Poster # P59A

Fabrication and Test of KO Preliminary Semi-Prototype for ITER First Wall Qualification

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Introduction

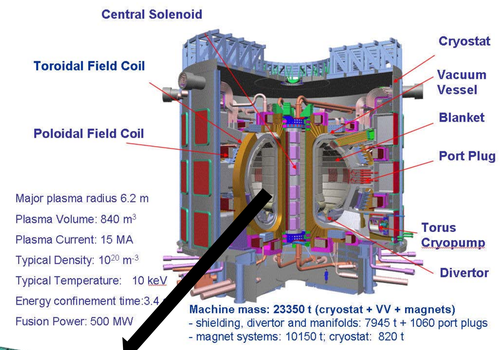
Backgrounds

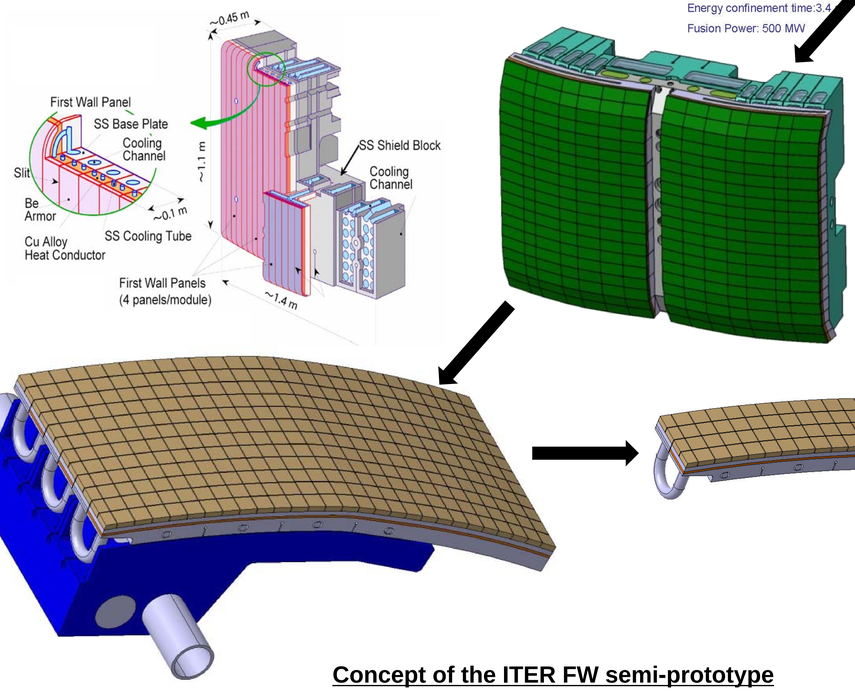
- ITER Blanket First Wall (FW) includes the Beryllium amour tiles joined to CuCrZr heat sink with stainless steel cooling tubes.
- Prequalification program needs to be performed with the goal to qualify the joining technologies required for the ITER FW.
- Based on the results of tests, the acceptance of the developed joining technologies will be established.
- The results of this qualification test will affect the final selection of the manufacturers for the ITER First Wall and the sharing between Parties.

Design for ITER FW Semi-prototype

ITER Blanket FW

- Developing of the HIP bonding, fabrication methods, and high heat flux test
- To qualify the joining technologies required for the ITER blanket first wall
- Manufacturing the first wall qualification mockups for ITER 1st qualification test (2009)
- Semi-prototype qualification test due to 2012



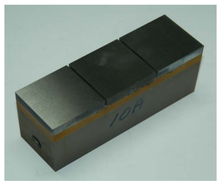


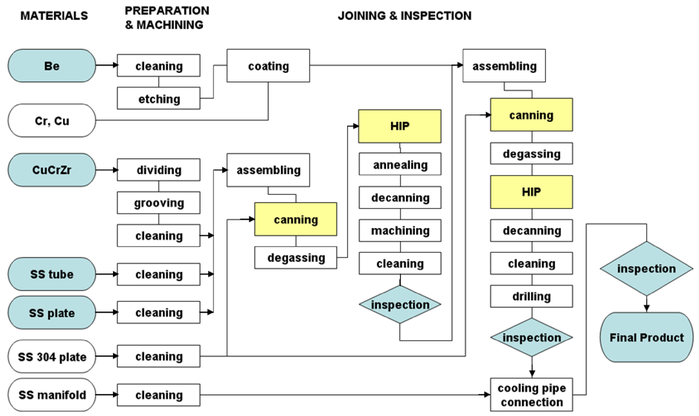
Concept of the ITER FW semi-prototype

Fabrication of Mockups and High Heat Flux Test Facilities

Mockup fabrication

A. CuCrZr joined to Stainless Steel (SS316) with HIP (1050 °C, 100 MPa, 2 hours)
B. Interlayers (1*Ti* / *0.5Cr* / *5Cu* [μm]) were coated with Be tiles
C. Coated Be tiles and CuCrZr/SS were joined by HIP (580 °C, 100 MPa, 2 hours)

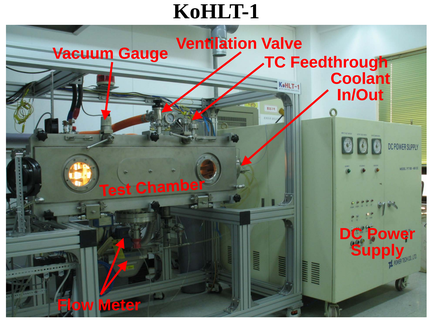




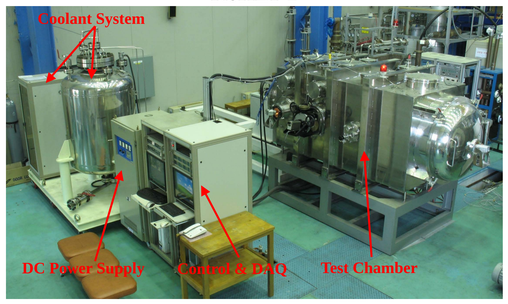
Test facility (KoHLT; Korea Heat Load Test facilities)

- Installed for the verification of the joining technology of the ITER blanket FW
- Radiation heating by graphite heater
- E-beam facility under construction

KoHLT-1

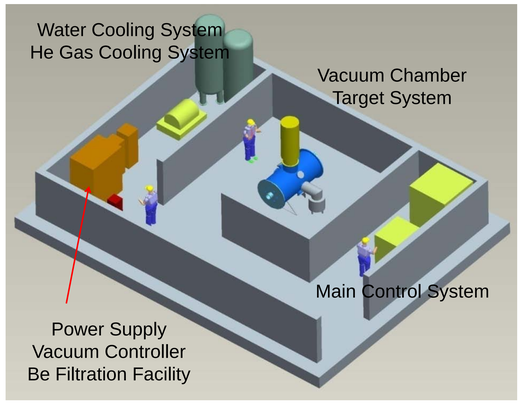


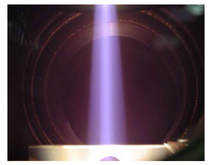
KoHLT-2



Facility	KoHLT-1 (Korea Heat Load Test Facility-1)	KoHLT-2 (Korea Heat Load Test Facility-2)	Electron Beam HHFT Facility
Major Target	PFCs	Large PFC	PFCs development inc. ITER blanket FW
Heat Flux (Target Area)	1.5 MW/m^2 (80×80 mm^2)	0.46 MW/m^2 (700×100 mm^2)	5 MW/m^2 (300×200 mm^2) MAX 10 GW/m^2
Heat Source	Graphite Panel (0.25 Ω)	Graphite Panel (~0.3 Ω)	Electron Beam (MAX 60 keV)
Power Supply	40 kW (DC 100V, 400 A)	80 kW (DC 200V, 400 A)	300 kW (DC 60 kV)
Test Chamber	Box-type chamber (0.3×0.3×1.2 m^3)	Box-type chamber (1.2×1.2×2.4 m^3)	Cylindrical chamber (Φ1.2m×D2m)
Filling Gas	He	He	Vacuum
Cooling Water	300 K, 0.1 MPa, 1 m/sec	~373 K, 3 MPa	300-373 K, 10 MPa
Beryllium Compatible	Yes	No	Yes

High heat flux test facility with E-gun system





E-gun system (under construction) from Von Ardenne

Electron beam facility for high heat flux tests (under construction, 2011~2012)

- Power : max. 300 kW, acc. voltage max 60 kV
- Beam scanning area : max. 70 x 50 cm^2 (about 4.7 MW/m^2 @30×20 cm^2)
- Super deflection system (Beam guidance system) : max. 10 kHz
- Continuous and pulsed operation
- Cyclic heat flux test
- PFCs development inc. ITER TBM FW
- EU FZJ (JUDITH-2 200 kW), US SNL (EB1200), RF Efremov (IDTF 800 kW), India (under construction)

Non-Destructive Test

UT examination (Ultrasonic Test)

(1) Probe (Panametrics)

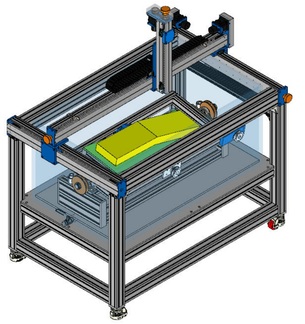
- Freq. : 10 MHz, Probe Diameter : 0.25 inch, Probe type : Flat (Non-focused), Water Distance : 20 μs

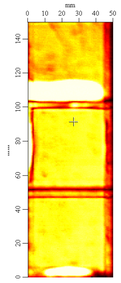
(2) UT instrument (Panametrics 5800)

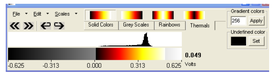
- PRF=160Hz, Sensitivity Gain = 74 dB, LF=20MHz, HF=1MHz, Energy=50uJ, Damping=50 ohm

(3) DAS settings

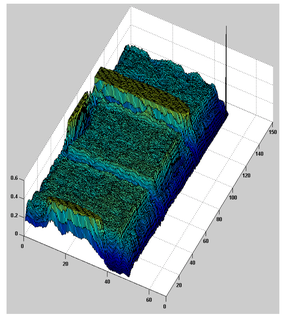
- Scan Parameters : Res. 0.5mm, Speed 15 mm/s, 80 x 80 mm, Gate 1 & 2 : TOF1, TOF2, Amp, WF
- Sampling Rate=100 MHz, Average =4

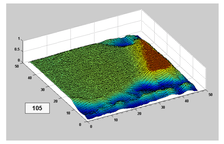


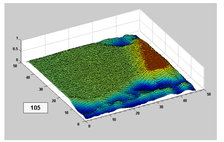




C-scan Image







3D image

Preliminary Analysis

Preliminary analysis with ANSYS-CFX

(1) 50 mm x 300 mm (12 Be tiles) mockup

- 25 mm x 25 mm, 12 Be tiles
- Temperature evolution at each mock-up

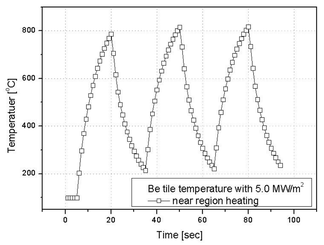
⇒ no temp. increase according to the accumulated cycles

- 1.5 MW/m^2 heat flux with outlet region heating
- Be surface temp. reaches to 548 ºC at heating phase

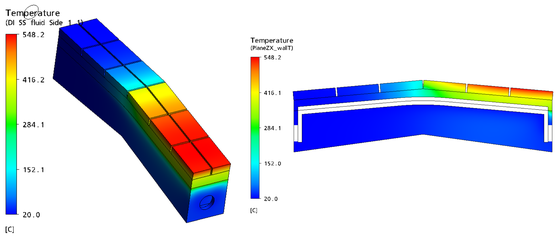
(2) 80 mm x 80 mm Slit mockup

-Case: single finger, transient 15s ON/15s OFF

- 5.0 MW/m^2
- Far region heating with 3 Be-tiles column
- T distribution at 20, 50, 80 sec
- T evolution for 95 sec

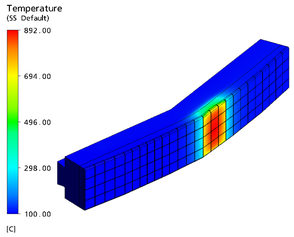


HHF test conditions



Overall temperature

Temperature distribution at center plane



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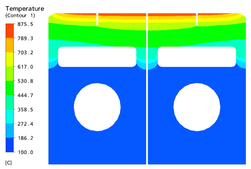
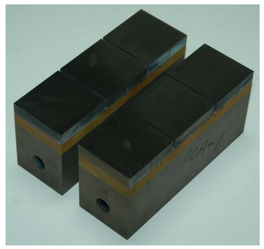


Temperature distribution at center plane

Fabrication of preliminary semi-prototype



Fabrication of small scale mockups

- Objective: Setting up key manufacturing technologies
- Applied technologies: HIP of multiple tiles, HIP of complex parts, slitting, grooving, EB welding
- Two times of HIP and EB welding was performed for the fabrication
- High joining strength of Be/CuCrZr was obtained as 115 MPa in the shear test
- The fabricated small SP mockups will be HHFT tested

Fabrication of preliminary SP (on going)

- Manufacturing of CuCrZr/SS part was completed
- Cover plates for the HIP pressure boundary will be machined and EB welded in this year
- Bending of SS and HIP joining of Be, CuCrZr/SS with SS are planned in this year