

# Improvements to the CeC Systems

CeC Experiment at RHIC  
CeC X Retreat

Jean Clifford Brutus  
August 16<sup>th</sup>, 2021



@BrookhavenLab

# Key Presentations

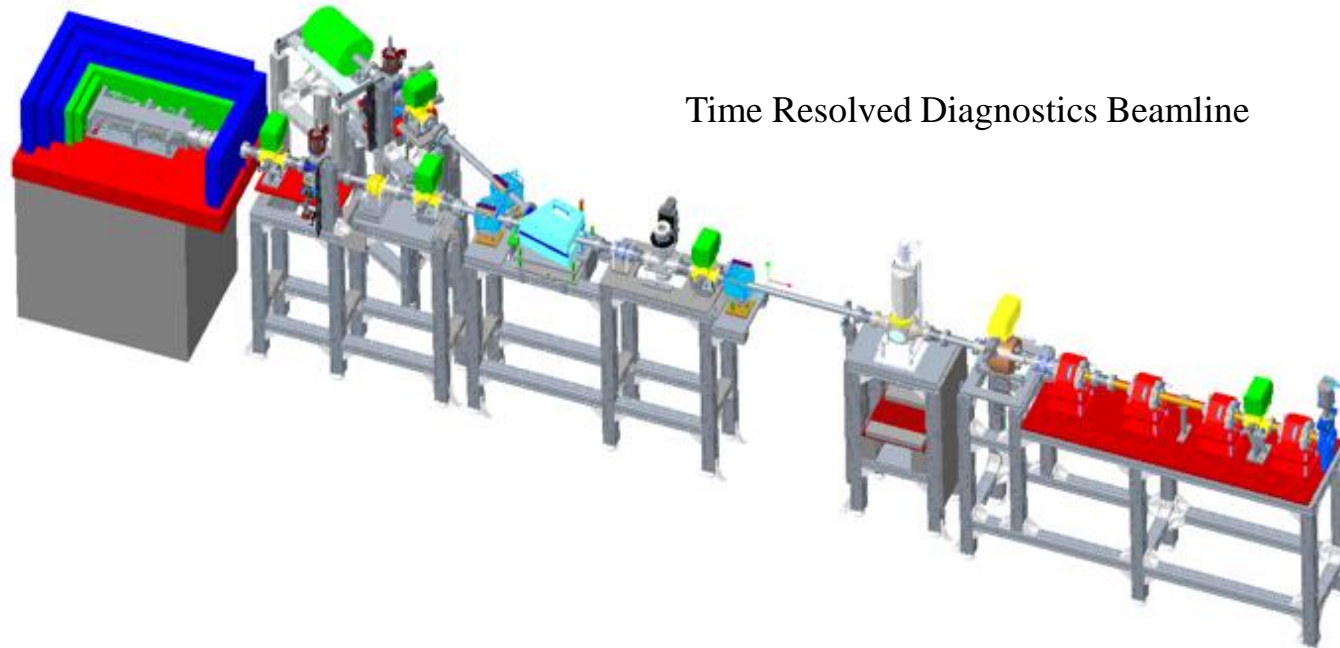
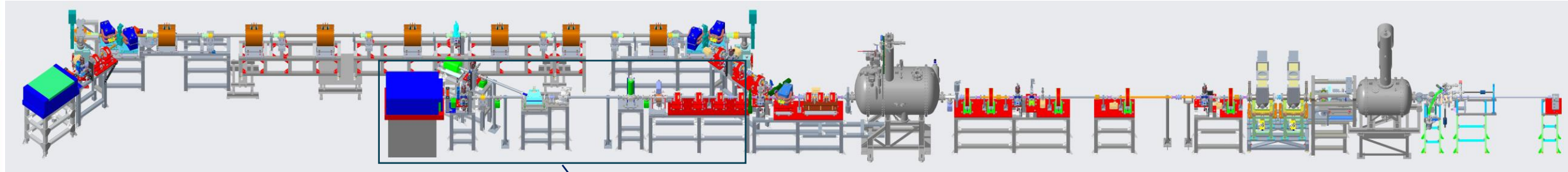
14:10 → 14:20	Break	🕒 10m
14:20 → 14:40	<b>Improvements to the CeC systems</b> Speaker: Jean Clifford Brutus	🕒 20m
14:40 → 15:00	<b>Photocathodes: production, transfer, QE mapping (M. Gaowei, E. Wang, L. Cultrera, T. Rao)</b> Speaker: John Skaritka (BNL)	🕒 20m
15:00 → 15:20	<b>Laser: time and intensity jitter, position stability, (L. Nguyen)</b> Speaker: Patrick Inacker-Mix (BNL)	🕒 20m
15:20 → 15:30	Break	🕒 10m
15:30 → 15:50	<b>CeC RF system: voltage and phase jitter and drifts (G. Narayan, F. Severino, Y. Than)</b> Speaker: Thomas Hayes (Brookhaven National Lab)	🕒 20m
15:50 → 16:10	<b>Orbit-drifts, noise/jitter, accuracy, slow feed-backs (R. Michnoff, P. Thieberger, A. Di Lieto)</b> Speaker: Igor Pinayev (BNL)	🕒 20m
16:10 → 16:30	<b>Diagnostics (including IR) - noise and its suppression (I. Pinayev, M. Paniccia)</b> Speaker: Rob Michnoff (BNL)	🕒 20m
16:30 → 16:50	<b>Diagnostics - time resolved emittance and energy spread, (Y. Jing, J.C. Brutus, D. Kayran, I. Pinayev)</b> Speaker: Andrei Sukhanov (BNL)	🕒 20m
16:50 → 17:00	<b>Closing</b>	🕒 10m

# CeC Shutdown 2021 Upgrades

#	Work
1	500 MHz Removal
2	Horizontal/Vertical Slit
3	Profile Monitor
4	Cathode System Upgrade
5	Replace Q1 in the TRDBL by one with working trim coils - in current quad two out of 4 trim coils are broken
6	500MHz Coax Inspection
7	DCCT
8	Solenoid
9	H/V Trims relocation
10	Wiggler/Undulator
11	Heating Jackets Removal
12	Compensating Coil

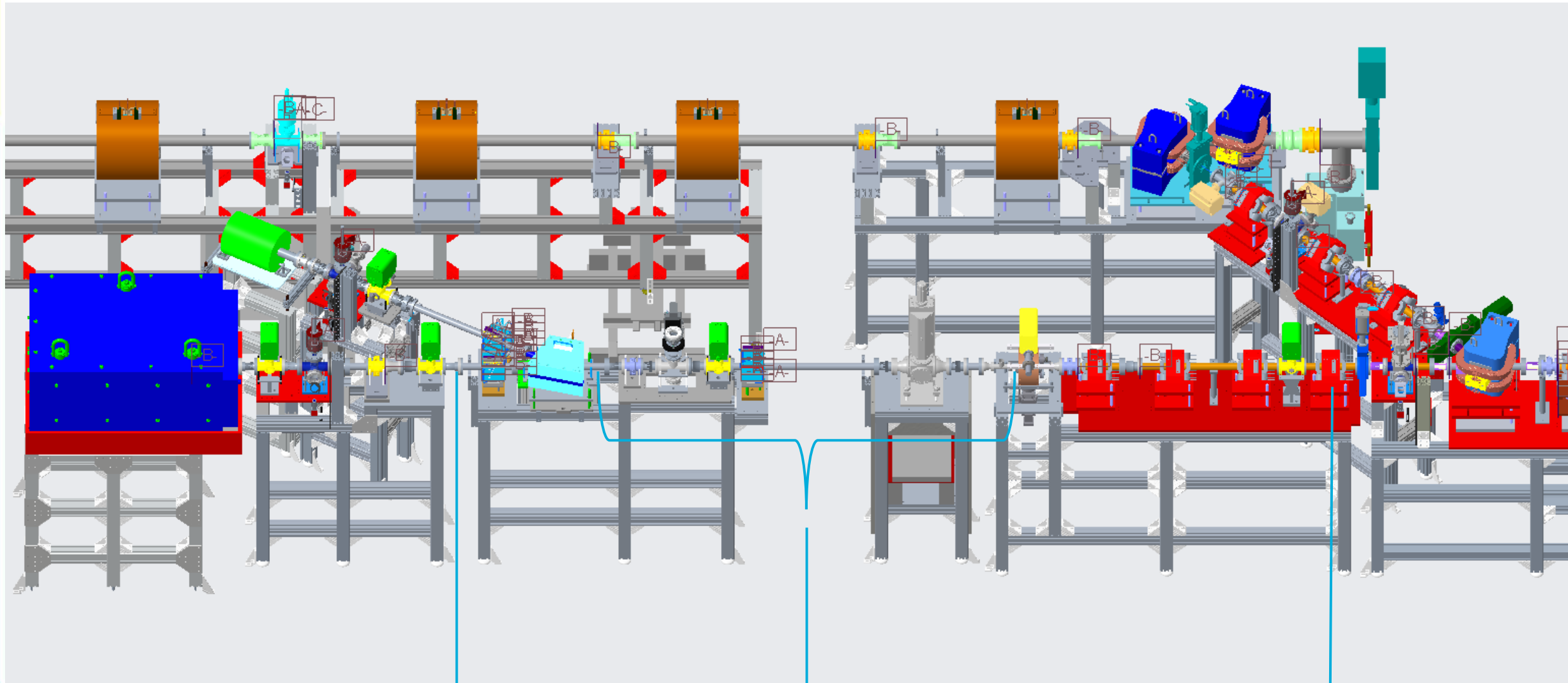


# CeC Beamline Modifications

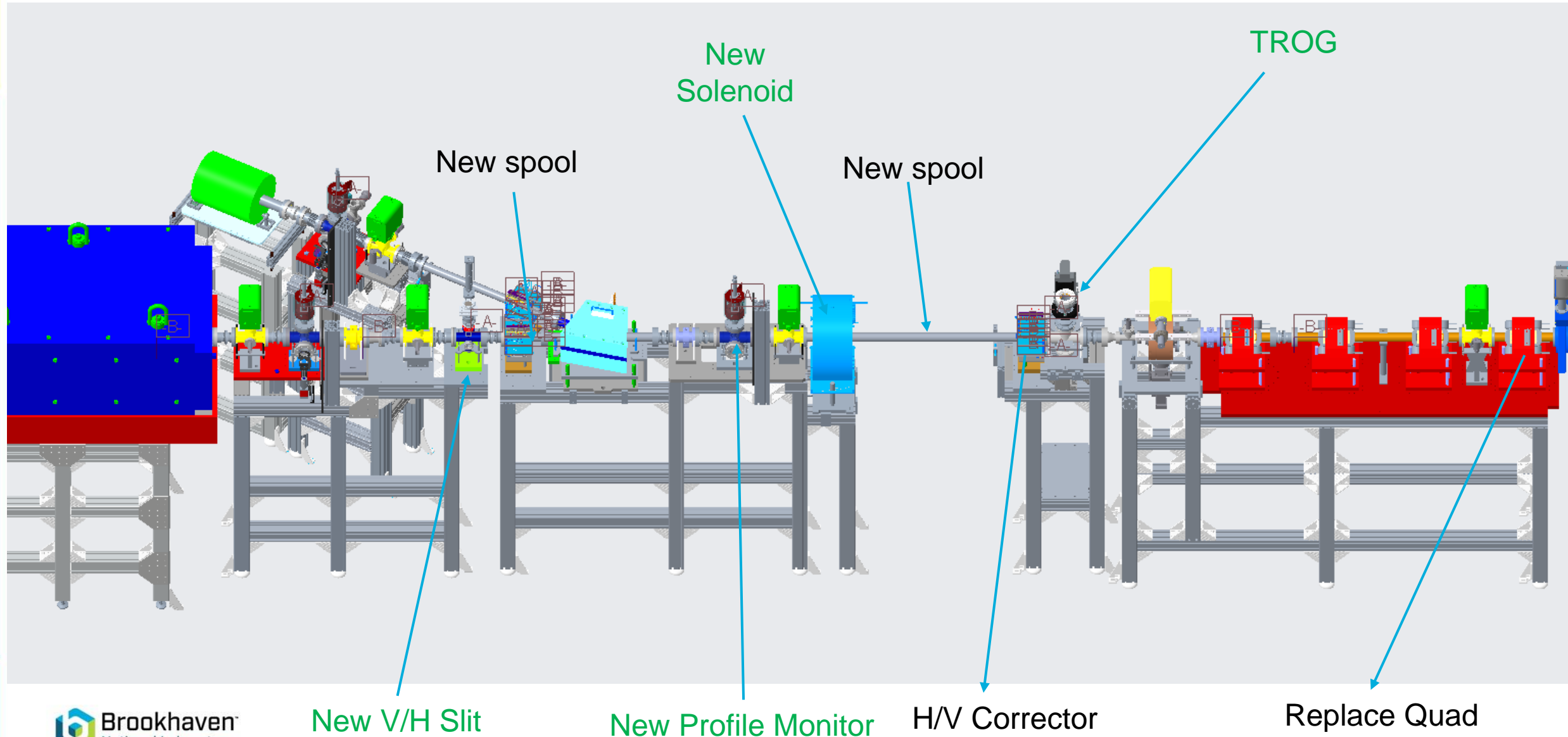


Time Resolved Diagnostics Beamline

# Changes to Diagnostics Beamline

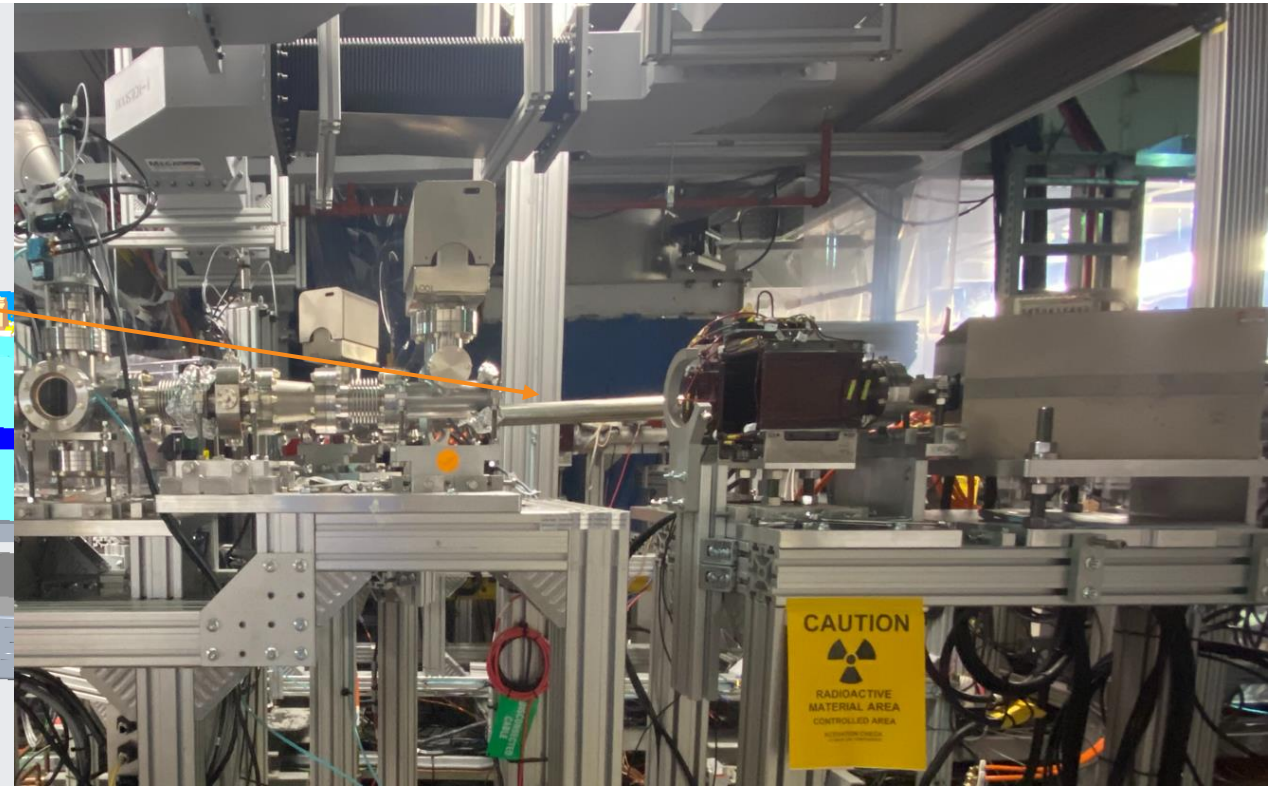
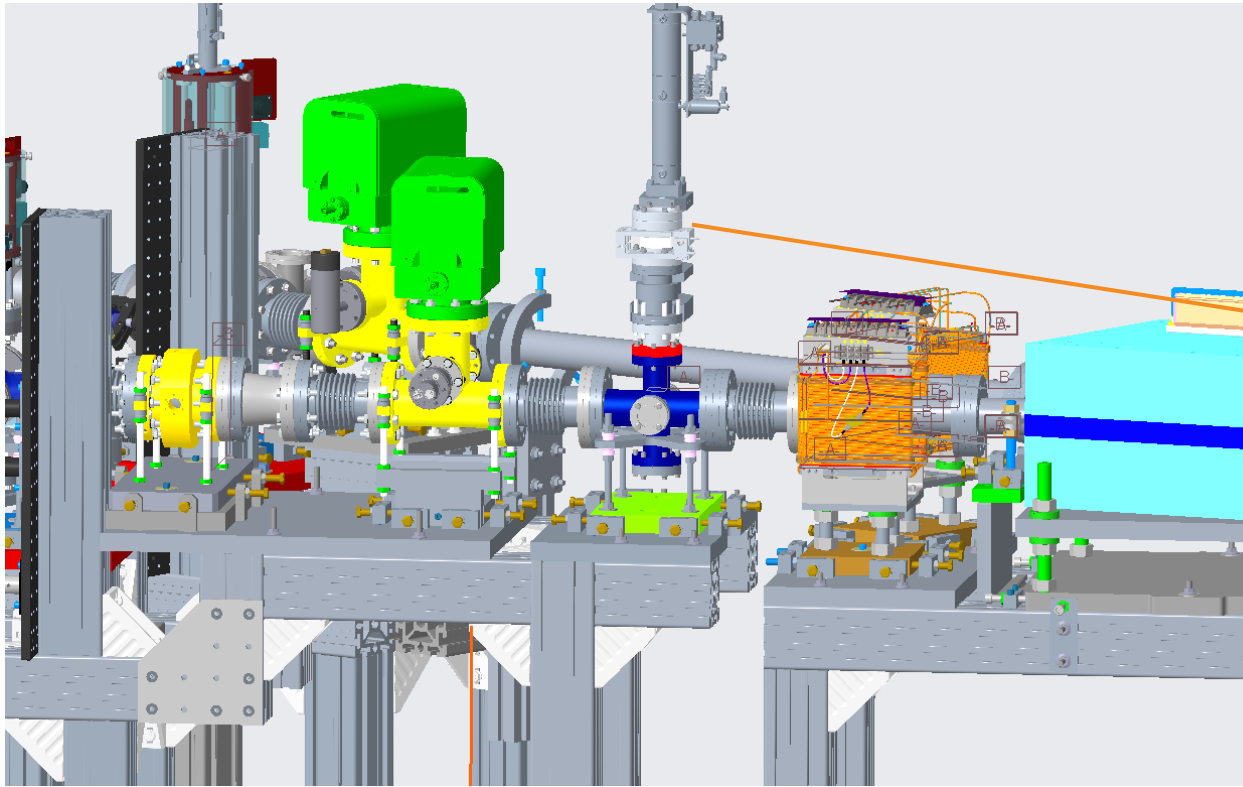


# Diagnostics Beamline Upgrade



# H/V Slit

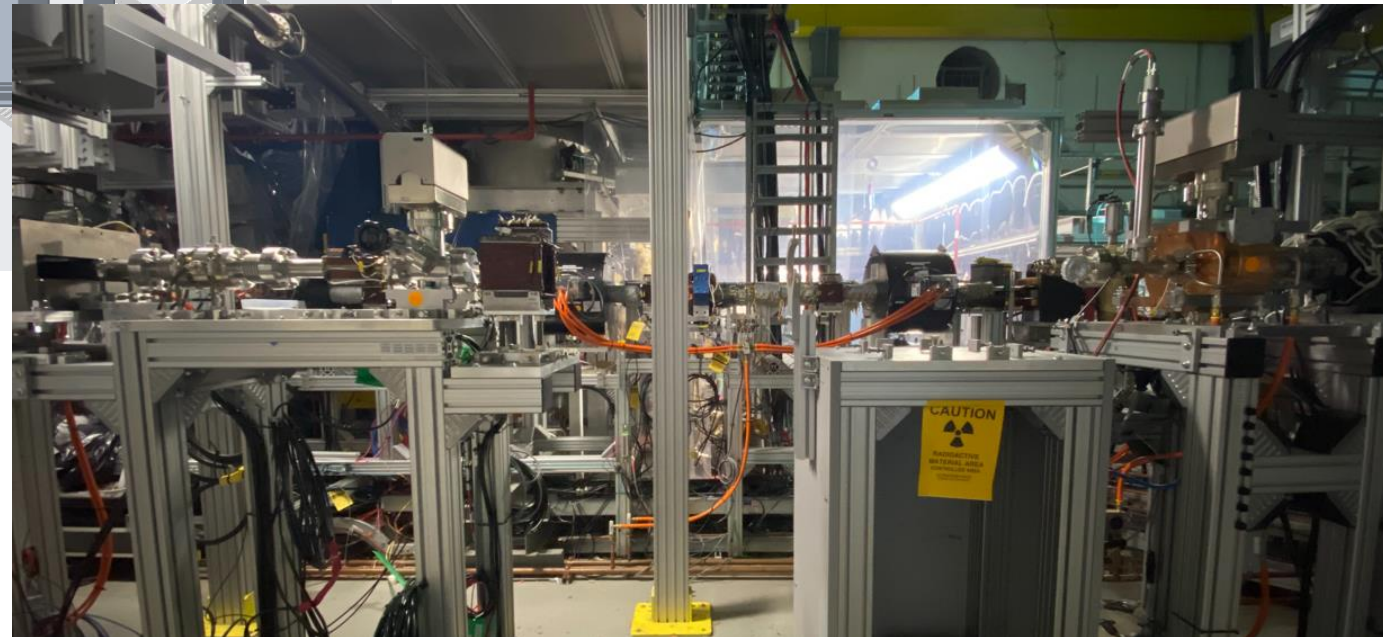
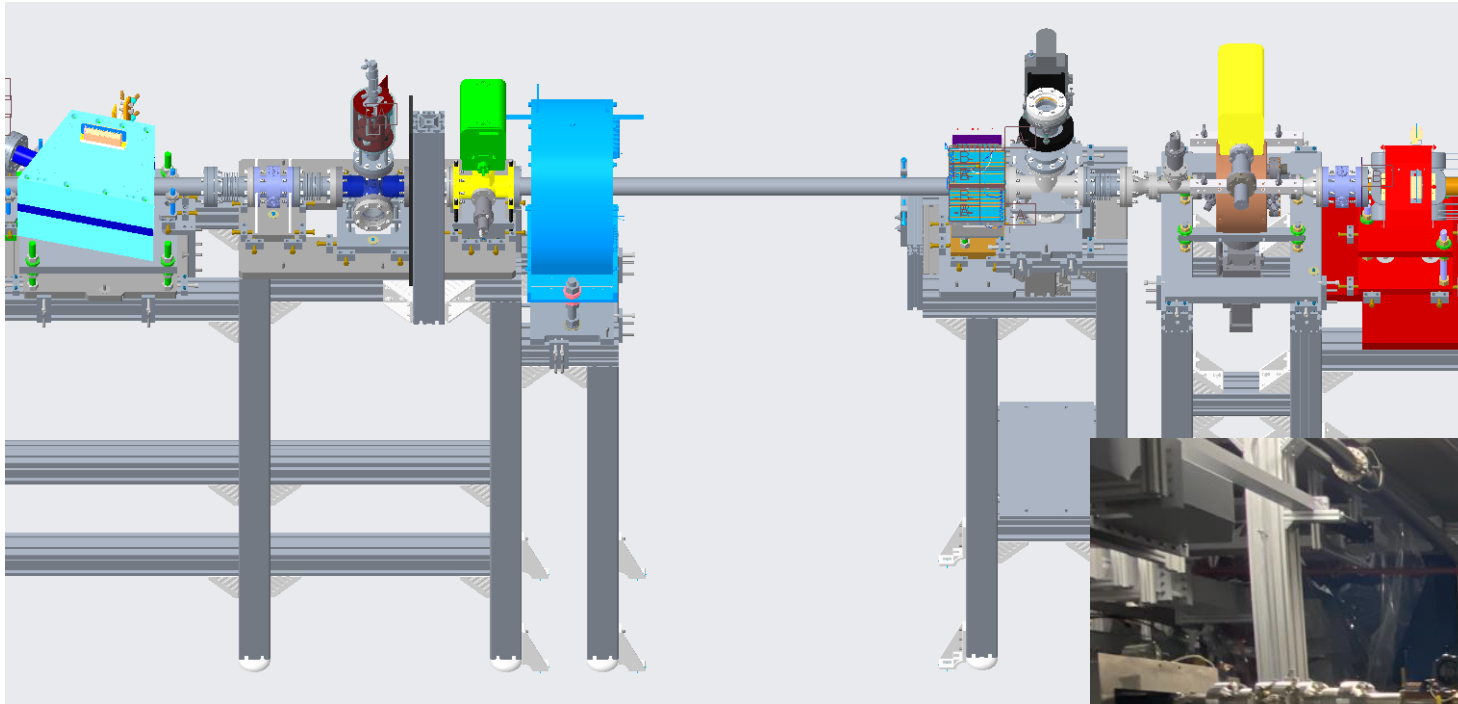
- Stand modification design completed
- Beamline vented and vacuum components removed
- BPM and ion pump relocated; survey to follow
- Delay from vendor for H/V Slit Custom cross 10/05/21





# Profile Monitor and Solenoid

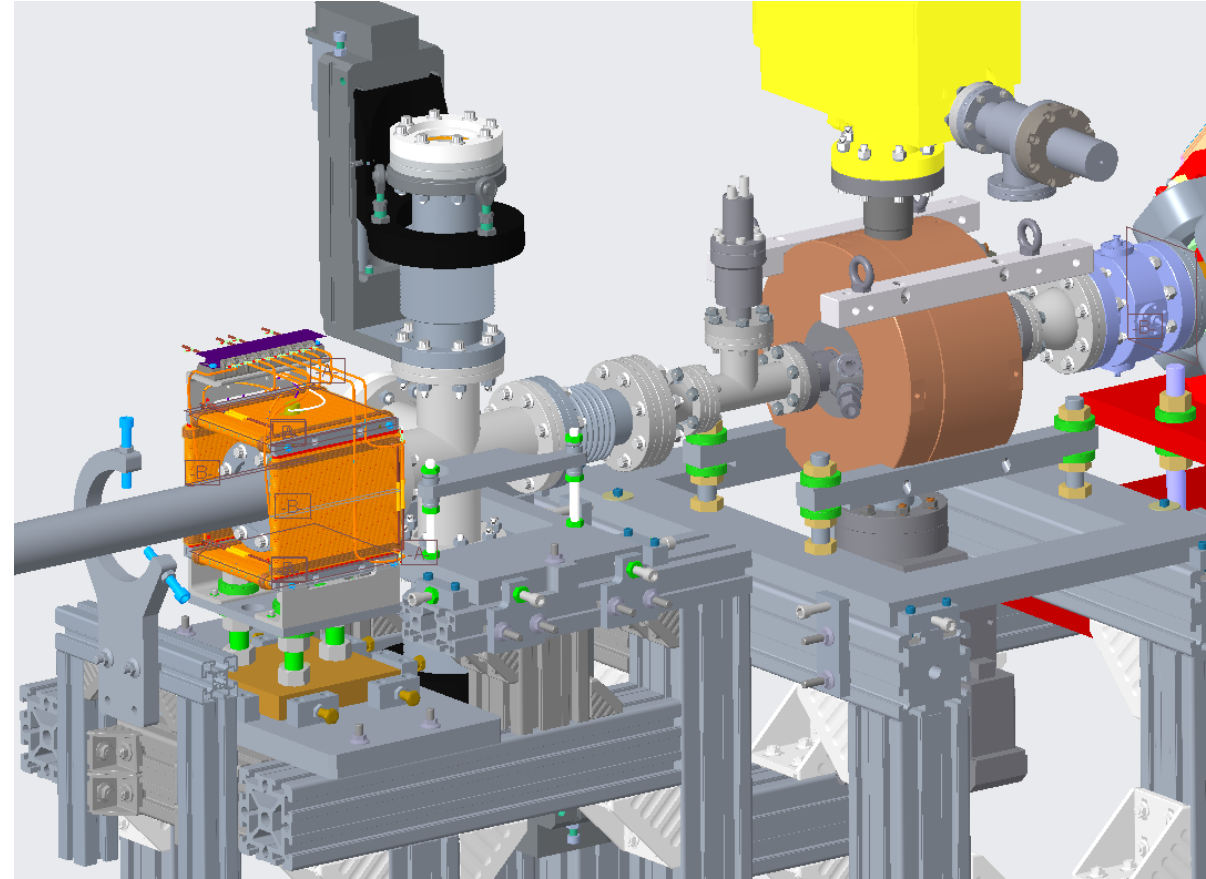
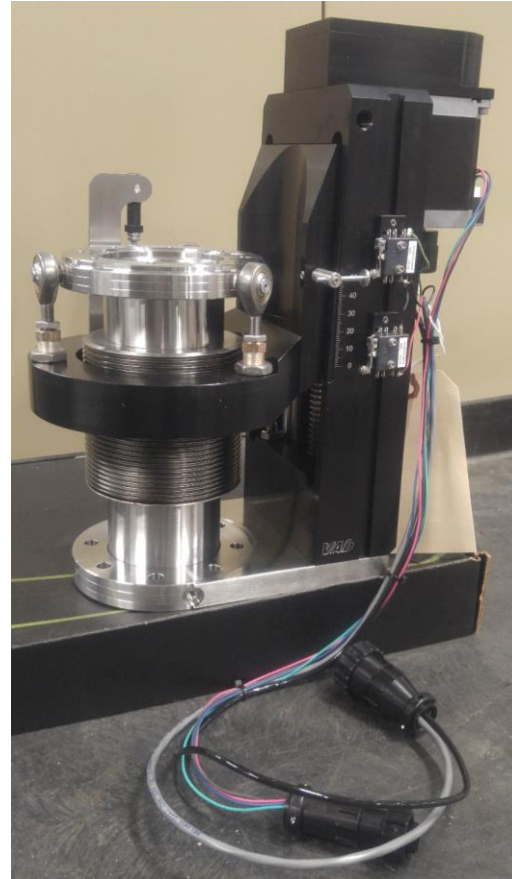
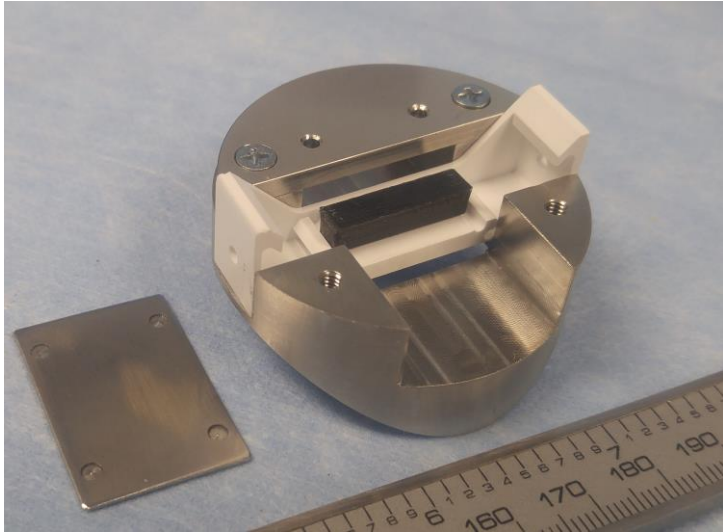
- Stand modification design completed
- Work in progress for relocation of H/V corrector and removal of Diamond detector stand
- Delay from vendor for profile monitor cross 10/05/21 – fabrication of new cross in house as backup





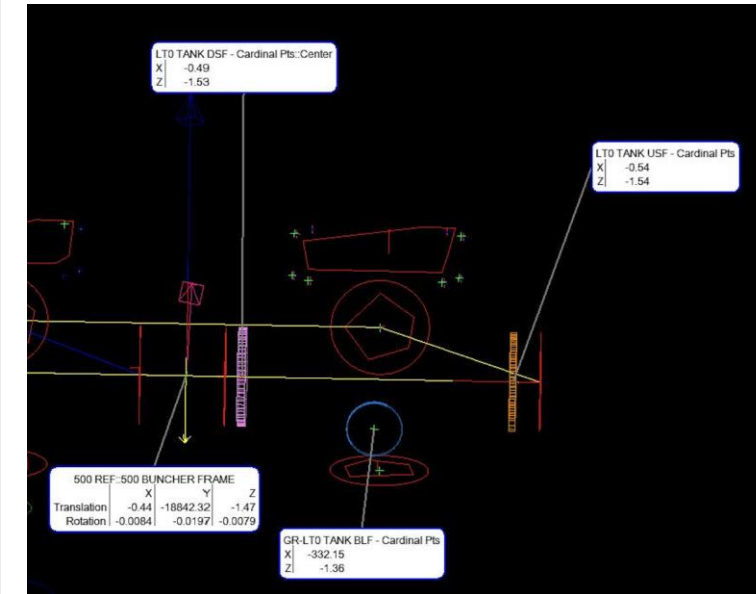
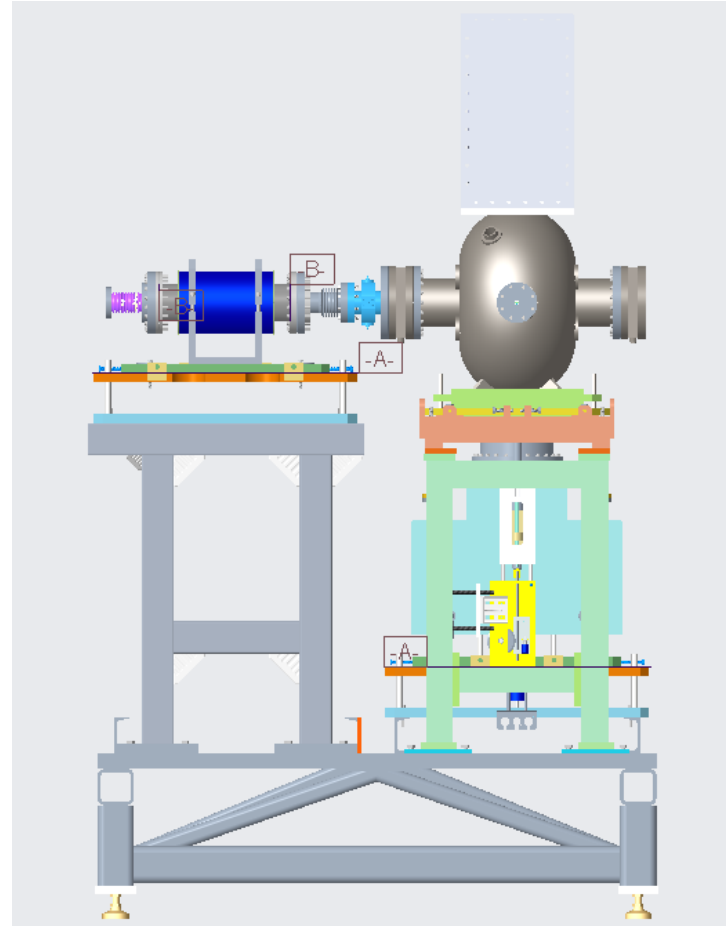
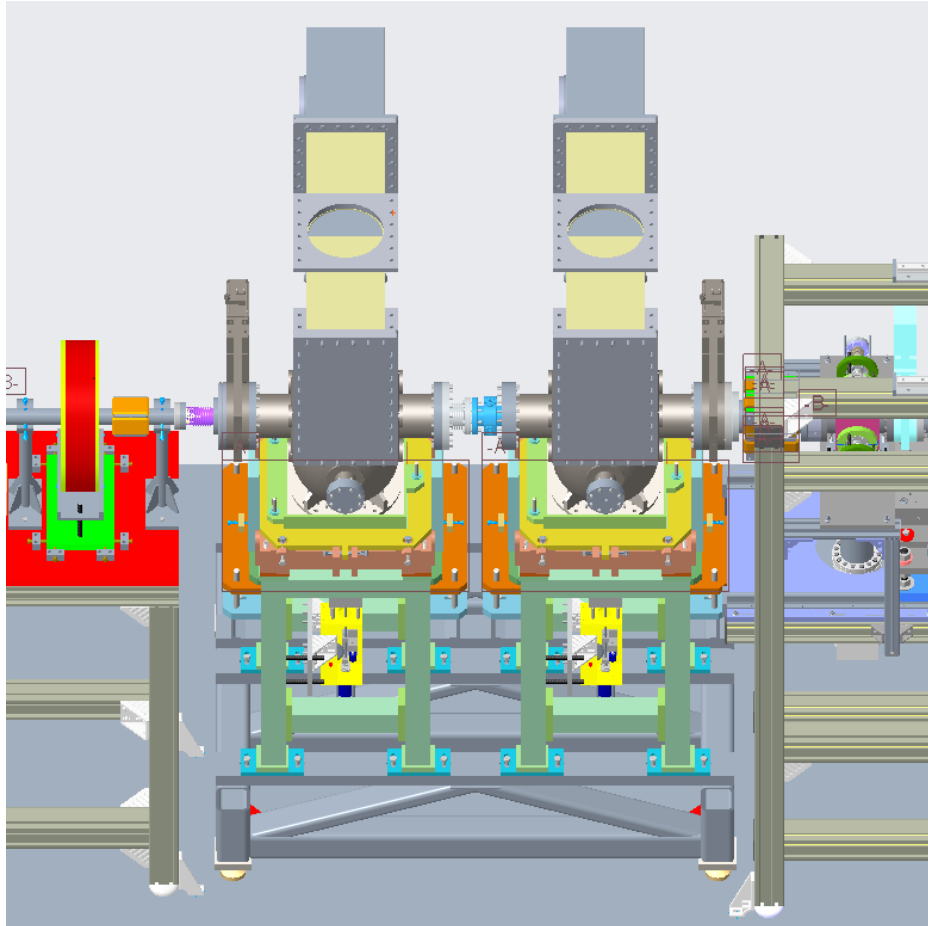
# Temporally Resolved Optical Gating - TROG

- New stand design completed
- Fabrication in progress



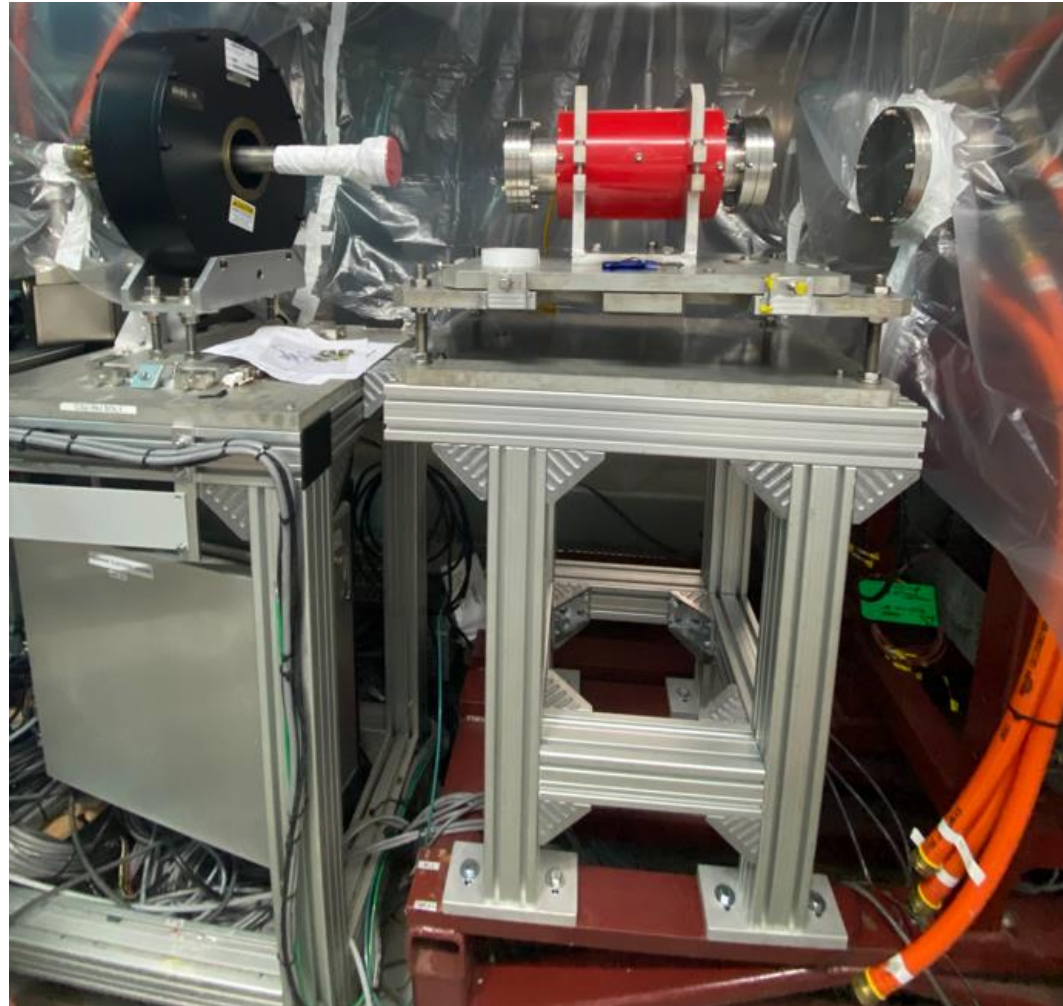
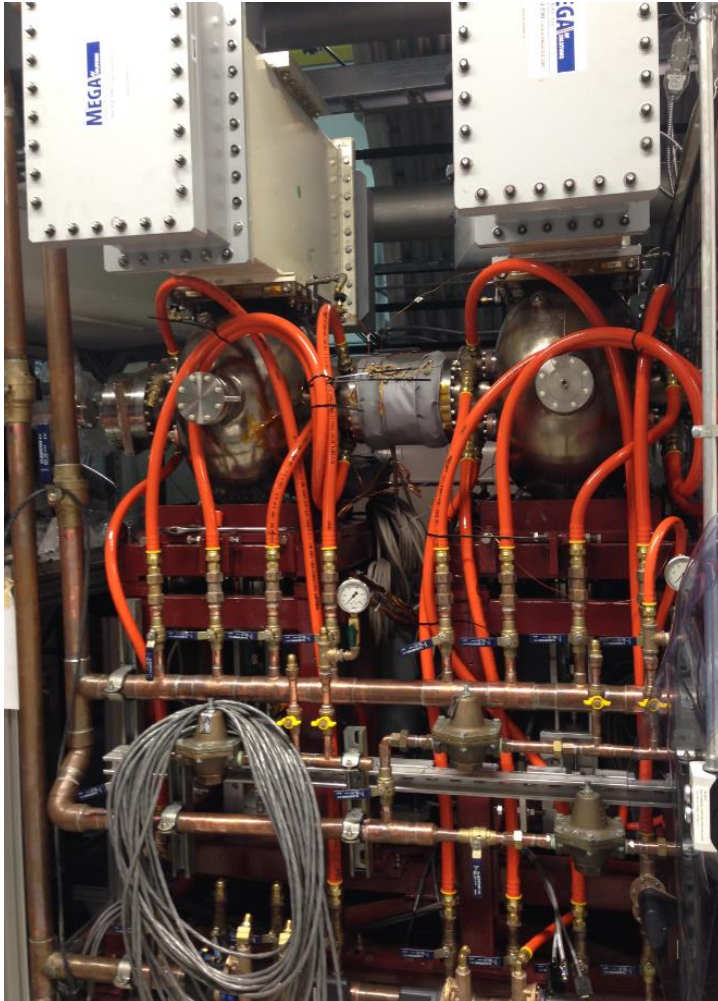
# 500 MHz Removal

- Design completed
- Design of coax reconfiguration completed
- Parts ordered and in house
- Single 500MHz surveyed: -1.5 mm axis; 0.02 degrees about Y axis



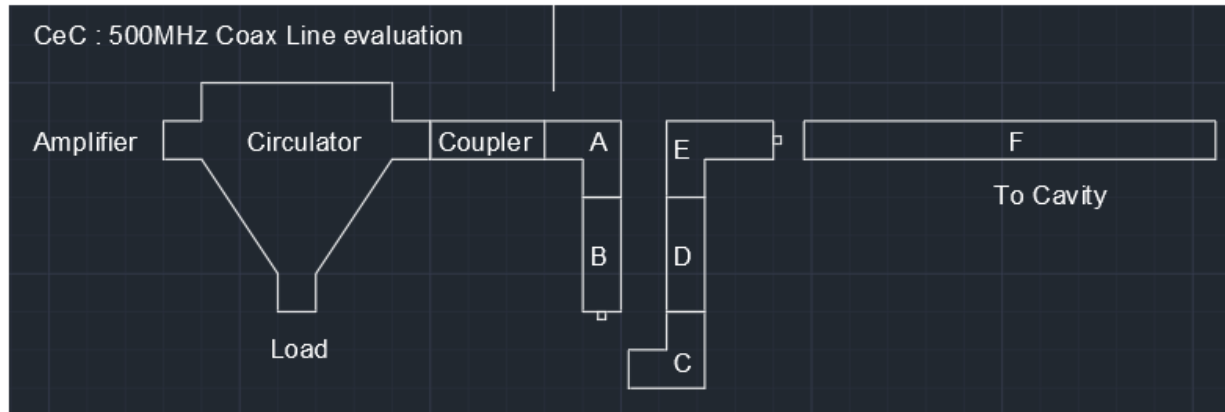
# 500 MHz & DCCT

- Removal completed
- All parts in house
- Installation in progress





# 500MHz Coax Inspection/Cleaning



- Received cleaning process from manufacturer
- Spare parts/Replacement parts ordered



Coupler 1.JPG



Coupler 2.JPG



A Coax A Clean 2.JPG



A Coax Clean 1.JPG



A Elbow - Air Feed.JPG



A Elbow Top.JPG



A B Outside.JPG



B Bullet Arcing.JPG



B Bullet Insulator 2.JPG



B Coax.JPG



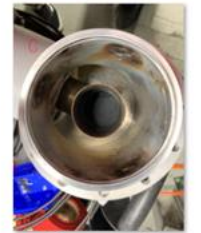
C D E.JPG



C Elbow Arcing 1.JPG



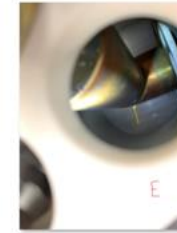
C Elbow Arcing 2.JPG



C Elbow Arcing 3.JPG



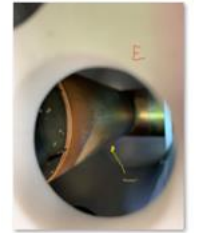
E Center Coax Center.JPG



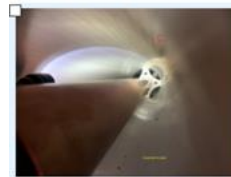
E Elbow 1.JPG



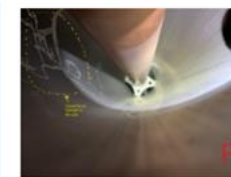
E Elbow 2.JPG



E Thermal Coloring.JPG



F Coax 1.JPG



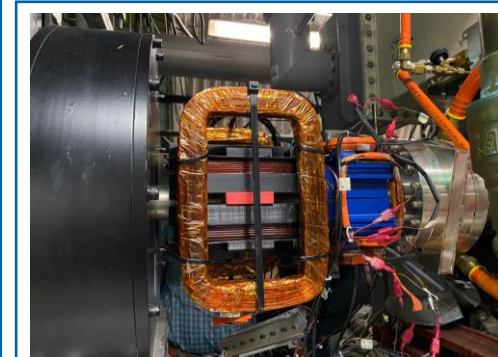
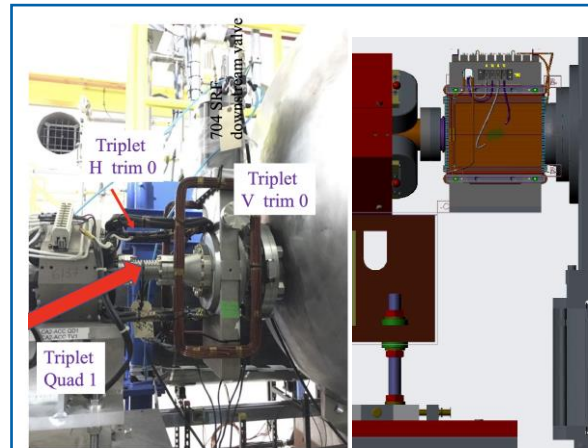
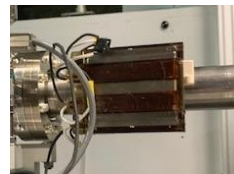
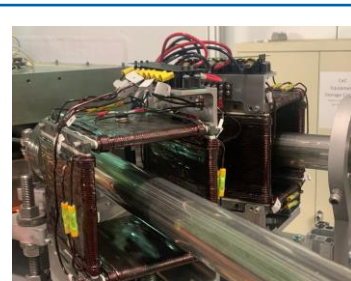
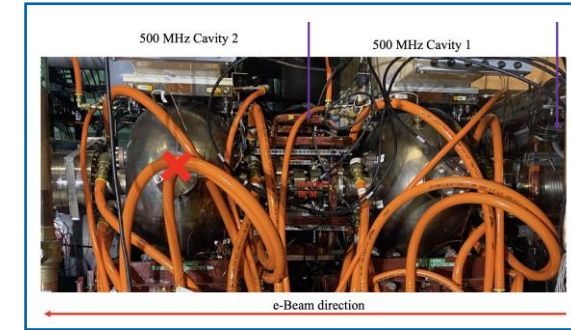
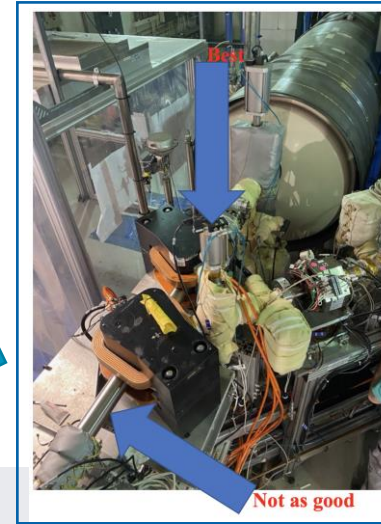
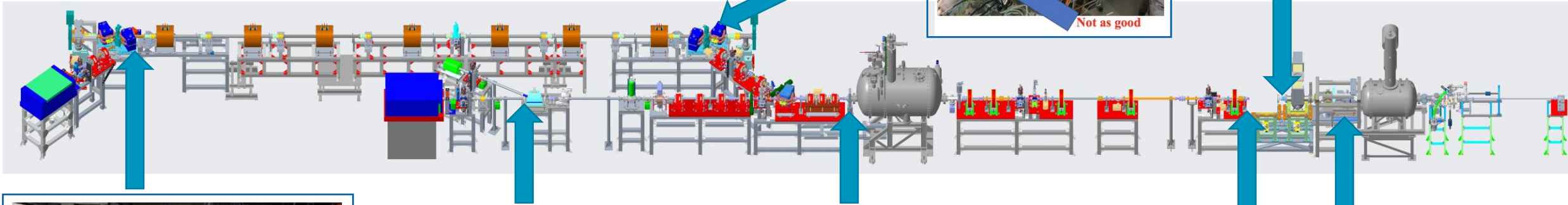
F Coax 2.JPG





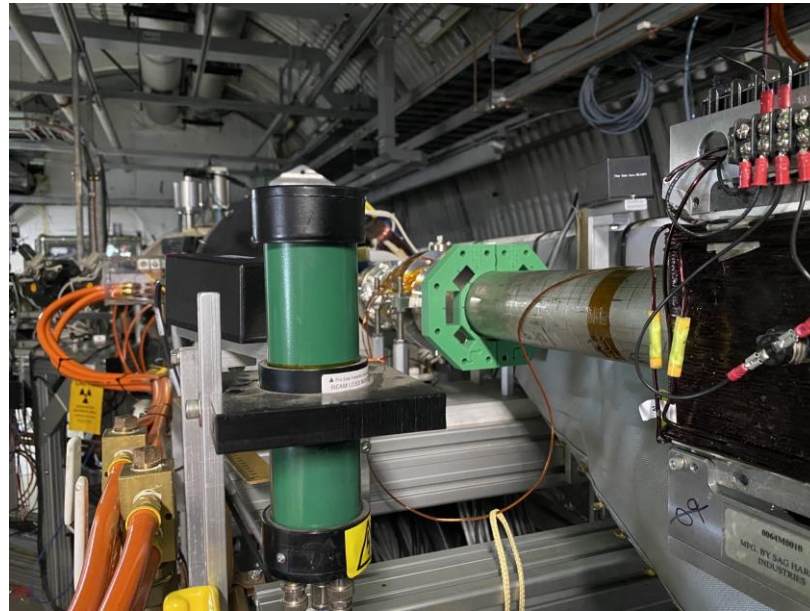
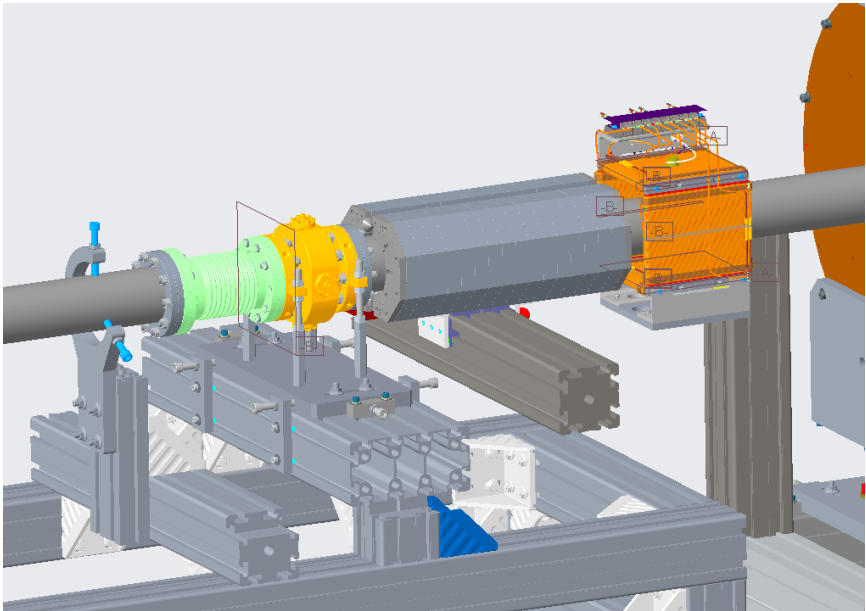
# Trim modifications in CeC Accelerator

- Take out Gun Trim 2 (large coils): Need to accurately fix Gun Trim 1
- Restore trims after 500MHz and after DCCT (E-measurement trims)
- Replace trims after 704MHz linac with new H/V correctors
- Replace TRDBL new large aperture with old trims with 2" aperture  
Keep H and V trims fed in series
- CeC section: Add vertical trim coils at the entrance and at the exit



# Short Diagnostics Undulator: 8 cm period, 0.6 kGs

- Will serve as source of THz radiation at frequency  $\sim 5$  THz to tune PCA. Will be removed for CeC demonstration.
- Design and prototype in progress

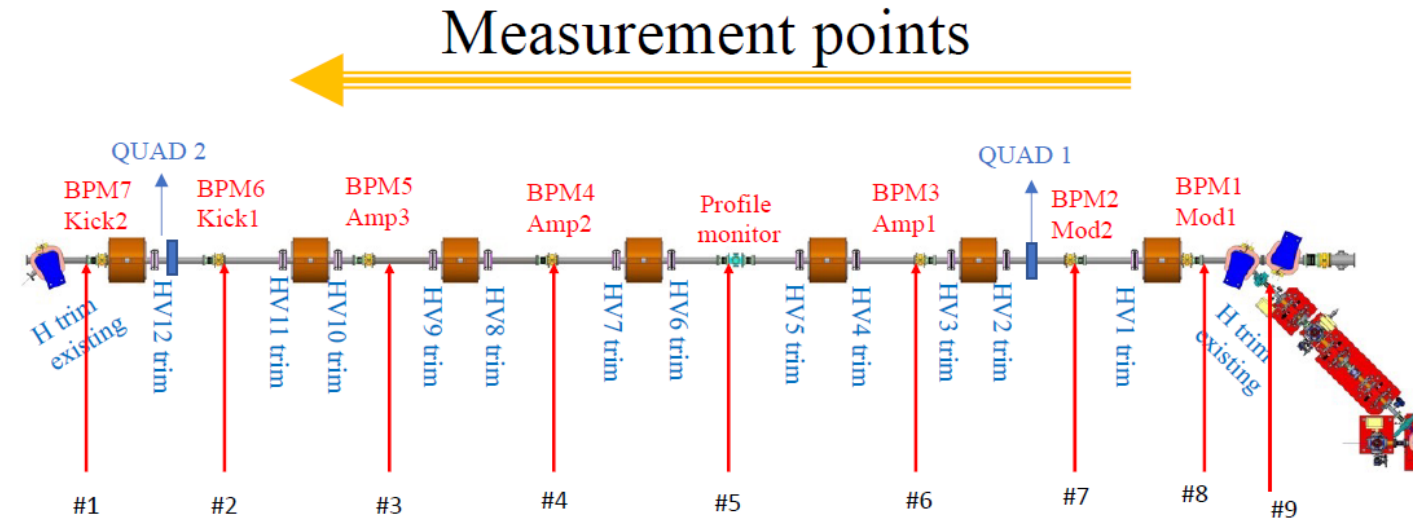




# Stray fields studies in CeC section

## Comments

- I used milliGauss meter today to investigate nature and values of stray magnetic fields in the CeC section
- Earth magnetic field :
  - Earth magnetic field was observed by walking along the CeC section with hand-held meter. Vertical component of the magnetic field has the same sign by varying from  $\sim +350$  mGs at the start (sol 1) to  $\sim +500$  mGs at the center and to  $\sim +250$  mGs close to the end of the CeC section (sol 7). Vertical component varies from -150 mGs to about +100 mGs
  - RHIC shell screens Earth magnetic field well with remaining components  $\sim 100$  mGs
- Compensating dipole magnets generate magnetic fields  $\sim 2$ -4 Gs at length  $\sim 40$  cm, e.g. angular kick  $\sim 1.8 - 3.6$  mrad opposite to the main dipoles, i.e.  $\sim 0.2$ -0.4% difference from the first dipole!
- The main finding from today – the back-out blankets and especially connecting cables are highly magnetic, have strong residual fields. Since they are not uniform and asymmetric, they are likely responsible for problems we had with angles of solenoids axes and lack of reproducibility. These blankets and cables need to be removed.
- Details of the stray fields induced by main power supplies are in the following slides



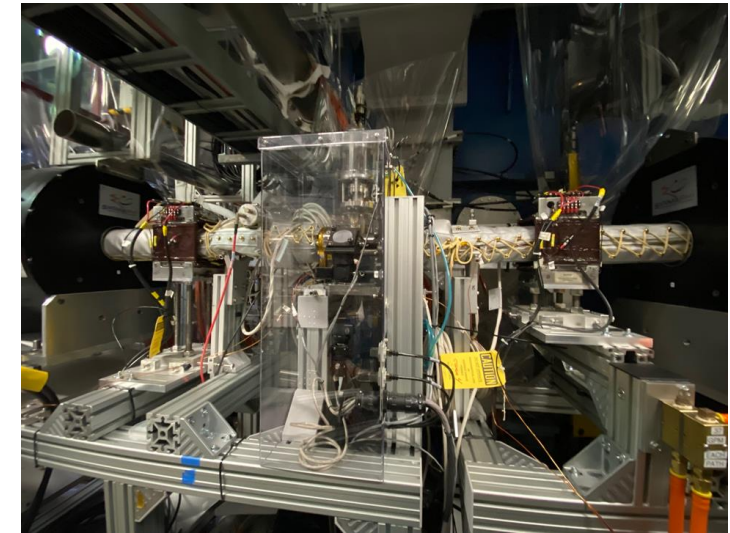
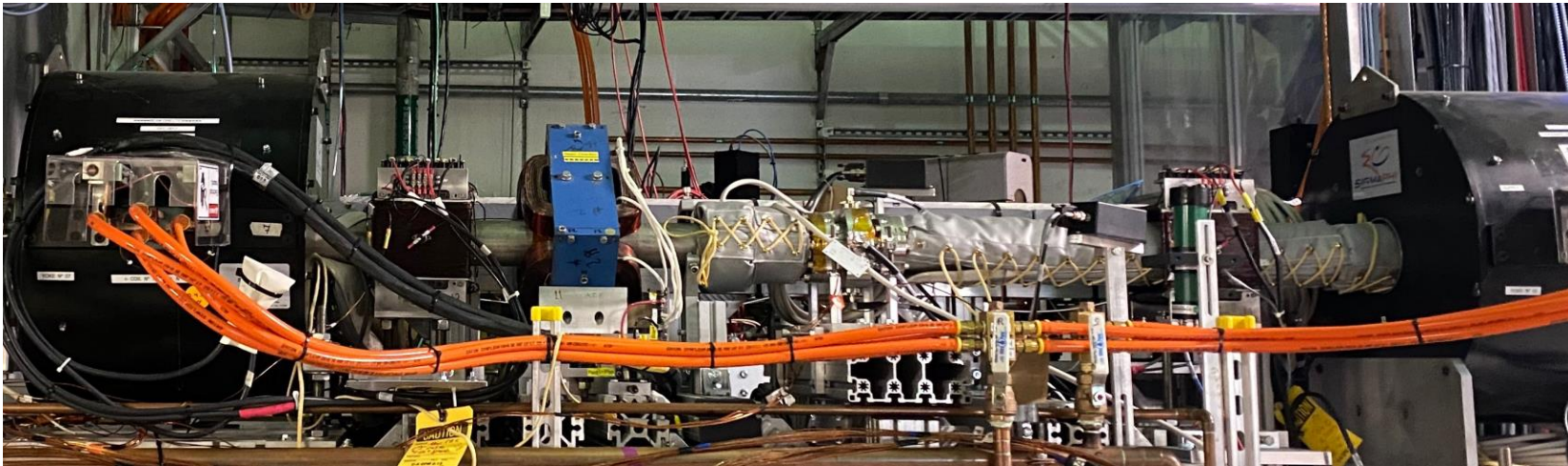
3D probe was placed  $\sim 5$ -6 cm above the IR axis.

## Results

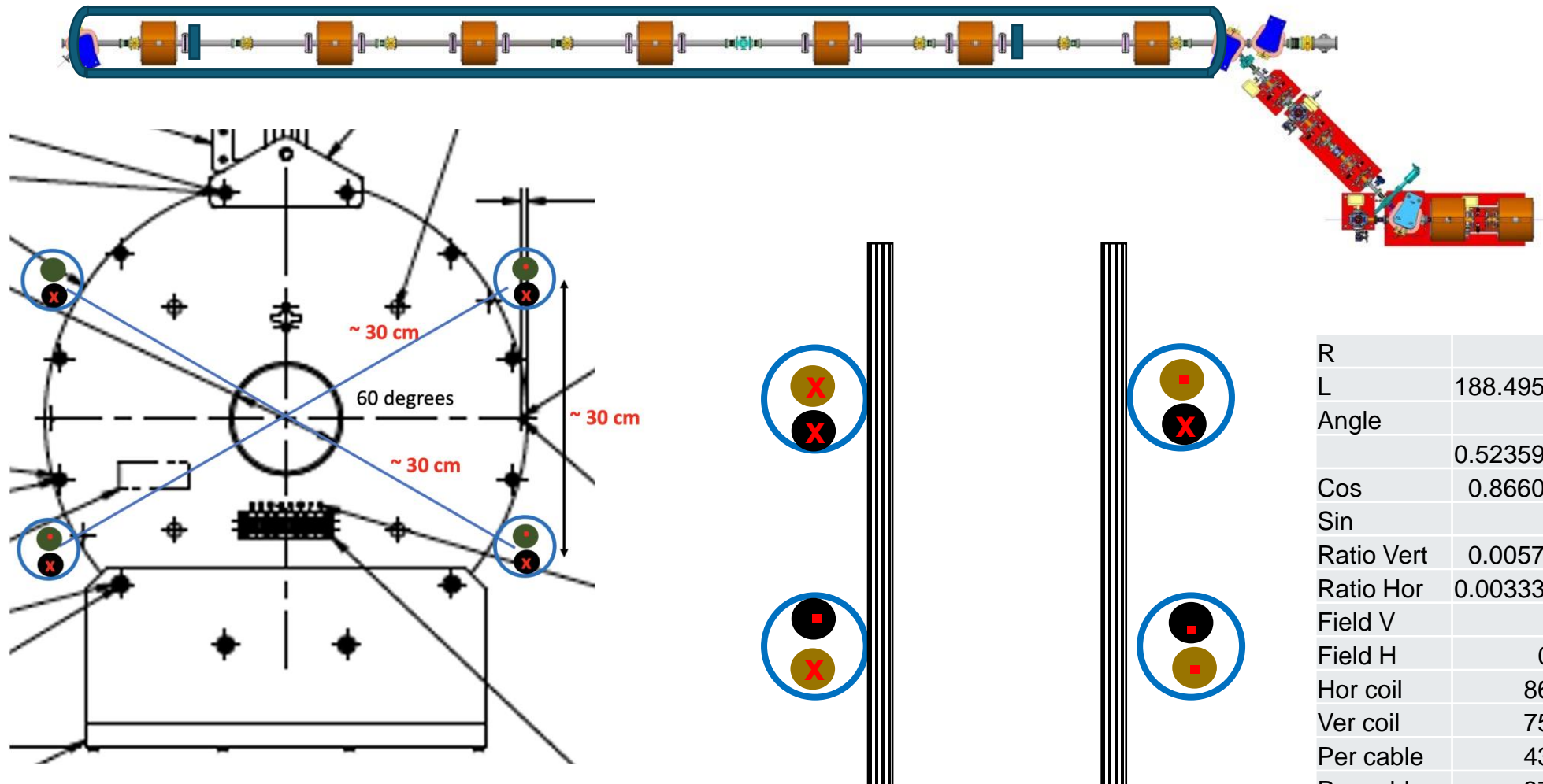
Point	1	1	1	2	2	2	3	3	3	4	4	4			
$\Delta B, \text{mGs}$	Y	X	Z	Y	X	Z	Y	X	Z	Y	X	Z			
Dipole 100 A	-150	30	-2000	24	-24	8	8	-1	-2	11	0	0			
Solenoid 1 (1-7)	-5	0	20	-2	-3	-3	0	0	0	0	0	1			
Solenoids 2-6				108	20	600	-180	6	1085	3	0	44			
Solenoids 3-(4)-5				4	1	-40	-139	-73	-1470	11	-6	-660			
30-degree/Sol4				0	0	0	0	0	30	144	42	620			
	5	5	5	6	6	6	7	7	7	8	8	8	9	9	9
	Y	X	Z	Y	X	Z	Y	X	Z	Y	X	Z	Y	X	Z
Dipole 100 A	9	0	0	3	0	-3	2	2	4	505	-125	490	1,500	300	
Solenoid 1 (1-7)	0	0	0	-3	0	-24	-34	-45	-390	1540	246	Saturated			
Solenoids 2-6	7	0	34	560	70	Saturated	-70	4	640	0	0	60			
Solenoids 3-(4)-5	6	0	-650	33	8	874	-6	0	-54	-16	0	-10			
30-degree/Sol4	-100	-50	670				0	0	0	0	0	2			

# Heating Jackets

- Search for explanation for unusual kinks in e-beam trajectory discovered, that in contrast with specifications, heating blankets and their cables have significant amount of magnetic materials, which distort magnetic fields in the CeC section
- Heating Jackets and their cables are highly magnetic and have to be removed from the insides of the solenoids, trims, quads... and the rest of the CeC section.
- 7 correctors need to be taken apart to remove jackets
- When blankets are removed, we need to remeasure stray fields from the solenoids, dipoles and most importantly – cables! Table shows that stray fields 1 m from solenoids are rather large for some of them and small for the others - we need to understand the reason and check if there are cable loops?



# Earth field compensation coil





# Summary

- Priority list
- Anthony is checking if we need to run new cable and order more PS for new compensating coils and H/V trims 8-12 weeks lead time
- Design modifications of beamline completed
- 500MHz removal completed
- Damaged quad replacement completed
- 500MHz coax inspection in progress
- Heating jackets removal in progress (7 correctors have to be split)
- DCCT installation in progress
- Delay of parts from KJL for H/V slit and profile monitor – looking for backup solution
- TRDBL modifications in progress
- Undulator design and fabrication in progress
- H/V trims relocation design in progress

# Thank You !

