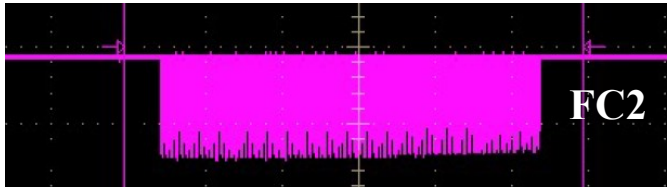
Emission Studies at PITZ

Studies of Charge Pulse Train:

Preparation and Preliminary Results

- **Motivation and Goals**
- **Preparation: (old-) data analysis + plans**
- **Preliminary Results**
- **Further Steps**

500 pulses in operation (~0.5nC/pulse)
Gun: 6.5 MW, 650 us



PPS Seminar at PITZ
Control Room 18.08.2016

HELMHOLTZ ASSOCIATION

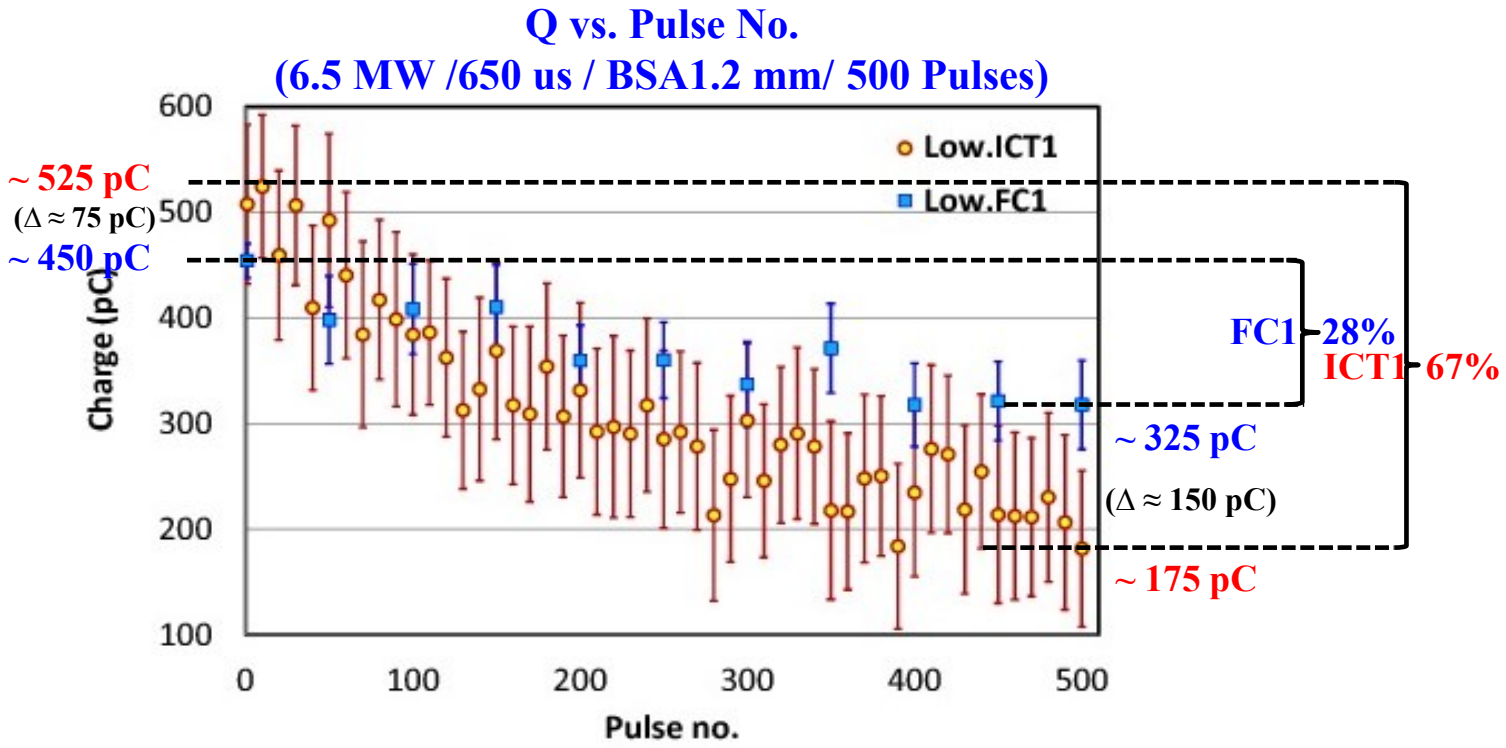
DESY

Motivation and Goals

- **Motivation: Requests from FLASH**
- **Goals**
  - **To understand charge extraction behaviors along a train of pulses**
  - **To experimentally (or numerically) model the emission process**

Preparation: (old-) data analysis + plans

- **Previous measurements: 12.07.2016**



Parameters:

Q measured at Low. ICT1 and Low. FC1
NoP = 500, Pgun = 6.5 MW, PL = 650 us
MMMG at -128^0
BSA = 1.2 mm, LT = 29.8%

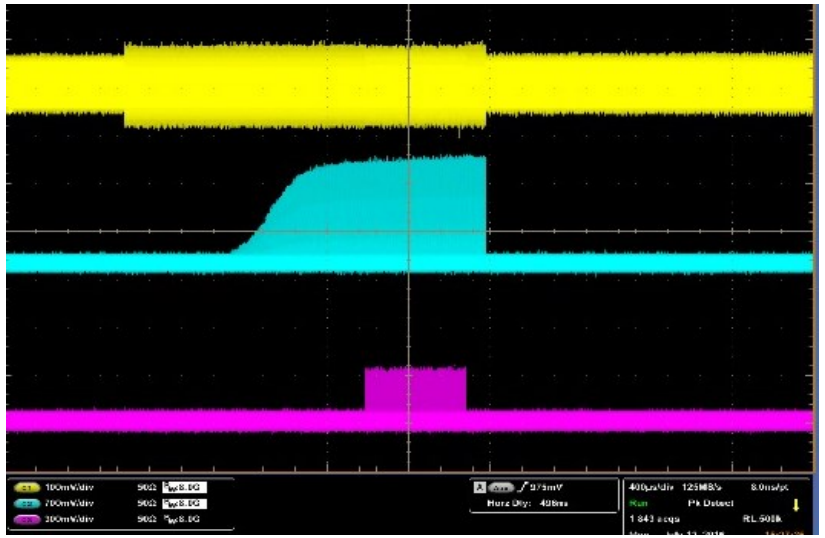
Observations:

1. Q decreases along the train, true for Low. ICT1 and FC1
2. Effect stronger for ICT1

Preparation: (old-) data analysis + plans

- **Possible explanations**
  - Laser output flat? → flat
  - Bump induced by scope trigger?
    → only observed for ICT1, Not for FC1!
  - Phase stability? → ±?
  - Space charge effects at cathode? → shielding?
  - Thermal lensing? → spot size varies

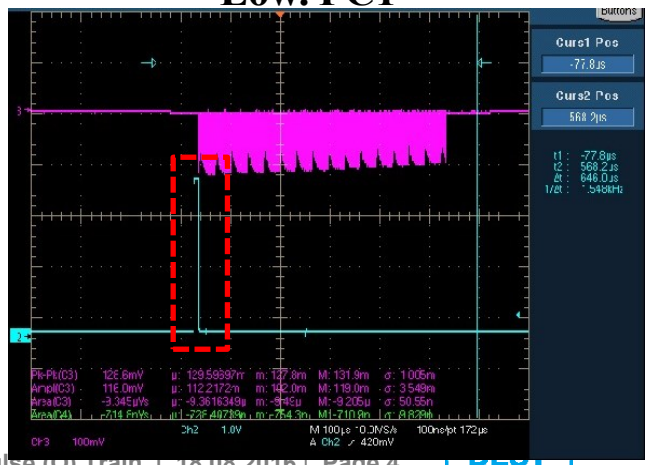
Previous measurements: 11.07.2016
Laser Pulse after adjustment



Previous measurements:
Snapshots from Scope
12.07.2016

Low. ICT1

Low. FC1



Preparation: (old-) data analysis + plans

- **Plans for new measurements**

  - Stable gun operation: 6/6.5 MW, 650 us
  - Check flatness of laser output (500 pulse train)
  - Check instruments for Q measurements: ICTs and FCs
  - Q measurements at MMMG for selected pulses #1, 10, 20, 50…500 from a 500-pulse train by adjusting the scape trigger timing
  - Schottky scans for selected pulses along the Q train
  - Momentum scans for selected pulses along the Q train

- **Setups + Parameters**

1. **Q-train measurements: 15.08.2016 MK, YC, MG, CS**

   BSA=1.2 mm (Xrms=272um, Yrms=289um), **LT = 15%,**
   Imain = 390 A, Using LOW. **FC2** and LOW. **ICT1**
   6 MW, 650 us, NoP = 500

2. **Q-train measurements: 16.08.2016 MK, YC**

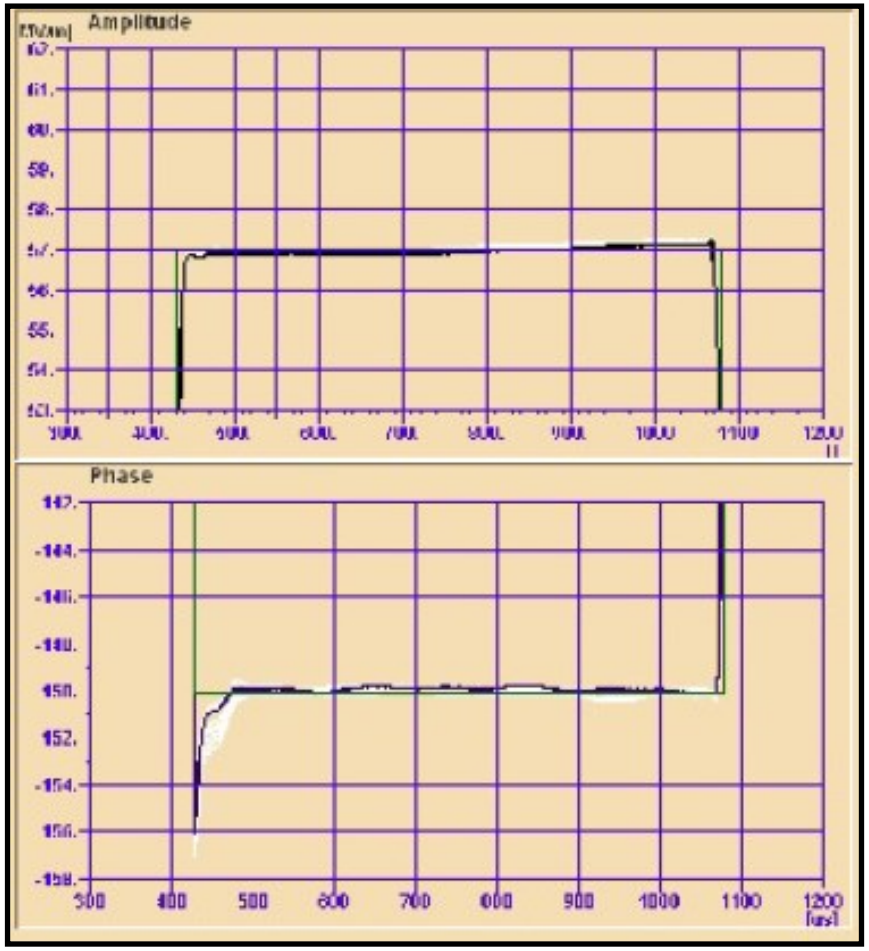
   BSA=1.2 mm (Xrms=271um, Yrms=291um), **LT = 50%,**
   Imain = 417 A, Using LOW. **FC2**
   6.5 MW, 650 us, NoP = 500

Preliminary Results

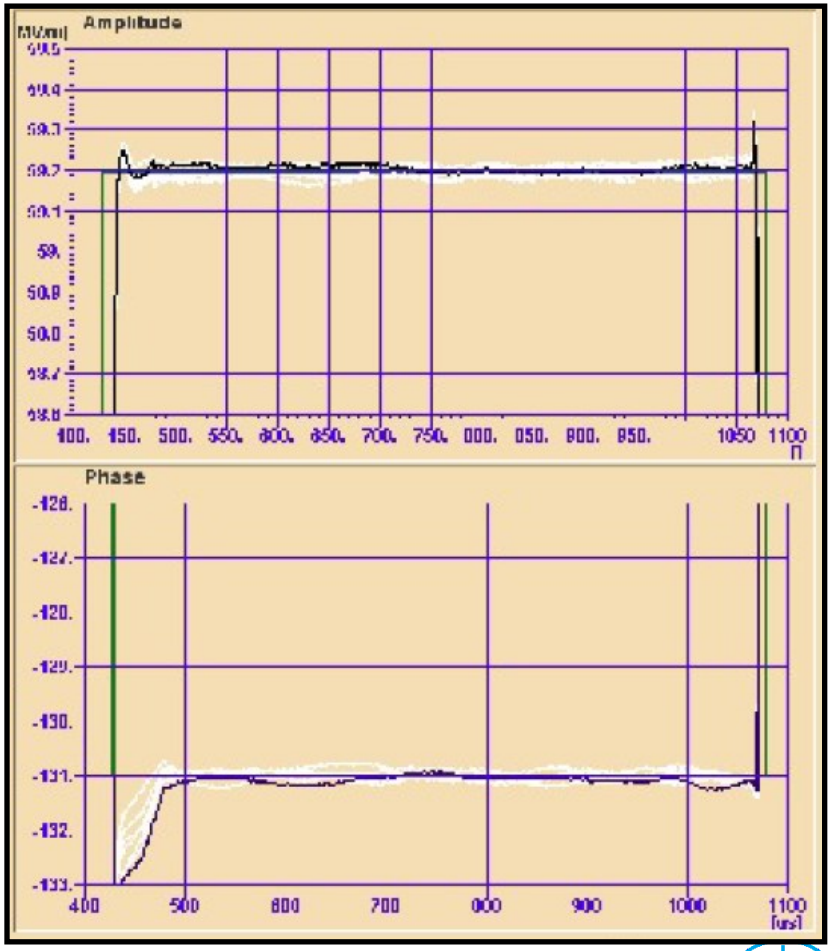
Gun in Operation

RF gun amplitude an phase profiles are rather flat

15.08.2016

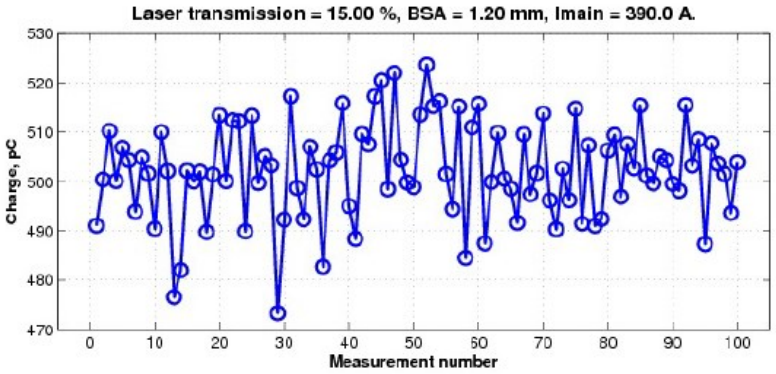


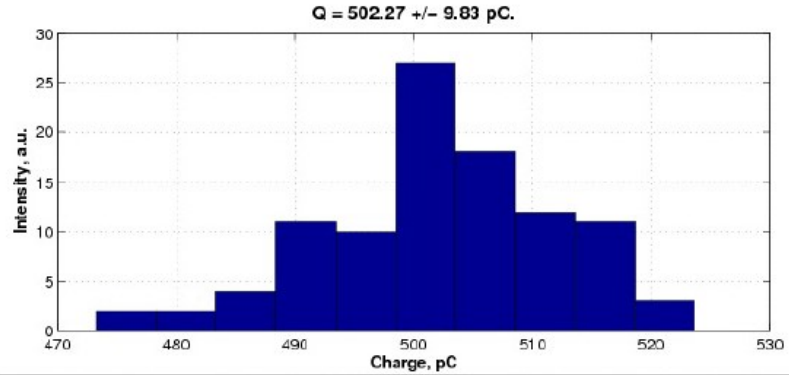
16.08.2016



Q measurements for the same bunch: ICT1 vs. FC2

Q ≈ 502pC using FC2

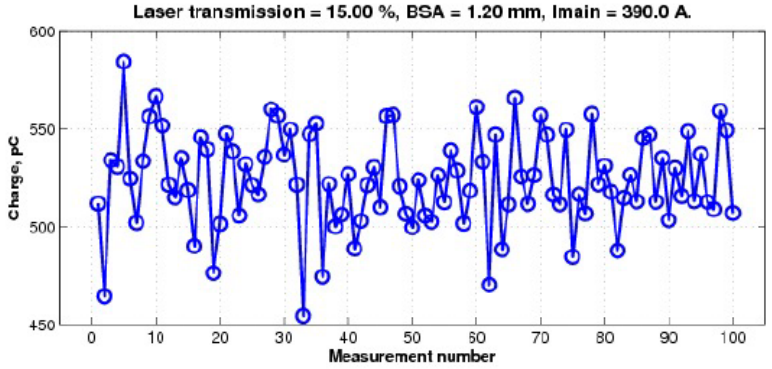


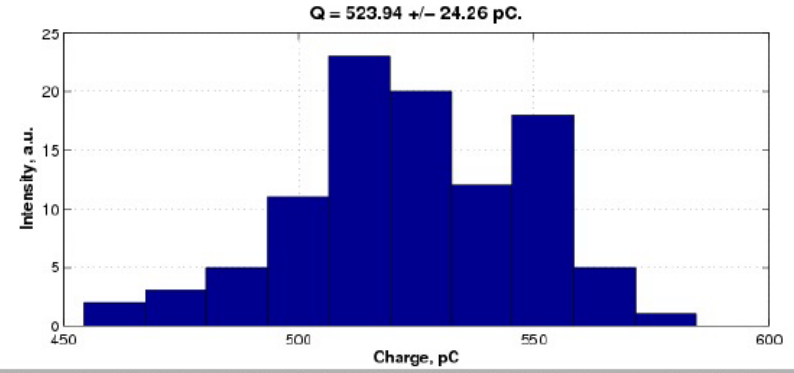


Data saved to /doocs/measure/ChargeMeasurements/2016/20160815M/charge_1244.txt
Charge measurement using Low.FC2.

File: http://pitzlb.ifh.de:8080/PITZelog/data/2016/33/15.08_M/2016-08-15T12:45:32-00.ps

Q ≈ 523pC using ICT1





Data saved to /doocs/measure/ChargeMeasurements/2016/20160815M/charge_1246.txt
Charge measurement using Low.ICT1.

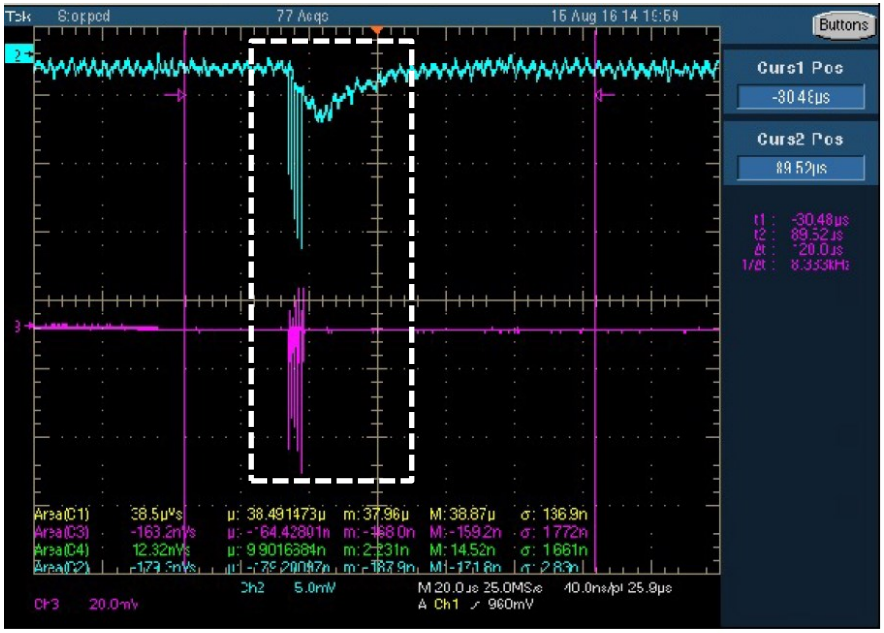
File: http://pitzlb.ifh.de:8080/PITZelog/data/2016/33/15.08_M/2016-08-15T12:47:11-00.ps

500 pC bunch: ICT1 is about 20 pC higher than FC2
1000 pC bunch: ~40 pC -> consistent?

Bump Signal for ICTs

laser shutter open

LOW.FC2 (pink) and LOW.ICT1 (cyan)



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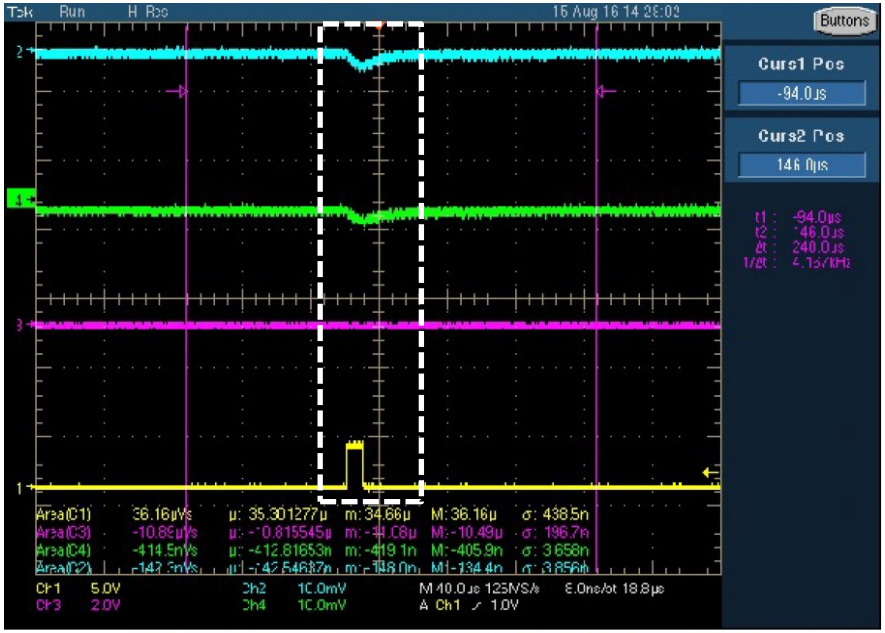
Bump observed for ICTs, not for FC2

laser shutter closed

LOW.FC2 (pink), LOW.ICT1 (cyan), HIGH1. ICT1 (green)



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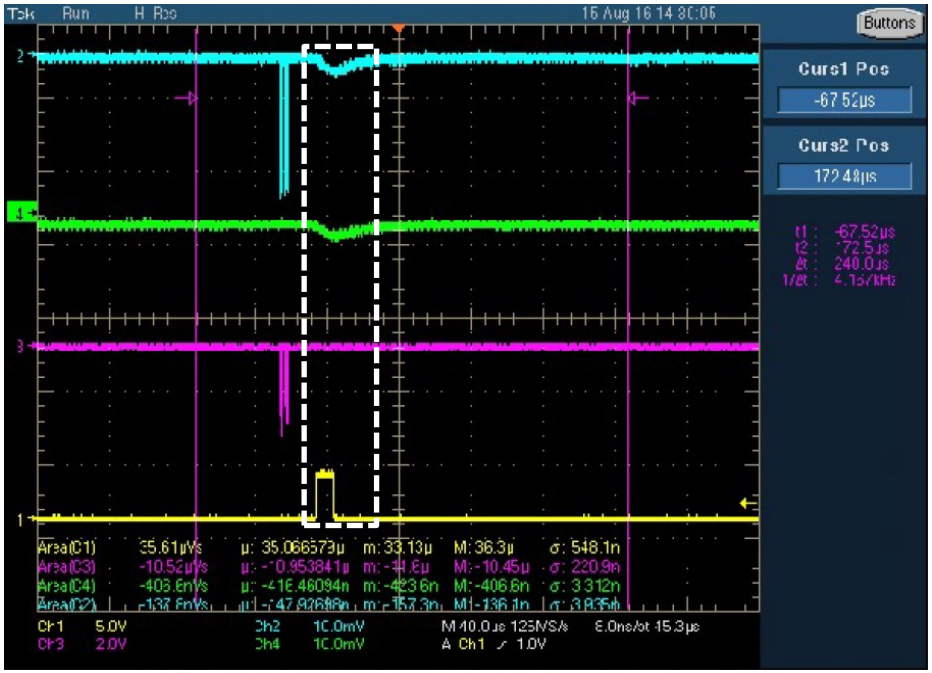
Bump still there when no beam

Bump Signal for ICT

Shifting scope trigger timing by -30 us

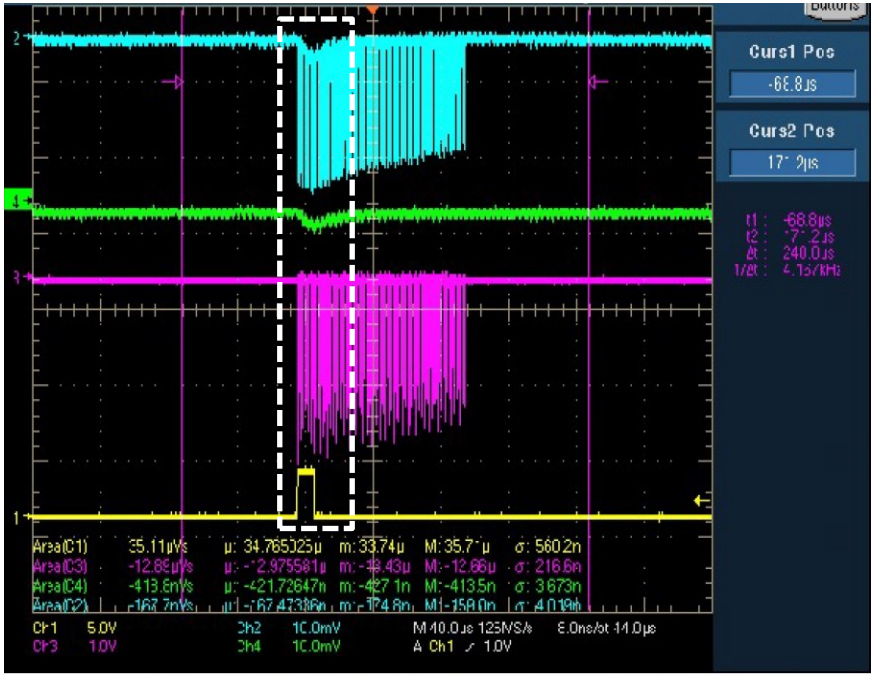
LOW.FC2 (pink), LOW.ICT1 (cyan), HIGH1. ICT1 (green)



File: http://pitzlb.ifh.de:8080/PITZelog/data/2016/33/15.08_M/2016-08-15T14:38:29-00.ps

Snapshot of 100 pulses

LOW.FC2 (pink), LOW.ICT1 (cyan), HIGH1. ICT1 (green)



File: http://pitzlb.ifh.de:8080/PITZelog/data/2016/33/15.08 M/2016-08-15T14:44:58-00.ps

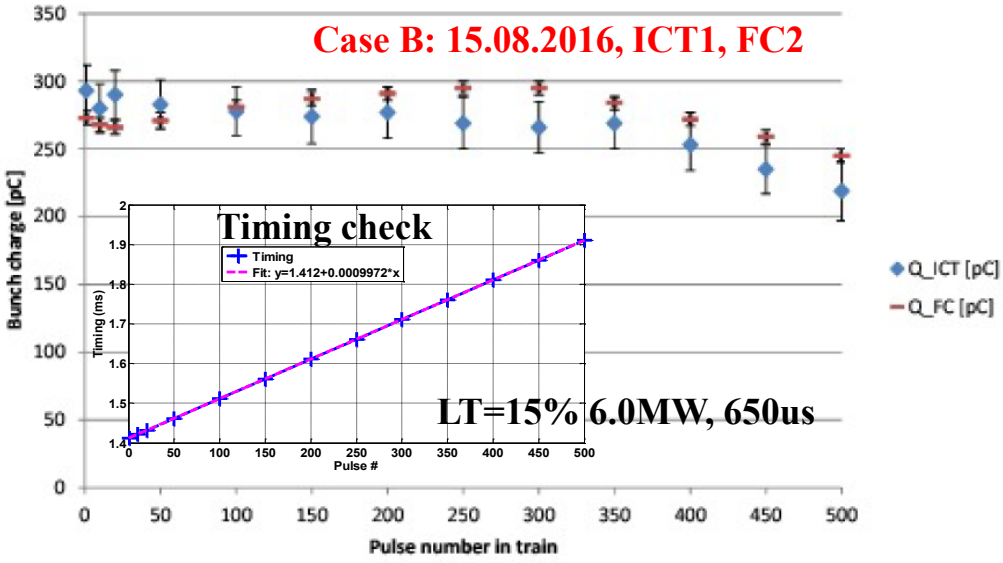
Bump still there when beam is shifted away
→ caused by the trigger?

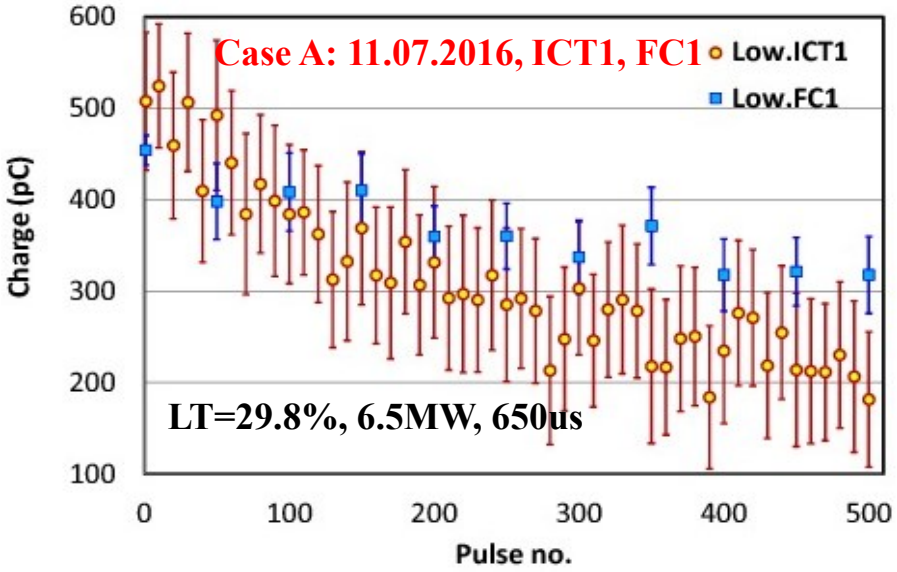
FC seems ok in this case
→ Use FC2 for Q-train measurements

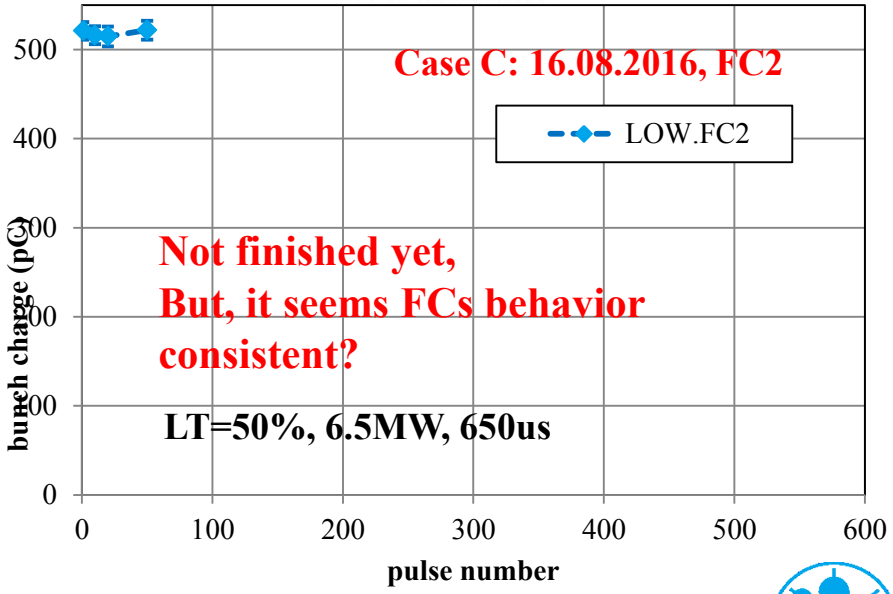
Q measurements for selected pulses along Q train at MMMG

BSA=1.2 mm, 500 Pulses

Q drops along the pulse train (head vs. tail)

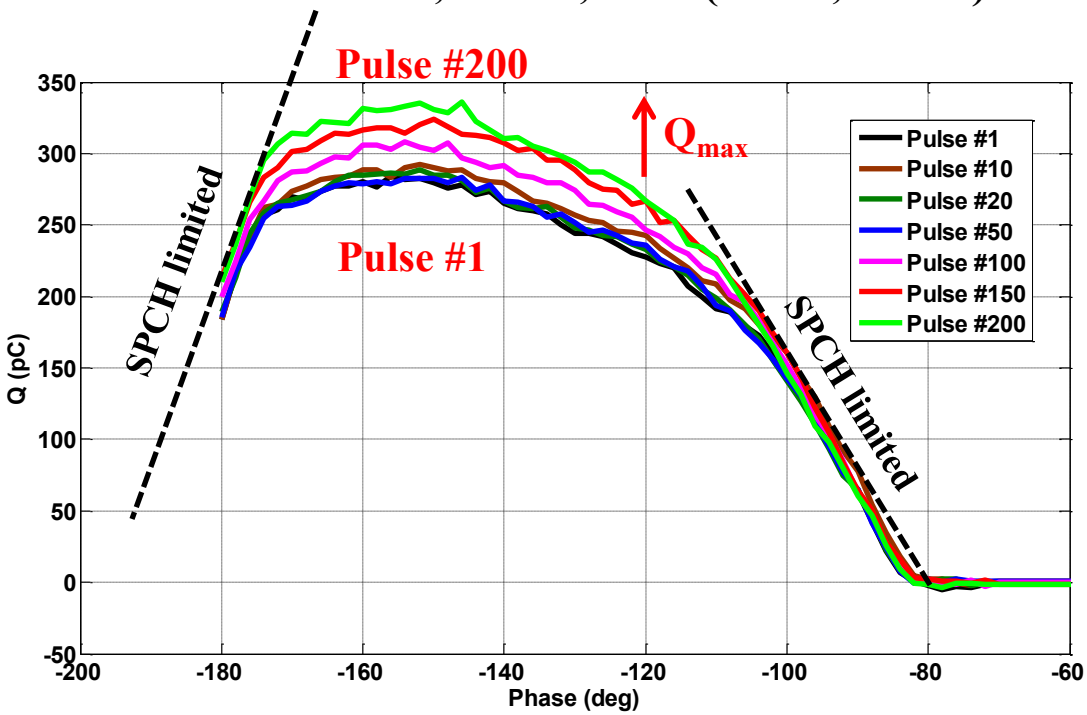






Schottky scans for selected pulses along Q train

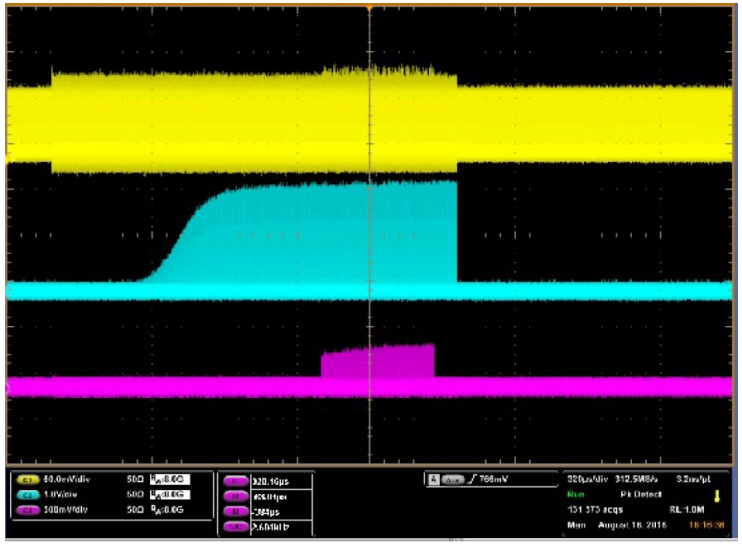
Case B: 15.08.2016, ICT1, FC1 (6MW, 650us)



Maximum extractable Q is increasing along the pulse train from pulse #1 to pulse #200

Corresponding laser signals

Shift: UV pulse train is slightly rising (probably influence of thermal lensing)



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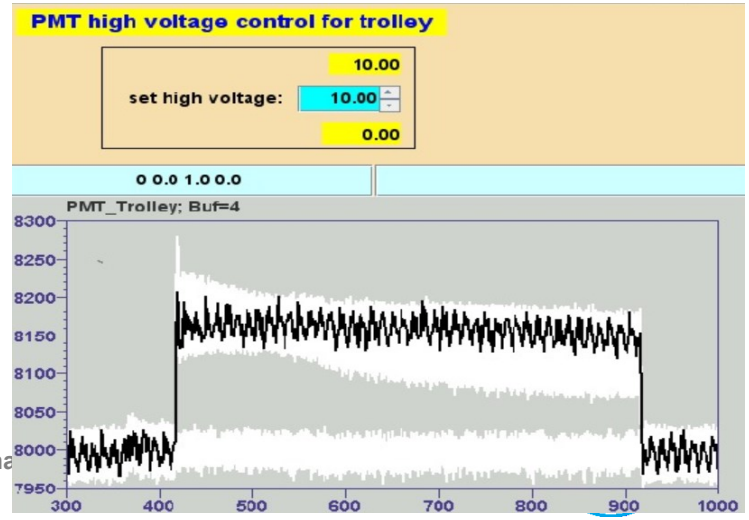
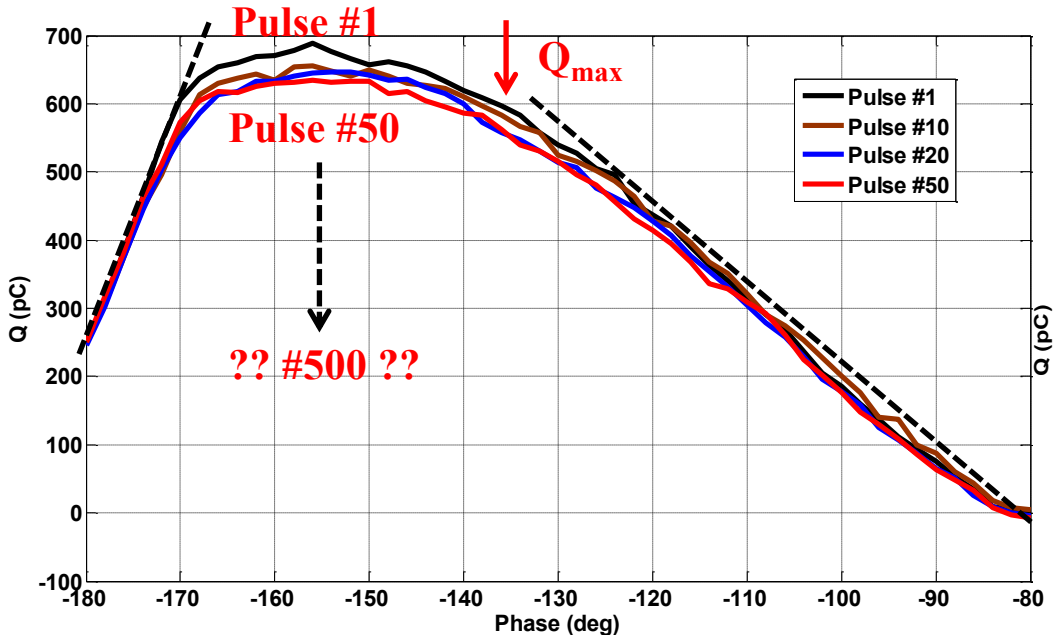
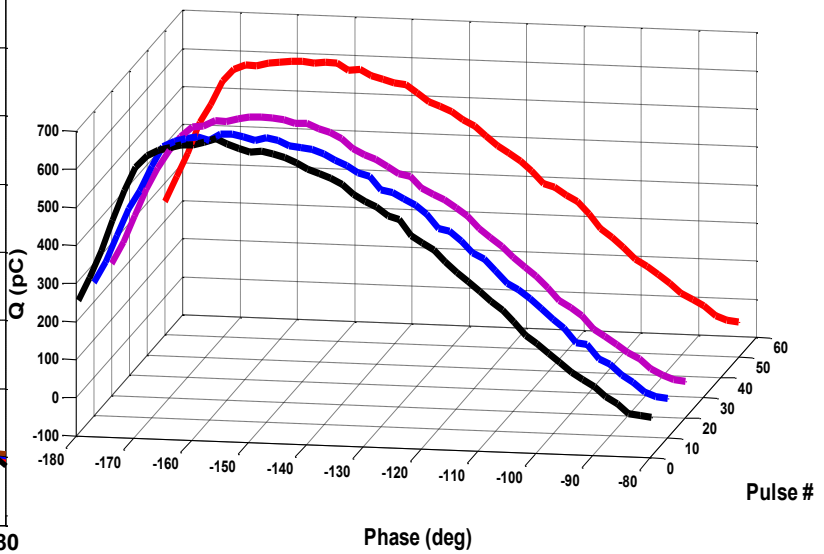


Schottky scans for selected pulses along Q train

Case C: 16.08.2016, FC2 (6.5MW, 650us)





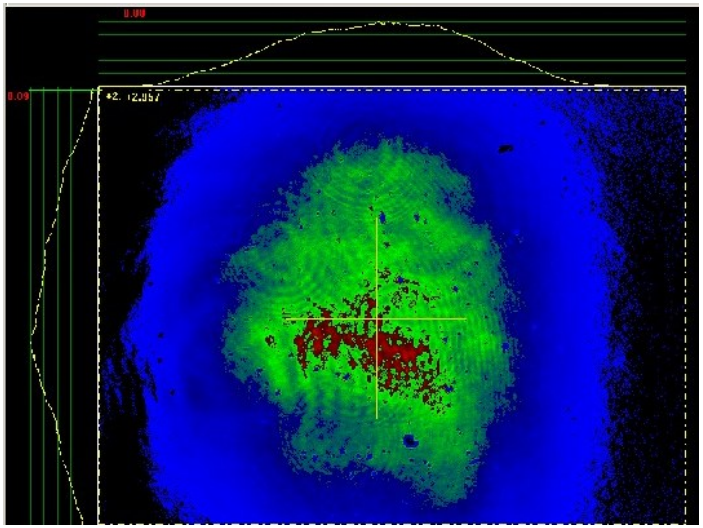
Maximum extractable Q is decreasing along the pulse train from pulse #1 to pulse #50
-> Space charge?
-> Surface states: recombination time involved?

Other issues during Q train measurements

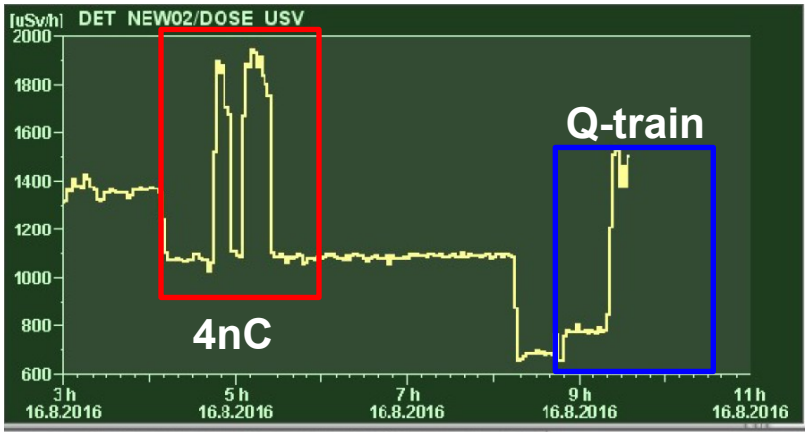
1. Radiation and damage

15.08.2016
Shift: no damage by use of long pulse trains

Laser at VC2, open aperture



16.08.2016
Shift: 2 peaks from the night shift(4nC x max 25 pulses)
now: 500 pulse x 0.5nC



2. Scripts

(1) Phase scan gui script was interrupting with this error (ttfr problem)
(2) Q measurement matlab script crashed several times during shifts

File: http://pitzlb.ifh.de:8080/PITZelog/data/2016/33/16.08_M/2016-08-16T09:35:08-00.ps