LLRF Upgrade at the Argonne Wakefield Accelerator Test Facility

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A poster presentation @ IPAC 21,

Argonne Wakefield Accelerator F

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Argonne Wakefield Accelerator Facility

AWA

The Argonne Wakefield Accelerator (AWA) is a premier electron accelerator with the world's highest bunch charge to carry out fundamental accelerator research with an emphasis on wakefield acceleration.

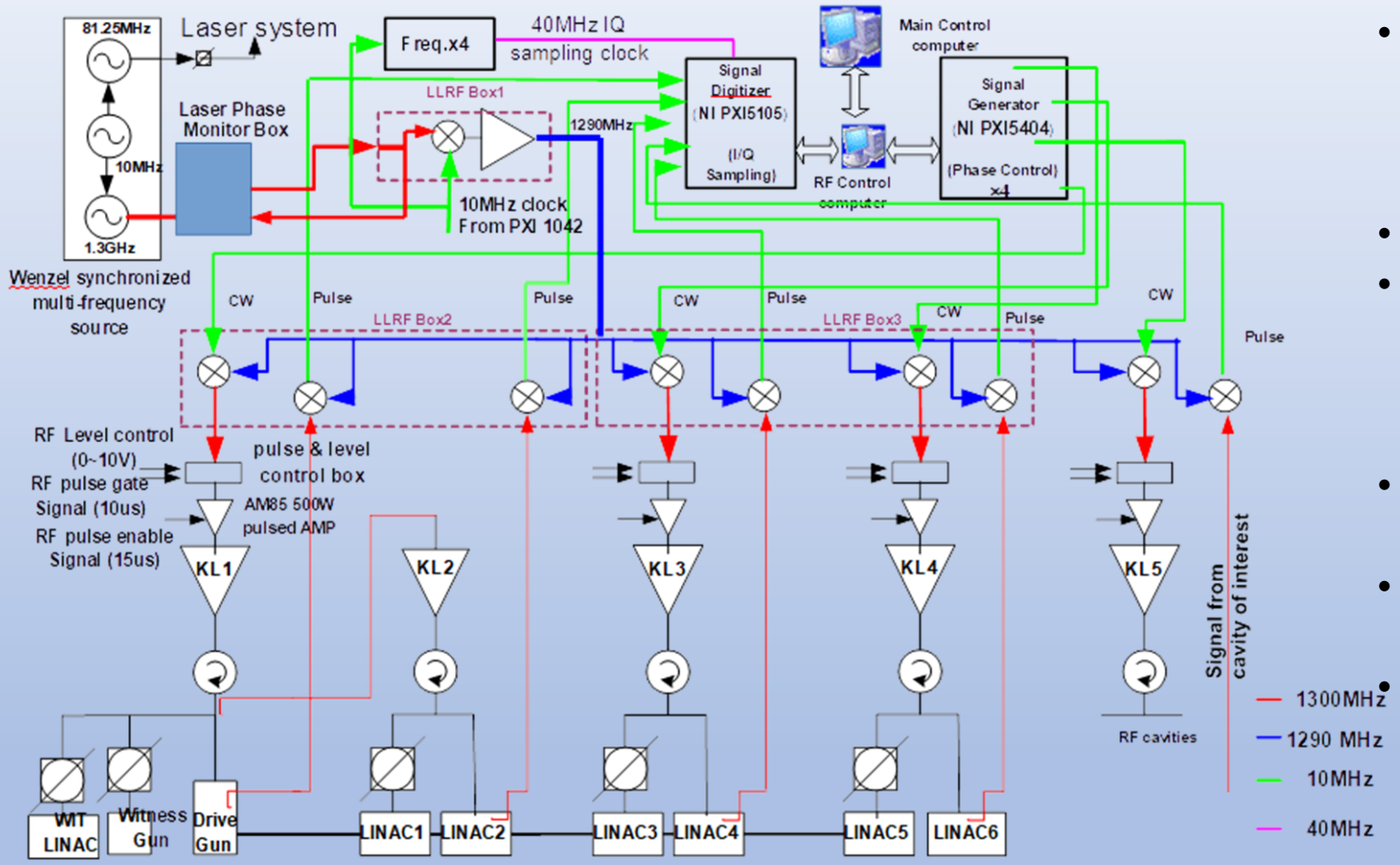
AWA Facility

- About AWA
- Capabilities

AWA Research Area of Focus

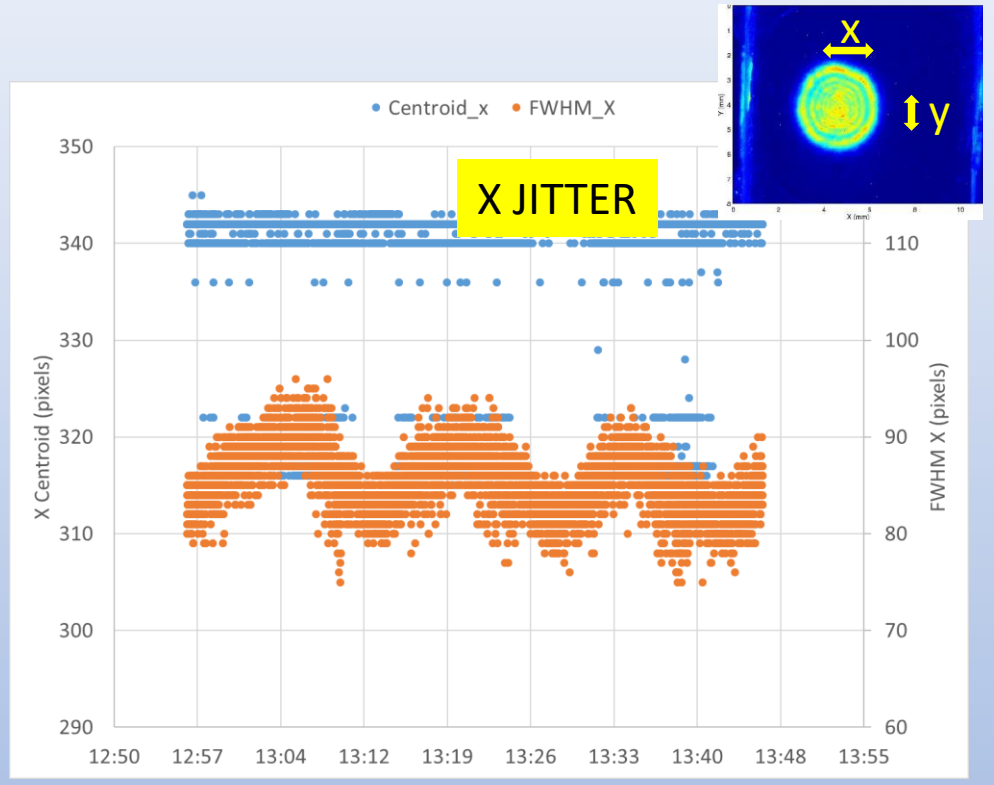
- **Advanced Structure Development**
- **Beam Driven Radiation Source**
- **RF Breakdown Studies**
- **Collinear Wakefield Acceleration**
- **Dielectric and Metallic Two-Beam Acceleration**
- **Electron Sources Research**
- **Phase Space Manipulation**
- **Diagnostics**

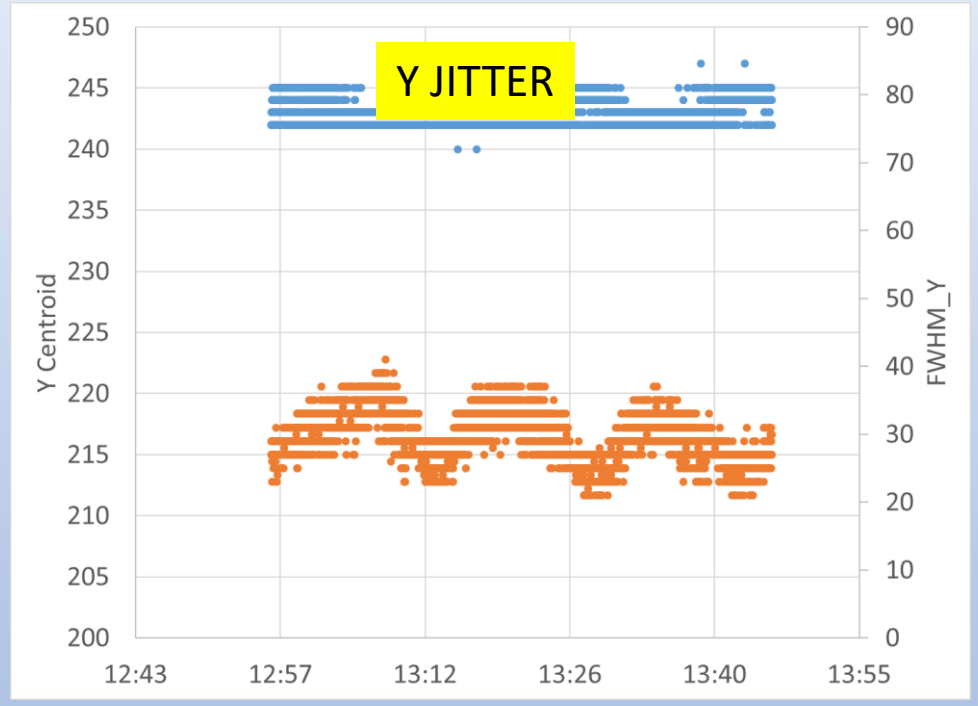
AWA Current RF System



- The LLRF part of AWA RF system is consists of four NI PXI-5404 and one NI PXI-5105 hosted in one PXI crate connected to LLRF Ctrl PC.
- The IF is of AWA LLRF system is 10MHz.
- The LO frequency of AWA LLRF is 1290MHz which is generated by mixing 1300MHz LLRF reference with 10MHz reference signal.
- The 1.3GHz LLRF signals are generated by mixing LO with IF generated by PXI-5404.
- The phase shifting of LLRF signal is done by shifting the 10MHz IF.
- For monitoring purpose, RF signals from pickups are down converted into 10MHz IF signal and then IQ sampled using NI-PXI5105

Motivation for the Upgrade—Beam stability, obsoleting hardware





The beam was jittering and there was no clear position drift recorded. But it is clearly showing that the beam size was swinging with time at about 15minutes per cycle.

We are hopping that by upgrading our LLRF system, we might improve the beam stability of AWA.

Working with Experts from LBNL on the Upgrade

Collaboration proposal: LBNL/ANL

- The collaboration will leverage off both engineering and physics experience at LBNL in designing controls and beam measurements for LCLS-II, HiRES, PIP-II, PPU and ALS-U LLRF systems. It will align the AWA LLRF system with other accelerators in the DOE complex.
- The LLRF upgrade will happen in the context of a larger effort, including a control system upgrade (EPICS) and a High power RF upgrade. Coordination is needed since all subsystems are tightly interconnected!

- LBNL will work with ANL to:
  - Provide a design solution for a new RF control architecture
  - Provide new LLRF chassis, identical to LCLS-II (and similar to HiRES) hardware
  - Assist in the characterization and deployment of RF controls in the field.
  - LCLS-II EPICS IOC and supporting tools, with initial custom software and firmware for AWA.
  - Path forward for future upgrades beyond the present SOW.

A Solid Plan is in Place and it's going smoothly

Description of work

Effort is separated in 3 phases:

- **Phase 1: SOW definition and RF chassis production**
  - Define effort and responsibilities (Completed)
  - Identify and order long-lead items for RF and MO/LO chassis (Completed)
  - Manufacture 3 LCLS-II 1.3 GHz LLRF chassis (In progress)
- **Phase 2: Characterize present AWA RF system stability**
  - Use LBNL-built hardware in "witness mode" during accelerator operations
    - Basic software functionalities provided, but any custom high-level screens will be developed by ANL personnel
  - Perform and analyze out-of-loop measurements of the characterize baseline performance
- **Phase 3: Deploy LBNL LLRF system as driver system for the accelerator.**
  - Deploy LBNL hardware, firmware and software at AWA
  - Characterize performance of newly deployed hardware
  - Establish plans for future upgrades: Laser-to-RF synchronization, phase reference line, produce more RF chassis for increased performance and simplified architecture.


Thank You