MEG実験2009
液体キセノン検出器の性能 I

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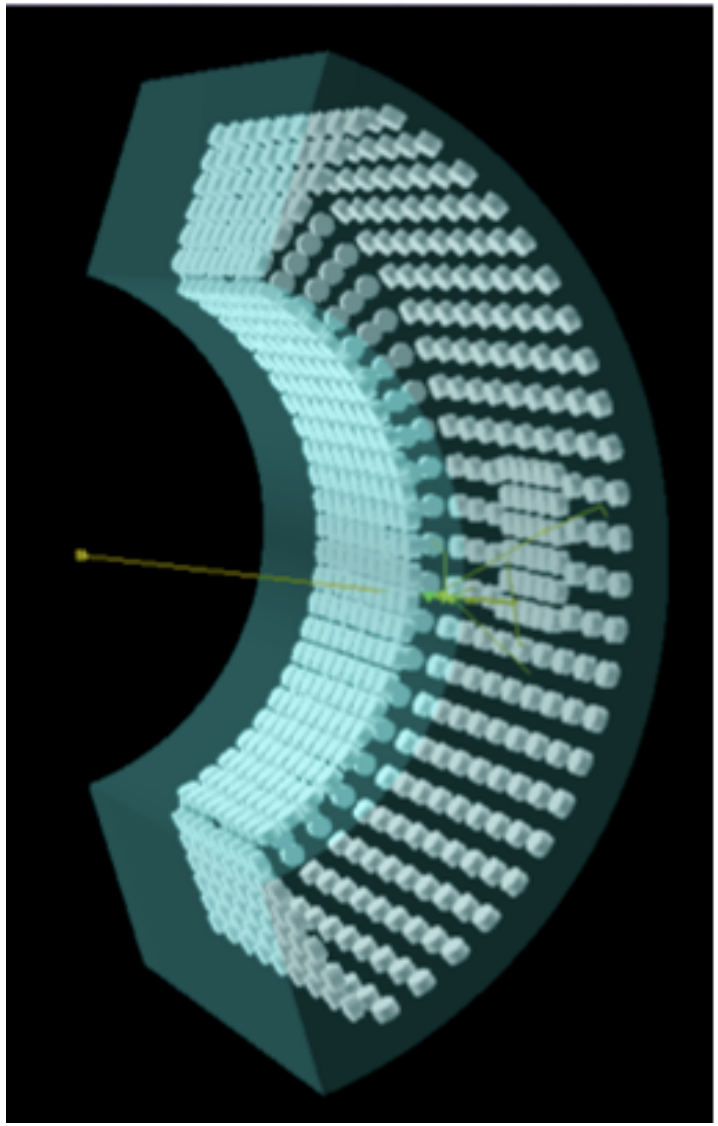
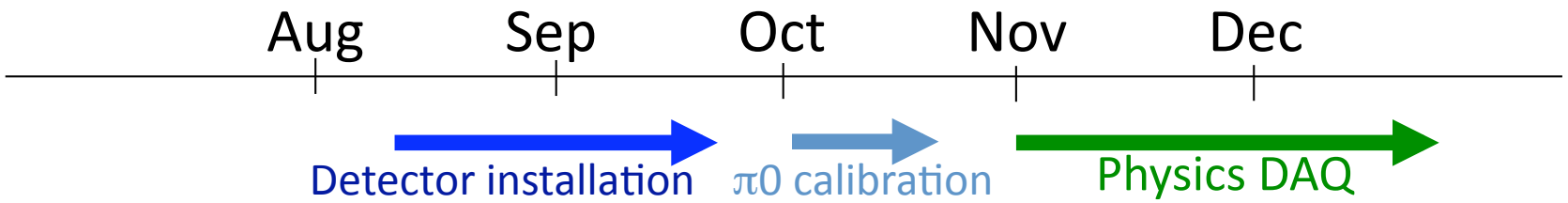
Liquid Xenon Detector

- 900 liters of liquid xenon with 846 PMTs
- Scintillation light from liquid xenon
  - High light yield (75% of NaI(Tl))
  - Fast response (τ = 45ns)
  - Short radiation length (X_0 = 2.77cm)
  - Homogeneous
  - No self-absorption of scintillation light
- Challenge
  - Low temperature (165K)
  - VUV light
  - Requires high purity



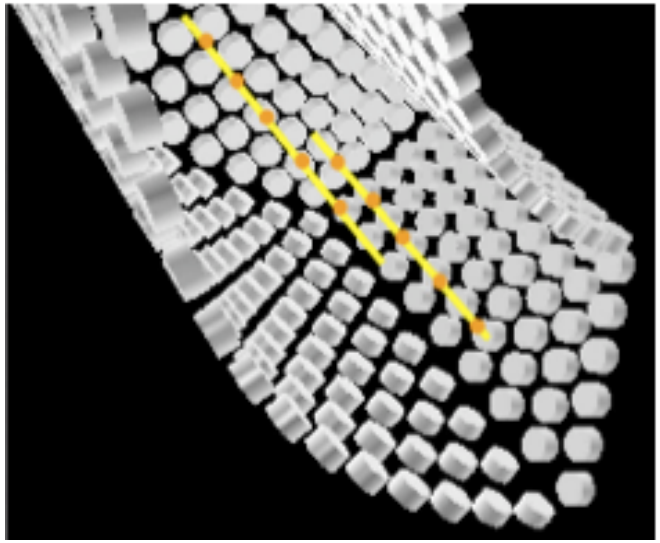
Liquid Xenon Detector Operation 2009

- Detector filled with liquid xenon again since July 2009
- Liquid purification done
- PMTs were checked and liquid xenon detector was ready
- Light yield remained the high value since the end of 2008 (->next talk)
- Waveform digitizer upgraded to DRS4 (no crosstalk of clock and lower noise level)
- We had a smooth physics run during 2009
- π^0 calibrations were done before MEG run
- Calibration data with LED, alpha, cosmic ray and Cockcroft-Walton accelerator were taken three times per week
- Light yield monitoring by CW, alpha, CR
  - Stable during 2009



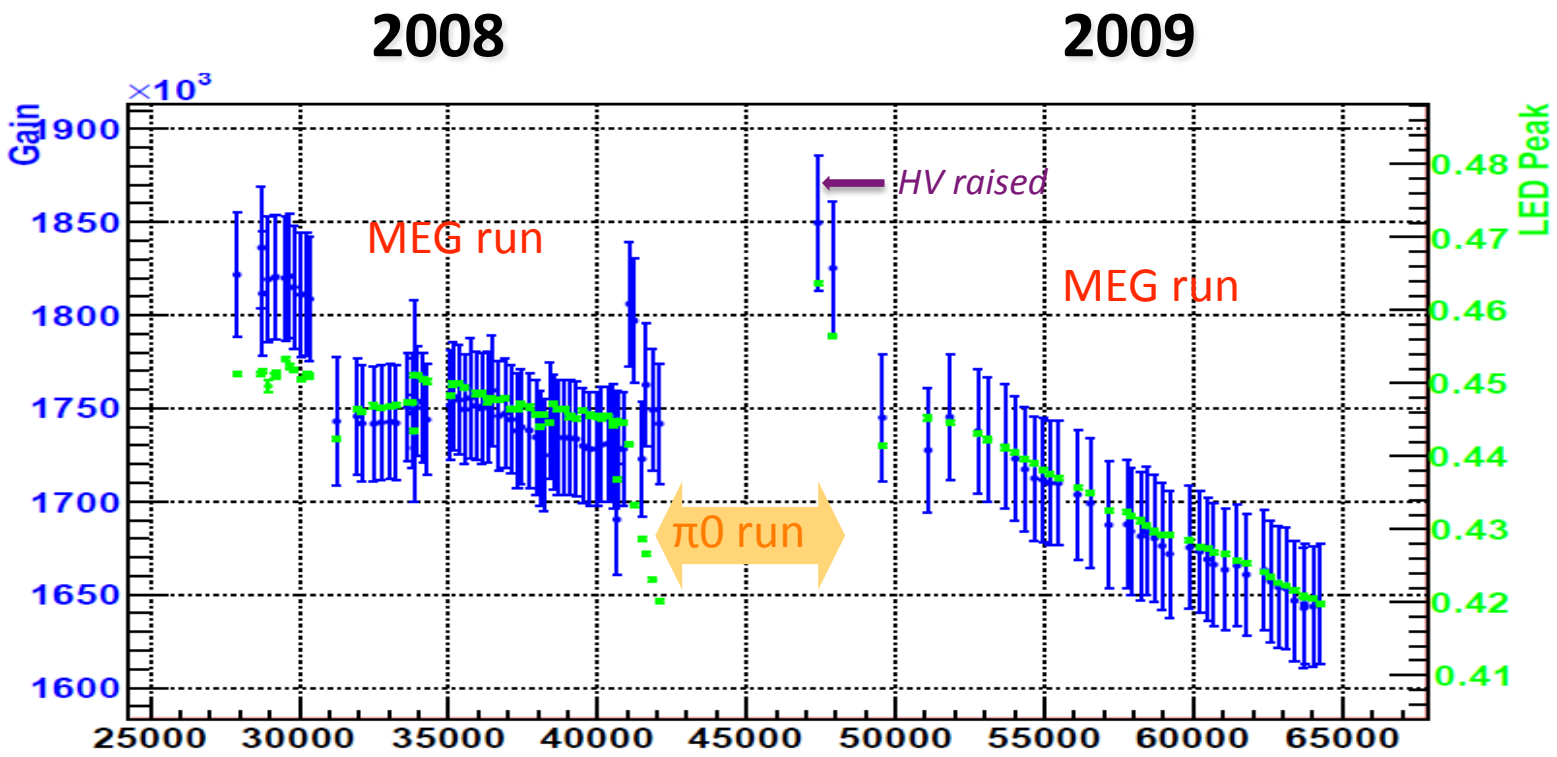
PMT Calibration

- Daily PMT gain calibration by multiple LEDs
- Calculating gain from statistical fluctuation of detected number of photon electrons
- Q.E. measurement using alpha event in LXe



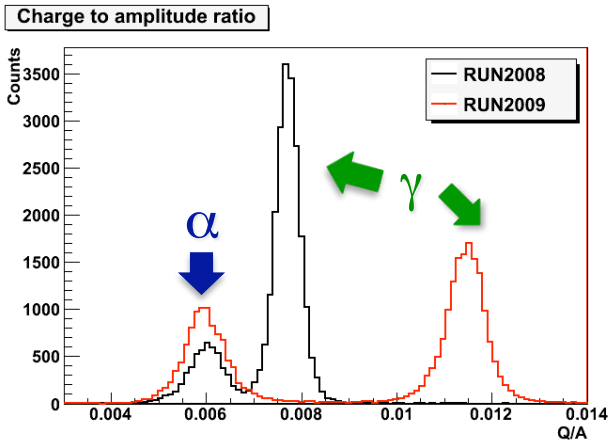
Gain

- Decreased by 10% during run 2009
- Gain was monitored with LED calibration throughout physics run
- PMT gain and LED peak with beam on; LED was constantly flushed during DAQ
- We can recover gain by increasing HV
  - Mean HV value of all 846PMTs ~ 830V
  - If we increase HV periodically at gain drop in 2010 MEG run,
    - HV value will reach 1000V in 4~5 years (HV limit for current PMT is estimated to be around 1300 V)
    - Shouldn't be a problem



Alpha run

- Q.E. was monitored with alpha runs
- Alpha events triggered in μ^+ beam since 2009
- New trigger for alpha separates α and γ much better during physics run
- α/γ separation based on different scintillation decay time
  - τ_α= 22 ns, τ_γ= 45 ns
- α-selection efficiency ≈ 90% with the beam on
- residual contamination from beam-related background < 20%
- Q.E. measurement with better efficiency as a result



Timing Measurement

- Photon time reconstruction
  - Waveform of each PMT is recorded
  - Time reconstruction done by fitting PMT time
  - Calibration constants (PMT time-offsets, time walk corrections, etc) are obtained by $\pi 0$ runs

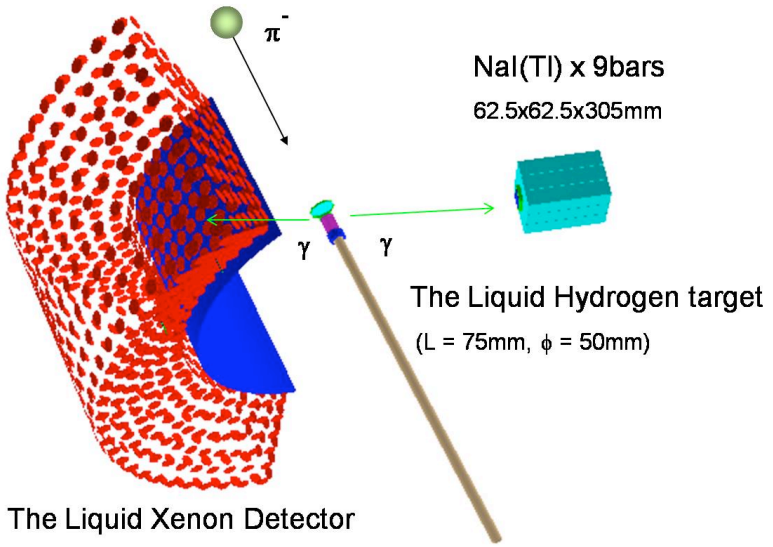
Timing Calibration

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

- π^0 decay provides 55-83MeV γ ray
- Monochromatic γ obtained by selecting back-to-back opening angle

- Evaluate detector performance around signal 53MeV energy (timing, energy, position)
- Time difference between detector and reference counter

  $\Delta t^{abs} = t_\gamma - t_{ref}$



Timing resolution in $\pi 0$ runs

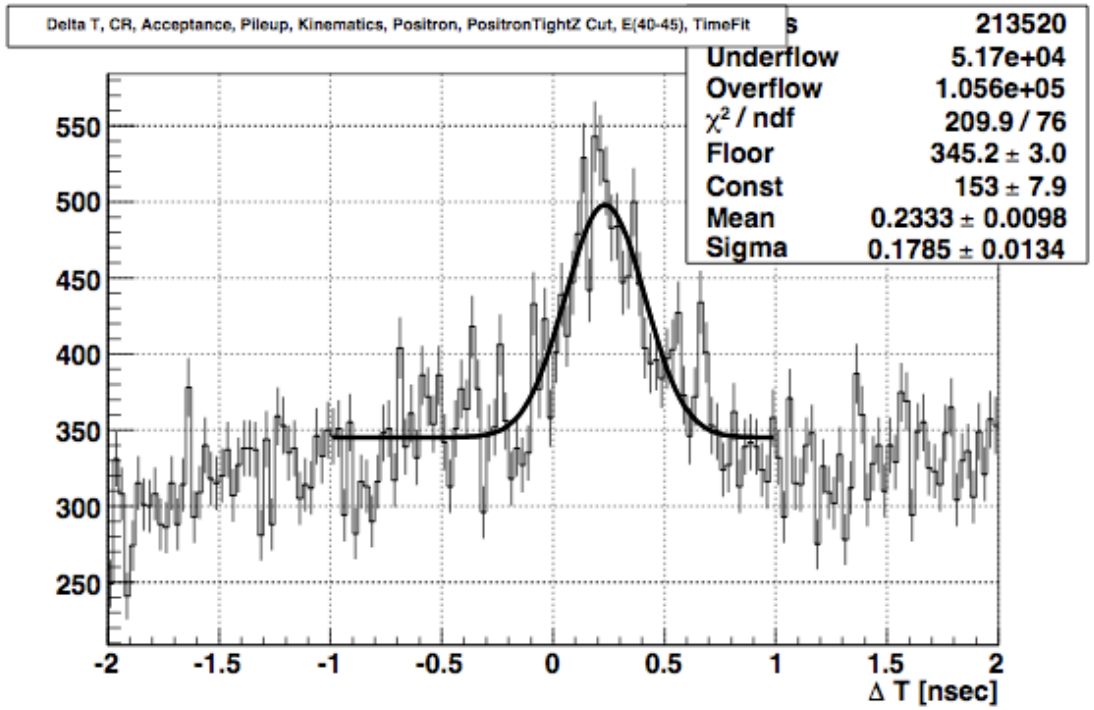
	2009 (σ)	2008(σ)
Intrinsic @55 MeV	37.5	45
Intrinsic @83 MeV	30.5	36
Absolute @55 MeV	171.4	135
Absolute @83 MeV	163.3	127

- Intrinsic resolution : $\sigma(T_{odd} - T_{even})/2$;
  dependent on number of photo-electrons
- Absolute resolution : $\Delta t^{abs} = t_{\gamma} - t_{ref}$;
  target $\oplus$ reference $\oplus$ xenon $\oplus$ DRS
  60psec 89.4psec ~67psec ~112psec

contribution of DRS is significant. Hardware? Calibration?

Radiative Muon Decay

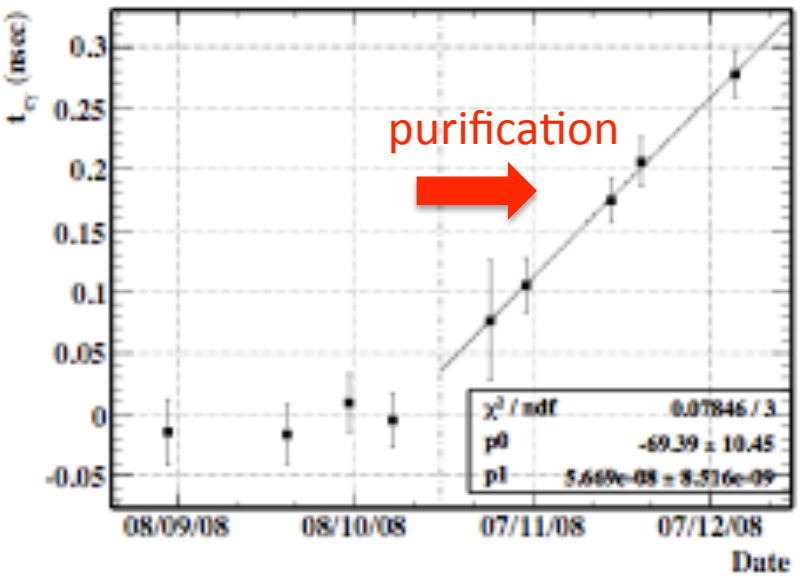
- Calibration of photon-positron relative timing
- Taken during physics run
- Sideband data
- Able to evaluate whole reconstruction performance
- Resolution: σ~180 psec
- Preliminary result of resolution worse than 2008, may be improved with complete calibration



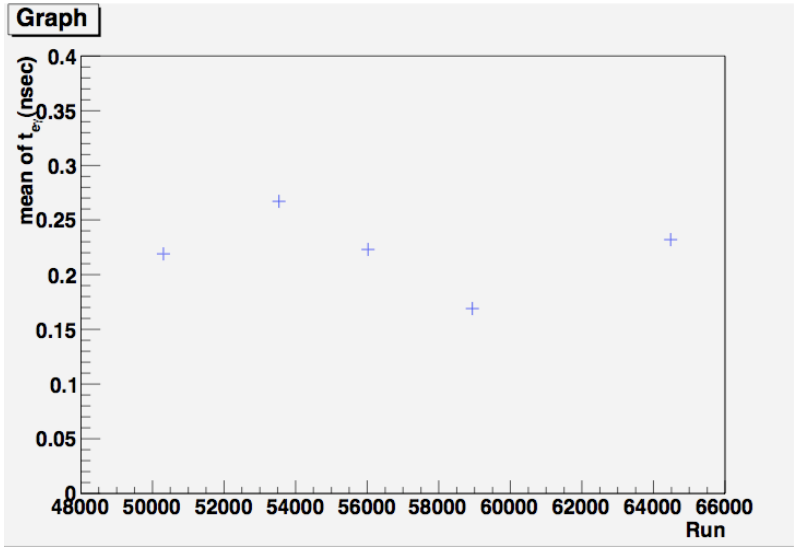
Drift of relative time

- In 2008, time reference (t_0) was changing with time because of purification and subsequent change of waveform
- No drift was seen in 2009

2008 (taken in RD runs with reduced muon beam intensity)



2009 (taken during physics data with normal beam intensity)



Conclusions

- Liquid xenon detector was running smoothly during 2009
- Light yield was monitored through calibration and was stable
- Gain is monitored by regular calibration. It decreased by 10% during the physics run in 2009, but can still be recovered by increasing HV. No problem is foreseen for another 4~5 years.
- LXe intrinsic timing resolution is a little better than 2008.
- Absolute resolution is worse than expected, mostly due to contribution from DRS chip
- Possible causes: hardware problem or calibration - under study
- Preliminary result of RD timing resolution shows it is worse than 2008. May be improved with the completion of calibration.