Concept of contamination control door for DEMO and proof of principle design

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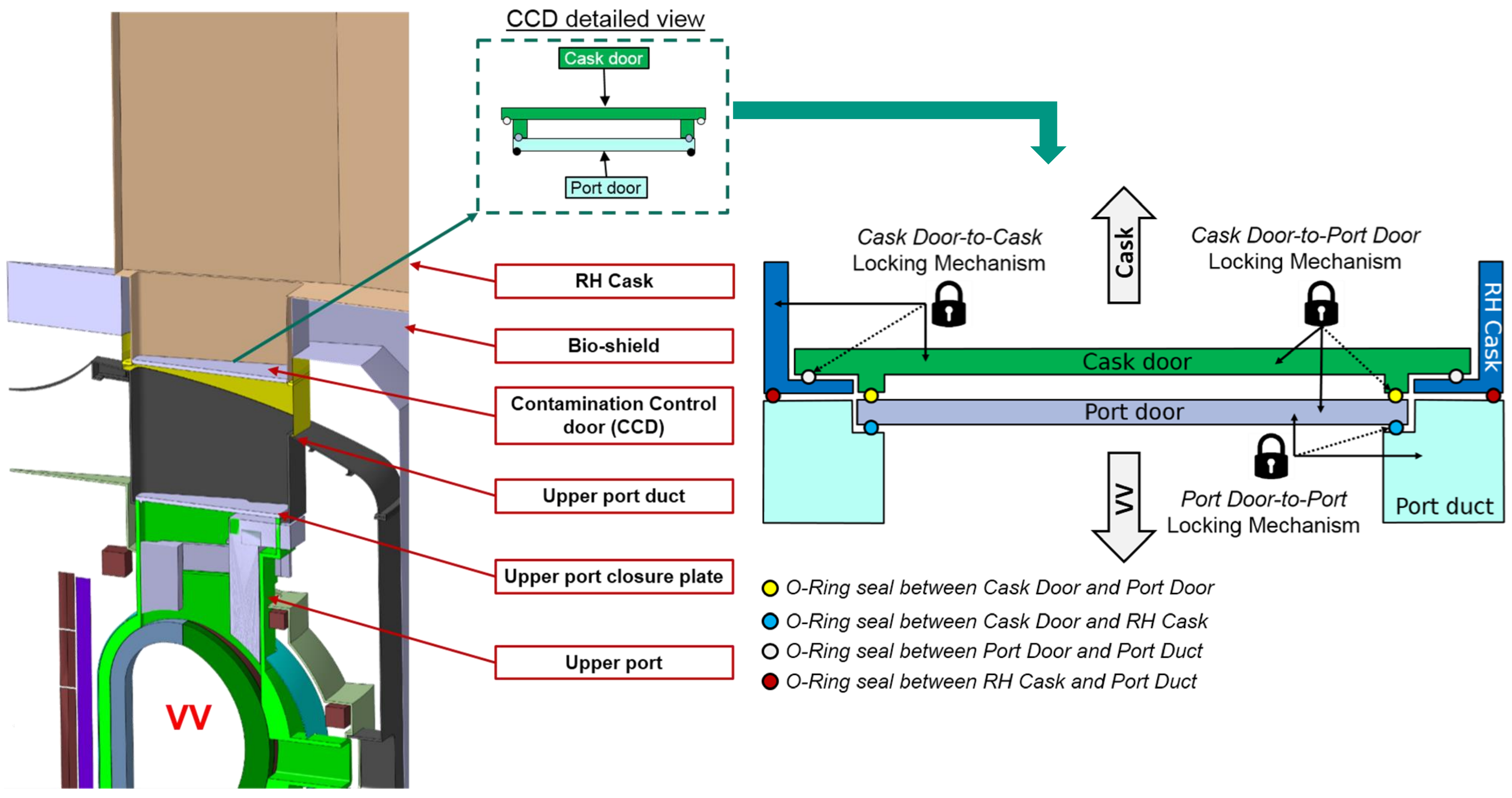
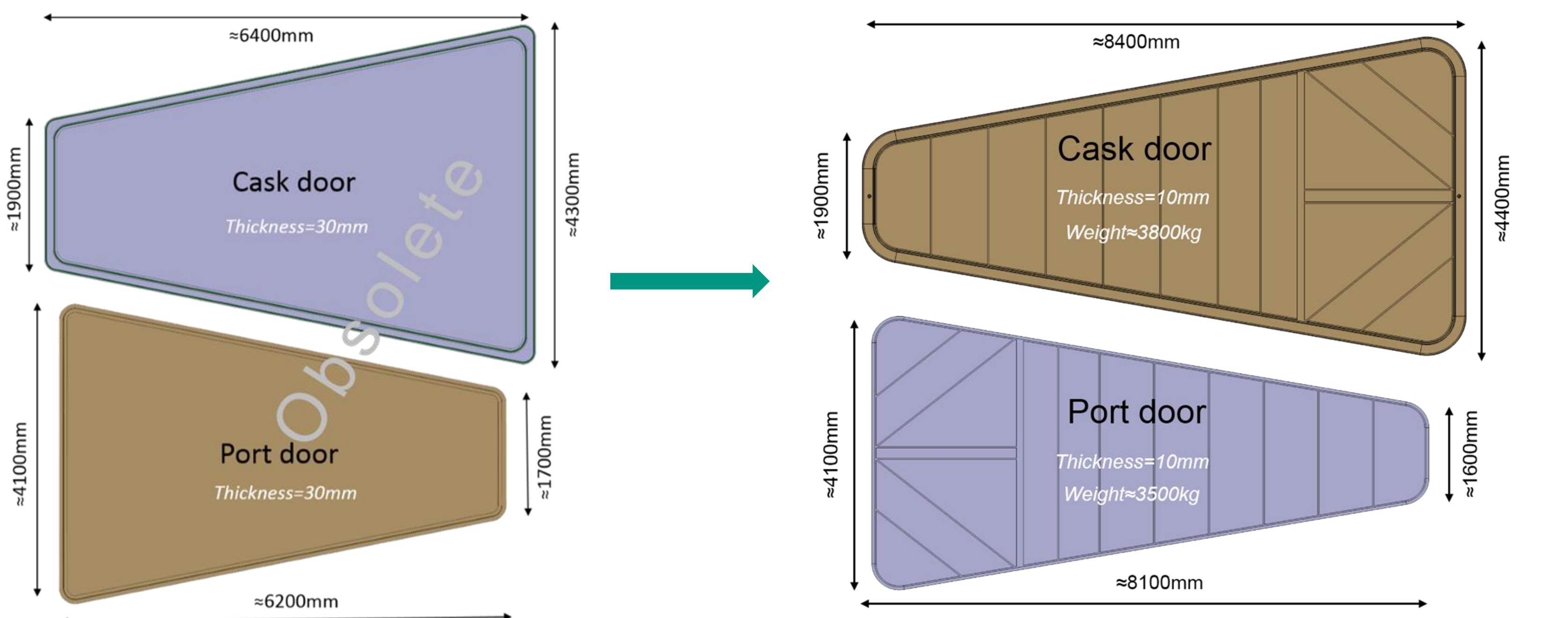
Abstract

During the maintenance period of DEMOnstration Power Plant (DEMO) remotely handled casks are required to confine and handle DEMO in-vessel components during their transportation between the reactor and the active maintenance facility. In order to limit the dispersion of activated dust a Contamination Control Door (CCD) is designed to be placed at an interface between separable containments (e.g. vacuum vessel and cask) to inhibit the release of contamination at the interface between them.
The remotely operated CCD, technically a double lidded door system, consists of two separable doors (cask door and port door), and three different locking mechanisms (i) between cask door and cask; ii) between cask door and port door; iii) between port door and port). The locking mechanisms are selected and assessed according to different criteria, and the structure of CCD is optimized using Abaqus Topology Optimization Module. Due to the elastic properties of CCD deflections will occur during the lifting procedure, which may lead to malfunction of CCD. A test rig is developed to investigate the performance of high risk components in the CCD in case of deflections and also malpositioning. Misalignment can be induced along three axes and three angles on purpose to test the single components and items. The aim is to identify a possible range of operating in case of misalignments.



Geometry

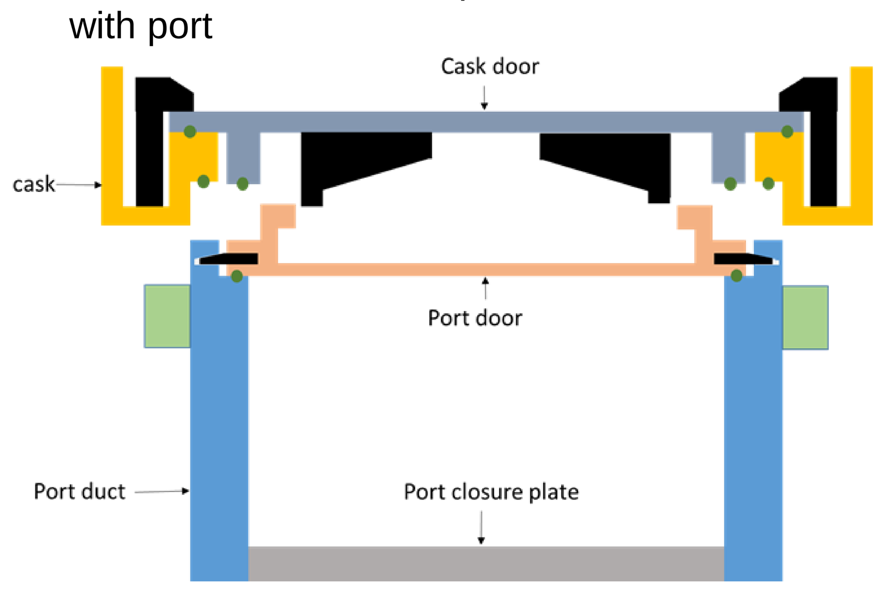


Geometry of cask door and port door before and after Abaqus Topology optimization
(DEMO Baseline: left: 16 vertical ports in vacuum vessel, right: 18 vertical ports in vacuum vessel)

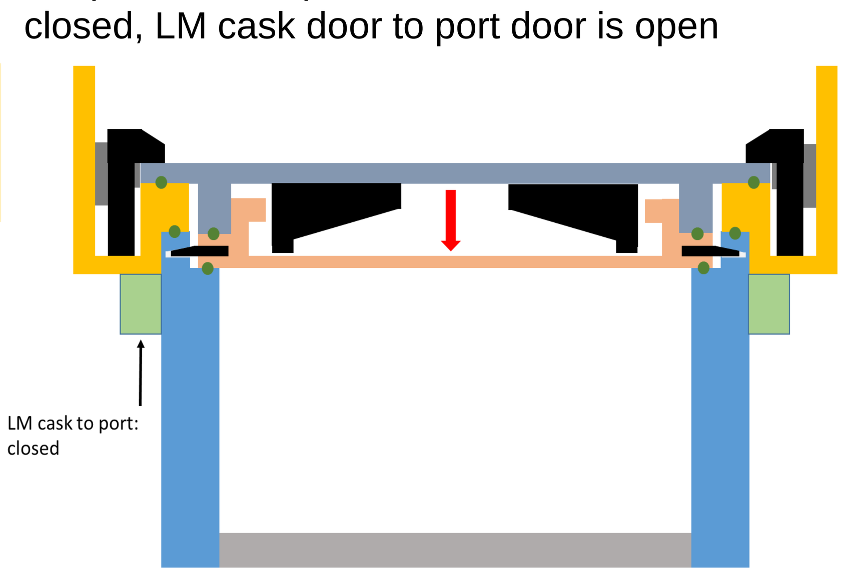
Operation sequence

E.g: closing of CCD

1. RH cask docks to the port duct, cask door is connected with cask, port door is connected with port

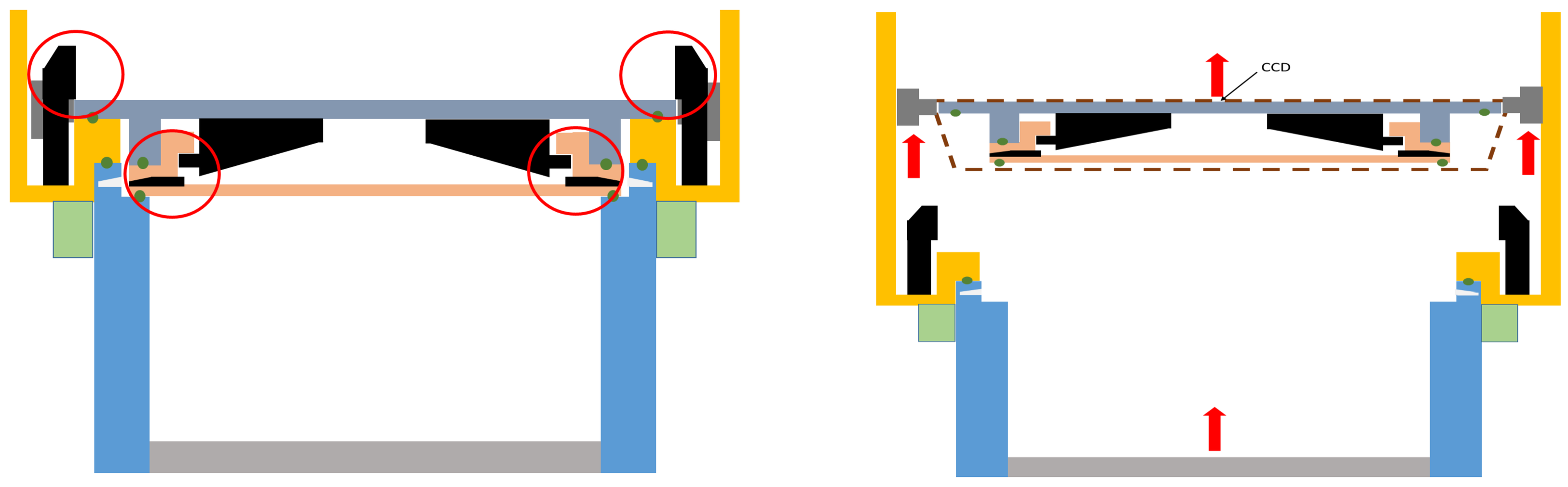


2. Close locking mechanism(LM) cask to port, while LM port door to port and LM cask door to cask are closed, LM cask door to port door is open



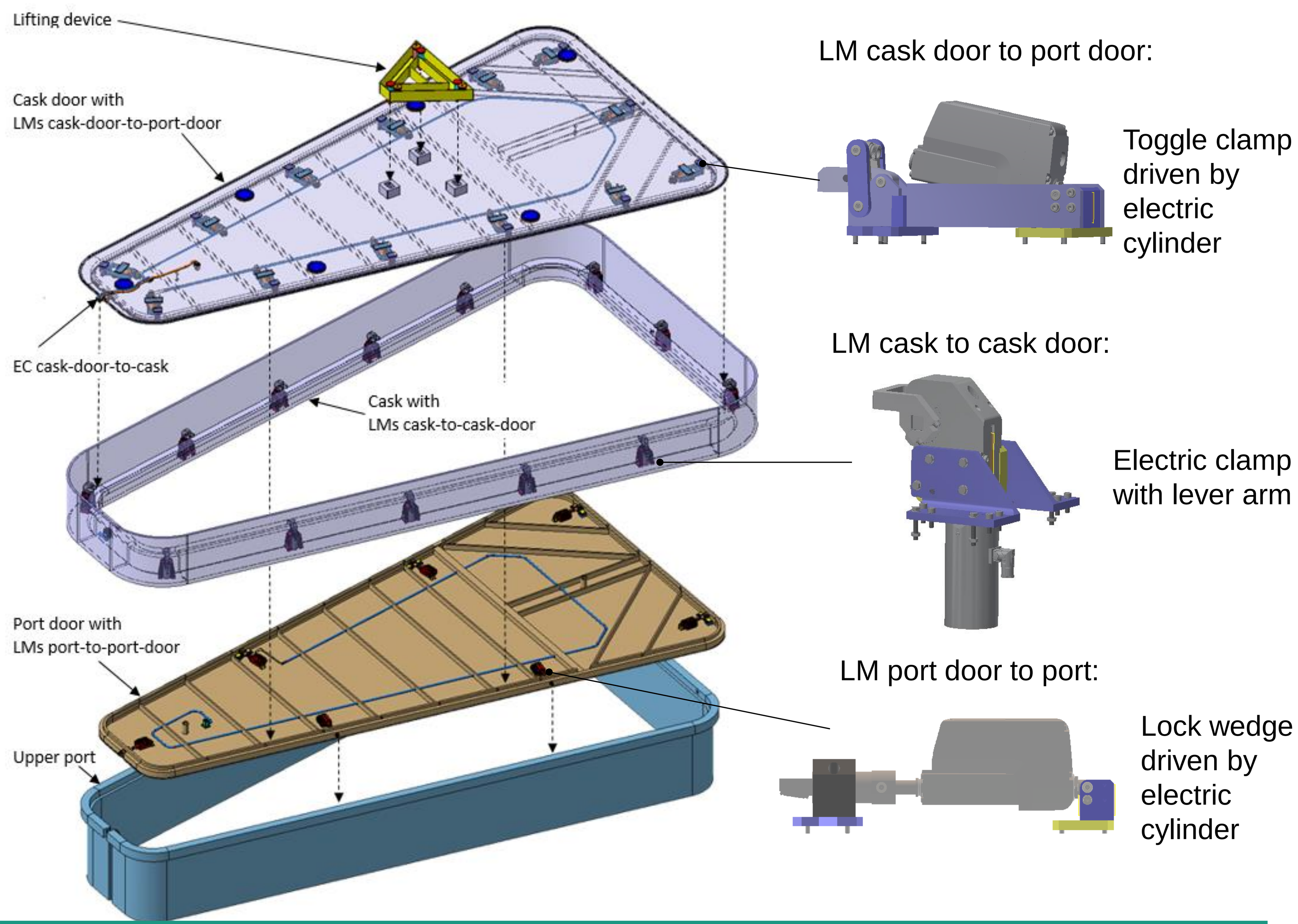
3. Open LM port door to port and LM cask door to cask, close LM cask door to port door

4. Lift CCD and store it in the cask. After removing port closure plate, components in VV are available



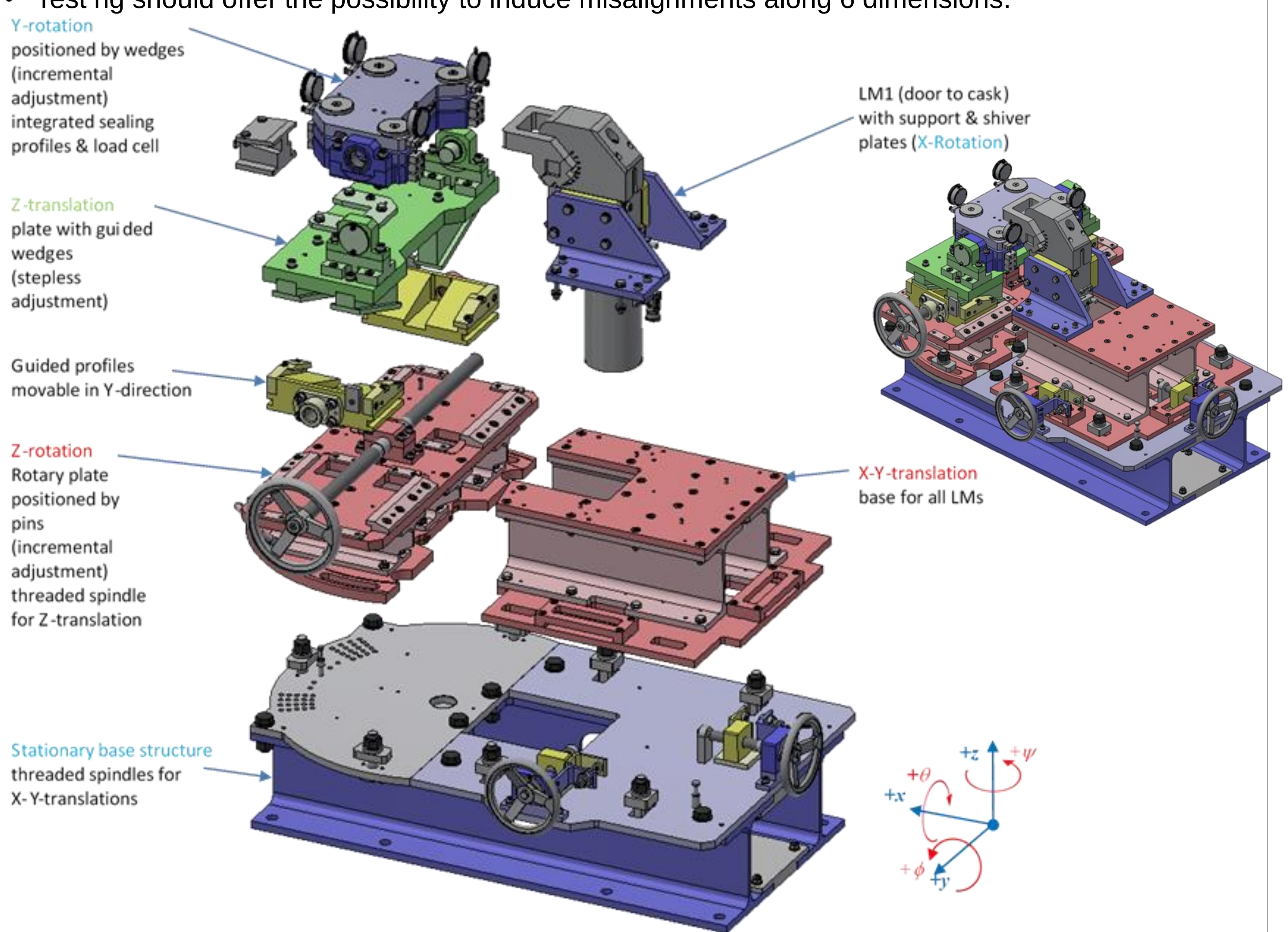
5. After removing the components inside VV and storing it in the cask, CCD is restored. RH cask and port duct is separated following reverse procedure.

Proof of principle design



Test rig

- Elastic properties of CCD lead to deflections due to bending during the lifting procedure.
- The deflection of the structure has impact on the correct positioning, attachment and locking of the CCD.
- The three locking mechanisms, alignment pins and electrical connectors are critical components identified by DFMECA
- The performance of these critical components should be investigated by test rig trials in a test rig.
- Test rig should offer the possibility to induce misalignments along 6 dimensions.



Measured values: misalignment caused by the test rig, compression of sealing by closing of LM, resulted clamping force under misalignments etc.

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