JÜLICH
FORSCHUNGSZENTRUM

TIK 3.1 Moderator & Reflector System

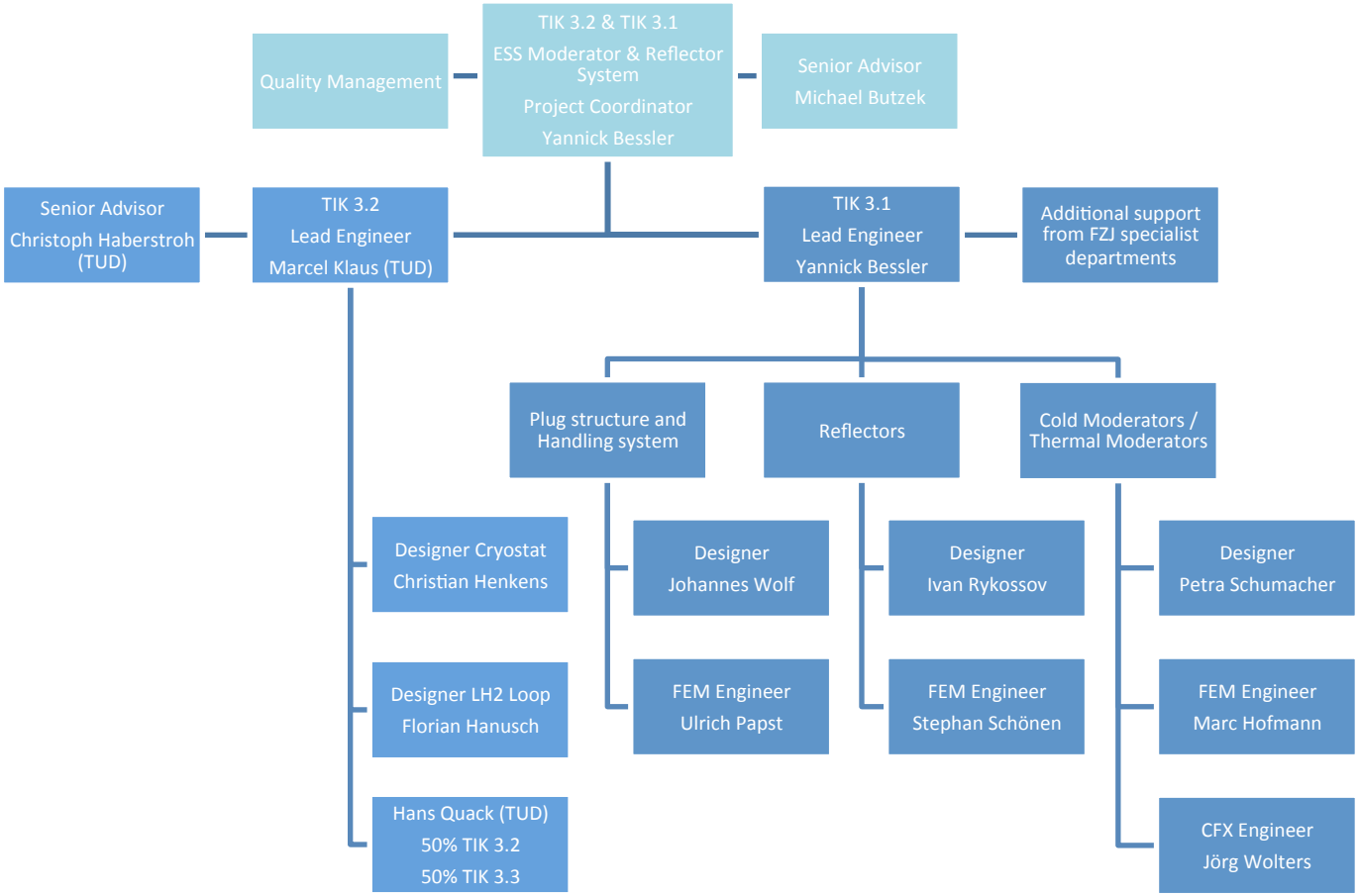
TAC Meeting

15. October 2015 | Yannick Beßler (FZJ), Daniel Lyngh (ESSS)

Outline

- Juelich ESS M&R System Project Team and Organization
- Focus areas of recent weeks
- Cold Moderator concept
- Alternative Reflector concept
- Twister concept
  - Response to TAC bearing question / recommendation
- Ongoing manufacturing tests
- Focus areas of the next weeks

Juelich ESS M&R System Project Team and Organization

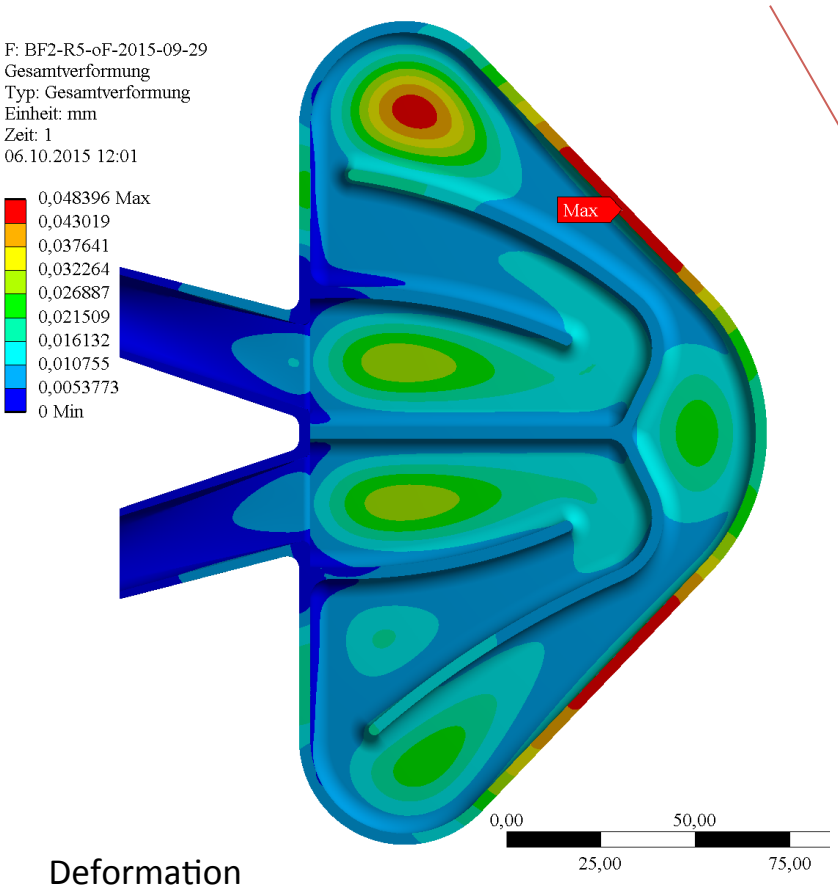


Focus areas of recent weeks

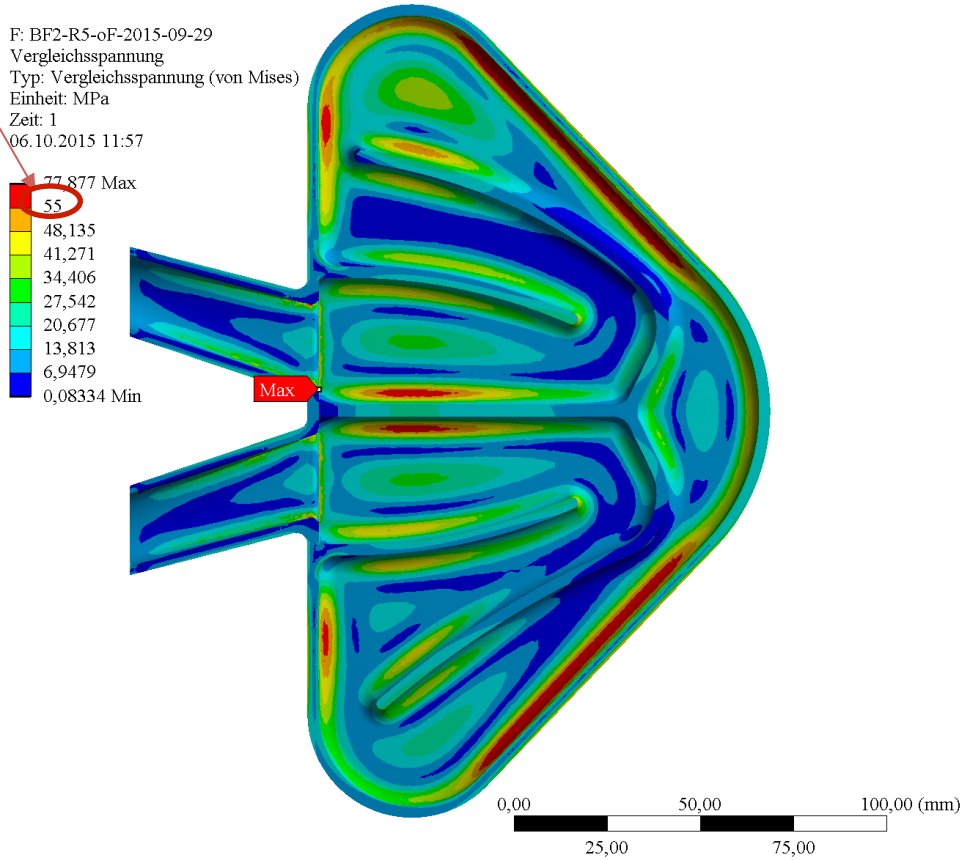
- Understanding the PDR documents
- Thermal Moderator machining and eBeam welding test
- Cold Moderator stress analysis and optimization (reduce local stress in order to follow the RCC rules)
- Shaft optimization with regard to streaming, bearing concept, stability, simplification, guiding the pipework, handling
- Connection Moderators / Reflectors to Shaft

Cold Moderator concept (FEM)

S=55MPa (RCC MRx)



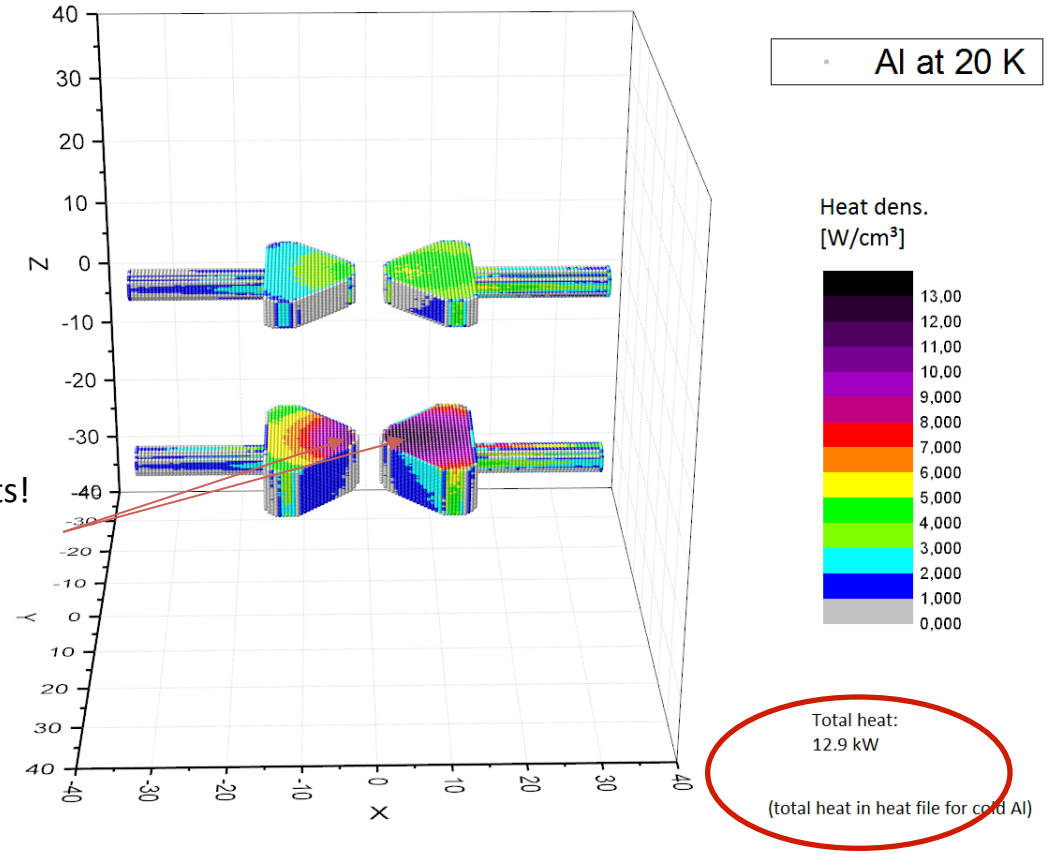
Deformation



Stress

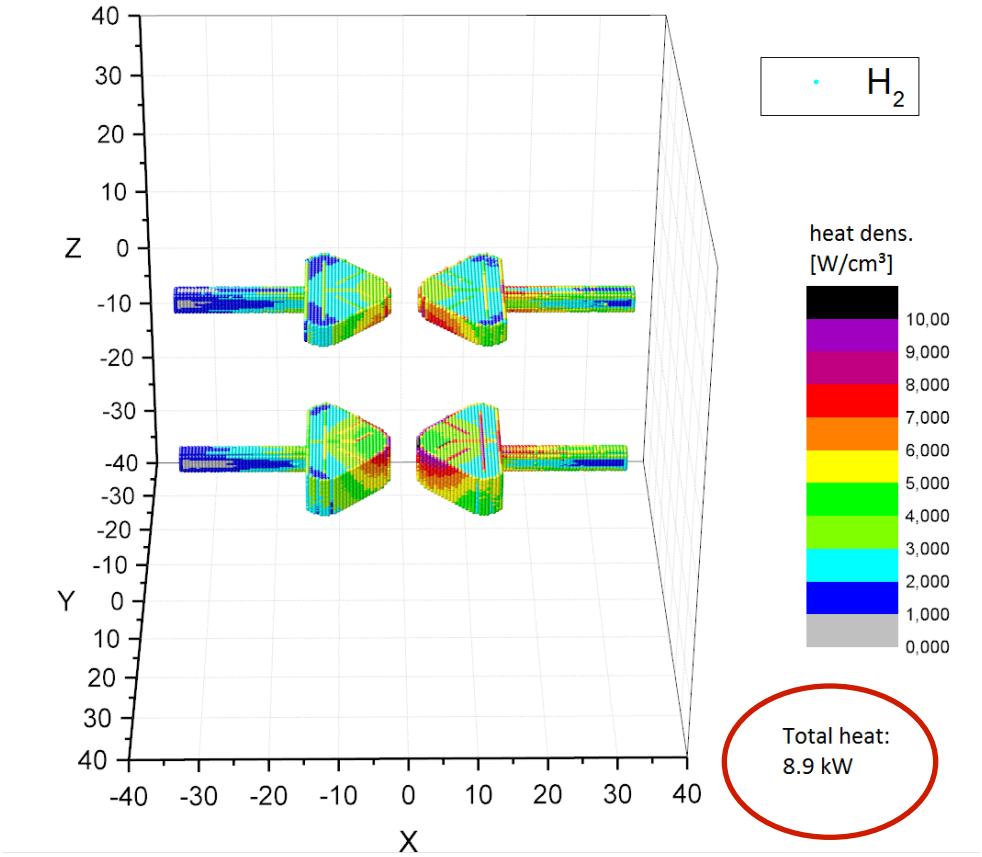
Cold Moderator concept (Heat Al)

selected from a text file with 13 million lines ...

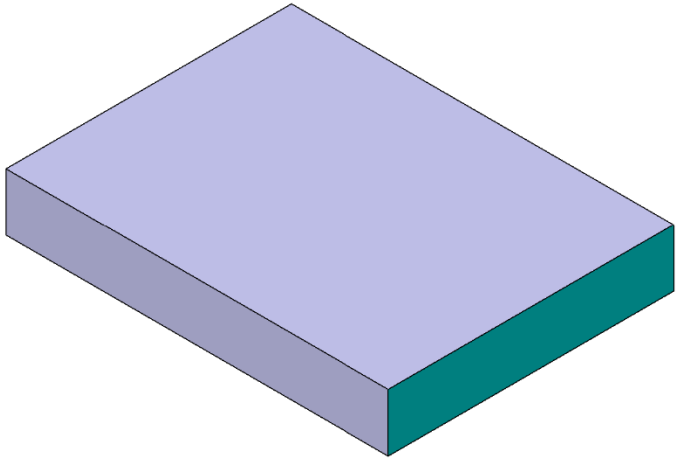


significantly different heat inputs!
(single analyze for each vessel necessary)

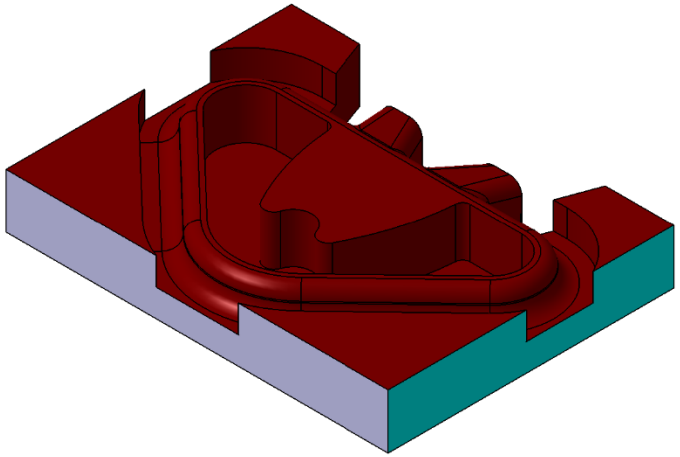
Cold Moderator concept (Heat H2)



Cold Moderator manufacturing step by step

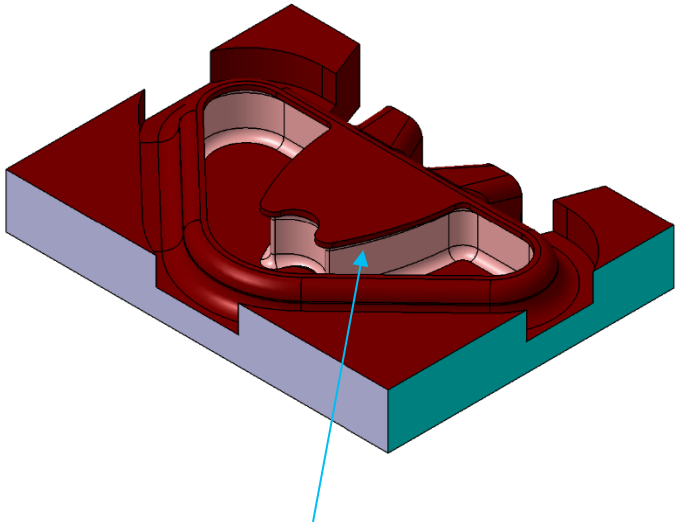


1 cutting

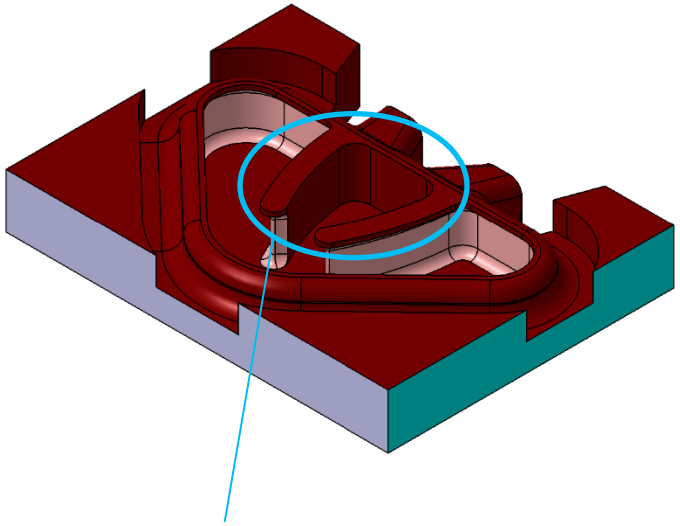


2 milling the grooves via HSC, fixed by frame structure

Cold Moderator manufacturing step by step

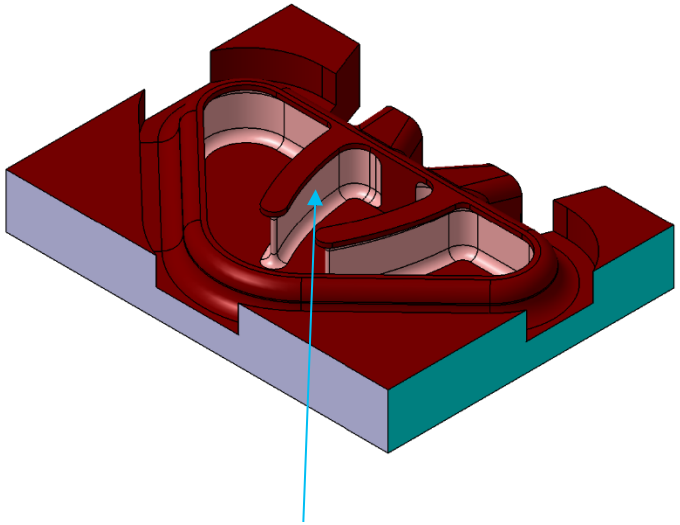


3 milling the undercut (stiffening in the core reduces deformations due to machining)

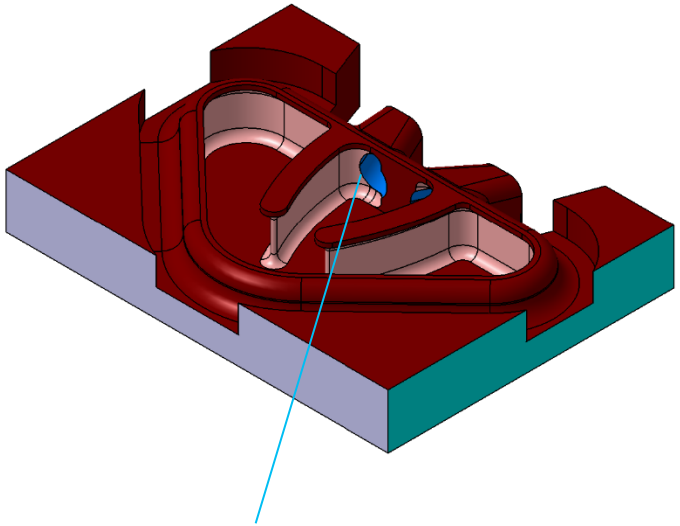


4 milling the core structure

Cold Moderator manufacturing step by step

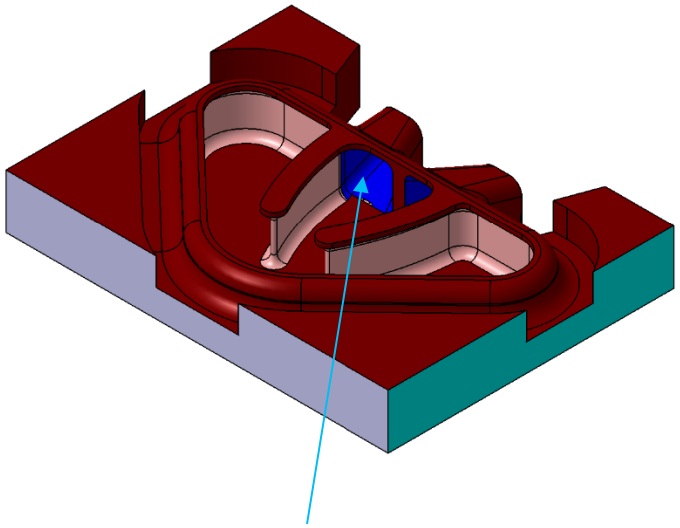


5 milling the undercut in the core
(option 1: existing grooves filled with ice
Option 2: EDM self made copper electrode
[noncontact process])

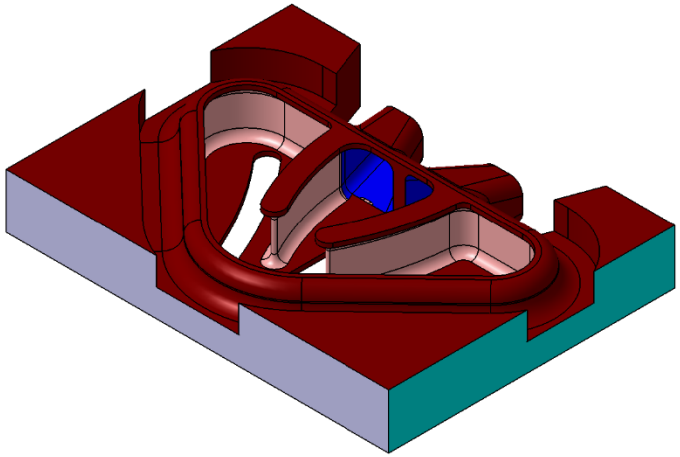


6 drilling of in- and outflow holes

Cold Moderator manufacturing step by step

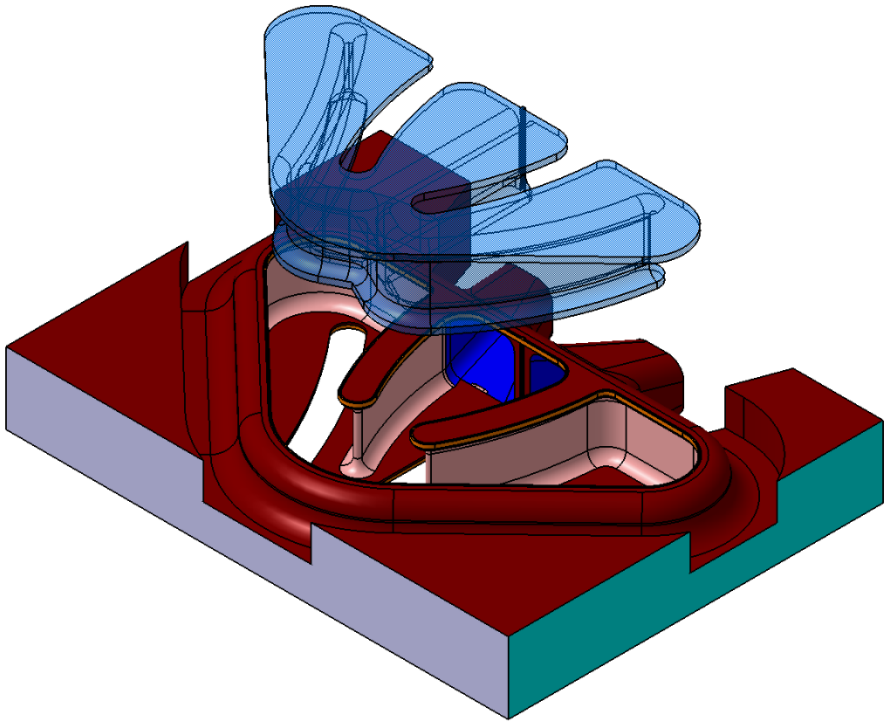


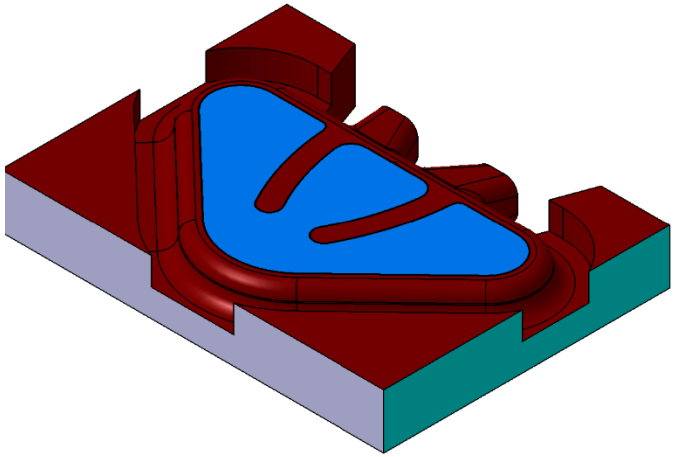
7 EDM wire eroding for good flow condition



8 milling of the bottom structure

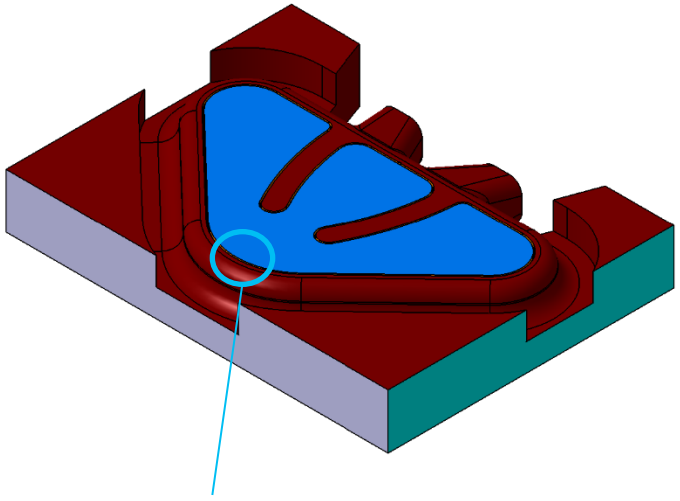
Cold Moderator manufacturing step by step



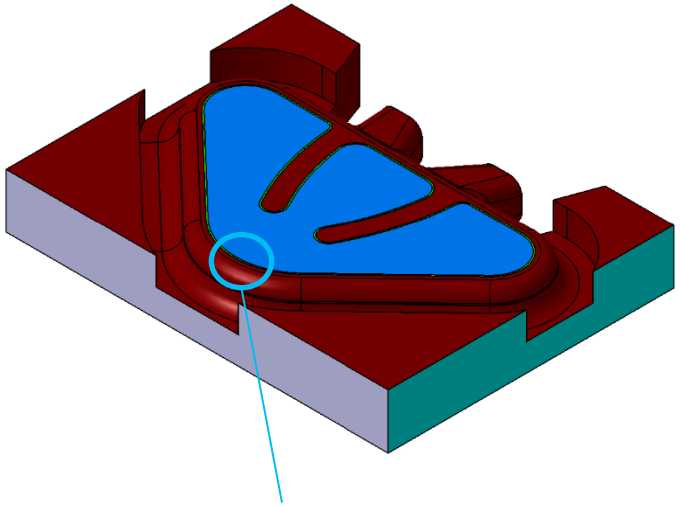


9 assembly parts (way of manufacturing for the blue part similar to the first part)

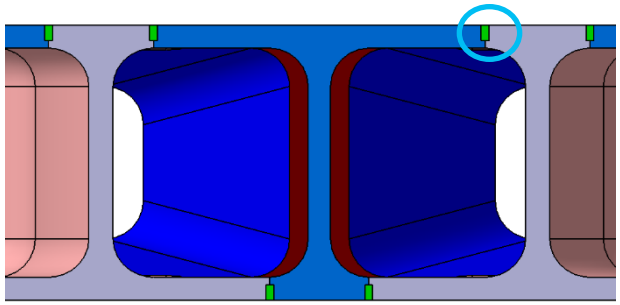
Cold Moderator manufacturing step by step



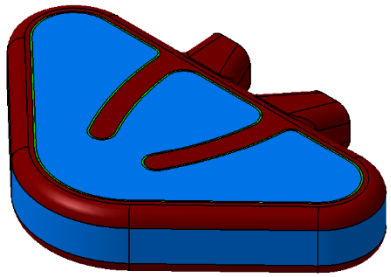
10 milling of the filler groove
(both parts together)



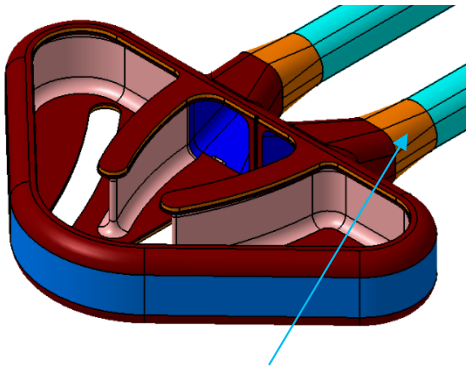
11 assembly of the filler (green part)



Cold Moderator manufacturing step by step

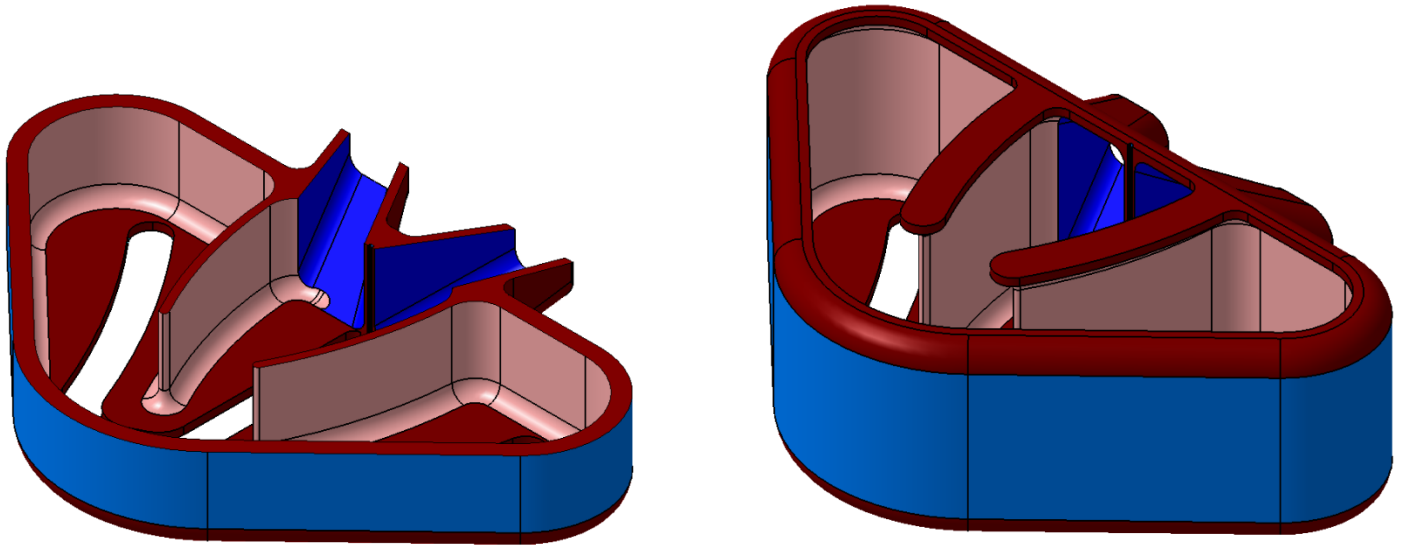


12 ebeam welding



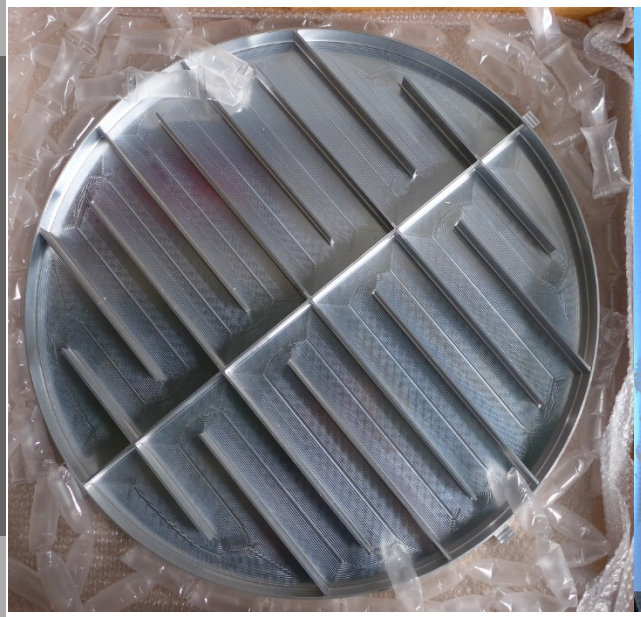
14 welding of the pipe connection
(Al-SS-Invar friction welding)

Cold Moderator (lower)

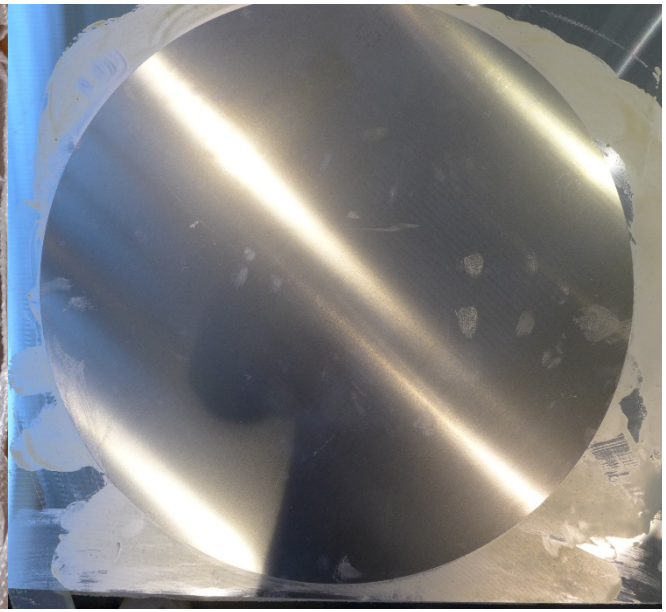


Lower Moderators is a copy of the upper one with 4mm outer wall thickness (stress too high) and 3mm cover plate

Ongoing manufacturing tests (6061-T6 welding via eBeam)



Thermal Moderator disk
(pre Moderator)



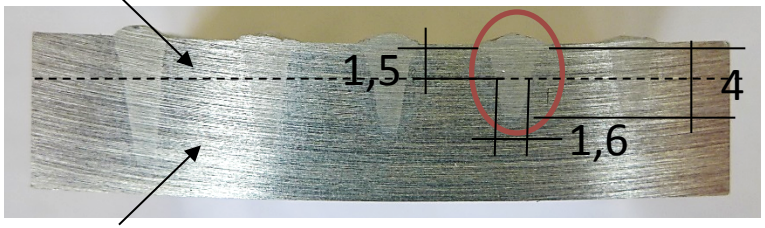
Thermal Moderator cover, full surface
(pre Moderator) fixed by beeswax

Soll-Maß	Ist-Maß 1
ø 694,00	694,05
ø 614,00	613,93
40,00	40,02
20,00	20,01
65,00	65,05
33,00	33,00
3,00	2,95
Ebenheit auf den Rippen	0,04-0,09

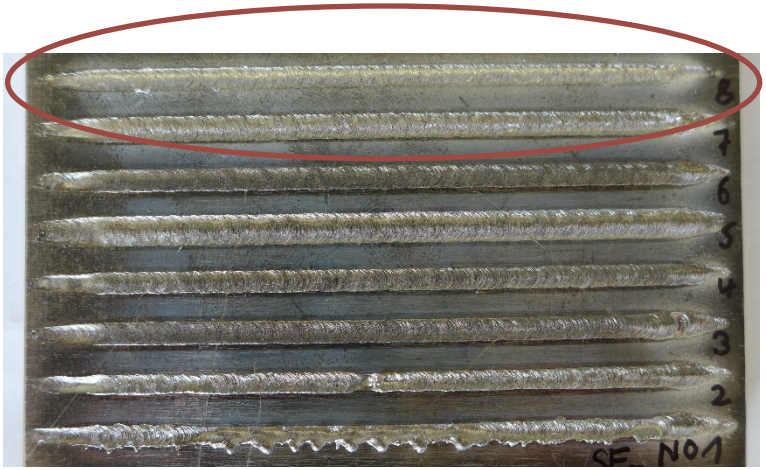
Measurement protocol:
High tolerance via HSC
for eBeam welding

Ongoing manufacturing 2 tests (6061-T6 welding via eBeam)

"Top plate"



"Vessel"



Schweissprotokoll
Elektronenstrahl-Schweißen

JÜLICH FORSCHUNGSZENTRUM

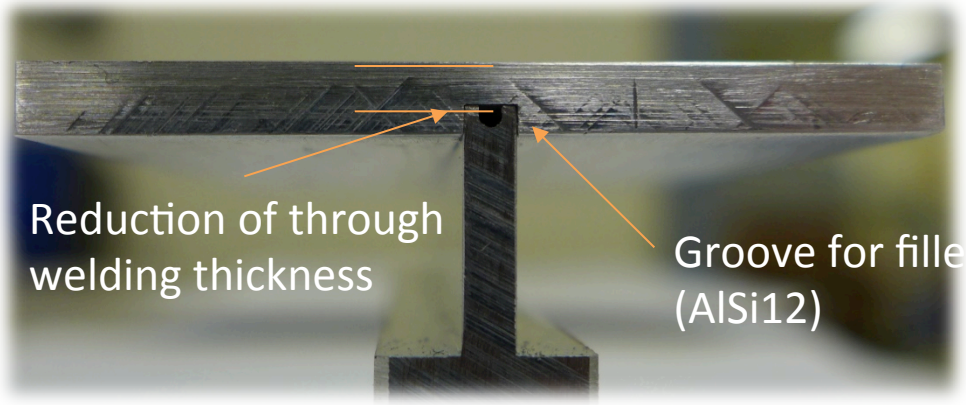
Auftrags-Nr.:	-	Werkstoff:	ALU
Zeichnungs-Nummer:	-	Schweißtiefe:	
Kunde:	Tiemann	Abmessung:	
Bezeichnung:		Reinigung:	Alkohol

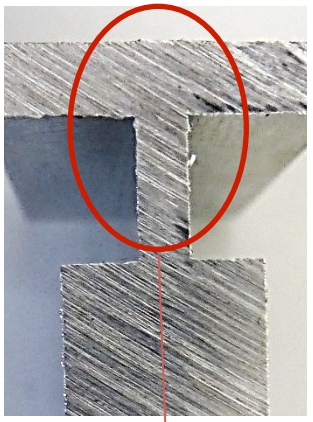
Maschinentyp:	EBM - K40	
Masch.-Operateur:	Hans-Josef Pistel	
Datum:	30. Juli 2015	
Vorrichtung:		
Programm:	LAENG_T2.EBC	
Kathodentyp:	Bandkathode 1.4	
Dateien:		

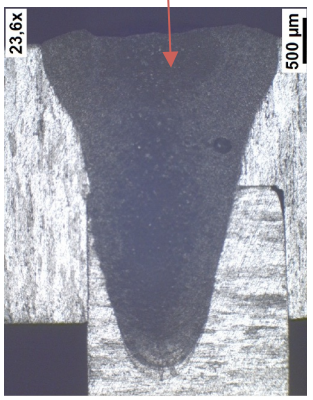
Nr.	U SH (kV)	I SQ (mA)	V F (mm/s)	Korrektur-wert Isk sw	Fokus 1 SL (mA)	Fokus 2 SL (mA)	Ablenkung Amplitude x (mm)	Amplitude y (mm)	Frequenz (Hz)	Figur (neu)	Slope Auf (mm)	Slope Ab (mm)	Arbeits-abstand (vom Tisch) mm	Fokus (mm)	Bemerkung
SF_N01	1500	100	220	408	1956		1,7	1,7	100	E1	10	10		0	
	150 kV	10 mA	22 mm/s							Kreis					
SF_N02	1500	100	220	408	1956		1,7	1,7	1000	E1	10	10		0	
	150 kV	10 mA	22 mm/s							Kreis					
SF_N03	1500	100	220	408	1956		1,7	1,7	10000	E1	10	10		0	
	150 kV	10 mA	22 mm/s							Kreis					
SF_N04	1500	100	220	408	1956		1,7	1,7	10000	E4	10	10		0	
	150 kV	10 mA	22 mm/s							Dreieck in X					
SF_N05	1500	100	220	408	1956		1,7	3	10000	E10	10	10		0	
	150 kV	10 mA	22 mm/s							Kreisbogen in X					
SF_N06	1500	100	220	408	1956		3	1,7	10000	E10	10	10		0	
	150 kV	10 mA	22 mm/s							Kreisbogen in X					
SF_N07	1500	100	220	408	1956		3	1,7	10000	E23	10	10		0	
	150 kV	10 mA	22 mm/s							Sinus quer					
SF_N08	1500	70	220	408	1956		1,5	1,5	10000	E1	10	10		0	
	150 kV	7 mA	22 mm/s							Kreis					

→Variation a.o. of the beam power to find the best parameters for AL6061 with AlSi12 filler

Ongoing manufacturing tests 3 (6061-T6 welding via eBeam)



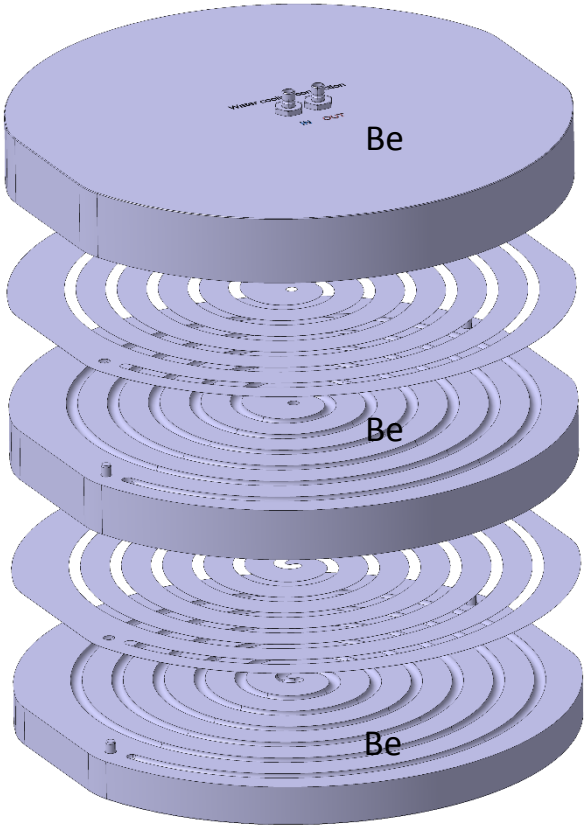




→test welding of double T-structures to contact the fluid guides with cover plates (thermal Moderators)

Through weld test: no side contact needs to be optimized

Alternative Reflector concept

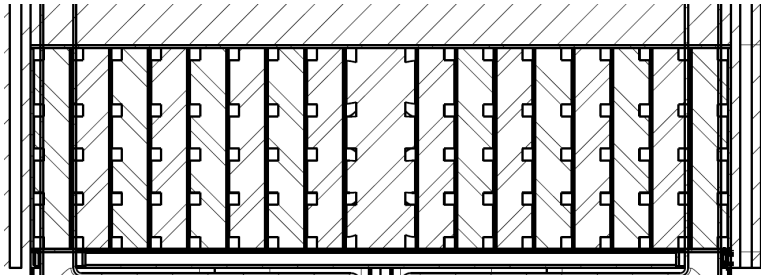


Rough improvement concept

- 3 easily cylinders with cooling channels
- Channels in series (no risk of clogging)
- No housing (problem with cooling)
- Easily separation / recycling (save money)
- Sealing the discs like SNS target via soft iron sealing

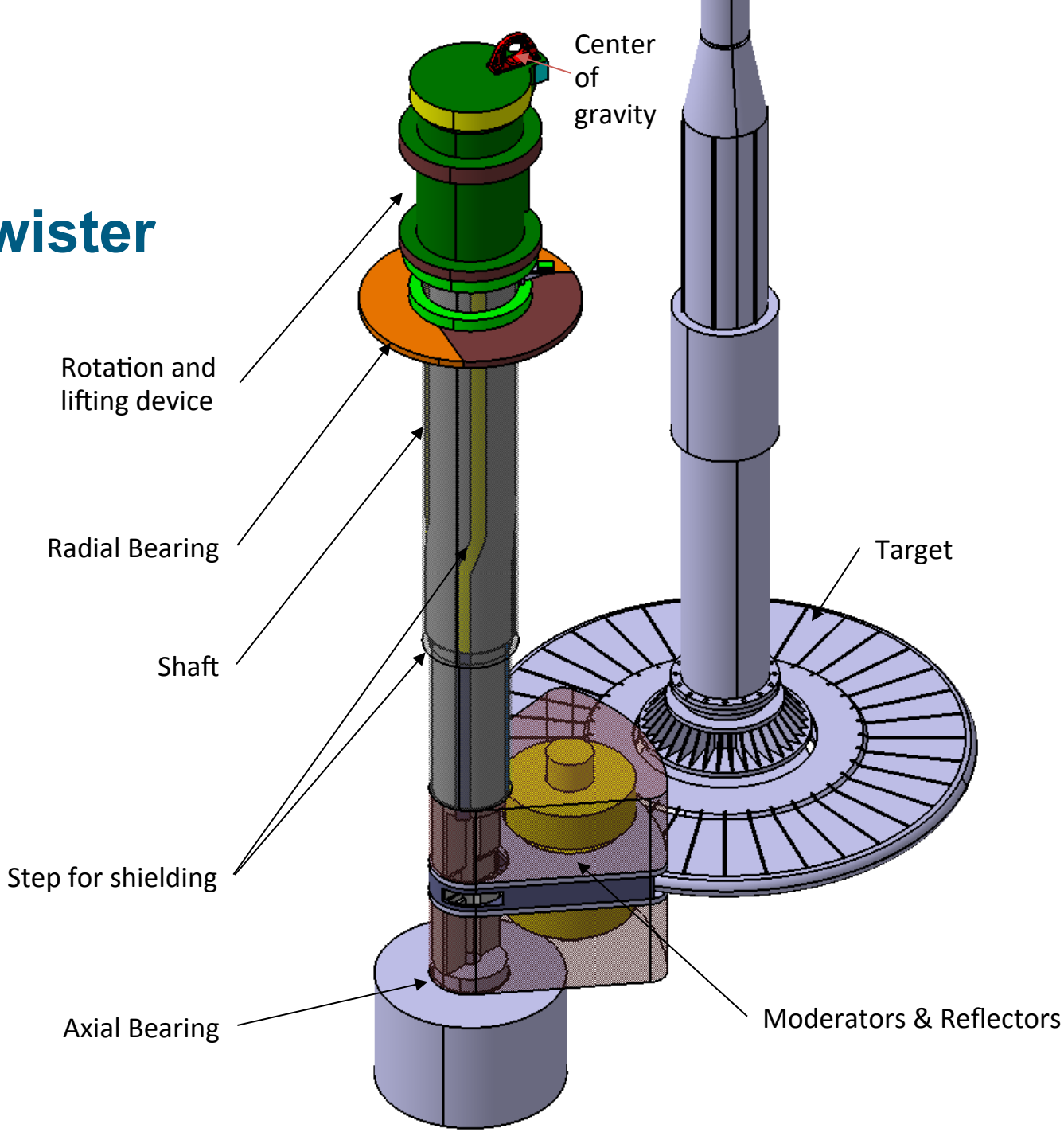
➢ High detail level of the PDR concept therefore good fallback solution

➢ Concept decision in agreement with Lund end of October

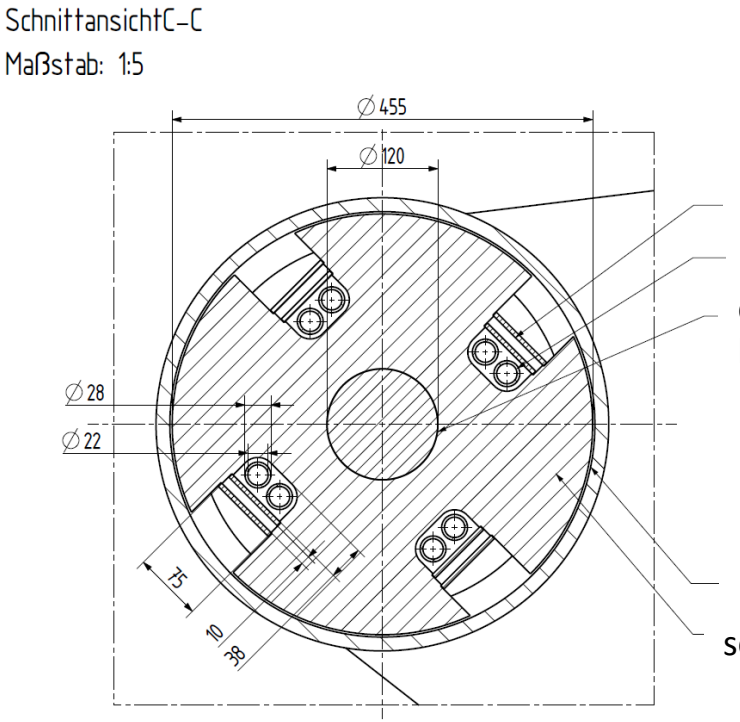


PDR concept (Be rings with Al walls between the rings)

Twister


Center of gravity
Rotation and lifting device
Radial Bearing
Shaft
Target
Step for shielding
Axial Bearing
Moderators & Reflectors

Shaft concept

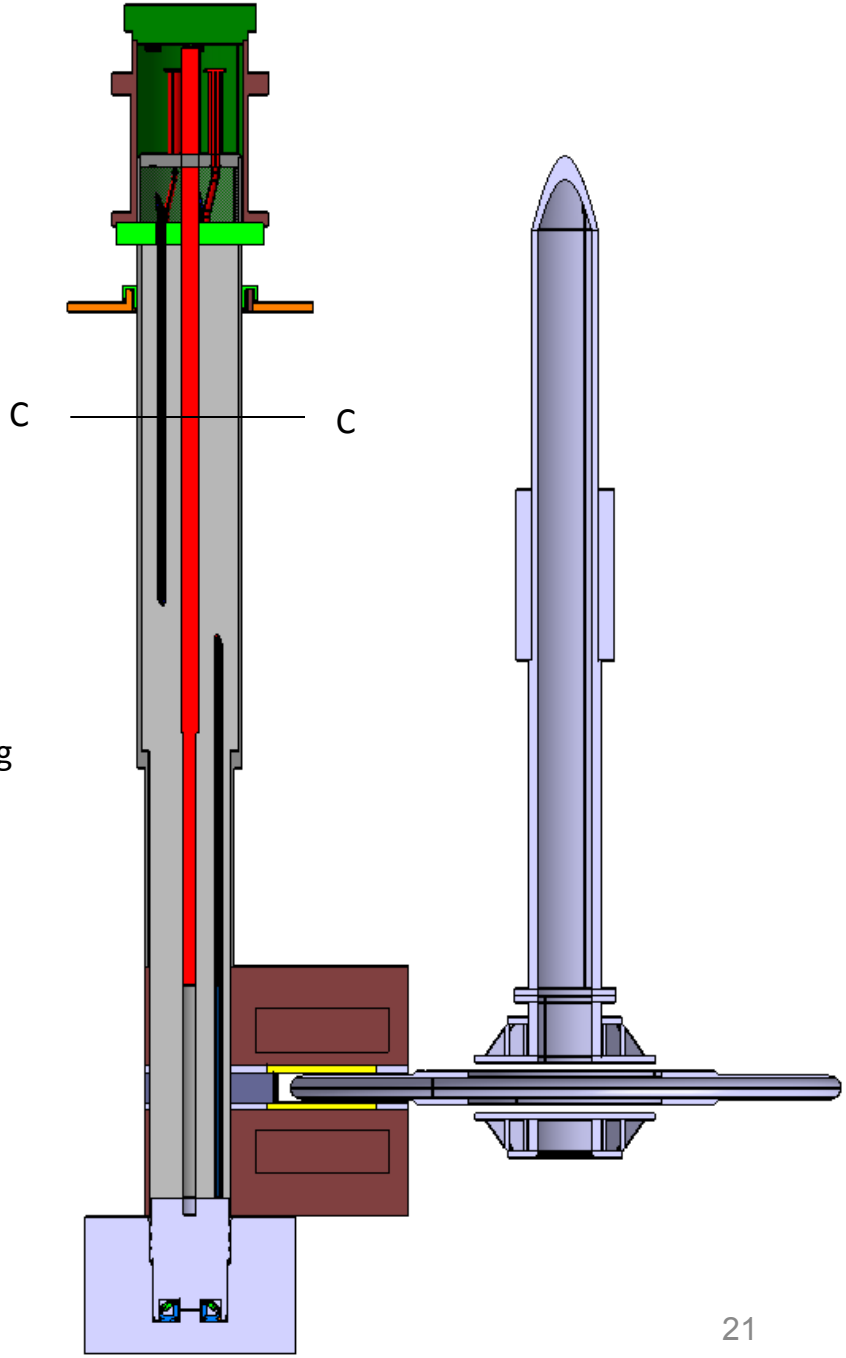


Cooling water (>750mm²)

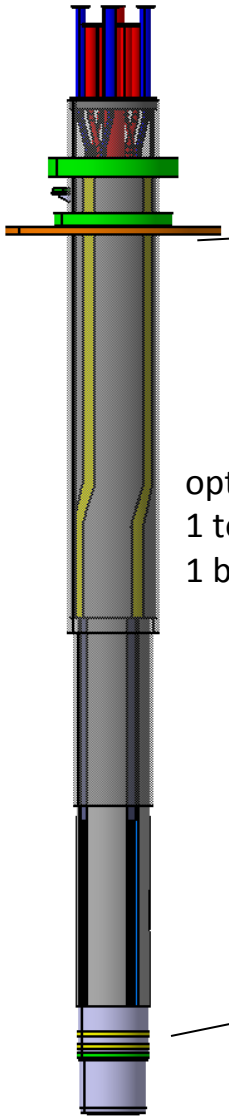
LH2 pipework

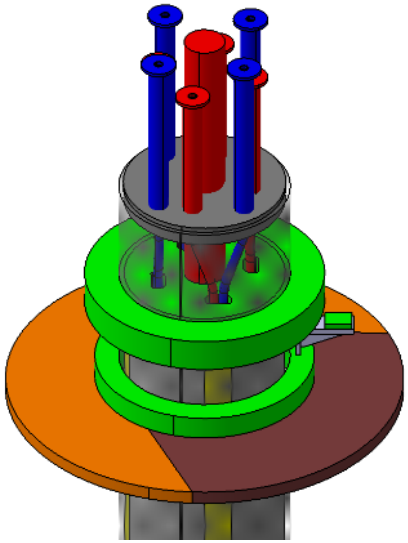
core and axial bearing cooling

solid shaft

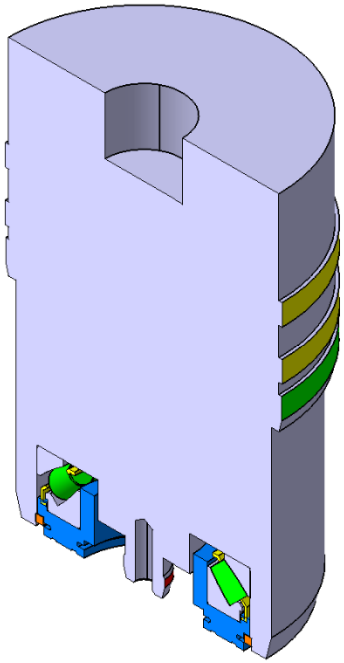


Twister bottom bearing

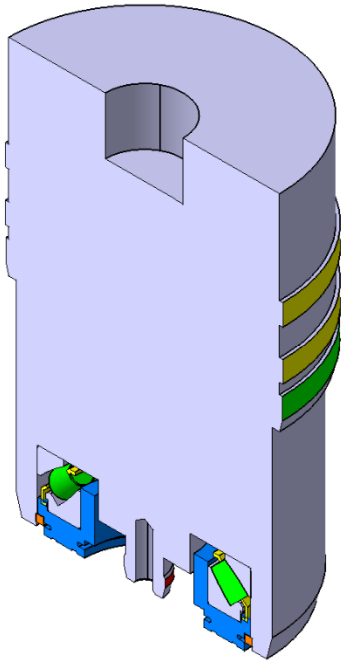


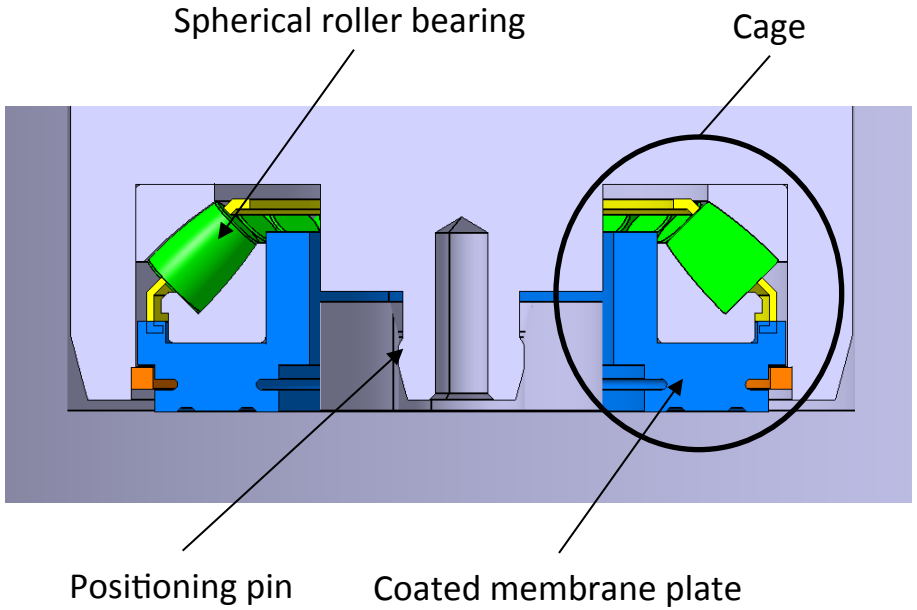


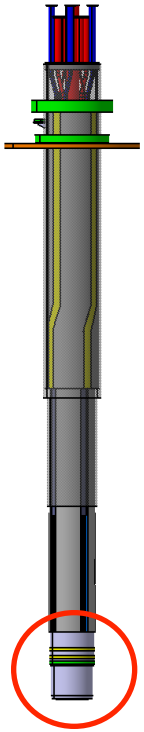
optimized design
1 top bearing (radial)
1 bottom bearing (axial)



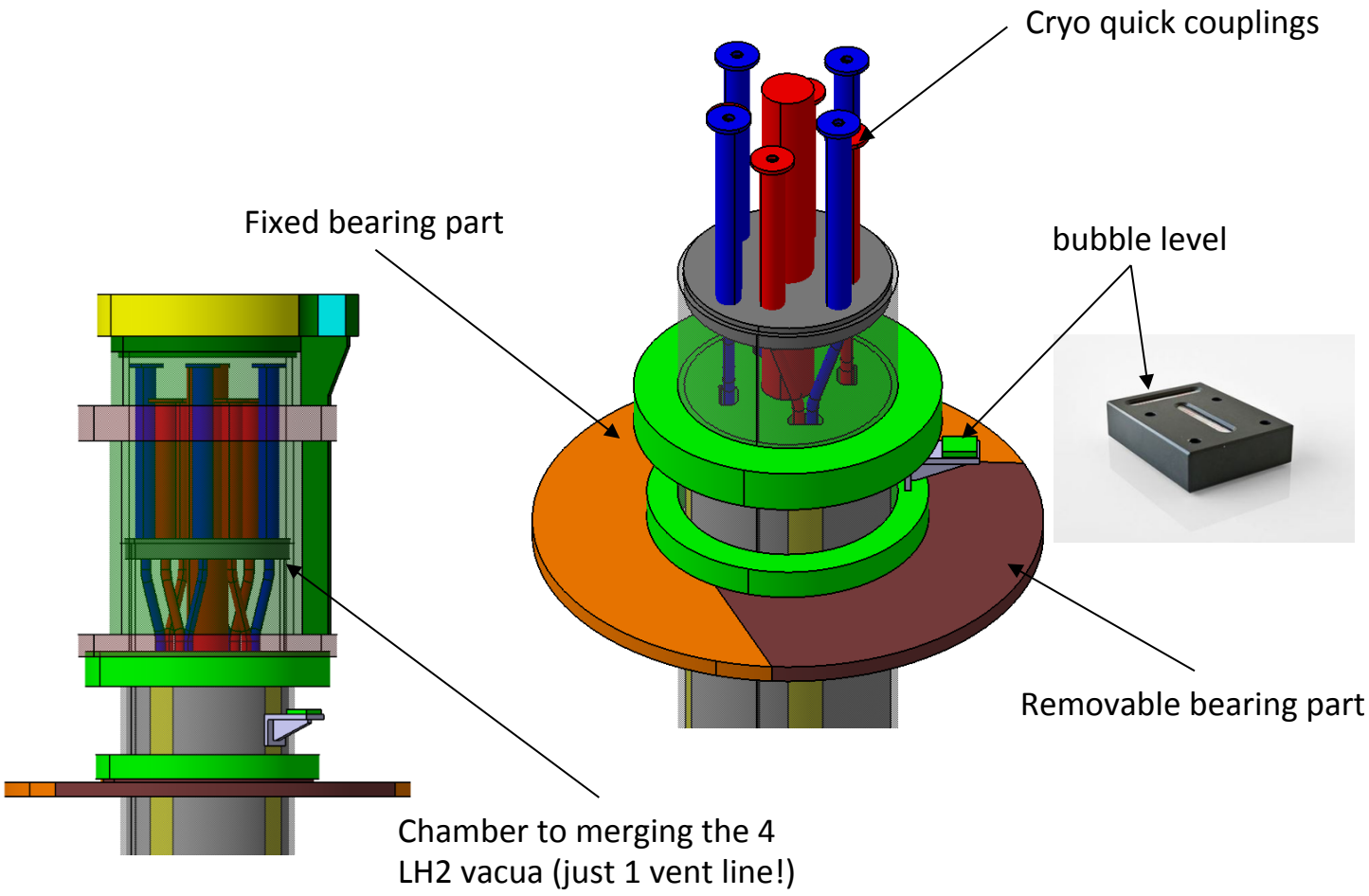
Twister bottom bearing

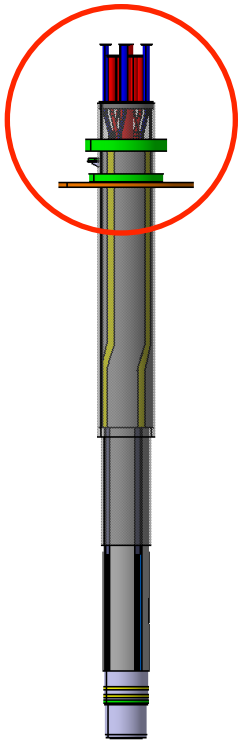






Twister top bearing





Focus areas of the next weeks

- **Preliminary Design optimization** planned to be ready in October (change meeting to be convened shortly [Nov.])
- **Cold Moderator incl. Pipework**: machining, eBeam welding, leak test, burst test, X-ray, Invar to Invar weld test, Invar to Stainless Steel weld test
- **Fluid dynamic analysis** for thermal and cold Moderators verification
- **Structural mechanical analysis** for Twister, Moderators, Reflectors
- **Ordering components** with long lead time (LH2 Pumps, Be)
- **RCC MRx** training and understanding how we can use it for cryogenic component / beryllium / ..