1. For the matching energy of electron and ion beams methods for electron energy measurement were discussed.
   - Recombination Monitor: Overlap of electron and ion beams detected by X-rays serve to maximize X-ray production. The detection of X-ray in the area of RF shielded bellows (could be Ti or Al bellows) to be reviewed by P. Thieberger. At this time there would be 4 monitors in each line (B & Y). The detector would be a scintillator/PMT. The scintillator will be outside beam pipe and under the Mu metal. Monitor could be installed within 11 cm of face of LF solenoid (not used for cooling). If the bellows location is not acceptable, it would require a special, thin wall beam pipe design (Dave G. prefers aluminum).
   - Use of spectrometer in dog leg in beam line, either electron transport injection line or after the 180° dipole.
2. Cooling Section:
   - Cooling Section beam pipe: Uses standard 5“ RHIC beam pipe (4.7” ID), except that the beam pipe between the 21° dipole and the adjacent LF solenoid will be 4”. A 4 to 5 transition will be after LF solenoid.
   - LF Solenoids:
     - There are currently 7 LF solenoids in each cooling beam line (14 total, B & Y).
     - Specification and drawings almost complete.

- HF Solenoids/Correctors:
  - There is now 1 Matching HF solenoid in each cooling beam line (B & Y); the second HF solenoid has been eliminated. The HF solenoids have H & V correctors.
  - Joe T asked whether HF aperture can be reduced. Jorge will check if this is possible.
  - Correctors installed in HF solenoids to have 10 times the number of turns as LF solenoids. (Correctors can also be longer with HF solenoids).
- Instrumentation:
  - BPM's:
    - There are 8 in each cooling beam pipe, B & Y (16 total). Animesh of MD to be asked about magnetic measurements on BPM.
    - The beam pipe diameter in cooling section will be standard RHIC size - 4.7" ID. Joe asked whether smaller BPM's can be installed in cooling section. (Meeting on 12/10 - Toby prefers 4" for BPM. This would require adapters. Not resolved. The BPMs will be installed next to the LF solenoids, not inside, with cable for BPM to be near solenoid (MB)).
  - Flying Wire PM: Plan to install in dog leg beyond 180 dipole, not in cooling section.

3. Electron Beam Transport Line – Injection and extraction:
   - 20° Dipoles:
     - 4 magnets to be acquired for electron transport into/out of cooling section. These dipoles will have 4” gap.
     - Design of vacuum chamber for 20° dipole: Can a large open chamber be used here? Are there RF issues, beam impedances, or shielding of electron beam requirements? M. Blaskiewicz to consider.
     - Magnet will have to be disassembled for bake-out. Chambers to be supported separately from magnet.
   - RF shielded valves (2”) to be ordered.
4. Power Supplies:
   - PS accuracy for 180° dipole needs to be discussed with R. Lambiase.

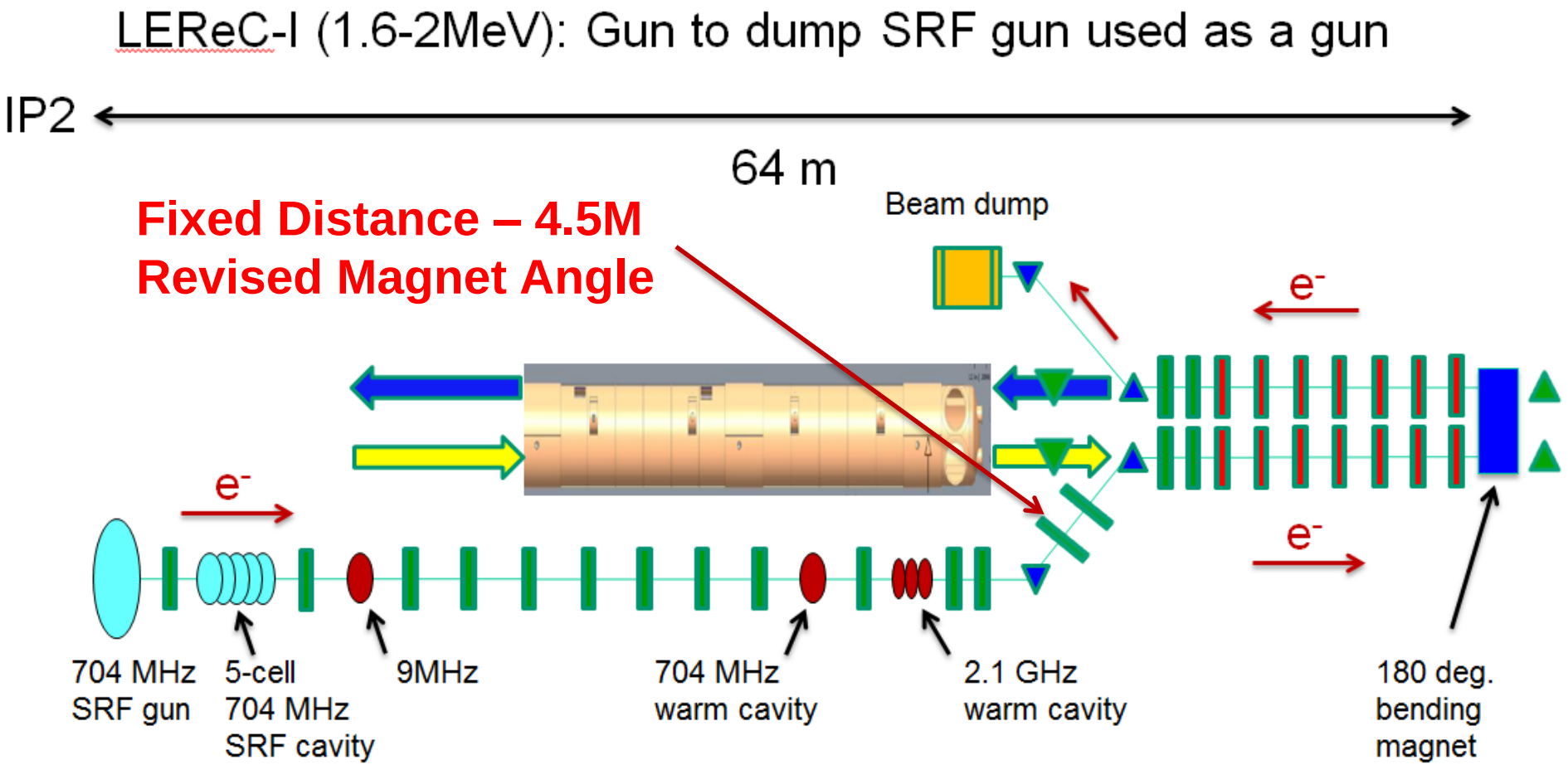
1. For the matching energy of electron and ion beams methods for electron energy measurement were discussed. Absolute energy of both beams must be known to within 10^{-2}.
   - Measure beam position in 180° dipole. This is unlikely to be able to determine 10^{-4} radial position resolution (MB). Discussion on PS accuracy.
   - Inverse Compton scattering with IR laser (JT to consult Vladimir).
   - Overlap of electron and ion beams detected by X-rays - maximize X-ray production. The detection of X-ray in the area of thin wall bellows was discussed (could be Ti or Al bellows) or it would require a special beam pipe design with thin radial window surface (Xmas tree beam tube design). The detector would be a scintillator/PMT (PT). Special thin wall chamber being considered but not in baseline.
   - Use of spectrometer in dog leg in beam line, either electron transport injection line or after the 180° dipole. In the risk list??
   - There should be a backup for measuring energy of both beams simultaneously (MM).
   - RHIC ion beam energy is measured at 10^{-3} accuracy now. We need to change beam energy in steps of 10^{-4} (WF).

2. Cooling Section:
   - LF Solenoids:
     - Joe T. plans to order an extra solenoid to perform a test of the fringe field entering the beam tube and evaluating the beam tube shielding. In the cost estimate.

- HF Solenoids/Correctors: Major revisions discussed today
  - Alexei said that these solenoids can be larger (longer in beam axis direction).
  - Correctors installed in HF solenoids to have 10 times the number of turns as LF solenoids (correctors can now be longer with HF solenoids).
- Instrumentation:
  - Joe said that Toby should get with Gary W. to add instrument elements to the cooling section beam line. Layout to be shown to Alexei and presented at next weeks meeting. Started
  - Flying Wire PM: Plan to install in middle of cooling section. ??
  - BPM: The beam pipe diameter in cooling section will be standard RHIC size (4.7" ID). Toby prefers 4" for BPM. This would require adapters. Not resolved. The BPMs will be installed next to the LF solenoids, not inside, with cable for BPM to be near solenoid (MB). Still 4.7" ID

3. Electron Beam Transport Line:
   - 20° Dipoles: 4 magnets will be acquired for electron transport into/out of cooling section. Apertures?

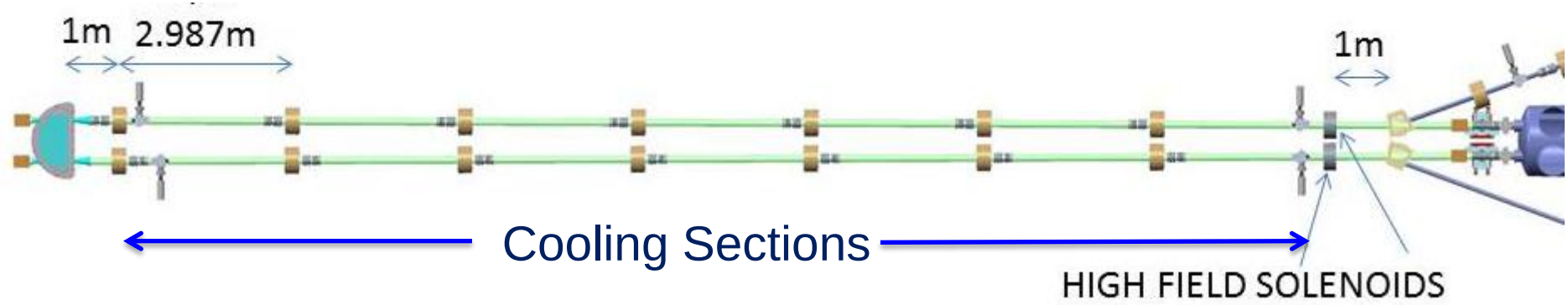
System Design Overview 1.0



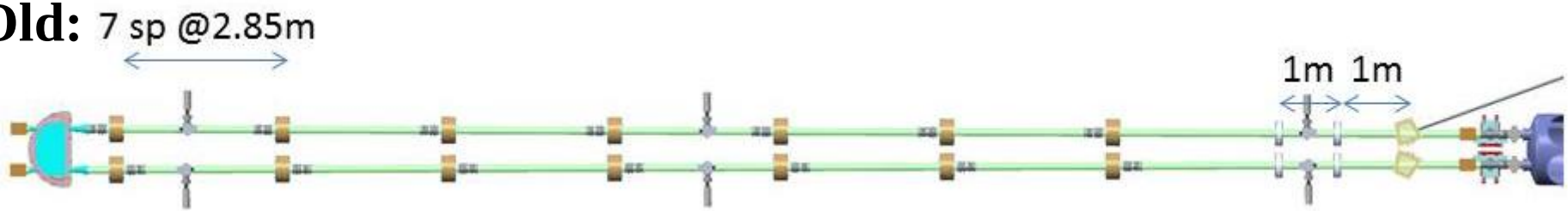
Revised Cooling Sections

Eliminate 2 of 4 high field (matching) solenoids & PS.
Keep 2 high field H & V correctors in matching solenoids (& PS)
Stretch cooling sections: same number of low field (compensating) solenoids, correctors, PS's, and BPM's.

New:



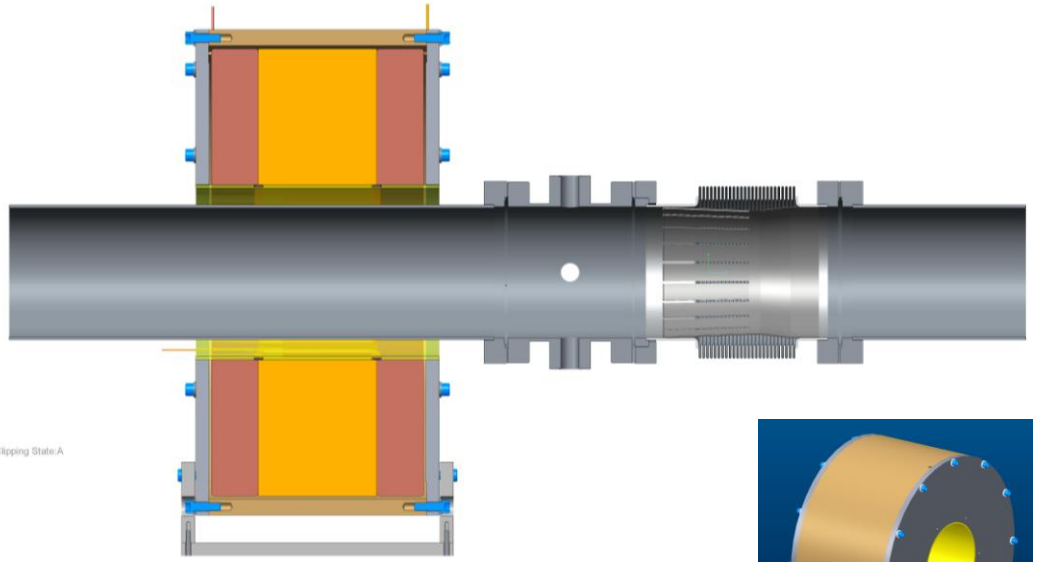
Old:

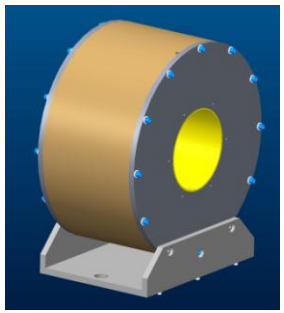


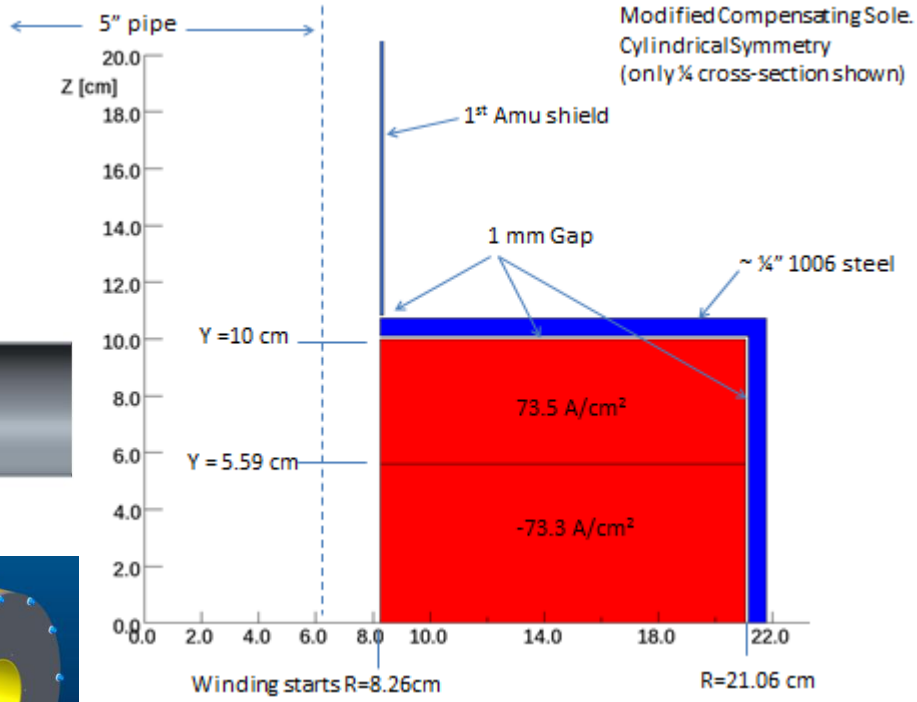
Compensating Solenoids

1. Compensating Solenoid: Presently based on W. Meng's design for 0.20kG with bucking coils.
2. From the Excel file, the Bz < 1 Gauss starts at Z = 19.7 cm., where cooling will be effective. The B**2 integral meets the required value (4E5 Gauss^2 - cm). The Bz integral is much more than 2000 Gauss-cm.

- **Backwind Center Solenoid Feed**
- **SOW in review**
- **Layout BPM, Bellows, Chamber Flange.**







Magnet and PS Specifications 10% margin

180 degree magnet — **AWG #10**

	I	V	0.499450 Ω
Before 1	9.8	25.3	5.99
Before 2	10.9	23	31.29
After	12	25.3	

Can still use BOPGL 50V 20A

12/9/2014

High Field Solenoid Core — **535 kcmil**

	I	V	0.013250 mΩ
Before 1	250	5.4	3.31
Before 2	250	5.4	9.31
After	250	6	

16V 310A BIGEN

Low Field Solenoid Core — **AWG #10**

	I	V	0.499450 Ω
Before 1	12.1	99	7.49
Before 2	13	90	126.49
After	15	119	

Can still use 150V 22A BIGEN

Low Field Solenoid Correctors - no change — **AWG #16**

	I	V	2.008
Before	0.8	0.2	1.61
After	0.8	0.2	1.81

BiRa 20V 2A MCOR

Low Field Solenoid 2 compensating coils in series — **AWG #10**

	I	V	0.499450 Ω
Before 1	10.3	100	7.74
Before 2	13.8	71	103.74
After	15.5	96	

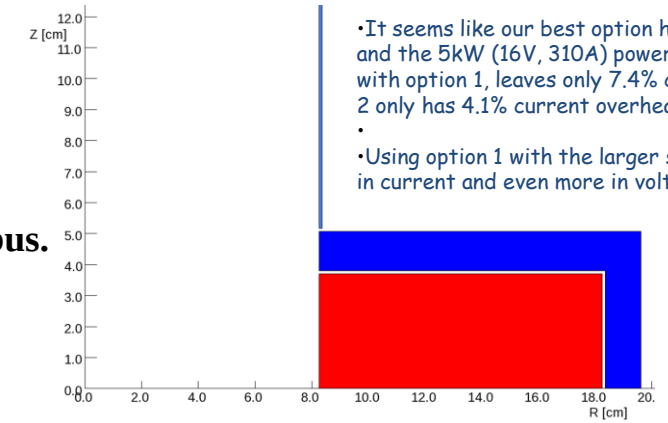
Use std Genesys 165V 20 in current mode. Precision not needed.

10% tuning margin for all

Matching Solenoids

Matching Solenoid w/corrector

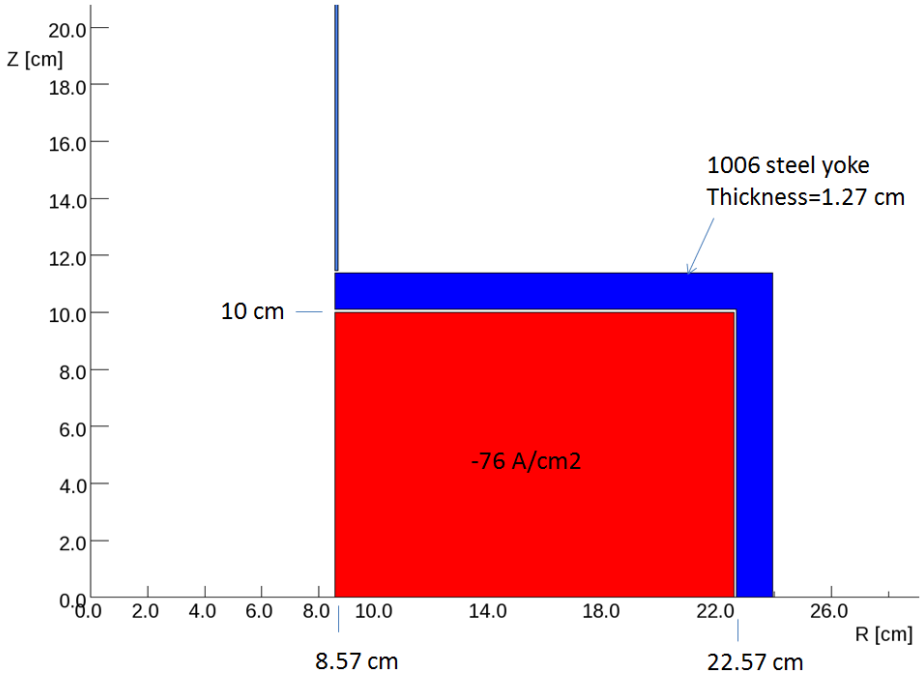
- 4 required in cooling section w/o bucking coil
- Corrector 100 Gcm, present specification.
- **Layout coil winding**
- **Can solenoid be longer or wider? w/o water cooled bus.**



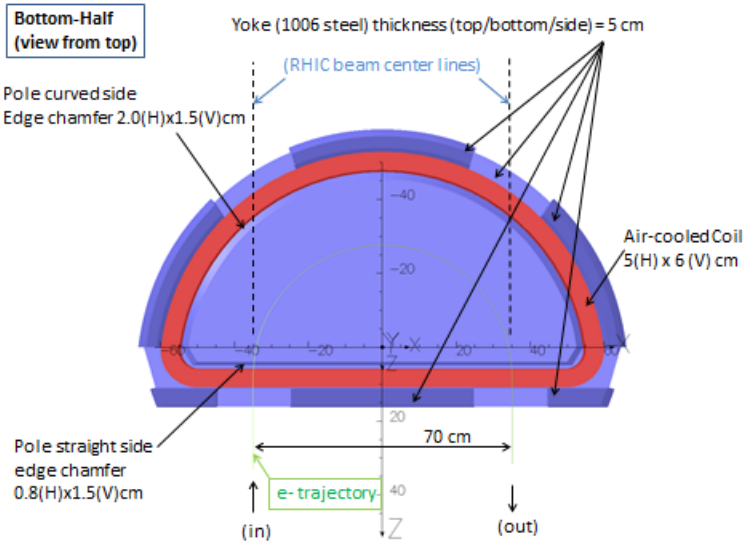
High Field Solenoid for LEReC (using solid conductor)

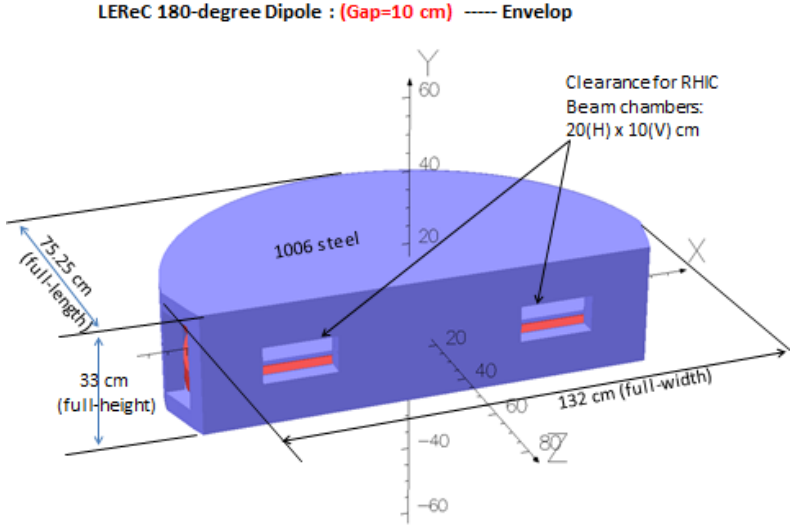
From: Meng, Wuzheng
Sent: Tuesday, December 16, 2014 10:50 AM
Subject: High Field Solenoid for LEReC

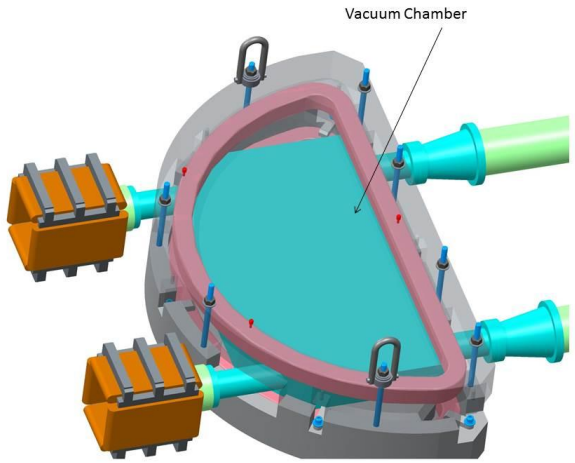
- Attached is the high field focusing solenoid design assumed to be built by using solid conductor (instead of water cooled hollow conductors).
- The Bz**2 integral meets the requirement (22500000 G^2-cm), however the central field is ~1.15 kG, lower than previous specified (1.5 kG).
- Conductor windings start from R=8.57 cm; so that we do not need to make vacuum chamber transitions.



180º Dipole Magnet







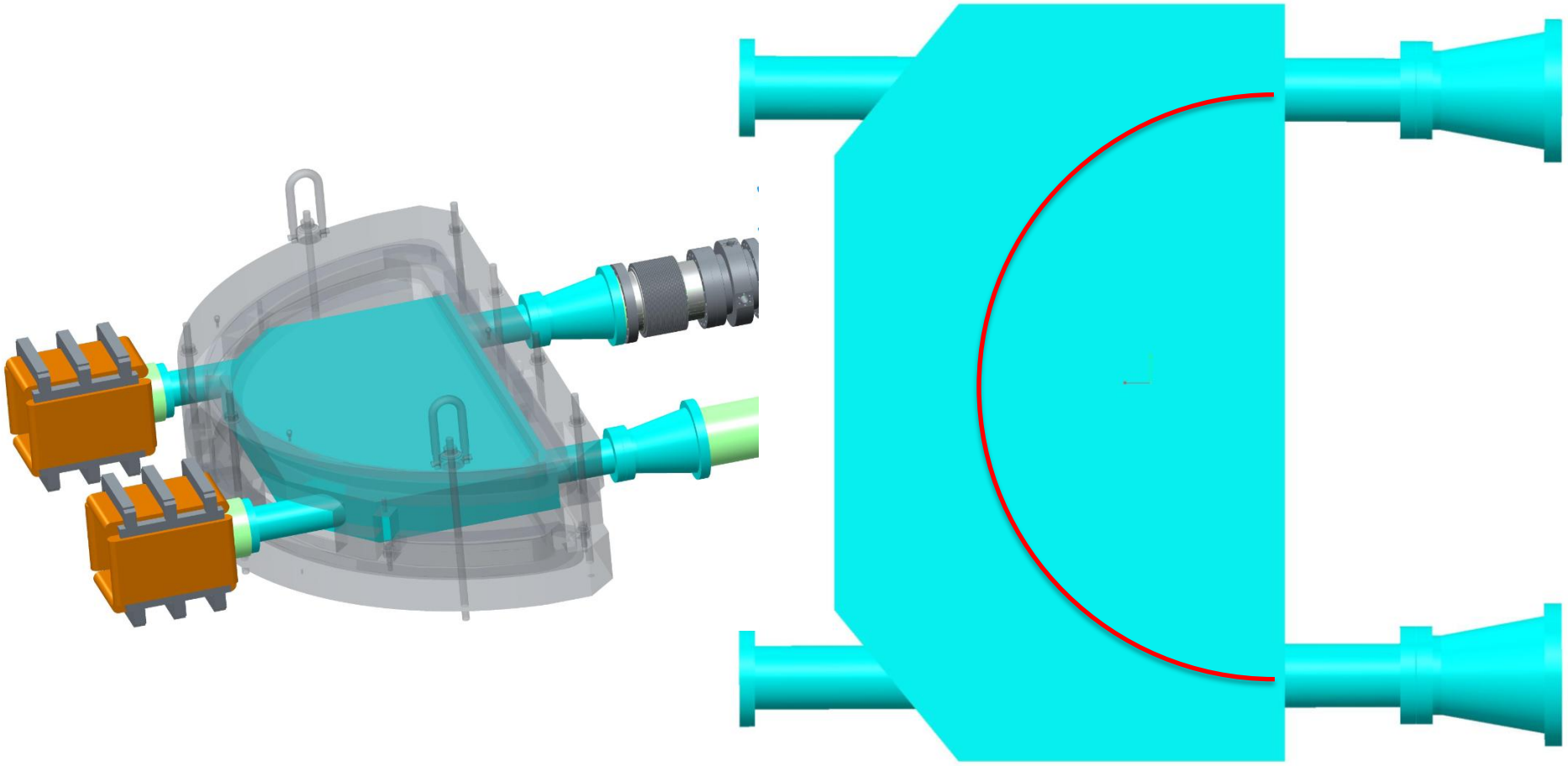
Electron tracking results and field qualities along entire trajectory on R=2 cm curved cylinder:

	Ek = 5 MeV	Ek = 1.6 MeV
Total current per coil (Ampere-turn)	2119.146	791.077
Overall current density (A/mm²) (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°

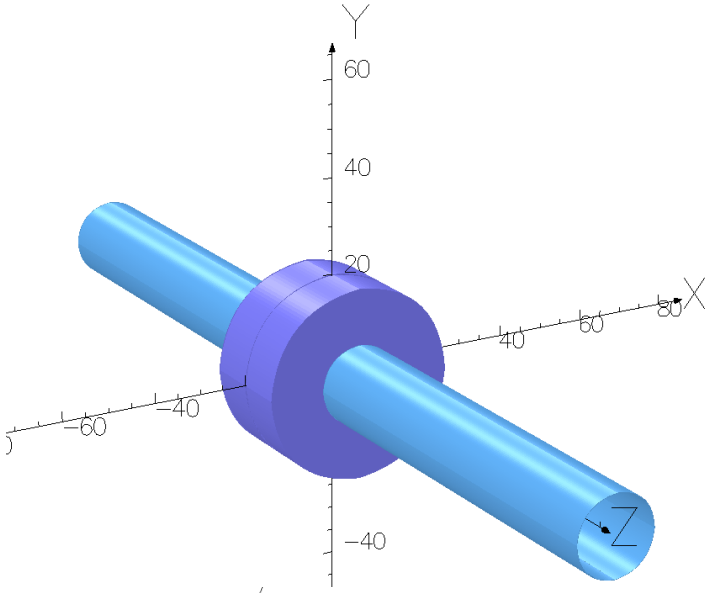
180° Dipole Magnet

Large open 180° vacuum chamber: are there beam impedance concerns? Should the electron beam path be shielded?

Similar issue for 21° chamber?

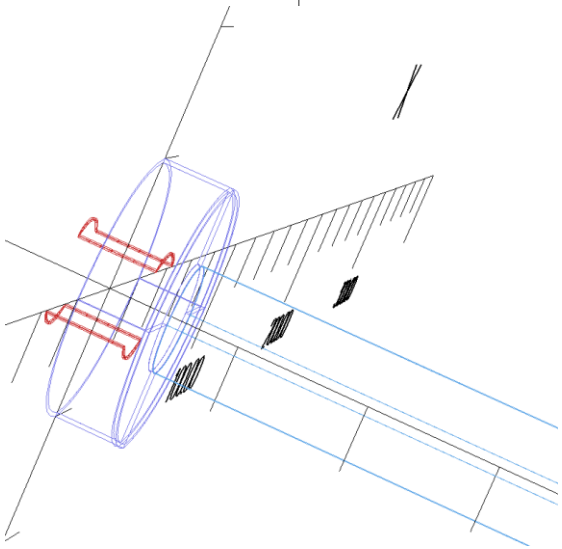


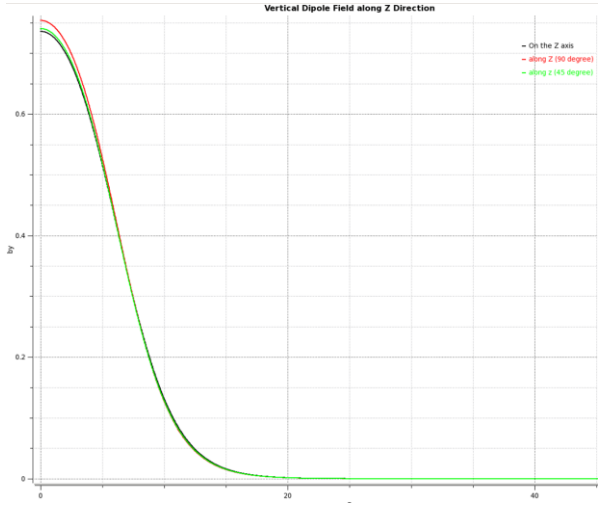
Compensating Solenoid Corrector



- **Space between correctors to locate solenoid lead? Revised.**
- **Matching Solenoid 10x field.**

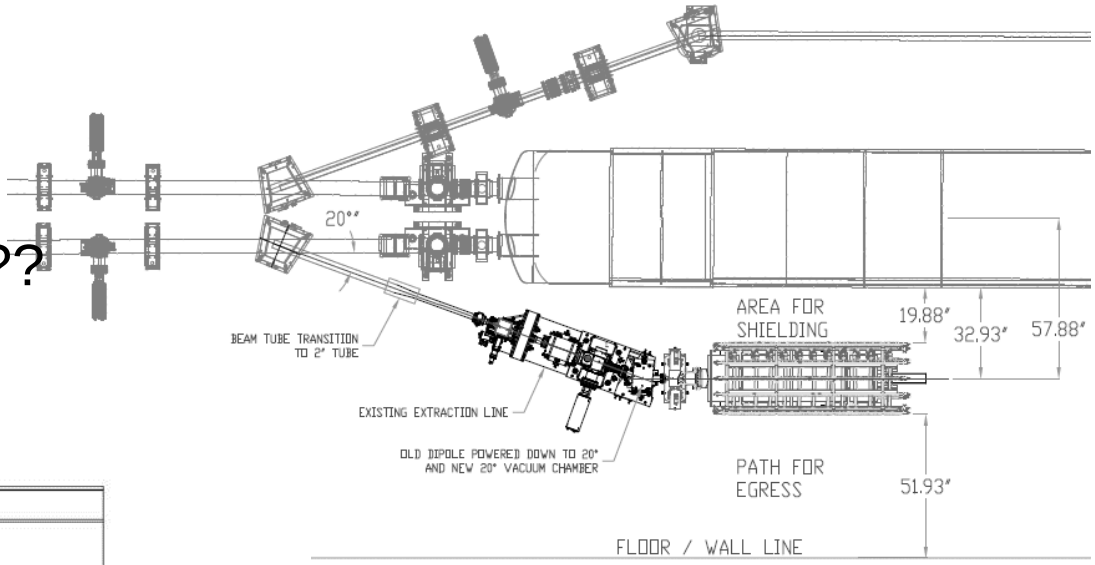
Dipole correction 10.24 A-T
Per coil; Straight section
Half-length: H1=6 cm
13 turns/.8 amps = 1 amp PS
(AWG #18 = 0.98 A/mm2)



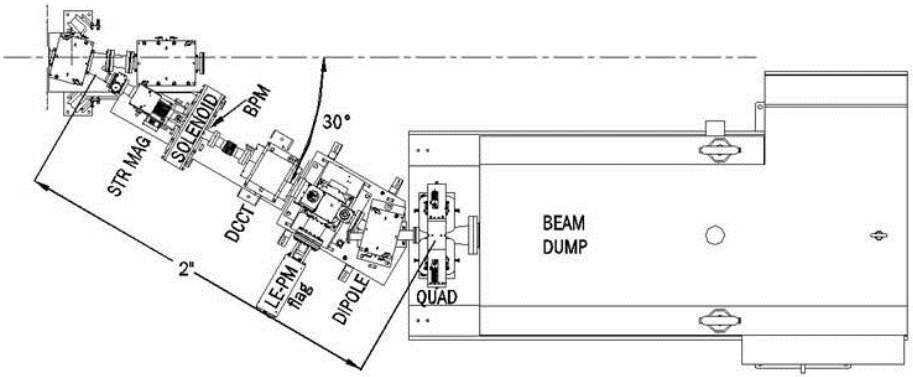


Beam Dump Line to Vacuum Valve:

(4) 20o dipoles 10 cm aperture
Or
(2) 20o dipoles 10 cm aperture
(2) 20o dipoles 6 cm aperture ??



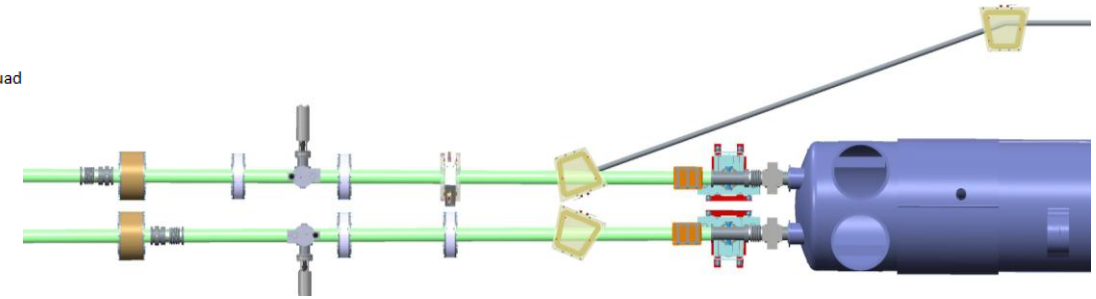
What components can we take from ERL extraction line? To be determined.



Extraction Line Components

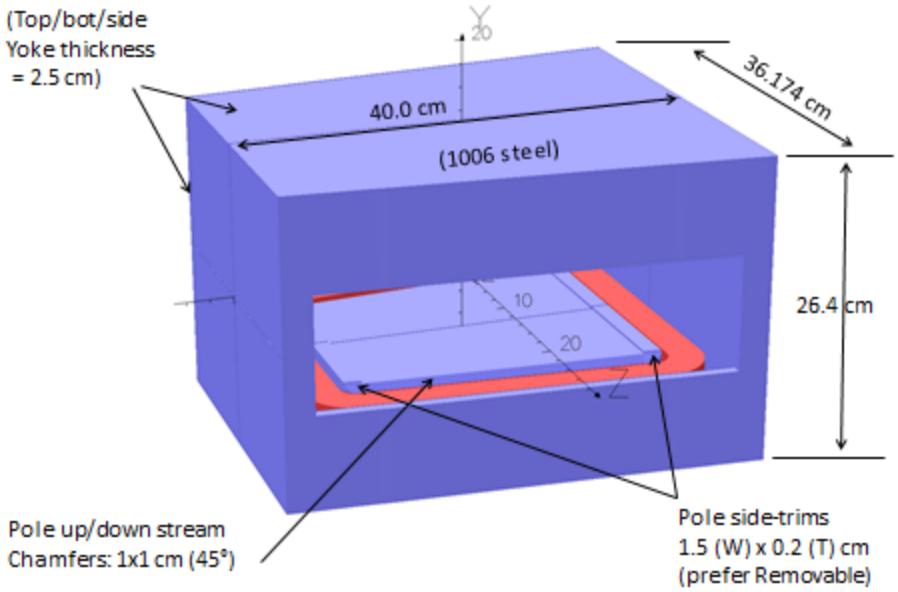
Per Alexei, LEReC aperture is 9.0cm (3.6"). ERL BD is 4.0" dia, upstream of quad is 2.0". The solenoid and quad

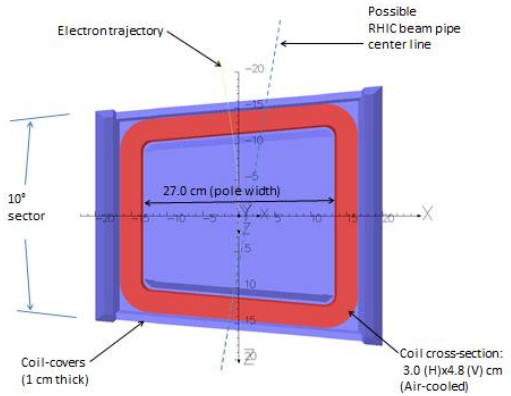
GM	Extraction Dipole - 20°w/ chamber(1)	new
GM	Steering magnet (1)	new
GM	Solenoid (1)	from ERL extraction
DG/TM	BPM (1)	new
DG/TM	DCCT (1)	new
DG/TM	Profile Monitor (1)	new
GM	Dipole magnet - 20° w/ chamber (1)	new
-	Quad (1)	from ERL extraction
MM	Bellows (2)	new



20^{o} Dipole Magnet

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



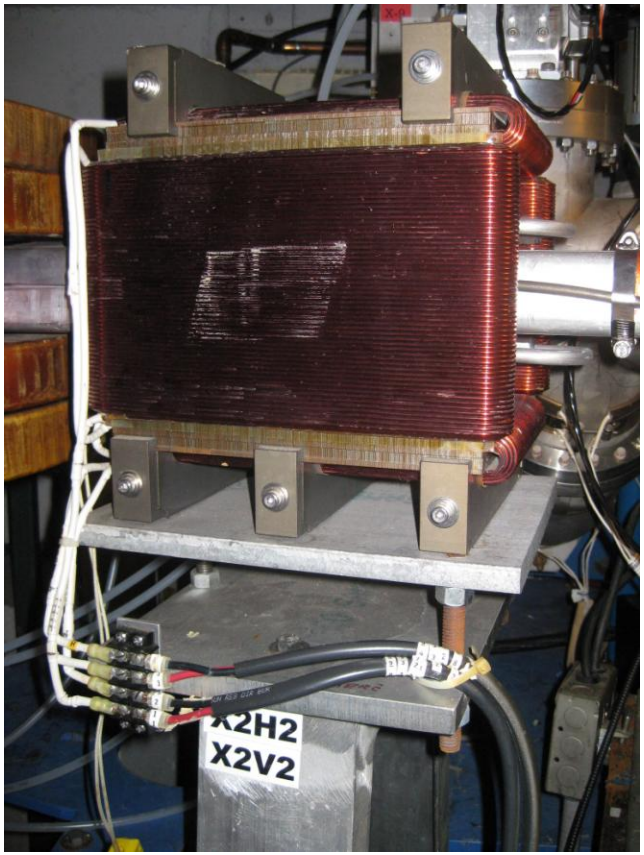


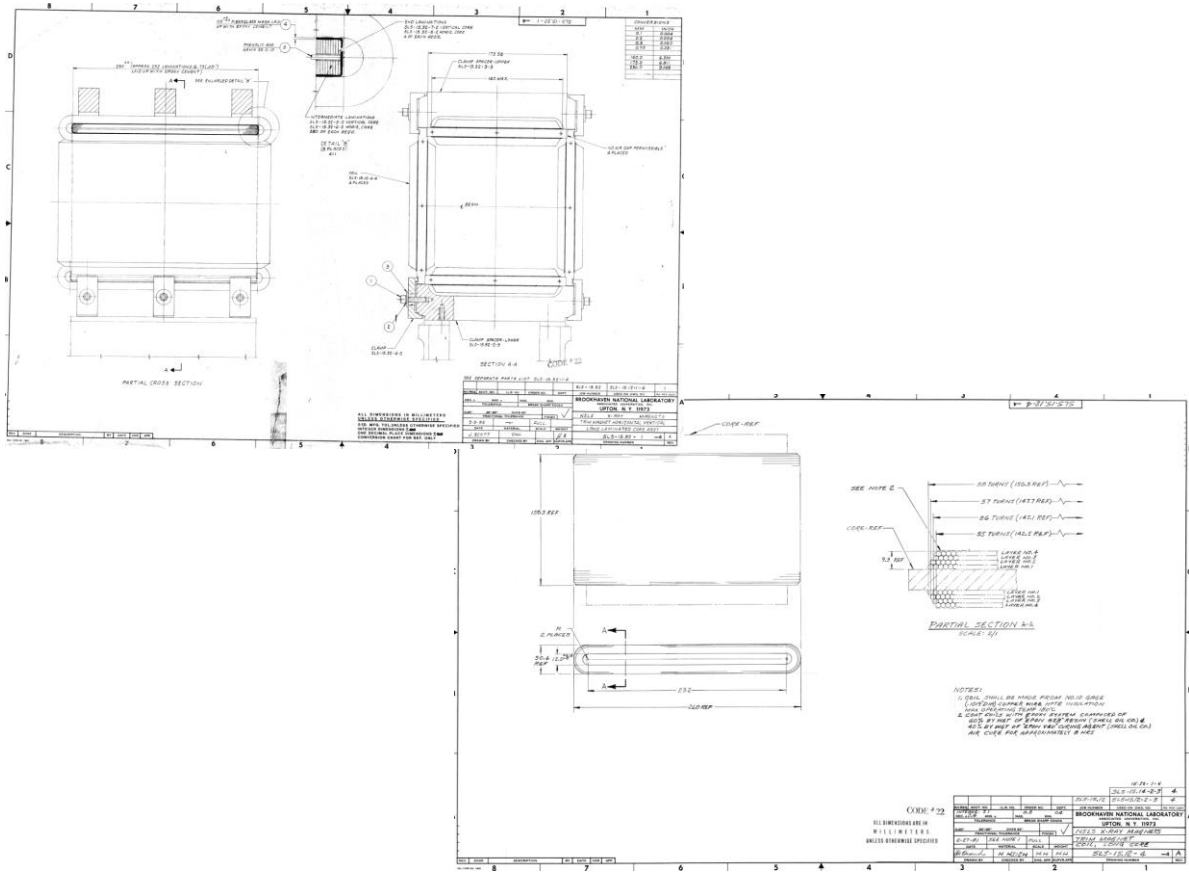
Electron tracking results and field qualities along trajectory on R=1 cm curved cylinder:

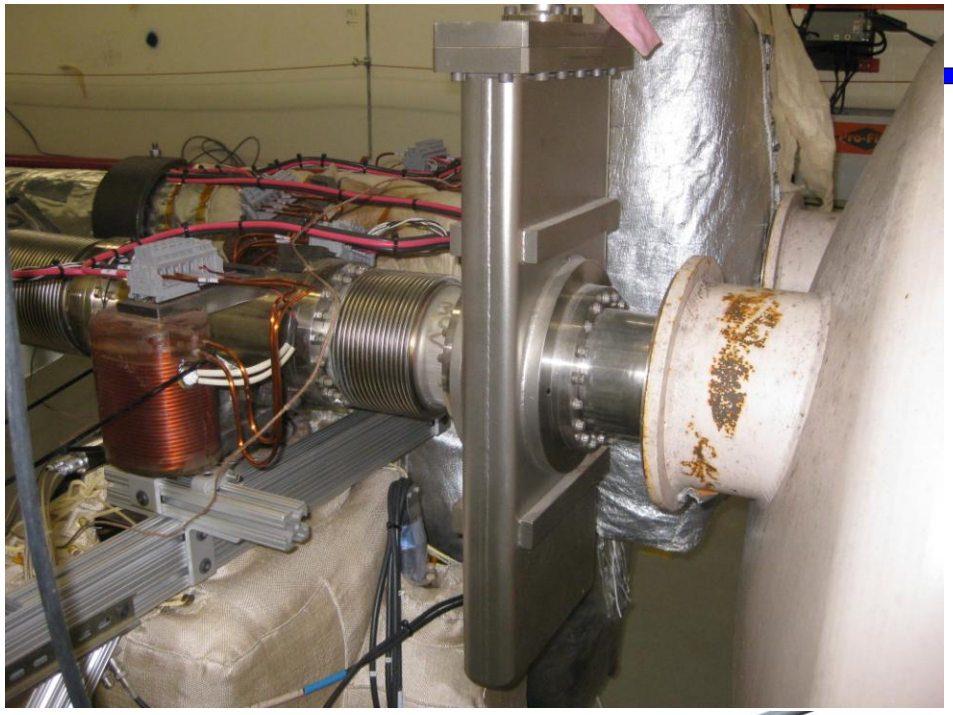
	Ek = 5 MeV	Ek = 1.6 MeV
Current per coil (Amp-turn)	1053.288	393.192
Overall current density (A/mm^2) (overall coil cross-section 3.0x4.8 cm)	0.73145	0.27305
Central Gap Field (Gauss)	251.20	93.73
Half b1-integral (dipole) (G-cm)	3.1982E3	1.1930E3
Half b3-integral (6-pole) (G-cm) [Ratio to dipole integral]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

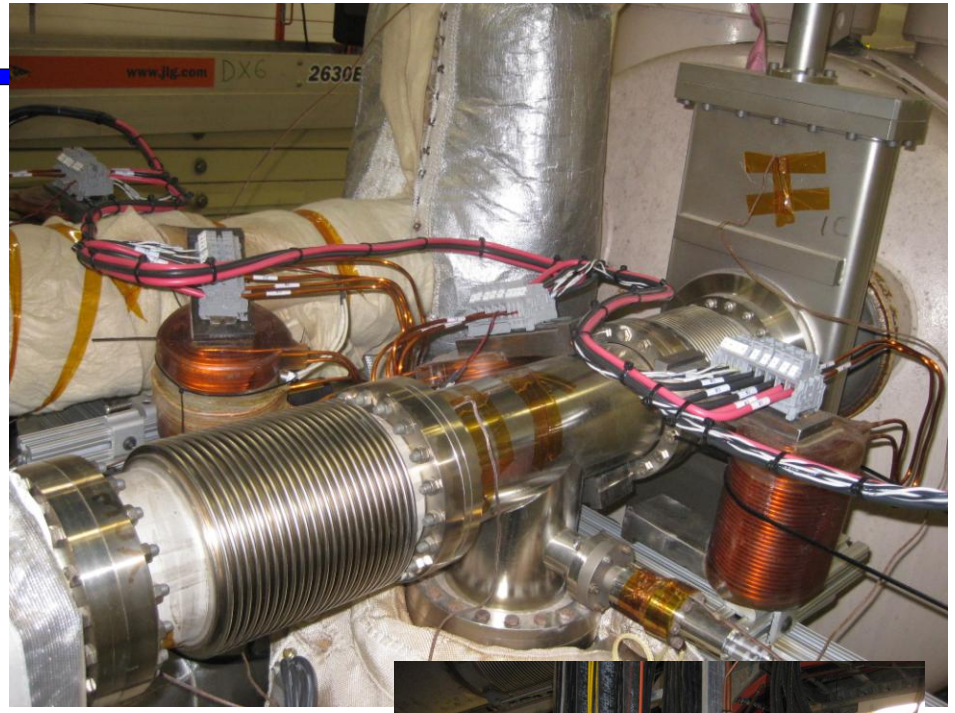
NSLS I Equipment

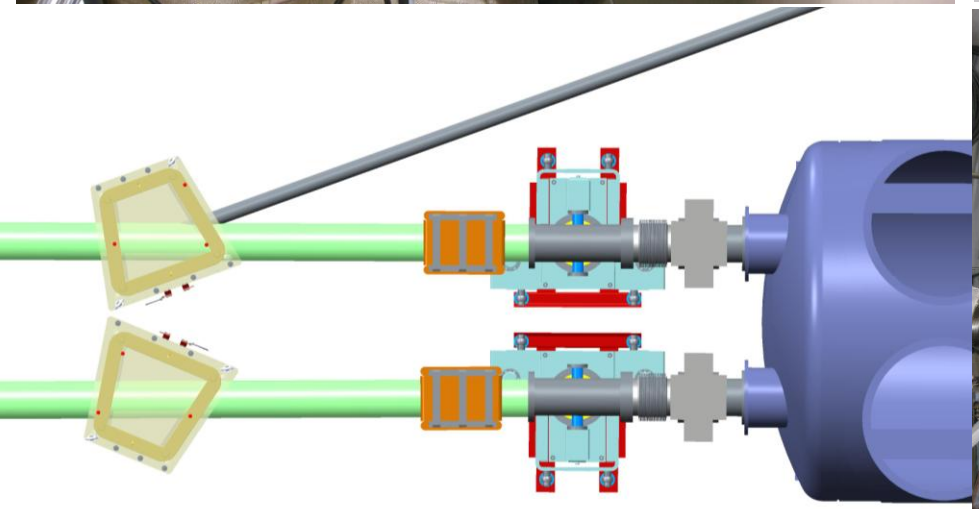
- Compensating dipole for 21^{o} e beam injection/extraction
- 375 Gcm/A
- Define Bl requirement for 21^{o} and 180^{o} compensation.

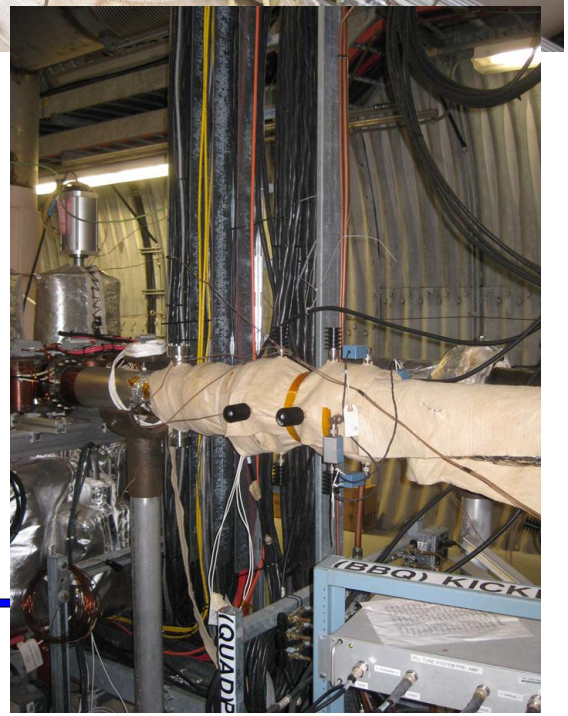








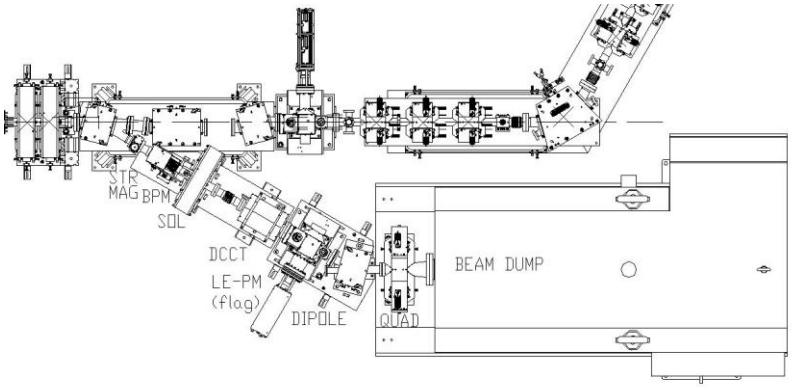


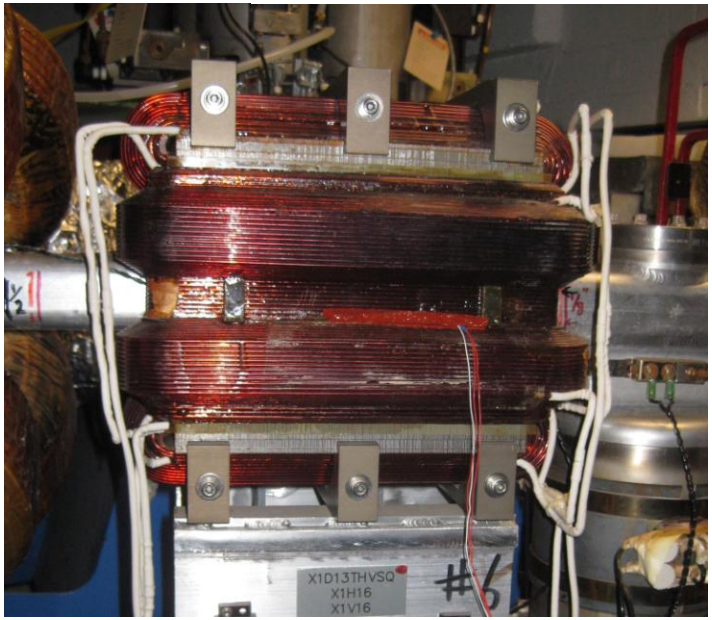


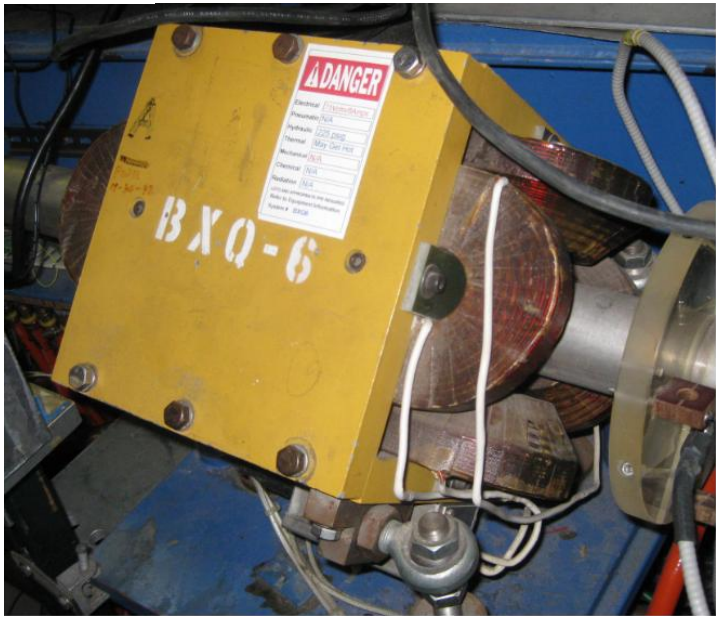
NSLS I Equipment

Beam dump line quadrupole(s)?

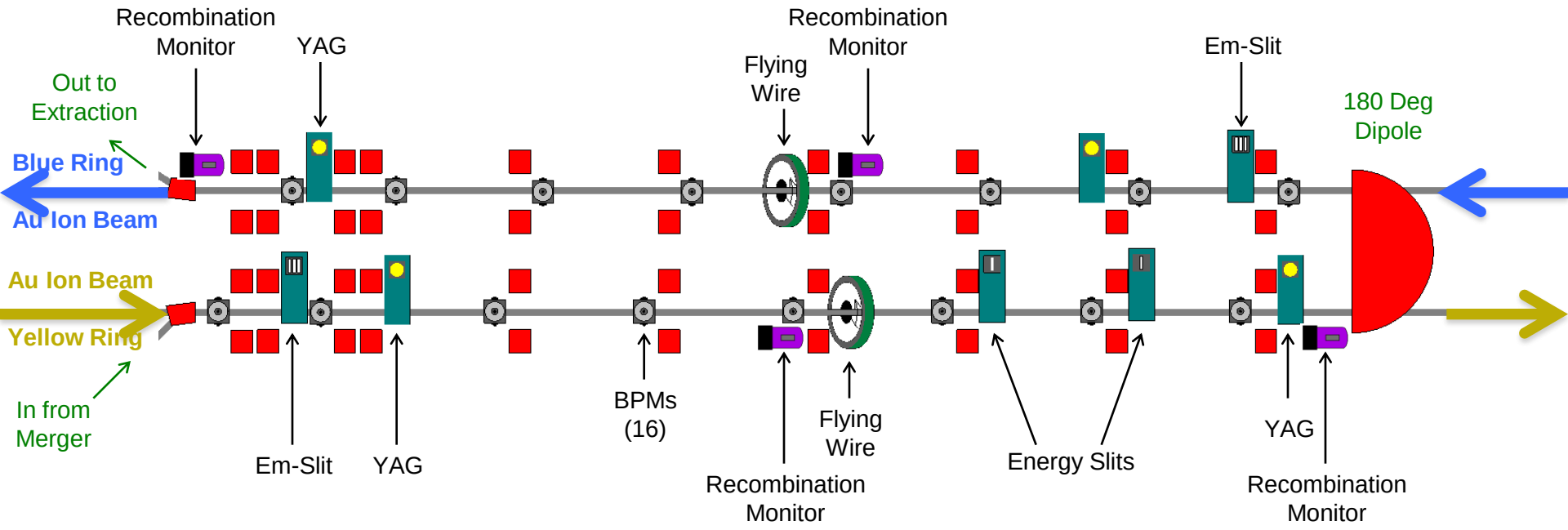
- ERL or
- NSLS I







Scope: Cooling Sections



Cooling Sections

BPM = 16

YAG = 4

Flying wire = 2

Emittance slits = 2

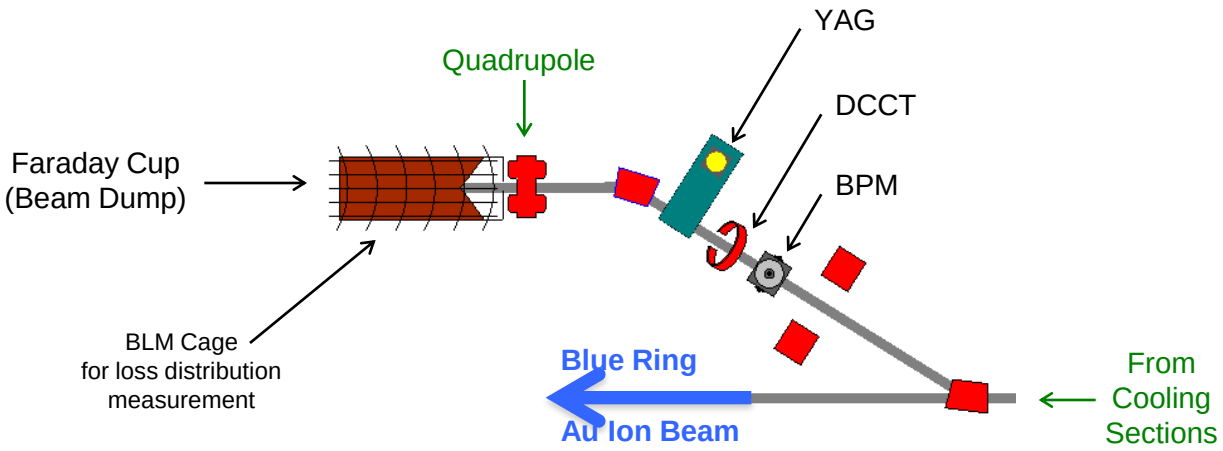
Energy Slits = 2

Recombination Mon = 4

Questions & concerns include:

- Energy Slits are 4 & 7m away from 180 deg. dipole. They can move to 4 & 1m away if one slit is built into a 3-position profile monitor. This would require a special design for the profile monitor – but this is a well known technique.
- Did we decide on 6 YAG Profile monitors AND 2 Flying Wire Scanners in the cooling section, or did the two Flying Wire Scanners replace the two middle YAG Profile Monitors?
- Do we really want the Halo Scrapers and the diagnostic beam line after the 5-Cell or should they be after the SRF Gun?
- Are all solenoids in the transport spaced 3m apart?

Scope: Extraction



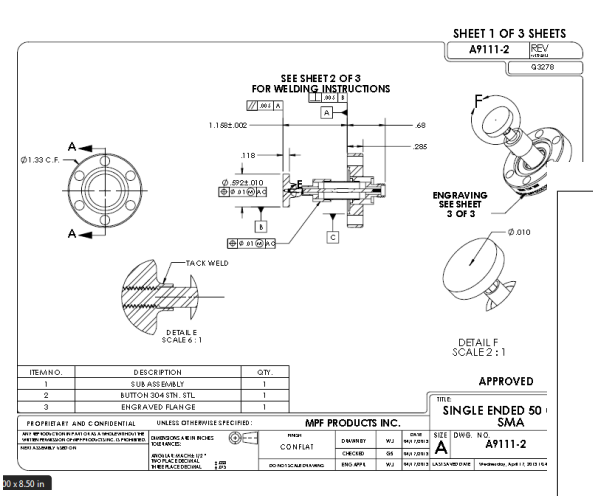
Extraction

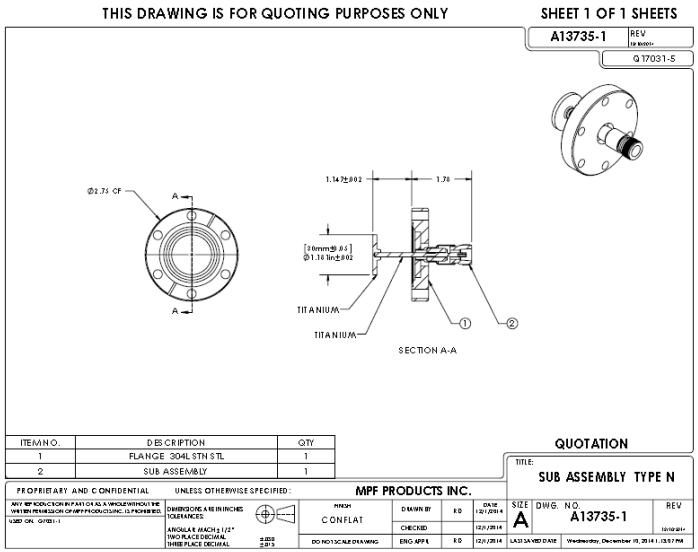
BPM = 1

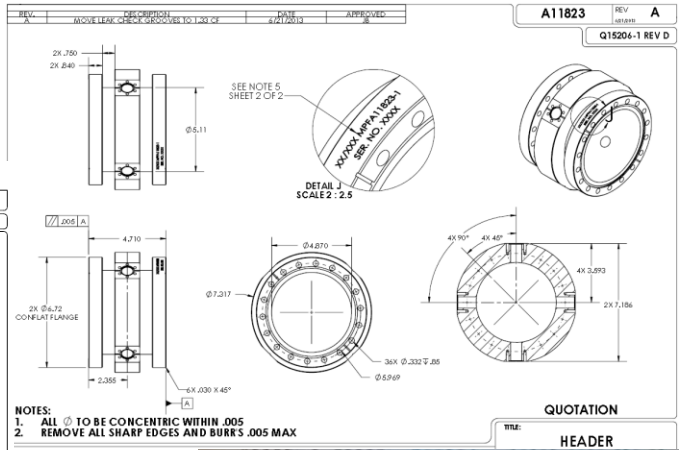
YAG = 1

DCCT = 1

Cooling Section BPM's

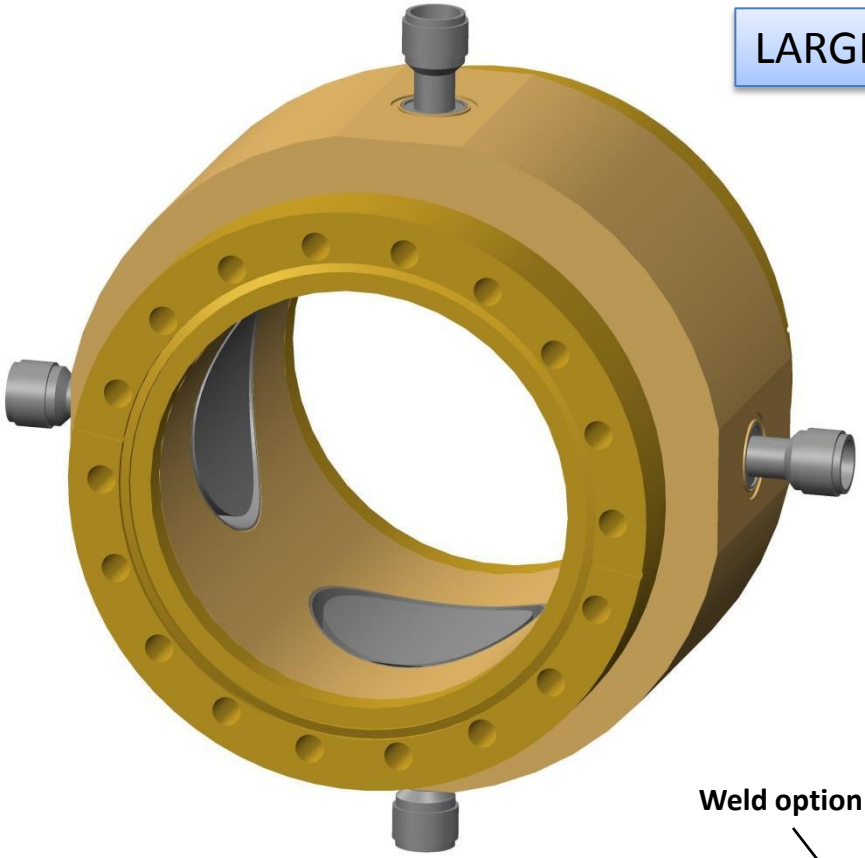


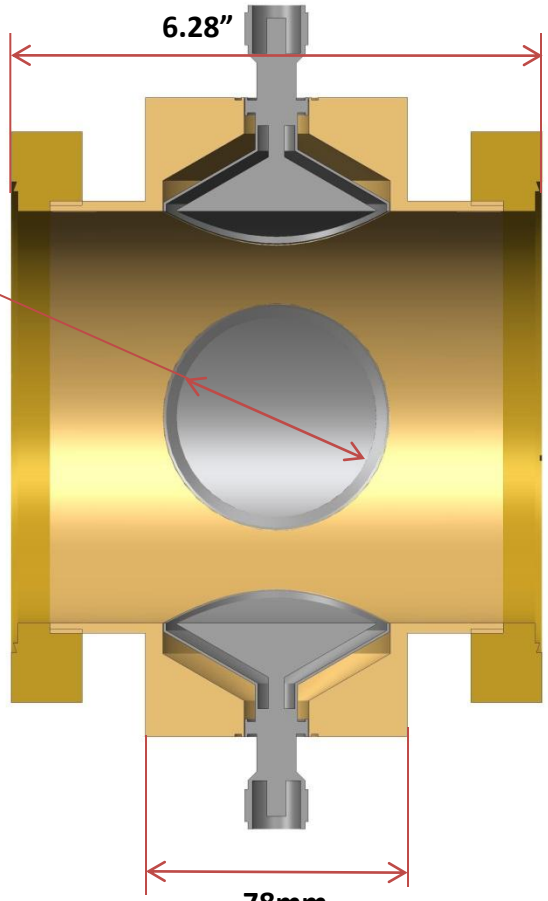


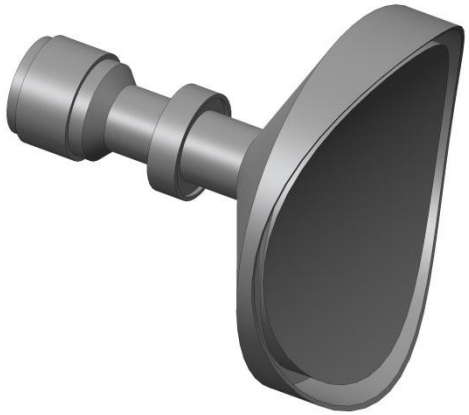


- Phone conference with MPF
- Larger diameter buttons on pick-up – 27 to 30 mm diameter
- Machined vacuum chamber, 304L, no threaded holes on flanges.
- Button hole size TBD microwave studio (D. Gassner).

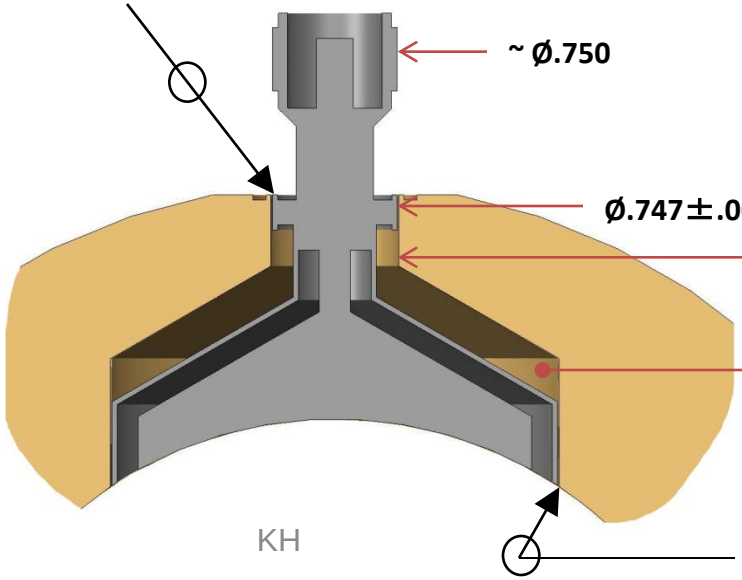
LARGE BUTTON BPM







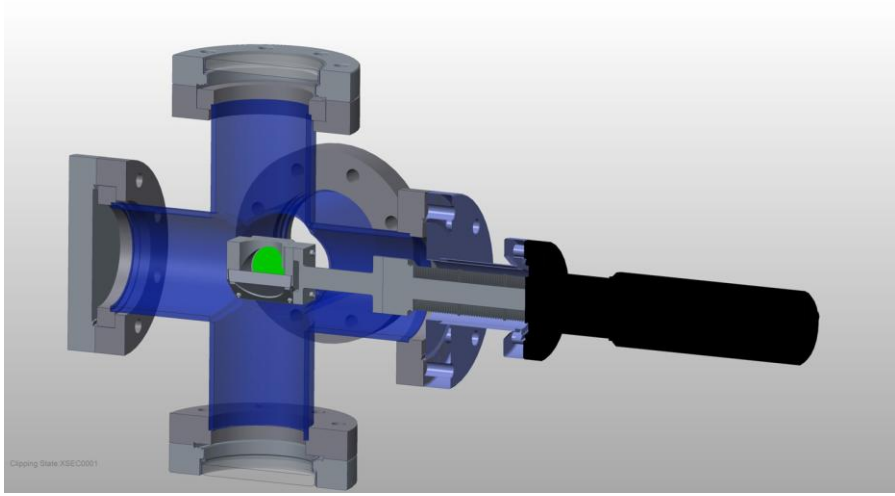
50 Ω HN CONNECTOR
With button and shield

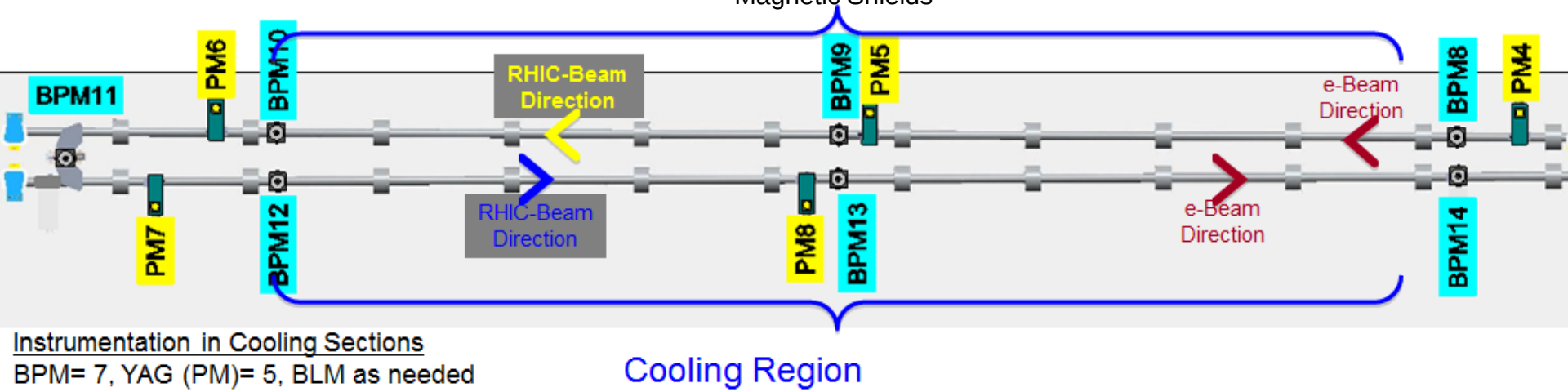


KH

Vacuum Chamber/System Requirements:

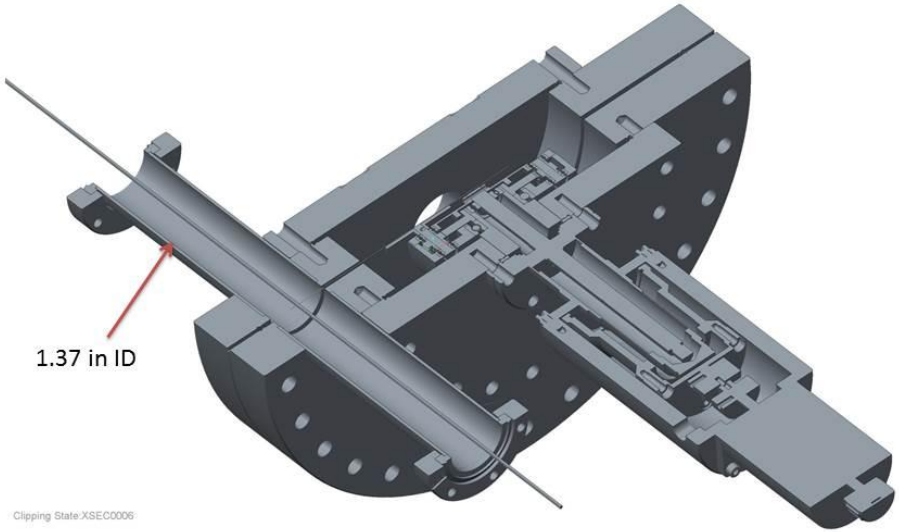
- 5” (12.7 cm) OD vacuum chamber, bake-out temperature.
- No ion pump tees in the cooling section.
- One RHIC shielded bellows per solenoid
- Transitions to 10 cm aperture dipole magnets.
- Dipole magnet vacuum chambers.
- 6 Profile Monitors, screen size??





Instrumentation in Cooling Sections
BPM= 7, YAG (PM)= 5, BLM as needed

Cooling Region



Flying Wire PM