TECHNISCHE UNIVERSITÄT DARMSTADT

Computational Electromagnetics Laboratory

Report from TU-Darmstadt

R.Cee, M.Krassilnikov,T.Lau, W.F.O.Müller,
S.Ratschow, S.Setzer, T.Weiland, I. Zagorodnov

Darmstadt University of Technology
Department of Electrical Engineering and Information-Technology
Computational Electromagnetics Laboratory (TEMF)
Schloßgartenstr. 8 , 64289 Darmstadt, Germany
weiland@TEMF.de, www.TEMF.de

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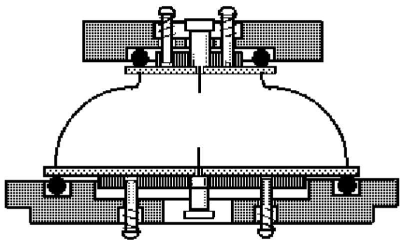
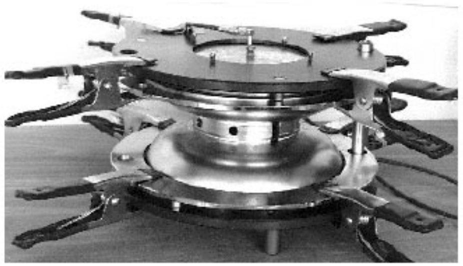
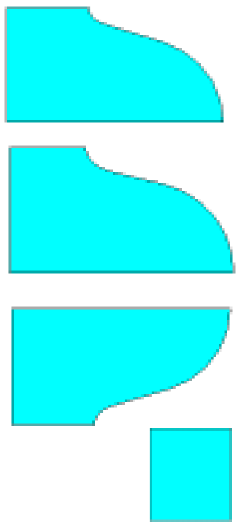
Reports from TU-Darmstadt

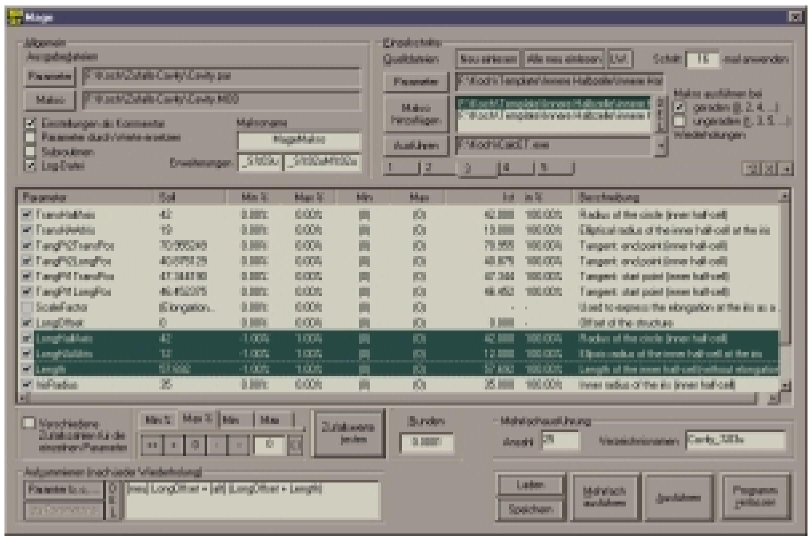
- *Computational Electromagnetics Laboratory*
  - Results from W. Mueller
  - Detailed Numerical Study of Space Charge Effects in the FEL rf-gun (PITZ)
  - V-Code Alignment Utility
  - A Code for Longitudinal Wake Field Calculation
  - Investigation of Surface Roughness Wake Fields

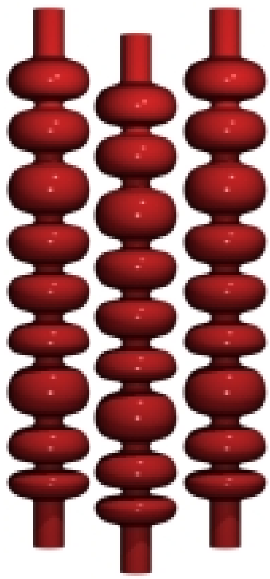
Simulation of Production Procedure





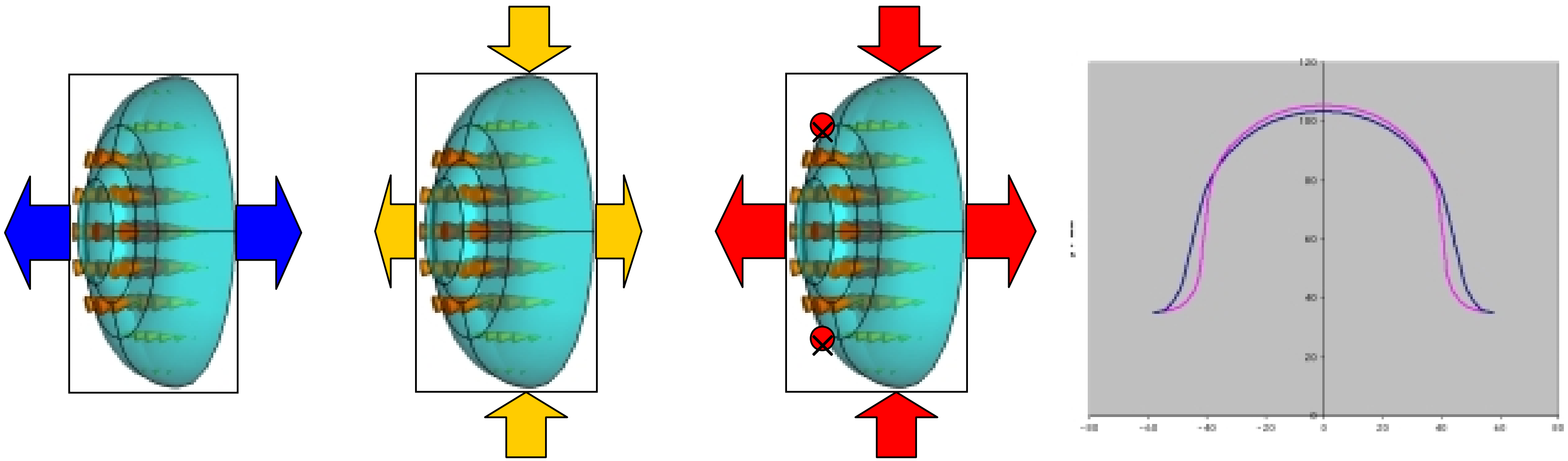






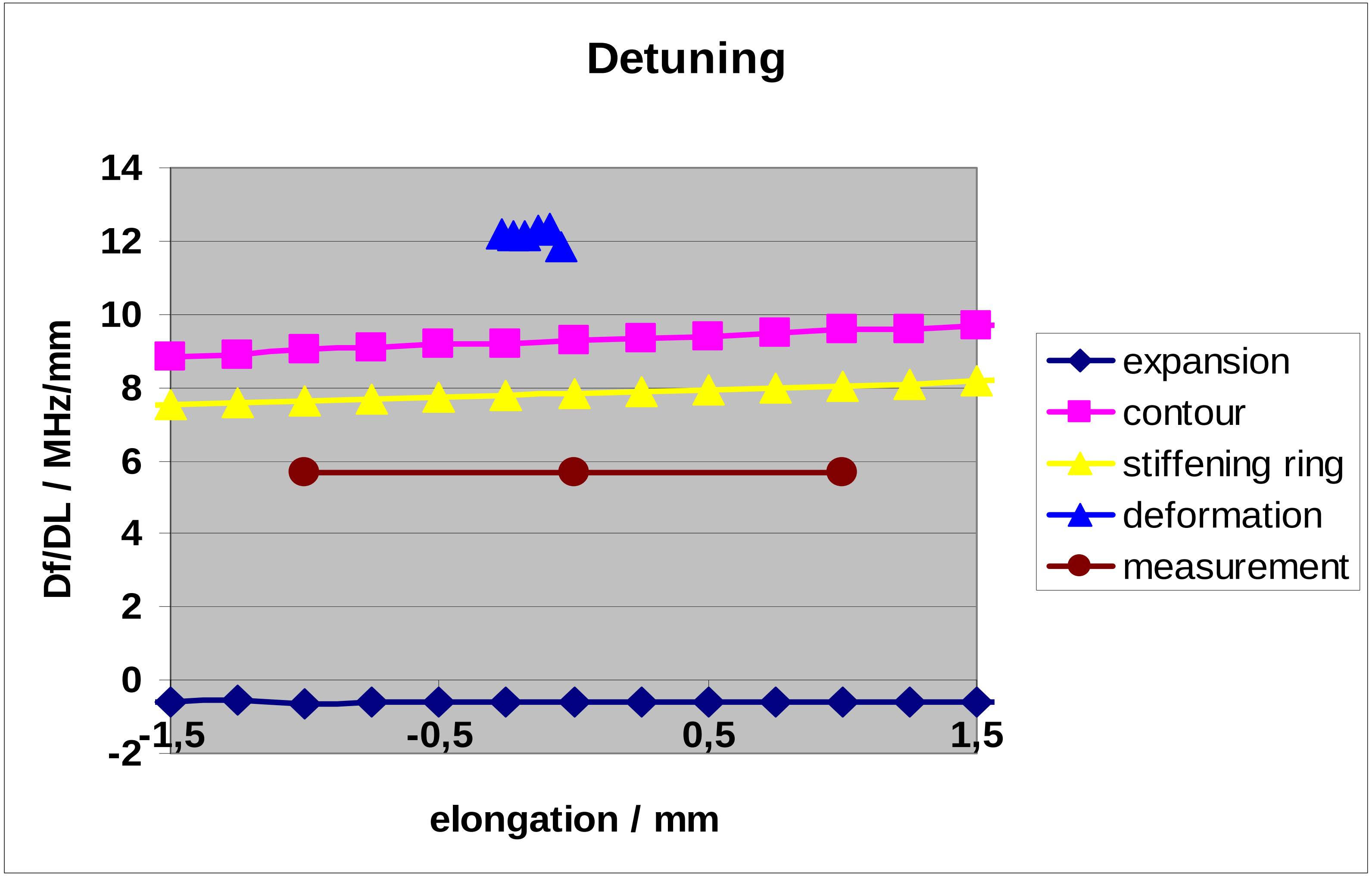
Different Methods of Deformation

- Linear Expansion
- Constant Length of 2D-Contours
- Constant Contours with Stiffening Ring
- Deformation from Numerical Simulation



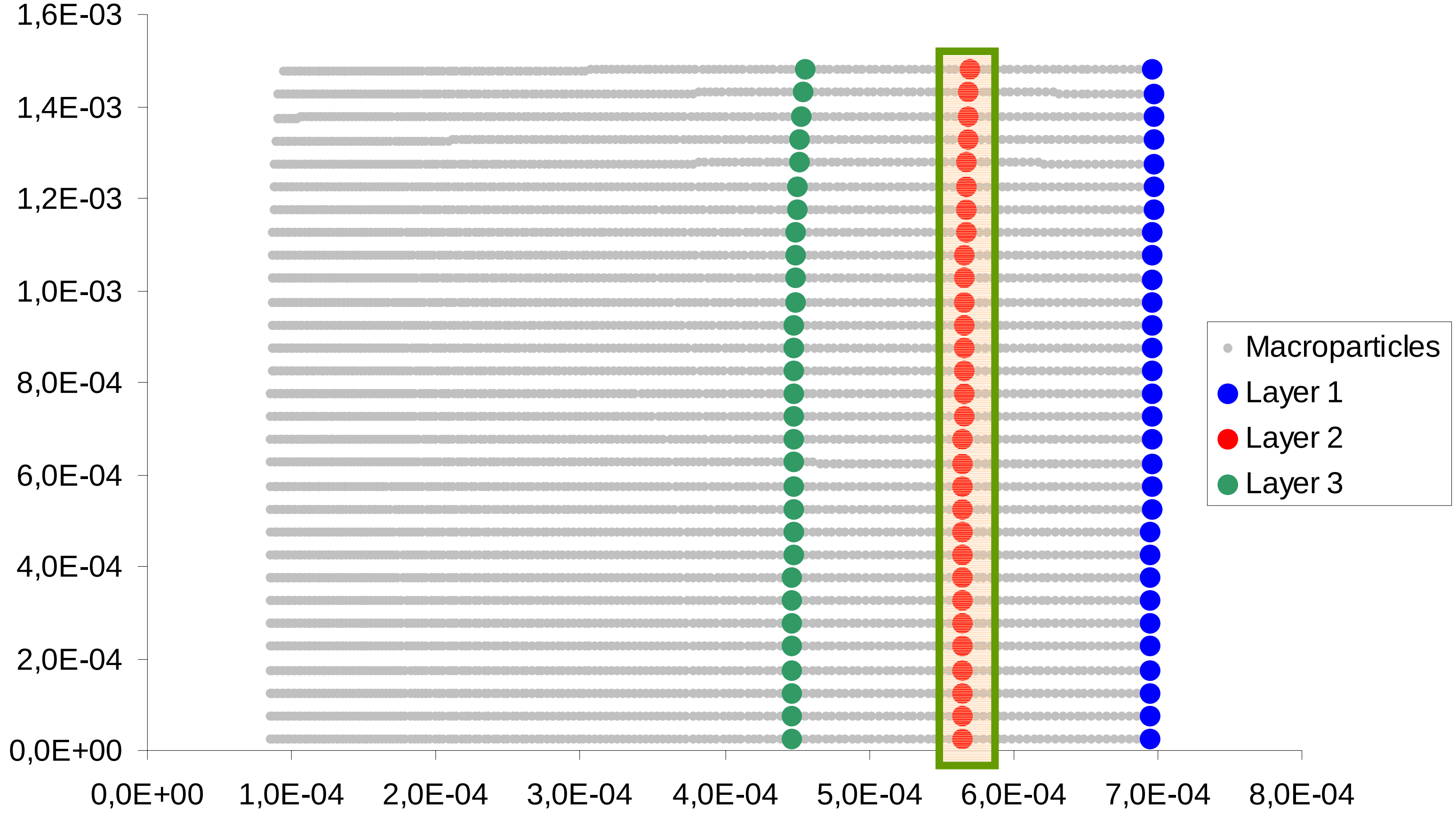
Results

- Detuning of a Half Cell in MHz/mm:

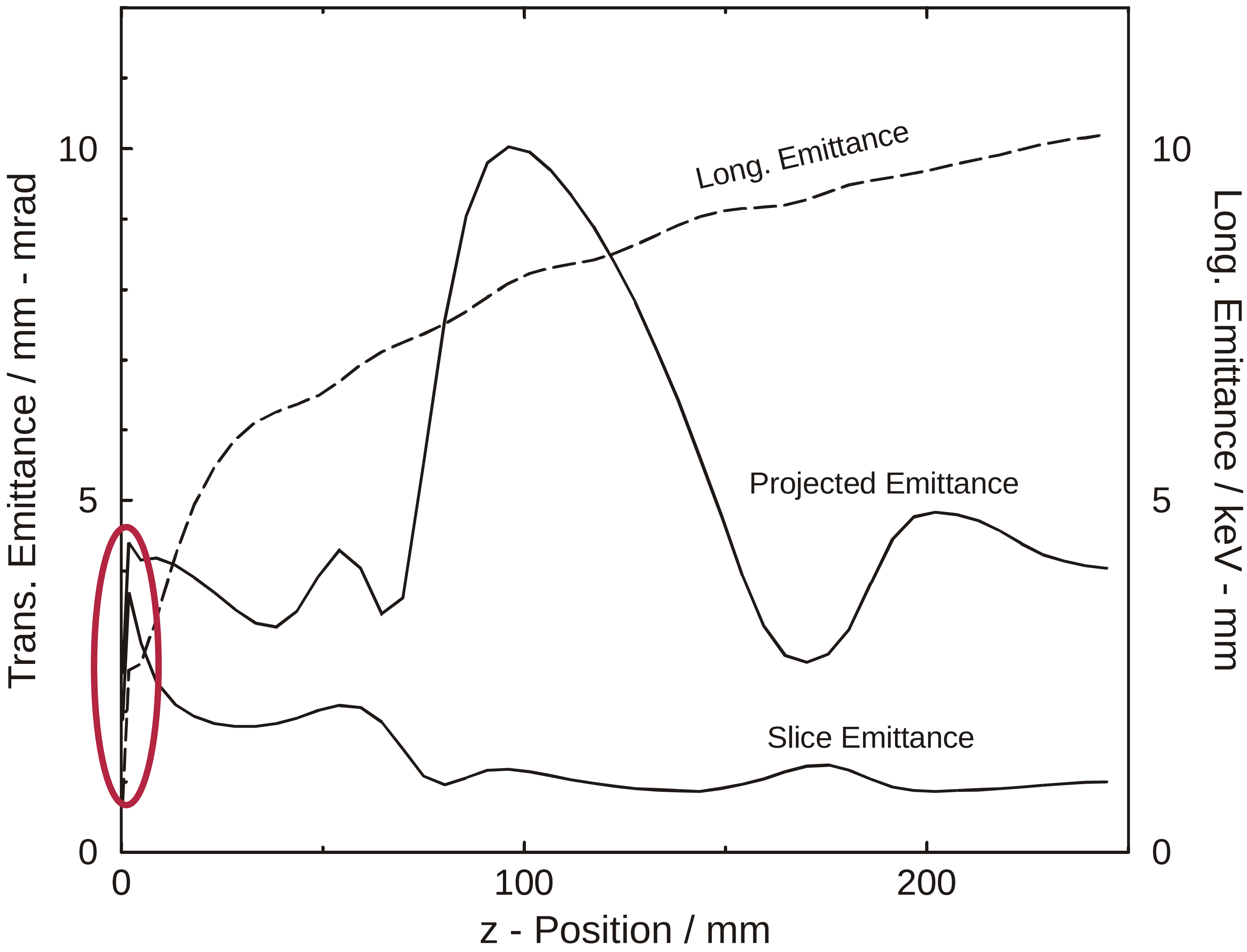


Space Charge Effects in the RF-Gun: Emittance Formation Study

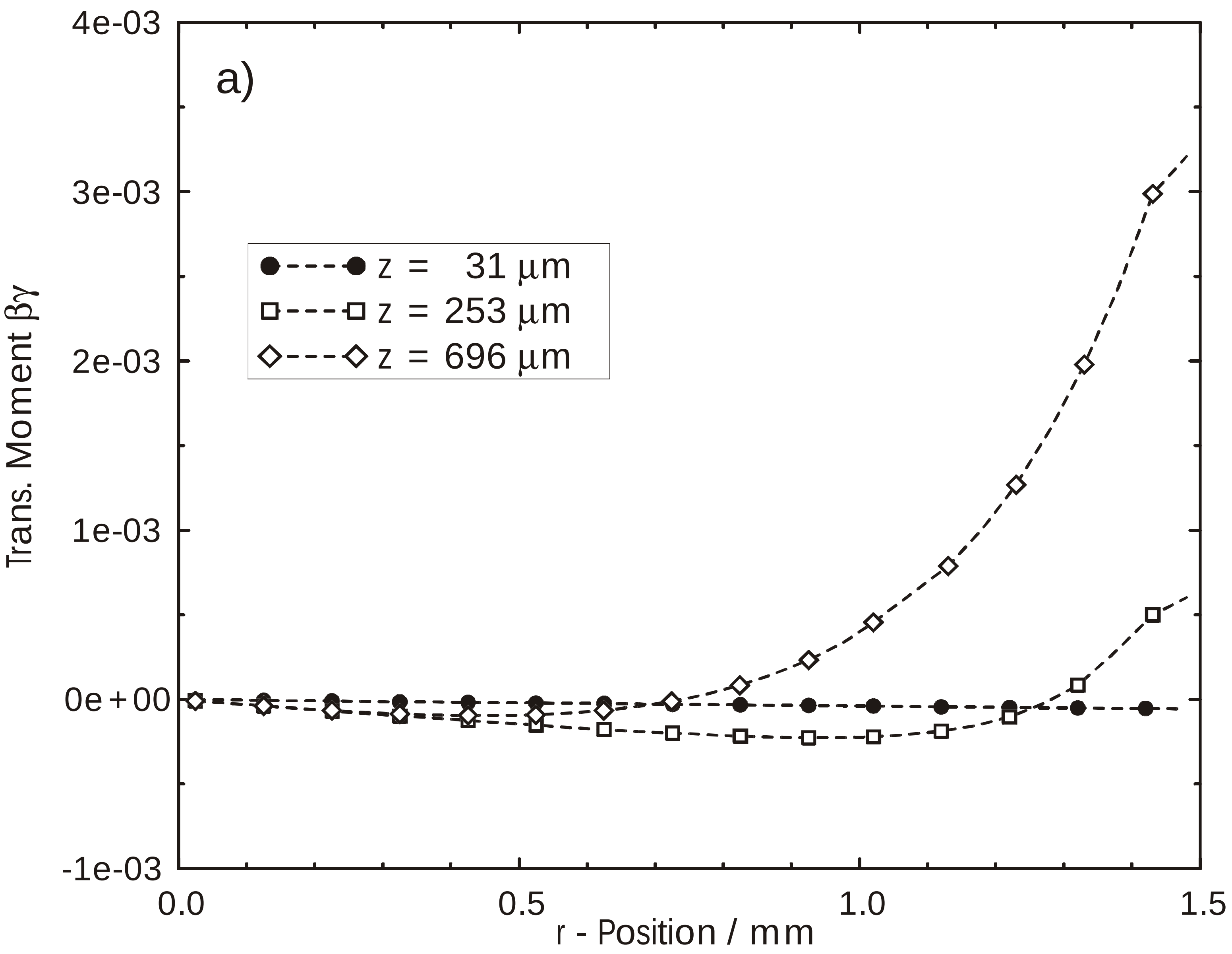
Beam slices



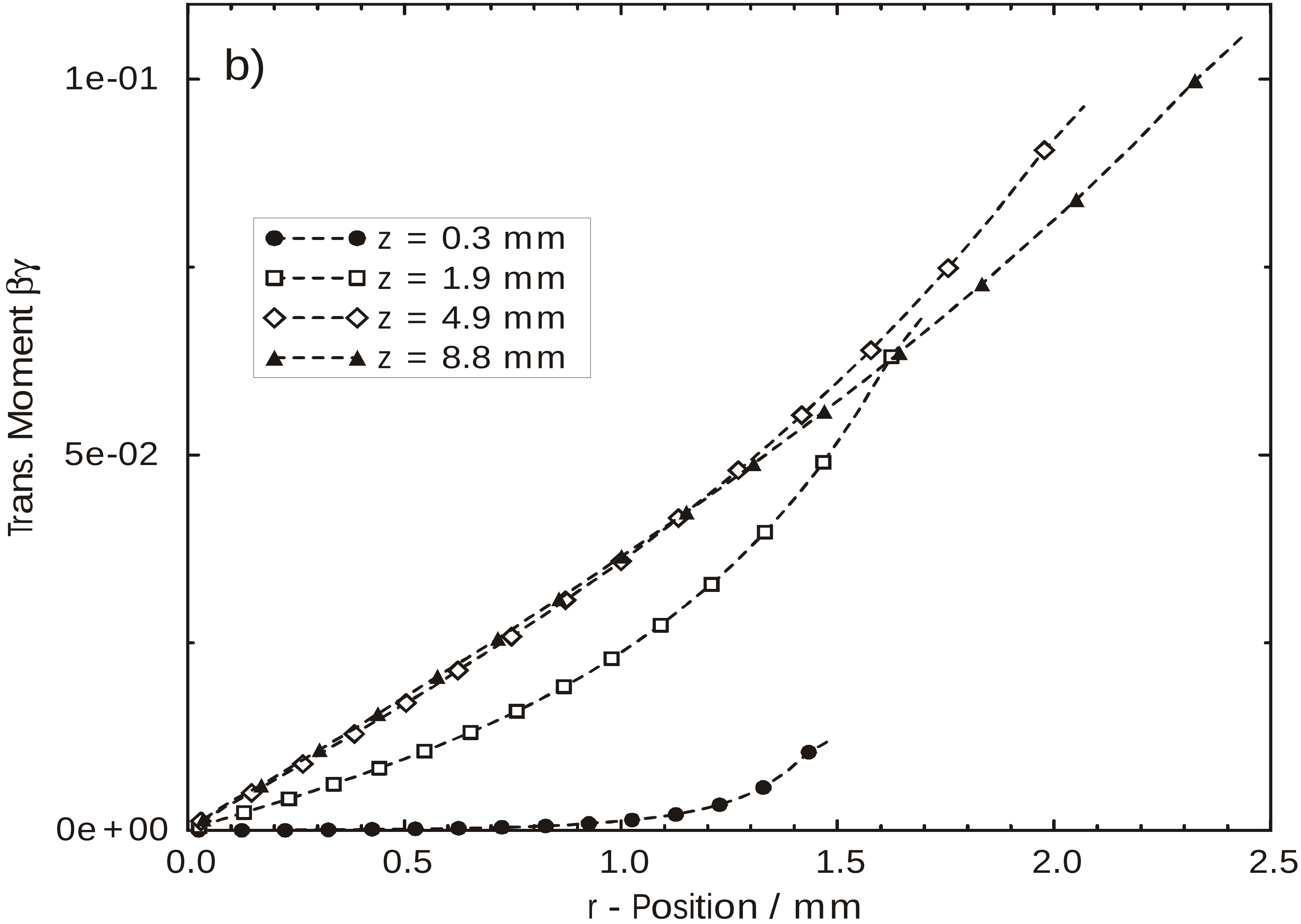
Space Charge Effects in the RF-Gun: Emittance Formation Study



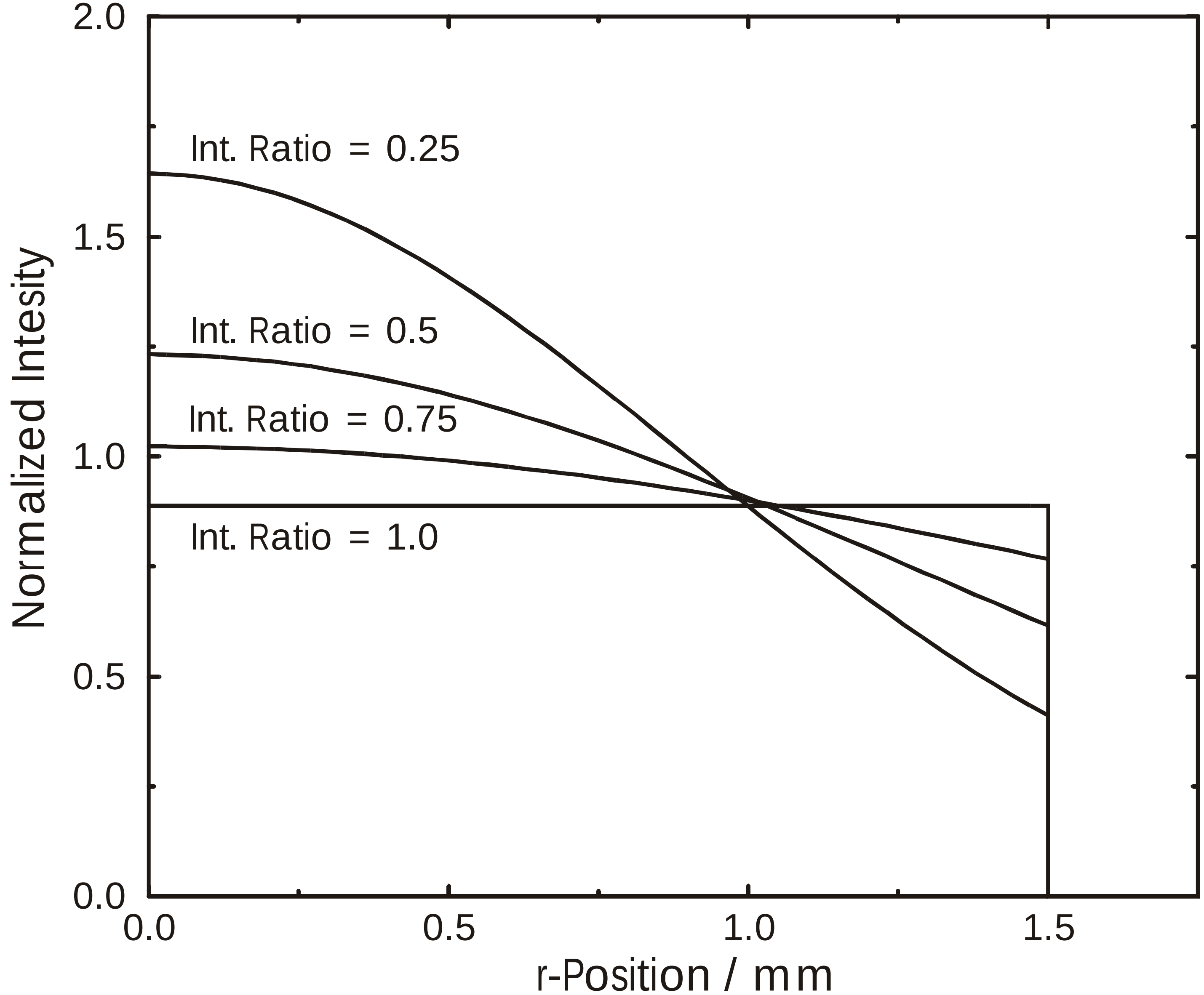
Space Charge Effects in the RF-Gun: Emittance Formation Study



Space Charge Effects in the RF-Gun: Emittance Formation Study

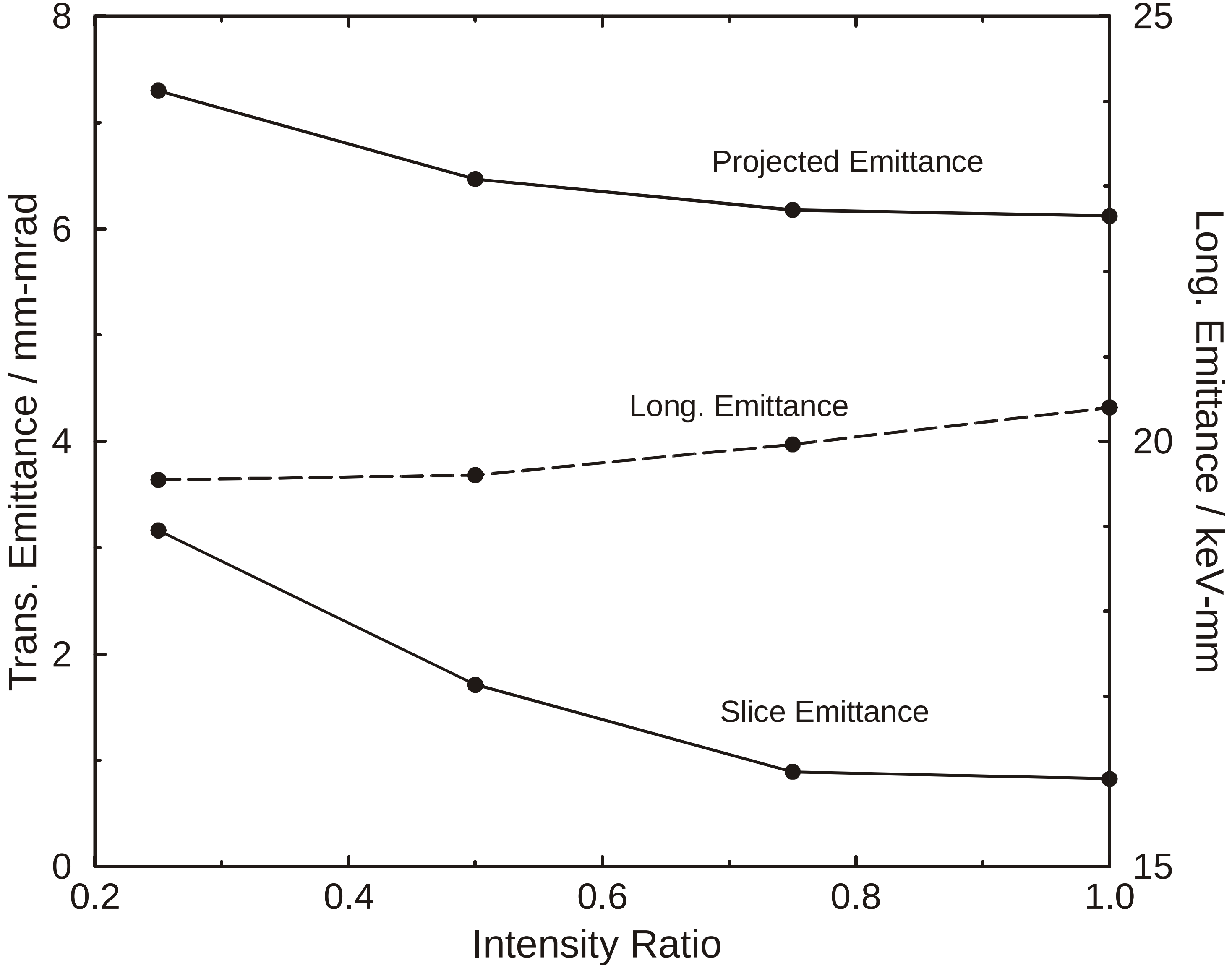


Influence of Transverse Laser Profiles on Beam Emittance at Gun Exit



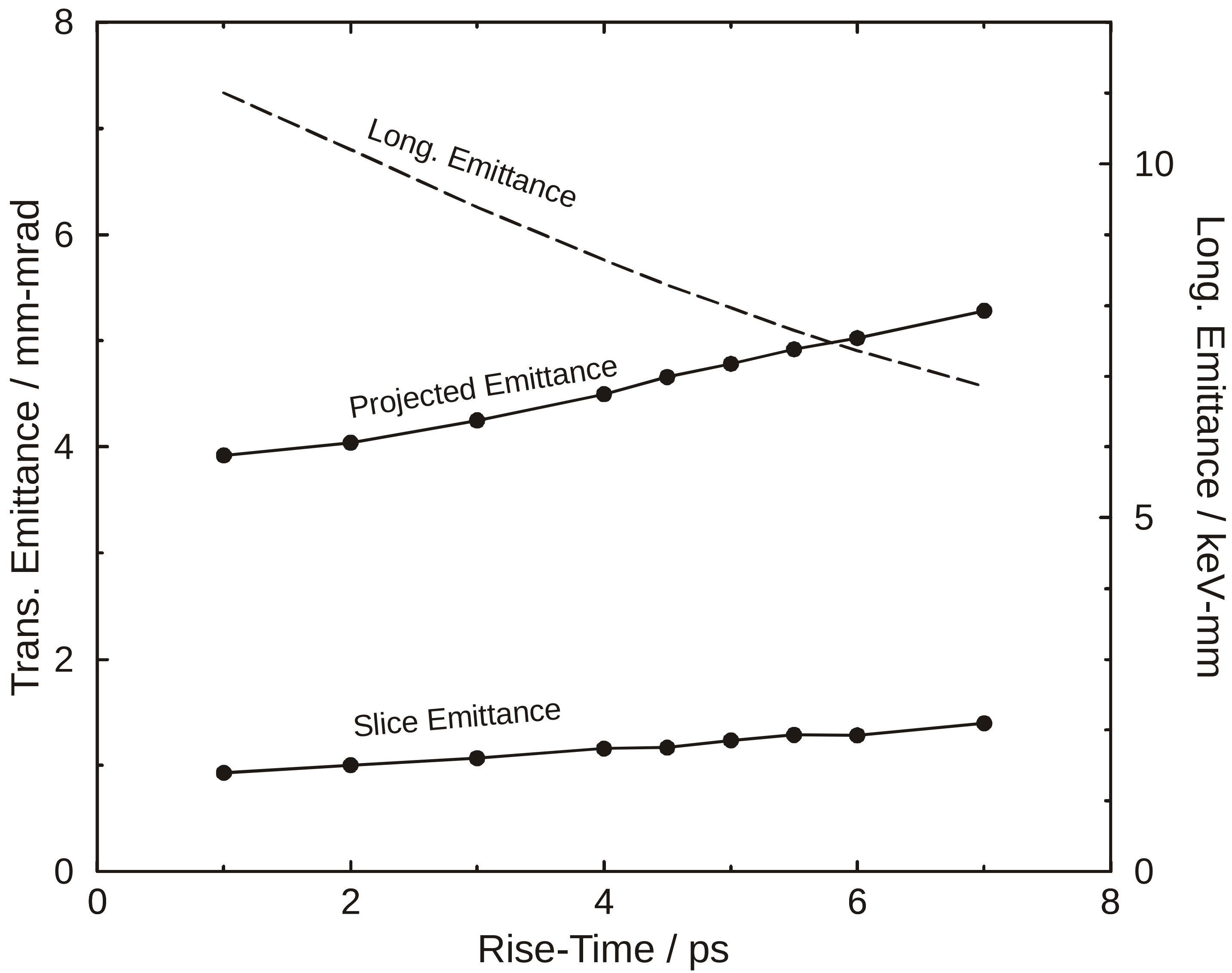
(Laser Pulse Length 10 ps FWHM, 2 ps rise/fall time)

Influence of Transverse Laser Profiles on Beam Emittance at Gun Exit

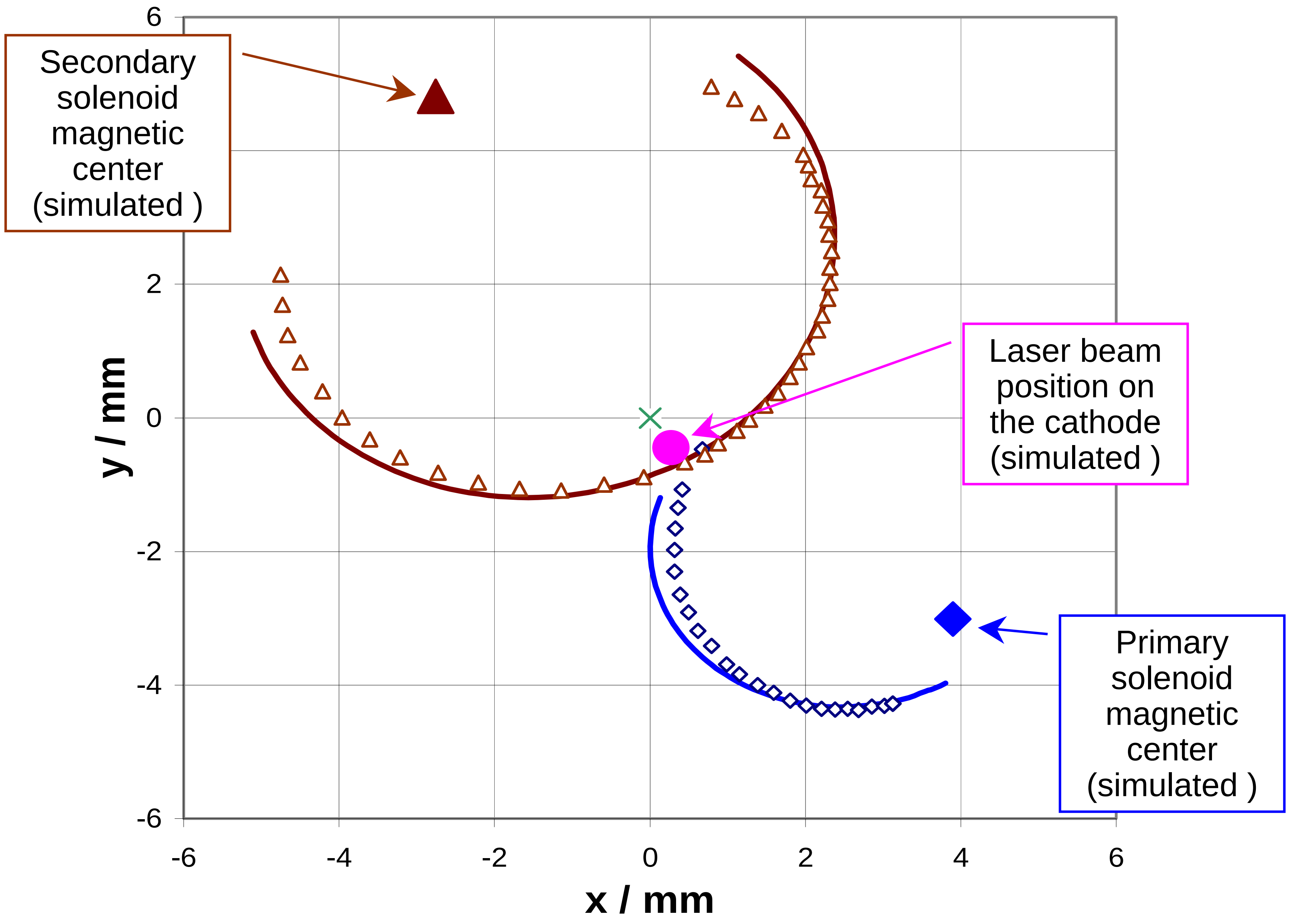


(Laser Pulse Length 10 ps FWHM, 2 ps rise/fall time)

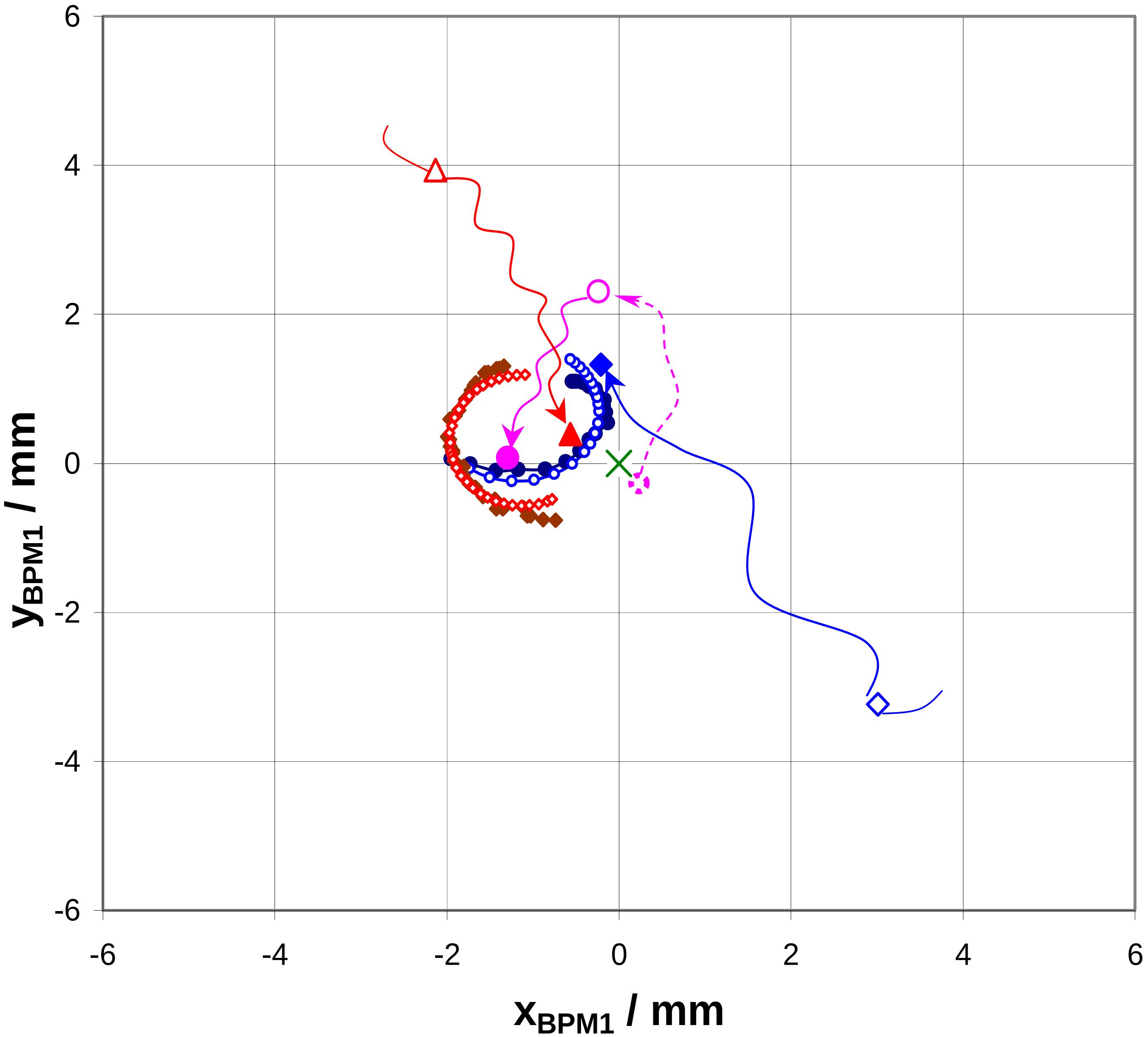
Dependency of the Emittances at the Gun Exit On the Laser Rise Time



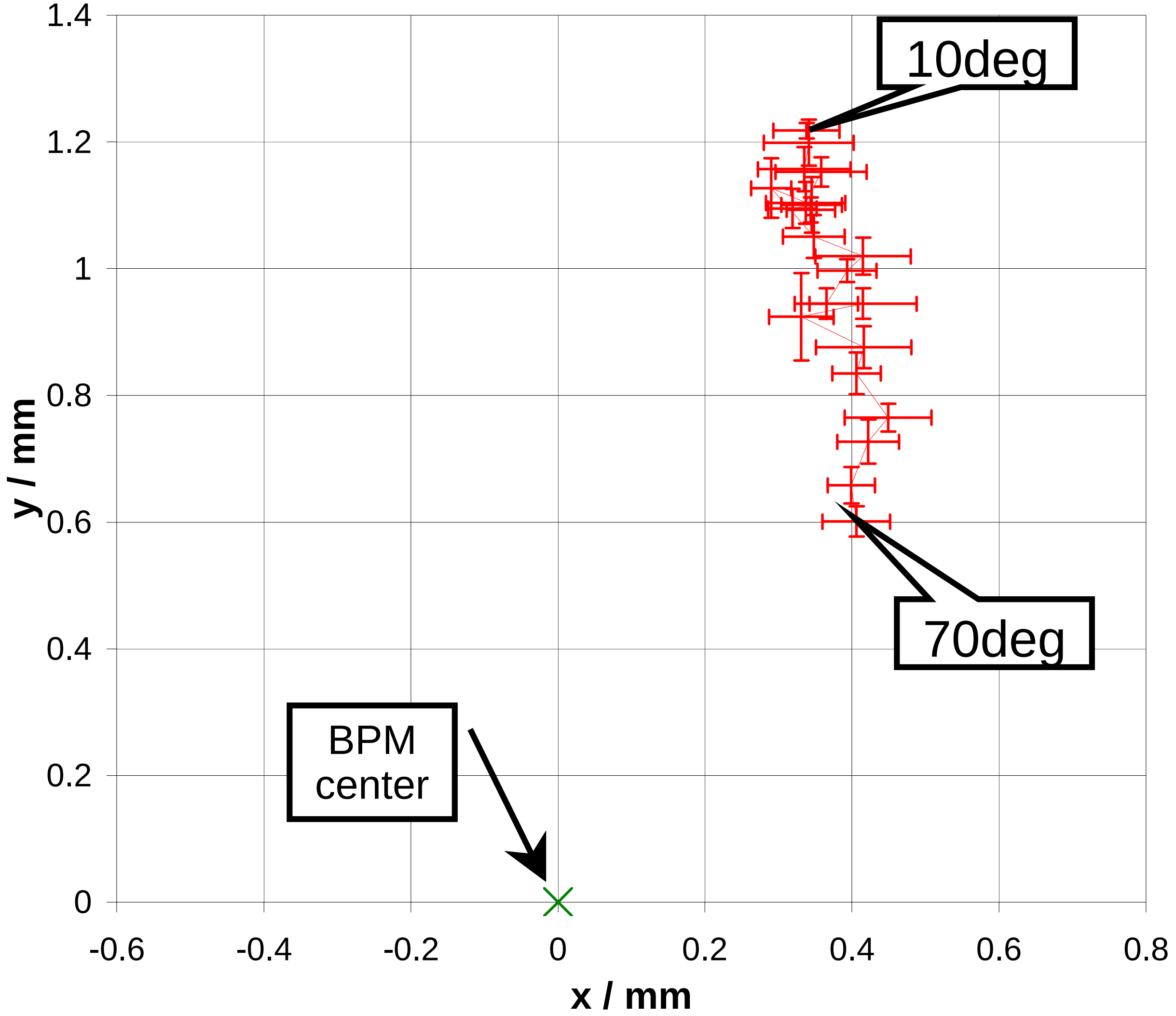
TTF Gun Alignment Study: Measurements&Simulations



TTF RF-Gun Alignment: First Steps



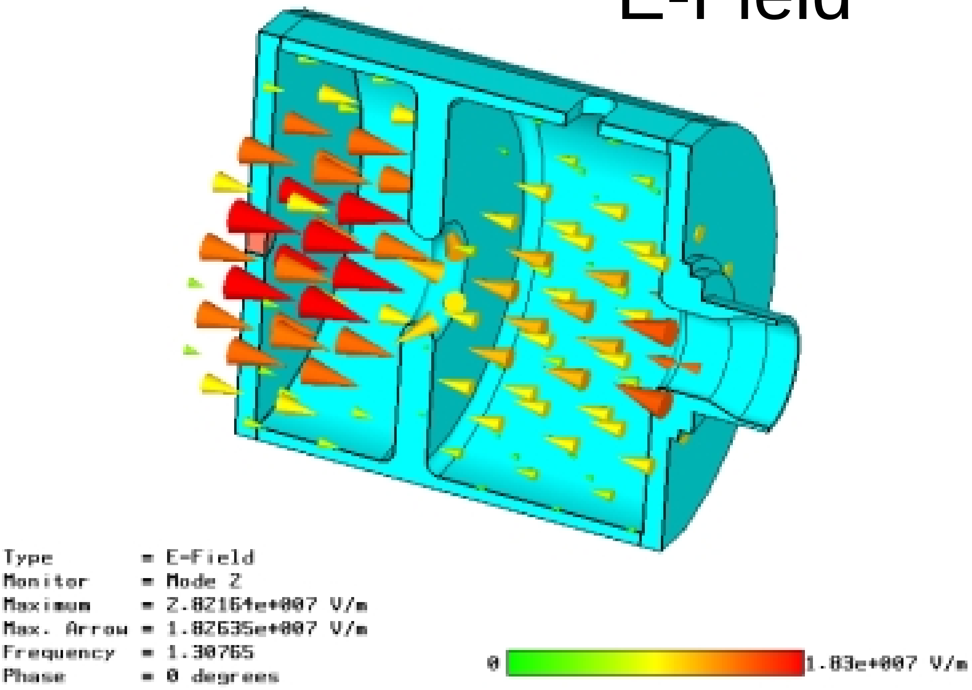
BPM1 Readings vs RF-Phase (with both solenoids off)



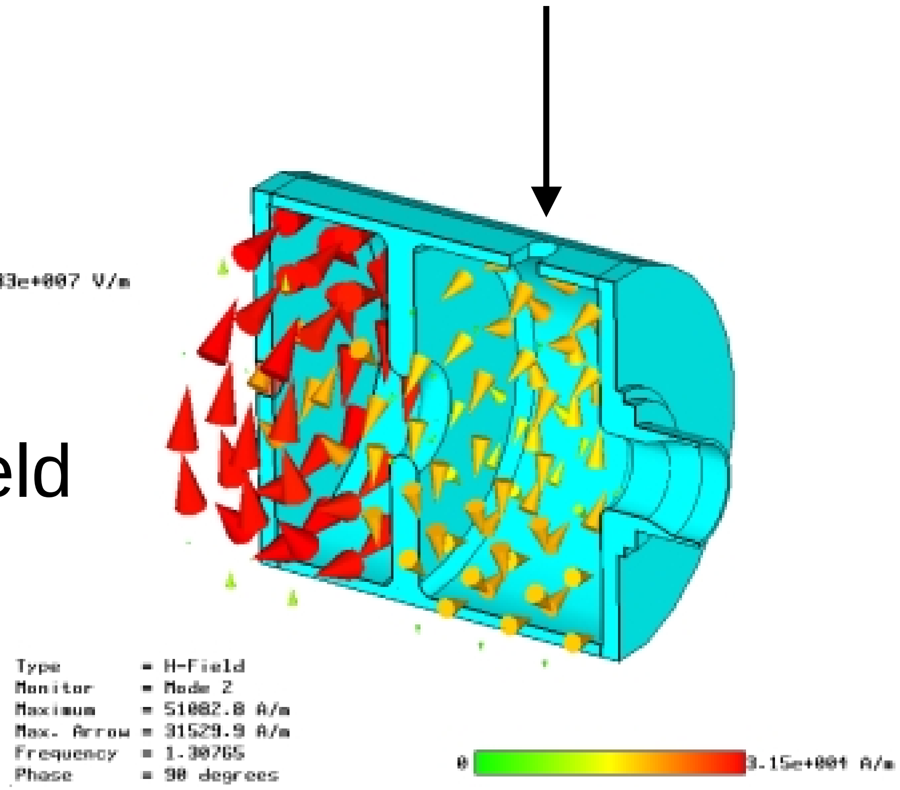
RF mode offset is to be taken into account

π-mode Offset Study

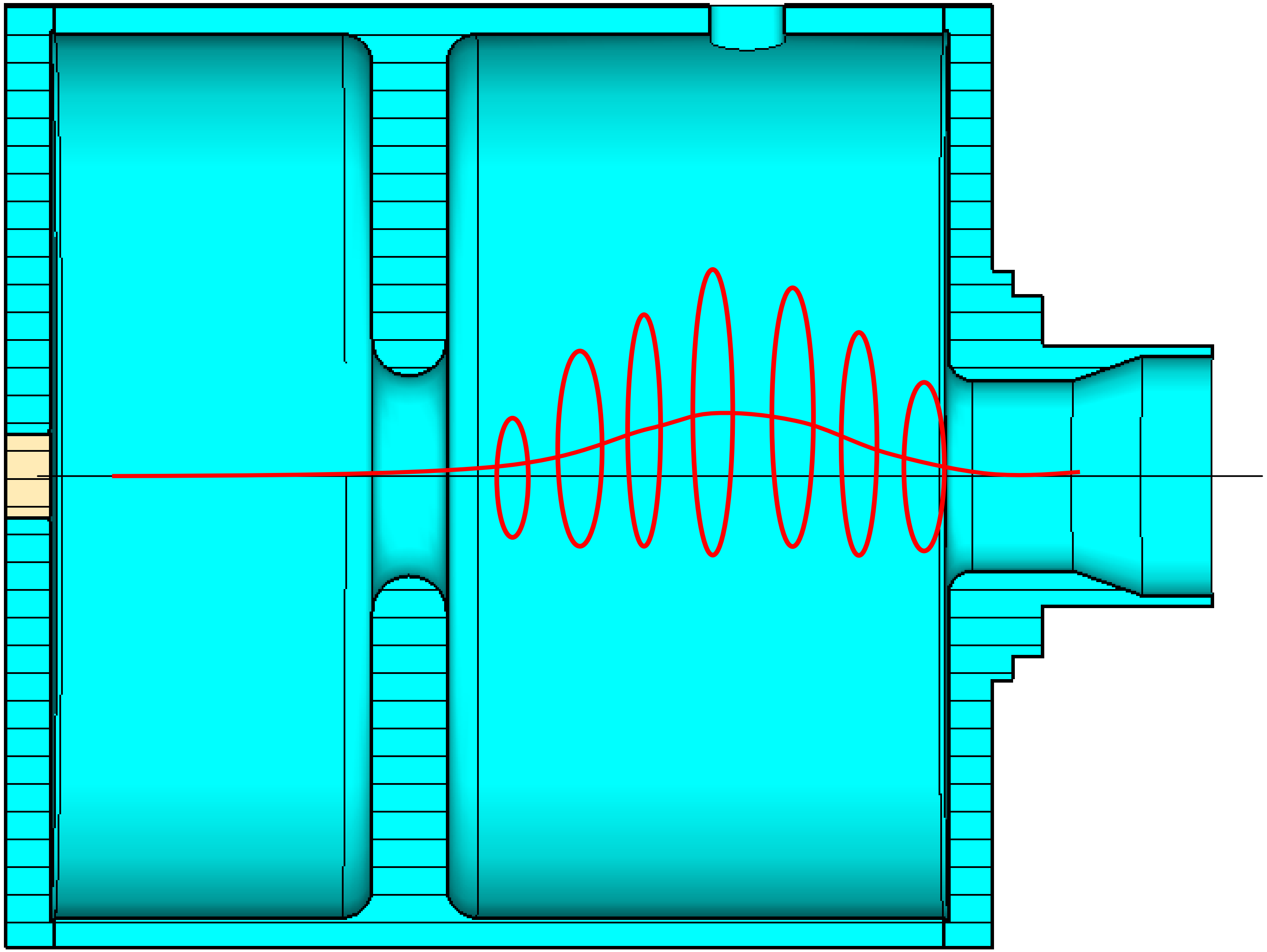
E-Field



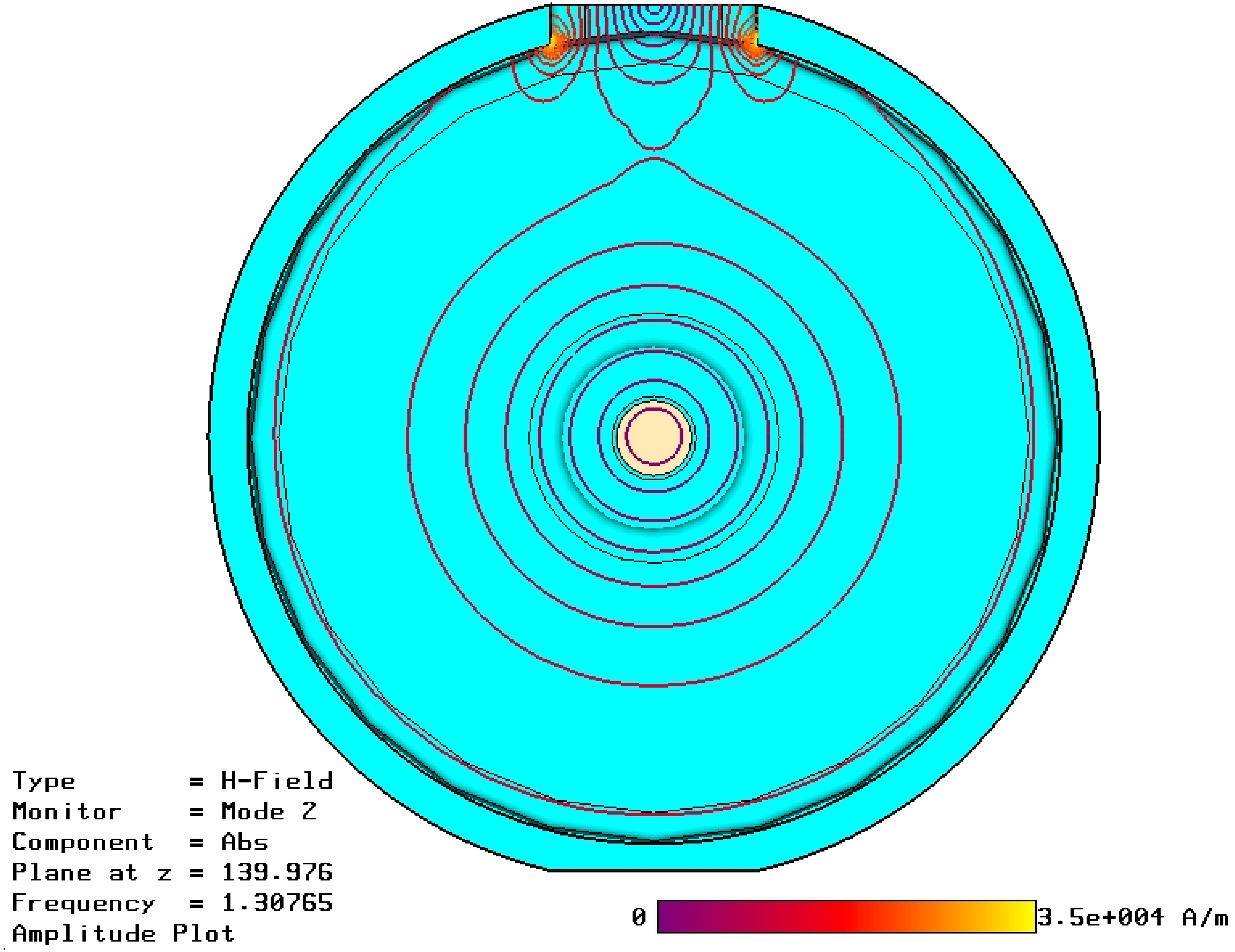
H-Field



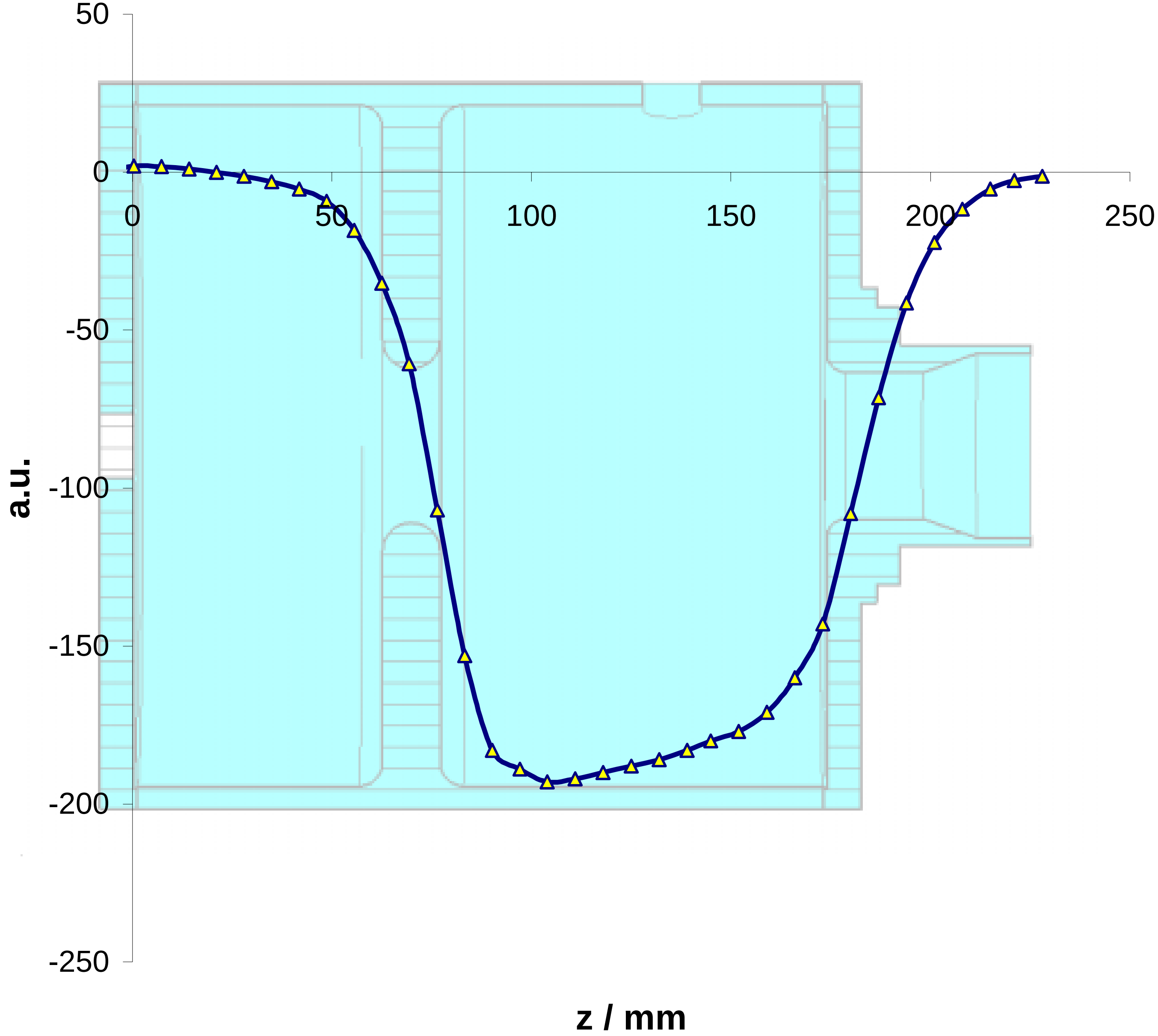
π-mode Offset Study



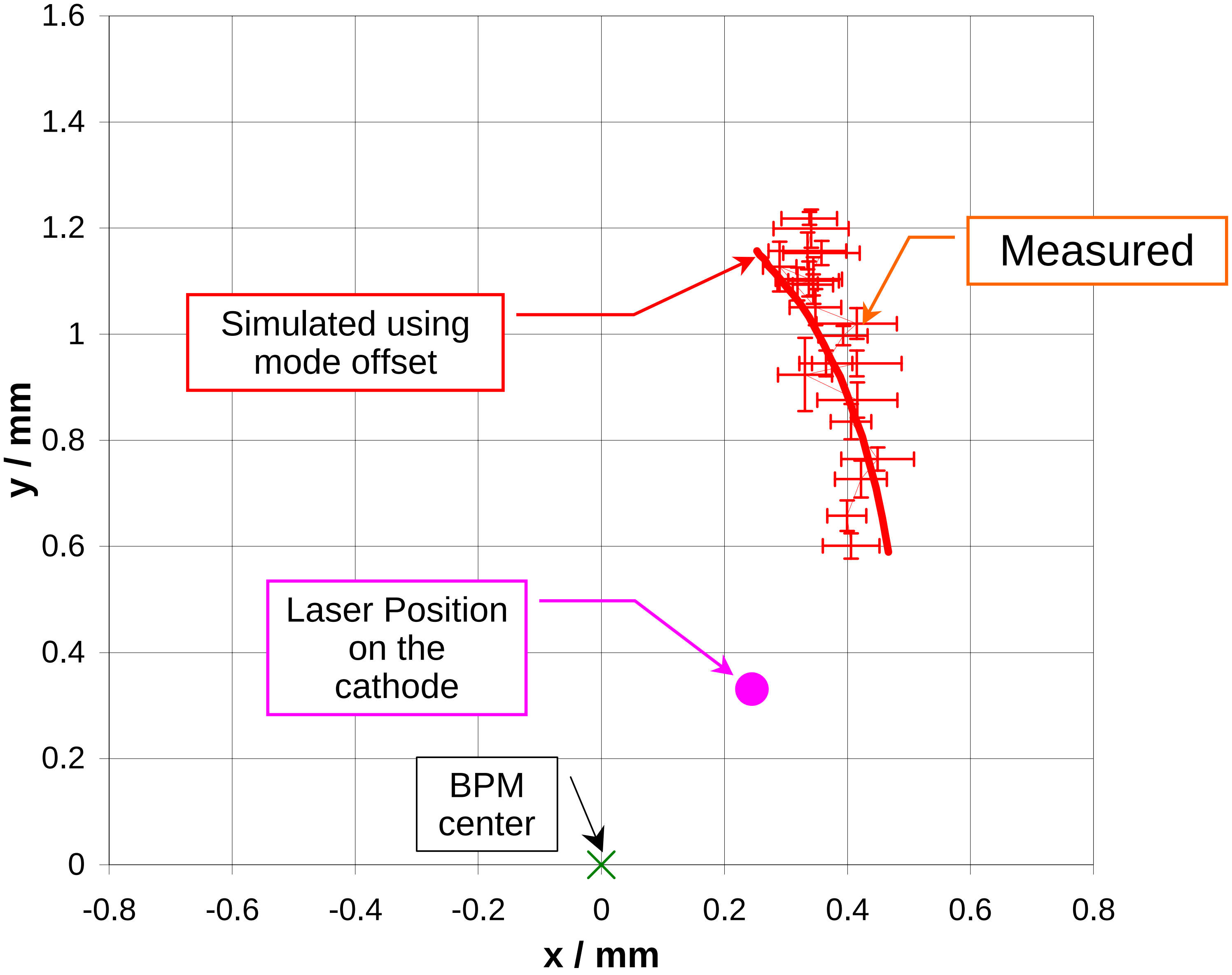
π-mode Offset Study : Magnetic Field Isolines



π-mode Offset Study: Hx on the cavity axis

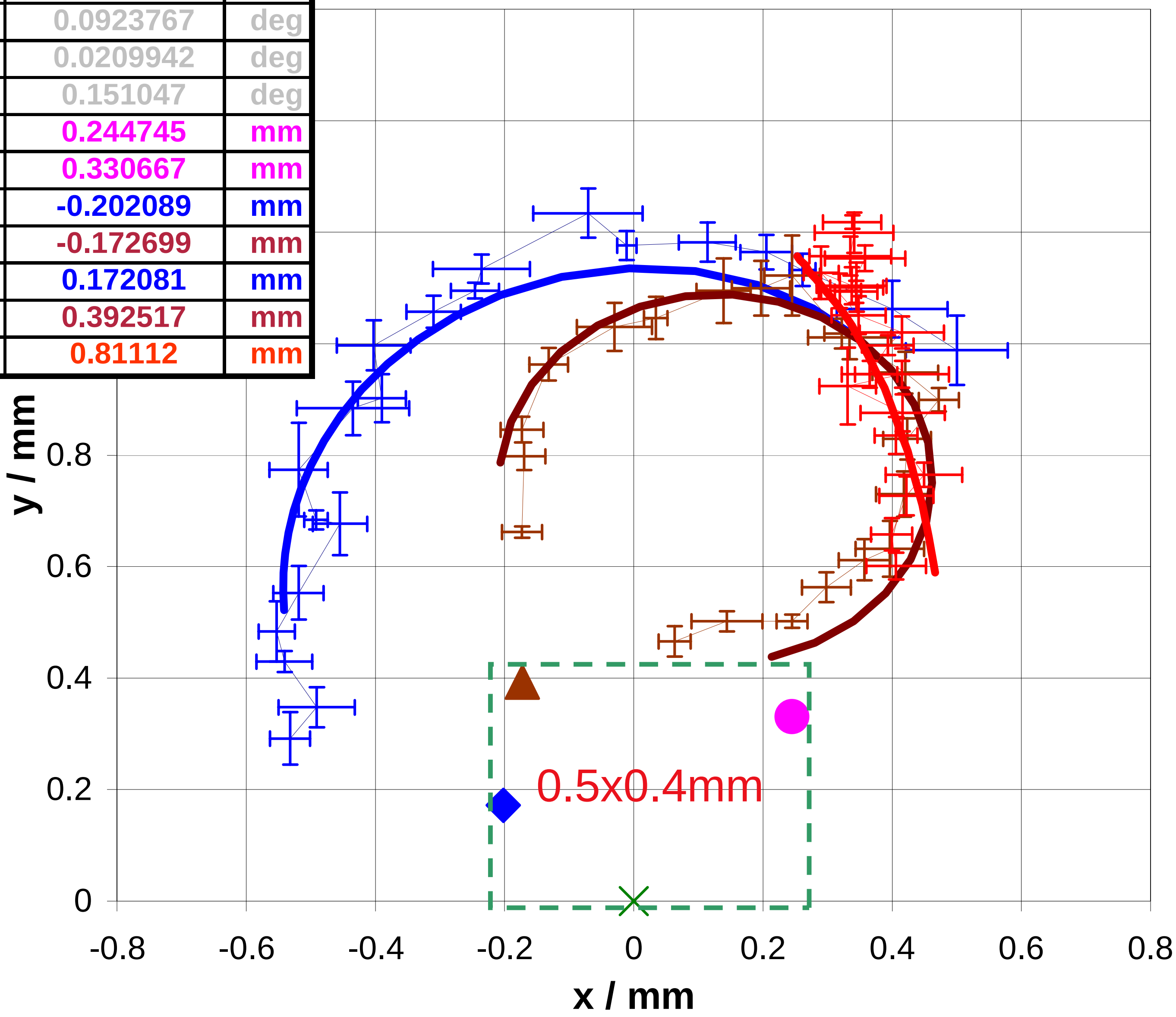


BPM1 Reading vs RF-Phase

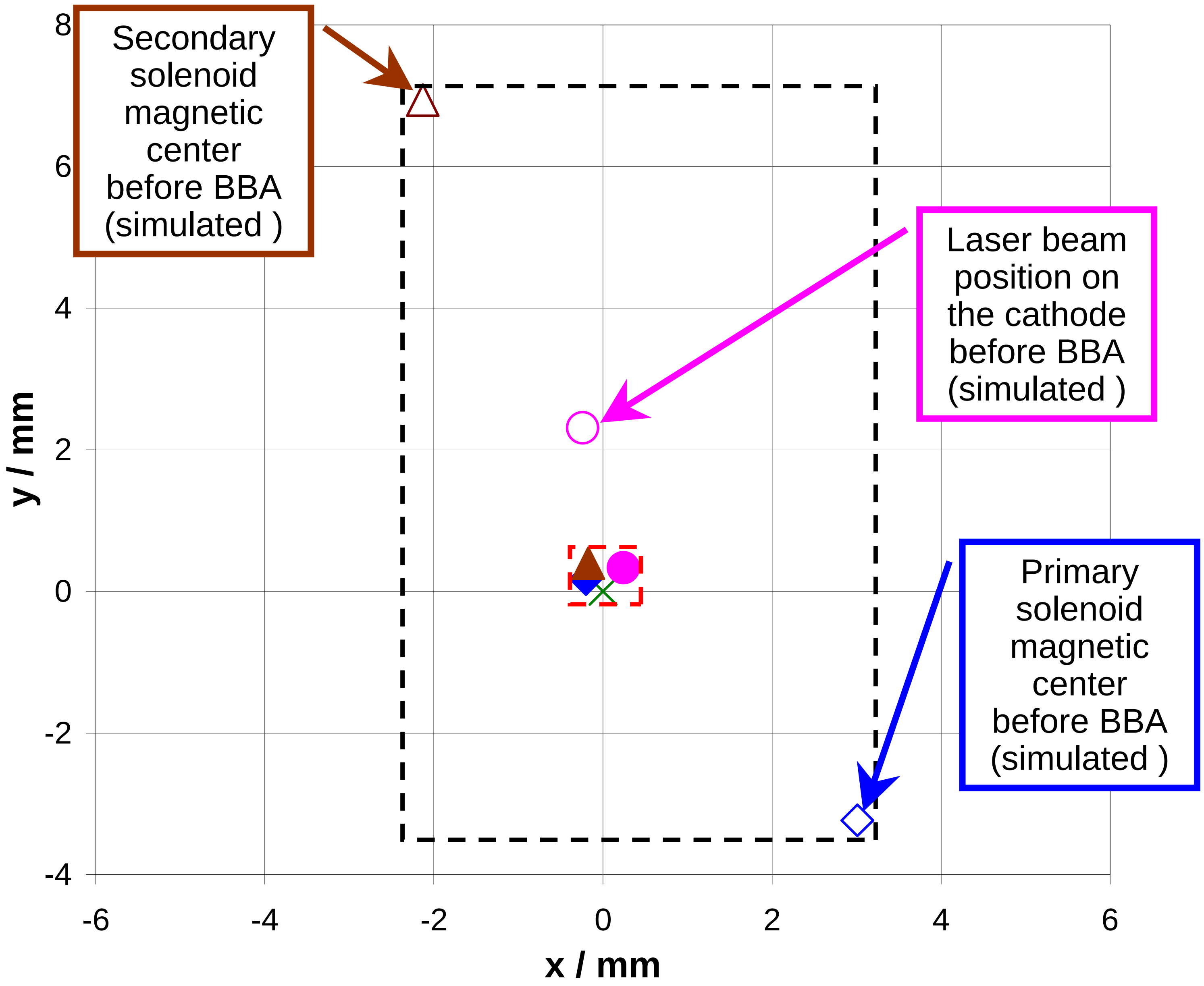


BPM1: Final Measurements&Simulations

AngleXSol1	0.0109052	deg
AngleXSol2	0.0923767	deg
AngleYSol1	0.0209942	deg
AngleYSol2	0.151047	deg
Laser_Beam_CenterX	0.244745	mm
Laser_Beam_CenterY	0.330667	mm
XSol1Center	-0.202089	mm
XSol2Center	-0.172699	mm
YSol1Center	0.172081	mm
YSol2Center	0.392517	mm
Y_nonsym	0.81112	mm



TTF RF-Gun Alignment: Before and After



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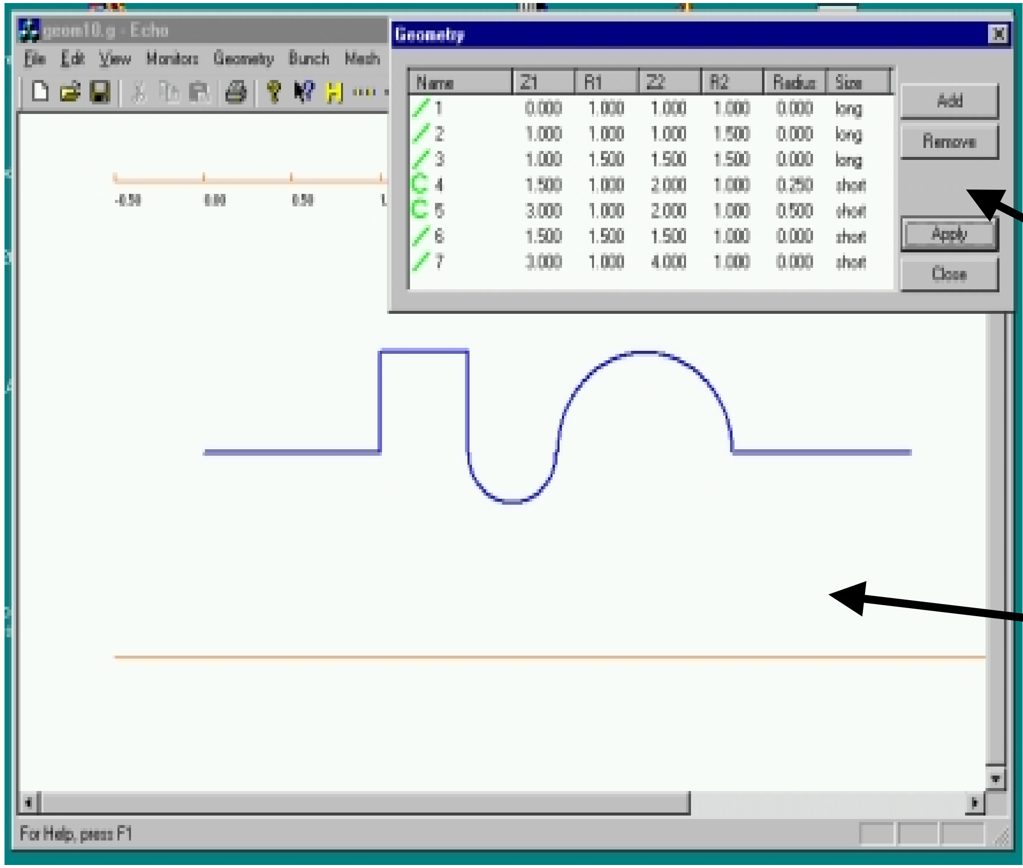
A Code for Longitudinal Wake Field Calculation



Geometry editor

Boundary shape

The implicit scheme [A.Novokhatski]:

- does not have dispersion in longitudinal direction.
- allows calculation for very long structures
- travelling mesh

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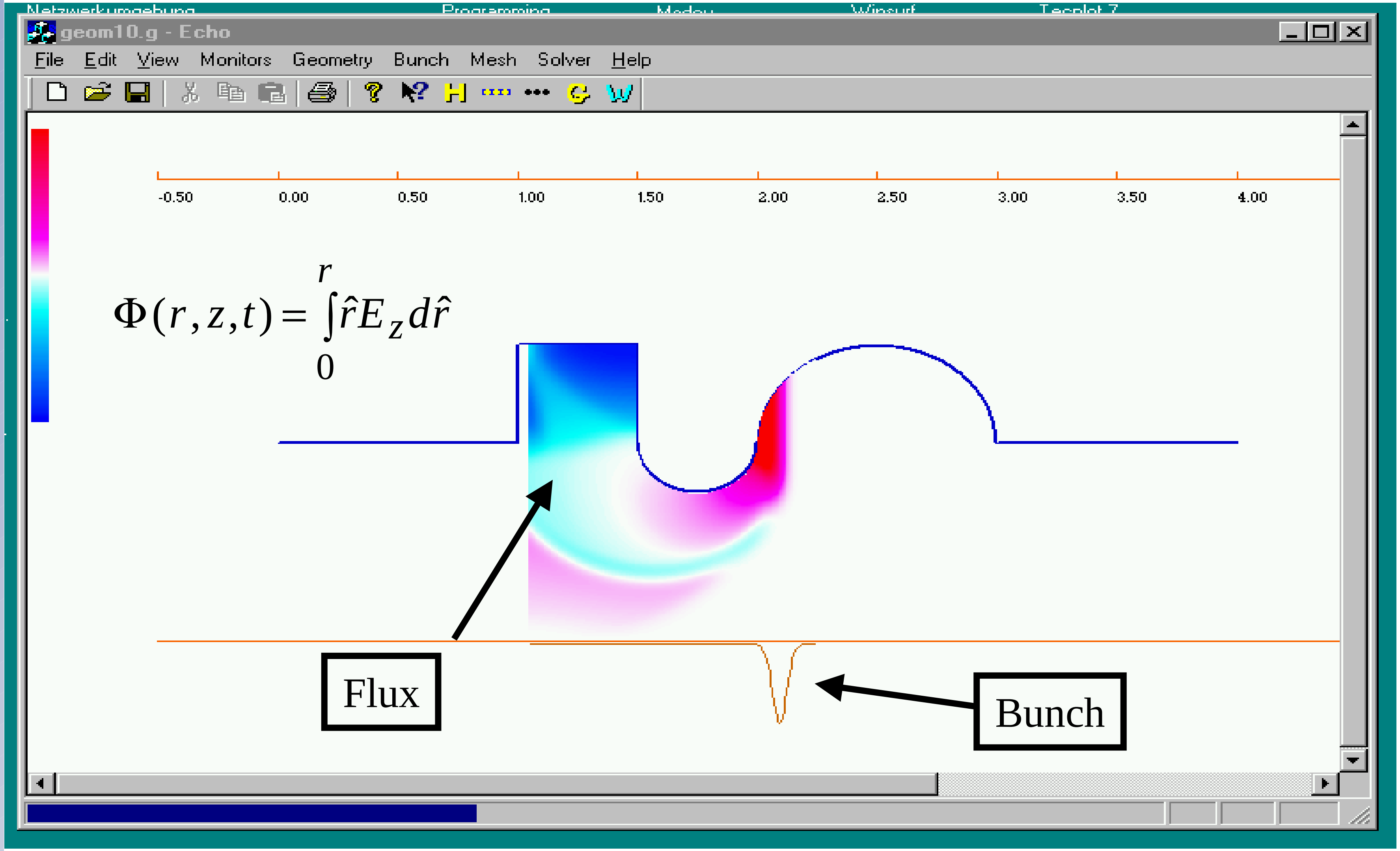
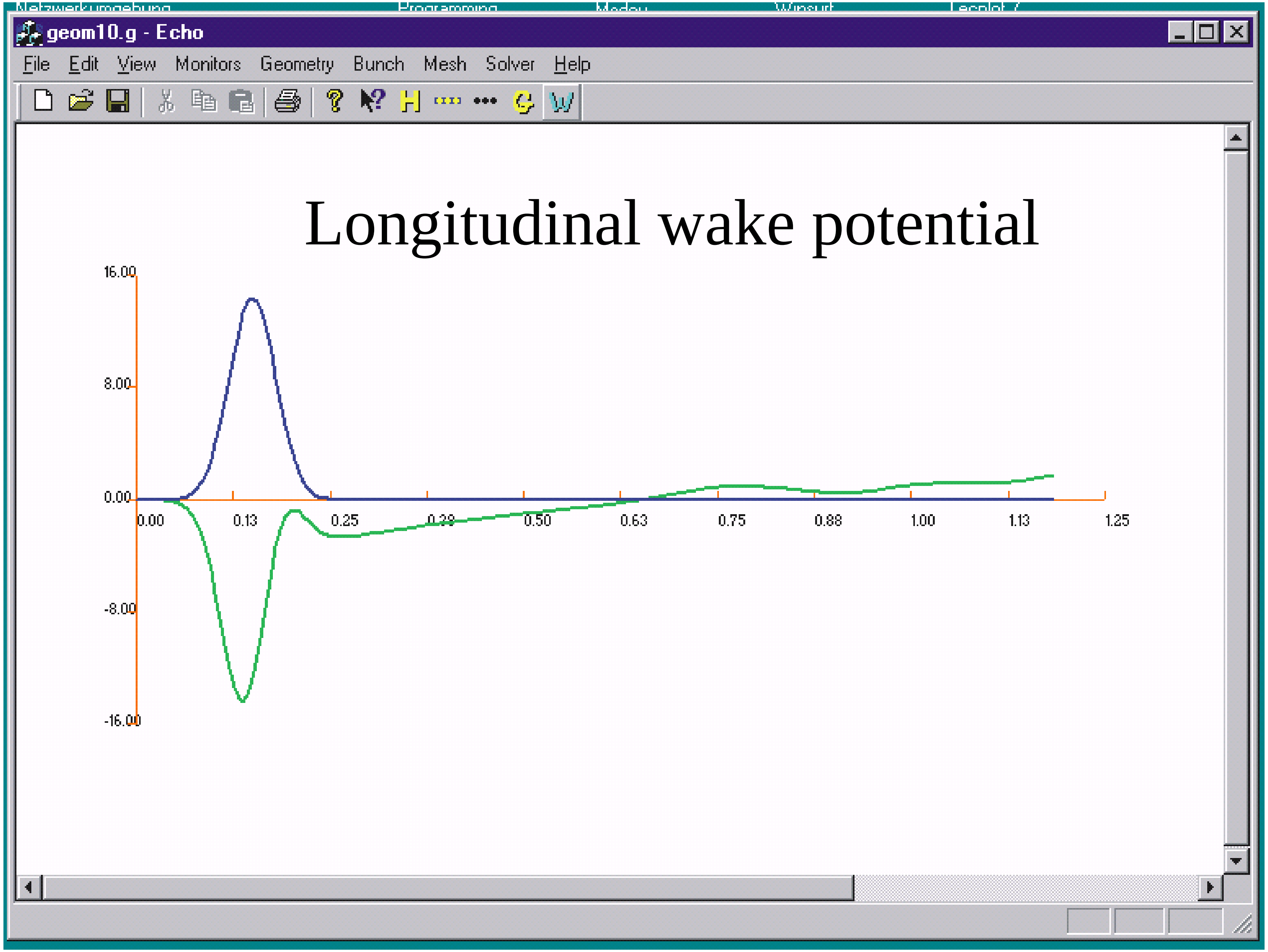
A Code for Longitudinal Wake Field Calculation



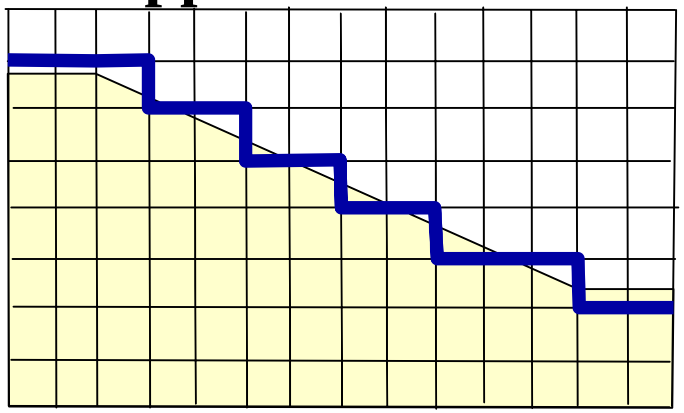
A Code for Longitudinal Wake Field Calculation



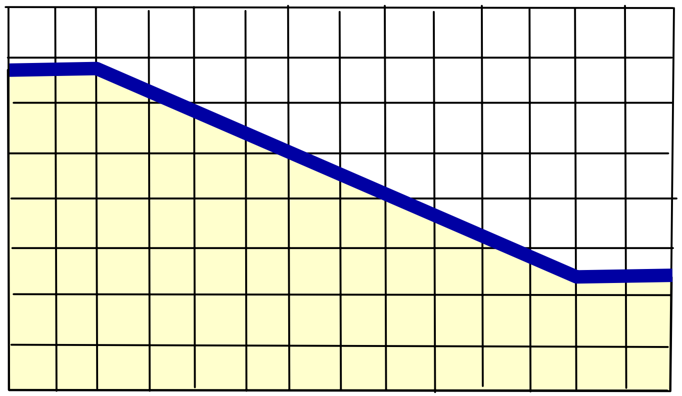
A Code for Longitudinal Wake Field Calculation

The staircase boundary approximation is realized in the code.

Staircase boundary approximation



Perfect boundary approximation



O(h) - - - - - - → O(h^2)

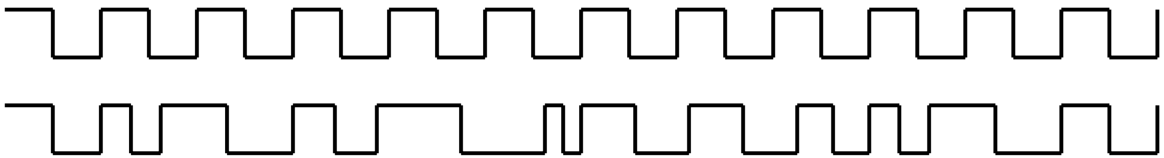
The new implicit scheme with perfect boundary approximation is developed.

It will allow calculation of longitudinal wake potential for **long smooth structures.**

Investigation of Surface Roughness Wake Fields

- **Further studies on the rough tube model according to A.Novokhatski and M. Timm.**

  - considered forms of 2D surface corrugations



periodic

non-periodic

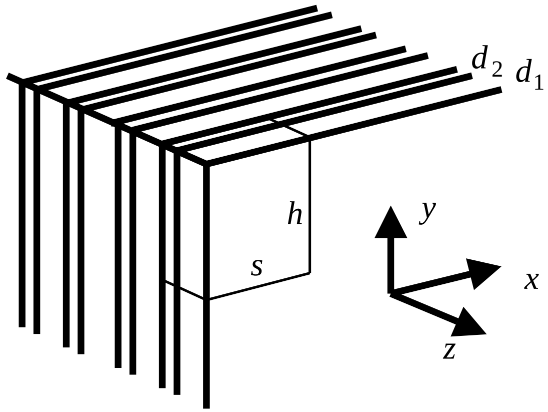
  - these corrugations are replaced by a single homogeneous layer of some equivalent dielectric constant

  - So far always $\varepsilon_r = 2$ was assumed, whilst the theoretical justification for this assumption was missing.

Wavenumber of Rough Tube Mode

- anisotropic averaging of the material distribution in the corrugation layer

$$\varepsilon_z \cong \varepsilon_1 \frac{d_1 + d_2}{d_1} \qquad \varepsilon_{x,y} \cong \frac{\kappa_2}{i\omega} \frac{d_2}{d_1 + d_2}$$



- new result for the wave number of the rough tube mode in contrast to the wave number of the thin dielectric layer mode

$$k^2_{0,RTM} = \frac{2\varepsilon_z}{R\delta} = \frac{2}{R\delta} \frac{d_1 + d_2}{d_1}$$

$$k^2_{0,TDLM} = \frac{2}{R\delta} \frac{\varepsilon_r}{\varepsilon_r - 1}$$

- this wavenumber is consistent with a mode matching calculation done by K. Bane and G. Stupakov
- further details see:
  - S.Ratschow, T. Weiland, M.Timm: On the mechanism of surface roughness wake field excitation. presented at PAC2001, Chicago, TOAA010.