Non-magnetized beam performance of RHIC electron cooling injector

Xiangyun Chang, Dmitry Kayran

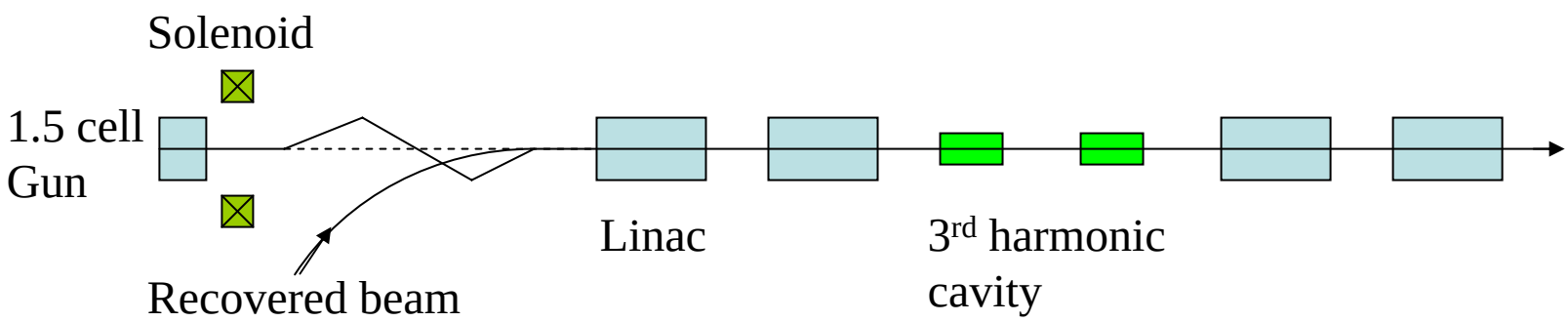
CAD, Brookhaven National Lab,
Upton, NY 11973

Requirements of RHIC e-cooling for a non-magnetized beam

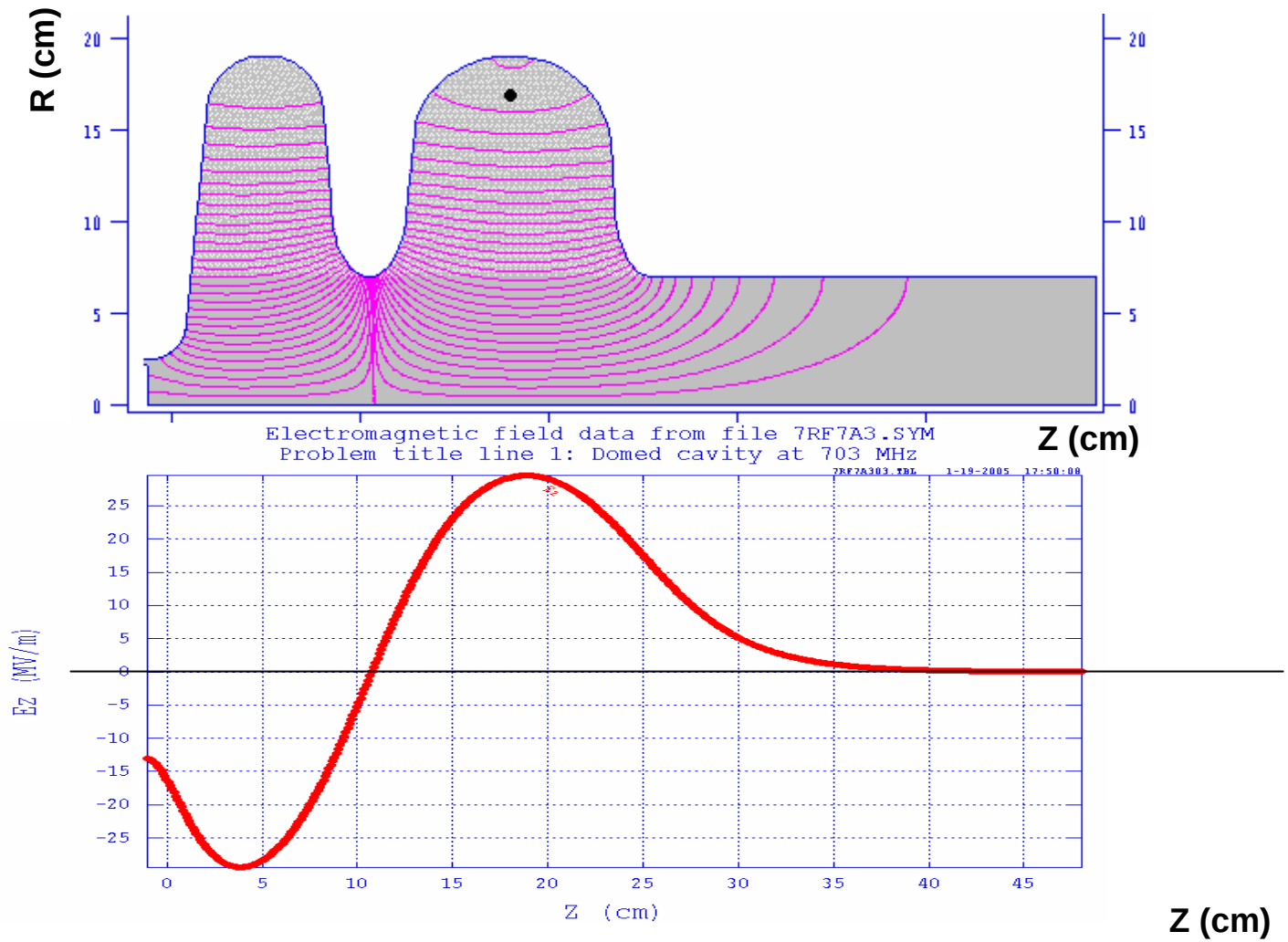
- Bunch charge 5nC.
- Emittance less than 4mm.mr (@5nC).
- The energy spread should less than 1×10^{-3} (@54MeV).
- Needs bend system for merging of the fresh low energy beam and the high energy beam.

System configuration

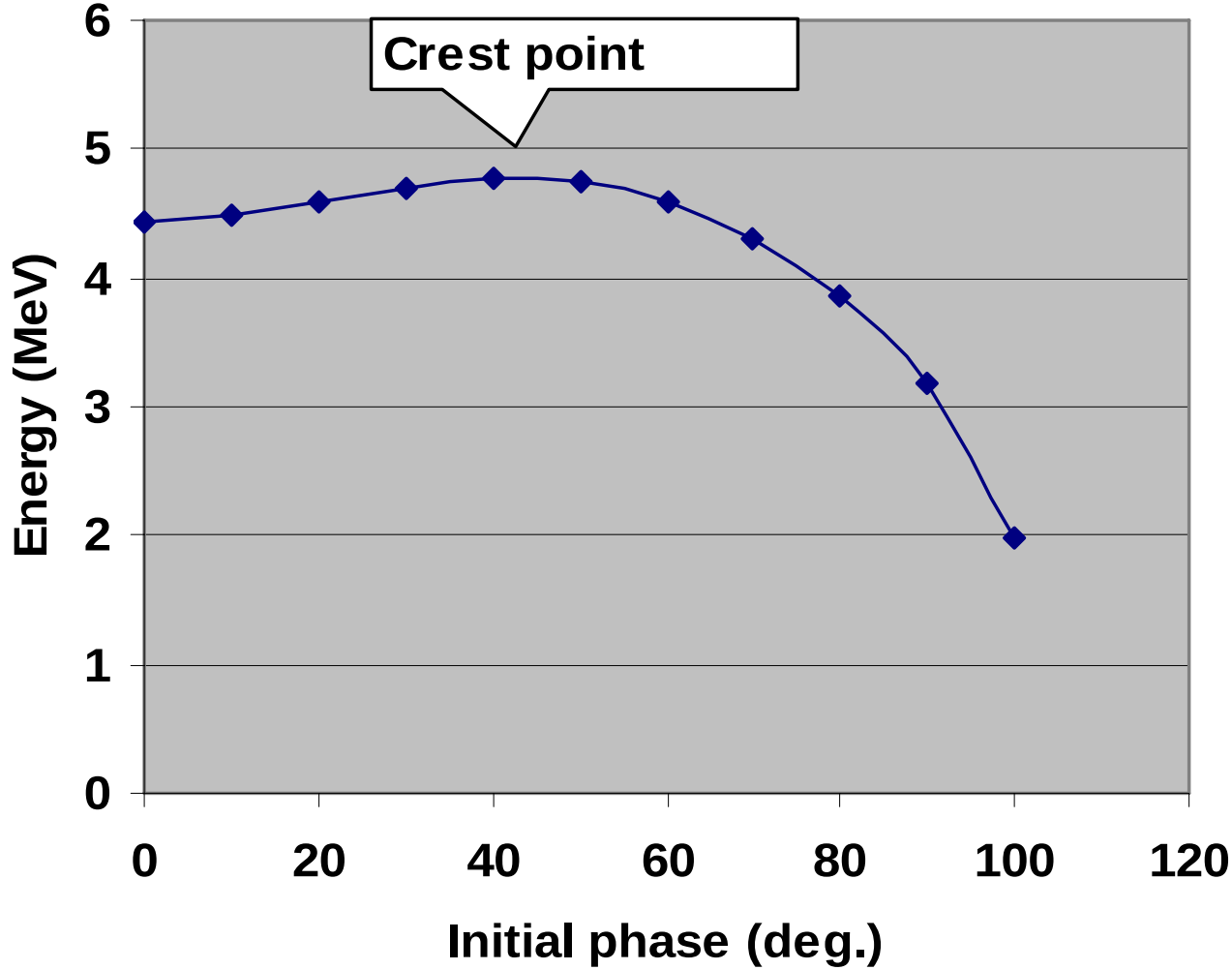
- The gun is followed by zig-zag (Litvinenko Vladimir, Dmitry Kayran) system and linacs
  - Best choice for merging beam at low energy region where the energy variation (of head and tail) is significant.
  - The chromaticity and the energy variation effect can be well compensated.



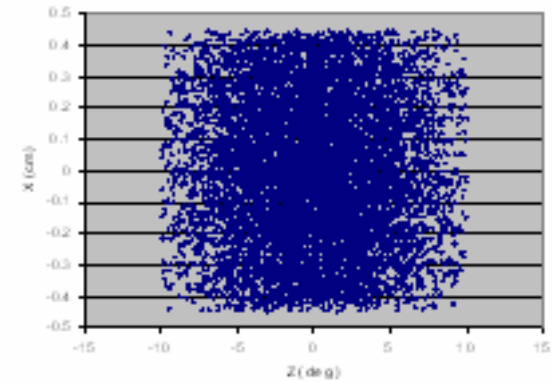
Electric field distribution of the simulated 1.5 cell gun

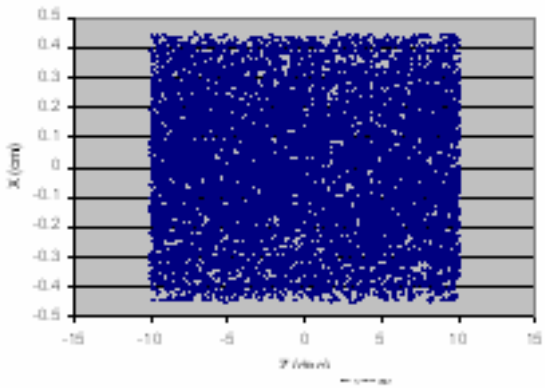


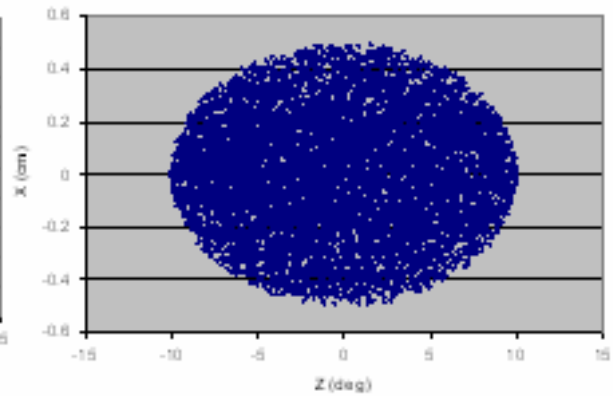
Energy gain from gun as a function of launch phase

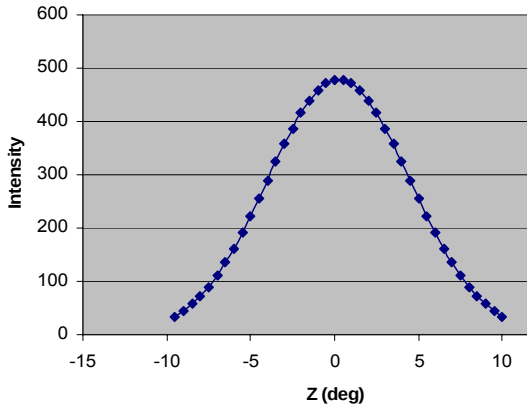


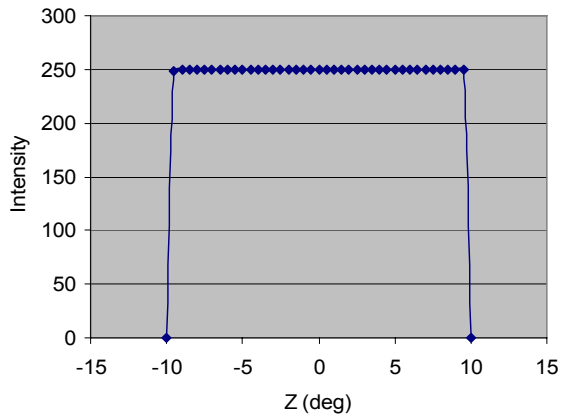
Laser distributions used in simulations

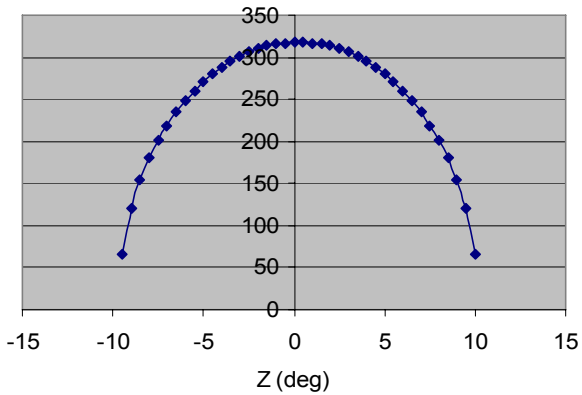










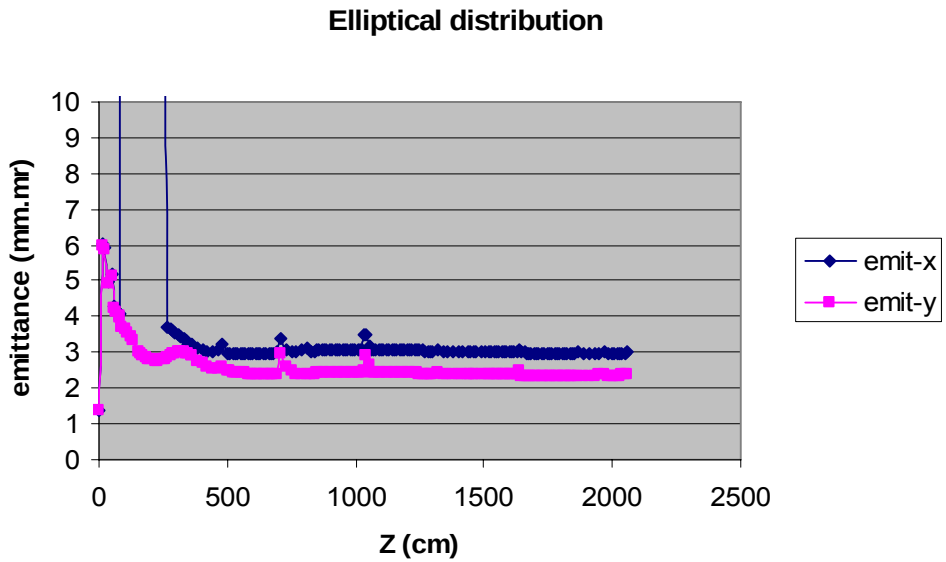


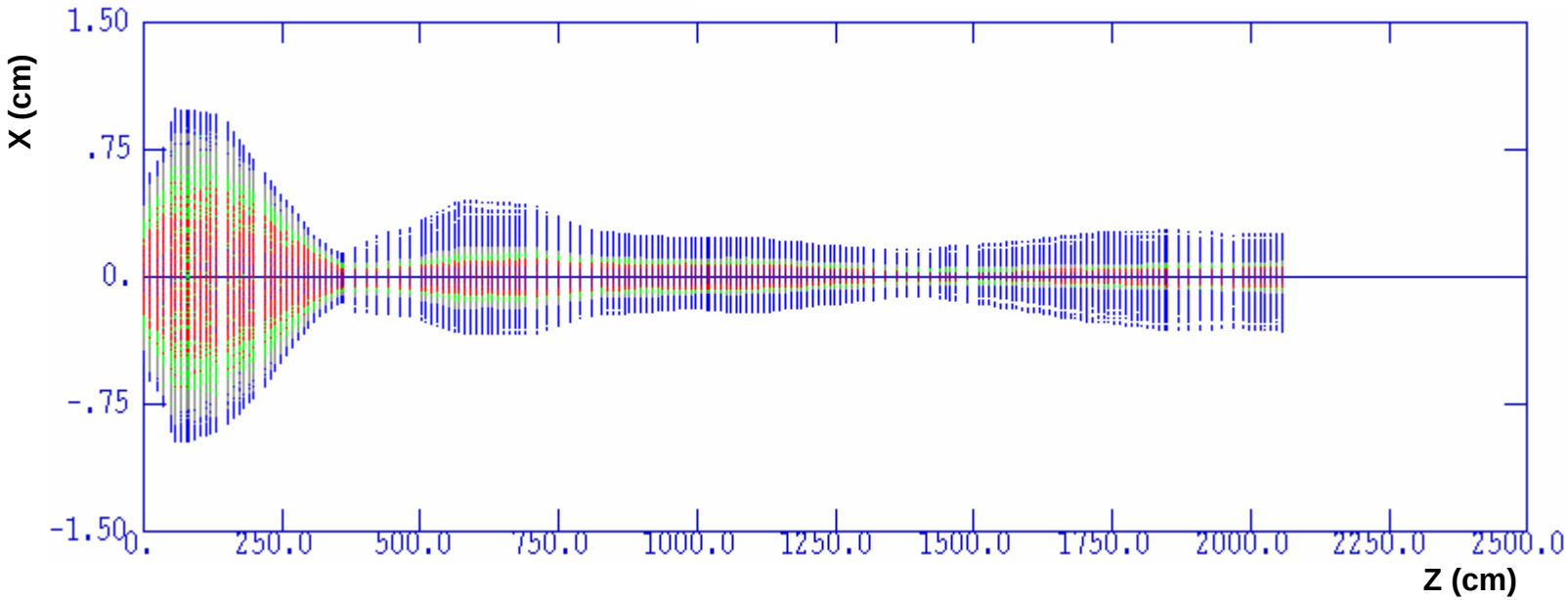
Gaussian **Beer can** **Ellipsoid**

Transverse dynamics (elliptical laser)

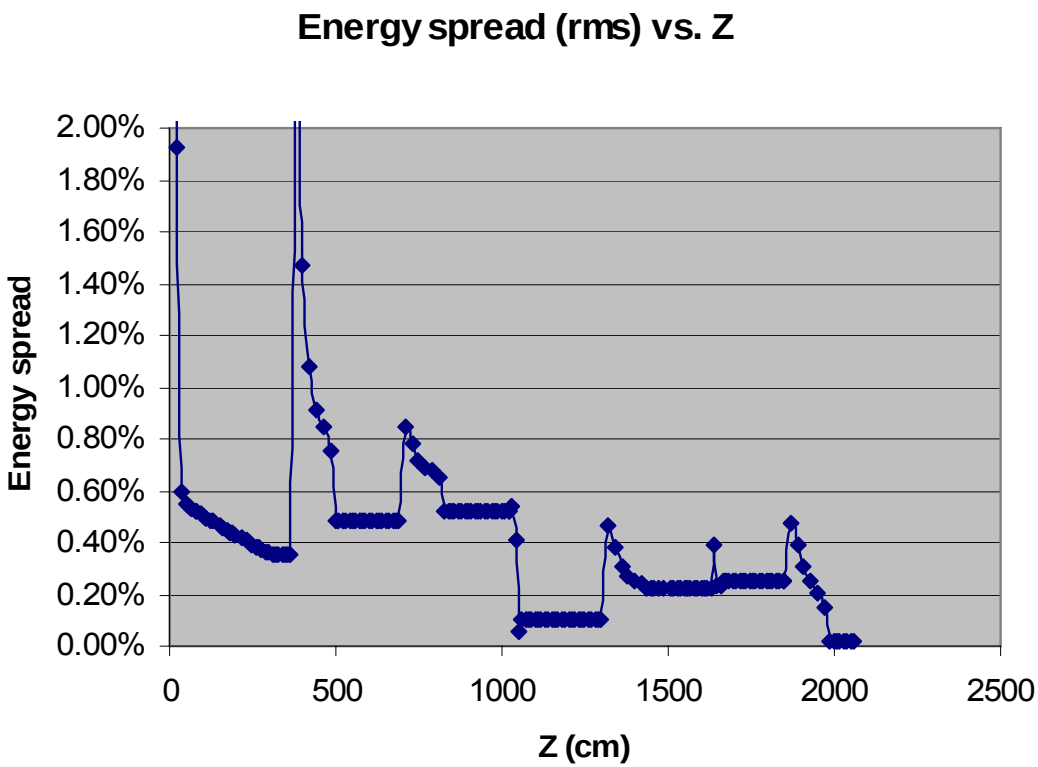
εx=3.0mm.mr

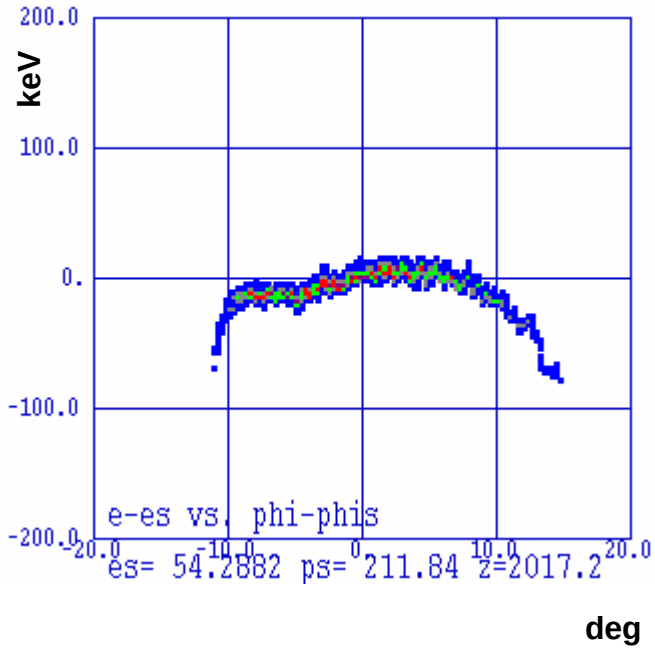
εy=2.4mm.mr





Longitudinal dynamics (elliptical laser)





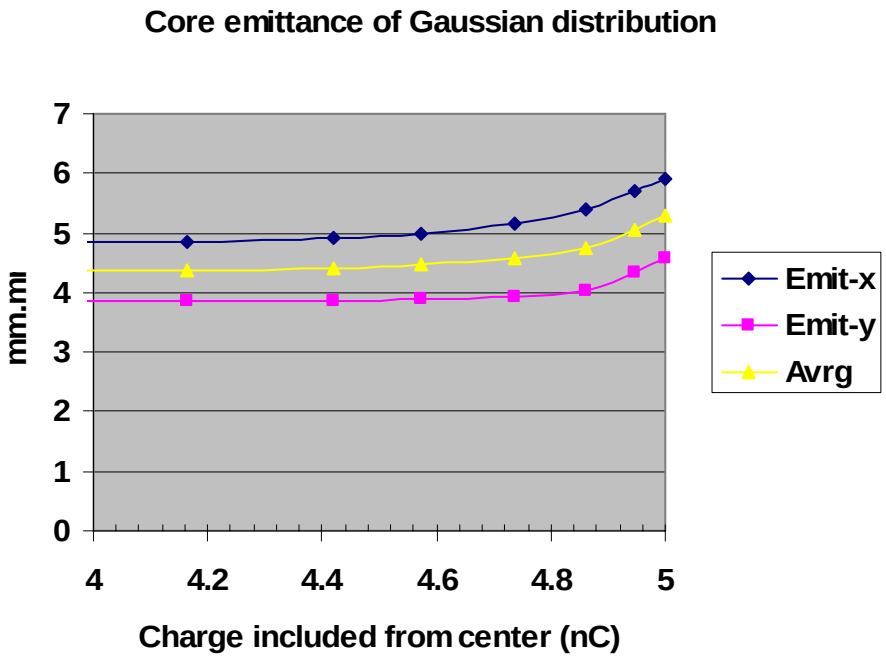
- $dE/E=0.2\times10^{-3}$

Simulations' Summary

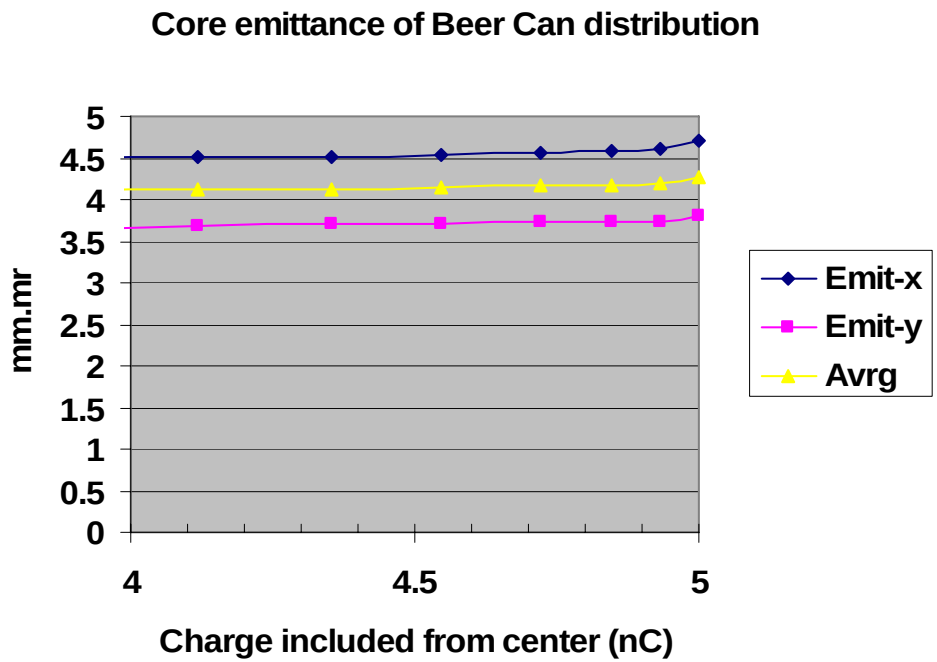
Charge / bunch = 5nC			
Laser distribution	$\varepsilon_{x(final)}$ (mm.mr)	$\varepsilon_{y(final)}$ (mm.mr)	Energy spread
Elliptical	3.0	2.4	0.2×10^{-3}
Beer can	4.7	3.8	$<0.6\times10^{-3}$
Gaussian	5.9	4.6	$<0.4\times10^{-3}$

The core emittance

- The particles on bunch ends contribute more to emittance, especially for beer can and Gaussian distributions

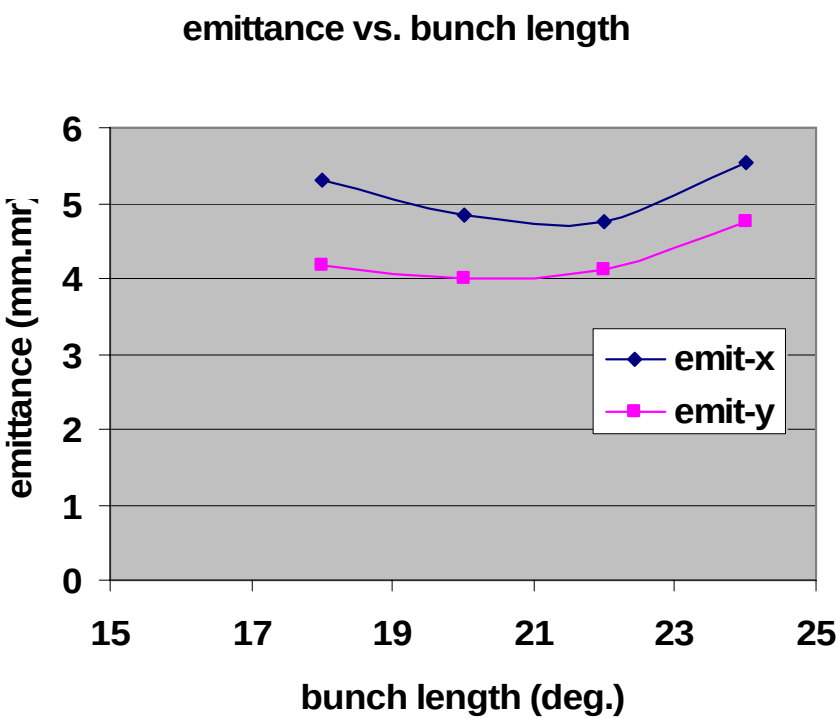


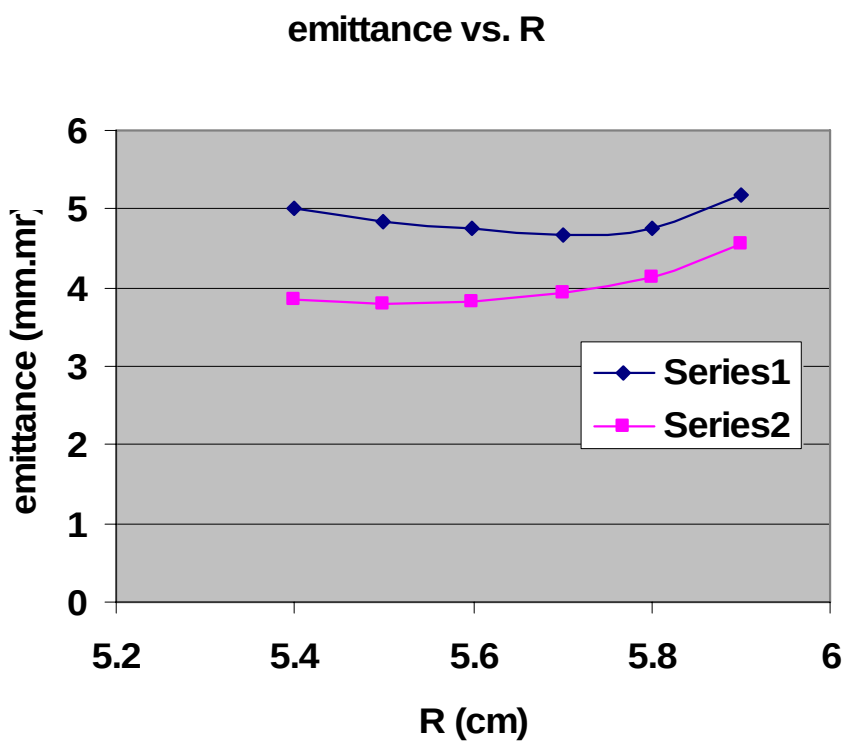
Gaussian



Beer can

Sensitivity to laser parameters





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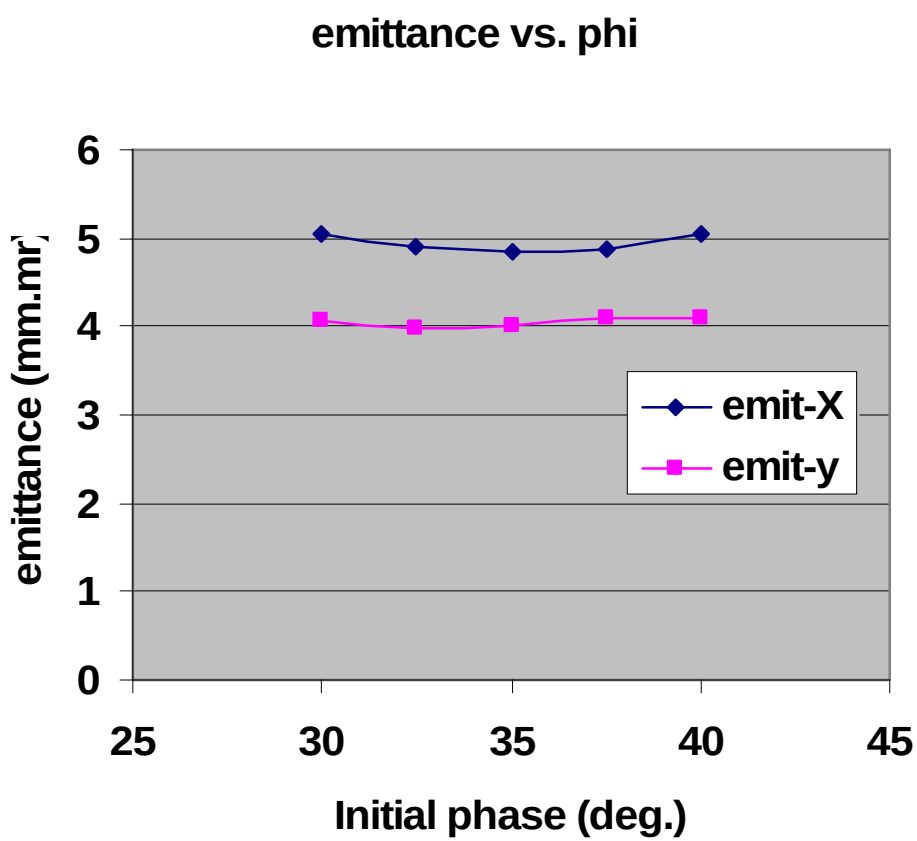
emittance vs. phi
emittance (mm.mr)
6
5
4
3
2
1
0
25
30
35
40
45
Initial phase (deg.)
emit-X
emit-y