

Beam Timing Upgrades For MicroBooNE

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External Beams Meeting

3 November 2016

Signals for MicroBooNE

- BNB

- BNB Trigger Signal
- BNB Monitor
- Impact

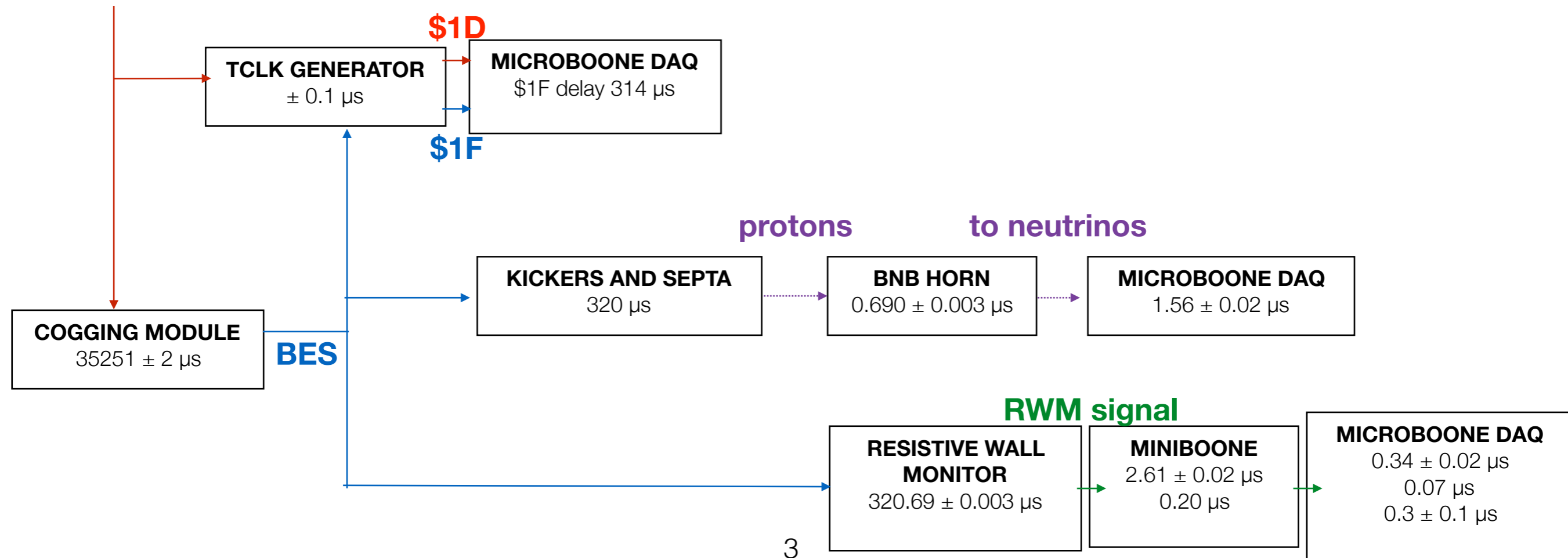
- NuMI

- NuMI Trigger Signal
- NuMI Monitor
- Impact

BNB Signal Paths

- For 2015-2016 running, open trigger window on coincidence of:
 - TCLK \$1D (protons to BNB)
 - TCLK \$1F (protons leaving Booster)

“proto”-\$1D
extract Booster
to BNB



Limitation of BNB Signal for Triggering

- Limitations of current system:

- The $\$1F$ notification may be delayed by 1.2 us unexpectedly

- Why:

- 1.2 us is how long it takes an event on the TCLK to be written.
 - The $\$1F$ is not the highest priority event to be written to TCLK. It may have to wait its turn.
 - As the accelerator complex grows to provide beam for the muon campus, this can become a bigger issue.

- Impact to uB:

- A delayed signal means that our DAQ trigger window (currently 1.8 us) would miss 75% of the beam pulse and so in danger of not triggering on genuine neutrino interactions.

- TCLK has intrinsic 100 ns jitter

- Why:

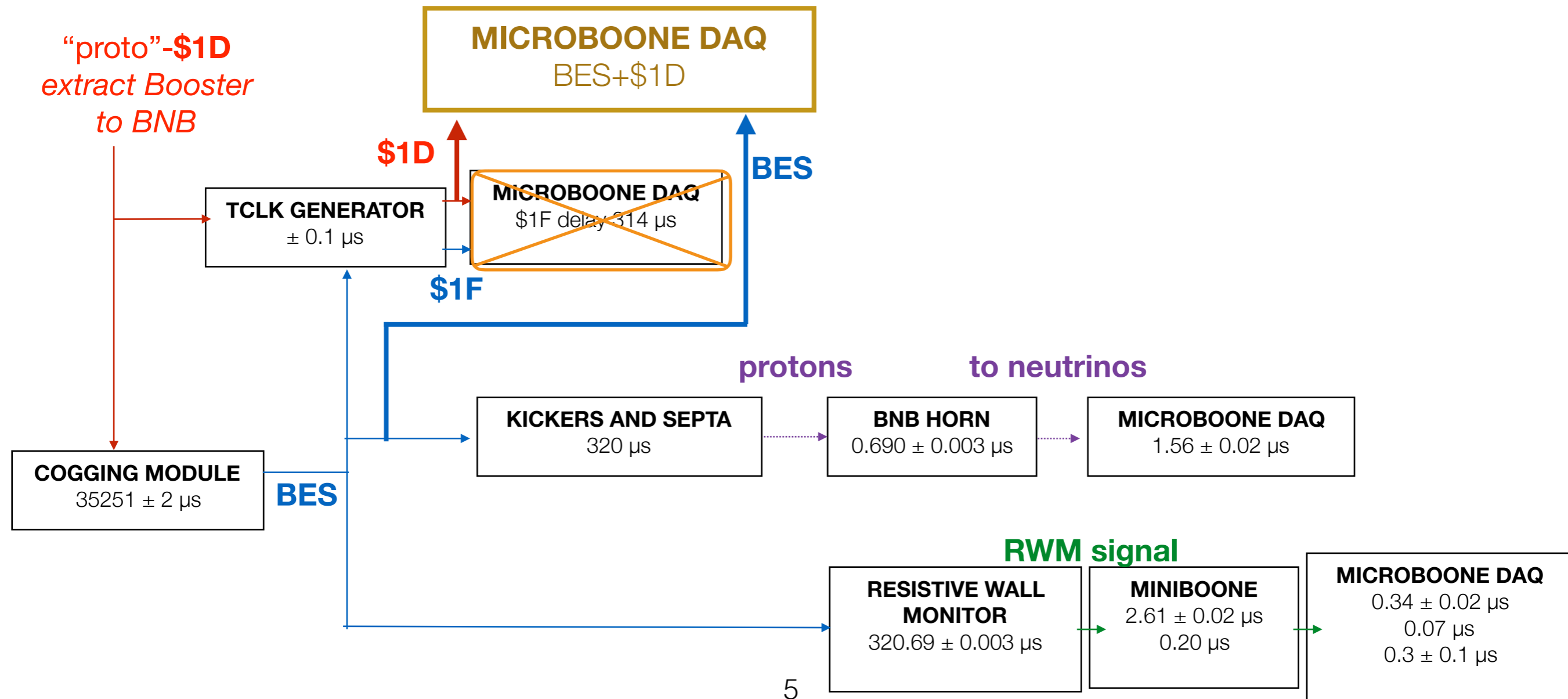
- The TCLK has a 10 MHz clock, this is the limiting factor in time resolution.

- Impact to uB:

- Want to know more precisely when neutrinos are in detector: study slightly out-of-time backgrounds!

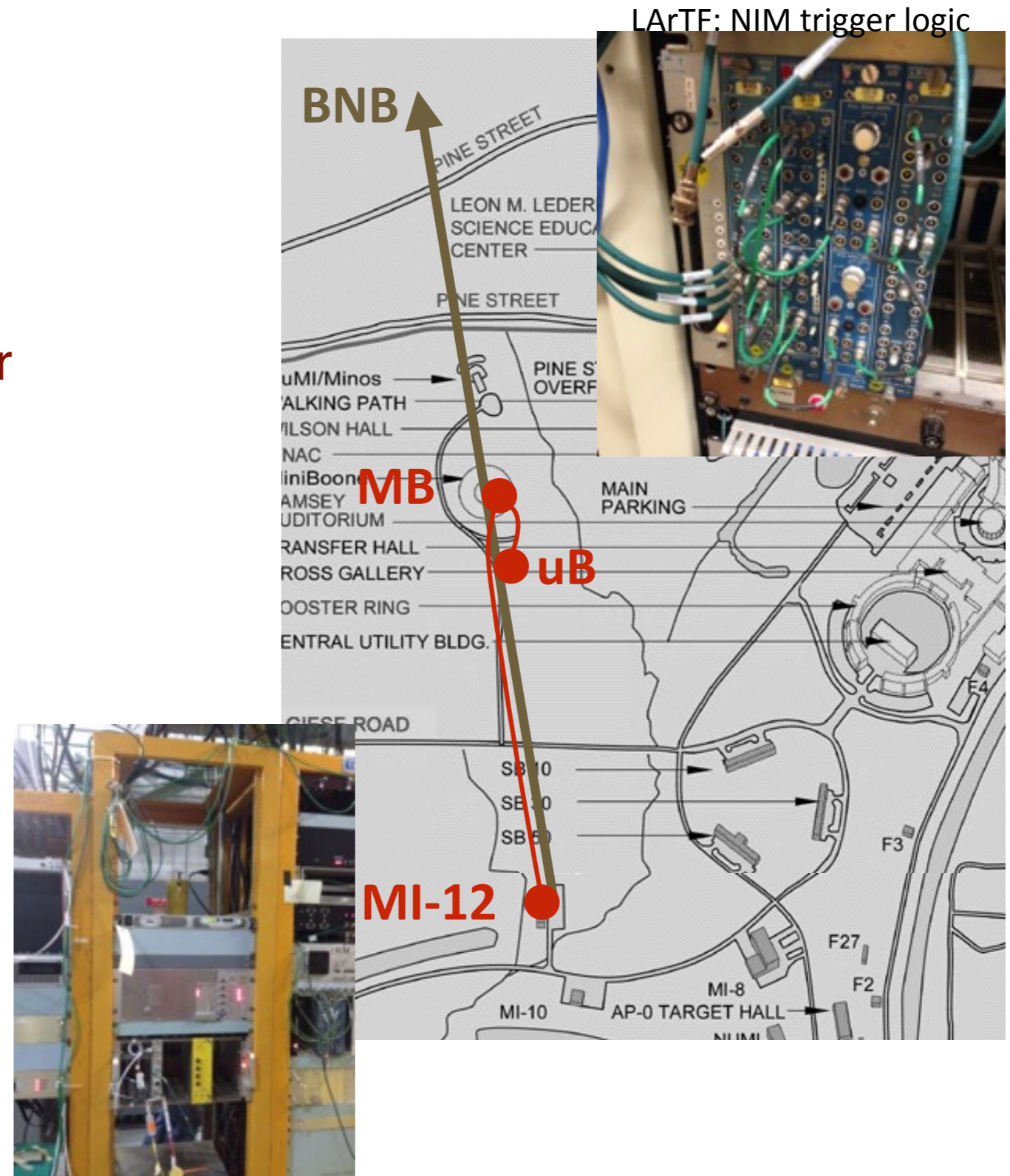
NEW BNB Signal Paths

- For 2016 running:
 - BES “Booster Extraction Synch” gated with TCLK \$1D



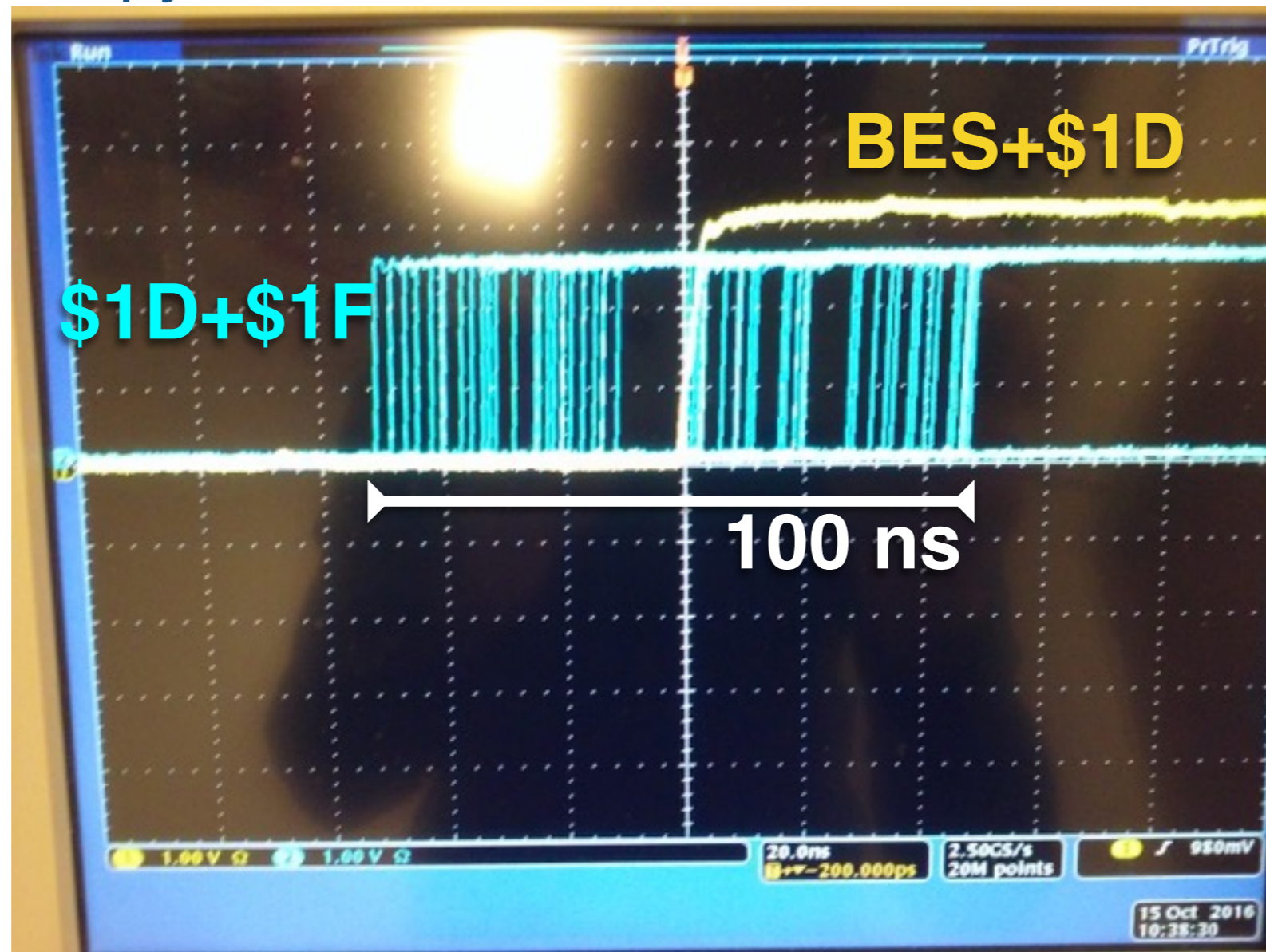
NEWBNB Signal Paths

- MI12:
 - BES delay module “Tawzer” (same as used for Booster Extraction magnets)
 - incoming signals: BES, Booster RF, \$1D enable, CAMAC 055 delay setting
 - outgoing signal: delayed BES gated with \$1D
 - sent on fiber to MB
- MB
 - routed directly to uB
- uB
 - switched from o/e going into trigger logic



gated BES vs \$1F

- Relative jitter between BES and \$1F is 100 ns
 - limiting resolution of the 10 MHz TCLK
 - BES is bad copy of \$1F



<http://dbweb6.fnal.gov:8080/ECL/uboone/E/show?e=32630>

BNB monitor path

- The signal path was complicated.
 - The Resistive Wall Monitor (RWM) signal is discriminated initially at MI-12



RWM

from BNB RWM

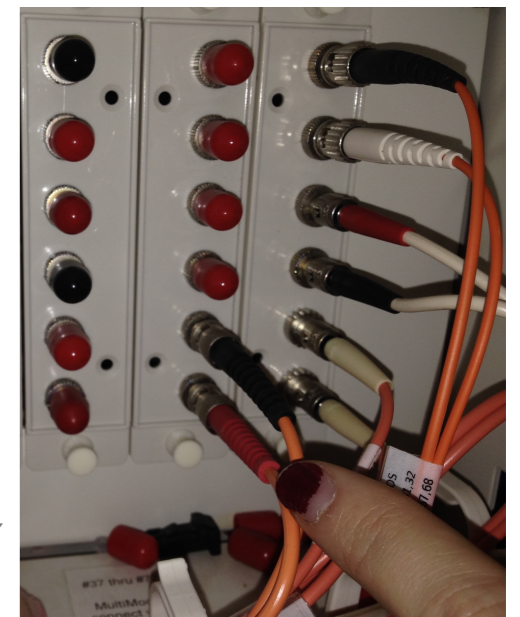


FAST COMTEC Discriminator

Highland
Technology e/o
J720 converter

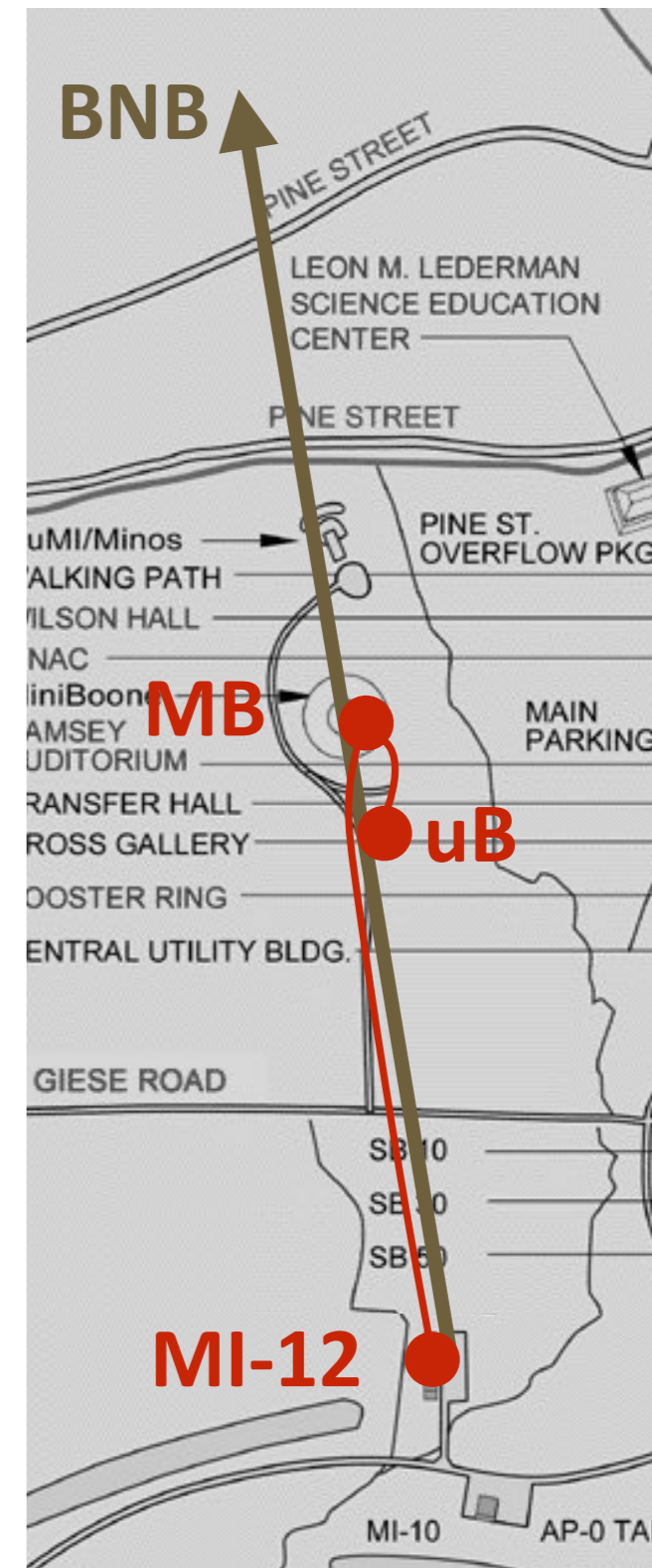


Fiber networking to
MiniBooNE



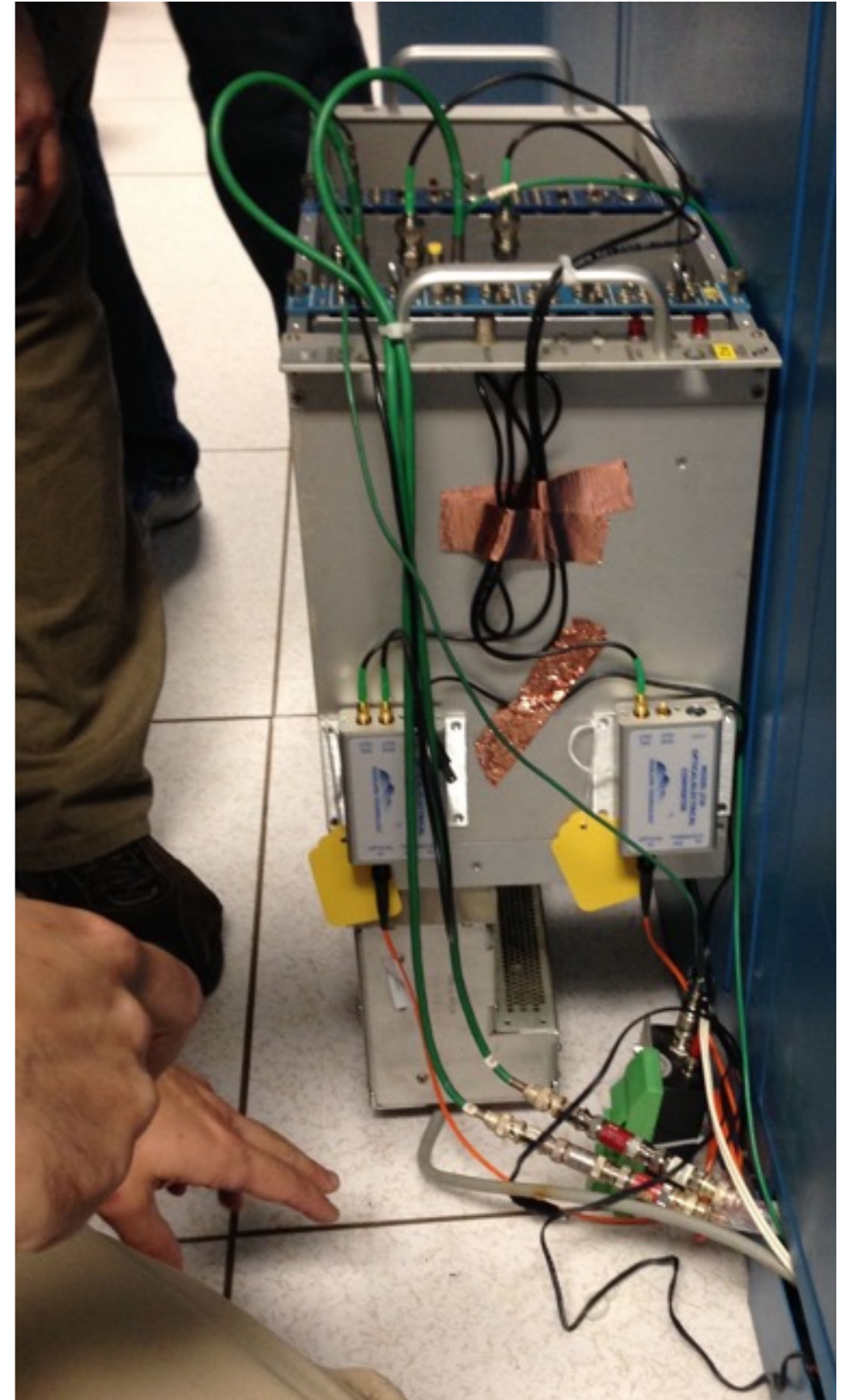
BNB monitor path

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 - Then it is sent on optical fiber to MiniBooNE



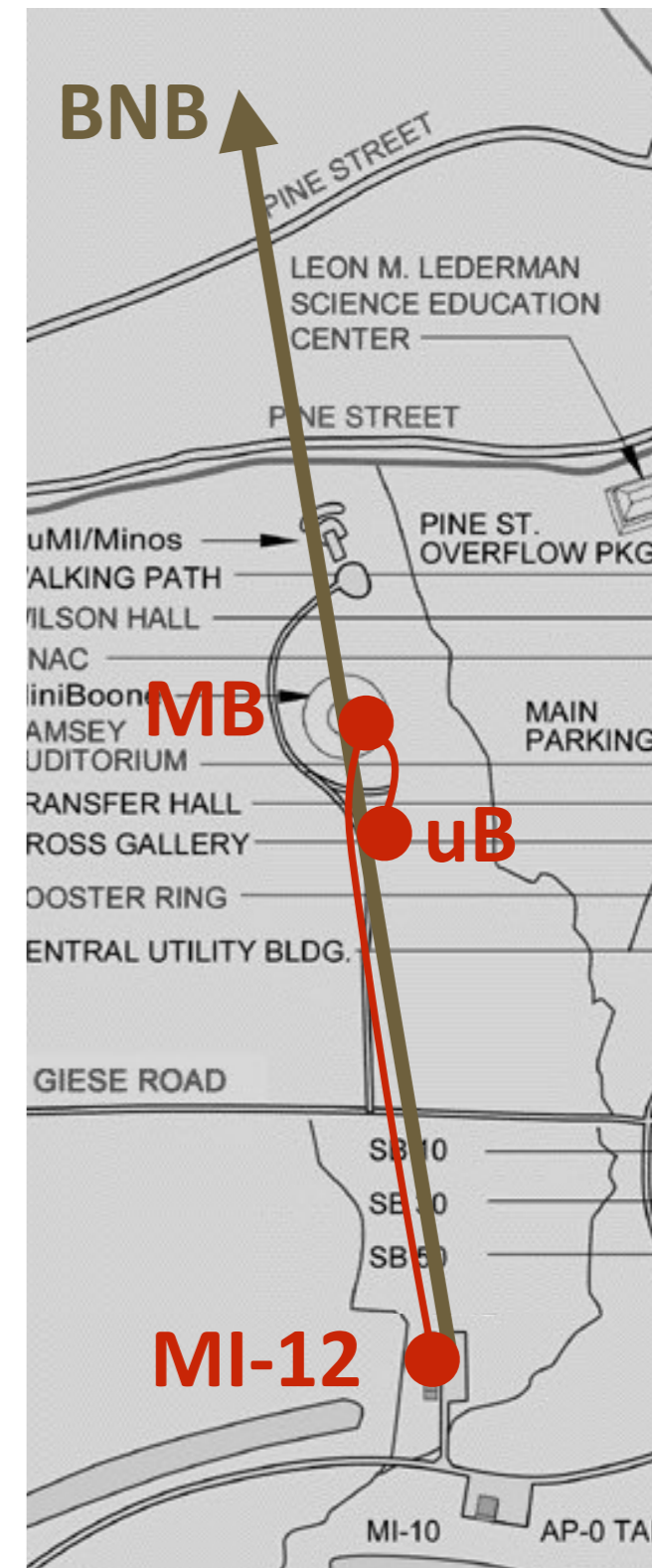
BNB monitor path

- The signal path was complicated.
 - The Resistive Wall Monitor (RWM) signal is discriminated initially at MI-12
 - Then it is sent on optical fiber to MiniBooNE
 - At MiniBooNE:
 - the signal is switched to copper
 - discriminated again
 - split
 - switched to fiber



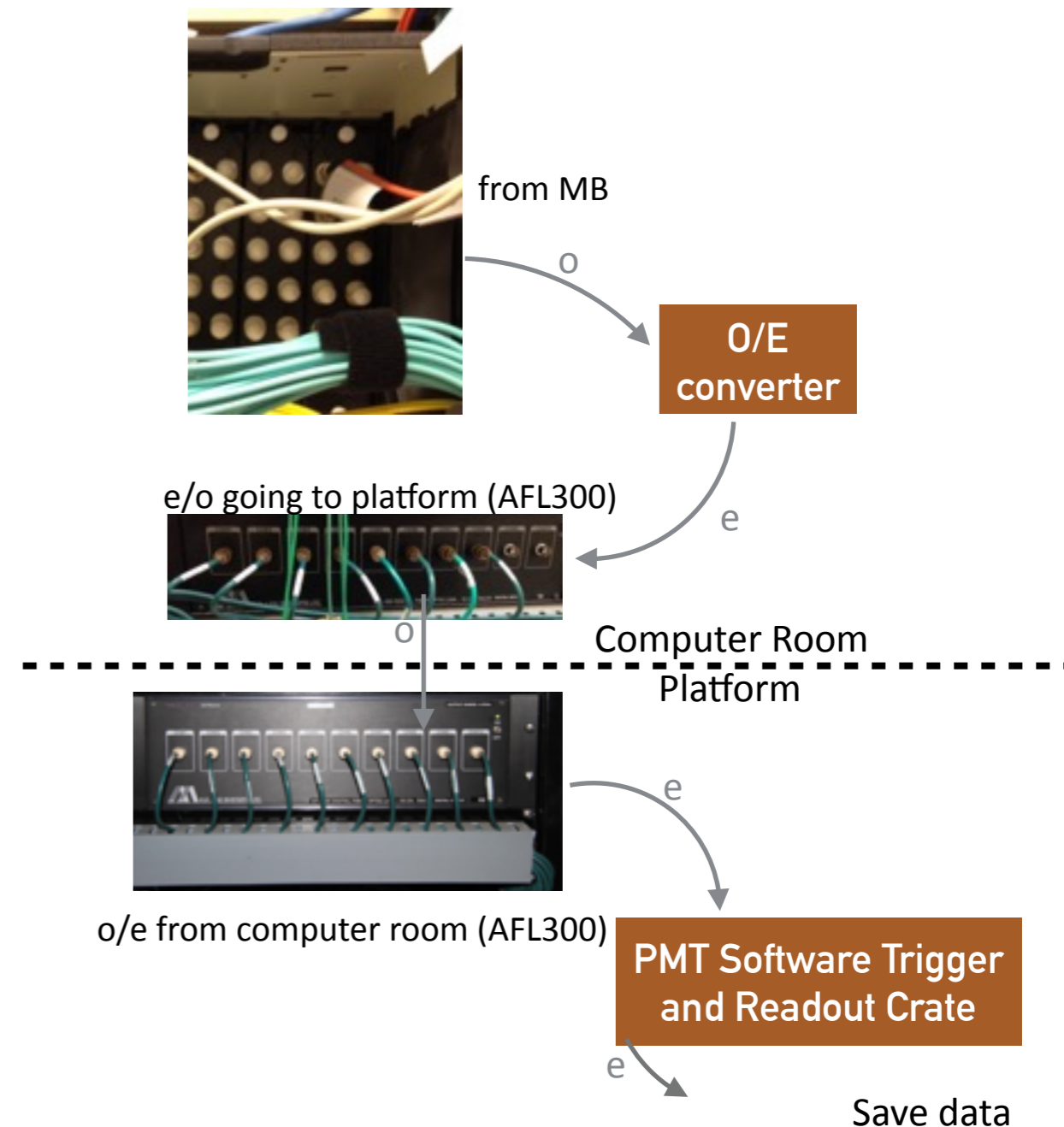
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 - Then the signal is sent on optical fiber to LArTF



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 - At MiniBooNE:
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 - Then the signal is sent on optical fiber to LArTF
 - At LArTF:
 - the signal is switched to copper
 - then to fiber and sent down the the platform
 - and back into copper on the platform
 - Finally the signal goes into the PMT readout board.



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 - The Resistive Wall Monitor (RWM) signal is discriminated initially at MI-12
 - Then it is sent on optical fiber to MiniBooNE
 - At MiniBooNE:
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 - ~~▸ discriminated again~~
 - ~~▸ split~~
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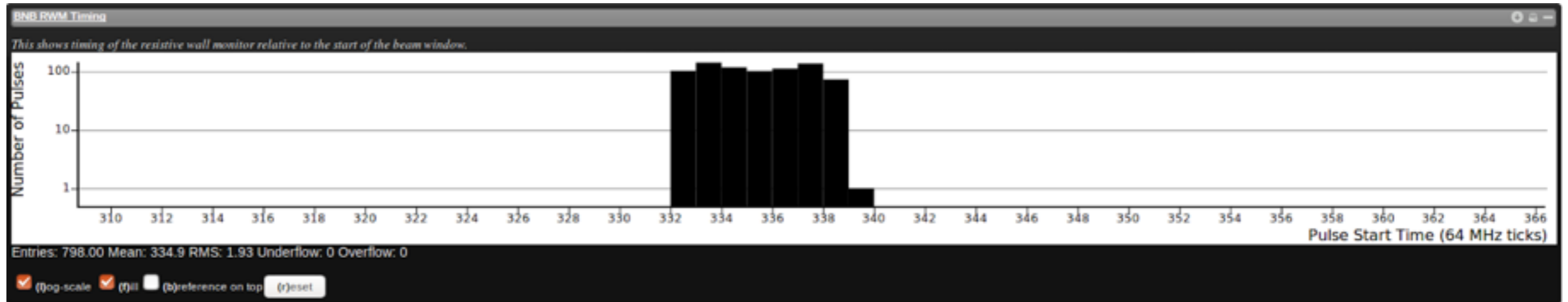
Simply patch optical fiber all the way for MI-12 to readout at LArTF!

Save data

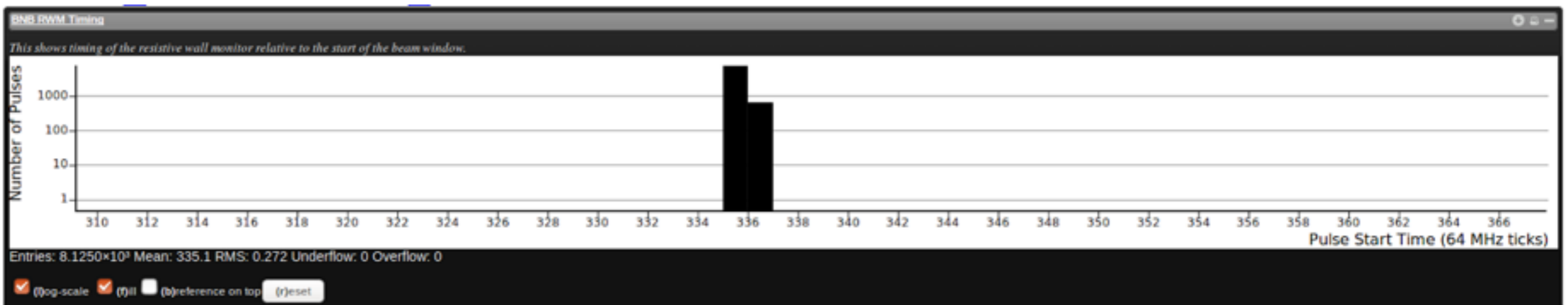
Monitoring BNB

Number of Pulses

old \$1D+\$1F



new BES+\$1D



Trigger arrival time - RWM arrival time

Signals for MicroBooNE

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- NuMI

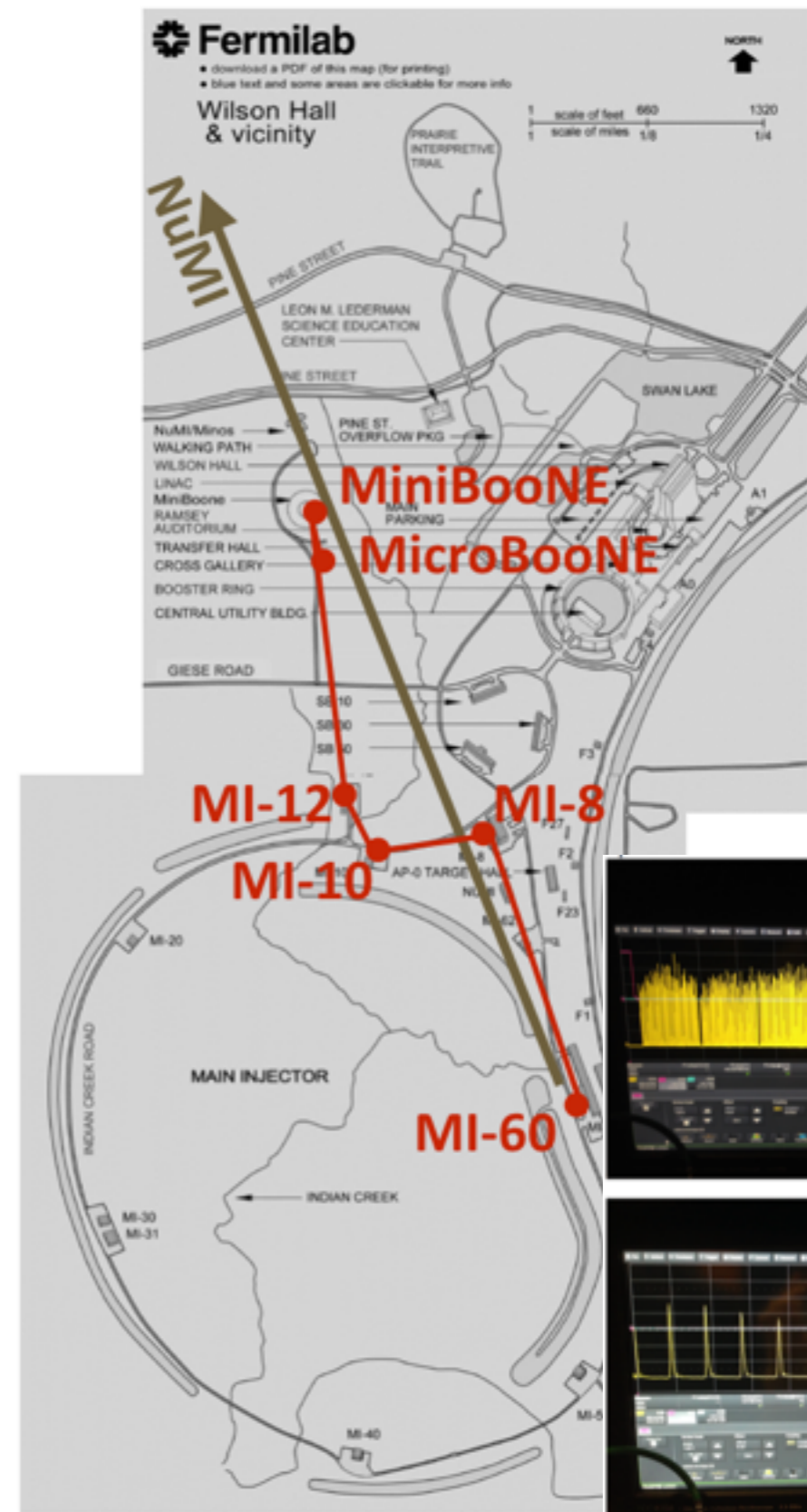
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New NuMI Trigger Signal

- MIBS \$74 = Main Injector Beam Synch signal to extract beam from Main Injector to NuMI.
 - New mezzanine board in MicroBooNE's I.R.M. box.
 - Replaces TCLK \$A9 (copy of this signal)
- Why?
 - MIBS \$74 is signal used to fire extraction magnets, we should trigger on the same.
- Commissioning now.

New NuMI Monitor!

- Similar to the BNB, NuMI also has an RWM to sense the proton beam time.
 - We weren't using this before!
- Will serve as a critical monitor of trigger signal
 - $\Delta t = t(\text{RWM signal}) - t(\text{MIBS } \$74)$
 - should be constant! Implemented in MicroBooNE's Online Monitoring!
 - if not, we will need to adjust our trigger!
- Commissioning now.



Summary

- Replacement trigger signals
 - BNB: \$1D+\$1F → BES+\$1D
 - NuMI: \$A9 → MIBS \$74
- Renovated path
 - BNB RWM
- New device to monitor NuMI:
 - NuMI RWM

Thanks!

- I am very happy and pleased to have helped design and implemented the changes needed to make our data-taking more robust!
 - (This is the way many folks in AD already expected us to have designed our experiment.)
- We've had incredible support from Accelerator Division:
 - External Beams: Craig Moore, Tom Kobilarcik, Michael Backfish
 - Controls: Greg Vogel, Dennis Nicklaus, Mike Kucera
 - Booster: Bill Pellico
- And thanks to everyone else who helped!
 - Zarko P., David C., Mike Matulik...