KPiX & IHEP RPC Studies

## Henry Band
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RPC Teststand

- ## RPC test stand with BaBar spares

- ## Available Gases
  - ### BaBar streamer gas - 34.9% Freon 134a, 60.6% Argon, 4.5% isobutane
  - ### BaBar avalanche gas – 75.5% Freon 134a, 19.4% Argon, 4.5% isobutane, 0.6% CF6
  - ### Argon
  - ### Ordered CERN/ANL
    – 94.5% Freon 134a, 5.0% isobutane, 0.5% CF6

- Trigger ~ 10 Hz
  - ### 3-fold coincidence Trig1*Trig3*IHEP 2

Trigger RPCs

Foam Shelves

Plywood Shelves

Test RPCs

Unistrut

Trig 3

Test 4

IHEP 2

Test 5

IHEP 1

Trig 2

Trig 1

Existing Double Rack
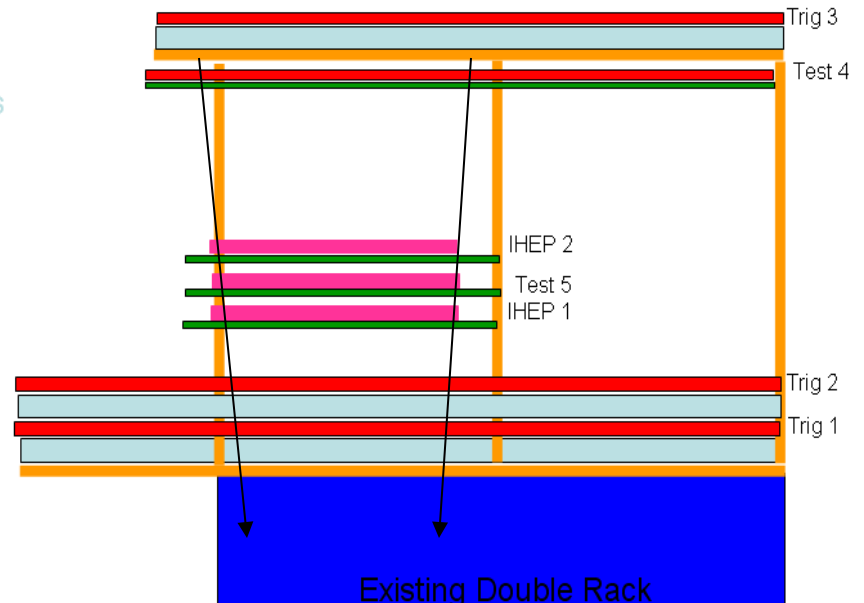
- Available RPCs

- IHEP *0.5 by 0.5 m (4 + 7)*

- Italian Bakelite *0.5 by 0.5 m*
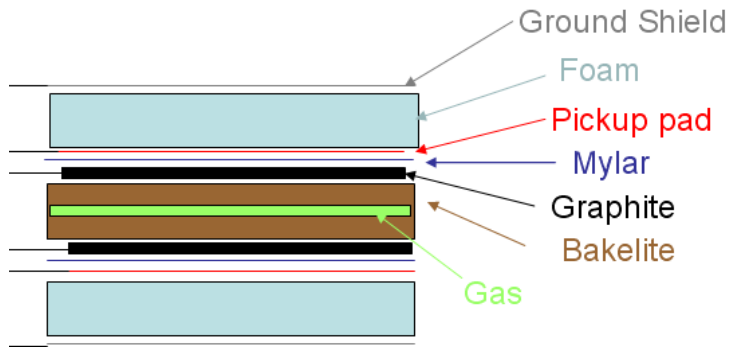- BaBar spares *1.1 by 1.3-1.6 m*

Teststar
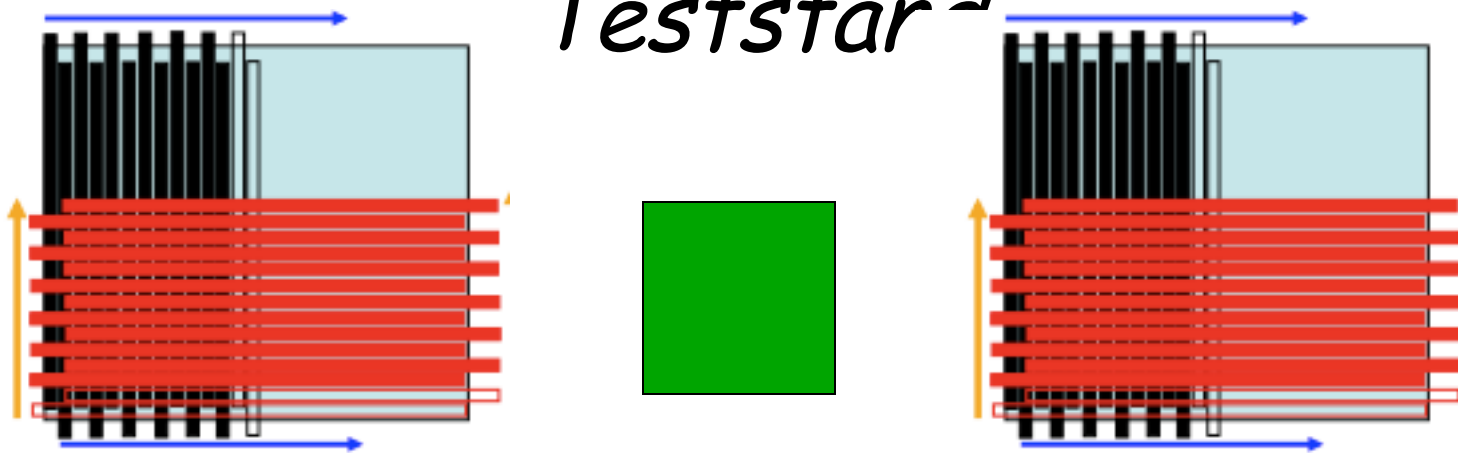
Trigger made from subset of x and y
strips to match IHEP chamber size

For these initial tests
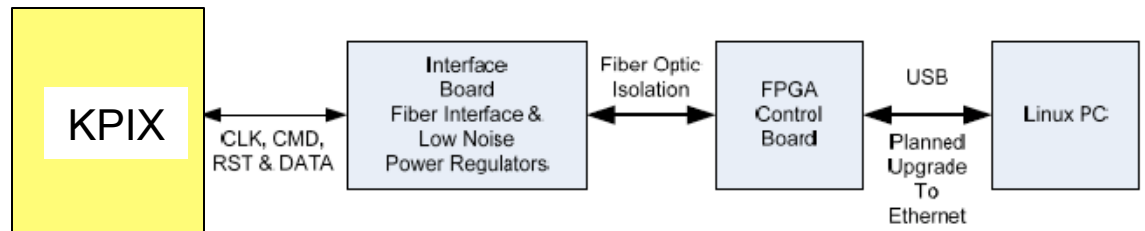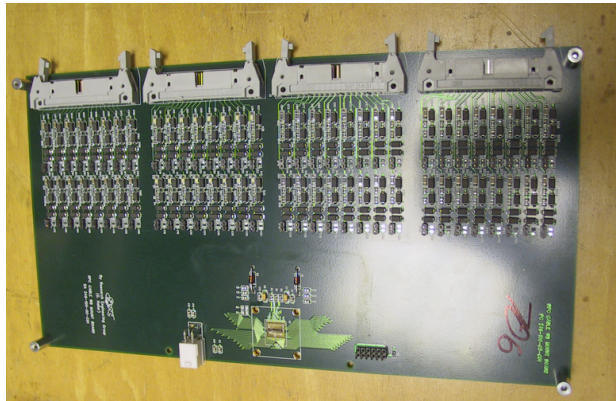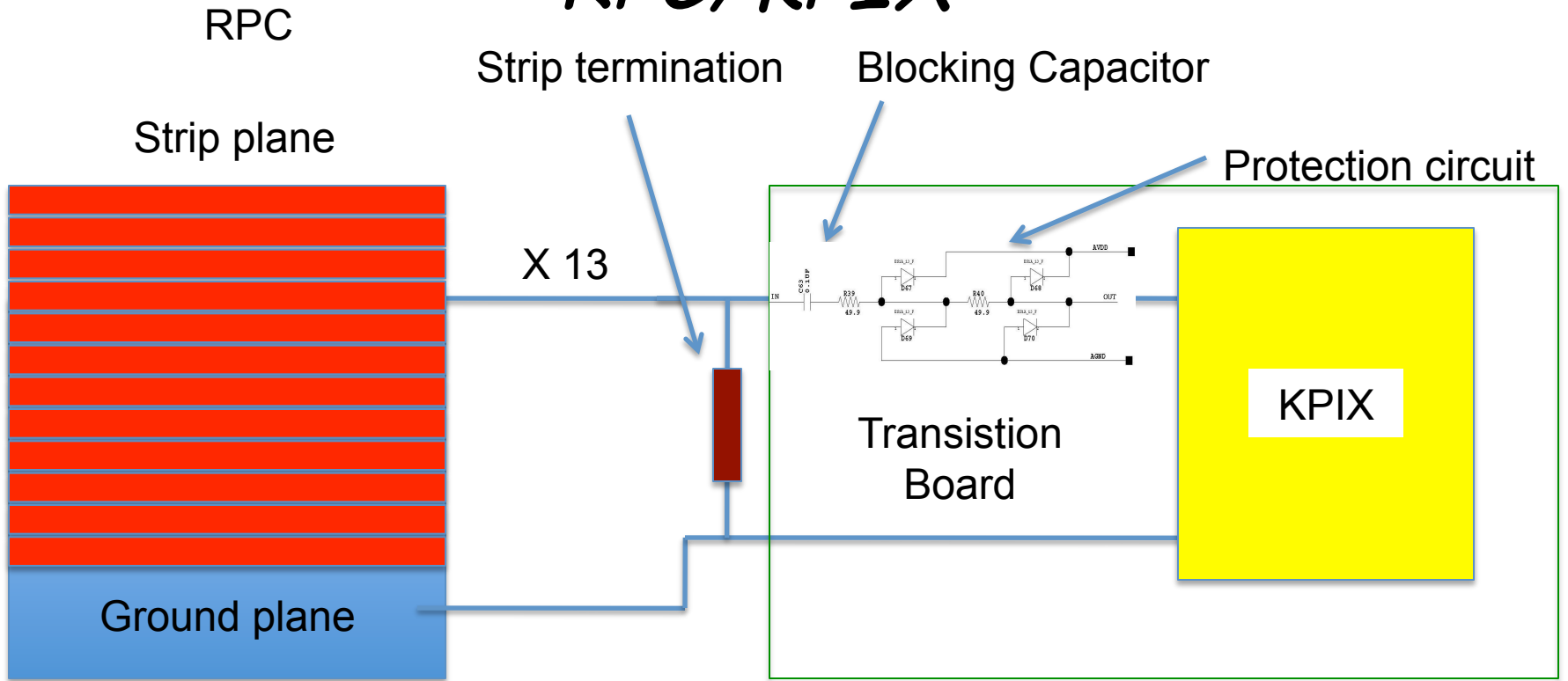Trigger coverage non-
uniform
Biased efficiency
measurement

Ped. subtracted max. strip number

RPCnmax	
Entries	10868
Mean	54.18
RMS	2.957
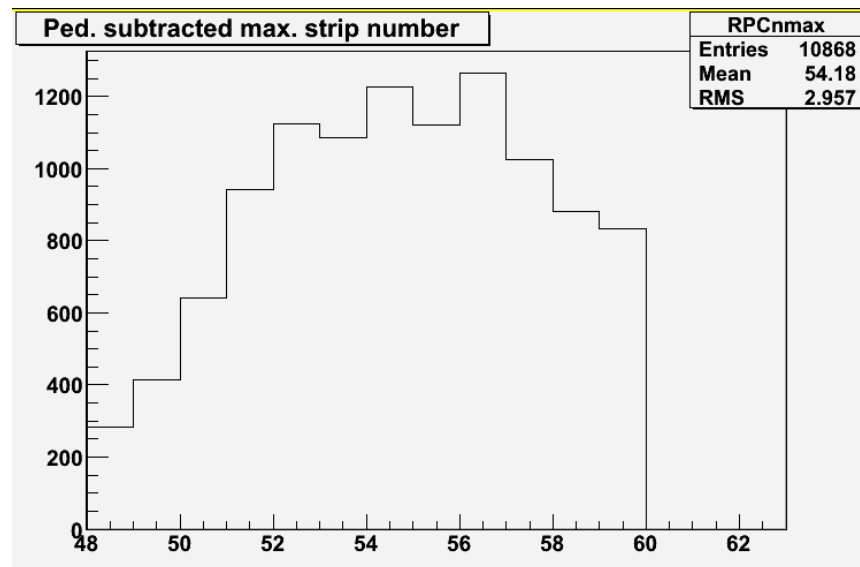
RPC details

- *IHEP and Italian RPC have 2mm gas gap & 2 mm Bakelite anode & cathode*
- *Pickup strips 22-38 mm pitch, capacitance to gnd .3-.6 nF*
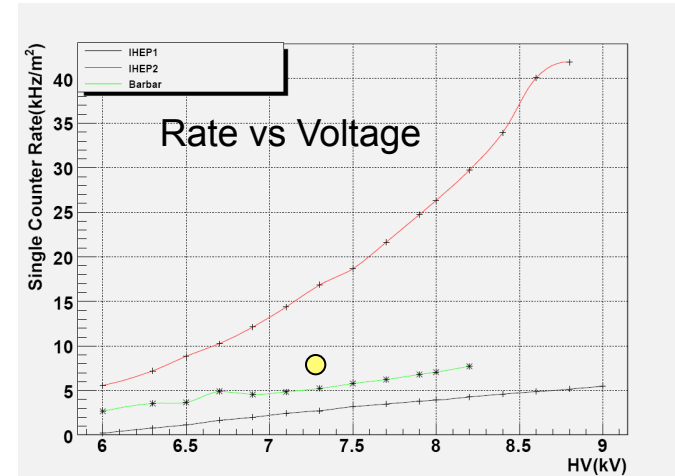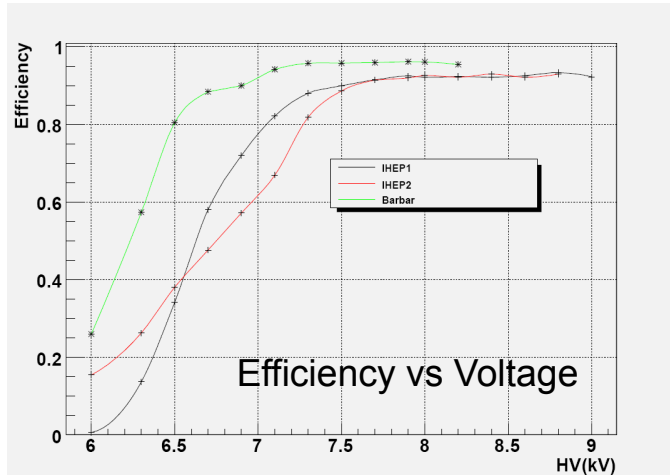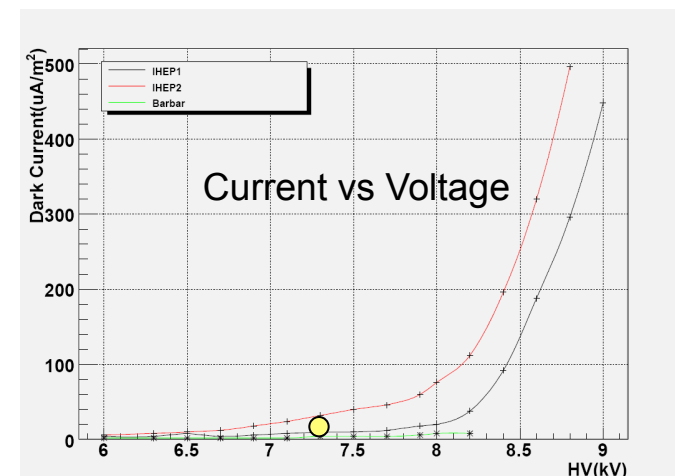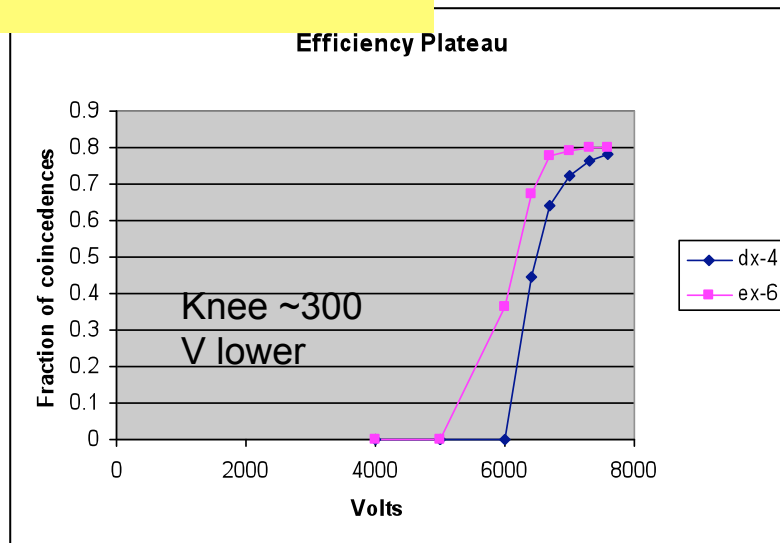- *IHEP RPCs have no linseed oil coating*

RPC/KPIX

RPC

Strip plane

Strip termination

Blocking Capacitor

Protection circuit

X 13

KPIX

Transistion Board

Ground plane

KPIX

KPIX ← CLK, CMD, RST & DATA → Interface Board / Fiber Interface & Low Noise Power Regulators ← Fiber Optic Isolation → FPGA Control Board ← USB / Planned Upgrade To Ethernet → Linux PC

Streamer Mode

Efficiency vs Voltage

Rate vs Voltage

New IHEP RPCS

Efficiency Plateau

Knee ~300 V lower

Current vs Voltage
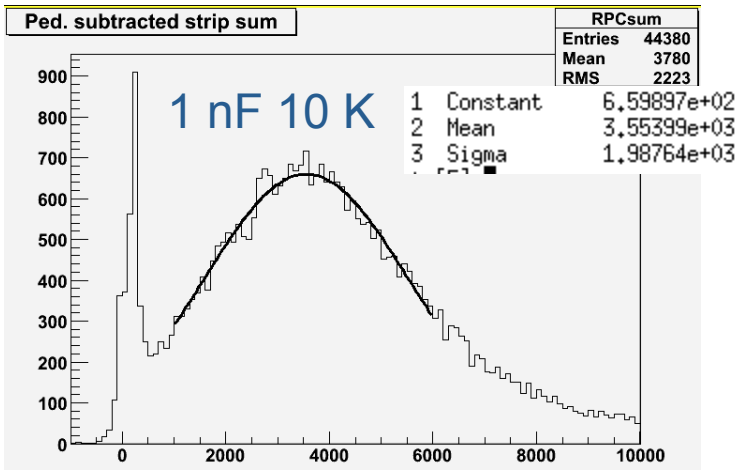
Preliminary RPC/KPIX Data

Ryan Herbst,
Dieter Freytag
SLAC

- "Proof of Concept"
- RPC interface board 64 channels
- First tests -AC coupling
  1. Optimize resistor/ capacitor values
  2. Protection circuits
  3. KPIX readout modes

- Vary
- *Strip Termination 5-100 kΩ*
- *Blocking Capacitor 0.1 – 5 nF*
- *KPIX int. time 1.4 – 4 μs*
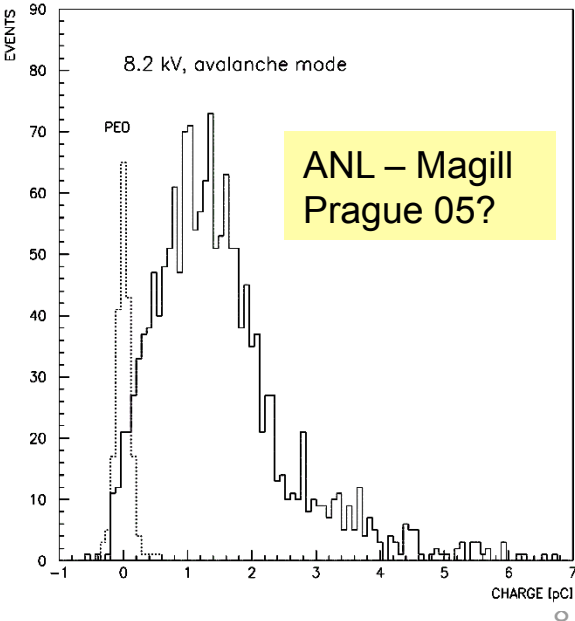- *Asynch. or triggered readout*
- *Periodic or DC resets*

9350 V

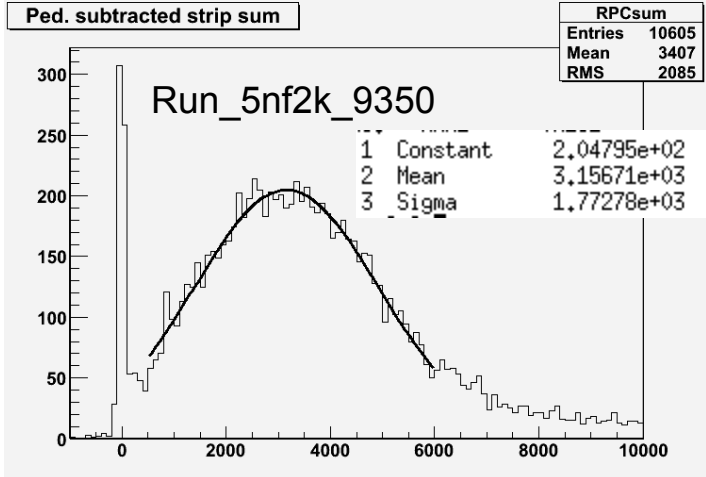*Compare transition board components*
~20% variation

1 nF 10 K

5 nF 10 K

fC ->

Run_5nf2k_9350
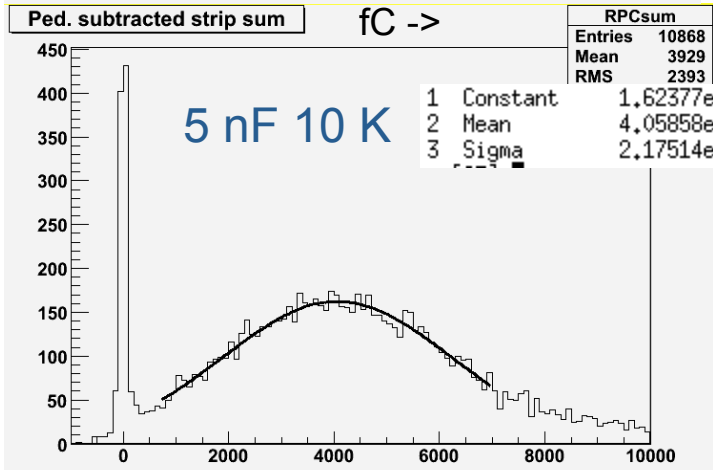
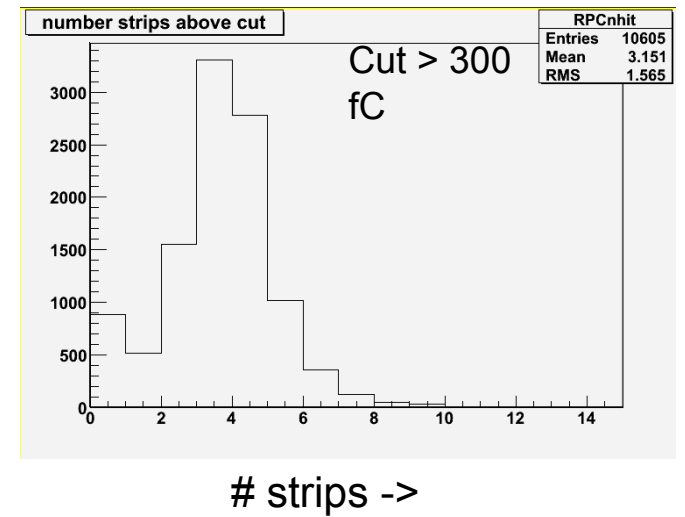RPC probably poorly aligned resulting in more events without signal

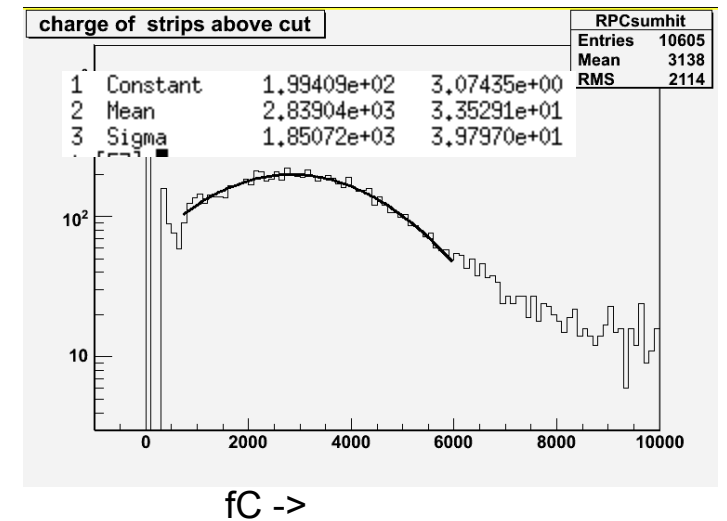Total charge 3-4 pC, larger, as expected, than ANL RPCs. Need absolute calibration.

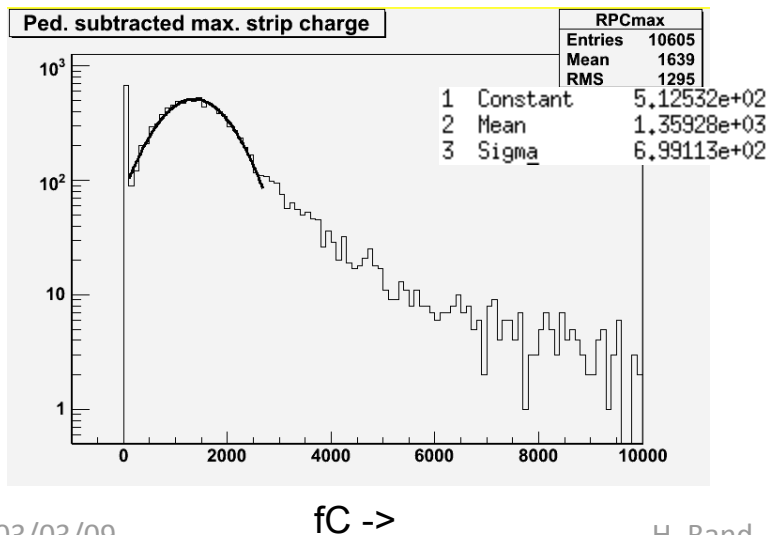ANL – Magill Prague 05?

8.2 kV, avalanche mode

Charge Sum of all strips
Charge of Max. strip
Charge Sum of strips above cut

Strips 3.8 cm wide

Ped. subtracted strip sum Run_5nf2k_9350

RPCsum	
Entries	10605
Mean	3407
RMS	2085

1	Constant	2.04795e+02	3.10145e+00
2	Mean	3.15671e+03	2.61547e+01
3	Sigma	1.77278e+03	3.14008e+01

fC ->

number strips above cut

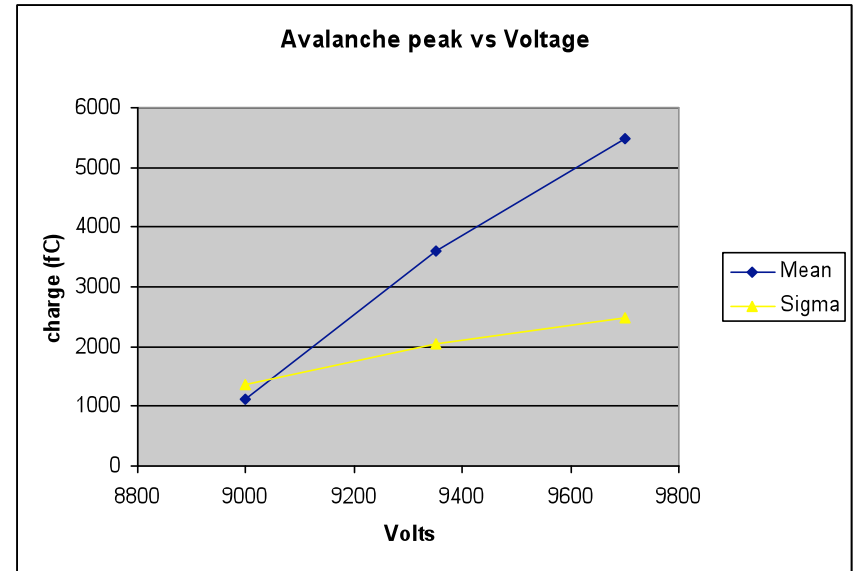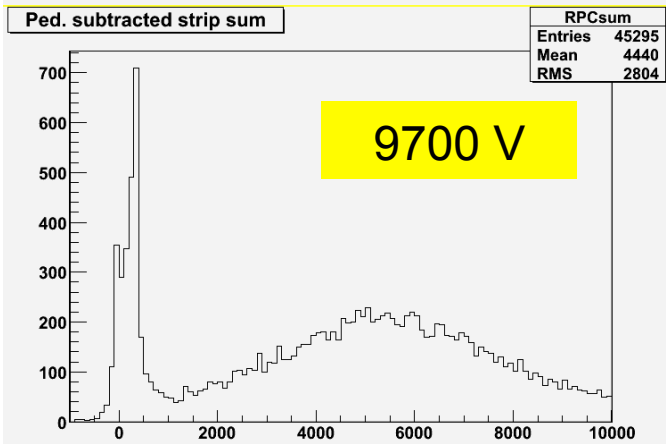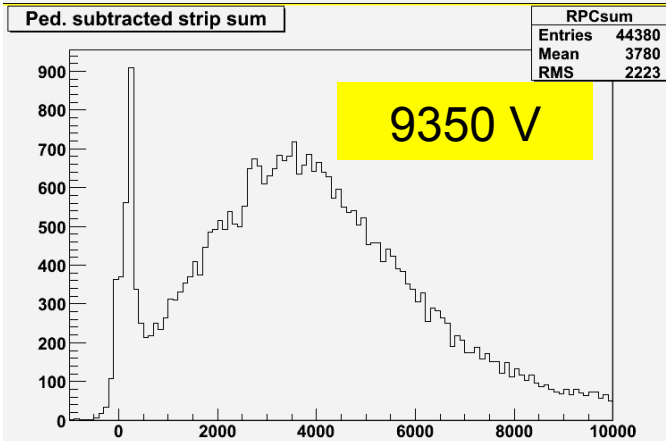| RPCnhit	
Entries	10605
Mean	3.151
RMS	1.565

Cut > 300 fC
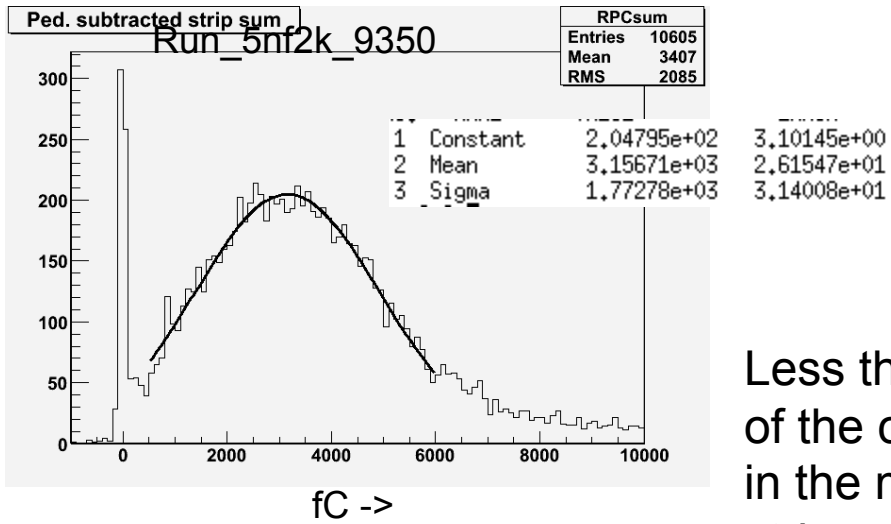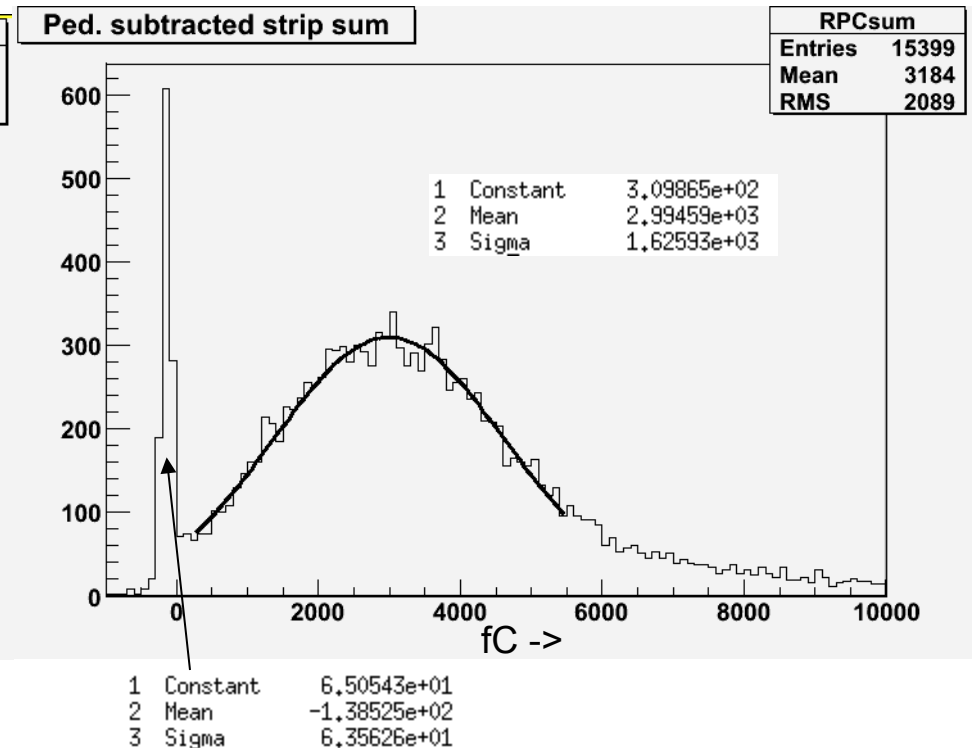
strips ->

Less than half of the charge is in the max. strip

Ped. subtracted max. strip charge

RPCmax	
Entries	10605
Mean	1639
RMS	1295

1	Constant	5.12532e+02
2	Mean	1.35928e+03
3	Sigma	6.99113e+02

fC ->

charge of strips above cut

RPCsumhit	
Entries	10605
Mean	3138
RMS	2114

1	Constant	1.99409e+02	3.07435e+00
2	Mean	2.83904e+03	3.35291e+01
3	Sigma	1.85072e+03	3.97970e+01

fC ->

HV Scan

Ped. subtracted strip sum — 9000 V

RPCsum	
Entries	10443
Mean	2008
RMS	1714

Ped. subtracted strip sum — 9350 V

RPCsum	
Entries	44380
Mean	3780
RMS	2223

Ped. subtracted strip sum — 9700 V

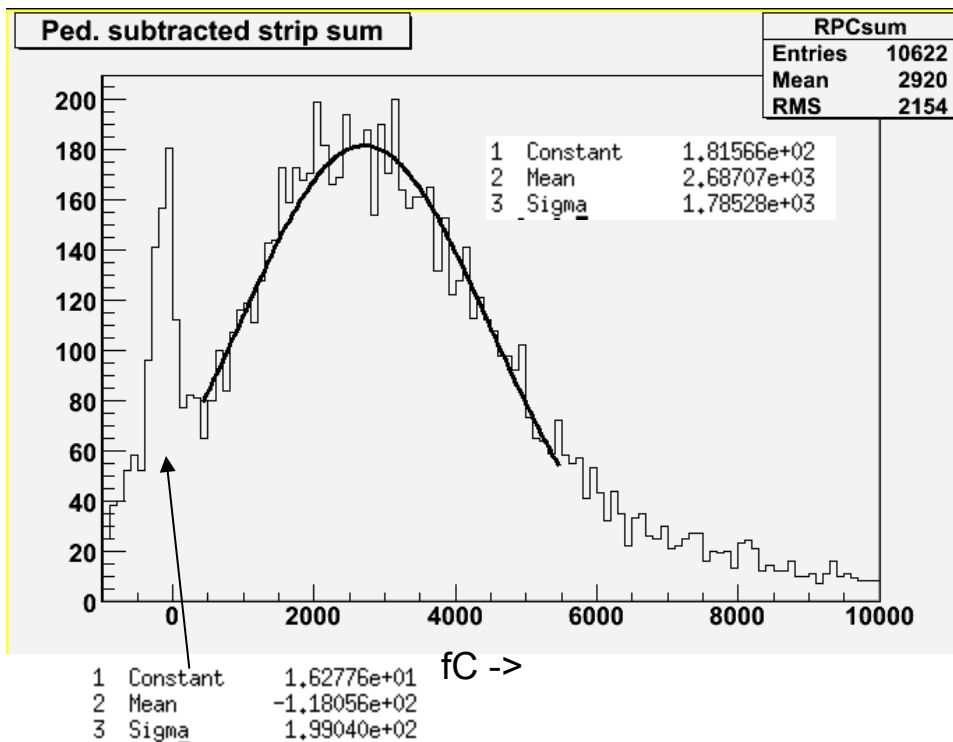| RPCsum	
Entries	45295
Mean	4440
RMS	2804

Avalanche peak vs Voltage
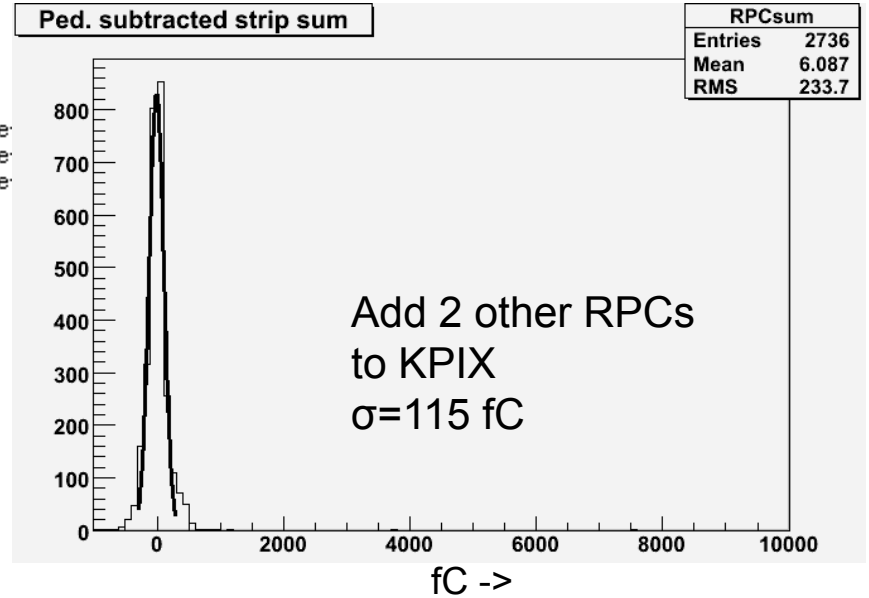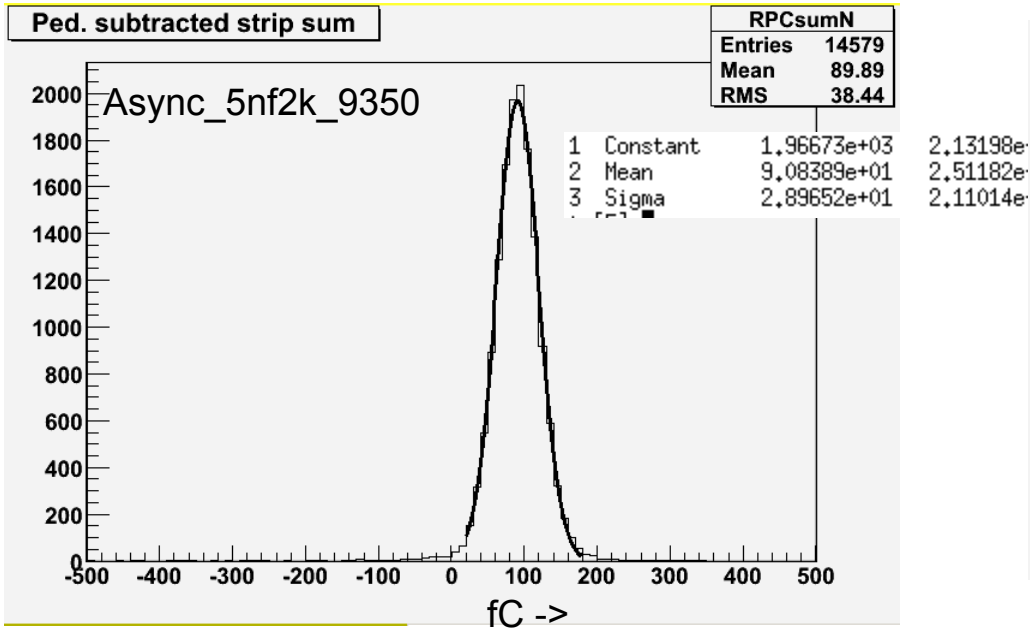
Strips above Threshold

KPIX Reset Mode Study

DC resets

per resets

In normal LC operation the KPIX charge amp is reset between beam pulses every 400ns
A continuous DC reset mode was added for cosmic rays tests
However, the noise seems 2-3 times worse in DC mode
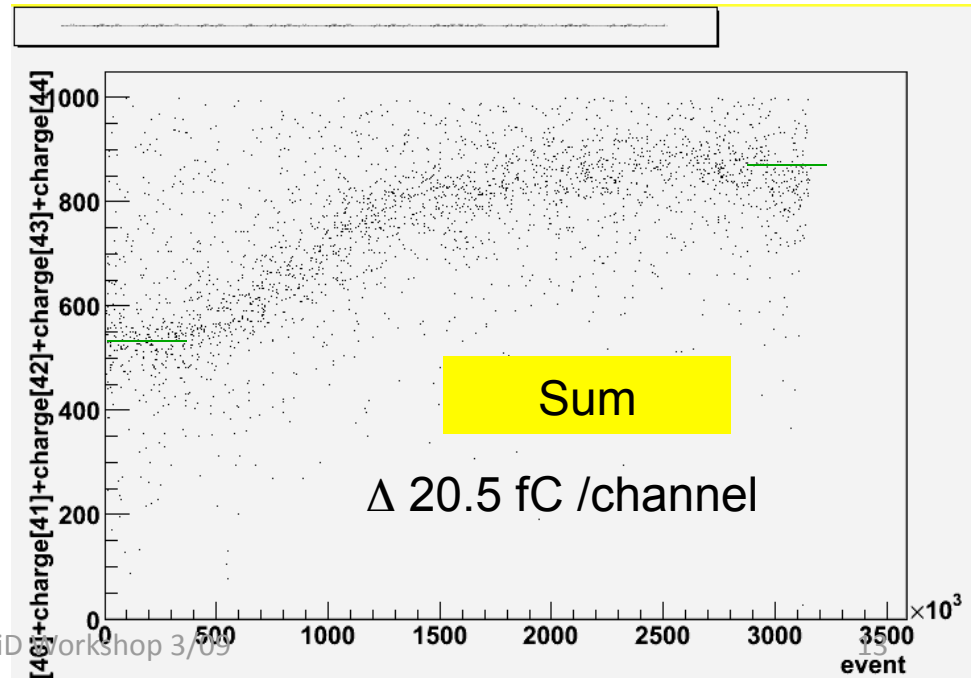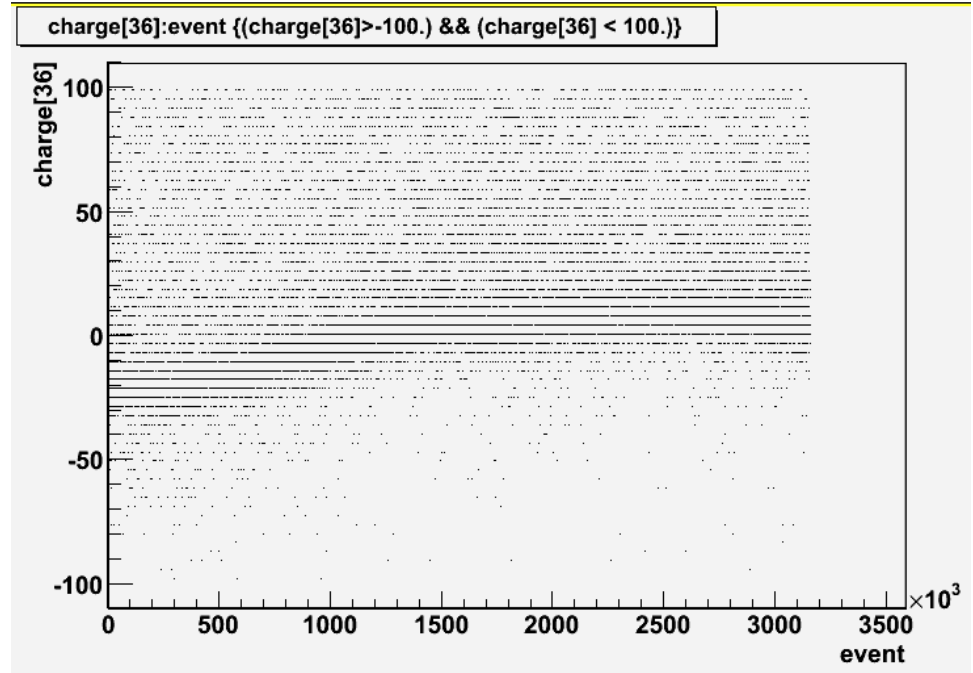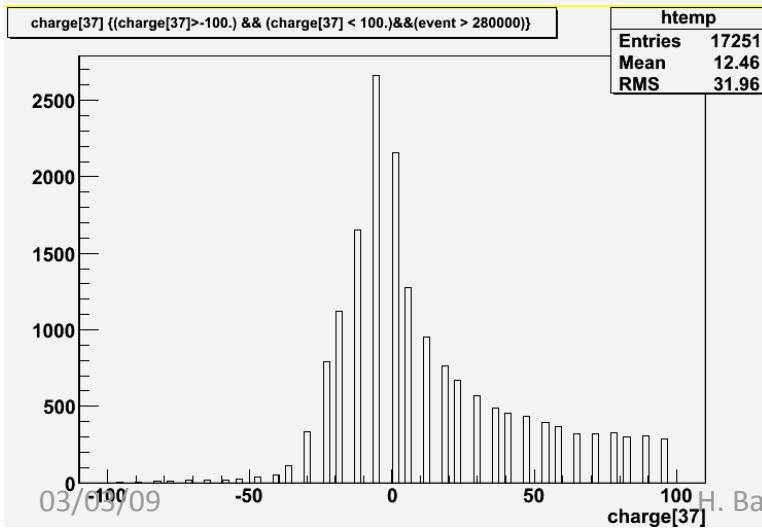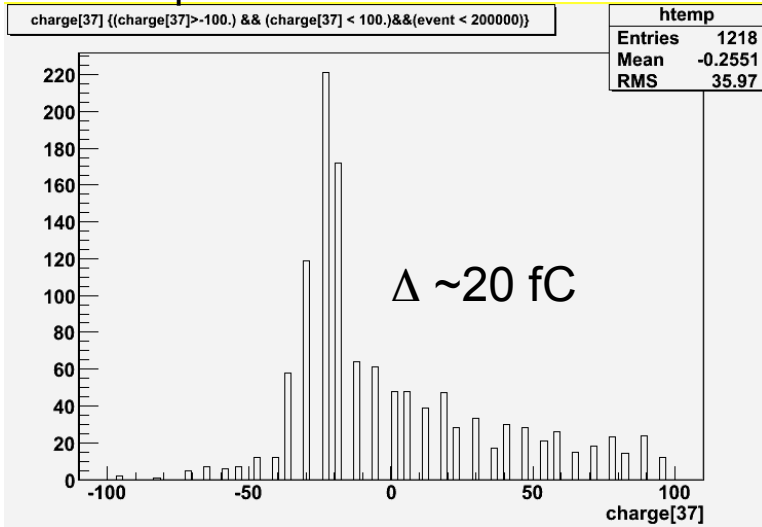Noise 8 times worse with no reset

Pedestal Studies

	RPCsumN	
Entries	14579	
Mean	89.89	
RMS	38.44	

Ped. subtracted strip sum

Async_5nf2k_9350

1	Constant	1.96673e+03	2.13198e
2	Mean	9.08389e+01	2.51182e
3	Sigma	2.89652e+01	2.11014e

fC ->

	RPCsum	
Entries	2736	
Mean	6.087	
RMS	233.7	

Ped. subtracted strip sum

Add 2 other RPCs
to KPIX
σ=115 fC

fC ->

	RPCsumN	
Entries	738	
Mean	25.98	
RMS	112.2	

Ped. subtracted strip sum

Run_5nf2k_9350

1	Constant	5.00560e+01	2.84743e+00
2	Mean	-5.52516e+00	2.06938e+00
3	Sigma	4.38373e+01	1.91578e+00

- Pedestal width higher for triggered events even if no track is seen
- Possible correlation between the time of the trigger and the reset
- Adding multiple RPCs increases the overall noise
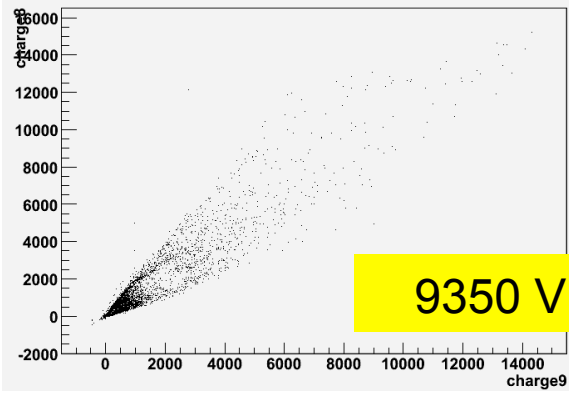- Without cables - noise ~ 5 fC/channel
- Need to better understand grounding

Pedestal Drift

Overnight rum shows pedestal drift with time, presumably due to temperature

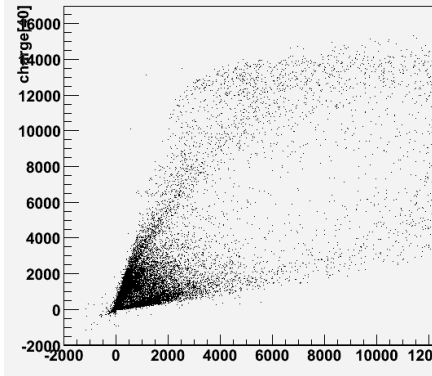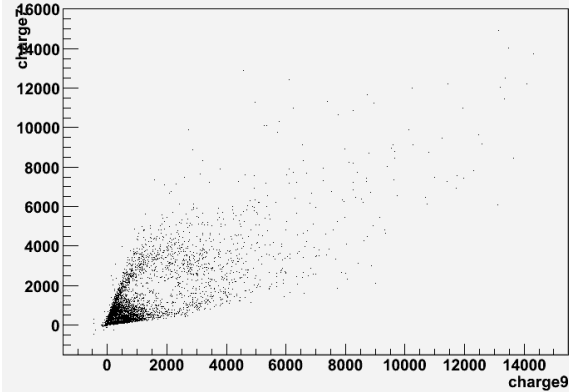charge[37] {(charge[37]>-100.) && (charge[37] < 100.)&&(event < 200000)}

htemp	
Entries	1218
Mean	-0.2551
RMS	35.97

Δ ~20 fC

charge[37] {(charge[37]>-100.) && (charge[37] < 100.)&&(event > 280000)}

htemp	
Entries	17251
Mean	12.46
RMS	31.96

charge[36]:event {(charge[36]>-100.) && (charge[36] < 100.)}

Sum

Δ 20.5 fC /channel

H. Band - SiD Workshop 3/09 13

Compare correlations

charge8:charge9

9350 V

charge7:charge9

charge5:charge9

charge[40]:charge[41]

9350 V + 1 MΩ

charge[39]:charge[41]
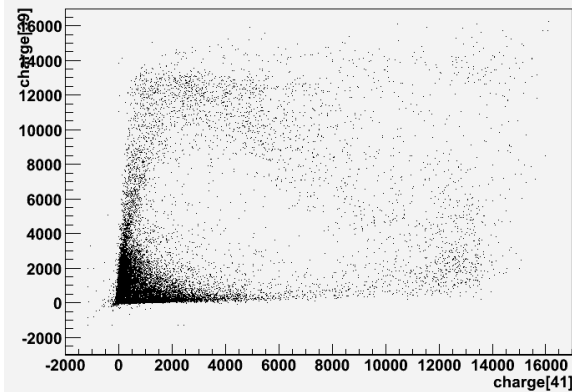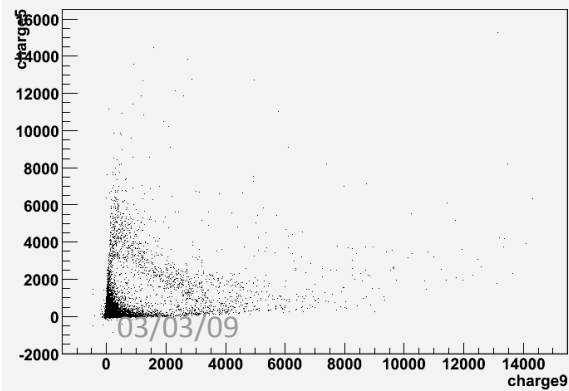
charge[37]:charge[41]
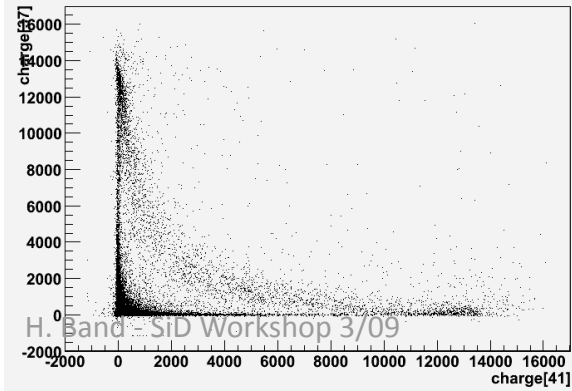
Recent developments

- Use all 64 channels for readout of 4 RPC planes to enable tracking studies

- 7 new IHEP RPCs in hand of varying bulk resistivity $3 \; 10^{11} - 5 \; 10^{12} \; \Omega cm$

- Improved software –GUI interface

Strips Above Threshold

- *FY2009 Milestones:*
  - *Relocate test-stand*
  - *Make current, rate, and efficiency measurements of IHEP test RPCs operating in avalanche mode.*
  - *Readout multiple RPCs with 1 KPiX(v. 7) chip*
  - *Readout negative RPC signals with KPiX(v. 7)*
  - *Test KPiX (v. 7 & v. 8) trigger and reset operating modes.*
  - *Optimize RPC/KPiX interface board design to maximize efficiency and minimize strip multiplicity.*

- *FY2010 & FY2011 Milestones:*
  - *Readout multiple KPiX chips*
  - *Use position and charge information from multiple RPC/KPiX devices to make fitted cosmic ray tracks*
  - *Study position resolution of RPC/KPiX tracks,*
  - *Test HCAL prototypes in teststand*
  - *Study response on IHEP RPCs to HF.*
  - *Begin IHEP RPC aging studies*