Studies on beam energy slope along RF pulse

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PPS#800

HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

Motivation

Investigate beam energy (momentum) slope along the RF gun pulse and try to compensate it

- Script for A3 event (laser) delay scan to measure beam mean momentum (~vertical position at LEDA, Disp1.Scr1):

  - …\Measure\scripts\MeasurementTools\CouKickBPM\BeamAtLEDAevaluator.m → calibration
  - …\Measure\scripts\MeasurementTools\CouKickBPM\BeamAtLEDAscanA3.m → measure
  - Both scripts uses *GetBeamAndBkg(camera,Nbimag,Nbkgimag,MOImanual)* for filtering and statistics

- Compensation of the slope with a slope of the RF amplitude

  - Try minimize projected rms momentum spread at LEDA for a long pulse train
  - Check with scanning script

Script for A3 event scan to measure beam mean momentum

- *BeamAtLEDAevaluator.m* → calibration in coupe with oma


ycal=[193.7 246.4];
pzcal=[6.622 6.586];
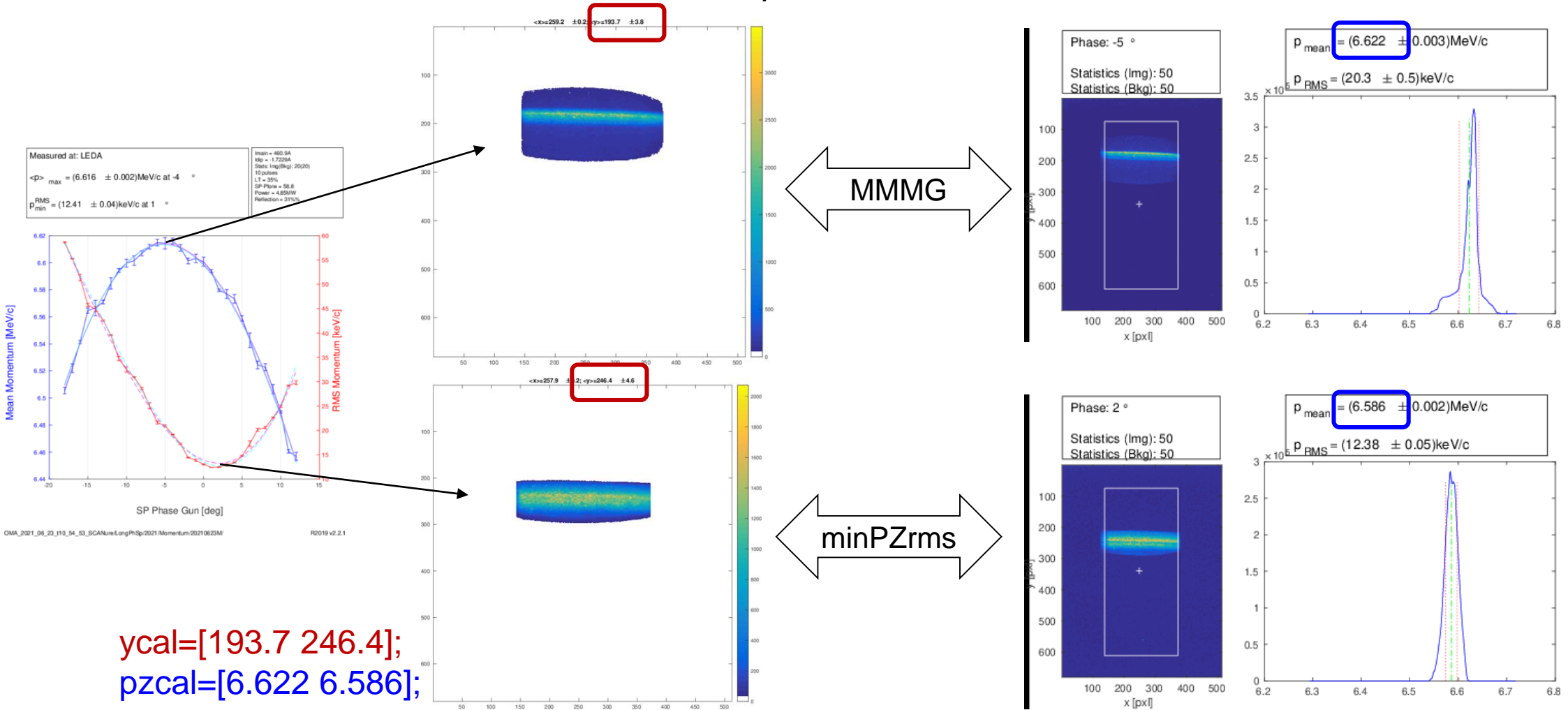
Script for A3 event scan to measure beam mean momentum

Currently → …\Measure\scripts\MeasurementTools\CouKickBPM\BeamAtLEDA*.m

- *BeamAtLEDAscanA3.m* → measurement of the <PZ> along the RF pulse

- Parameters:

    - Image statistics
      Nbimag=20; - beam image frames #
      Nbkgimag=20; - background image frames #

    - A3 scan
      Nt=50; → number of steps
      dtus=2; → step duration in us (recalculated wrt. 9.23…ns)

    - Calibration from the *BeamAtLEDAevaluator.m* + *oma*
   ycal=[193.7 246.4];
      pzcal=[6.622 6.586];
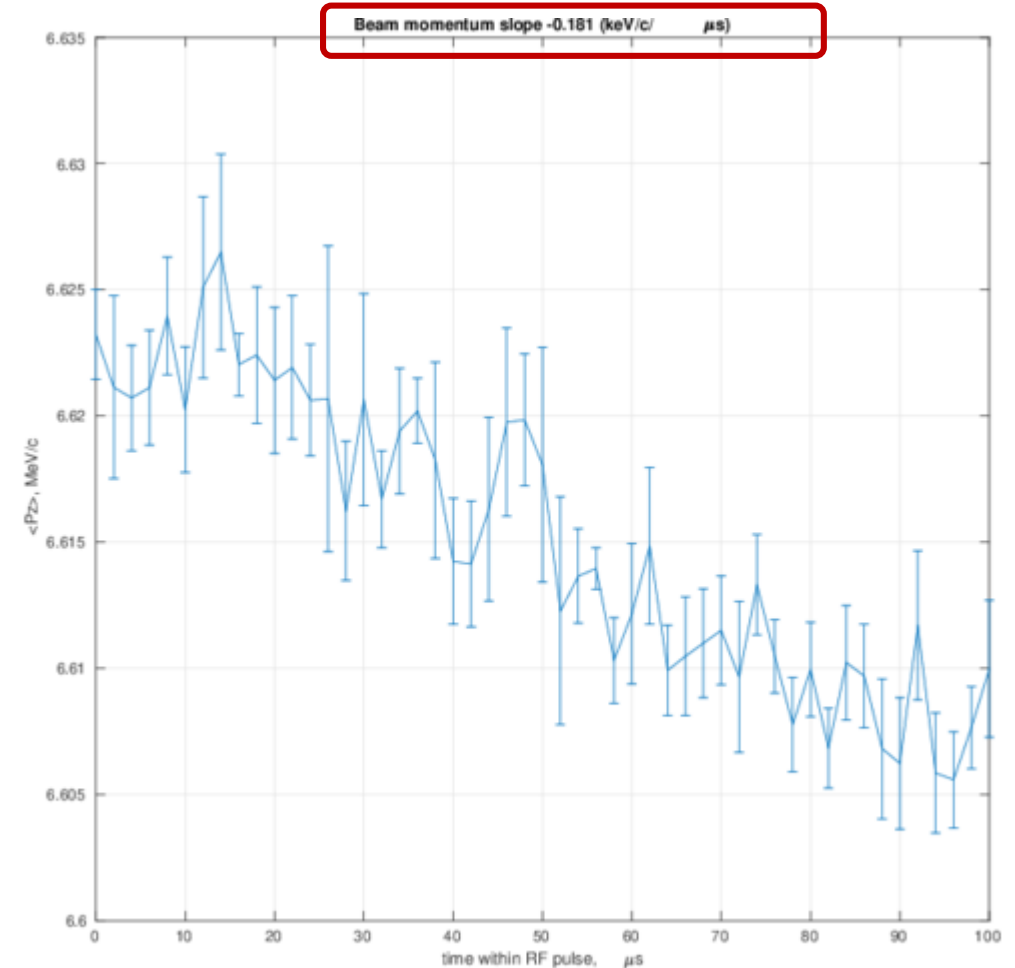
Data saved to /doocs/measure/BeamTransport/Trajectory/2021/20210623M/Eslope_100_1119.mat

Compensation of the slope with a slope of the RF amplitude

Minimization of the projected rms momentum spread at LEDA for a long pulse train
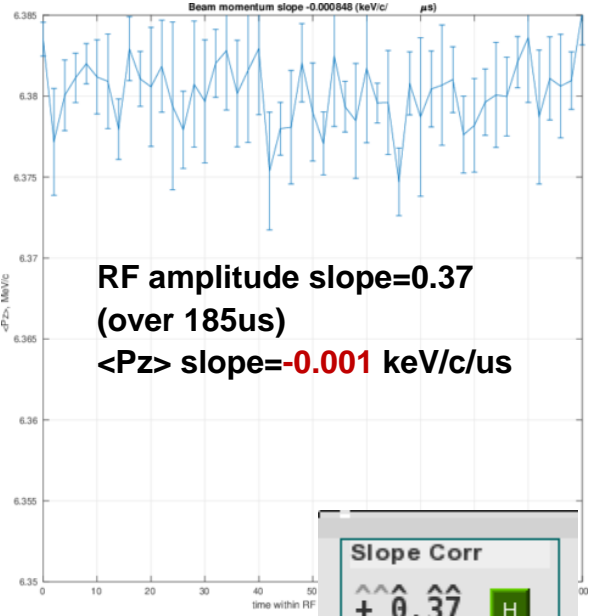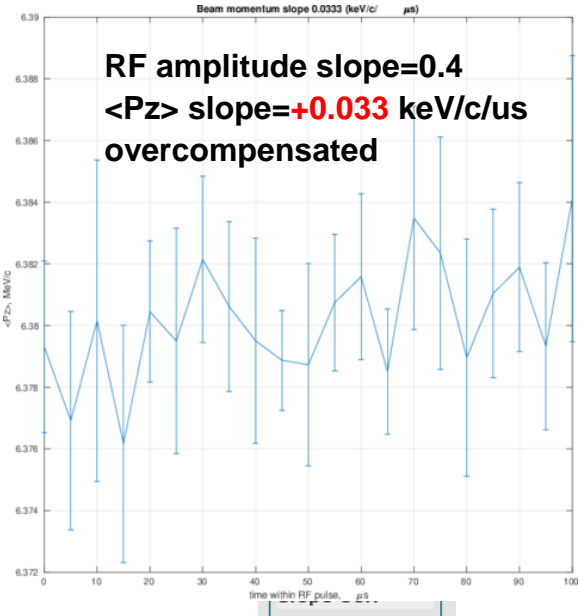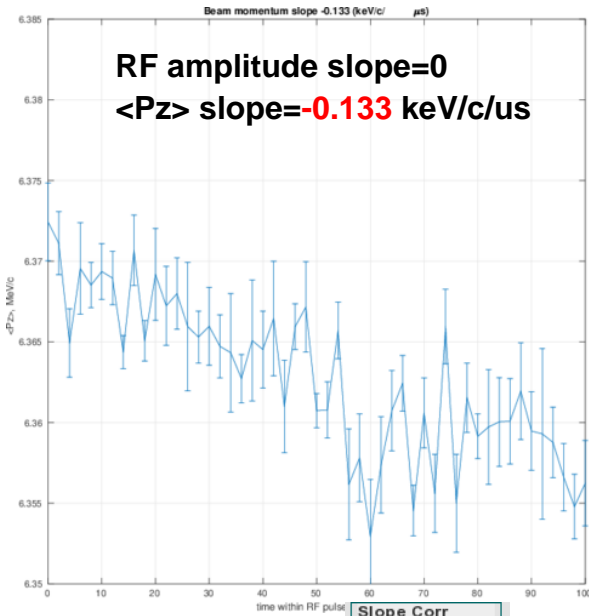
- 100 pulses, LT=3% (low charge) → compromising non-saturation and good S2N

- Scanning *Slope Corr* (manually) and grabbing PZ projection at LEDA with oma
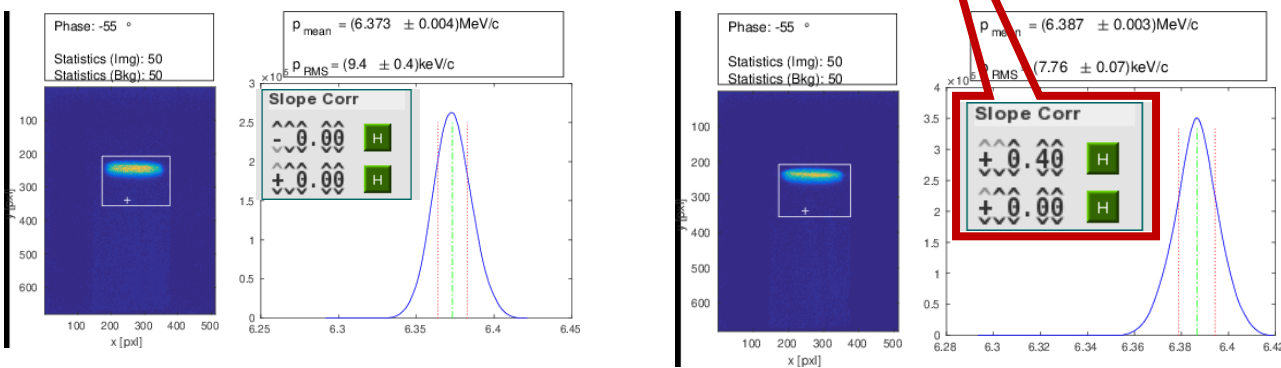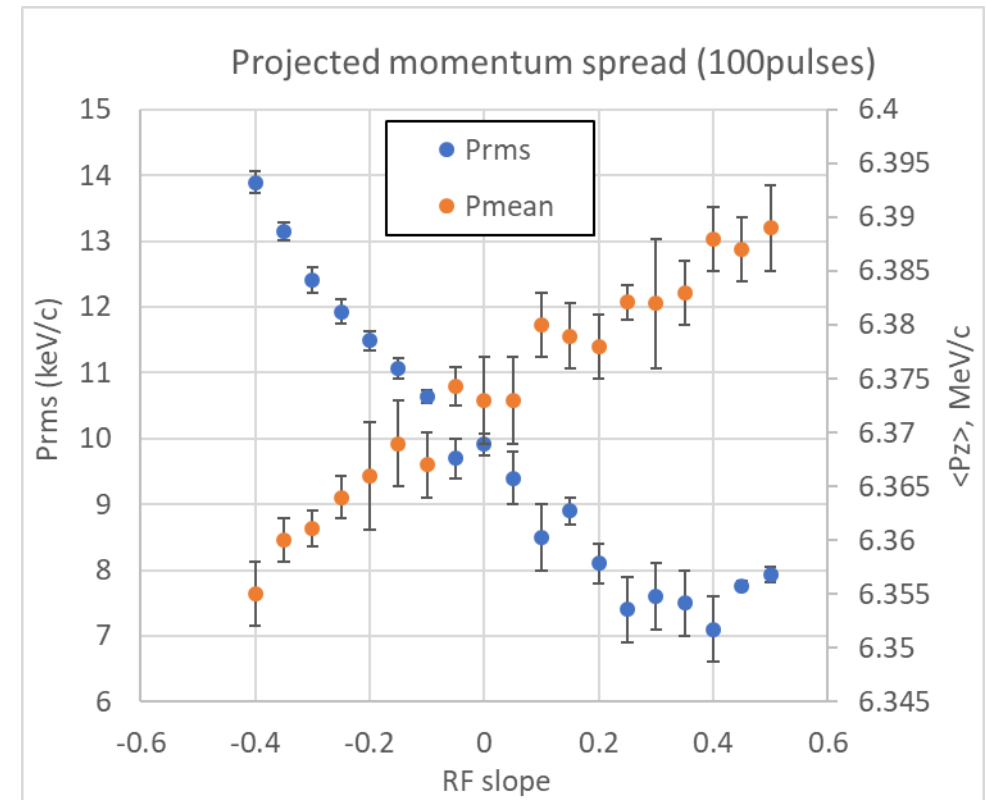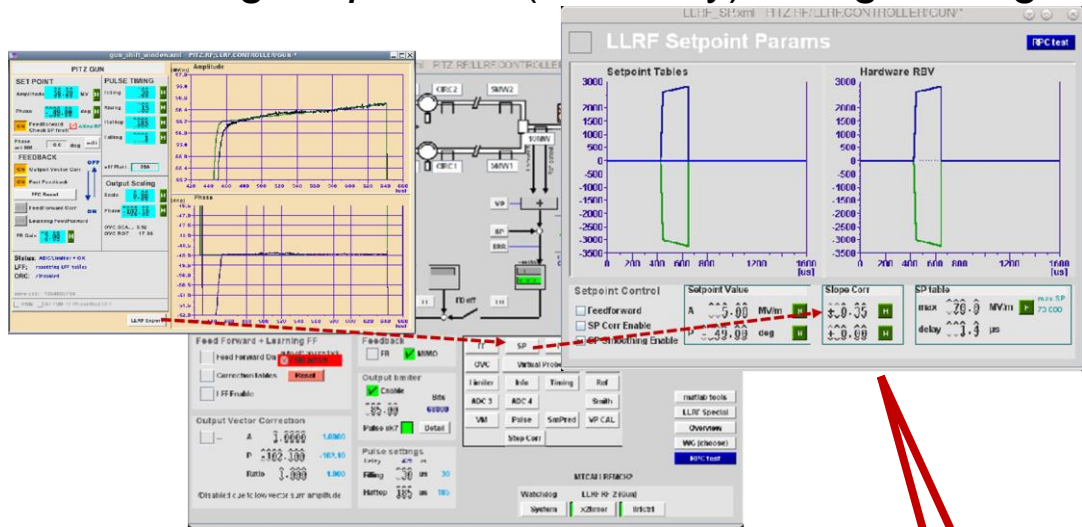
Compensation of the slope with a slope of the RF amplitude

Minimization of the projected rms momentum spread at LEDA for a long pulse train

- 1 pulse, LT=50% (~300pC), A3 scan, MMMG phase

RF amplitude slope=0
$<Pz>$ slope=**-0.133** keV/c/us

RF amplitude slope=0.4
$<Pz>$ slope=**+0.033** keV/c/us
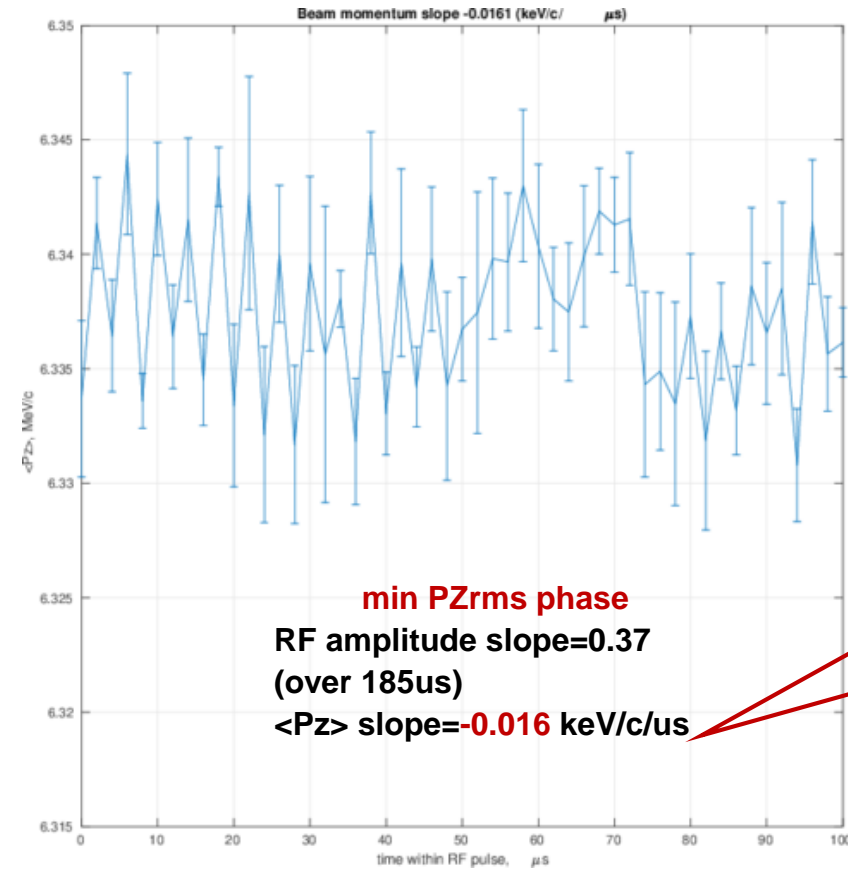overcompensated

RF amplitude slope=0.37
(over 185us)
$<Pz>$ slope=**-0.001** keV/c/us
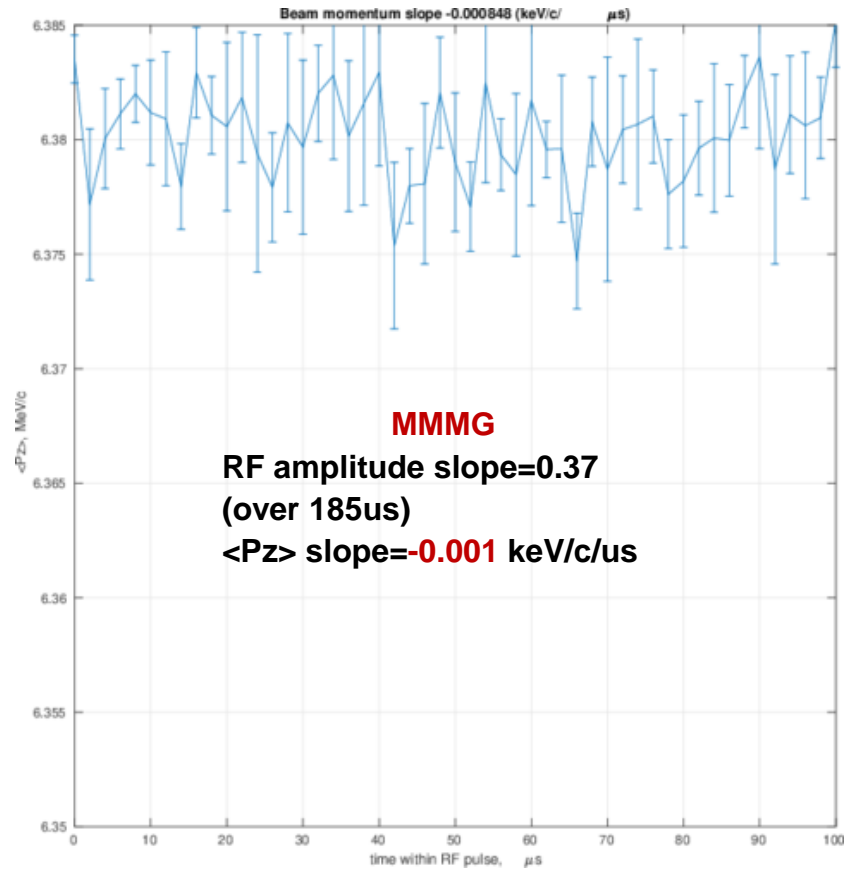
Compensation of the slope with a slope of the RF amplitude

Minimization of the projected rms momentum spread at LEDA for a long pulse train

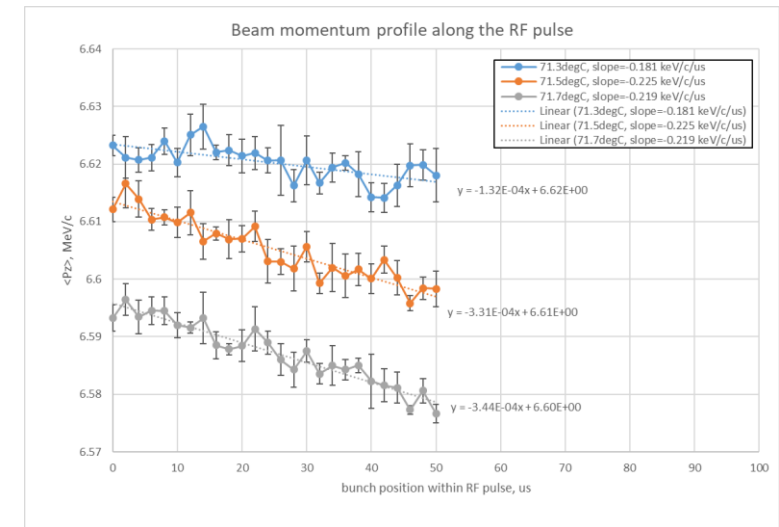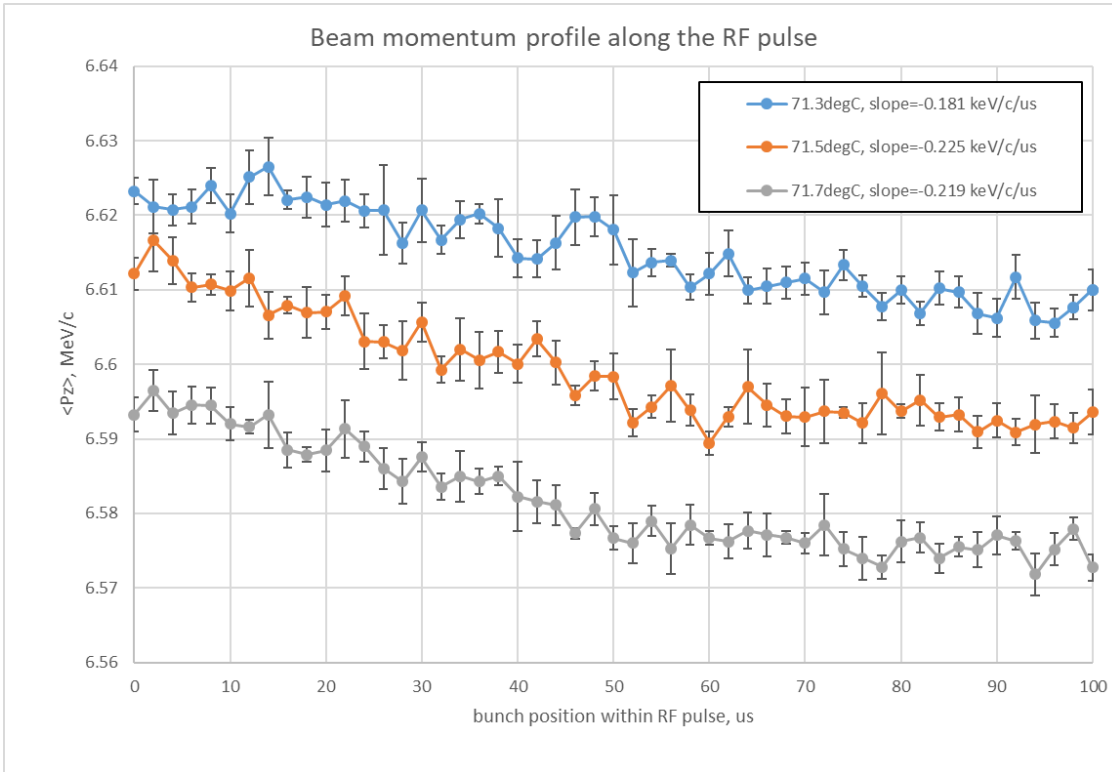- 1 pulse, LT=50% (~300pC), A3 scan, MMMG and minPZrms phases

MMMG
RF amplitude slope=0.37
(over 185us)
<Pz> slope=-0.001 keV/c/us

min PZrms phase
RF amplitude slope=0.37
(over 185us)
<Pz> slope=-0.016 keV/c/us
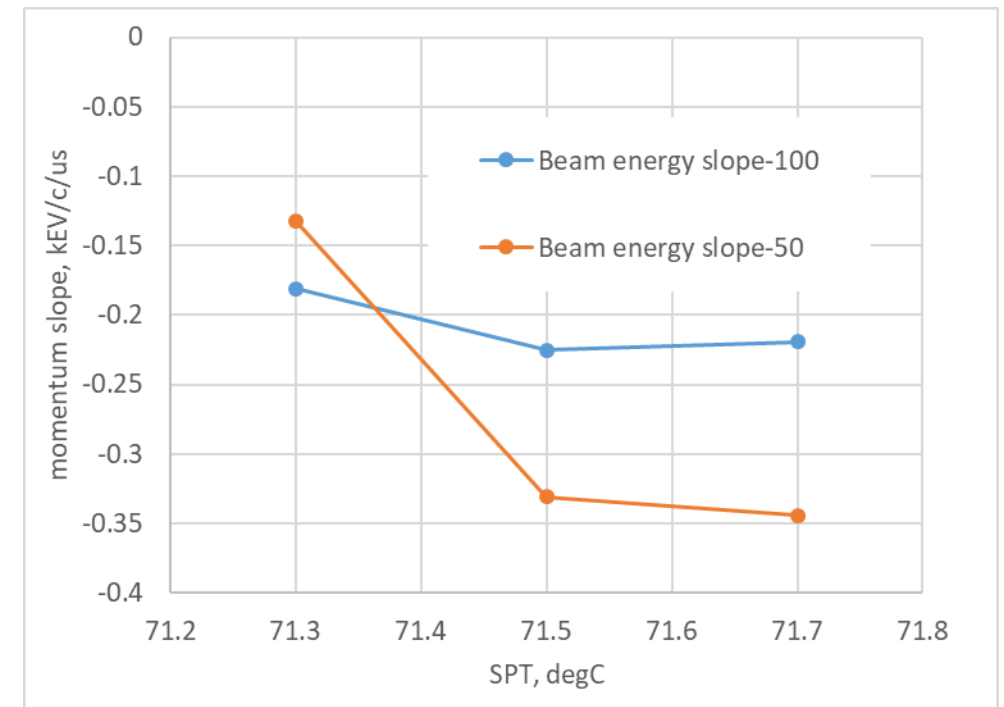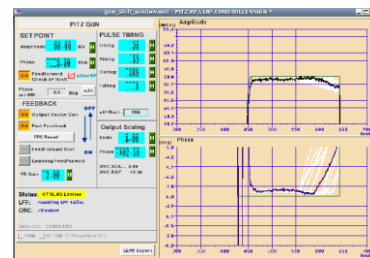
Worse!
Maybe we also
need a phase
slope?

Beam energy slope vs gun temperature

Changing resonance conditions of the gun cavity

- NB: FB was not disabled during gun SPT changing

- Tails → LLRF limiter issue

Conclusions

Studies on beam energy slope along RF pulse

- Script for A3 event (laser) delay scan to measure beam mean momentum → in development & tests

- Gun temperature dependence taken*:

  - A weak dependence found

  - But maybe more thorough studies could be done (tuning the resonance and LLRF limiter)

- Compensation of the slope with a slope of the RF amplitude

  - Minimization of the projected rms momentum spread at LEDA for a long pulse train → in principle works

  - Check with scanning script → OK

  - Works fine, e.g. for SPA=56.2 the slope +0.37 over 185us → makes the PZ profile flat (within error bars)

  - But the phase of the min PZrms → worse! Maybe we also need a phase slope?