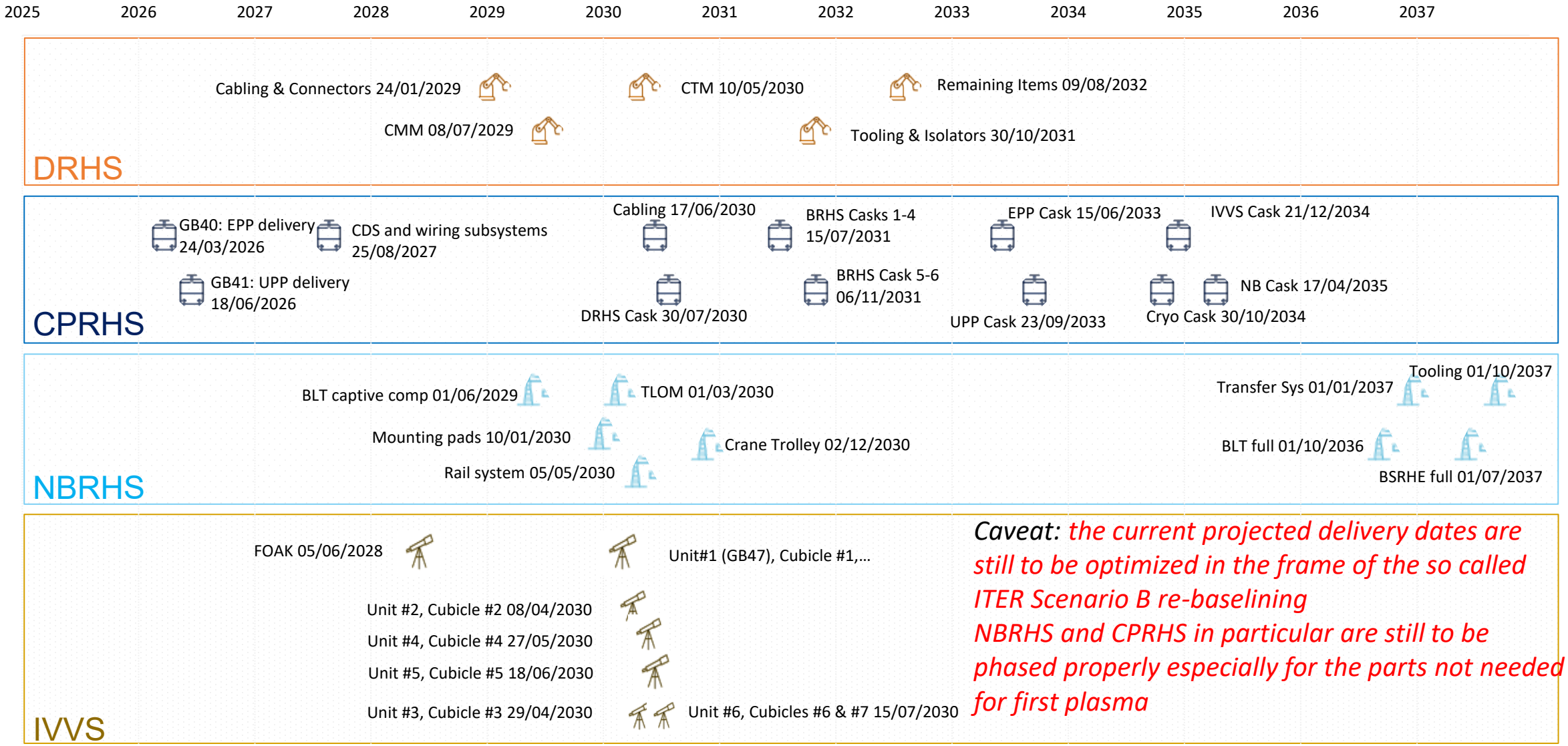
Lab test and prototyping are running in parallel with main design activities, complemented by thematic workshops

Involved industries and laboratories :

- *DRHS (OMF 340 lot 1):* ***AEIL (started 04/2014)****, Ariane-Framatome, Wood - expired*
- *CPRHS (OMF 577):* ***CNIM****-Bertin* ***(09/16)*** *– contract with 1st in cascade terminated*
- *NBRHS (OMF 340 lot 3):* ***Jacobs (03/2015)****, AEIL, Nuvia-Cegelec - expired*
- *IVVS (OMF 383):* ***Bertin****-CNIM* ***(11/2015)****, Tecnatom*
- *Engineering support contract (OMF 1034):* ***ANN (10/2020)****, Assystem France, Onet*

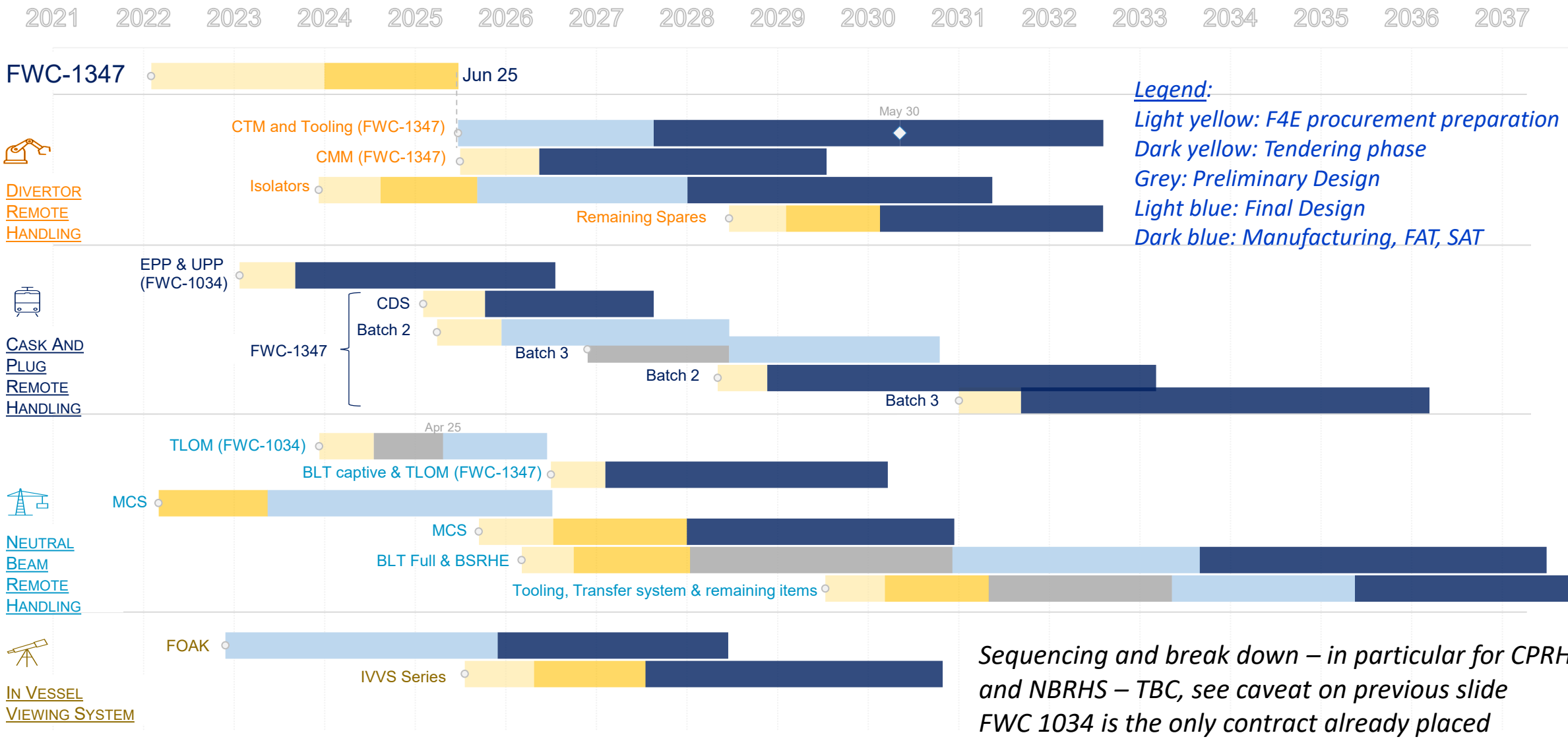
- *Active grant beneficiaries:* **VTT**, TAU, **Tamlink**, Fluiconnecto
- *Other contractors and sub-contractors:* **RACE**, **REEL**, **Walischmiller**, **Ab Solving Oy**, ASE Optics Europe, **ISAE-SUPAERO**, **Magics Instruments**, **TreeC** and **GTD** – besides, there is a significant number of external service providers across the various suppliers
- *For technical staff insourcing:* ***Leonardo, ATG,*** *and* ***Latesys***

Projected delivery dates as they stand today



Caveat: the current projected delivery dates are still to be optimized in the frame of the so called ITER Scenario B re-baselining
NBRHS and CPRHS in particular are still to be phased properly especially for the parts not needed for first plasma

Procurement overview (aligned with delivery dates)



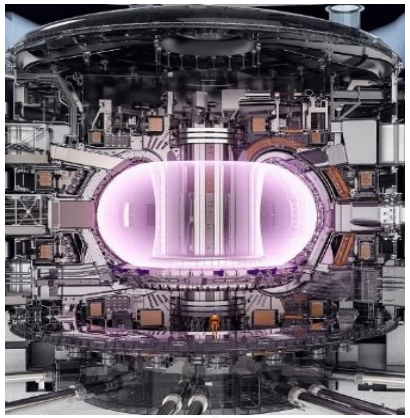
Legend:
Light yellow: F4E procurement preparation
Dark yellow: Tendering phase
Grey: Preliminary Design
Light blue: Final Design
Dark blue: Manufacturing, FAT, SAT

Sequencing and break down – in particular for CPRHS and NBRHS – TBC, see caveat on previous slide
FWC 1034 is the only contract already placed

Business Opportunities

- The previous slide shows a significant number of tenders to be launched (>18), typically medium-large, for final design and/or manufacturing. We have a long term program extending beyond 2035 still to be implemented, much larger than the one that has been done so far.
- The range of pre-developed and novel radhard and control system technologies to be integrated in each RH system is large, there is a need for a collaborative approach between integrators and specialized companies.
- Opportunities for SMEs too, can materialize in different areas typically as subcontractors to main suppliers.
- Tenders opened to non-nuclear industries for RH equipment without nuclear safety functionalities.
- We definitively need, and privilege, industries with open and dynamic collaborative approach.
- Stay tuned on our call for tenders from early 2024 onwards!

Q&A



FUSION FOR ENERGY

ISFNT15

INTERNATIONAL SYMPOSIUM ON FUSION NUCLEAR TECHNOLOGY

Thank you for your attention

Follow us on:

www.f4e.europa.eu

www.twitter.com/fusionforenergy

www.youtube.com/fusionforenergy

www.linkedin.com/company/fusion-for-energy

www.flickr.com/photos/fusionforenergy

Bringing the power of the sun to earth