Prospects for muon on electron scattering at JLab

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RENEW-HEP

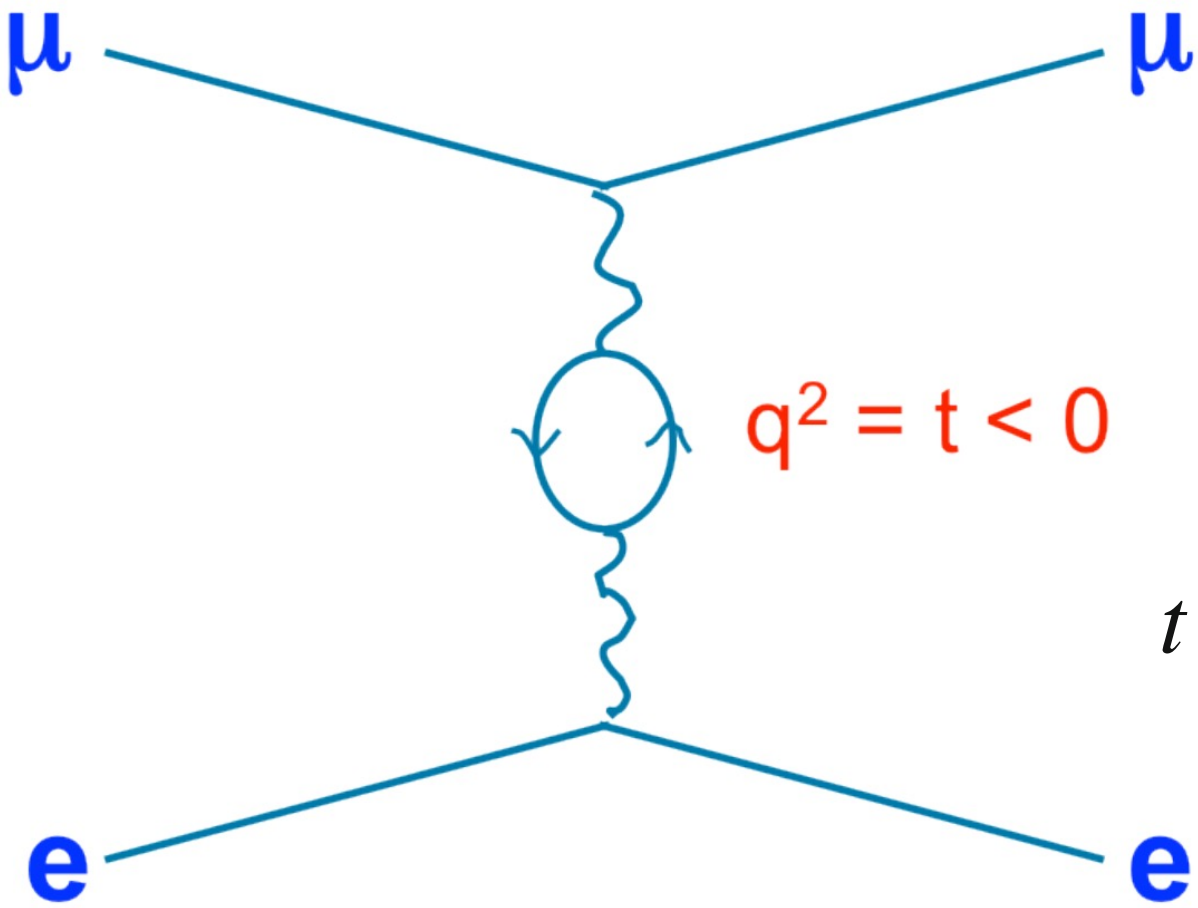
- **RENEW: Reaching a New Energy Sciences Workforce (DOE initiative)**
  Mar 12, 2024: DE-FOA-0003280
- ***"Traineeship on secondary beams at Jefferson Lab"***
  Apr 30, 2024: Pre-proposal
  Jul 23, 2024: Full proposal, PIs: M. Kohl (HU), P. Achenbach (Jlab)
  Nov 4, 2024: Pre-award notice, $100k / 2 yrs, Jan 1, 2025 - Dec 31, 2026
  → one graduate student, one partial UG, conference travel
  Jan 19, 2025: Recommended for funding – however, award never made

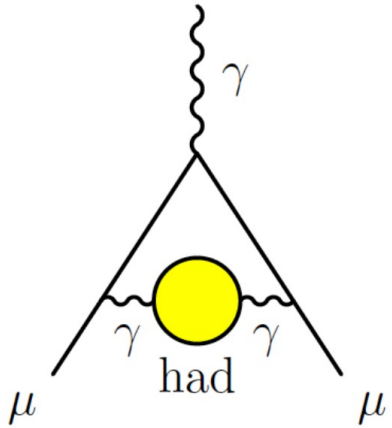
- **Development of secondary beam facility behind the Hall A beam dump using a high-intensity e-beam at 11 GeV (22 GeV after upgrade)**
  → Muons, neutrinos, and DM particles
  → μ-e scattering, ν-A scattering, BDX
  → High-intensity detector test facility

- **Vault design with beam stopper and collimation system to enable, collimate, or stop charged particles and photons**
- **Characterization of beam properties**
- **Simulations**
- **Detector commissioning**

Muon-electron scattering

- t-channel process, sensitive to running coupling α(t)
- Sensitive to hadronic vac. polarization (HVP), lead correction for g_μ-2
- G. Abbiendi et al., https://arxiv.org/pdf/1609.08987





$$t(x) = \frac{x^2 m_\mu^2}{x - 1}$$

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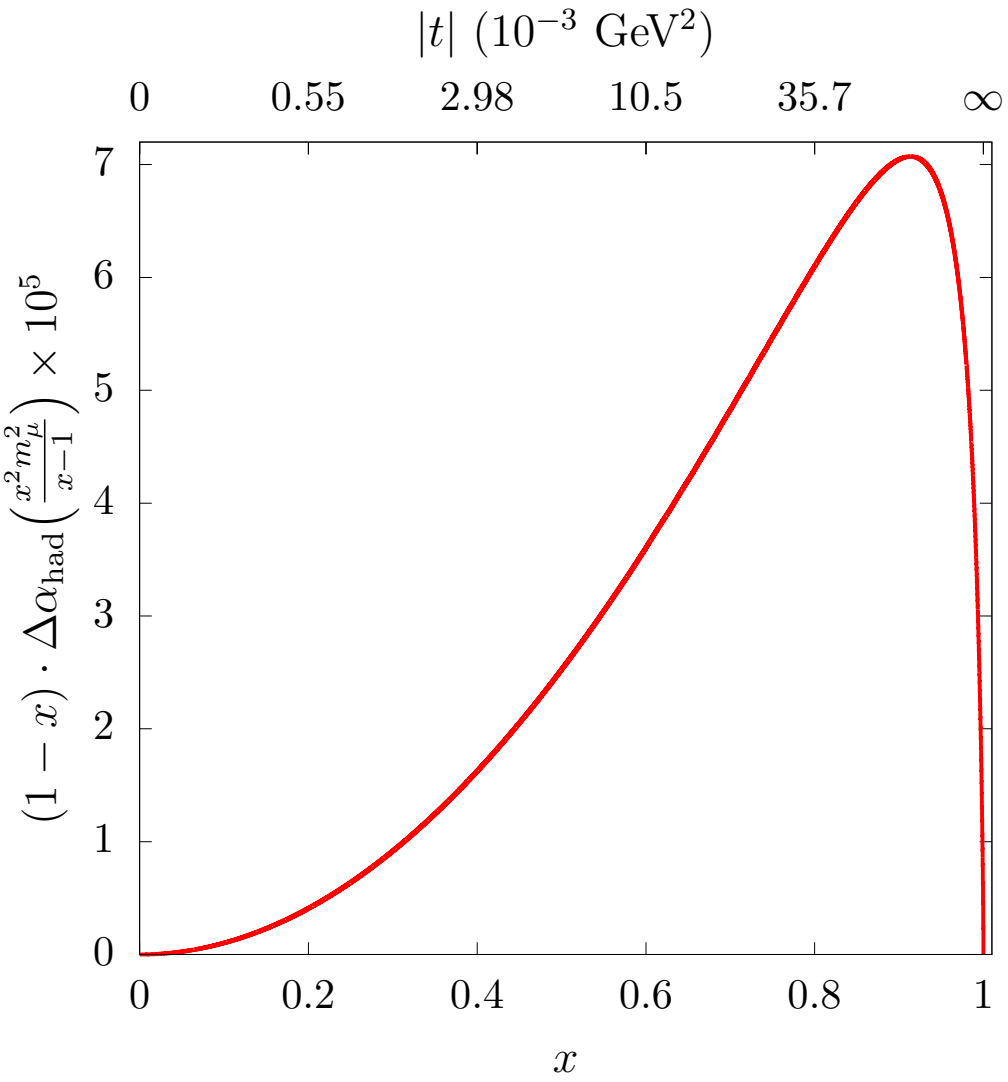

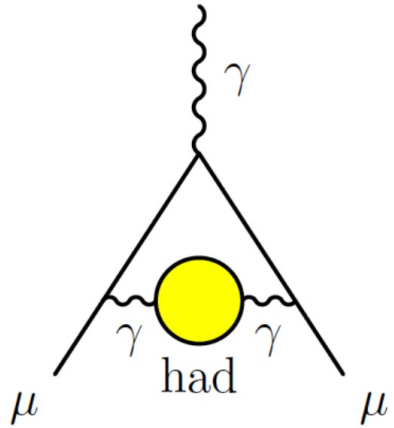

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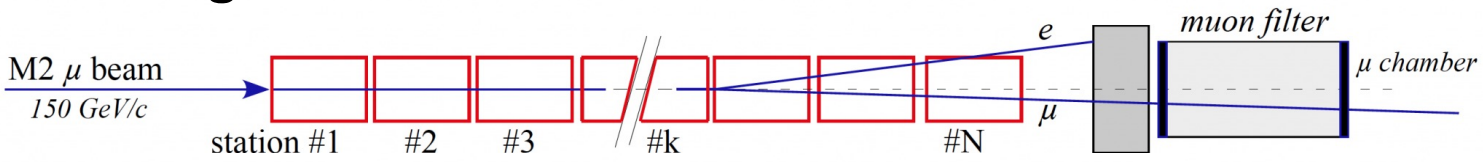
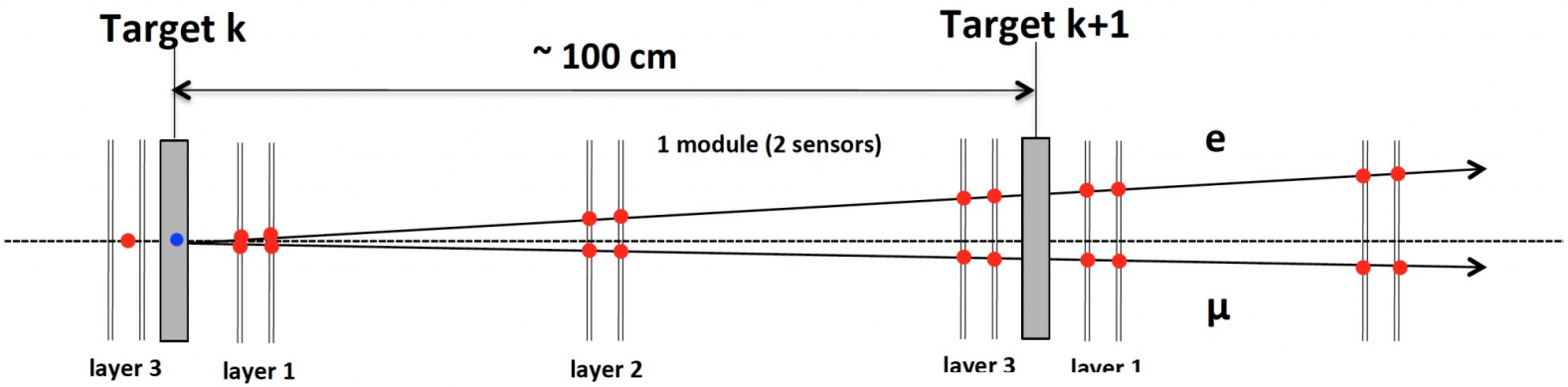
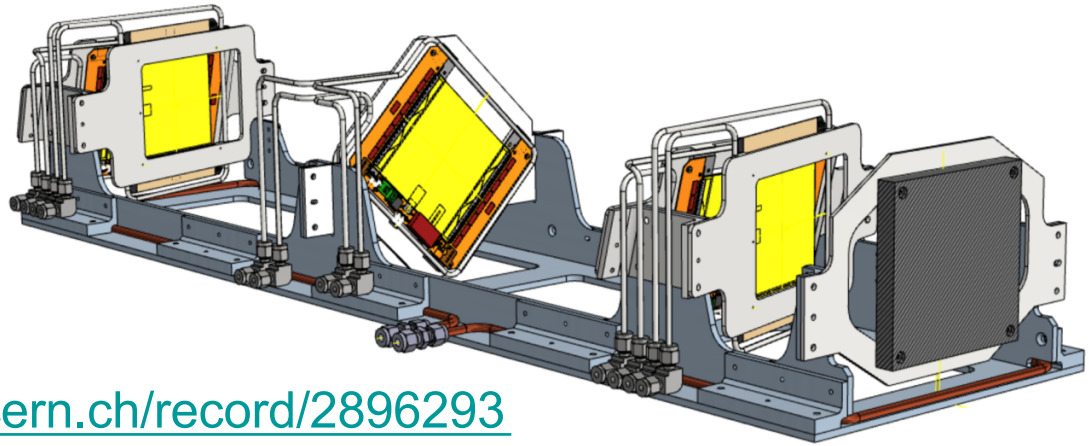
MUonE @ CERN

- https://web.infn.it/MUonE/
- **M2 beamline with 160 GeV muons, 40 stations planned**
- **Conceived 2016; engineering run 2023; small-scale experiment 2025**
- **Coverage of x < 0.93**



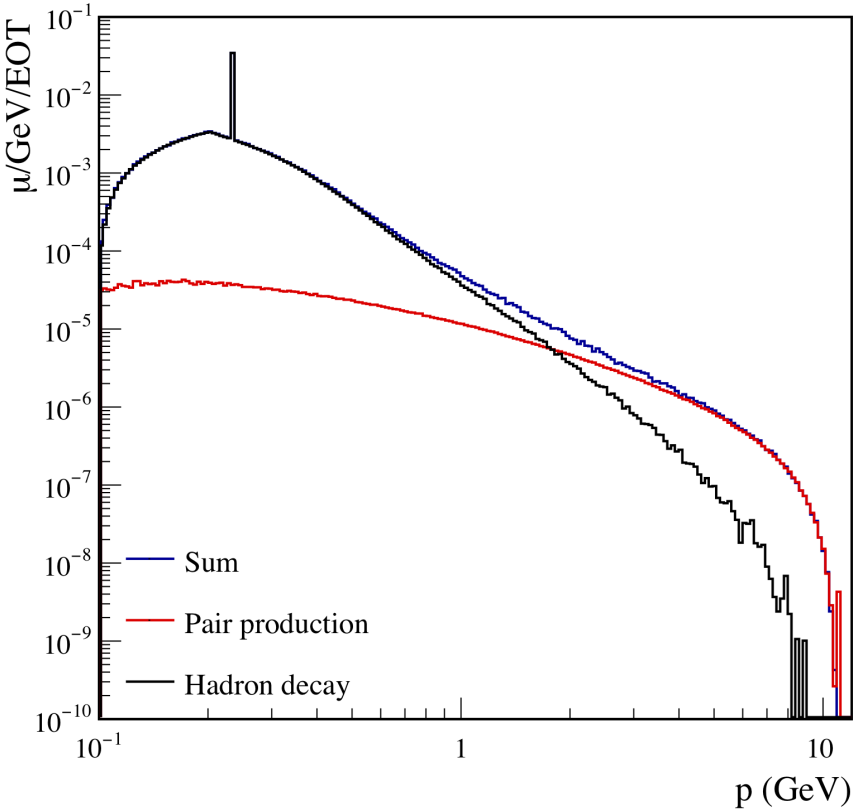


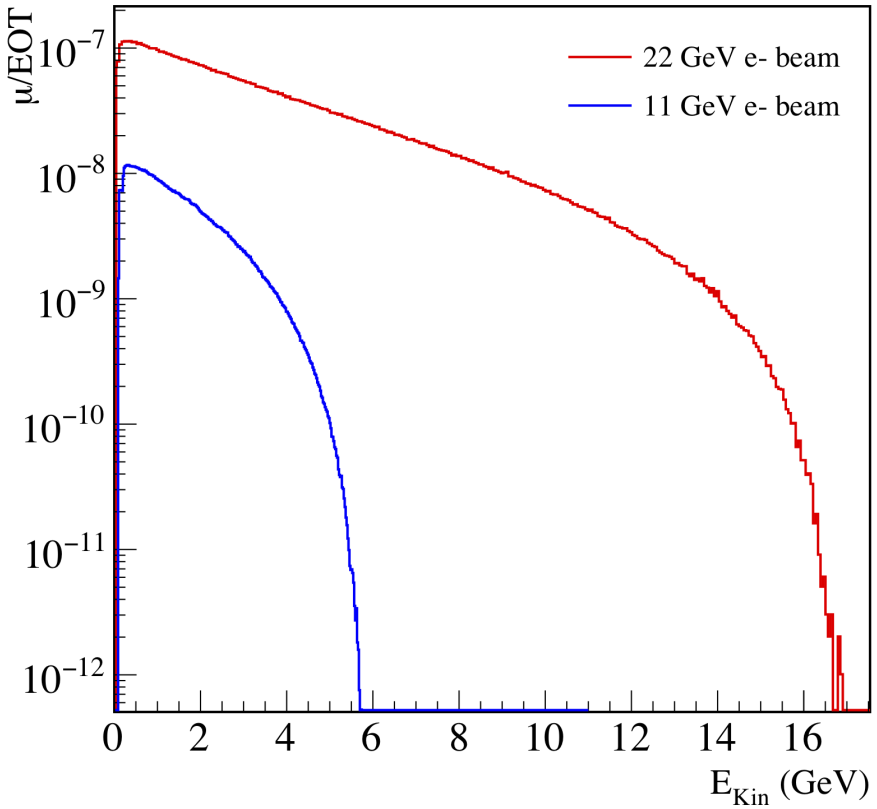


2024 MUonE Proposal https://cds.cern.ch/record/2896293

Muon flux behind Hall A

- **FLUKA simulations**
- **High flux of muons up to several GeV**
- **2.5x10^{-6} (3x10^{-7}) μ/EOT x 50 μA electrons → few 10^{8} (10^{7}) μ/s on 1 m^{2}**
- **M. Battaglieri et al., https://doi.org/10.3390/instruments8010001**
- **A. Fulci, Master's thesis, University of Messina (2021)**





Muon-electron scattering at JLAB

- At 11/22 GeV: partial overlap with MUonE; coverage of x < 0.5
- Diffuse beam of unseparated μ^+ and μ^-; high-Z target plate(s)
- Consider magnet for charge separation to isolate charge-odd effects
- Forward muon in coincidence with recoil electron
- Tracking of incoming $\mu^\pm$ and outgoing $\mu^\pm$ e^- pair (GEMs)
- Vertex reconstruction, scattering and recoil angles from 3 tracks
- Typically, up to ~20° opening angle for recoiling e^-
- Strong correlation between recoil electron angle and momentum
- Fast timing counters for trigger and vetos
- PID and $\mu^\pm$, e^- energies with Cerenkov (aerogel, RICH), EM calorimeter

- Precision Standard Model measurement, test of radiative corrections
- Precise measurement of differential cross section $d\sigma/dt$, onset of HVP
- Precise simulations including radiative effects; model independence
- Textbook experiment
- Collaborators welcome