Fermilab

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STC upgrade - Conceptual design

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17 May 2016

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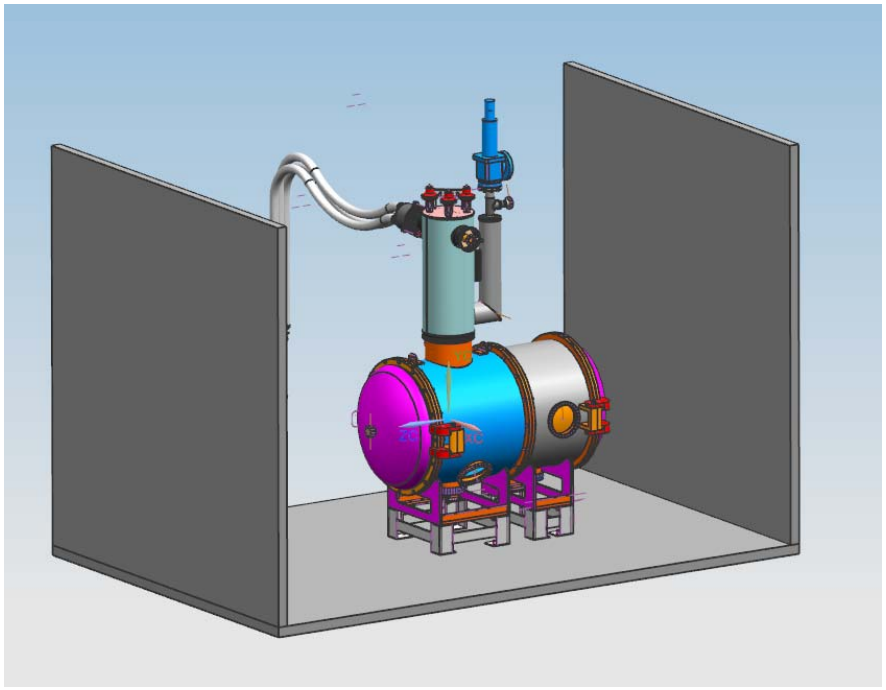
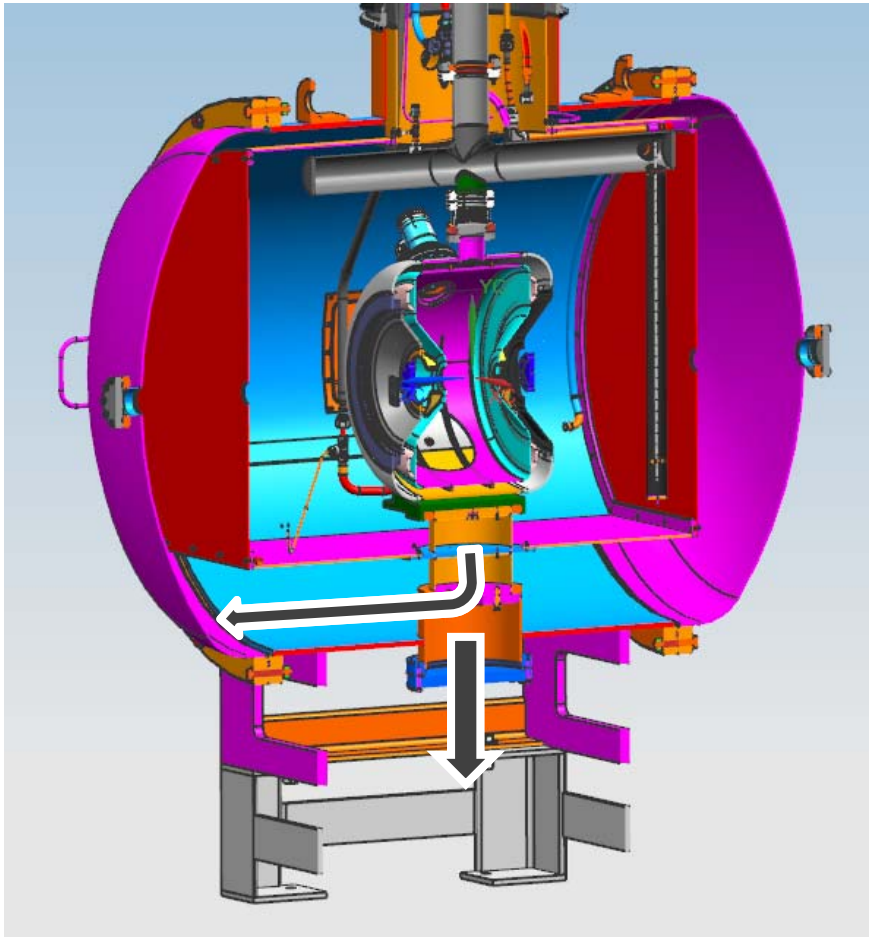
1. Requirements



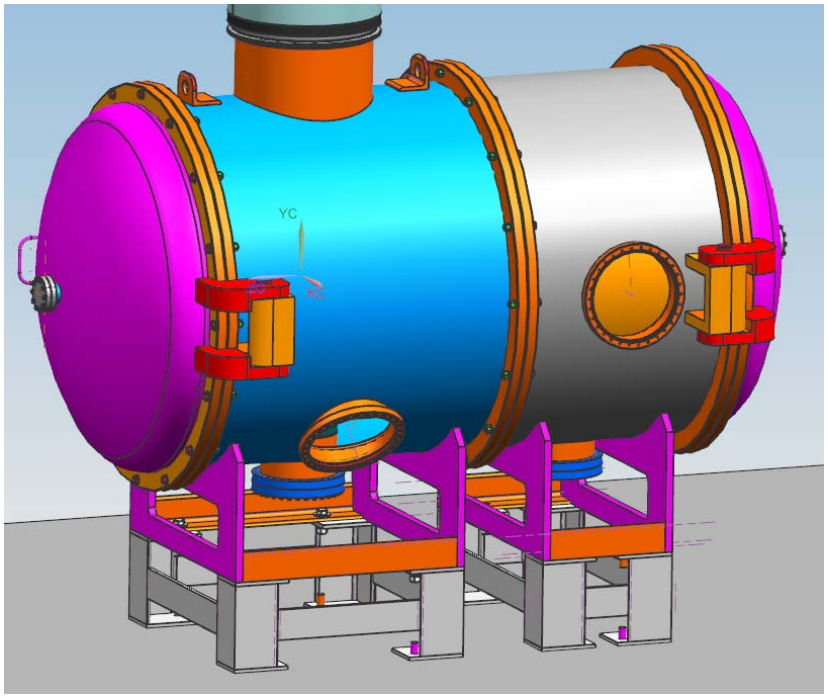
- Fit SSR1, SSR2 and HB650 inside
- Keep the thermal and magnetic shields as-is
- Remove the supporting post
- Be able to open completely the two doors of the vacuum vessel
- Leave the original STC in its current location

2. Dismounting



1. The door on the right will be dismounted.
2. The closures on the thermal shield will be removed.
3. The two phase helium pipe will be dismounted and some modifications will be done.
4. Temporary supports for the thermal shield will be set up.
5. The thermal shield will be disconnected from the supporting post.
6. The top part of the supporting posts will be cut and the interface with the thermal shield will be unscrewed.
7. Then the bottom part will be disconnected from the top part.
8. Finally the top part will be removed.
9. Some cryogenic lines will be modified.

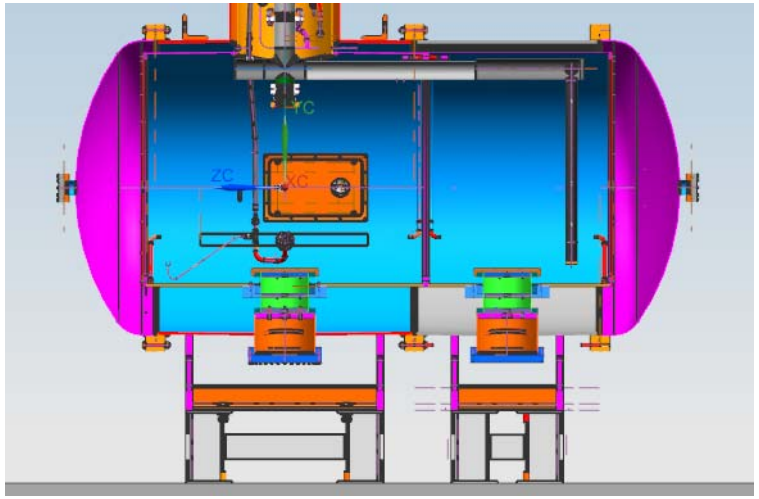
3.1 Modification of the vacuum vessel



Having an extension's length of 765 mm, it is still possible to open the door completely.

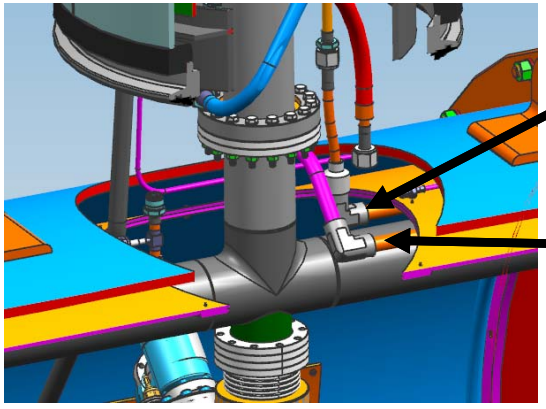
A supporting posts and a coupler port have been set up on the extension.

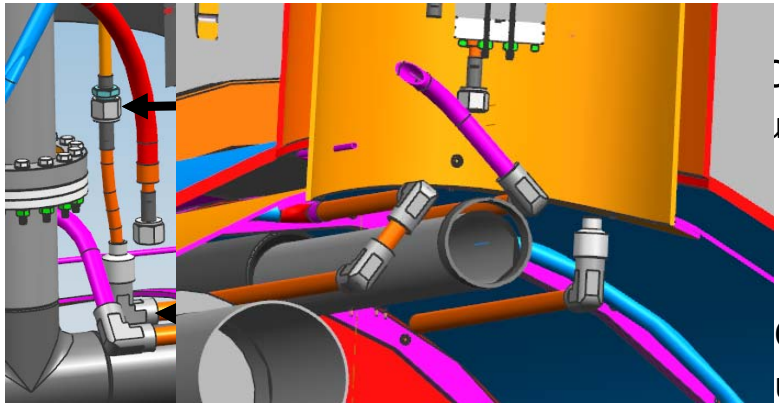
3.2 Modification of the thermal shield and 80K line



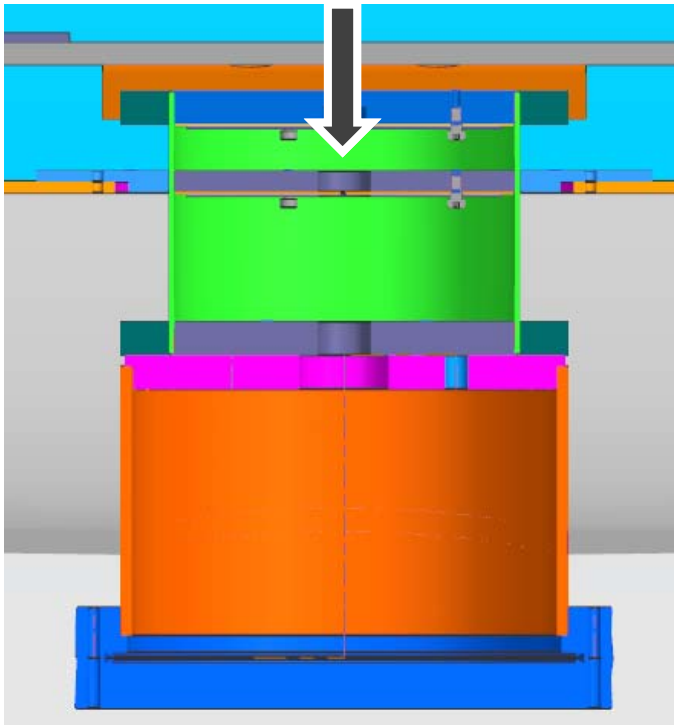
The existing thermal shield won't be modified, in the same way as we did for the vacuum vessel, an extension can be added.

It will be necessary to re-design partially the 80K line. The LN2 inlet won't be modified, just the outlet.





3.3 Modifications of the supporting posts



The height of the supporting has been reduced around 50 mm.

The design of the top part is based on the design used for SSR1 and HB650 cryomodule.

4. Heat loads

- Heat loads by conduction

STC now

Diameter G10 (m)	0.2
Thickness G10 (m)	0.003
Length 80K to 300K in G10 (m)	0.07625
Length 2K to 70K in G10 (m)	0.07615
Q 80K (W)	3.04
Q 2K (W)	0.51

STC upgrade

Diameter G10 (m)	0.2
Thickness G10 (m)	0.003
Length 80K to 300K in G10 (m)	0.07375
Length 2K to 80K in G10 (m)	0.026463
Q 80K (W)	2.21
Q 2K (W)	1.47

---------- For each supporting post ----------

+1.8 W from the chimney of the vacuum vessel on the 80K stage
+ 0.4 W from the chimney of the vacuum vessel on the 2K stage

- Heat loads by radiation

On the 80K stage around 8.5 W
On the 2K stage around 0.6 W

On the 80K stage around 12.3 W (1.5 W/m^2)
On the 2K stage around 1 W

- Synthesis

Around 14 W at 80K,
and 1.5 W at 2K in static
+ dynamic

Around 26 W at 80K,
and 4.4 W at 2K in static
+ 24 W in dynamic

→ 1.25 g/s

5. Venting requirements

The pipe sizing has been calculated considering a pressure of 4.76 bar and a gas temperature at the outlet of 6.9 K.

Scenario : Loss of insulating vacuum

Surface area of helium	1.50	2.10	m2
Heat flux	6000	40000	W/m2
Heat input	Q	93000	W
Latent heat 4He	L	23	$kJ.kg^{-1}$
Helium flow evaporated from loss	q_m	4.04	$kg.s^{-1}$
		14557	kg/h

If the flow is subcritical

Minimum cross-sectional flow area	A	1733.93	mm2
Diameter of the nozzle	D	46.99	mm

Scenario : Cavity vacuum loss

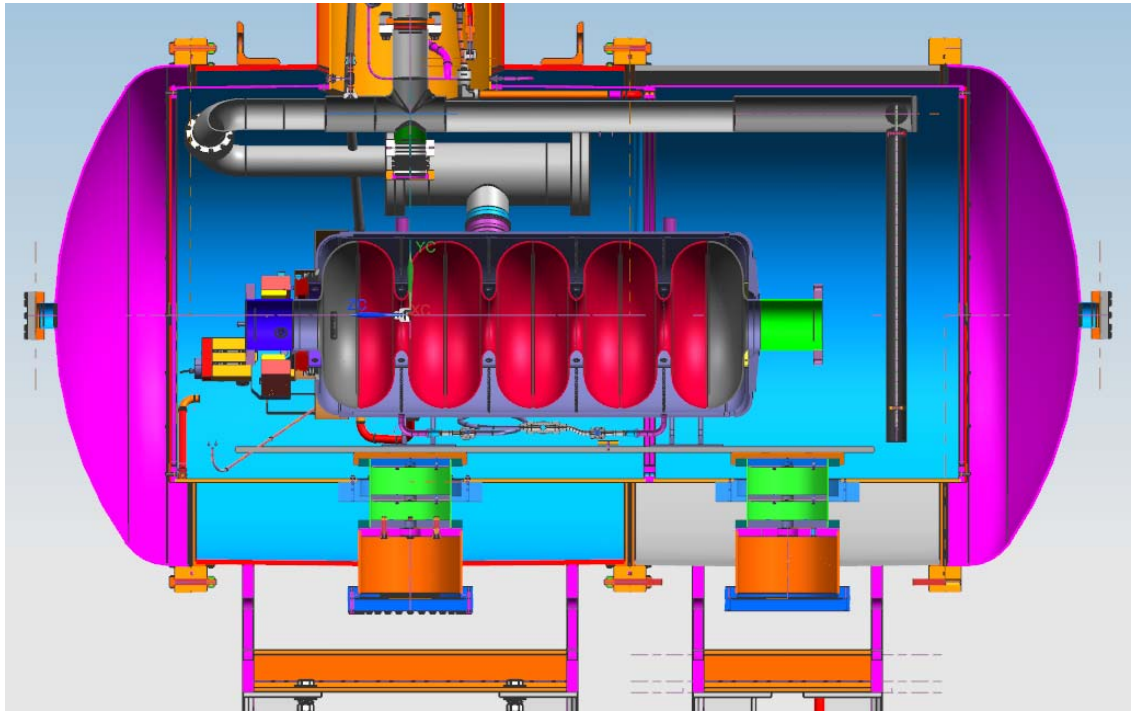
Surface area of helium		1.81	m2
Heat flux		40000	W/m2
Heat input	Q	72237	W
Latent heat 4He	L	23	$kJ.kg^{-1}$
Helium flow evaporated from loss	q_m	3.14	$kg.s^{-1}$
		11307	kg/h

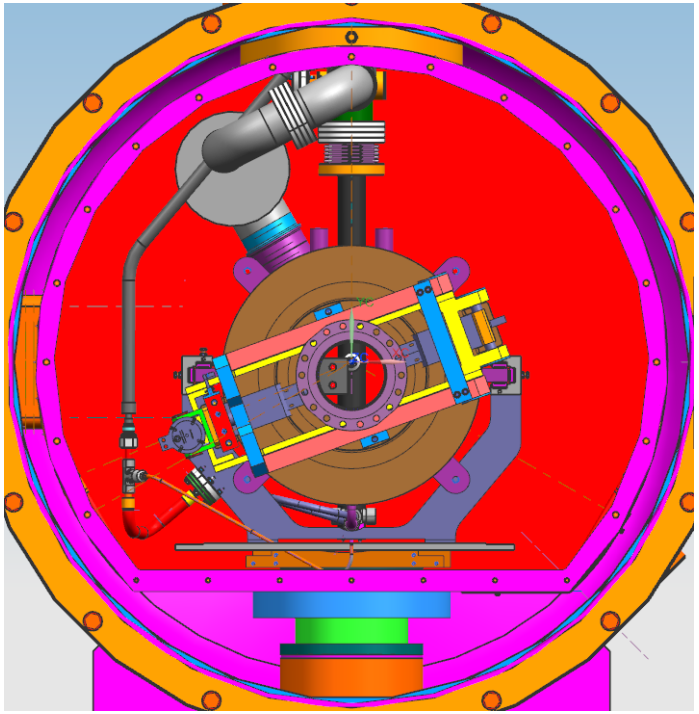
If the flow is subcritical

Minimum cross-sectional flow area	A	1346.82	mm2
Diameter of the nozzle	D	41.41	mm

Right now, the two phase helium pipe on STC is a 3.5” (88.9 mm) diameter pipe.
I suggest changing with a 3” (76.2 mm) diameter to save room to fit SSR2 inside.

6. New design - HB650 configuration



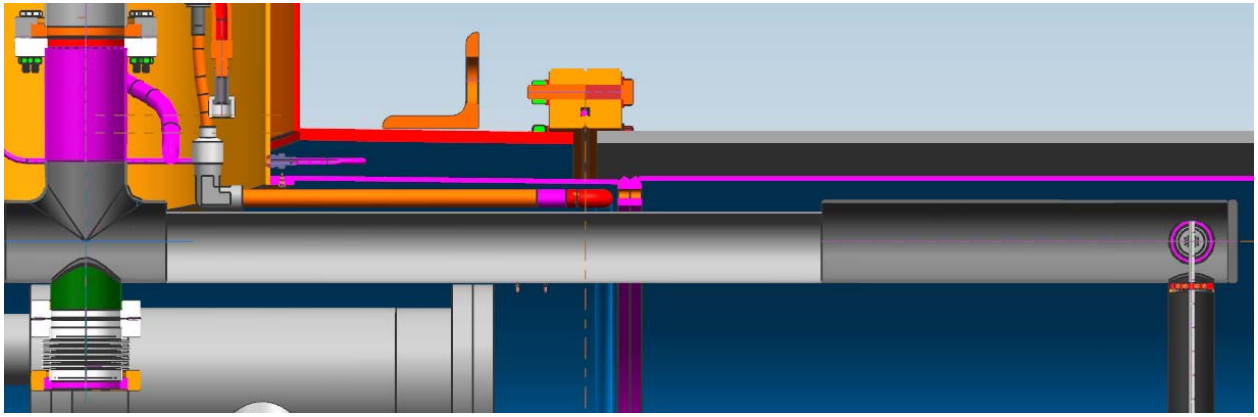


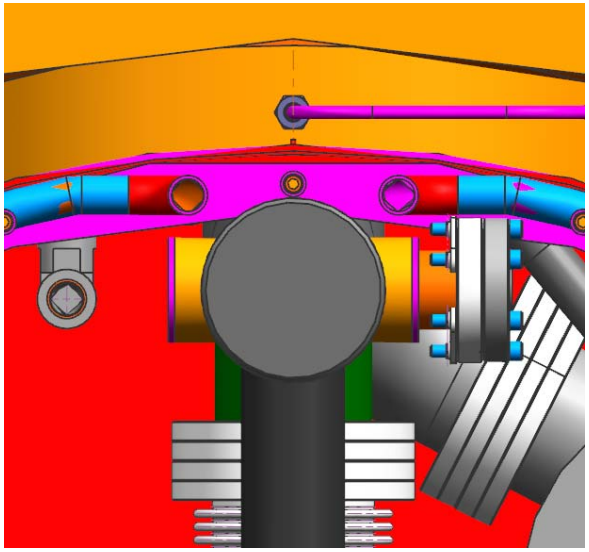
- The dressed cavity is on a table which is fixed on the supporting post of the extension and the table is able to slide on the other supporting post.
- Flanges have been set up on the dressed cavity.
- Then we have a U connection with a flex hose and two non standard elbows.

6. New design - HB650 configuration

Two phase helium pipe and thermal shield

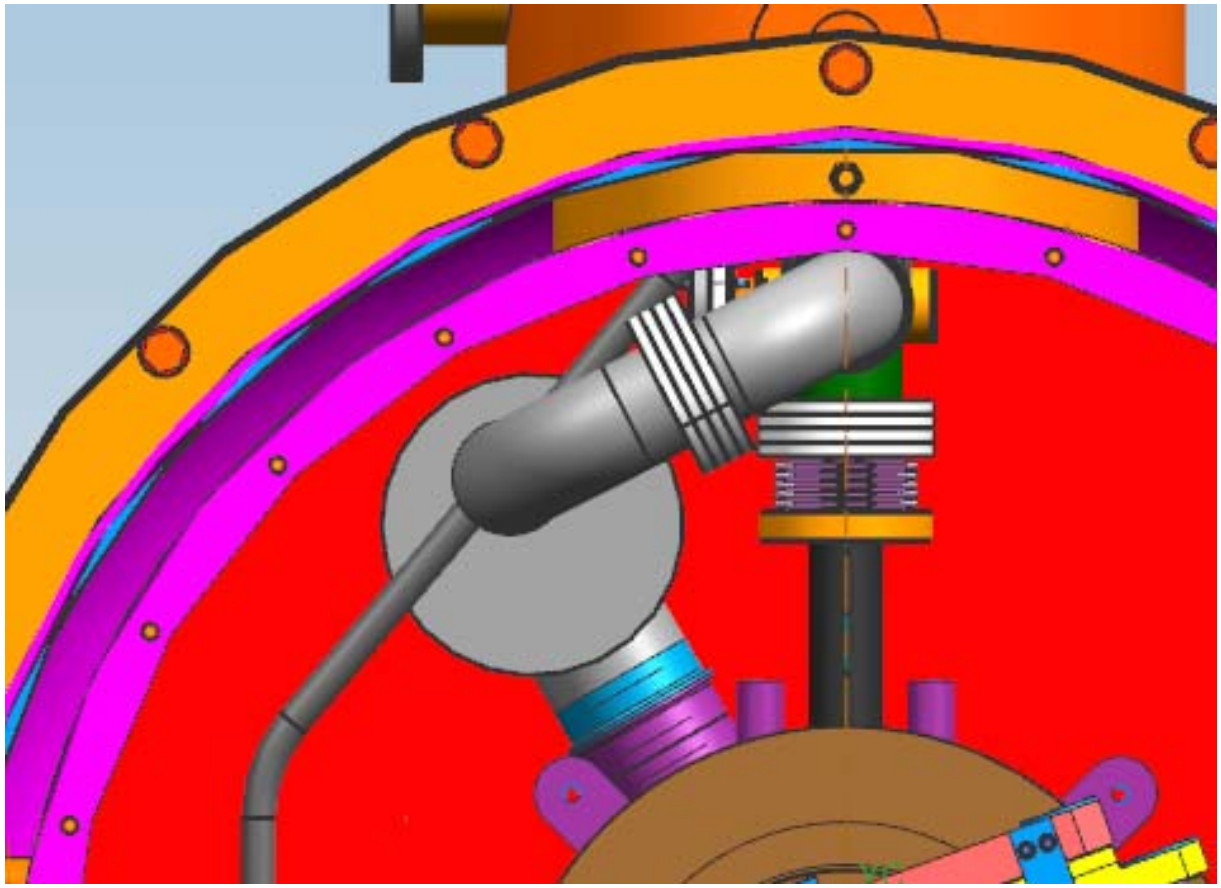
Non concentric and non standard reducers have been set up to avoid contact with the flange of the thermal shield. In this configuration, there is just a gap of 6 mm. It will be better to cut slightly the flange.





6. New design - HB650 configuration

Two phase helium pipe and thermal shield

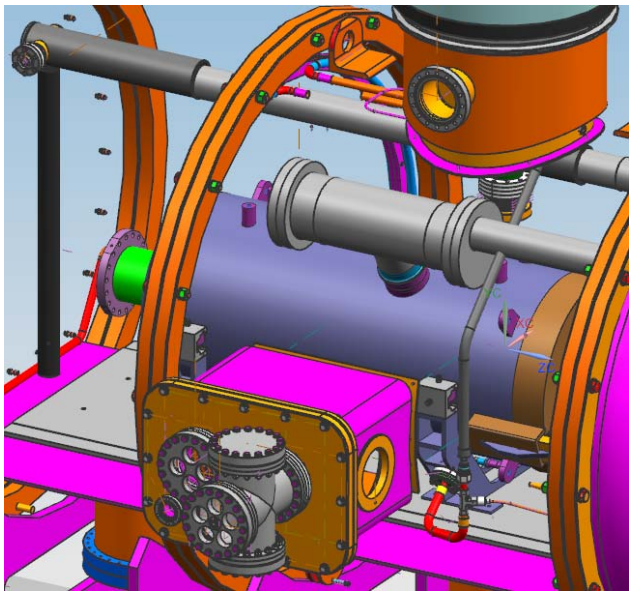


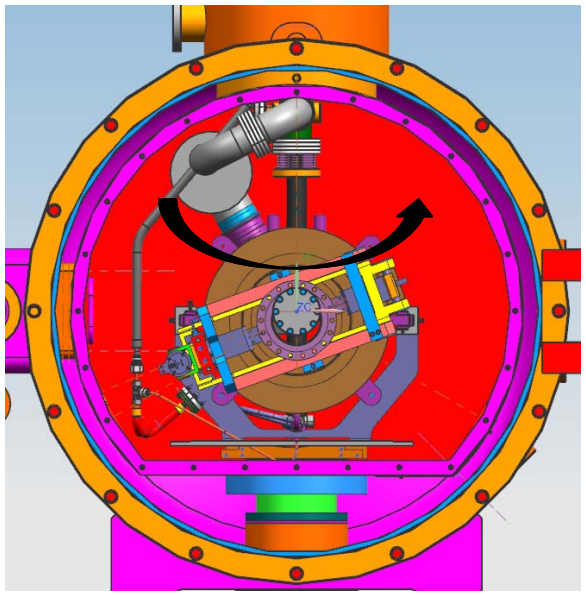
On this side there is a gap of 18 mm

6. New design - HB650 configuration

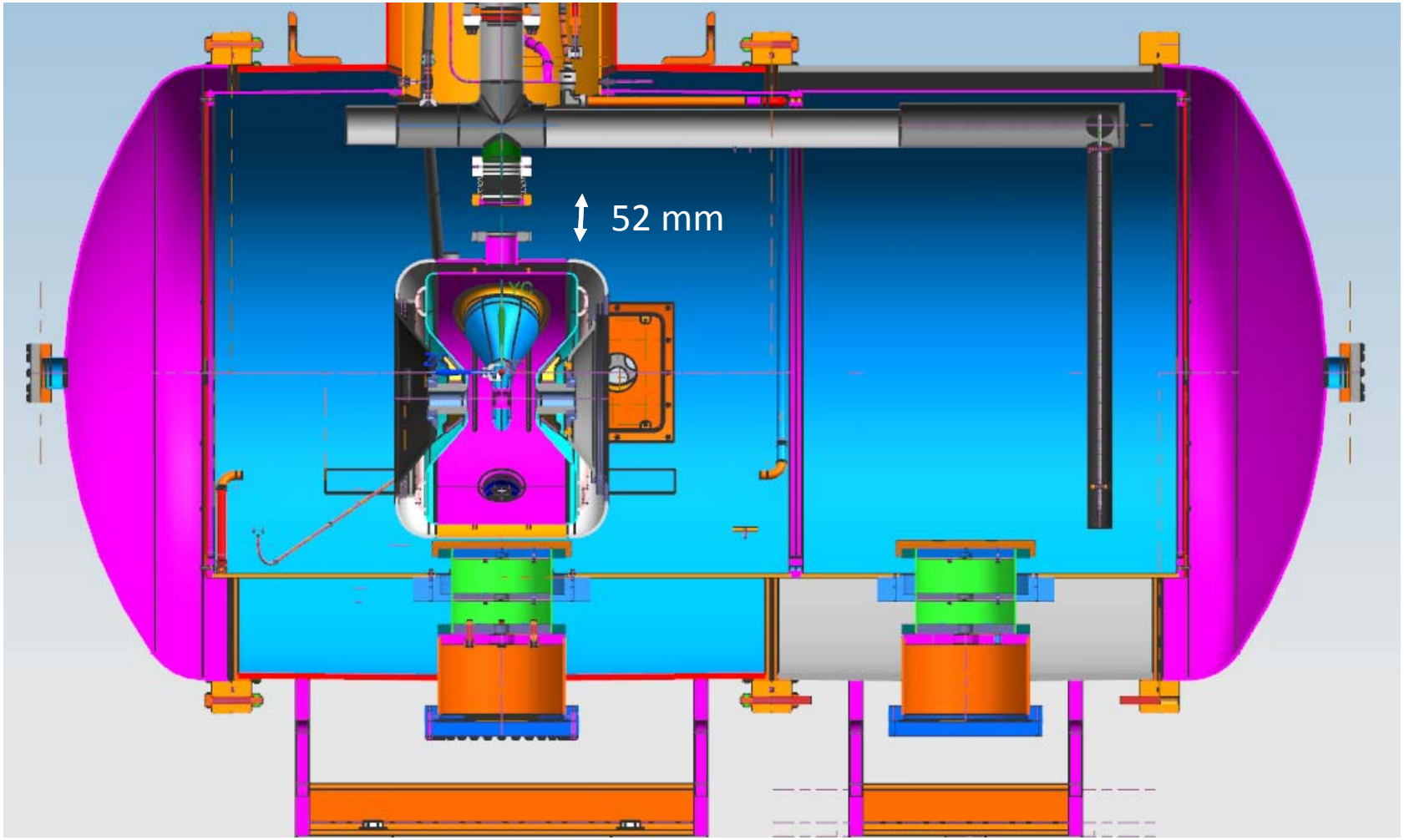
Cool-down warm-up line

It will be necessary to re-design partially this line in order to get the compatibility with SSR1, SSR2 and HB650. This line will change of side and different set of connection will be designed for each cavity, for this we will need a flanged connection with the helium container (weld fitting from Swagelok - standard).





7. New design - SSR1 and SSR2 configuration



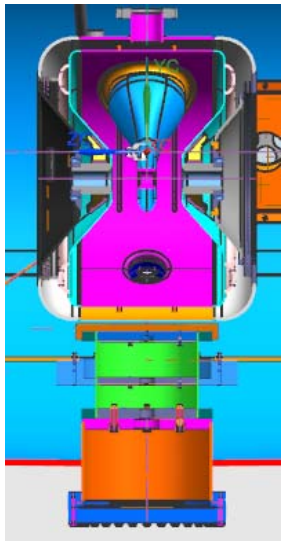
7. New design - SSR1 and SSR2 configuration

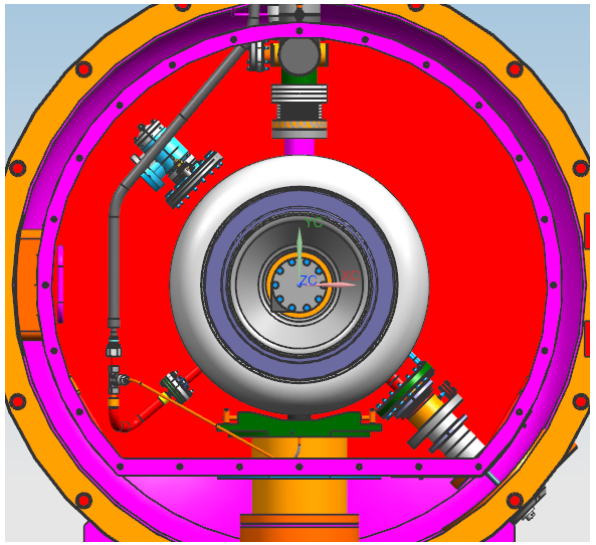
SSR1

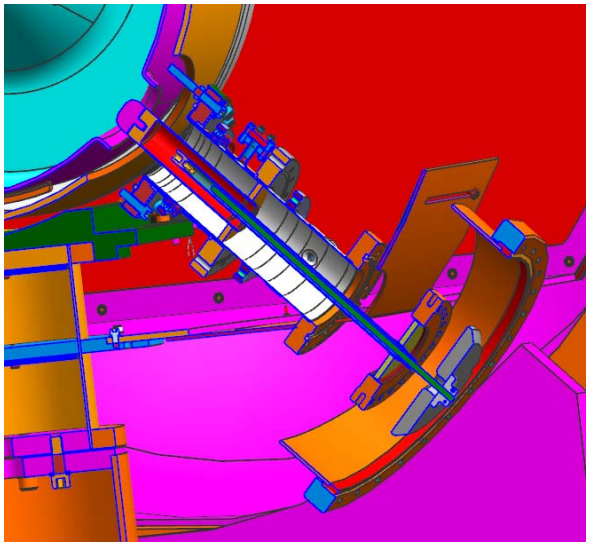
The orange plate on the supporting post can be designed in a such way that the vertical location of SSR1 will be the same as it is now. Therefore the coupler and its interface won't change.

SSR2

Due to the fact the diameter of SSR2 is bigger, the location of the coupler axis will be shifted vertically around 26 mm. The same opening can be used, but the closure will be different.







Cost estimate

325 MHz Spoke Resonator Test Cryostat
Original and 2 K Conversion Cost Estimate

TNicol - May 10, 2016

M&S (no G&A)	Vendor	PO	Date	Cost	STC mod est*
Vacuum vessel	Ability Engr	557319	9/17/2007	$78,950	$45,000
Thermal shield	Meyer Tool	579460	3/4/2008	$17,290	$15,000
MLI					$2,000
Magnetic shield (engineering)	Amuneal			$3,865	
Magnetic shield (fabrication)	Amuneal			$39,632	$30,000
Transfer lines	PHPK	602435	9/22/2011	$13,794	
Feedcan	PHPK	602435	9/22/2011	$83,132	
Heat exchanger	DATE		4/27/2006	$7,650	
Check valve	WEKA			$6,811	
Internal piping assembly (original)	Meyer Tool	582756	9/25/2008	$26,045	$25,000
Support posts					$12,000
Support stand					$5,000
Total M&S				**$277,169**	**$134,000**

*: M&S only.