Tuning and maintaining SASE

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From beginner to expert level

Maintaining SASE at a given level
Obtaining SASE after maintenance

~~Changing energy/wavelength~~
~~SASE from scratch~~

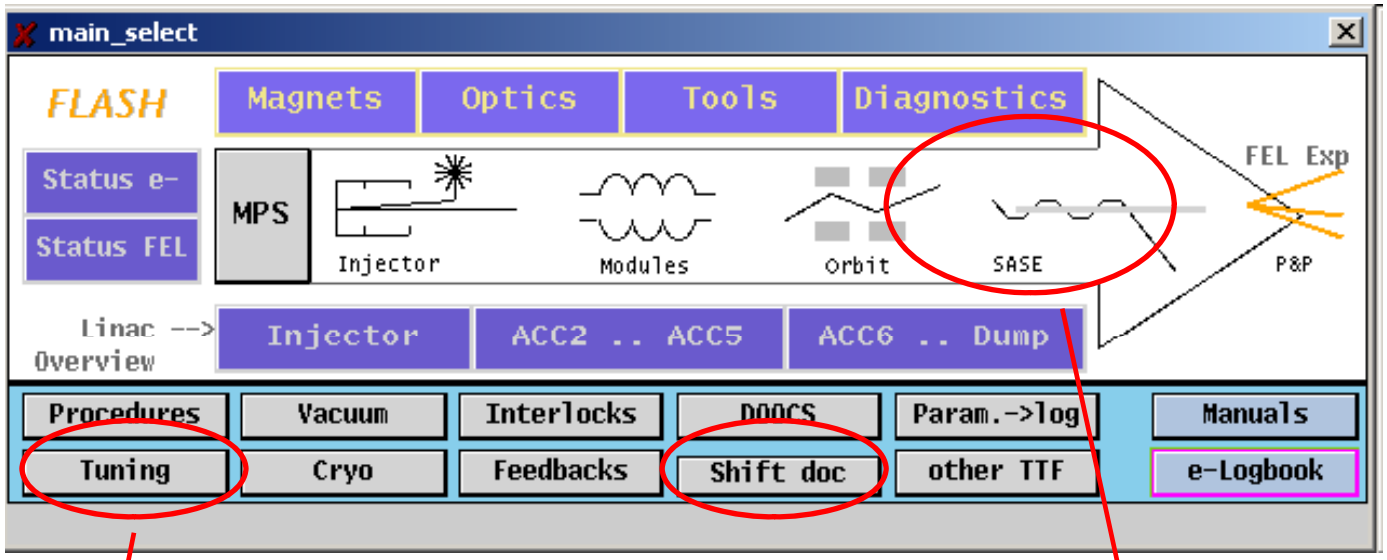
Physics

1. Electron beam quality → laser/cathode/charge
2. Large current density → compression/focusing
3. Overlap photons/electrons → orbit

1. **Compression (RF phases and gradients)**
2. **Orbit undulator (entrance correctors)**
3. Dispersion (orbit collimator)
4. Charge (space charge effects)
5. Optics (beam sizes/quads)

For users:
Poynting stability/position

Panels for SASE

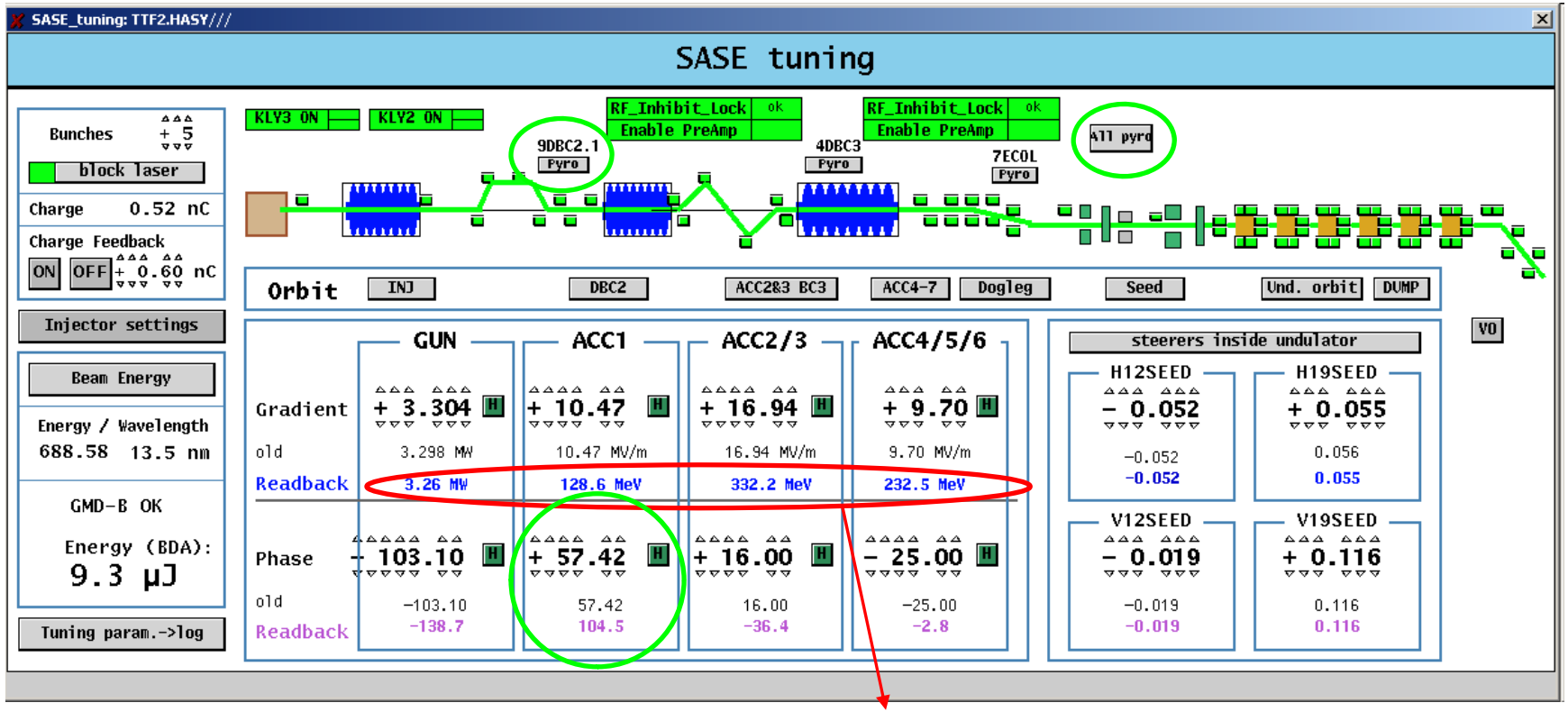


See Schreiber

Knob for SASE tuning (1)

Knob with all SASE detectors

SASE Tuning

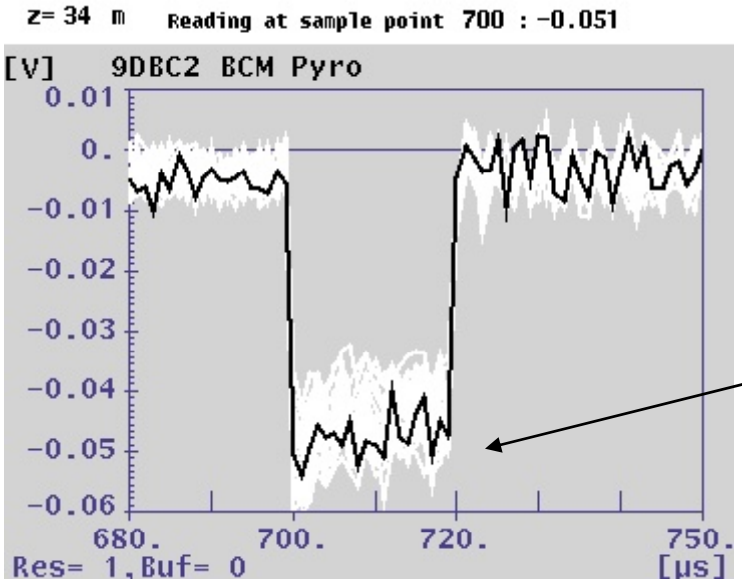


Vector sum

RF parameters: compression/wavelength

RF (phase/amplitude) in 0.1 steps

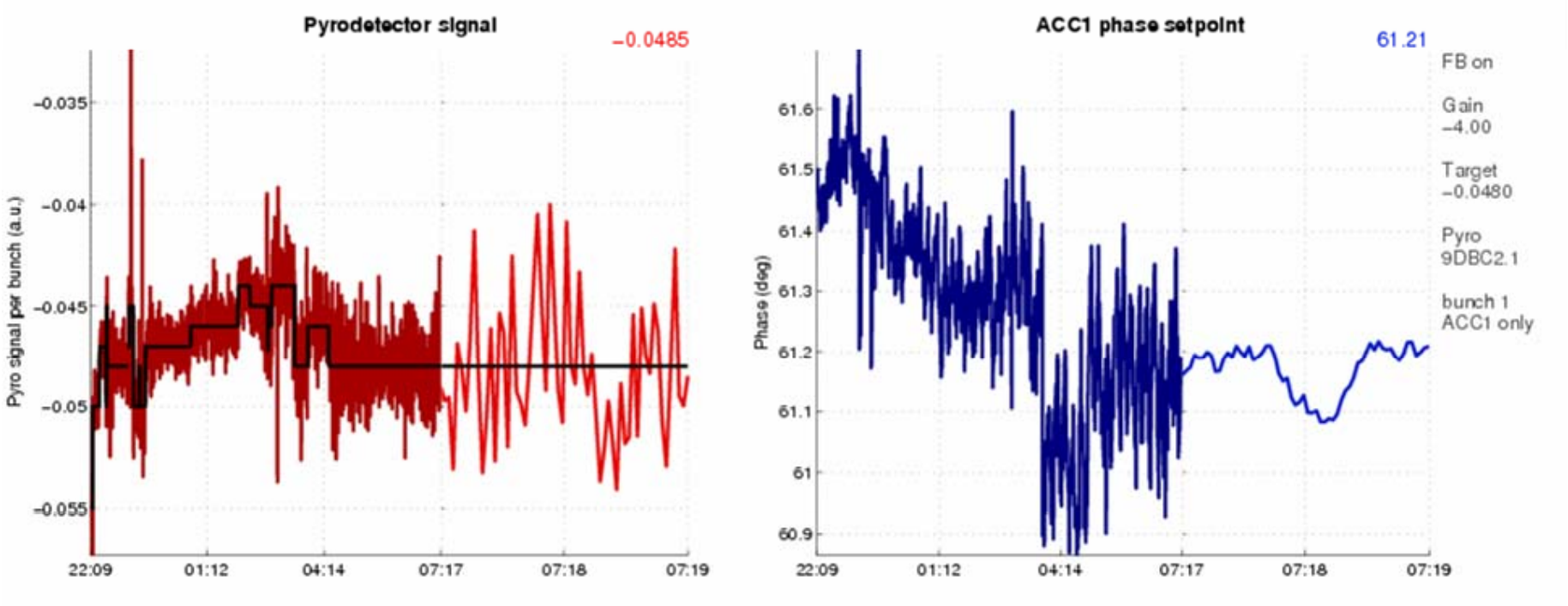
ACC1 phase regulated by pyro signal



Signal depends on charge and compression

Pyro Feedback

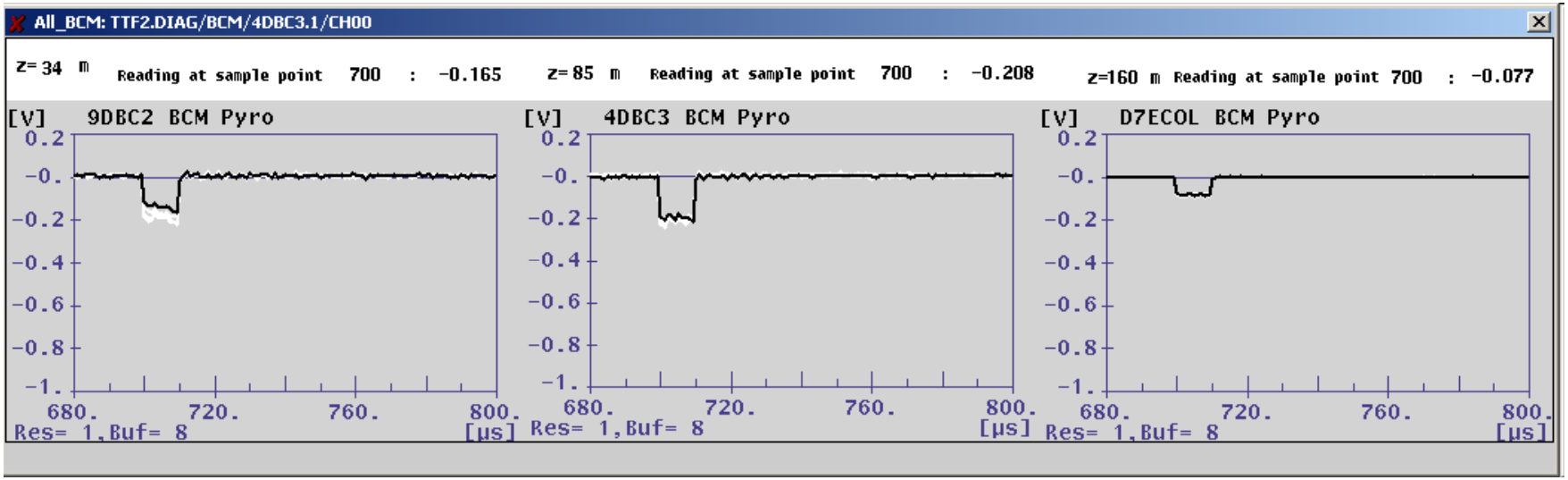
The pyro/phase feedback is **ON**.
Target value: **-0.0480** (a.u.)
Gain: **-4.00**
The pyro signal is determined by looking at **bunch 1** at pyro **9DBC2.1**.
The feedback controls the phase of **ACC1**.



Closing (MATLAB) window STOPS FEEDBACK: DON'T CLOSE

ACC1 phase regulated by pyro signal

But info on ALL pyro's is important

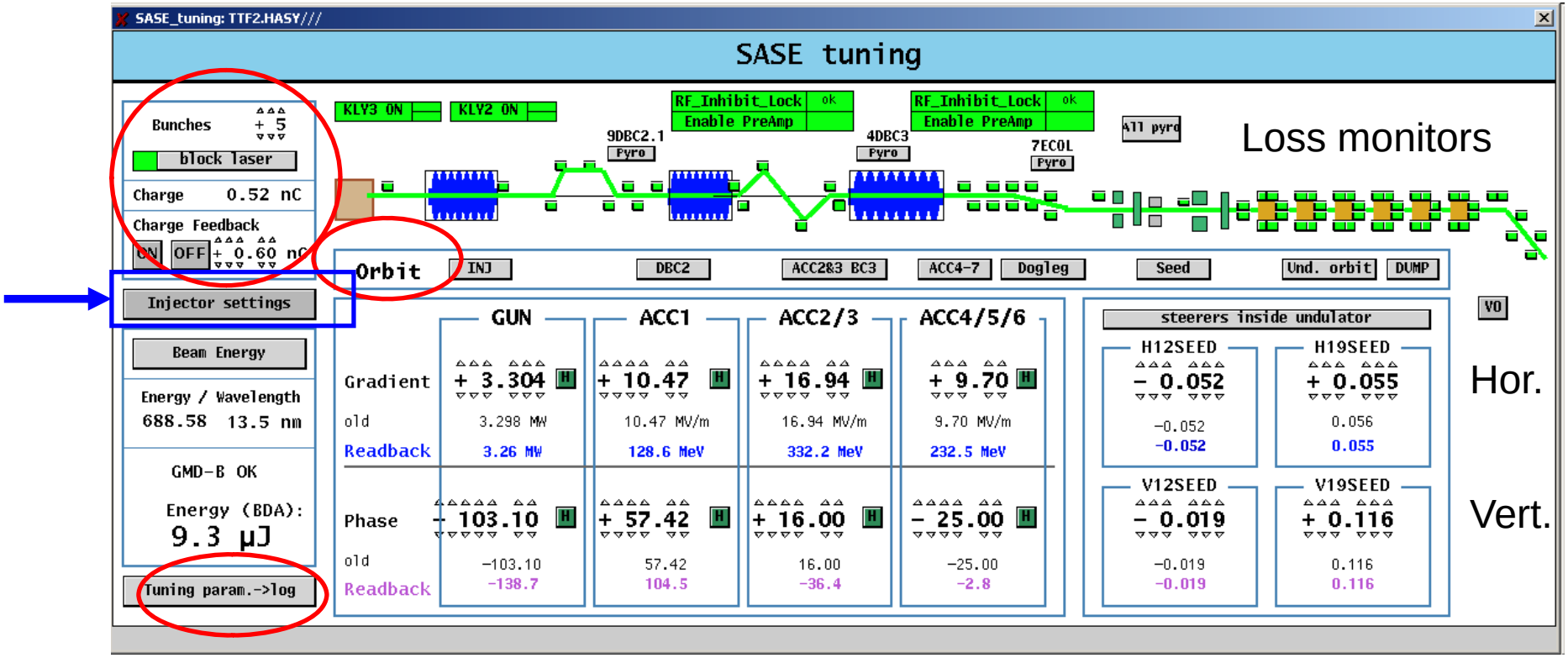


ACC1

ACC1+ACC2&3
NOT regulated

ACC1+ACC2&3+ACC456
NOT regulated

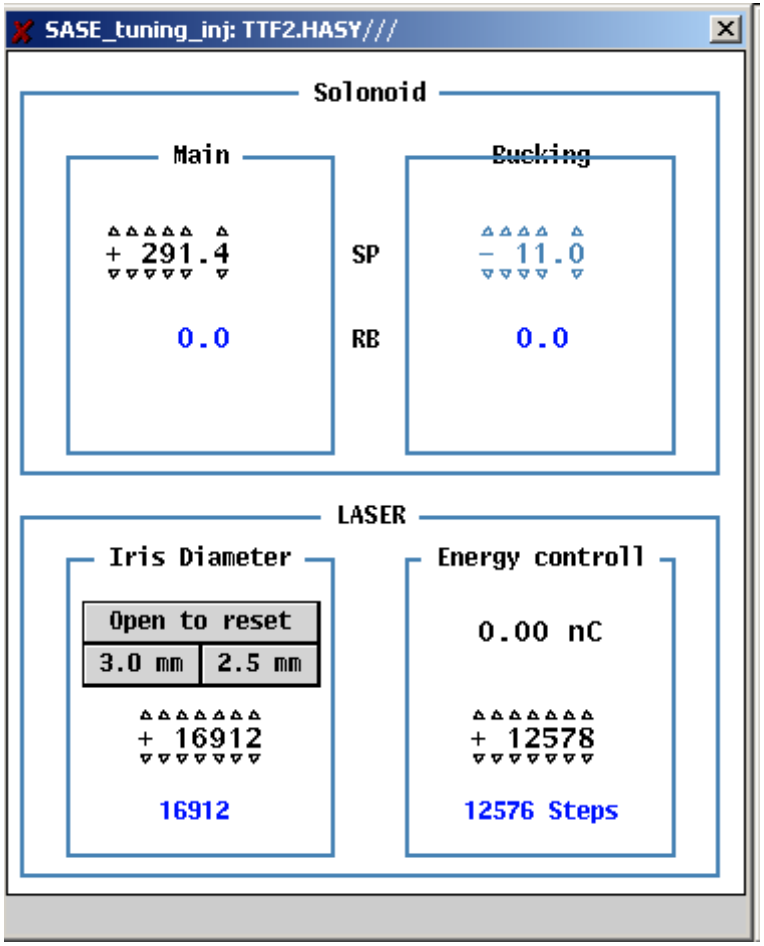
SASE Tuning



Correctors: entrance angle/offset

Correctors in 0.01 to 0.001 steps (hysteresis)

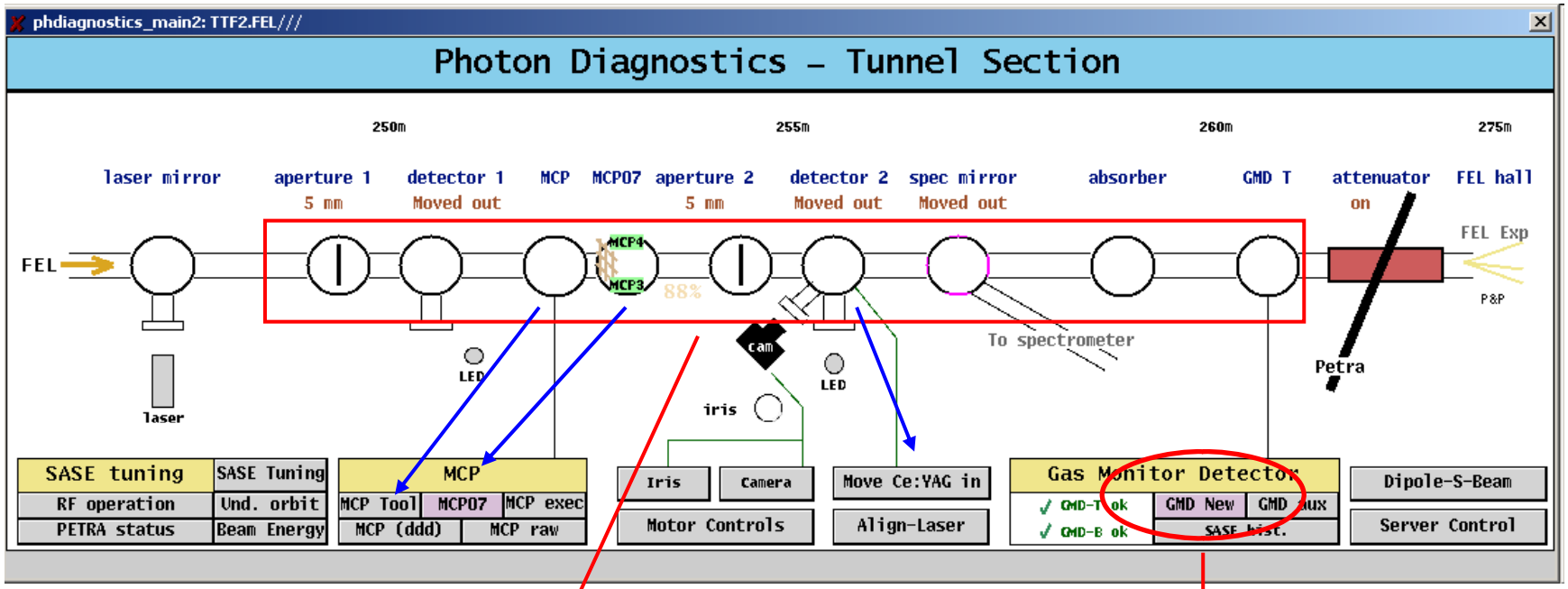
SASE Tuning: Injector



Focusing of beam

Charge control

SASE Detectors

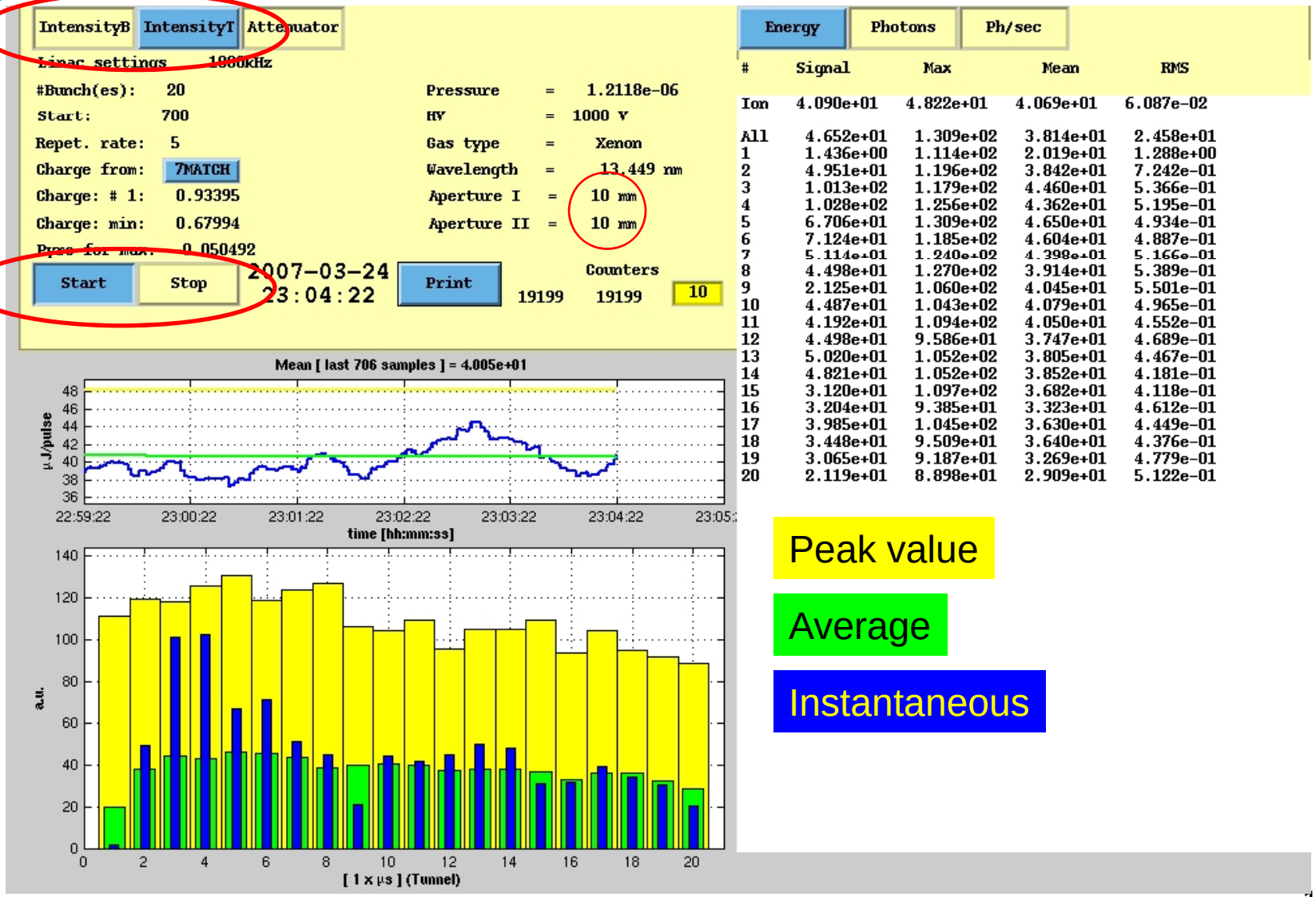


What is moved into the beam

GMD during user operation:
Keep SASE

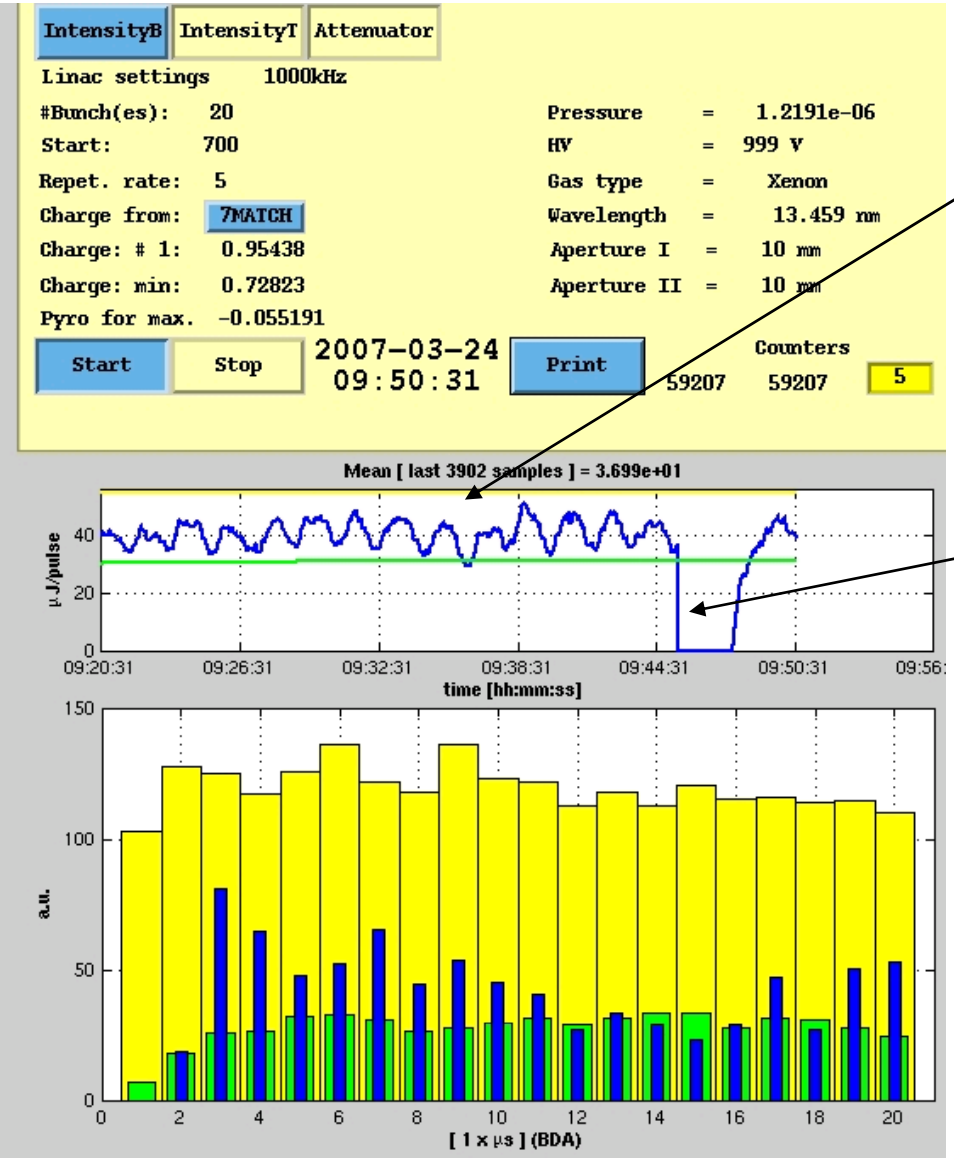
GMD during user operation: Keep SASE

Detector in FBD or Tunnel



Settings can only be changed by experts

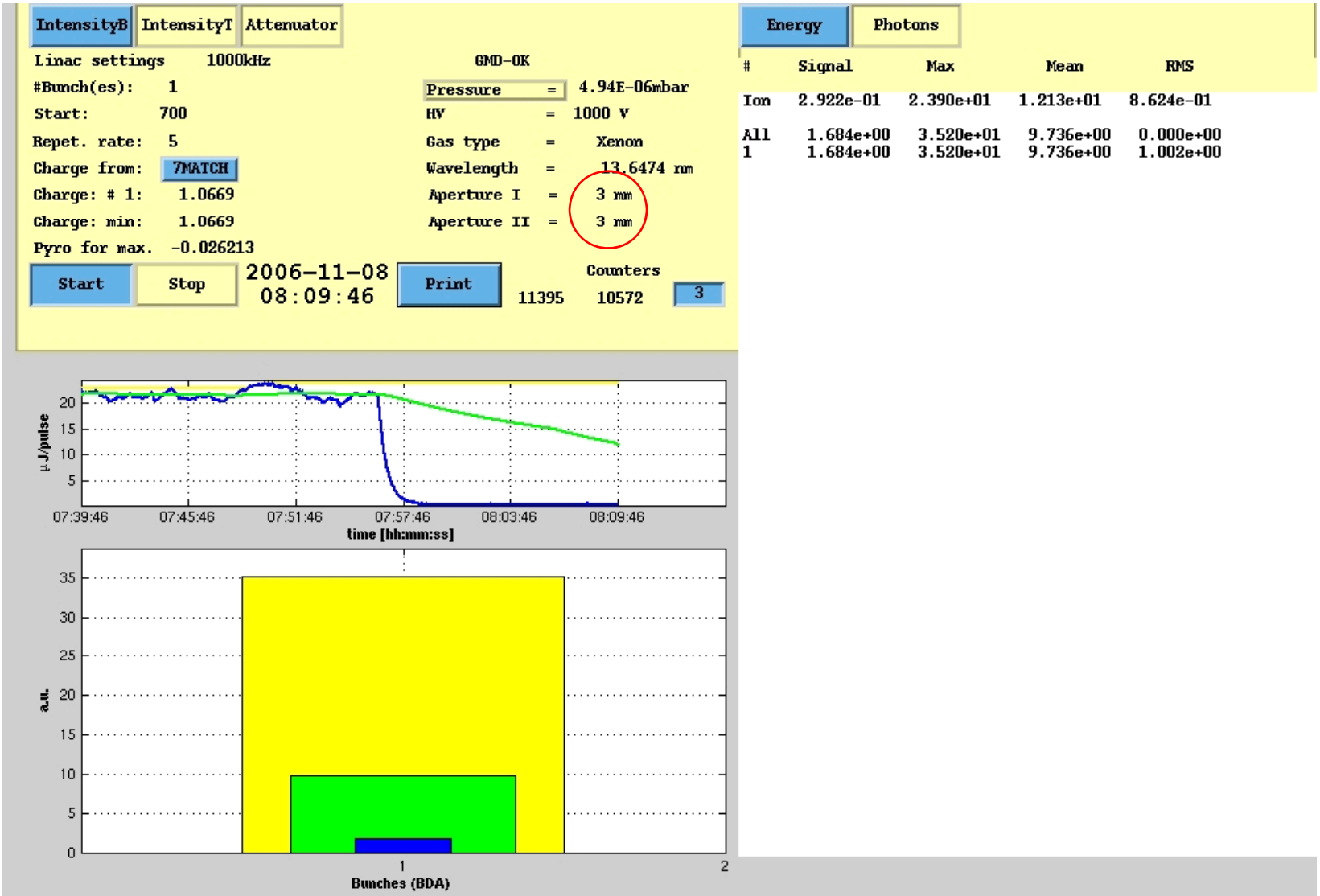
Doing nothing is sometimes better than tuning…..



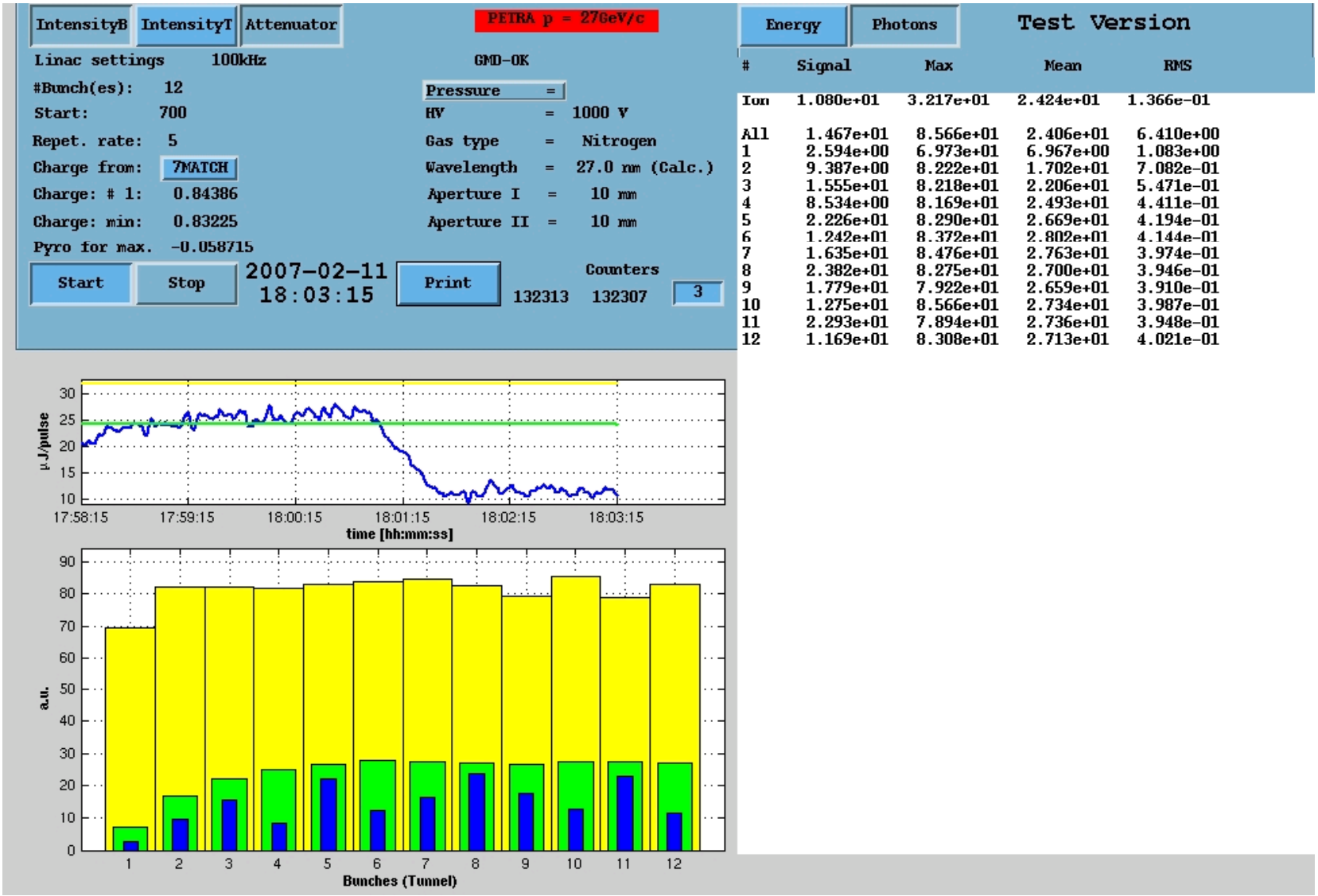
Oscillations are *normal*: don't panic, but wait!!!!

Users can change settings without notifying the BKR

User changing apertures



Petra had a problem with a magnet power supply



SASE and Users

Tuning while users are measuring

Phase/gradient changes → arrival time changes
→ wavelength changes

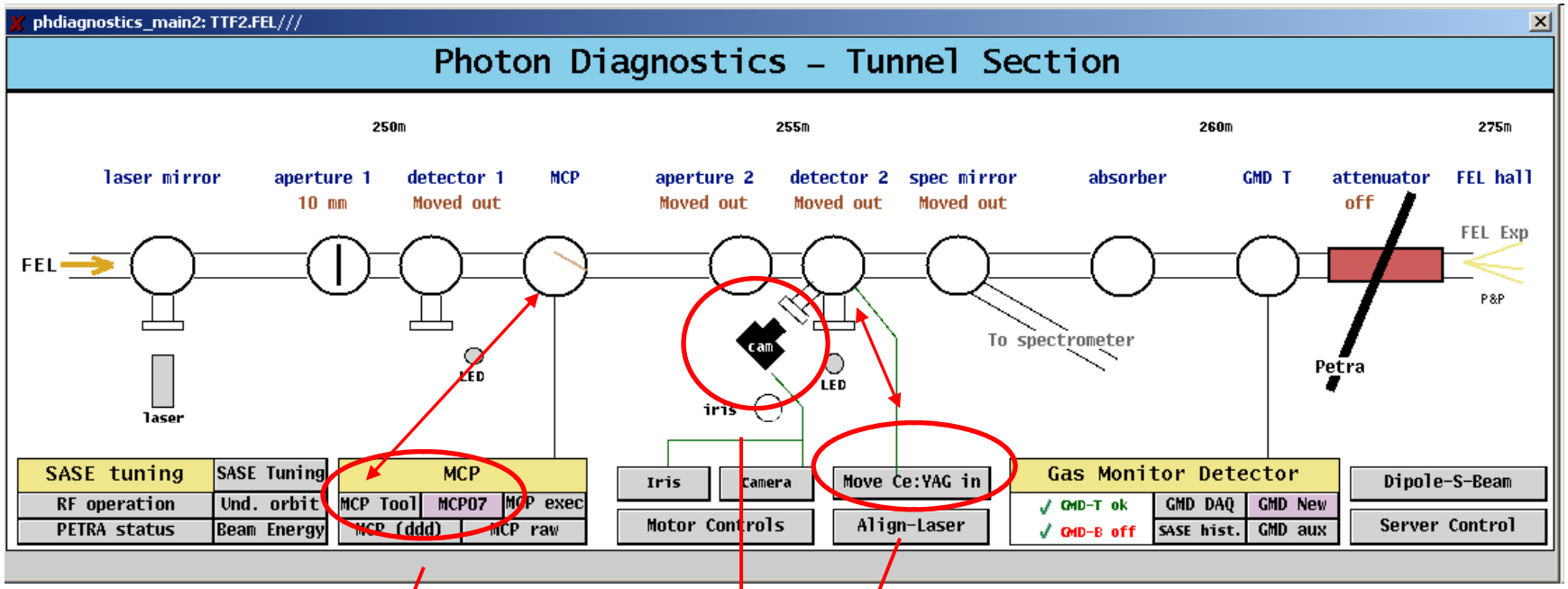
Orbit changes → transport changes
→ transmission changes (spot on samples)

We are almost blind to these changes:

- **TEO**
- **Photon BPM**
- **online spectrometer**
- **autocorrelation**

SASE Detectors: tuning after maintenance

Start with ZERO SASE, but known settings



YAG screen: interceptive:
position

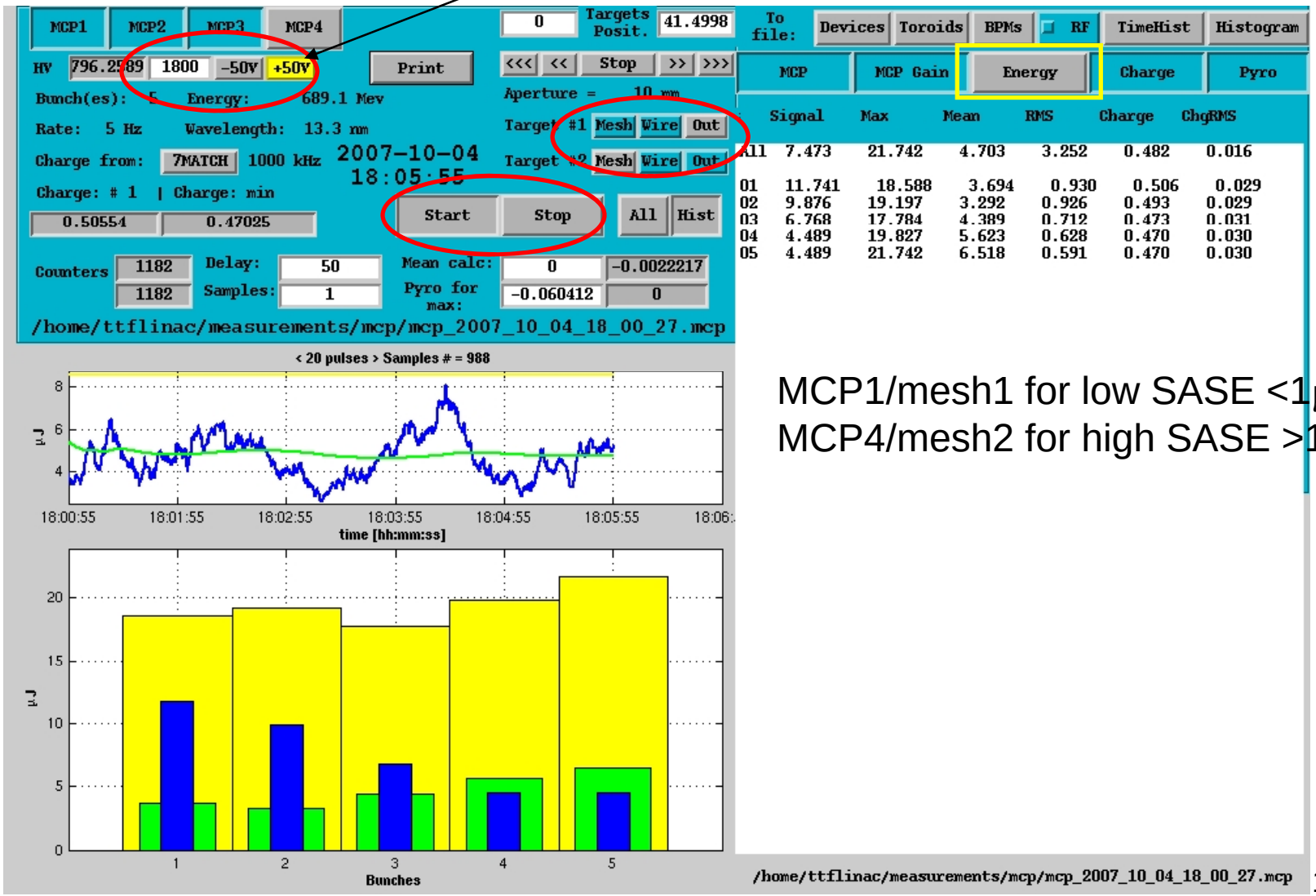
Tune from spontaneous to saturation: **startup**, **wavelength change**, **from scratch**

Magnet settings loaded and cycled
RF settings loaded, RBV (=IST) almost the same as before maintenance

ReadBack Value (RBV), SetPoint (SP)

SASE tuning for longer wavelength

MCP voltage much too low=+50V/too high=-50V



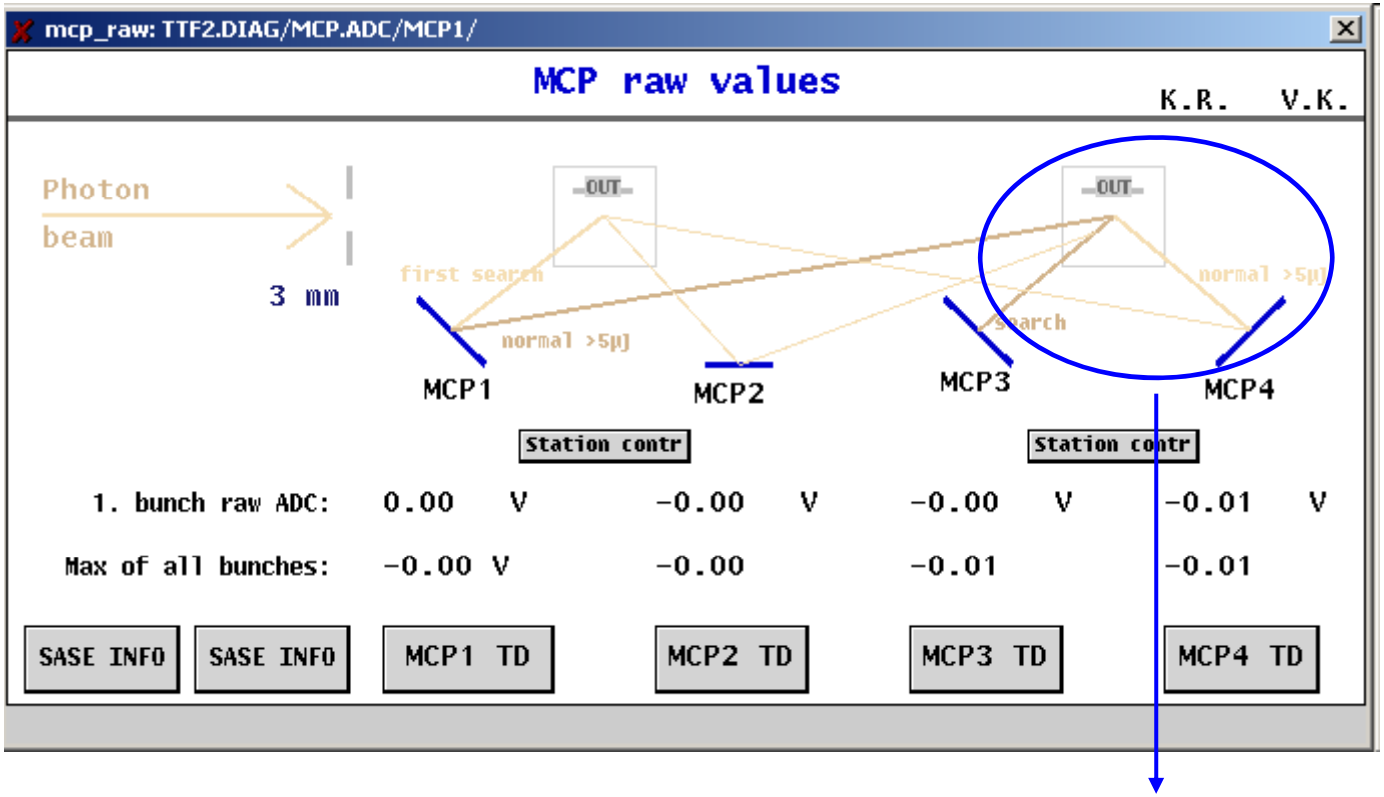
MCP1/mesh1 for low SASE <1µJ
MCP4/mesh2 for high SASE >1µJ

Calibration by use of external file: NOT automatic

Tuning for longer wavelength: layout detector

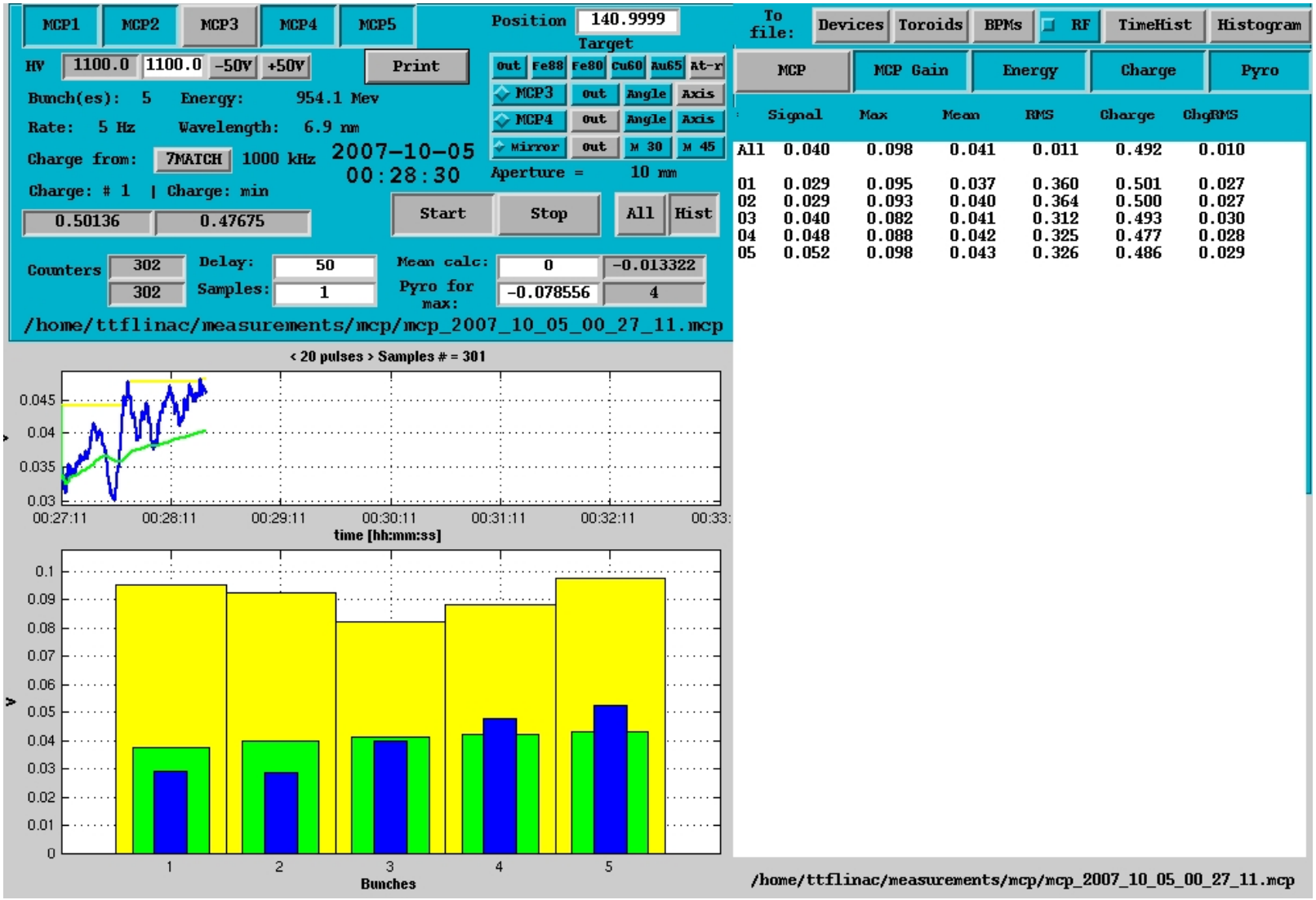
Target 1

Target 2

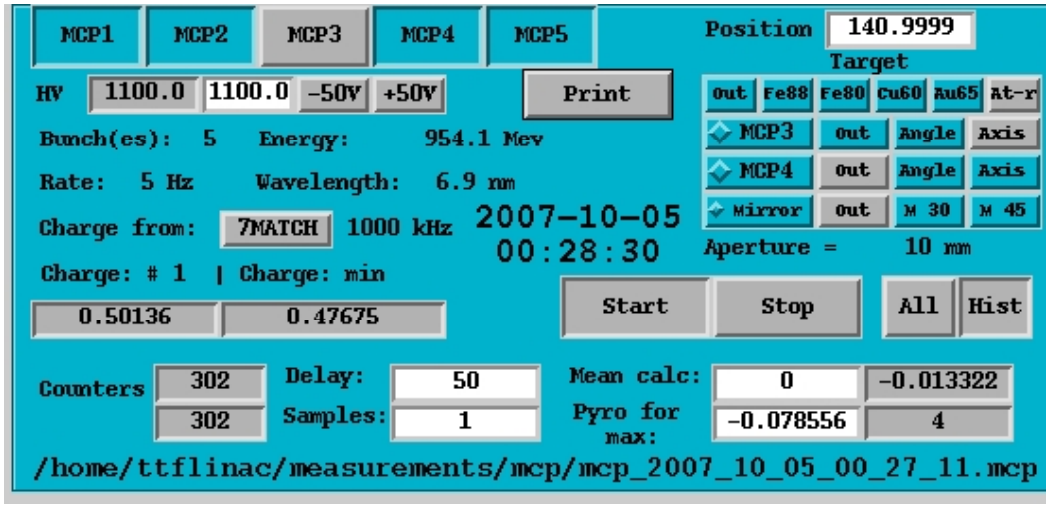


Normal use

SASE tuning for shorter wavelength



SASE tuning for shorter wavelength

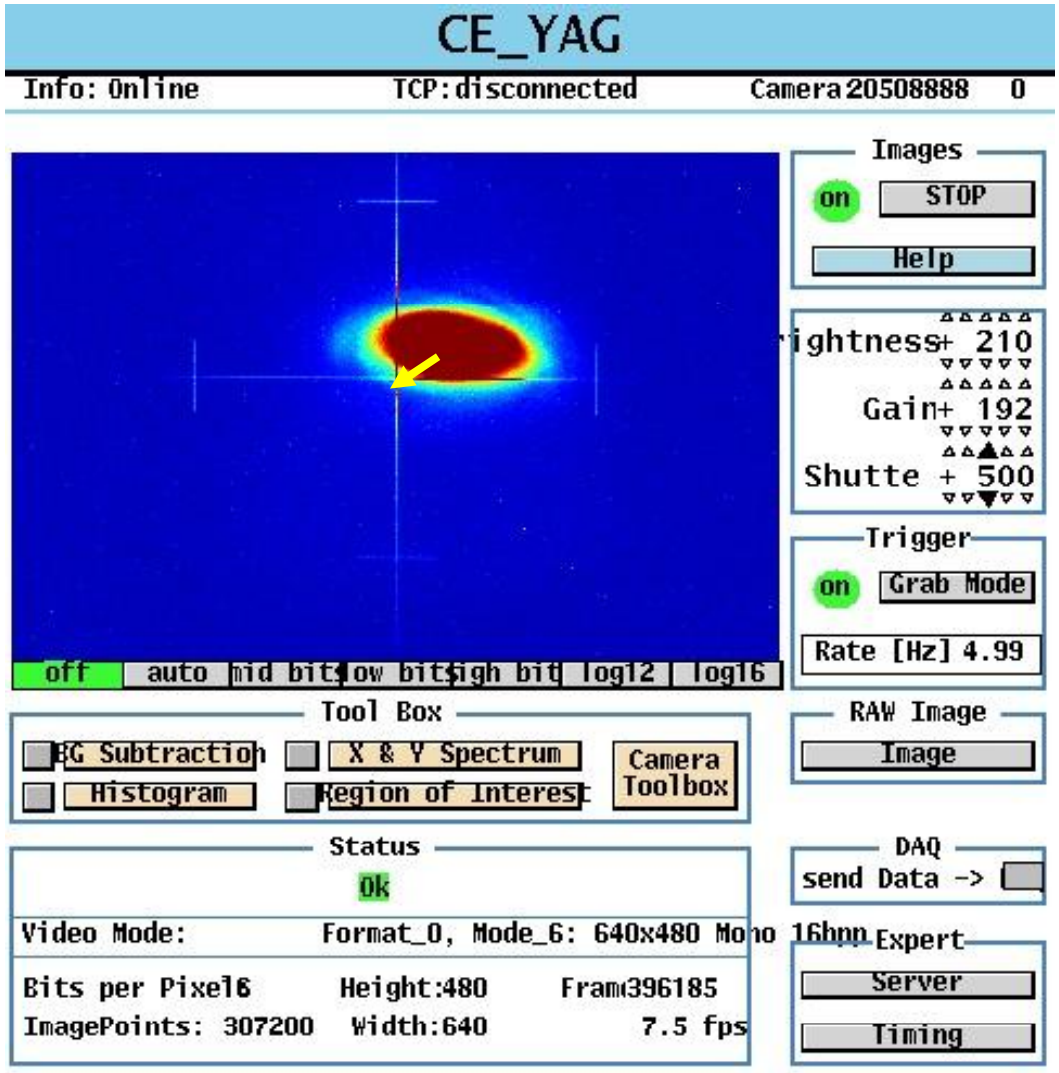


Mesh targets moved in

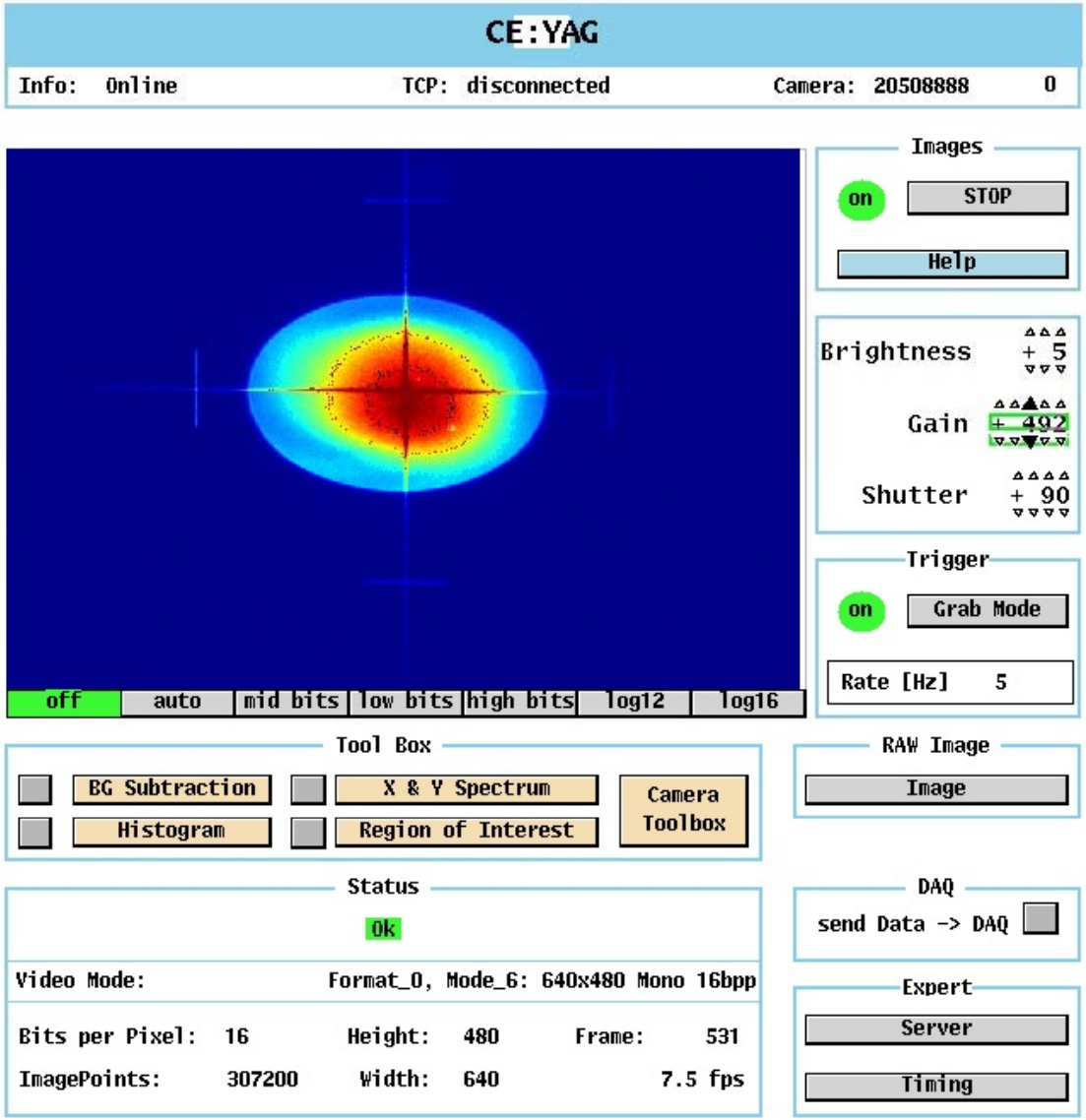
Mirror targets moved in

MCP3 and MCP4 can be moved in under an angle (with target) or on-axis (blocking radiation to any other detector)

Position of the FEL beam



PERFECT



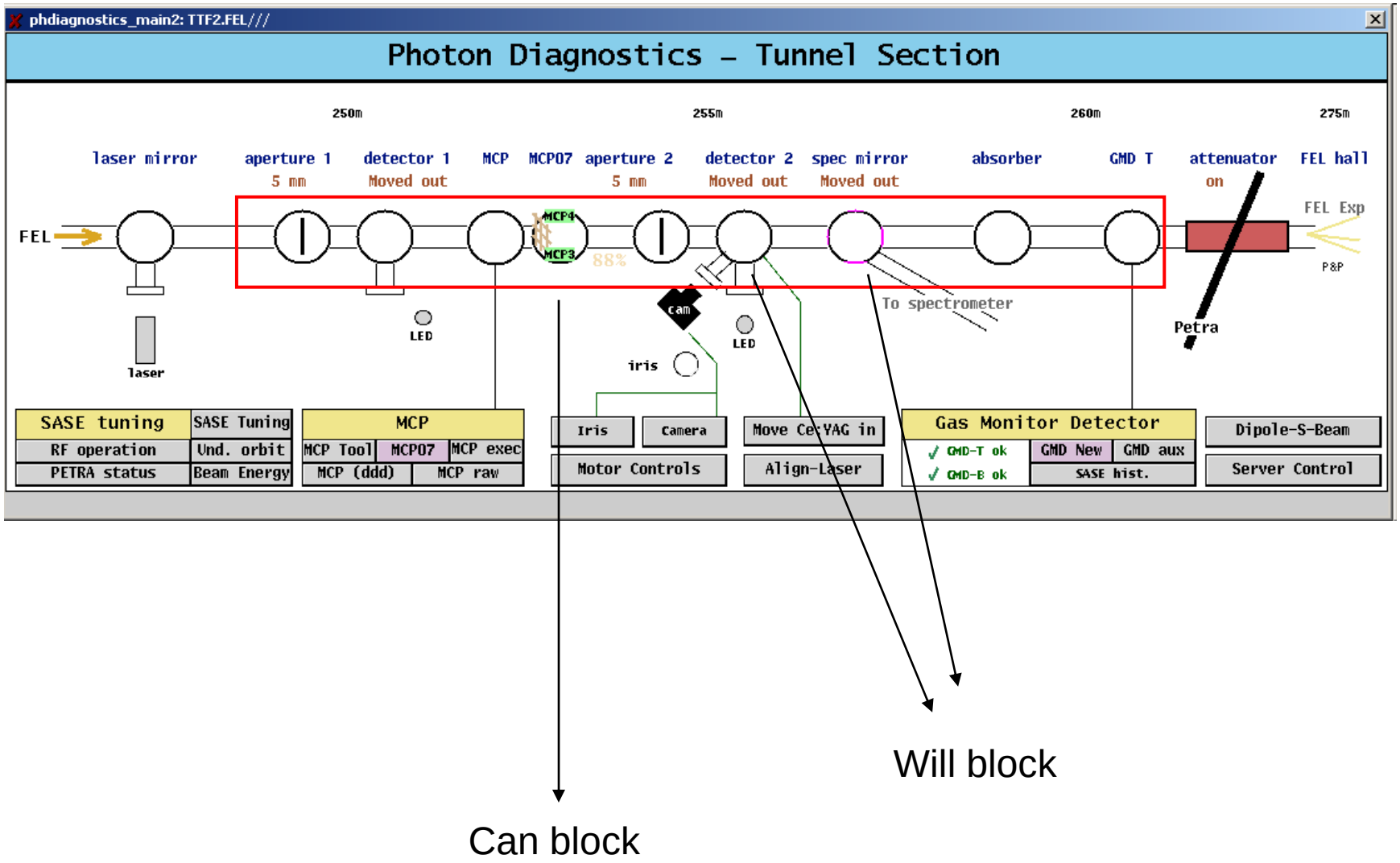
YAG screen between MCP and GMD: blocks GMD

New MCP07 detector CAN block the YAG screen

- MCP3 or 4 on-axis
- Mirror in

SASE Detectors

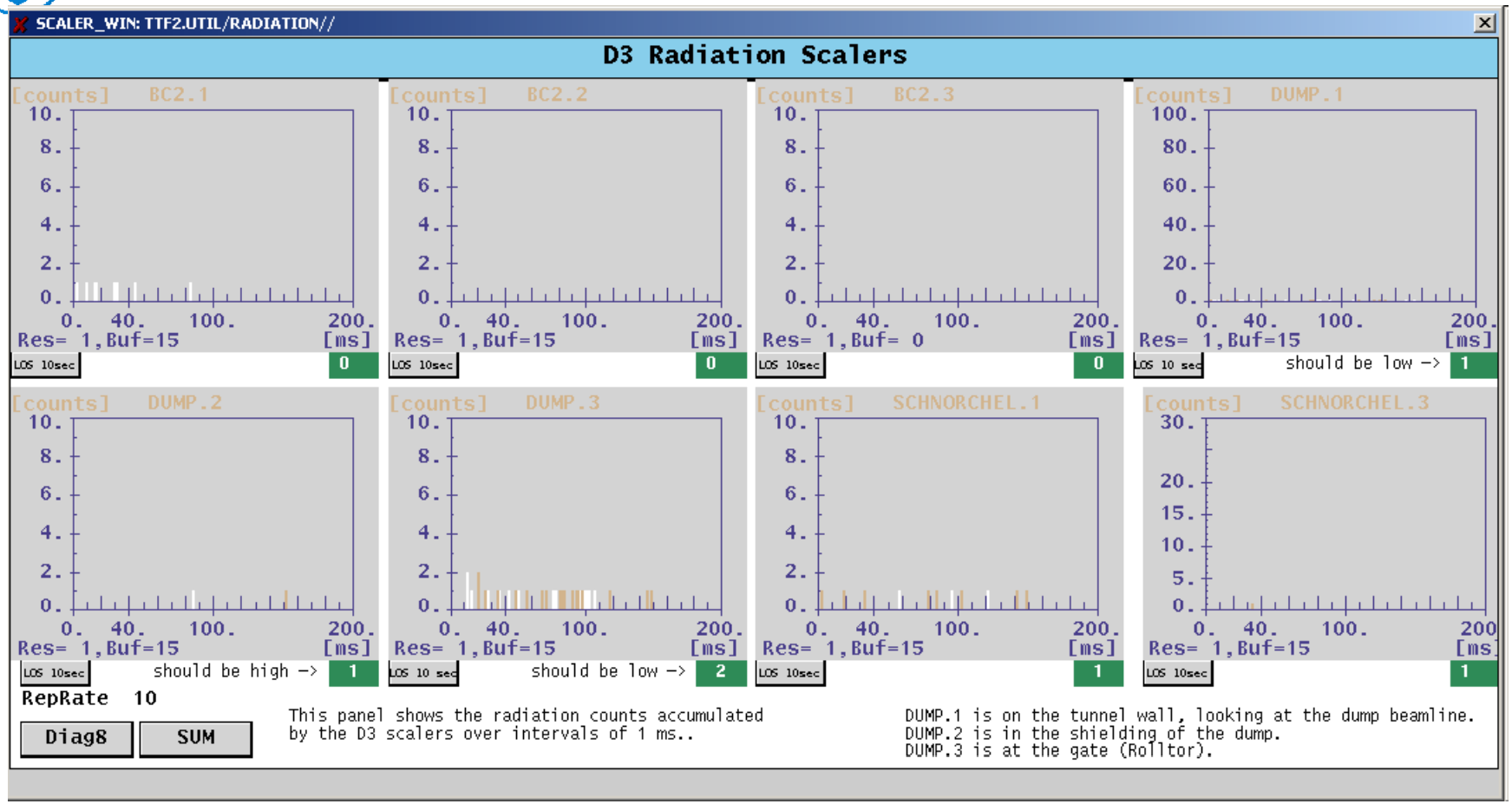
What is moved into the beam



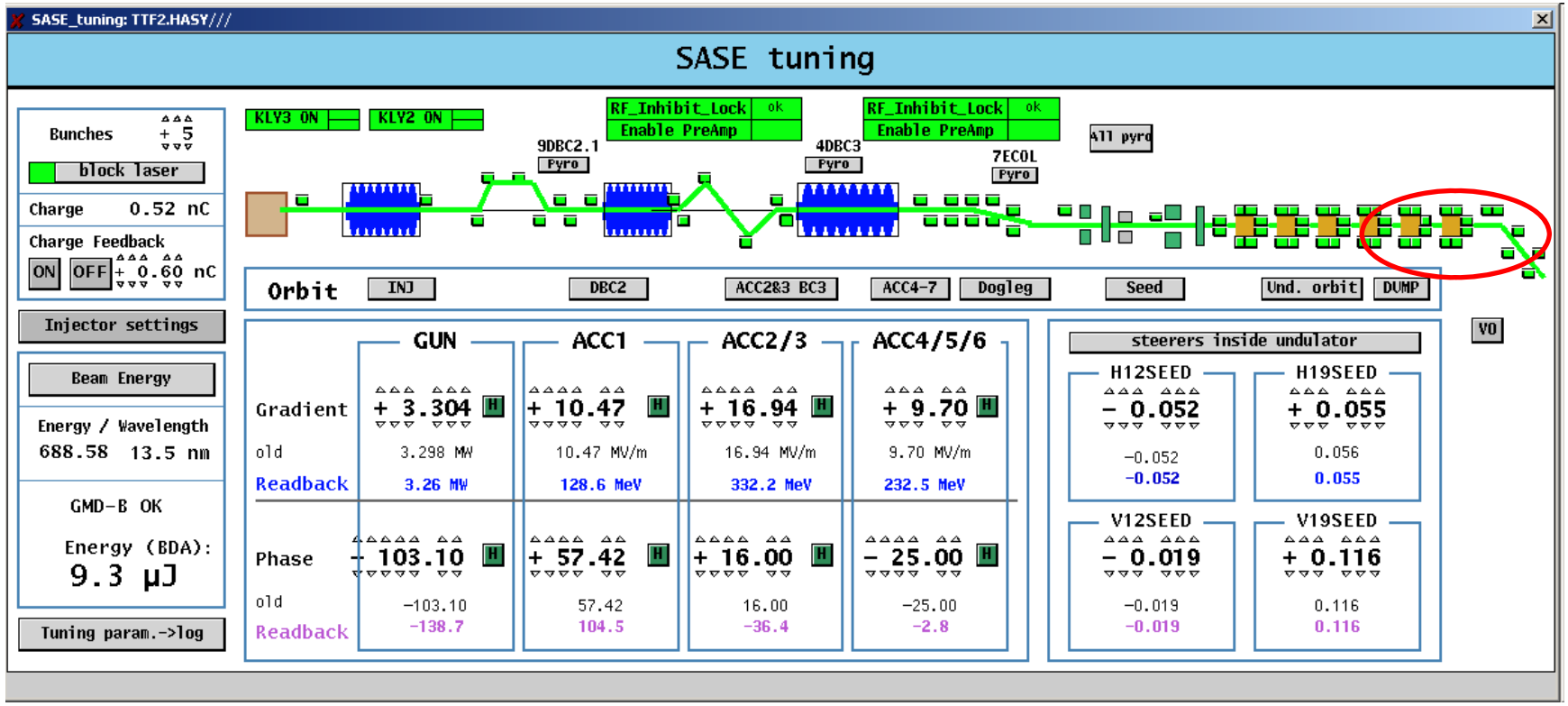
Will block

Can block

Beam loss is visible as SASE on MCP



Beam Loss = SASE?



YAG screen out again, SASE 12-15 uJ av

IntensityB | IntensityT | Attenuator

Linac settings 100kHz

#Bunch(es): 20
Start: 700
Repet. rate: 5
Charge from: 7MATCH
Charge: # 1: 1.0776
Charge: min: 1.0653
Pyro for max. -0.038352

GMD-OK

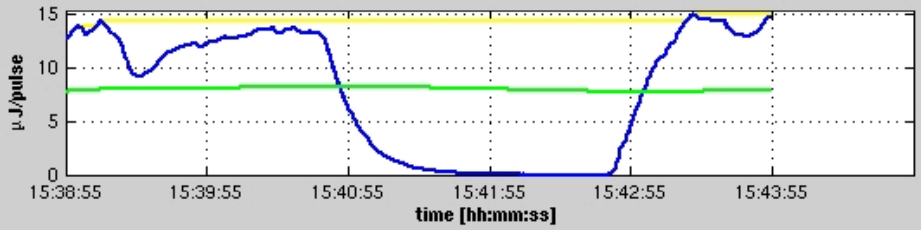
Pressure = 1.99E-06mbar
HV = 999 V
Gas type = Nitrogen
Wavelength = 32.6821 nm
Aperture I = 5 mm
Aperture II = 5 mm

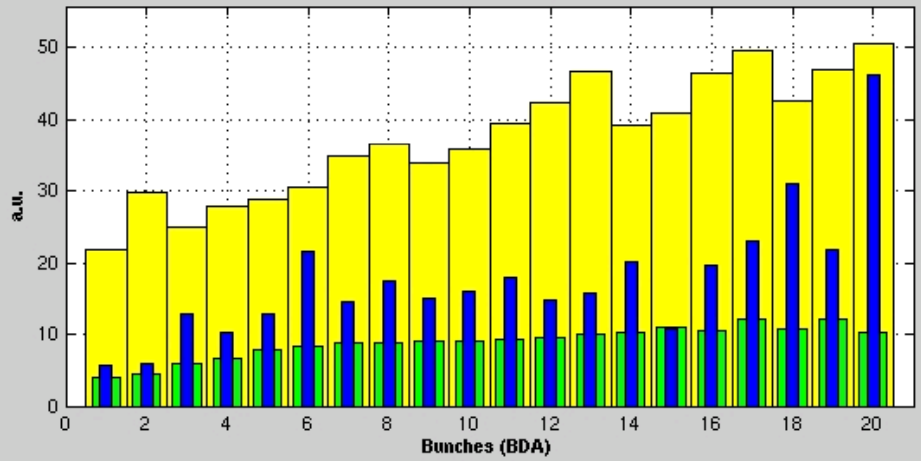
Start | Stop

2006-09-27
15:43:55

Print

Counters: 7280 7256 3

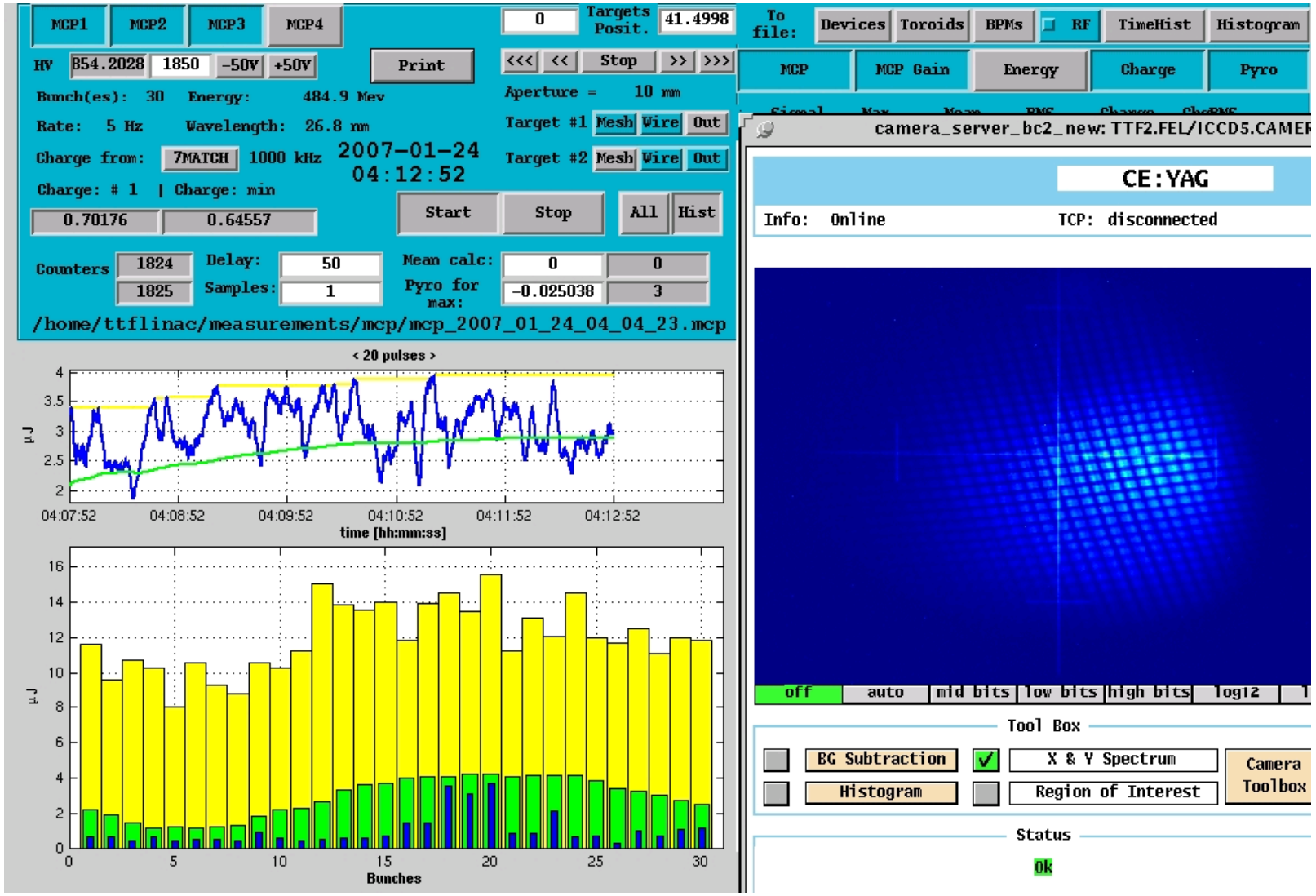




Energy | Photons

#	Signal	Max	Mean	RMS
Ion	1.485e+01	1.508e+01	7.911e+00	3.365e-01
All	1.725e+01	5.065e+01	8.914e+00	8.925e+00
1	5.577e+00	2.177e+01	3.933e+00	1.019e+00
2	6.015e+00	2.983e+01	4.350e+00	9.662e-01
3	1.290e+01	2.497e+01	5.789e+00	7.798e-01
4	1.036e+01	2.777e+01	6.513e+00	7.352e-01
5	1.278e+01	2.890e+01	7.886e+00	6.626e-01
6	2.166e+01	3.062e+01	8.246e+00	6.660e-01
7	1.465e+01	3.485e+01	8.797e+00	6.384e-01
8	1.757e+01	3.645e+01	8.828e+00	6.399e-01
9	1.503e+01	3.390e+01	9.111e+00	6.417e-01
10	1.596e+01	3.587e+01	9.165e+00	6.428e-01
11	1.789e+01	3.941e+01	9.305e+00	6.437e-01
12	1.485e+01	4.243e+01	9.588e+00	6.335e-01
13	1.579e+01	4.661e+01	1.007e+01	6.512e-01
14	2.019e+01	3.922e+01	1.014e+01	6.540e-01
15	1.071e+01	4.089e+01	1.094e+01	6.568e-01
16	1.958e+01	4.655e+01	1.045e+01	6.631e-01
17	2.300e+01	4.957e+01	1.208e+01	6.469e-01
18	3.088e+01	4.259e+01	1.082e+01	6.897e-01
19	2.189e+01	4.687e+01	1.215e+01	6.497e-01
20	4.614e+01	5.065e+01	1.025e+01	7.525e-01

MCP combined with YAG screen (with mesh in)



Wavelength change/Start from Scratch

CALL THE EXPERT