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EPICS MODULES TOOLKIT FOR RF TEST STANDS

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Irfu

CONTEXT

CEA IRFU Involved in the control system of the following projects :

- IFMIF : Injector, diagnostics, cavities.
- ESS : Injector, cavities couplers conditioning, test cavities demonstrator
- SARAF: Injector, cavities couplers conditioning, test cavities, rebuncher…
- …

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Similar needs :

- Analysis of the RF signal
- Automatic RF conditioning sequence.

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- Automatic RF conditioning sequence.

Conditioning concept

« *All existing high power couplers exhibit severe outgassing and multipacting barriers of vacuum and RF exposed surfaces, as a result of geometrical configurations and surface conditions (material, contaminants, finishing).*”

These problems can be overcome by design and different procedures like cleaning, baking followed by RF Conditioning -application of RF power under various conditions and in various configurations:

- *Pulsing the RF with different duty factors*
- *In continuous wave mode (CW)*
- *as traveling wave mode*
- *as standing wave mode*
- *Sweeping of frequency or RF power amplitude*

Objective: to clean the surfaces from contaminants (molecular or particulate) and minimize conditions for multipacting. During this process the QA of different coupler components and associated instrumentation is obtained. »

CONTEXT

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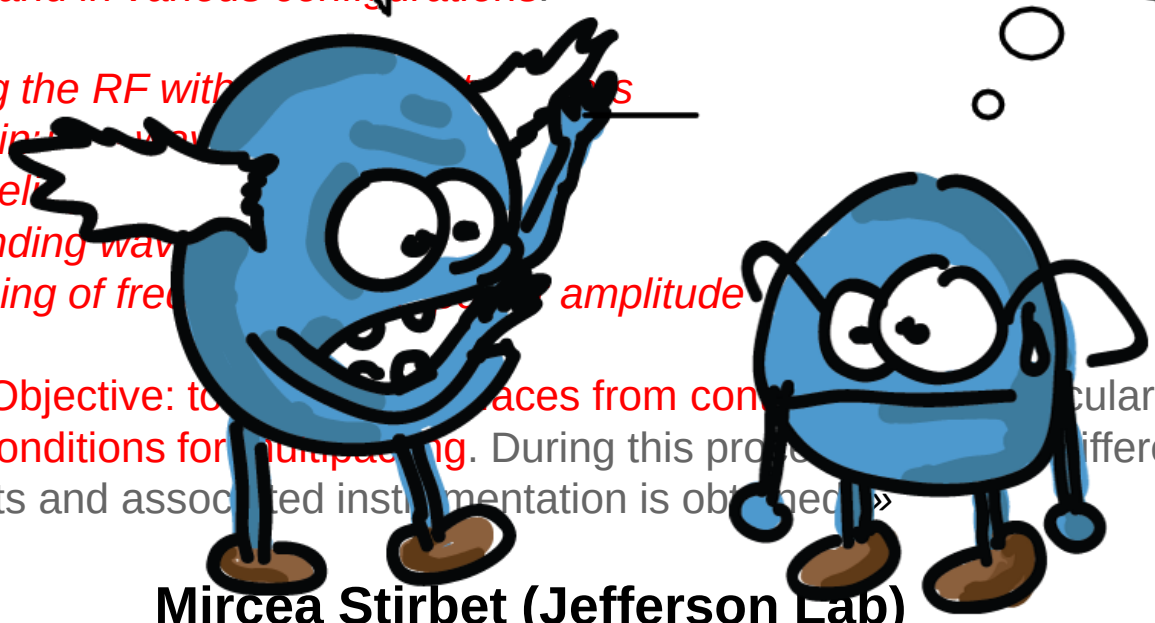

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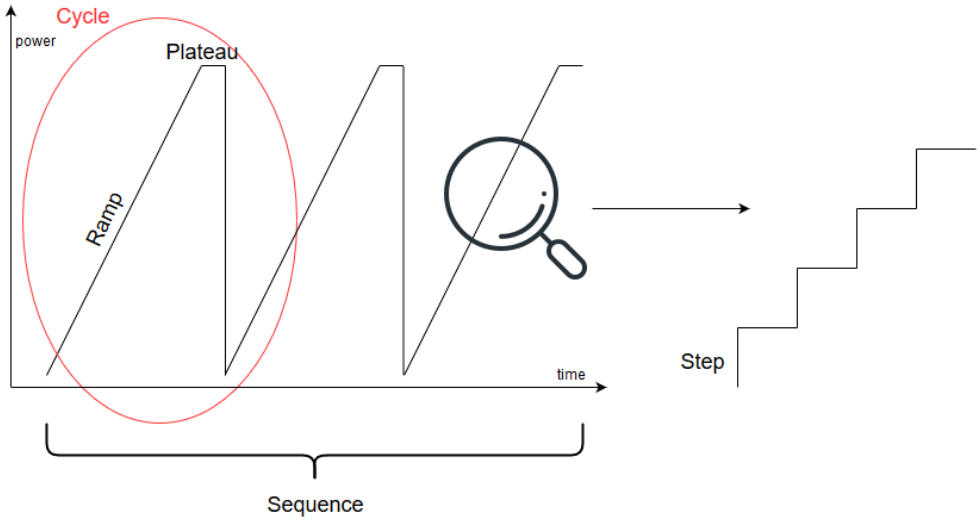
Mircea Stirbet (Jefferson Lab)

RF Conditioning: Systems and Procedures

CEA IRFU standard method.

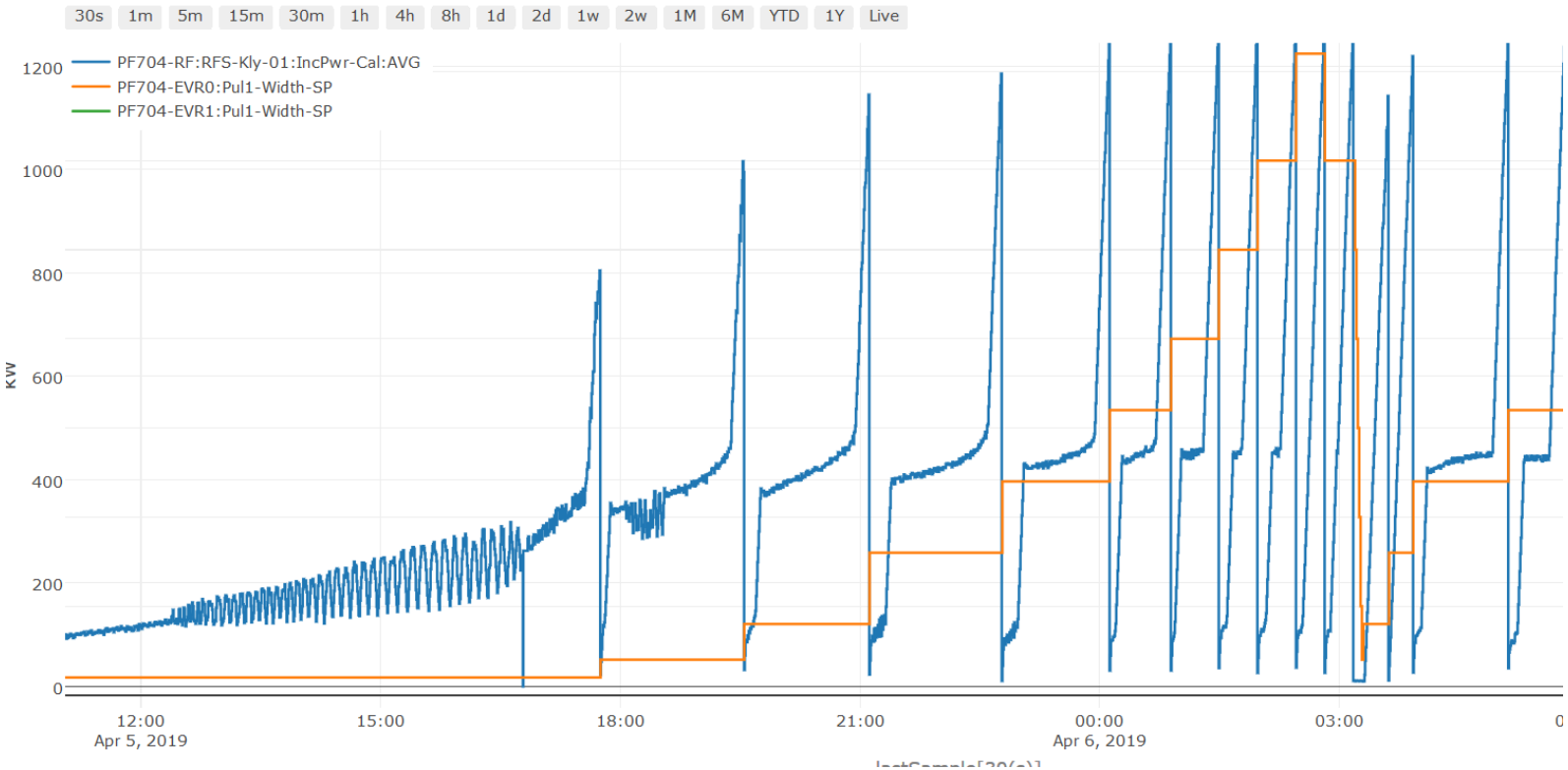
A **conditioning sequence** is composed of a set of **cycles** with the RF pulse width increased at each cycle.
A **cycle** is defined by a RF pulse width and is composed of a **RF power ramp** terminated by a **plateau**.
A **RF power ramp** is composed of a set of **steps** with the RF power increased at each step.
A **step** is defined by a RF power value and a number of RF pulses.
A **plateau** is defined by a RF power value and a number of RF pulses.



If the vaccum/temperature/leak (PM/Pue-) defect happen we insist on the zone, by pausing the RF power or decreasing it

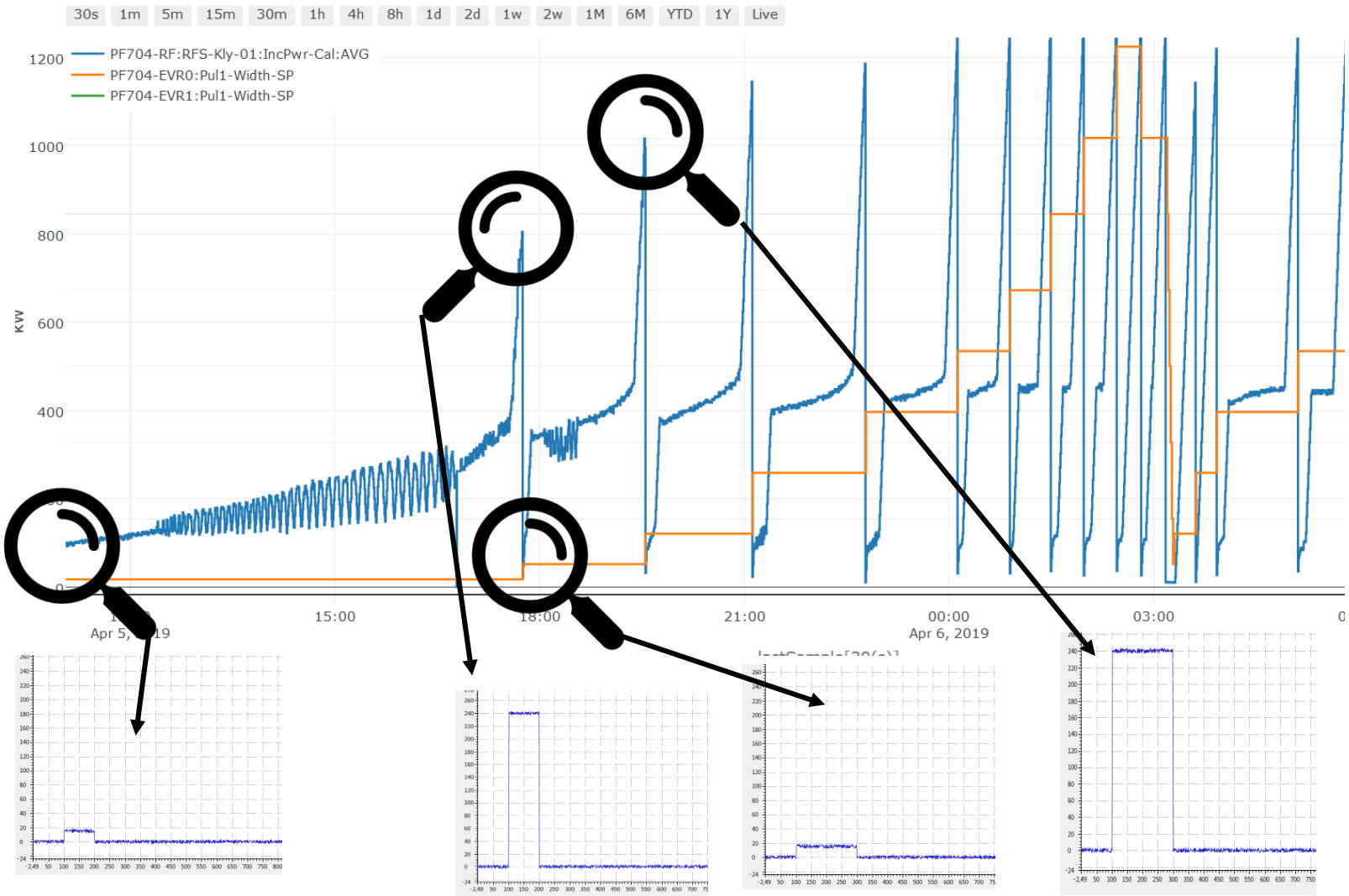
CONTEXT

Example



CONTEXT

Example



EPICS MODULES TOOLKIT

CalibrationApp : is a support application module that allows to **convert** signal data contained in **waveform**.

- Breakpoint table EPICS (non linear conversion)
  - Standard
  - Apply to RF power signal conversion
  - Apply to Cavity field
- Polynomial function

```
file calibBPTPwr.template
{
    pattern
    {SIGNAL,                          ,NELM,RAWL,RAWH,EGU,PREC,BPT}
    {"PF352-RF:RFS-KCirc-01:IncPwr" ,16000,0,10,kW,3,typeVtoDbmPCIRDIR}
    {"PF352-RF:RFS-KCirc-01:RefPwr" ,16000,0,10,kW,3,typeVtoDbmPCIRREF}
    {"PF352-RF:RFS-Kload-01:IncPwr" ,16000,0,10,kW,3,typeVtoDbmPLOCDIR}
}
```

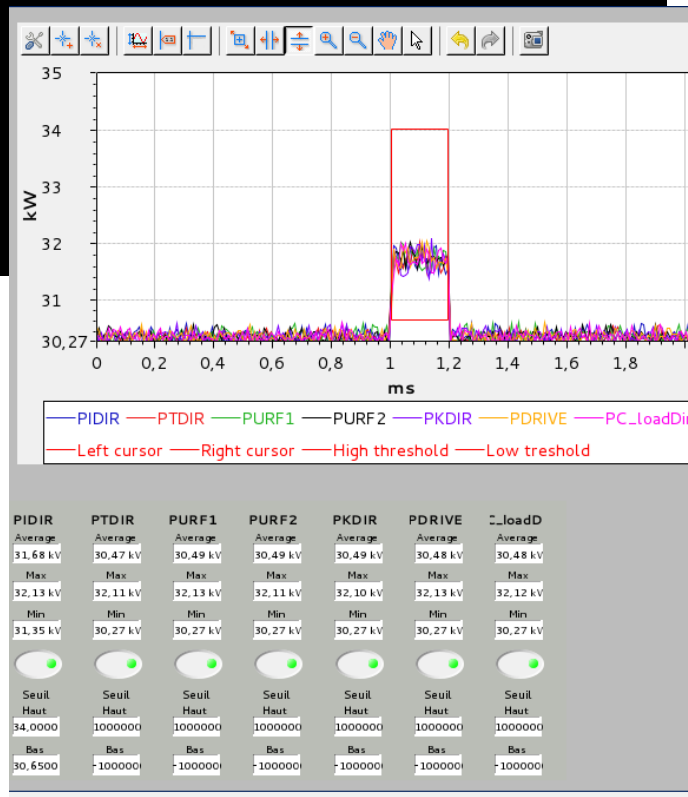
- $(SIGNAL)-Cal : waveform calibrated
- Records to configure signal (attenuation, field cavity, polynomial degree…etc)

EPICS MODULES TOOLKIT

SignalProcessing : is a support application module that computes **statistics** on a **signal waveform**. It manages **cursors** to delimit a pulse, uses **thresholds** to delimit the area of interest and creates a compressed signal for GUIs.

```
file signalProcessing.template
{
    pattern
    { SIGNAL, NELM, LTHR, HTHR, EGU, SRATE}
    {"PF352-RF:RFS-KCirc-01:IncPwr",16384, 20, 200, mW, 250000

}
```



- Records light waveform for GUI
- Records to configure cursors/treshold
- Records of statistics (max, avg, min, count of pulse)
- Some defaults detection (truncated pulse, wanted width, wanted power… etc)

EPICS MODULES TOOLKIT

ConditioningSeq : is a support application module that allows to execute a sequence of RF conditioning.

```
epicsEnvSet("power","PF704-RF:RFS-KAtt-01:kW")
epicsEnvSet("count","PF704-RF:RFS-Kly-01:IncPwr-Cal:Trig")
epicsEnvSet("width","PF704-EVR0:Pul1-Width-SP")
epicsEnvSet("major","PF704-Cpl:DefaultMajor")
epicsEnvSet("minor","PF704-Cpl:DefaultMinor")
epicsEnvSet("critic","PF704-Cpl:DefaultCritic")
epicsEnvSet("exp","PF704-Cpl:Conditionning-01")

seq ConditionningWF "power=$(power), countPulse=$(count), width=$(width),
defaultMajor=$(major), defaultMinor=$(minor), defaultCritic=$(critic), Experiment=$(exp)"

dbLoadRecords("SeqConditionning.template","EXPERIMENT=PF704-Cpl:Conditionning-01")
```

- Records to configure and monitor the sequence
- Handle generic defaults :
  - Minor : pause the RF.
  - Major : decreasing the RF
  - Critical : Stop the all sequence

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```
epicsEnvSet("power","PF704-RF:RFS-KAtt-01:kW")
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epicsEnvSet("major","PF704-Cpl:DefaultMajor")
epicsEnvSet("minor","PF704-Cpl:DefaultMinor")
epicsEnvSet("critic","PF704-Cpl:DefaultCritic")
epicsEnvSet("exp","PF704-Cpl:Conditionning-01")

seq ConditionningWF "power=$(power), countPulse=$(count), width=$(width)
defaultMajor=$(major), defaul
```

```
dbLoadRecords("SeqConditionni
```

```
#Default major for the conditioning sequence :decrease power
record(calc,"$(SECTION)-$(SUBSECTION):DefaultMajor"){
  field(INPA,"$(SECTION)-$(SUBSECTION):VAC-PwrC-01:PresDefault CPP")
  field(INPB,"$(SECTION)-$(SUBSECTION):VAC-PwrC-02:PresDefault CPP")
  field(INPC,"$(SECTION)-$(SUBSECTION):VAC-PwrC-03:PresDefault CPP")
  field(INPD,"$(SECTION)-$(SUBSECTION):VAC-PwrC-04:PresDefault CPP")
  field(INPE,"$(SECTION)-$(SUBSECTION):VAC-Ves-01:PresDefault CPP")
  field(INPF,"$(SECTION)-$(SUBSECTION):VAC-Cav-01:PresDefault CPP")
  field(INPG,"$(SECTION)-$(SUBSECTION):VAC-Cpl-01:Pres.SEVR CPP")
  field(INPH,"$(SECTION)-$(SUBSECTION):VAC-Cpl-02:Pres.SEVR CPP")
  field(INPI,"$(SECTION)-$(SUBSECTION):VAC-Cpl-03:Pres.SEVR CPP")
  field(INPJ,"$(SECTION)-$(SUBSECTION):VAC-Cpl-04:Pres.SEVR CPP")

  field(CALC,"(!(A && B && C && D && E && F)) || ((G + H + I +J)>0?1:0)")
  field(PINI,"YES")
}
```

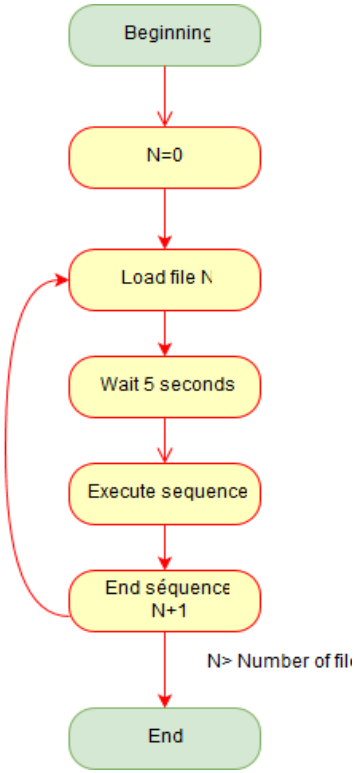
- Records to configure a
- Handle generic default
  - Minor : pause the
  - Major : decreasing
  - Critical : Stop the

EPICS MODULES TOOLKIT

SaveRestoreApp : is a support application module that allows to save or restore the current state of a list of PVs.

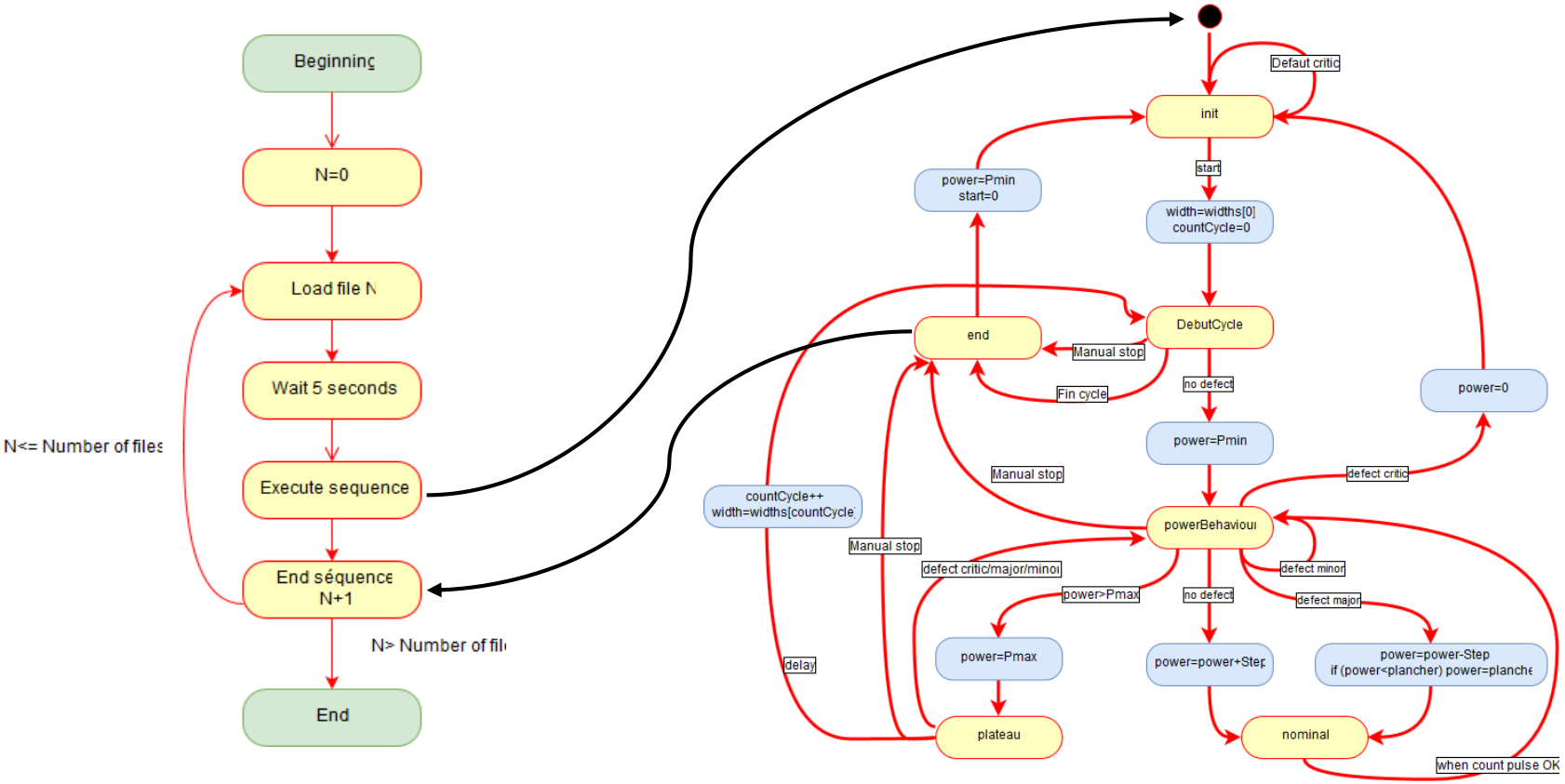
- Based on autosave file format (and code)
  - *.sav file
  - *.req file
- save/restore operations performed by IOC records
- Restore SNL sequence for sub-sequence

```
epicsEnvSet("defect" ,"PF704-Cpl:DefaultCritic")
epicsEnvSet("loadFile","PF704-Cpl:Conditionning-01:PathSav")
epicsEnvSet("start","PF704-Cpl:Conditionning-01:Rdy-Seq")
epicsEnvSet("exp","PF704-Cpl:Conditionning-01")

seq SequenceLoad
"defect=$(defect),loadFile=$(loadFile),isSeqStarted=$(start),Experiment=$(exp)"


dbLoadRecords("SaveRestoreC.template",PREFIX=PF704-Cpl:Conditionning-01)
dbLoadRecords("SeqLoad.template",EXPERIMENT=PF704-Cpl:Conditionning-01)
```

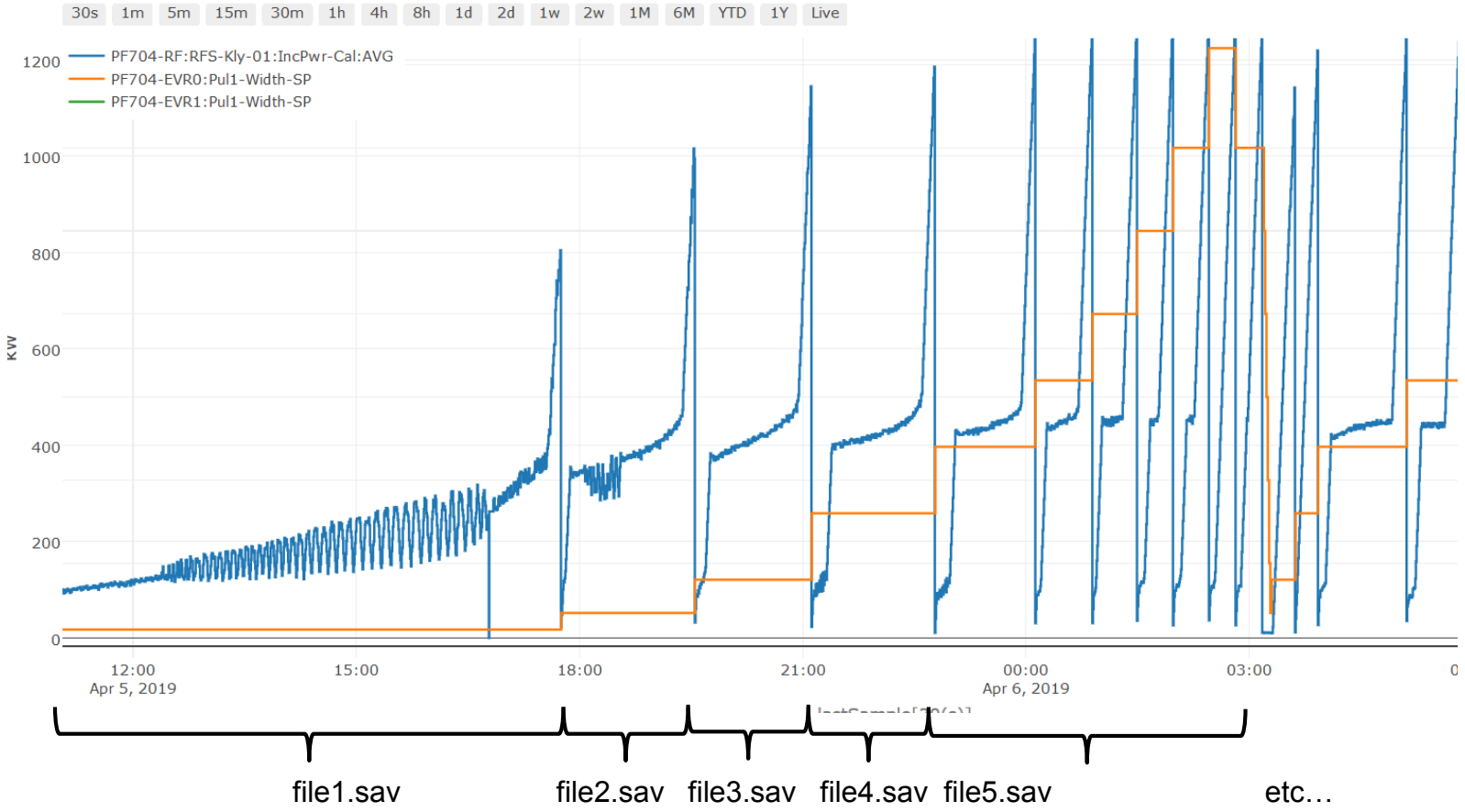


- Records to configure and execute the sequence

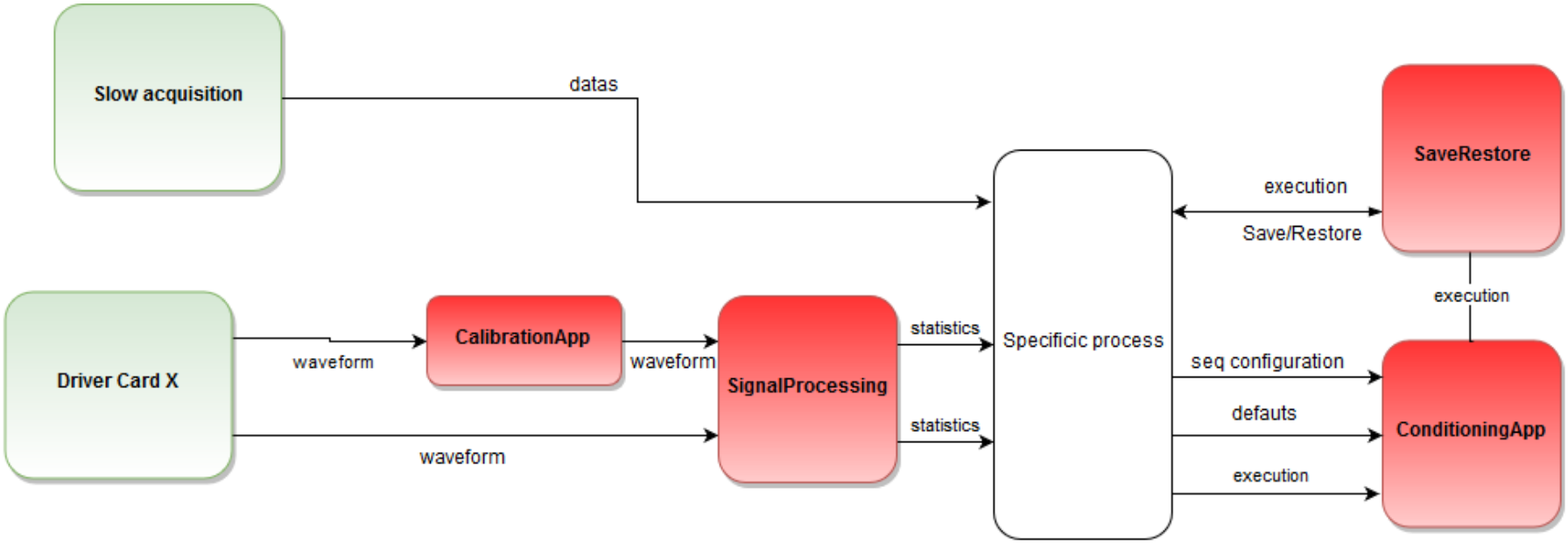
SaveRestoreApp + ConditioningSeq

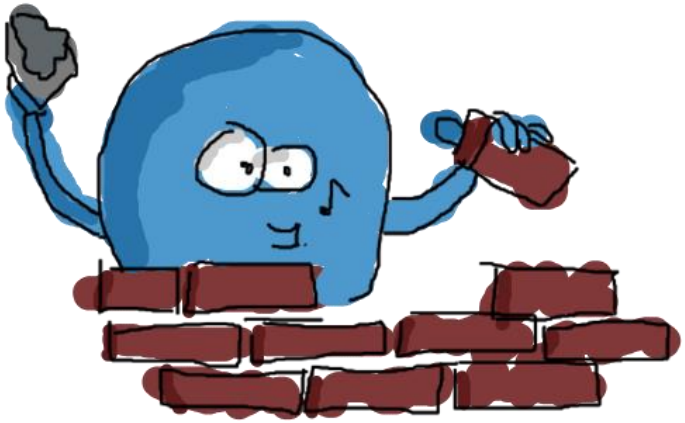


SaveRestoreApp + ConditioningSeq



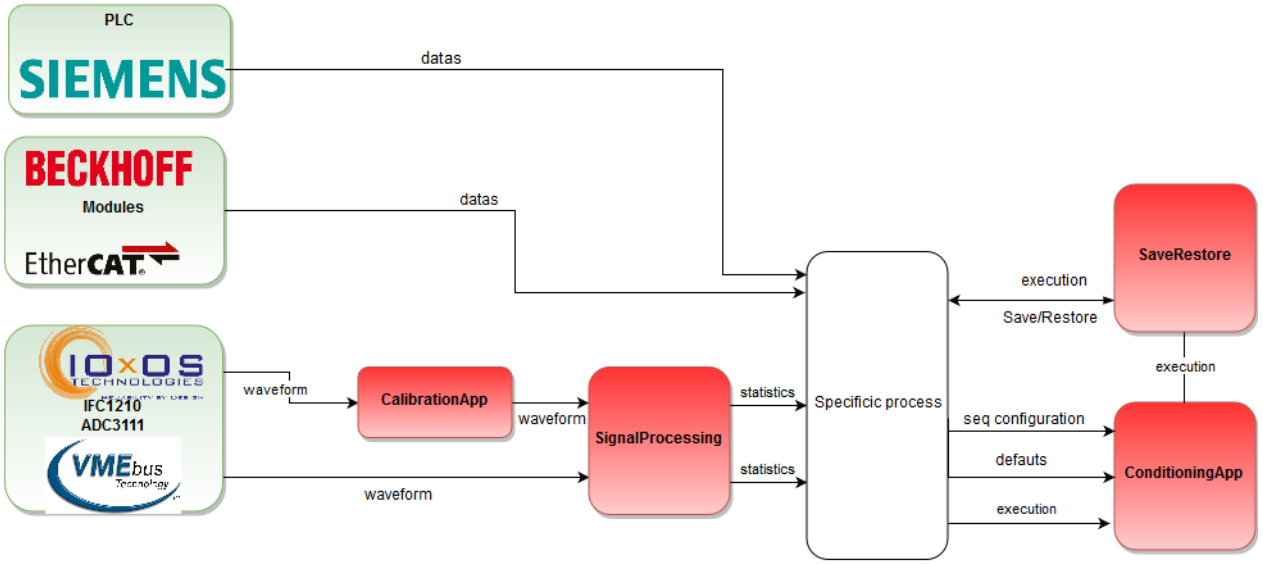
APPLICATIONS



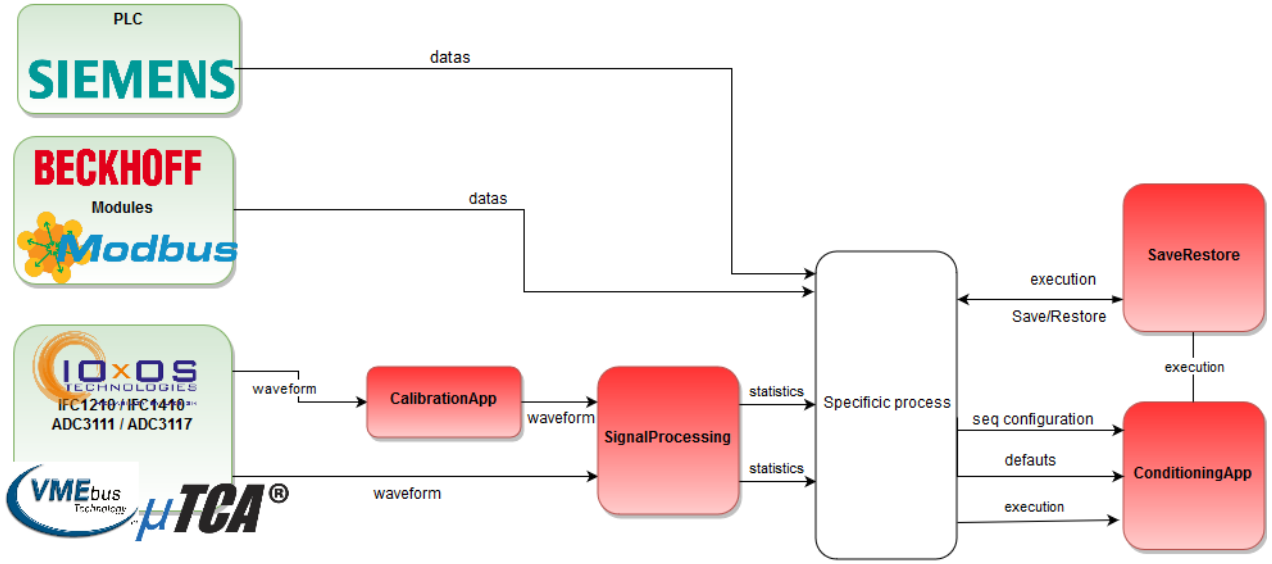


APPLICATIONS

ESS
test stands

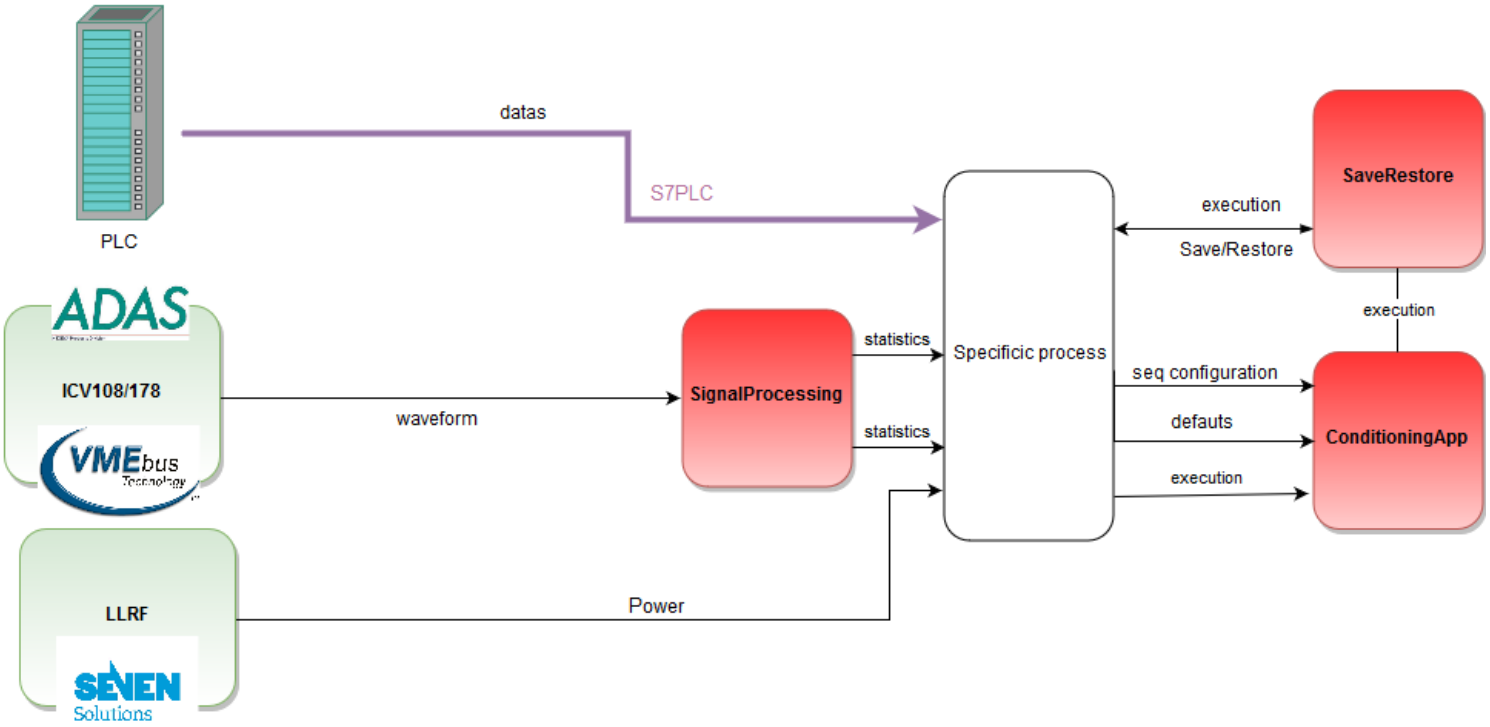


SARAF
test stands



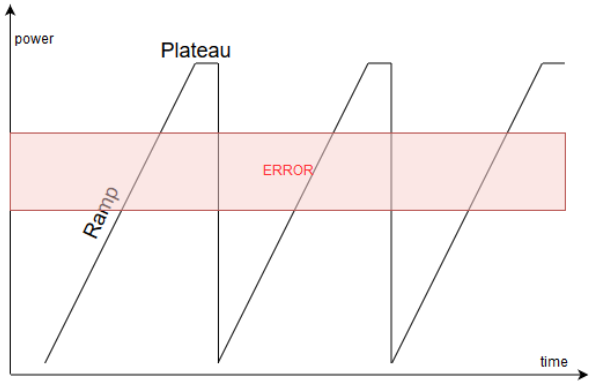
APPLICATIONS

IFMIF
Cryomodule



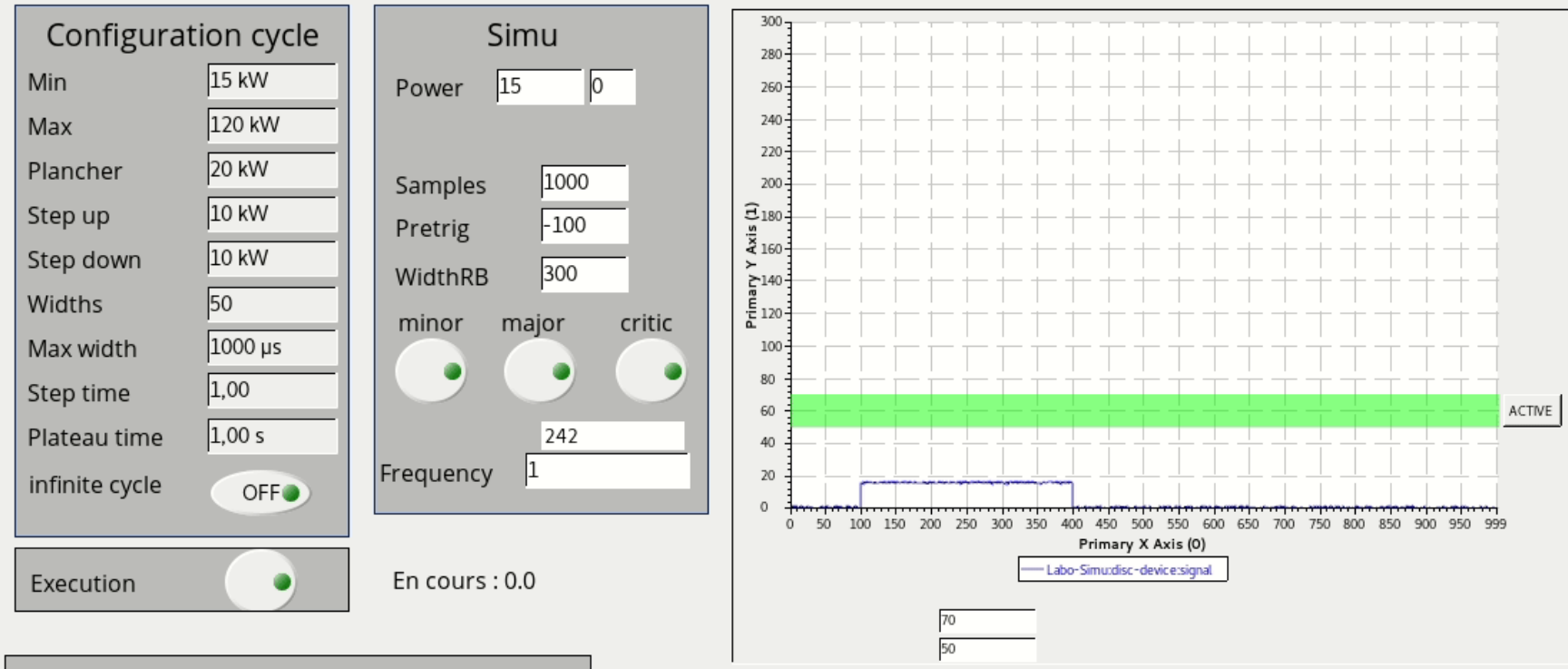
SPECIAL CASE

- IFMIF :
  - Coupler 7 can’t handle some power area



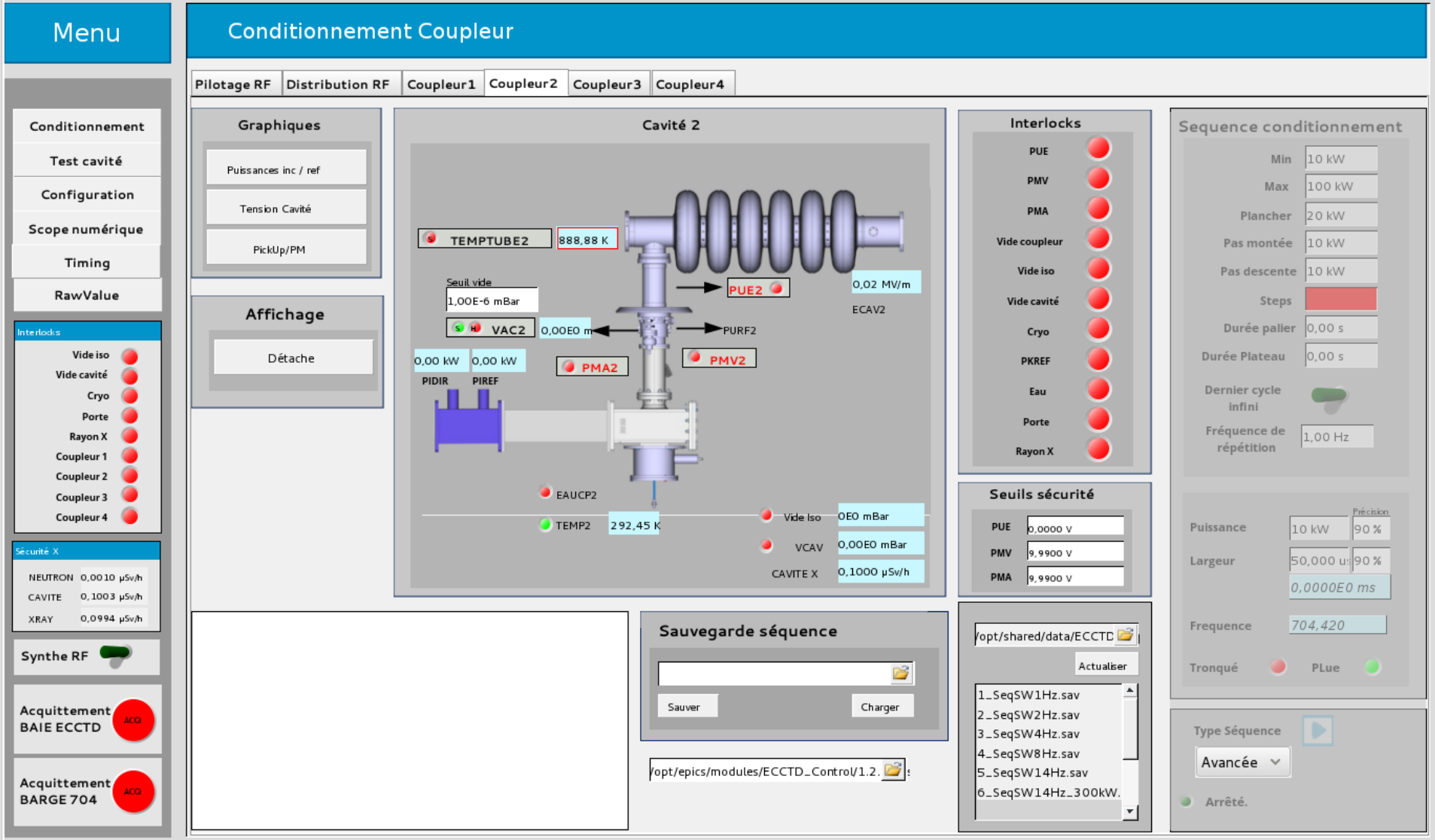
✓ Monitor the power in the sequence -> can apply some external rules (calcout, aSub, other clients…)

Demo (if gif can be displayed…)

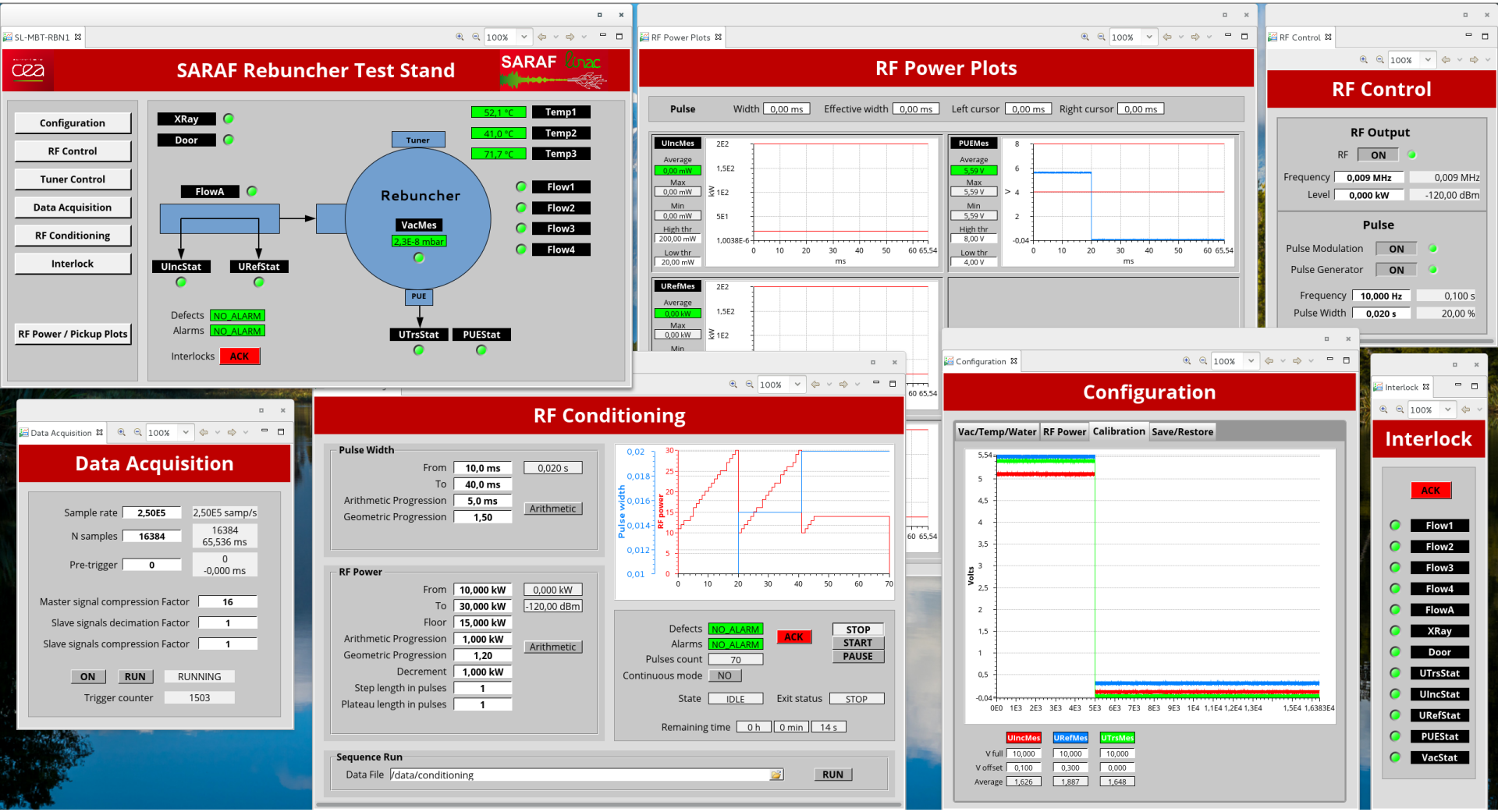


ECCTD ESS

Will be introduced at ICALEPCS



SARAF Rebuncher Test Stand (F. Gohier, Y. Lussignol)



ESS :

- Coupler Cavities Test stand (x2)
- RFQ couplers
- ECCTD : Elliptical Cavities and Cryomodule Test stand Demonstrator
- RFQ Conditioning (sequence used by E. Trachanas)

Saraf:

- C2TS : Coupler cavities Test Stand
- ECTS : Equiped Cavities Test Stand
- RBTS : Rebuncher Test stand
- Cryomodules (future)

IFMIF LIPAC:

- Sathori : Equiped Cavities test stand
- SRF : Cryomodule conditioning on site

Thanks for your attention

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