MAX-PLANCK-INSTITUT
FÜR PHYSIK

Electron Bunch Length measurements in 2022

Giovanni

2022 measurements

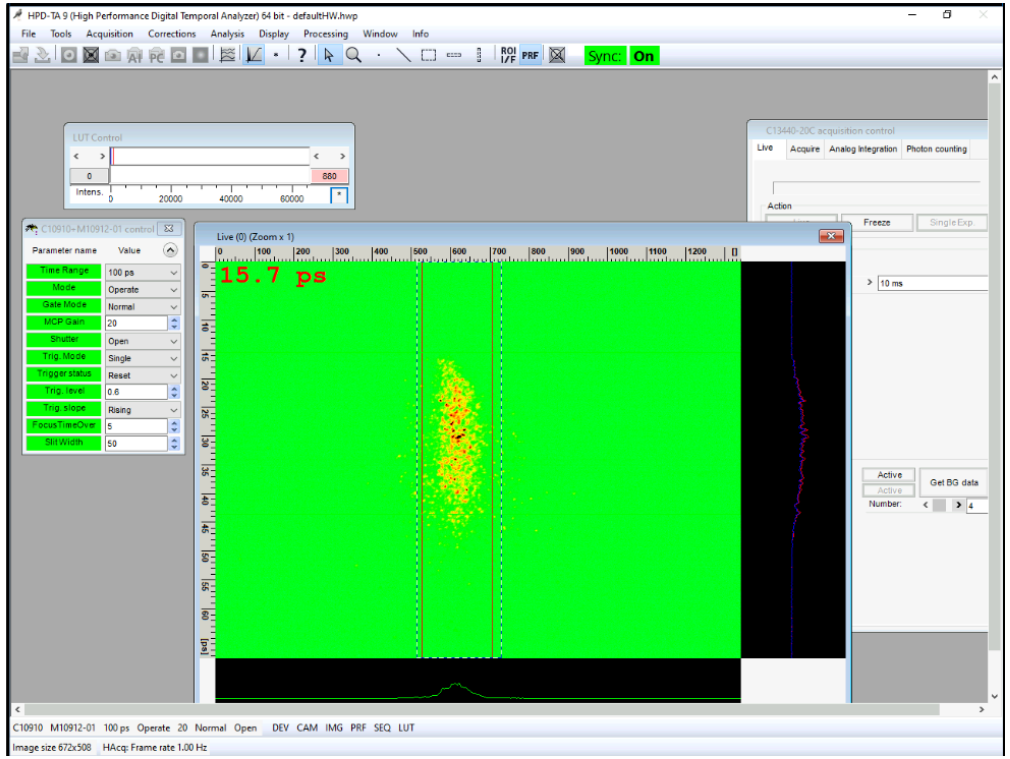
- Upstream streak camera was replaced in June 2022, improving light yield
- Measurements in July-November 2022 performed with Livio
  - Electron beam focused at BTV350, trajectory/focus adjusted using Basler next to streak
  - 30-06-2022, 19-07-2022, 19-08-2022, 31-10-2022, 19-11-2022, 24-11-2022
  - Data recorded in H5 files

- Notes:
  - Length estimates are based on gaussian fits of individual events
  - Analysis: /user/awakeop/electron_beam_setup/streak_waterfall_UPSTREAM_new.py
  - No correction for resolution, which should be subtracted
    - 18 pixels / sqrt(N_photoelectrons) based on Kaan Oguzhan, et al. For example 4 pixels (~0.5ps) when getting 20 photoelectrons.

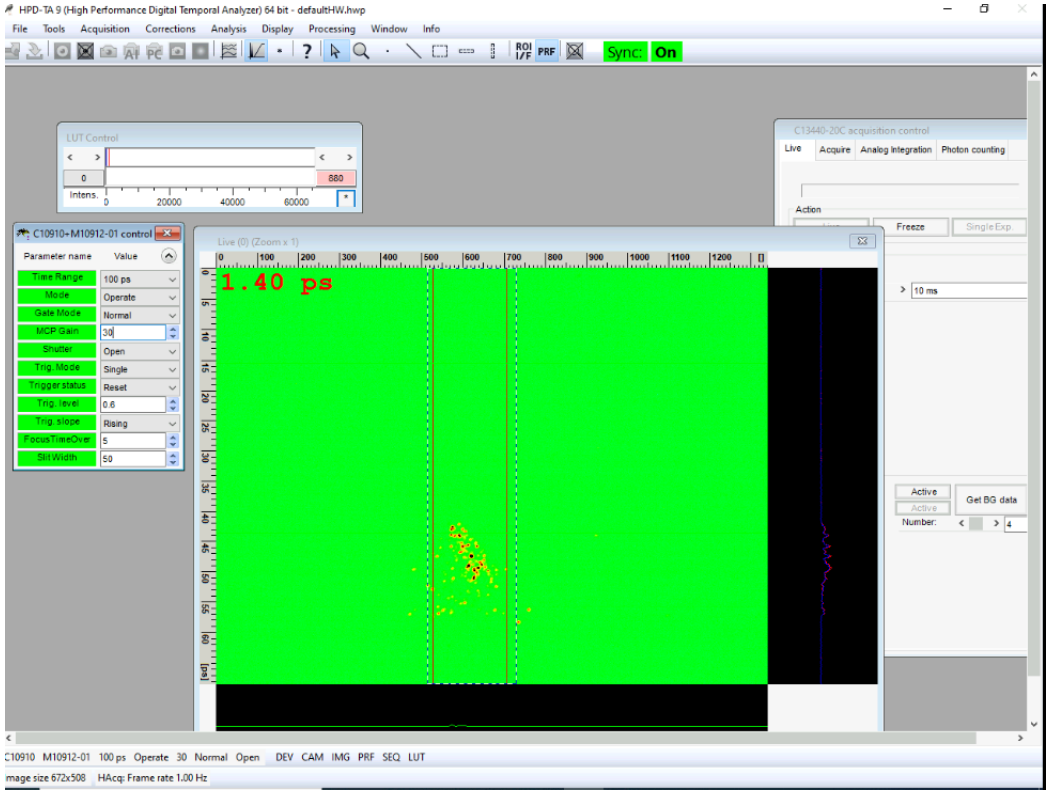
30-06-2022

Say hello to our new streak camera

Electron bunch length from ONE shot



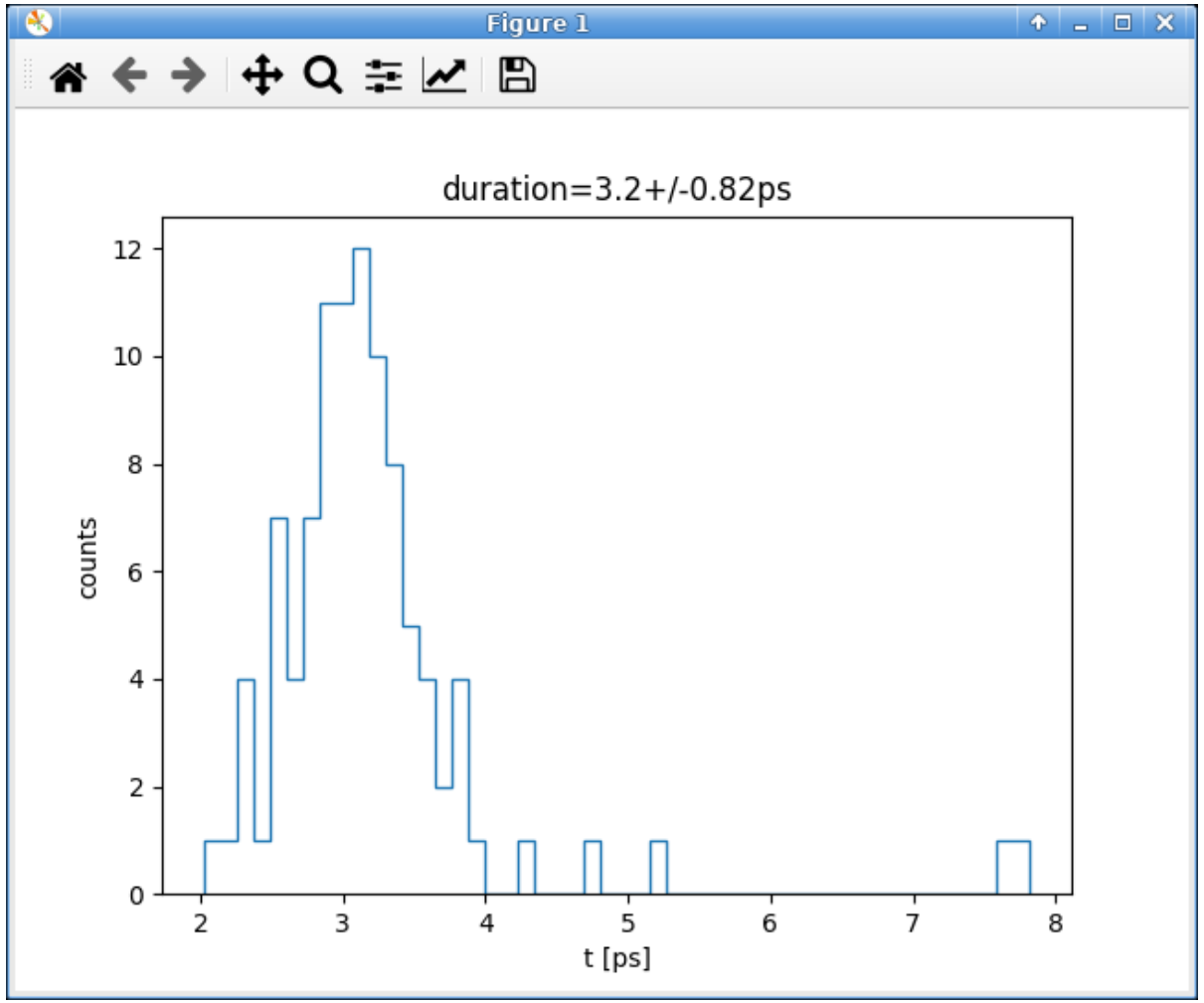
Added a band pass filter, increase MCP to 30



19-07-2022, 250pC: 3.2 ± 0.8 ps

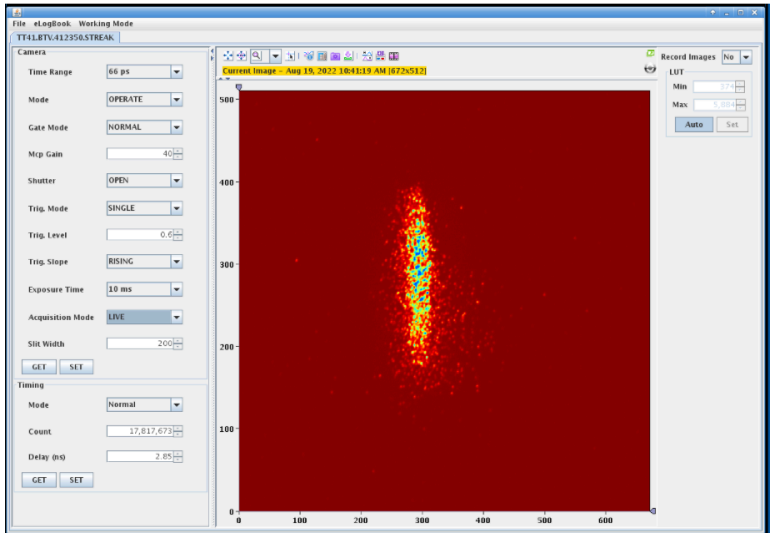
Electron bunch length data in Run 191

Histogram of ~100 measurements

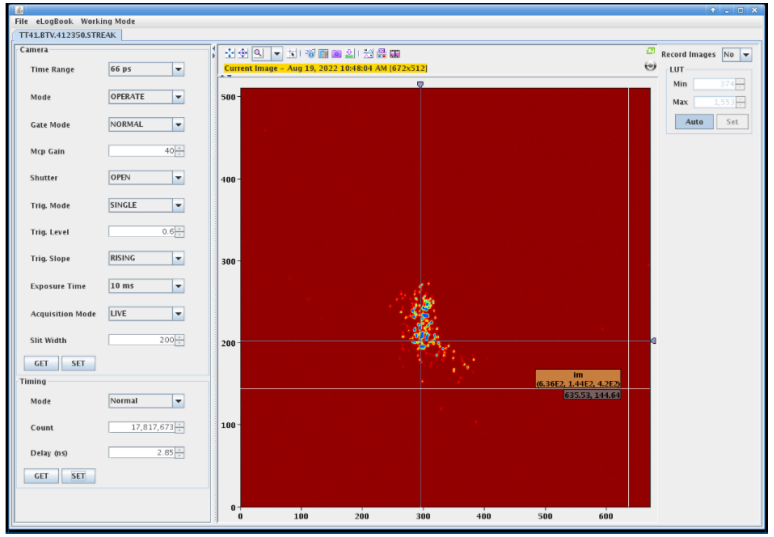


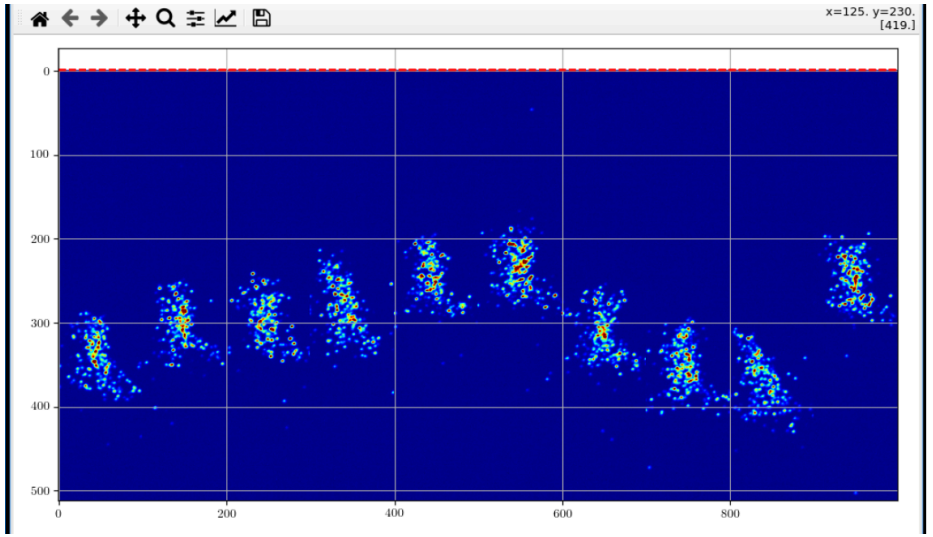
19-08-2022, 750 pC: 4.13 ± 0.33 ps

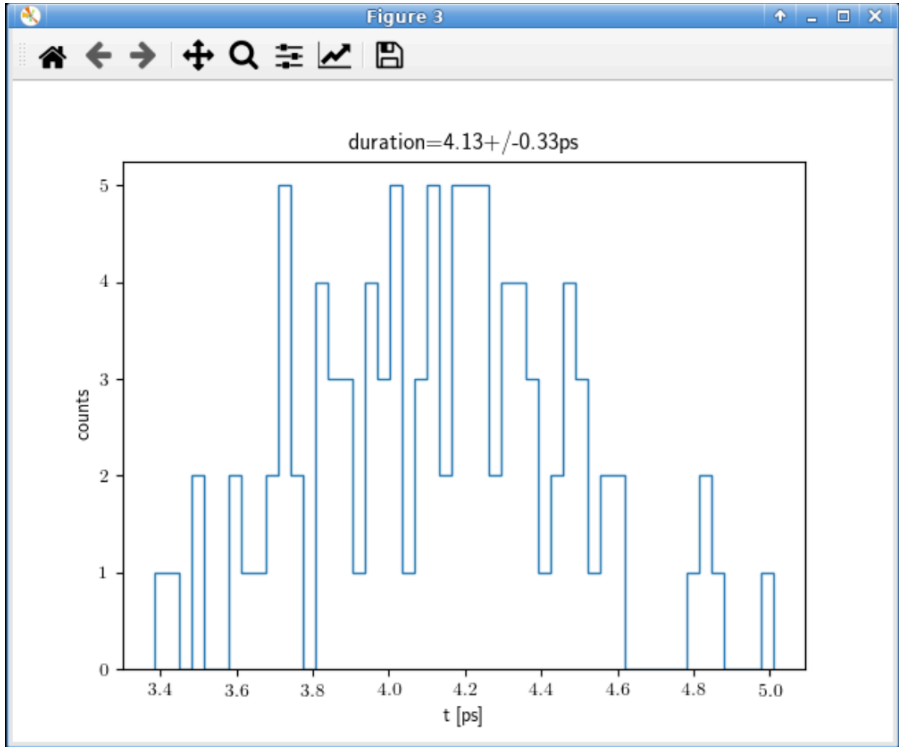
No Bandpass



Bandpass

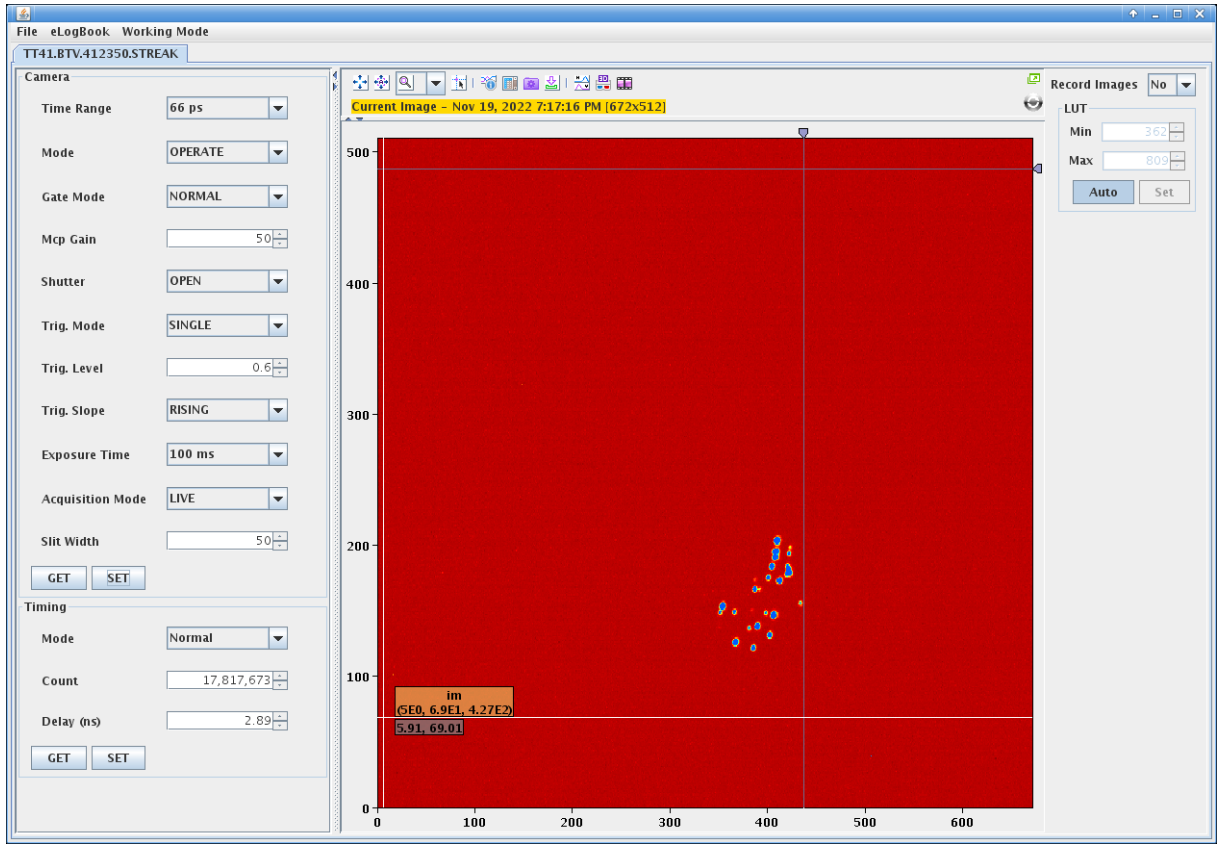


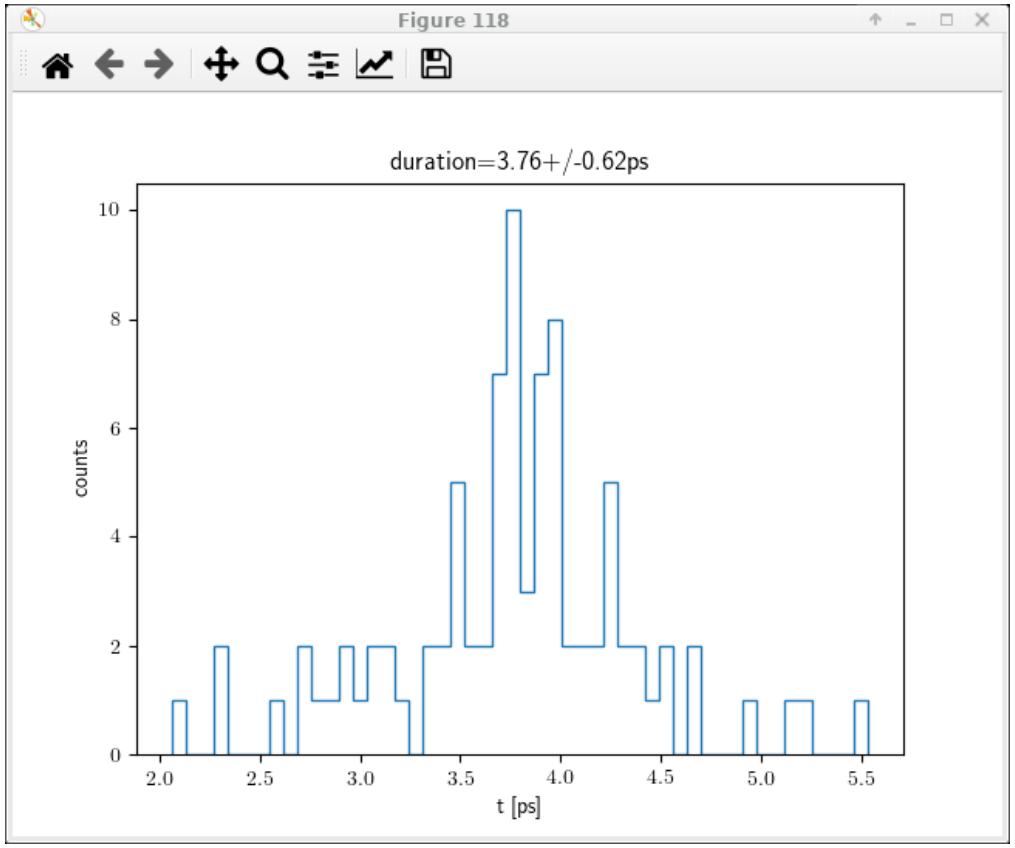




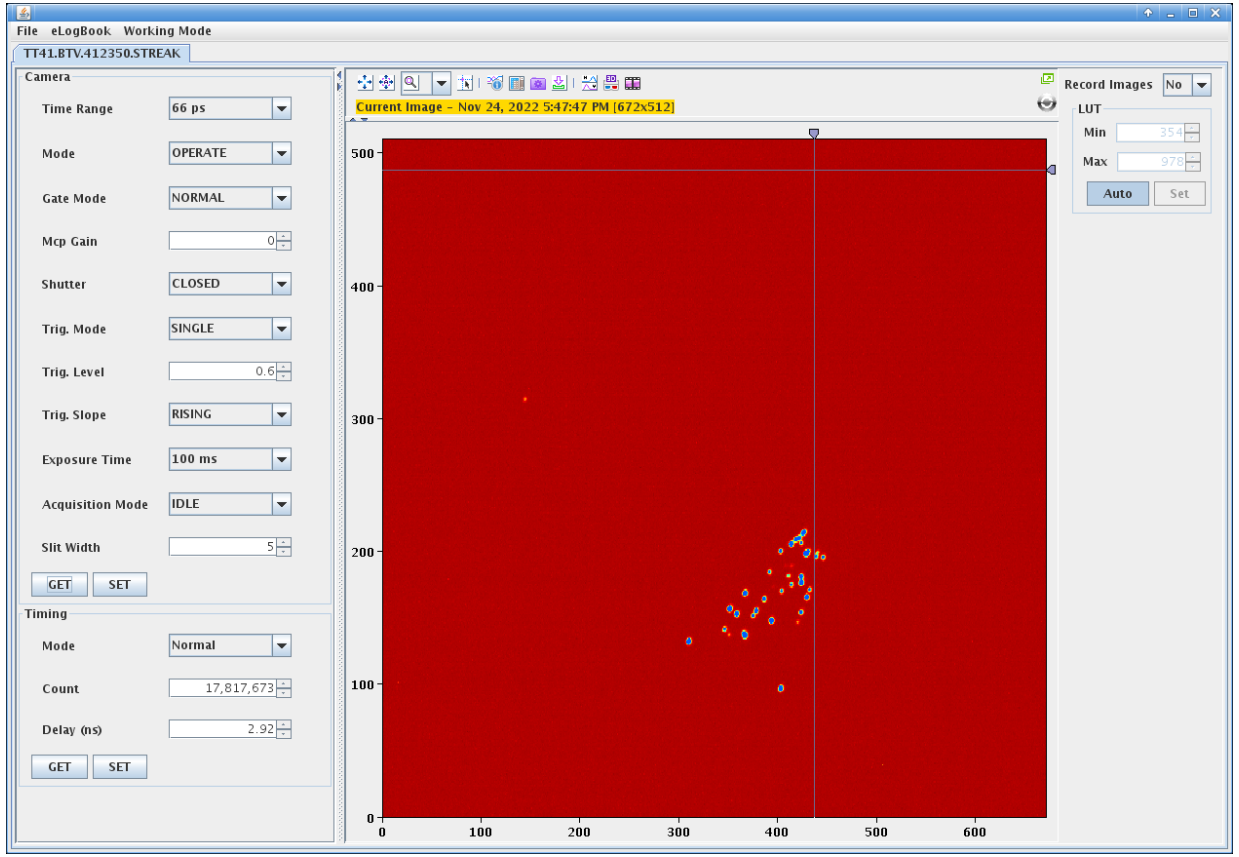
19-11-2022, 650pC: 3.76 ± 0.62 ps

bunch length measurement, upstreak, only electrons with bandpass

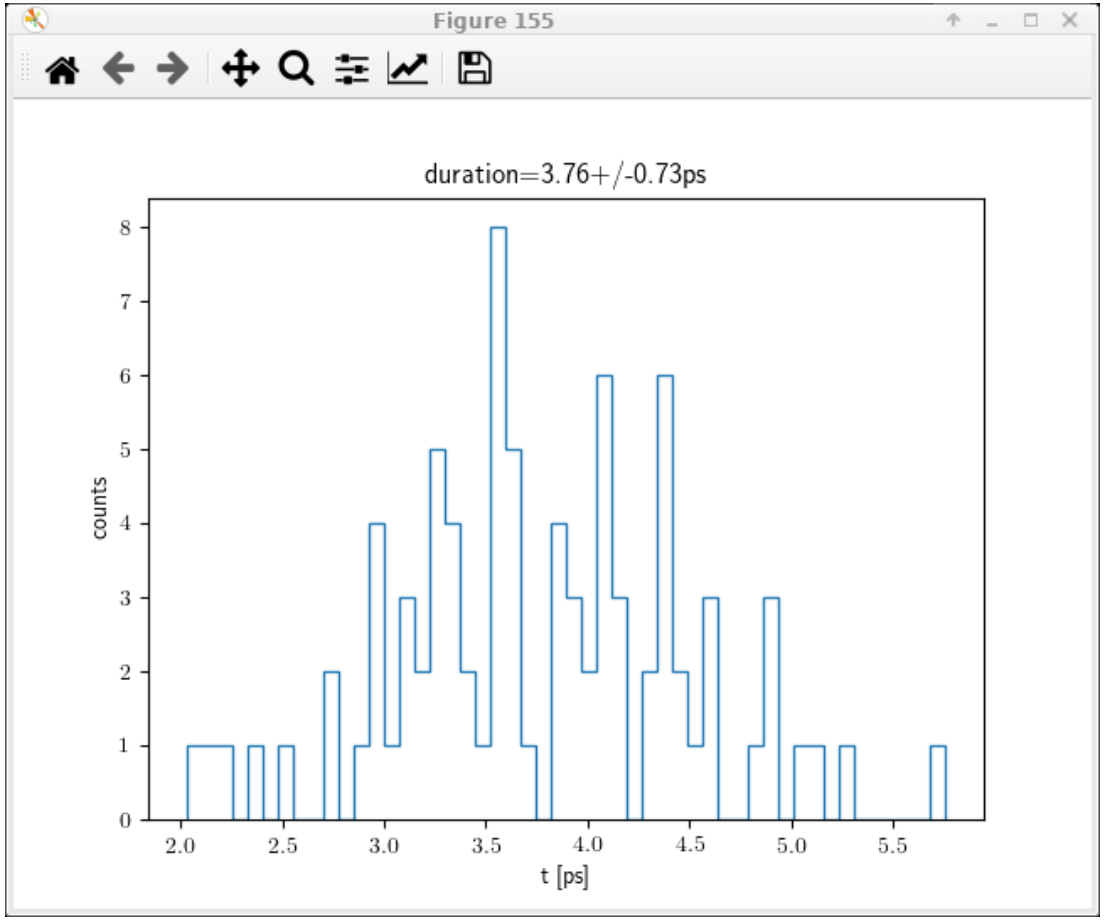




24-11-2022, “high-charge”: 3.76 ± 0.73 ps

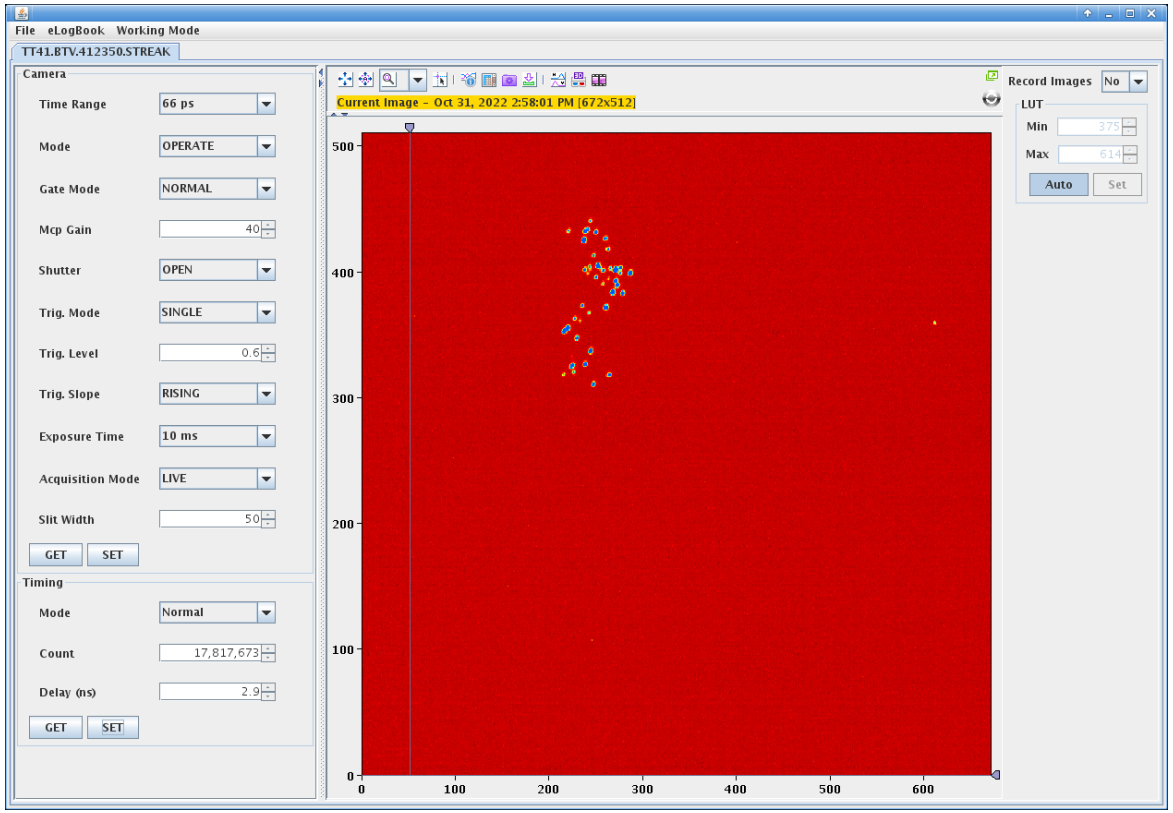


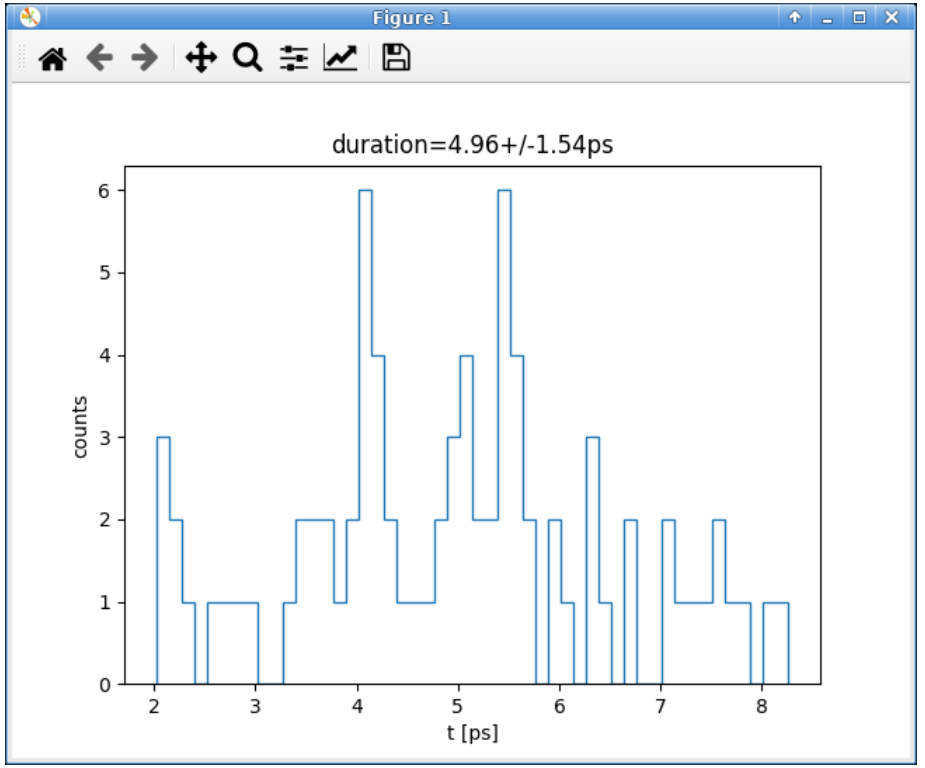
run 345 with 200um slit width



31-11-2022, 750 pC: 4.96 ± 1.54 ps

length with band-pass





Backup: 2019 measurements

https://indico.cern.ch/event/863684/#2-bunch-length-measurement-in

Electron injector measurement:

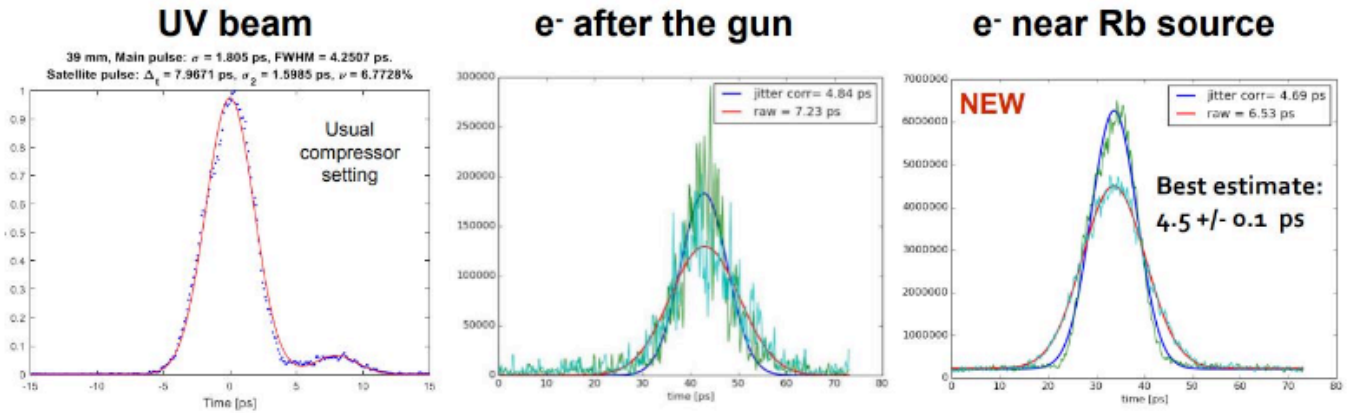
Bunch length

Seong-Yeol Kim, Steffen Doebert, Giovanni Zevi Della Porta,
Stefano Mazzoni, Ishkhan Gorgisyan, Eduardo Granados, Harsha Panuganti

AWAKE Technical Board Meeting

November 19th, 2019

Electron source measurement during summer run



S. Mazzoni, I. Gorgisyan, E. Granados, H. Panuganti. 35th TB (G. Porta)
See also Edu's slides @ collaboration meeting and Stefano's slide in backup.

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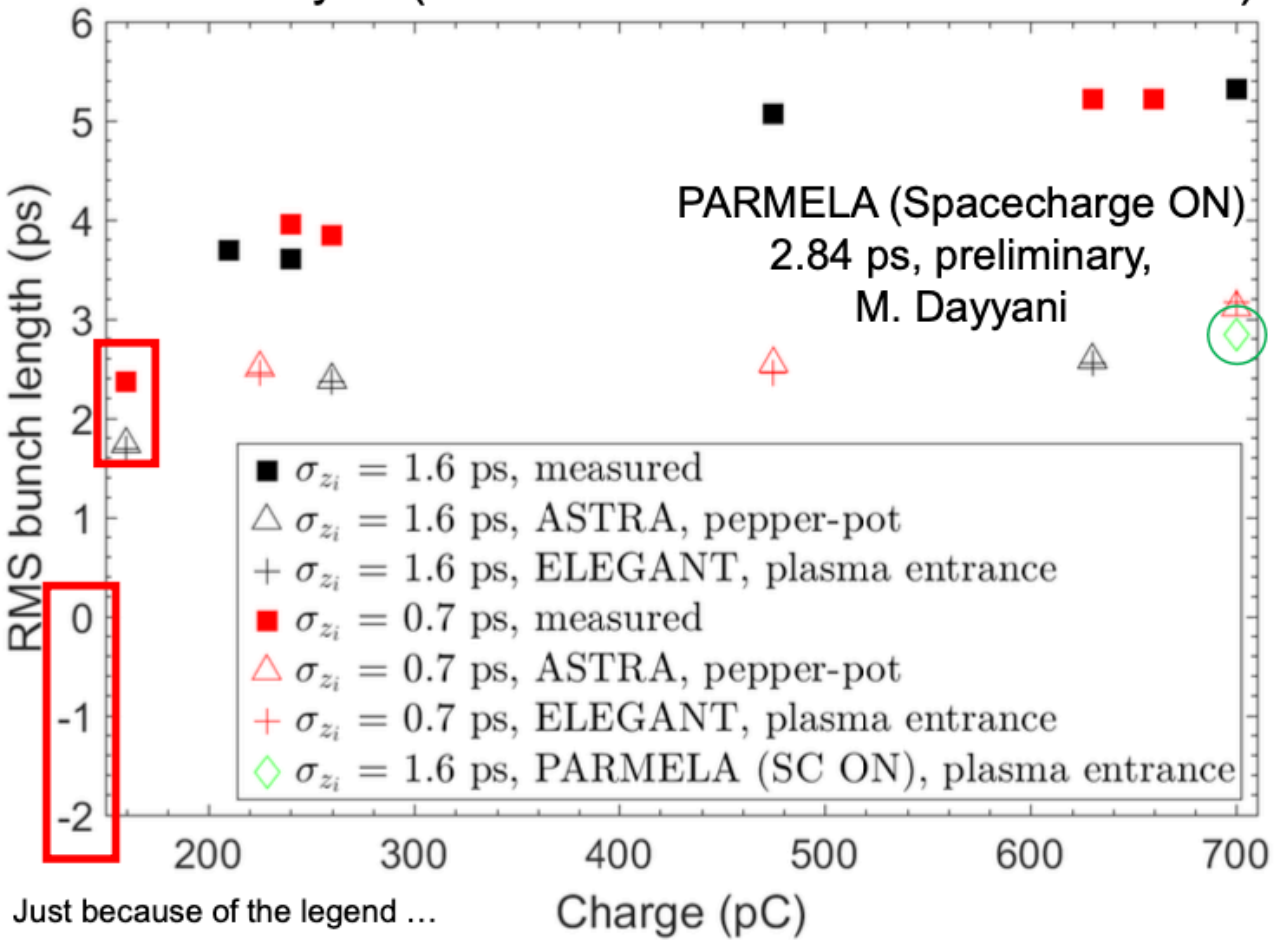
- Original bunch length estimate came from UV measurement of the laser by Micha in Summer 2018 (σ_z = 2.2 ps)
- Comparing injector data from December 2018 with simulations indicated shorter bunch length
- 2019 measurement campaign, gave shorter value in the UV, this time measured directly on the beamline (σ_z = 1.6 ps)
- However, measurements using OTR of the electron beam at the pepper pot indicated larger bunch length (σ_z = 4-5 ps) but where limited by light intensity
- Final campaign, series of measurements in front of the plasma cell to hopefully clarify the situation

ASTRA // ELEGANT simulation for bunch length study

Measured data (at the end of the line)			
$\sigma_{z,i}$ = 0.7 ps		$\sigma_{z,i}$ = 1.6 ps	
Beam charge (pC)	Avg. bunch length (ps)	**Beam charge (pC)**	Avg. bunch length (ps)
160	2.38		
240	3.96	210	3.70
260	3.84	240	3.61
630	5.22	475	5.07
660	5.22	700	5.33

ASTRA (SC) // ELEGANT (CSR)					
$\sigma_{z,i}$ = 0.7 ps			$\sigma_{z,i}$ = 1.6 ps		
Beam charge (pC)	At pepper-pot	At plasma	**Beam charge (pC)**	At pepper-pot	At plasma
160	1.74	1.70	225	2.51	2.46
260	2.39	2.37	475	2.55	2.46
630	2.59	2.56	700	3.12	3.17

Data analysis (measurements: no error consideration)



Just because of the legend …

ASTRA // ELEGANT simulation for bunch length study

What else to be considered?

- Bunch length measurement did not deconvolve the point spread function of the streak camera (> 0.3 ps),
- Resolution of the streak camera: > 0.7 ps

- If two factors are considered from the initial values, then the bunch length is similar with the simulation results for low charge case (160 pC)

- Still there is discrepancy except for the lower charge case, and even if the space charge is considered, bunch length is compressed