MEG実験
液体キセノン検出器の性能

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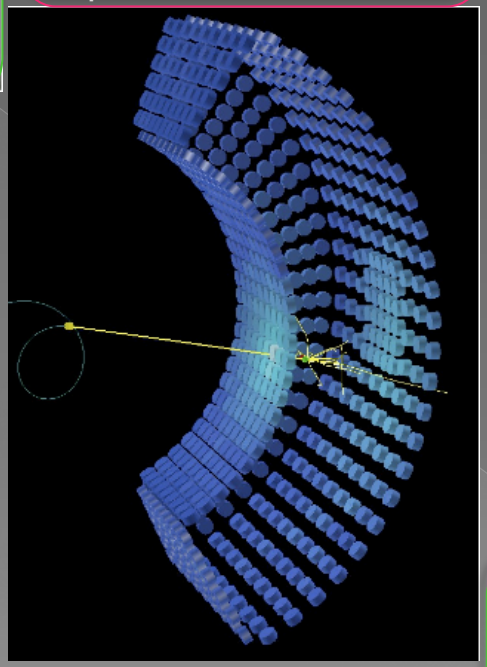
- Liquid xenon detector and its calibrations
- Monitoring during run 2010
  - Gain
  - Light yield
- π^0 calibration
  - Energy resolution
  - Timing resolution
- Performance of liquid xenon detector

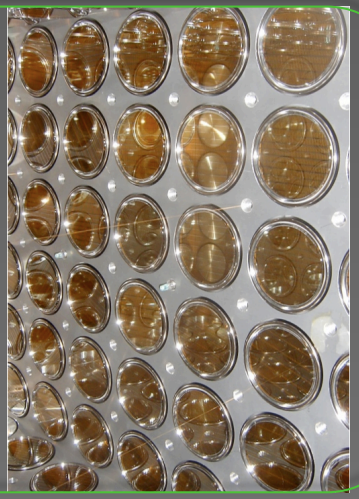
Liquid Xenon Detector

LED: gain measurement

846 PMTs
immersed in 900l
liquid xenon



Alpha: QE
estimation



CW accelerator
Li(p,γ)Be 18MeV γ
B(p, γ)C 4,11MeV 2γ
Light yield monitoring

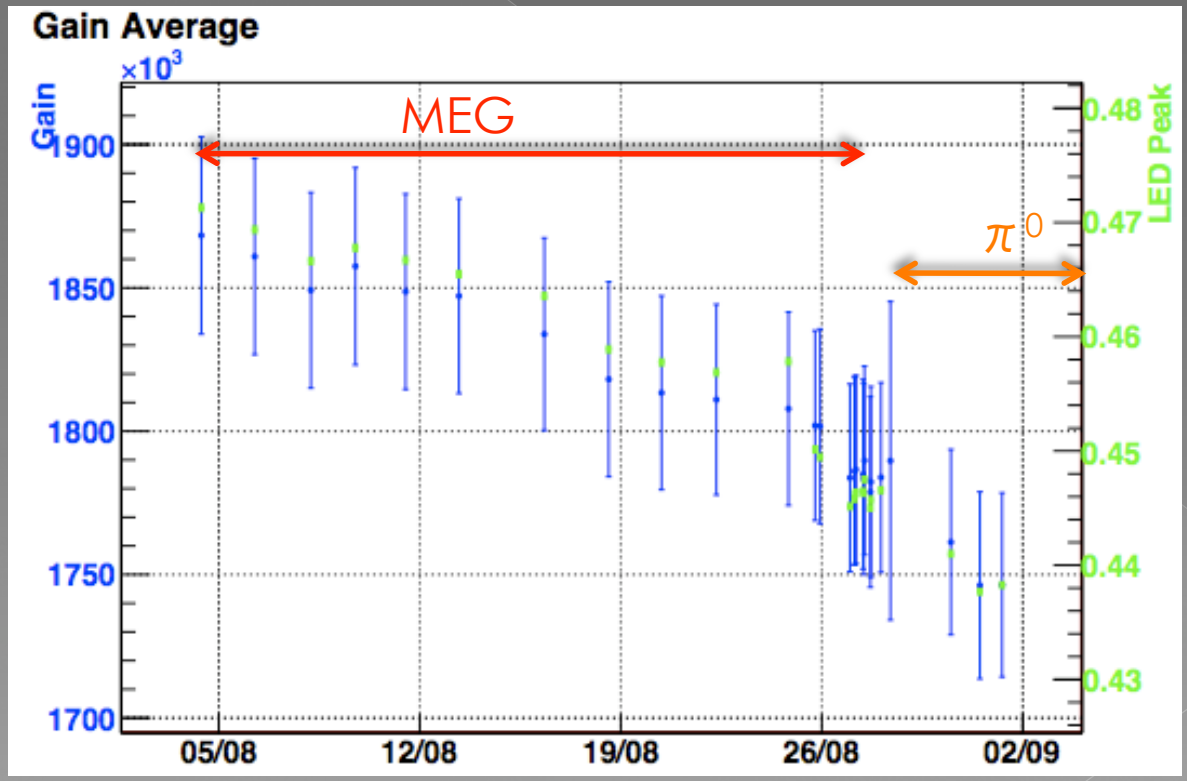
Cosmic ray:
Light yield monitoring

AmBe:
4.4MeV γ source
light yield monitoring

- AmBe , cosmic ray, and alpha calibrations were done 3 times every week
- Exclusive π^0 runs were done in early September

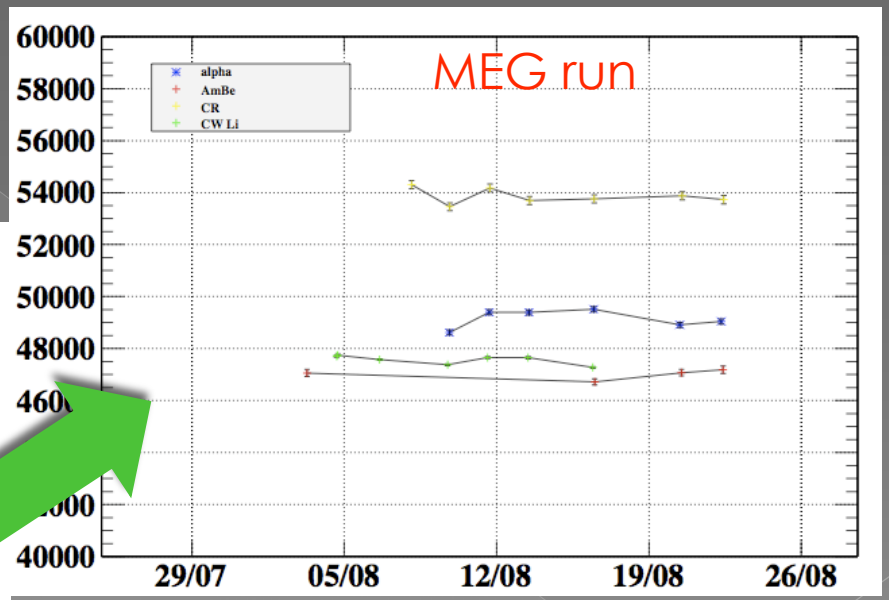
Gain Monitoring

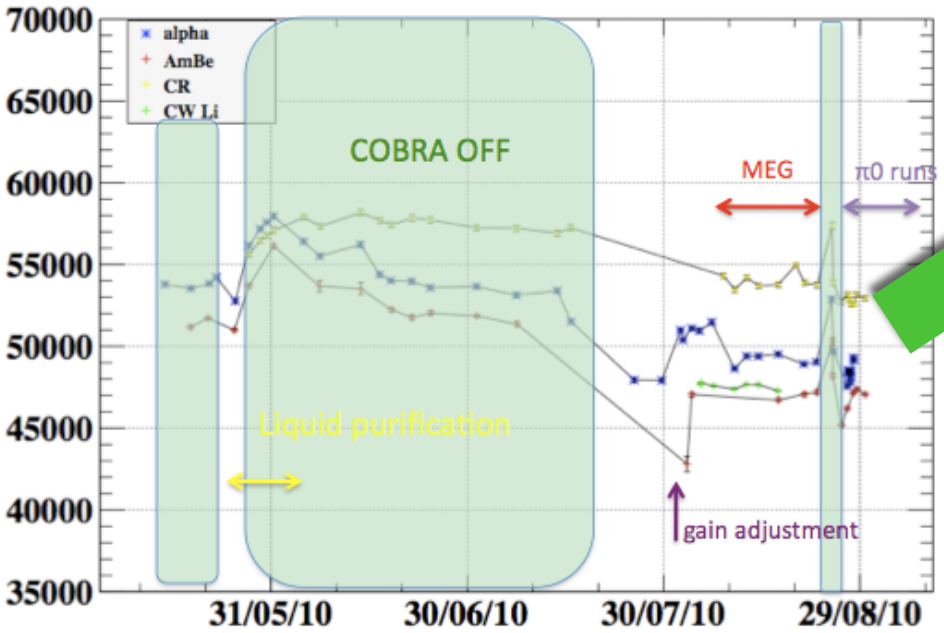
- Gain was calculated with statistical fluctuation of detected photon electrons from multiple LEDs with different attenuations
- LED runs were taken regularly to monitor the decrease of gains
- Gain adjusted at beginning of physics run
- Decrease rate in MEG runs was similar to 2009 (~ 1.5% per week)
- Gains can be restored by raising HV. Not a problem for the experiment



Light Yield Monitoring

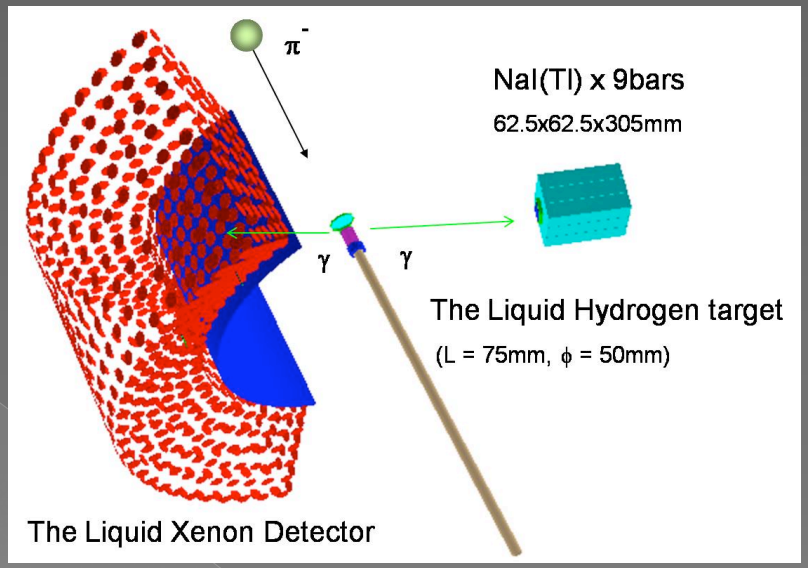
- Light yield was monitored with various runs including alpha, AmBe, cosmic rays and Cockcroft–Walton runs
- During π^0 runs, light yield was monitored as well
- Slightly higher light yield than last year
- Stable within 1% during MEG runs





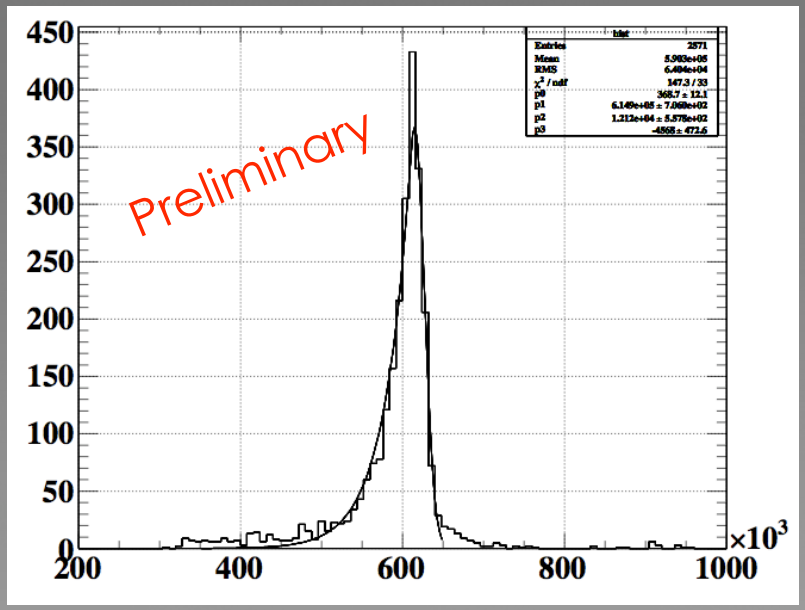
π^0 calibration

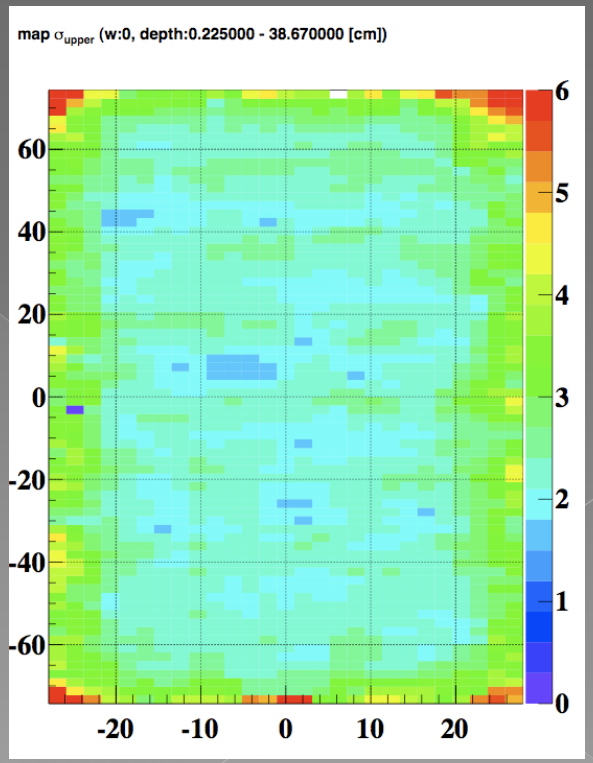
- $\pi^- + p \rightarrow \pi 0 + n$
- $\pi^0 \rightarrow \gamma\ \gamma$ (55MeV, 83MeV)
- $\pi^- + p \rightarrow \gamma + n$ (129MeV)
- Evaluate detector performance around signal 53MeV energy
- p^0 decay provides 55-83MeV g ray
- Monochromatic g obtained by selecting back-to-back opening angle
- Used to evaluate energy scale, energy, timing and position resolutions
- Run2010: 10 days of dedicated calibration; full scan of xenon detector for energy resolution and timing resolution



Energy resolution

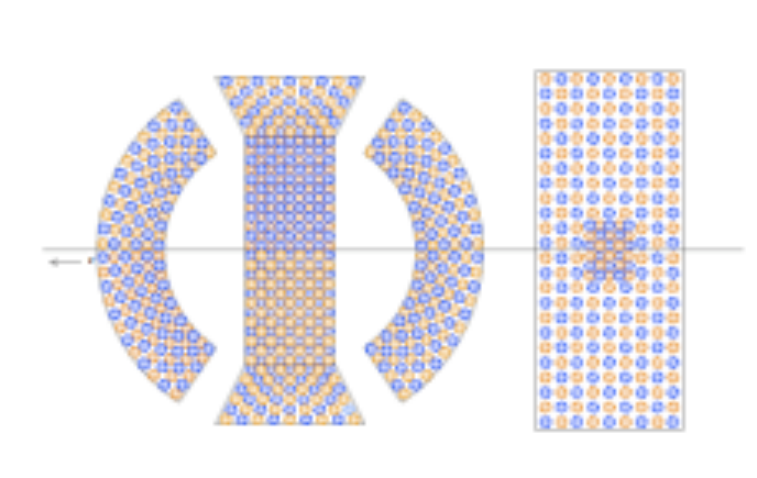
- 55MeV γ from π^0 decay
- The number of scintillation photons = Σ (weight x PMT charge / gain / Q.E.)x energy scale x correction factor
- Resolution: 2.2% (average, depth>2cm)



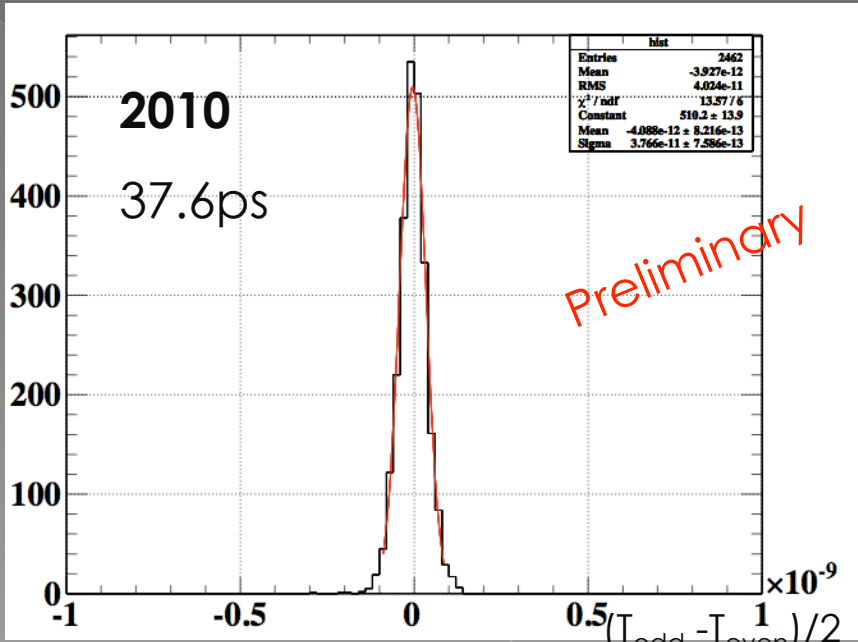


Intrinsic Timing resolution

- $\sigma\,(T_{odd} - T_{even})/2$
  - time difference between two groups of PMTs
  - dependent on number of photo-electrons

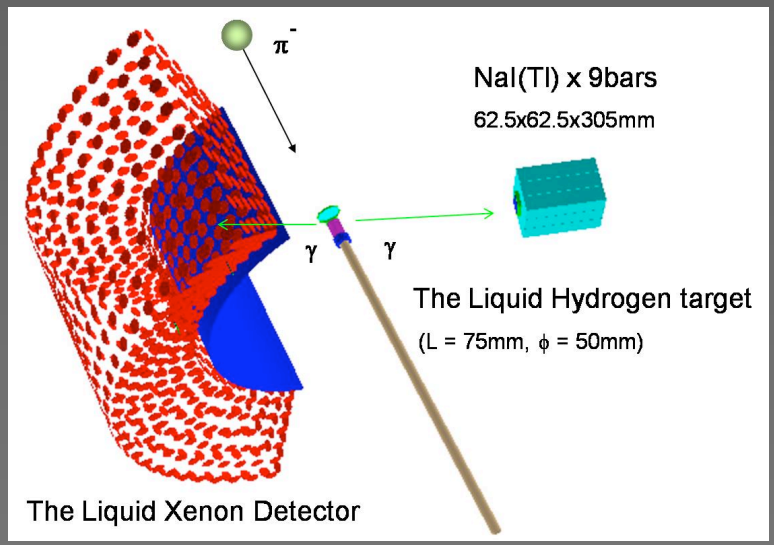


PMTs are divided into two groups.



Absolute Timing Resolution

- Use time difference of 2γ from π^0 decay
- Time difference between detector and reference counter (plastic scintillator in front of NaI detector)
  - $\Delta T_{abs} = T_{\gamma} - T_{ref}$

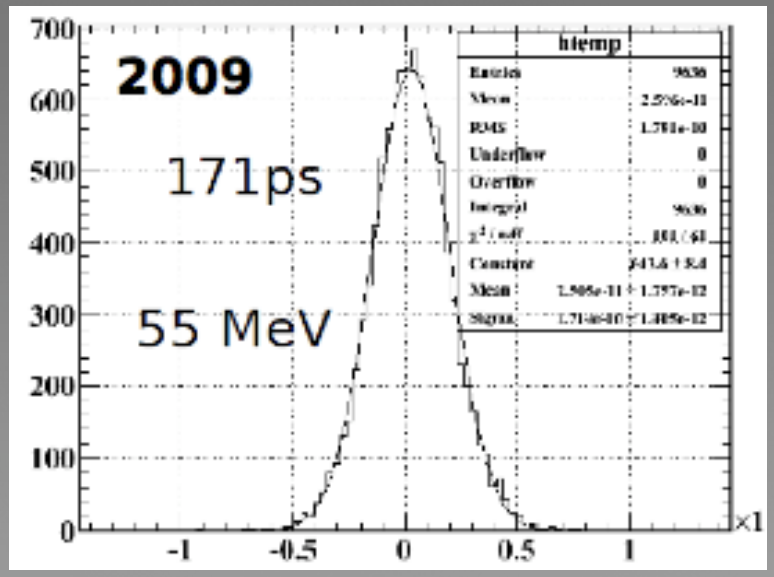


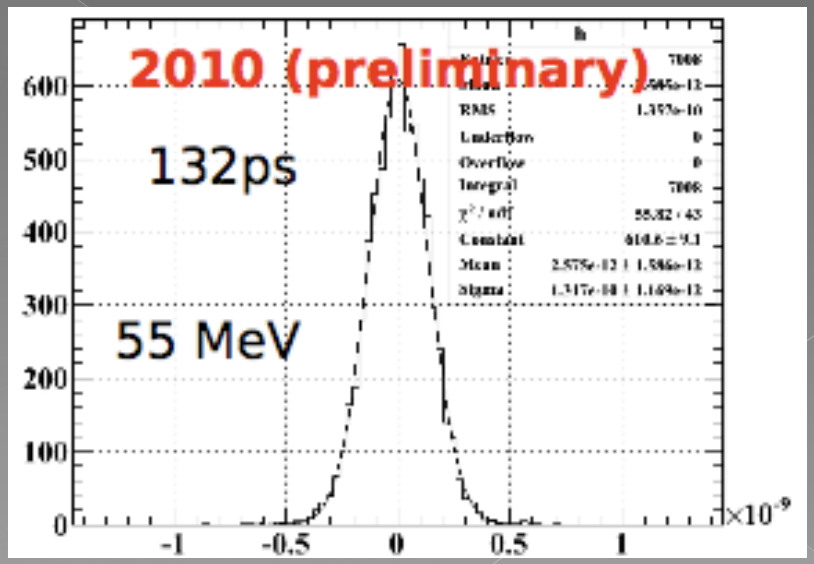
- Contributing factors: target ⊕ reference ⊕ xenon ⊕ DRS
- Spread of decay point in target: 60 psec
- Effect of reference counter: 65psec
- Effect of electronics

- Timing resolution between gamma and positron is estimated with radiative decay

Timing resolution

- σT_{abs}=132psec
- In 2009, timing resolution was worsened due to contribution from new waveform digitizer (~ 112psec). This has been improved in 2010 (~76psec) by reducing noise and minimizing jitters.





Liquid Xenon Detector Performance

	2009	2010(preliminary estimate)
Gamma energy (%)	2.1	1.5
Gamma timing (psec)	>67	68
Gamma position (mm)	5(u,v)/6(w)	5(u,v)/6(w)
Gamma efficiency (%)	58	58

Further improvement on gamma energy resolution

- Currently the best energy resolution in certain positions is 1.5% with strict quality cut
- Better QE estimation
  - Understand LXe optical properties
  - MC : reflection with polarization, etc.
- Fine calibration
  - Better quality data of π^0 run with BGO
  - Uniformity calibration with high energy gamma
- Develop more sophisticated reconstruction algorithms

Conclusions

- MEG run for 2010 has begun
- Gain is monitored by regular LED runs and is decreasing in beam at a similar rate as last year
- Light yield is monitored with alpha, AmBe, CW, cosmic rays and is stable
- π^0 calibrations are done and preliminary results have shown similar energy resolution as last year and better timing resolution than 2009
- Energy resolution is still expected to be improved, possibly with better QE estimation