

BPM Commissioning (cont'd)

BPM Commissioning in week 12/2021

M. Krasilnikov, PPS, 08.04.2021

BPMs Commissioning in week 12/2021

Main goals

1. DISP3.BPM1 → commissioning (find signals, zero-crossing, calibration)
2. HIGH2.BPM1 → calibration with screen before (HIGH2.Scr2)
3. LOW.BPM1,2, BOO.BPM1,2, RFD.BPM1,2: refine calibration refined wrt ($\sim 0, \sim 0$)
4. If p.3 does not work for BOO,BPM1,2 → the same approach as p.2
5. DISP3.BPM2 → calibration
6. Check nonlinearity:
 - a. Wider range ($>5\text{mm}$)
 - b. X-calibration vs. Y-offset and Y-calibration vs. X-offset
7. Some measurements of effective $\langle P_z \rangle$ pulse train profile (before measurements at FLASH)

LOW.BPM2 calibration refinement

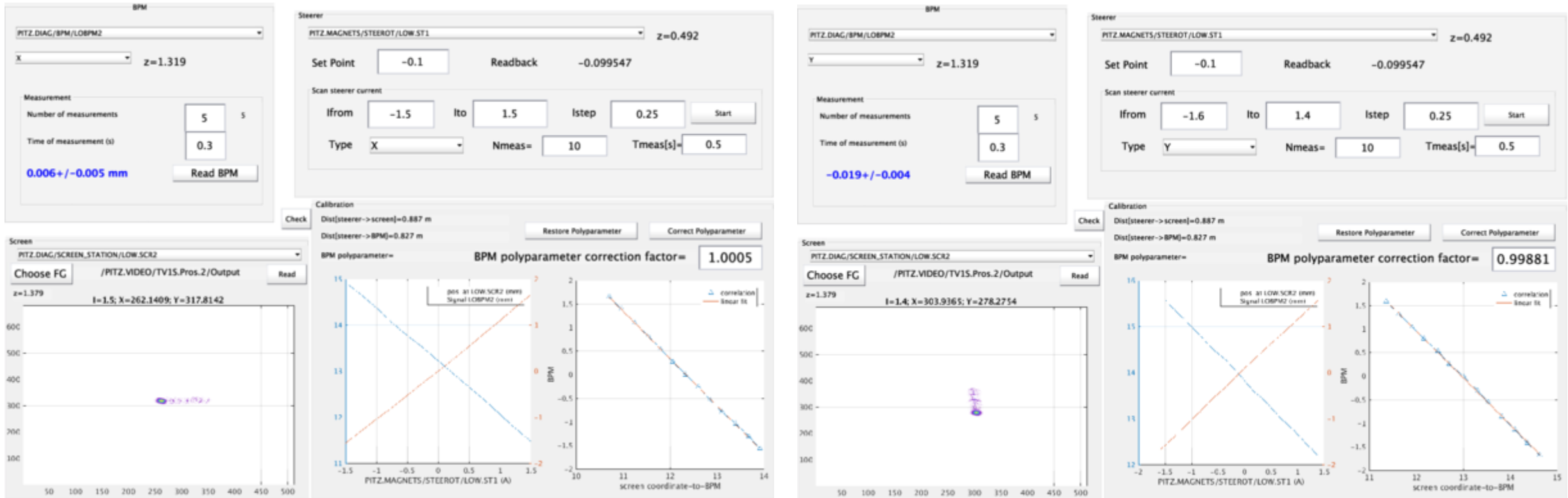
28.03.2021M

LOW.St1(x/y)-LOW.BPM2-LOW.Scr2:

X-calibration: $(x,y)=(-1.5\text{mm}\dots+1.5\text{mm},0)$

Y-calibration: $(x,y)=(0,-1.5\text{mm}\dots+1.5\text{mm})$

Nominal RF power (SP56.2), 0.5-0.6nC



LOW.BPM1 calibration refinement

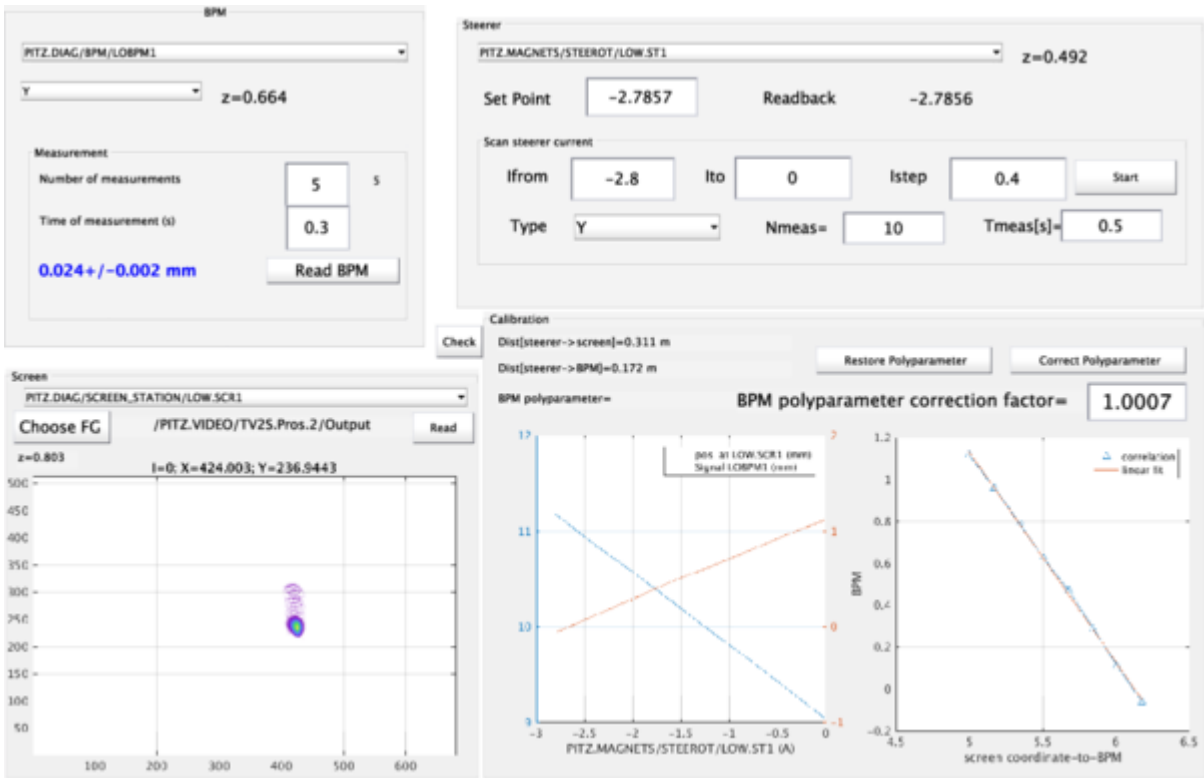
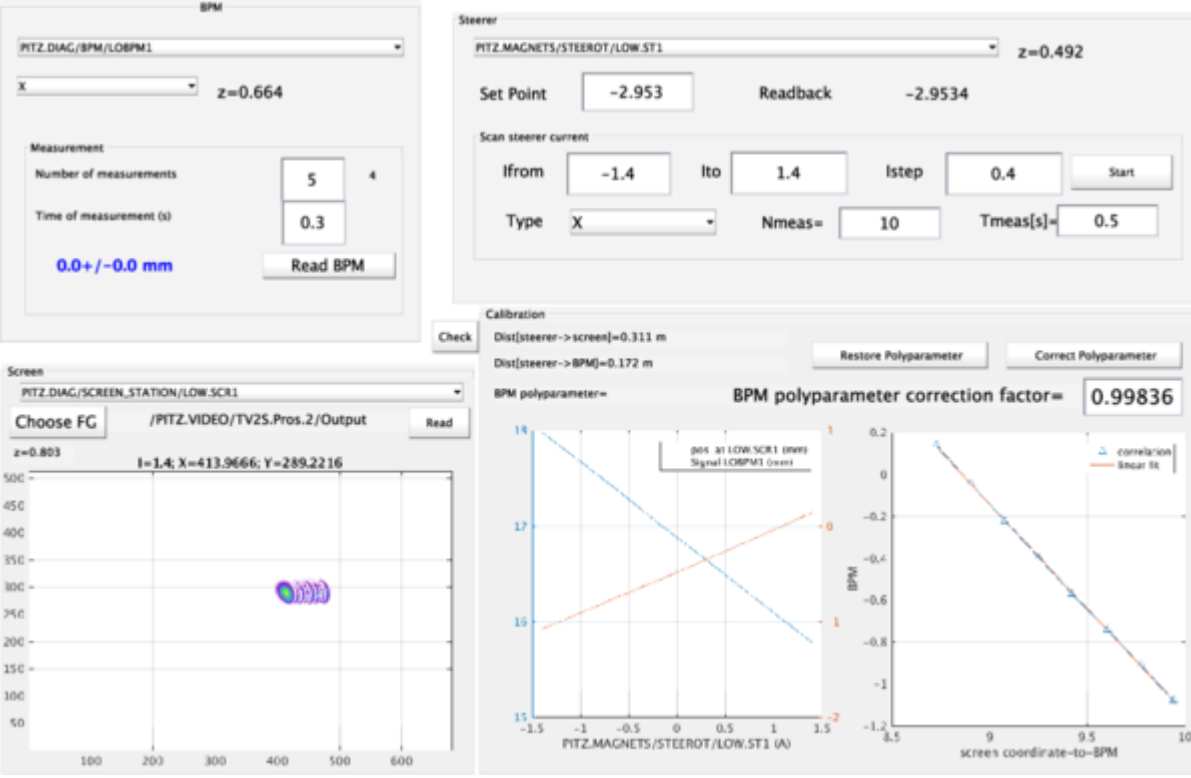
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LOW.St1(x/y)-LOW.BPM1-LOW.Scr1:

X-calibration: $(x,y)=(-1.1\text{mm}\dots+0.1\text{mm},0)$

Y-calibration: $(x,y)=(0,-0.1\text{mm}\dots+1.1\text{mm})$

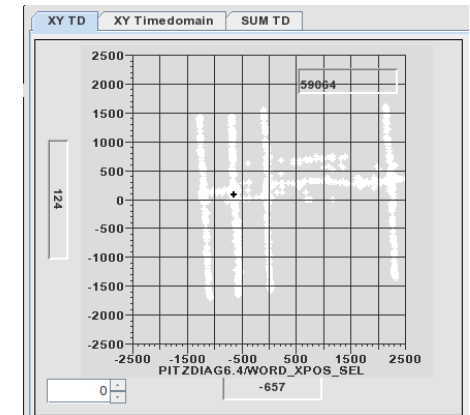
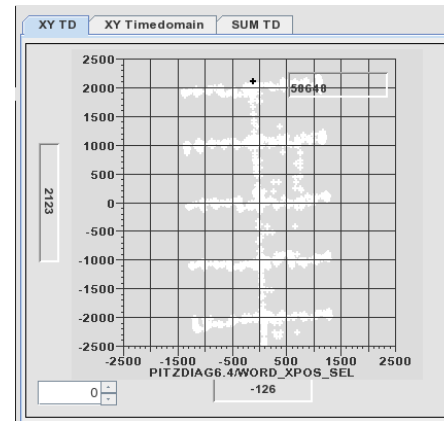
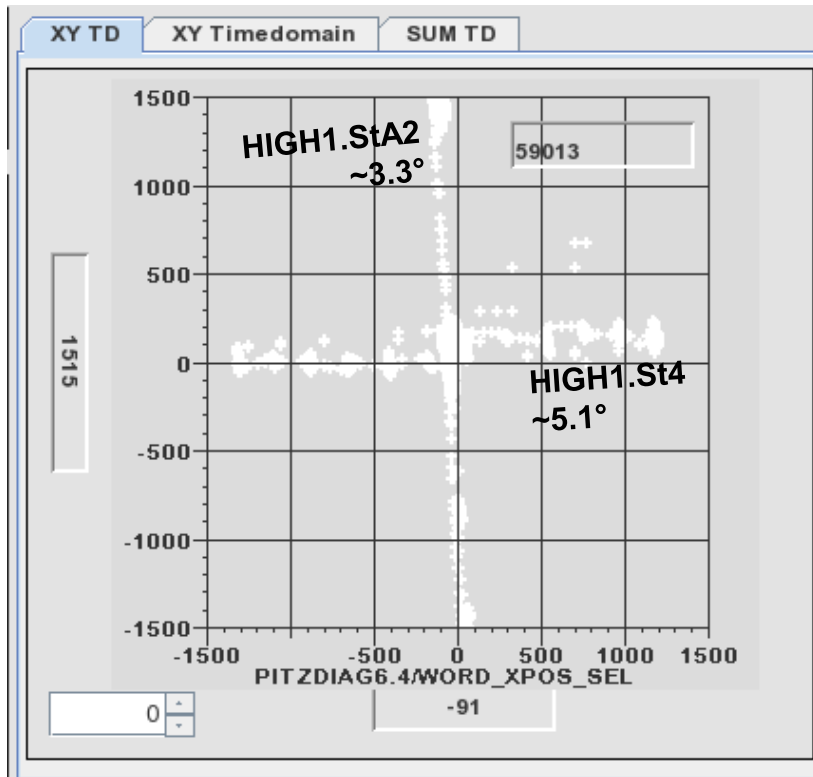
Reduced RF power (SP27, 1MWg), 0.5nC



RFD.BPM1: calibration vs \perp offset

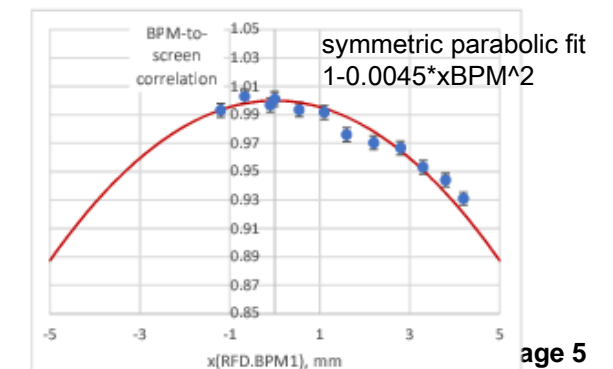
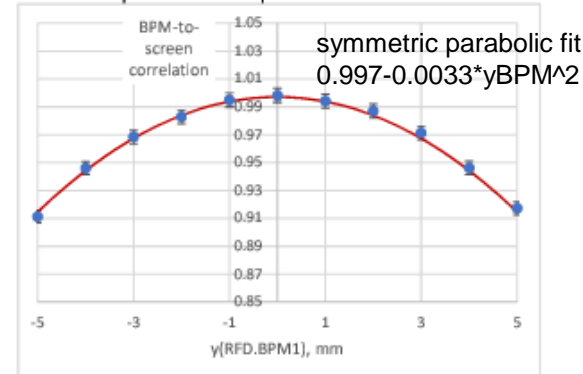
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HIGH1.St4/HIGH1.StA2-RFD.BPM1-PST.Scr1



HIGH1.StA2	RFD.BPM1-<Y>	Correlation RFD.BPM1-X-to-Scr
0.45	-5	0.91118
0.59	-4	0.94602
0.712	-3	0.96834
0.826	-2	0.9828
0.927	-1	0.99491
1.03	0	0.99817
1.14	1	0.99403
1.24	2	0.98705
1.34	3	0.97134
1.47	4	0.94618
1.593	5	0.91714

HIGH1.St4	RFD.BPM1-<X>	Correlation Scr2RFD.BPM1-Y
2.5	-1.2	0.99321
2	-0.67	1.003
1.5	-0.1	0.9969
1.49	0	1.001185
1	0.54	0.99365
0.5	1.1	0.9919
0	1.6	0.97607
-0.5	2.2	0.97039
-1	2.8	0.96665
-1.5	3.3	0.9532
-2	3.8	0.94411
-2.5	4.2	0.93105

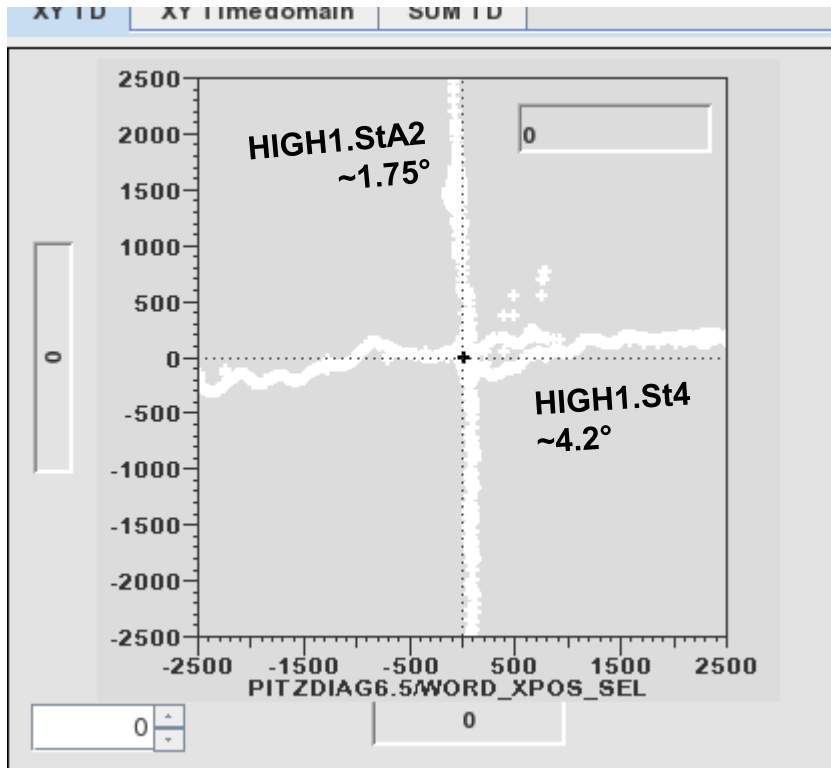


From PST.Scr1: Xangle=2.9° ; Yangle=1.4°

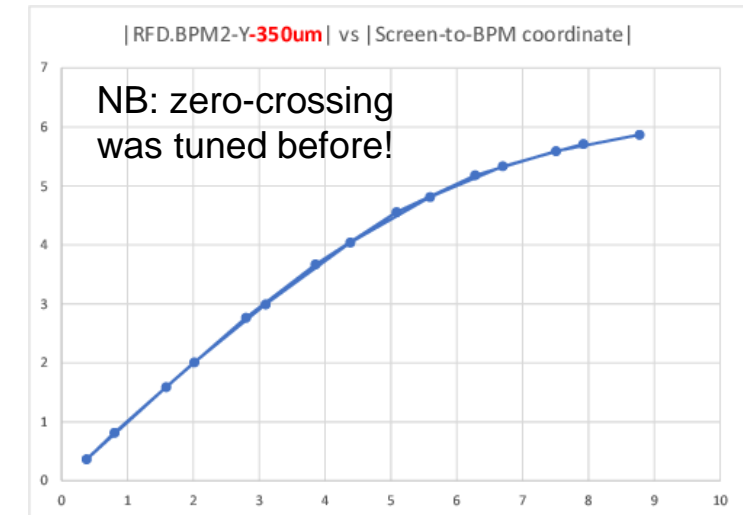
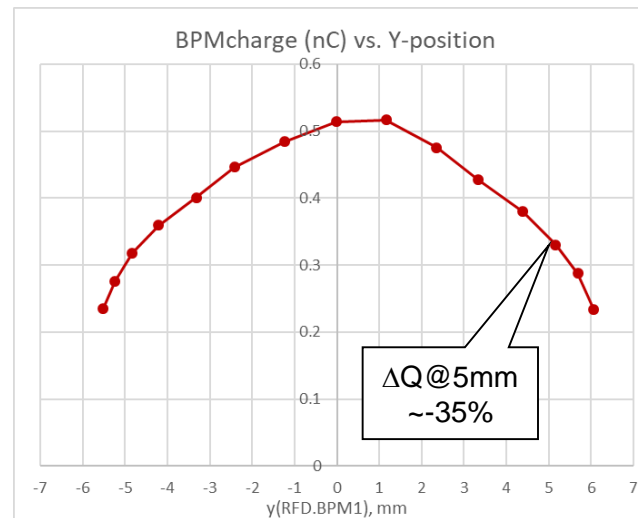
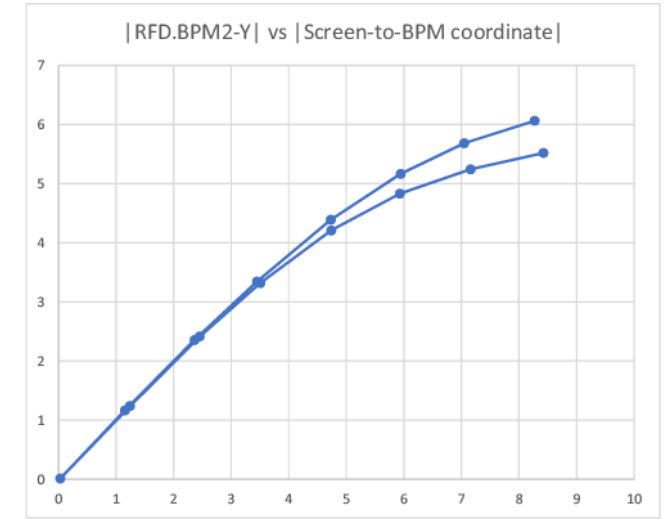
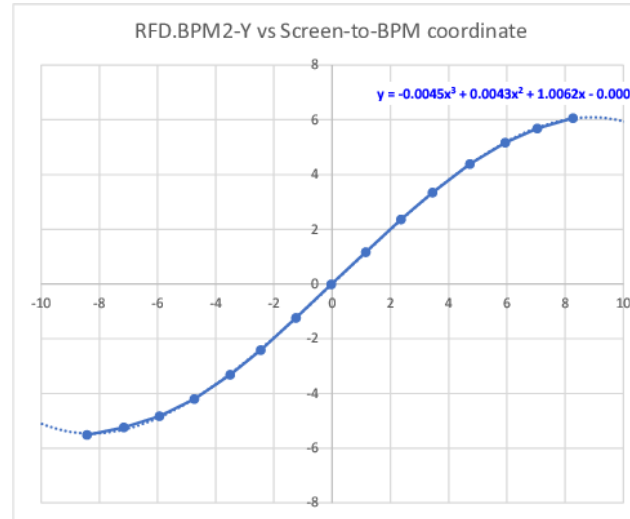
RFD.BPM2: nonlinearity check for Y=0-crossing

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HIGH1.St4/HIGH1.StA2-RFD.BPM2-PST.Scr1



From PST.Scr1: Xangle=2.9° ; Yangle=0.17°



$$Q/Q(0,0) = -0.0153y^2 + 0.0084y + 0.9929$$

BOO.BPM1: calibration refinement

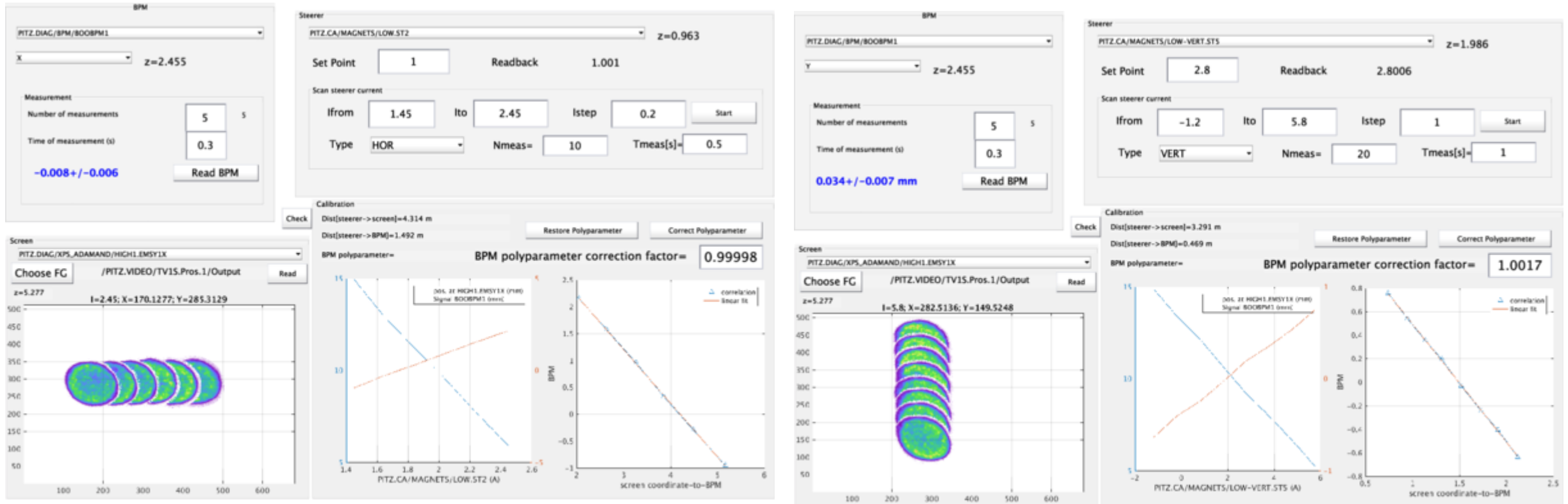
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LOW.St2/LOW-VERT.ST5-BOO.BPM1-LOW.Scr2:

X-calibration: $(x,y)=(-1.0\text{mm}\dots+2.0\text{mm},0)$

Y-calibration: $(x,y)=(0,-0.6\text{mm}\dots+0.8\text{mm})$

Nominal RF power (SP56.2), 0.5-0.6nC, no booster



BOO.BPM2: calibration refinement

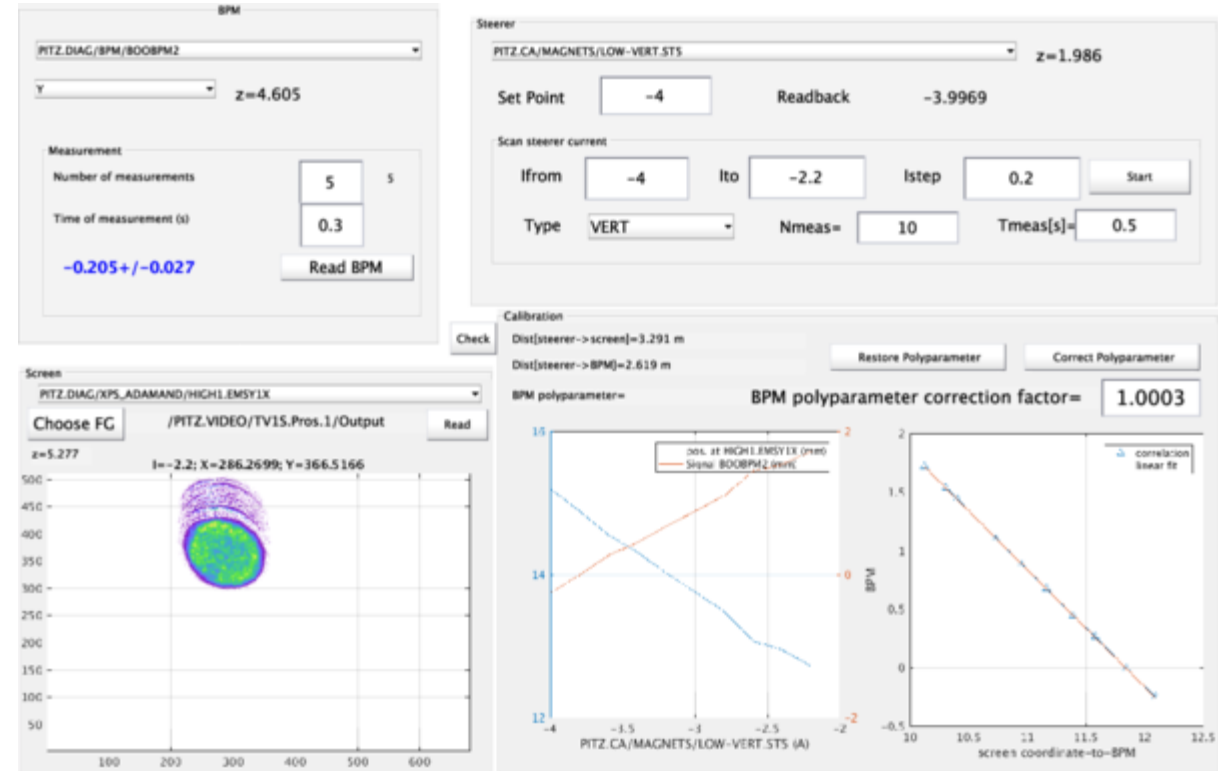
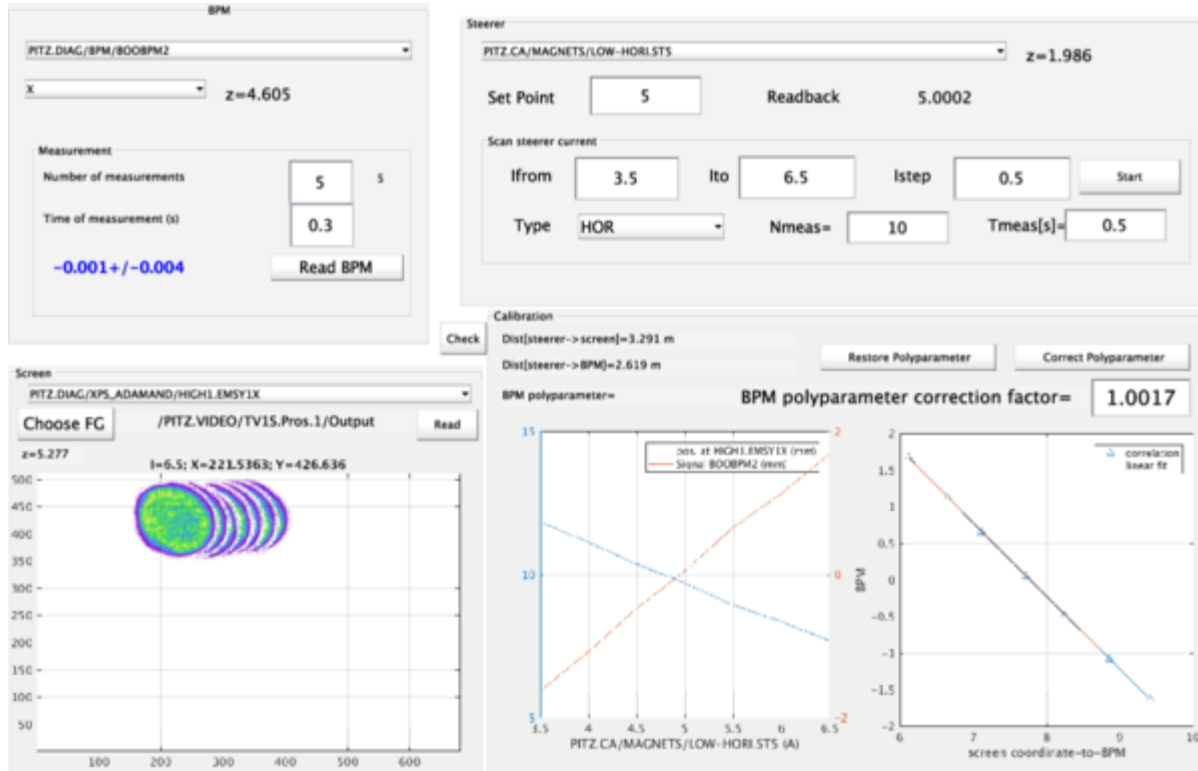
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LOW.St2/LOW-VERT.ST5-BOO.BPM2-LOW.Scr2:

X-calibration: $(x,y)=(-1.5\text{mm}...+1.5\text{mm},0)$

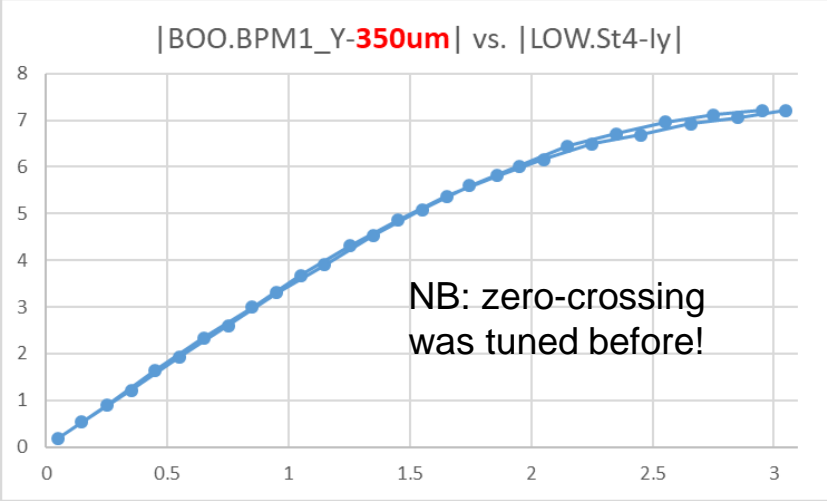
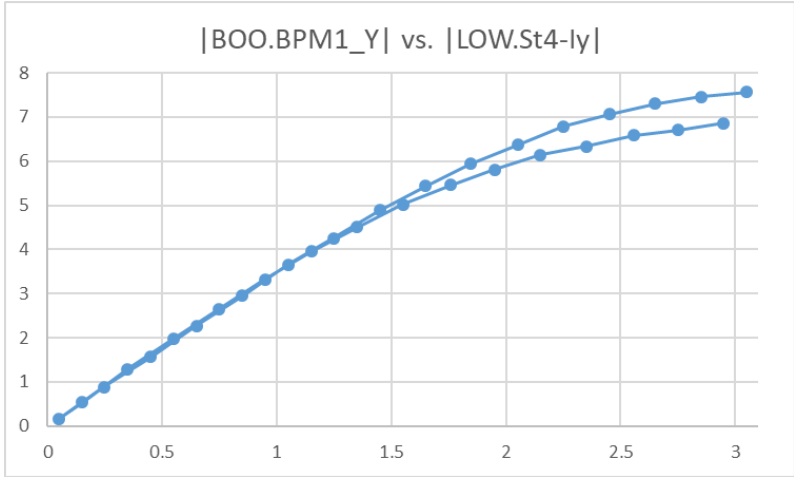
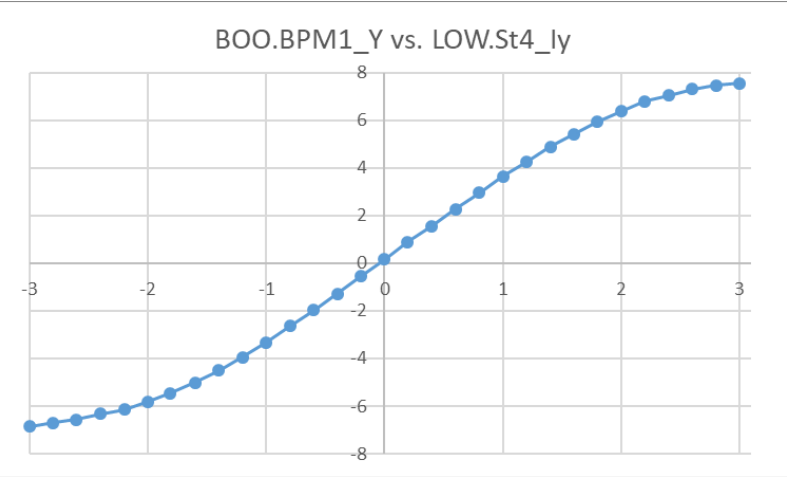
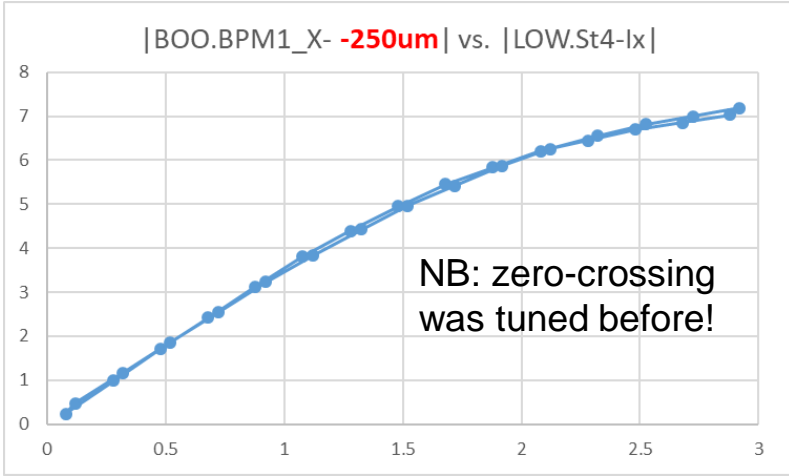
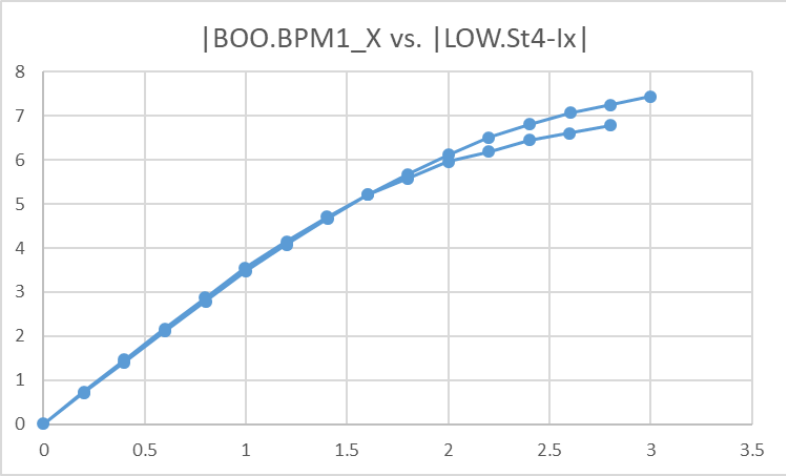
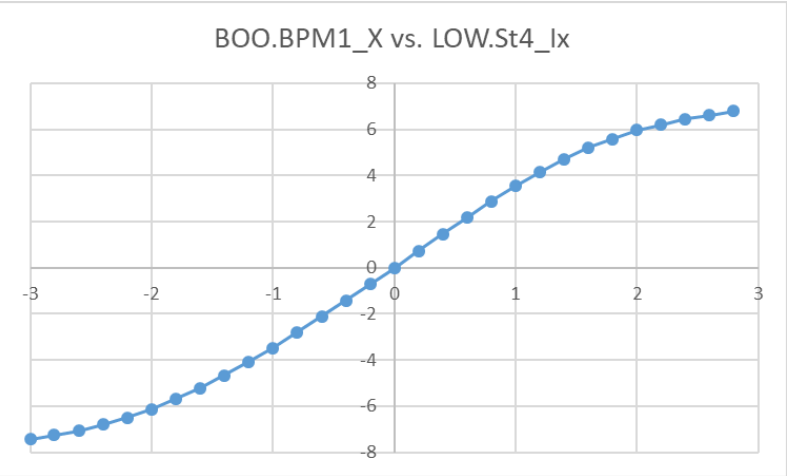
Y-calibration: $(x,y)=(0,-0.3\text{mm}...+1.7\text{mm})$

Nominal RF power (SP56.2), 0.5-0.6nC, no booster



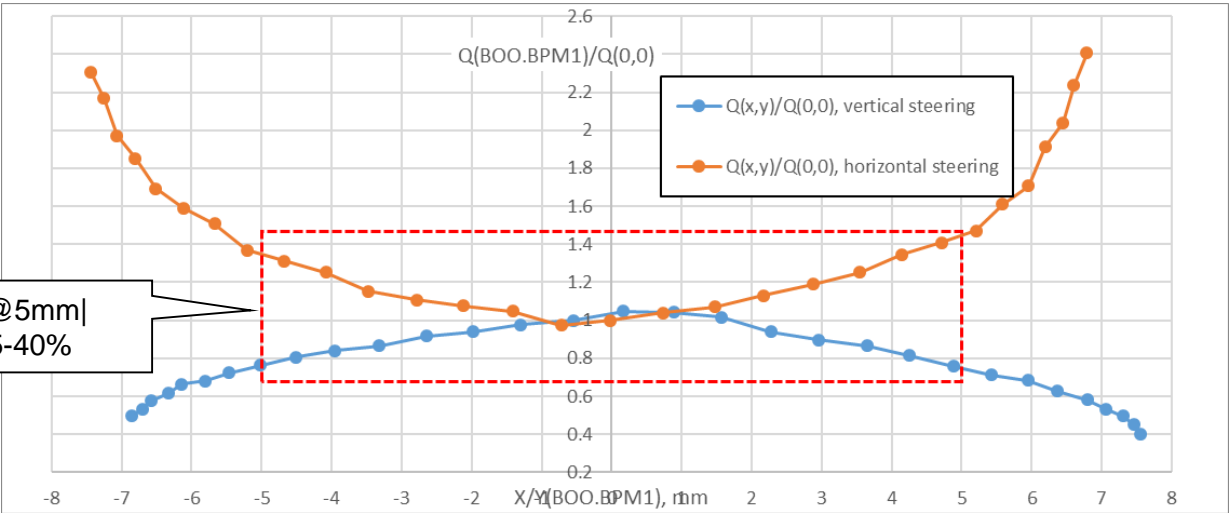
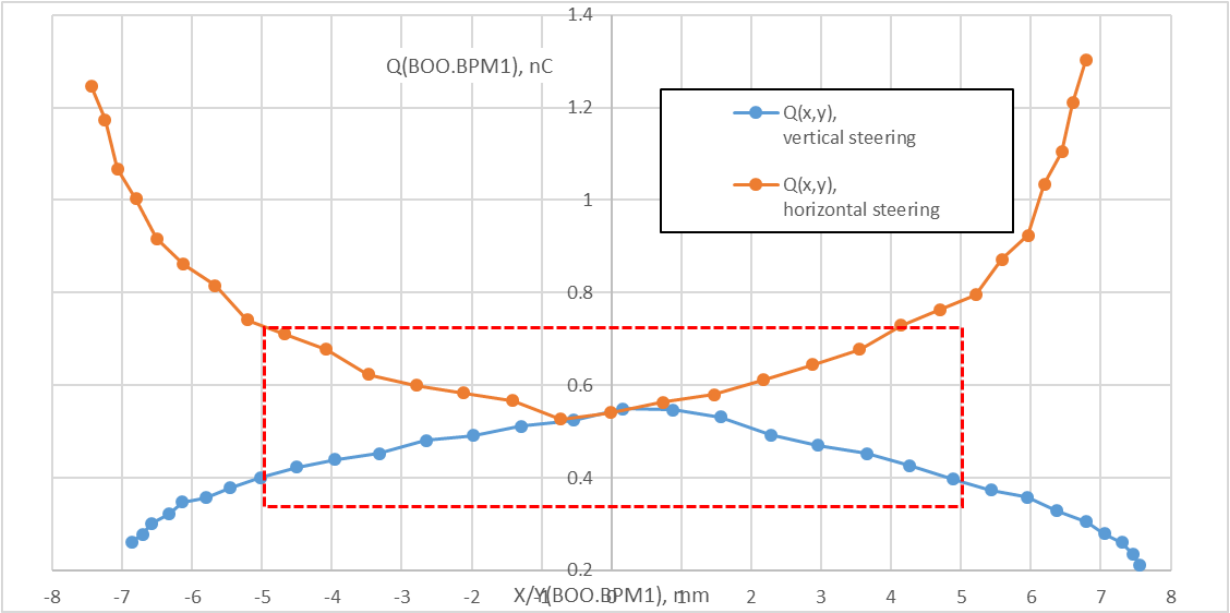
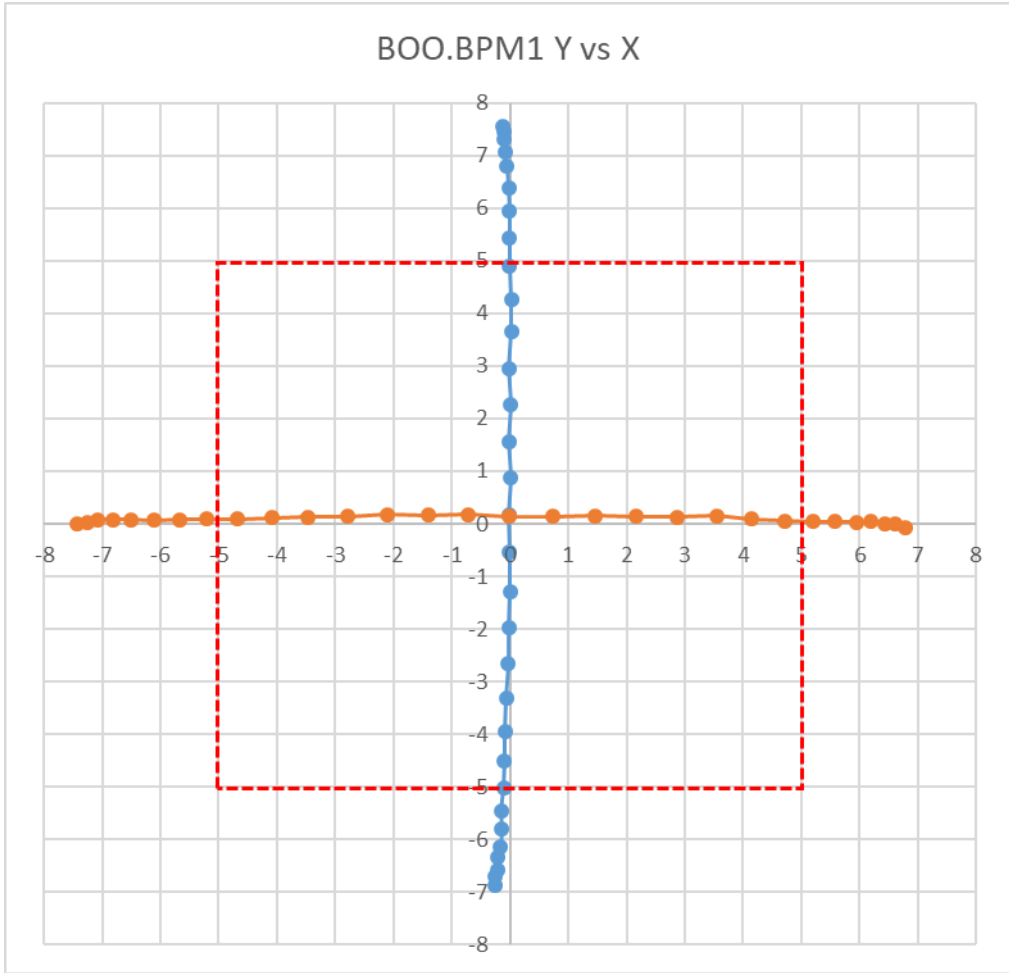
BOO.BPM1 nonlinearity check

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BOO.BPM1 bunch charge

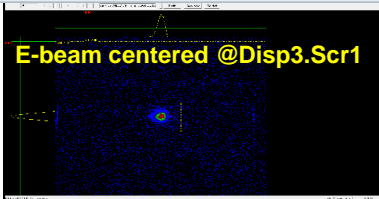
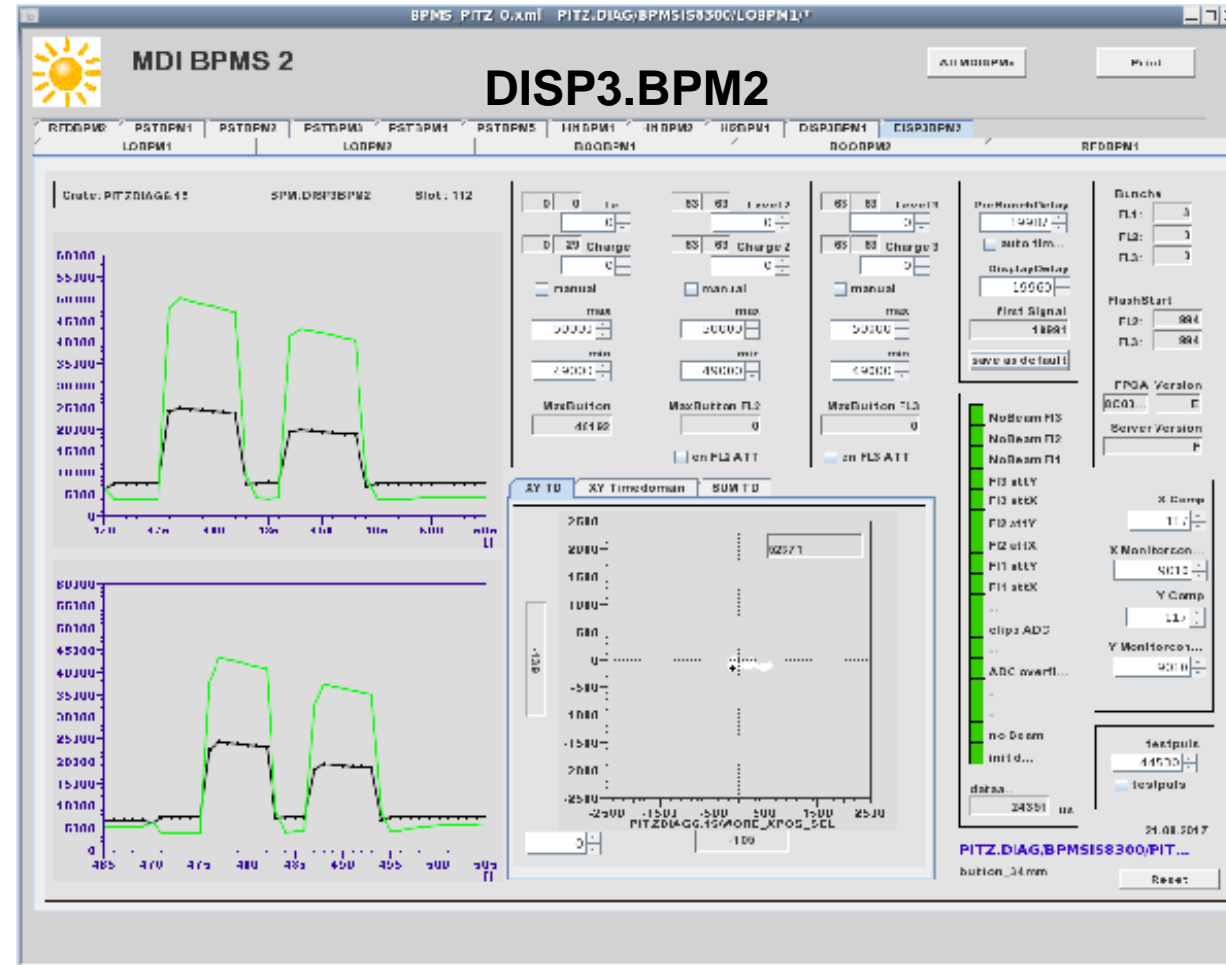
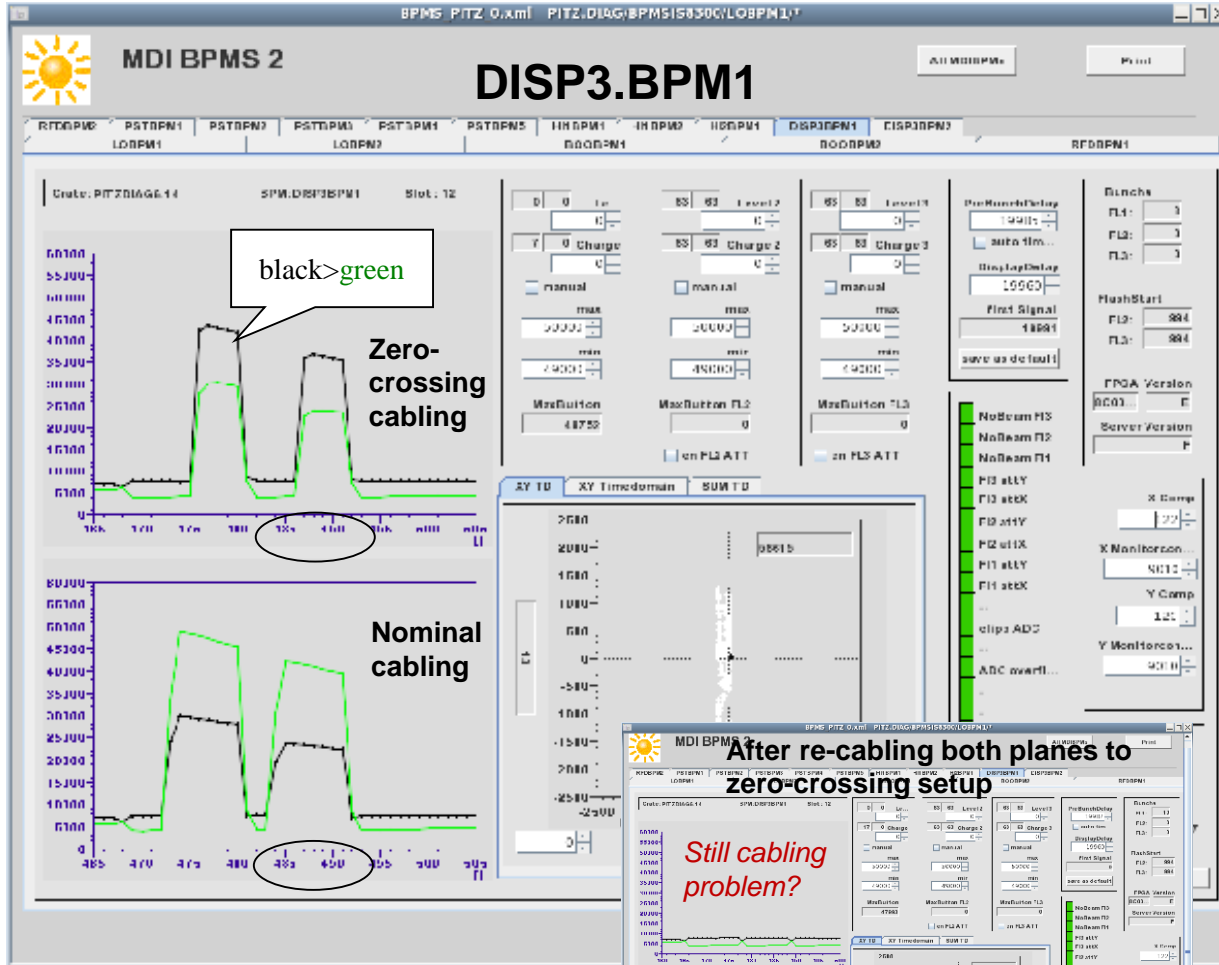
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$|\Delta Q @ 5mm|$
~35-40%

DISP3.BPM1,2

27-28.03.2021M



Screen DISP3.Scr2 was aligned, but no beam found (timing?)

BPM, week 12/2021

2.5 shifts

Achievements:

- LOW.BPM2, RFD.BPM1,2: calibration **refined** wrt ($\sim 0, \sim 0$), $\Delta x, y \sim 1.5 \text{mm}$ \rightarrow $|\text{BPM-screen-correlation-1}| < 0.3-0.5\%$
- LOW.BPM1: calibration **refined** for very low beam energy ($P_{\text{gun}} \sim 1 \text{MW}$), nominal $x/y \sim 0.2 \text{mm}/1.4 \text{mm}$
- BOO.BPM1,2 with HIGH1.Scr1: rather large e-beam (no booster) and rather limited scan range \rightarrow but **calibrated**
- Some measurements of effective $\langle P_z \rangle$ pulse train profile taken \rightarrow compared with FLASH (next slide)
- DISP3.BPM2: signals found, but no beam at DISP3.Scr2 (timing or camera alignment?)

Problems:

- **Prebunch delays** for all BPMs have to be retuned by $-2-3 \text{ns}$ after the MBI ns adjustment on 27.03.2021
- DISP3.BPM1: **no signal** from X-plane after re-connection to the zero-crossing setup, signal shape/amplitudes – delay line are not equal or wrong cabling? (hopefully fixed by Mario)
- Either RFD.BPM1,2 or HIGH1.St4(hor)/HIGH1.StA2 have 2-6 deg **roll errors**?
- **Calibration nonlinearity** (e.g., X-calibration dependence on y-position) observed
- **Nonsymmetric nonlinearity** (wrt large offsets) even after the zero-crossing tuning with corresponding cabling
- Strong **BPM-charge** dependence on a beam position
- HIGH2.BPM1: signals found at HIGH1.BPM1, but not from the user server? (fixed by Grygorii)

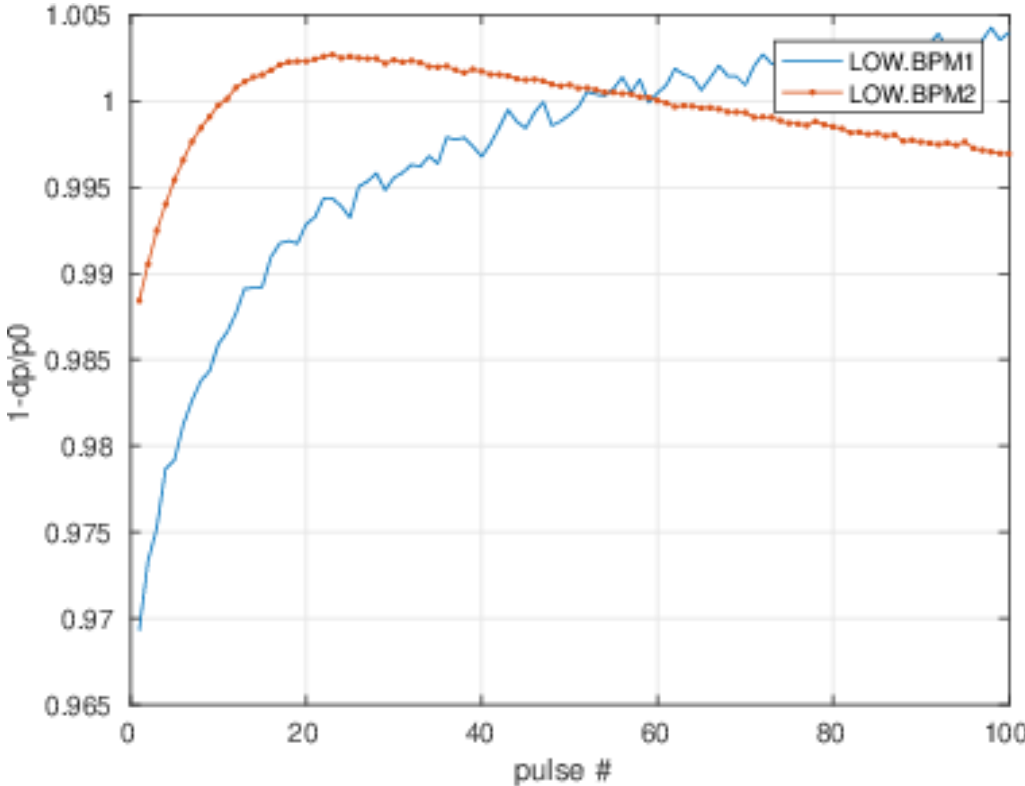
Next steps:

- Detailed investigations on RFD.BPM1,2-HIGH1.St4(hor)/HIGH1.StA2 tilts?
- DISP3.BPM1: obtain signal from X-plane, zero calibration, then procedure for calibration
- Alternative zero-crossing check?
- Also calibration procedure for DISP3.BPM2 (might be lower priority)
- Look-up table for BPM-charge(x,y)?
- HIGH2.BPM1: calibrate after the user server will be operational
- Improve tools (trajectory0, BPMlive,...)

Effective $\langle P_z \rangle$ profile of a pulse train

PITZ and FLASH (30.03.2021M)

- PITZ



- FLASH

