Measurement of Muon Flux in CJPL (China JinPing Underground Laboratory)

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CJPL

Outline

- Basic Situation
  - Detector
  - Experiment Sites
- Experiment
  - Schematic Diagram
  - Threshold
  - Time Window
- Results
  - Rate
  - Detection Efficiency
  - First Muon Event @ CJPL
- Summary

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Detector

- Plastic Scintillator

  100cm×50cm×5cm

- PMT: CR136

  Voltage: 12V±0.5V (tune through potentiometer)

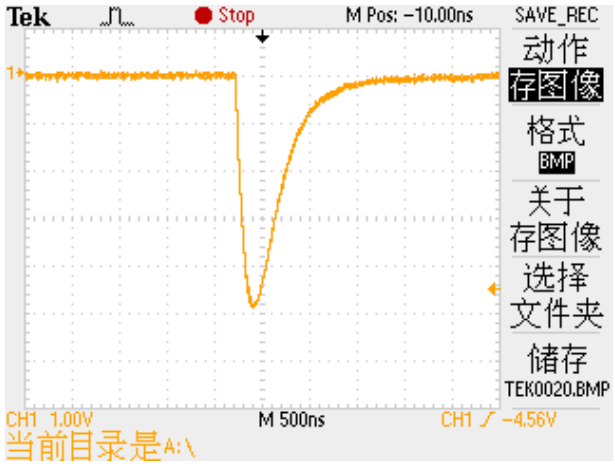
- Output

  negative pulse (0 to -5V)

  leading edge ~90ns

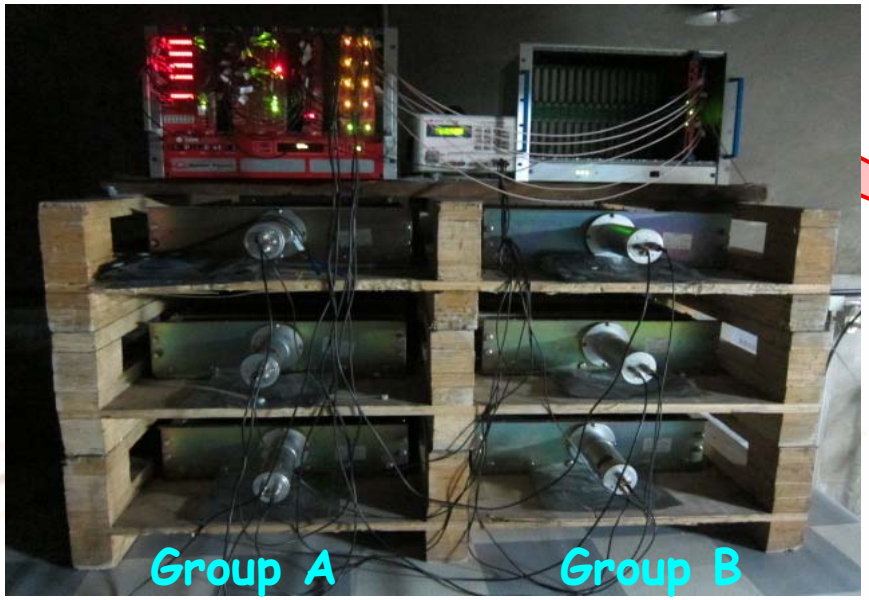
  trailing edge ~620ns

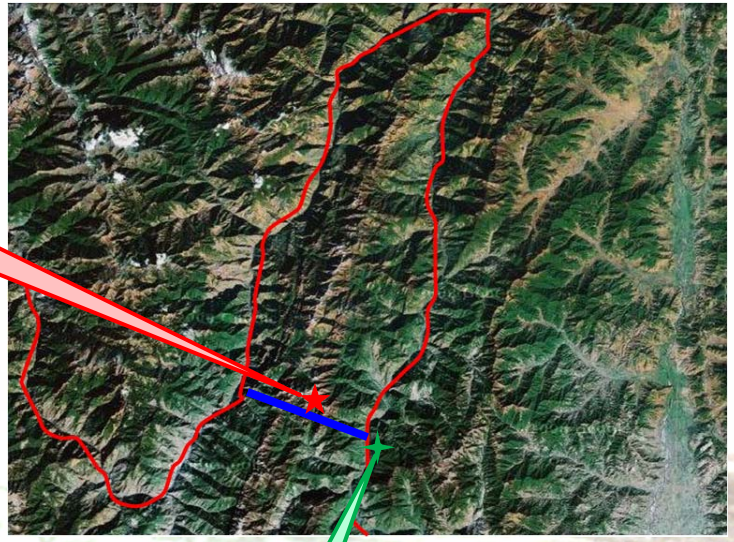
  FWHM ~400ns



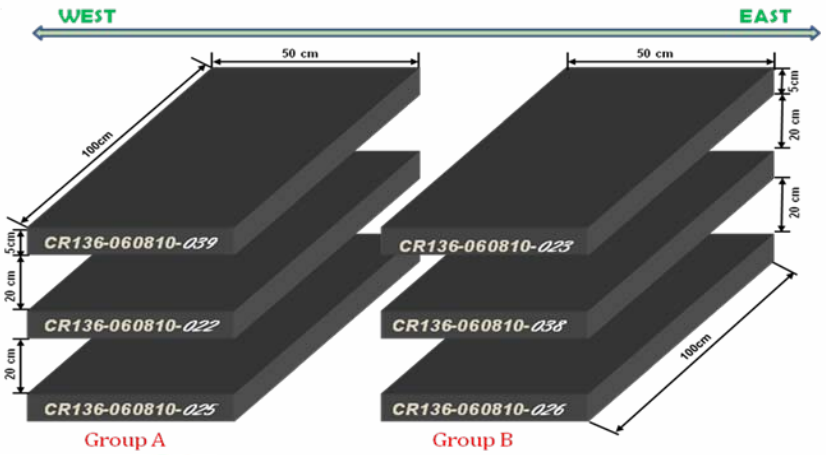
Experimental Sites

CJPL: Underground Level





B-21: Ground Level



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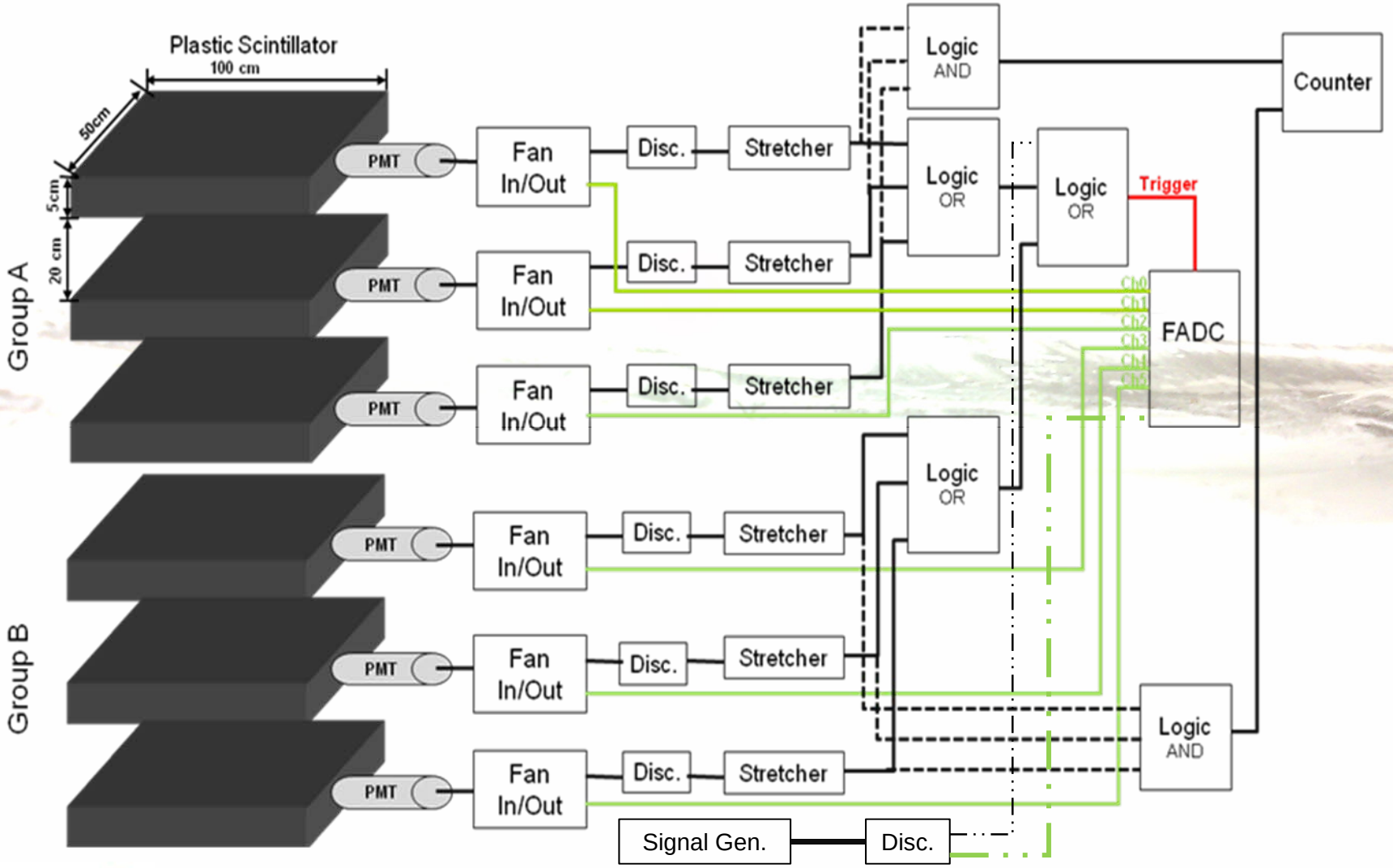
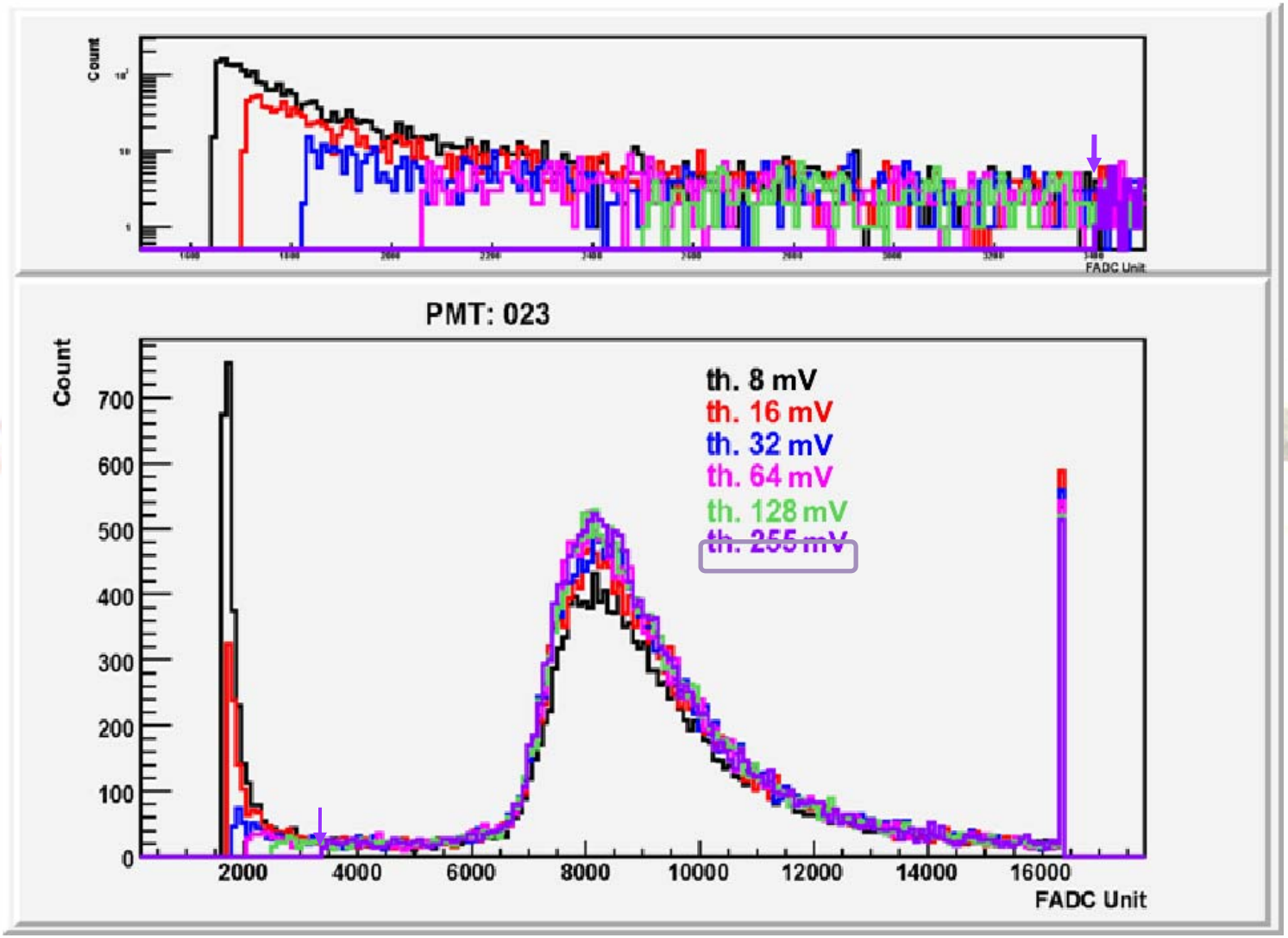
Schematic Diagram



Threshold Selection



The limit of hardware discriminator is -255mV.

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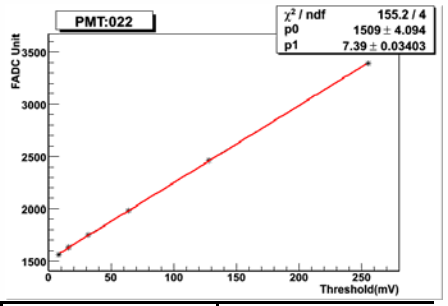
FADC Calibration



	Threshold	8	16	32	64	128	255
PMT 023	Bin Cut	1644	1706	1825	2063	2509	3407
	Fitting	$Y = 7.12X + 1595.54$ ($\chi^2 = 247/4$)					
PMT 038	Bin Cut	1564	1624	1751	1988	2453	3372
	Fitting	$Y = 7.30X + 1512.62$ ($\chi^2 = 202/4$)					
PMT 026	Bin Cut	1390	1453	1576	1808	2258	3149
	Fitting	$Y = 7.10X + 1343.82$ ($\chi^2 = 310/4$)					
PMT 039	Bin Cut	1640	1708	1827	2058	2519	3404
	Fitting	$Y = 7.12X + 1595.70$ ($\chi^2 = 414.5/4$)					
PMT 022	Bin Cut	1560	1628	1753	1981	2460	3391
	Fitting	$Y = 7.39X + 1509.31$ ($\chi^2 = 155.2/4$)					
PMT 025	Bin Cut	1395	1453	1567	1806	2258	3142
	Fitting	$Y = 7.08X + 1343.66$ ($\chi^2 = 252.8/4$)					

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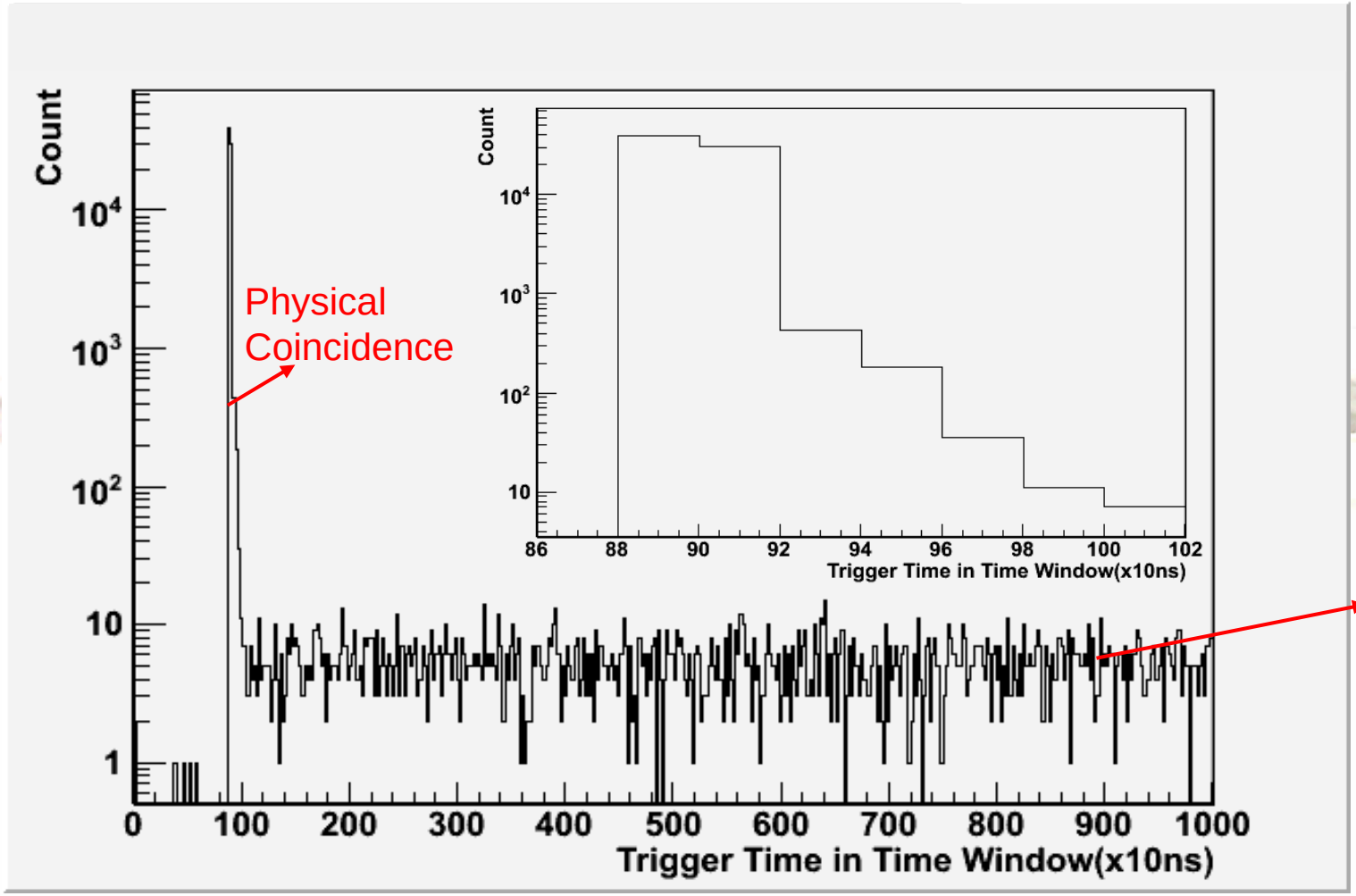
Window Width Selection

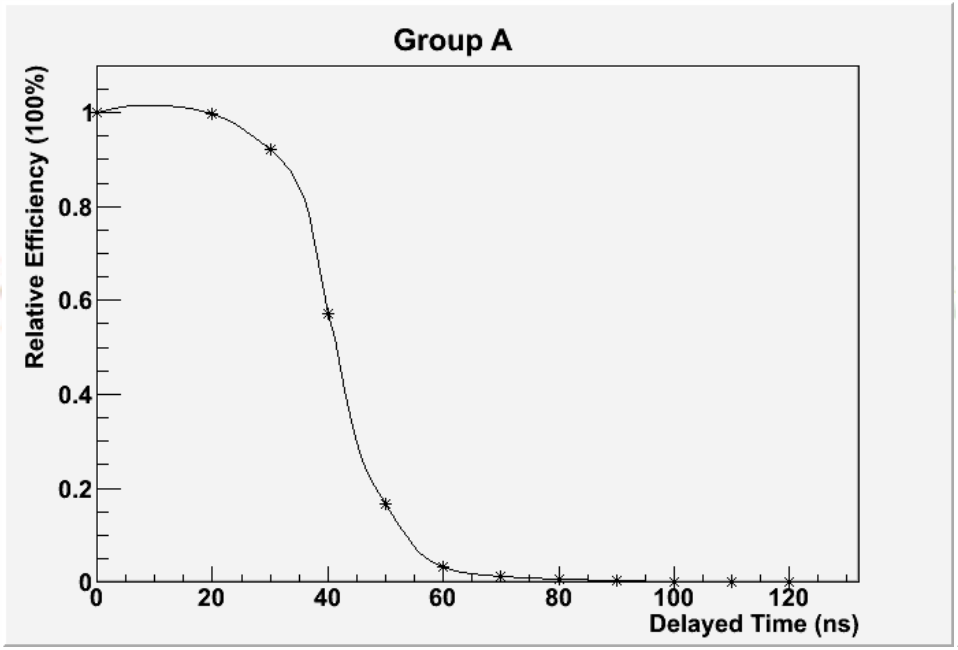


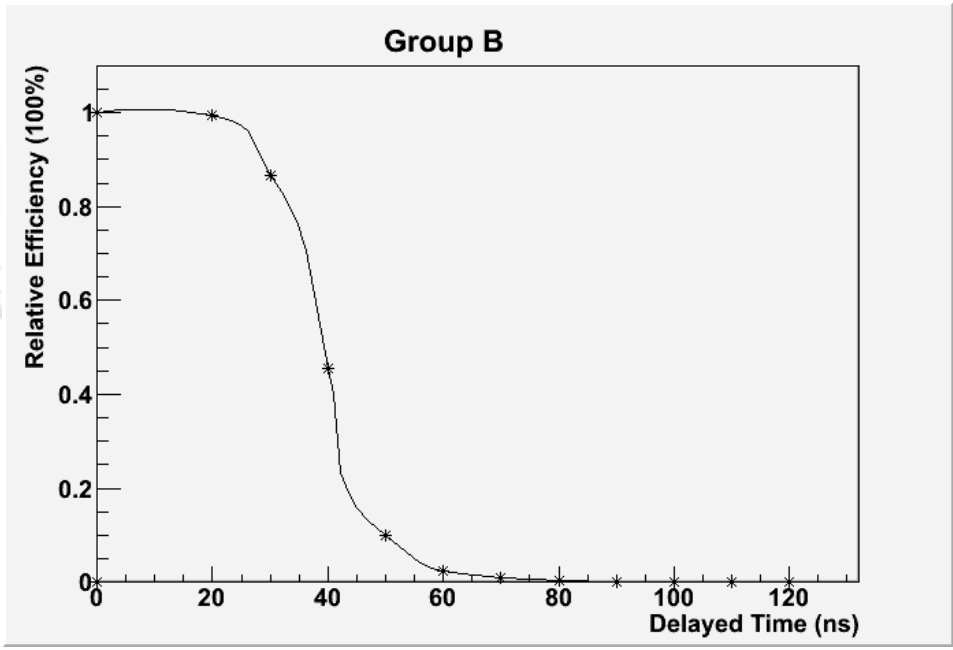
Time Interval
88 – 100:
12 FADC Units
→ 120ns

Random Coincidence

Coincidence Curve

Time Window:





Time window of 120ns would be fine.

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Counting Rate

• B-21	Group A				Group B			
Logic	9	2	5	9&2&5	3	8	6	3&8&6
FADC Rate(Hz)	85.18	78.82	81.82	29.93	89.31	82.38	84.88	31.49
Counter Rate(Hz)	89.64	84.91	83.52	30.26	88.44	83.48	85.40	31.44

Corrections of Detection Efficiency & Solid Angle are needed for the Muon Flux.

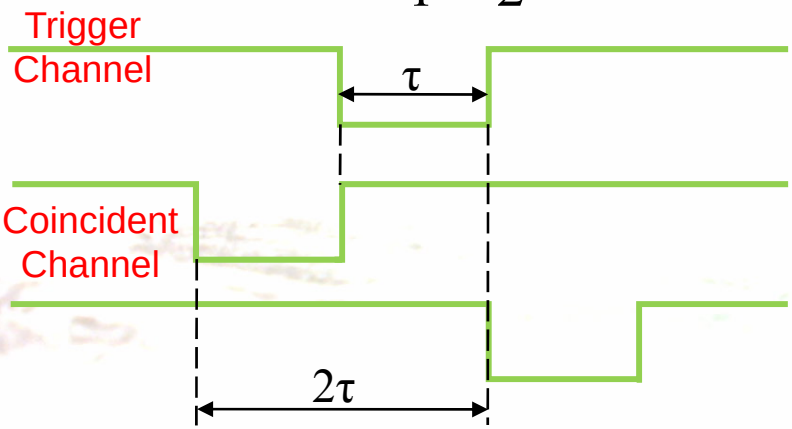
- CJPL

Background rate for each detector: ~1Hz

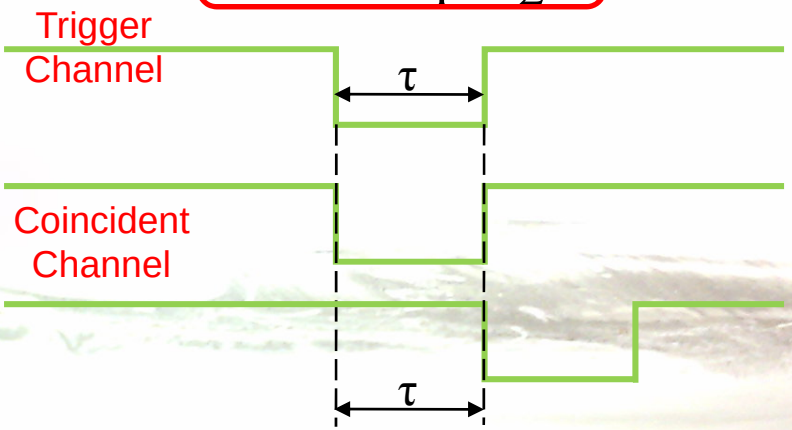
Several Candidates of Muon Event

Rate of Random Coincidence

- $N = 2N_1N_2\,\tau$ OR $N = N_1N_2\,\tau$



Hardware "AND" Coincidence



Hardware "OR" & Software "AND" Coincidence

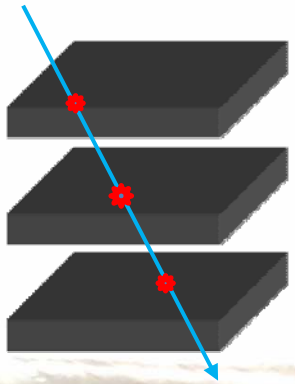
B-21	Group A			Group B		
Logic	Single	2-Fold Coincidence	3-Fold Coincidence	Single	2-Fold Coincidence	3-Fold Coincidence
Rate of Random Coincidence(Hz)	~82	8.1e-4	7.9e-9 (0.25 cpy)	~85	8.7e-4	8.8e-9 (0.28 cpy)

Detection Efficiency

- Tested in B-21 (The Middle Detector)

  Threshold: -255mV

  Time Window: 120ns



$$\eta = \frac{N_{3-fold\_coincidence}}{N_{upper\&lower\_coincidence} - N_{upper\&lower\_random\_coincidence}}$$

$$\eta_A = 29.93 / (30.38 - 0.0008) \times 100\% = 98.52\%$$

$$\eta_B = 31.49 / (31.83 - 0.0009) \times 100\% = 98.93\%$$

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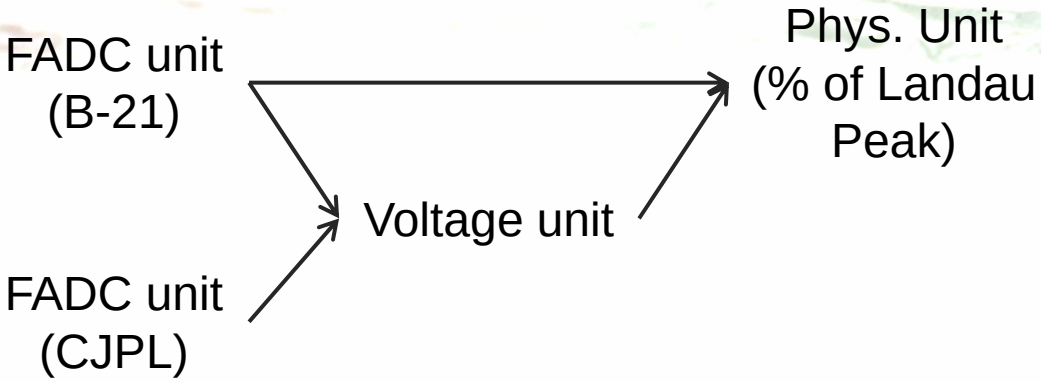
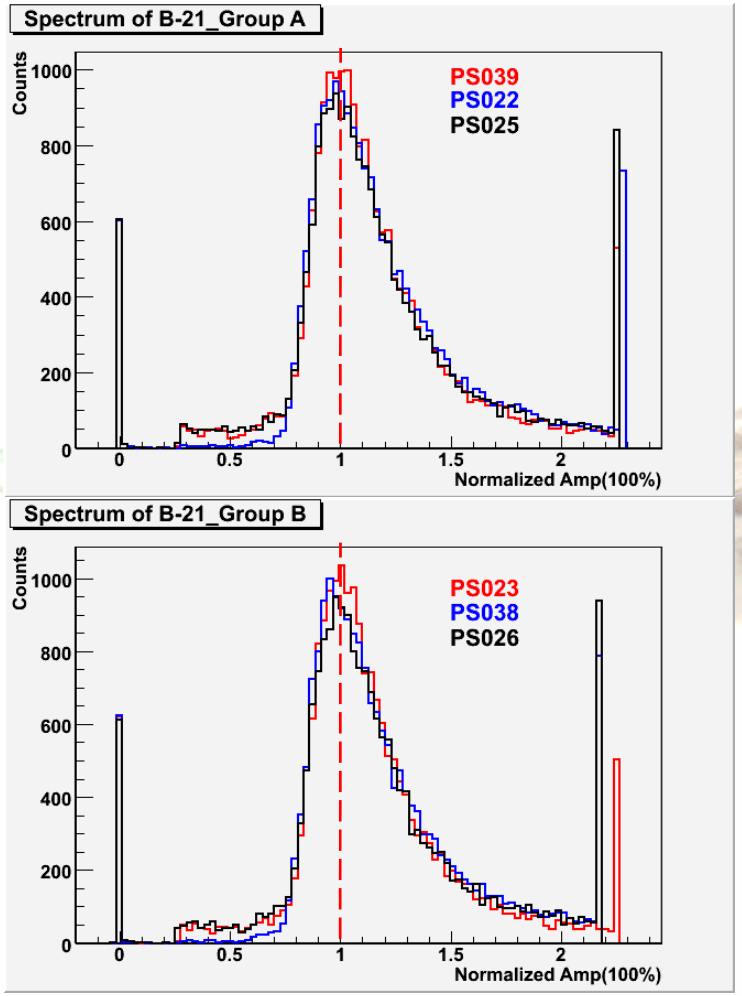
Normalization

- Normalized to Landau Peak
- Comparable for different detectors and sites

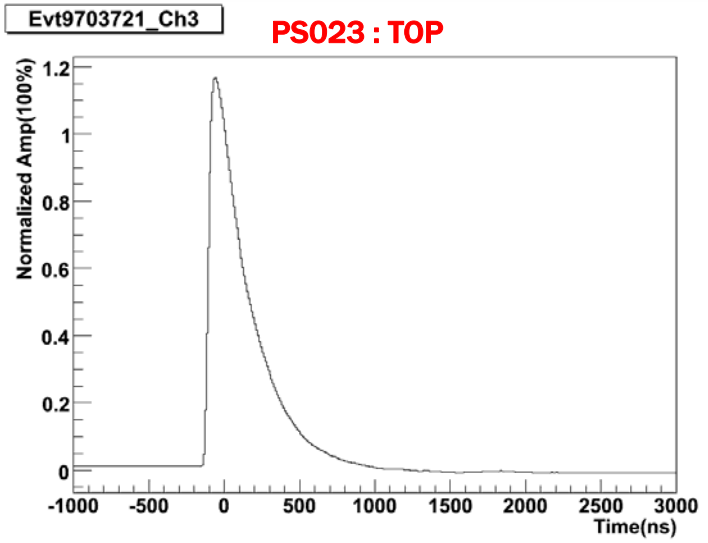


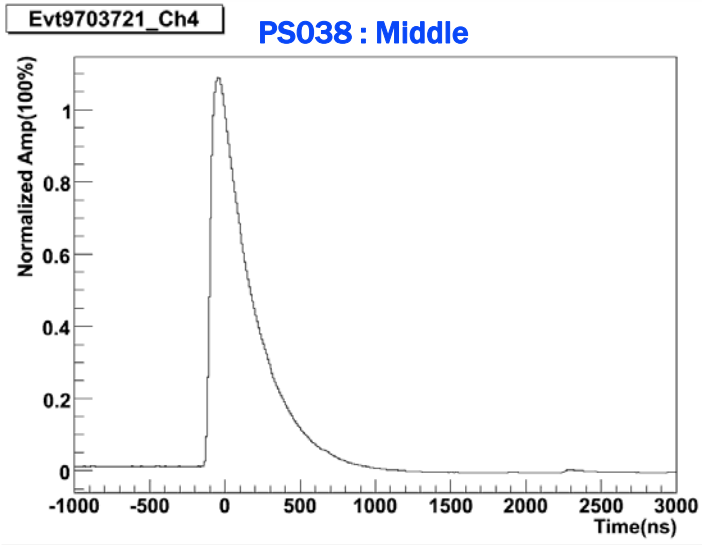
Assume that the performance of detector & PMT are stable both in B-21 & CJPL.

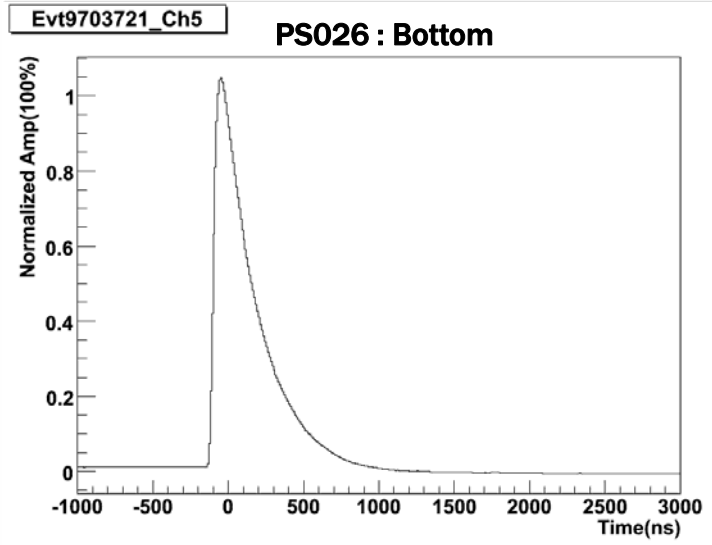


First Muon Event @ CJPL (Candidate)

- **Date:** 2010/12/02
- **Time:** 04:49:19
- **Group No.:** B







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Summary

- Detectors works well
- Several Candidates of Muon Event in CJPL
- Muon flux detection in CJPL is undergoing
  Prediction: < 100 $m^{-2}y^{-1}$ (10^{-7} -10^{-8} of Ground Level)

Thank you very much!

Comments and Questions?

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