ARIES-ACT1
SCLL Blanket and Manifolding

Christina Koehly

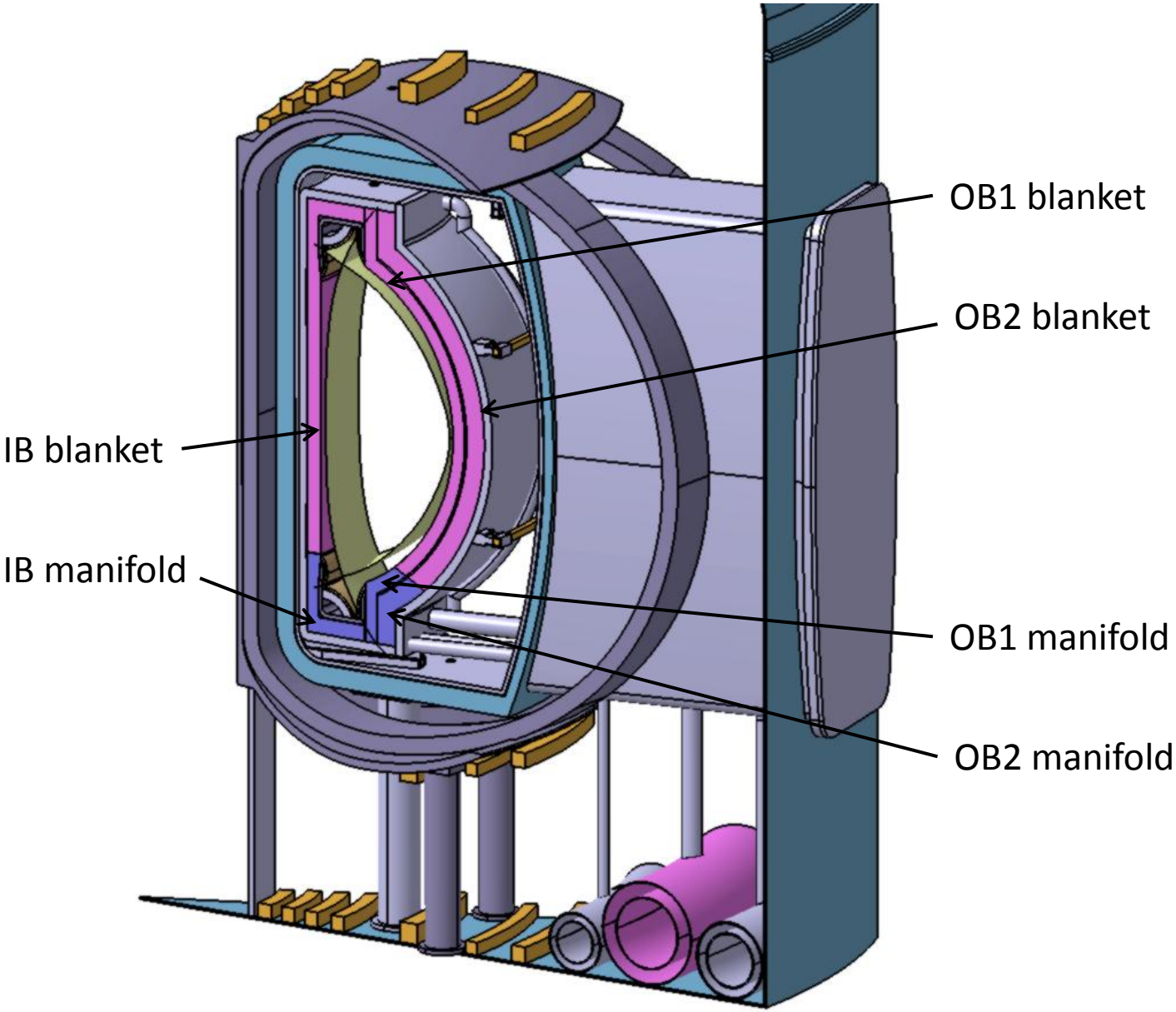
ARIES Project Meeting
UCSD, January 22, 2013

ARIES-ACT1 – SCLL Blanket and Manifolding

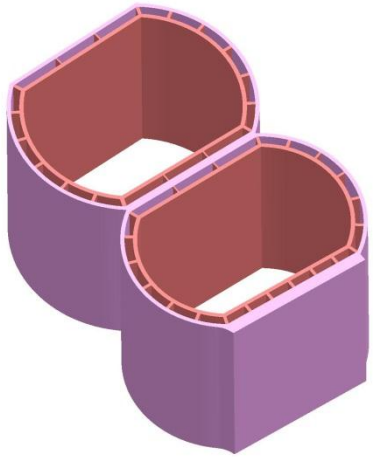
Object:

- Development of a more detailed design of the blanket and manifold/ flow distribution system for the SCLL blankets
- Main focus on fabrication, manufacturing and re/assembling during maintenance as well as MHD issues
- A basic design proposal from Siegfried Malang for a MHD improved flow (Y-shaped pipe connections up to one (IB) or max. two (OB) access pipes) as well as Xueren Wangs power core design from October 2012 has been taken as start point

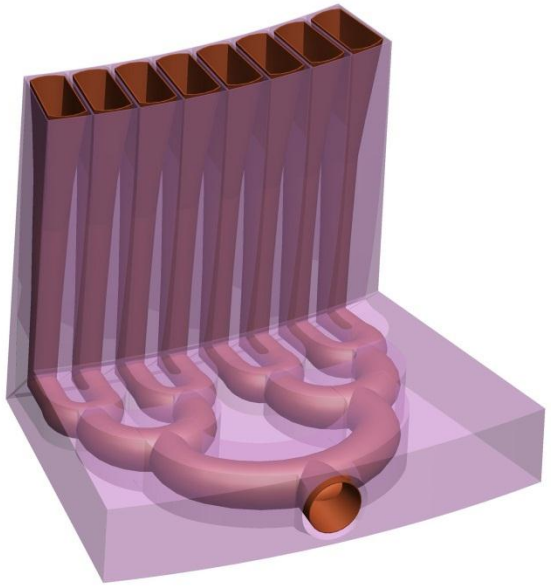
ARIES-ACT1-Power Core, Xueren Wang Oct. 2012



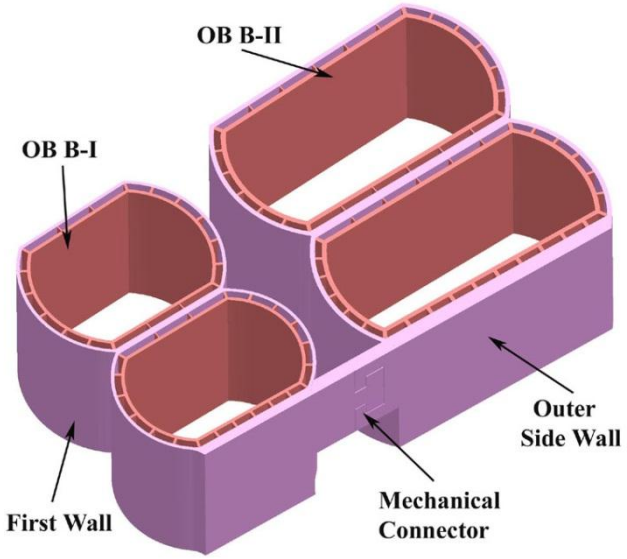
ARIES-ACT1, Xueren Wang and Siegfried Malang



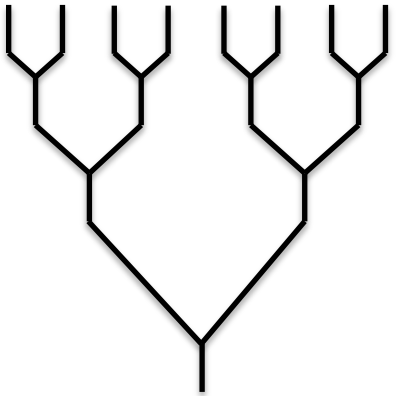
Principle configuration of OB2 blanket



First design concept of IB blanket manifold



Principle configuration of OB blanket



Y-shaped pipe connections
Example for IB

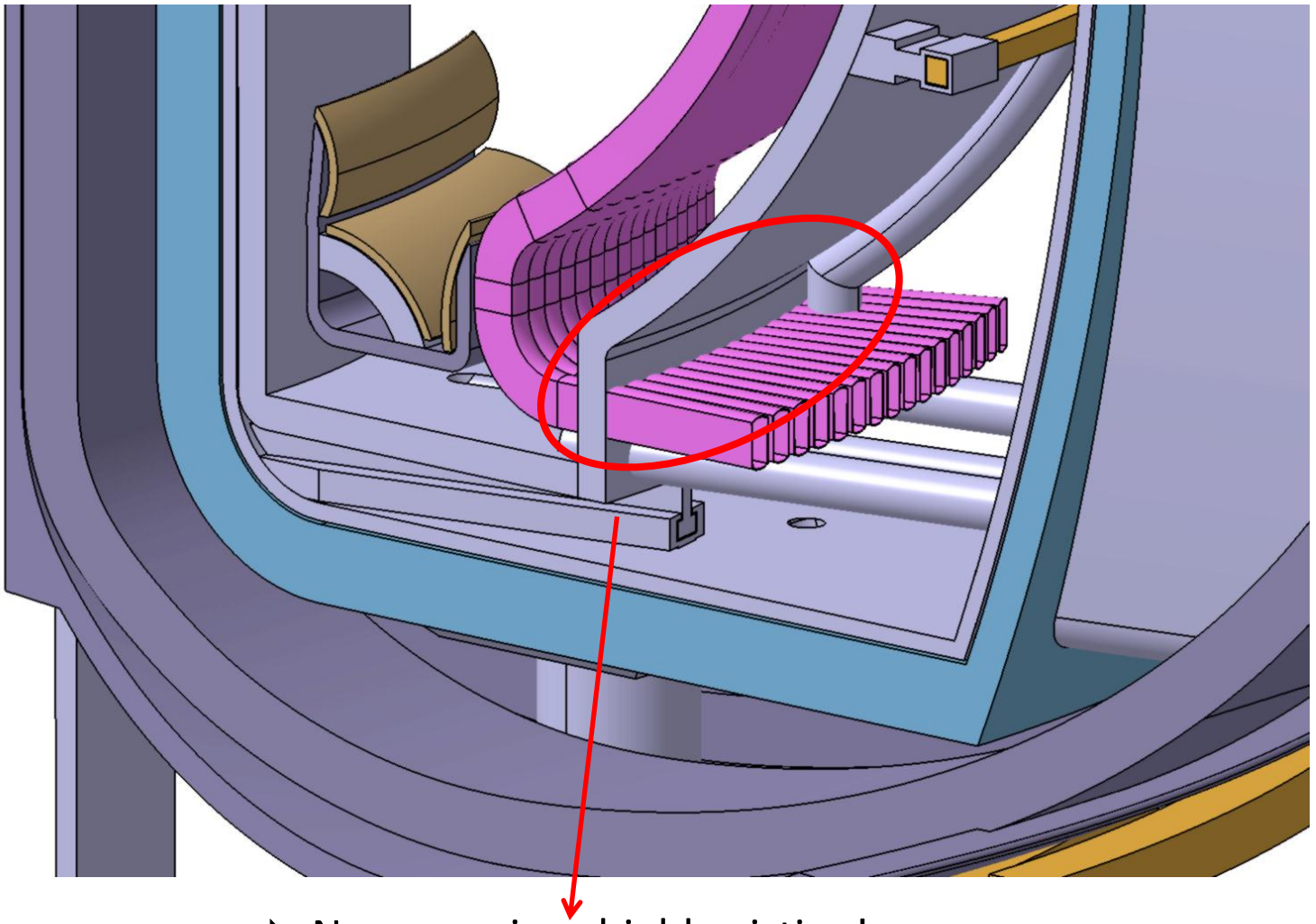
ARIES-ACT1 – SCLL Blanket and Manifolding

Complexity:

- Material manufacturing: SiCf/SiC
  - ⇒ Manufacturing of concentric SiCf/SiC pipes (inner and outer pipe with fins) as one part is possible
    - ⇒ More expensive, but would avoid cross-flows within the concentric pipes between inlet and outlet flow (good for MHD)
    - ⇒ Statements of manufacturing possibility for long (several meters) and 3D parts not yet available
  - ⇒ Manufacturing of concentric SiCf/SiC pipes as separate parts
    - ⇒ Easier and cheaper, but small amounts of cross-flows between inner and outer pipes, because inner pipe not leak-tight connected
    - ⇒ Increase of assembling complexity, because of difficulties in assembling Y-shaped concentric pipes
    - ⇒ Complicated shapes of the outer pipe and complex bonding areas would be the consequence
- Joining/cutting technologies for Sicf/SiC pipes (leak-tight and inside the reactor)
  - ⇒ Joining technologies are still under development and not yet completely verified for Fusion purposes
    - ⇒ Available first experimental results are not suitable to transfer it to applications for inside the reactor
    - ⇒ No detailed statements about sizes of possible joining/cutting machines are available
    - ⇒ Difficult to estimate the needed space inside the reactor!

ARIES-ACT1 – Manifold V1a

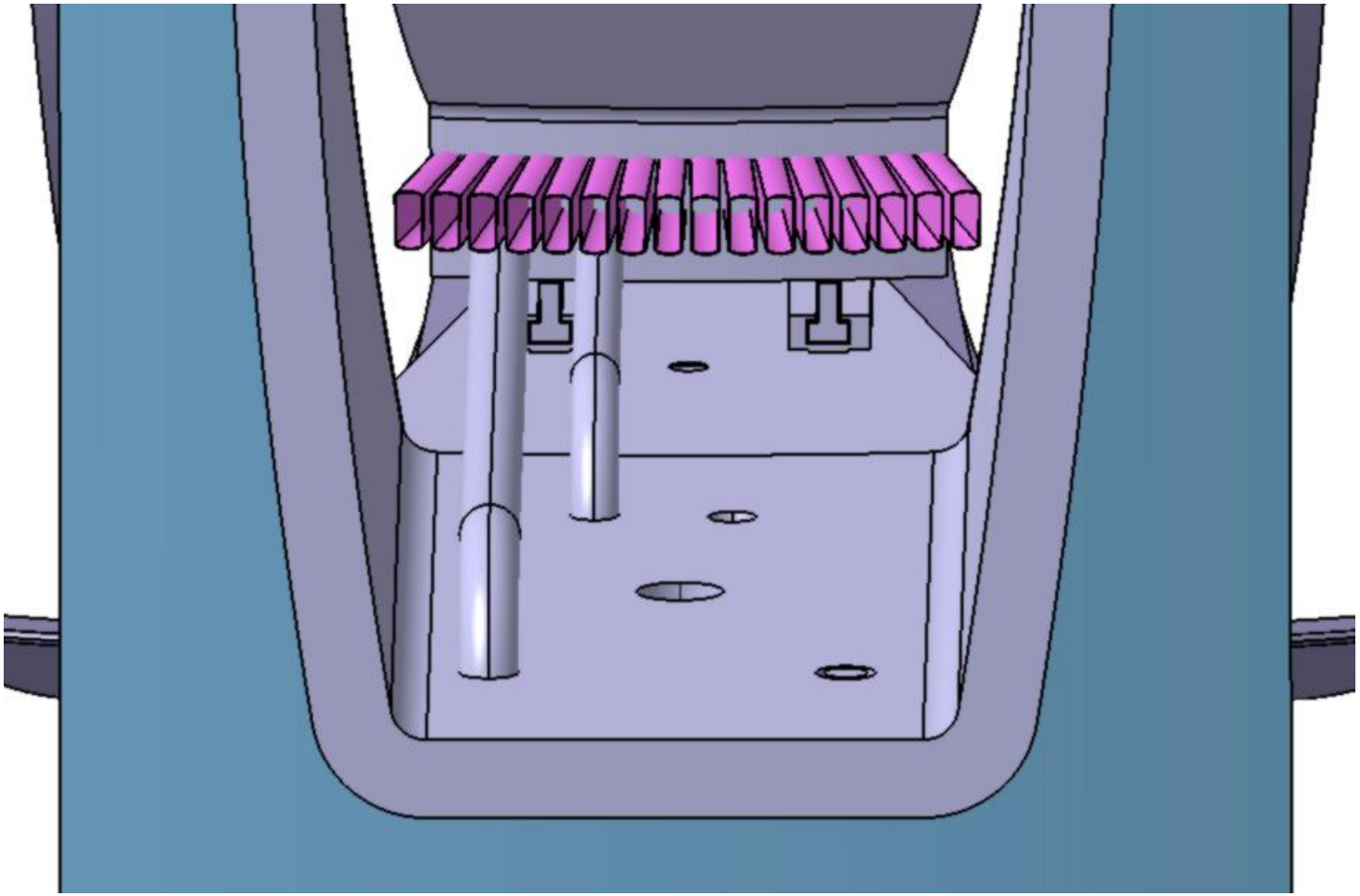
Construction of rectangular OBI channels till the outside of the structural ring



⇨ No more ring shield existing!

ARIES-ACT1 – Manifold V1a

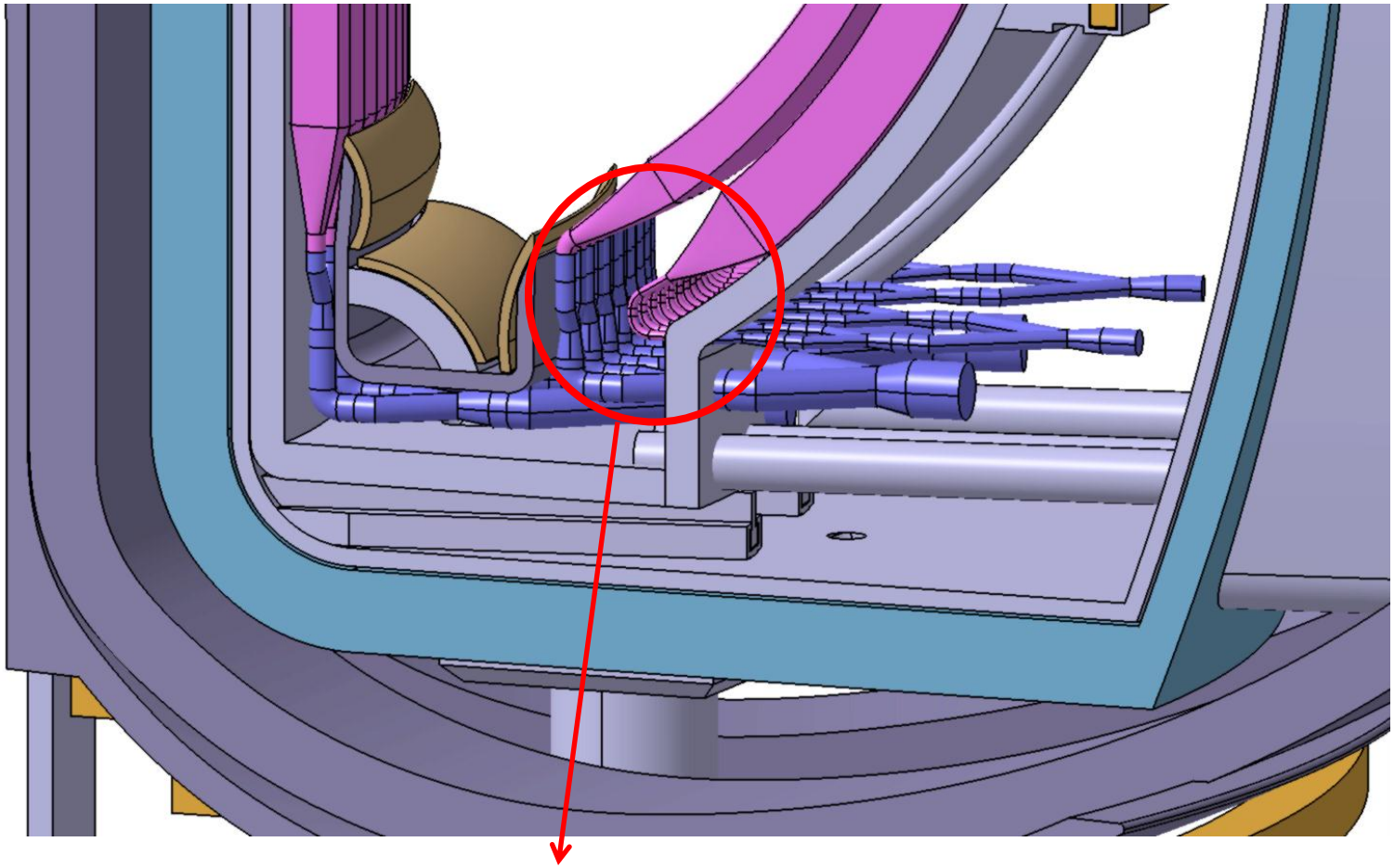
Port view



⇨ No more ring shield existing!

ARIES-ACT1 – Manifold V1b

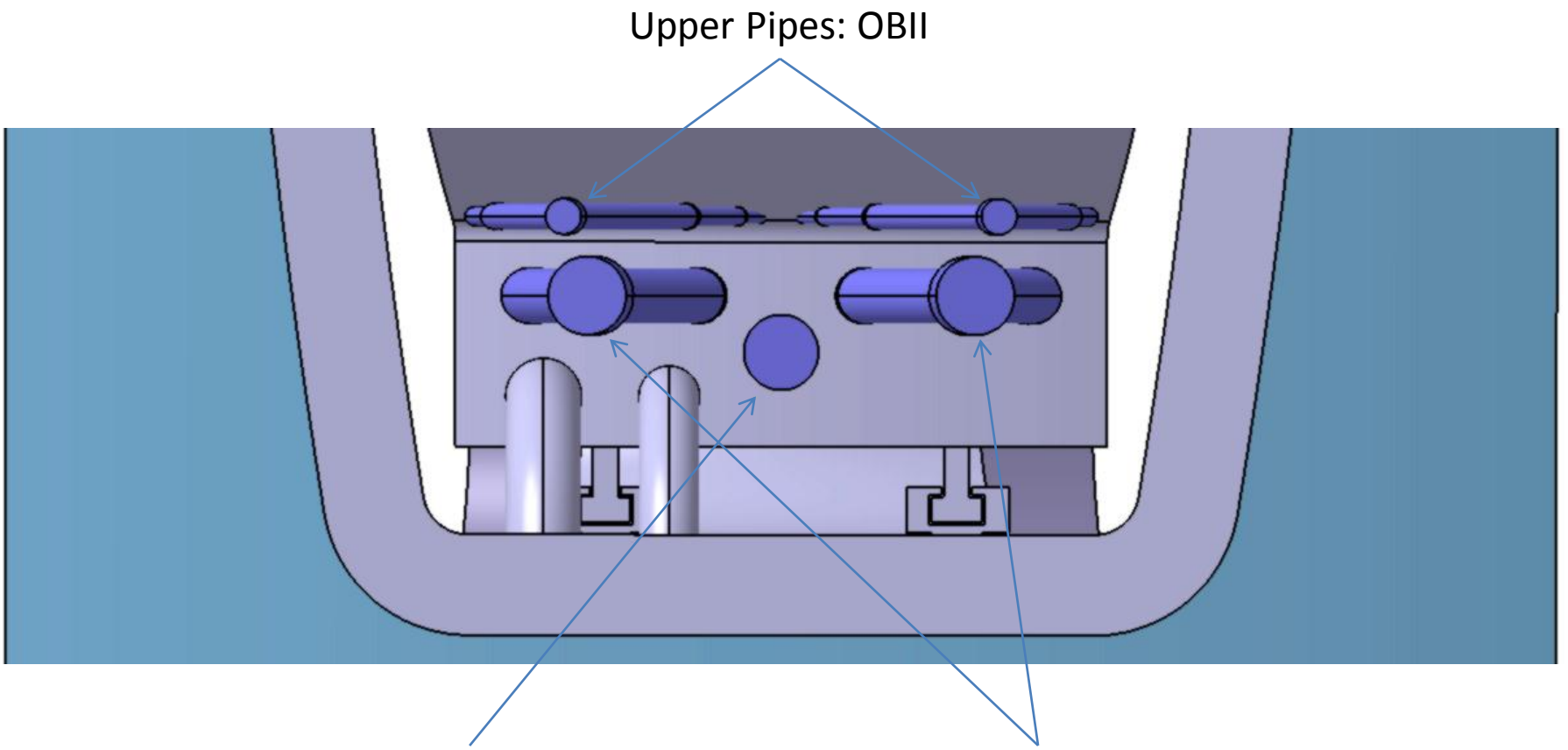
Rectangular IB/ OB channels changing to circular pipes inside the structural ring, joined to 1 (IB) or 2 (OB) access pipes



⇨ Too much empty space between pipes (no shielding)!

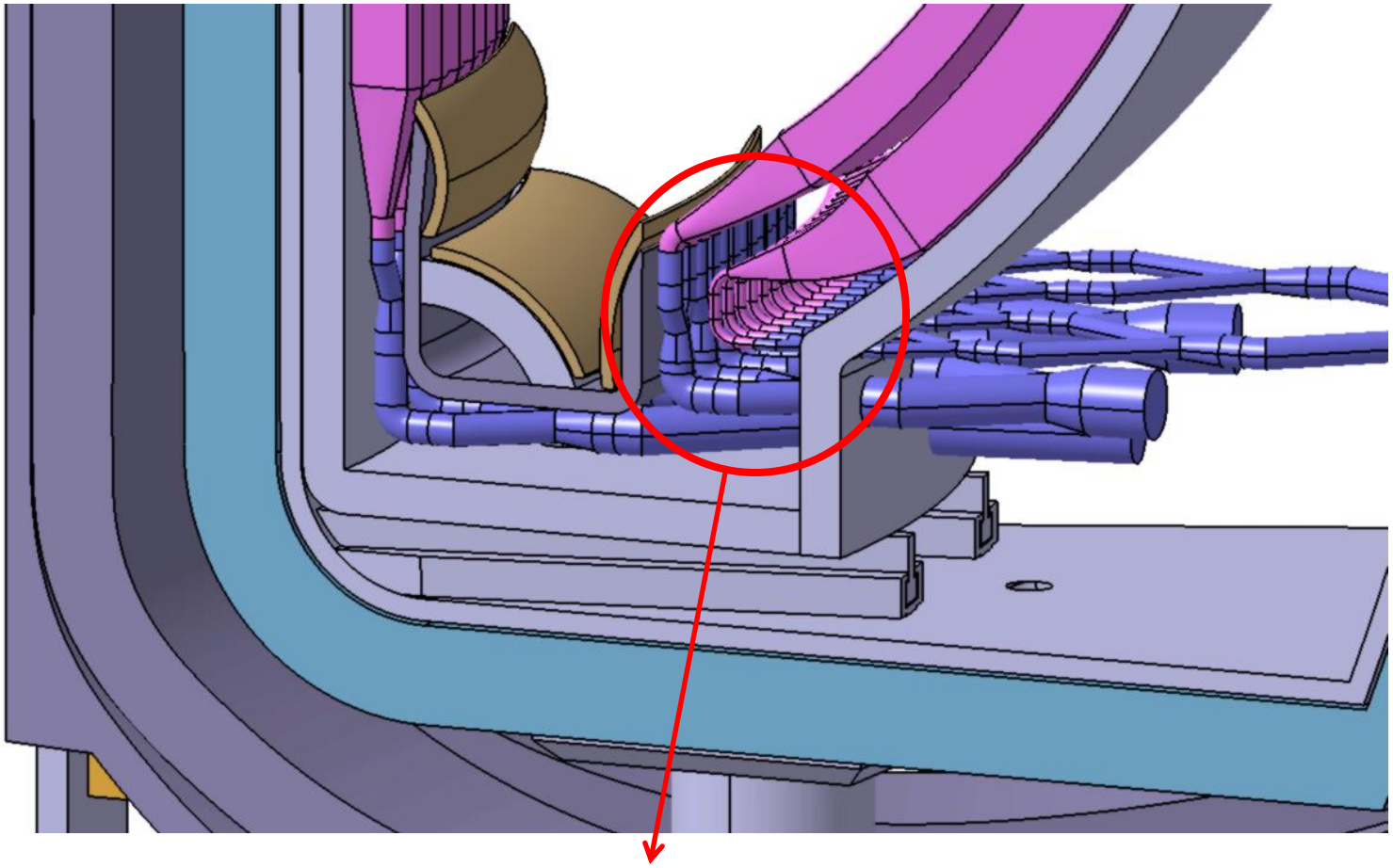
ARIES-ACT1 – Manifold V1b

Port view



ARIES-ACT1 – Manifold V2

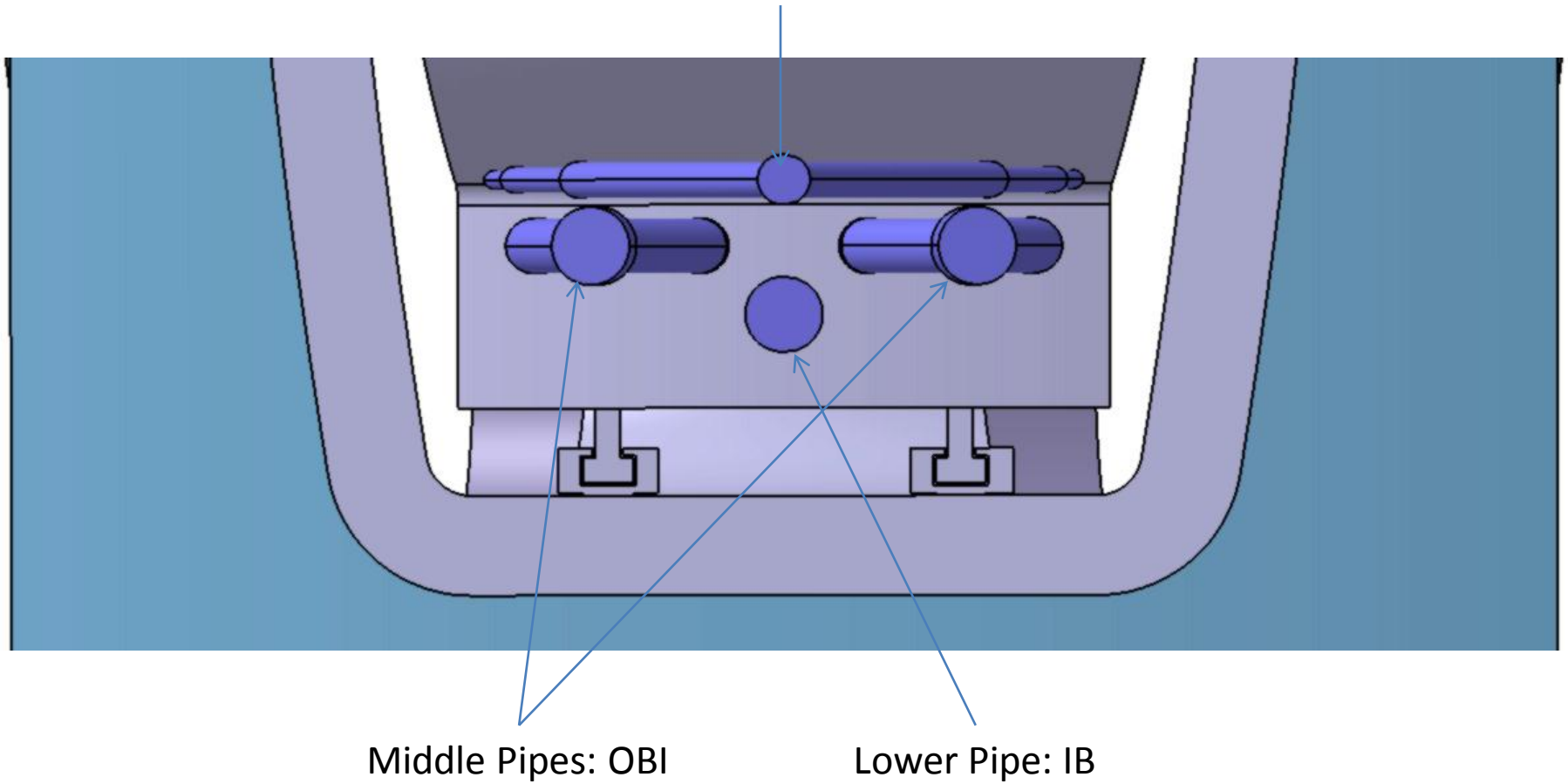
Adaption of manifold contour of OBII closer to OBI (to avoid empty space), OBII joined to 1 access pipe (enough space available)



⇨ Still too much empty space between pipes and structural ring!

ARIES-ACT1 – Manifold V2

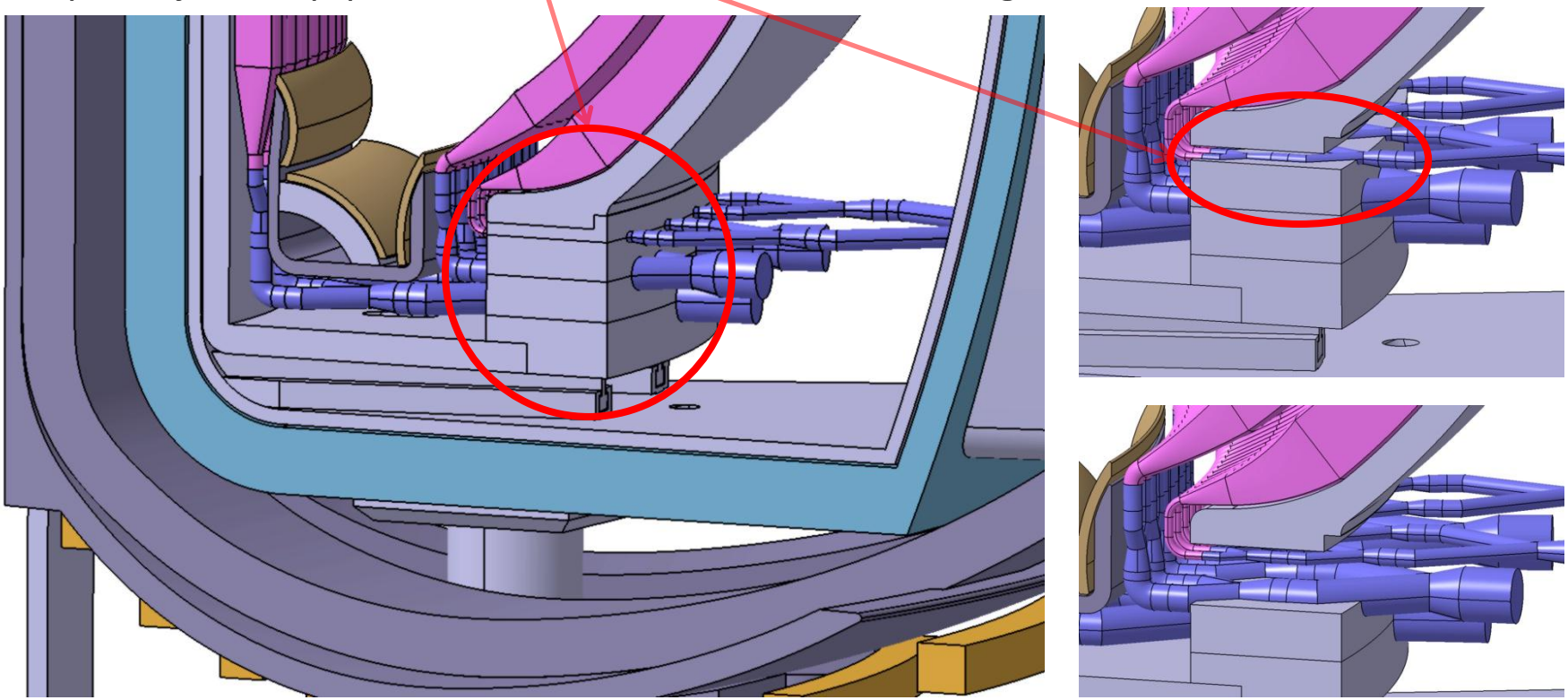
Port view:



ARIES-ACT1 – Manifold V3

Structural ring thickened at position of lead-through, divided into several blocks, where the pipes are embedded (not structural, structural ring still remained)

Shape of joined pipes remained inside structural ring block



- ⇨ Better shielding, cutting of only few pipes inside the reactor for maintenance
- ⇨ Dis-/Assembly of embedded pipes in Hot Cells
- ⇨ Cooling of divided blocks more difficult => separate cooling pipes necessary!

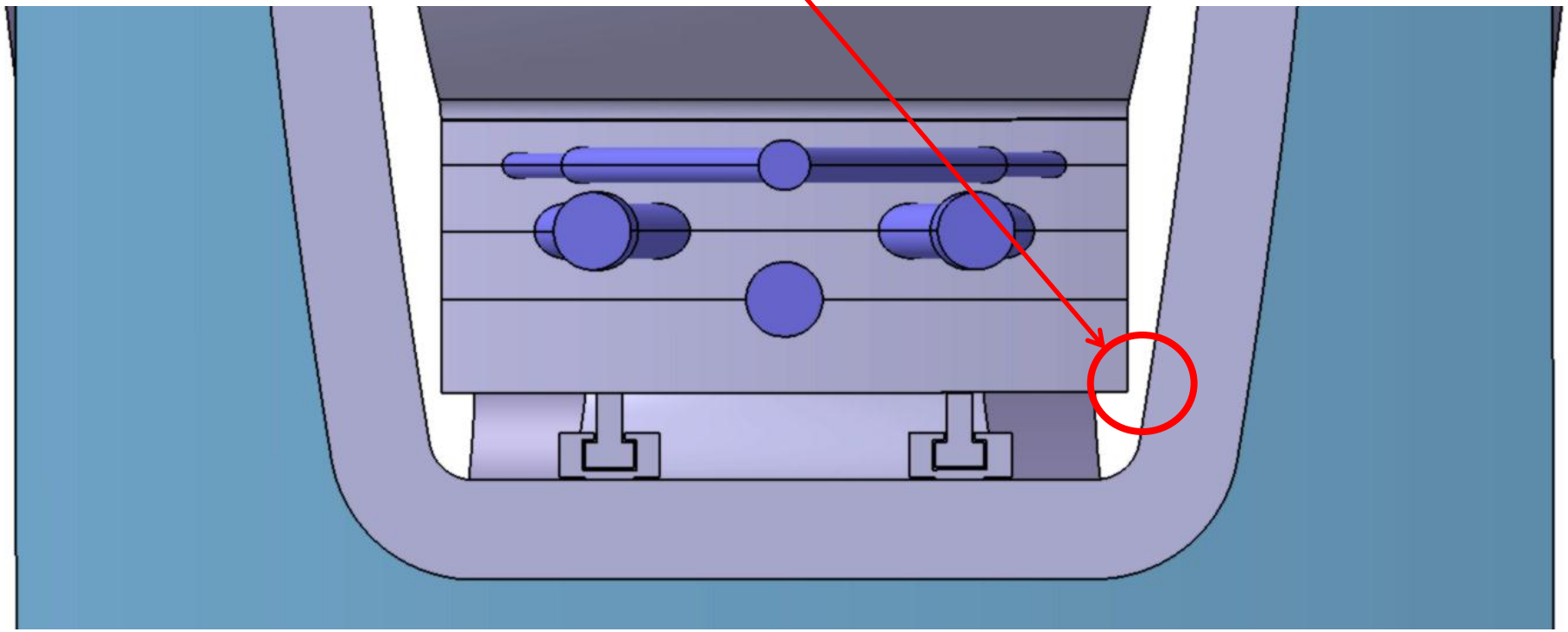
ARIES-ACT1 – Manifold V3

Port view:

Structural ring thickened!

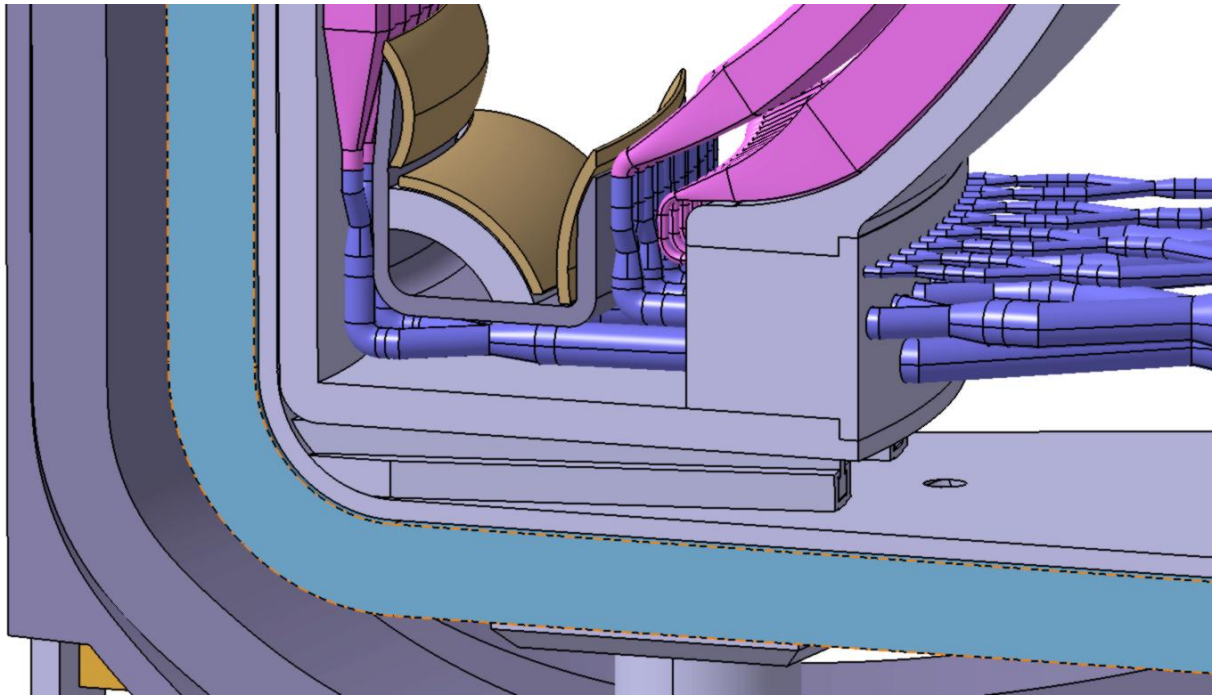
=> Distance between edge of sector and port reduced from 155mm to 78mm!

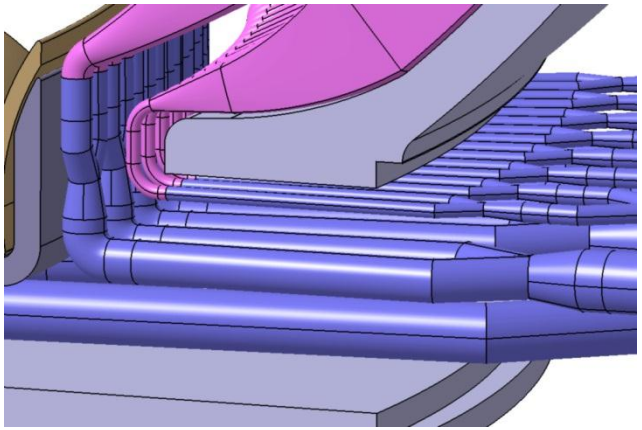
=> But maintenance through port still possible!



ARIES-ACT1 – Manifold V4

Structural ring thickened at position of lead-through as V3, but divided into only one block, pipes are going straight through the block => longer pipes, manifolding starts later (outside of ring block)!



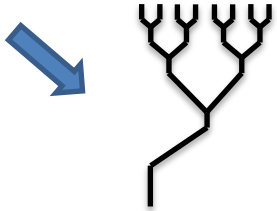


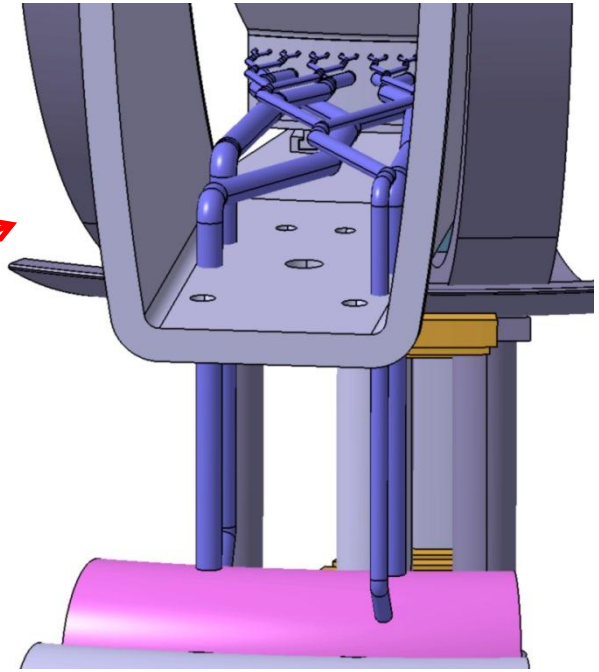
- ⇨ Good shielding block, but many pipes have to be cut inside the reactor close to the block to maintain the blanket! => possible?
- ⇨ Cooling of additional ring block easier, only one additional pipe is necessary!

ARIES-ACT1 – Manifold V4

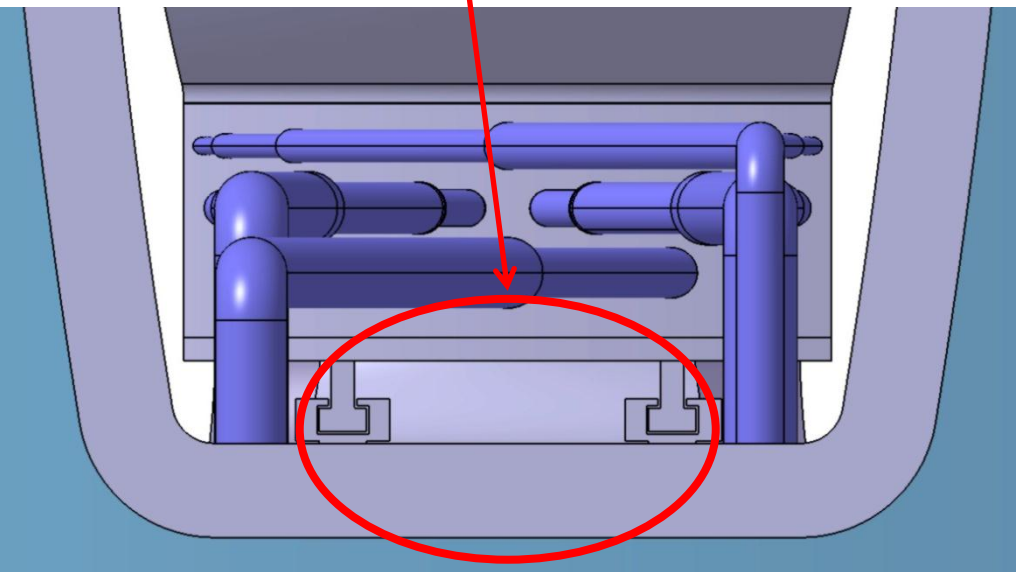
Port view:

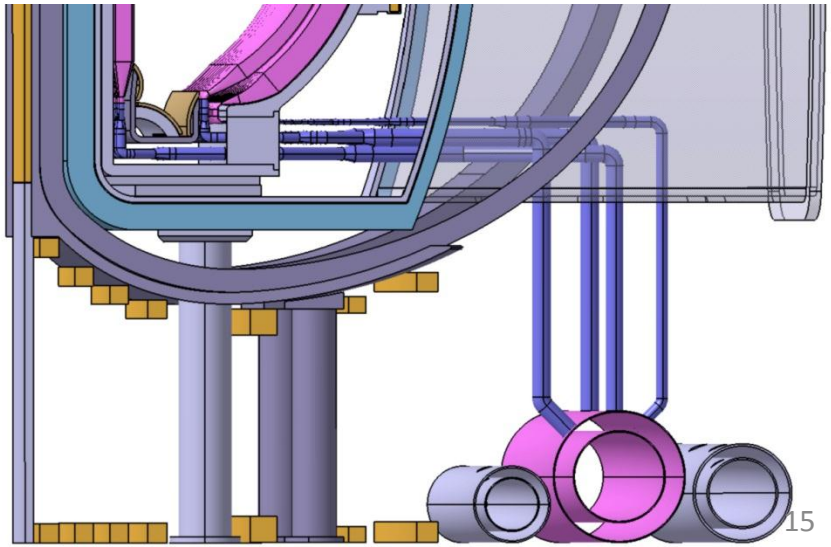
- ⇨ Structural Ring thickened as in V3
- ⇨ Extension of pipes till ring header
- ⇨ Symmetry of pipe joints are kept



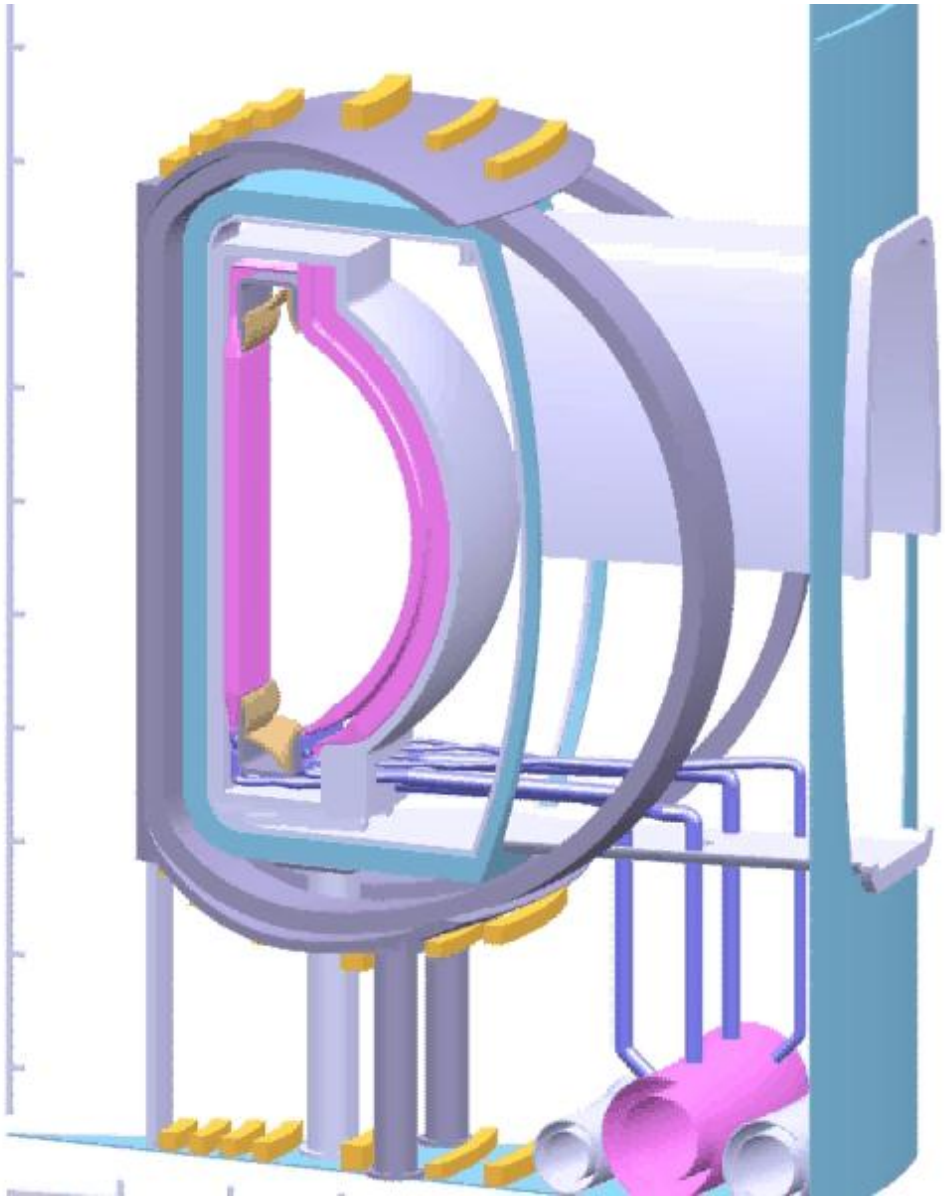


- ⇨ Center space kept free for vacuum pipe

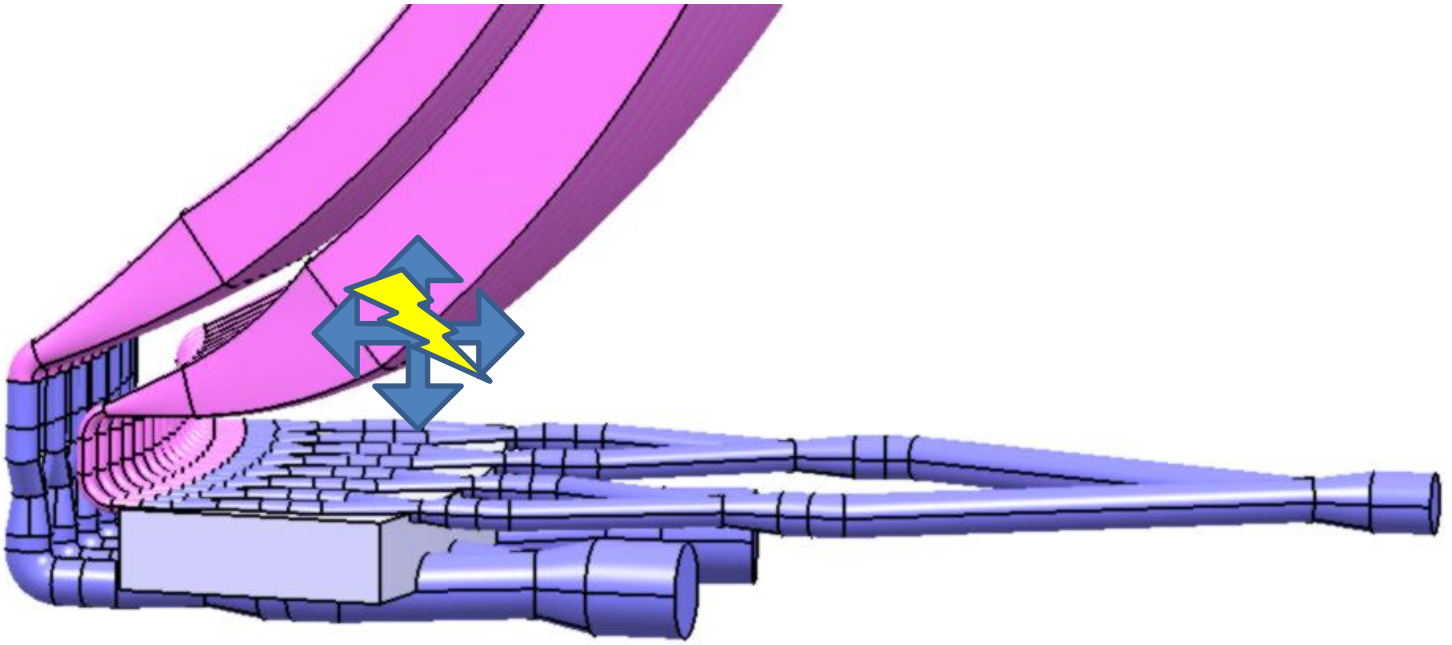




ARIES-ACT1 – Manifold V3, Disassembly Simulation

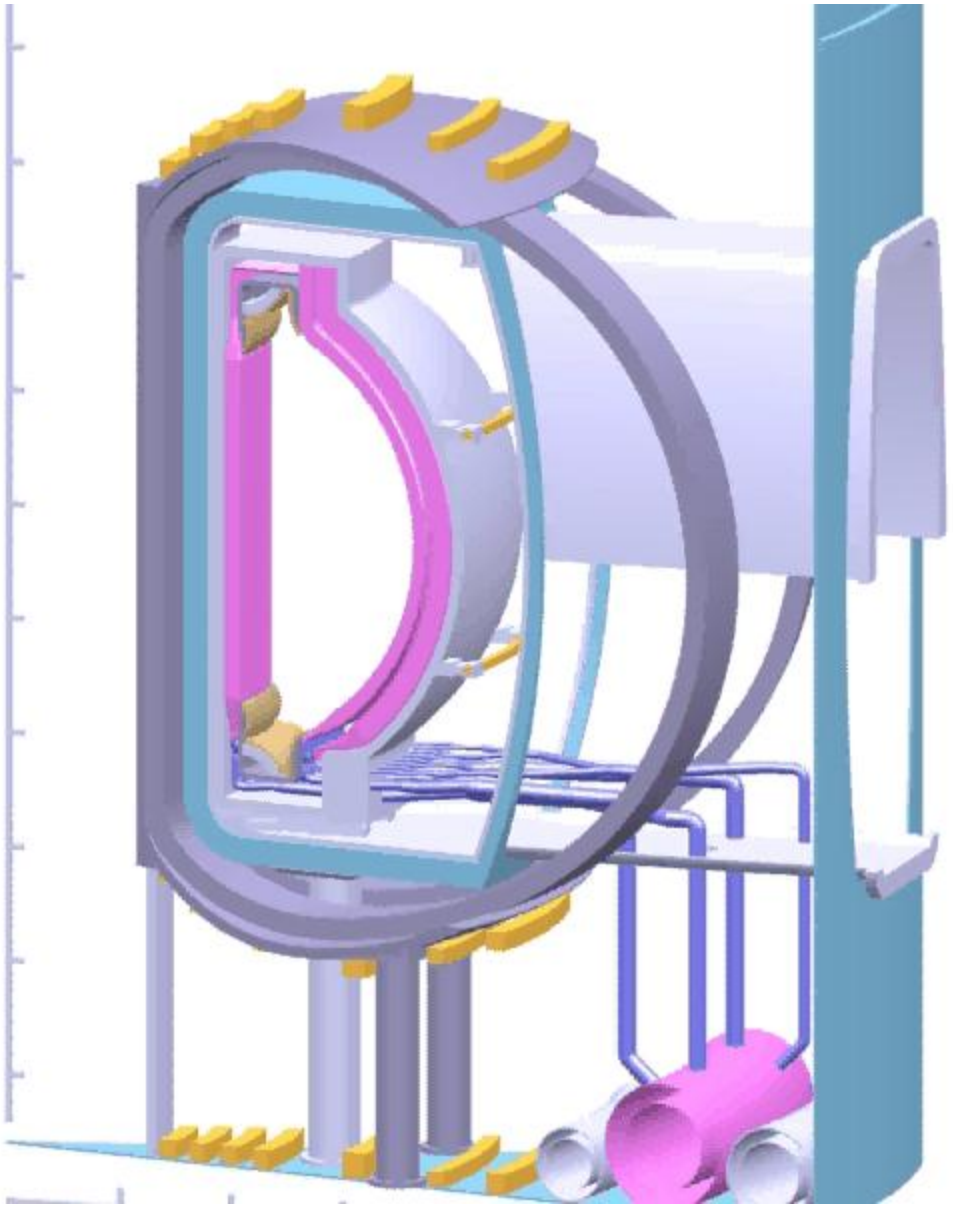


ARIES-ACT1 – Manifold V3, Disassembly Simulation

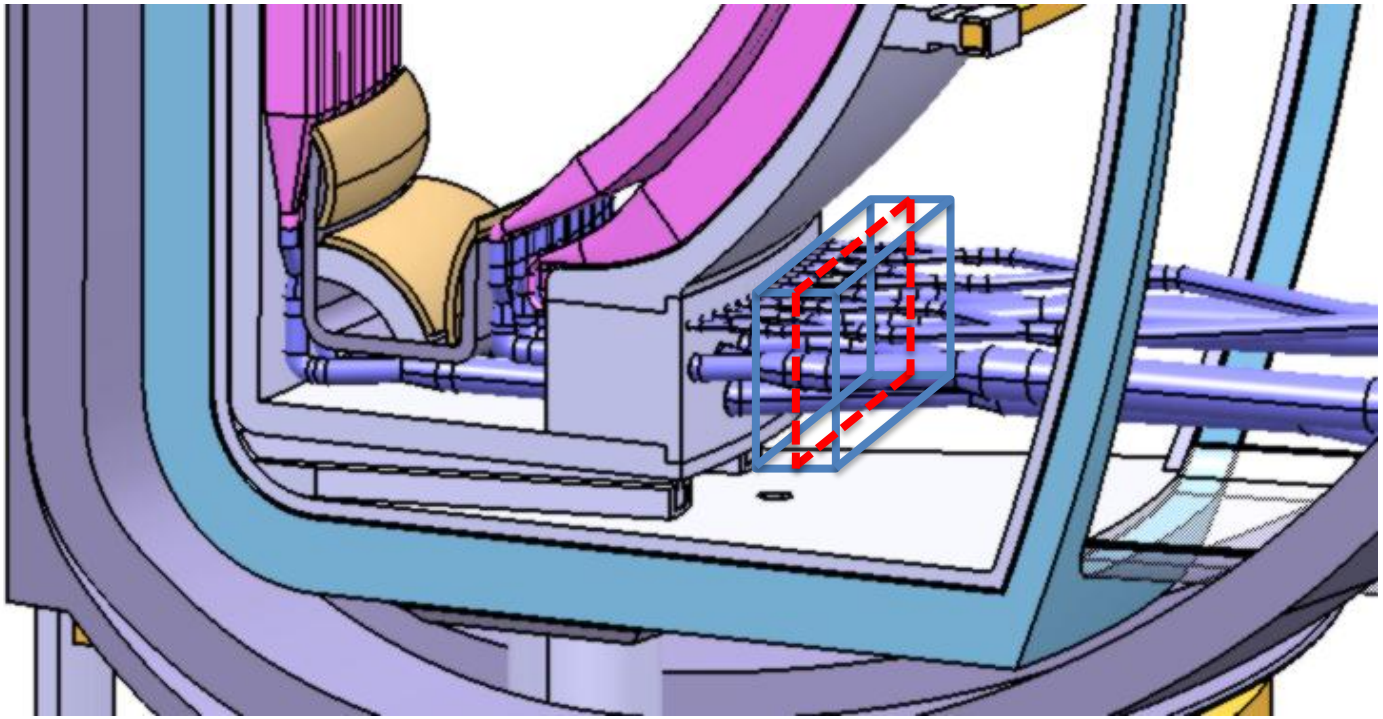


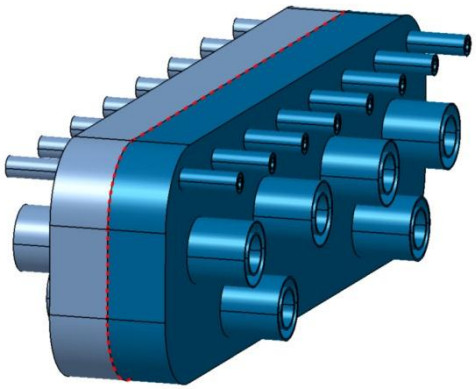
- ⇨ OB1 and OB 2 can not be moved from the last block
- ⇨ Additional 4cm gap between OB1 and OB2 needed for disassembling the last block!

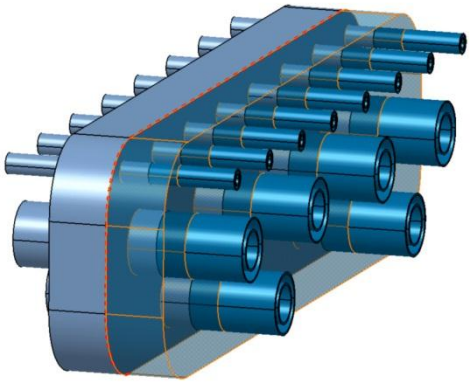
ARIES-ACT1 – Manifold V4, Disassembly Simulation



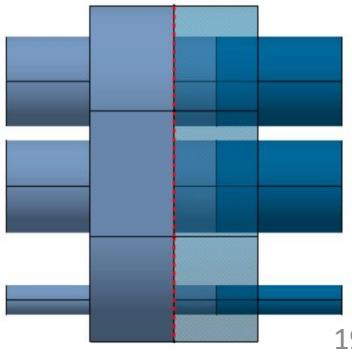
ARIES-ACT1 – Manifold V4, Disassembly Simulation

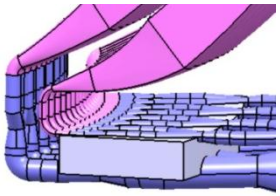




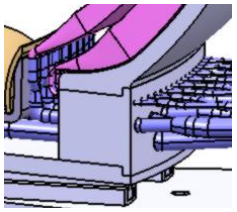


- ⇨ Many pipes have to be cut inside reactor for disassembly
- ⇨ possible?
  - ⇨ Adding of one “joining area”





ARIES-ACT1 – Summary



Manifold V3		Manifold V4	
Pro	Con	Pro	Con
Better shielding		Better shielding	
Cutting of only few pipes inside the reactor for maintenance		Could be avoided by an additional “joining area” like two half of a block, where on each side the pipes are connected, joining and cutting inside the reactor takes place only one time around the two half of blocks	Cutting of many pipes inside the reactor for maintenance => possible (space, available tools,…)?
Dis-/Assembly of embedded pipes in Hot Cells	Dis-/Assembly need an additional 4cm gap between OB1 and OB2!	Dis-/Assembly of embedded pipes in Hot Cells	Cutting of many pipes in Hot Cells => possible?
	Cooling of divided blocks more difficult => separate cooling pipes for each piece of block necessary!	Cooling of additional block easier, only one additional pipe is necessary!	

ARIES-ACT1 – Summary 2

- Several design options has been worked out
- Manifolding V3 and V4 seems the most promising
- Because of open questions at Manifolding V4, Manifolding V3 should be preferred for a further detailed design
- Additional space of 4cm between OB1 and OB2 is required for this solution
- Way of pipe manufacturing should be discussed (inner/outer pipe as one or two parts?)

Thank you for your attention!

Example for SiCf/SiC composite structure

Silicon-carbide-fiber-reinforced silicon carbide matrix composites with woven cooling tubes.

http://www.grc.nasa.gov/WWW/RT/RT2001/5000/5130jaskowiak.html