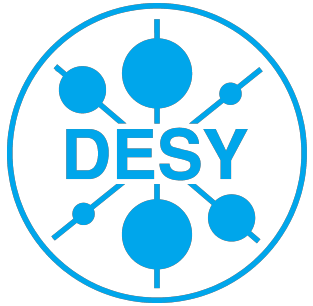
OCELOT orbit correction and optimizer

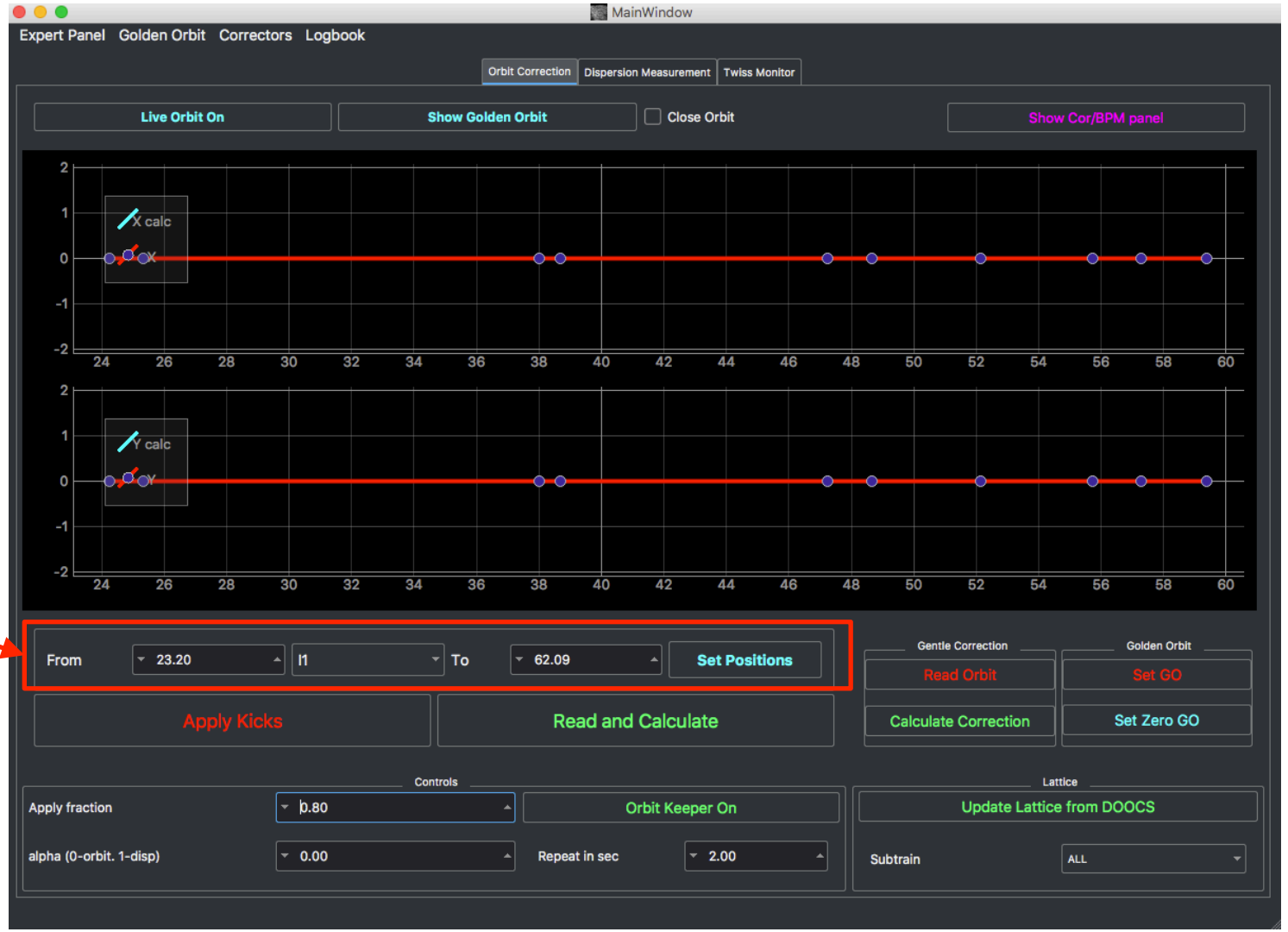


Sergey Tomin

Outline

- OCELOT orbit correction tool
  - Orbit correction
    - ► Dispersion measurement
    - ► Twiss Monitor
    - ► Golden Orbit Adviser
  - Adaptive Feedback
- OCELOT Optimizer
  - Dispersion minimization
  - SASE optimization

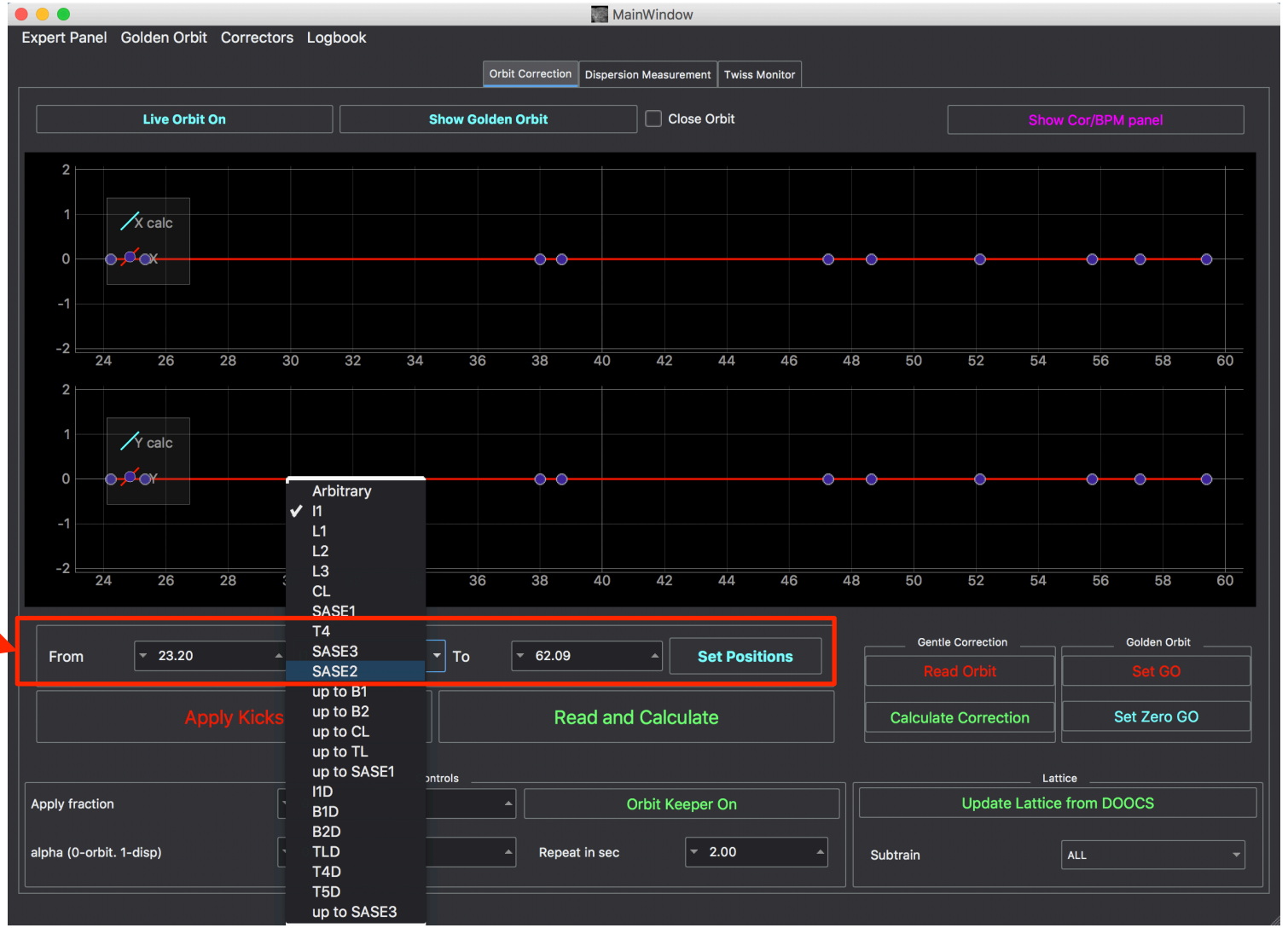
Orbit Correction Tool



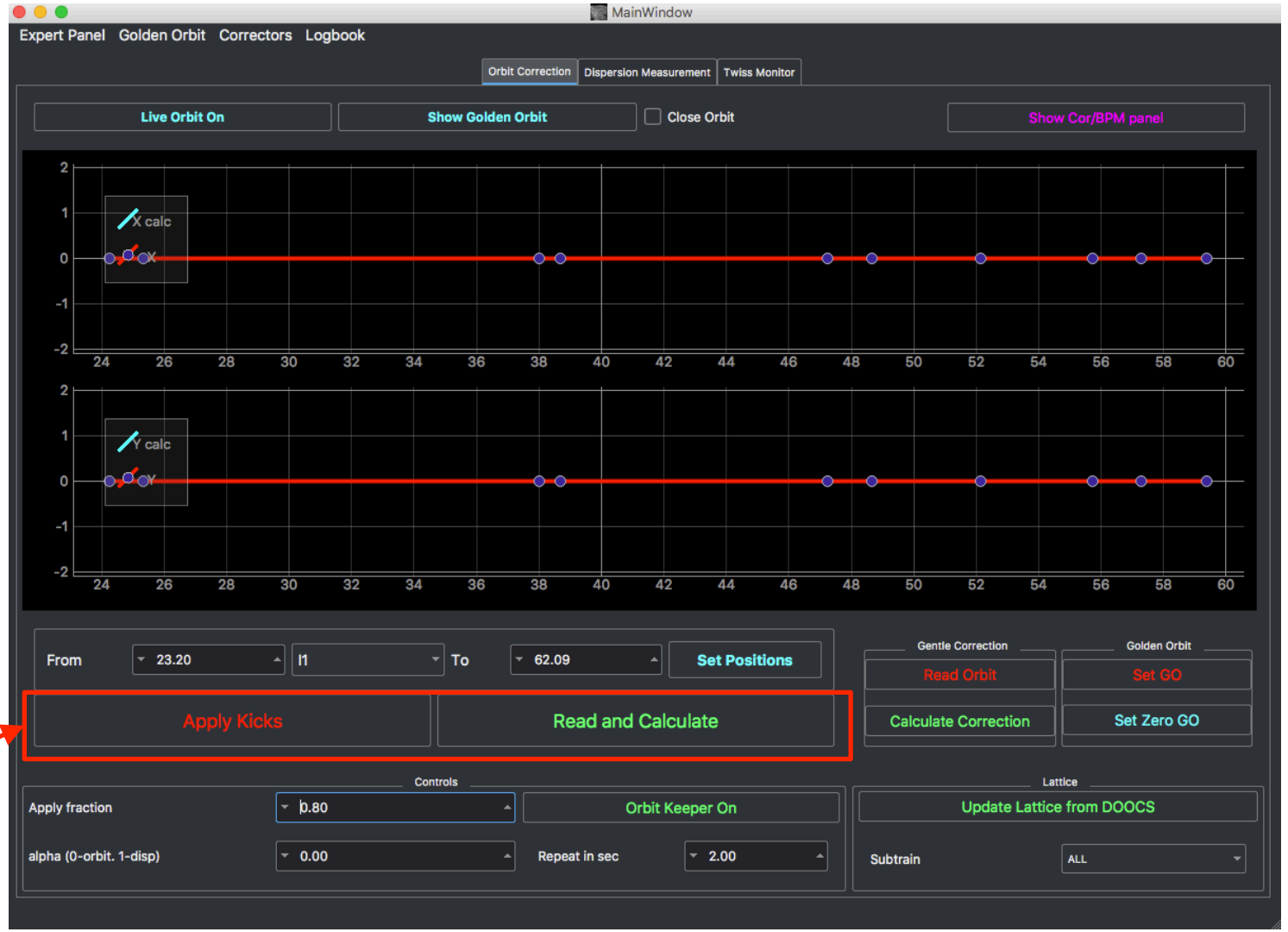
Choice of the accelerator section

Orbit Correction Tool

Choice of the accelerator section



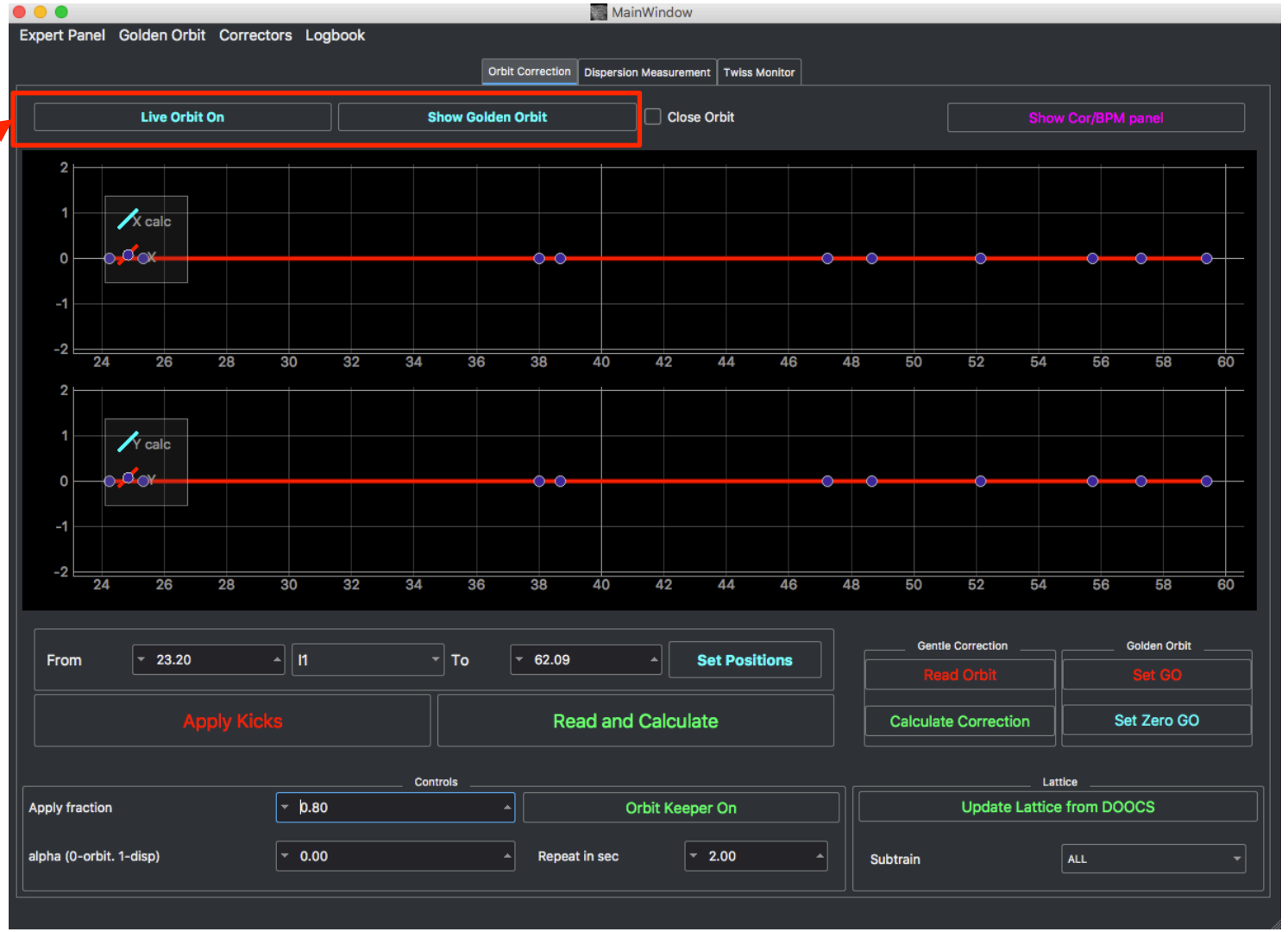
Orbit Correction Tool



Normal operation (w/o switching the beam off):
Read and calculate,
Apply Kicks

Orbit Correction Tool

Switch on/off:
1. “Live orbit“ – orbit wrt the golden orbit
2. „Show GO“ – show GO if one was store



Orbit Correction Tool

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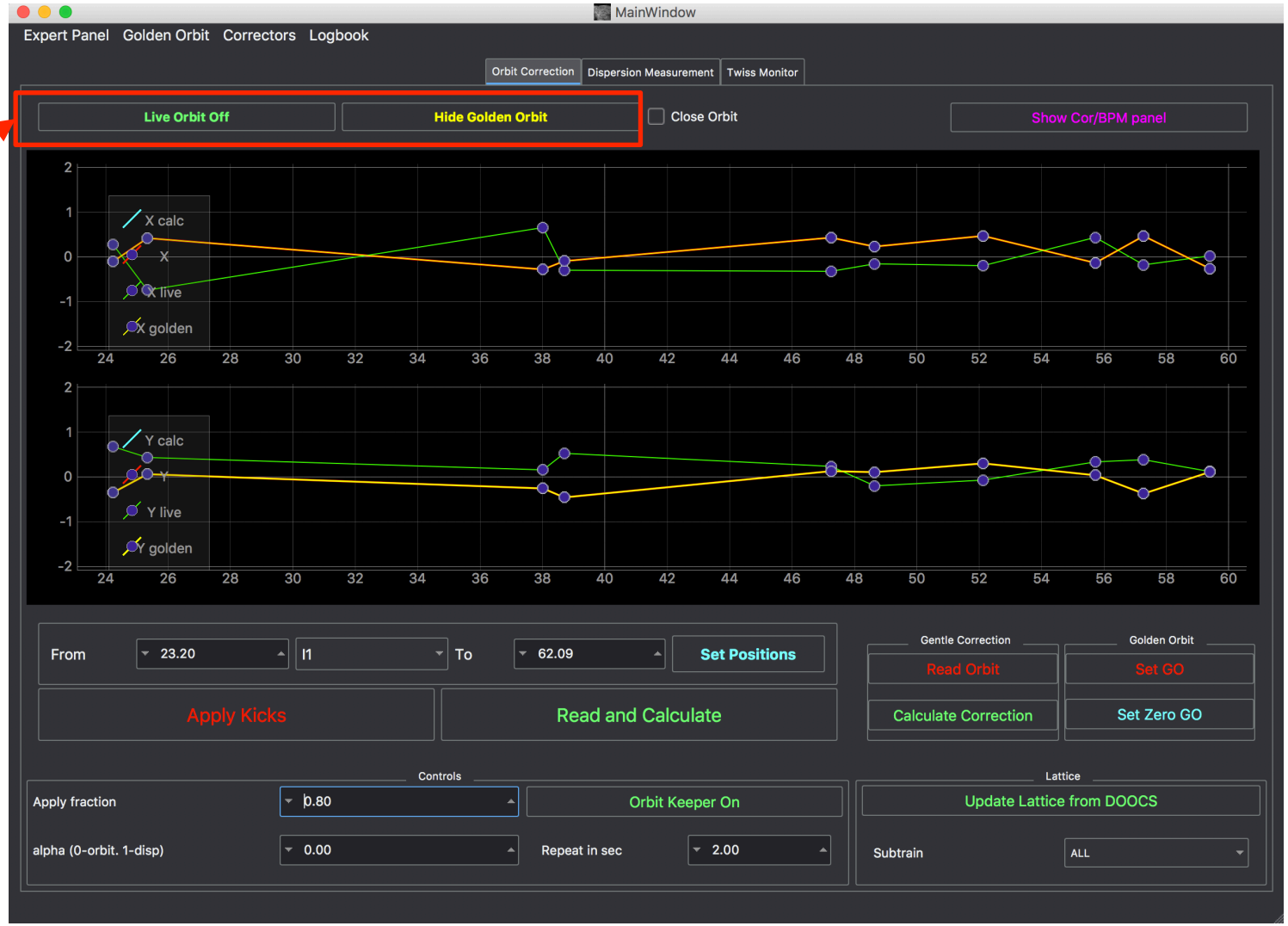


Orbit Correction Tool

Close Orbit – calculates the kicks in such a way to prevent distribute oscillation from correction to downstream sections. By default, only for 5 last BPMs takes into account to calculate closed correction (can be changed in Settings).

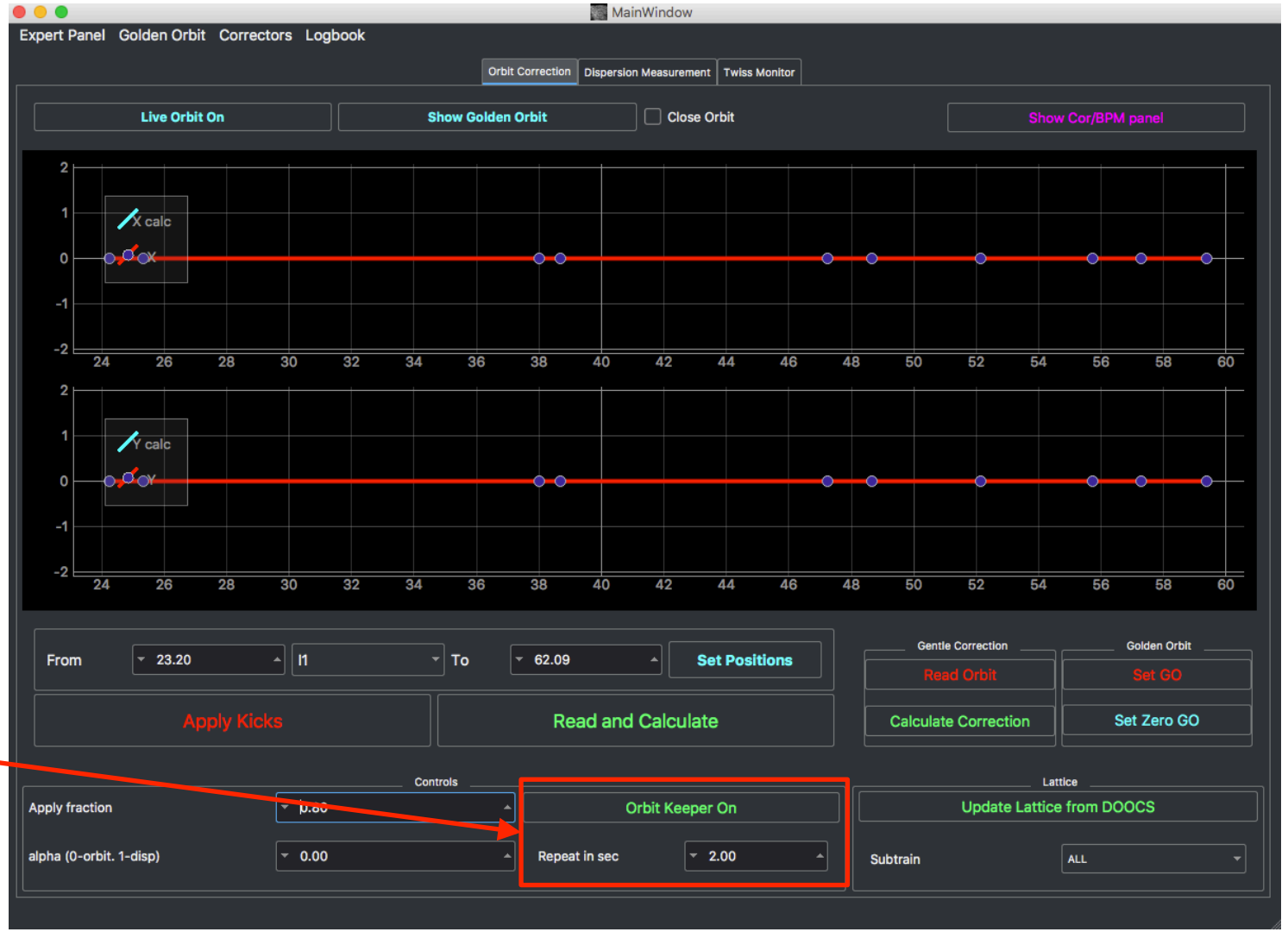
"Apply Fraction": The fraction of the kicks to be applied – by default 0.8

"Gentle Correction":

1. "Read Orbit": switch beam on, read orbit, switch beam off, and calculate correction.
2. "Calculate Correction" can be used to recalculate kicks w/o orbit reading

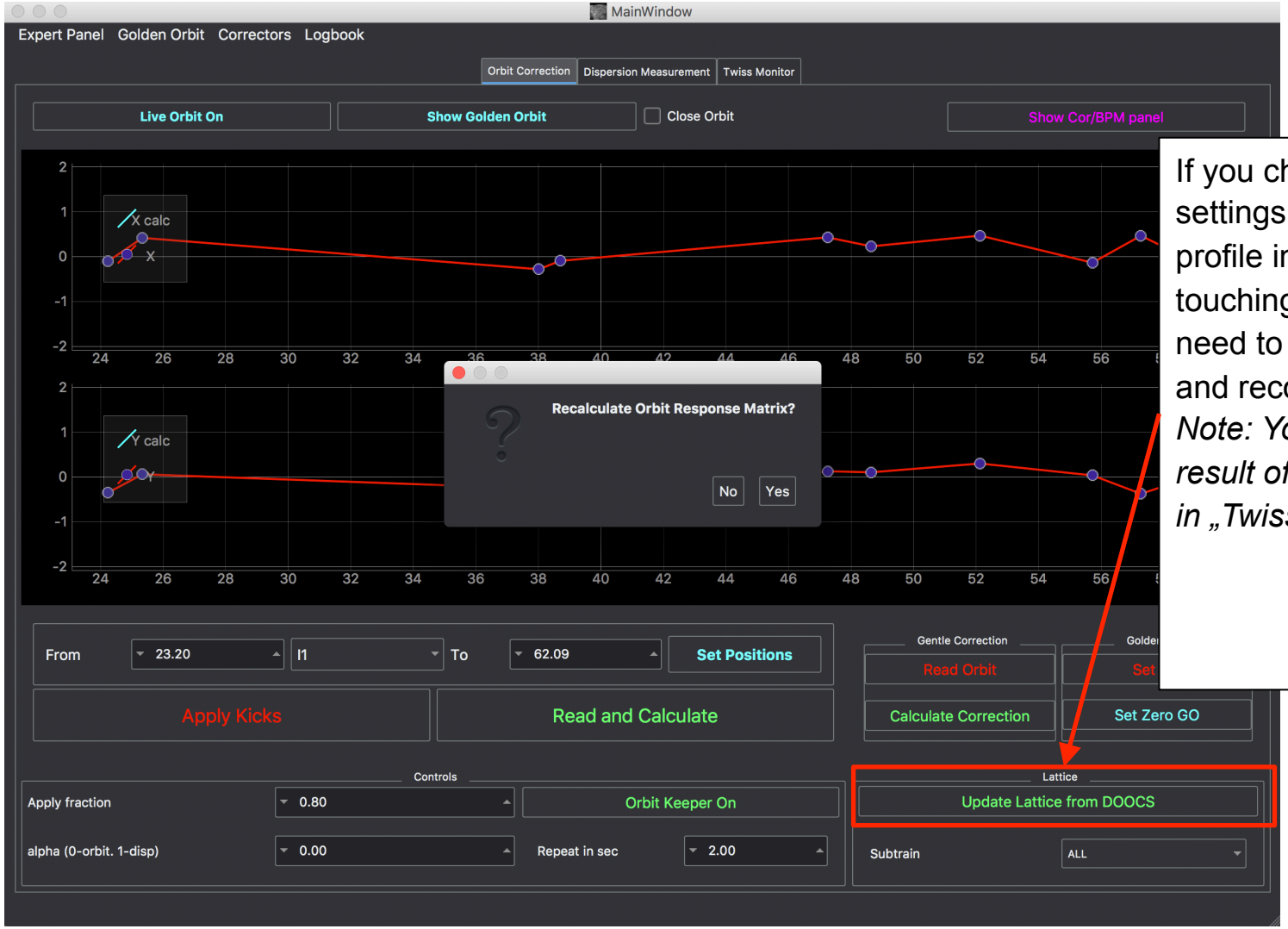
Note: The first reading is rather slow.

Orbit Correction Tool



Sometimes you need to repeat correction for the same section many times. This option can save you from routine.

Orbit Correction Tool



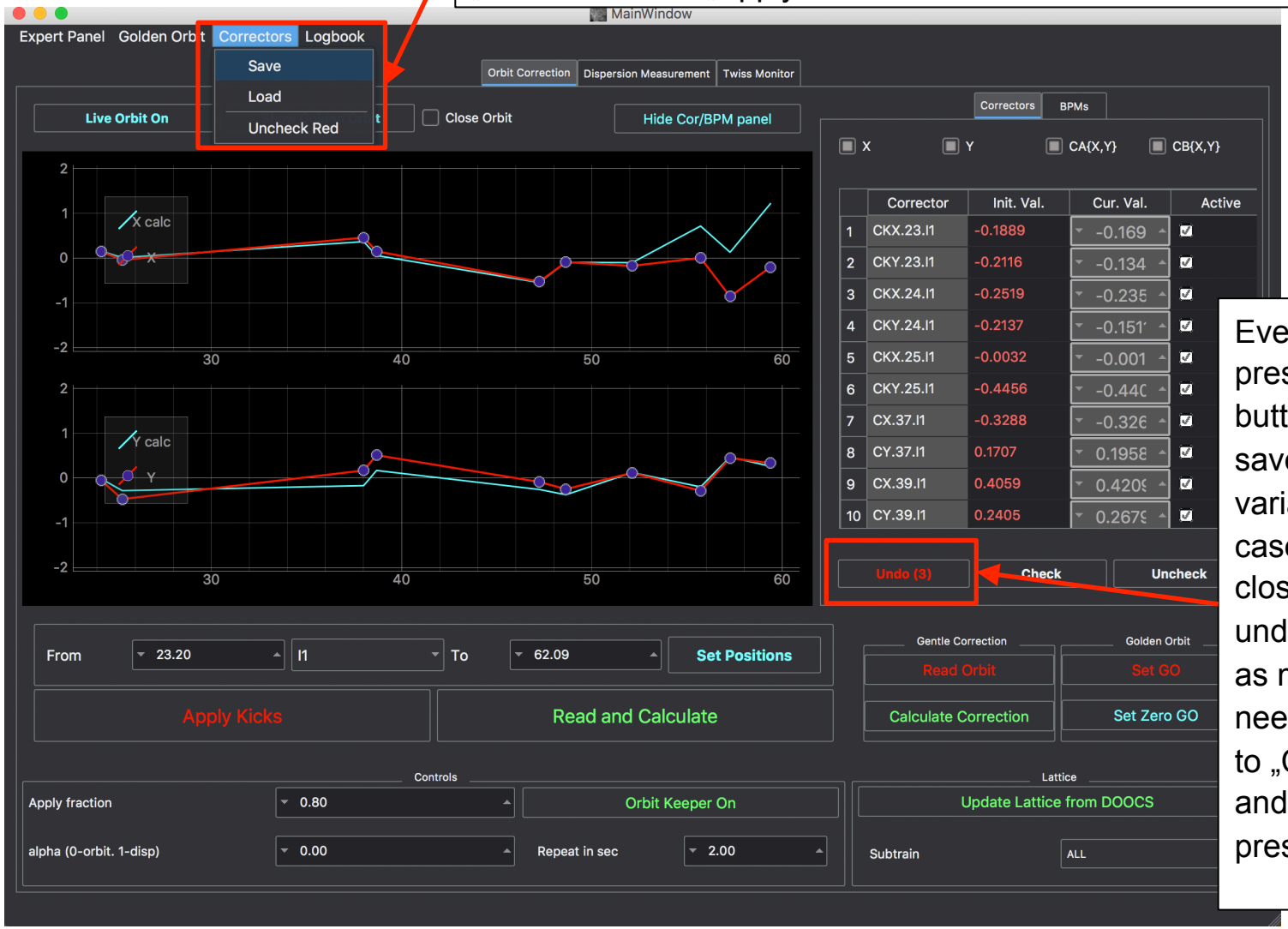
If you change the quad settings a lot or the energy profile in linacs without touching quads you might need to update the lattice and recolculate RM

Note: You also can see result of the lattice updating in „Twiss Monitor“ tab

Orbit Correction Tool

Orbit Correction Tool

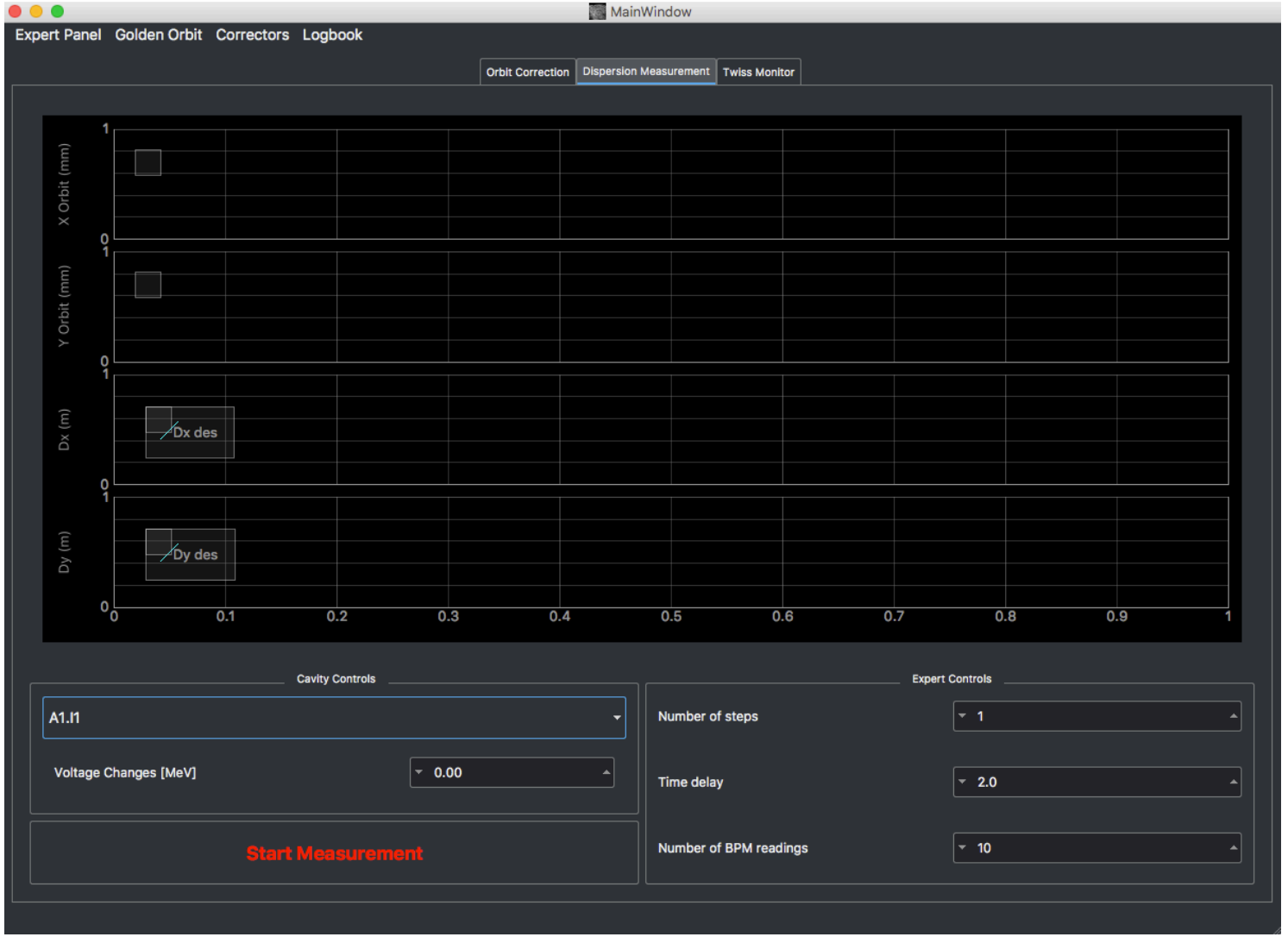
This option is to save correctors current kicks to file, which means you can restore kicks even you close the tool. For restoring press „Load“ and than „Apply Kicks“.



Every time, when you press „Apply Kicks“ button the kicks saved in a temporal variable (will be lost in case of the tool closing). To make undo -> press „Undo“ as many times as you need (it sends kicks to „Cur. Val“ column) and then you have to press „Apply Kicks“.

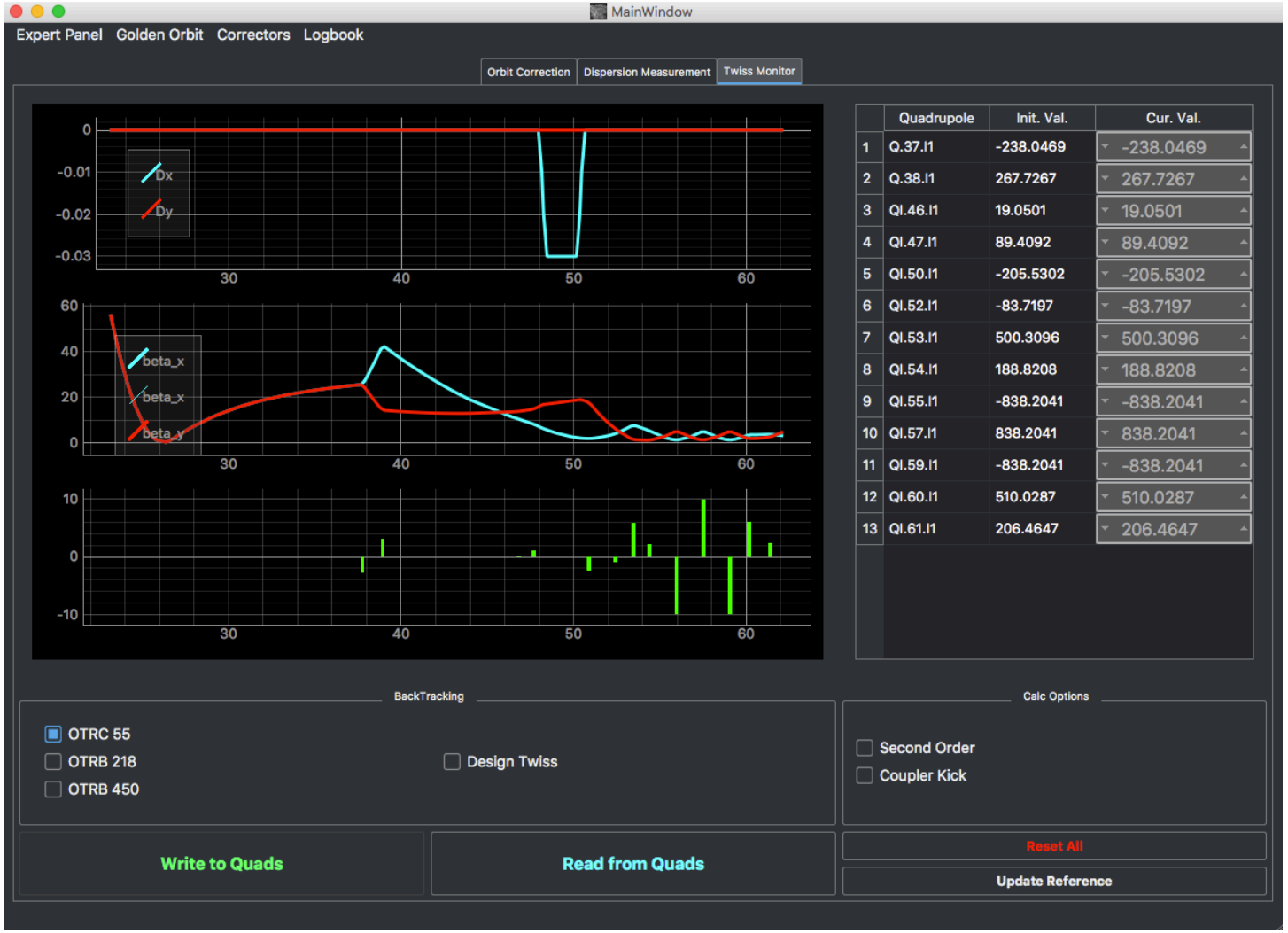
Orbit Correction Tool. Dispersion measurement

- How it works
  - Choose RF station
  - Set up Voltage changes: e.g. - 2MV
  - Press “Start Measurement”
- The Longitudinal FB should be switched off



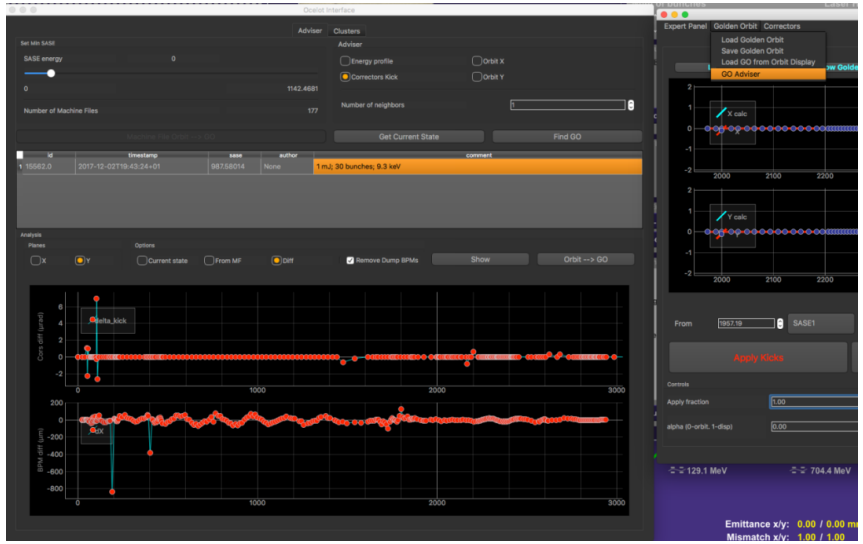
Orbit Correction Tool. Twiss Monitor

- To check design settings with current setup.

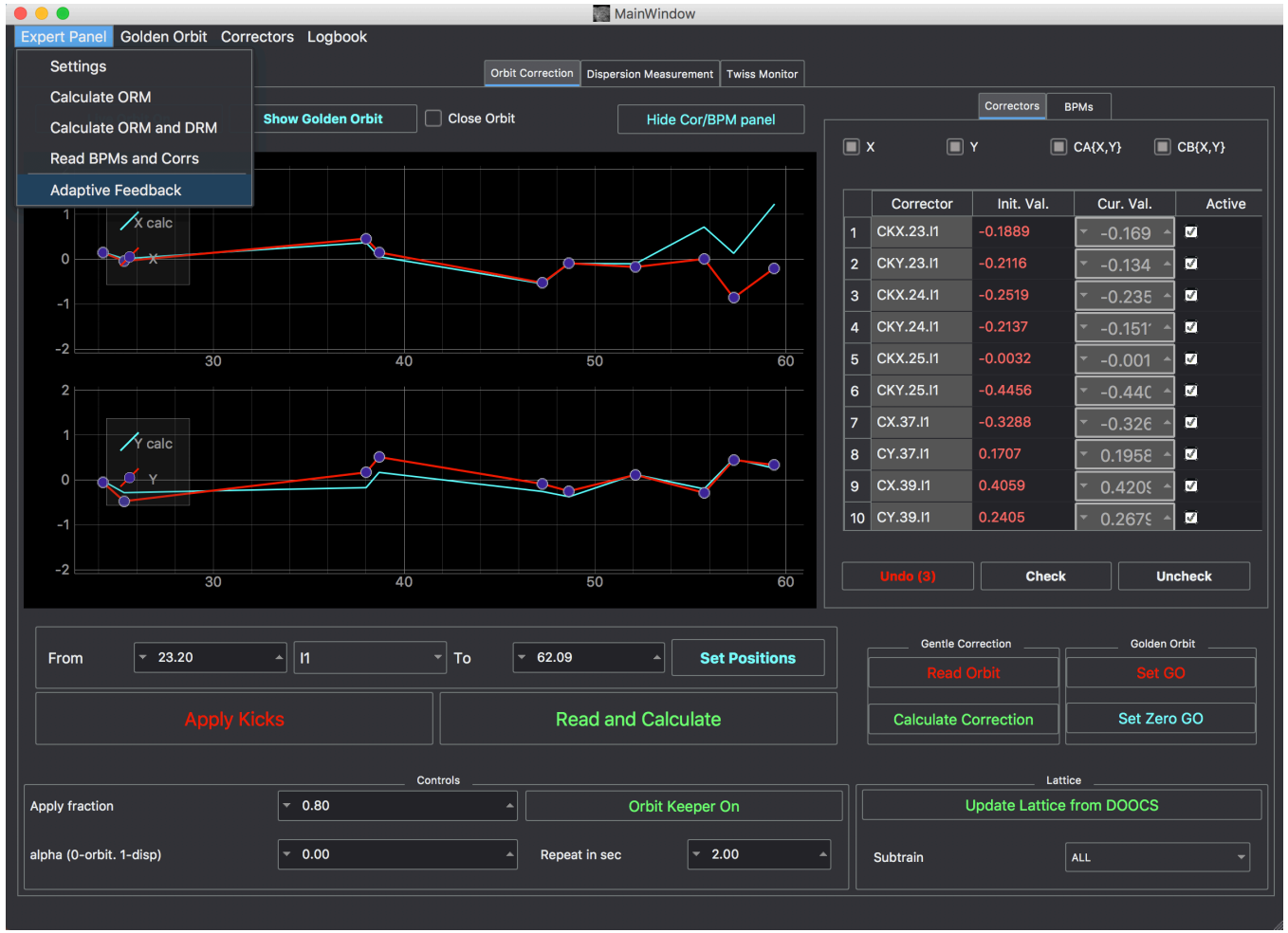


Golden Orbit Adviser

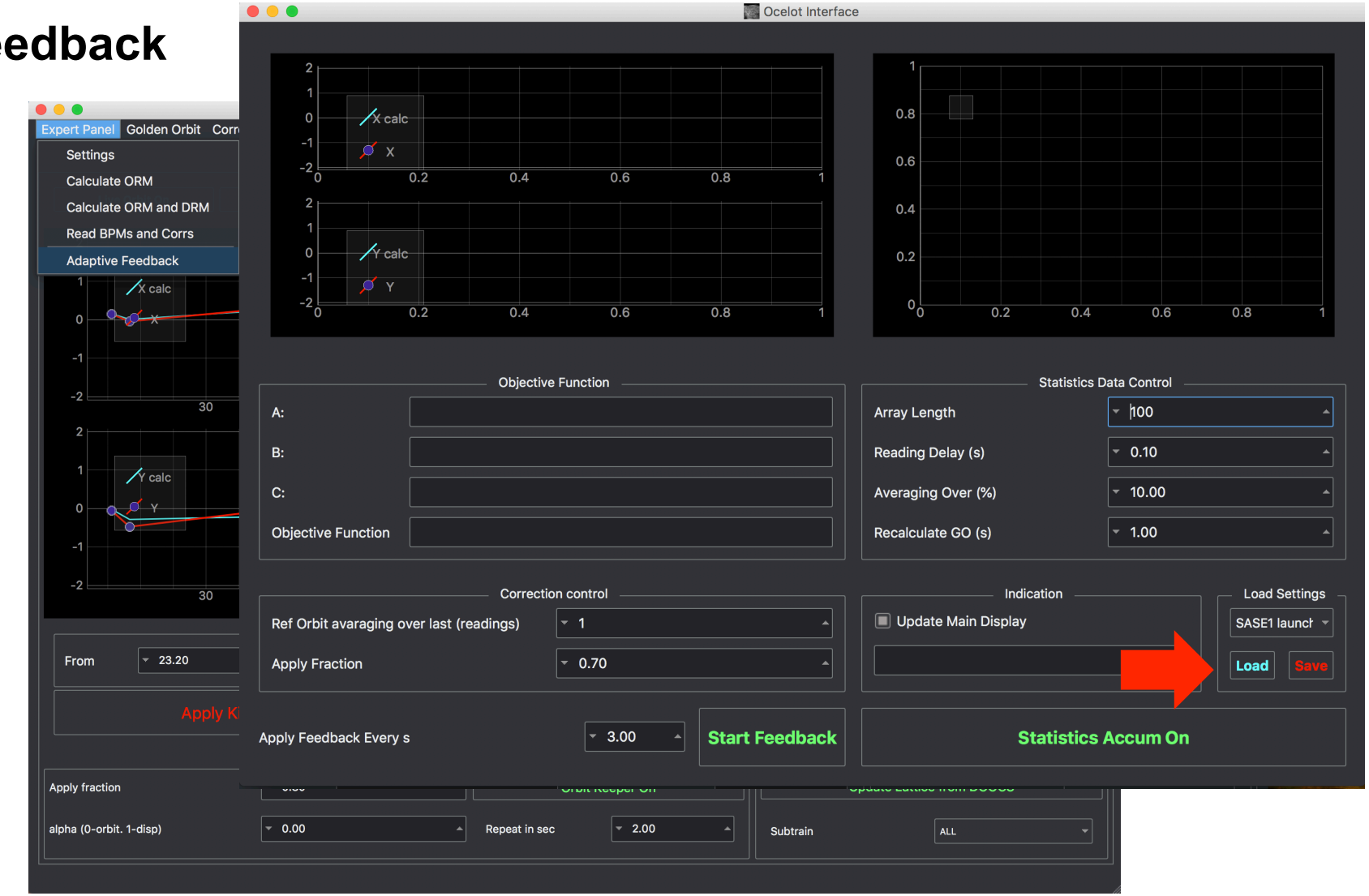
- Recently we introduced to the Ocelot orbit correction tool a "Golden orbit adviser" (in test mode).
- The idea is to find the machine file in the database that is as close as possible to the current machine setup.
- For instance, you can select as a reference vector the corrector kicks (or beam orbit in X/Y plane) and ML method (Nearest Neighbors) will find the machine file with the corrector kicks (or orbit) closest to the current conditions.



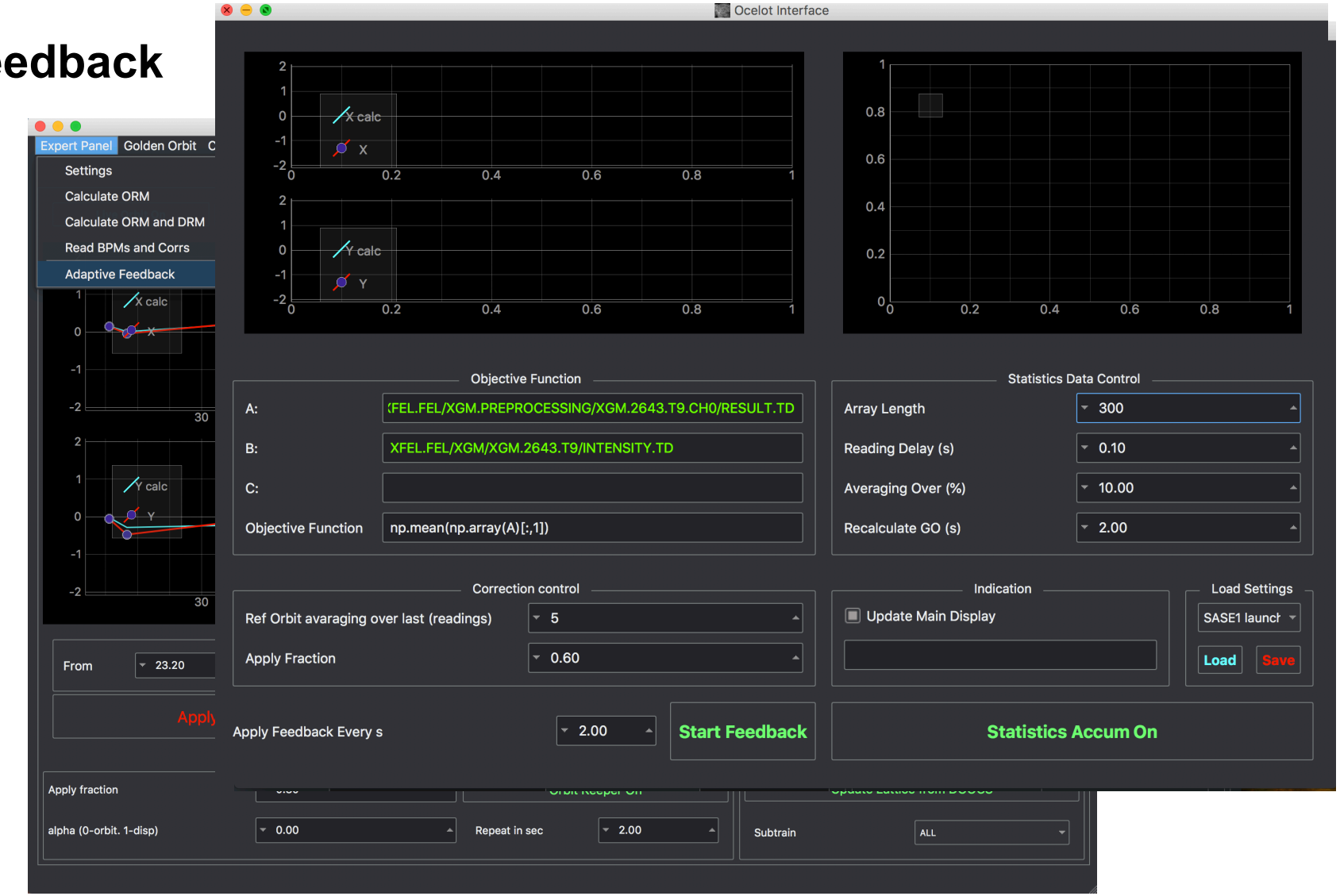
Adaptive Feedback



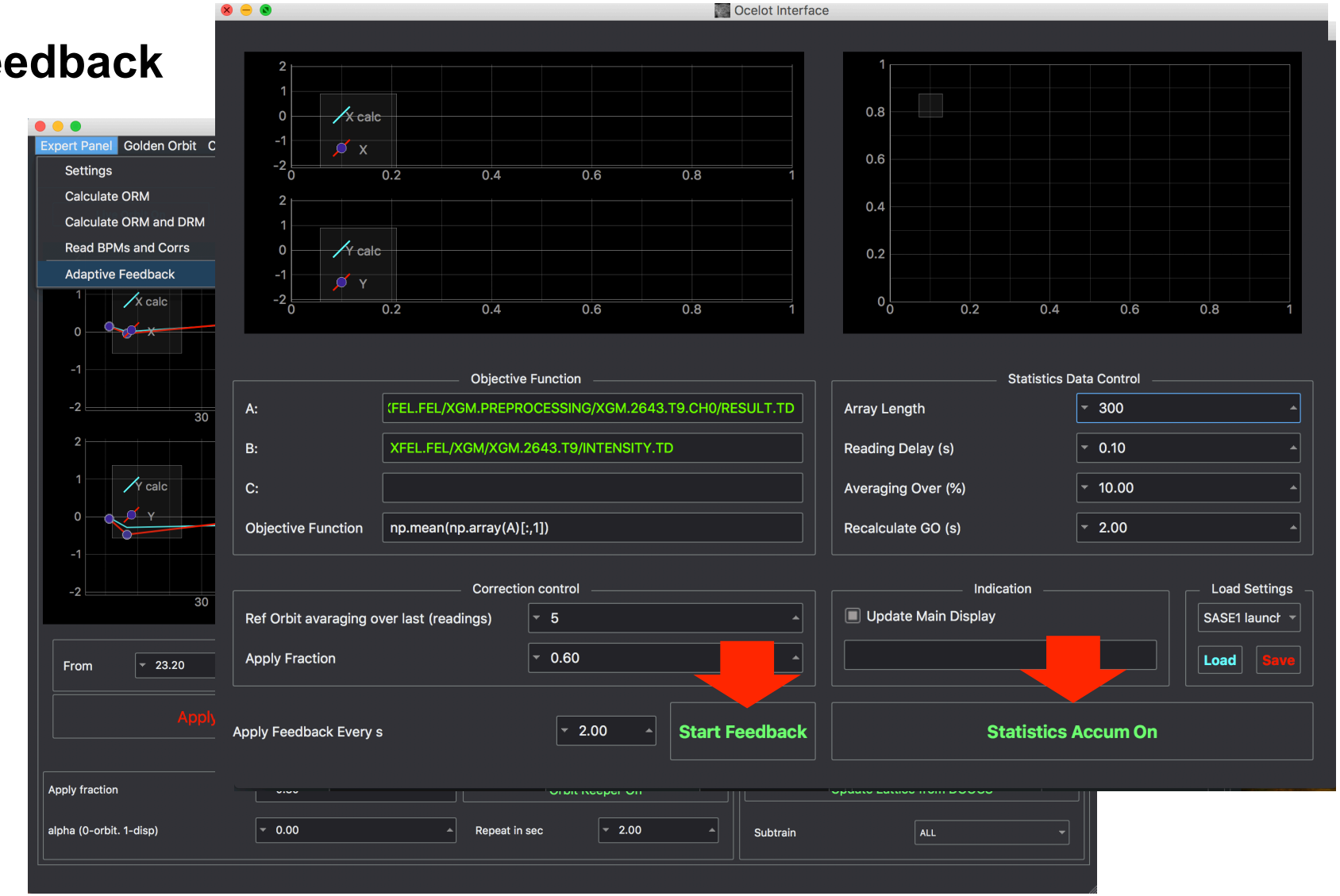
Adaptive Feedback



Adaptive Feedback

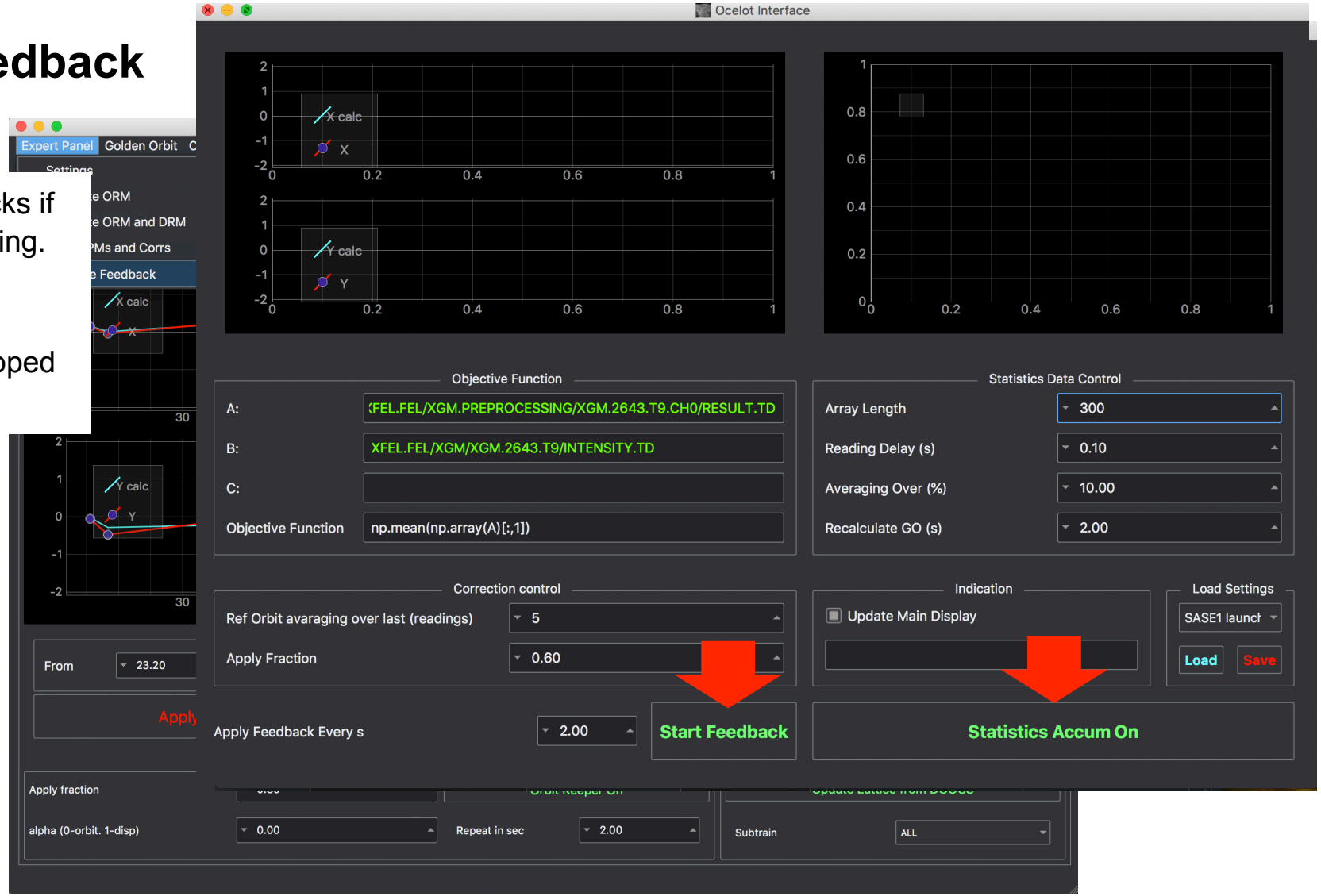


Adaptive Feedback



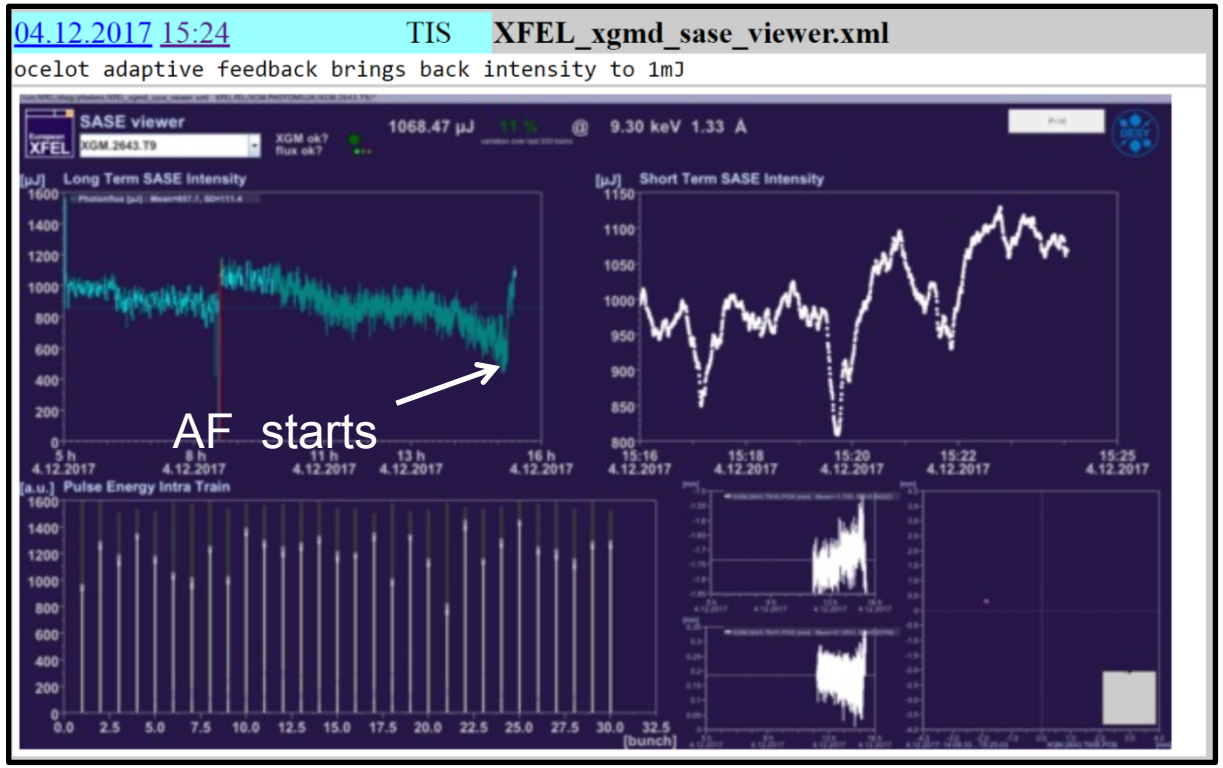
Adaptive Feedback

Adaptive FB also checks if the stadard FB is running. And if you switch the standard FB on the Adaptive FB will be stoped



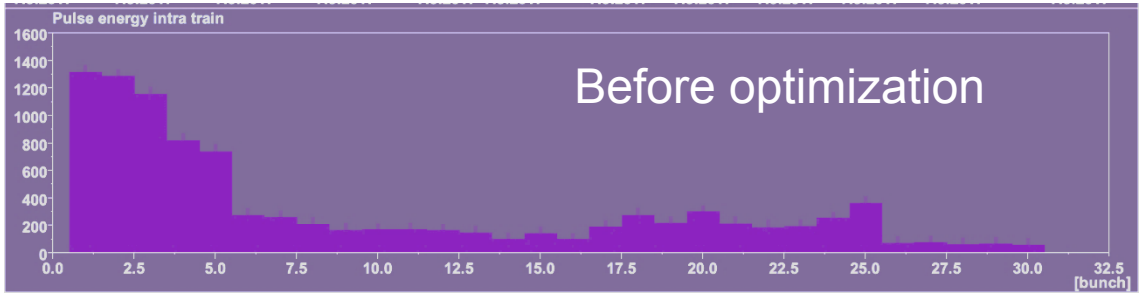
Adaptive feedback (SASE1)

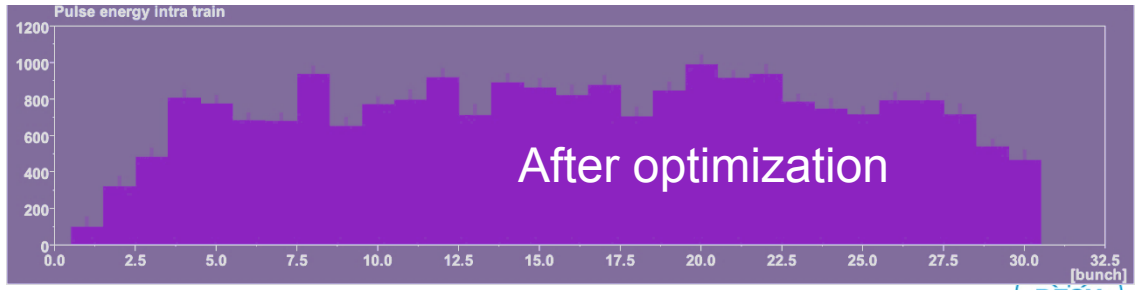
- Algorithm of Adaptive Feedback*
  - Shot-to-shot collection of orbits (~ 300 - 700) and the corresponding SASE pulse energy.
  - Sorting orbits according to SASE energy.
  - Taking 10-20% of the orbit with highest SASE and calculating new golden orbit for the feedback.



Adaptive feedback (SASE1)

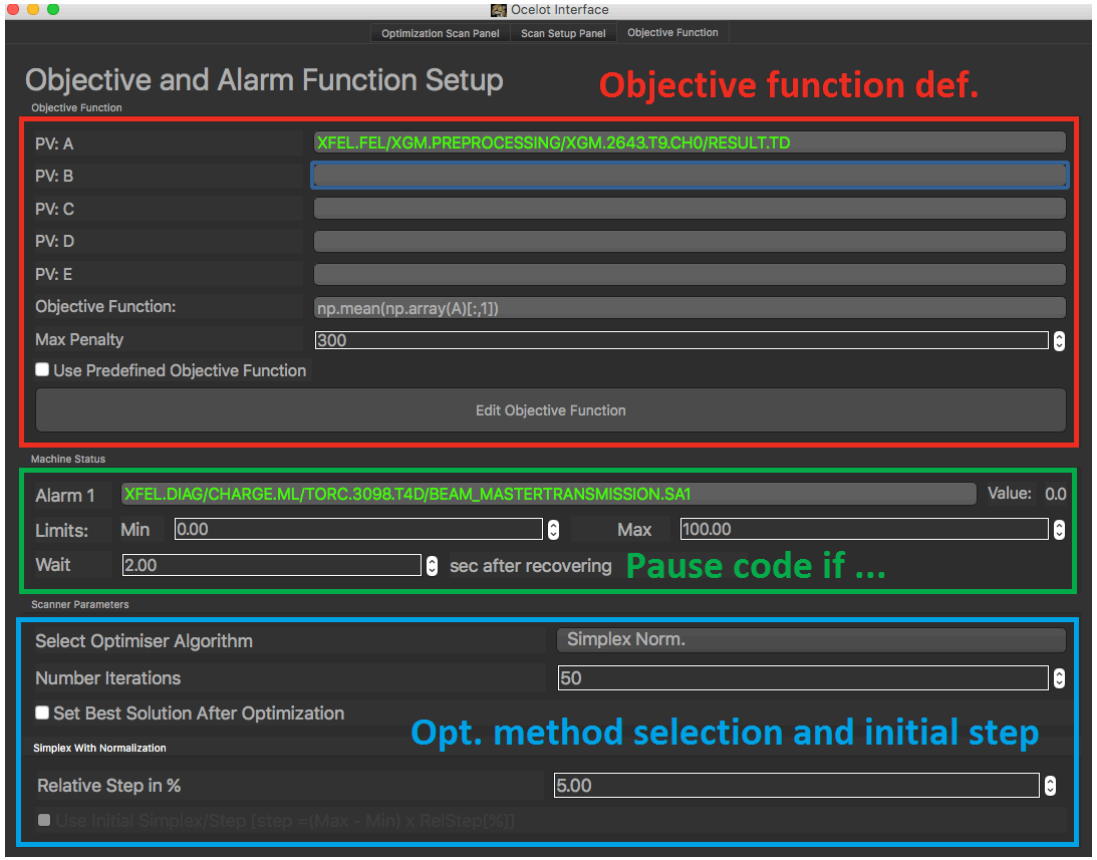
- Optimization of the orbit upstream the undulator. Only first three bunches were lasing before optimization. The IBFB was not commissioned at that time. Thus not all bunches were on the same orbit.
- The adaptive feedback optimizes by default the averaged SASE signal over all bunches in one bunch train. However, it is also possible to optimize for dedicated bunches if required.
- The lasing of the first bunches was suppressed but all following bunches contributed to the SASE level after the optimization with the adaptive feedback.





OCELOT Optimizer

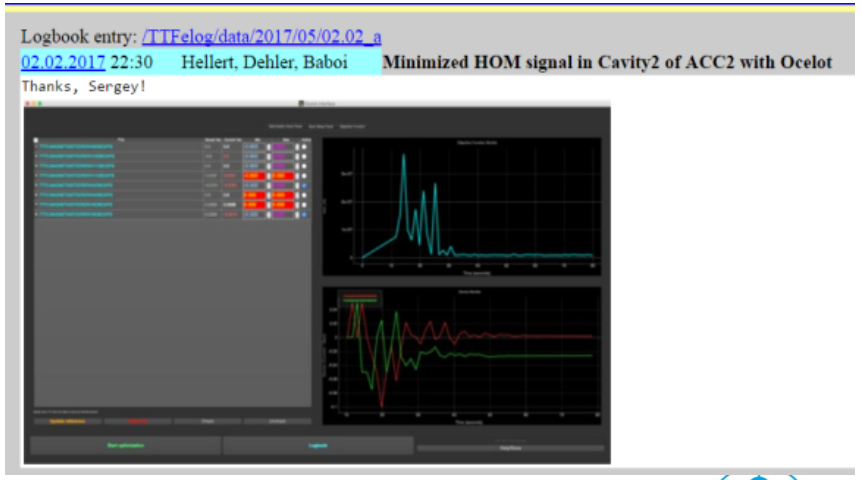
OCELOT Optimizer



OCELOT Optimizer

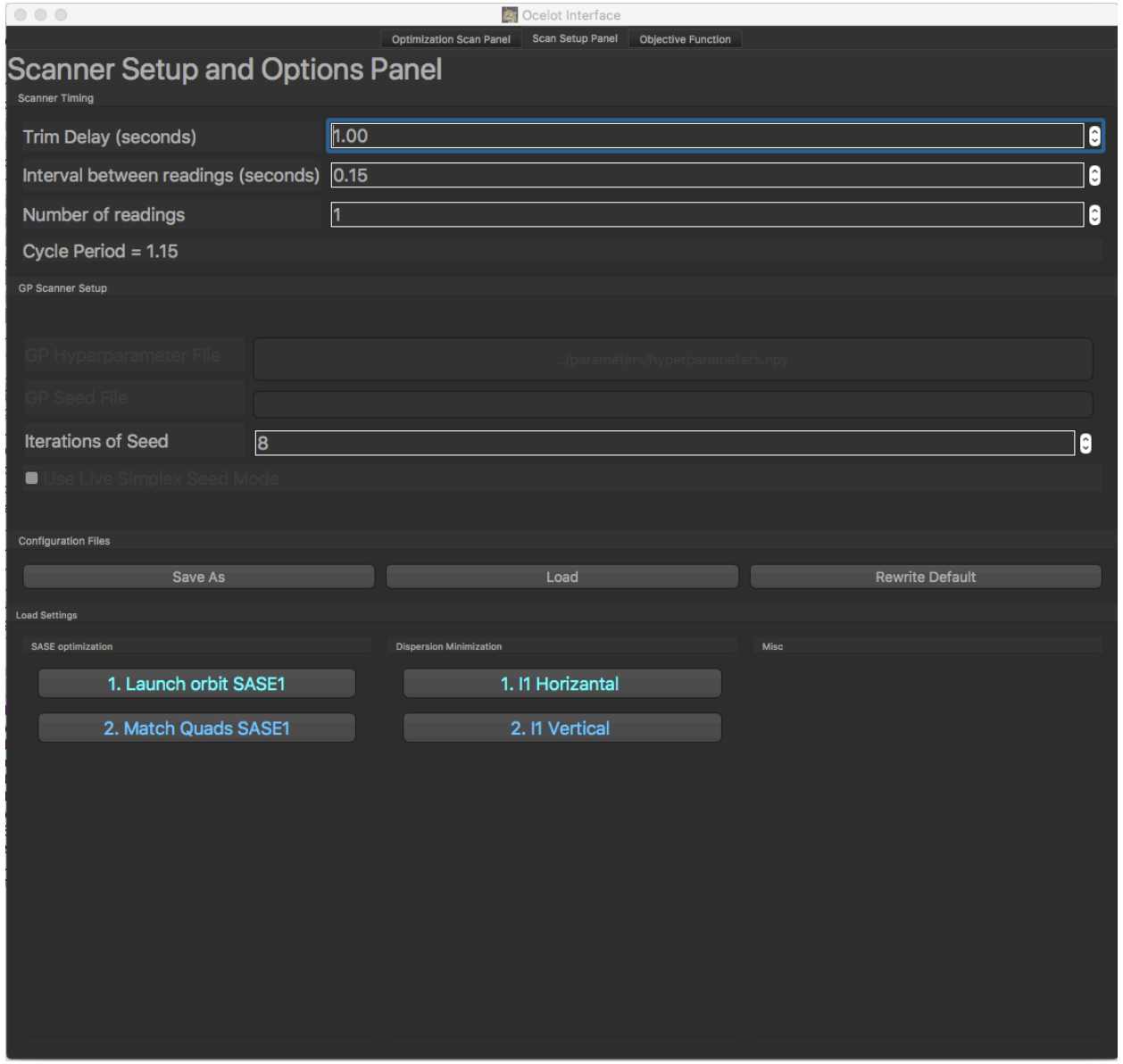
- Several different customized variants of the optimizer were used only a few times for different tasks.

- Examples for earlier customized setups:
  - Minimization of beam losses while keeping a reasonable orbit in the main dump beamline.
  - Orbit distortion compensation with air coils in an undulator section.
  - Minimization of HOM (higher order mode) signal in an accelerator module (FLASH).
  - SASE maximization (FLASH).
  - Dispersion correction (FLASH)

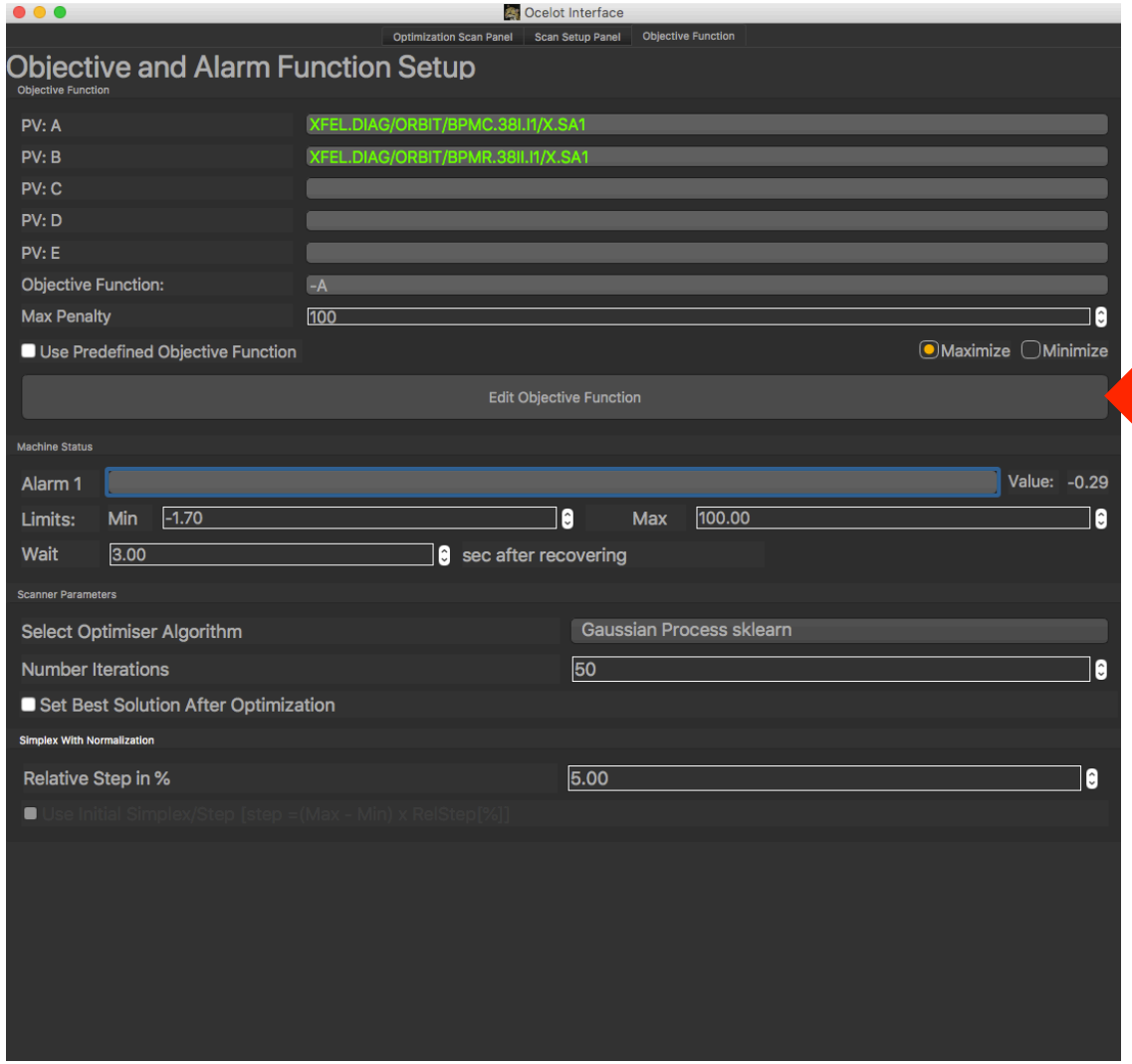


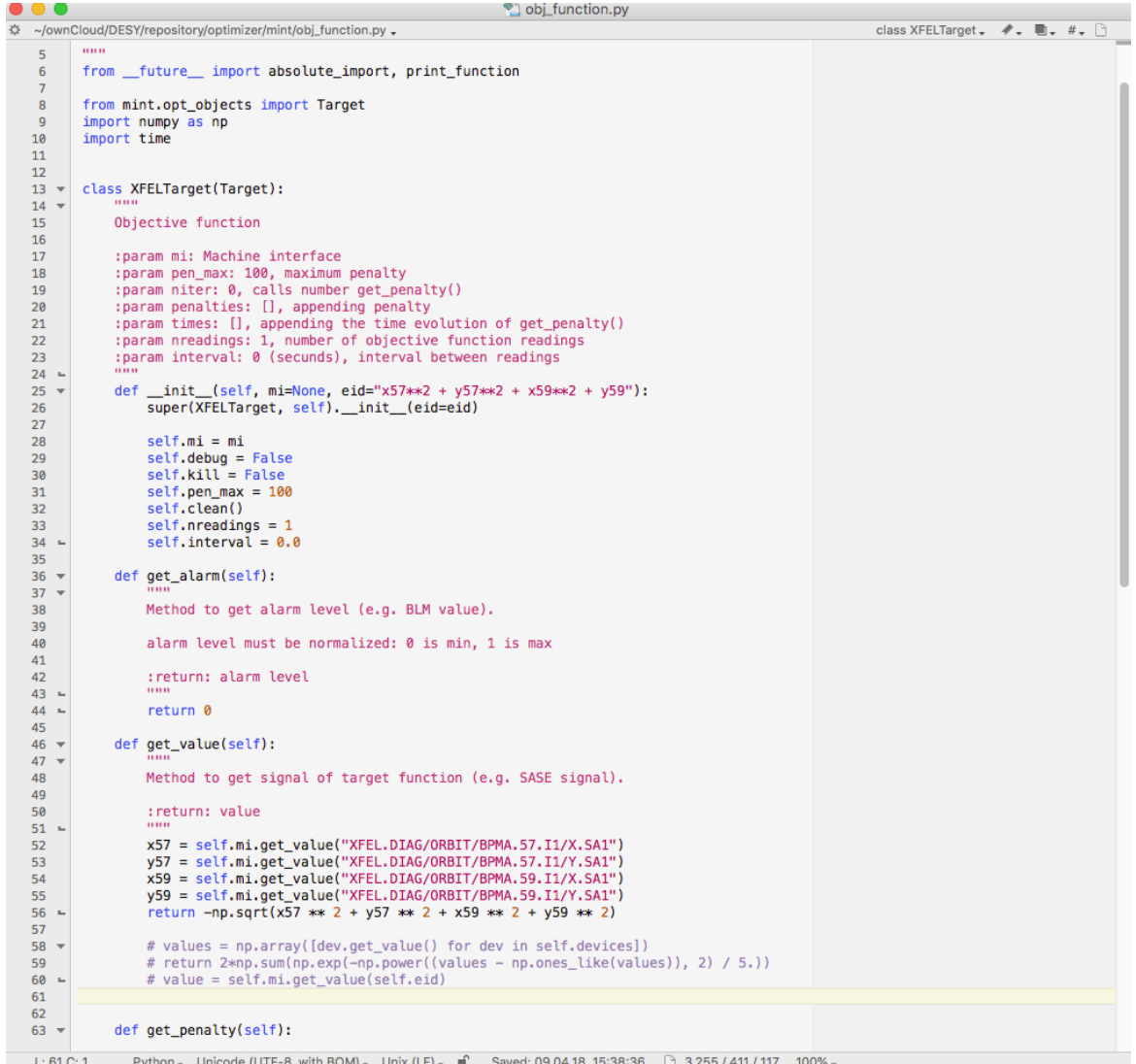
OCELOT Optimizer

- Trim delay: delay between setting new values to the devices and start reading the Target function.
- Some noisy signals like SASE might need averaging. For that, you can use “Number of readings” and Interval between readings”
- Any configuration can be saved and loaded.
- There are 4 standard configs: 2 for SASE1 optimization and 2 for dispersion minimization
- During dispersion minimization the Longitudinal FB should be switched off



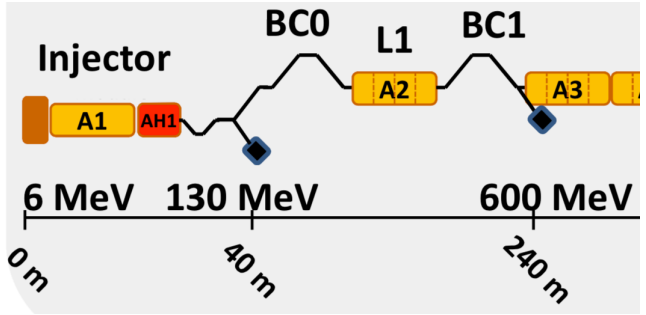
Objective Function

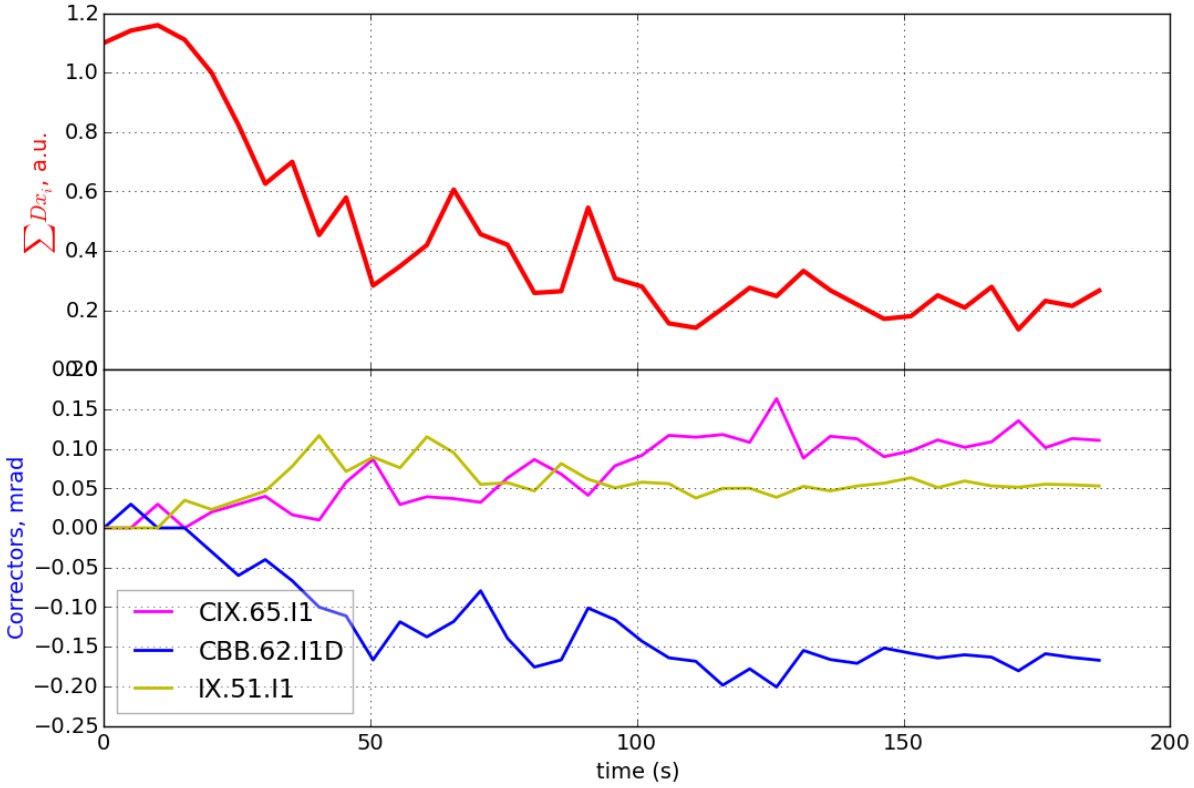




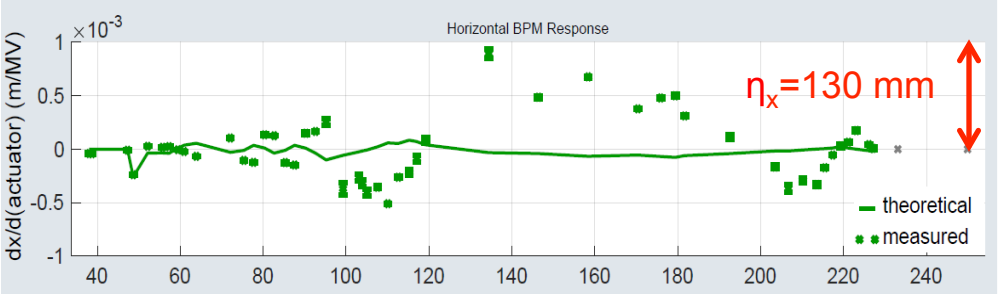
OCELOT Optimizer: local dispersion correction

Horizontal spurious dispersion correction with 3 corrector magnets.

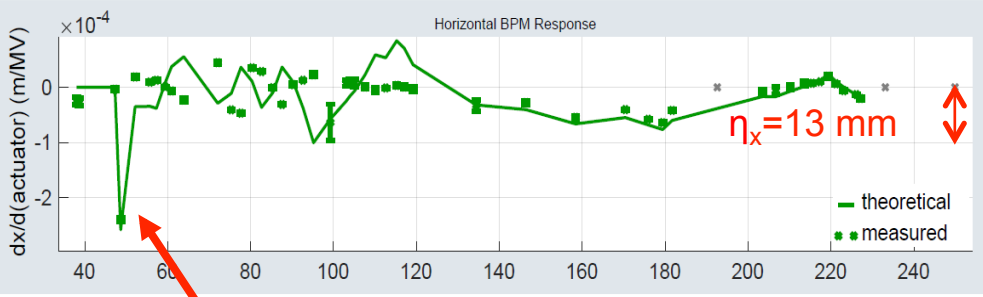




Before correction



After correction



Laser Heater chicane

OCELOT Optimizer: SASE optimization

- Air coils between the undulator cells were used to optimize the SASE signal
- Up to 6 air coils are typically used at the same time.