

# Diagnostic System for Low Level RF Control System for VUV-FEL

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## Outlook

- VUV-FEL
- LLRF
- Source of perturbations
- Diagnostic System for LLRF

# VUV-FEL

## - the pilot facility for the XFEL

- 260 m long (tunnel 100 m)
- 6 Cryo-modules
- TESLA technology
  - 48 superconductive cavities
- Development platform for XFEL

# Tunnel

- no access during operation
- no service tunnel
- risk of radiation damage

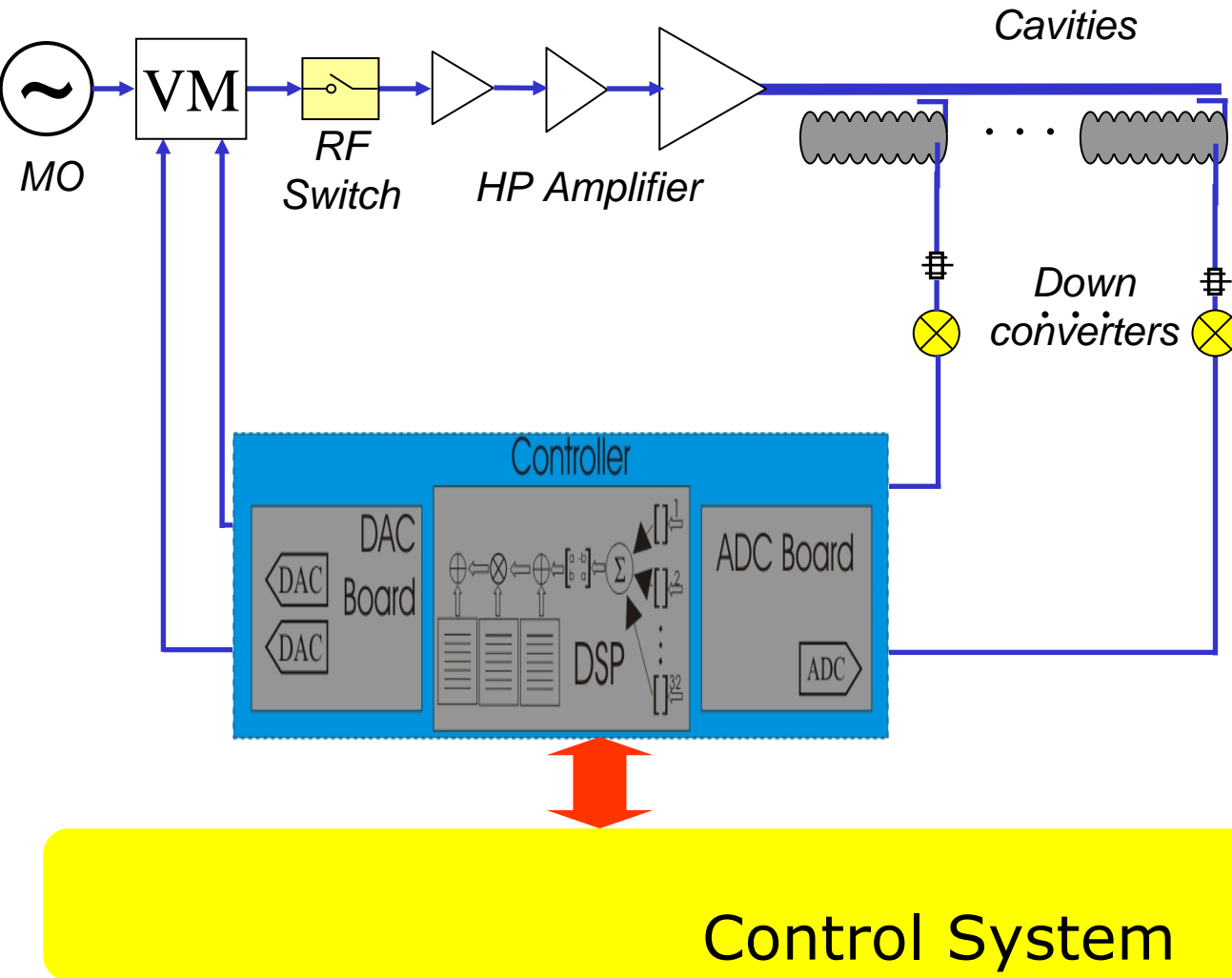
Place for electronic



# Outlook

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# Control System in VUV-FEL



Control System

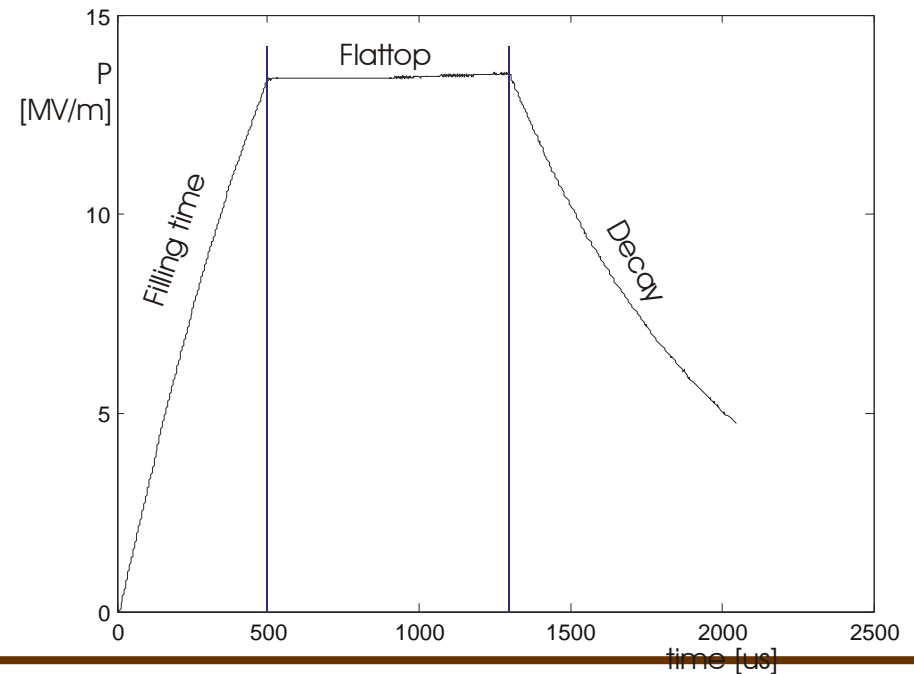
# LLRF - requirements

- Electrical field : 30 MV/m
- Required field stability :  
 **$10^{-5}$  in amplitude,  $0.01^\circ$  in phase**
- Continuous operation is required  
**one maintenance day per month**

# LLRF- Goals

Provide:

1. stable RF field in cavity during beam
2. continuous operation



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# Source of perturbation

## *Hardware*

- MO – phase
- VM –  $P_{in}$ , nn
- Klyston –  $P_{out} = f(P_{in})$
- RF Power distribution
- Probes – individual char
- Mixers – nn, offset
- ADCs – nn, offset
- DACs – nn, offset
- Timing – time & temp.
- Power Supplies
- Noise level
- ...

## *Software*

- Numerical errors
- Calibration
- Parameters
- Control System
- ...

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# Diagnostic System - Goals

The diagnostic system **cannot increase reliability!**

but can decrease **maintenance cost**  
(minimize time and man power necessary to repair)

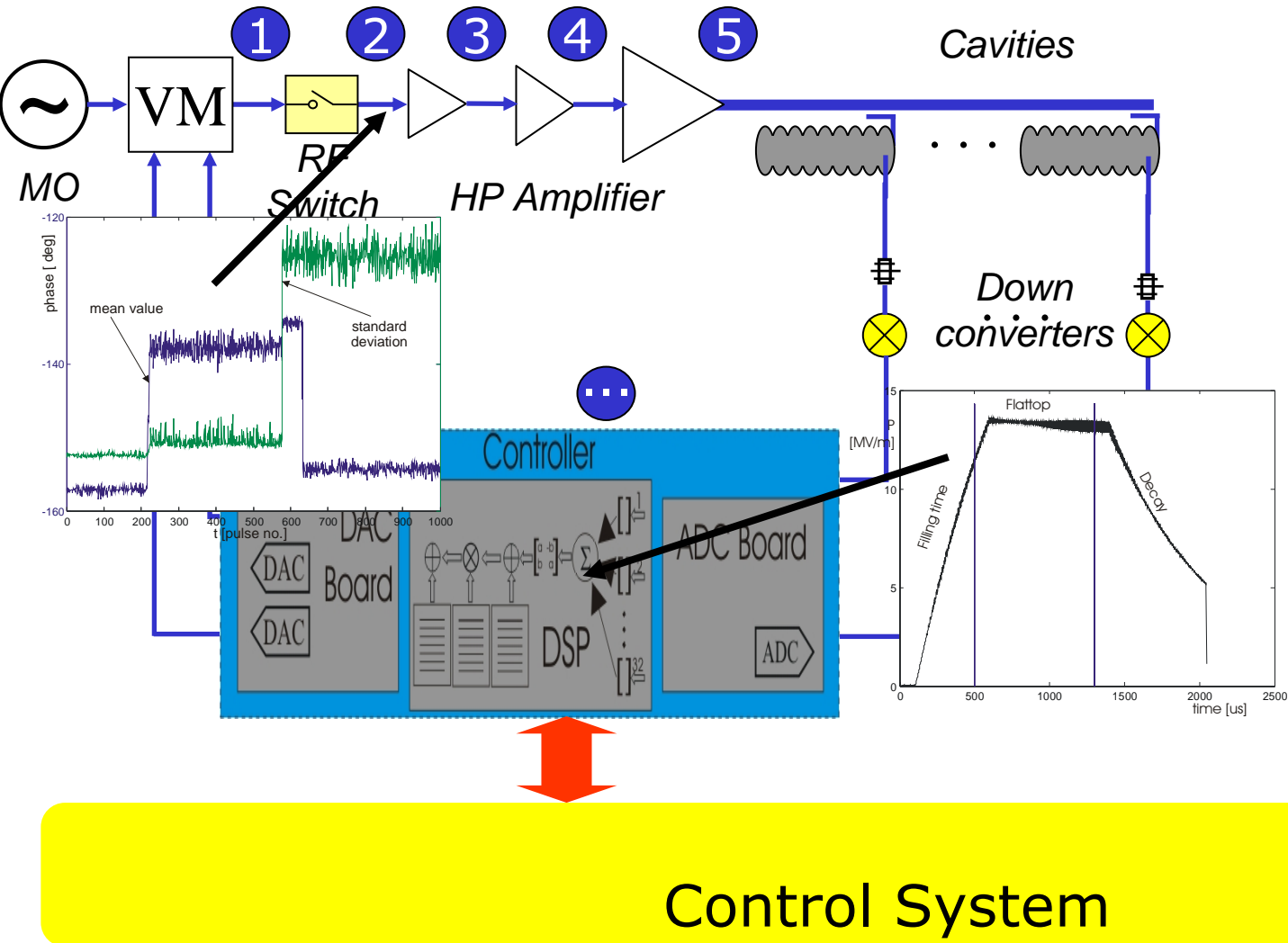
provide **the high availability**

# Diagnostic System - Goals

*Diagnostic have to be:*

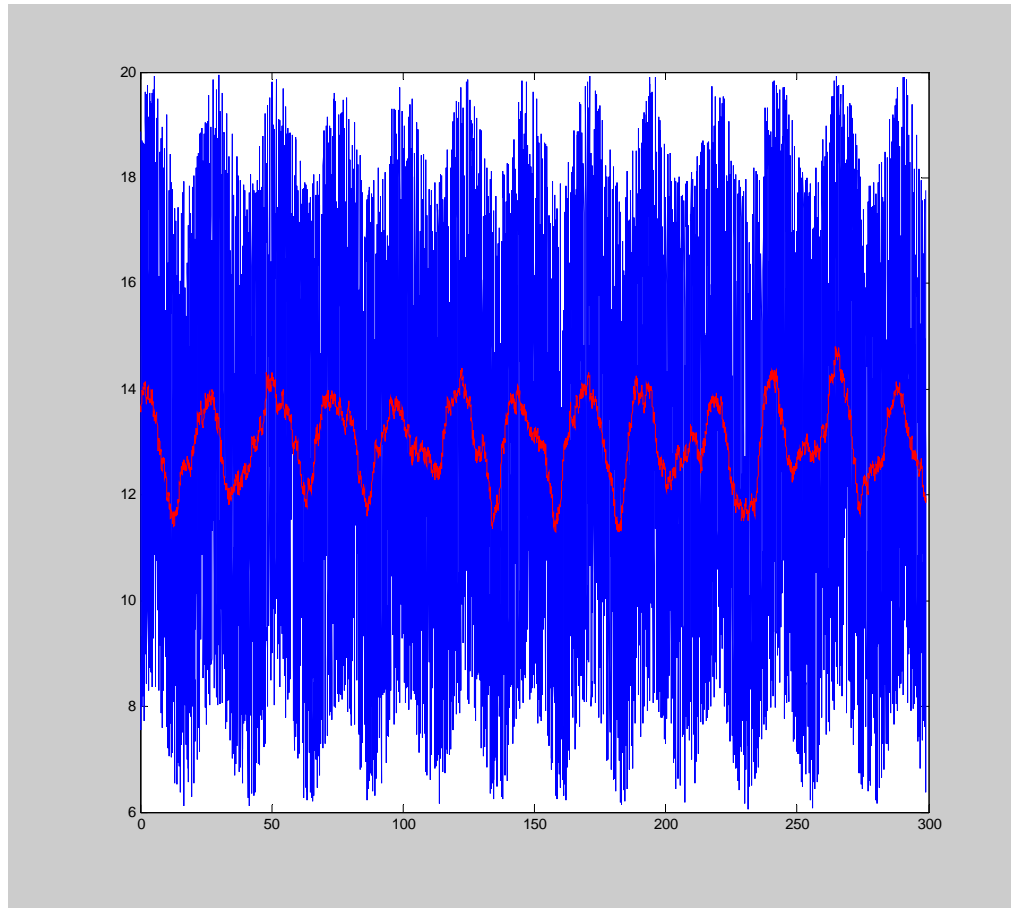
- Cheap
- Flexible (easy modification, extend...)
- Failures of diagnostic cannot stop operation

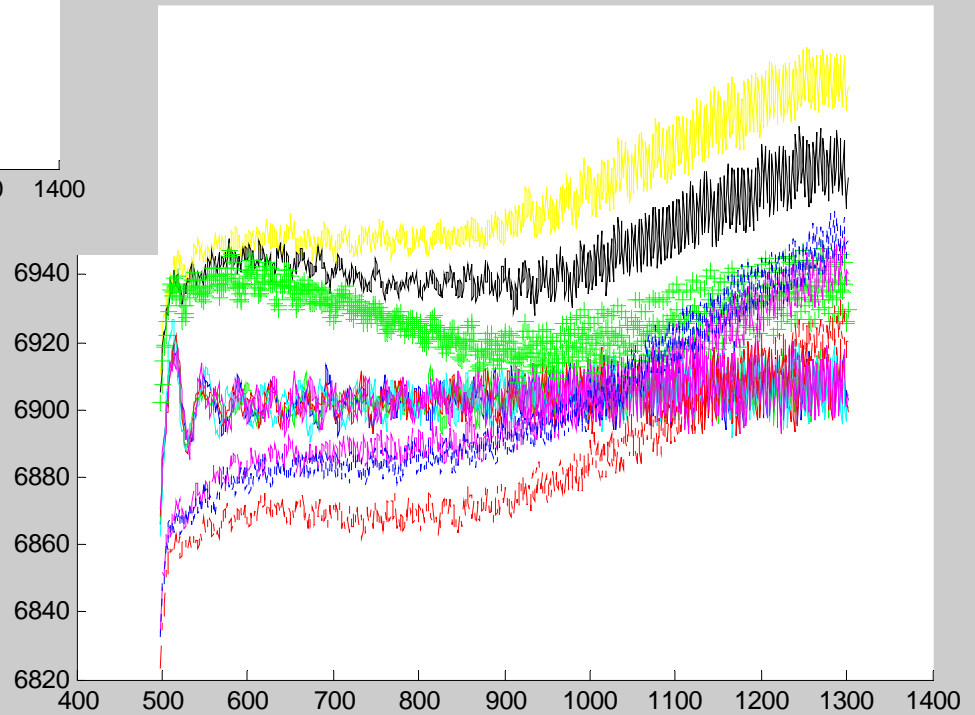
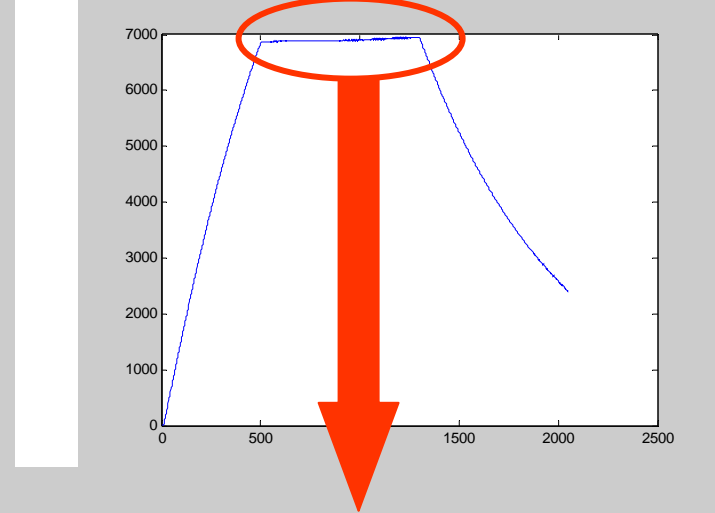
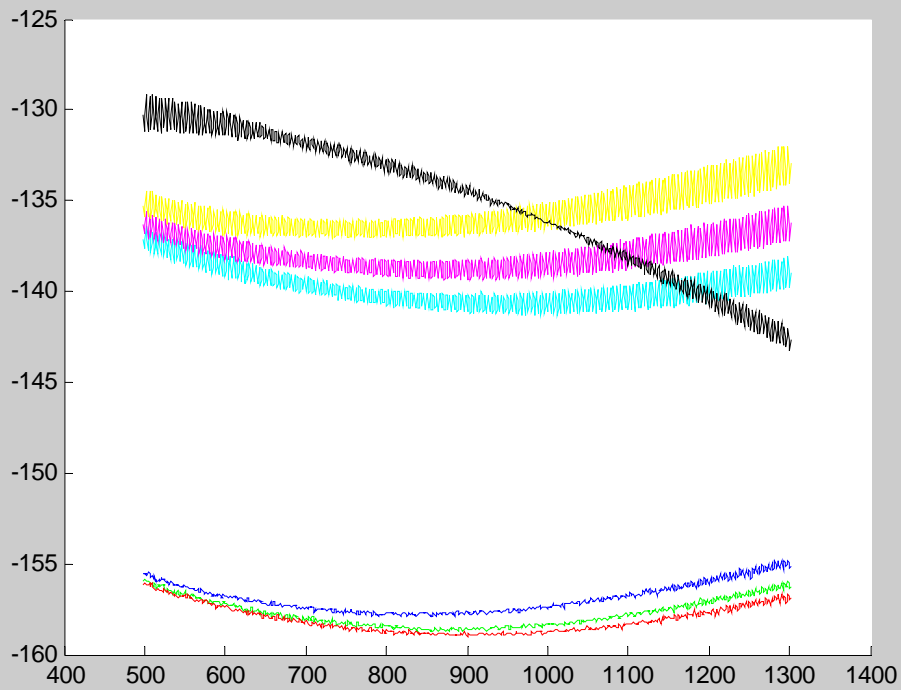
# Monitoring



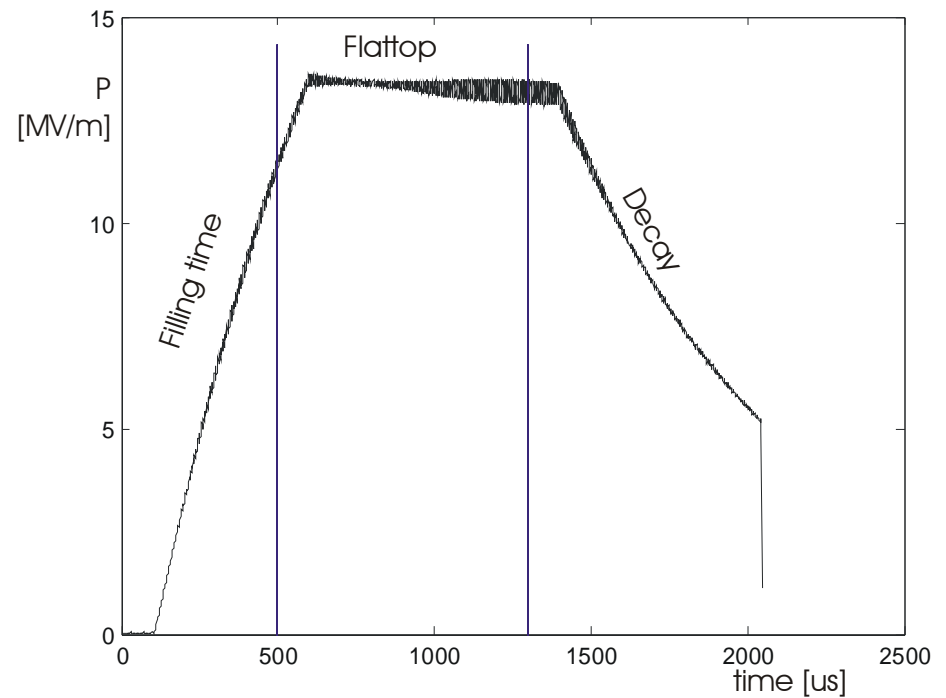
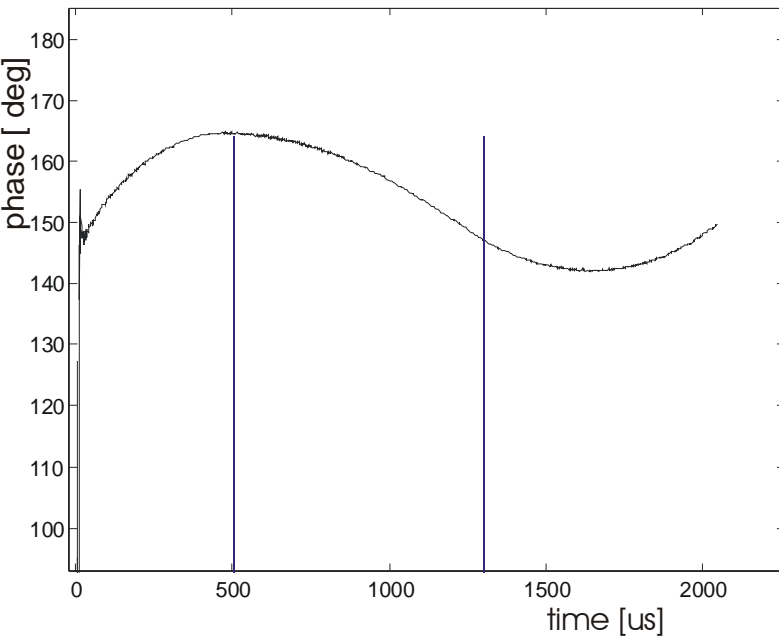
Control System

# Phase between two points in time



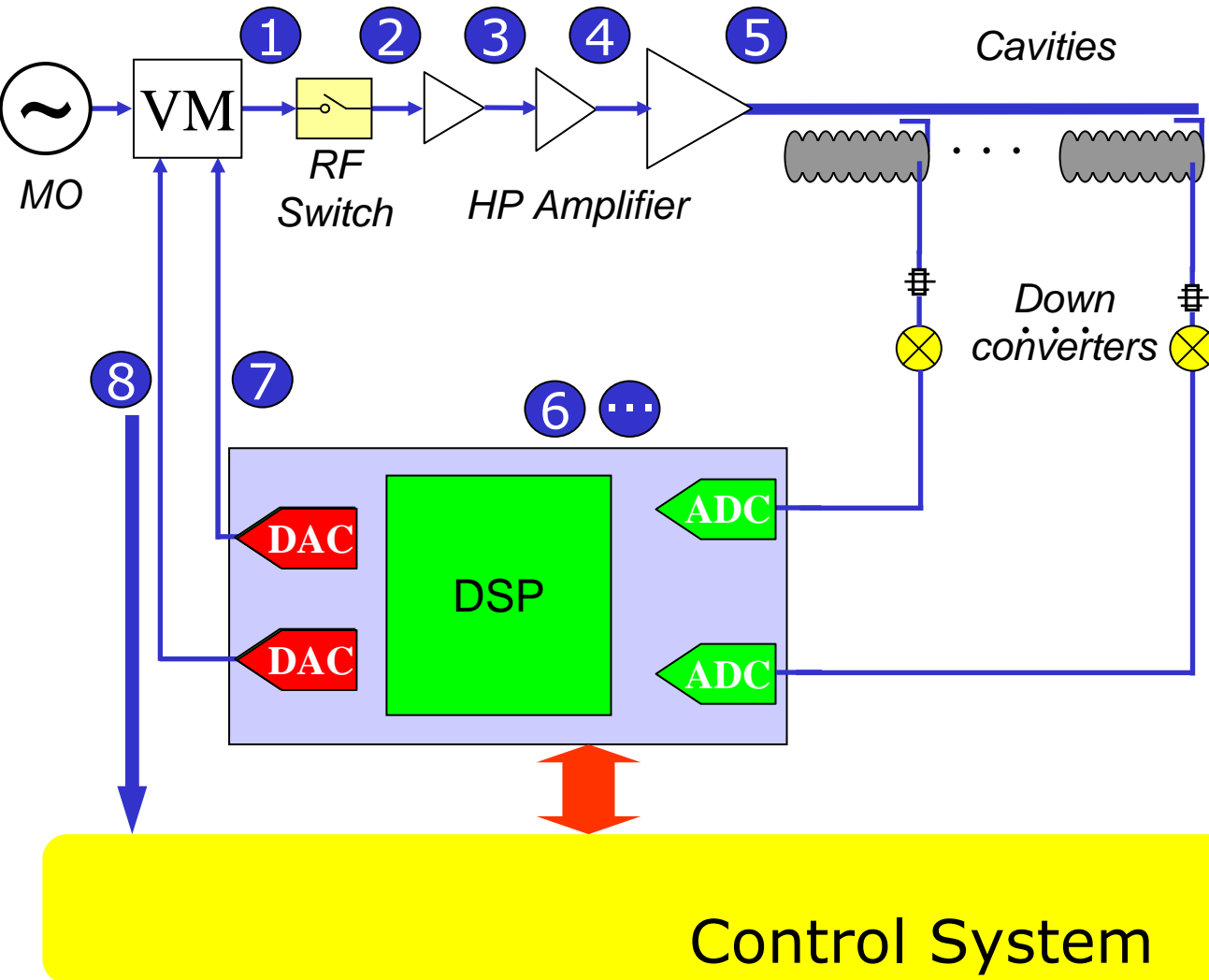


# Unacceptable data from the system



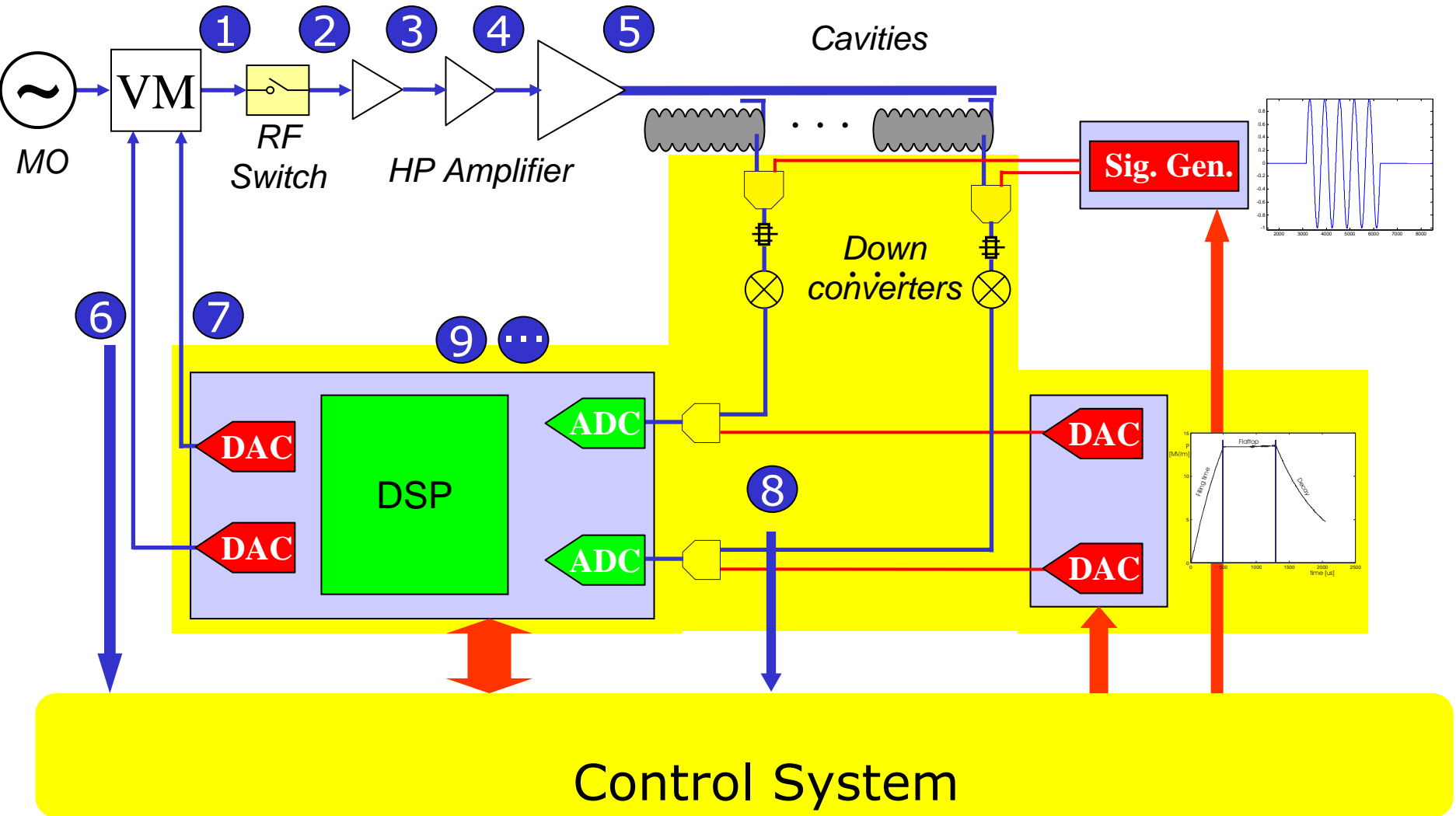


# Diagnostic

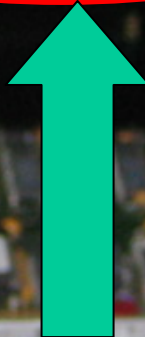


- Tests:
- Hardware
  - Algorithm

# Diagnostic & Calibration



2 x optolink 3.125 Gbps

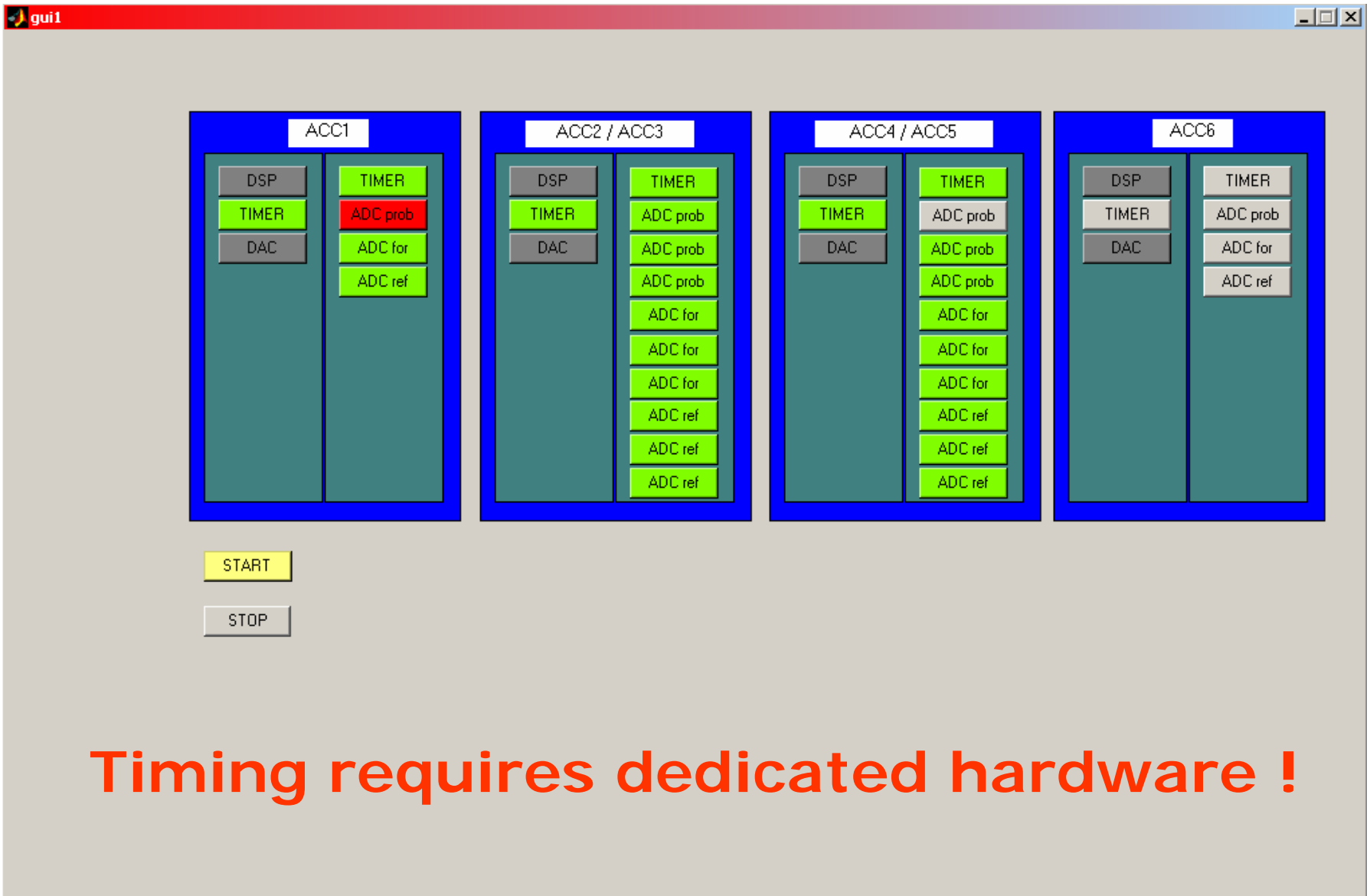


Ethernet

Digital IO

10 x ADC,  
14 bits,  
105 MMz

4 x DAC,  
14 bits,  
200 MMz



**Timing requires dedicated hardware !**

# Diagnostic System for VUV-FEL

- Monitoring
- Diagnostic
- Calibration

# Monitoring

- Error detection
- Timing signals (synchronization, phase)
- Pfor & Pref
- Probes
- Field stability (RMS, p-p, ...)
- Detuning
- Loaded Q
- Limits of set value
- ...

# Diagnostic

- Detect malfunction
- Locate damage hardware
  - Crate, board, input
- Perform components tests
  - ADCs, DACs
  - Interfaces
  - Memory, DSP blocks ...
  - Timing distribution
- ...

# Calibration

- timing
- probes
- vector sum
- ADCs and DACs offset
- downconverter
- attenuators
- .....



# What we want to do?

- Provide possibility to read data form different points of the system
- Design an universal diagnostic interface and implement it to all electronic boards
- Integrate diagnostic elements in control system
  - Sources of test signals
  - RF Switches
  - ...
- Provide self-diagnostics for all boards



**THE END**