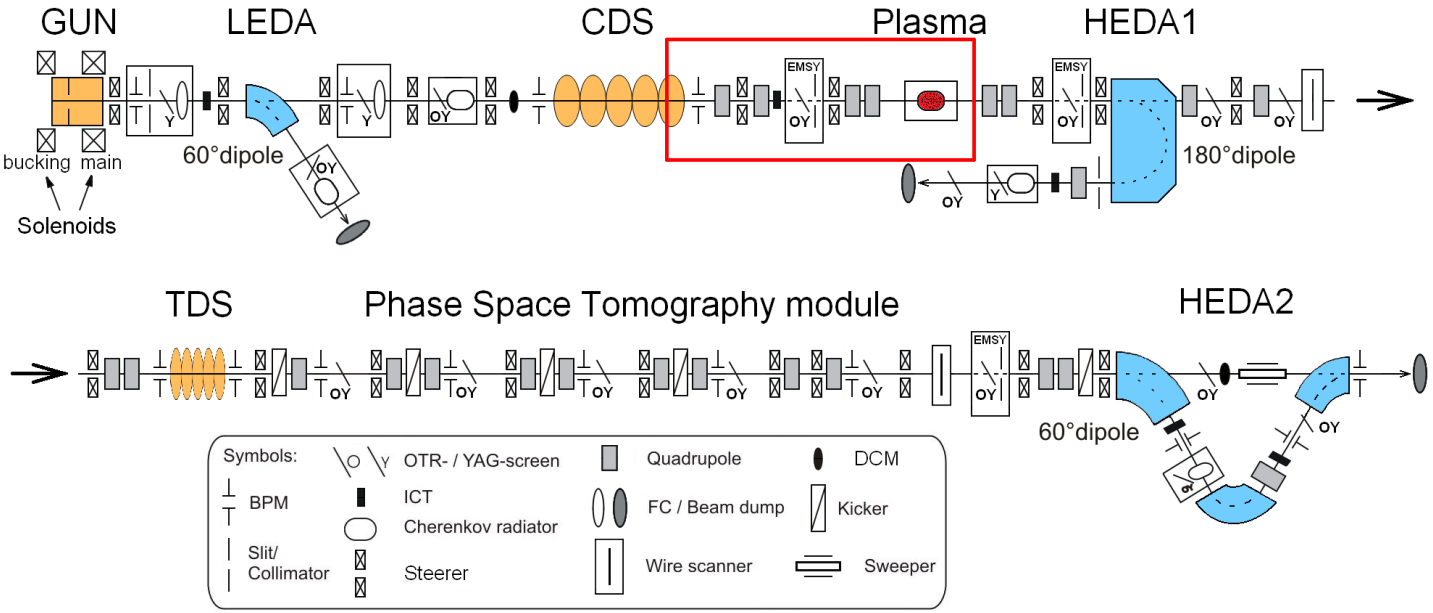
EXPERIMENTAL FOCUSSING OF THE BEAM FOR SELF MODULATION.



Yves Renier

Experimental focussing of the beam for self modulation

PITZ Physics Seminar, 19th of March 2015

HELMHOLTZ ASSOCIATION

DESY

Table of Contents

Self Modulation Needs Small Beam Size

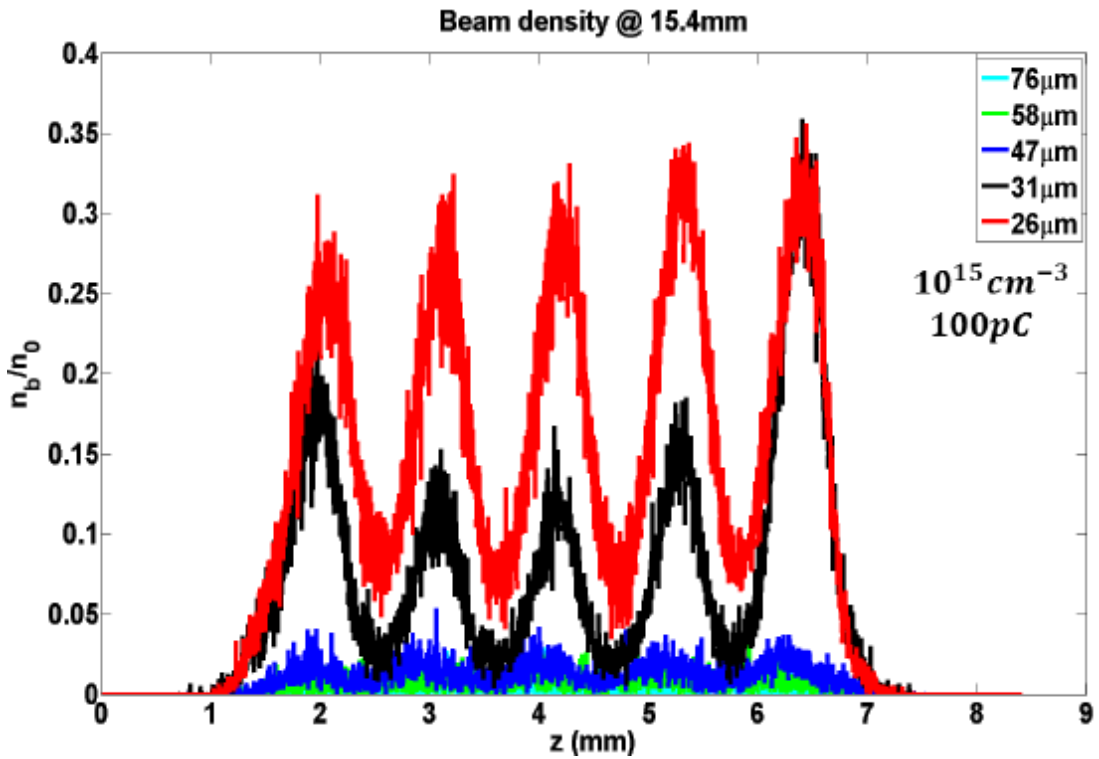


Figure 1: Beam density for different incoming beam size (Simulations from G. Pathak)

Matching solution were found

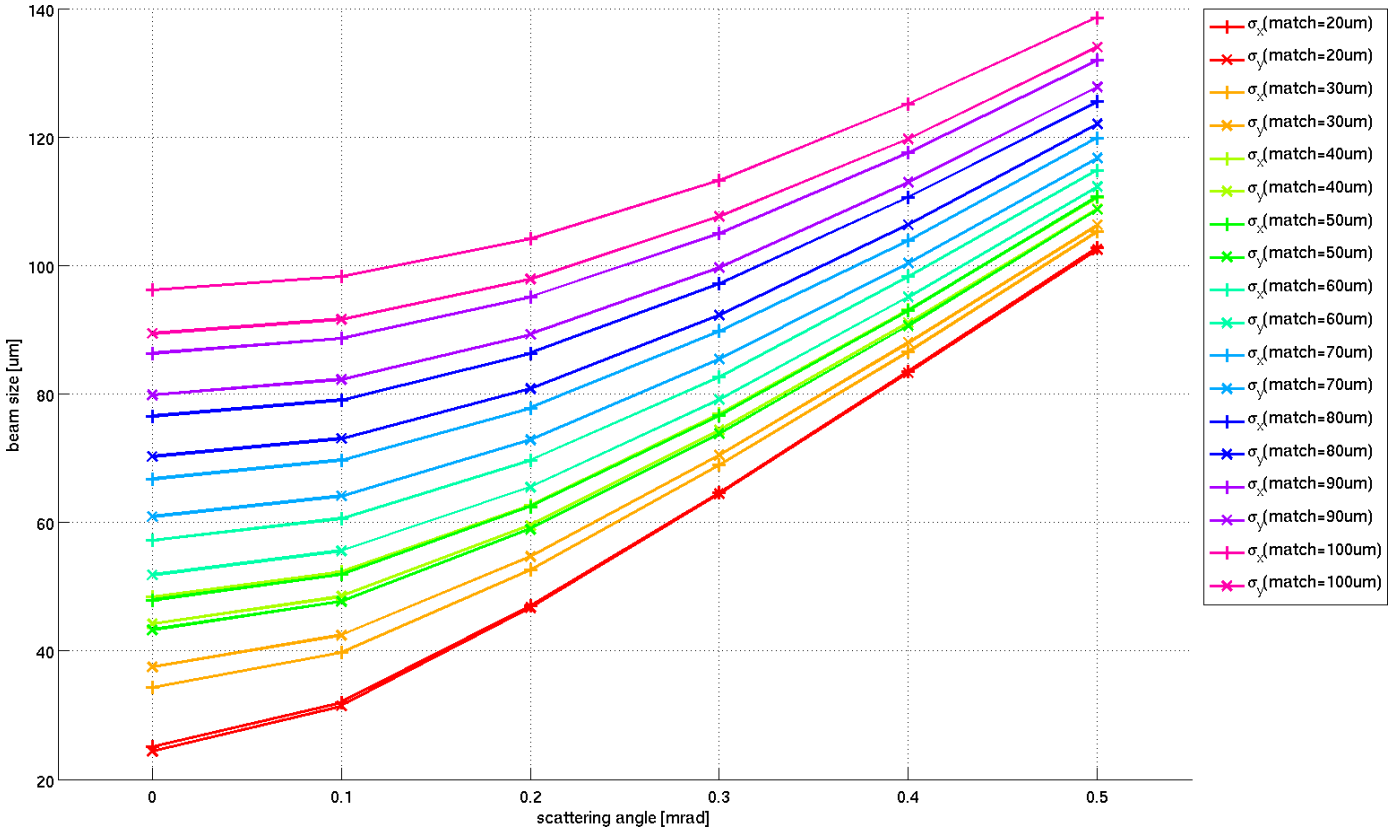
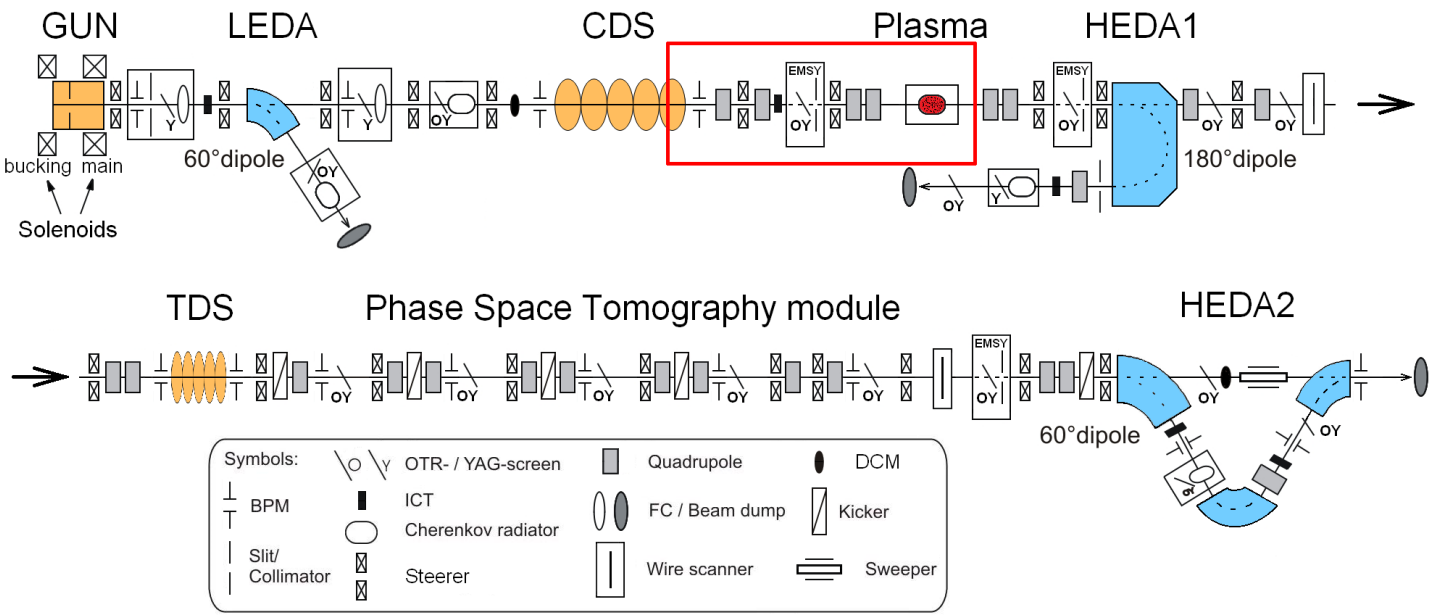


Figure 2: Beam size at the plasma entrance function of scattering for different matching conditions

Hard to Measure with the Plasma-cell in



Difficulties

- EMSY1 cannot be used to measure Twiss.
- Only 1 screen between CDS and plasma.
- Strong focussing needed $\Rightarrow$ HIGH1.SCR1 out of phase from plasma entrance.

Table of Contents

Experimental validation

Measure small beam size at plasma location

- Once the plasma cell is installed.

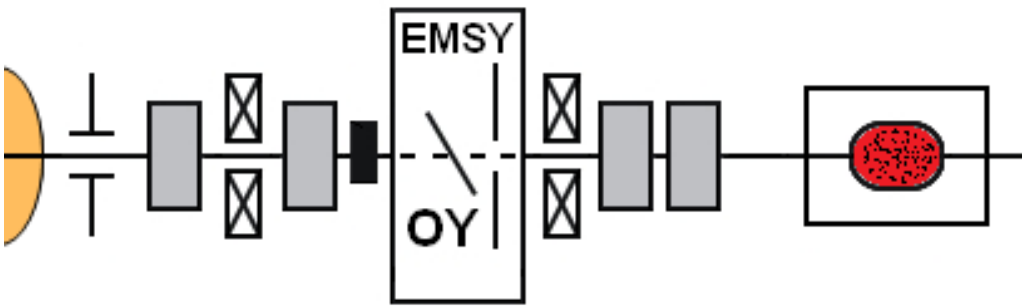


Figure 3: beam-line after CDS with plasma cell

Experimental validation

Measure small beam size at plasma location

- 2 weeks ago, HIGH1.SCR2 was installed instead.

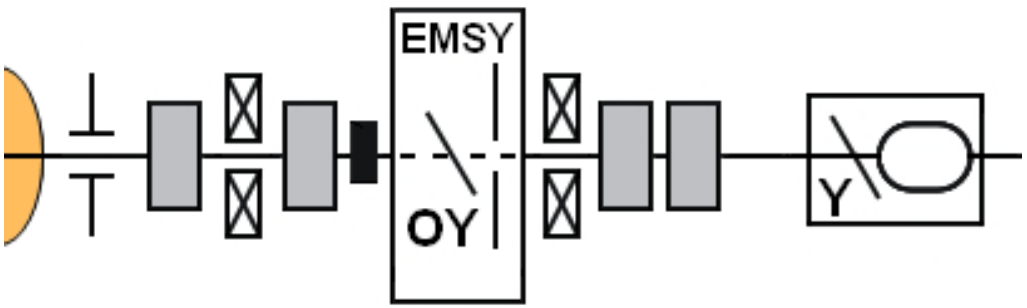


Figure 4: beam-line after CDS with HIGH1.SCR2

Table of Contents

Test Matching from simulation

Settings tried

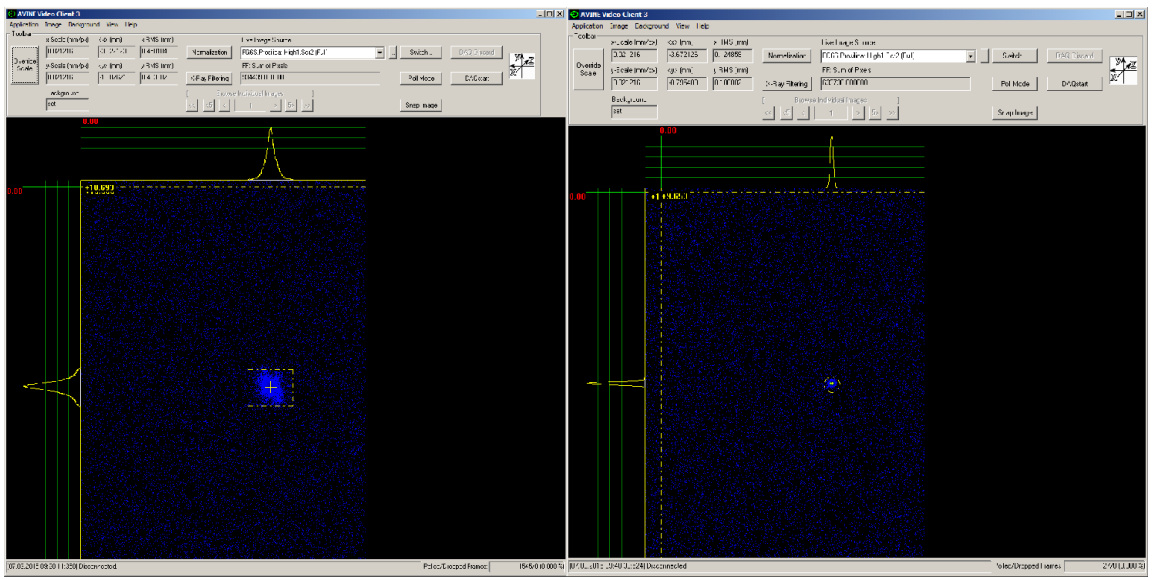
σ_{match}	K(Q1)	K(Q2)	K(Q3)	K(Q4)
$20\mu m$	31.7549	-53.9421	70.1053	-67.6903
$30\mu m$	43.9011	-61.2260	51.5382	-30.1889
$40\mu m$	-47.6223	50.6120	33.8521	-71.1830
$60\mu m$	51.1921	-62.6109	14.9923	20.0438
$80\mu m$	51.5901	-62.9060	14.4936	21.4218
$100\mu m$	51.9486	-63.2014	14.1735	22.7946

Remark

- Matching with MAD from Twiss obtain with Astra (gun $\rightarrow$ CDS end).
- Solenoid optimised experimentally to get focalized beam at HIGH.SCR2.

Results

$\sigma_{match}[\mu m]$	$\sigma_{meas}[\mu m]$	$I_{solenoid}[A]$
20	550	387
30	500	387
40	100	405
60	500	388
80	470	388
100	450	388



Remarks

- All but 40μm matching : larger σ than expected. Also, $I_{solenoid}$ different from other cases and simulation ($I_{simu} = 364$A) ?

Remarks

- All but 40μm matching : larger σ than expected.
- 40μm matching : very different solution.

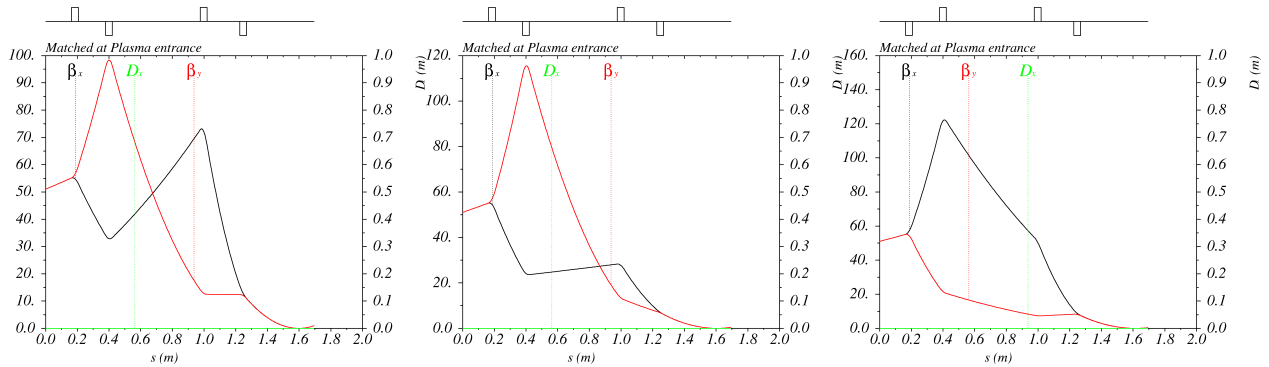


Figure 5: 20μm 30μm 40μm

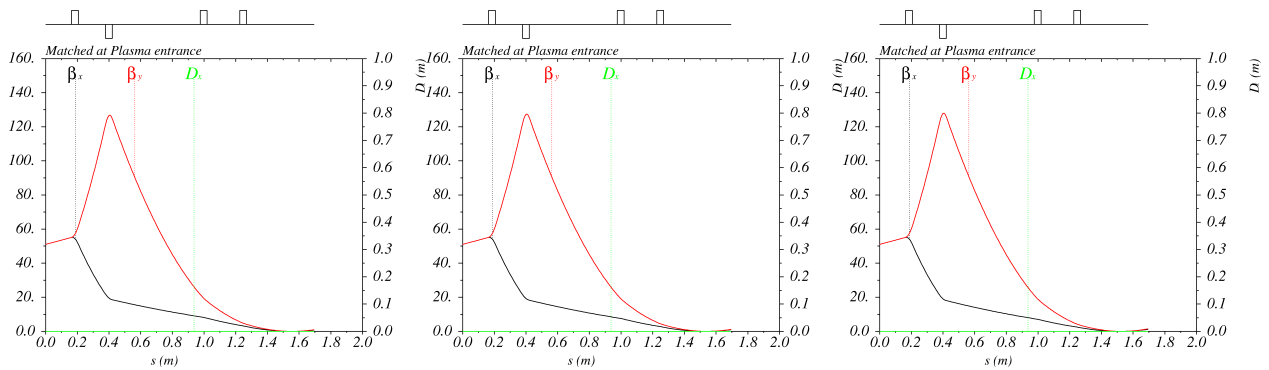


Figure 6: 60μm 80μm 100μm

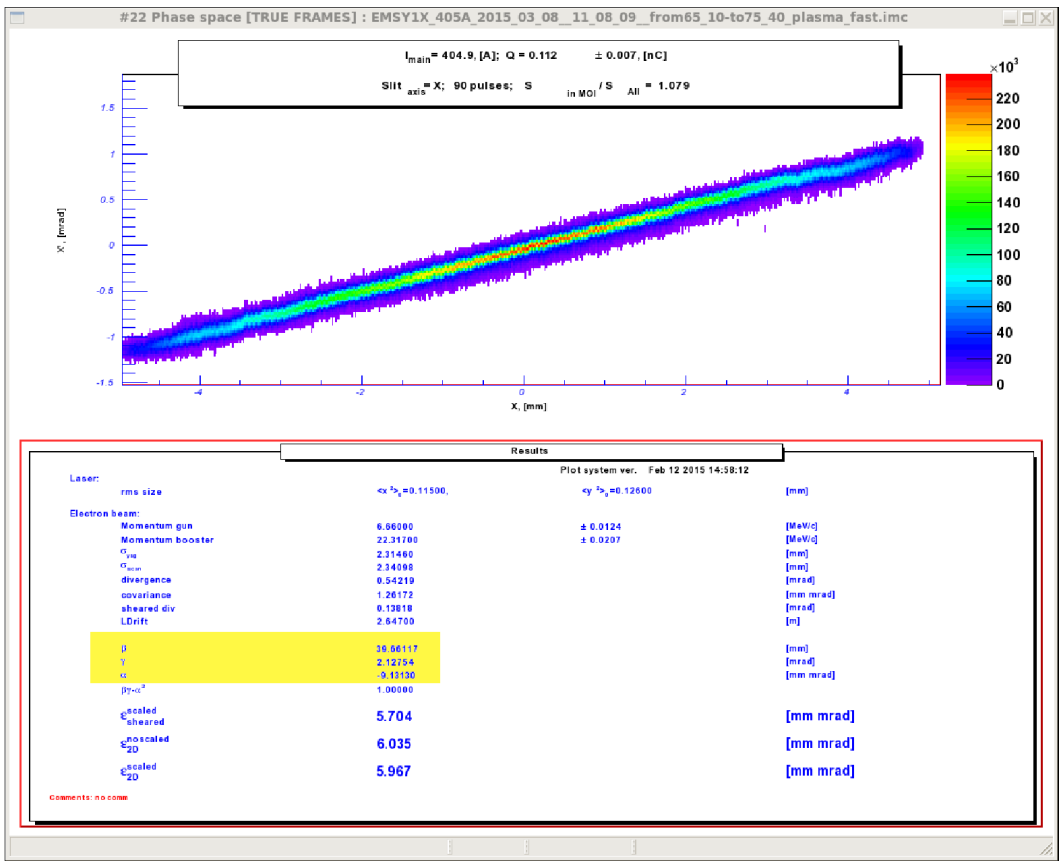
Remarks

- All but 40μm matching : larger σ than expected.
- 40μm matching : very different solution.
- Twiss at the end of the booster different from simulation ?

Twiss measurement

tried methods:

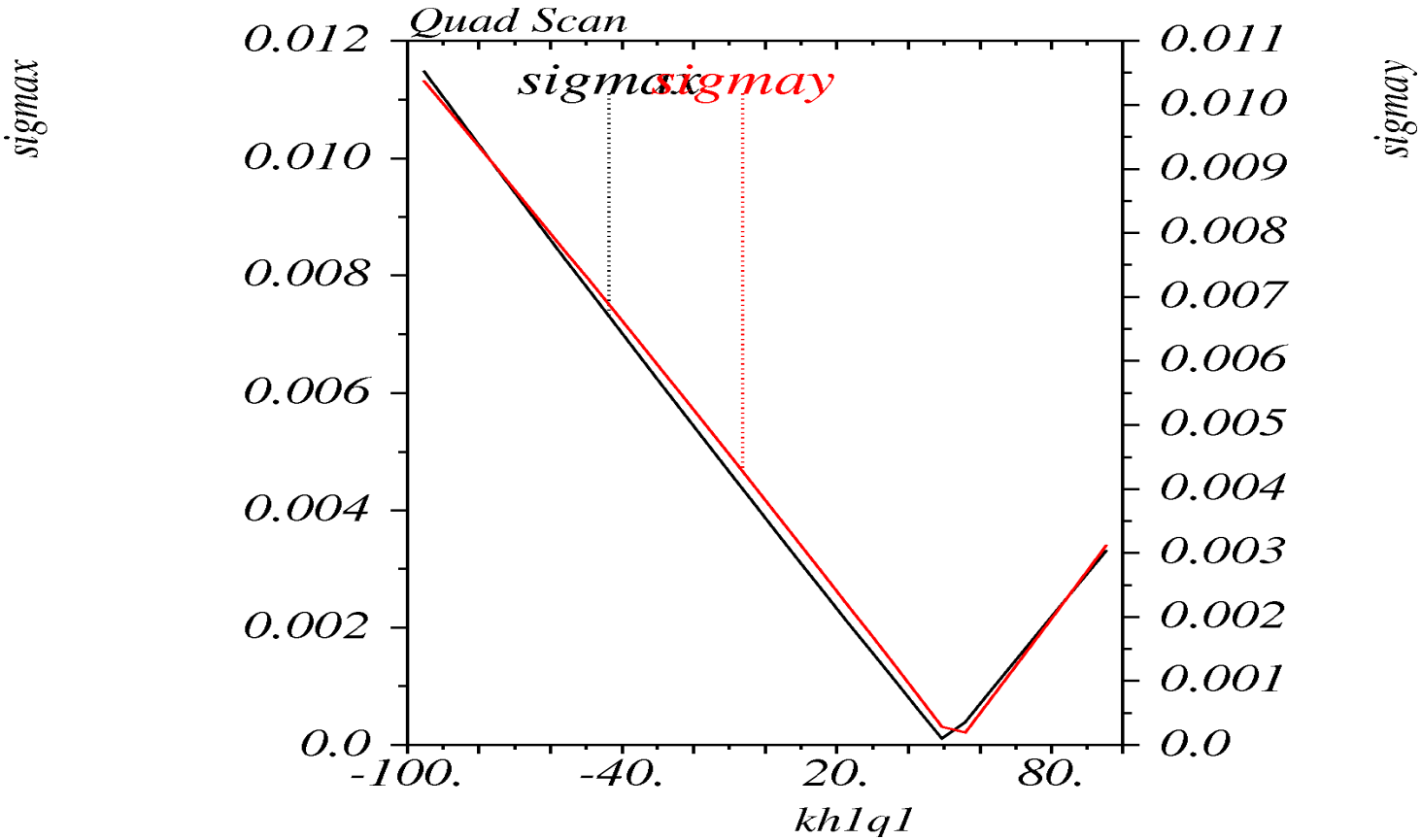
- EMSY measurement (Not when plasma cell in).



Twiss measurement

tried methods:

- EMSY measurement (Not when plasma cell in).
- Quad scan.



results from EMSY measurement

	at EMSY1		CDS exit (bp)		CDS exit (sim.)	
plane	X	Y	X	Y	X	Y
α [1]	2.12	-4.24	-10.6	-5.07	-12.3	-12.3
β [m]	39.7	15.3	52.9	21.6	51.02	51.02

Remark

- Wrong slit used for X, Horizontal meas. not valid.
- ”CDS exit (bp)” number from back-propagation with MAD.
- still number from X are much closer to simulation?

Quad scan

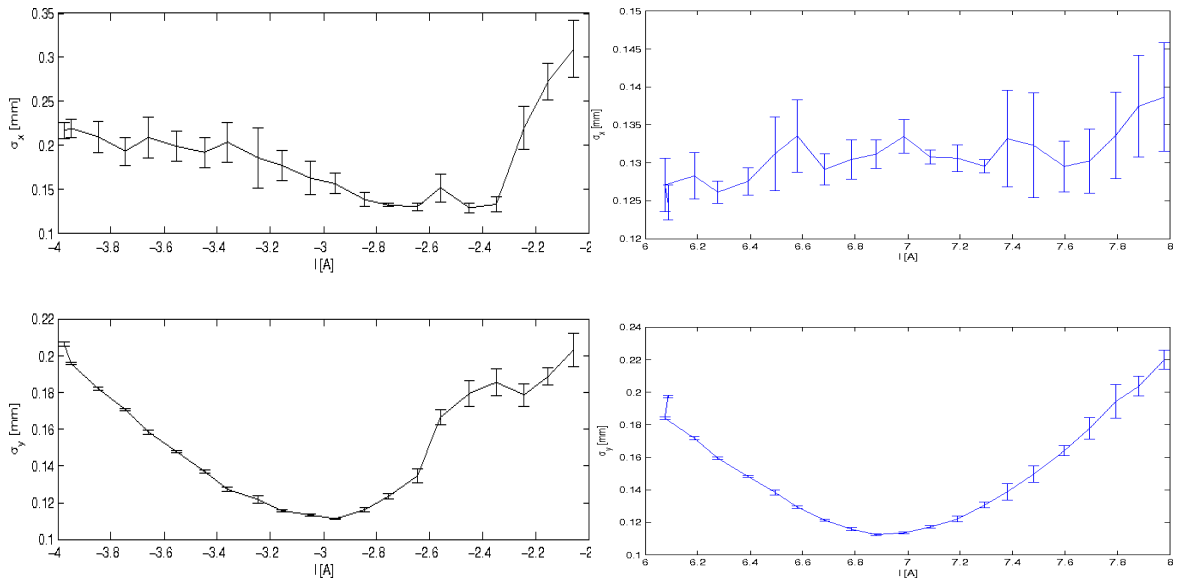


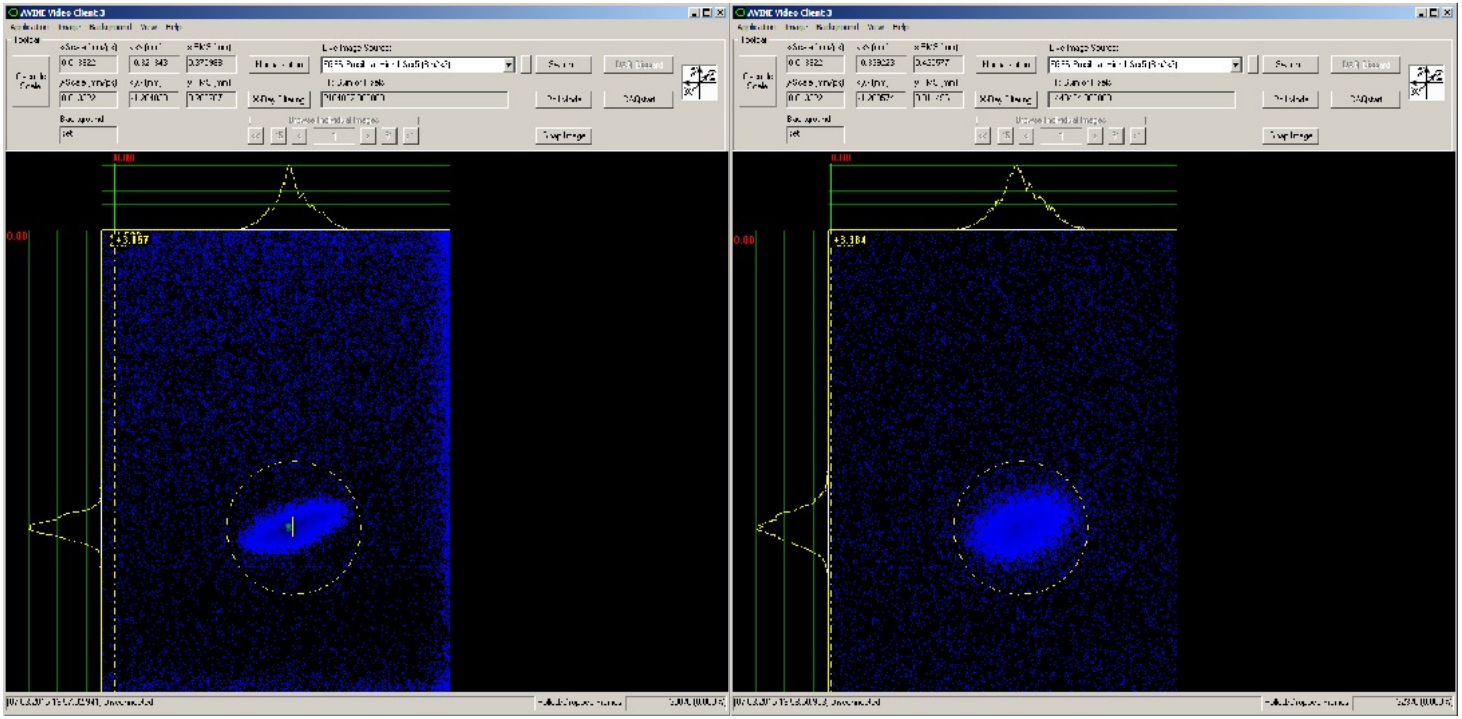
Figure 7: HIGH.Q3 & HIGH.Q4 scan

Remarks

- Horizontal scan looks very bad (resol ? beam hitting beam-pipe?).
- Vertical scan limited by screen resolution.

Table of Contents

Scattering with 2μm foil



$$\sigma_{xp\ foil} = \frac{\sqrt{\sigma_{scat}{}^2 - \sigma_{no\ scat}{}^2}}{L(foil \rightarrow plasma)} \quad (1)$$

Result

$\sigma_{xp\ foil} = 0.393\text{mrad}$

$\sigma_{yp\ foil} = 0.448\text{mrad}$

Table of Contents

Conclusion and prospects

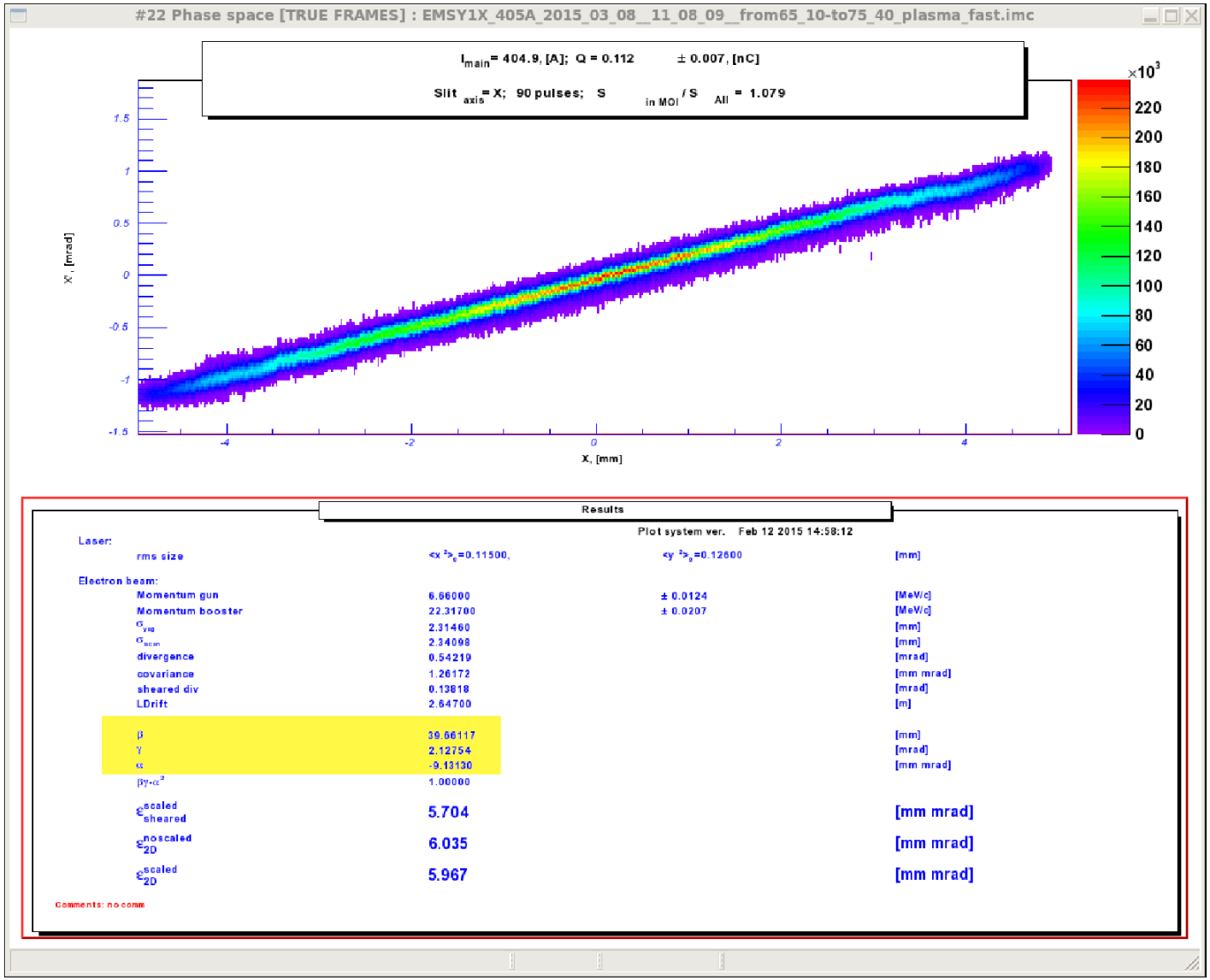
Conclusions

- Settings for 100μm beam found.
- Quad scan cannot measure Twiss (screen resol.).
- Good EMSYX measurements with the settings used for 100μm would be nice.
- 0.1mrad scattering found for 2μm foil ($\simeq$ 10μm increase of σ)

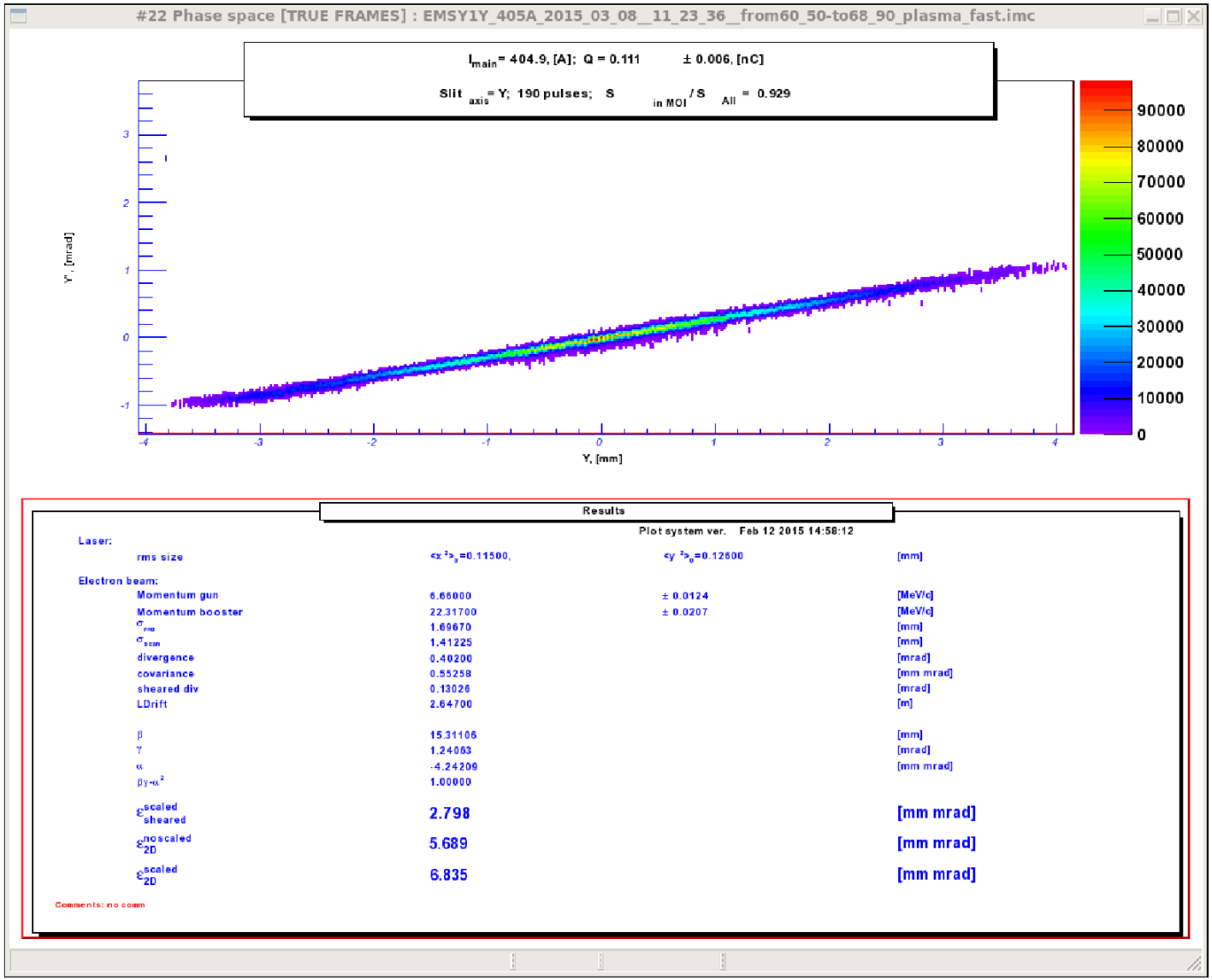
Prospects

- Why X quad scan look so bad ?
- Reproduce Y quad scan with EMSY meas. Twiss.
- 100μm too large? Try matching with meas. Twiss.

EMSYX


#22 Phase space [TRUE FRAMES] : EMSY1X_405A_2015_03_08__11_08_09__from65_10-to75_40_plasma_fast.imc
I main = 404.9, [A]; Q = 0.112 ± 0.007, [nC]
Slit axis = X; 90 pulses; S in MOI / S All = 1.079
X', [mrad]
X, [mm]
×10^3
220
200
180
160
140
120
100
80
60
40
20
0
Results
Plot system ver. Feb 12 2015 14:58:12
Laser:
rms size
<x²>0=0.11500,
<y²>0=0.12600
[mm]
Electron beam:
Momentum gun
6.66000
± 0.0124
[MeV/c]
Momentum booster
22.31700
± 0.0207
[MeV/c]
σvis
2.31460
[mm]
σscan
2.34098
[mm]
divergence
0.54219
[mrad]
covariance
1.26172
[mm mrad]
sheared div
0.13818
[mrad]
LDrift
2.64700
[m]
β
39.66117
[mm]
γ
2.12754
[mrad]
α
-9.13130
[mm mrad]
βγ-α²
1.00000
ε scaled sheared
5.704
[mm mrad]
ε noscaled 2D
6.035
[mm mrad]
ε scaled 2D
5.967
[mm mrad]
Comments: no comm

EMSYY


#22 Phase space [TRUE FRAMES] : EMSY1Y_405A_2015_03_08__11_23_36__from60_50-to68_90_plasma_fast.imc
I main = 404.9, [A]; Q = 0.111 ± 0.006, [nC]
Slit axis = Y; 190 pulses; S in MOI / S All = 0.929
Y', [mrad]
Y, [mm]
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Results
Plot system ver. Feb 12 2015 14:58:12
Laser:
rms size
<x²>0=0.11500, <y²>0=0.12600 [mm]
Electron beam:
Momentum gun 6.66000 ± 0.0124 [MeV/c]
Momentum booster 22.31700 ± 0.0207 [MeV/c]
[mm]
[mm]
divergence 0.40200 [mrad]
covariance 0.55258 [mm mrad]
sheared div 0.13026 [mrad]
LDrift 2.64700 [m]
β 15.31106 [mm]
γ 1.24063 [mrad]
α -4.24209 [mm mrad]
βγ-α² 1.00000
ε scaled sheared 2.798 [mm mrad]
ε noscaled 2D 5.689 [mm mrad]
ε scaled 2D 6.835 [mm mrad]
Comments: no comm