Summer Student intermediate Reports
-PITZ-

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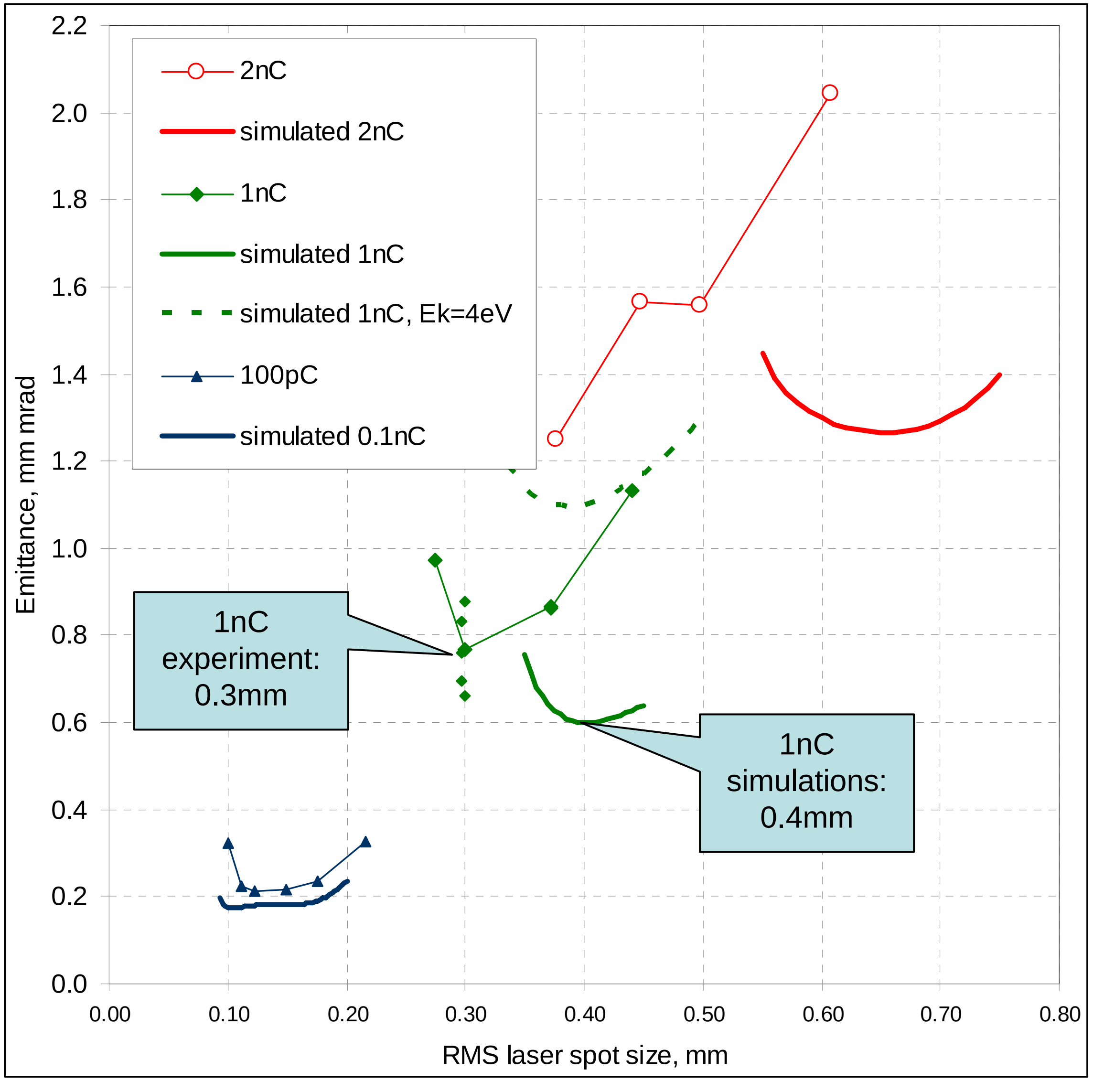
Motivation (1): detailed understanding beam measurements at PITZ

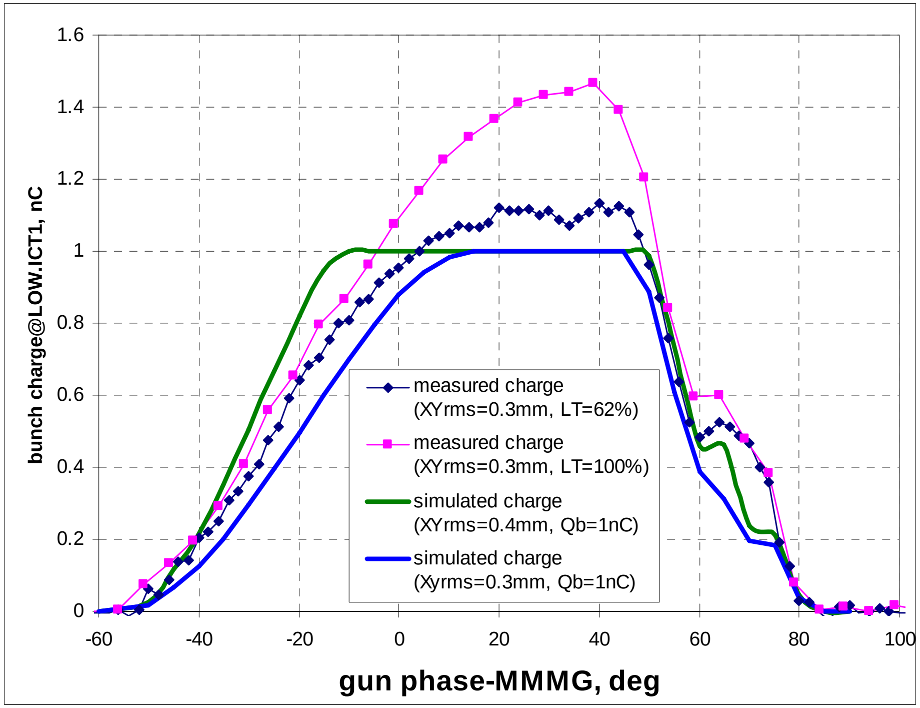
Measured and simulated beam emittance



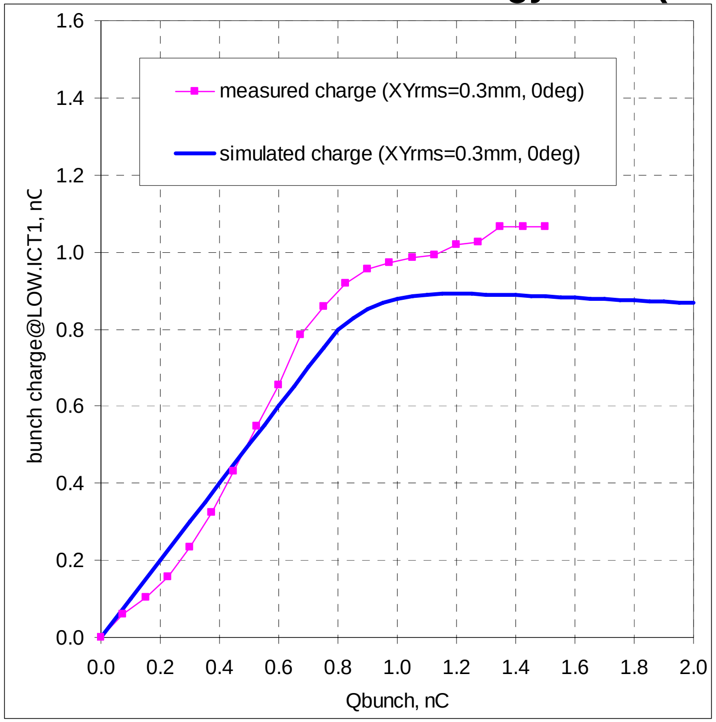
Experimentally obtained optimum laser spot size at the cathode differs from the simulations!

Motivation (2): detailed understanding beam measurements at PITZ

Measured and simulated Schottky scans (1nC)



Measured and simulated laser energy scan (1nC)



- Direct plug-un machine settings into ASTRA does not produce 1nC at the gun operation phase (+6deg), whereas 1nC and even higher charge (1.1nC) are experimentally detected
- Simulated (ASTRA) phase scans w/o Schottky effects (solid thick lines) have different shapes than the experimentally measured (thin lines with markers)

- Laser transmission (LT) scan for the operation phase (pink curve with markers) shows higher saturation level, whereas the simulatted charge even goes slightly down while the laser intensity (Qbunch) increase

Reasons of the discrepancy? ➔ **emission**

Goal: ASTRA simulation of the experimental phase scans

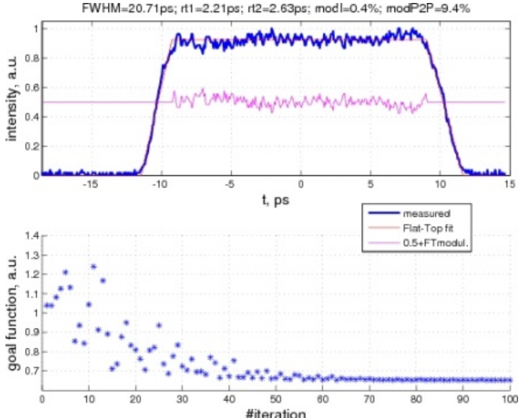
The Schottky effect describes the lowering of the work function or electron affinity of a material by an external electric field, which leads to an increased electron emission from a cathode. In *Astra* the charge of a particle is determined at the time of its emission as:

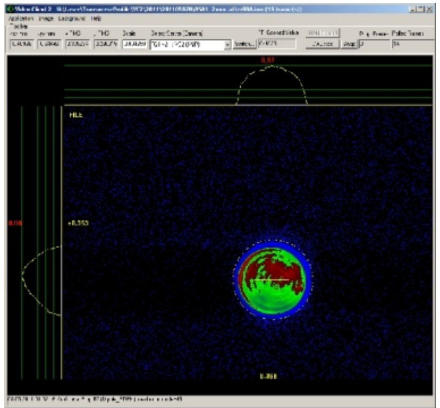
$$Q = Q_0 + Srt\_Q\_Schottky \cdot \sqrt{E} + Q\_Schottky \cdot E$$

where *E* is the combined (external plus space charge) longitudinal electric field in the center of the cathode.

The charge *Q0* is the charge of the particle as defined in the input distribution (eventually rescaled according to the parameter *Qbunch*) and *Srt_Q_Schottky* and *Q_Schottky* describe the field dependent emission process.

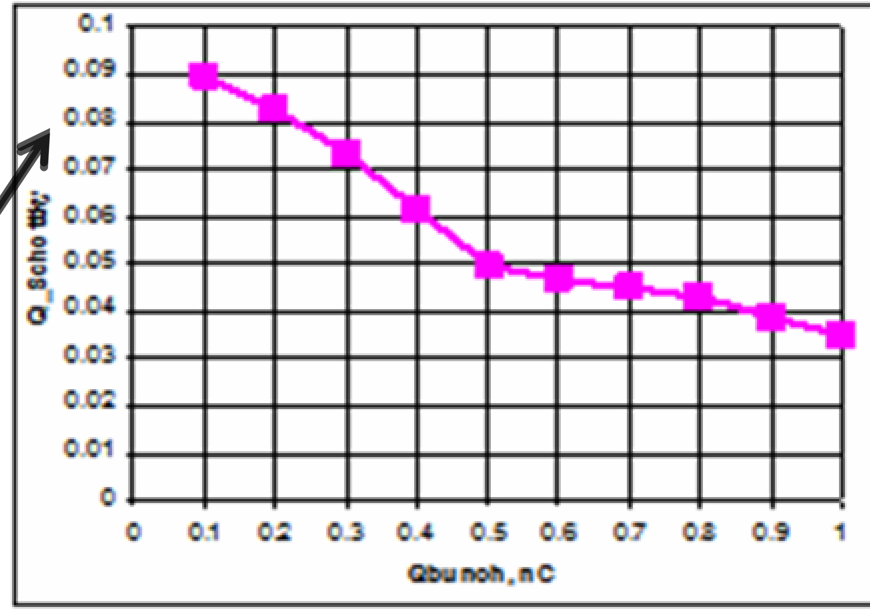
Another possible source of the discrepancy is the uncertainty of the cathode laser pulse measurements: transverse distribution (rms size and halo) and temporal profile

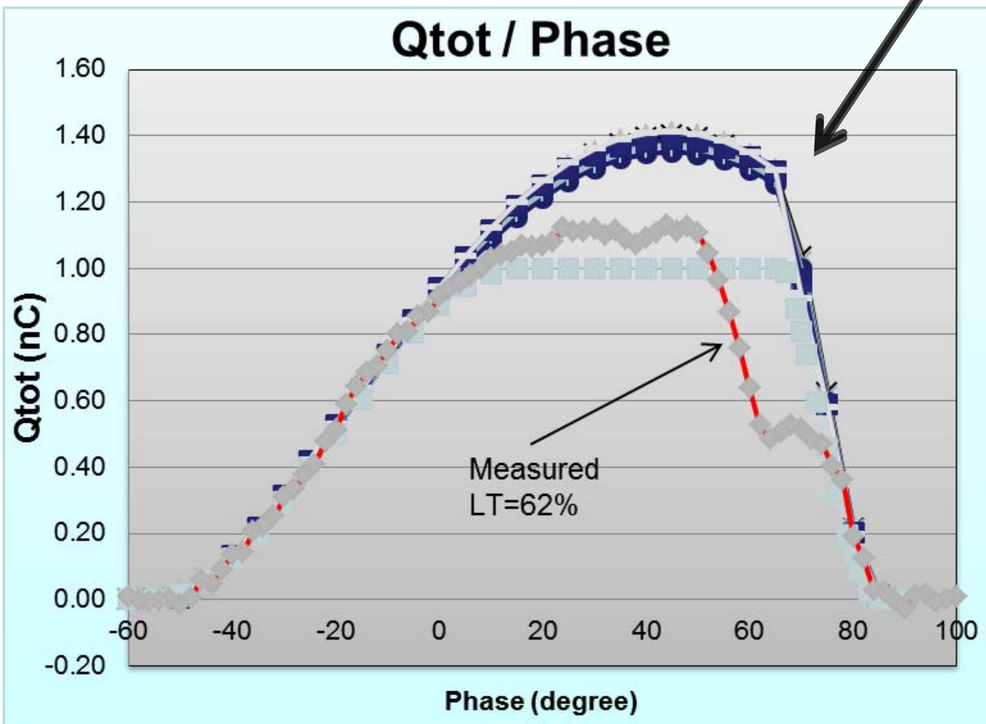


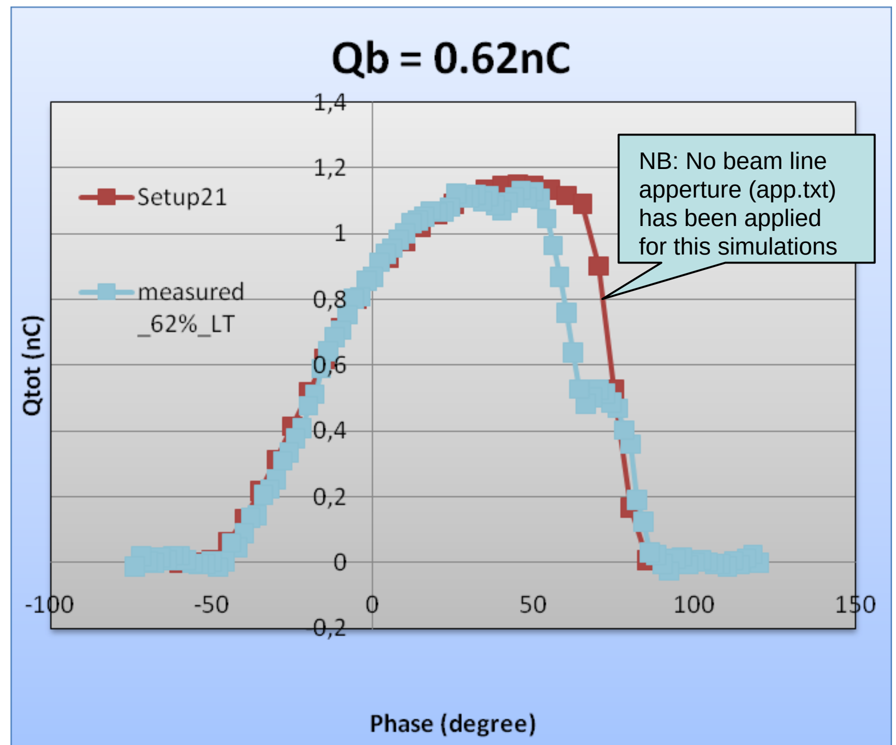


What I've done?

- ASTRA getting involved
- First results from ASTRA



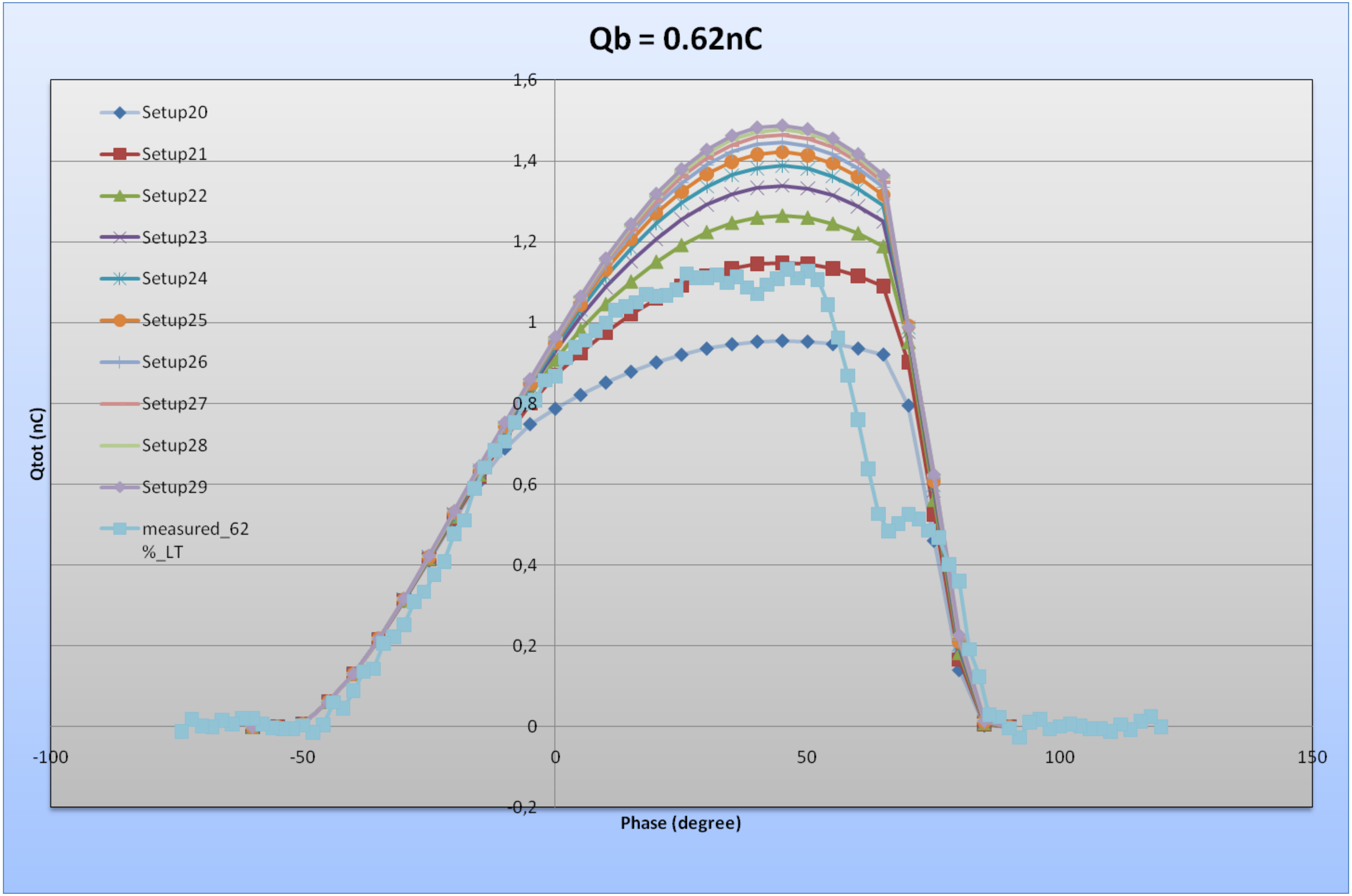




SETUP21
- Qbunch=0.62nC
- Q_Schottky=0.02 nC/(MV/m)
- SRT_Q_Schottky=0
- XYrms = 0.3mm

Keep Qbunch=0.62nC constant

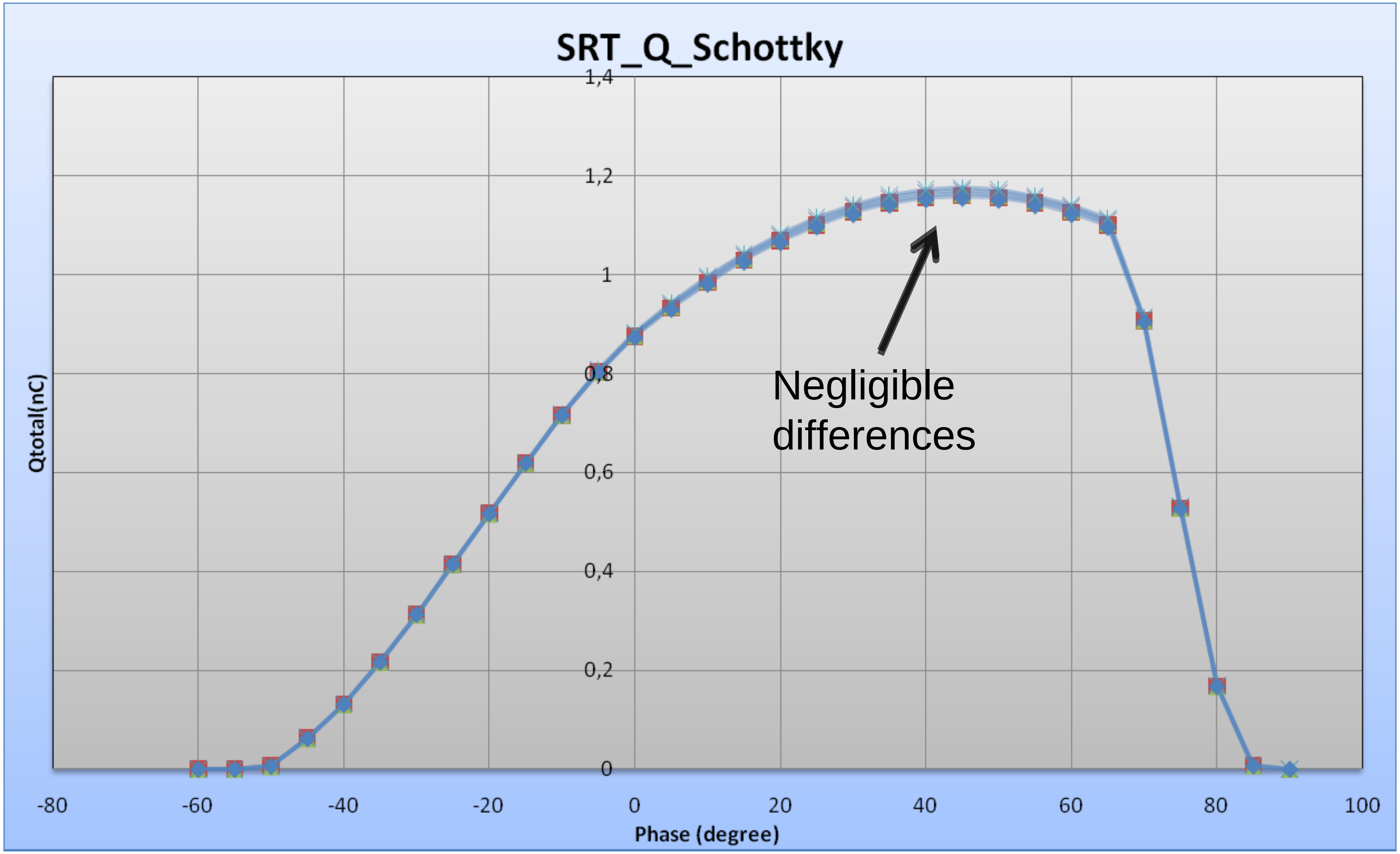
Q_Schottky=[0.01 : 0.01 : 0.1] nC



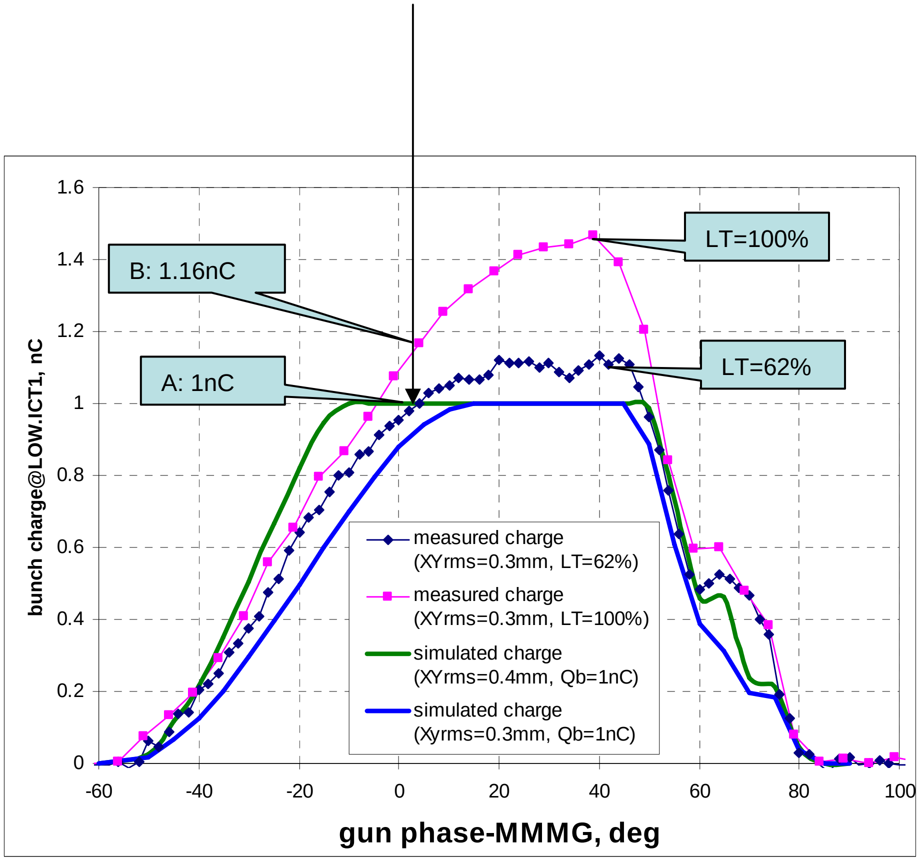
What about **SRT_Q_Schottky** parameter?

Q_bunch = 0.62 nC
Q_Schottky=0.02 nC } constant

SRT_Q_Schottky=[0.002 : 0.002 : 0.01]

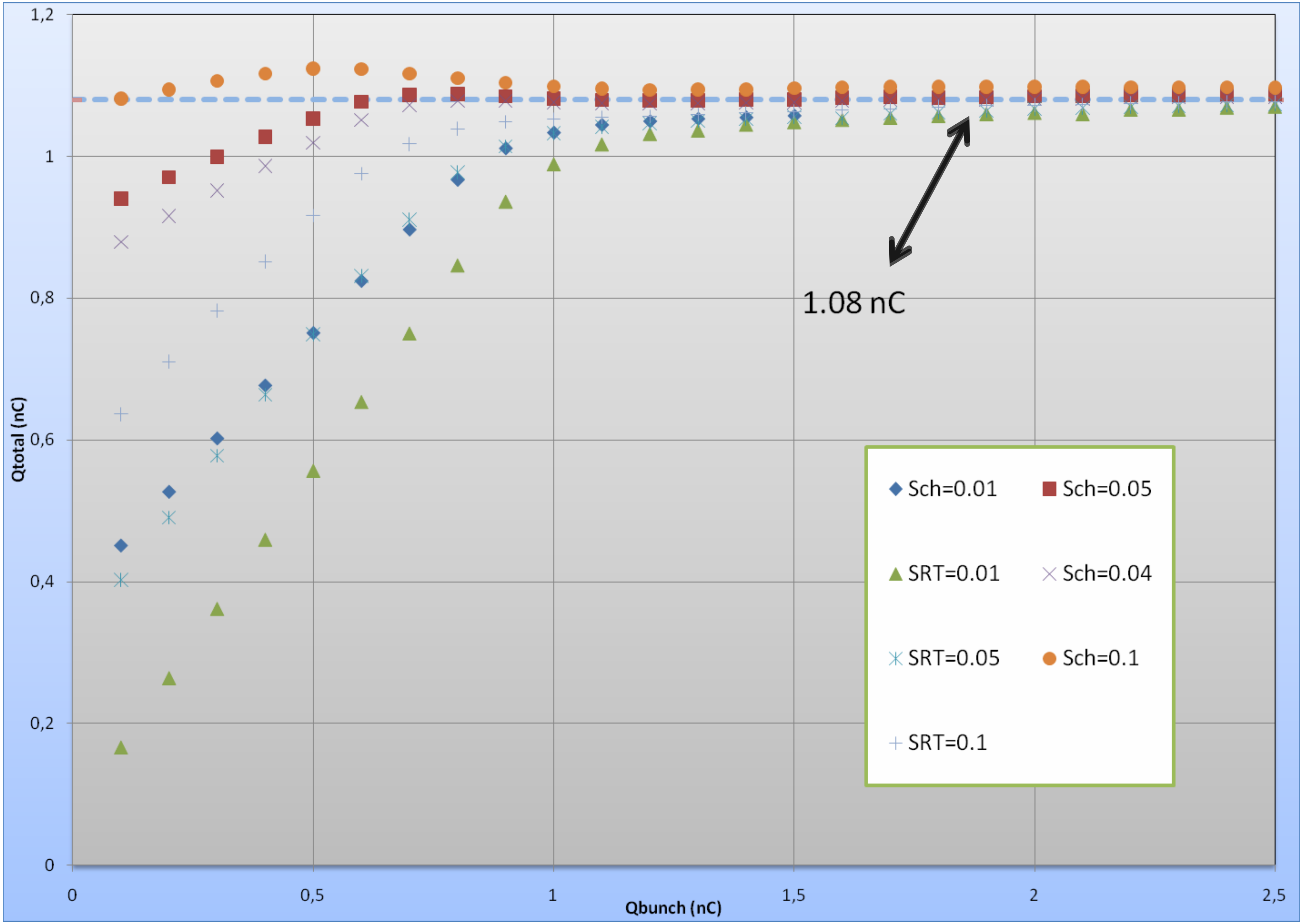


Idea: Qbunch scan at operation phase



$$Q_{simulated}(Q^*_{bunch}) \to 1nC$$

$$Q_{simulated}\left(Q^*_{bunch} \cdot \frac{100\%}{62\%}\right) \to 1.16nC$$


1,2
1
0,8
0,6
0,4
0,2
0
Qtotal (nC)
0
0,5
1
1,5
2
2,5
Qbunch (nC)
1.08 nC
Sch=0.01
Sch=0.05
SRT=0.01
Sch=0.04
SRT=0.05
Sch=0.1
SRT=0.1

NEW TASKS

- <u>Understand</u> the behavior of **Schottky Effect**.
- <u>Understand</u> the reasons of the **emission discrepancy.**
- **Simulate** and grasp using ASTRA to deepen in **Photoemision** procces.
- Prepare my **report**.
- *Personal Tasks:*
  - **Learn** and **enjoy** this experience at DESY.