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Simulated installation of a Breeding Blanket segment in a Two-Port Mover context

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Context for the simulation

The Two Port Mover (TPM) is a blanket handling system, which uses two ports to operate the Breeding Blankets (BB). The study promotes simulation and visualization for the TPM concept, concentrating on demonstrating functionalities and designed actions within In-Vessel Maintenance Development task. The study is performed under the context of assessing the operational procedures for installing the Blanket Leg Unit and Lower Port Winch of the Two-Port Mover. Developed virtual environment provides means for understanding the constraining rotations of the breeding blanket during the removal and installation process of blankets. The study assesses the TPM_01-system (CR01-Two port mover – Single lift point with lower isolated end-effector).

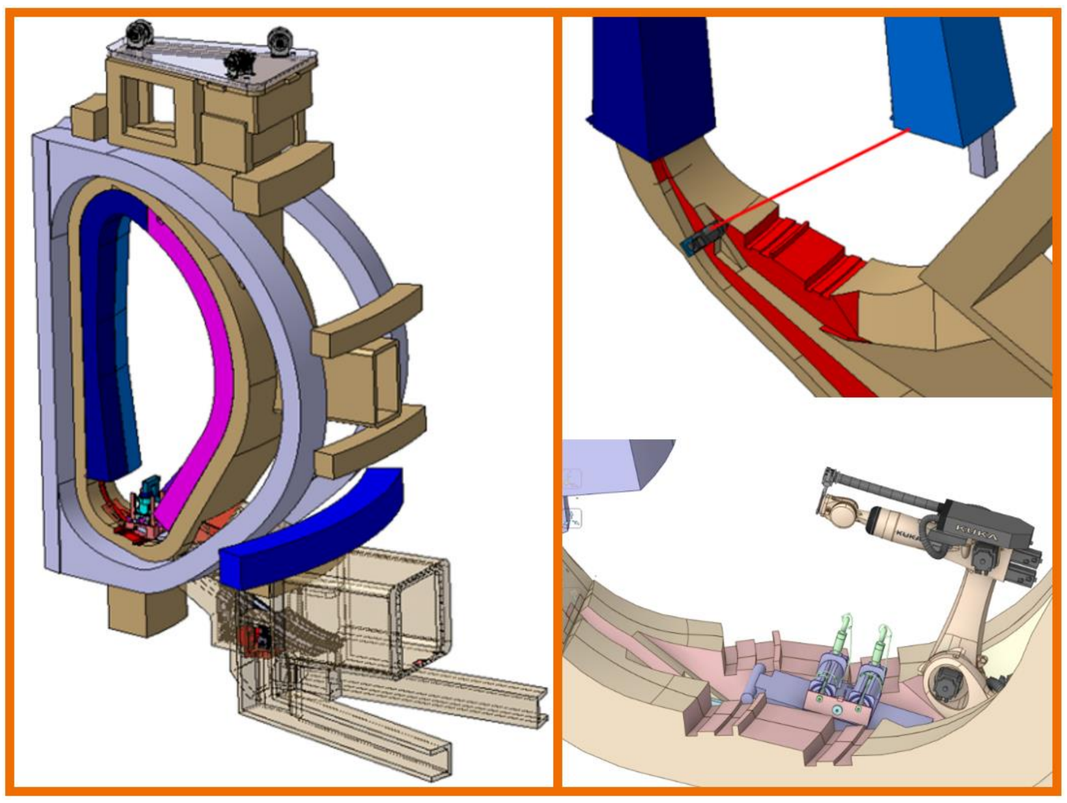

Fig 1. Left: Two-Port Mover (TPM) with Lower Manipulator System (LMS) and Upper Winch System (UWS); Top Right: Lower Port Winch (LPW) guiding In-Board Breeding Blanket (IBB); Lower Right: LPW deployed on a carriage and a manipulator for attaching IBB cable interfaces to the winch.

The Lower Port Winch (LPW) and the cables from the In-Board Breeding Blanket (IBB) are connected via winch-cable interface.

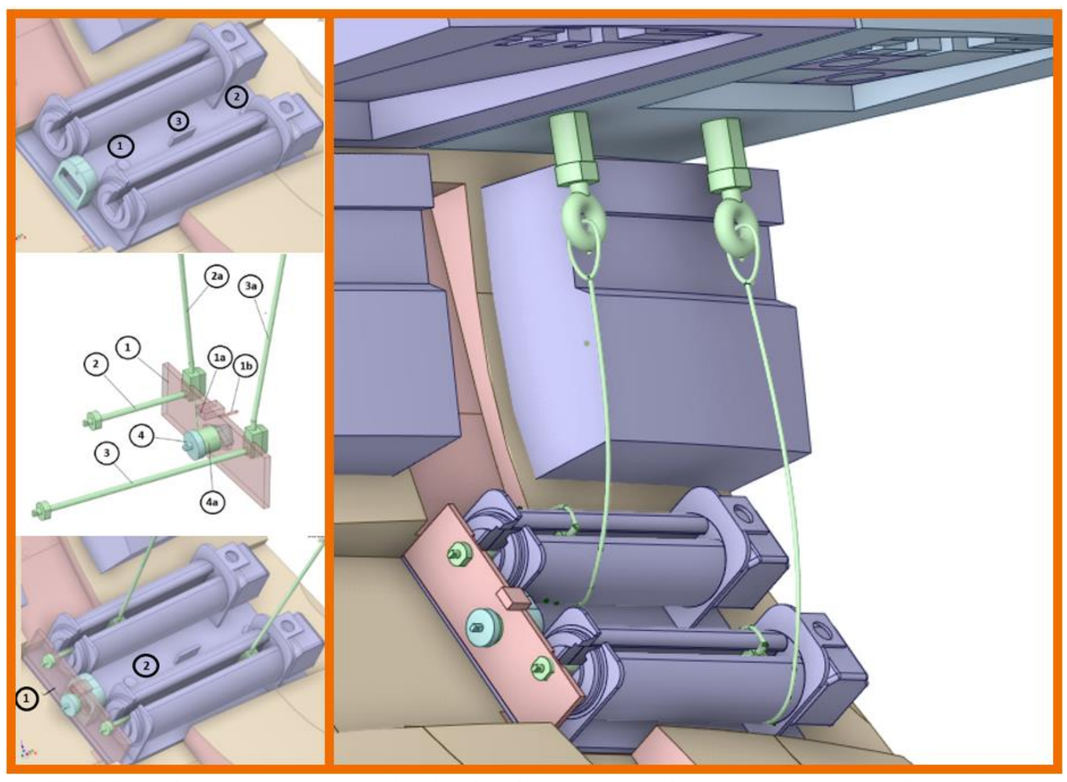

Fig 2. Top Left: Winch body attached to the slot of Vacuum Vessel (VV) with Remote Handling (RH) features; Middle Left: 1) Winch-cable interface plate, 1a) RH feature, 1b) Dowel-pin, 2) Shaft for winch1, 2a) Cable for winch1, 3) Shaft for winch2, 3a) Cable for winch2, 4) Twistlock, 4a) Twistlock transportation spring; Lower Left: 1) Winch-cable interface, 2) Winch body; Right: Cable connection bolts attached to the In-Board Breeding Blanket (IBB)

Dynamic simulation

Dynamic simulation assesses movement of IBB and cables within the Vacuum Vessel sector. Setup consisted of a Unity game-engine with AGX Dynamics for Unity module. Dynamic physics enable the cabling and the connection plate to collide with the surrounding environment and proper adjustments to the performed procedures can be ensured. The final connection with the connection plate and the winches is performed by a remotely operated manipulator. In the context of this simulation, the manipulator was controlled with a haptic device, Haption Virtuose 6D Tao. This ensured precise control of the connection process, but also demonstrated how the cables would interact while being handled by the manipulator.

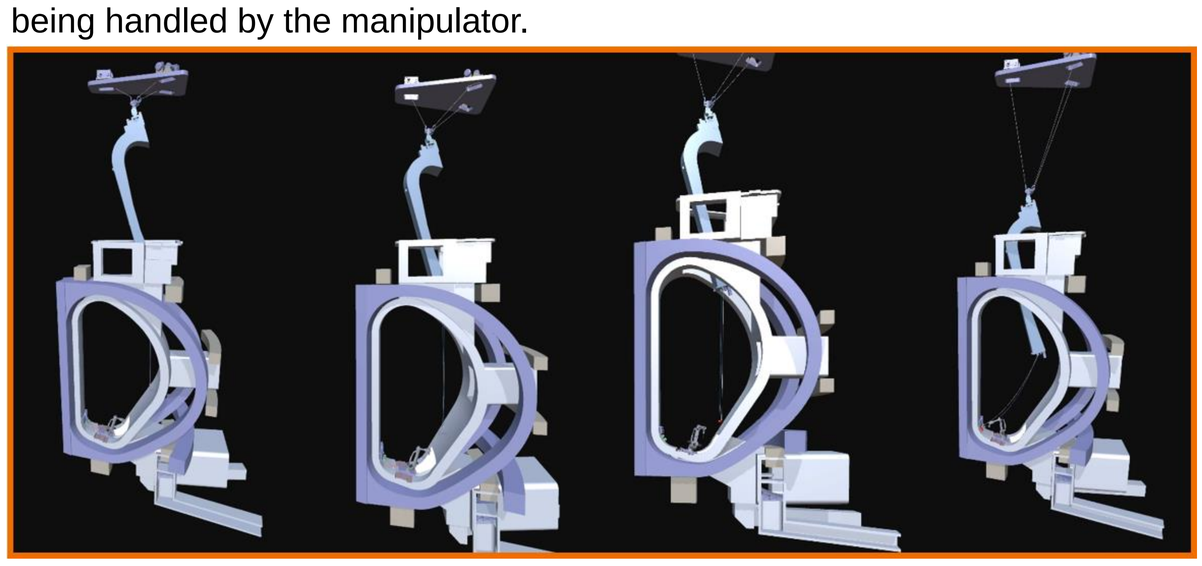

Fig 3. Blanket Leg Unit is lowered with winches of the TPM, and the cables to be attached to the LPW are hanging from the blanket.

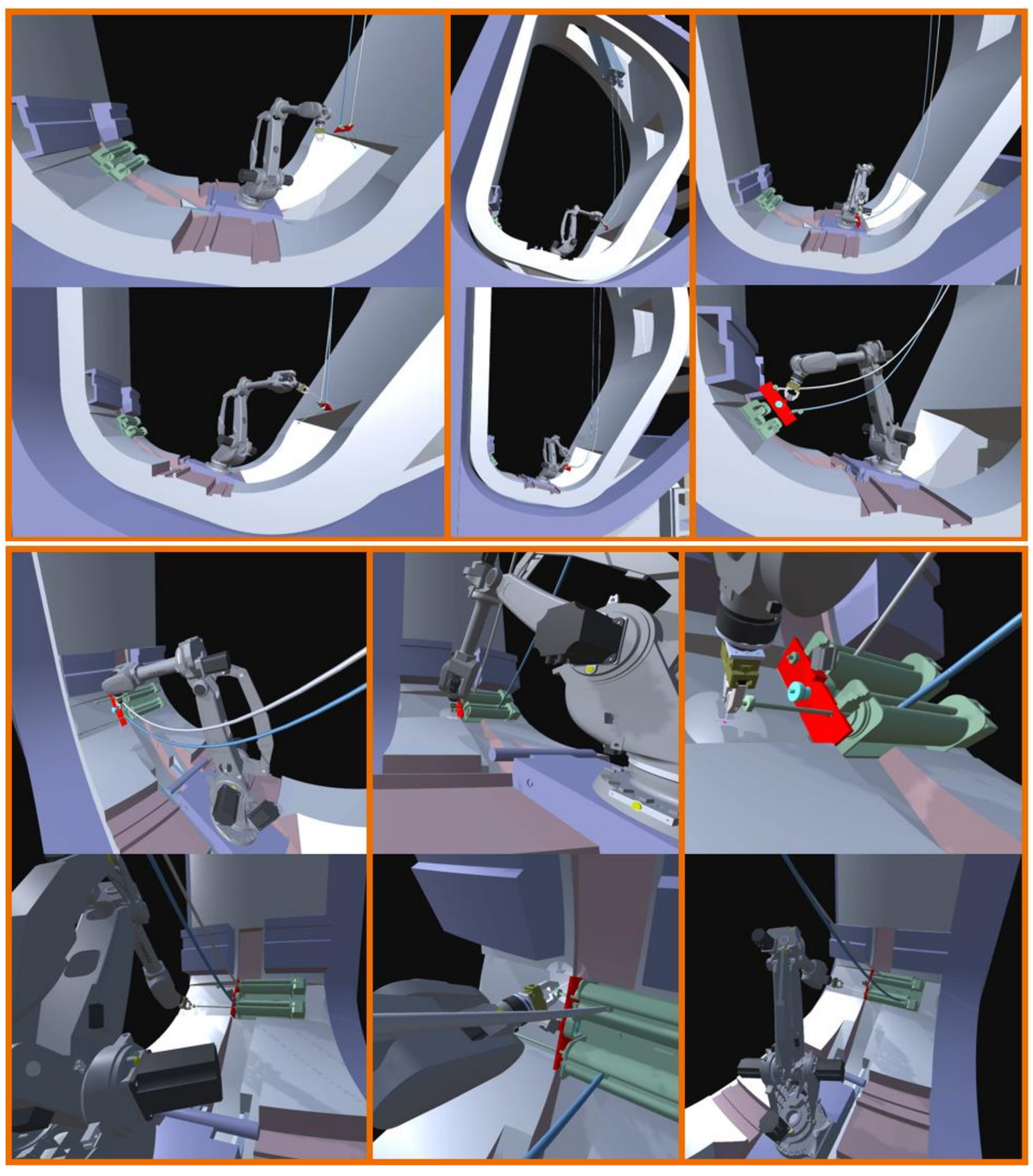

Fig 4. Winch-cable interface is installed to its place in LPW with remotely operated manipulator. In this context control is performed with a haptic device.

Conclusion & Future work

Unity with AGX Dynamics emerges as an efficient way to visualize dynamic phenomenons. Cable reaction to reactor outboard wall was able to be demonstrated, as well as the functionality of the winches. The pipeline to study dynamics in DEMO context with used tools are to be continued in future.

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