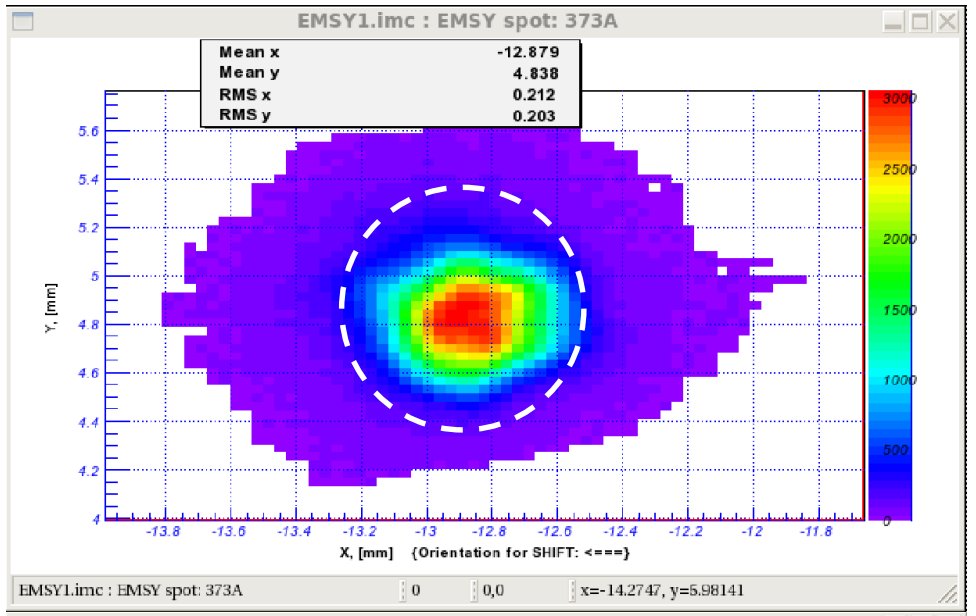
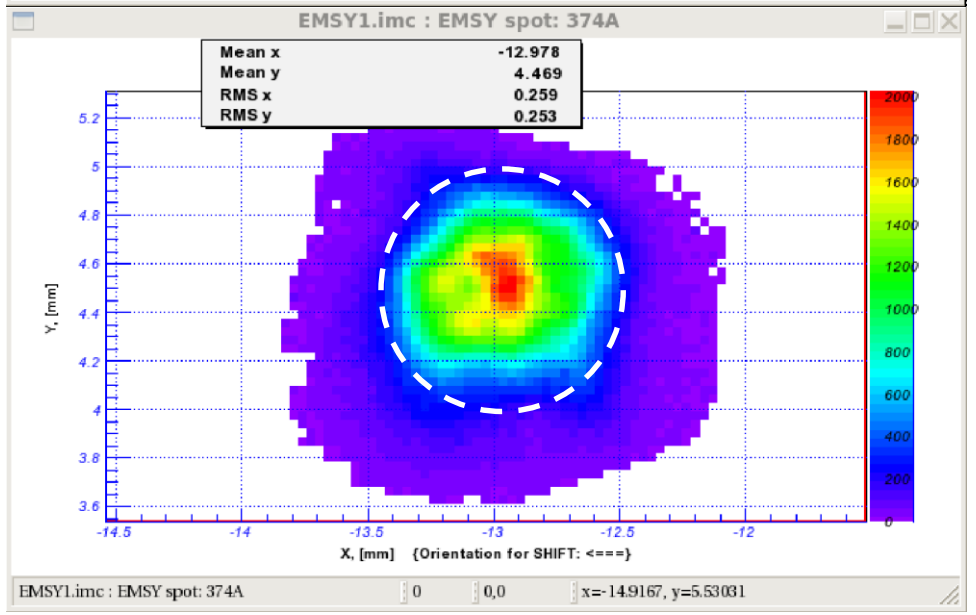
Emittance measurements summary for MBI and PHAROS shaping





Houjun Qian
25.03.2021

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

MBI emittance study

250 pC BSA1mm, 6.3 MeV/c, 50 um slit

- 5 nm cathode, booster steering free

Scale1	unscaled	EMSY1	Scaling factor	date
0.53	0.44	0.21	1.22	2019.07.03A
0.66	0.51	0.29	1.3	2020.09.26N
0.67	0.55	0.27	1.2	2021.02.25A

- 10 nm cathode, ‘4 nC’ steering, bad booster steering

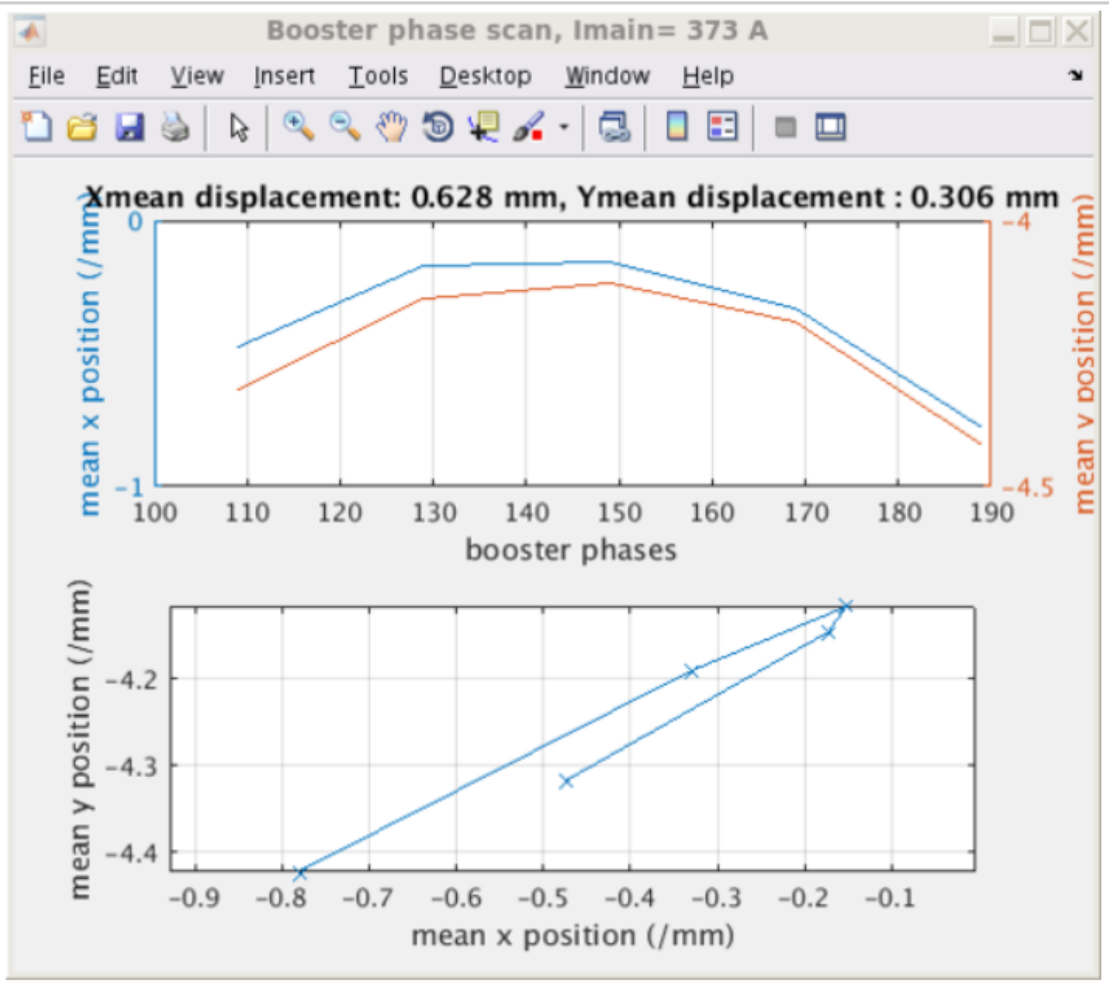
Scale1	unscaled	EMSY1	Scaling factor	date
0.47	0.41	0.27	1.15	2019.07.12A
0.6	0.49	0.21	1.24	2021.03.17A

Booster steering free
4 nC steering, very bad booster steering

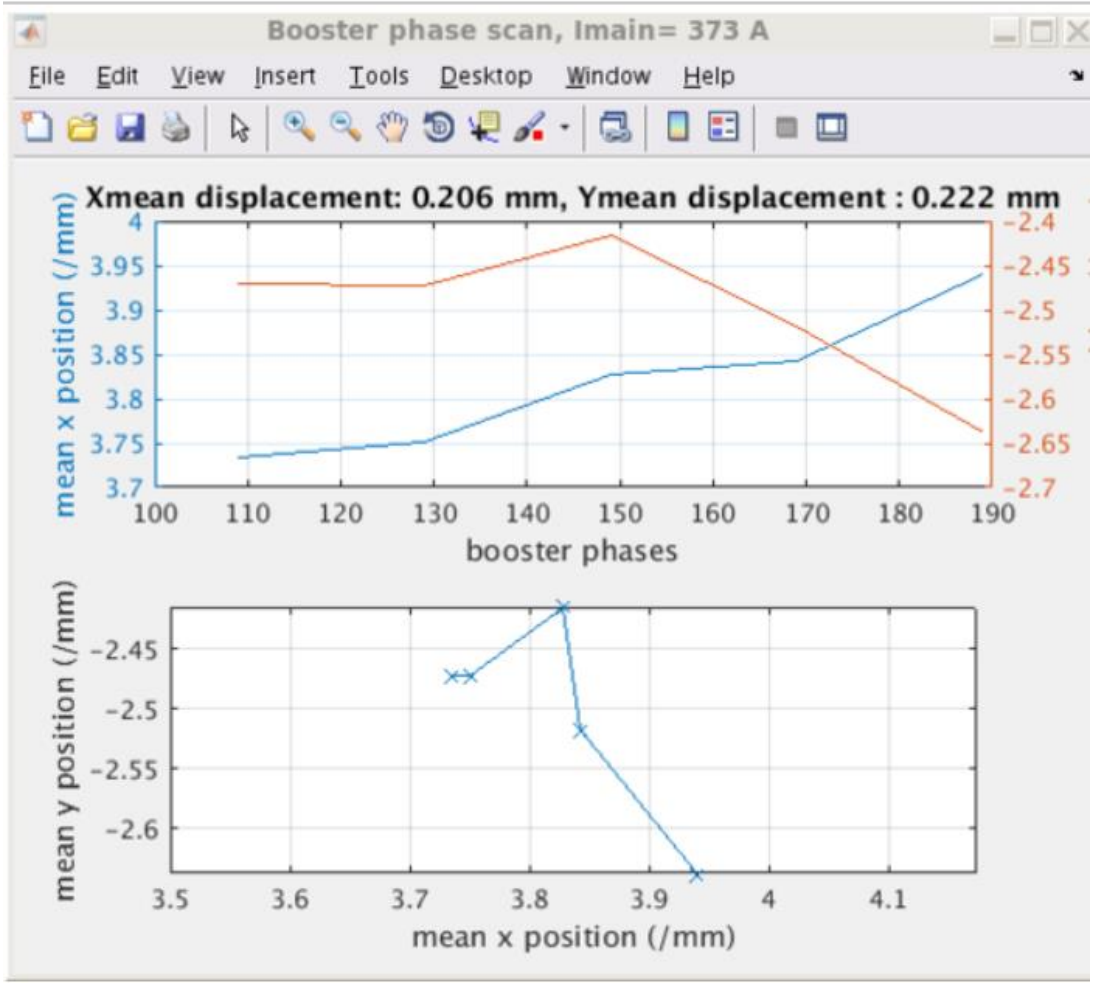
  - Compared to best 5 nm in 2020/2021, ~11% better
  - Compared to best 5 nm in 2019, ~11% worse
  - Compared to best 10 nm in 2019, ~25% worse
- Some difficulties: charge drift, better after regen ns timing adjustment
- Next step: check 5 nm cathode with ‘4 nC’ steering

4 nC steering vs 2019.07 booster steering free steering

17.03.2021 11:24 O. Lishilin, A. Lueangaramwong **Booster bba for the settings below**



17.03.2021 11:37 O. Lishilin, A. Lueangaramwong **Booster BBA check for the newly l**



MBI emittance study

250 pC BSA1mm, 6.3 MeV/c

- 10 nm cathode, ‘4 nC’ steering, bad booster steering

Scale1	unscaled	EMSY1	Scaling factor	steering	Slit width	cathode	Gun quads	date	Charge
0.47	0.41	0.27	1.15	Steering free	50 um	10 nm		2019.07.12A	250
0.67	0.55	0.27	1.2	Steering free	50 um	5 nm	Fresh optimization	2021.02.25A	250
4 nC steering, gun quads optimization from history									
0.60	0.46	0.21	1.25	4 nC steering	50 um	10 nm	Optimization from history	16.03.2021N	250
0.57	**0.45**	**0.21**	**1.3**	4 nC steering	10 um	10 nm	Optimization from history	16.03.2021N	250
Gun quads effect									
0.62	0.60	0.22	1.04	4 nC steering	50 um	10 nm	Fresh optimization	17.03.2021A	270
0.64	0.50	0.22	1.28	4 nC + diff high1.scr4 pos	50 um	10 nm	Fresh optimization	17.03.2021A	240
0.57	**0.44**	**0.22**	**1.32**	4 nC steering	10 um	10 nm	Fresh optimization	17.03.2021A	230
Steering effect									
0.83	0.57	0.26	1.45	Steering free	50 um	10 nm	Optimization from history	17.03.2021M	233
0.71	0.63	0.22	1.12	Steering free+diff H1.scr1	50 um	10 nm	Optimization from history	17.03.2021M	250-270

MBI emittance study

500 pC BSA1.3mm, 6.3 MeV/c

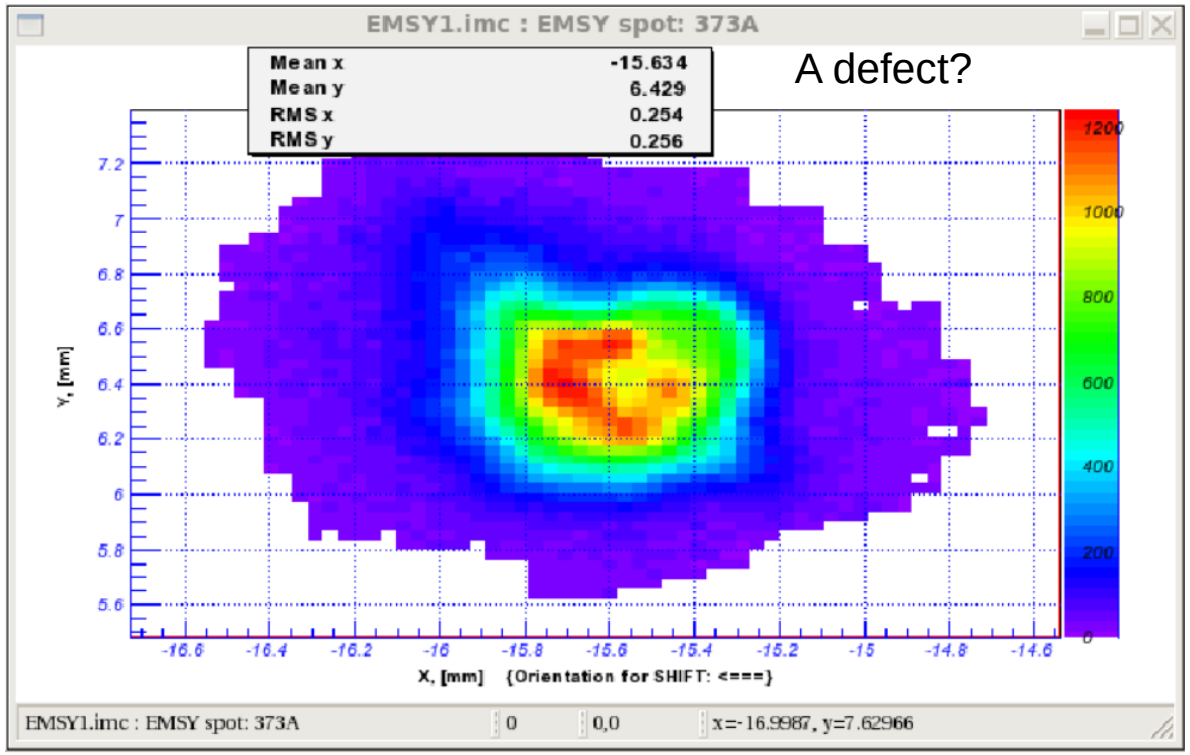
- 10 nm cathode, ‘4 nC’ steering, bad booster steering

Scale1	unscaled	EMSY1	Scaling factor	steering	Slit width	cathode	Gun quads	date	Charge
0.47	0.41	0.27	1.15	Steering free	50 um	10 nm		2019.07.12A	250
0.67	0.55	0.27	1.2	Steering free	50 um	5 nm	Fresh optimization	2021.02.25A	250
4 nC steering, gun quads optimization from history									
0.60	0.46	0.21	1.25	4 nC steering	50 um	10 nm	Optimization from history	16.03.2021N	250
0.57	**0.45**	**0.21**	**1.3**	4 nC steering	10 um	10 nm	Optimization from history	16.03.2021N	250
Gun quads effect									
0.62	0.60	0.22	1.04	4 nC steering	50 um	10 nm	Fresh optimization	17.03.2021A	270
0.64	0.50	0.22	1.28	4 nC + diff high1.scr4 pos	50 um	10 nm	Fresh optimization	17.03.2021A	240
0.57	**0.44**	**0.22**	**1.32**	4 nC steering	10 um	10 nm	Fresh optimization	17.03.2021A	230
Steering effect									
0.83	0.57	0.26	1.45	Steering free	50 um	10 nm	Optimization from history	17.03.2021M	233
0.71	0.63	0.22	1.12	Steering free+diff H1.scr1	50 um	10 nm	Optimization from history	17.03.2021M	250-270

EMSY1 screen effect

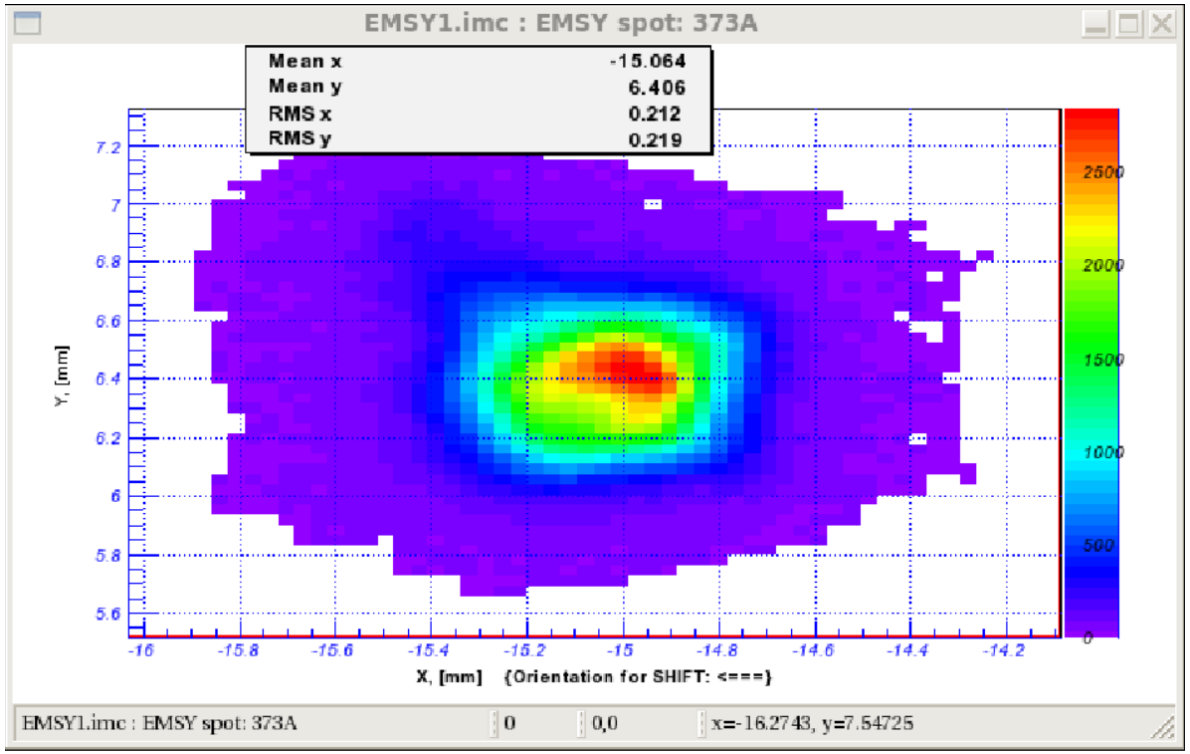
Is 4 nC steering a EMSY1 screen effect + booster steering effect?

Booster Steering free, Xyrms=0.255 mm



0.83/0.57 um.rad, 0.255 mm, scaling 1.45 (17.03.2021A, Uniform), 1200/2000, 222 pC, 50 um slit

Beam steered away with high1.st1, Xyrms=0.215 mm

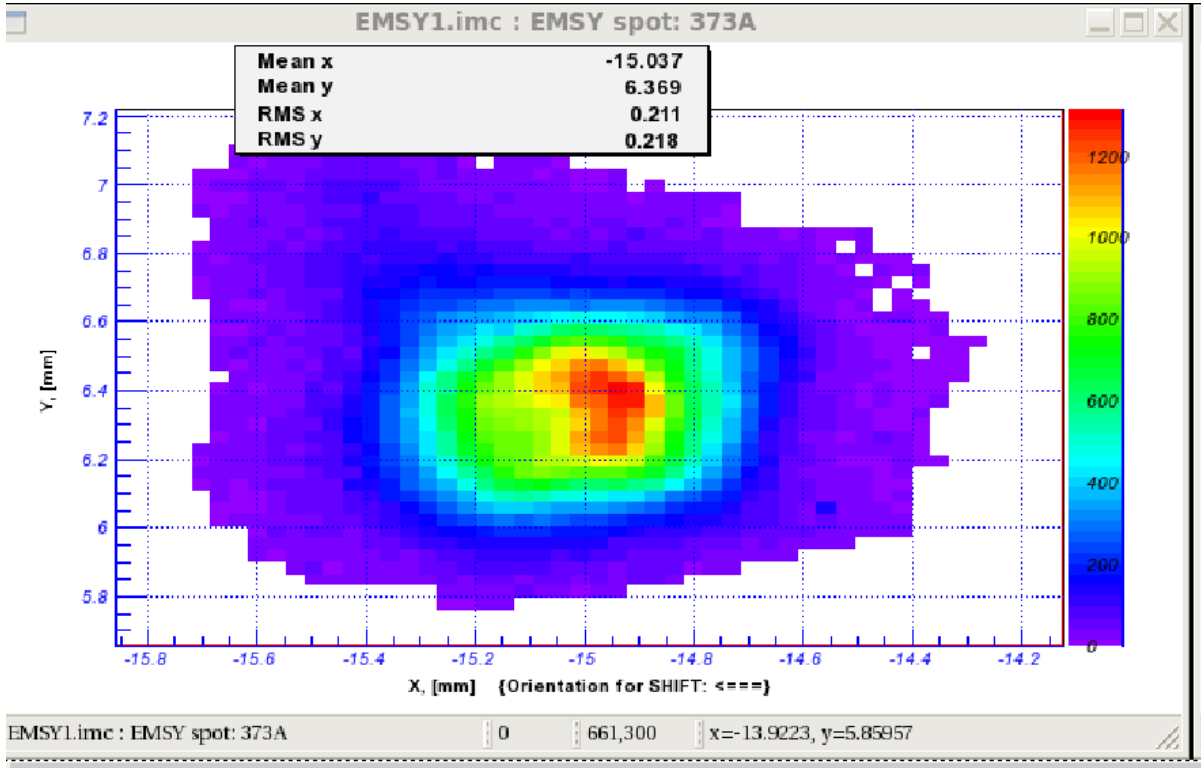


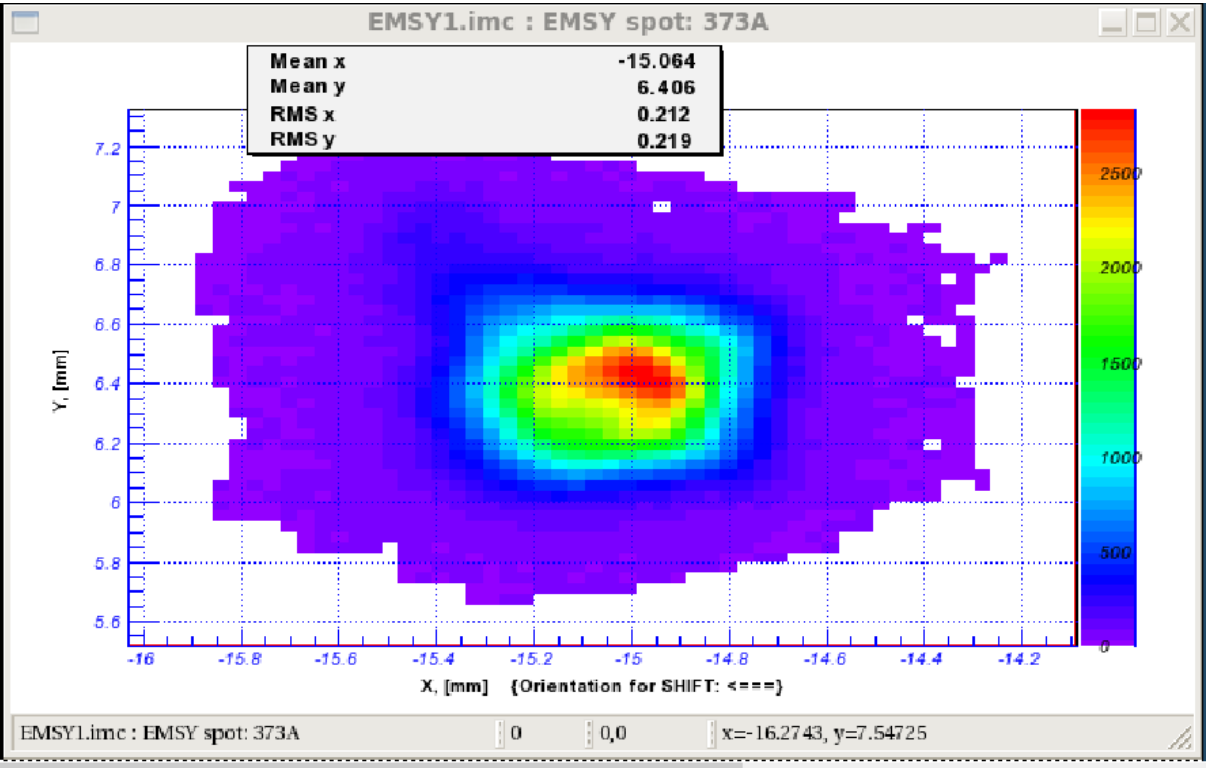
0.71/0.63 um.rad, 0.222 mm, scaling 1.12 (17.03.2021A, Uniform), 3000/2000, 250 pC, 50 um slit

1 pulse vs 2 pulse

EMSY1 beam size vs statistics

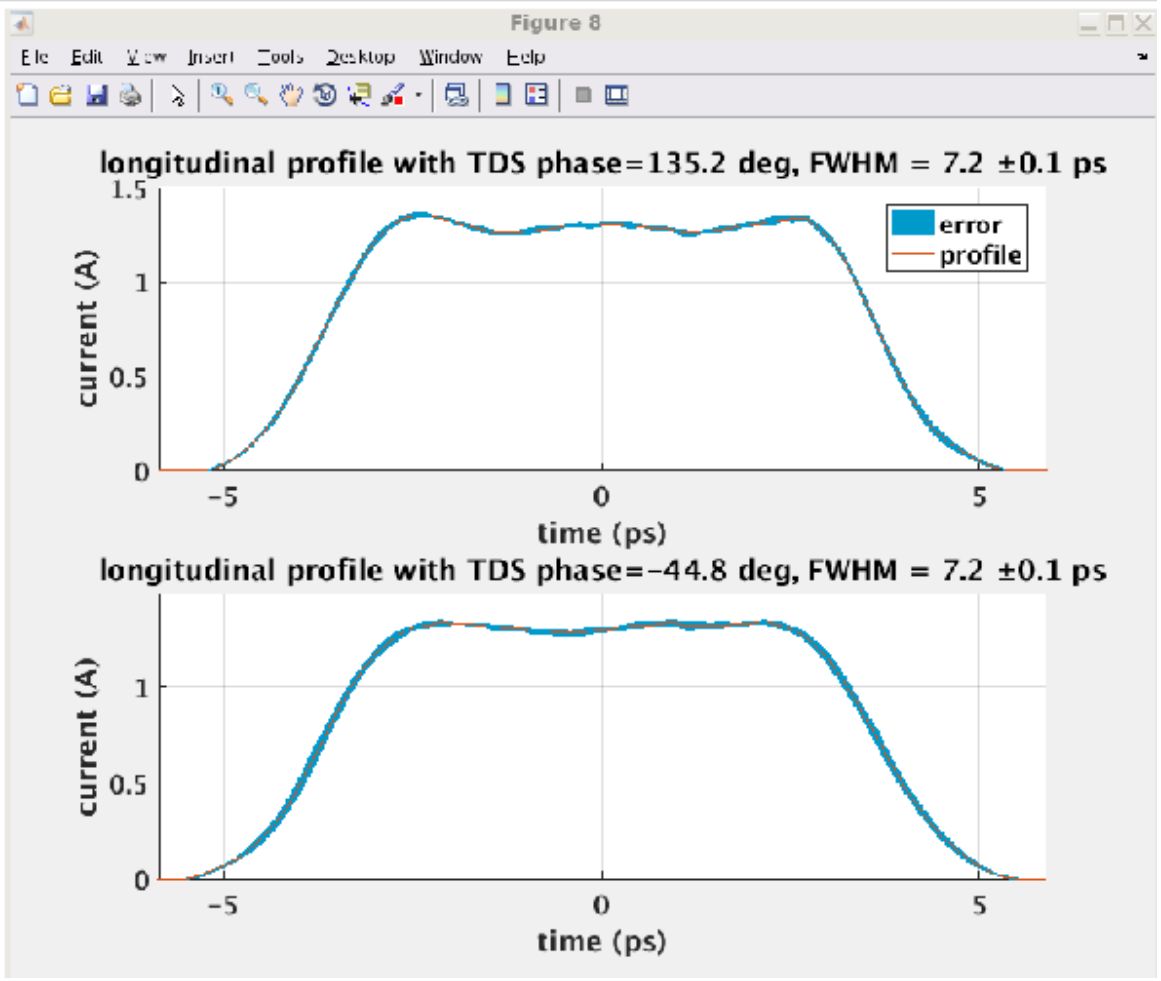
Still we should keep similar statistics, with bigger halos, the EMSY1 beam size might be sensitive to SNR



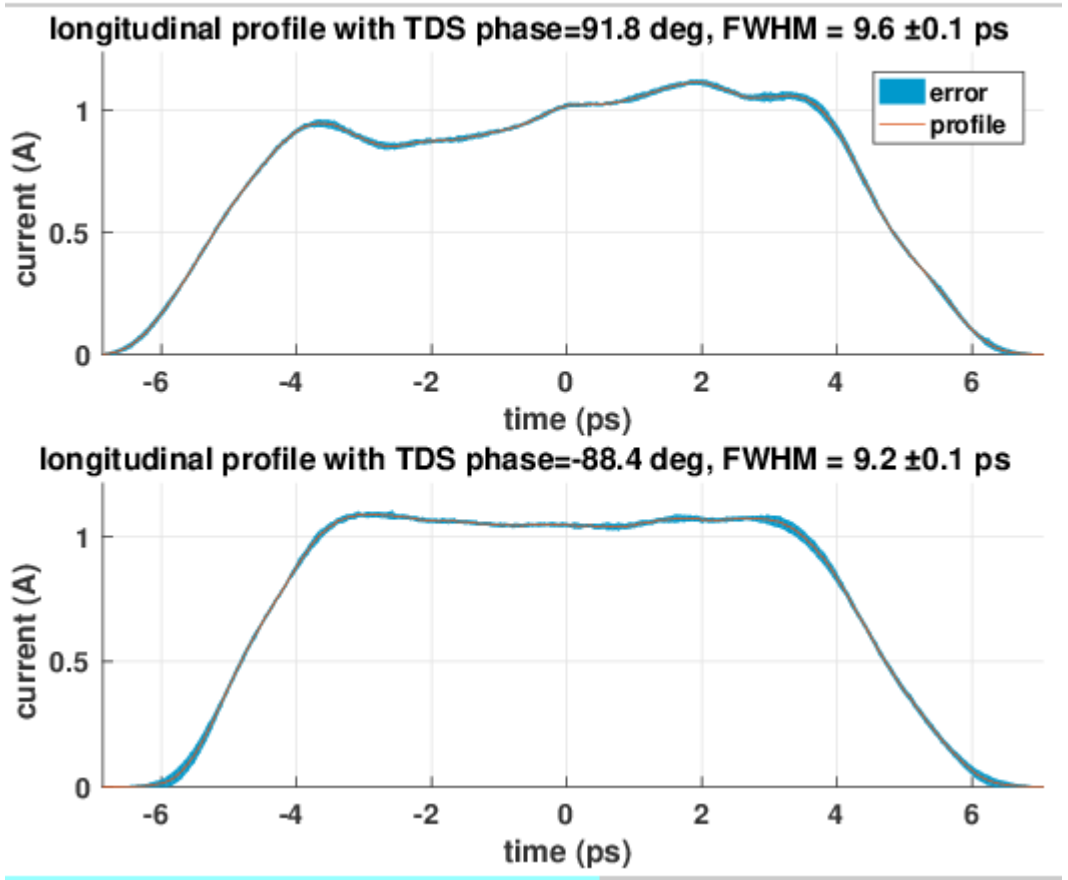


PHAROS shaping

26.02.2021 06:51 O. Lishilin, C. Koschitzki **tuned profile more**



17.03.2021 23:16 T.Weilbach, Z. Aboulbanine **Pharos flattop 9ps**



PHAROS emittance study

250 pC BSA1mm, 6.3 MeV/c

- 10 nm cathode, ‘4 nC’ steering, bad booster steering

Scale1	unscaled	EMSY1	Scaling factor	steering	Slit width	cathode	Gun quads	date	Charge
0.81	0.68	0.32	1.2	Steering free	50 um	5 nm	Fresh optimization	2021.02.26A	300
4 nC steering, gun quads optimization from history									
0.69	0.59	0.26	1.16	4 nC steering	50 um	10 nm	Optimization from history	17.03.2021N	275
0.61	**0.58**	**0.26**	**1.05**	4 nC steering	10 um	10 nm	Optimization from history	17.03.2021N	275
Charge effect									
0.61	0.55	0.26	1.11	4 nC steering	50 um	10 nm	Optimization from history	17.03.2021N	250
0.56	**0.54**	**0.25**	**1.04**	4 nC steering	10 um	10 nm	Optimization from history	17.03.2021N	250
Steering effect									
0.95	0.76	0.31	1.25	Steering free	50 um	10 nm	Optimization from history	17.03.2021M	275

By ICT adc

PHAROS emittance study

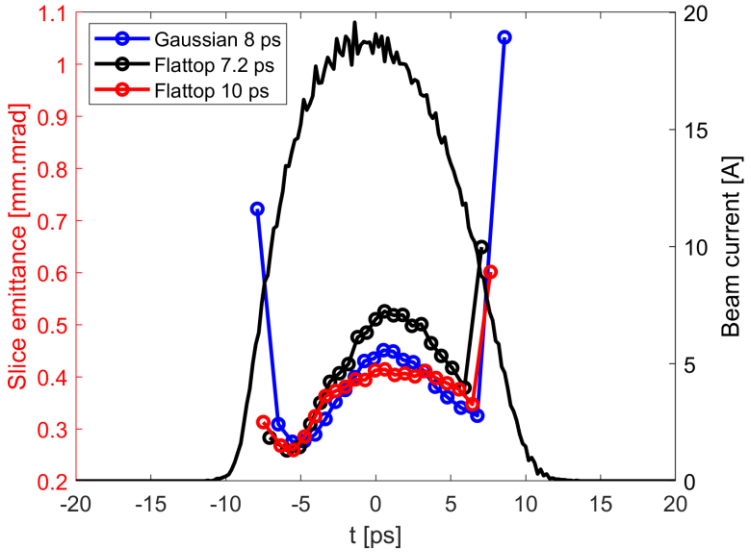
250 pC BSA1mm, 6.3 MeV/c

- 10 nm cathode, '4 nC' steering, MBI vs Pharos flattop shaping

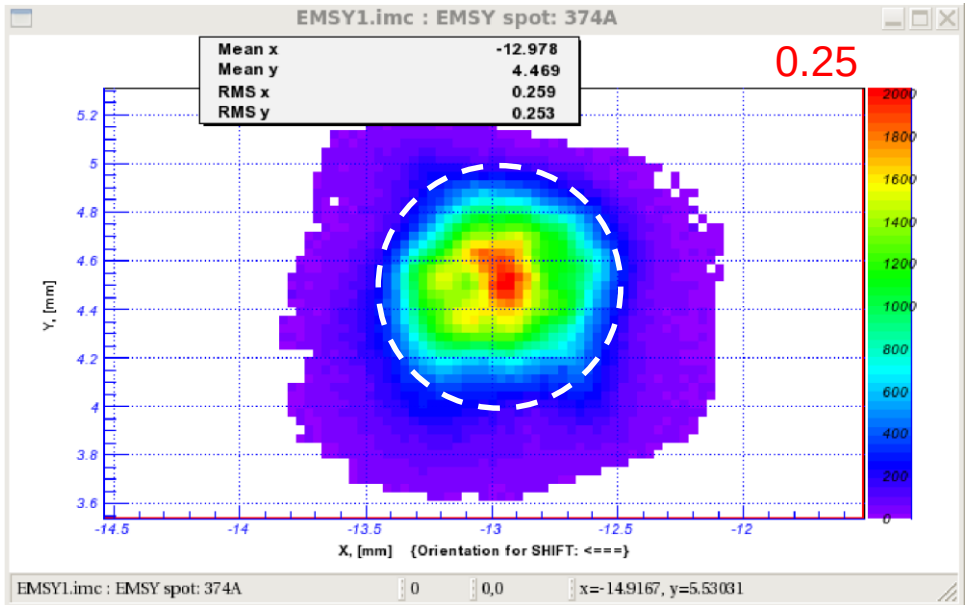
Scale2	Scale1	unscaled	EMSY1	Scaling factor	steering	Slit width	cathode	Gun quads	date	Charge
	MBI ~8 ps Gaussian									
0.72	0.57	0.45	0.21	1.26	4 nC steering	10 um	10 nm	Optimization from history	16.03.2021N	250
	Flattop ~9.4 ps									
0.58	0.56	0.54	0.25	1.04	4 nC steering	10 um	10 nm	Optimization from history	17.03.2021N	250

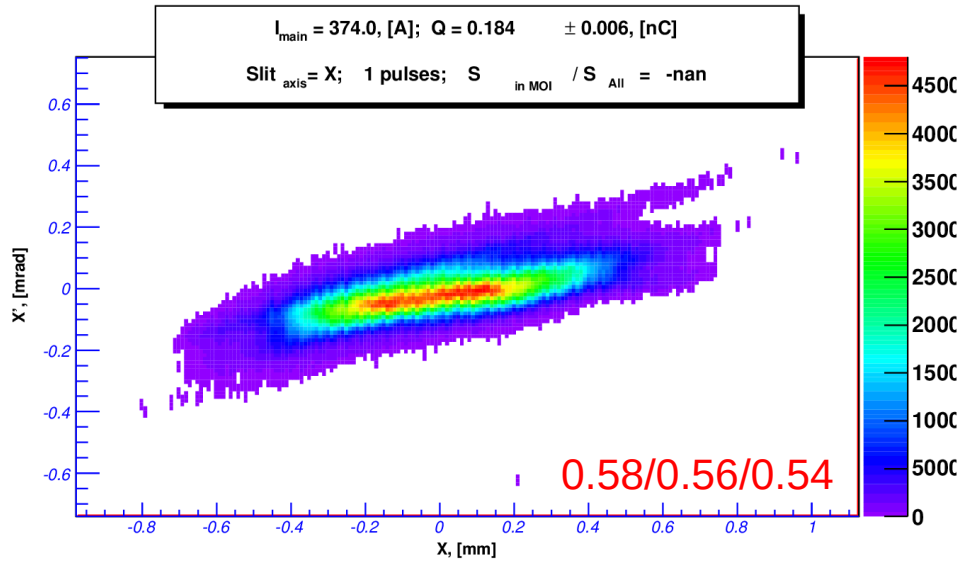
- Shaping effect: scale2 reduce by ~20%, scaling factor reduce by ~20%, but scale1 similar, unscaled higher by 20%
- Ideal simulations
  - Pro: flattop shaping helps phase space in tails, reducing halos
  - Con: flattop shaping distorts more LPS due to sharper edges

	Proj (100%)	slice	Mismatch	dE
Gaussian	0.75	0.42	0.60	3.6
Flattop7	0.58	0.43	0.37	6.3
Flattop10	0.52	0.38	0.35	7.3



PHAROS ~9 ps flattop, 374A





MBI ~8 ps Gaussian, 373A