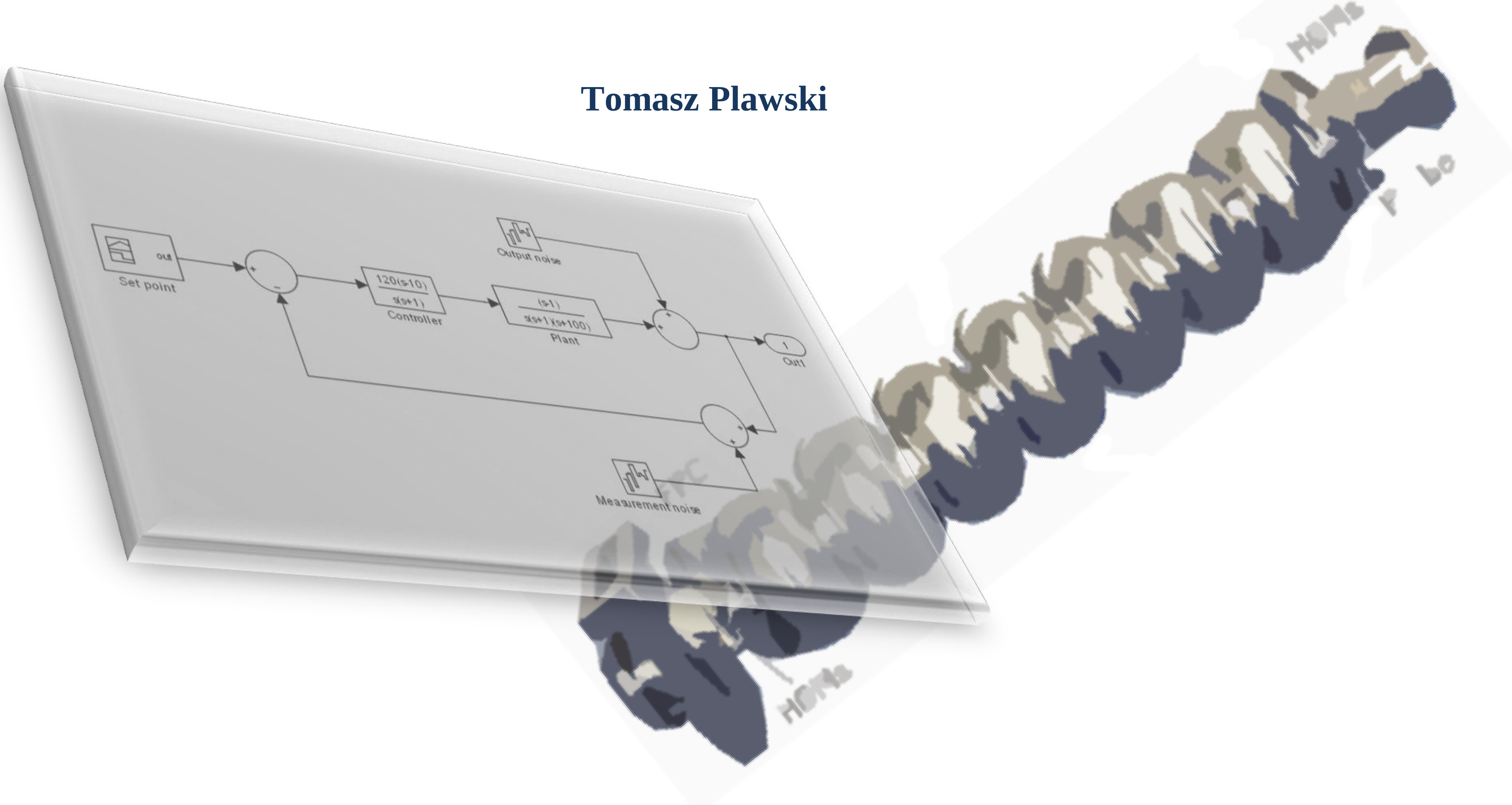
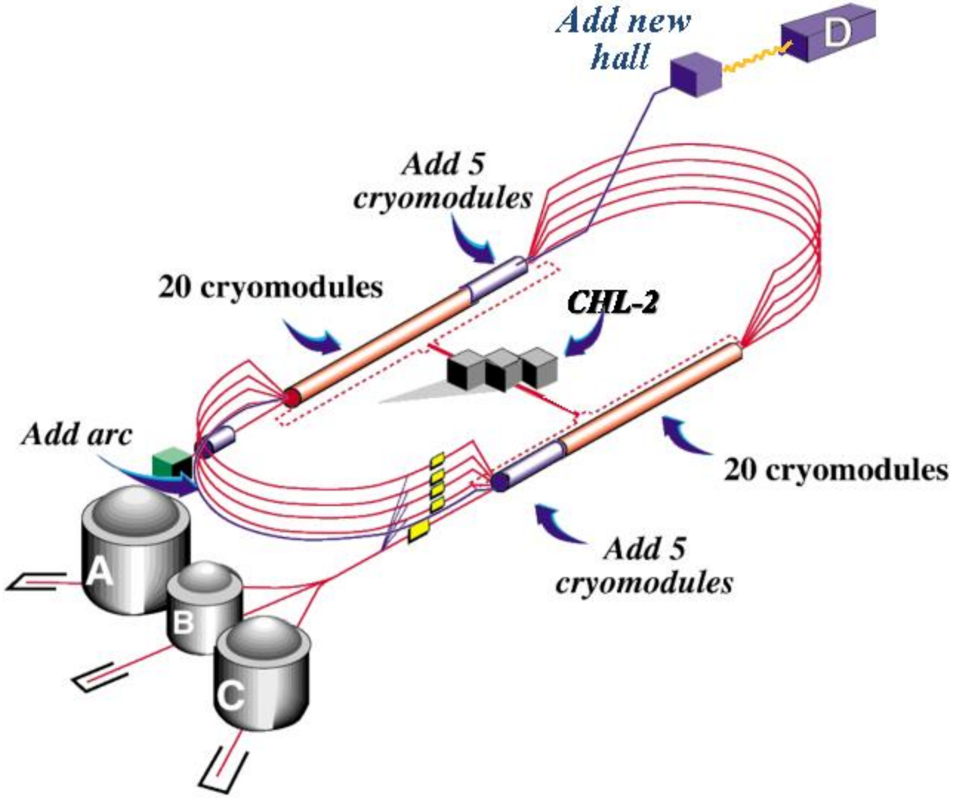
LLRF Activities at Jefferson Lab

Tomasz Plawski



The CEBAF Accelerator Overview

CEBAF, the Continuous Electron Beam Accelerator Facility, has been serving the nuclear physics research community since 1995. This is a cw electron linear accelerator using SRF technology (418 installed superconducting cavities).



LLRF Team Assignments

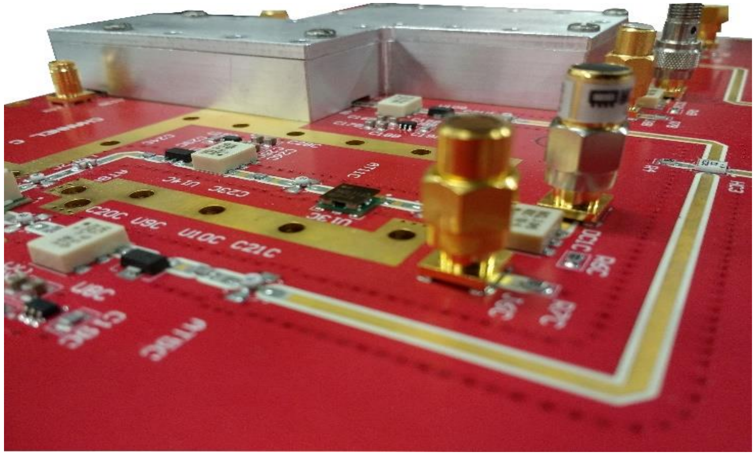
- The CEBAF accelerator support
  - SC cavities - linacs
  - NC cavities – Injector, Separator
  - CEBAF DC PhotoGun
  - Timing and Synchronization
- New Design
  - Field Control System 3.0
- LERF – (Low Energy Recirculator Facility)
  - LCLS-II cryomodule/ LLRF testing
  - Isotope production at LERF
- Upgrade Injector Test Facility (UITF)
- Jefferson Lab Electron-Ion Collider (JLEIC)
- Projects for other laboratories

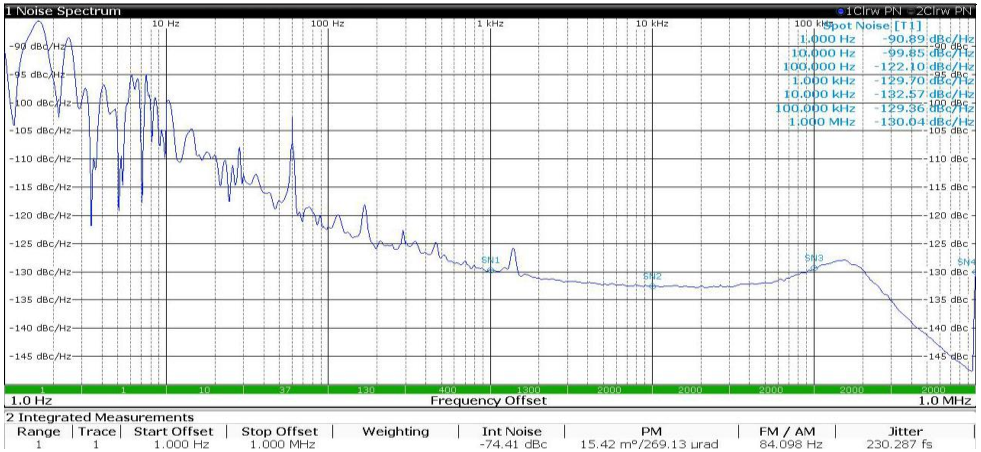
New LLRF System for the CEBAF Accelerator

Field Control System 3.0 Key Features

- Builds upon LCLS-II and prior JLAB designs
- Precise, low noise and high isolation RF receiver
- Fast, low noise and high isolation ADCs
- Ultra low noise, flexible clock synthesizer
- FPGA board with FMC connectors
- UDP over Ethernet communication

See R. Bachimanchi et al. poster "The CEBAF Third Generation LLRF System, LLRF 3.0"





LLRF2019, Chicago   T. Plawski

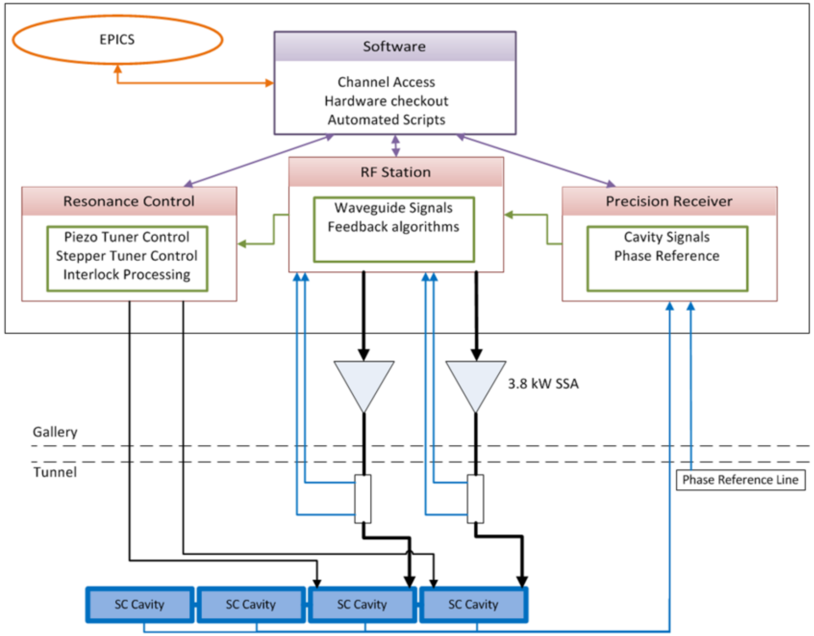
Commissioning the LCLS-II LLRF System in the LERF* Facility

First opportunity to operate LCLS-II LLRF systems

Concurrent testing of two LCLS-II cryomodules built in JLAB

Productive collaboration of multi-laboratory team (FNAL, JLAB, LBL, SLAC)

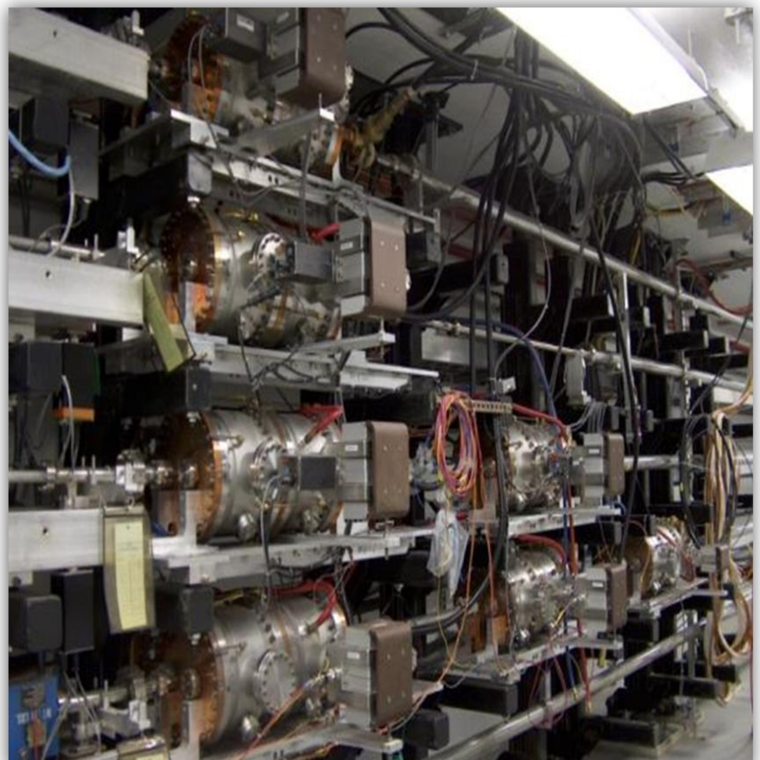
See C. Hovater et al. poster "COMMISSIONING THE LCLS-II LLRF SYSTEM IN THE LERF CRYOMODULE TEST FACILITY"

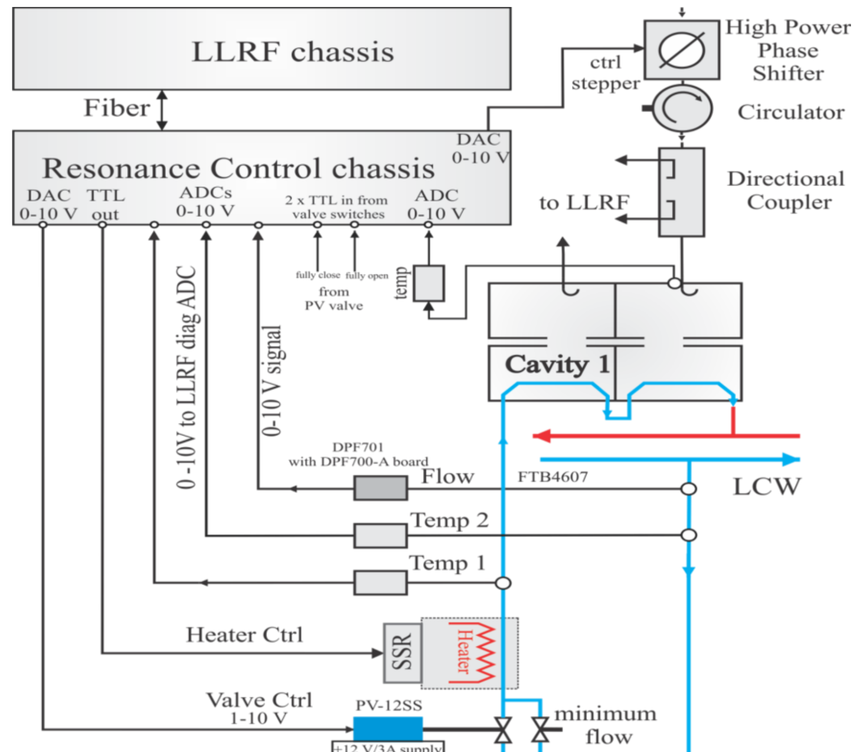


*** LERF - Low Energy Recirculator Facility/ Jefferson Lab**

Completion of Resonance Control System for the CEBAF Separator

- Water systems equipped with heaters and valves are used to control LCW flow and temperature
- We use FPGA-based hardware and EPICS-based predictive control algorithm to control cavity resonance
- 16 normal conducting cavities are now equipped with this system





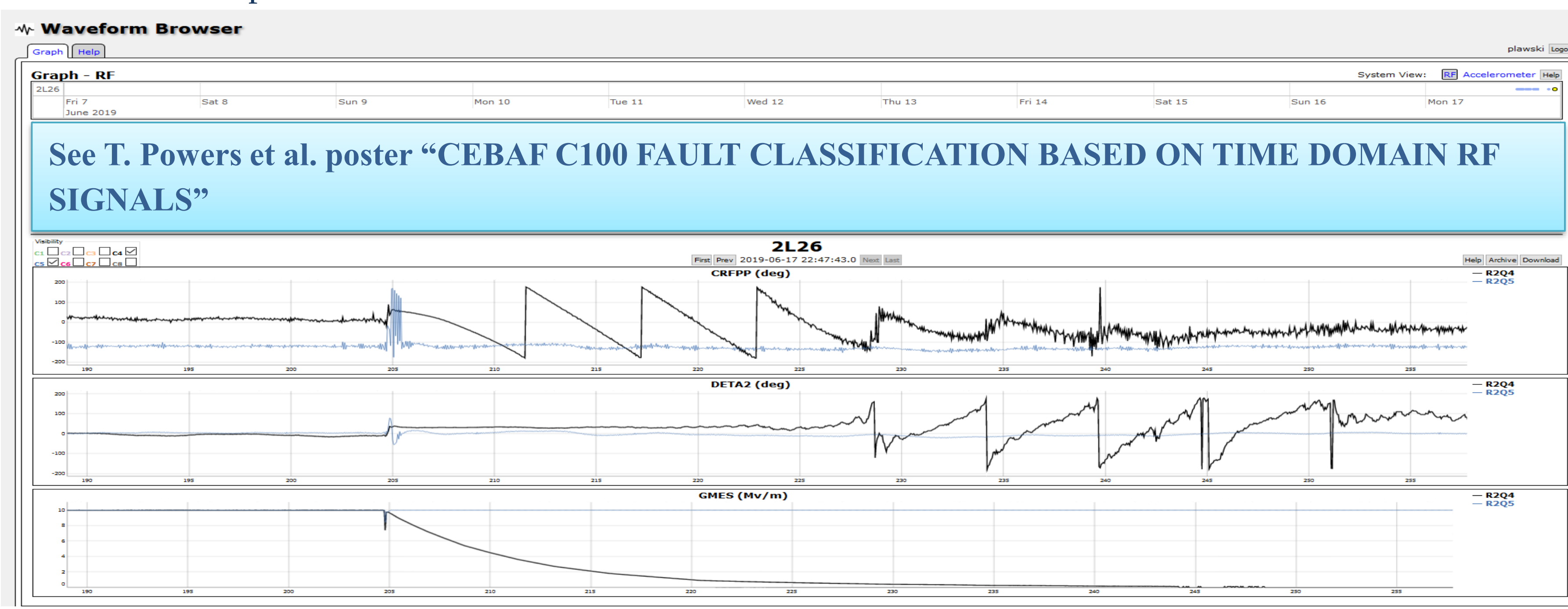
Data Harvester- Waveform Browser

This application is used for viewing LLRF acquired waveforms

It uses a MySQL database to manage waveforms

User can select event/time, location (zone/cryomodule/ cavity) and set of signals e.g. cavity probe, detuning angle.

Machine Learning Team plans to use data from the harvester , classifies it with trained ML model and use the result to prevent SC cavities faults



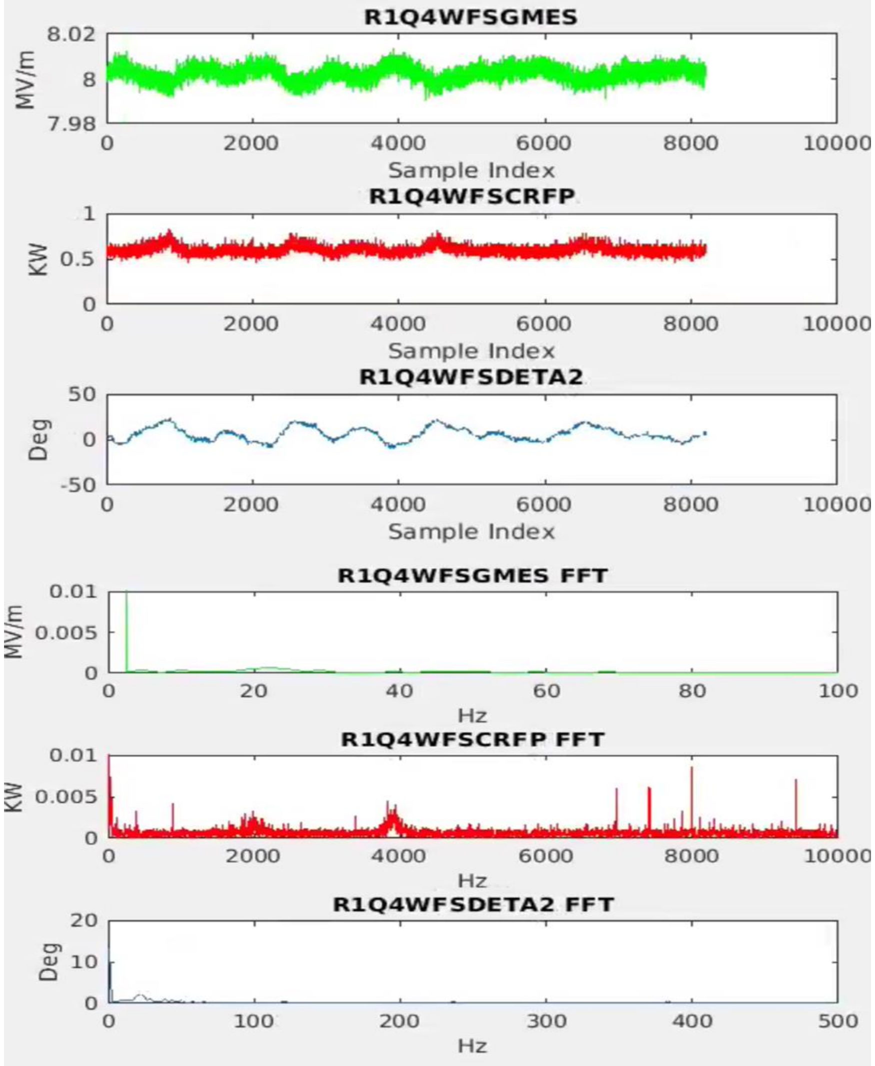
See T. Powers et al. poster "CEBAF C100 FAULT CLASSIFICATION BASED ON TIME DOMAIN RF SIGNALS"

SRF Cavity Data Extraction and Analysis *

MATLAB as an Experimental Physics and Industrial Control System (EPICS) interface for cavity data

labCA – An EPICS channel access interface to cavity data

*Summer student project (SULI)



Thank you for your attention!

***LLRF Team**: R. Bachimanchi, C. Hovater, J. Latshaw, C. Mounts, T. Plawski*

Upgraded Injector Test Facility - UITF

- Upgrade total energy to 123 MeV to retain $\frac{E_{Inj}}{E_{pass1}}$ ratio.
- Upgrade Gun HV to reduce space charge effects, minimize losses, improve A_Q stability.
- Upgrade $\frac{1}{4}$ cryomodule to reduce/eliminate x/y coupling.
- Upgrade all the elements between Gun and $\frac{1}{4}$ for 200 keV beam energy.