A radial TPC for future $\mu \to e\,\gamma$ searches

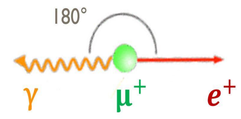
CLFV2026 - The 5th International Conference on Charged Lepton Flavor Violation - Rome, June 2026

The $\mu \to e\,\gamma$ decay

SEARCHING FOR NEW PHYSICS!

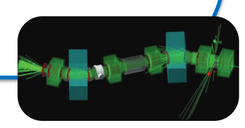
In the Standard Model (SM) of particle physics the $\boldsymbol{\mu \to e\,\gamma}$ decay **is** practically **forbidden** (its branching ratio is predicted to be $\mathcal{B}(\mu \to e\,\gamma) \sim 10^{-54}$), because it **violates the Charged Lepton Flavor symmetry**.
So why are we searching for it?

- if observed: direct evidence of New Physics beyond the Standard Model
- if not observed: stringent constraints on the theories that try to extend the SM



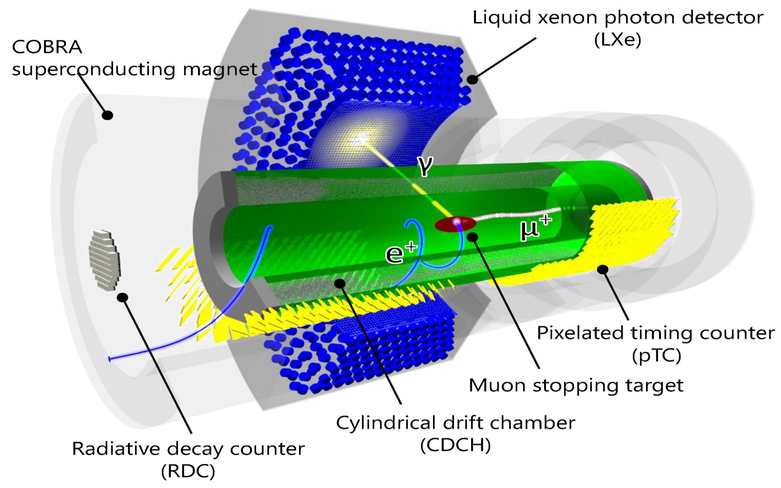
The **MEG II experiment**, located at the Paul Scherrer Institute (**PSI**, Switzerland), currently holds the world's most stringent upper limit on the decay's *branching ratio*: $\mathcal{B}(\mu^+ \to e^+\,\gamma) < 1.5 \cdot 10^{-13}$.

Running until the end of 2026, MEG II aims to reach a **target sensitivity** of $\mathbf{6 \cdot 10^{-14}}$. In parallel, the **HIMB** (High-Intensity Muon Beams) project at PSI plans to increase the muon beam intensity up to $10^{10}\mu/s$ by 2030. The use of **beams with increased intensity**, combined with **new** photon and positron **detection technologies**, would allow reaching a sensitivity of $\sim \mathcal{O}(10^{-15})$.



The MEG II detector

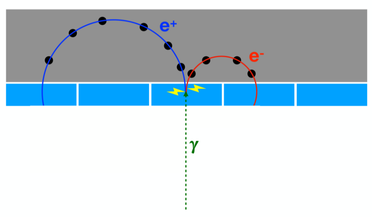
- $\boldsymbol{\mu^+}$ ($\sim 10^7 \mathrm{s}^{-1}$) are stopped on a **plastic target**
- $\boldsymbol{e^+}$ are tracked by a drift chamber (**CDCH**) in a magnetic field + a scintillating detector (**pTC**)
- $\boldsymbol{\gamma}$ are detected by a calorimeter (**LXe**)

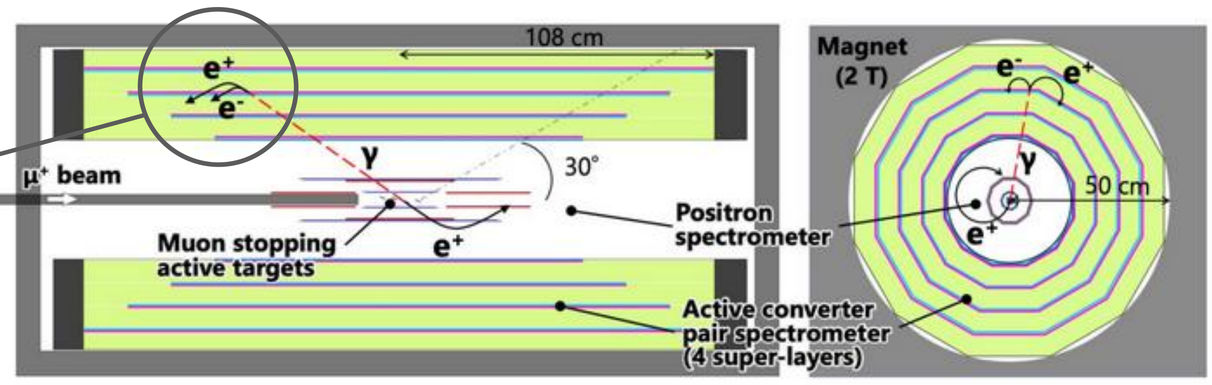


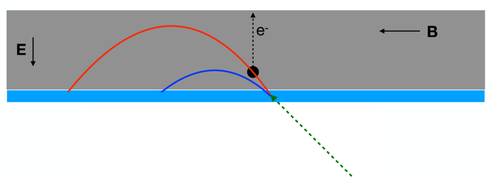
Possible next generation experiment at higher intensity

Future $\mu \to e\,\gamma$ experiments

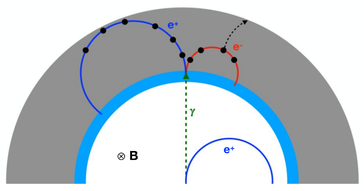
In future $\mu \to e\,\gamma$ experiments at higher muon rates (up to $10^{10}\mu/s$) it may be more convenient to **reconstruct the photon** by converting it in an e^+e^- pair (**pair conversion approach**).







longitudinal view



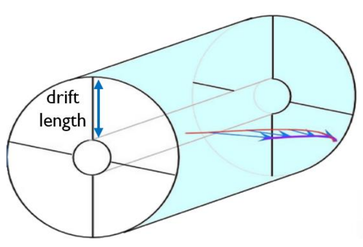
transverse view

Radial TPC as tracking detector

To track leptons from the pair conversion approach, the detector must satisfy stringent constraints:

- **lightweight**
- **compact**
- **high-rate capability**

Our candidate solution is a **radial Time Projection Chamber** (TPC) with a drift length $\sim \mathcal{O}(10\mathrm{cm})$ and a **stereo strip readout** system.
A single hit resolution around $\sim 500\mu\mathrm{m}$ will be needed.



radial TPC (drift $\sim \mathcal{O}(10\mathrm{cm})$)

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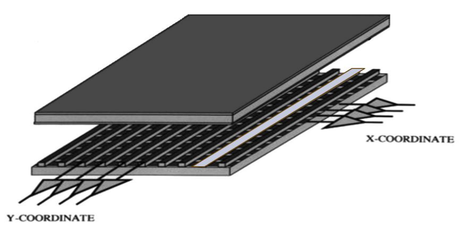
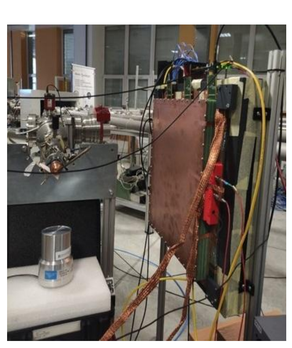


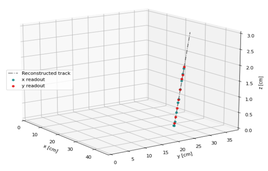
stereo strip readout

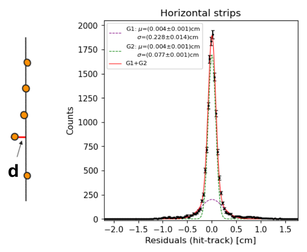
First prototype – Test beam @ Atomki lab

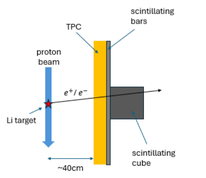
A **prototype** of the detector with a **drift length of 3 cm** and two planes of **orthogonal strips** was built and characterized in a test beam in synergy with the n_TOF collaboration:

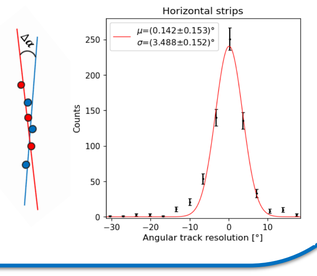
- **spatial** resolution: $\sim \mathbf{800\mu m}$
- **angular** resolution: $\sim \mathbf{2°}$





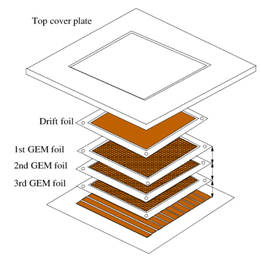






Next step – new prototype

A new prototype with a **drift length of 10 cm**, a **3 GEM** amplification stage and two planes of **orthogonal strips** is under construction. A test beam is planned at the PSI, at the end of 2026.



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