HCCB Design Status

Presented by

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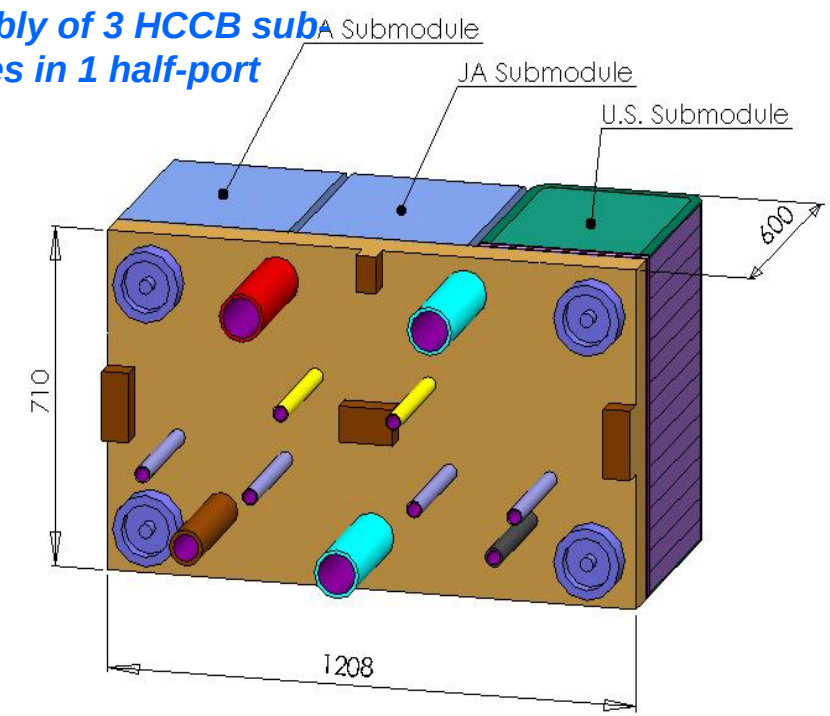
Progress on submodule design- Key Activities

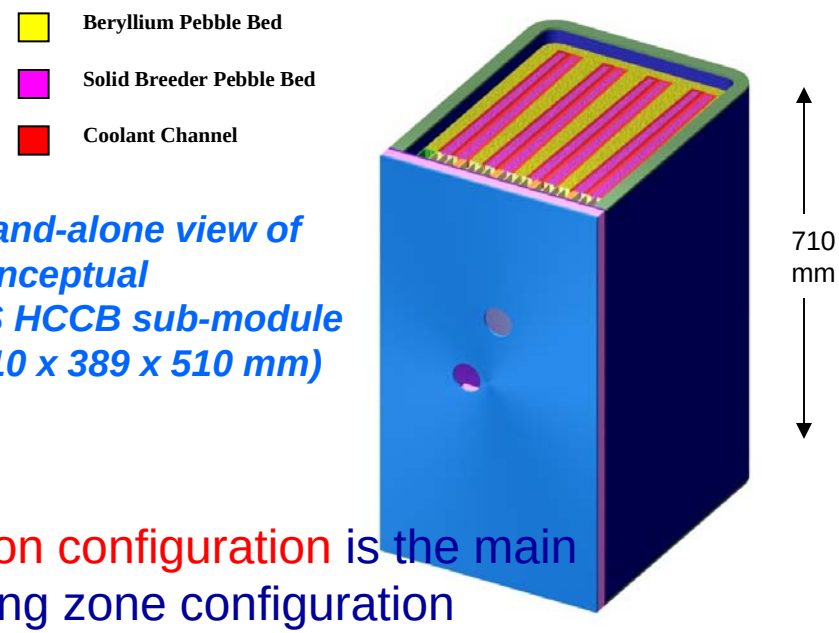
- An integrated mechanical design approach combining fabrication technique, performance requirement flow distribution schemes, and assembly procedure - detailed by Hunt
- An integrated simulation approach coupling thermal, flow, and structure for use in the design analysis - detailed by Narula
- Safety analysis is being performed to demonstrate that the US modules are not different from the EU or JA modules - detailed by Reyes
- A 3-D CAD-based neutronics analysis approach is being established - detailed by Youssef

Main Features of the HCCB FW/Blanket

- Use of high pressure helium (~8 MPa) operating between 300°C and 500°C
  - A toroidally oriented helium flow scheme for the FW surface heat removal
  - Radial flow schemes for removing the volumetric heating in the breeding zones.
- Use of a single-size (0.6-0.8 mm) pebble bed of Li ceramic breeder material such as Li_4SiO_4 and Li_2TiO_3 with varying ^6Li enriched.
- Use of a single-size (1 mm) Be pebble bed as a neutron multiplier.
- Use of a low pressure (0.1-0.2 MPa) helium/H_2 purge gas to extract tritium from the breeder and neutron multiplier zones.

Assembly of 3 HCCB sub-modules in 1 half-port





Stand-alone view of conceptual US HCCB sub-module (710 x 389 x 510 mm)

Edge-on configuration is the main breeding zone configuration

Some Revisions to the HCCB Design and Costing

- The toroidal width of the half-port module is reduced by 40 mm
  - The HHCB submodule torodial width is reduced by 13 mm and changed from 402 mm to 389 mm
- TBWG's current port layout scheme calls for each half port having its own helium-cooling system
  - Has an impact on costing for the HCCB ancillary equipment, which increases the cost by 300k for Task 1.8.2.2.

HCCB Baseline ITER Testing Strategy

The baseline strategy case is to test a series of submodules that occupy one-third-of-a-half-port, each with its own first wall structure

- This Baseline HCCB assumes a "supporting international partnership," which is envisioned where another international partner takes the lead role in defining half-port TBM configuration layout, overall ITER interface, and the final delivery of the half-port module to ITER site.
- Under the supporting partnership arrangement, the US contributes by carrying out portions of overall R&D and engineering design and analysis and by providing a sub-module TBM and portions of the ancillary system hardware.

Collaboration Model for HCCB

- R&D
  - IEA: General topical areas for solid breeder blanket R&D including ferritic steel fabrication technology development
  - Bilateral:
    - example topics:
      - Ceramic breeder material development and characterization
      - In-pile pebble bed assembly tests
      - Neutronics diagnostic development
- Test Submodule
  - Supporting partnership role with one-third-of-a-half-port sized sub-module – with its own first wall structure
    - Test module design and partially integrated mock-up tests
- Ancillary Equipment
  - Multilateral collaboration on Helium flow loop
  - Bilateral collaboration on tritium processing system consistent with test submodule collaboration

Objectives and characteristics of the HH submodule

- The EM submodule is the first submodule of a series submodules to be tested in the ITER device during the ITER HH phase. It is a design that embodies the general geometrical replicate of the HCCB ITER DT test sub-modules.
- ITER H-H operation will provide a fusion relevant testing environment to verify the design approach, fabrication technique and structural support of the first wall and the breeding containing structures that will be used to subsequent nuclear-grade test sub-modules and ITER DT licensing.
- Its main ITER testing goal includes measuring forces and the mechanical response of the TBM structure to transient EM loads and providing data on ferromagnetic perturbation of ITER fields.
  - In addition, it is expected that the sub-module approach would give a lower EM load as compared to that of a full half-port module approach. This provides a different piece of test data to validate EM and structural simulation model and methodology.
  - A portion of breeding zones will be filled with ceramic breeding and beryllium pebble materials. The integrity of the pebble bed against the EM loads will be evaluated by monitoring the purge gas pressure drop.

H-H Test Submodule Milestones for HCCB

Description	Orig Dur	Early Start	Early Finish
Test Blanket			
	2412	02JAN06	31MAR15
HCCB			
	2412	02JAN06	31MAR15
Begin Preliminary Design	0	02JAN06 *	
Preliminary Fabrication Scheme Defined	0		28SEP07
International Agreement Established	0		31DEC07
Prelim Design Review	0		31DEC08
Contract/Bid Specification Development Complete	0		28SEP09
Fabrication Contract Award	0		31MAR10
Begin Prototype Fabrication	0	01APR11	
Begin Prototype Qualification Tests	0	30MAR12	
Submodule Detailed Design Final Review	0		28DEC12
Begin Submodule Fabrication	0	31DEC12	
Begin Submodule Acceptance Tests	0	30SEP13	
Deliver to Host Party	0		28FEB14 *
Ready to Ship to ITER	0		31MAR15