- CBPM gain calibration - 4 waves method

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CBPM 4-wave gain calibration

Goal

- speed-up significantly data taking for gain calibration
- make full ring gain calibration a routine task

How

- introduce ring-wide wave to bump many locations at once
- 4 π/4 out-of-phase waves is enough for calibrating all locations

Machine study R&D

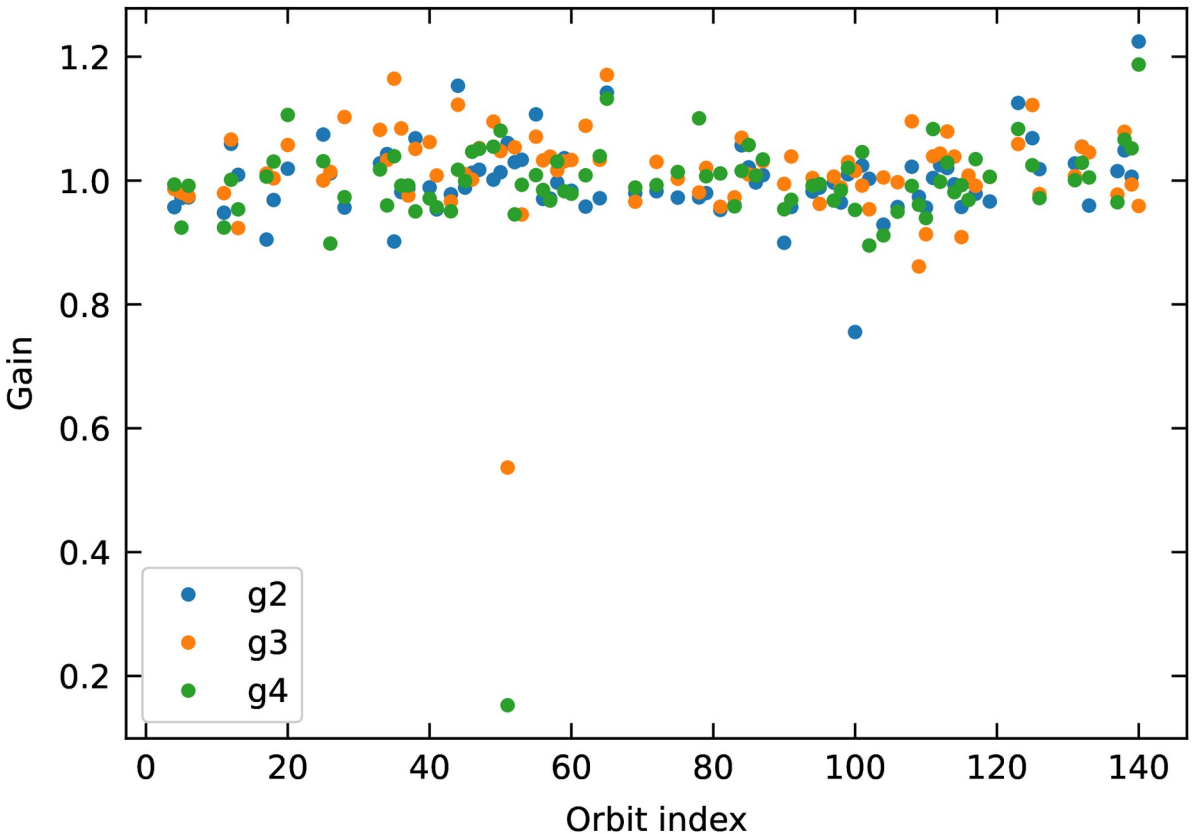
See instr. elog 2303

Message ID: **2303**	Entry time: **2024-06-11, 18:15, Tuesday**
Author:	Antoine T Chapelain, Vardan Khachatryan
Subject:	CBPM gain calibration R&D
Category:	Repair/Maintenance
Instrument:	CESR BPM
Sub-System:	CBPM_II
Shift Key:	20240611_1800

Managed to collect 3 waves out of 4

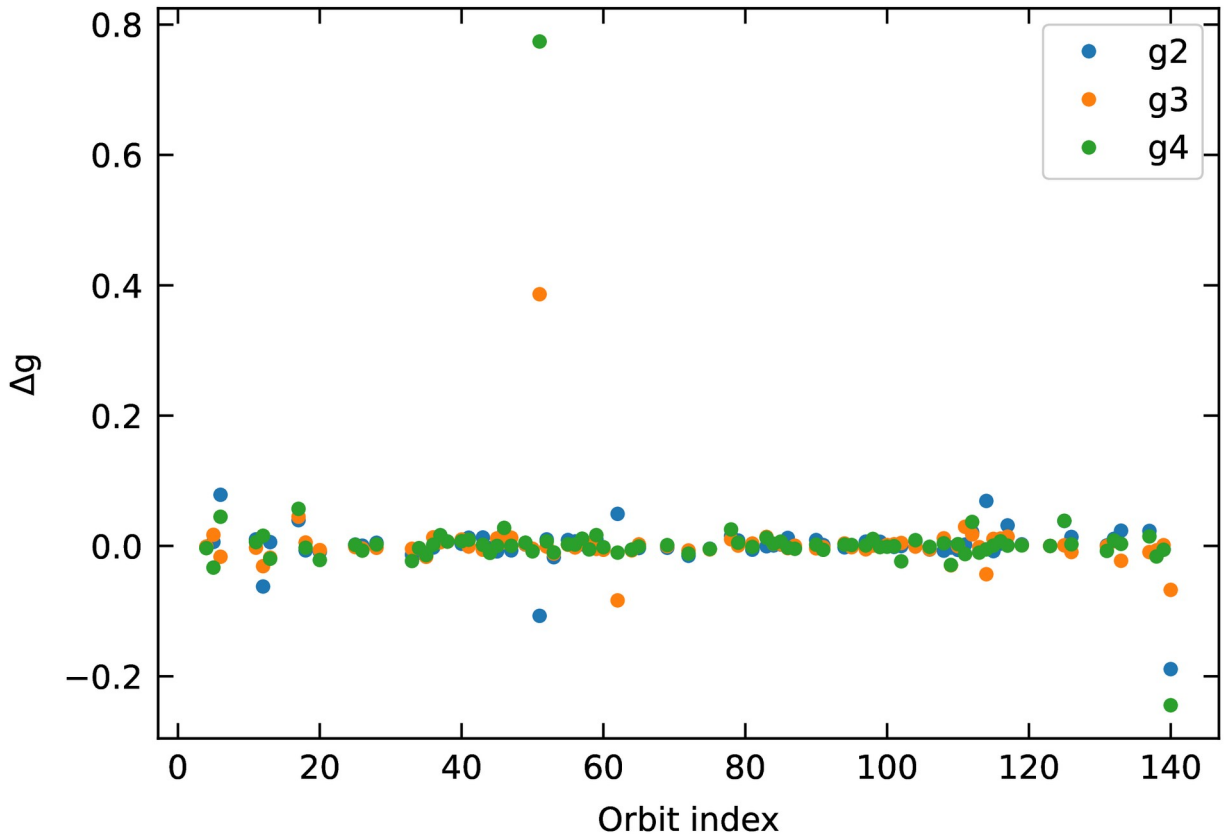
Measured gains

Exclude locations with only 3 working buttons



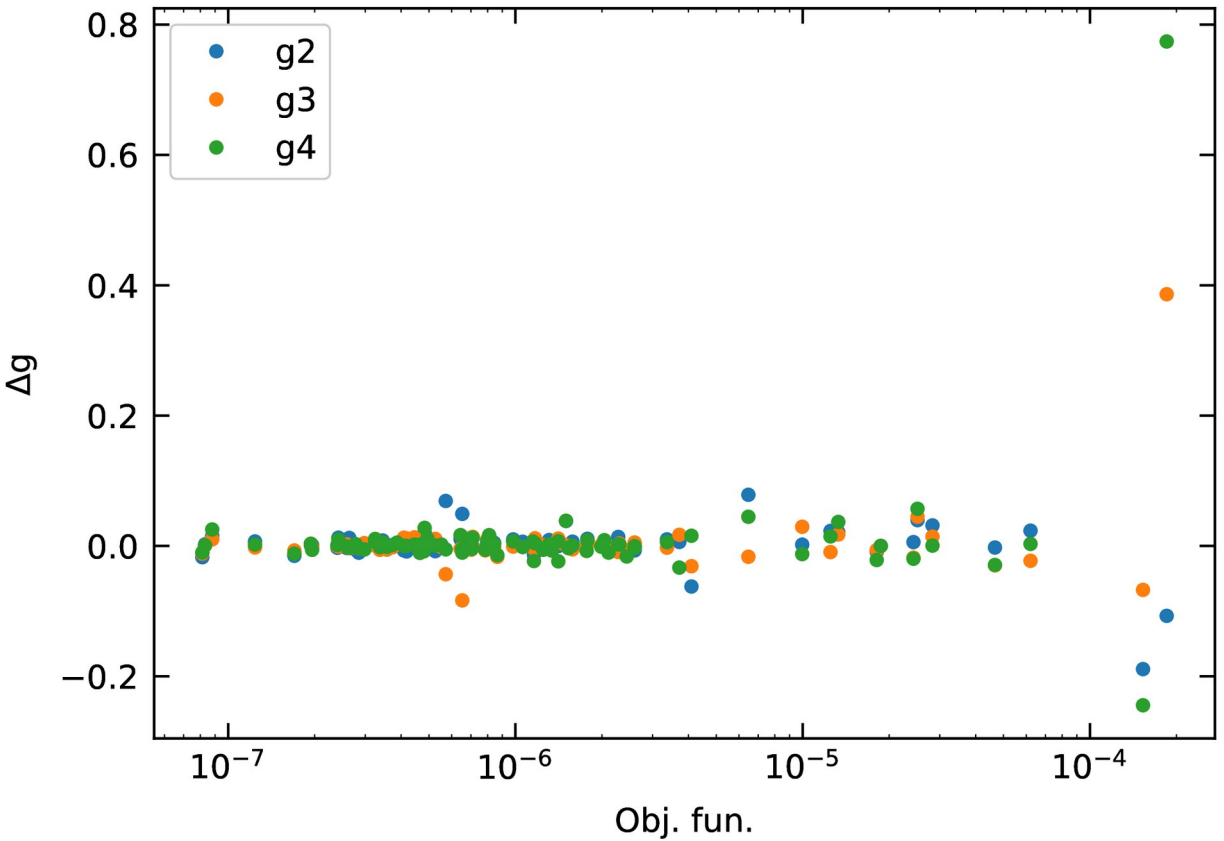
Comparison with reference gains

Reference gains = gains measured over the past couple years via local bumping



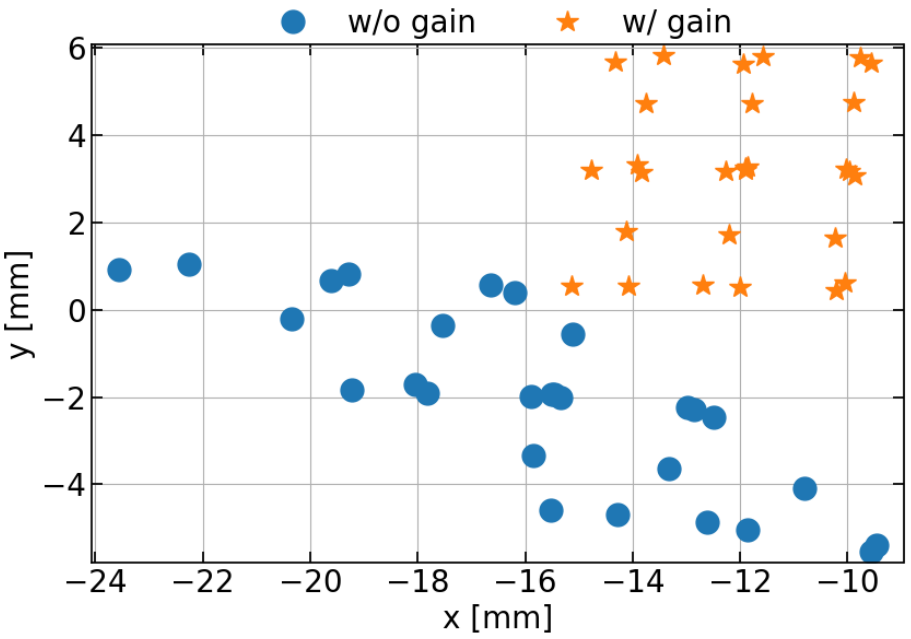
Comparison with reference gains

Objective function is minimized during gain reconstruction

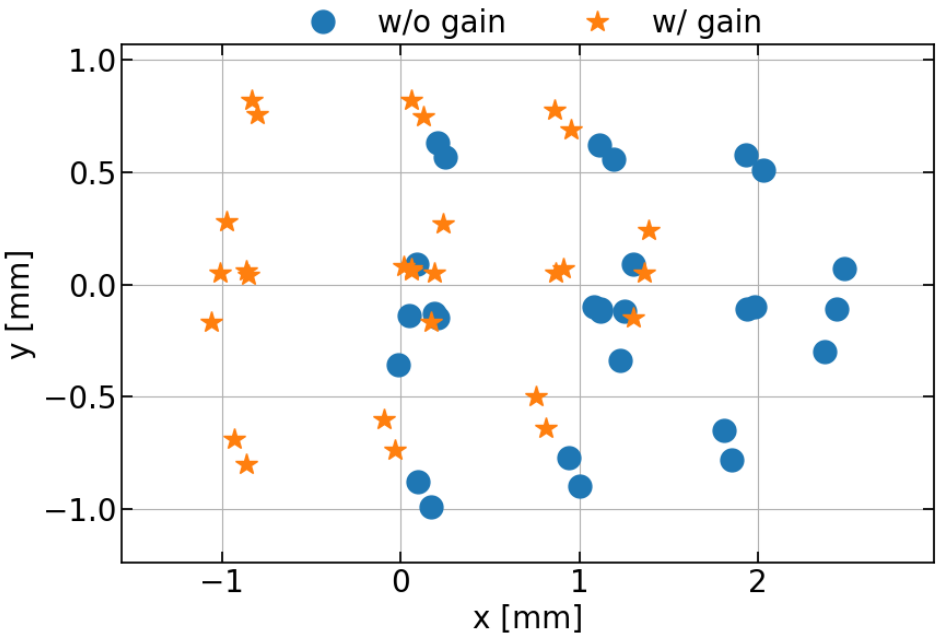


Large objective function results

34W and X3D have largest objective functions



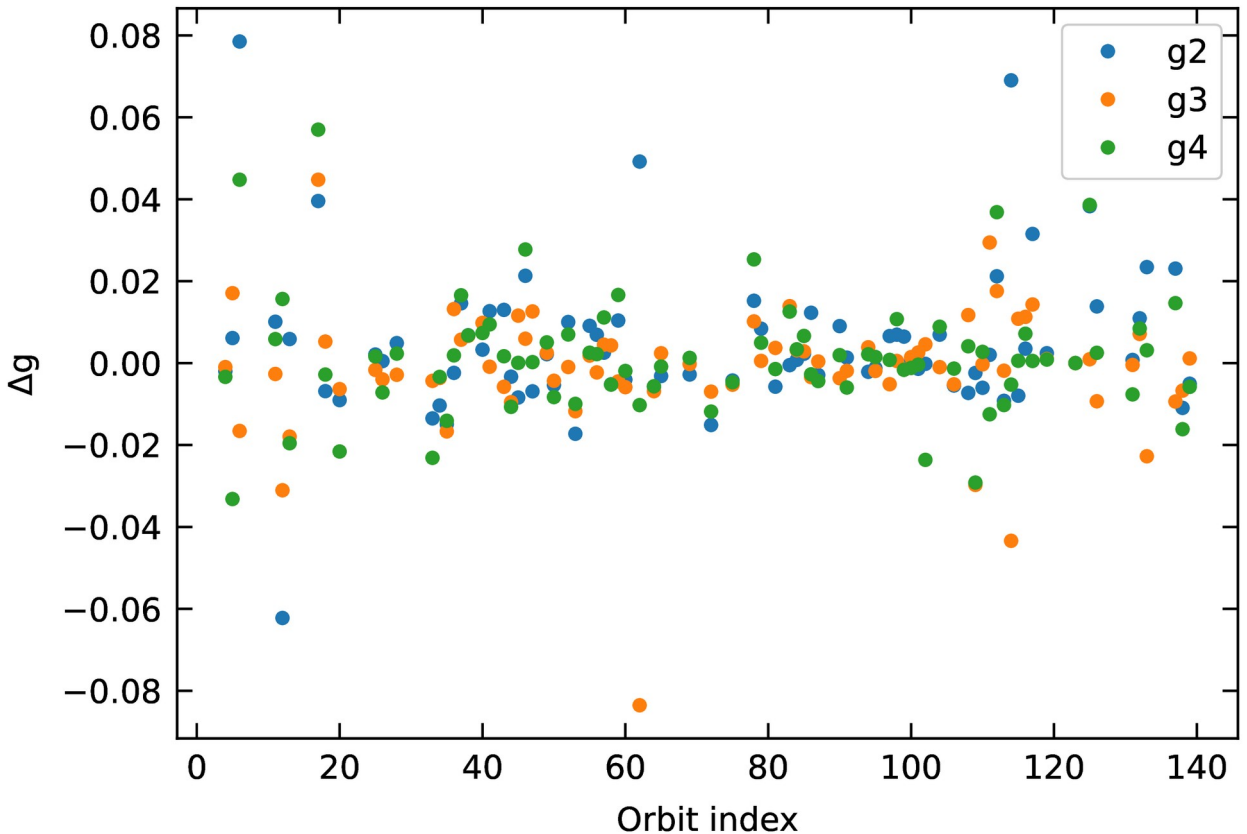
34W



X3D

Comparison with reference gains

Keep objective function **< 1e-4**



Behind the scene

Some reference gains have been re-analyzed using reference data and different results were found (probably some analysis mistake back then):

- X1A → discrepancy with wave analysis resolved
- 44W → discrepancy remains

Some reference gains were not propagated to BPM_INST_params:

- 47W, X3B → discrepancy resolved

Remaining discrepancies

5 locations show unexplained discrepancies:

node_index	cbpm	obj fun	g3	g2	g4	orbit_index
1	X5C	4.100000e-06	-0.031050	-0.062230	0.015646	12
3	X6A	2.510000e-05	0.044764	0.039568	0.056990	17
44	44W	6.530000e-07	-0.083540	0.049200	-0.010260	62
87	12E	5.720000e-07	-0.043390	0.069030	-0.005250	114
108	X4D	6.470000e-06	-0.016570	0.078510	0.044766	6

Old reference gains were all re-analyzed but results did not change

More digging needed to understand what's going on

Takeaway

3-wave gain calibration is **a success!**

Let’s make the **4-wave method** the standard calibration procedure:

- will allow calibrating 90^{+}% of all CBPMs (local bumping for left over)
- **need new code** to automatically update BPM_INST_params
- two MS shifts reserved during start-up

Going forward, we could **routinely** gain calibrate all the CBPMs

Extras