A COMPREHENSIVE DESIGN OF THE UPPER PORT #18 INTERSPACE SUPPORT STRUCTURE FOR THE ITER DIAGNOSTIC PORT.

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1. INTRODUCTION

This paper describes the design strategy for the ex-vessel components of Upper Port #18 for ITER diagnostics to integrate tenant diagnostics and to ensure overall design considerations. One of the ITER diagnostic ports, upper port #18 (UP #18), has three diagnostic systems: 1) Vacuum ultra-violet spectrometer (VUV), which measures and identifies all impurities in the ITER plasma; 2) Neutron activation system (NAS), which measures the first wall neutron fluence; 3) Upper vertical neutron camera (UVNC), the multichannel neutron collimator, which measures the time-resolved neutron emission profile. The ITER diagnostic port is divided into two main areas. One is the integrated port plug, in-vessel component, is equipped with diagnostic first wall (DFW) and diagnostic shield module (DSM) which has a role of neutron shielding and of diagnostic safety. The other area is interspace support structure (ISS) and port cell support structure (PCSS). These structures are installed on the outside of the vacuum vessel. The diagnostic electronics and detectors are located in this area, away from the plasma, to protect the equipment from nuclear radiation. During the maintenance phase, the shut-down dose rate (SDDR) should be controlled to check the diagnostic status or to replace the diagnostic by hand. The ISS/PCSS structures are mounted on permanent remote handling rails. The ISS/PCSS structures are detached from the rails and each structure is removed with a trolley when maintenance is required. Therefore, the final design of the ISS needs to be done from the perspective of neutron and gamma shielding for the human passage area, structural integrity, cooling performance, and maintainability.

2. DESIGN STRATEGY

Fig. 1 shows the UP #18 overall configuration. The VUV detector shielding and the UVNC preamplifier shielding are installed on the PCSS. The VUV sight pipe is routed through the ISS to provide the optical path between the port plug and the port cell equipment.

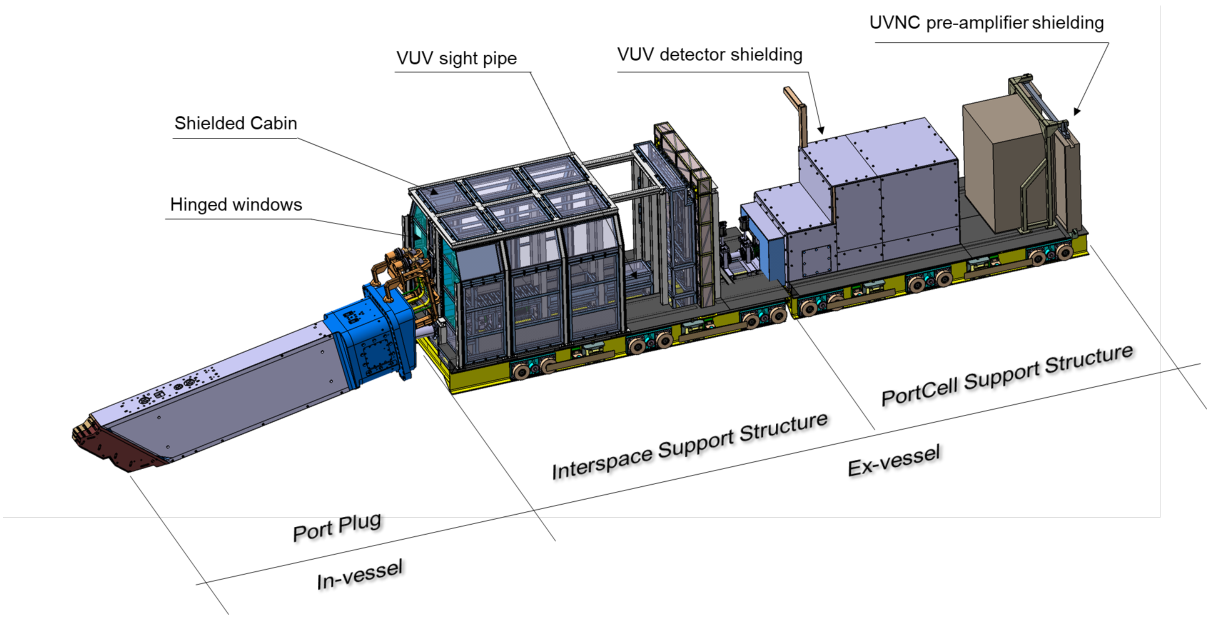

Fig. 1 Upper Port #18 overall configuration

In order to meet the SDDR requirements, a shielded cabin concept has been adopted for the UP #18 ISS. Borated heavy concrete panels will be installed on the ISS frame. The human passage is fully shielded to decrease SDDR. This allows access to the inside of the shielded cabin for diagnostic maintenance. The front hinged windows can be opened for port plug components. The windows can be opened separately to minimize the occupational radiation exposure.

3. NEUTRONIC ANALYSIS

Neutronic analysis was performed to estimate the SDDR at the human passage inside the shielded cabin. The neutron source was a standard plasma source with a fusion power of 500 MW as described in the MCNP ITER C model. Neutronics analysis was conducted using D1S-UNED v3.1.4 with FENDL 3.1 cross-section library. Fig. 2 shows the SDDR result. It shows that the SDDR is less than 100 μSv/h which meets the ITER requirement.

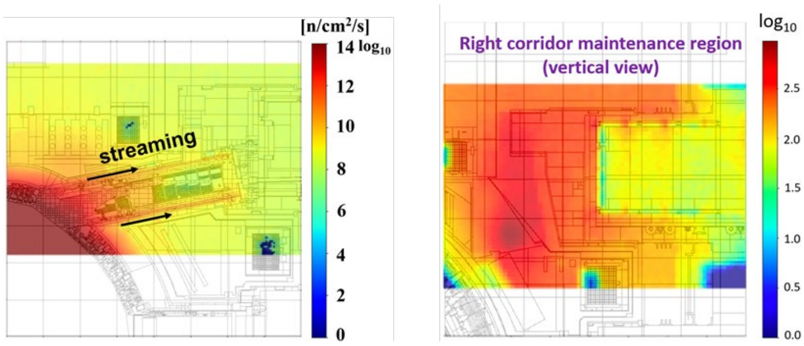

Fig. 2 Neutronics analysis for UP#18 (left – neutron flux in port plug, right – SDDR in ISS area)

4. STRUCTURE AND FLUID ANALYSIS

The structural analysis presented in this paper aims to assess the structural evaluation of the shielded cabin with ISS. This evaluation was carried out on the basis of RCC-MR (2007) code. The integrity of structures using the H-beam meets the design allowable stress under the ITER's severe load conditions. A hydraulic analysis was also carried out to investigate the temperature distributions and cooling characteristics in the ISS under baking conditions. The temperature inside the shielded cabin is kept below 35ºC and has a good cooling flow pattern due to the design that takes the flow passage into account.

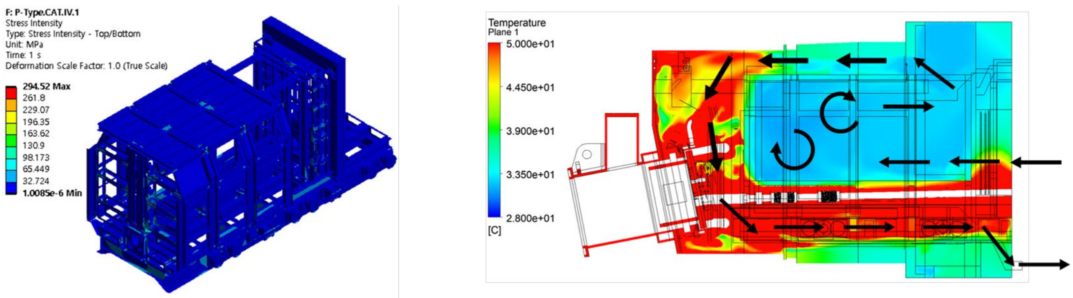

Fig. 3 Engineering analysis for UP#18 (left – structural analysis, right – CFD analysis)

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