MEG Run2008
測定器の較正

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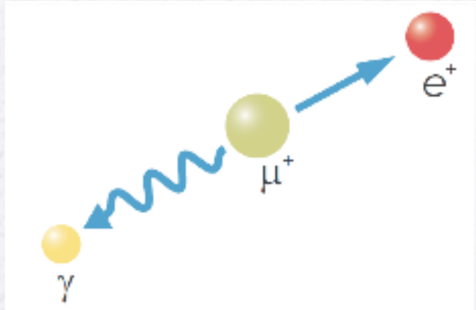
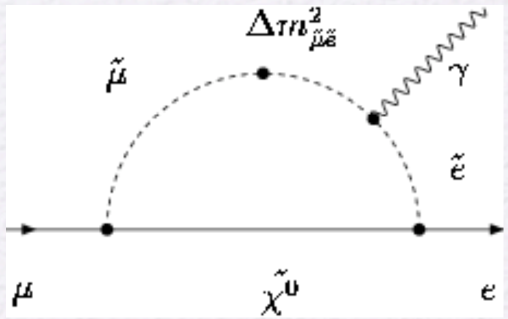
Contents

- Introduction
- 2008 run
- Liquid Xenon γ-ray Detector
  - -calibration
  - -light yield
  - -stability

MEG Experiment



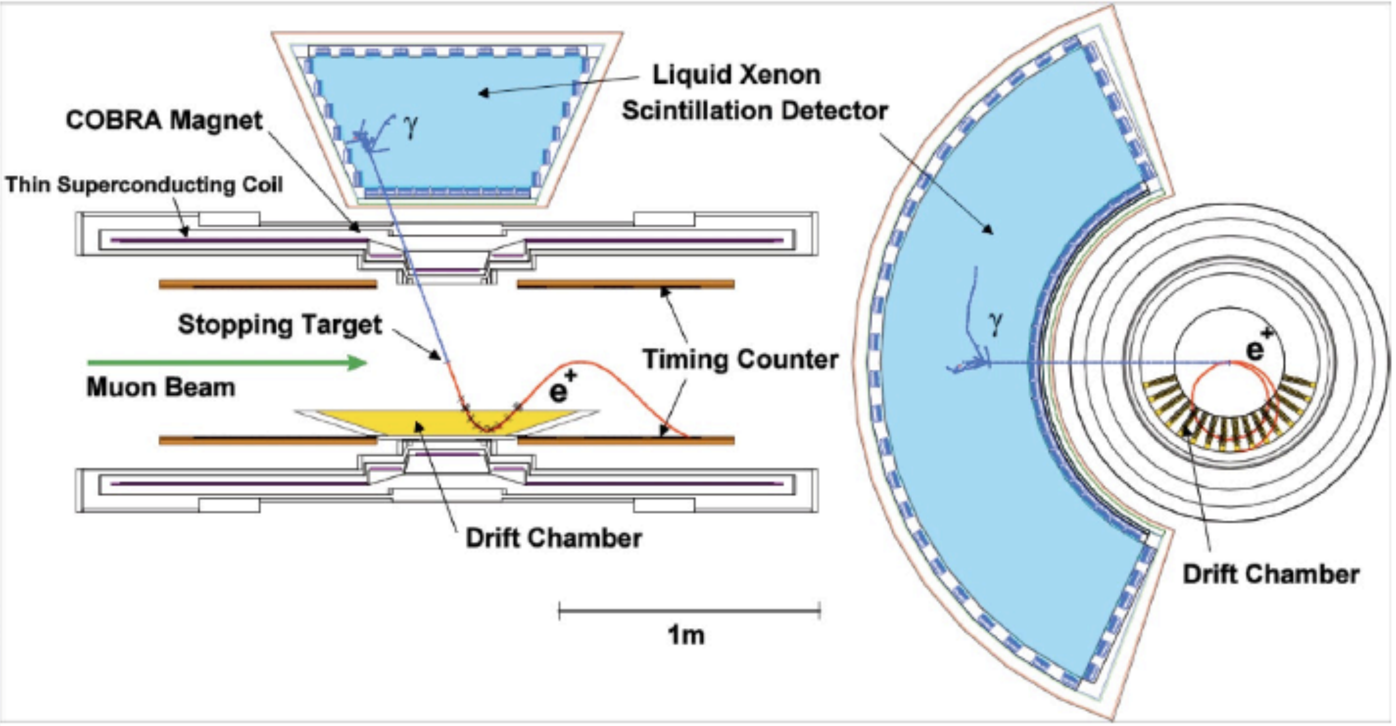
- Lepton flavor violation is forbidden in the standard model (SM)
- Physics beyond the SM predict observable B.R. (10^{-15} – 10^{-13})
- Current limit is given by MEGA(1999) (B.R. ~ 1.2 × 10^{-11})
- Backgrounds
  - Prompt : Michel decay with high energy e+ and γ.
  - Accidental : High energy e+ and γ (radiative muon decay, AIF…)
- Precise energy, time and opening angle measurement is important.
- Approved in 1999 at PSI in Switzerland
- Japan, Italy, Switzerland, Russia, and USA, ~ 65 collaborators
- Explore Br(μ→eγ) ~ 10^{-13}



MEG Detector

The most intense DC muon beam at PSI in Switzerland. (1.8 mA proton current)

COBRA magnet with gradient field



Liquid xenon gamma ray detector

Plastic scintillator to measure precise time of positron

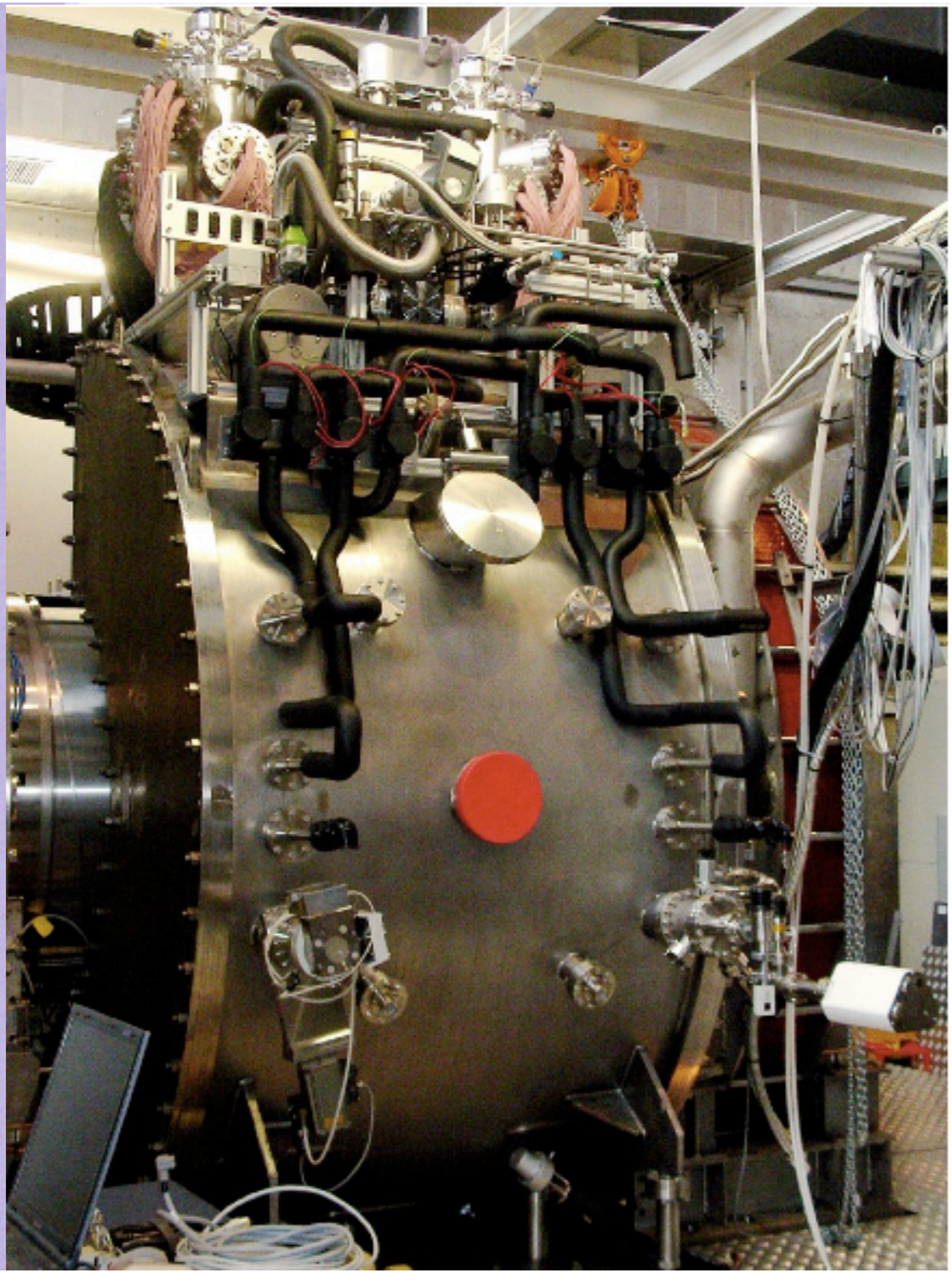
Very thin drift chamber to measure low energy positrons

2008 run

What we have been doing so far…

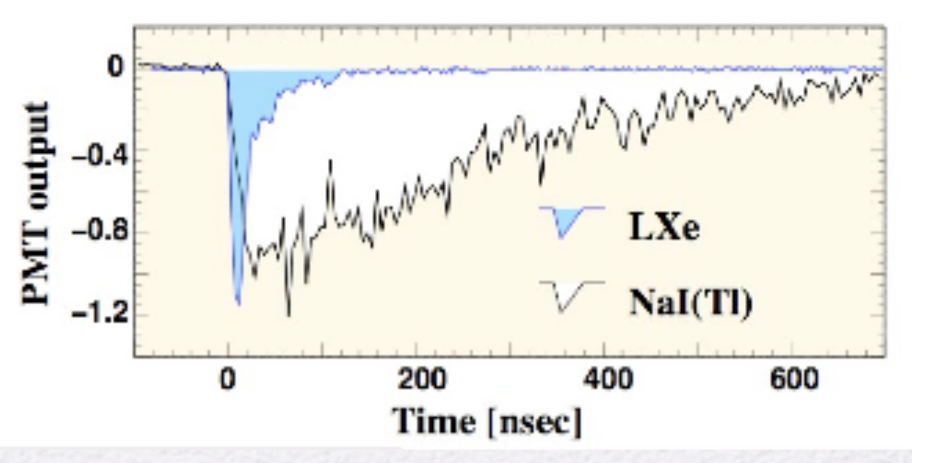
- Maintenance work
- Detector installation
- Evacuation, cooling, LXe transportation
- Purification
- Stability check
- Michel run → 西口創　MEG Run2008 陽電子スペクトロメータ
- π^0 run → 西村康宏　MEG Run2008 液体キセノンガンマ線検出器
- Trigger setting
- Background measurement → 内山雄祐　MEG Run2008　バックグラウンド
- MEG run

Liquid Xenon
γ-ray Detector



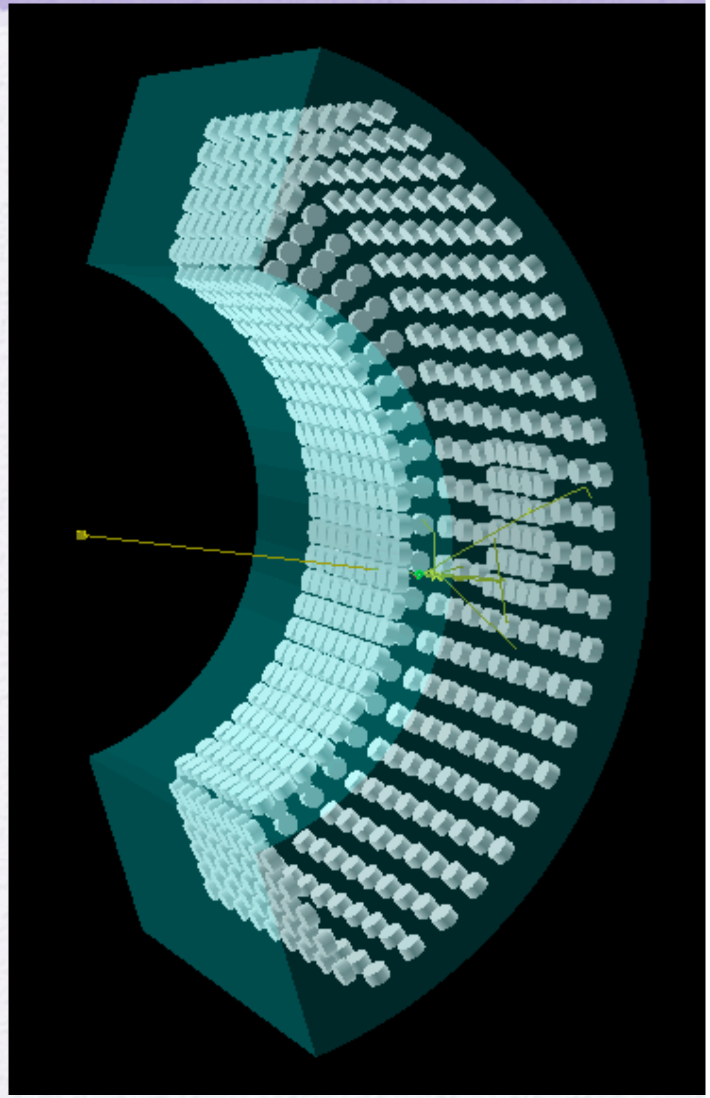
Liquid Xenon

- High light yield (75% of NaI(Tl))
- Fast response (t=45ns)
- Short radiation length (X 0=2.77cm)
- Homogeneous
- No self-absorption of scintillation light
- Challenge
  - – Low temperature (165K)
  - – VUV light
  - – Require high purity (Resolution strongly depend on absorption length) ➡ Purification system : H_2O and O_2 contamination removal



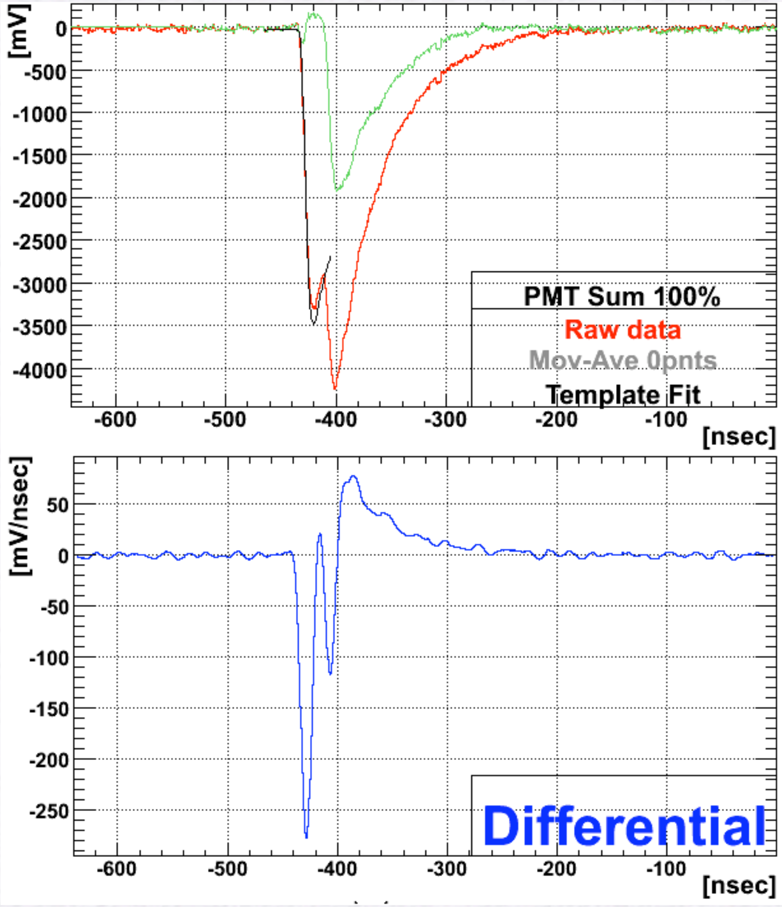
Detector Concept

- Scintillation light from liquid Xenon
  - Use scintillation process only
  - High light yield, fast signal
  - Uniform over large volume
- ~3 ton (880 liters) liquid Xenon with 846 PMTs
  - Unsegmented
- Measure energy, position, timing at the same time
- Identify pileup events by light pattern, time distribution, and waveform.



Measurement Principle

- Energy
  - Sum of all PMT output charge
- Timing
  - Weighted mean of PMT time
- Position
  - Light distribution
    - Peak : position
    - Broadness : depth



Pileup Identification

- Pileup events become dominant background source as increasing beam intensity
- The detector can identify pileup events by
  - Pattern of the light distribution
  - Time difference of every PMT
  - Waveform recorded from all PMTs

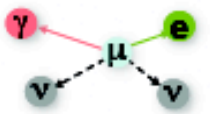
Major improvements over last year

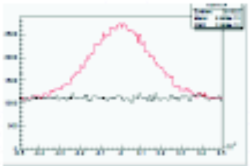
- Bad PMT channels fixed (down to 3 currently)
- HV feed-through prob. solved

Calibration and Monitoring : Various Ways

Xenon Calibration

μ radiative decay





Lower beam intensity < 10^7

Is necessary to reduce pile-ups

Better σ_t makes it possible to take data with higher beam intensity

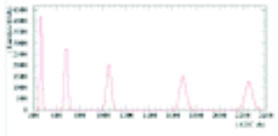
A few days ~ 1 week to get enough statistics

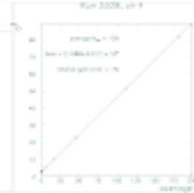
Laser

(rough) relative timing calib.

< 2~3 nsec

LED

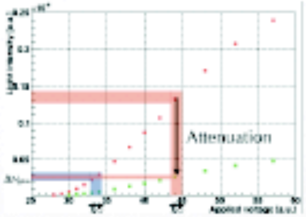




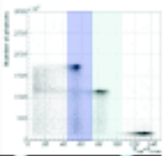
PMT Gain

Higher V with light att.

Can be repeated frequently



$\pi^0 \rightarrow \gamma\gamma$



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

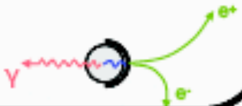
$\pi^0 \rightarrow \gamma\gamma$ (55MeV, 83MeV)

$\pi^- + p \rightarrow \gamma + n$ (129MeV)

10 days to scan all volume precisely

(faster scan possible with less points)

LH_2 target

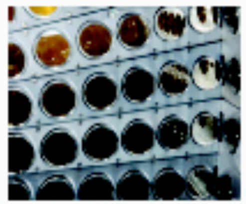


alpha

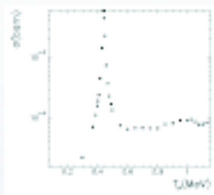
PMT QE & Att. L

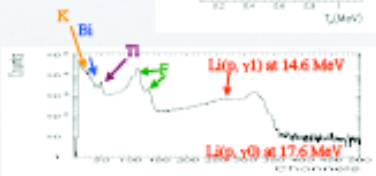
Cold GXe

LXe



Proton Acc





Li(p,γ)Be

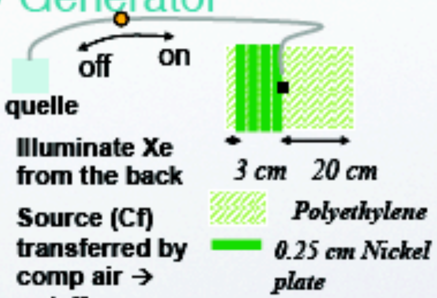
LiF target at COBRA center

17.6MeV γ

~daily calib.

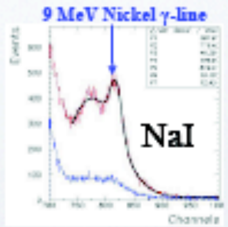
Can be used also for initial setup

Nickel γ Generator



Illuminate Xe from the back

Source (Cf) transferred by comp air → on/off



- PMT Calibration
  - Alpha-QE estimation, absorption length monitor
  - LED-PMT gain, time offset
- Monitoring
  - Cosmic Ray, alpha, LED, Cockcroft-Walton Accelerator
  - Ex. Light yield, gain stability

π^0 calibration

PMT Calibration

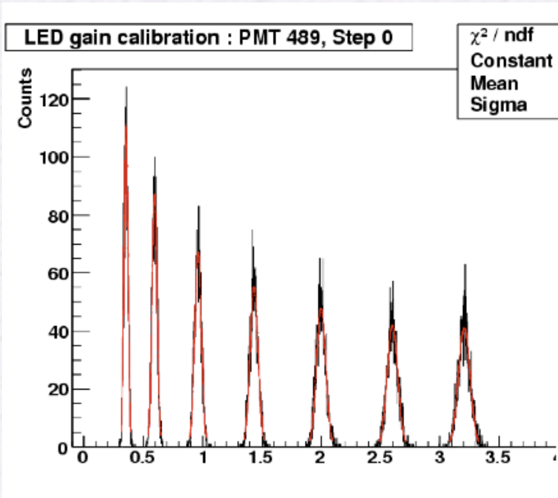
LED

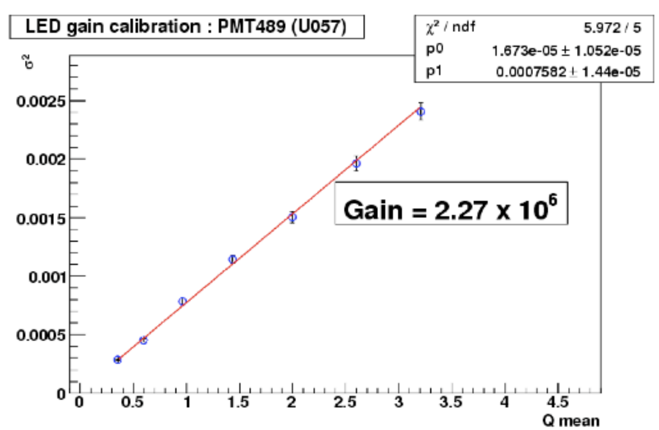
- Daily PMT gain calibration by multiple LEDs

$$I_{sig} = Gain \times e \times N_{p.e.} = M_{ADC} \times C$$

$$\sigma_{N_{p.e.}}^{2} = \overline{N}_{p.e.} \text{ (poisson)} \rightarrow \sigma_{ADC}^{2} = Gain \times \overline{M}_{ADC} \times e / C$$

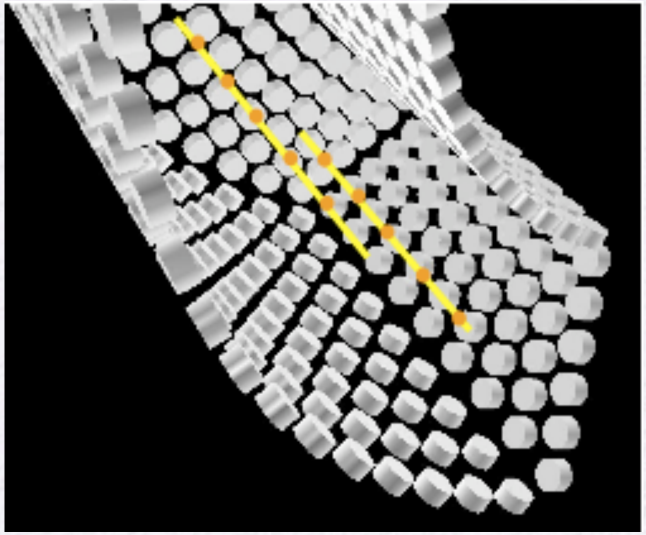
- Calculating gain from statistical fluctuation of detected number of photon electrons



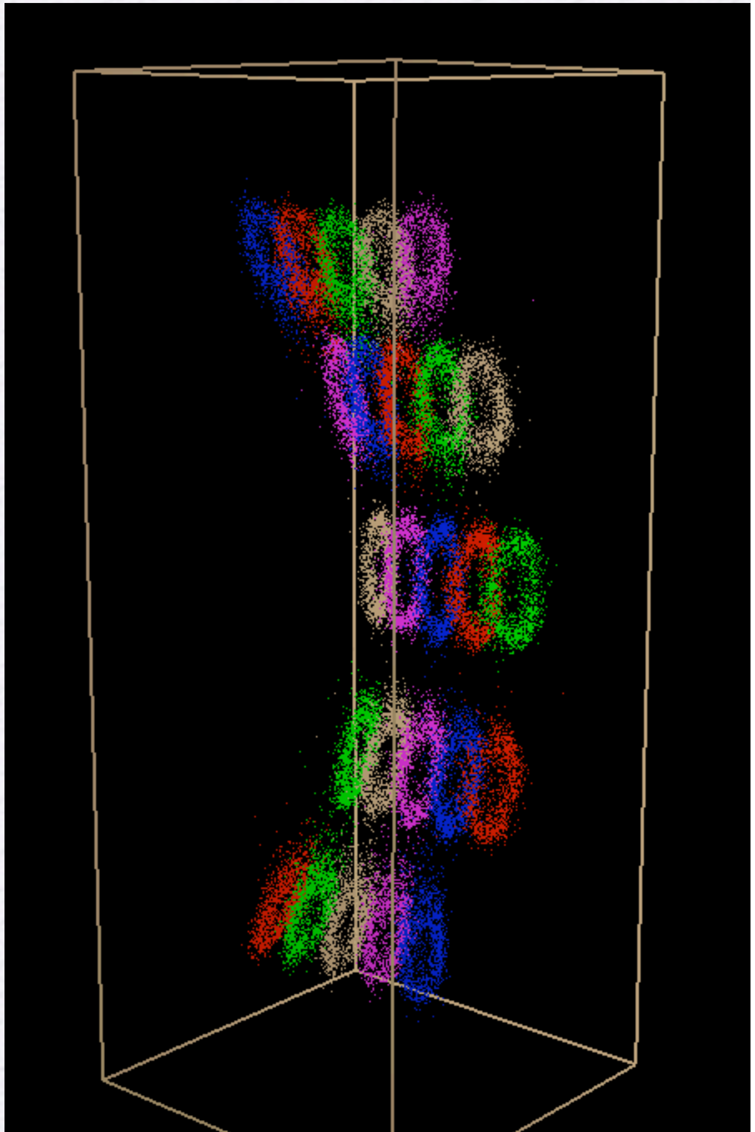


Alpha

- Q.E. measurement using alpha event in LXe
- Reliable light source
- Constant light emission
- Using scintillation light from LXe
  - Same spectrum
  - Can monitor and correct LXe status



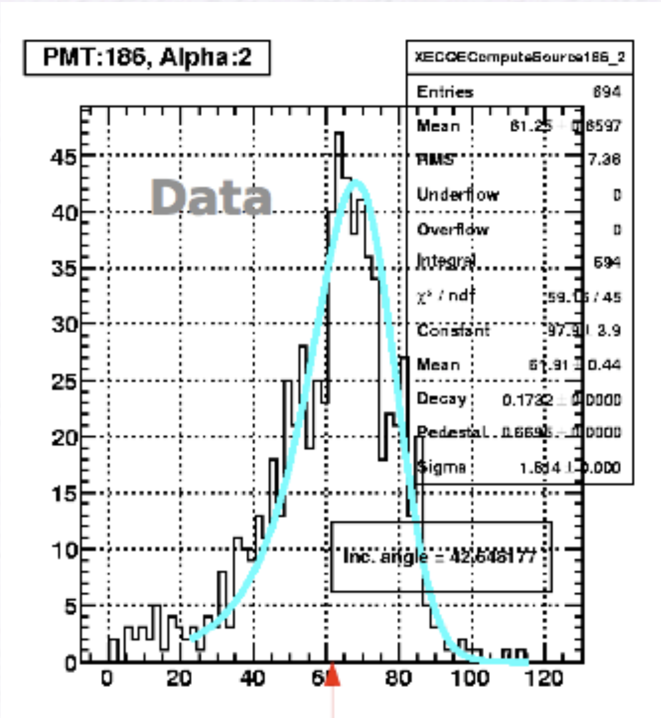
Am source on wire

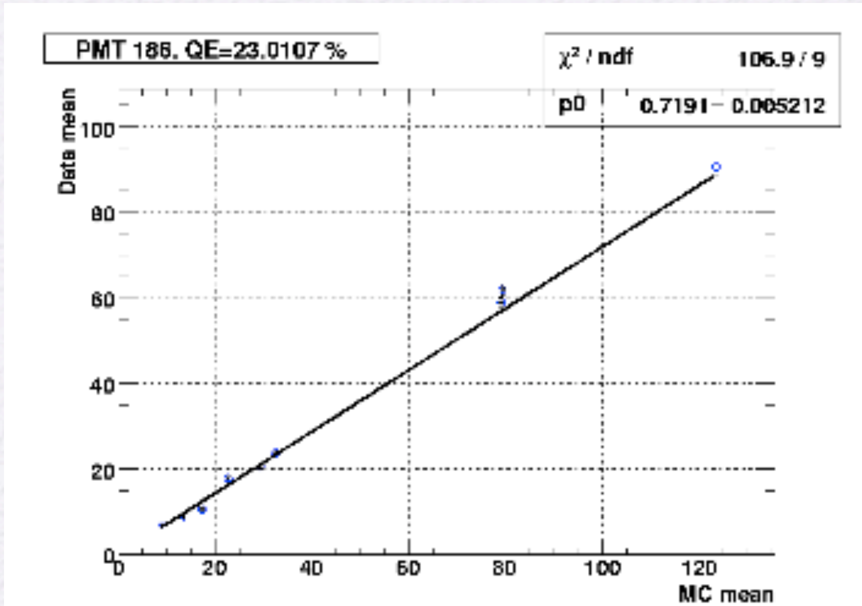


Reconstructed α event

How to calculate QE?

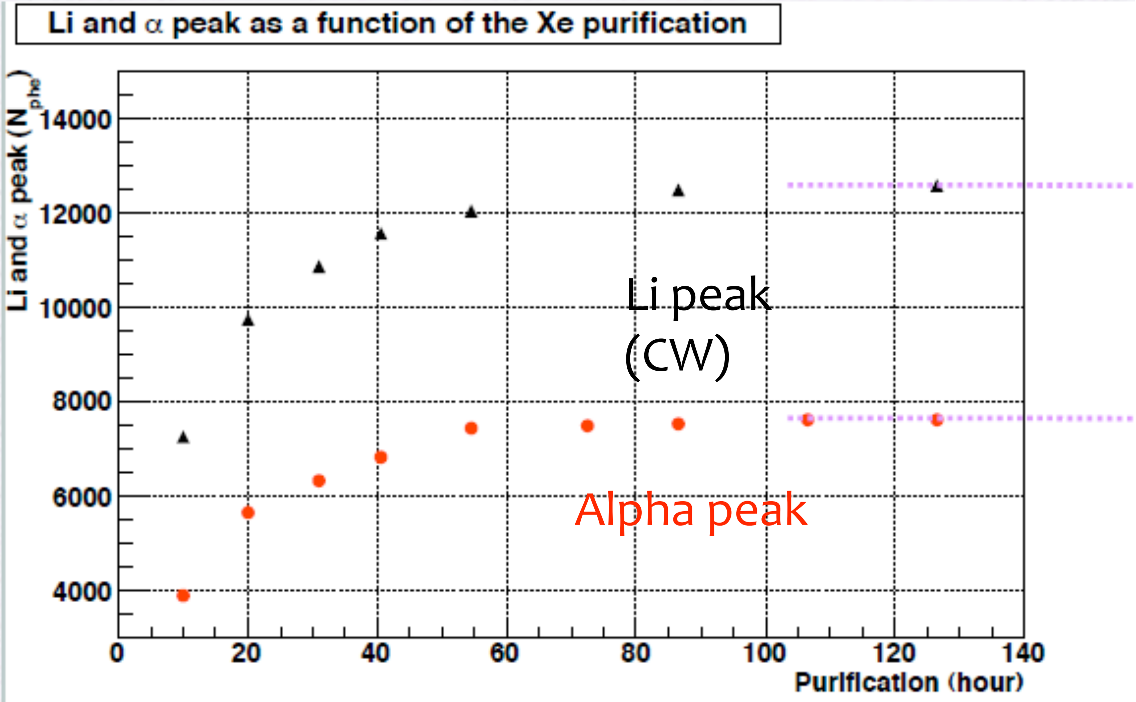
- Charge fitting -
- Using gain from LED
- Comparison b/w Data and MC
- Fitting with data from multiple alpha sources in different positions

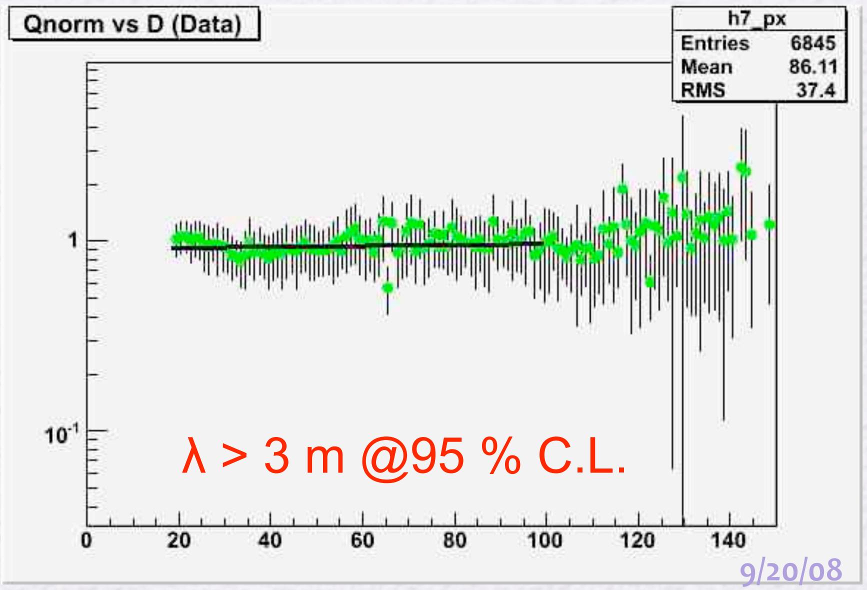




Light Yield

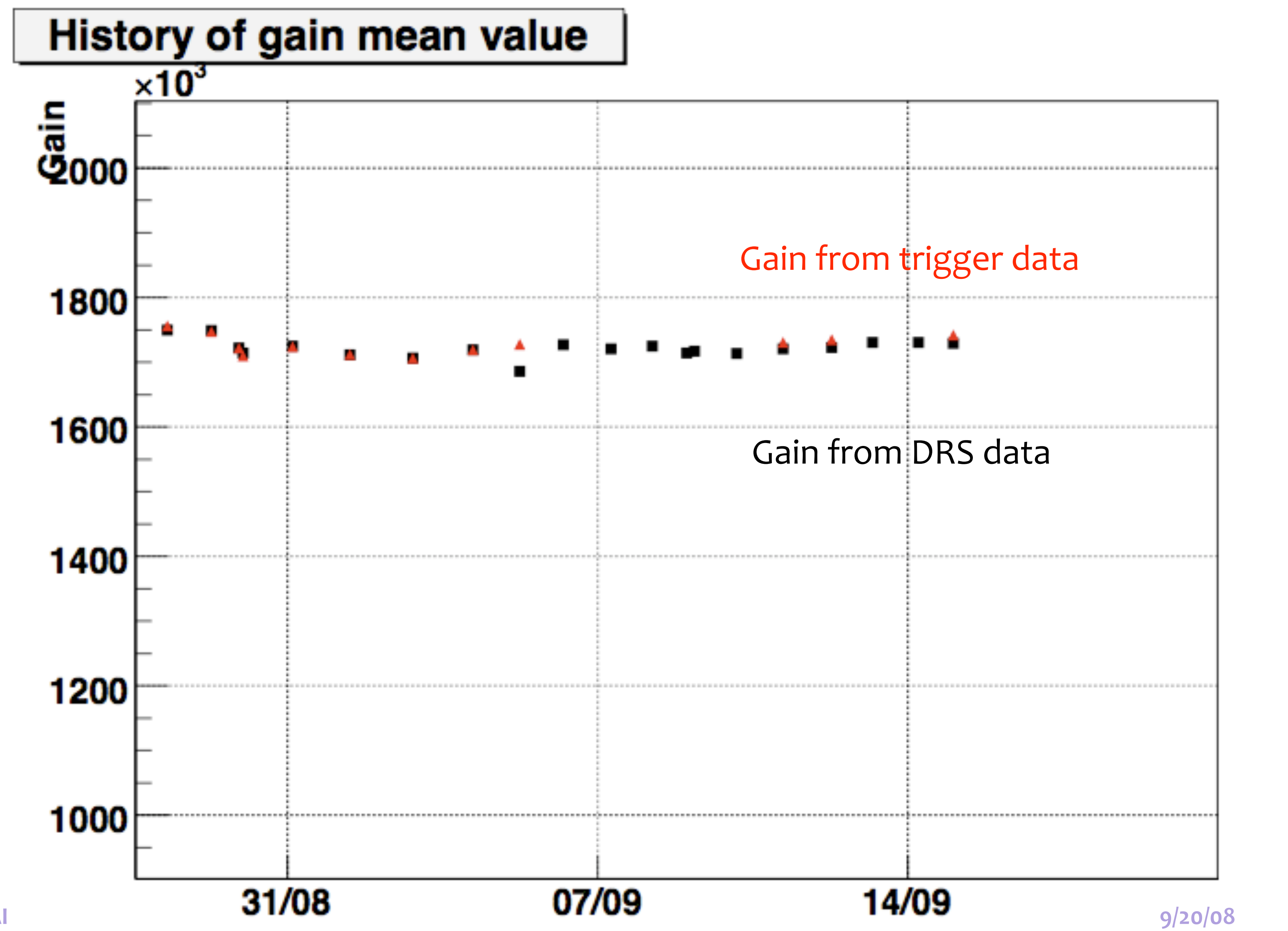
- Light yield increased by % compared to last year
- Due to new filter system that removes O_2
- Long absorption length also achieved after over 100 hours of liquid phase circulation





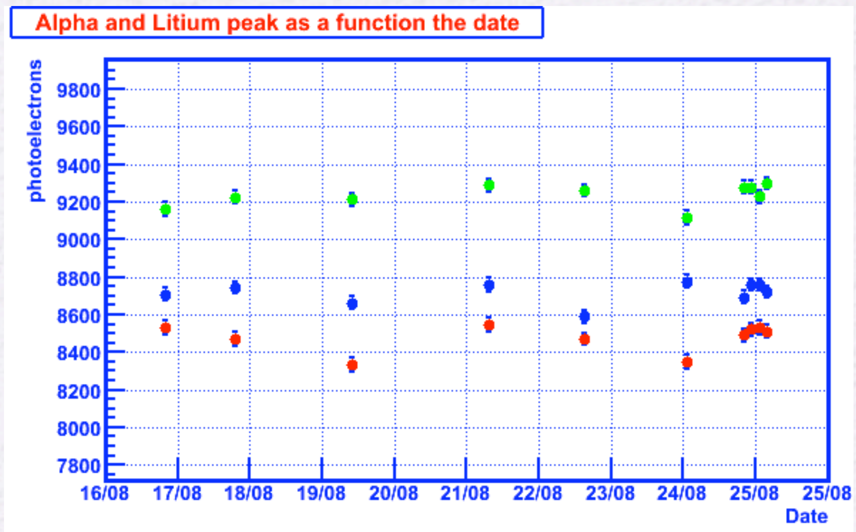
Stability

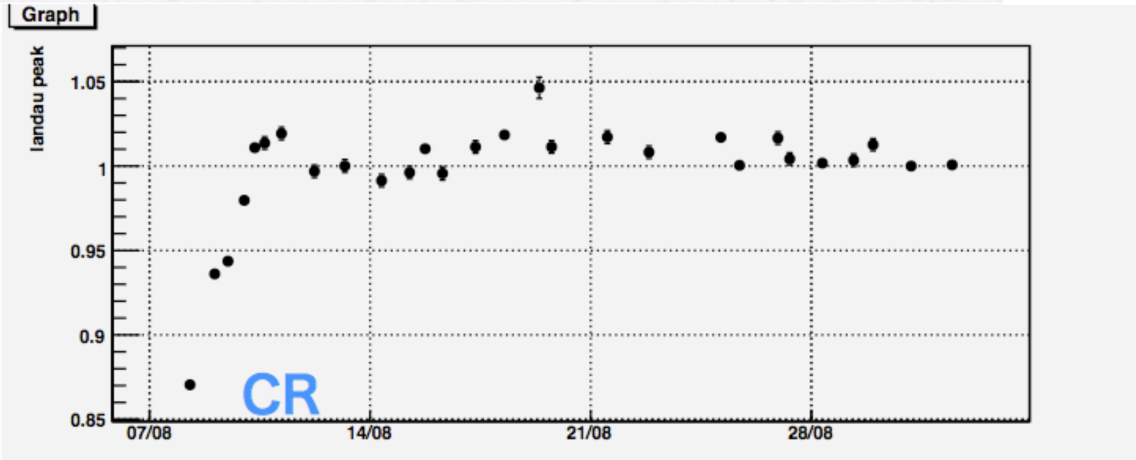
gain



Light Yield

- monitored using alpha, CW and cosmic ray data





Stable within 1~2%

Summary

- Daily calibration of LED and alpha
- Stability monitoring
- After purification, light yield increased and long absorption length achieved