Fast shutter concepts for the new ITER core CXRS upper port plug baseline considering the actuator located inside and outside the port plug

David Antonio Castaño Bardawil, Yury Krasikov, Anatoly Panin, Olaf Neubauer, Wolfgang Biel

Institut für Energie- und Klimaforschung, Plasmaphysik - Forschungszentrum Jülich

INTRODUCTION

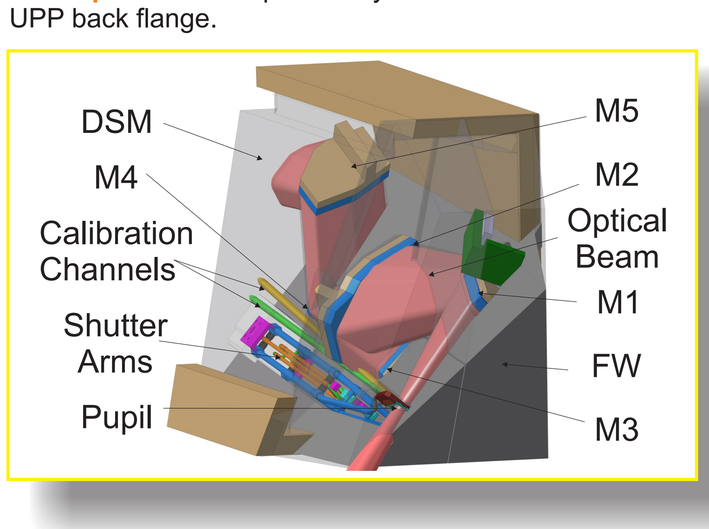
The ITER core charge exchange recombination spectroscopy (CXRS) diagnostic, designed to analyze and study the plasma, is located in the vacuun vessel (VV) upper port #3 (UPP3).

The core CXRS optical system requires protection, specially for the first mirror (M1), against degradation during plasma pulses, dwell time (time between plasma burns), wall conditioning, and maintenance. Implementing protective shutter mechanisms is one of the ways to reduce degradation effects.

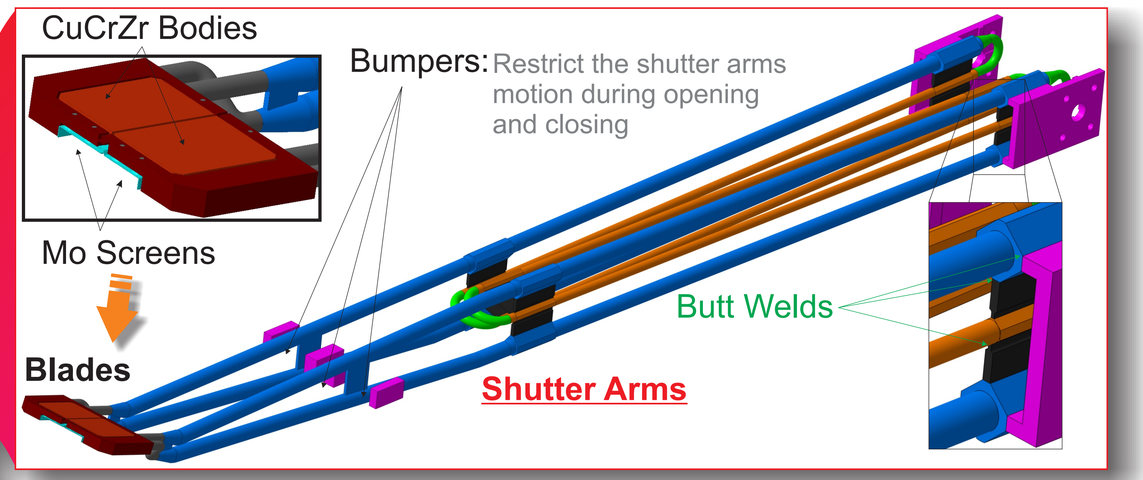
Two conceptual solutions are proposed and compared as possible candidates for the new core CXRS UPP Layout. Both conceptual solutions make use of the same shutter mechanism (**shutter arms**) with different locations of the driving component (actuator). *The fast shutters are planned to operate within fractions of seconds*.

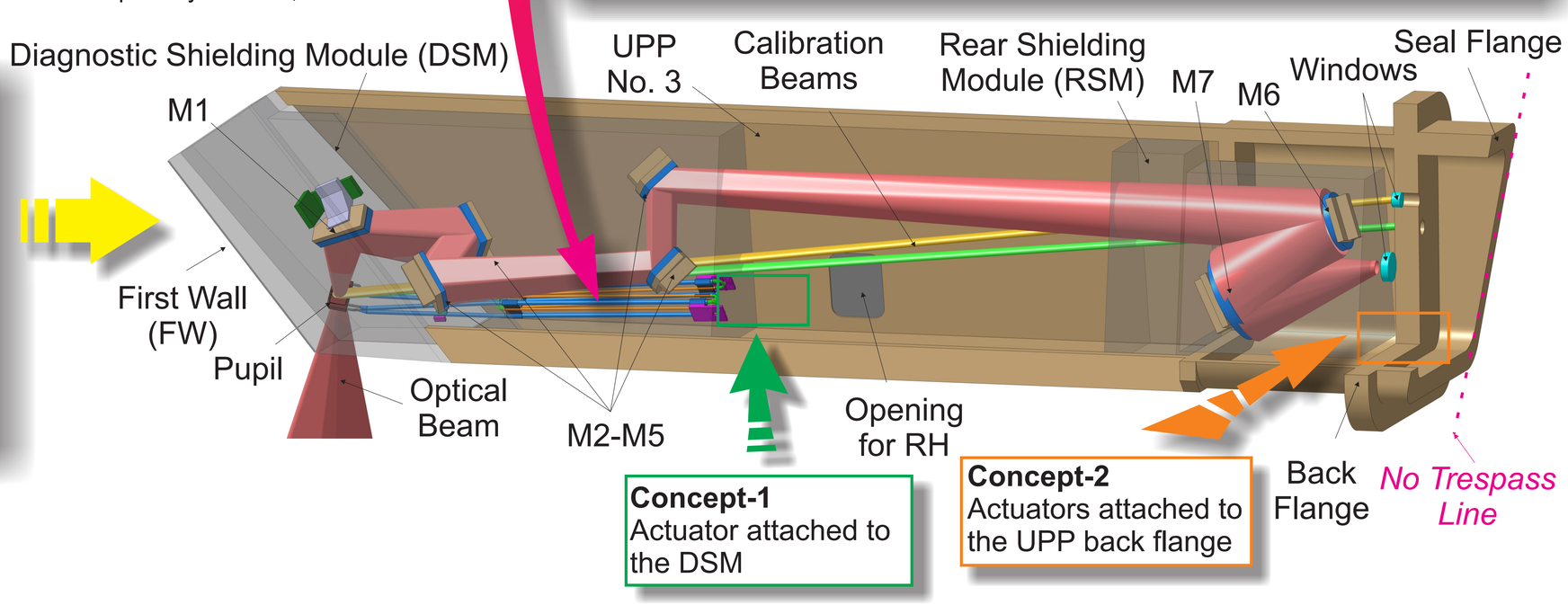
Concept-1 uses a pneumatic (helium) actuator in the primary vacuum side, attached to the Diagnostic Shielding Module (DSM).

Concept-2 uses two parallel hydraulic actuators located outside of the primary vacuum, attached to the UPP back flange.



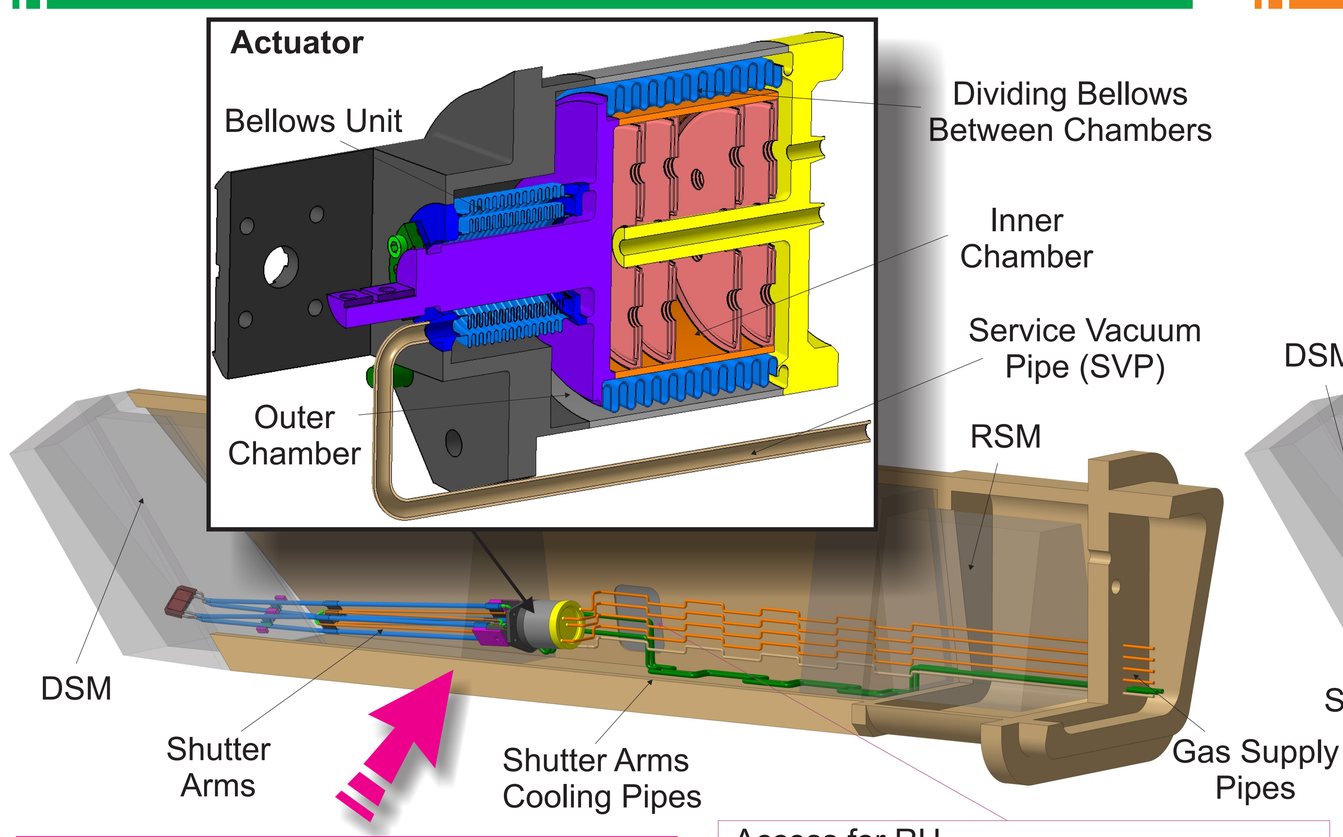
The shutter arms position and alignment depend on the pupil's location and the surrounding components inside the DSM.

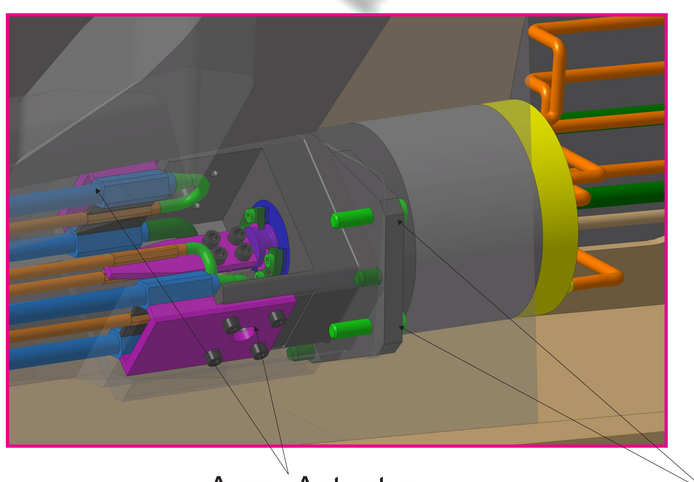




SHUTTER CONCEPTS

CONCEPT-1

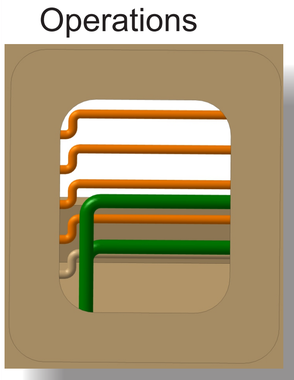




Arms-Actuator Interface Connection

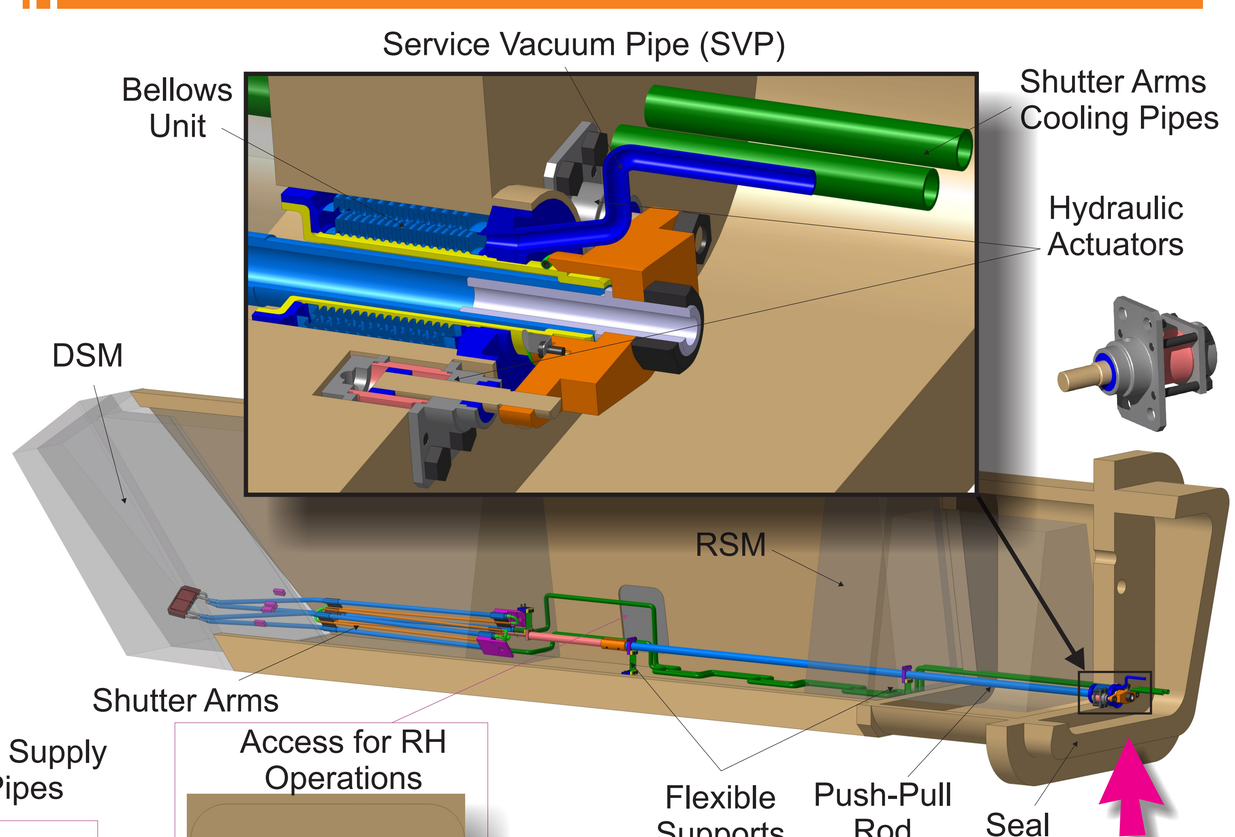
Actuator-DSM Interface Connection

Access for RH Operations

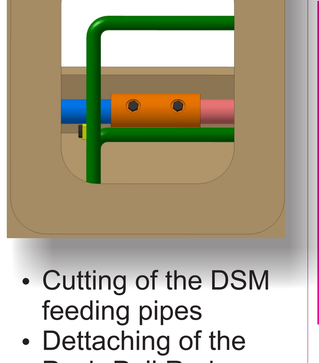


Cutting of the
- DSM feeding pipes
- Actuator's Helium and Service Vacuum pipes

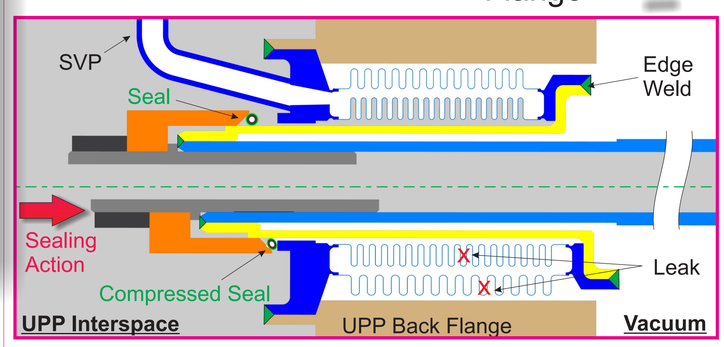
CONCEPT-2



Access for RH Operations



- Cutting of the DSM feeding pipes
- Dettaching of the Push-Pull Rod



Security action to seal the bellows unit in case both bellows have an air leak into the vacuum vessel.

SUMMARY

- The design approach of Concept-1 is to create a compact fast shutter unit that can be replaced once the DSM is extracted from the UPP3. Due to the conditions in the DSM region (ultra-high vacuum, magnetic fields, neutron fluxes, high temperatures), the actuator type is restricted mainly to pneumatic actuators without sliding components.
- On the other hand, Concept-2 is designed to have the fast shutter divided into two sections, the shutter arms and the driving system (push-pull rod, flexible supports, the bellows unit, and the actuators). This approach allows the implementation of other driving component types (hydraulic, pneumatic, electric, and magnetic, among others) and different maintenance strategies for the fast shutter system.

CONCLUSIONS

The two fast shutter concepts showed to be suitable candidates for the new core CXRS baseline layout, and it is recommended to continue a design optimization process for both concepts. In particular, for Concept-2, further efforts are encouraged to be performed; using other kinds of actuators may provide alternative designs, not only for the core CXRS UPP but as well for other ITER systems. Additionally, Concept-2 can implement any generic solution adopted by ITER, reducing the overall complexity of the machine.

In future studies other comparison topics are foreseen to be covered, such as a detail design of components, a complete RAMI (Reliability, Availability, Maintainability, and Inspectability) analysis, among others. This will determine the best choice for the core CXRS UPP layout.

d.castano.bardawil@fz-juelich.de