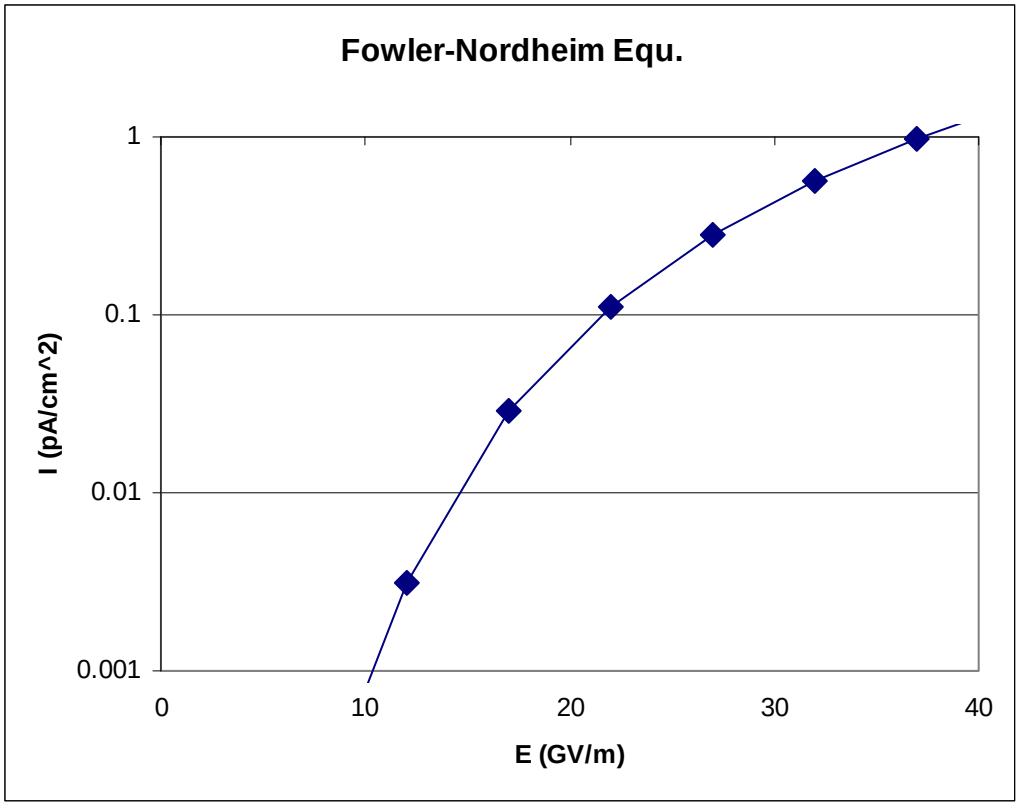
Electric and Magnetic Fields

W. Morse

BNL

FN Field Emission Current vs. E



Recent Progress from LC/ERL R&D (5mm gap tests) Cornell/JLab

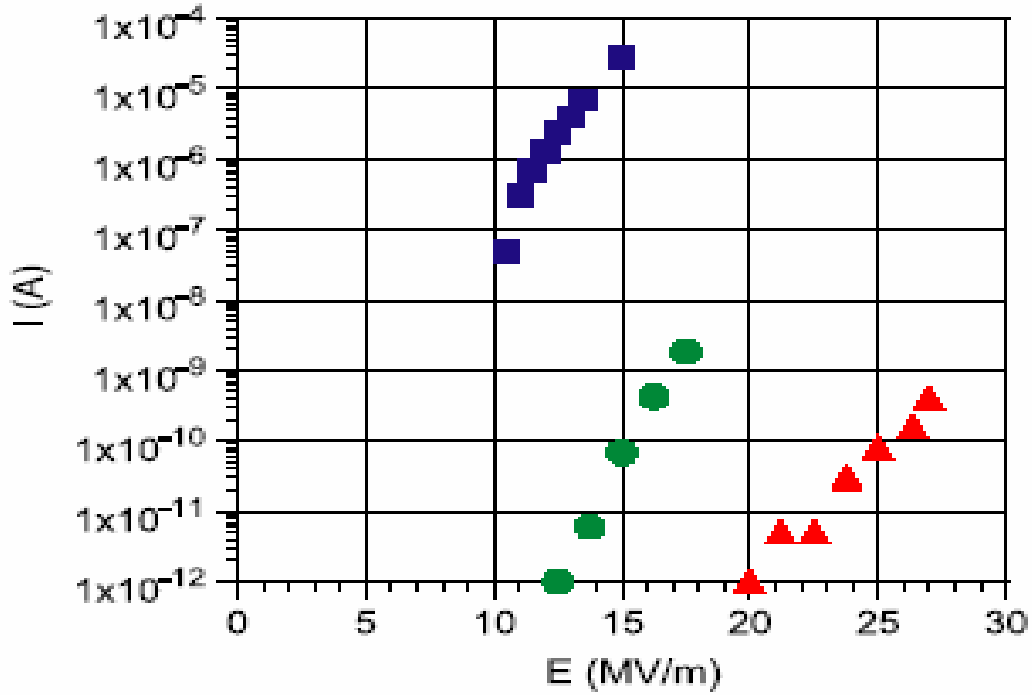
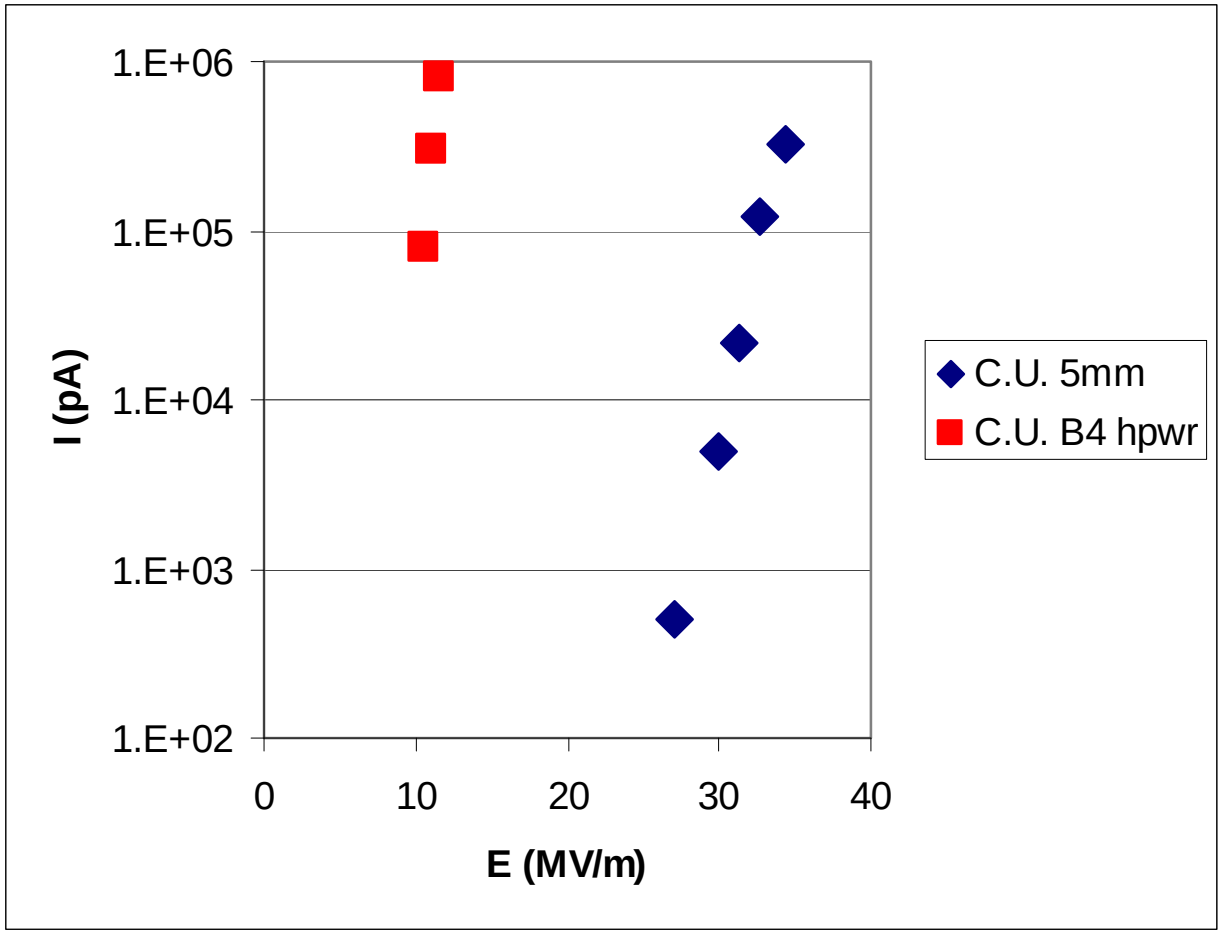


Fig. 4. Field emission current as a function of applied gradient for a 150-mm-diameter stainless steel electrodes: (squares) a typical untreated sample, (circles) first measurement of GCIB treated sample, (triangles) re-measurement of GCIB treated sample after high-voltage conditioning [14].

High Pressure Water Rinsing



Gap Spacing - 1990

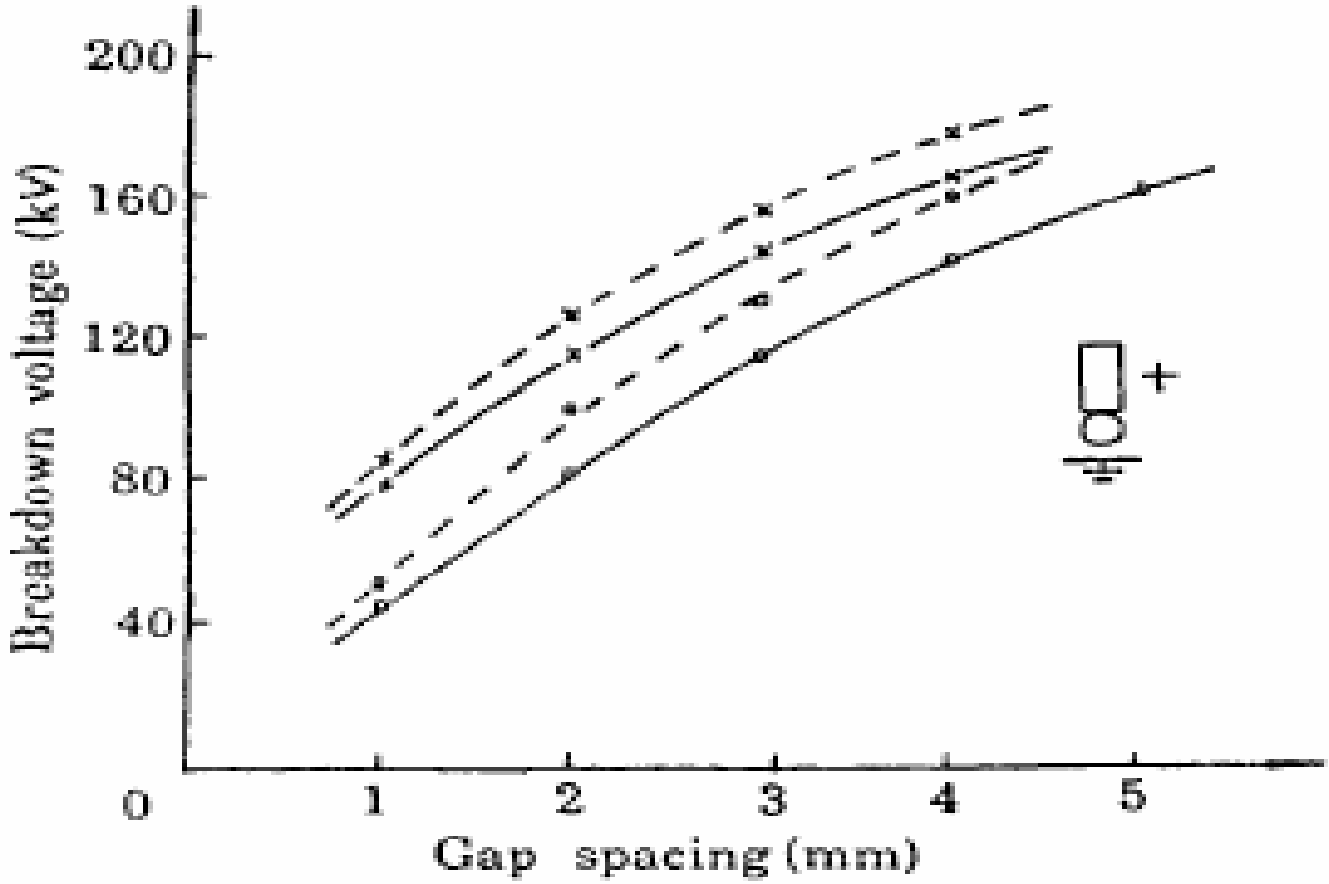
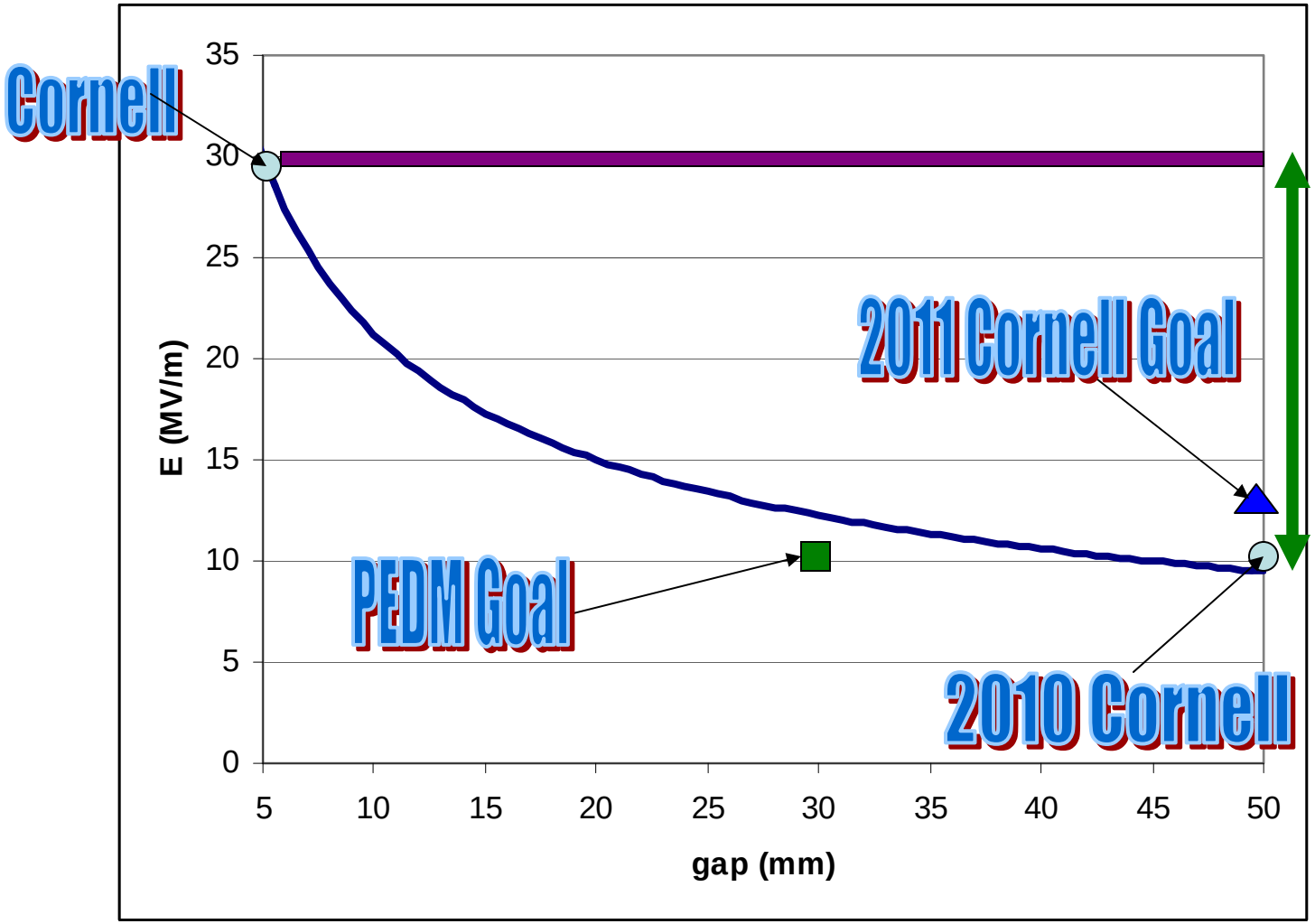


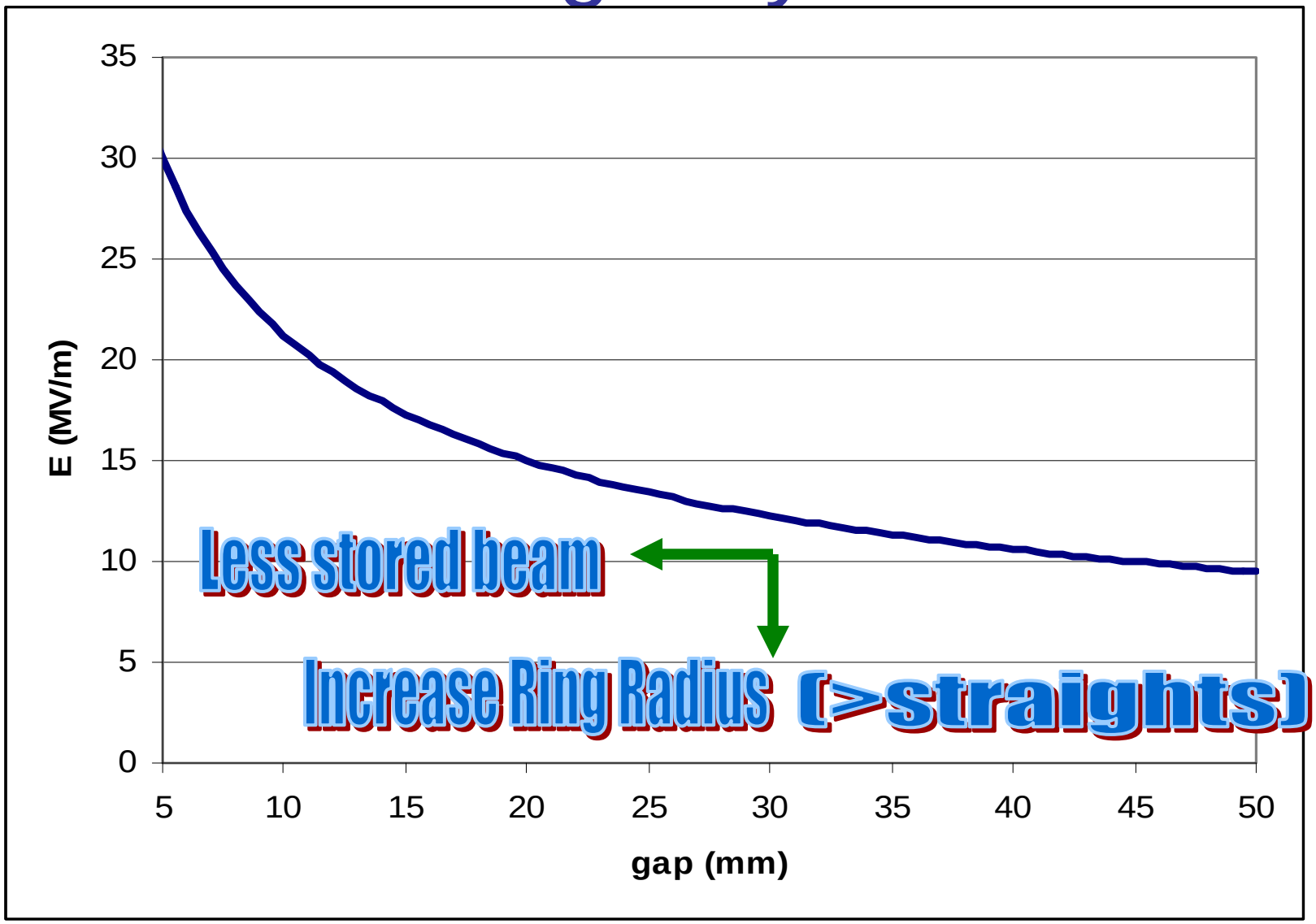
Figure 5.

Positive dc breakdown voltage vs. gap spacing.
o o o: Aluminum, × × ×: stainless steel.
—— : room temperature, - - -: cooled by liquid N_2.

How to Scale HPWR to 3cm gap?



Contingency Plan

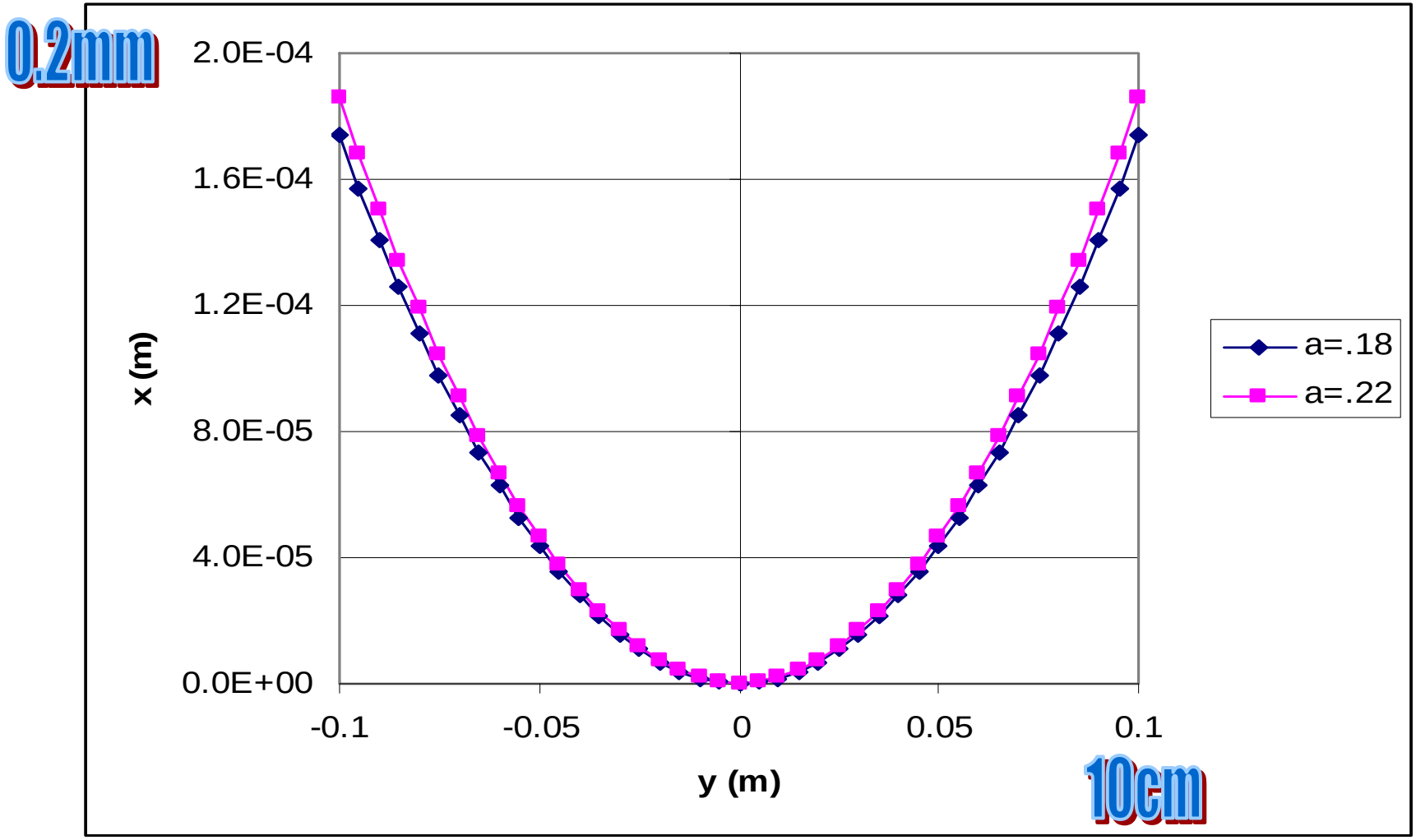


Electrode Shape

- Equi-potential Surface.
- α = 0.20 $\pm$ 0.02 for SCT.
- $\pm$ 0.02 is for no sextupoles.
- $\pm$0.10 with sextupoles.

$$\Phi(\rho, y) = \frac{E_0 \rho^{\alpha}}{R_0^{\alpha}} \left(\frac{\rho}{1+\alpha} - \frac{1+\alpha}{2} \frac{y^2}{\rho} + \ldots \right) + c$$

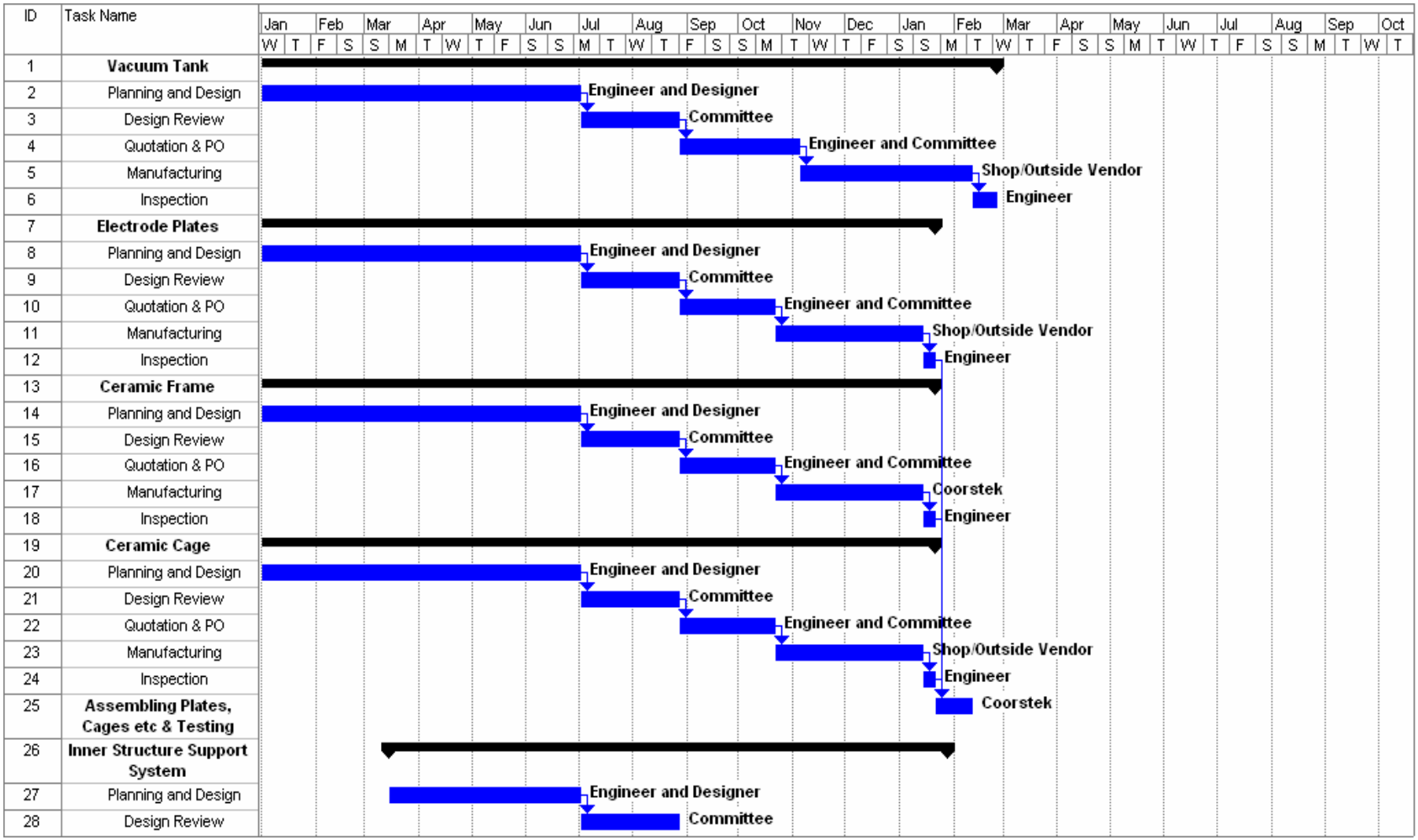
Sagitta = (180±6)μm for ±0.02
±30μm for ±0.1



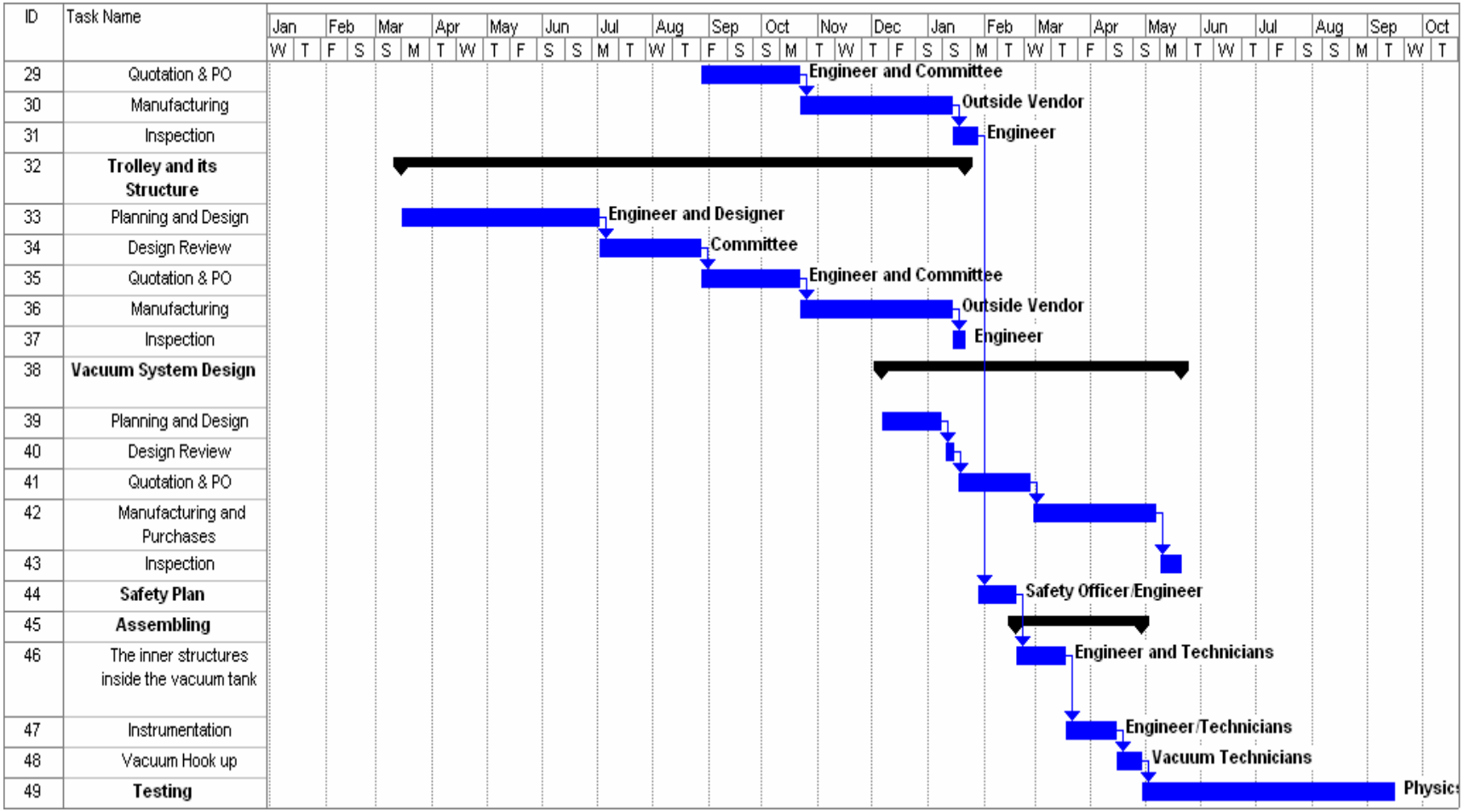
R&D First E Module

Item	K$
Electrode Plate	27.5
Vacuum Tank	35.7
End Flange	13.5
Ports	35.5
Vacuum Tank Assembly	6.3
Electrode Assembly	3.8
Inner Support Structure	48.1
Gauges	22.5
Vacuum Equipment	104.1
Vacuum Hookup	5.0
Instrumentation and Commissioning	52.5
Total	**356.4**

First E Module Timeline



Start date set arbitrarily to Jan 1.

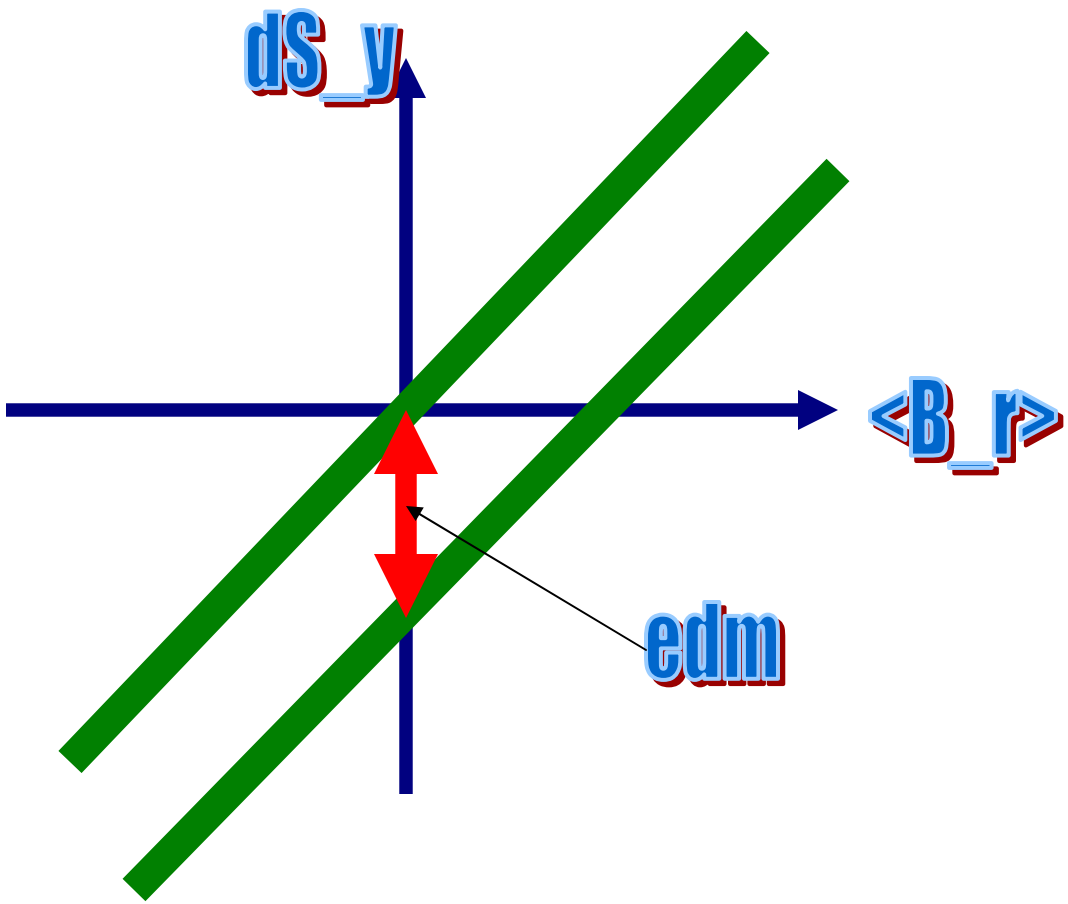


Canceling Earth's Magnetic Field

- Need factor 3×10^8 shielding.
- Outside active.
- Cancel field at surface of passive shield.
- Passive = 10^5 for 6M$ delivered (not installed).
- Inside active.
- Make CW/CCW bpms read the same.

Inside Active Feed-back Every 10^3s?

- Plot for 10^4 runs: $dS/dt^* = \mu B^* + dE^*$



Conclusions

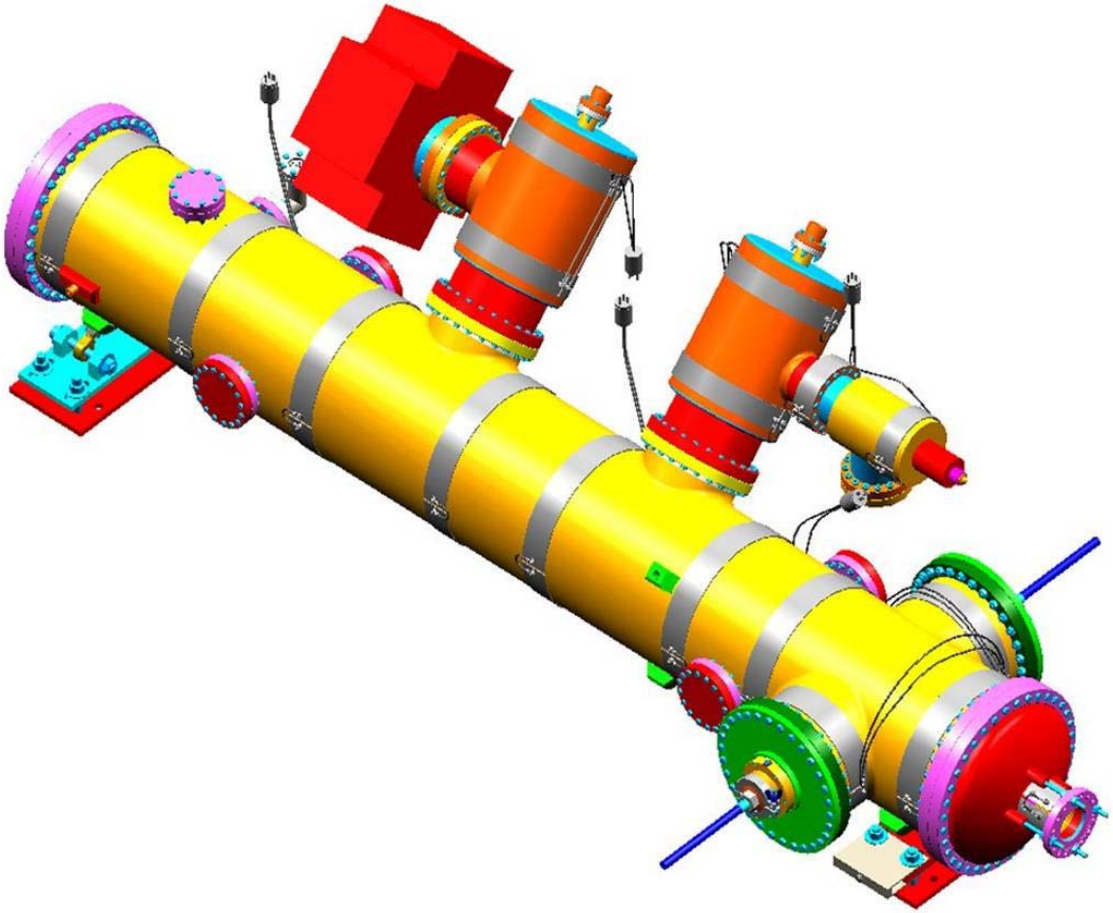
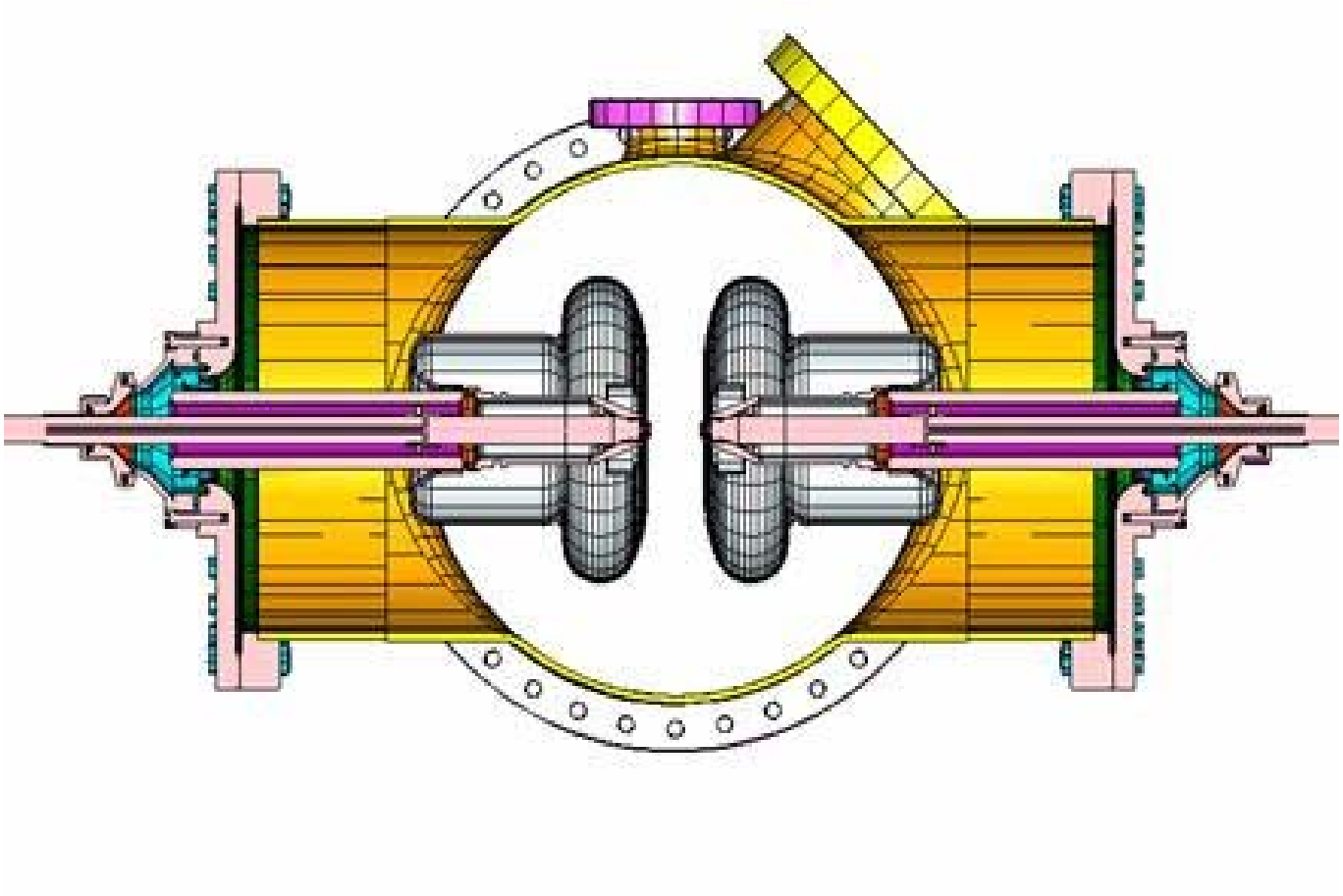
- PEDM E spec is under the HPWR curve = low technical risk.
- Contingency plan: reduce gap and/or increase bending radius.
- Need to increase bending radius anyhow if straights are not long enough.
- Shielding earth’s B field = low technical risk.
- Contingency plan: go from 4 to 5 layers for several M$ more.

Extra Slides

Large Scale Electrodes

Parameter	Tevatron pbar-p Separators	BNL K-pi Separators	PEDM
Length	2.6m	4.5m	3m
Gap	5cm	10cm	3cm
Height	0.2m	0.4m	0.2m
Number	24	2	80
Max. HV	±180KV	±200KV	±200KV

Tevatron pbar-p Separator Module



HV Feedthrough to 0.2m High Electrodes