

Beam studies considering different positions for EMSY1

Transverse emittance optimization comparing flat-top and 3D ellipsoidal laser profiles (shifted (and fixed) booster position, different positions of EMSY1)

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PITZ physics seminar

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Flat-top, EMSY1 at 5.37m

ASTRA simulation setup: fixed parameters

- Laser temporal profile: **flat-top** with 21.5ps FWHM length and 2ps rise and fall times
- 0.55 eV average kinetic energy of the photoelectrons
- Gun gradient: 60.58 MV/m corresponding to $P_z \sim 6.7$ MeV/c beam momentum after the gun
- Gun ASTRA phase **fixed** to -1deg (\sim on-crest)
- Initial Z position of CDS booster: 2.7m
- Bunch charge: 1 nC
- Searching for the best transverse emittance at **EMSY1**

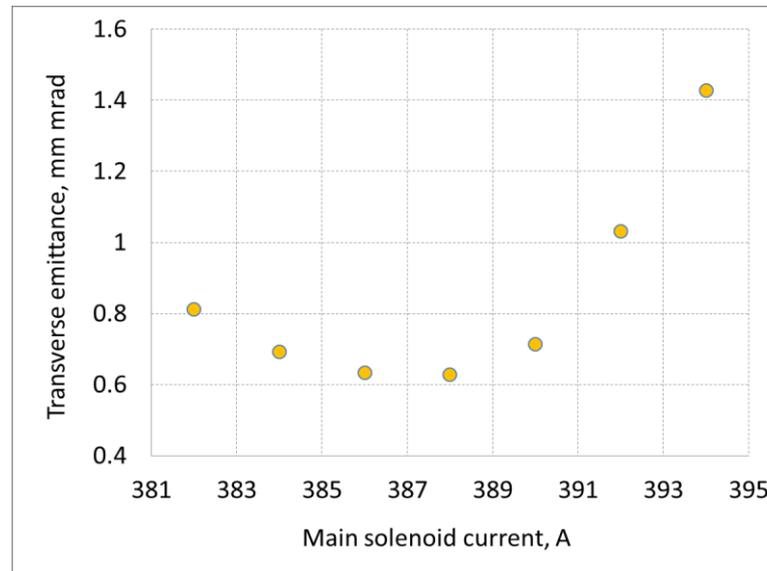
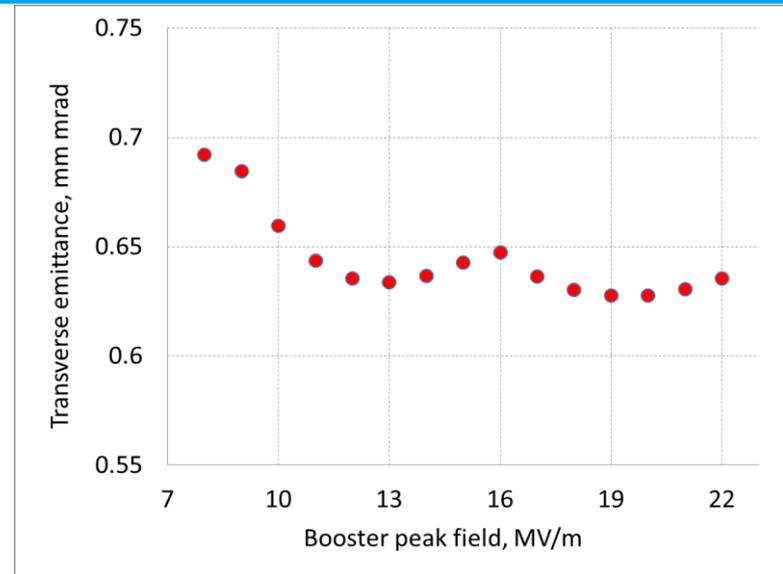
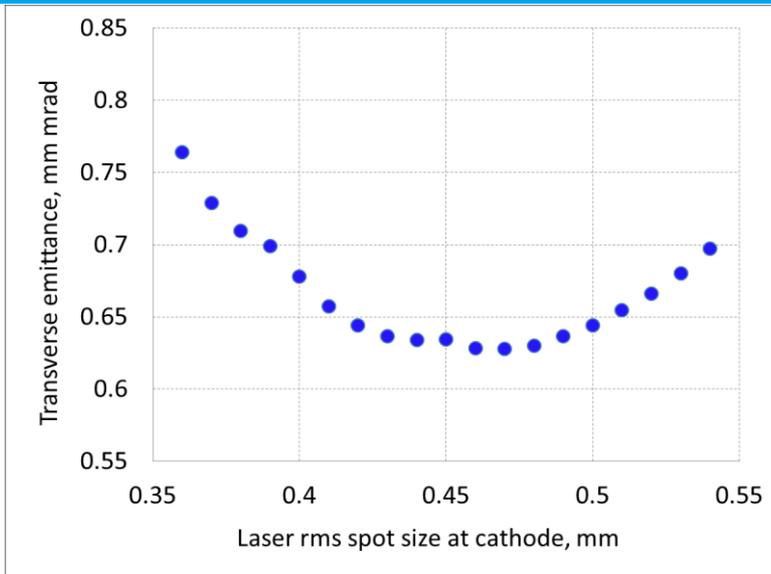
ASTRA simulation setup: varied parameters

- Laser transverse rms spot size on the cathode \rightarrow [0.36:0.01:0.54] mm
- CDS booster gradient \rightarrow [8:1:22] MV/m
- Main solenoid current \rightarrow [382:2:394] A

Emittance optimization at EMSY1 (Z=5.37m)



Flat-top, EMSY1 at 5.37m



3D ellipsoid, EMSY1 at 5.37m

ASTRA simulation setup: fixed parameters

- Laser temporal profile: **3D ellipsoidal** with $T_{rms}=5.5ps$ (same rms bunch length at EMSY1 as for flat-top case)
- 0.55 eV average kinetic energy of the photoelectrons
- Gun gradient: 60.58 MV/m corresponding to $P_z \sim 6.7$ MeV/c beam momentum after the gun
- Gun ASTRA phase **fixed** to -2deg (\sim on-crest)
- Initial Z position of CDS booster: 2.7m
- Bunch charge: 1 nC
- Searching for the best transverse emittance at **EMSY1**

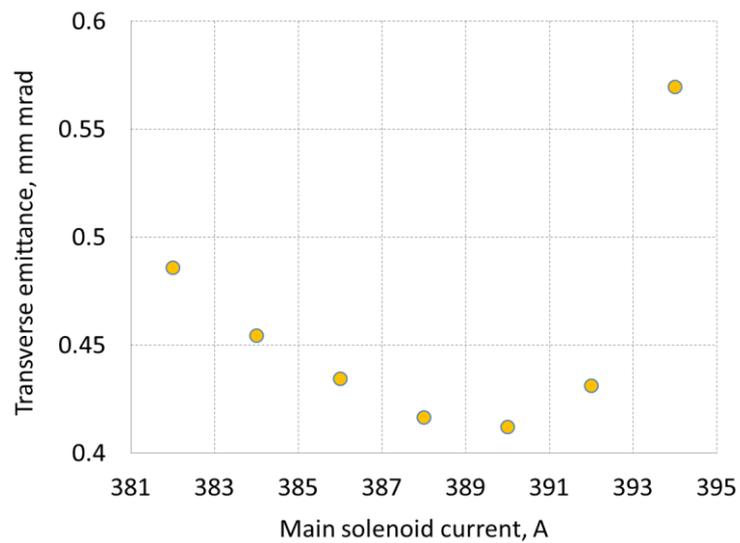
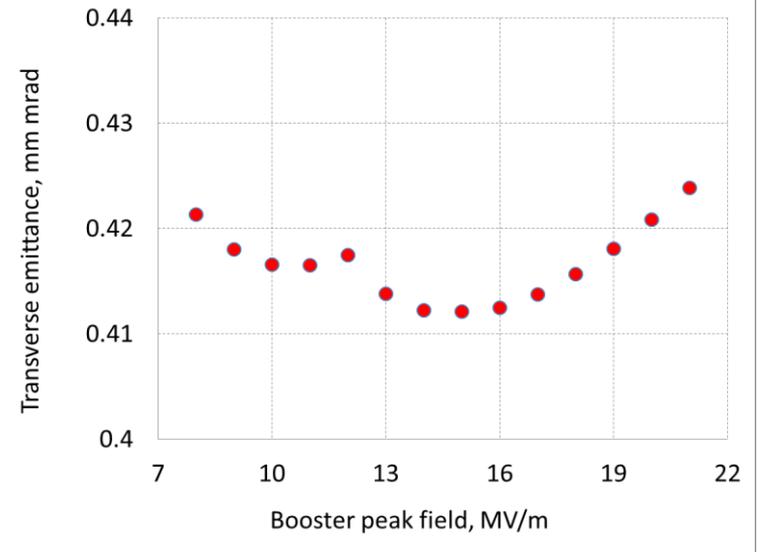
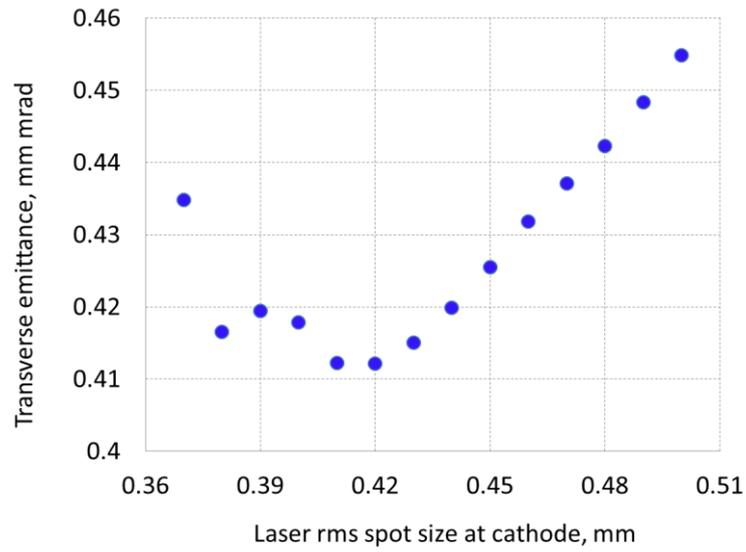
ASTRA simulation setup: varied parameters

- Laser transverse rms spot size on the cathode $\rightarrow [0.37:0.01:0.5]$ mm
- CDS booster gradient $\rightarrow [8:1:21]$ MV/m
- Main solenoid current $\rightarrow [382:2:394]$ A

Emittance optimization at EMSY1 (Z=5.37m)



3D ellipsoid, EMSY1 at 5.37m



Optimization of the EMSY1 position (flat-top)

ASTRA simulation setup: fixed parameters

- Laser temporal profile: **flat-top** with 21.5ps FWHM length and 2ps rise and fall times
- 0.55 eV average kinetic energy of the photoelectrons
- Gun gradient: 60.58 MV/m corresponding to $P_z \sim 6.7$ MeV/c beam momentum after the gun
- Initial Z position of CDS booster: 2.7m
- Bunch charge: 1 nC
- Searching for the best transverse emittance at **EMSY1**

ASTRA simulation setup: varied parameters

- Laser transverse rms spot size on the cathode → [0.38:0.02:0.54] mm
- Gun phase → [-2:1:1] deg
- CDS booster gradient → [8:2:22] MV/m
- Main solenoid current → [380:1:391] A

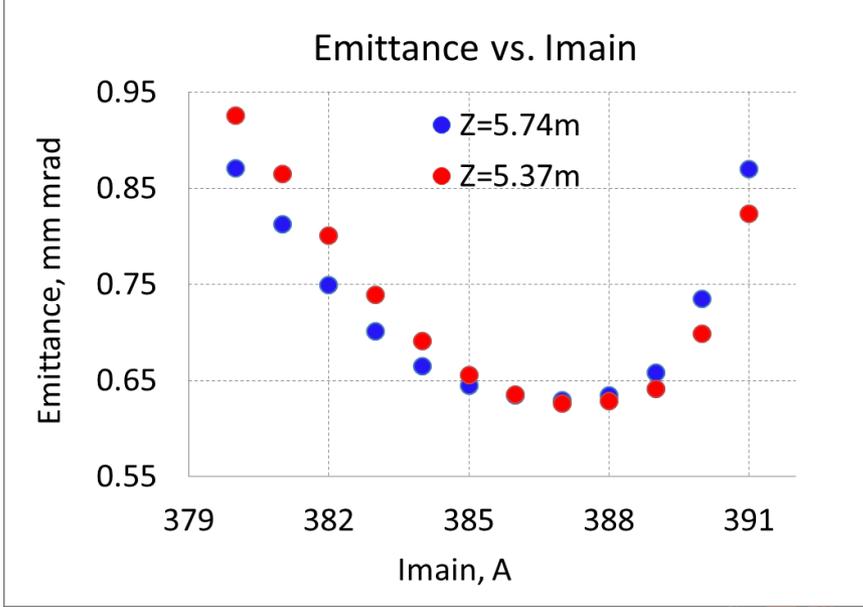
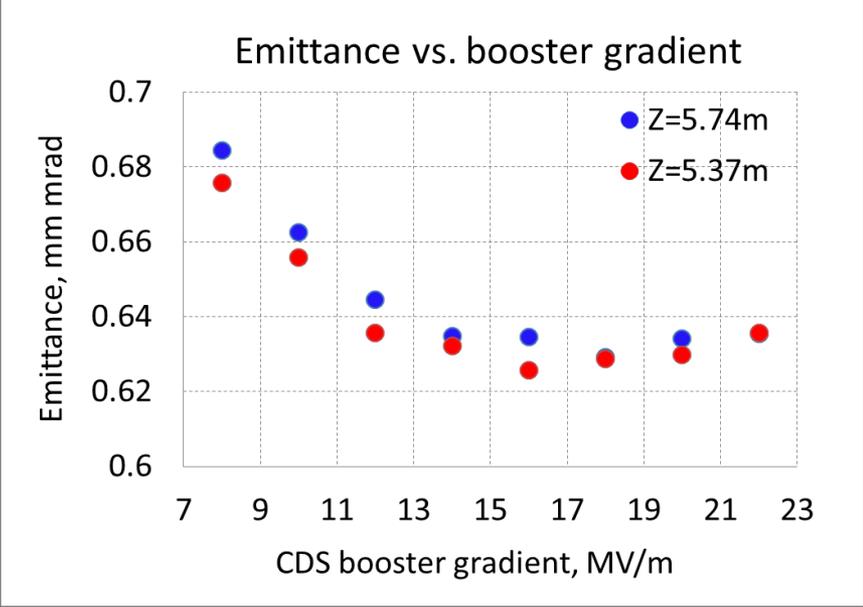
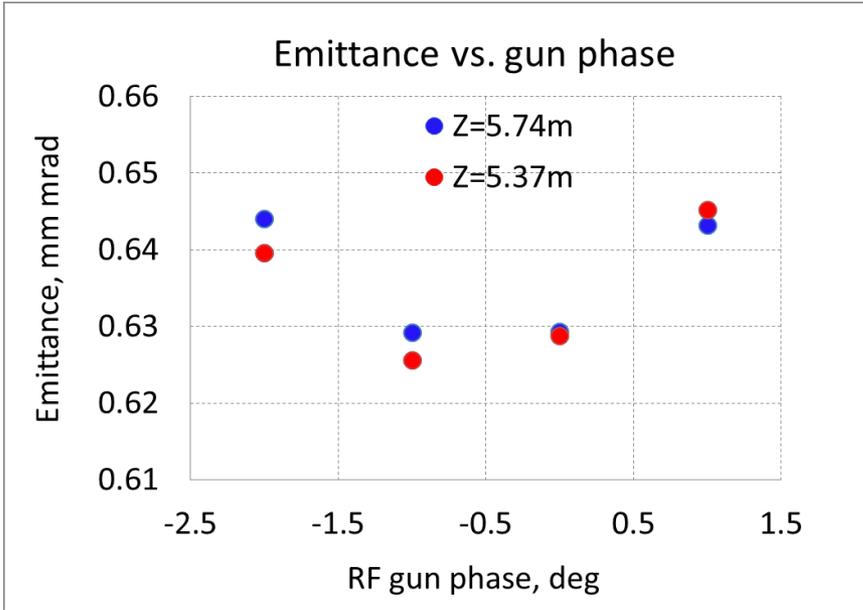
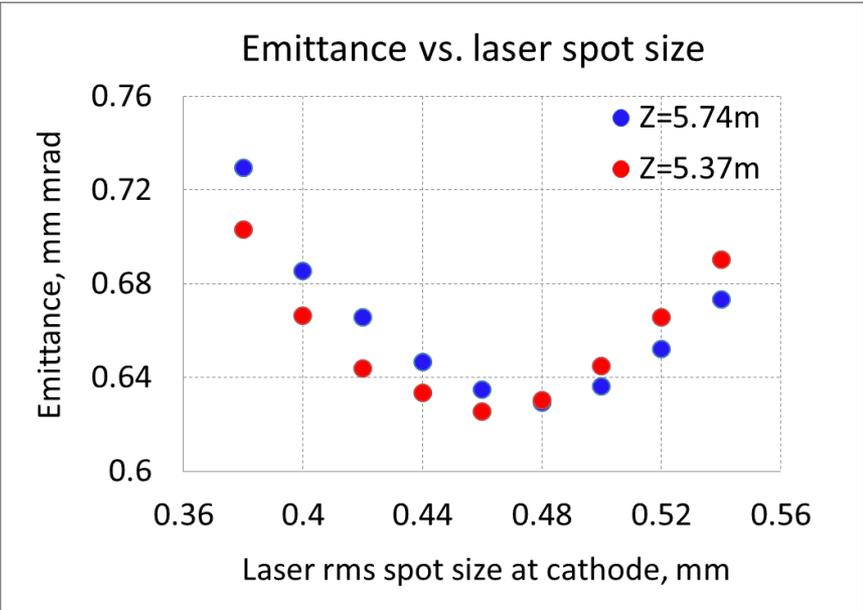
Emittance has been optimized at EMSY1 with two different positions:

Position of EMSY1: $Z=5.74$ m

Position of EMSY1: $Z=5.37$ m (shifted towards the cathode by the same distance as CDS booster position)



Optimization of the EMSY1 position (flat-top)



Optimization of EMSY1 position (3D ellipsoidal)

ASTRA simulation setup: fixed parameters

- **3D ellipsoidal** cathode laser pulse with 5.5 ps rms emission time (initial bunch length)
- 0.55 eV average kinetic energy of the photoelectrons
- Gun gradient: 60.58 MV/m corresponding to $P_z \sim 6.7$ MeV/c beam momentum after the gun
- CDS booster starting position: 2.7 m
- Bunch charge: 1 nC
- Searching for the best transverse emittance at **EMSY1**

ASTRA simulation setup: varied parameters

- Laser transverse rms spot size on the cathode → [0.36:0.02:0.5] mm
- Gun phase → [-4:1:0] deg
- CDS booster gradient → [0:2:22] MV/m
- Main solenoid current → [381.5:1.5:390.5] A

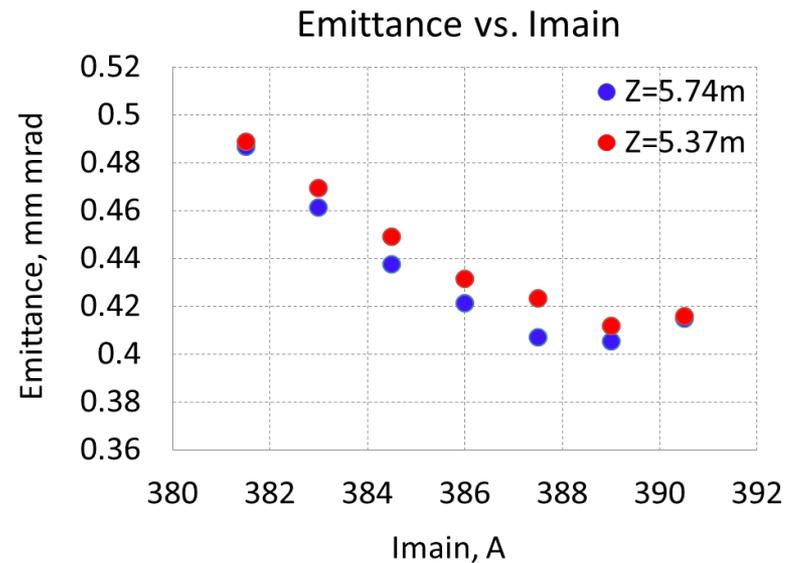
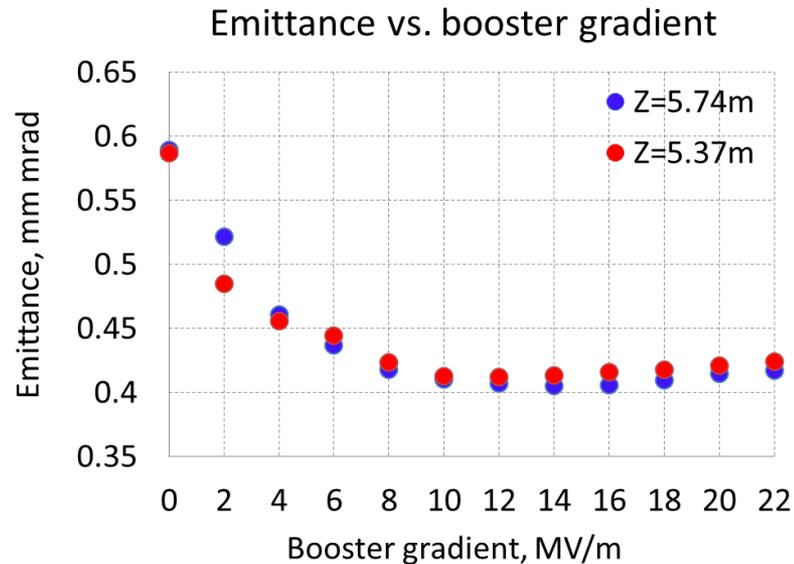
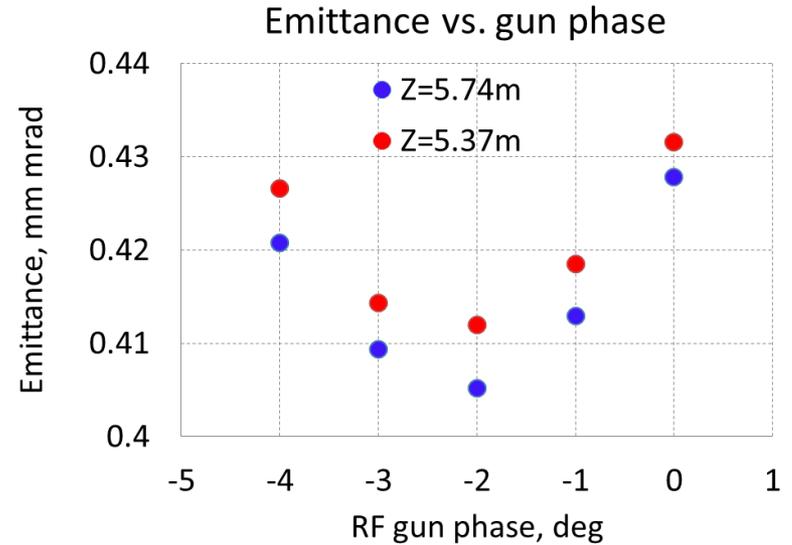
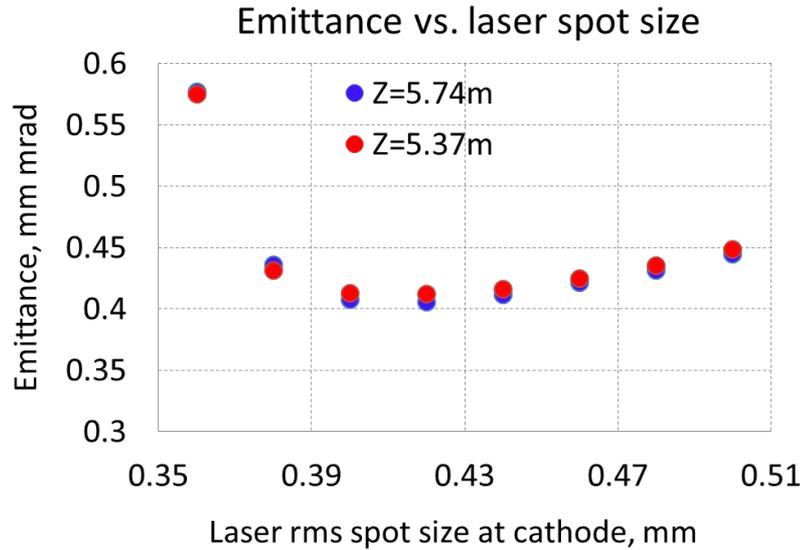
Emittance has been optimized at EMSY1 with two different positions:

Position of EMSY1: $Z=5.74$ m

Position of EMSY1: $Z=5.37$ m (shifted towards the cathode by the same distance as CDS booster position)

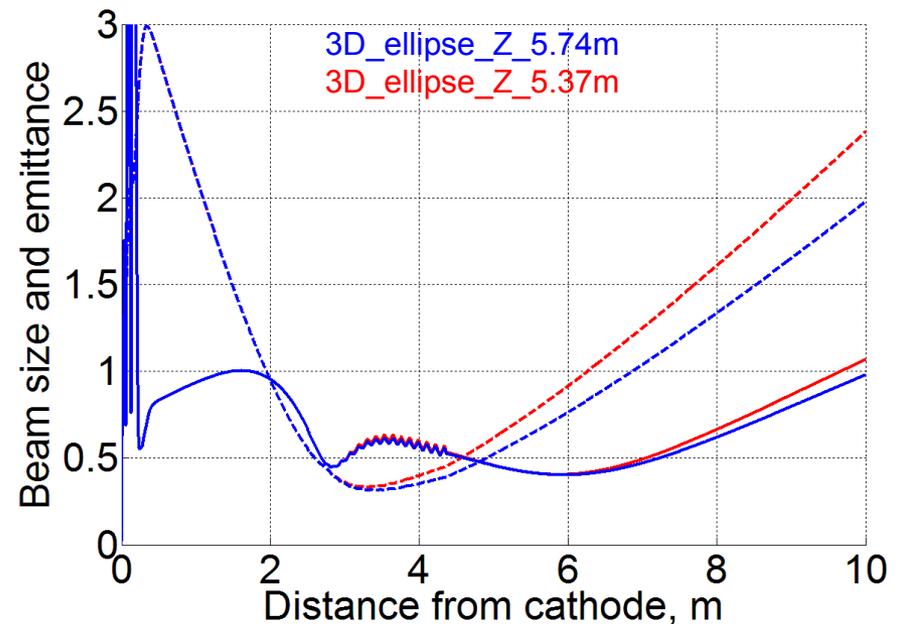
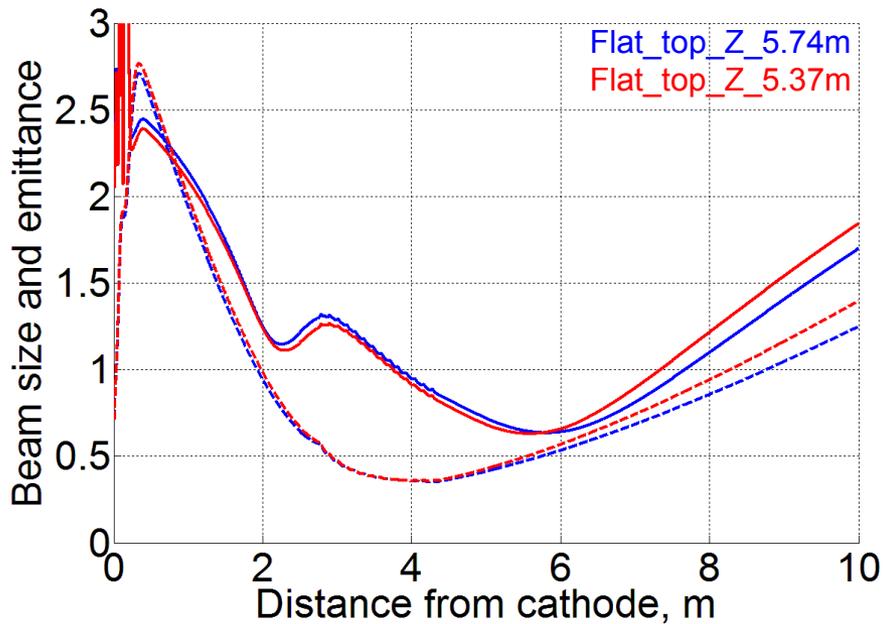


Optimization of EMSY1 position (3D ellipsoidal)

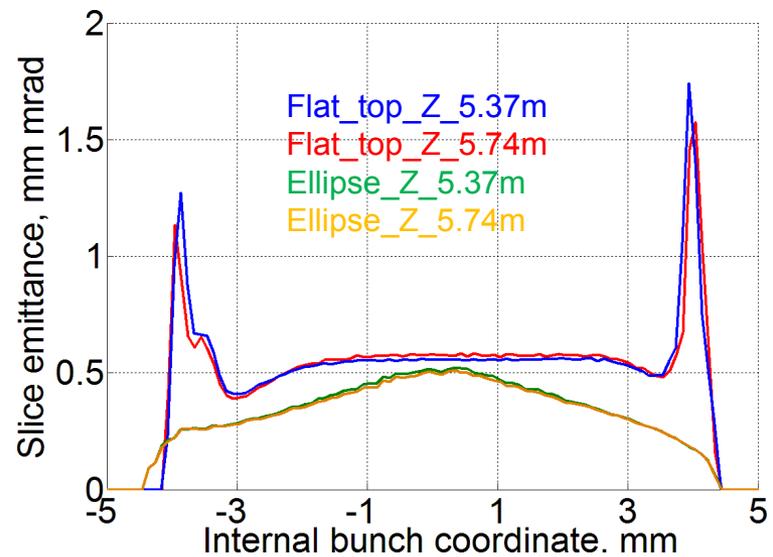
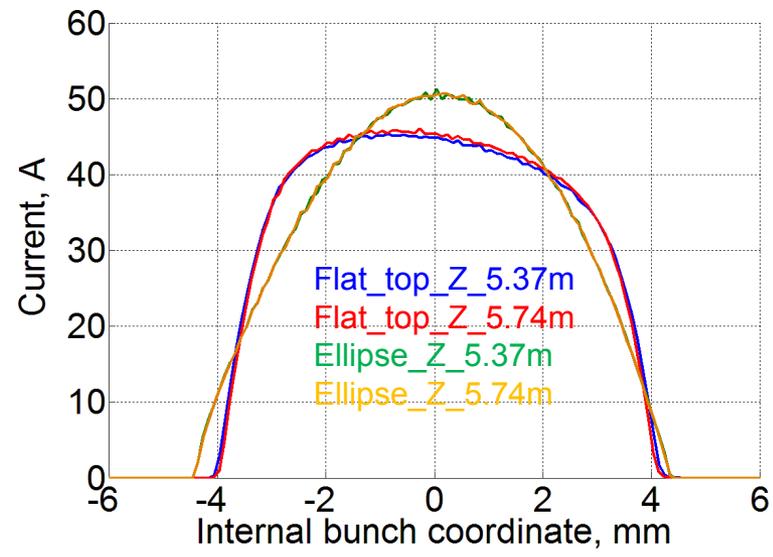
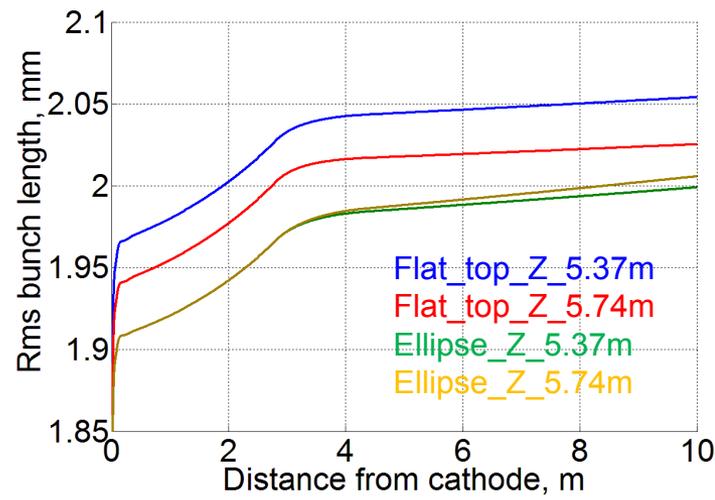


BD comparing different EMSY1 positions (fixed booster position)

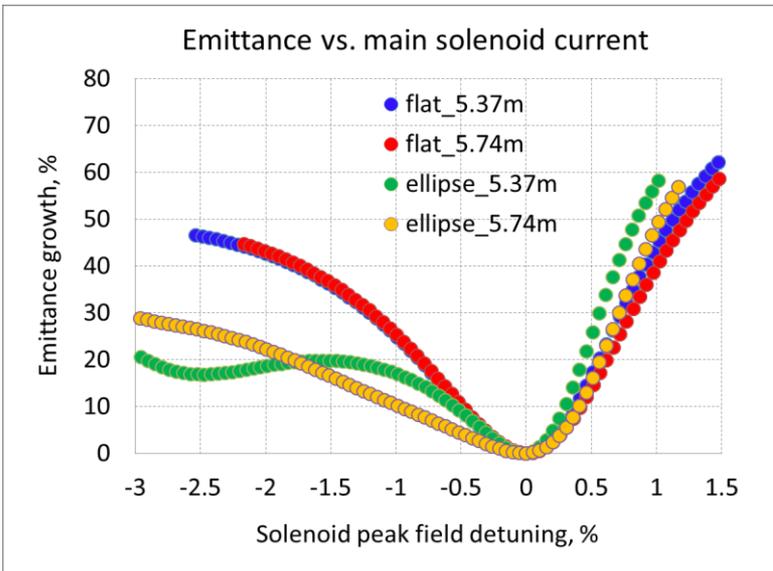
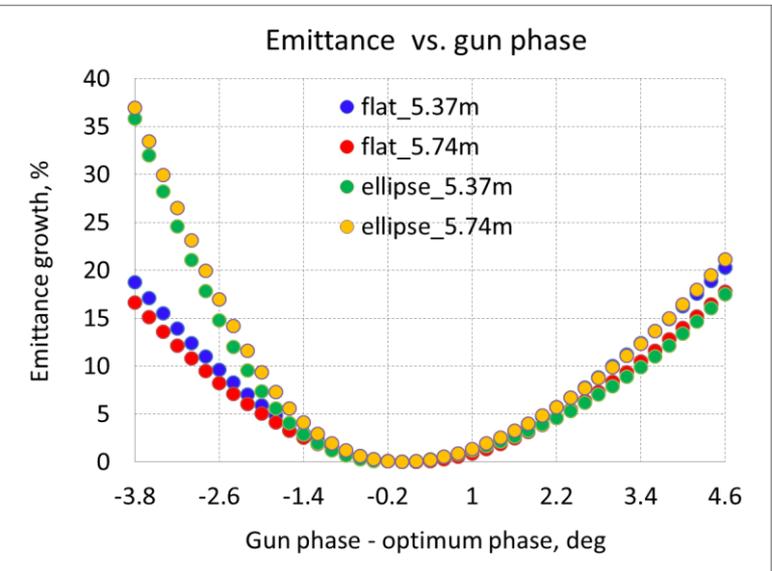
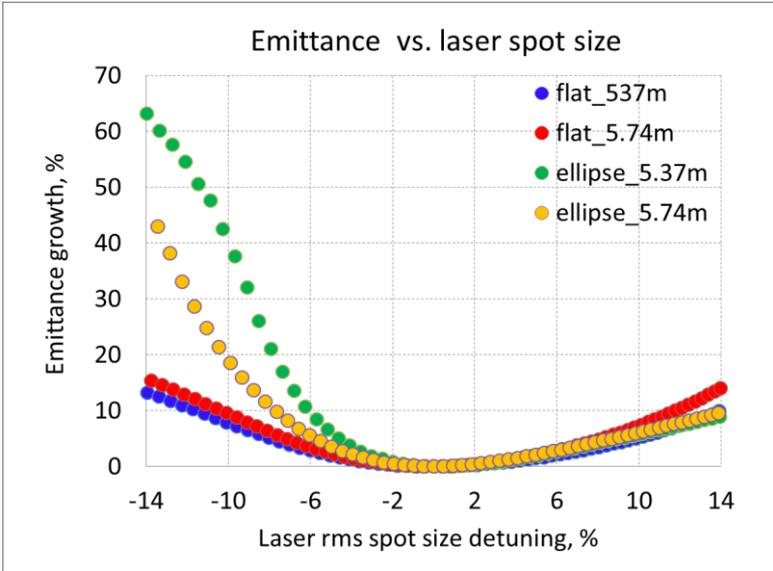
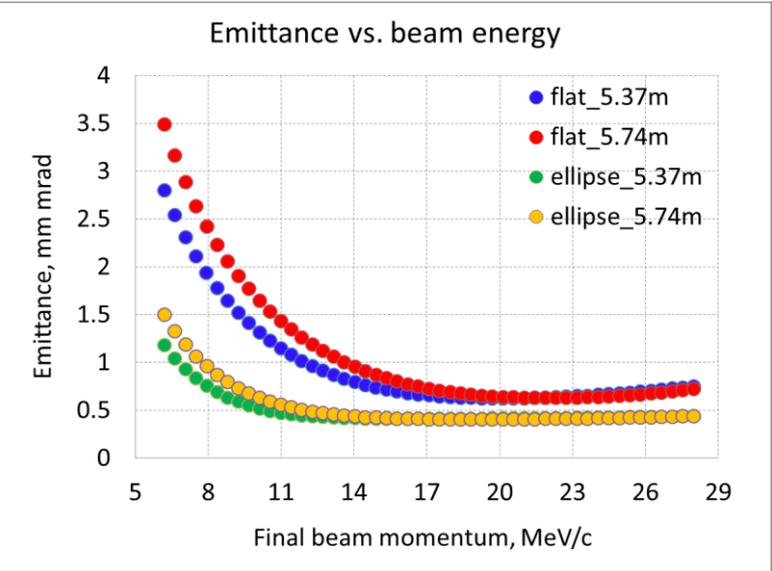
Evolution of transverse beam properties along the beamline



BD comparing different EMSY1 positions (fixed booster position)



Beam tolerances comparing two different EMSY1 positions



Summary of beam studies: different positions of EMSY1

Beam studies comparing different positions of EMSY1 (booster position fixed !)

Temporal	profile	Flat-top	3D homogeneous	Flat-top	3D homogeneous
Transverse	distribution	radial homogeneous	3D homogeneous	radial homogeneous	3D homogeneous
Trms	ps	6.272	5.5	6.272	5.5
XYrms	mm	0.46	0.42	0.48	0.42
Th. emit.	mm mrad	0.39	0.356	0.407	0.356
Ecath.	MV/m	60.58			
RF gun phase	deg	-1.0	-2.0	-1.0	-2.0
MaxBz	T	0.2277	0.22888	0.2277	0.22888
EMSY1 position	m	5.37	5.37	5.74	5.74
MaxE	MV/m	16	12	18	14
Charge	nC	1			
Momentum	MeV/c	20.6	17.2	22.4	18.9
Projected emittance	mm mrad	0.638 0.63 (5.6m)	0.425 0.405 (5.88m)	0.636 0.635 (5.8m)	0.405 0.402 (5.95m)
Th. / proj.	%	61	84	64	88
<Sl. emit.>	mm mrad	0.555	0.403	0.546	0.394
Rms bunch length	mm	2.05	1.99	2.02	1.99
Peak current	A	45.5	50.9	45.9	50.9
Longitudinal emittance	pi keV mm	76.9	46.2	79.2	51.5

