Muon Trigger Upgrade at PHENIX

RIKEN/RBRC
Itaru Nakagawa

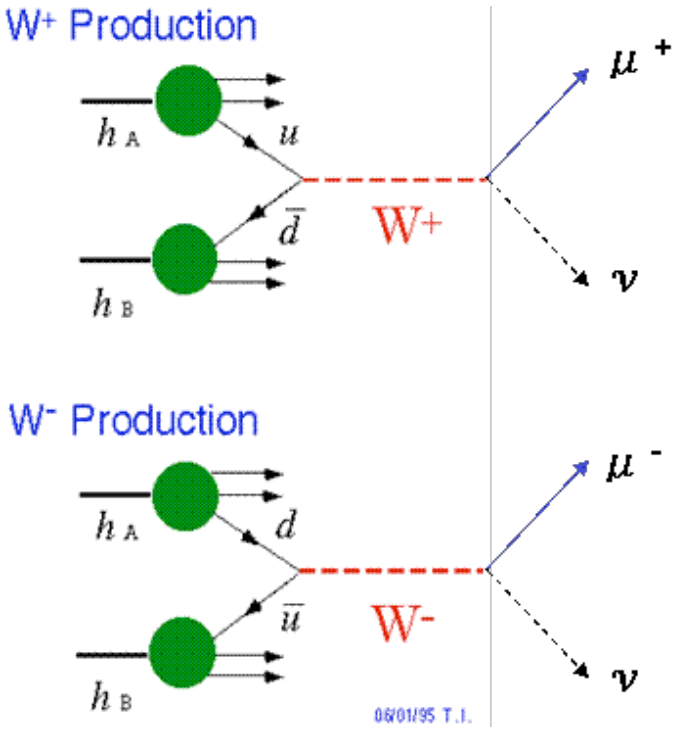
Summary

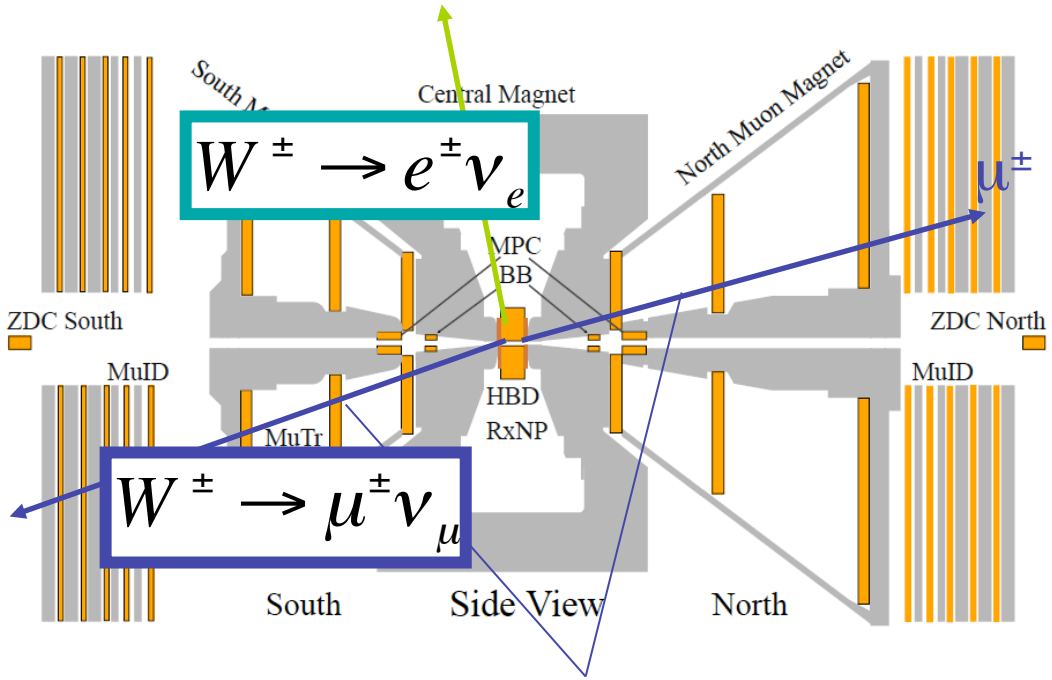
- Polarized sea quark measurement via W is very Sexy program for RHIC Spin and should take maximum advantage of it
- However existing PHENIX Muon Arms Cannot Handle High Rates at sqrt(s)=500 GeV
- Need Trigger Upgrade!
- New Triggers have been developed and are under commissioning now

We are getting very close to be ready for W production Run!!

√s=500 GeV @ RHIC

$$A_L^{W^+} = -\frac{\Delta u(x_1)\bar{d}(x_2) - \Delta\bar{d}(x_1)u(x_2)}{u(x_1)\bar{d}(x_2) + \bar{d}(x_1)u(x_2)} \quad \text{(LO)}$$

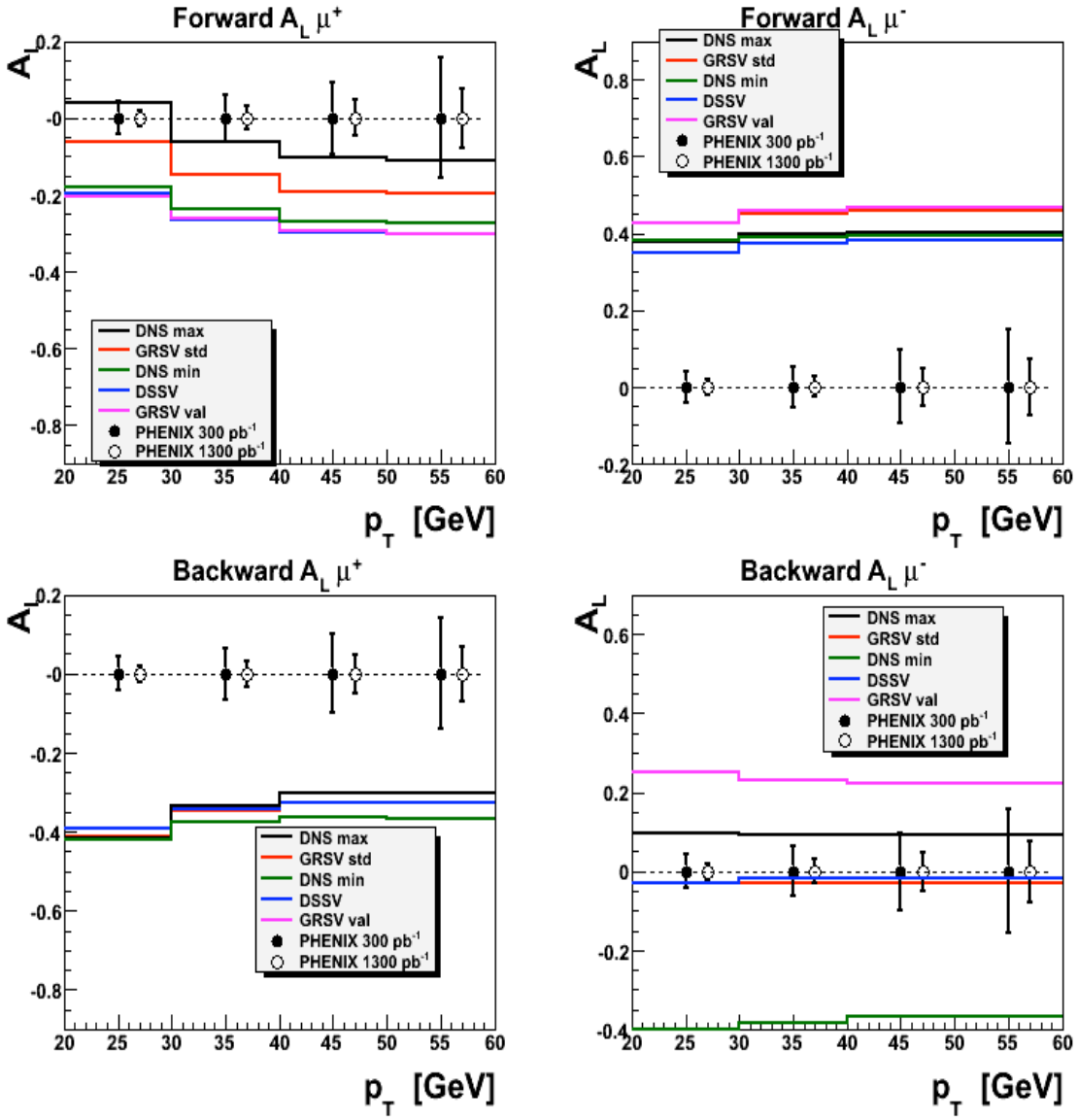




$$x_1 \neq x_2$$

Parity Violation Asymmetry
Clean flavor separation
w/o fragmentation uncertainty

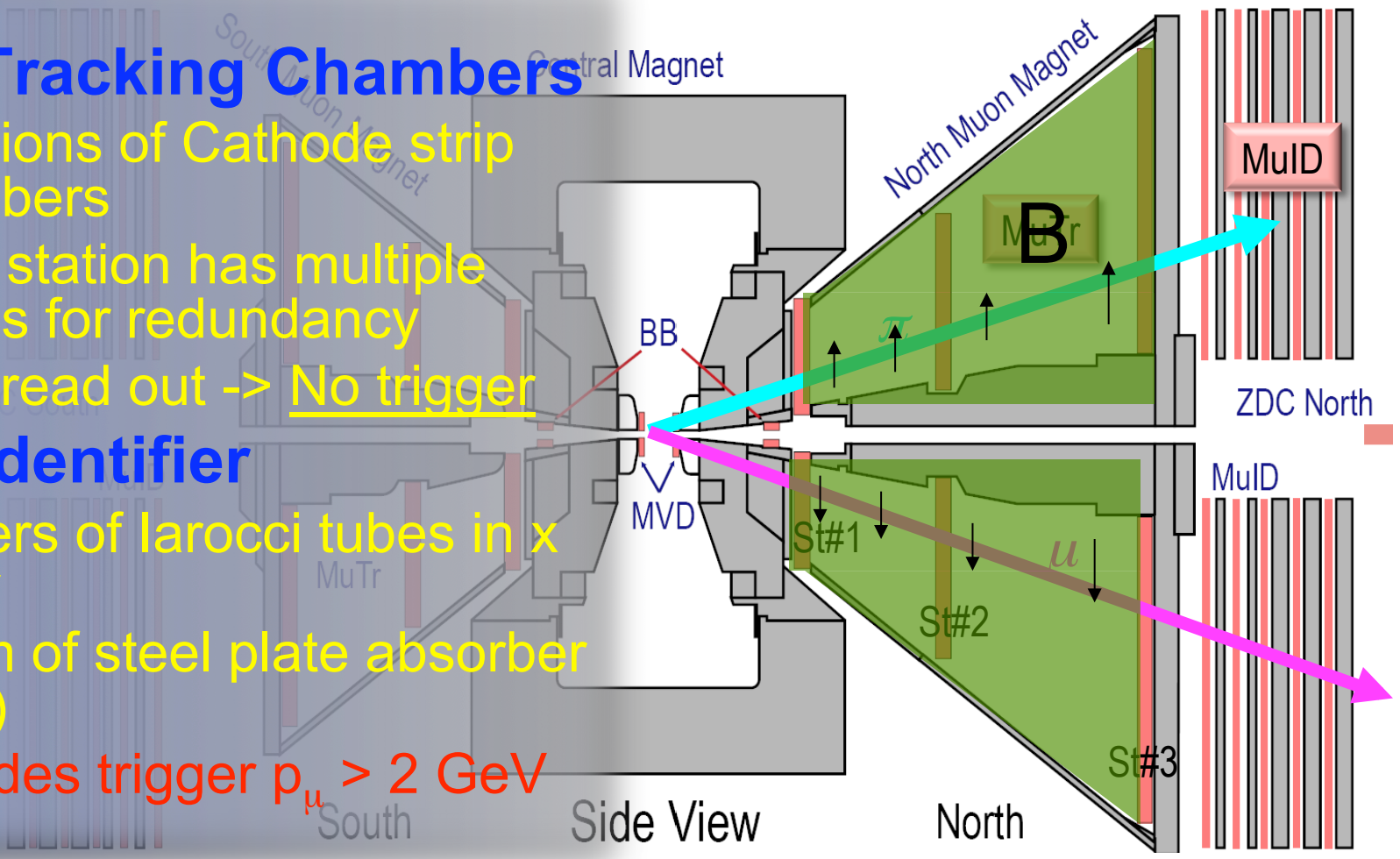
Projected Sensitivity @ PHENIX



- Full Detector Simulation
- S/B ~ 3/1 Assumed
- 300 pb^{-1} and 1300 pb^{-1}

Current Muon System

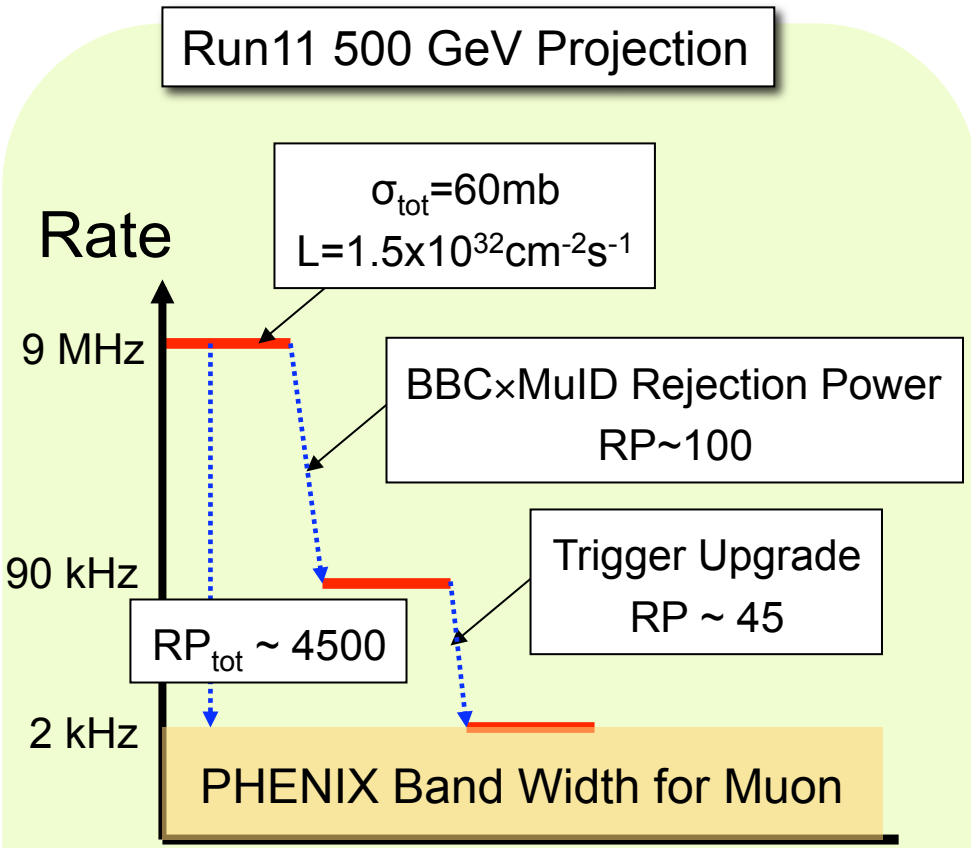
1. **Muon Tracking Chambers**
   - 3 stations of Cathode strip chambers
   - Each station has multiple planes for redundancy
   - Slow read out -> No trigger
2. **Muon Identifier**
   - 5 layers of Iarocci tubes in x and y
   - 80 cm of steel plate absorber (total)
   - Provides trigger p_μ > 2 GeV



Same configuration in South

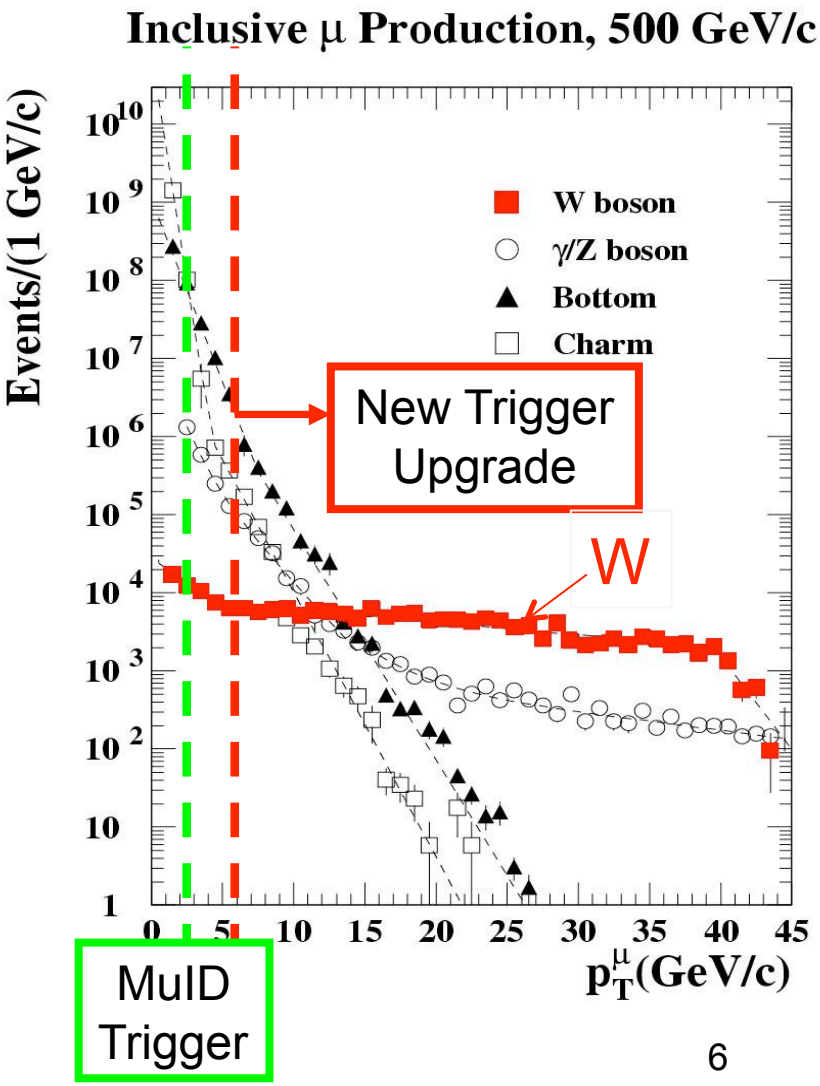
High Momentum Muon Trigger

Run11 500 GeV Projection



Required Rejection Power

1. High Rejection Power
2. High Efficiency



PHENIX Muon Trigger Upgrade

(I) 2 dedicated trigger Resistive Plate Chambers (RPC) stations (CMS design):

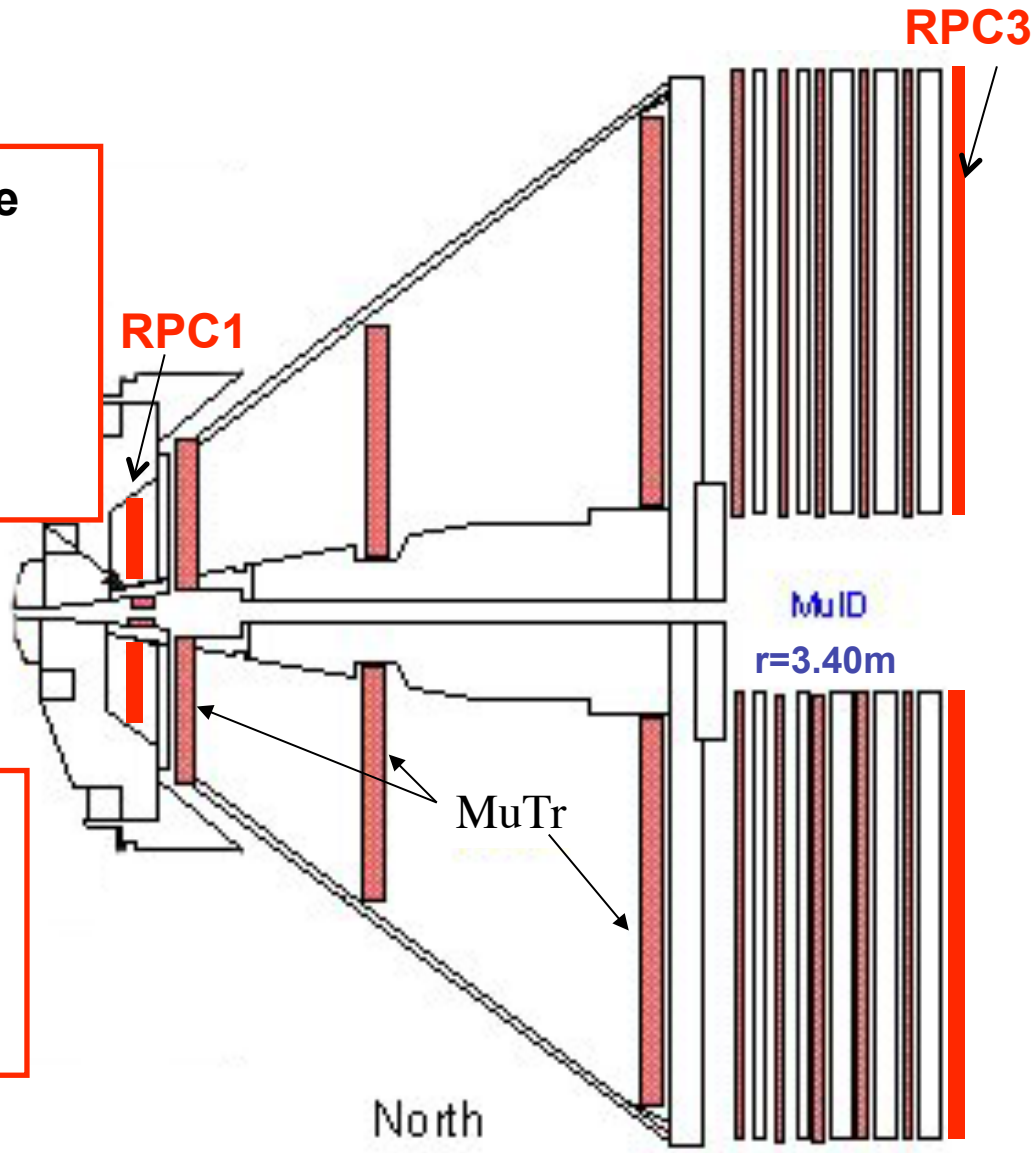
~ 1 degree pitch in φ

NSF (Funded)

(II) MuTr front end electronics

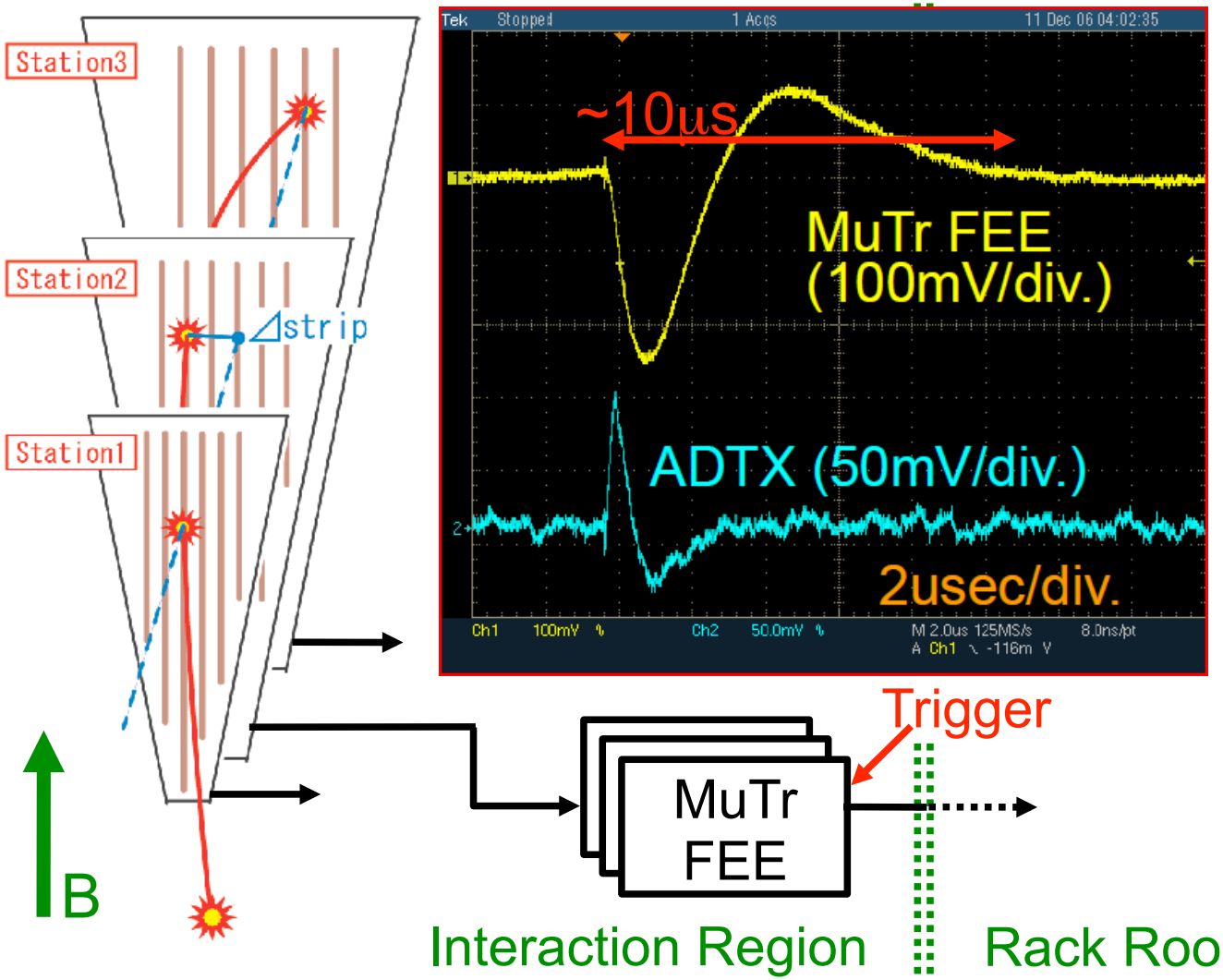
(MuTr-FEE Trigger)

JSPS (Funded)



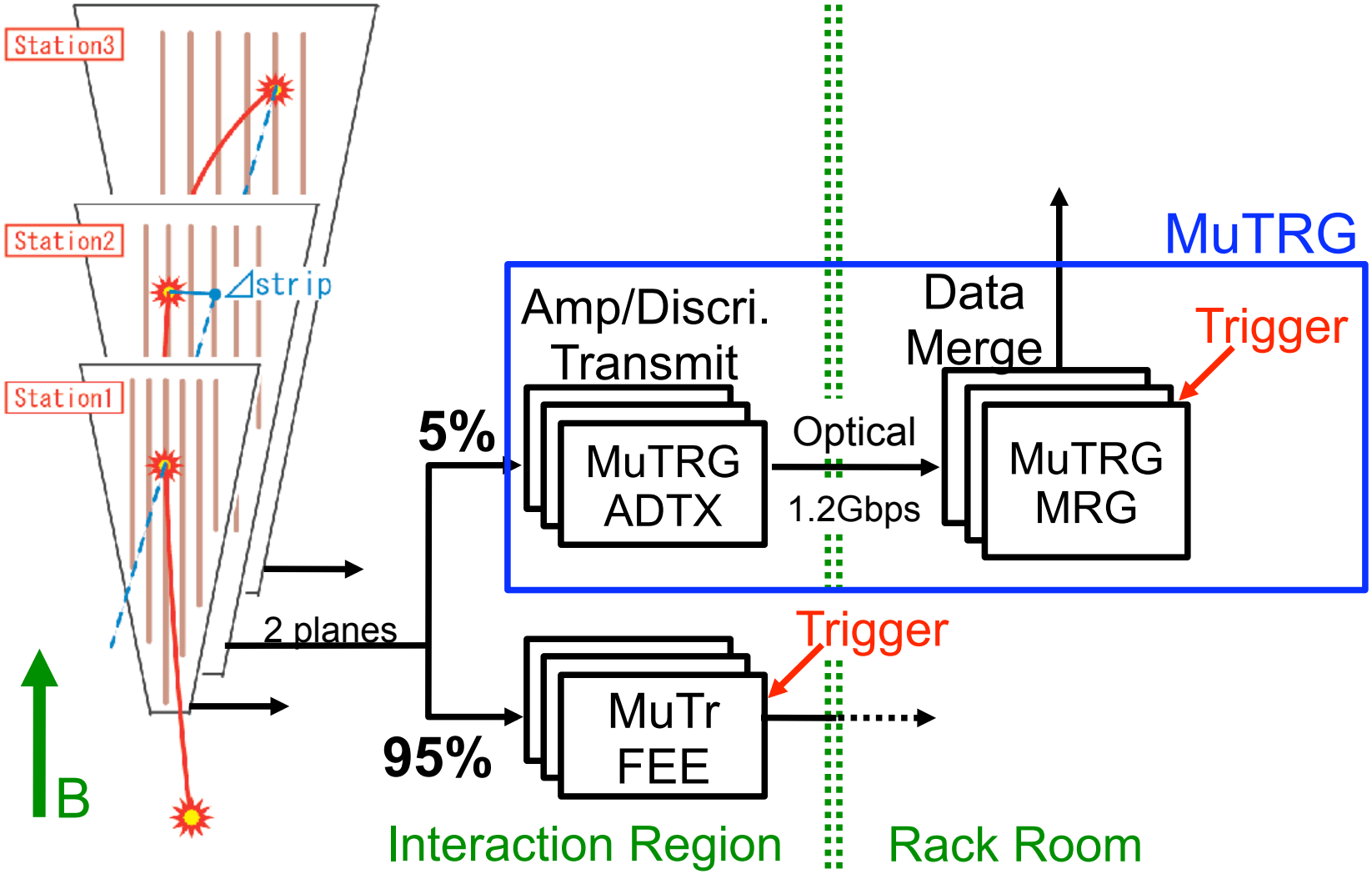
W Trigger System

Trigger events with straight track
(e.g. Δstrip <= 1)

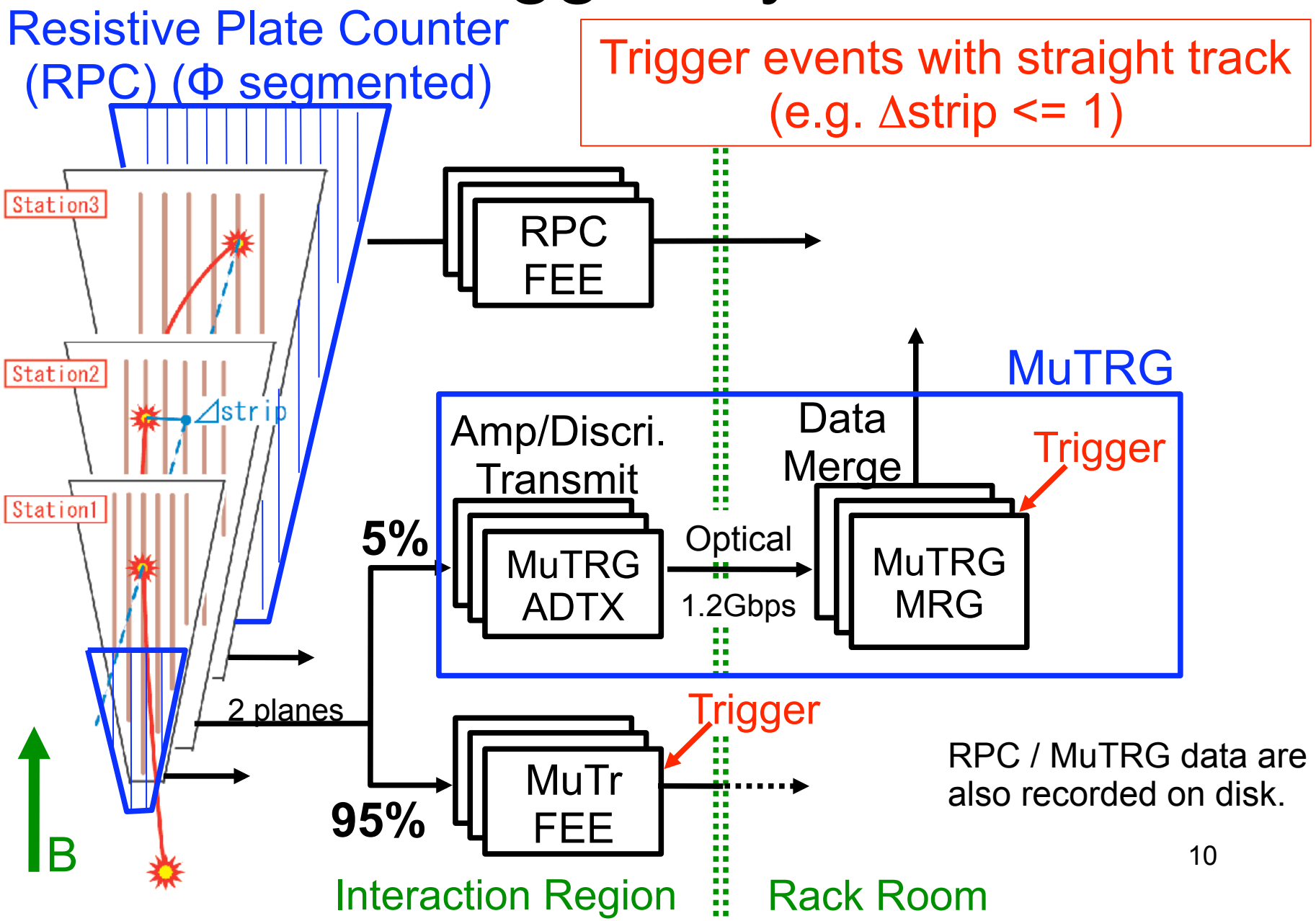


W Trigger System

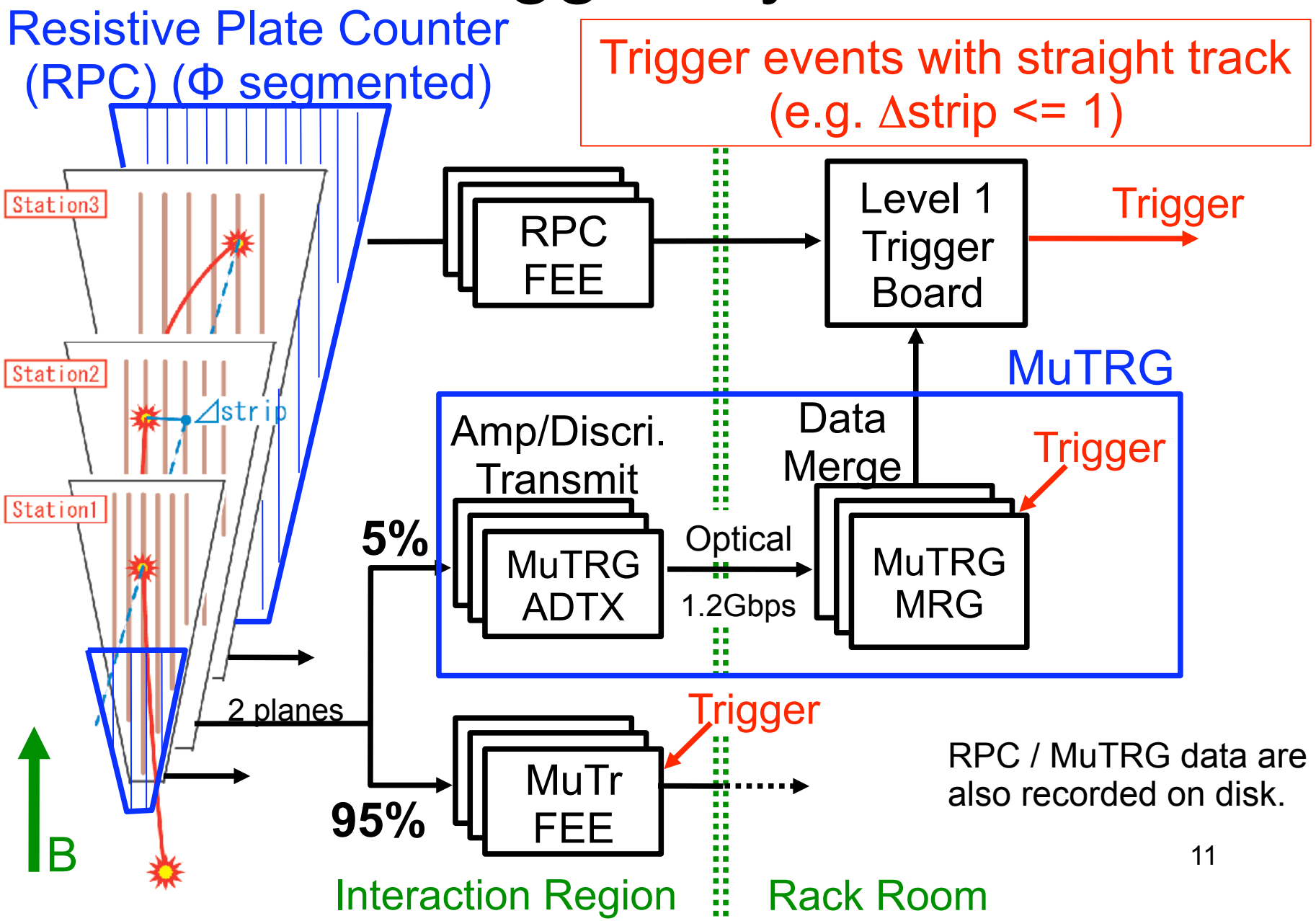
Trigger events with straight track
(e.g. Δstrip <= 1)



W Trigger System



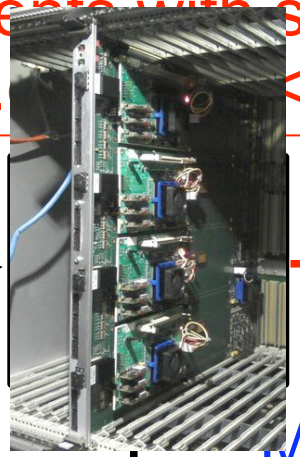
W Trigger System



W Trigger System

Resistive Plate Counter (RPC) (Φ segmented)

Trigger events with straight track (e.g. <= 1)



Trigger

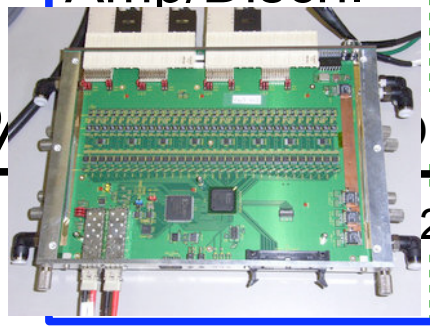
RPC FEE

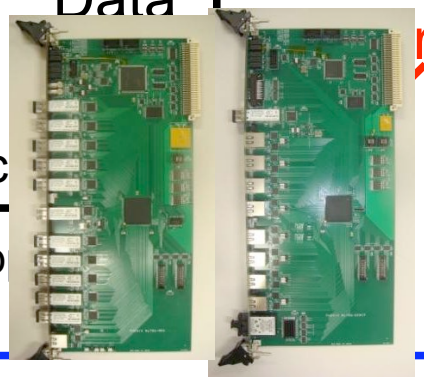
MuTRG

Amp/Discri.

Data

Trigger





5%

Optic

2Gb

Station3

Station2

Station1

strip

2 planes

95%

MuTr FEE

Trigger

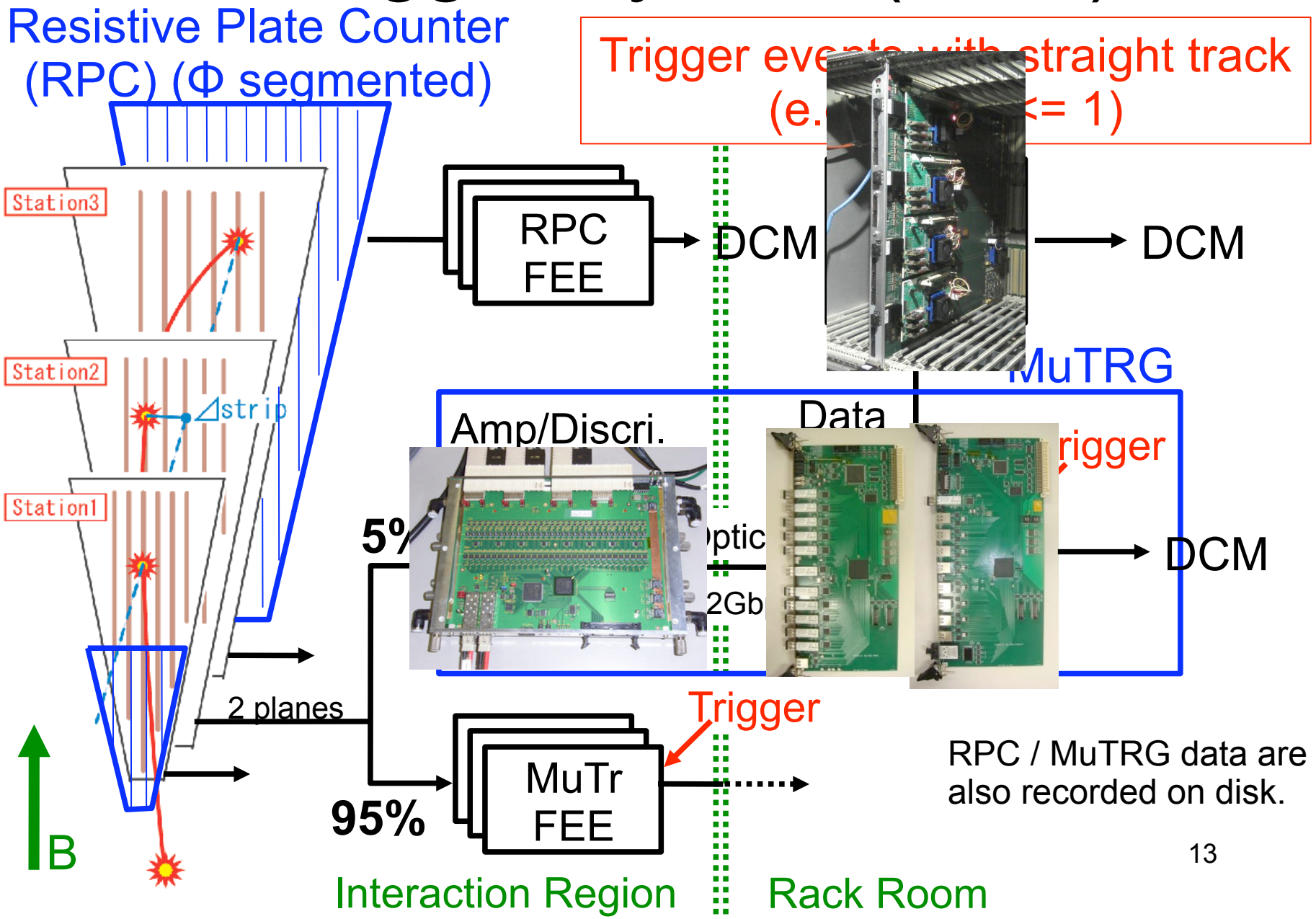
B

Interaction Region

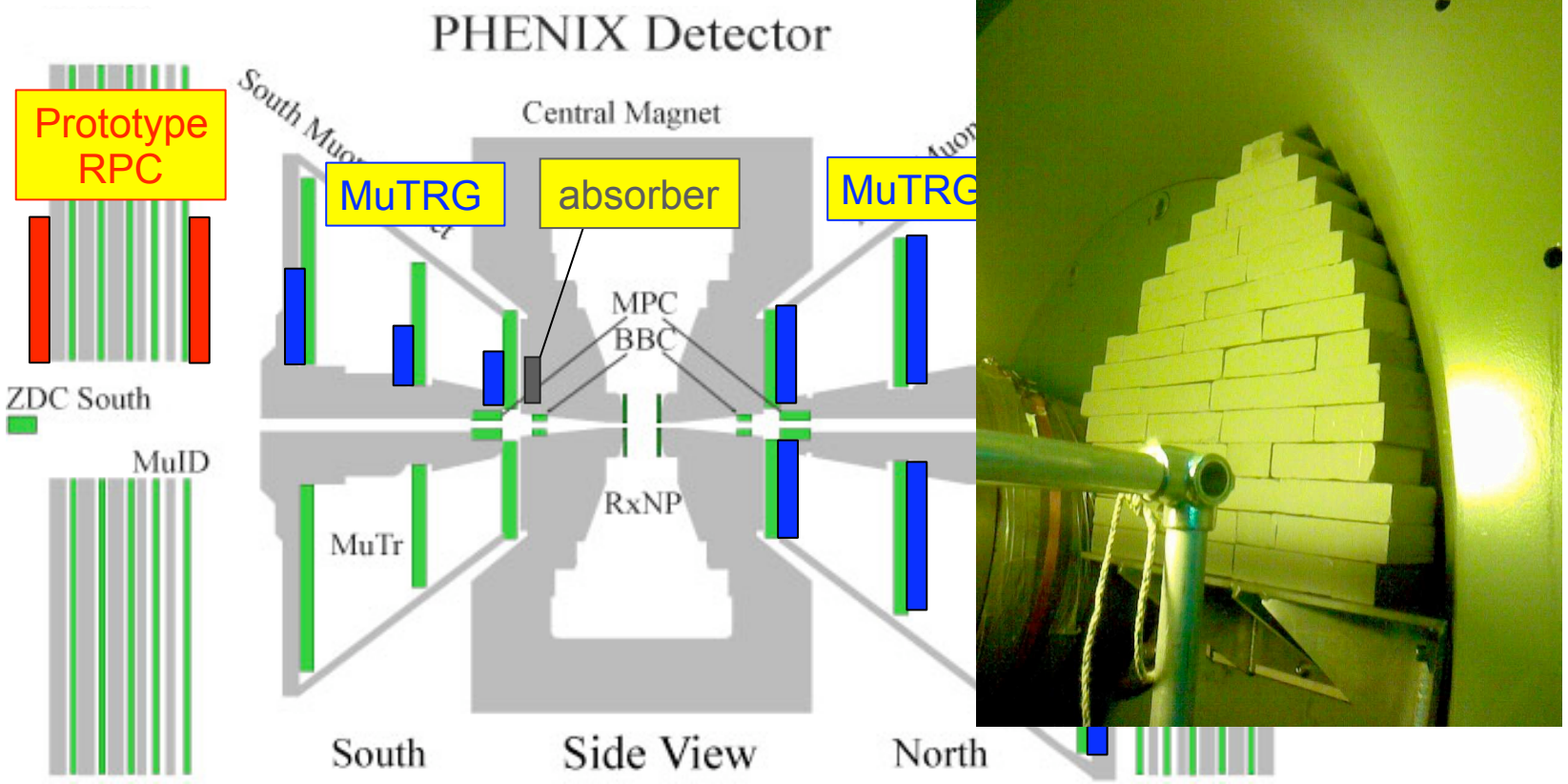
Rack Room

RPC / MuTRG data are also recorded on disk.

W Trigger System (Final)

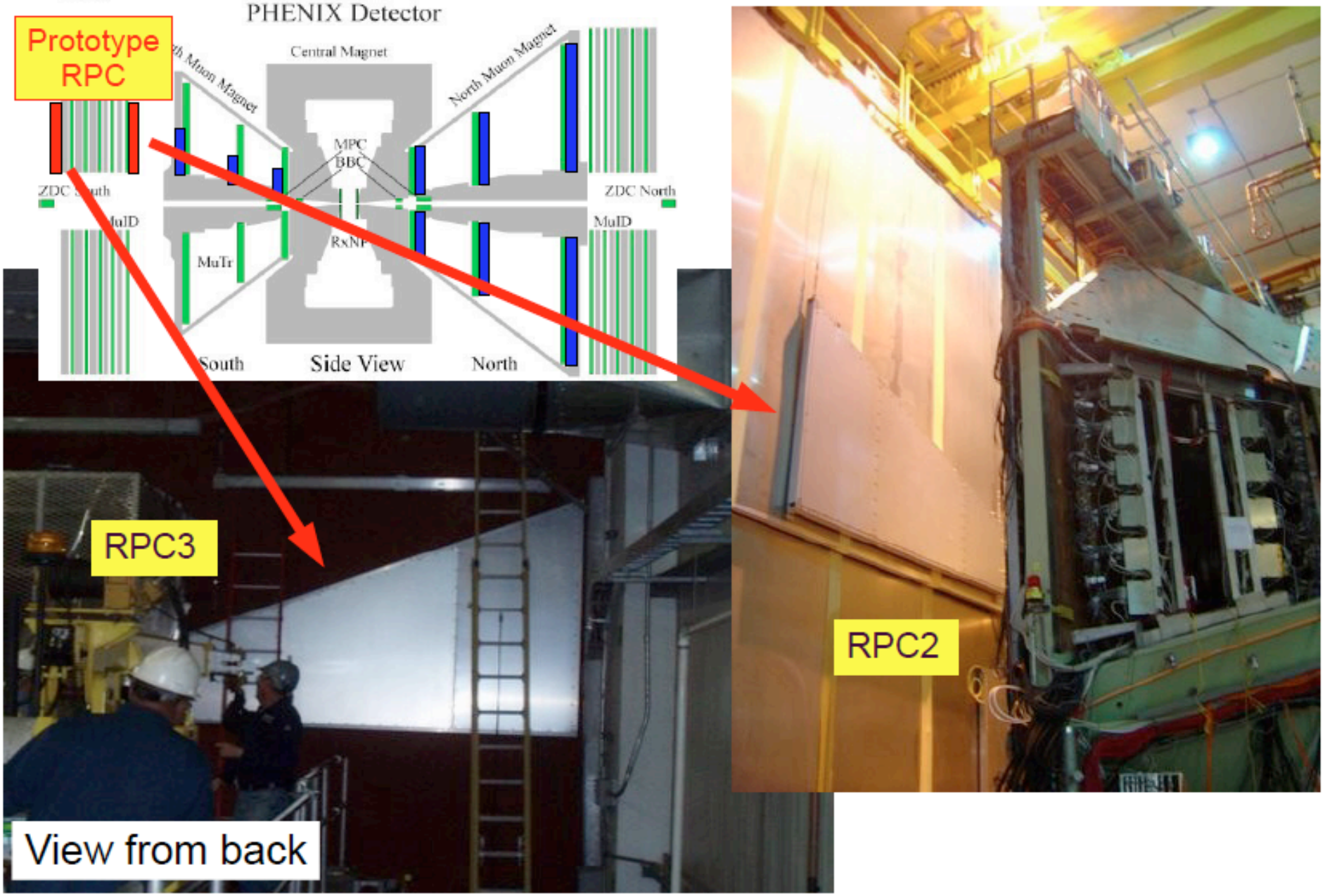


W Trigger Instrumentation in RHIC 2009 run

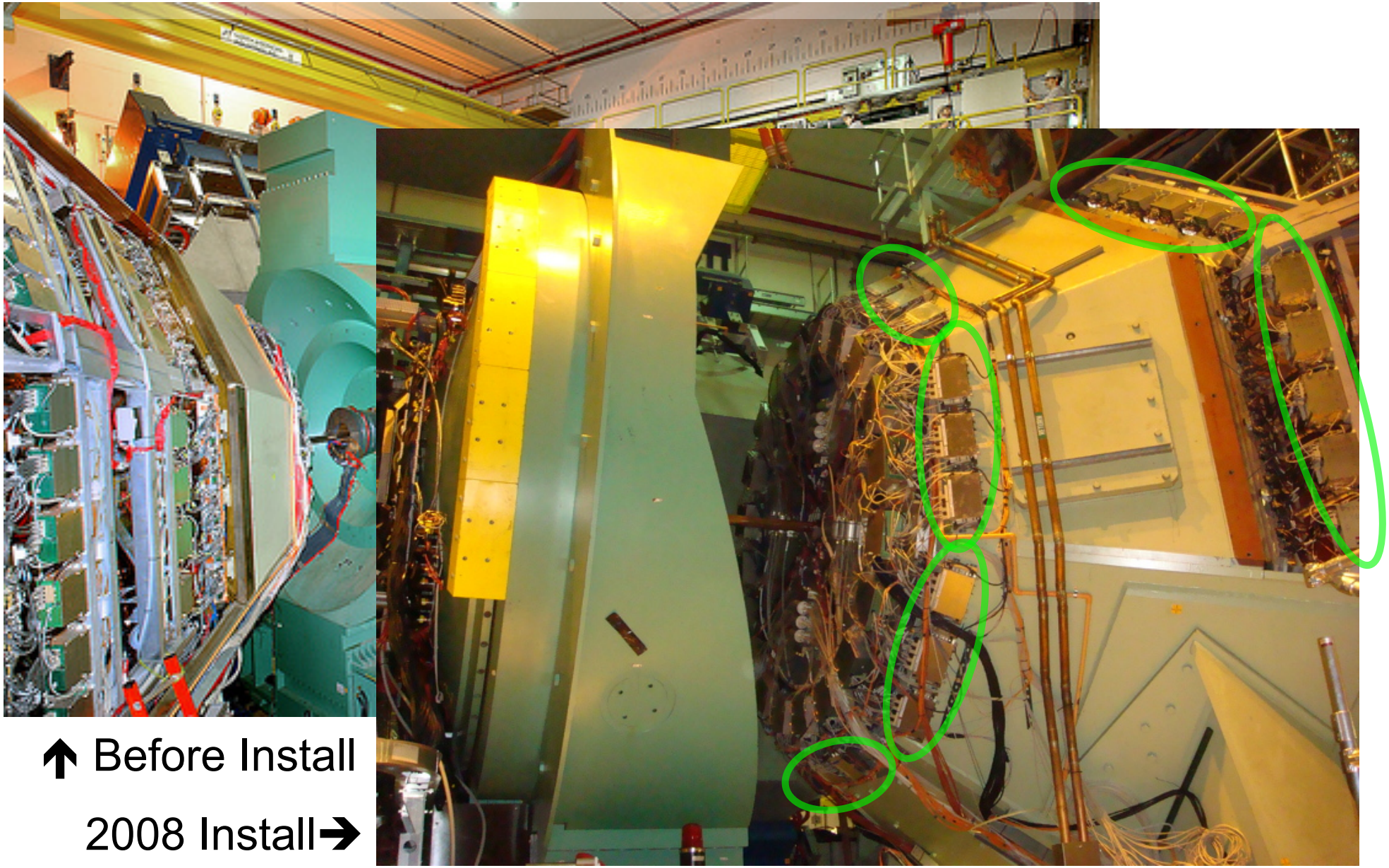


- Full Installation to North Arm, 1/2 octant installed to South
- Demonstrate performance of RPC and MuTRG with beam of √s=500 GeV.

Prototype RPC installed in 2009 run



New MuTRIG-FEE in North Arm



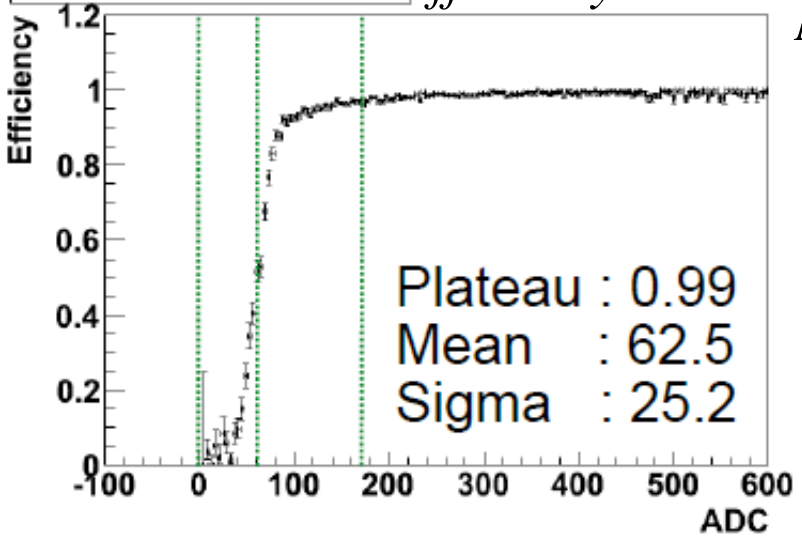
↑ Before Install

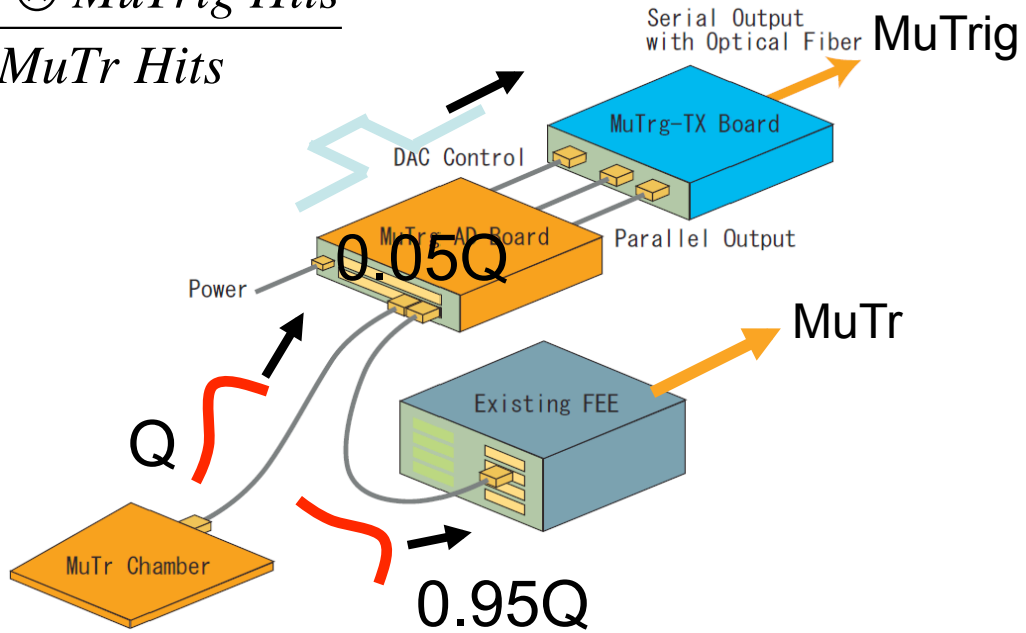
2008 Install➔

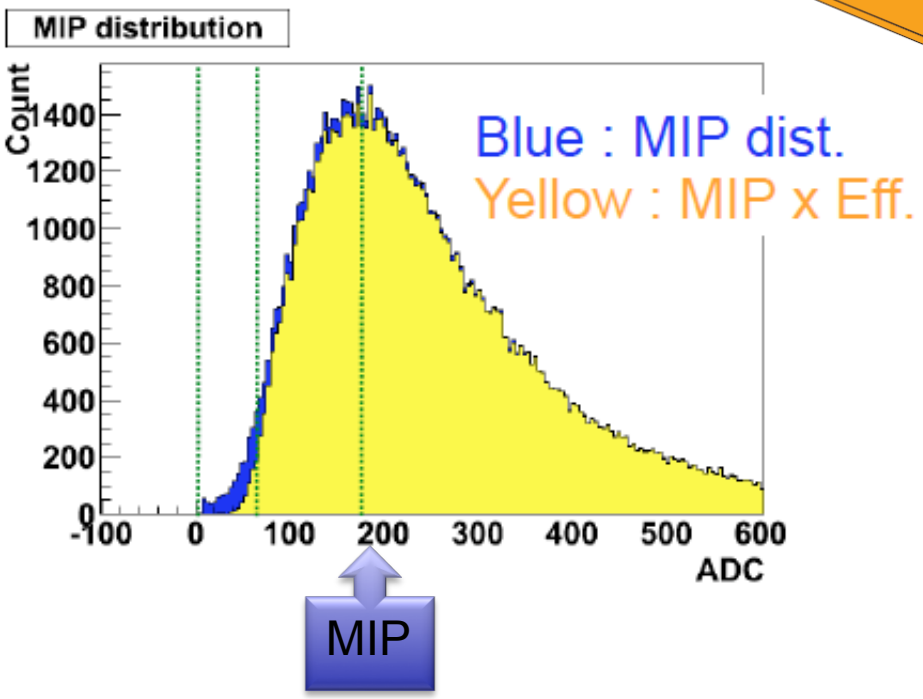
MuTR-FEE Trigger Performance

Single Cathode Plane Efficiency

$$Efficiency = \frac{MuTr \otimes MuTrig\ Hits}{MuTr\ Hits}$$



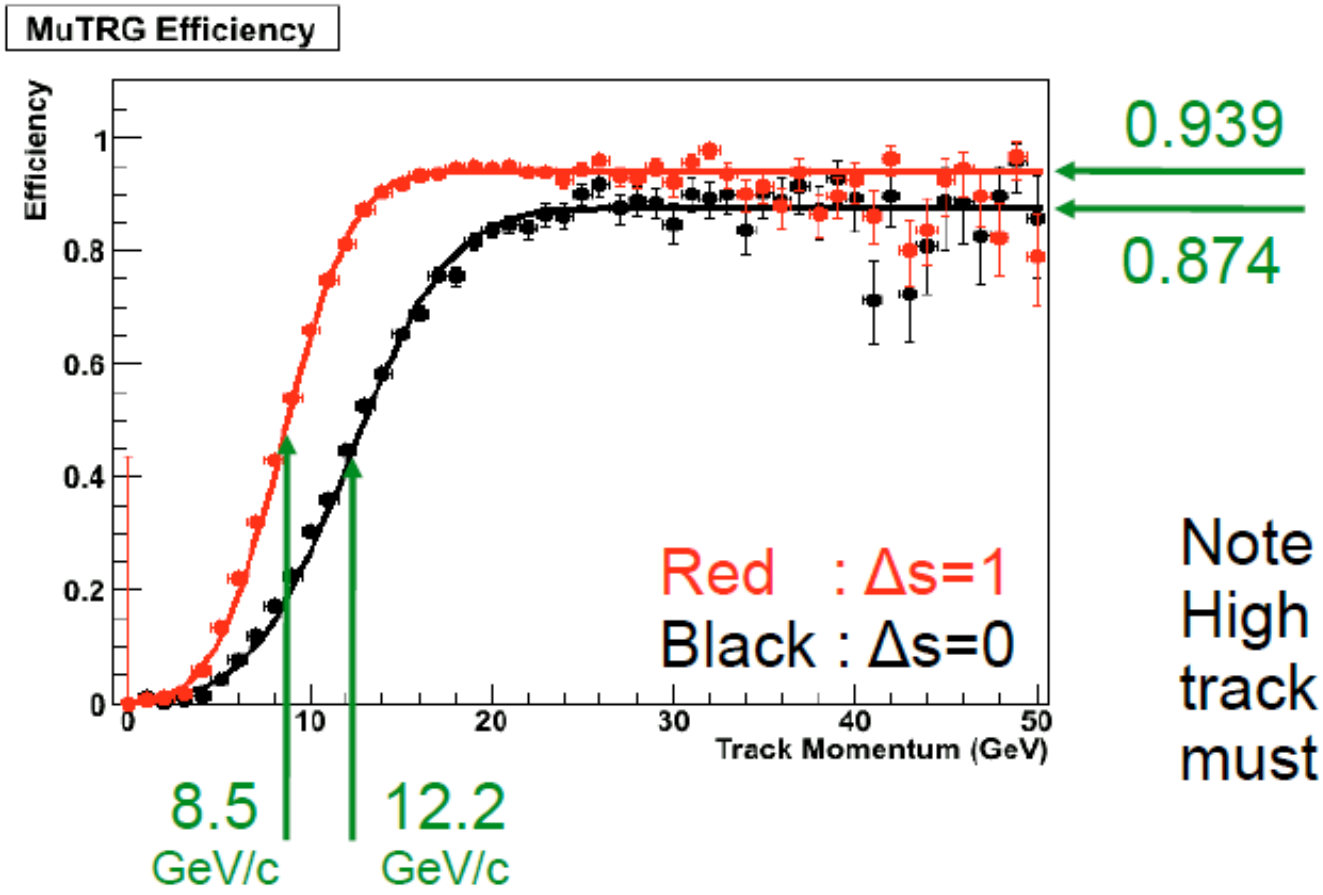


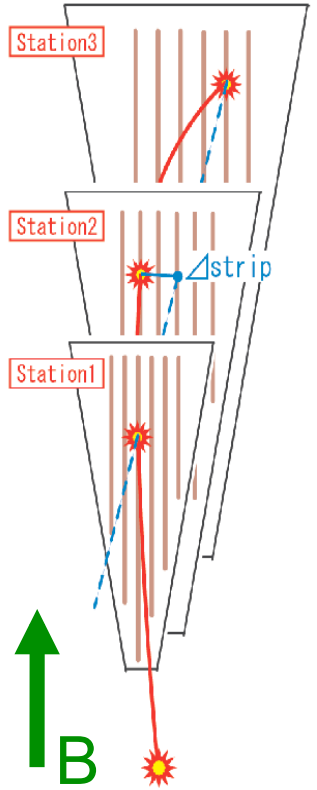


MuTRG and MuTr have matching properly.

Efficiency for MIP is 96% (Yellow / Blue)

MuTRG Efficiency for Track

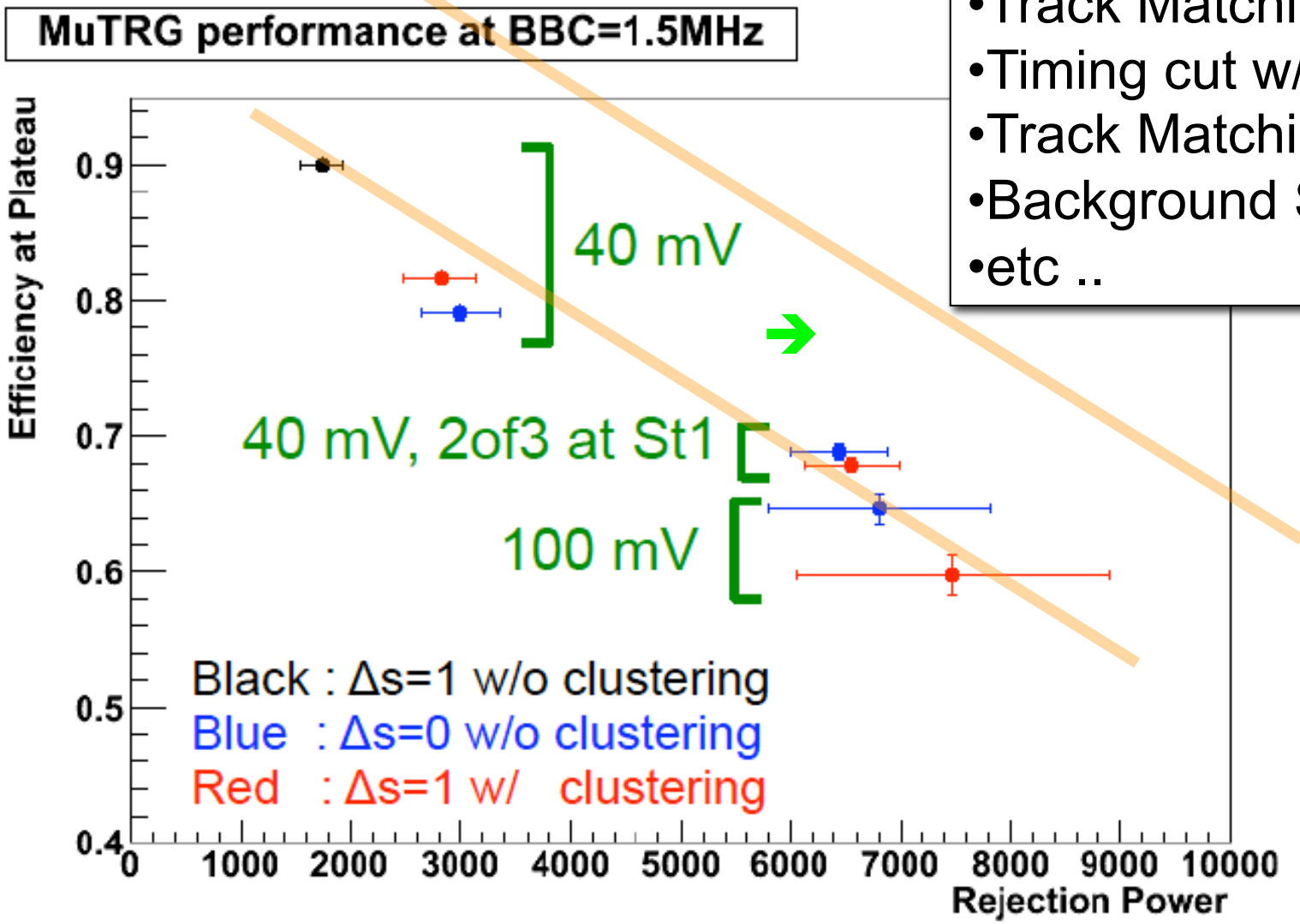




Note :
High momentum track in this plot must be fake.

Track Efficiency = (hit efficiency/station ~ 96%)^3 x (vertex cut efficiency)

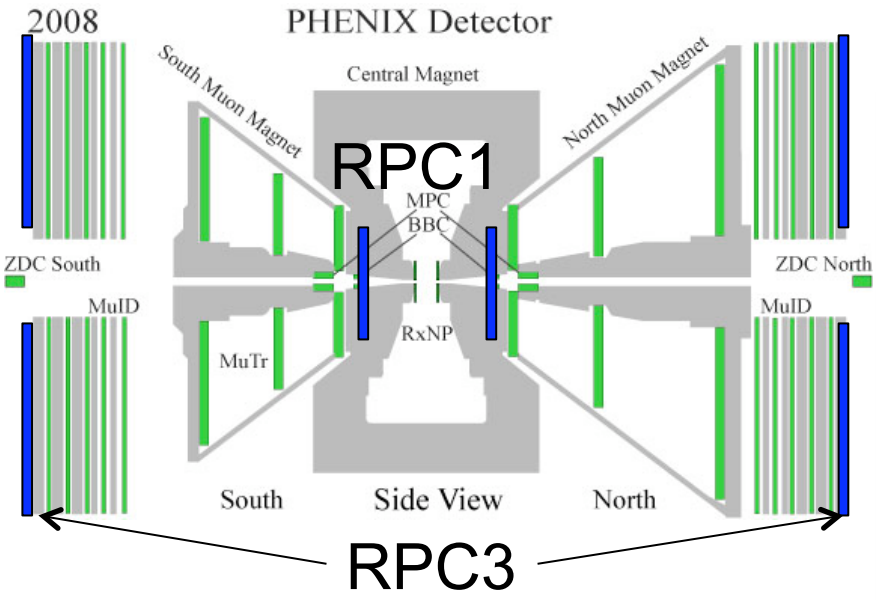
MuTRG System Run09 performance

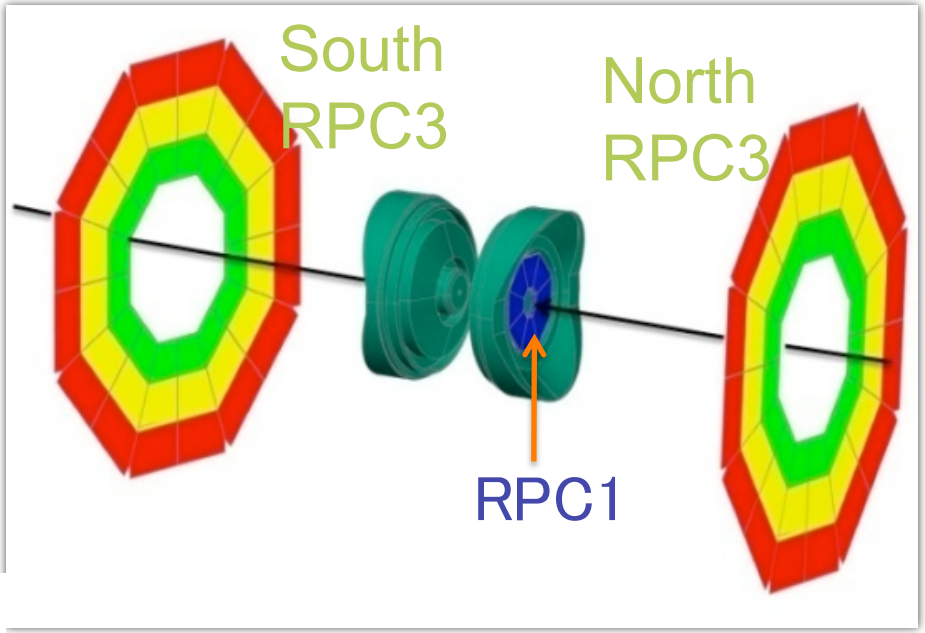


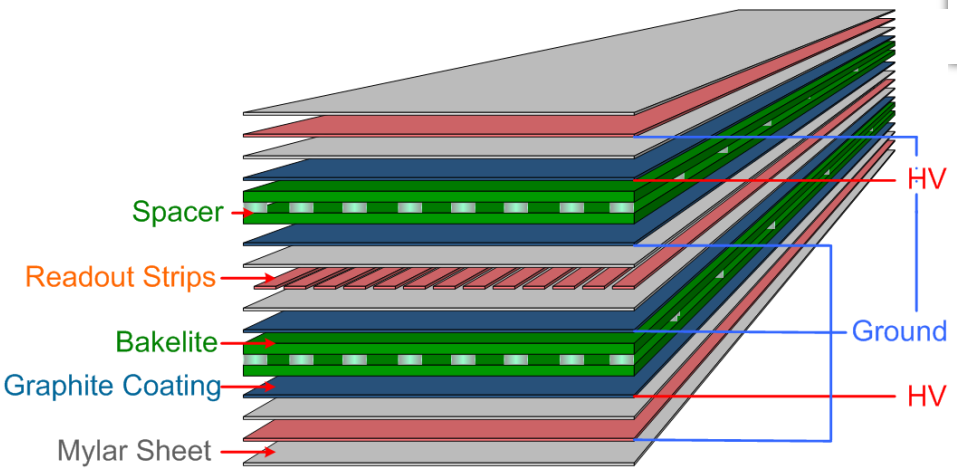
- MuID Algorithm
- Track Matching w/ MuID
- Timing cut w/ RPC
- Track Matching w/ RPC
- Background Shields
- etc ..

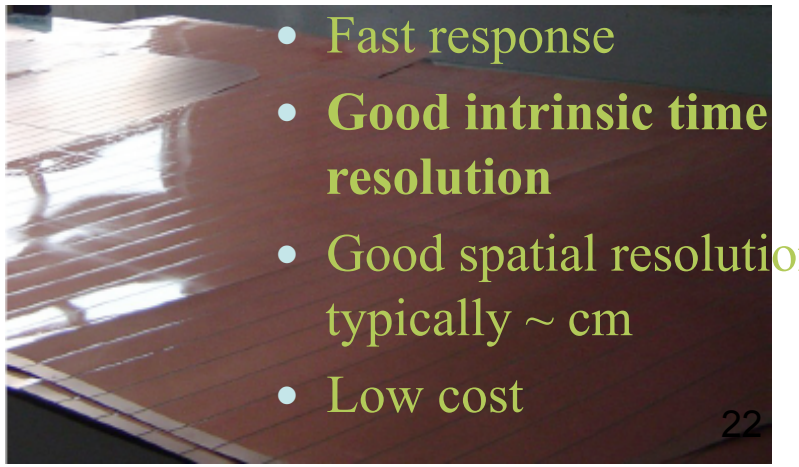
RPC

RPC



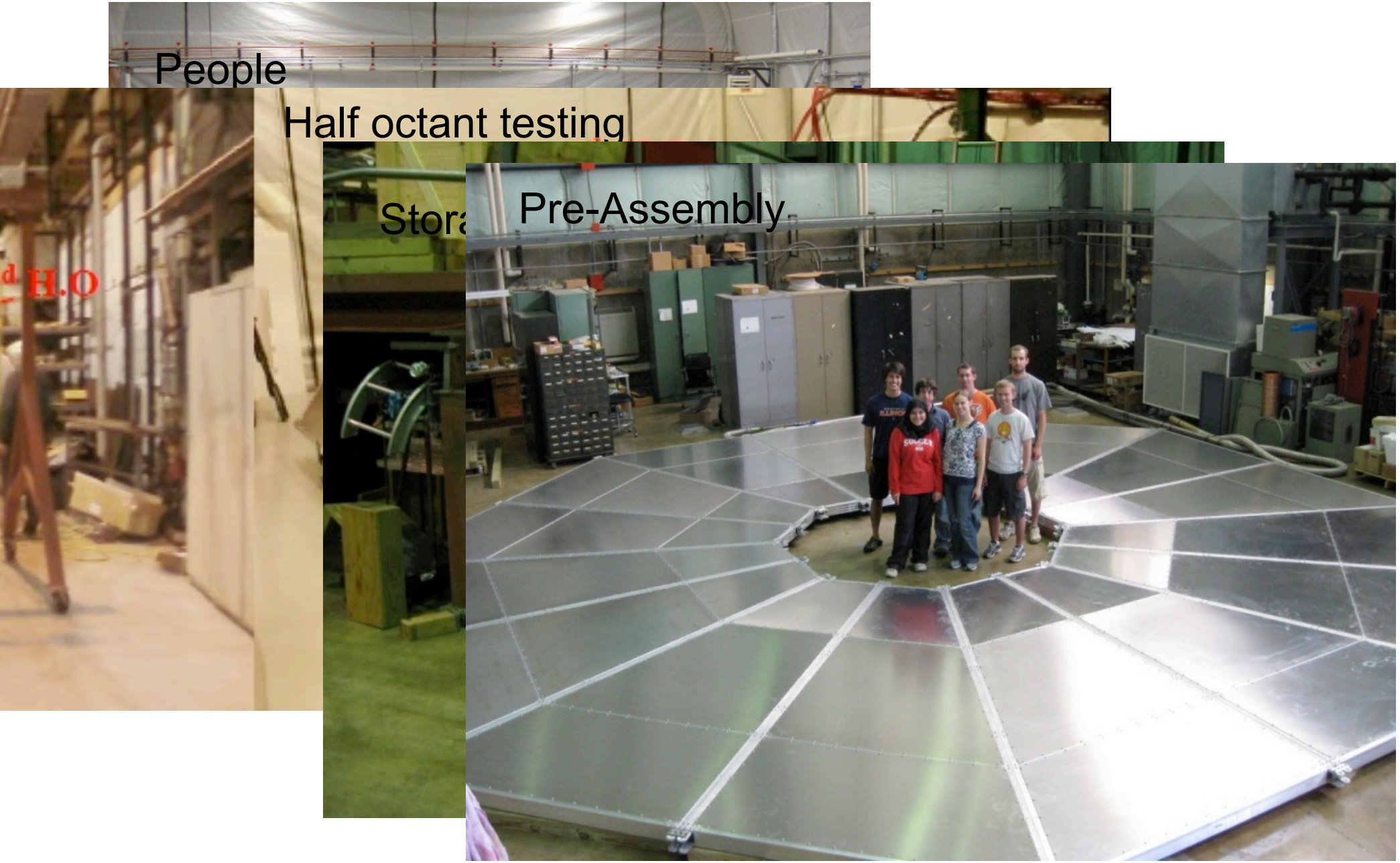




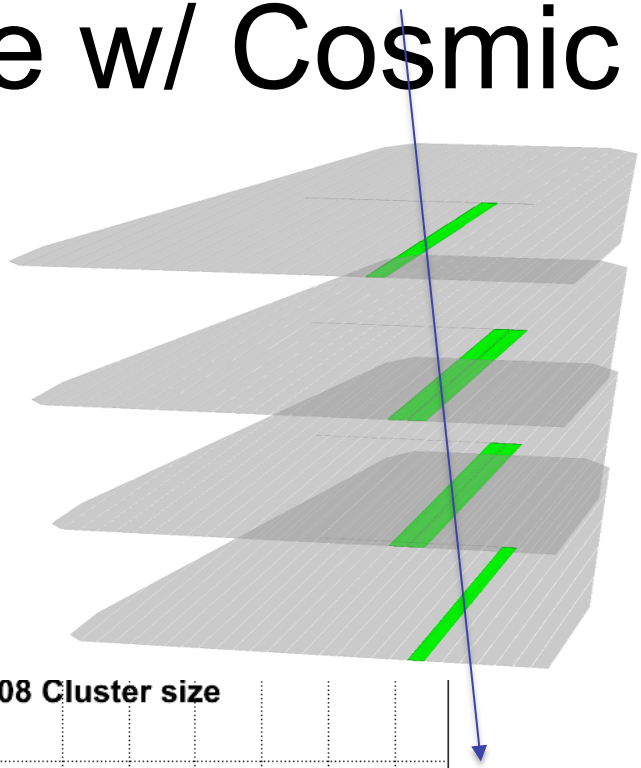


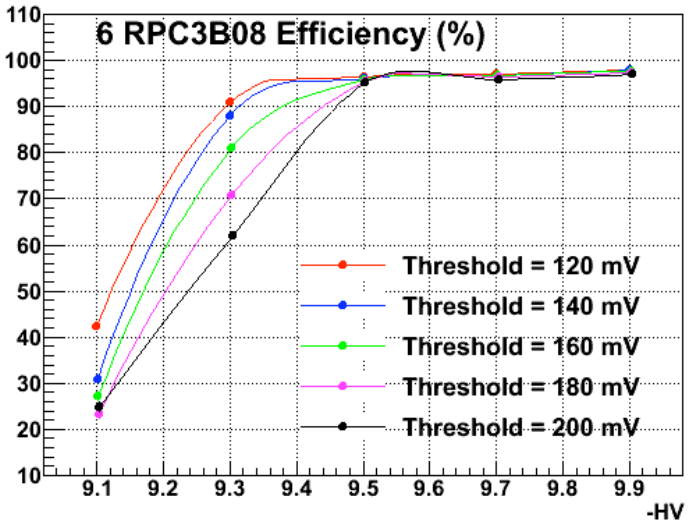
- Fast response
- **Good intrinsic time resolution**
- Good spatial resolution: typically ~ cm
- Low cost

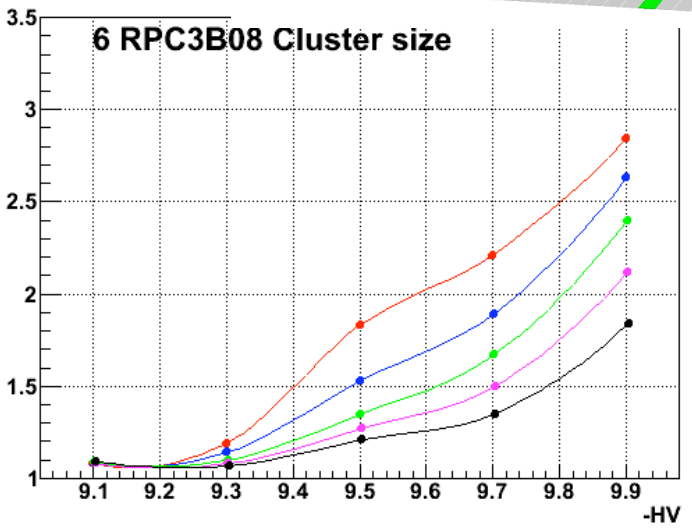
RPC Construction



RPC Performance w/ Cosmic

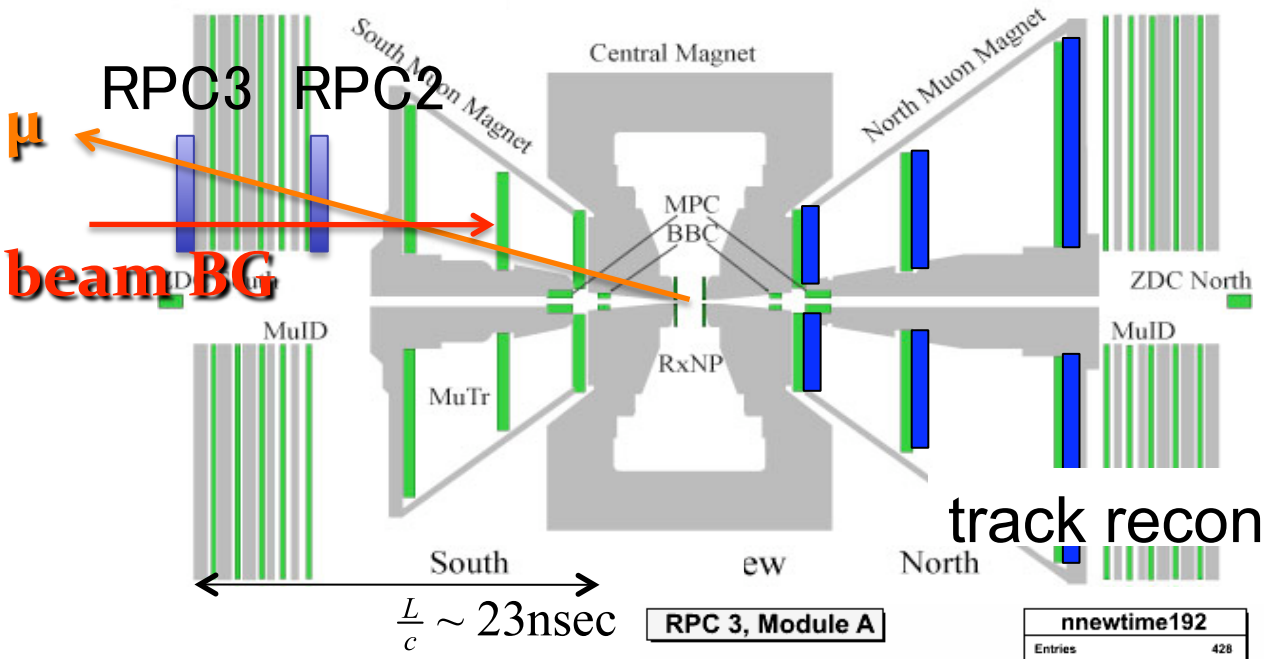




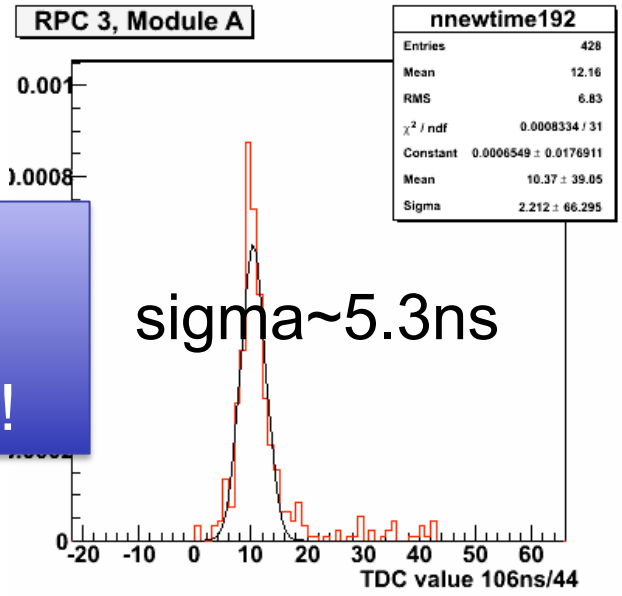


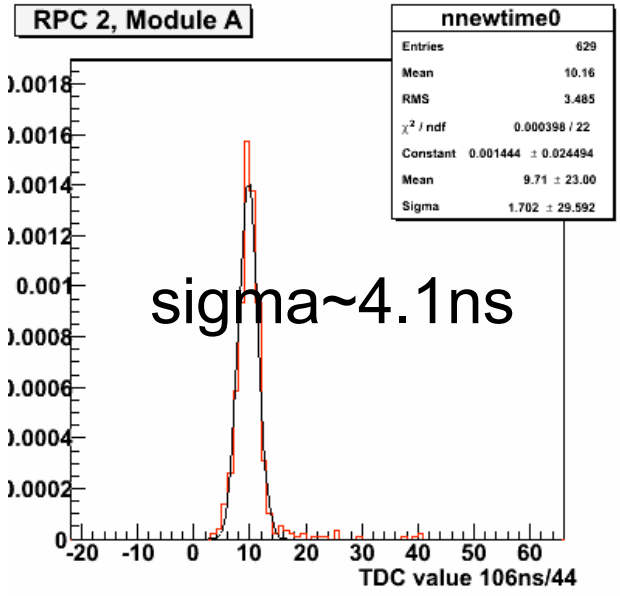
Cosmic Ray test with stack of 5 detector modules

Prototype RPC Performance @ Run9



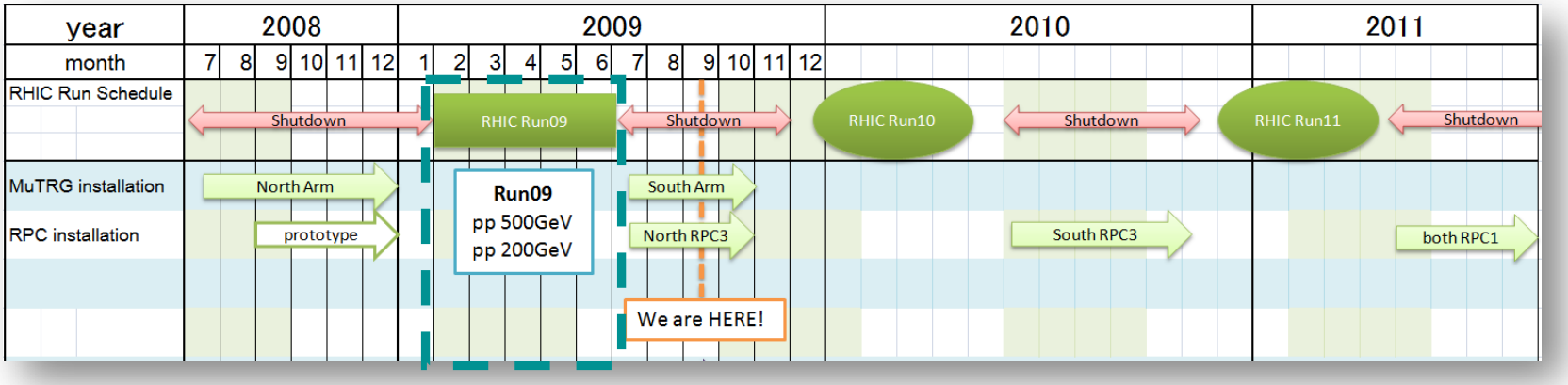
track reconstructed events

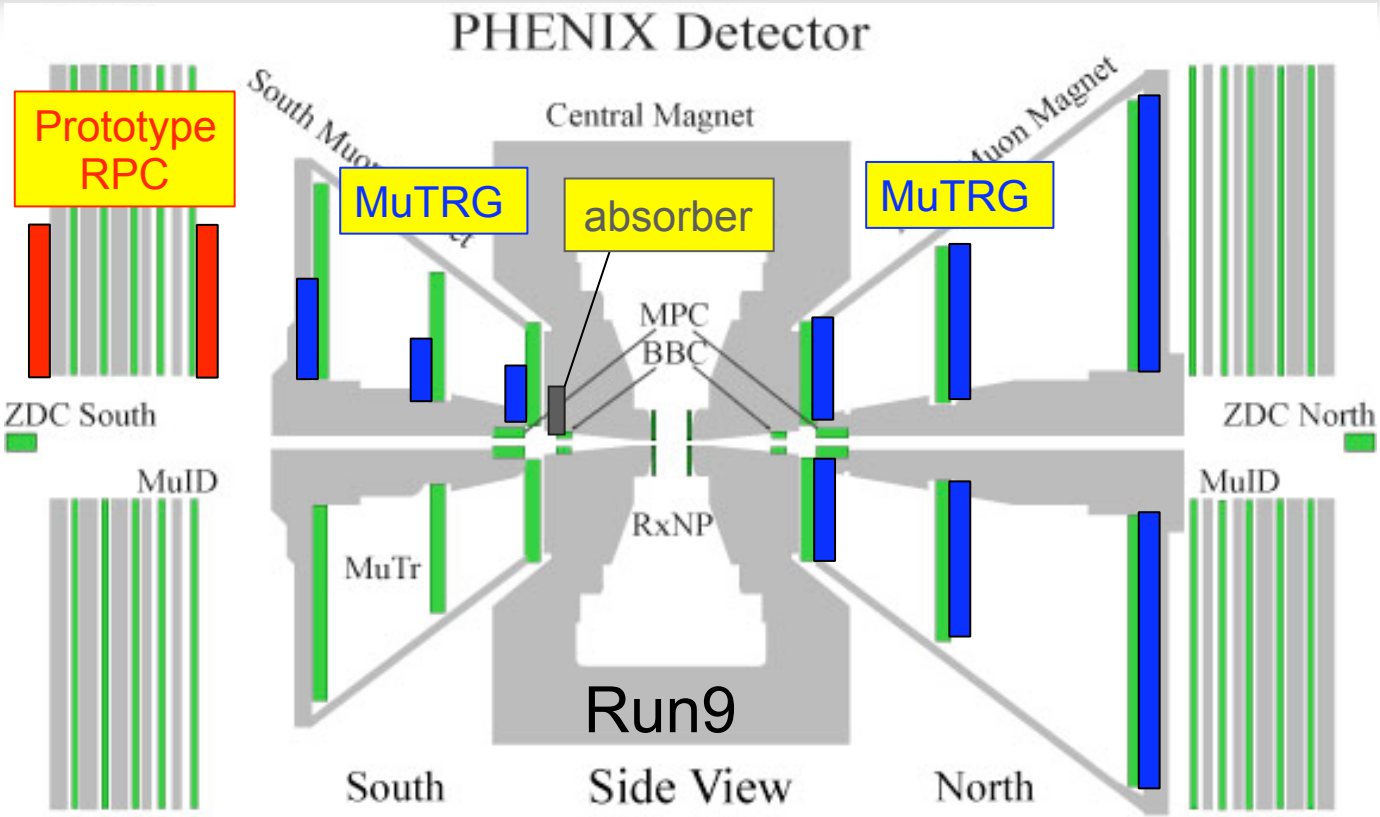




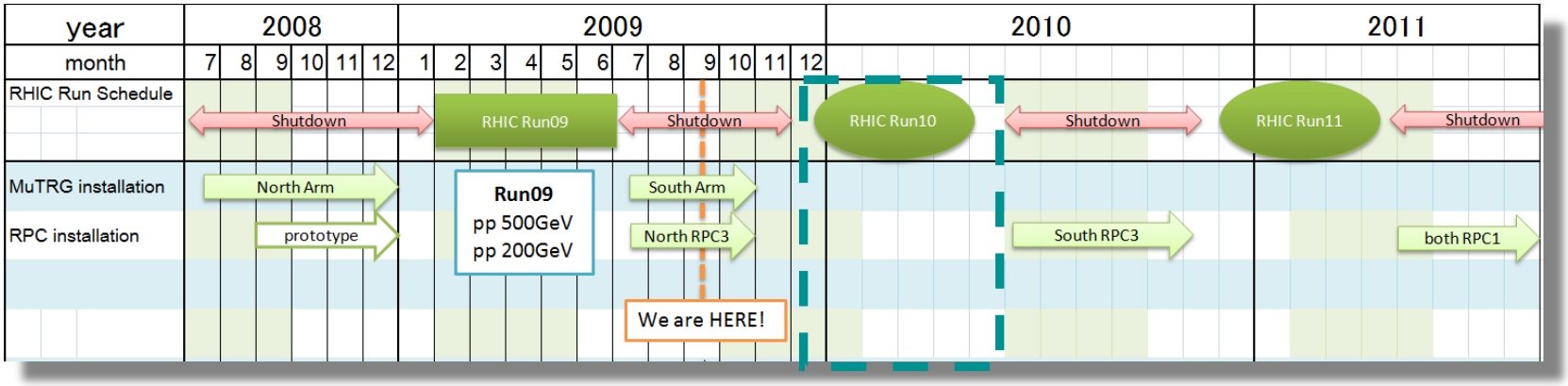
Demonstrated Satisfactory Timing Resolution w/ beam!

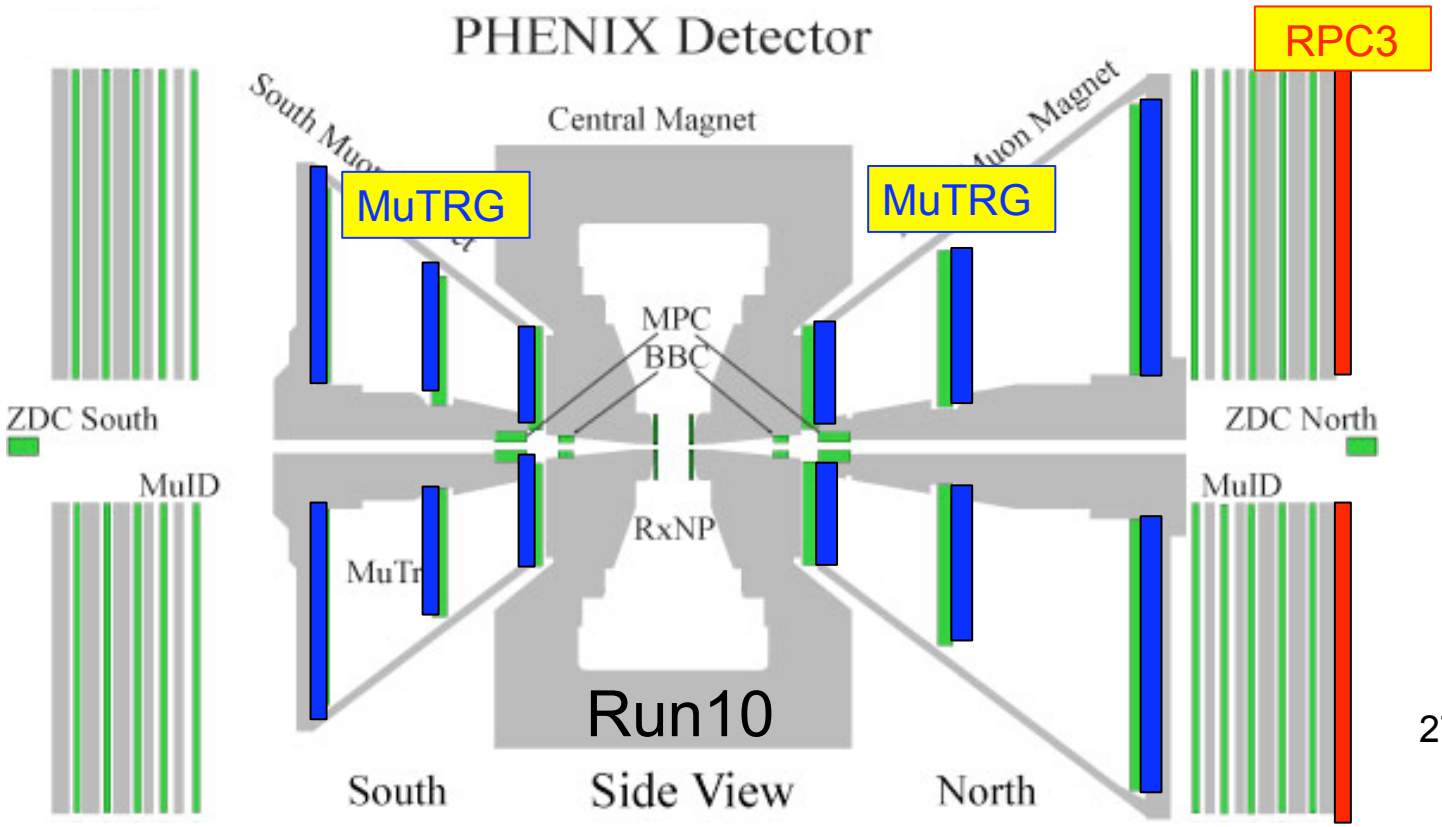
Road Map to Run11 Production Run





Road Map to Run11 Production Run





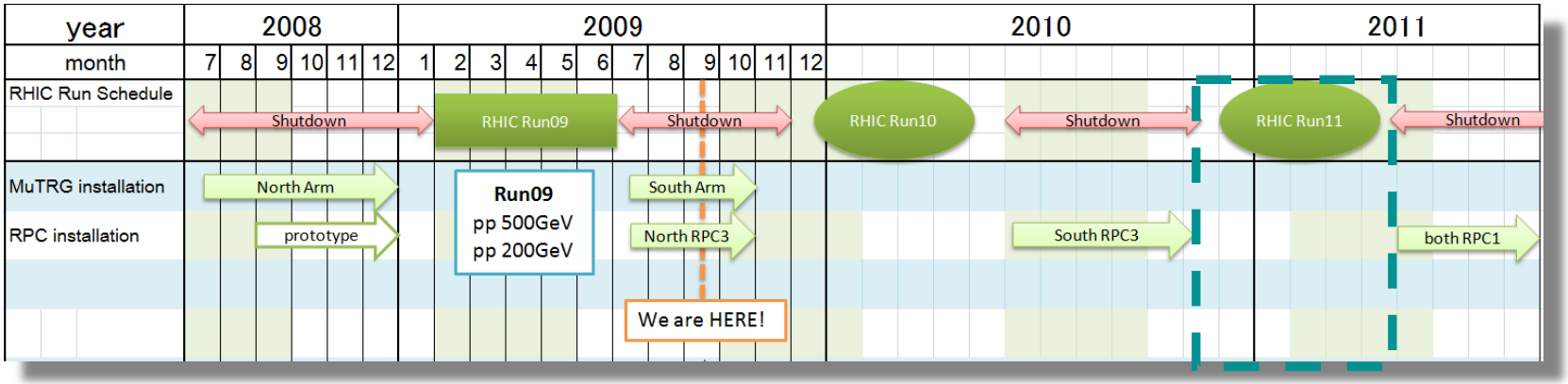
Installation to South Muon Arm

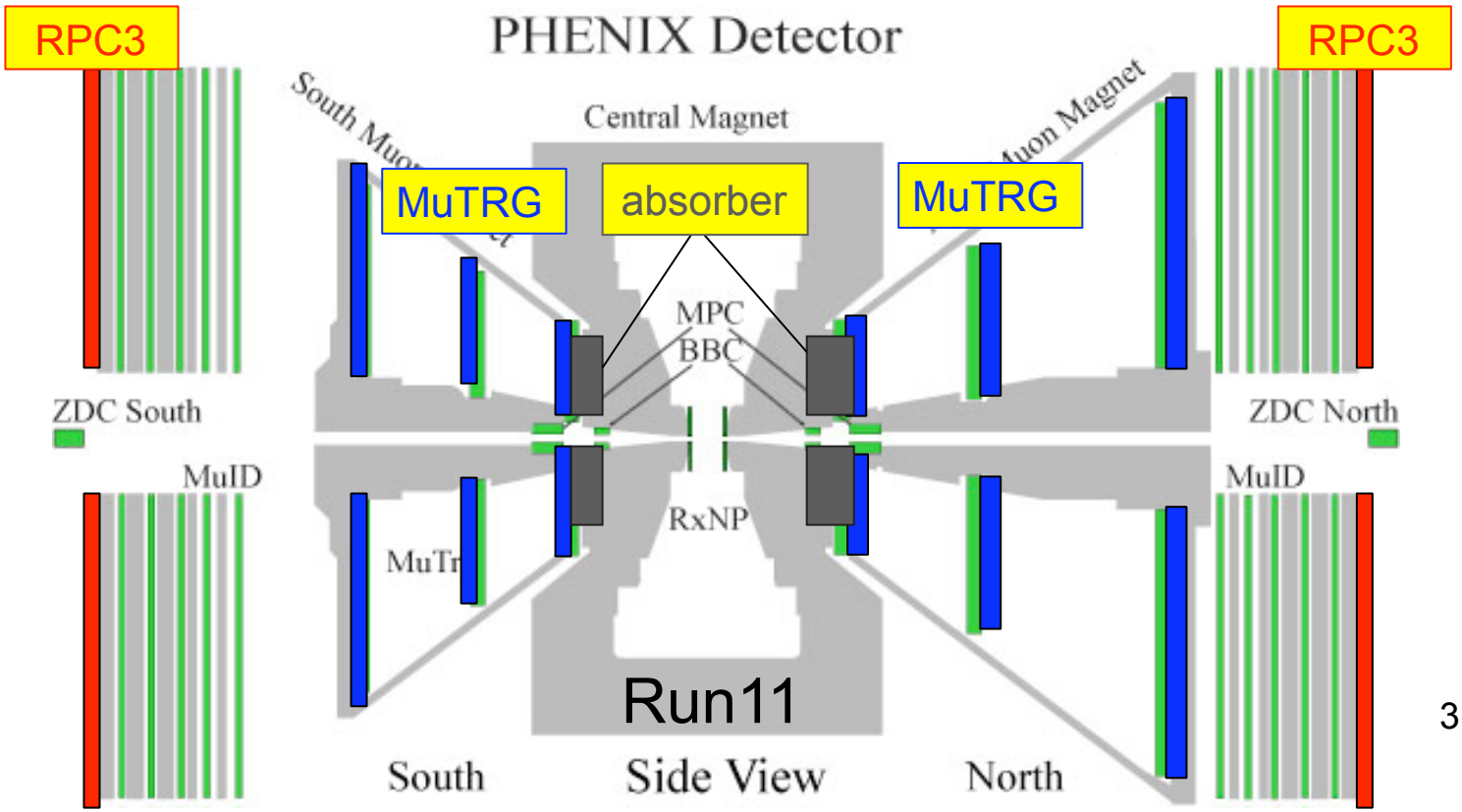
- Post Run9 Shutdown
- **Completed!**
- Under Commissioning in Run10 Au-Au Run

RPC3 North Installation (Nov.'09)

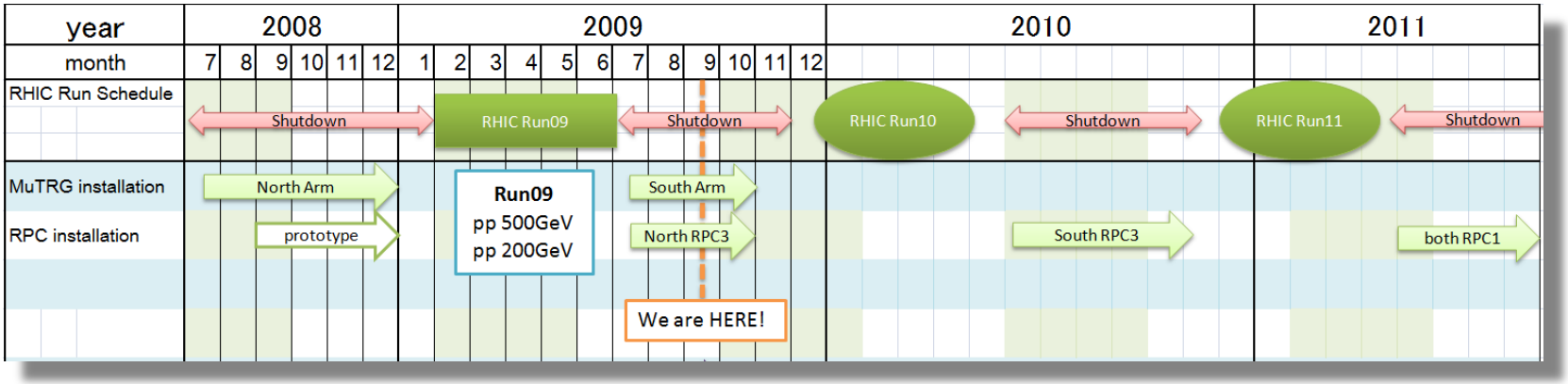
RPC3 North Completed Installation

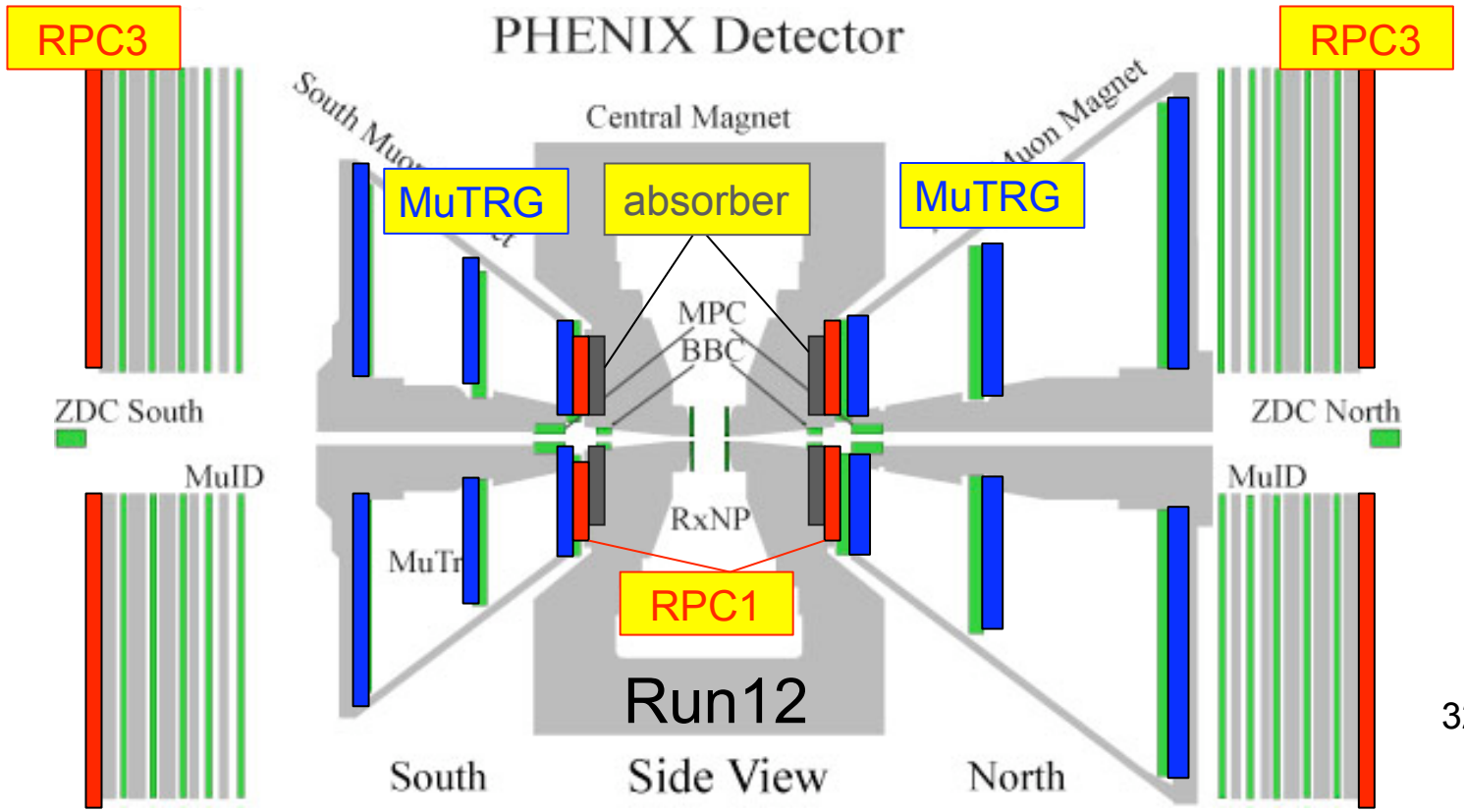
Road Map to Run11 Production Run





Final Muon Trigger Configuration





Summary

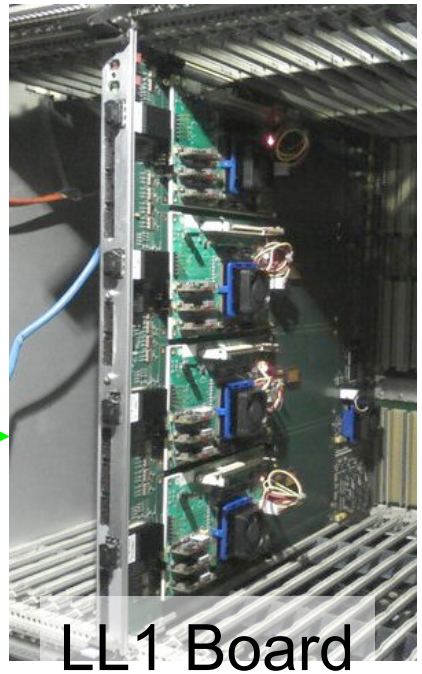
- Seak Quark Polarization Measurement @ PHENIX via W-Boson
- High Momentum MuTR-FEE Trigger is Competed Installation and to be Commissioned in Run10
- Both MuTr-FEE Trigger and RPC Commissioning Demonstrated Designed Performances.
- More rejection power are expected from
  - RPC (Timing & Matching)
  - MuID Algorithm
  - Background Shields

PHENIX Muon Arms are getting ready for pp Production at 500 GeV in Run11

Backup Slides

LL1 Trigger Readiness

MuTRG-MRG Boards



LL1 Board

- Communication test ✔
- LL1 Boards Production Completed
- On going ADTX - MRG - LL1 - GL1 chain test now.
- New high momentum trigger will be operated in Run10 for commissioning