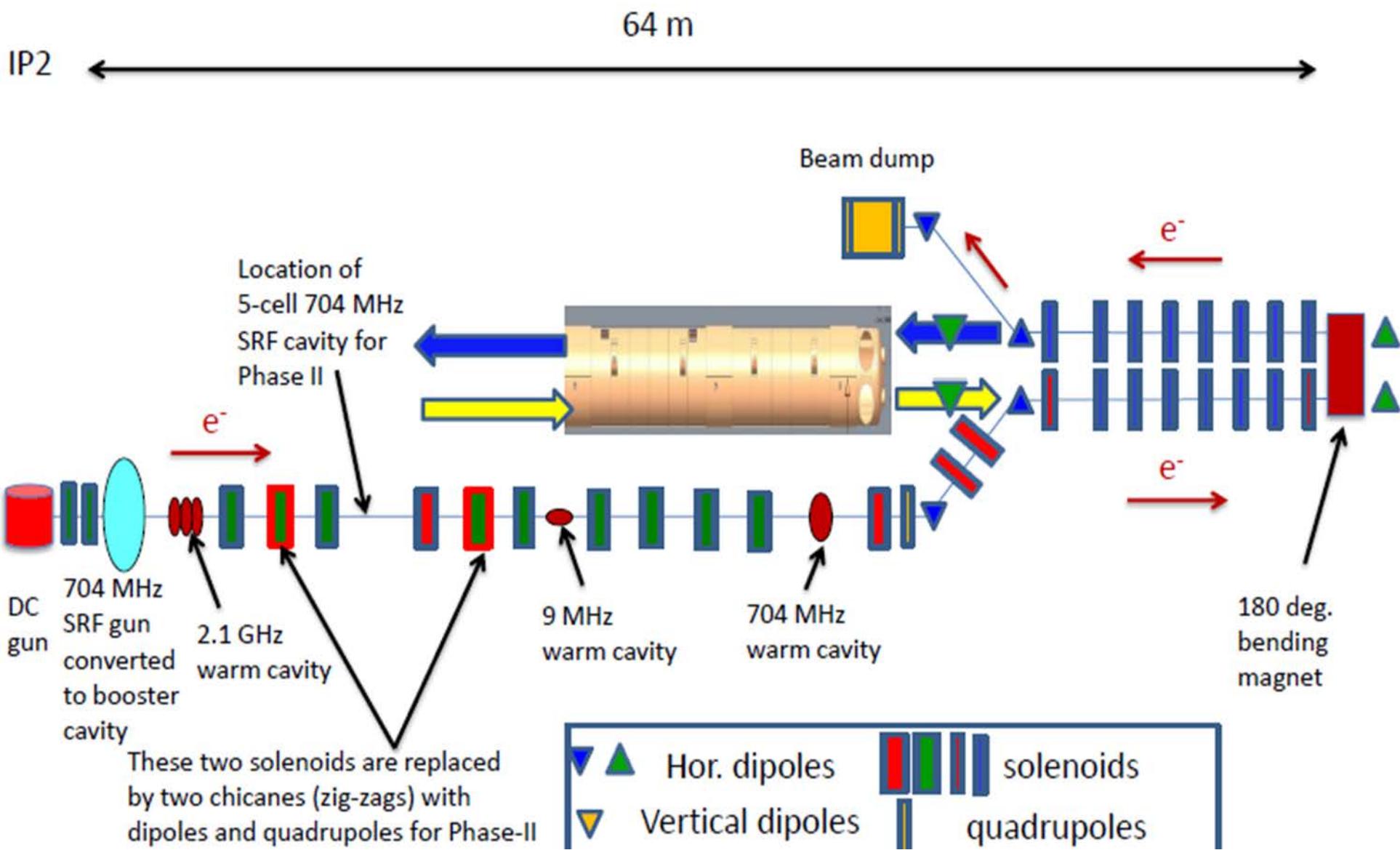


# LEReC Phase-I (electron beam energies 1.6-2MeV):

## 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

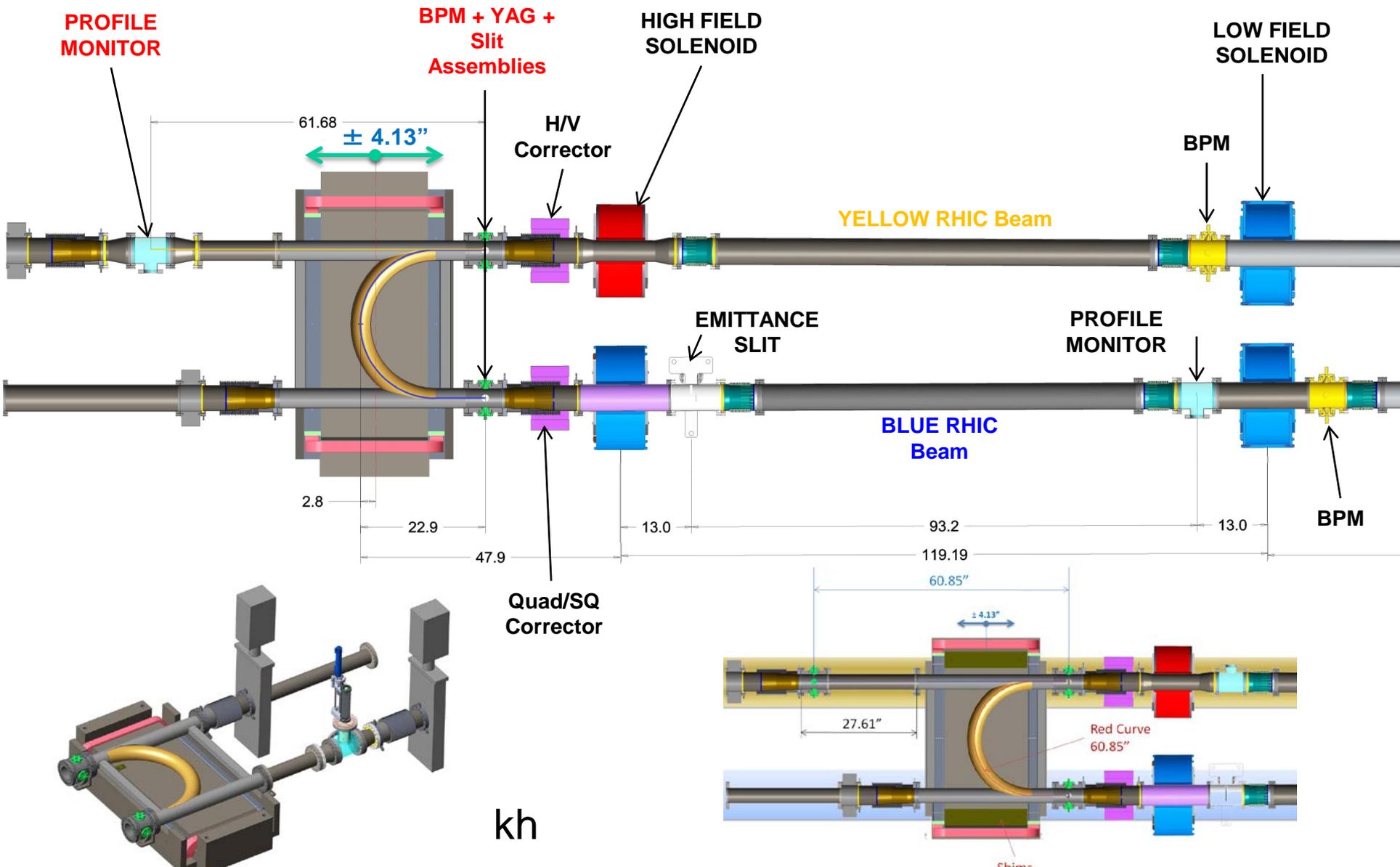
3.75"OD/3.62"ID beam line  
 9.2 cm ID

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

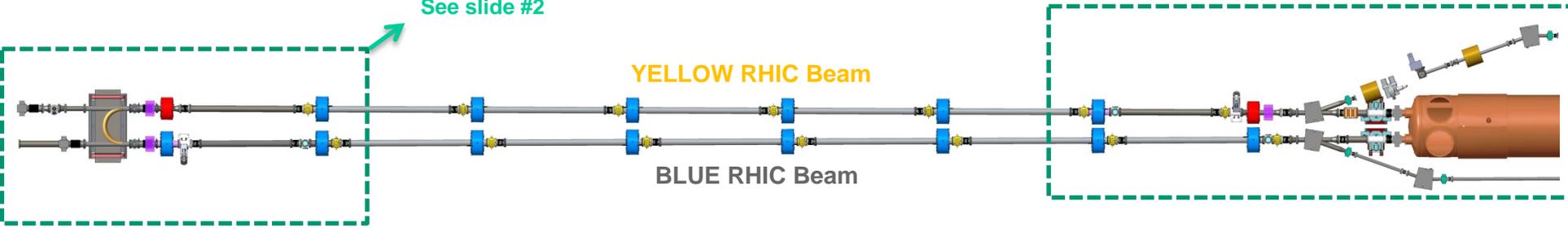
2.5"OD/2.38"ID beam line  
 (6 cm ID)

Low Energy RHIC electron *Cooling*

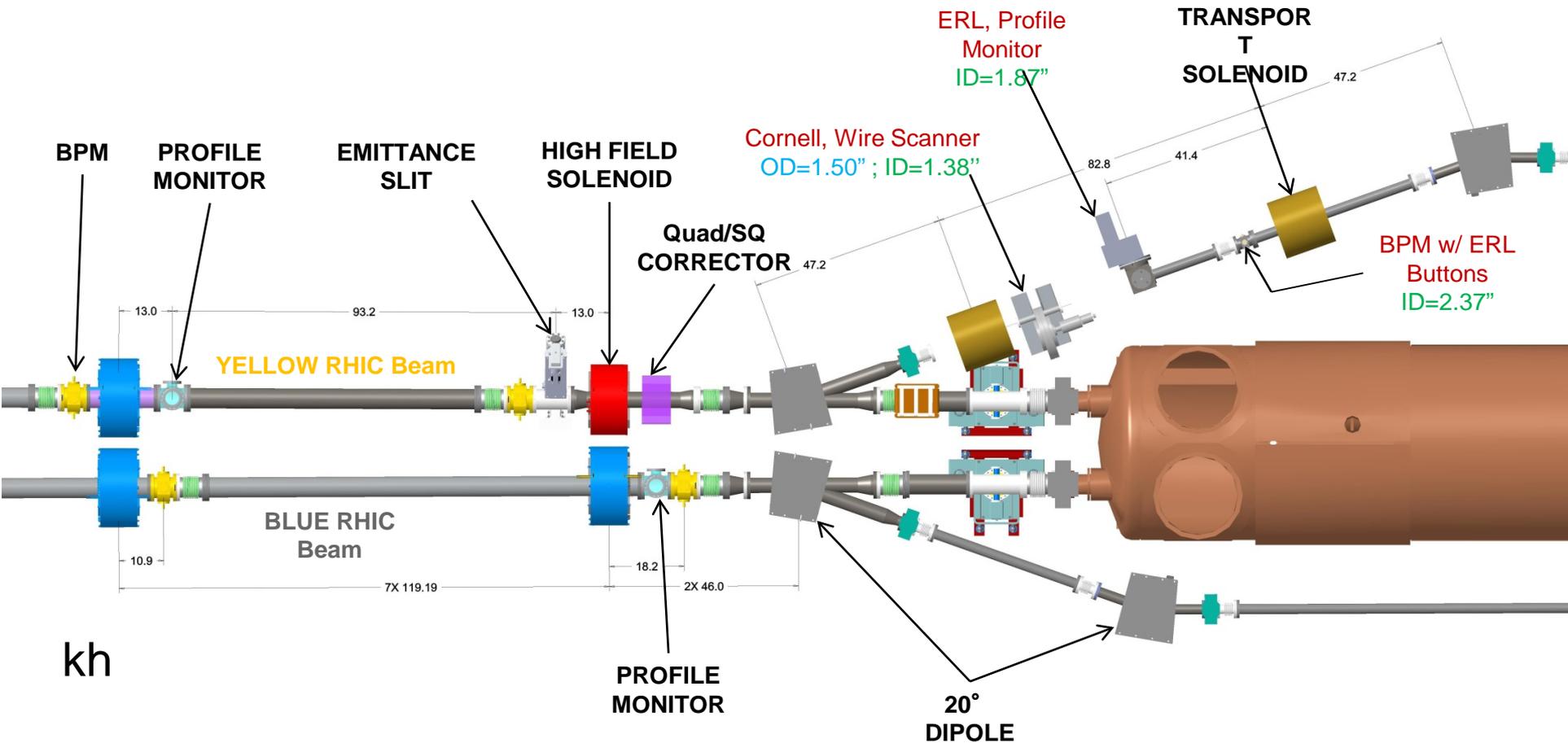
# 180° Dipole Magnet Neighborhood IV



See slide #2



## 20° Dipole Neighborhood IV



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

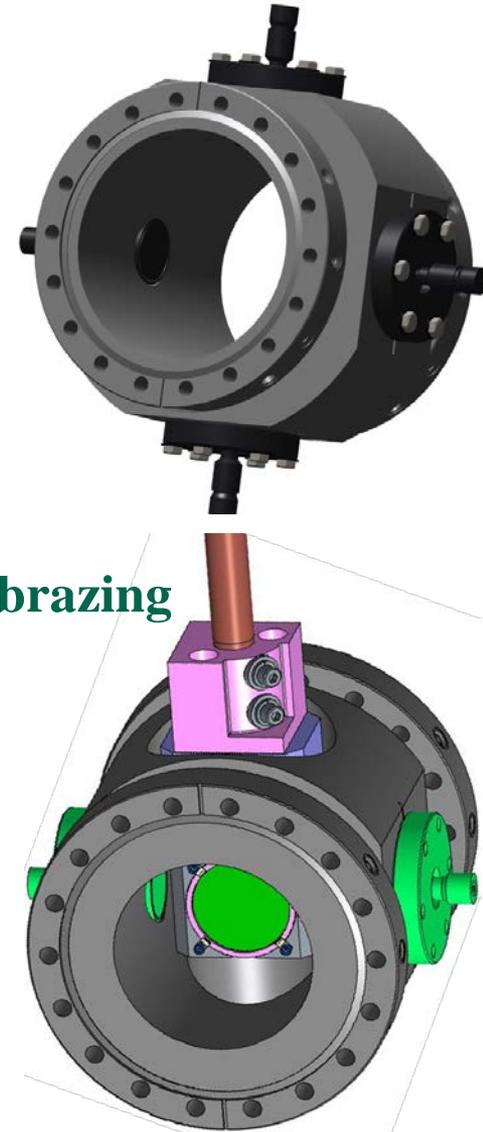
- Order Placed with MPF
- Final Design Review 6/23/2015, no issues
- MPF approved to start fabrication
- Increased number of button first articles for 2 BPM's one standard, one 180 magnet special
- MPF updated delivery schedule
- Agreed on vacuum bakeout for components

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

MPF will vacuum bake housing @450C/48hr

BNL will vacuum bake 1<sup>st</sup> article housing

- First Article delivery buttons 9/28/2015
- First Article delivery housing 9/01/2015
- Can the buttons “see” low charge bunches during commissioning?



# Cooling Section *Standard* Profile Monitors

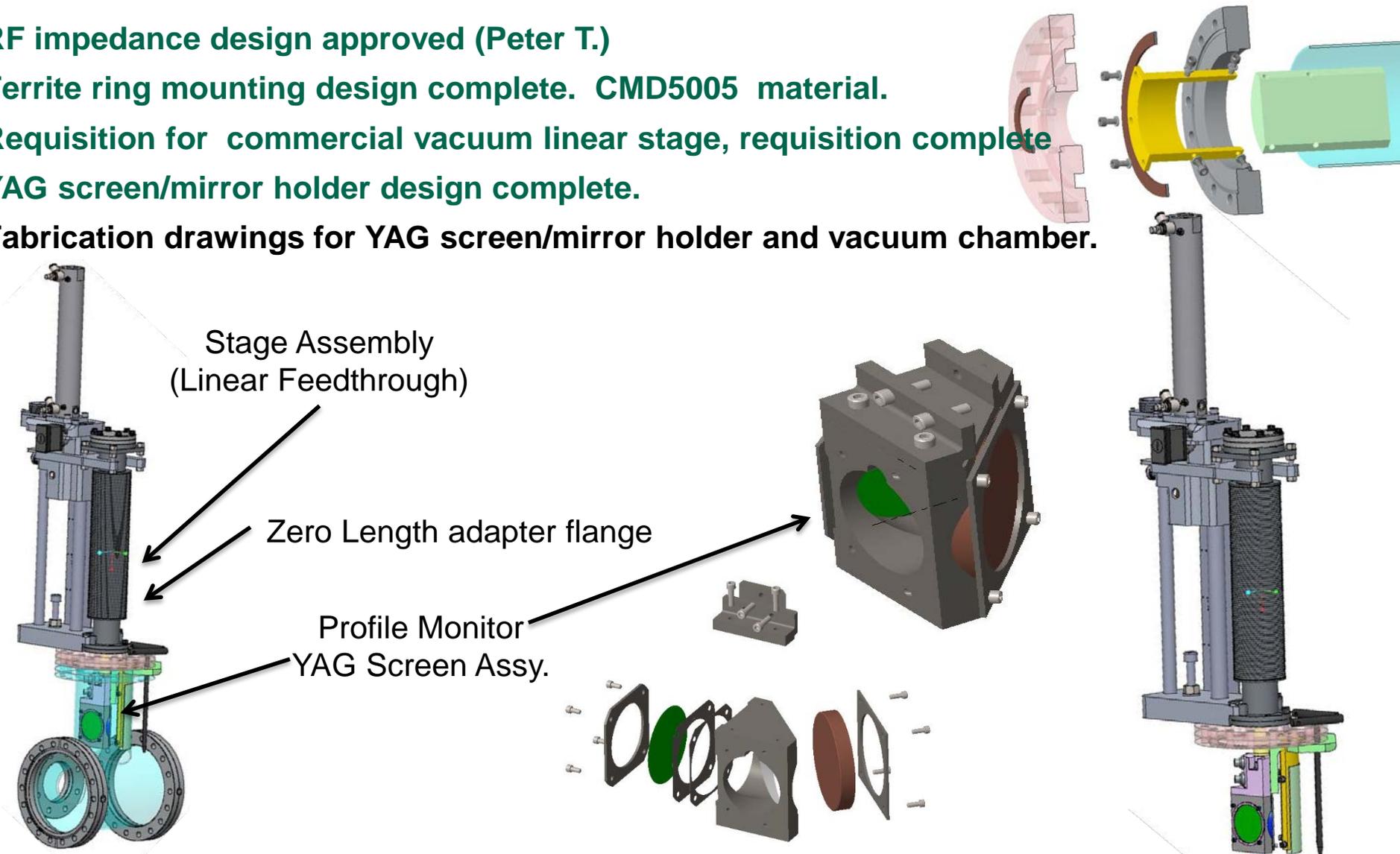
RF impedance design approved (Peter T.)

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.



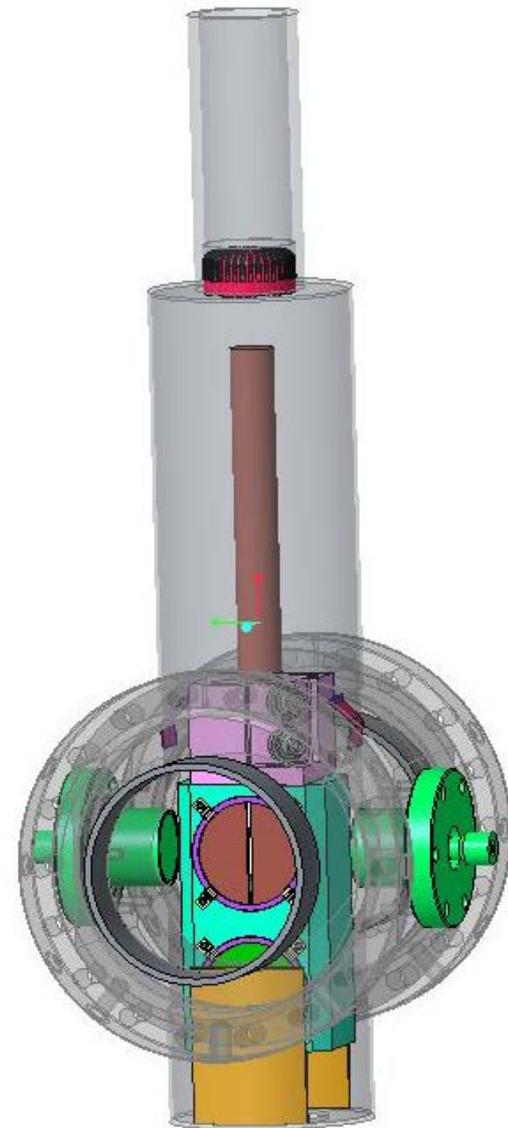
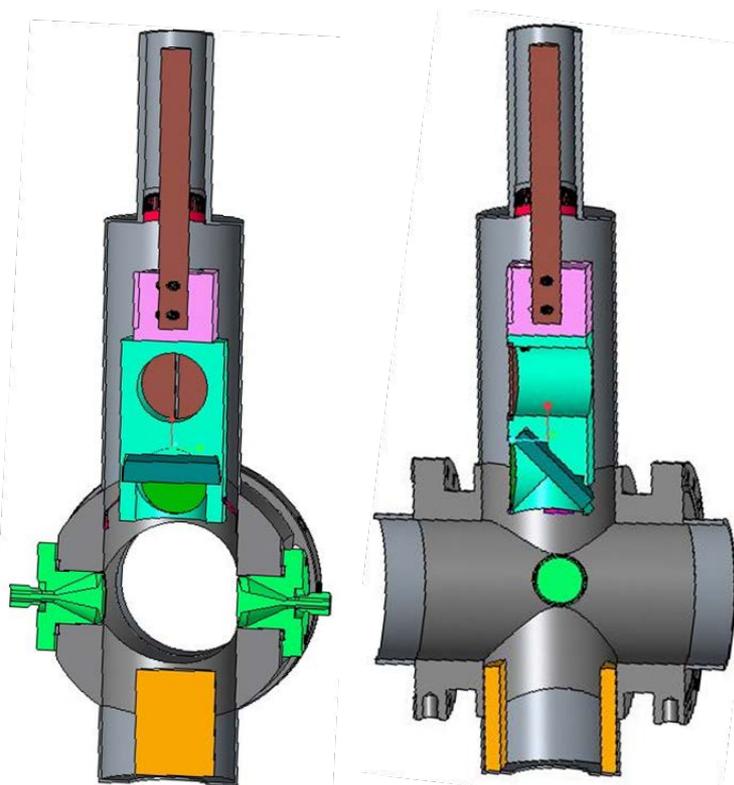
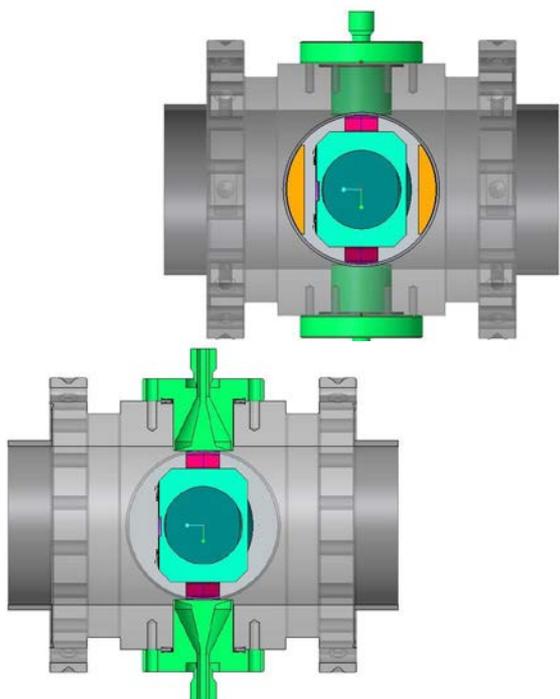
# Cooling Section “hybrid” BPM, PM, Slit

RF impedance analysis complete

Chamber design complete

Final design of RF impedance grounding fingers

Final design of RF impedance ferrite configuration and mounting



# Cooling Section PM meeting (yesterday)

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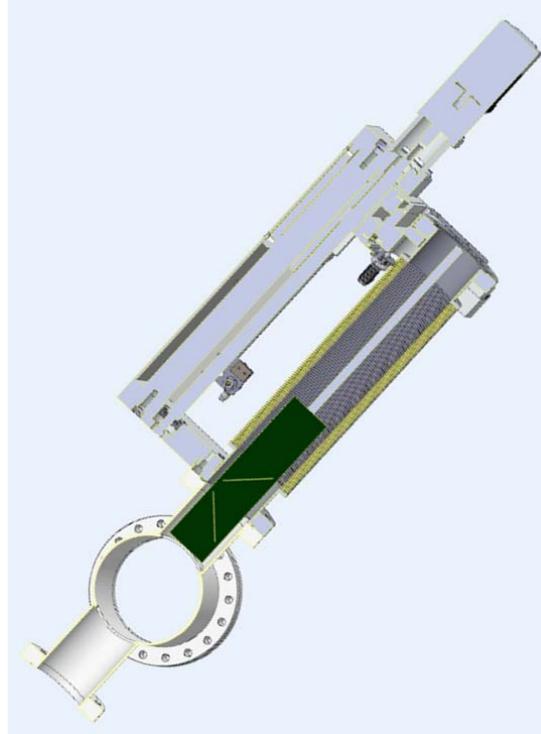
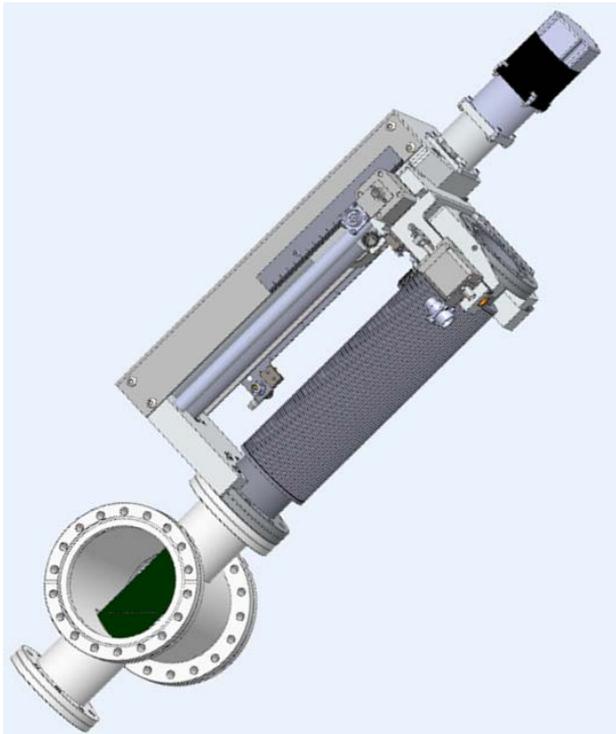


## Notes from today's meeting:

- Gary is near complete with the drawings for the standard profile monitor and is submitting them for checking.
- Toby will verify mirror thickness with Vendor (Gary will provide drawing).
- Both Hybrids PM, Slit, BPM systems will be 3 position vacuum translating stage drives. The second hybrid may substitute the slit position (which is not needed) for a fault study beam stop.
- Dan is in contact with KL on the transverse position accuracy of the vacuum translating stage, also will ask KL about the additional cost and delivery for a higher accuracy assembly.
- Dan will order angle mount windows welded to a larger flange if available for all of the cooling section profile monitors + 1 spare. The windows will be coated with a thin metallic coating to disperse charge. Peter believes Dan Steski can do it for us.
- Dan will submit all drawings available to CS for cost estimate before he goes on vacation (reference Gary and Joe on the RFQ).
- The grounding requirements for the hybrid head has been revised. Now the head must be ground to the sliding fingers in all three positions. It was agreed that the only way to do this was on the sides of the instrument head transverse to the beam as shown below.
- The standard profile monitor will not receive be modified for grounding fingers.
- The emittance slits will be investigated whether they need grounding fingers – a new concern as a result of this meeting.

# 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.
- Does the slit need 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**

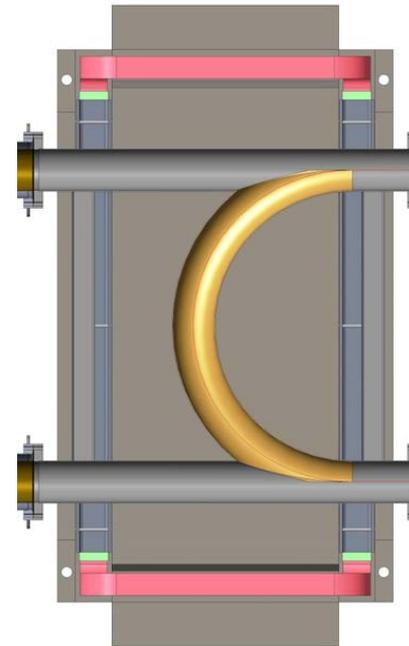
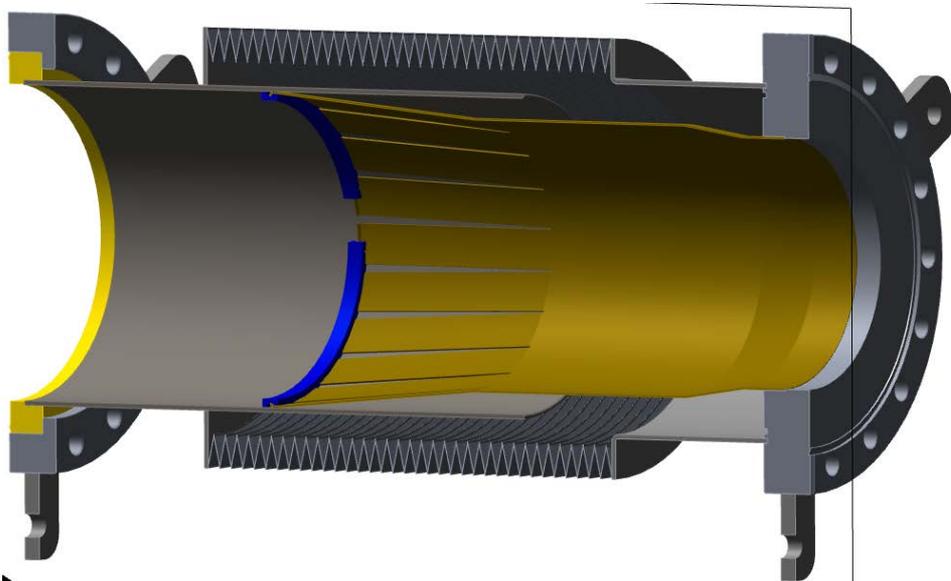
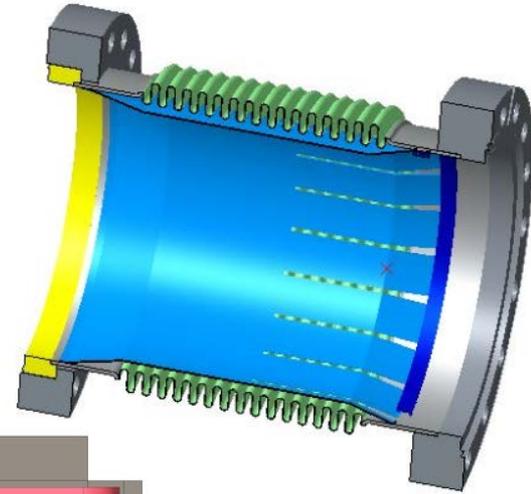
180 chamber 316L vacuum annealed to 900C after welding.

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

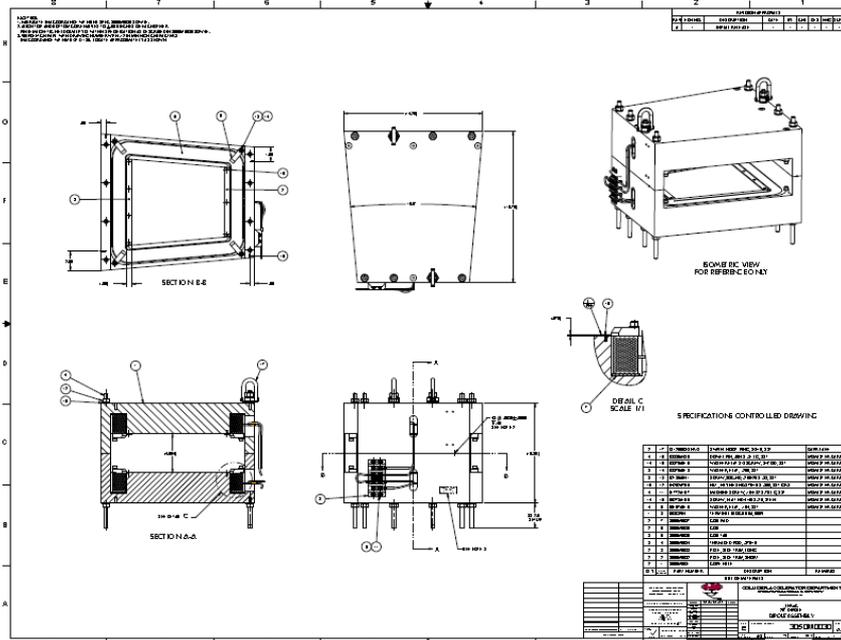
Estimated Delivery 1<sup>st</sup> two magnets 10/1/2015

Will visit ET next week

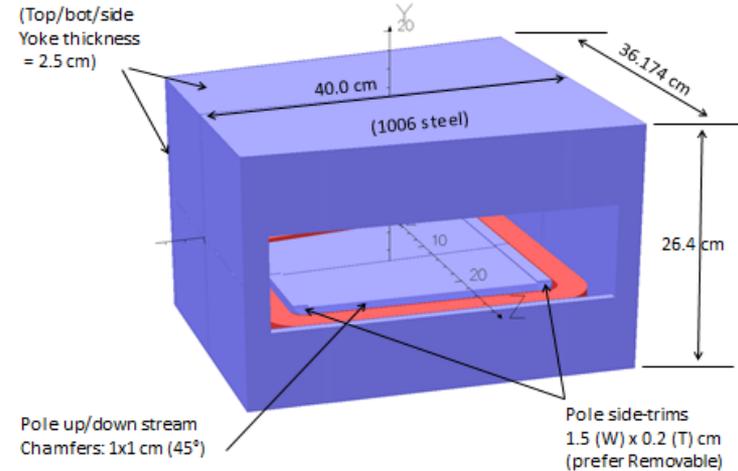
Distance Between Pole Faces = 10.4 cm (4.1 in.)

Magnet Vertical Gap = 10 cm

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



LEReC 20-degree Dipole (Gap clearance=10 cm)  
(distance between pole faces =10.4 cm)



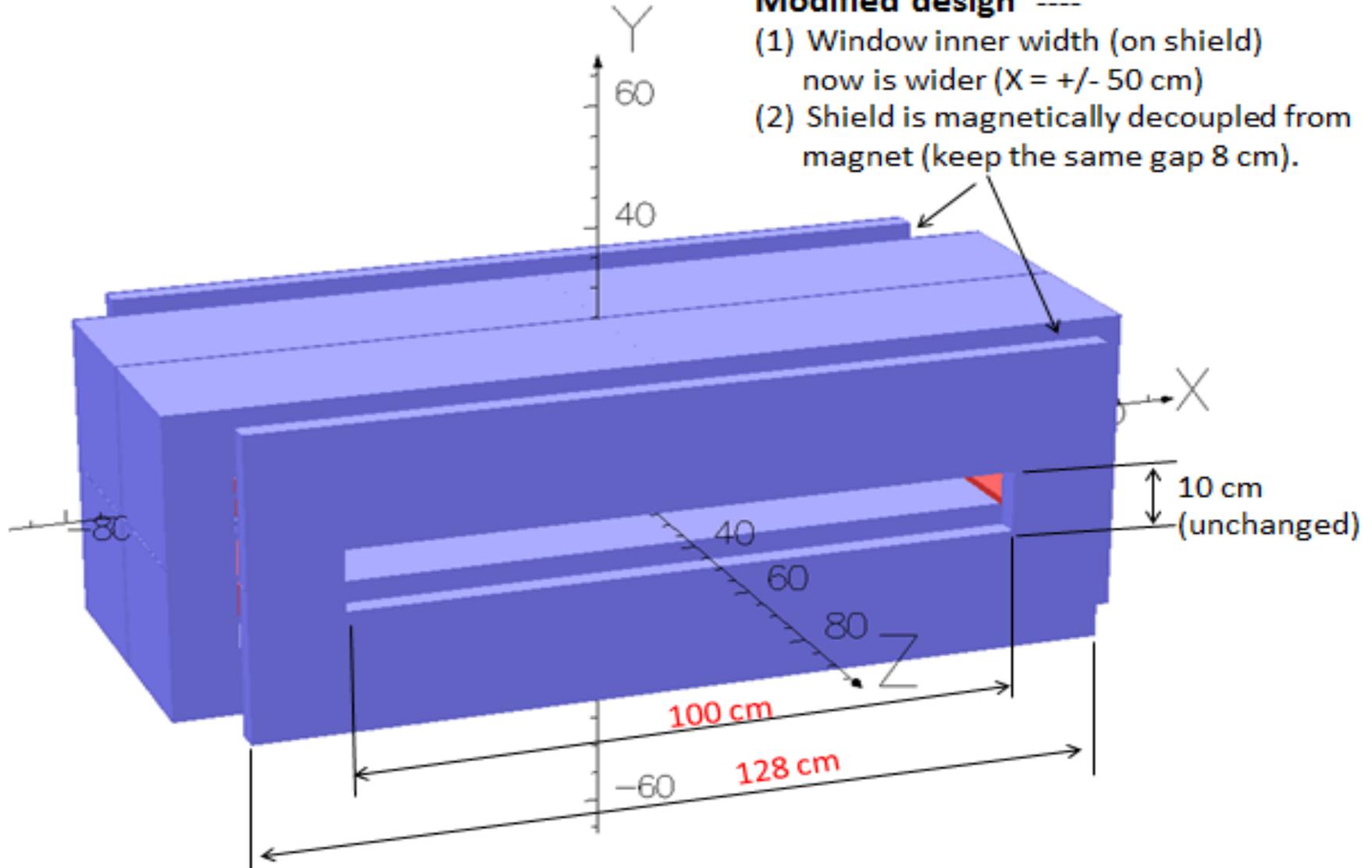
Electron tracking results and field qualities along trajectory on R=1 cm curved cylinder:

	Ek = 5 MeV	Ek = 1.6 MeV
Current per coil (Amp-turn)	1053.288	393.192
Overall current density (A/mm <sup>2</sup> ) (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

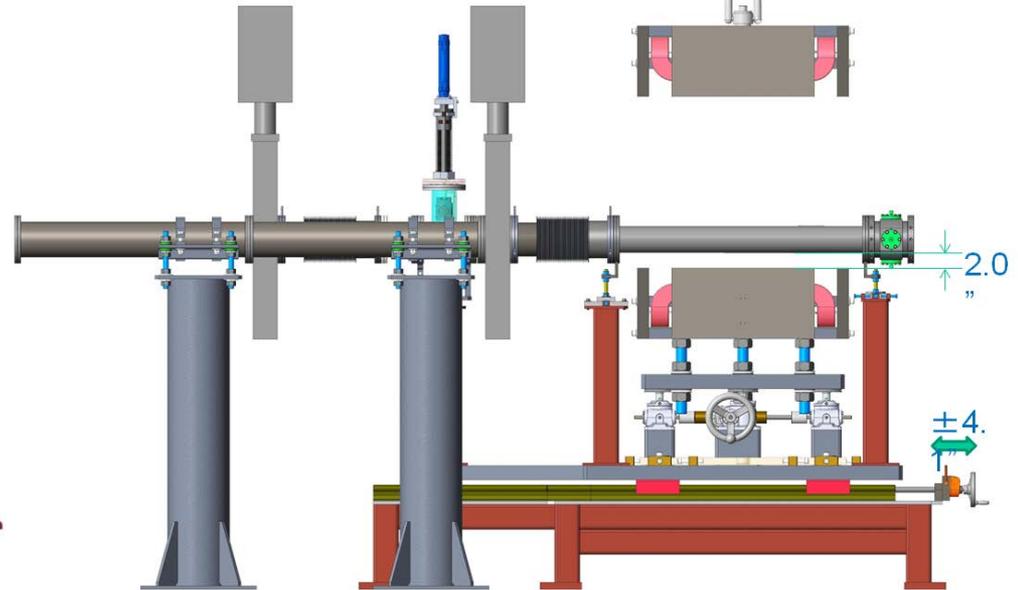
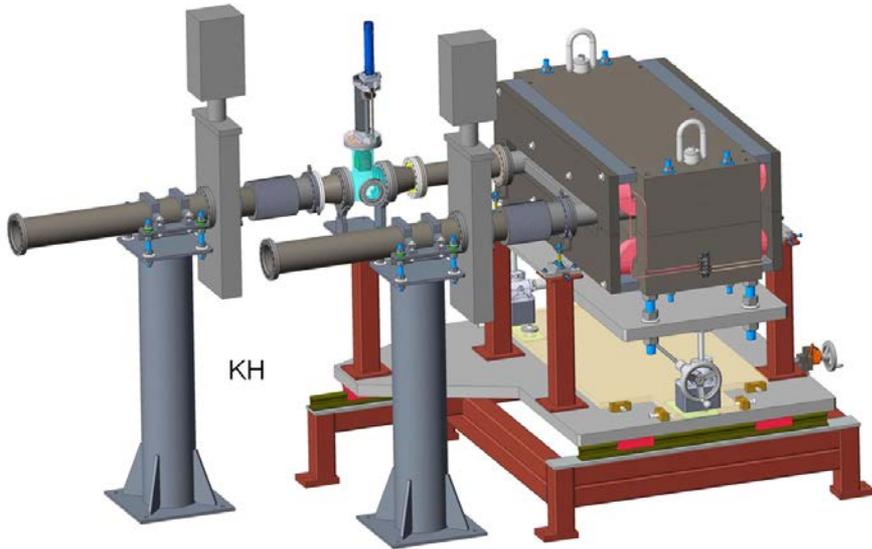
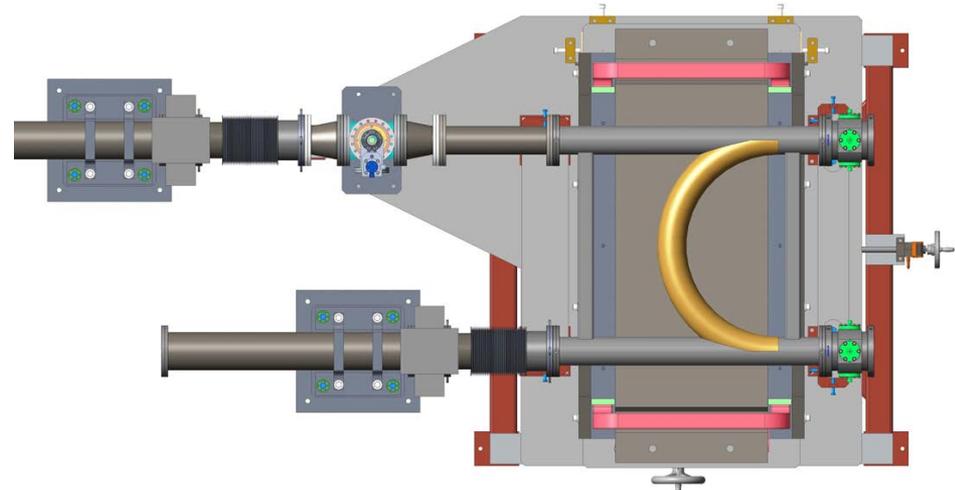
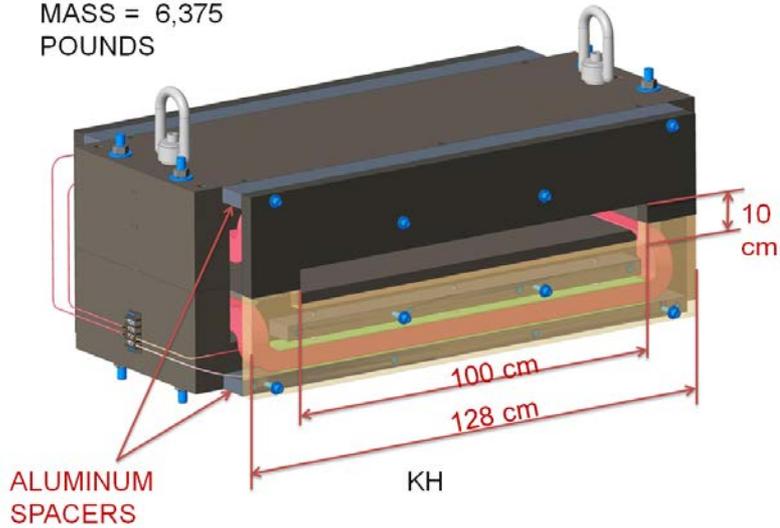
## Modified design ----

- (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



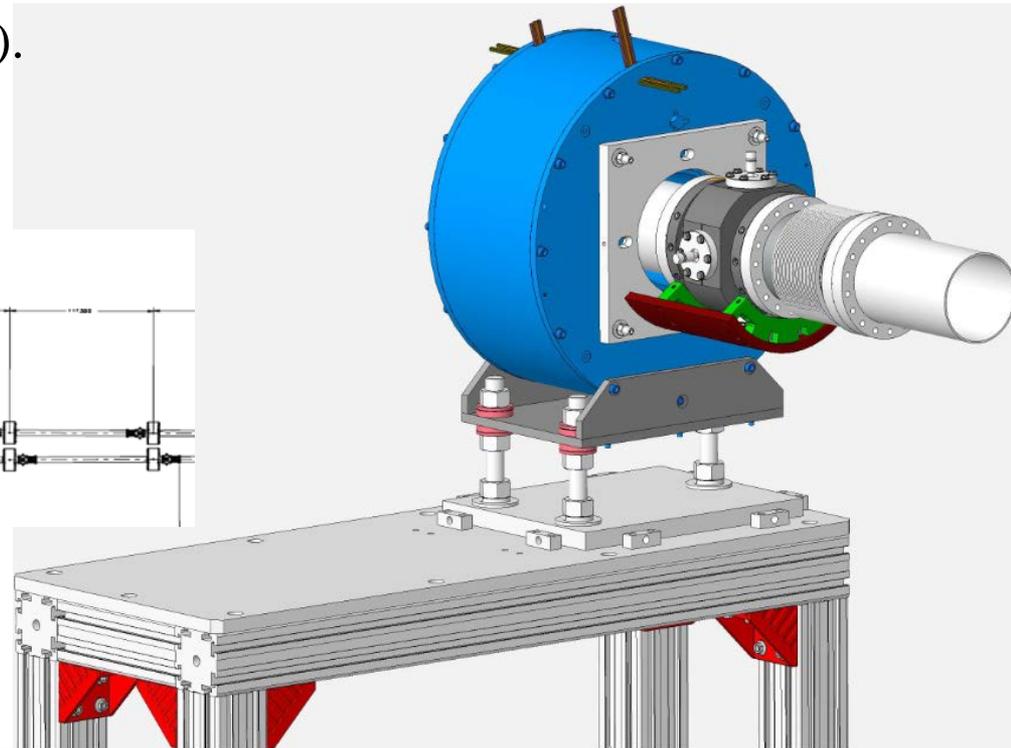
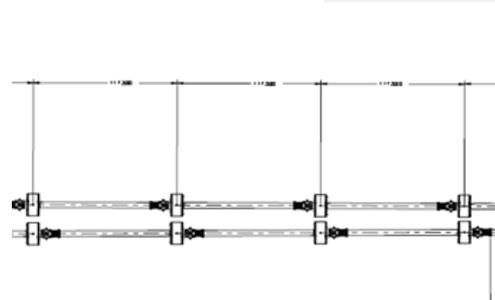
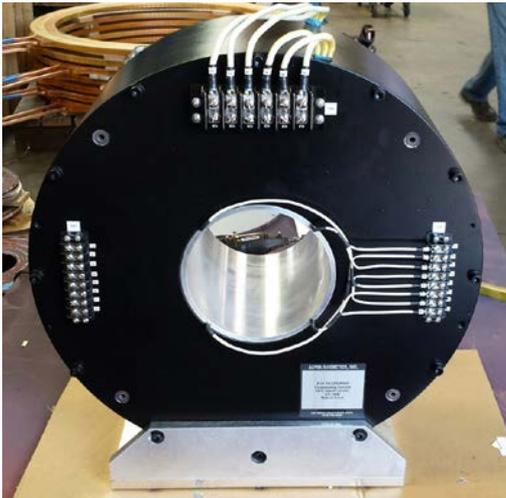
# Compensating and Matching Solenoids

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

## HALL PROBE / SOLENOID GRANITE TABLE (Measurement Schedule)

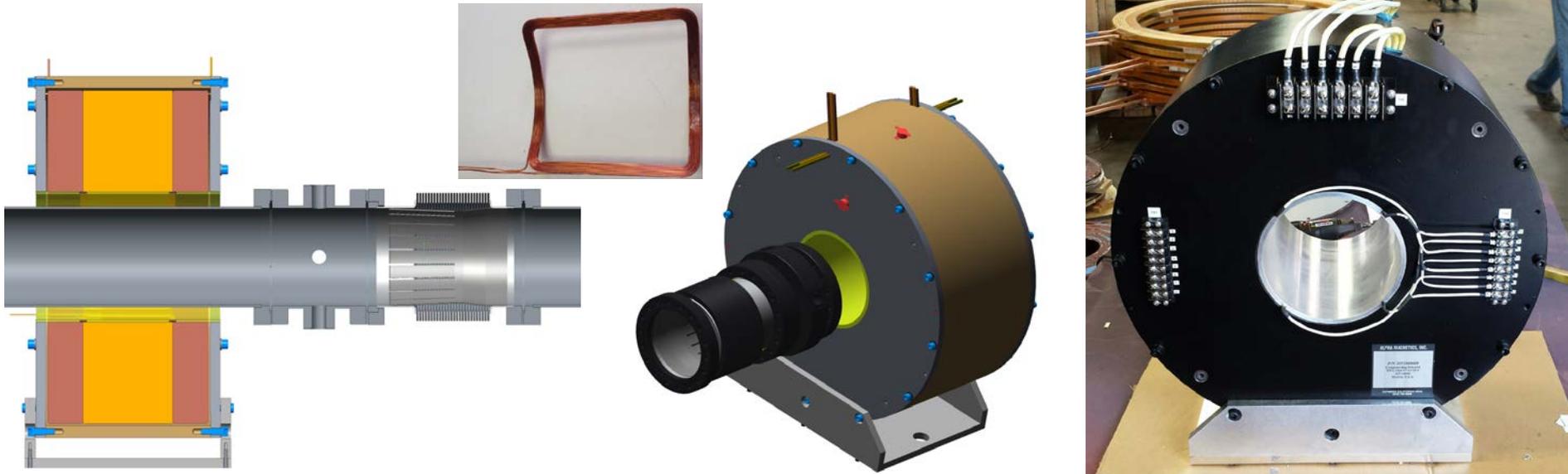
August 3-7: complete permanent magnet measurements

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



Low Energy RHIC electron Cooling

# 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)*

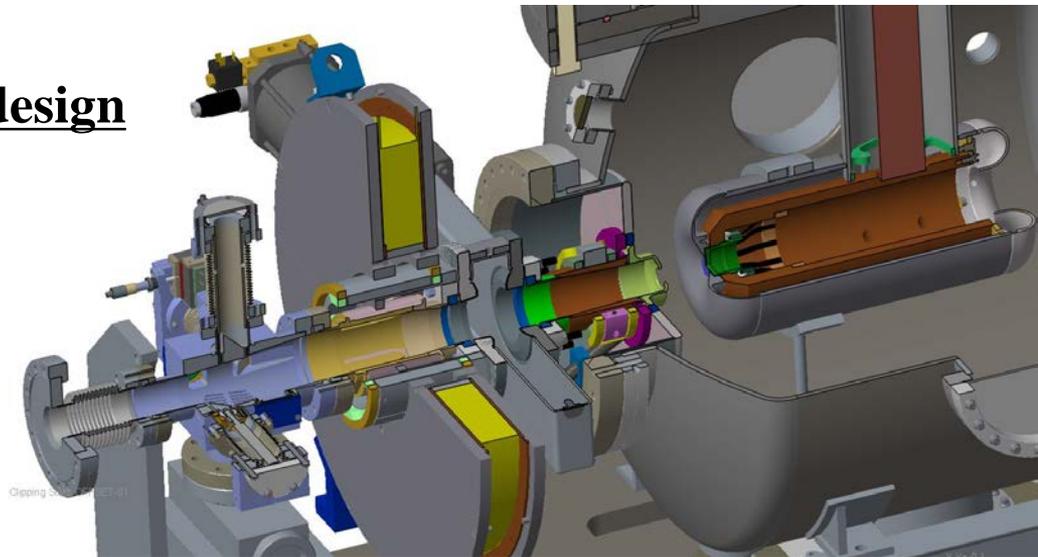
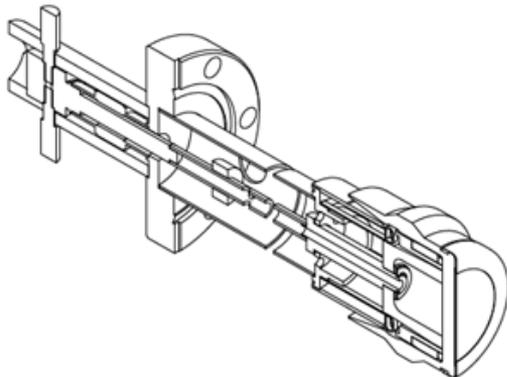
**DC Gun to Booster SRF booster cavity beam line (JH)**

**DC Gun cathode coating system vacuum chamber (PC)**

**DC Gun cathode transfer load lock and vacuum chamber**

**DC Gun cathode insertion drive**

**Cathode production coating system design**



**Low Energy RHIC electron Cooling**

# LEReC Design Room Other Work

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

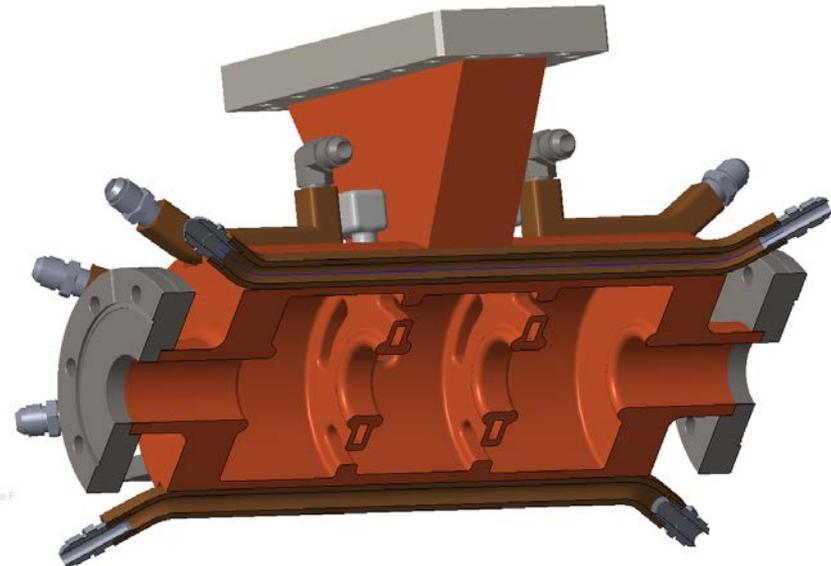
**Phase 2: 5 cell cavity positioning (RM) – Revised Position on hold**

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)



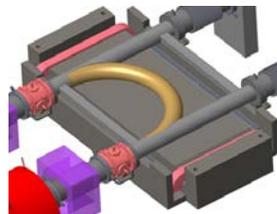
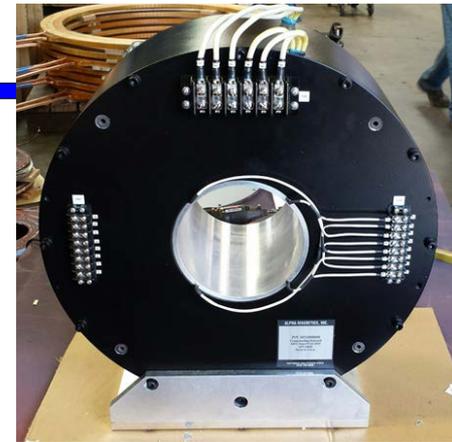
# Installation Step – 2015 Shutdown

## Cooling Section Purchase Orders in Place

- HF and LF solenoid magnets in fabrication, 1<sup>st</sup> 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)

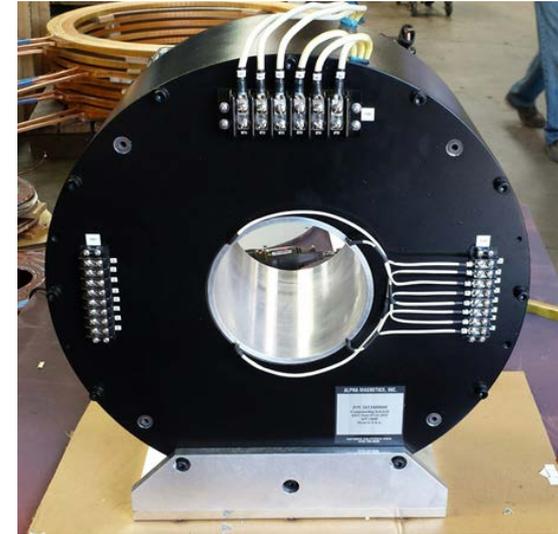


# Installation Step – 2015 Shutdown Punchlist

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## Cooling Section Parts in Hand

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

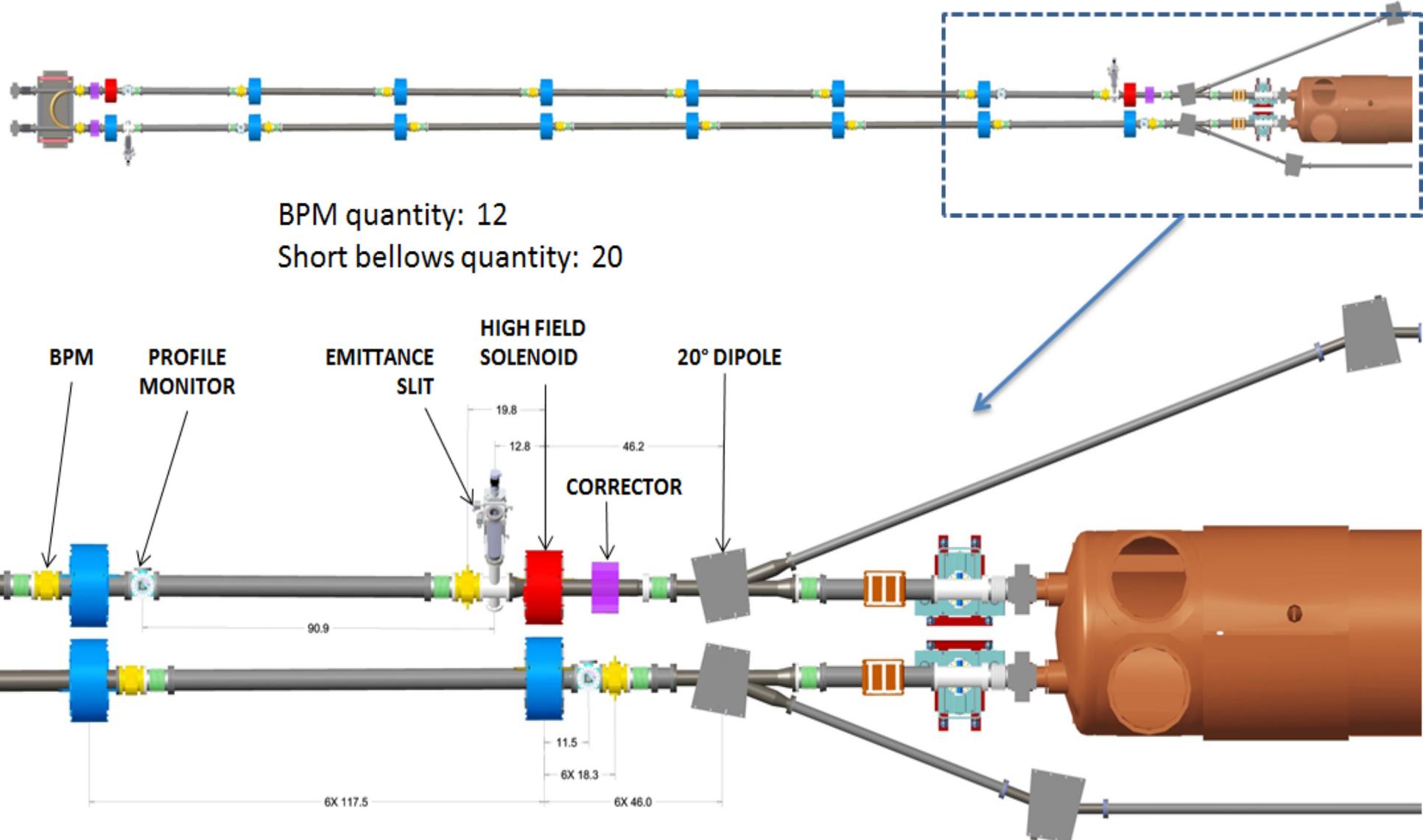


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# Reference Slides

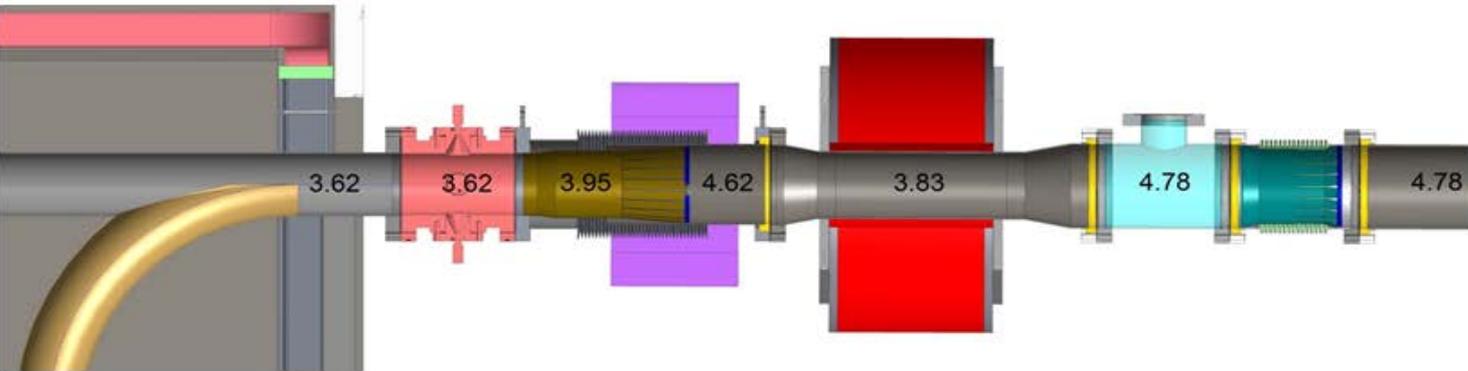


# 20° Dipole Magnet Neighborhood

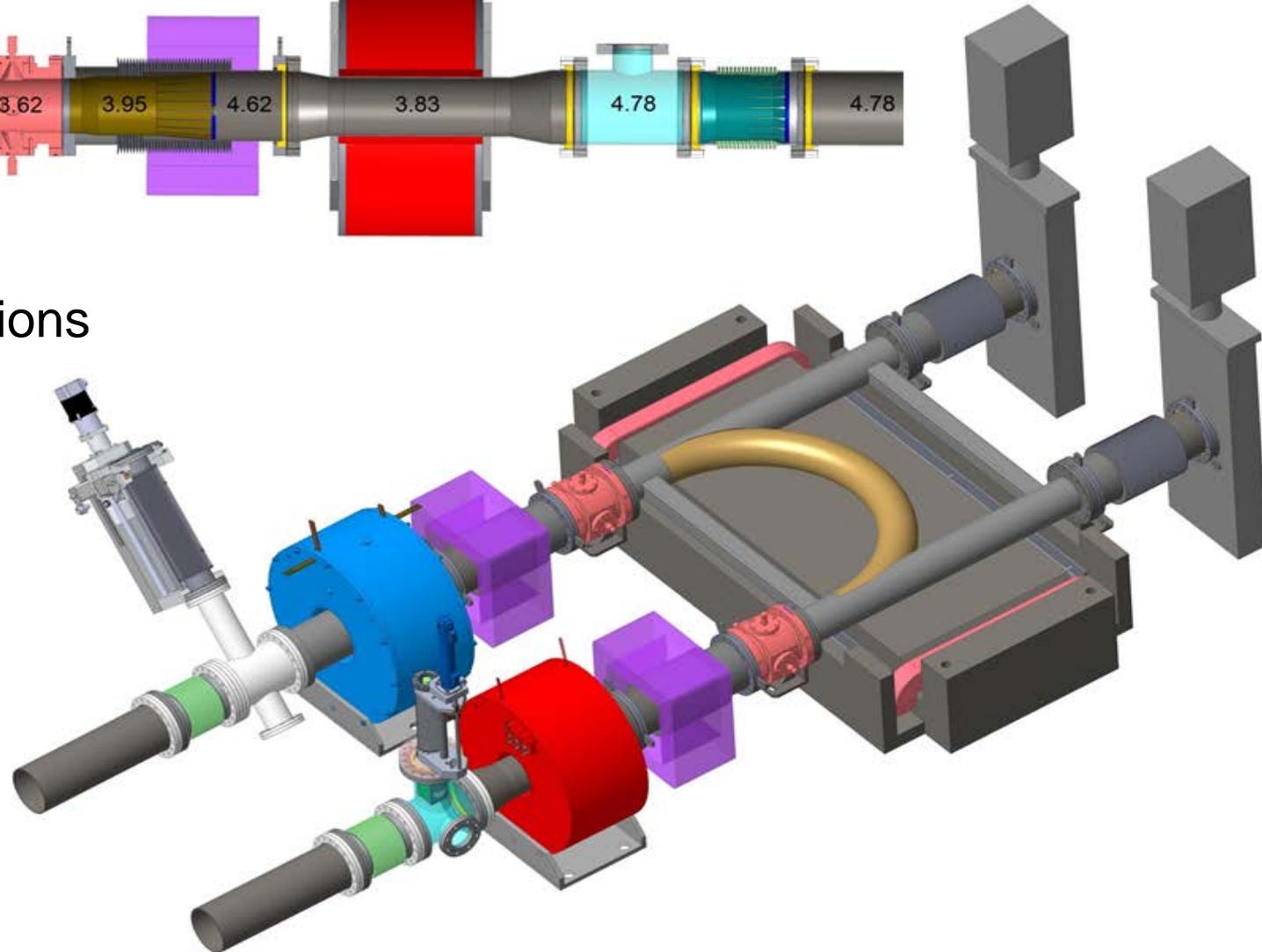


Low Energy RHIC electron Cooling

# 180° Dipole Magnet Neighborhood II



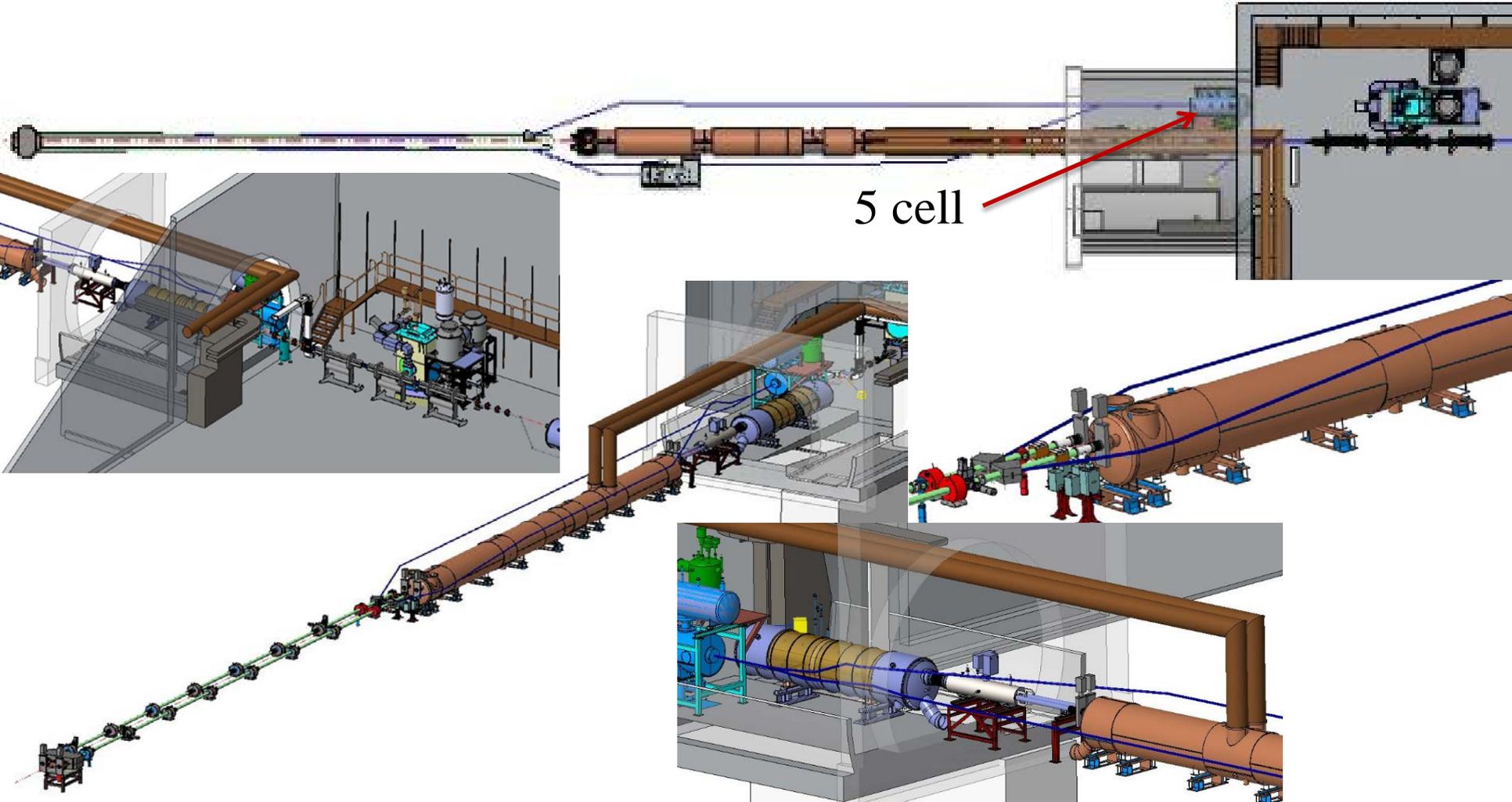
Aperture Transitions



Low Energy RHIC electron Cooling

# 5 cell cavity location

New updates?

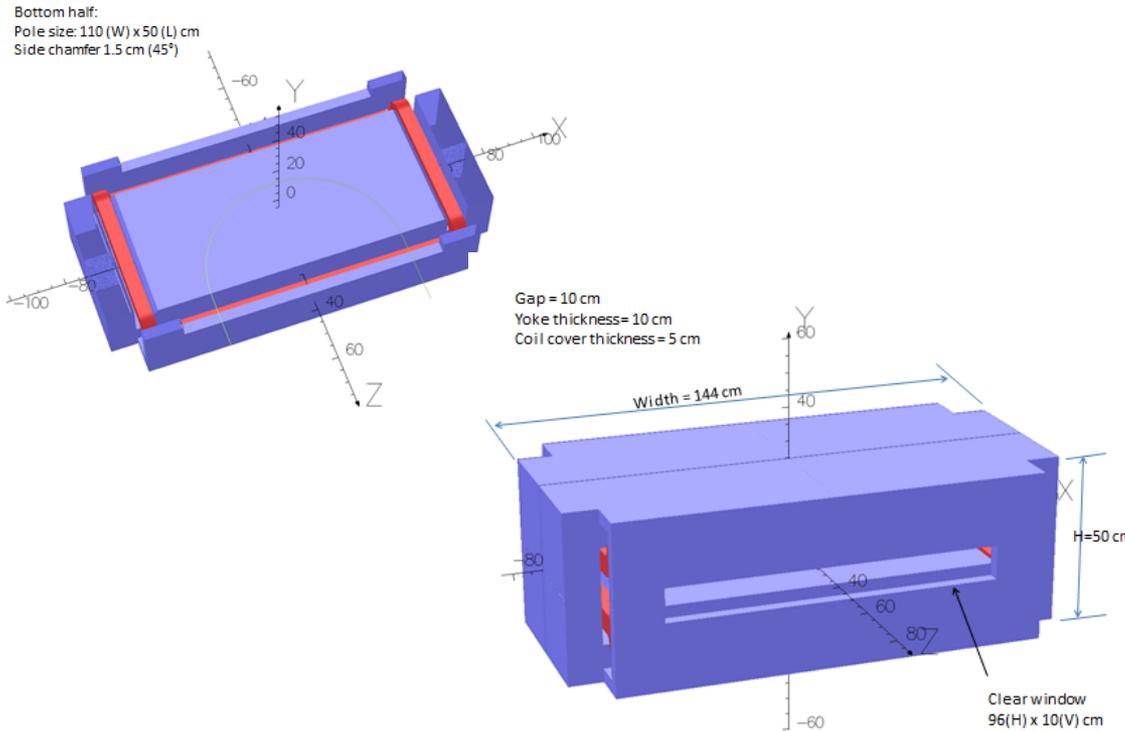


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# 180° Dipole Magnet

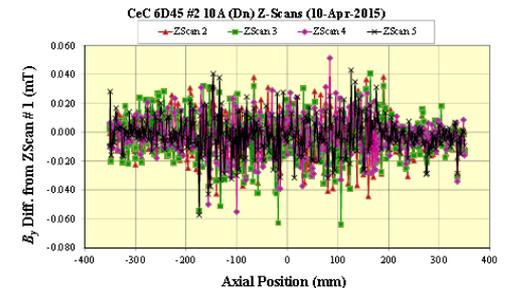
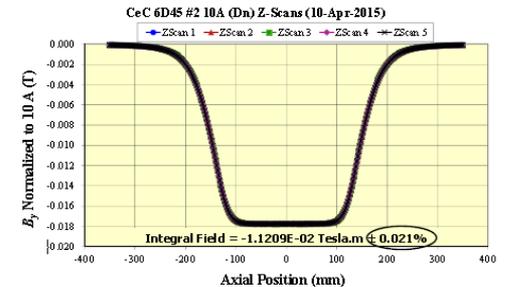
## Requisition Status

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 <sup>2</sup> ) (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°

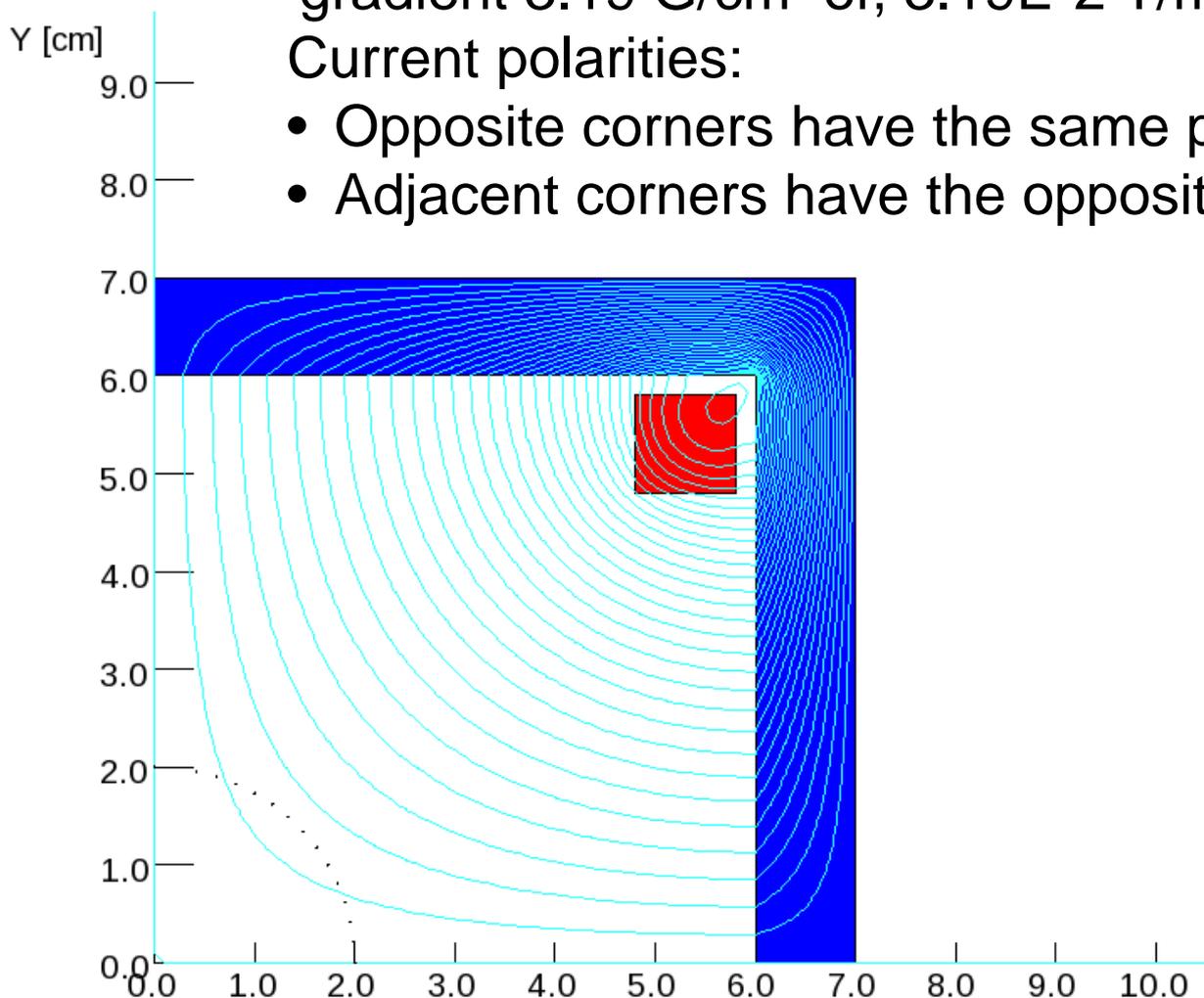


# LEReC Dipole Skew Quad Corrector

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

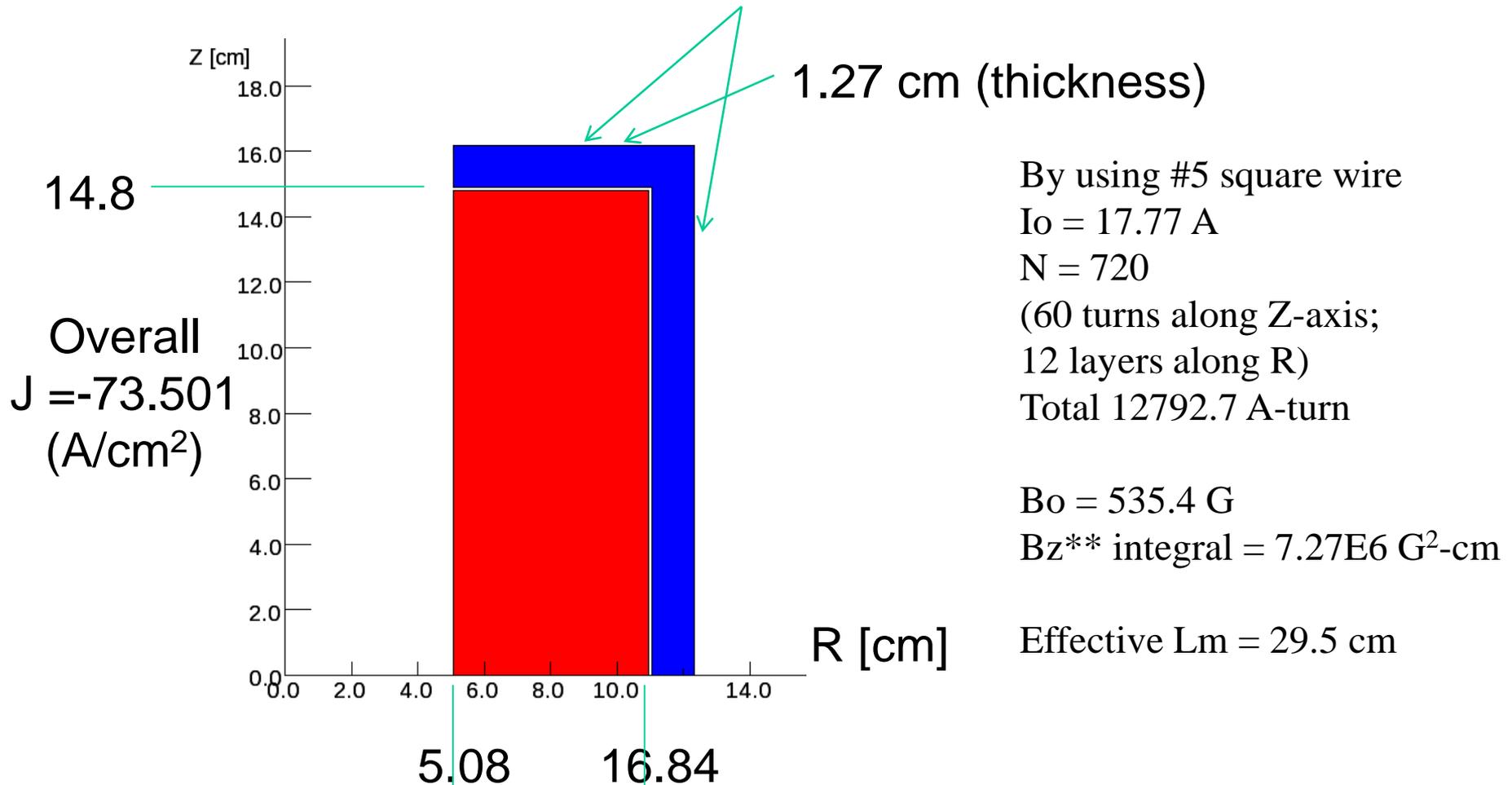
Current polarities:

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



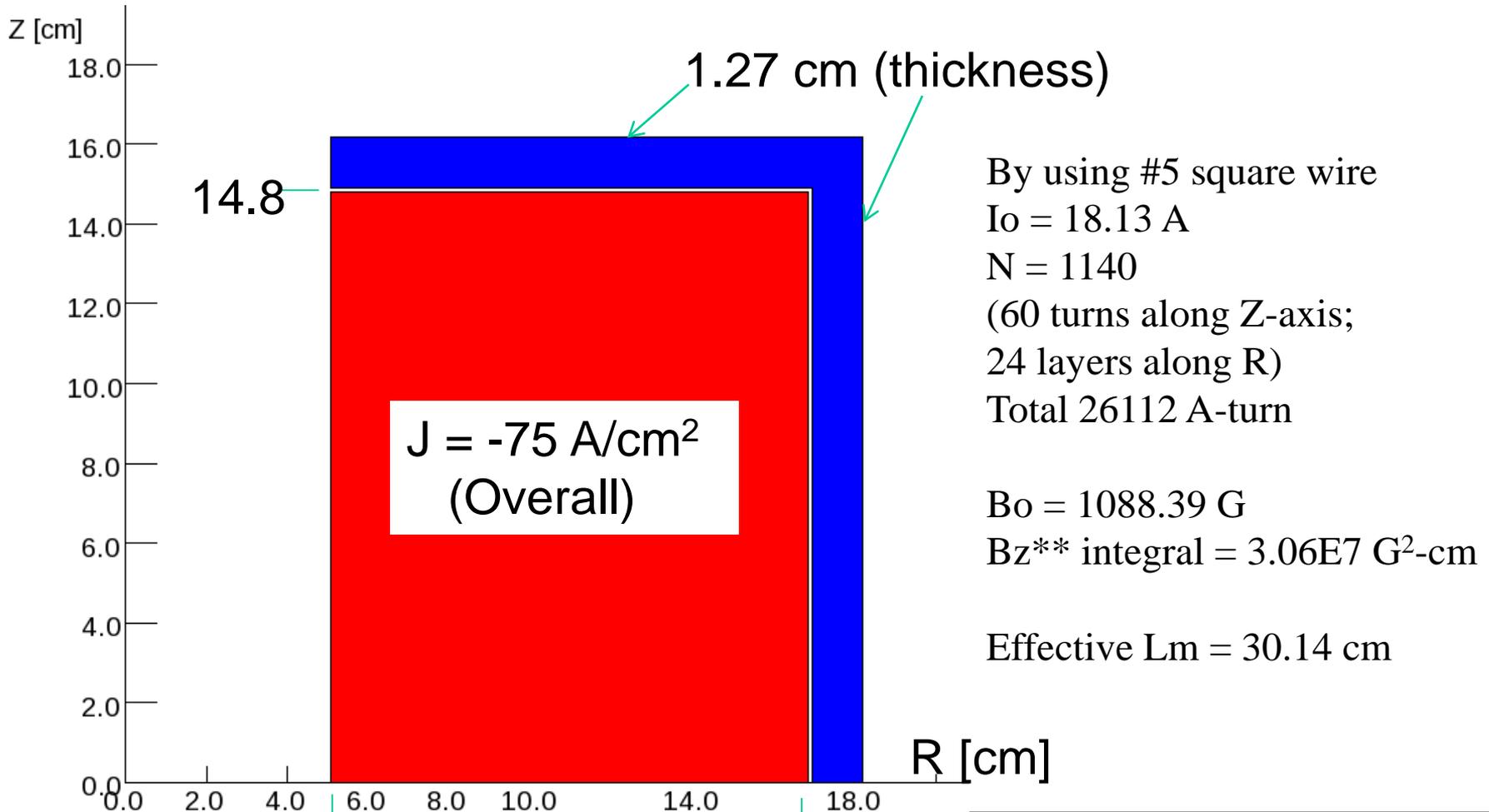
# Transport Line Matching Solenoid

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 KHIU 16.84 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](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

