

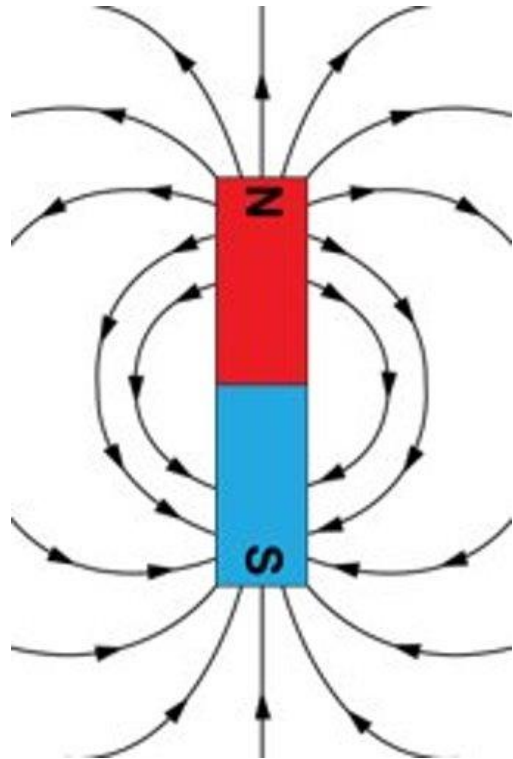
Status and prospects of MUonE experiment

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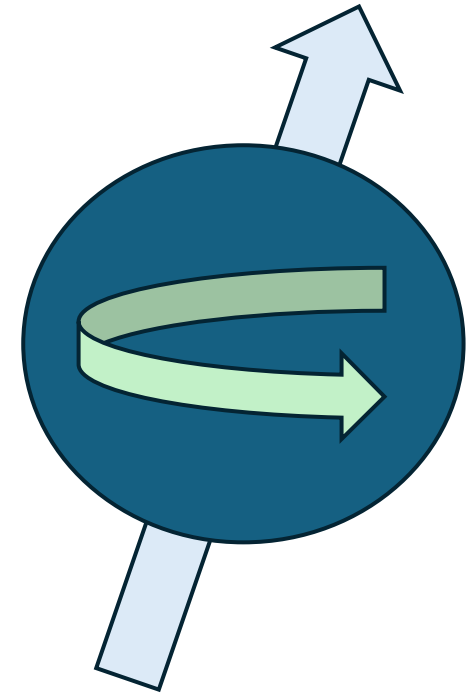
What is it all about?

$$\boldsymbol{\tau} = \boldsymbol{\mu} \times \boldsymbol{B}$$



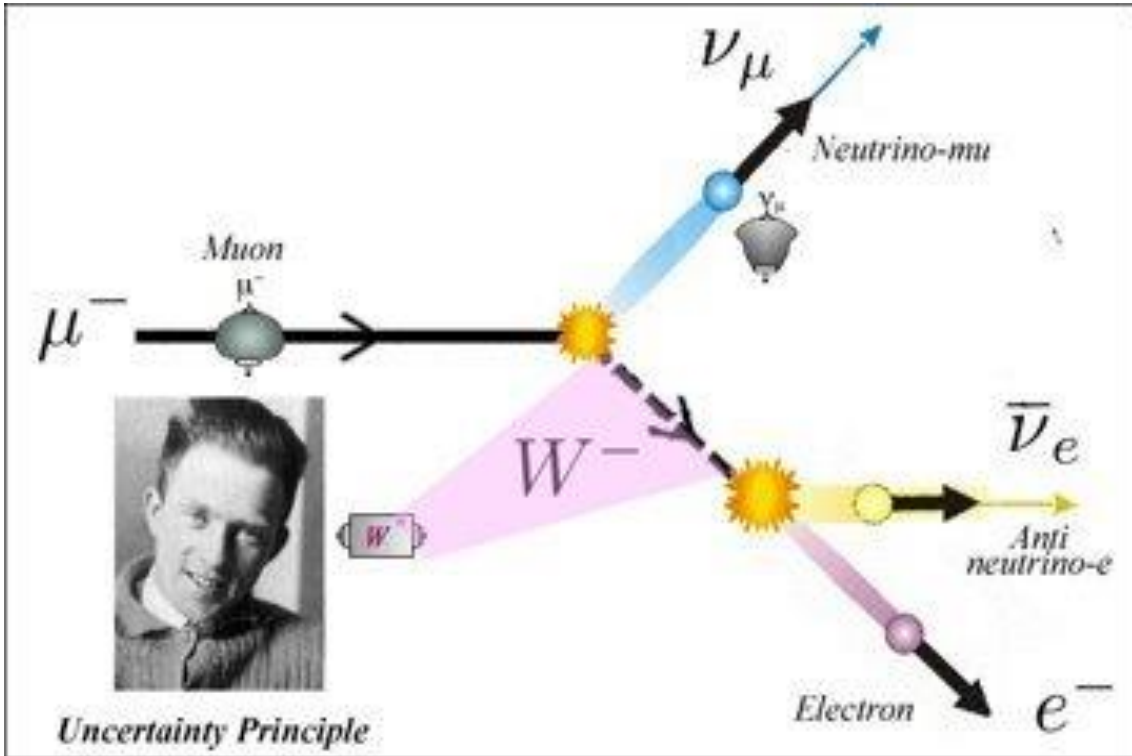
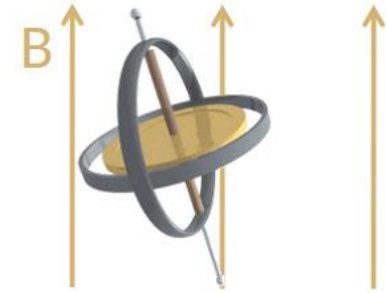
$$\boldsymbol{\mu}_S = g_s \left(\frac{e}{2m} \boldsymbol{S} \right)$$

$$\boldsymbol{S} = \frac{\hbar}{2} \boldsymbol{\sigma}$$

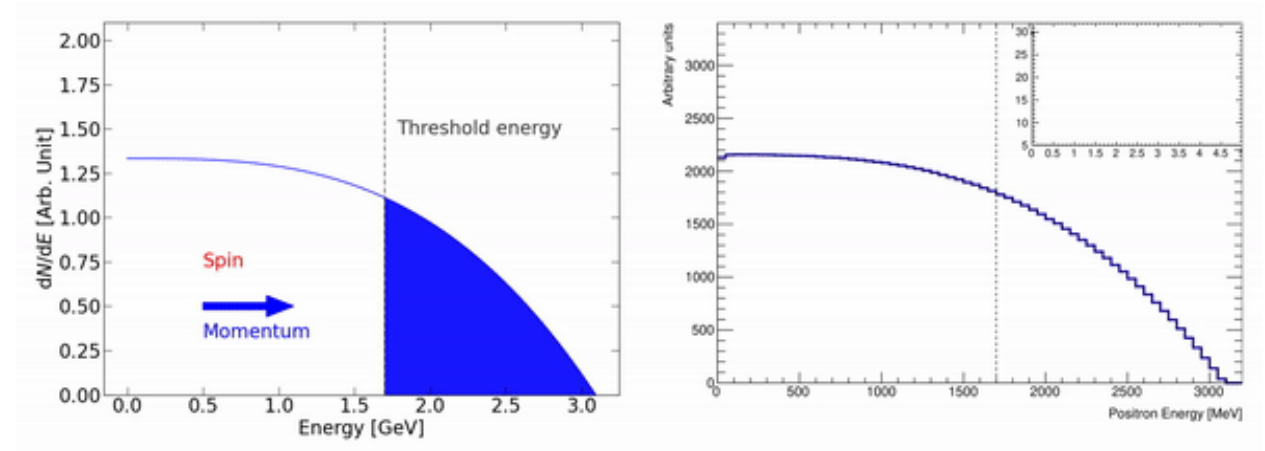


QUANTUM MECHANICS

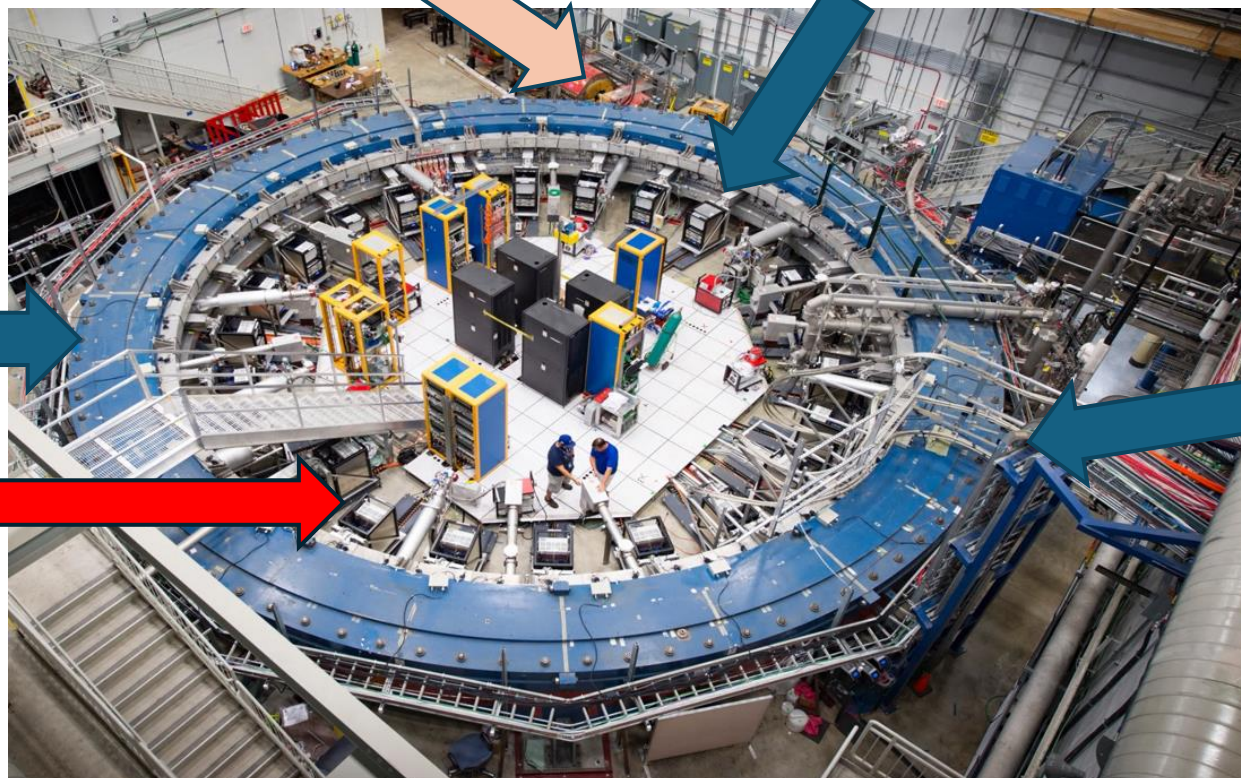
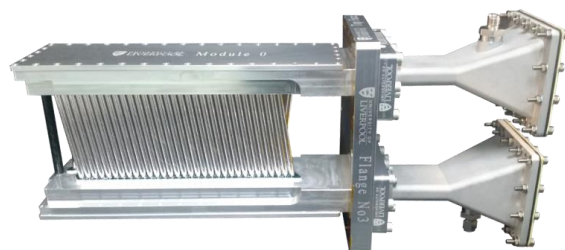
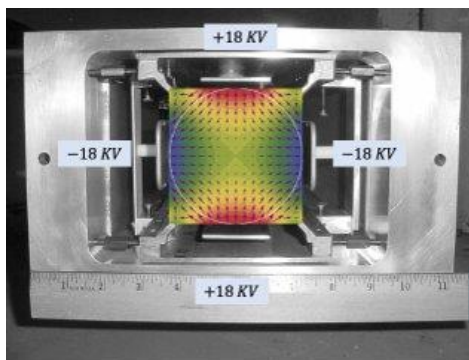
Standard approach



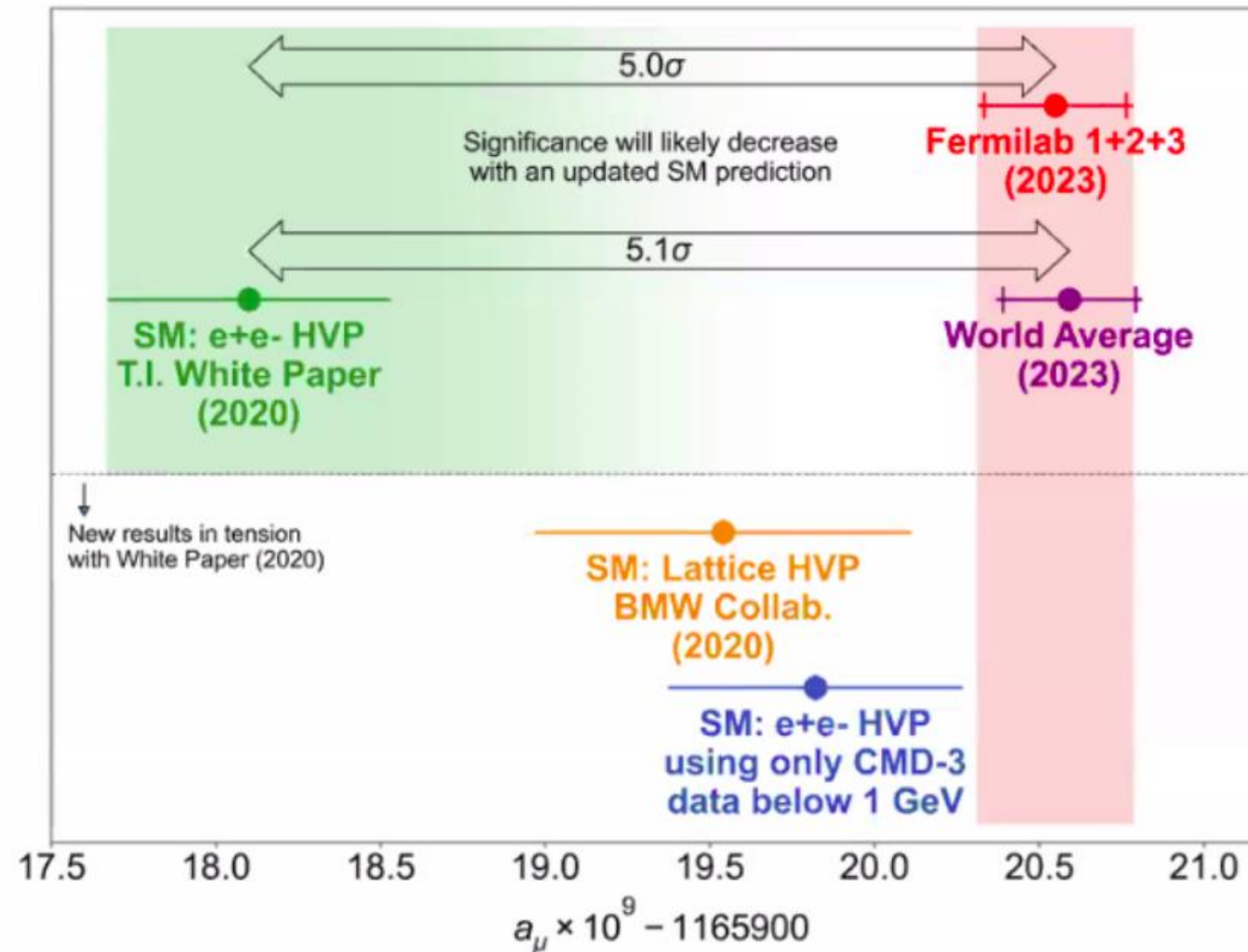
- Weak force --> Decay in the direction of the spin



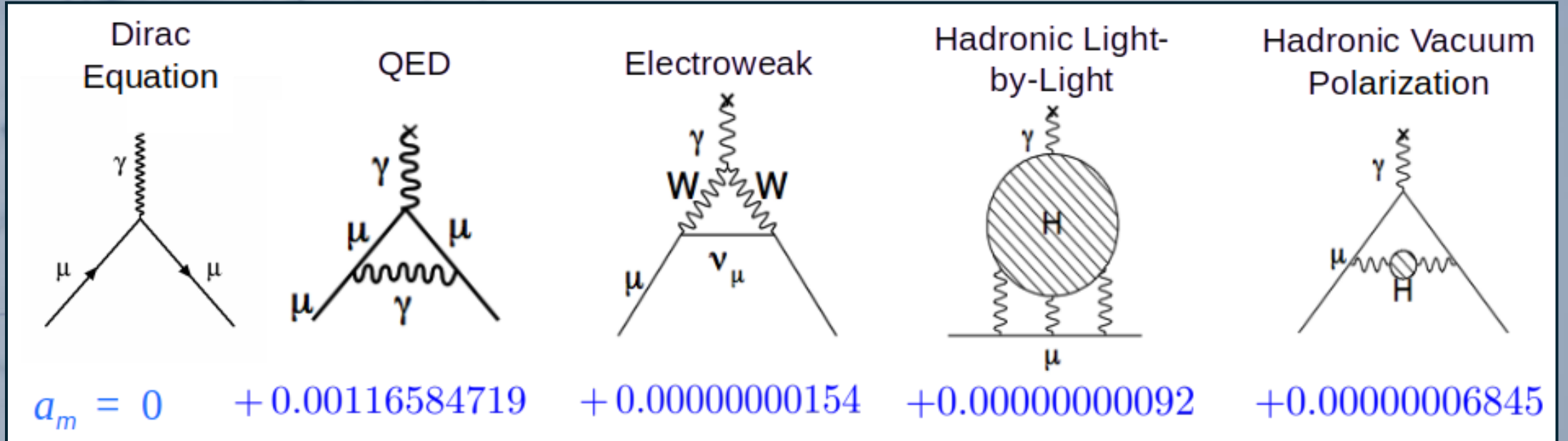
Experiment (g-2) FNAL



Value of the anomalous magnetic moment



What have we really measured?

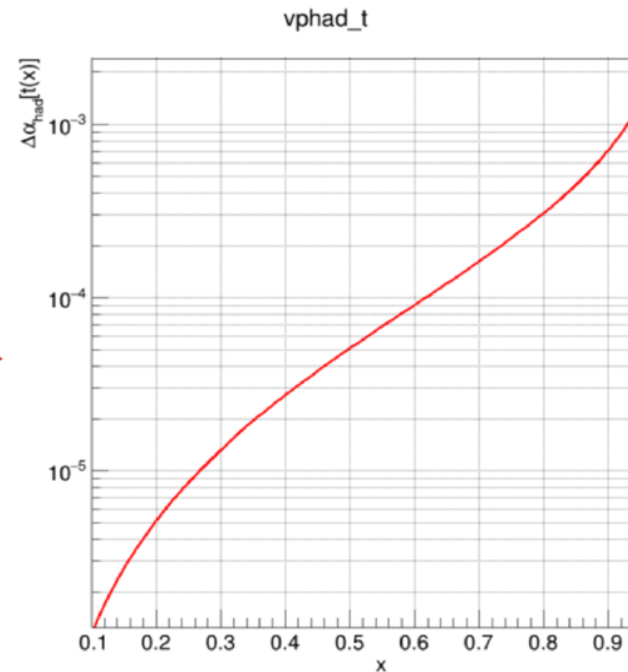
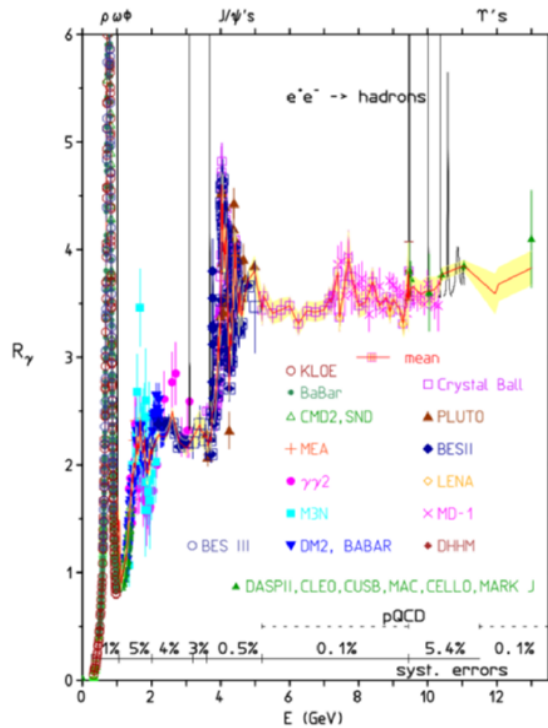
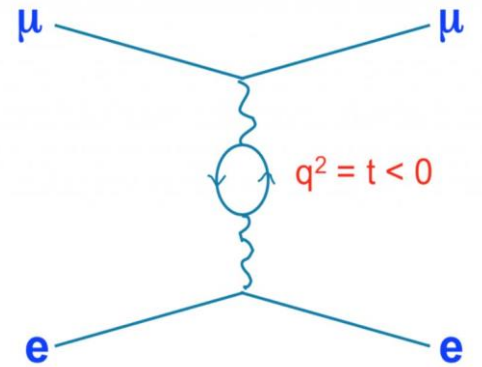


- Information about vacuum properties

White Paper: Phys. Rept. 887 (2020) 1-166
<https://doi.org/10.1016/j.physrep.2020.07.006>

Timelike --> Spacelike

- Hadronic vacuum polarization
- Electron – positron annihilation data measured in timelike region
- Corrections to Coulomb scattering



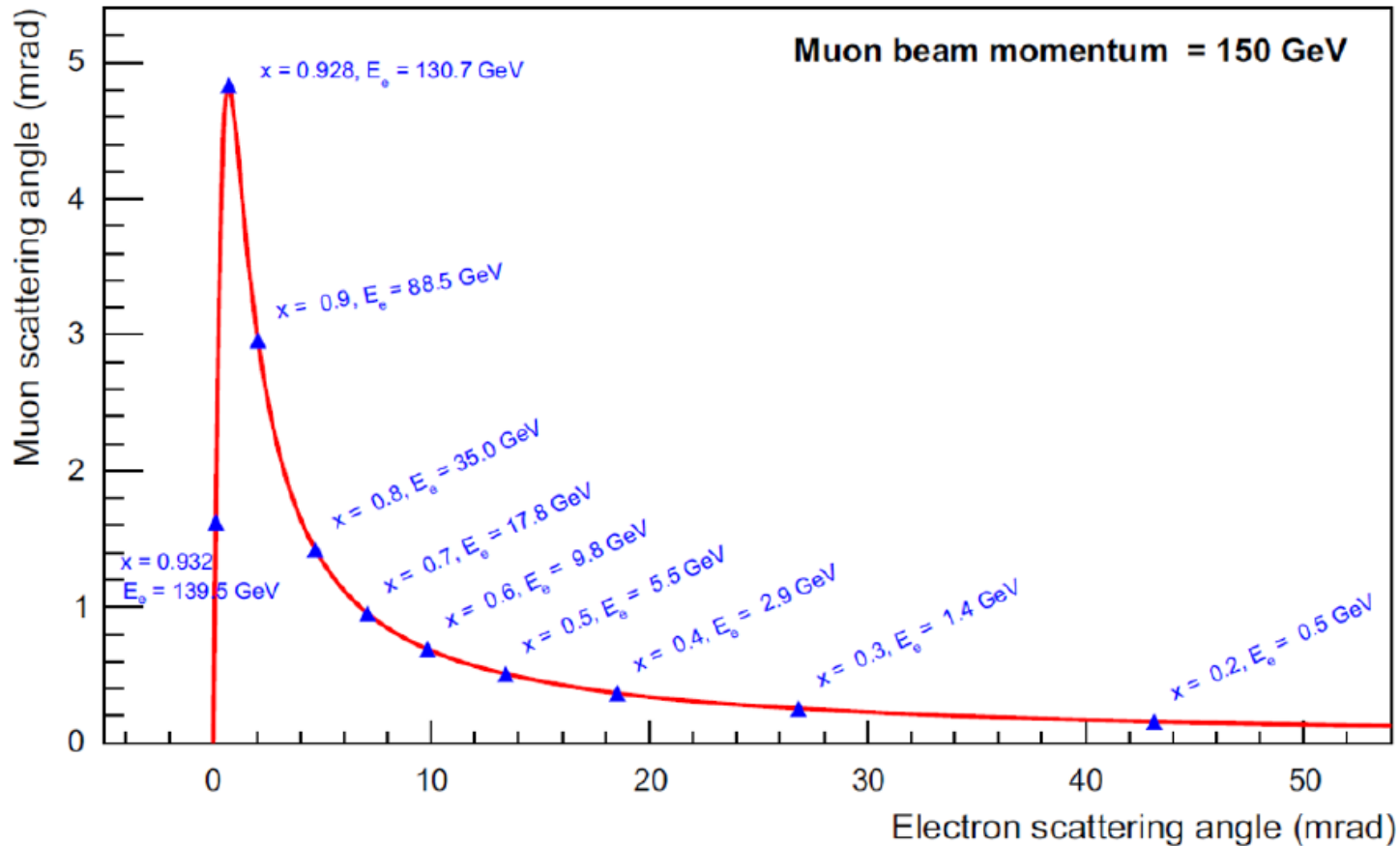
$$a_\mu^{HLO} = \left(\frac{\alpha m_\mu}{3\pi}\right)^2 \left(\int_{m_{\pi^0}^2}^{E_{cut}^2} ds \frac{R_{had}^{data}(s) \hat{K}(s)}{s^2} + \int_{E_{cut}^2}^{\infty} ds \frac{R_{had}^{pQCD}(s) \hat{K}(s)}{s^2} \right)$$

$$a_\mu^{HLO} = \frac{\alpha}{\pi} \int_0^1 dx (1-x) \Delta\alpha_{had}[t(x)]$$

Correlation curve

- Measure u and e scattering angles

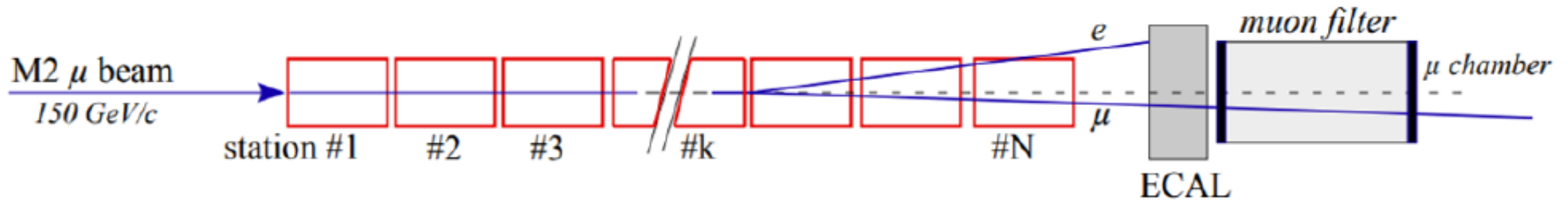
$$R(\theta_i) = \frac{d\sigma_{data}(\Delta\alpha_{had}(t) \neq 0)/d\theta_i}{d\sigma_{MC}(\Delta\alpha_{had}(t) = 0)/d\theta_i} = \frac{dN_{data}(\Delta\alpha_{had}(t) \neq 0)/d\theta_i}{dN_{MC}(\Delta\alpha_{had}(t) = 0)/d\theta_i}$$



$$R(\theta_i) = \left| \frac{\alpha(t)}{\alpha} \right|^2 = \frac{1}{|1 - \Delta\alpha_{lept}(t) - \Delta\alpha_{HAD}(t)|^2}$$

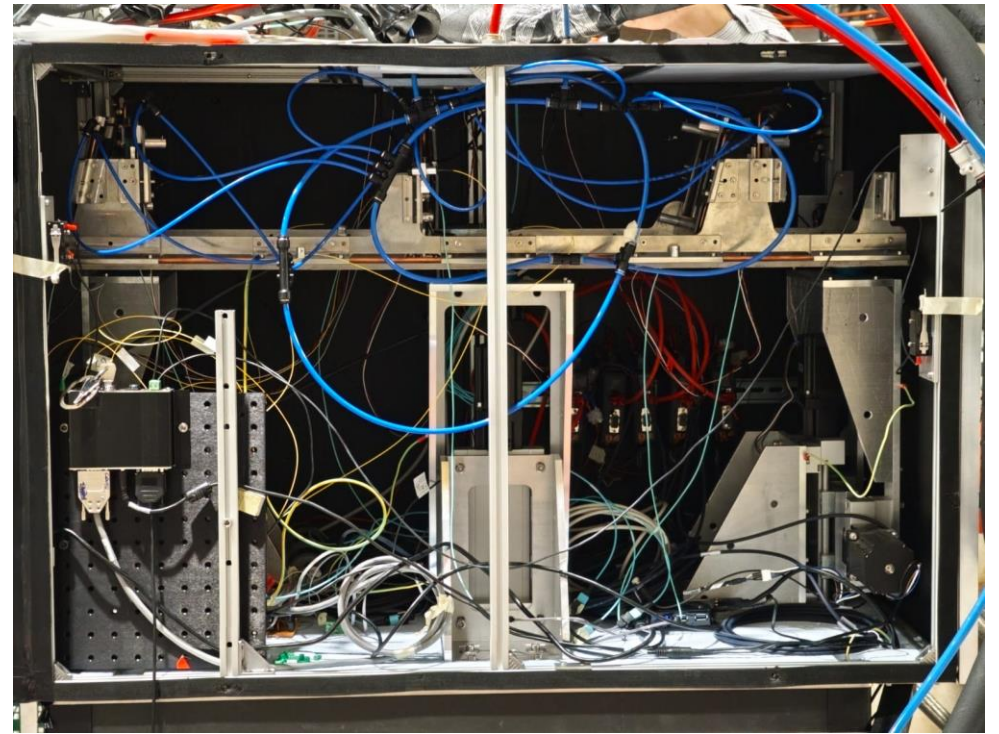
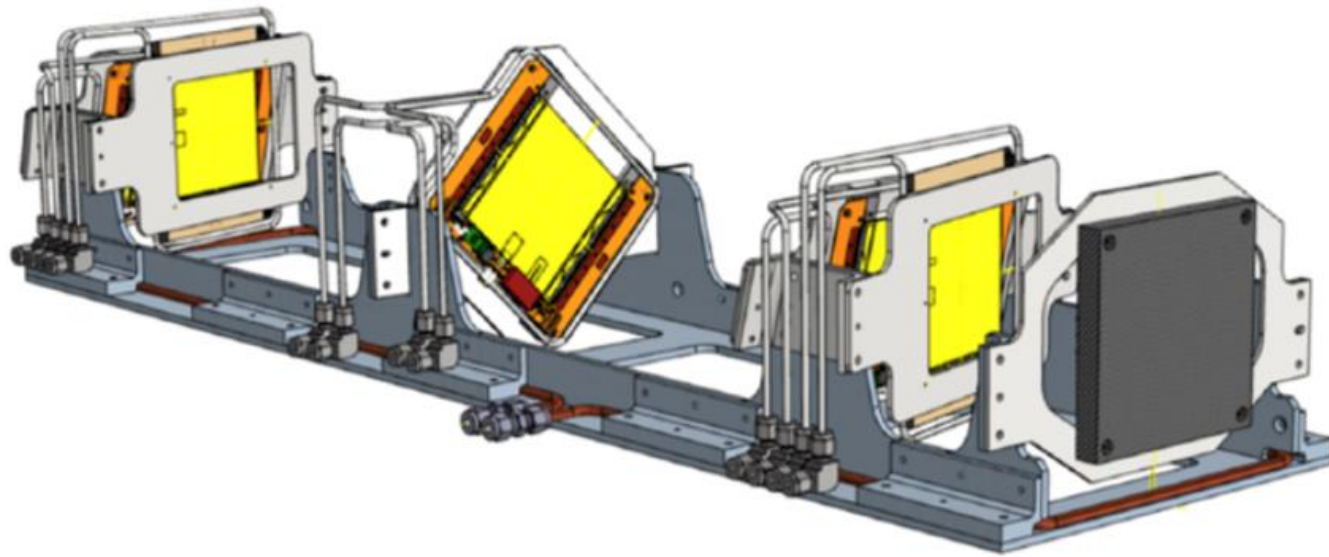
MUonE experiment

- Intense muon beam
- Detector with high spatial resolution
- $N \sim 40$
- Particle energy and identification

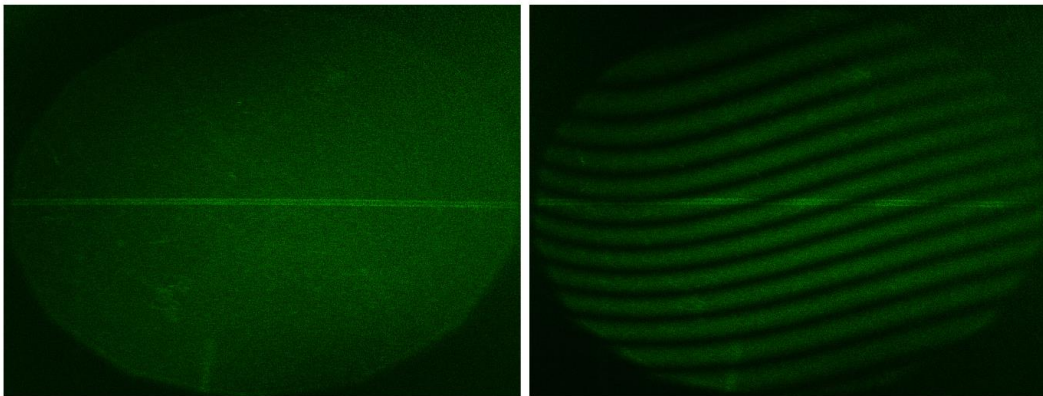
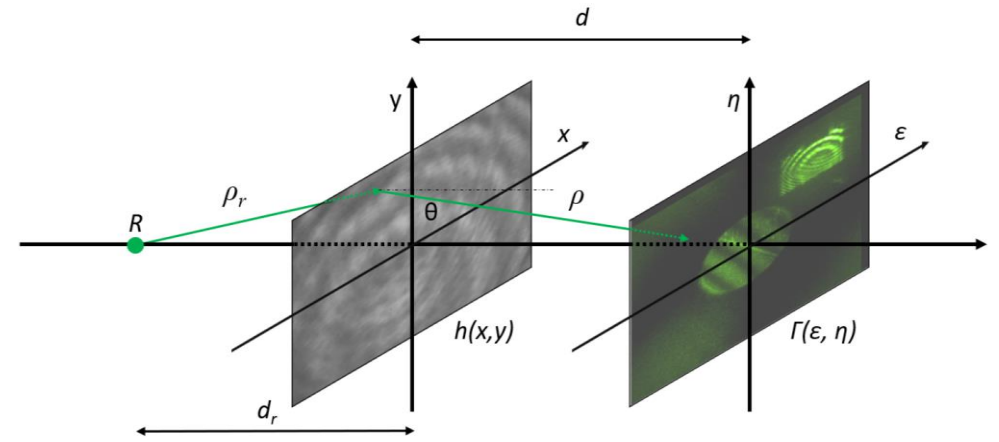
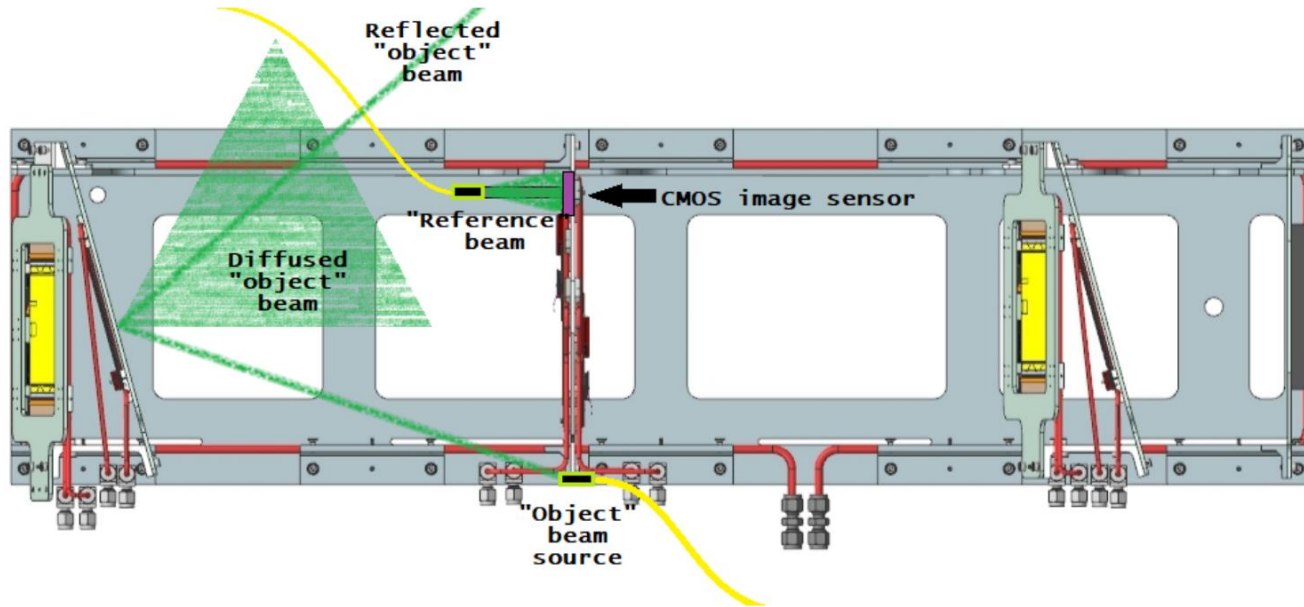


MUonE station

- 2S CMS modules (10 cm x 10 cm)
- Target (B, C)
- Angular resolution 0.2 mrad

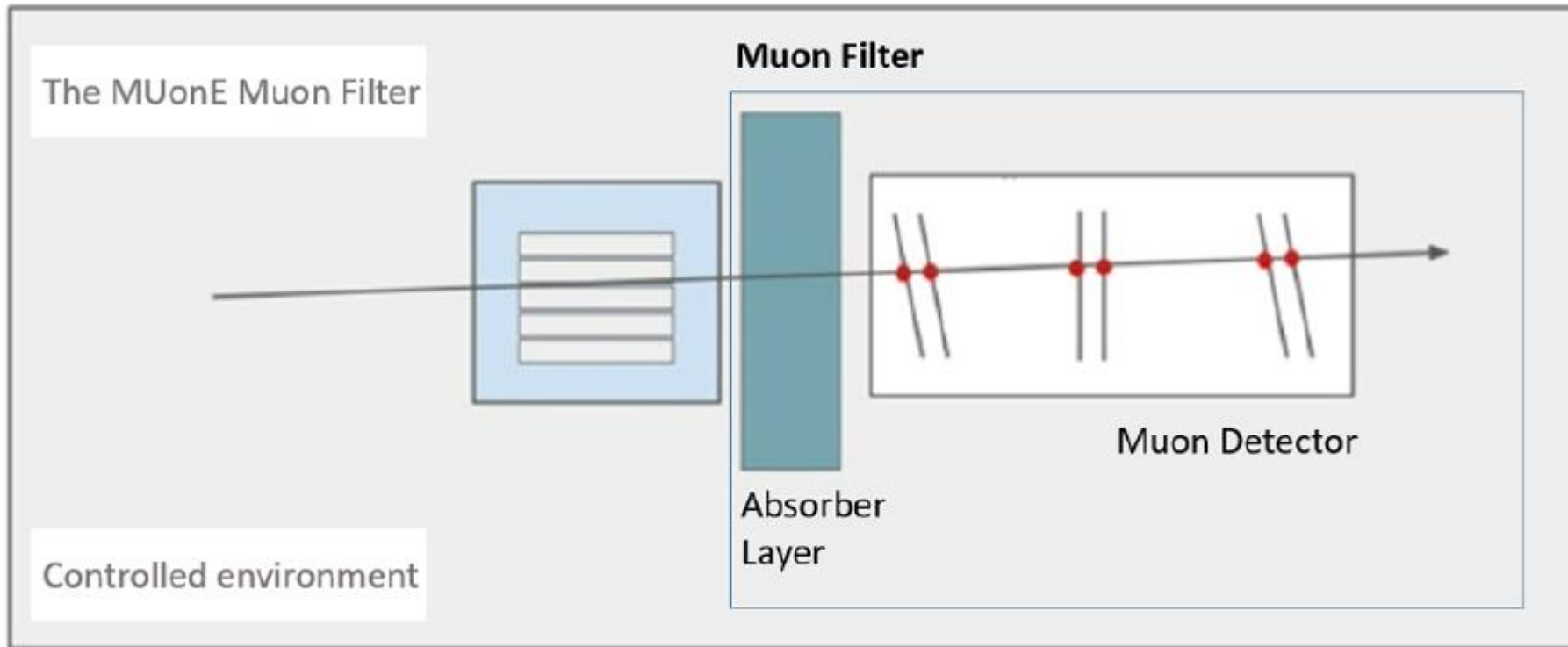


Holography



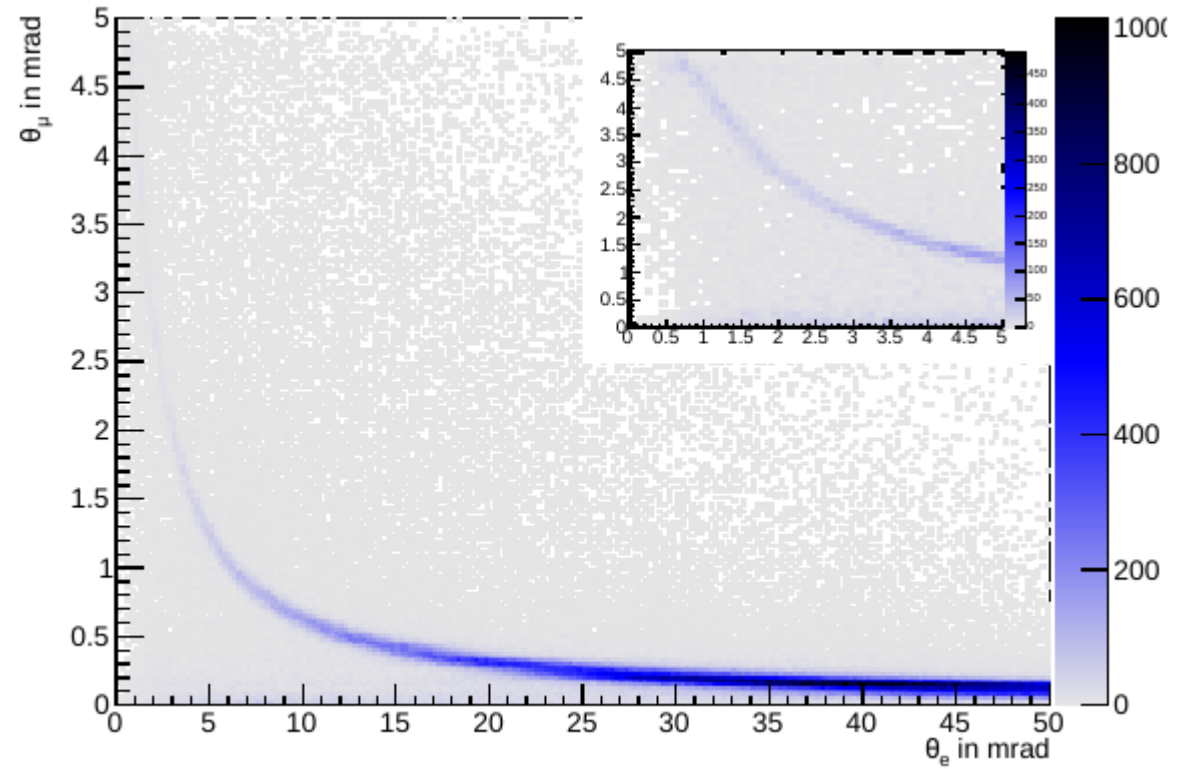
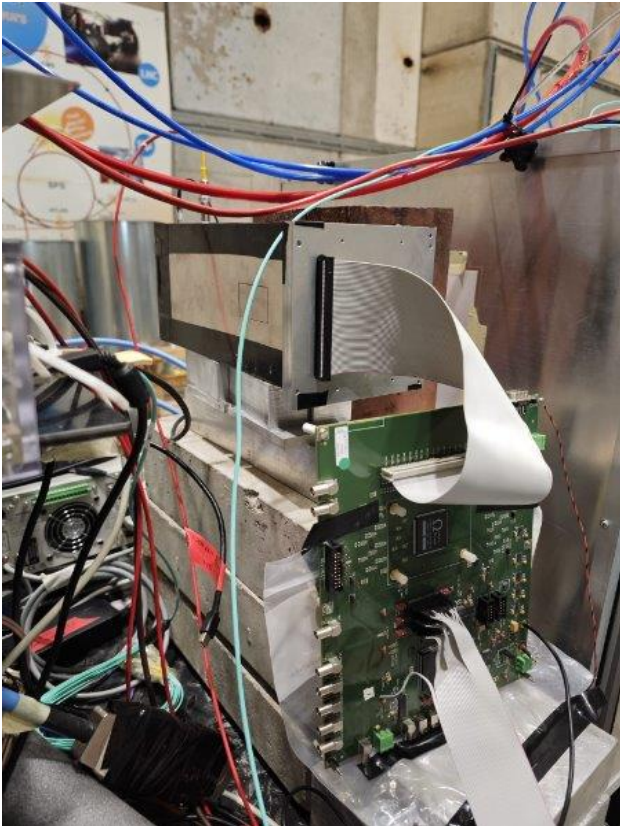
Muon filter

- Particle identification
- Pion contamination
- Another station



Homemade variant

- Scintillating fibers
- SiPM



Conclusions

- Independent measurement of hadronic contribution
- Two test runs + one in 2025 before LS3
 - 2 stations + ECAL + Muon filter
 - All systems working
- Ready for data taking after LS3
- 3 years of running ($\sim 0.3\%$ accuracy)