How to limit the FZP scanner range of flOMNI

Source of `local_contact_only-howto_limit_the_fzp_scanner_range.pdf`. The original text is kept unchanged; the section "Update 2026-10-20" lists what the present flOMNI loop (PREEMPT_RT, 100 µs, branch `rt_preemt`) needs in addition. "ahead movement" (element 0) is called **move-beyond** from 2026-10-23 on: the sample stage moves beyond the scan point towards the next one, the FZP compensates and sits off-centre, which gives it stroke for the next step.

```
to limit the fzp scanner ranges
in PID_ FAST FZP PID LOOP
0: reduce to small ahead movement range, such as -0.05
4: reduce error threshold, eg 0.01
5: inform PID that FZP range is small, such as 0.1

in PID_ _FZP
limit the analog output LB and UB
```

Update 2026-10-20 (flOMNI loop on PREEMPT_RT, mpc2844)

The limited range is the present operating state: `PID_x_fzp` / `PID_y_fzp` `Ub` / `Lb` = ±1.5 V because the cap sensors are calibrated over about ±2 V only (flOMNI `feedback_report.md` 6n). FZP ≈ 0.13 µm/V in x, ≈ 0.05 µm/V in y, so ±1.5 V ≈ ±0.19 µm (x) / ±0.08 µm (y). In the sample stage PIDs (`PID_x`, `PID_y`) `FAST_FZP_PID_LOOP` is `0,0,0,0,0.1,0,0`: no move-beyond, (5) = 0 (the sample stage always compensates fully).

Changing the FZP range now involves, in addition to the text above:

- **`Feedforward`** (static FZP feedforward): `ff_limit`, `out_min` / `out_max` to the same values as the FZP `Ub` / `Lb` (they limit drive + feedforward). Since 2026-10-26 (`fzp_ff_priority` 1, `pid_priority` 1,1) `ff_limit` is not used: the feedforward has the range first, the FZP PID limits follow `Ub` / `Lb` − feedforward (flOMNI `FeedbackLoop/scan_modes.md`); `out_min` / `out_max` still limit the sum.
- **`FreqGen`** `out_min` / `out_max` (channels 0 / 1) limit the FZP drive only while an excitation is running (measurements).
- **`OnTargetTrigger`** `WaitForSlew` and **`TargetSelect_x` / `_y`** `use_final`: keep the defaults (1 / 0) with a small range. `use_final` 1 + `WaitForSlew` 0 ("exposure during the motion") only makes sense when the FZP range covers the scan step; steps larger than the range then still wait for the sample stage.
- Move-beyond (0) must fit into the stroke: the FZP holds it during the exposure, together with the Abbe correction (up to `correction_limit_um` 0.1 µm when enabled) and noise. Rule ≈ half the stroke (the loop settings refuse more than 0.6 × stroke minus the Abbe limit): at ±1.5 V ≈ −0.1 µm (x), ≈ −0.04 µm (y); at ±7 V −0.5 / −0.2 µm (tested). Production: 0. Details: calibration how-to, section "Move-beyond".
- (5) compares the real FZP drive incl. the feedforward (input 8 of `PID_x` / `PID_y` = `Feedforward` output since 2026-10-23; before it was the FZP PID output without the feedforward).
- After a change: web HMI tab **Loop check** level 1 (expected settings) and, with the beamline ready, the scan test (level 4: positioning time, stability during the exposure per step size).

With the loop settings (since 2026-10-23): `flomni.rt_settings.set(fzp_range_V_x=..., fzp_range_V_y=...)` (web HMI tab *Loop settings*) sets `PID_*_fzp` `Ub` / `Lb` and the `Feedforward` limits together; a move-beyond that no longer fits is refused, or clamped with `adjust=True` (rule `move_beyond_*_fits`). `FreqGen` limits stay manual (measurements only).