MEG液体キセノン検出器の性能とμ粒子崩壊事象の測定

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Outline

- Muon data in 2007
- Toward physics analysis
- Prospect of 2008

μ→eγ trigger data in 2007

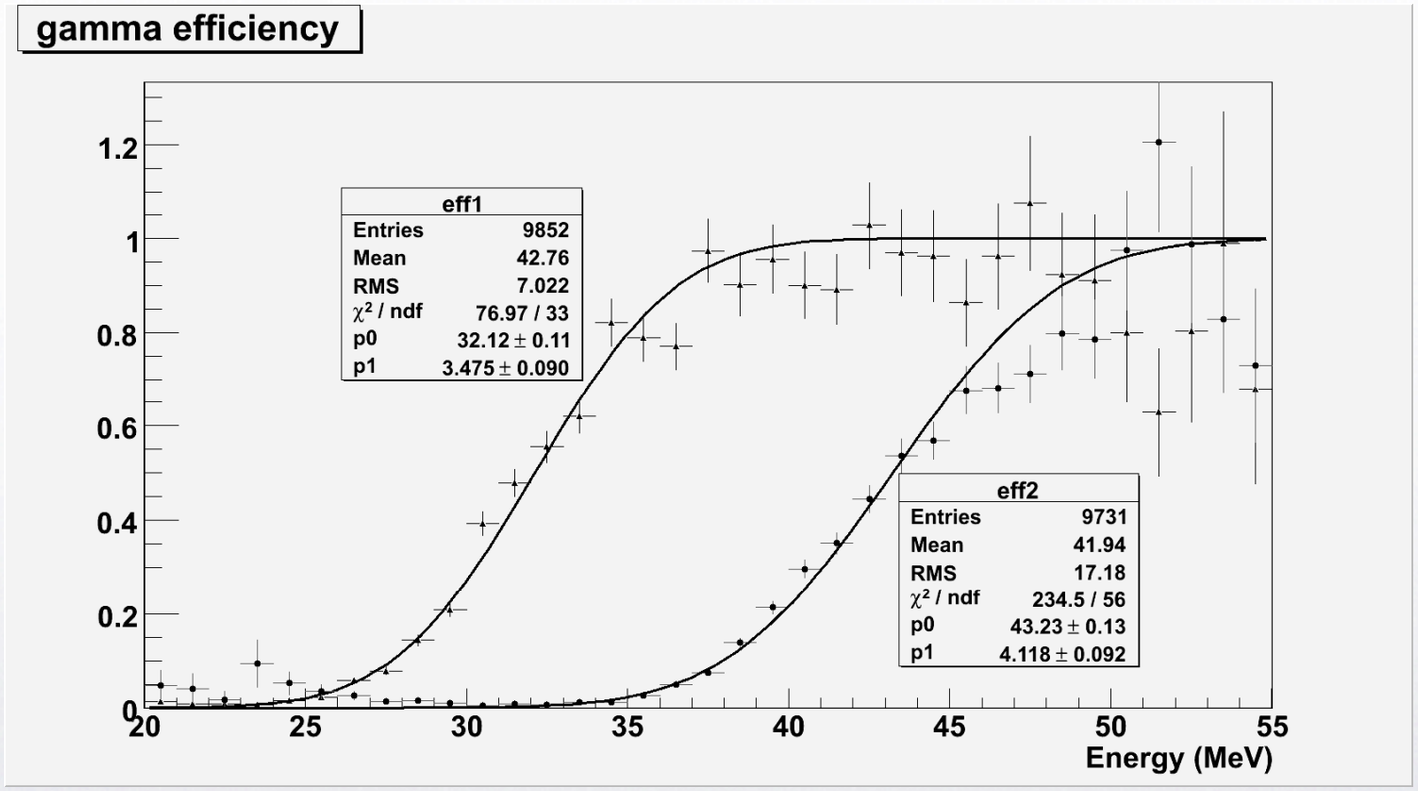
- Operated from 15 to 17/Dec.
- Collected ~ 630k μ→eγ trigger, in 29 hours in real time.
- About 2×10^{12} muon stops on the target, during live time of trigger. (acceptance and efficiency is not taken into account.)
- Rates in agreement with expectations
  - Trigger 0 : ~ 4 Hz (@ 40 MeV threshold) μ→eγ trigger
  - 1 : ~ 6 Hz (@ 35 MeV threshold) loose energy
  - 2 : ~ 20 Hz (only up/down $e^+\gamma$ correlation) loose angle
  - 3 : ~ 10 Hz (DT = 20 ns) loose time
  - 4 : ~ (no e-g correlation, DT = 20 ns) radiative decay
  - 5 : ~ (no e-g correlation, DT = 40 ns) radiative decay, wide time

Trigger efficiency

Trigger efficiency can be obtained by comparing event rate of μ→eγ trigger and loose condition triggers.

Example:

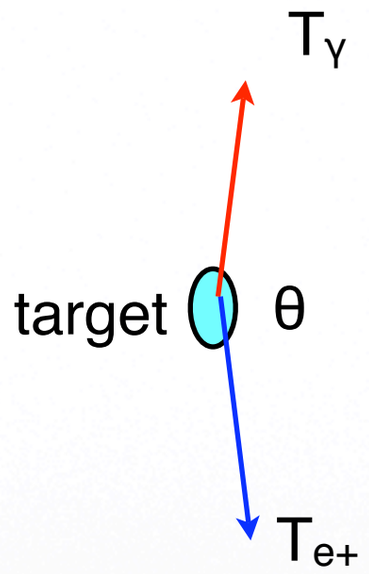
Event rate comparison with various gamma energy thresholds

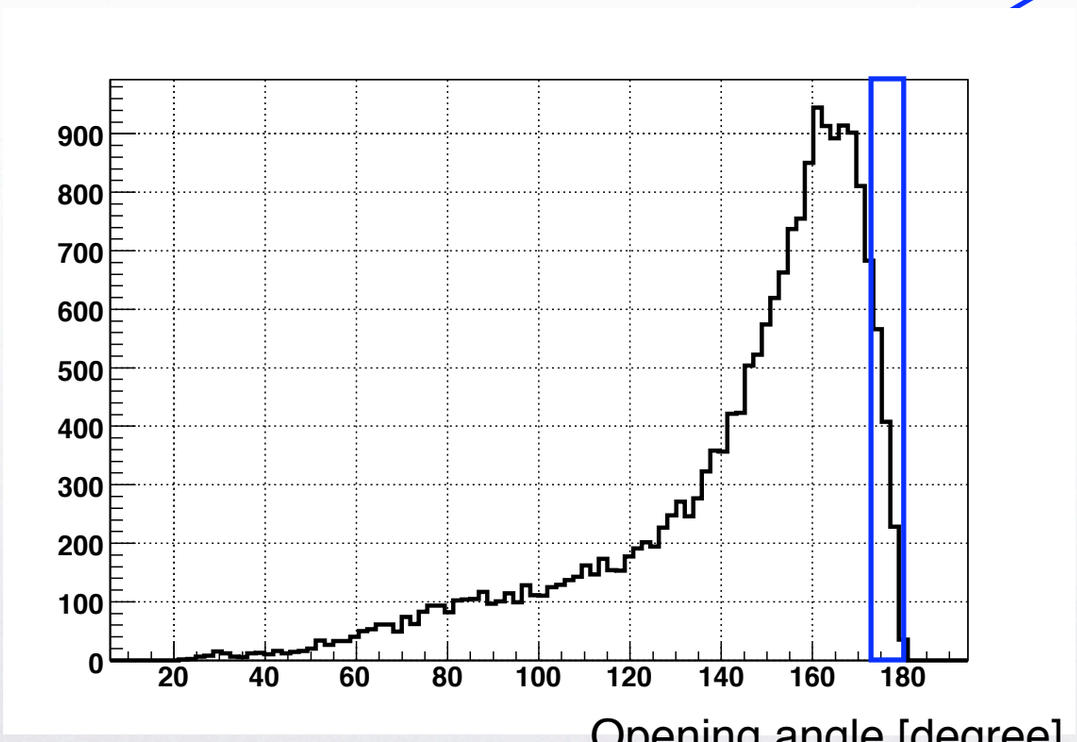


** this plot was made from calorimeter-self-trigger rus (not in μ→eγ runs). Threshold is different from μ→eγ runs.

γ-e⁺ opening angle and time distribution

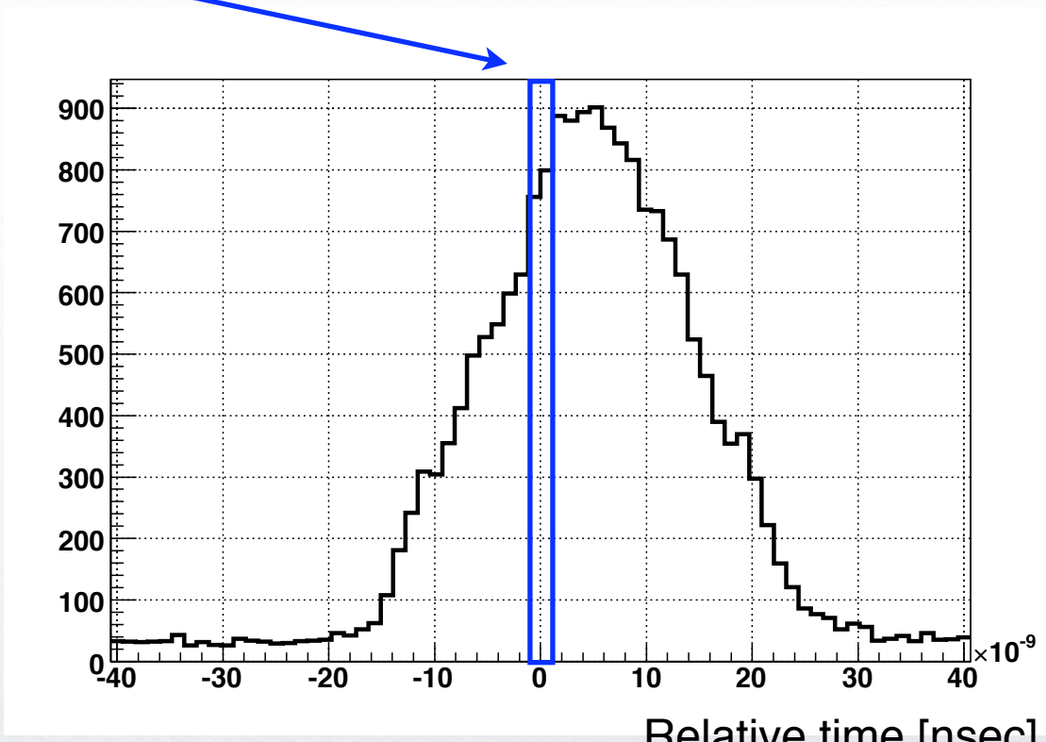
Distribution of all pairs of γ and positron,
in μ➔eγ trigger events.





Opening angle [degree]

5σ region



Relative time [nsec]

Unfortunately, center of trigger was not at 0 in 2007.

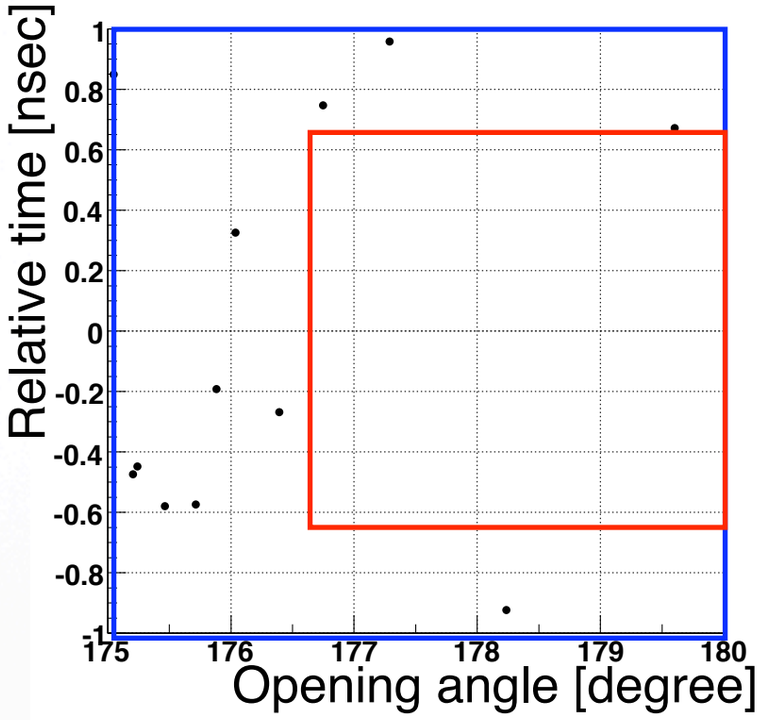
Events around signal region

Very preliminary

Analysis was done with preliminary reconstructions.
No pileup rejection of calorimeter.
No positron track selection.

E_γ, E_{e+}, $T_{e\gamma}$, $\theta_{e\gamma}$

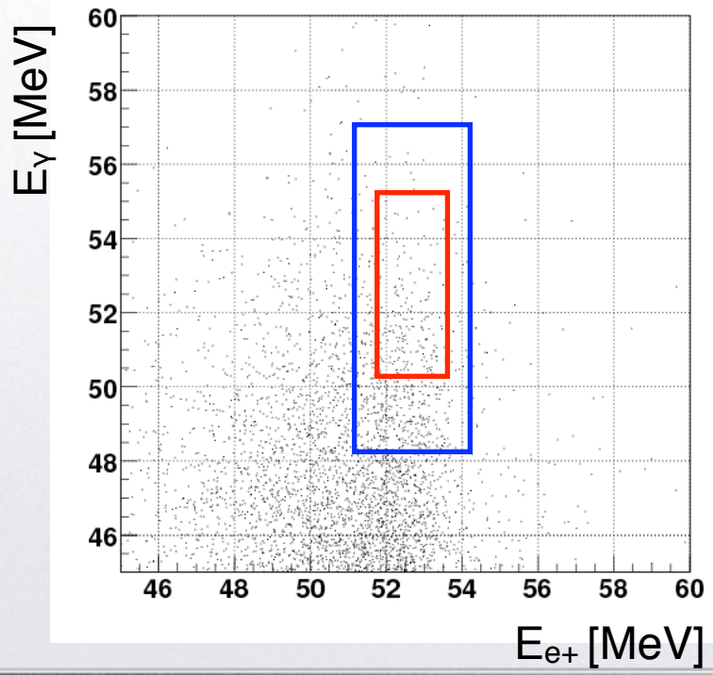
Reconstruction result with preliminary analyses.
No background events in 2 sigma region.

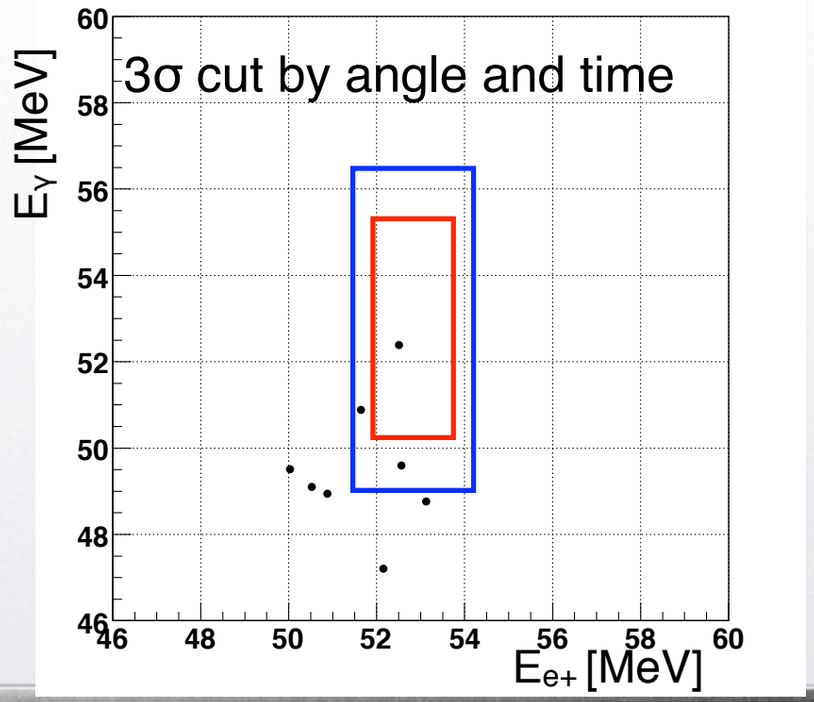


3σ region

2σ region

No selection with angle and time





Towards physics result

Maximum likelihood analysis is being prepared

Signal　　Radiative decay　　Accidental pileup

$$L(s, s') = \Pi P(xi) = \Pi(sS(xi) + s'S'(xi) + (N-s-s')B(xi))/N$$

L　　: likelihood function
xi　　: observables
N　　: total number of events in analysis box
s　　: number of signals
s'　　: number of radiative decays(RD)
S(xi)　: probability density function(p.d.f.) of signal
S'(xi) : p.d.f. of RD
B(xi)　: p.d.f. of accidental background

Points are how to define likelihood function and how to obtain p.d.f.

Signal PDF

$$S(xi) = S1(T_{e\gamma})S2(\theta_{e\gamma})S3(E_e)S4(E_\gamma)S5(d)S6(v)$$

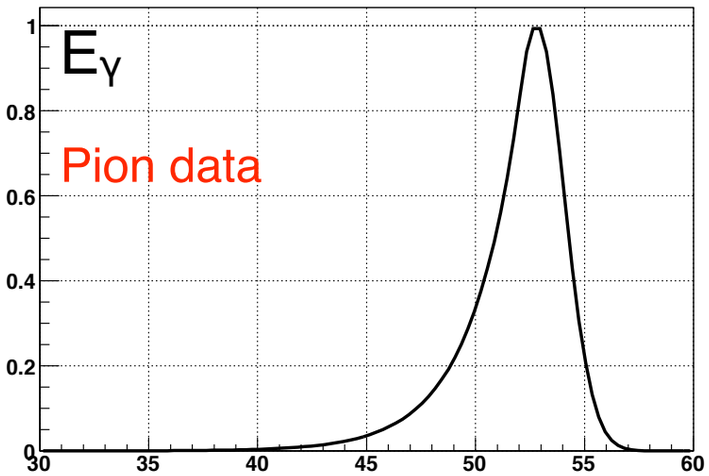
vertex

time

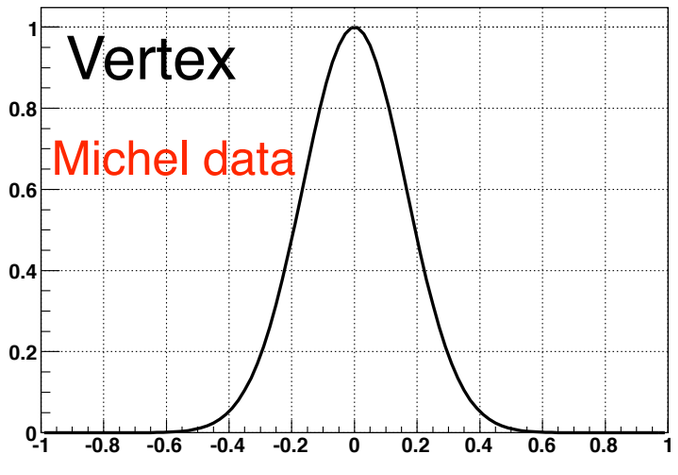
angle

energy

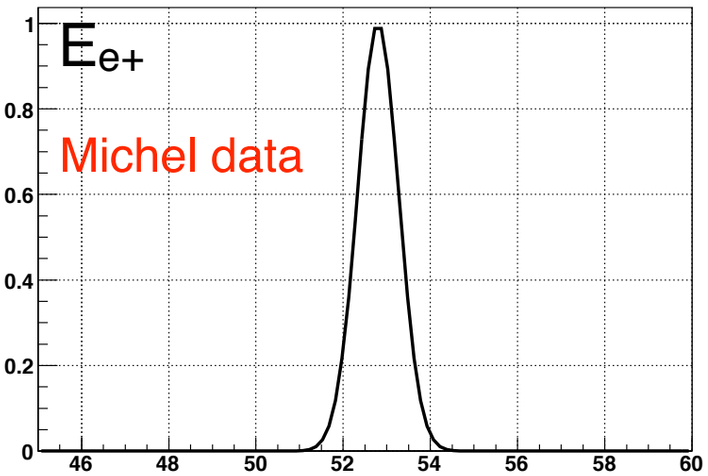
first conversion depth in calorimeter



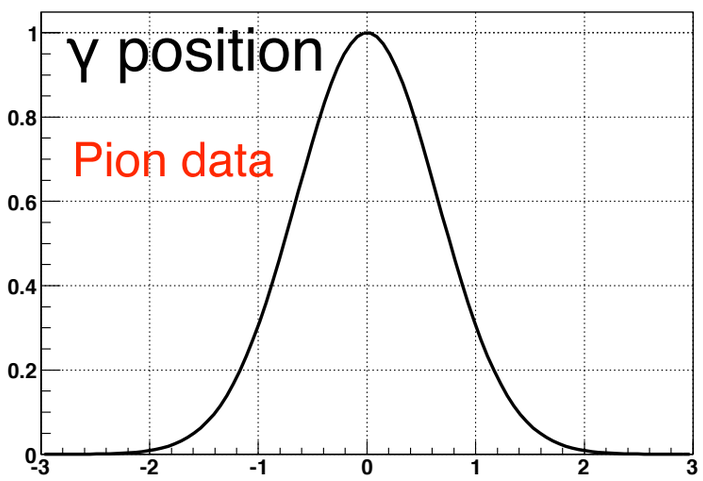
[MeV]



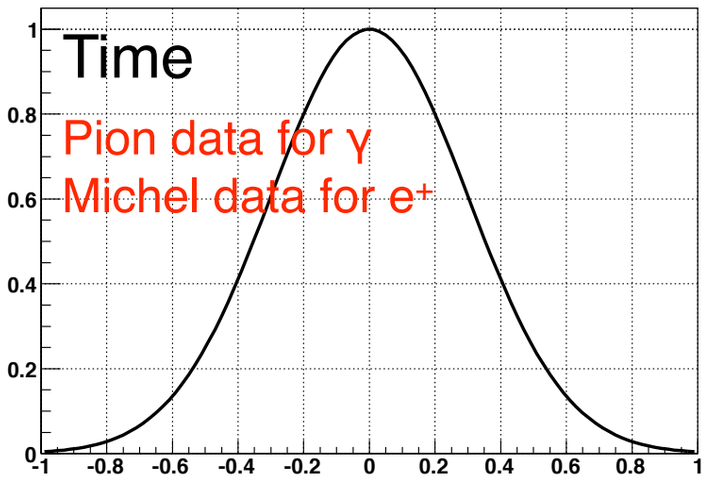
[cm]



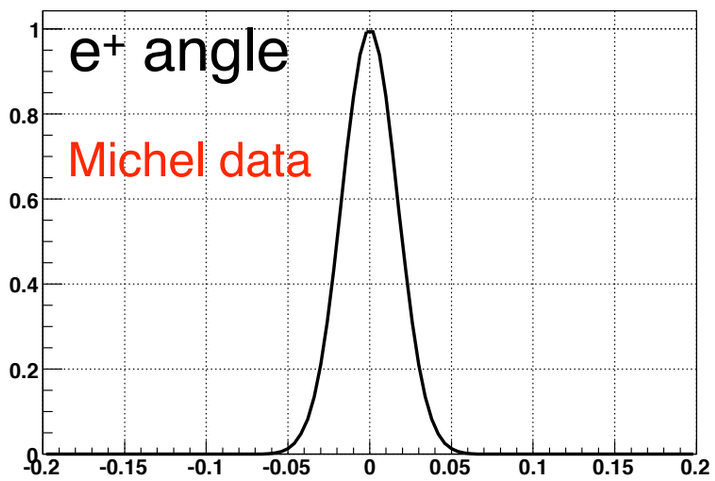
[MeV]



[cm]



[nsec]



[rad]

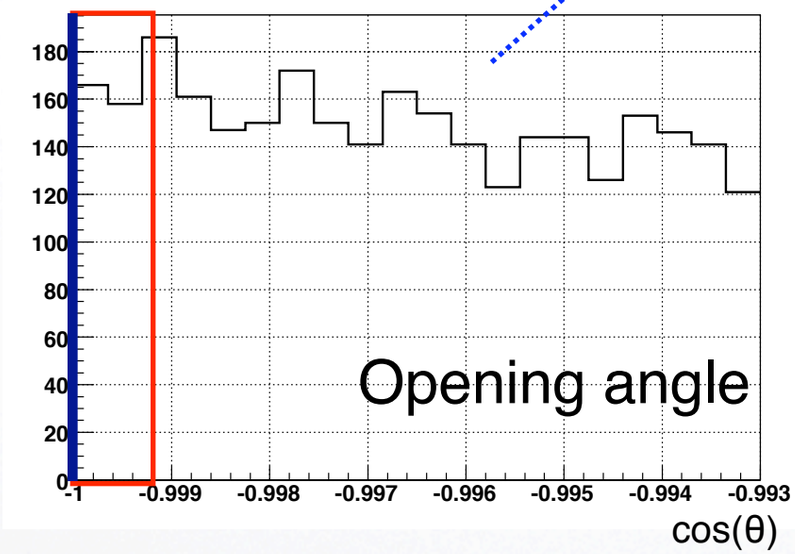
Background PDF

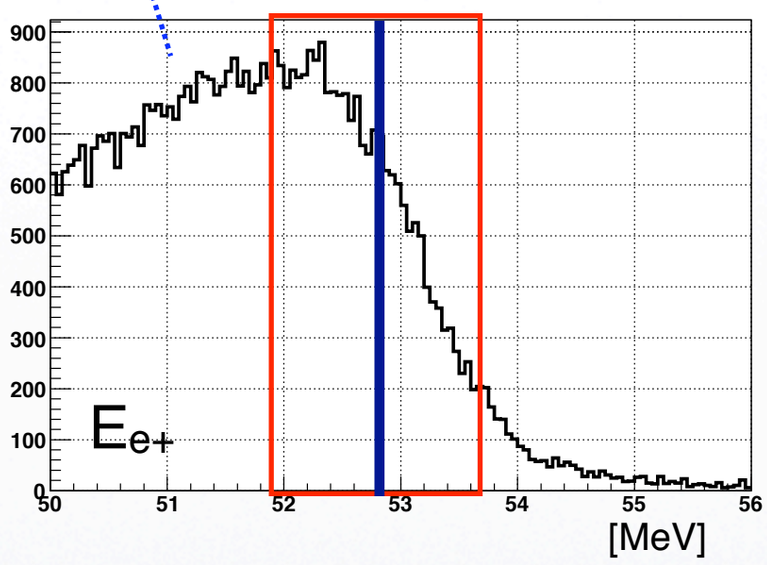
Accidental background

Distribution can be obtained from “off-timing” data.

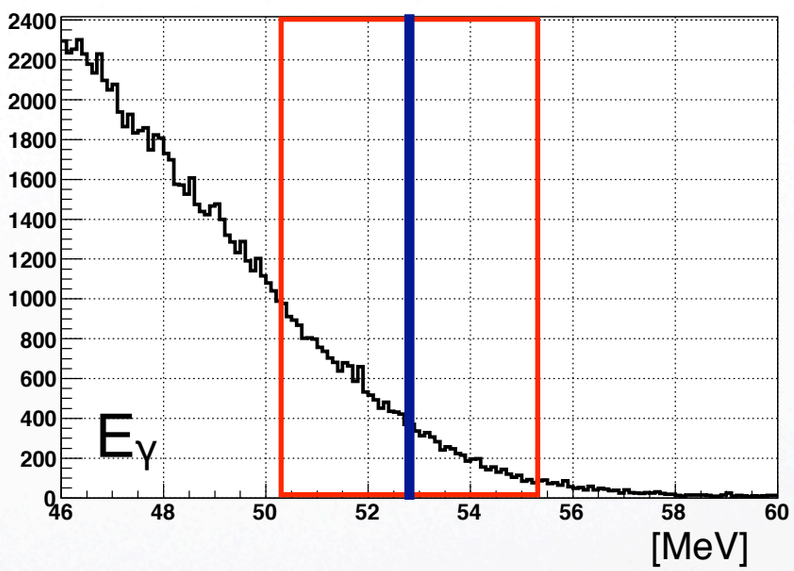
$$B(xi) = B1(T_{e\gamma})B2(\theta_{e\gamma})B3(E_e)B4(E_\gamma)B5(d)B6(v)$$

must be flat





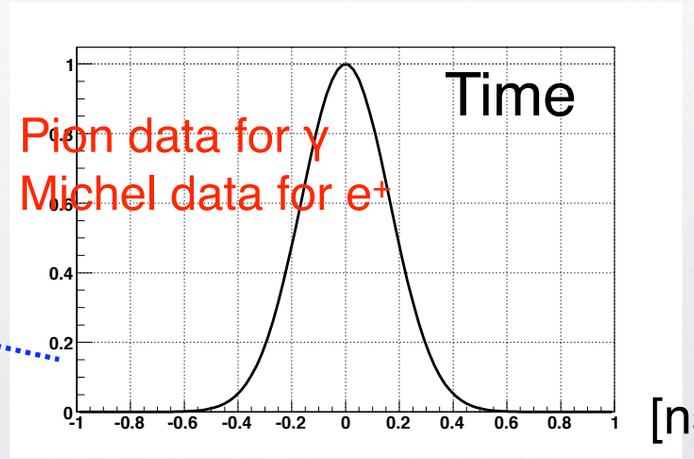
2σ region



Radiative decay

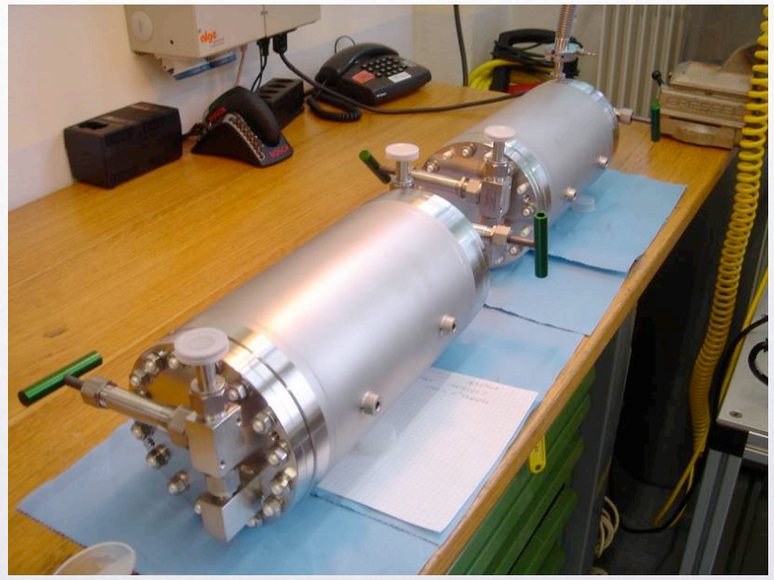
$$S'(xi) = S'1(T_{e\gamma})S'2(\theta_{e\gamma},E_e,E_\gamma)S'5(d)S'6(v)$$

From MC

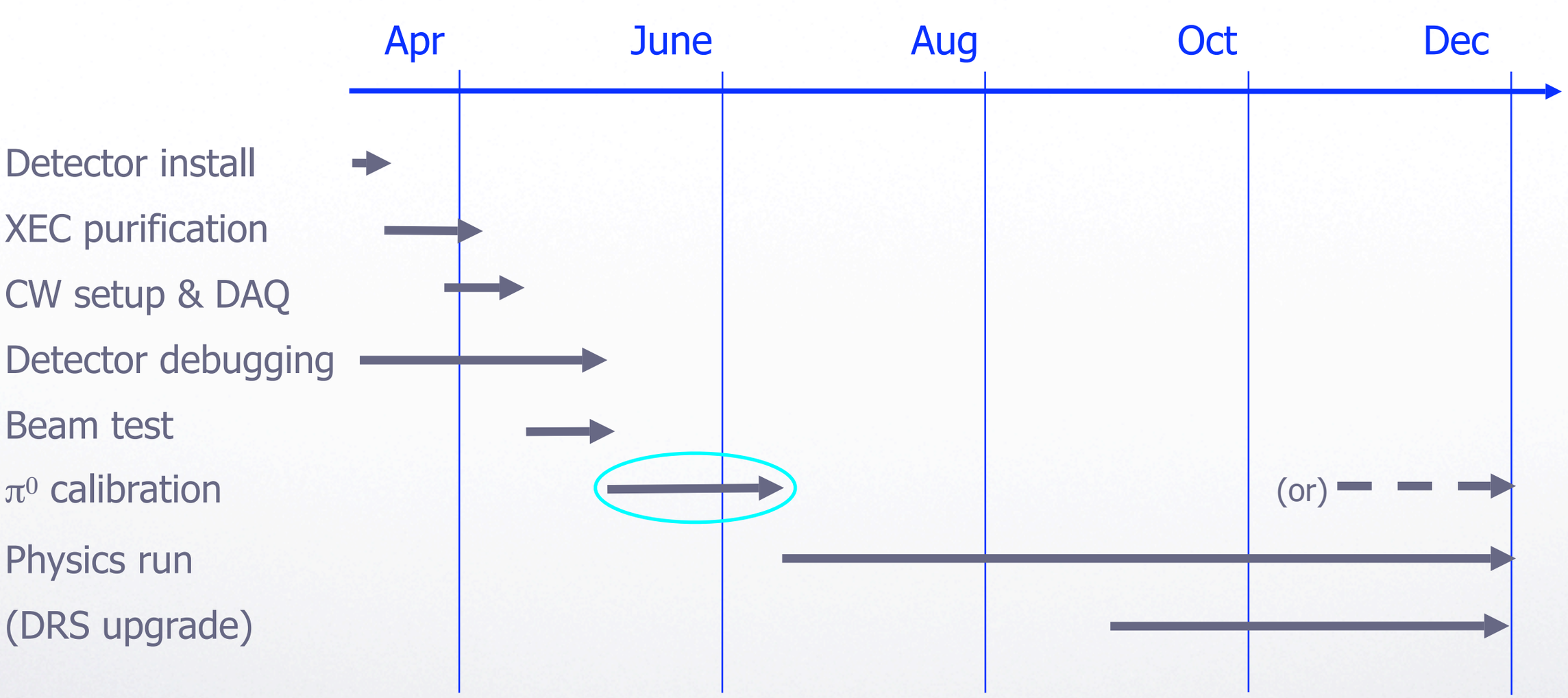


Prospects in 2008 (calorimeter)

- Improvement of electronics
  - New version of waveform digitizer (DRS4), with better linearity and stability.
  - Noise study.
- Better PMT calibration
  - Number of alpha sources will be increased for better estimation of Q.E.
  - LED is modified for better estimation of gain. (Increased light attenuation)
  - More LEDs were installed for better estimation of time offset.
- Xenon purification
  - New purifier will be installed (removes water and oxygen).
  - Number of photoelectrons could be doubled ?



Plan 2008



5 months DAQ for physics result in 2008
DRS upgrade is scheduled during DAQ

Prospect of 2008 run

	*MEGA (1999)	MEG 2008 prospects
Gamma Energy (%)	3.3-5.7	5.0
Positron Energy (%)	0.93-1.6	1.1
Gamma Position (cm)	15.6	9.0
Positron Angle (mrad)		17
Gamma Time (nsec)	1.6	0.15
Positron Time (nsec)		0.12
Acceptance	0.3 %	9%
Gamma efficiency (%)		>40%
Positron efficiency (%)		65%
Muon rate (10^8/sec)	2.5(Pulse,6-7% duty)	0.3(DC)
Running Time (week)	20	24
Single Event Sens(10^{-13})	23	2.2
Accidental Rate($10e^{-13}$)		1.0
#Accidental Events	2	0.5
90% CL Limit(10^{-13})	120	6.9

⊕0.25 with DRS2

FWHM

1 week is defined to be 4×10^5 sec

*Phys. Rev. Lett. 83, 1521 (1999): Brooks et al.

Summary

- 2007 run
  - All the components of the MEG experiment were constructed.
  - Various kinds of data for studying sub-detectors were taken.
  - Trigger system was developed for μ➔eγ trigger.
- Present
  - Development of reconstruction and physics analysis are being done in parallel.
  - Improvements of hardware is also being done.
- 2008 run
  - We will be ready to restart data taking in June-July.
  - Hopefully, new limit of μ➔eγ branching ratio from this year's data.