CBPM machine studies February 2025

Antoine, Vardan, Jim

CESR Machine Studies meeting – March 6th, 2025

CBPM gain calibration

CBPM calibration: quick recap

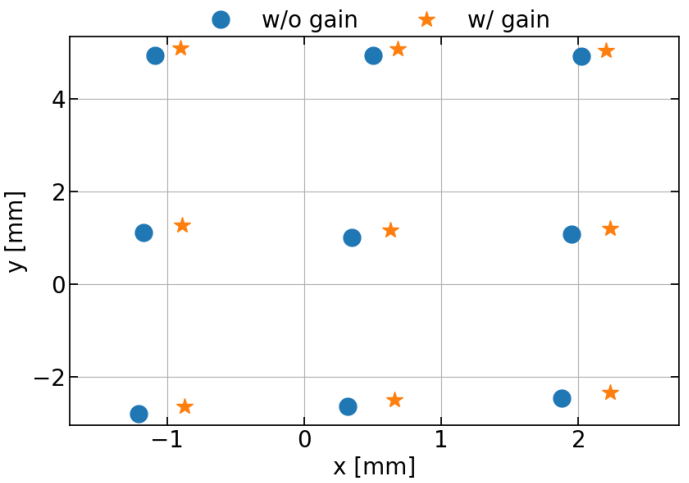
What: relative calibration of the CBPM pick-up electrode signals to account for differences in readout electronics and electrode geometry (displacement, tilt etc.)

Why: without calibration, hundreds of microns offset in reconstructing beam position

How: collect CBPM data for a 9-point grid of beam positions and extract relative gain while reconstructing the beam position

$$\text{f.o.m.} = \sum_{i=1}^{9} \left[\sum_{j=1}^{4} \left[b_{ij} - \frac{f_{b_{ij}}(x_i, y_i)}{\alpha^{gain}{}_j} \right]^2 \right]_i$$

fit parameters



click link for more details

Feb. 19th machine study

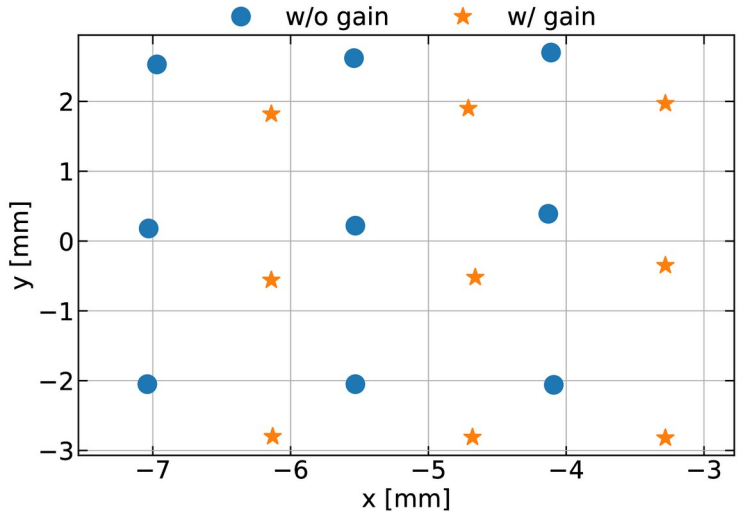
See instr. elog 2418, collected 4 dataset:

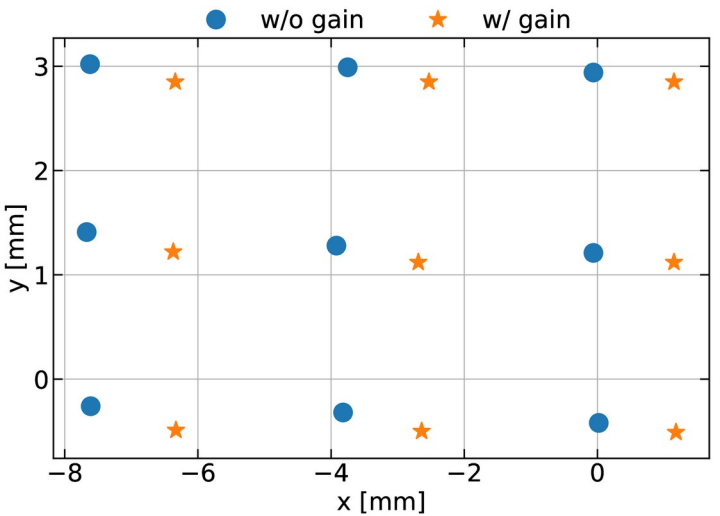
- each dataset corresponds to a well-defined wave in the CESR orbit
- each dataset is made of 9 beam positions evenly spaced on a grid
- each wave is offset by π/4 w.r.t. to the previous one

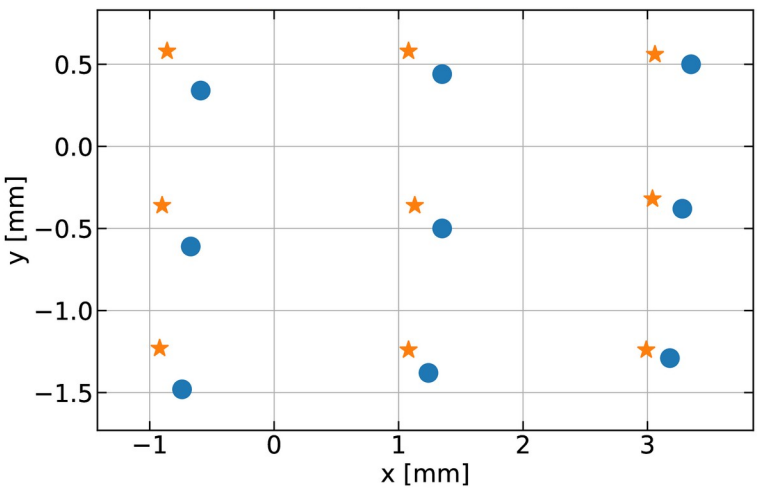
All together, the 4 dataset allow to calibrate all the CBPM locations around the ring

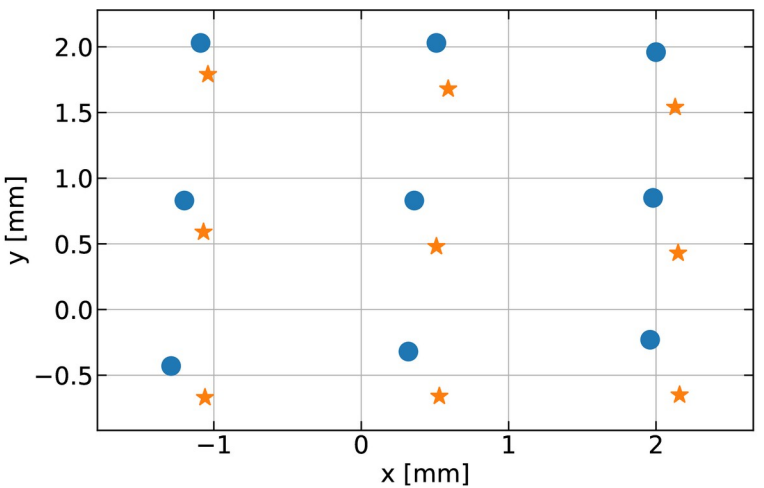
Update in analysis: at each CBPM location, identify the best wave to analyze (previously analyzed all the 4 waves together)

Random example of 9-point grids



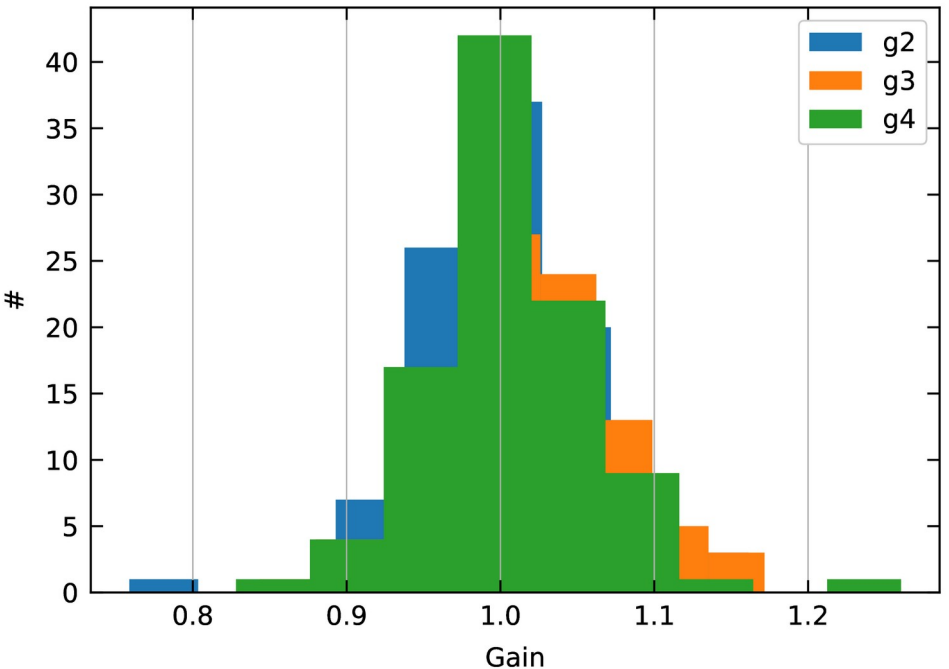


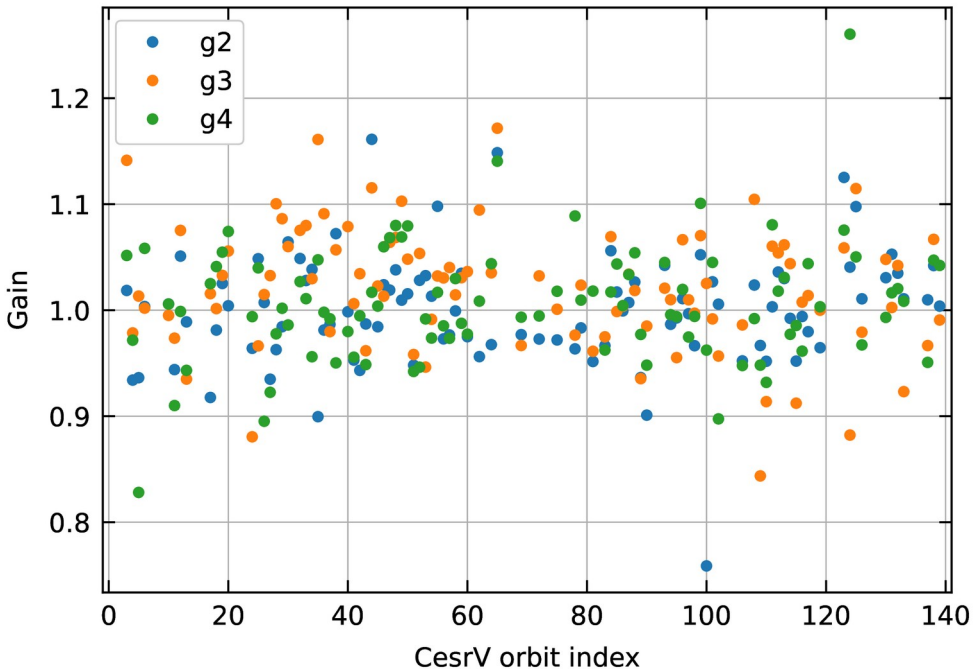




Measured gains

Gain values normalized to “button 1” (bottom inner electrode)

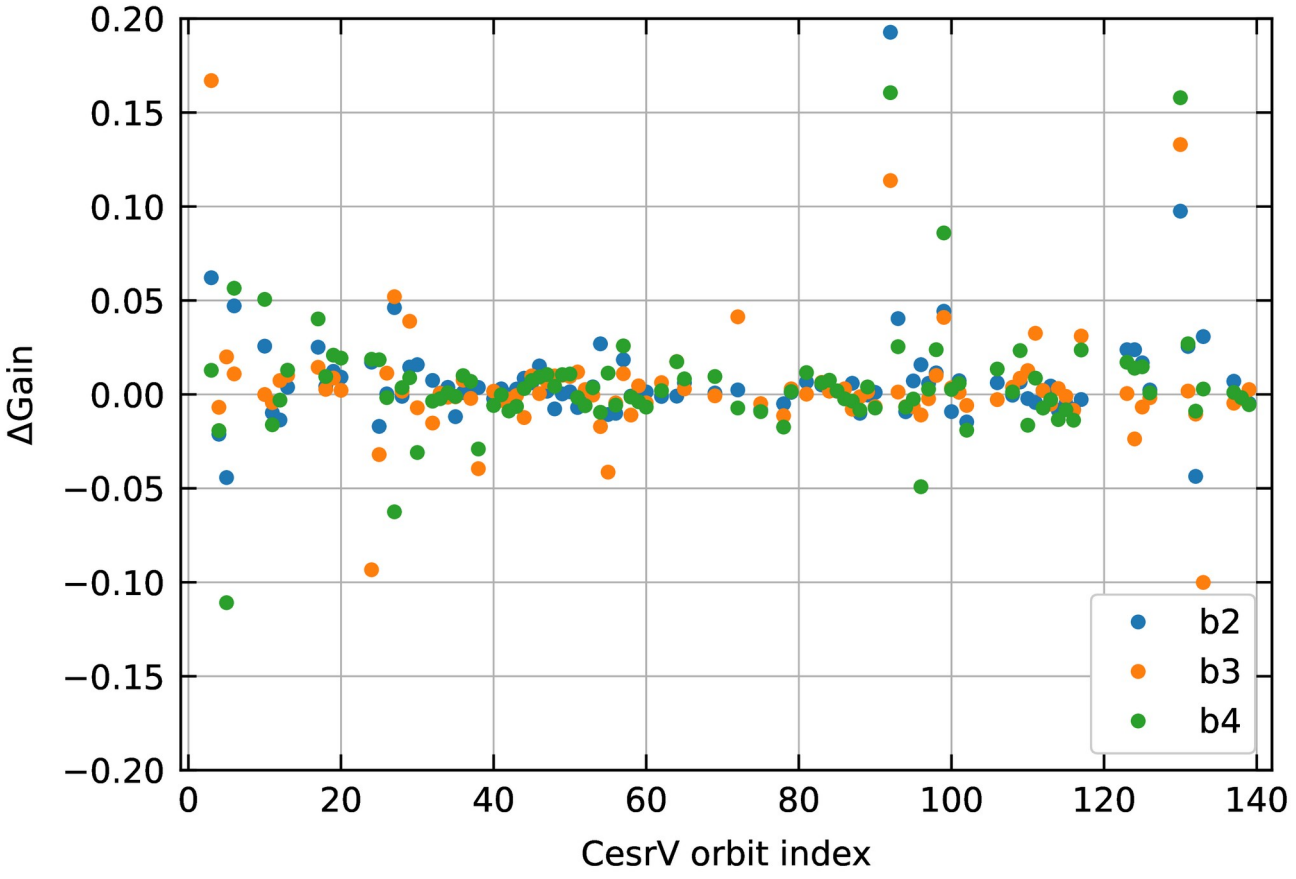




Combined std dev = 0.056

Comparison with previous gains

Feb 19th 2025 v. September 11th 2024



Comparison with previous gains

Feb 19th 2025 v. September 11th 2024

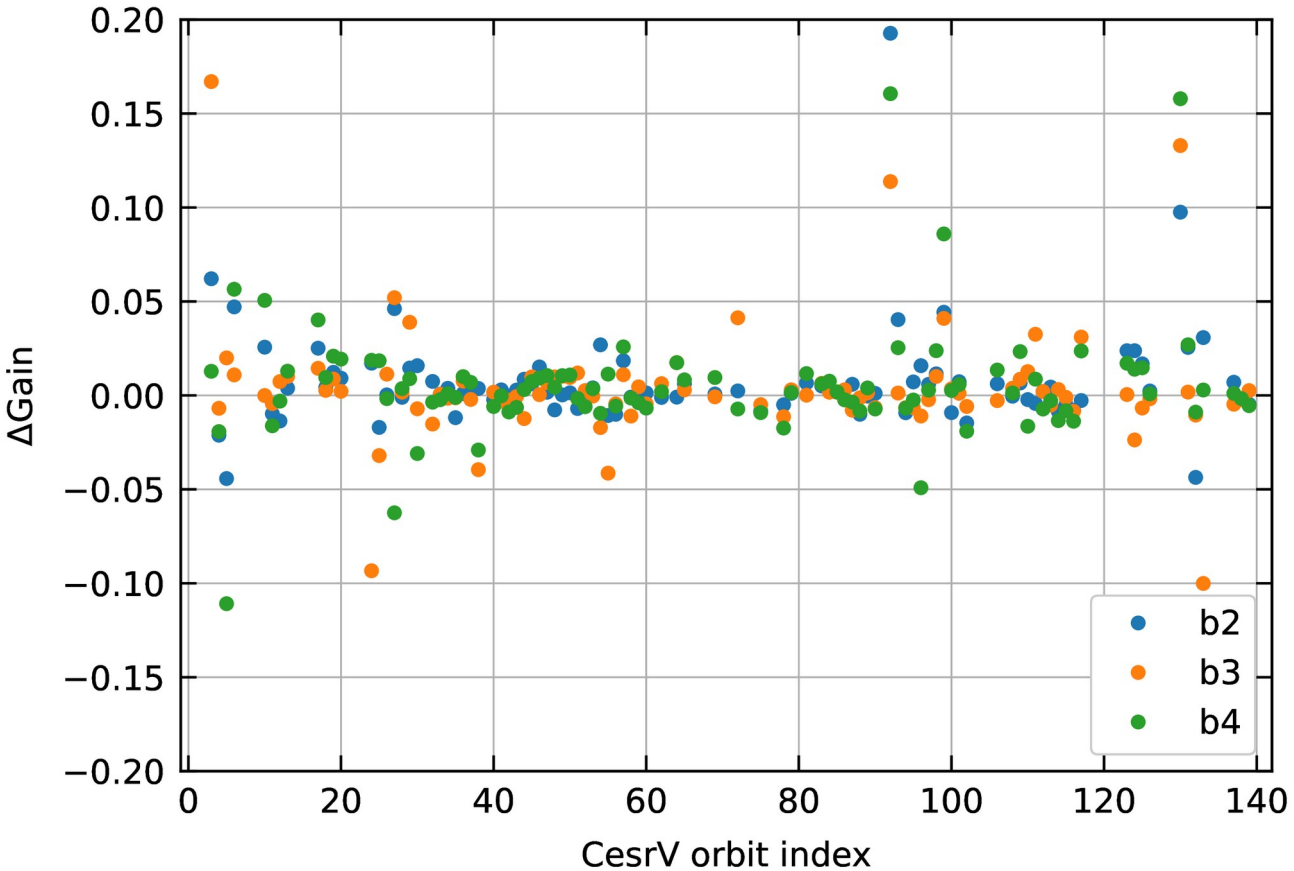
Locations of CBPM readout electronics swapped between those two dates:

X2A	X2D	X4A (x2)	X4C	X5A (x2)
10AW	38W (x2)	34E	33E	X2C

All locations showing largest gain changes have had swapped electronics or have not been calibrated for 10^{+} years until this Feb. 2025 (34E, X2A)

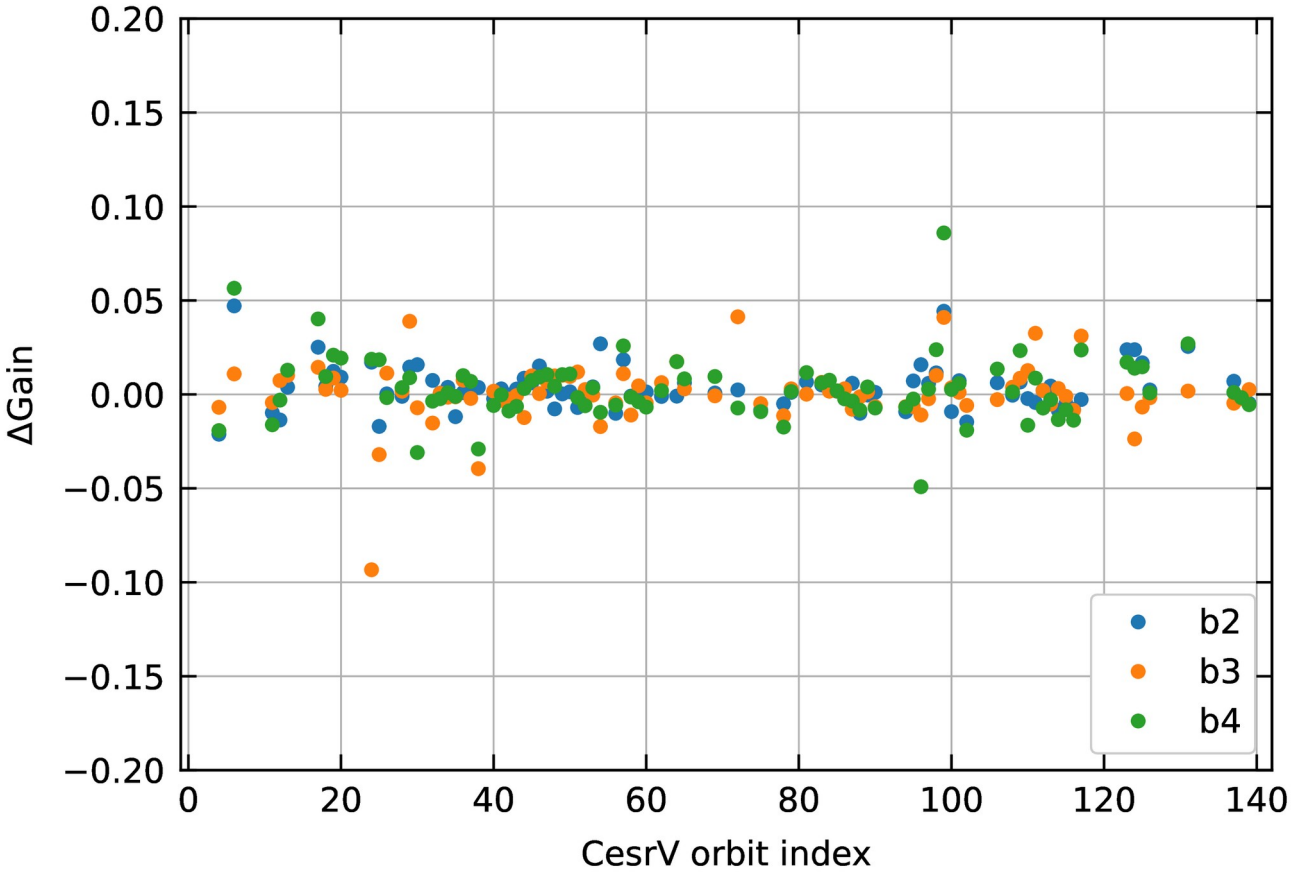
Comparison with previous gains

Feb 19th 2025 v. September 11th 2024: **with** swapped electronics locations



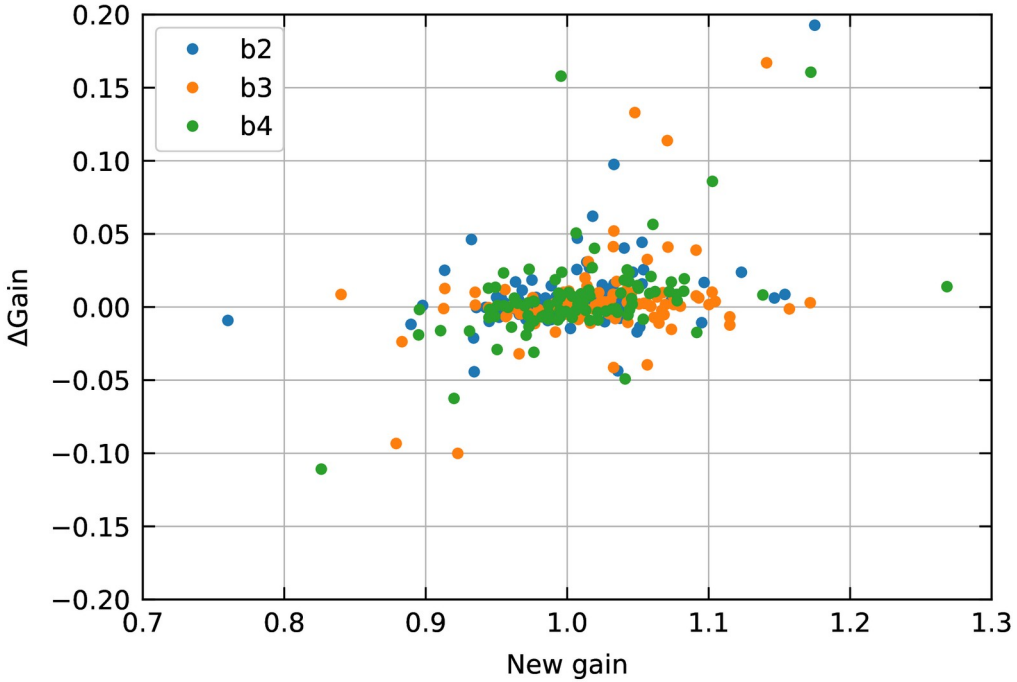
Comparison with previous gains

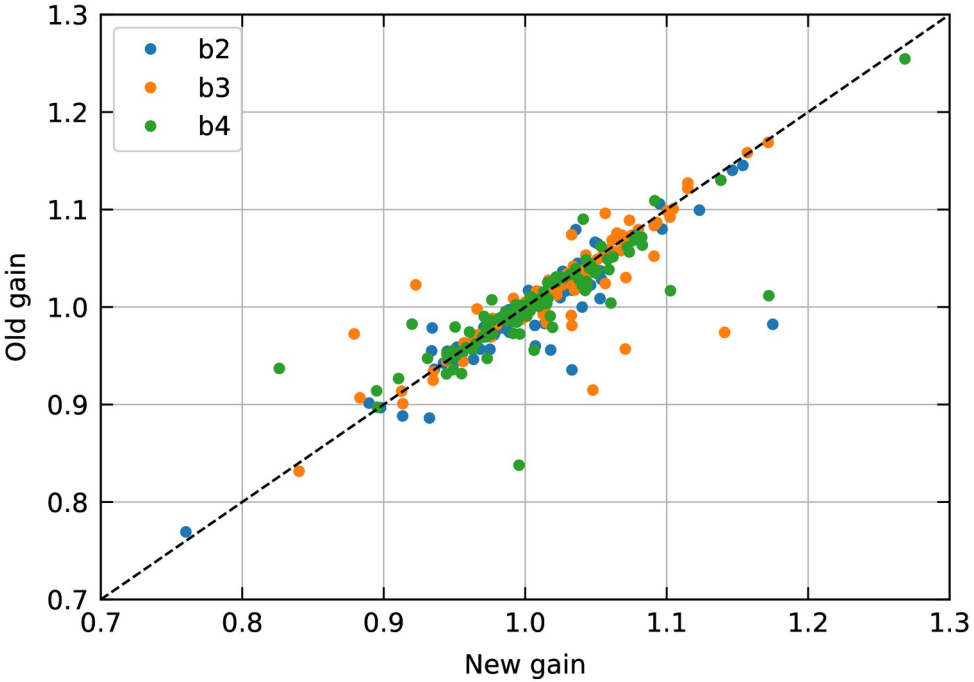
Feb 19th 2025 v. September 11th 2024: **without** swapped electronics locations



Comparison with previous gains

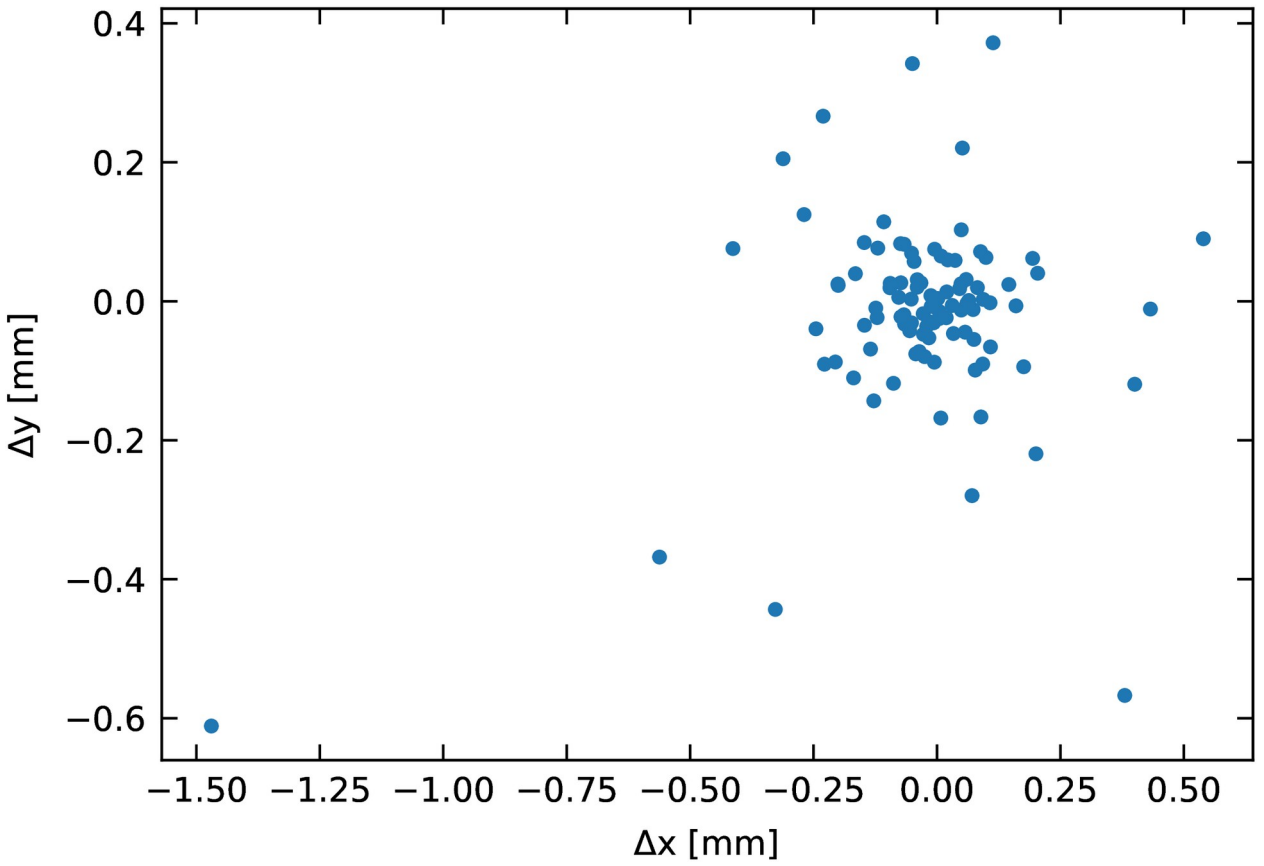
Feb 19th 2025 v. September 11th 2024: **with** swapped electronics locations





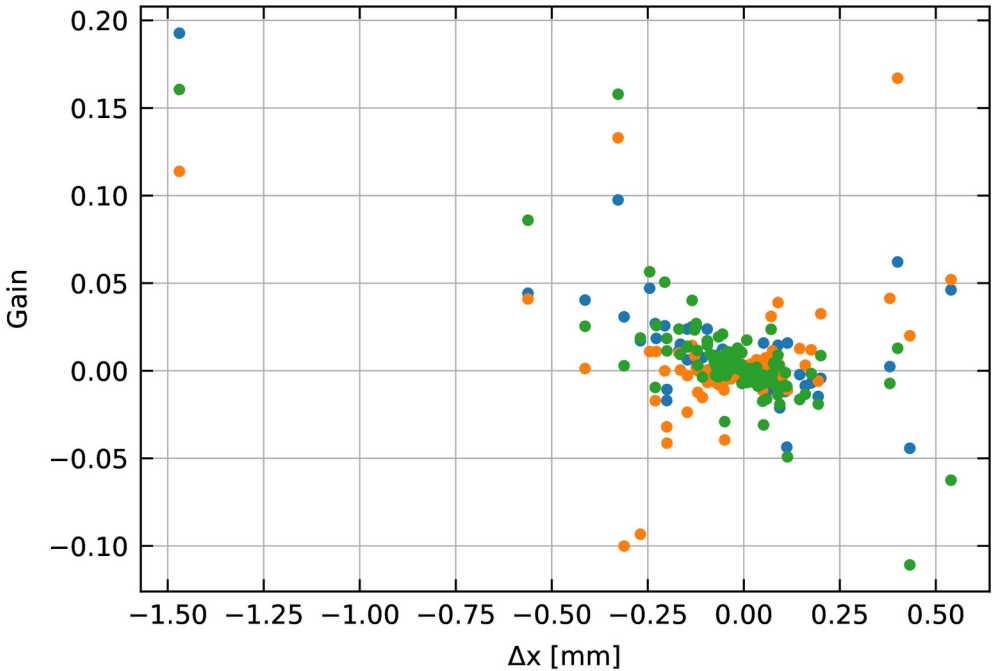
Impact on beam position

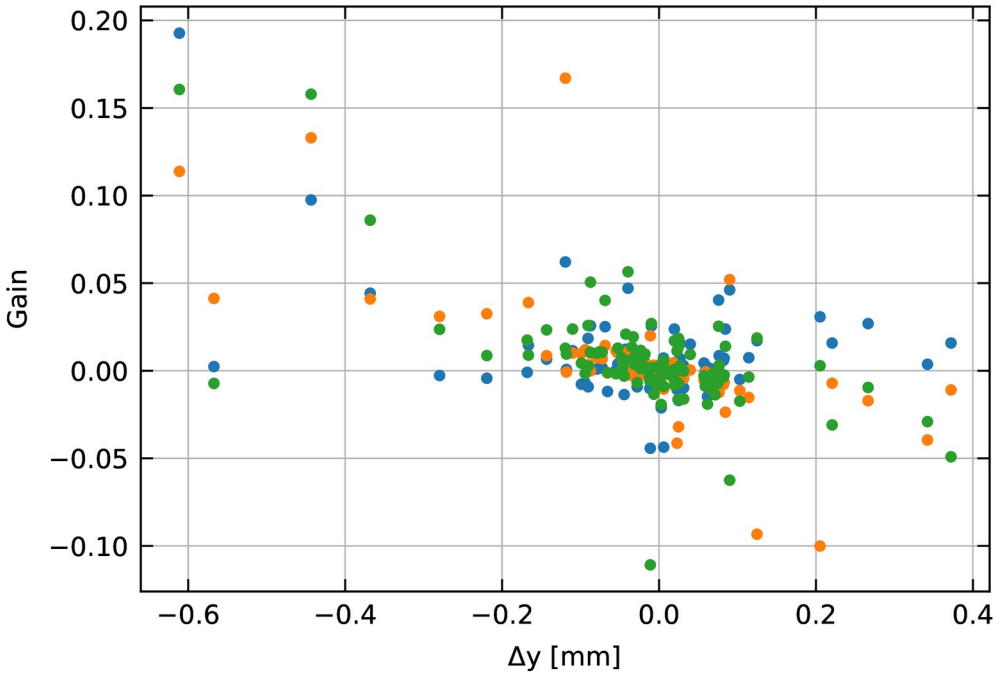
How much did the gain changes affect the measured beam position (real orbit)?



Impact on beam position

How much did the gain changes affect the measured beam position (real orbit)?





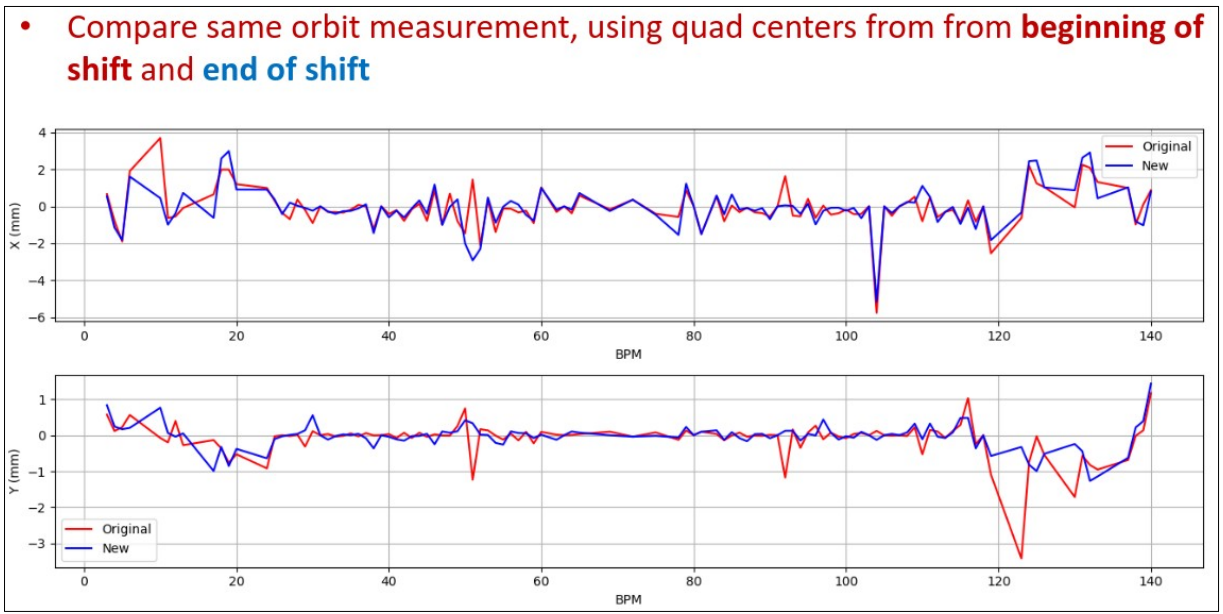
CBPM gain calibration and quad offset centering

CBPM quad offset centering: quick recap

What: measure x/y offset between magnetic and pick-up electrode centers

Why: without centering, up to several millimeters offset in beam position

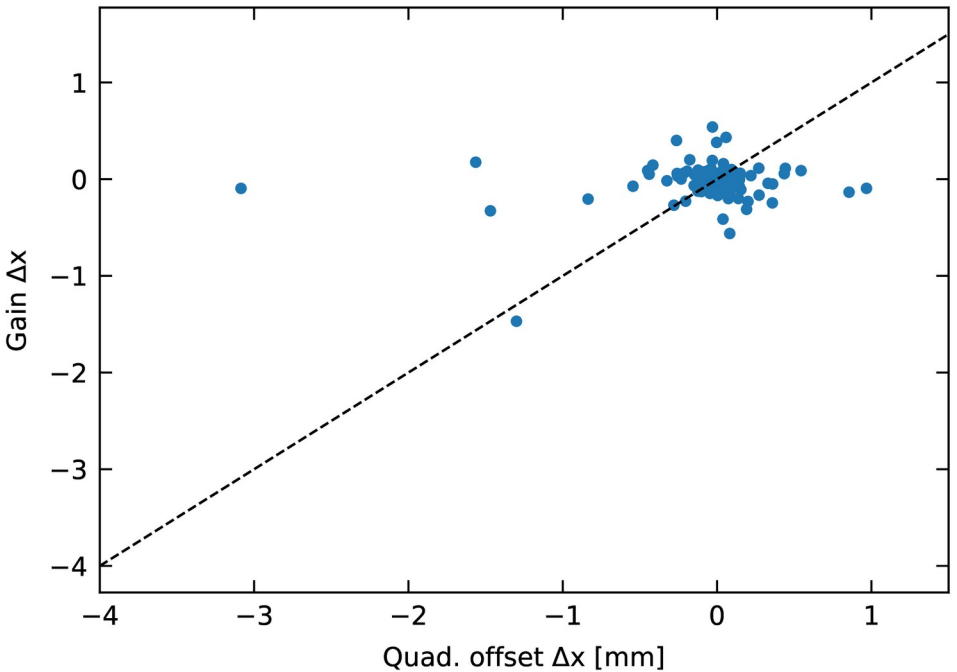
How: vary quadrupoles strength and observe change in beam position

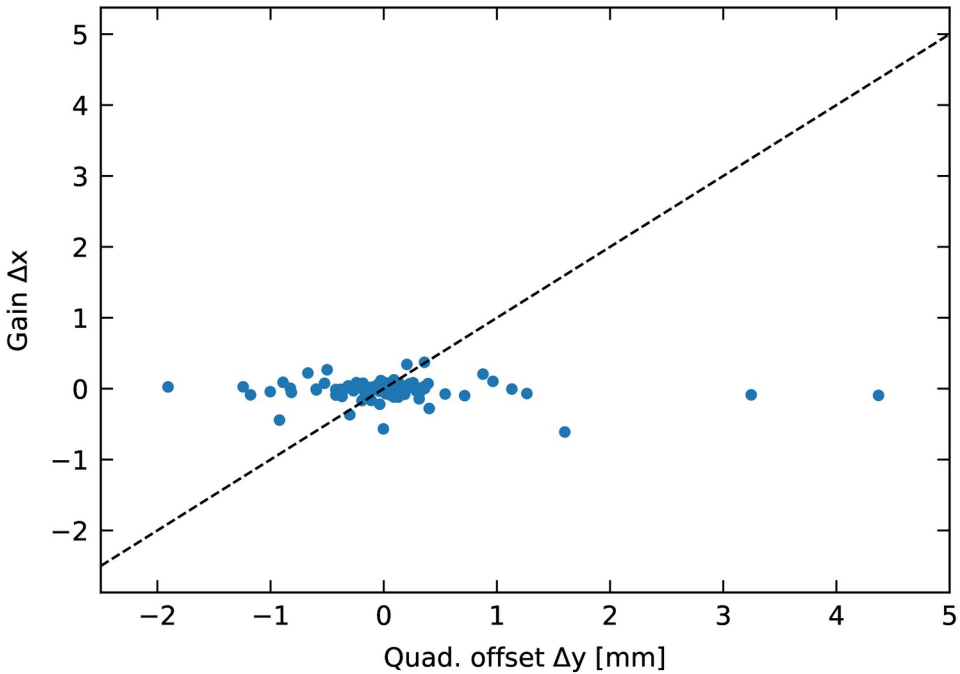


see J. Shanks' talk and CHESS MS elog 2594

Gain calibration v. quad offset

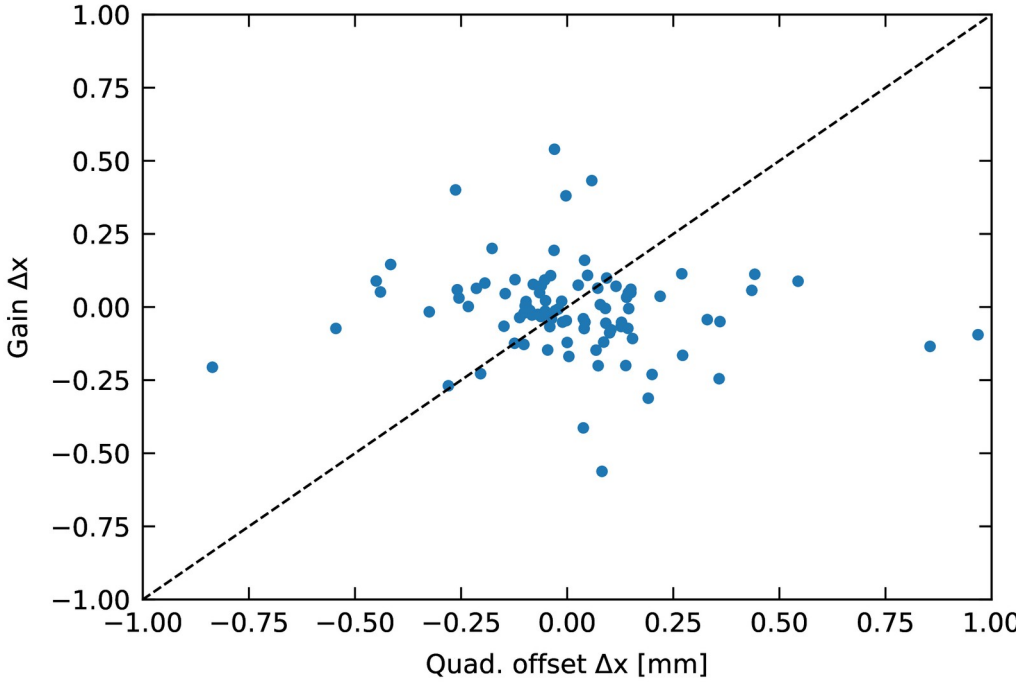
Comparing change in position due to **gain changes** to change in position due to **quad offset changes**: can gain changes drive the quad offset changes?

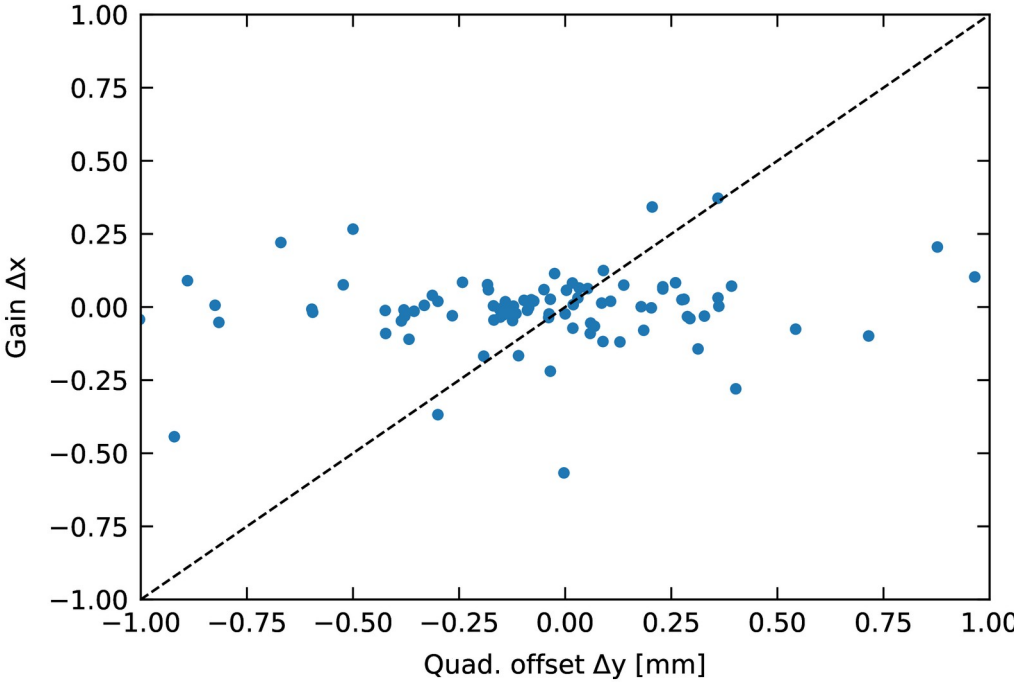




Gain calibration v. quad offset

Comparing change in position due to **gain changes** to change in position due to **quad offset changes**: can gain changes drive the quad offset changes?





More topics next time

More topics next time

CBPM gain calibration v. beam position

Libera gain calibration

Extras