SUMMARY OF MEASUREMENTS RELATED TO EMITTANCE AT FLASH (KW 43)

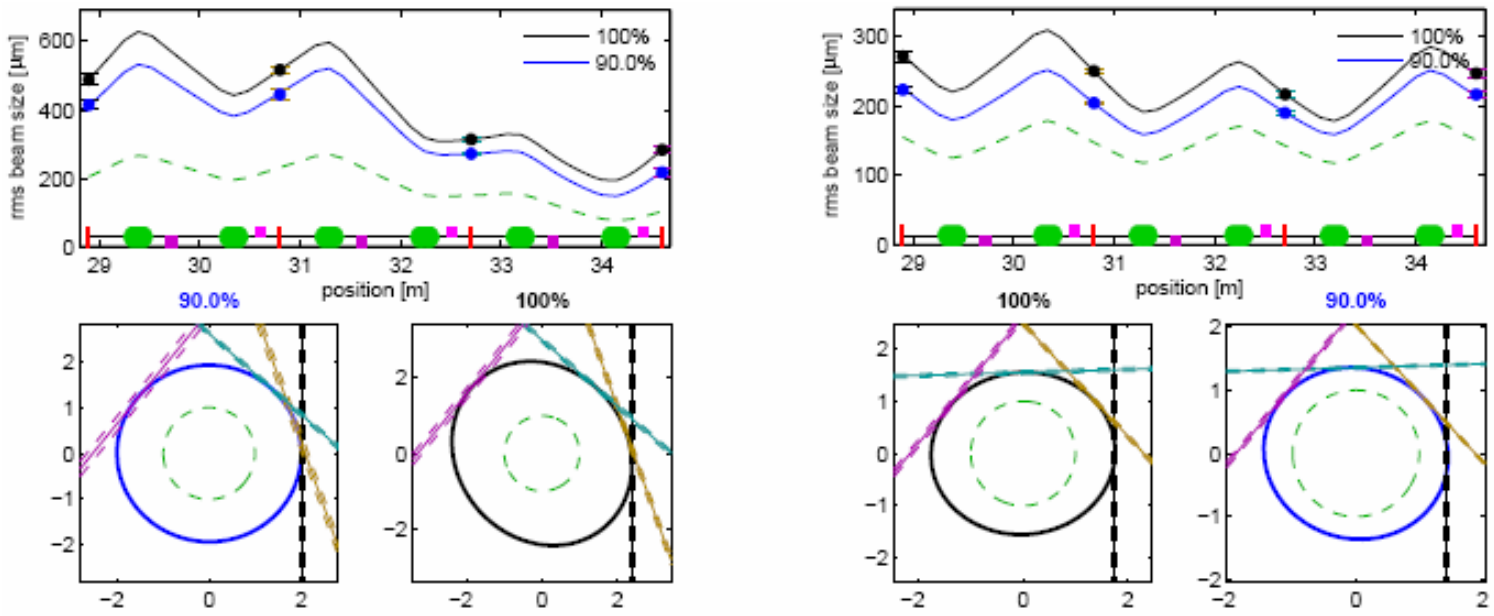
Eduard Prat

Thanks to Winni Decking, Torsten Limberg and Florian Loehl

Contents

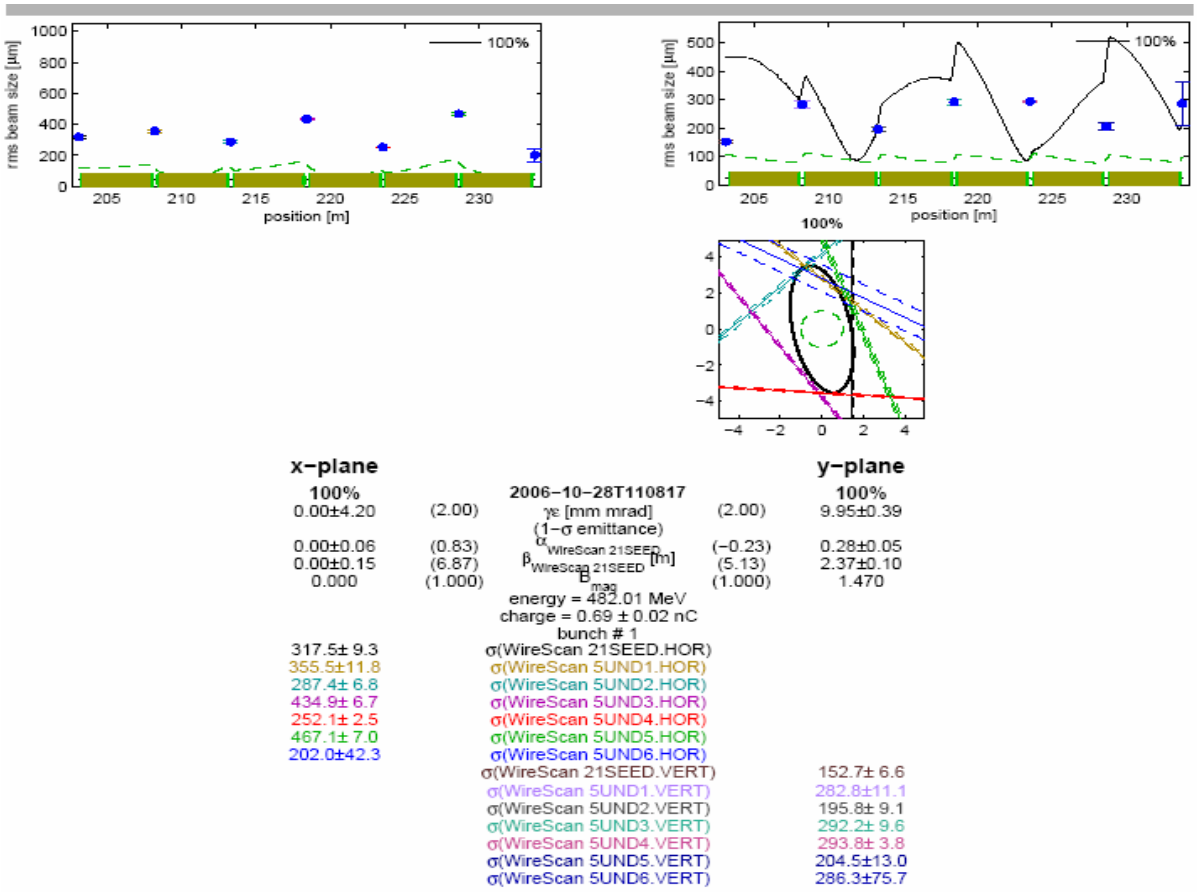
- Introduction
  - emittance measured at DBC2
  - emittance calculation problem in the undulator
  - dispersion generation
- Beam profile measurements
  - ACC45
    - On crest
    - 20 degrees of crest
    - 20 degrees of crest + dispersion correction (horizontal plane)
    - 20 degrees of crest + dispersion generation (horizontal plane)
  - ACC1
    - On crest
    - 20 degrees of crest
- Orbit response measurements in the undulator
- Outlook

Introduction: Emittance at DBC2



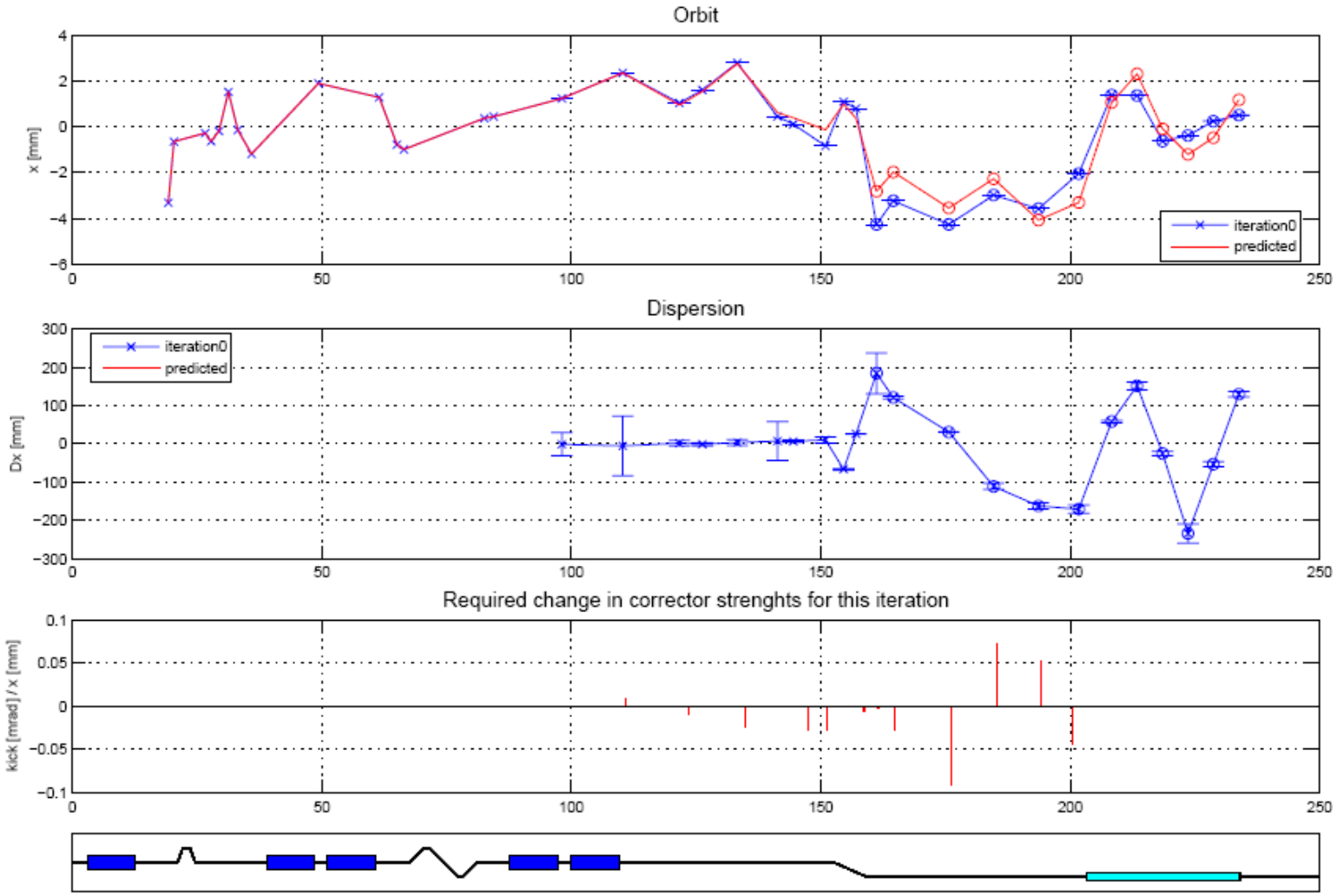
x−plane					y−plane	
90.0%	100%		2006−10−28T080948		100%	90.0%
7.74±0.45	11.62±0.48	(2.00)	$\gamma\varepsilon$ [mm mrad]	(2.00)	5.46±0.13	3.95±0.07
			(1−σ emittance)			
−3.42±0.28	−3.11±0.18	(−3.28)	$\alpha_{Screen\ 4DBC2}$	(1.35)	1.50±0.06	1.49±0.05
4.97±0.36	4.70±0.25	(4.76)	$\beta_{Screen\ 4DBC2}$ [m]	(2.76)	3.14±0.10	2.97±0.07
1.001	1.008	(1.000)	B_{mag}	(1.000)	1.008	1.004
			energy = 117.00 MeV			
			charge = 0.72 ± 0.02 nC			
			bunch # 1			
413.9±13.1	488.8±16.1		σ(Screen 4DBC2)		271.9± 7.5	223.8± 5.2
444.6±14.0	516.9±11.0		σ(Screen 6DBC2)		250.7± 4.5	204.8± 2.3
271.1± 5.4	313.2± 6.7		σ(Screen 8DBC2)		217.3± 4.5	190.4± 2.7
216.7±11.3	282.2±10.3		σ(Screen 10DBC2)		247.4± 6.6	216.8± 4.7

Introduction: Emittance in the undulator



In the horizontal plane, the combination of beam sizes, optics and energy gave a non real emittance for all the cases

Introduction: Generation of dispersion
↓Q3/5ECOL by 10%

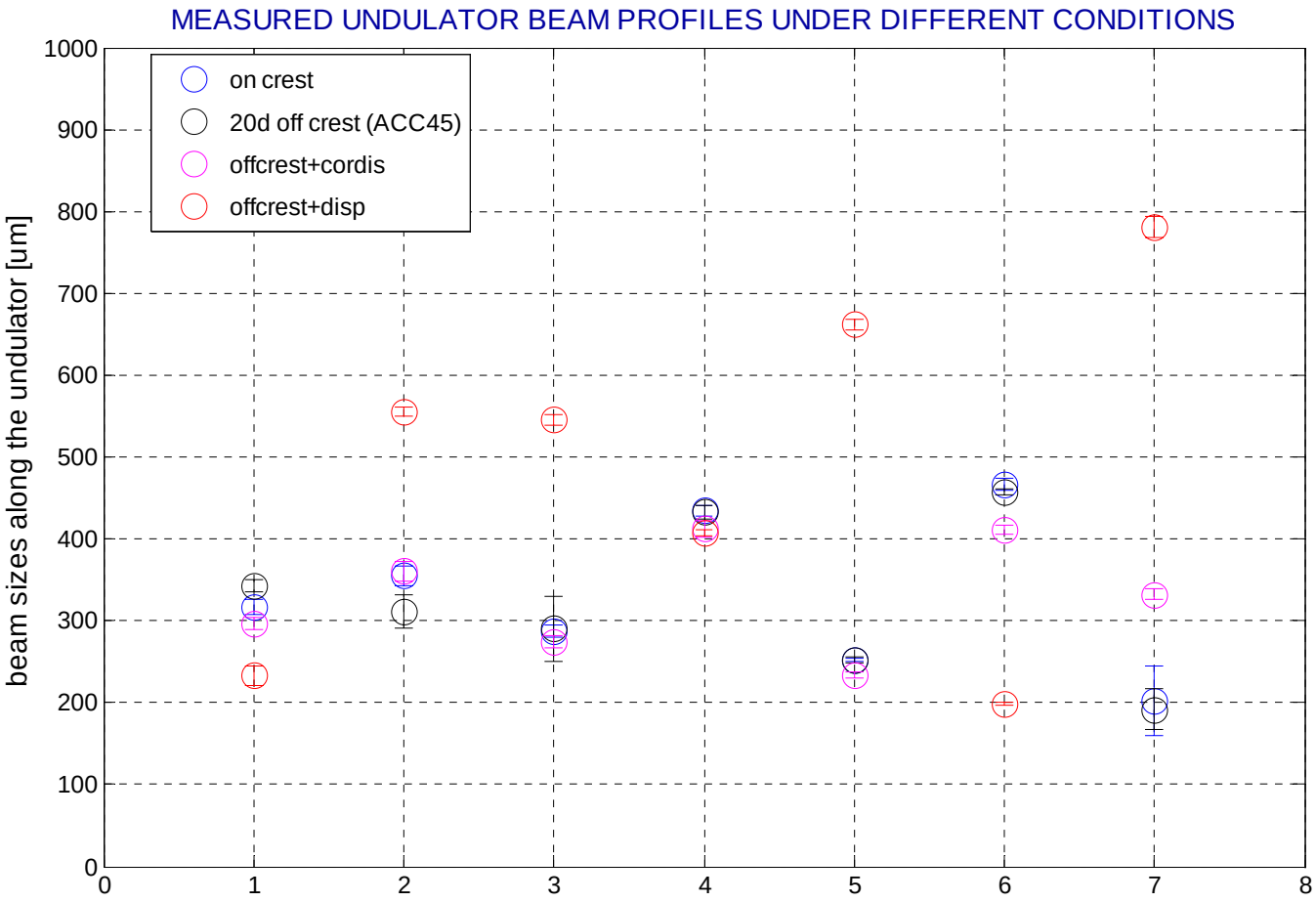


Beam profile measurements – ACC45 (I)
Horizontal plane

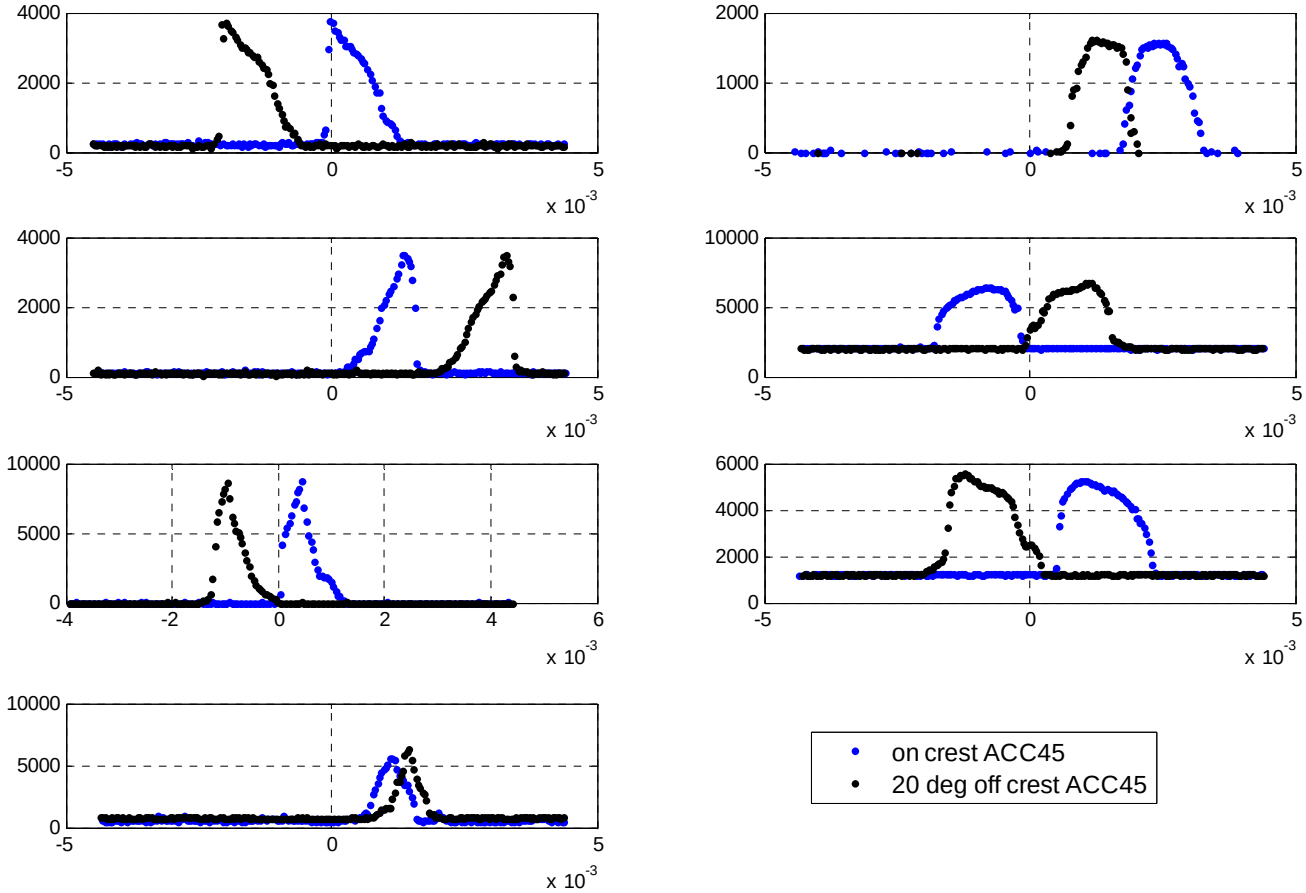
	Beam sizes [μm]				Dispersion [mm]		
	ON CREST	20DEG OFF	20DEG OFF dispersion corrected	20DEG OFF dispersion generated	Initial	After correction	After generation
21SEED	317.5±9.3	343.6±7.6	296.3±7.2	233.6±12.1	5	2.3	-170
5UND1	355.5±11.8	311.7±20.6	360.8±12.5	556.2±5.6	-17	-4.8	70
5UND2	287.4±6.8	290.6±39.5	274.5±8.1	545.5±6.1	0	3.1	155
5UND3	434.9±6.7	433.2±8.2	412.3±9.5	407.5±4.0	31	6.2	-20
5UND4	252.1±2.5	252.8±3.3	233.8±4.2	662.1±6.0	14	2.2	-230
5UND5	467.1±7.0	457.1±3.2	411.5±5.5	198.6±2.2	16	-7.5	- 50
5UND6	202.0±42.3	191.8±25.3	332.6±6.5	780.8±12.2	-20	-9.8	120

No difference when one goes to 20 degrees of crest
Reasonable results with extra dispersion (except for the red points)

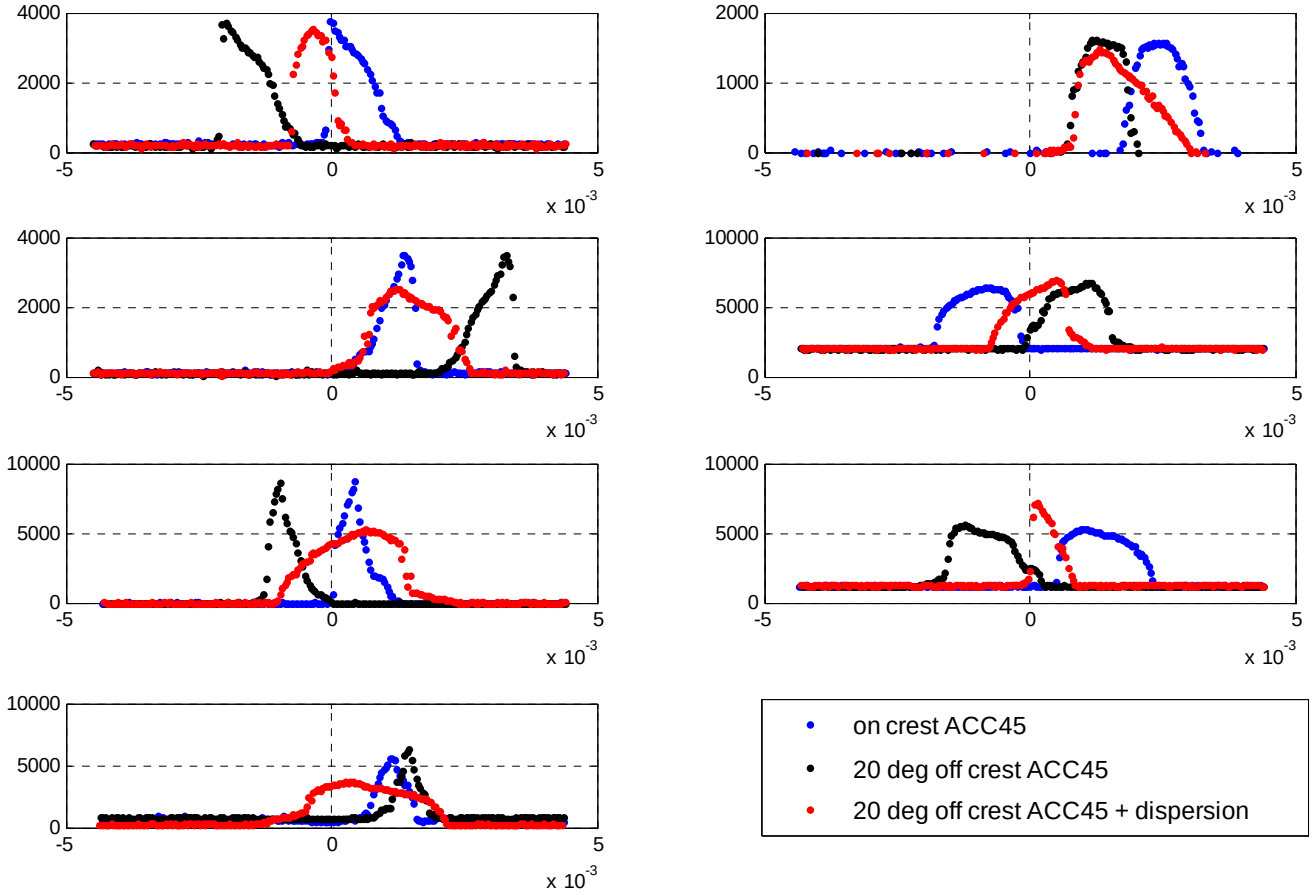
Beam profile measurements – ACC45 (II)
Horizontal plane



Beam profile measurements – ACC45 (III)
Horizontal plane



Beam profile measurements – ACC45 (IV)
Horizontal plane



Beam profile measurements – ACC45 (V)
Vertical plane

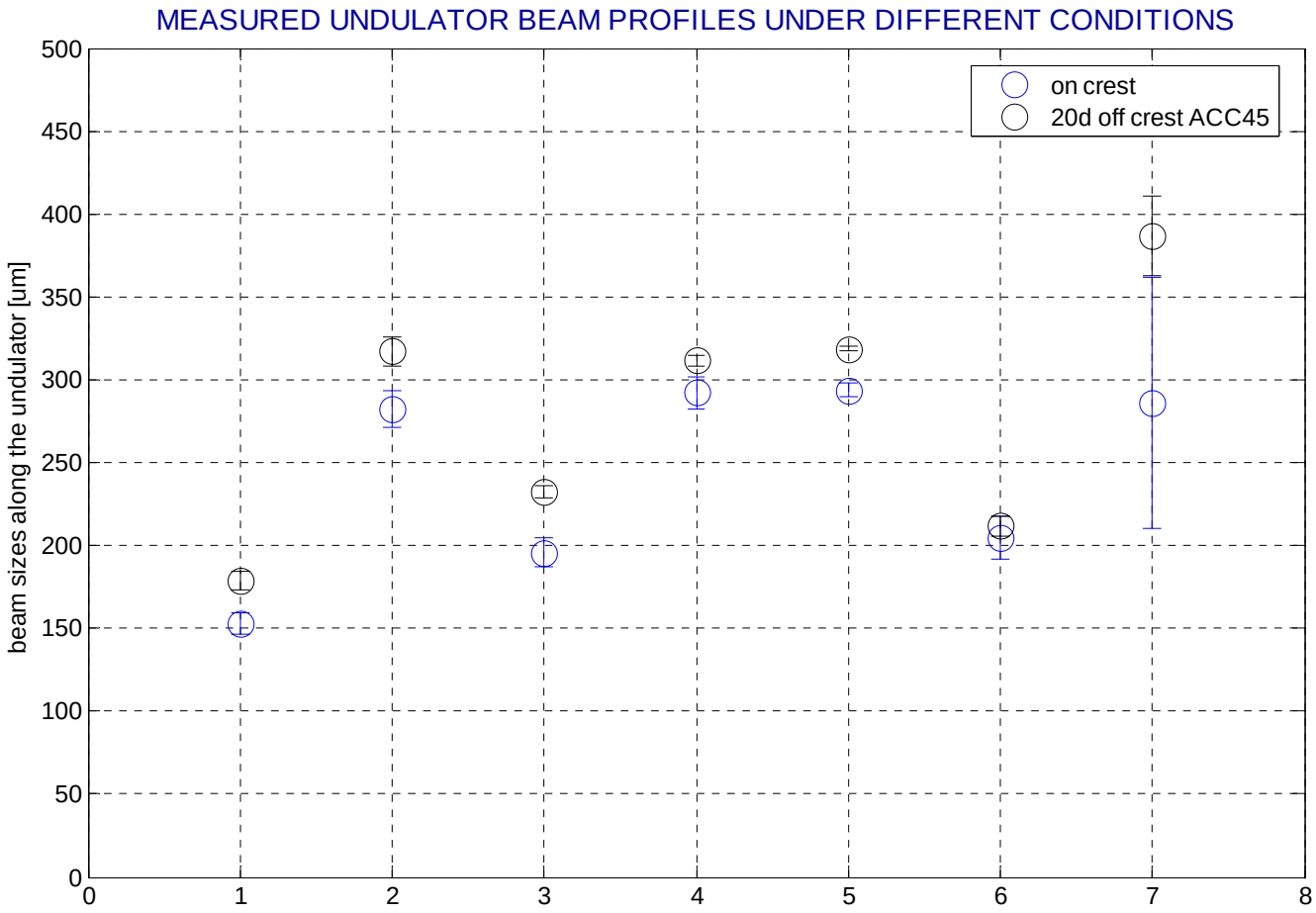
	Beam sizes [μm]		Dispersion [mm]
	ON CREST	20DEG OFF	Initial
21SEED	152.7±6.6	179.1±5.7	-2.6
5UND1	282.8±11.1	317.3±8.7	-31.9
5UND2	195.8±9.1	232.7±3.6	-8.86
5UND3	292.2±9.6	311.6±3.3	31.6
5UND4	293.8±3.8	318.7±1.6	25.3
5UND5	204.5±13.0	211.7±6.2	-22.5
5UND6	286.3±75.7	386.4±24.0	-7.1

Unlike in the horizontal plane, here beam size goes systematically a little bit up at off crest condition.

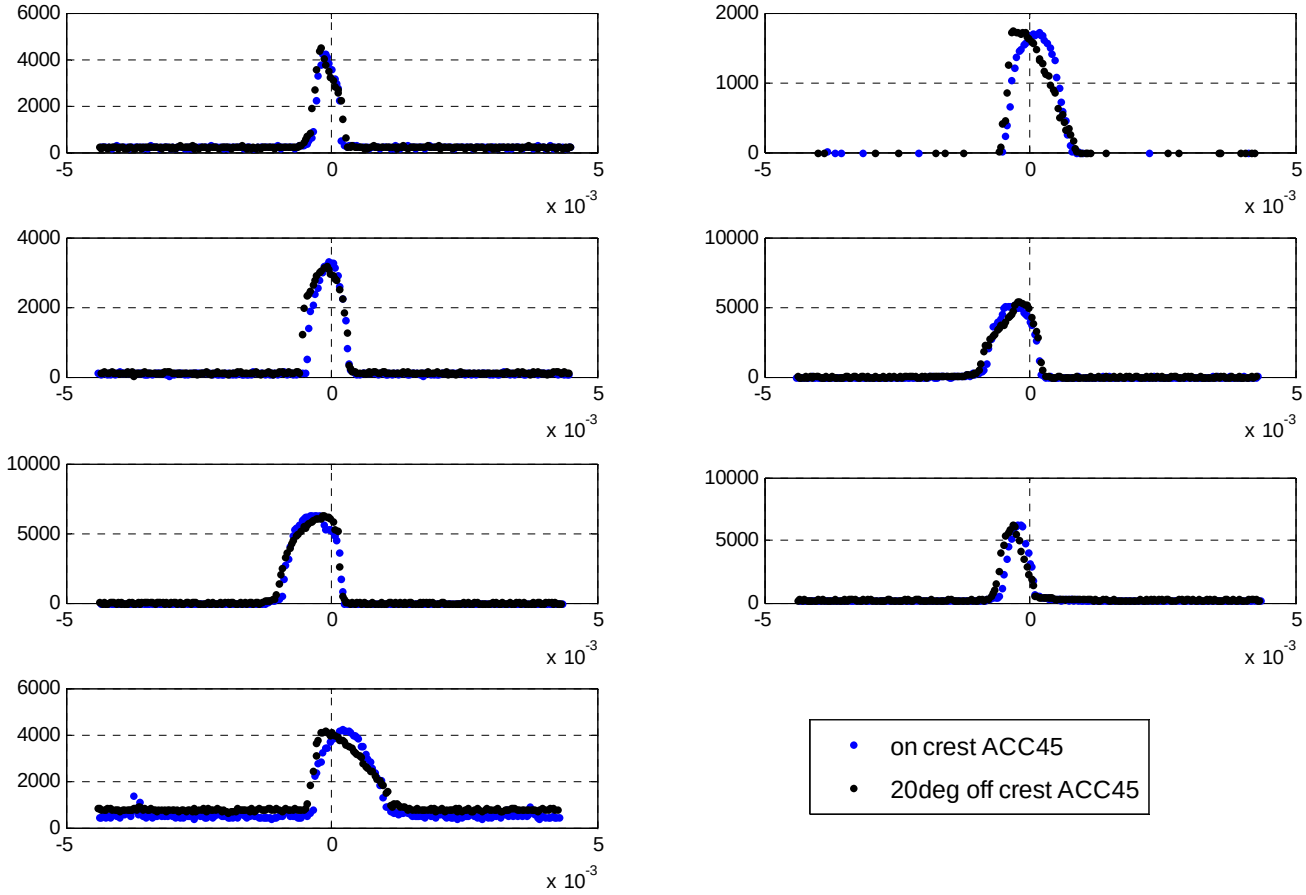
Dispersion from ACC45 is similar but can play a bigger role since vertical beam sizes are smaller.

Dispersion coming upstream ACC45 can be bigger in the vertical plane.

Beam profile measurements – ACC45 (VI)
Vertical plane



Beam profile measurements – ACC45 (VII)
Vertical plane

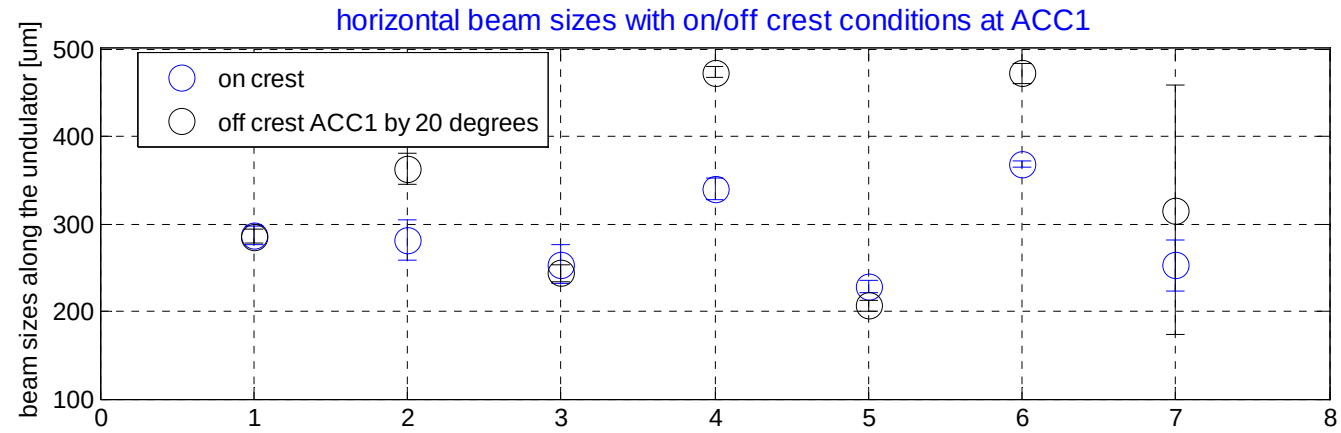


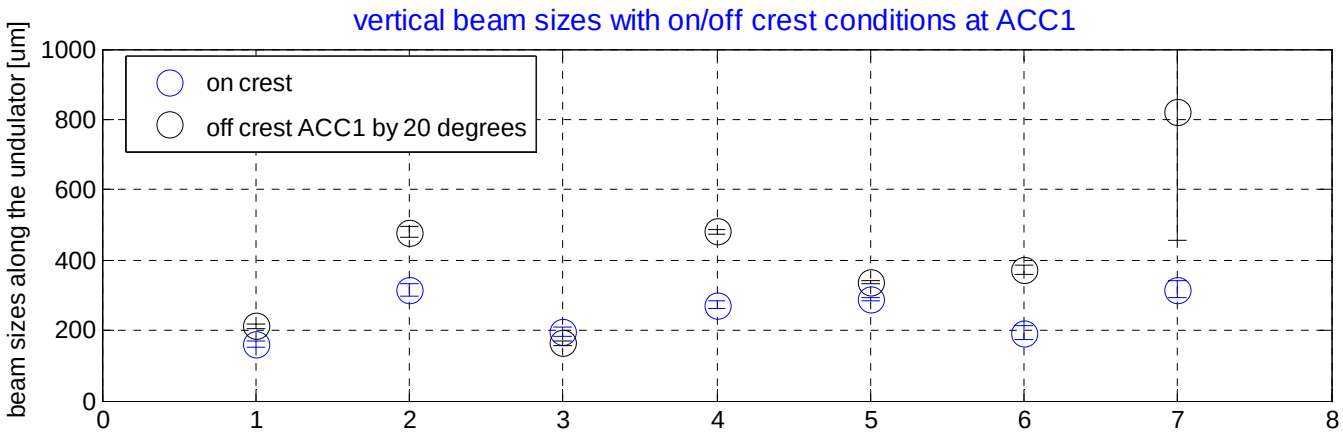
Beam profile measurements – ACC1 (I)

	Horizontal Beam size [μm]		Vertical Beam size [μm]	
	ON CREST	20DEG OFF	ON CREST	20DEG OFF
21SEED	282.2±10.3	285.8±8.7	162.0±7.9	212.8±6.7
5UND1	282.8±22.8	362.3±17.8	314.7±16.1	478.6±14.9
5UND2	253.8±22.6	243.8±10.0	196.8±11.8	164.4±6.5
5UND3	340.0±11.7	472.9±6.4	272.9±11.2	480.7±5.8
5UND4	229.0±7.0	206.3±6.6	287.4±3.5	336.9±5.6
5UND5	368.8±3.6	471.8±10.8	193.8±21.2	372.5±12.0
5UND6	252.7±29.5	-	316.6±24.3	-

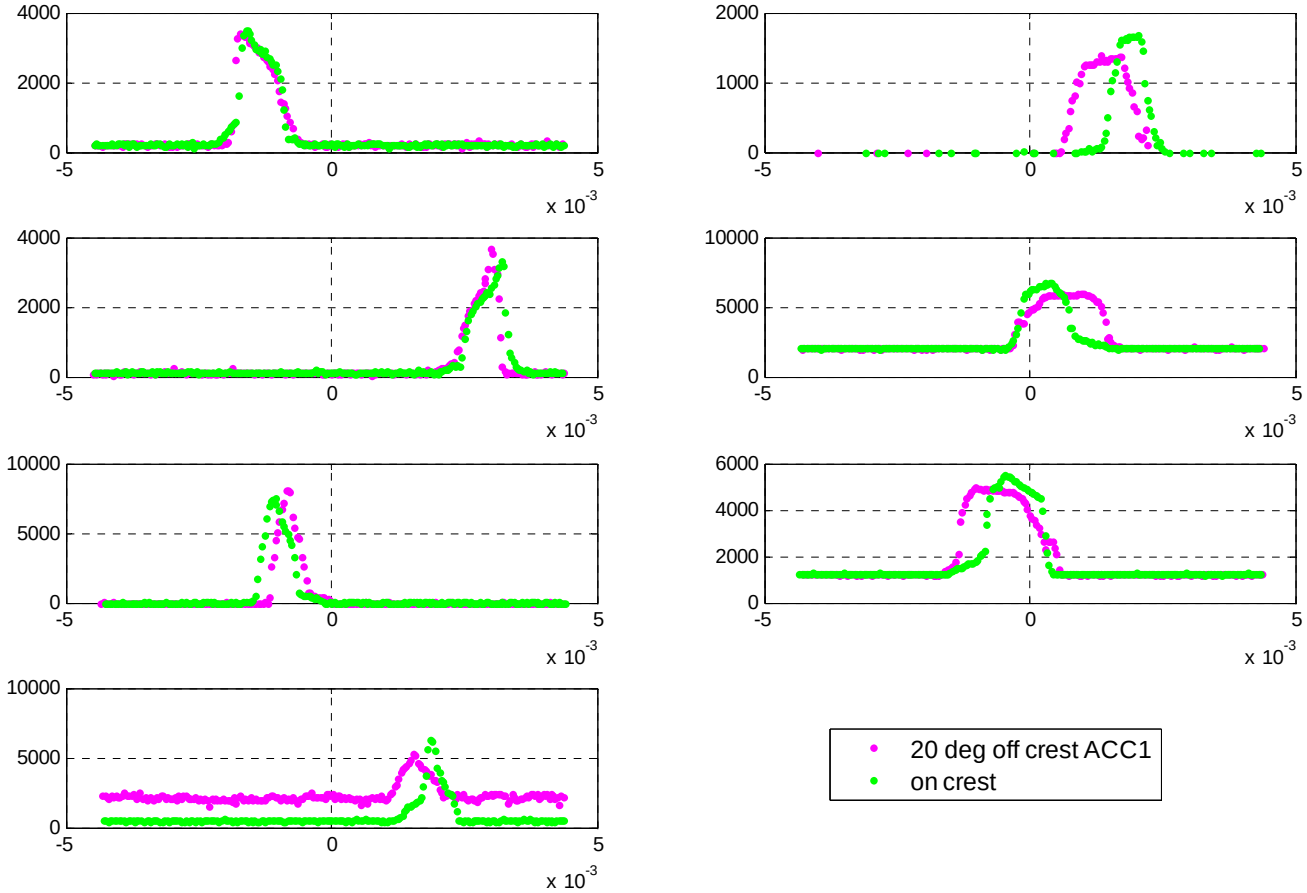
Increasing of beam sizes specially at UND1, UND3 & UND5
Probably due to dispersion… (we could not measure it)

Beam profile measurements – ACC1 (II)

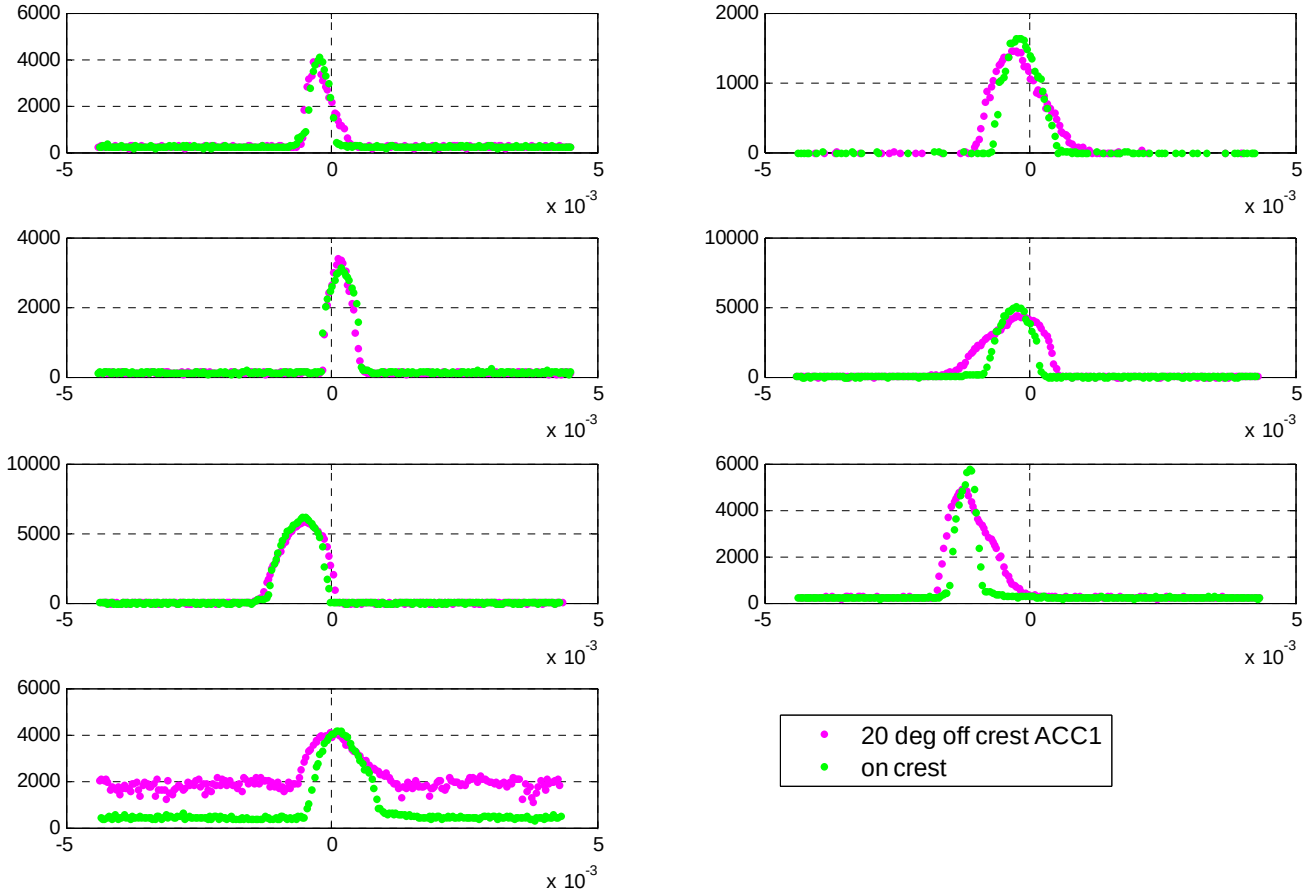




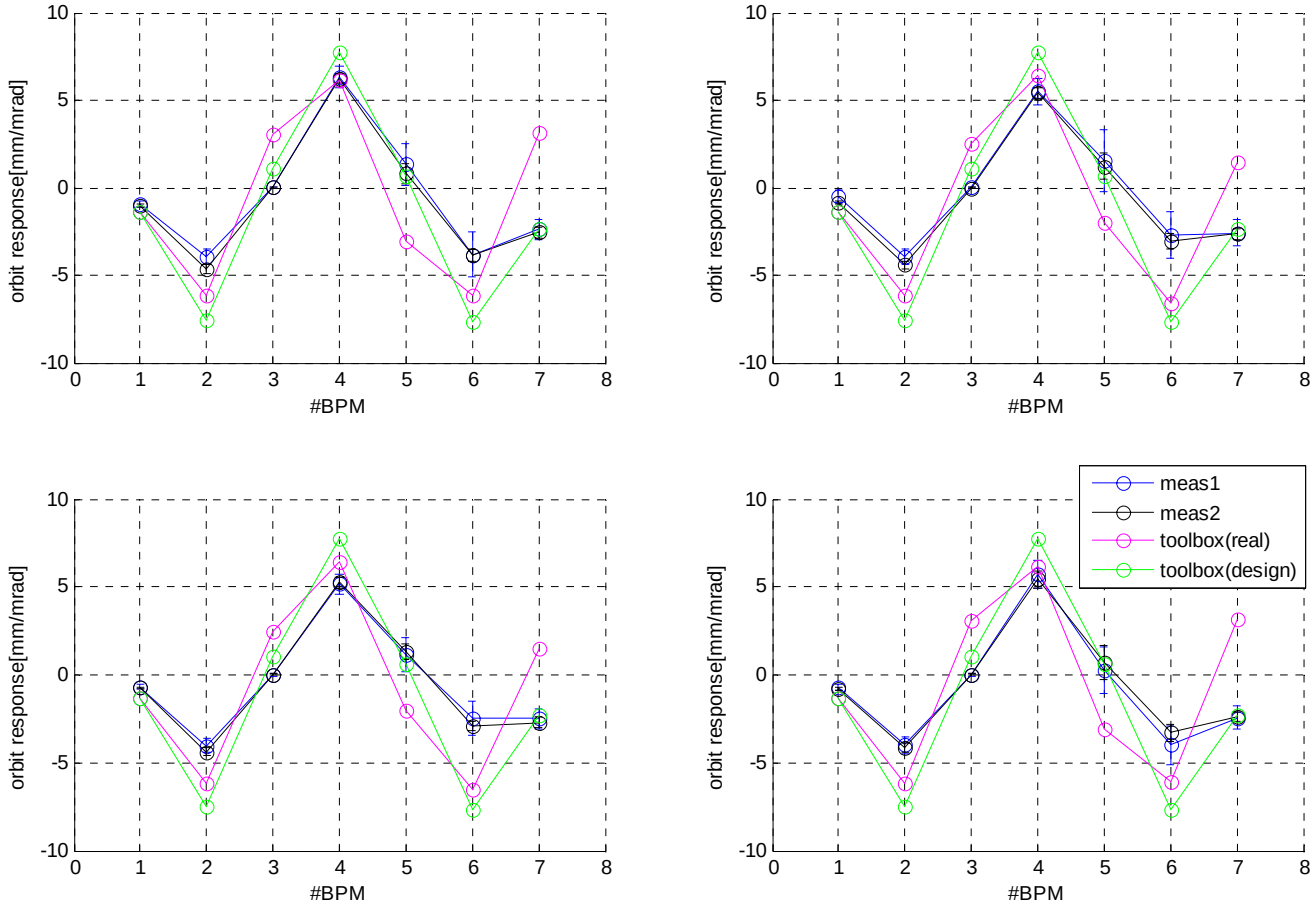
Beam profile measurements – ACC1 (III)
Horizontal plane



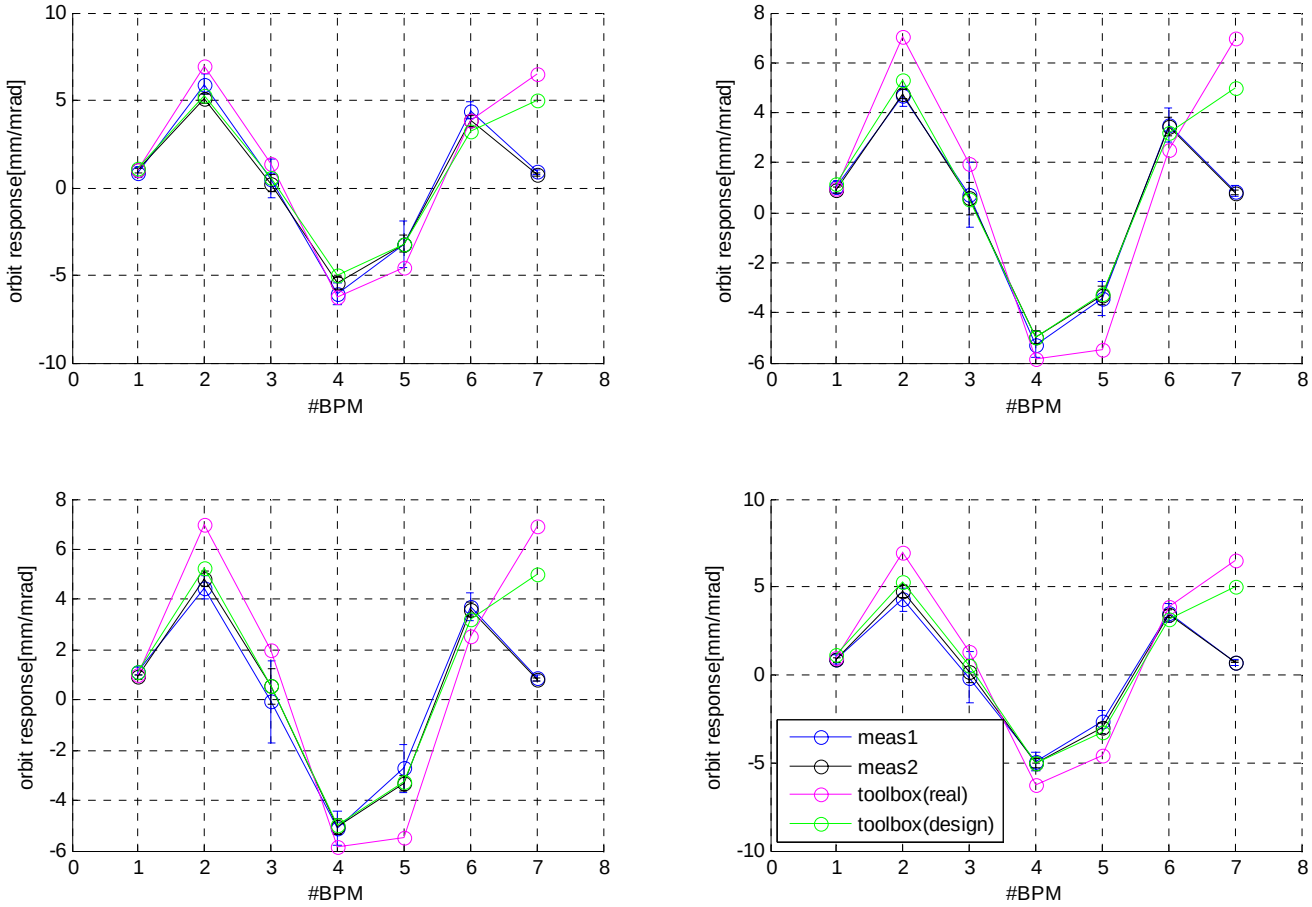
Beam profile measurements – ACC1 (IV)
Vertical plane



Orbit response measurements in the undulator (I): H19SEED



Orbit response measurements in the undulator (II): V19SEED



Orbit response measurements in the undulator (III)

- There is a disagreement between the measurements and the model.

- When one takes the design values instead of the real ones, there is a much better agreement.

	Design	Real
K_{Q5UND}	7.7575	7.7206
K_{Q6UND}	-7.2479	-6.6715
ratio	1.07	1.16

A final comment:
The emittance tool would give some real result if one takes the design optics

		ε_x [mm mrad]		ε_y [mm mrad]	
	Injector	11.6 ± 0.5		5.46 ± 0.1	
		Real optics	Design optics	Real optics	Design optics
Undulator	Initial (11.00h)	-	18.5 ± 0.7	10.0 ± 0.4	10.1 ± 0.4
	20 deg off ACC45	-	14.3 ± 1.5	13.9 ± 0.3	14.0 ± 0.3
	Everywhere on crest (21.00h)	-	12.9 ± 1.3	10.3 ± 0.5	10.3 ± 0.5
	20 deg off ACC1	-	16.5 ± 1.0	14.3 ± 0.8	11.9 ± 0.9

Outlook for the next accelerator studies

- Orbit response measurements
  - BPM's along the machine
  - wire scanners in the undulator

- Emittance measurements:
  - Injector (optimizing if it's necessary)
  - SEED section
  - Undulator