MEG Experiment
A New Experiment to Search for $\mu \rightarrow e \gamma$ at PSI

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Abstract
A new experiment to search for the lepton flavor violating decay, $\mu \rightarrow e \gamma$ is planned at the Paul Scherrer Institute (PSI). The experiment is designed to search for this decay with a sensitivity down to $10^{-15}$ branching ratio. The gamma-ray and positron from the decay can be detected by a liquid xenon scintillation detector and thick-walled superconducting spectrometer with gradient magnetic field, respectively. Current status of the preparation for the experiment will be presented focusing on the results from the beam test of the 100-liter prototype of the liquid xenon detector using laser Compton backscattering photon and the excitation test of the superconducting magnet.

$\mu \rightarrow e \gamma$
- Lepton flavor violating process
- Event signature
  - Back to back
  - Time coincidence
- Signal: $E_{\gamma}=\gamma 250$ MeV
- Extremely small branching ratio in the SM with finite neutrino mass
  - $\text{BR}(\mu \rightarrow e \gamma) < 10^{-15}$
  - $\text{BR}(\mu \rightarrow e \gamma) = (4 \pm 3\%)$
- Sensitive to the physics beyond the SM
  - Extremely small branching ratio in the SM with finite neutrino mass.
  - $\text{BR}(\mu \rightarrow e \gamma) < 10^{-14}$
- Lepton flavor violating process
  - $\text{BR}(\mu \rightarrow e \gamma) < 10^{-15}$
- Magnet
  - Five superconducting coils with three different radii to form graded magnetic field.
  - B$_{max}$ = 1.26T, B$_{min}$ = 0.49T @ operating current = 360A
- COBRA (Constant Bending Radius) Spectrometer
  - Concept of COBRA Spectrometer
  - Excitation Test of the Magnet
    - Excitation test was done to study the performance of the magnet.
    - Excitation up to 83% of full operating current was done due to the problem of the quench protection heaters.
- Mechanical strength was checked by measuring the strain of the superconducting magnet (Fig.10).
- Performance was measured by using high-energy photons up to 40 MeV/\text{amu}
- High-suppression of stray field (~50 Gauss)

Preliminary Results from the Beam Tests
- Strong correlation between the observed $N_{pe}$ and depth parameter due to the light absorption disappeared after the xenon purification.
- For evaluating energy resolution, shallow events (depth parameter < 45) with large leakage of the light is discarded (30%)
- Energy resolution $\gamma > 2\%$ (no correction for first conversion depth) for 40 MeV/\text{amu} photons ~ very preliminary.

Detailed analysis is in progress (Energy, position, timing resolutions, etc.)

COBRA (Constant Bending Radius) Spectrometer
- Concept of COBRA Spectrometer
- Excitation Test of the Magnet
- Construction was finished (Fig.9)

Summary
- A new experiment with a sensitivity down to $10^{-15}$ is planned at PSI
- R&D works on the sub-detectors are going well.
- Liquid xenon scintillation photon detector
  - Prototype detector with 120-liter $\text{Xe}$ was constructed.
  - Purification system was developed and long absorption length over 100 cm achieved.
  - Performance was measured by using high-energy photons up to 40 MeV/\text{amu}
  - Energy resolution $\gamma < 2\%$ (no correction, very preliminary).
- Detailed analysis is in progress (Energy, position, timing resolutions, etc.)
- MEG Experiment
- LXE Scintillation Photon Detector
  - High light yield ($W_{\text{Xe}}(\text{LXE}) = 24eV$, $W_{\text{Xe}}(\text{NaI}) = 17eV$)
  - Good energy resolutions (energy, position, time)
  - Design goal: $\alpha_1 = 1\%$, $\alpha_2 = 2\%$, $\alpha_3 = 50\%$
  - Fast decay ~ useful for pile-up rejection
  - Spatially uniform response

Prototype Detector
- Constructed to demonstrate the performance of the proposed full-scale detector
- 69 liter active volume of LXE (120 liter in total)
- Viewed by 238 PMTs
- Large enough to test with ~50 MeV photon
- Xenon purification system was developed in this prototype detector.
- Long absorption length over 100 cm achieved (~10 cm without xenon purification)

Beam Tests at Laser Compton Backscattering Facility
- Laser Compton backscattering facility at TERA S in AIST, Tsukuba, Japan
- Response to 40, 20, 10 MeV LCS photons was studied.
- Spread of the Compton edge is used to evaluate the energy resolution
- Data taken in Feb. 2002 (without purification, $\lambda_{\text{peak}} = 10cm$) and Apr. 2003 (with purification, $\lambda_{\text{peak}} = 100cm$)