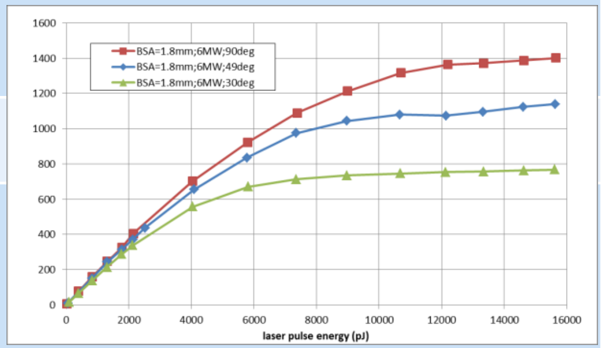
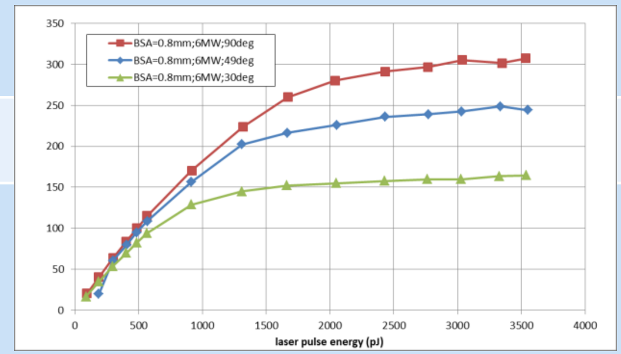
Emission (re-) measurements at PITZ.

M. Krasilnikov
Nov. –Dec. 2015

HELMHOLTZ
GEMEINSCHAFT

DESY

Emission studies

<table>
<tr><th>Pgun</th><th>Phase w.r.t. Phi0</th><th>BSA=1.8mm</th><th>BSA=0.8mm</th></tr>
<tr><td rowspan="3">6 MW</td><td>90 deg</td><td rowspan="3">
</td><td rowspan="3">
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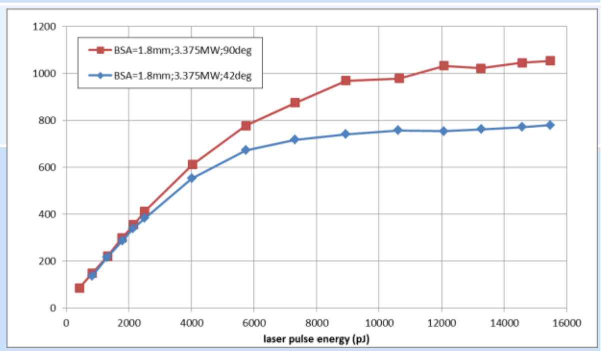
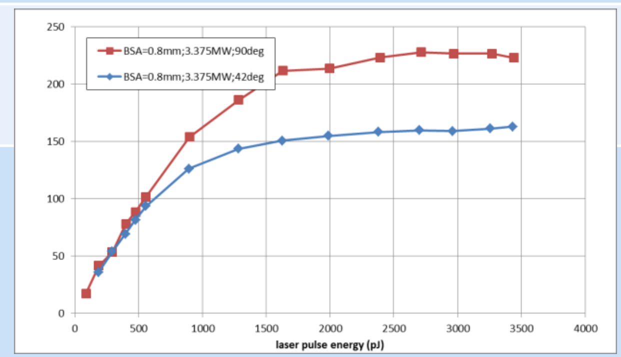
<tr><td>49 deg</td></tr>
<tr><td>30 deg</td></tr>
<tr><td rowspan="2">3.375 MW</td><td>90 deg</td><td rowspan="2">
</td><td rowspan="2">
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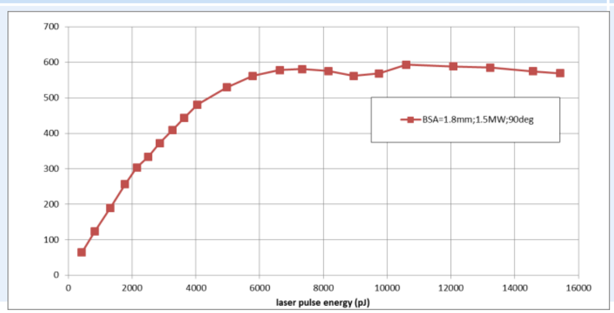
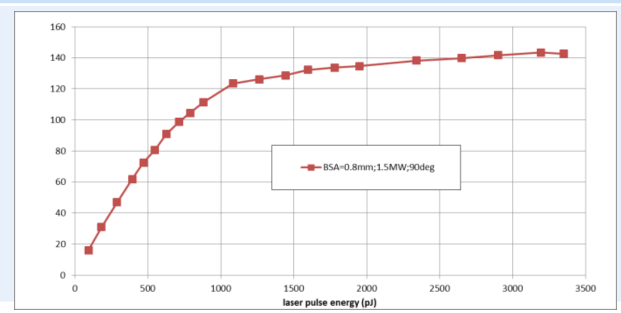
<tr><td>42 deg</td></tr>
<tr><td>1.5 MW</td><td>90 deg</td><td>
</td><td>
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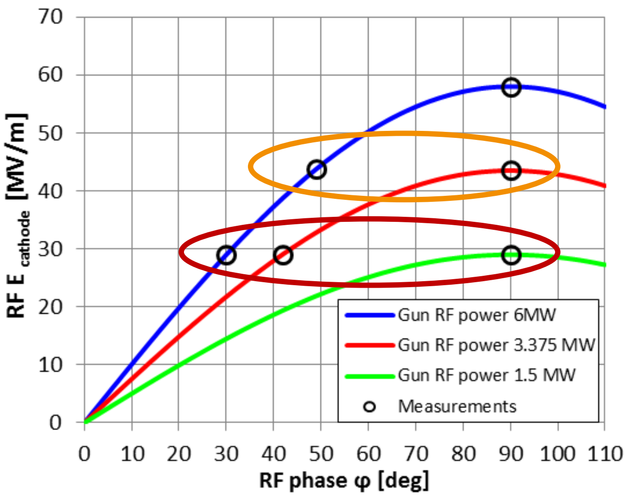
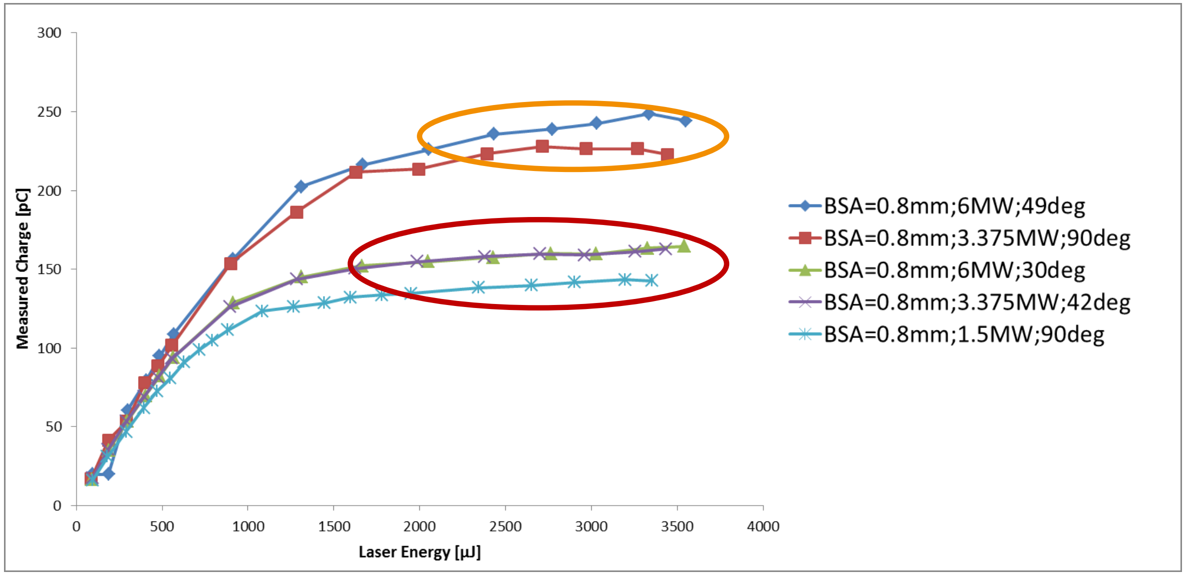
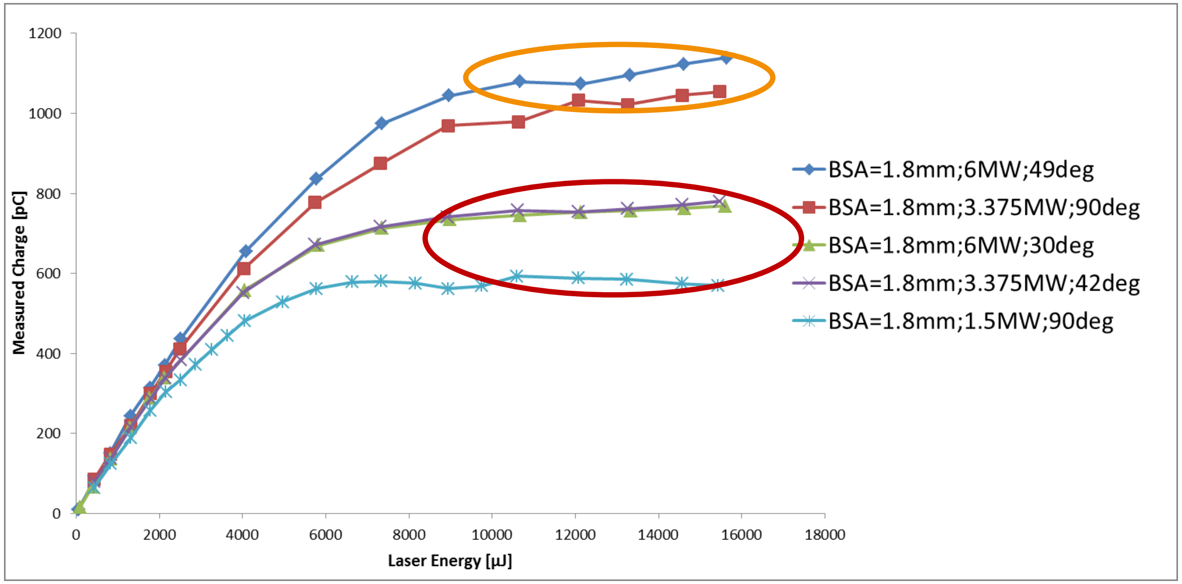
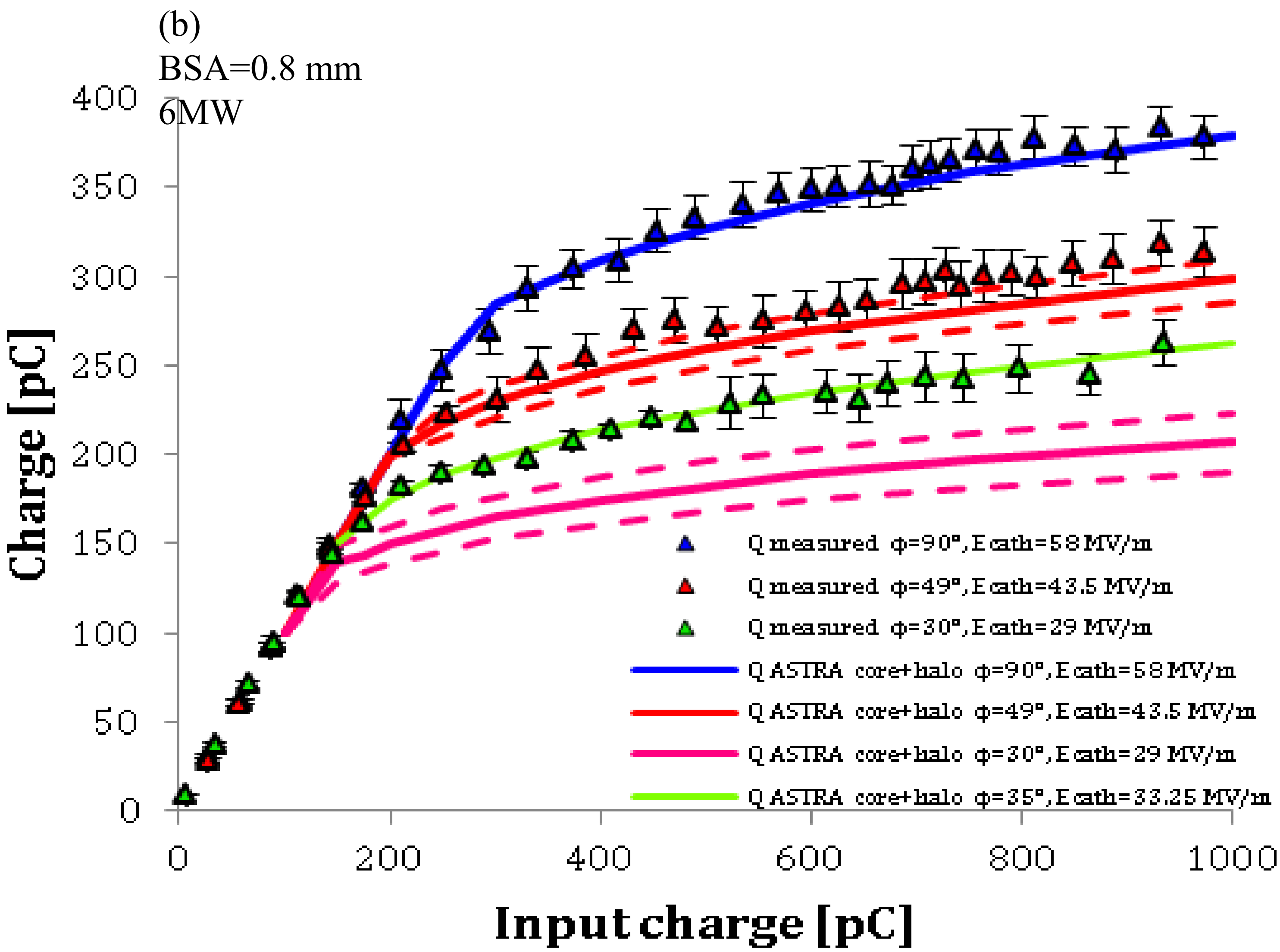
Emission studies



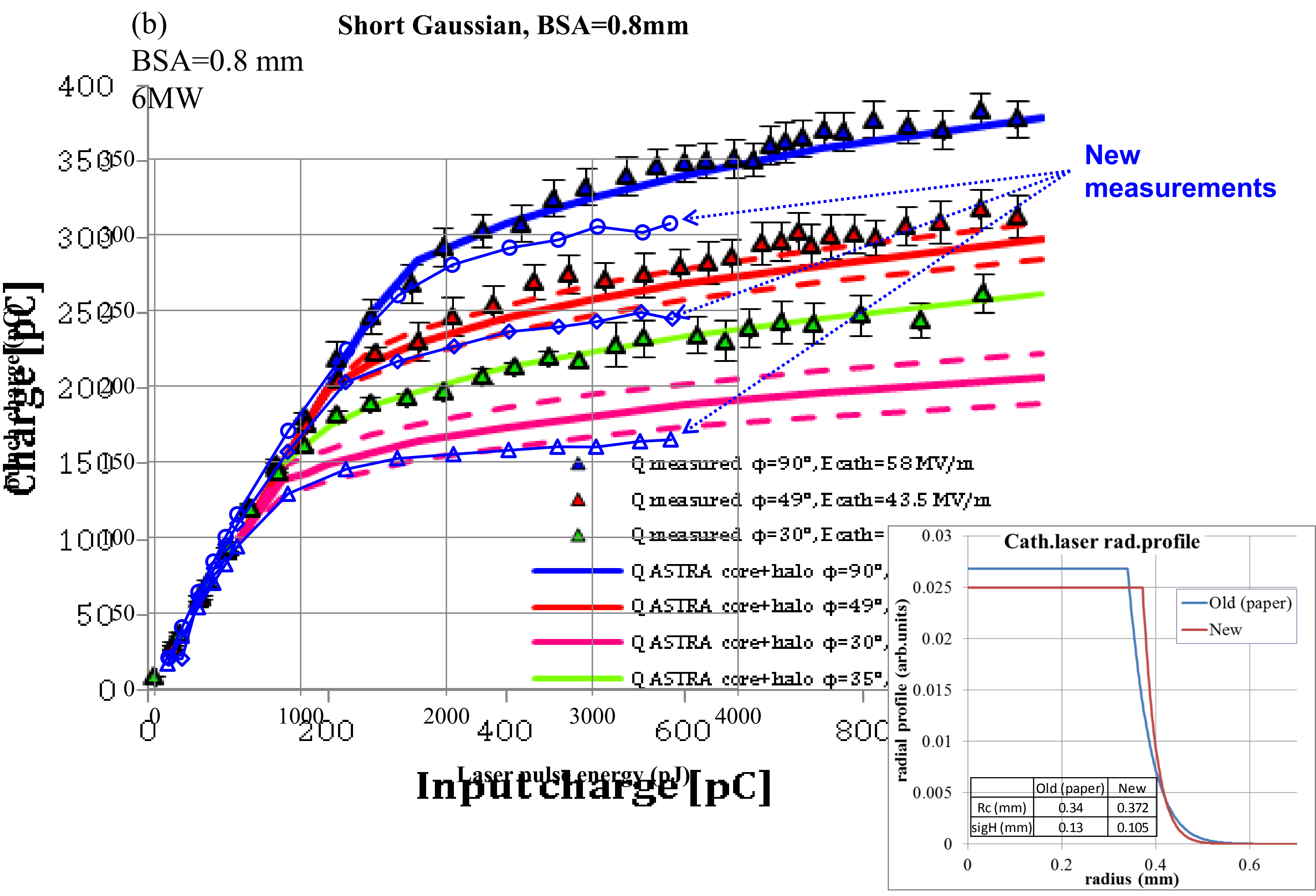




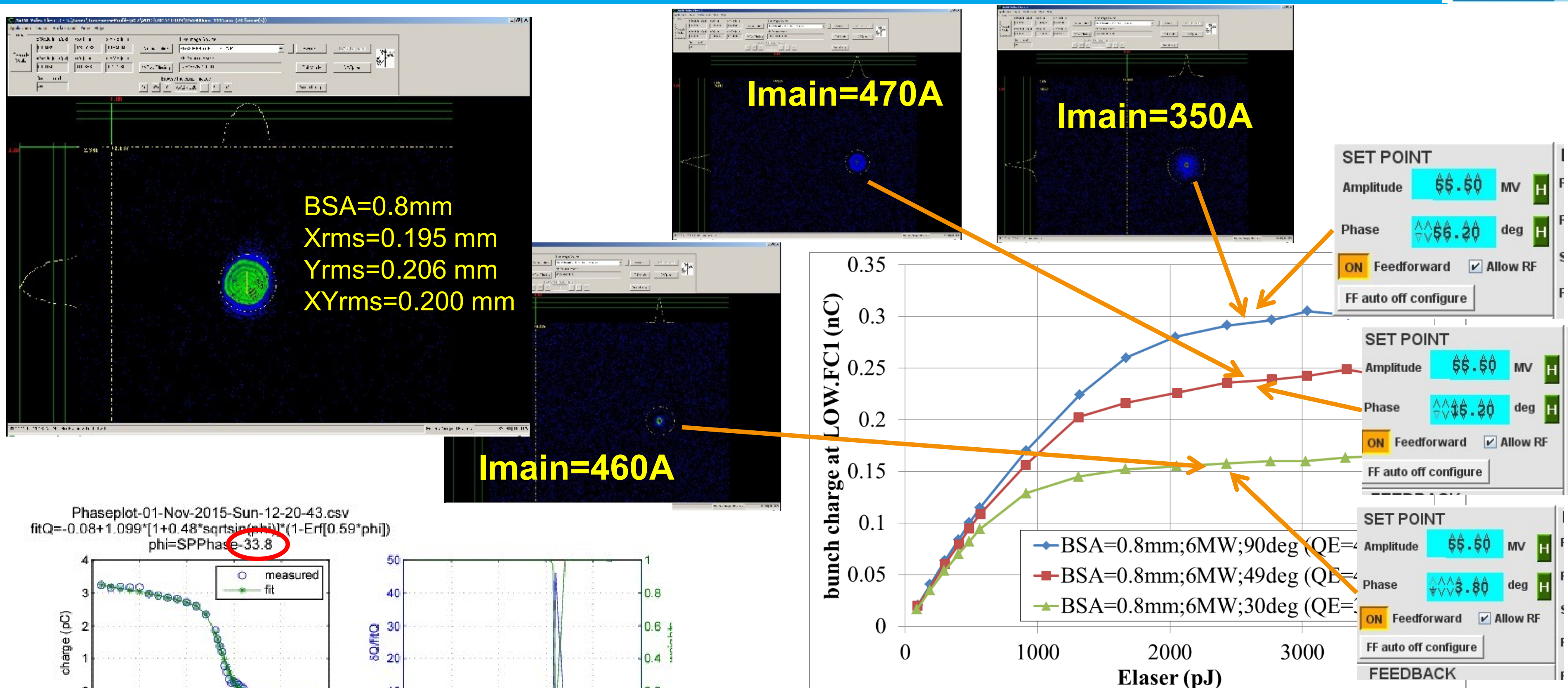
Emission studies (data used in the paper draft Fig.11b)

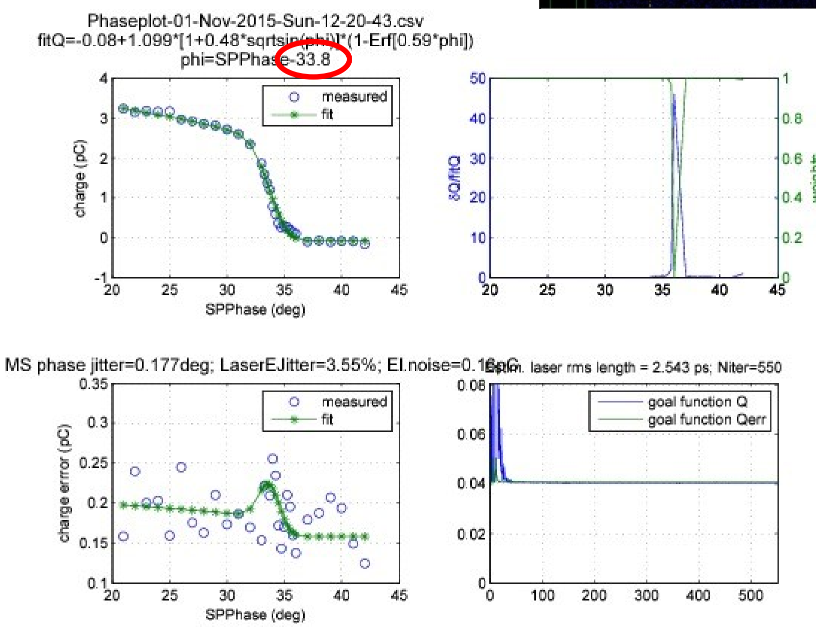


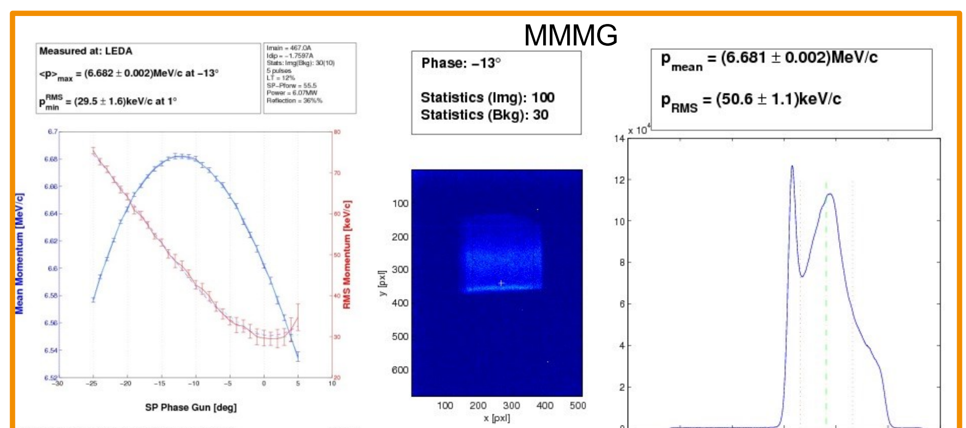
Emission studies (data used in the paper draft Fig.11b)



New setup for 6MW, BSA=0.8mm → 1.11.2015M-A



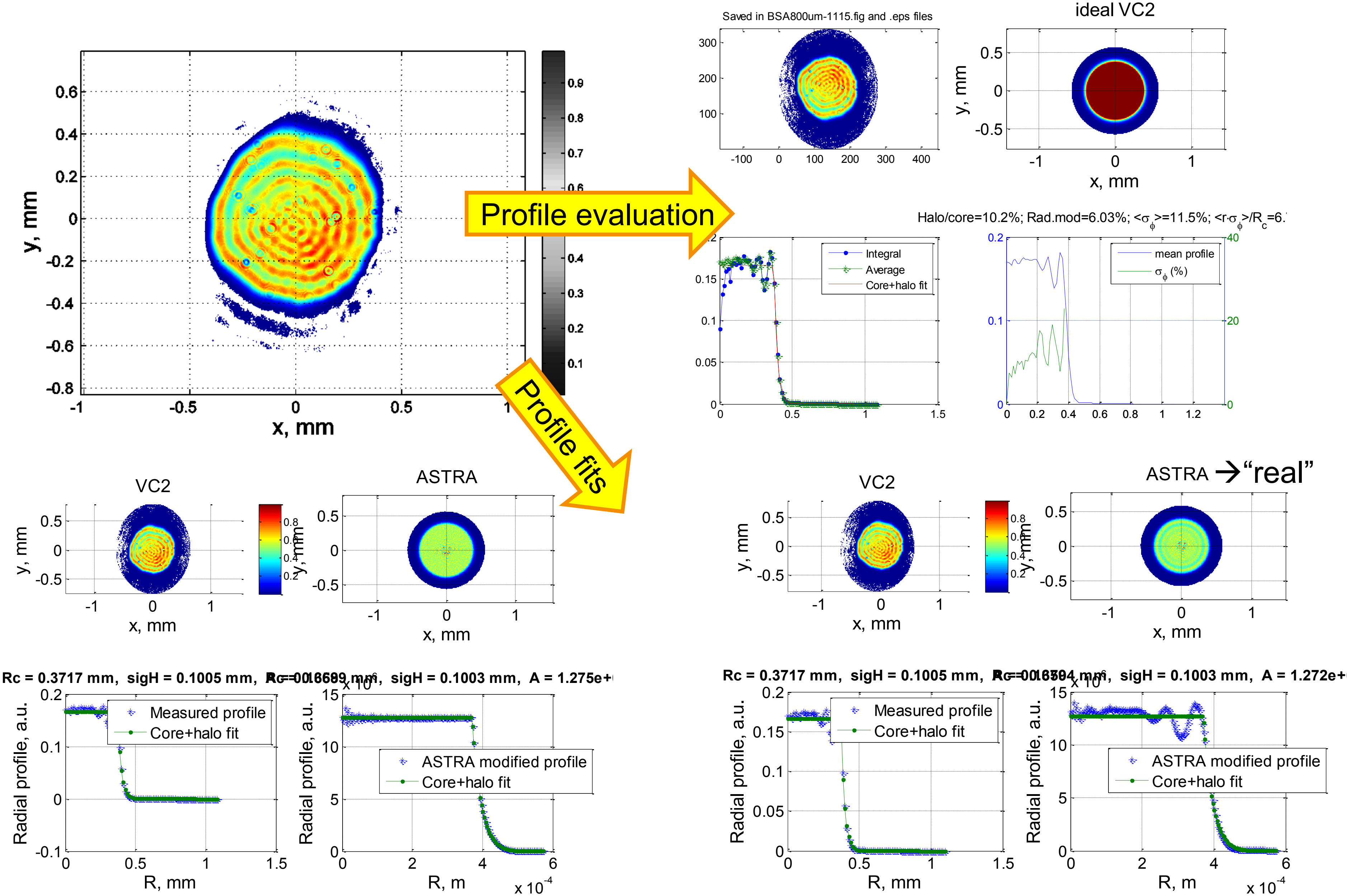




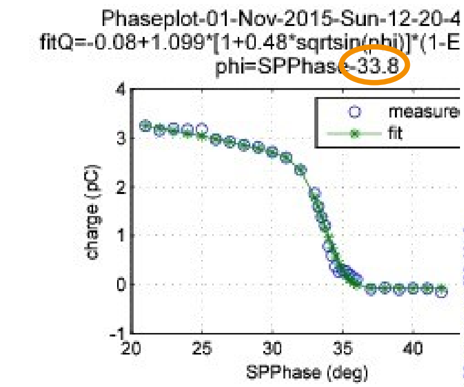
New setup for 6MW, BSA=0.8mm → strategy for simulations

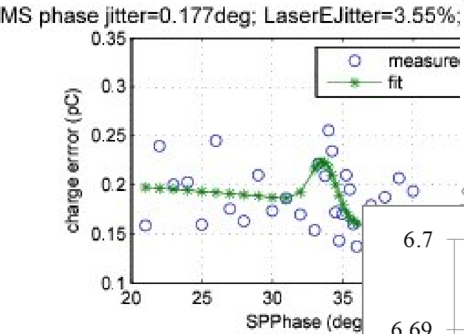
1. Uncertainty: Gaussian laser pulse length rms (fwhm) → 0.85 (2.0); 0.95 (2.24); 1.1 (2.59)ps
2. Ecath=? : maxPz=6.681MeV/c at MMMG phase
   a) Simulated MMMG phase → Pz(phase)
   b) Simulate zero crossing phase
3. Transverse distribution (XYrms=0.200mm):
   a) Radial homogeneous
   b) flattop core + Gaussian halo
   c) "real" = ring structure in the core + Gaussian halo
4. Calculate coefficient(s) for Qinput for the measured data (Elaser→Qinput)
5. Scans for phases 30;49;90deg* (*→ cross check with 2b), charge collection at LOW.FC1 (z=0.8m), Imain=460;470;350A [MaxB(1)=-(7.102e-5+5.899e-4*Imain)]

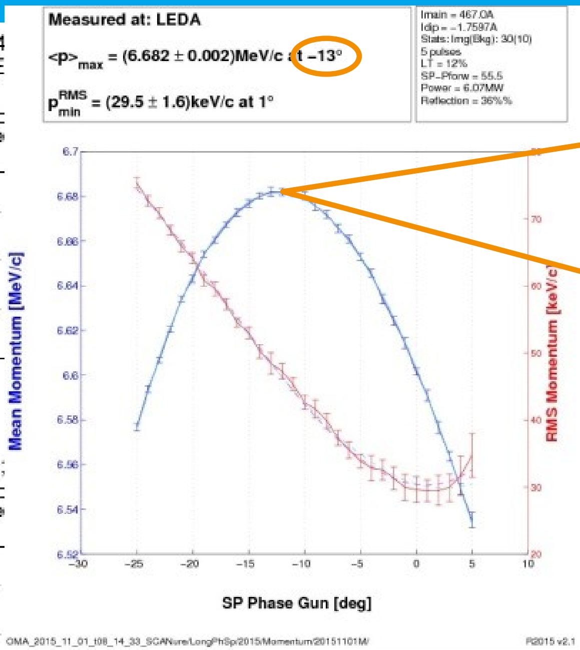
New setup for (6MW, BSA=0.8mm) → VC2

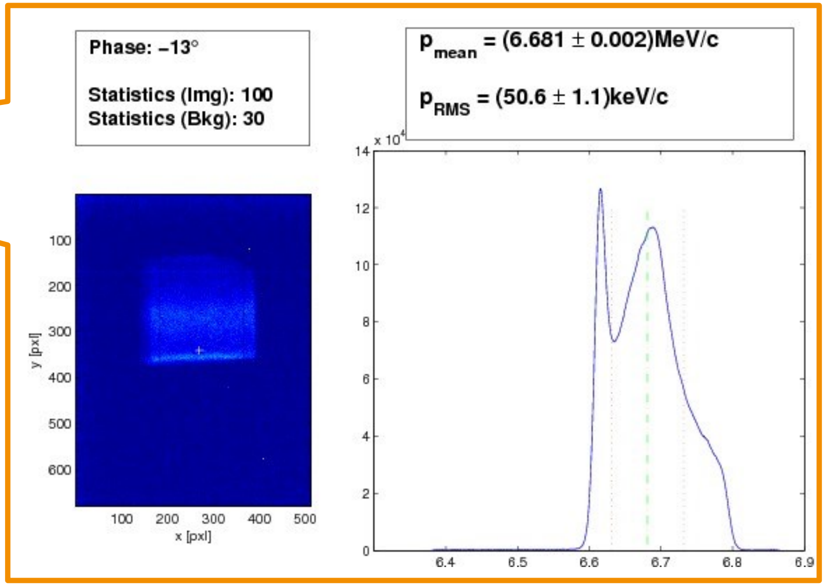


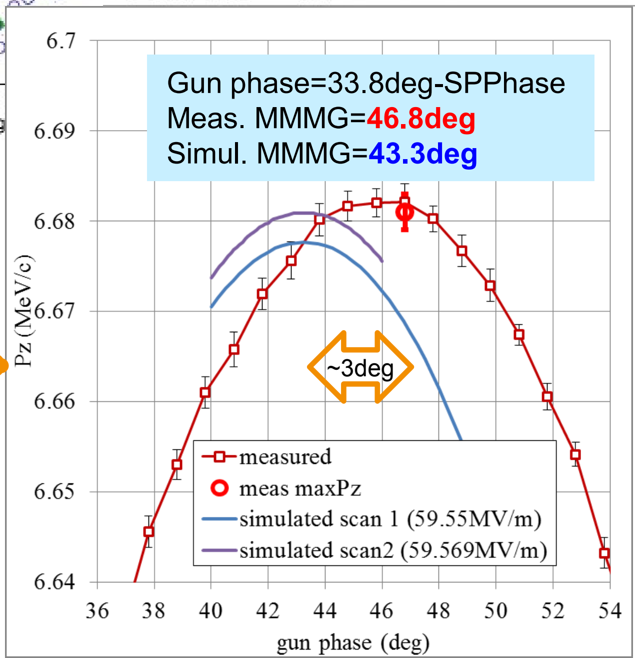
New setup for (6MW, BSA=0.8mm) → Pz

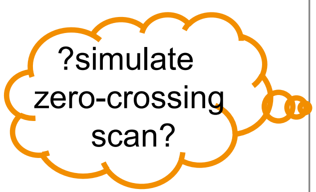


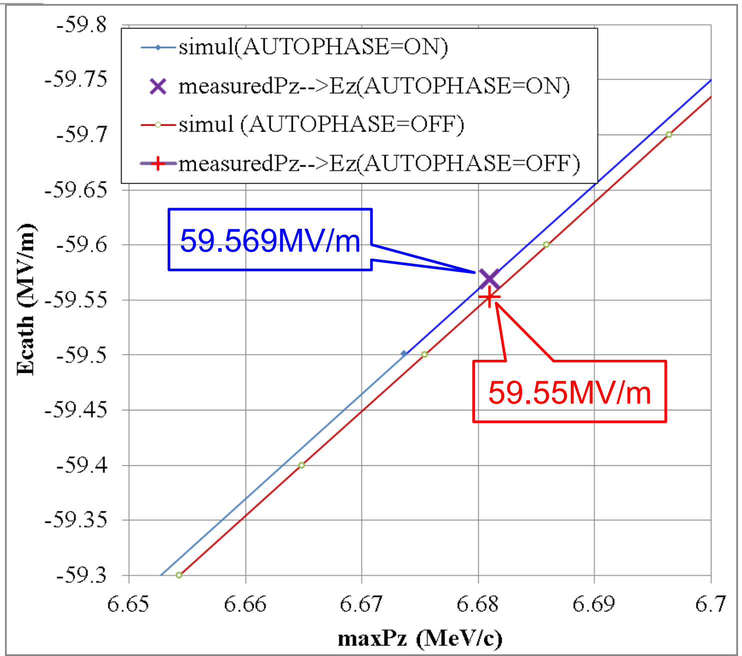




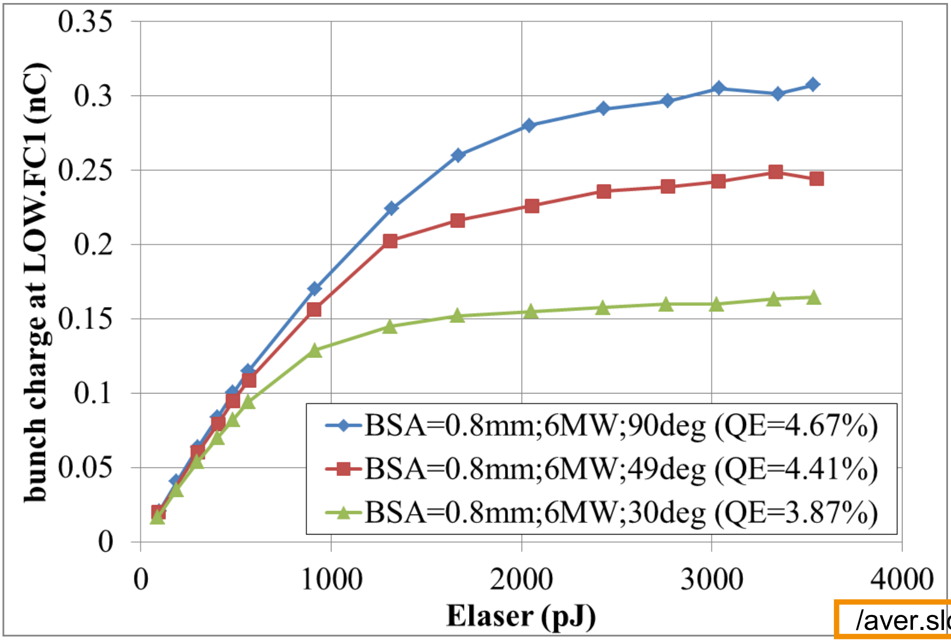




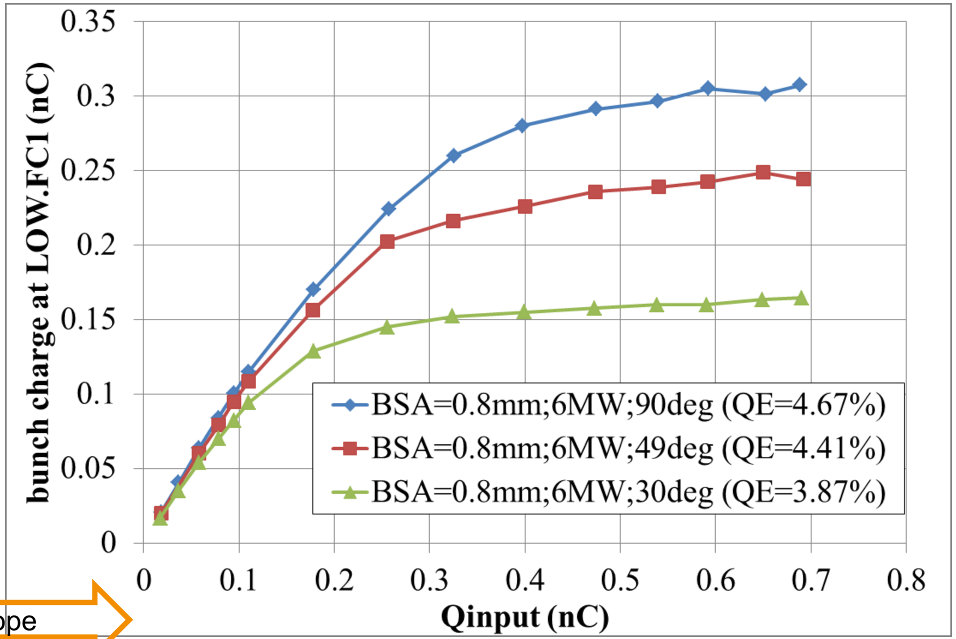


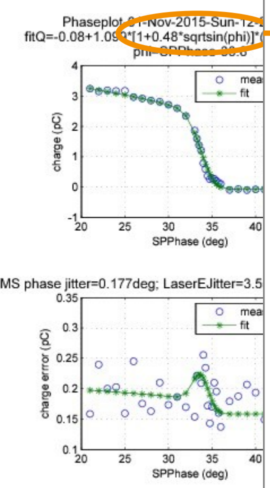


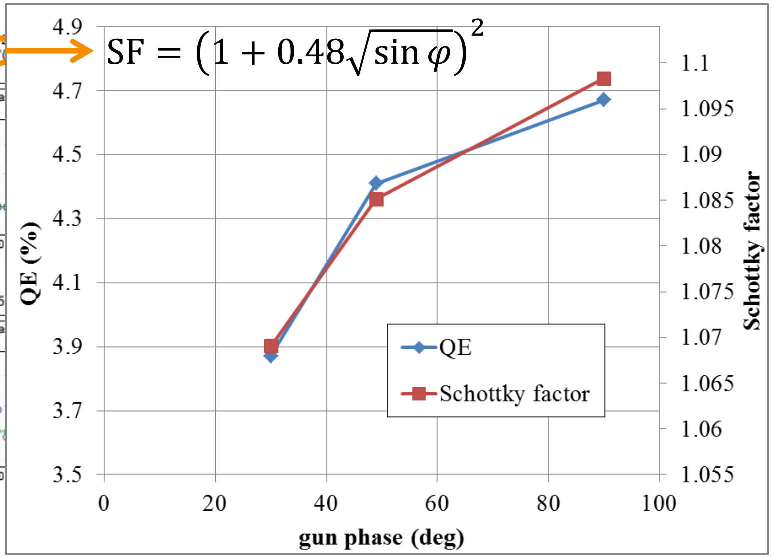
Qinput determination

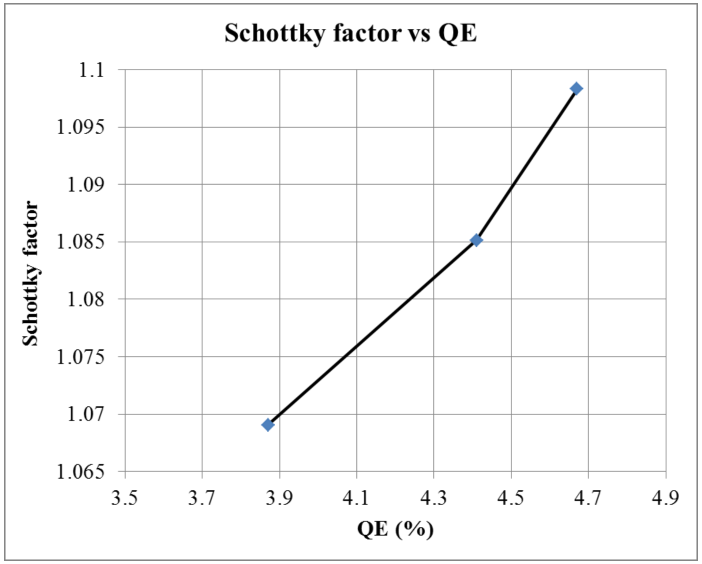


/aver.slope

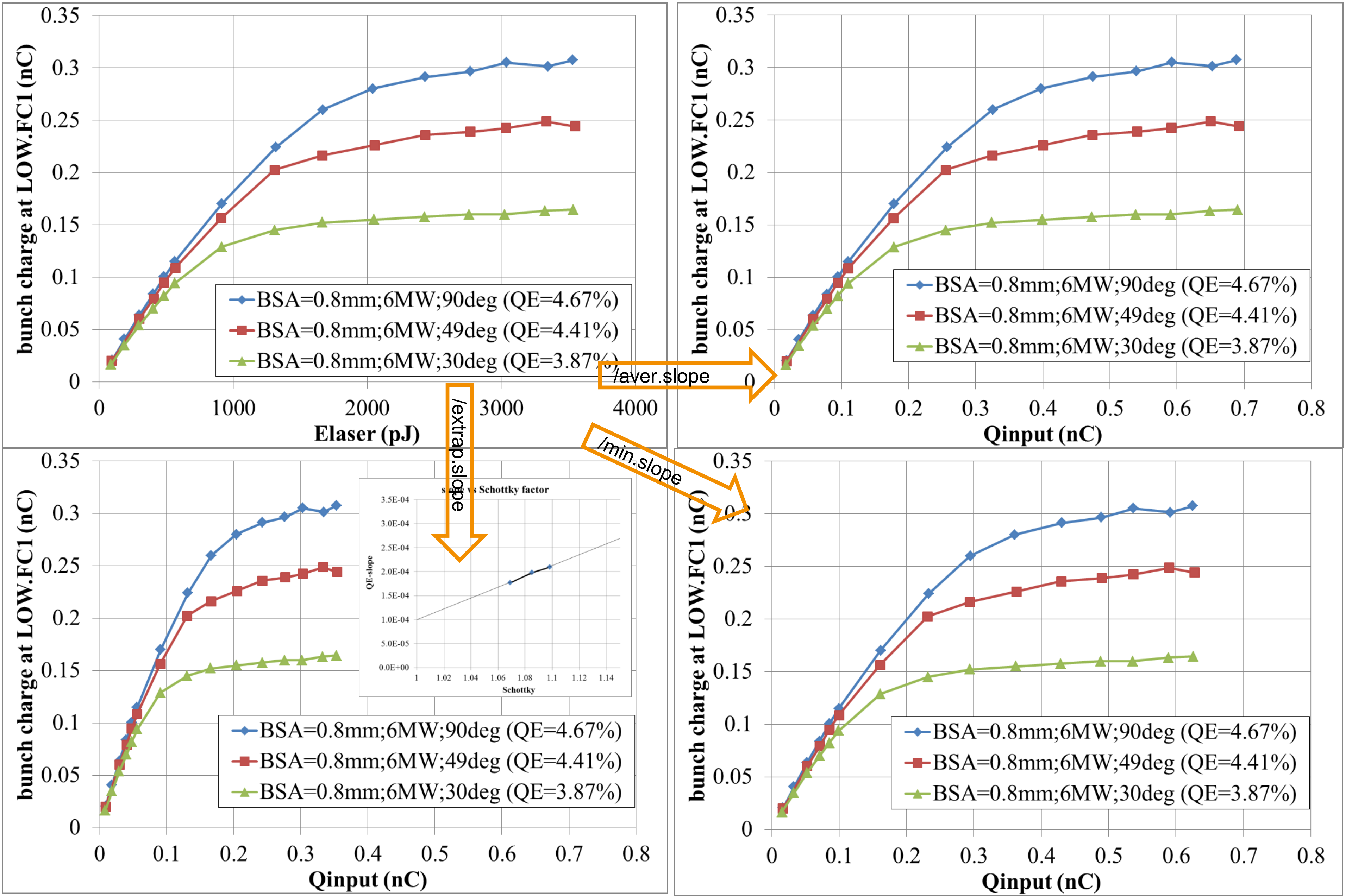






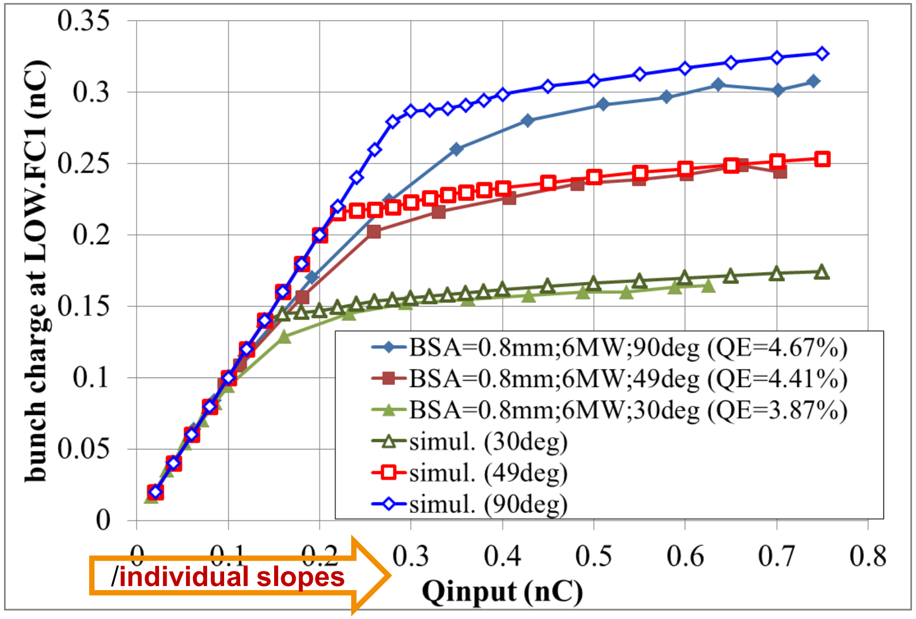


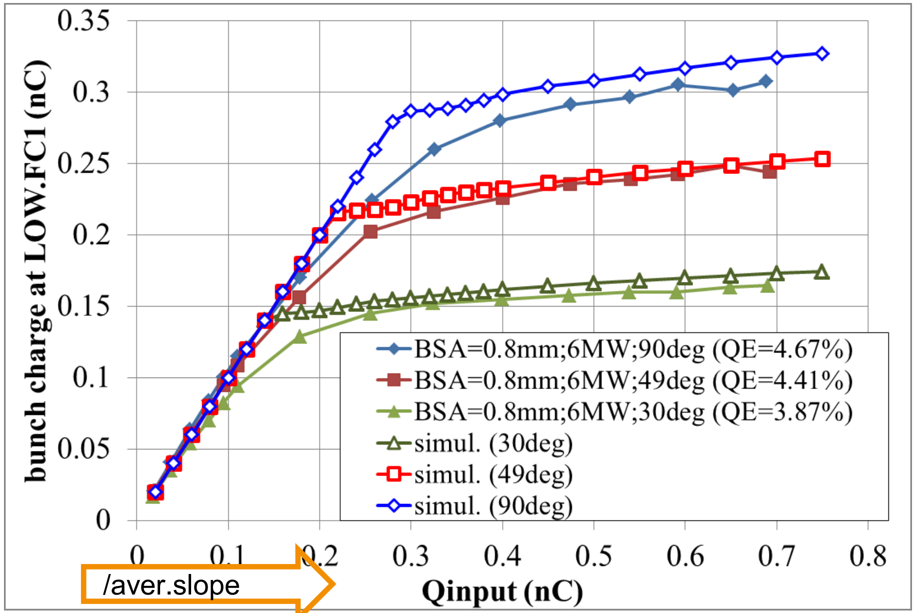
Qinput determination

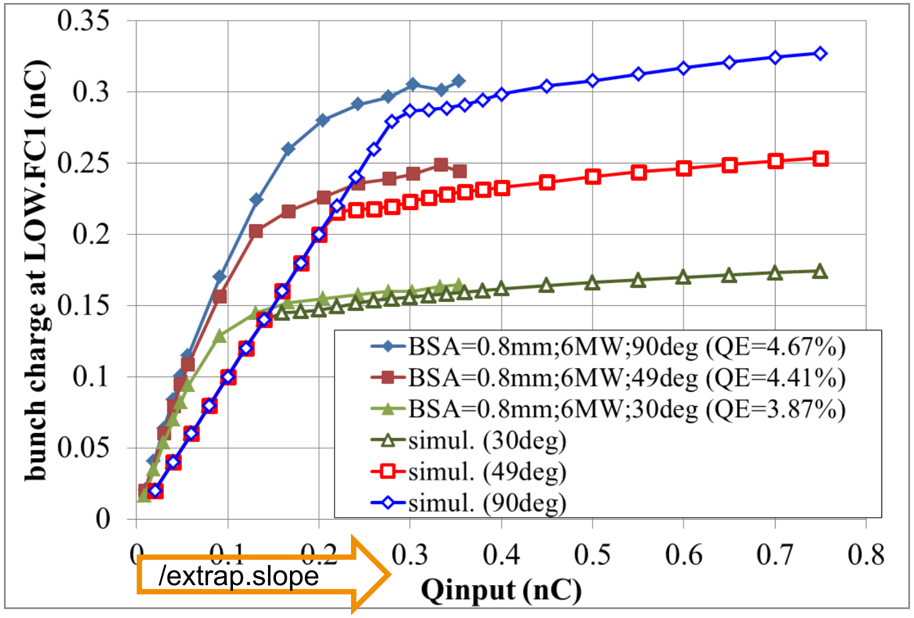


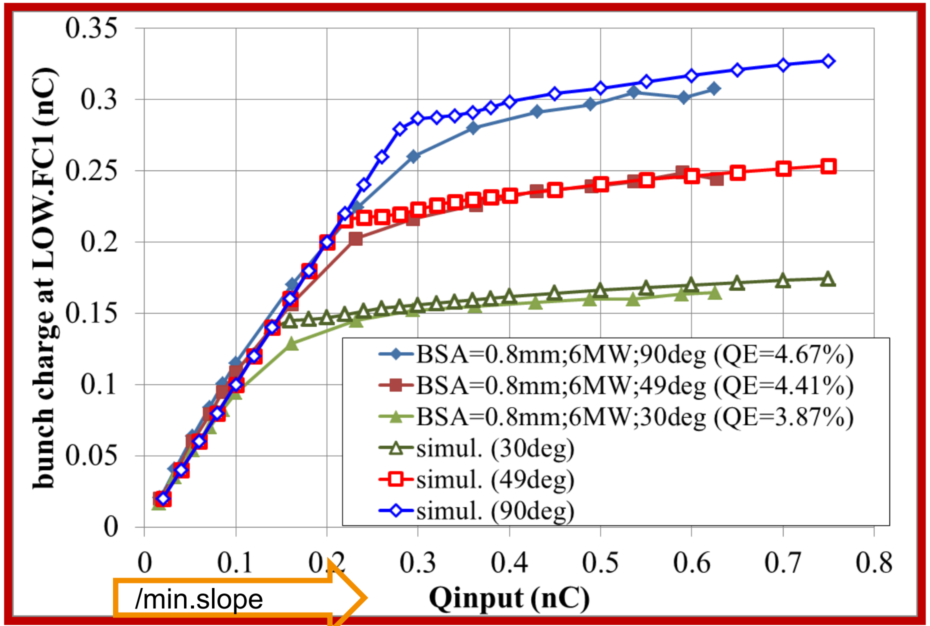
Run 4 (first guess)

Laser temporal Trms(fwhm)=0.85ps (2.0ps)
Laser transverse: core+halo(MK), 0.2mm rms
RF gun MaxE(1)=-59.569MV/m
ASTRA: 200k particles, no Schottky

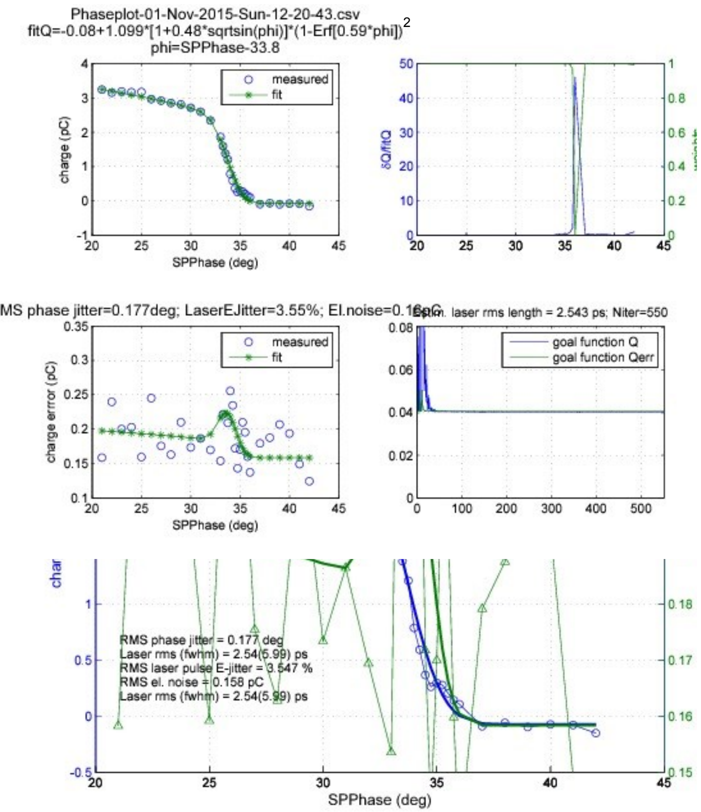


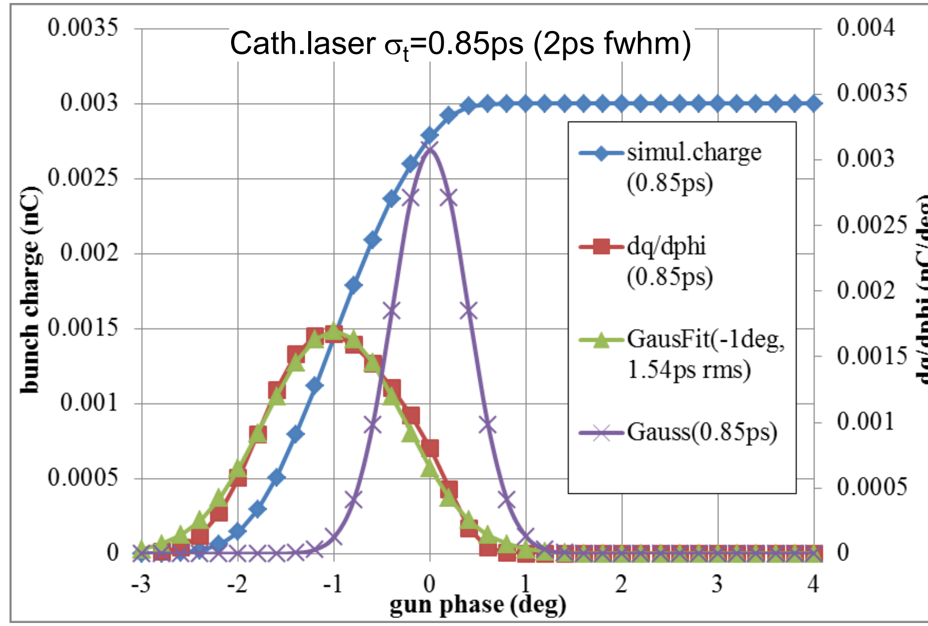


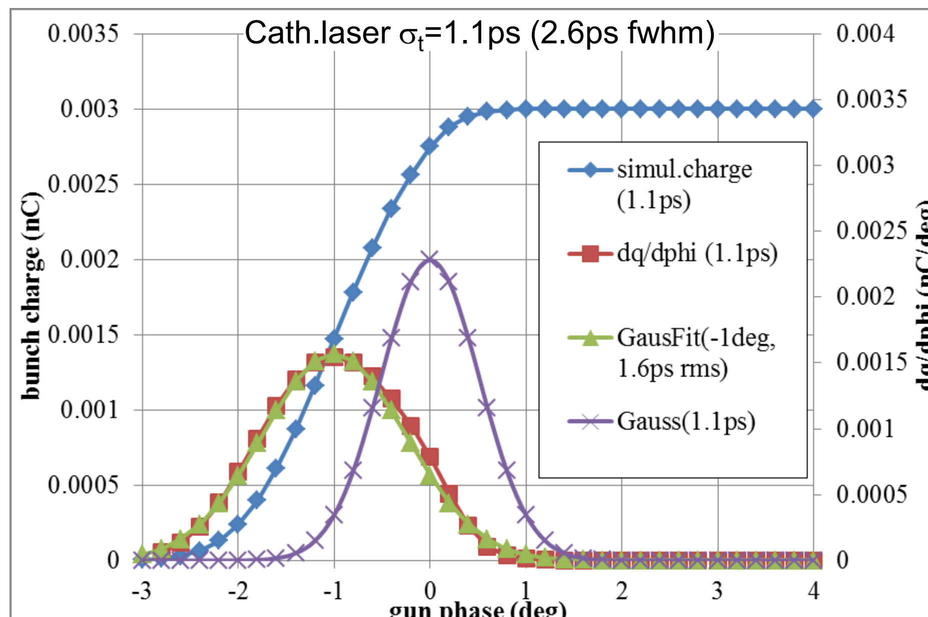




Zero-crossing phase simulations





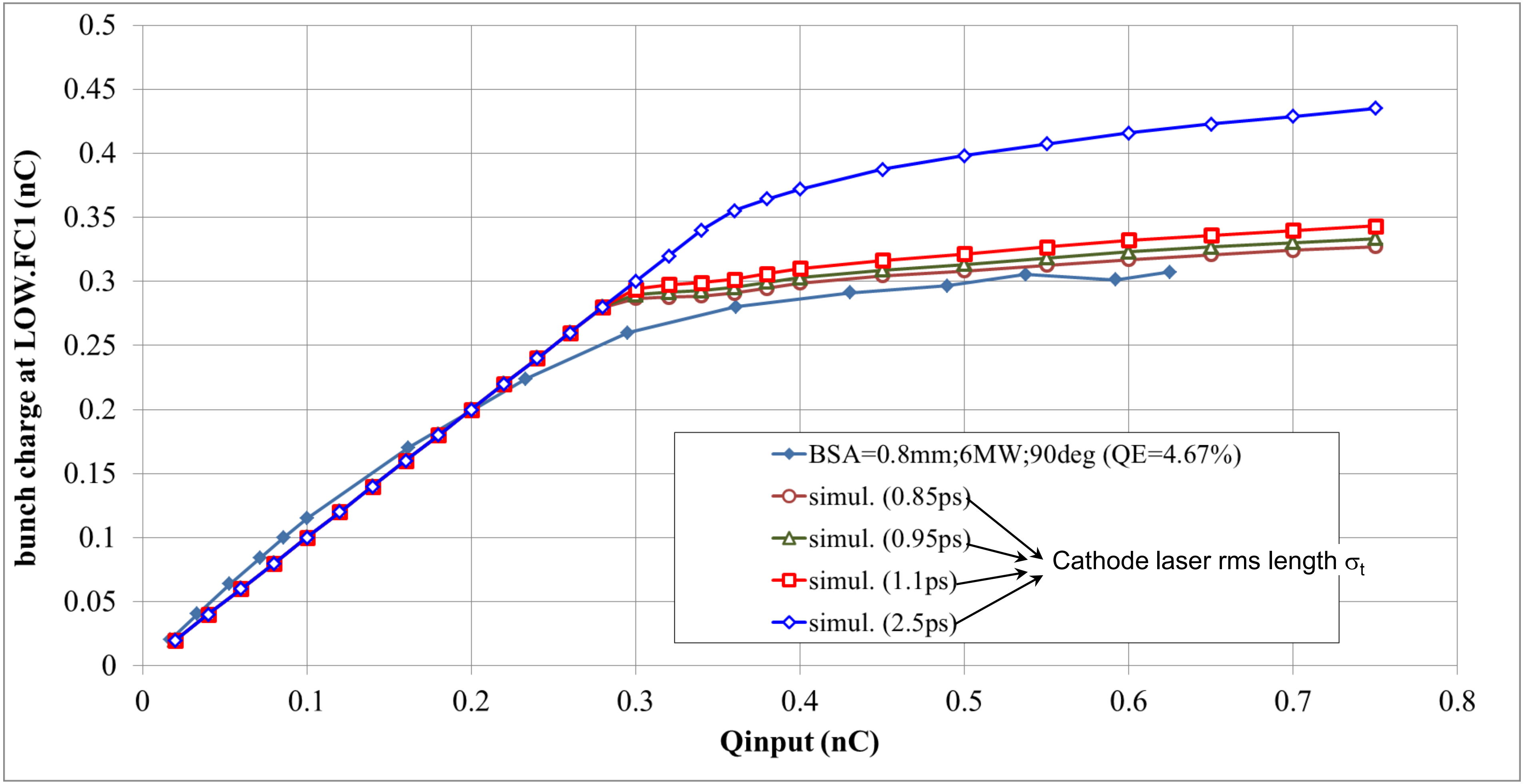


cathode laser		delta phi	dq/dphi-Gauss.fit	fit-σ_t/σ_t
σ_t (ps)	fwhm (ps)	deg	fit-σ_t (ps)	
0.85	2	-1	1.54	1.81
1.1	2.6	-1	1.6	1.45

- 1deg (of 3deg MMMG determination discrepancy) [30;49;90deg]→[29;48;89deg]?
- Wider Gaussian fit (but not 2,5ps from experiment!)
- ?Cathode response time (dependent on E@cath)

Impact of the cathode laser length onto LT-scan (run5)

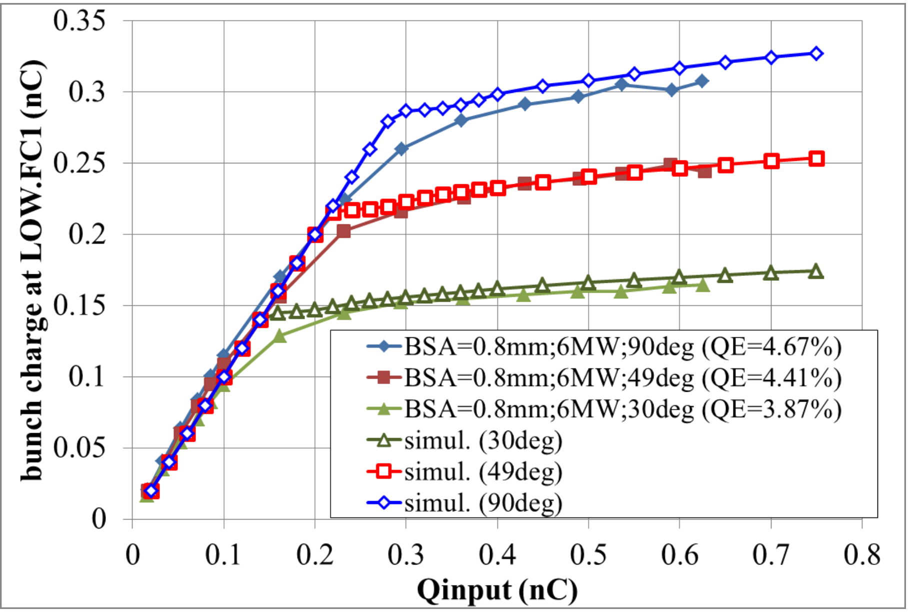
- Ecath=59.569MV/m
- Gun phase =90deg (AUTOPHASE=OFF)
- Laser transverse (flattop core +Gaussian halo, XYrms=0.2mm)



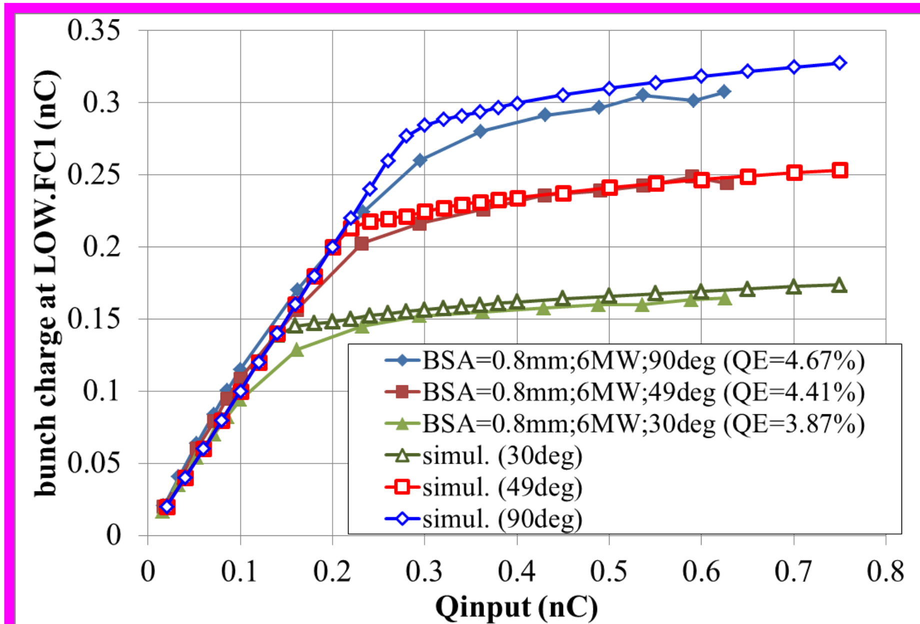
- σ_t=0.85ps (2ps fwhm) → closer, but still Qinput~0.3nC→ large discrepancy

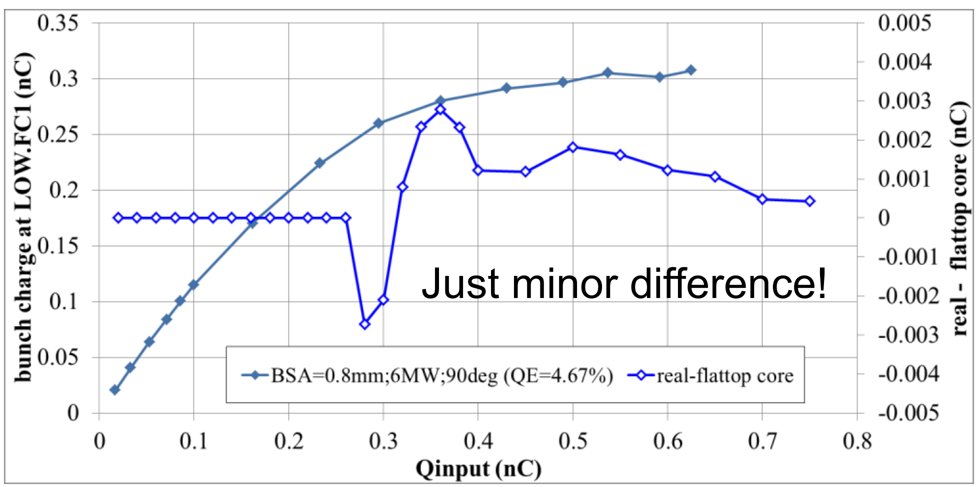
Run 6: (0.85ps; 59.569MV/m; "real" distribution)

flattop core + Gaussian halo



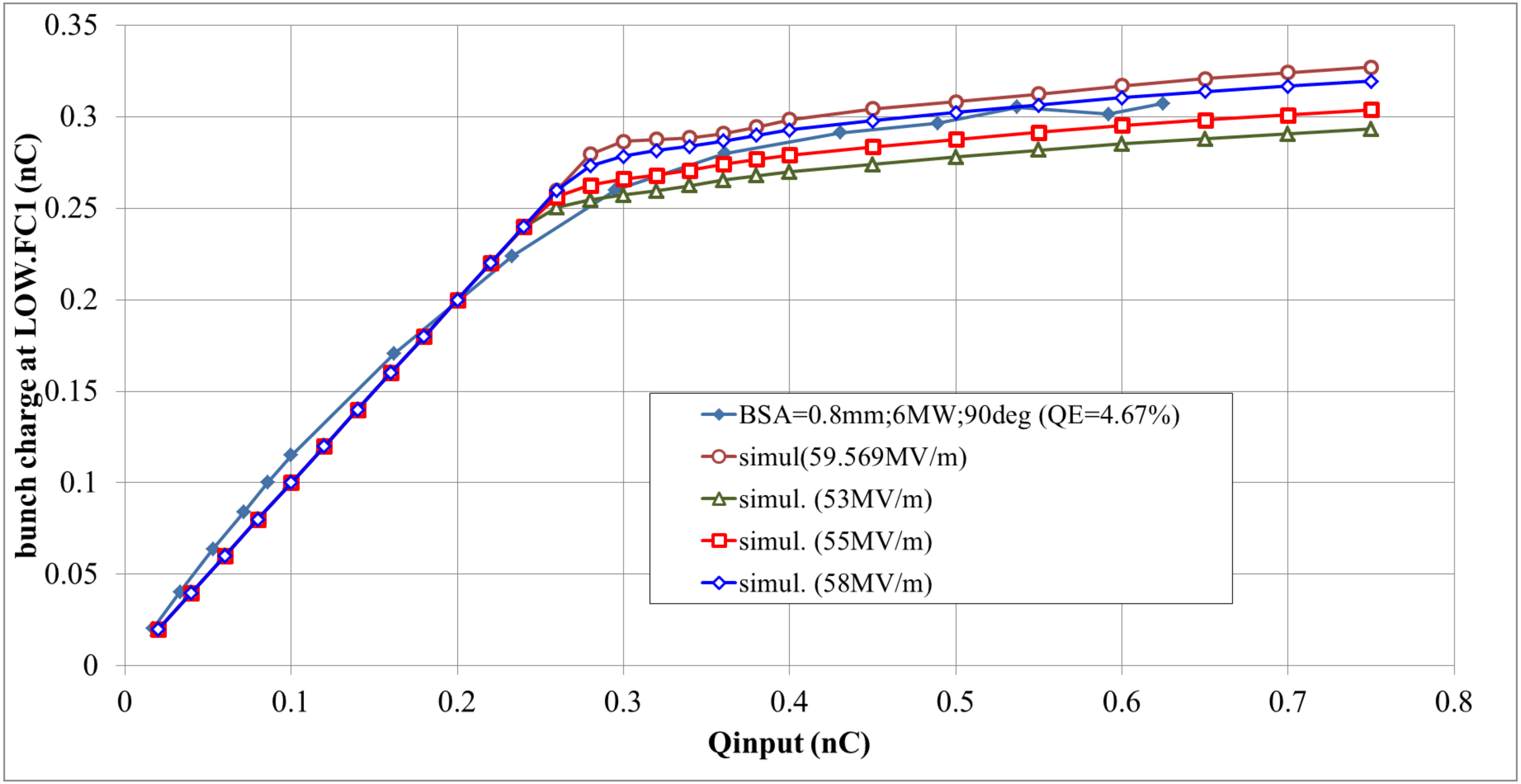
"real" = ring structure in the core + Gaussian halo





Impact of the Rf gun gradient onto LT-scan (run7)

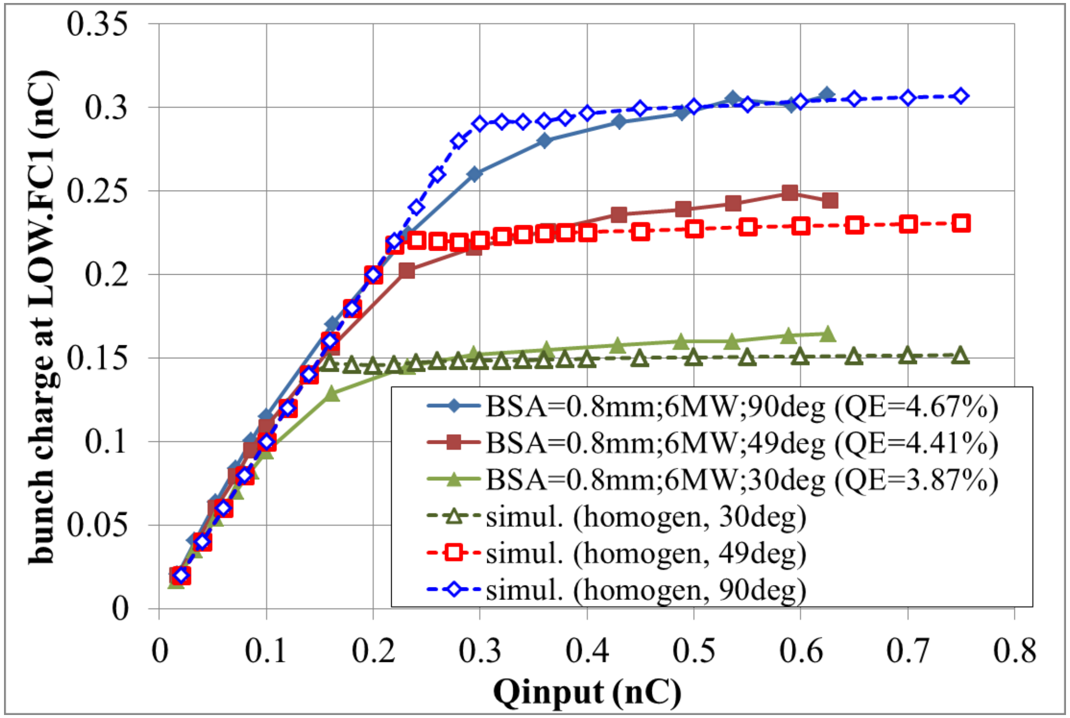
- σ_t=0.85ps (2ps fwhm) Gun phase =90deg (AUTOPHASE=OFF)
- Laser transverse (flattop core +Gaussian halo, XYrms=0.2mm)

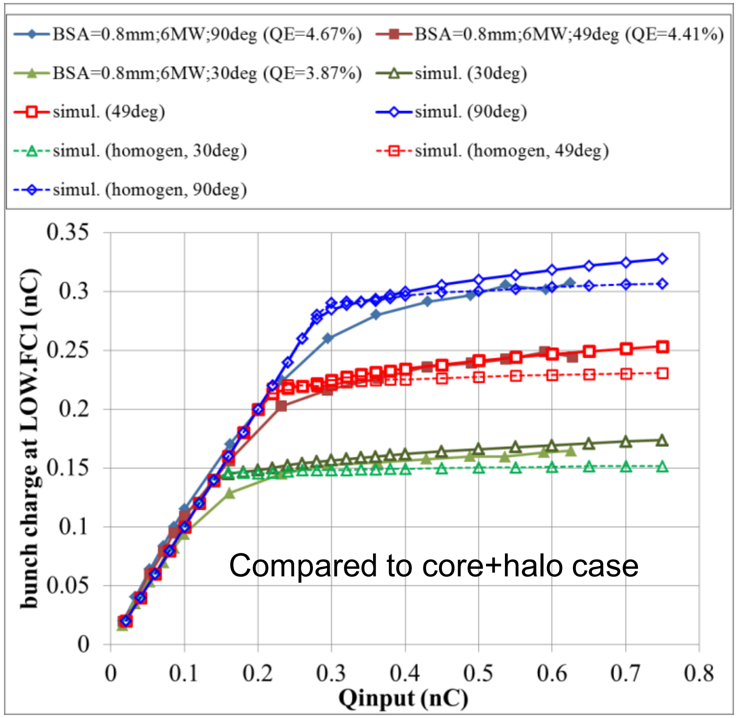


Ecath=58MV/m → better?

LT-scans simulations for the radially homogeneous laser distribution (run8)

•Ecath=59.569MV/m
•σ_t=0.85ps (2ps fwhm)
• Laser transverse (radial homogeneous, XYrms=0.2mm) → no halo

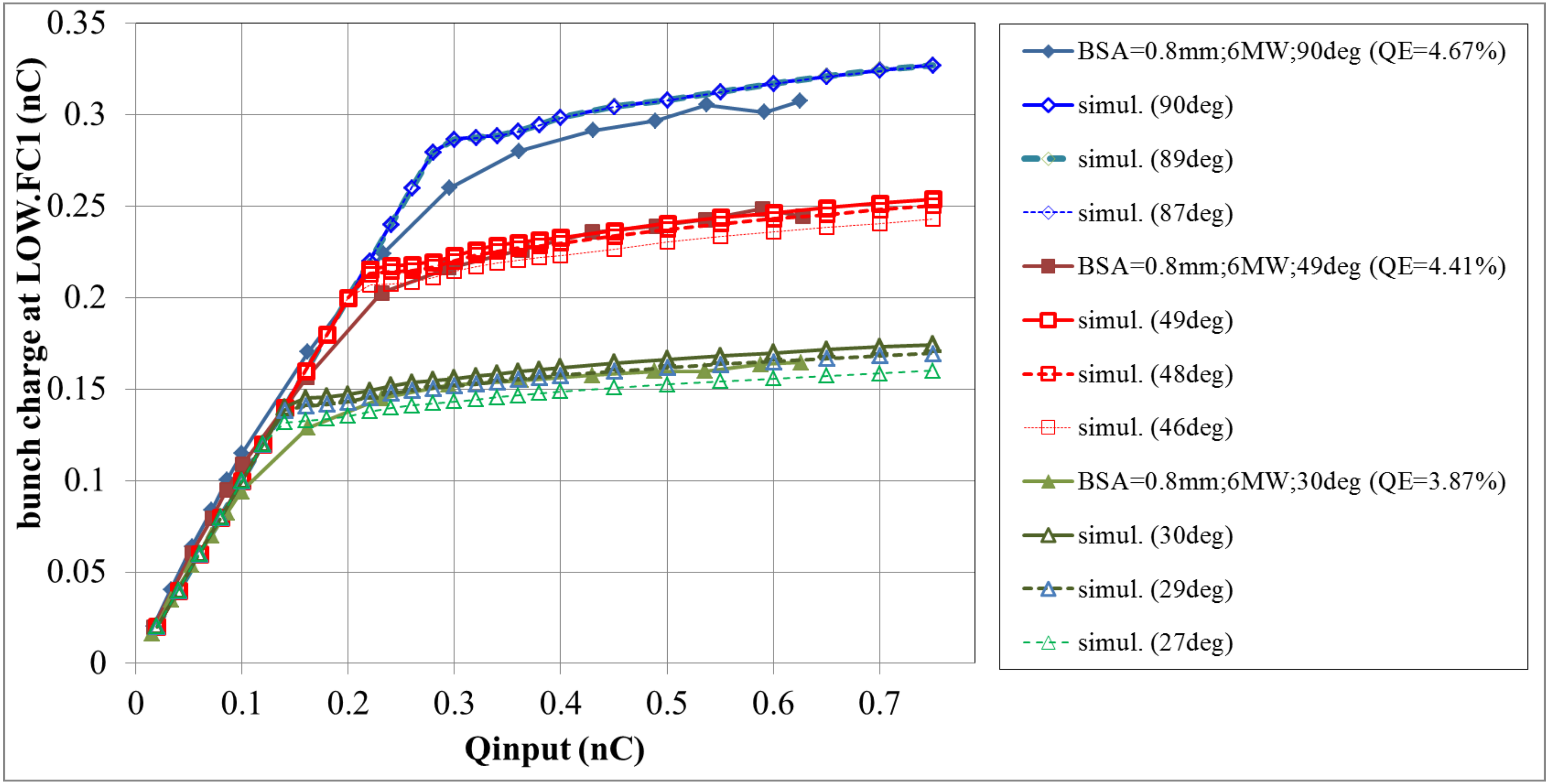




➔ Flat after the saturation

LT-scans simulations for 1 and 3deg (~>zero-crossing) phase offset (runs 9+11)

- Ecath=59.569MV/m
- σ_t=0.85ps (2ps fwhm)
- Laser transverse (flattop core+Gaussian halo, XYrms=0.2mm)



➔ 1 deg:

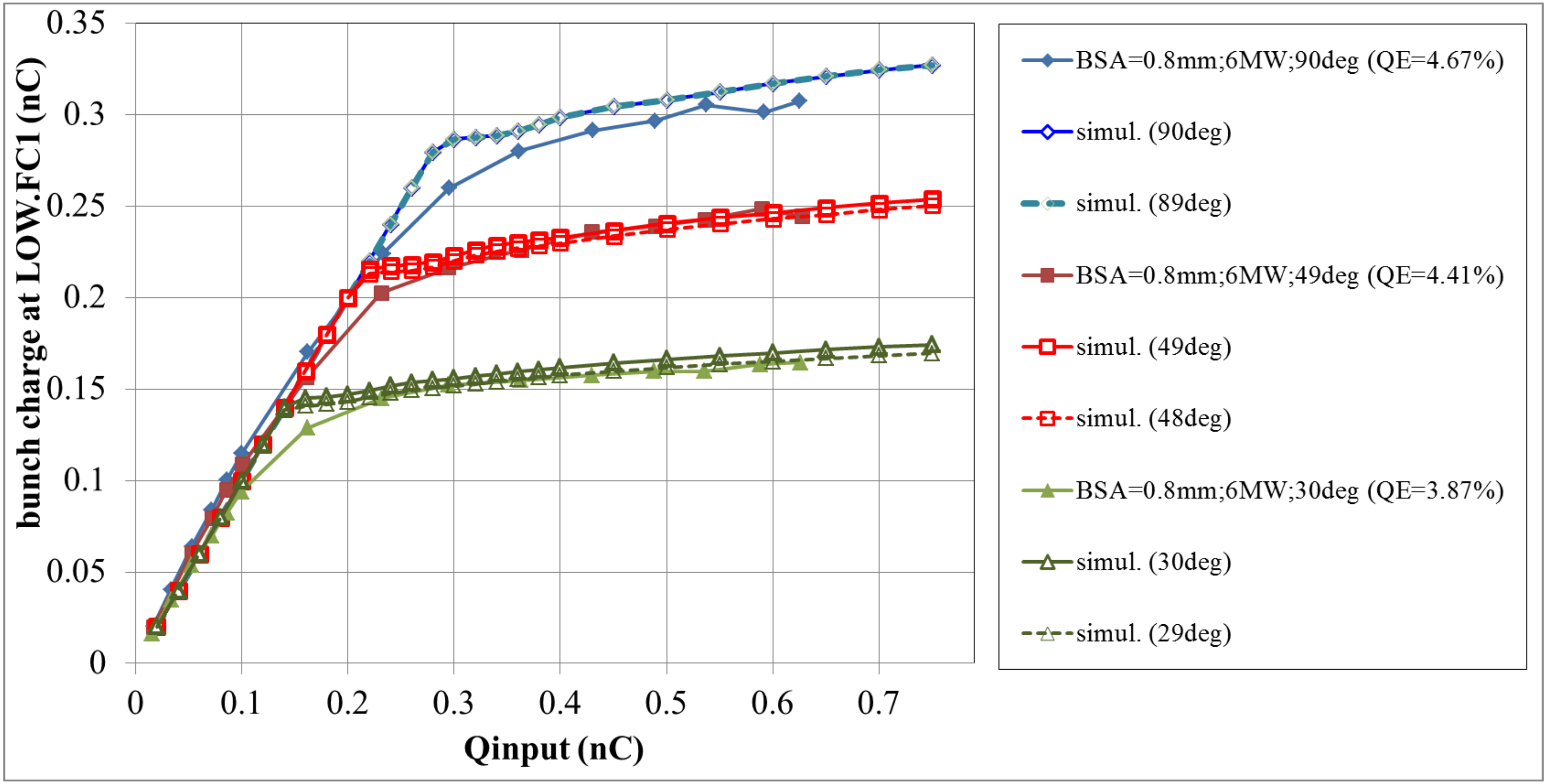
- better agreement for 49 and 30deg
- No difference for 90deg

➔ 3 deg:

- Overestimation for 49 and 30deg
- No difference for 90deg

LT-scans simulations for 1deg (~>zero-crossing) phase offset (run 9)

- Ecath=59.569MV/m
- σ_t=0.85ps (2ps fwhm)
- Laser transverse (flattop core+Gaussian halo, XYrms=0.2mm)

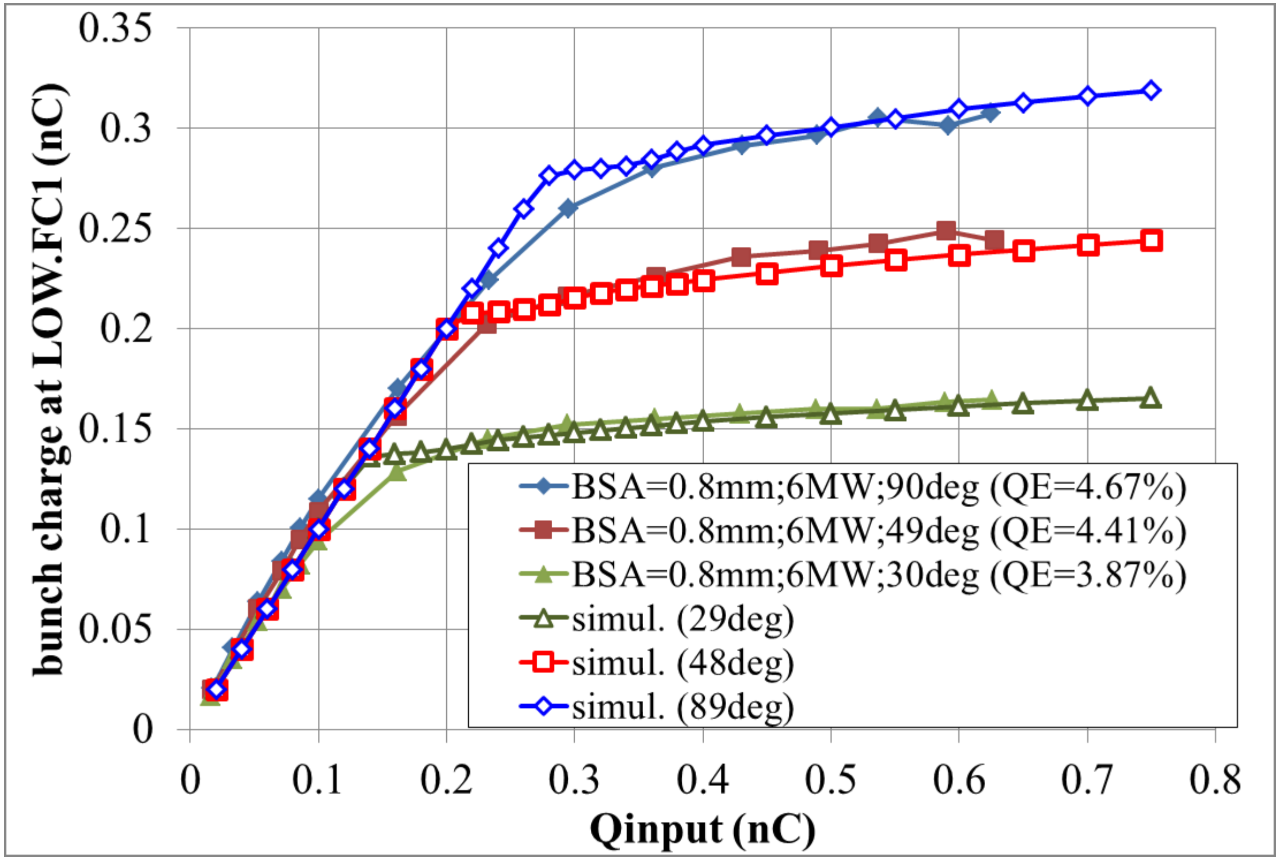


➔ 1 deg:

- better agreement for 49 and 30deg
- No difference for 90deg

LT-scans simulations for 58MV/m and 1deg (~>zero-crossing) phase offset (run 10)

- **Ecath=58MV/m**
- σ_t=0.85ps (2ps fwhm)
- Laser transverse (flattop core+Gaussian halo, XYrms=0.2mm)

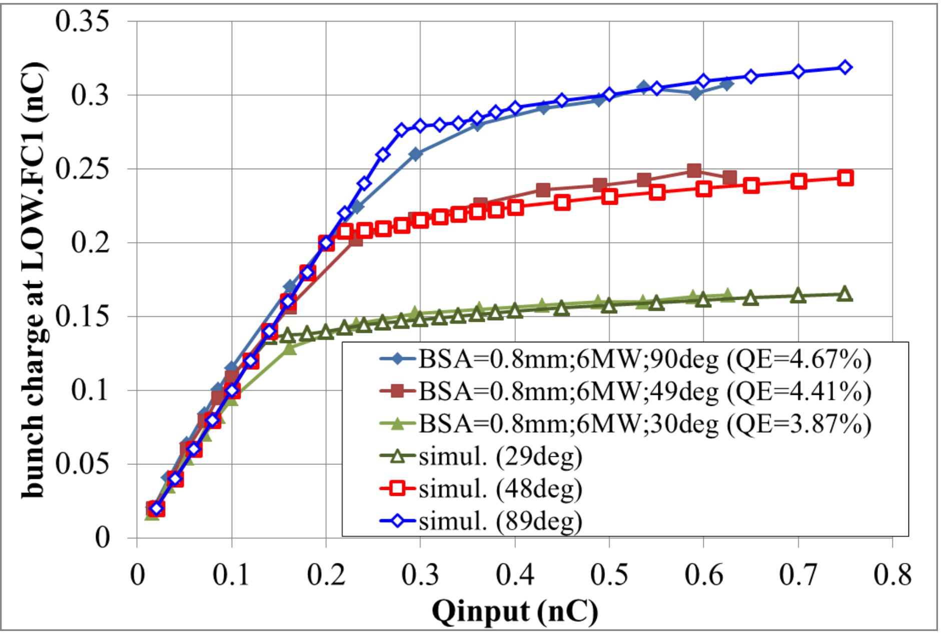


- better agreement for 90deg
- but worse for 49deg
- But the max PZ momentum is by 2.5% less (6.518MeV/c instead 6.681MeV/c)

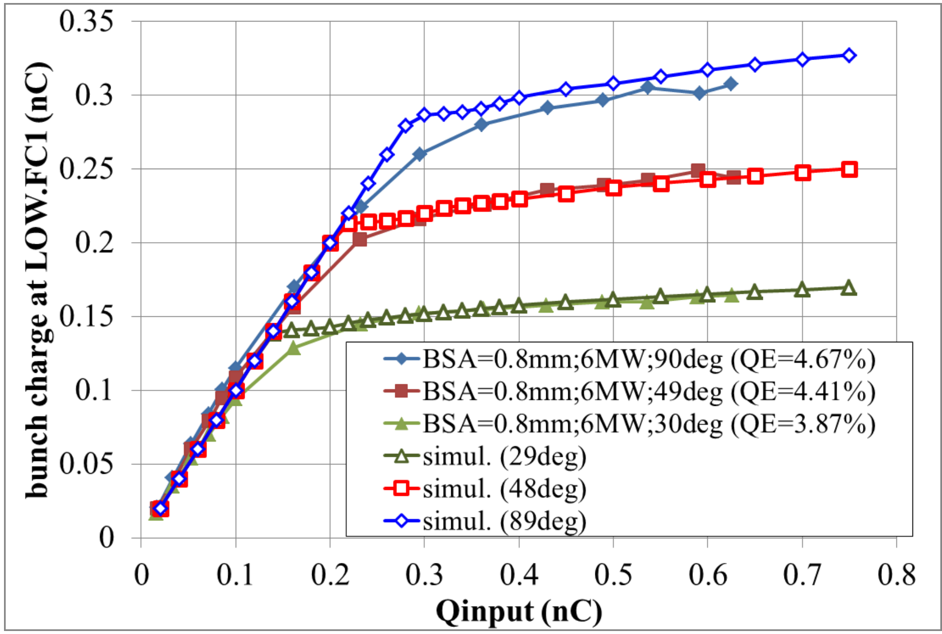
LT-scans simulations 1deg (~>zero-crossing) phase offset (58MV/m vs. 59.569MV/m)

- σ_t=0.85ps (2ps fwhm)
- Laser transverse (flattop core+Gaussian halo, XYrms=0.2mm)

58MV/m



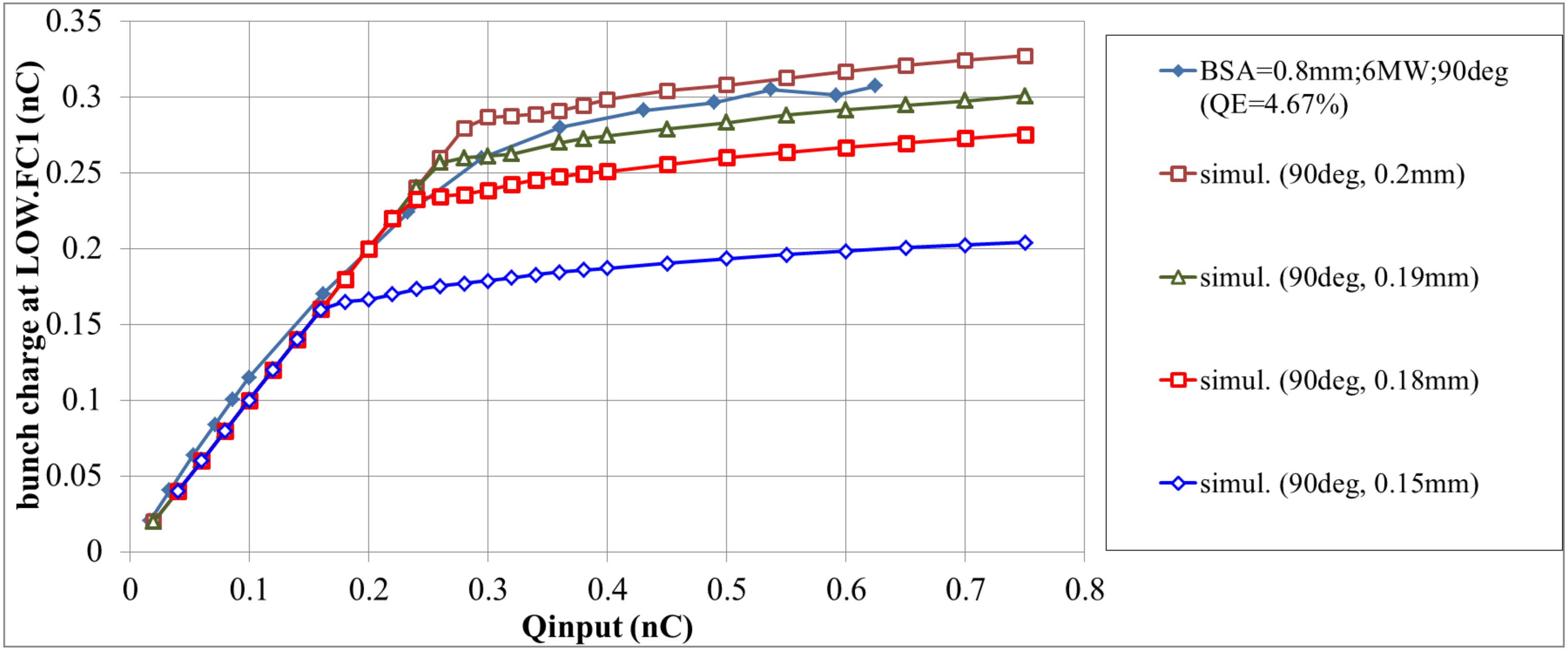
59.569MV/m



- But the max PZ momentum is by 2.5% less (6.518MeV/c instead 6.681MeV/c)

Impact of the cathode transverse rms size (run12)

- Ecath=59.569MV/m
- Gun phase =90deg (AUTOPHASE=OFF)
- Laser transverse (flattop core +Gaussian halo, XYrms=0.2; 0.19;0.18 and 0.15mm)



- It seems that XYrms=0.2mm (default) is the best choice (or 0.195mm?)

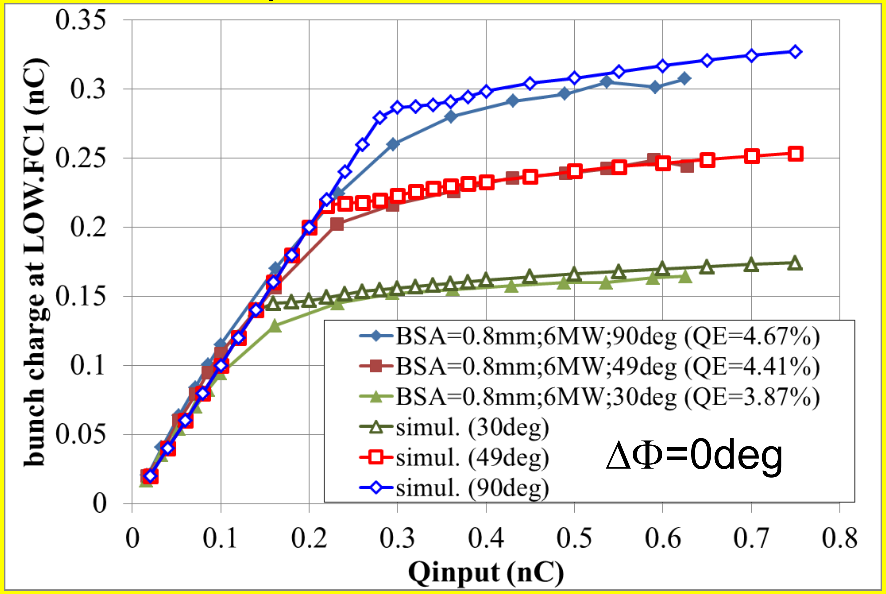
Summary and next steps

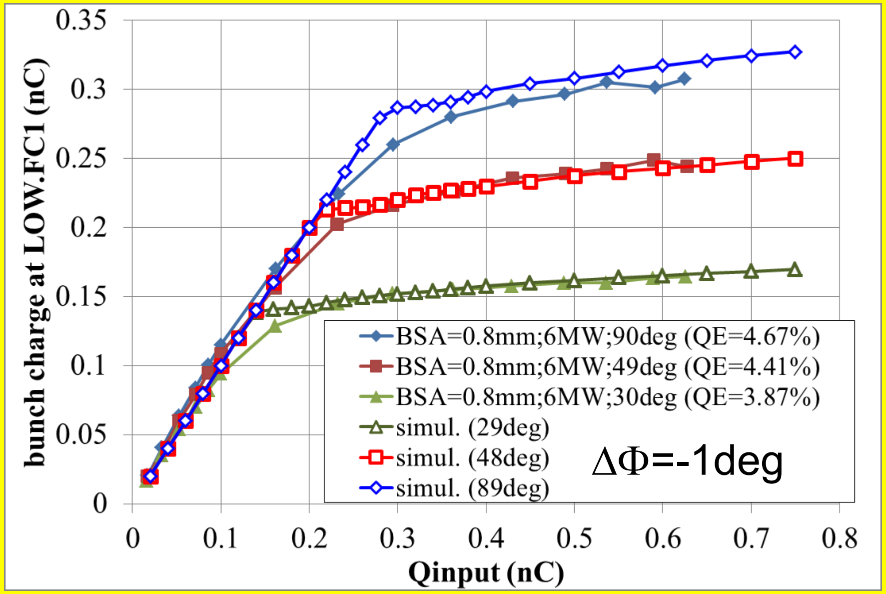
- Fitted:
  - Ecath=59.569MV/m →maxPz=6.681MeV/c at MMMG phase
  - MMMG phase: simulated ➔ 43deg, measured 46.8-1deg. 2deg are still not well-understood
- Gaussian laser pulse length rms (fwhm) → chosen 0.85ps (2.0ps) → better coincidence, especially for 90deg data
- Simulated zero crossing phase → 1deg phase shift + widening of the "reconstructed" laser profile (image space charge effect)
- Transverse distribution (XYrms=0.200mm):
  - Radial homogeneous → flat curves after saturation
  - flattop core + Gaussian halo
  - "real" = ring structure in the core + Gaussian halo → not much improvements
- Calculate coefficient(s) for Qinput for the measured data (Elaser→Qinput), minimum slope yields better coincidence with experimental data (Schottky effect is hardly to be implemented into current version of ASTRA by using the core+halo model)
- Scans for phases 30;49;90deg for charge measured at LOW.FC1 (z=0.8m), solenoid default calibration used Imain=460;470;350A [MaxB(1)=-(7.102e-5+5.899e-4*Imain)] delivered simulations close to the measurements, but still not perfect agreement
- Fine tuning (-1deg phase shift) slightly improves agreement (-3deg is too much)
- Ecath was varied (53;55;58MV/m vs. 59.569MV/m), 58MV/m delivers a bit better agreement, but the max Pz is ~2.5% lower that the measured one
- RMS laser spot size fine tuning does not improve agreement

- Next steps (?):
  - ?Other RF power levels (3.375MW and 1.5MW)
  - ?Another BSA=1.8mm

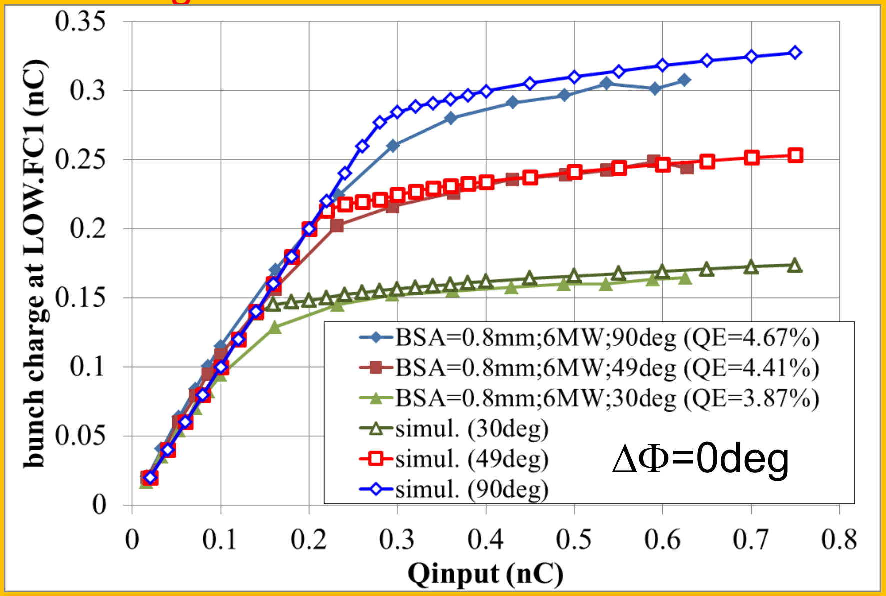
Figure 11b: proposals

flattop core + Gaussian halo





“real” = ring structure in the core + Gaussian halo



“real” = ring structure in the core
+ Gaussian halo
ΔΦ=0deg
→ ongoing

BSA=0.8mm, 1.5MW in the gun