

Minutes of LEReC Beam Line Status Meeting

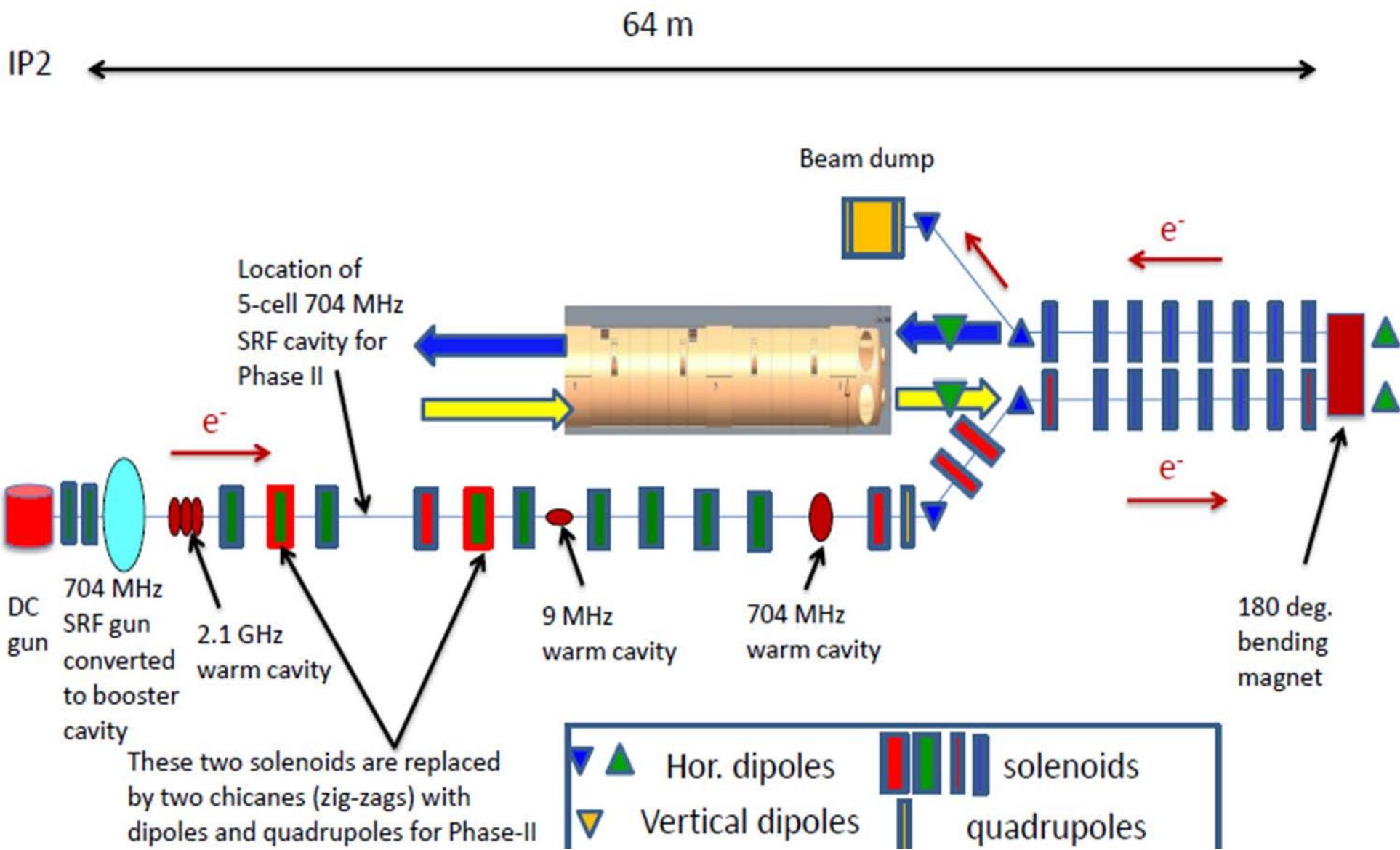
27 August 2015

- Beam Line Layout – Cooling Section (CS)
 - G. Mahler working on Mu Metal shield design with component stand. Toby to ask Dave G. about routing of BPM connector. A method to do field measurement through the pipe to be developed. The effect of holes in the shielding for various stands (e.g., beam pipe) needs to be evaluated.
- Beam Line Layout – Transport to Cooling Section and eGun-to-Booster: Meeting held on beam line of eGun to Booster Cavity.
- Instrumentation
 - **MPF Visit – BPM Status:**
 - Brazing to start next week
 - Waiting for coax connectors
 - Discuss future BPM Hybrid design – no problems mentioned
 - Vacuum firing of first housings by subcontractor – discolored (purple) will redo.
 - (BPM contract: Delivery of housing on 9/1 and buttons on 9/28) from last mtg.
 - **Meeting held on Standard Profile Monitor - Review**
 - Wedge shaped view window, coated on vacuum side
 - YAG screen block to be grounded when “in”
 - **Meeting held on Hybrid BPM – Review:**
 - Mounting design of ground springs
 - New mounting for slit
 - Mounting of mirror and YAG screen
 - BPM design for eGun-to-booster cavity region needs to be developed: button vs stripline design. T. Miller said that R. Michnoff needs to look at it.
 - The ERL BPM is planned for use in the transport line. M. Blaskiewicz to check impedance.
- Magnets: LF (Compensating) Solenoid field measurement being done by Anamesh (Andy while he is out)
- RF Cavities: Meetings for warm RF cavities are ongoing:
 - Detail design can start on 704MHz.
 - 2.1GHz Cavity will have mechanical balancing tuners. The primary tuner does not have to be automatically actuated.
- Other
- Component Stands: K. Hamdi started to develop layout of 180 Dipole stand, but will hold off for now due to unknowns. Sliding design not required if energy recovery design is not used. He is working on 20 dipole stand.

LEReC Phase-I (electron beam energies 1.6-2MeV):

Gun-to-dump mode

July 8, 2015



Overall Layout

64 m

IP2

H & V Correctors

LEReC-I (1.6-2MeV): Gun to dump
 SRF gun used as a booster cavity

Add Quad and Skew Quad Correctors

Move BPM close to 180 magnet combine with PM.

Add Quad and Skew Quad Correctors

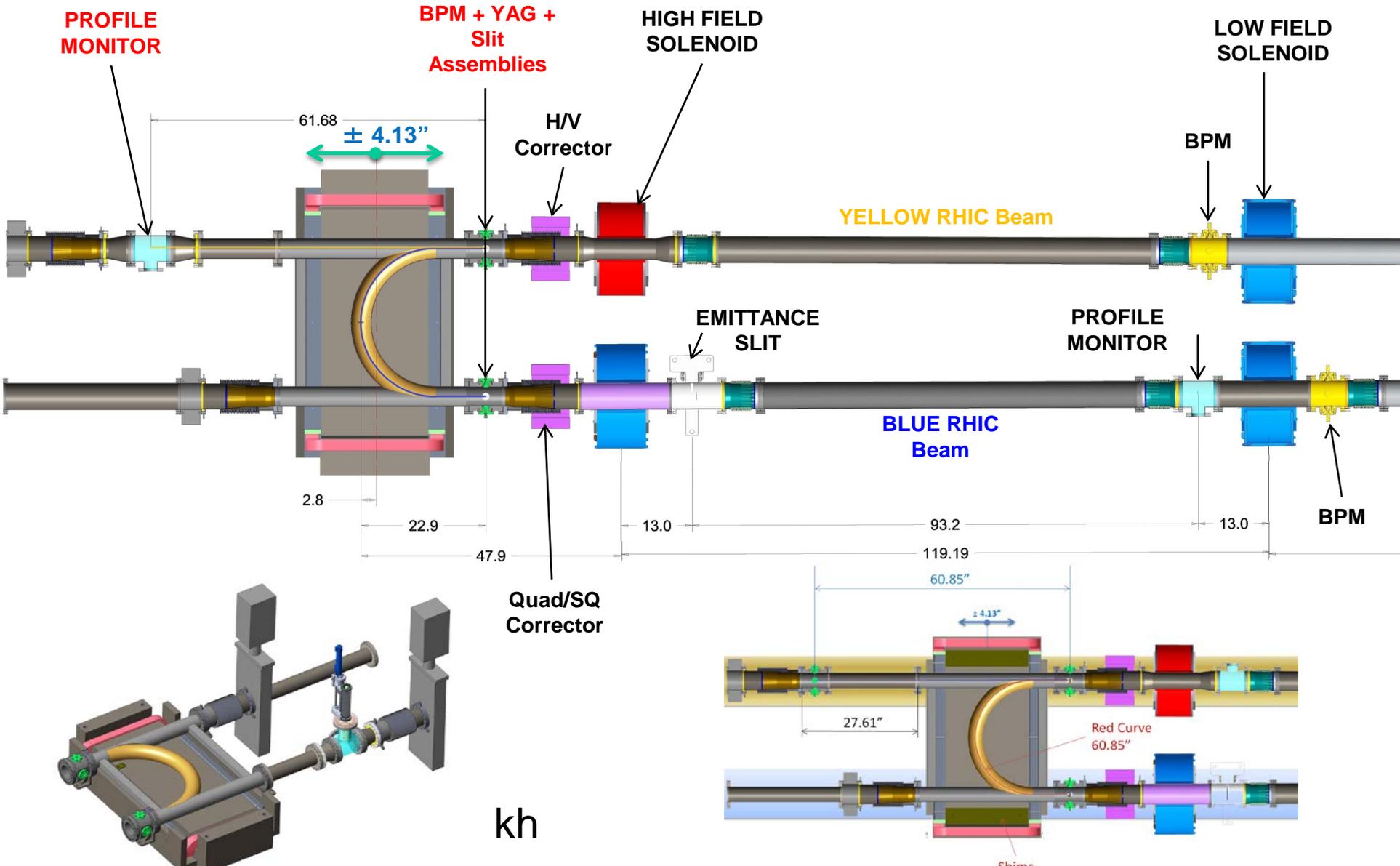
3.75"OD/3.62"ID beam line
 9.2 cm ID

5.0"OD/4.78"ID beam line
 12 cm ID

2.5"OD/2.38"ID beam line
 (6 cm ID)

Low Energy RHIC electron *Cooling*

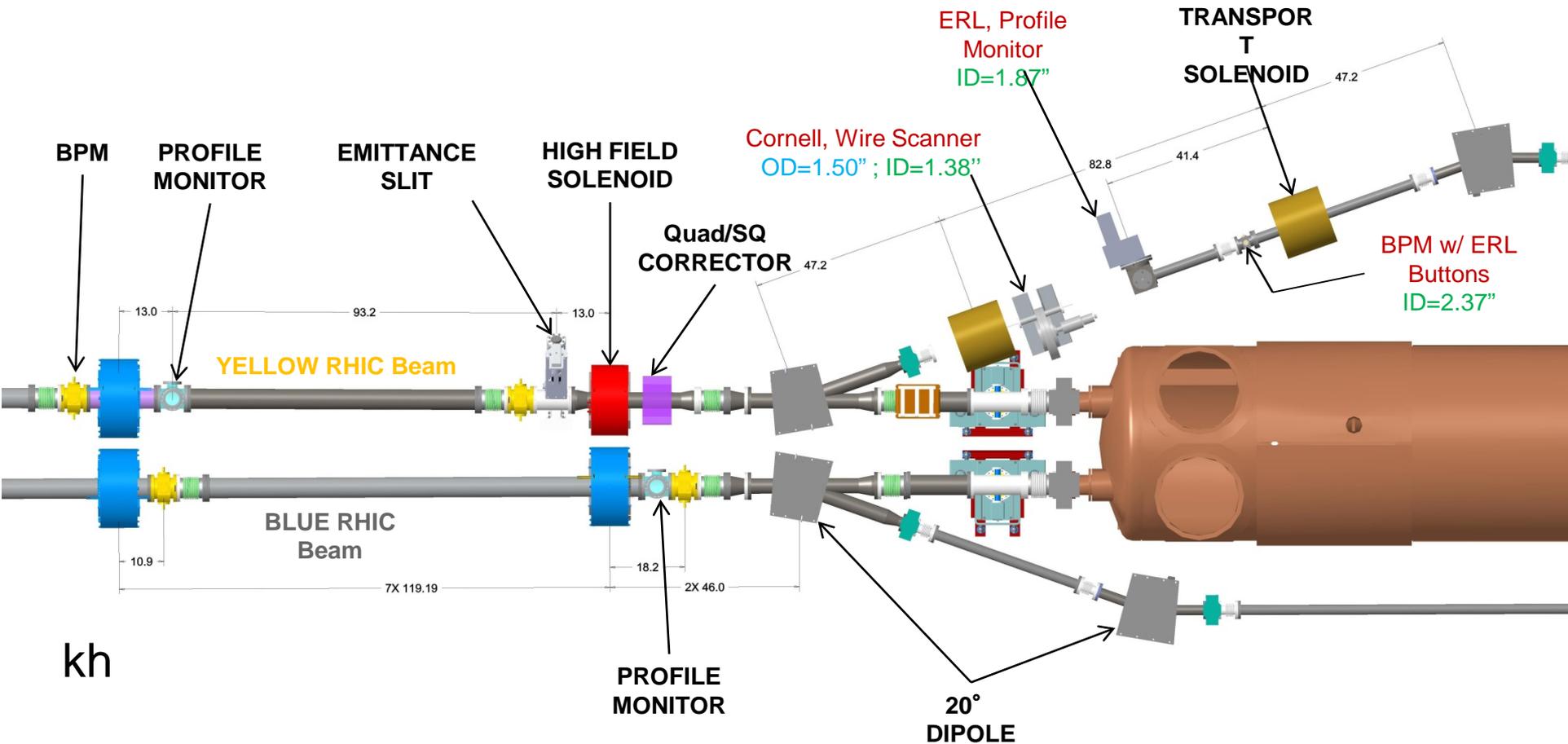
180° Dipole Magnet Neighborhood IV



See slide #2



20° Dipole Neighborhood IV



Large Dia. BPM Housings (4.8 ID), 28mm buttons

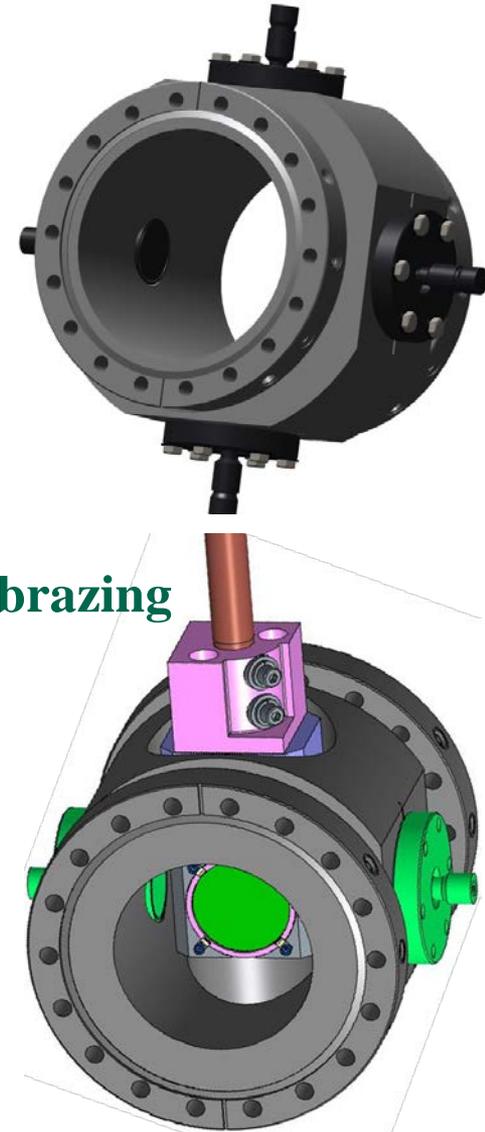
- Order Placed with MPF
- Final Design Review 6/23/2015, no issues
- MPF approved to start fabrication
- Increased number of button first articles for 2 BPM's one standard, one 180 magnet special
- MPF updated delivery schedule
- Agreed on vacuum bakeout for components

MPF will vacuum bake buttons @900C/1hr during brazing

MPF will vacuum bake housing @450C/48hr

BNL will vacuum bake 1st article housing

- First Article delivery buttons 10/12/2015
- First Article delivery housing 10/01/2015
- MPF visit today, they will update their schedule
- Can the buttons “see” low charge bunches during commissioning?



Cooling Section *Standard* Profile Monitors

RF impedance design approved (Peter T.)

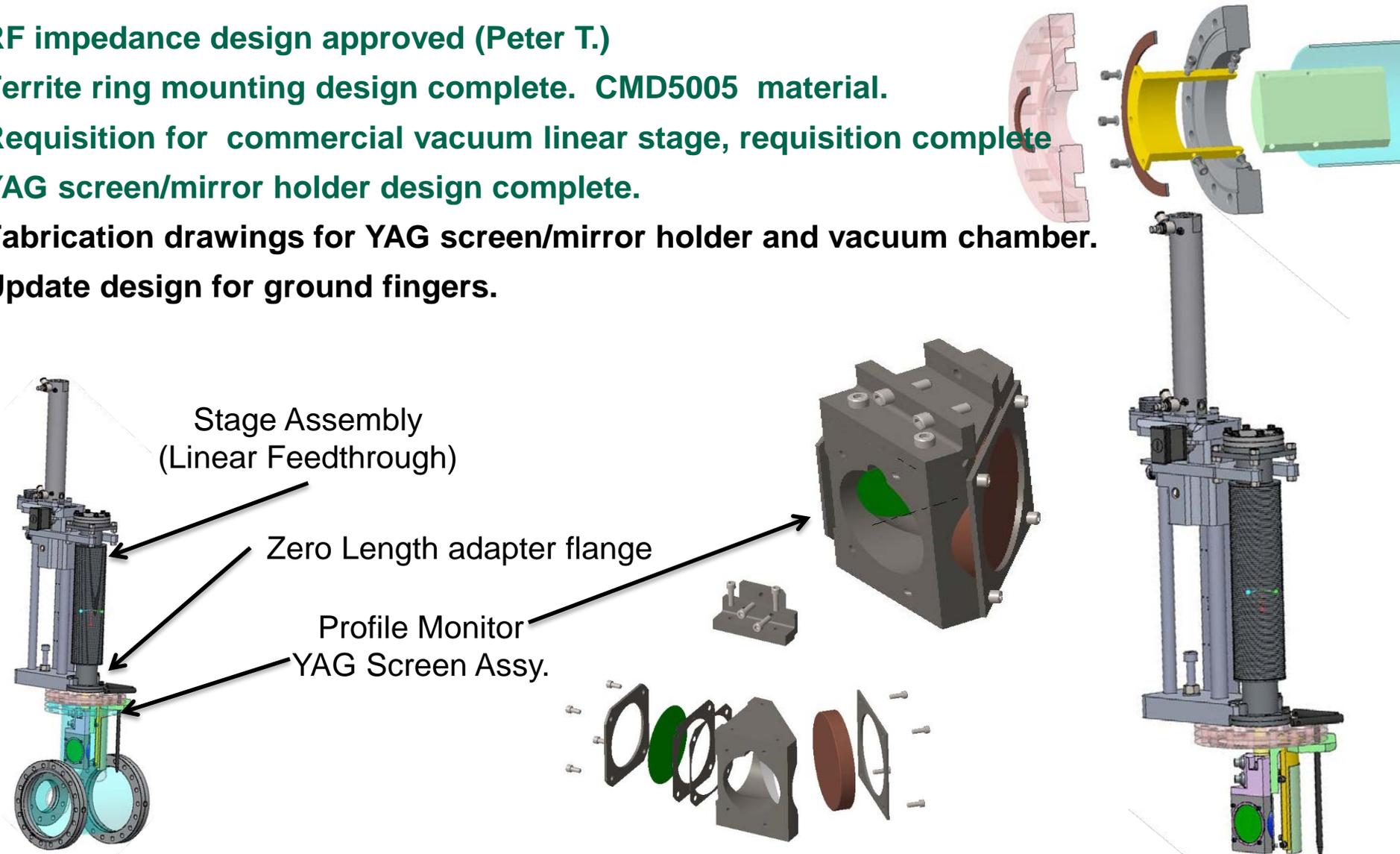
Ferrite ring mounting design complete. CMD5005 material.

Requisition for commercial vacuum linear stage, requisition complete

YAG screen/mirror holder design complete.

Fabrication drawings for YAG screen/mirror holder and vacuum chamber.

Update design for ground fingers.



Cooling Section “hybrid” BPM, PM, Slit

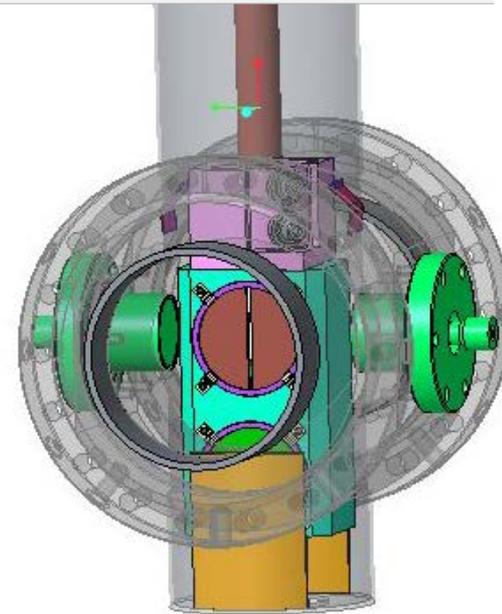
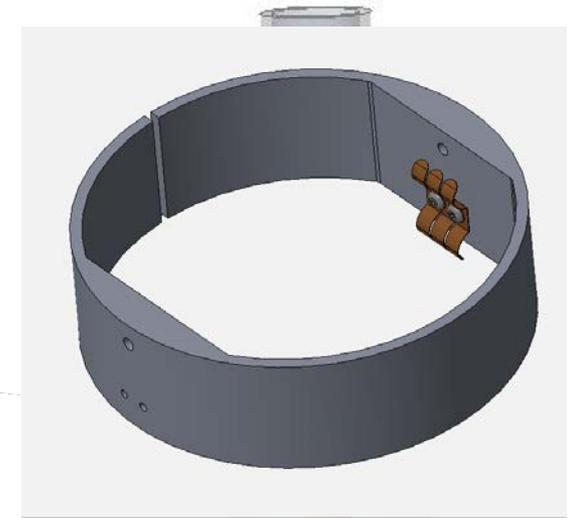
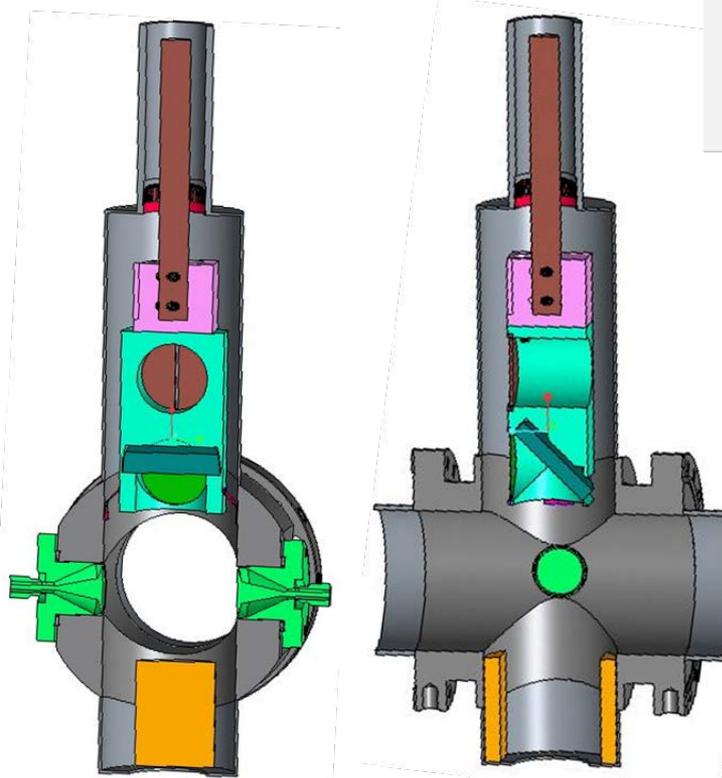
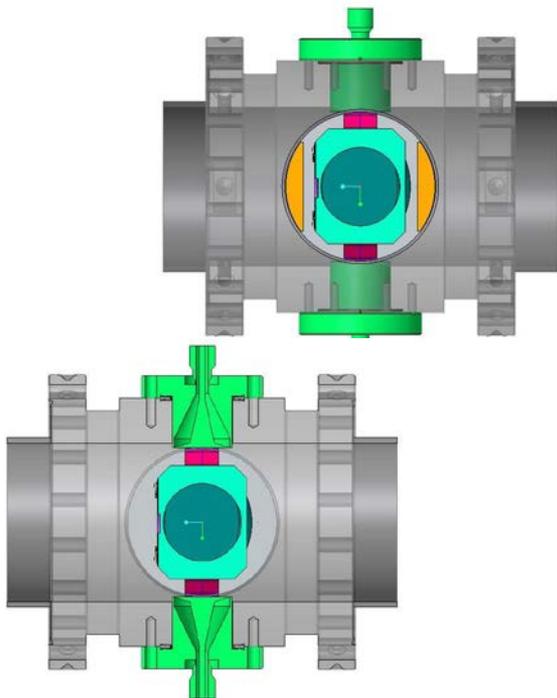
RF impedance analysis complete

Chamber design complete

Need approved fabrication drawing (CO with MPF?)

Design of RF impedance grounding fingers defined

Design of RF impedance ferrite configuration and mounting



Cooling Section PM meeting

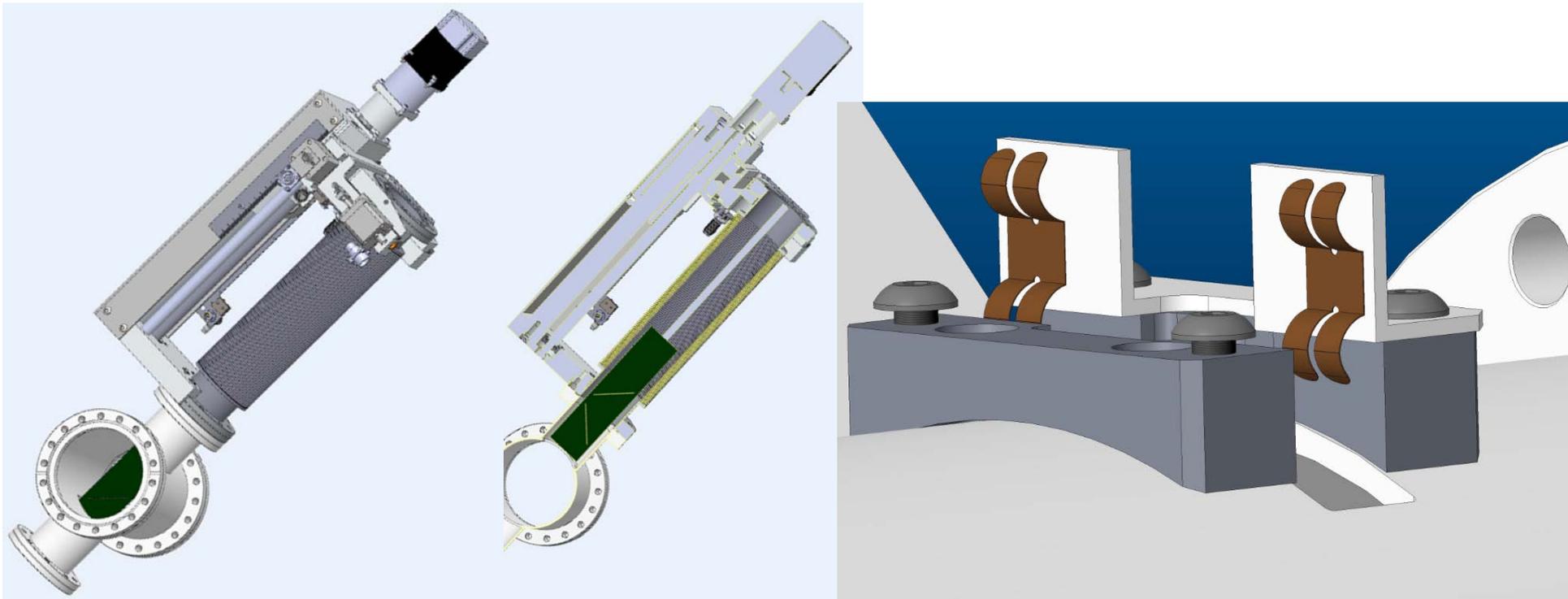


Notes:

- **Mirror thickness specified**
- Both Hybrids PM, Slit, BPM systems will be 3 position vacuum translating stage drives. The second hybrid **will** substitute the slit position (which is not needed) for a fault study beam stop.
- Dan transverse position accuracy of the vacuum translating stage – **will order 2 and measure.**
- **Joe** will order angle mount windows welded **4.5 flange** for all of the cooling section profile monitors + 1 spare (**7 units**).
- The windows will be coated with a thin metallic coating to dispartate charge. **Dan Steski can do it for us. Awaiting quote for internal coated window from KL.**
- **CS has preliminary drawings for standard profile monitor for cost estimate.**
- The grounding requirements for the hybrid head has been revised. **Grounding fingers and mounting frame defined.**
- **The standard profile monitor will be modified for grounding fingers in the inserted position. TBD**
- **The emittance slits needs grounding fingers – New grounding finger hardware defined.**

Cooling Section Emittance Slits

- Requisition for commercial vacuum linear stage.
- Fabrication drawings complete and approved.
- Central Shops requisition approved for vacuum chamber and W slit.
- The slit needs to be grounded at the vacuum chamber when scanning.
- Delivery dates: shifter, vacuum chamber, W slit, mounting hardware.



Vacuum Hardware

Beam line bellows & 180 accordion bellows purchase orders.

“Standard Chamber Length” defined

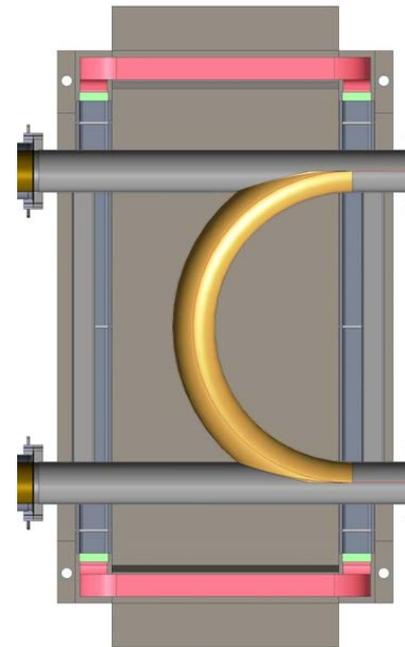
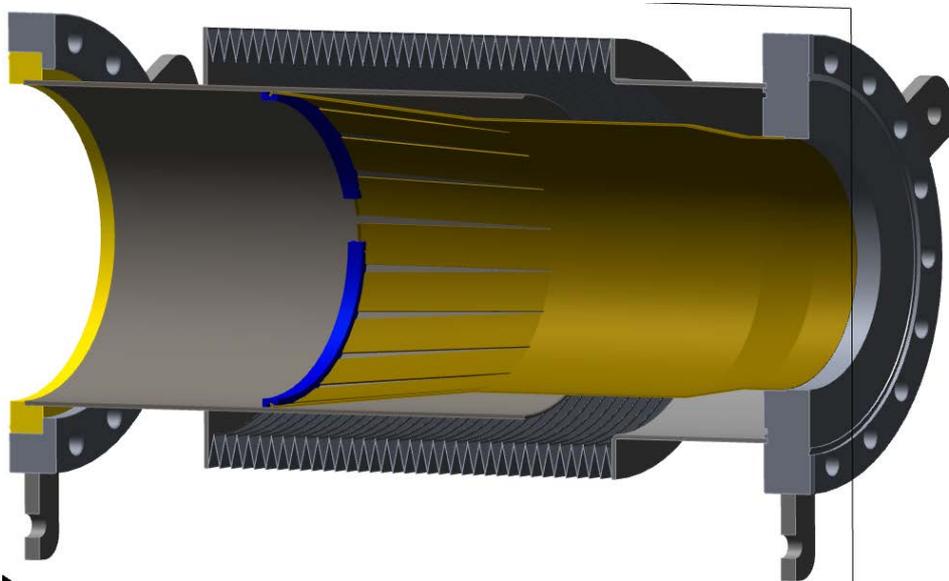
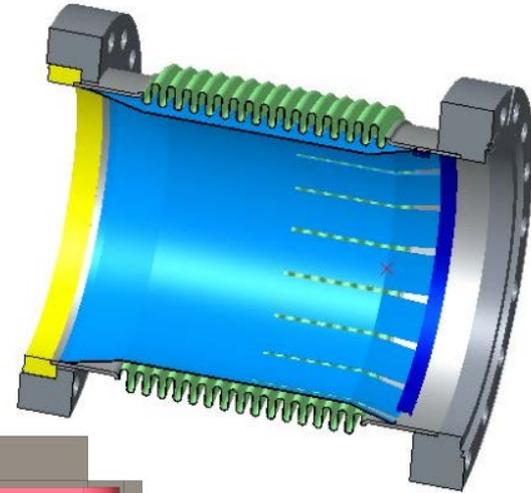
180 chamber 316L vacuum annealed to 900C after welding.

180 chamber in shops, 20 chamber prepare RFQ

Test chamber welded and measured.

Shielded valves on order

DC Gun shielded valves and vacuum equipment.



Low Energy RHIC electron Cooling

20° Dipole Magnet

Requisition approved SOW – 2 magnets by 10/1/2015.

Order Placed 5/6/2015 Everson Tesla

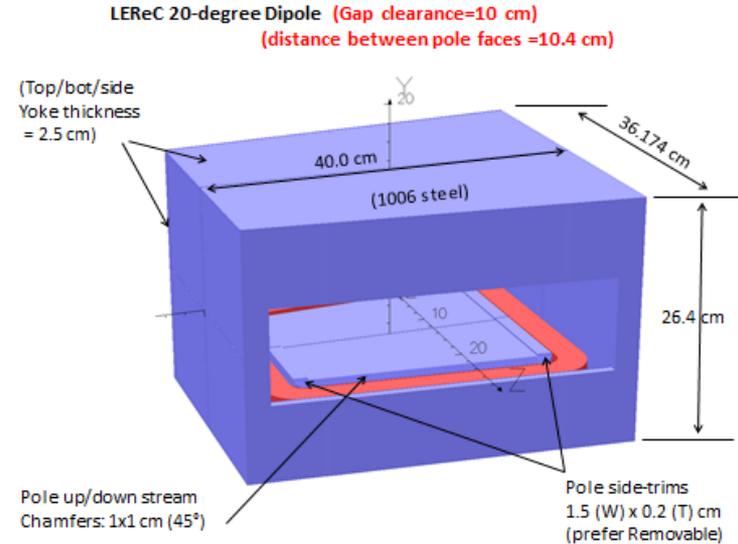
Estimated Delivery 1st two magnets 10/1/2015

Will visit ET next week

Distance Between Pole Faces = 10.4 cm (4.1 in.)

Magnet Vertical Gap = 10 cm

Vacuum Chamber V Aperture = 9.5 cm (3.74 in.)



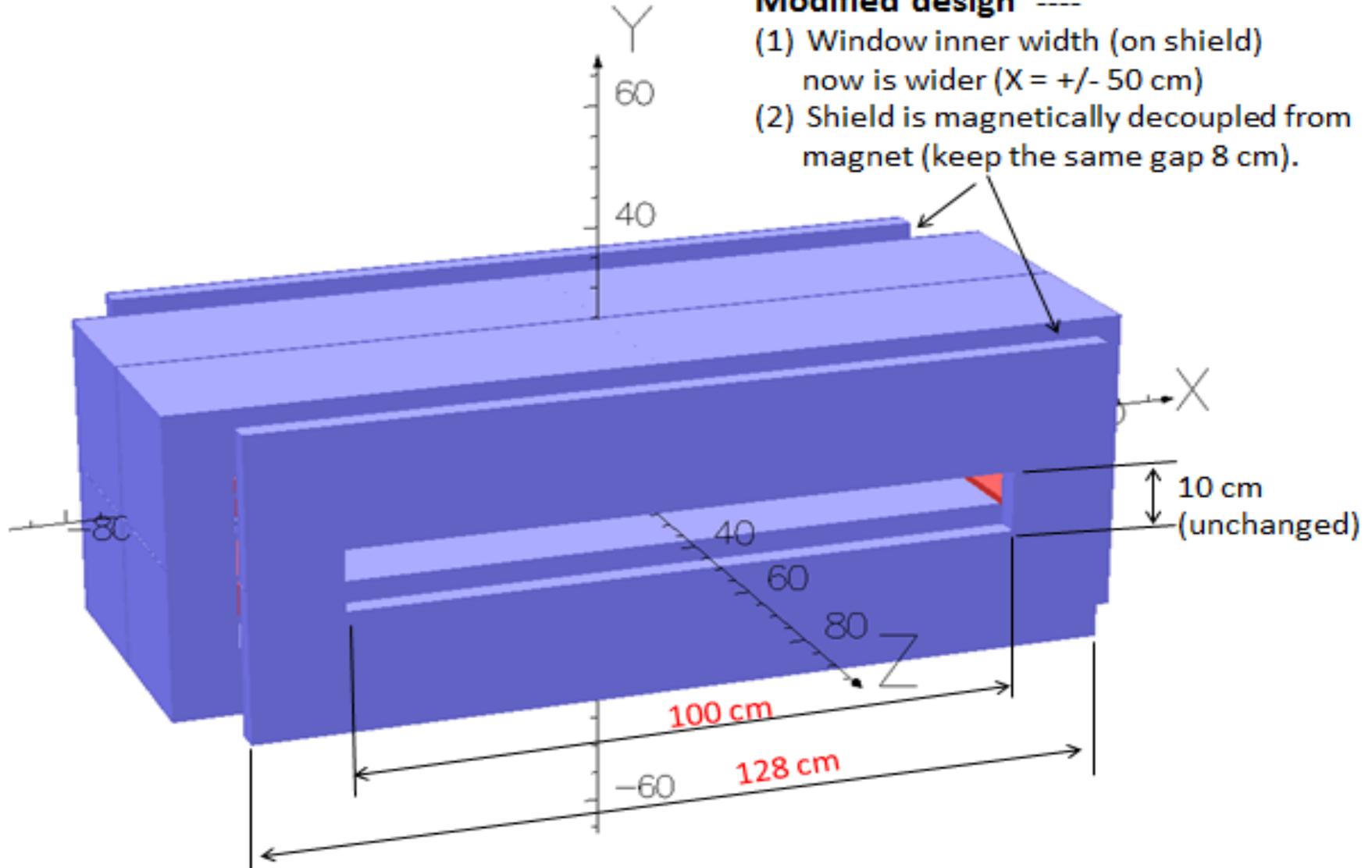
Electron tracking results and field qualities along trajectory on R=1 cm curved cylinder:

	Ek = 5 MeV	Ek = 1.6 MeV
Current per coil (Amp-turn)	1053.288	393.192
Overall current density (A/mm ²) (overall coil cross-section 3.0x4.8 cm)	0.73145	0.27305
Central Gap Field (Gauss)	251.20	93.73
Half b1-integral(dipole) (G-cm)	3.1982E3	1.1930E3
Half b3-integral(6-pole) (G-cm) [Ratio to dipole integral]	1.803E-2 [5.64E-6]	7.019E-3 [5.88E-6]
Half bending angle from tracking tests (required 10°)	10.013°	10.006°

180° Dipole Magnet Revised

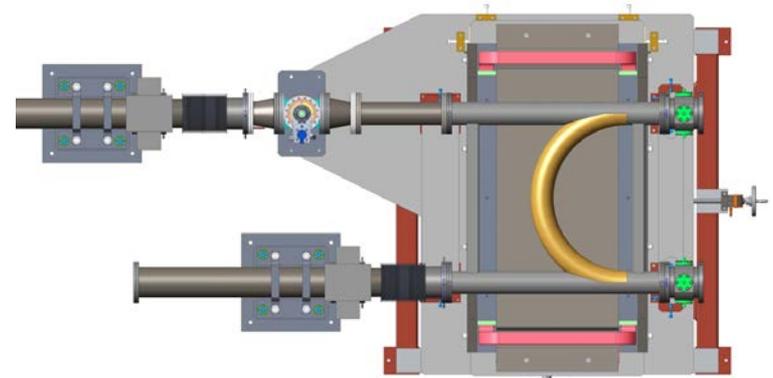
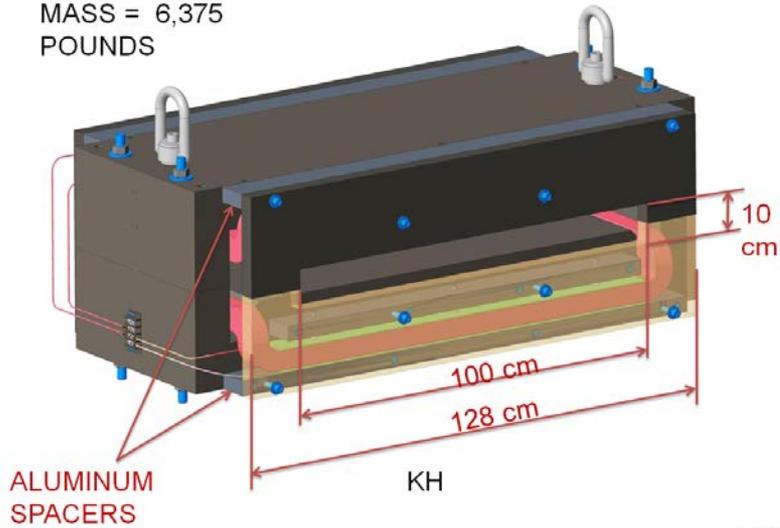
Modified design ----

- (1) Window inner width (on shield) now is wider ($X = \pm 50$ cm)
- (2) Shield is magnetically decoupled from magnet (keep the same gap 8 cm).

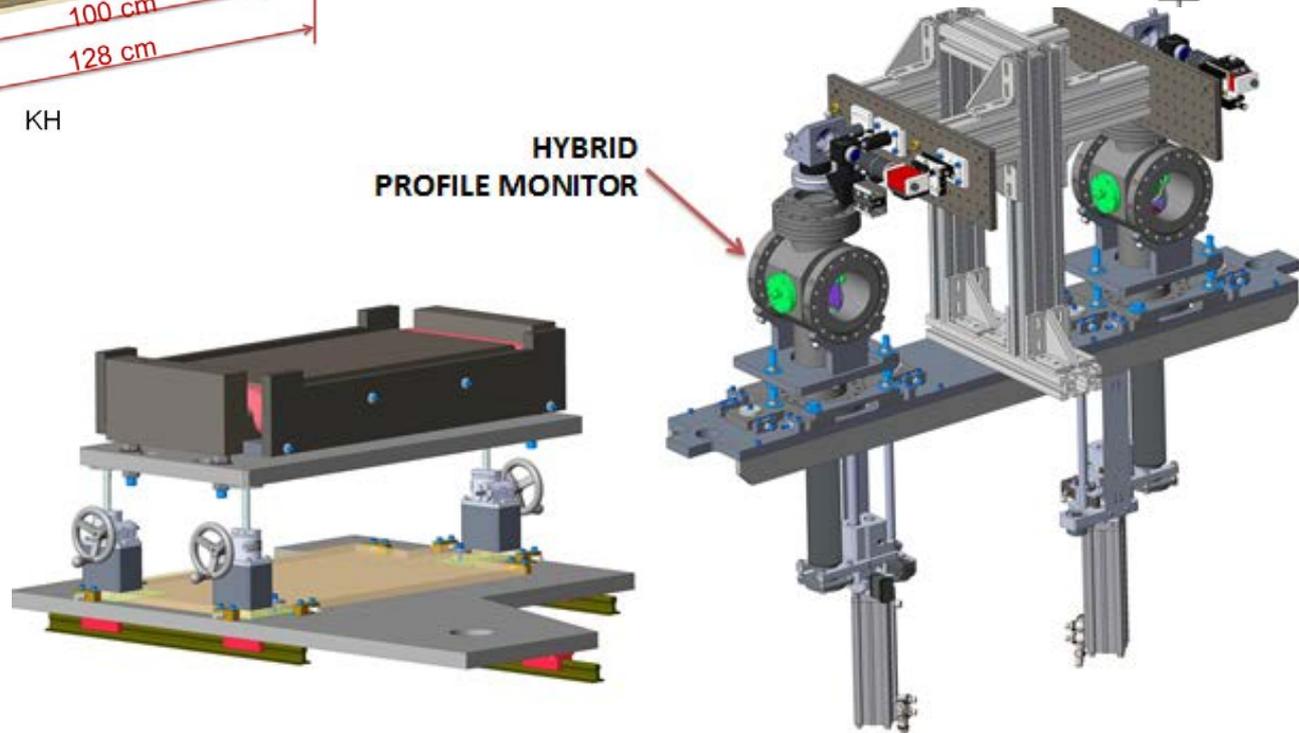


180° Dipole Magnet Revised

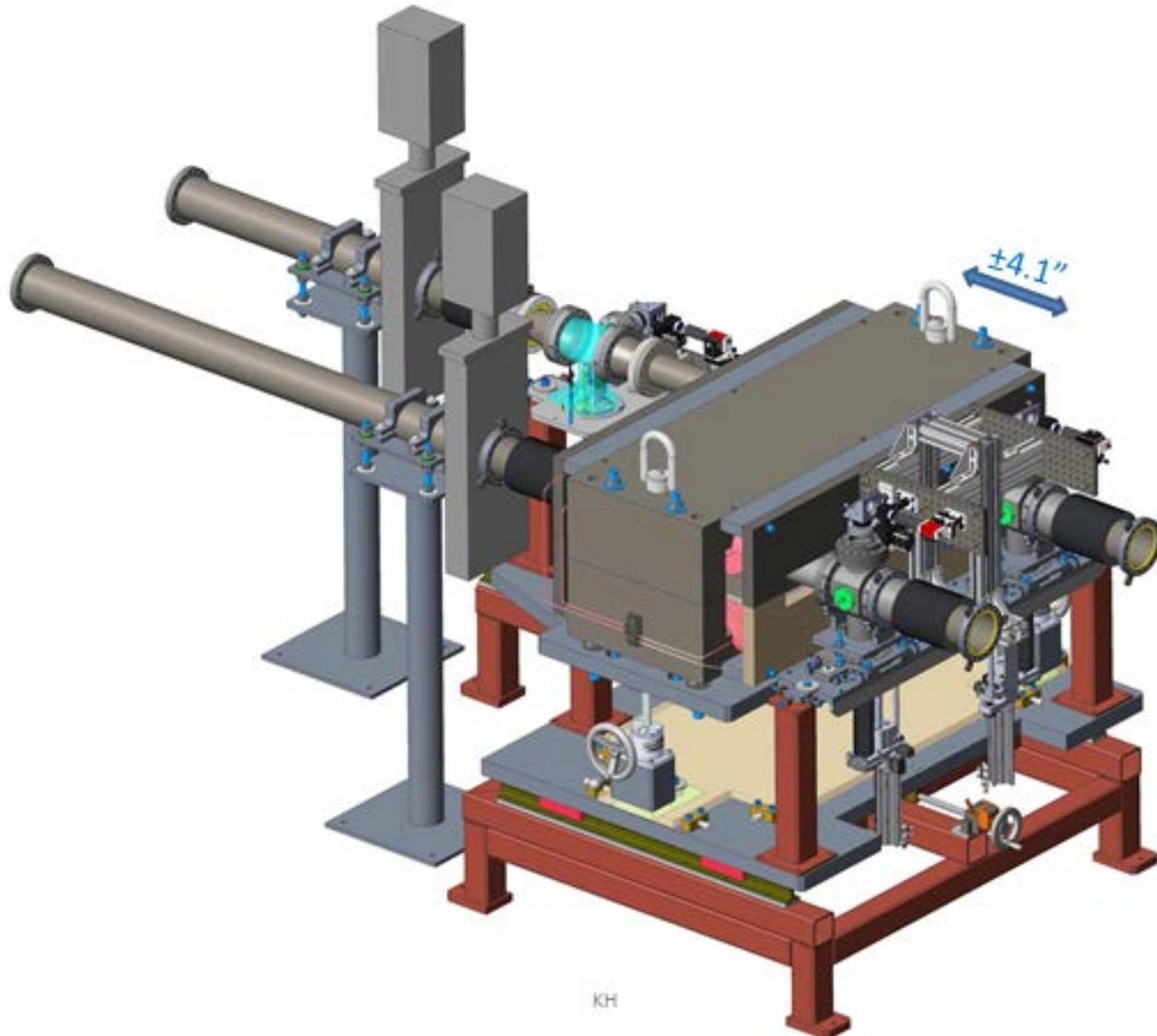
MASS = 6,375
POUNDS



HYBRID
PROFILE MONITOR



180° Dipole Magnet Revised



Low Energy RHIC electron Cooling

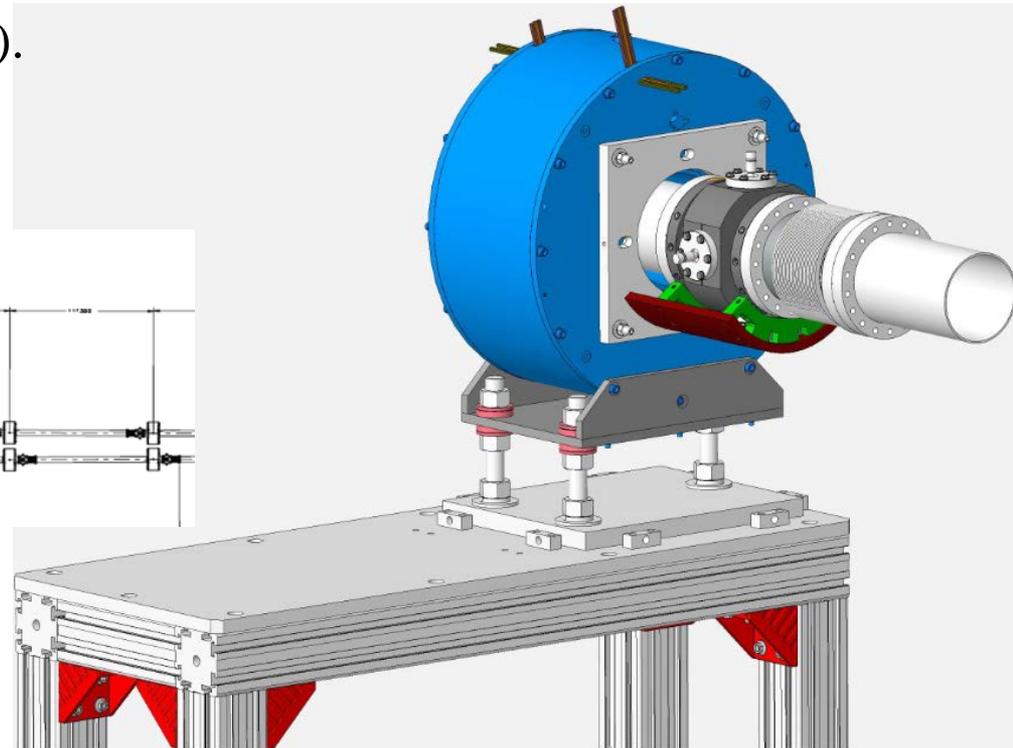
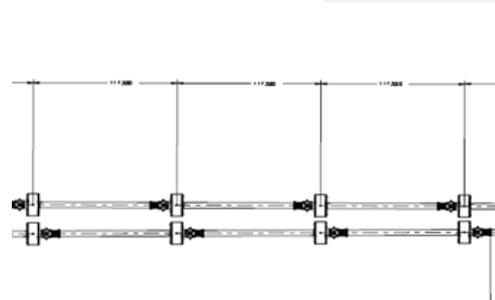
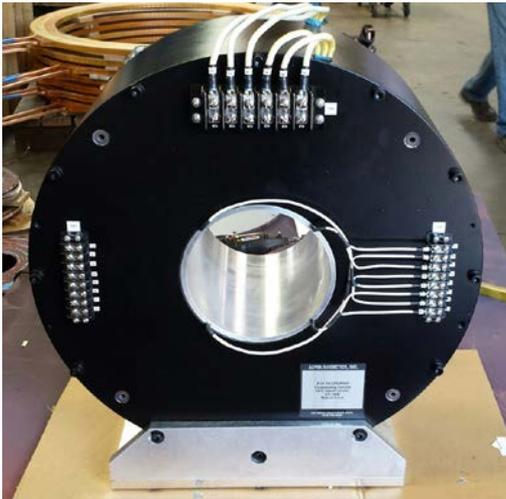
Compensating and Matching Solenoids

Buckley magnets complete 8/20/2015 + 6 weeks shipping + customs.

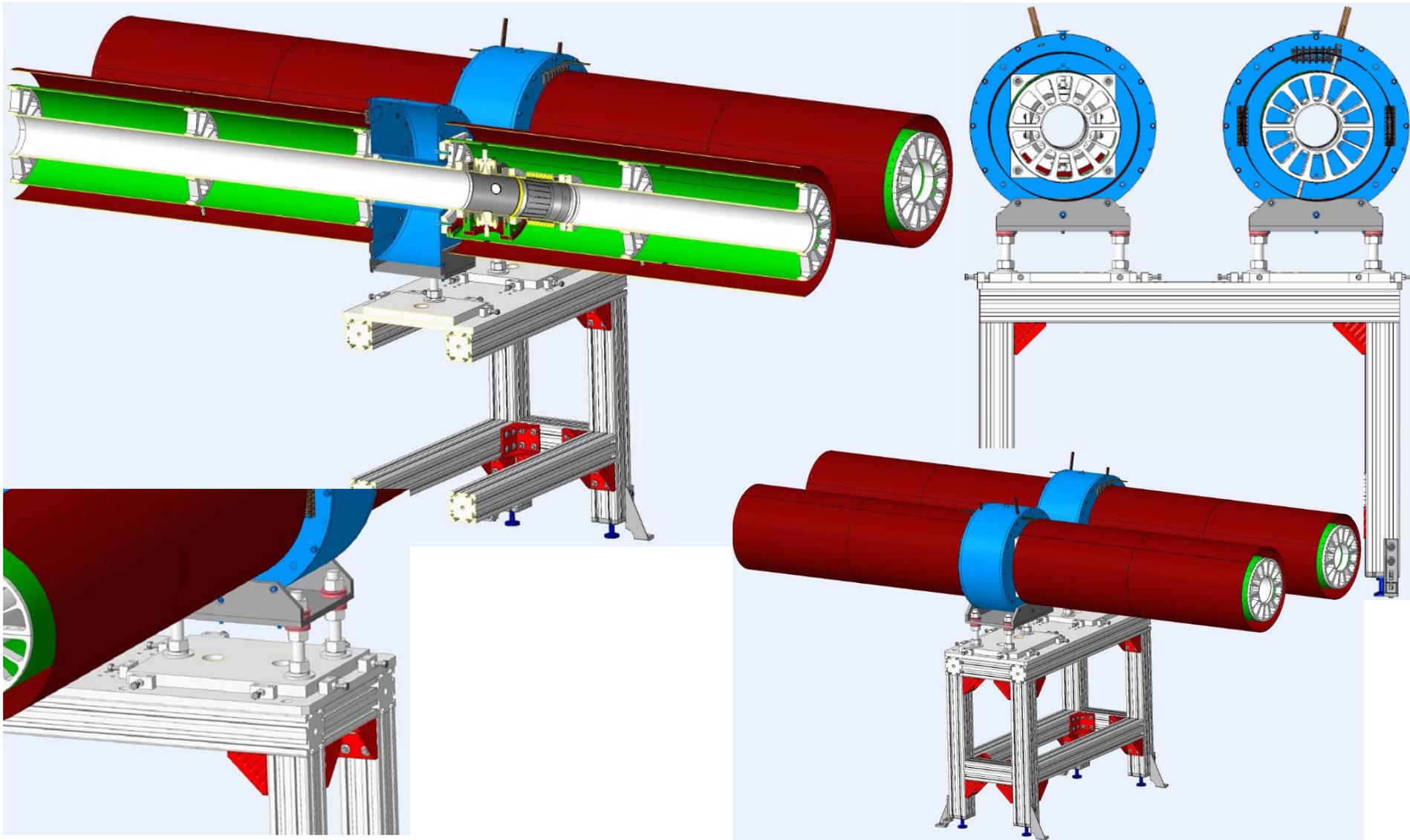
Alpha Magnetics update: **1st production magnet + 4 more in house.**

Magnetic Measurement ordered and **received 1% 3D probe,**
0.1% ordered, late August delivery.

- Design support stand assembly – provide space for mu metal shields, separate beam pipe stand support.
- Magnetic shielding analysis (Wuzheng).
- Design prototype mu metal shields and supports - measure.



Compensating and Matching Solenoids



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Compensating and Matching Solenoids

HALL PROBE / SOLENOID GRANITE TABLE (Measurement Schedule)

August 3-7: complete permanent magnet measurements

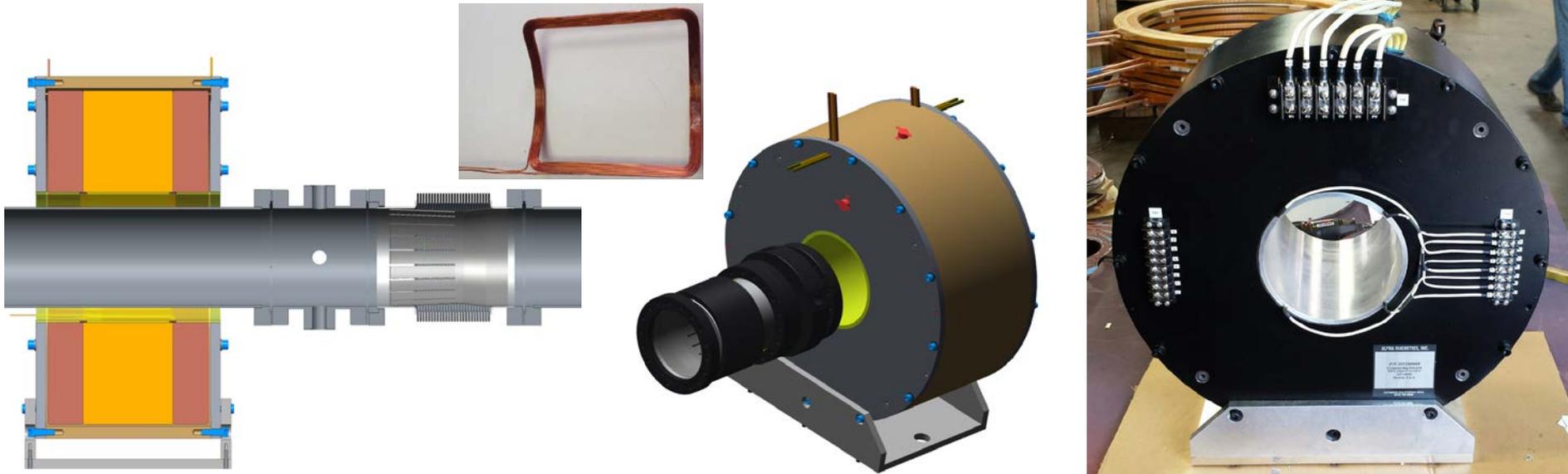
August 10-14:

August 17-21: reconfigure Hall probe (Sullivan), then resurvey (Karl)

August 24/25: Jain reviews survey data, first solenoid (Sauerwald)

August 26 – Sept. 30: move solenoid granite table out of Annex

October first solenoid complete, will try for 2 per week.



Compensating Solenoids Measurement



We have done a preliminary scan (on-axis only) to check out the measurement system and the results seem to be good in terms of magnet performance. We tuned the main coil and bucking coil currents to match the central fields expected from Wuzheng's calculations. An adjustment of about +2% had to be made to the design currents to get the design fields.

The on-axis field drops below 1 Gauss level at approximately +/- 18 cm from the magnet center. This is a faster fall off than the +/- 21 cm expected. I am not sure if the earth's field of about 0.2 Gauss is helping with this.

The second field integral at the adjusted current settings comes out to be $4.019\text{E-}05$ T².m, which meets the $4.0\text{E-}5$ T².m requirement.

Thanks, Animesh

LEReC Cooling Section Design Room



LF & HF solenoid and 20° dipole magnets fabrication drawings (KH)

Beam Diagnostics: BPM chamber and buttons (VDM)

Beam Line 5" bellows with shields fabrication drawings (GW)

20° dipole vacuum chamber for impedance review (KH)

180° dipole fabrication drawings (KH) **Spectrometer magnet (180° dipole) revisions (KH)**

180° vacuum chamber + large sliding bellows fabrication drawing (KH)

Beam Diagnostics ES W slit & chamber fabrication drawings (VDM)

20° dipole vacuum chamber fabrication drawings (KH)

Beam Diagnostics: standard PM fabrication drawings (GW)

Beam Diagnostics: special "hybrid" ES/PM/BPM fabrication drawings (GW)

Beam line solenoid/BPM stands & vacuum chamber stand (VDM)

20° magnet stand drawing (KH) ↙

180° magnet w/hybrid BPM stand drawings (KH)

Cable tray and penetration drawings and excel sheet (AF)

Magnetic shielding drawing and solenoid magnetic measurement test station

HF dipole, quadrupole, and skew quadrupole corrector drawings

LEReC Design Room Source Design Work



DC Gun Vacuum Chamber Fabrication Drawings (JH)

DC Gun SF6 Pressure chamber specification control drawings (JH)

DC Gun cathode cooling design for Karl S. Cornell (JH)

DC Gun stands (JH)

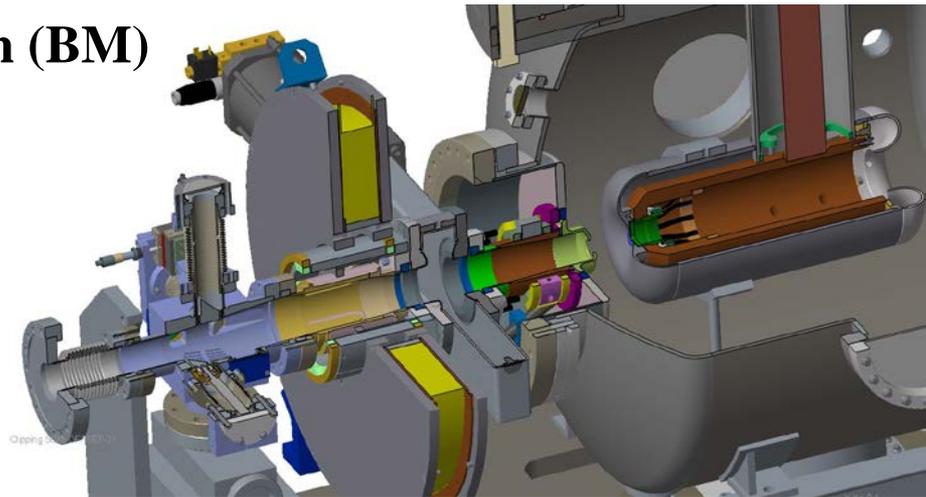
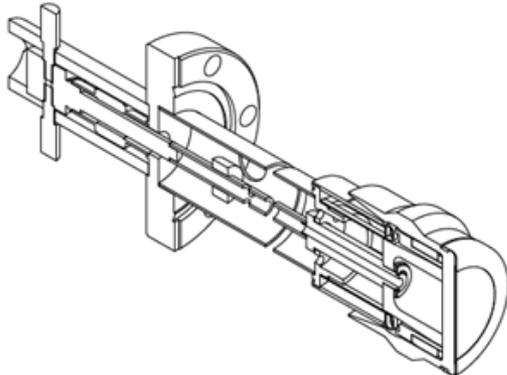
DC Gun to Booster SRF booster cavity beam line (JH)

DC Gun cathode coating system vacuum chamber (PC)

DC Gun cathode transfer load lock and vacuum chamber (WJ)

DC Gun cathode insertion drive (WJ/VDM)

Cathode production coating system design (BM)



Low Energy RHIC electron Cooling

LEReC Design Room Other Work

RHIC 1:00 move real estate drawings (V.DM.)

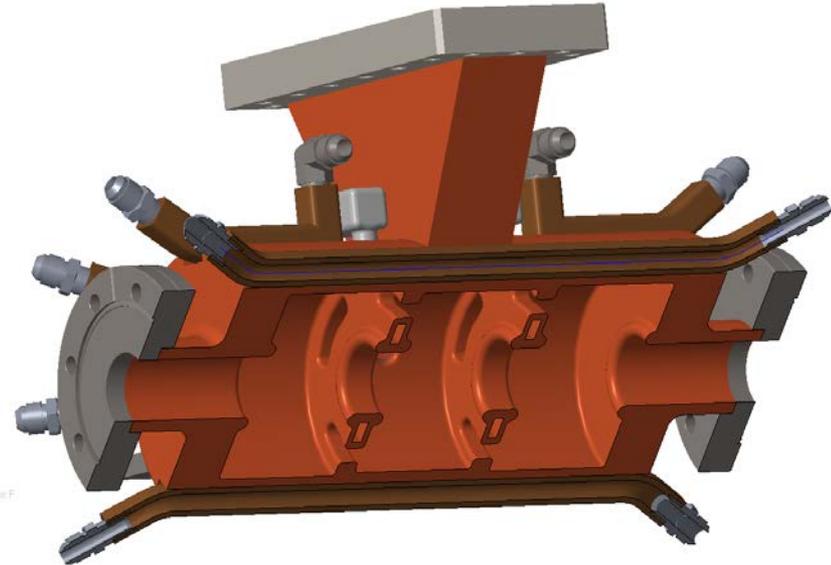
Phase 2: 5 cell cavity positioning (RM) – Revised Position on hold

Phase 1 and 2 cryogenic system layout (RM)

2.1 GHz warm cavity fabrication drawings (MG)

704 MHz warm cavity fabrication drawings

Transport line layout drawing (RM/VDM)



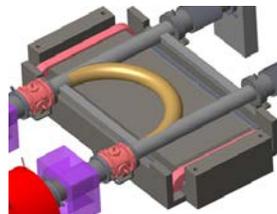
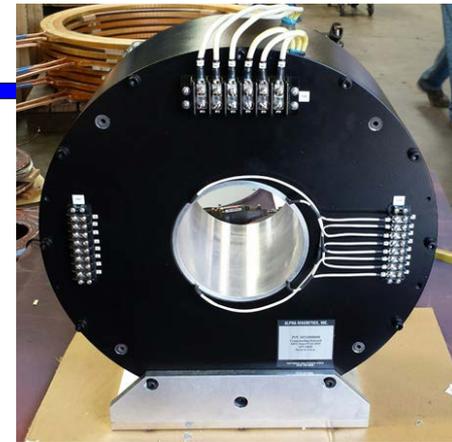
Installation Step – 2015 Shutdown

Cooling Section Purchase Orders in Place

- HF and LF solenoid magnets in fabrication, 1st article in transit
- Shielded vacuum valves, bellows, tuning (sliding) bellows, gauges?
- Beam tubes being coated
- BPM chambers and buttons ordered FDR approved
- 20° merger magnets
- Beamline shielded bellow and 180° magnet sliding bellows
- Profile monitor and emittance slit vacuum linear drives

Cooling Section Critical Items (not ordered yet)

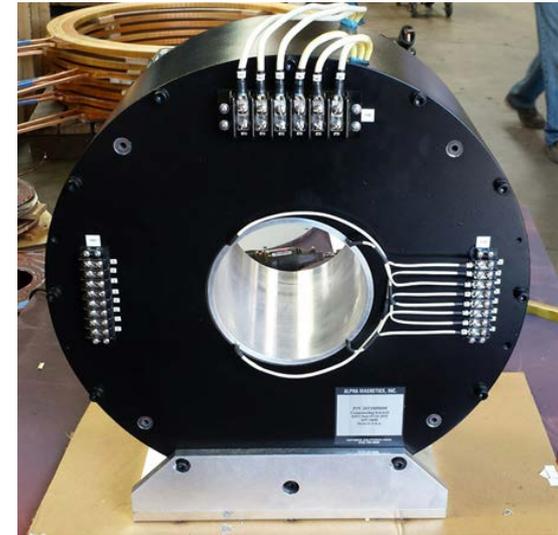
- 20° magnet vacuum chamber (MM preparing RFQ)
- Special RF vacuum gaskets
- Diagnostics chambers & hardware: PM, ES, PM/ES/BPM
- Beamline equipment stands
- 180° magnet (spectrometer magnet – moved to 2016)



Installation Step – 2015 Shutdown Punchlist

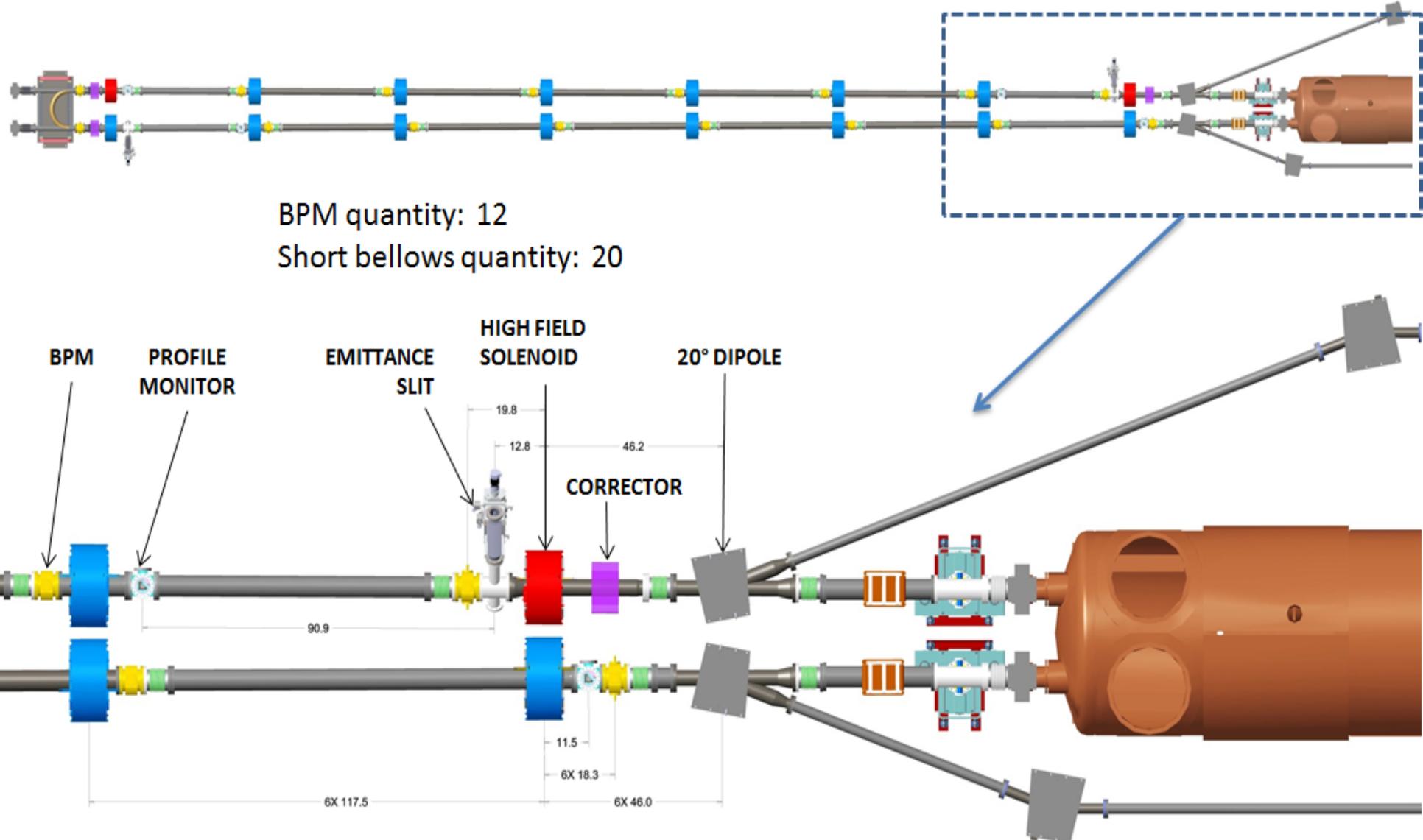
Cooling Section Parts in Hand

- 5 of 15 LF solenoid magnets
- 5” beam tubes and flanges
- Shielded vacuum valves



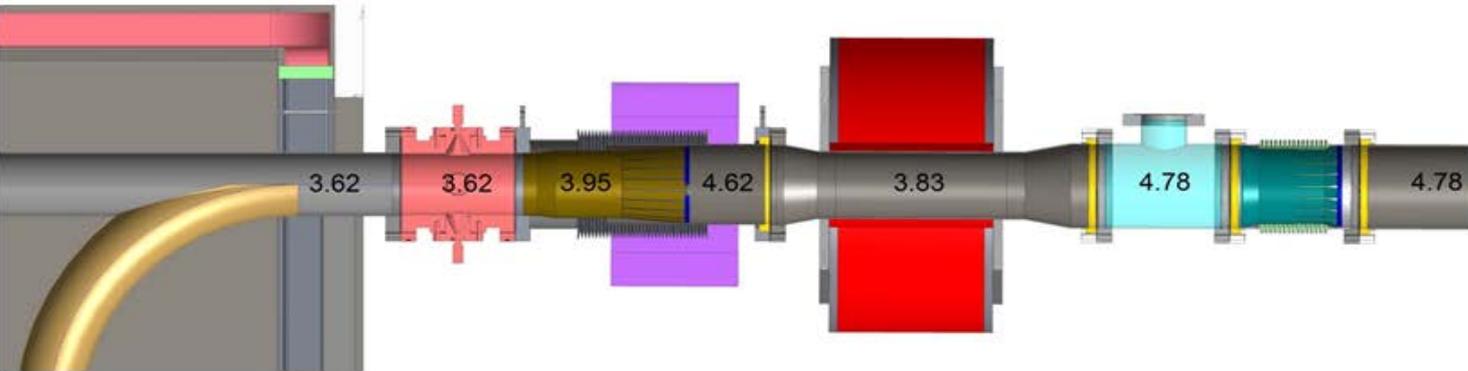
Reference Slides

20° Dipole Magnet Neighborhood

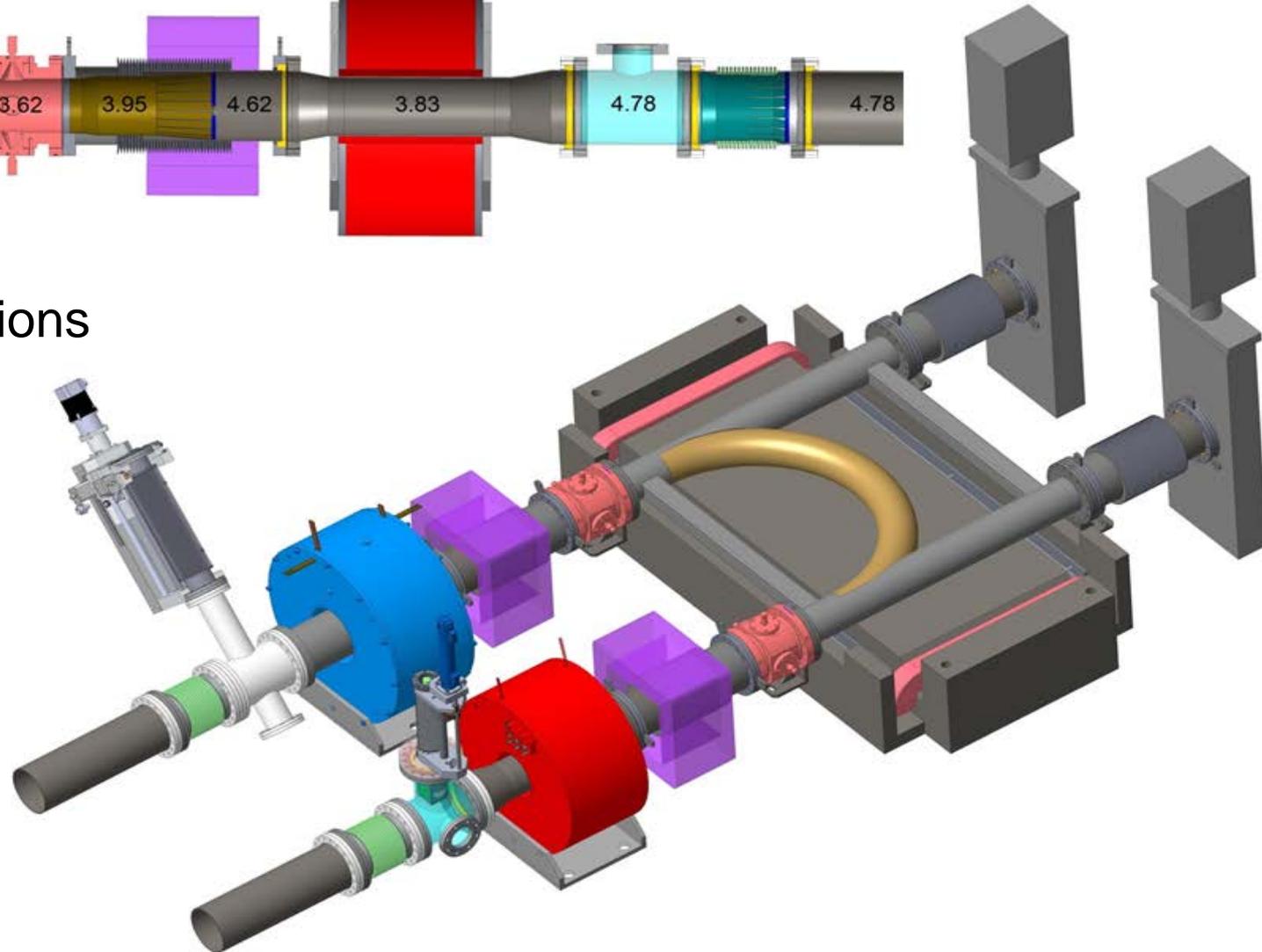


Low Energy RHIC electron Cooling

180° Dipole Magnet Neighborhood II



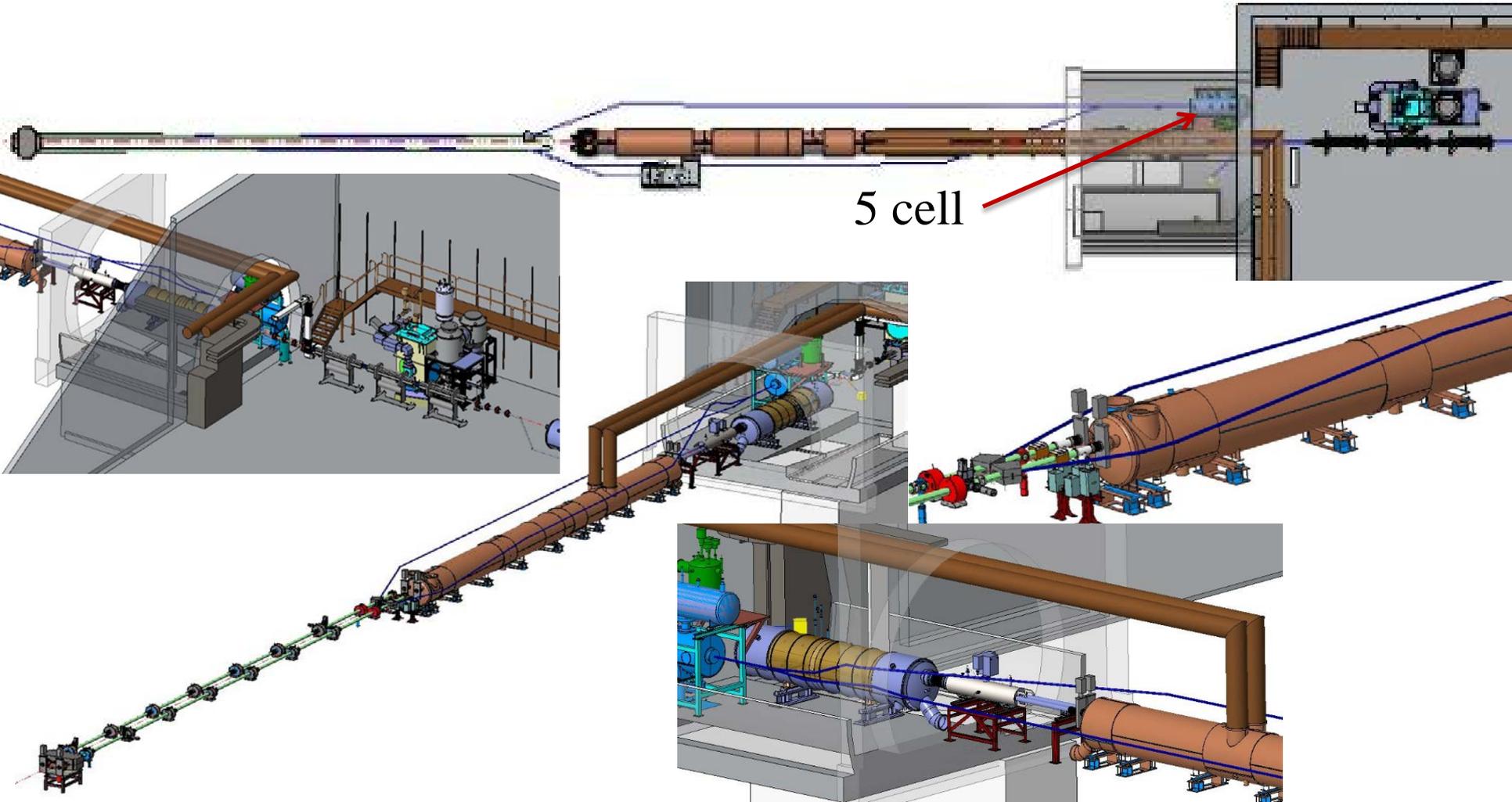
Aperture Transitions



Low Energy RHIC electron Cooling

5 cell cavity location

New updates?

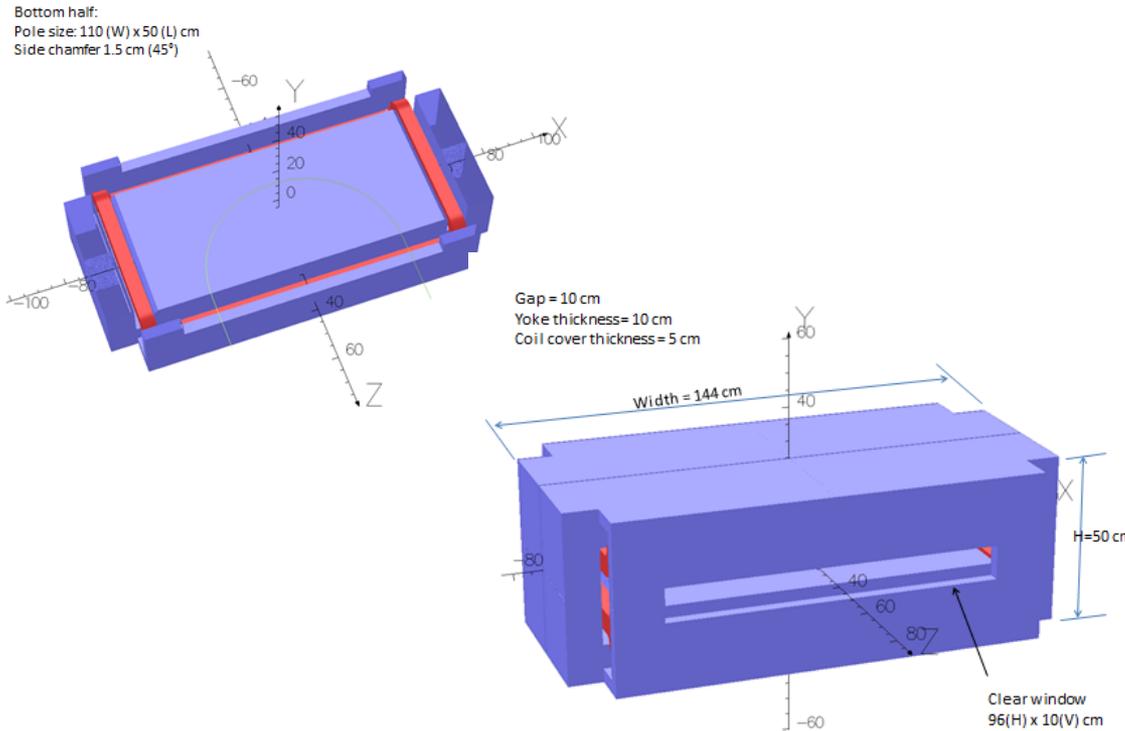


Low Energy RHIC electron Cooling

180° Dipole Magnet

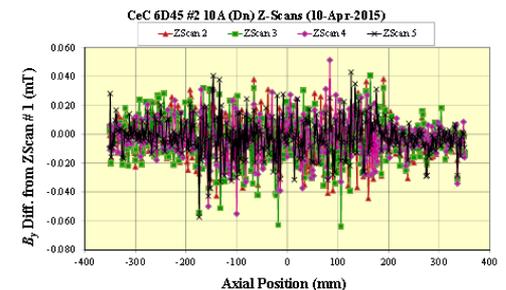
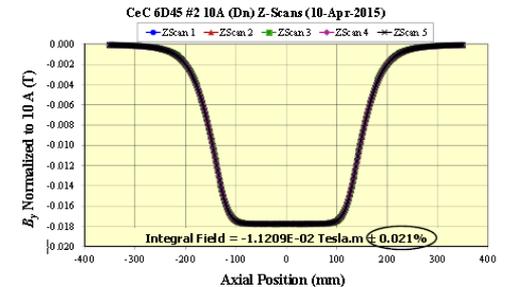
Requisition Status

Range of motion for magnet core +/- 10cm.
 Magnet Vertical Gap = 10.0 cm (3.94 in.)
 Vacuum Chamber Aperture = 9.5 cm (3.75 in.)



Electron tracking results and field qualities along entire trajectory on R=2 cm curved cylinder:

	Ek = 5 MeV	Ek = 1.6 MeV
Total current per coil (Ampere-turn)	2119.146	791.077
Overall current density (A/mm ²) (coil-pack cross-section: 5.0 x 6.0 cm)	0.7064	0.2637
Central Field deep inside magnet (Gauss)	525.21	195.78
Effective Magnetic Length (cm)	109.43	109.57
Full b1-integral (dipole) (G-cm)	5.7471E4	2.1452E4
Full b3-integral (6-pole) (G-cm) [Ratio to dipole integral]	0.132 [2.30E-6]	0.005 [2.44E-7]
Full bending angle as shown in tracking studies (required 180°)	180.002°	180.003°

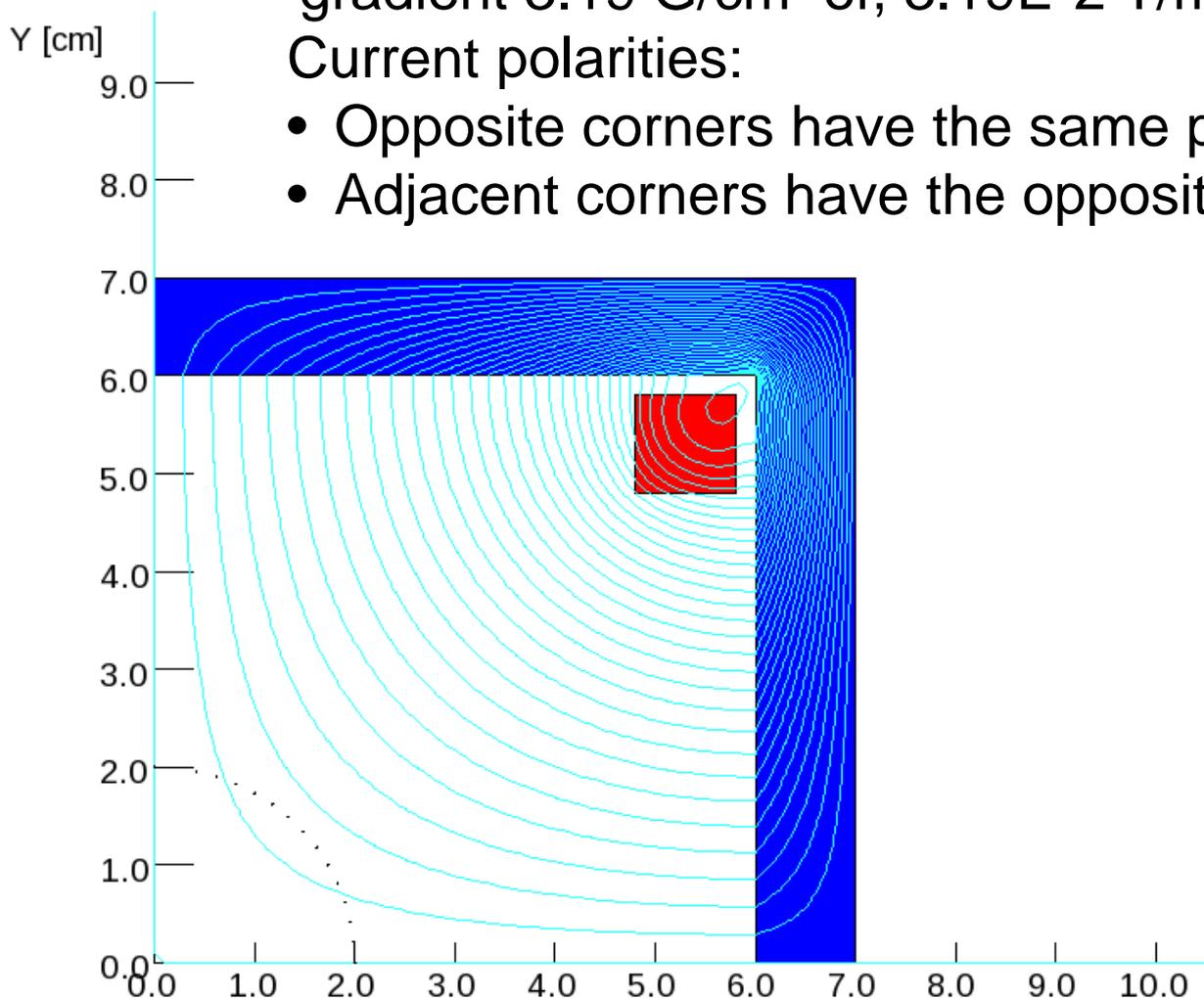


LEReC Dipole Skew Quad Corrector

Window-frame Skew Quad: 100 A-turn per corner = s-quad
gradient 3.19 G/cm or, 3.19E-2 T/m

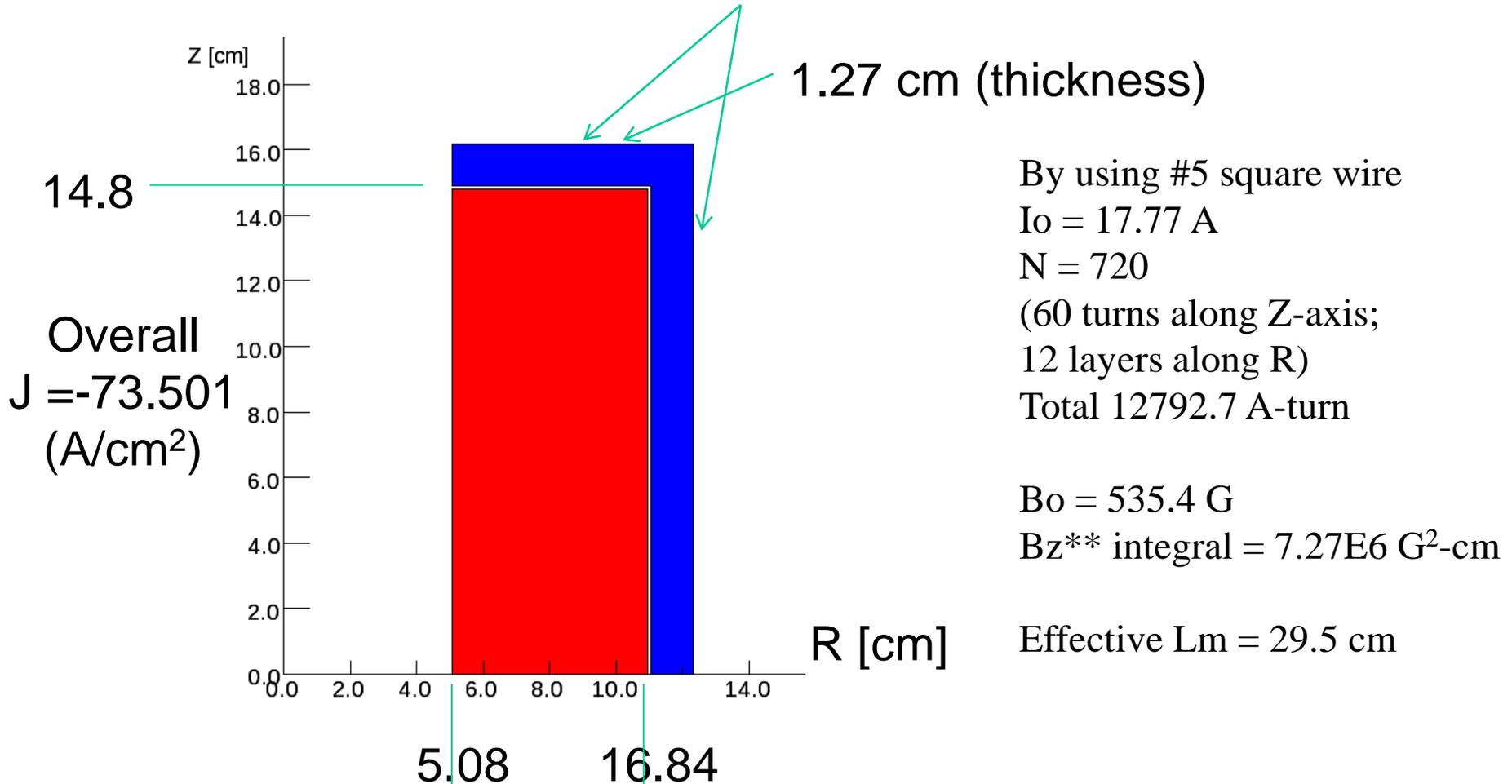
Current polarities:

- Opposite corners have the same polarity
- Adjacent corners have the opposite polarities.



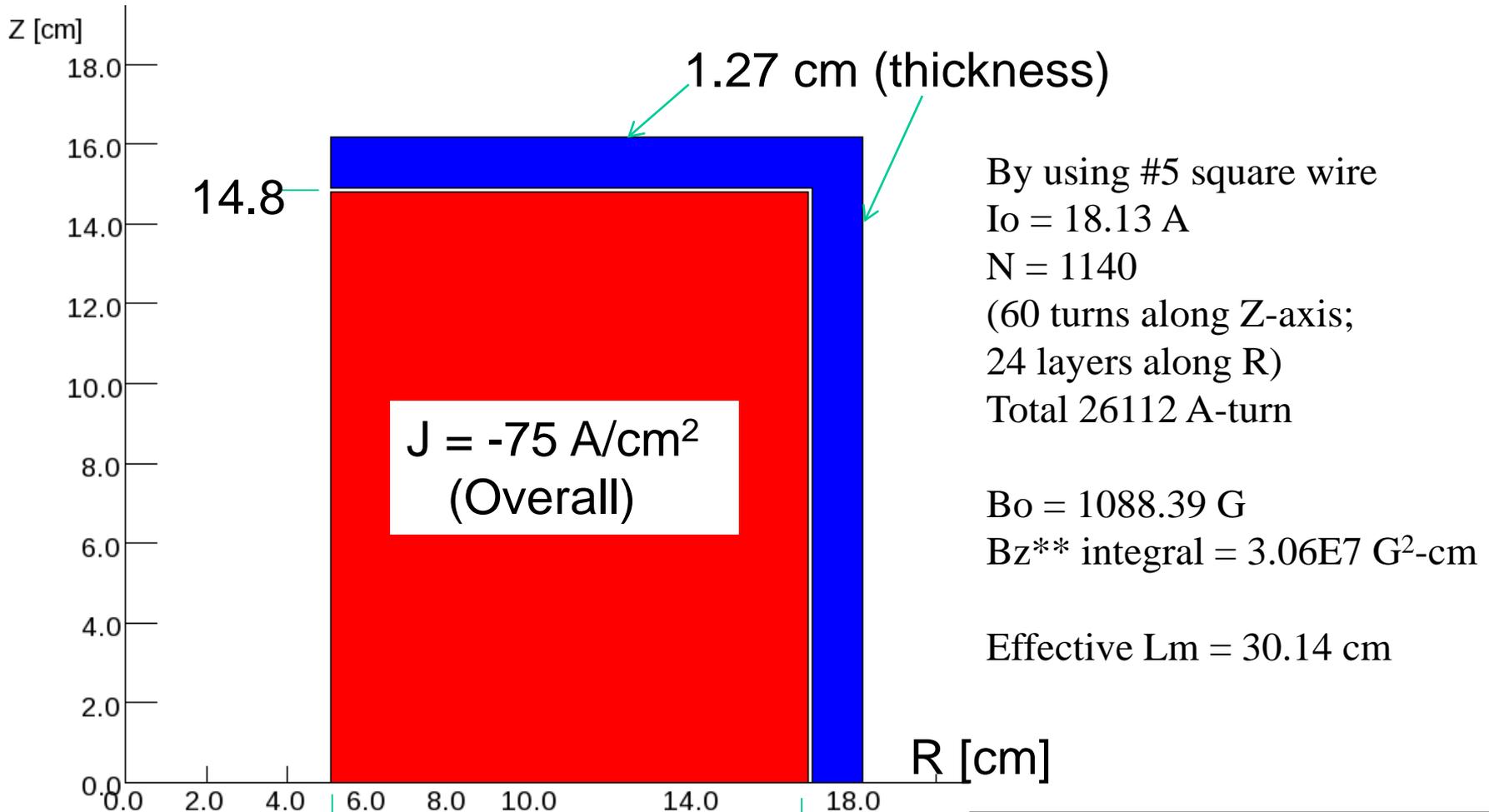
Transport Line Matching Solenoid

Transport Solenoid (preliminary) ----- to be mounted on 2.5" pipe
(Copper winding starts at R=2")



Transport Line Merging Solenoid

Merging Solenoid (preliminary) ----- to be mounted on 2.5" pipe
(Copper winding starts at R=2")



5.08 16.84

LOW ENERGY KHI U C Electron Cooling

Sector 1 Relocation Meeting 5/22/2015

Sector 1 Instrument Relocation for LEReC Summary



Champions need to confirm the relocation plan so the *mechanical design work* can proceed.

More details can be found here:

http://www.cadops.bnl.gov/Instrumentation/InstWiki/index.php/Instrumentation_Relocation

Systems in the LEReC Region (40m - 63m) to be Relocated

7 separate mechanical assemblies

ARTUS Kickers - Blue V, Yellow H
IPMs (Ionization Profile Monitors)- Blue H, Yellow V
Moveable BPM & LF Schottky, X-Y stage BI1 41m
BBQ PLL Kicker stripline (1m) YO1
Triple Purpose Pick-Up on Moveable X-Y Stage YO1 ~42m
Cable Tray Waterfall

New Location

Sector 2
Sector 12
Sector 1 (closer to Q4)
Sector 1 (closer to Q4)
Sector 1 (closer to Q4)

Champion

Drees
Tepikian
Brown/Blaskiewicz
Marusic
Minty/Marusic

Mech E.

Fite

Phillips/Sampson

Systems to be Removed

Electron Detectors (8)
Quad Pick-up (0.25m) YO1 40.1m
Luminescence Monitor Cross at B02 53.1m
Stochastic Cooling Ceramic Pick-Ups[6-9 GHz] at BI1 67.8m



Zhang/Blaskiewicz
Minty
Minty
Mernick



Beam Loss Monitor Detector Reconfiguration, Sector 1

1 BLM per IPM will move with the IPMs to sector 12

Drees

Sector 2 Modifications

LEReC:

- Move cable tray/Modify cable tray
- Move Access Controls Gate
- Remove stairway and part of cross-over platform
- Tunnel Penetrations

