DAQ System for Testing the Micromega Trigger with Cosmic Rays at Harvard

M. Bledsoe, N. Felt, M. Franklin, B. Garber, P. Giromini, J. Grotto, J. Huth, C. Rogan, A. Tuna, A. Wang

NSW Electronics Meeting
February 12, 2016

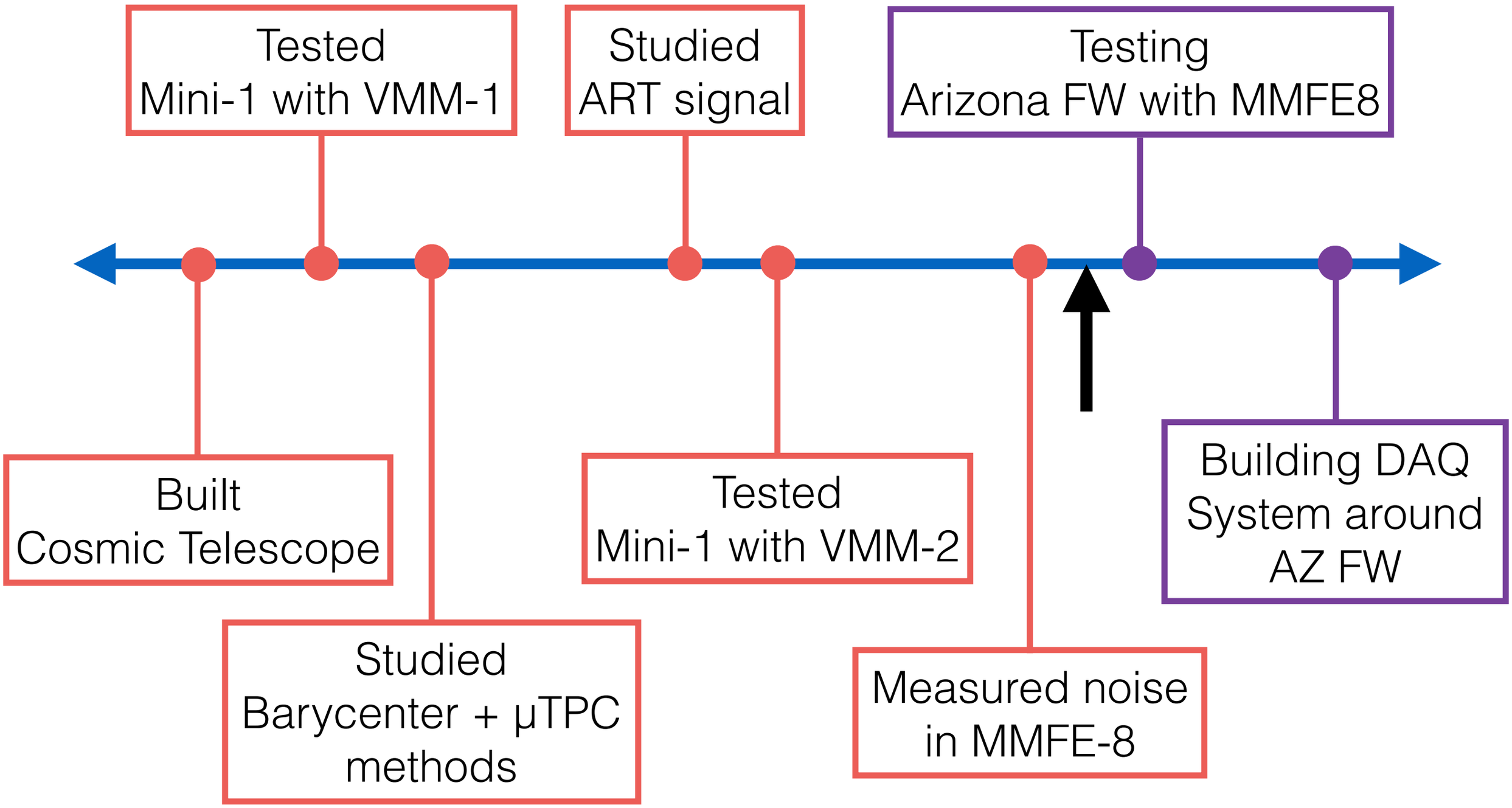
Outline

- We want to have a working DAQ system to test the MM trigger at Harvard with cosmic rays

Topics:

1. Previous/recent work
2. Plan for DAQ system
    - VMM Synchronization
    - Calibration

Our Timeline



Introduction

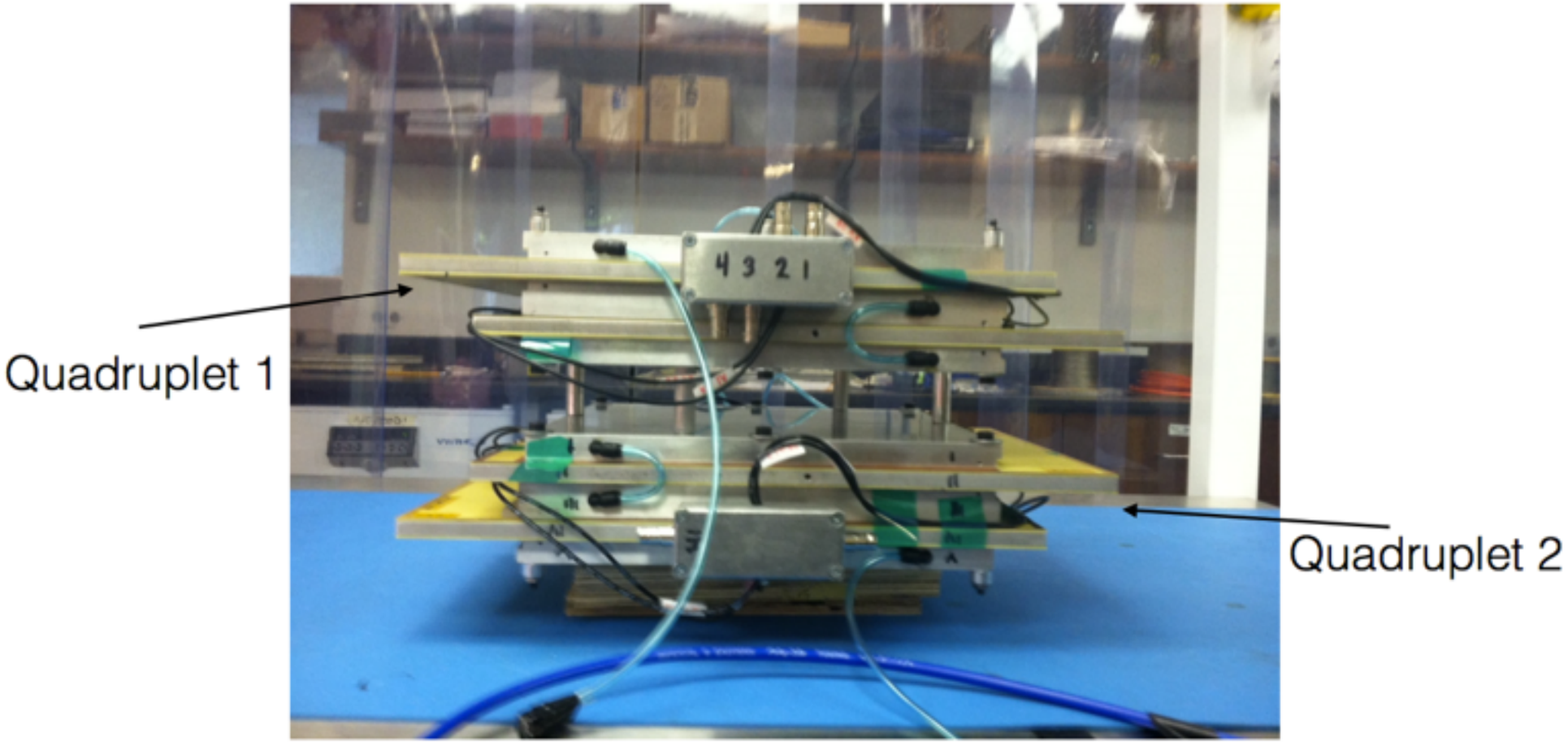
Harvard Cosmic Ray Telescope (HCRT)

ATL-COM-UPGRADE-2014-038

- We previously collected cosmic ray data using the Mini-1 board with VMM1
- Now we would like to do it with the MMFE-8 board and VMM2

Plan of attack for DAQ system

- Want to conduct a cosmic ray test using an octuplet equipped with the MMFE-8 boards
- We have a octuplet ready to test, need more electronics



Current Firmware Work

- We have been testing firmware provided by Arizona for the 8 VMMs and the accompanying GUI on the MMFE-8 board
- Have been debugging with Arizona
- We have reached a stable, working version for 8 VMMs
- Our plan to build our DAQ system is to use the available firmware and hardware

Future plan of attack for DAQ system

- Two remaining tasks for building the final DAQ system for our test:

1. **VMM synchronization** across the octuplet
2. **Calibration** of multiple VMMs

VMM Synchronization

- We want to take data with 8 VMMS on 8 different MMFE-8 boards

- Every board has its own BC clock and each VMM has its own BC counter

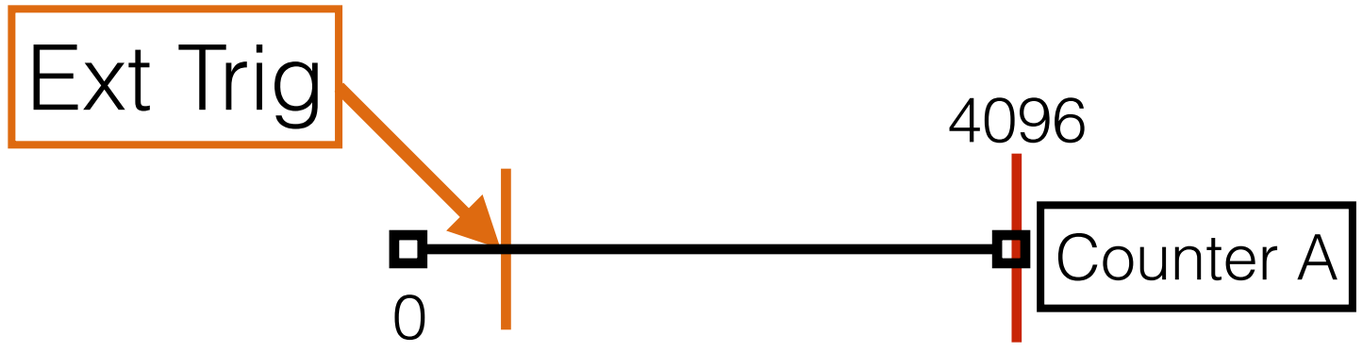
- We want to synchronize the BC counter for all VMMs and all boards

- We also need to send soft resets which needed to preserve token logic, but these reset the VMM BC counters

VMM Synchronization

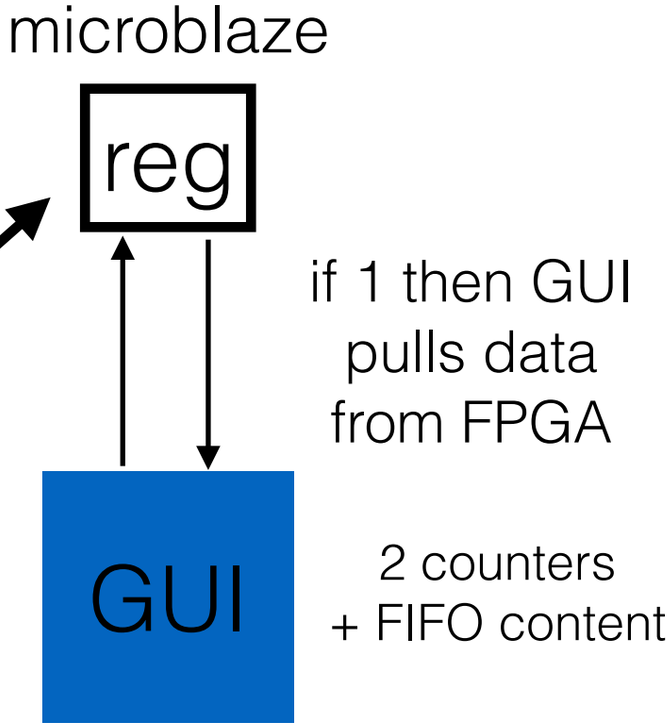
- Plan is to use the external trigger to synchronize the VMMs and to send the soft resets
- We are implementing two additional counters in the FPGA
  - Counter **A**: Counts # CKBC in the FPGA
  - Counter **B**: Counts # of External Triggers
  - Write these counters to a register in the FPGA
  - The counter word and the VMM data in the FPGA FIFO will then be pulled, presently done by the Arizona GUI
  - The result will give us enough information to match the trigger with the data

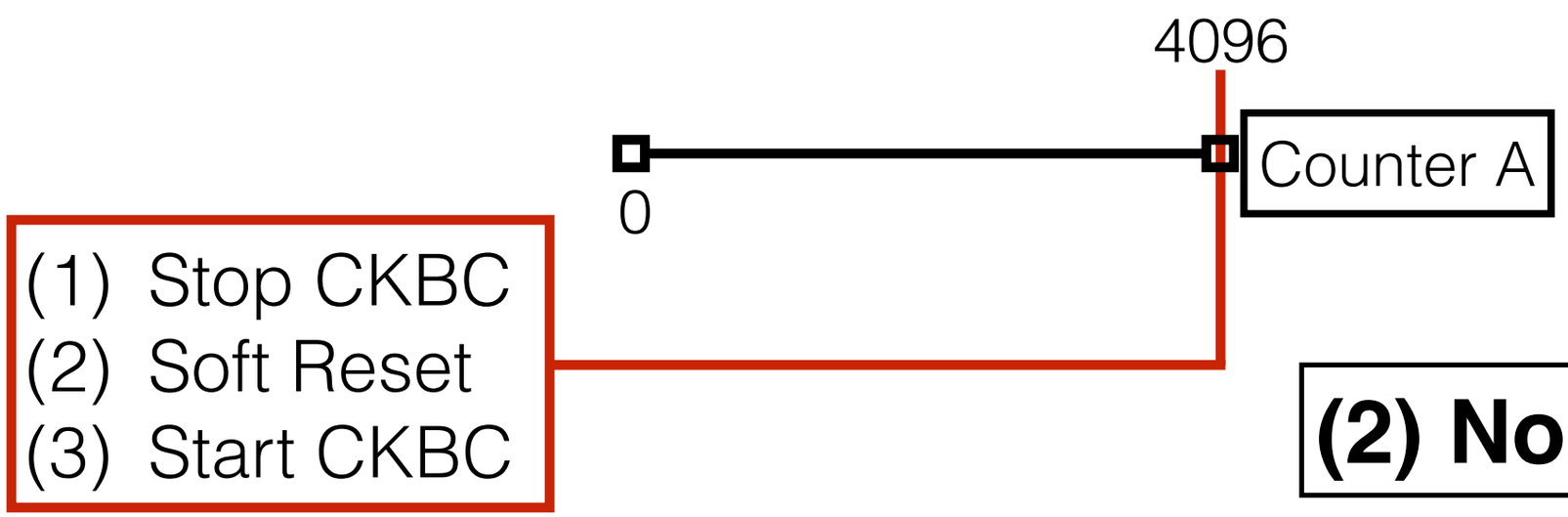
VMM Synchronization



(1) External Trigger

(1) Stop CKBC, inhibit Ext Trig
(2) Wait Δt = T to drain VMM FIFOs
(3) Set reg signaling that trigger happened
(4) Soft Reset
(5) Start CKBC, allow Ext Trig





(2) No External Trigger

Calibration of Multiple VMMs

- Next step is to have a calibration system for the PDO and TDO so we can collect data
- We want to efficiently scan through all channels on all VMMs on all the boards that we are using

PDO Calibration

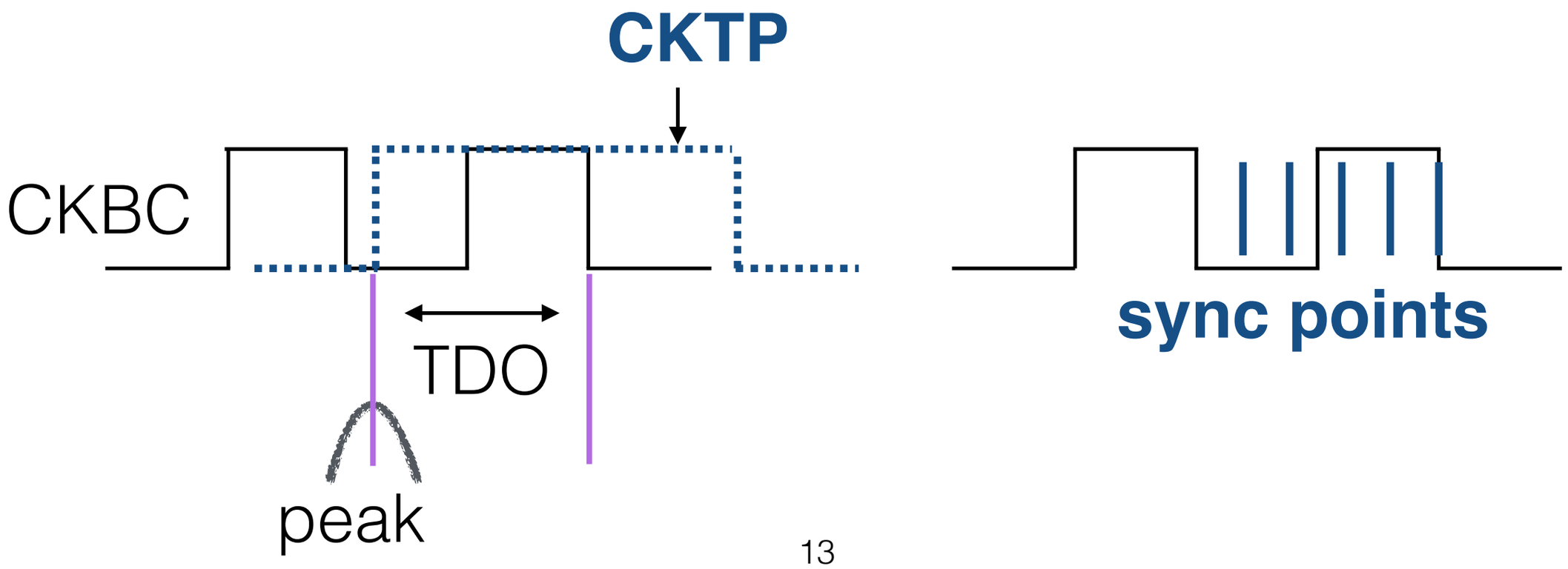
- PDO: send test pulses with different DACs, but DAC conversion is different for each VMM

- We can use the FPGA on-board ADC built by Arizona

- We have tested it and it works well

TDO Calibration

- Previously, we calibrated the TDO by slowing down CKBC, but this was a quick fix
- Better calibration: synchronize CKTP with CKBC and delay it using ticks of the faster mother clock (200 MHz)
- Code is mostly done, wrapping up



Conclusion

- Have been testing the firmware and GUI from Arizona
- We are close to having a full DAQ system
  - Will work on implementing external trigger synchronization scheme
  - Calibration is well on its way
- We have an expanding team (many new students!) to work on this

Backup

Summary of Past Work

- Our goal: have a working DAQ system to test the MM trigger at Harvard with cosmic rays

1. Built the Harvard Cosmic Ray Telescope (HCRT) with a CAMAC based trigger[1]

2. Tested Mini-1 board with VMM1[1]

ATL-COM-UPGRADE-2014-038

Summary of Past Work

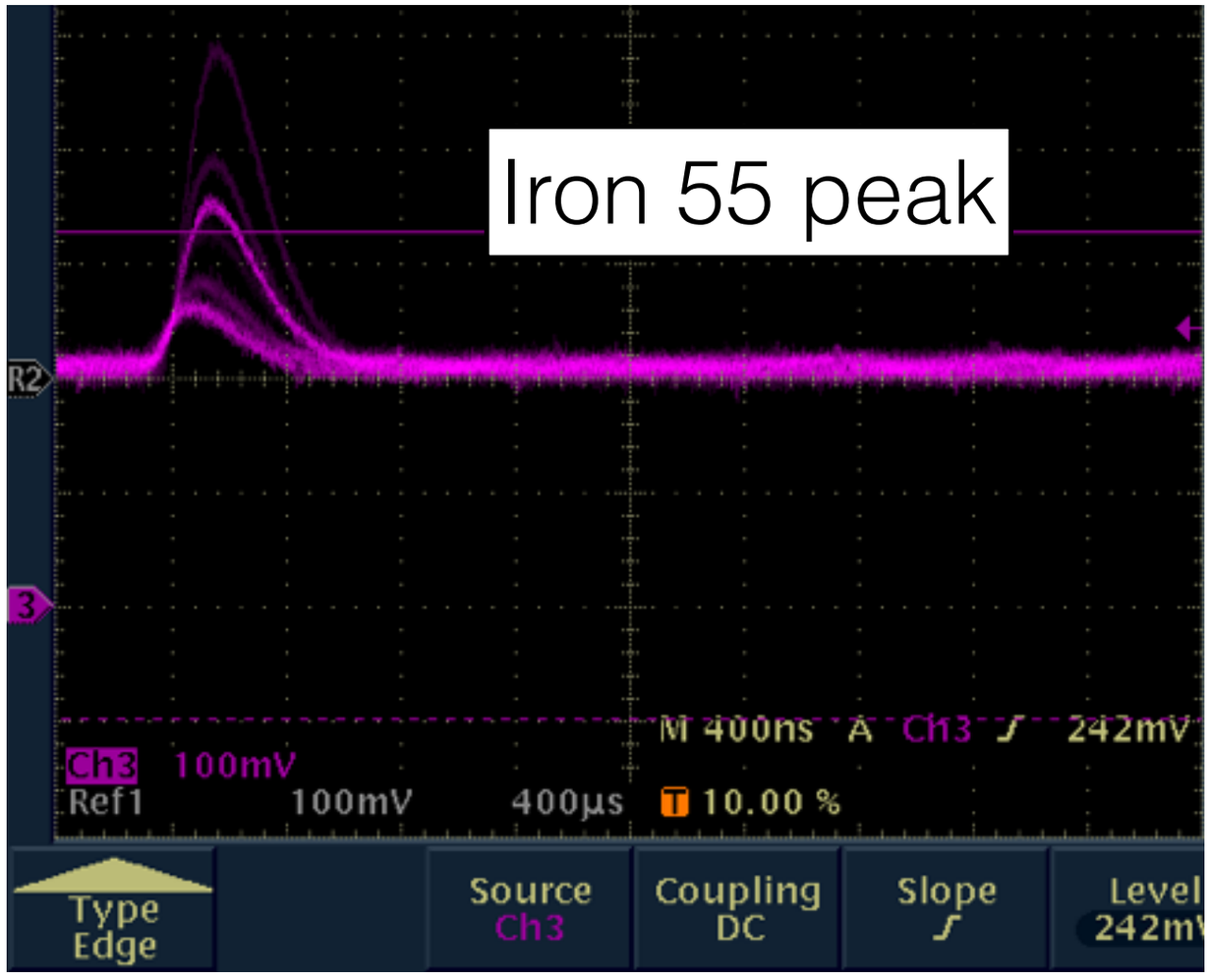
- Instrumented a 10 x 10 cm^2 MM with two Mini-1 boards and studied the barycenter and μTPC methods for tracks[1]

- Studied spatial and timing resolution of the ART signal[2]

- Tested Mini-1 with VMM2, found bugs and reported them for fixes in VMM3[4]

Summary of Past Work

- Testing/learning firmware provided by Arizona
  - Started with the version for one VMM
  - Used this to test the noise in an MMFE-8 board with a MM chamber, found negligible noise[5]



External documents + talks

1. Test of a resistive micromega v3.0 prototype with VMM1 readout using >- 0.8 GeV/c^2 cosmic muons, **ATL-COM-UPGRADE-2014-038**

2. Test of the VMM1 Address in Real Time (ART) output using >- 0.8 GeV/c^2 cosmic muons, **ATL-COM-MUON-2014-069**

3. Re-analysis of the 2012 test-beam data, **ATL-COM-MUON-2014-051**

4. Bench test of VMM2 mini-1 boards, **ATL-COM-MUON-2015-078**

5. Measurement of the Noise in an MMFE-8 Front-End Board, https://indico.cern.ch/event/465405/