

MEG実験用液体キセノン検出器プロトタイプの 新型PMT導入による分解能の向上

日本物理学会第60回年次大会
東京理科大学野田キャンパス

2005年3月24日

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Contents

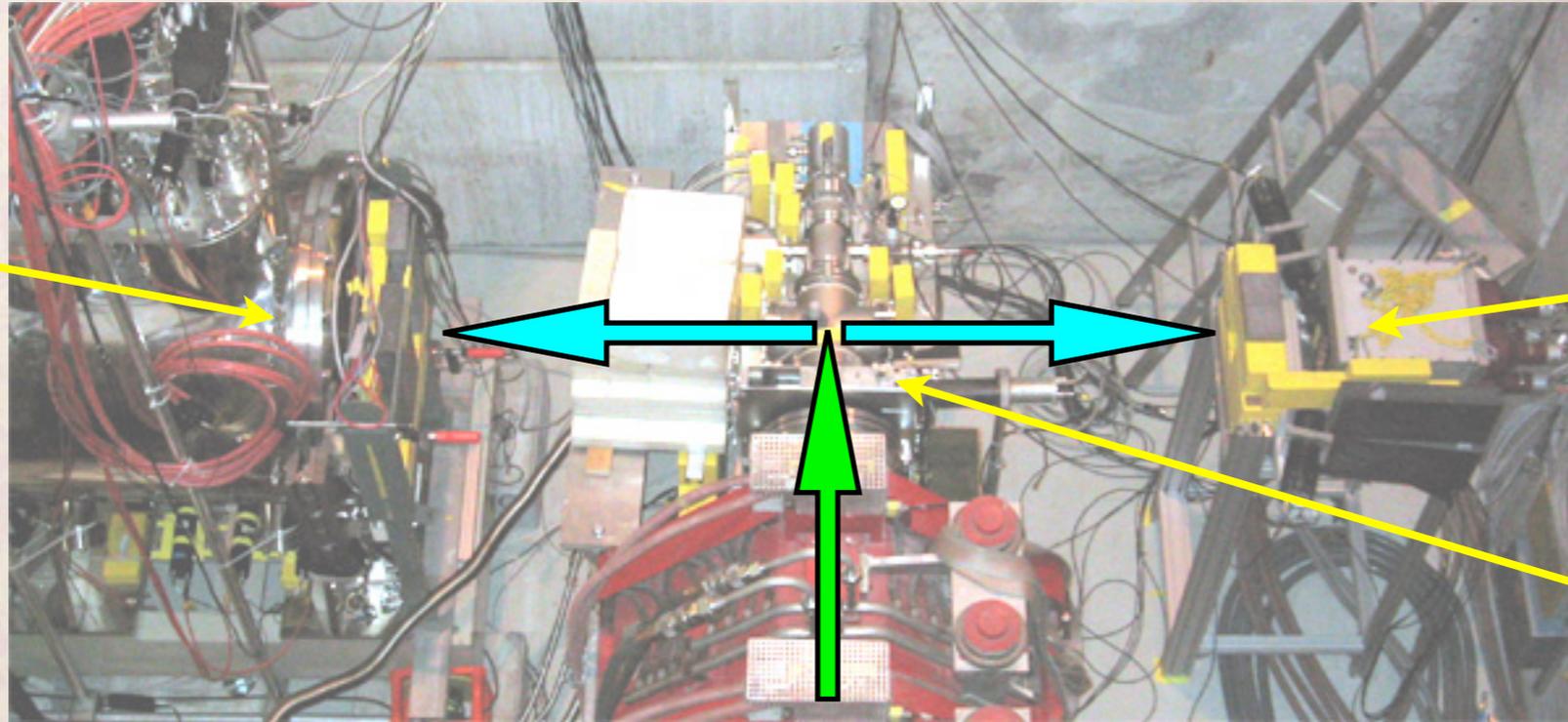
π^- beam test was performed to estimate resolution in signal and higher energy region. (55 MeV and 83 MeV)

Updates and comparison of π^- beam test in 2003 and 2004.

- π^- beam test
- Updates from previous beam test
- Analysis
 - Energy resolution
 - Time resolution
- Summary

π beam test

LXe detector



NaI+LYSO

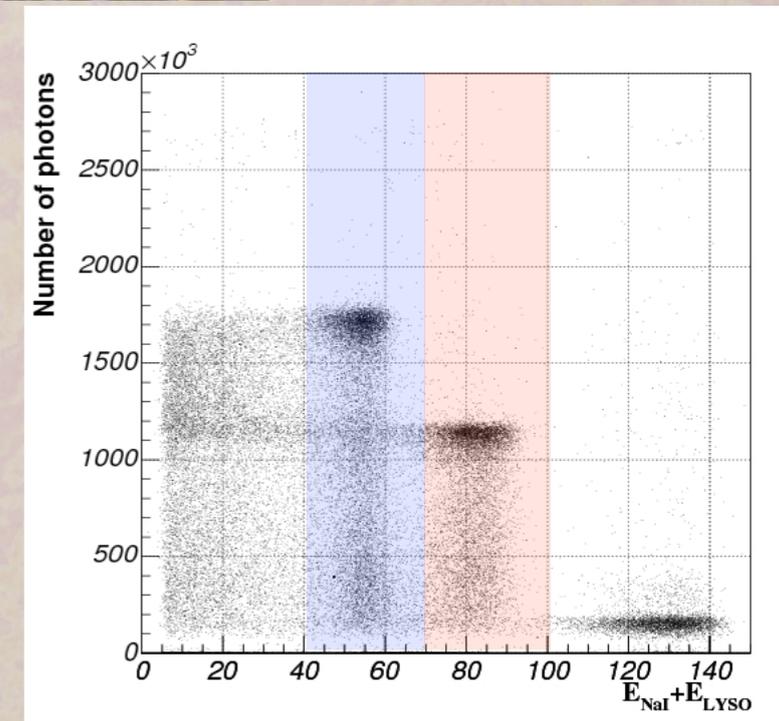
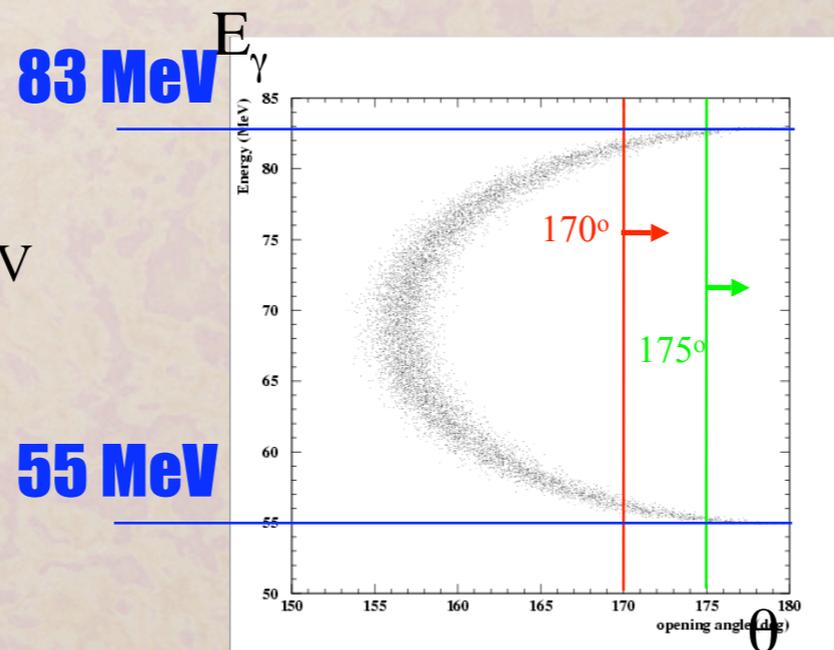
LH2 target

$\pi p \rightarrow \pi^0 n$

$\pi^0(28\text{MeV}/c) \rightarrow \gamma\gamma$

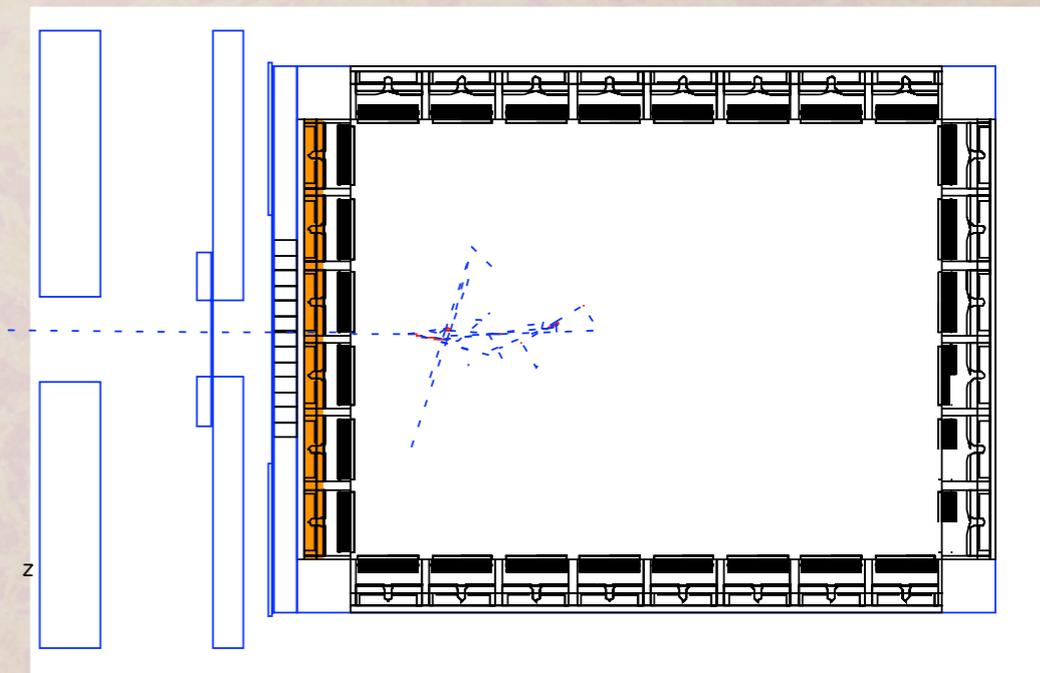
$54.9\text{ MeV} < E(\gamma) < 82.9\text{ MeV}$

- Requiring $\theta > 170^\circ$
FWHM = 1.3 MeV
- Requiring $\theta > 175^\circ$
FWHM = 0.3 MeV



Updates from previous test

- Result of beam test 2003
- Energy **1.6 %** (right σ)
- Time **102 psec**
- Updates from previous beam test
- Improvement of PMT
- Newly installed calibration source
- Filled space in beam window to reduce inefficiency.
- High power refrigerator (189W@165K) \longrightarrow
- Waveform digitizer \longrightarrow
- New analysis softwares (ROME)



24aWJ T, Haruyama

24aWJ Y, Uchiyama

Improvement of PMT



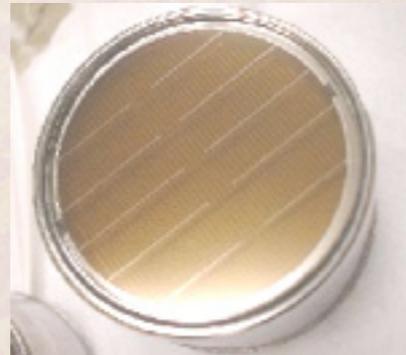
1st generation R6041Q



Rb-Cs-Sb
Mn layer
QE~4-6%
reduction of output
in very high BG



2nd generation R9288TB



K-Cs-Sb
Al strip
Higher QE ~15-17%
Still slight reduction
of output in very
high BG



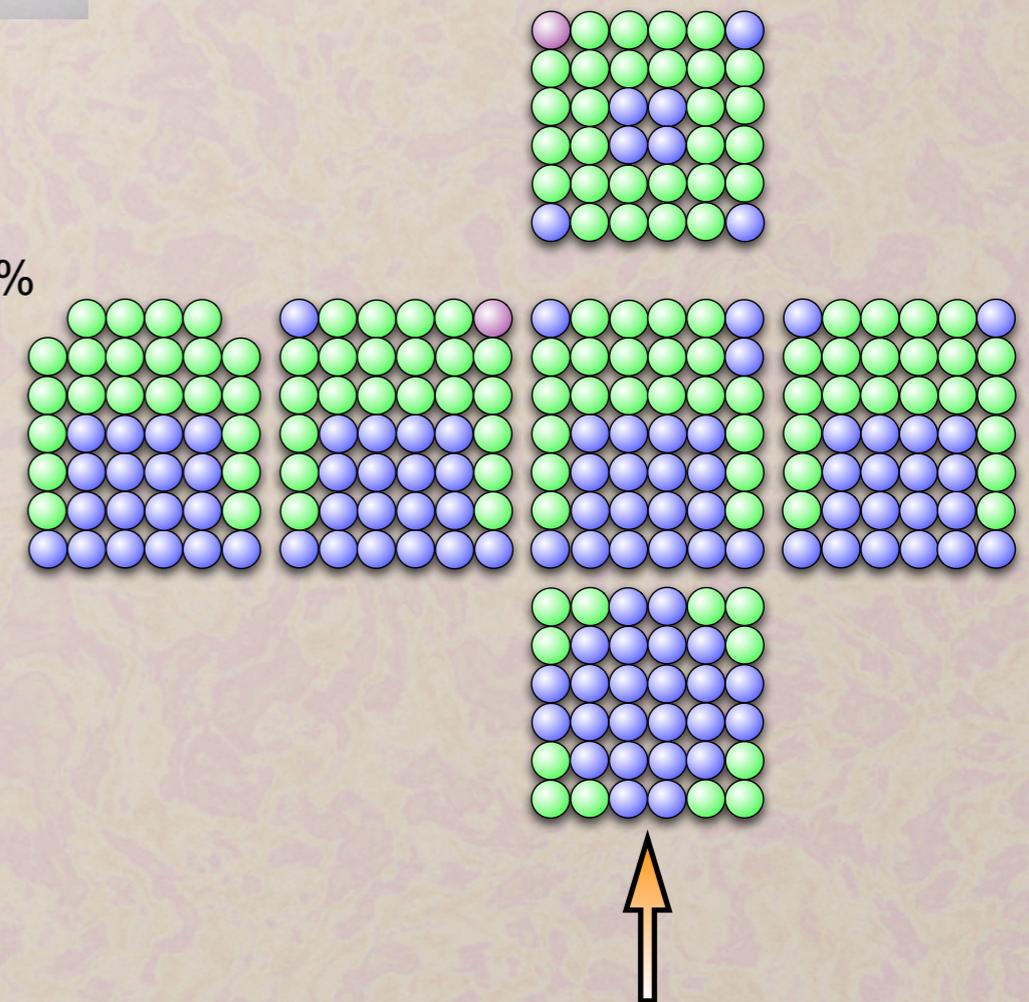
3rd generation R9288ZA



K-Cs-Sb
Al strip density is
doubled.
Higher QE~15-17%
Much better
performance in
very high BG

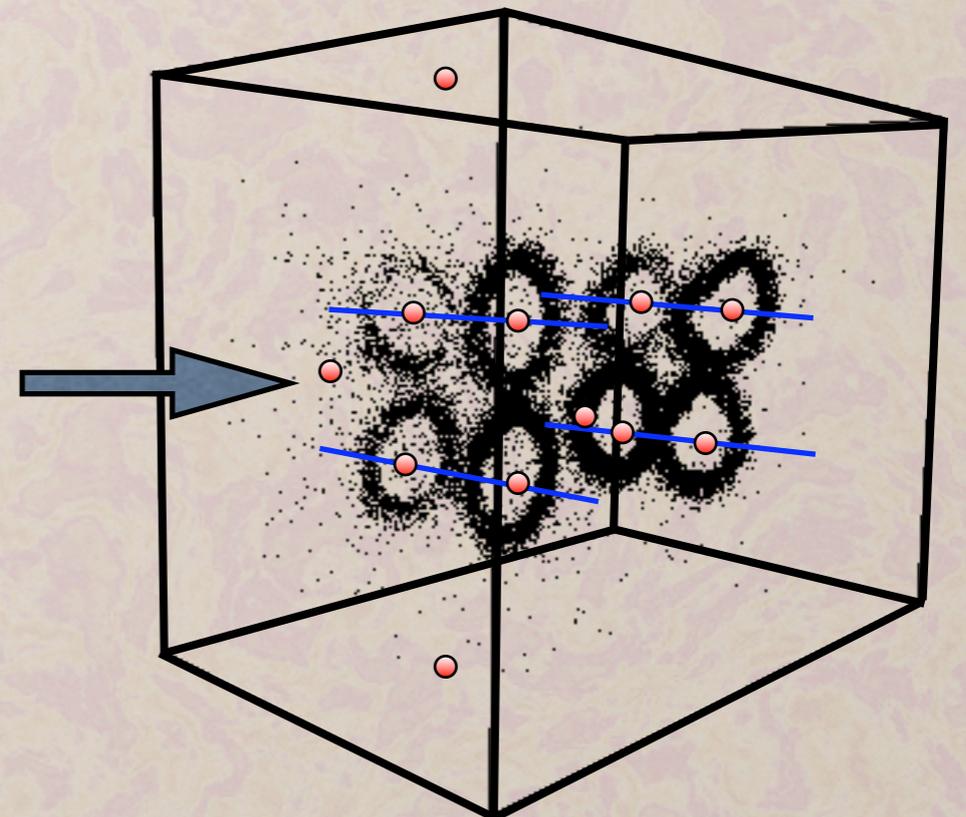
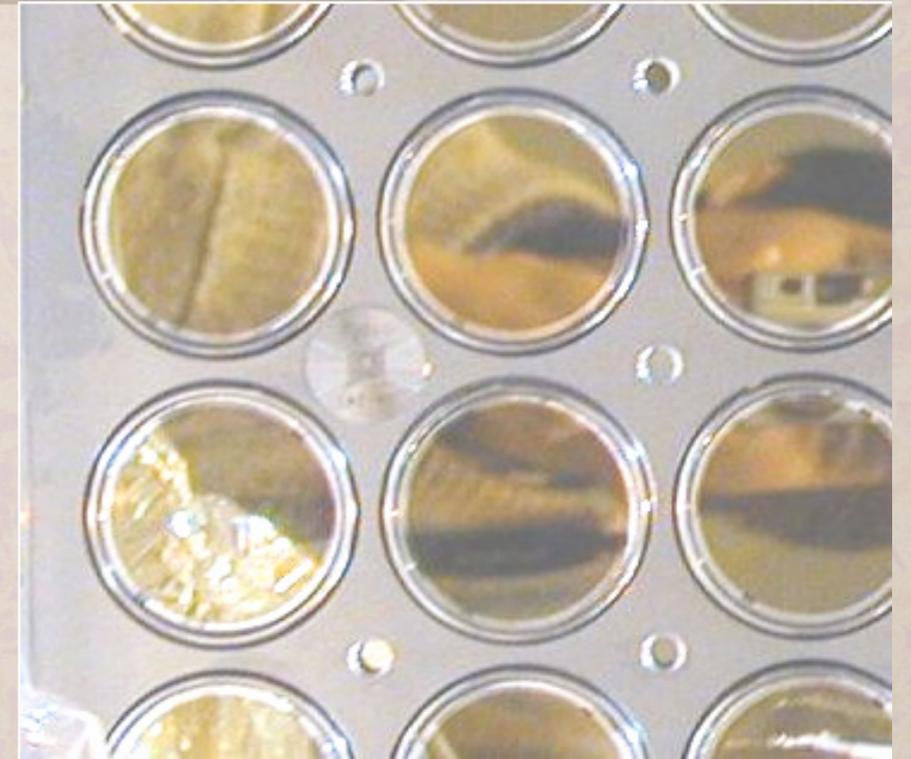


24pWJ H,Natori's talk

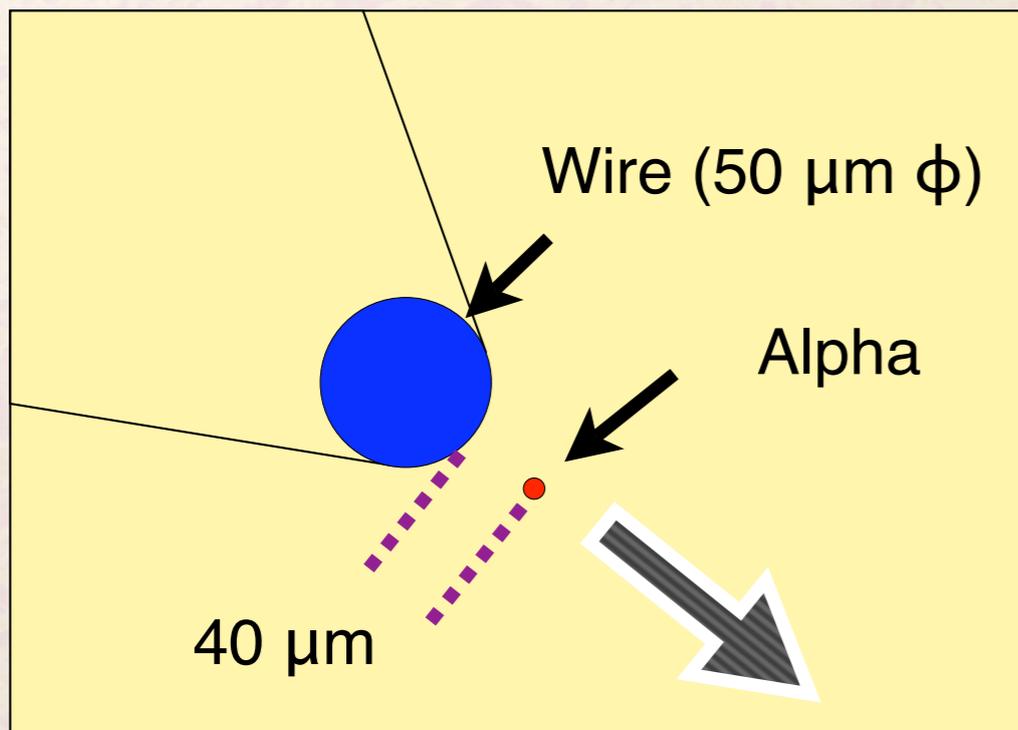


Newly installed α source

- 4 tungsten wires plated with Au (50 micron ϕ)
- Po attached on the wires, 2 active points per wire
- Active points are coated with Au (200-400Å)
- Fixed on the wall with spring.

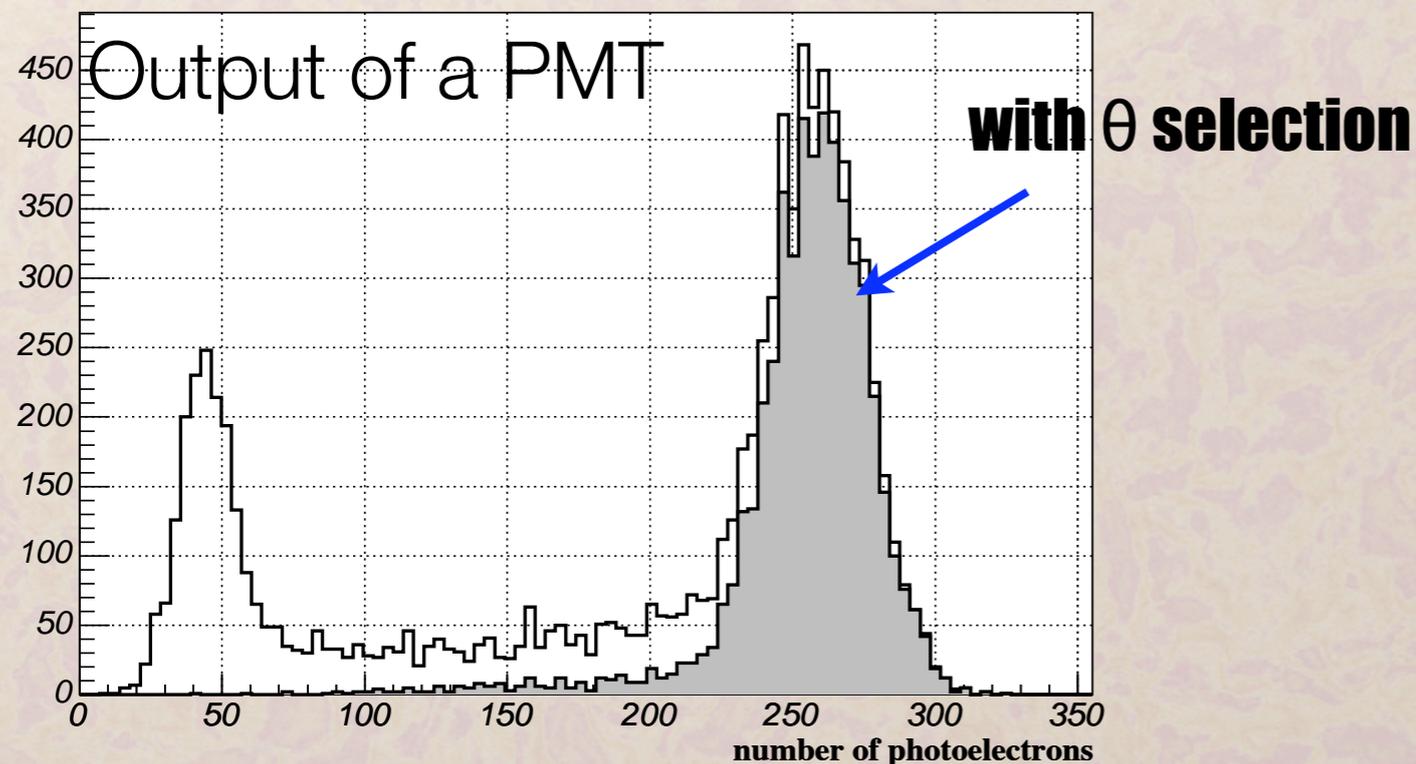


Analysis of alpha

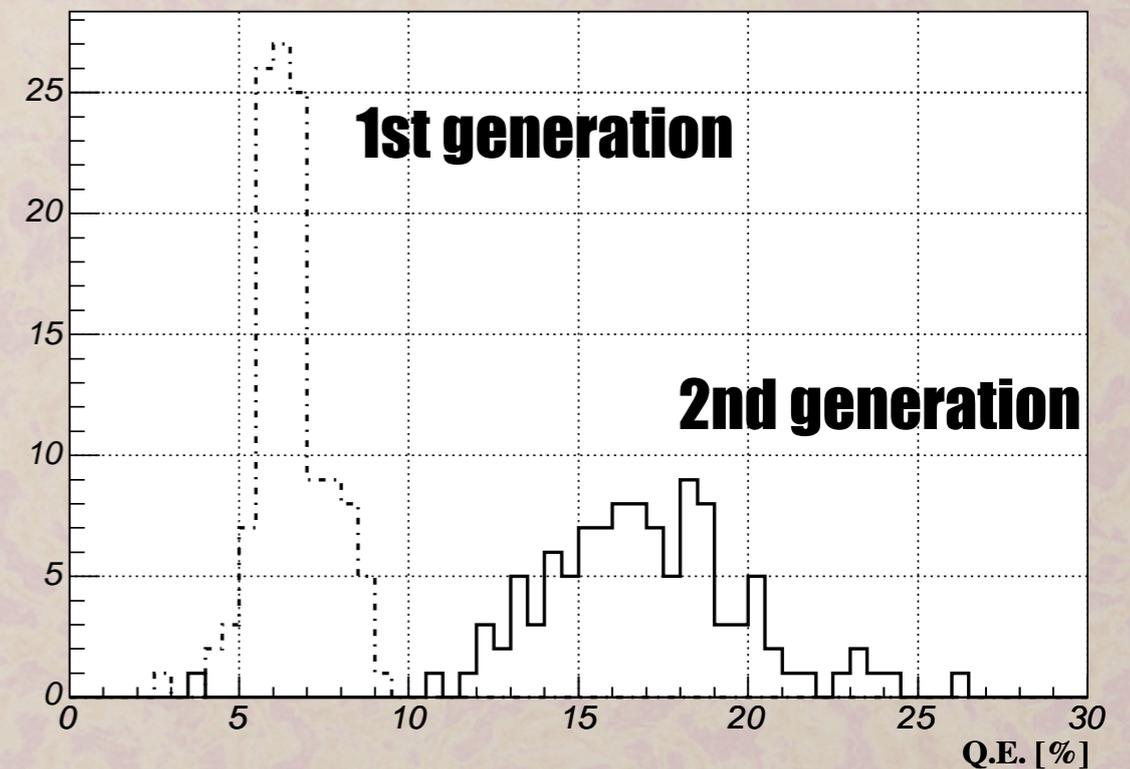


Alpha source are used for

- Q.E. estimation
- purity monitor
- optimization of MC

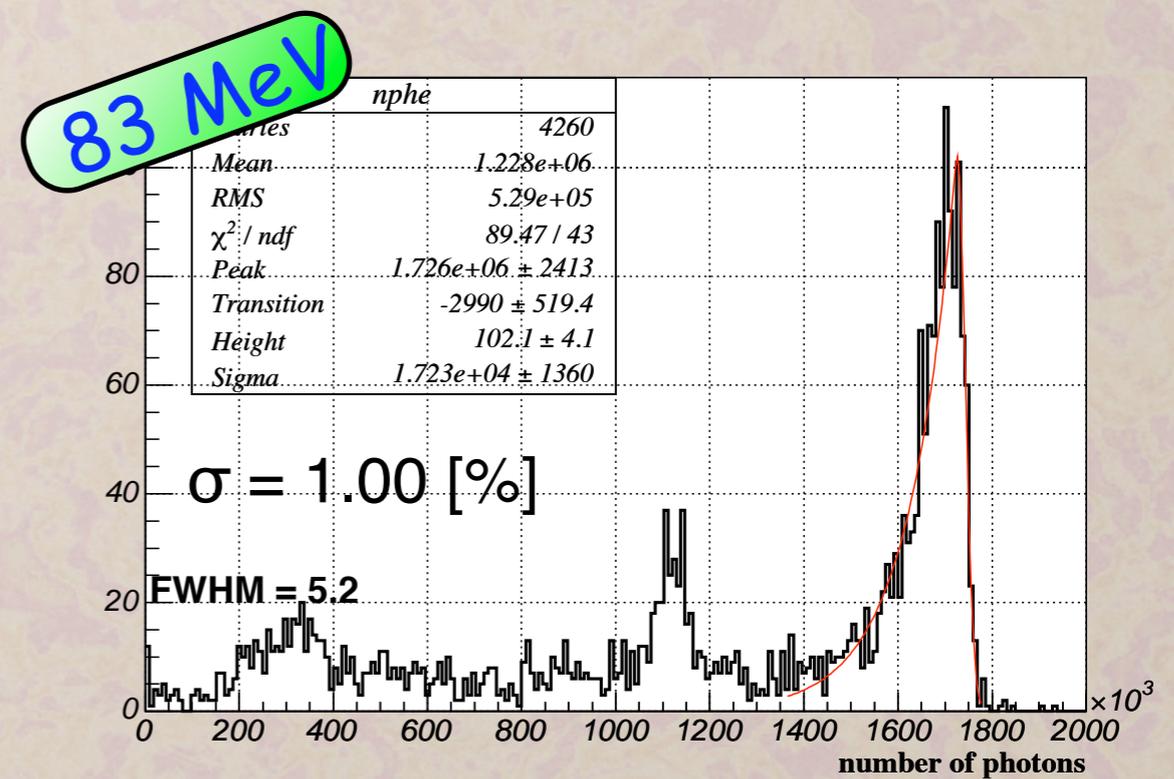
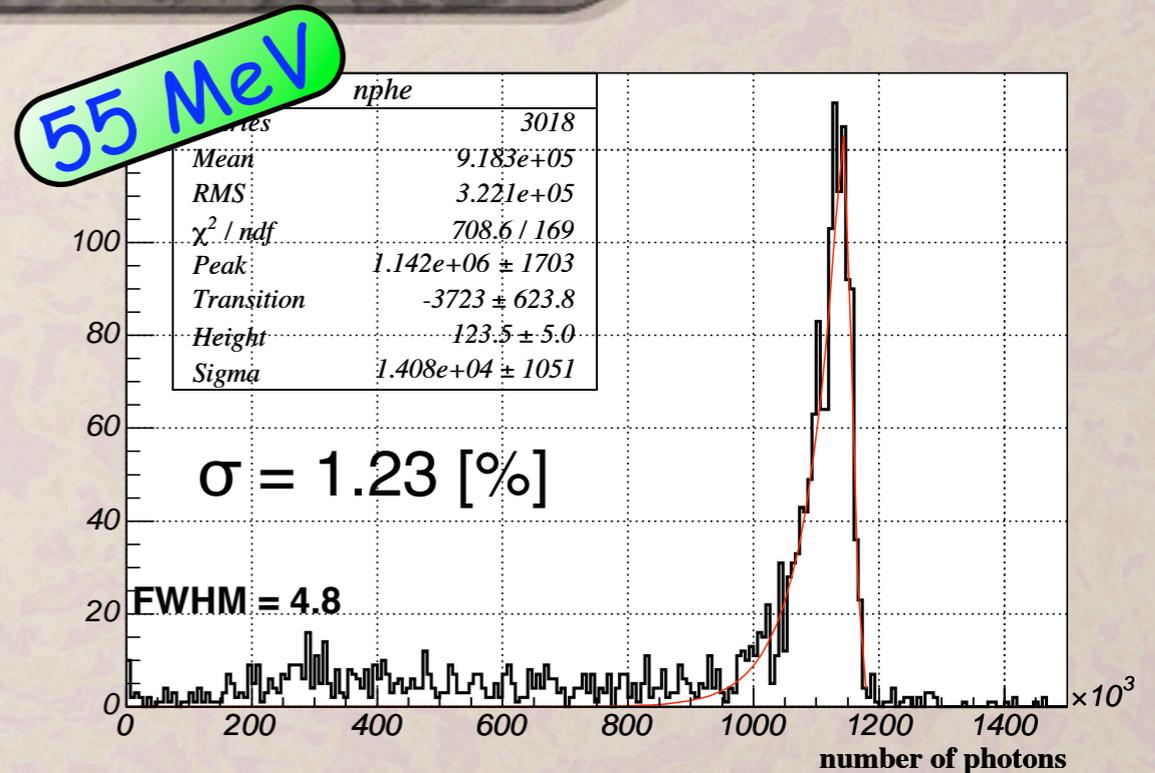
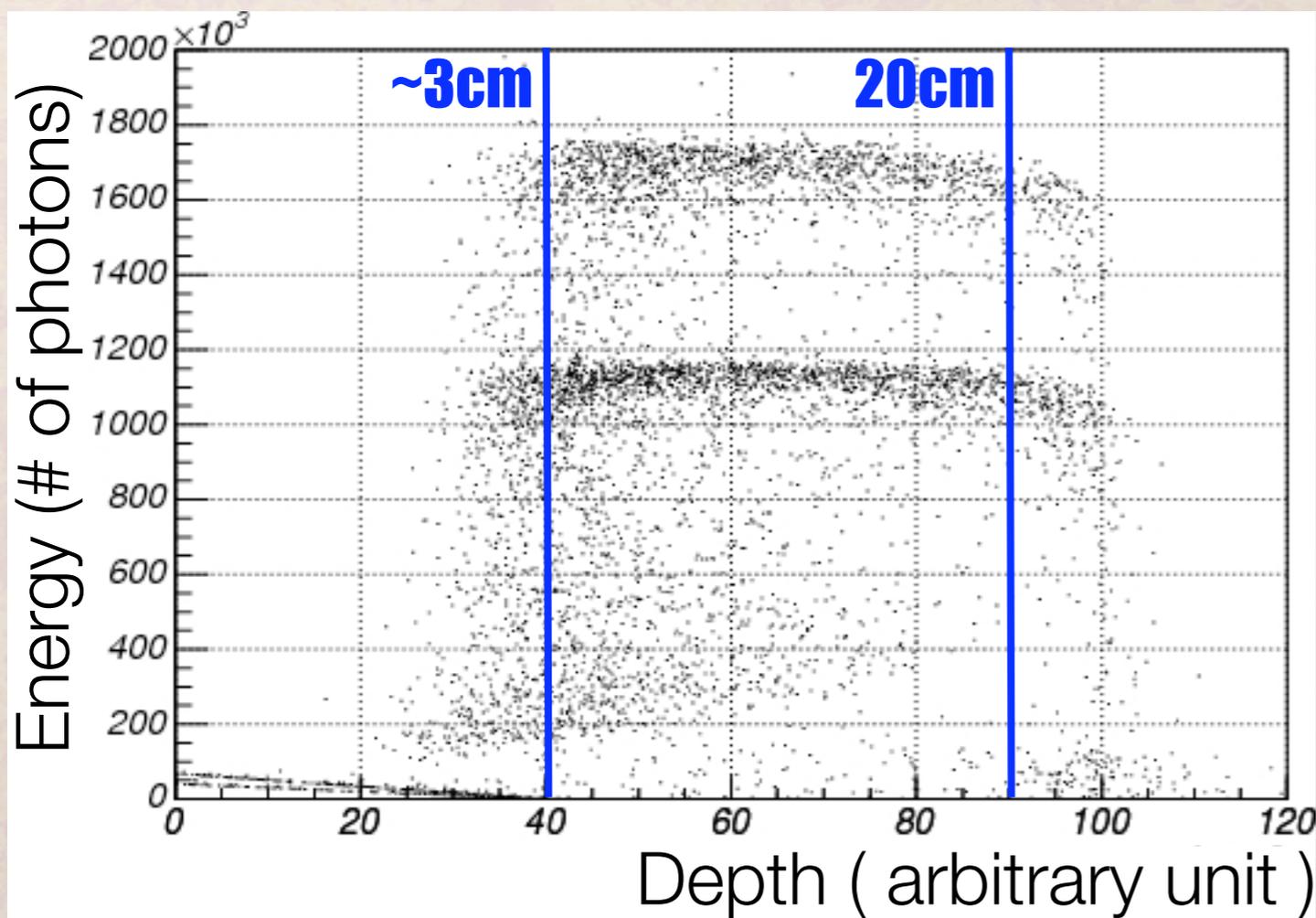


Q.E. of PMTs



Energy Resolution

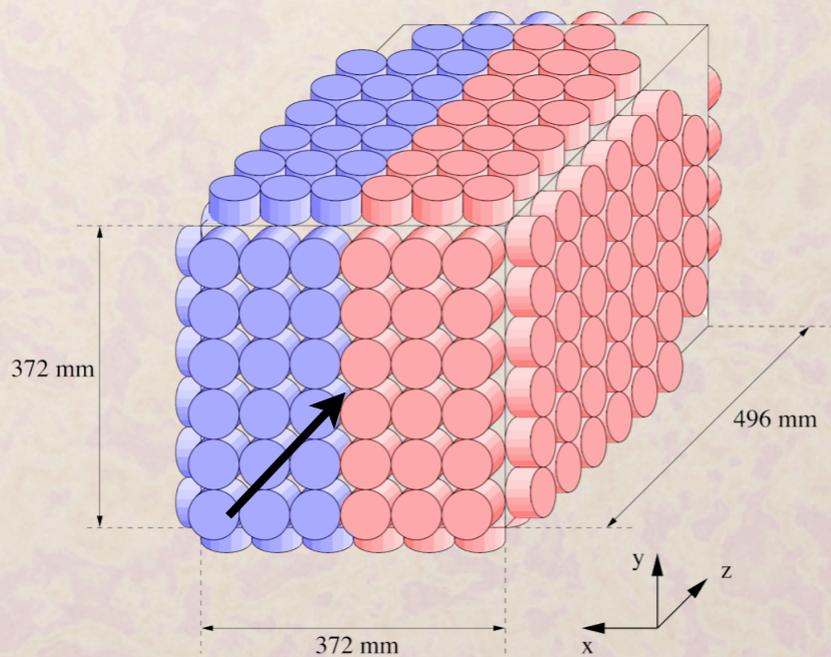
- Sum of photons taking into account Q.E.
- Depth selection. (22%)
- Depth dependence correction.



Intrinsic Time Resolution

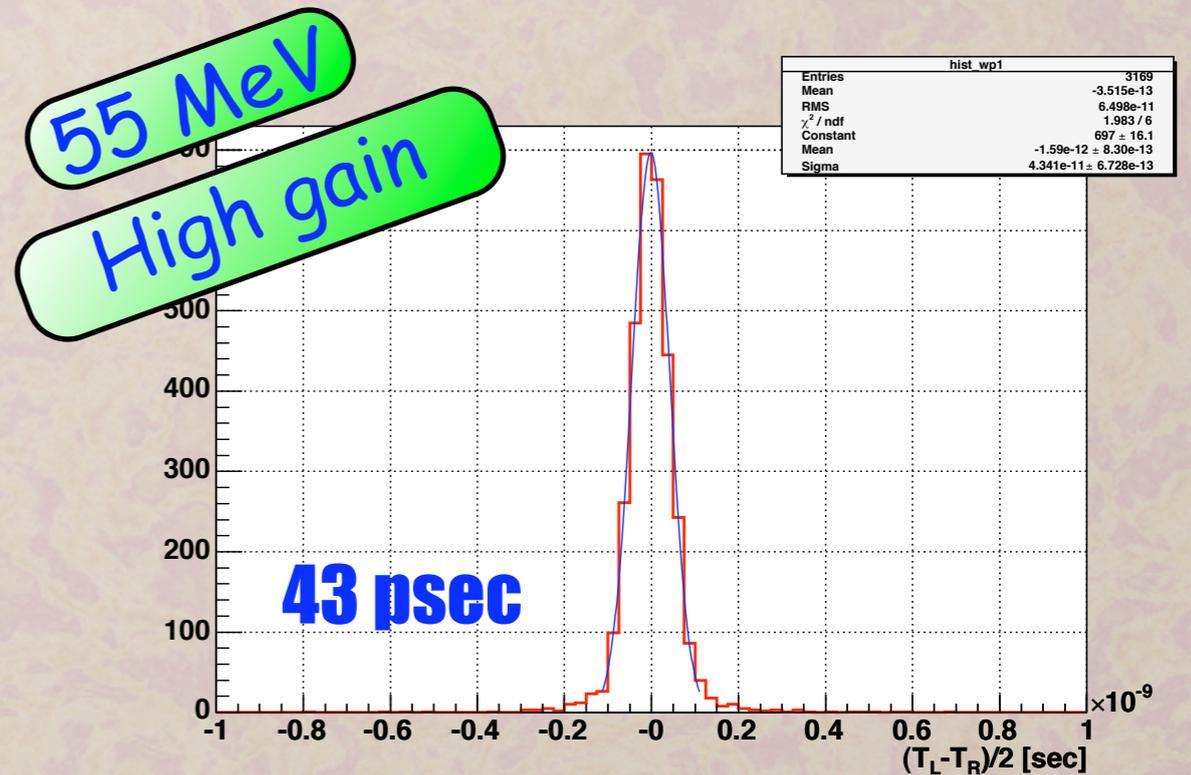
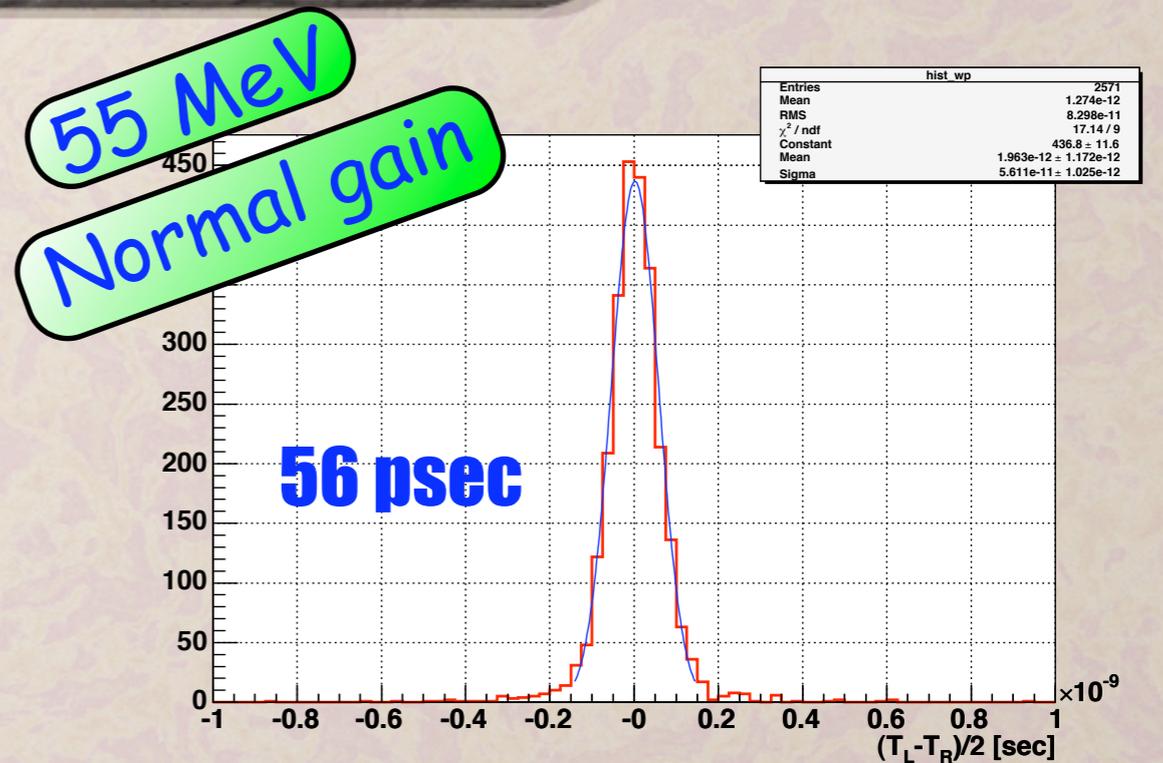
$$\Delta(T_R - T_L)/2$$

L-R Analysis to get rid of affection from conversion depth reconstruction.



Gain

	normal	high
1G PMT	0.5 E-6	1.0 E-6
2G PMT	1.0 E-6	5.0 E-6



Absolute Time Resolution

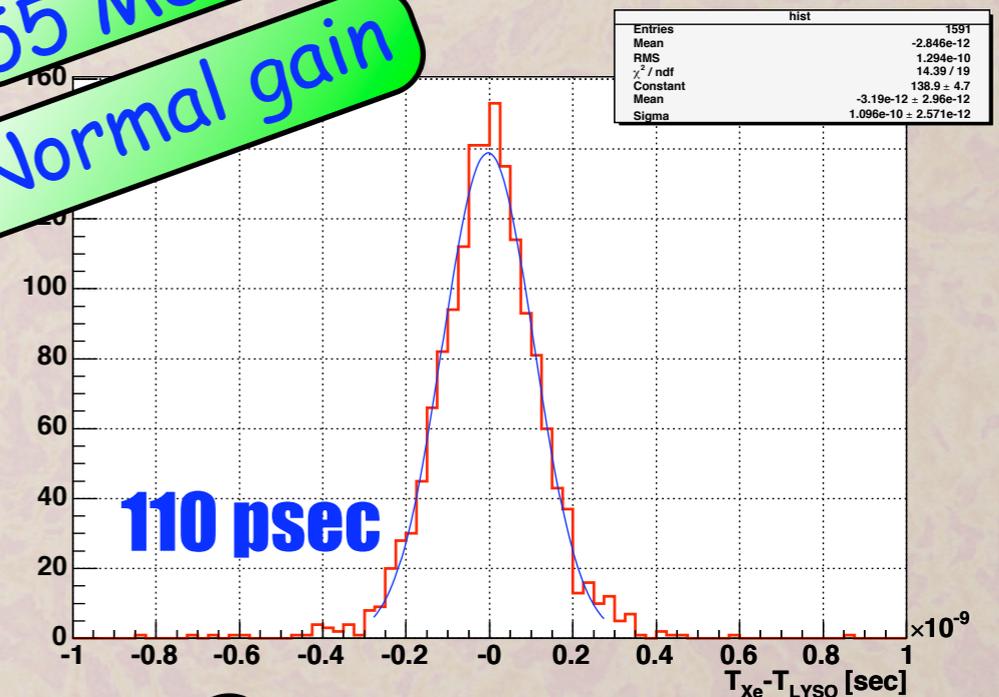
$$\Delta(T_{xenon} - T_{LYSO})$$

$\sigma_t(\text{Xe-LYSO})$ contains

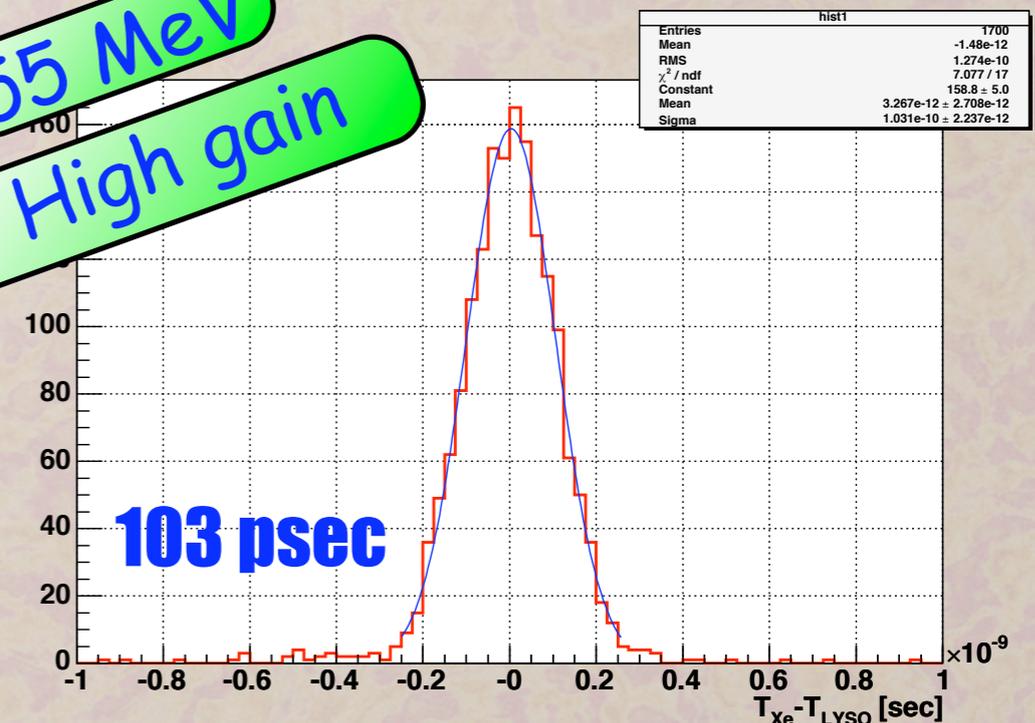
- resolution of LYSO > 61psec
- effect from beam spot and target size. 60psec



55 MeV
Normal gain



55 MeV
High gain



Practical Time Resolution

Normal gain

LYSO target

$$110 \ominus 64 \ominus 61 = 65$$

Intrinsic depth
 $= 56 \oplus 33$ psec

Practical timing resolution of Xe



High gain

$$103 \ominus 64 \ominus 61 = 53$$

$$= 43 \oplus 31$$
 psec

Comparison 2003&2004

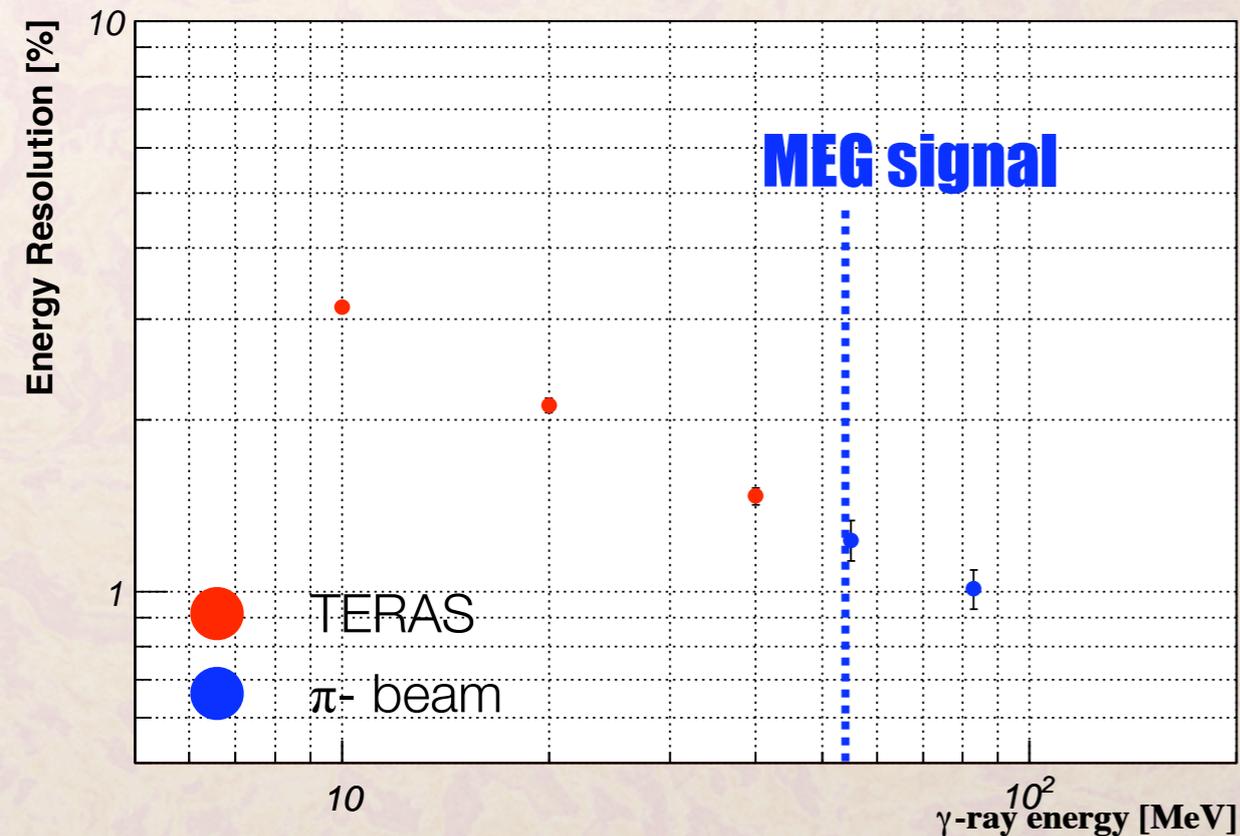
		2003	2004
Energy resolution [%]	55 MeV	1.6	1.2
	83 MeV	1.2	1.0
Time resolution [psec]	55 MeV (normal gain)		< 65
	55 MeV (high gain)	102	<53

Summary of π beam test

- Many updates from previous test
- PMT, calibration source, refrigerator, reduction of material, waveform, software ...
- Energy resolution for 55 MeV gamma rays were improved from 1.6% to 1.2%.
- Time resolution for 55 MeV gamma rays were improved from ~100 psec to ~50 psec.

Summary of prototype tests

Prototype test is completed.



Energy	1.3 %
Time	60 psec
Position	4 mm

- Energy&position resolution for 10,20,40 MeV gammas @ TERAS
- Energy&time resolution for 55,83 MeV gammas @ π^- beam test
- Liquefaction and keep LXe only with refrigerator
- Attenuation length measurement and purification technique (pre-print physics/0407033)
- PMT development and test
- Calibration and reconstruction algorithms
- High speed purification with liquid pump (<100 l/hrs).

Final detector is under construction.

Liquid phase purification

Liquid phase (high speed) purification was successfully done.

