

## IS ENGINEERING

M. Garlaschè; A. Dallochio; D. Steyaert

on behalf of L4 IS Team

Integrated mechanical design and engineering:

- analytical/Finite Element analyses
- experimental tests

From conceptual design to product engineering...

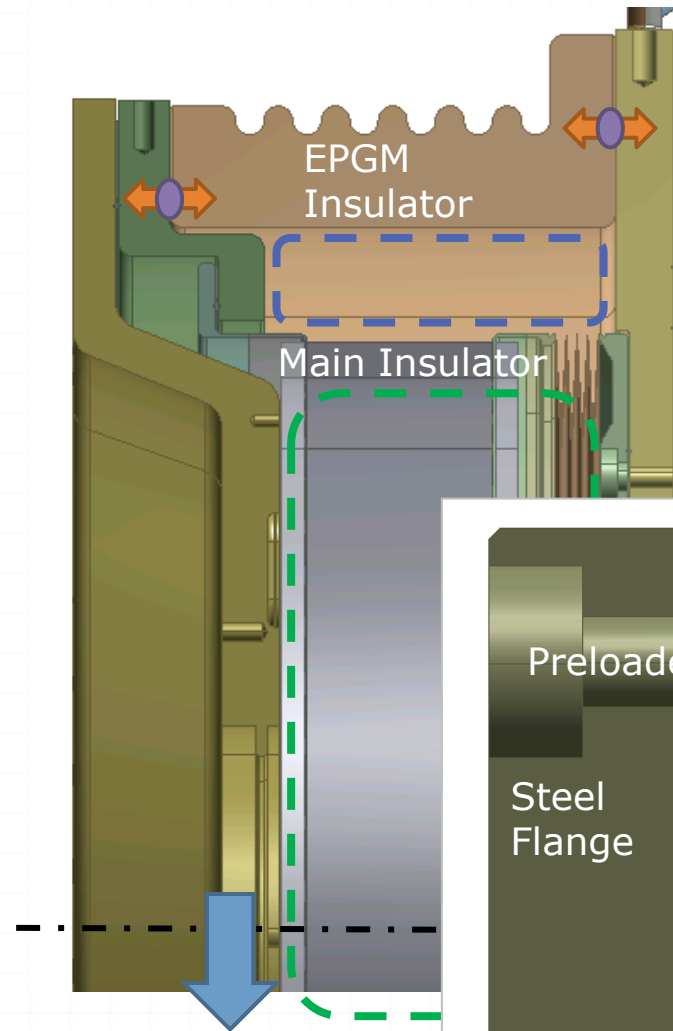
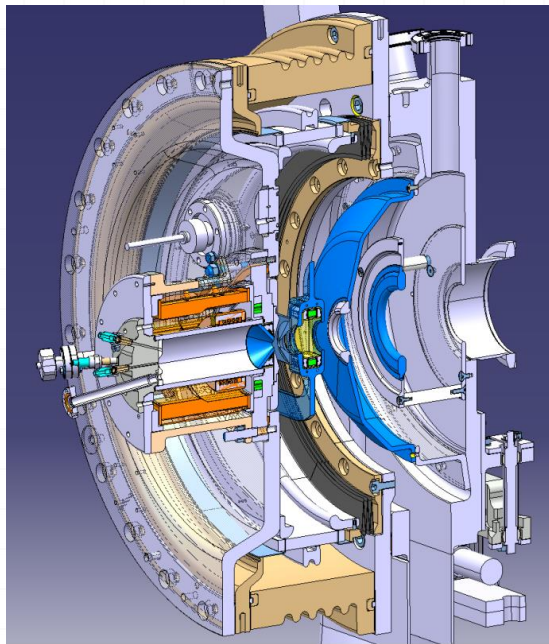
				L4-ISWP		
drawing <i>SPLNFHR ...</i>		_	D	E	F	G
units produced :		DESY	SLHC	ISO1	ISO2	ISO3
Design / Eng. / Prod.	<u>Frontend, support</u>	o		2	-	-
	<u>Pumping port</u>					
	<u>Main insulator</u>	o		2	x	x
	Extraction optics	o		2	x	x
	<u>Plasma Generator</u>	1	o	2	2	1
	<u>Flange</u>	o		2+	2-x	x
	RF-Transfo-Matching	o	o	2	-	-
	<u>Handling-gear</u>	o		1	x	x
o : obsolete			2	Produced and sucessfully tested		
x : mandatory work			2	Produced being tested		
			2	Partially/not yet designed		
			2	Produced but Failed		

Courtesy J. Lettry

# IS01 - Front End

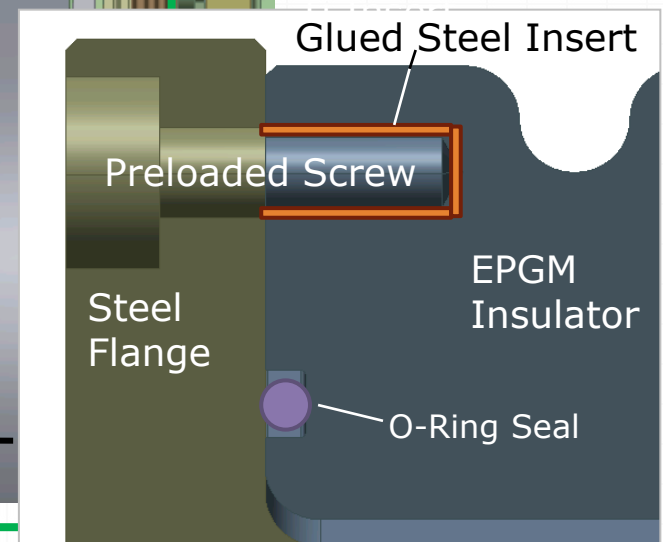


		L4-ISWP		
drawing SPLNFHR ...		E	F	G
units produced :		IS01	IS02	IS03
Design / Eng. / Prod.	Frontend, support	2	-	-
	Pumping port	2	x	x
	Main insulator	2	x	x
	Extraction optics	2	x	x
	Plasma Generator	2	2	1
	Flange	2+	2-x	x
	RF-Transfo-Matching	2	-	-
Handling-gear	1	x	x	
o : obsolete		Produced and successfully tested		



## Main Loads

- Plasma Generator →
- 1<sup>ary</sup> vacuum - - - -
- 2<sup>ary</sup> vacuum - - - -
- O-Ring Seal ↔



Engineering Department

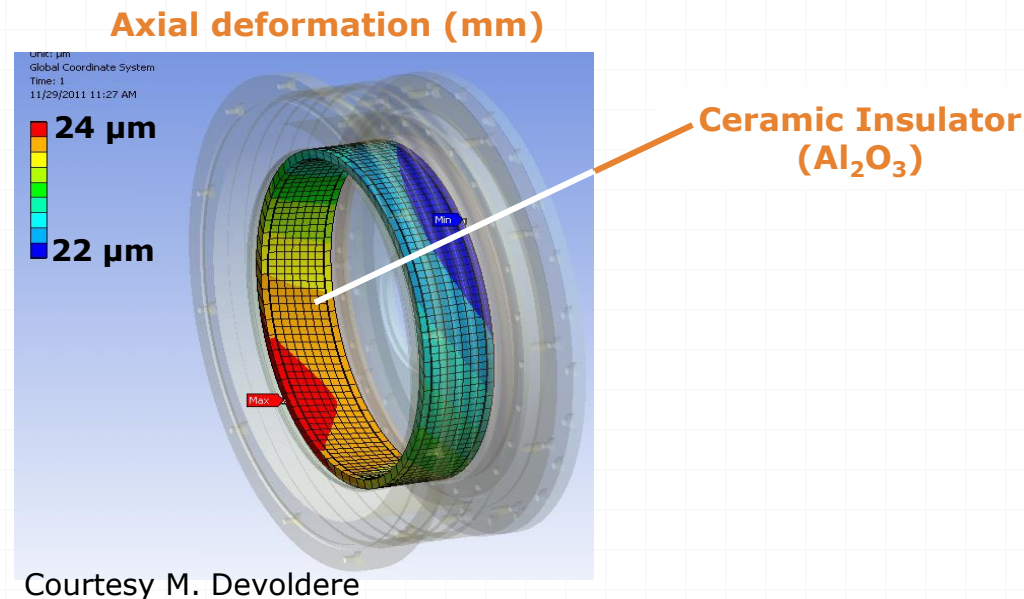
## Goal

- Structural analysis of IS Front End
- Assess performance of EPGM External Insulator

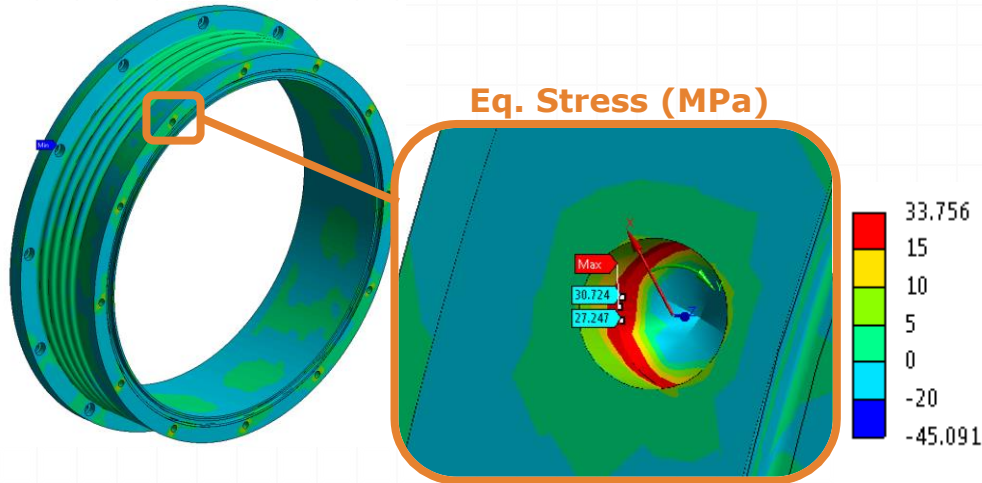


## Results

- Worst case loading condition **identified**  
Loss of primary vacuum
- Resistance of structure **confirmed**  
Max: 20MPa on generator flange
- Deformation of components **negligible**  
Few  $\mu\text{m}$  axial displacement on ceramic Main Insulator and Generator Flange

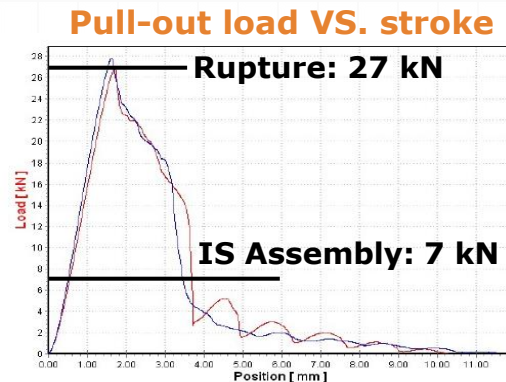


## EPGM Insulator Results

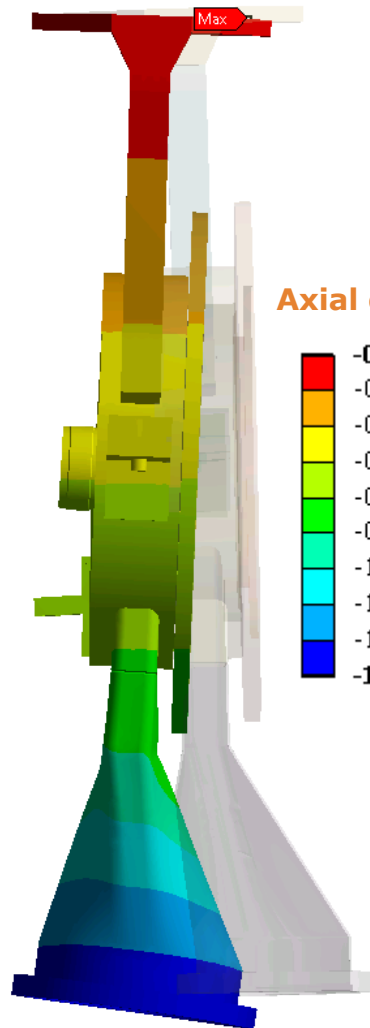


- Global stresses **OK**
- **Peak stress** in correspondance of inserts..

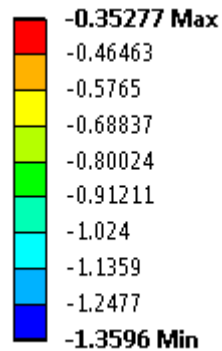
## Pull-out Test



- **Validation** of resistance to screws tightening force
- Choice of Insulator **fiber orientation**



Axial displacement (mm)



		L4-ISWP		
drawing SPLNFHR ...		E	F	G
units produced :		IS01	IS02	IS03
Design / Eng. / Prod.	Frontend, support	2	-	-
	Pumping port	2	x	x
	Main insulator	2	x	x
	Extraction optics	2	x	x
	Plasma Generator	2	2	1
	Flange	2+	2 - x	x
	RF-Transfo-Matching	2	-	-
	Handling-gear	1	x	x
o : obsolete		Produced and successfully teste		

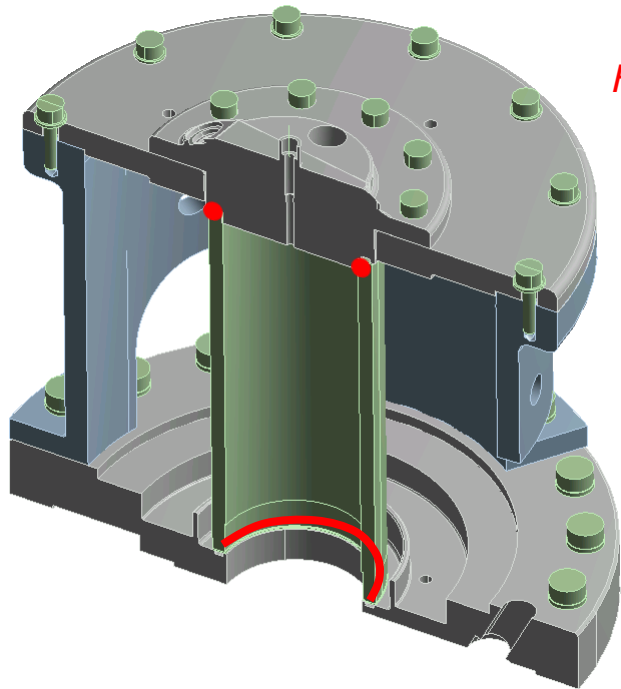
## Goal

- Assess resistance of components
- Minimize Front End displacements (beam axis)

## Results

- Stresses **negligible**
- **Improved Support stiffness** to obtain acceptable deformations

# IS02 – Plasma Generator

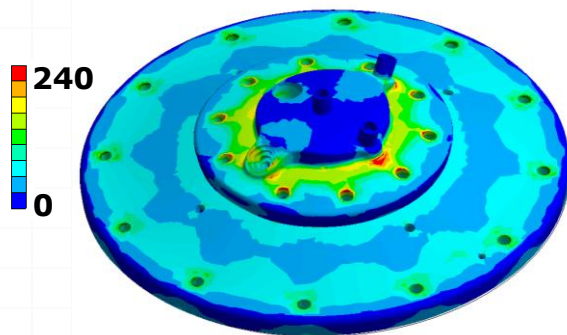


*Helicoflex seals*

		L4-ISWP		
drawing SPLNFHR ...		E	F	G
units produced :		IS01	IS02	IS03
Design / Eng. / Prod.	Frontend, support	2	-	-
	Pumping port	2	x	x
	Main insulator	2	x	x
	Extraction optics	2	x	x
	Plasma Generator	2	2	1
	Flange	2+	2-x	x
	RF-Transfo-Matching	2	-	-
	Handling-gear	1	x	x
o : obsolete		Produced and successfully tested		

## Goal

Design towards UHV standard by implementing metallic seals



**Tresca equivalent stress (MPa)**

## Results

- Stresses: design **optimized**
- Assembly procedure: vacuum tightness guaranteed by using special metallic seals (HNRV helicoflex)

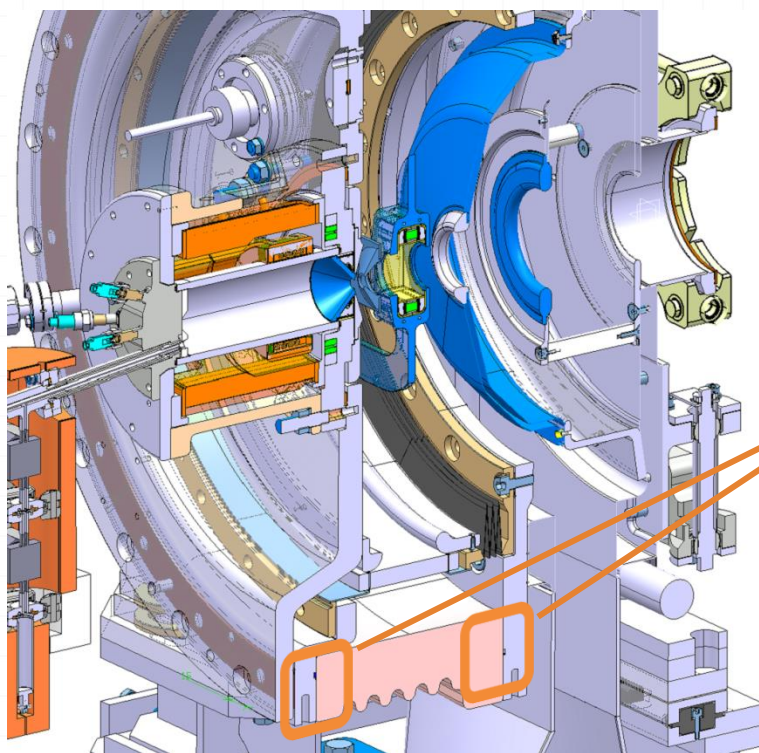
# IS02/03 v1- Ext. Insulator



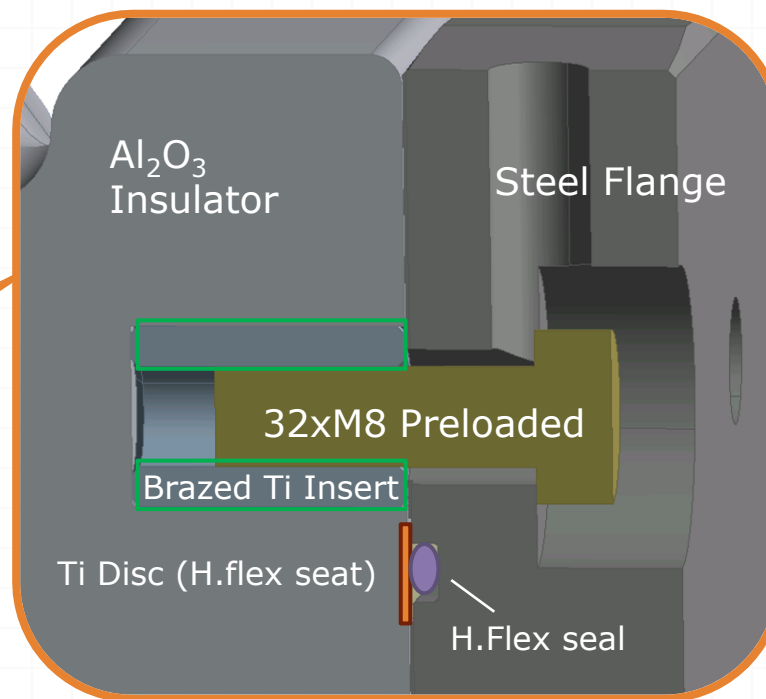
## Goal

- Improved UHV reliability with metallic seals
- EPGM →  $\text{Al}_2\text{O}_3$

		L4-ISWP		
drawing SPLNFR ...		E	F	G
units produced :		ISO1	ISO2	ISO3
Design / Eng. / Prod.	Frontend, support	2	-	-
	Pumping port	2	x	x
	Main insulator	2	x	x
	Extraction optics	2	x	x
	Plasma Generator	2	2	1
	Flange	2+	2-x	x
	RF-Transfo-Matching	2	-	-
Handling-gear	1	x	x	
		o : obsolete	Produced and successfully tested	



Complex brazing of Titanium Inserts with Insulator



Engineering Department





# IS02/03 v1- Ext. Insulator



## Goal

- Improved UHV reliability with metallic seals
- EPGM → Al<sub>2</sub>O<sub>3</sub>

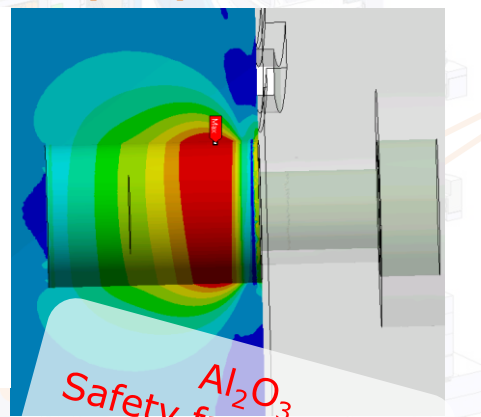
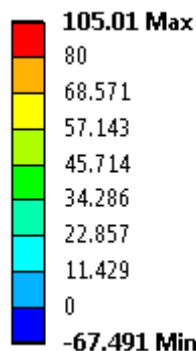
		L4-ISWP		
drawing SPLNFR ...		E	F	G
units produced :		IS01	IS02	IS03
Design / Eng. / Prod.	Frontend, support	2	-	-
	Pumping port	2	x	x
	Main insulator	2	x	x
	Extraction optics	2	x	x
	Plasma Generator	2	2	1
	Flange	2+	2-x	x
	RF-Transfo-Matching	2	-	-
Handling-gear	1	x	x	
		o : obsolete	Produced and successfully tested	

## Outcome

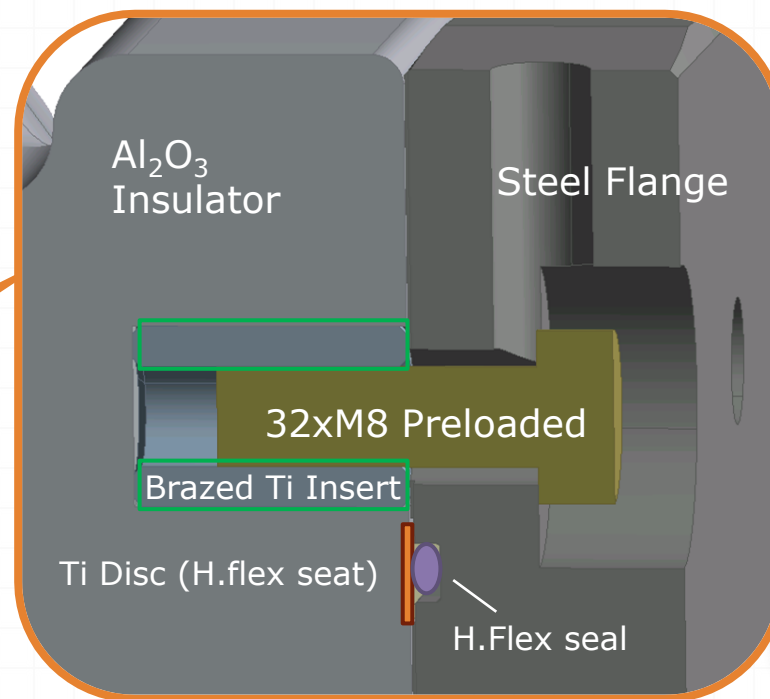
- **High stress** in ceramic
- **Test campaign** launched for
  - Checking brazing procedure
  - Mastering bolts preload
  - Understanding Al<sub>2</sub>O<sub>3</sub> struct. behaviour

Complex brazing of Titanium Inserts with Insulator

Principal stress (MPa)



Al<sub>2</sub>O<sub>3</sub>  
Safety factor = 1.4  
→ **CRITICAL!**



Engineering Department

EN

## *..mastering bolts preload*



- Influence of Ti thermal treatment on friction @ preload  
**Friction increases** after Titan thermal treatment
- Change of friction coefficient during lifetime  
**No measured change** (NOTE: to be ideally assembled once)

Courtesy EN/MME-ES

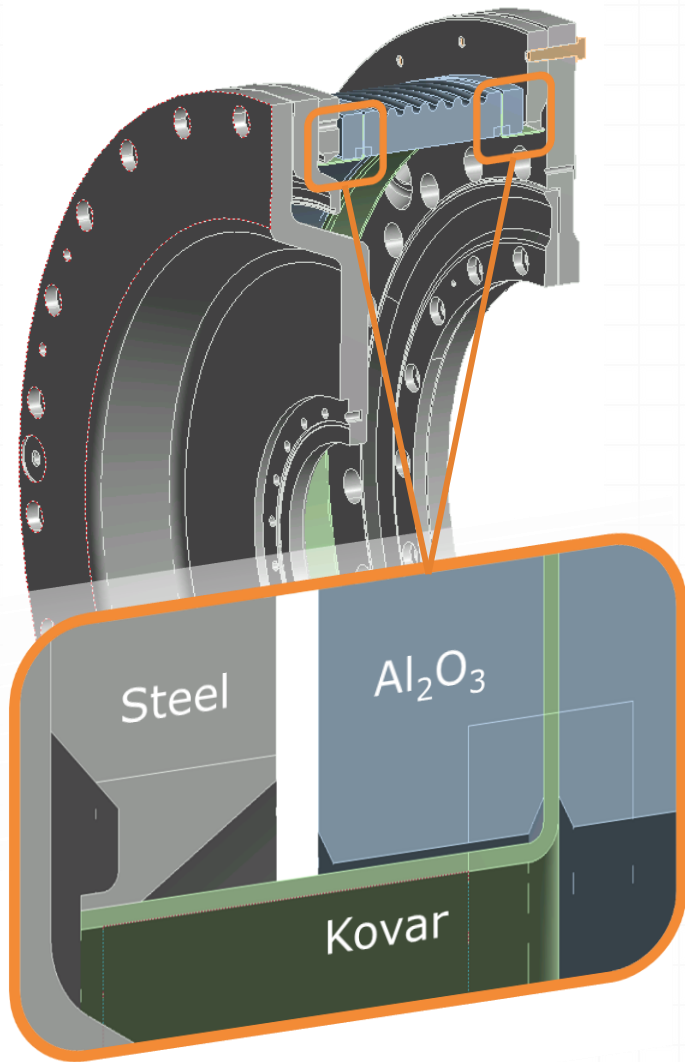
## *..understanding Al<sub>2</sub>O<sub>3</sub> properties*



Tests foreseen

- Rupture properties
- Tightening brazed insert
- Pull-out

**Ongoing – needed  
for brazing &  
struct. assessment**



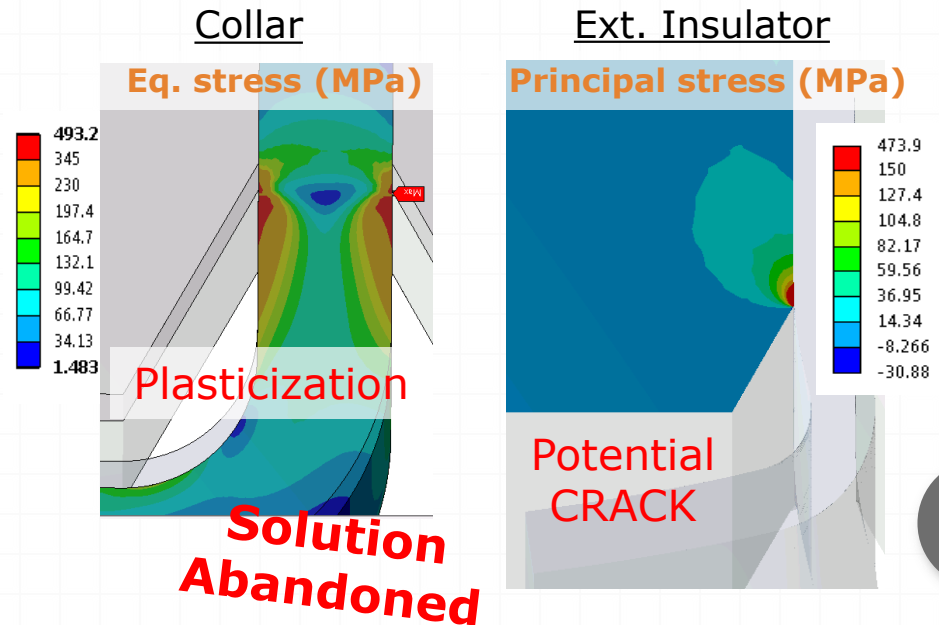
## Goal

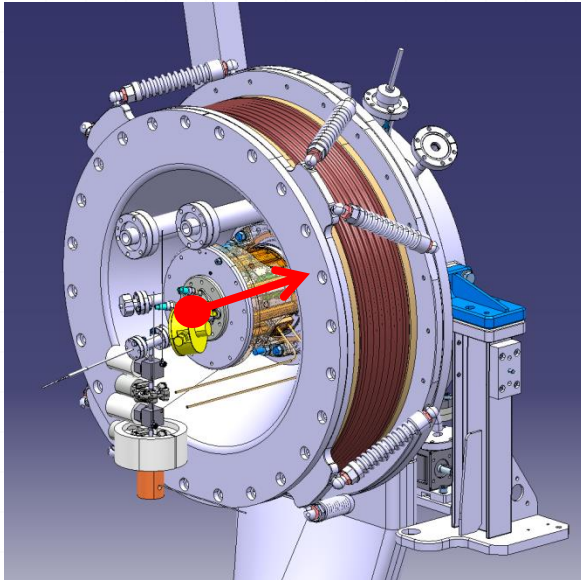
Alternative design with

- No brazed inserts
- Insulator ( $\text{Al}_2\text{O}_3$ ) brazed to collars (Kovar)

## Outcome

Vacuum-related load transmitted solely through collar-insulator





## Goal

- Alternative design with Insulator brazed to collars
- Reduce load on collar and Ext. Insulator by bellow + support rods
- New Requests:
  - improve optics → no 2ary vacuum

## Results

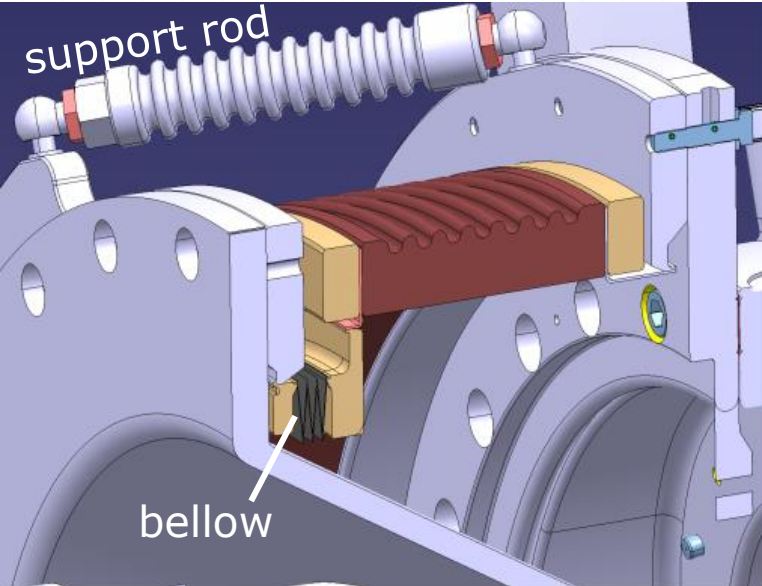
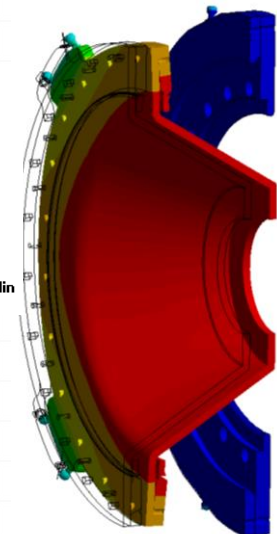
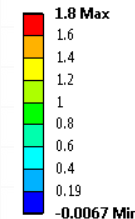
Stresses: negligible

Displacements

..elastic, predictable

**BASELINE**  
Optimization ongoing for  
reducing displacements

Axial displ. (mm)



# Conclusions and future outlook



		<i>drawing SPLNFHR ...</i>	E	F	G
			IS01	IS02	IS03
Product Engineering	Front-end, support				
	Pumping port	✓	✓		
	Main insulator	✓	✓	✓	
	Extraction optics				
	Plasma Generator			✓	
	Flange	✓	✓		
	Handling-gear	✓			
IS-TS 152	IS-test stand 152		✓		
Ancillaries	Pumping system	✓			
	Cs-Oven		✓		
	Cs-test stand 357		✓		

June 2011 → Present:

	Completed
	On-going

**Engineering activities required  $\approx$  3 FTE (2 Fellows working 50% on the L4 IS)**

Present → future...

	On-going
	To be done

**Estimate for future engineering activities  $\approx$  1,5 FTE (1 Fellow working 50% on the L4 IS)**

## What's Next (IS02 / IS03):

- Design finalization of Front-End and Ext. Insulator: structural analysis and experimental validation
- Cesium Oven – thermo-mechanical calculations
- Structural analysis to integrate IS03 Plasma Generator
- Cold Cs Trap: thermal analysis



**Thank you for your Attention!**

Engineering Department

EN

