



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

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# Outline

- **Basic Situation**

  - Detector

  - Experiment Sites

- **Experiment**

  - Schematic Diagram

  - Threshold

  - Time Window

- **Results**

  - Rate

  - Detection Efficiency

  - First Muon Event @ CJPL

- **Summary**

# Detector

- Plastic Scintillator

100cm × 50cm × 5cm

- PMT: CR136

Voltage:  $12V \pm 0.5V$  (tune through potentiometer)

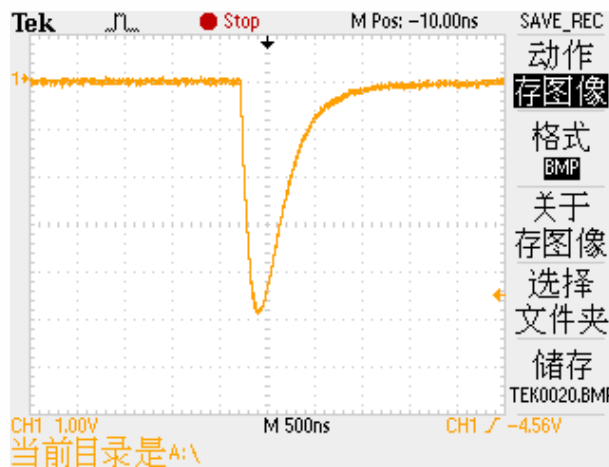
- Output

negative pulse (0 to -5V)

leading edge  $\sim 90\text{ns}$

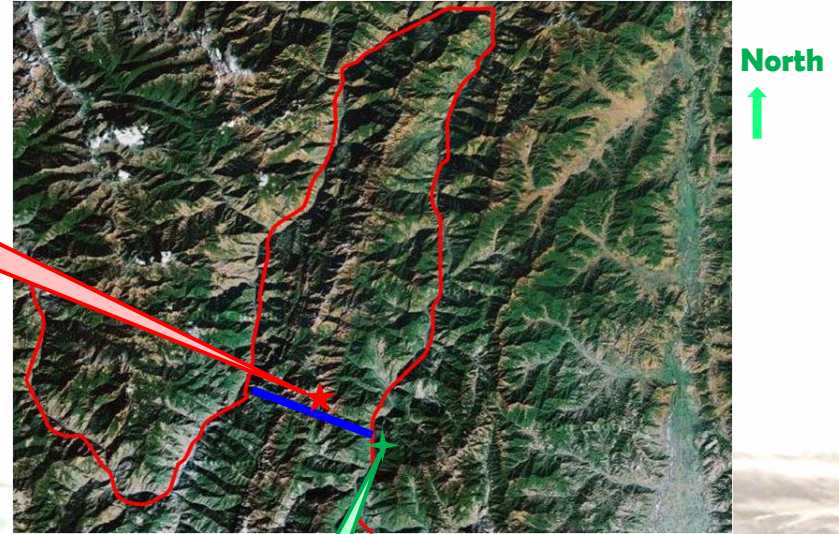
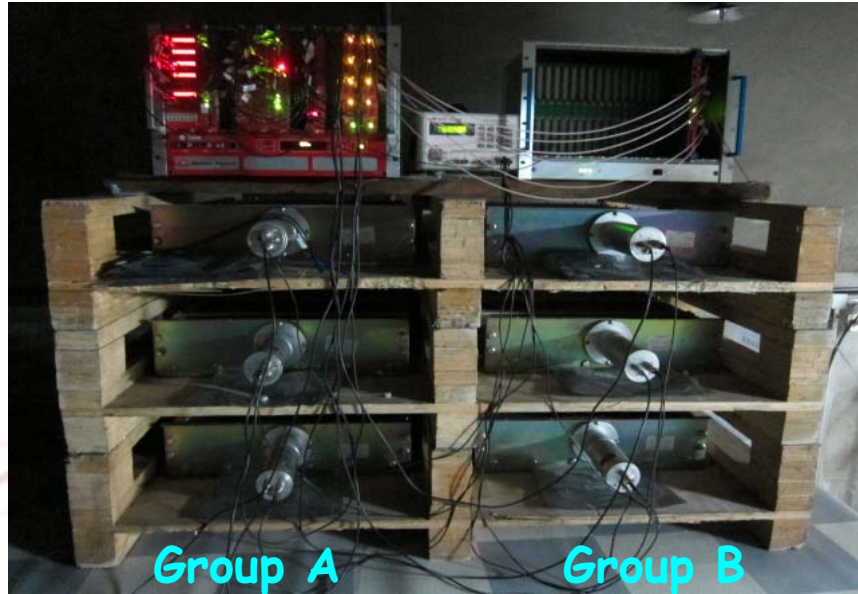
trailing edge  $\sim 620\text{ns}$

FWHM  $\sim 400\text{ns}$

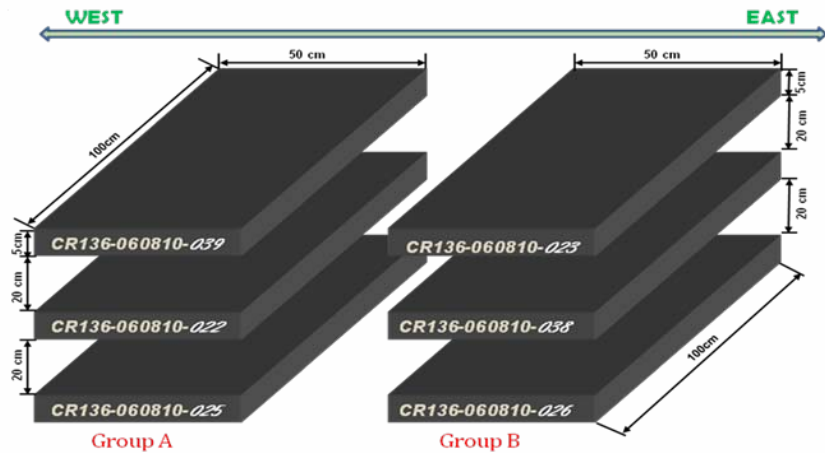


# Experimental Sites

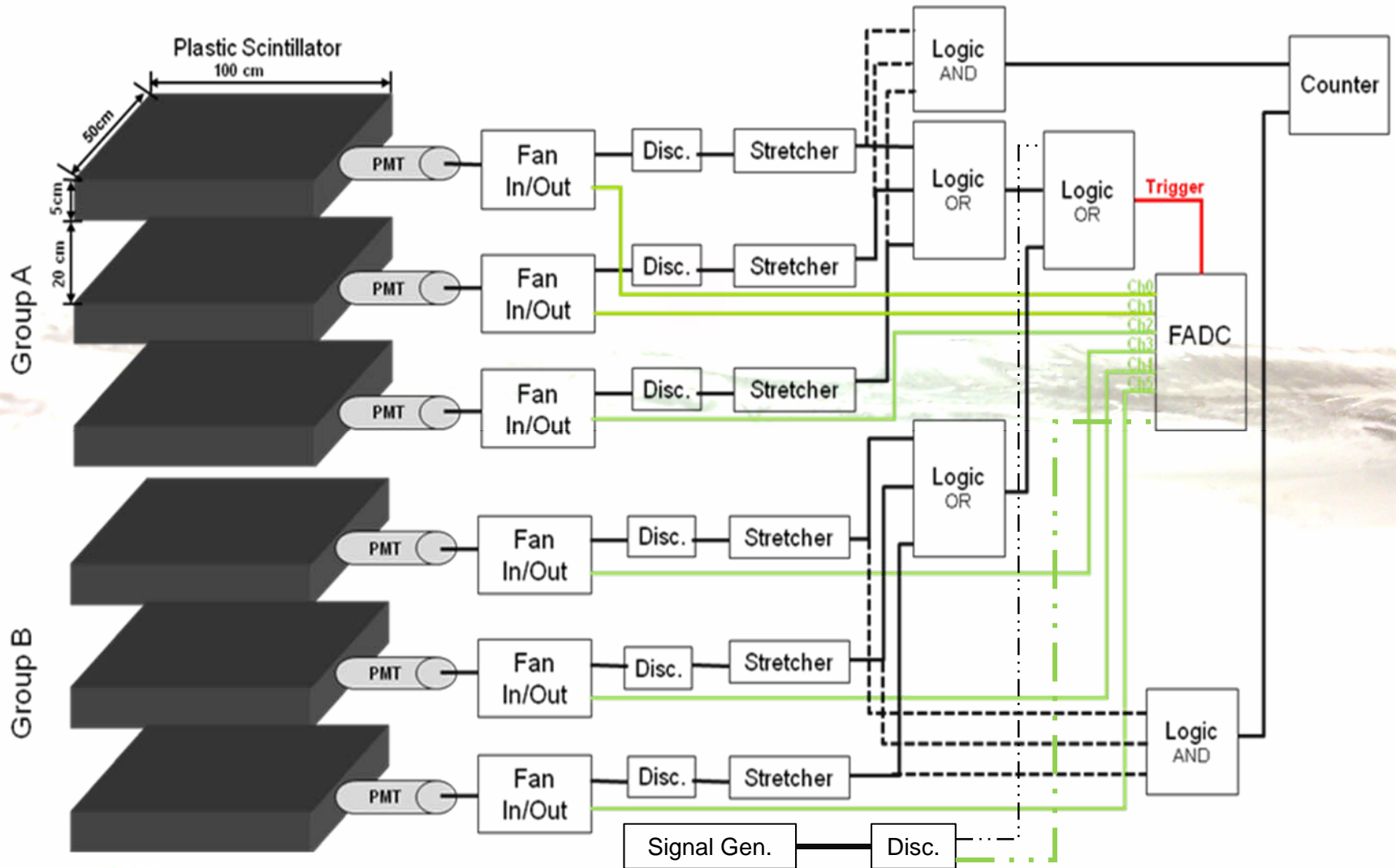
CJPL: Underground Level



B-21: Ground Level

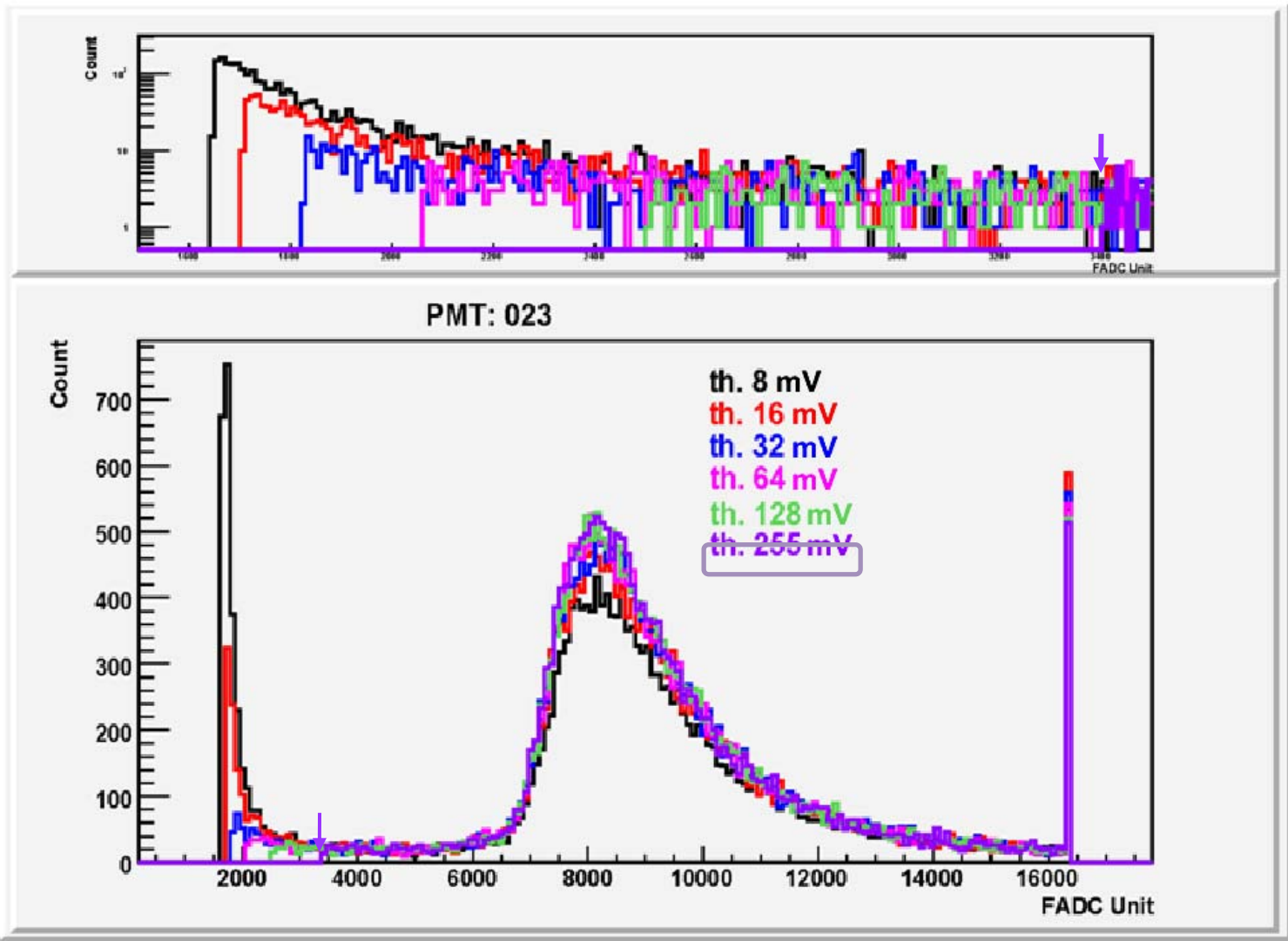


# Schematic Diagram



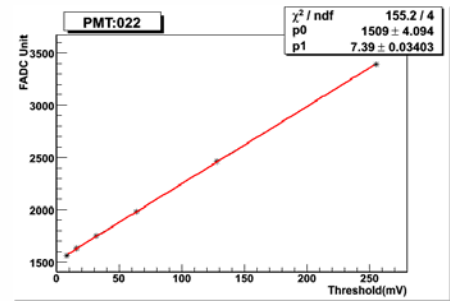


# Threshold Selection



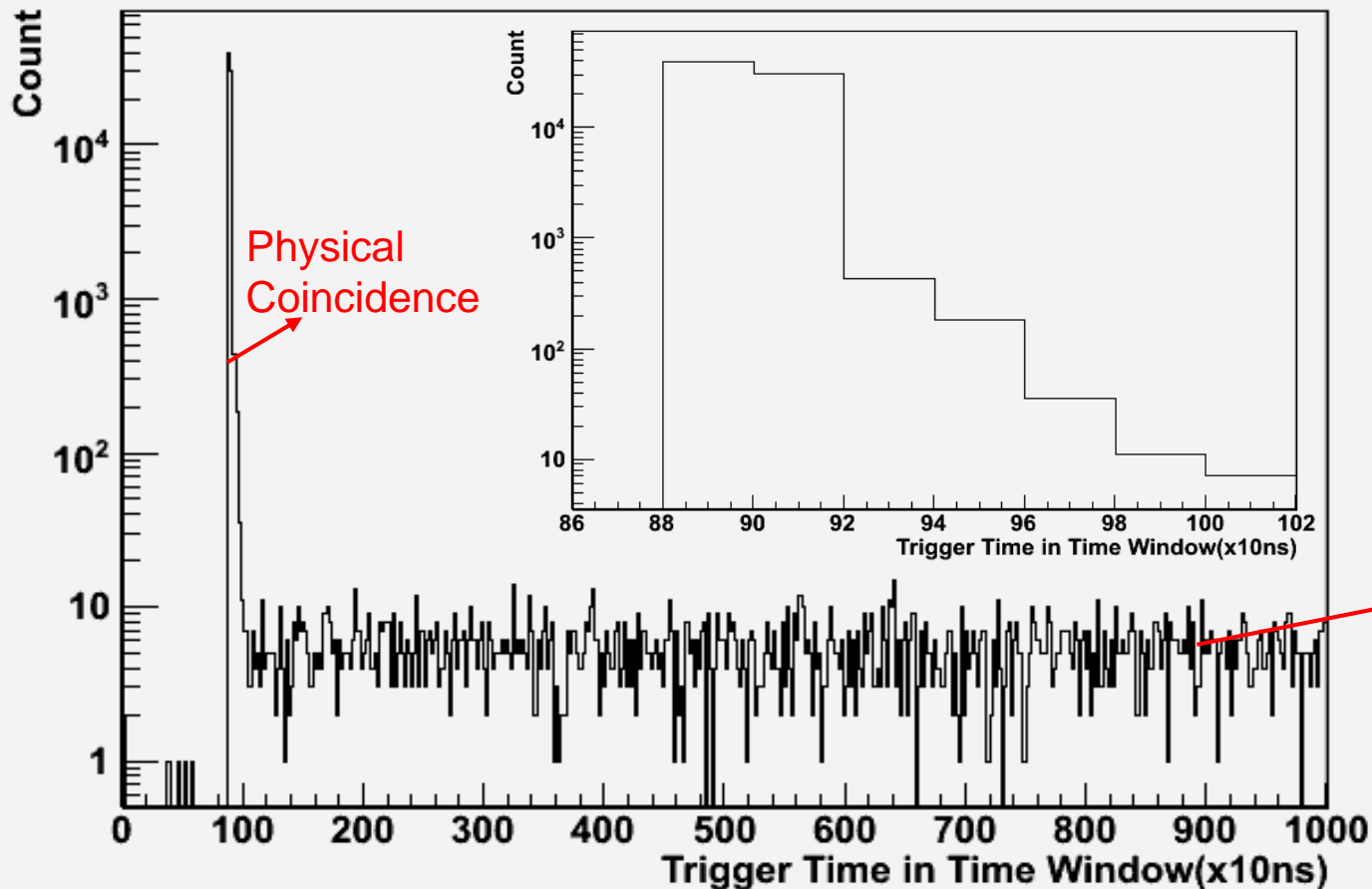
The limit of hardware discriminator is -255mV.

# 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	$Y = 7.08X + 1343.66$ ( $\chi^2 = 252.8/4$ )					

# Window Width Selection



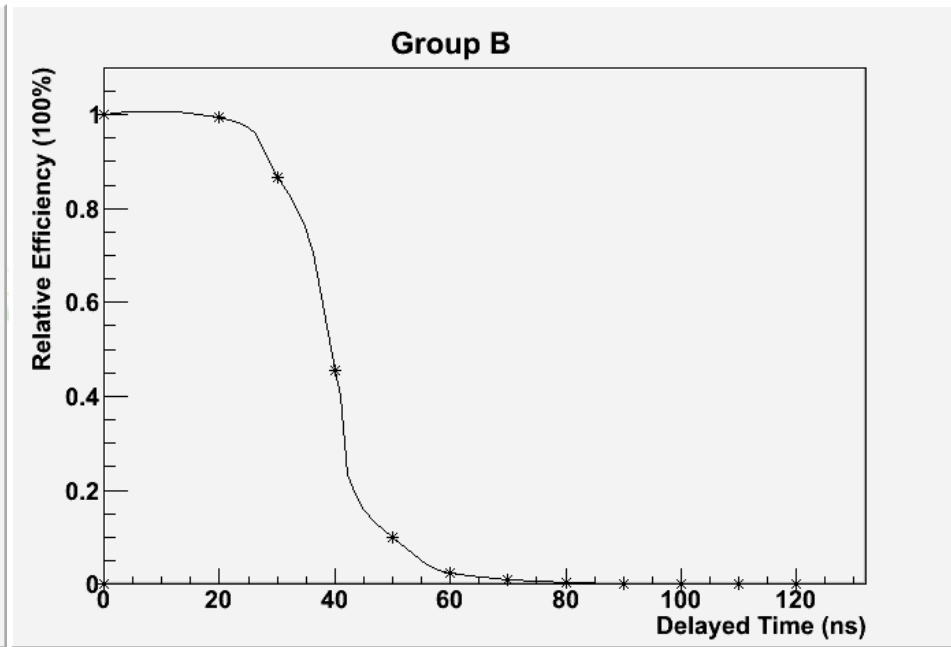
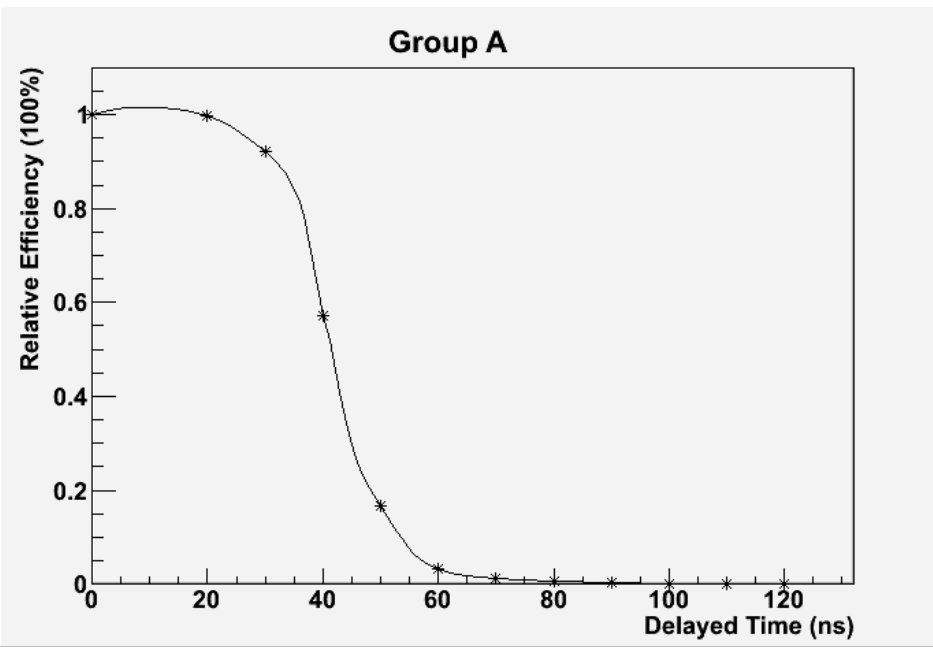
Time Interval  
88 – 100:  
12 FADC Units  
→ 120ns

Random  
Coincidence



# Coincidence Curve

Time Window:



Time window of 120ns would be fine.

# Counting Rate

● B-21	Group A				Group B			
	9	2	5	9&2&5	3	8	6	3&8&6
Logic								
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.

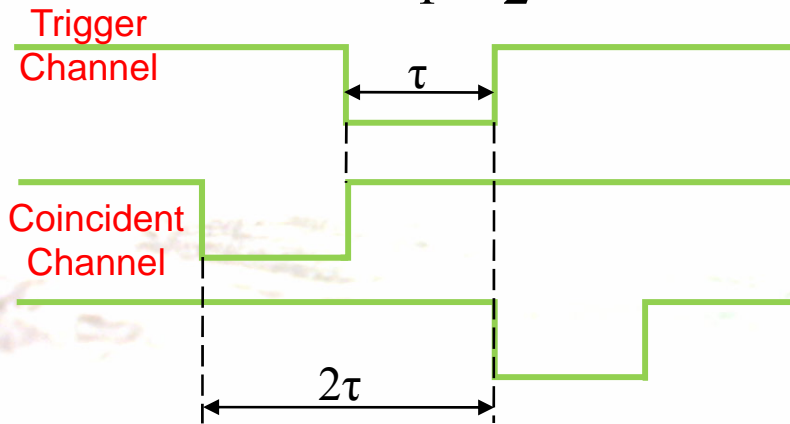
- CJPL

Background rate for each detector:  $\sim 1\text{Hz}$

Several Candidates of Muon Event

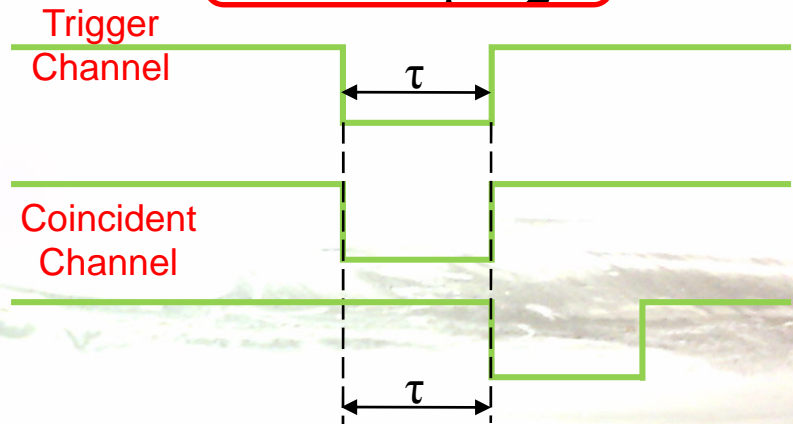
# Rate of Random Coincidence

- $N = 2N_1N_2 \tau$



OR

$$N = N_1N_2 \tau$$



Hardware "AND" Coincidence

Hardware "OR" & Software "AND" Coincidence

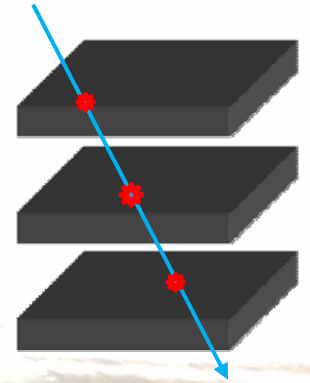
B-21	Group A			Group B		
	Logic	Single	2-Fold Coincidence	3-Fold Coincidence	Single	2-Fold Coincidence
Rate of Random Coincidence(Hz)	~82	8.1e-4	7.9e-9 (0.25 cpy)	~85	8.7e-4	8.8e-9 (0.28 cpy)

# Detection Efficiency

- Tested in B-21 (The Middle Detector)

Threshold: -255mV

Time Window: 120ns



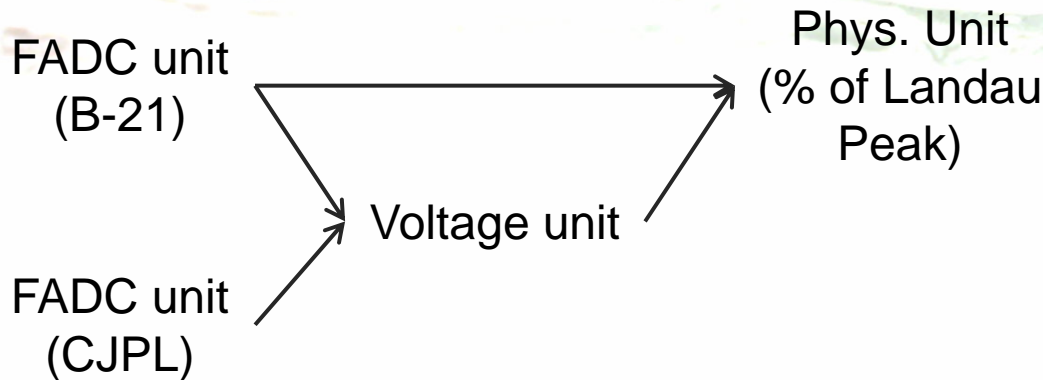
$$\eta = \frac{N_{3\text{-fold\_coincidence}}}{N_{\text{upper\&lower\_coincidence}} - N_{\text{upper\&lower\_random\_coincidence}}}$$

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

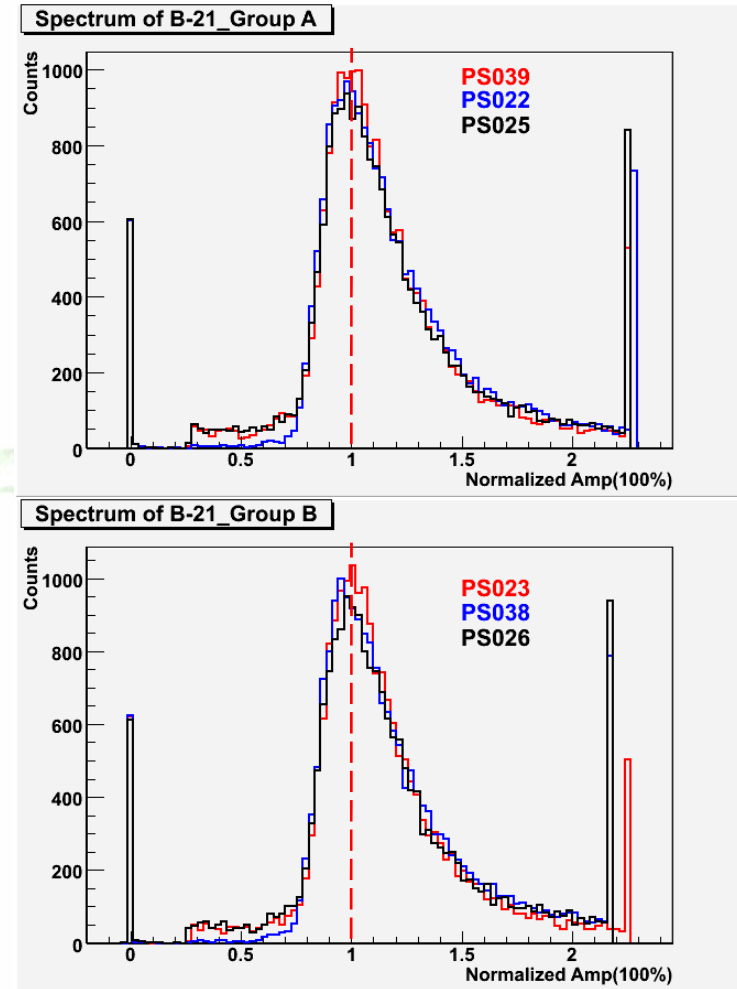
$$\eta_B = 31.49 / (31.83 - 0.0009) \times 100\% = 98.93\%$$

# Normalization

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



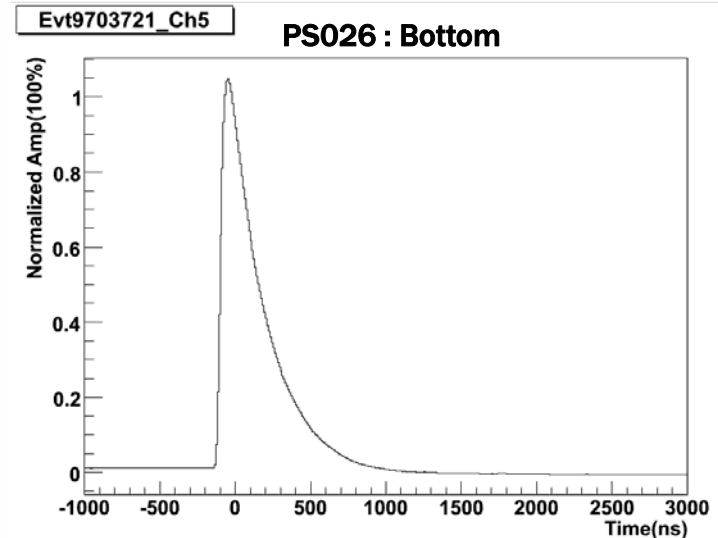
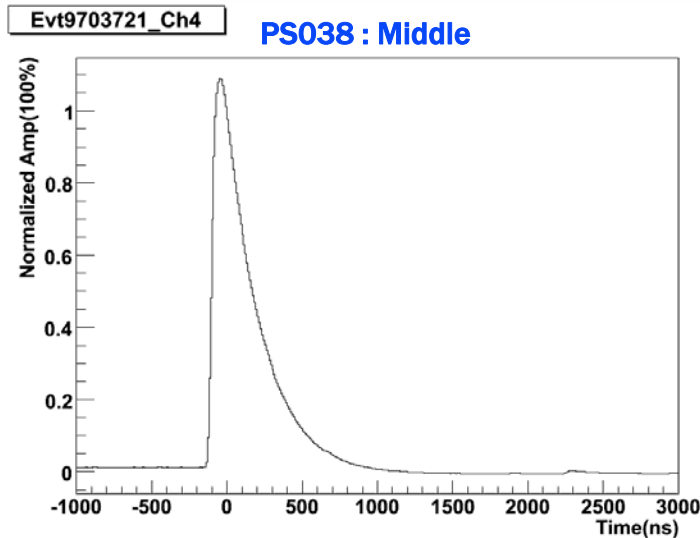
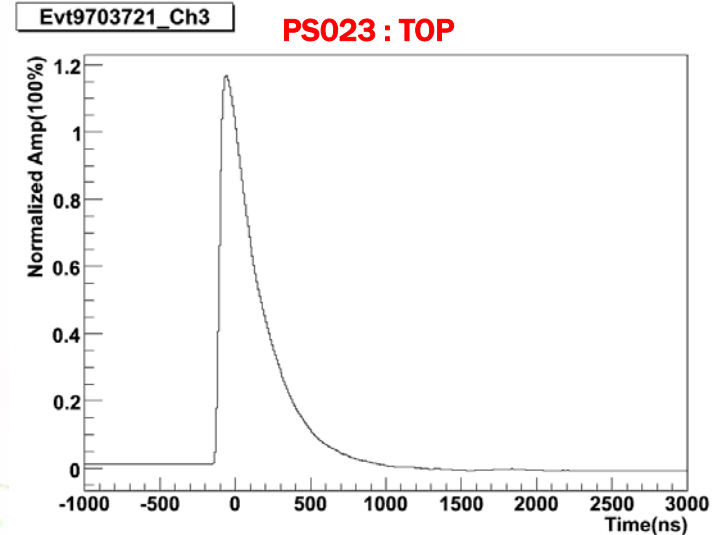
Assume that the performance of detector & PMT are stable both in B-21 & CJPL.





# First Muon Event @ CJPL (Candidate)

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



# Summary

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

Thank you very much!

Comments and Questions?