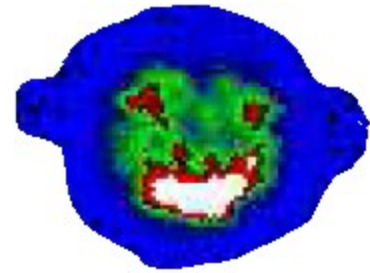


PITZ Benchmarking-2015



M. Krasilnikov

PITZ RC meeting, 25.06.2015

PITZ-BM2015-1: Beam dynamics in PITZ RF-gun w/o space charge

Experimental data: 17.06.2015M; M. Gross, M. Krasilnikov

RF-gun setup:

- RF power in the gun 5MWg → 6.06MeV/c at MMMG phase
- Basic measurements: cathode laser spot (grid) imaging with e-beam into first screens in the LOW section:
 - Laser grid → BSA
 - Low charge (LT), long pulse train operation for a good contrast
 - Tune the main solenoid current to obtain a sharp image of the laser grid
 - Take and save images of electron distributions at LOW.Scr1,2,3
 - BSA → whole cathode, electron beam (=cathode) imaging

Benchmark → confirm with simulations (e.g. ASTRA) :

- **RF field** dynamics (fit E_{cath} and launch phase phase)
- **Solenoid field** (calibration) → reproduce obtained imaging values of the main solenoid current (NB: Bucking solenoid → compensation)
- Check obtained **zoom** factors (image analysis required)

Outlook:

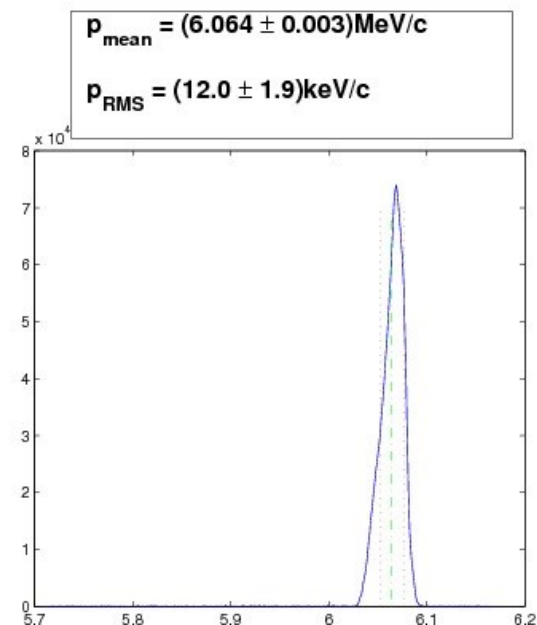
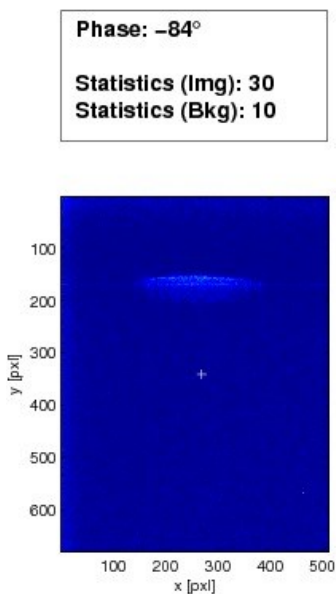
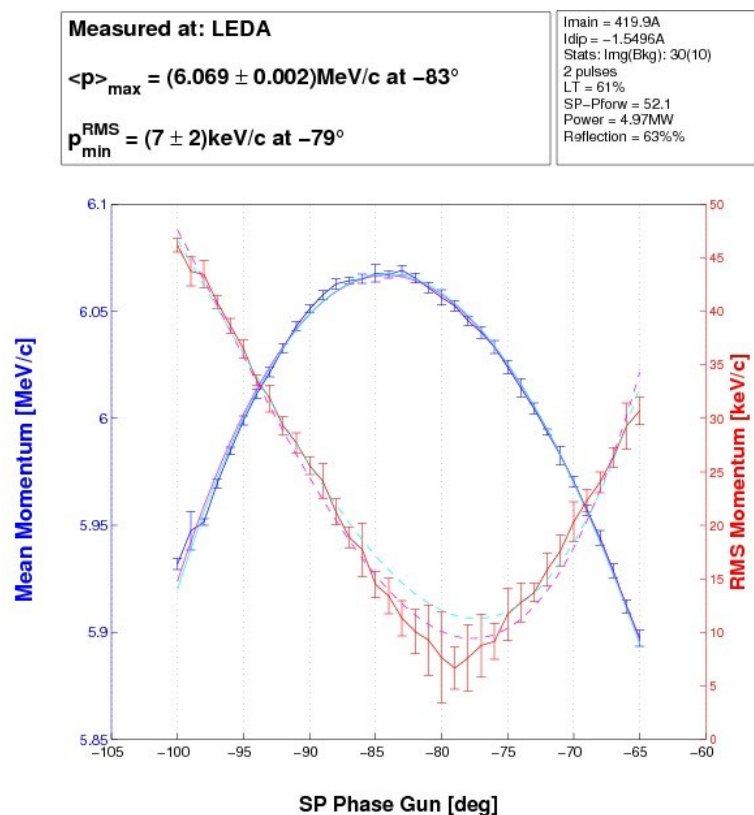
- Repeat the measurements for 3MWg (may be also 5MWg for consistency)

PITZ-BM2015-1: Beam dynamics in PITZ RF-gun w/o space charge

Experimental data: 17.06.2015M; M. Gross, M. Krasilnikov

RF-gun setup:

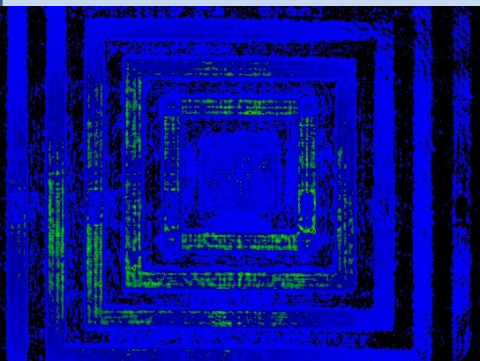
- RF power in the gun 5MWg \rightarrow 6.06MeV/c at MMMG phase



PITZ-BM2015-1: Beam dynamics in PITZ RF-gun w/o space charge

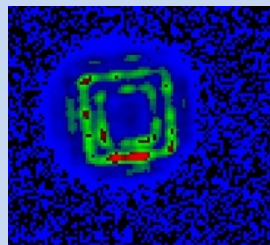
Images → ...\pitz\docs\measure\BeamTransport\Trajectory\2015\20150617M

BSA grid imaged on VC2



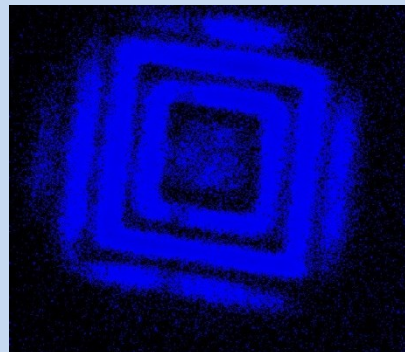
Electrons at LOW.Scr1

$I_{main}=462.5A$
 $I_{buck}=35.34A-comp.$
 $LT=1\%$
40pulses



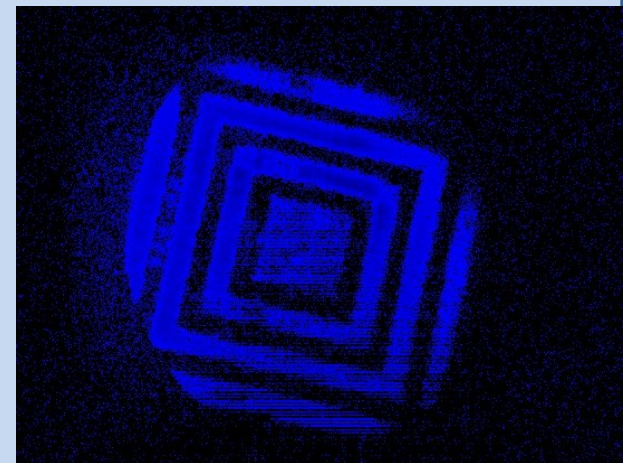
Electrons at LOW.Scr2

$I_{main}=423.6A$
 $I_{buck}=35.1A-comp.$
 $LT=10\%$
200pulses

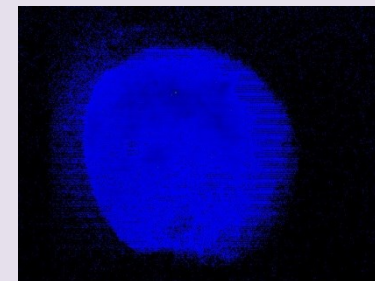
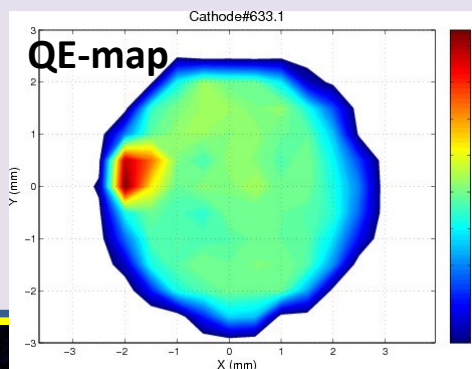
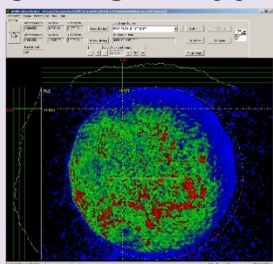


Electrons at LOW.Scr3

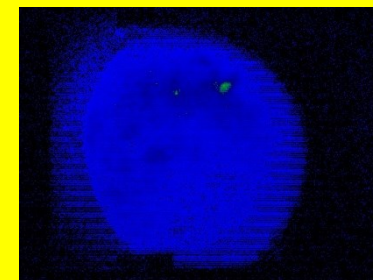
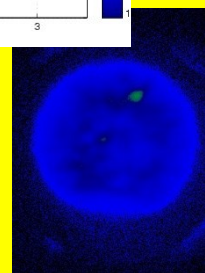
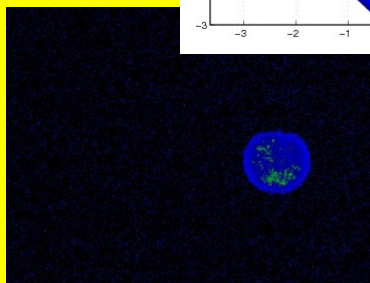
$I_{main}=397.16A$; $I_{buck}=32.91A-comp.$
 $LT=5\%$; 200pulses



BSA=4.5mm at VC2



BSA=5.0mm at VC2



PITZ-BM2015-2: Electron beam asymmetry investigations

Experimental data: 21.06.2015M; M. Krasilnikov, S. Rimjaem

RF-gun setup:

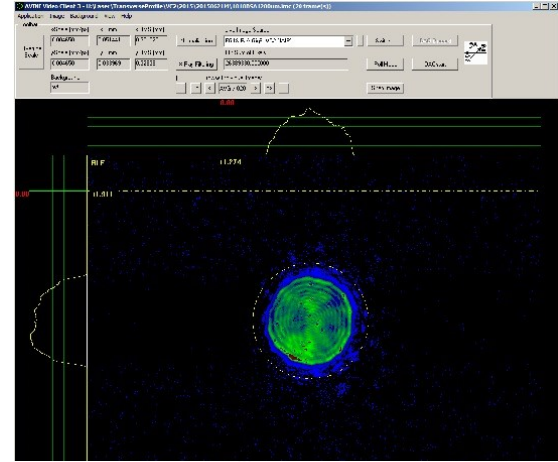
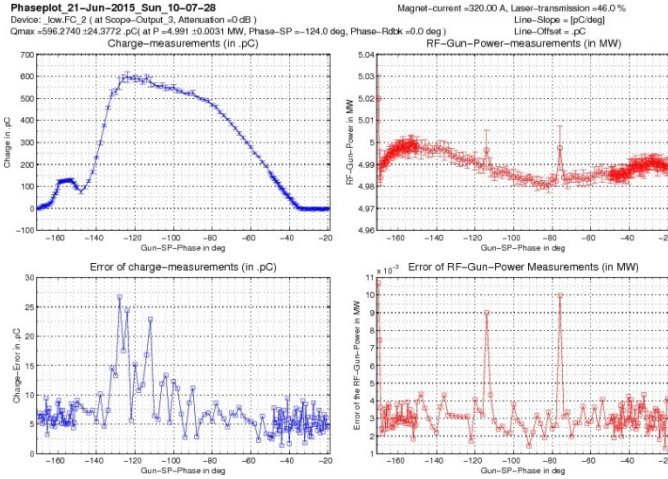
- RF power in the gun 5MWg → 6.06MeV/c at MMMG phase, Q=500pC, BSA=1.2mm
- Electron beam shape studies have been done at different screens for various machine settings.
 - Electron beam transverse shape:
 - * LOW.Scr1 - round for various solenoid currents
 - * LOW.Scr2,3 - a x-y tilt (coupling) observed, this tilt varies with a solenoid current while going through the focus
 - * "Eye"-structure (rhombus) observed already at LOW.Scr3
 - Electron beam studies at LEDA:
 - * there is a tilt (x-pz) observed (especially pronounced at lower solenoid currents ~389A), which is independent on gun phase, steering (LOW.St1,2), laser displacement (+/-0.5mm x/y at VC2)
 - * no double-beam structure (like in HEDA1) observed at LEDA for the above mentioned parameters
 - Electron beam shape at HIGH1.Scr1:
 - * horns of the beam can be modified by beam line aperture in the low section (e.g. LOW.Scr3 empty tube or empty space, as well as "collimator" in LOW.Scr2)

Benchmark → find origin of the transverse (coupling) kick.

PITZ-BM2015-2: Electron beam asymmetry investigations

RF-gun setup:

- RF power in the gun 5MWg → 6.06MeV/c at MMMG phase, Q=500pC, BSA=1.2mm



Measured at: LEDA

$\langle p \rangle_{\max} = (6.0589 \pm 0.0017) \text{MeV/c at } -84^\circ$

$p_{\min}^{\text{RMS}} = (6.6 \pm 0.6) \text{keV/c at } -78^\circ$

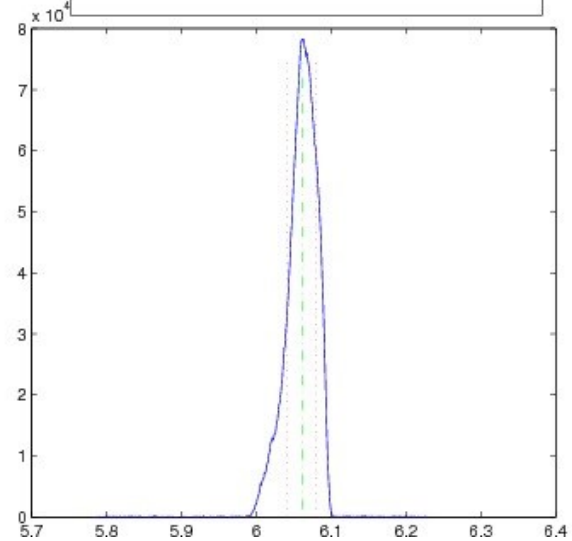
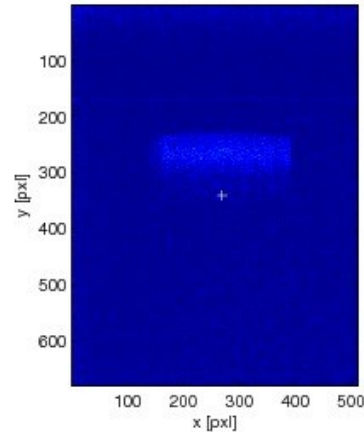
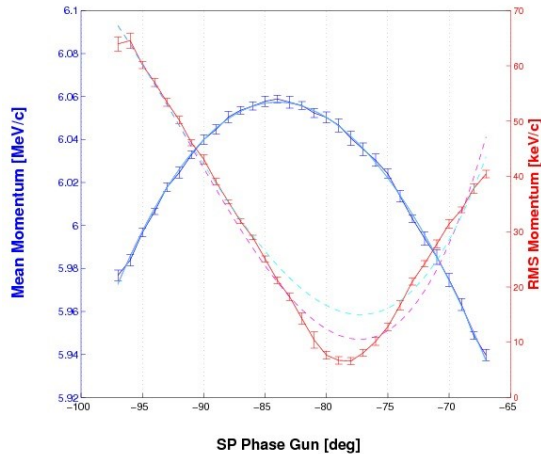
I_{mean} = 419.9A
 I_{dip} = -1.5698A
 Stats: I_{mg}(B_{kg}): 30(10)
 1 pulses
 LT = 46%
 SP_P_{forw} = 52.1
 Power = 4.99MW
 Reflection = 64%%

Phase: -84°

Statistics (I_{mg}): 30
 Statistics (B_{kg}): 10

$p_{\text{mean}} = (6.0608 \pm 0.0017) \text{MeV/c}$

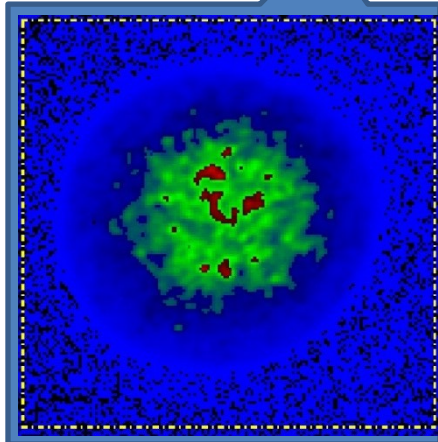
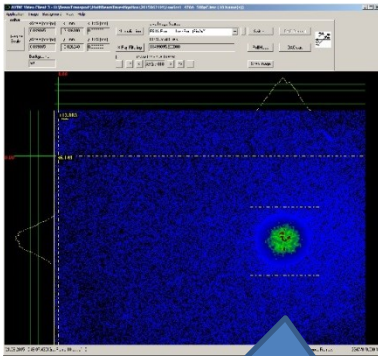
$p_{\text{RMS}} = (19.7 \pm 0.5) \text{keV/c}$



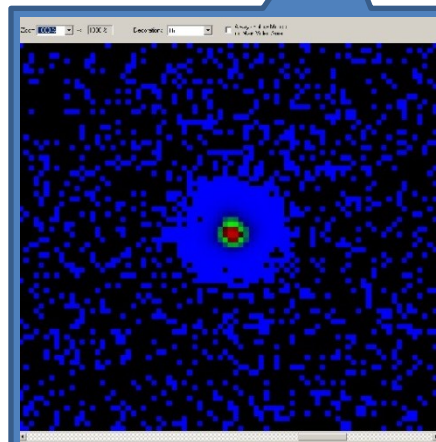
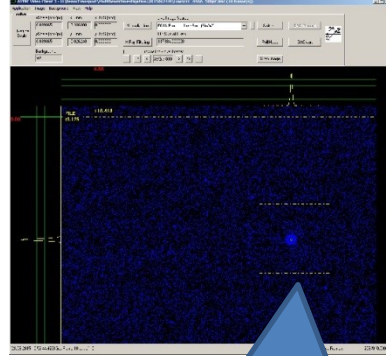
PITZ-BM2015-2: Electron beam asymmetry investigations

- Electron beam shape studies have been done at different screens for various machine settings.
 - Electron beam transverse shape:
 - * **LOW.Scr1 - round for various solenoid currents**
 - * LOW.Scr2,3 - a x-y tilt (coupling) observed, this tilt varies with a solenoid current while going through the focus
 - * "Eye"-structure (rhombus) observed already at LOW.Scr3

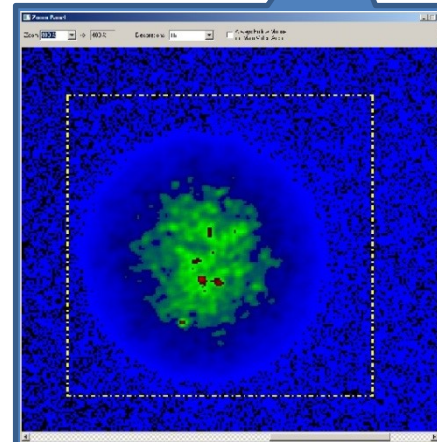
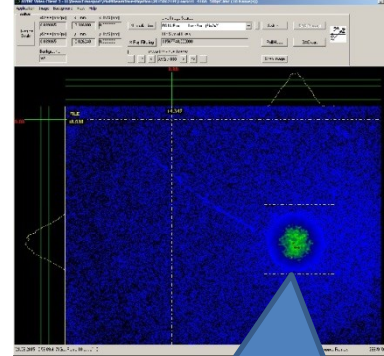
Overfocused beam @ Low.Scr1,
 $I_{\text{main}} = 470 \text{ A}$, 500 pC, 16 pulses



Focused beam image @ Low.Scr1,
 $I_{\text{main}} = 440 \text{ A}$, 500 pC, 1 pulse



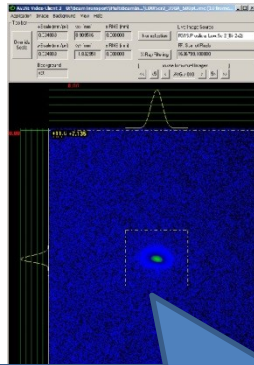
Underfocused beam @ Low.Scr1,
 $I_{\text{main}} = 410 \text{ A}$, 500 pC, 16 pulses



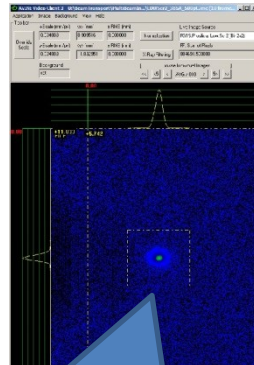
PITZ-BM2015-2: Electron beam asymmetry investigations

- Electron beam shape studies have been done at different screens for various machine settings.
 - Electron beam transverse shape:
 - * LOW.Scr1 - round for various solenoid currents
 - * **LOW.Scr2,3** - a x-y tilt (coupling) observed, this tilt varies with a solenoid current while going through the focus
 - * "Eye"-structure (rhombus) observed already at LOW.Scr3

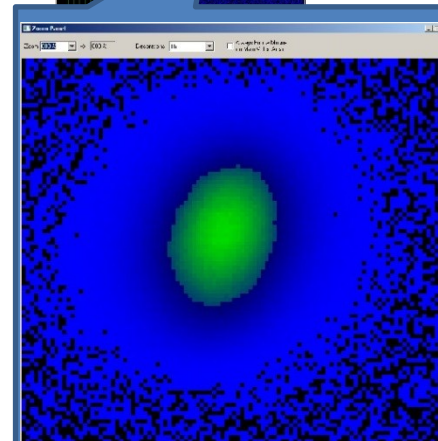
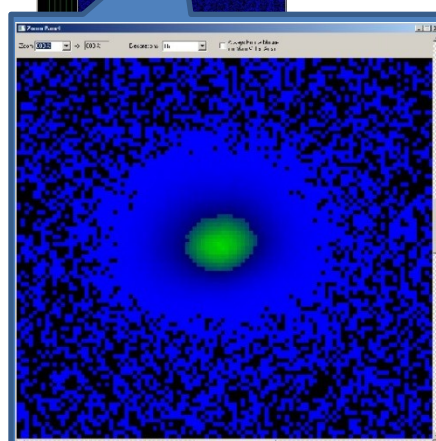
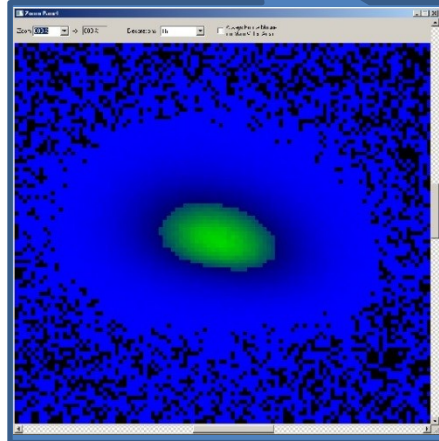
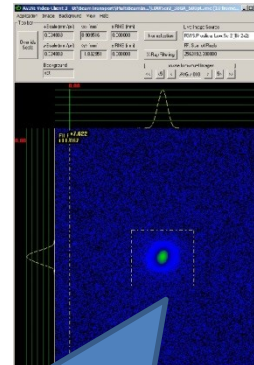
Overfocused beam @ Low.Scr2,
 $I_{\text{main}} = 390 \text{ A}$, 500 pC, 10 pulses



Focused beam @ Low.Scr2,
 $I_{\text{main}} = 385 \text{ A}$, 500 pC, 8 pulses



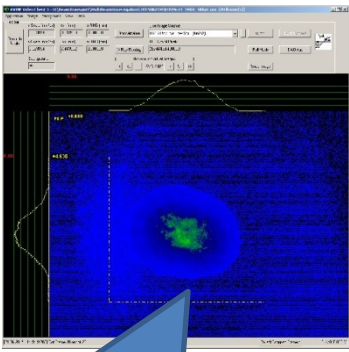
Underfocused beam @ Low.Scr2,
 $I_{\text{main}} = 380 \text{ A}$, 500 pC, 15 pulses



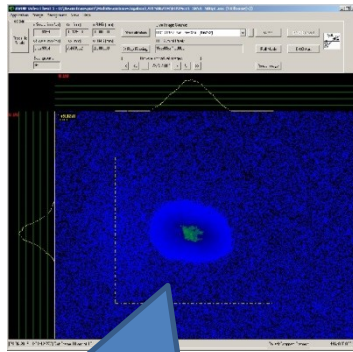
PITZ-BM2015-2: Electron beam asymmetry investigations

- Electron beam shape studies have been done at different screens for various machine settings.
 - Electron beam transverse shape:
 - * LOW.Scr1 - round for various solenoid currents
 - * **LOW.Scr2,3** - a x-y tilt (coupling) observed, this tilt varies with a solenoid current while going through the focus
 - * **"Eye"**-structure (rhombus) observed already at LOW.Scr3

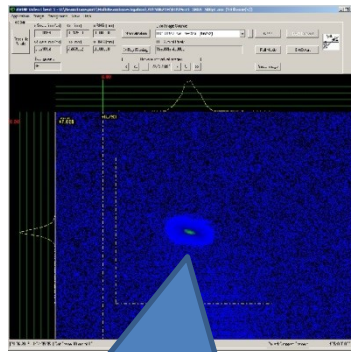
Overfoc.beam @ Low.Scr3
I_main = 390A, 30 pulses



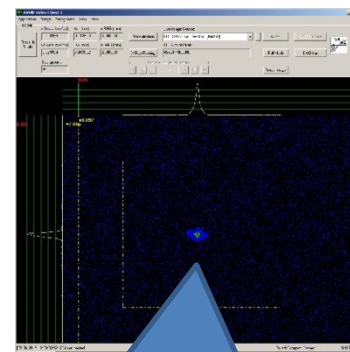
Beam Low.Scr3,
I_main = 385A, 10 pulses



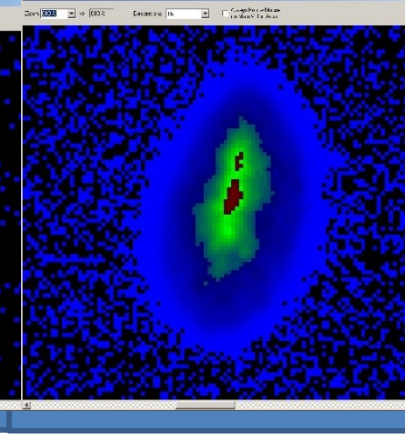
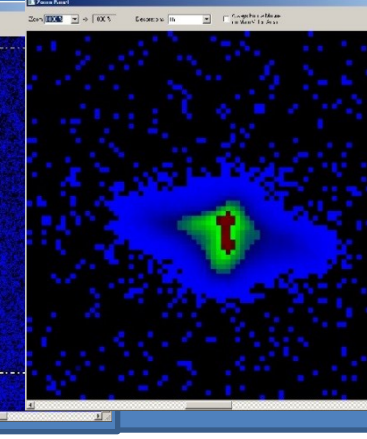
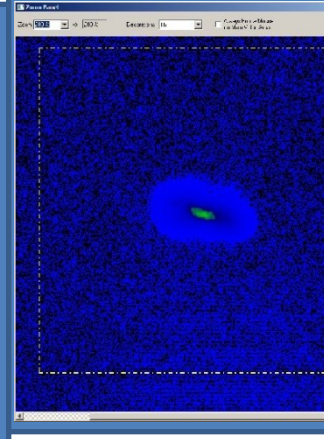
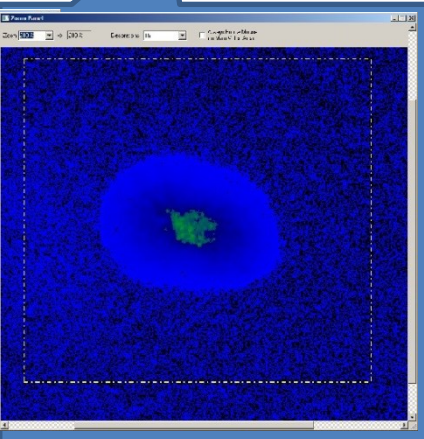
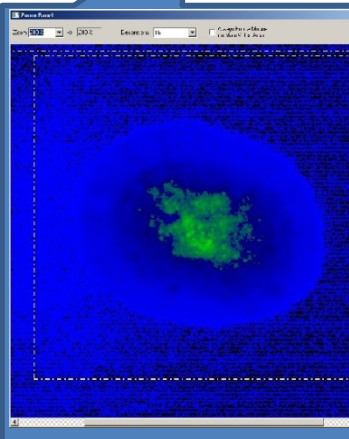
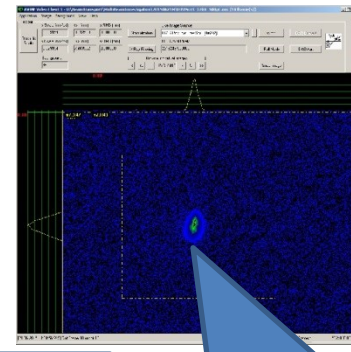
Beam Low.Scr3,
I_main = 380A, 2 pulses



Beam Low.Scr3,
I_main = 375A, 1 pulse

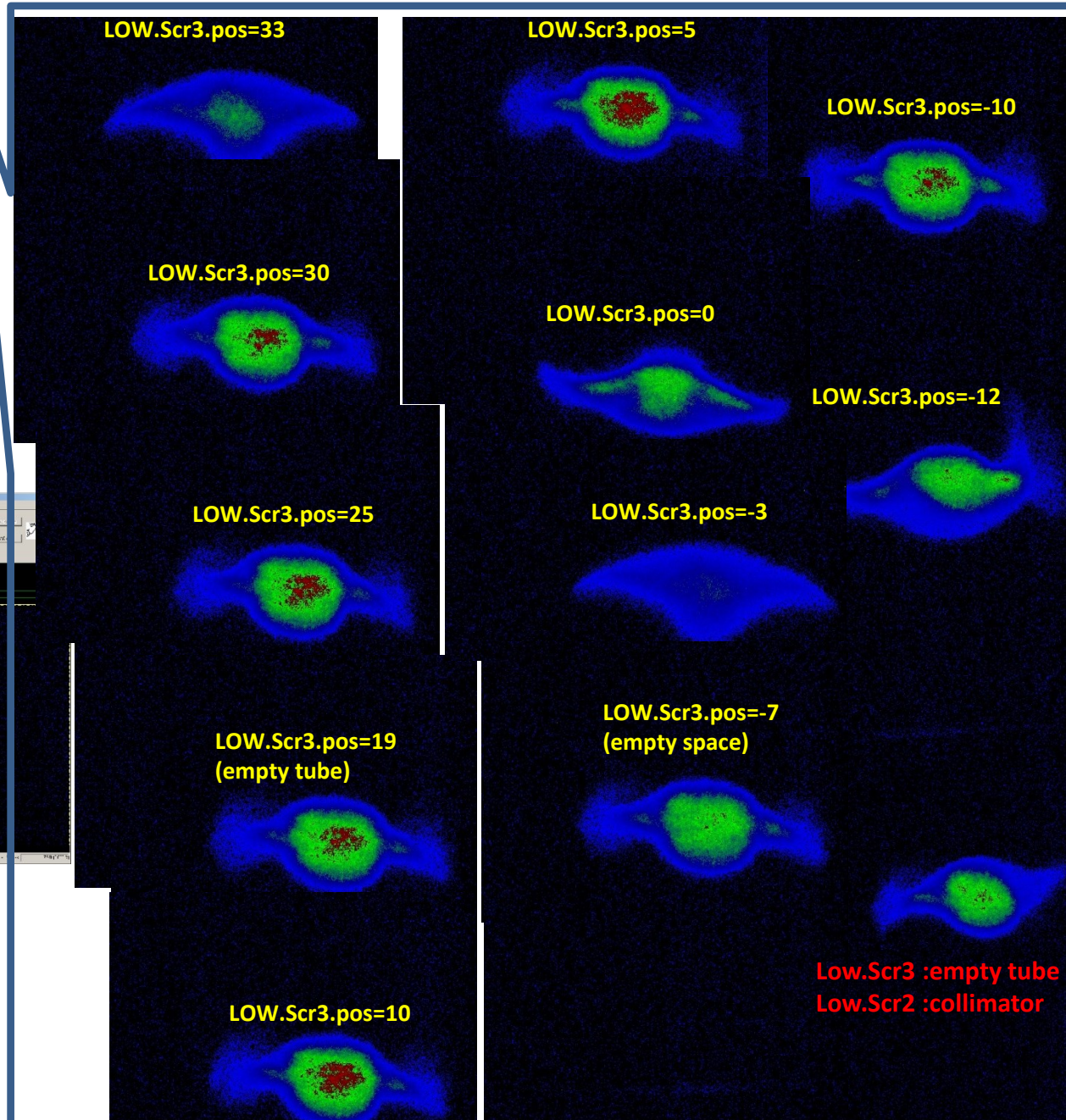


Beam Low.Scr3,
I_main = 370A, 1 pulse

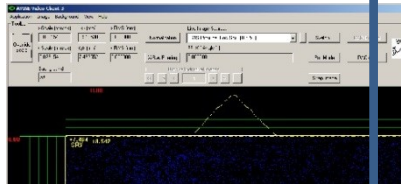


PITZ-BM2015-2: Electron beam asymmetry investigations

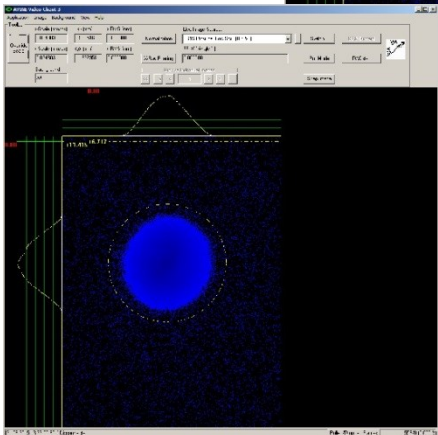
- **Electron beam shape at HIGH1.Scr1** (BSA=1.2mm, 500pC, 5MWg, MMMG phase, I_{main}=360A):
horns of the beam can be modified by beam line aperture in the low section (e.g. LOW.Scr3 empty tube or empty space, as well as "collimator" in LOW.Scr2)



Beam @ Low.Scr3



Beam @ Low.Scr2



Low.Scr3 :empty tube
Low.Scr2 :collimator