Performance of PHENIX Resistive Plate Chambers

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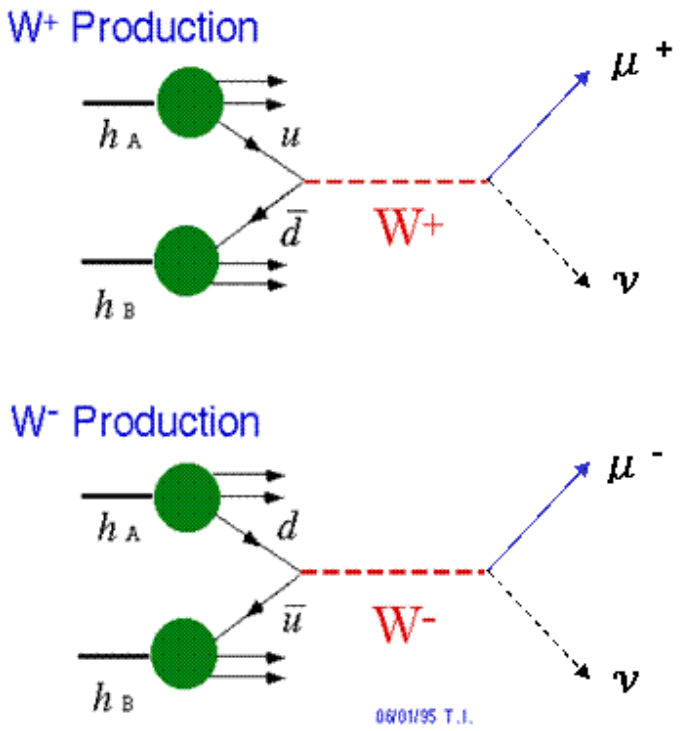
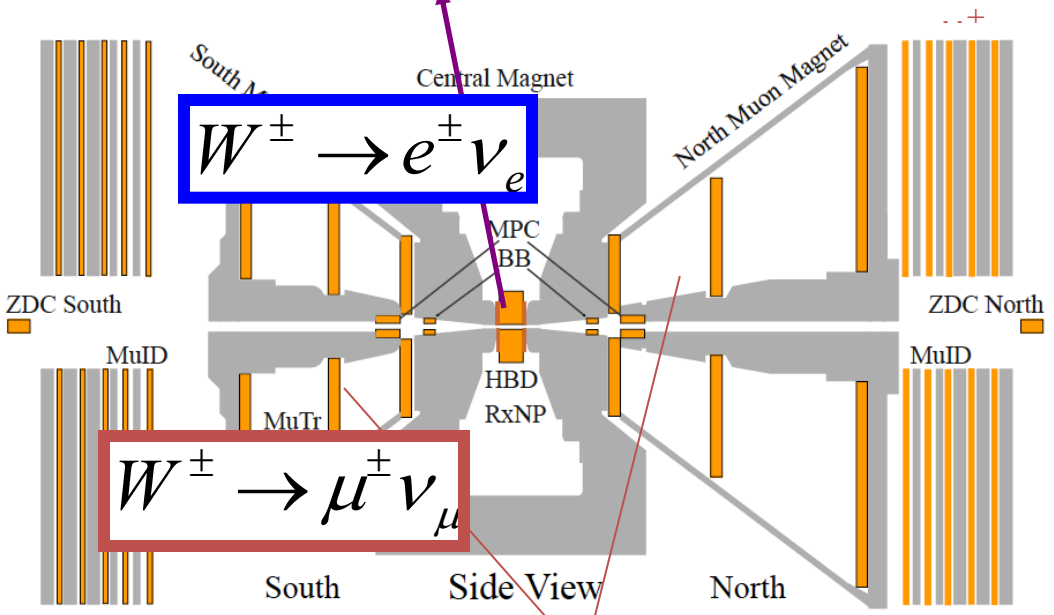
Introduction



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

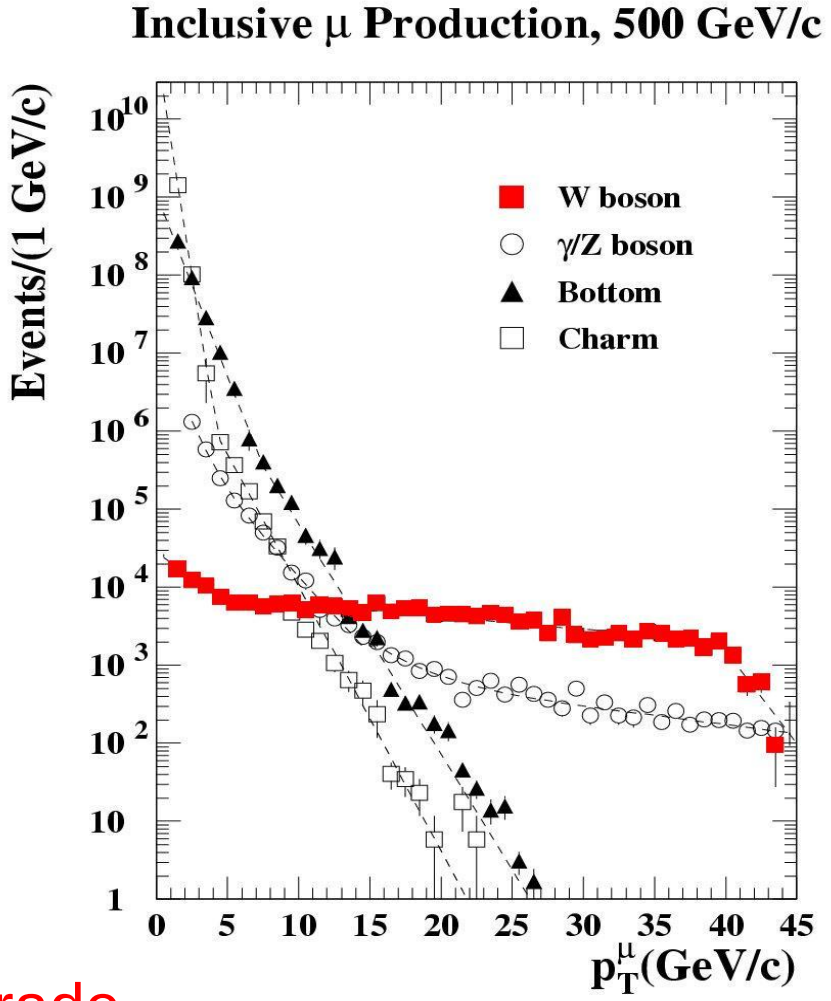


$$x_1 \neq x_2$$

Parity Violation Asymmetry
Clean flavor separation
w/o fragmentation uncertainty

Necessity of Muon Trigger Upgrade

- *W* dominate only above 20-25 GeV
- Hadronic decays dominate muon rates
- DAQ cannot take full rate @500GeV
- Current muon trigger momentum "blind" - *Need for a momentum sensitive muon trigger*



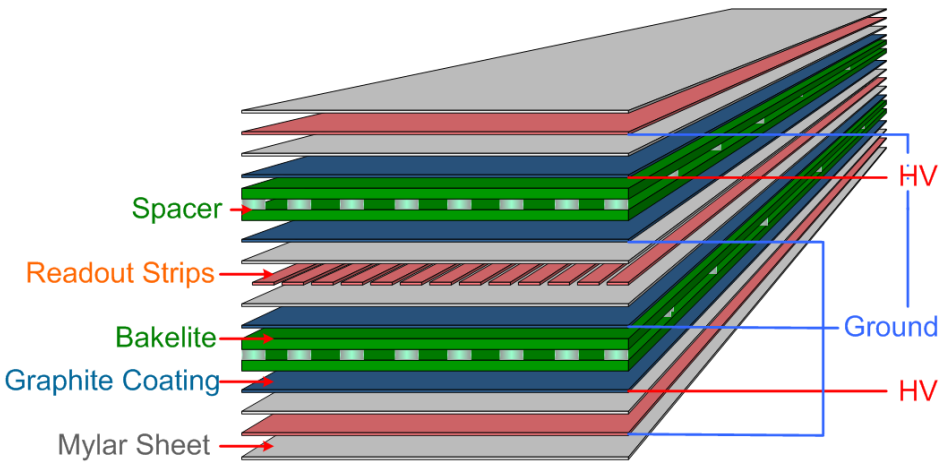
Huge background muons + Limited space + Associated cost

➔Add Resistive Plate Chambers(RPCs)

➔Add fast readout electronics for Muon tracker

Necessity of Muon Trigger Upgrade

RPC Concept and Design



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

Characteristics of RPC

- Fast response
  - Suitable for the trigger device
- Good intrinsic time resolution: 1-2 ns
- Good spatial resolution: typically ~ cm
  - Determined by the read-out strip width and cluster size
- Low cost
- Typical gas mixture

  95% $C_2H_2F_4$ + 4.5% i-C_4H_{10} + 0.5% SF_6

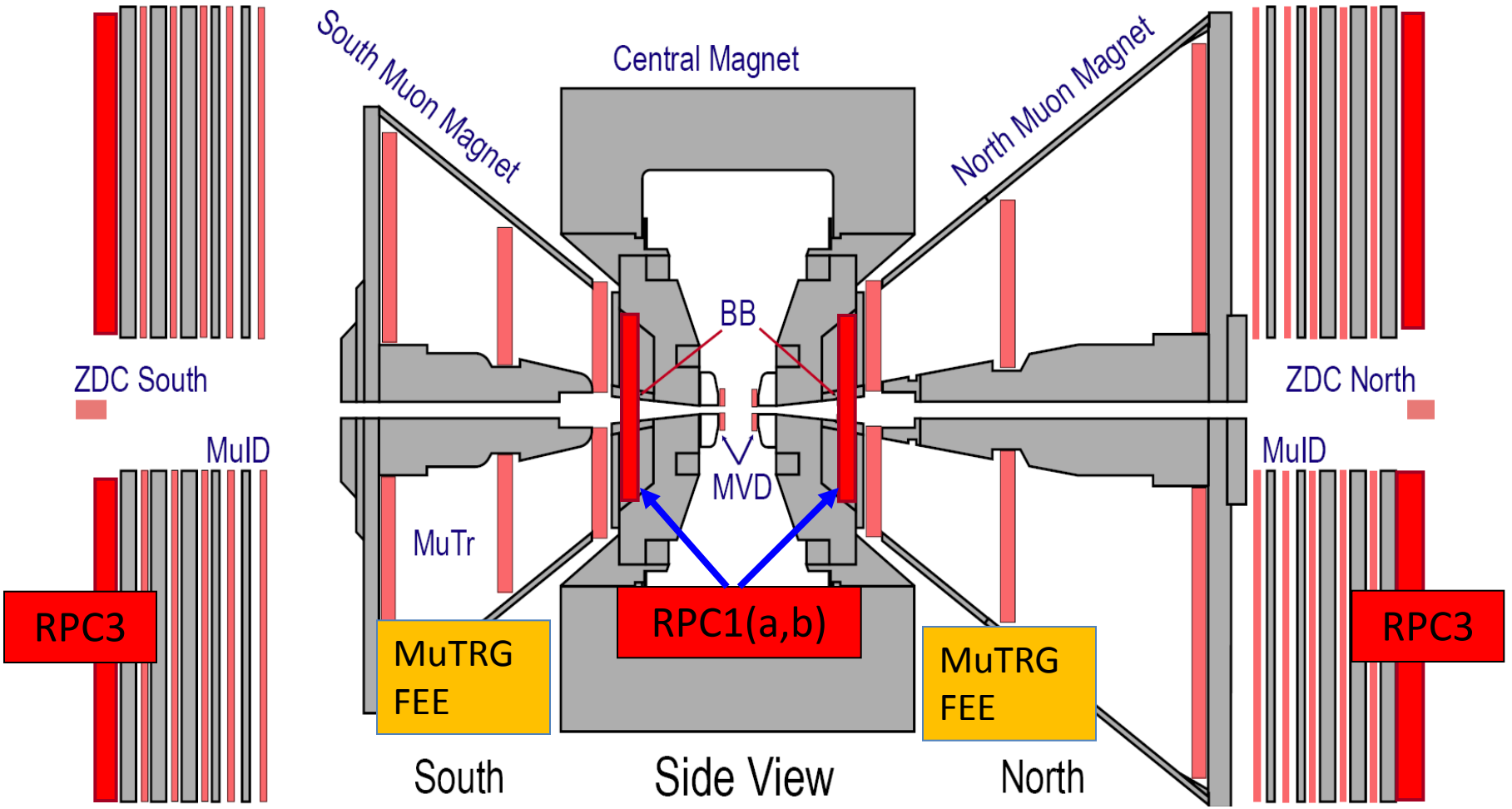
Function of RPCs in the Upgrade

Raw p+p collision rates up to 9.6 MHz. Need trigger reduction factor up to 10000 to accommodate bandwidth of PHENIX DAQ.

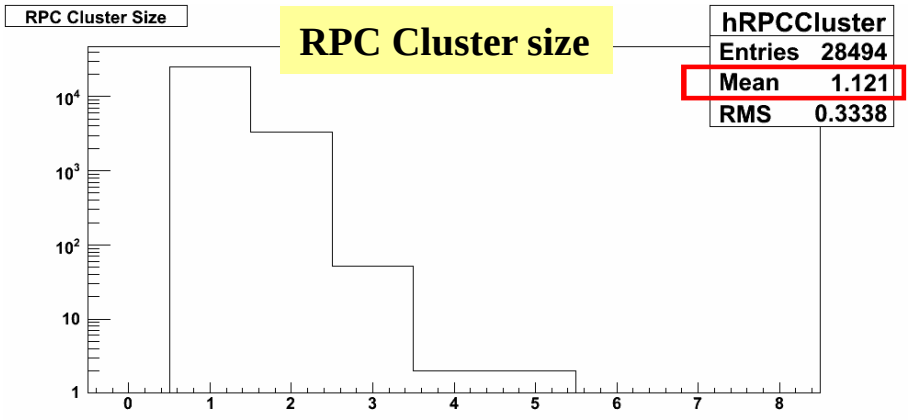
A. RPCs have good timing information to correctly align W-event with correct beam crossing.
B. RPCs give additional hit information for momentum measurement.
C. RPC trigger information used for rejection of beam related backgrounds.
D. RPCs give information for suppression of cosmic rays at trigger level and off-line.
E. RPCs work together with the muon tracker that provides precise tracking allowing a tighter momentum cut.

SCOPE OF THE MUON TRIGGER UPGRADE:

MuTRG Frontend electronics upgrade + Resistive plate chambers (RPC)



RPC Module QA Test Results



PHENIX RPC Detector Requirement

Efficiency	> 95%
Time resolution	≤ 3 ns
Average cluster size	≤ 2 strips
Rate capability	0.5 kHz/cm^2
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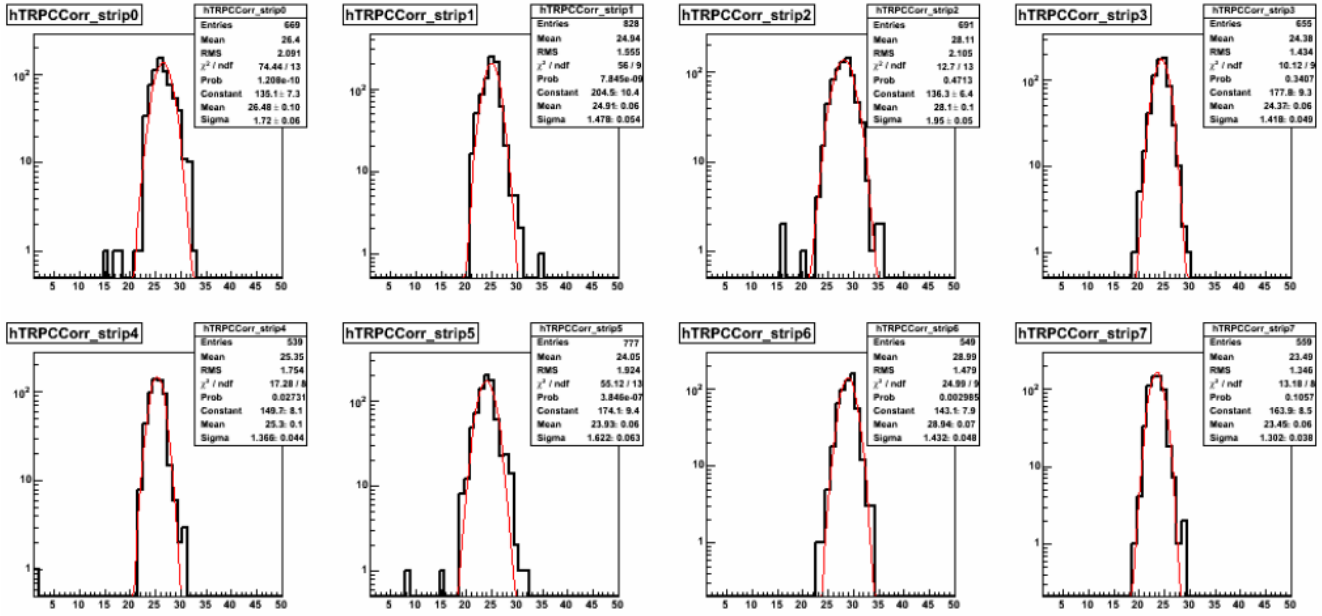
1.72±0.06 ns | 1.47±0.05 ns | 1.95±0.05 ns | 1.42±0.05 ns



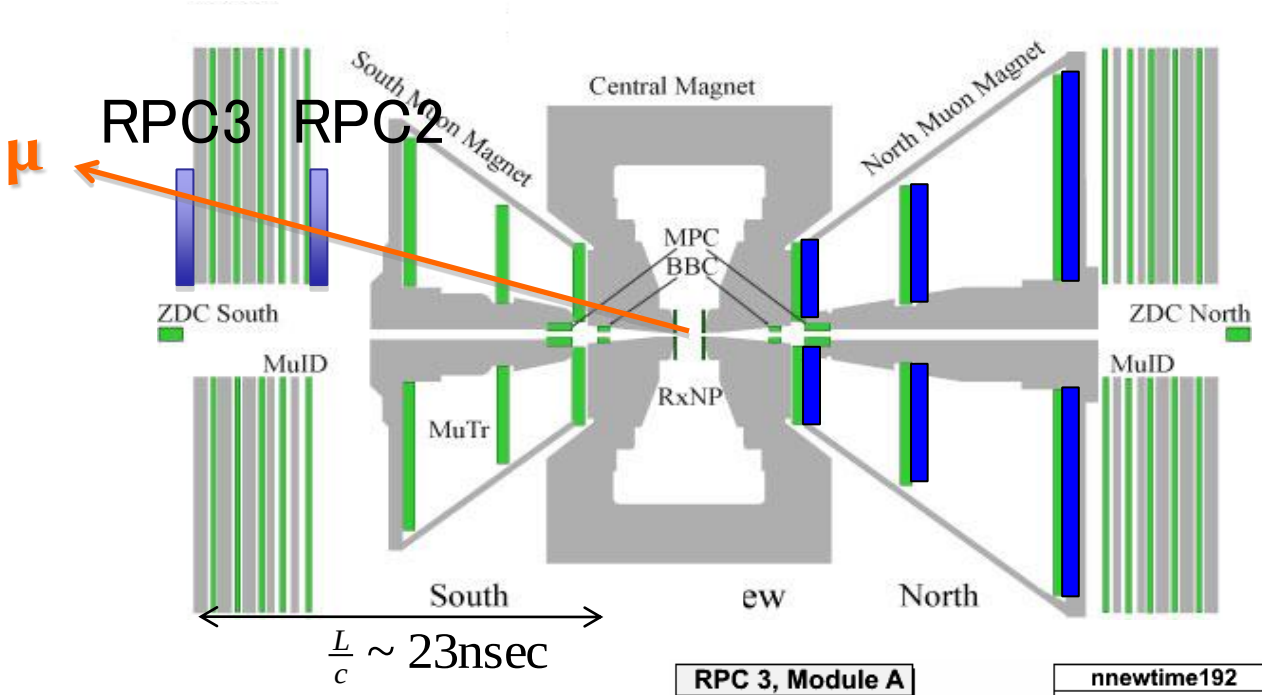
1.36±0.04 ns | 1.62±0.06 ns | 1.43±0.05 ns | 1.30±0.04 ns

RPC cluster size and strip rise time resolution fulfill our requirements.

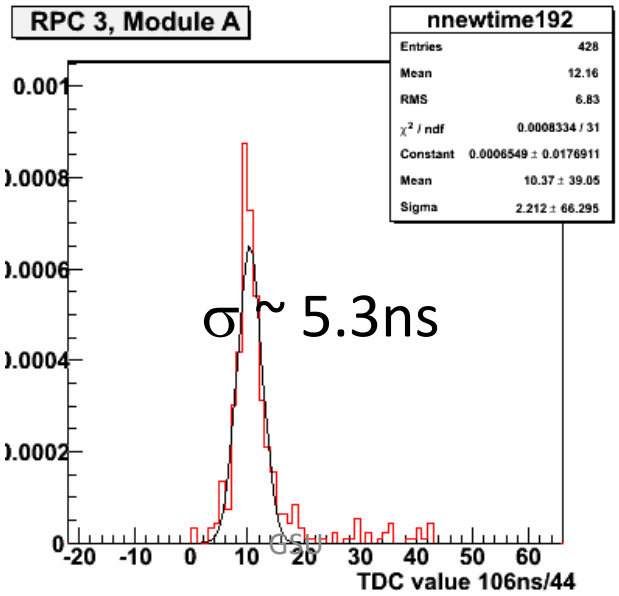
The results from 16 readout strips show similar resolution.

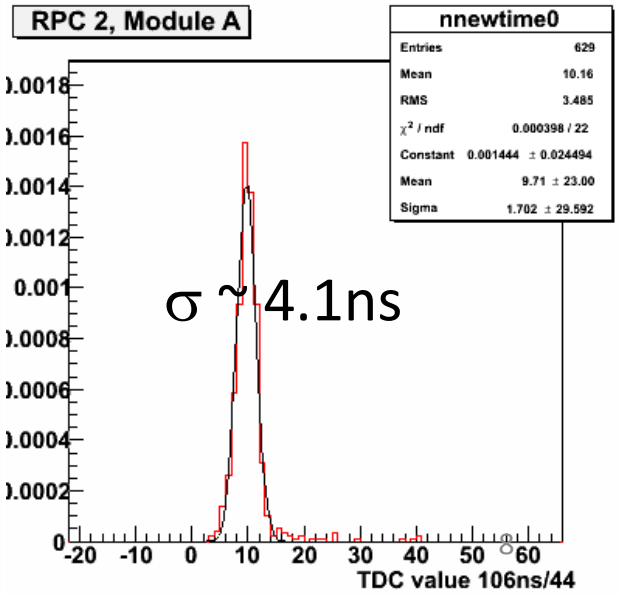
RPC Strip Timing Resolutions

Prototype RPC Performance @ Run9

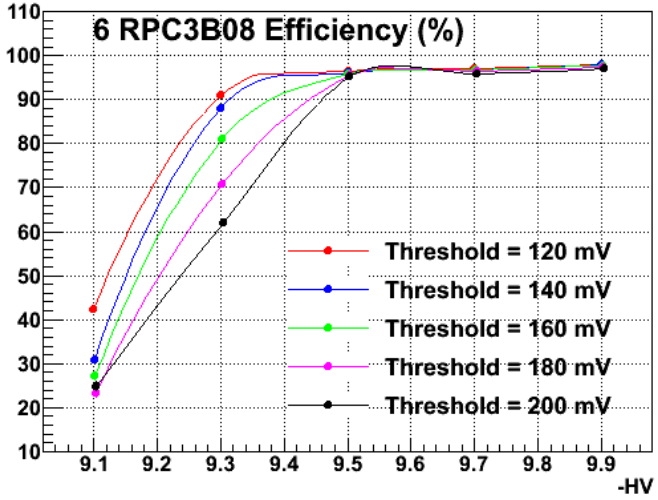


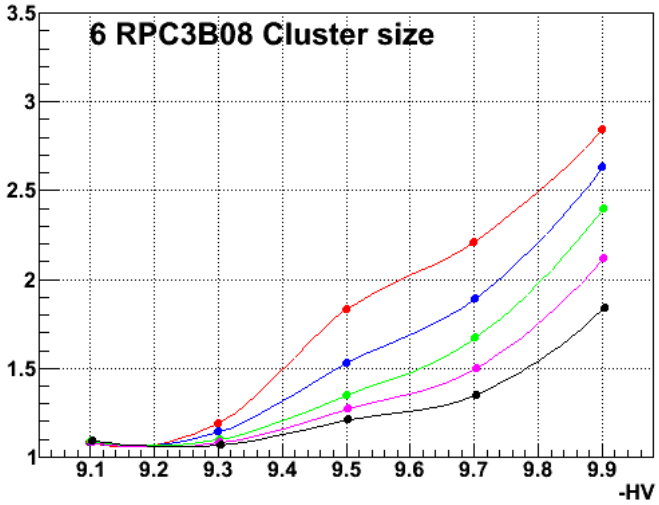
Demonstrated satisfactory Timing Resolution w/ beam!

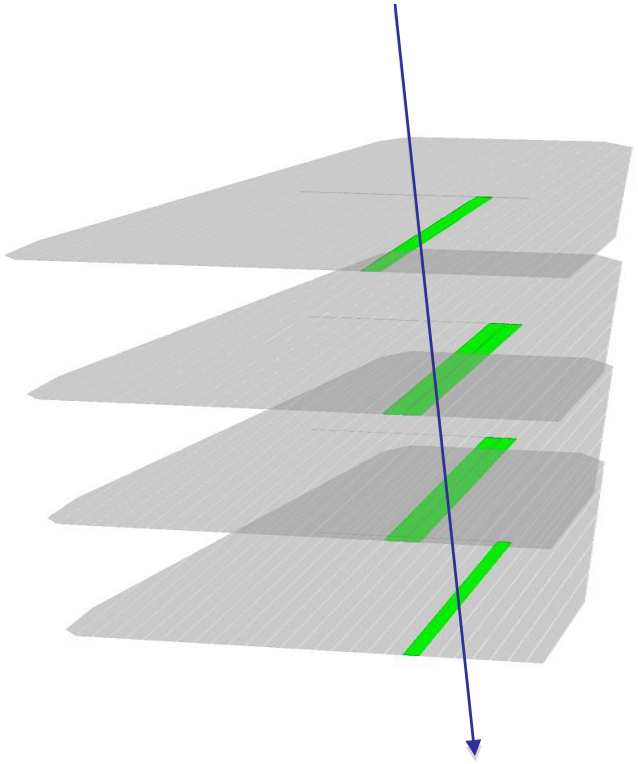




RPC Performance w/ Cosmic







Cosmic Ray test with stack of 5 detector modules

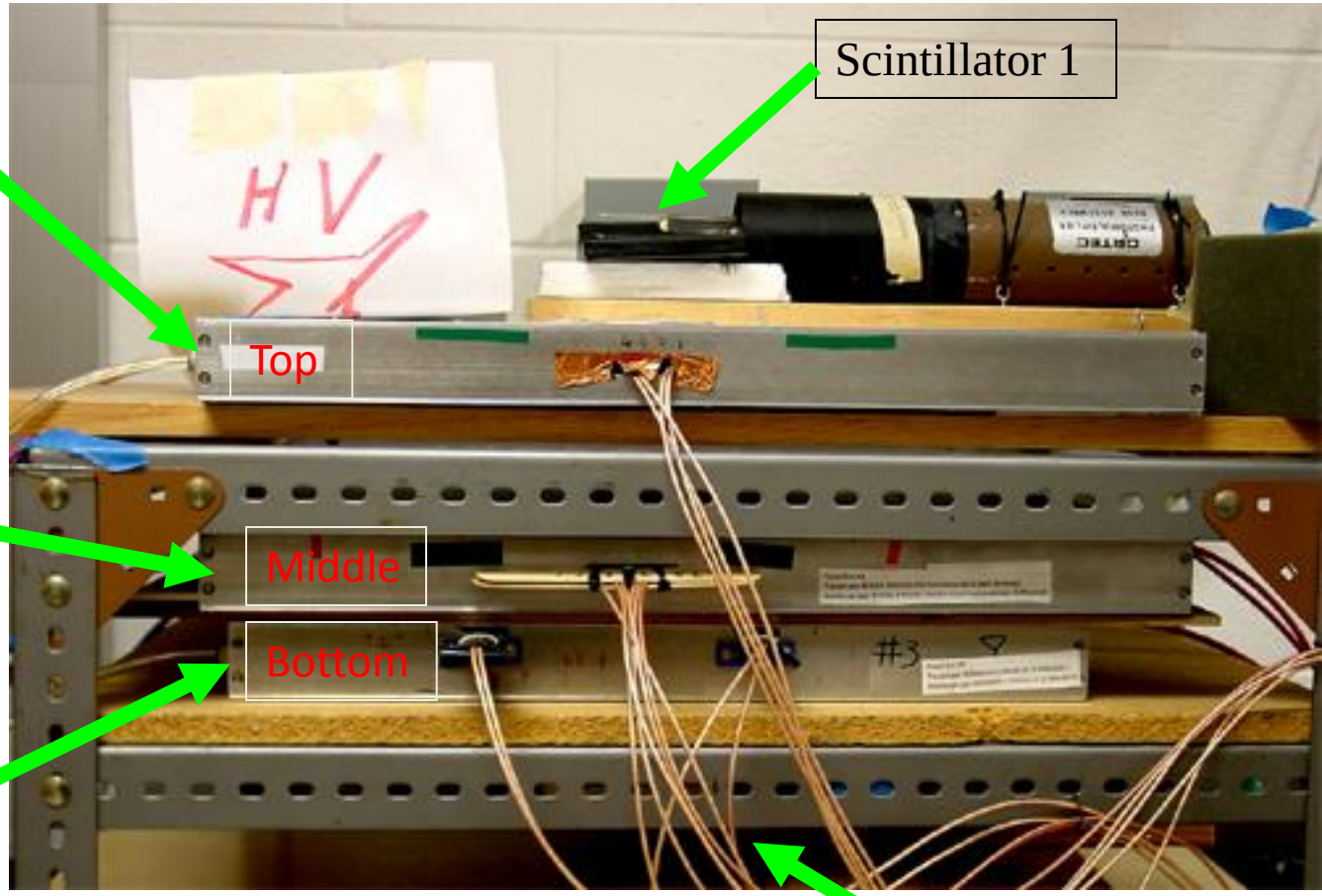
RPC3 North Completed Installation

RPC Monitor Setup at GSU

RPC1:
Two oiled Korean gas gaps (35 cm by 35 cm), the assembled RPC has been shipped to BNL, and later shipped back to GSU, label: KrOilUp, KrOilDown

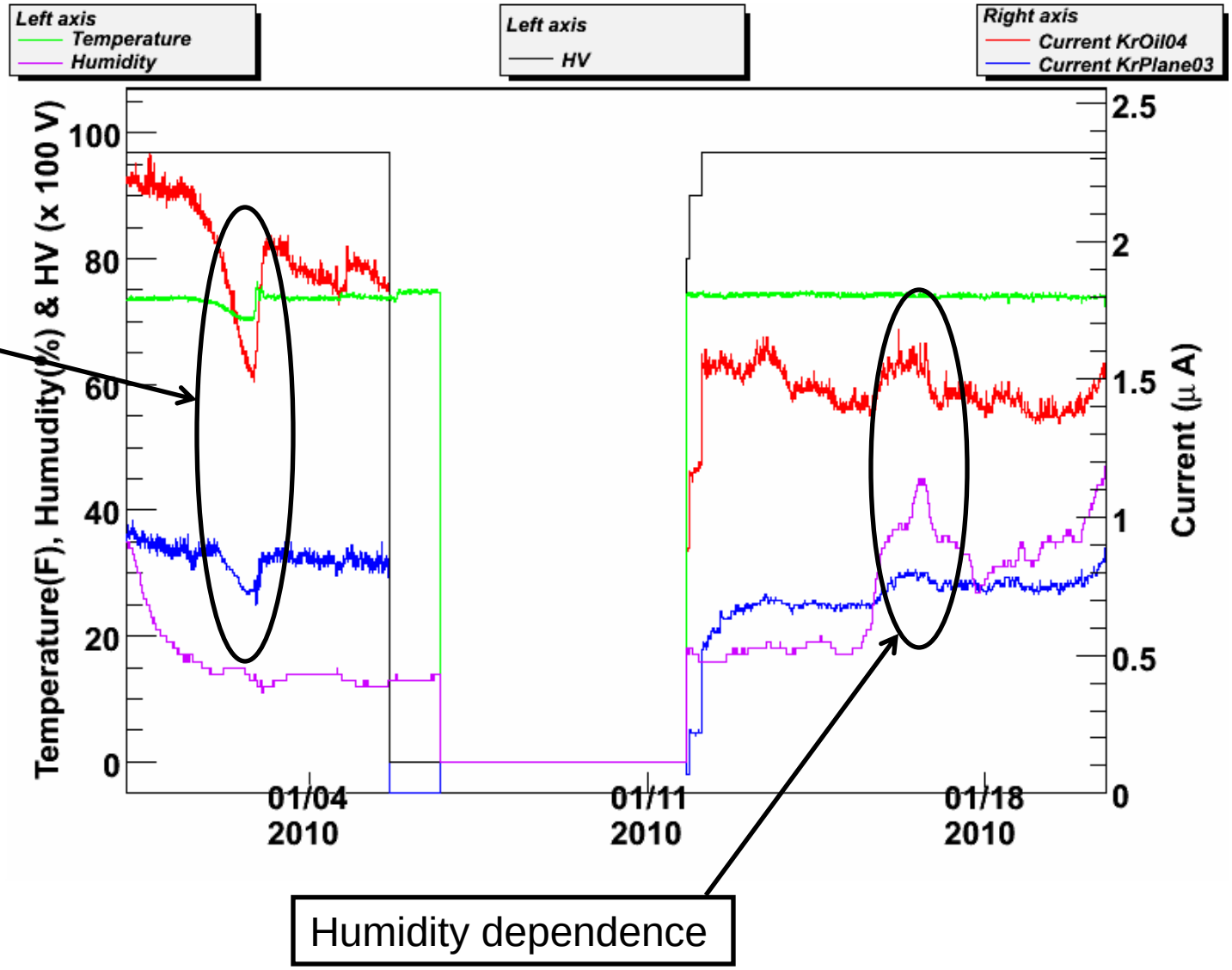
RPC2:
One oiled Korean gas gap, one non-oiled Korean gas gap (35 cm by 35 cm), the assembled RPC has been kept at GSU all the time: KrOil04, KrPlane03

RPC3:
GSU production RPC, (30 cm by 30 cm, non-oiled)
Label: L30BAK1C, L30BAK6C



Each scintillator is 10 cm by 10 cm
RPC readout strips are 5 cm or 6 cm wide
Scintillator cover two readout strips for each RPC

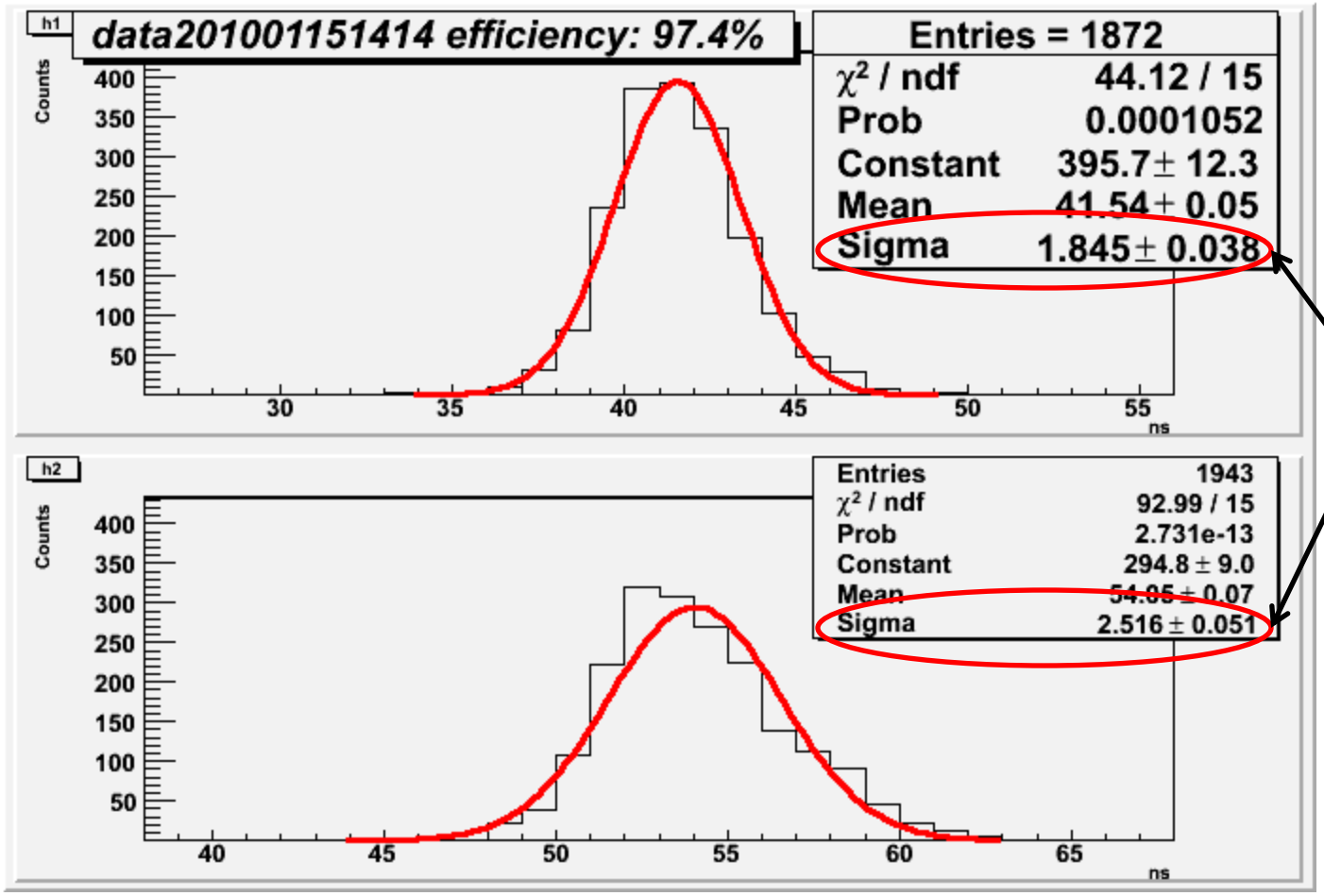
Dark Current Variation vs Temp & Humidity



Temperature dependence

Humidity dependence

Efficiency & Timing Study



Reasonable timing

Summary

- At PHENIX W boson decay will be used to probe the flavor separated quark/antiquark polarization of the proton.
- The muon trigger is being upgraded to permit isolation of the rare W-decay muons.
- RPC Commissioning Demonstrated Designed Performances.

Session G7: Instrumentation for Relativistic Heavy Ion Physics
8:30 AM–10:30 AM, Sunday, February 14, 2010
Room: Delaware A

Sponsoring Unit: DNP
Chair: J.H. Lee, Brookhaven National Laboratory

Abstract: G7.00004 : Performance of PHENIX Resistive Plate Chambers
9:06 AM–9:18 AM

Preview Abstract

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The PHENIX experiment at the Relativistic Heavy Ion Collider at BNL uses polarized pp collisions to study the proton spin structure. One of the major emphases of the PHENIX spin program is to cleanly measure the sea quark and antiquark polarizations via single spin asymmetry of the W-decay muons. At forward rapidity, Resistive Plate Chambers (RPCs) will be used at PHENIX as a level-1 trigger to select high transverse momentum muon events from a large background of low transverse momentum muons. In addition, RPCs will be used offline to reduce cosmic muon backgrounds. Detector modules for one RPC station are currently being installed and tested at the PHENIX experimental site. In parallel, RPC prototypes are continuously monitored at a separate testing facility to study various environmental effects on the RPC performance. A report on results from these tests and performance will be presented. Results from the RPC prototype cosmic run to study the RPC's efficiency will also be presented.