



VTT

Finnfusion Annual Seminar 2024

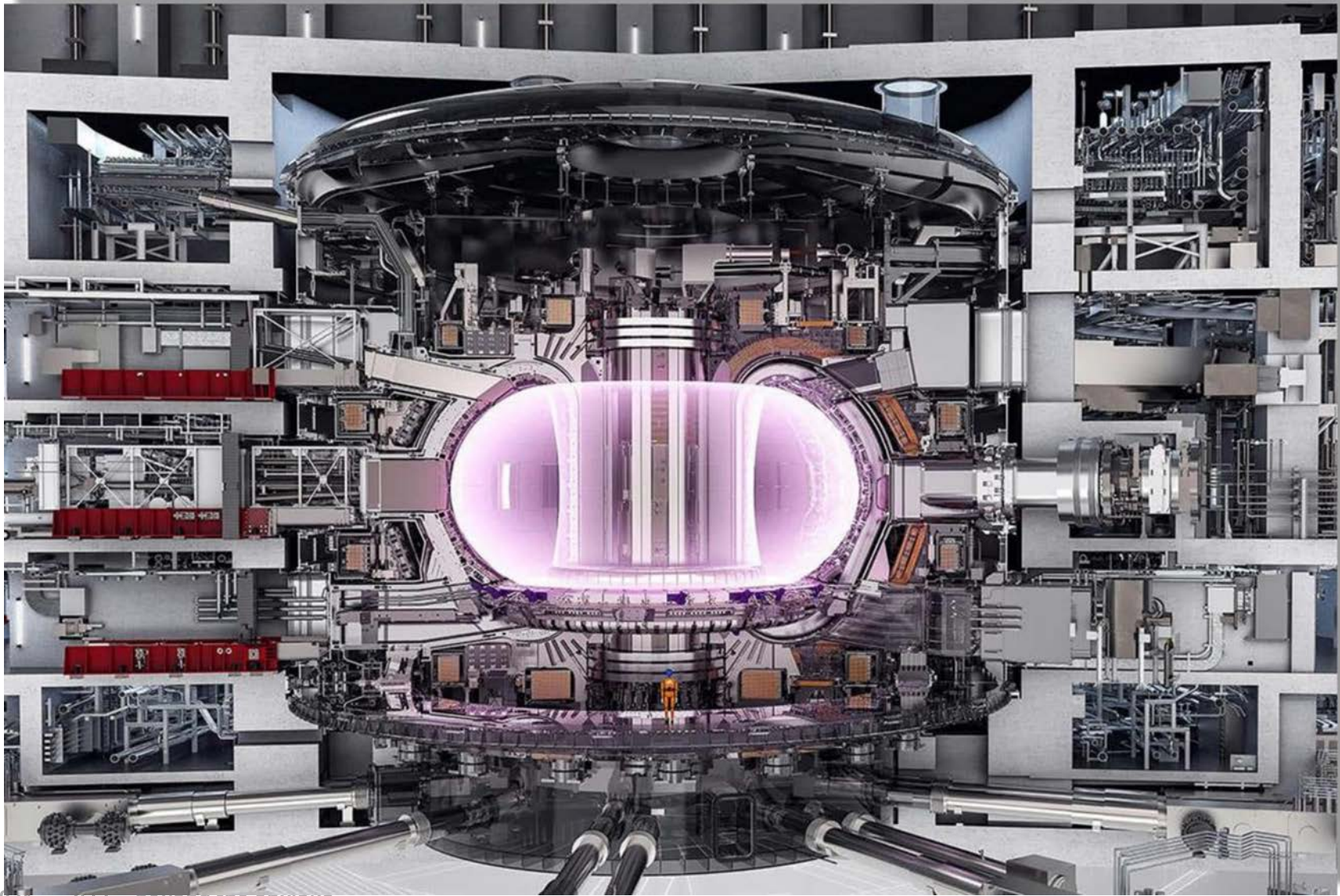
DTP2 activities for ITER

**Mikko Siuko
Hannu Saarinen
Jarmo Alanen**

31/05/2024 **VTT – beyond the obvious**

Once upon a time...

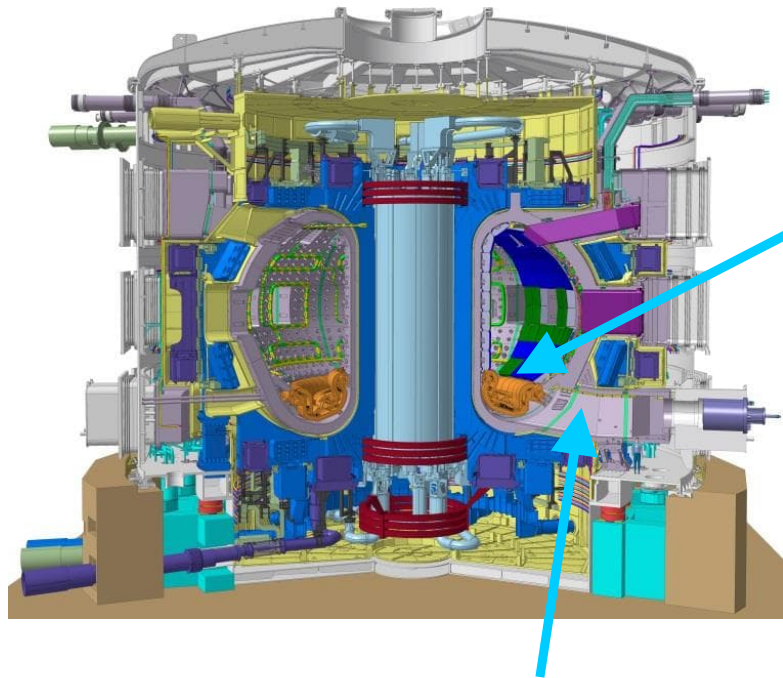




ITER Divertor Test Platform 2 (DTP2) context



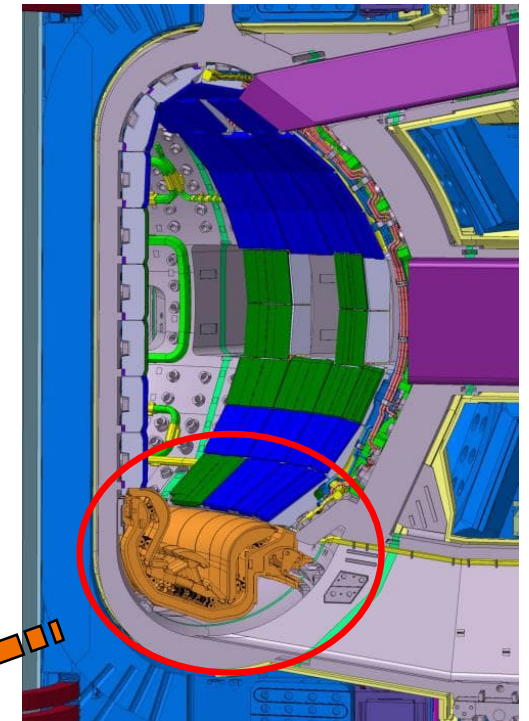
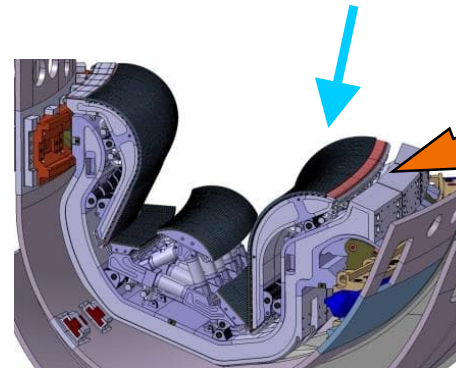
- DTP2 is for developing and testing devices, sequences and operational procedures for divertor cassettes maintenance with the [CMM robot](#).



Maintenance Tunnel
(a 1 to 1 prototype at DTP2)



Divertor Cassette (54)



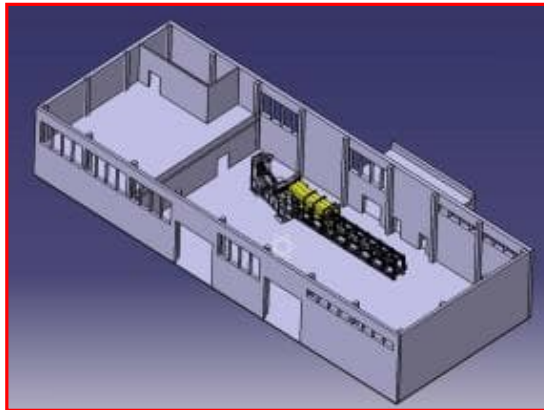
Pictures:
Credit © ITER Organization, 2011

ITER Divertor Test Platform – DTP2

VTT



Divertor Region Mock-up



DTP2



Control Software



Cassette Multifunctional Mover

31/05/2024 VTT – beyond the obvious



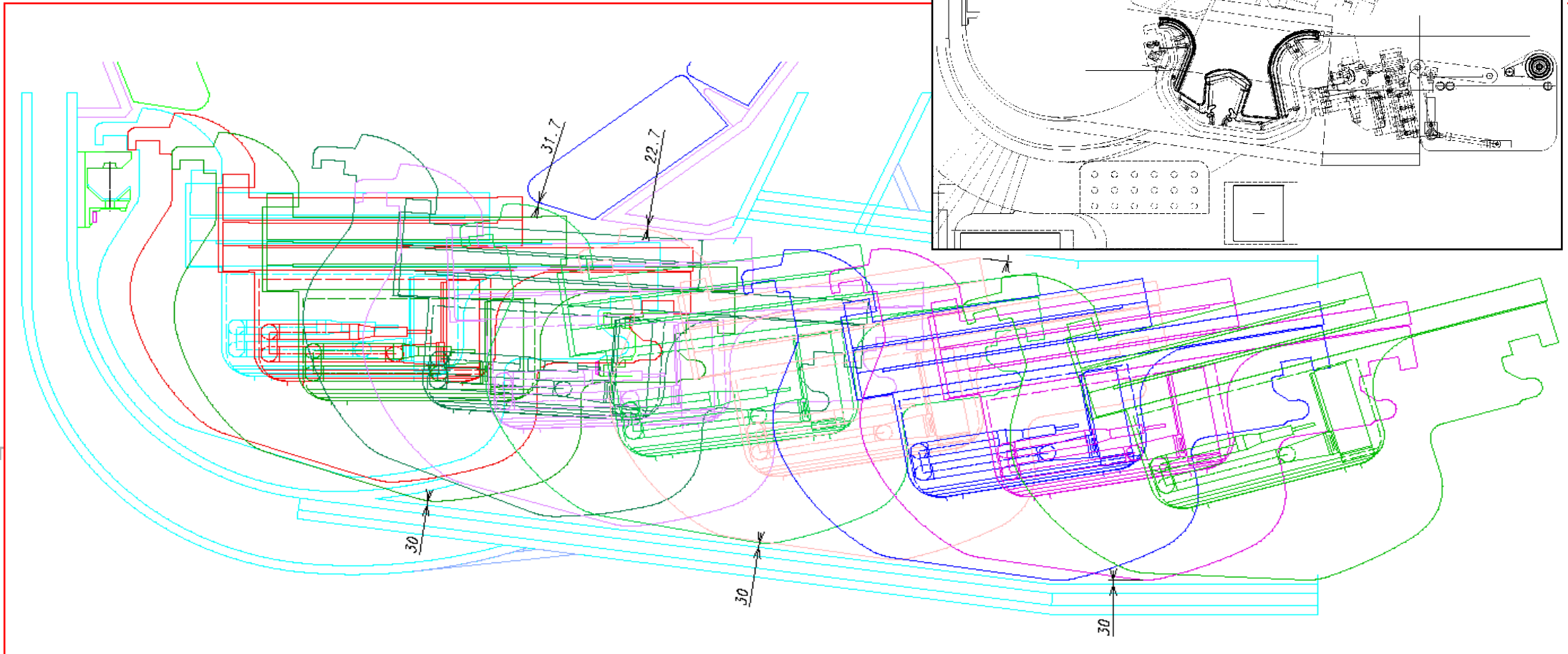
Divertor Cassette Mock-up

Second cassette replacement

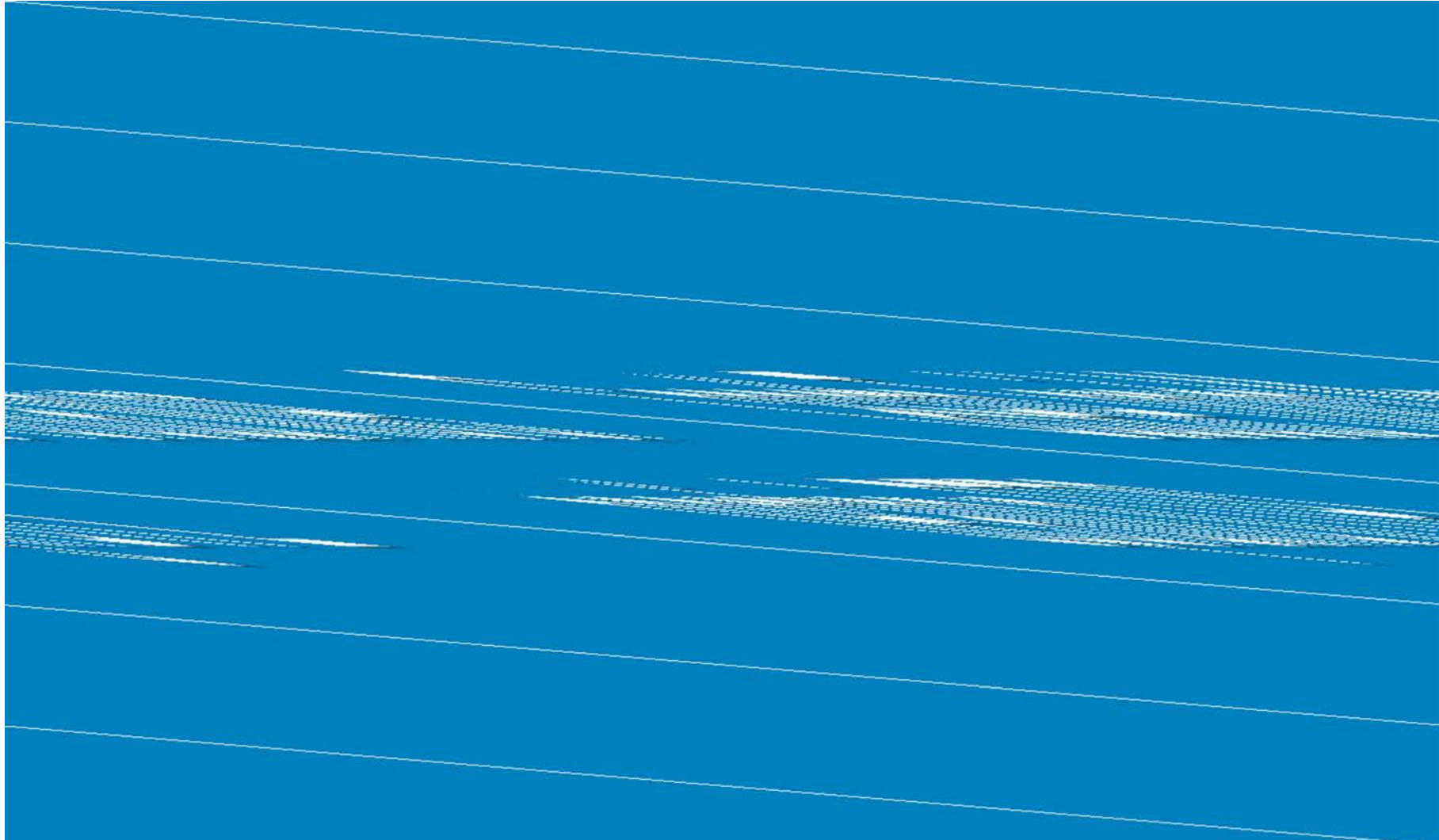
- Prepare maintenance tunnel
 - Open tunnel door, Remove diagnostic rack, Remove cooling pipes
- Replace the cassette
 - Drive mover into the reactor, open cass. locking, lift the cassette and move sideways, carry the 10ton cassette out through the tunnel, close the tunnel, carry cassette and mover to the hot cell with container cask.
 - New cassette insertion, same operations in opposite order.
- Cassette flexibility, Mover flexibility, Trajectory - manage them all
 - The control system and VR-interface support the operation of all the tools and all the operations.

Hey, Tell them how the rest cassettes are reached !!!

In old times



Cassette Toroidal Mover

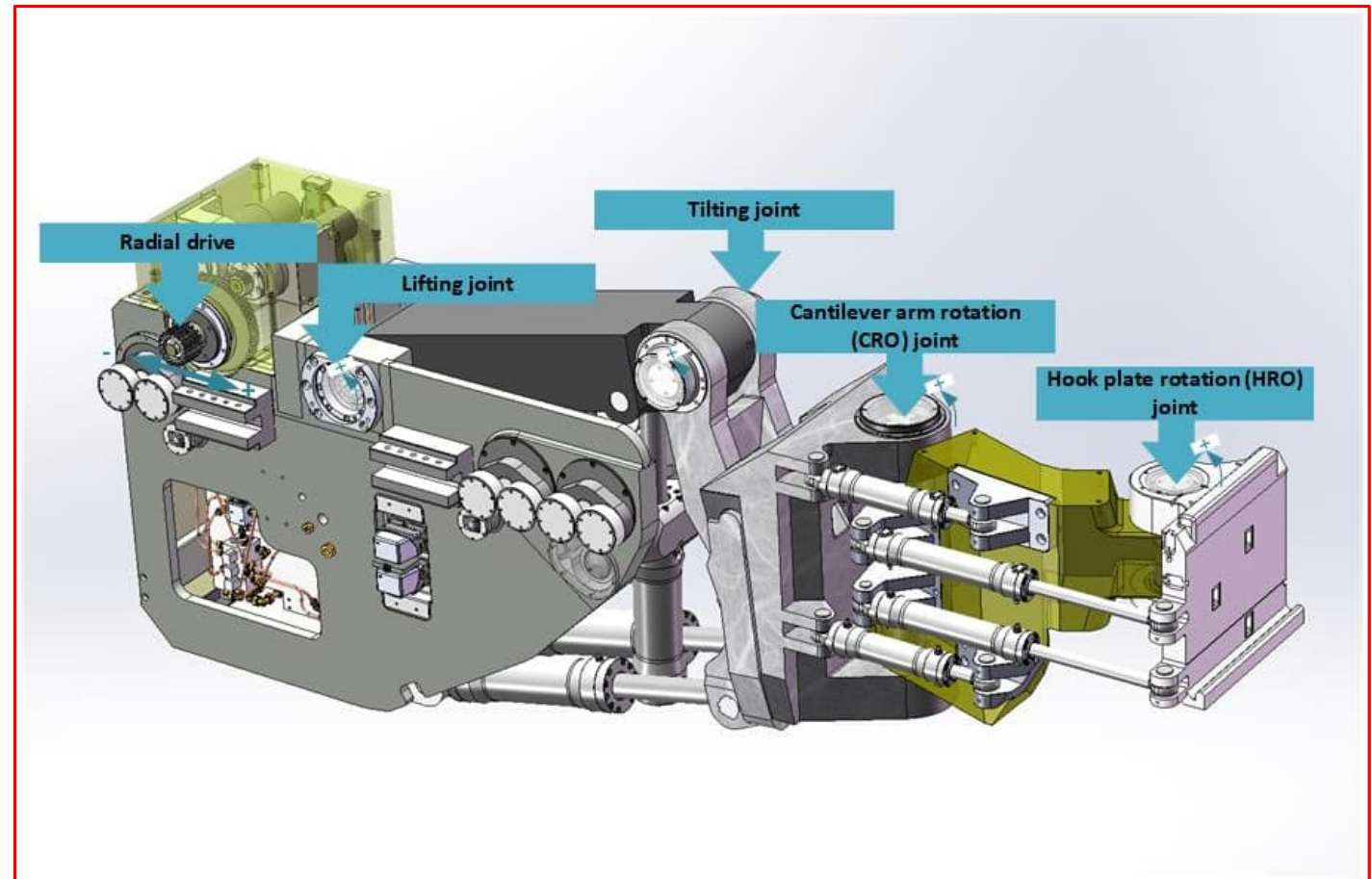


Second Cassette RH operations



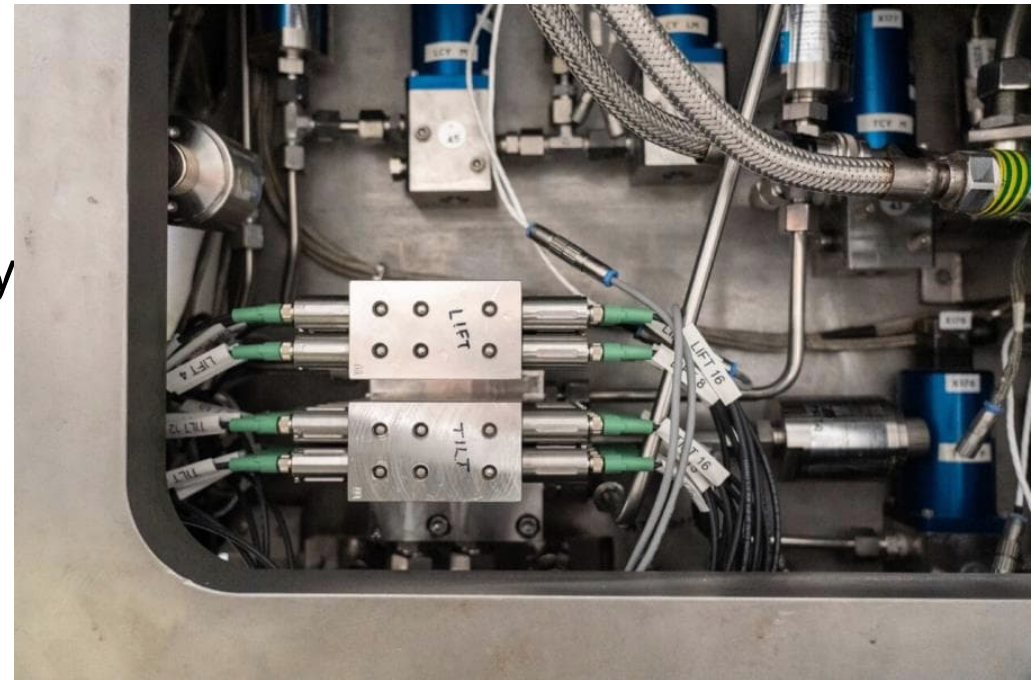
Cassette Multifunctional Mover (CMM)

- To take the divertor cassettes and move them to a cask which brings them to the hot cell for refurbishing
- After the cassettes have been refurbished, CMM brings them back to the bottom of the vacuum vessel



Digital Hydraulics

- Replacing servovalves due to servo reliability problems
- New way to control Hydraulic Energy, accurate, fast, efficient
- Water Hydraulic version Developed for F4E –needs
- Requires special control electronics and software
- Has been applied to oil hydraulics already few years



DTP2 Control system

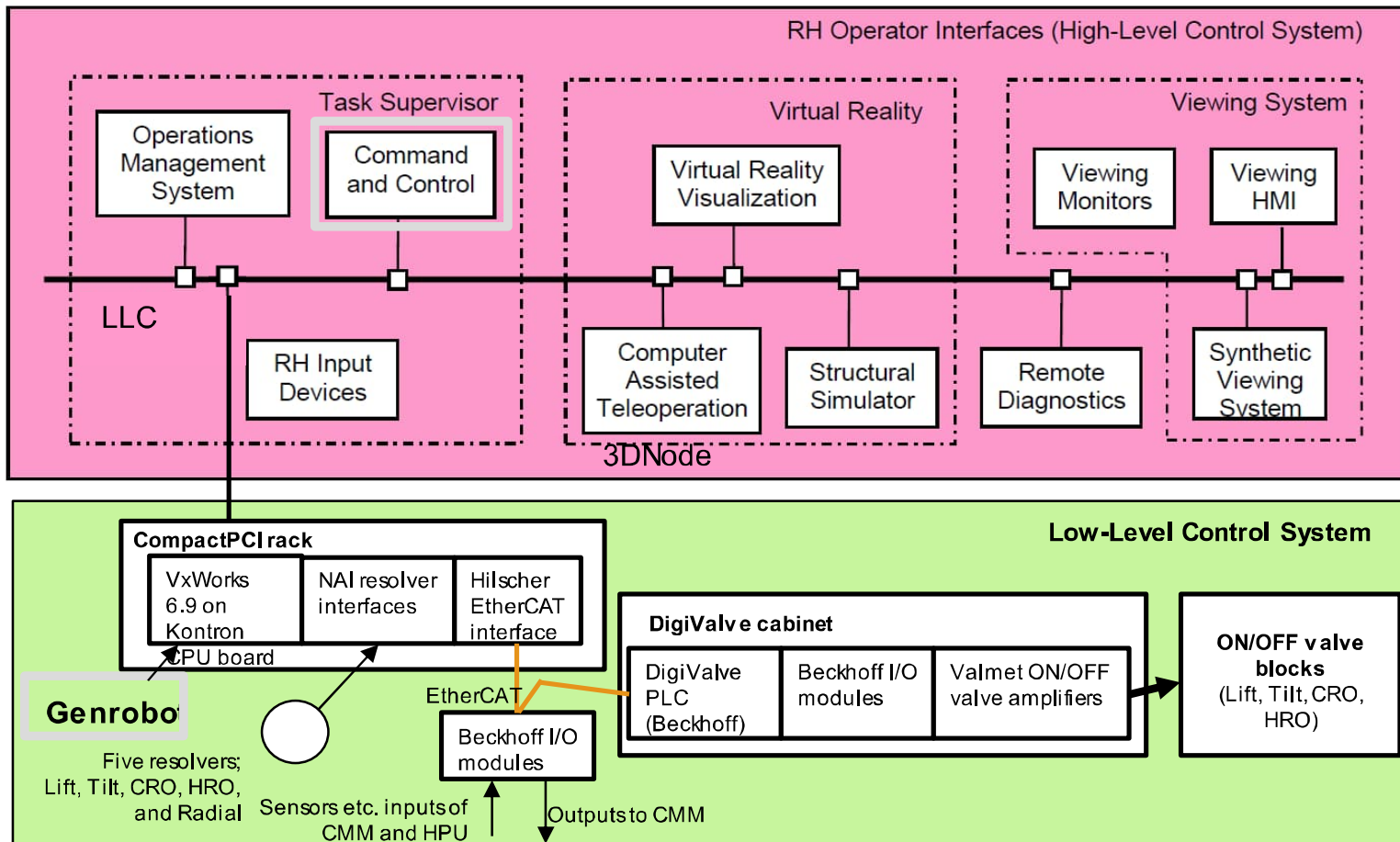
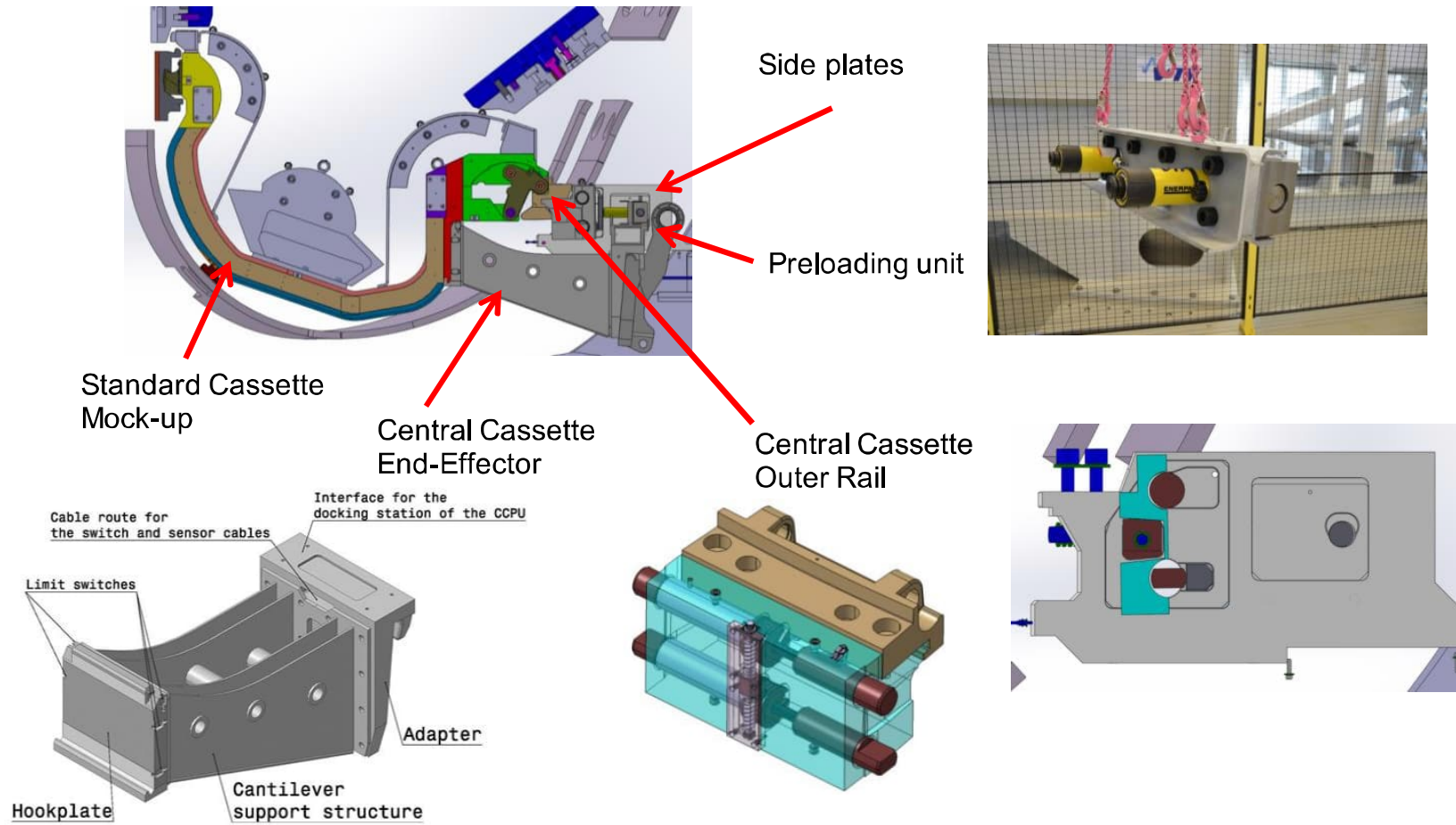
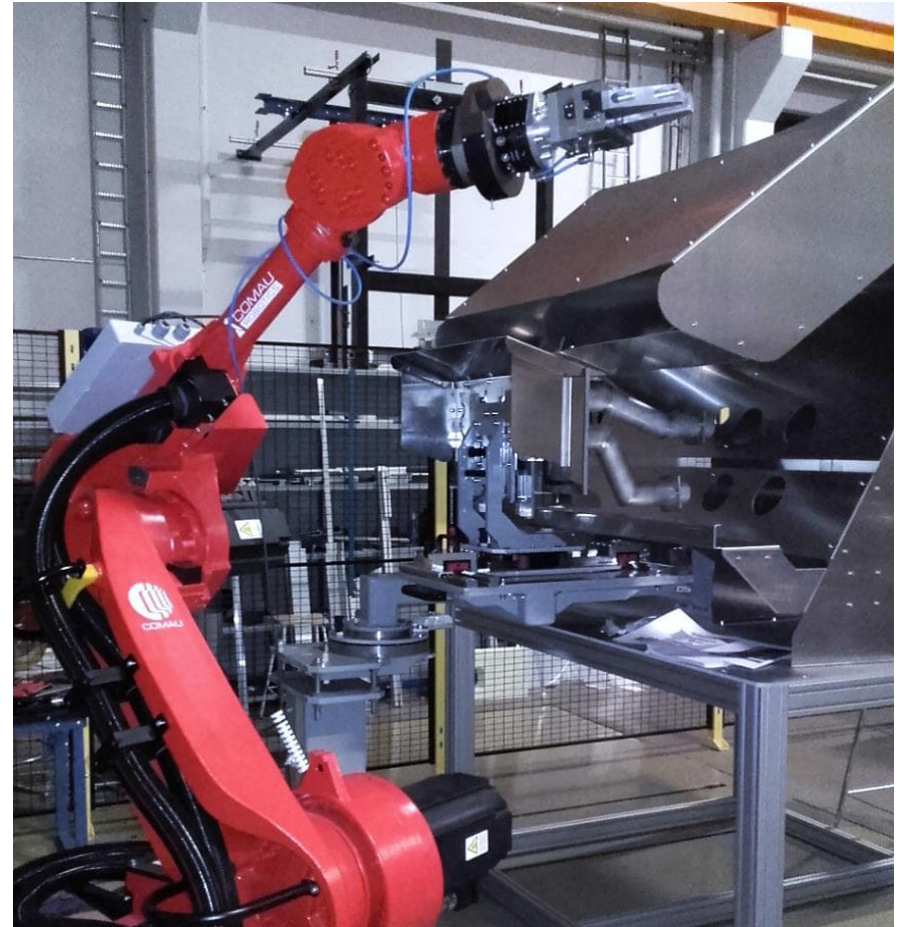
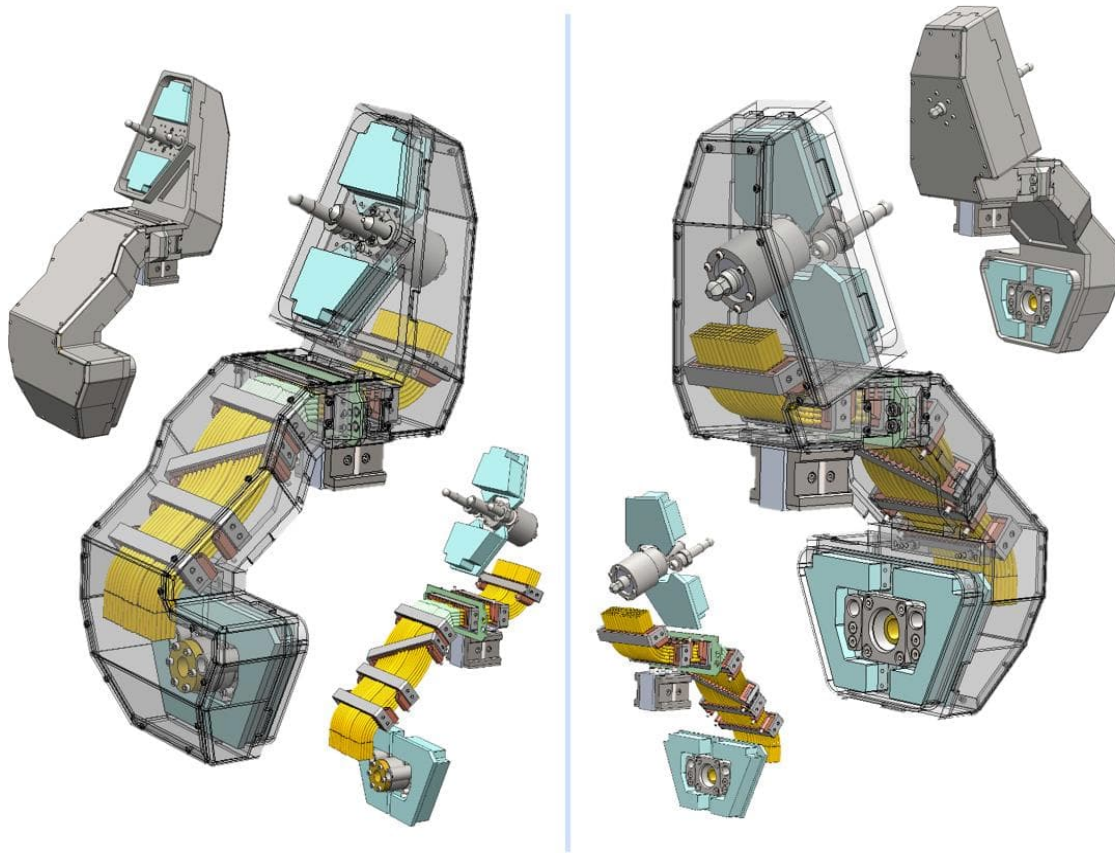


Figure adapted from ITER_D_2EGPEC

Examples of the developed and manufactured RH equipment for the Divertor area



RH-Connector – Connecting and disconnecting



Conclusion

- We constructed DTP2 to test (and to prove) that the ITER divertor replacement was possible to be done totally remotely.
- Since that, we have improved the mechanics and processes many ways, found unexpected situations, tested new ideas.
- Innovations:
 - replace risky servovalves with Digital Hydraulics.
 - mapping and localizing objects with a camera for robot or teleoperator.
 - structural simulator for control system etc.
- Plenty of nice ideas to improve the control or operator interface of robots and mechanics.
- Lot of cumulated experience and solved problems.
- Willing to apply learned things to Fusion or industry needs.

bey⁰nd

the obvious

Thank you!

vttresearch.com