



First Wall and Shield Generic Design

First Wall Quality Mockup Testing

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VLT Call**



Sandia is a multiprogram laboratory operated by Sandia Corporation, a Lockheed Martin Company,
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Brief introductory comments

The ITER FW/Shield design is evolving.

- Mike Hechler and Mike Ulrickson are doing a great job.
- The IO appreciates the responsive US team and quality of work.

Example: acceptance of US (new) approach to EM analyses

ITER management is evolving.

- The Council is engaged; STAC & MAC are formed.

The US post-Omnibus budget is evolving.

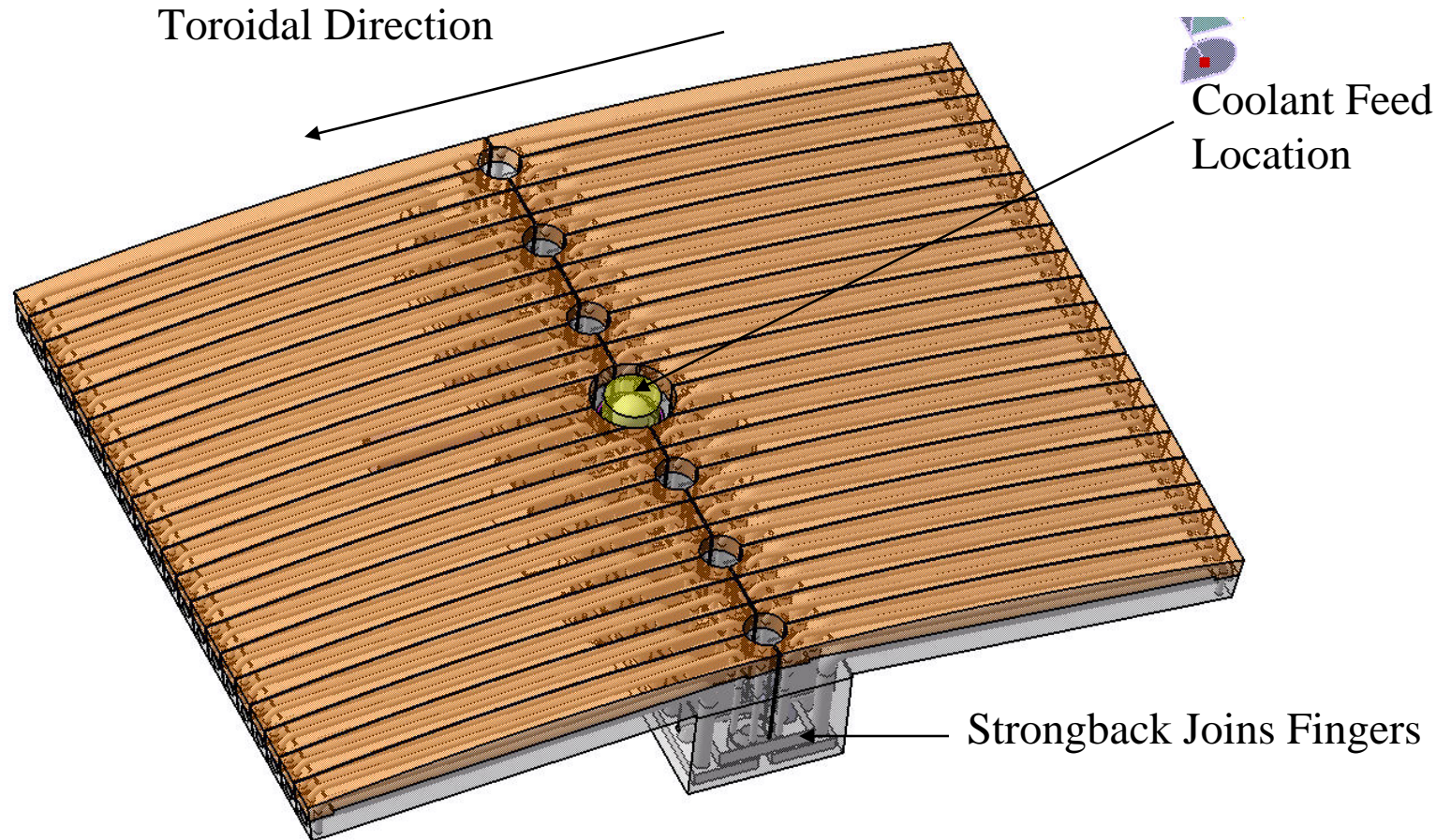
- The DOE and IO are developing budget cases.
- For US FW/Shield, fabrication and testing of FWQ mockups are the highest priority, then design.



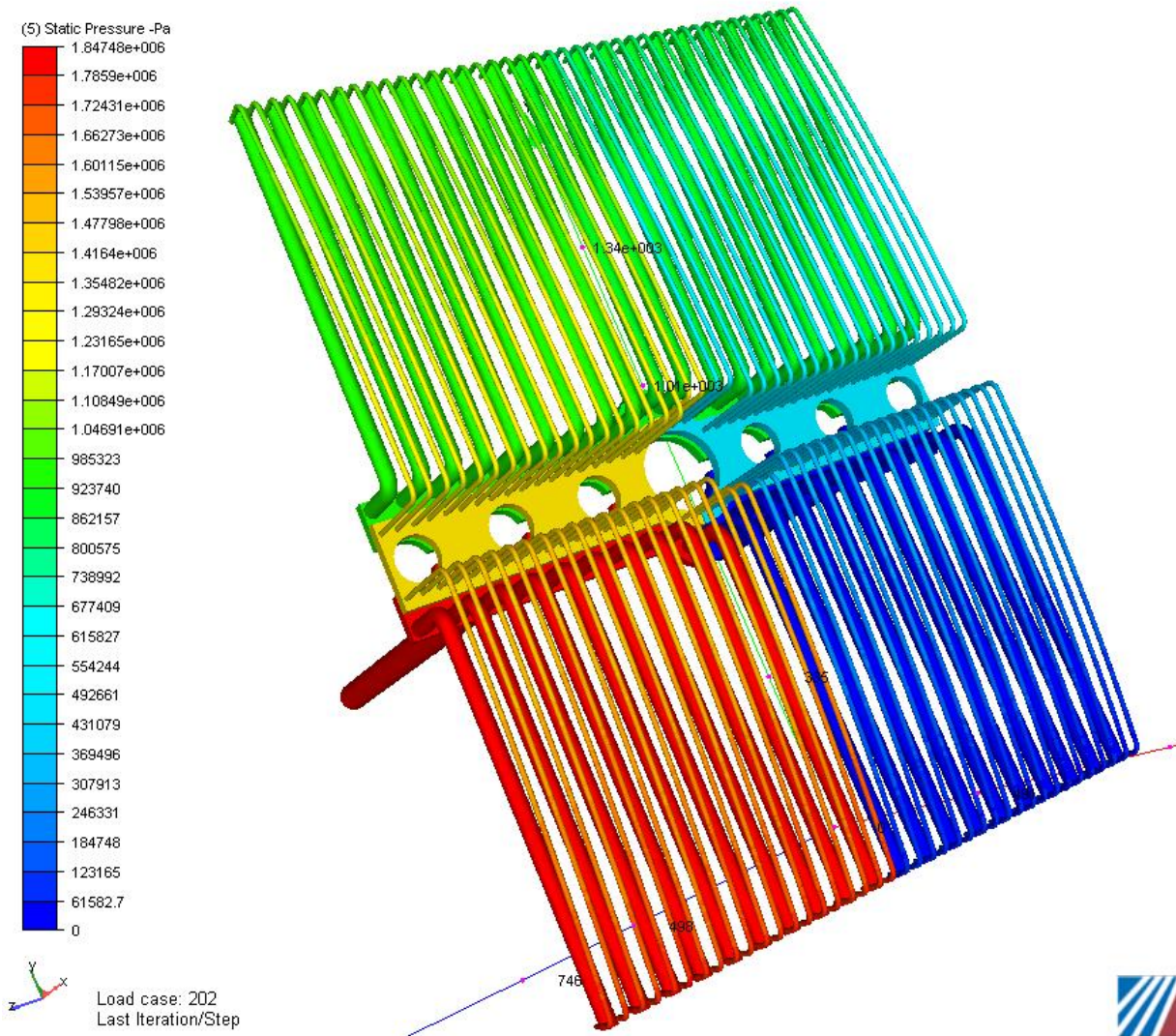
Outline

- **Main Features of the new design**
 - **Single first wall panel per shield module**
 - **First wall panel removable inside vessel**
 - **First wall fingers run in the toroidal direction**
 - **Simplified attachment of the first wall to the shield**
- **US contributions to the new design**
 - **Flow and Pressure drop analysis**
 - **Eddy current forces during a disruption**
 - **Shield module coolant passages (in progress)**
 - **Estimation of the toroidal resistance of Shield Modules (if connected for vertical stability)**
- **US Testing of First Wall Quality Mockups**

Single First Wall Panel



Coolant Flow and Pressure Drop





Electromagnetic Forces

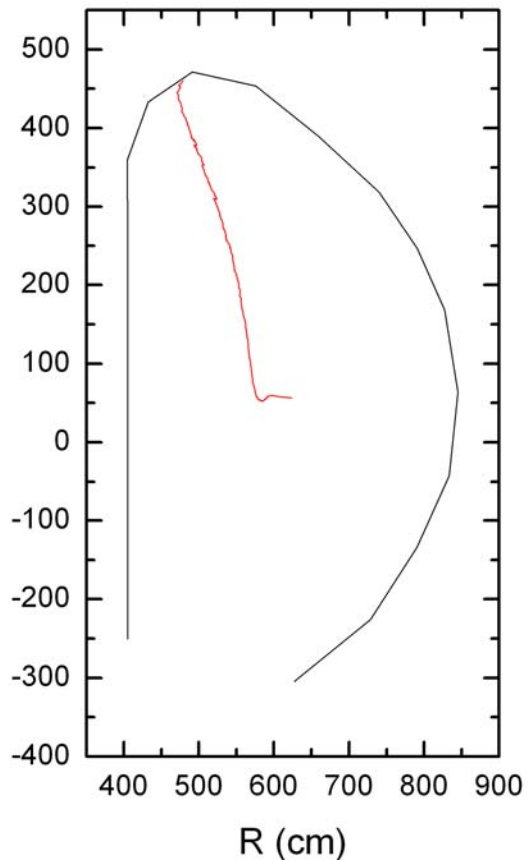
- **Disruption Case**

- Major disruption with 36 ms linear current decay
- Disruption stays near the midplane but moves into the upper inner corner near the end.
- Plasma moves in toward the inner wall early in the disruption.

- **Disruption data from DINA runs from IO**

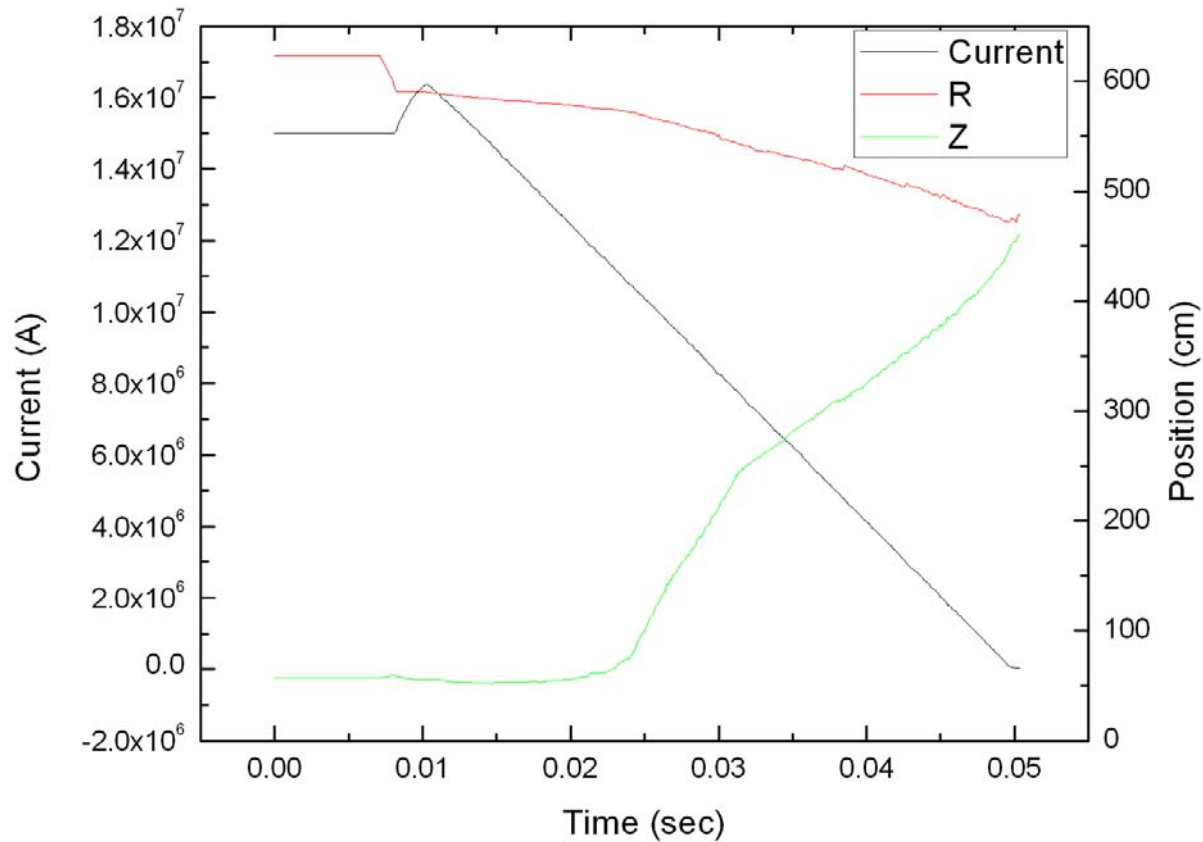
- **Baseline case had 4 FW panels per SM and fingers running in the poloidal direction.**

Evolution of a Major Disruption

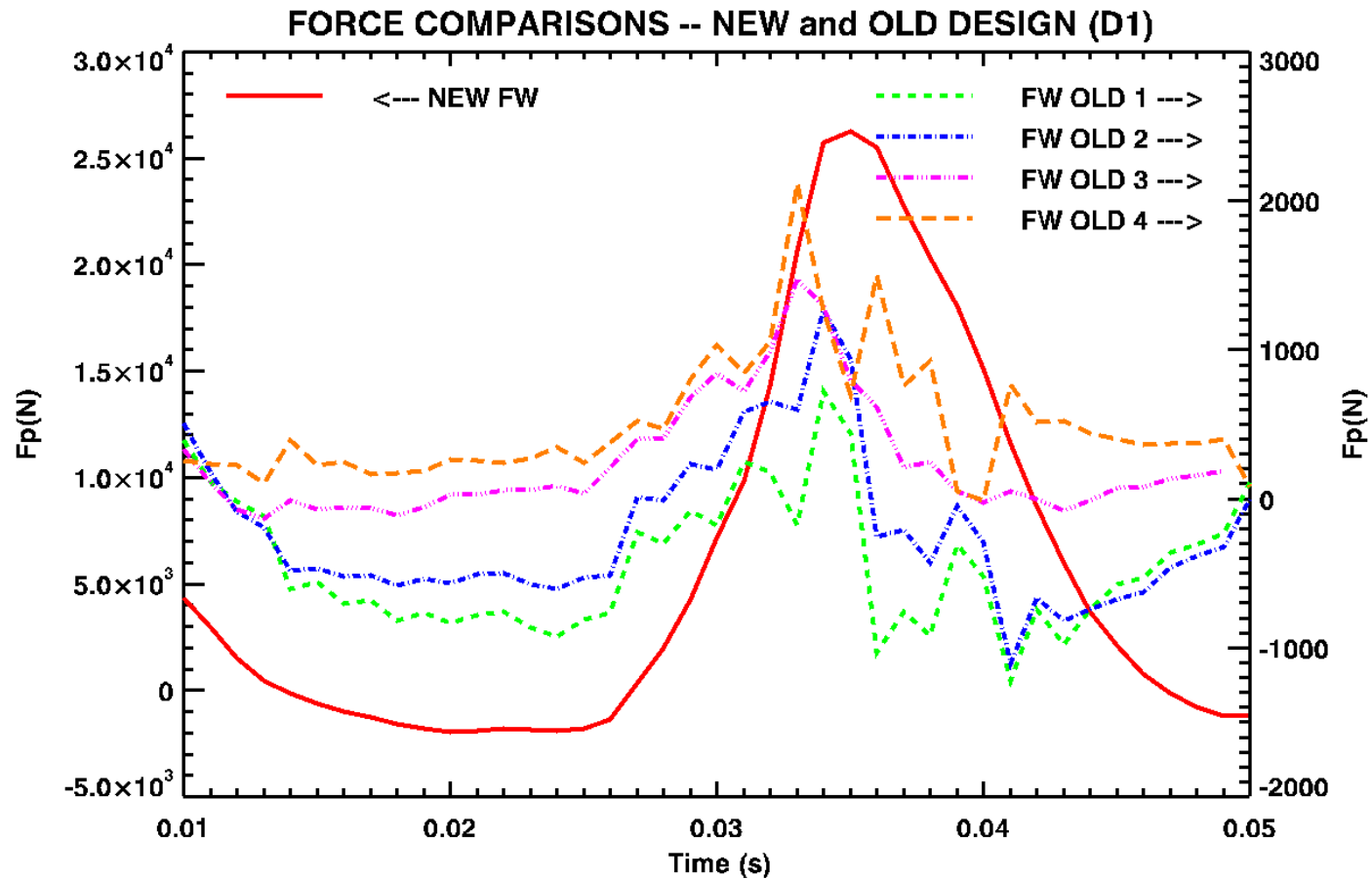


- Red curve shows the position of the centroid of the plasma current as the disruption progresses.
- The black curve is the surface of the First Wall.

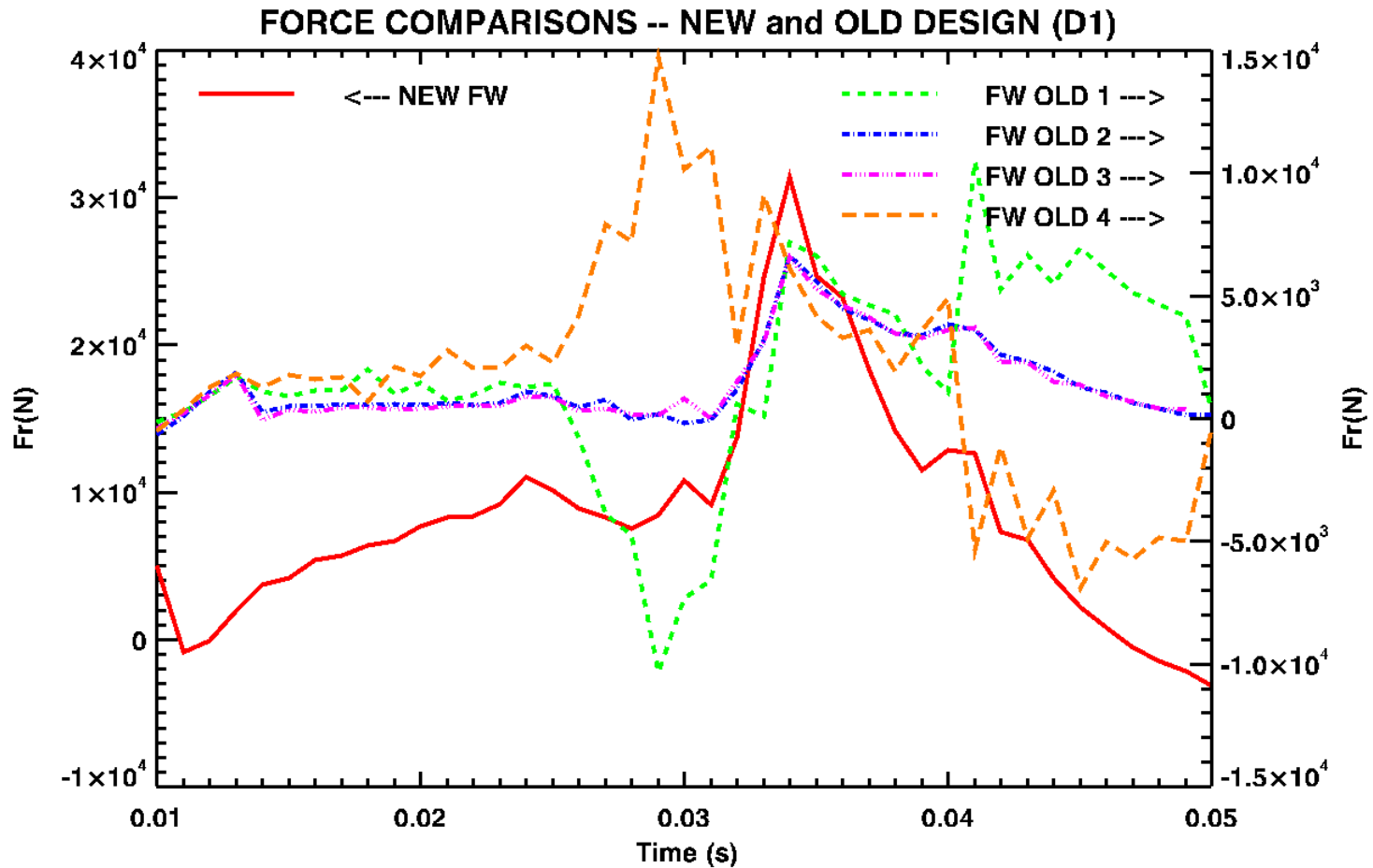
Current Decay and Plasma Position



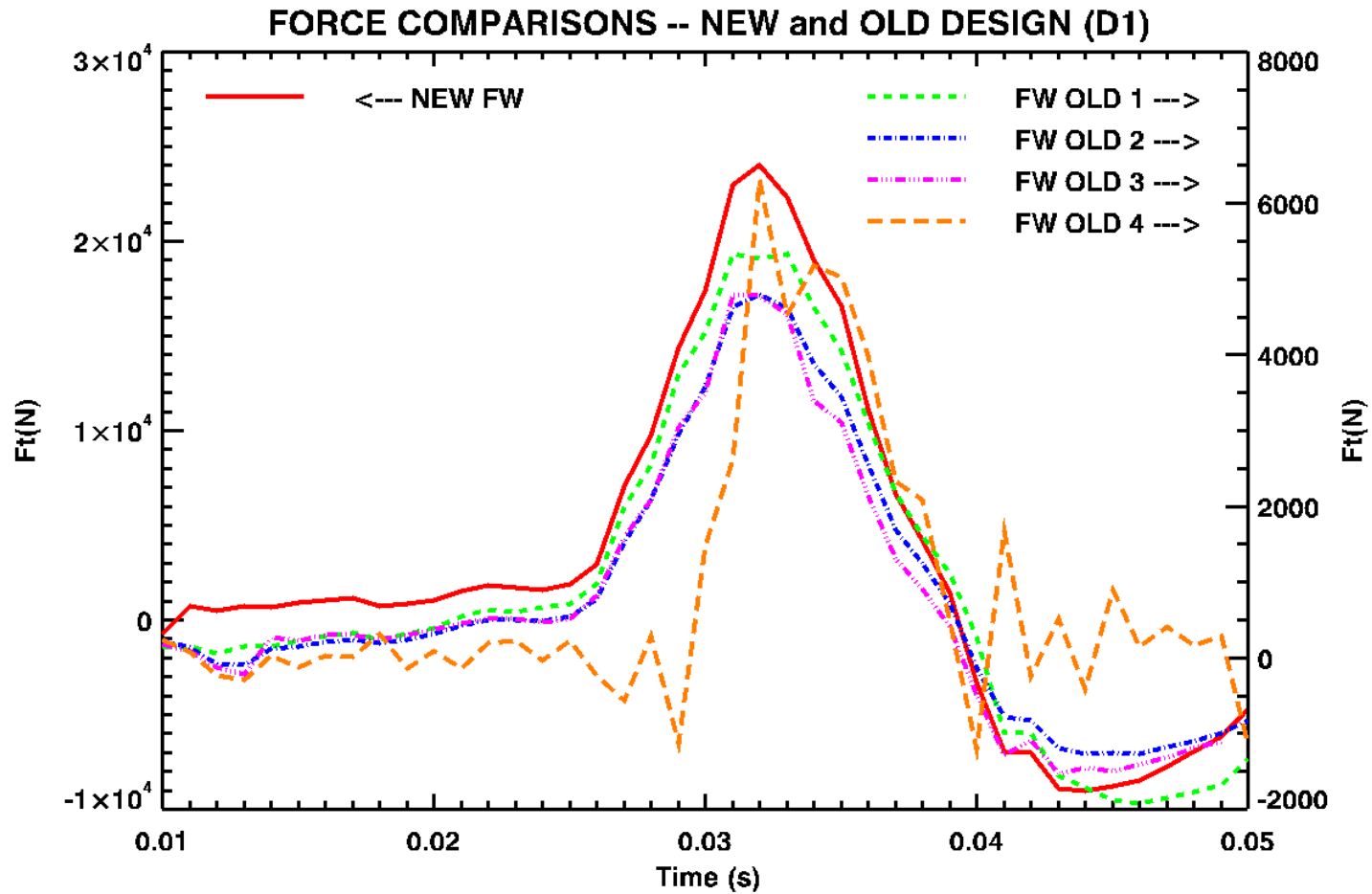
Poloidal Force



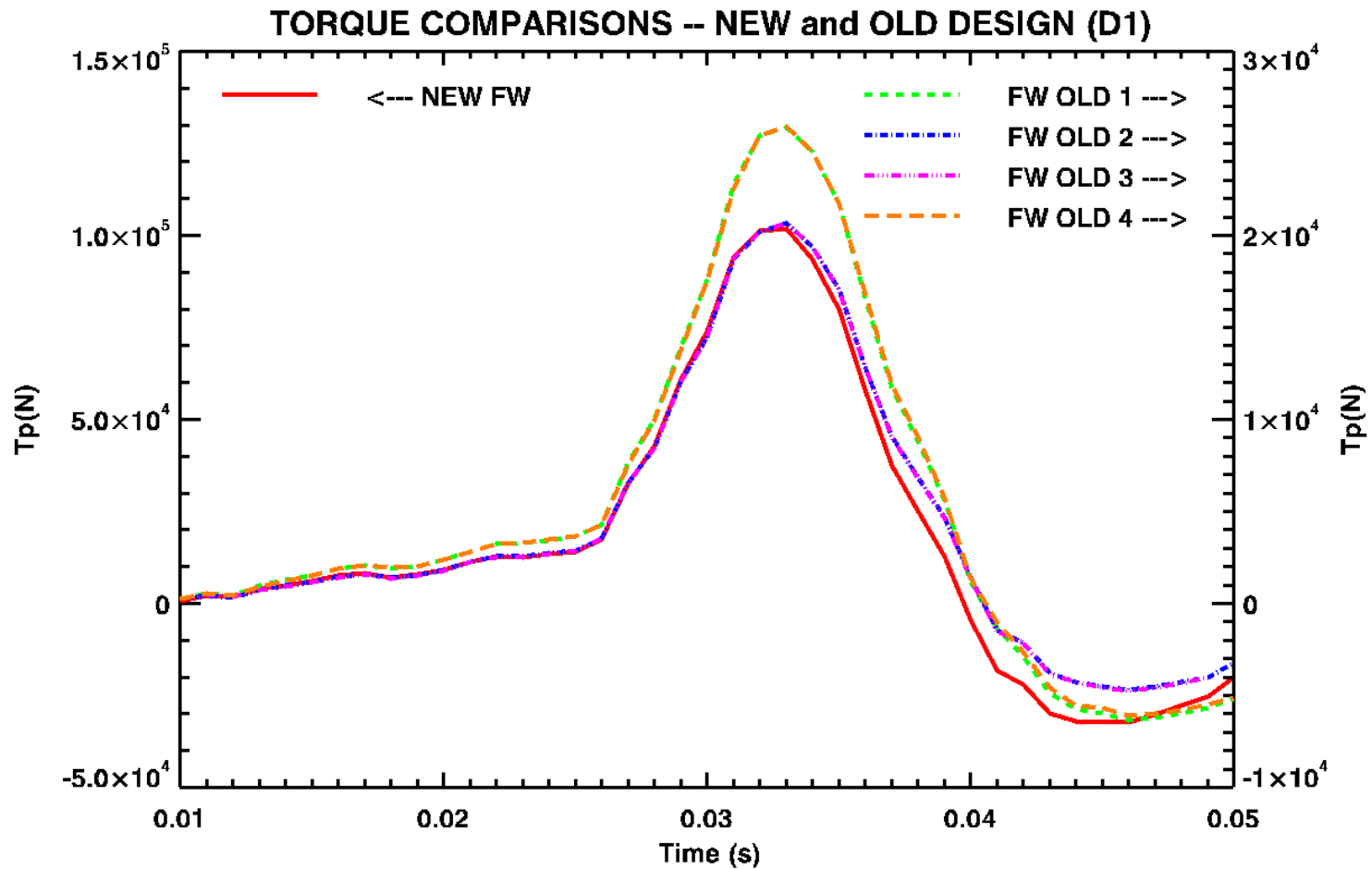
Radial Force



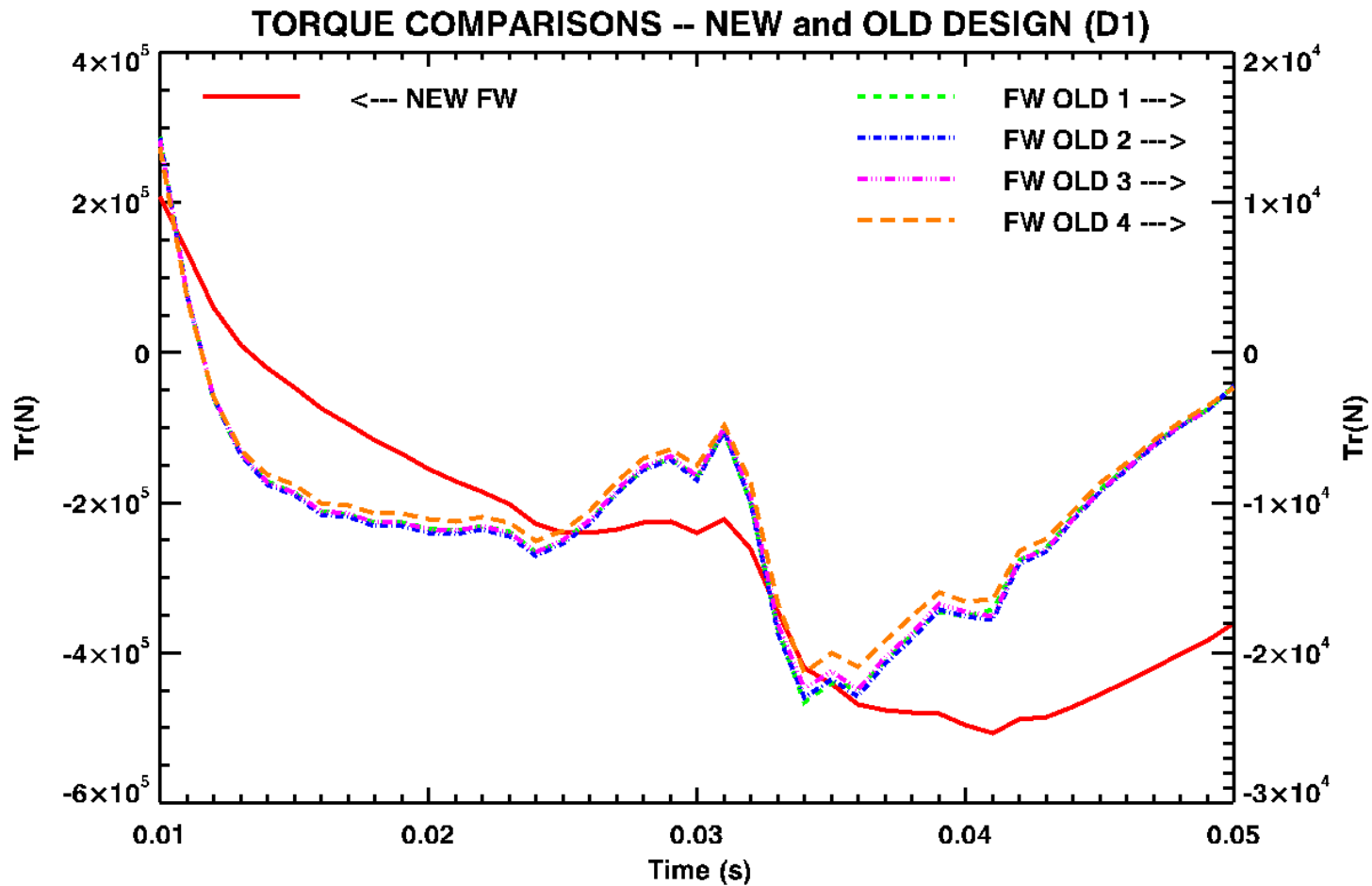
Toroidal Force



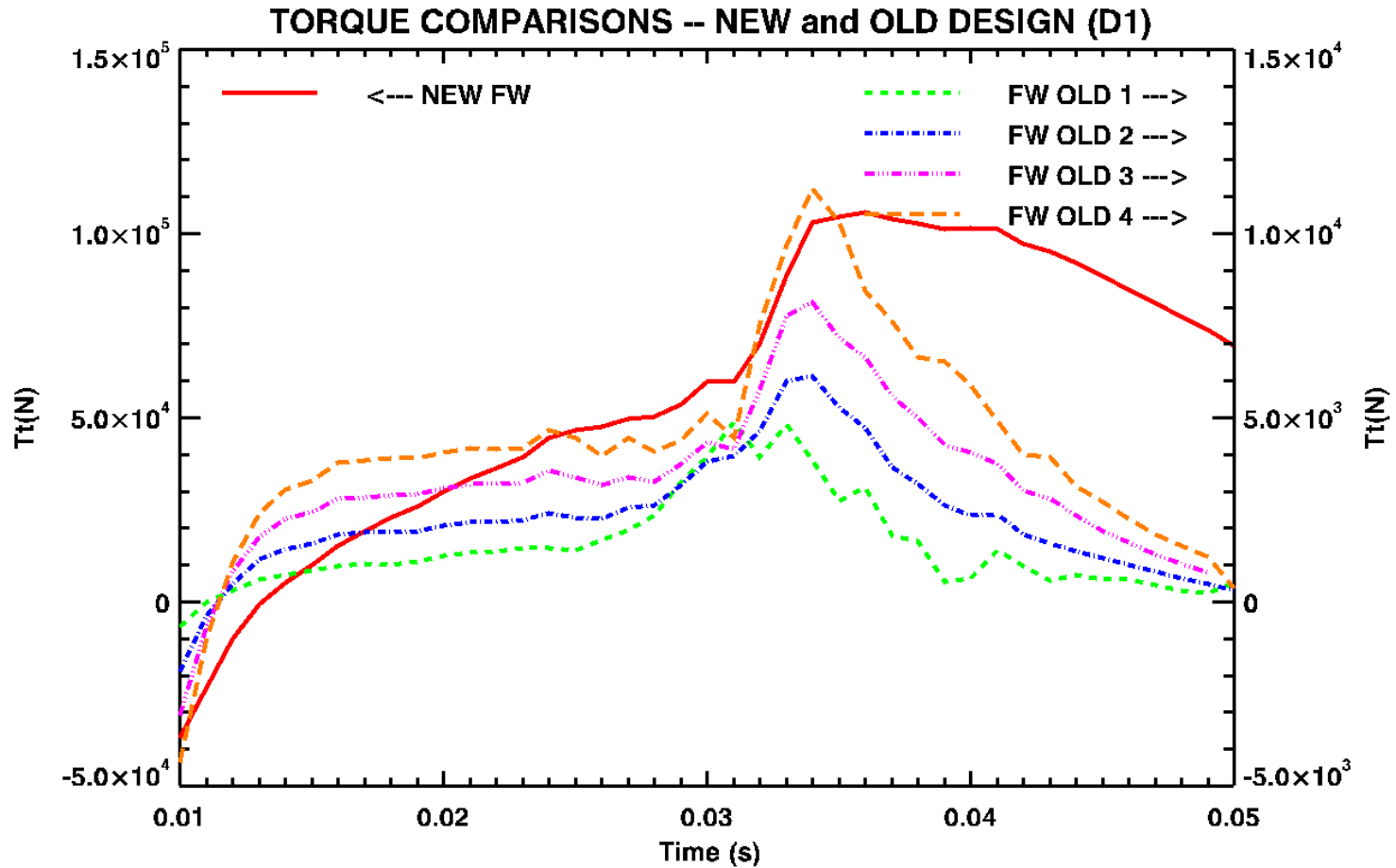
Poloidal Torque



Radial Torque



Toroidal Torque

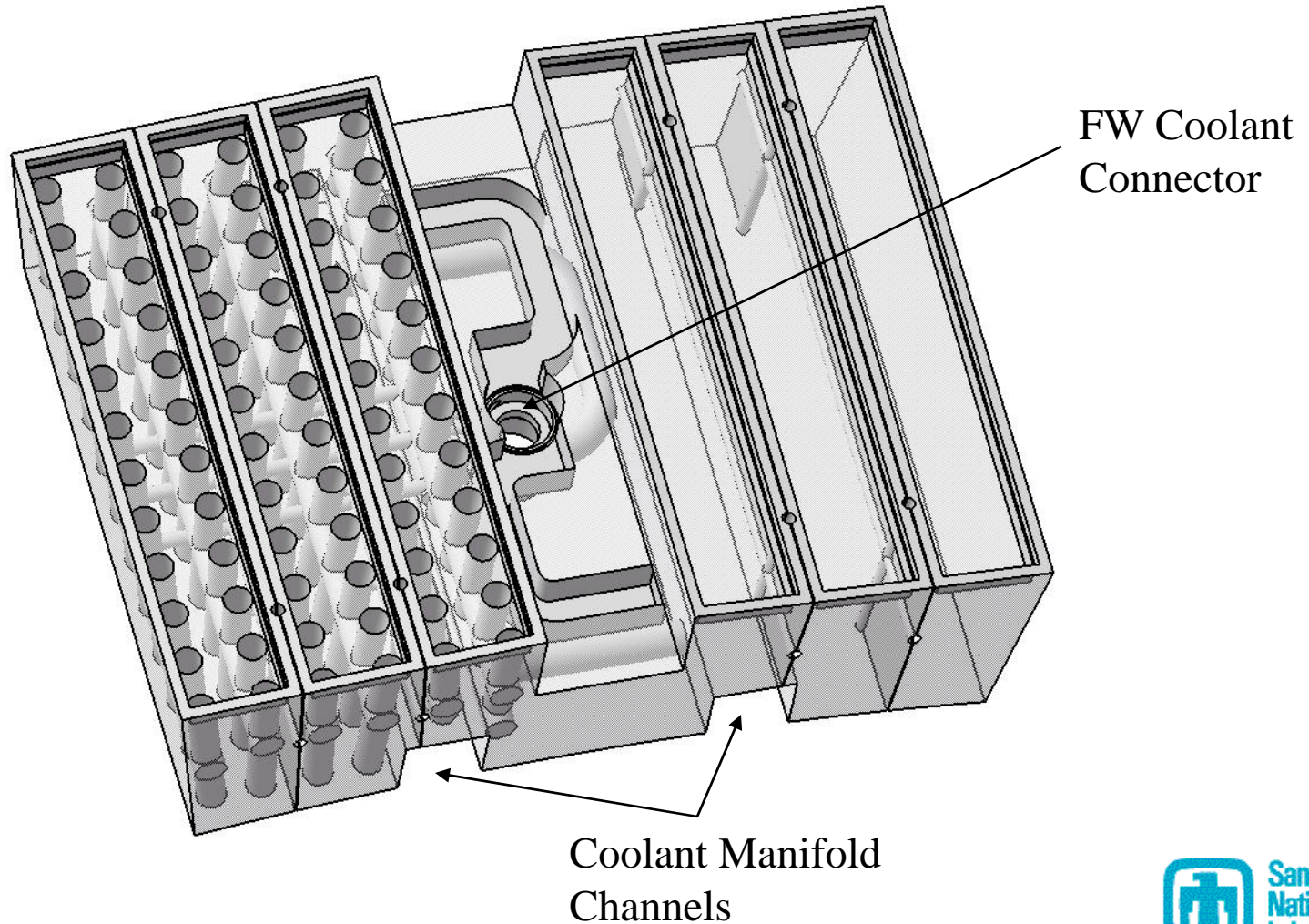




Summary of Disruption Forces on FW

- The net force increases by a factor of 5 to 25 with the greatest increase in the poloidal (vertical) direction. The maximum values are $2.5-3 \times 10^4$ N compared to $1-14 \times 10^3$ N in the baseline.
- The torque on the FW panel increases by a factor of 5 to 20 with the greatest increase in the torque about the radial direction and torque about the toroidal direction. The maximum torques are $1-5 \times 10^5$ Nm as compared to $2-2.5 \times 10^4$ Nm in the baseline 4 panels per shield module.
- However, the halo current forces are decreased.

Inner Wall Shield Block





Preparation for FWQM Testing

- **The US is fabricating two First Wall Quality Mockups**
- **Each ITER Party involved in FW/S fabrication will supply one mockup to the US and one to the EU for heat flux testing**
 - 10,000 cycles at 0.7 to 0.875 MW/m² steady state
 - 2,000 cycles at 1.4-1.7 MW/m² transient
- **The purpose of the testing is to qualify the joining of Be to Cu alloy heat sinks.**
- **Both mockups must not be damaged during the test.**



US FWQ Mockup Under Fabrication



FWQM Test Setup on EB-1200

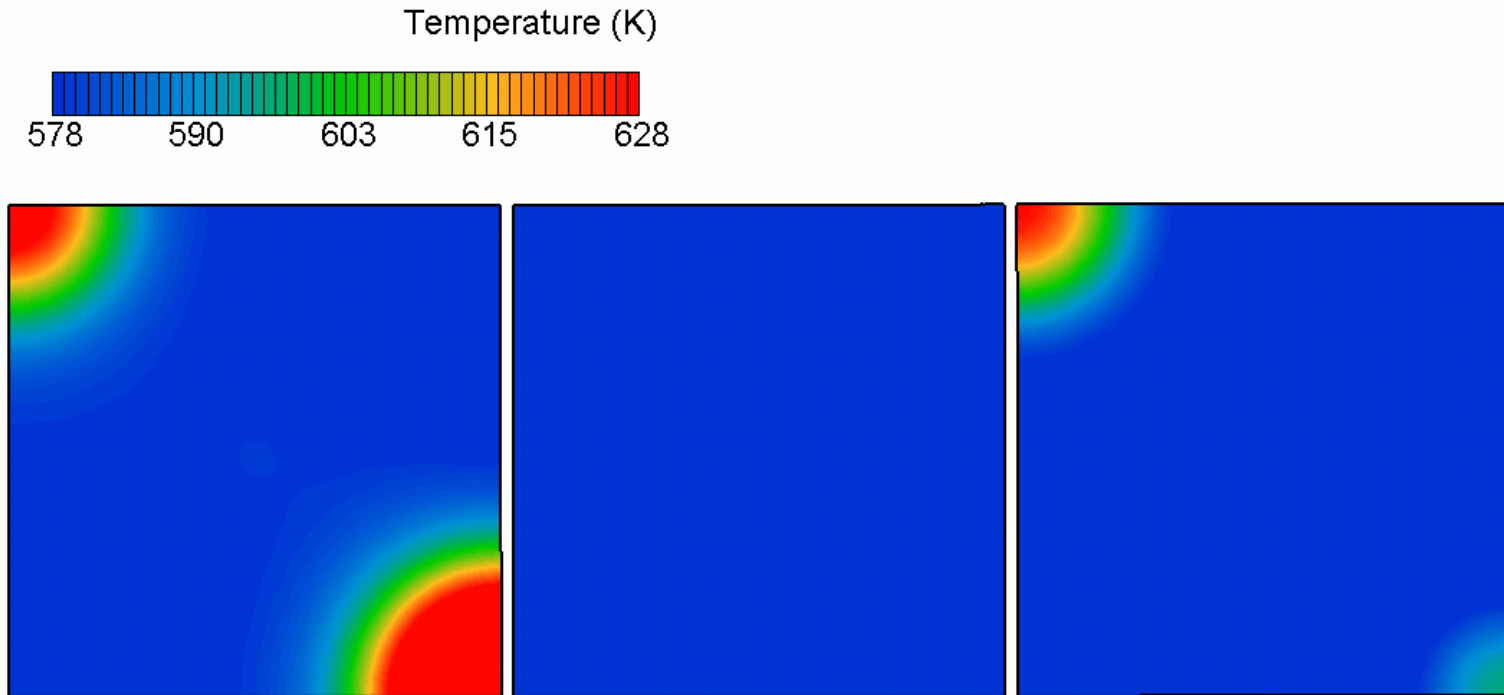




Modification of the EB-1200 for Testing

- **Our target area is being modified to hold 4 FWQM for simultaneous testing**
- **Two pairs of mockups will be heated in an A/B cycle with 48 sec on and 48 sec off and 0.875 MW/m² heat flux.**
- **12,000 cycles will require about 3.5 months of continuous operation (extended single shift)**
- **We will perform periodic emissivity calibration**
- **Increased surface temperature (~100C) will indicate de-bonding and failure**

Be-Cu Joint Flaw Size Study



- Flaws are easily detected from measuring the surface temperature of the tile
- E-beam heating allows the surface temperature to be measured (compared to radiant heating where the surface T is contaminated by stray signal).



Summary

- **The First Wall Shield design team is making significant contributions to the generic design of ITER components**
- **Preparation of First Wall Quality Mockups is on schedule for delivery of the initial mockup in February 2008.**
- **Modification of the EB-1200 facility for FWQM testing is on schedule for start of testing in early March 2008.**