MEG最初の一年、その展望

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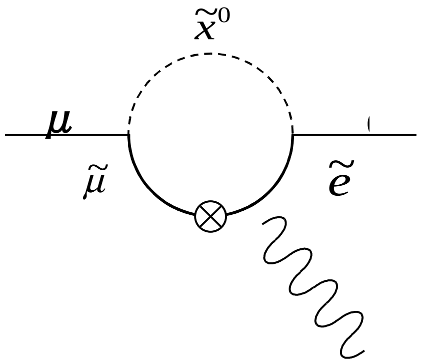
Contents

Introduction

$\mu \rightarrow e\,\gamma$

- Lepton Flavor Violation (LFV) is strictly forbidden in SM
- Neutrino oscillation
  - LF is not conserved
  - Contribute $\propto (m_\nu/m_W)^4$
- Supersymmetry
  - Off-diagonal terms in the slepton mass matrix



$Br(\mu \rightarrow e\gamma) \propto (\sin\theta_{\tilde{\mu}\tilde{e}}(m_{\tilde{\mu}}^2 - m_{\tilde{e}}^2)/m^2_{SUSY})^2$

$$m_{\tilde{l}}^2 = \begin{pmatrix} m_{11}^2 & m_{12}^2 & m_{13}^2 \\ m_{21}^2 & m_{22}^2 & m_{23}^2 \\ m_{31}^2 & m_{32}^2 & m_{33}^2 \end{pmatrix}$$

Just below the current limit

$Br(\mu \rightarrow e\,\gamma) = 1.2 \times 10^{-11}$

(MEGA, PRL 83(1999)83)

Other LFV search experiments

- $\tau \quad \mu\gamma$, $e\gamma$
  - KEK, BELLE
  - SLAC, BABAR
- μ -e conversion
  - J-PARC, PRISM project, PRIME

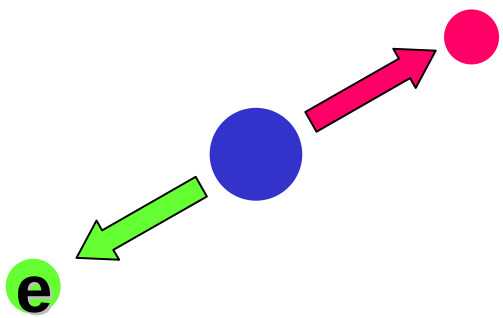
MEG

μ $e\gamma$ decay search experiment at Paul Scherrer Institut

Japan, Italy, Switzerland, Russia, USA

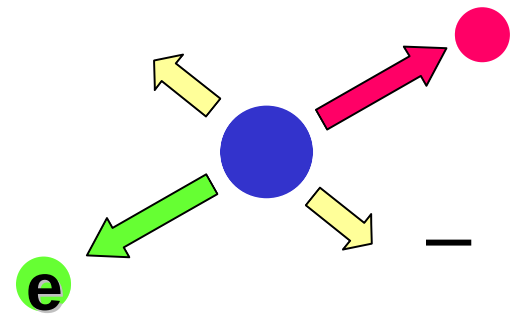
Signal and Background

- Signal

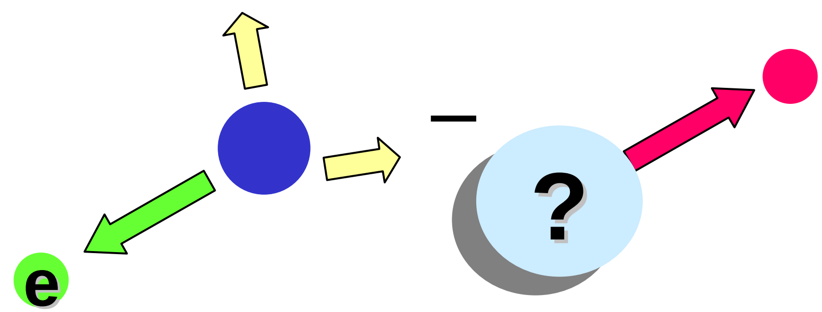


- $E_\gamma = m_\mu /2 =$ 52.8MeV
- $E_e = m_\mu /2 =$ 52.8MeV
- $\theta = 180^o$
- Time coincidence

- Background
  - Radiative μ decay



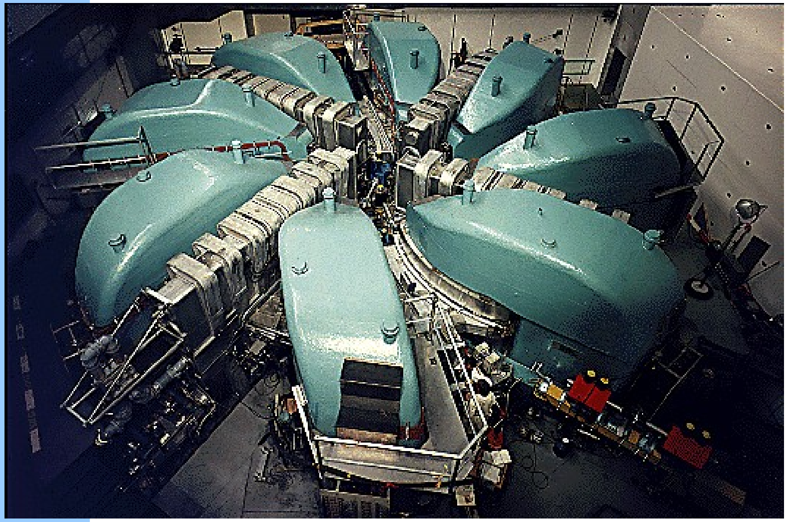
  - Accidental overlap

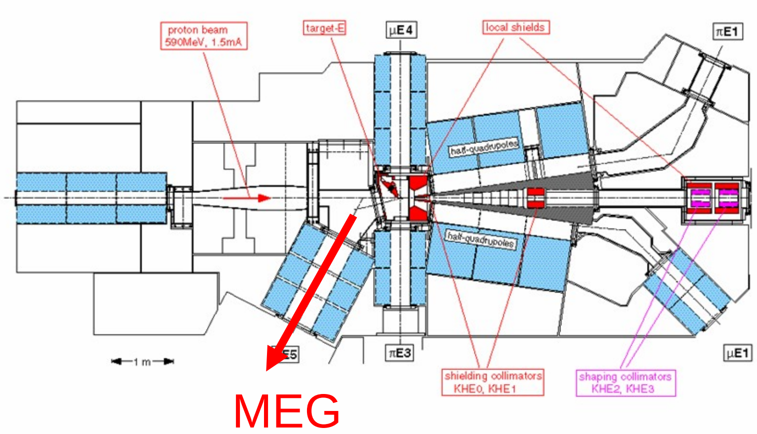


Essentials

- Intense muon beam
  - DC beam is better to reduce accidental pile-up events
- Gamma Detector — Liquid Xenon Detector
  - Good resolutions
  - Capability of identifying pile-up events
- Positron Detector — COBRA spectrometer
  - Good resolutions
  - Low amount of material
  - Blind to low energy positrons

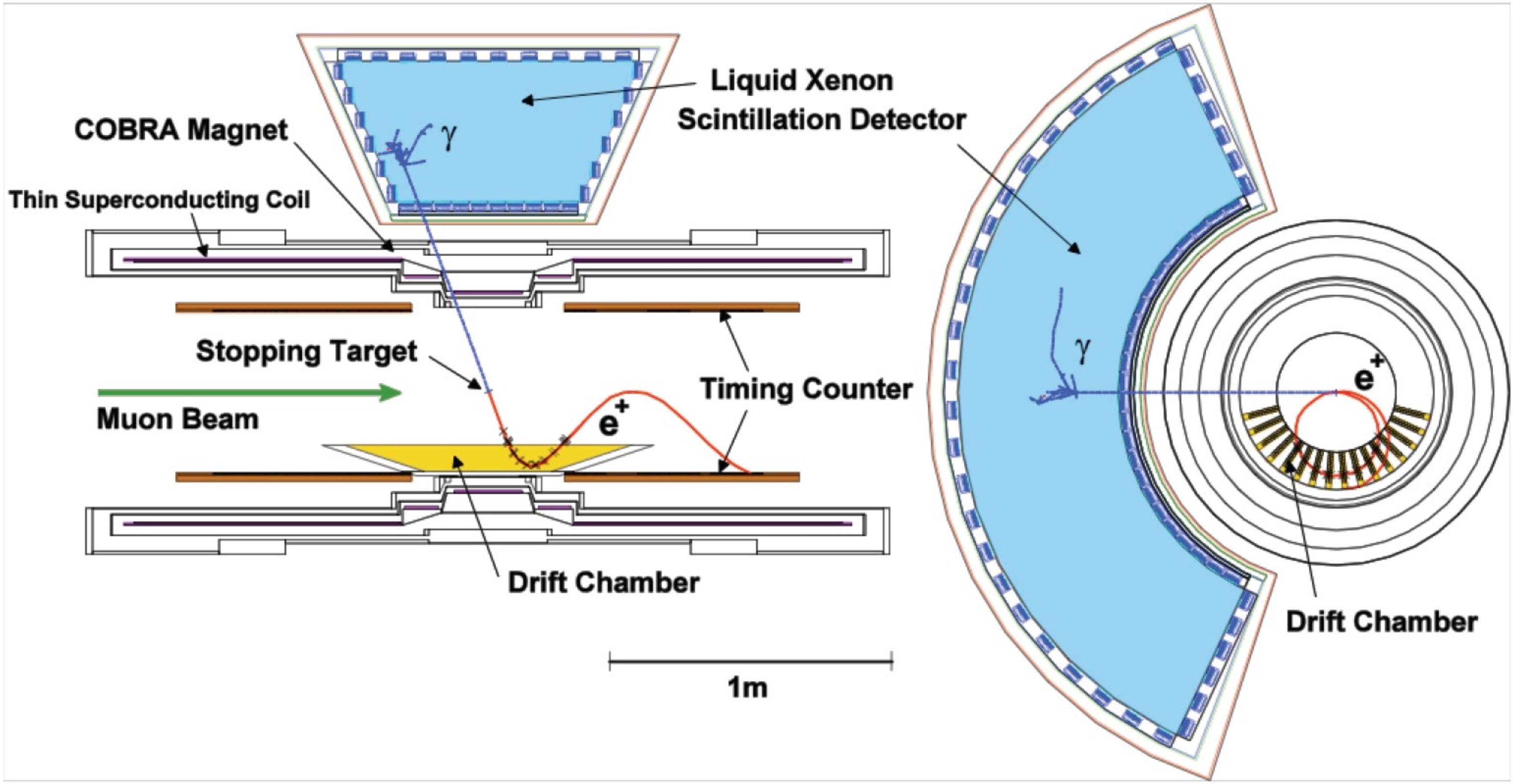
PSI Proton Cyclotron





Proton energy: 590MeV
Nominal operation current: 1.8mA.
Max > 2.0mA possible.

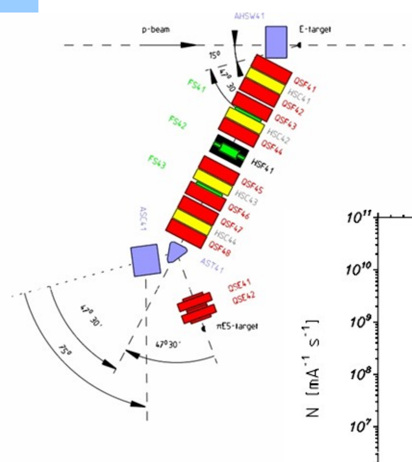
MEG Detector

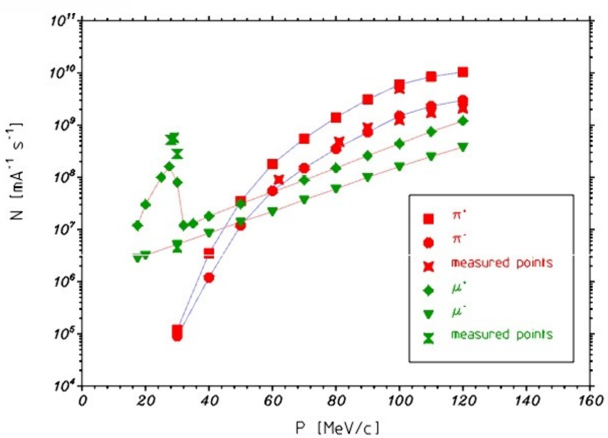


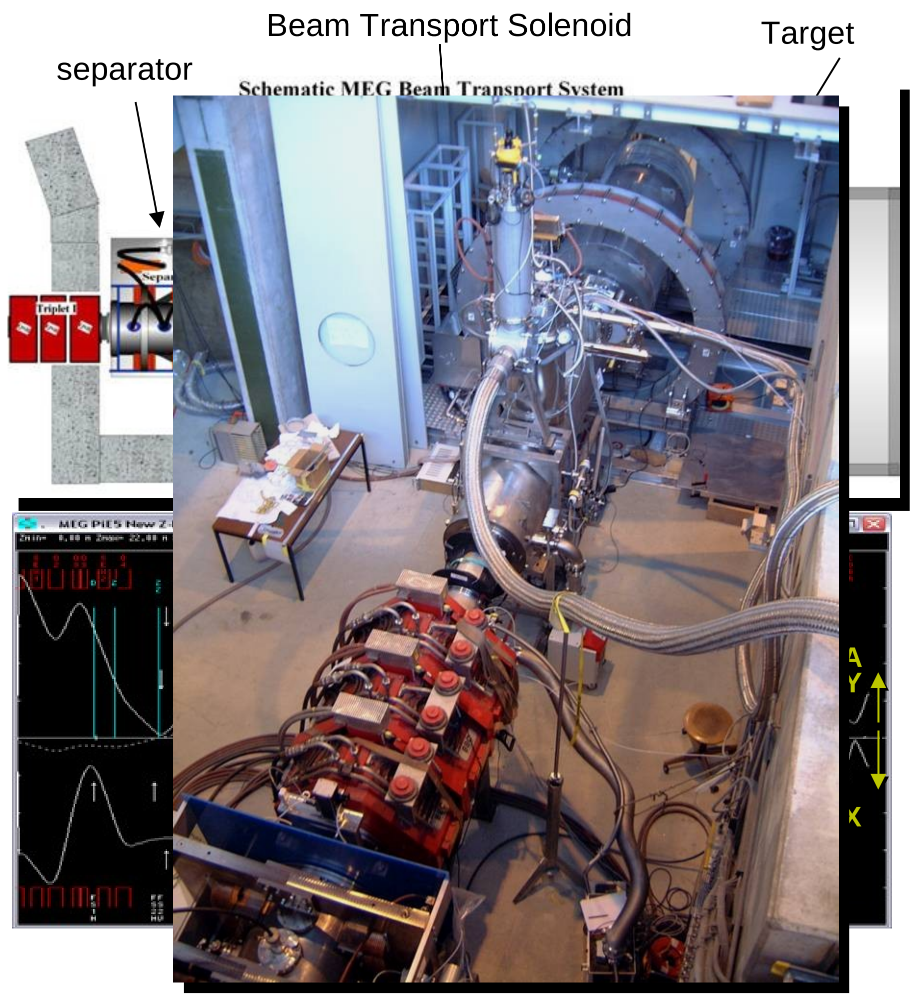
- Liquid xenon photon detector
- COBRA spectrometer – Magnet, DC, TC
- All detector waveforms are recorded.

Beam Line

- Length 10.4 m
- Solid angle 150 msr
- Momentum acceptance (FWHM) 10 %
- Momentum resolution (FWHM) 2 %



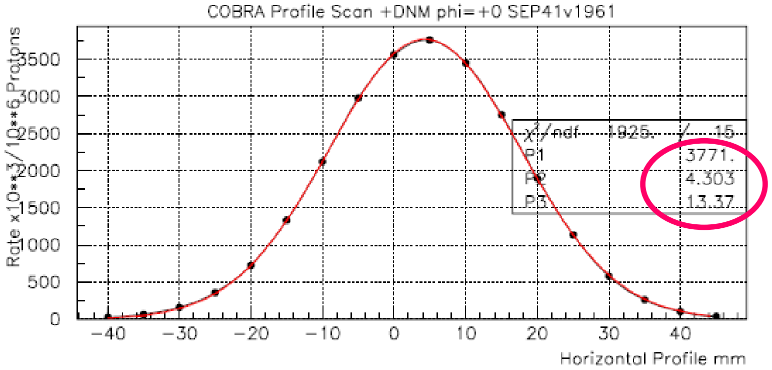




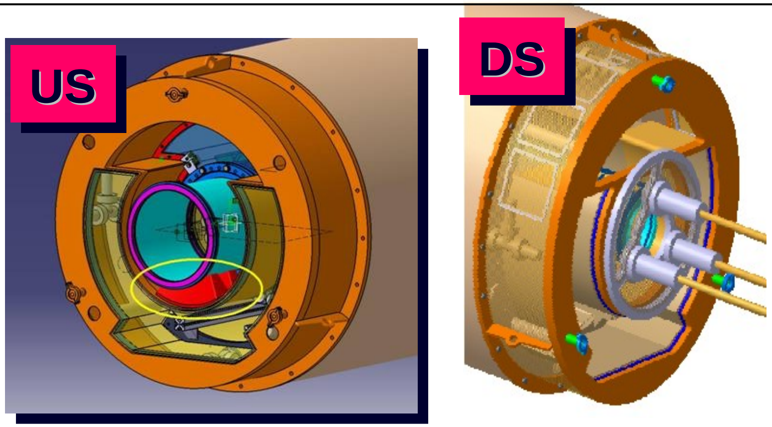
森田裕一 “MEG実験におけるビームチューニング” 29日午後

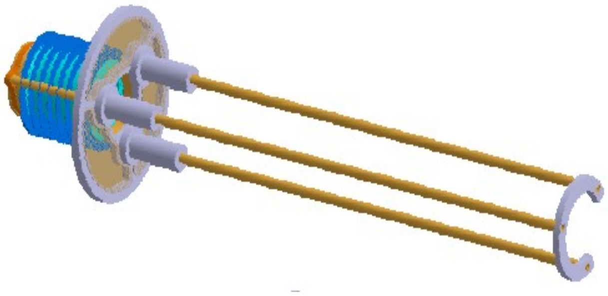
Beam Line Commissioning

- **2005 mid July – end August**
  - **Beam Transport Solenoid (BTS) Commissioning**
  - **Bfield mapping**
  - **Phase space measurements up to end BTS**
- **2005 beg November – end December**
  - **Commissioning BTS with Cryo-plant and Control system**
    - **BTS automated operation**
  - **Phase Space measurements inside COBRA**
    - **Pill scinti + APD on 3-D measuring machine**



- End-caps and insertion system
  - Complex design He/Vacuum/N2/Air interface
  - Materials minimized Al & CH2/EVAL (background)

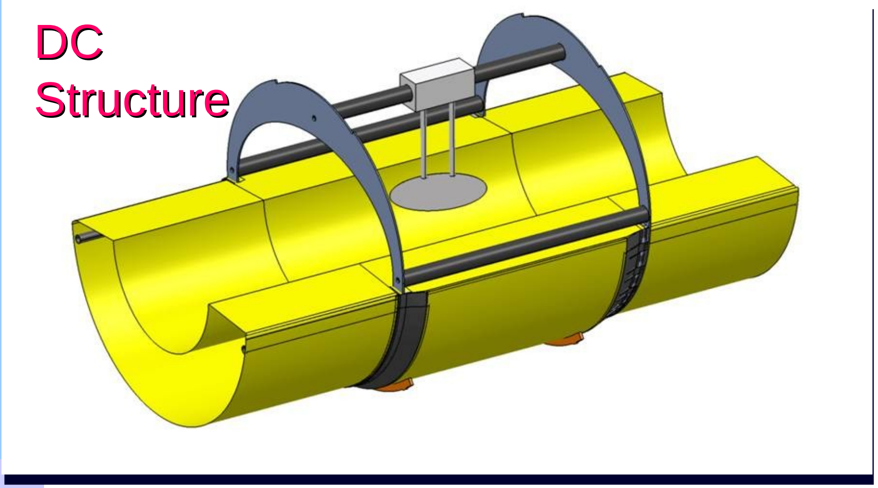


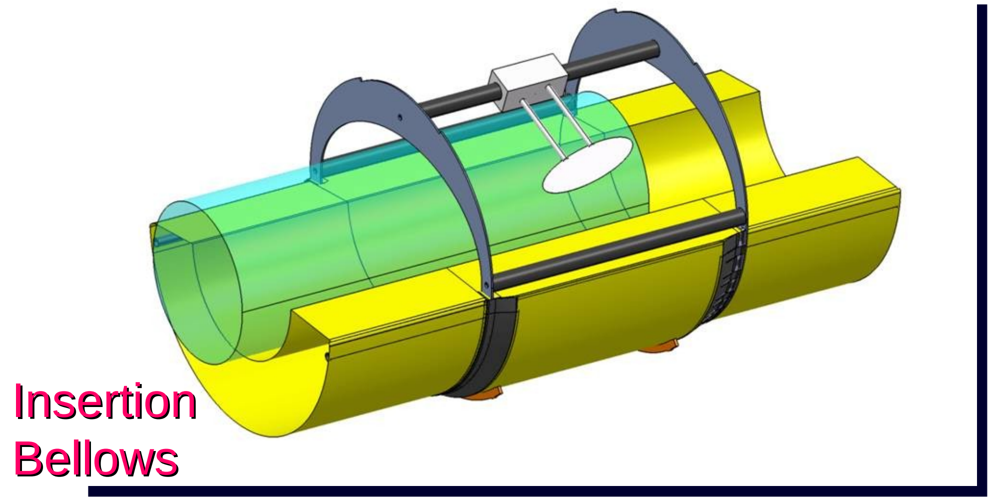


Calibration target installation

Target System

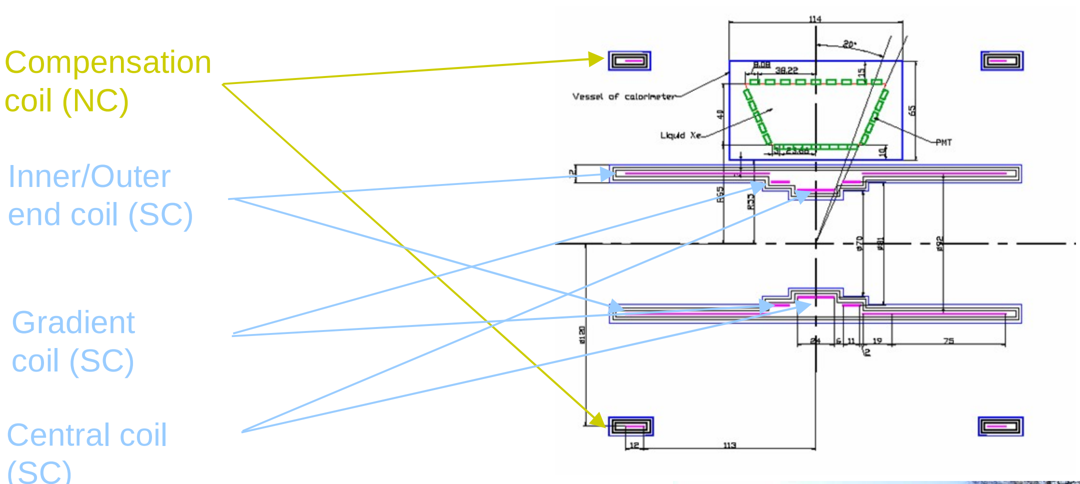
- Various solutions under study
  - Target material
    - Rohacell form/CH2 combination
    - Complete Rohacell
    - CH2 or polystyrene Target + wire frame

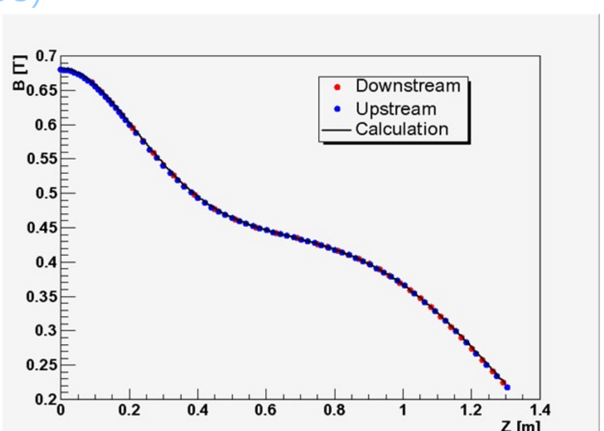


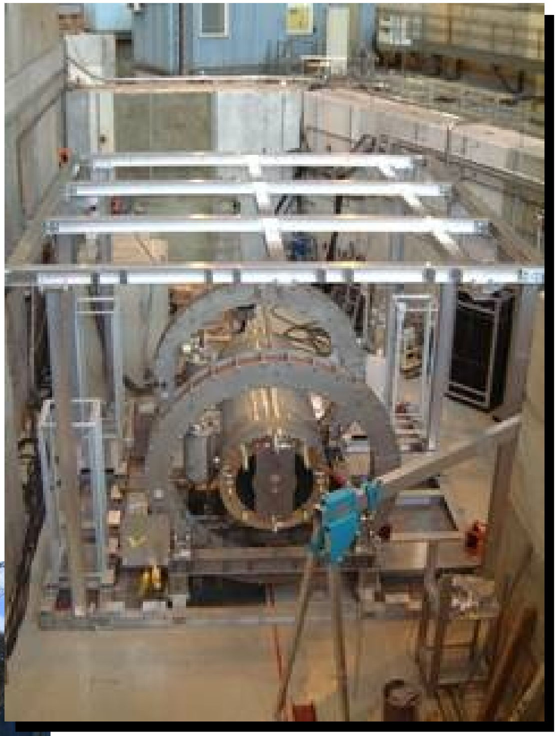


COBRA Magnet

- 360A, 1.27T
- $0.197X_0$ around the center

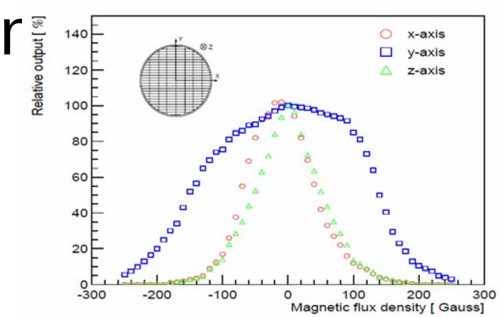






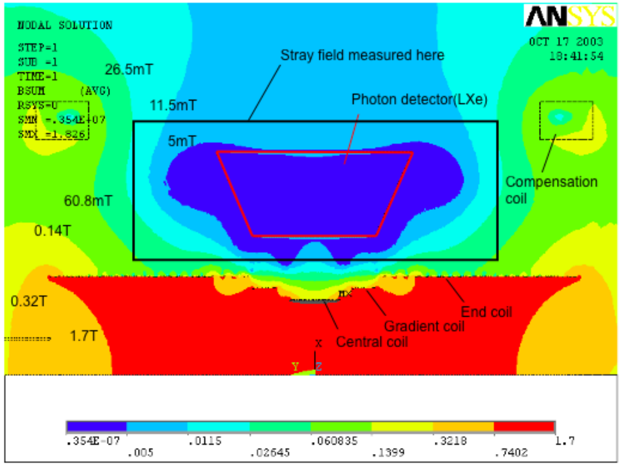
COBRA Magnet

- Cooling by using two GM-type refrigerators
  - No need of helium for operation
- Compensation coil to reduce field strength around the xenon

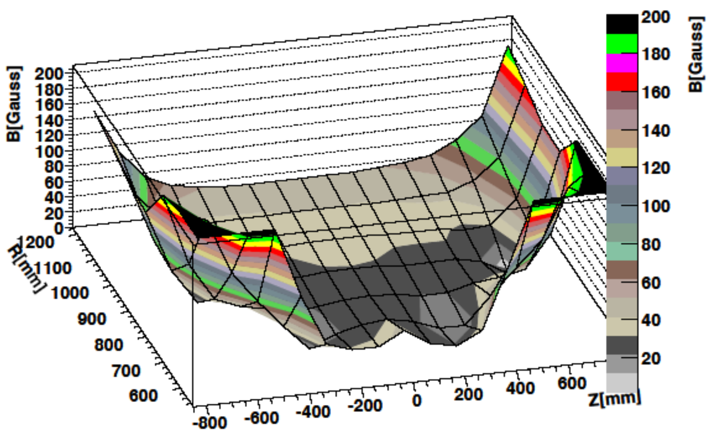


- Field measurement has been completed recently

Design field



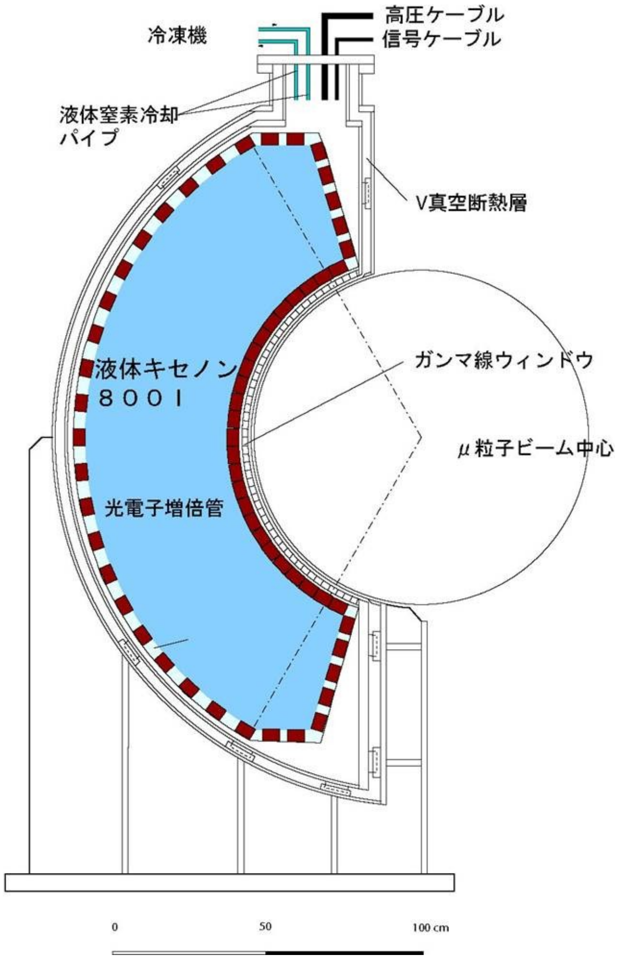
Measured field around the xenon detector



Liquid Xenon Detector

- 800~900 liquid xenon
- 846 PMTs immersed in the liquid
- No segmentation

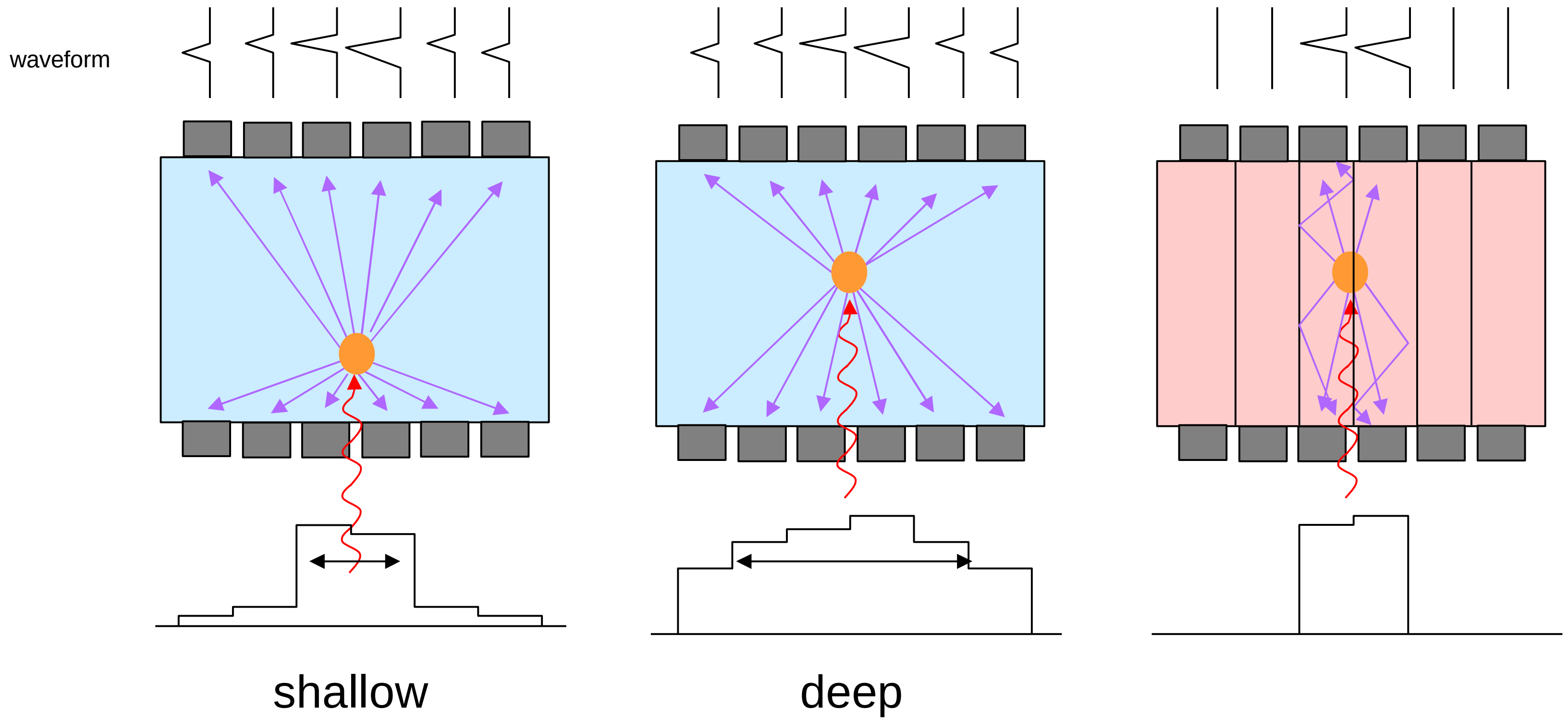
- Why Liquid Xe ?
  - Good resolutions
    - Large light output yield
    - W_{ph}(1MeV e) = 22.4eV
  - Pile-up event rejection
    - Fast response and short decay time
    - τ_s = 4.2nsec, τ_T=45nsec (for electron, no E)



• 西村康宏 “MEG実験用光電子増倍管の液体キセノン中におけるLEDを用いた利得解析と現状” 27日午後

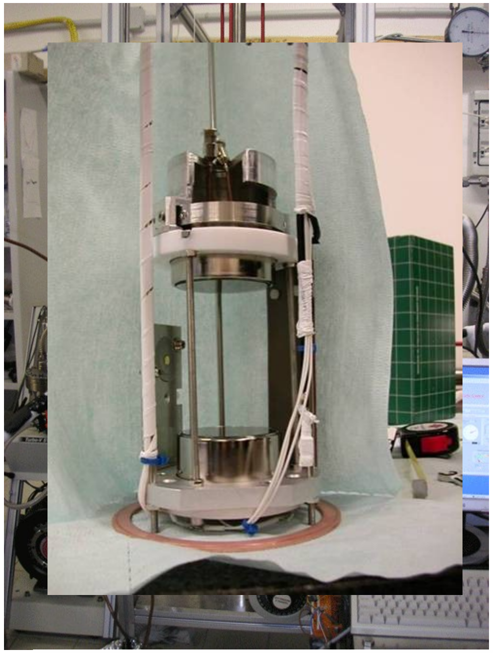
Depth Reconstruction

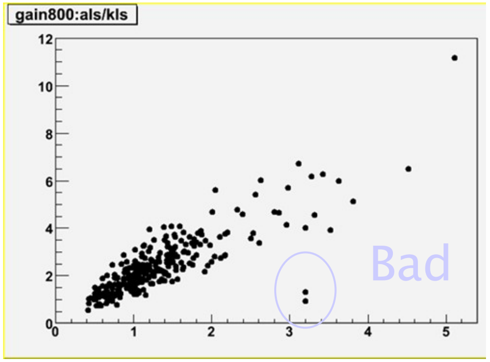
- Broadness of light distribution at the entrance side

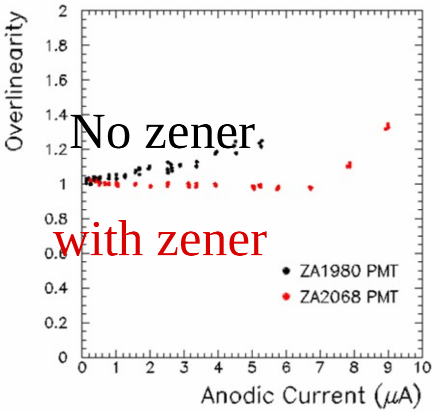


PMT test in LXe

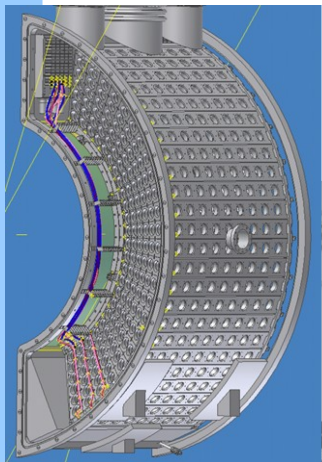
- All PMTs were tested in LXe before installing to the detector
  - Pisa LXe PMT test facility
  - Xenon Detector Large Prototype
- QE, Gain, response linearity
- All information is stored in a database for future use.







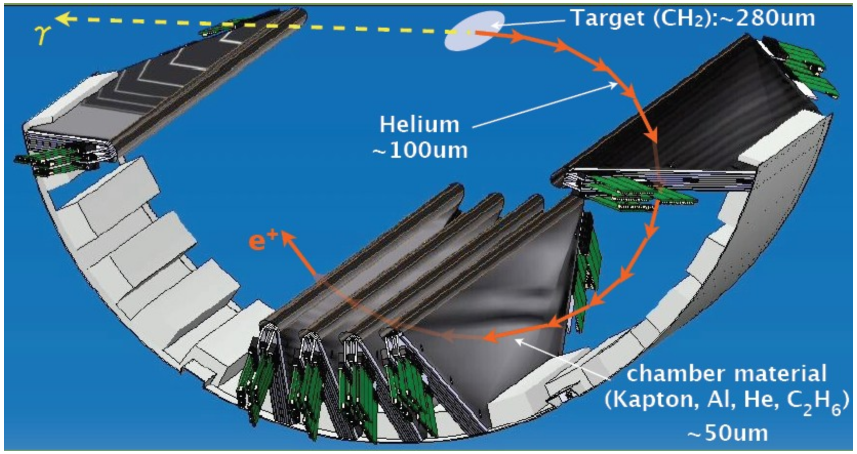
Construction Status



- Cryostat Construction in progress in Italy
- Delivery in June
- PMT installation and setup after that
- Ready in September

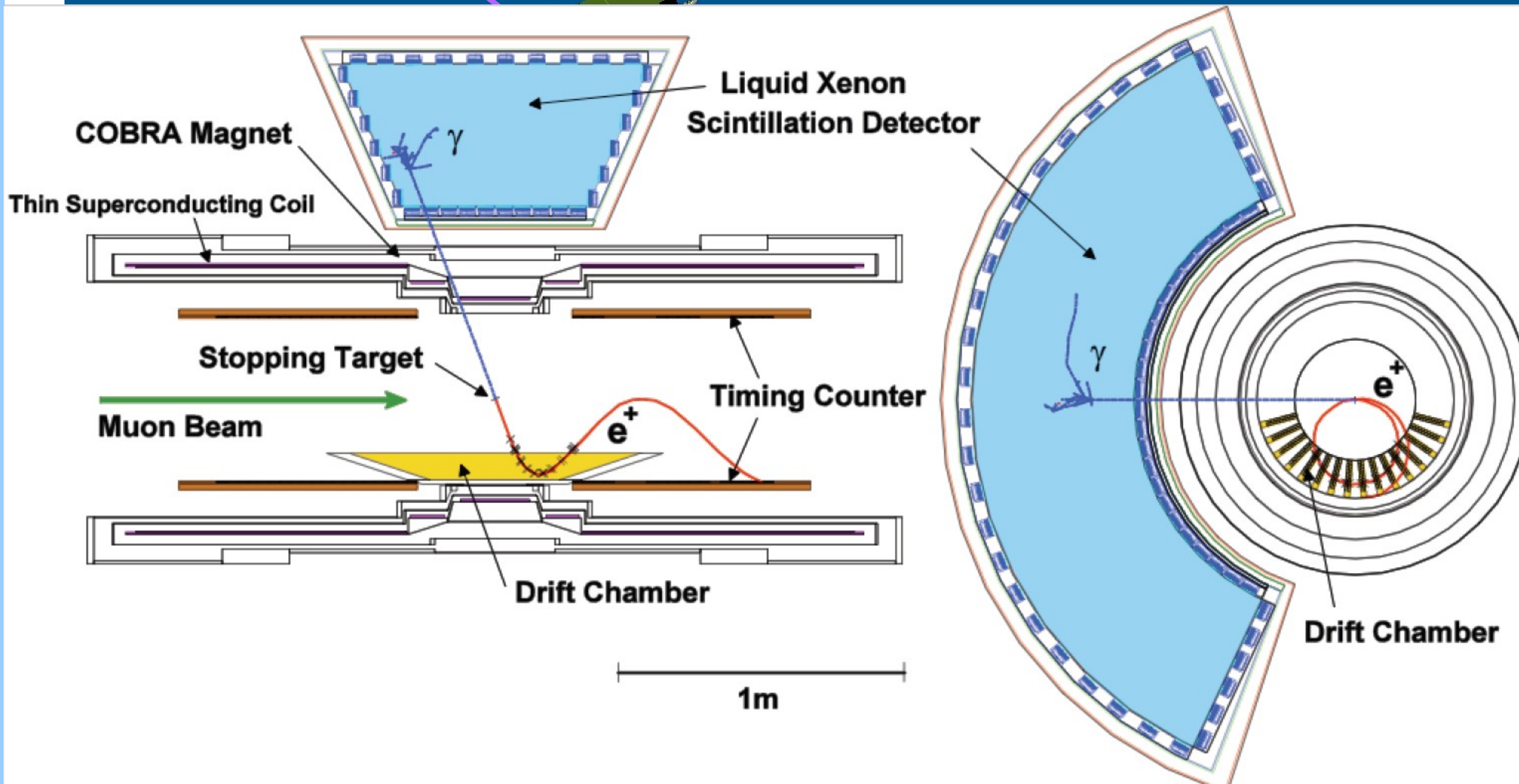
DC

- Position resolutions (~300μ m) for both r and z.
- Vernier pad readout for z measurement
- Low amount of material
- Need very precise pressure control ~1Pa



TC

APD F.E. Board



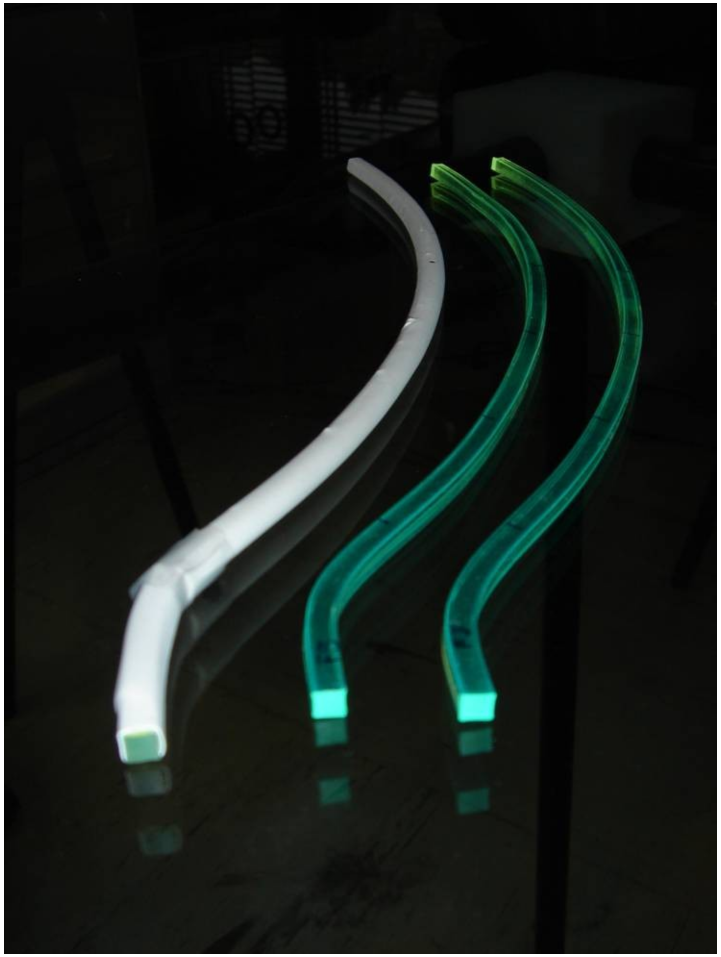
THE FIBRES

- FIBRES ARE GLUED AS WELL
- TEMPORARY ALUMINIUM BEAMS ARE USED TO HANDLE THE DETECTOR DURING INSTALLATION
- PTFE SLIDERS WILL ENSURE A SMOOTH MOTION ALONG THE RAILS

PM-Scintillator Coupling

TC Assembly

- PMT test completed
- Assembly test started



Electronics

Trigger Tree

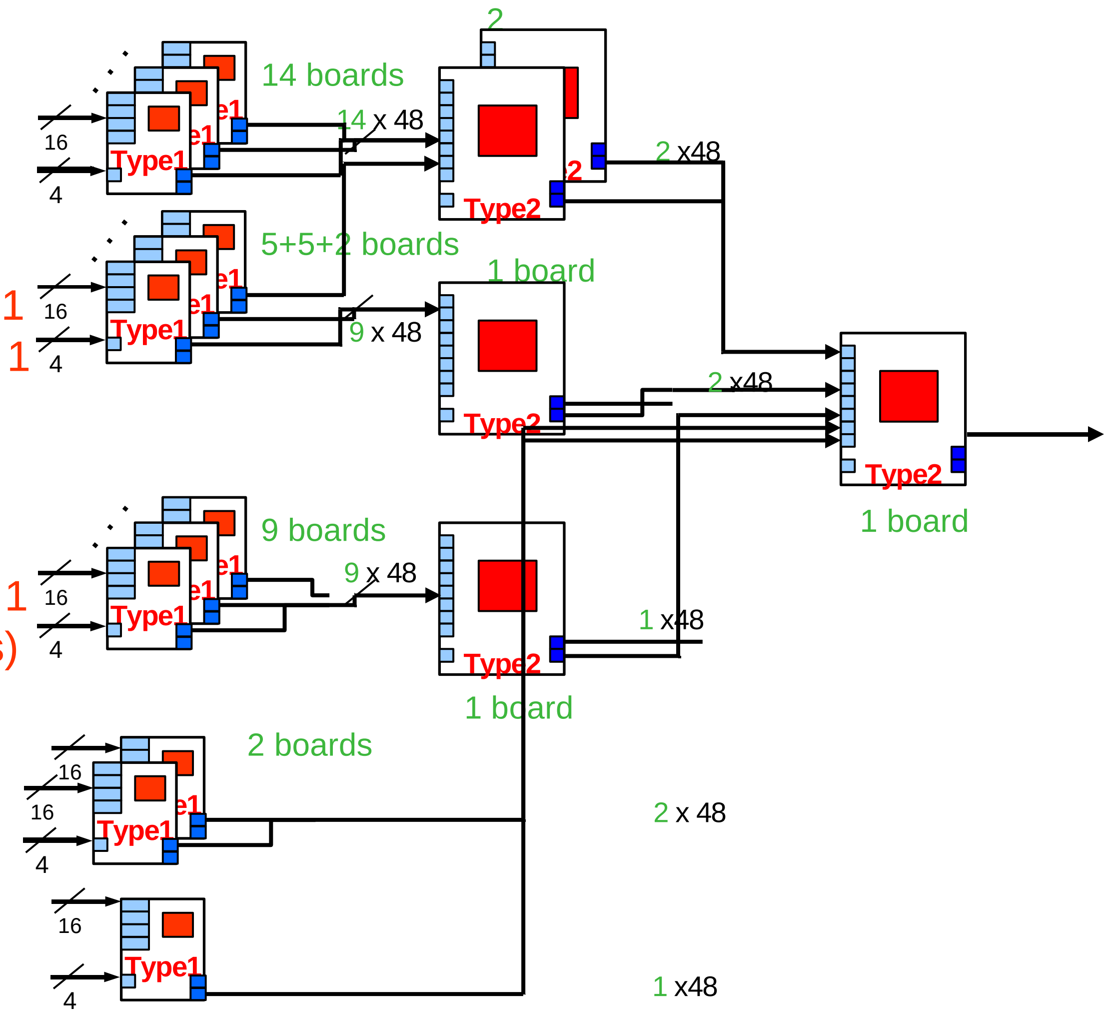
LXe front face
(216 PMTs)

LXe lateral faces
back (216 PMTs) 4 in 1
lat. (144x2 PMTs) 4 in 1
up/down
(54x2 PMTs) 4 in 1

Timing counters
curved (640 APDs) 8 in 1
u/d stream (30x2 PMTs)

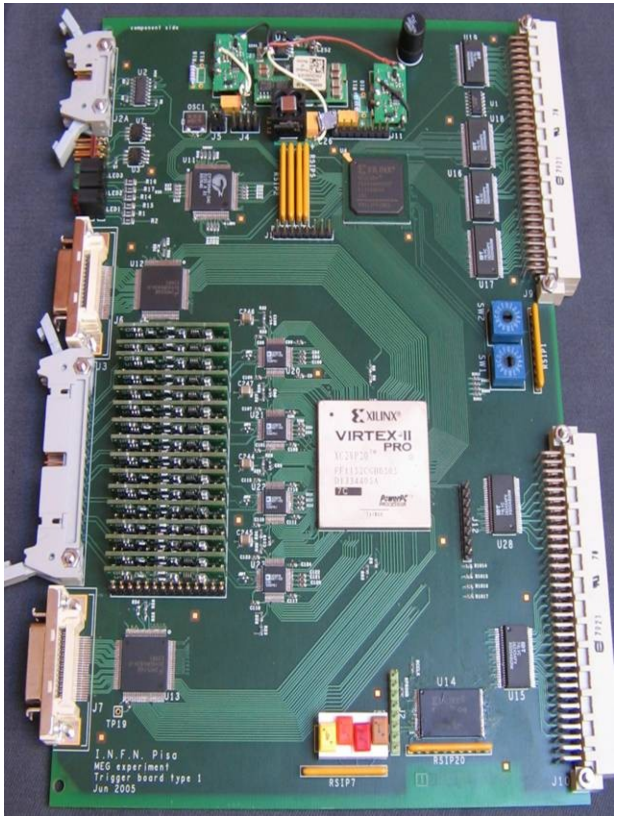
Drift chambers
16+16 channels

Auxiliary devices
16 channels



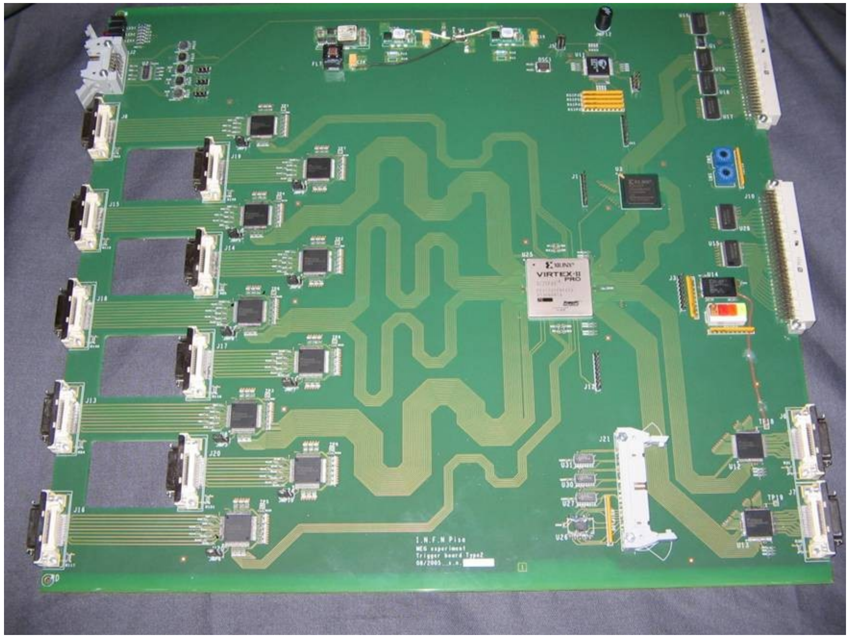
Trigger Electronics

- PCB production finished
- Currently board mounting in progress
- Ready to install in June

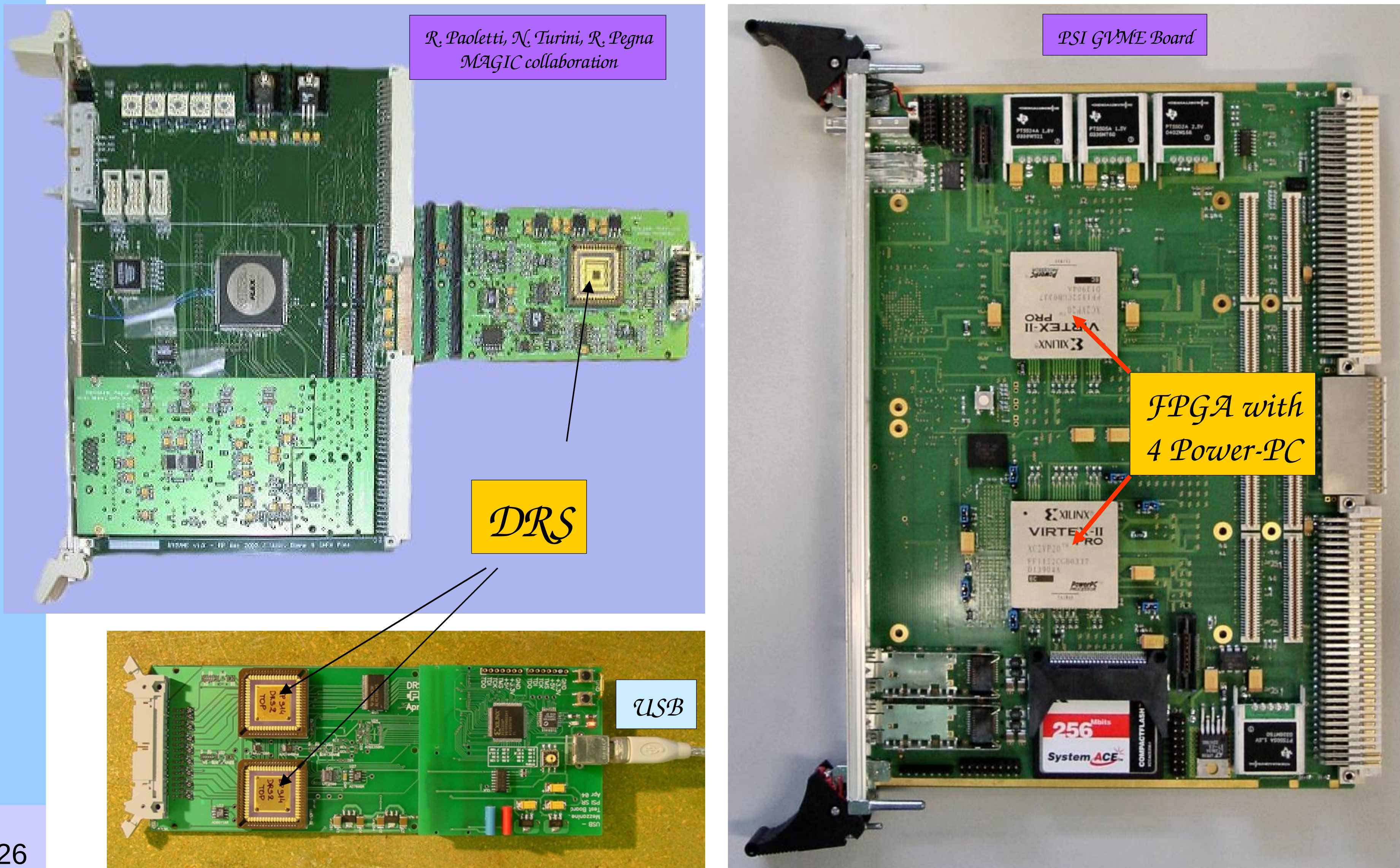


Type 1

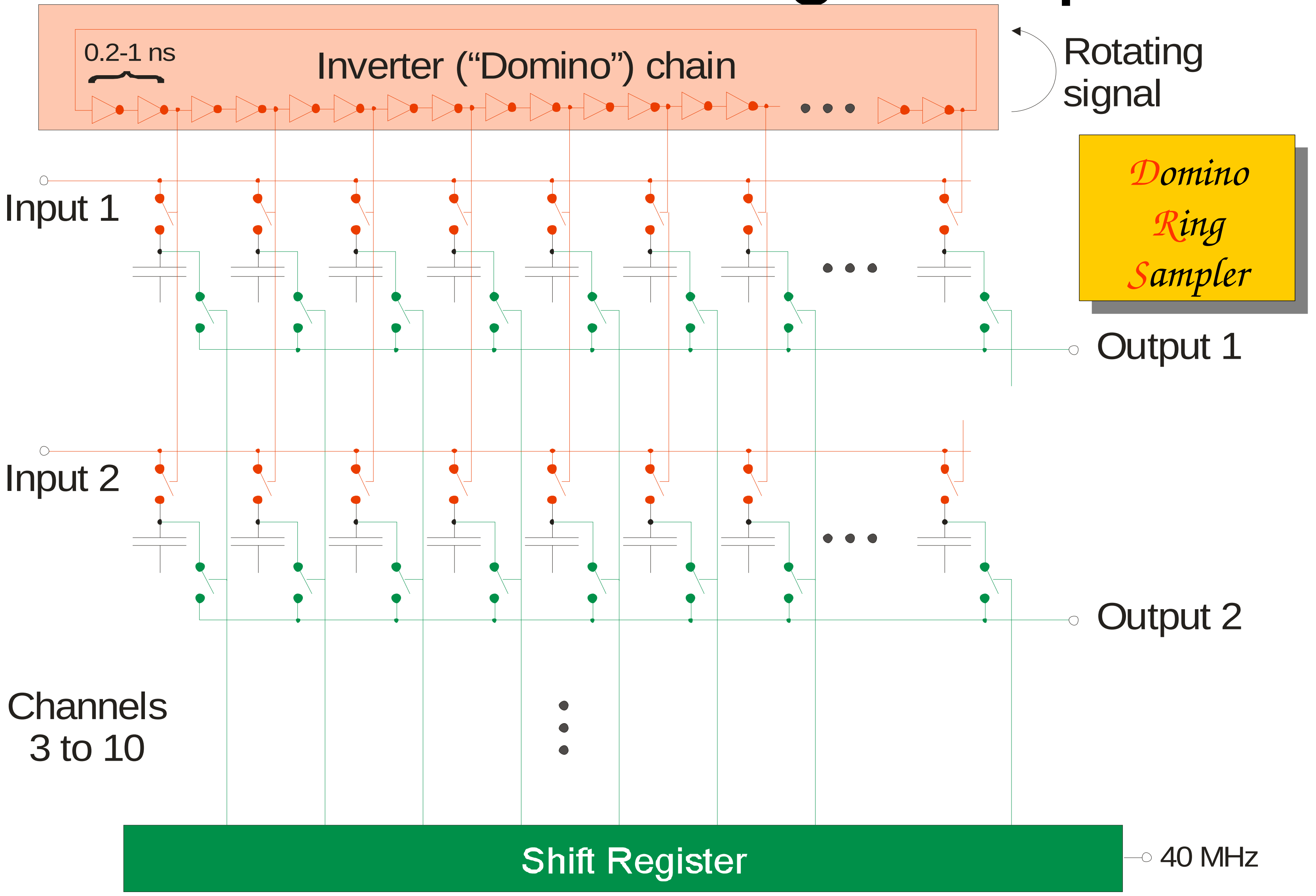
Type 2



DAQ/Waveform Digitizer

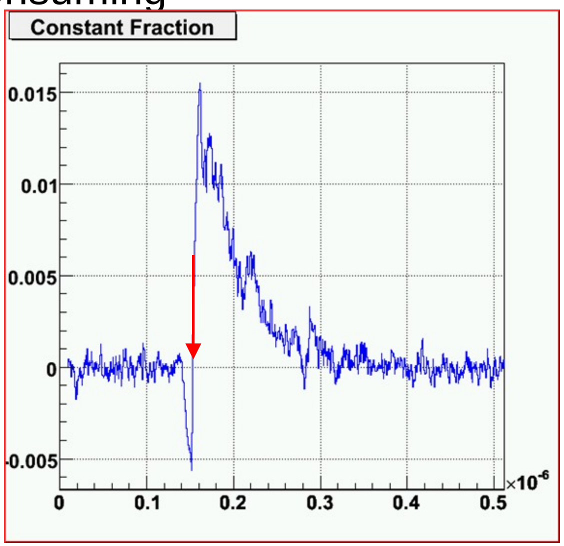


DRS – Domino Ring Sampler



Waveform Analysis

- Q,T evaluation from waveforms
- Pile-up rejection
- Waveform fitting is very CPU time consuming

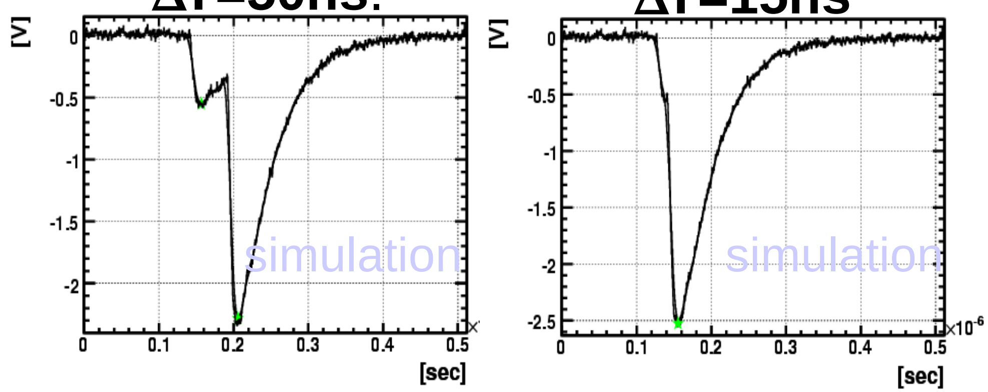


- Constant fraction
  - Fraction:0.3, delay 10nsec

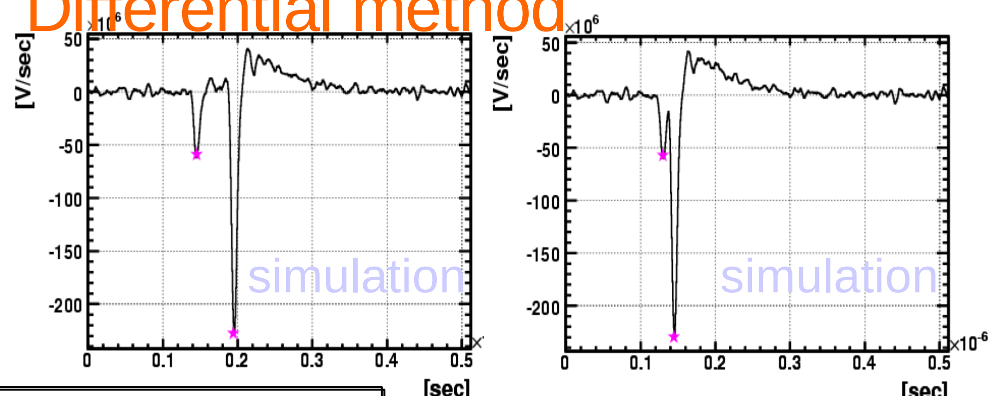
Peak search method

ΔT=50ns.

ΔT=15ns



Differential method



11MeV + 42MeV

- 内山雄祐 “MEG実験用液体キセノン検出器の波形解析による性能評価” 27日午後

Background and Sensitivity

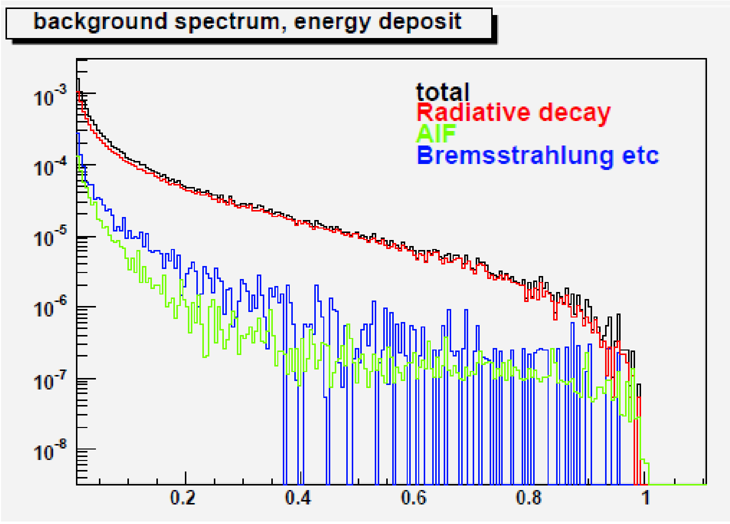
$$N_{acc} = (N_\mu \cdot f_e^0 \cdot \frac{\Omega}{4\pi} \cdot \varepsilon_e) \cdot (N_\mu \cdot f_\gamma^0 \cdot \frac{\Omega}{4\pi} \cdot \varepsilon_\gamma) \times (\frac{\delta\omega}{\Omega}) \cdot (2\delta t) \cdot T \cdot f_{P_\mu},$$

4E7sec

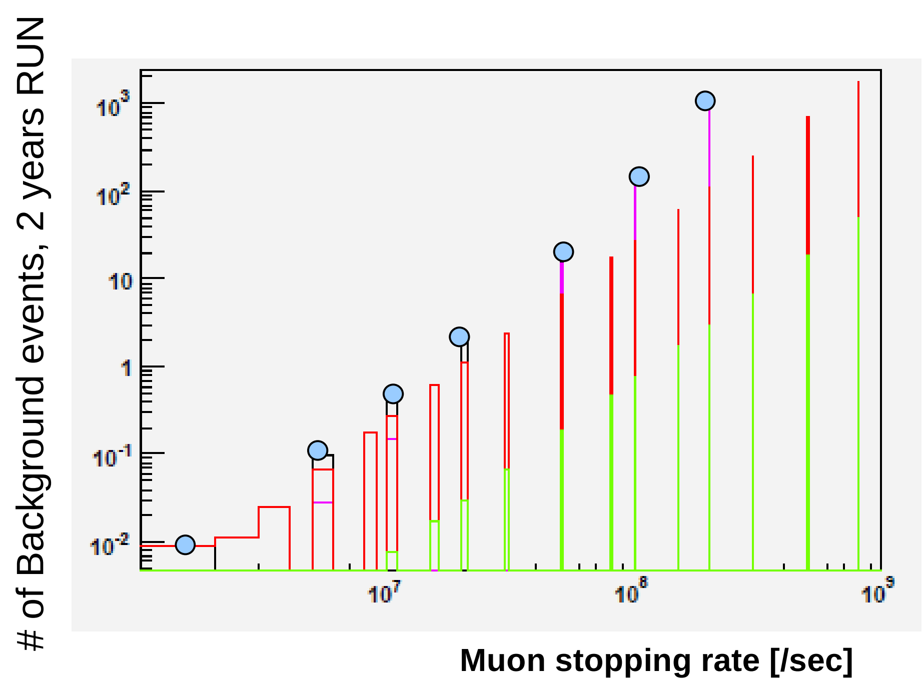
$\delta\ \theta_{e\gamma}$ = 14mrad

100psec

1



Energy deposit/ 52.8MeV

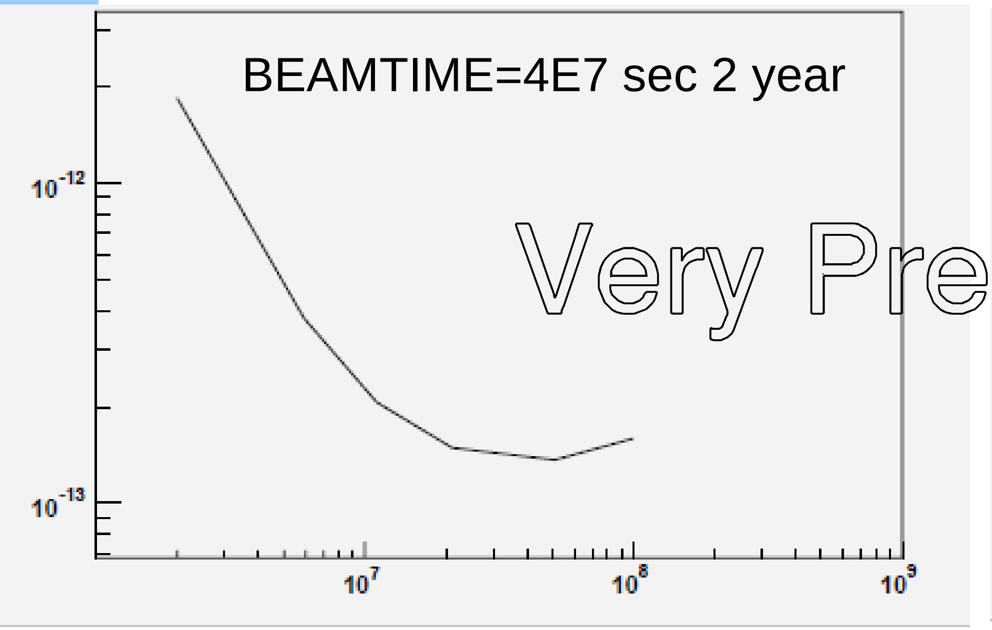


PILE UP EVENTS

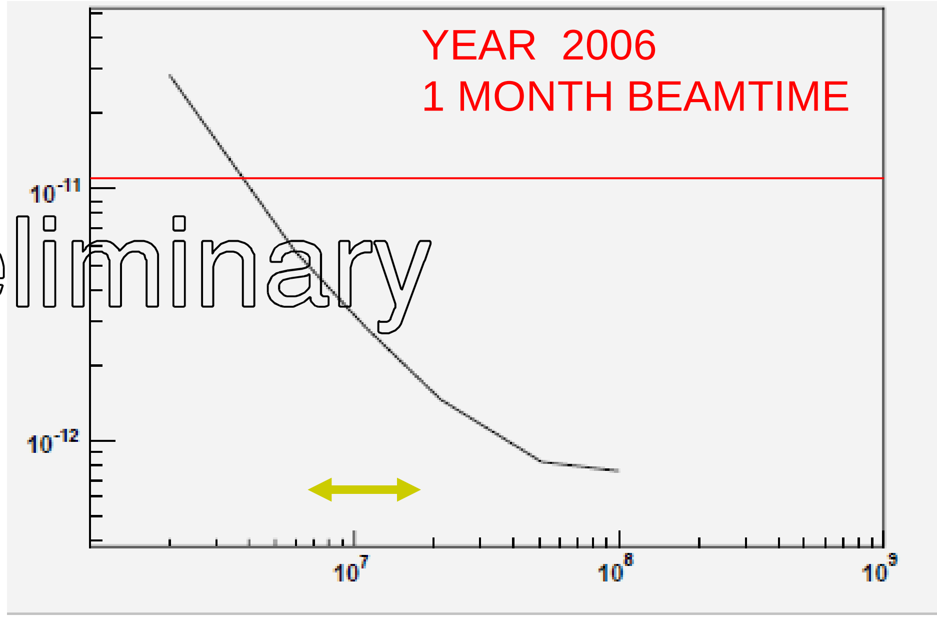
RD+RD dominant

How Far Can *We* Go?

- Expected sensitivity at 90% C.L.



muon beam intensity (/sec)



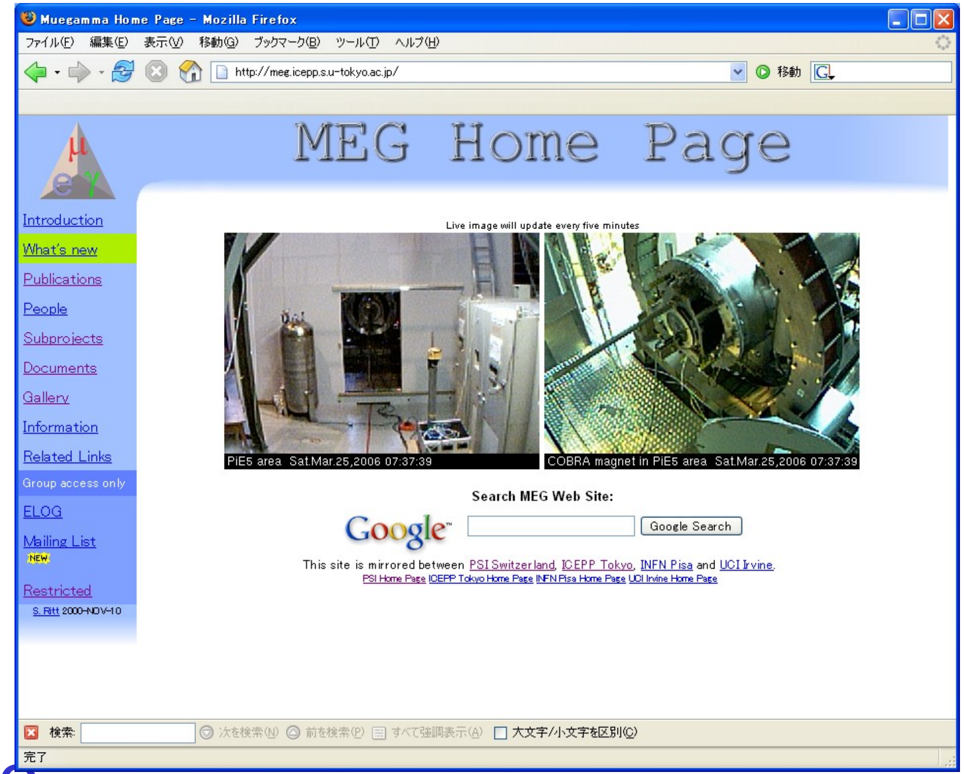
muon beam intensity (/sec)

Schedule

- MEG beam time; Apr-Jun, Aug-Dec
- DC/TC run with beam; Sep-
- LXe
  - Setup; -Sep~Oct, Calibration run; ~Nov –
  - Ready in Nov
- DAQ/Trigger; Ready in Jun
- Ready to start DAQ; ~mid Nov

Summary

- MEG starts in 2006
- Detectors are getting ready
- Analysis/online softwares also
- For further information, visit http://meg.icepp.s.u-to



• 澤田龍 “汎用データ解析ソフトウェア生成ツールROME&ARGUS” 30日午後