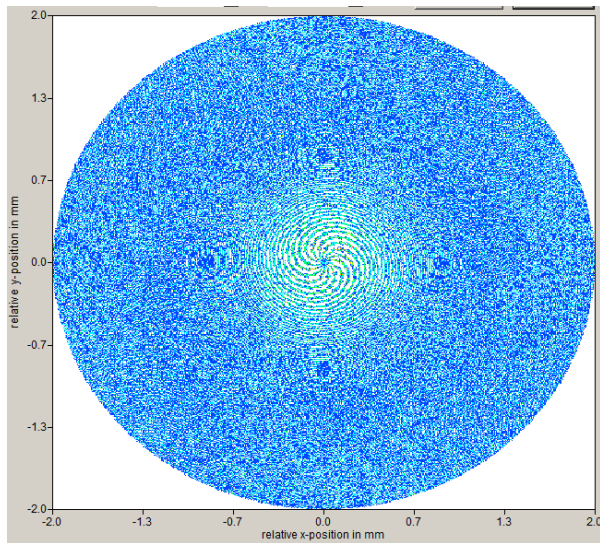


Emittance optimization for 100pC bunch charge and flat-top temporal laser profile

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PITZ Physics Seminar
Zeuthen, 04.04.2012

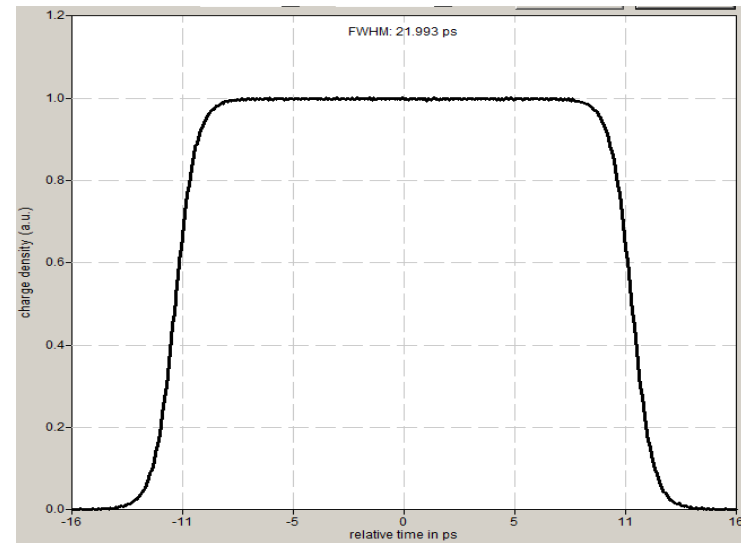
Transverse and longitudinal laser profiles

Laser transverse profile



Various diameter

Laser temporal profile



FWHM = 22 ps
rise/fall = 2ps

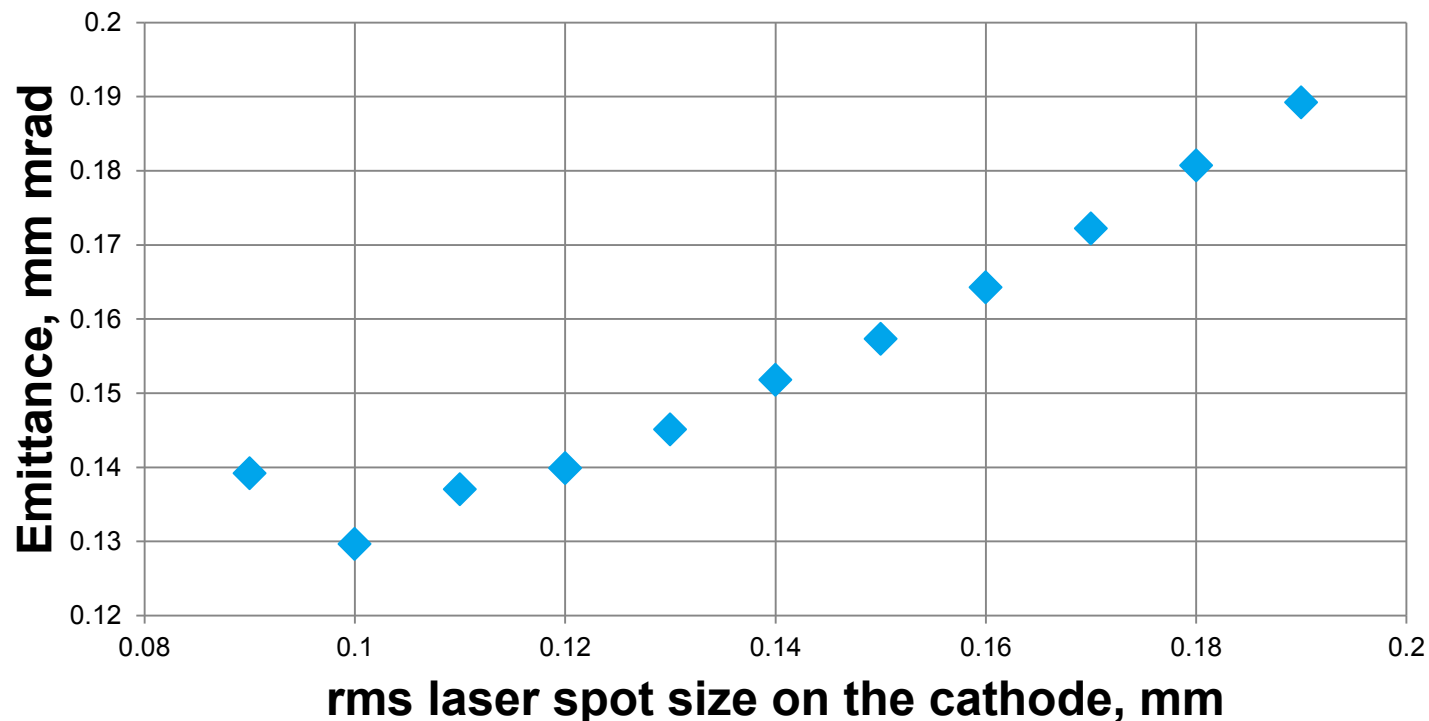
Parameters for ASTRA simulations

- > Laser transverse rms size → [0.09:0.01:0.19] mm
- > Gun gradient → 60 MV/m
- > Gun phase → MMMG, defined from autophasing → 6.6384 MeV/c
- > Main solenoid current → [370:1:384] A
- > Booster gradient → [0:1:16] MV/m
- > Booster phase → MMMG, defined from auto phasing → [6.6384 :20.617] MeV/c
- > Bunch charge → 100 pC
- > $2 \cdot 10^5$ particles



Emittance vs. rms laser spot size

Emittance vs. BSA

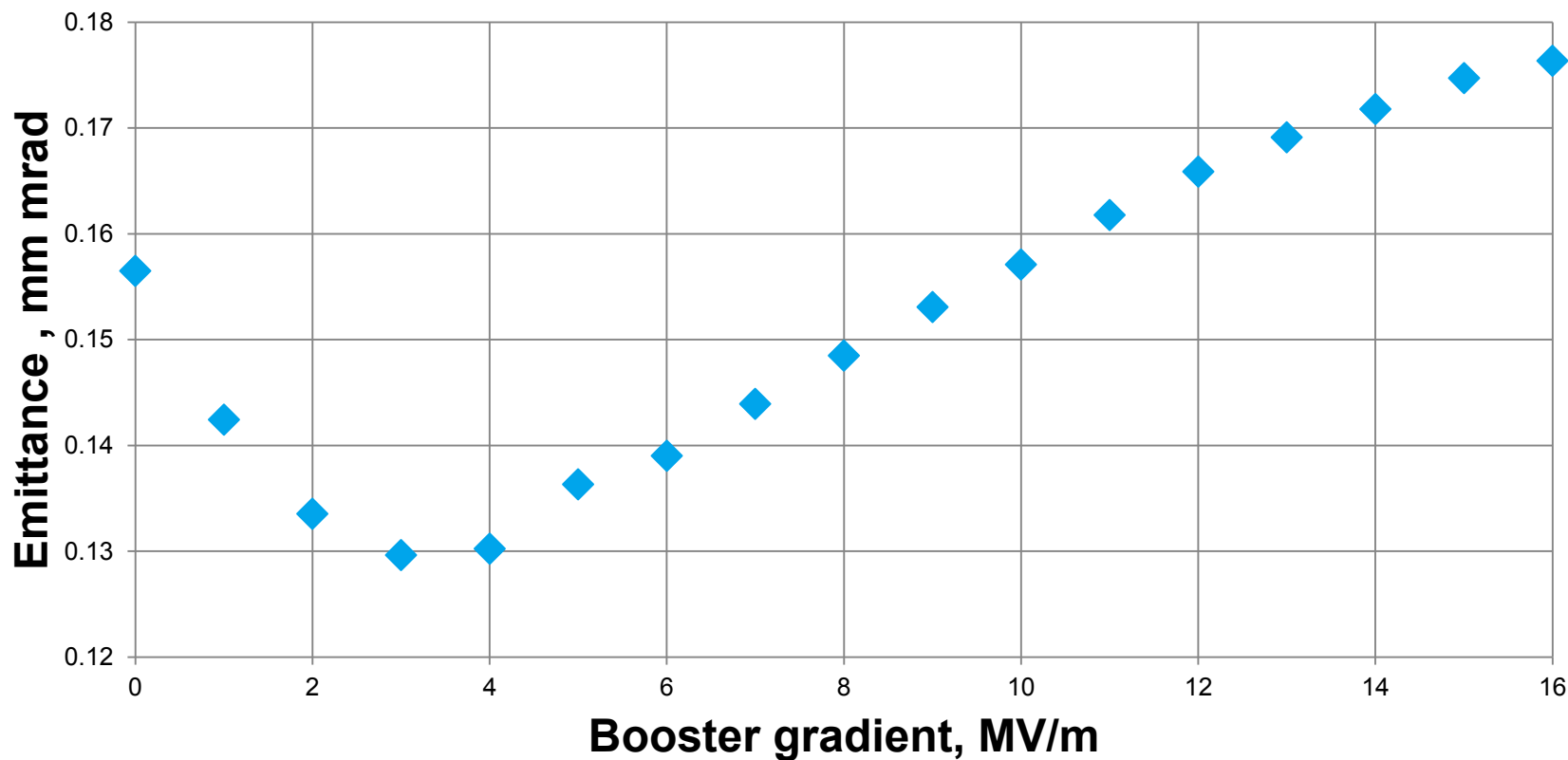


Best emittance values from multiparameter scan (booster gradient and solenoid current can be different for each point on the graph)



Emittance vs. booster gradient

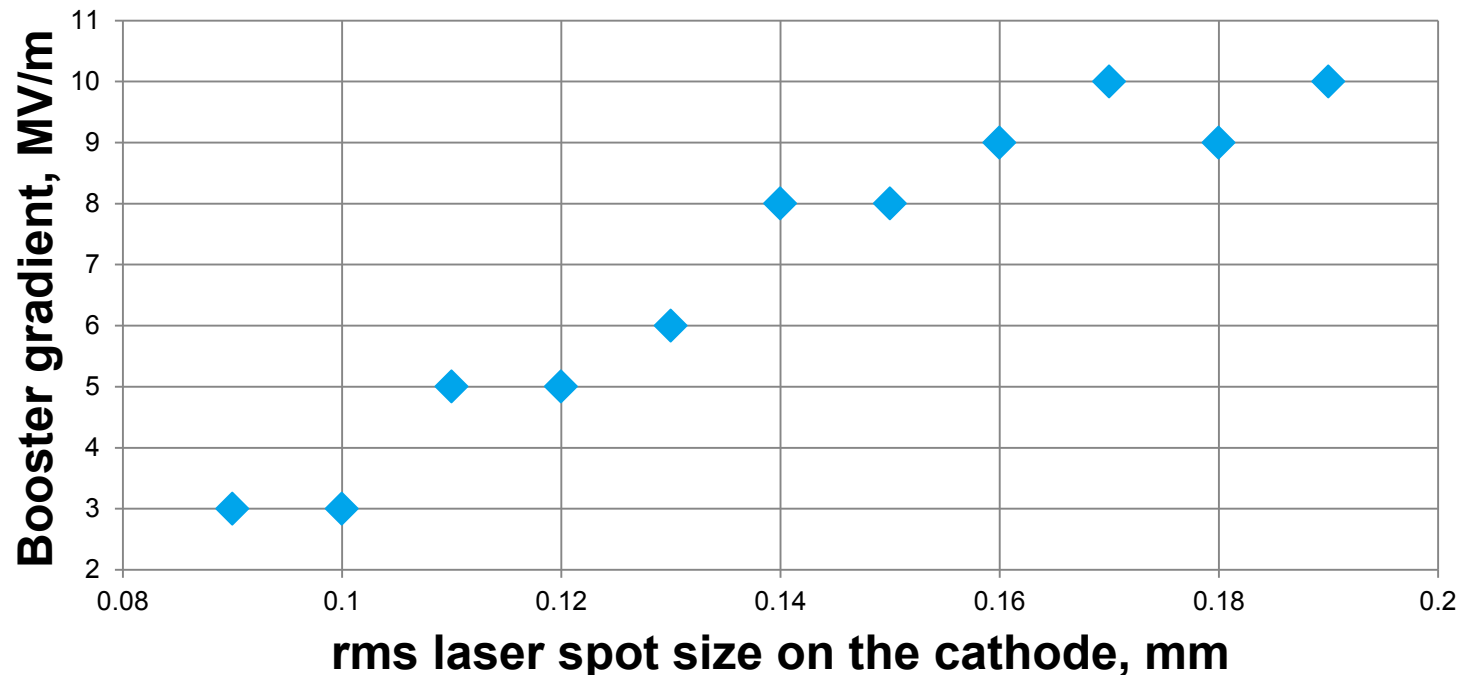
Emittance vs. booster gradient



Best emittance values from multiparameter scan (rms laser spot size on the cathode and solenoid current can be different for each point on the graph)



Booster gradient vs. BSA for the best emittance

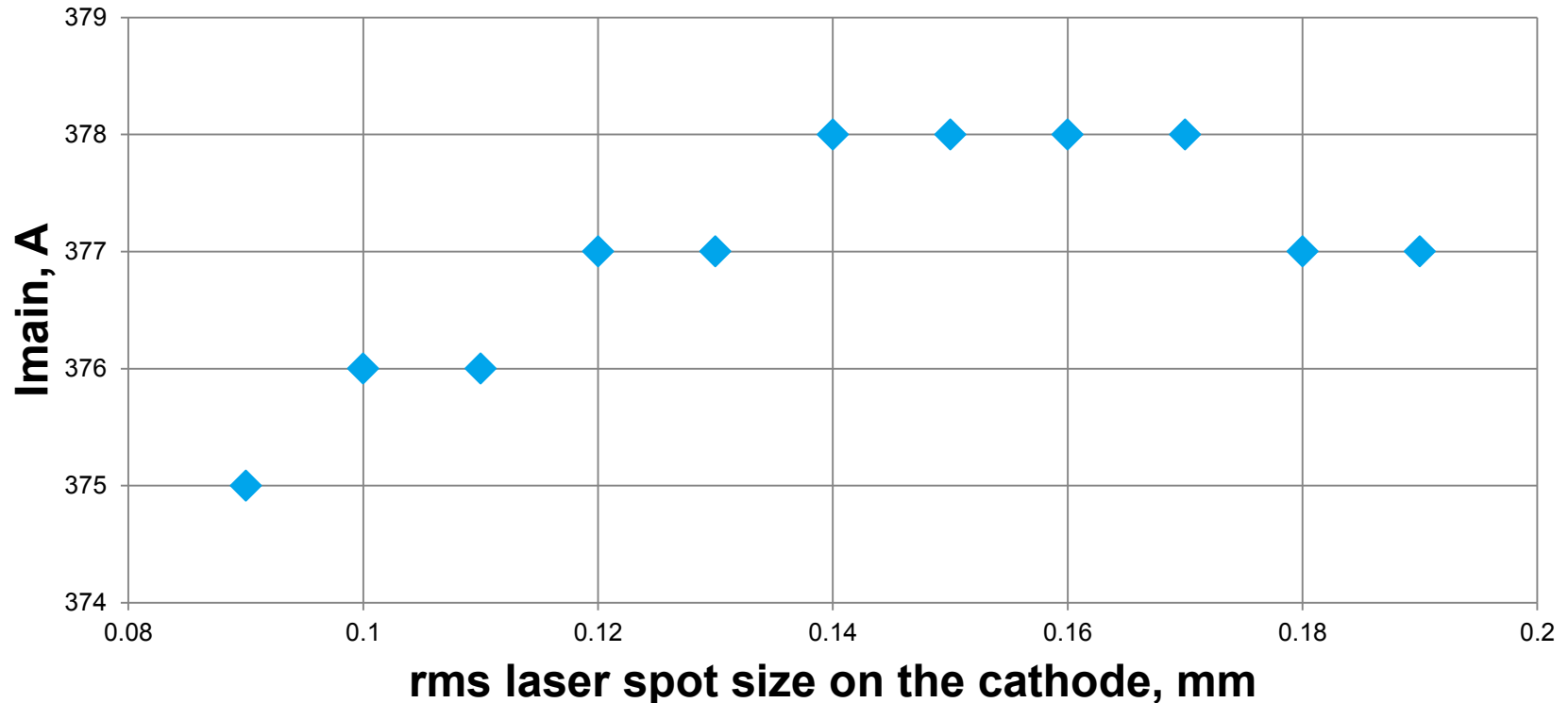


For each BSA, the minimum emittance value was found at the given booster gradient and solenoid current. Solenoid current can be different for each point on the graph.



Solenoid current vs. BSA

Imain vs. BSA for the best emittance



For each BSA, the minimum emittance value was found at the given booster gradient and solenoid current. Booster gradient can be different for each point on the graph.



Best emittance value

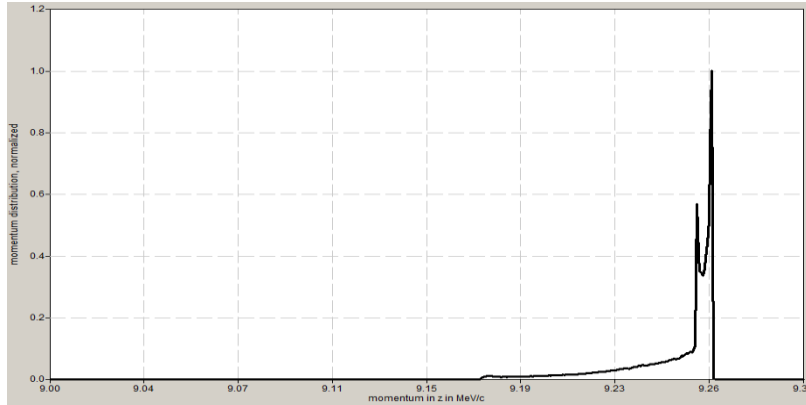
Conditions

- > Laser transverse rms size \rightarrow 0.1 mm
- > Gun gradient \rightarrow 60 MV/m
- > Gun phase \rightarrow MMMG, defined from auto phasing \rightarrow 6.6384 MeV/c
- > Main solenoid current \rightarrow 376 A
- > Booster gradient \rightarrow 3 MV/m
- > Booster phase \rightarrow MMMG, defined from auto phasing \rightarrow 9.2619 MeV/c
- > Bunch charge \rightarrow 100 pC
- > $2 \cdot 10^5$ particles

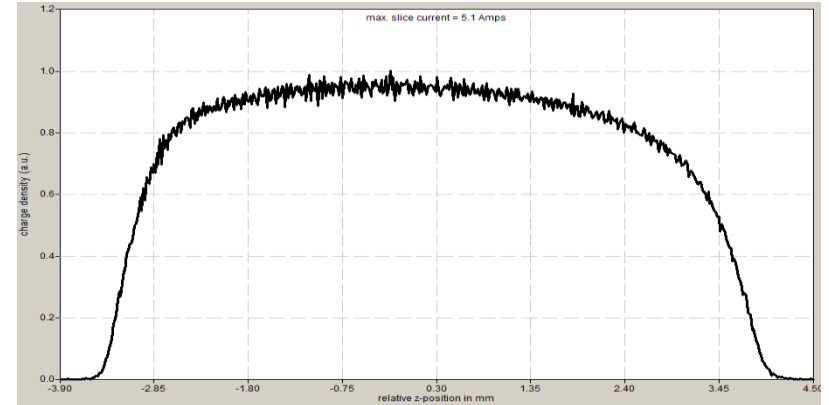


Best emittance value

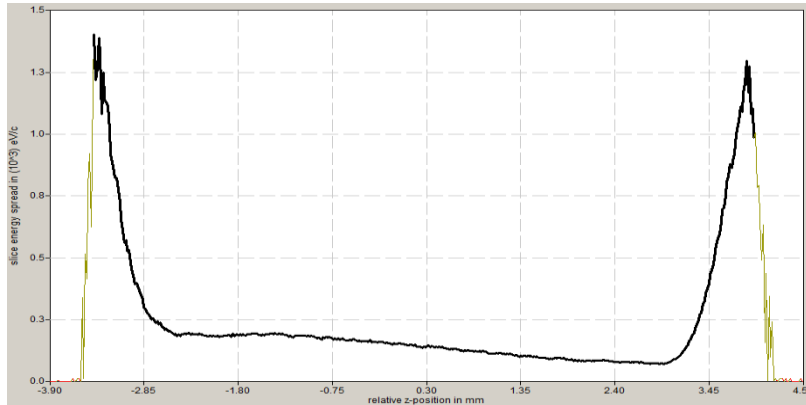
Momentum distribution



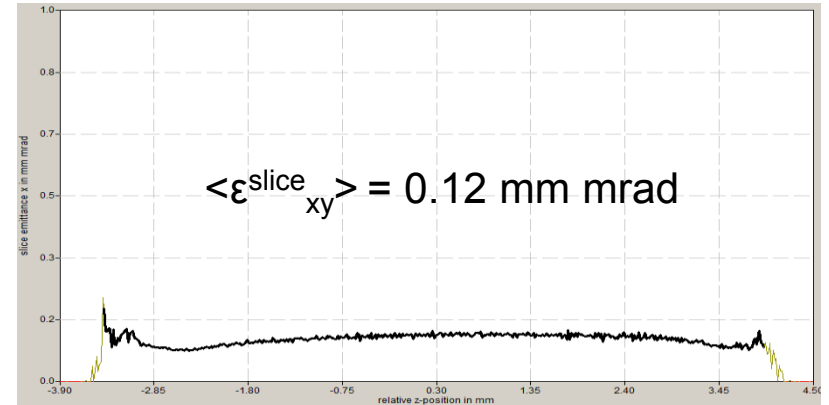
Current profile



Slice energy spread

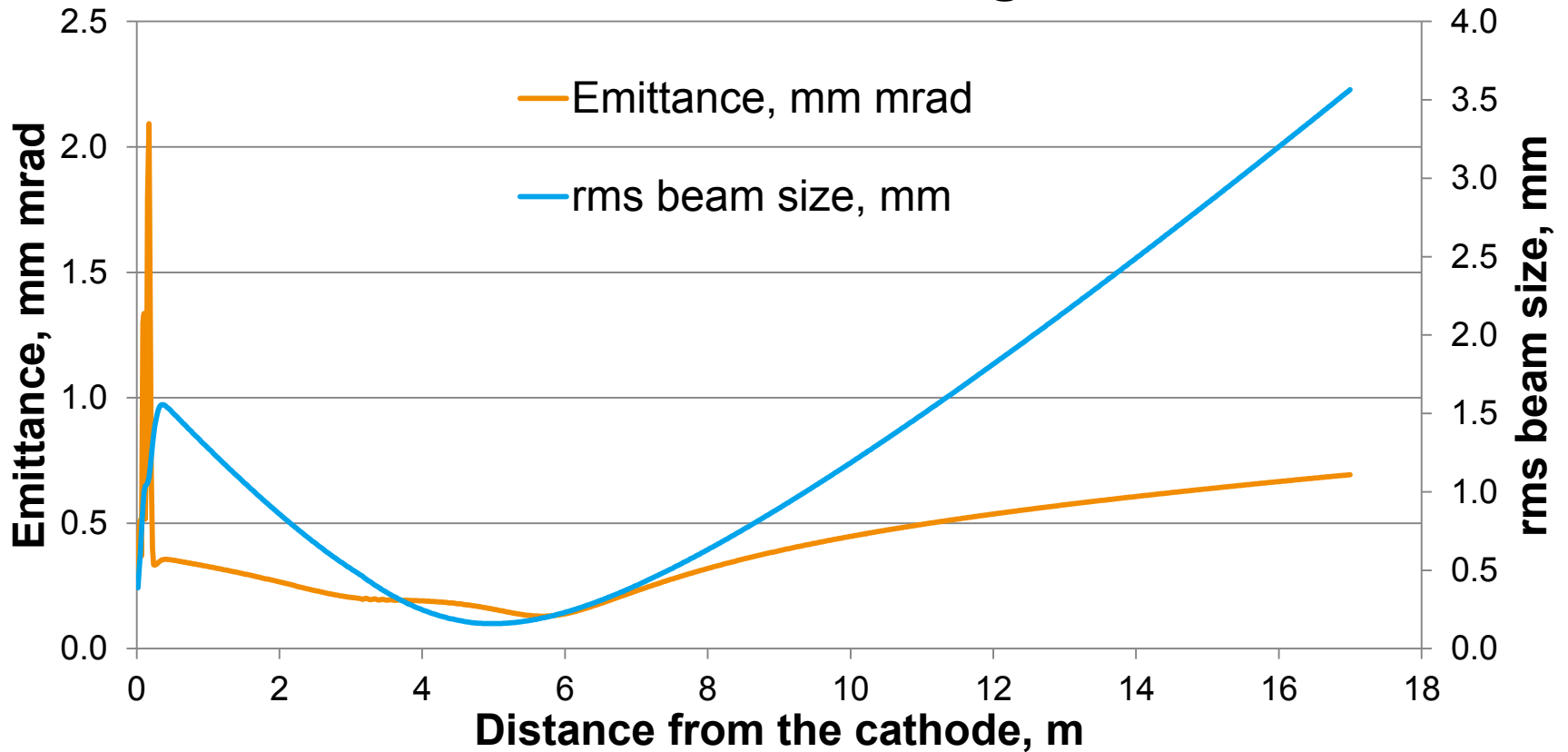


Slice emittance



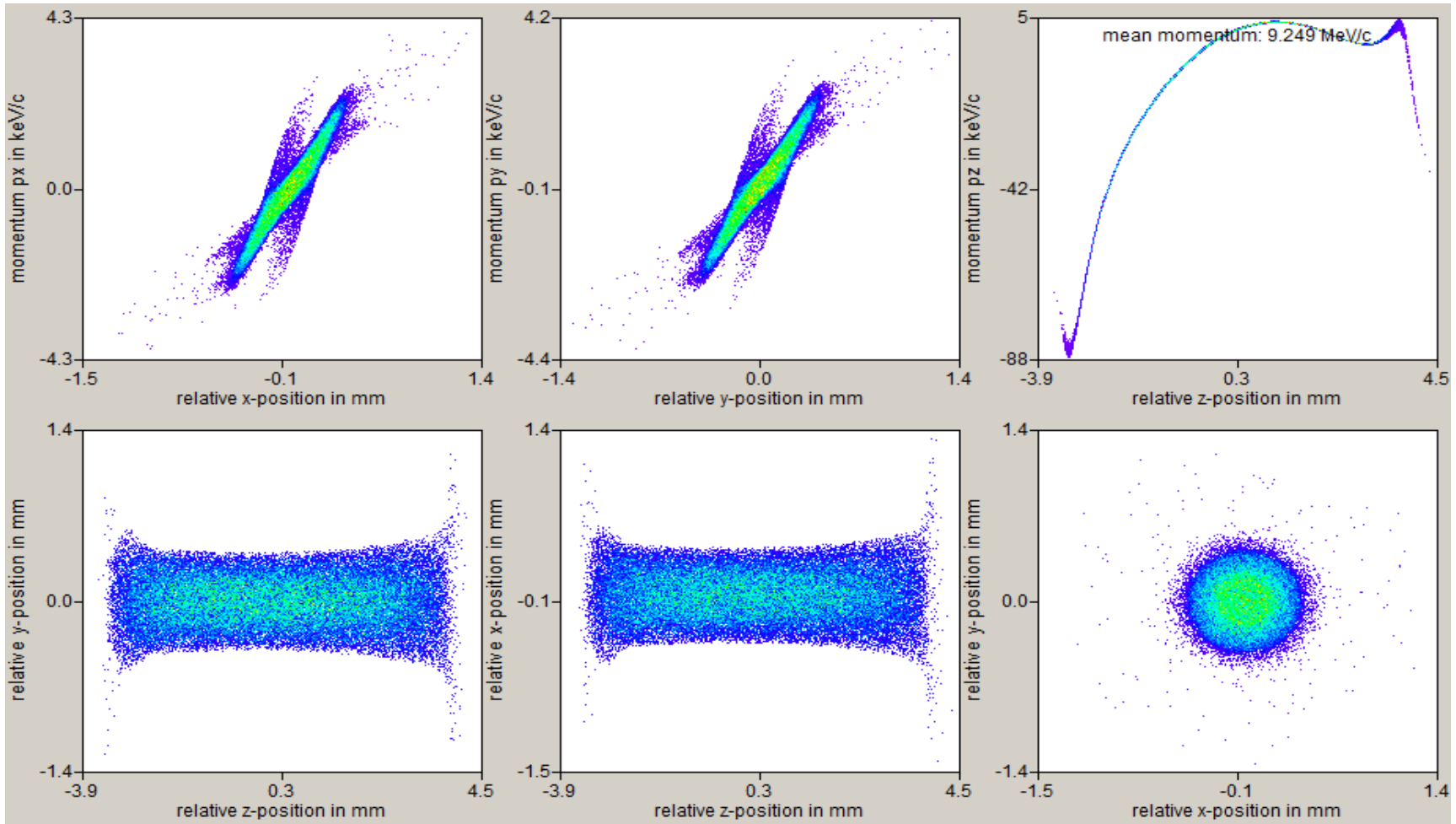
Best emittance value

Emittance and beam size along the beam line



Best emittance value

Phase spaces and beam distributions, $\epsilon_{xy}^{\text{projected}} = 0.13 \text{ mm mrad}$



Summary

- > Minimum emittance value for 100 pC bunch charge, flat-top temporal laser profile with FWHM = 22 ps, 2 ps rise/fall time, gun accelerating gradient 60 MV/m and MMMG phase defined from autophasing was found for the following conditions:
 - rms laser spot size on the cathode: 0.1mm
 - Booster accelerating gradient: 3MV/m
 - Main solenoid current: 376 A
- > $\epsilon_{xy}^{\text{projected}} = 0.13 \text{ mm mrad}$
- > $\langle \epsilon_{xy}^{\text{slice}} \rangle = 0.12 \text{ mm mrad}$
- > $\epsilon_{xy}^{\text{thermal}} = 0.085 \text{ mm mrad}$
- > $\epsilon_{xy}^{\text{thermal}} / \epsilon_{xy}^{\text{projected}} = 0.65$
- > Tolerance studies have to be done including gun launching phase

