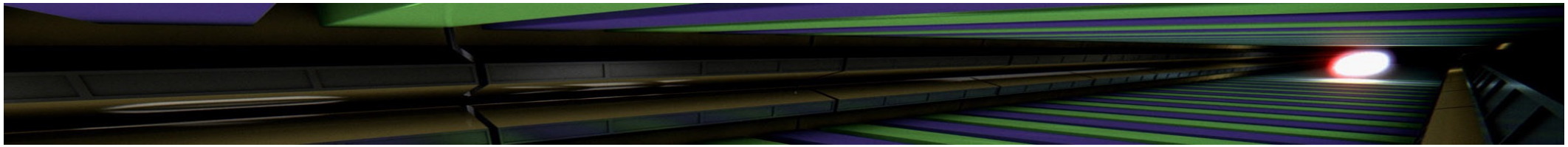


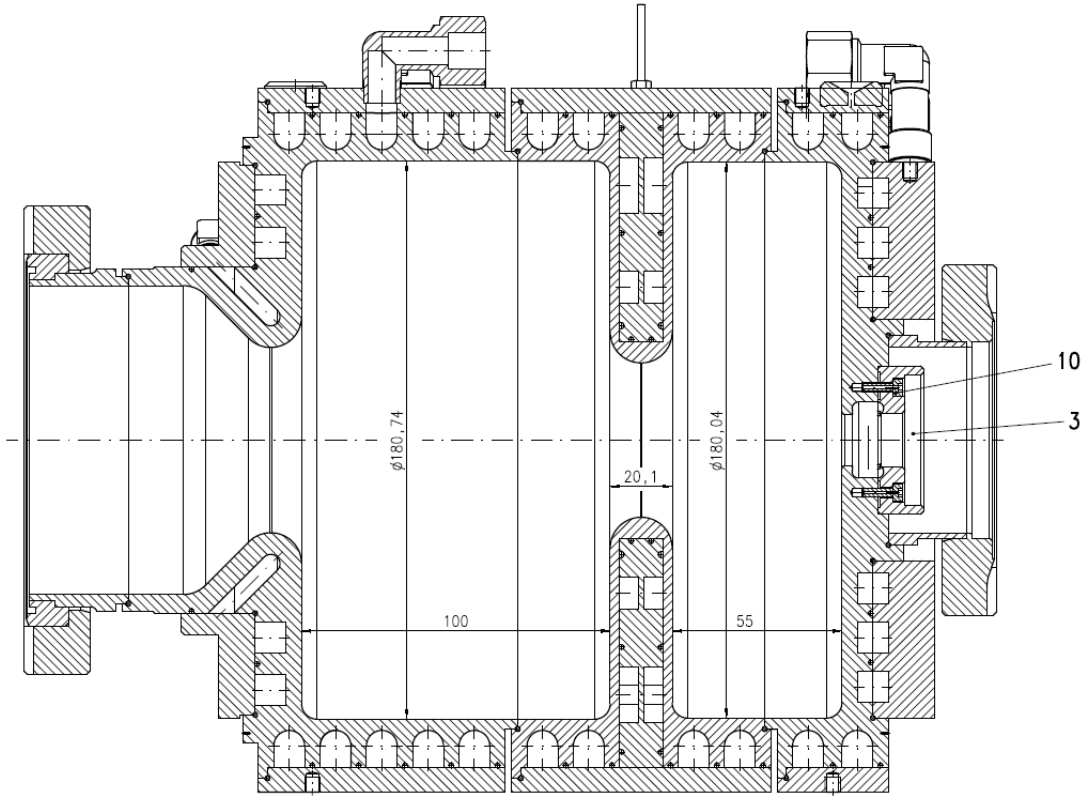
XFEL-Gun Operator Training

F.Brinker

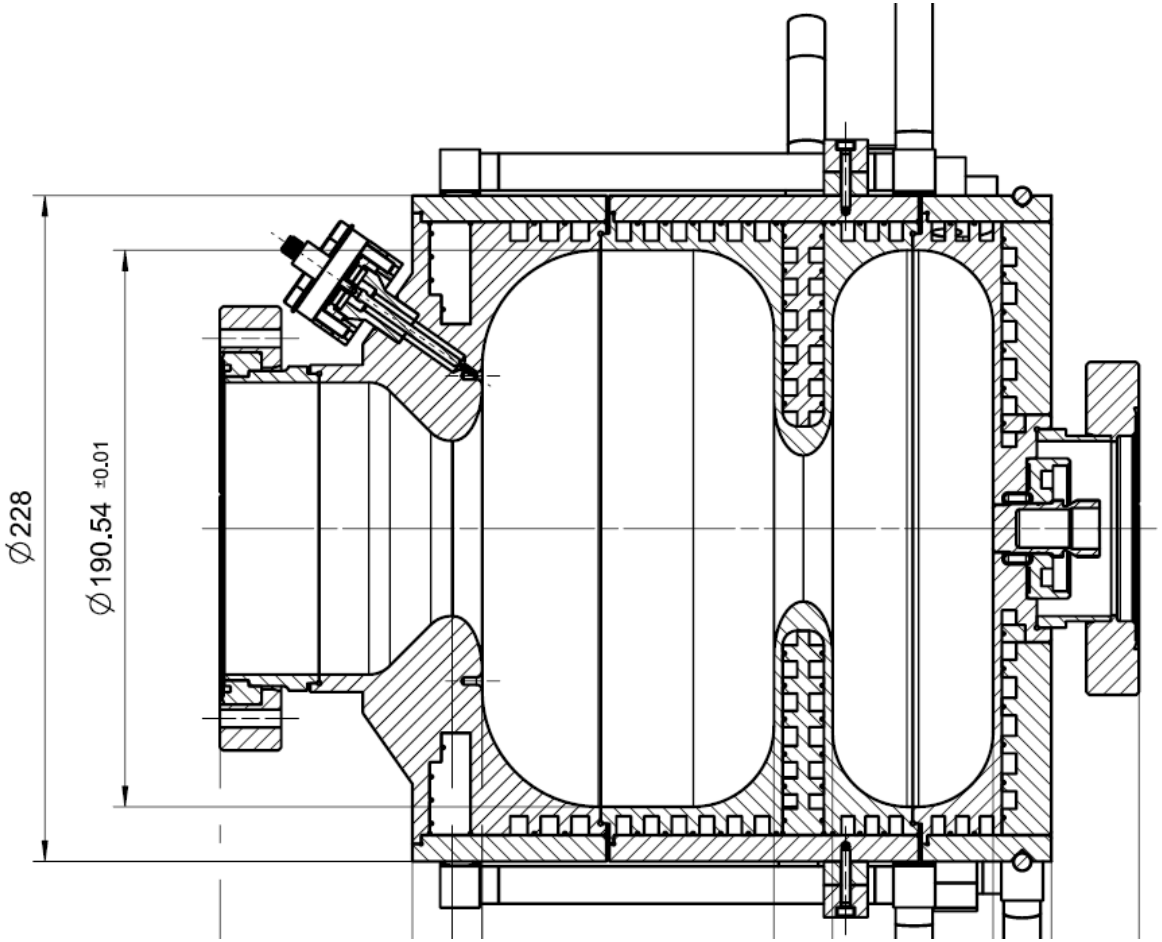
Content

- New Gun 5
- Interlock systems
- Temperature regulation
- FSM and fast Ramp Up procedure
- PWM and slow ramp
- Fast protection

Cross section of guns for 1.3 GHz

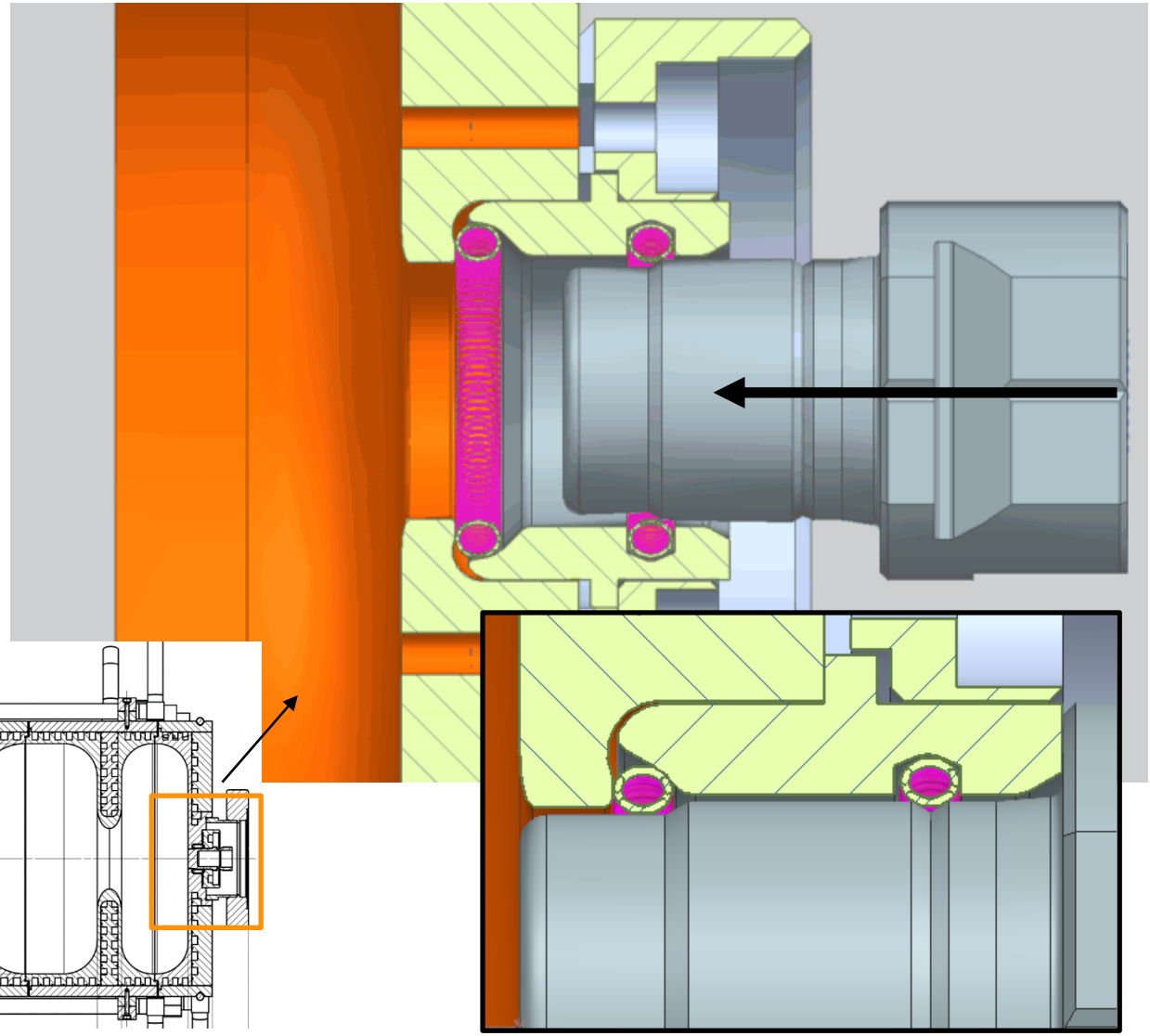


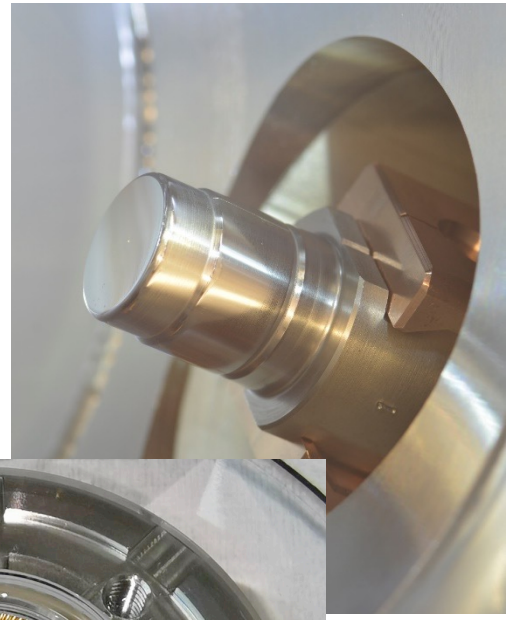
Gun 4

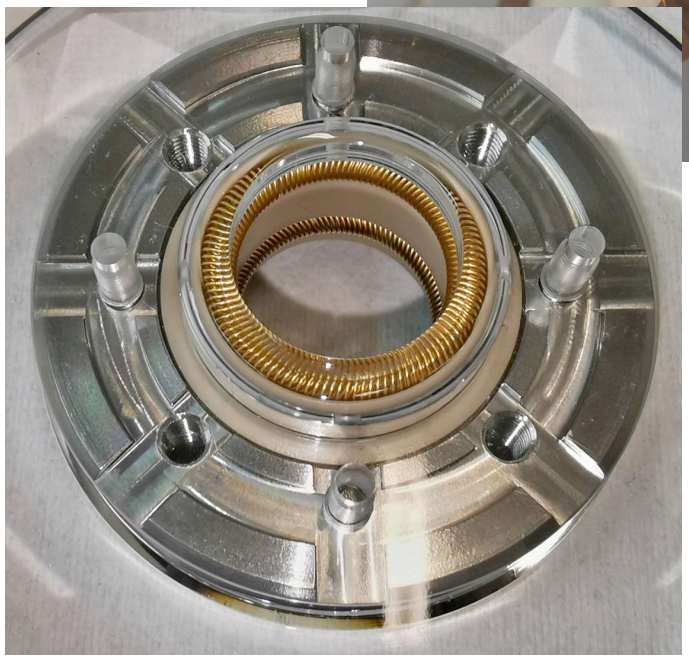


New Gun 5

Cathode with new RF-spring



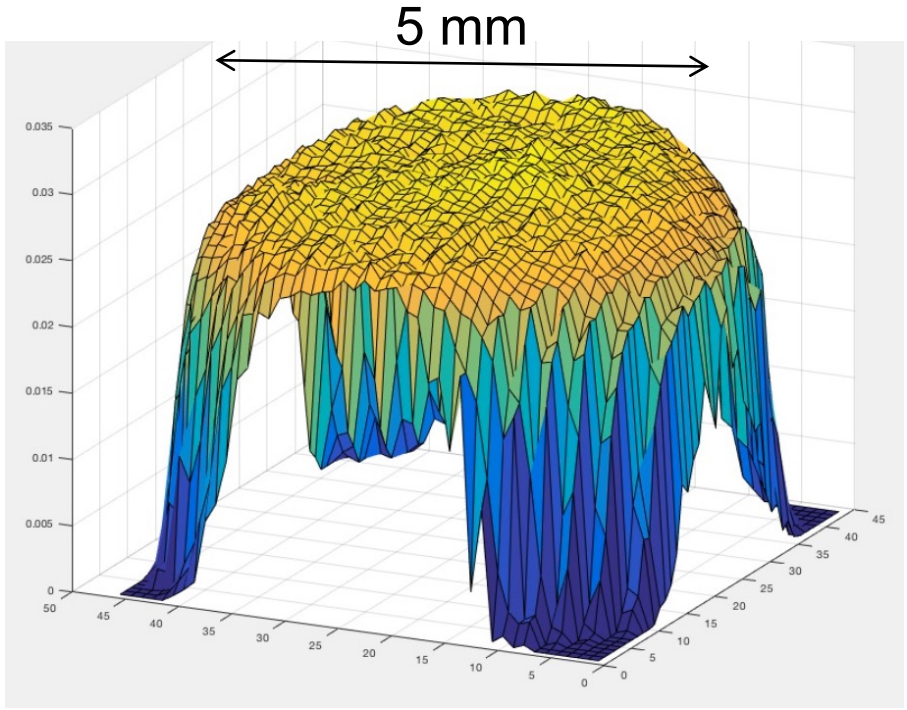




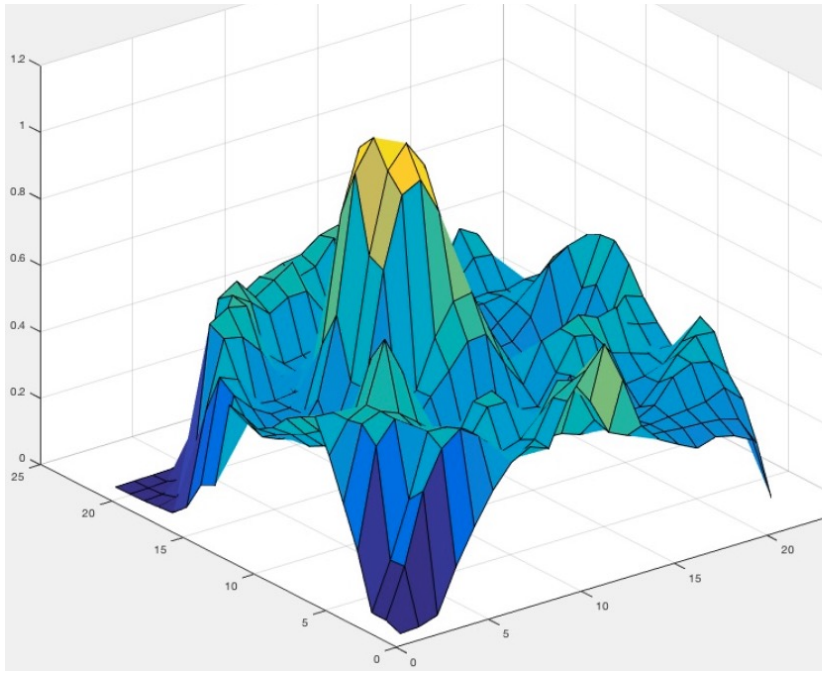
Cathode exchange : When?

Quantum efficiency: simply the relation of electrons and photons

QE = 10% means 10 photons are needed to get 1 electron



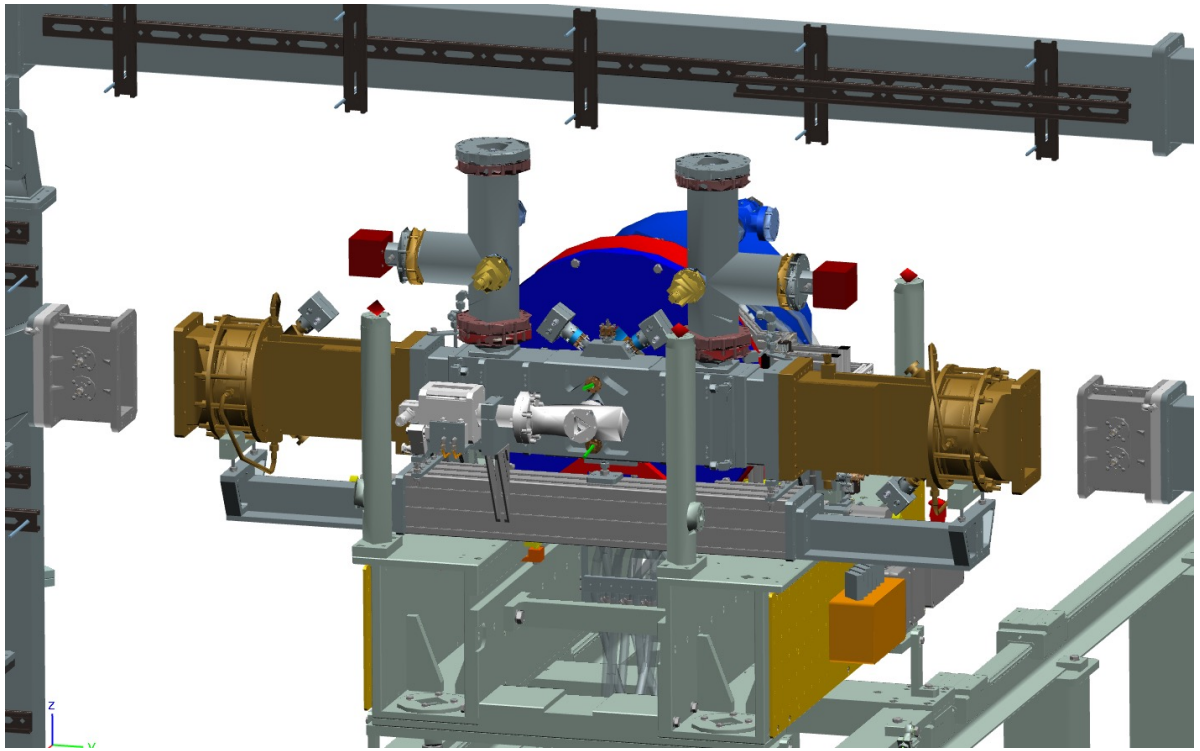
Fresh cathode

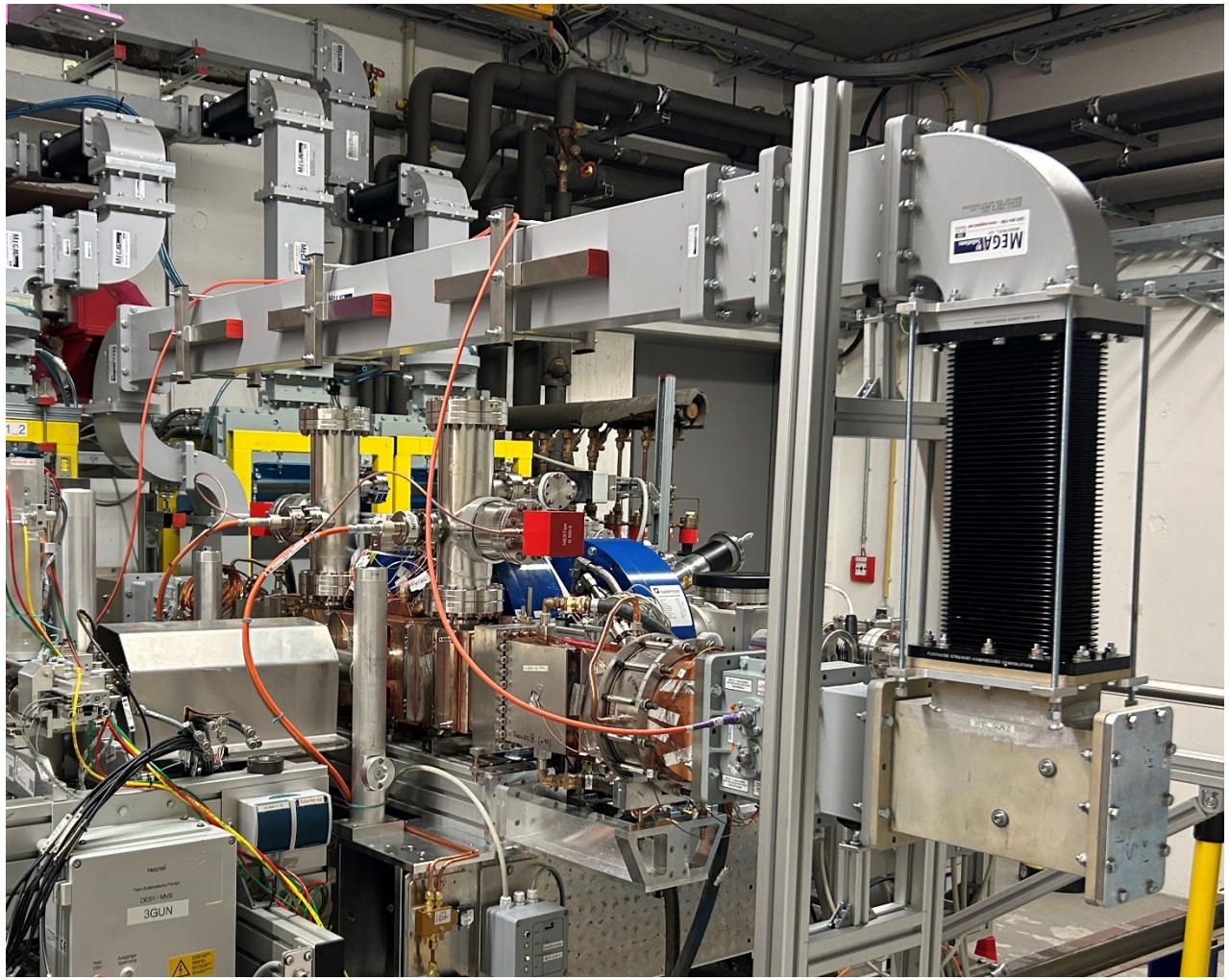


Cathode after years of operation

With the new cathode springs we will probably do this more often

Gun 5 : symmetric coupler with 2 vacuum windows





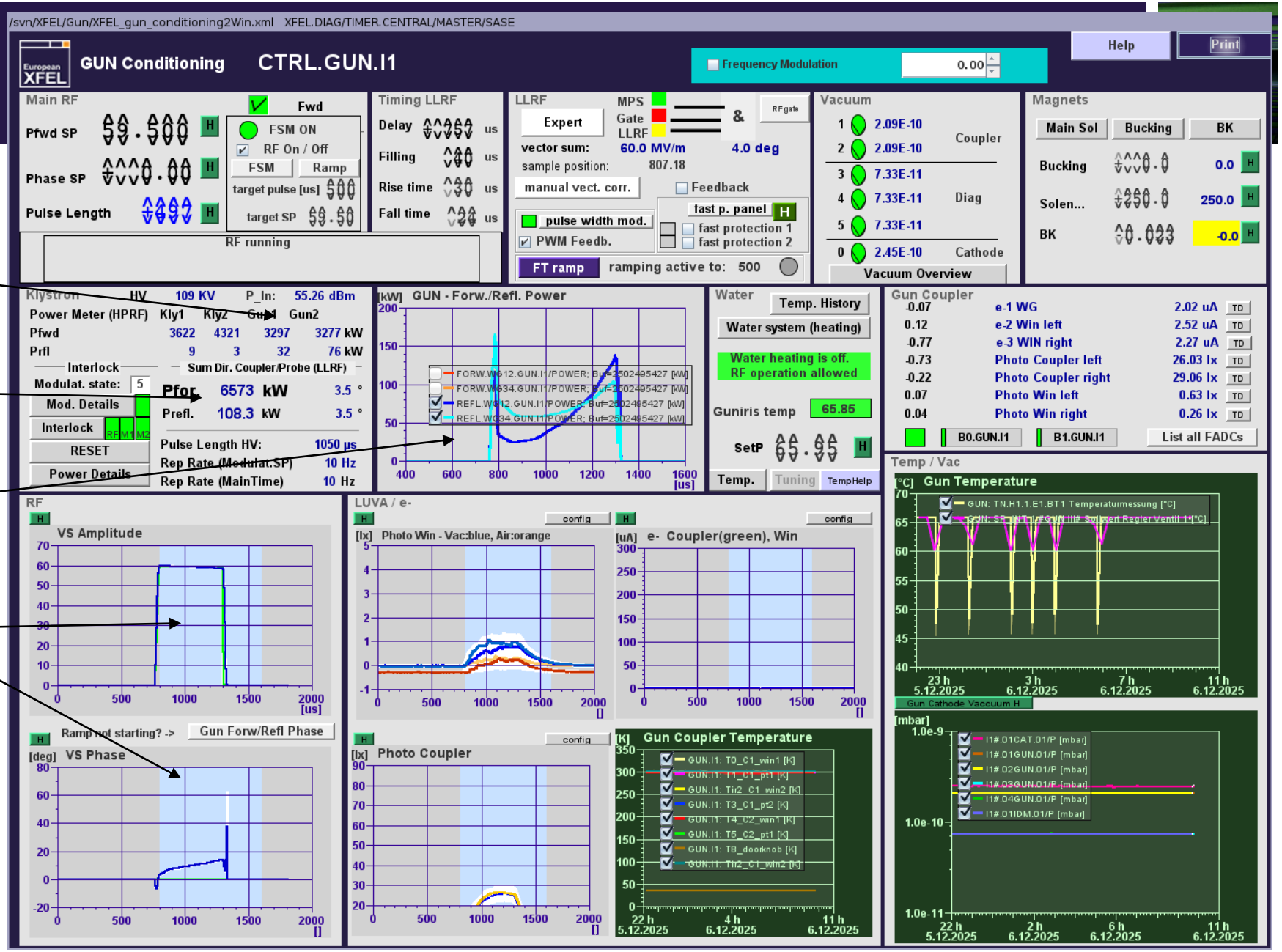
New panel:

Readings from 2 directional couplers

Sum of the signals

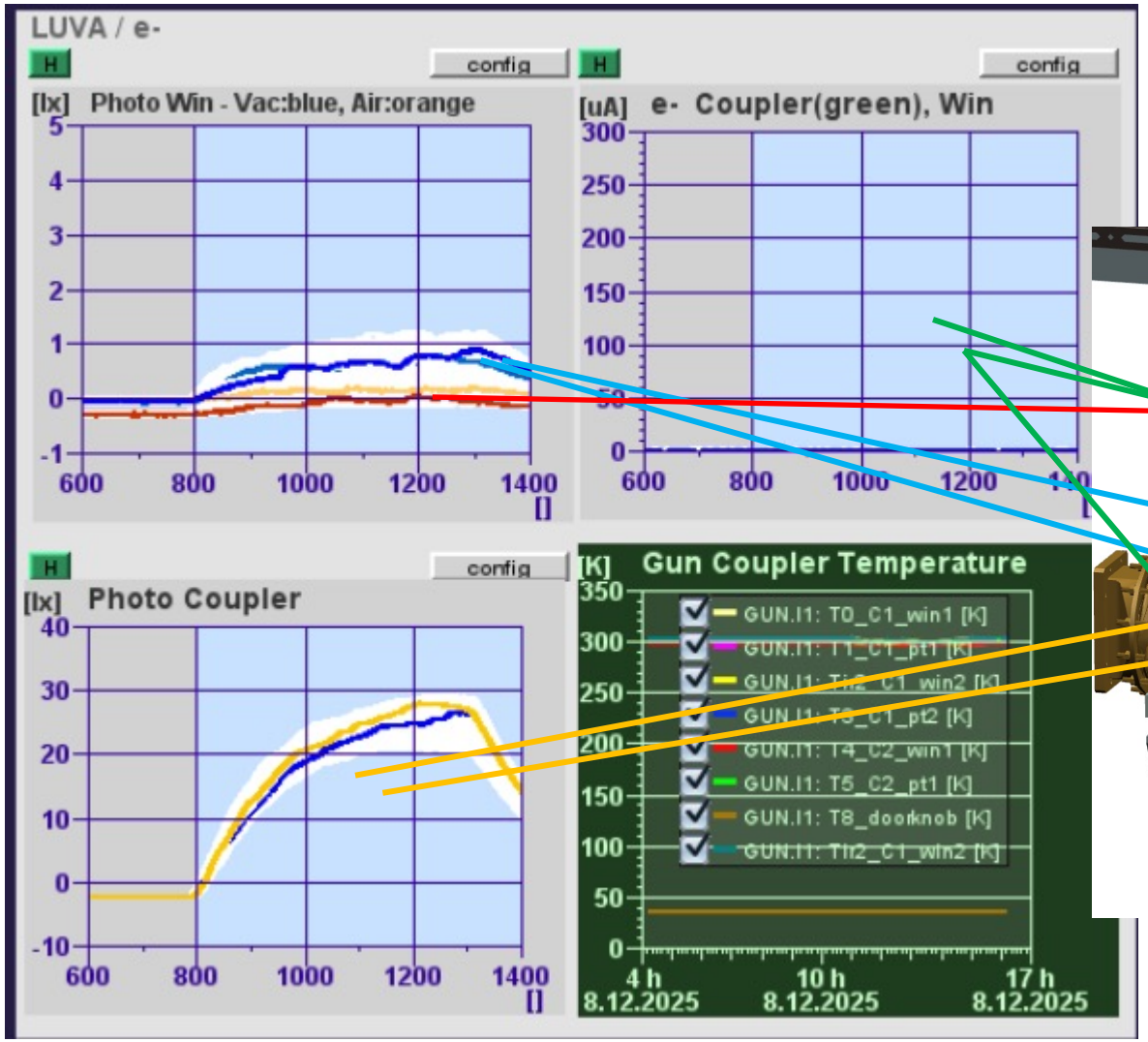
Traces from directional couplers

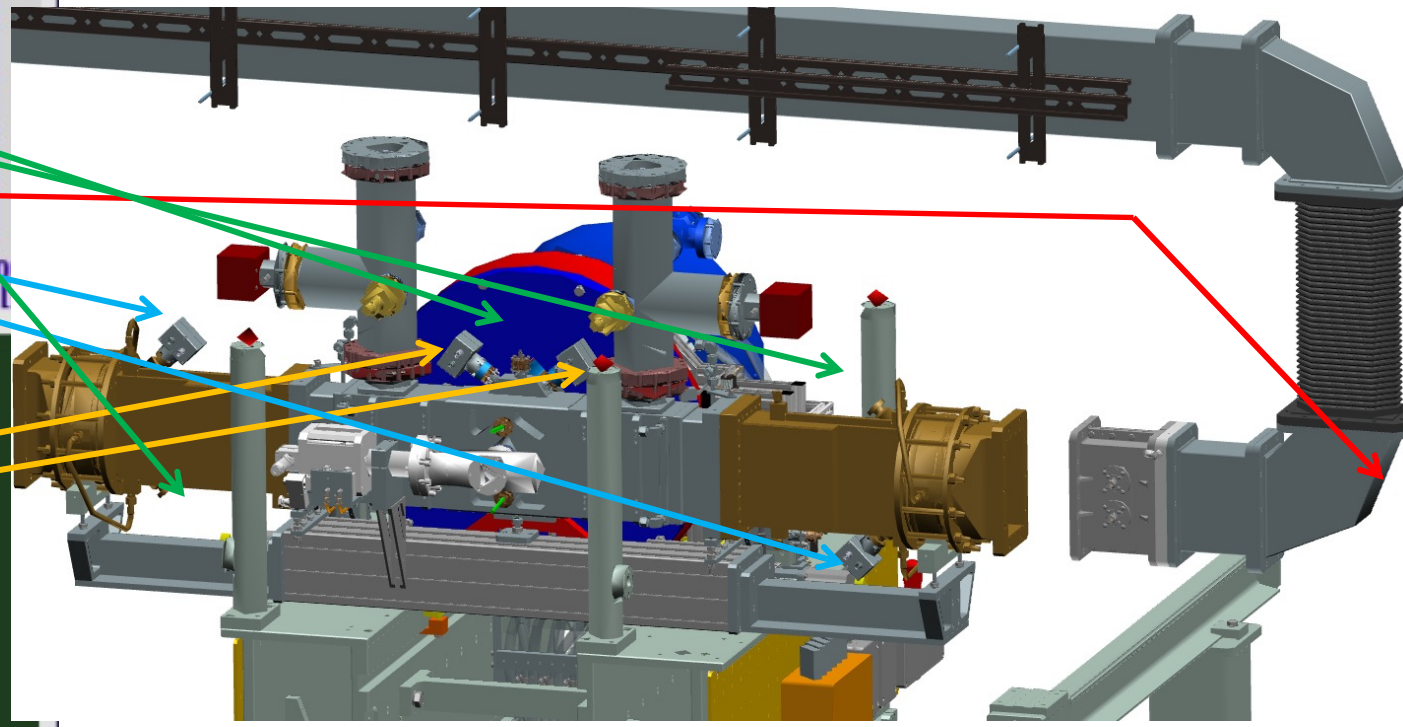
Traces from gun probe



Gun signals and interlocks

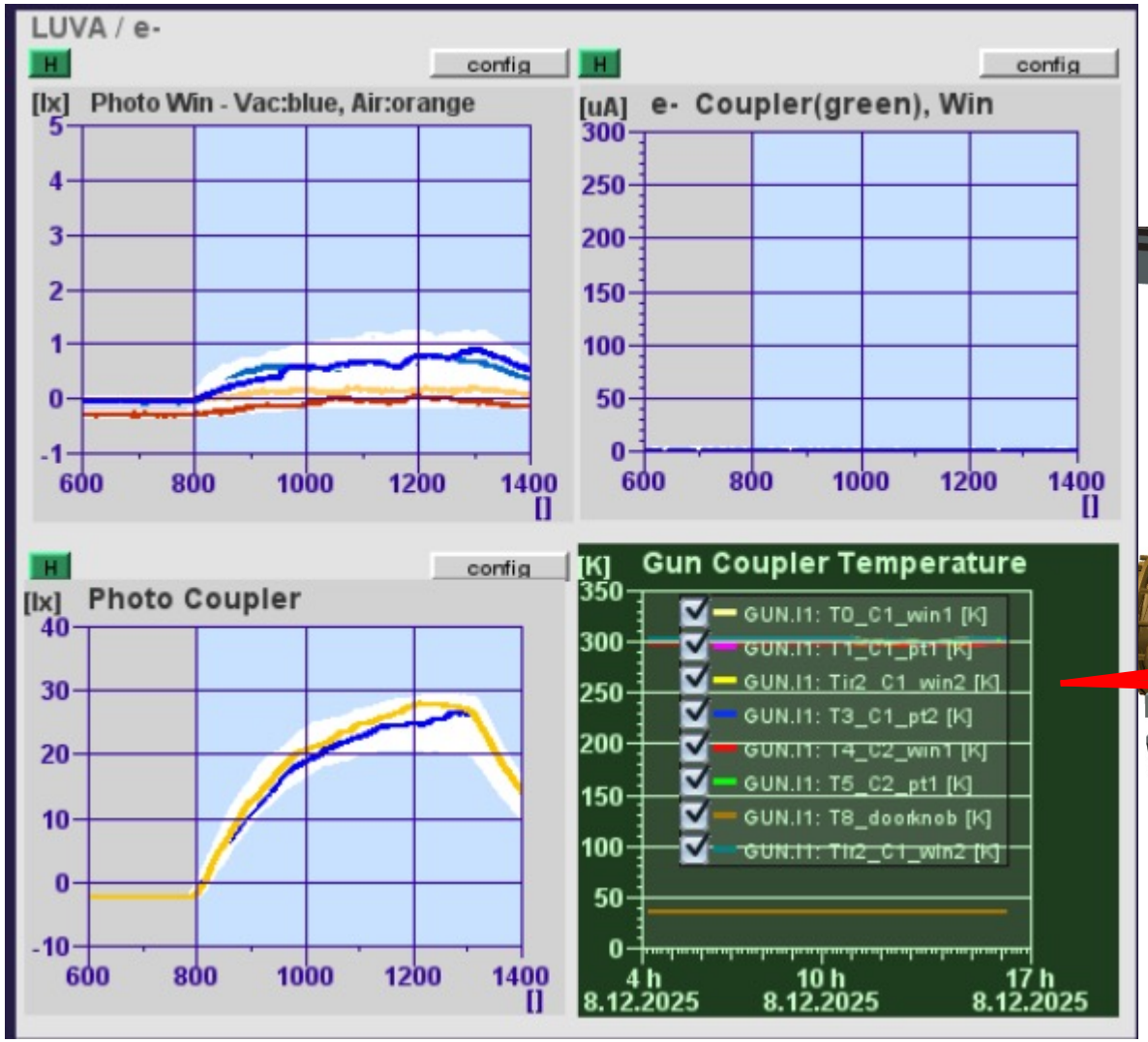
Light and electron detection

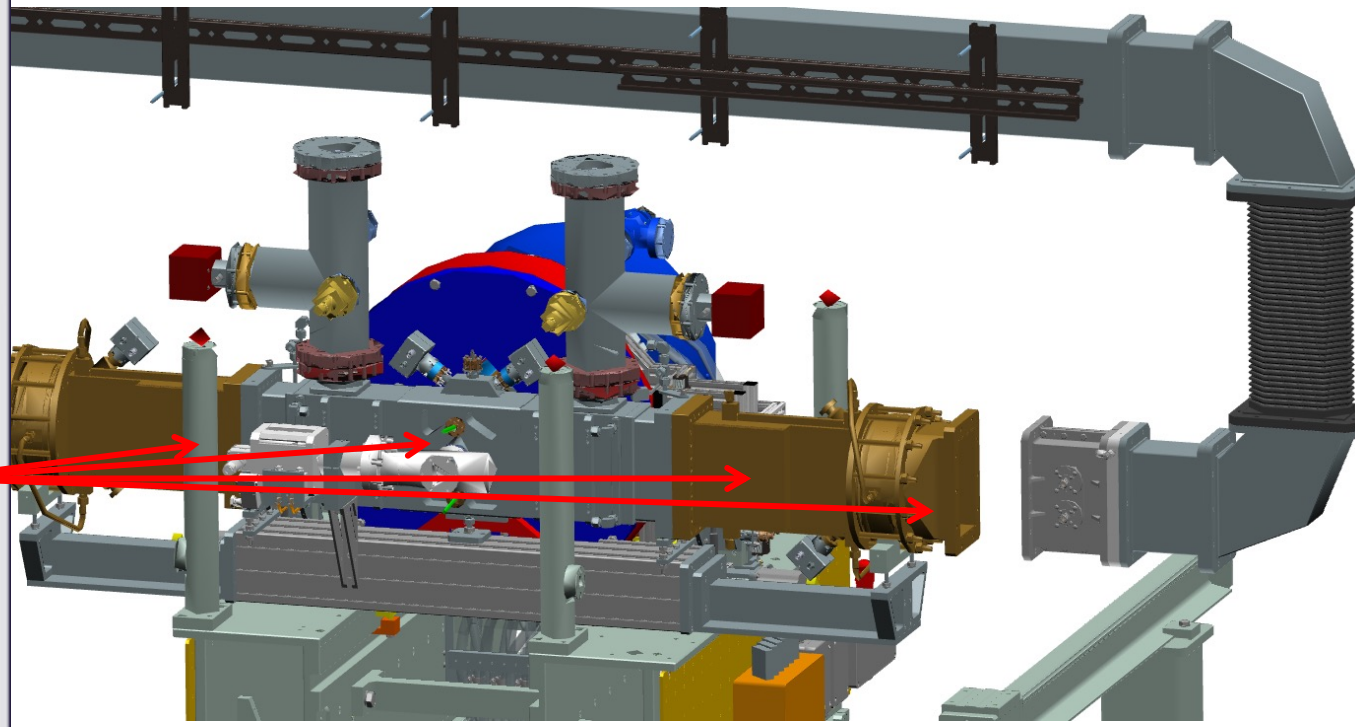




Gun signals and interlocks

Temperatures



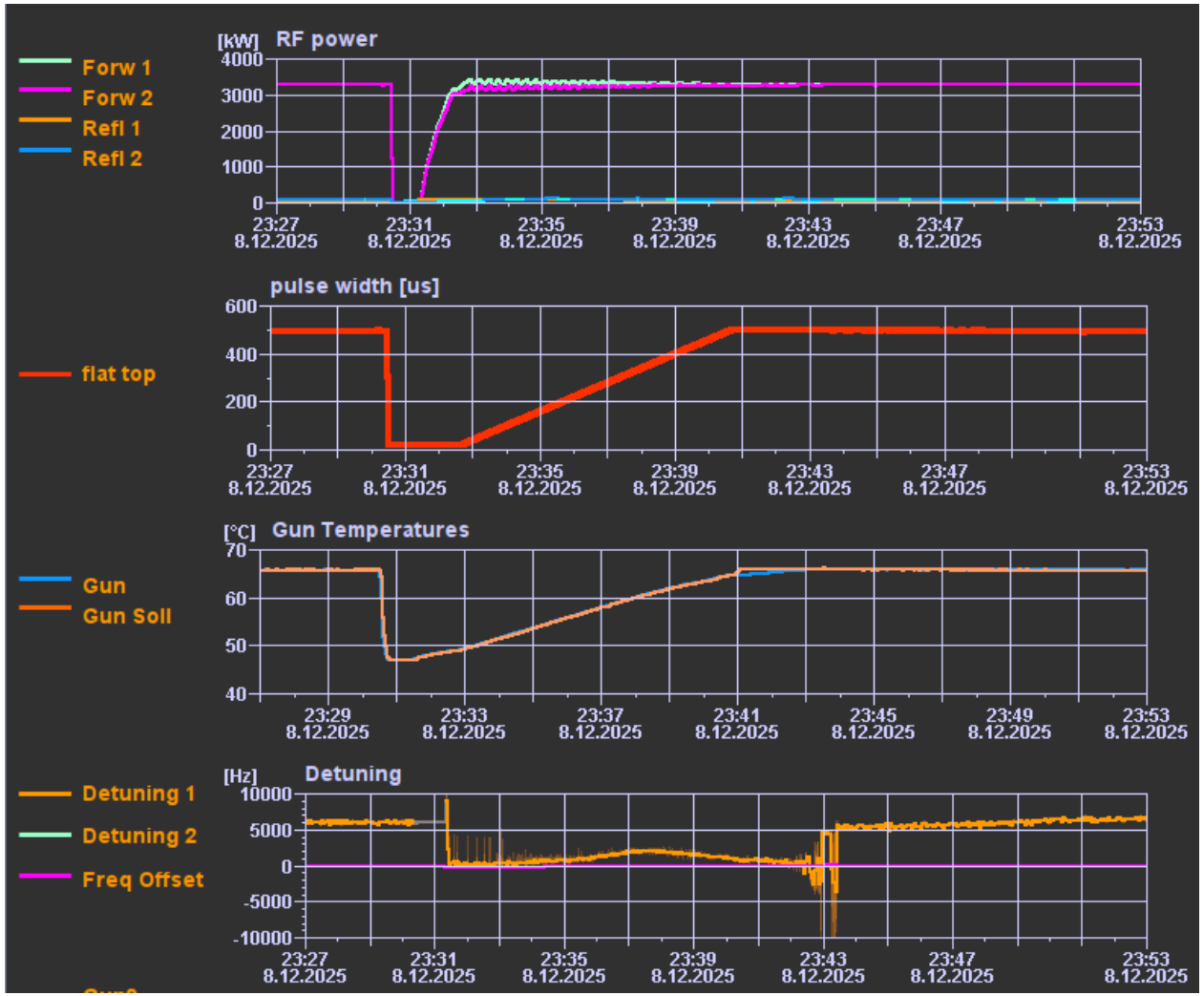


FSM – finite state machine (O.Hensler)

- Two modes of operation: RF On or Off
- Checks a number of states before proceeding to the next
- Loops through to verify that all is still ok.
- In case of trips it resets interlocks and ramps up again

Ramp up

- RF gets off – the temperature goes down
- FSM follows with the temperature
- RF restart
- FSM
  - activates the frequency detuning
  - ramps up the amplitude
  - ramps up the pulse length
- With increasing power the temperature rises
- At the end the parameters have been restored
- FSM
  - Waits for stabilization
  - Switches of the frequency detuning
  - Switches on the PWM and feedback
  - Declares RF-running



Frequency modulation

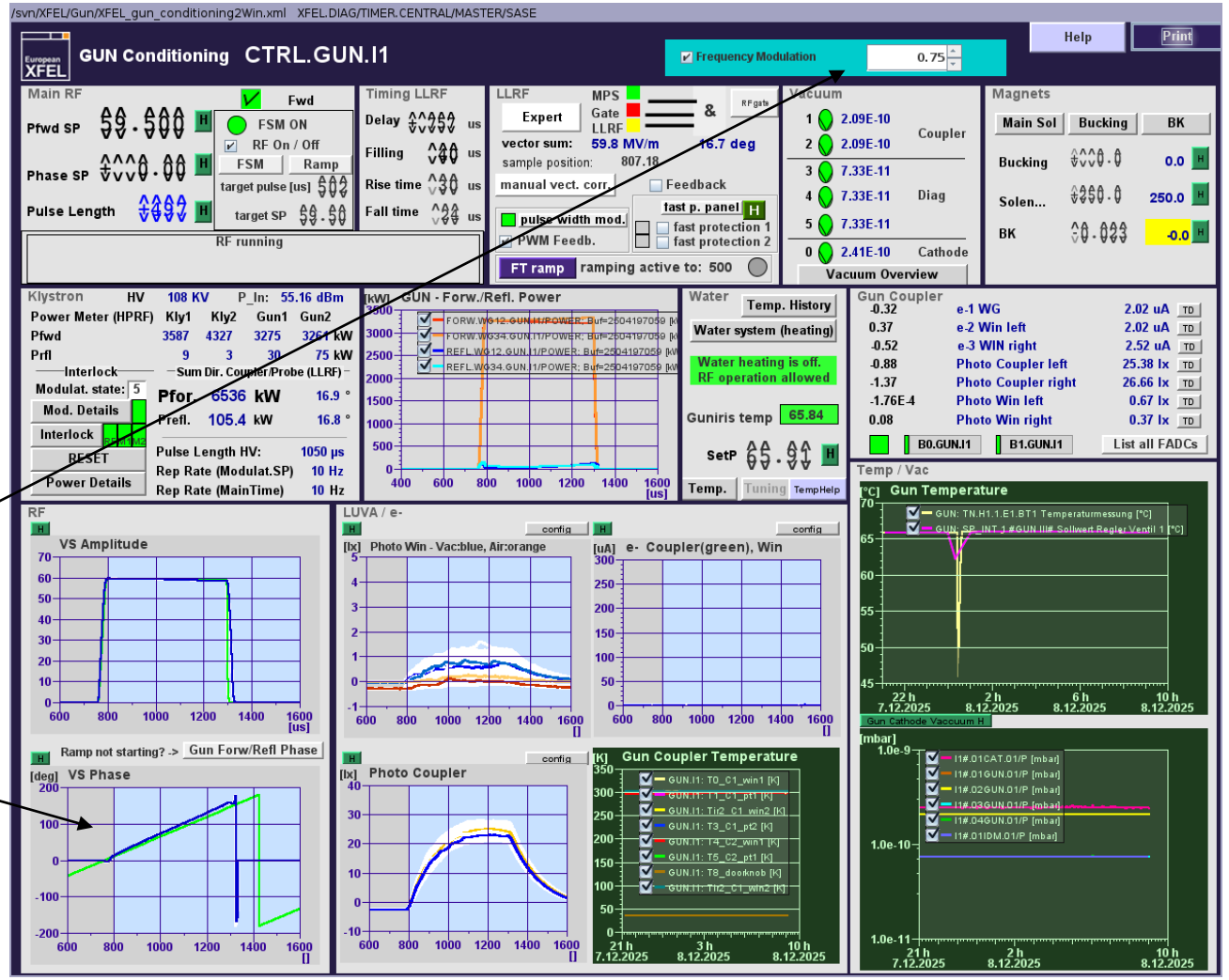
- The resonance frequency of the gun varies with the temperature
- Instead of adjusting the temperature one can also just set the frequency to resonance

Frequency offset

Phase drift

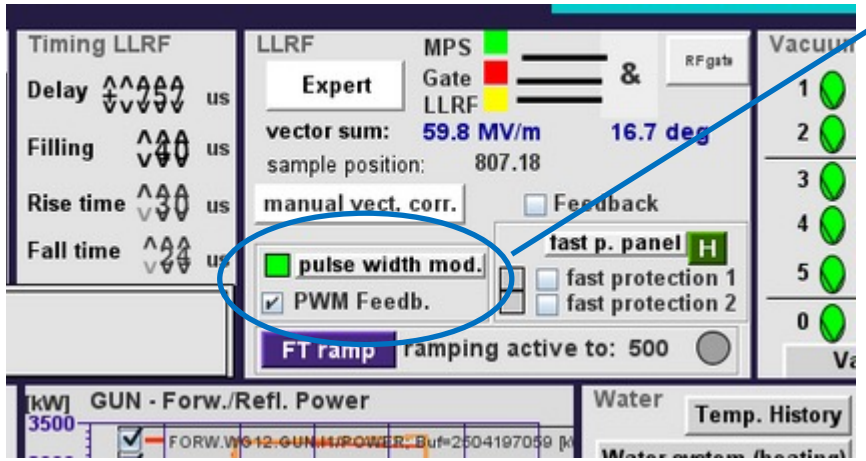
Works only for the gun alone

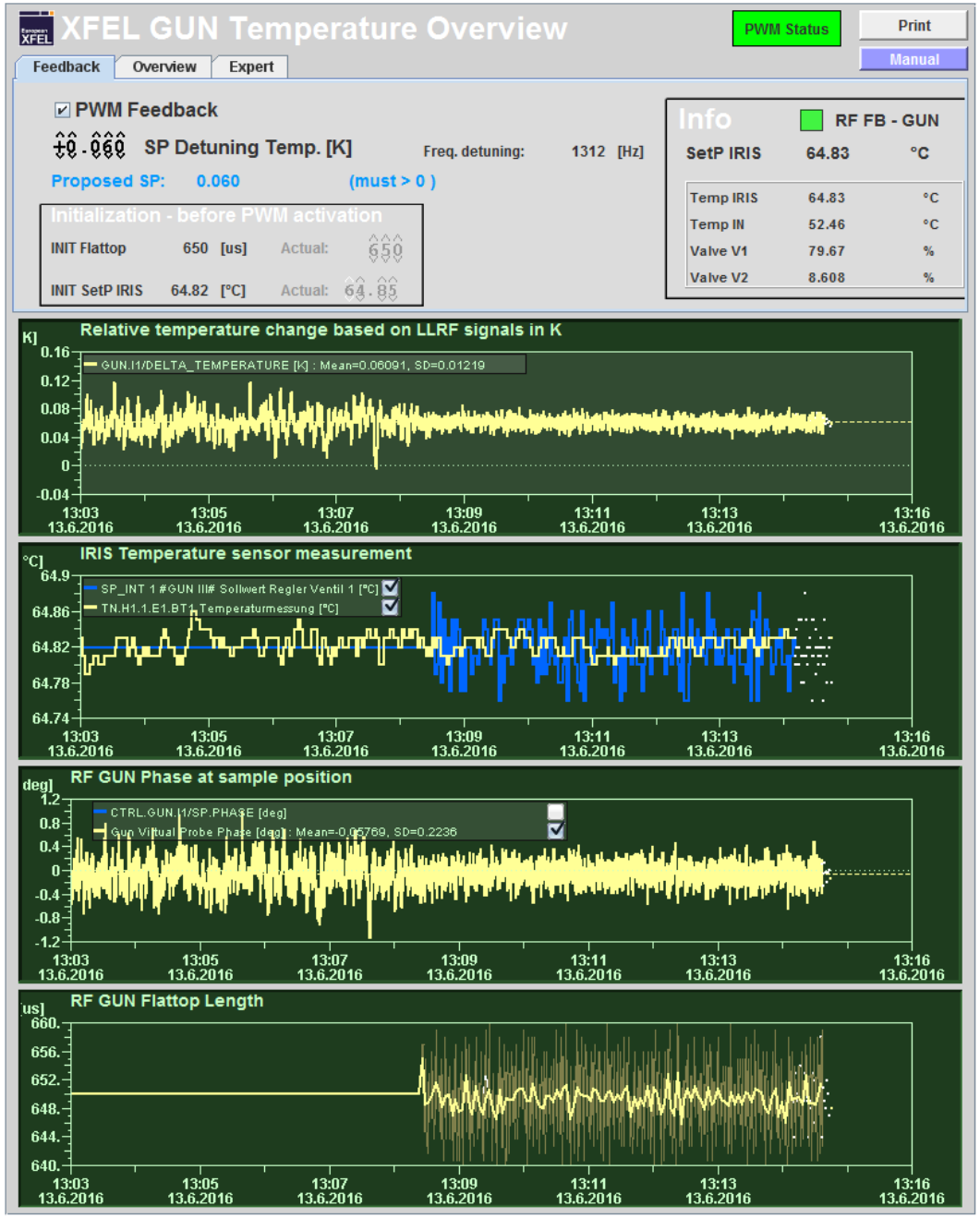
The laser and other RF runs asynchronous during this time



Pulse width modulation

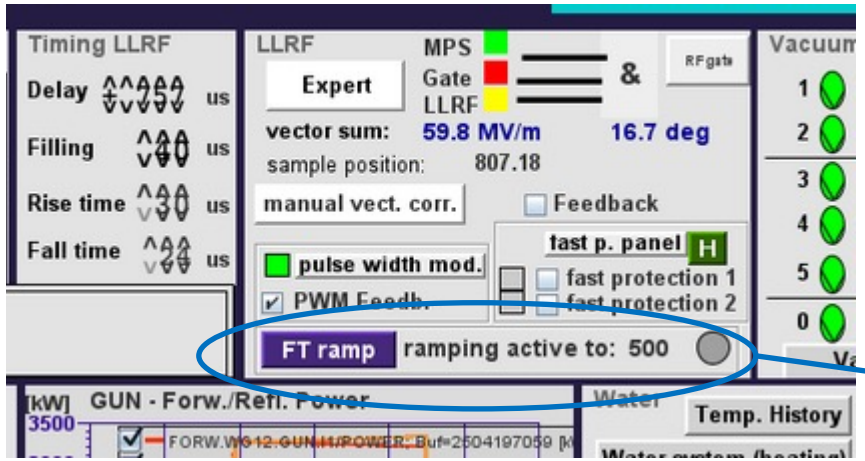
- Fast measurement of gun temperature/detuning (0.1sec vs. 7 sec)
- Compensate temperature deviations with the RF pulse width
- Compensate also for cooling water drifts after the ramp up





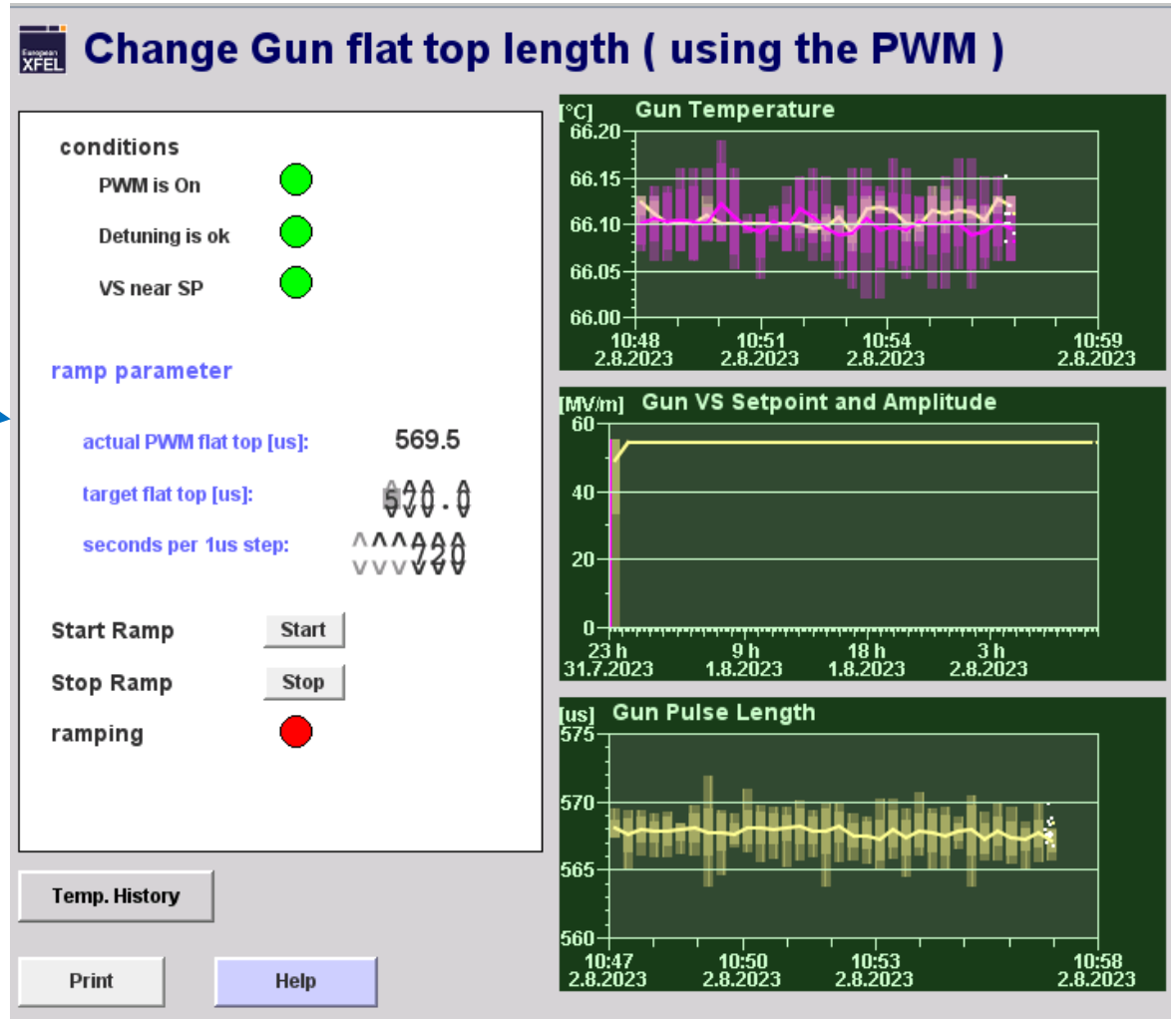
Slow ramp up with PWM

- Advantage: no influence on stability (SASE etc.)

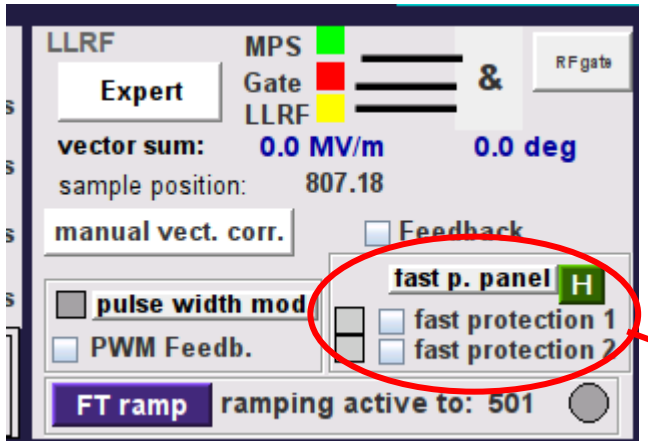


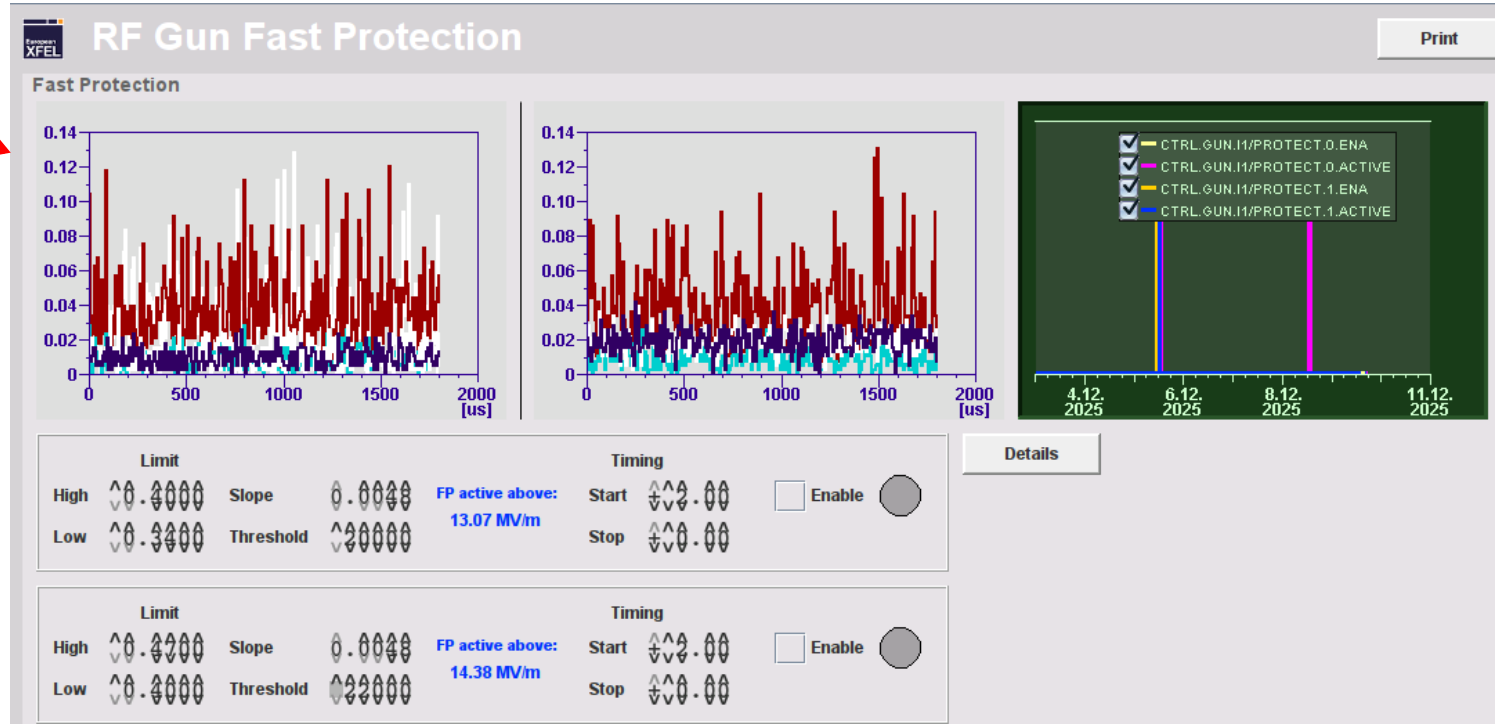
- Increases slowly the target length for the PWM – not the pulse length directly
- Increases also the temperature SP
- Pauses when one of the conditions is bad
- Changes only by 1 us for each step

Very smooth changes – can be done even during user operation



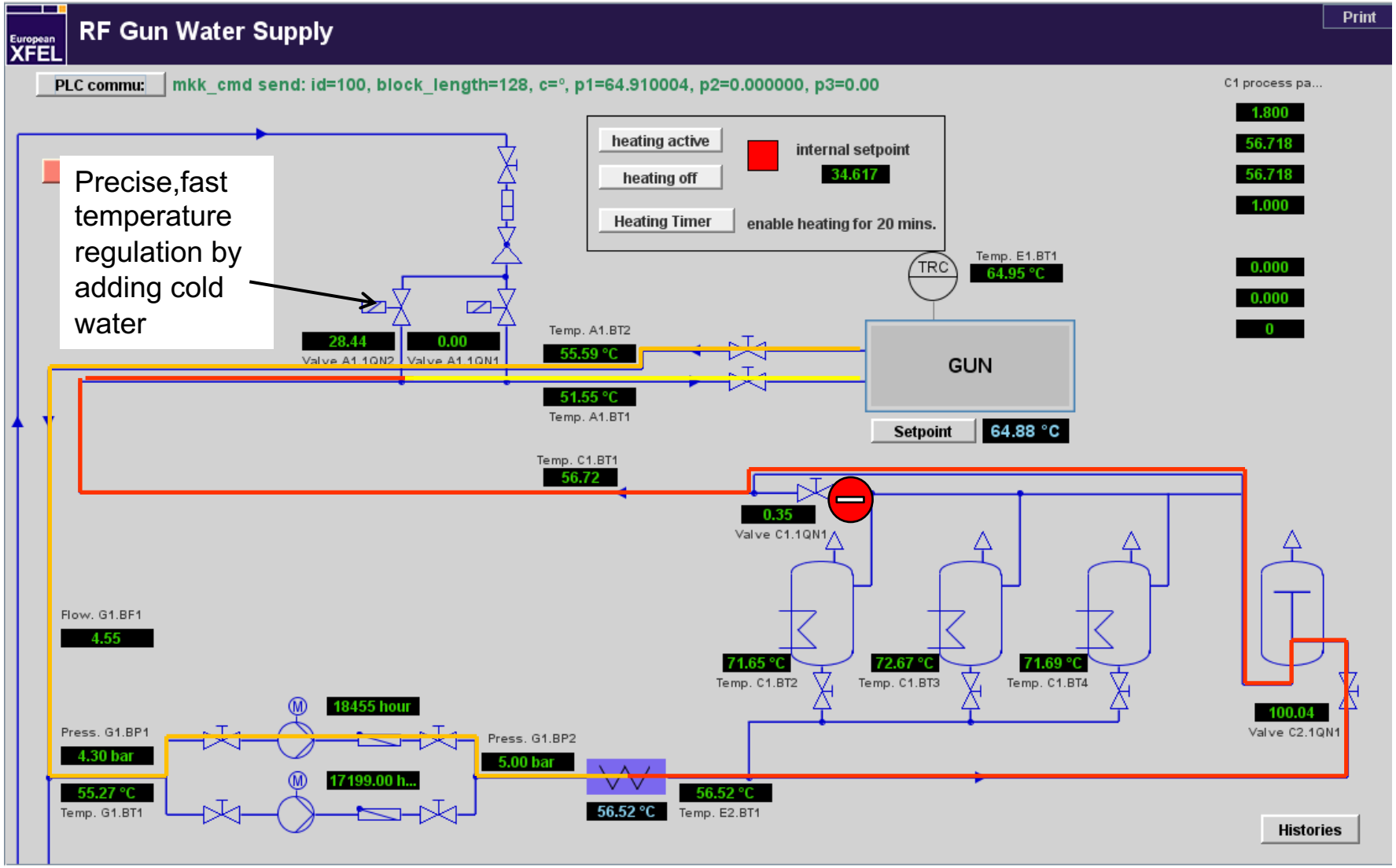
LLRF fast protection – looking at the reflected power



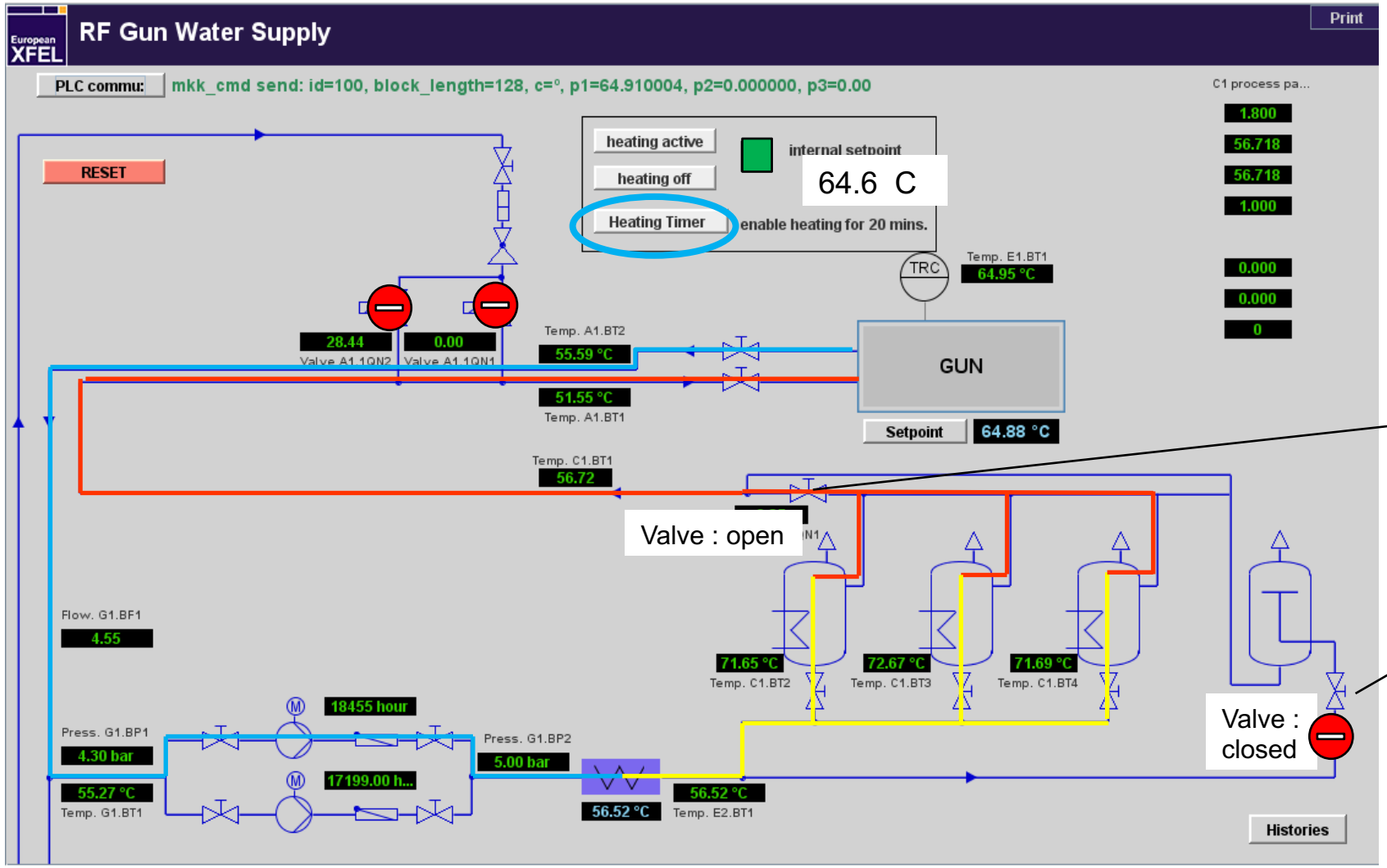


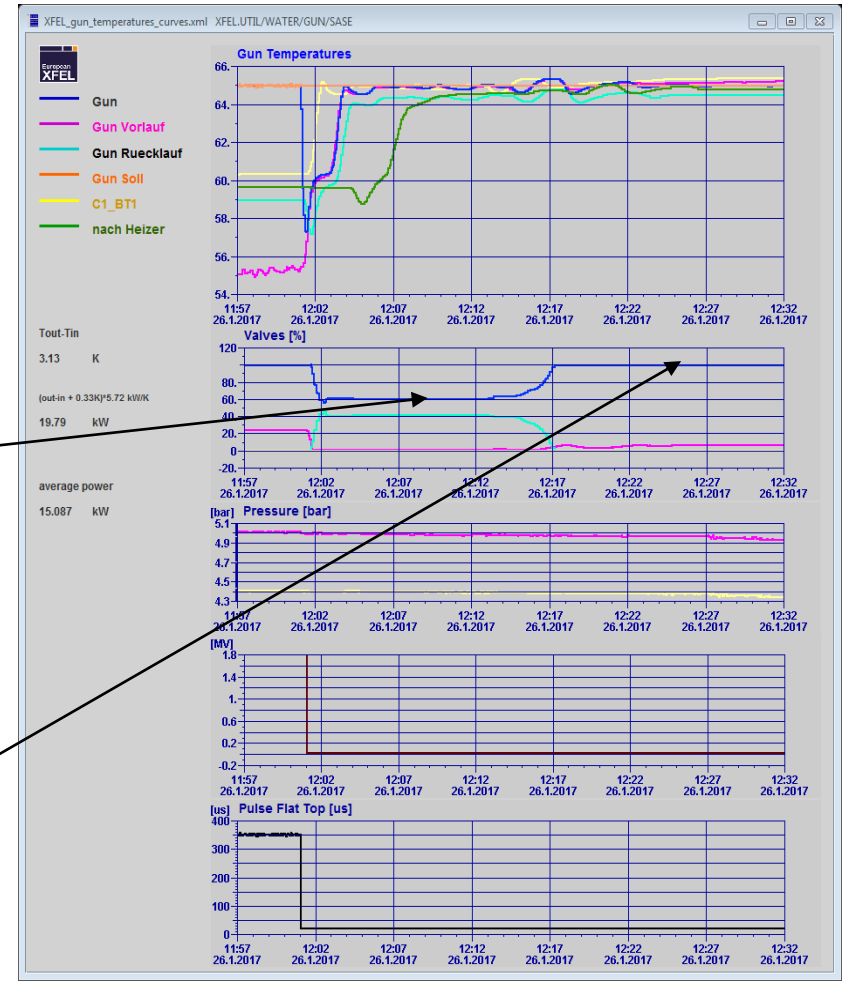
If the reflected amplitude exceeds the limit, the pulse will be cut – but the next pulse is allowed again

Water temperature regulation – gun operation



Water temperature regulation – heating up if needed

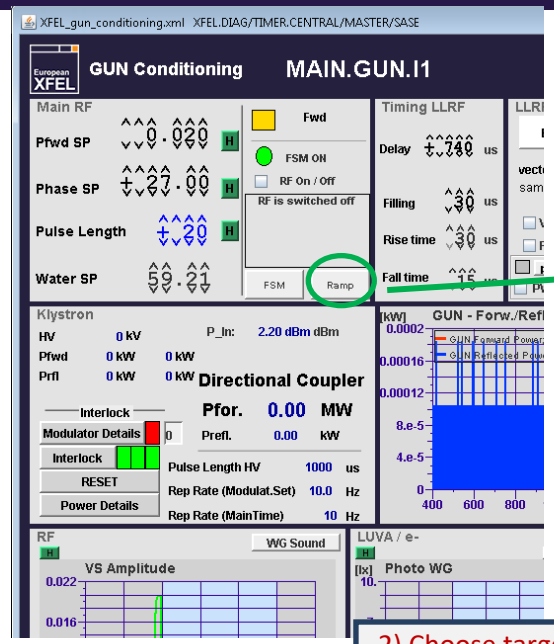




Thank you for listening!

Fast Gun Ramp Up – by FSM

Typically the parameters are taken from the last run!



1) FSM On

2) Choose targets: gradient and pulse width

Estimation for the start temperature

Only for new parameters!

3) Set start temperature and **wait until it's reached** (~0.2 C)

4) Start ramp by switching FSM RF On

FSM messages