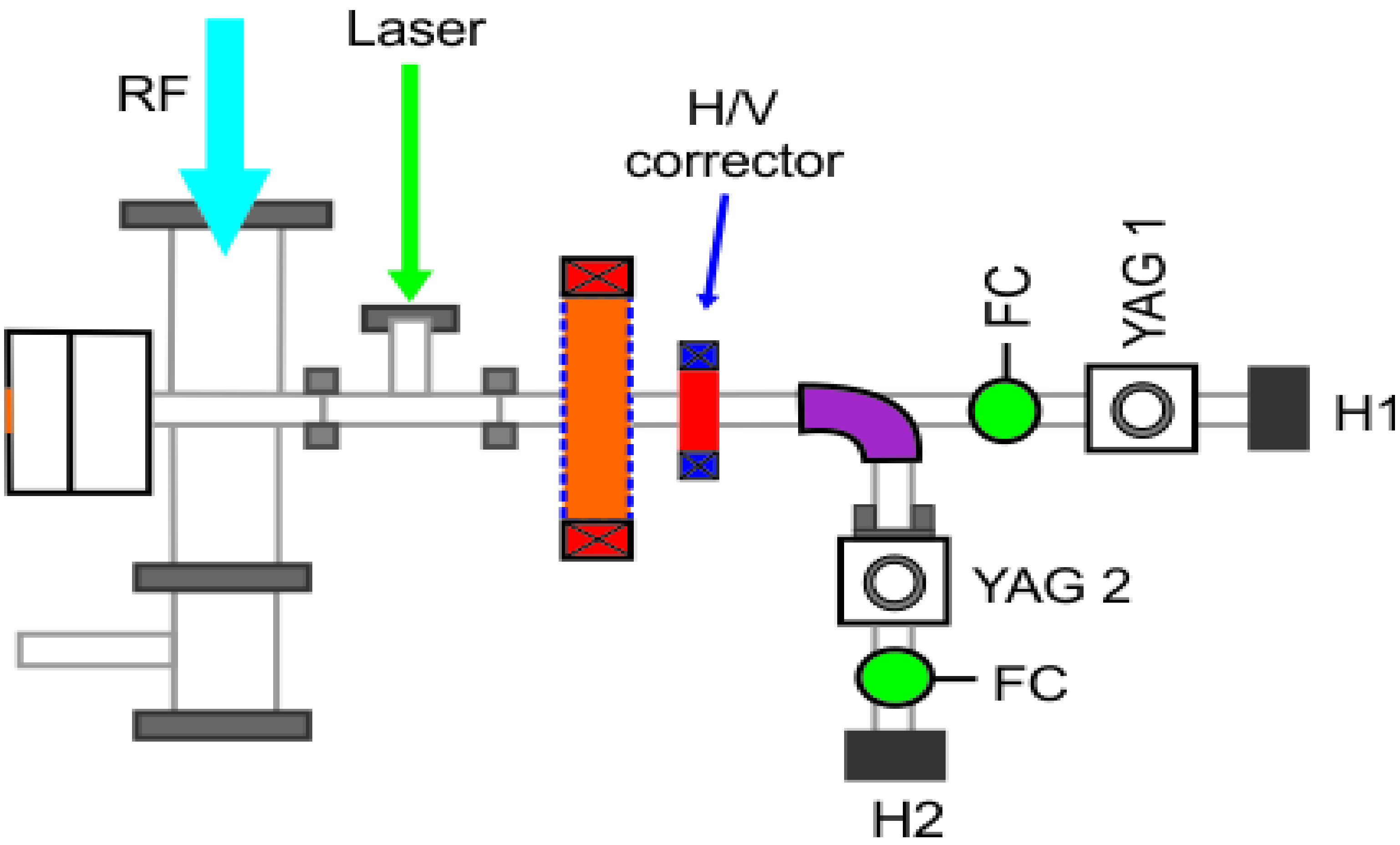
An Overview of Beam Diagnostic and Control Systems for AREAL Linac

Presenter G. Amatuni

Contents:

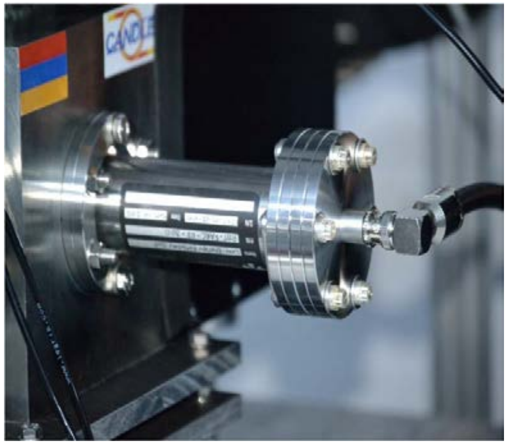
1. Current status of existing diagnostic system.
2. Diagnostic system approaches for 50MeV upgrade.
3. Current architecture of the control system and its upcoming modifications.

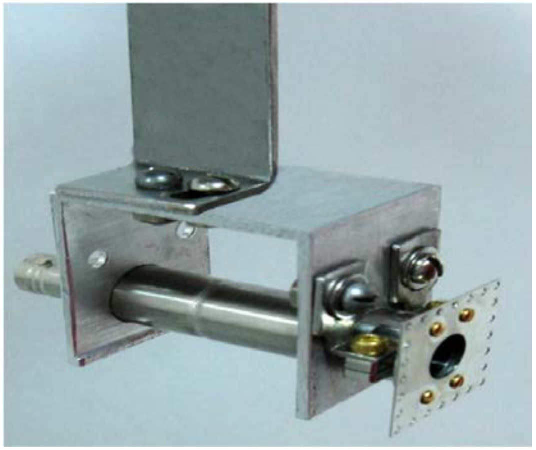
Current status of the diagnostic system

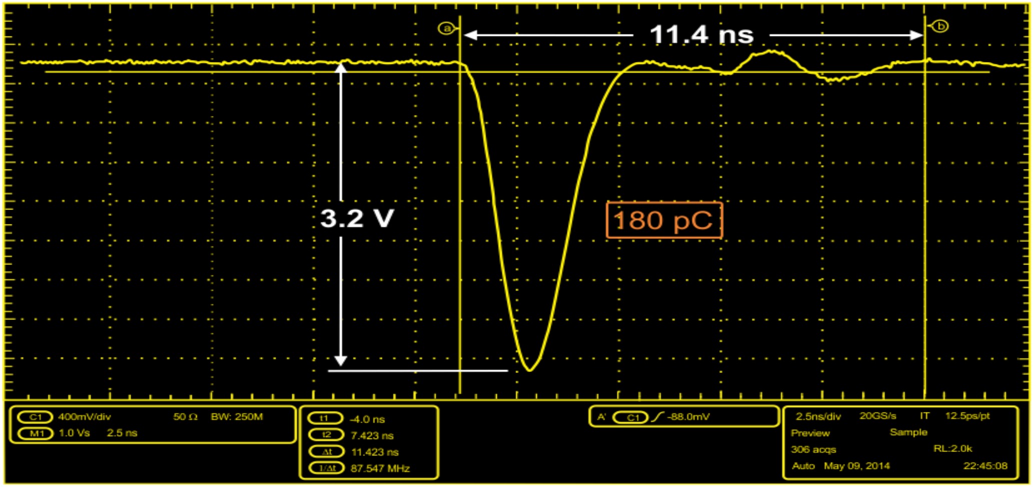


Beam charge measurements:

50Ω impedance matched FCs



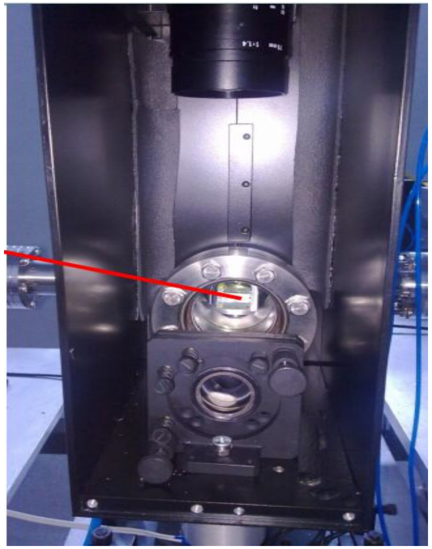




Depending on laser intensity beam charges in the range of 10-250pC were obtained.

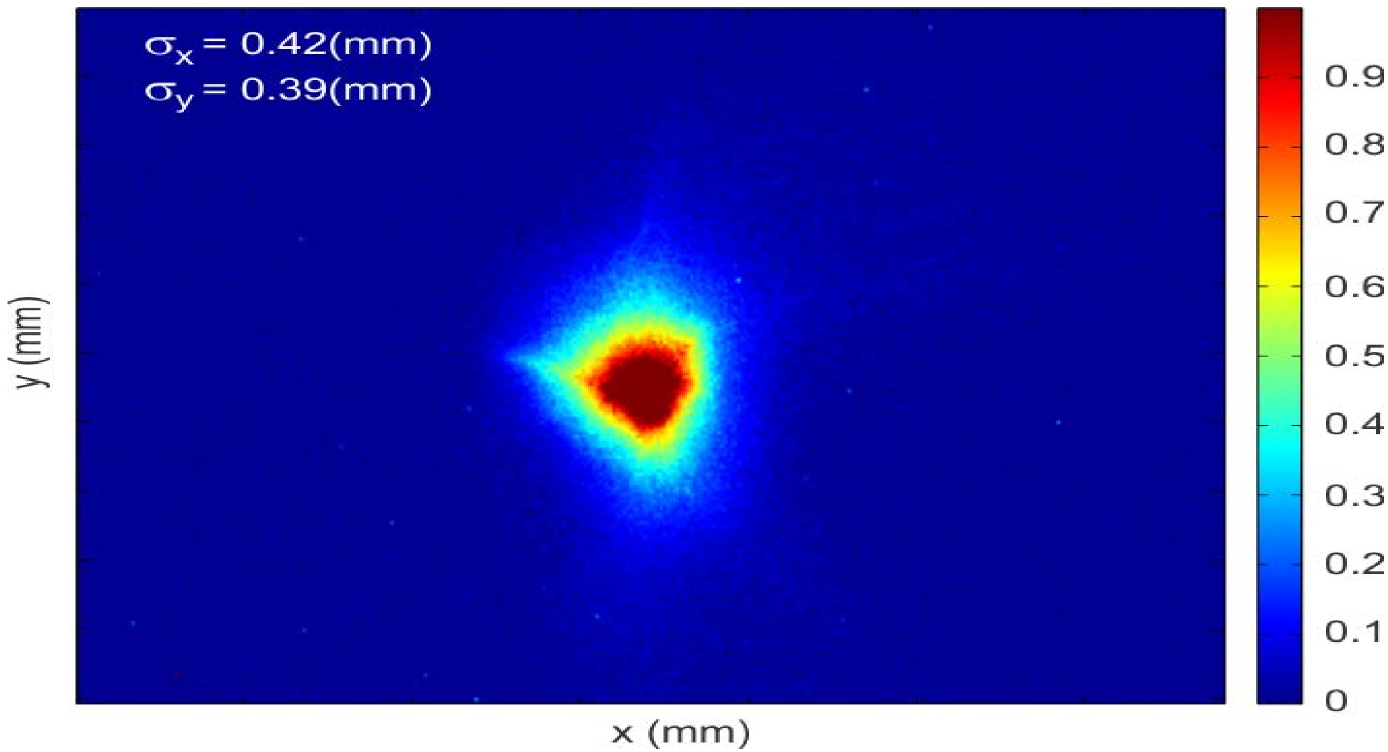
Beam transverse profile measurement

At the gun section two screen stations are allocated with YAG:Ce scintillation crystals with 35x25 mm^2 area and 200 μm thickness.



Optical black box and YAG:Ce holder

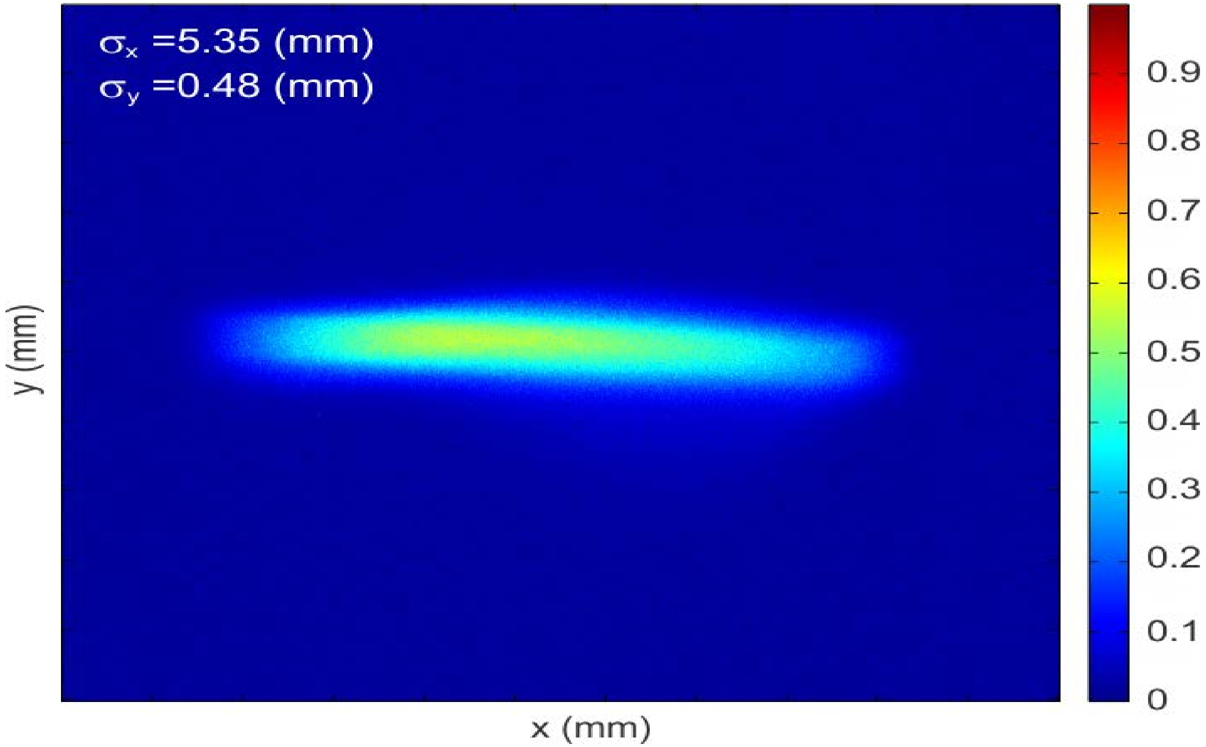
The readout system of YAG1 (YAG2) screen monitor consists of optical system with 0.16 (0.24) magnification and Point Gray Flea2 08S2 (Flea2 20S4 CCD) camera. The horizontal/vertical beam profile is calculated by the projection of digitized image onto corresponding axes. Observable areas of these both systems are 30x23 mm^2.



Electron beam transverse profile at YAG1

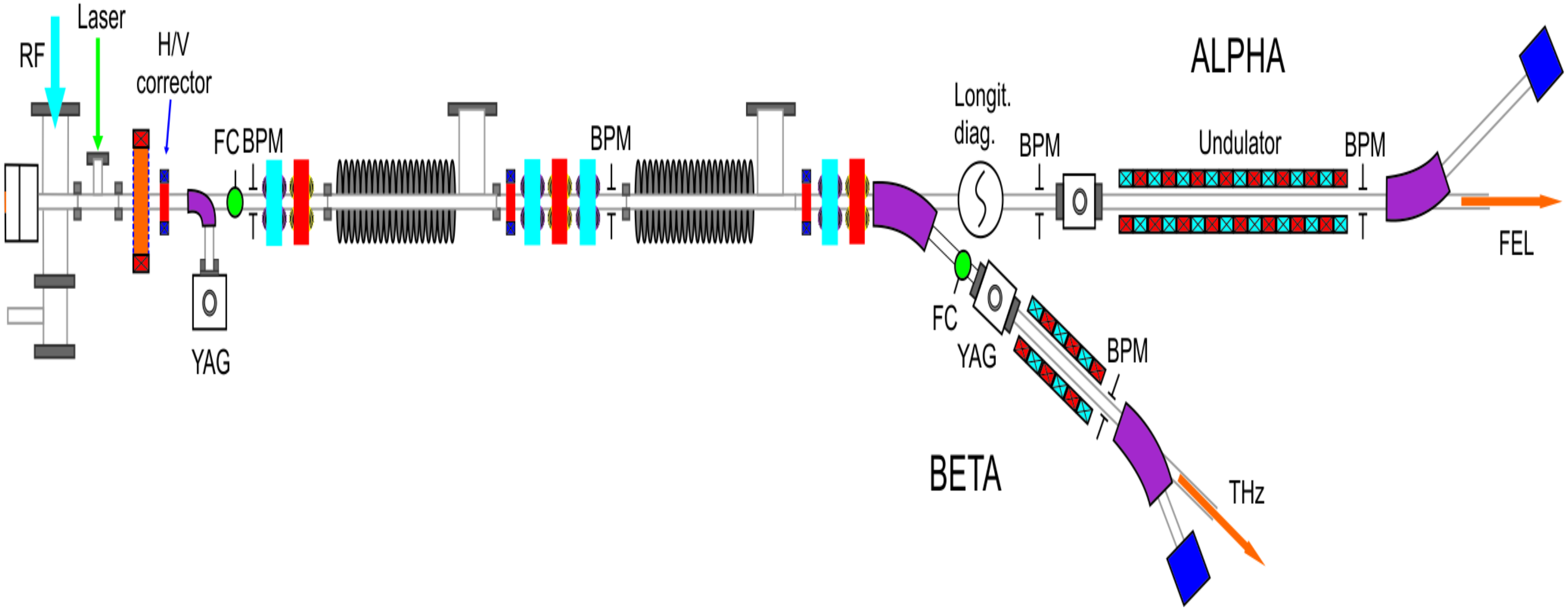
Beam energy and energy spread measurements

Measurements of the beam energy and the energy spread have been performed using the dipole based spectrometer section with the YAG2 screen. Due to the limited space f diagnostics at gun section, 90° bending magnet is chosen. Absolute energy measurement is given by the geometry and calibration of the dipole and the subsequen drift length (about 20 cm). The energy spread is estimated by observing the beam in a dispersive section where the beam horizontal spot size is a convolution of the emittance and dispersion contributions. In order to maximize the momentum resolutio of the spectrometer, the dispersive contribution to the beam size should be large compared to the emittance contribution. This is achieved by providing horizontal focusing at YAG2 screen.



Electron beam profile at the spectrometer YAG screen.
The comparison with spectrometer dispersive characteristics shows that the image corresponds to 3.7MeV beam energy and rms energy spread below 2%.

50 MeV upgrade program



Beam position: 4 500MHz resonant stripline BPMs- developed at PSI they are optimized for high dynamic range and sensitivity in the bunch charge range from 10-250pC and provide single-bunch rms resolution below 10μm.

Transverse Beam Emittance: Quadrupole scan method.

Bunch Length: RF phasing scheme.

Control System Architecture Overview

The AREAL linac control system is based on "client-server" model and has three layers of hierarchy.

Device Interface

- ➢ Communication with devices of subsystems:

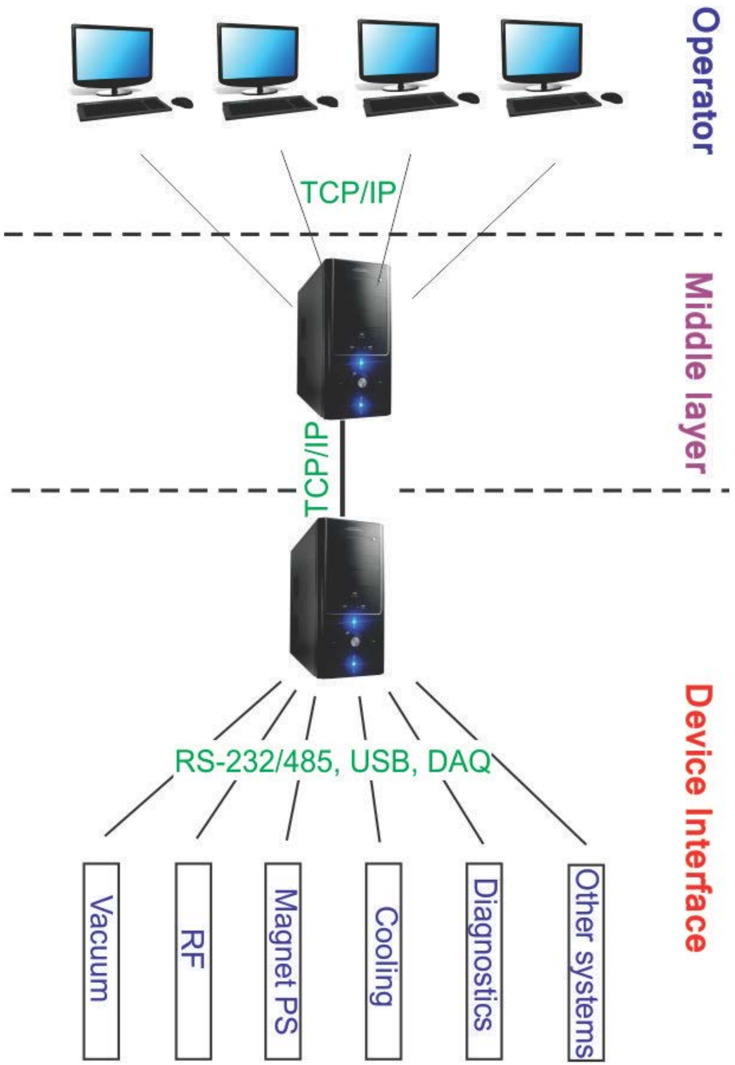
Middle layer

- ➢ Data base server. MySQL data base.

Operator

- ➢ Client GUI

- Vacuum system
- RF system (LLRF)
- Magnet system
- Cooling system
- Diagnostic system
- Laser system
- Radiation safety



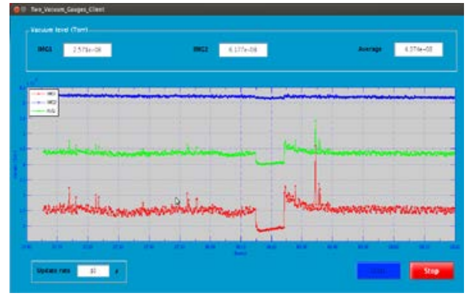
AREAL subsystems control

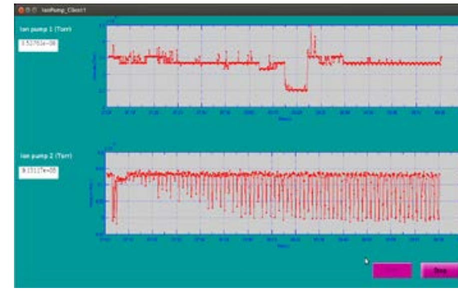
Vacuum system

- 2 ion pumps
- 3 vacuum gauges
- gate valve and fast closing valve

RS – 232/485, DAQ connection

Home made controller for shutters

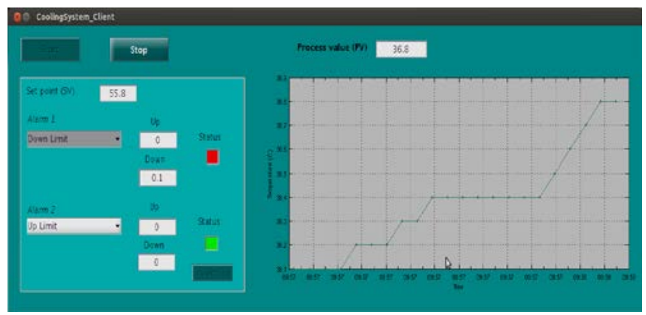




Cooling system

- Temperature Controller (DTA)

RS –485 connection

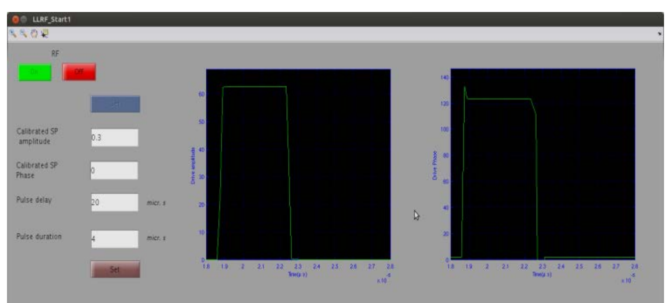


- ✓ *Read temperature data*
- ✓ *Set set-point value*
- ✓ *Choose different alarm modes*

RF system

- LIBERA (EPICS)

Ethernet connection



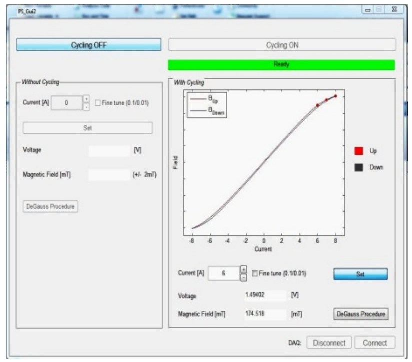
- ✓ *Calibrated SP amplitude*
- ✓ *Calibrated SP phase*
- ✓ *Pulse delay*
- ✓ *Pulse duration*

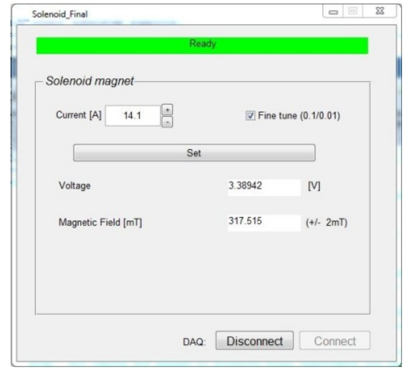
AREAL subsystems control

Magnets
- Dipole
- Solenoid

Home made power supplies

DAQ connection





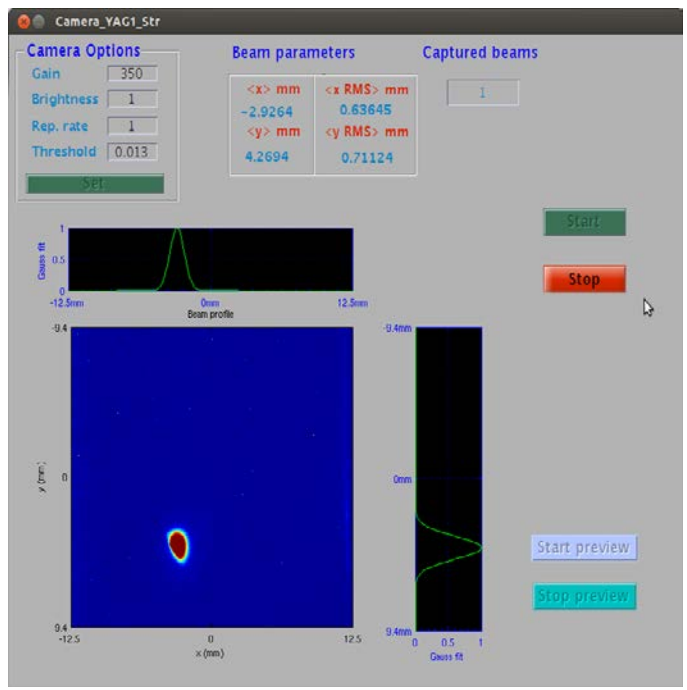
- ✓ Set the value of the current
- ✓ Power on/off
- ✓ Degaussing for bending magnet

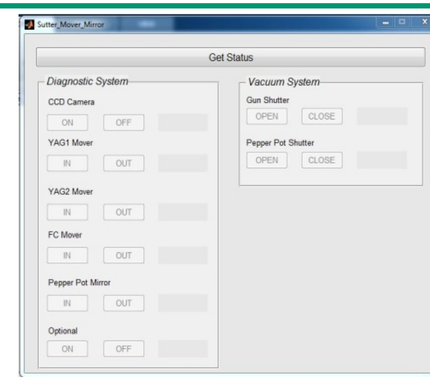
Diagnostic system
- CCD cameras
- Movers
- FC

Home made controller for movers

IEEE1394b, DAQ connection

No external timing
Beam acquisition algorithm



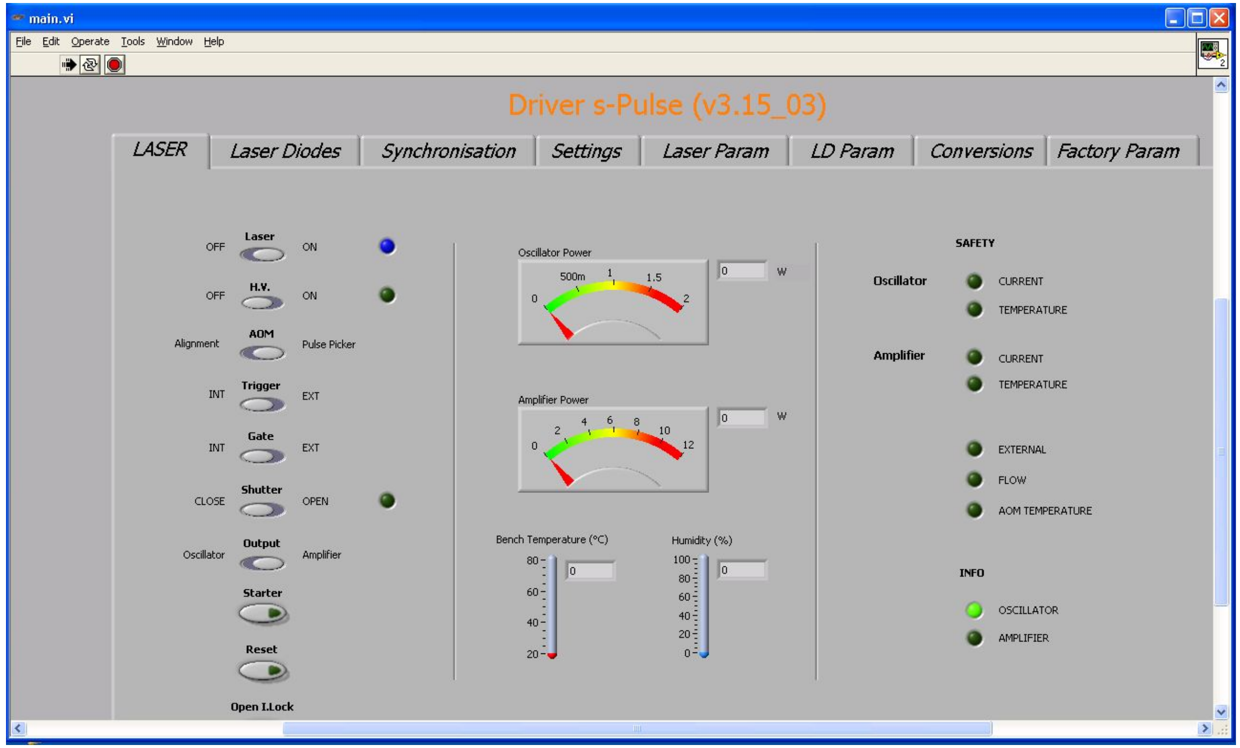


- ✓ Set camera parameters
- ✓ Gaussian fit
- ✓ Calculate x,y rms and beam centroid position
- ✓ Acquisition mode
- ✓ Preview mode

AREAL subsystems control

Laser system

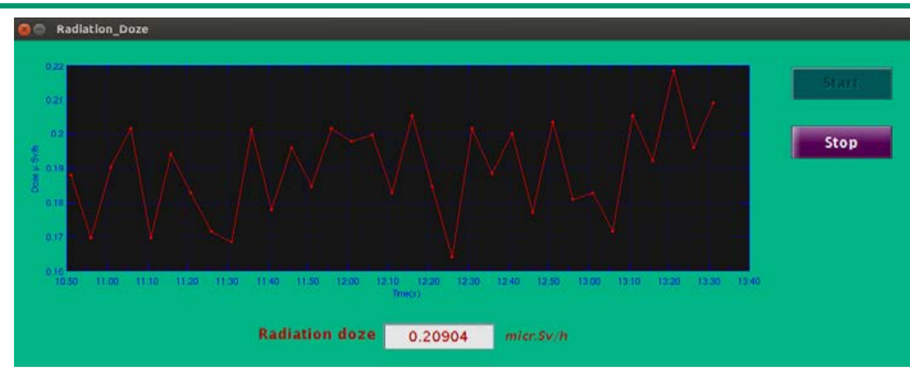
Local control



Radiation safety system

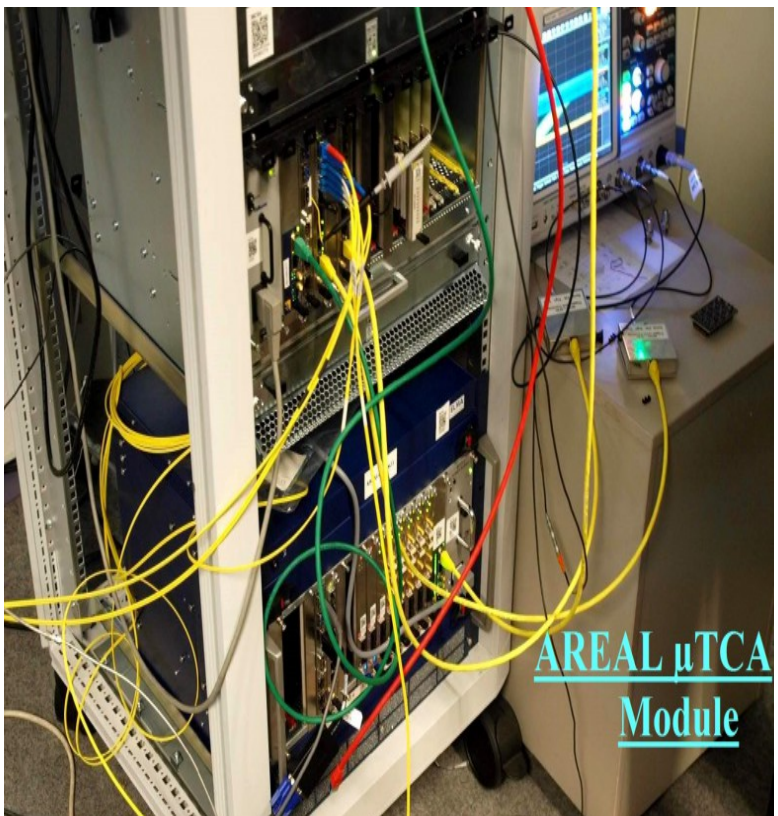
- Gamma-scout

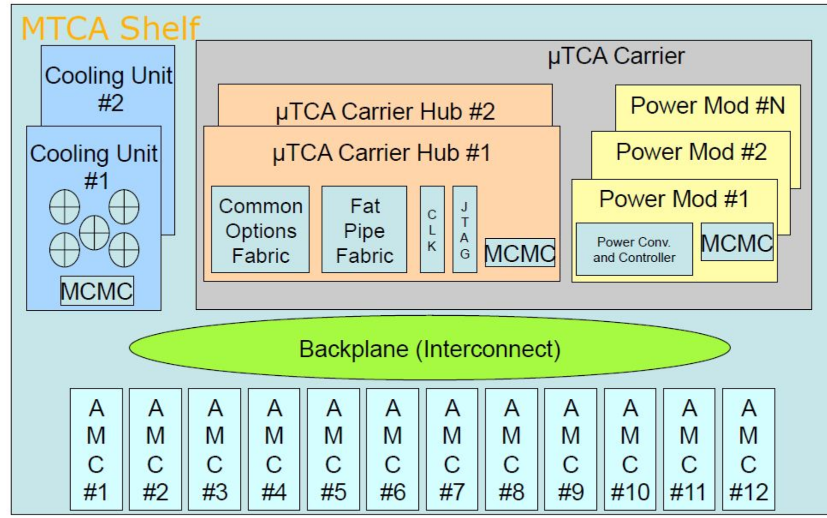
USB connection



µTCA

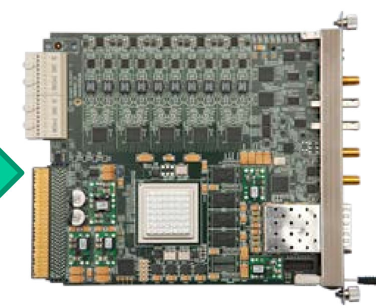
µTCA — Micro Tele-Communication Computing Architecture





RTM

AMC



μTCA Modules

μTCA crate

μTCA modules

Crate: *Elma 039-362 Index B*

MCH: *N.A.T. GmbH – Germany*

CPU: *Concurrent Technologies*

TIMER: *X2TIMER*

9 ADC boards, **3 RTM down converter boards**

3 RTM SIS8900 boards: *Struck Innovative System*

Backplane: *ELMA Electronic GmbH*

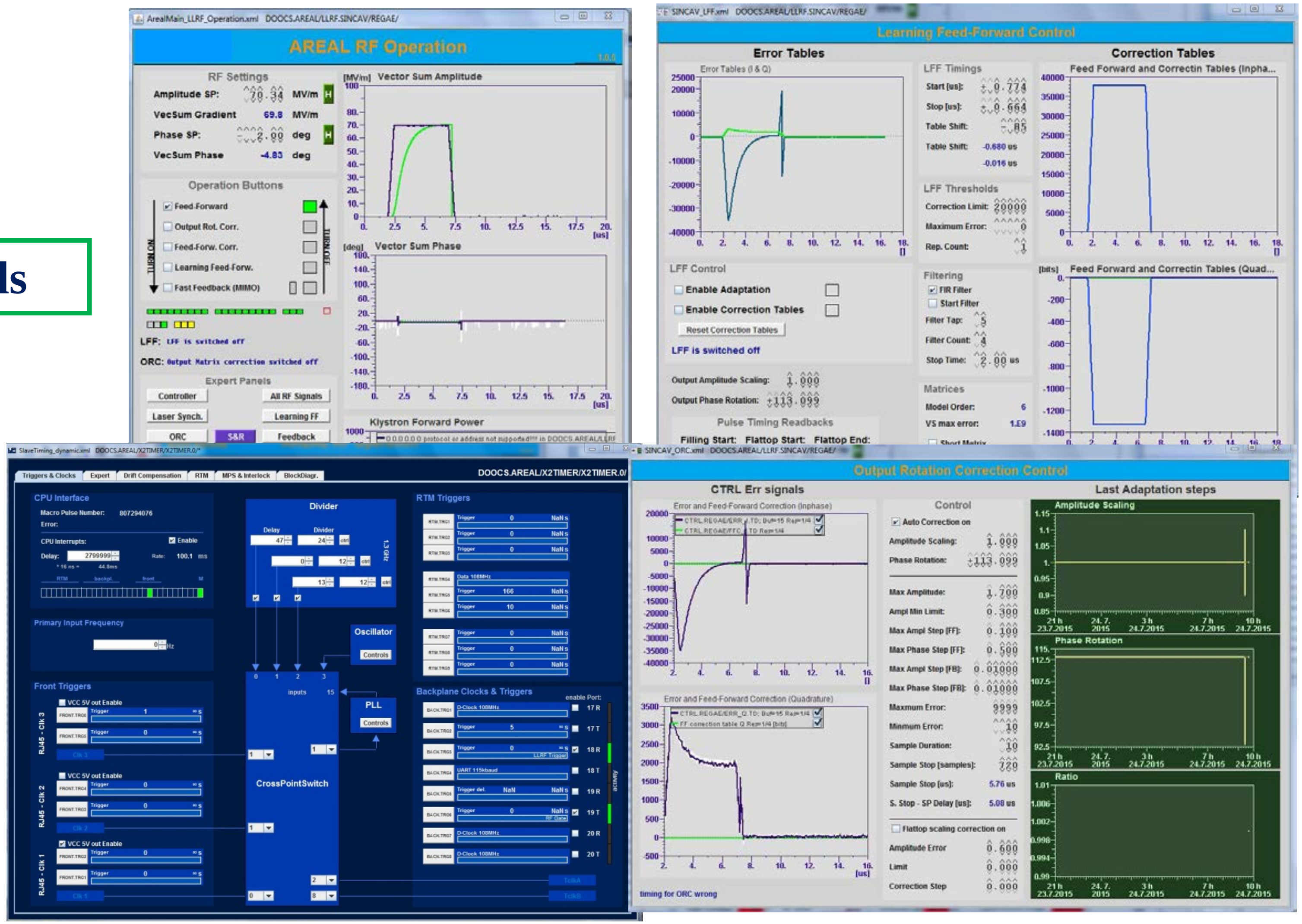
ADC SIS8300L

- 4 lane PCI Express Connectivity
- 10 Channels 125 MS/s 16-bit ADC
- 10 MS/s to 125 MS/s
- Per Channel Sampling Speed
- AC and DC Input Stage
- Internal, Front Panel, RTM and Backplane Clock Sources
- Two 16-bit DACs for Fast Feedback Implementation
- High Precision Clock Distribution Circuitry
- Programmable Delay of Dual Channel Digitizer Groups
- Gigabit Link Port Implemenation to Backplane
- Twin SFP Card Cage for High Speed System Interconnects
- Virtex 5 FPGA
- 32 MSample Memory per Channel

µTCA and DOOCS control system

DOOCS – (Distributed Object Oriented Control System)

jddd Panels



Future tasks

μTCA integration into AREAL Control System.

- RF

  1. From LIBERA to μTCA

  2. Control of accelerating cavities (50 MeV upgrade)

- Diagnostic system

  1. FC signals

  2. BPM (from VME to μTCA)

  3. Trigger signals (from X2Timer)

PYTHON interfaces

THANK YOU!!!