



SBND Trigger System: Status and MTC/A Configuration



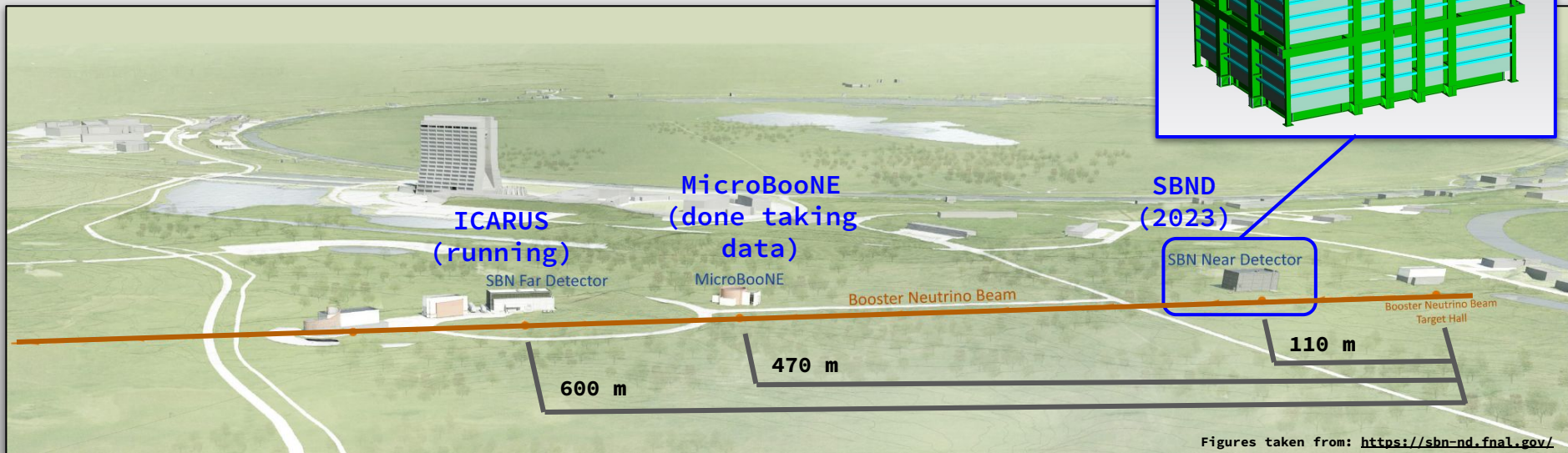
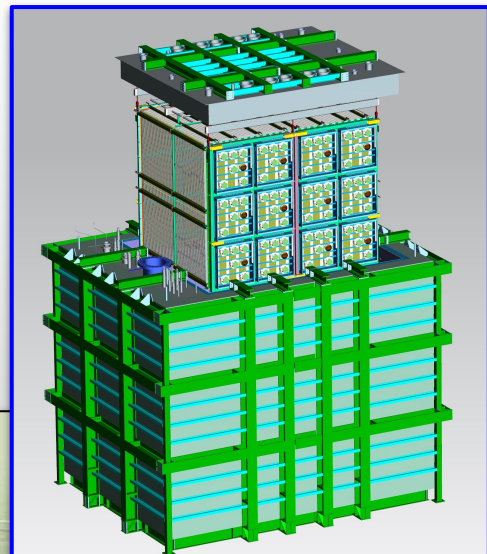
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On behalf of SBND Collaboration
University of Texas at Arlington

SBND Overview:

Nebot-Guinot and
Balasubramanian's talks
on Tuesday (08/02) and
Del Tutto's talk today
(08/04)!

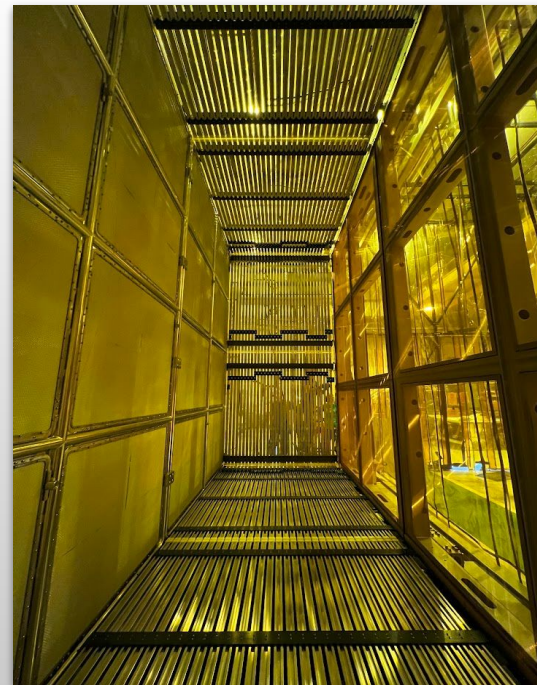
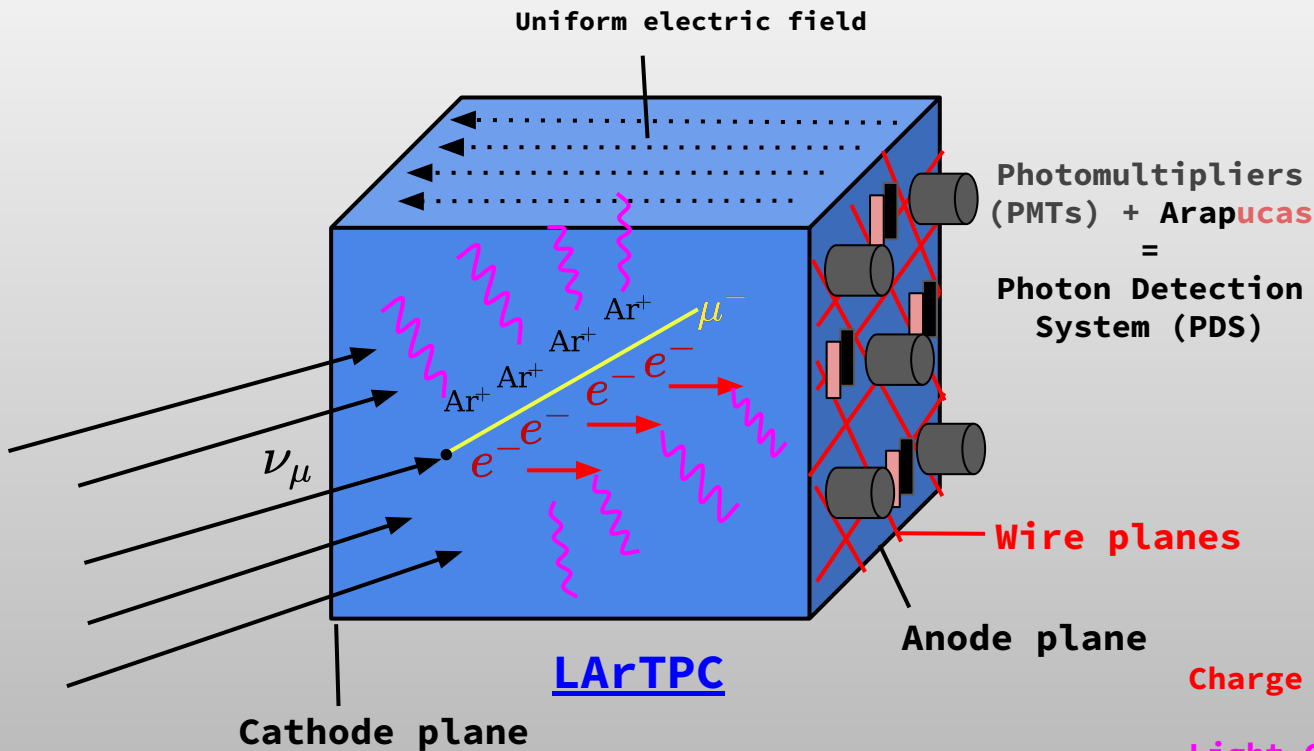
Active volume: 112 ton liquid argon

- Liquid Argon Time Projection Chamber (LArTPC);
- Sits in the beamline of the Booster Neutrino Beam (BNB) at Fermilab;
- SBND will record around 2 million neutrino events per year;
- Goals: eV-scale sterile neutrino and other Beyond Standard Model searches, neutrino-Argon cross-section measurements!



Figures taken from: <https://sbn-nd.fnal.gov/>

SBND LArTPC:



Inside view of one of SBND's TPCs. Photo by Mônica Nunes.

Charge Drift Time: $\mathcal{O}(ms)$

Light Collection: $\mathcal{O}(ns)$

Hardware Trigger Overview:

Goal:

The main goal of a trigger system is to select and qualify detector events based on logic operations inside the electronics which decides to pass or not data to the Data Acquisition (DAQ) System.

SBND will collect charge and scintillation light!

--> CAEN monitor sum signal to MTC/A;

→ Main PTB input/output signals;

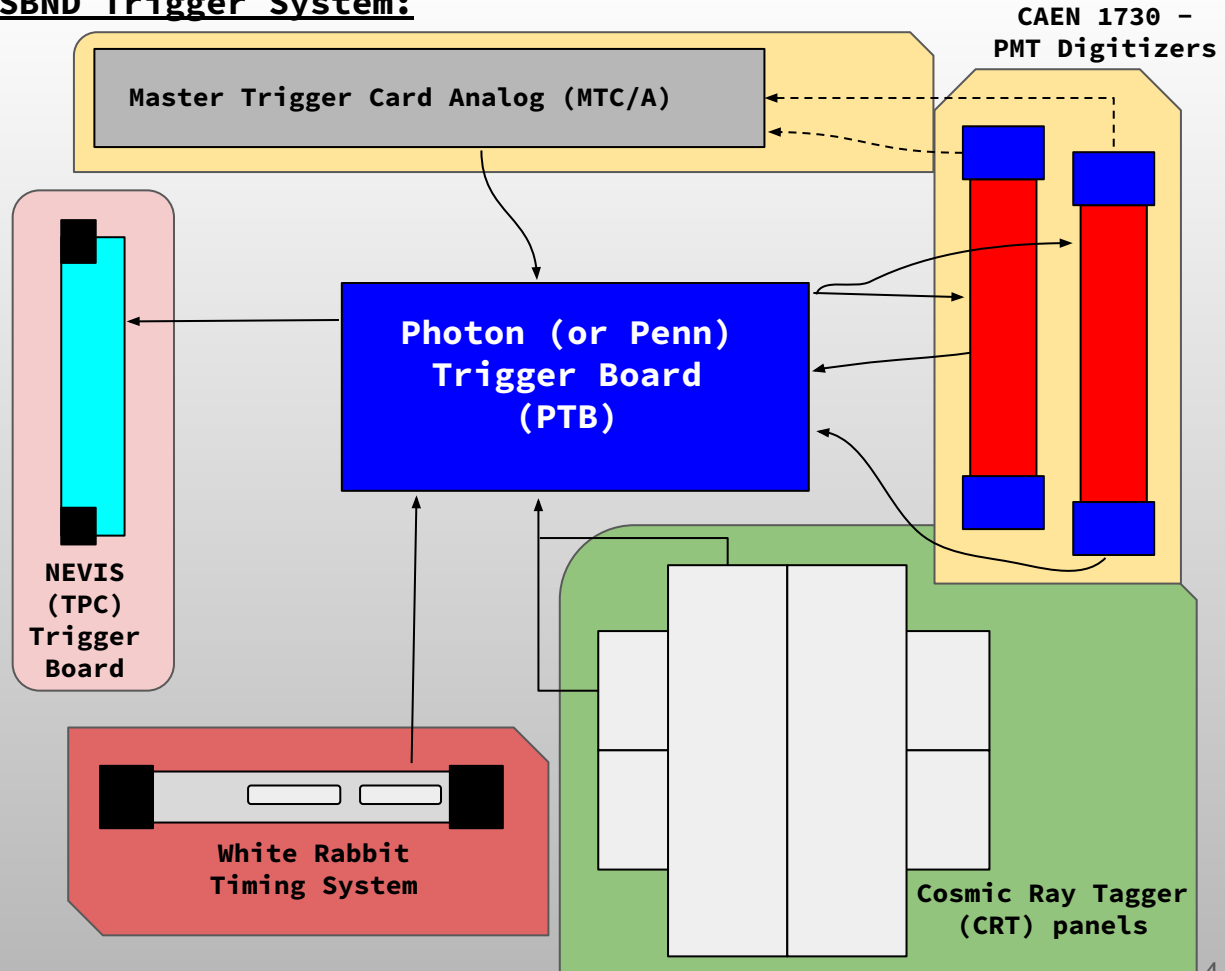
Dedicated to the TPC (charge particles) triggers;

Photon Detection System (PDS) triggers;

CRT triggers;

Beam Early Warning (EW) Signals.

SBND Trigger System:



PTB: Inputs

MicroZED: programmable board that contains:

- Field Programmable Gate Array (FPGA) implements trigger logic and has interface with timing;
- CPU (with Linux) configures the FPGA and communicates with the DAQ software.

Motherboard: establishes hardware interface with the other subsystems.

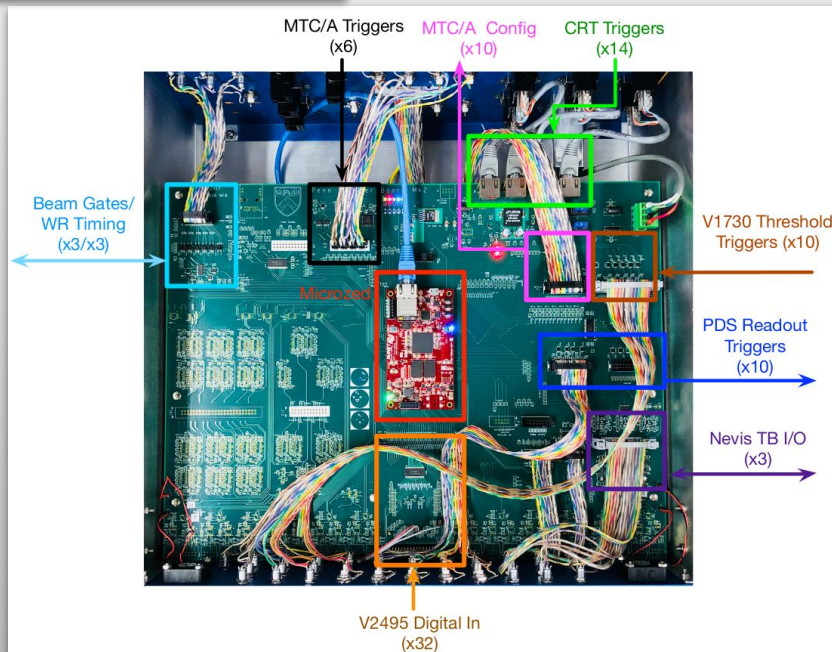
Main goal: the PTB will receive and perform logic operations with the subsystem inputs and it will send the information (timestamp + type of trigger + status) to the DAQ.



Front view.

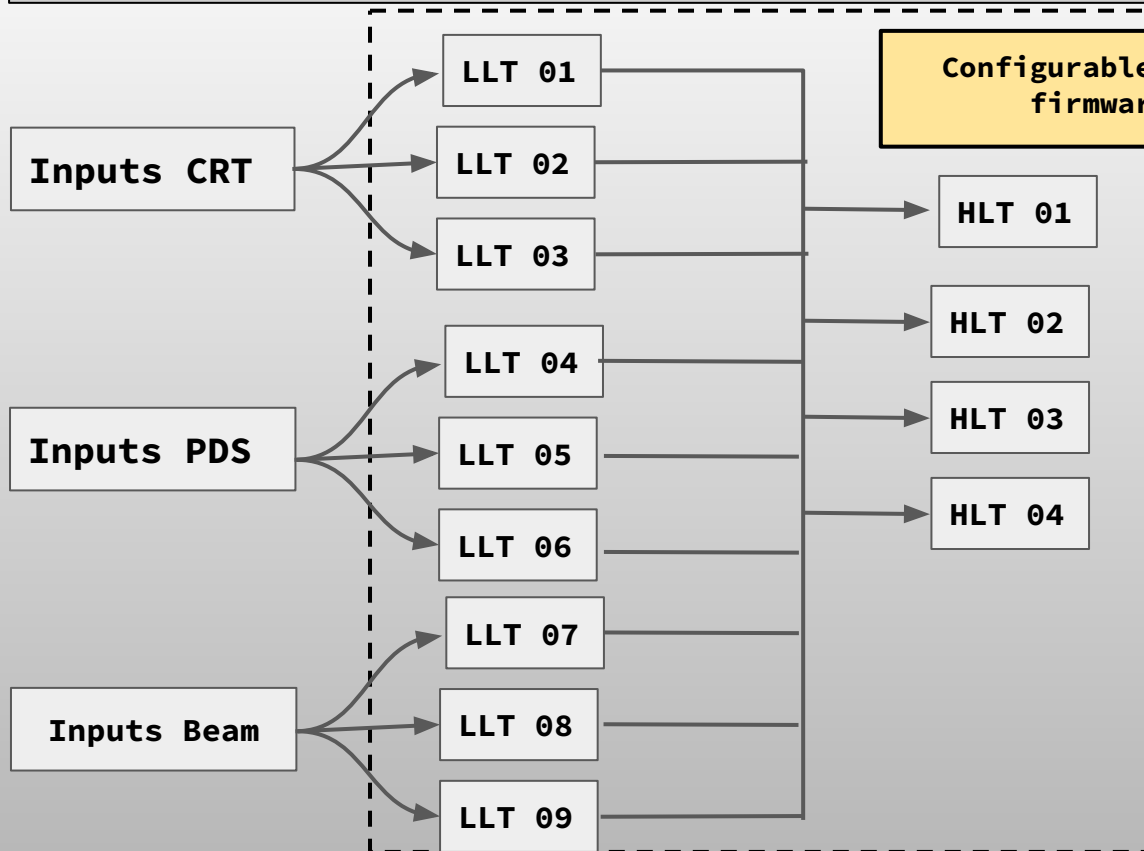
Photon (or Penn)
Trigger Board
(PTB)

Inside view.



PTB: Low- and High-Level Triggers

PTB



Low-Level Trigger (LLT):
Trigger condition at the subsystem level. Examples:

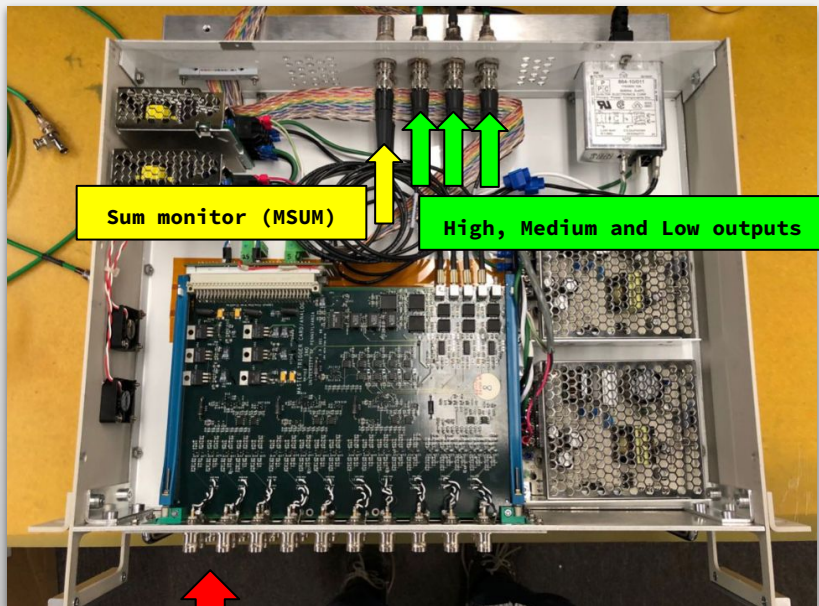
- LLT01: CRT hit on the left side of the cryostat;
- LLT02: Top and Bottom CRT hits;
- LLT04: MTC/A medium PMT activity;
- LLT07: Beam ON.

High-Level Trigger (HLT):
Combination of LLTs.
Example:

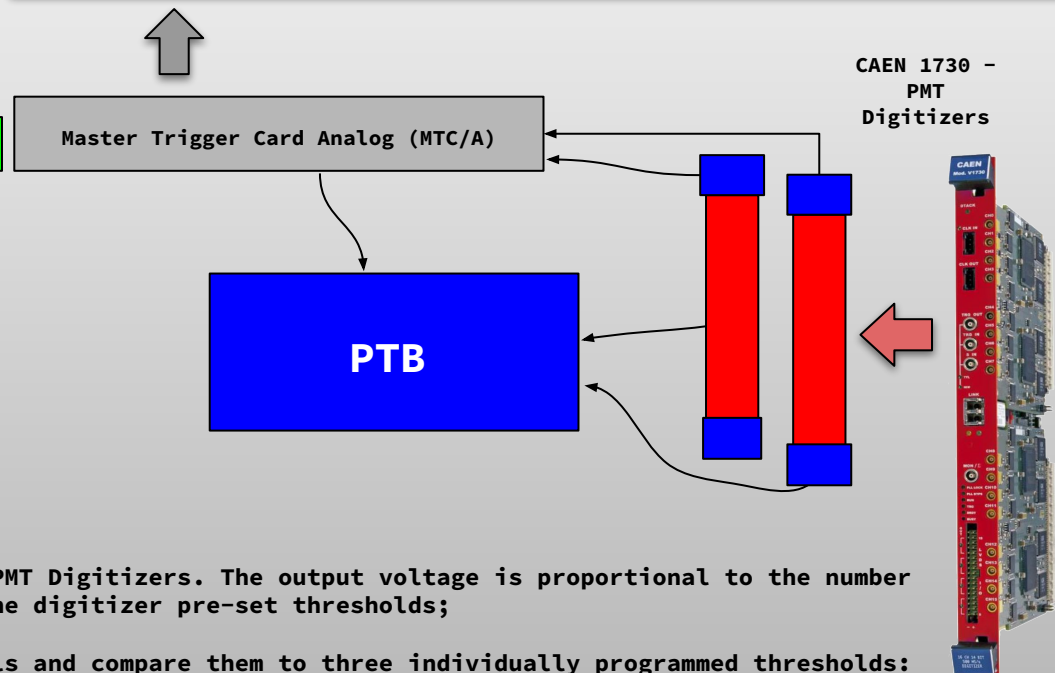
- HLT 02: LLT02 and LLT04.

MTC/A:

Inside view

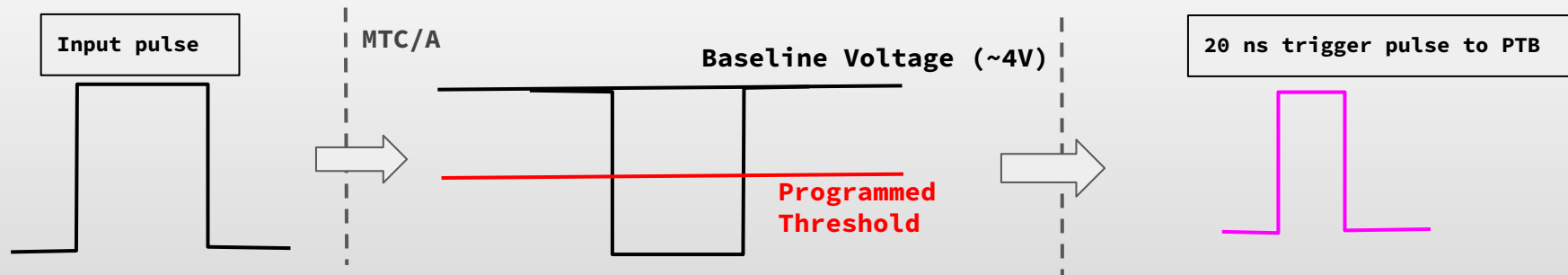


Front view



- MTC/A receives signals from the PMT Digitizers. The output voltage is proportional to the number of PMT pairs that have crossed the digitizer pre-set thresholds;
- The MTC/A will sum all the signals and compare them to three individually programmed thresholds: LOW, MEDIUM and HIGH. The output of these discriminators will be the input to the PTB.

MTC/A: Programming DAC thresholds



- MTC/A Digital to Analog Converter (DAC) thresholds are configurable with the PTB Linux side.

MTC/A 1

MTC/A 2

— High threshold	—
— Medium threshold	—
— Low threshold	—
— Syncbar	—
— Clock	—

Ribbon cable

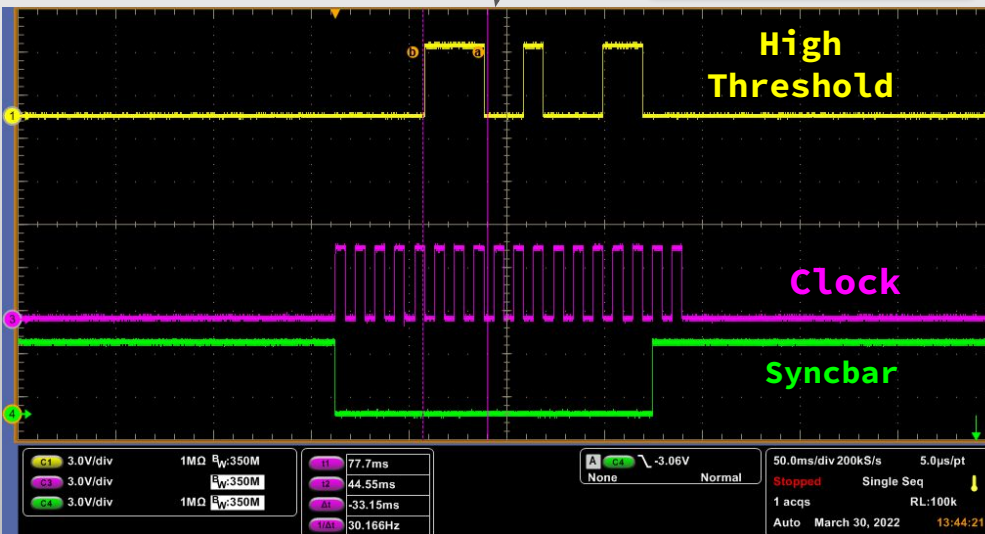


Back view of the MTC/A and the PTB.

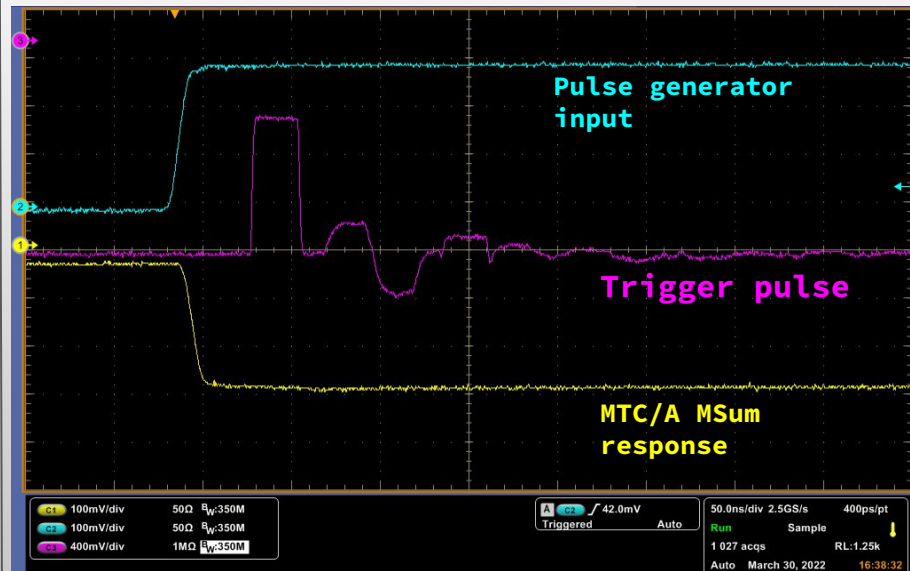
MTC/A: Programming DAC thresholds

Example: setting
High Threshold =
3.9 V

Bitstream



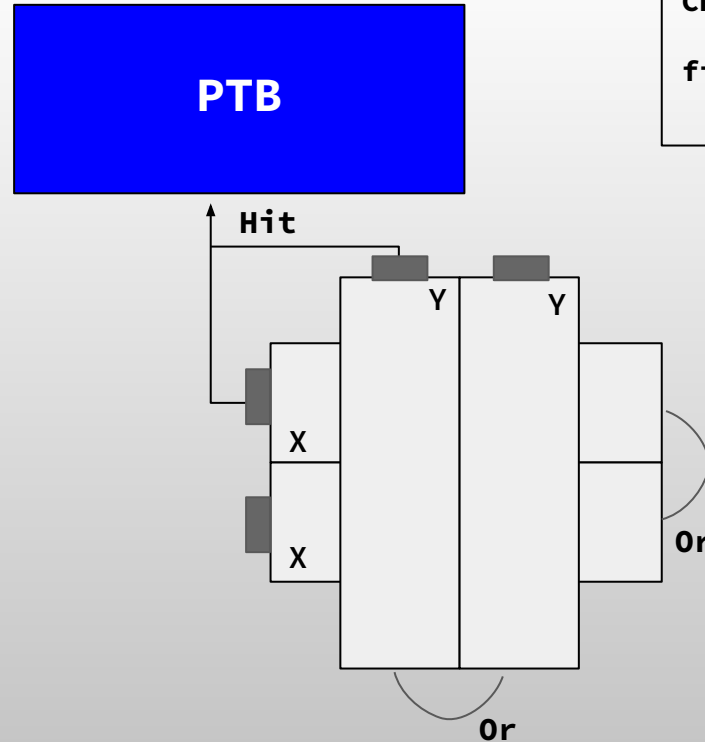
Threshold values should be defined by the user as a 12-bit number, from -5V to 5V.



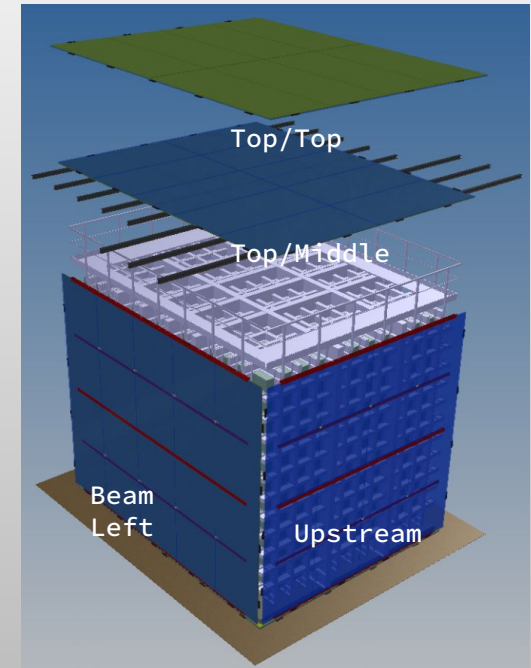
MTC/A 20 ns trigger pulse sent to the PTB after High Threshold satisfied the trigger condition.

CRT:

- Tag muons from cosmic sources that pass through SBND;
- Scintillation strips placed side by side and covered by an aluminium case;
- The signal will be collected by SiPMTs and processed by electronics placed on the edge of each module;
- The PTB will receive the signal from an entire X and Y plane (= Hit).

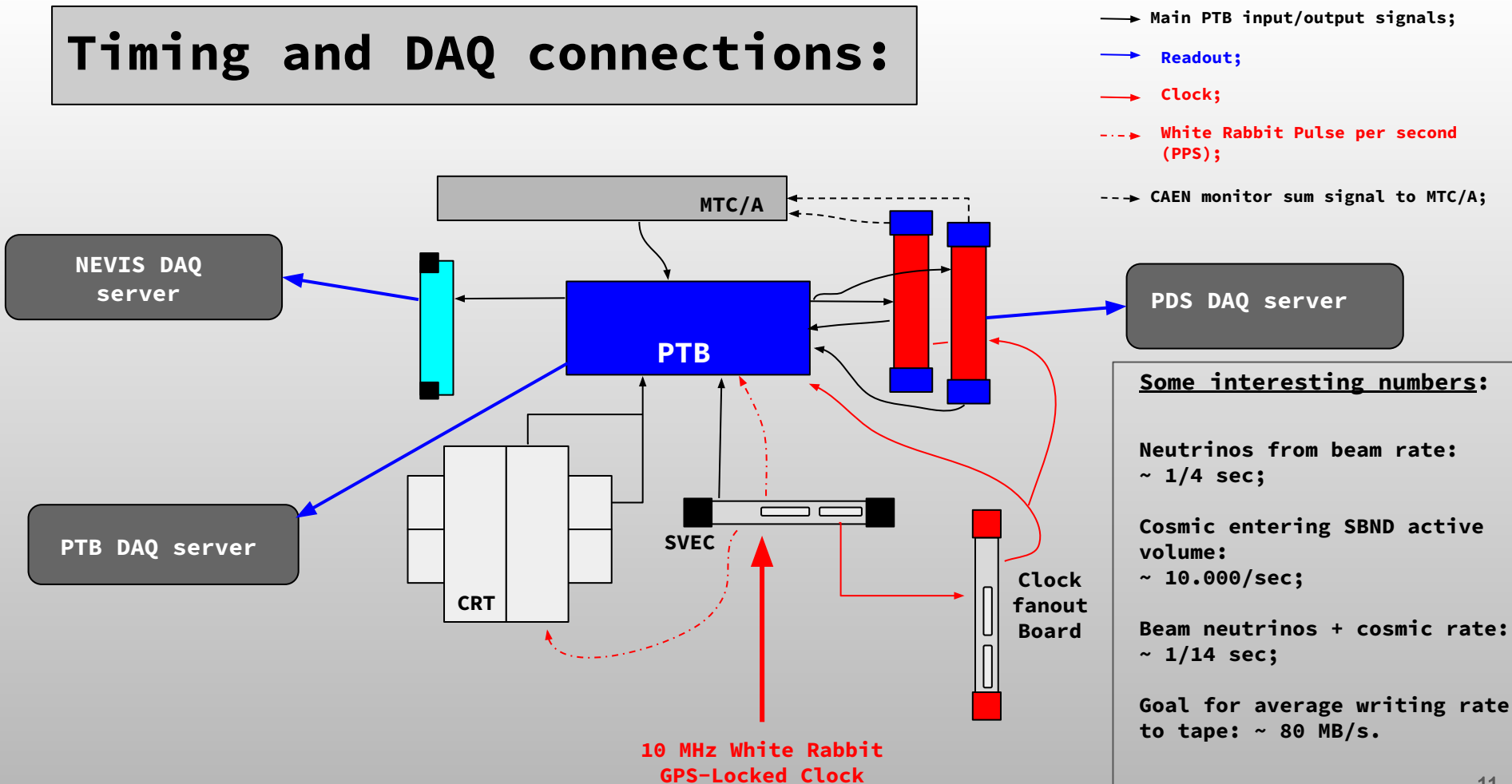


CRT panels will be the last step of SBND installation, after filling the detector with liquid Argon!



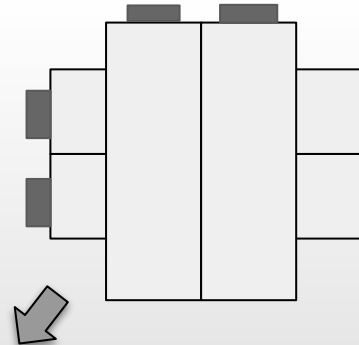
CRT panels covering the cryostat faces.

Timing and DAQ connections:

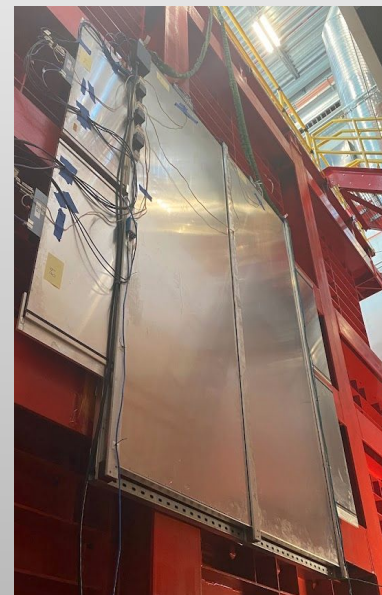


CRT##: Beam Muon Telescope

- One frame on south cryostat wall (beam entrance): CRT Upstream and one frame on the north cryostat wall: Downstream;
- Each frame has roughly 2m x 2m active area;
- The idea is to record muon hits from neutrino beam interactions with rock (2-3 cm spatial resolution, 1-2 ns time resolution);
- Trigger: coincidence of beam + both CRT frames + PTB;
- Use the trigger hardware, DAQ and Data Quality Monitor (DQM) for physics running.



CRT Upstream.



CRT Downstream.

Summary:

- **SBND will record millions of neutrino events per year;**
- **Efficient trigger system required to select/qualify events inside TPC (neutrinos from the beam, cosmic muons...);**
- **SBND Commissioning ongoing work is successfully integrating the hardware trigger components into the timing system and the DAQ!**



Thank you!