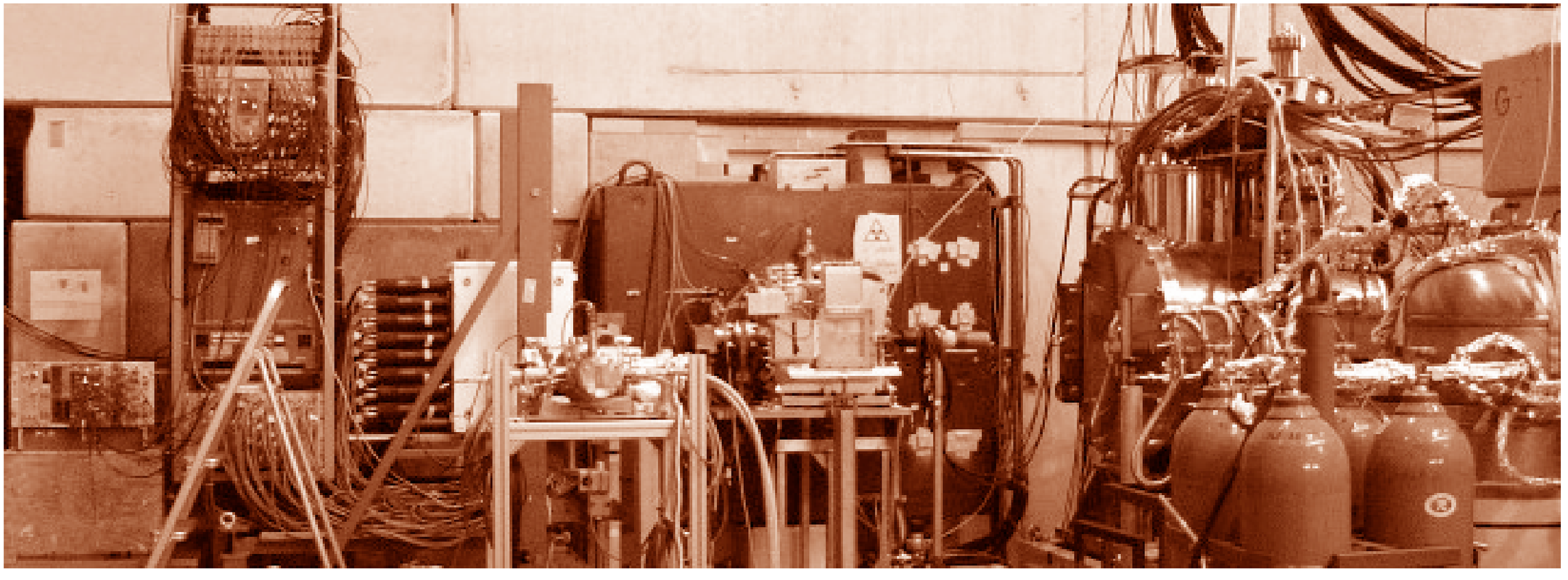
JPS meeting, '04 Spring, @ Kyushu Univ., Hakozaki campus



MEG 実験用 LXe Scintillation detector の $\pi^- p \to \pi^0 n$ を用いたビームテスト : I

西口 創 @ 東京大学

東大素粒子センター　早大理工総研[A]　高エ研[B]　BINP-Budker[C]　INFN-Pisa[D]　PSI[E]

岩本敏幸，大谷航，小曽根健嗣，笠見勝祐[B]，菊池順[A]，澤田龍，鈴木聡[A]，寺沢和洋[A]，道家忠義[A]，春山富義[B]，
久松康子，真木晶弘[B]，三原智，森俊則，山下了，山田秀衛，吉村剛史[A]，A.Baldini[D]，F.Cei[D]，M.Grassi[D]，
P.-R.Kettle[E]，D.Nicolo[D]，A.Papa[D]，S.Ritt[E]，G.Signorelli[D]，Y.Yuri[C]

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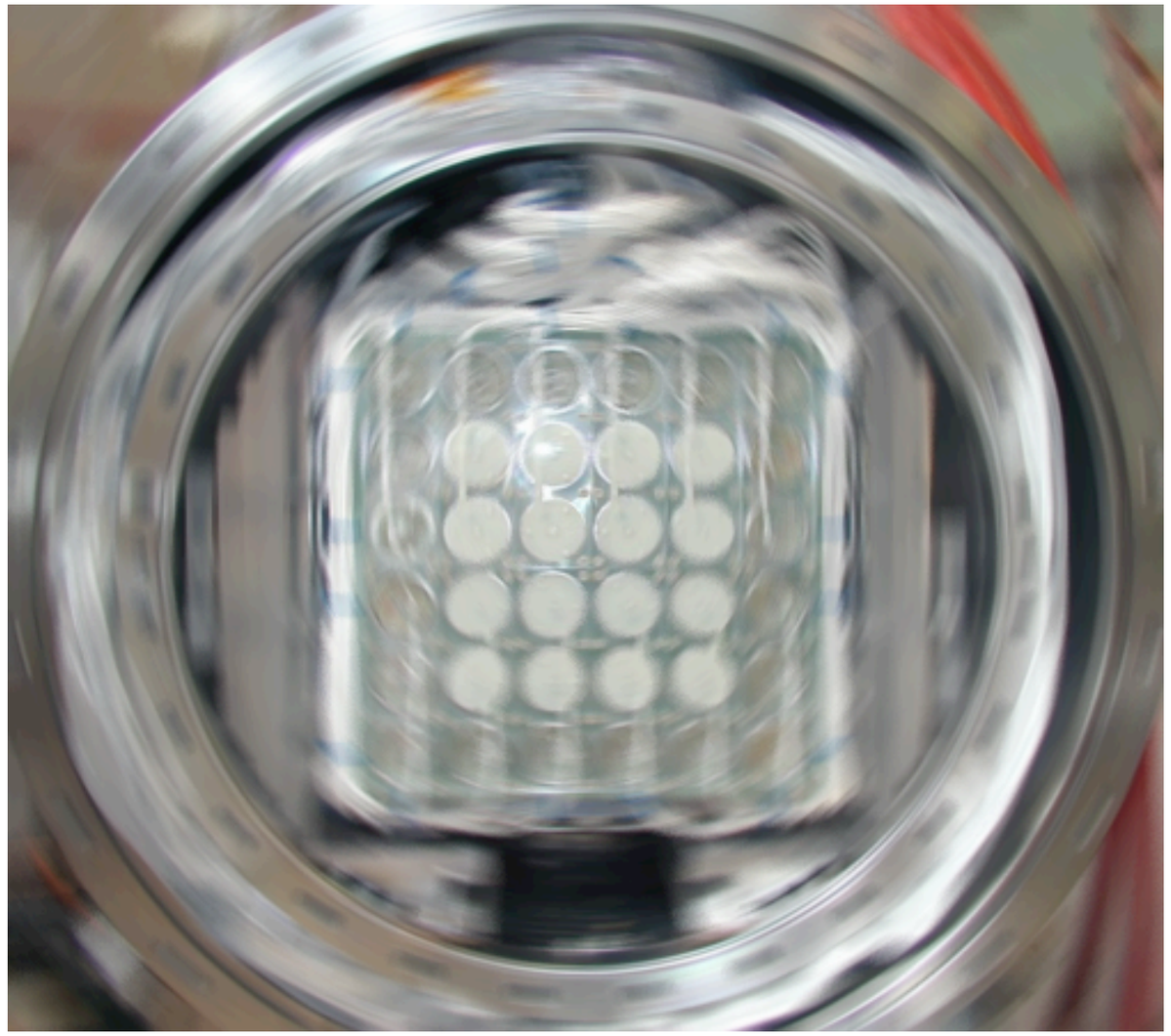
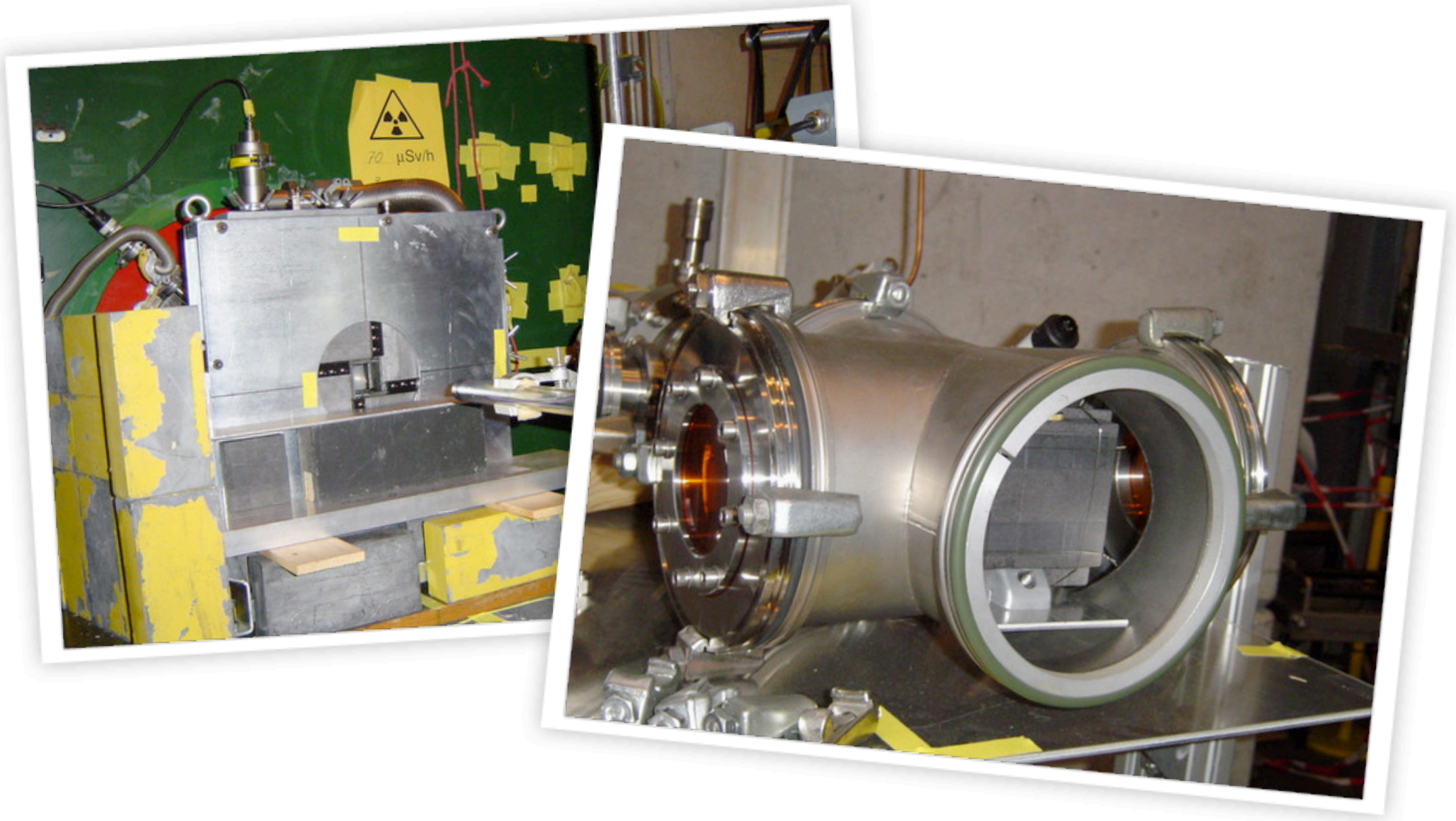
- R&D status
- Beam test @ PSI
  - $\pi^- p \rightarrow \pi^0 n$ process
  - beam line & detector setup
  - beam test overview
- Plans in 2004



R&D status on the Large Prototype Liquid Xenon detector

- 2001
  - construction, cooling & liquefaction test @ KEK
- 2002
  - R&D on a xenon purification system
  - 60 MeV electron beam test @ KSR
- 2003
  - Beam test @ TERAS (Laser Compton gamma)
  - shipping from KEK to PSI
  - beam test @ PSI,
    using γ from the $\pi 0$ decay



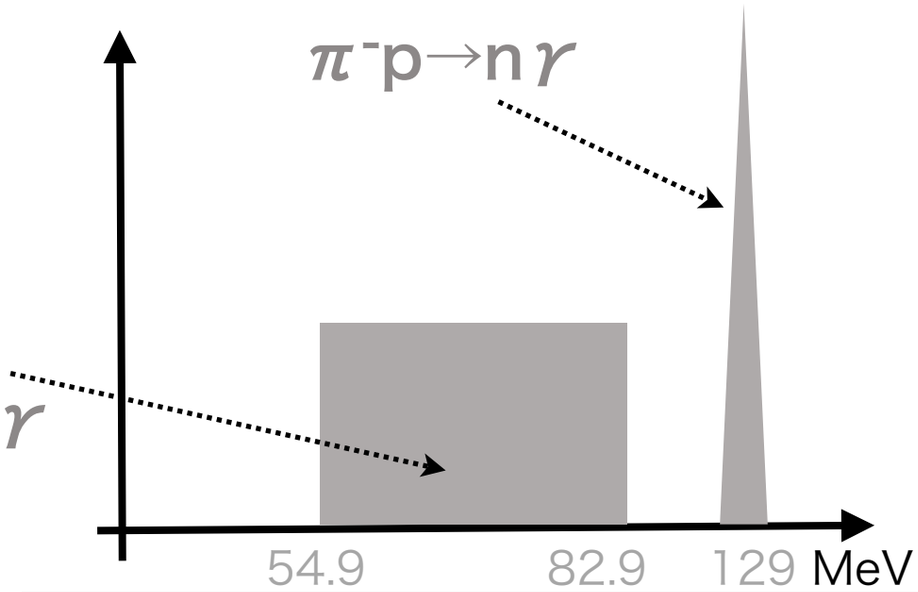
Beam test @ PSI

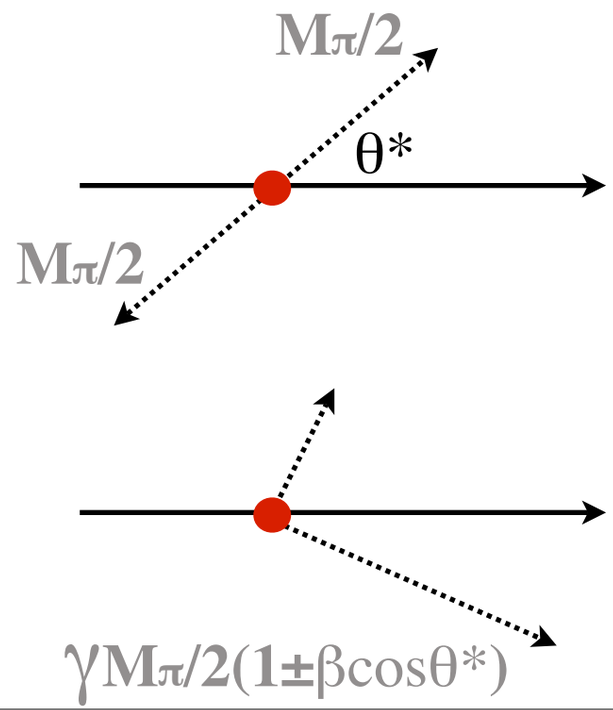
γ from π^0 decay

- Elementary process

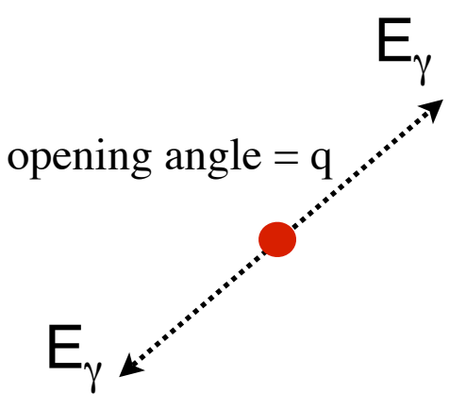
$\pi^- p \to \pi^0 n$

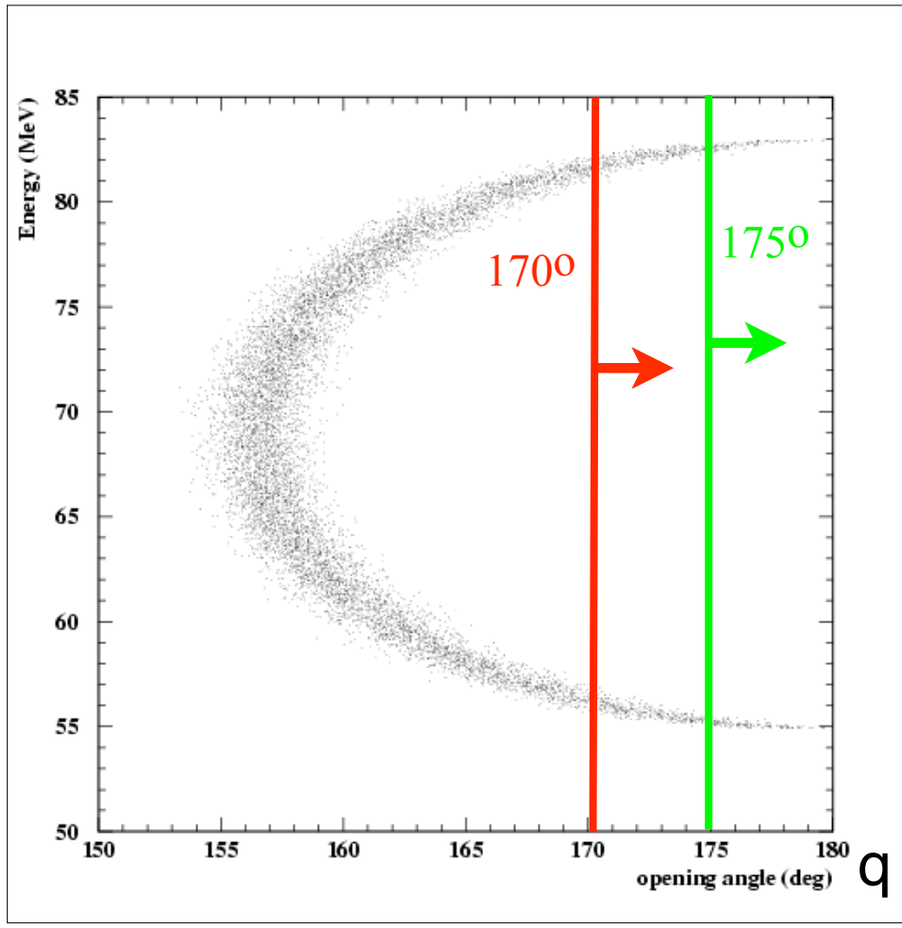
$\pi^0 \to \gamma\gamma$

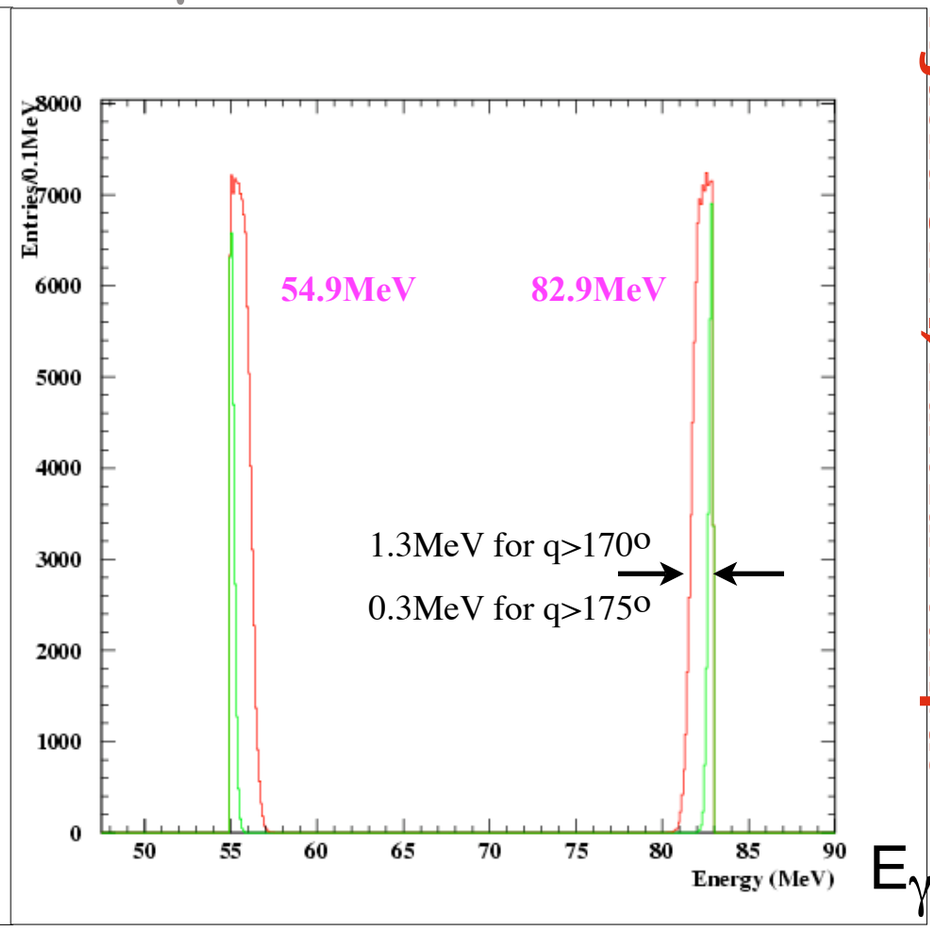




- Angular selection

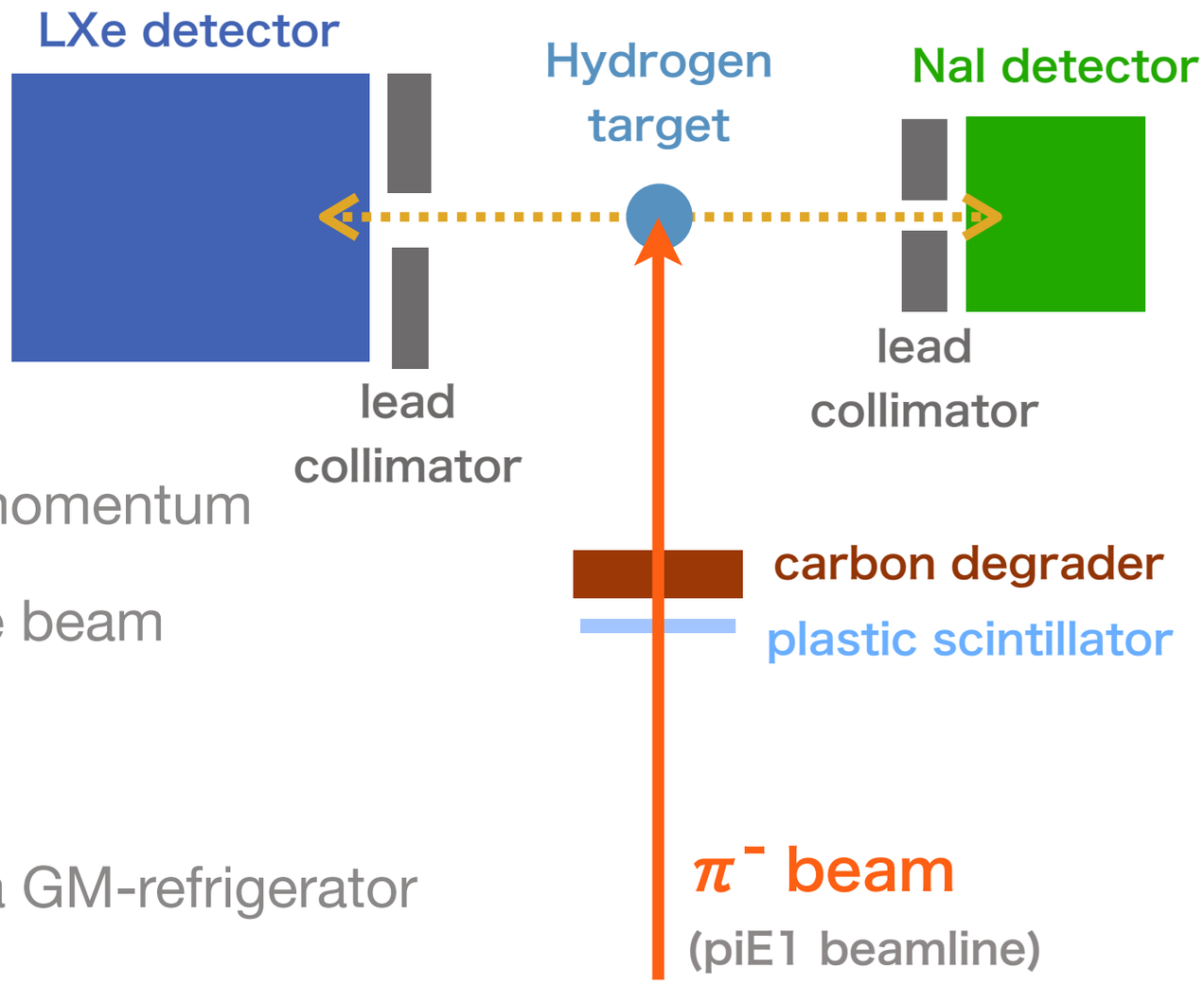


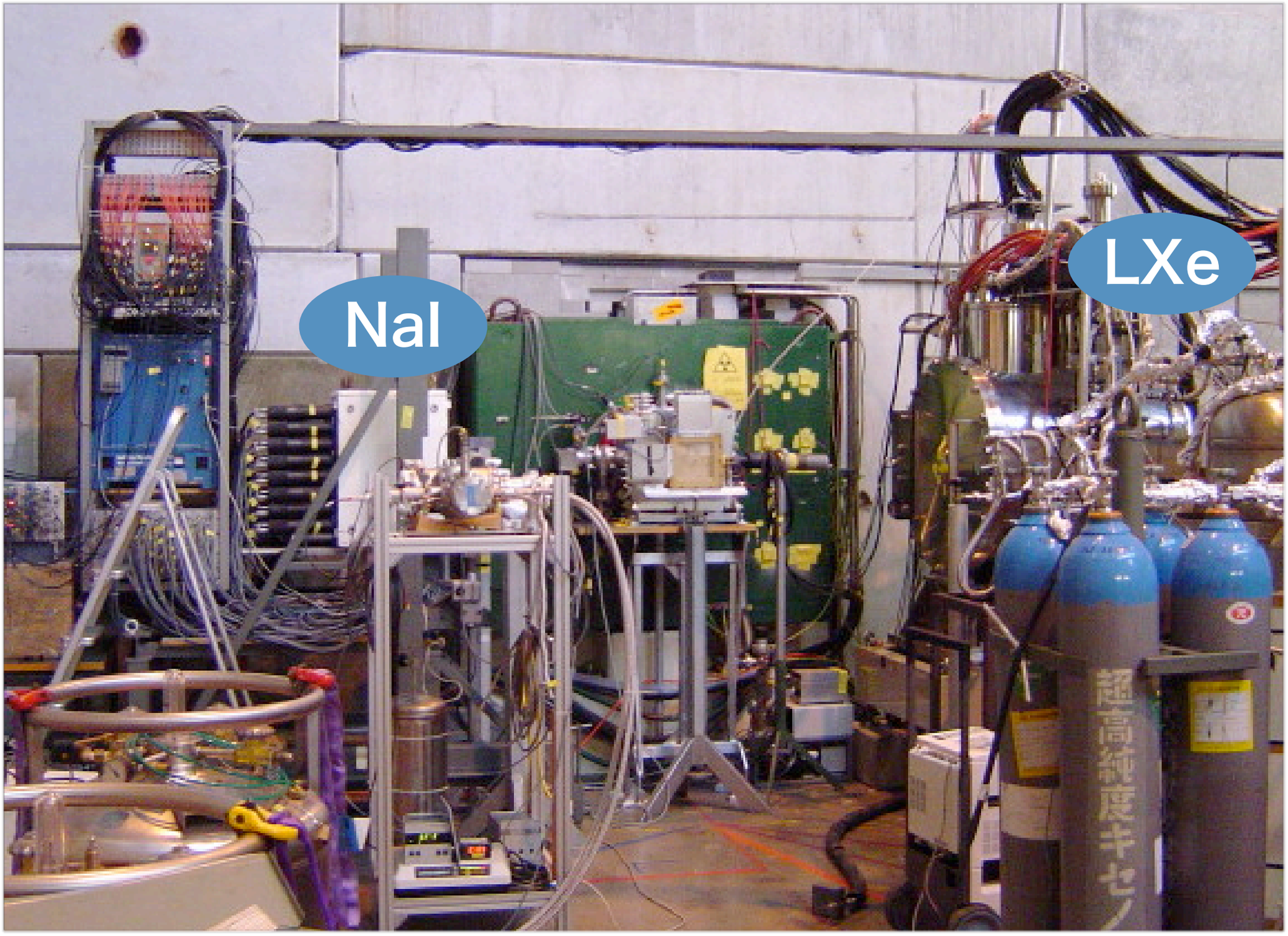




Experimental Setup

- Beam
  - π^- beam from piE1 beamline
  - carbon degrader to degrade momentum
  - plastic scintillator to define the beam
- Target
  - Liquid Hydrogen cooled with a GM-refrigerator
- Opposite γ tagging detector
  - NaI crystals array detector
  - Angular selection ~ 5 degree

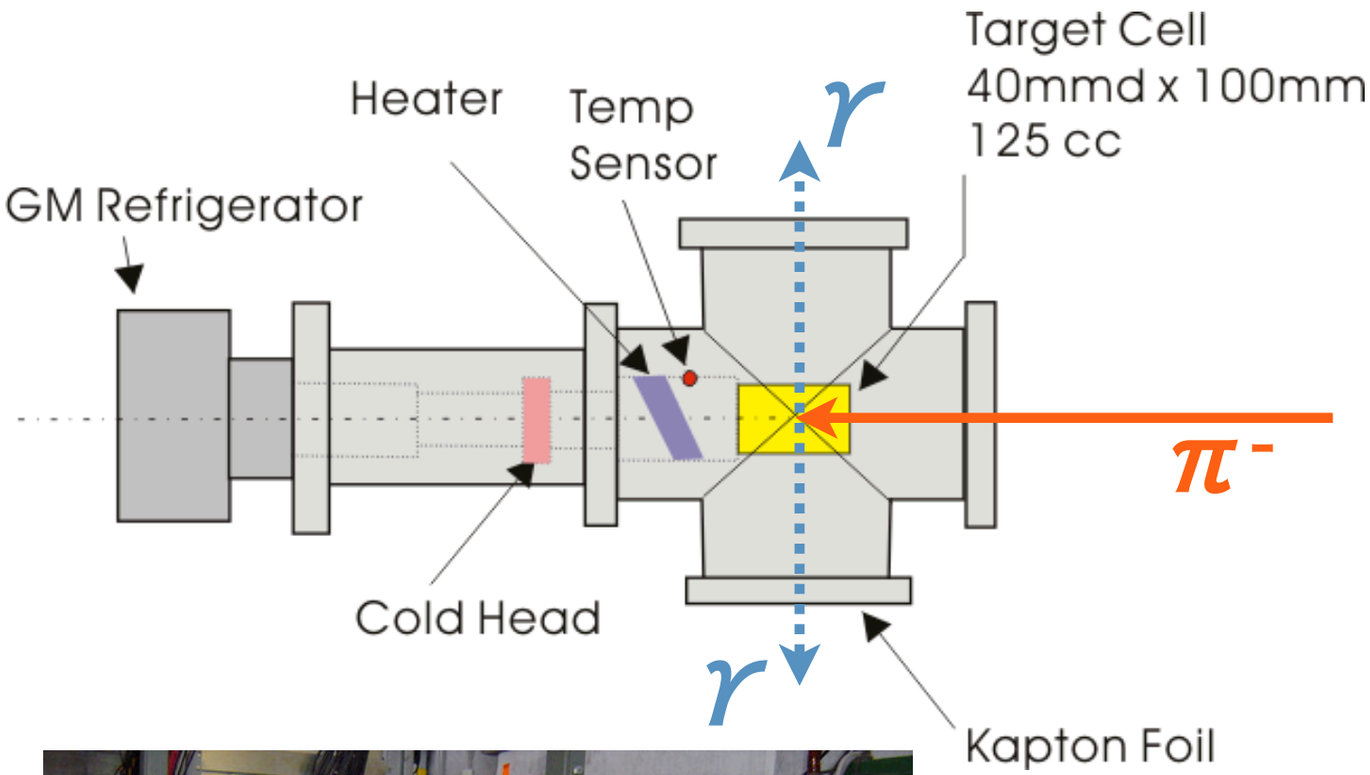


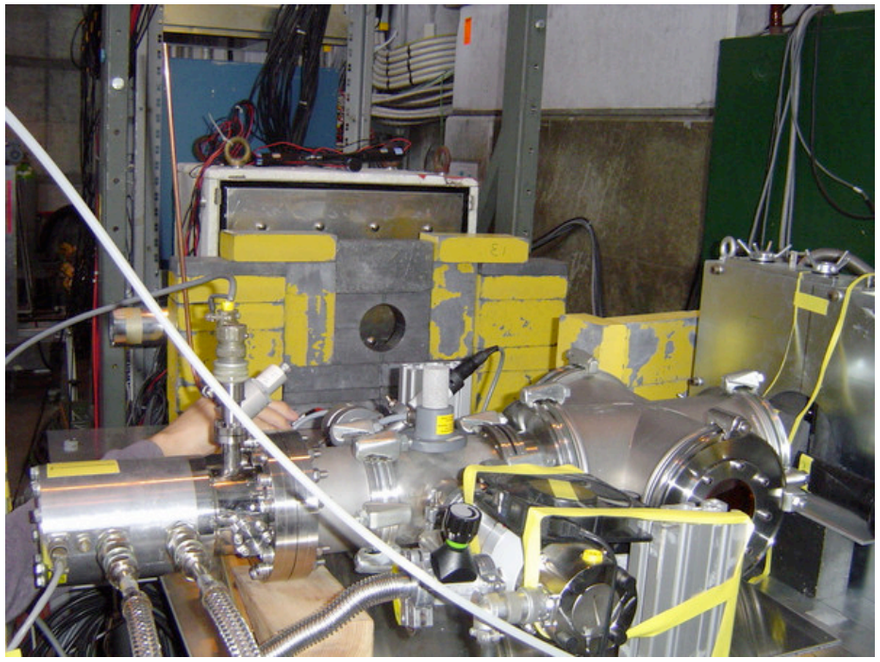


Snapshot

Hydrogen Target

- Liquid H2 cooled with a GM-refrigerator
- Temperature control
- Target cell
  - 0.5mm (t) Al
  - 40mm (d) x 100mm
  - 125cc liquid H2
- Kapton foil window
- pion entrance
- gamma exit

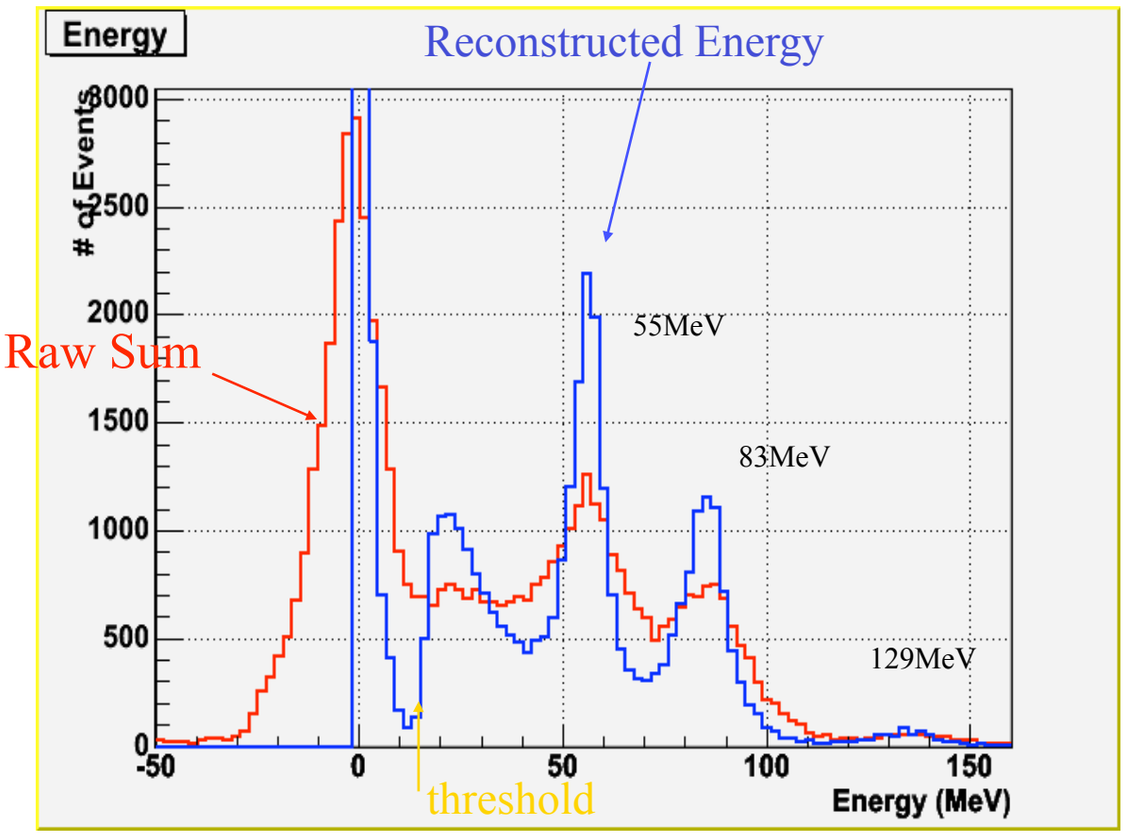




NaI detector

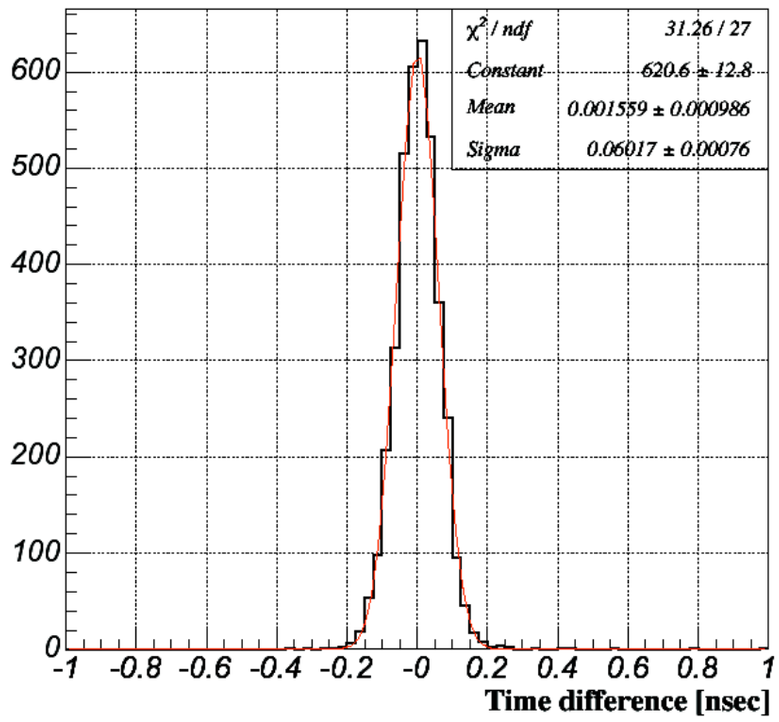
- 8x8 NaI crystals array
  - 6.3cm x 6.3cm x 40.6cm
  - Located 110cm from the target
  - HV calibration by cosmic ray

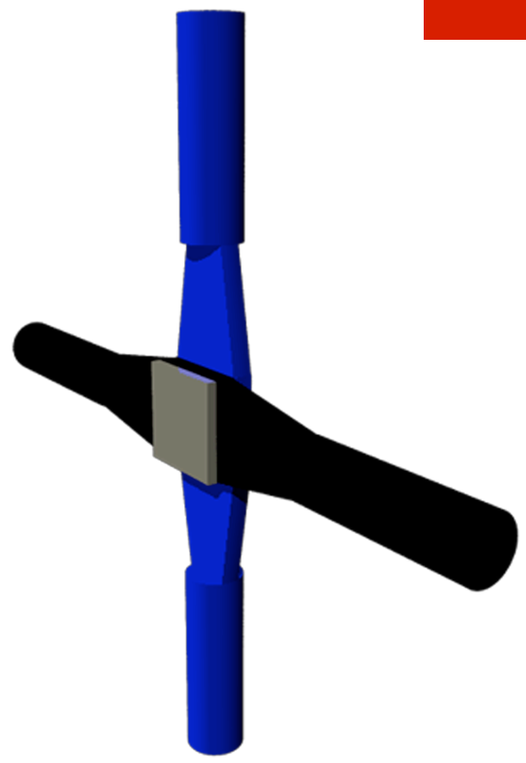
- Energy resolution
  - 7.0%(55MeV), 6.5%(83MeV), 6.1% (129MeV)
- Position resolution
  - 2.7cm (x), 1.6cm (y)



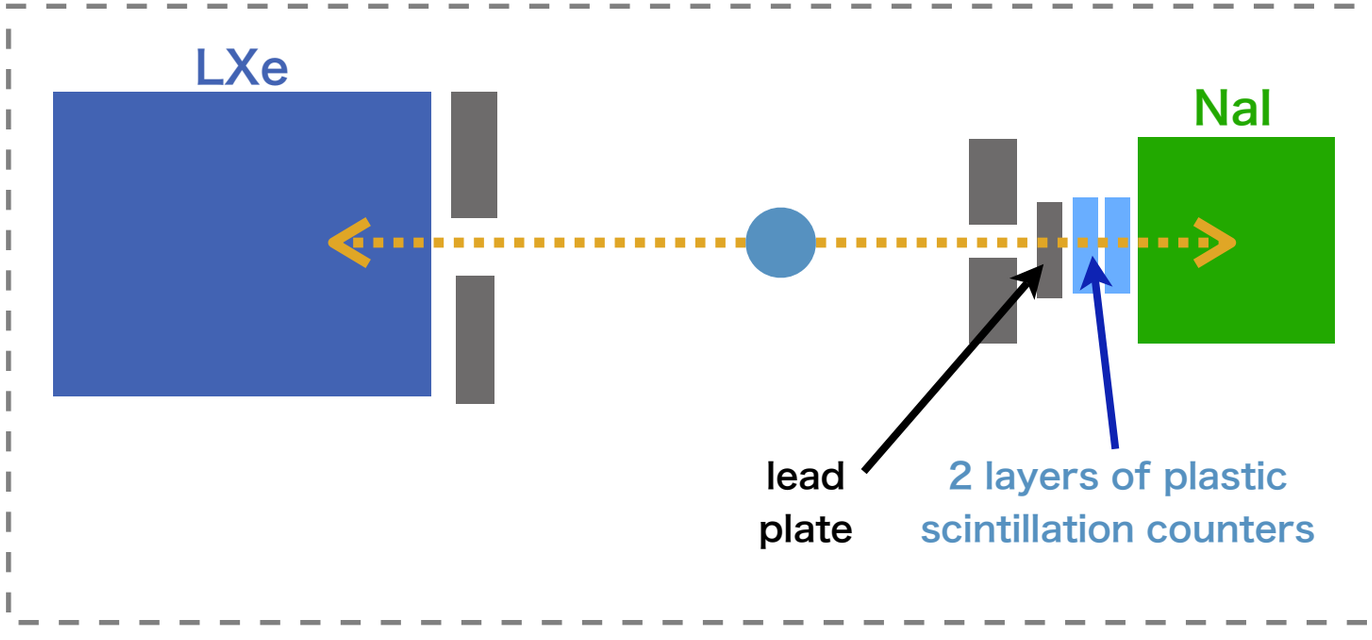
Timing counter

- 2 counters with lead
  - 5cm x 5cm x 1cm : BC404
  - Hamamatsu R5505
  - 6mm^{t} lead plate (γ converter)
- Efficiency
  - ~40% (for 83MeV γ)
- Timing resolution
  - 60 psec (sigma)
  - pion stopping distribution in the target must be considered in subtraction



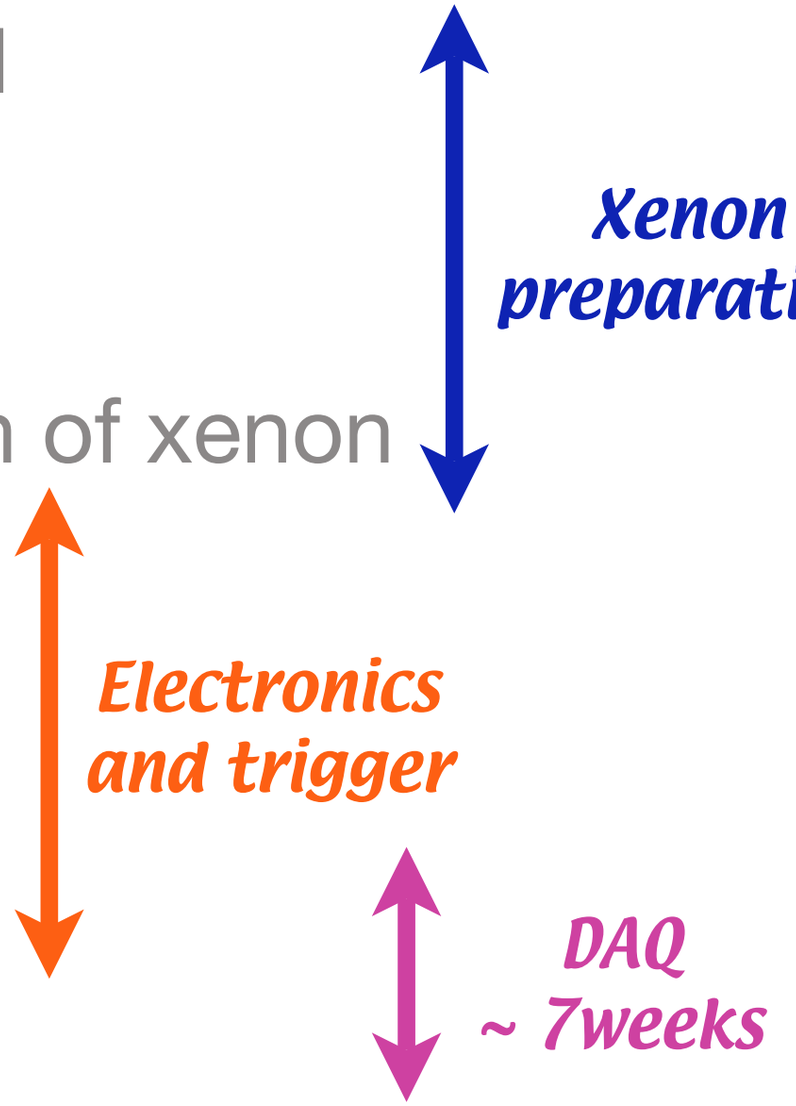


timing counter setup

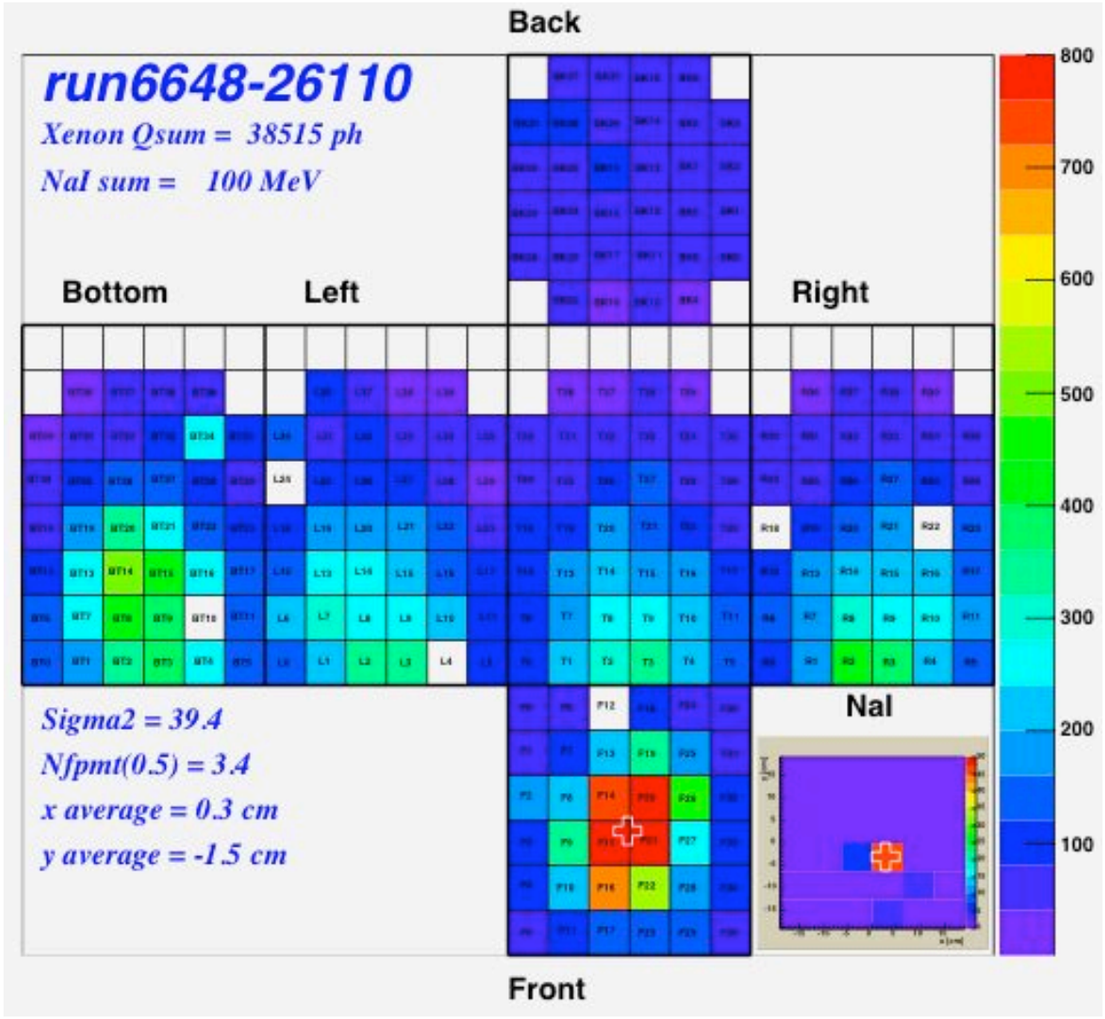


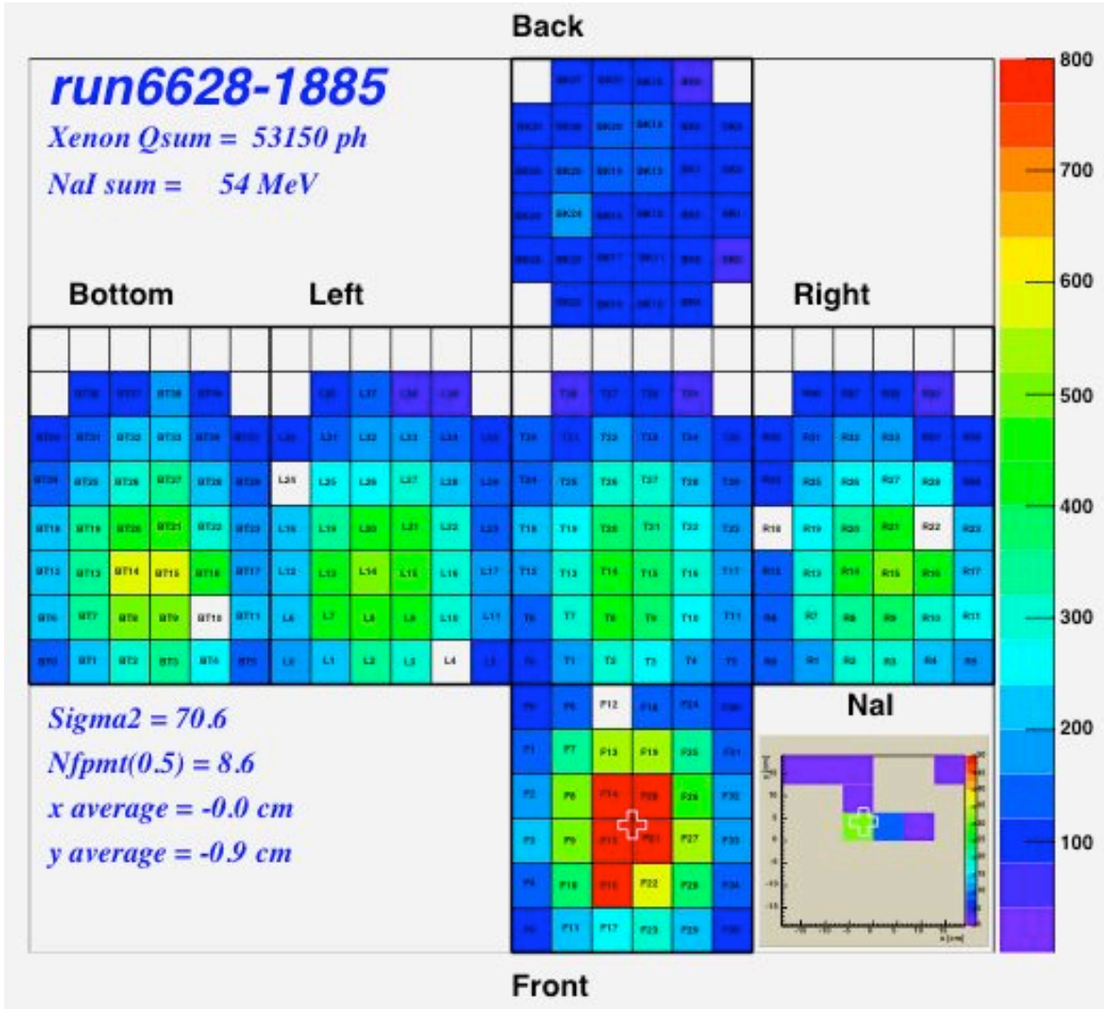
Schedule of the beam test

- 25/Sep. : Evacuation started
- 27/Sep.~ : Beam tuning
- 29/Sep.~01/Oct. : Pre-cooling
- 02/Oct.~05/Oct. : Liquefaction of xenon
- 05/Oct.~ : Electronics setup
- 05/Oct.~ : Purification started
- 06/Oct.~ : Test DAQ start
- 15/Oct. : First pi0 event
- 06/Dec.~07/Dec. : Recovery
- 07/Dec. : Cold xenon gas data for PMT calibration



Typical event (online display)

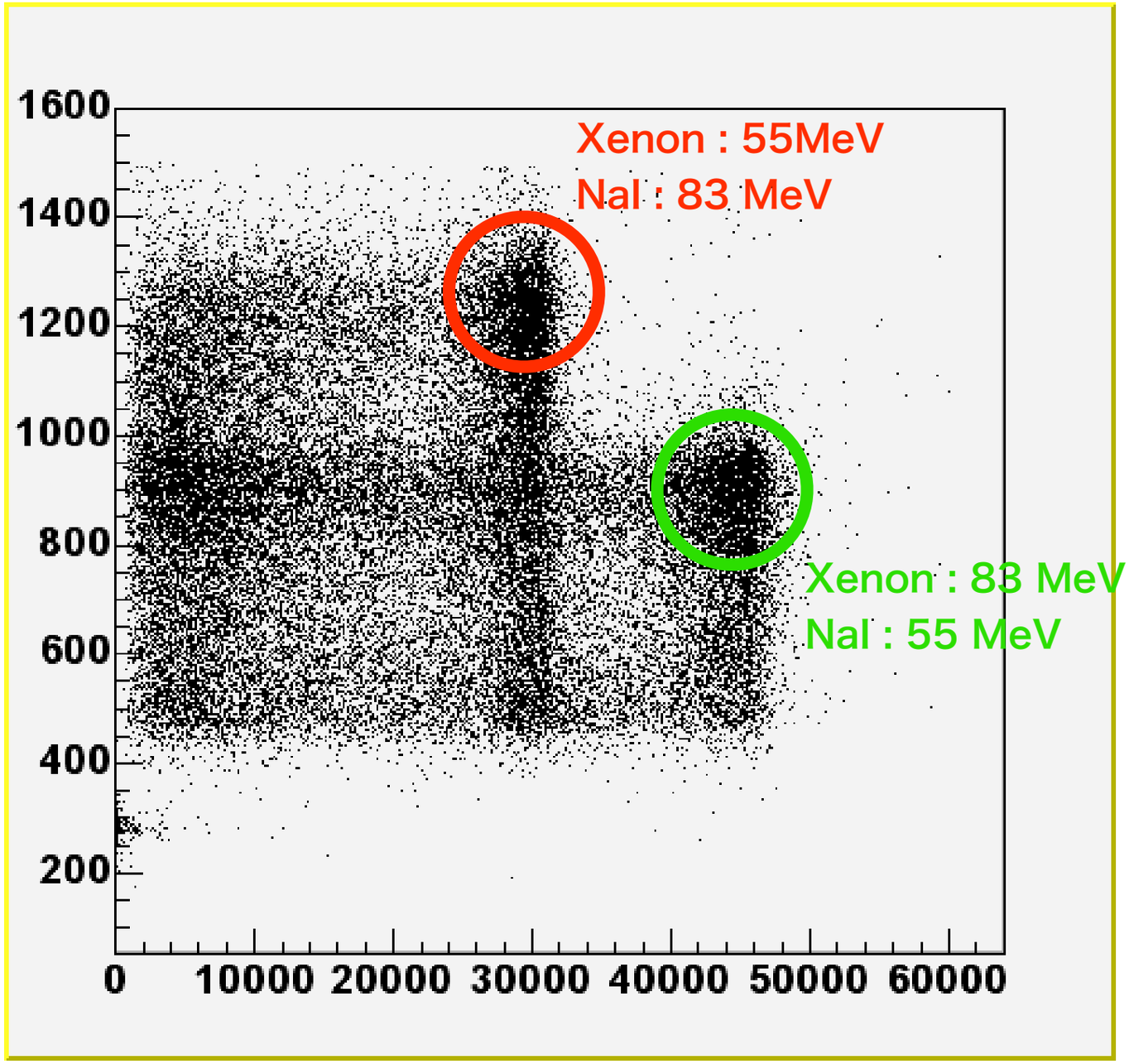




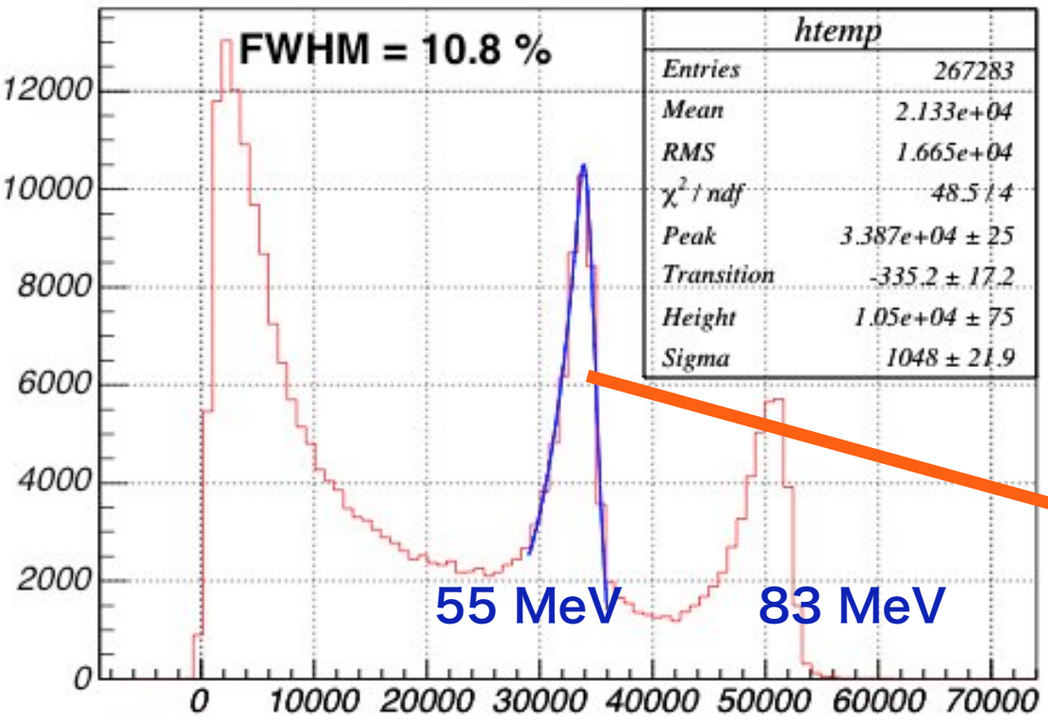
Xenon : 55MeV
NaI : 83 MeV

Xenon : 83 MeV
NaI : 55 MeV

π^0 events example

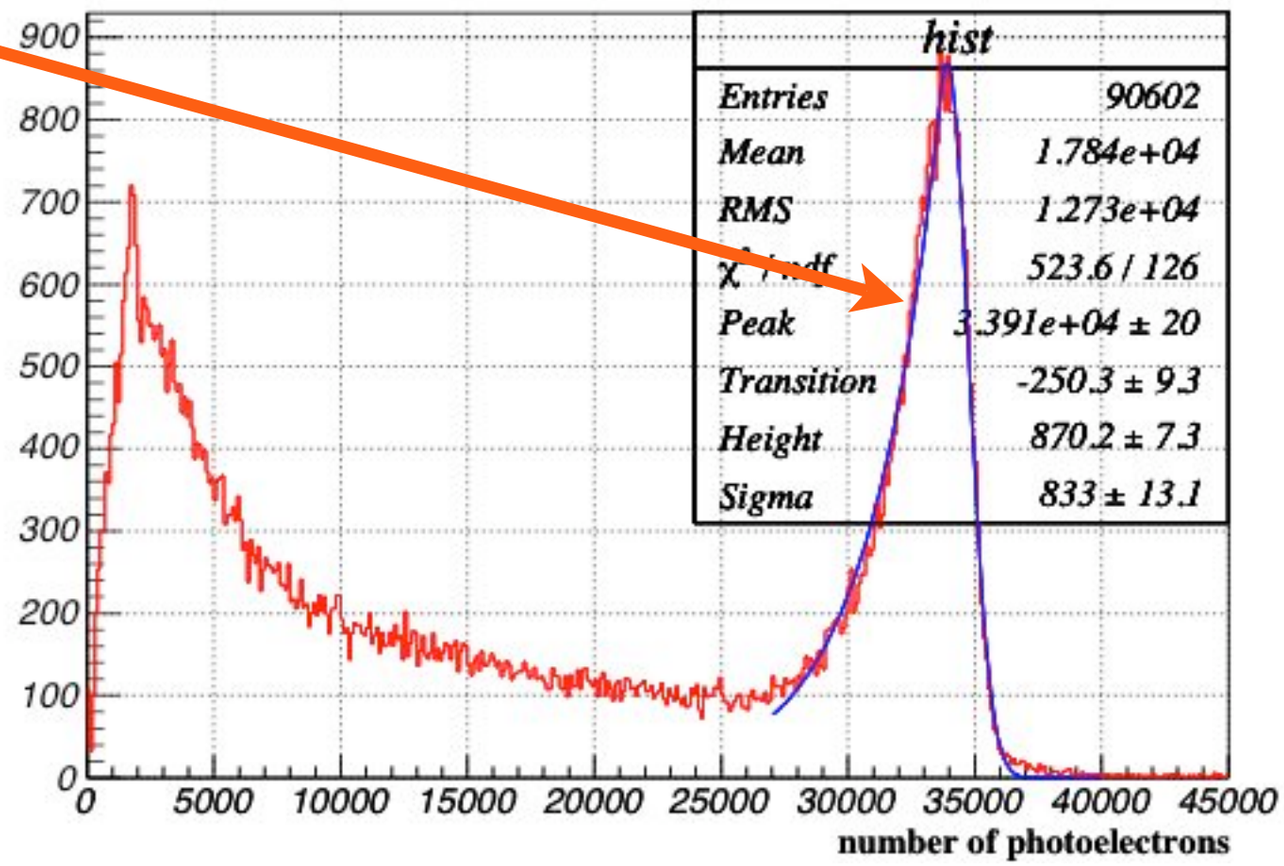


Energy spectrum example

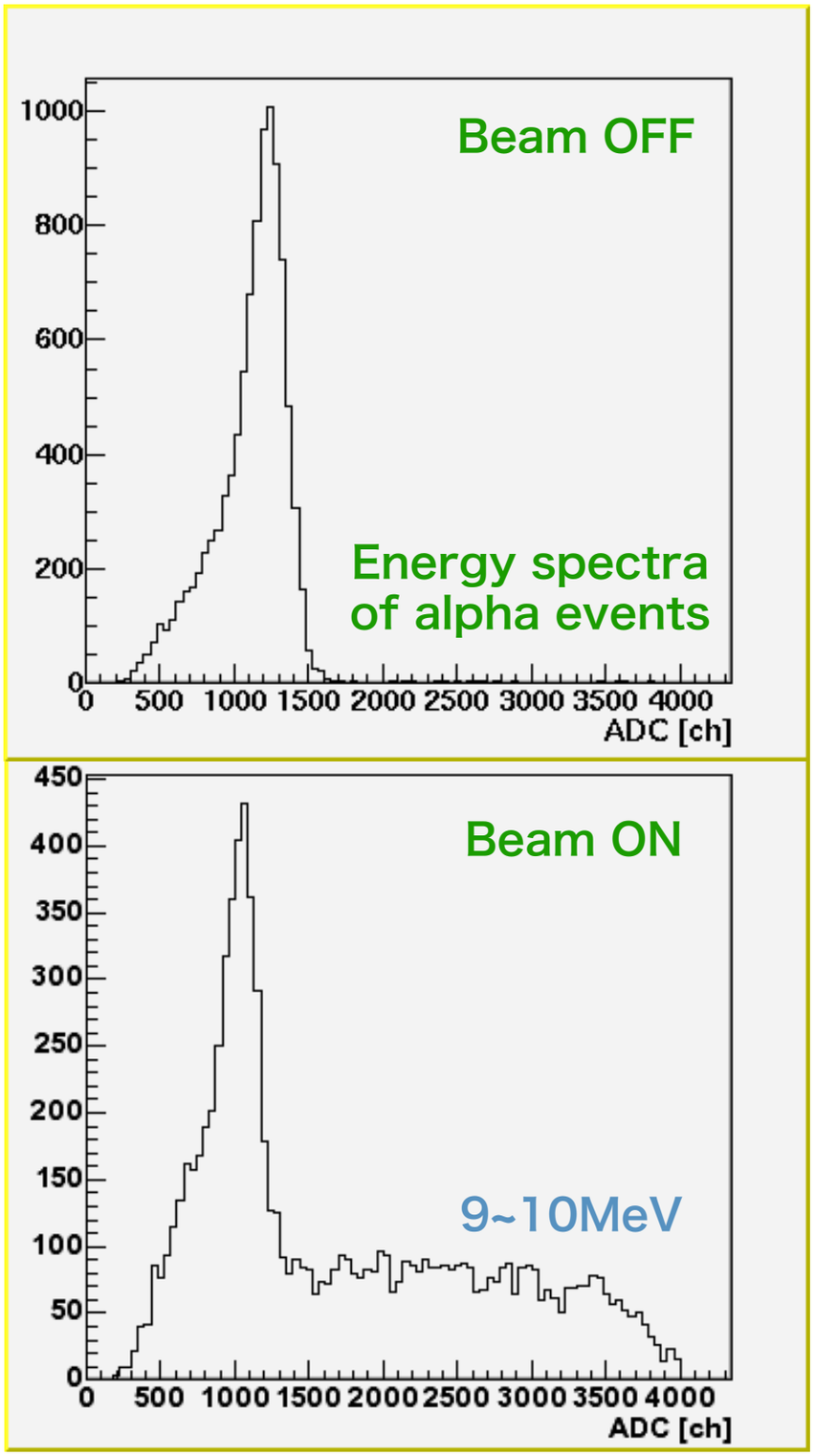


raw spectrum

after event selection
(NaI : 83 MeV)



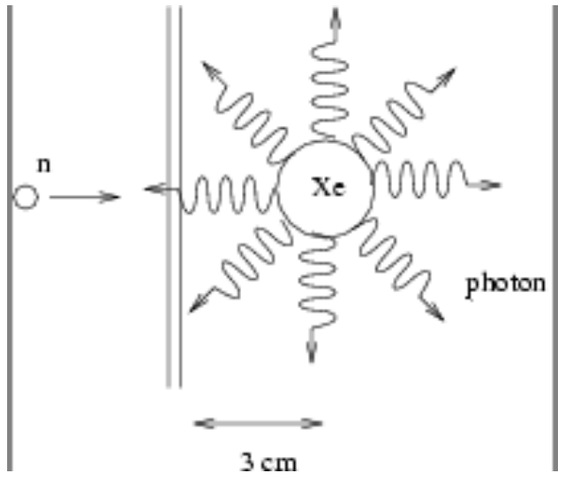
Neutron background



- Most probably caused by beam-related neutrons
- Corresponding to 1.5E6 p.e./sec
- Not due to bleeder current shortage but due to photocathode saturation because we observed the same effect even with lower PMT gain

Thermal neutron in Xe

- **Absorption length ~ 3 cm**
- **Capture close to calorimeter walls**
- **Multi γ, ΣE(γ) = 9.3 MeV**

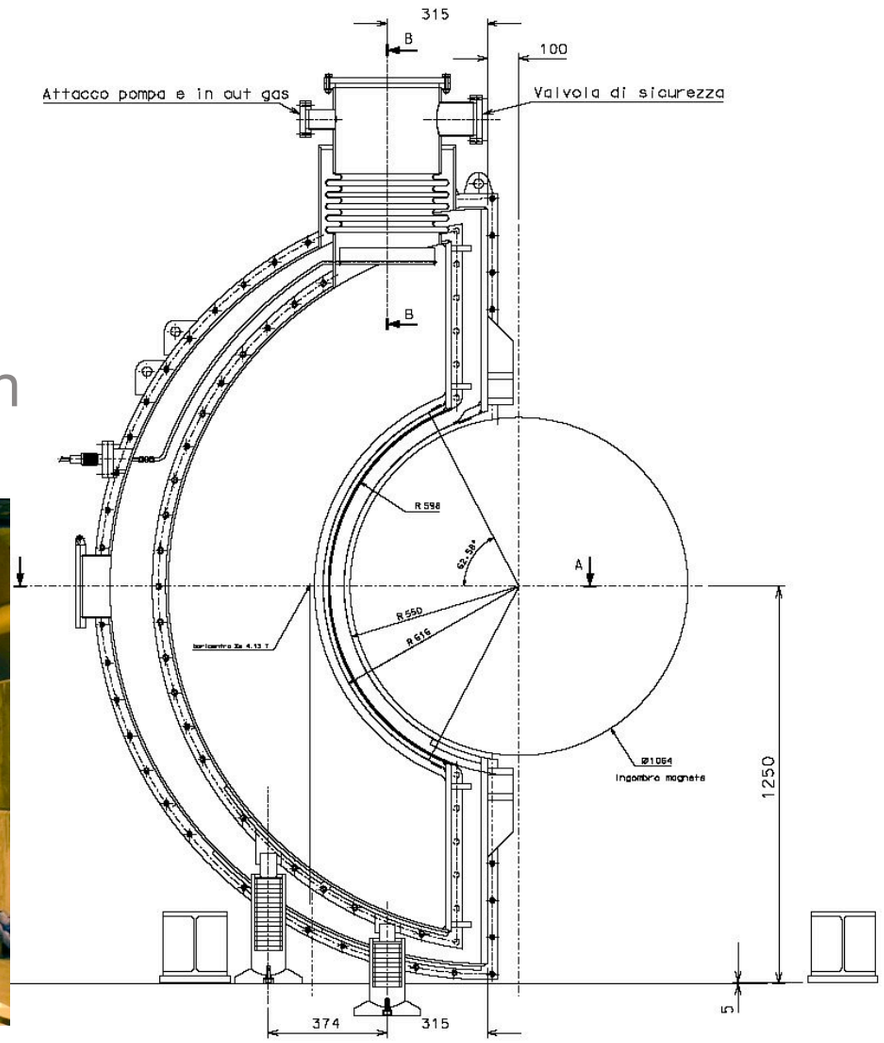


Analysis and Results

NEXT PRESENTATION

Plans in 2004

- Liquid phase purification test
- Neutron background measurement
- Magnetic field effect check
- Final detector construction
  - cryostat design renewal
  - Refrigerator will be assembled and delivered soon

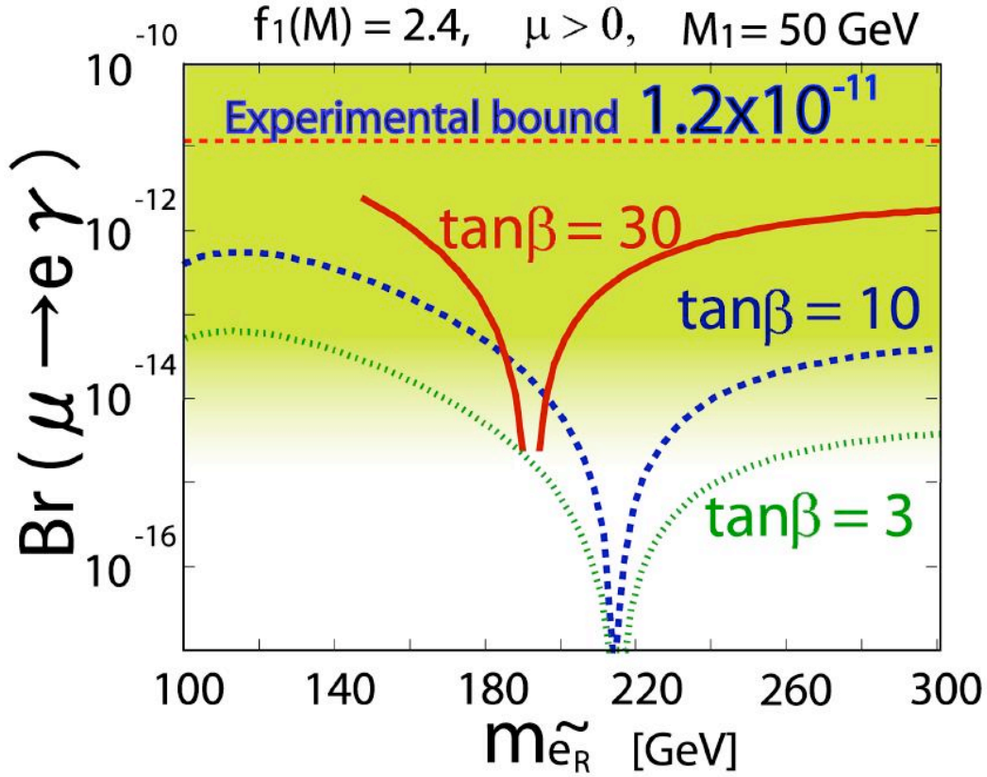


Appendix

Additional transparencies

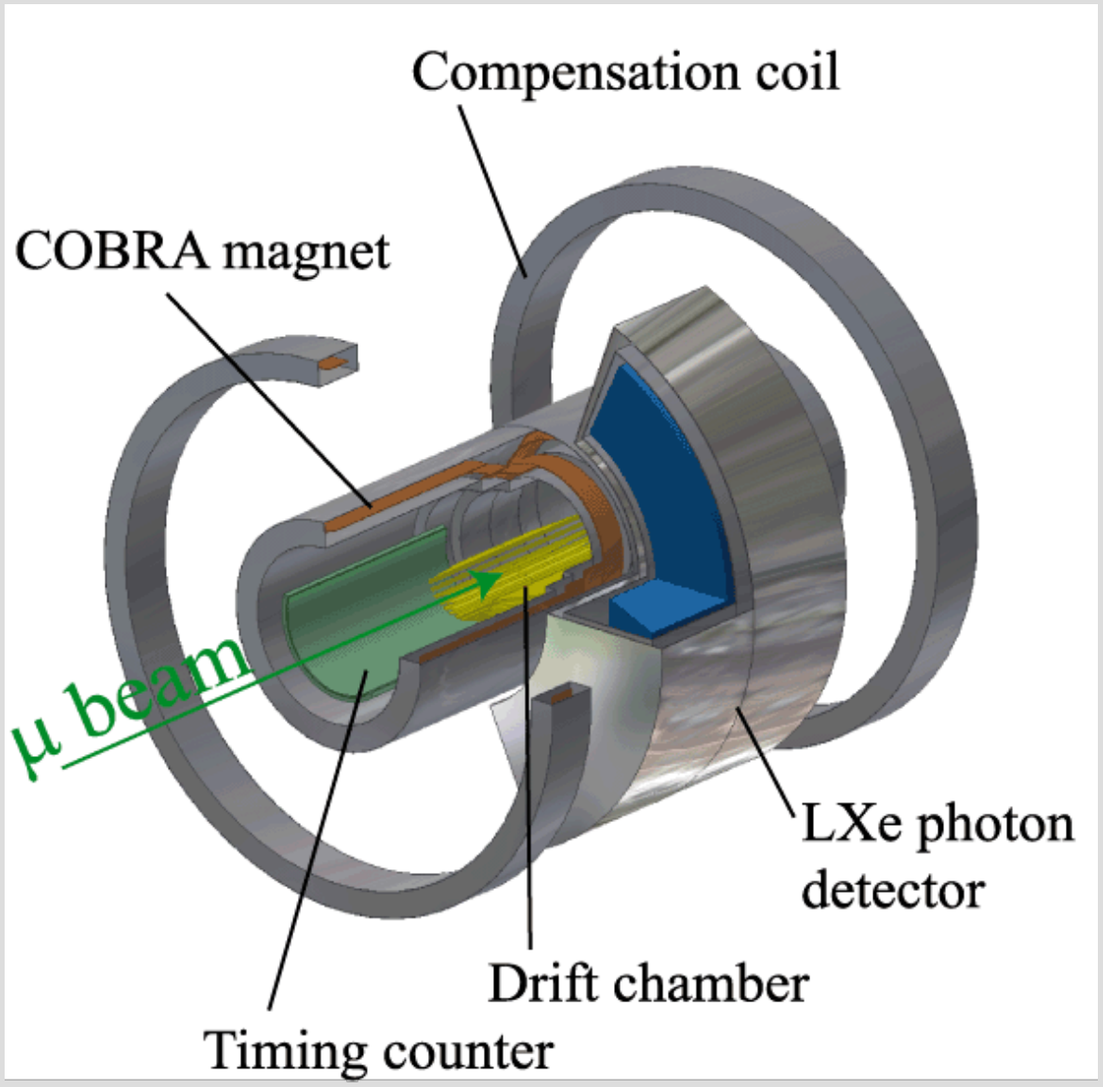
MEG experiment

- Search experiment for μ→eγ
  - "μ→evν" ~ 100% (Normal μ decay in SM)
  - "μ→eγ" violates Lepton Flavor Conservation
  - SUSY-GUT models predict higher branching
    $Br(\mu \to e\gamma) = 10^{-11} \sim 10^{-15}$
  - **Sensitive to physics beyond the SM !!**



- New experiment with a sensitivity of Br : $10^{-13} \sim 10^{-14}$ planned at Paul Scherrer Institut (PSI)

MEG detector



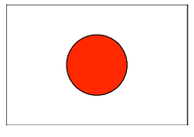
Detector Overview

Features

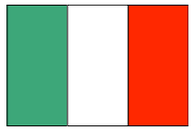
- The most intense DC muon beam @ PSI
- Liquid Xenon photon detector
- Positron spectrometer with gradient magnet field
- Thin superconducting magnet
- Thin drift chamber and timing counter for positron tracking
- Engineering run will start in 2004,5
- Physics run will start in early 2006

MEG Experiment Collaboration

4 countries
10 institutions

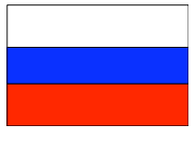


ICEPP, University of Tokyo
KEK
Waseda University

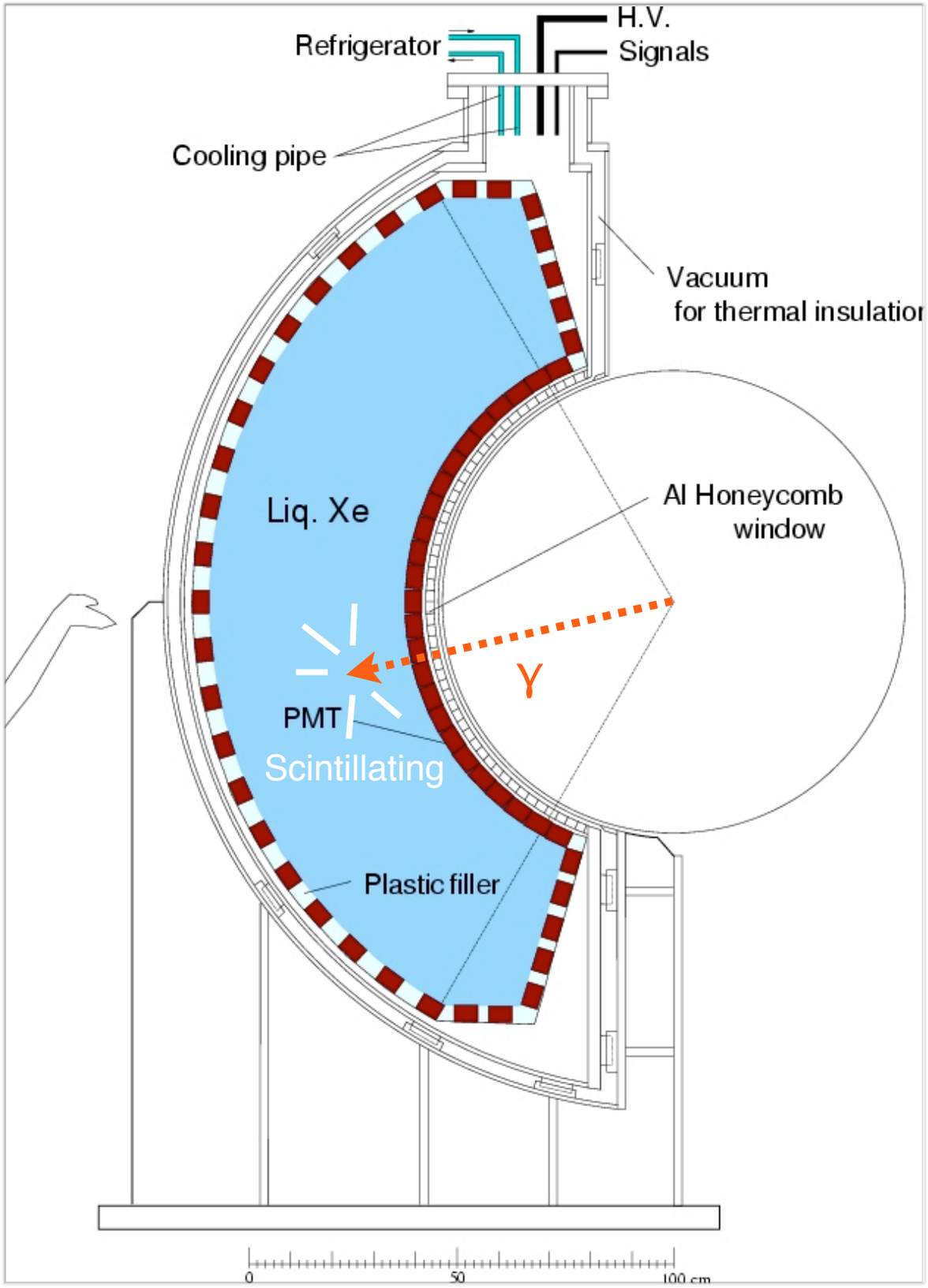


INFN & Genova University
INFN & Lecce University
INFN & Pavia University
INFN & Pisa University

Paul Scherrer Institut
ETH-Zurich



Budker Institute



Liquid Xenon Photon detector

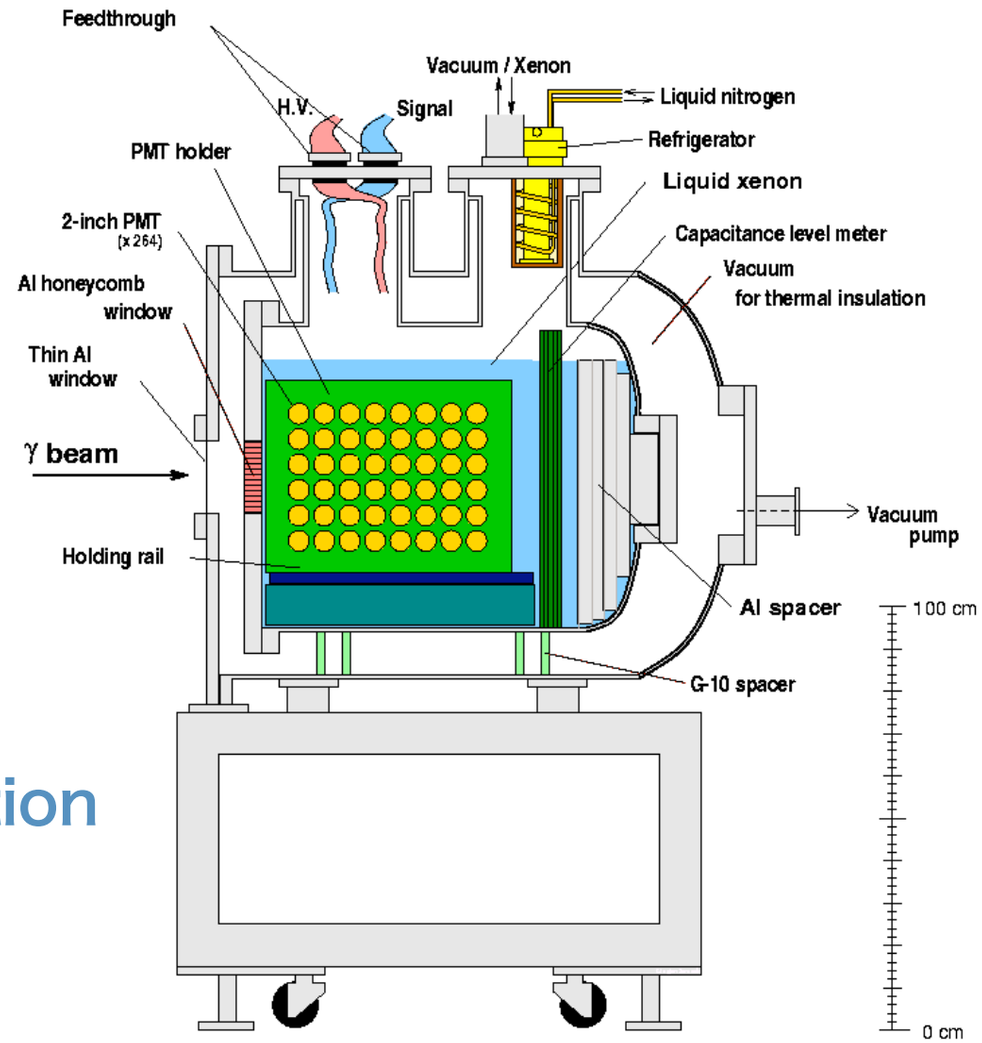
Features

- High light yield (75% of NaI)
  - Good resolutions
- Fast signal (4.2nsec decay time)
  - Reduce pileups
- Liquid (good uniformity)
  - No need segmentation

Design

- Active volume of LXe ~ 800L
- 800 PMTs immersed in LXe

Large Prototype LXe detector



70 Litter active volume (120 L LXe in use)

228 PMTs

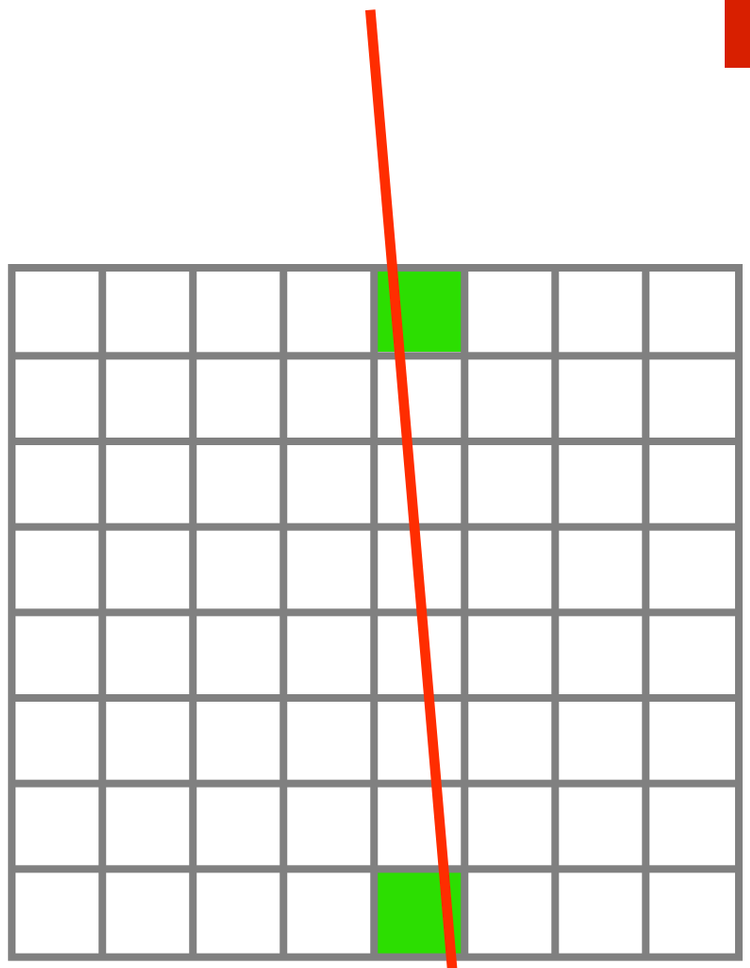
Total system check in a realistic operation

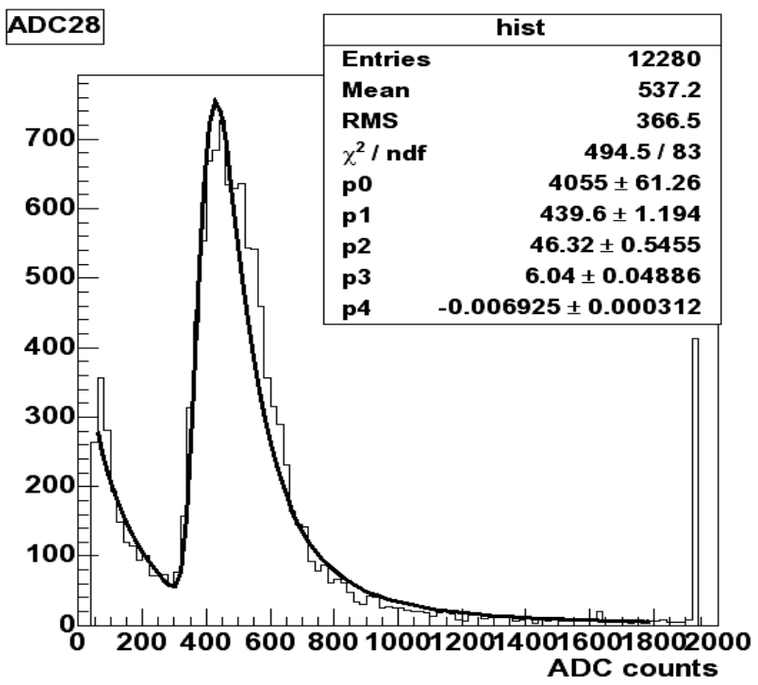
Purification system for Xenon

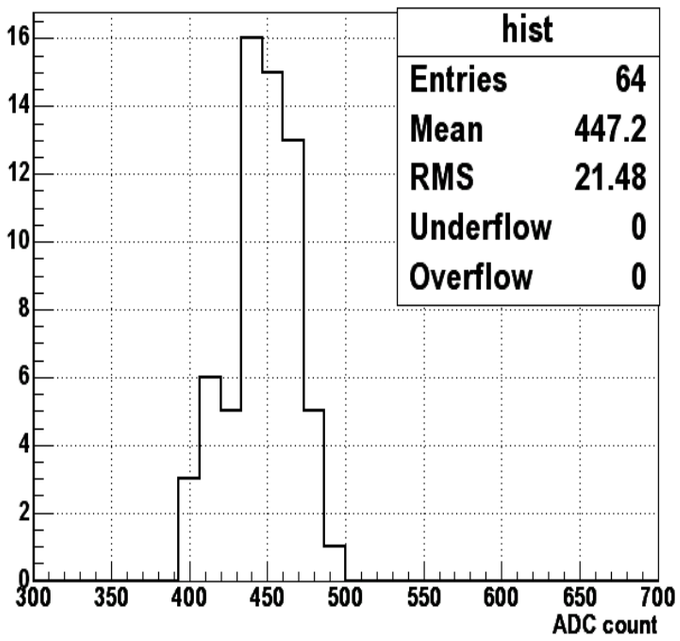
Performance test

NaI detector calibration

- High voltage value for each PMT is adjusted by using cosmic ray events
- Pedestal subtraction and gain correction are done in the offline analysis
- Energy and vertex reconstruction are performed by using corrected charge information

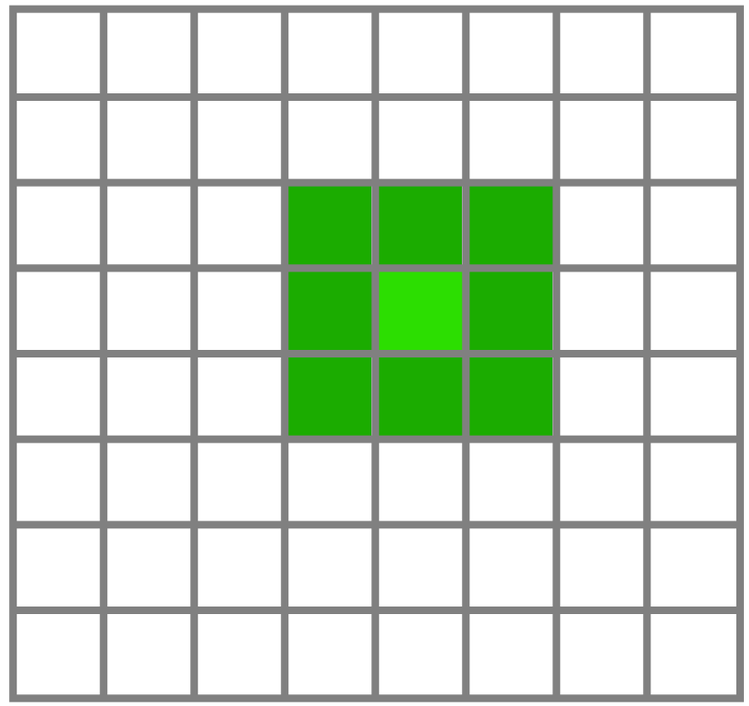


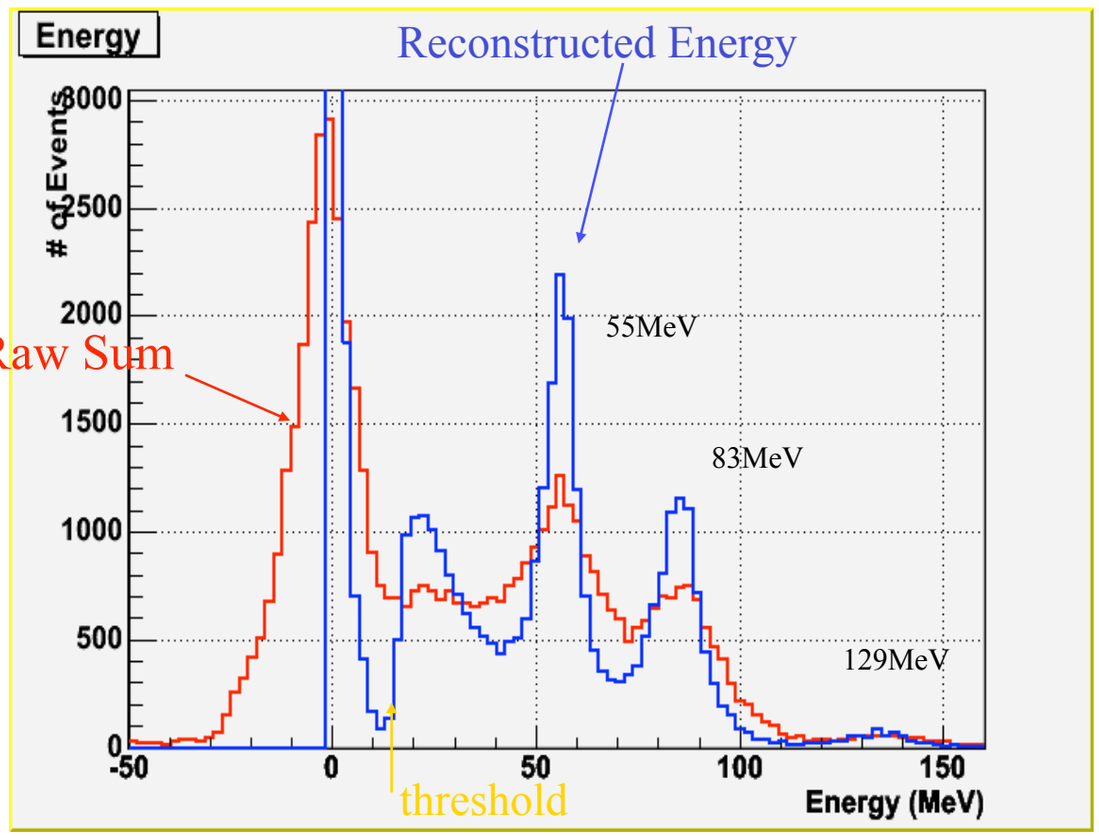




NaI energy estimation

- Search for the NaI crystal with maximum charge
- Charge sum in the surrounding NaI's
- The calibration parameter is determined by using 129 MeV gamma data (and MIP peak)





NaI vertex reconstruction

- Search for the NaI crystal with maximum charge
- Fit the charge distribution of the raw or column (8 NaIs in each) that include NaI with maximum charge using Gaussian