Engineering and Design
HCCB

Prepared by
A. Ying
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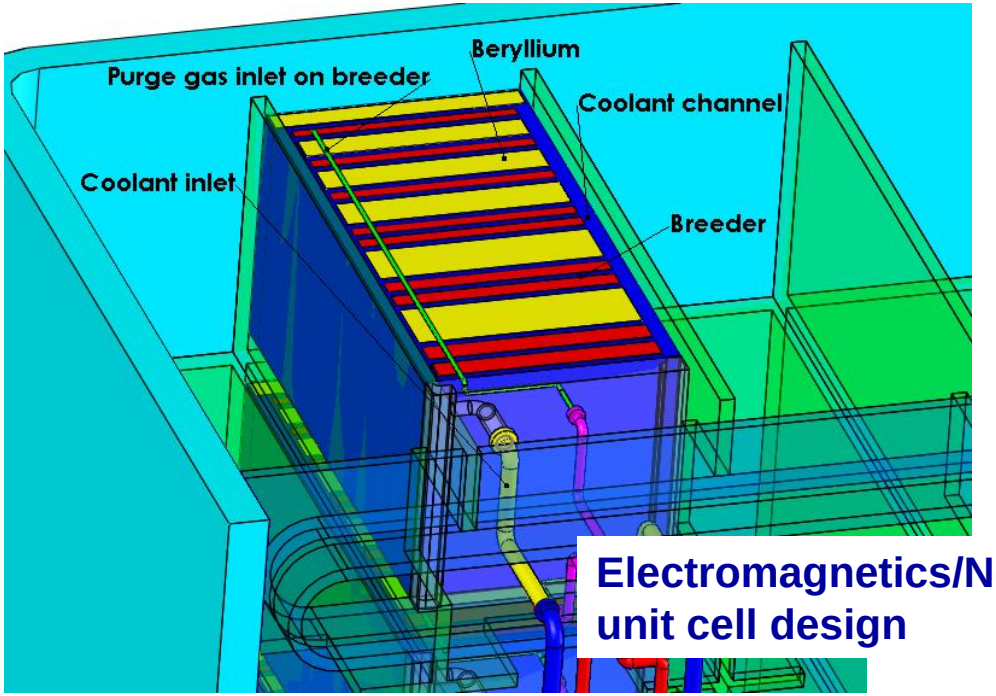
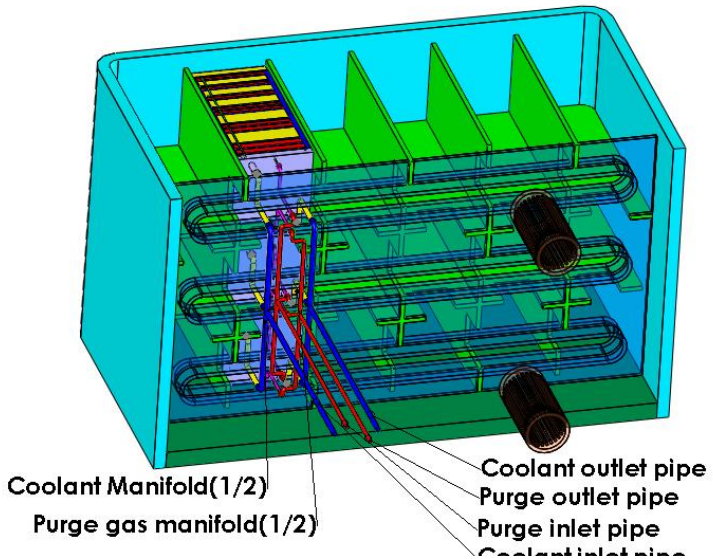
The Issue

Because the US test design and subsequent mockup and test article procurement and fabrication activities are impacted by the host party's test blanket module design, it is necessary that the US HCCB host party be identified as soon as possible. The US host should be chosen based on technical expertise and based on prior collaboration history in order to capitalize on the well established and ongoing international collaborations.

Ceramic Breeder Test Submodule
Inserting “US” unit cells into the EU HCPB structural box

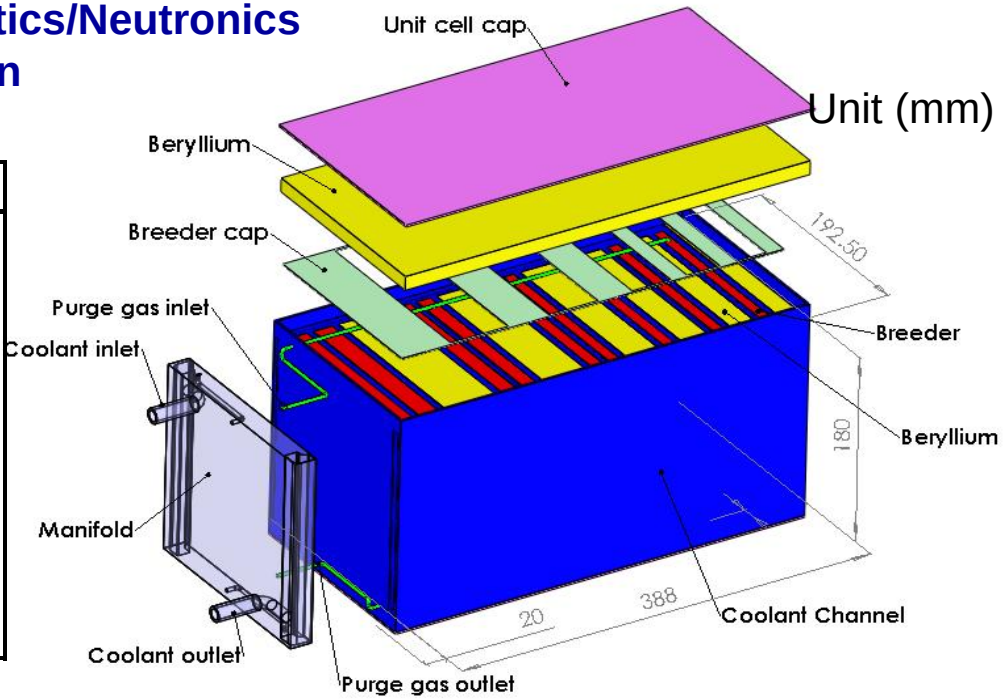
WBS 1.8.2





Electromagnetics/Neutronics unit cell design

Neutonics Submodule Operating Conditions		
Helium Coolant		
	Pressure	**8 MPa**
	Temperature, In/Out	**100/250 C**
Helium Purge		
	Pressure	**0.1 MPa**
	Temperature, average	**225 C**
Breeder	**Min/Max**	**100/350 C**
Beryllium	**Min/Max**	**100/350 C**
FS	**Min/Max**	**100/300 C**



Unit (mm)

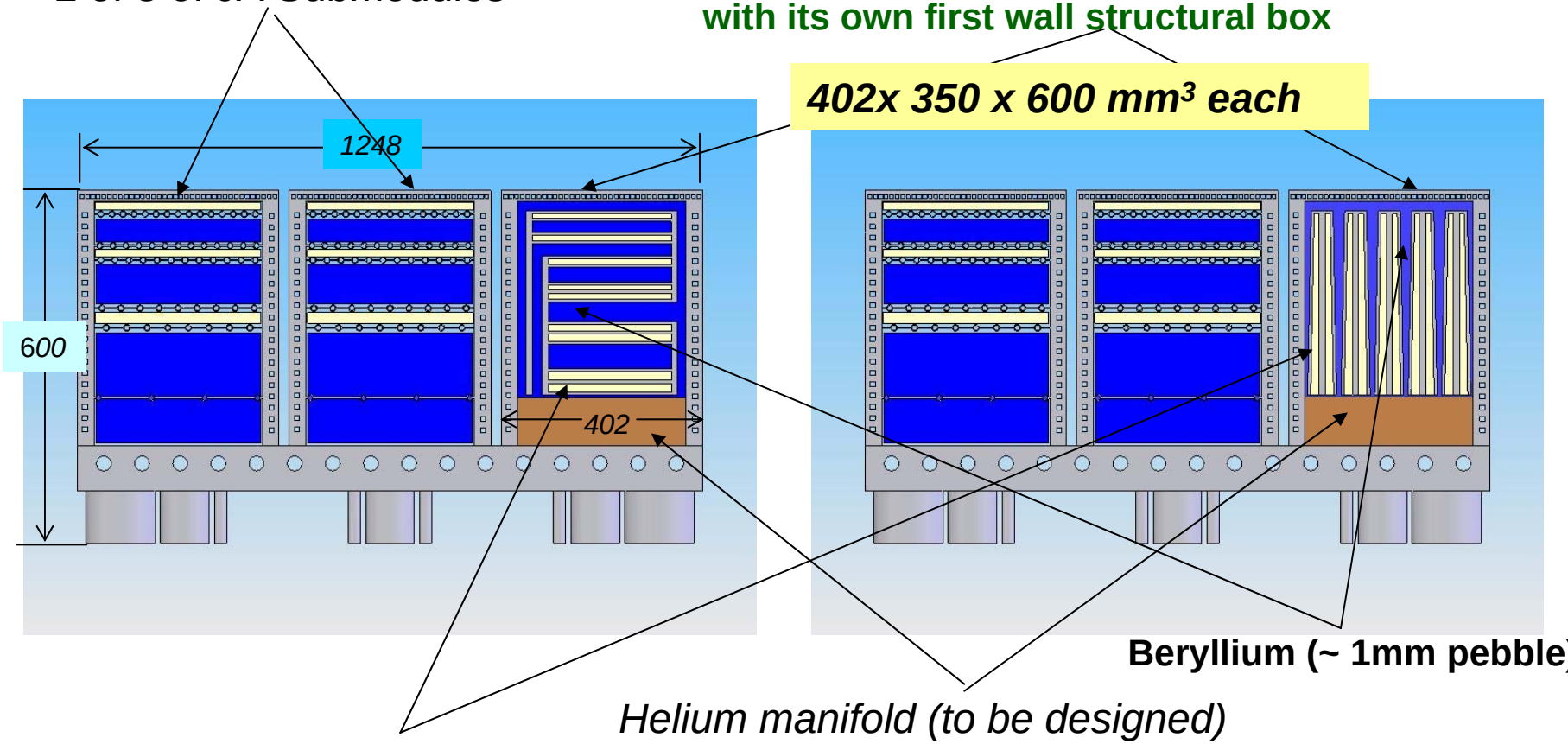
This submodule approach shares the test space with Japan, which features designing the US blanket configurations into one of the three Japan's submodules

WBS 1.8.2.1.3

An example submodule design combines layer and edge-on configurations in one physical unit with its own first wall structural box

2 of 3 of JA Submodules

402x 350 x 600 mm³ each

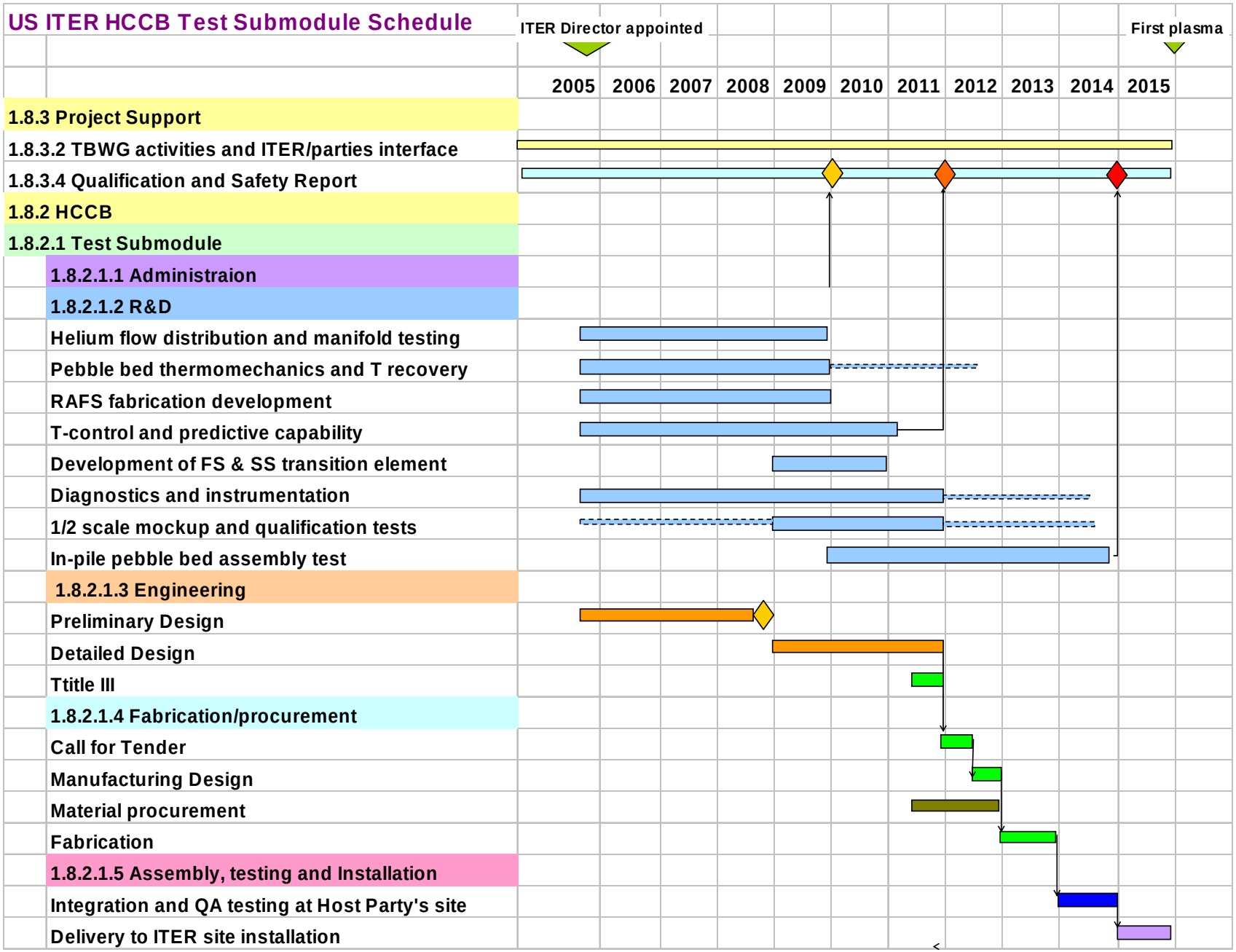


Beryllium (~ 1mm pebble)

Helium manifold (to be designed)

Ceramic breeder:
Li_4SiO_4- 40% ^6Li enriched (single size ~0.4 mm)
Li_2TiO_3- 70% ^6Li enriched (single size ~ 0.6 – 0.8 mm)

US ITER HCCB Test Submodule Schedule



WBS 1.8.2.1.3.1 (2006-2008)
Title I: Preliminary Design (an EM test submodule design that embodies the general geometrical configuration of the HCCB ITER test submodules)

- The objective of this WBS is to develop a test submodule design representing the helium-cooled ceramic breeder blanket concepts that satisfies a matrix of technical specifications and has a high possibility ready to proceed to detailed design development. The % complete is about 30-35% of the total design effort.
- The preliminary design will be developed from the existing conceptual designs and engage the following activities:

1. Develop HCCB “project” definition. (2006-2007)
   - Define the top-level functional needs;
   - Develop a list of approaches for each functional needs;
   - Define performance metrics for the design;
   - Define the design parameters that most directly determine the design (e.g. material selection, structural configuration),
   - Establish the driving design considerations (technical specifications, qualifications, etc.),
   - Perform parametric analyses that quantify the performance metrics for a given design,
   - Develop Draft “Bilateral/multi-lateral International Collaborative Agreements”
2. Finalize Design-To Specifications (2007)
3. Assess Design Issues and Risks (2008)
4. Finalize Project Management Plan and Conduct the Preliminary Design Review (July, 2008)

	WBS: 1.8.2.1.3.1 Title I: Preliminary Design		2005	2006	2007	2008
Item #	Activity ID					
1	1	Project Definition				
		Define functional Needs				
		Define Performance Matrices				
		Define Design Parameters				
2	2	Establish Driving Design Considerations				
3	3	Perform Parametric Analyses				
	3.1	Perform neutronics analysis to identify a technically meaningful test submodule configuration				
	3.2	Perform design analysis for structural mechanics and electromagnetics				
	3.3	Identify reference test submodule design				
4	4	Develop International Collaborative Agreements				
5	5	Finalize Design to Specifications				
6	6	Assess Design Issues and Risks				
7	7	Finalize Project Management Plan (including final international collaborative agreements)				
8	8	Preliminary Design Review				

Overlapping in schedule implies that an iteration process is taking place

WBS 1.8.2.1.3.2 (2009-2011) Title II: Detailed Design (specifically for EM test submodule)

- The scope of this WBS is the detail engineering and design of the reference test submodule concept and its supporting subsystems that developed within the preliminary design phase. It includes validation tests of a ½ scale mockup to confirm that the design is proceeding with the right choice. The detailed design package includes technical specifications and requirements, fabrication drawings and procedures, material specifications, quality assurance requirements, testing specifications and requirements, and instrument schematics and wiring diagrams. The technical specification document (TSD) should cover the general requirements and technical requirements, and will include at least (i) contract stages and schedule, (ii) responsibilities, (iii) QA basic requirements, (iv) applicable codes and standards, (v) acceptance criteria, and (vi) detailed technical specifications and requirements unique to TBMs, such as materials, design, fabrication (including welding), examination and testing, maintenance and inspection, and packaging and transportation. Note that specific requirements such as tolerances, surface roughness and outgas rate should be also included in the technical requirements.

	WBS: 1.8.2.1.3.2 Title II: Detailed Design		2009	2010	2011
Item #	Activity ID	Description			
1	1	Resolve Design Issues and Risks			
2	2	Complete Design and Design Analysis			
3	3	Develop Technical Specification Documents			
4	4	Establish Qualification Criteria and Non-Destructive Testing Methods			
5	5	Establish Material Specifications			
6	6	Develop Fabrication Drawings			
7	7	Develop Instrumentation Specifics and Wiring Diagram			
8	8	Develop Contract Agreement and Detailed Design Review			