PROJECTED EMITTANCE MEASUREMENTS AT FLASH

FEL studies – February 2007

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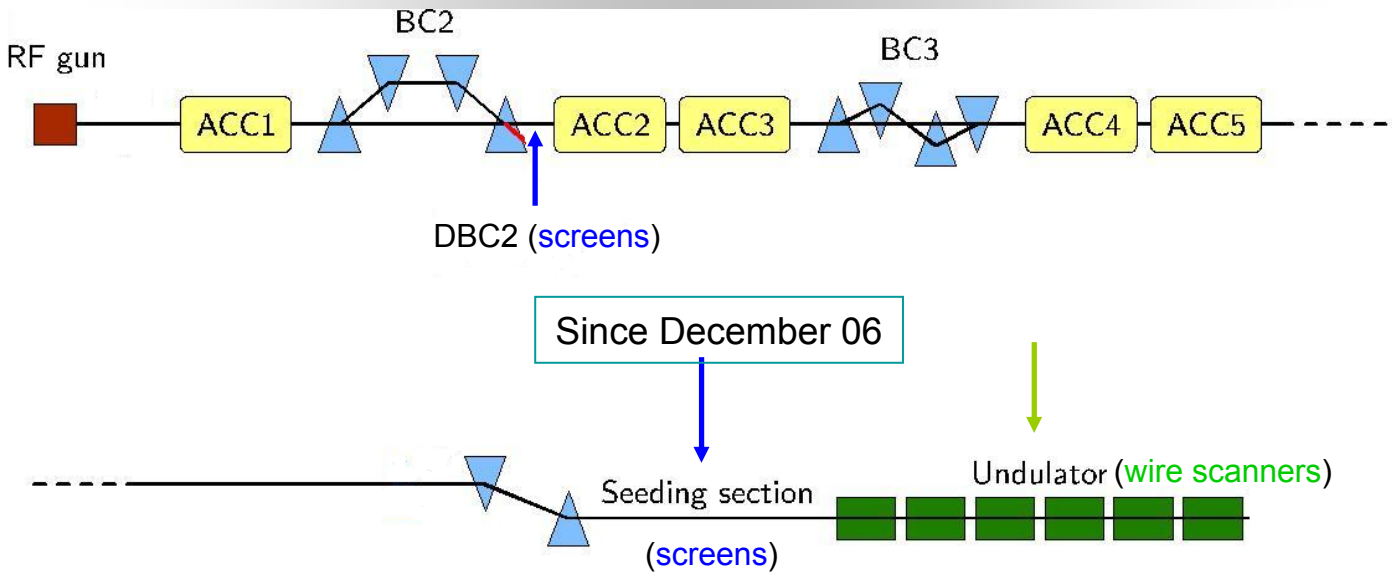
Beam Dynamics Meeting, 26-02-2007

Overview



- When: FEL studies - 17th and 21st (& 22nd) of February 2007
- Where: DBC2, SEED and undulator
- Standard conditions: on crest for all accelerator modules, 1nC (22-02: SASE conditions)

About the measurements in the undulator:

- All the measurements were done with the 10 μm carbon wire
- New matching tool:
  - It uses the toolbox from Vladimir and Nina
  - Option to limit the quad currents
  - Option to user quads which share power supplies
  - Option to choose between Gaussian or rms beam sizes

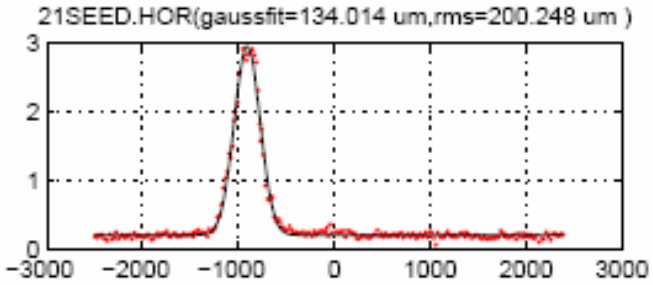
Summary table for the 17th of February

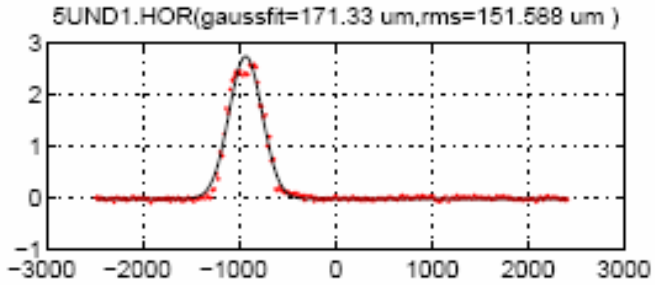
Where & when	Comments	ε_x [mm mrad]	ε_y [mm mrad]
Injector 08.47h	Matched	3.72 ± 0.12	3.78 ± 0.07
Seed 12.30h	Matched	2.74 ± 0.22	2.95 ± 0.09
Undulator 17.01h	Mx = 1.039, My = 1.145	4.25 ± 0.34	4.37 ± 0.31
Undulator 17.55h	Mx = 1.025, My = 1.163	5.13 ± 0.26	4.44 ± 0.17
Undulator 18.11h	Mx = 1.050, My = 1.113	5.12 ± 0.20	5.14 ± 0.23
Undulator 18.45h	Mx = 1.031, My = 1.052	5.15 ± 0.18	4.89 ± 0.15

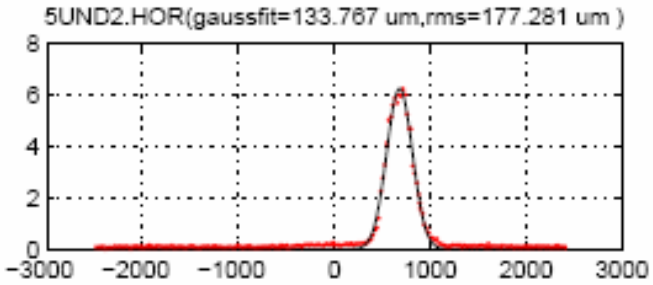
SEED section — Similar emittances as in the injector
Matching worked properly

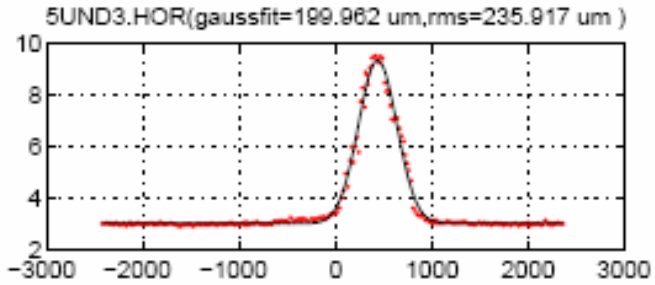
Undulator — Similar emittances as in the injector

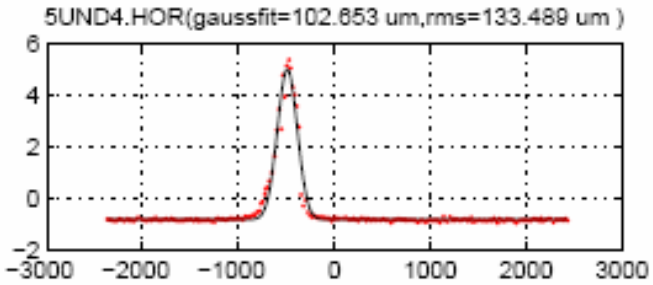
Taking rms or gaussian beam sizes: Beam profiles example (17-02)











- A gaussian fit represents well the beam
- rms is very sensitive to the beam tails

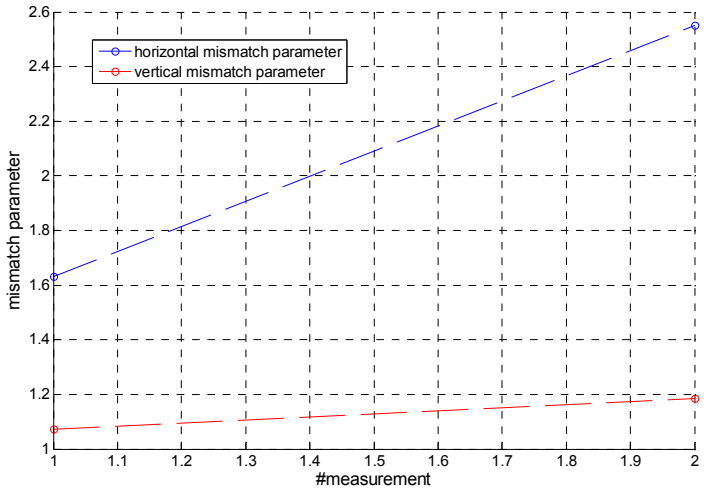
Taking rms or gaussian beam sizes: Emittance results (17-02)

Where & when	ε_x [mm mrad]		Mismatch x		ε_y [mm mrad]		Mismatch y	
	rms	gauss	rms	gauss	rms	gauss	rms	gauss
Undulator 17.01h	4.25	3.58	1.039	1.167	4.37	3.62	1.145	1.053
Undulator 17.55h	5.13	3.84	1.025	1.021	4.44	3.86	1.163	1.257
Undulator 18.11h	5.12	4.02	1.050	1.070	5.14	4.38	1.113	1.072
Undulator 18.45h	5.15	3.56	1.031	1.053	4.89	4.22	1.052	1.017

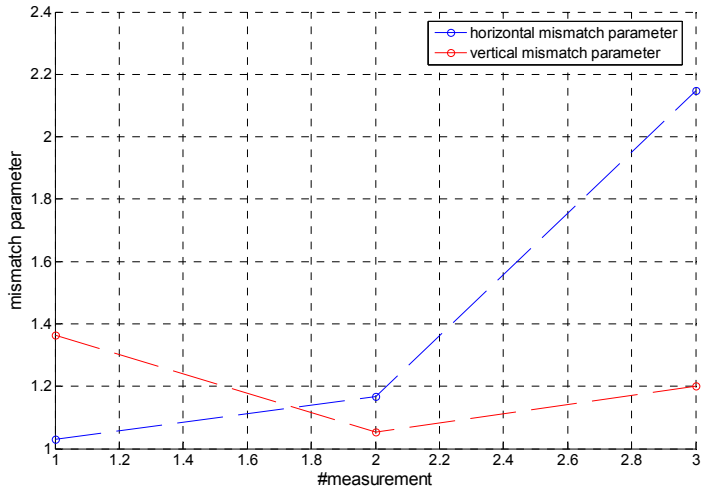
- Emittance systematically smaller with a gaussian beam
- Similar mismatch parameters

Matching in the undulator

With rms beam sizes

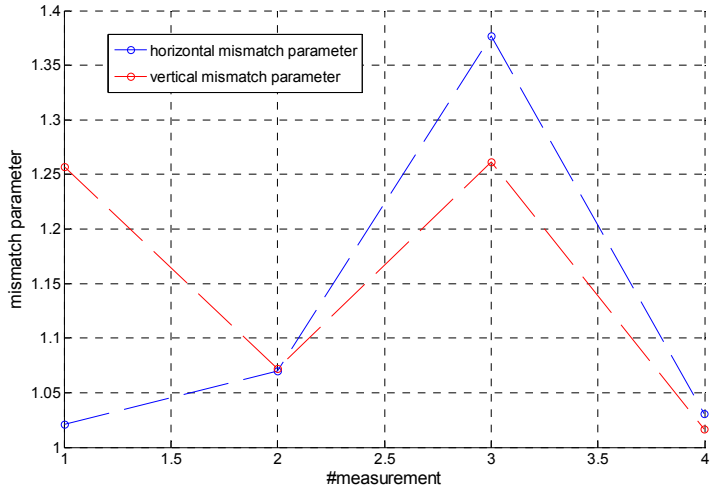


With gaussian beam sizes



- Limiting the quad current variation helps
- Taking Gaussian beam sizes instead of rms sizes helps
- Cycling should do the rest

With gaussian beam sizes

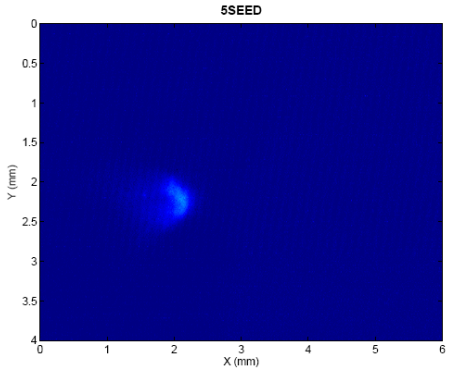


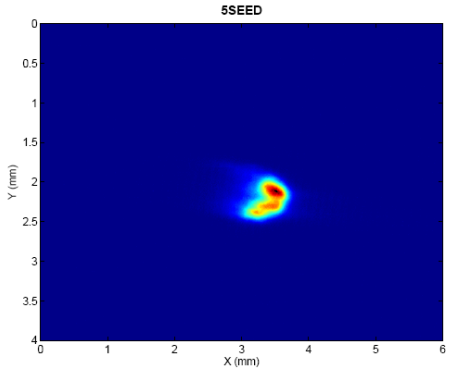
Summary table for the 21st of February

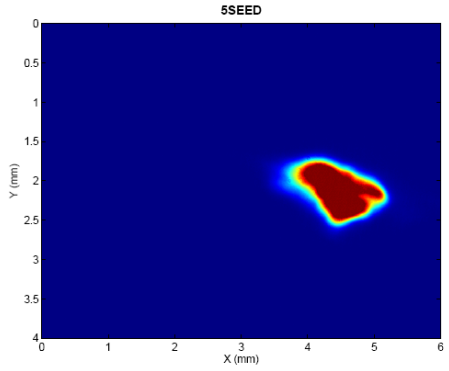
Where & when	Comments	ε_x [mm mrad]	ε_y [mm mrad]
Injector 18.18h	Matched	4.75 ± 0.17	3.41 ± 0.15
Seed	Not proper measurement		
Undulator 22.28h	Mx = 1.256, My = 2.073	4.24 ± 0.48	4.43 ± 0.66
We started from scratch here…			
Undulator 00.13h	Mx = 1.528	5.79 ± 0.61	-
Undulator 01.31h	Mx = 1.342, corrected dispersion	4.30 ± 0.37	-
Undulator 02.18h	Mx = 1.136, 6 degrees off crest at ACC1	6.28 ± 2.39	-
Injector 03.03h	Mx = 3.422, My = 1.713	3.67 ± 1.54	2.99 ± 0.22

DBC2 section	Big initial mismatch in the 2nd attempt
SEED section	Not proper measurement since strong dependence of the beam size on the horizontal position Matching did not work
Undulator	Imaginary calculated emittances in the vertical plane Not possible to try matching

Screen problematic





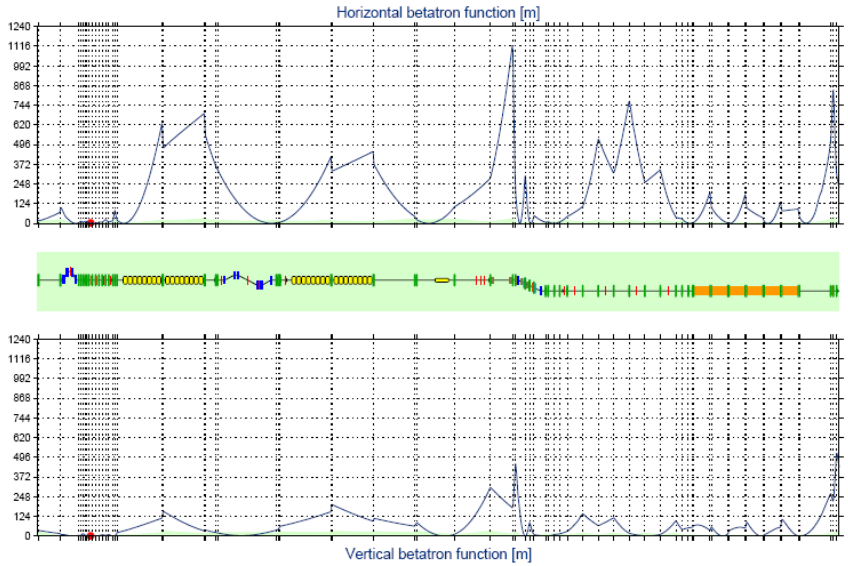


- Strong dependence of beam intensity and beam size on horizontal position for at least 3 out of 5 screens in the SEED section.
- This has been observed only during the measurements on the 21st of February. Previously, only a weaker dependence in one screen was observed and matched worked properly.
- Possible explanation: screen and/or optical set-up misalignment?
- Further studies are required

Playing around with Q9/10ACC5

	Beam size at 21SEED	
	σ_x [μm]	σ_y [μm]
Reference	153.4 ± 13.7	318.9 ± 11.5
↑Q9ACC5 by 0.5A	69.1 ± 17.9	300.5 ± 13.0
↓Q9ACC5 by 0.8A	416.3 ± 31.8	329.0 ± 20.2
↓Q10ACC5 by 0.8A	82.0 ± 20.3	291.7 ± 8.3

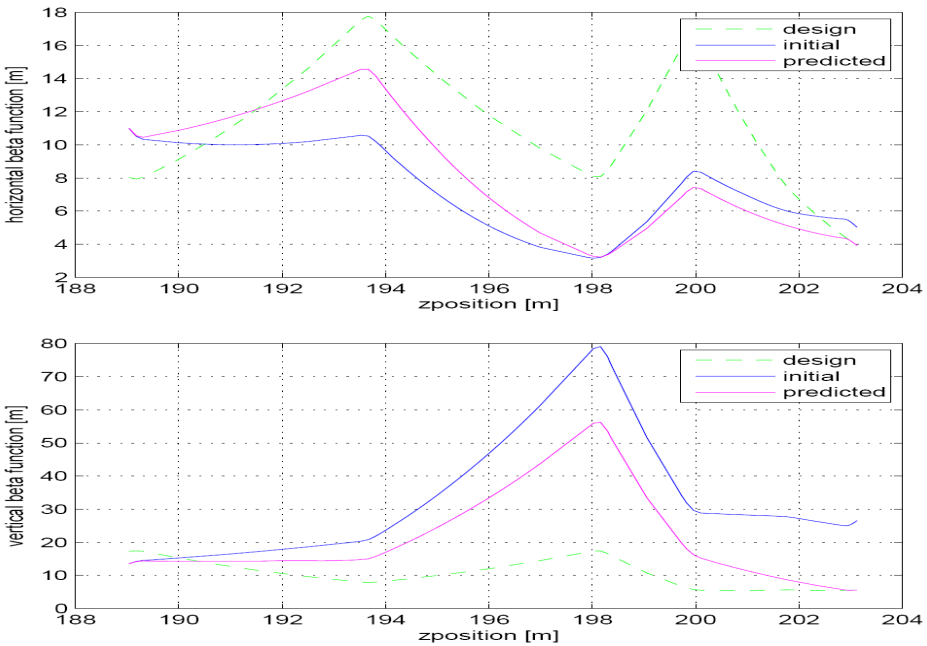
Modifying Q9ACC5 and Q10ACC5 had an effect to the beam only in the horizontal plane



	Design		Calculated from DBC2 meas.	
	β_x [m]	β_y [m]	β_x [m]	β_y [m]
Q9ACC5	14.4	24.2	452	400
Q10ACC5	13.1	26.9	94	105

Measurements on the 22nd of February SASE conditions

Where & when	Comments	ε_x [mm mrad]	ε_y [mm mrad]
Undulator 20.49h	Mx = 1.025, My = 3.011	8.18 ± 0.45	6.18 ± 1.34
Undulator 21.44h	Attempt to match, Mx = 1.163, My = 1.706	8.36 ± 0.38	6.93 ± 0.45



Just 1 measurement and 1 matching attempt
No time for more ☹

Summary and next steps

Summary

- ✓ New matching tool for the undulator
- × Not proper status of the machine makes measurements very complicated
- × In the SEED screens, observed dependence of the beam size on the horizontal position

Next steps

- Further studies to solve the problematic in the screens of the SEED section: work on the alignment of the optical set-up and OTR screens …
- Further studies on wire scanners problematic
- Improve the matching tool: include an option to modify the beam size in the calculation of the emittance …
- Next measurements after the shutdown (with OTR aligned, wires in the SEED section …)