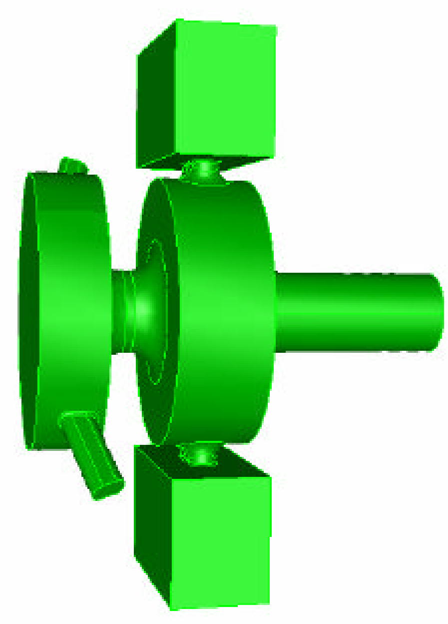
RF-GUN DESIGN FOR LCLS

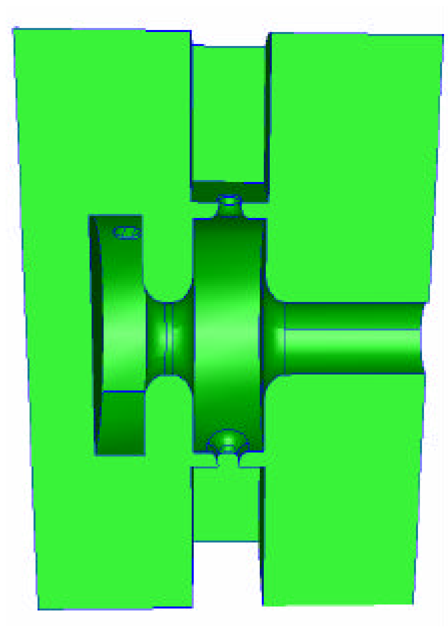
Liling XIAO, Zenghai LI
ACD, SLAC

Design Issues

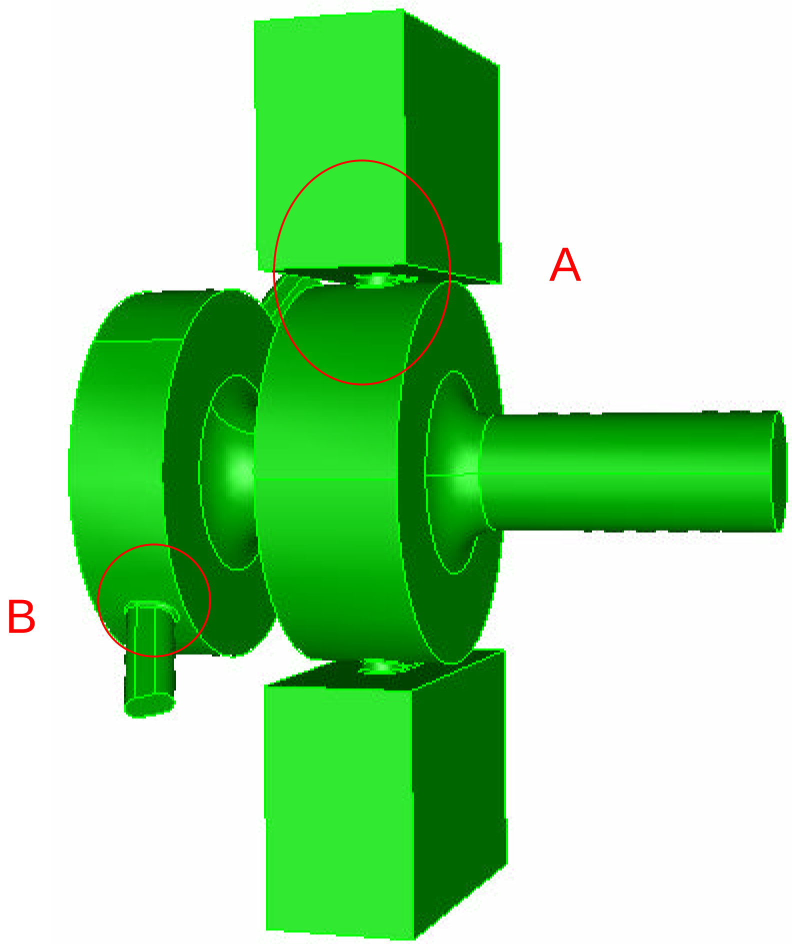
1. Requirements:
   f_0=2.856GHz
   ß=2
   (E0-E1)E0<10%
   DTmax<50^oC

2. Structure Configuration:
   (modified BNL/SLAC/UCLA
   1.6 cell S-band gun)
   dual RF feeds
   larger rounding on RF aperture
   racetrack coupler cell

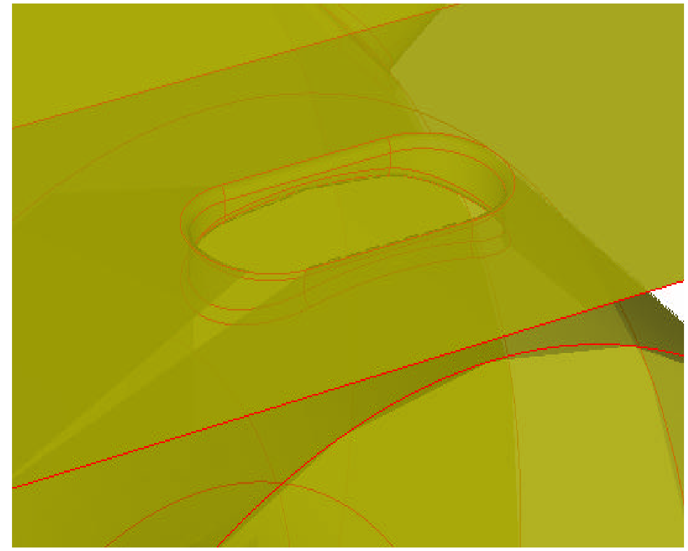




Starting Point



A



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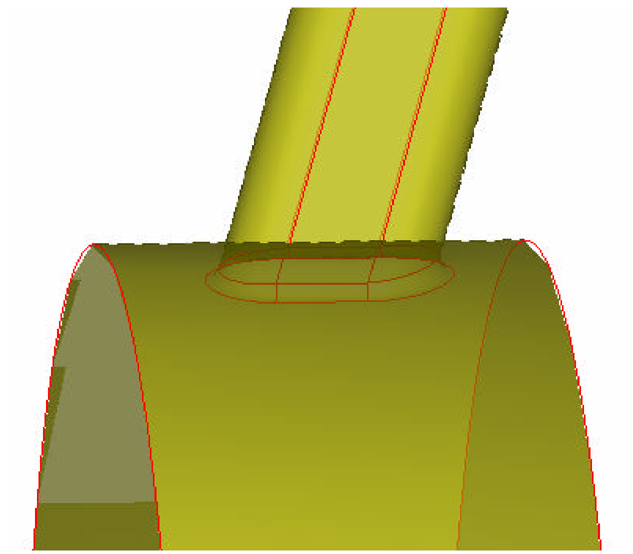
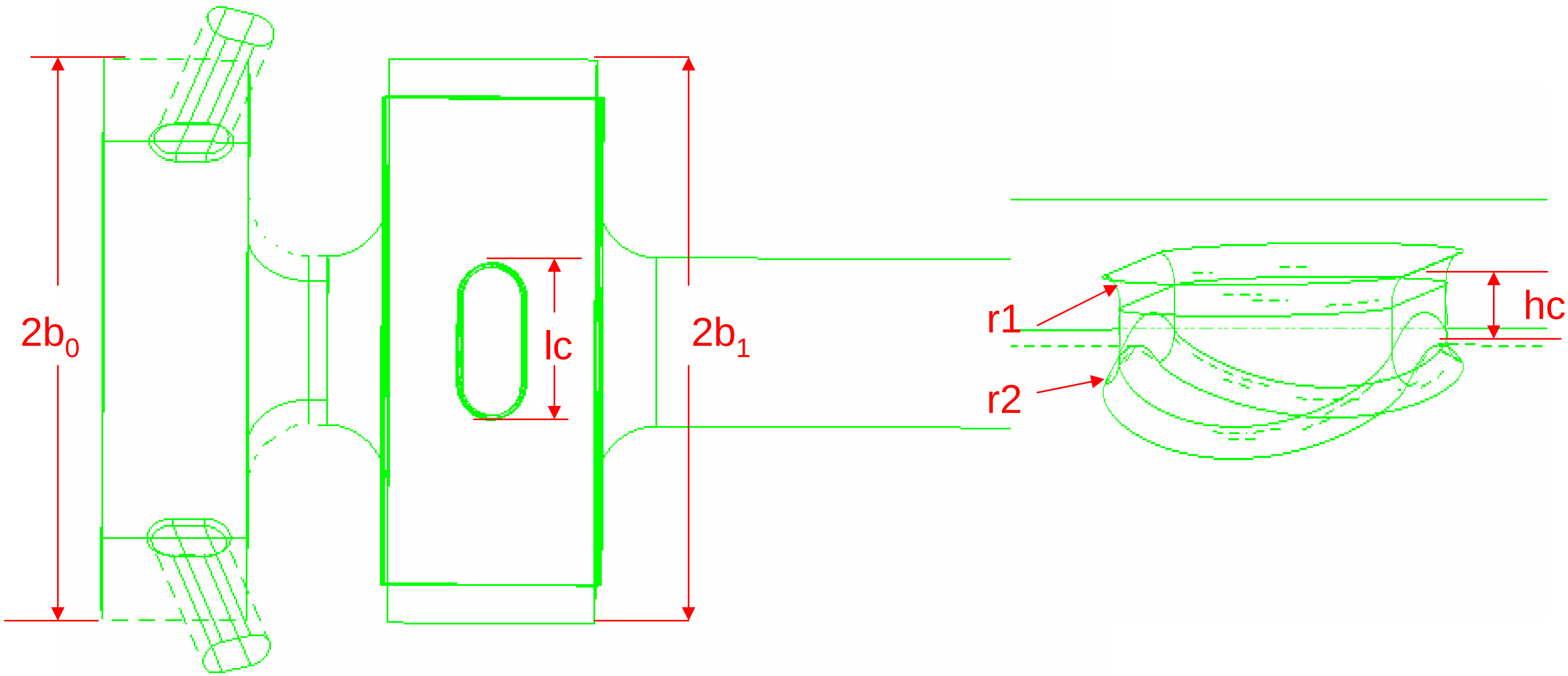


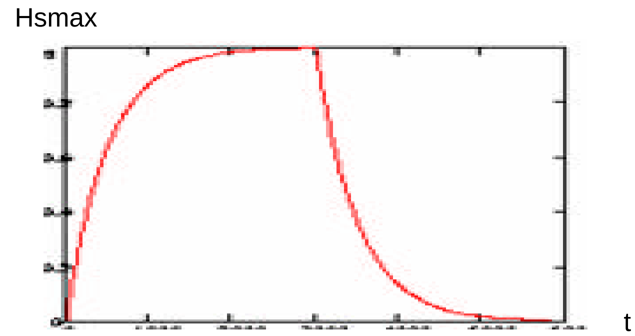
Results: f=2.86288GHz, ß=2.65, DT=150^{O}C



The dimensions need to be adjusted.

Pulse Heating

- The temperature rise at the end of a pulse is

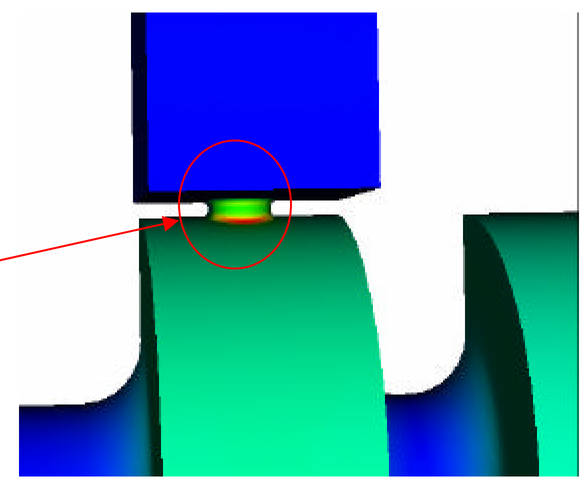


$$\Delta T_{\max} = \frac{R_s}{K}\sqrt{\frac{D}{p}}\,\frac{1}{2}\int_0^{t_p} \left|H_{s\max}(t)\right|^2 \frac{dt'}{\sqrt{t-t'}}$$

$$D = K / C_s r$$

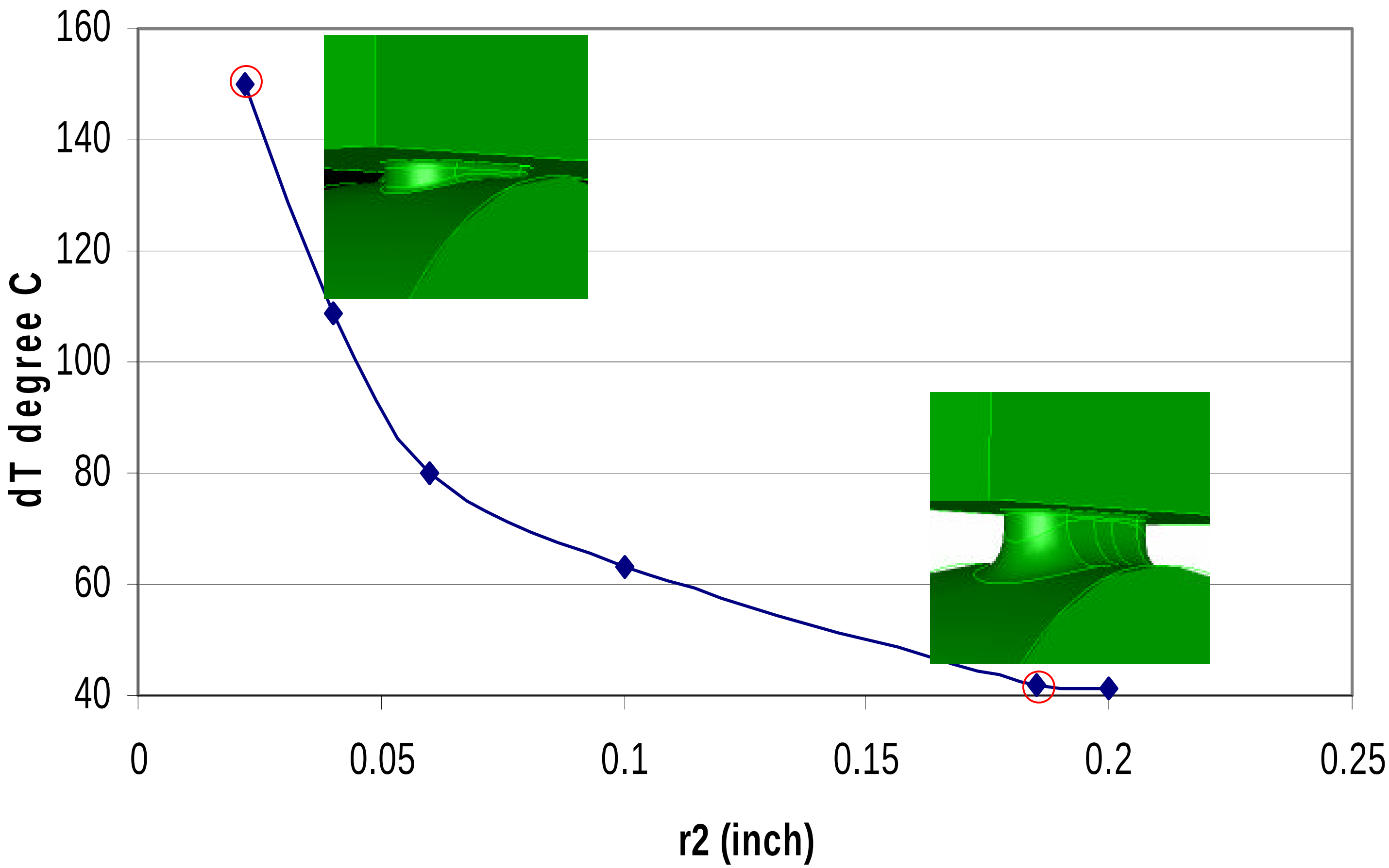
$$R_s = \sqrt{\frac{wm}{2s}} = \frac{1}{s d_s}$$

$$d_s = \sqrt{\frac{2}{wms}}$$



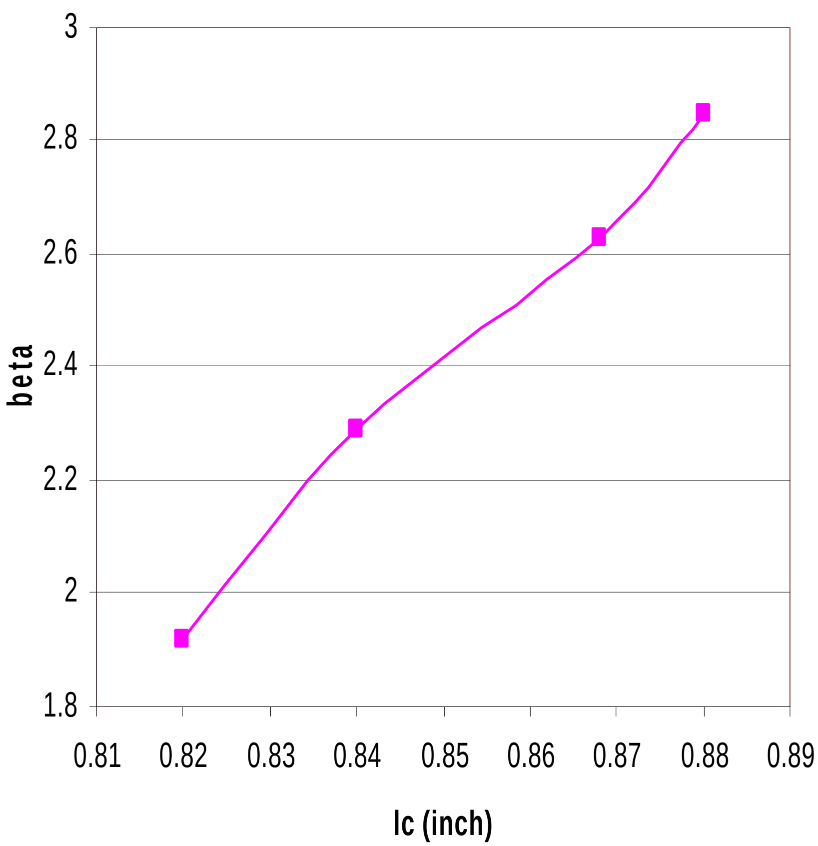
Maximal surface magnetic field locates on the coupling aperture edge.

Assuming: Ecathode=120MV/m, f=2.856GHz, ß=2, Q0=13300, tp=3ms

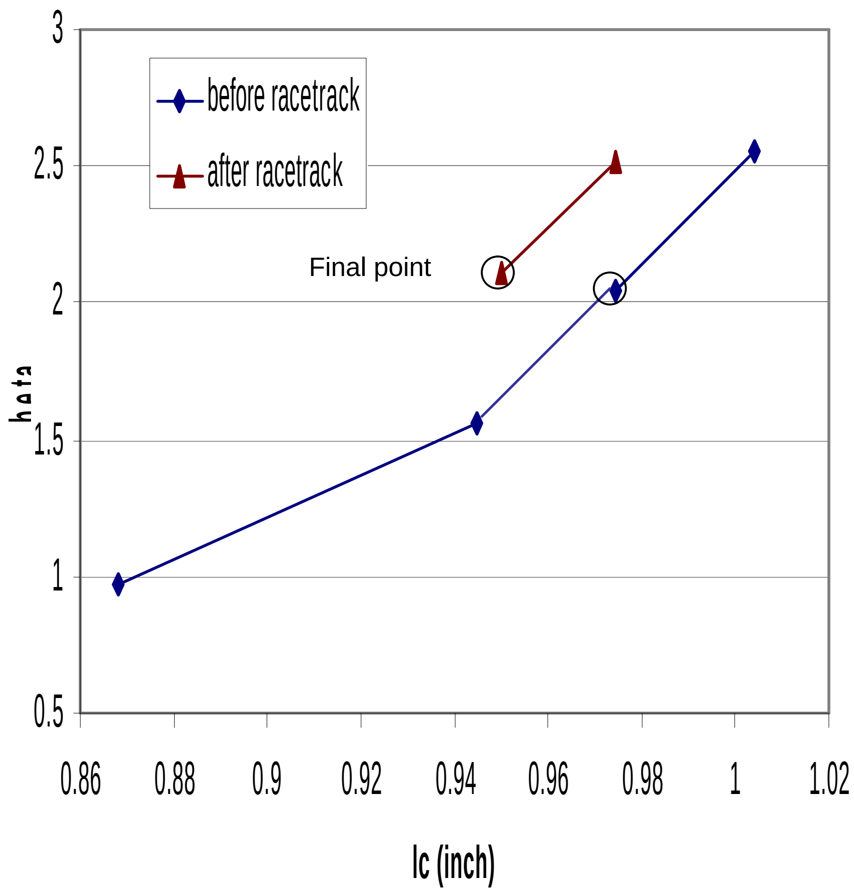


Temperature rise vs. the rounding radius of the RF aperture

hc=0.056 inch



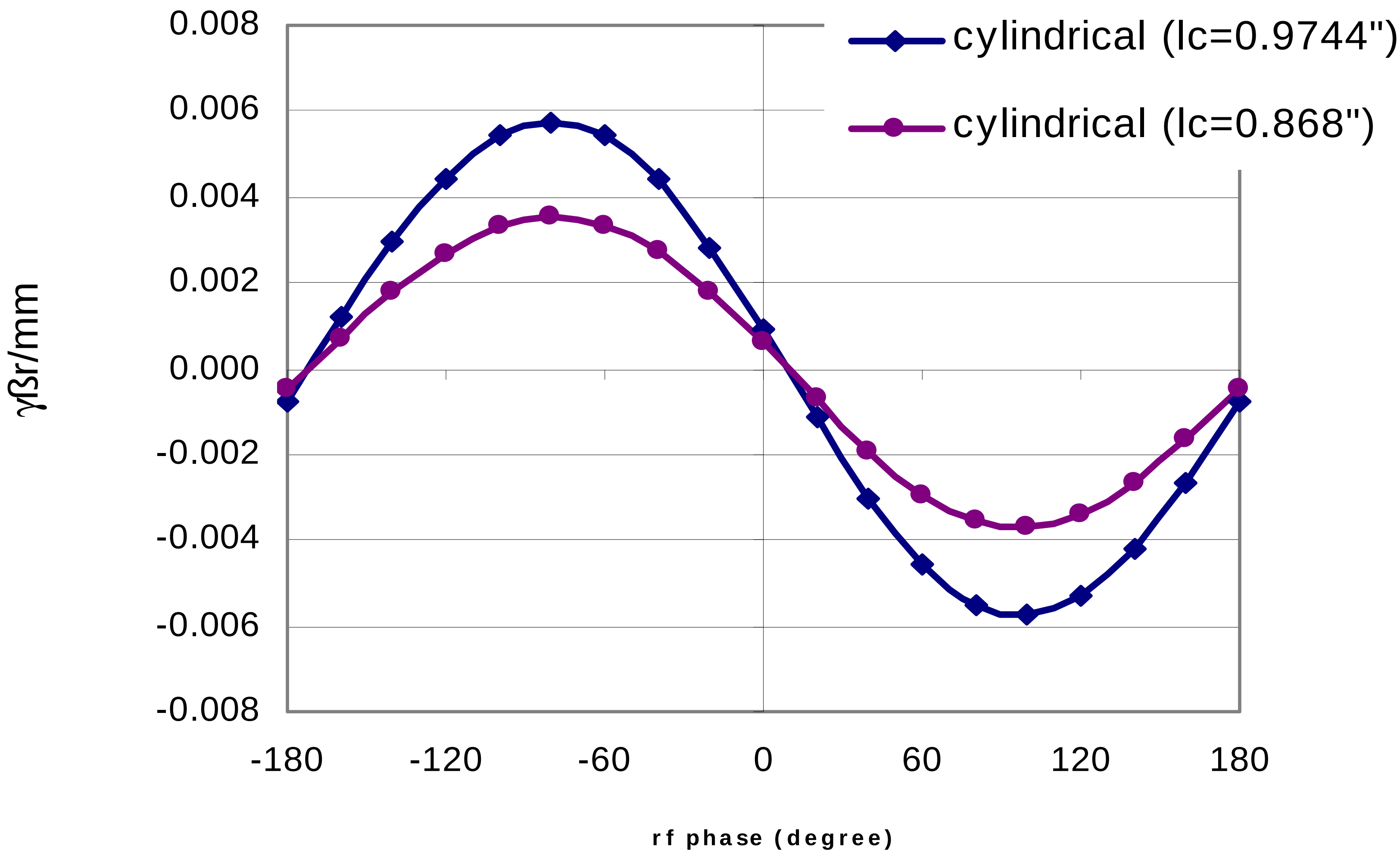
hc=0.2165 inch



Coupling factor vs. the length of the rf aperture

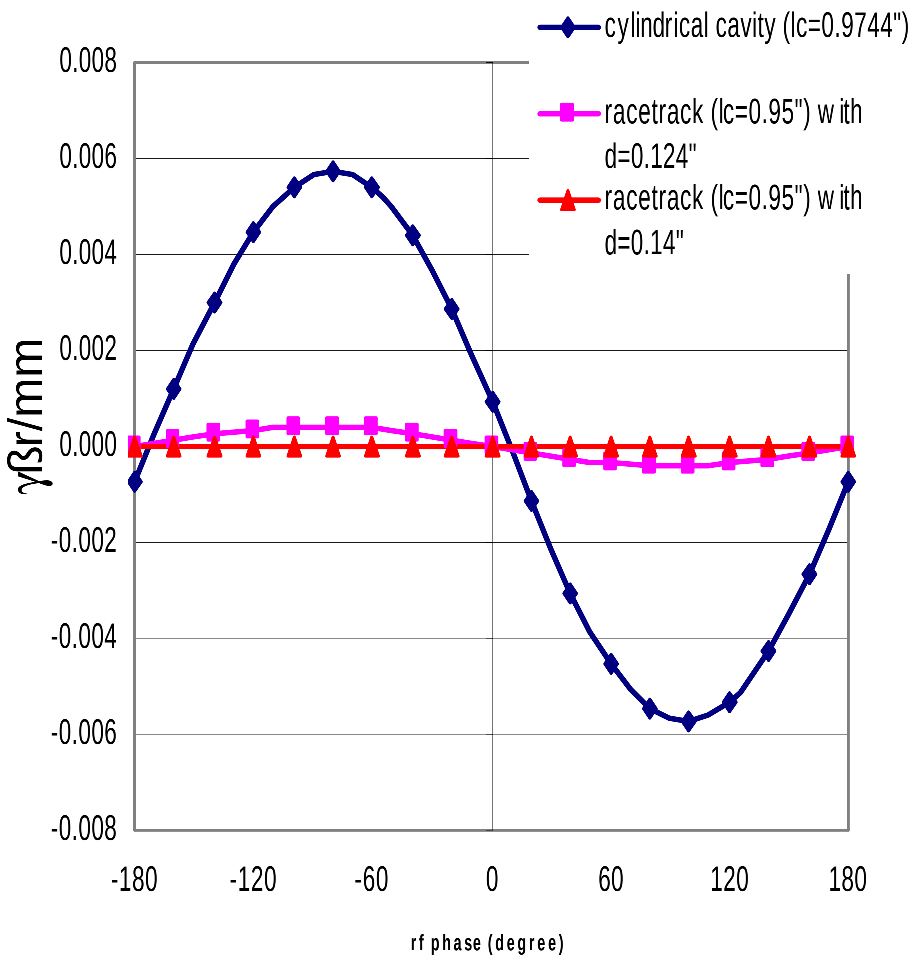
The field-balances on all the points are within 3%.

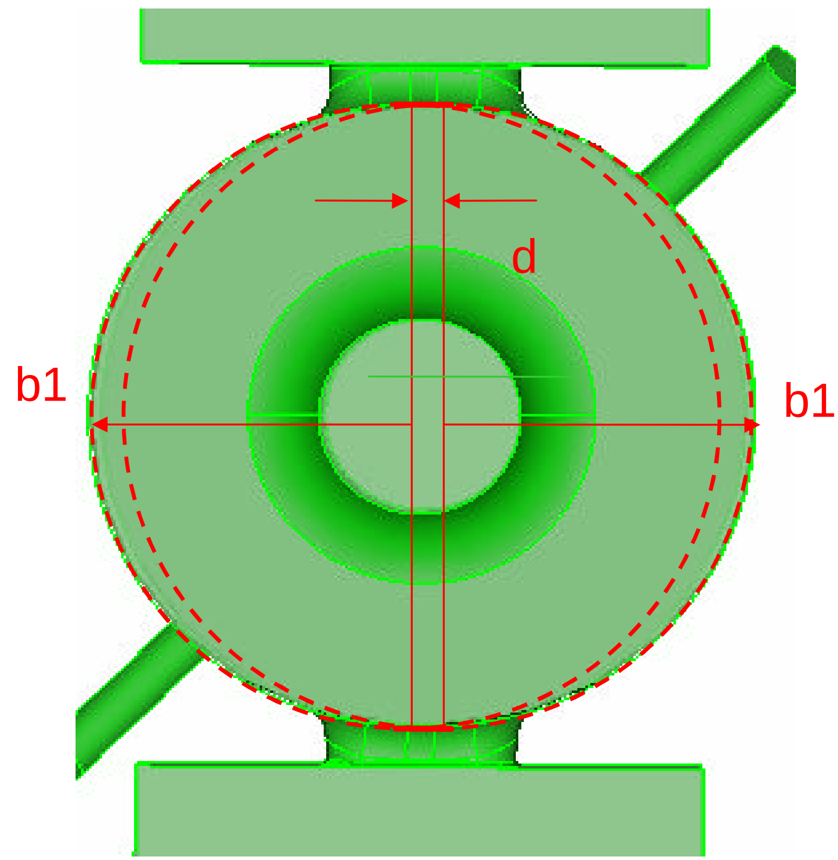
R0=9mm



Quadruple moments in the cavity

R0=9mm





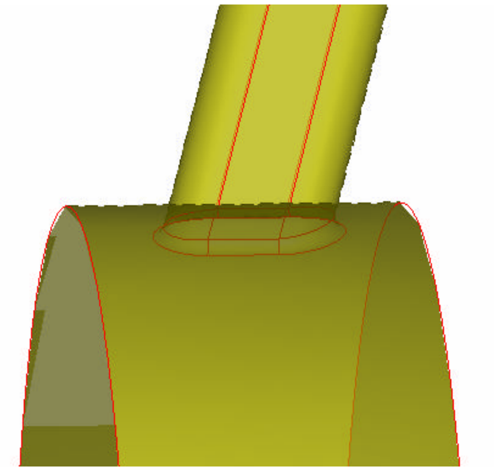
Quadruple moments before and after racetrack

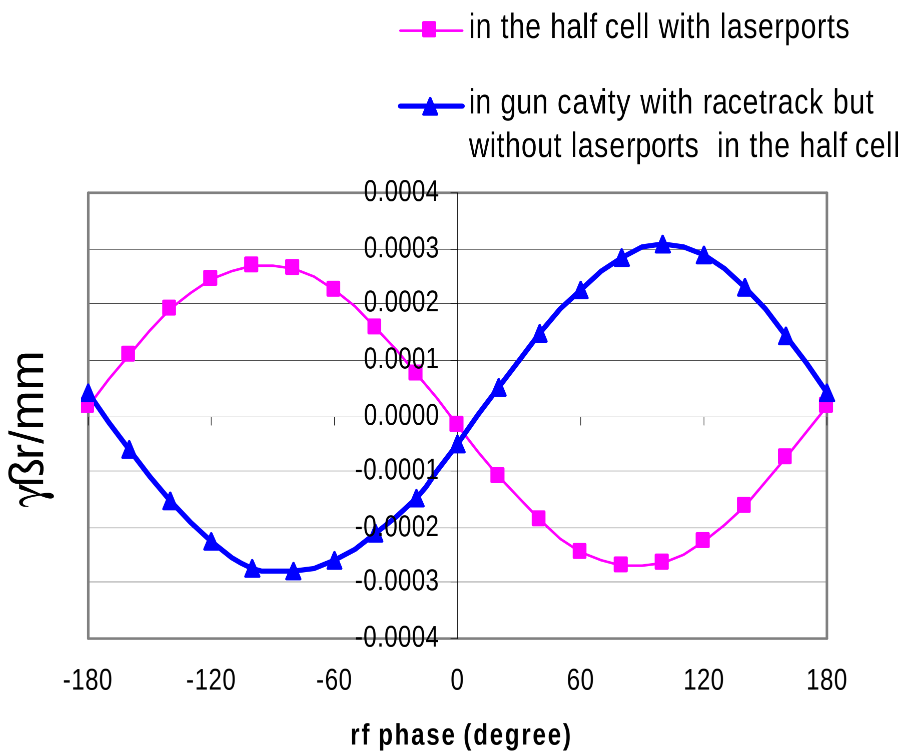
Laser ports effect:

R0=9mm

1: max DT=36^{o}C on the laser ports

2: the quadruple moment caused by the laser ports is the same order as in racetrack coupler cell.





Keep Ecathode=120MV/m

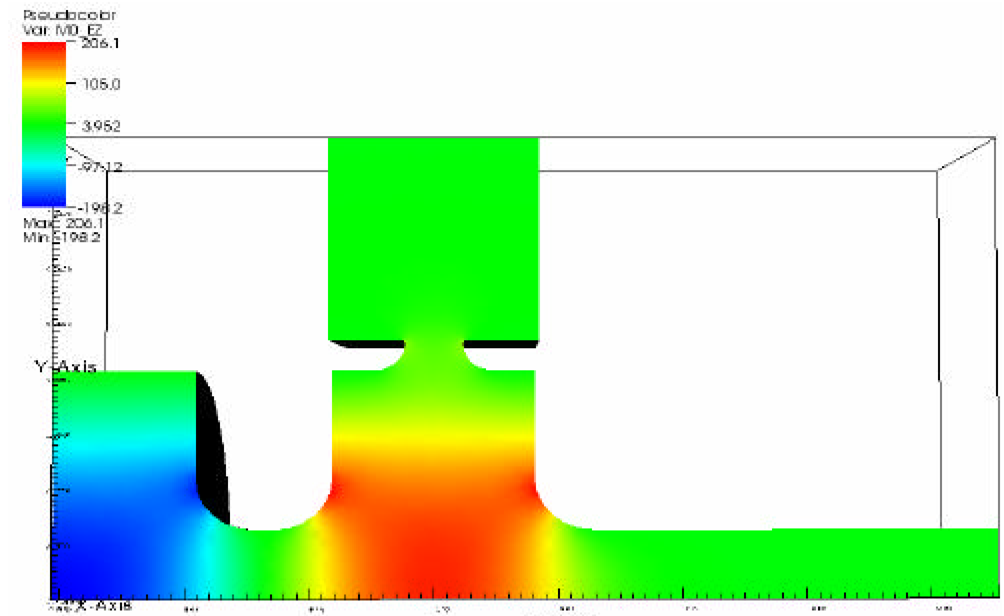
RF-GUN Dimensions

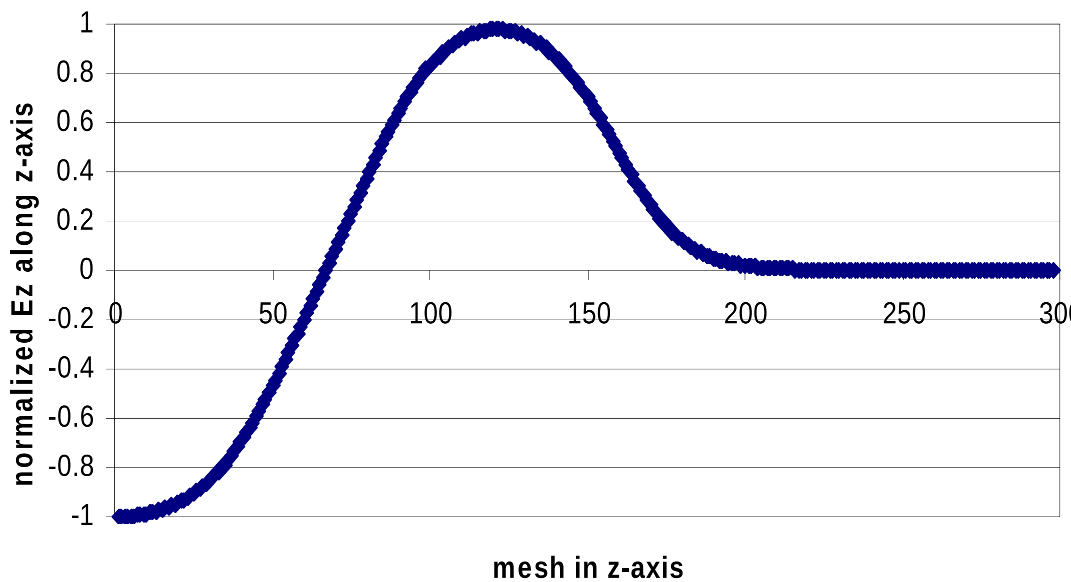
Parameter	Value
Race track arc radius **b1**	**1.5999 inch (original:1.6435”)**
Race track arc separation **d**	**0.134 inch (original: 0)**
Race track cell length **l1**	1.28 inch
Half cell radius **b0**	**1.6361 inch (original:1.6335”, and not consider the laser ports)**
Half cell length **l0**	0.896 inch
RF coupling hole size (slot length) **lc**	**0.95 inch (original:0.868”)**
RF coupling hole radius of curvature **rc**	0.1875 inch
RF coupling hole size (slot width) **2rc**	0.375 inch
RF coupling hole thickness **hc**	**0.2165 inch (original: 0.056”)**
RF coupling hole rounding radius **r1** on up side	0.022 inch
RF coupling hole rounding radius **r2** on down side	**0.185 inch (original: 0.022”)**
Cell iris radius **a**	0.492 inch
Disk thickness **t**	0.868 inch
Disk rounding radius **r**	0.375 inch
Laser port hole size (slot length) **ll**	0.433 inch
Laser port hole radius of curvature **rl**	0.125 inch
Laser port hole size (slot width) **2rl**	0.250 inch
Laser port hole rounding radius **r3**	0.030 inch
Laser port offset the cathode plate	0.531 inch
Laser port angle	18 degree
Waveguide	2.840 inch*1.340inch

RF-GUN's Results

Rf properties	value
F0(GHz)	**2.856035**
Q0	**13369**
ß	**2.1**
Mode Sep. Δf (MHz)	**3.4**
ΔT max(^{o}C)	**44**
E0:E1	**1:0.978**
maxE:Ecath.	**1.05:1.0**

Ez distribution in the RF-gun structure





Dual Feed Gun Geometry: