Beam energy slope at PITZ: correction studies

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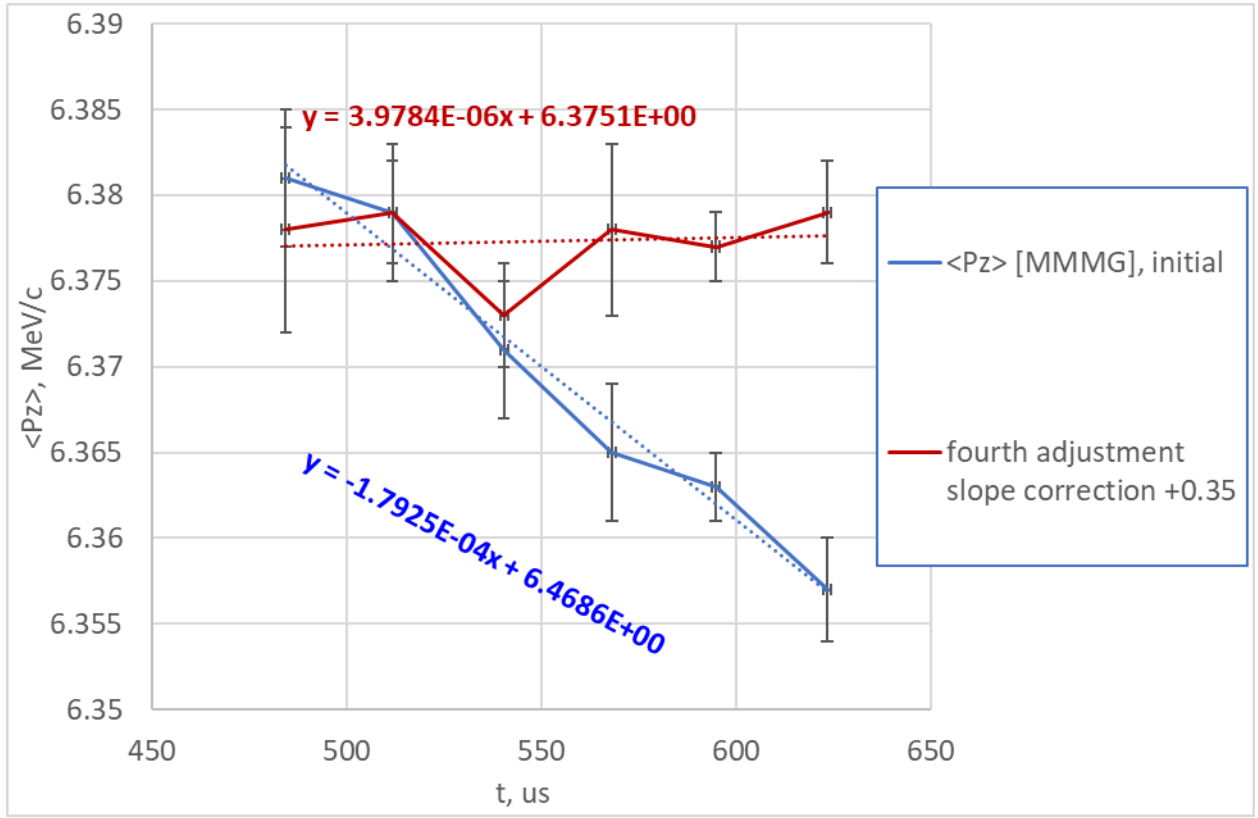
10.06.2021

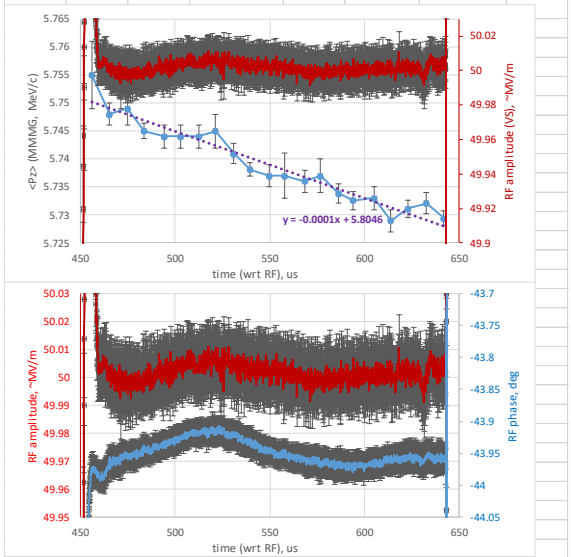


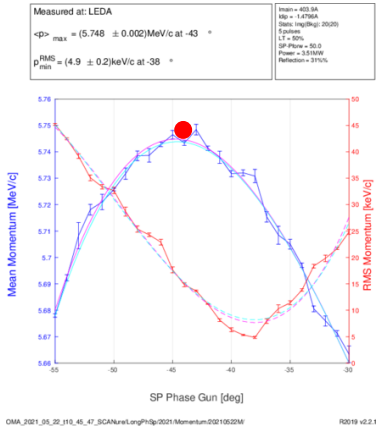
<PZ> within RF pulse, SP=50, BSA=1mm, ~280pC

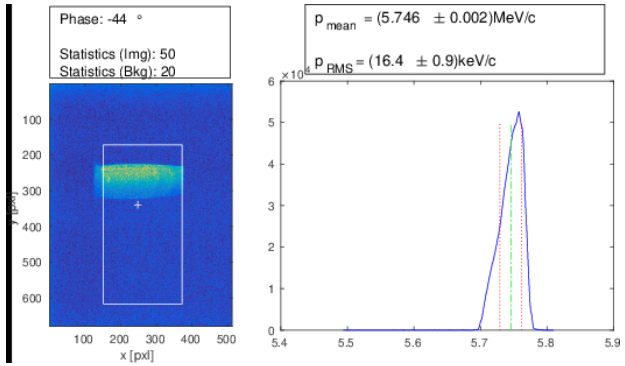
Measurements of the week 20 (21.05.2021M)

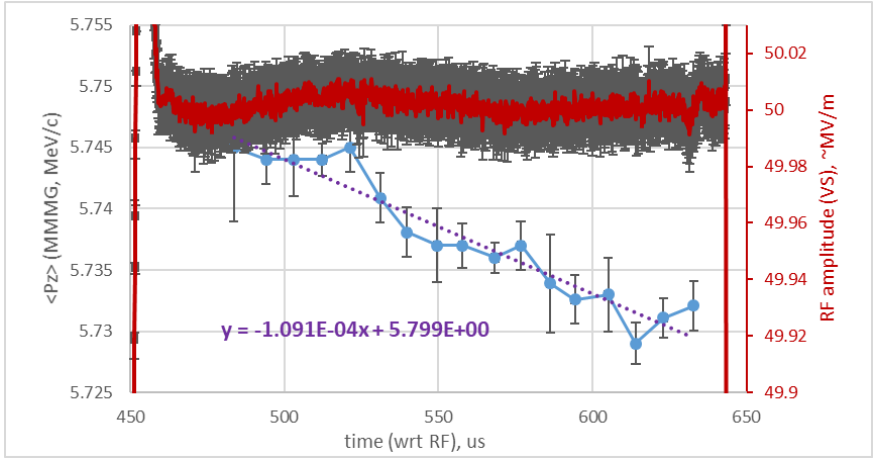
- MMMG phase, 5pulses

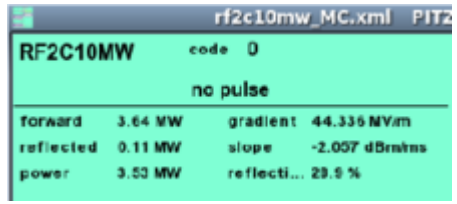
	A3 event	1st pulse	<Pz>(MMMG)	errPZ	PZrms	errPZrms
	1446408	455.8	5.755	0.006	15	1.1
	1447408	465.3	5.748	0.002	14.4	0.2
	1448408	474.8	5.749	0.003	13	1.1
nominal	1449408	483.6	5.745	0.0013	15.4	0.4
	1450408	494.1	5.744	0.002	14.8	0.3
	1451408	503.1	5.744	0.002	14.4	0.9
	1452408	512.4	5.744	0.002	15.8	0.2
	1453408	521.4	5.745	0.003	15.8	0.4
	1454408	531.1	5.7409	0.0018	16.23	0.11
	1455408	539.8	5.7381	0.0012	14.7	0.6
	1456408	549.6	5.737	0.002	16.4	0.7
	1457408	557.8	5.737	0.004	16.6	0.4
	1458408	568.4	5.736	0.002	17.2	0.4
	1459408	576.8	5.737	0.003	16.7	0.3
	1460408	586.4	5.7339	0.0017	15.7	0.7
	1461408	594.3	5.7326	0.0016	16.1	0.7
	1462408	605.1	5.733	0.002	15.2	0.8
	1463408	614.1	5.729	0.002	16.6	0.2
	1464408	623.1	5.7311	0.0016	15.5	0.6
	1465408	632.9	5.7321	0.0019	15.9	0.3
	1466408	642.1	5.7294	0.0013	17.6	0.13

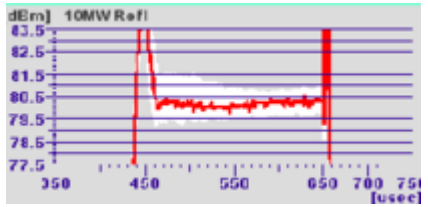










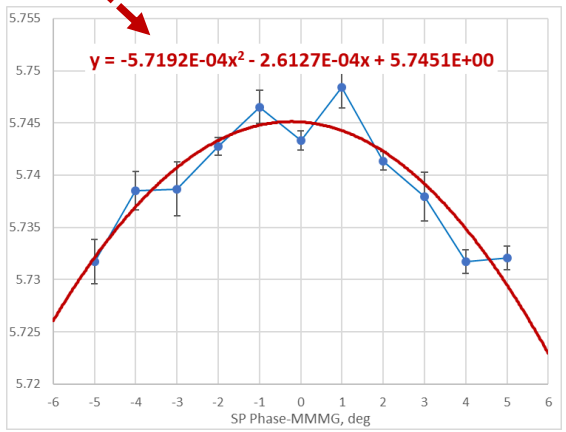


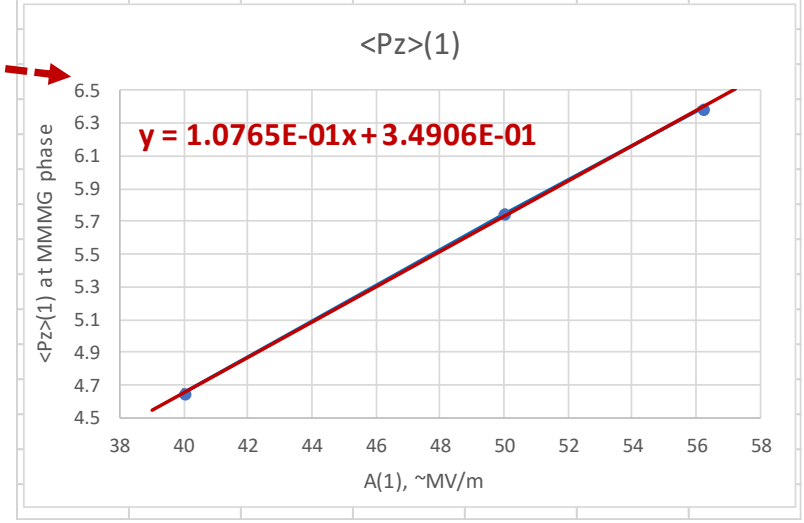
SP=50 Analysis

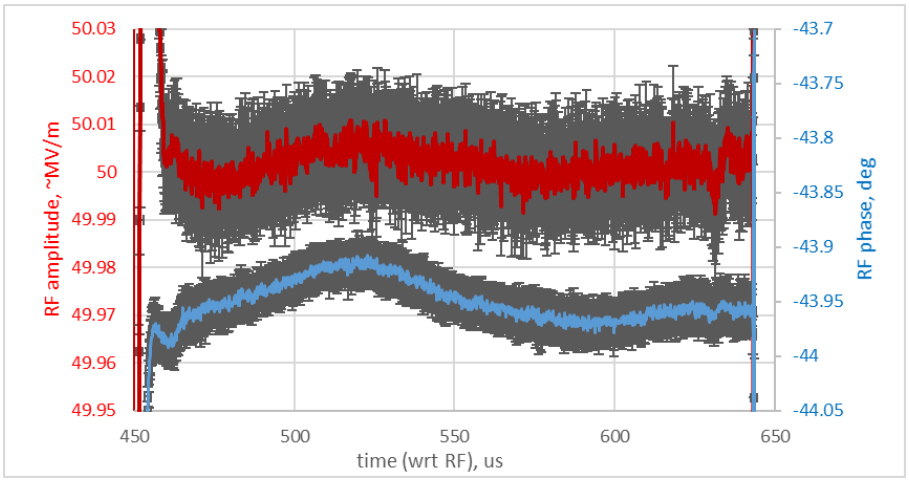
Measurements of the week 20 (21.05.2021M)

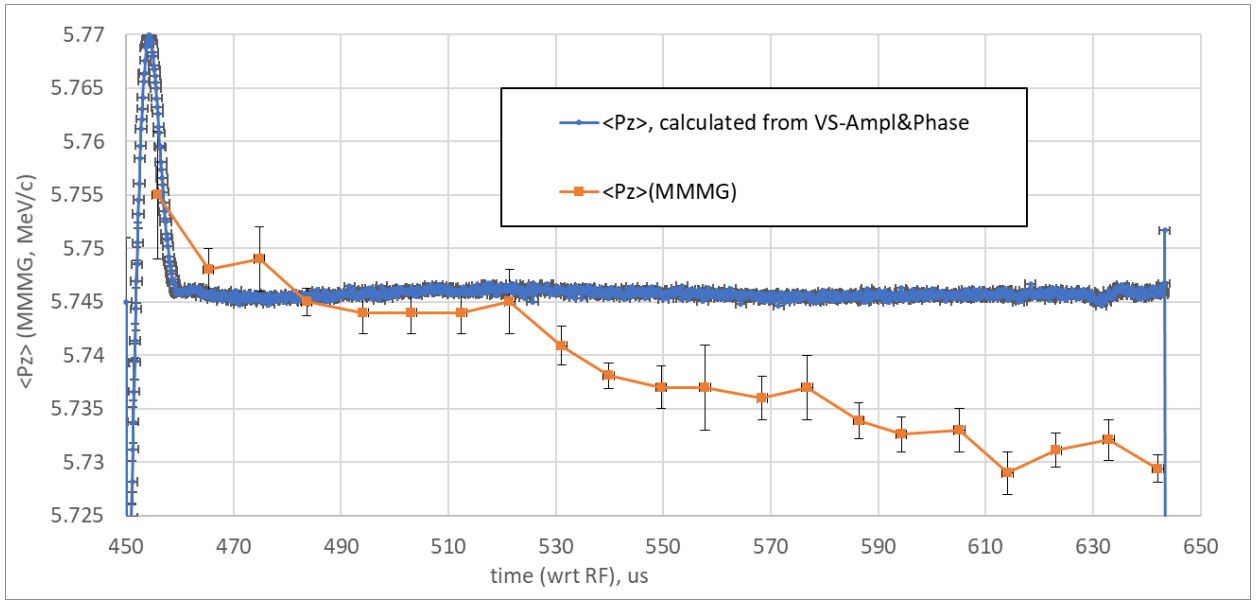
Phase scan at LEDA and <Pz> vs. SPAmpl

SPA	A(1)	errA(1)	Phase(1)	errPhase1	<Pz>(1)	err<Pz>(1)
40	39.99121	0.00904	-36.9712	0.01811	4.649	0.0013
50	49.99478	0.0101	-43.9406	0.017267	5.745	0.0013
56.2	56.20264	0.014066	-44.9427	0.016339	6.391	0.003





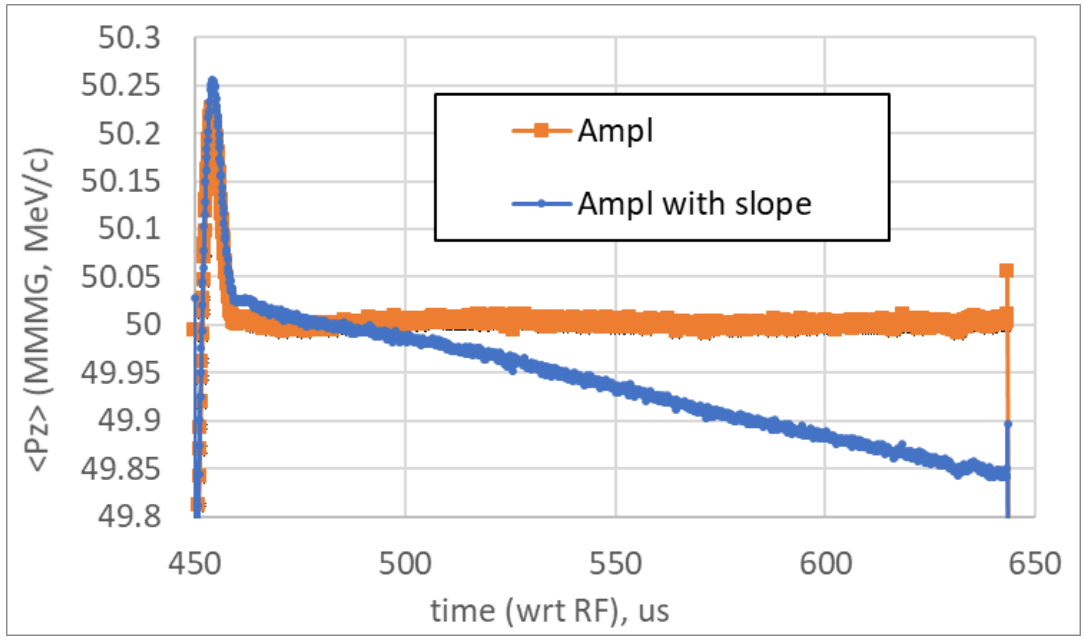


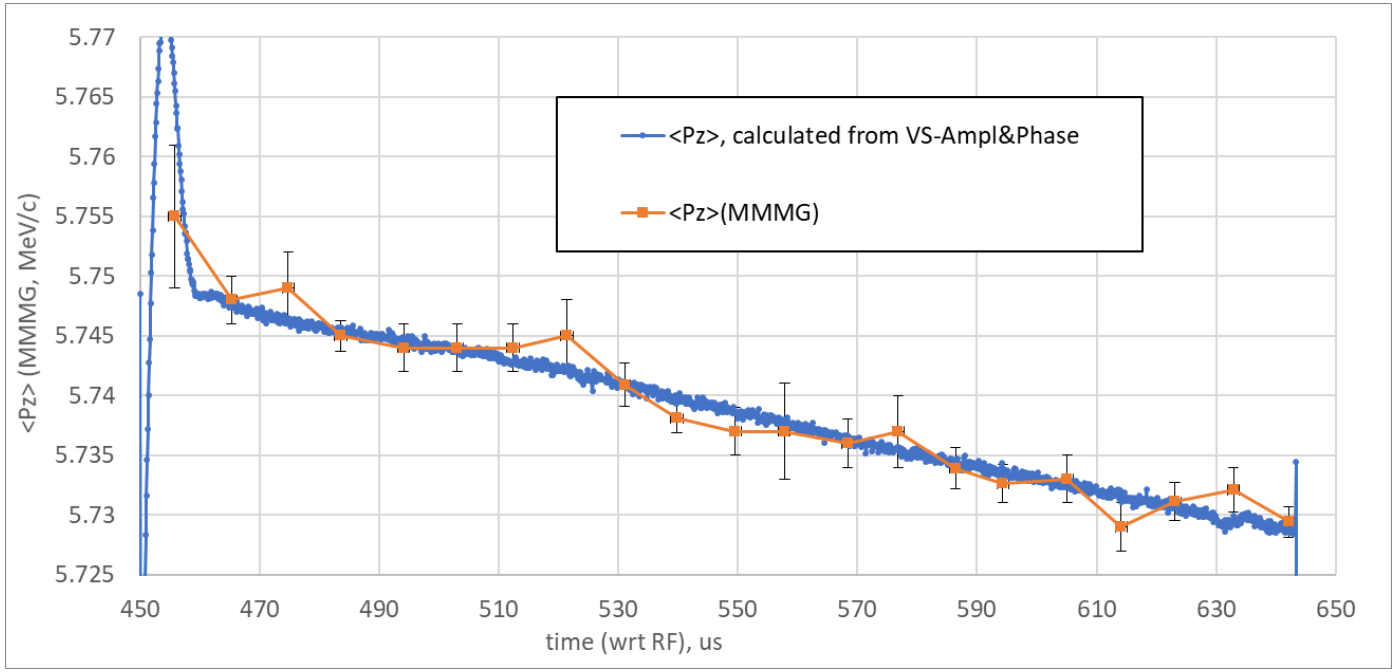


SP=50, + Amplitude slope

Artificial Amplitude slope to reproduce <Pz>(t)

$$slope = -0.001 \frac{MV/m}{\mu s}$$

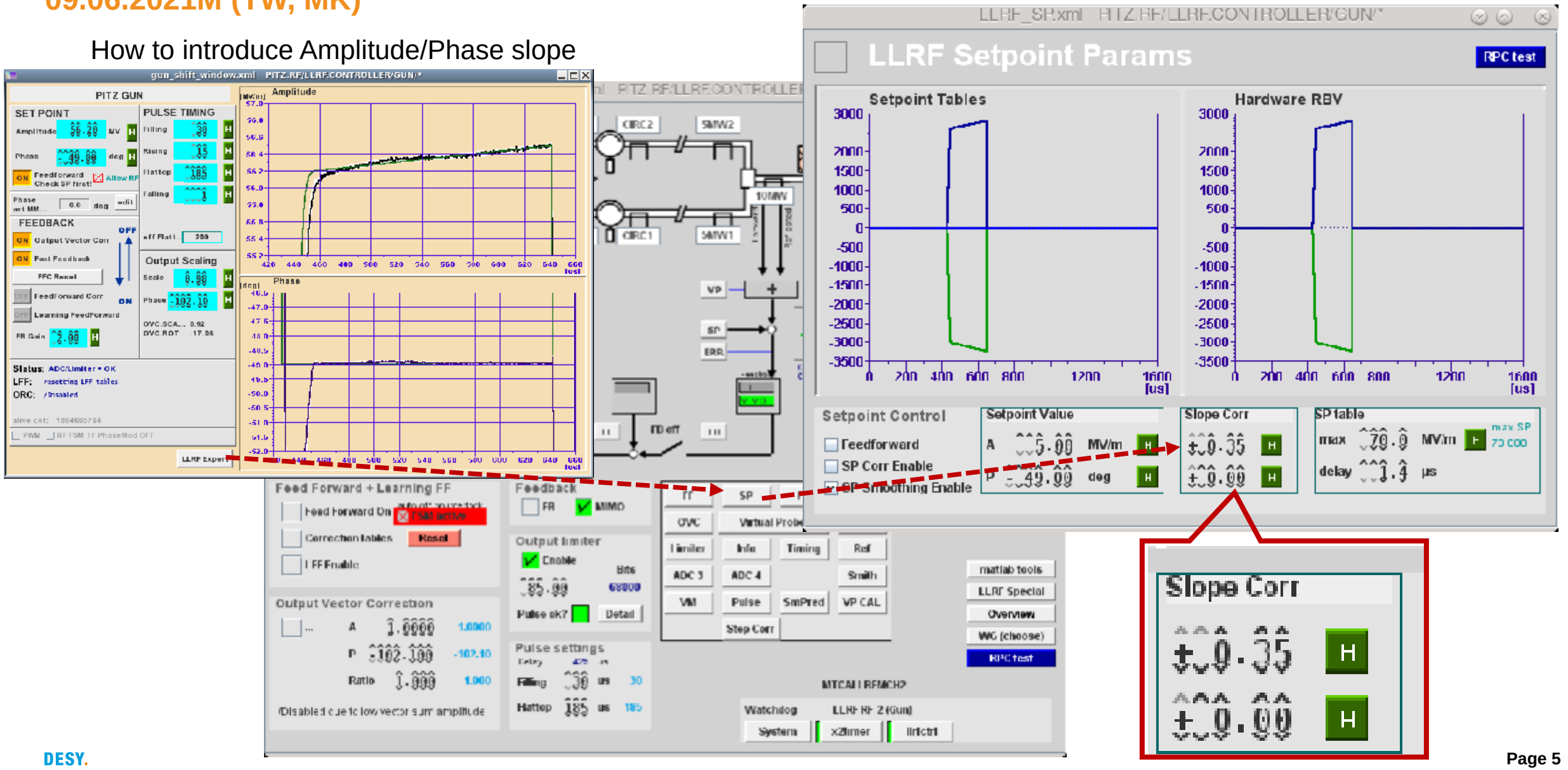




Beam energy slope correction with amplitude slope

09.06.2021M (TW, MK)

How to introduce Amplitude/Phase slope



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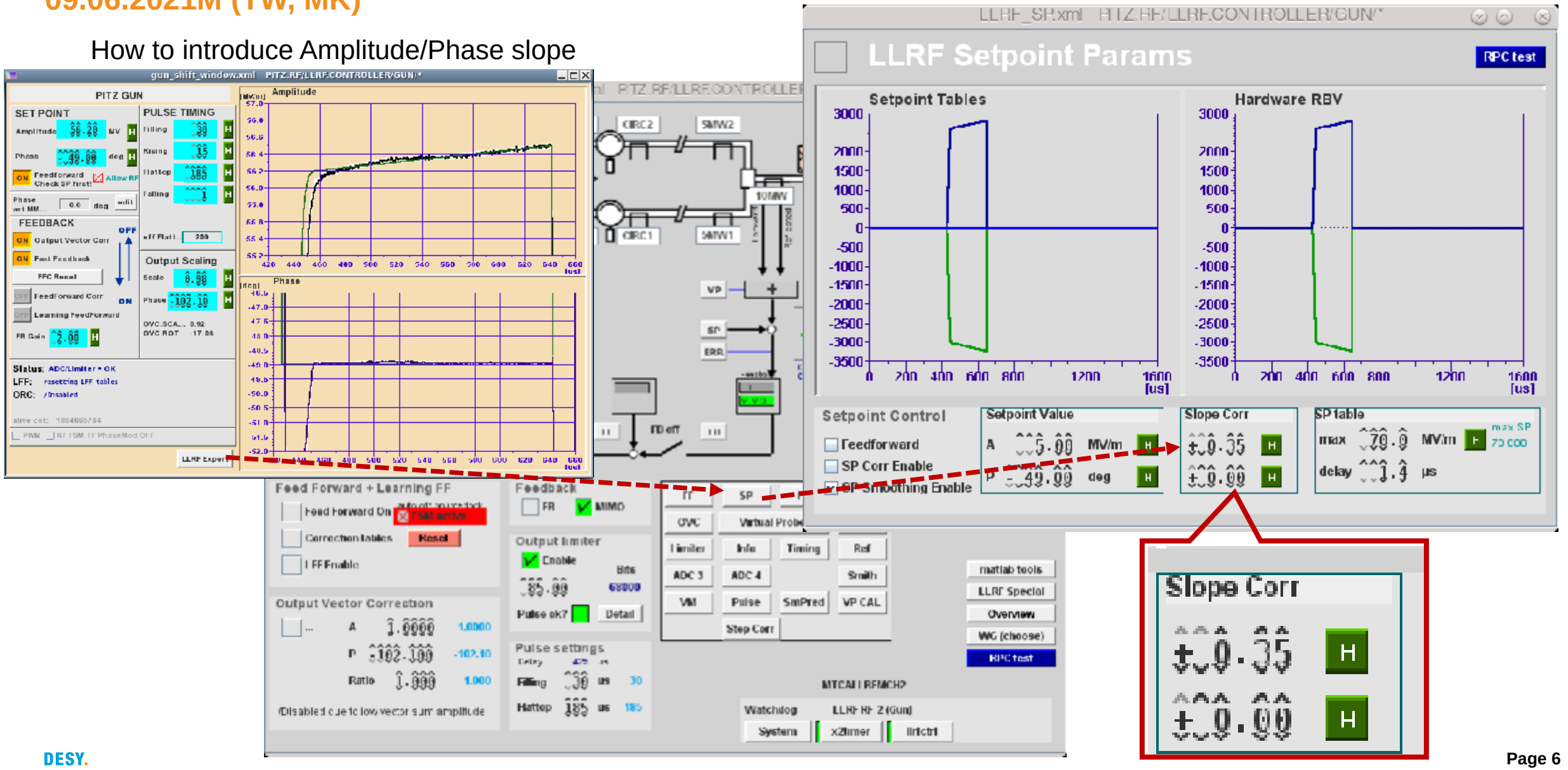
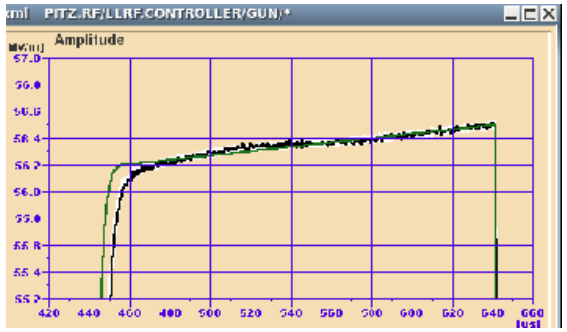
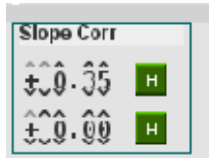


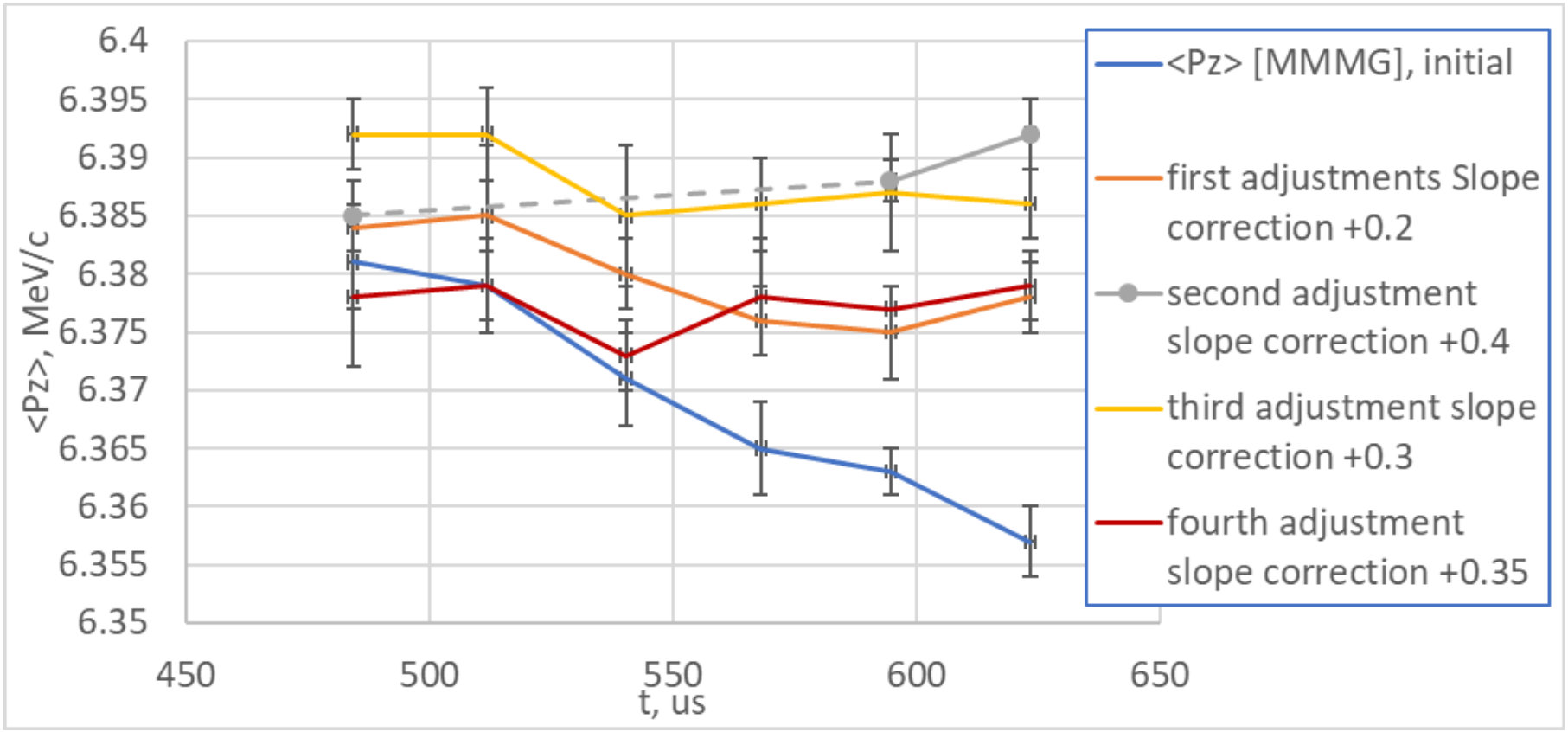
Beam energy slope correction with amplitude slope (SP=56.2)

09.06.2021M (TW, MK)





Slope=0.35 over 185us RF flattop

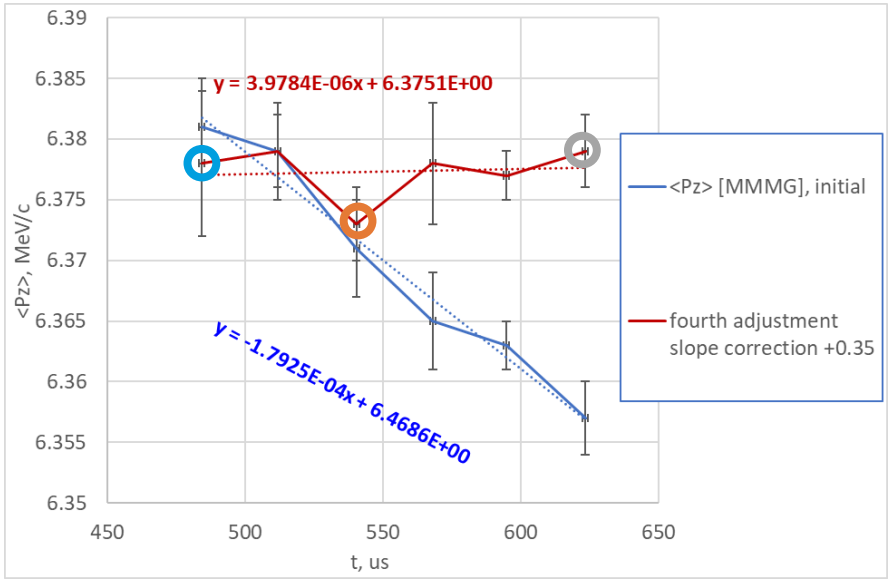


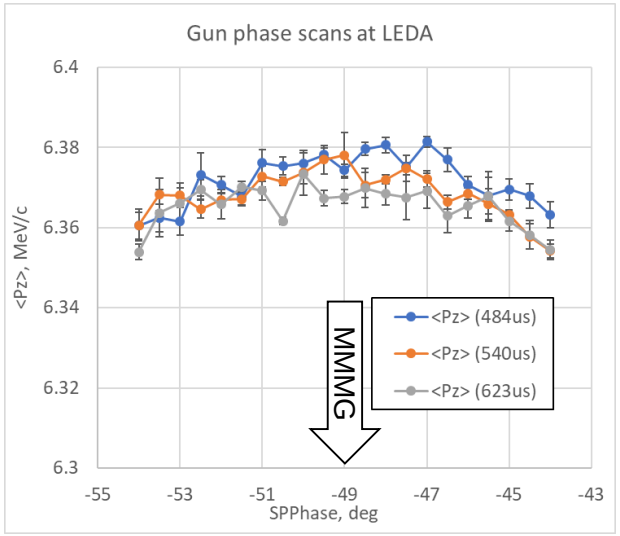
Beam energy slope correction with amplitude slope (SP=56.2)

09.06.2021M (TW, MK)

used

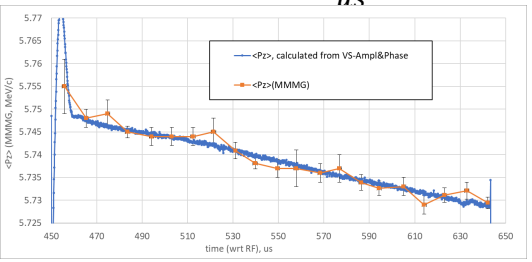
$$slope = \frac{0.35}{185} = 0.00189 \frac{MV/m}{\mu s}$$

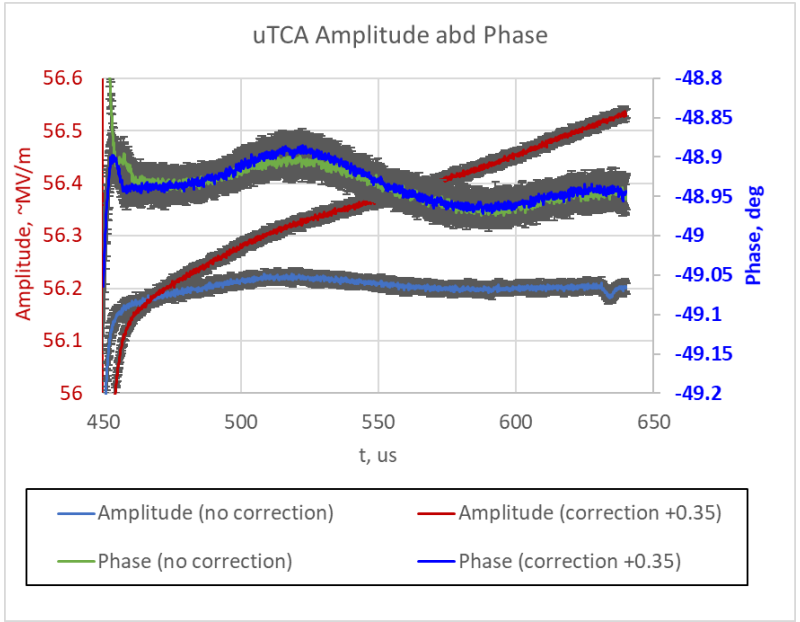


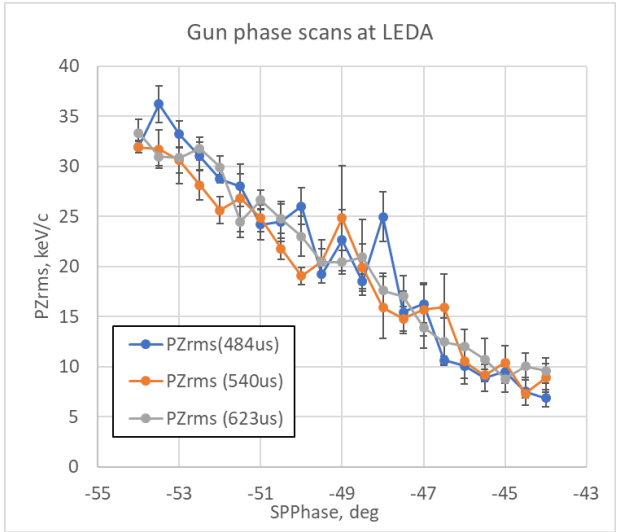


NB: Estimated for SP=50

$$slope = -0.001 \frac{MV/m}{\mu s}$$







Summary

Beam energy slope correction

- Electron beam energy slope along the RF gun pulse has been observed for the nominal settings at PITZ
  - LEDA measurements by scan A3 (laser)
  - Slopes ~$-3 \cdot 10^{-5} \frac{d \log<P_z>}{dt}$ are well measurable at e.g. MMMG phase
  - Cannot be explained by measured amplitude/phase profiles (very flat)
- The $< P_z >$ slope can be compensated by introducing a positive amplitude slope
  - For SP=56.2 the slope -0.35 over 185 us flattop RF pulse ($0.0019 \frac{MV/m}{\mu s}$)

    → the momentum slope ~$+6 \cdot 10^{-7} \frac{d \log<P_z>}{dt}$ (0 within error bars)
  - Well agreed with estimated slope $-0.001 \frac{MV/m}{\mu s}$ to explain results for SP=50
- Still it is not clear where the slope comes from (RF power coupler kick, beam loading, uTCA measurement artifact ($\beta(t)$-?) ,…?)
- How to improve the tuning procedure:
  - Long pulse train (low charge, small BSA, e.g. Pharos 0.1 MHz) → minimize energy spread at LEDA at MMMG phase?
  - Fine tuning resonance/FB
  - …?

Backup

Regular studies of the beam energy slope along the RF pulse

Measurement program

1. SPA=SPA0=56.2(?), Sharp gun resonance (|slope|~< 5), stabilize water (incl. valves), setup FB
2. Find first pulse location w.r.t. VS signals (uTCA) --> Ampl(1),Phase(1) (I still have some questions to the procedure, see the last slide in the attached file)
3. LEDA scan around MMMG using 1 pulse (if possible), recording VS-amplitude&phase especially at the location of the 1st pulse (found in p.2) --> <PZ>(Ampl(1),Phase(1)) --> vector
4. SPA=SPA+/-0.5, repeat 1-3
5. Form a matrix <PZ>(Ampl(1),Phase(1)) , based on that we can plot expected <Pz> profile along the RF pulse <Pz> (Ampl(n),Phase(n)) for e.g., SP0, then we can compare it with the measured <Pz> by shifting A3 event (laser).