PHENIX Upgrade for W Physics

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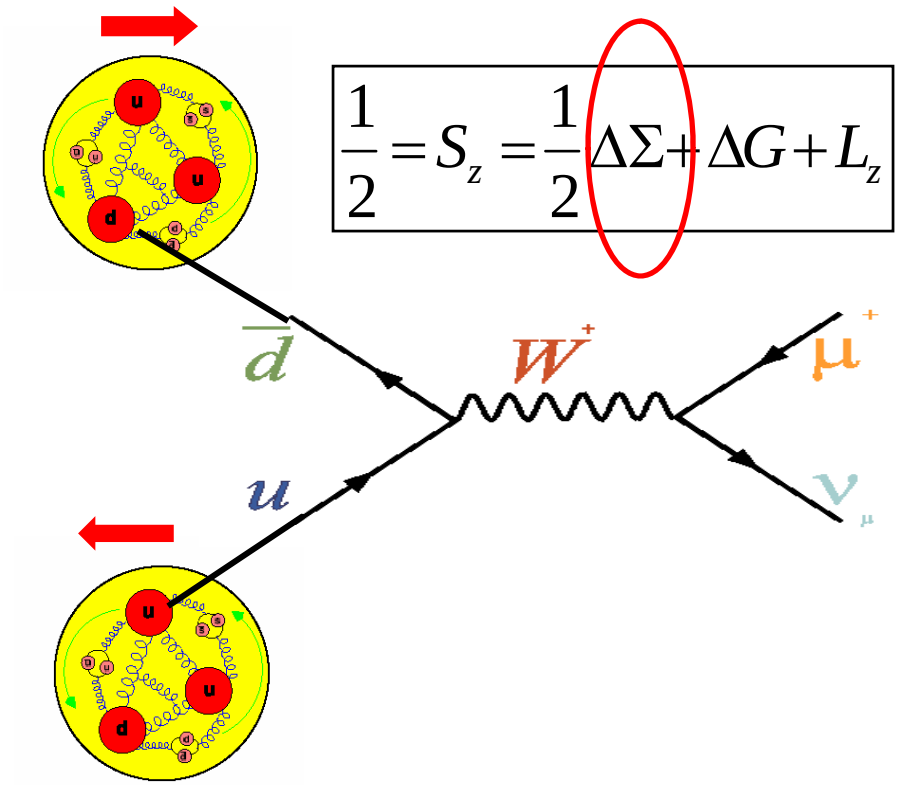
UIUC

RHIC & AGS User's meeting

Forward upgrade – W Spin Physics



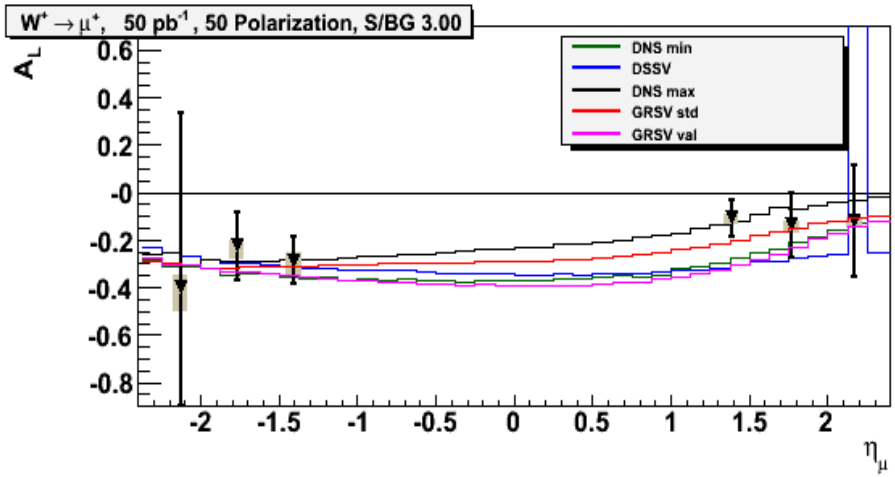
$$\frac{1}{2} = S_z = \frac{1}{2}\Delta\Sigma + \Delta G + L_z$$

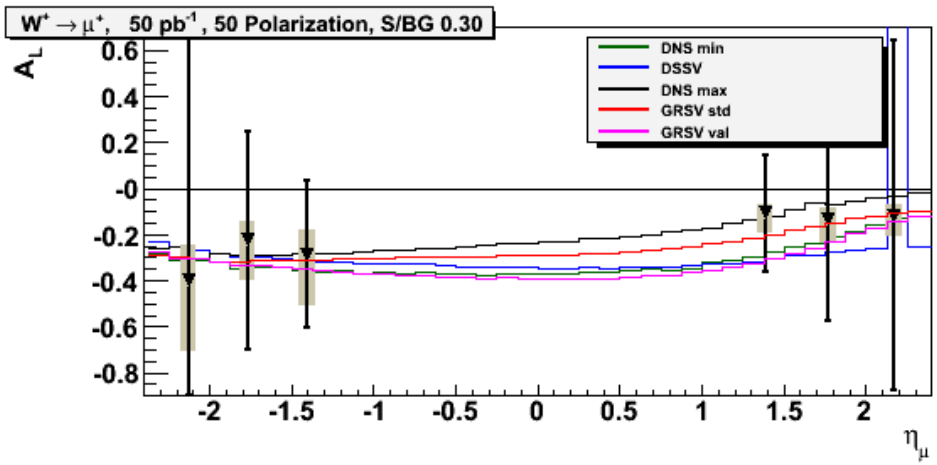
$$A_L = u + \bar{d} \rightarrow W^+ \rightarrow \mu^+ + \nu_\mu$$

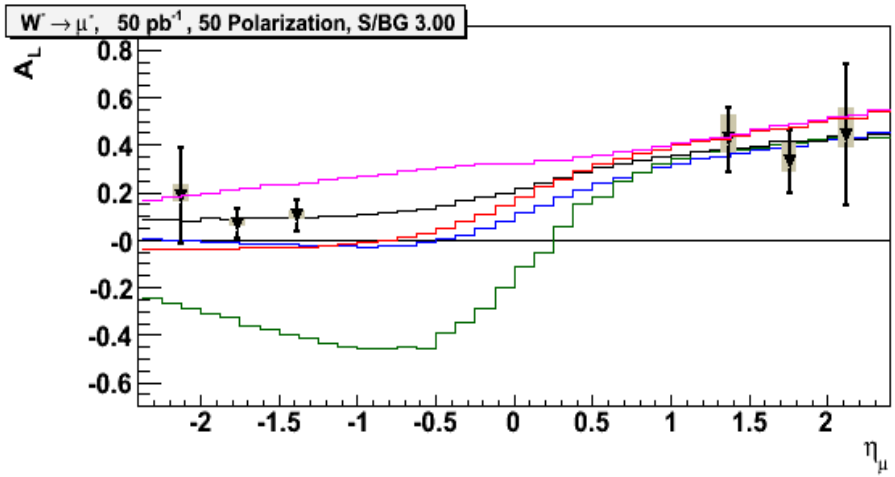
$$A_L = d + \bar{u} \rightarrow W^- \rightarrow \mu^- + \bar{\nu}_\mu$$

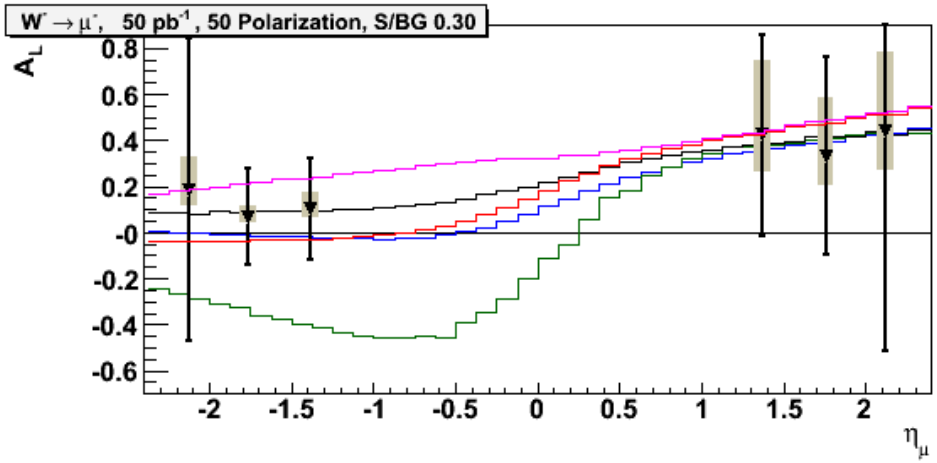
- Understanding proton spin structure: measurement of quark and anti-quark helicity distributions.
- W-mass ➔ high Q^2!
  Independent of knowledge of hadron fragmentation functions
- quark polarizations can be accessed via single spin asymmetries in W boson production
- W^+ ,W^- production is tagged through muons emitted with high transverse momentum in the forward direction.

Run10 A_L projections





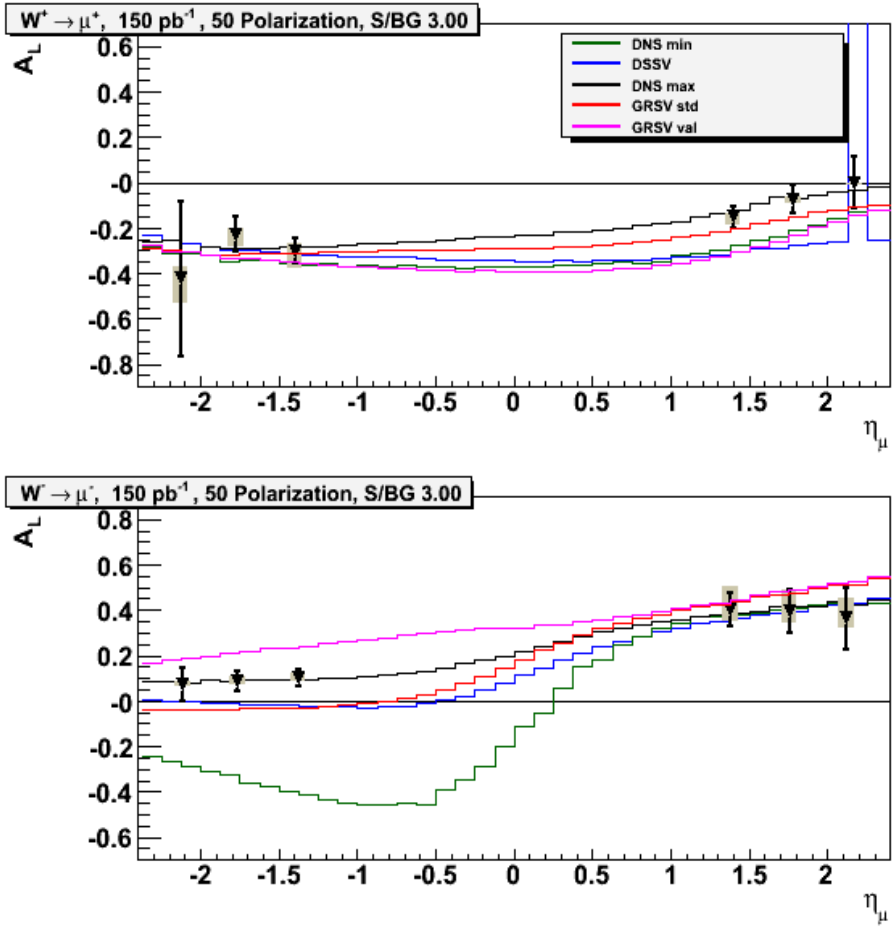


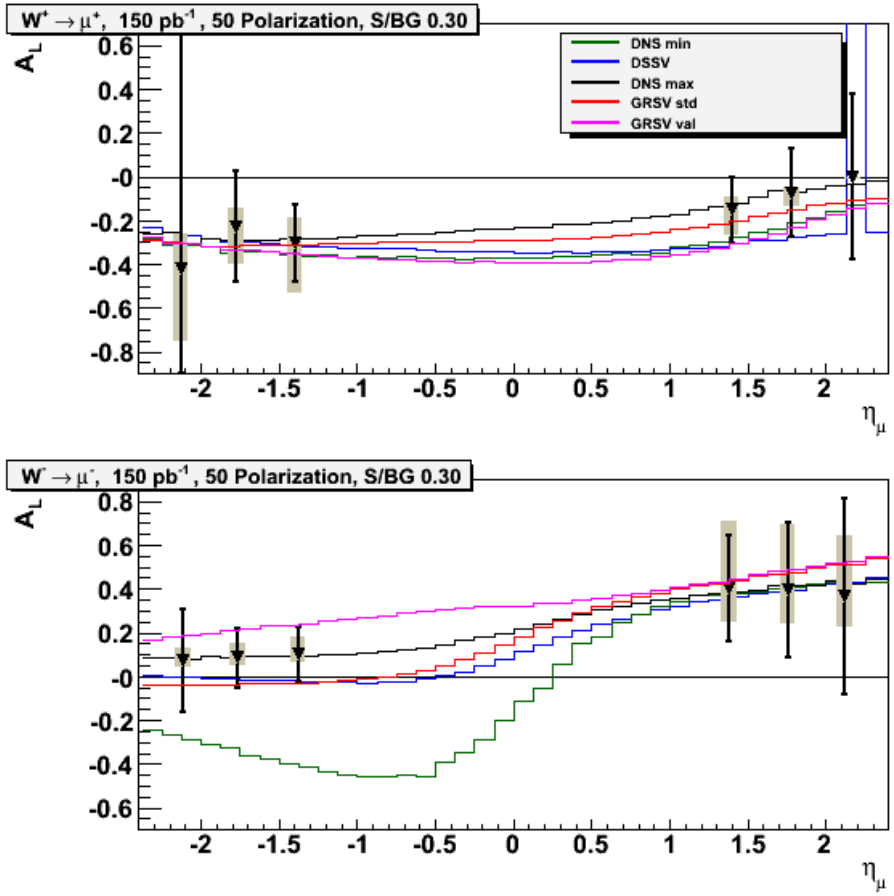


Run10 Projection
S/B ~ 0.3 (conservative)

Run10 Projection
S/B ~ 3.0 (Expected)

Run11 A_L projections

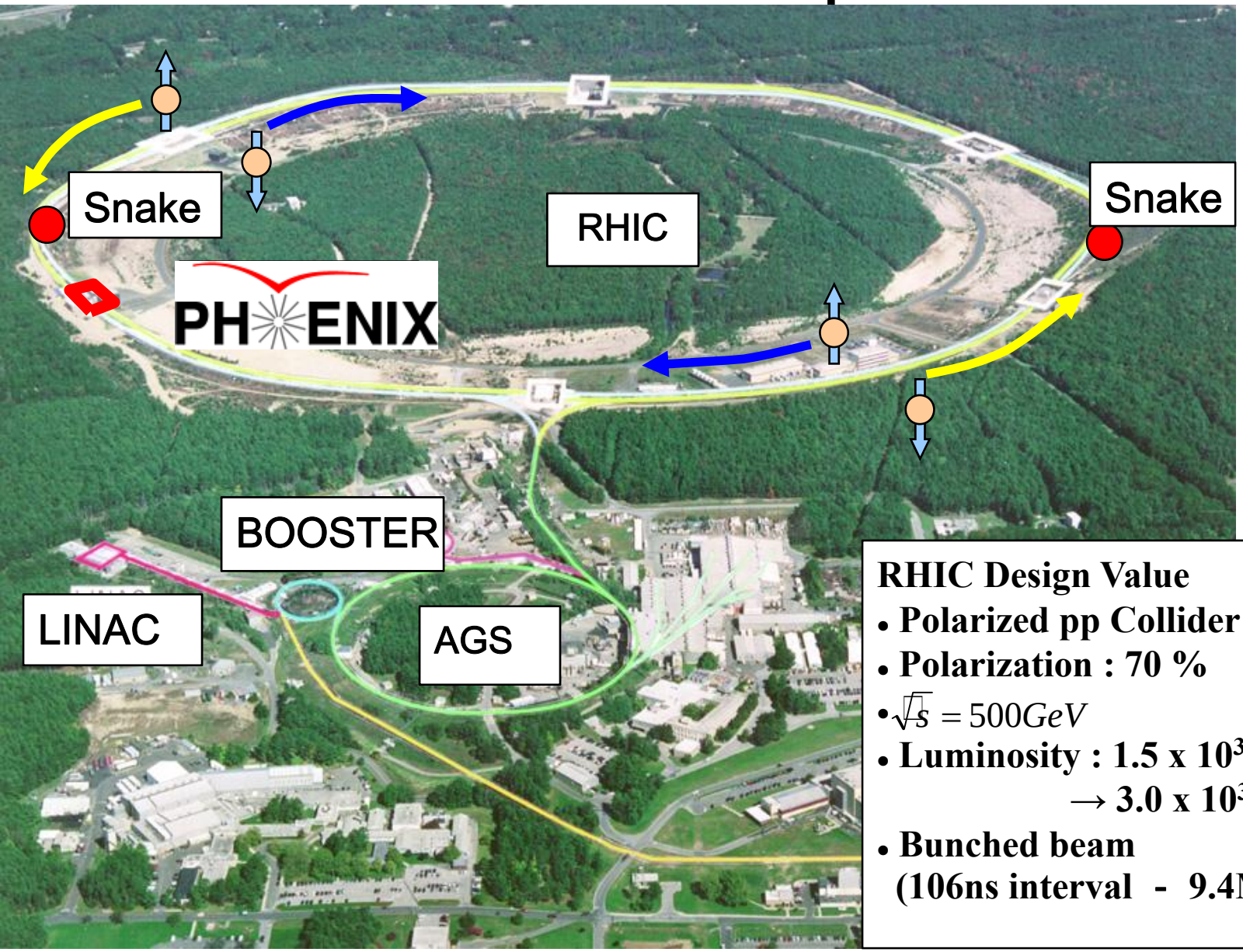




Run11 Projection
S/B ~ 0.3 (conservative)

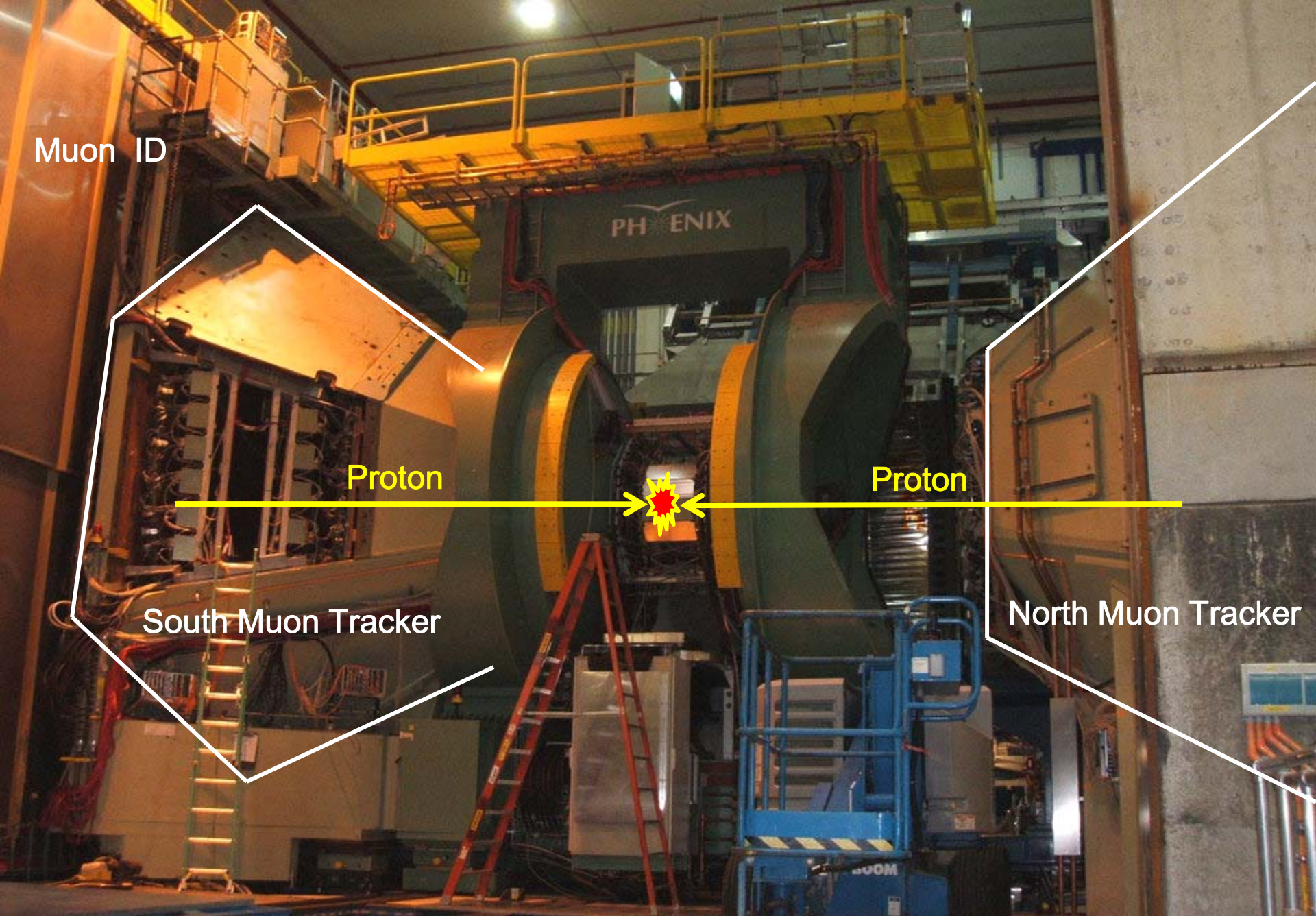
Run11 Projection
S/B ~ 3.0 (Expected)

RHIC spin



RHIC Design Value

- **Polarized pp Collider**
- **Polarization : 70 %**
- $\sqrt{s} = 500GeV$
- **Luminosity : 1.5 x $10^{32}cm^{-2}s^{-1}$**
  → 3.0 x $10^{32}cm^{-2}s^{-1}$
- **Bunched beam**
  (106ns interval - 9.4MHz)


Muon ID
PHENIX
Proton
Proton
South Muon Tracker
North Muon Tracker

Current Muon Tracker and ID

Muon Tracker

80cm of steel & Copper absorber
3 stations of cathode strip chamber
3gap + 3 gap + 2 gap
Each gap has non-stereo and stereo strip plane.
Total 16 cathode strip planes .
1.2<|Eta|<2.4

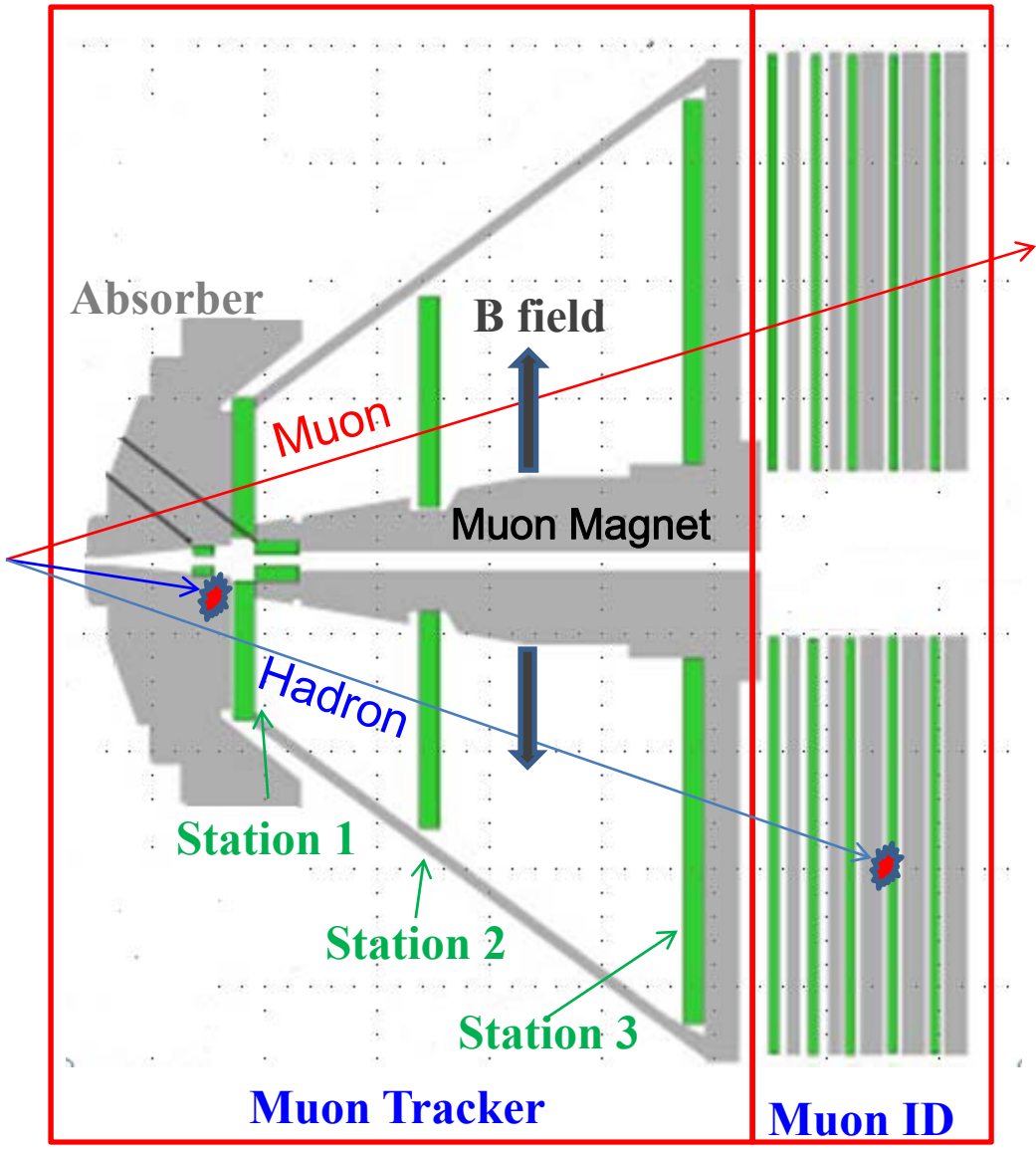
Muon Identifier

5 gaps of larocci tube in x and y directions
Total 80 cm of steel plates

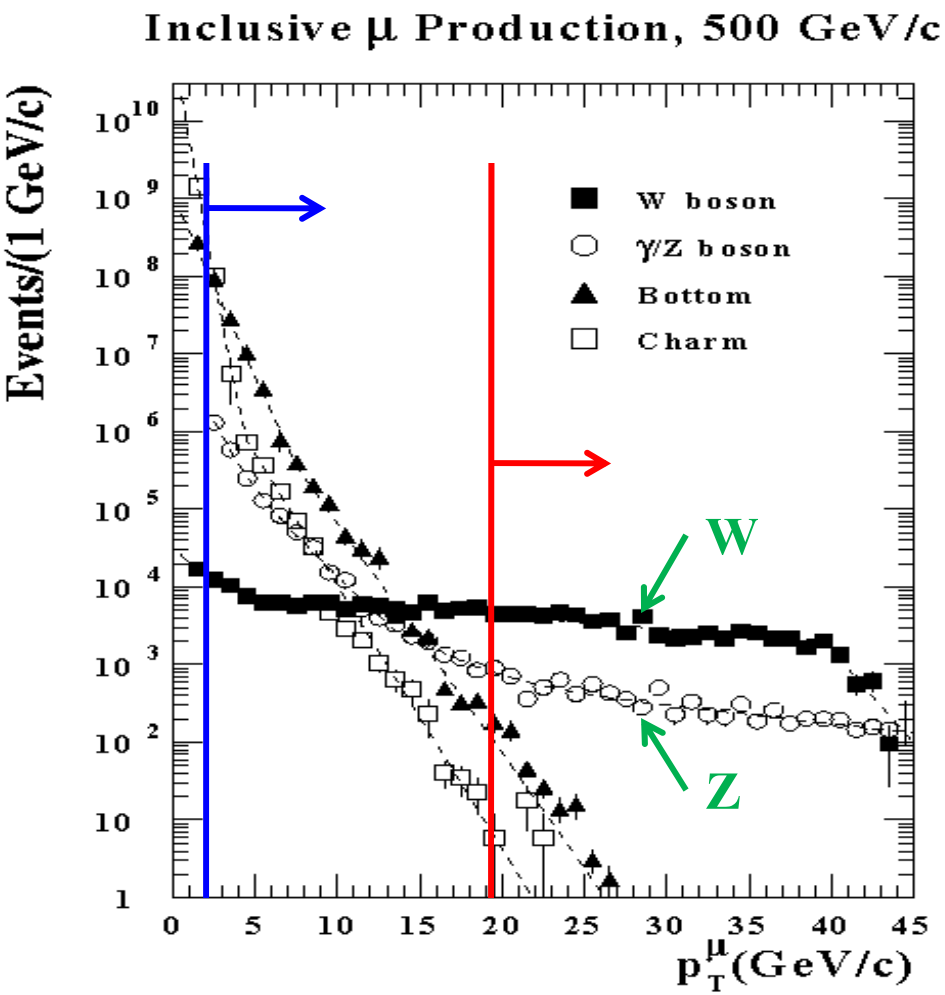
Muon Tracking

Traking using hit positions from each station
Most hadrons are absorbed before reaching MuonID last gap

Rejection of the current MuID based first level trigger is to low for efficient selection of W events :
rejection power ~100 -500
(depending on beam background)



Muon trigger upgrade



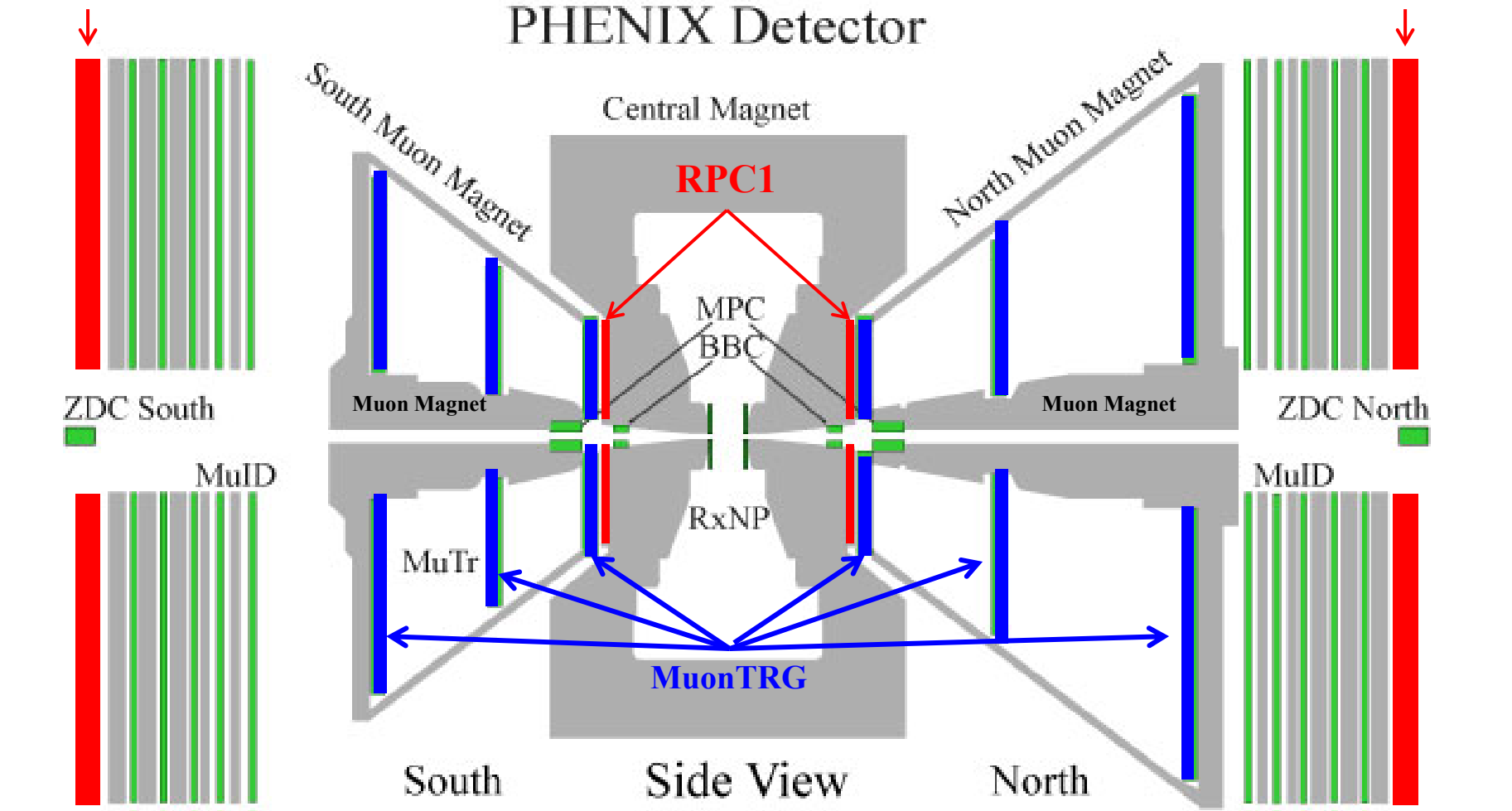
- **Existing Muon Trigger**

  Momentum threshold is too low
  Expected luminosity at the next 2011 run is 1.5 x $10^{32}cm^{-2}s^{-1}$
  ~9 MHz pp collision rate

- **Need High momentum Trigger**

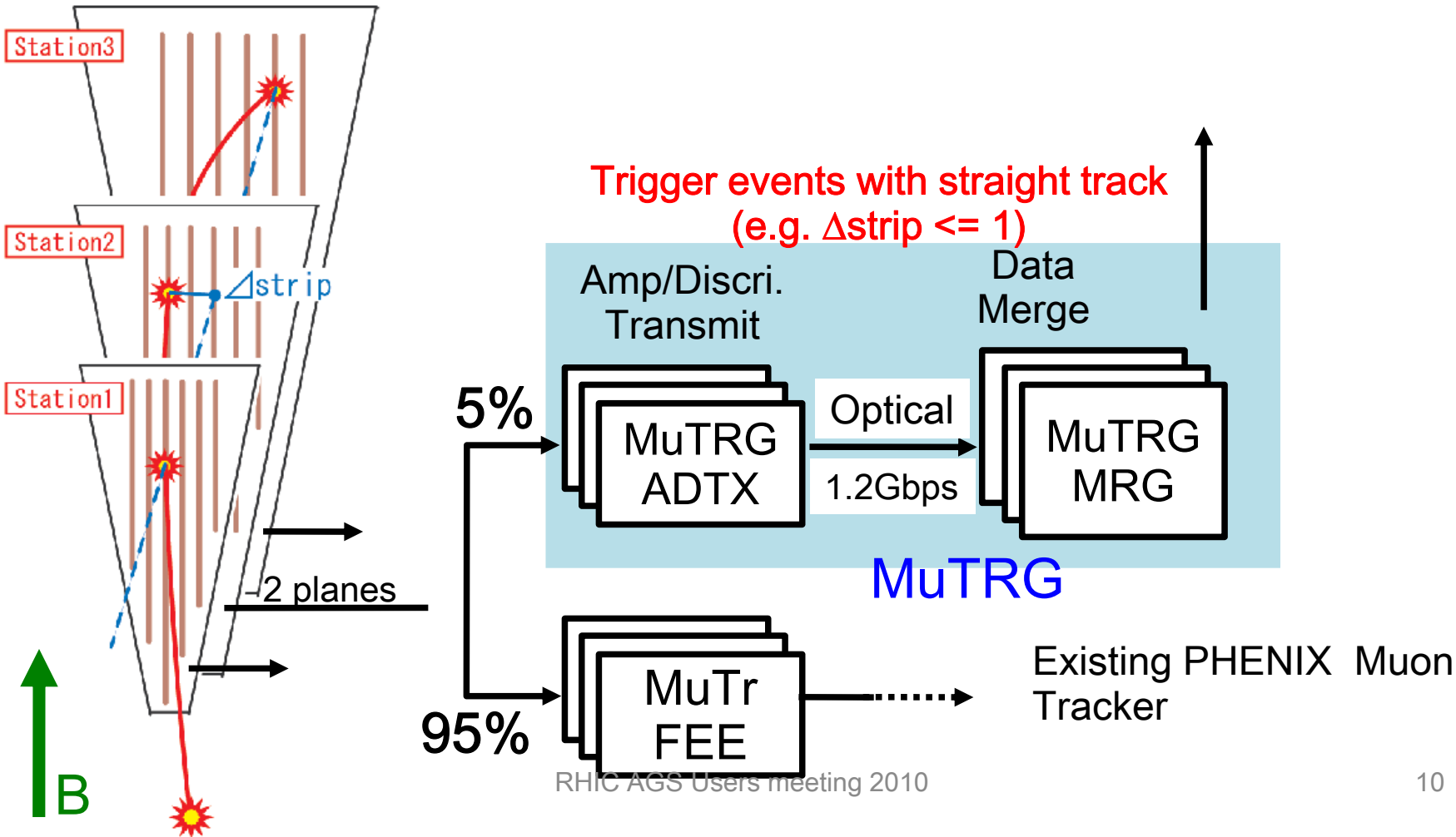
  Fast online tracking and Select straight track
  DAQ Bandwidth ~2kHz
  Rejection Power ~ 4500

Upgrade – 2 stages

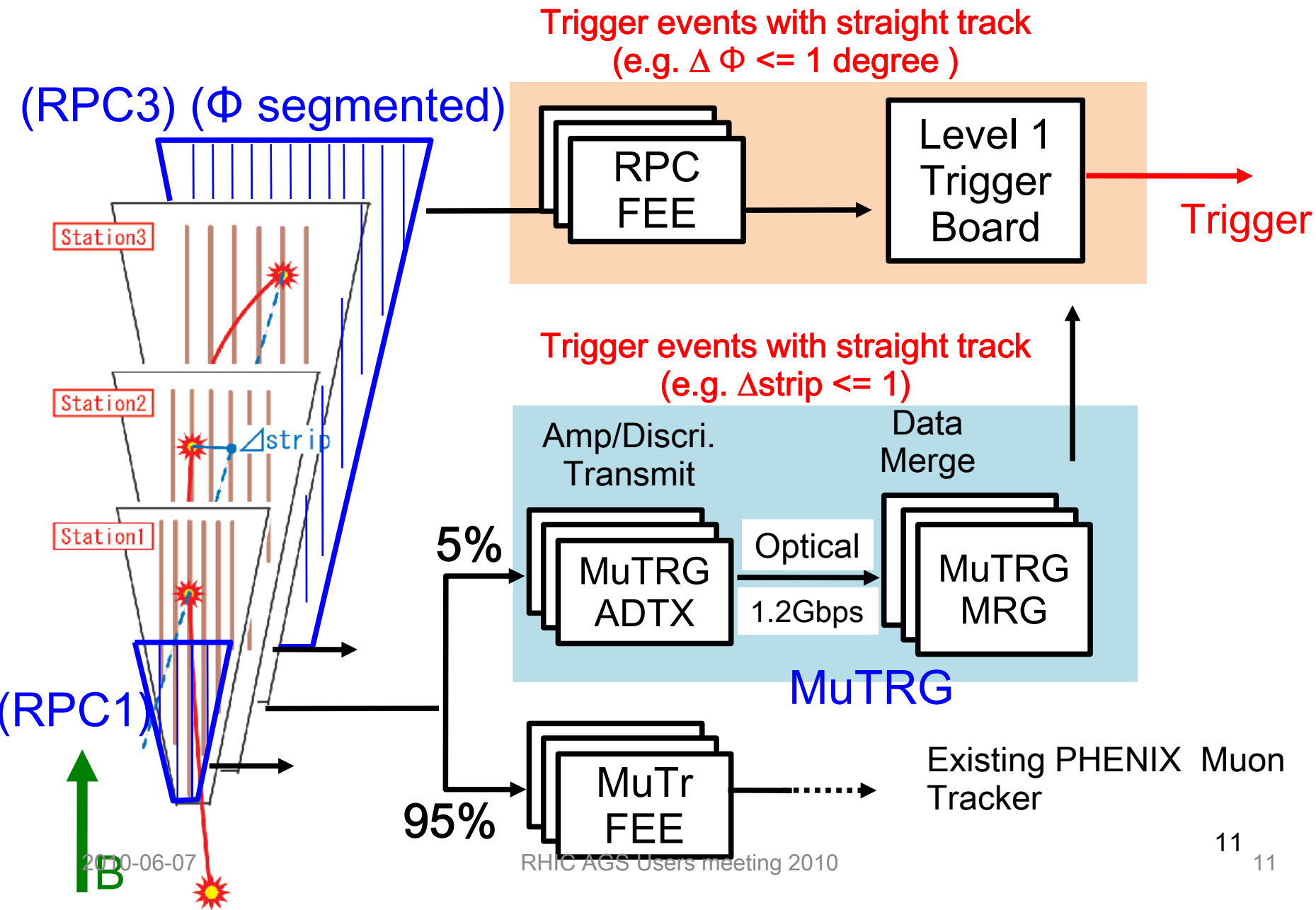


1) **MuonTRG(MuTRG) :Addition of fast level 1 electronics to existing muon traker**
2) **Resistive Plate Chamber(RPC) : Addition of RPC with new front end electronics and new LL1 trigger processors**

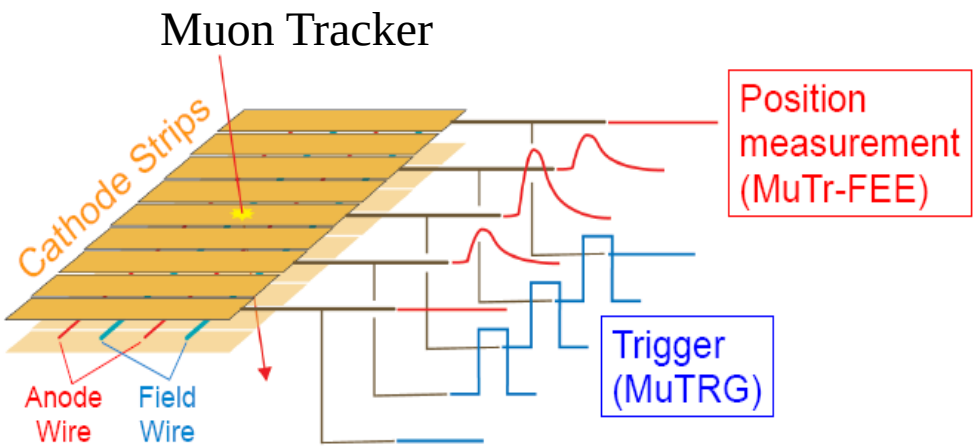
W Trigger System

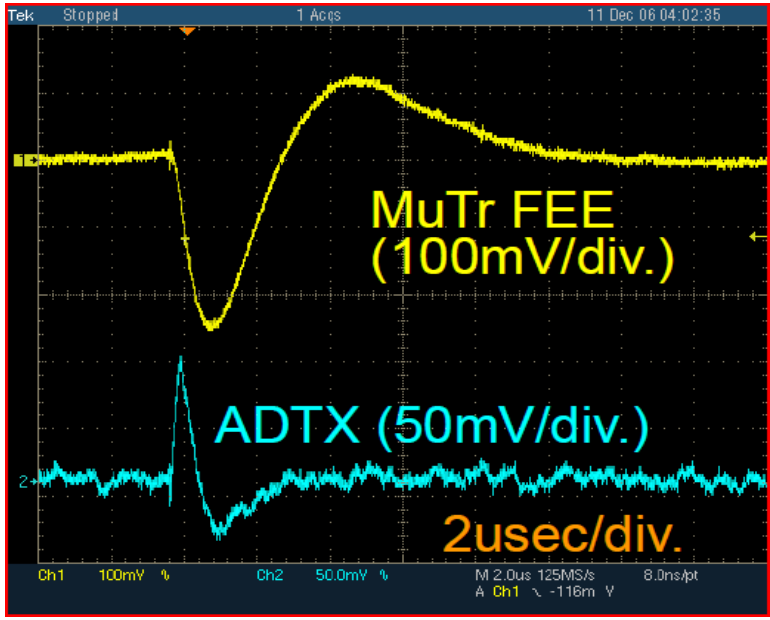


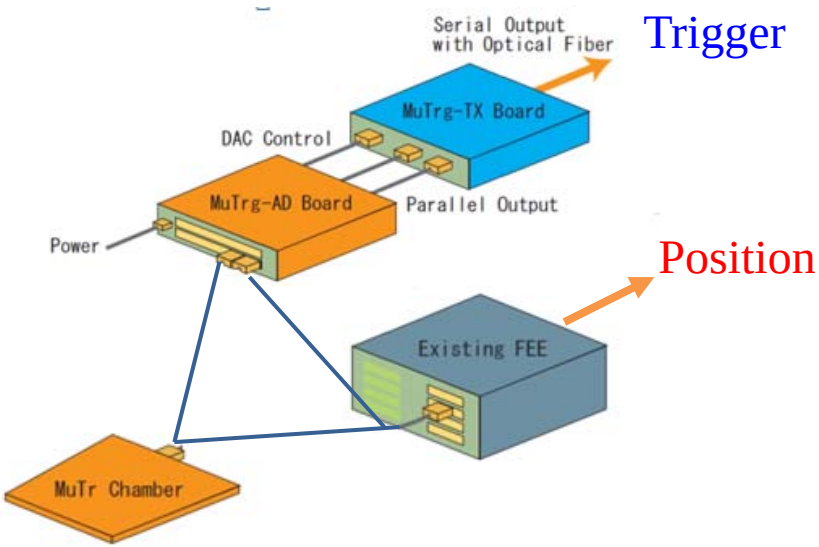
W Trigger System



MuTRG Boards



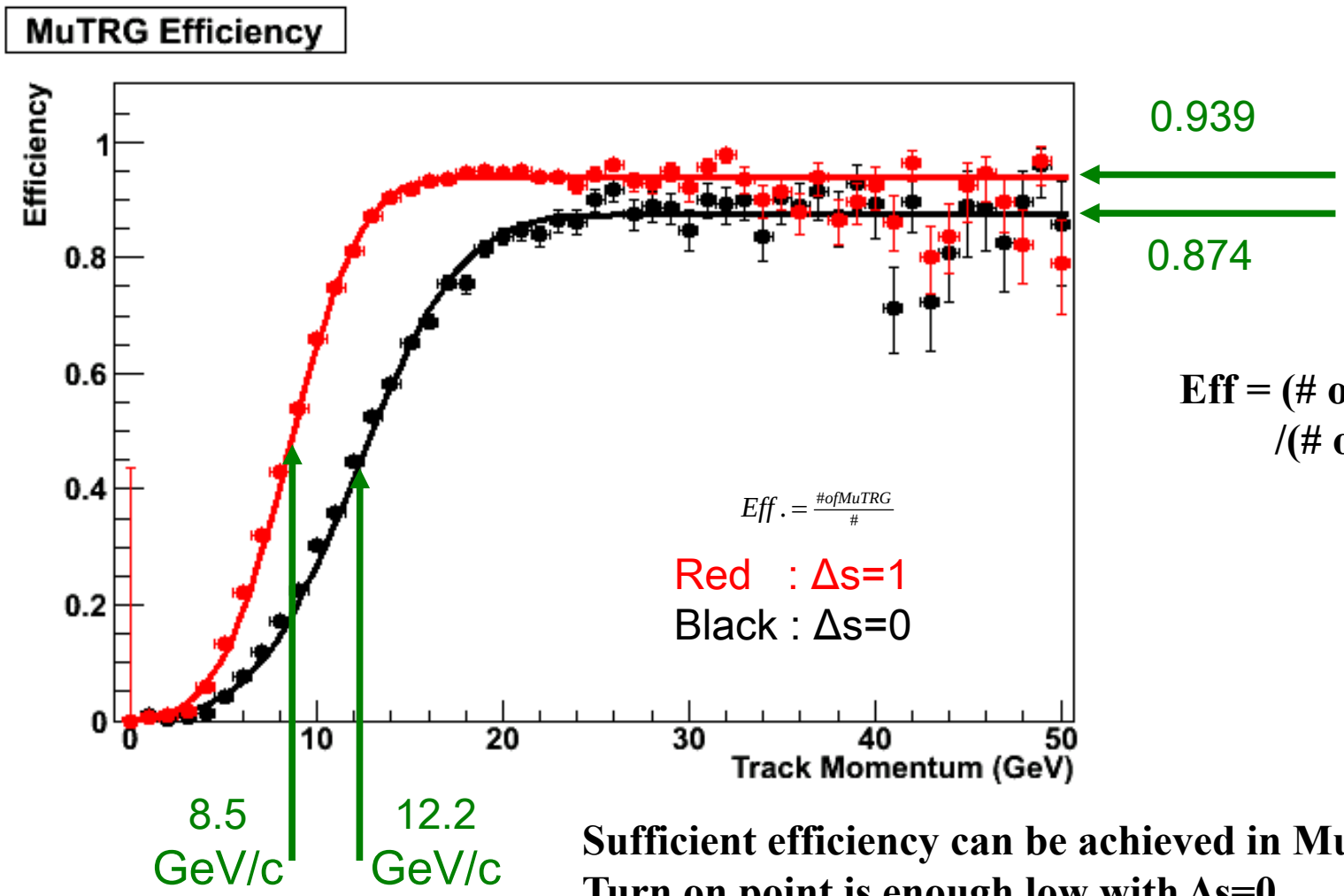




MuTRG-ADTX

MuTRG-MRG, MUTRG-DCMIF

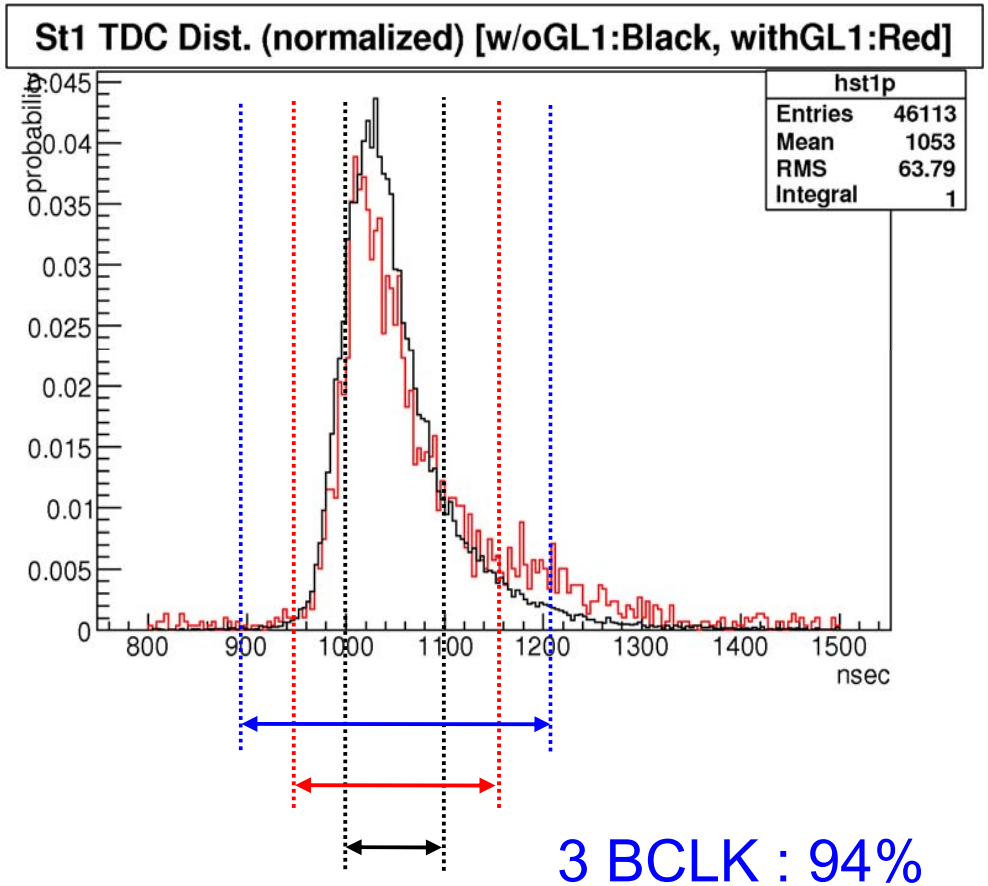
MuTRG Efficiency for Track



Eff = (# of MuTRG) /(# of MuTr hits)

Sufficient efficiency can be achieved in MuTRG
Turn on point is enough low with Δs=0.
(12.2 GeV/c in p, ~6 GeV/c in pT)

MuTRG Timing Resolution

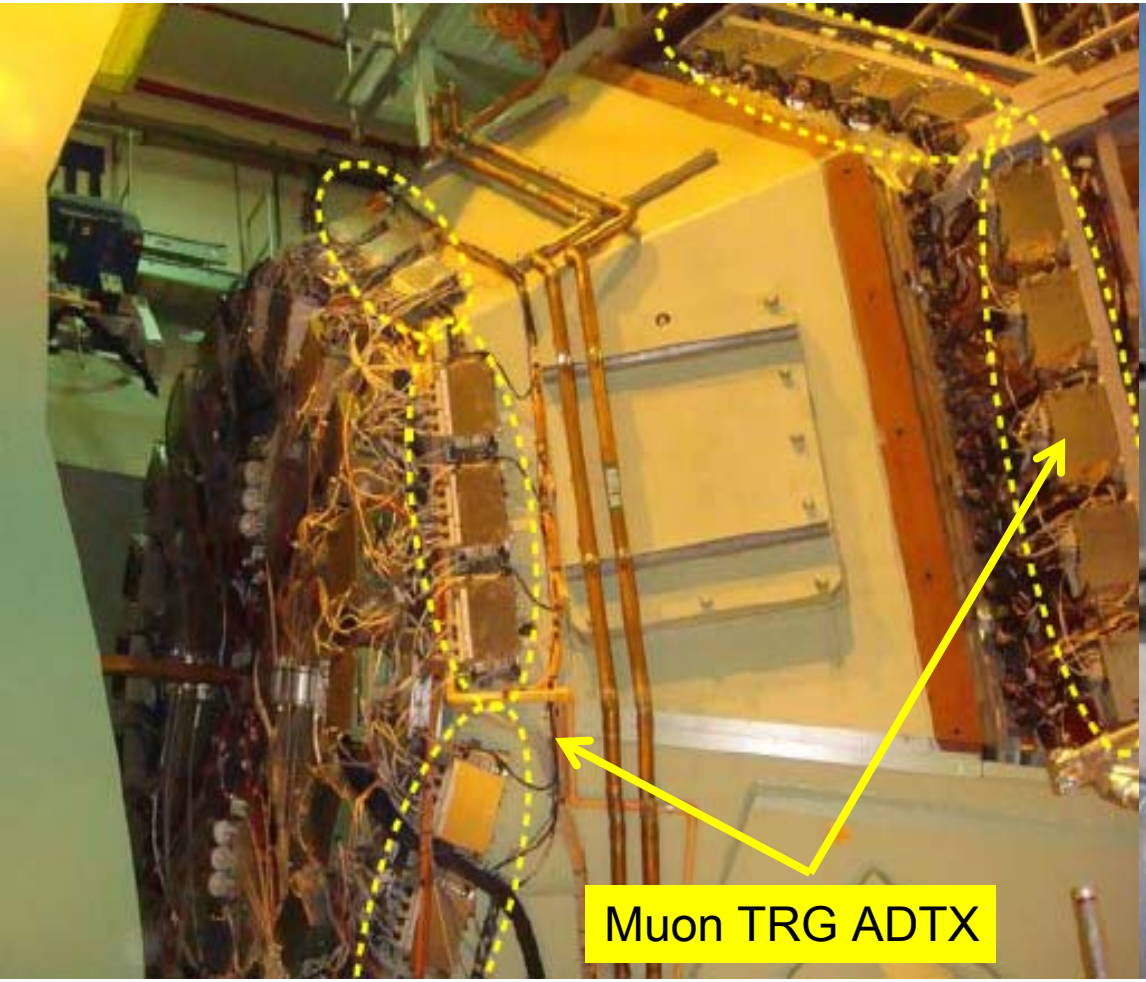


3 BCLK : 94%
2 BCLK : 84%
1 BCLK : 64%

Timing resolution is consistent Between cosmic ray data and beam data.

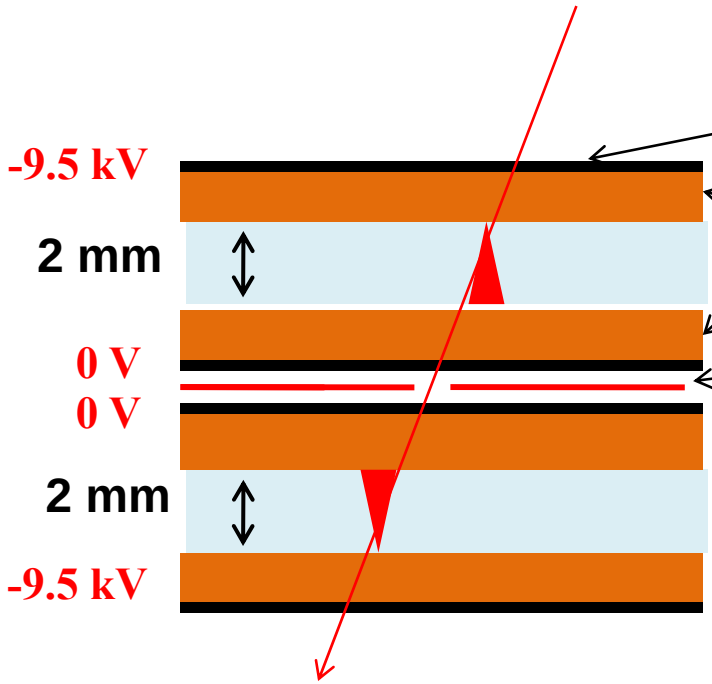
Efficiency is 94% with 3 BCLK gate.
RPC timing information is necessary.

MuTRG installed at PHENIX



Muon TRG installed at North and South Muon tracker

Resistive Plate Chamber (RPC)



Graphite : resistivity 100 – 500kΩ/cm^2

Bakelite : resistivity 10^{10} - 10^{11} Ω·cm

Signal Strip : Good time resolution 1-2ns / Efficiency 96% for M.I.P
Noise Rate 0.5 ~ 5 Hz/cm^2

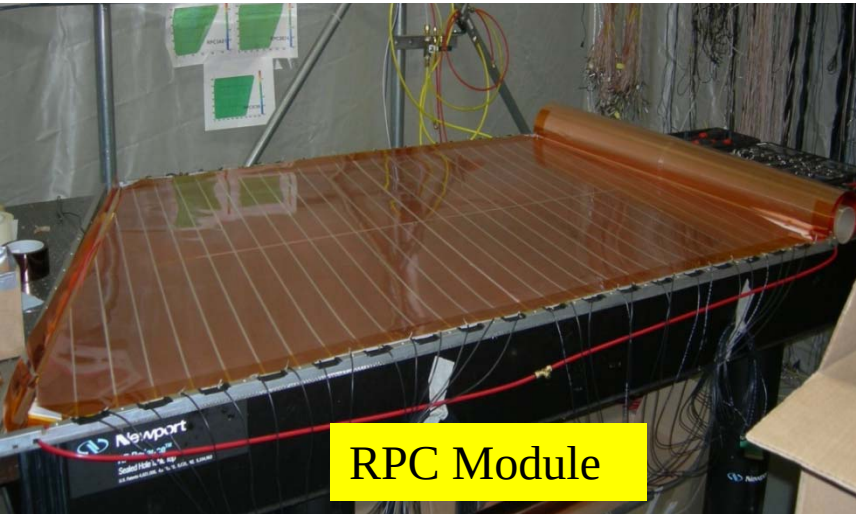
Mixed Gas :

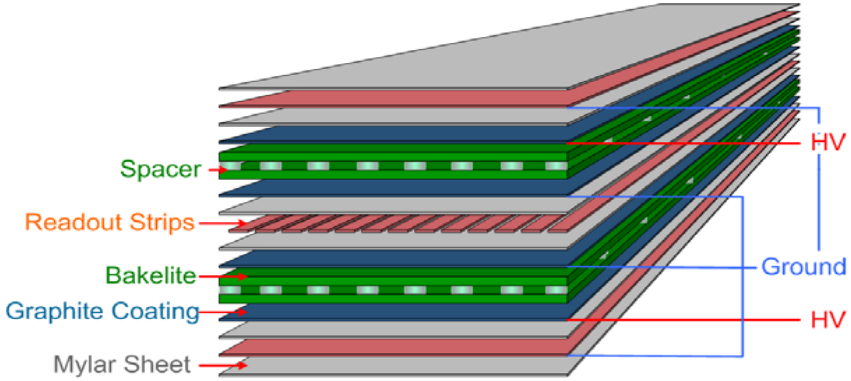
- **95% $C_2H_2F_4$ (base gas for avalanche)**
- **4.5% i-C_4H_{10} (photon quencher)**
- **0.5% SF_6 (electron quencher)**
- **20 – 40% (relative humidity)**

Requirement

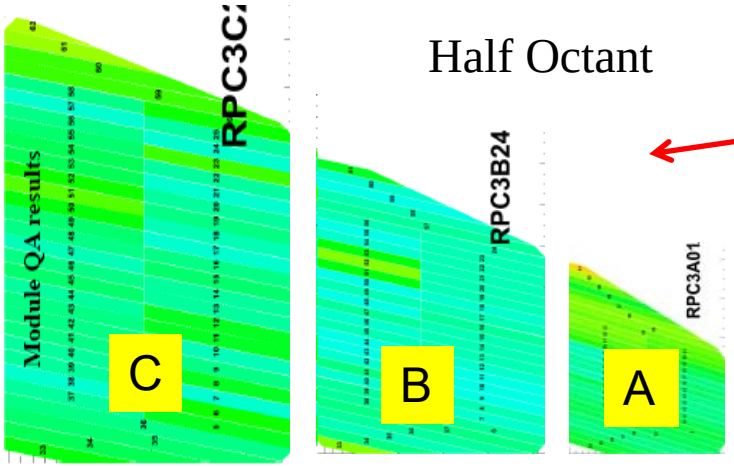
Time resolution	≤ 3 ns
Average cluster size	≤ 2 strips
Efficiency	> 95%
Rate capability	0.5 kHz/cm^2
Number of streamers	< 10 %

RPC3 Assembly

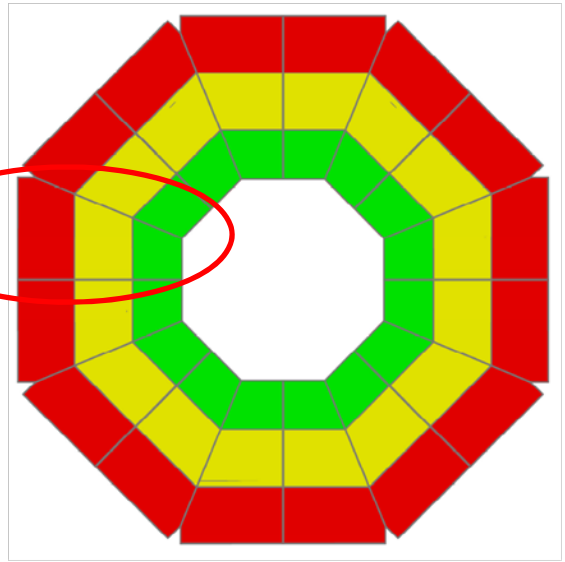




RPC Module Cross section

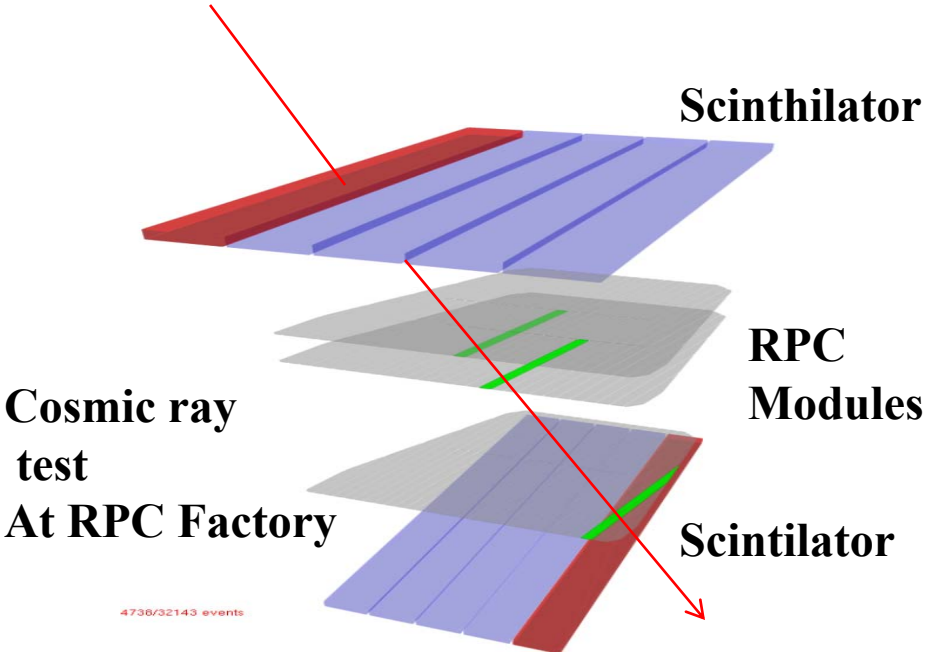


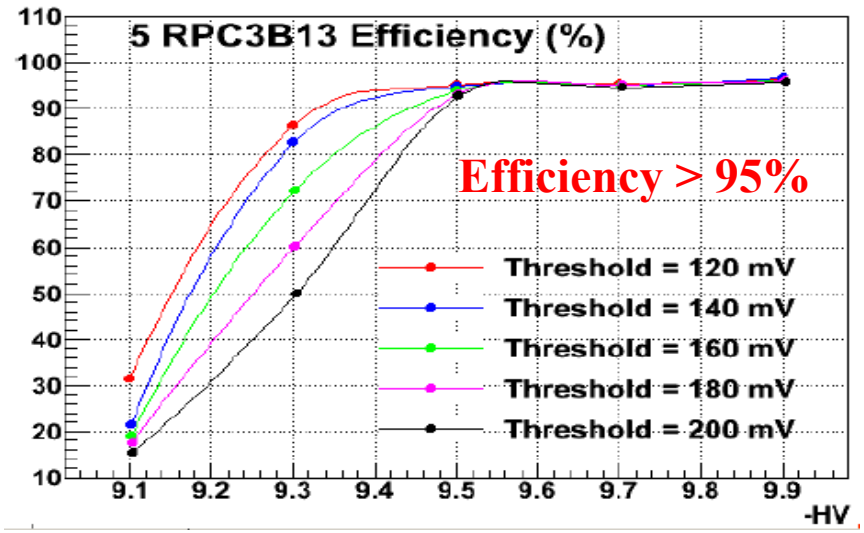
Half Octant

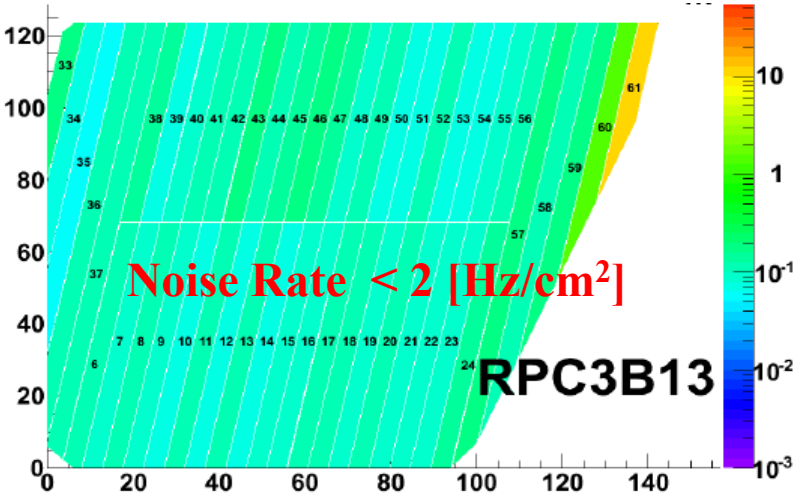


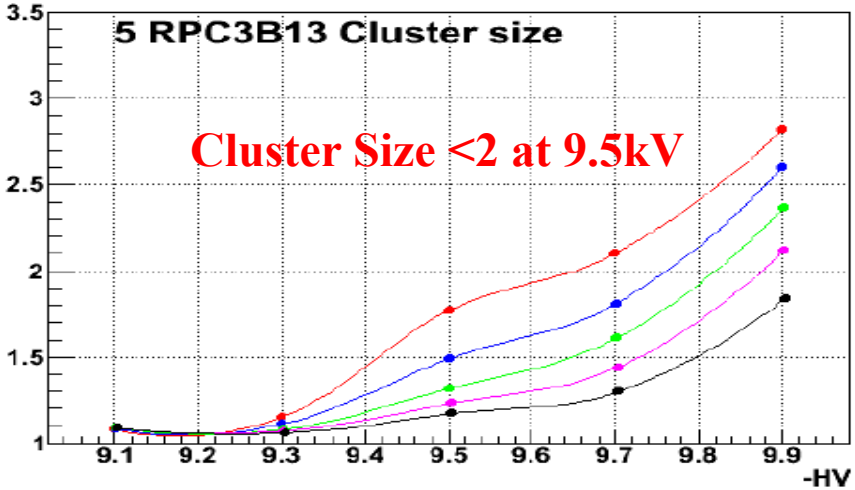
RPC3 : 16 Half octants

RPC Module Eff. & Noise rate

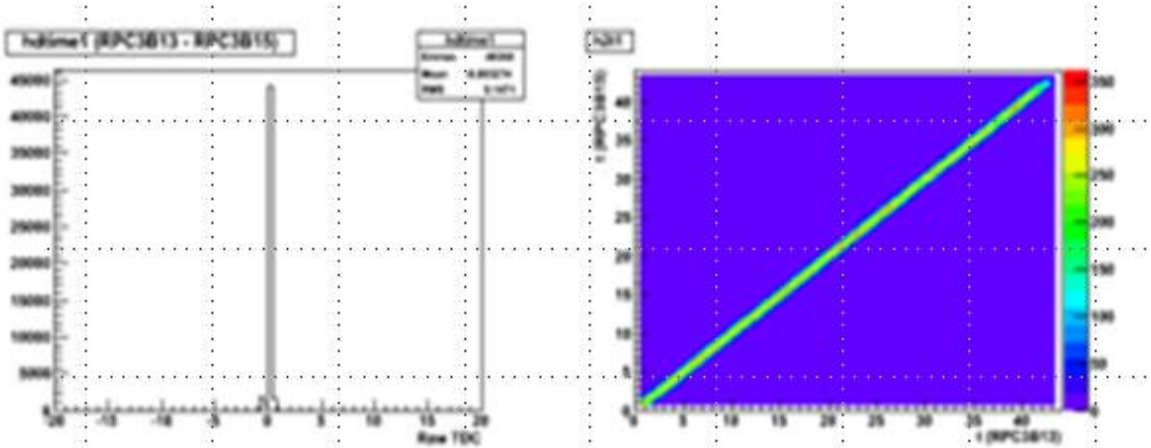






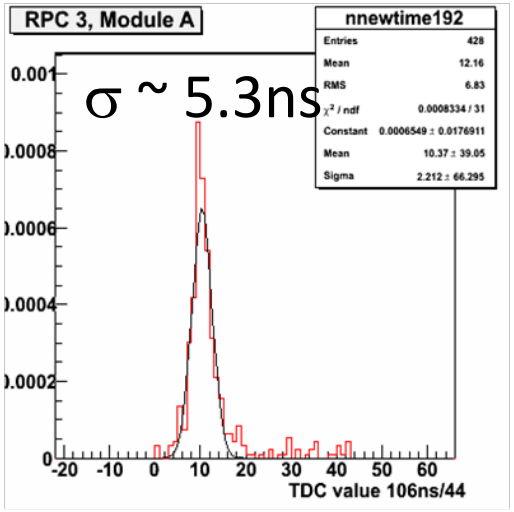


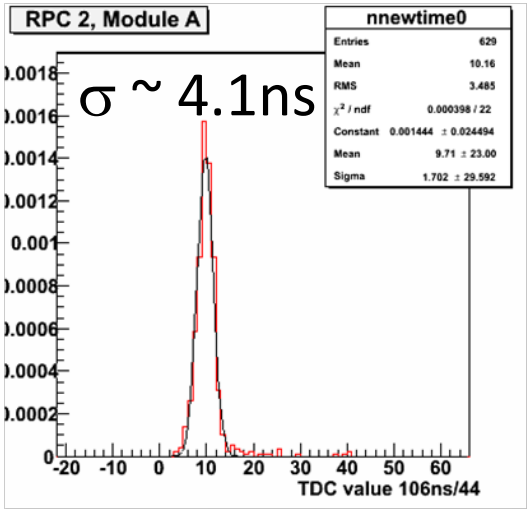
RPC Timing



Timing difference between two RPC modules

Cosmic ray test
at RPC Factory
Timing resolution ~ 2 ns



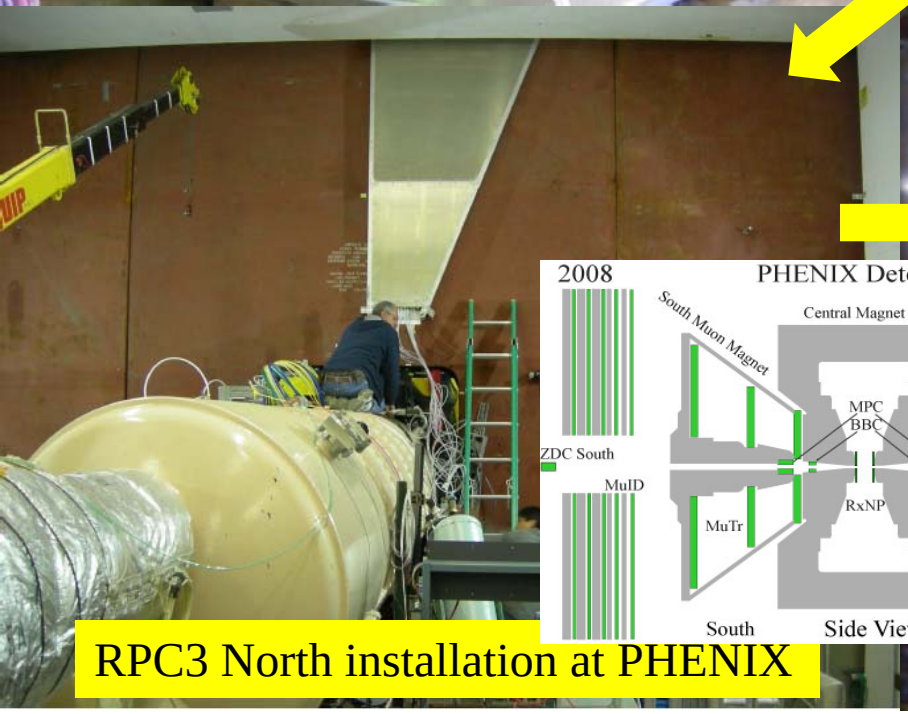


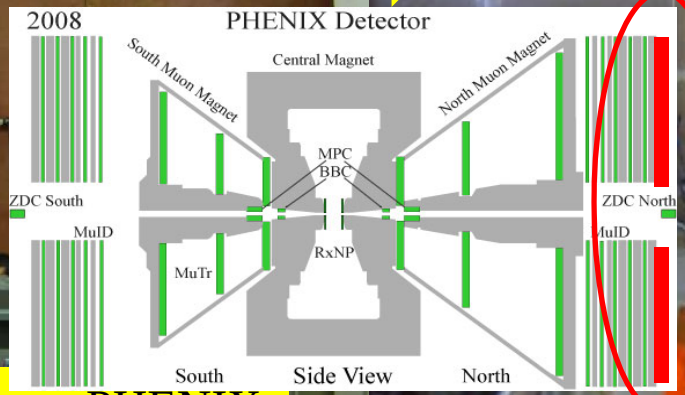
Run9 Beam
(From two prototype half octants)

Timing resolution ~ 5 ns
(uncorrected collision vertex)

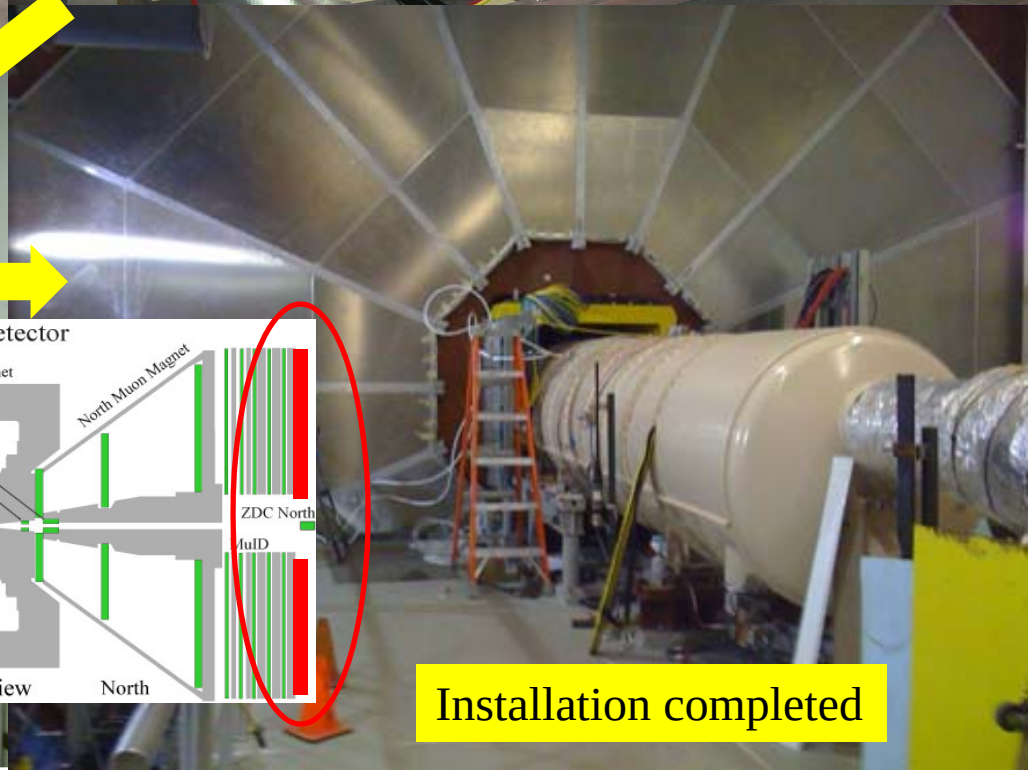
RPC3 Frame at UIUC

Half Octant assembly at Factory



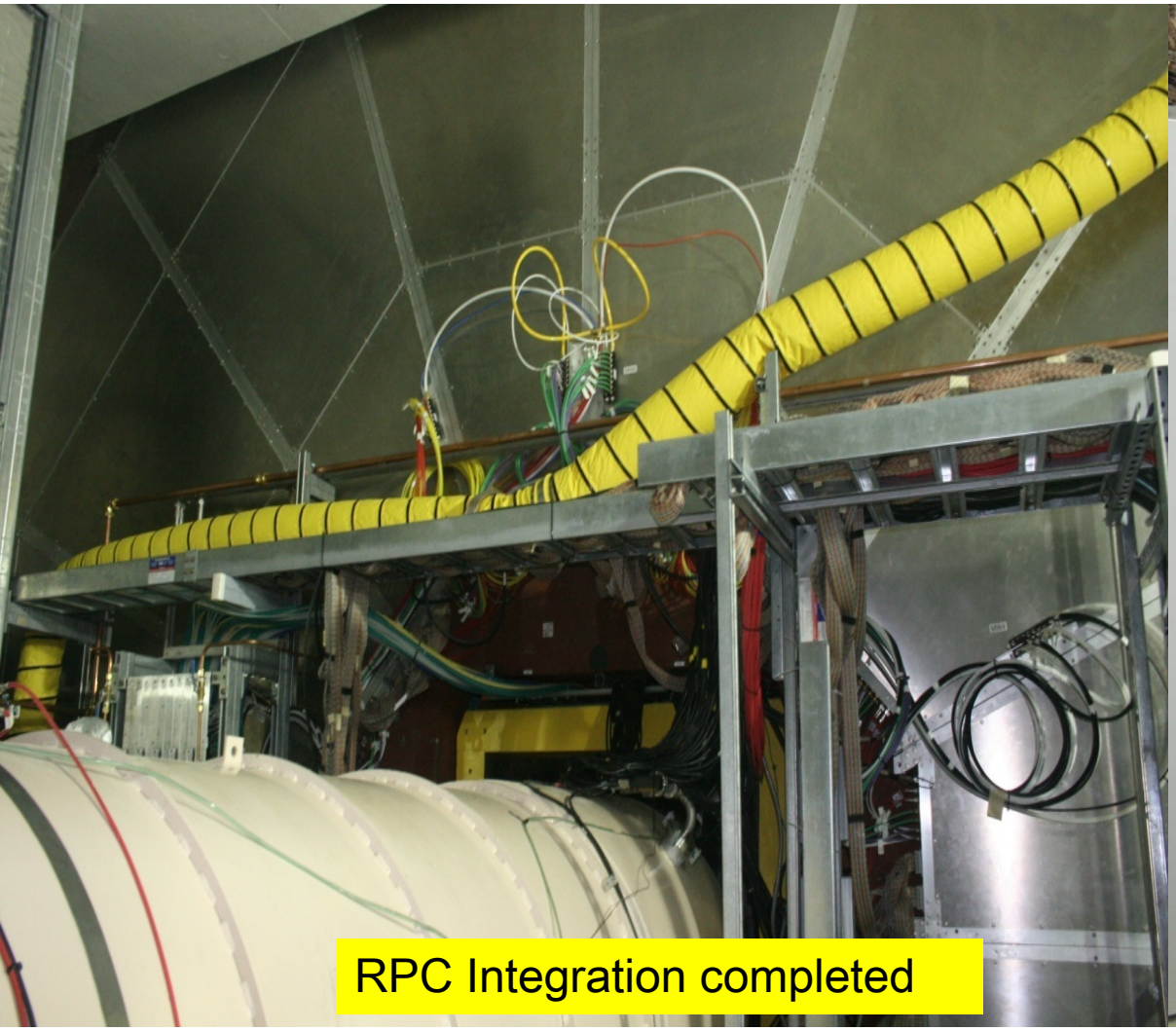


RPC3 North installation at PHENIX



Installation completed

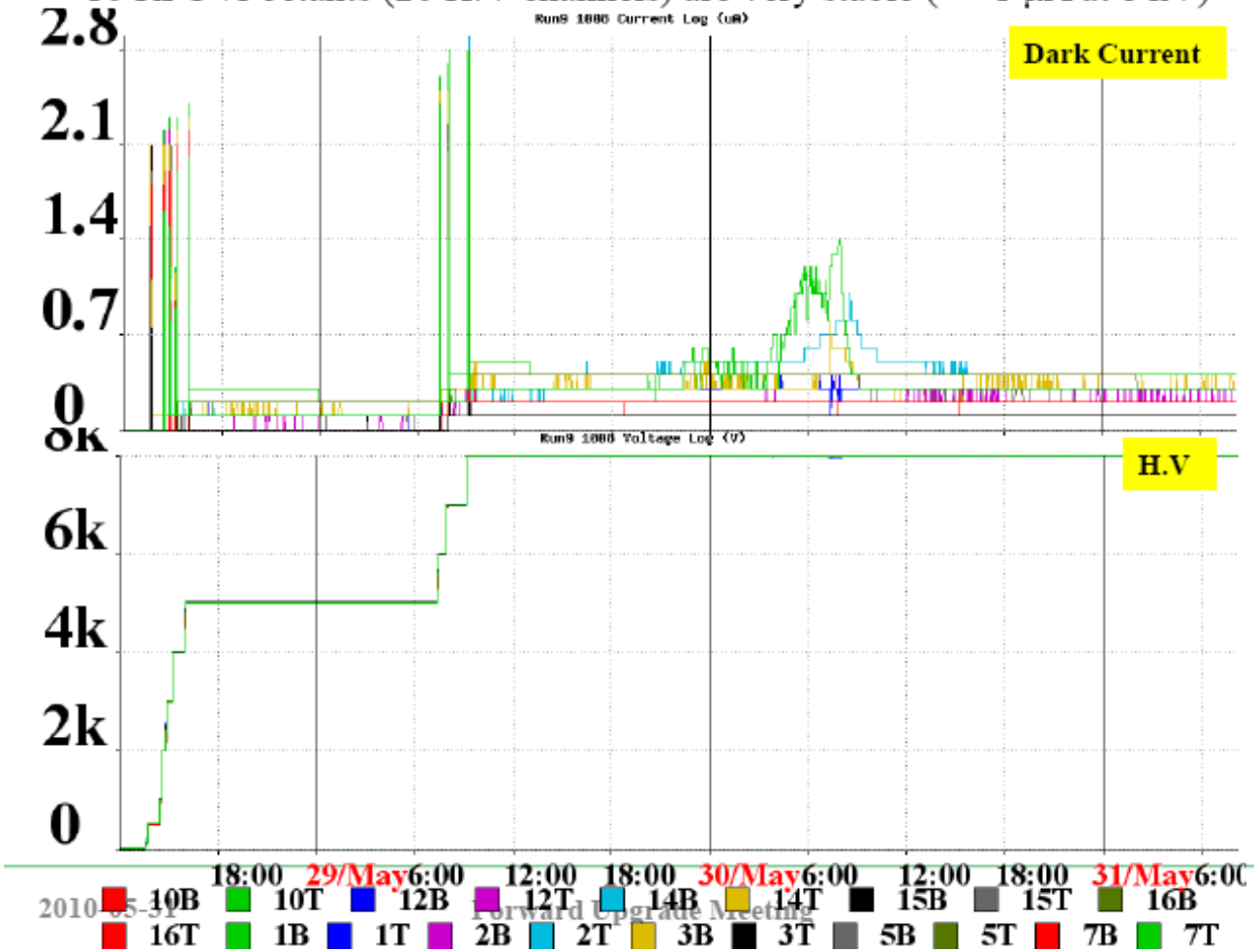
RPC3 North Integration completed



RPC3 North is being Commissioned in Run10 / RPC3 South assembly complete soon

Dark currents monitoring

10 RPC ½ octants (20 H.V channels) are very stable (<< 1 μA at 8 kV)



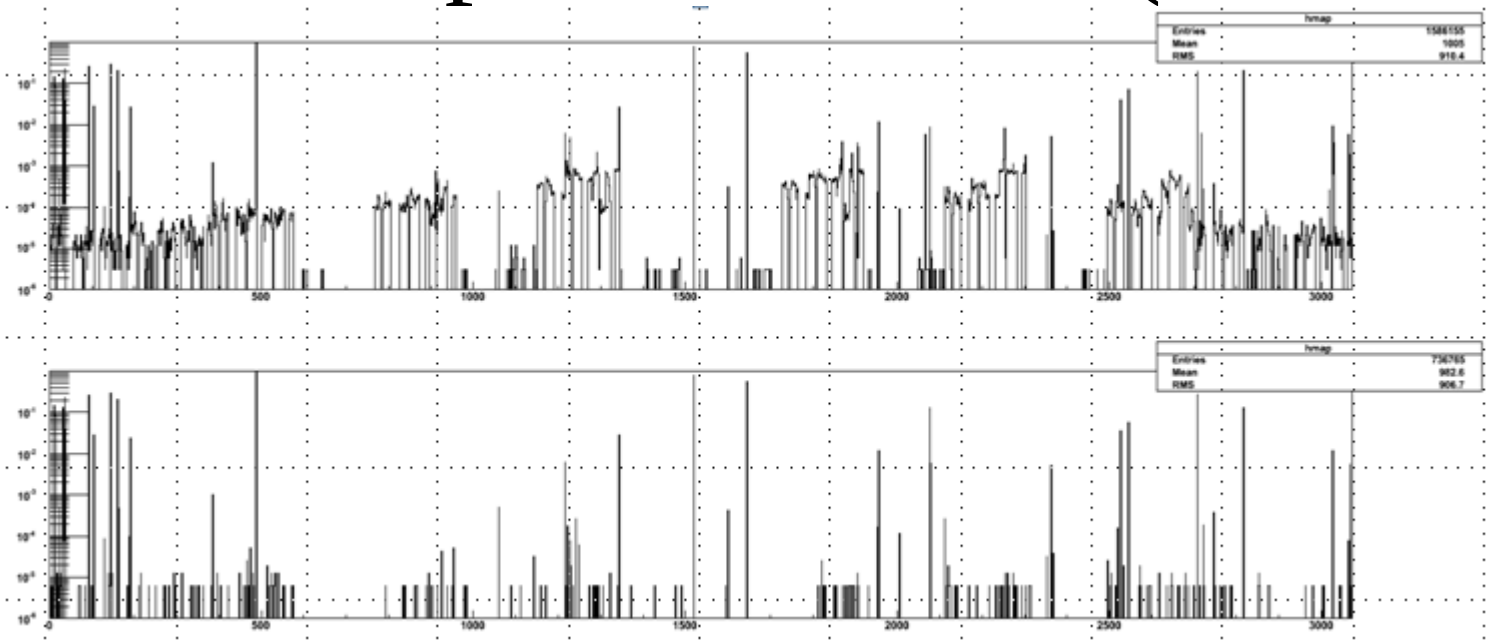
May/23/2010

10/16 halt octants working well

6/16 has Gas valence Problem

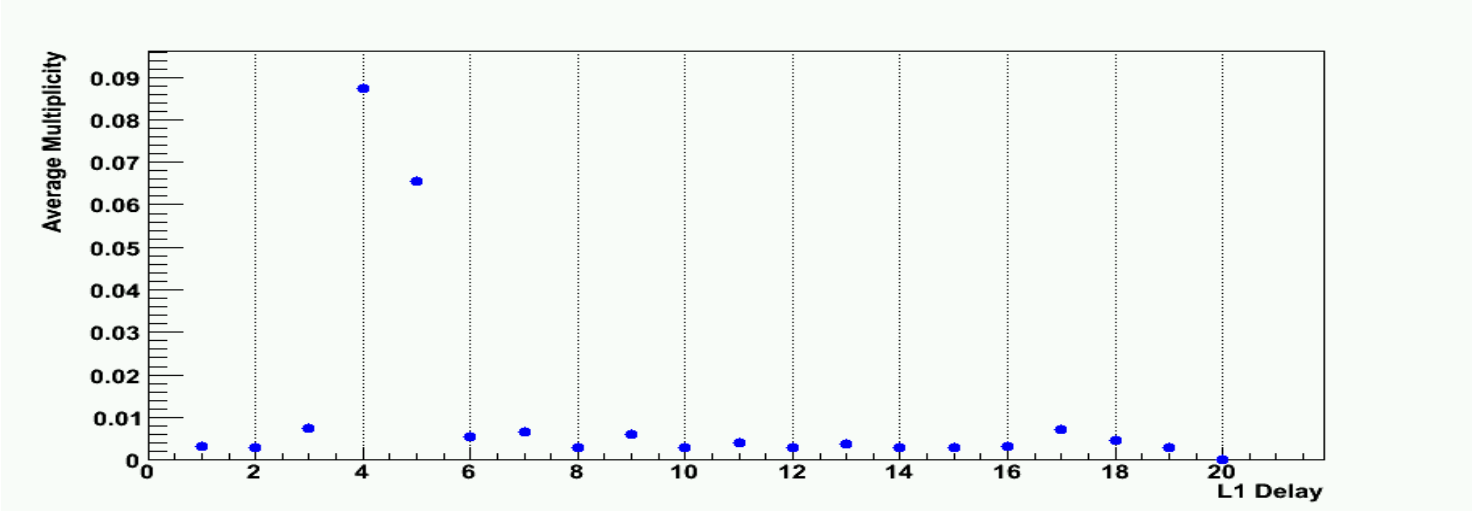
-> Adjust gas valence
RHIC shut down period

Hit map and Time in (Cosmic ray)



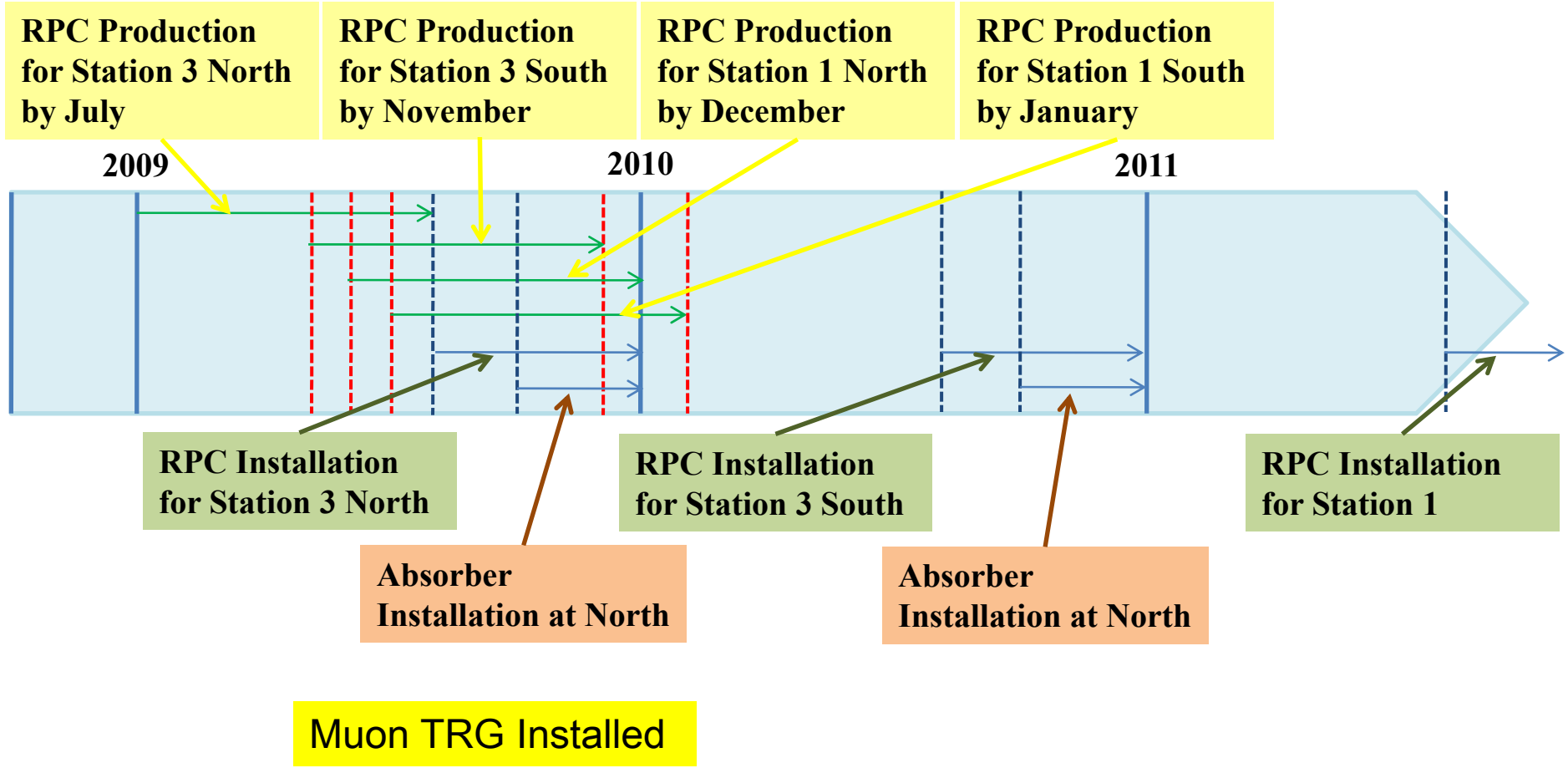
Timed in

Timed out



Timing scan

Schedule


RPC Production for Station 3 North by July
RPC Production for Station 3 South by November
RPC Production for Station 1 North by December
RPC Production for Station 1 South by January
2009
2010
2011
RPC Installation for Station 3 North
RPC Installation for Station 3 South
RPC Installation for Station 1
Absorber Installation at North
Absorber Installation at North
Muon TRG Installed

Summary