

# THz experiment with modulated PHAROS

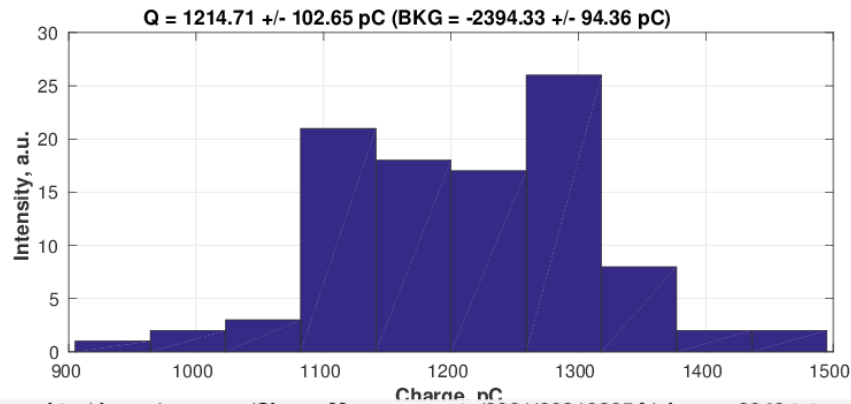
Laser shaping, TDS measurements, CTR spectrum, longitudinal phase-space and emittance

Georgi Georgiev  
20 Apr 2021

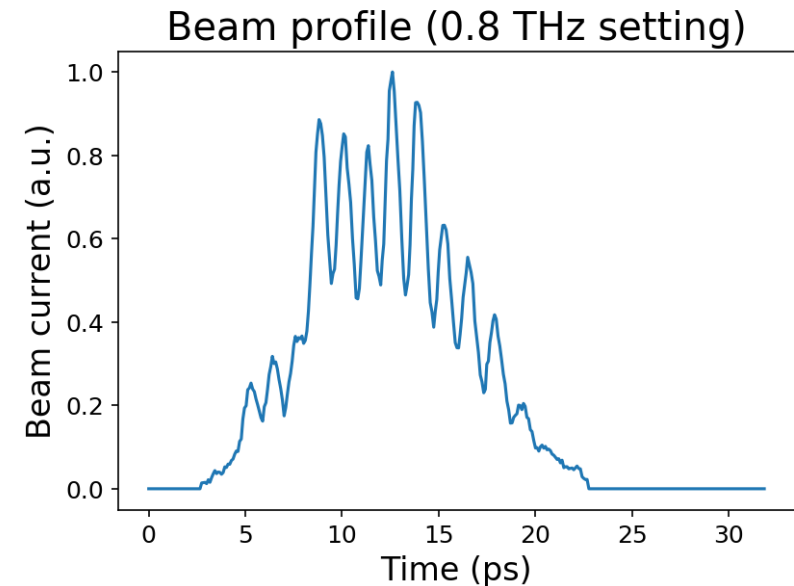
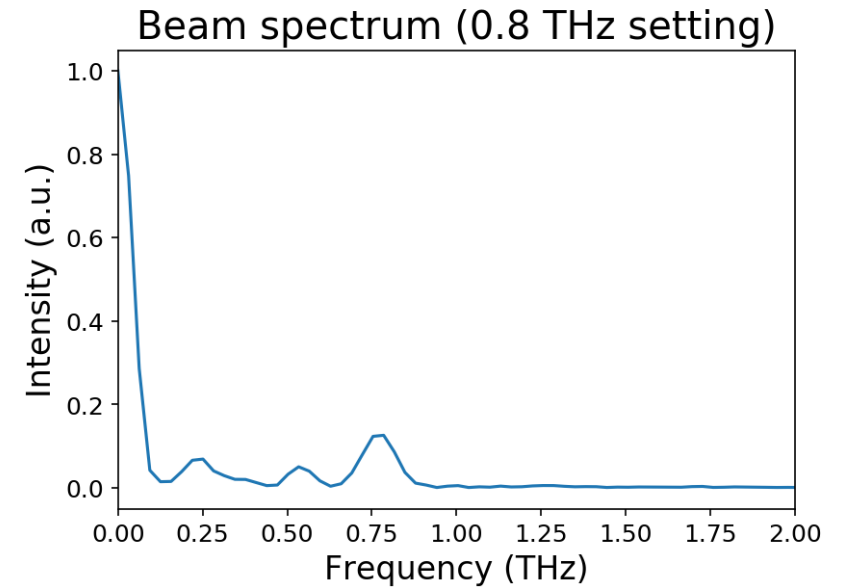
# THz modulations with PHAROS

## Beam shaping

- Different from MBI
  - MBI - difference frequency beating
  - PHAROS – chirped beam modification
  - Small separation - interference
- Highest frequency – 0.8 THz
  - Already shows interference
- Beam charge – 1.2 nC
  - Rep. rate of 250 kHz



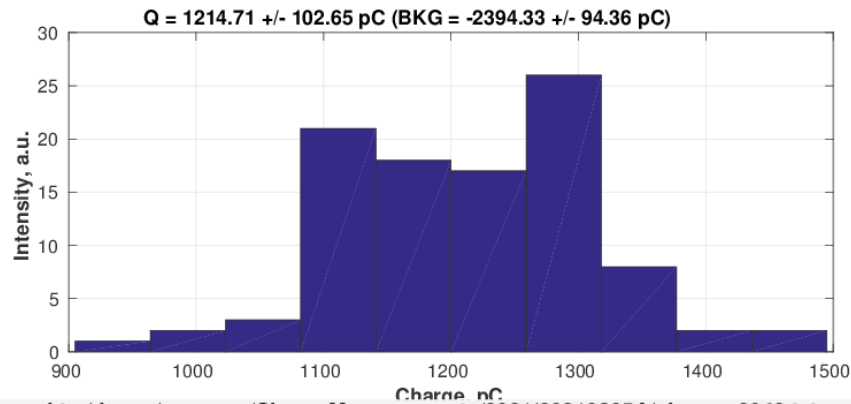
Data saved to /docs/measure/ChargeMeasurements/2021/20210305A/charge\_2048.txt  
Charge measurement using Low.ICT1; calibration corrected by 1/0.82275; stat.:100/50



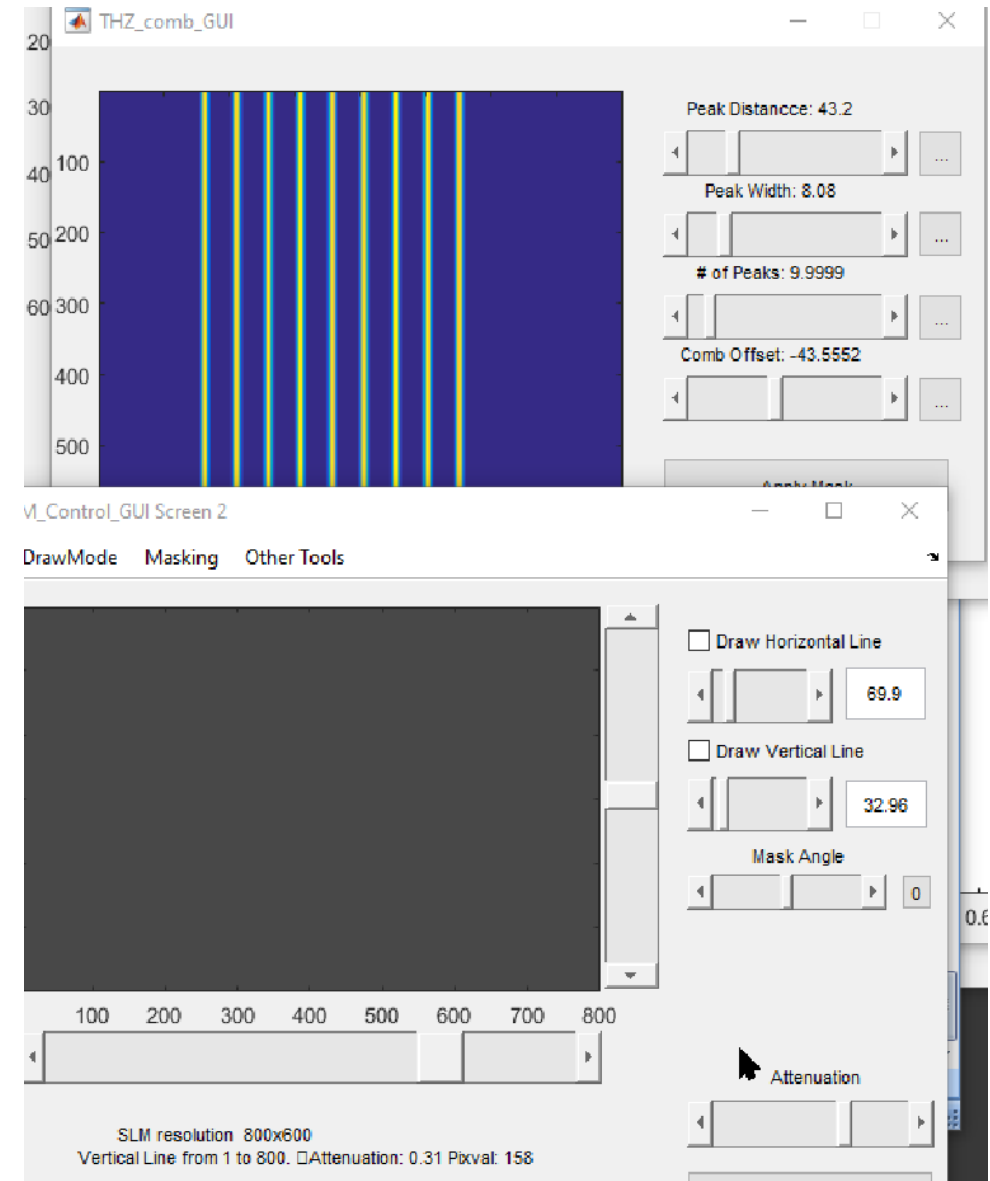
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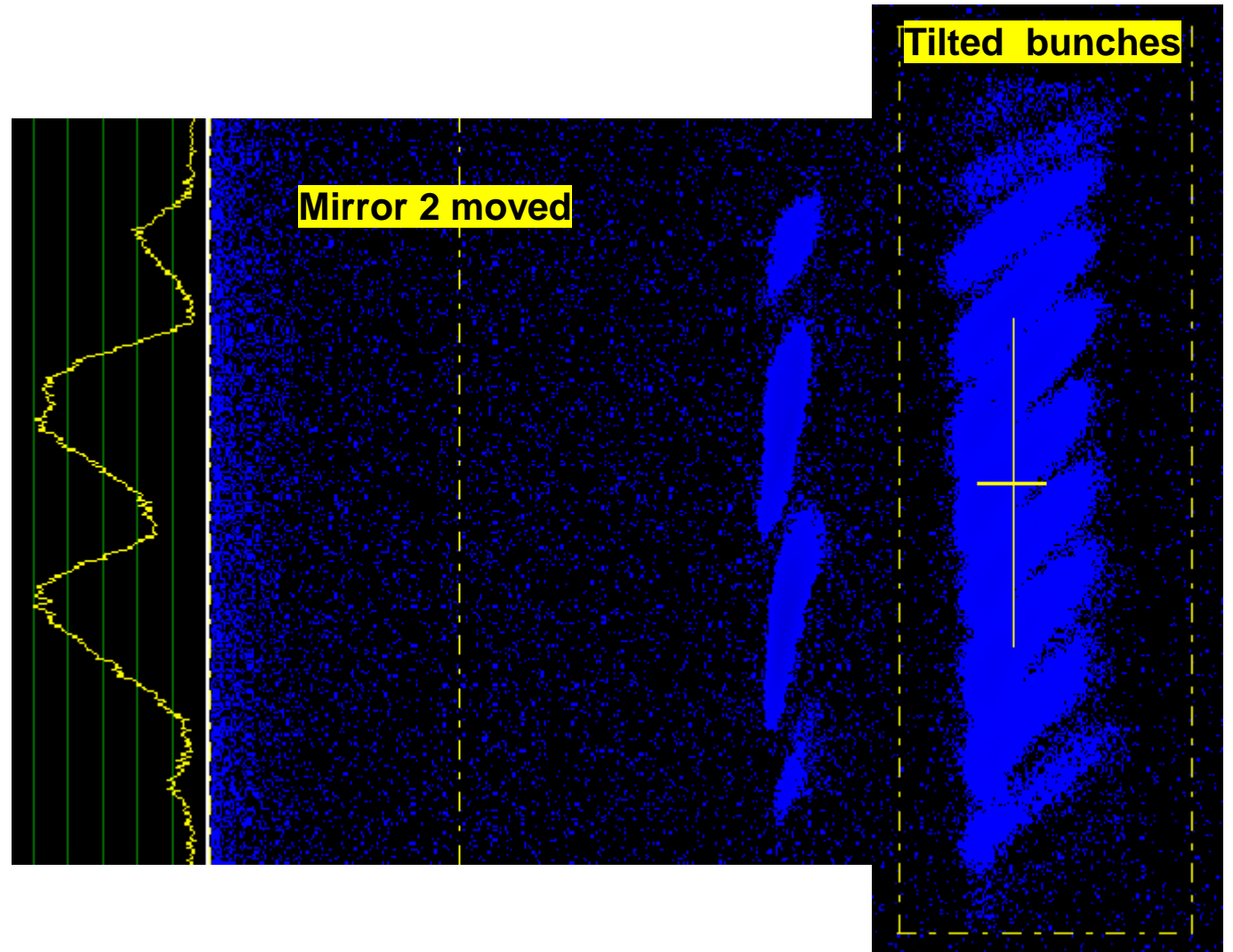


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# Shaping problems

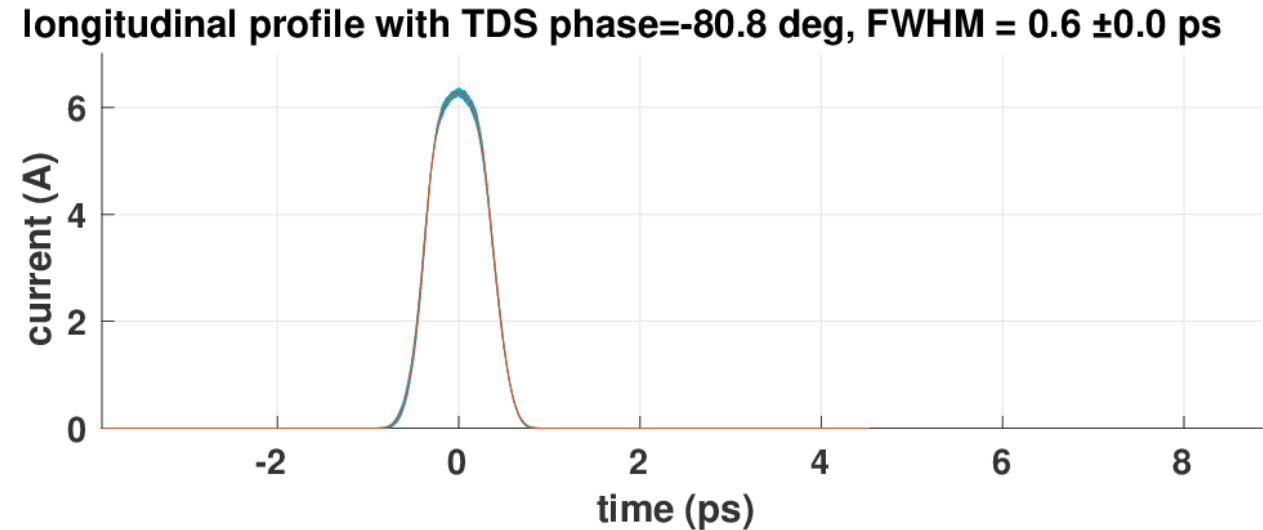
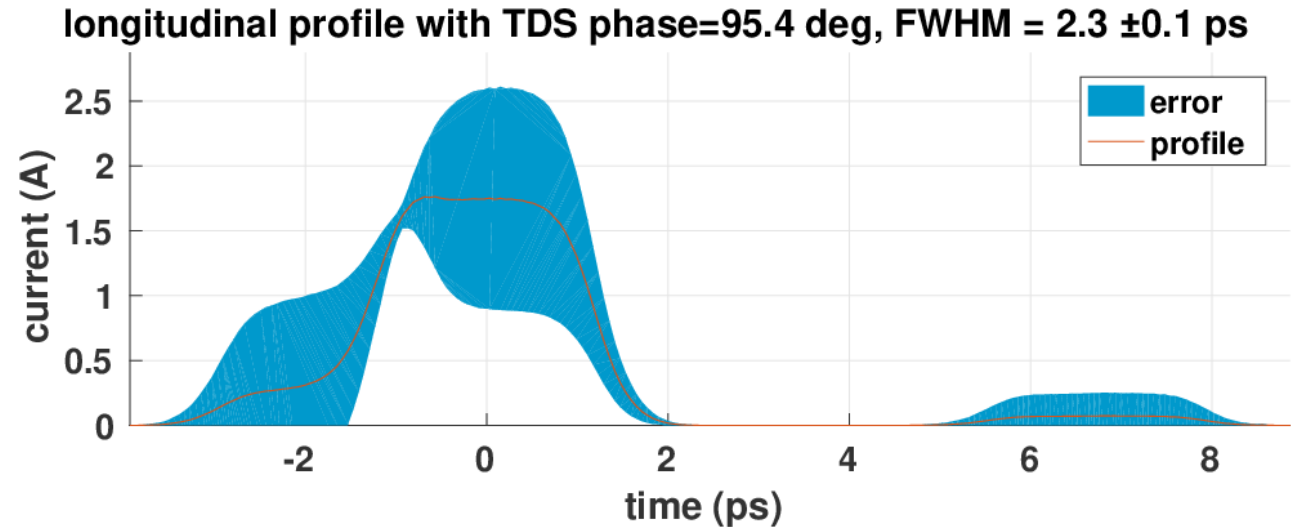
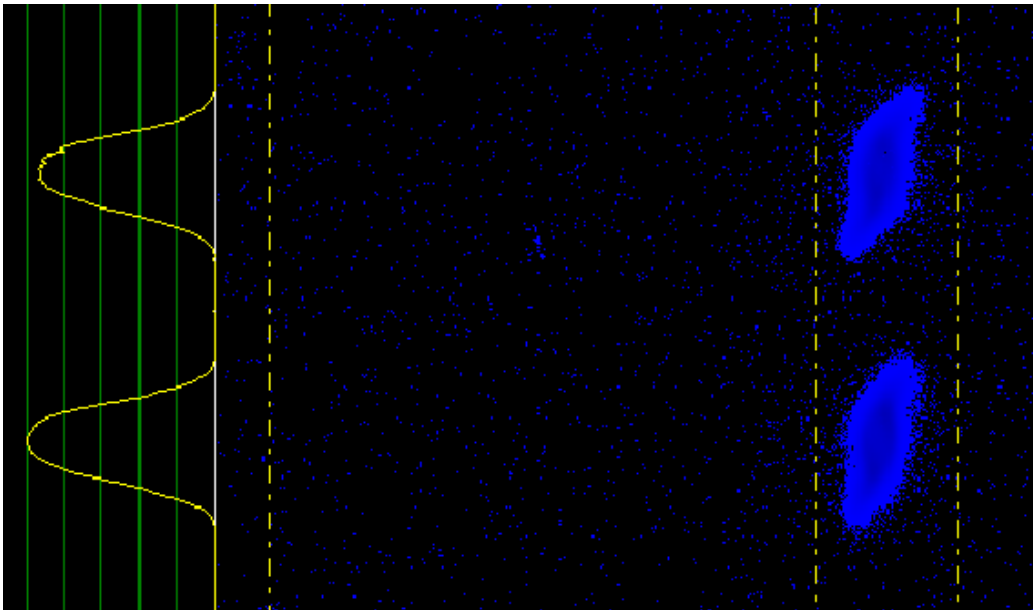
- Bunches appear tilted of PST.Scr2
  - Tilt changes with main solenoid field
- Possible cause
  - Quadrupoles steering free
  - Dispersion+chirp (time-offset coupling)
- Mirror 2 position
  - Changed to align beam on BSA
  - Lost high frequency shaping
  - Restored position – restored shaping



# Measurement problem

## TDS script noise cut limit

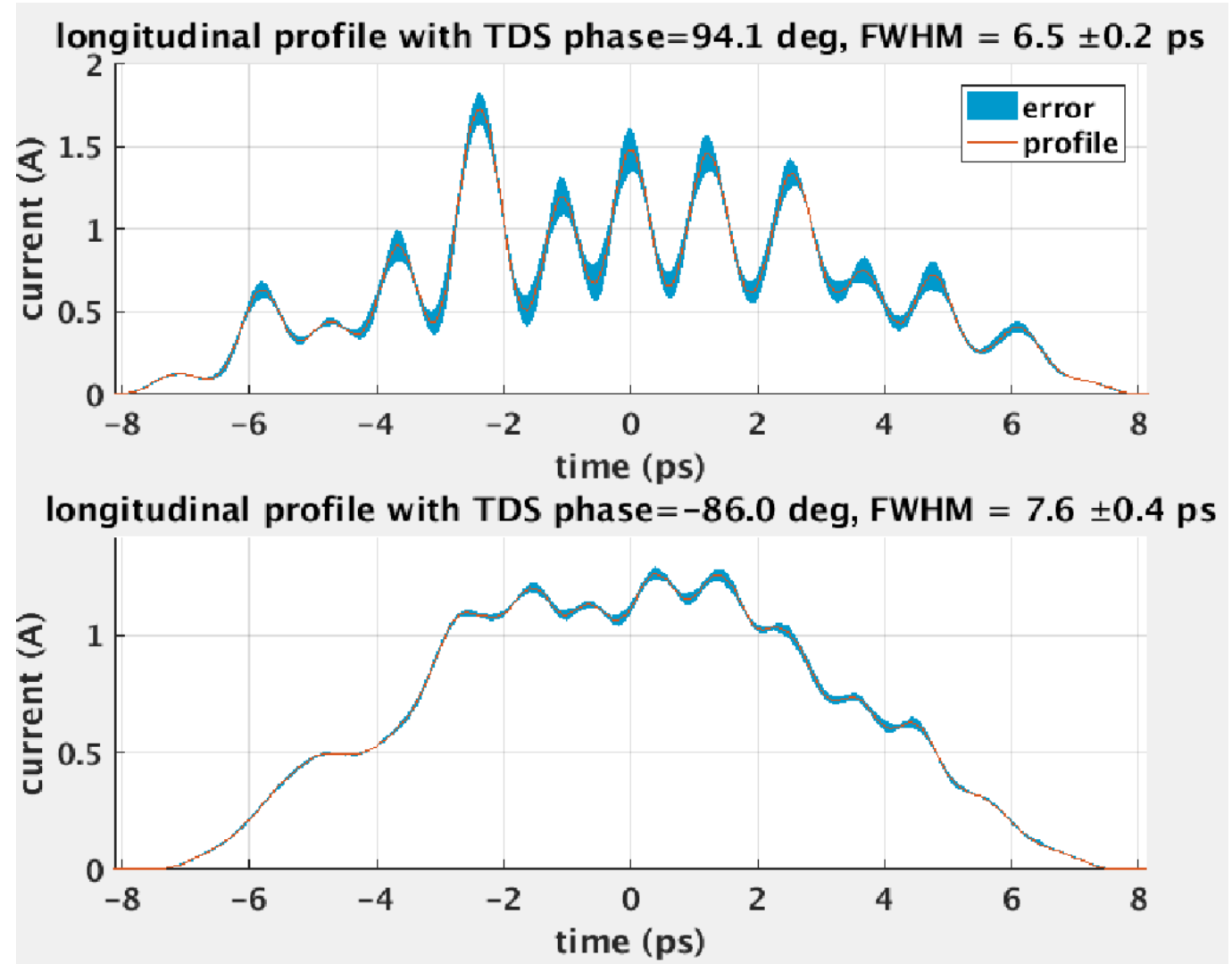
- TDS script reports wrong profile
  - Any beam with clearly separated peaks
- TDS script noise cut
  - Selects only largest island
  - Not compatible with modulated beams
  - Wrong S parameter, etc.



# Measurement problem

## TDS projection

- TDS gives different S parameter and profile
  - Profile difference visible of PST.Scr2
  - Unclear reason

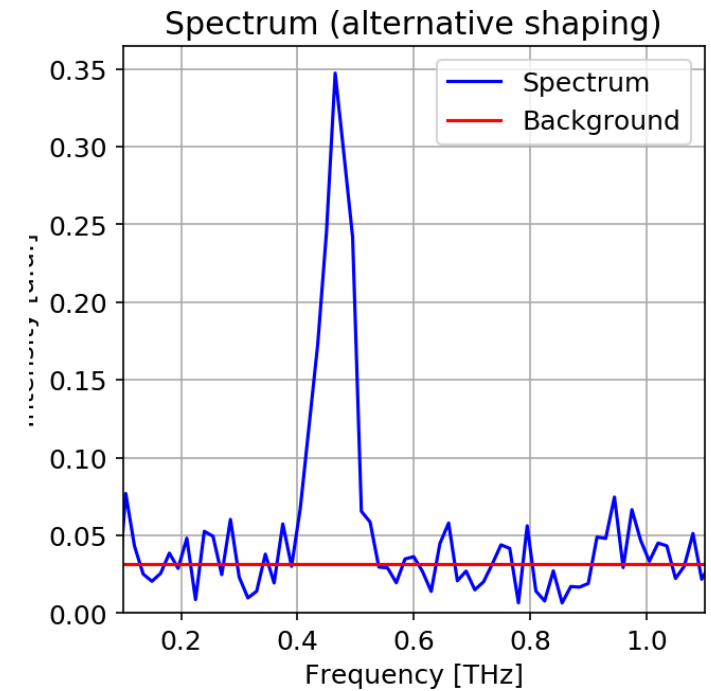
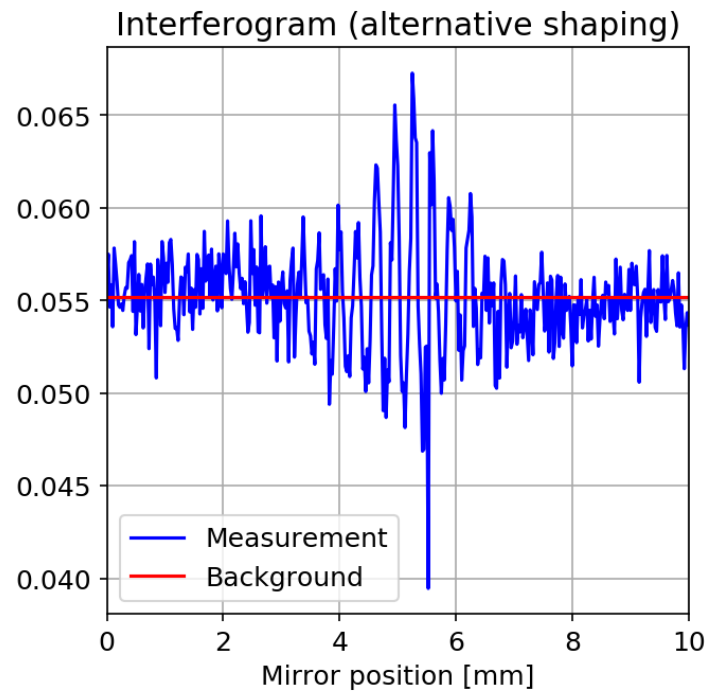


# CTR spectral measurement

- Pyrodetector and Michelson interferometer
- Measurements with 0.8 THz modulated laser
  - No prominent peak detected at 500 pC
  - Signal too weak at 100 pC
  - Overall: **no CTR at 0.8 THz measured**

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- Measurement with alternative shaping
  - Higher contrast, lower frequency
  - Pattern in the interferogram
  - Clear peak  $\sim 0.5$  THz

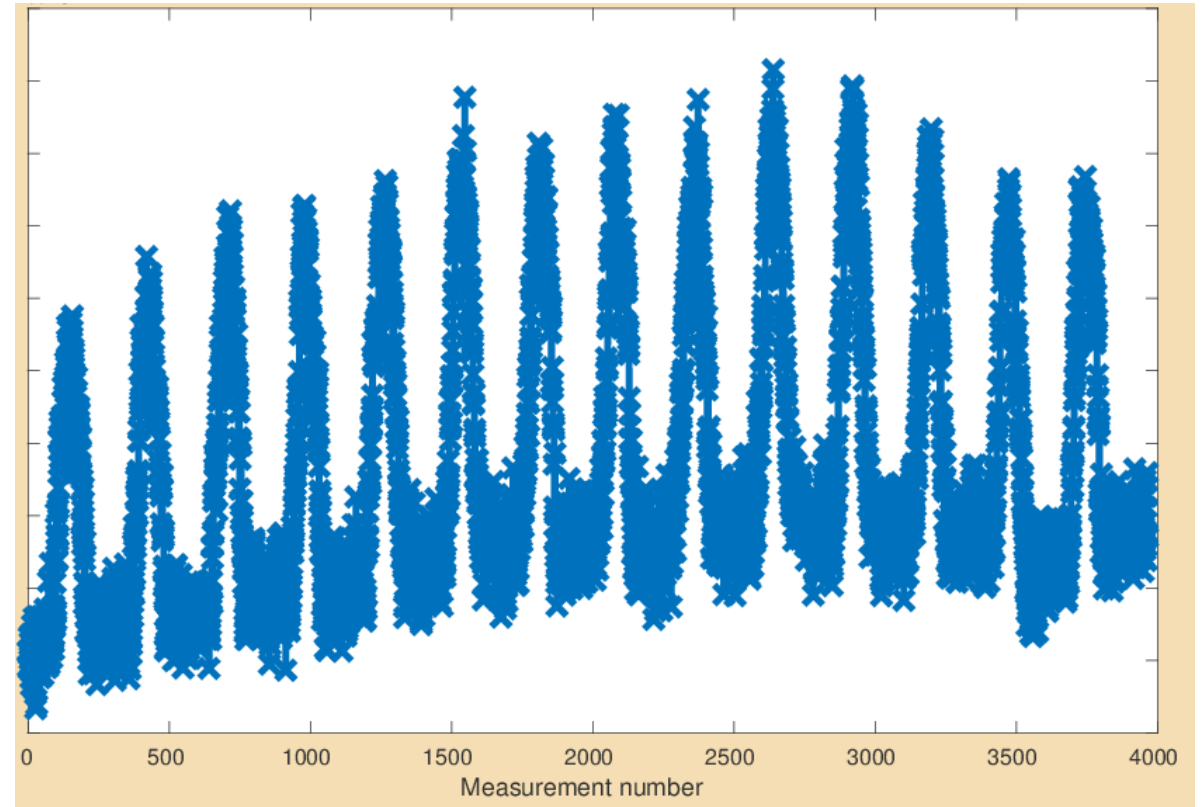




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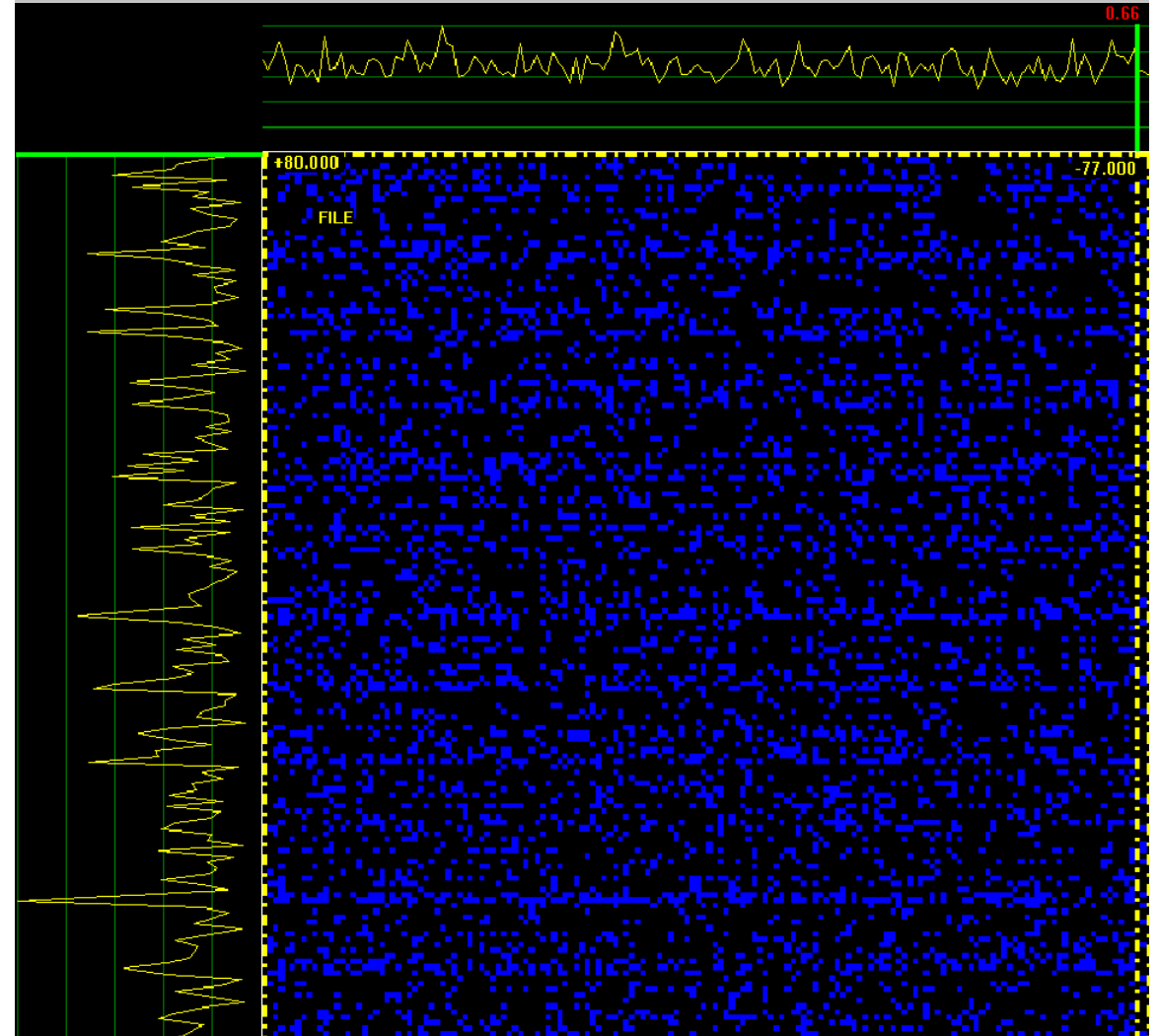
## Pyrodetector noise

- Periodic fluctuations in signal from pyrodetector
  - About 30s period
  - Prominent over noise baseline
  - Only appear with beam on Al-plate
  - Between/from detector and scope
- Impossible to measure reliable interferogram
- Fixed
  - Detector and collecting cone realigned
  - Coaxial cable and amp. moved to board



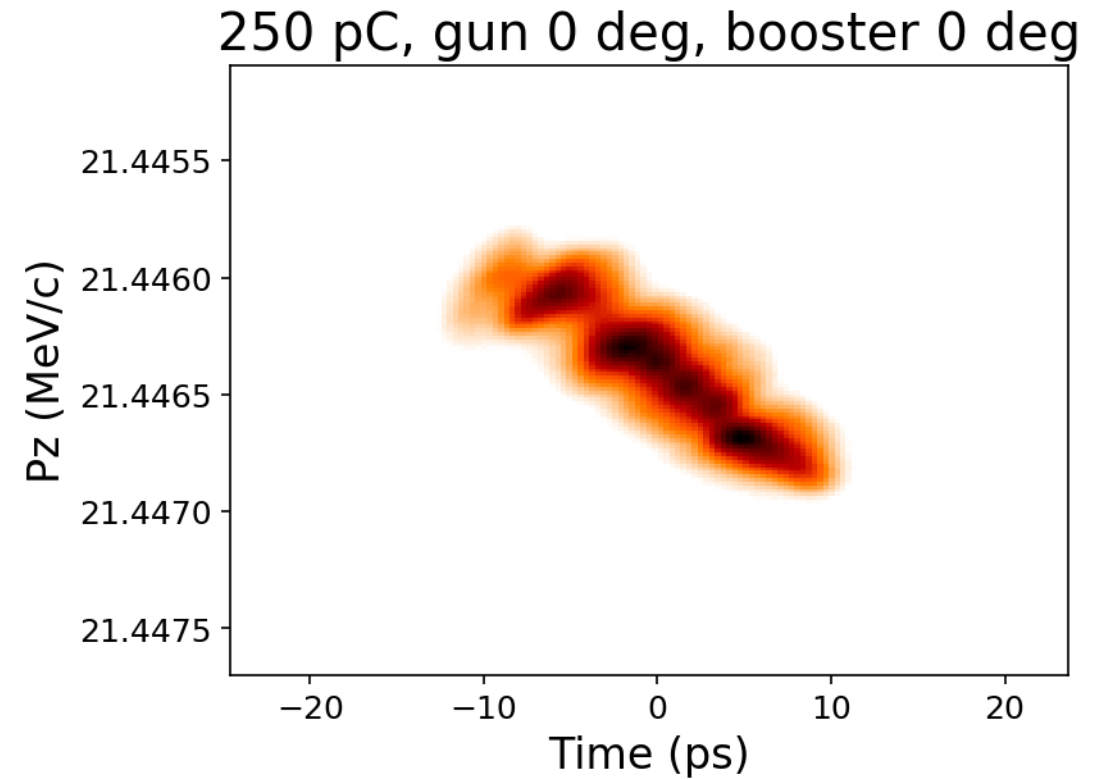
# CTR transverse profile

- THz camera measurement
  - Image of CTR from modulated beam
  - High frequency PHAROS modulation
- No image pattern captured
  - CTR signal too weak



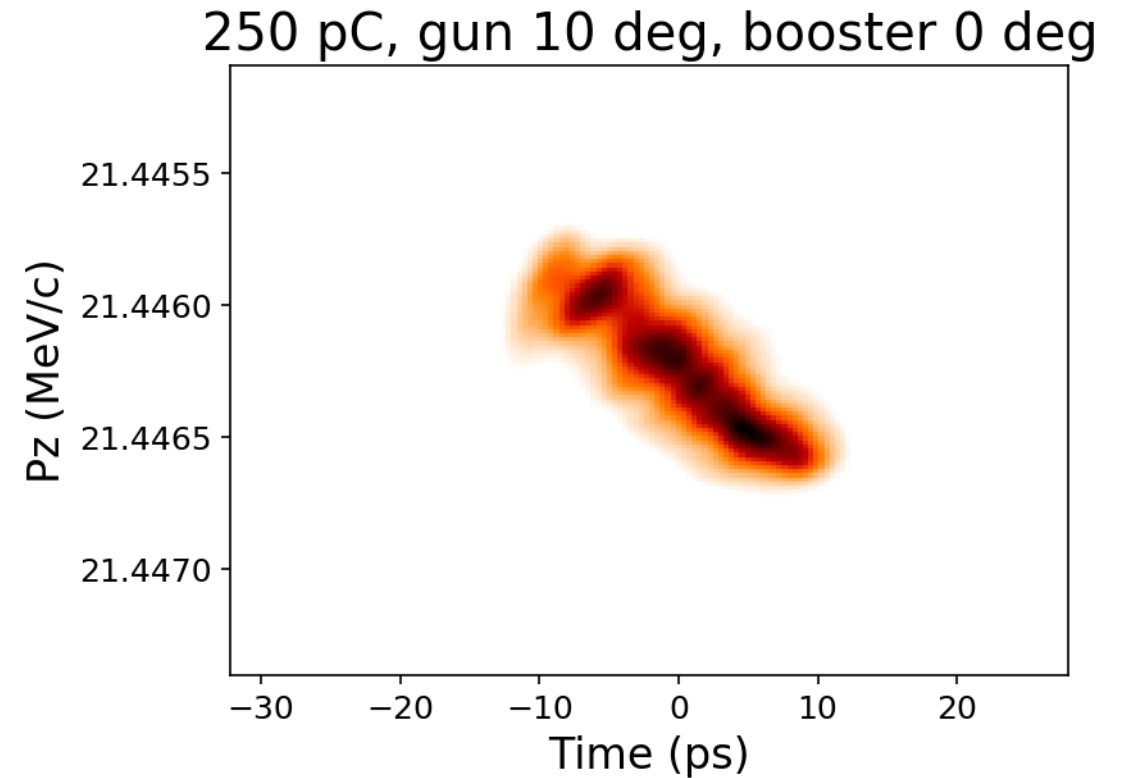
# Longitudinal phase-space

- Modulation presence in LPS
- 250 pC beam (program not updated)
- Phases of gun and booster
  - Both MMMG – no clear modulation



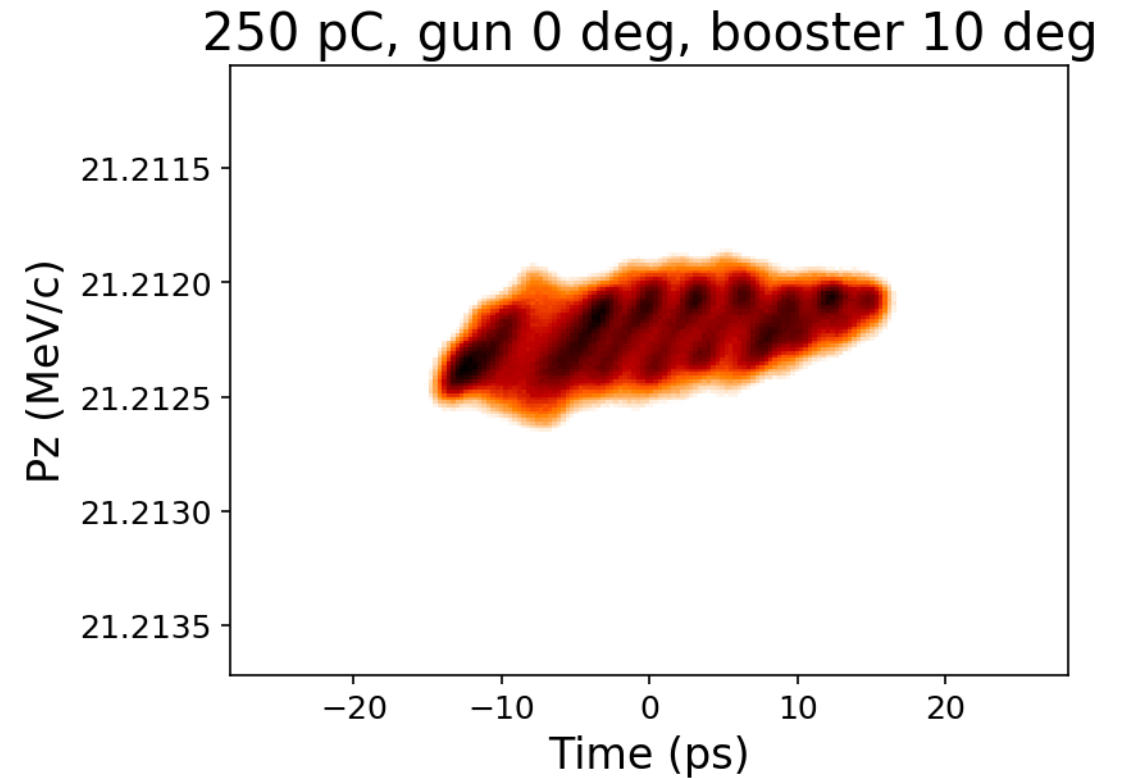
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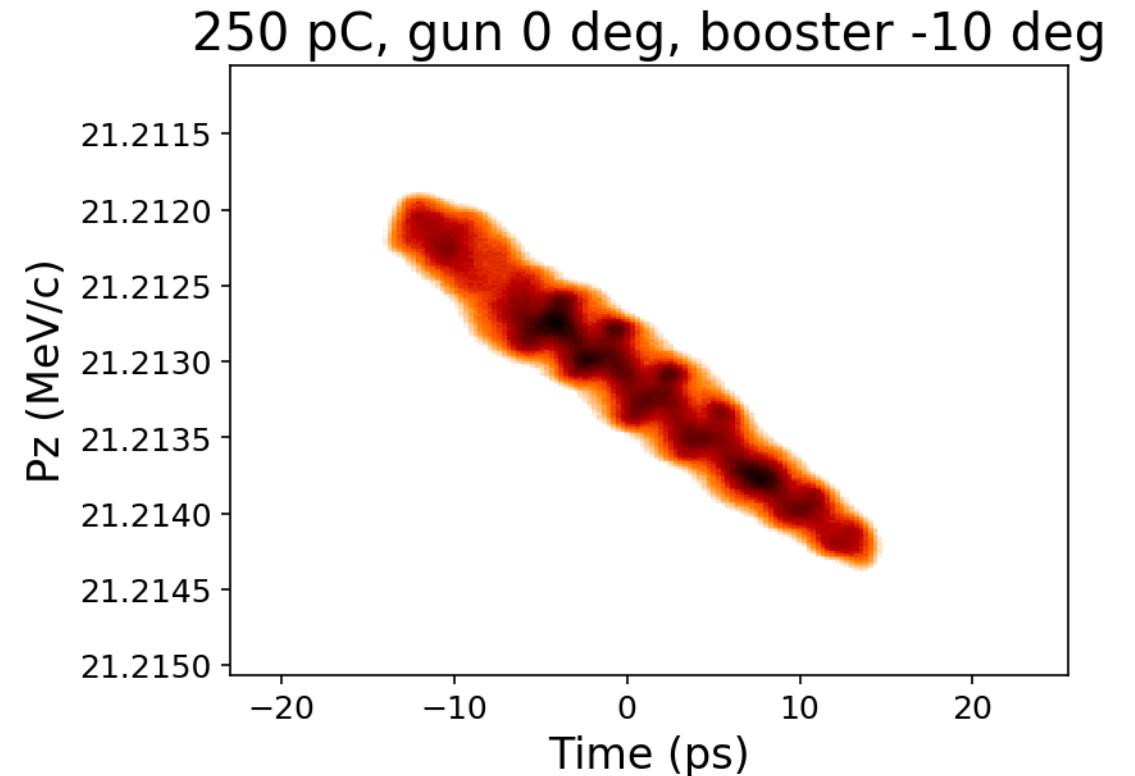
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    - Compensate correlated dE/dz
    - Modulations visible and chirped



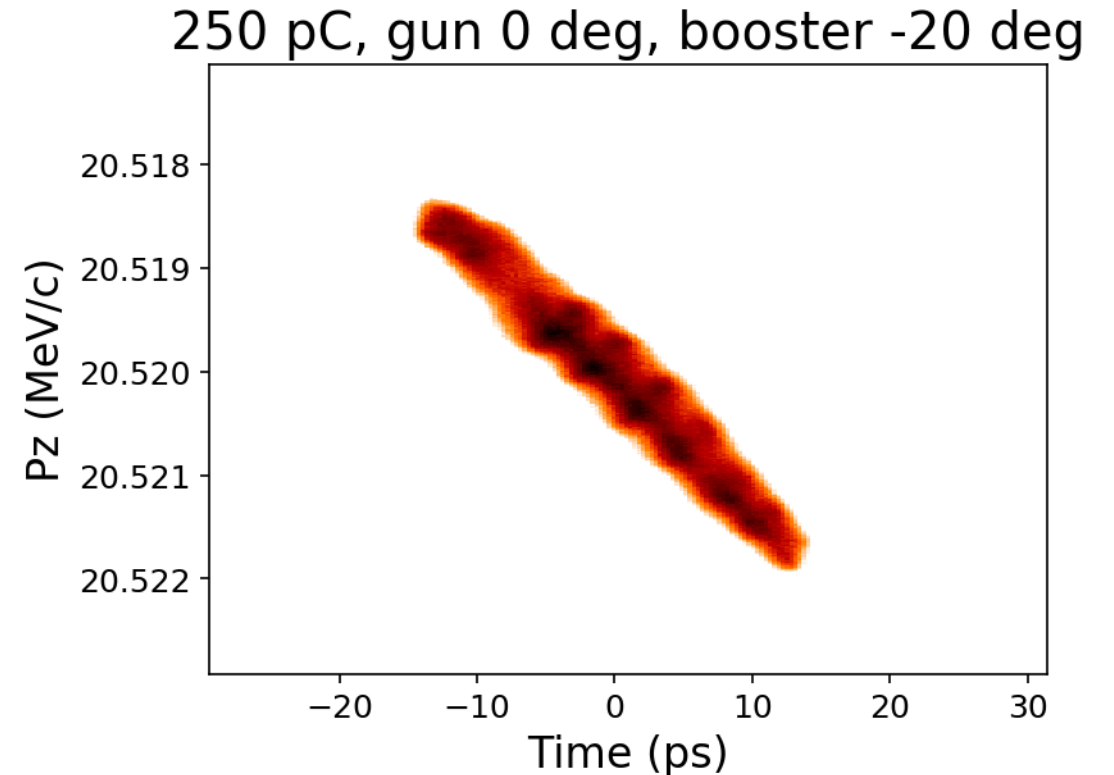
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  - Booster stretching
    - -10 deg: LPS modulation structure visible



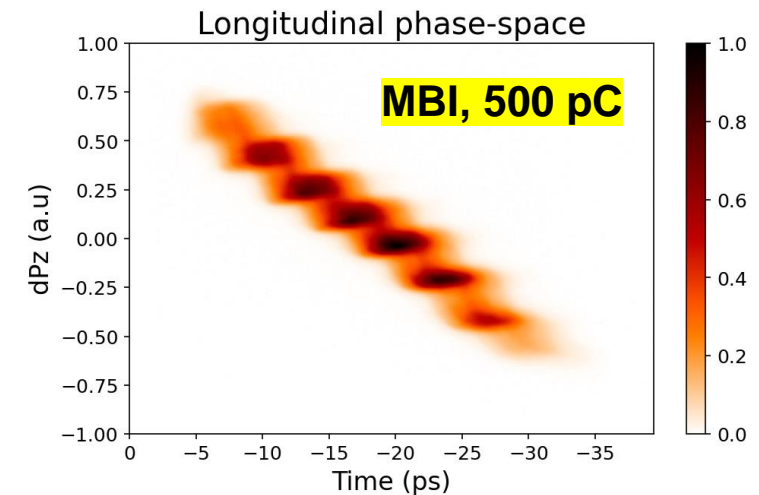
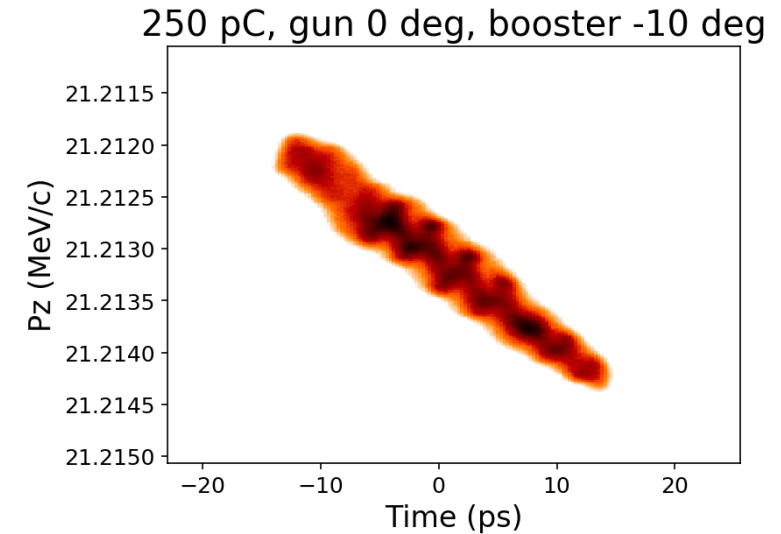
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- Overall worse contrast to 0.4 THz case (MBI)
  - Resolution limit, laser mod. contrast, SC





# Emittance

- Modulated beam, 0.8 THz, 500pC, BSA 2.5mm

## EMSY1

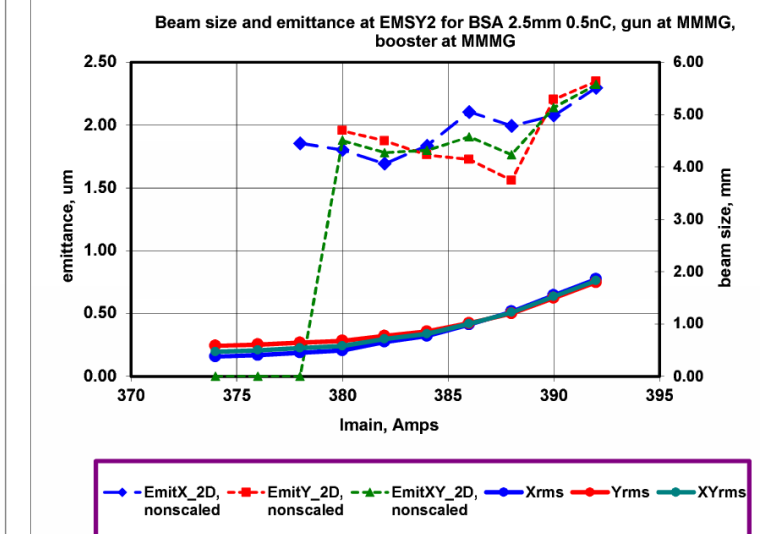
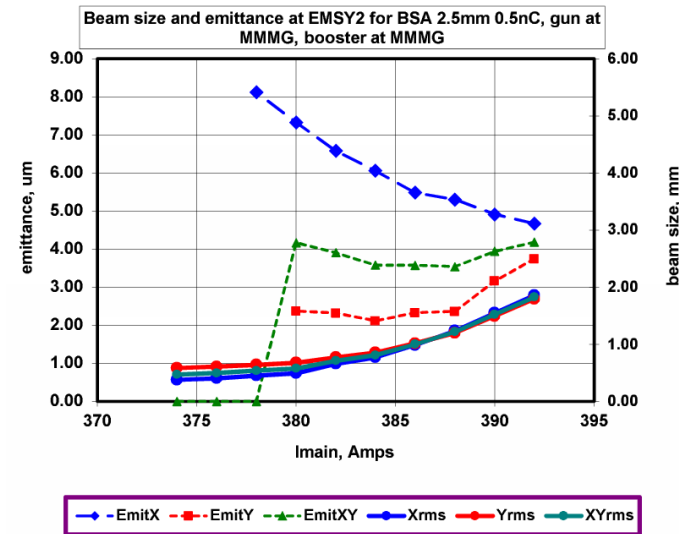
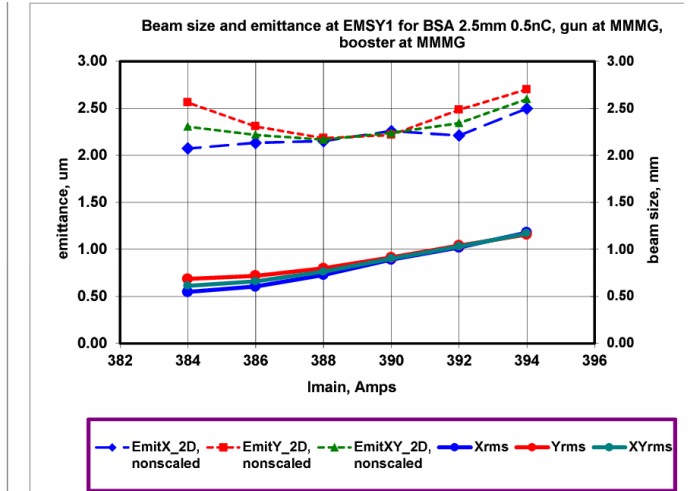
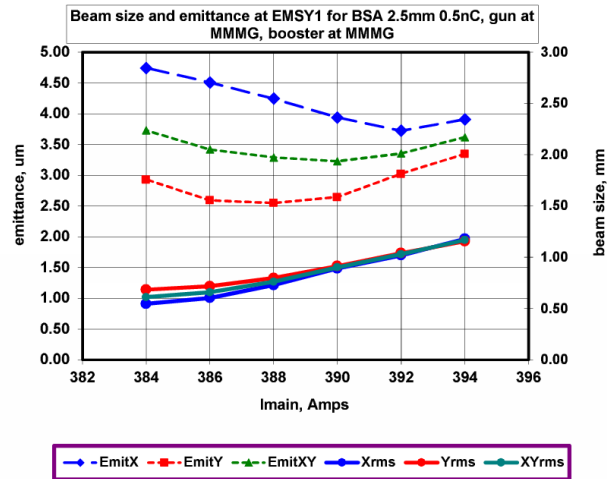
- \* Minimum emittance for  $I_{main}=390A$
- \* EmitX = 3.939 mm mrad
- \* EmitY = 2.646 mm mrad
- \* EmitXY = 3.228 mm mrad

## EMSY2 (to PST.Scr2)

- \* Minimum emittance for  $I_{main}=388A$
- \* EmitX = 5.302 mm mrad
- \* EmitY = 2.365 mm mrad
- \* EmitXY = 3.541 mm mrad

## EMSY2 issues

- Fluctuating non-scaled
- Huge scaling factor in X



# Next

- DLW - redoing of 2017 program

**Thank you**