

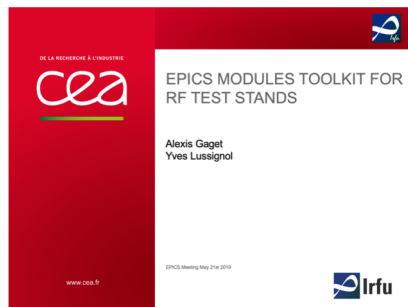
Automatized RF Conditioning Application

Emmanouil Trachanas
Electrical and Computer Engineer
European Spallation Source
Emmanouil.Trachanas@esss.se

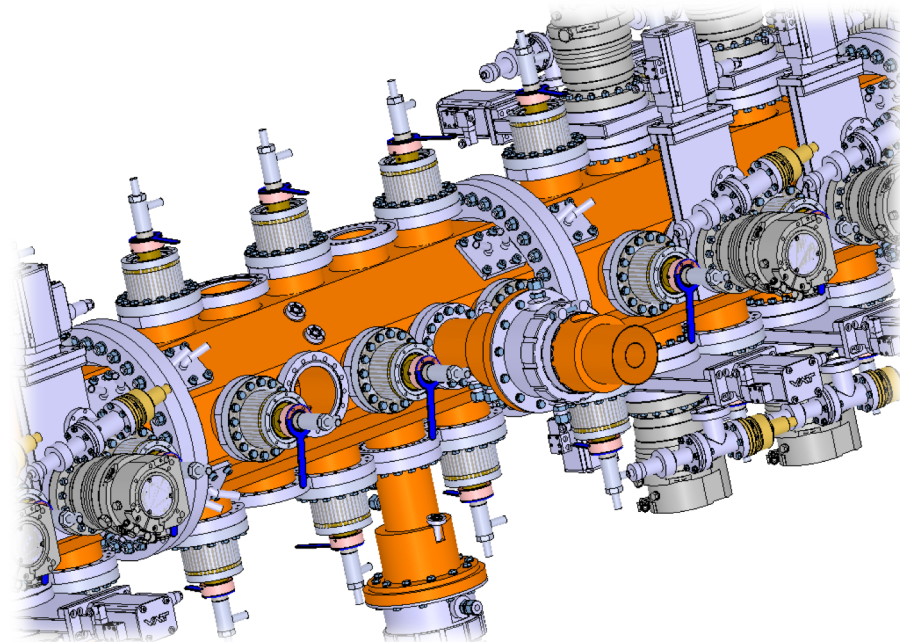
Thomas Fay
Control Systems Engineer
European Spallation Source
thomas.fay@esss.se

Scope of the project

“Create a EPICS/IOC application implementing the algorithm for the automatized RF conditioning procedures of NCL cavities”



Grateful to **Alexis Gaget**
and other colleagues for the
base code and assistance during
integration



Application Characteristics

Algorithm Implemented on SNL

- Code integration and Modification
- **EPICS modules provided by CEA**

One centralized menu with 2 tabs

- ✓ Configurable Cycle
- ✓ Threshold Input
- ✓ Work with Interlock IOC
- ✓ Generalized module for flexibility

Depending on the fault, power stays the same or decreases. In case of critical fault RF LPS shuts power down until fault is corrected.



OPI created on BOY editor of CS studio

The application sets the klystron power and its parameters and reads PVs as response and clasifies possible errors with severity (Minor-Major-Critical)

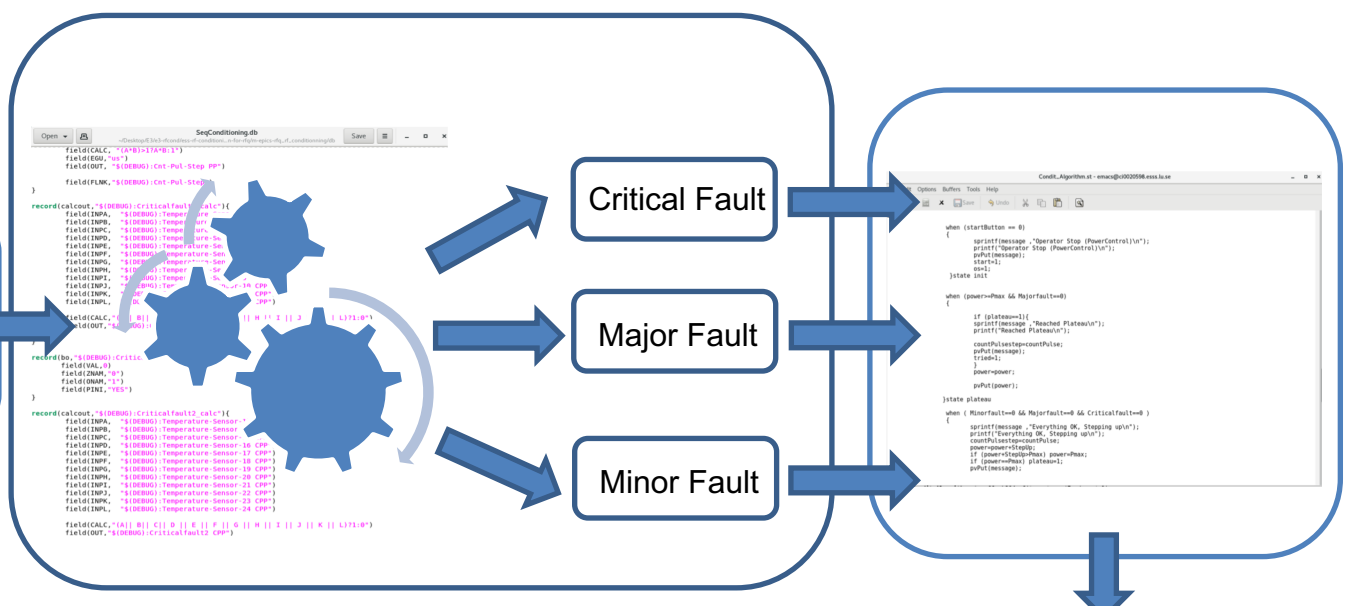
IOC Architecture

.db file
System – Software interface

snl Algorithm

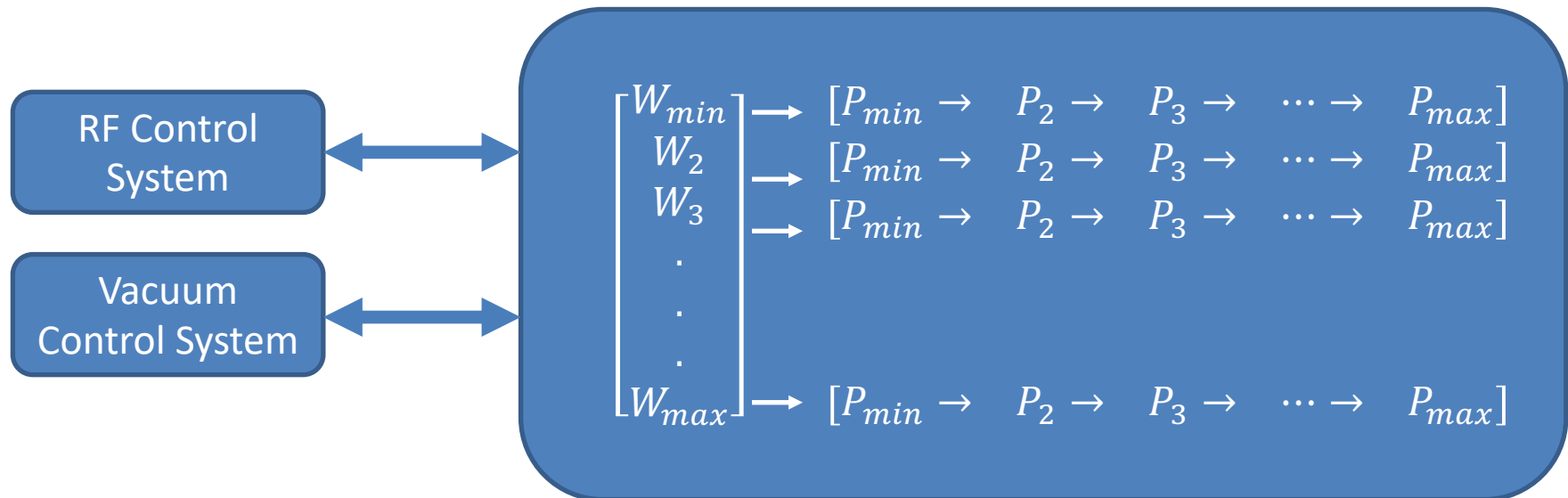
PVs

- Vacuum
- Thermocouples
- Electron Pick-Ups
- Arc-Detectors
- RF -bi-directional Couplers
- Pick Ups

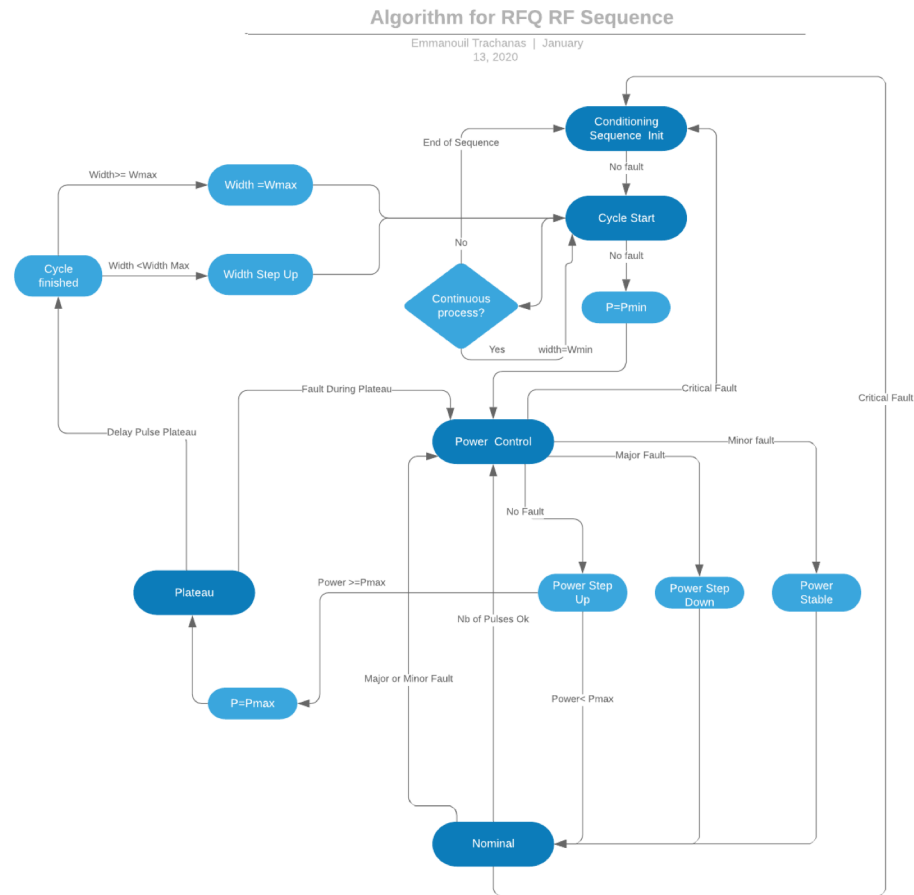


Conditioning Method

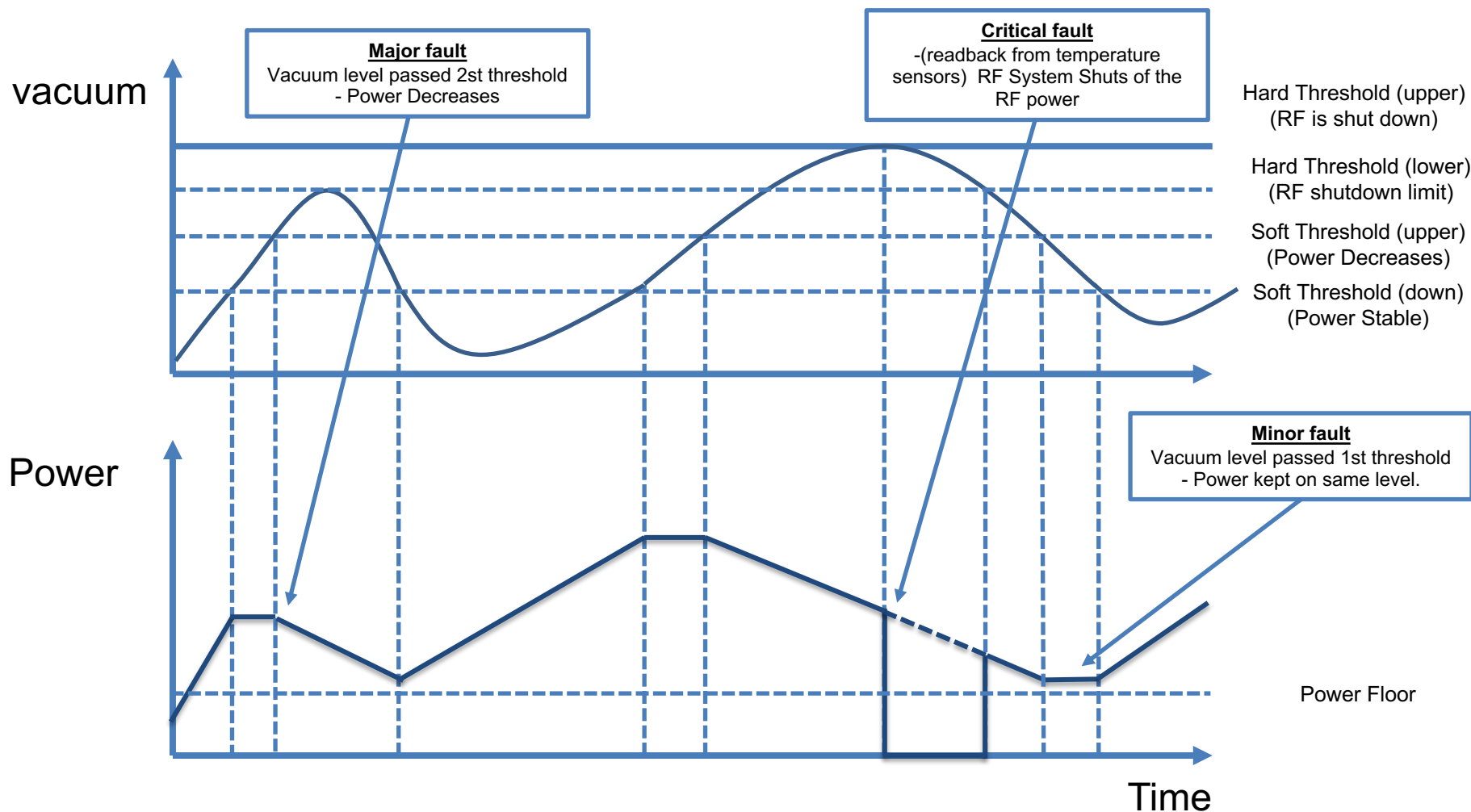
We define the pulse width vector $\mathbf{W} = [w_{min}, w_2, w_3, \dots, w_{max}]$. Each w_i constitutes a cycle and a power vector $\mathbf{P} = [P_{min}, P_2, P_3, \dots, P_{max}]$ is assigned to each cycle. Each value of the power vector is assigned to the klystron (for a number of pulses) and the readback of vacuum and RF interlocks is checked. **Depending if there is an interlock or not power is set accordingly.** Before reaching the next cycle P_{max} is assigned for a given amount of time (plateau)



Algorithm Flowchart



Example



Application Menu (1/3)

RFQ Conditioning Sequence

Cycle
Info

Cycle Configuration

Pmin	10 kW
Pmax	100 kW
Power Step Up	10 kW
Power Step Down	10 kW
Power Low Limit	20 kW
Pulse Width Min	100 μs
Pulse Width Max	1000 μs
Pulse Width Step	10 μs
Cycle Duration	1 s
Plateau Duration	5 s

Infinite Off

Operator Start/stop

On

Save

Read-Back Parameters

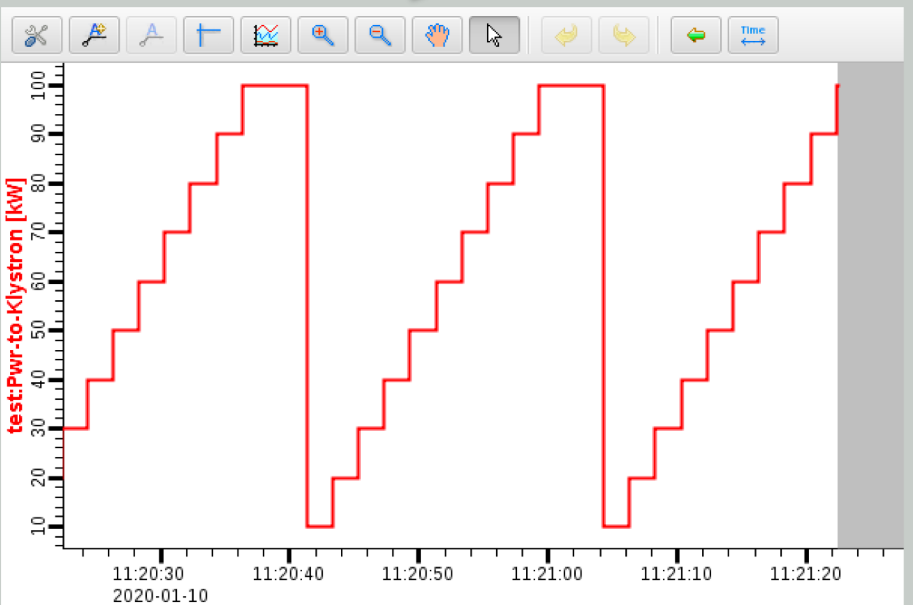
Power	100 kW
Repetition Rate	1 Hz
Pulse Width	120 μs

Reached Plateau

Vacuum Soft Threshold

Vacuum Hard Threshold

Plots



RF power configuration

Read-out Klystron Power Temperature and vacuum Signal Interlock,

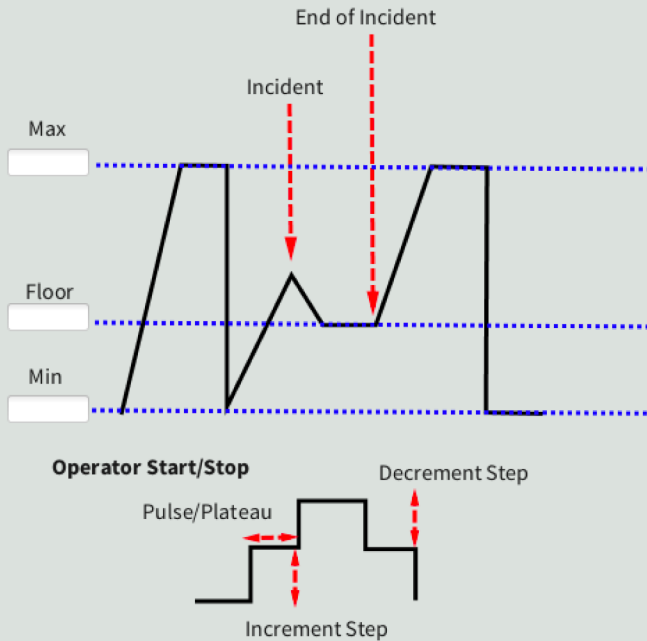
Execution

Save a Screenshot

Application Menu (2/2)

RFQ Conditioning Sequence

Cycle Info



Memorandum

Pmin: Minimum Power on Cycle
Pmax: Maximum Power on Cycle
Power Step Up: Power increment Step
Power Step Down: Power Decrement Step
Pulse Width Step: Pulse width step for proceeding to next cycle.
Power Low Limit: Power cannot drop down this value if surpassed during a cycle
Repetition Rate: Repetition Rate of pulses.
Plateau Duration: Desired Duration of Plateau for each cycle.
Pulse Width Step: Number

Testing EPICS module

Testing OPI running
in parallel with Conditioning application
for local testing

RFQ RF Conditionning Application Testing OPI

Simulated Pulse

Height	15
Noise	1
Samples	16384
Pretrig	-1000
Width	80

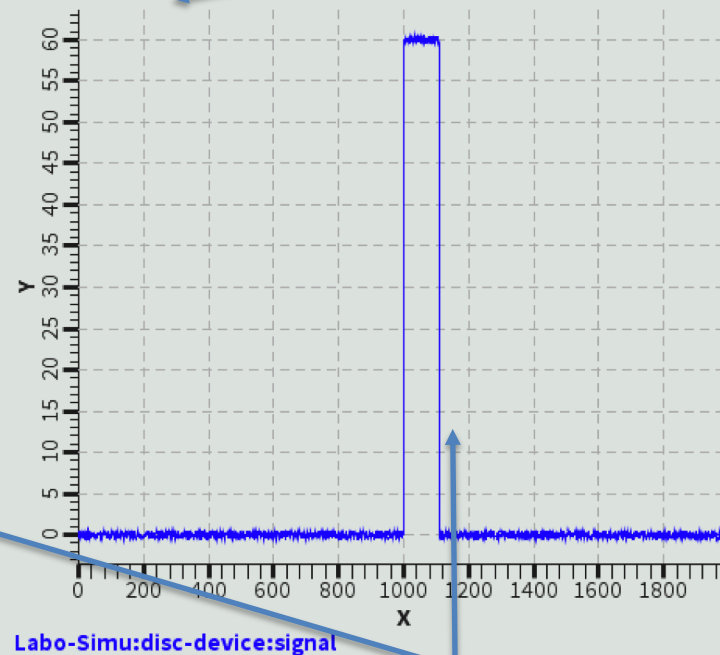
Count Pulses 30

Repetition Rate 1 Hz

Minor Fault

Major Fault

Critical Fault



Labo-Simu:disc-device:signal

Simulates an RF pulse and injects faults

Status And Future Steps

- ✓ Design of OPI -DONE
- ✓ Algorithm Integrated
- ✓ Set-up mock up functional environment.

✓ Milestone I

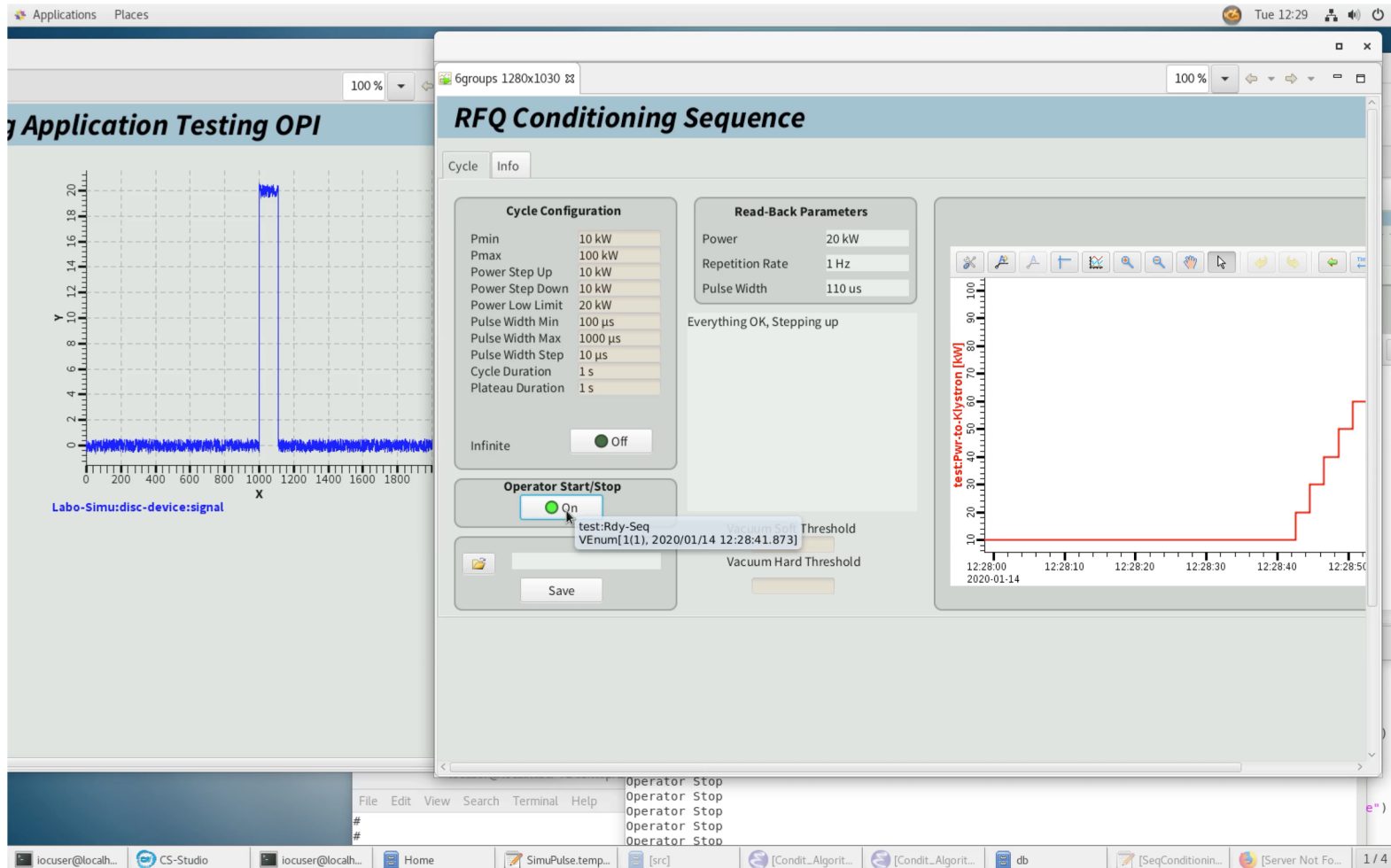
- ✓ Local Tests for algorithm verification
- Manual and Documentation On going

Milestone II

- Integrated Tests (Test stand 2 as a first step)
- List of PVs from Control Systems
- Creation of Generic module

Milestone III

Back Up Slide



The screenshot displays the 'RFQ Conditioning Sequence' control interface. On the left, a plot titled 'Application Testing OPI' shows a signal trace with a sharp peak at approximately 1000 units on the X-axis. The main control panel includes:

- Cycle Configuration:** Pmin (10 kW), Pmax (100 kW), Power Step Up (10 kW), Power Step Down (10 kW), Power Low Limit (20 kW), Pulse Width Min (100 μs), Pulse Width Max (1000 μs), Pulse Width Step (10 μs), Cycle Duration (1 s), Plateau Duration (1 s). Includes an 'Infinite' checkbox (currently Off).
- Read-Back Parameters:** Power (20 kW), Repetition Rate (1 Hz), Pulse Width (110 us). Status: 'Everything OK, Stepping up'.
- Operator Start/Stop:** A green 'On' button is active. A tooltip shows 'test:Rdy-Seq VEnum[1(1), 2020/01/14 12:28:41.873]'. A 'Save' button is visible below.
- Vacuum Hard Threshold:** A field for setting the threshold.
- Graph:** A plot of 'test:Pair-to-Klystron [kW]' showing a step-wise increase in power over time from 12:28:00 to 12:28:50 on 2020-01-14.

The bottom of the screen shows a terminal window with the text 'Operator Stop' repeated five times, and a taskbar with various application icons.