

GPTAS Filman/EPICS: Staff Operations Manual

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This manual collects commands and procedures that general users must not touch: they can change encoder zero-points, motor limits, the wavelength calibration, and the system state. **Use only if you are responsible for the spectrometer.** The user-facing command reference is in the separate *Filman: User Guide*.

Commands are shown in **RED** bold monospace. **Commands are case-insensitive; filenames are case-sensitive.**

Full motor list for GPTAS

#	name	function	#	name	function
0	C1	monochromator ω (θ_M)	10	FM	(not in use)
1	A1	monochromator 2θ ($2\theta_M$)	11	FA	(not in use)
2	C2	sample ω	12	IL	upstream narrower (left)
3	A2	sample 2θ	13	IR	upstream narrower (right)
4	C3	analyzer ω	14	IT	upstream narrower (top)
5	A3	analyzer 2θ	15	IB	upstream narrower (bottom)
6	RX	sample tilt X	16	OL	downstream narrower (left)
7	XS	translation X	17	OR	downstream narrower (right)
8	RY	sample tilt Y	18	OT	downstream narrower (top)
9	YS	translation Y	19	OB	downstream narrower (bottom)

Further channels: #20–24 H1–H5 (monochromator horizontal-focusing blades) and #25 V0 (vertical focus) — these are driven *automatically* by the autofocus when it is enabled (the mode is shown by “**LI**”); #26 RN (monochromator rotation) and #28 EL (exchange between the old and new monochromator) — *not used in normal operation*; #27 ON (not in use); #31–39 TA–TI (analyzer blades, DACS system). “**QU**” lists everything that is defined.

For sample tilt alignment, scan motor #6 (RX) or #8 (RY) using “**SC**” (e.g. **ax = 6** or **ax = 8**).

Autofocus calibration

The autofocus library is the file `nc1foc.dat` in the Filman working directory (`$FILMAN`, i.e. `/home/4g/lib`): calibration points ($k_i \rightarrow$ H1–H5, V0) plus an **active** flag and the mode.

Filman *re-reads the file before every command*, so an edit takes effect immediately — no restart needed. A verbatim copy of the file in force is embedded in every scan’s `.meta` sidecar (`#nc1|` lines), so past scans remain reconstructible after recalibration.

To recalibrate: optimize the blades at 4–6 values of k_i spanning the range of use, and enter the optima as calibration points (interpolation is a cubic spline; with fewer than 4 points it degrades gracefully to lower order). **Outside the calibrated range the evaluation is clamped to the nearest endpoint** (no extrapolation) — so the calibration points must cover the FULL k_i range that will be used, up to the highest k_i .

Restricted commands and the “EX” escape (new in 2026)

The following rarely used or hazardous commands refuse direct entry (typo insurance):

FL DF FI FA FF RM ER SM CD CS PS SS

Typing one prints “‘FI’ is a restricted command - type EX FI ... to run it” and does nothing. To run one deliberately, prepend “EX”:

Example

```
1 TRAX> FI
2 'FI' is a restricted command - type EX FI ... to run it
3 TRAX> EX FI
4 (FI runs)
```

The bypass is one-shot: it applies only to the command that follows EX on the same line.

MG values (data-saving mode): only MG=2 (standard: `.ngx + .meta`) and MG=0 (no save) are accepted. MG=1 (the legacy binary-only save) is retired — it crashes under the current compiler and is rejected at input; the “FL” toggle likewise refuses to enter it.

“SE” command: SEt (redefine) the current motor angle

“SE *XX* *YYY*” redefines the current angle of motor *XX* to be *YYY*. The motor does *not* move; only the encoder readout is shifted. Use this when:

- the encoder zero has drifted (e.g. after a power cycle or maintenance);
- the motor has been physically reset to a known reference (e.g. the centroid of a known Bragg peak found with “**cr**”).

“SE” on a *frozen* motor is refused (unfreeze with “DR” first). After “SE”, confirm with “QU”. The offsets of all axes can be listed with “ZR” (despite its name, ZR only *displays* the offsets; it does not zero anything).

Example: redefine the C2 angle

```
1 TRAX> SE C2 28.41
2 ENCODER 2 changed from 28.40 to 28.41
```

“SL”, “>”, “<” commands: motor limits

“SL” lists the lower and upper software limits of every defined motor. **Do not loosen them without checking clearances first.**

- “**XX>YYY**” set the lower limit of motor *XX* to *YYY*.
- “**XX<YYY**” set the upper limit of motor *XX* to *YYY*.

Know the three layers of protection, from soft to hard:

1. **Filman software limits (L/U)**: checked by *scans* only. Bare “**MV**” bypasses them by design.
2. **Motor-record limits (IOC)**: refuse out-of-range targets for every client including MV; wider than L/U.
3. **Hardware limit switches (PLC)**: last resort. A scan that reaches one reports “motor(N) +limit error!!!” and aborts. **Never command a further move in the same direction while sitting on a switch** — the PLC latches an axis error and a PLC restart (UPS power cycle) is required to clear it (see Restart procedures).

None of the three layers models collisions with the sample environment (cryostat, shielding) — clearances are the operator’s responsibility.

Example: list and tighten the A2 limits

```

1  TRAX> SL
2  MOTOR  #    LOWER  UPPER
3  C1      0      0      40
4  A1      1      4     100
5  C2      2     -10    200
6  A2      3      4     100
7  ...
8  TRAX> A2>10
9  TRAX> A2<100

```

Wavelength calibration: “RS5” / CLAX mode

The wavelength is calibrated against an Al_2O_3 powder standard. Filman has a dedicated mode **CLAX** (RS5) which automatically sets the scan parameters, finds the powder peaks, and refines k_i together with the 2θ encoder offset.

Variables for CLAX:

- **SX**: sign of A2 axis (+1, 0 [both], -1). **NO NEED TO CHANGE.**
- **JS**: scan number from which “GO” starts.
- **JP**: number of peaks for which the moment has already been determined (auto-incremented).■
- **T1**: if set ($\neq 0$), skip the measurement and only re-run the least-squares fit on the peaks already measured.
- **T2, T3, T4**: reserved switches; normally leave at the default. (The scan set actually used is selected automatically from k_i : $k_i > 4 \text{ \AA}^{-1}$ uses one set, otherwise the other.)

Per-scan parameters (NS, DS, TS, DT, NP, MN) — *same one-line rule as the main scan sets*:

- **NS**: scan number.
- **DS**: $d^* = 2\pi/d$ of the chosen Al_2O_3 reflection.
- **TS**: θ shift (offset of the calculated centre).
- **DT**: 2θ step.
- **NP**: number of points.
- **MN**: monitor / counting time. **MN=0 disarms that peak** (it is skipped with “Improper scan parameter”).

Procedure:

1. Mount the Al_2O_3 powder standard at the sample position. Make sure A2 is driven and *every other main axis is frozen*: “**DR A2**”, “**FR C1, A1, C2, C3, A3**”. (An unfrozen axis aborts the mode immediately.)
2. Enter CLAX mode: “**RS5**”. The prompt becomes “CLAX>”.
3. Type “**GO**”.
4. After the powder peaks are scanned, CLAX runs a least-squares fit, updates k_i , and adjusts the A2 ($2\theta_s$) encoder offset. If *no* peak yields a usable moment (e.g. no beam), the calibration is refused with “Calibration not possible” and the encoder is left untouched (older versions could silently corrupt A2 here — fixed Aug. 2026).
5. Verify with “**QU**”, then re-derive C1, A1 with “**CABR**” for the new k_i and reset them with “**SE C1 xx.xx**”, “**SE A1 yy.yy**”.
6. Exit CLAX with “**RS1**” to return to 3-axis mode. After the mode work, restore the frozen axes: “**DR C1, A1, C2, C3, A3**” and **save with** “**SV**” (mode switches save the state *immediately*, including your FR/DR pattern — but a plain exit does not save the restore).

Restart procedures (rewritten for the EPICS system, 2026)

The system now consists of:

- (i) the control rack: Yokogawa PLC (motor drivers) + C-2000 counter;
- (ii) the **motor IOC** server: Raspberry Pi 172.16.21.13;
- (iii) the **counter IOC** server: Raspberry Pi 172.16.21.14;
- (iv) the Linux PC (`gptasdeb`) where Filman (`flmmu`) runs;
- (v) the TEMCON note PC.

The LabVIEW control PC and the PXI are **retired** — ignore any old notes about `filman_interface_main`. Work down from the lightest restart.

(0) Recovery after emergency stop

- “**Q**” on the Filman terminal: nothing else needed; the prompt returns automatically.
- Red E-stop button on the rack: **rotate** the button in the direction of the arrow to release it (do not pull).

Level 1 — restart Filman

“**SV**”, “**AB**”, then “**filman**” in the Linux terminal. The IOCs and the PLC are unaffected — motor positions are never lost by a Filman restart.

Level 2a — restart the counter IOC (counter dead / counting errors)

1. `ssh 4g@172.16.21.14`
2. Check nothing is left running: `ps aux | grep '[c]2000'` and `screen -ls` must both be empty. Kill leftovers: `pkill -f 'linux-aarch64/[c]2000'`.
3. Start with the wrapper (**always** — never start the binary by hand):
`/home/4g/epics/c2000/start_c2000.sh`
4. Verify the startup log has **no** “cas WARNING” line. That warning means a second instance is still alive — **two IOCs on one serial port shred every reply** (this exact failure produced days of mysterious counting errors in Aug. 2026). Go back to step 2.
5. Check from `gptasdeb`: `caget 4G:CO:WORK 4G:CO:ETIM`.
6. To look at the console: `screen -r c2000ioc`; detach with **Ctrl-A d**. Typing **exit** inside kills the IOC.

Level 2b — restart the motor IOC (all motors dead)

1. `ssh 4g@172.16.21.13`, check for leftovers as above.
2. `screen -S ioc`
3. `cd /opt/epics/epics7081/base/app/motorYokogawa/iocBoot/ioctest`
4. `../../bin/linux-aarch64/ioctest st.cmd > logYYMMDD.txt 2>&1`
(redirect to a *file*: console output slows the polling measurably)
5. Detach with **Ctrl-A d**. Check: `caget 4G:MC:m02.RBV`.

Level 3 — PLC axis-error latch

Symptom: one axis refuses *every* move (typically after driving onto a hardware limit switch or a drive fault). The PLC has latched an error for that axis and will not accept starts until it is cleared:

1. Read the axis error with **WideField3** on the engineering PC (PLC at 172.16.24.3).
Note: the Filman motor number is *not* the PLC axis number — use the mapping table in `REPORT_filman_modernization_2026.md` §9.1.
2. Power-cycle the PLC: rack UPS OFF, wait a few seconds, UPS ON.
3. Restart the motor IOC (level 2b).
4. Verify with a small real move.

Do this together with the instrument scientist.

Counter device wedge

If the counter IOC log streams timeouts although only *one* IOC instance is running, the C-2000 itself may be wedged: power-cycle the counter bin in the rack, then restart the counter IOC (level 2a). (The C-2000 also goes silent for a moment about every 30 s — *that* is normal and absorbed automatically; do not chase it.)

TEMCON communication failure

Quit TEMCON on the note PC, reboot the TEMCON note PC, log in as **TEMCON** (password: posted at the instrument / ask the instrument scientist), restart the TEMCON program, then restart Filman (level 1).

Quick diagnostics from the Filman PC

```
$ caget 4G:MC:m02.RBV          (a motor answers = motor IOC alive)
$ caget 4G:CO:WORK 4G:CO:ETIM  (counter IOC alive)
$ camonitor 4G:CO:ETIM         (watch it count; Ctrl+C to stop)
```

Data files

With the standard `MG=2`, every scan is saved as a numbered sector file `4g0NNNNN.ngx` plus a sidecar `4g0NNNNN.meta` containing the full machine state at save time (all variables, auxiliary motor angles, autofocus state, the focus calibration, and the heading as a `#title|` line). The `.meta` exists because the live variables change over time — the sidecar is the only trustworthy record of the conditions of a given scan. The `ngx2spice` converter turns `.ngx` (+`.meta`) into SPICE-format files for analysis.