SHMS Q1 Radiation Damage

Jan 24, 2022
Hall C meeting

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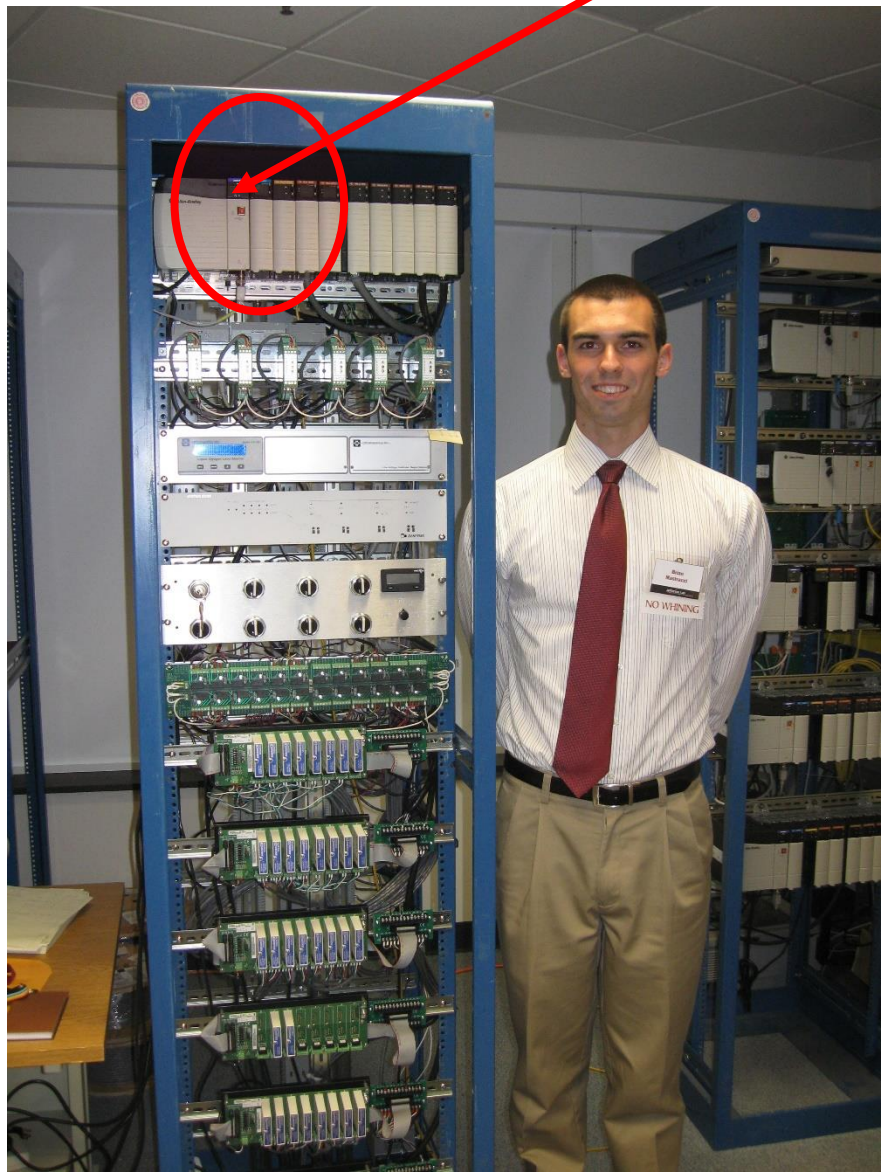
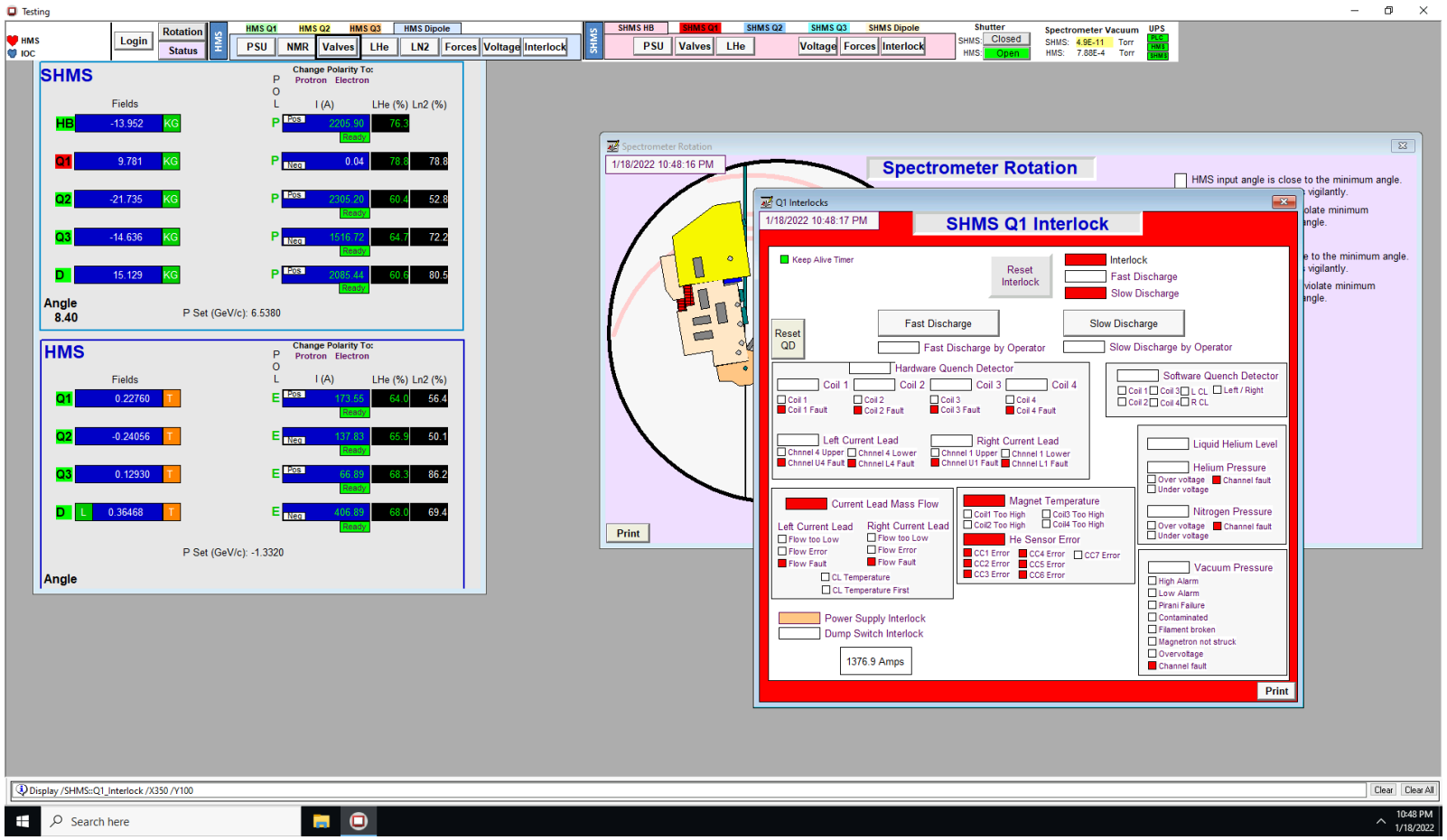
Recent Log Activity Jan 11 to Jan 22 2022

Date	Log Entry	Event	Corrective Action
1-11-22	3970550	SHMS Q1 Right Current Lead Mass flow	Valve and Controller replaced
1-17-22	3972848	SHMS Shower High Voltage Alarms	Shower card replaced
1-17-22	3972956	HMS Q1 Interlock	PSU power cycled
1-18-22	3973740	SHMS Q1 ControlNet Module (inside Hut) 8.40 Deg	Power cycled ControlNet
1-20-22	3974398	SHMS Q1 Left Current Lead Mass Flow controller	Valve and controller replaced
1-20-22	3974431	SHMS Angle drift (NEW event)	Power cycled rotation rack (encoder module)
1-20-22	3974486	SHMS Q1 Right Current Lead Mass flow (showing signs of blockage?)	Valve position is nearly twice what it should be
1-20-22	3974559	SHMS Q1 ControlNet Module (inside Hut) 6.17 Deg Comment on Beam position needed checked	Power cycled ControlNet
1-21-22	3974742	SHMS Q1 vacuum interlocks PSU	Beam off until vacuum recovered and re-steered
1-21-22	3974420	Radcon's full survey map of Hall C	
1-22-22	3975749 3975752 3975757	HMS Q2 Vacuum HMS Q3 Vacuum SHMS Transfer Line Vacuum	Lots of Vacuum issues going on. Some instrumental some real.

ControlNet Module Failure
Inside SHMS Shed Hut Electronics Room



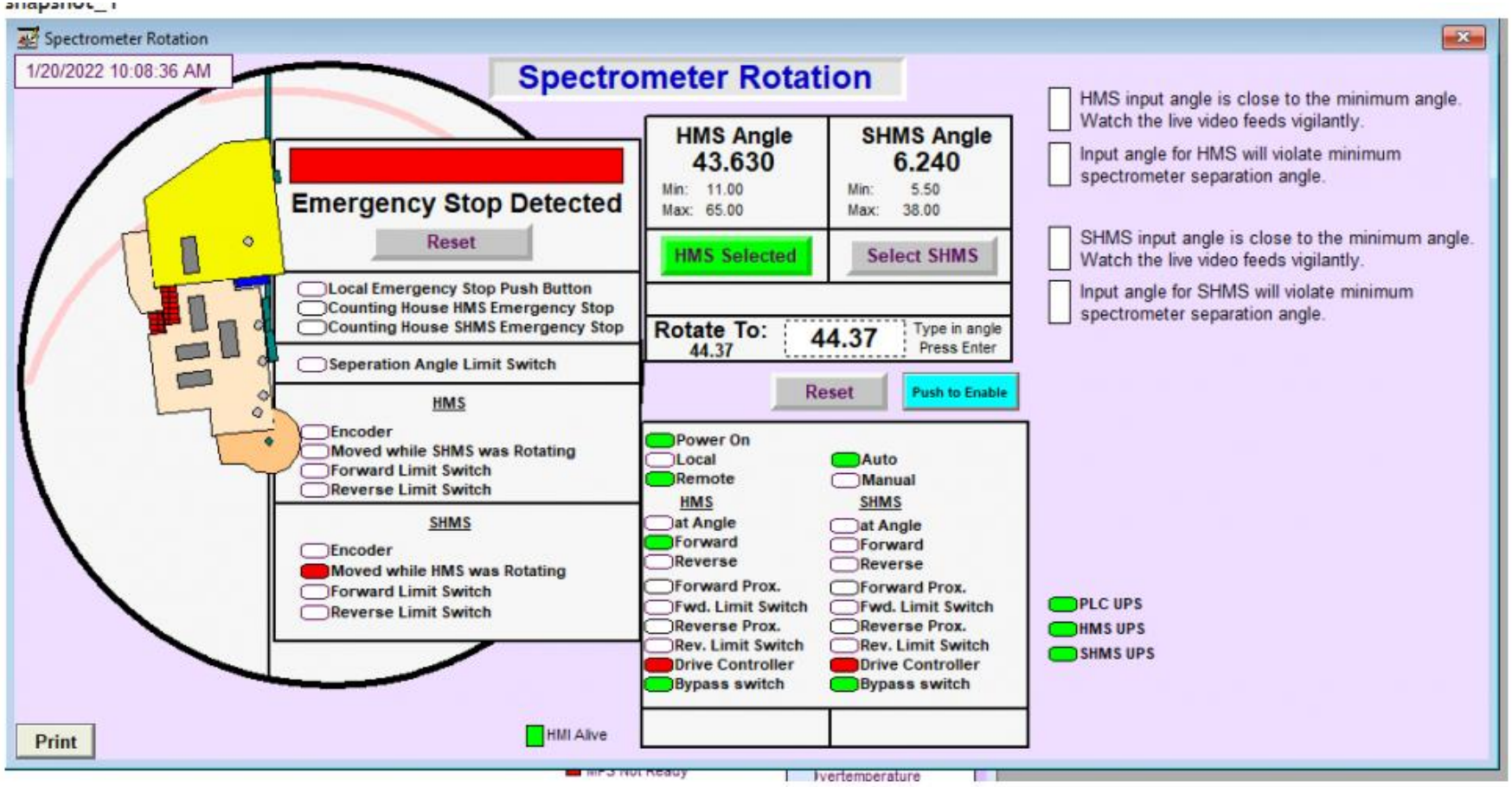


Over the last 7 years, this only occurs during Beam on Conditions and under high radiation conditions.

Rotation Modules in Control Rack

SHMS Angle's read back started to drift after a rotation.
Power cycling the Encoder and the rotation rack reset the unit.

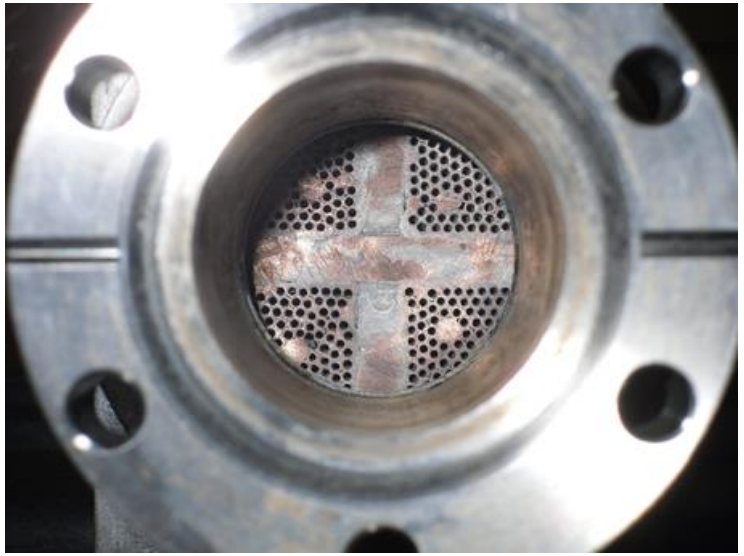
First occurrence of this happening,

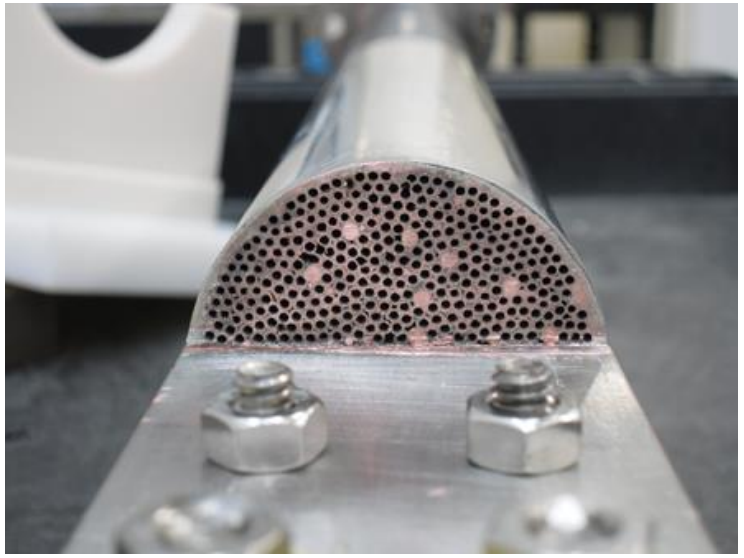


Concerns of radiation damage to a SC magnet

- Coil/conductor insulation, varnish coatings and B-stage epoxy breakdown leading to exposed conductor and internal shorts.
- Current leads, mass flow meters/controllers and JT valves becoming blocked from debris.
- Breakdown of superinsulation leads to higher heat load on Magnet and cryo system.
- Multiple instruments and equipment failures occurring, leading to beam down time and expensive repairs. Toll on technical staff for constant repairs.
- Magnet and cryo Controls being effected as well. Loss of magnet controls can effect other magnets, other Experimental halls and Cryo plant.
- Activation of hardware. Too hot to handle and/or ship parts back for repairs.
- No spare SC magnets. Lead time for a new magnet >5 years. Loss of magnet = loss of spectrometer.

Current Leads could become plugged from degradation of insulating material and B-stage binder material of the coils





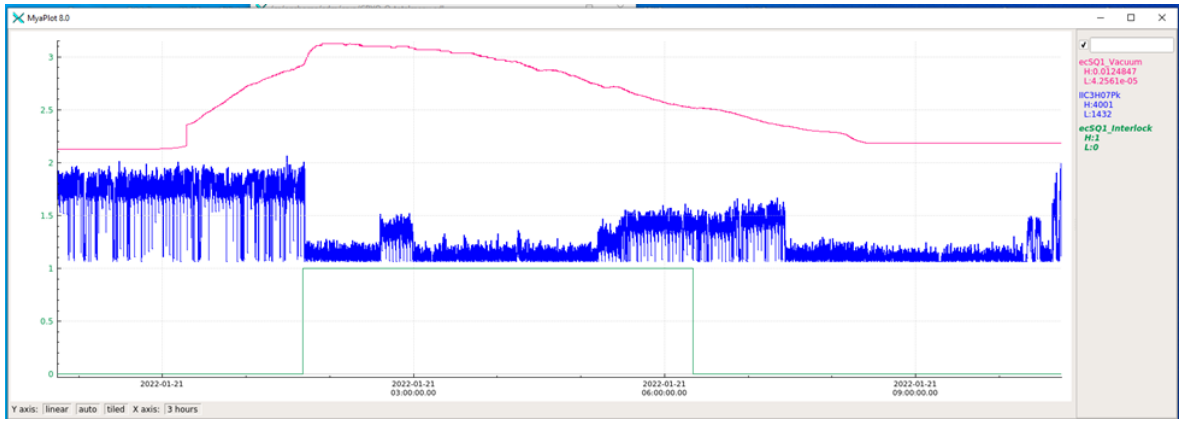
Current Lead Mass Flow Controller

- The Current Lead's Helium Mass flow controllers are mounted upstream of the current leads and have a finer mesh screen/pressure plate that the Helium gas passes through. This screen can be contaminated or clogged with B-stage or Kapton residue.
- Both meters were replaced. Right meter now shows signs of blockage as it's open position is nearly twice of the others to obtain the same flow.

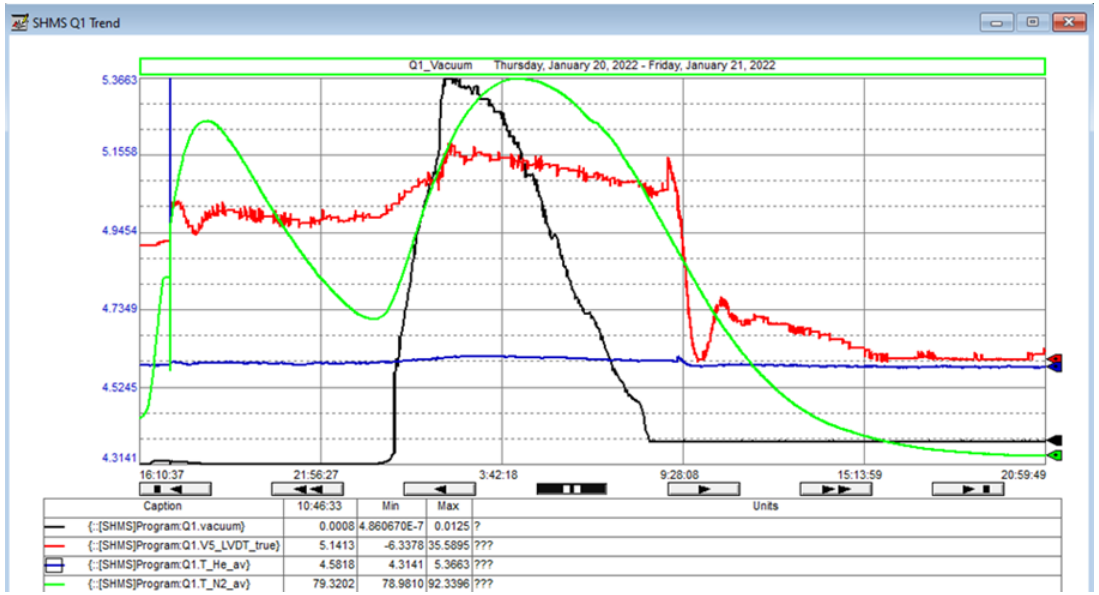
O-rings deteriorate to tar
CVI (or PHPK) O-ring leads to loss of vacuum in U-tubes and transfer Lines

Evidence of Beam Radiation on Heating and Vacuum - Jan 21, 2022

Vacuum Rise and recovery along with Beam Delivery

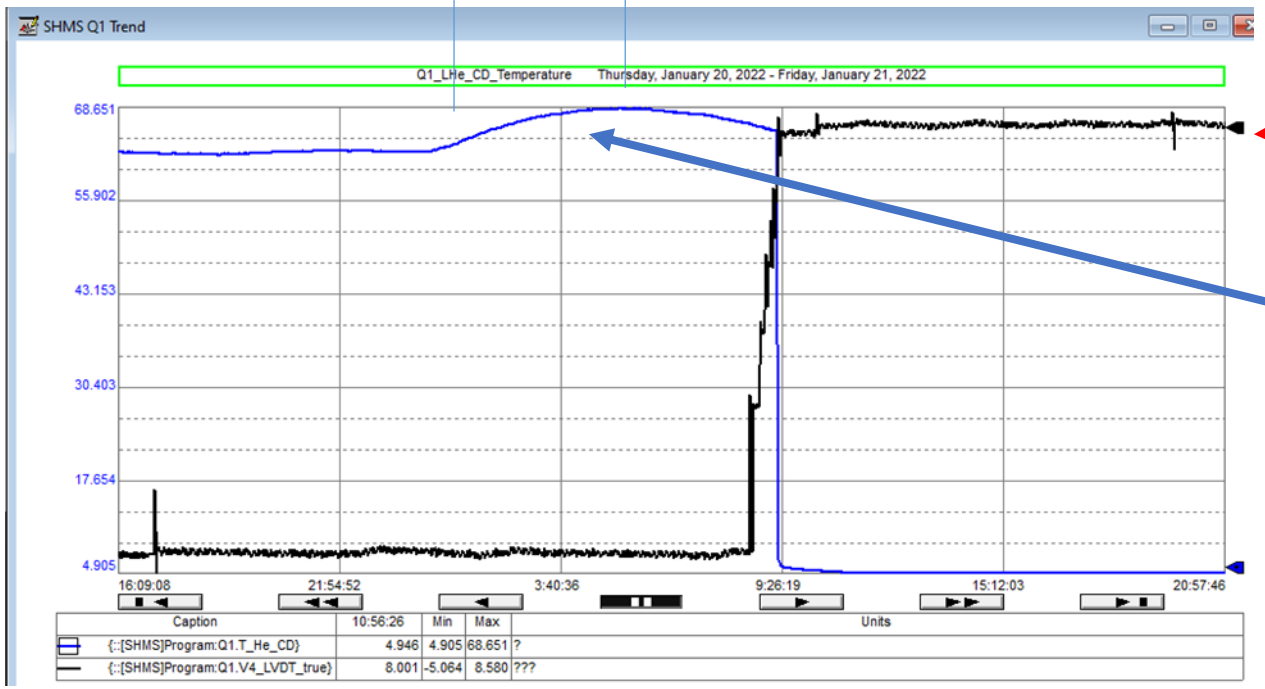


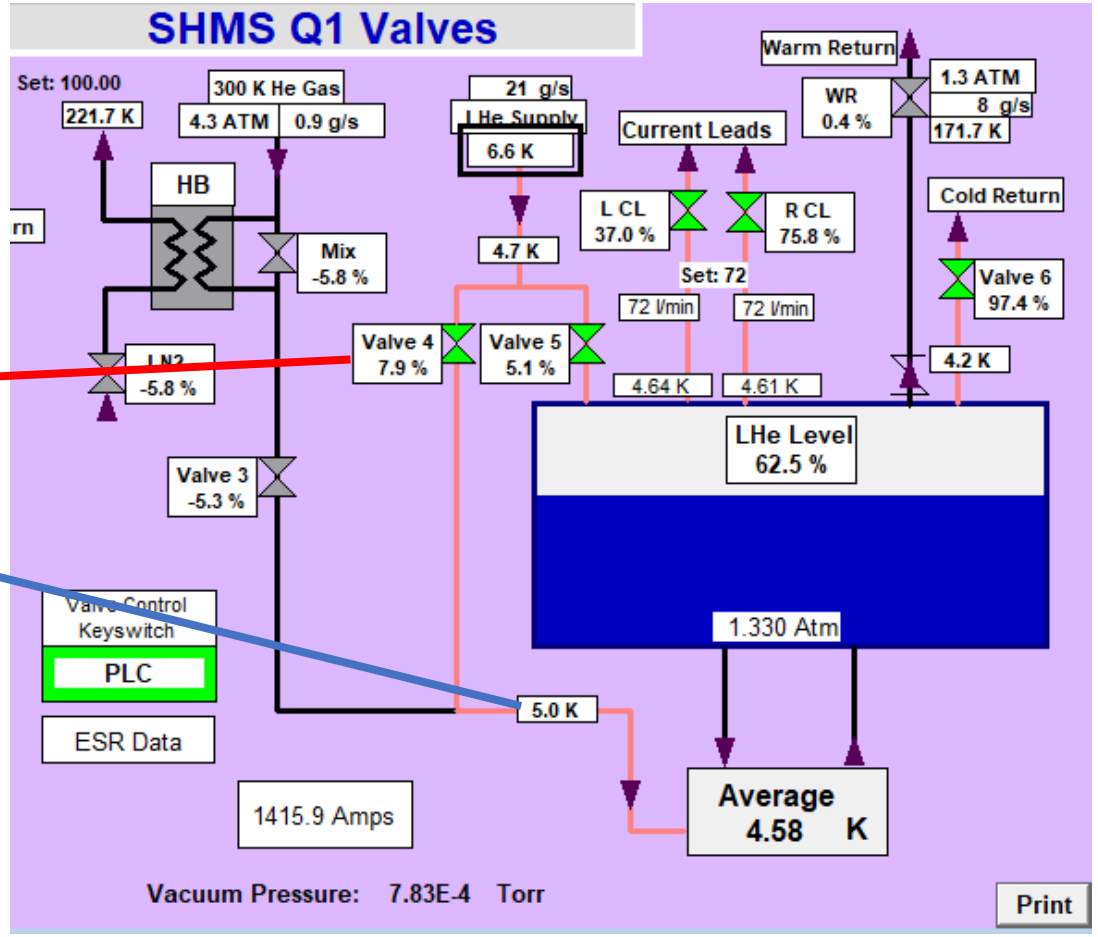
He and LN2 temps, Vacuum and JT (He supply) during same time period



Took the additional step of using the Bottom Fill JT to cool more internal piping for additional Cryo-pumping capacity.

Vacuum Rise





SHMS Q1 Signage Degradation
Area is between flanges labeled (BP2) and (BP3)

June, 2021

Nov 13, 2021

Jan 21, 2021

Survey Data July 14, 2021

July 14, 2021
Primarily setup for
SHMS at 5.5 deg

OD= 73.0 mm
ID = 62.7 mm
X= mm
Y= mm
Z = mm

OD= 273.1 mm
ID = 254.5 mm
X= mm
Y= mm
Z = mm

OD= 323.9 mm
ID = 303.2 mm
X= mm
Y= mm
Z = mm

DS TGT FLG
(1)

OD= 42.7 mm
ID = 37.0 mm
X= -2.5 mm
Y= 0.2 mm
Z = 674.4 mm

BP @ TGT FLG
(2)

OD= 70.1 mm
ID = 41.3 mm
X= -10.6 mm
Y= -0.5 mm
Z = 728.0 mm

BP2
(3)

OD= 51.0 mm
ID = 41.3 mm
X= -7.9 mm
Y= -1.7mm
Z = 2497.5 mm

BP3
(4)

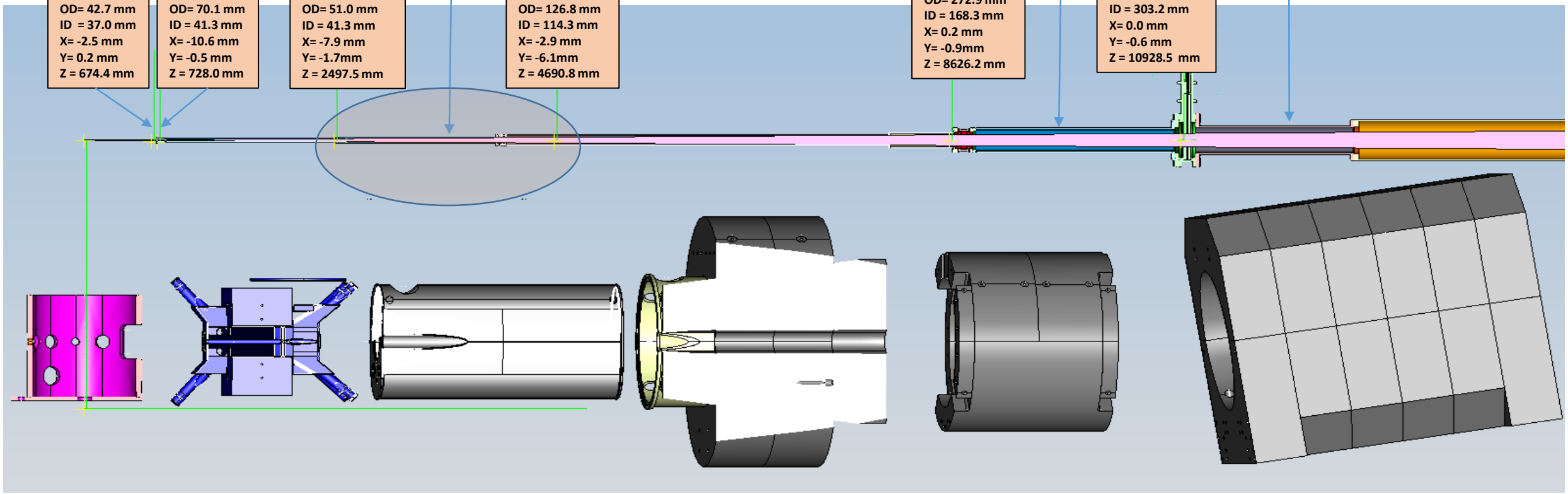
OD= 126.8 mm
ID = 114.3 mm
X= -2.9 mm
Y= -6.1mm
Z = 4690.8 mm

US BELLOWS FLG
(5)

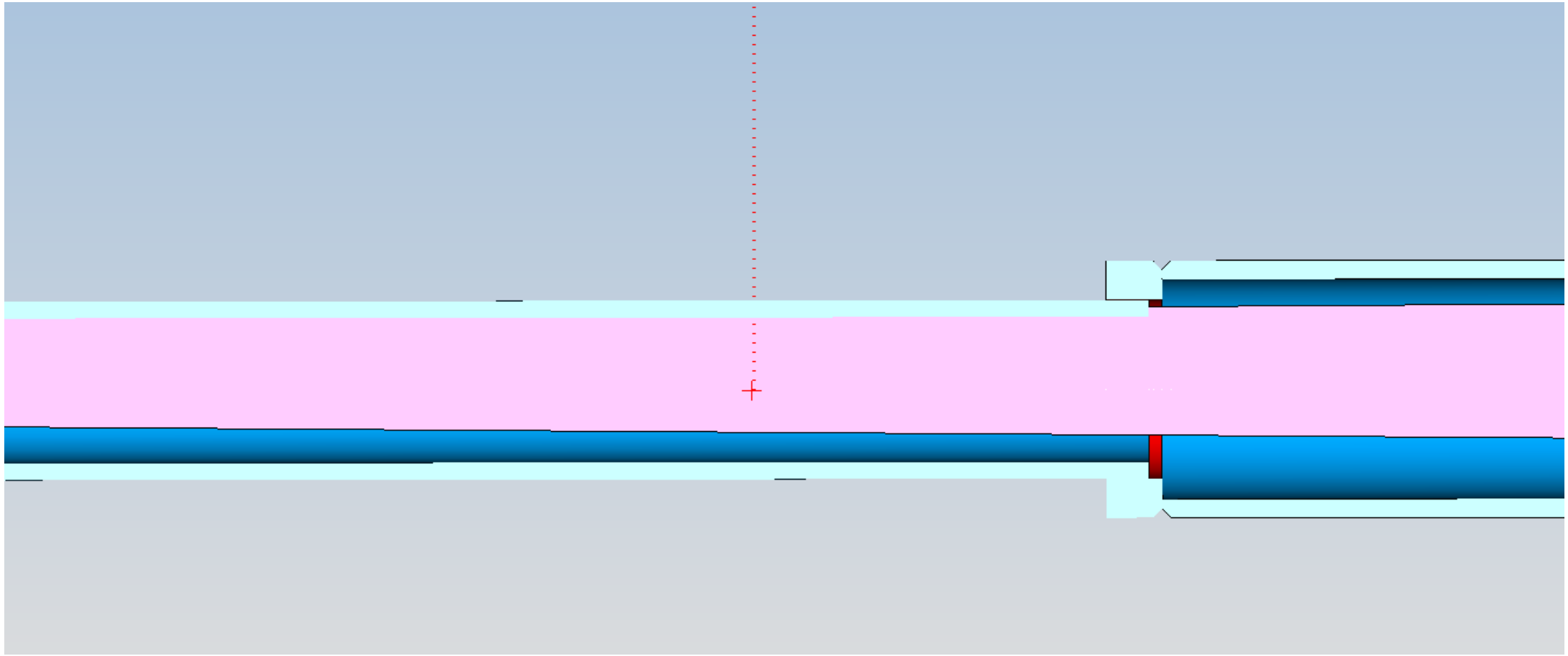
OD= 272.9 mm
ID = 168.3 mm
X= 0.2 mm
Y= -0.9mm
Z = 8626.2 mm

US GATE VALVE FLG
(6)

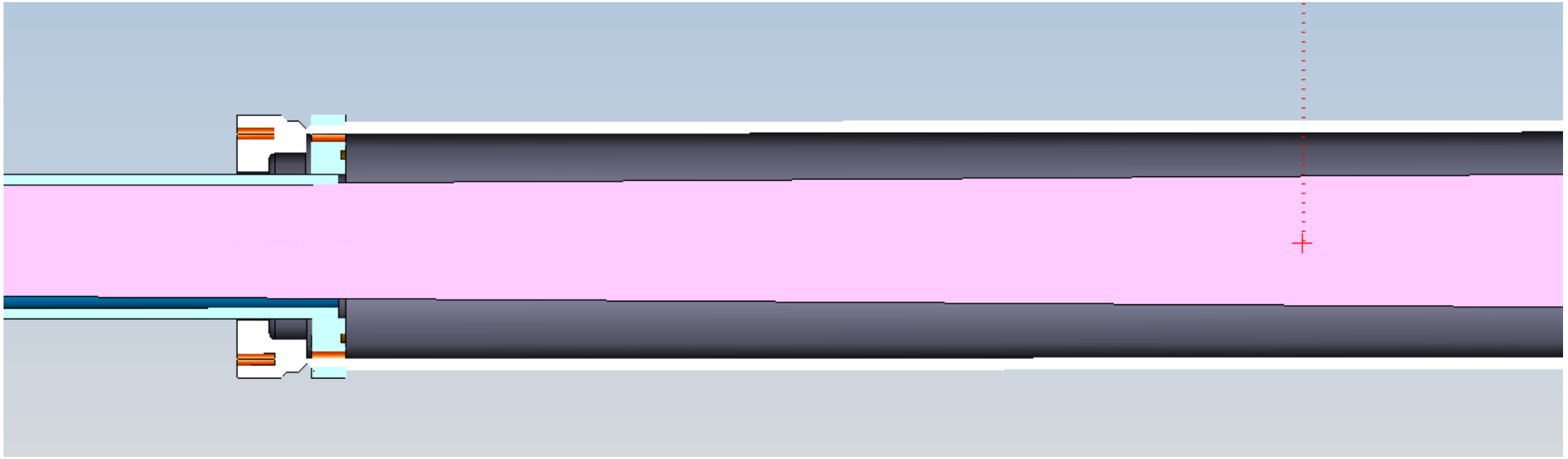
OD= 597.3 mm
ID = 303.2 mm
X= 0.0 mm
Y= -0.6 mm
Z = 10928.5 mm



BP2
Beam pipe shown aligned to vector define by points (2) and (3)



BP3
Beam pipe shown aligned to vector define by points (2) and (3)

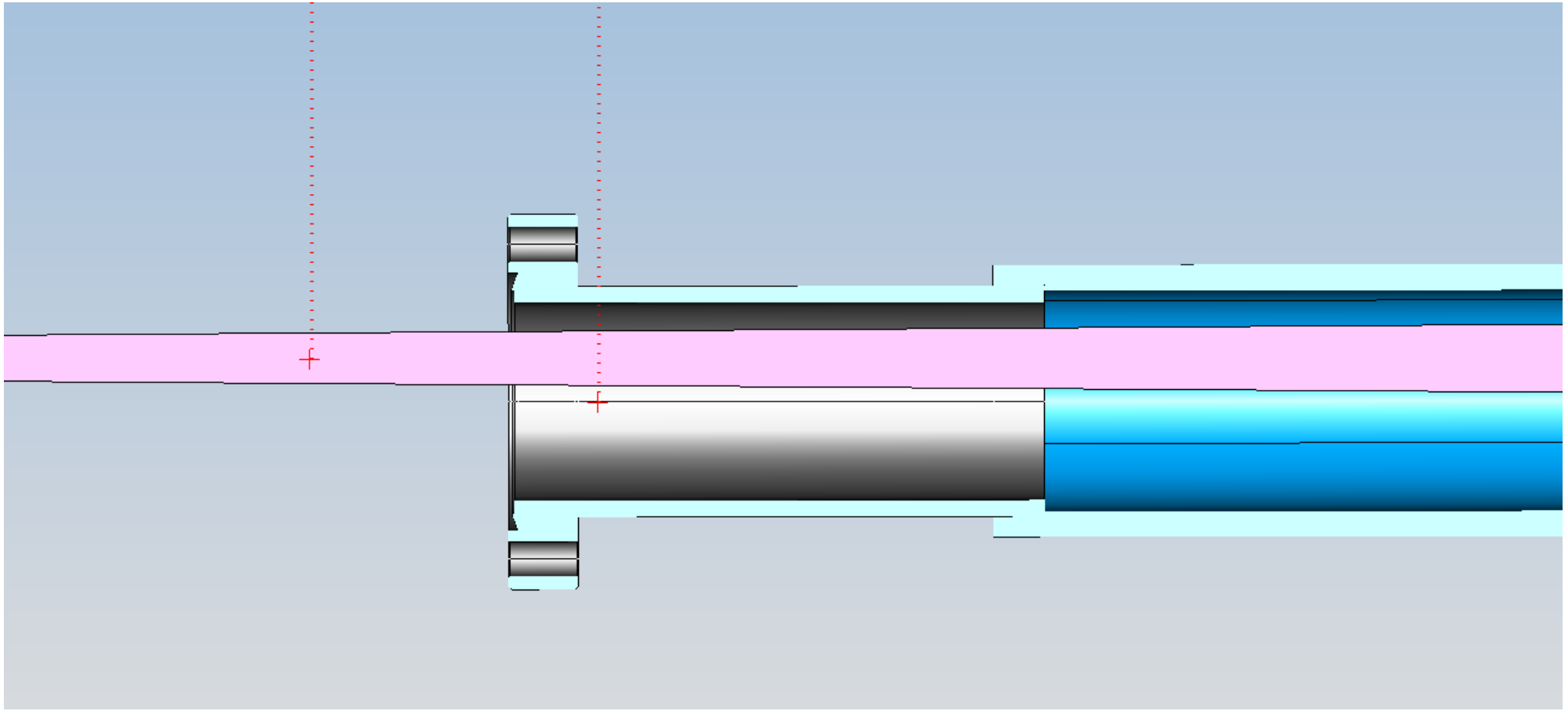


Conclusion

- SHMS Q1 turns out to be a good beam position device.
- Not good for the health and reliability of the Magnet.
- Additional Beam loss monitors should be installed between HB and Q1, on the SHMS deck if possible. Designers will look into space restraints.
- Once the SHMS Q1 magnet fails, that is the end of the SHMS, unless a d-QQD optical tunes is acceptable.
- HB (d) is probably suffering as well.

Backup on Beam pipe

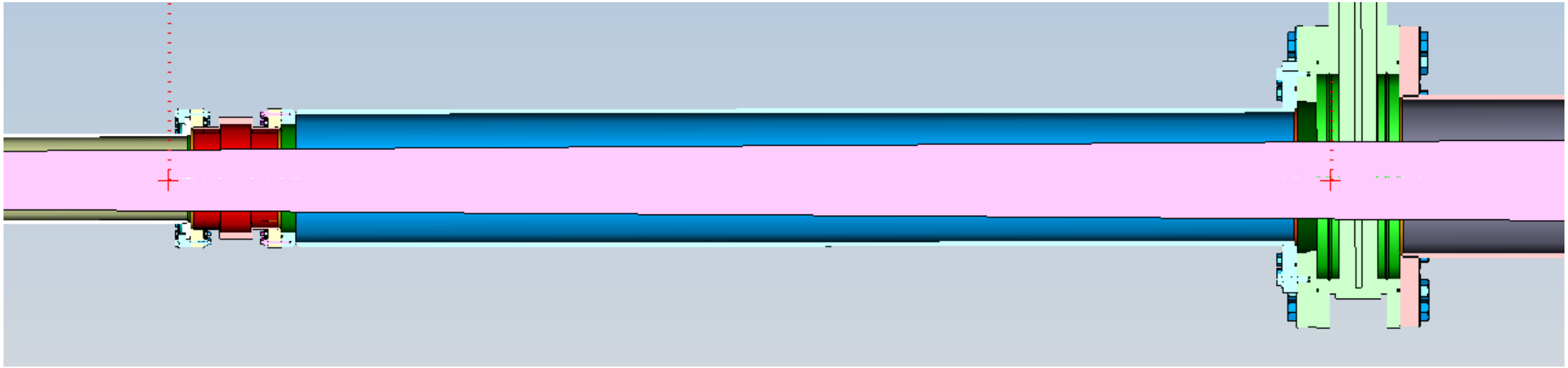
DS-TGT-FLG and BP@ TGT FLG data points with beam centered at DS-TGR-FKG point Beam pipe shown aligned to vector define by points (2) and (3)



US BELLOWS FLG

US BELLOWS FLG (5) and US GATE VALVE FLG (6) data points
with beam centered at DS-TGR-FKG point

Beam pipe shown aligned to vector define by points (2) and (3)



Hall C Downstream Beam Line Measurements

Feb 04, 2019
Large Beam

Z= 0.703 m
OD= 70 mm
ID= 37.0 mm
X= -0.76 mm
Y= 2.01 mm

Z= 2.627 m
OD= 101 mm
ID= 90.1 mm
X= -12.15 mm
Y= 13.21 mm

Z= 4.043 m
OD= 169 mm
ID= 154.1 mm
X= -16.1 mm
Y= 17.45 mm

Z= 8.595 m
OD= 273 mm
ID= 260.3 mm
X= -4.84 mm
Y= 7.06 mm

Flange Ø
Z= 10.83 m
OD= 457 mm
X= 0.51 mm
Y= 3.73 mm

Large Angle beam line
Configuration 1

Feb 02, 2017
Med Beamline

Z= 0.716 m
OD= 69.4mm
ID= 37.0 mm
X= 0.8 mm
Y= -3.7 mm

Z= 5.774 m
OD=272.8mm
ID= 260.3 mm
X= -4.8 mm
Y= -1.7 mm

Z= 8.642 m
OD= 272.8mm
ID= 260.3 mm
X= -2,7 mm
Y= -3.8 mm

Z= 10.86m
OD= 457.5mm
ID= 438.2mm
X= 0.0 mm
Y= 0.6 mm

Medium Angle beam line
Configuration 2

July 14, 2021
Primarily setup for
SHMS at 5.5 deg

Z= 0.729 m
OD= 70 mm
ID= 37.0 mm
X= -5.5 mm
Y= -2.8 mm

Z= 2.495 m
OD= 51 mm
ID= 41.3 mm
X= -11.7 mm
Y= -1.3 mm

Z= 4.693 m
OD= 127 mm
ID= 114.3 mm
X= -19.5 mm
Y= -3.8 mm

Z= 7.954 m
OD= 127 mm
ID= 114.3 mm
X= -32.4 mm
Y= -3.0 mm

Z= 8.807 m
OD= 273 mm
ID= 260.3mm
X= -36 mm
Y= 0.2 mm

Pipe Ø
Z= 10.811m
OD= 273 mm
ID= 260.3mm
X= -28.1 mm
Y= 1.2 mm

Z= 12.612 m
OD= 325 mm
ID= 303.23mm
X= -23.3 mm
Y= 6.6 mm

Aug 08, 2018
Small Beamline

Z= 0.721 m
OD= 69.9 mm
ID= 37.0 mm
X= -0.3 mm
Y= -0.3 mm

Z= 2.54 m
OD= 50.7 mm
ID= 41.3 mm
X= 1.6 mm
Y= 2.0 mm

Z= 4.00 m
OD= 74.1 mm
ID= 62.71 mm
X= 1.1 mm
Y= 3.7 mm

Z= 8.69 m
OD=273.1 mm
ID= 260.3mm
X= -2.6 mm
Y= 3.2 mm

Z= 8.84 m
OD= 273.1mm
ID= 260.3 mm
X= -2.9 mm
Y= 2.9 mm

Flange Ø
Z= 10.84 m
OD= 457.1mm
ID= 438.2mm
X= -0.1 mm
Y= 2.8 mm

Small Angle beam line
Configuration 3

Surveyed Data:
IDs are from CAD model
X and Y #s are how far out from true position center of beamline is at that Z location