# GUI development for the ATLAS sMDT MiniDAQ system

University of Michigan ATLAS group

US ATLAS SUPER program final presentation

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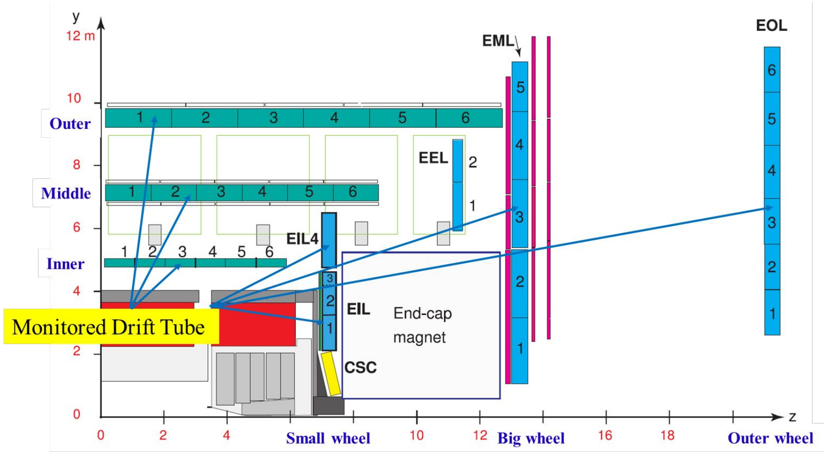
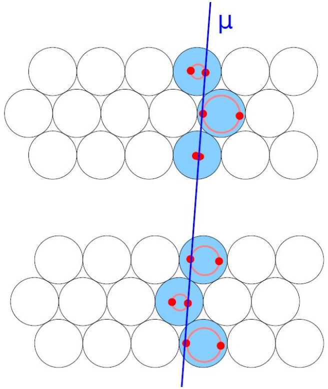
# Contents

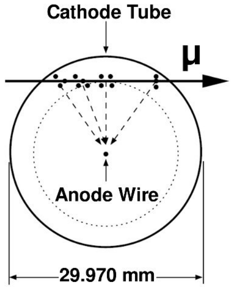
# ATLAS and Muon spectrometer Overview

- ATLAS:
  - general purpose particle detector
  - search for new physics
  - perform precision measurements

- Precision muon chambers - Monitored Drift Tubes (MDT):
  - slow response (~800 ns)
  - precise position resolution (~100 μm)
  - determine muon p with resolution of 10% at 1 TeV
- Trigger muon chambers:
  - Resistive Plate Chambers (RPC)
  - Thin Gap Chambers (TGC)
  - fast response (1-20 ns)
  - limited position resolution (~1 cm)

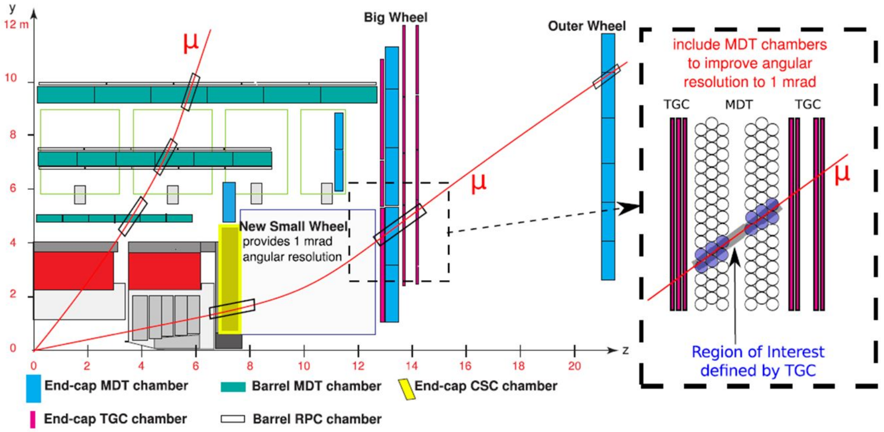


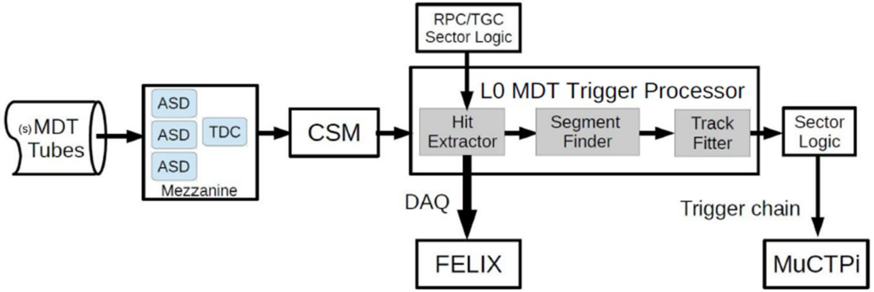



# Phase-II MDT upgrade

- Phase-II upgrade
  - collision rate increased by 5-7 factor
  - MDTs - improve the trigger muon momentum resolution at first trigger level
  - RPCs/TGCs - provide timing and regions of interest for MDT triggers
  - New electronics required due to:
    - larger event rate - 1MHz at first trigger level and 10 kHz for data recorded to the tape (100kHz and 1kHz currently)
    - longer latency - 10 microseconds for first trigger level (2.5 microseconds currently).

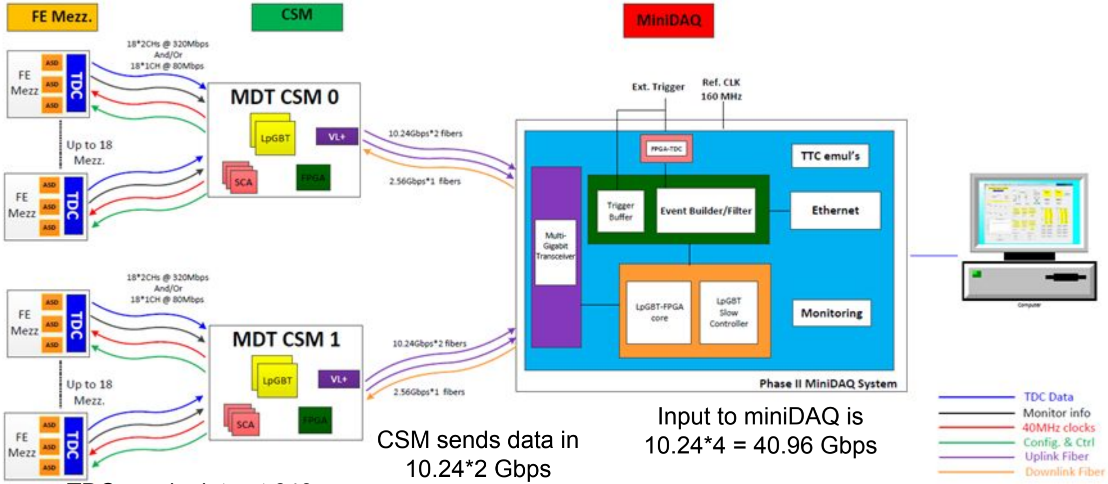



- Upgrade front-end electronics:
  - Amplifier/Shaper/Discriminator (ASD)
  - Time to Digital Converter (TDC)
  - Chamber Service Module (CSM)
  - L0 MDT trigger processor



# MiniDAQ system

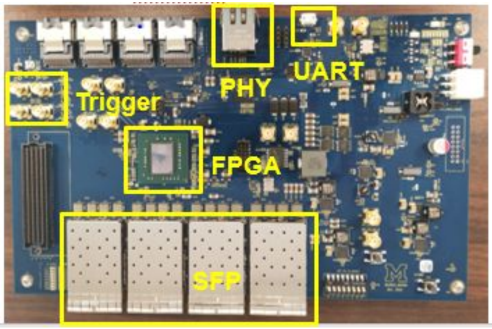
- Need a mobile MiniDAQ system to:
  - integrate new electronics
  - test chambers
  - chamber integration/ commissioning on surface and inside collision hall
- MiniDAQ system will connect to:
  - two CSMs
  - each CSM connects to up to 18 mezz cards
  - each mezz card will have 3 ASD chips and 1 TDC chip
  - Total: miniDAQ handles 108 ASD and 36 TDC chips




TDC sends data at 640 Mbps

CSM sends data in 10.24*2 Gbps

Input to miniDAQ is 10.24*4 = 40.96 Gbps



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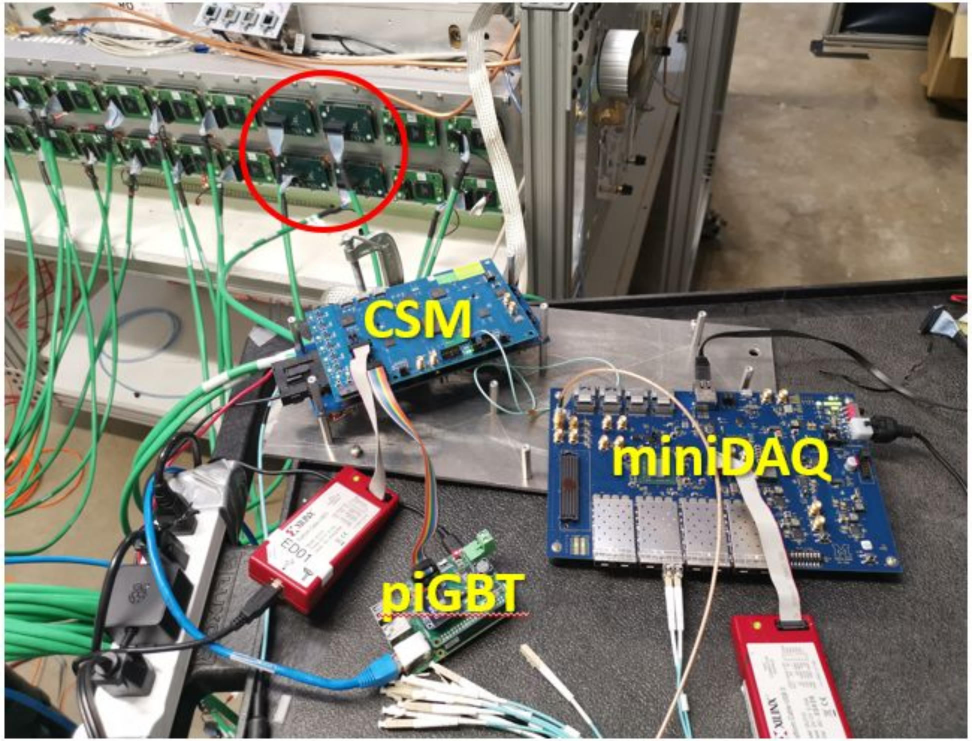


# GUI Outline

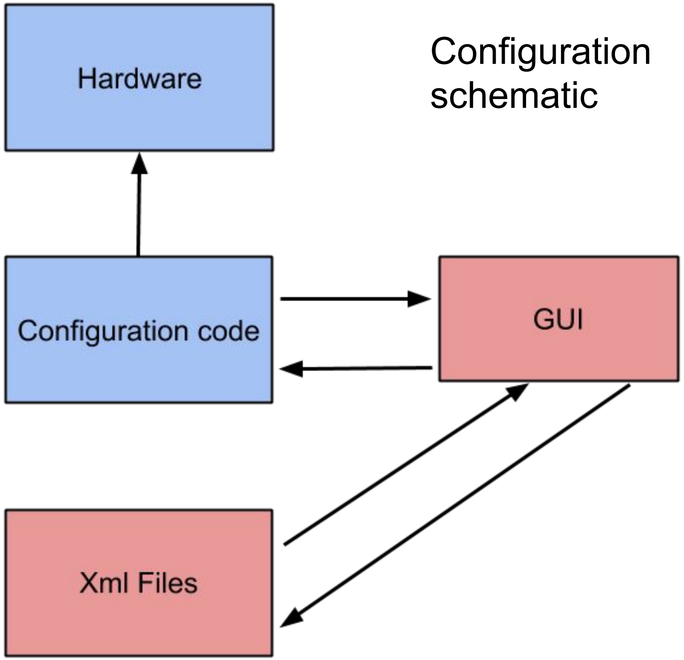
- Michigan responsible for building:
    - half of 96 new sMDT chambers
    - 22k TDCs
    - 1.2k CSMs
    - A mobile miniDAQ system to test newly built chambers and front-end electronics
    - Perform detector-electronics integration and commissioning
- The miniDAQ system requirements:
    - configure/control all front-end chips, CSM boards, and FPGA data processing eval. Board (of CSM board).
    - collect data at different running conditions
    - analyze and monitor the output data
    - record data on a PC
- All configure/control/monitor tasks will be done through a GUI running on a PC

# GUI connection logic

- **Configuration Code:**
  - stores TDC, ASD, and CSM values in memory, connects to both the hardware and GUI values.

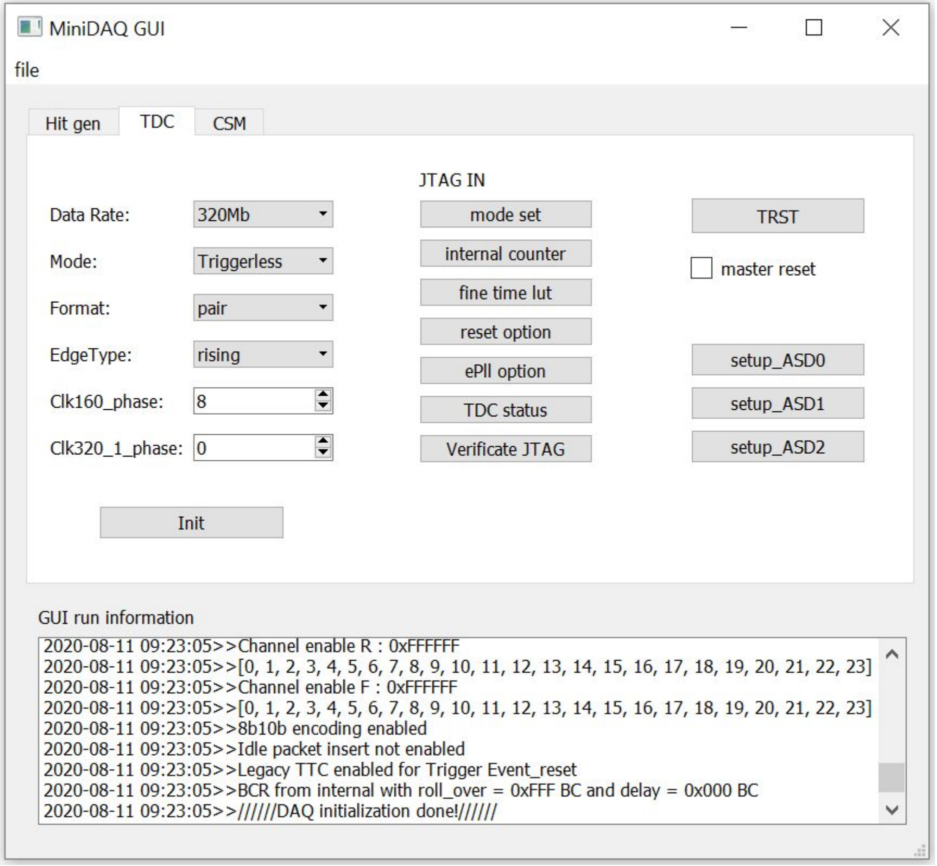
- Parameters can be determined, loaded, and saved in one of two ways:
  - **GUI** - change individual parameters, easily connect to hardware through config. code, save setup to xml file.
  - **Xml files** - easily load and save all TDC, ASD, and CSM parameters to GUI and connect to hardware through config. code.

Configuration schematic



# GUI current progress

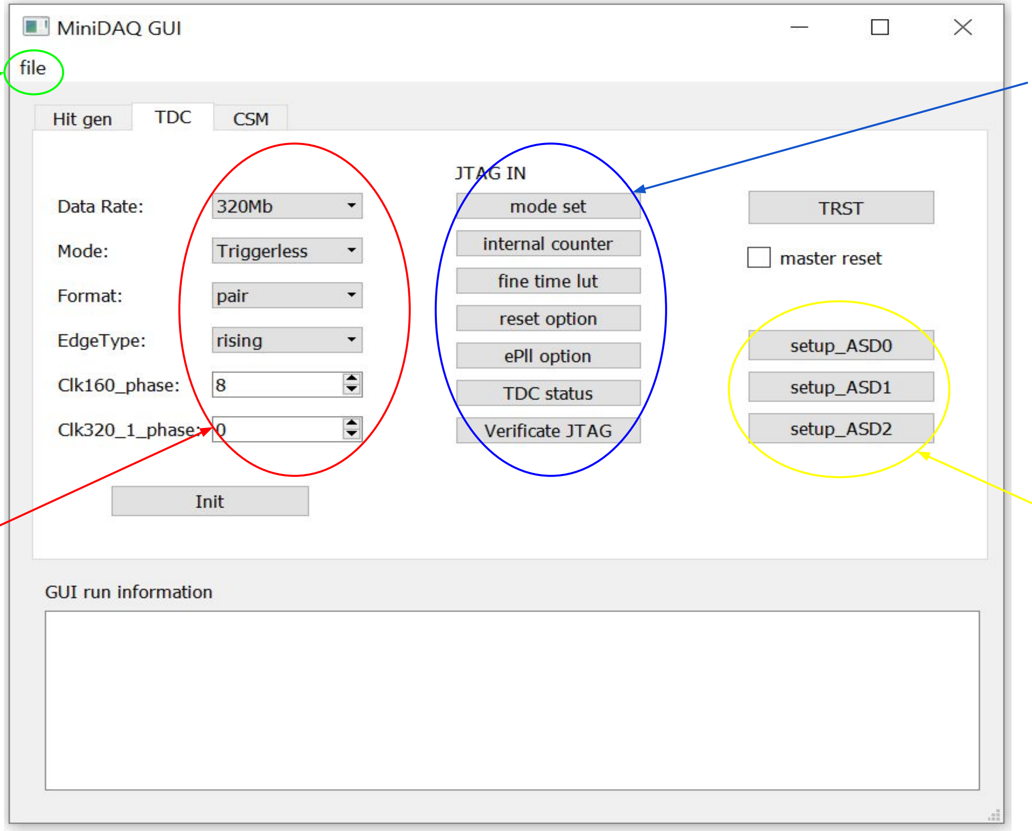
- Have implemented functions to:
  - Tell the FPGA how to configure the TDC
  - Tell PC how to decode data from the TDC
  - Create, load, and save common TDC configs.
  - Perform similar operations for ASD and lpGBT within the CSM.
- GUI created with python, PyQt, and QtDesigner



# GUI current progress: TDC and ASD

Menu bar for loading and saving setup to xml file

TDC general function setup

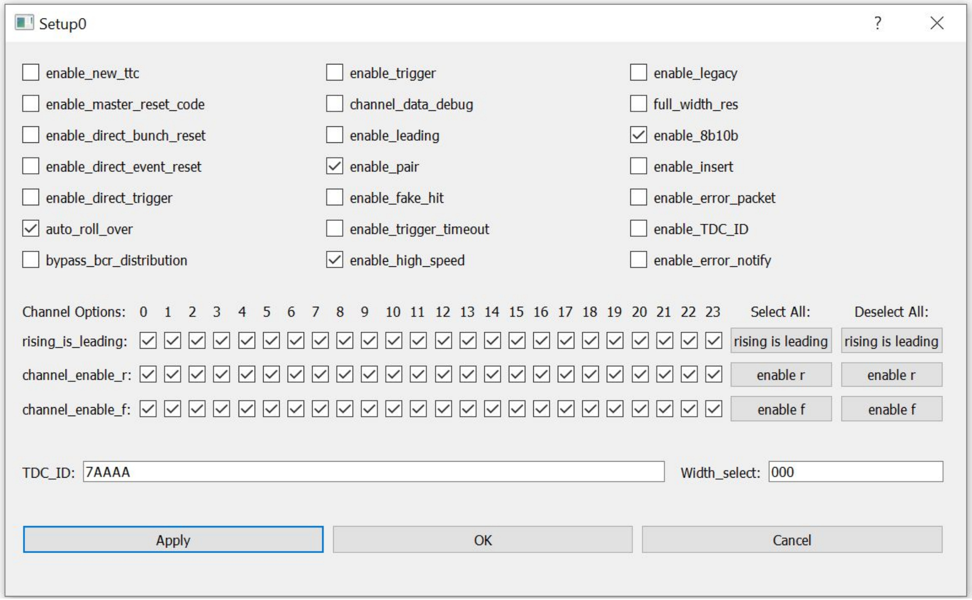



TDC detailed function setup

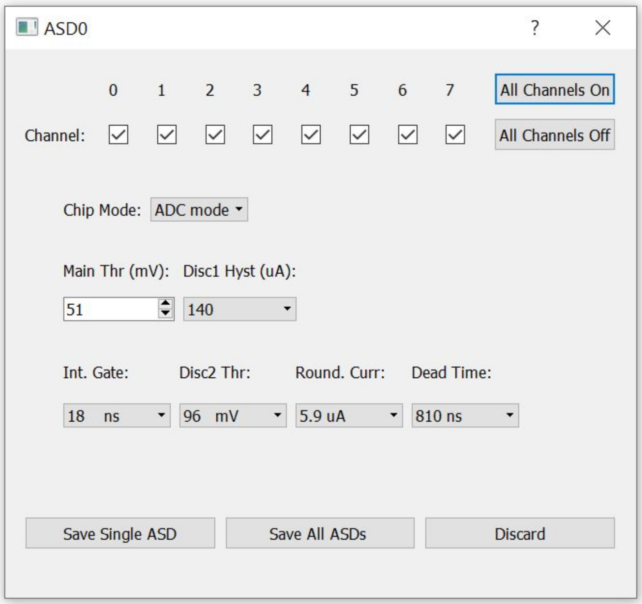
ASD function setup -three ASDs per TDC

# GUI current progress: TDC and ASD

Example of TDC detailed function- Mode Set:



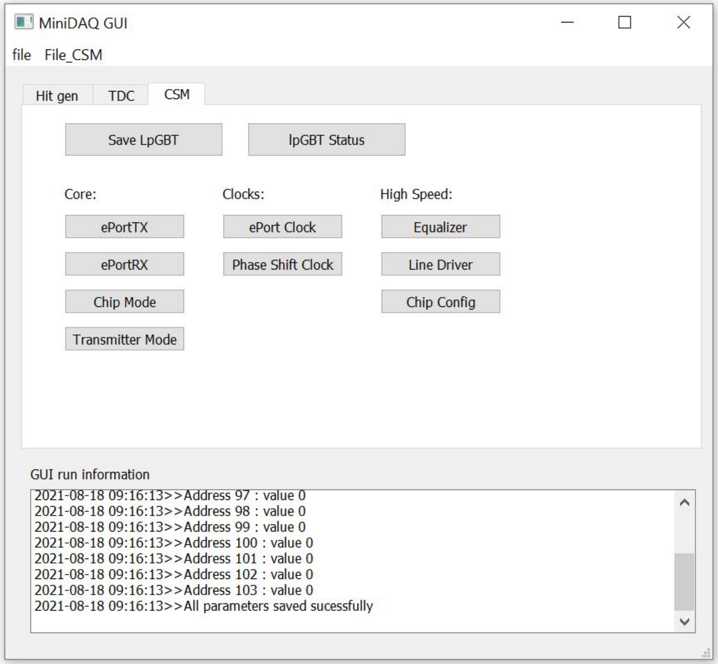

Example of ASD function - ASD0:



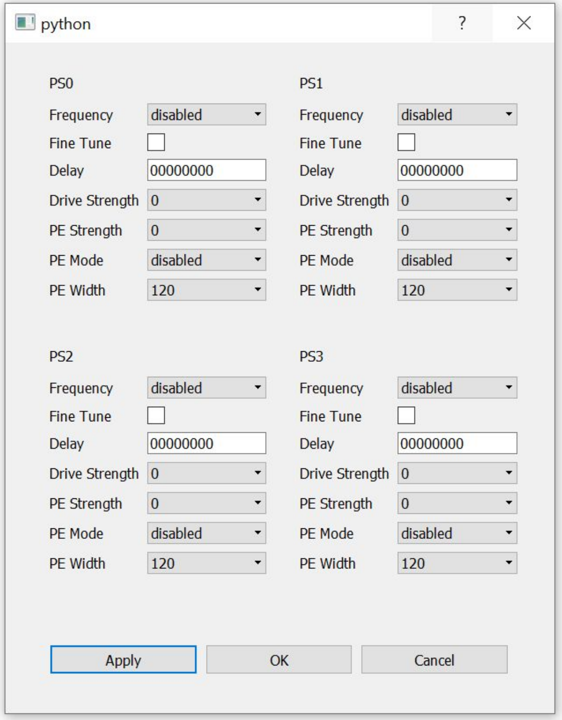
# GUI current progress: lpGBT for CSM board

- Low power GBT (lpGBT) within the CSM is still in the final stages of development.
- Not many people use lpGBT at the moment, GUI for it is needed to enable easy future use
- Current CERN lpGBT configuration method:
  - Web-based control GUI with a raspberry pi board.
- My GUI will allow:
  - Configuration of lpGBT without requiring the internet
  - Will remove the need for a raspberry pi board.

lpGBT general board:




Example of lpGBT detailed setup - Phase Shift Clock



# Next steps

- Future Steps:
    - Import similar configuration for further CSM implementation and FPGA evaluation board
    - Add modes for noise runs and cosmic ray runs
    - Implement code to analyze and monitor output data
    - Further test functionality and continue to make necessary improvements
- Expect this system to be in use for the next ten years at Michigan and CERN

# Final Remarks

- **Thank you!**
  - Mentors:
    - Advisor: Junjie Zhu
    - Graduate Student Advisor: Yuxiang Guo
  - Additional thanks to:
    - US ATLAS SUPER Program
- Questions?

# Resources

[1] Requirements and Specifications of the Phase-II TDC for the ATLAS MDT Detector

[2] Evidence for the production of three massive vector bosons with the ATLAS detector

[3] mini_DAQ diagram from Xueye Hu