Status of the Modular and Field-Period Replacement Maintenance

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ARIES Meeting

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Outline

- Update the conceptual design of protecting the welds between the coolant access pipe and manifold region for the modular maintenance
- Report the conceptual design of protecting the welds for the shield-only design module.
- Review the conceptual design of protecting the welds for the field-period maintenance.

Radial Build Updates for Modular Maintenance

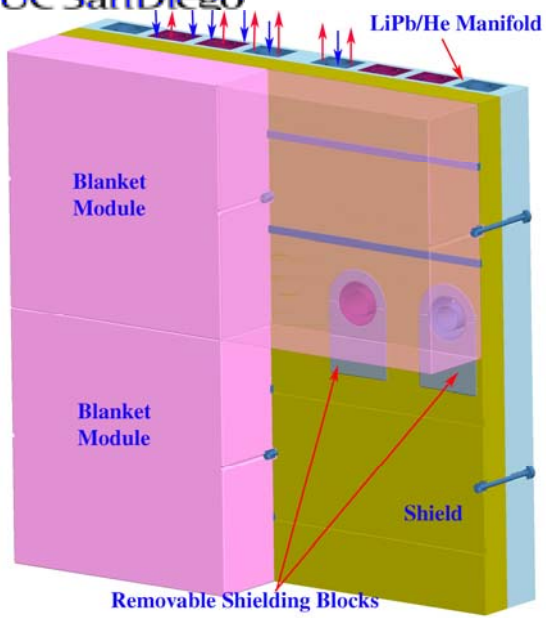
Nominal Blanket/Shield Zone:

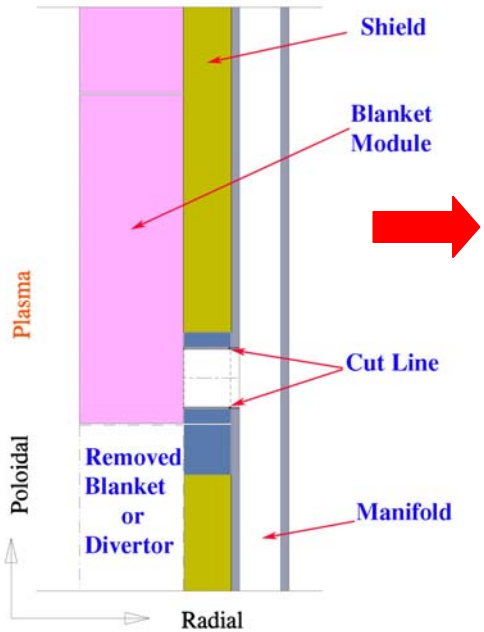
- Increase the thickness of the HT shield from 18 cm to 28 cm.

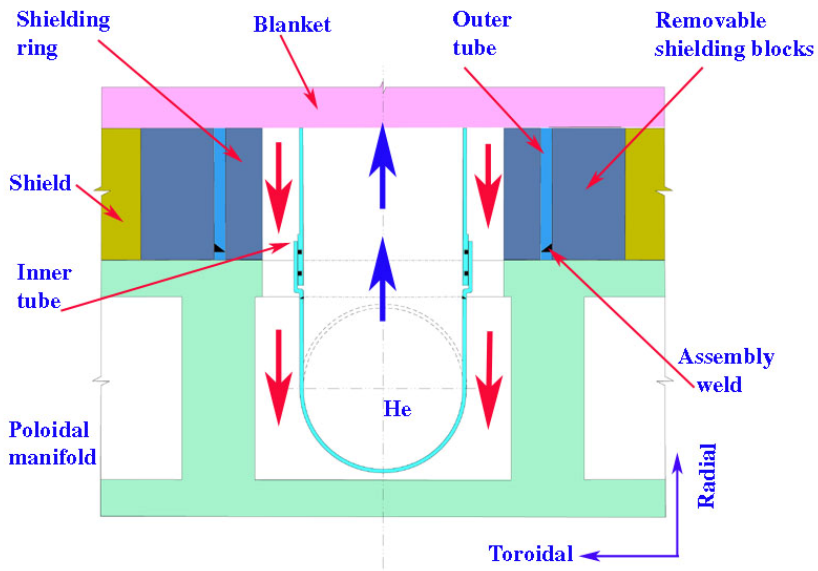
Shield-Only Zone:

- Add 15 cm He manifolds behind HT shield.

Possible Solution of the Protecting the Welds (Old Design:One Cut only)



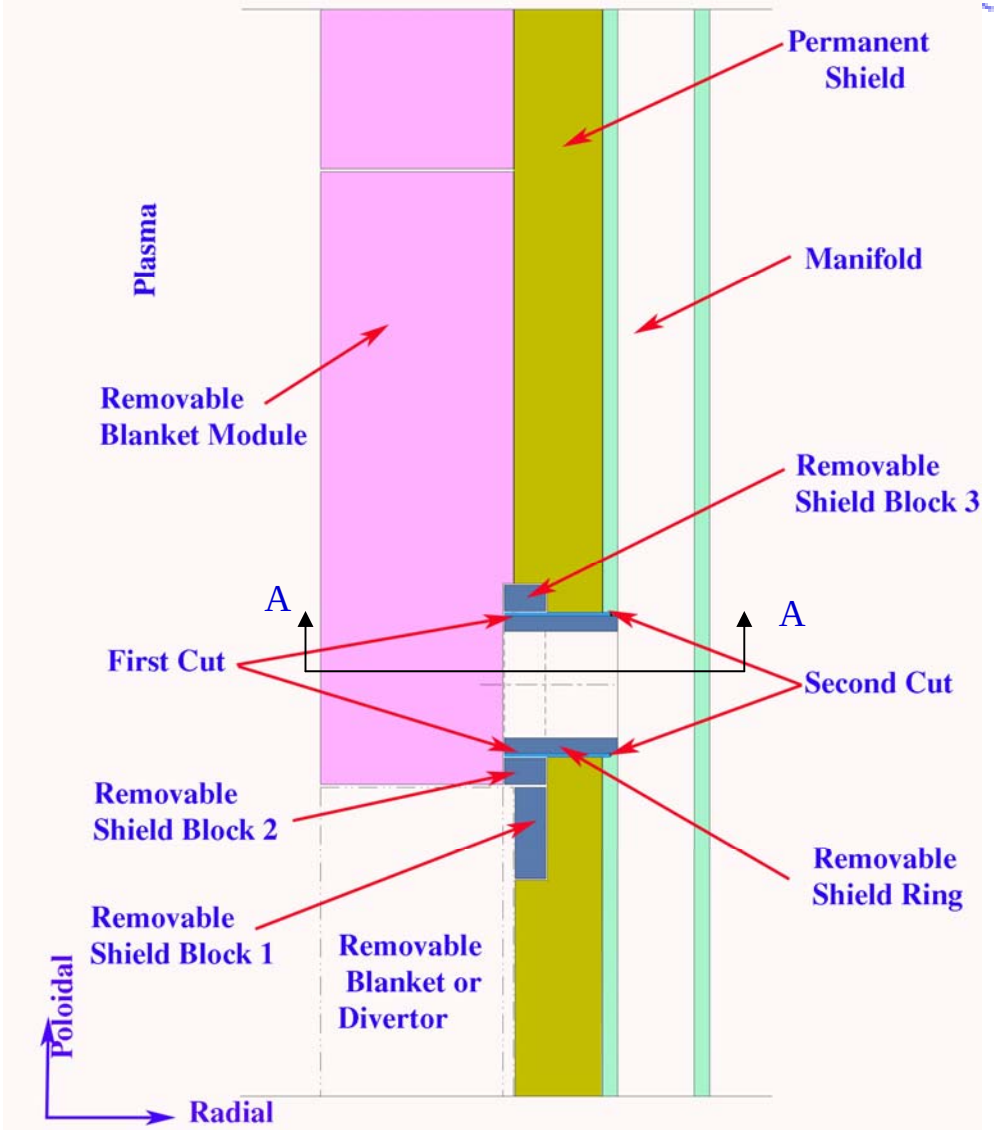




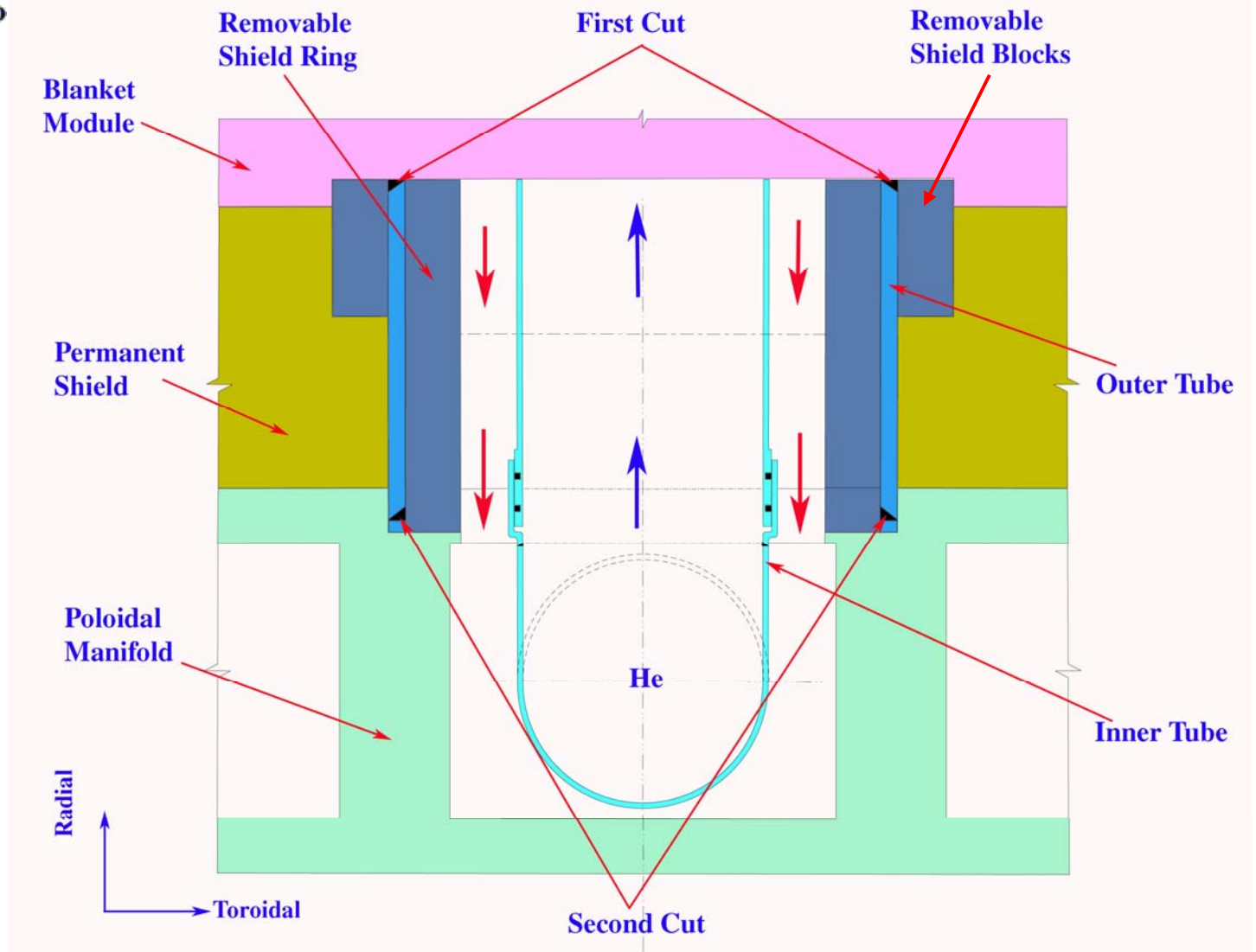
- The weld between the outer coolant access pipe and the manifold is protected by a shielding ring inside the tube in order to reduce the neutron flux at the weld location.
- This ring as well as the removable shielding blocks at the outside of the pipe can be made of steel, W, or WC with 100 % density without any cooling channels.
- Only one cut is needed to disconnect the blanket module and manifold.

Reference Solution of Protecting the Welds (Two Cuts)

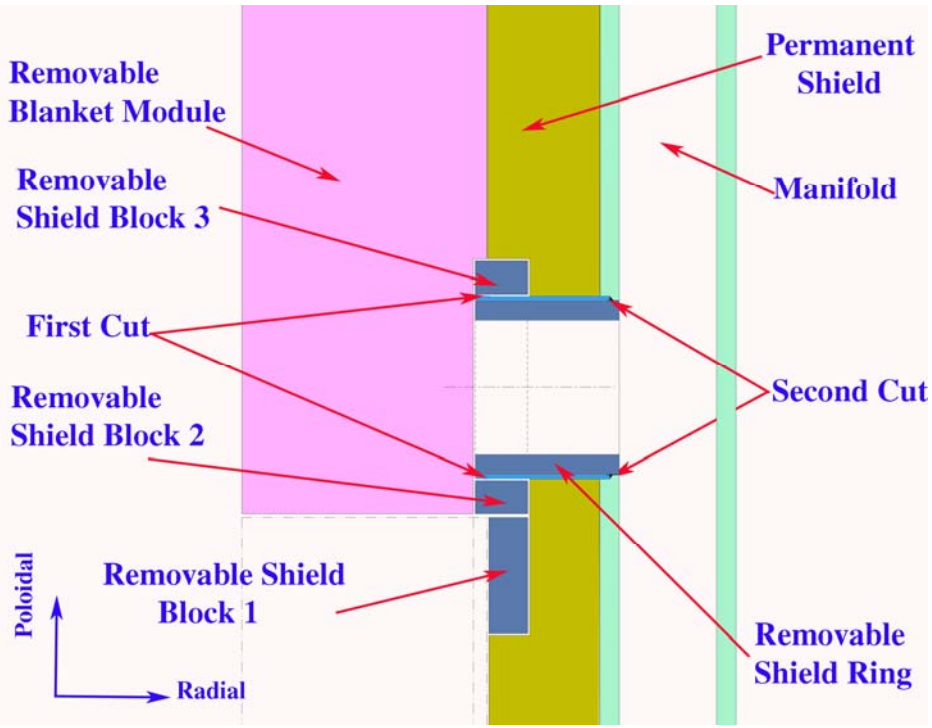
- First cut is close to breeding module with tools coming from outside;
- Second cut is ~4 cm deep inside the manifold region with in-bore tools;
- With the two cuts, the blanket module and a short piece of the access tube can be installed as new parts, and the second cut located in the manifold region is therefore re-weldable.

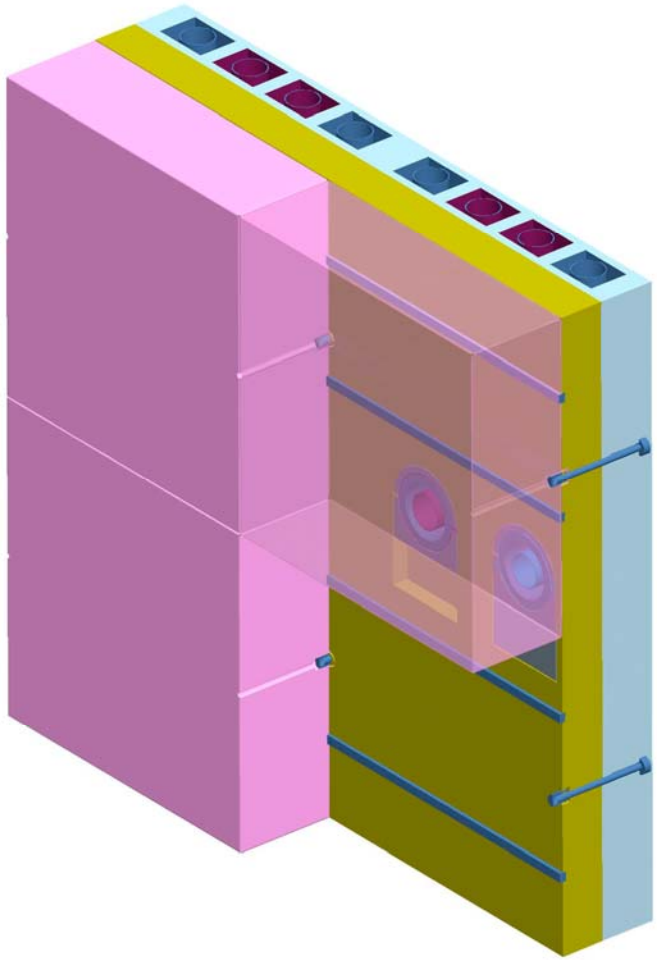


Cross-section AA Showing Details of the Protecting the Welds Between the Access Pipe Connecting to the Manifold



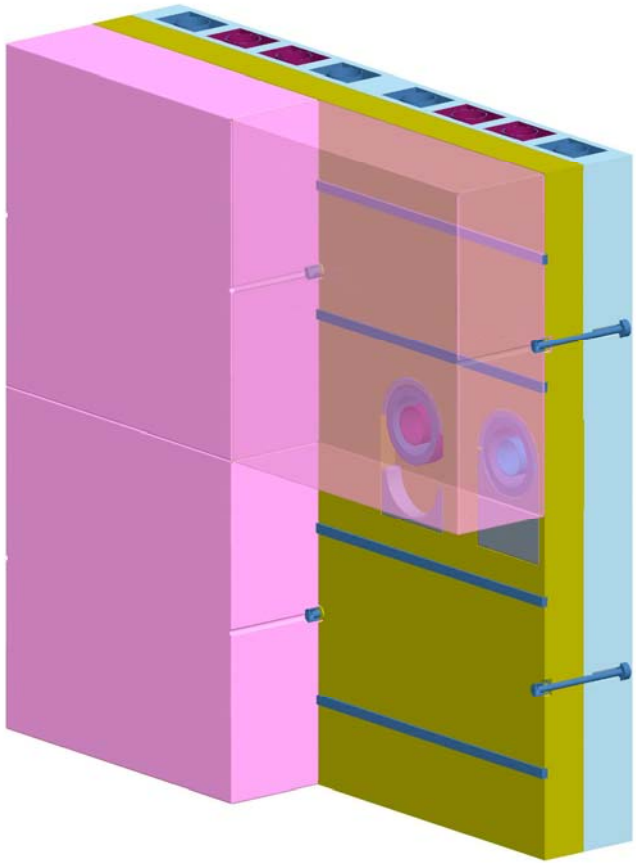
Steps to Cut the Coolant Connections from the Outside through the Open Window

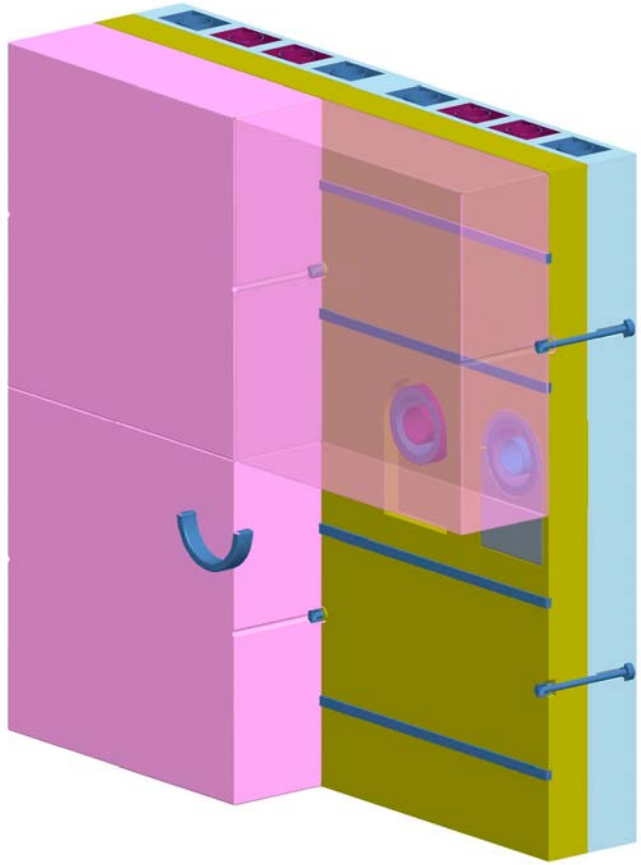




1.Remove Shield Block #1 from the radial direction.

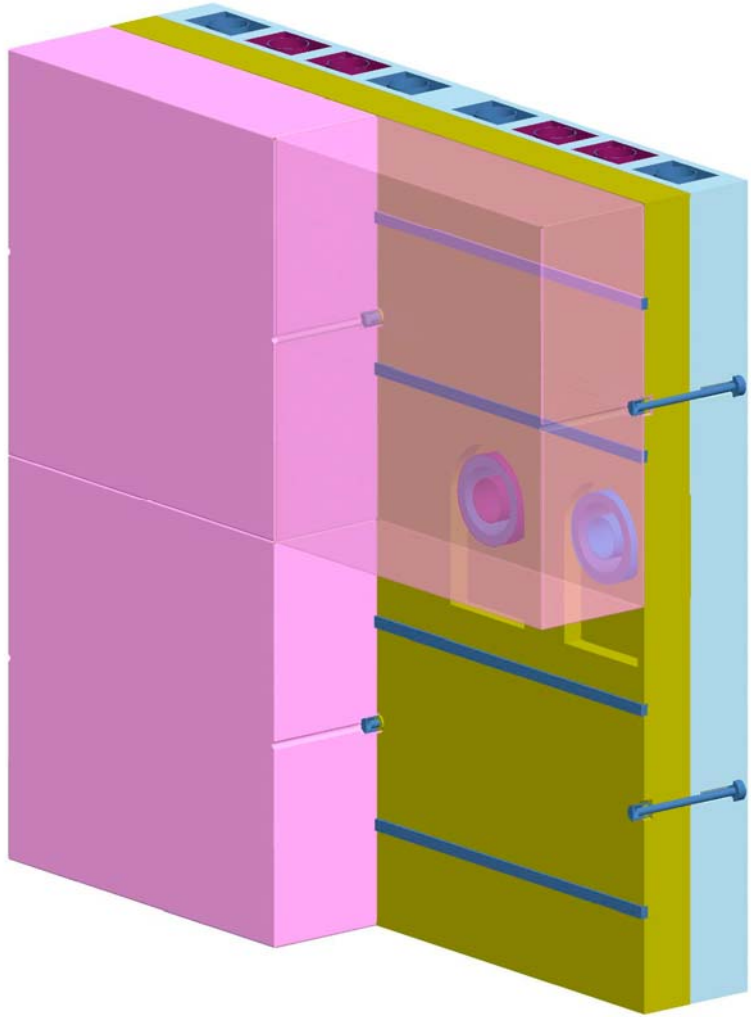
Steps to Cut the Coolant Connections from the Outside through the Open Window (cont.)





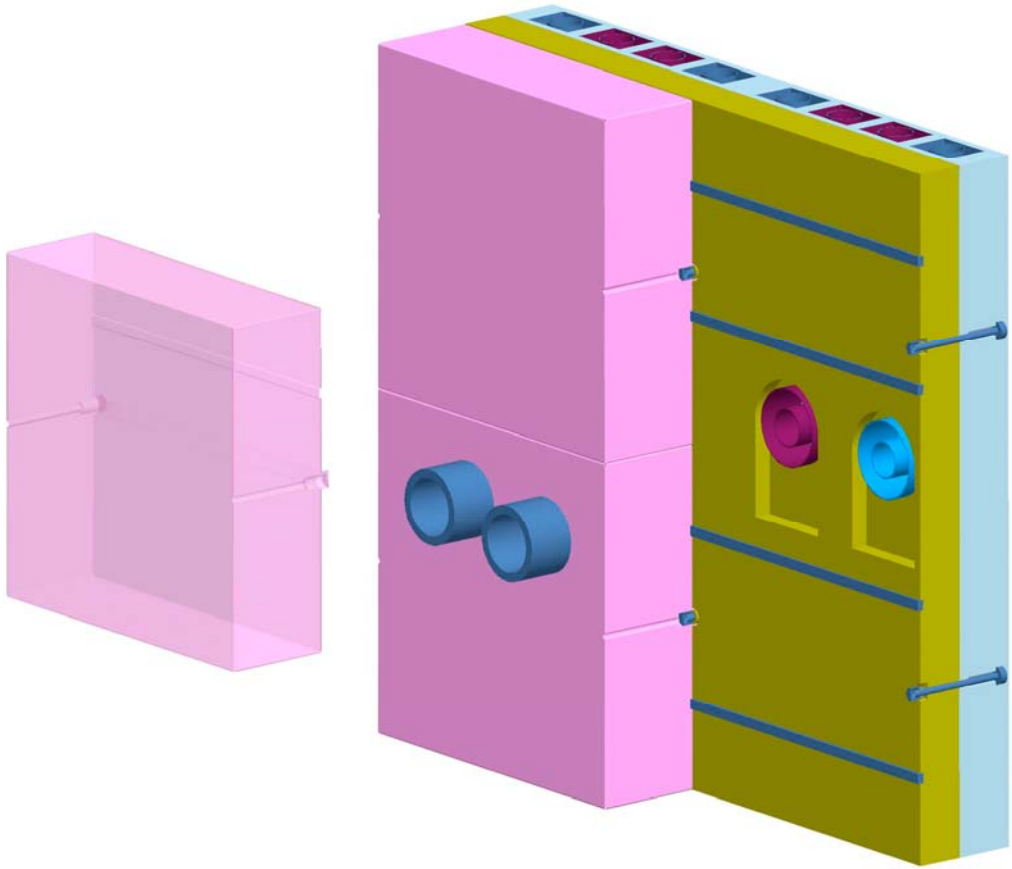
2.Lower the Shield Block #2 down vertically, then remove it; turn the Shield Block #3 in 180 degree and lower it down vertically, then remove it.

Steps to Cut the Coolant Connections from the Outside through the Open Window(cont.)



3.Repeate the same steps to remove another three shielding blocks of the He access tube.

Steps to Cut the Coolant Connections from the Outside through the Open Window(cont.)



4. Make the first cut near the blanket module with an articulated boom, and remove the blanket module; then remove the Shielding Ring out, and make the second cut in the manifold region with in-bore tools.

Possible Shield-only Module Design

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- The WC-Shield-only zones cover 5% of the FW area;
- There are 6 shield-only zones, ~7 m^2 each;
- To avoid using a large He access tube, one shield-only zone would be sub-divided into two shield-only modules in each zone, and each module has 3.5 m^2 surface area;
- A concentric coolant tube will be used to connect the shield-only module and the He manifold
  - ✓*Diameter of the inner tube: ~19 cm*
  - ✓*Diameter of the outer annular tube: 31 cm*

Shield-only Module Manifolding and Possible Solution of the Protecting the Welds

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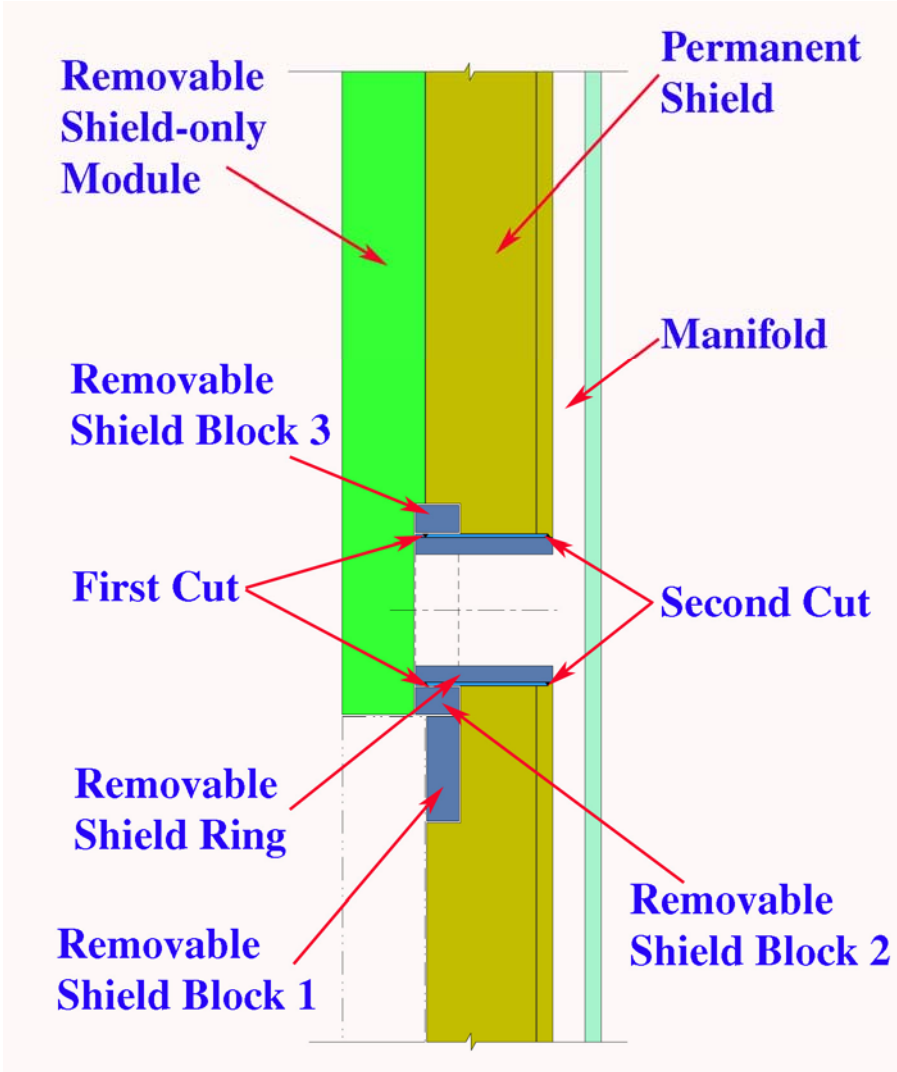
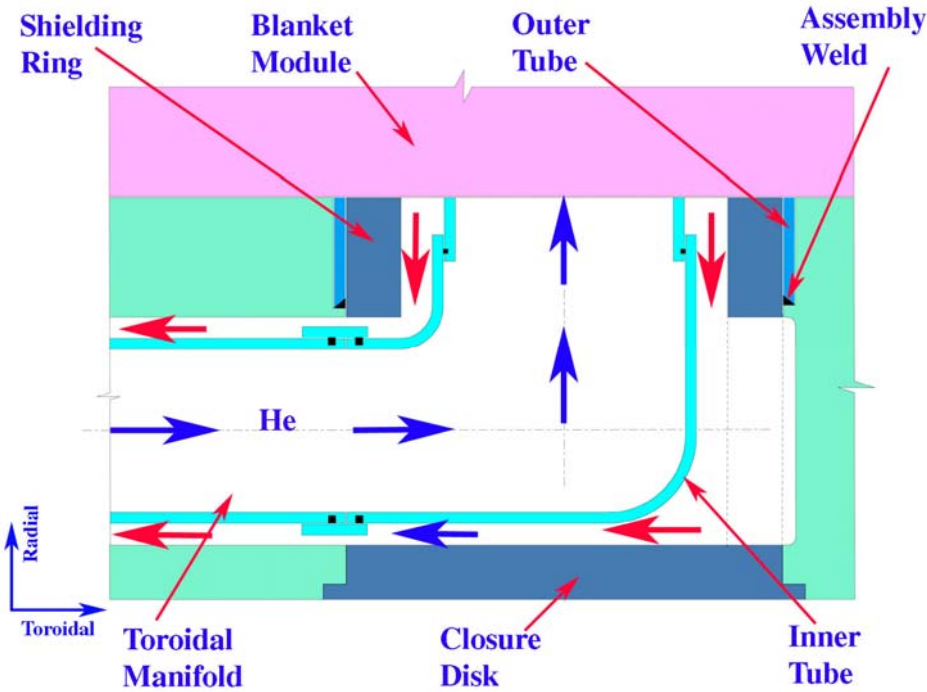
- A 15 cm He manifold is added to the HT shield, and combine the HT shield and the manifold to one component;
- The approach of the nominal breeding blanket to protect the welds and cut the access pipe in two locations is adopted.

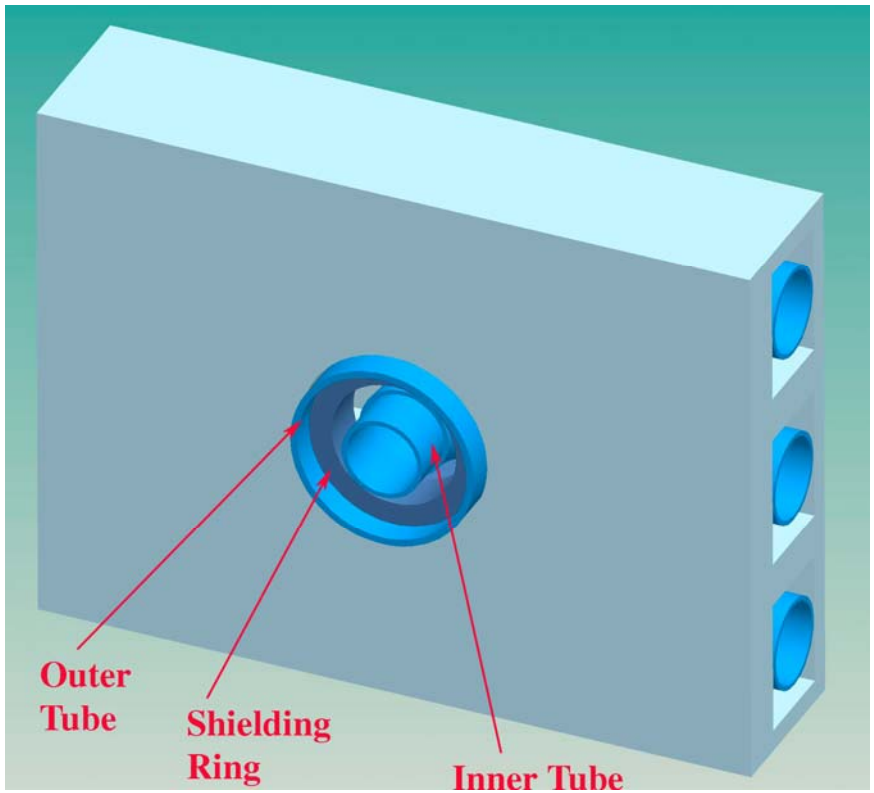


Review the Approach of Protecting the Welds for Field-Period Maintenance

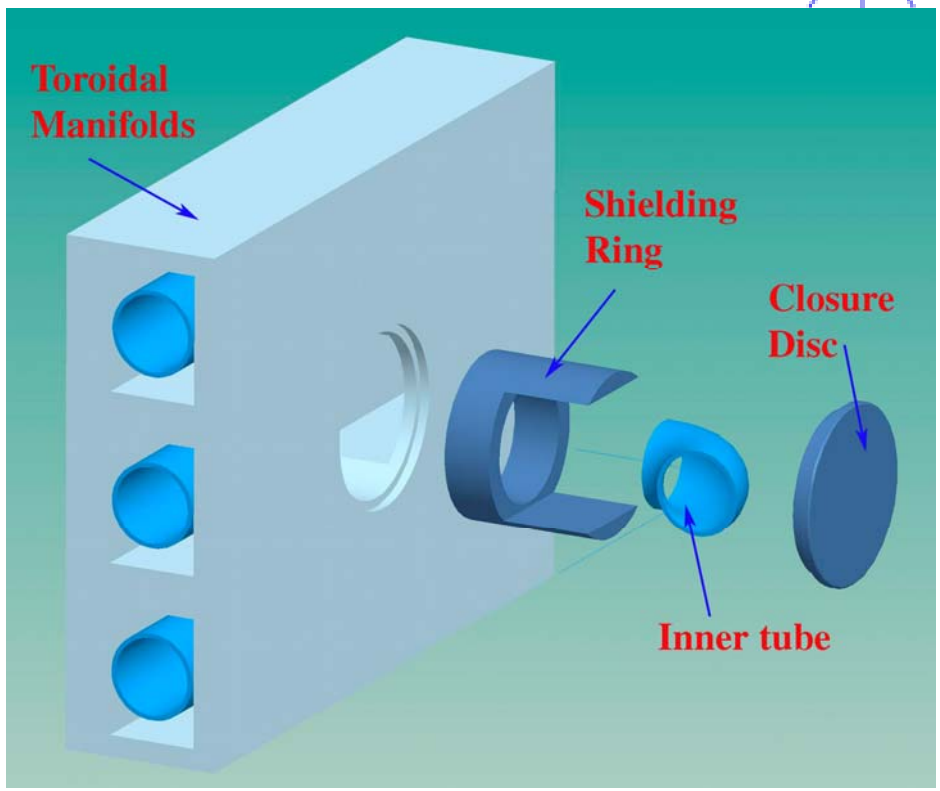
- To disconnect the breeder modules from the manifolds, closure discs at the outer surface of the manifold ring have to be opened, using bayonet-like geometry for force transfer and thin sealing welds.
- After removal of the inner tubes between inlet and outlet flow with sliding seals, a shielding ring can be removed and the assembly weld at the outer tube can be cut with in-bore tools.
- This design offers the possibility to have the assembly welds located about 10 cm inside the manifold in order to provide additional shielding for this weld.
- This is possible in the case of the port maintenance too, when we allow for cutting/rewelding the access tube at two locations: the first weld has to be cut/re-welded with an articulated boom working from the plasma side; the second cut with in-bore tools.



3D Drawings Showing the Access Pipes to Connecting Coolant Manifolds



View from the front of manifolds



View from the back of manifolds

Summary

- A possible solution of protecting the assembly welds between the access pipes connecting to the coolant manifolds for the port maintenance with DCLL blankets has been found.

- The shield-only module design is proposed, and the approach of protecting the welds will be the same as that of nominal blanket module.

- Cut/Re-welding the access tube for the field-period maintenance will be through backside of the manifold after the replacement unit is extracted in toroidal direction.