

Some figures to match R&D Topics –FNAL Nov. 7, 2005

See also the summary of Working Group 3a at Nanobeam 2005

Nanobeam 2005 (Oct. 17-21 Oct. 2005, Kyoto, Japan) at <http://wwwal.kuicr.kyoto-u.ac.jp/user1/nanobm/>.

### 1. Simulations for bombardment of cathode by field-emitted $e^-$ .

J.H. Han et al, PRST-AB 8, 033501 (2005). 1/5-cell L-band gun with  $Cs_2Te$  photocathode. Excitation laser: 1) Simulations flattop transverse profile with  $\sigma=0.47$  mm, Gaussian temporal profile with  $s=2.2$  ps; 2) Measured 0.44/0.51 mm horizontal/vertical and  $\sim 2.3$  ps.  $E_{max}=21.6$  MV/m, main solenoid and bucking coil switched off.

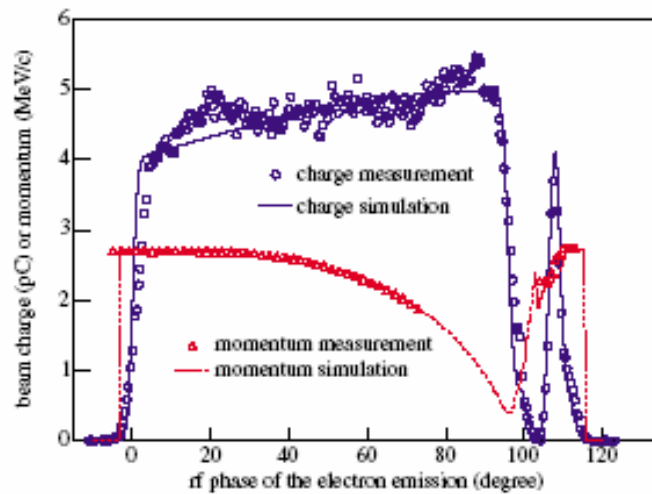


FIG. 10. (Color) Beam charge and momentum as a function of the emission phase.

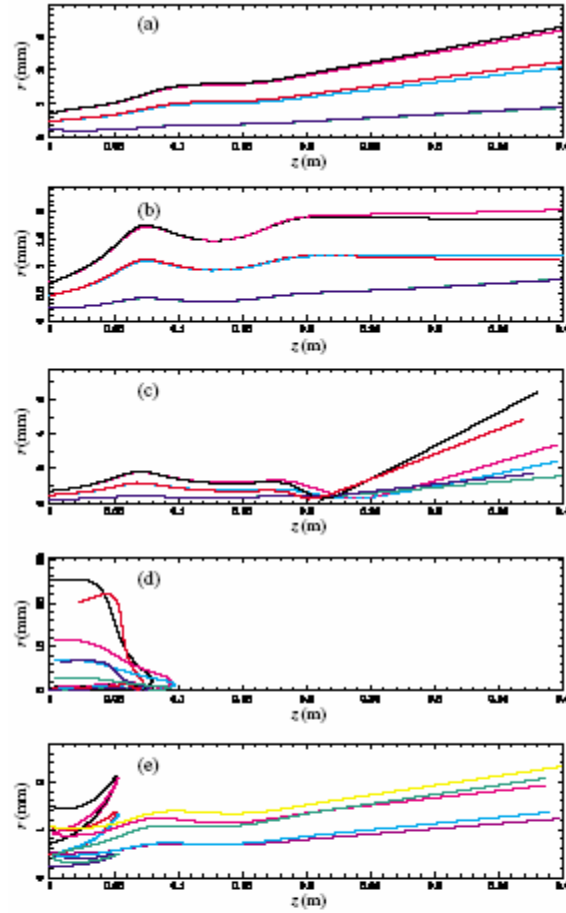


FIG. 11. (Color) Beam trajectories at characteristic emission phases. At  $5^\circ$  (a) the electron beam can be fully extracted and smoothly accelerated because it is synchronized to the rf field in the full cell and hence gains its maximum momentum. At  $90^\circ$  (b) the electron beam is decelerated and then accelerated again in the full cell. At this phase the transverse rf focusing is optimal to send the beam down the beam line. At  $96^\circ$  (c) particles get lost due to deceleration and overfocusing. At  $104^\circ$  (d) all emitted electrons return and disappear in the backplane of the cavity. At  $108^\circ$  (e) a fraction of the electrons moves back to the cathode, to disappear or to produce secondaries, depending on the impact energy. The other fraction of the primaries barely survives and flows out of the cavity.

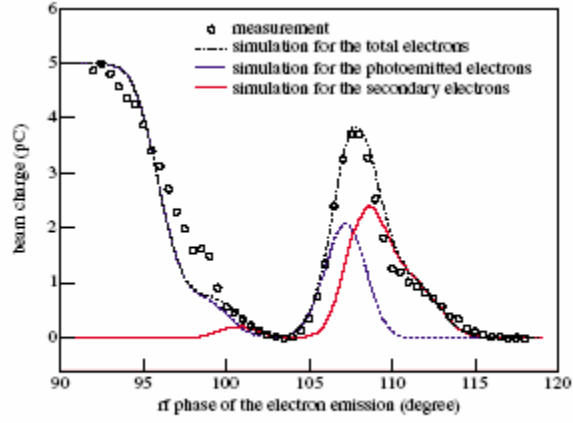


FIG. 12. (Color) Beam charge at the bump. In the simulation, the primary electrons and the secondary electrons are distinguished.

Y. Luo et al., PAC03, p. 2126. PWT 1/2-10-1/2 cell S-band gun.

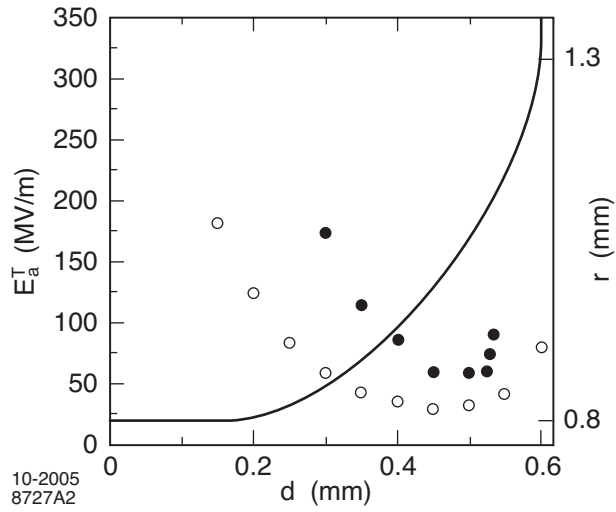
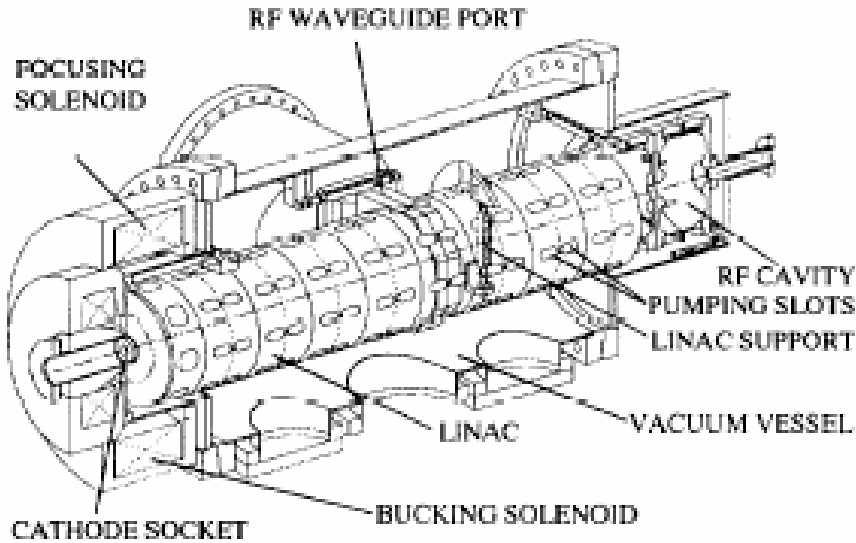


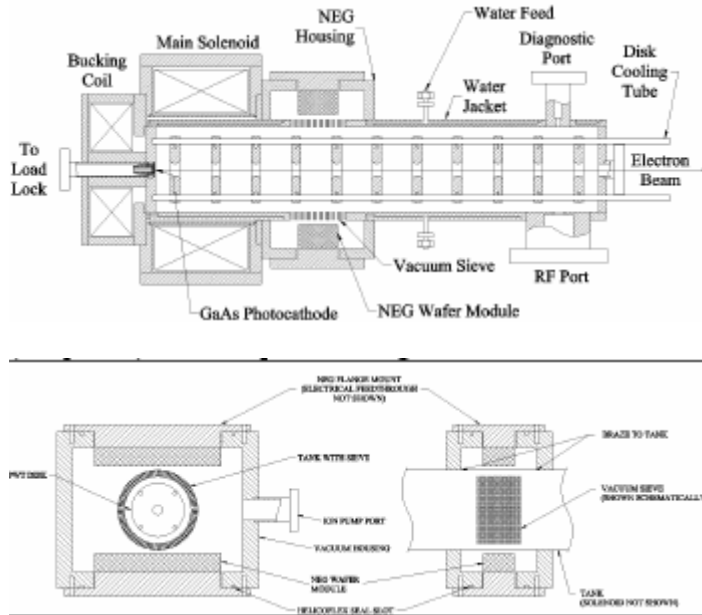
Figure 1: Threshold peak axial field,  $E_a^T$ , for electrons emitted from the first iris at an annular distance  $r$  from the cell axis ( $d$  from the center plane of the disk) in an S-band rf gun to reach the cathode surface: open and closed circles are data points for 0 and 90° rf phase at emission respectively; the solid line represents the iris profile in the  $r$ - $d$  plane. (Data from ref. [8].)

## 2. Vacuum pumping schemes.

a) Z-slots. R.L. Sheffield, PAC93, p. 2970.



b) Vacuum-rf sieve. D. Yu et al., PAC03, p. 2129. Tank diameter can be as small as 1.3 times OD of disk or as much as several times larger.



### 3. Choice of rf structure.

HOM (TM012) compared to 1.6-cell conventional (TM010) design. J.W. Lewellen, Linac2002, p. 671; PRLST-AB 4 (2001) 040101. Using tapered cell wall, obtain similar  $E_{z,r}(r=0)$ ; shunt impedance about factor 2 lower.

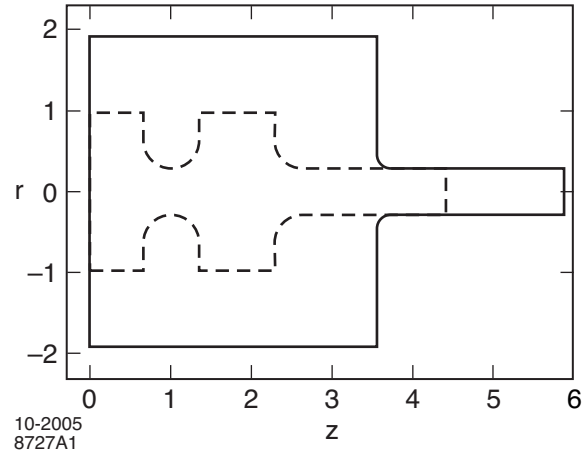


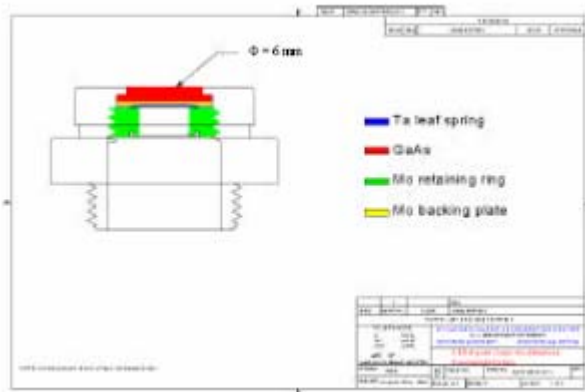
Figure 2: Cross section of the HOM TM012 rf gun (solid line) superimposed on standard 1.6 cell TM010 gun (dotted line), where the units for  $r$  and  $z$  are the same. (Similar to ref. [9].)

**4. Conductance estimates.** J.E. Clendenin, Nanobeam2005.

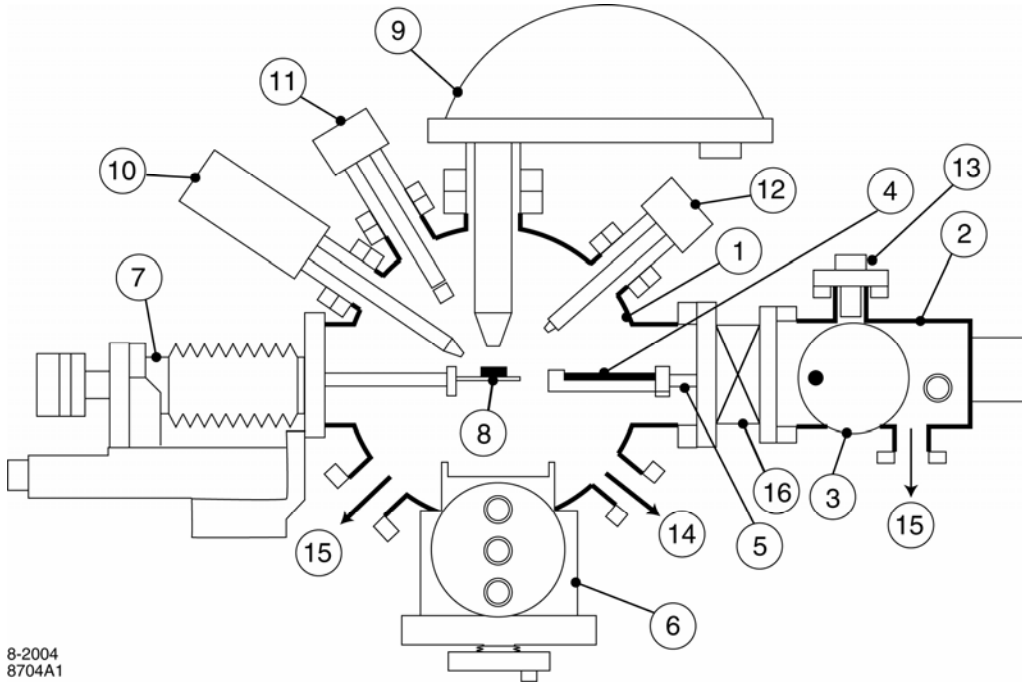
Table 1. Conductance and pressure differential at cathode for various gun designs and 2 assumed outgassing rates for Cu.

Gun Design	Conductance (l/s)	$\Delta P$ (Torr) for:	
		$10^{-11}$ Torr-l/s $\text{cm}^{-2}$	$10^{-12}$ Torr-l/s $\text{cm}^{-2}$
BNL 1.6-cell SB with conventional pumping	3.7	$1.6 \times 10^{-9}$	$1.6 \times 10^{-10}$
with sieve	12	$5 \times 10^{-10}$	$5 \times 10^{-11}$
PWT (2/2+7 to 10 cells)	28	$2 \times 10^{-10}$	$2 \times 10^{-11}$
PWT (1.5 cells)	50	$1.2 \times 10^{-10}$	$1.2 \times 10^{-11}$
HOM	75	$8 \times 10^{-11}$	$8 \times 10^{-12}$

**5. Mounting of GaAs crystal.** H. Braun et al., CTF Note 98-13 (1998).



**6. Ion bombardment experimental studies.** Prepare GaAs cathodes in Cathode Test System (CTS) at SLAC, transfer to XPS system to bombard with specific ion species over a range of energies.



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1. Analysis chamber
2. Loadlock chamber
3. Sample plate entry
4. Sample transfer plate
5. Rack and pinion travel
6. Sample plate stage
7. XYZ $\mu$  Omniax<sup>TM</sup> manipulator
8. Sample on XYZ $\mu$
9. Electrostatic energy analyzer
10. X-ray source
11. SEY/SEM electron gun
12. Microfocus ion gun
13. Sputter ion gun
14. To pressure gauges and RGA
15. To vacuum pumps
16. Gate valve

From D. Palmer et al., PAC05.

7. Field emission. H. Matsumoto, LINAC96, p. 626: <25 pA peak current at 140 MV/m.

