Technical Specification

Installation of the dipole at Jefferson Lab

This document describes the procedure of installation of the dipole at Jefferson Lab. All the operations will be performed by JLAB expect for the splicing and associated operations which will be performed by Sigmaphi. The duration of Sigmaphi's intervention is estimated at 5 days.

The WPS/PQR for all the welds to be done by JLAB's welders can inspire from Q2/Q3 SDMS welding documents: the welds geometries are identical.

1 Dipole and CCR positioning

Both dipole and CCR will be positioned by JLAB. The HYSPAN bellows have been chosen to allow a maximum positioning defect of 3mm in the three directions.

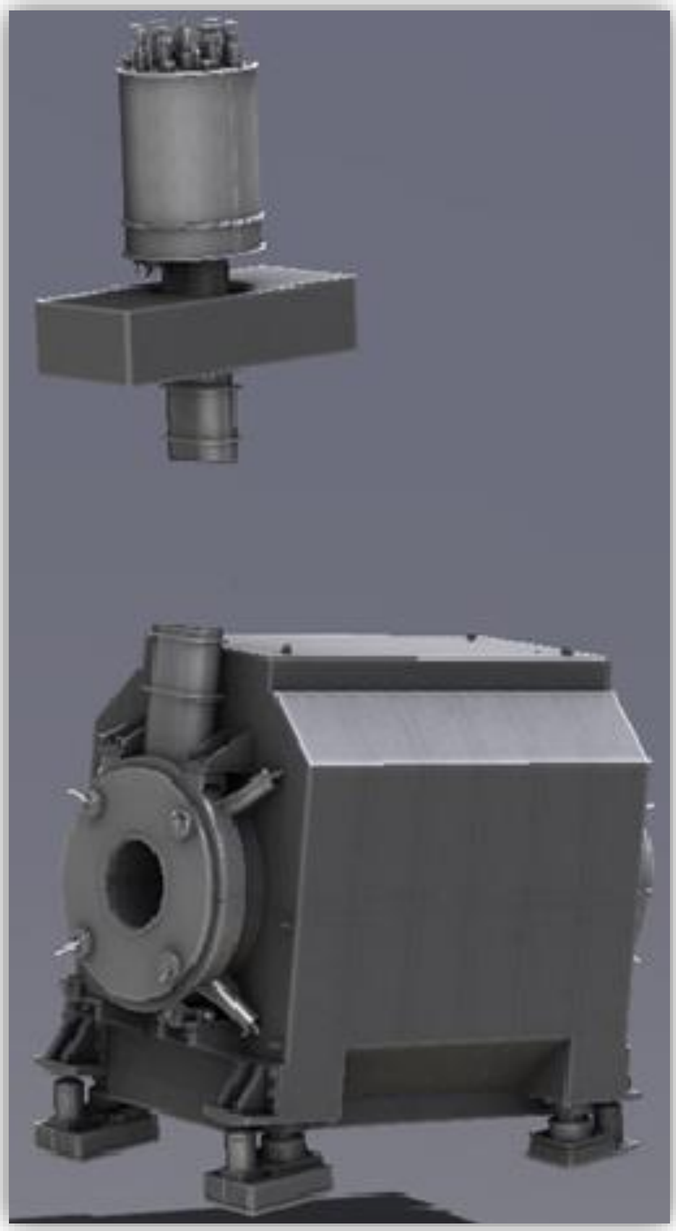

Figure 1: positioning of the CCR relative to the dipole

2 Welding of the superior part of helium chimney

These 3 helium return pipes and bellows need to be welded before the installation of the vapor cooled leads.

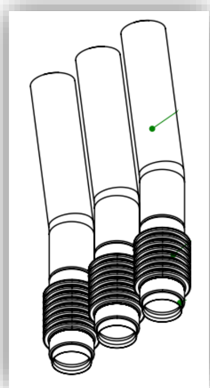

Figure 2: pipes & bellows welded on the CCR

3 Preparation of the half tubes

The bellows have been damaged during transport from SDMS to Sigmaphi. These parts have been replaced by tubes and new larger bellows have been purchased. The following half tubes having been sent to JLAB before this event it will be necessary to cut these parts on site. The best way to do this operation consists in doing a blank mounting of all these parts between the dipole and the CCR and cut the half tubes in position.

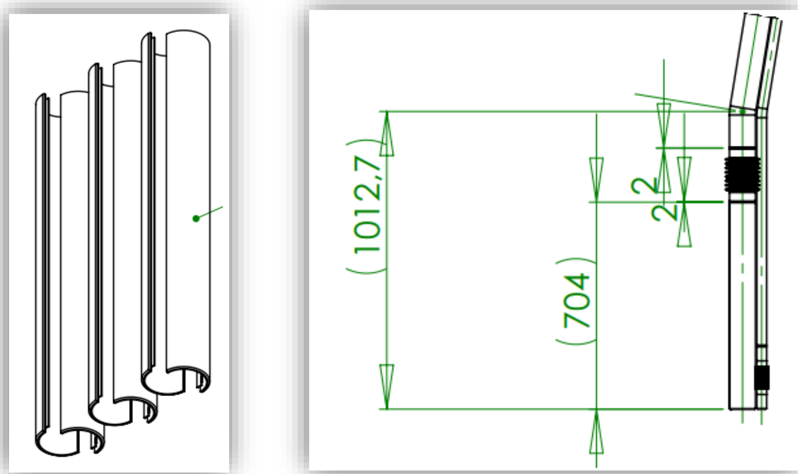

Figure 3: theoretical length of half tubes after cut

4 VCL installation

The vapor cooled leads can then be installed into the CCR. JLAB's team should previously ensure that it's possible to install the VCL's after having positioned the CCR (height of the crane, other accessibility constraints). Sigmaphi advises to do a leak test at the junction between CCR and VCL before the splicing and can provide the tooling for this helium leak test:

Figure 4: tooling for the leak test on VCL

Sigmaphi advises also to do an electrical test at 1500V between VCL's and CCR helium reservoir once the VCL's are installed.

5 Splicing

The splicing between conductors from the CCR and from the dipole will be performed by Sigmaphi thanks to the following tooling. A power supply and a temperature regulation system are necessary for this soldering. This material will be provided by Sigmaphi.

A procedure dedicated to this spicing has been sent to JLAB:

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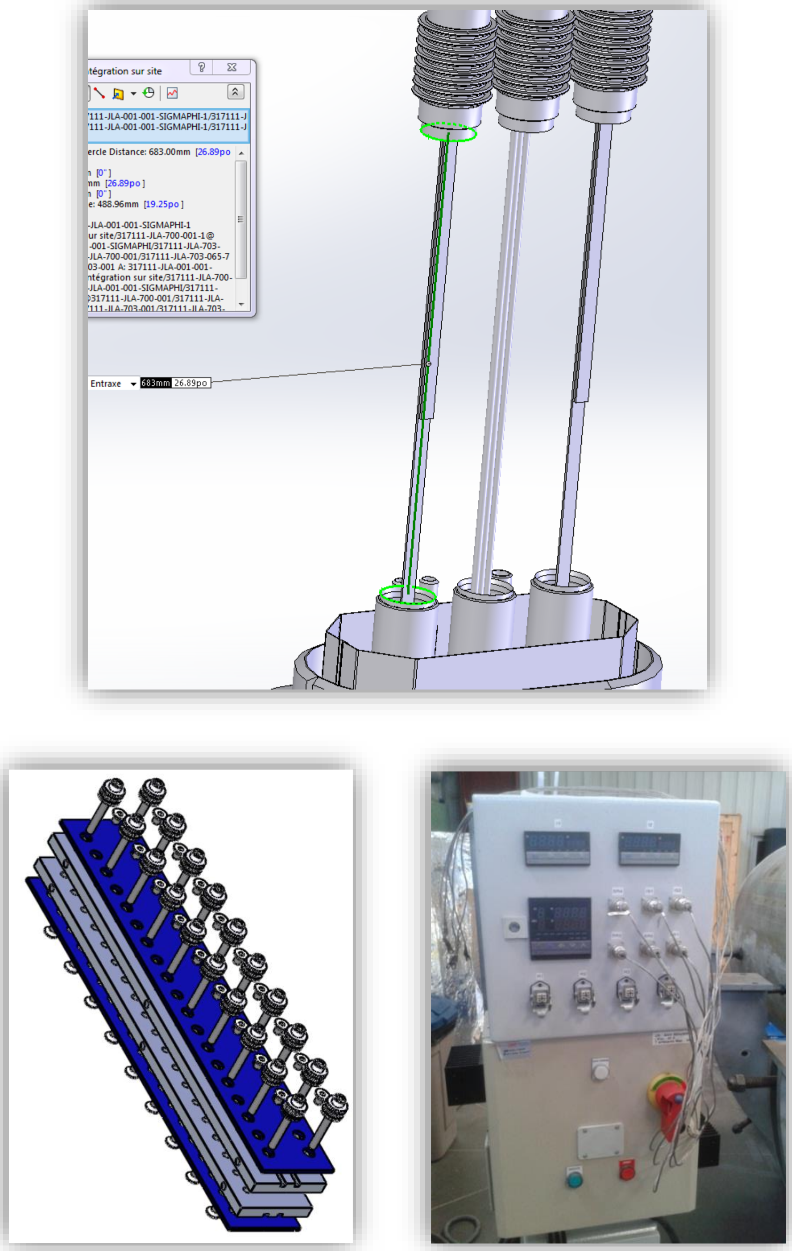

Figure 5 : view of the connections between CCR & dipole, soldering tool & regulation system

6 Instrumentation of current leads

There are 4 pairs of potential taps to install on the junction between coil outputs and current leads. The wires join the feedthrough of the CCR through the central return pipe and are identified as followed. This operation will be performed by Sigmaphi. There are also 4 voltage taps and four Carbon-Ceramic already installed on the current leads whose position is given hereafter. These wires need to be pulled through the CCR during VCL installation.

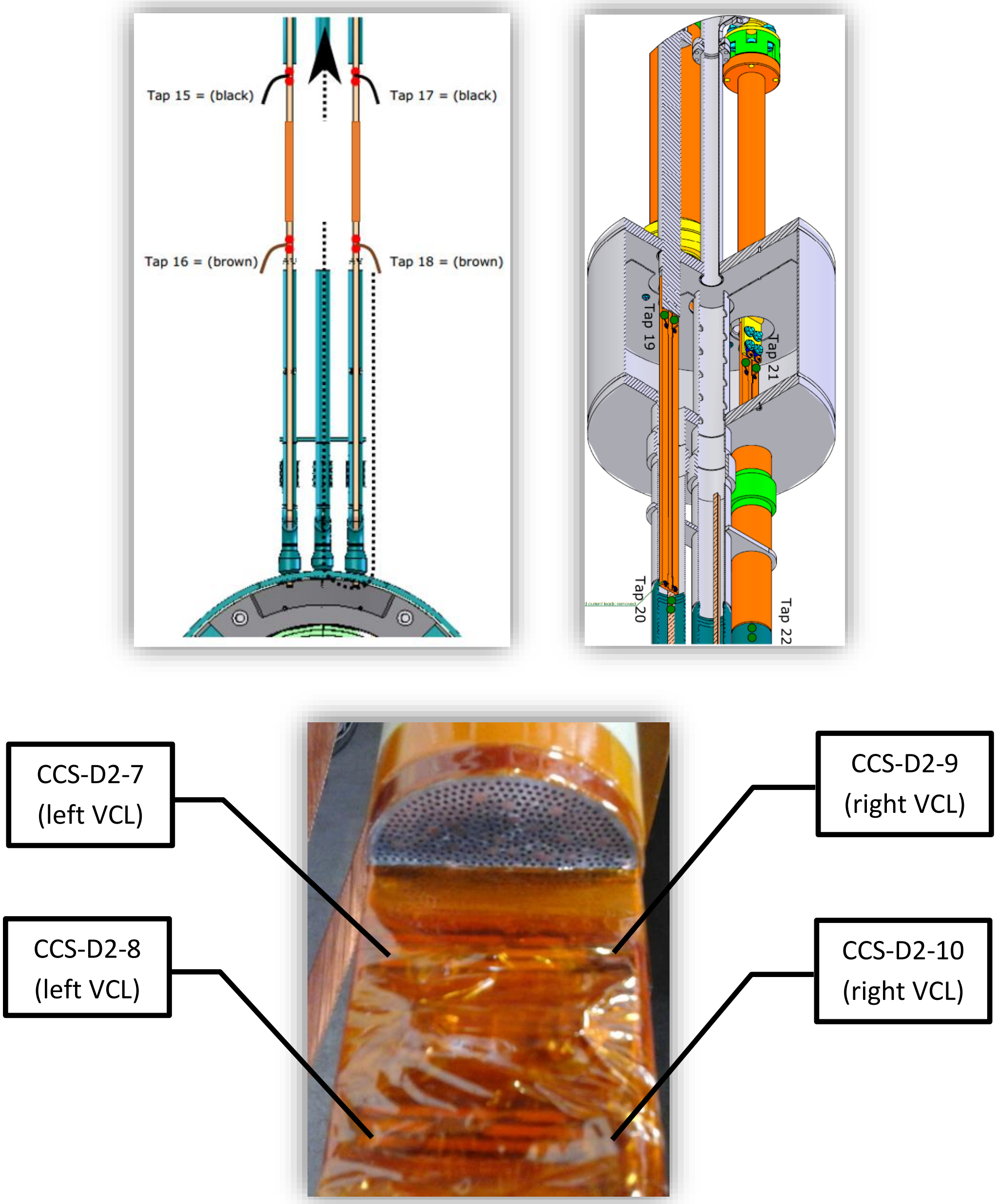

Figure 6: instrumentation on splicing and current leads

7 Connection of 4K instrumentation on the CCR

There are three sets of wires inside the helium chimney:

- The wires connected to thermoswitches
- The wires connected to potential taps
- The wires connected to the temperature sensors (carbon-ceramic and PT100)

The thermoswitches will not be used anymore so these wires have been cut at Sigmaphi.

JLAB's team should verify they have the adequate crimping tool for the feedthrough preparation.

The following scheme gives the position of potential taps on the coil:

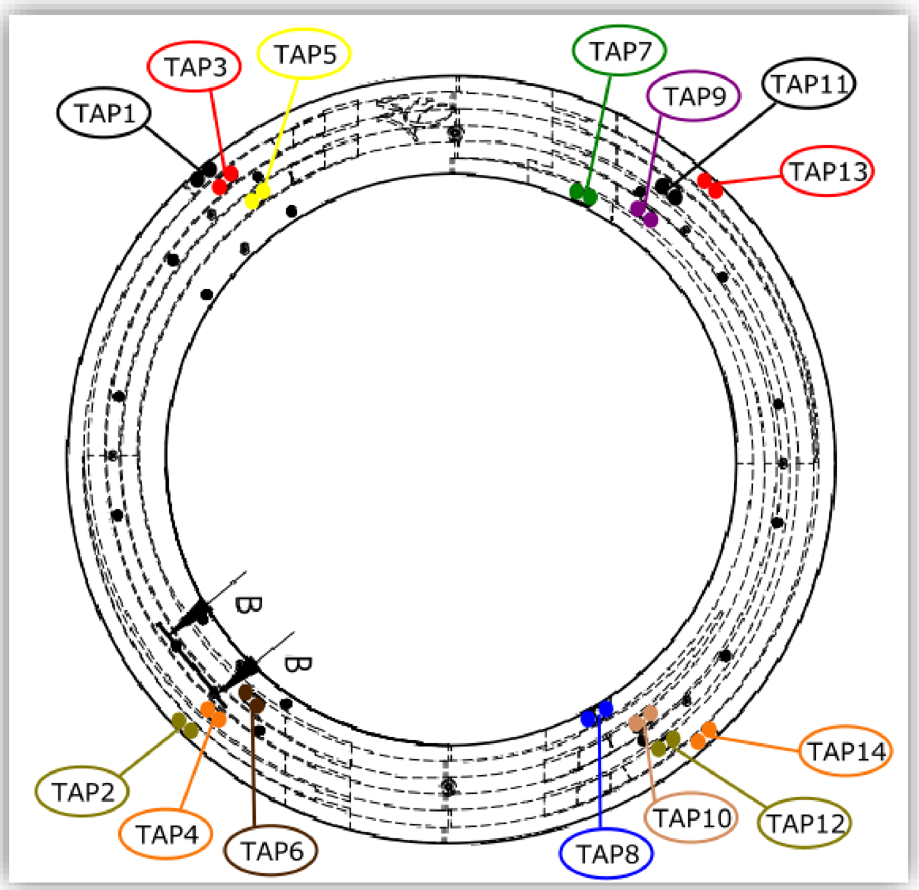

Figure 7: position of potential taps on the coil

The following table gives Sigmaphi's and JLAB's designations for the potential taps:

SP's designation	JLAB's designation	Pinout N°
TAP 1	1/1	*Not used*
TAP 1_R	1/1_R	*Not used*
TAP 2	1/2	*Not used*
TAP 2_R	1/2_R	*Not used*
TAP 3	1/A	E
TAP 3_R	1/A_R	a
TAP 4	1/B	F
TAP 4_R	1/B_R	b
TAP 5	1/C	G
TAP 5_R	1/C_R	c
TAP 6	1/D	J
TAP 6_R	1/D_R	d
TAP 7	1/8	K
TAP 7_R	1/8_R	e
TAP 8	2/1	L
TAP 8_R	2/1_R	f
TAP 9	2/A	M
TAP 9_R	2/A_R	g
TAP 10	2/B	N
TAP 10_R	2/B_R	h
TAP 11	2/C	P
TAP 11_R	2/C_R	i
TAP 12	2/D	R
TAP 12_R	2/D_R	j
TAP 13	2/6	*Not used*
TAP 13_R	2/6_R	*Not used*
TAP 14	2/7	*Not used*
TAP 14_R	2/7_R	*Not used*
TAP 15	I+L1	C
TAP 15_R	I+L1_R	*Y*
TAP 16	I+L2	D
TAP 16_R	I+L2_R	Z
TAP 17	I-L1	T
TAP 17_R	I-L1_R	m
TAP 18	I-L2	S
TAP 18_R	I-L2_R	k
TAP 19	I+M1	A
TAP 19_R	I+M1_R	W
TAP 20	I+M2	B
TAP 20_R	I+M2_R	X
TAP 21	I-M1	V
TAP 21_R	I-M1_R	u
TAP 22	I-M2	U
TAP 22_R	I-M2_R	n

These AWG24 wires are connected on a 41 pins feedthrough LESKER IFDRG417013A thanks to a 41 pins connector LESKER FTACIR41V. All the feedthrough coming from the 4K circuit will be connected on the following part mounted on the central tube of the CCR:

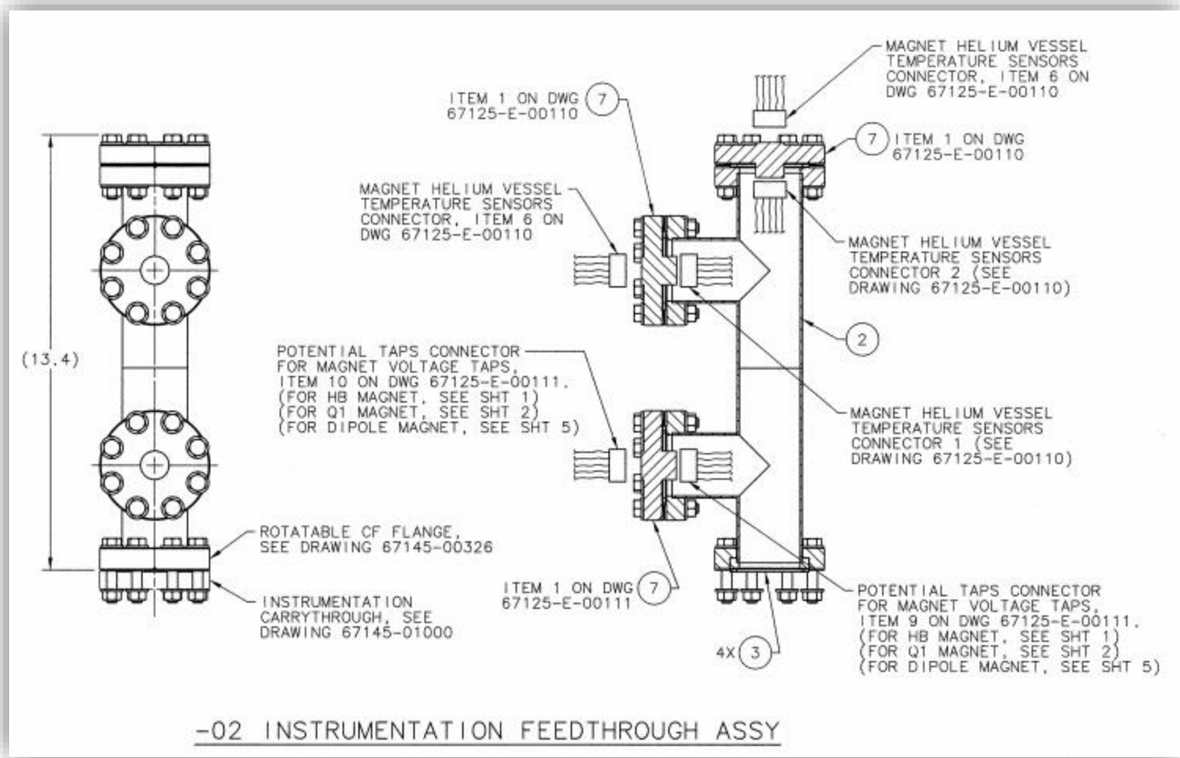

Figure 8: fixation of feedthroughs on this part

The following schemes give the position of Carbon-Ceramic sensors and PT100. CCS-D2 sensors are calibrated at 3 temperatures (4K, 77K and 22°C) and CCS-C2 sensors are calibrated on the full temperature range.

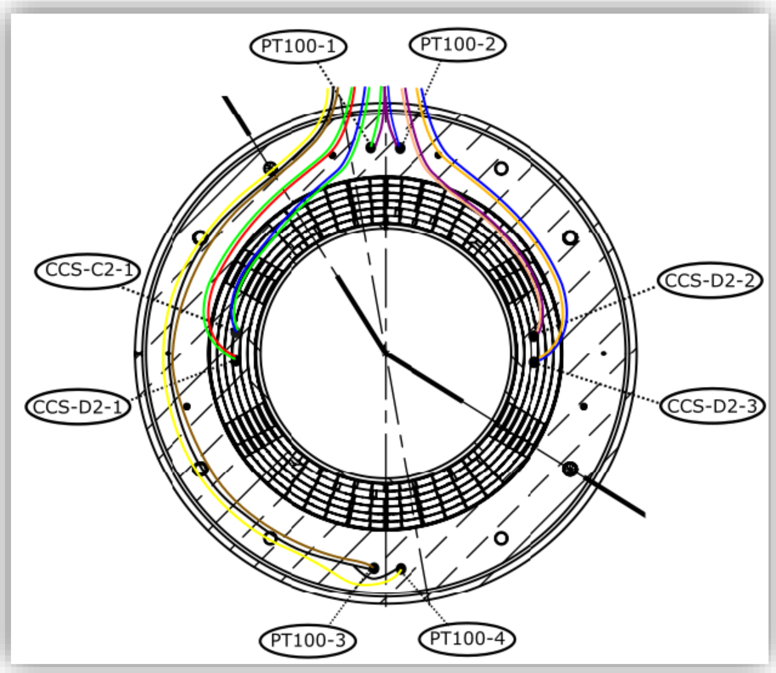

Figure 9: temperature sensors at the opposite side to the chimney

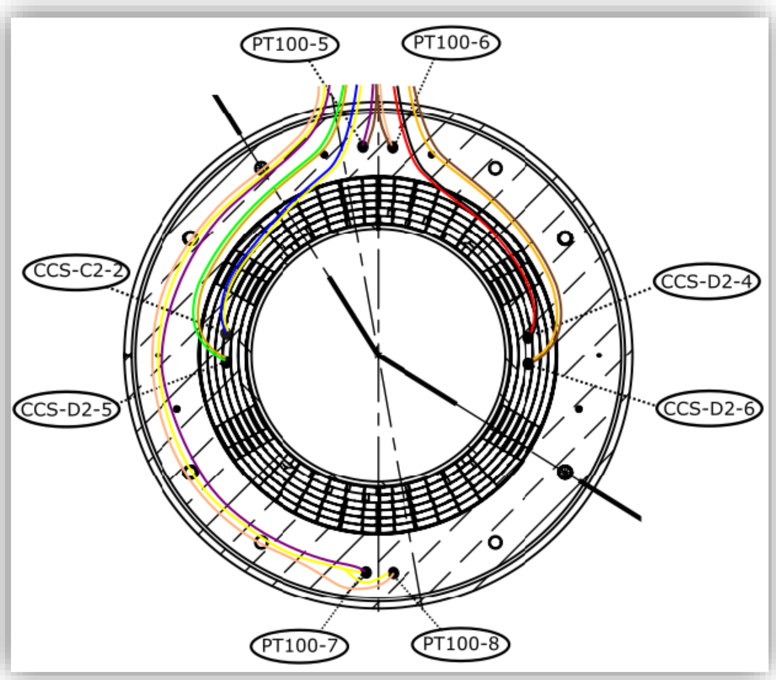

Figure 10: temperature sensors at chimney side

The following tables give Sigmaphi's and JLAB's designations for the temperature sensors on the coil:

SP's designation	JLAB's designation	Connector 1	Connector 2	Pinout N°
CCS-D2-1-V+	CC-4_R-V+		X	14
CCS-D2-1-V-	CC-4_R-V-		X	15
CCS-D2-1-I+	CC-4_R-I+		X	13
CCS-D2-1-I-	CC-4_R-I-		X	16
CCS-D2-2-V+	CC-2-V+	X		6
CCS-D2-2-V-	CC-2-V-	X		7
CCS-D2-2-I+	CC-2-I+	X		5
CCS-D2-2-I-	CC-2-I-	X		8
CCS-D2-3-V+	CC-2_R-V+		X	6
CCS-D2-3-V-	CC-2_R-V-		X	7
CCS-D2-3-I+	CC-2_R-I+		X	5
CCS-D2-3-I-	CC-2_R-I-		X	8
CCS-D2-4-V+	CC-3-V+	X		10
CCS-D2-4-V-	CC-3-V-	X		11
CCS-D2-4-I+	CC-3-I+	X		9
CCS-D2-4-I-	CC-3-I-	X		12
CCS-D2-5-V+	CC-1_R-V+		X	2
CCS-D2-5-V-	CC-1_R-V-		X	3
CCS-D2-5-I+	CC-1_R-I+		X	1
CCS-D2-5-I-	CC-1_R-I-		X	4
CCS-D2-6-V+	CC-3_R-V+		X	10
CCS-D2-6-V-	CC-3_R-V-		X	11
CCS-D2-6-I+	CC-3_R-I+		X	9
CCS-D2-6-I-	CC-3_R-I-		X	12
CCS-D2-7-V+	CC-5-V+	X		18
CCS-D2-7-V-	CC-5-V-	X		19
CCS-D2-7-I+	CC-5-I+	X		17
CCS-D2-7-I-	CC-5-I-	X		20
CCS-D2-8-V+	CC-5_R-V+		X	18
CCS-D2-8-V-	CC-5_R-V-		X	19
CCS-D2-8-I+	CC-5_R-I+		X	17
CCS-D2-8-I-	CC-5_R-I-		X	20
CCS-D2-9-V+	CC-6-V+	X		22
CCS-D2-9-V-	CC-6-V-	X		23
CCS-D2-9-I+	CC-6-I+	X		21
CCS-D2-9-I-	CC-6-I-	X		24
CCS-D2-10-V+	CC-6_R-V+		X	22
CCS-D2-10-V-	CC-6_R-V-		X	23
CCS-D2-10-I+	CC-6_R-I+		X	21
CCS-D2-10-I-	CC-6_R-I-		X	24
CCS-C2-1-V+	CC-4-V+	X		14
CCS-C2-1-V-	CC-4-V-	X		15
CCS-C2-1-I+	CC-4-I+	X		13
CCS-C2-1-I-	CC-4-I-	X		16
CCS-C2-2-V+	CC-1-V+	X		2
CCS-C2-2-V-	CC-1-V-	X		3
CCS-C2-2-I+	CC-1-I+	X		1
CCS-C2-2-I-	CC-1-I-	X		4

SP's designation	JLAB's designation	Connector 1	Connector 2	Pinout N°
PT100-1-M	PT102-1-M	X		25
PT100-1-O	PT102-1-O	X		26
PT100-1-C	PT102-1-C	X		27
PT100-2-M	PT102-1_R-M		X	25
PT100-2-O	PT102-1_R-O		X	26
PT100-2-C	PT102-1_R-C		X	27
PT100-3-M	PT102-2-M	X		28
PT100-3-O	PT102-2-O	X		29
PT100-3-C	PT102-2-C	X		30
PT100-4-M	PT102-2_R-M		X	28
PT100-4-O	PT102-2_R-O		X	29
PT100-4-C	PT102-2_R-C		X	30
PT100-5-M	PT102-3-M	X		31
PT100-5-O	PT102-3-O	X		32
PT100-5-C	PT102-3-C	X		33
PT100-6-M	PT102-3_R-M		X	31
PT100-6-O	PT102-3_R-O		X	32
PT100-6-C	PT102-3_R-C		X	33
PT100-7-M	PT102-4-M	X		34
PT100-7-O	PT102-4-O	X		35
PT100-7-C	PT102-4-C	X		36
PT100-8-M	PT102-4_R-M		X	34
PT100-8-O	PT102-4_R-O		X	35
PT100-8-C	PT102-4_R-C		X	36

8 Mechanical & Electrical protection of conductors

The following parts will be installed by Sigmaphi at both extremities of the splicing in order to center and maintain in position the conductors inside helium return pipes:

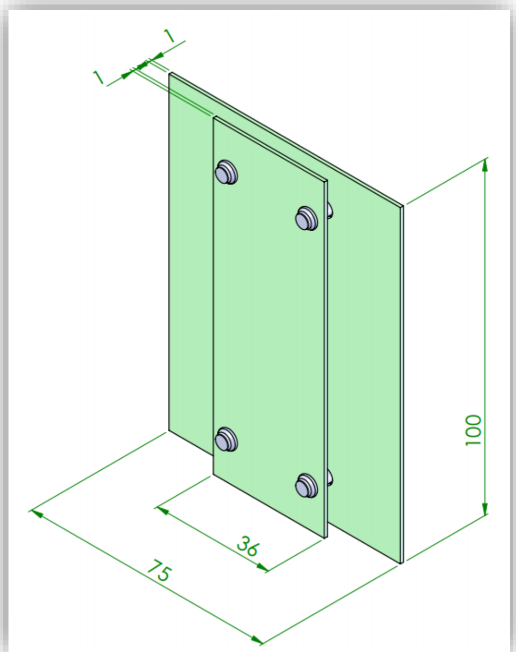

Figure 11: maintain in position of the conductors

All the splicing area will be wrapped with fiberglass tape and impregnated with epoxy resin. This operation will be performed by Sigmaphi.

9 Helium pipes welding

Once the instrumentation has been installed and tested JLAB's team (ASME qualified welders) can proceed to the welding of two half tubes (previously cut) around conductors and instrumentation and to the welding of the helium supply pipe. The half tubes are composed of back welding plates in order to avoid heating the conductors and the wires. The temperature of carbon ceramic sensors on the conductors shall be measured during welding in order to avoid any overheating. A helium leak test has to be performed on the helium circuit after welding.

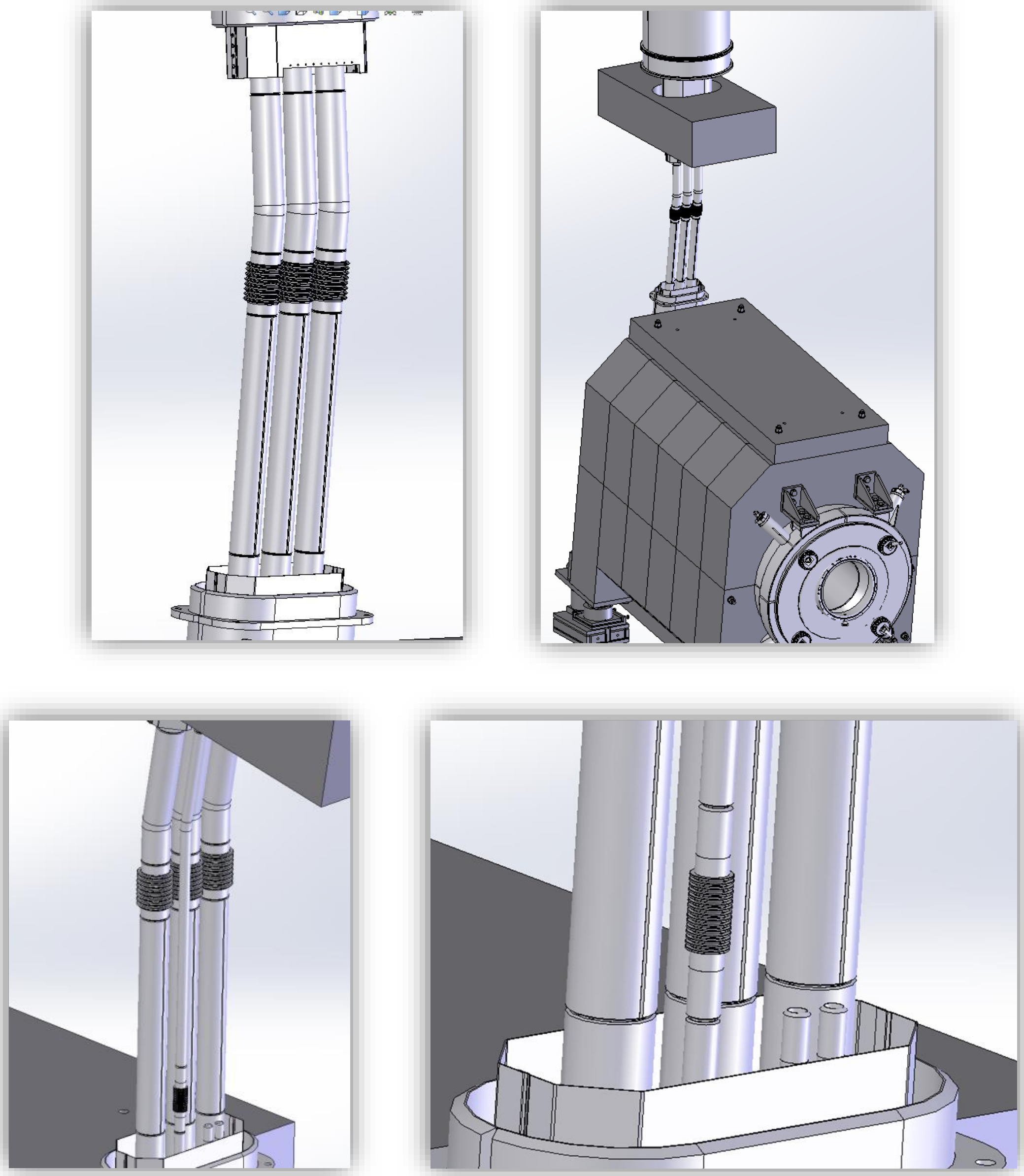

Figure 12: helium pipes welding

10 Installation of the first MLI

The 10 layer MLI (N°06) is then installed by JLAB around the 4 helium pipes.

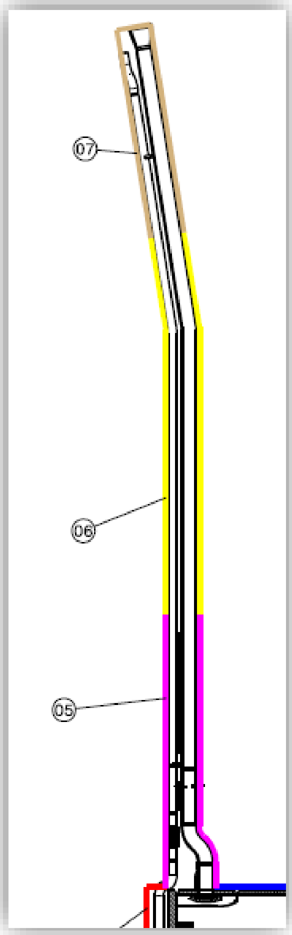

Figure 13: view of the multilayer installation on helium pipes

11 Nitrogen pipes welding

The nitrogen supply and return pipes are then welded by ASME qualified welders. Precautions will be taken close to the MLI: a protection blanket will be installed between pipes and MLI. A helium leak test has to be performed on the nitrogen circuit after welding.

12 Installation of the thermal shield

The copper shield is fixed on nitrogen return pipe thanks to copper blocks soldered on the copper shield. Apiezon N grease will be installed between pipes and copper blocks before tightening this assembly. Several G10 spacers are installed around the nitrogen supply pipe in order to avoid any contact between supply pipe and copper shield. All the copper shields are then mounted and fixed thanks to rivets.

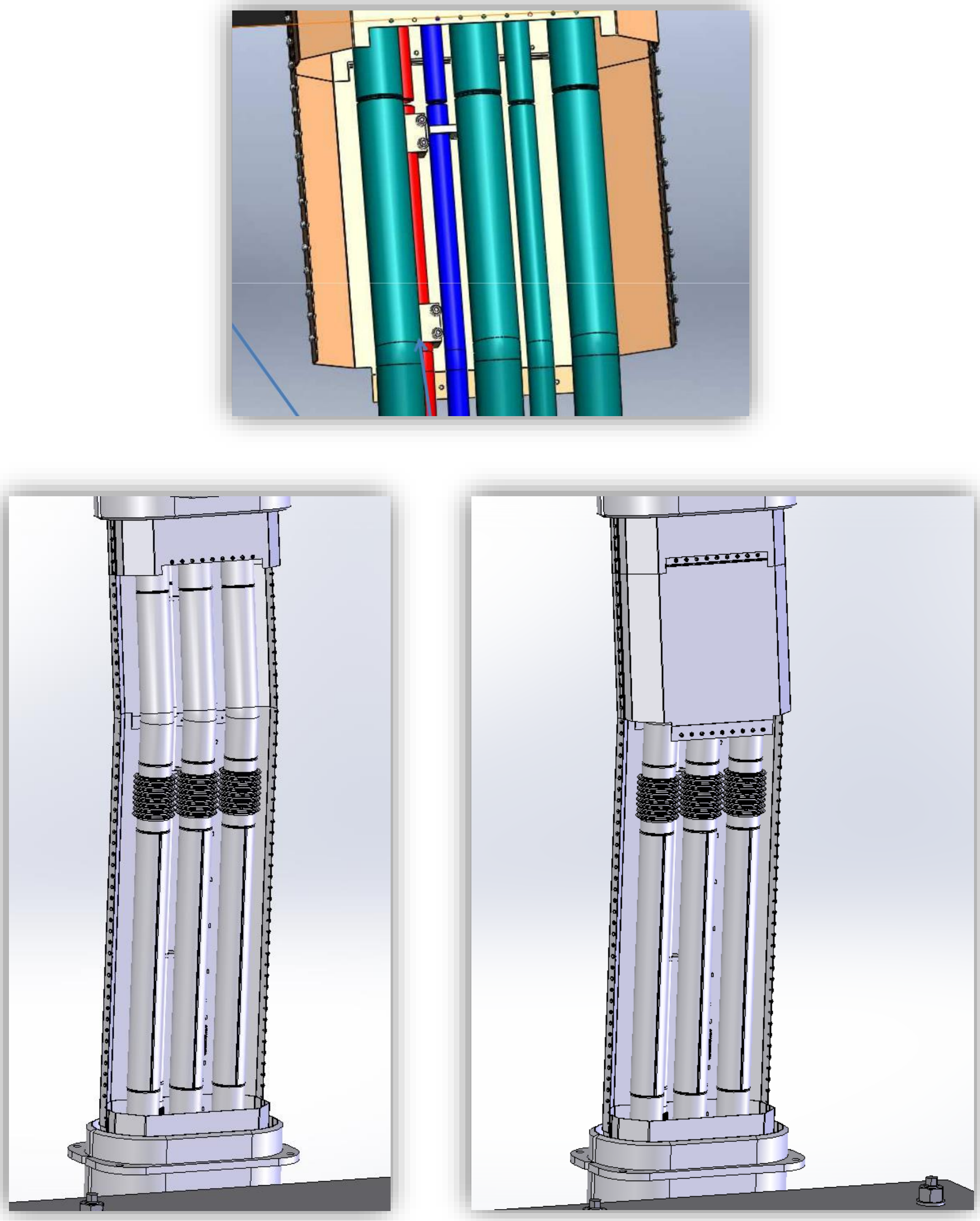

Figure 14: fixation of the copper shields

13 Connection of the 77K instrumentation on the CCR

Eight PT100 sensors are installed on the thermal shield at the following positions. These wires will be connected to the CCR by using a fish cable to pull it. The wires are thermalized on the copper shield on the whole length of the chimney.

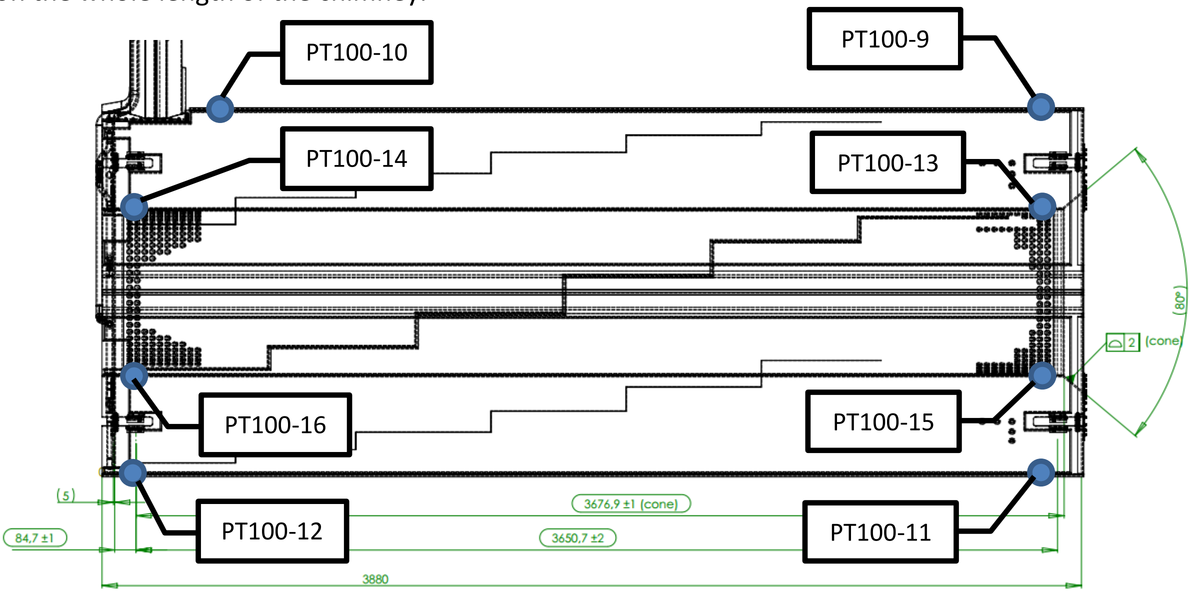

Figure 15: position of the PT100 sensors on the thermal shield

SP's designation	JLAB's designation	Pinout N°
PT100-9-M	PT102-6-M	1
PT100-9-O	PT102-6-O	2
PT100-9-C	PT102-6-C	3
PT100-10-M	PT102-6_R-M	13
PT100-10-O	PT102-6_R-O	14
PT100-10-C	PT102-6_R-C	15
PT100-11-M	PT102-7-M	4
PT100-11-O	PT102-7-O	5
PT100-11-C	PT102-7-C	6
PT100-12-M	PT102-7_R-M	16
PT100-12-O	PT102-7_R-O	17
PT100-12-C	PT102-7_R-C	18
PT100-13-M	PT102-8-M	7
PT100-13-O	PT102-8-O	8
PT100-13-C	PT102-8-C	9
PT100-14-M	PT102-8_R-M	19
PT100-14-O	PT102-8_R-O	20
PT100-14-C	PT102-8_R-C	21
PT100-15-M	PT102-9-M	10
PT100-15-O	PT102-9-O	11
PT100-15-C	PT102-9-C	12
PT100-16-M	PT102-9_R-M	22
PT100-16-O	PT102-9_R-O	23
PT100-16-C	PT102-9_R-C	24

The feedthrough for LN_2 instrumentation is "instrumentation A" on the following figure:

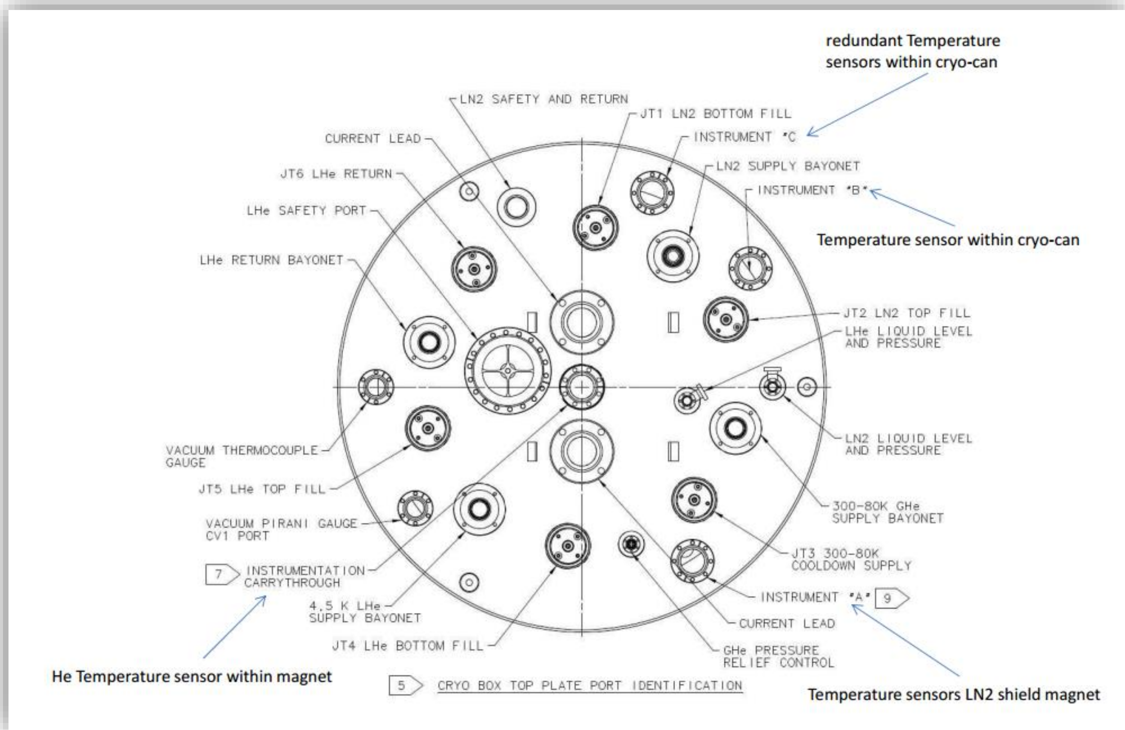

Figure 16: position of the instrumentation feedthrough

14 Installation of the second MLI

The second MLI is composed of 2 panels of 20 layers each (N°46 & 56). The junction will be performed with Velcro tapes.

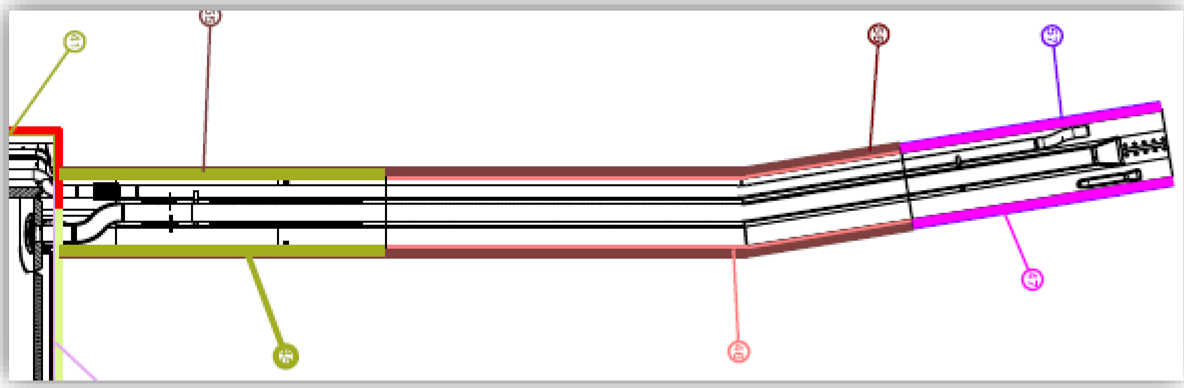

Figure 17: installation of the 2nd MLI

15 Welding of the outer vessel chimney

The outer chimney is then welded by JLAB's team around this assembly. The interfaces for the handling of these heavy parts will be defined by JLAB.

Precautions will be taken to protect the MLI: a protection tissue will be fixed on the MLI in welding areas.

Once the welding is finished, the vacuum tightness of the OVC will be checked with a helium bag around it. Moreover, the vacuum tightness of helium and nitrogen circuits will be checked by introducing gaseous helium under 6 bars pressure in these circuits and by installing the detector on the vacuum vessel.

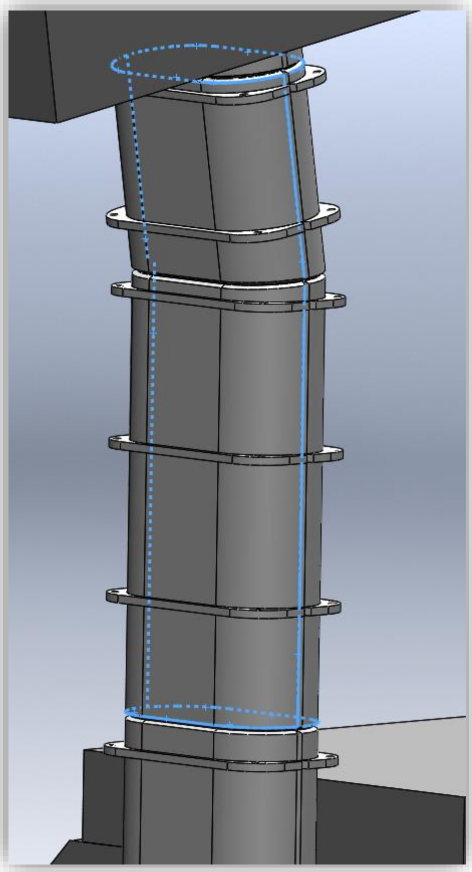

Figure 18: installation of the vacuum chimney