



**FUSION
FOR
ENERGY**

**Big Science
Business
Forum
2022**

Participation of EU industry to ITER project and Fusion

Carlo Damiani

Programme Manager – Remote Handling

6th October 2022



Bringing
the power
of the sun
to earth



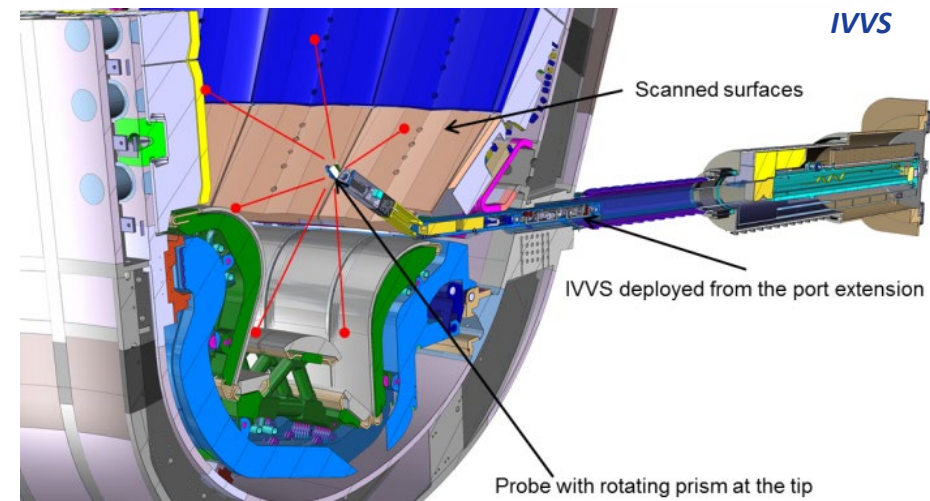
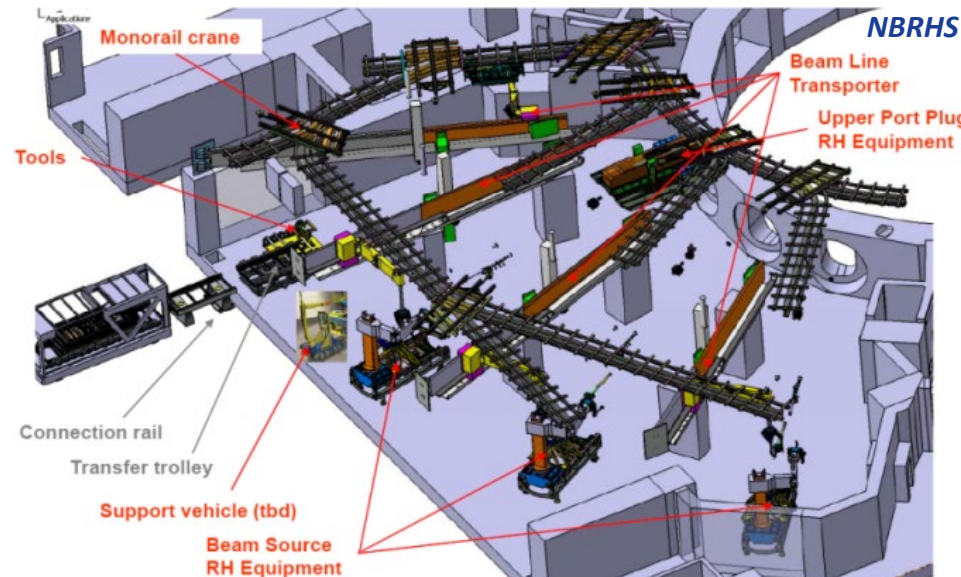
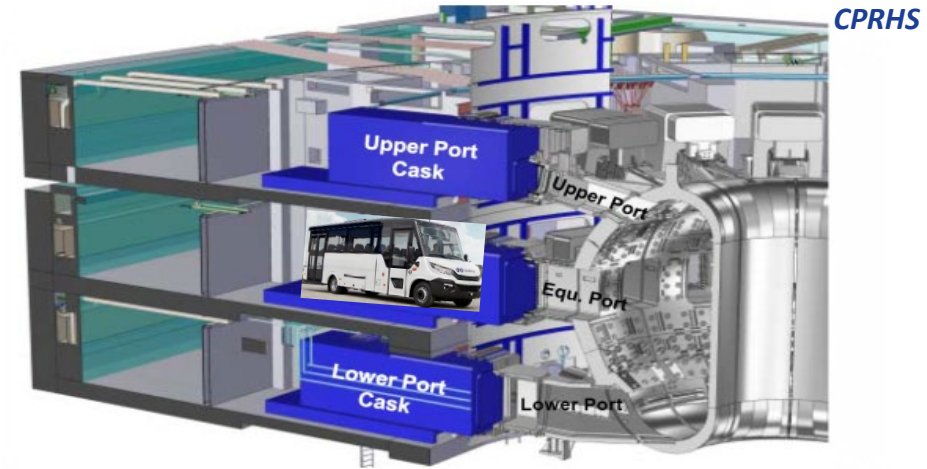
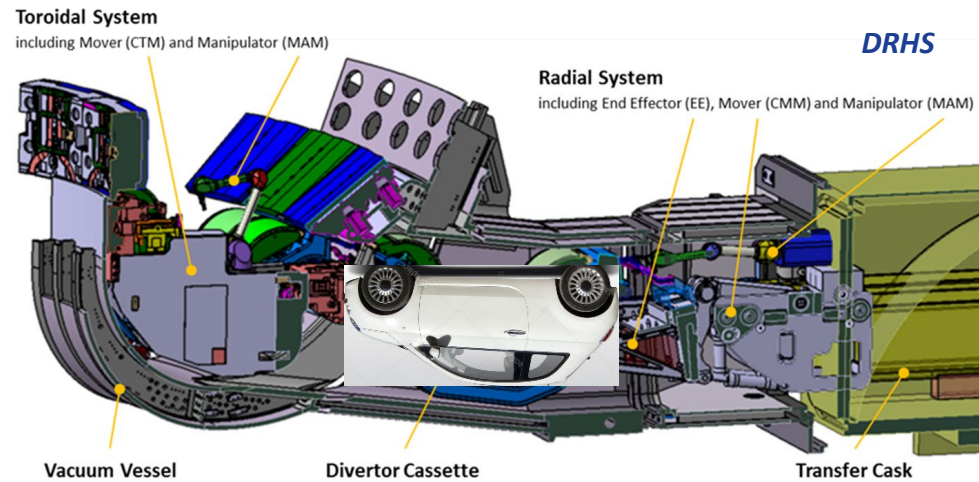
- **Introduction to the European contribution to ITER RH**
- **Current status of our procurements**
- **Outlook to long term**
- **Business Opportunities**
- **Q&A**

Introduction 1 – F4E RH Scope



FUSION
FOR
ENERGY

Big Science
Business
Forum
2022



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

Introduction 2 – F4E RH Scope

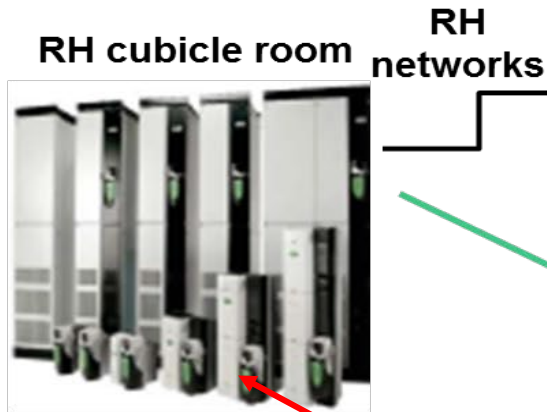


FUSION FOR ENERGY

Big Science Business Forum 2022

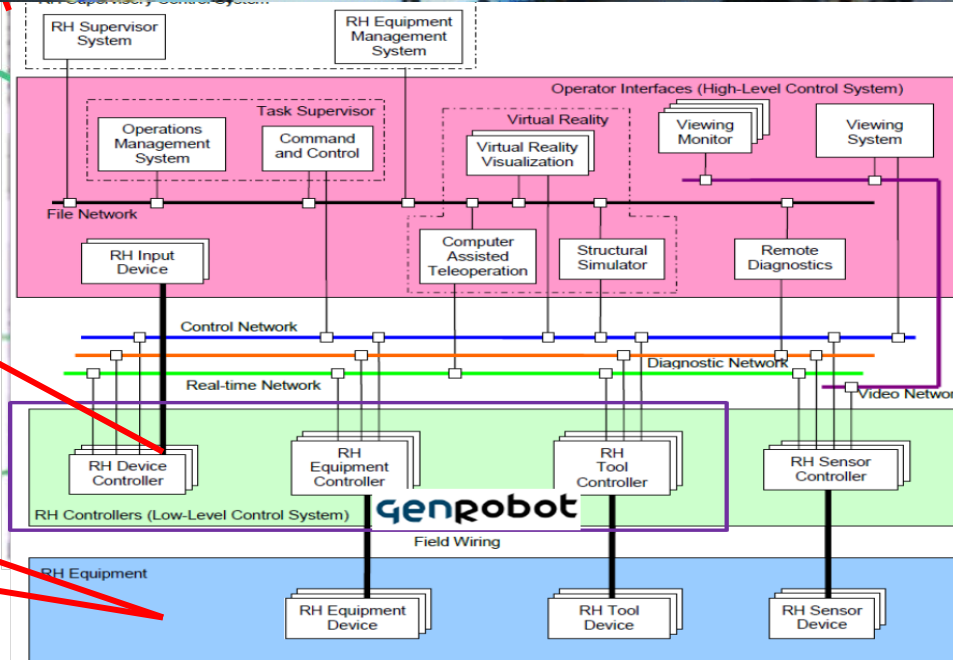


Example of JET RH control room

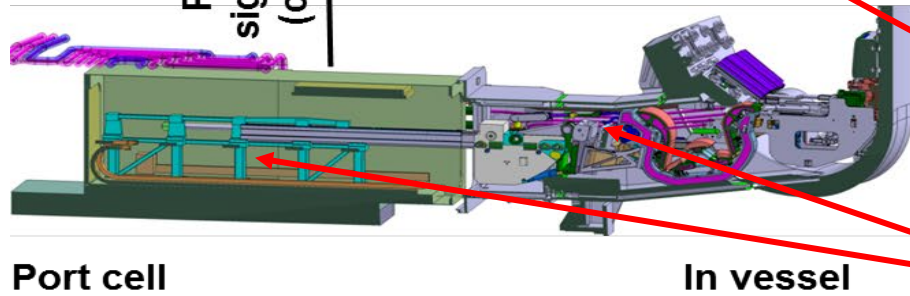


Power and signal cabling (cable trays)

~150 m



- 6 main layers:
- Field equipment
- Cabling, connectors, switch-points
- LLCS
- Networks
- HLCS
- Supervisor



Port cell

In vessel

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

We have held DRHS Preliminary Design Review (January 2019), NBRHS crane and IVVS PDR (January 2020), CPRHS 1st assembly cask PDR (September 2020 and March 2021). 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): Ansaldo (10/2020), Assystem France, Onet

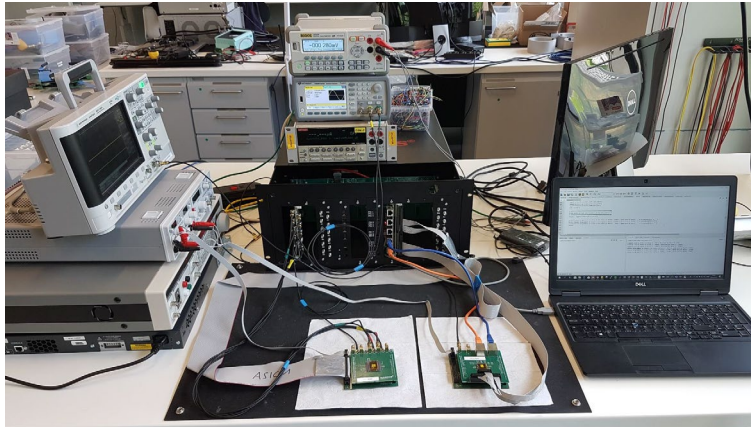
- Active or recent grant beneficiaries and (sub)contractors: **Tamlink**, Fluiconnecto, TUT, VTT, RACE, Reel, Walischmiller, Capula, **Ab Solving Oy**, HIT, ASE Optics Europe, **ISAE-SUPAERO**, **Magics Instruments**, **GTD (Vitrociset, ATG, Latesys for technical staff insourcing)** – besides, there is an significant number of external service providers across the various suppliers

Status of our procurements – 2 (Q3/19)

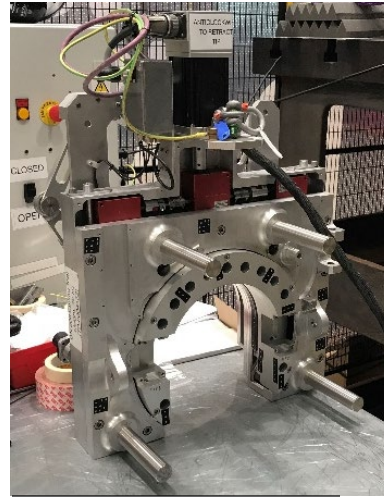


FUSION FOR ENERGY

Big Science Business Forum 2022



Lab tests on 1-MGy-rated electronics



NBRHS cutting tool for 200 mm pipes

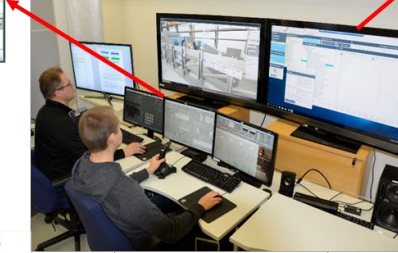


Design of HMI for Command and Control



Porting of GENROBOT on DTP2-CMM

RH control system development



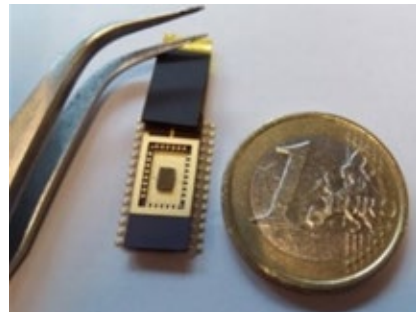
RH Workcell with RH Operators Interfaces



Upgrade and Performance tests to the Remote Diagnostics Application



Performance tests platform for GENROBOT controllers



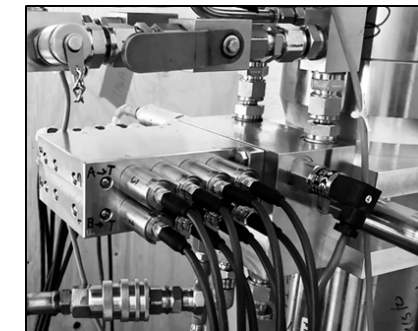
Rad-hard multiplexer (it reads 10 limit switches) for RH applications



Test bed for GENROBOT software for RH control



Reflectivity tests on PFC prototypes in support of IVVS optical design



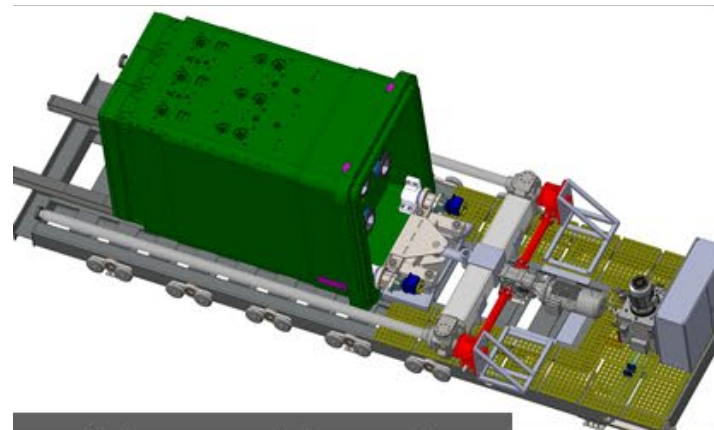
DRHS digital valve lab tests

Status of our procurements – 3 (Q1/20)

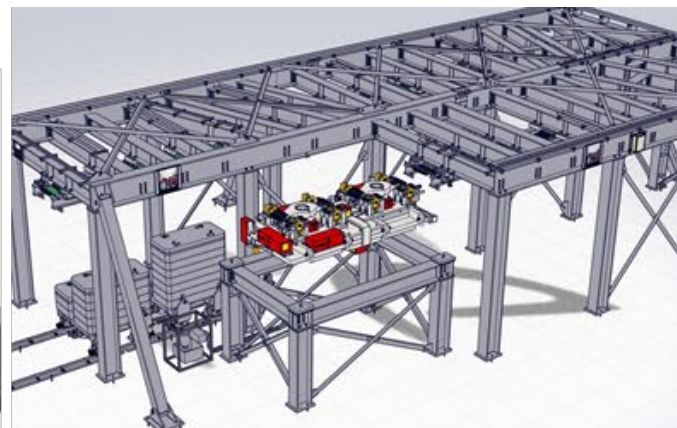


**FUSION
FOR
ENERGY**

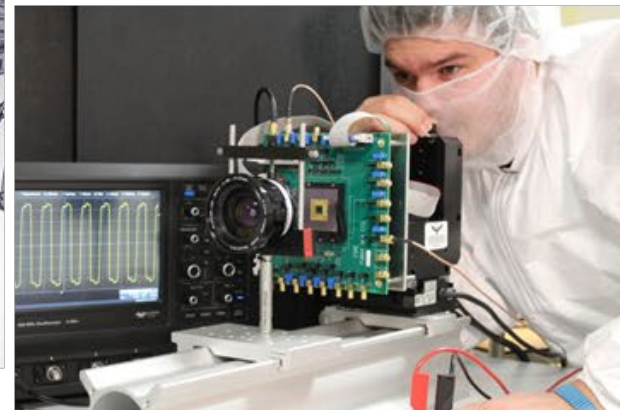
Big Science
Business
Forum
2022



1st assembly cask preliminary design



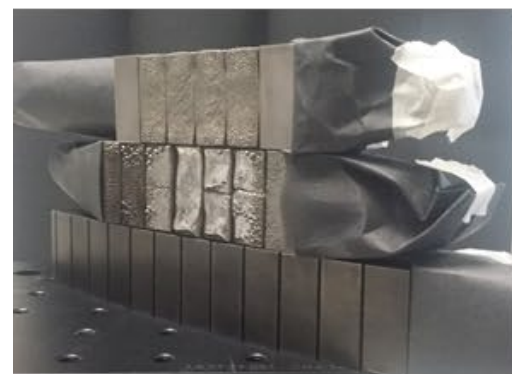
NBRHS monorail crane prototype and test bed



Lab tests on 1-MGy-rated camera sensor (left)



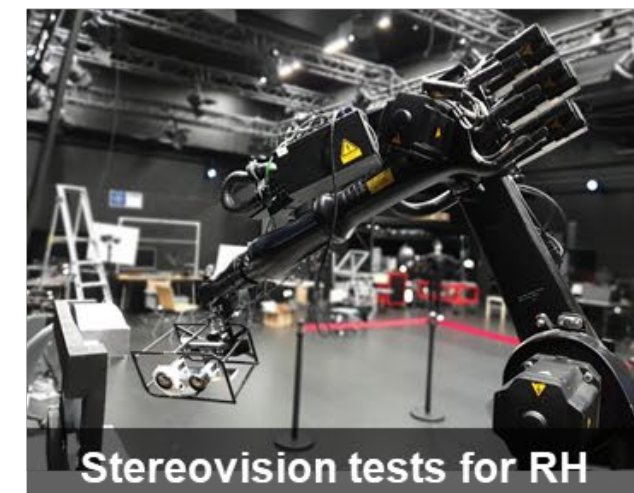
and sample image taken after 1MGy γ -irradiation (right)



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



Tests on new DRHS digital valves



Stereovision tests for RH

Status of our procurements – 4 (Q3/20)

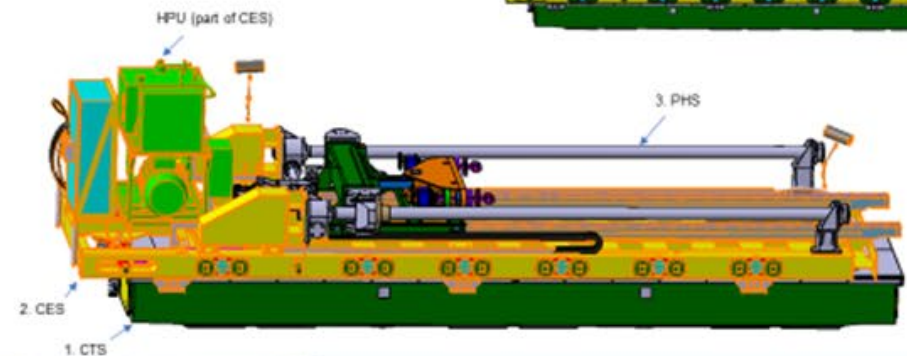
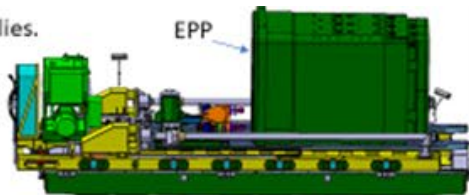


**FUSION
FOR
ENERGY**

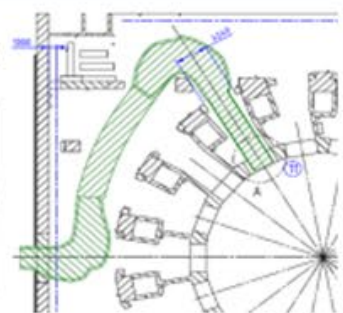
Big Science
Business
Forum
2022

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

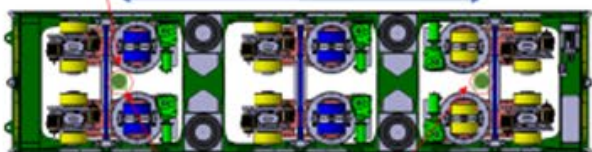
1. Cask Transfer System (CTS)
2. Cask Envelope System (CES)
3. Plug Handling System (PHS)



Optical reading head Smart Tap

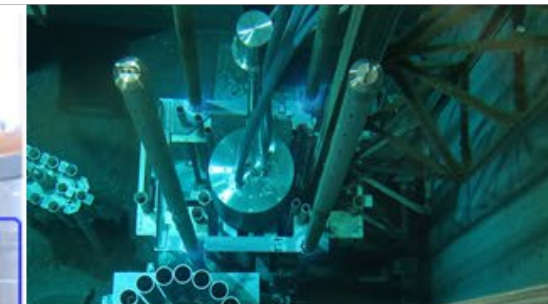
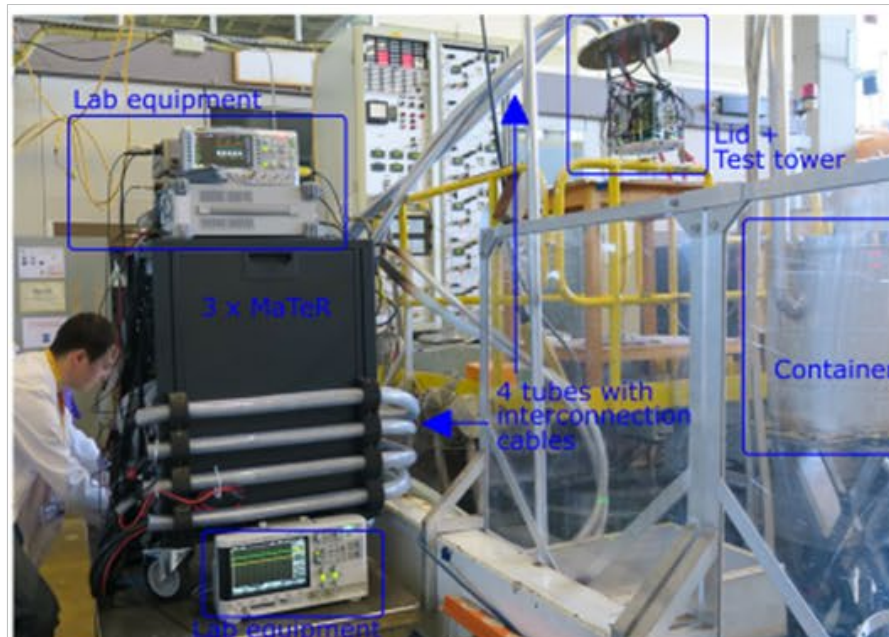


Wired Manual Control Device

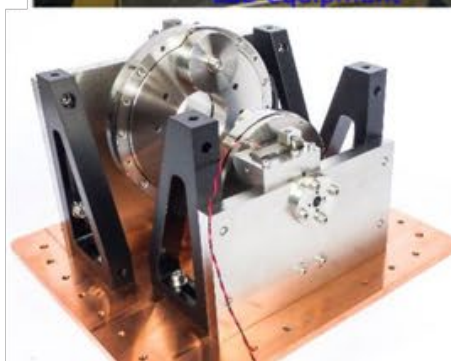


Optical Reading Heads CTS Underside view

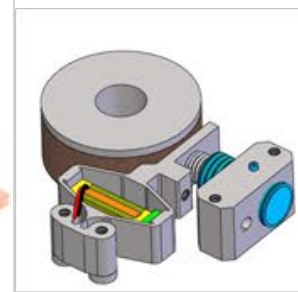
1st assembly cask preliminary design completed



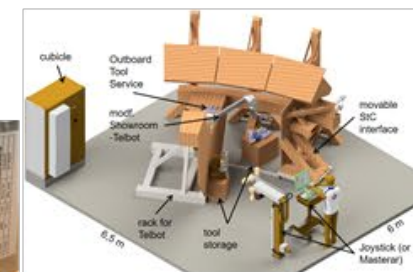
Set up (left) and execution (above) of gamma ray tests at 1 MGy on electronics for multiplexers for RH application



Test on IVVS piezo actuator for laser scanning prism rotation



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

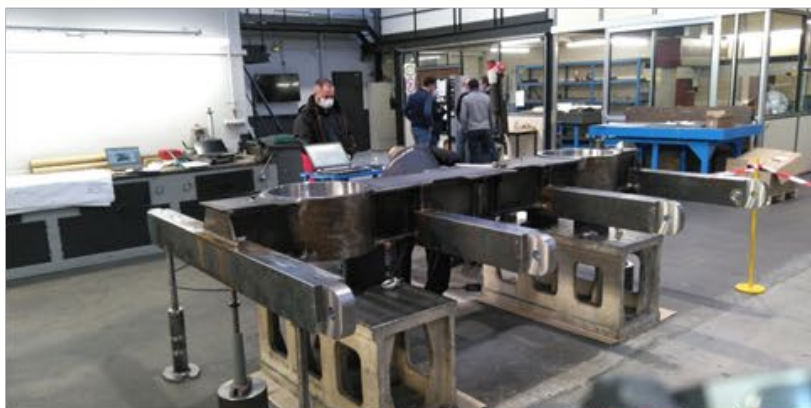


Status of our procurements – 5 (Q1/21)



FUSION
FOR
ENERGY

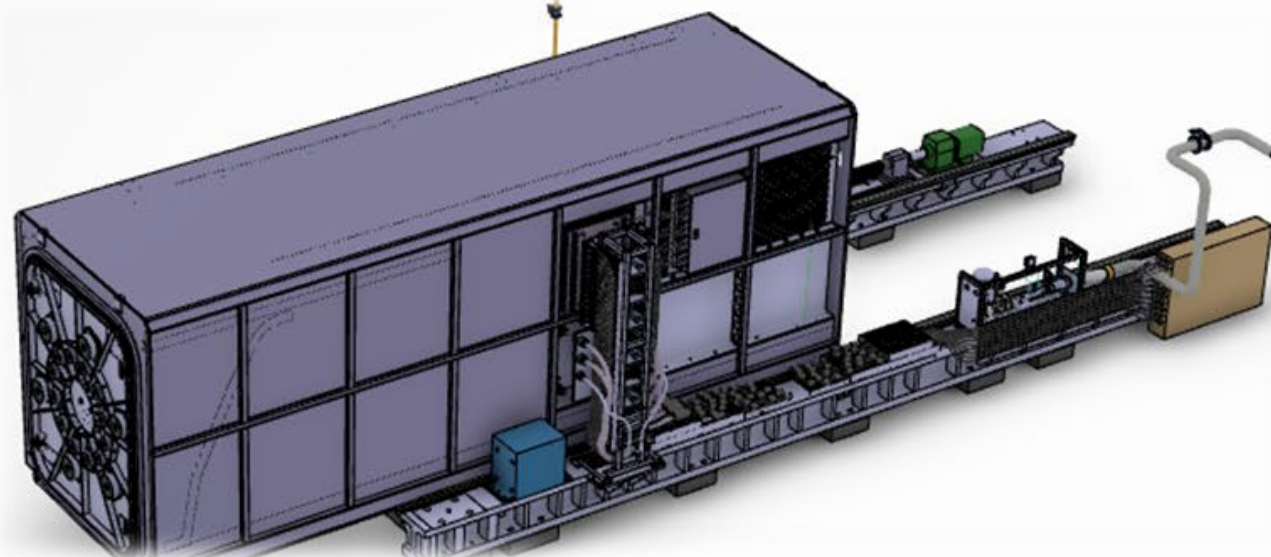
Big Science
Business
Forum
2022



crane trolley structure before and after painting



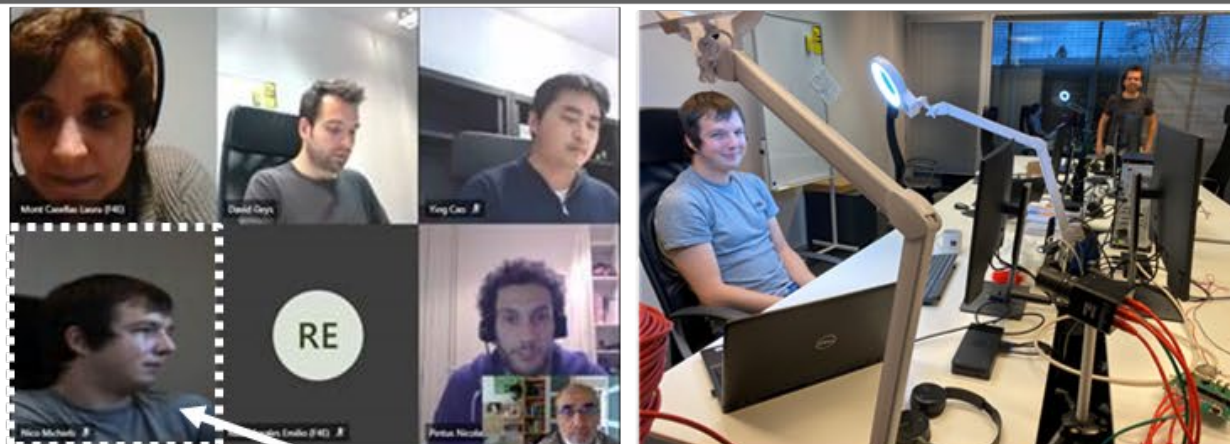
NBRHS monorail crane prototype manufacturing



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



Special encoder for IVVS scanning head developed



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

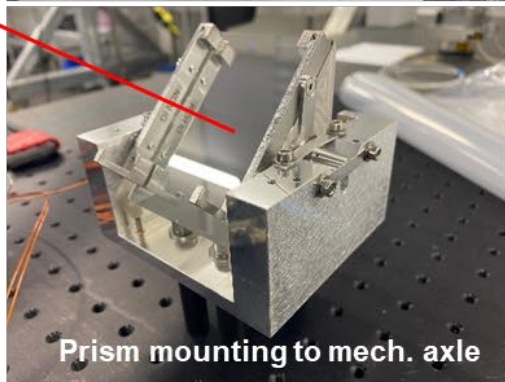
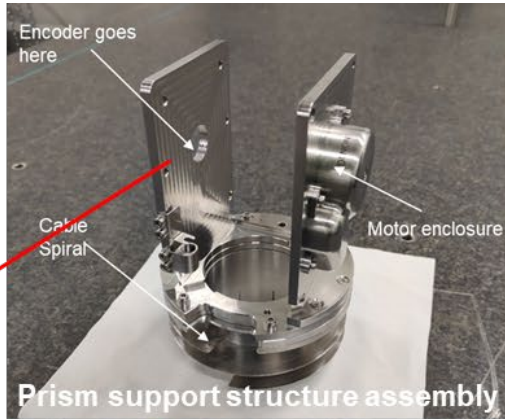
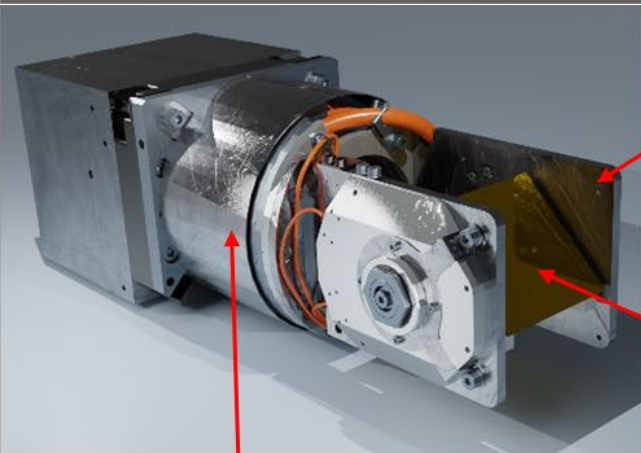
Status of our procurements – 6 (Q3/21)



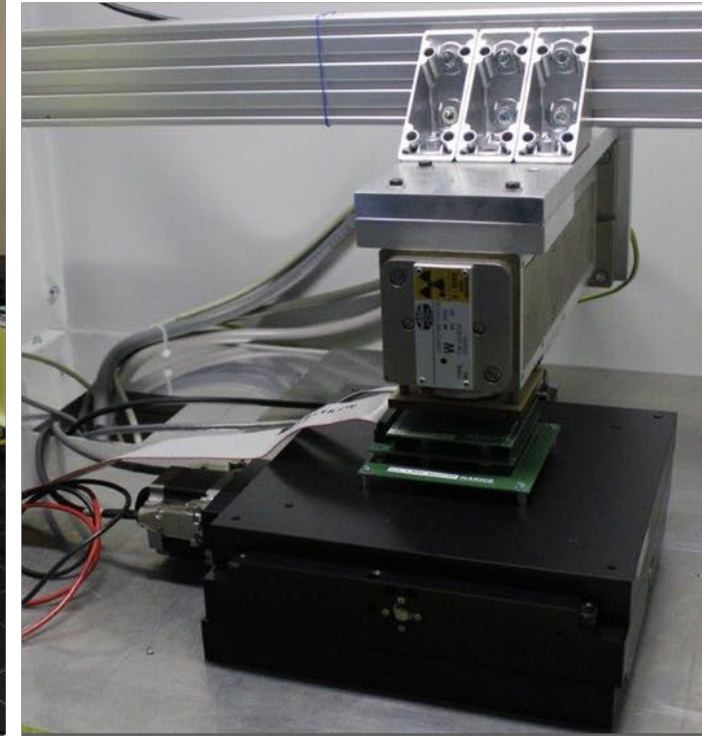
FUSION FOR ENERGY

Big Science Business Forum 2022

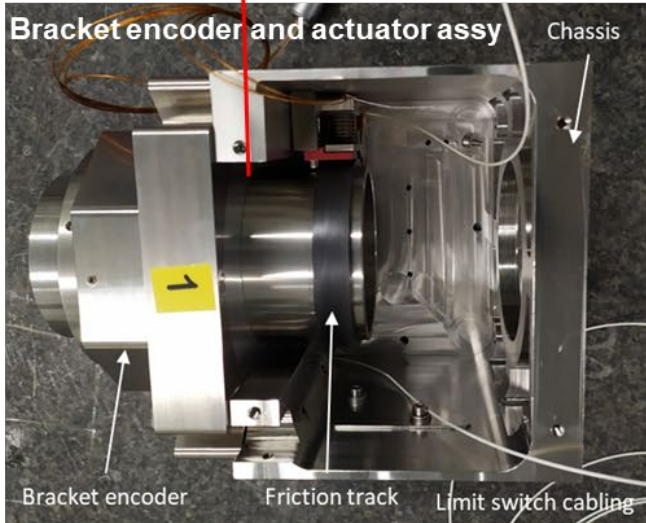
IVVS scanning head prototype (render) and components (real)



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



X-ray irradiation on ASICs building blocks (OnSemi i3T80 and TSMC65nm technologies)



Status of our procurements – 7 (Q3/21)

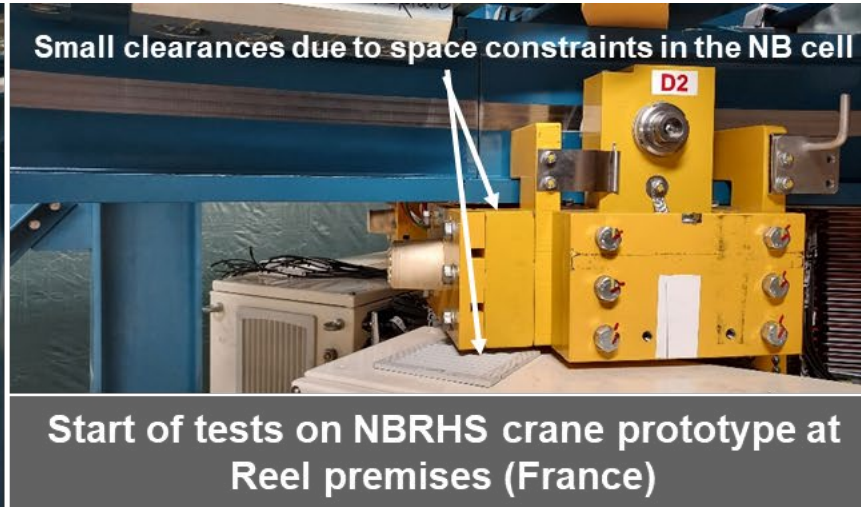


FUSION FOR ENERGY

Big Science Business Forum 2022

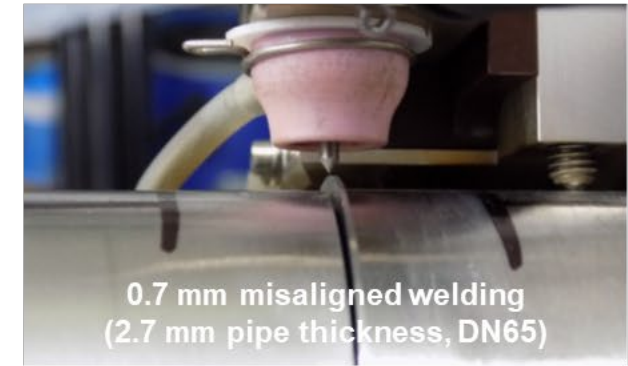


Trolley (yellow) with counterweight (yellow) attached near rail bend (blue)

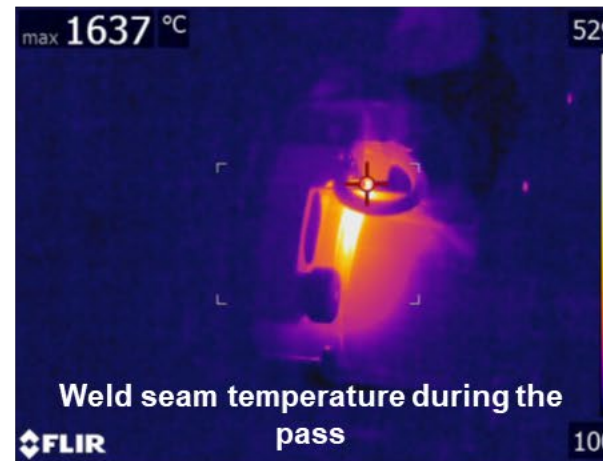


Small clearances due to space constraints in the NB cell

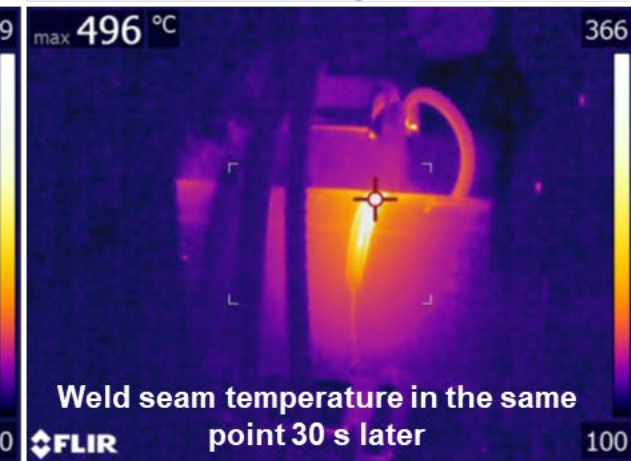
Start of tests on NBRHS crane prototype at Reel premises (France)



0.7 mm misaligned welding (2.7 mm pipe thickness, DN65)



Weld seam temperature during the pass



Weld seam temperature in the same point 30 s later

Welding tests at RACE (UK) for divertor pipes in support of the final design of the RH pipe welding tool (autogenous, single pass welding with filler ring)

Status of our procurements – 8 (Q1/22)



FUSION FOR ENERGY

Big Science Business Forum 2022

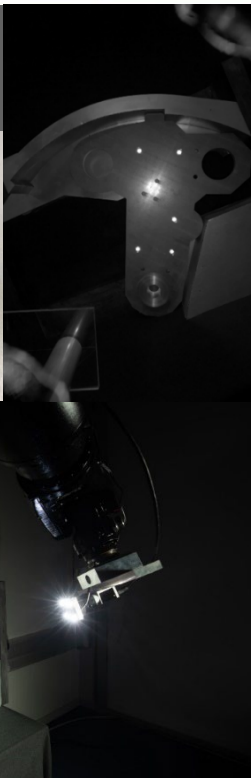


Completion of test campaign on NBRHS crane prototype at Reel premises (France). Extreme offset loading configurations and induced ± 4 mm rail misalignments trialed

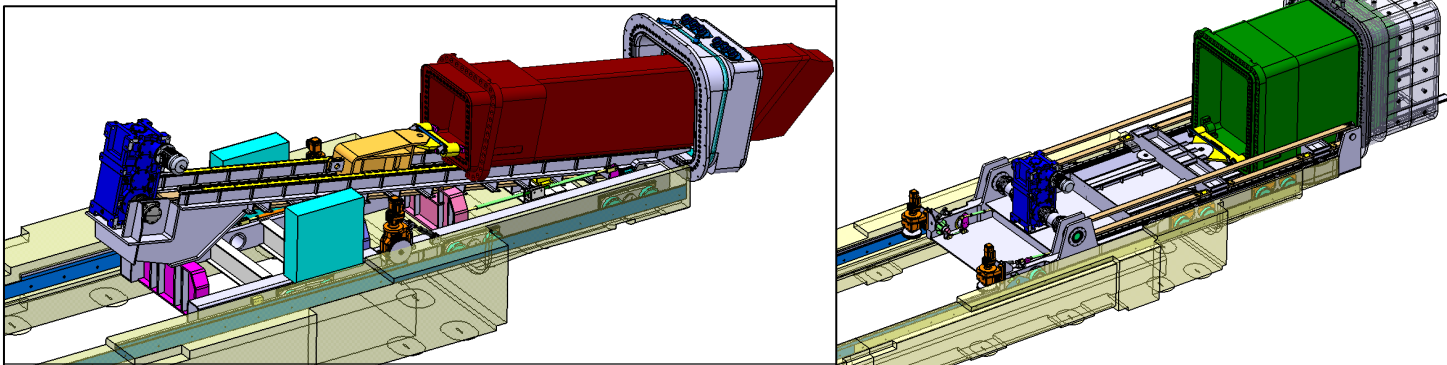
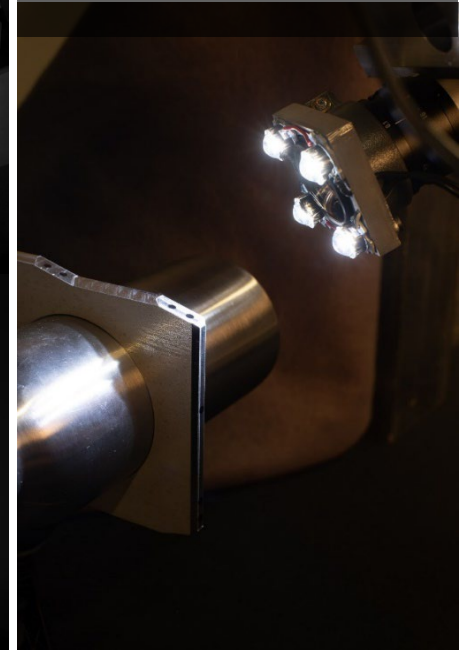
Development of high brilliance retro-reflective markers



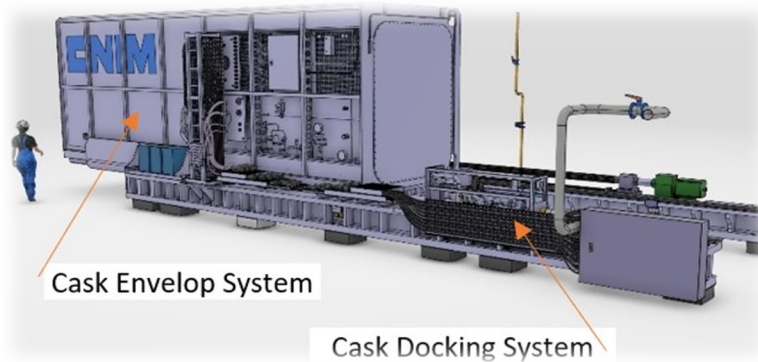
Application of retro-reflective markers to the localization of the Divertor knuckle



Application of circular marks to detect pipe flanges for pipe weld-cut operation



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

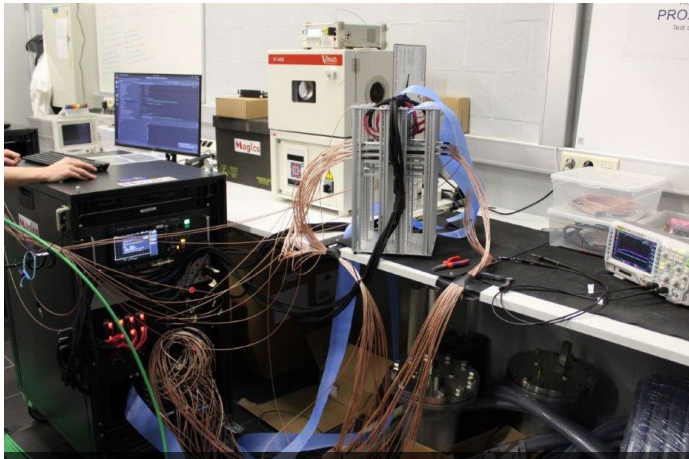


Status of our procurements – 9 (Q1/22)

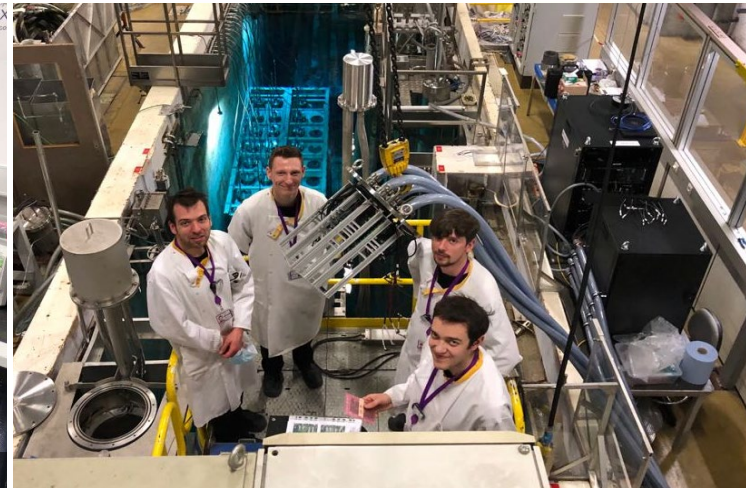


FUSION
FOR
ENERGY

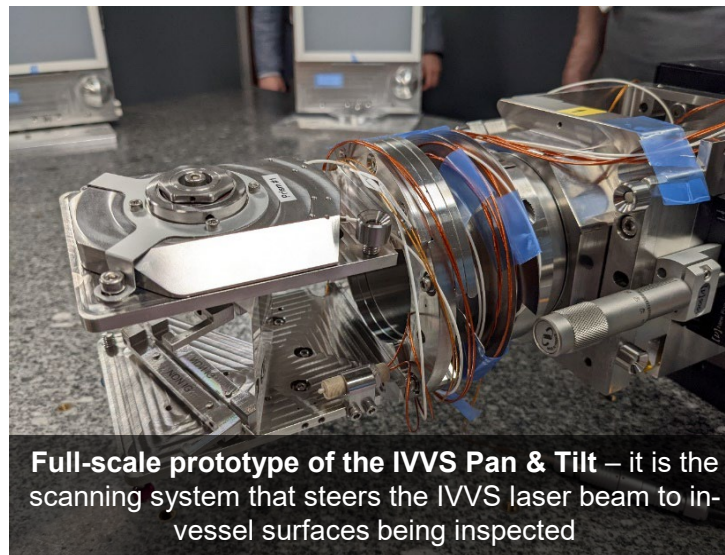
Big Science
Business
Forum
2022



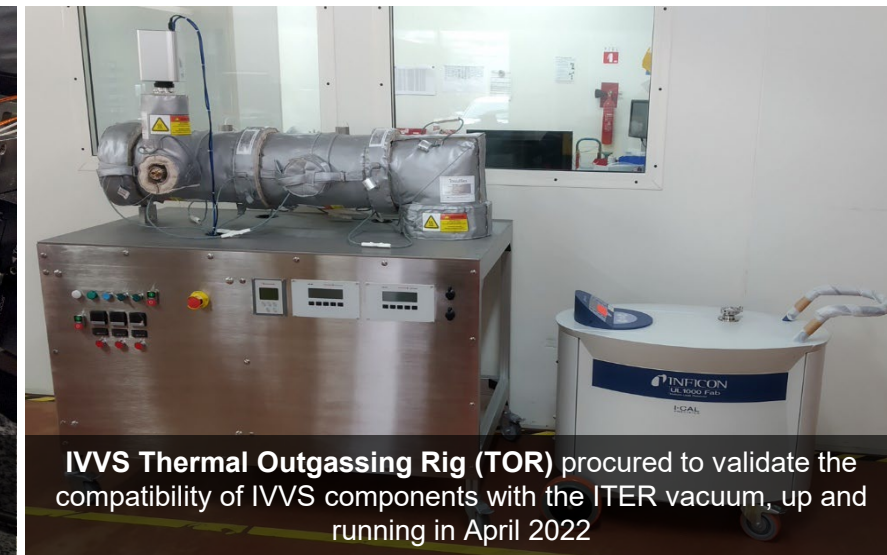
Test tower containing the samples of the Proxima chip (i.e. camera serializer) being characterized at different T and V levels before irradiation experiment.



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



Full-scale prototype of the IVVS Pan & Tilt – it is the scanning system that steers the IVVS laser beam to in-vessel surfaces being inspected



IVVS Thermal Outgassing Rig (TOR) procured to validate the compatibility of IVVS components with the ITER vacuum, up and running in April 2022

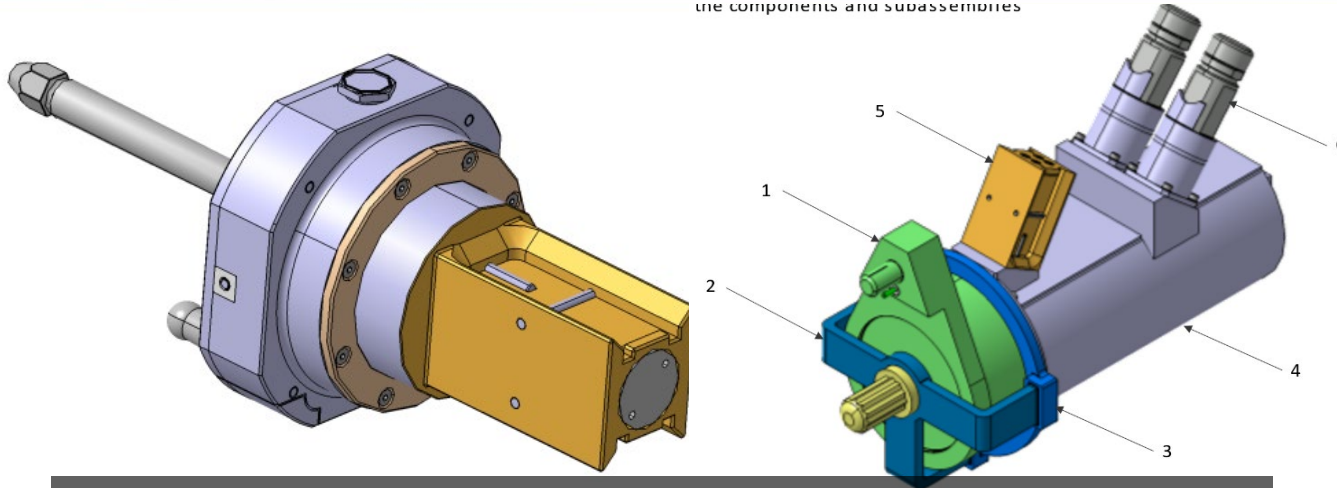
Status of our procurements – 10 (Q3/22)



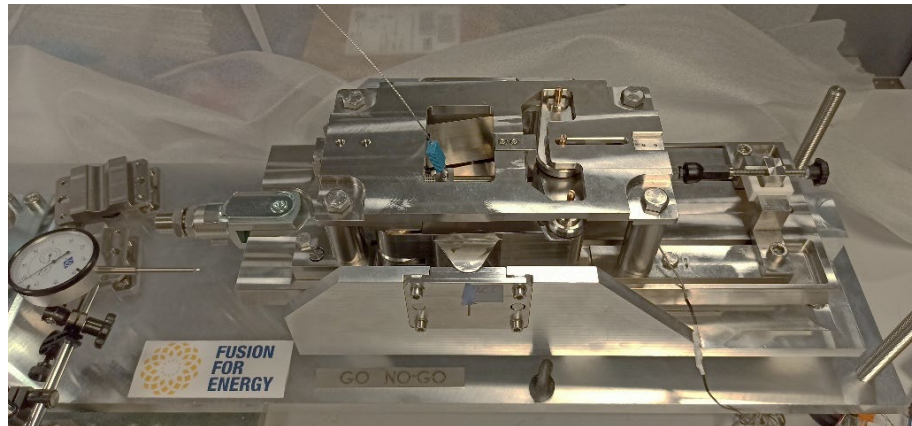
FUSION
FOR
ENERGY

Big Science
Business
Forum
2022

the components and subassemblies



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



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



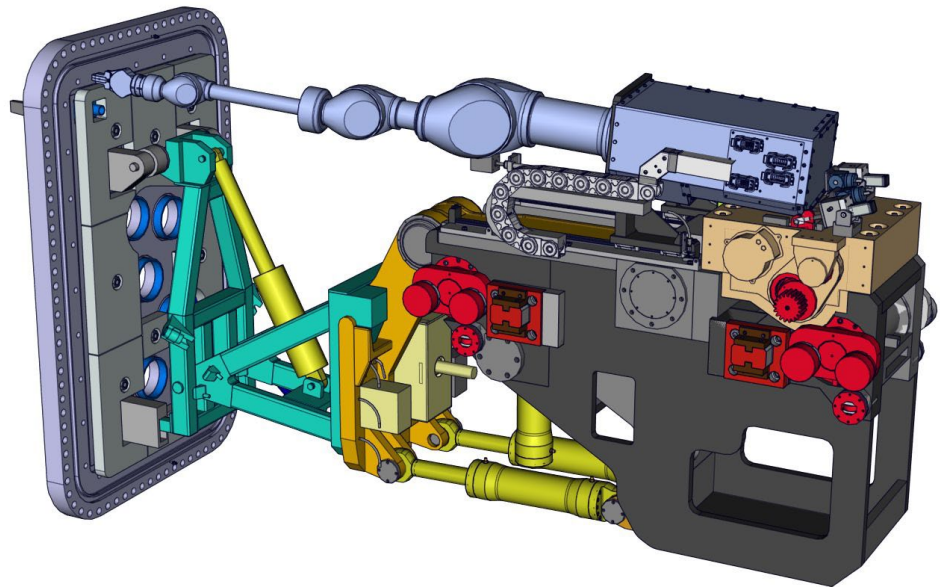
IVVS – Full-scale prototype of the Remote-handling Compatible Connector – it is the high-density electrical/optical connector assembly that services the IVVS Cartridge when installed; it must be connected/disconnected via remote tooling located in the CPRHS

Status of our procurements – 11 (Q3/22)

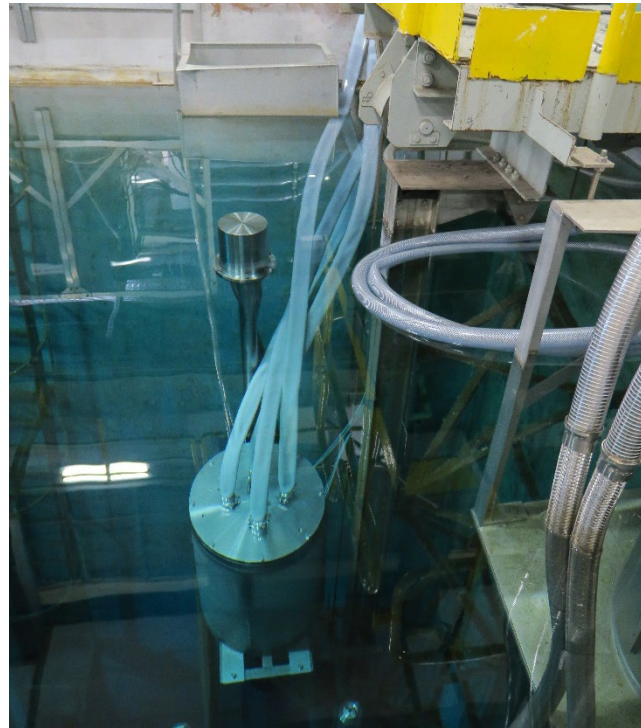


FUSION
FOR
ENERGY

Big Science
Business
Forum
2022



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)

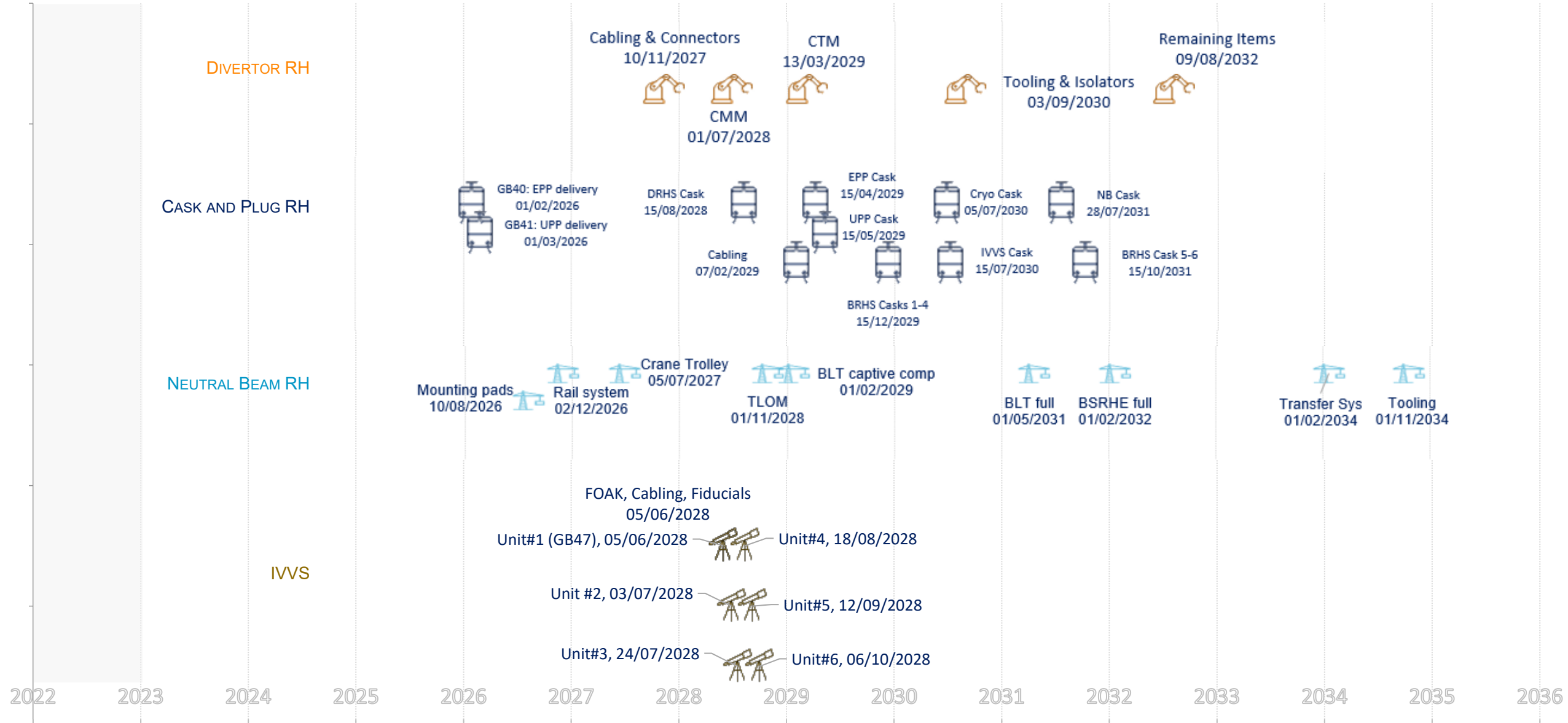


RAD-HARD - Test tower with camera serializer chips (inside the enclosure) being lifted up just after **1MGy** irradiation at the underwater Co-60 source RITA at SCK-CEN

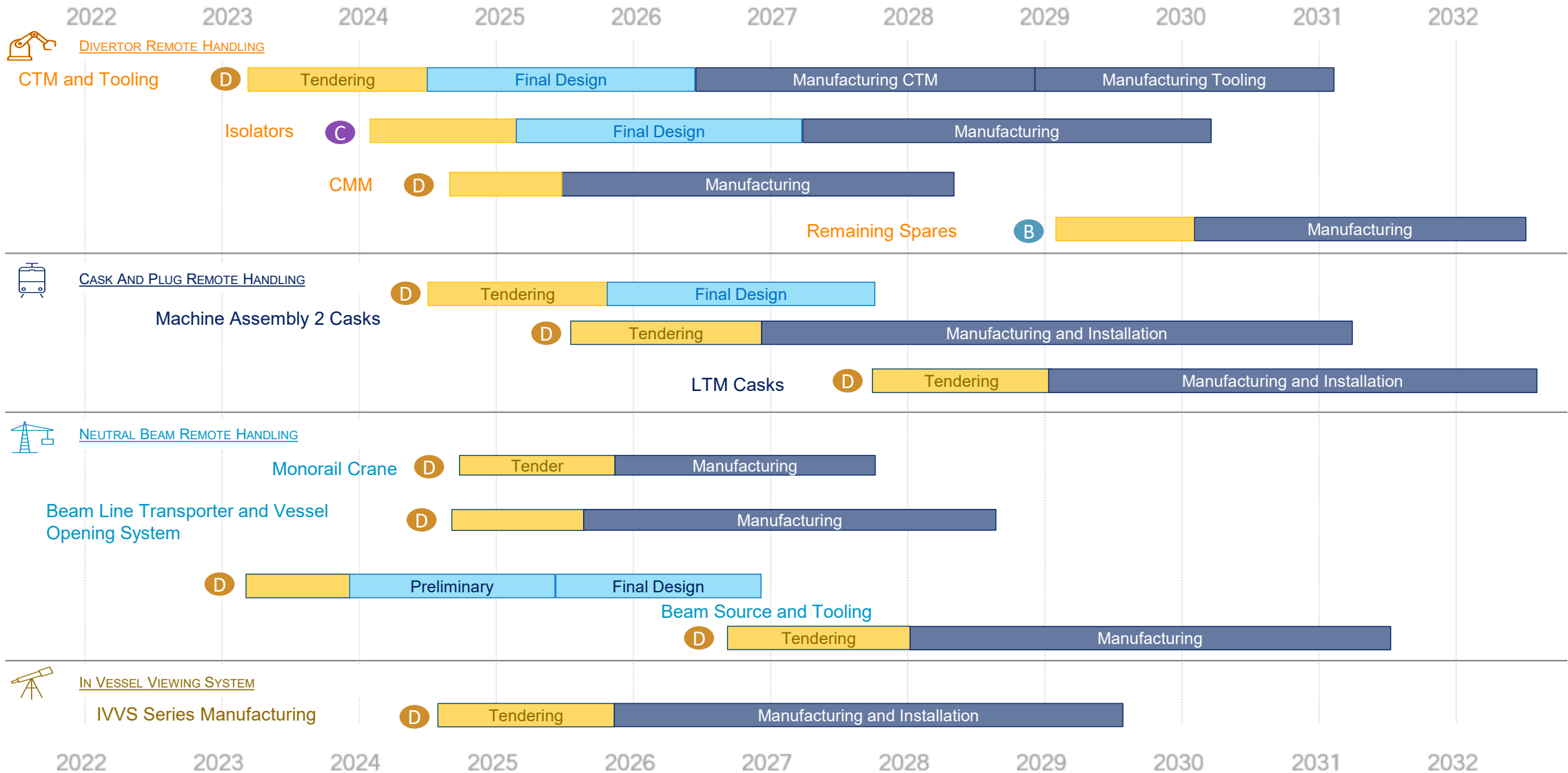


NBRHS - Joint visit from IO and F4E RH in the final day of the successful test campaign of the crane prototype at supplier premises

Outlook to long term - 1



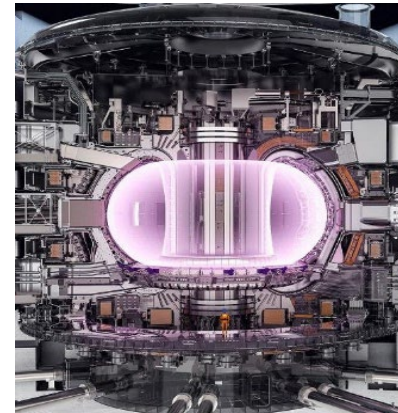
Outlook to long term - 2





- The previous slide shows a significant number of tenders (typically medium-large, typically final design and/or manufacturing) to be launched, and there is a significant long term programme still to be implemented (> of what done so far, in volume)
- The span of technologies on each of our future procurement is large
- Opportunities for SMEs too can materialize in different areas (typically as subcontractors to main suppliers)
- We need and privilege an open and dynamic approach to our collaboration with industries
- Stay tuned on our call for tenders!







**FUSION
FOR
ENERGY**

**Big Science
Business
Forum
2022**

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**