RF Gun
Beam Based Alignment

PITZ1 Experience

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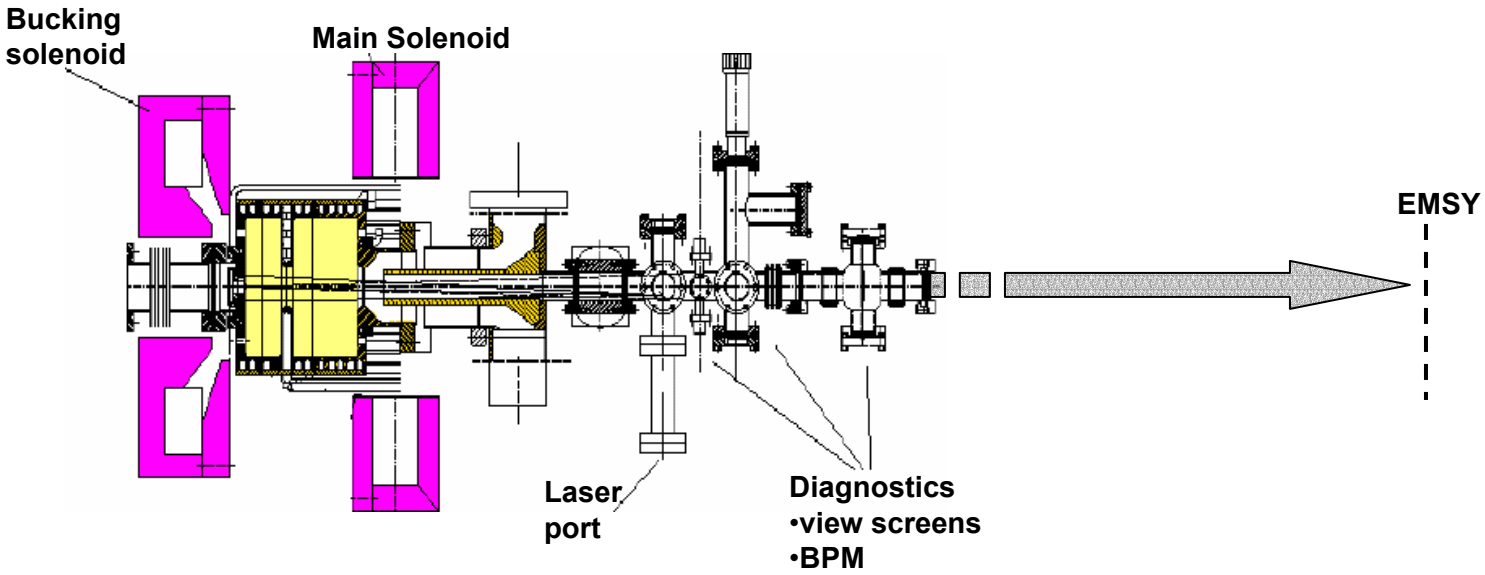
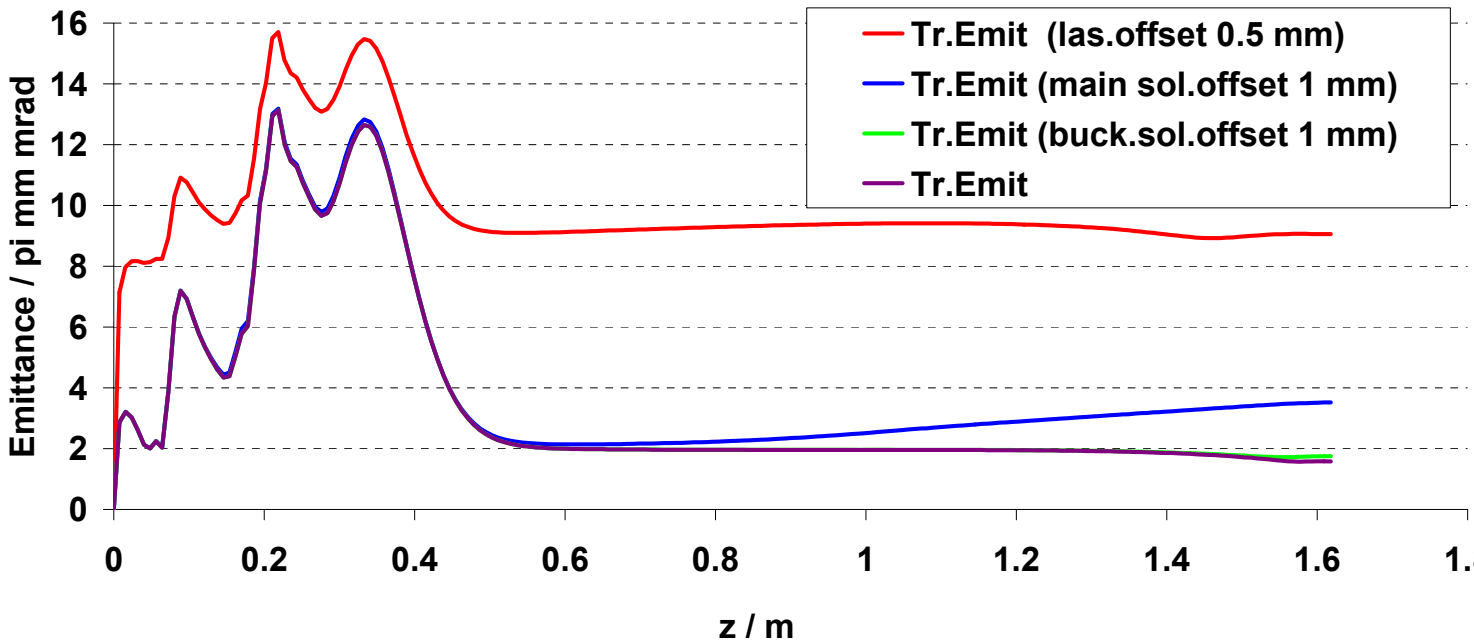
- Electron beam misalignments in the RF Gun
- PITZ1 RF gun alignment
  - Cathode laser alignment
  - Solenoid alignment
  - Reference RF phase
- Conclusions

Electron Beam Misalignments in the RF Gun





ASTRA simulations:

Laser:
Hom:XYrms=0.5mm
F-T:Lt/rt=20/2 ps
Therm. Ek=0.55 eV

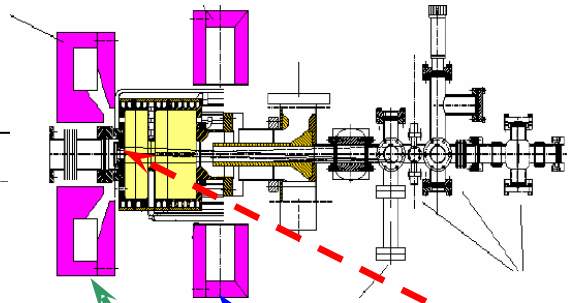
RF:
Ecath=42 MV/m
Phase=-3.5 deg

Main solenoid
Bz_max=0.174T
@0.276m (~300A)

Buck. Solenoid
On

Electron Beam Misalignments in the RF Gun

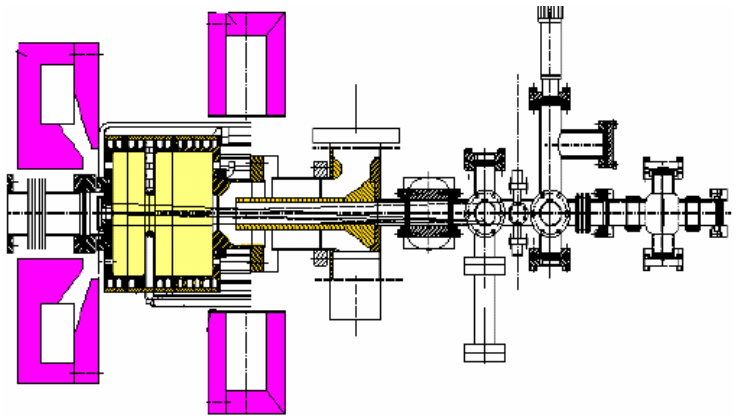
ASTRA simulation



Beam Based Alignment Principles

Sweep RF gun and solenoid parameters

Electron beam position measurements



Simulation of misalignment

Correction of misalignment

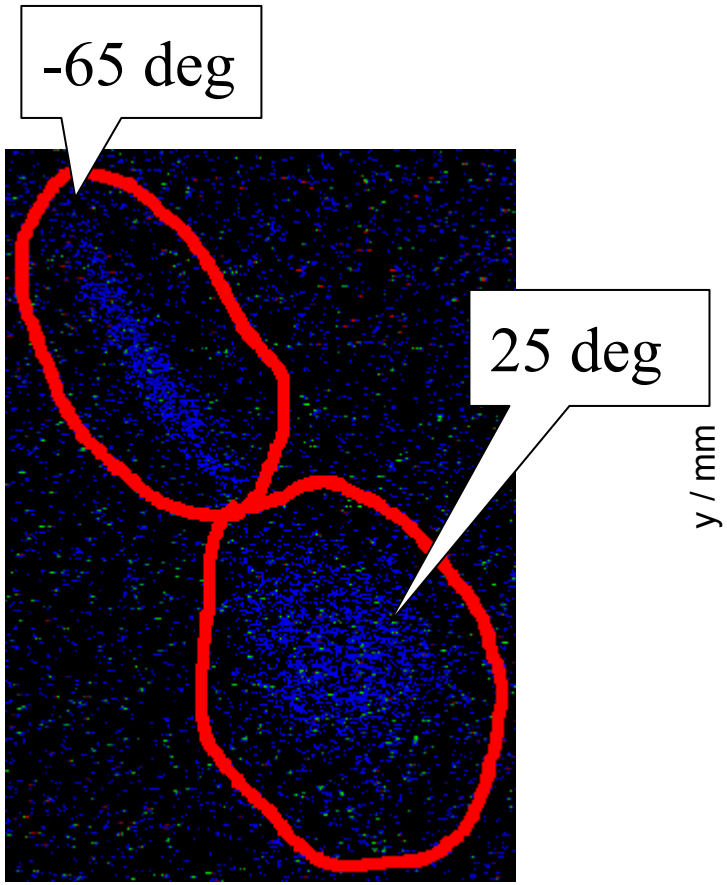
PITZ1 RF Gun vs. TTF1 RF Gun

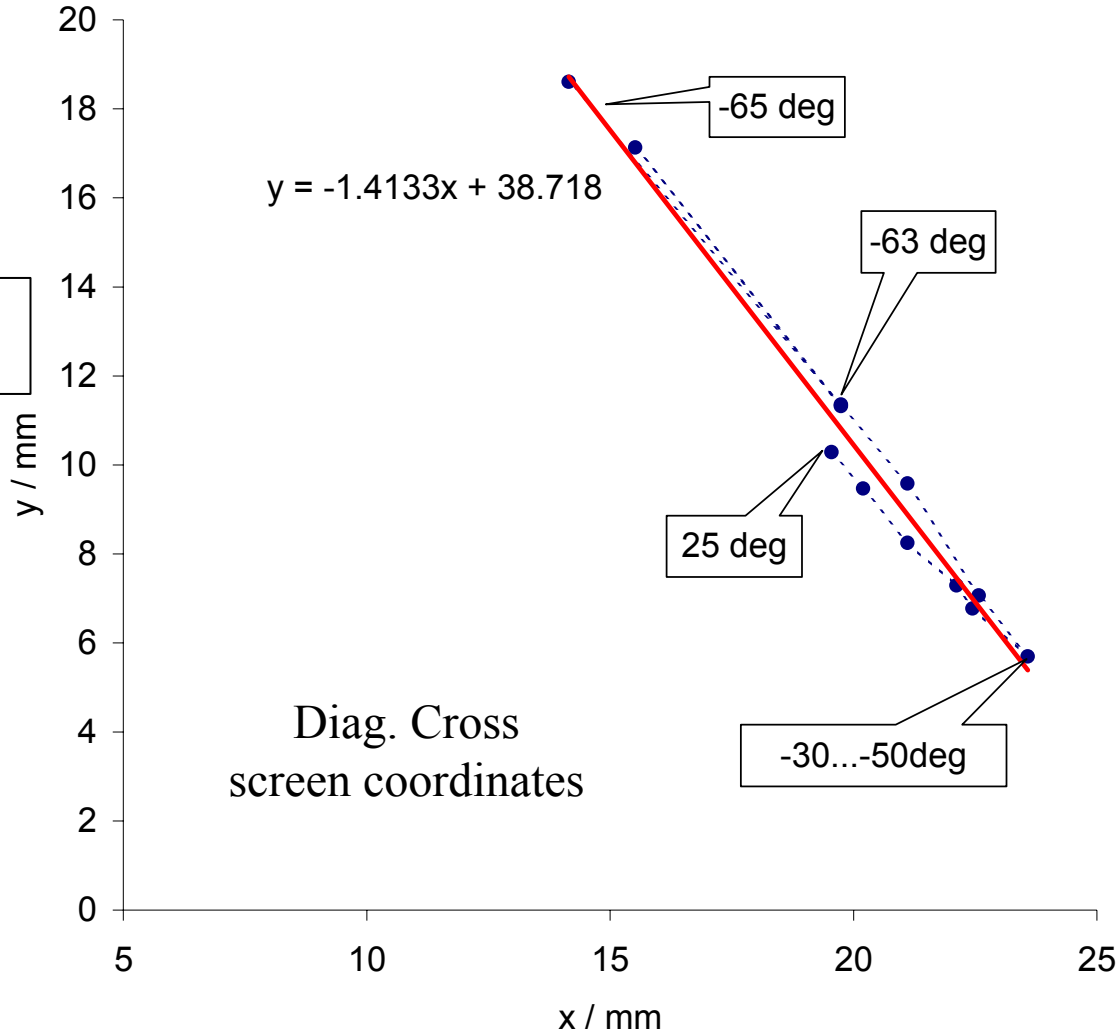
- (+) Coaxial coupler (RF field symmetry)
- (-) Less RF diagnostics (RF gradient and SP Phase)
- (-) Misalignment of Diag. Cross (~5mm x 2mm) – BPM can not be used
- (+) Solenoid micro movers, M3,M4 remotely controlled
- (-) Non-uniform electron beam

- (-) Dipole kick from coupler
- (+) Gradient + RF Phase –> 'on-line'

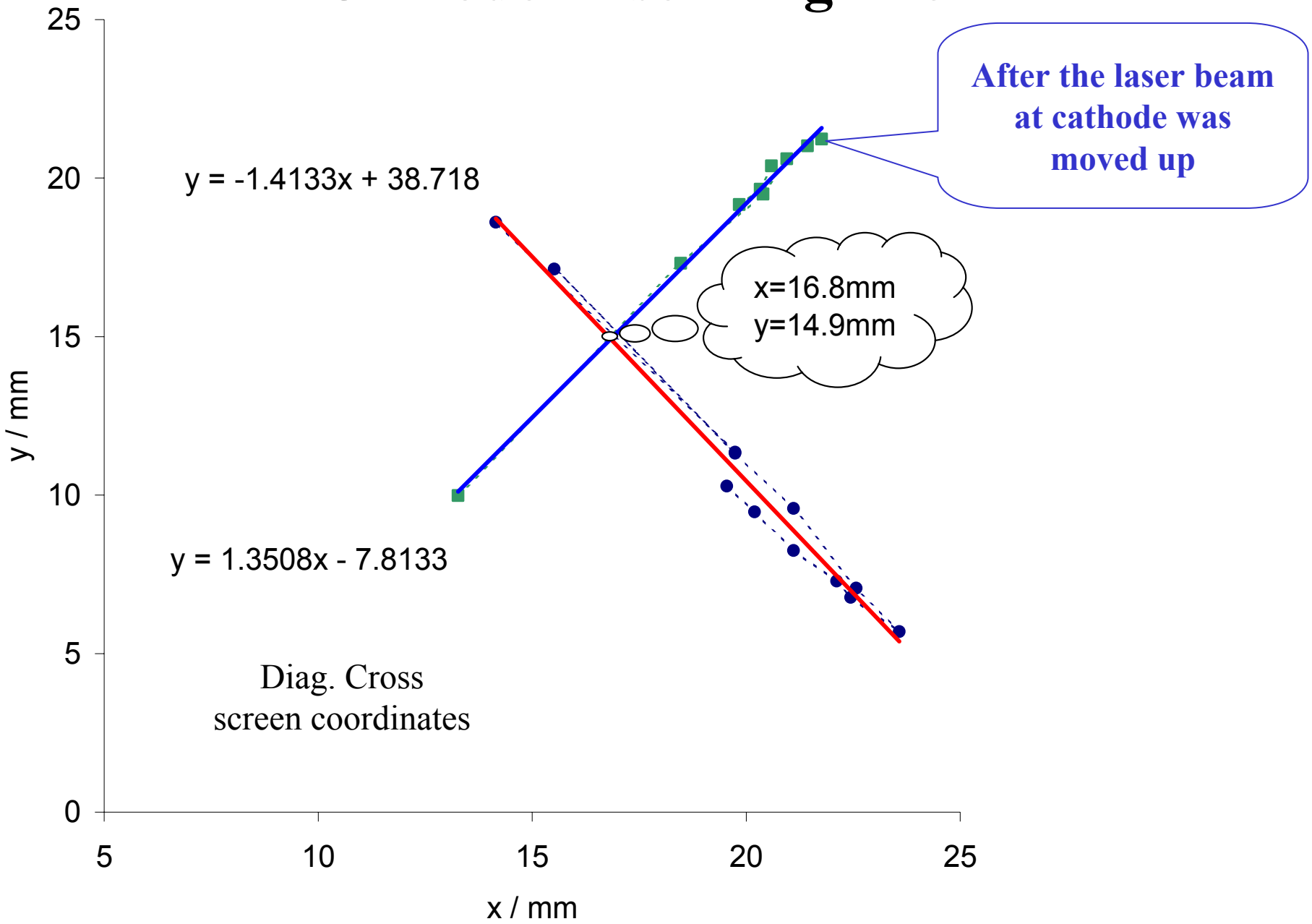
Cathode Laser Alignment

Low RF SPV, low beam charge, solenoids off,
sweep SP RF phase => beam position @ Diag.Cross screen



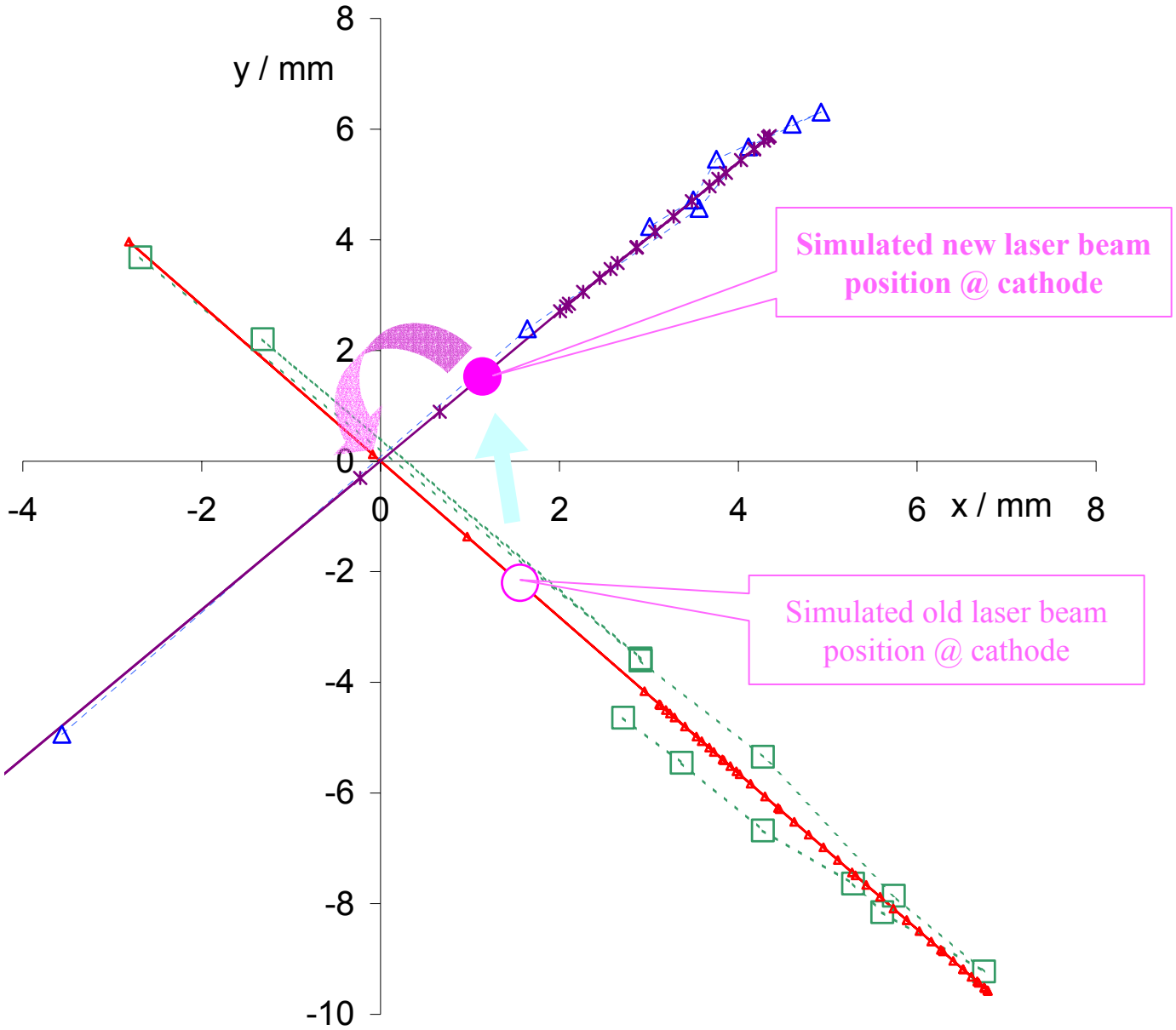


Cathode Laser Alignment



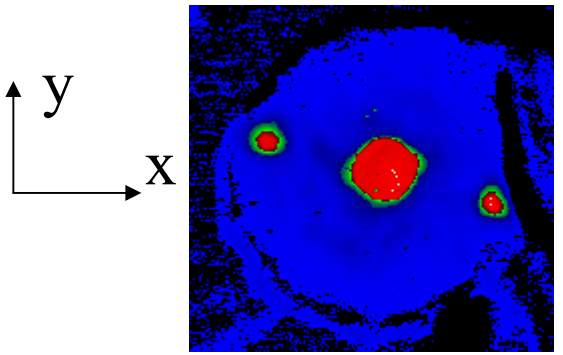
Cathode Laser Alignment

~beam line centroid coordinates

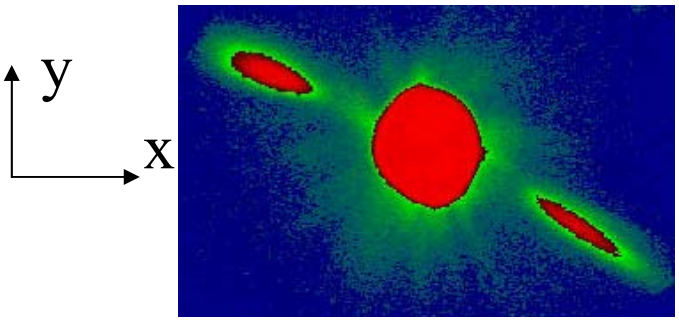


RF Gun Alignment: Satellites observation

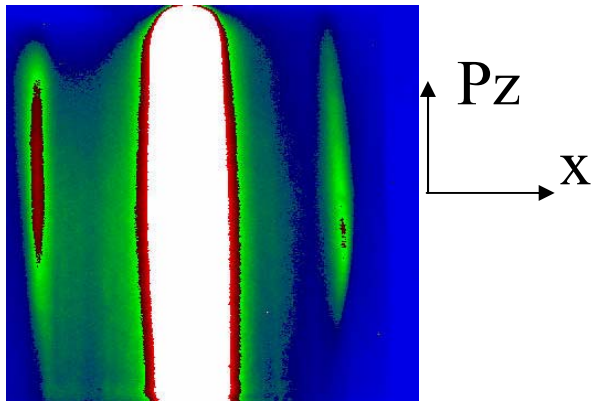
@Diag.Cross



@PP Screen

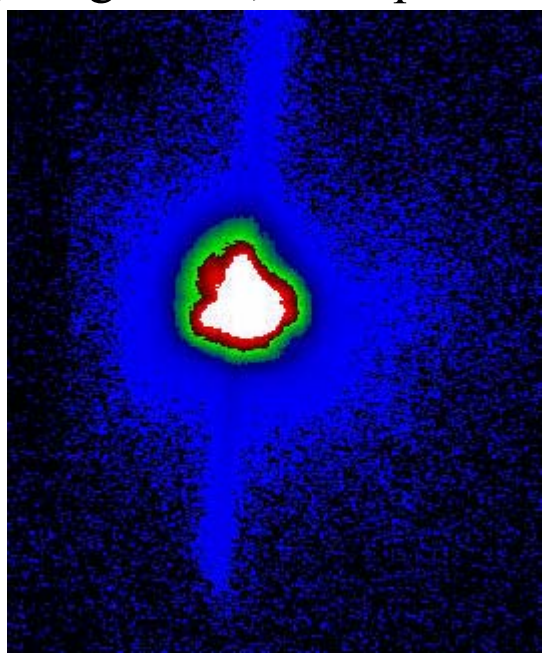


@Dispersive Arm

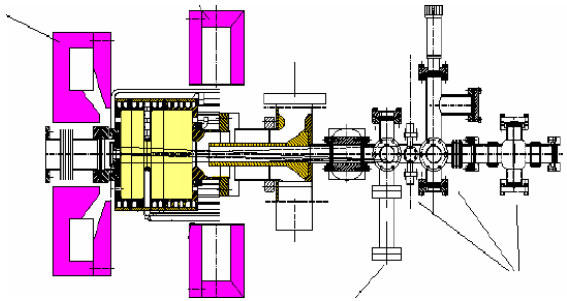


Vacuum mirror

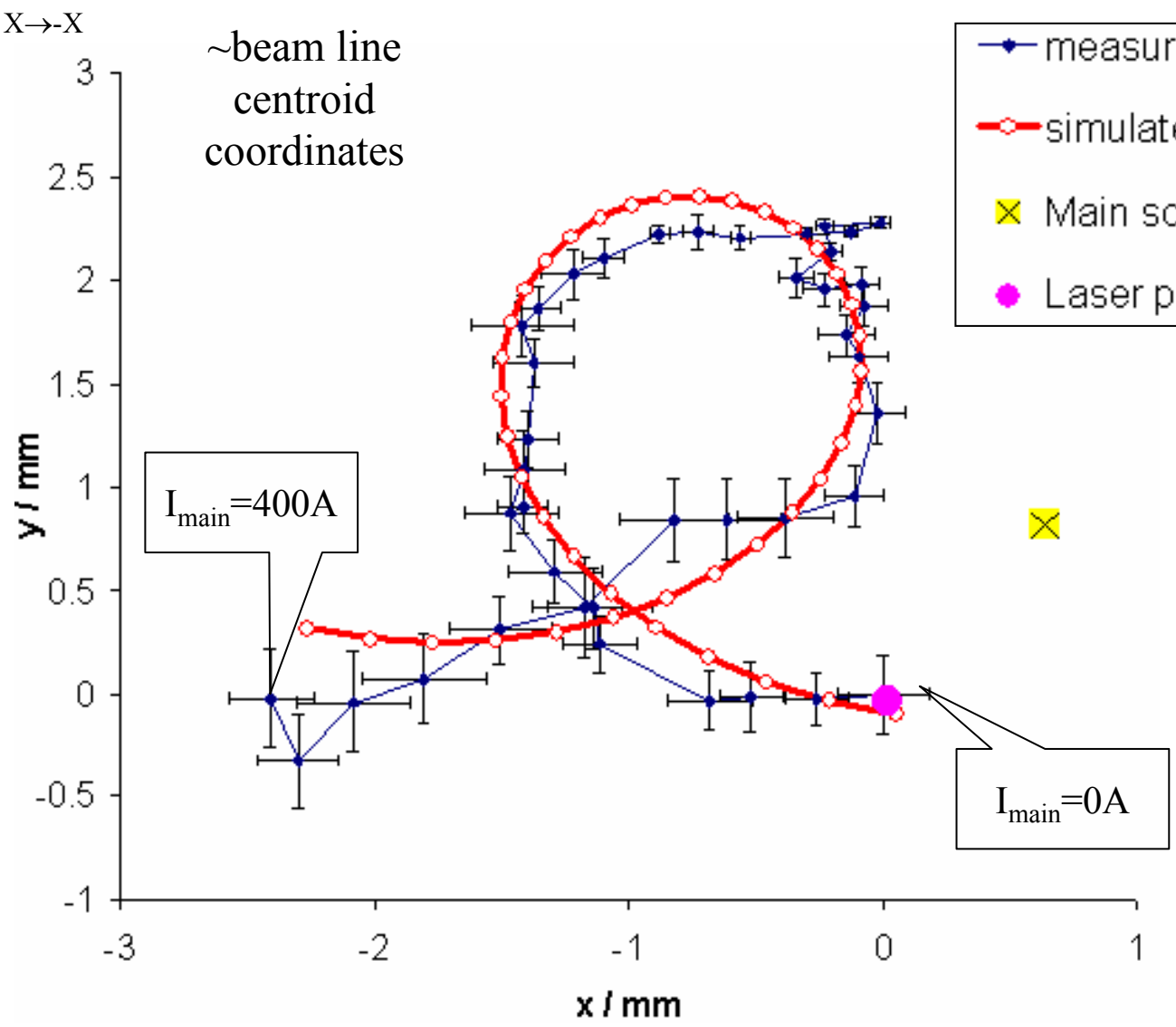
@Diag.Cross, “low phase”



Beam Position @Diag.Cross Screen as a Function of Main Solenoid Current

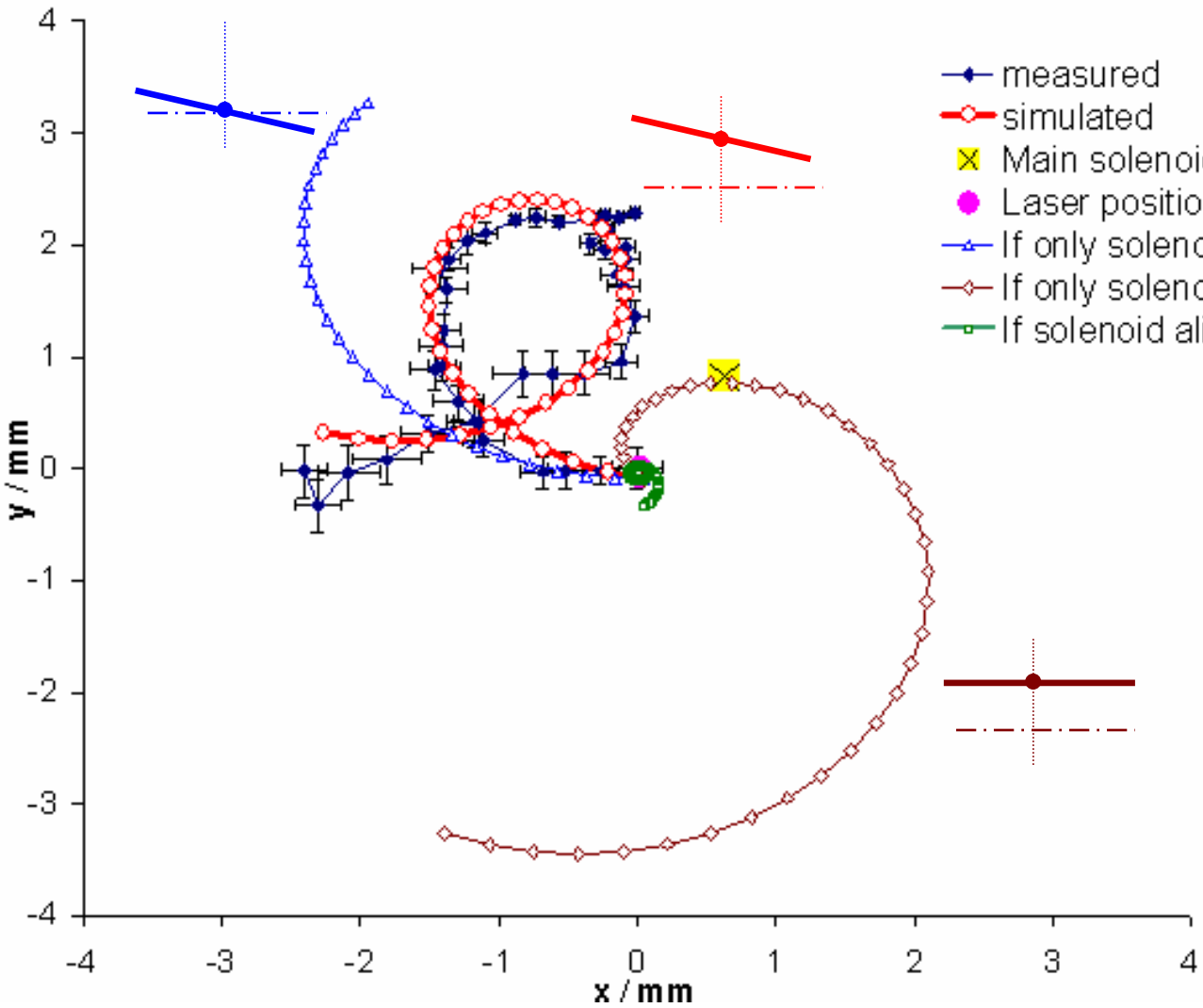


Simulated RF Gun Misalignment



XSolMainCenter	0.64	mm
YSolMainCenter	0.82	mm
AngleXSolMain	0.004	deg
AngleYSolMain	0.156	deg
Laser_Beam_CenterX	0.01	mm
Laser_Beam_CenterY	-0.03	mm

Simulations of Solenoid Misalignments



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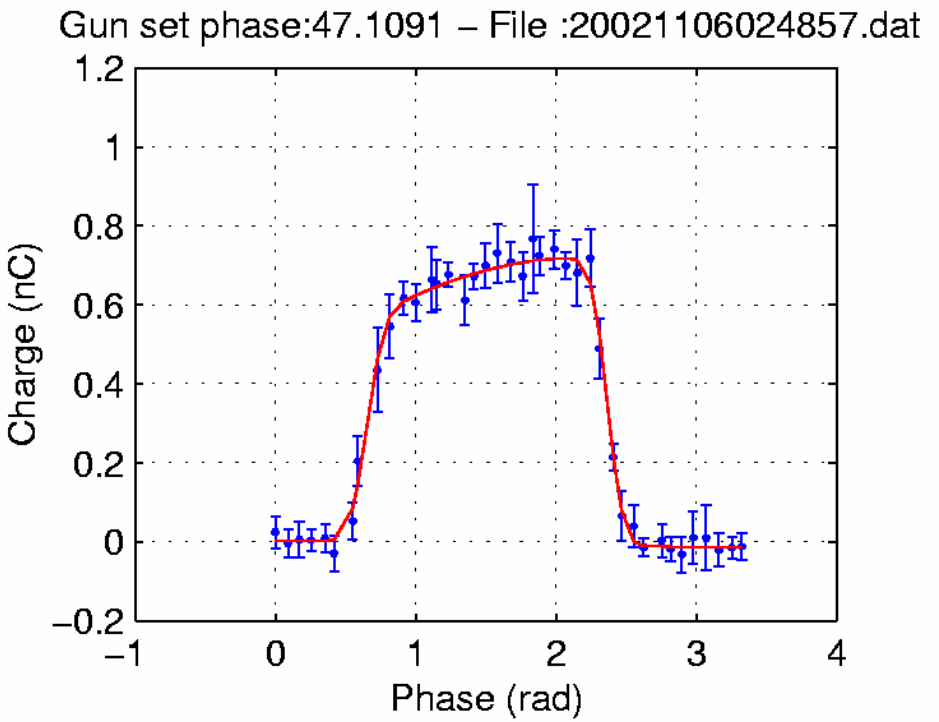
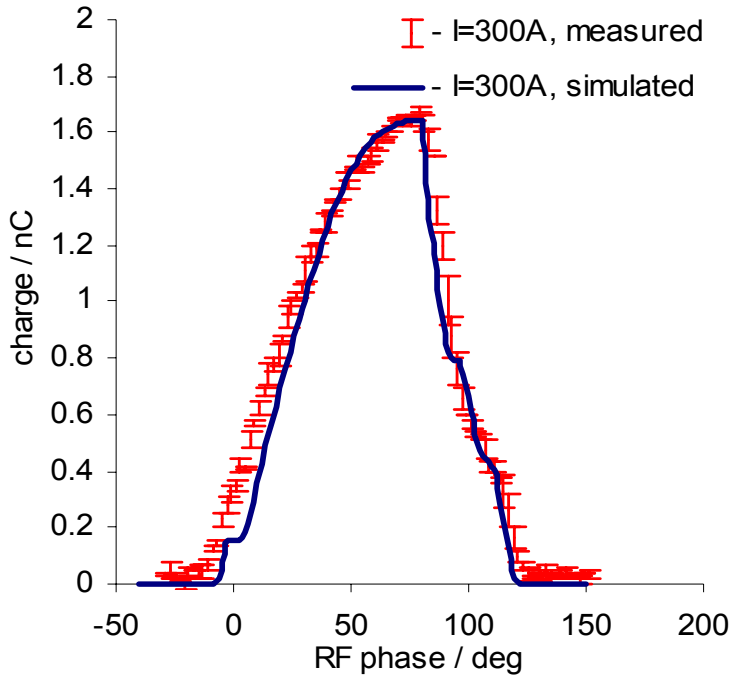
Phase Scan at TTF and PITZ

TTF



PITZ

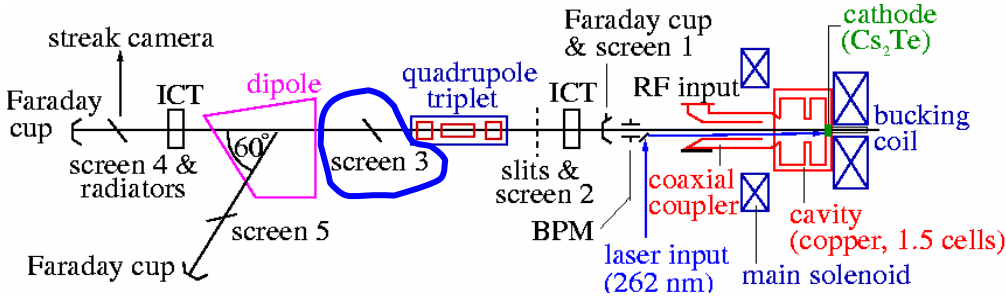


Reference RF Phase

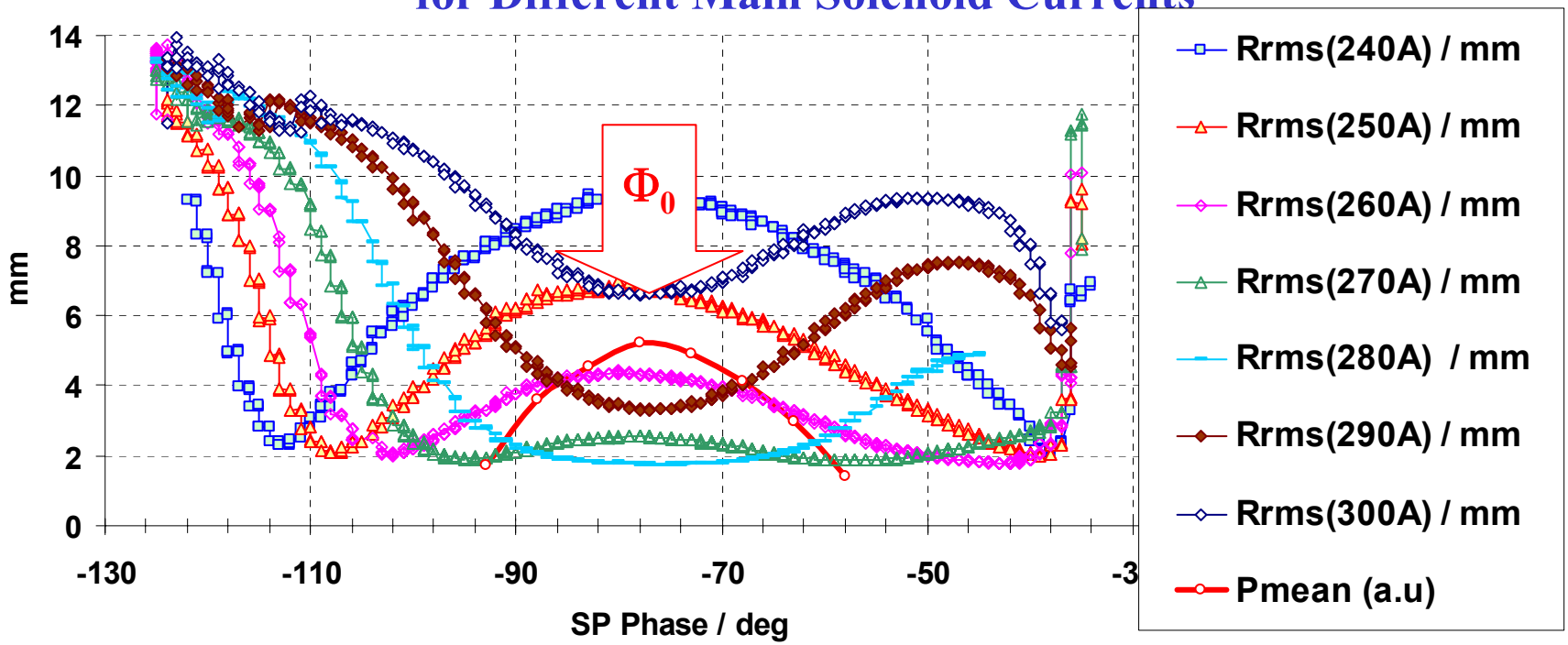
Set Point (SP) RF phase

?

RF phase with maximum mean energy gain Φ_0

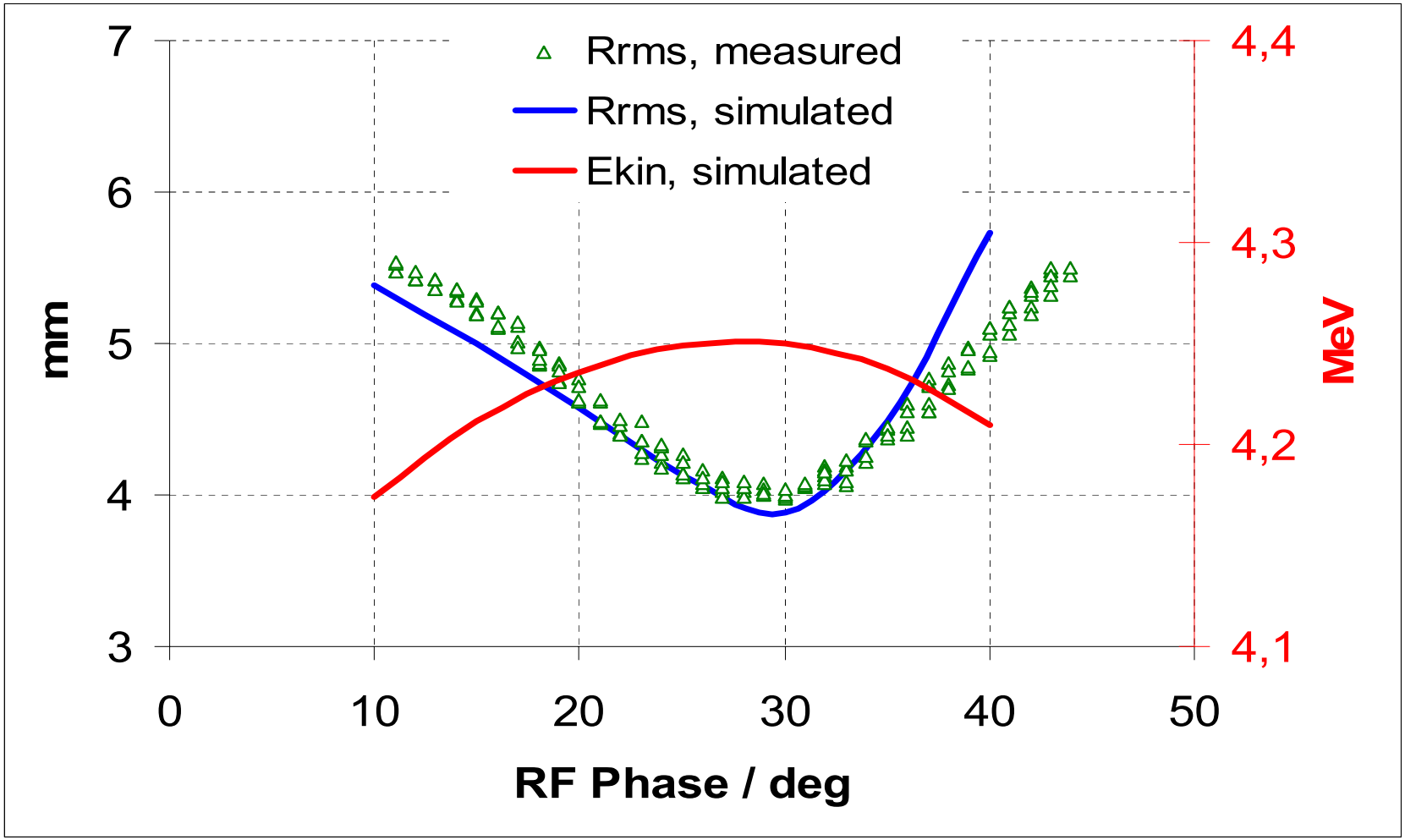


Transverse RMS Beam Size at Screen 3 as a Function of SP Phase for Different Main Solenoid Currents



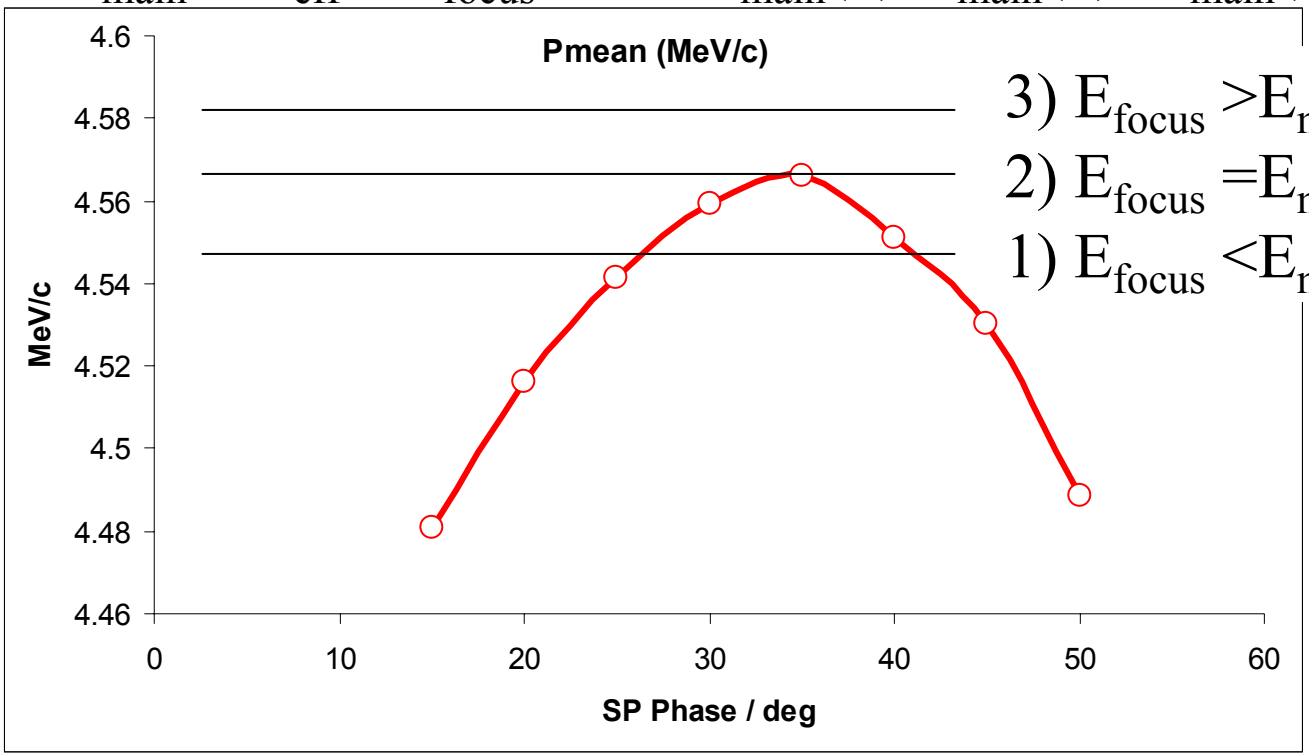
Reference RF Phase

Transverse RMS Beam Size at Screen 3 as a Function of SP Phase (Main Solenoid Current=300A)



Reference RF Phase

$I_{main} \rightarrow B_{eff} \rightarrow E_{focus}$ $I_{main}(1) < I_{main}(2) < I_{main}(3)$

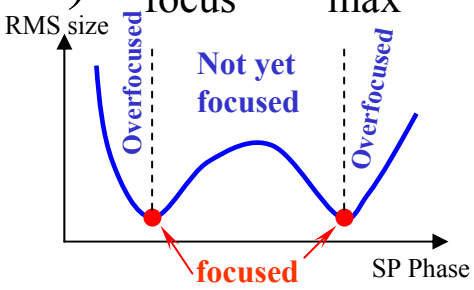


Method:

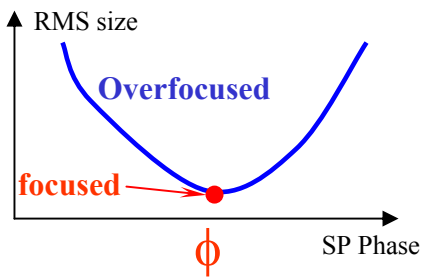
measure transverse RMS size of the electron beam as a function of SP Phase for definite solenoid current.

- **easy**
- **quick**
- **reliable**

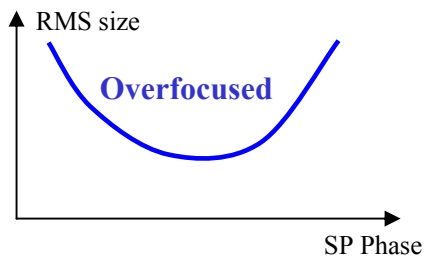
1) $E_{focus} < E_{max}$



2) $E_{focus} = E_{max}$



3) $E_{focus} > E_{max}$



Conclusions

• Alignment of the RF Gun has an impact on the electron beam quality. For the PITZ 1 setup the most important cathode laser alignment

• Satellites by chance helped to check laser alignment

• On-line RF gun alignment was complicated by Diag.Cross misalignment

• Reference RF phase set procedure has been proposed