DESIGN AND IMPLEMENTATION OF BREAKDOWN ANALYSIS SYSTEM IN THE FERMI LLRF

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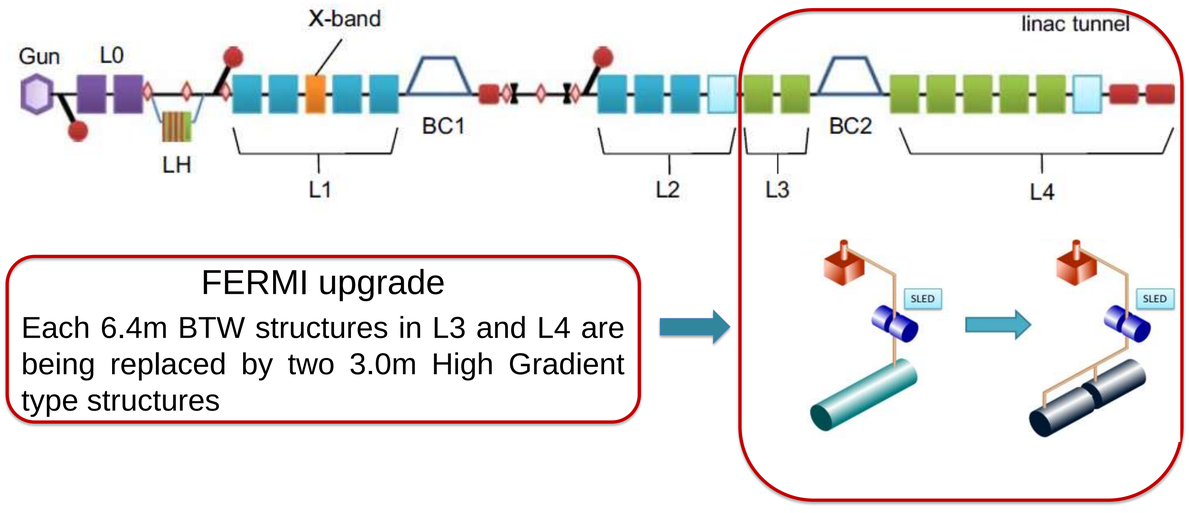
Abstract

In the framework of FERMI Linac upgrade project, new high-gradient S-band accelerating section has been designed. A Cavity Test Facility (CTF) has been setup in FERMI for conditioning and high power testing of the new HG prototype. This Cavity Test Facility is equipped with BOC type pulse compressor and additional breakdown diagnostic dedicated hardware based on NI systems. Breakdown diagnostic implementation study into FERMI LLRF system is ongoing to implement the same on all accelerating sections of FERMI LINAC.

Introduction

FERMI has achieved its nominal performance goals. However, the needs to go beyond the present attainments, heads to a Linac final energy increasing request. Presently, the current 6.4m long BTW structures are limited to 24MV/m due to high break down rate. To solve this issue, a plan to replace each old BTW structures with two 3.0m long new design high-gradient (30MV/m) ones, is ongoing, leading to a final Linac energy of 1.8 GeV.

Actual Linac Energy **1.5 GeV @ 10Hz** → Target Linac Energy **1.8 GeV @ 50Hz** → Solution **High Gradient 30MV/m**

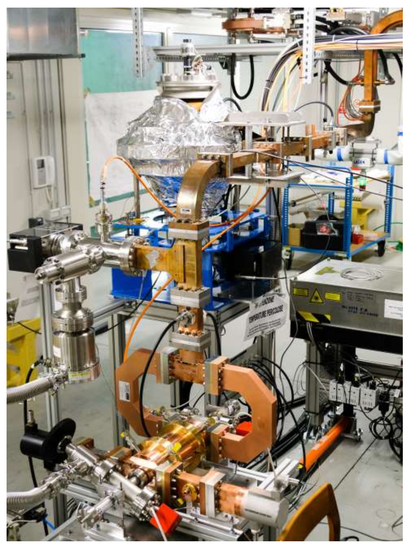


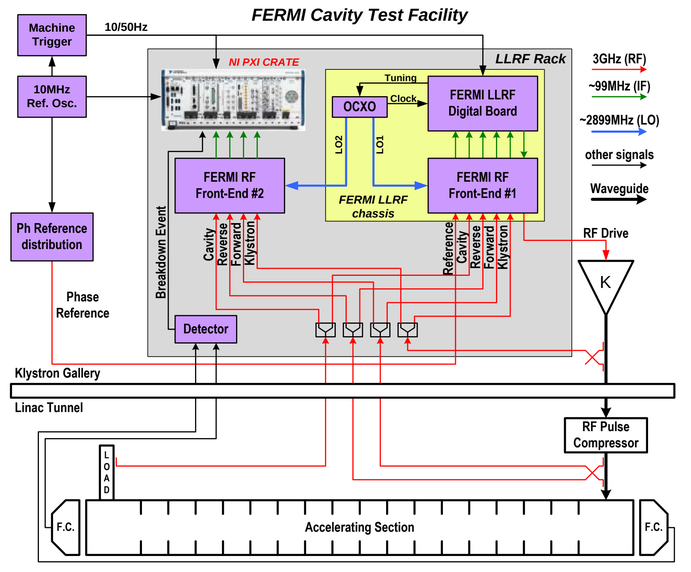
FERMI upgrade

Each 6.4m BTW structures in L3 and L4 are being replaced by two 3.0m High Gradient type structures

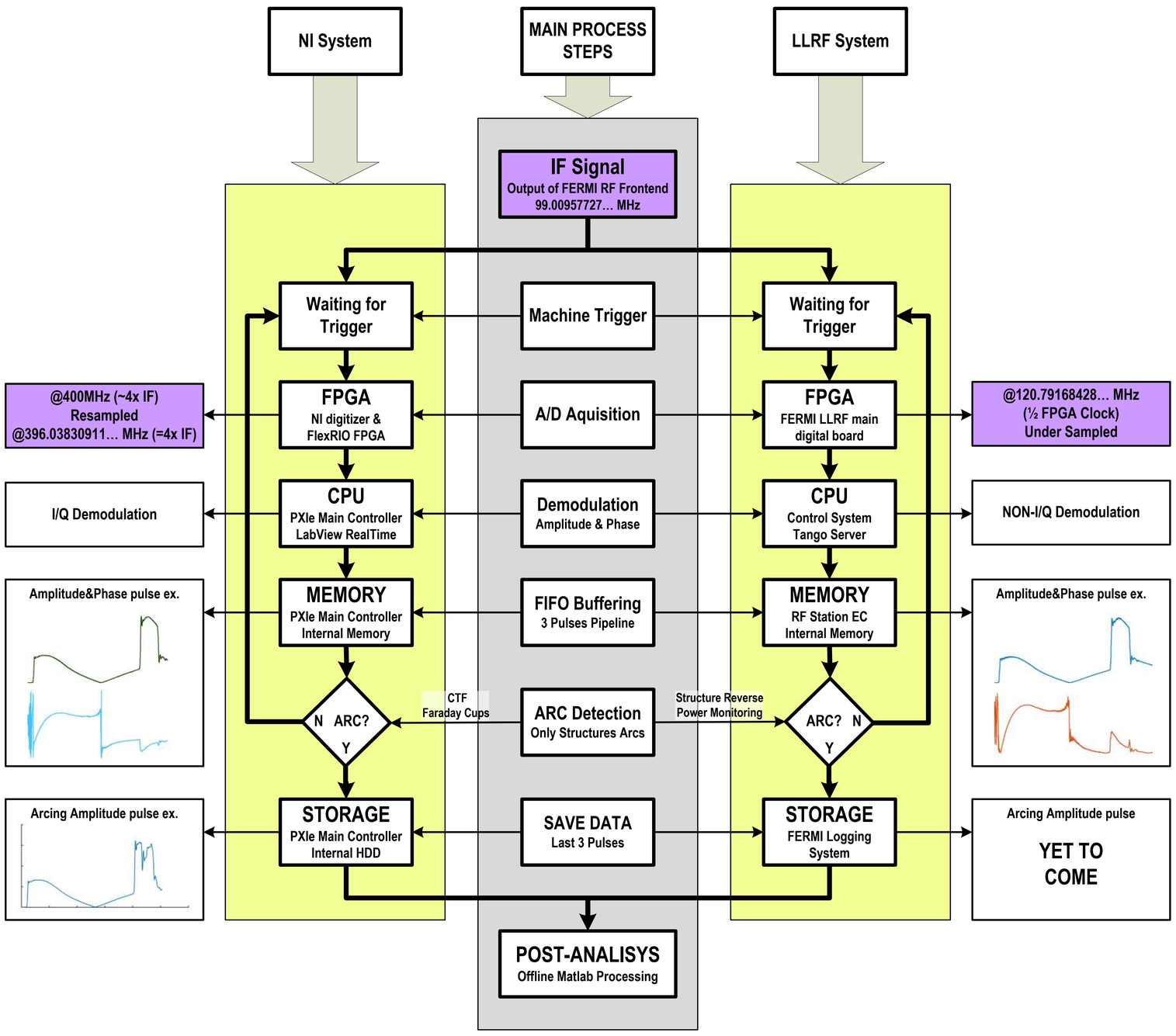
HG prototype, CTF and Breakdown Diagnostic [1]

A tuning-free short prototype of the HG S-band accelerating structure has been built in collaboration with PSI to validate the new design. A Cavity Test Facility has been setup in FERMI to power the prototype, verify the reliability at planned gradient and check the highest gradient it can perform. NI hardware/software breakdown diagnostic based on CERN used system has been integrated into CTF. Subset of CERN developed acquisition and post-processing software can be used to produce breakdown related data such as BD rate value as well as arc spatial position. Integration of the NI system into CTF allows FERMI LLRF to acquire same RF data at the same time.



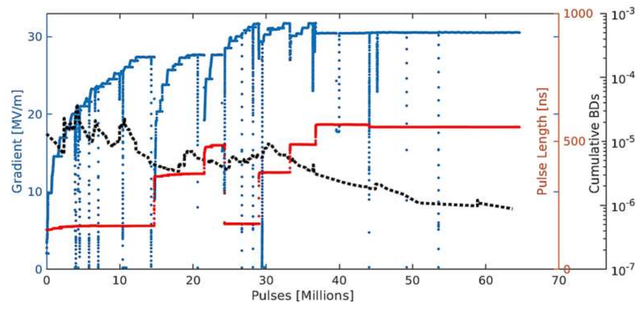


Breakdown Diagnostic main configuration on different systems comparison

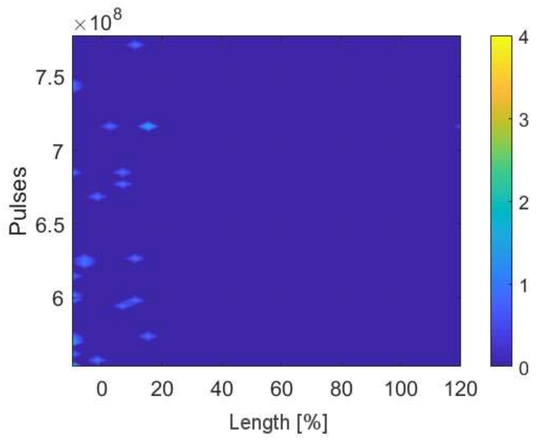


Post-Processing Reports

Example of trend information



Example of arcing position outcome



Conclusions

The HG prototype has been successfully operated up to 35MV/m with a good BD rate, well beyond most designed expectations.

At the moment it is running at the higher gradient of 39MV/m*, collecting data.

As FERMI LLRF System in CTF will be ready to collect breakdown data, a comparison between post-processing results coming from the two systems will be performed.

If everything is consistent, then all FERMI LLRF Systems will be equipped with this new feature making available these new important BD related information for all FERMI accelerating structures.

* Rate limited by RF power availability

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Thomas Geoffrey Lucas (The University of Melbourne) supporting post-processing data analysis

[1] N. Shafqat *at al.,* “Commissioning of S-Band Cavity Test Facility at Elettra for conditioning of high gradient structures for the FERMI Linac upgrade” ISBN: 978-3-95450-208-0, *Proceedings of IPAC2019*, Melbourne, Australia.