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An Optimal Procedure for RF Conditionning at the FREIA Laboratory

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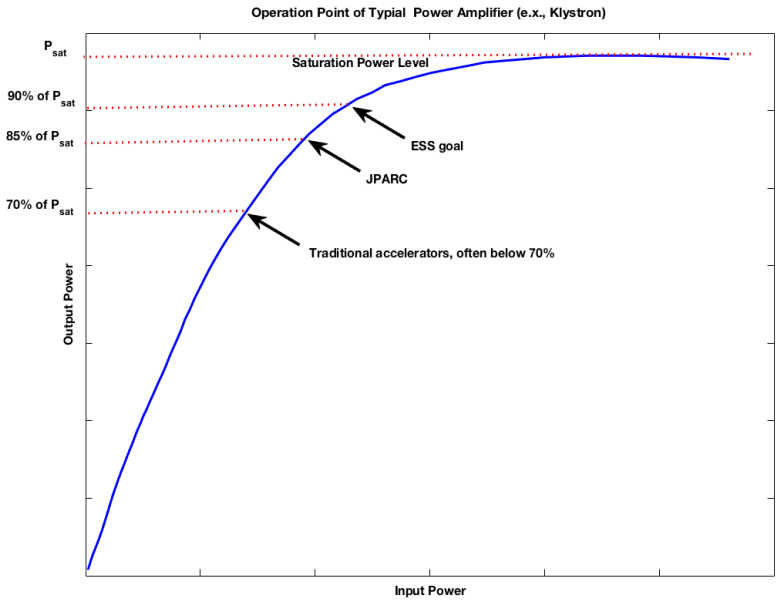
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Background and Motivation

This slide discusses and proposes to test an optimal procedure for power coupler conditioning

1) In the purpose of addressing challenges at ESS
   (high efficiency, high availability)
2) Reduce the time and effort of overall power coupler conditioning in cavity production at FREIA.



So far, there has no stander conditioning procedure being found.

Many different methods are adopted:

- traveling wave processing,
- standing wave (cavity detuned) processing ,
- frequency sweeping,
- power sweeping,
- bias voltage processing,
- warm and ‘cold’ processing,
- with vacuum interlock at different vacuum levels.

Due to the over-coupling, conditioning for dressed cavity/ cryomodule will only use standing wave, but follows the same procedure.

Typical Coupler Conditioning Procedure(I)

DESY is in charge of the development of 1110kW peak-power power coupler for 1.3 GHz TESLA cavity, which is chosen for the XFEL.

- In total of 800 input couplers are tested.
- This conditioning procedure a successful work and was applied similarly to others coupler.

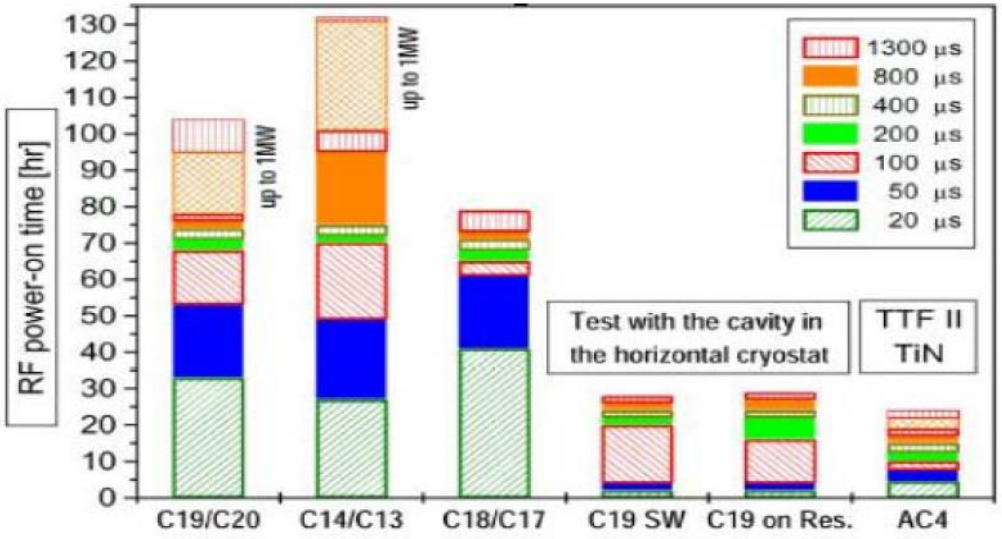


Fig. status of DESY power coupler conditioning

Typical Coupler Conditioning Procedure(II)

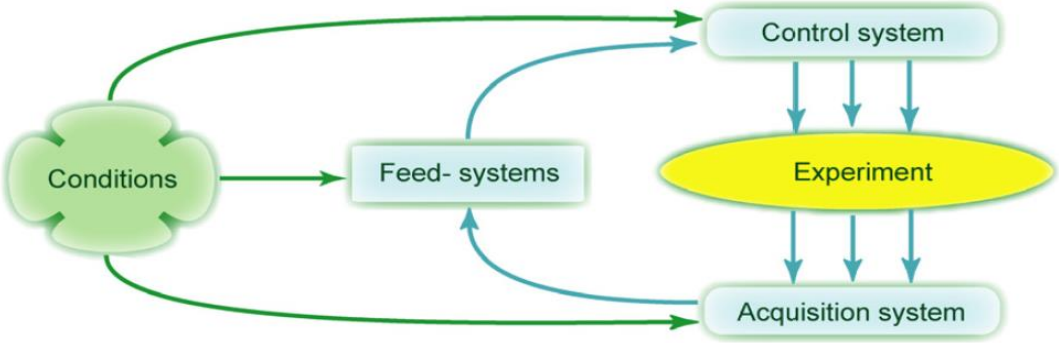
DESY conditioning experience:

• **Conditioning should start with pulsed (low amplitude and duty factor) RF followed by cycling the RF power, or keeping the power constant for at least 24 hours, under the control of a fast vacuum feedback loop and/or of a computer program (allow for out gassing of less than 2 10-7 mbar).**

- RF conditioning computer controlled,
- Starting with small pulse duration,
- Interlocks on electron activity, vacuum and arcing,
- Electronic module to control RF amplitude as function of vacuum outburst

A Conditioning System

Acquisition system, control system and feedback can help to adjust and control the testing parameters with respect to the conditions.



- Condition: defined by experts
  (interlock trig threshold and auto conditioning threshold)
- Acquisition system: RF power, vacuum levels and all the interlocked signals.
- Control system : software controlling
  (duty and peak power of pulse, switching on and off the RF power, and resetting system)

RF-Vacuum Feedback system

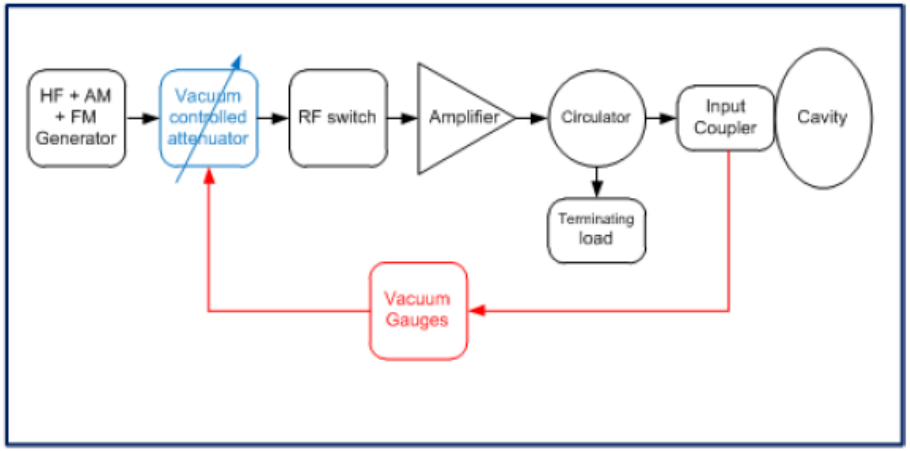
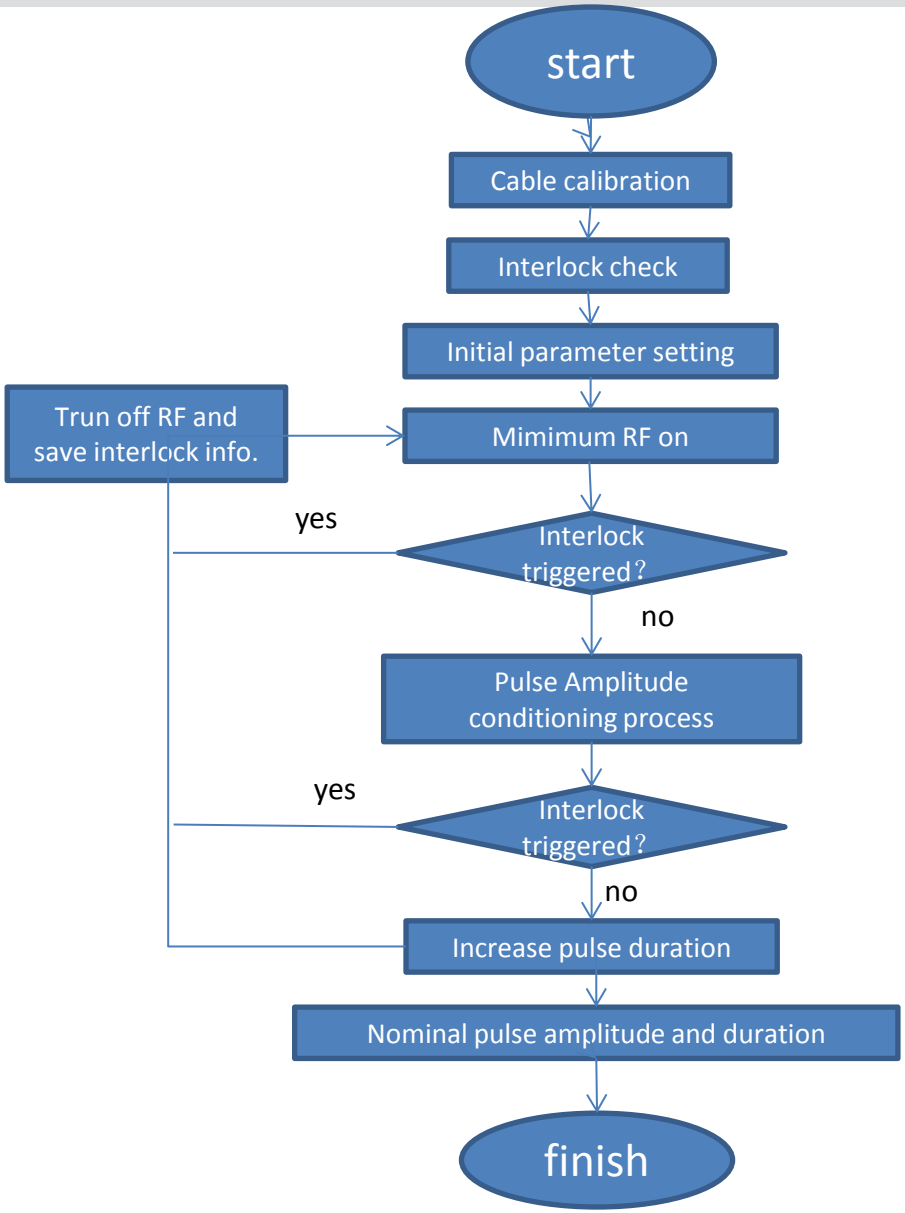


Fig. Layout of a simple RF-Vacuum Feedback system

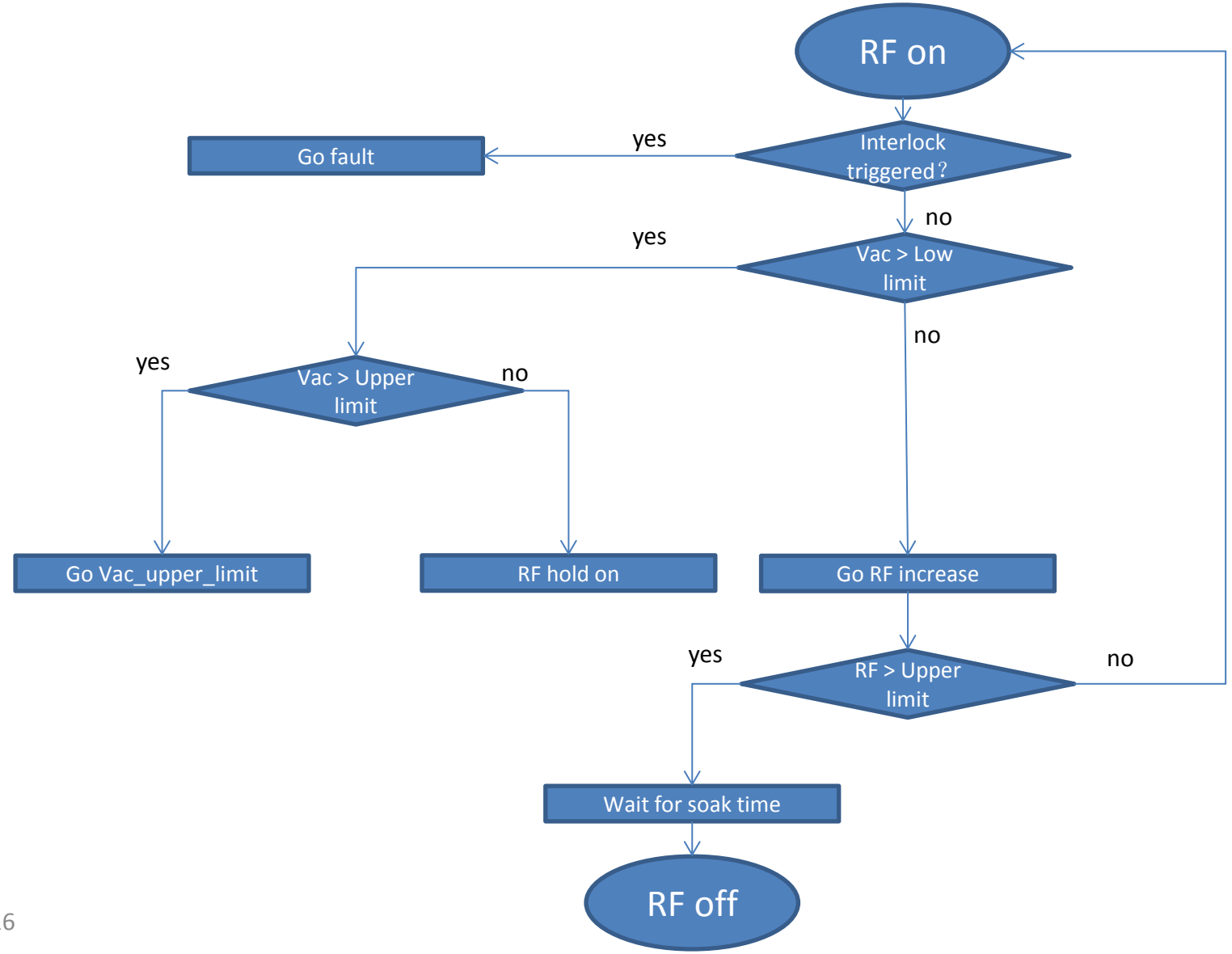
Following principles need to fulfil for an effective feedback system:

- Regulate RF power as a function of vacuum pressure around the coupler as fast as possible.
- Apply a longer repetition period than the vacuum reading delay.
- Conditioning procedure logic

Conditioning Procedure Logic



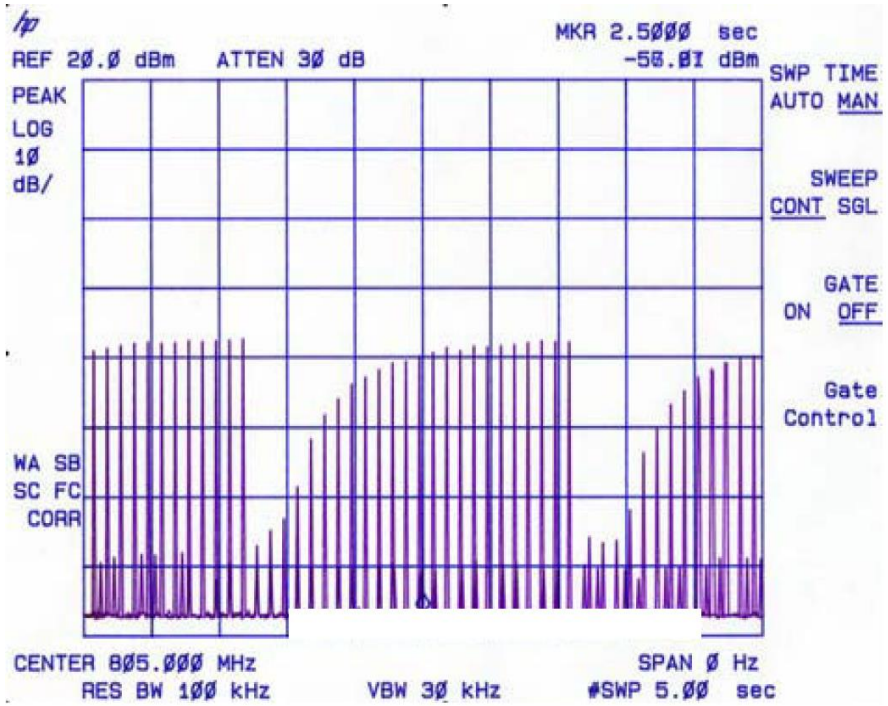
Pulse Amplitude Conditioning Logic



Analog RF-Vacuum feedback in JLAB

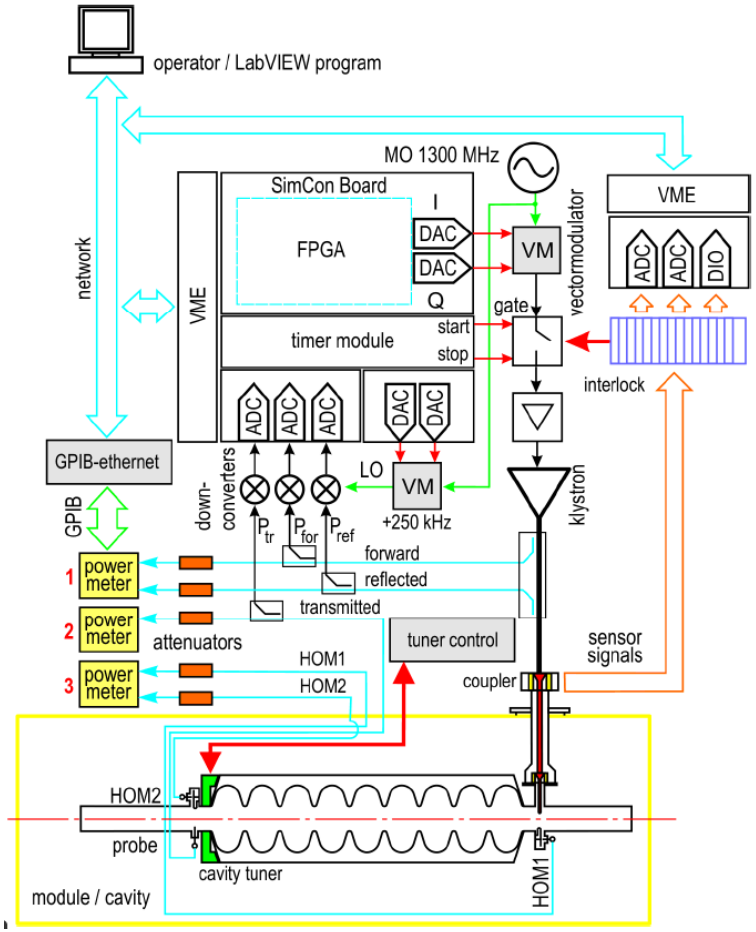
- A fast interlock system based on this analog vacuum feedback.
- Key parameters:

Vacuum Interlock :
5e-7 mbar,
Software Vacuum Upper Limit :
3e-7 mbar
Software Vacuum Low Limit :
2.5e-7 mbar



All the data acquisition and controls are accomplished by using a LabView-based program

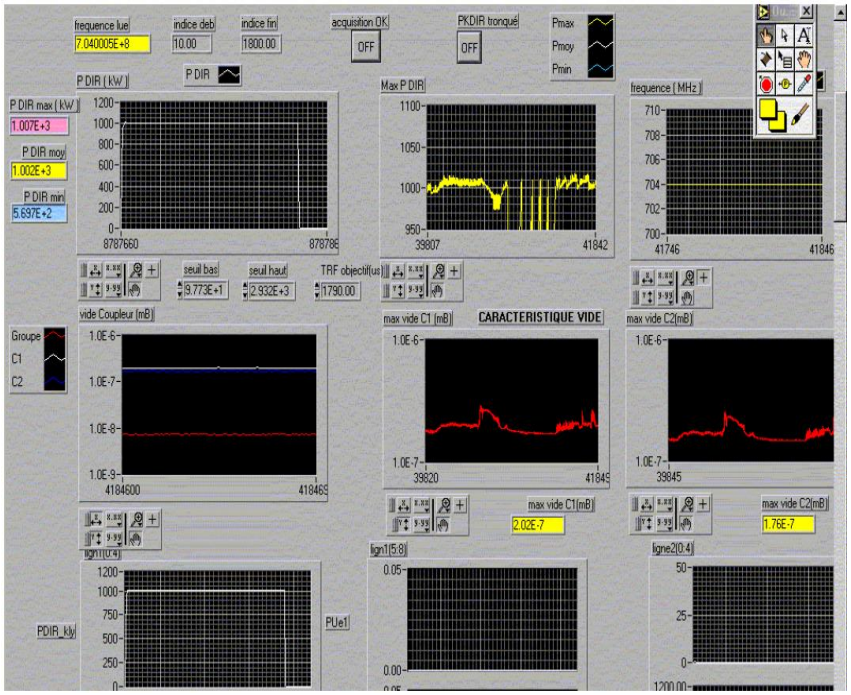
RF-Vacuum feedback in DESY



This automatic RF conditioning module follows the same principle of conditioning stander and integrates a FPGA module, which can provides a faster and more reliable data processing.

Key parameters:
Vacuum Interlock :
5e-7 mbar,
Software Vacuum Upper Limit :
1e-7 mbar
Software Vacuum Low Limit :
1e-8 mbar

RF-Vacuum feedback in CEA



The RF power level is increased every N pulses/ certain time according to a user defined step, only if no incident has occurred, otherwise it is reduced automatically.

Key parameters:
Vacuum Interlock :
3e-7 mbar,
Software Vacuum Limit :
2,7e-7 mbar

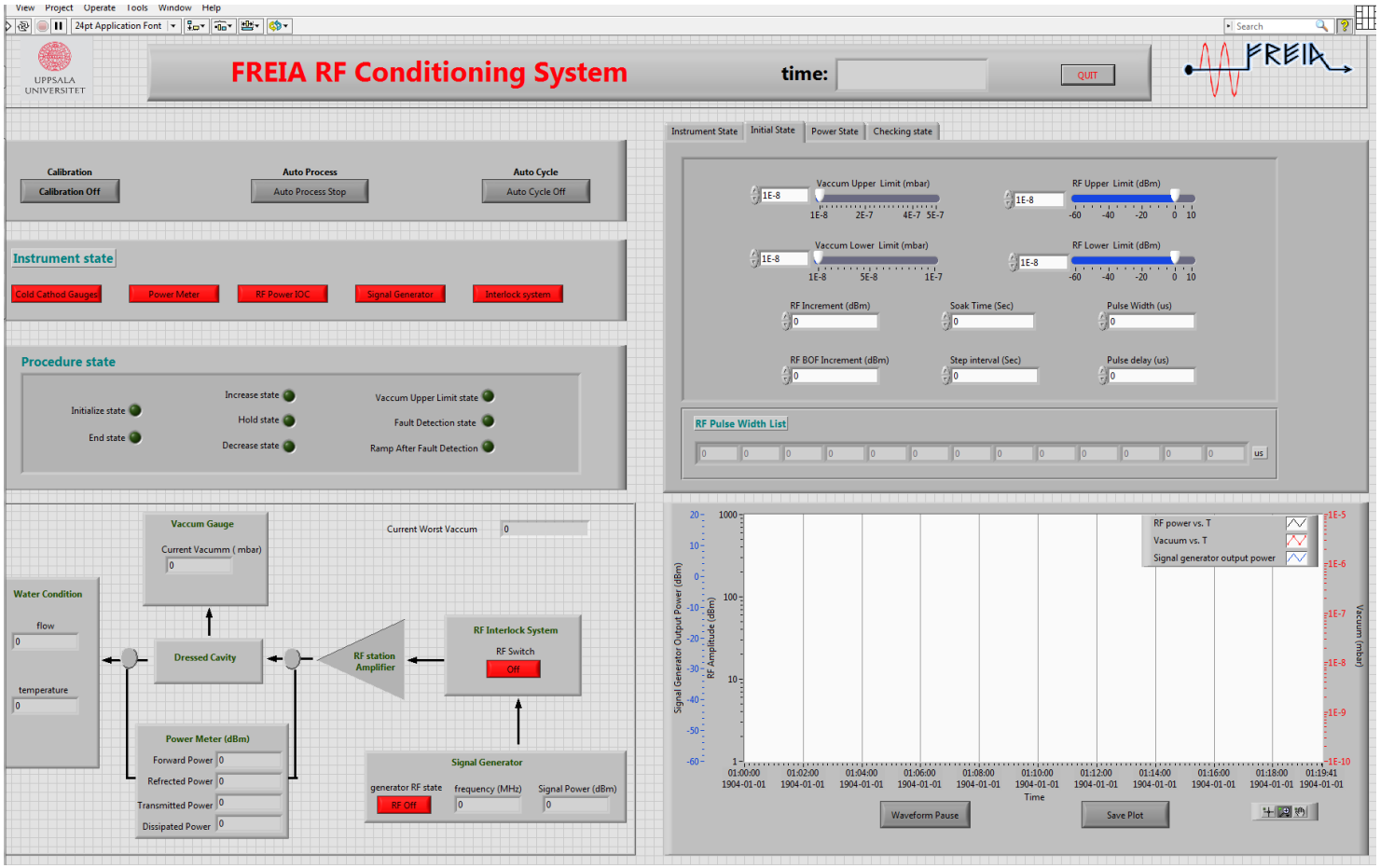
Hardware list

The main devices for the RF conditioning process are:
Programmable Logic Controller (PLC)

- Signal Generator
- Power Meter
- Vacuum Gauge Controller (VGC)
- Cold Cathode Gauges (CCG)
- Arc Detector
- Electron Detector
- Fast RF Interlock Switch
- Voltage Controlled Attenuator
- Vacuum Pumping Cart

RF conditioning control at FREIA

Base on signal generator.



RF conditioning control at FREIA

- Next step

Conditioning stytem base on Lund control system.

Reference

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