

# Completion of Fast Shutdown

Nilanjan Banerjee for John Dobbins

**BROOKHAVEN**  
NATIONAL LABORATORY

*a passion for discovery*

Office of Science  
U.S. DEPARTMENT OF ENERGY



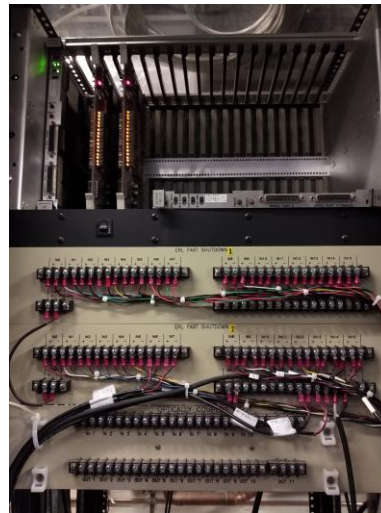
Cornell Laboratory for Accelerator-based Sciences and Education (CLASSE)



## Diagnostics

1. **Fast Fibre Monitors (0.1  $\mu$ s):** Radiation – Very important for  $> 100$  nA, under development.
2. **Beam Position Monitors (10  $\mu$ s):** Beam position or intensity fluctuations – Not essential!
3. **Low Level Radio Frequency Controllers (1  $\mu$ s):** Cavity field fluctuation – Already used!

## Fast Shutdown Board

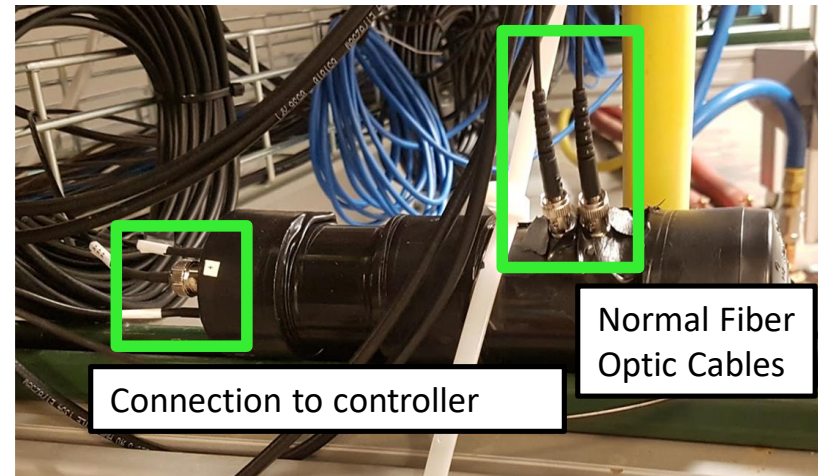
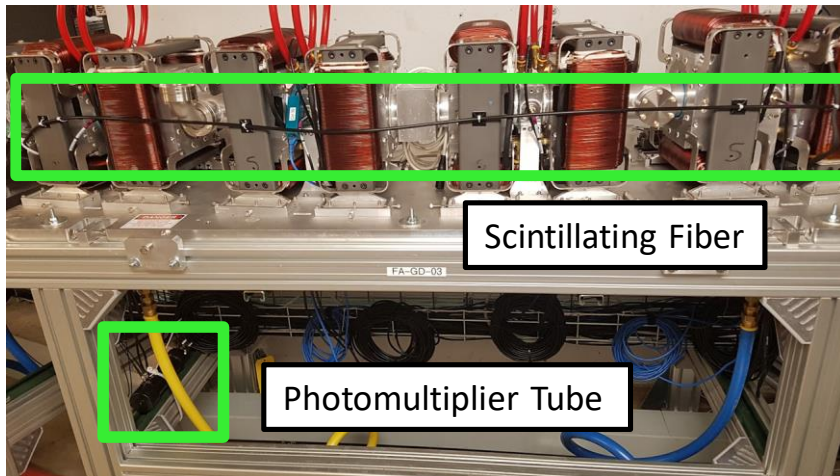


## Bunch Pattern Generator

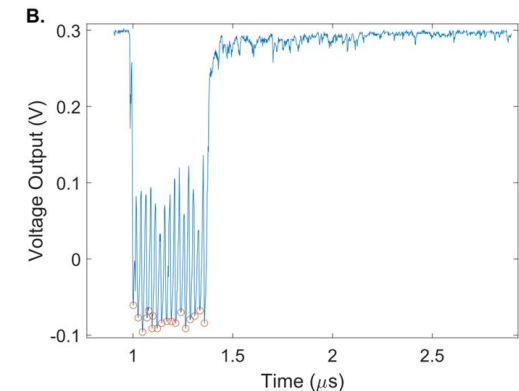
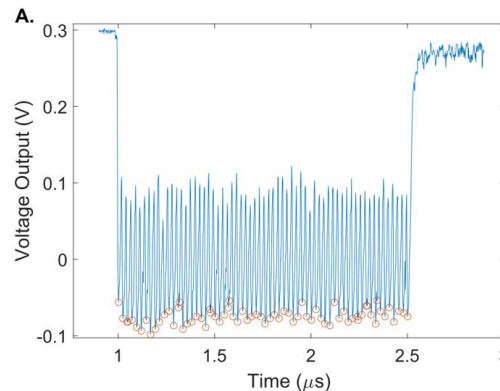


Laser Shutter

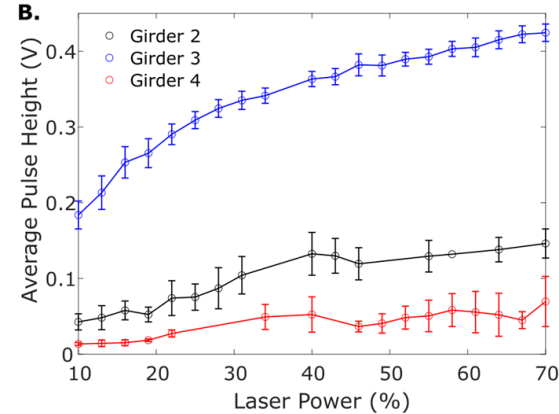
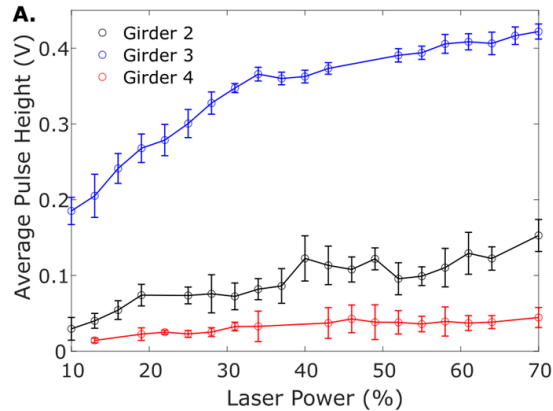
- Scintillating fibres have been installed in the permanent magnet arcs and 27 PMT modules have been assembled and checked for light leaks.
- PMTs have been installed on the first 4 girders and basic properties of the system have been verified.



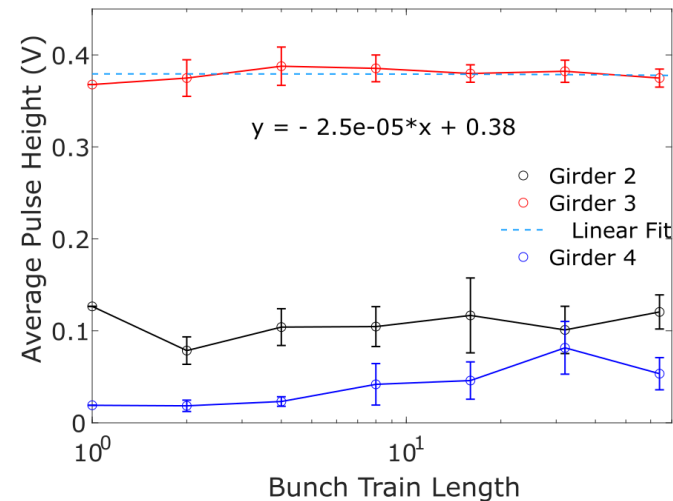
REU student Malida Hecht did rigorous testing of BLM responses.



The beam was lost in the second girder on purpose at low beam currents.



- Response varies non-linearly with bunch charge.  
This may be a space charge related effect.
- Pulse height is independent of bunch train length.



PMT not subject to dead time effects at current operational levels.



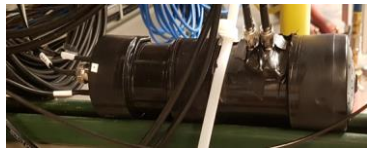
## Scintillating Fibres



- All fibres installed in PM arc.
- Install fibres in the splitter.  
Not terribly important if we stay within micro-amps.

X 2

## PMTs



- 27 PMTs are assembled into enclosures and 4 installed in girders.
- Install PMTs in remaining girders.
- Assemble parts for 13 more PMT assemblies for a total of 40.

X 4

## PMT DAQ/Controllers



- There are 8 assembled chassis, each chassis hosts 4 PMTs.
- We should assemble 2 additional chassis to cover all the 40 PMTs.
- Firmware to do:
  1. Modify Red Pitaya FPGA code to process BPM clock and trigger.
  2. Add PS code to drive SPI DAC which commands the PMT HV set point.

X 4

## FSD Fan-in



- There are 4 assembled FSD Fan-in chassis each providing 16 inputs. The inputs are the outputs of the PMT DAQ chassis.
- Firmware to do:
  1. Create *microZED* FPGA code to produce a logical OR of the inputs and drive the output.
  2. Add PS code to supervise FPGA, i.e. reset, arm, test, readout bits.

BPM Clock and Trigger

Fast Shutdown Board

- Procure cables for connecting PMTs to DAQ/control chassis.

Misc

## Fast Shutdown

Dedicated hardware for fast shutdown system has been demonstrated to be able to turn off the laser beam over the summer during high-current operations.

## LLRF Initiated Shutdown

All 10 SRF cavities of CBETA can initiate beam shutdown if the fields are beyond tolerance levels.

## Fast Beam Loss Monitors

A lot of work already done! But a substantial amount of work is still left.