Conceptual Design of LCLS II BPM System on MicroTCA.4
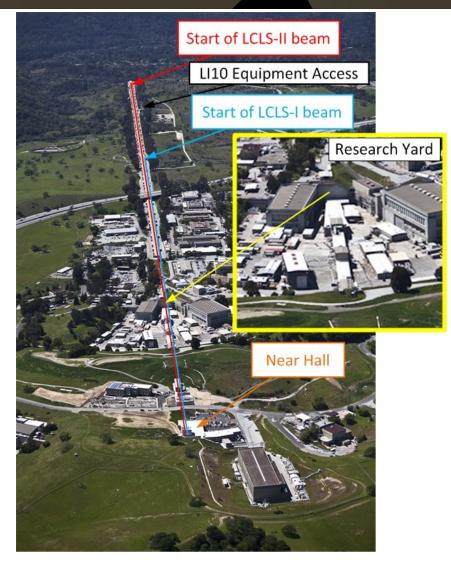
Chengcheng Xu
on behalf of

S. Hoobler, R. Larsen, J. Olsen, S. Smith,
T. Straumann, A. Young
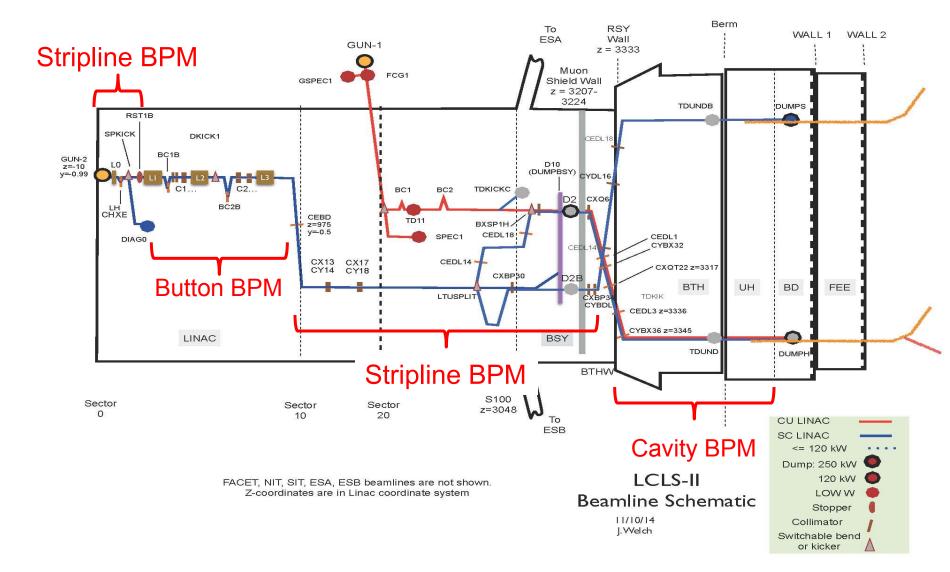
- LCLS-II is a XFEL with super conducting LINAC

- It is capable of 1 MHz CW beam

- Maximum beam power will reach ~1MW

- Maximum bunch charge 300pC

- Minimum bunch charge 10pC

Start of LCLS-II beam

LI10 Equipment Access

Start of LCLS-I beam

Research Yard

Near Hall

LCLS-II
Beamline Schematic
11/10/14
J. Welch

FACET, NIT, SIT, ESA, ESB beamlines are not shown.
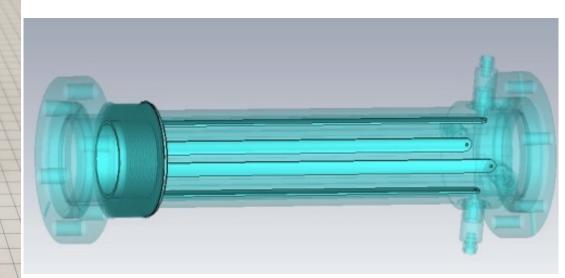Z-coordinates are in Linac coordinate system

- Build BPM control system for LCLS-II
  - Stripline BPM (SLAC, LBNL)
  - Button BPM
  - Cavity BPM
- Provide orbit and TMIT information to fast-feedback and machine protection system

Stripline BPM

- Standard SLAC Linac pickups, 1" diameter, 4.75" length

- LBNL APEX Gun pickup, 1.18" diameter, 5.11" length
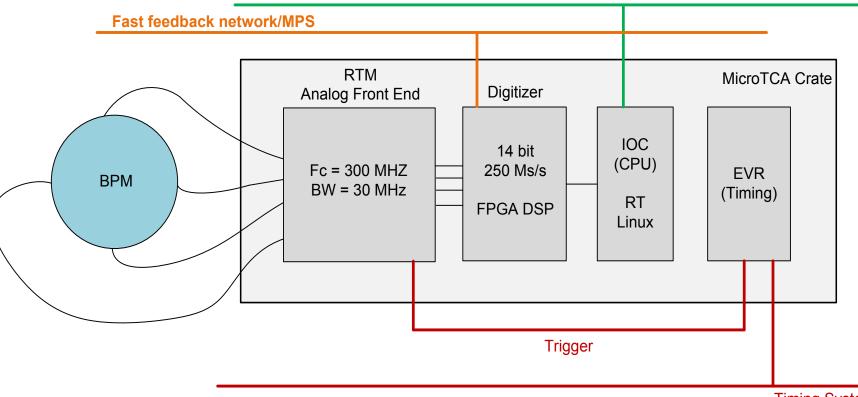
- Process BPM signal at 300MHz

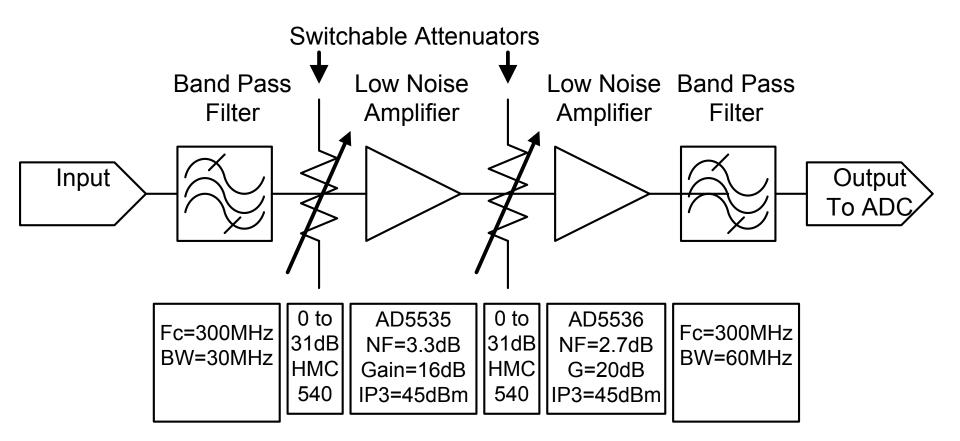

SLAC BPM

LBNL BPM

Stripline BPM System Architecture

EPICS Channel Access Network

Fast feedback network/MPS

MicroTCA Crate

RTM
Analog Front End

Digitizer

BPM

Fc = 300 MHZ
BW = 30 MHz

14 bit
250 Ms/s

FPGA DSP

IOC
(CPU)

RT
Linux

EVR
(Timing)

Trigger

Timing System
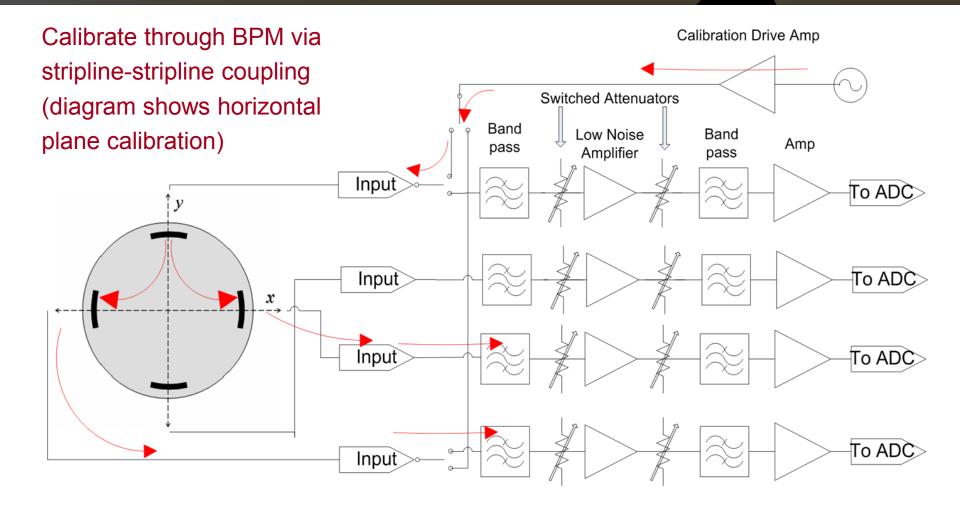
7

- We will utilize the signal processing portion of the BPM RTM designed for LCLS-I
- BPM calibration circuit has to be redesigned to accommodate 1MHz beam rate
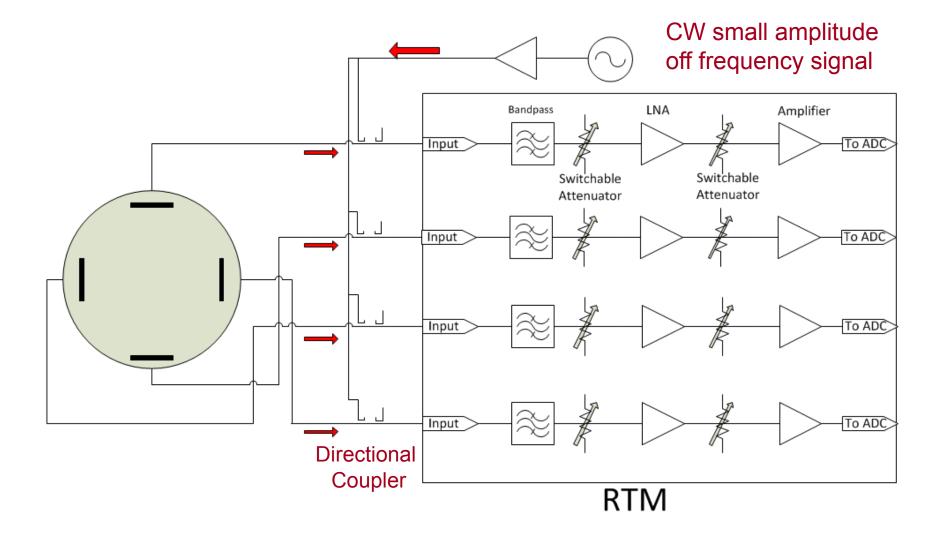
Switchable Attenuators

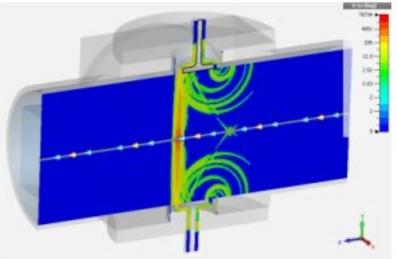Band Pass Filter | Low Noise Amplifier | Low Noise Amplifier | Band Pass Filter

Input → Output To ADC

| Fc=300MHz BW=30MHz | 0 to 31dB HMC 540 | AD5535 NF=3.3dB Gain=16dB IP3=45dBm | 0 to 31dB HMC 540 | AD5536 NF=2.7dB G=20dB IP3=45dBm | Fc=300MHz BW=60MHz |

Calibrate through BPM via stripline-stripline coupling (diagram shows horizontal plane calibration)

CW small amplitude off frequency signal

Bandpass

LNA

Amplifier

Input

Switchable Attenuator

Switchable Attenuator

To ADC

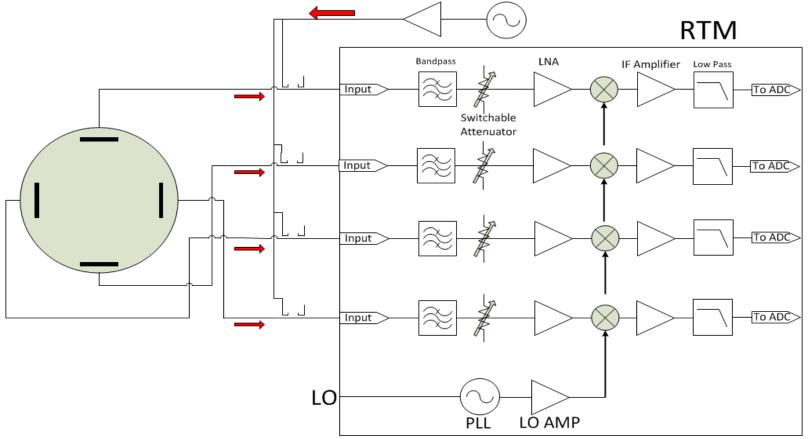Directional Coupler

RTM

Button BPM Pickup

- Button BPMs are located in the cryomodule

- Designed by Fermilab

- It is very similar to the European XFEL cold button BPM pick up

- The pickup has 20mm diameter with 3mm gap
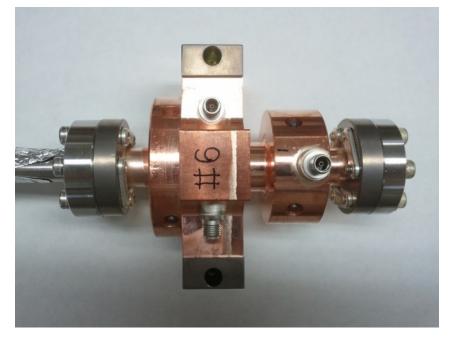

Simulation of the pickup in CST
Curtesy of A. Lunin FNAL

Button BPM Electronic

- The BPM signals will be processed 1.5 - 2GHz

- Signal will be down-mixed to an IF signal and sampled at 119MHz
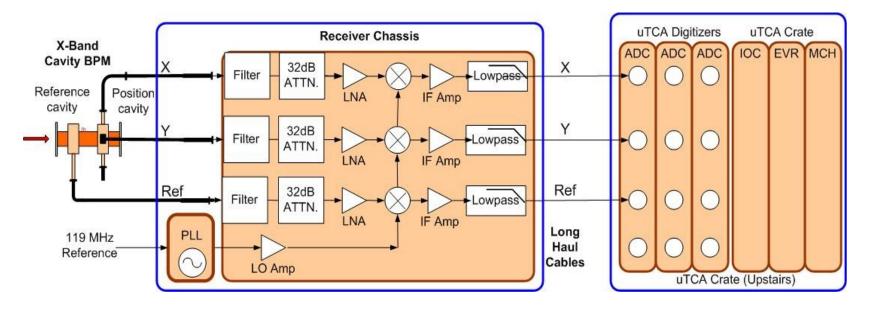
- BPM pickup developed in collaboration with PAL

- Currently being used at LCLS-I's undulator hall

- The receiver will processes the TM010 monopole reference cavity signal and a TM110 dipole cavity signal at approximately 11 GHz using a heterodyne technique
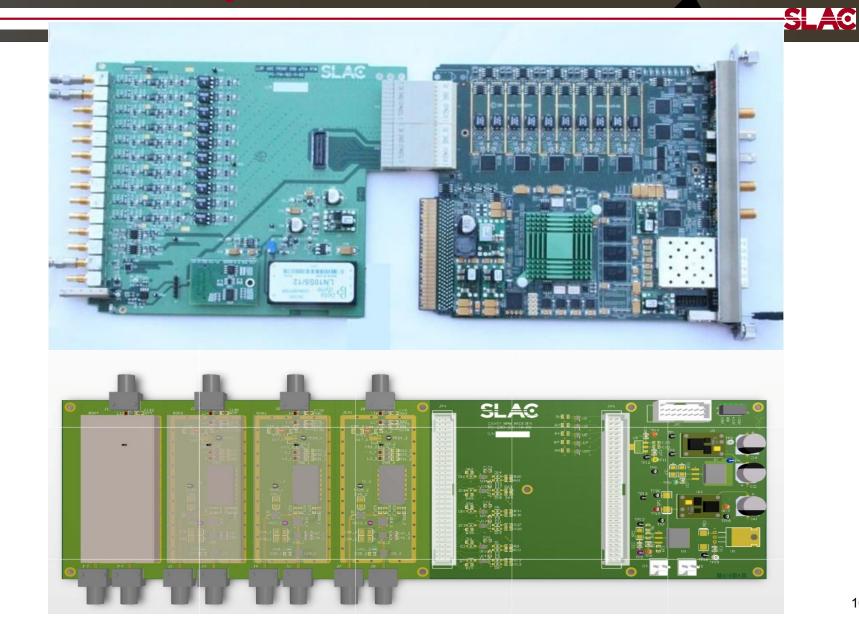
- Due to the high loss of signal strength over cables, the down-converter has to reside inside the tunnel
- The ADC and processing electronics will reside in the surface building

- **Struck Digitizer (SIS8300/SIS8300-L/SIS8325)**
- **With SLAC modifications**
  - **250 MSa/sec sampling clock 14bit ADC**
  - **125 MSa/sec sampling clock 16 bit ADC**
- **The BPM and LLRF system will try to use the same digitizer**

MicroTCA Components

CPU: Concurrent Technologies AM 310/302-52

- 2-core Core i7 processor

- 2 GB RAM

- Ethernet interface

- Serial port for IOC console

MicroTCA Carrier Hub

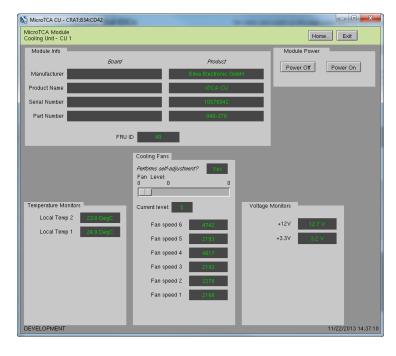- 2 Gigabit Ethernet interfaces

- Serial port for MCH console
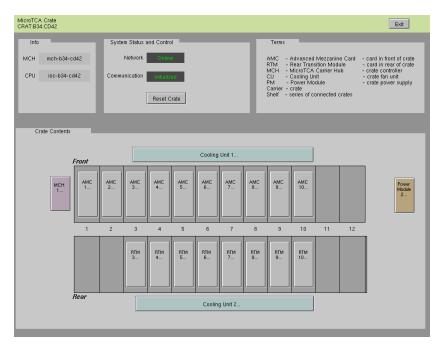
Power Supply and Timing

- The plan is to use Wiener's 1kW power module due to the low power noise ripple

- LCLS-II will be a 1MHz machine
    - Can no longer use the MRF EVR module for timing
    - SLAC has to develop a new timing system

IPMI Monitoring using EPICS

The SLAC EPICS IPMI software provides remote monitoring and control of MicroTCA systems via their MCHs. EPICS monitors temperature, voltage, current, and fan speed sensors and system reset. These readbacks and control signals are available to users via EPICS PVs. The software runs in an EPICS IOC process and is configured with a list of MicroTCA systems to monitor. For each remote system, it discovers the MCH vendor and uses the appropriate message protocol

BPM System

Thank you