Lepton Flavour Experiments with Novel Beams

W. Ootani, ICEPP, Univ. of Tokyo

ICFA Seminar, Toyama, Japan, 3 November 2026



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Scope and Acknowledgements

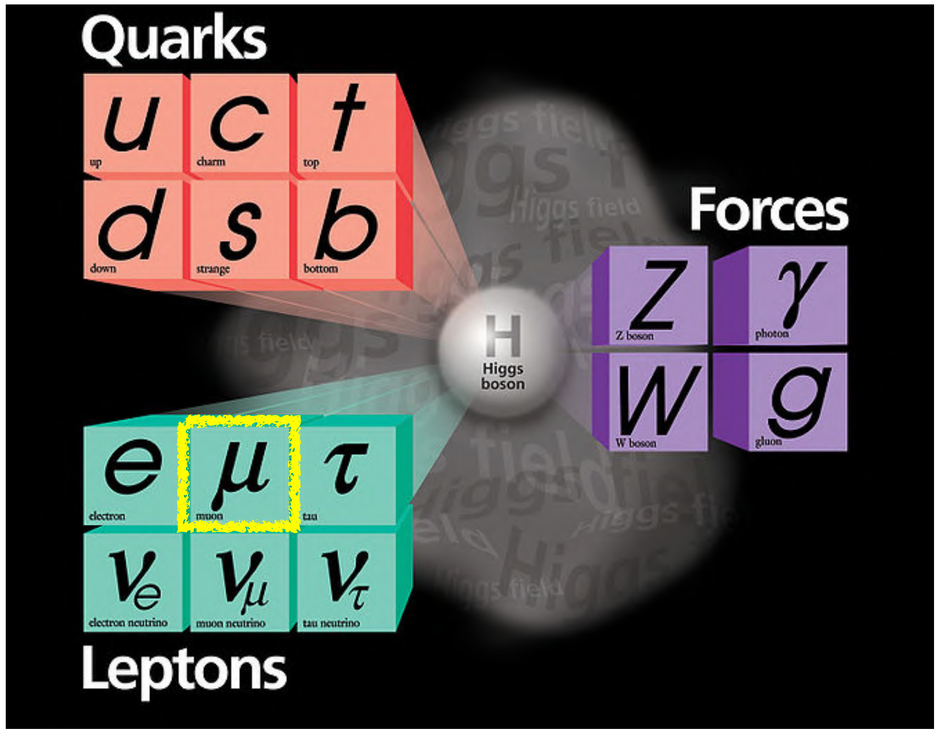
- Given the limited time and my research interests, this talk will inevitably be selective and focus on **lepton flavour violation (LFV) experiments using high-intensity muon beams**
- Many thanks to Yuki Fujii, Tamasi Kar, Stefano Miscetti, Hajime Nishiguchi, Yuri Oksuzian, and Andre Schoening for providing valuable materials and information

Lepton Flavour

- Nearly 90 years after the discovery of the muon, Rabi's famous question remains unanswered:

  "Who ordered that?"

- At the same time, lepton flavour has played a crucial role in advancing particle physics



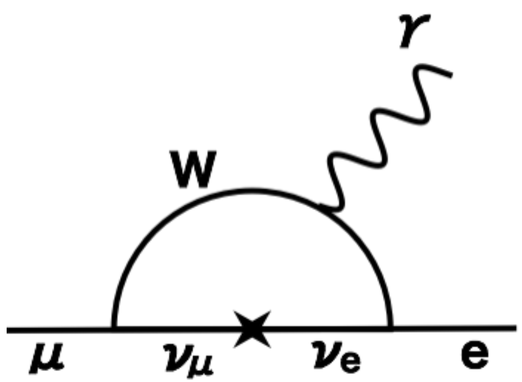


"Who ordered that?" **(Isidor Isaac Rabi)**

Is Charged Lepton Flavour Conserved?

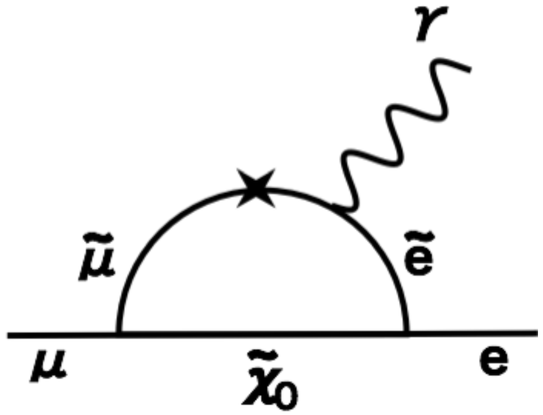
- Charged lepton flavour conservation is only an accidental symmetry in the Standard Model
- Broken only by tiny neutrino masses, but at an unobservably low rate
- Observable charged lepton flavour violation (LFV) would be a clear signature of physics beyond the Standard Model
- LFV experiments can probe effective new physics scales of $10^2 - 10^5\,\mathrm{TeV}$, depending on the underlying operators and couplings

$\mathcal{B}(\mu \to e\gamma) \sim 10^{-54}$

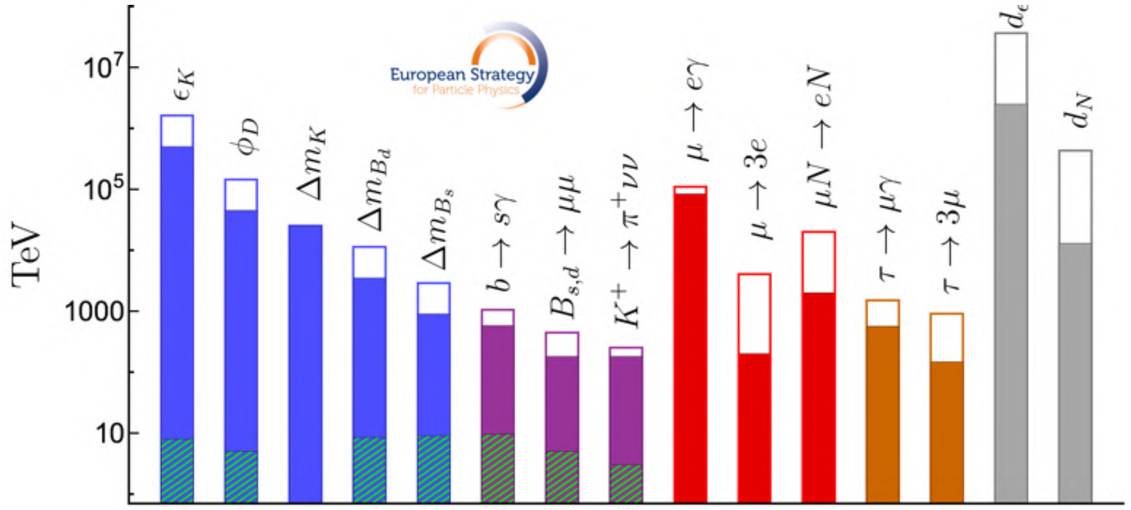


SM+m_ν

$\mathcal{B}(\mu \to e\gamma) \sim 10^{-11}$-$10^{-15}$



Beyond SM

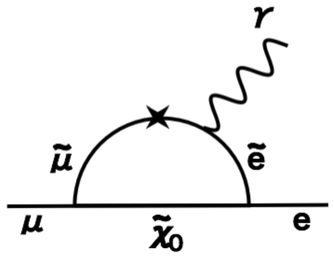


Note: *Effective NP scales derived from bounds on dimension-six operators, assuming unit Wilson coefficients.*

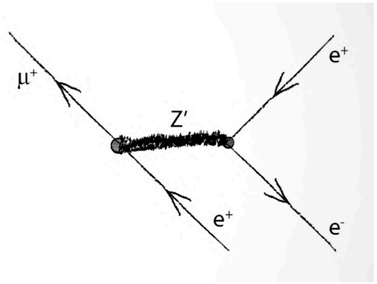
Physics Briefing Book: Input for the 2026 update of the European Strategy for Particle Physics

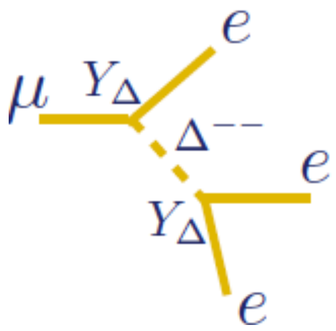
Golden Channels of Muon LFV

$$\mu^+ \to e^+\gamma$$

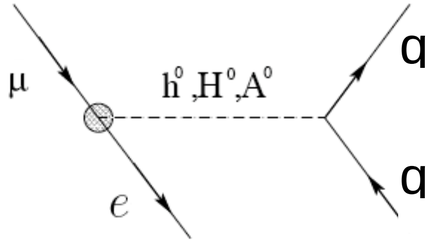


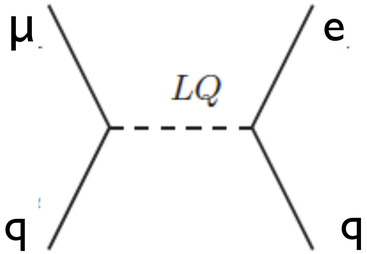
$$\mu^+ \to e^+e^+e^-$$

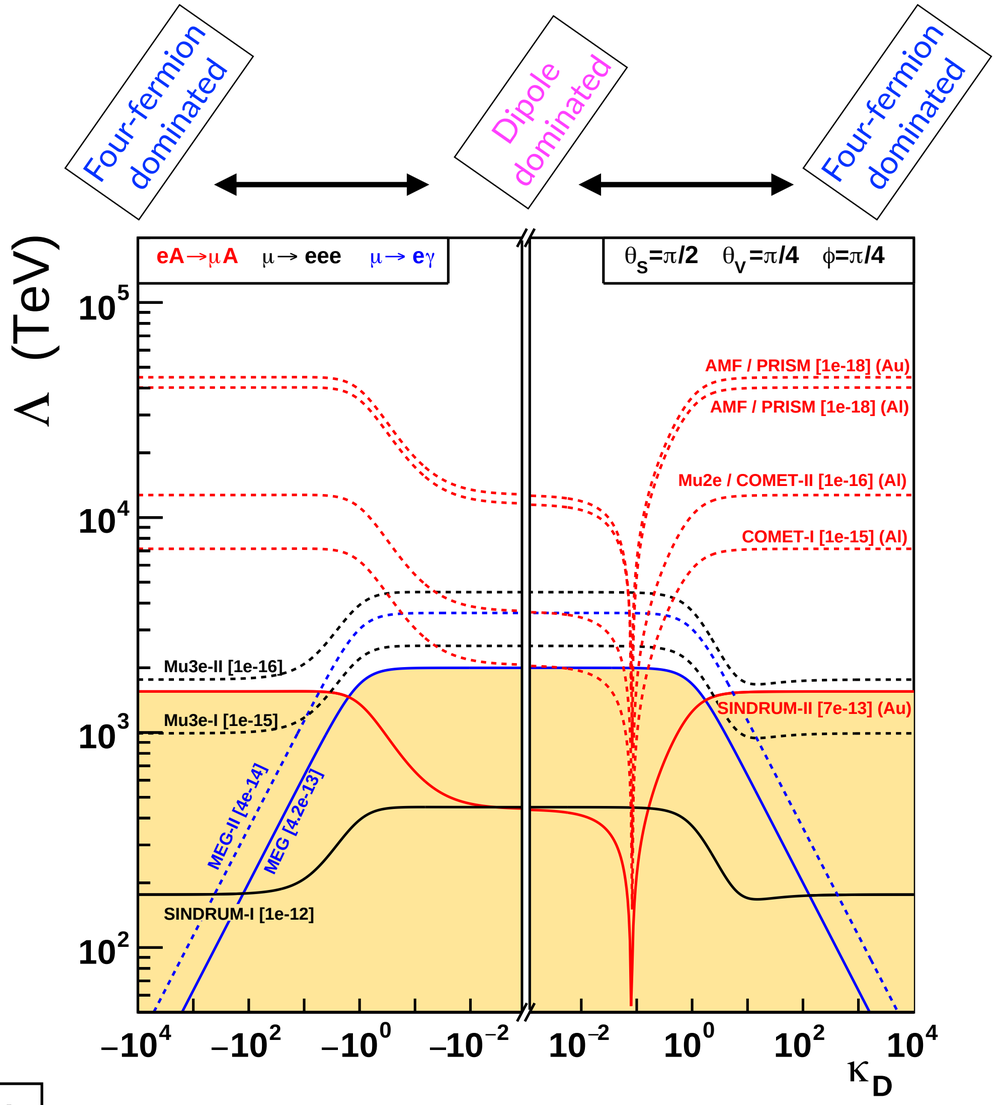




$$\mu^- N \to e^- N$$







S. Davidson and B. Echenard, EPJC 82 (2022) 836.

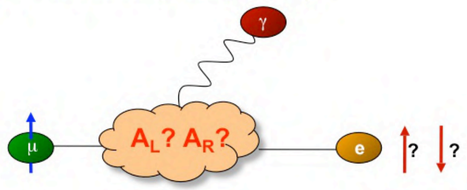
Strong complementarity among different muon LFV channels!

Experimental Approaches

μ-decays

$$\mu^+ \to e^+\gamma \qquad \mu^+ \to e^+e^-e^+$$

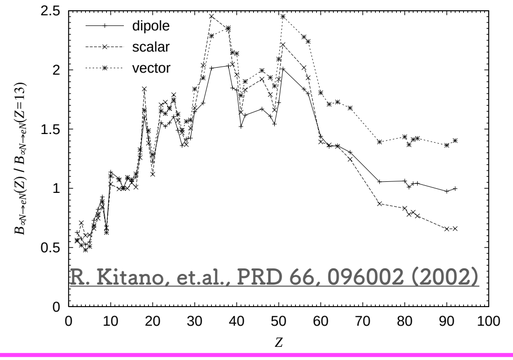
- Continuous muon beam
  - To minimise accidental BG
- Key challenge
  - High-precision detectors capable of operating at high rates
- Experiment
  - **MEG II** for $\mu^+ \to e^+\gamma$: Ongoing at **PSI**
  - **Mu3e** for $\mu^+ \to e^+e^-e^+$: Upcoming at **PSI**
  - **Future experiment with HIMB at PSI:** R&D phase
- Beyond discovery
  - Angular correlations to distinguish between new-physics scenarios



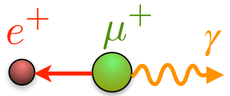
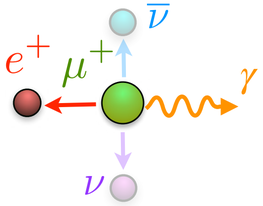
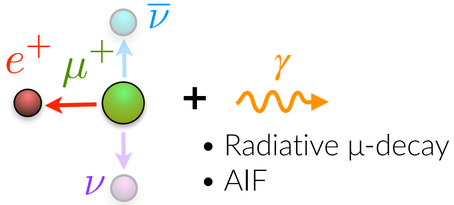
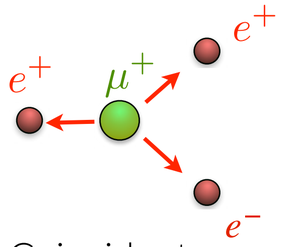
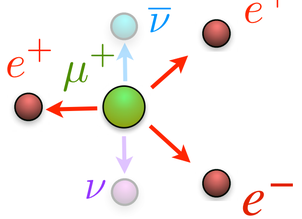
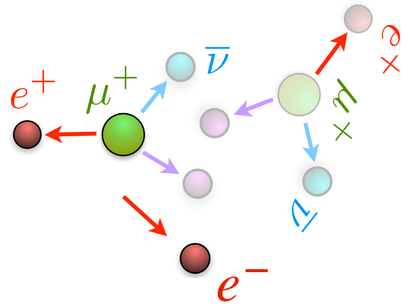
$\mu - e$ conversion

$$\mu^- N \to e^- N$$

- Pulsed muon beam
  - To minimise beam-related BG with delayed measurement
- Key challenge
  - High-quality pulsed beam with excellent extinction ($< 10^{-10}$)
- Experiment
  - **COMET**: Upcoming at **J-PARC**
  - **Mu2e**: Upcoming at **Fermilab**
- Beyond discovery
  - Nuclear dependence to distinguish between new-physics scenarios



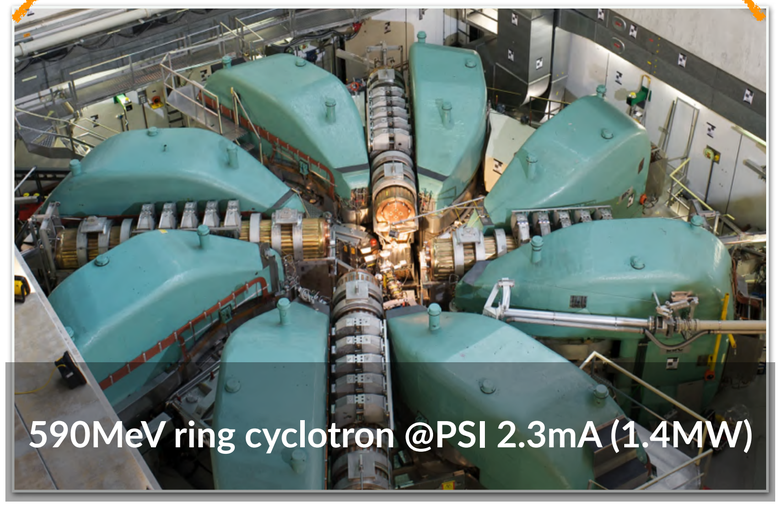
Search for LFV Muon Decays

	Signal	Prompt BG	Accidental BG	Key Concepts
$\mu^+ \to e^+\gamma$	 • Coincident • Monochromatic energies ($E_e = E_\gamma = 52.8\,\mathrm{MeV}$) • Back-to-back		 • Radiative μ-decay • AIF	• A continuous beam helps suppress accidental backgrounds → **PSI** • **Photon measurement is challenging** • **Two-body decay** → can concentrate on the kinematic edge
$\mu^+ \to e^+e^+e^-$	 • Coincident • A single decay vertex • $\Sigma E_e = m_\mu$ • $\Sigma \vec{p}_e = 0$		 • Bhabha scattering • Photon conversion • Mis-reconstruction	• A continuous beam helps suppress accidental backgrounds → **PSI** • **Three-body decay** → Need to detect **low-momentum electrons and positrons** • Need **high-rate tracking capability**

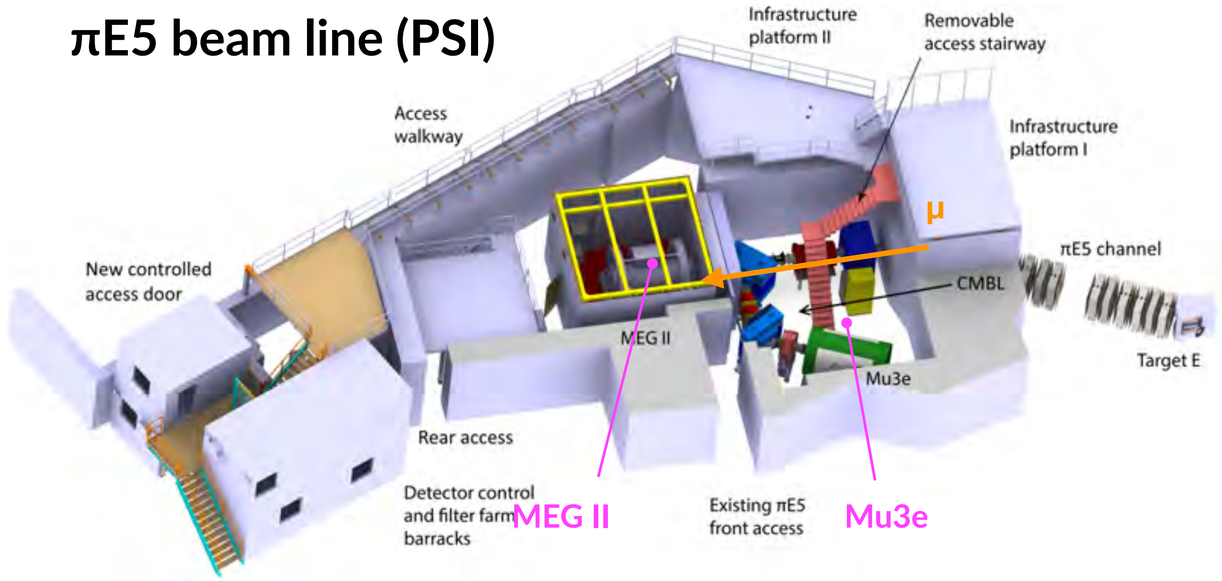
Search for LFV Muon Decays

- World's most intense DC muon source at Paul Scherrer Institute (PSI)
- High-Intensity Proton Accelerator (HIPA)
  - $590\,\mathrm{MeV}$ ring cyclotron, $2.3\,\mathrm{mA} \rightarrow 1.4\,\mathrm{MW!}$
  - The world's highest-intensity muon beam (max $\sim 10^8\,\mu^+/\mathrm{s}$)
- Shared by MEG II ($\mu^+ \rightarrow e^+\gamma$) and Mu3e ($\mu^+ \rightarrow e^+e^+e^-$)



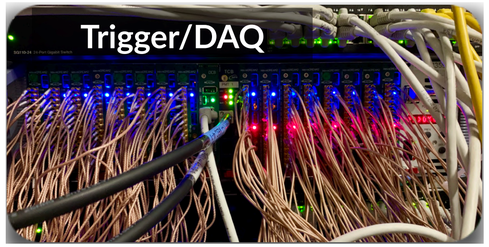


πE5 beam line (PSI)

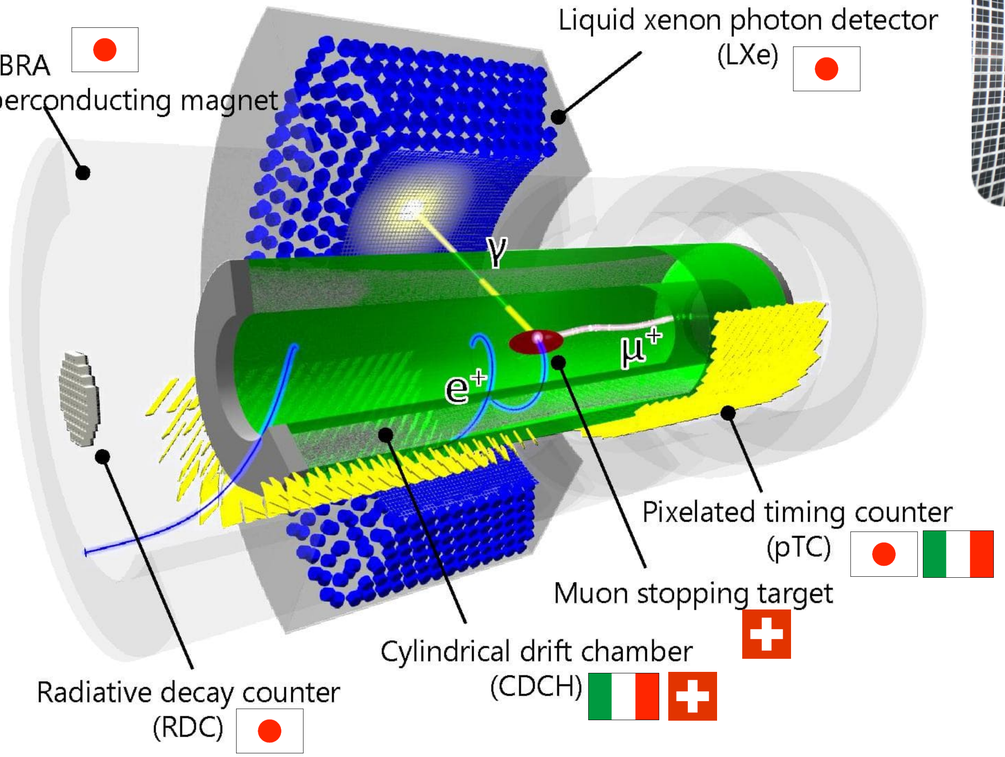


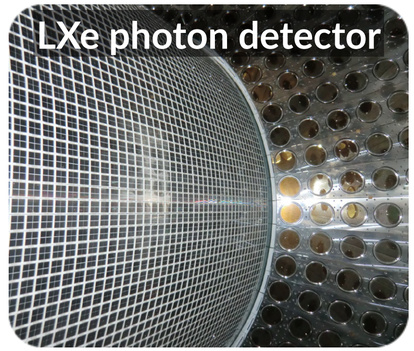
Euro. Phys. J. C(2024)84:190

MEG II Experiment : $\mu^+ \rightarrow e^+\gamma$

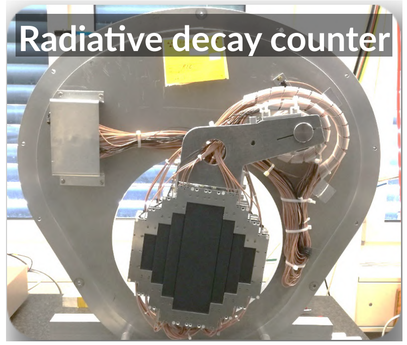


- ~9000ch waveform readout

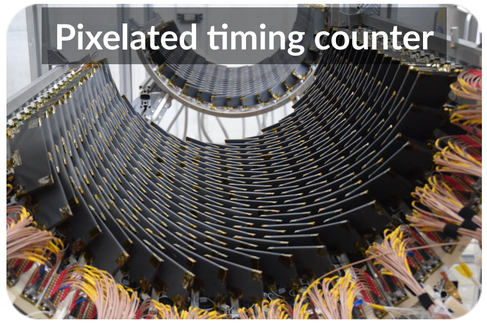




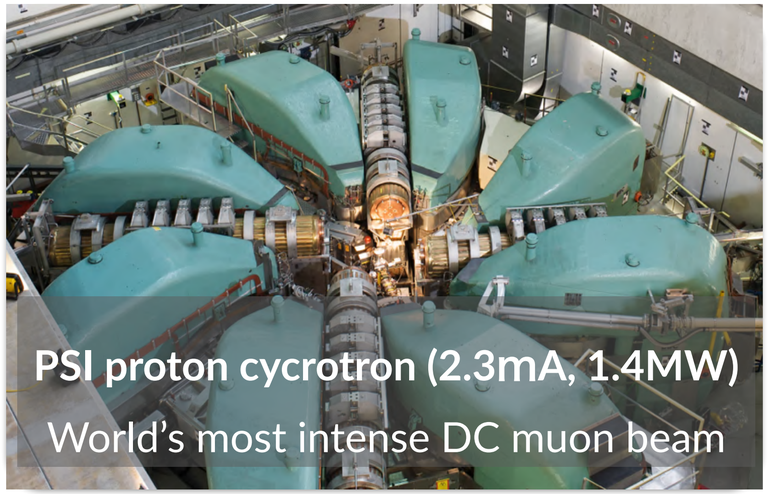
- LXe 900L (~2.7ton)
- Highly granular scintillation readout with SiPM(×4092) + PMT(×668)



- New in MEG II
- BG-γ suppression by identifying associated low mom. positron



- ×512 fast plastic scintillator plates
- 40ps time resolution averaged over multiple hits



Target BR sensitivity: 6×10^{-14}
($\times$ 10 better than MEG)



- Ultra-low-mass with single gas-volume
- Drift cells with stereo wires

MEG II : Status and Prospects

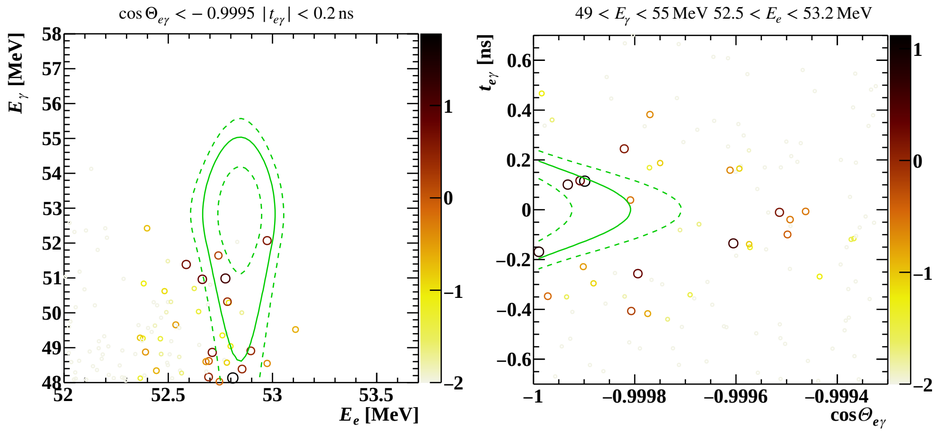
•Physics data-taking

- Started in 2021; **successfully completed in September 2026!**

•Latest result Euro. Phys. J. C(2025)85:1177

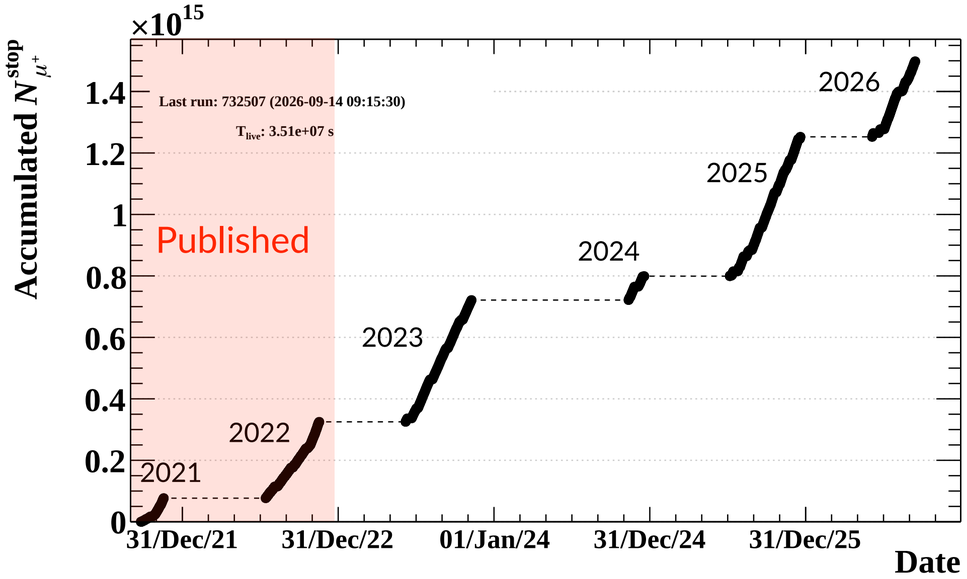
- $\mu^+ \to e^+\gamma$ search analysis of the first two years' data (2021–2022)
- No signal excess observed, setting the most stringent limit;

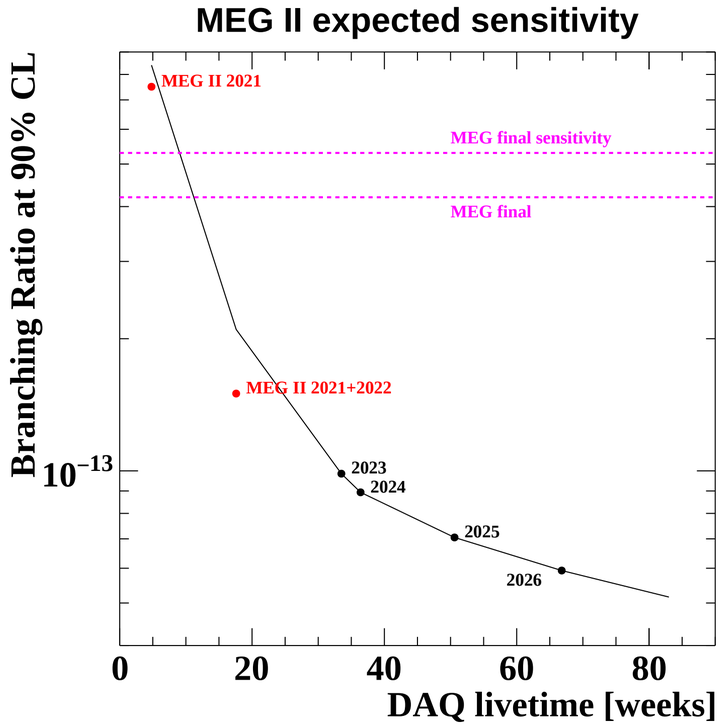
$$\mathcal{B}(\mu^+ \to e^+\gamma) < 1.5 \times 10^{-13}\ (90\,\%\ \text{C.L.})$$



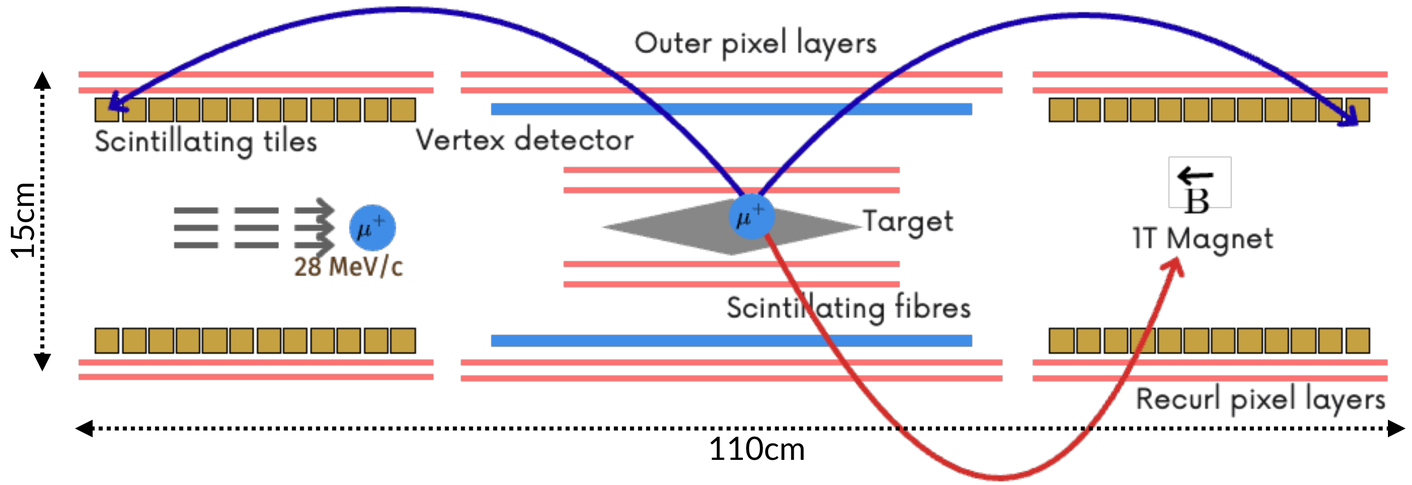
•A much larger dataset remains to be analysed (≈4× 2021–2022 statistics)

- Expected to reach the final sensitivity goal 6×10^{-14}, hopefully with a positive signal



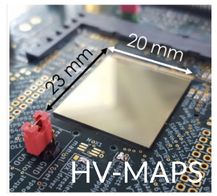


Mu3e Experiment : $\mu^+ \to e^+e^+e^-$



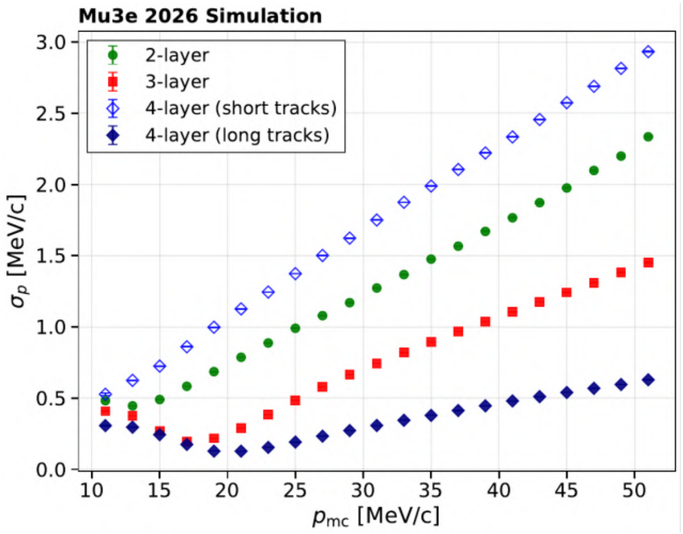
•Challenges

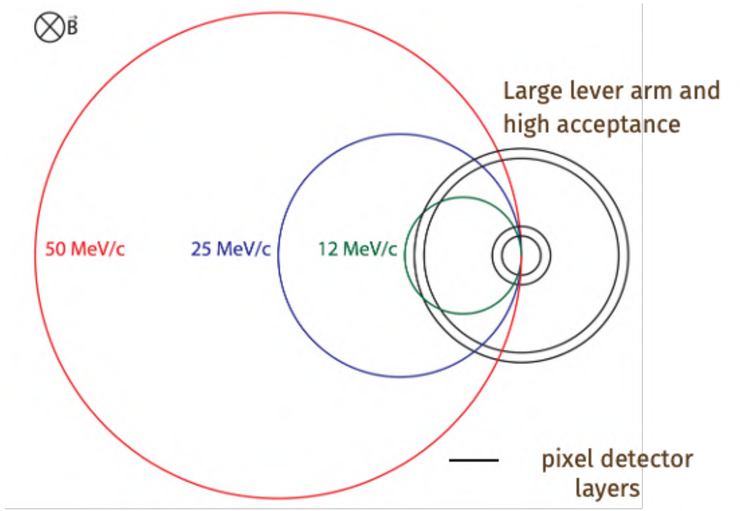
- Three-body kinematics require efficient detection of low-momentum electrons and positrons
- High rate capability

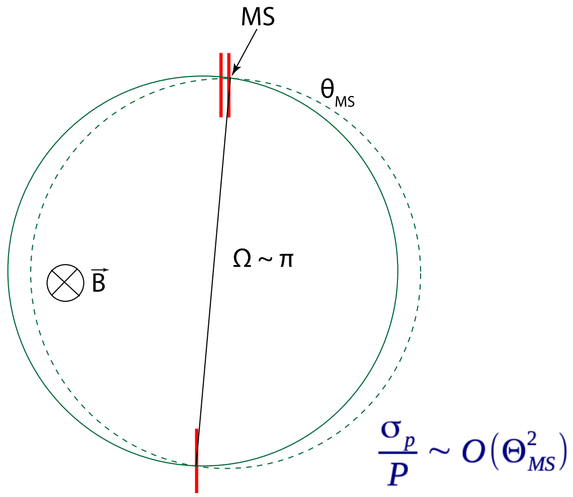


•Key technologies

- Ultra-thin four-layer pixel tracker ($50\,\mu$m-thick HV-MAPS)
- Scintillating fibres and tiles for timing
- Streaming DAQ with GPU filter farm for online event selection

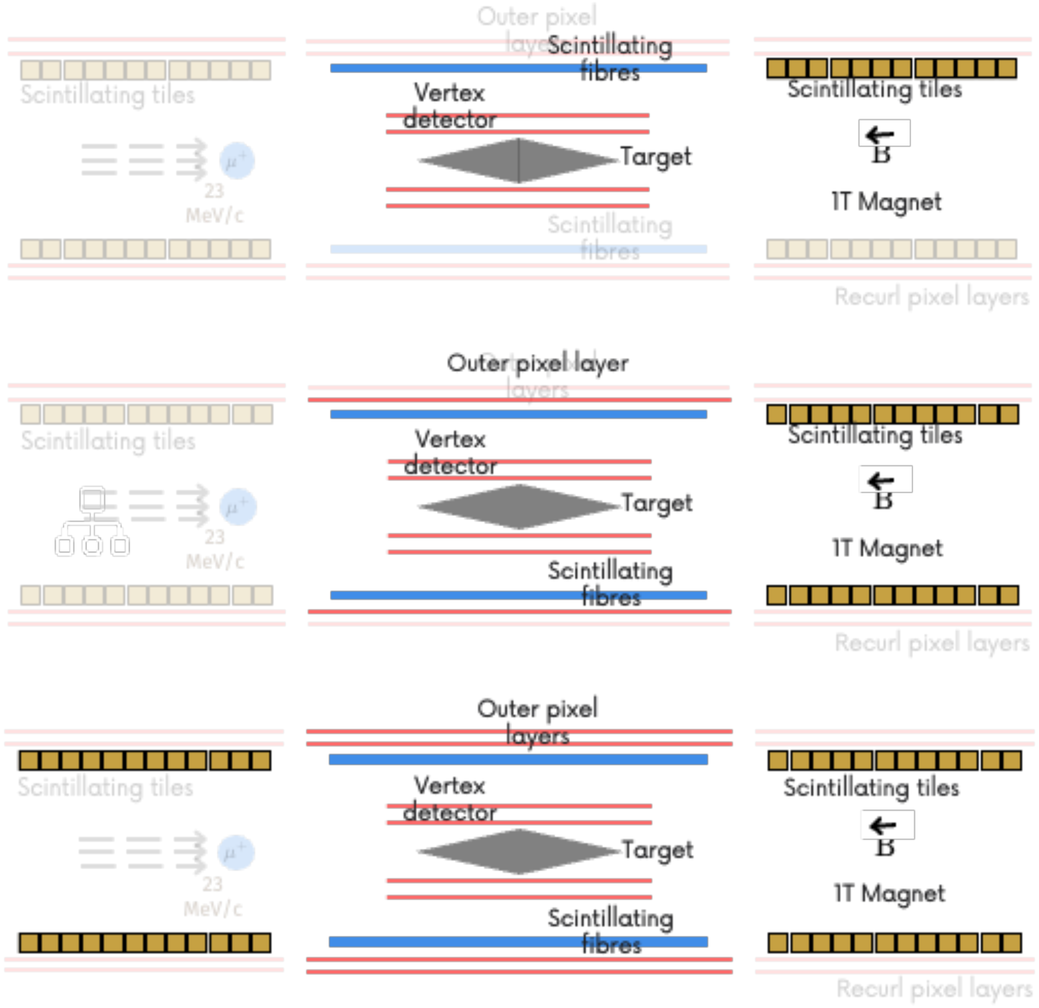






"Half turn" recurler for best precision

Mu3e :Timeline



- **Jun. 2025: Commissioning run with minimal detector configuration**
  - Full vertex detector (108 MuPix11($50\ \mu\mathrm{m}$) chips)
  - 1 out of 6 SciFi
  - 3 out of 14 SciTiles
- **Oct. 2026: 8-week beam campaign**
  - GPU filter farm commissioning
  - Detector commissioning
    - 70μm Mupix11, outer pixel layer 3, full SciFi, full downstream SciTile
  - BG measurement
- **2027: Phase 0 as first physics run**
  - **Surpass SINDRUM limit (10^{-12}) in < 2 weeks!**

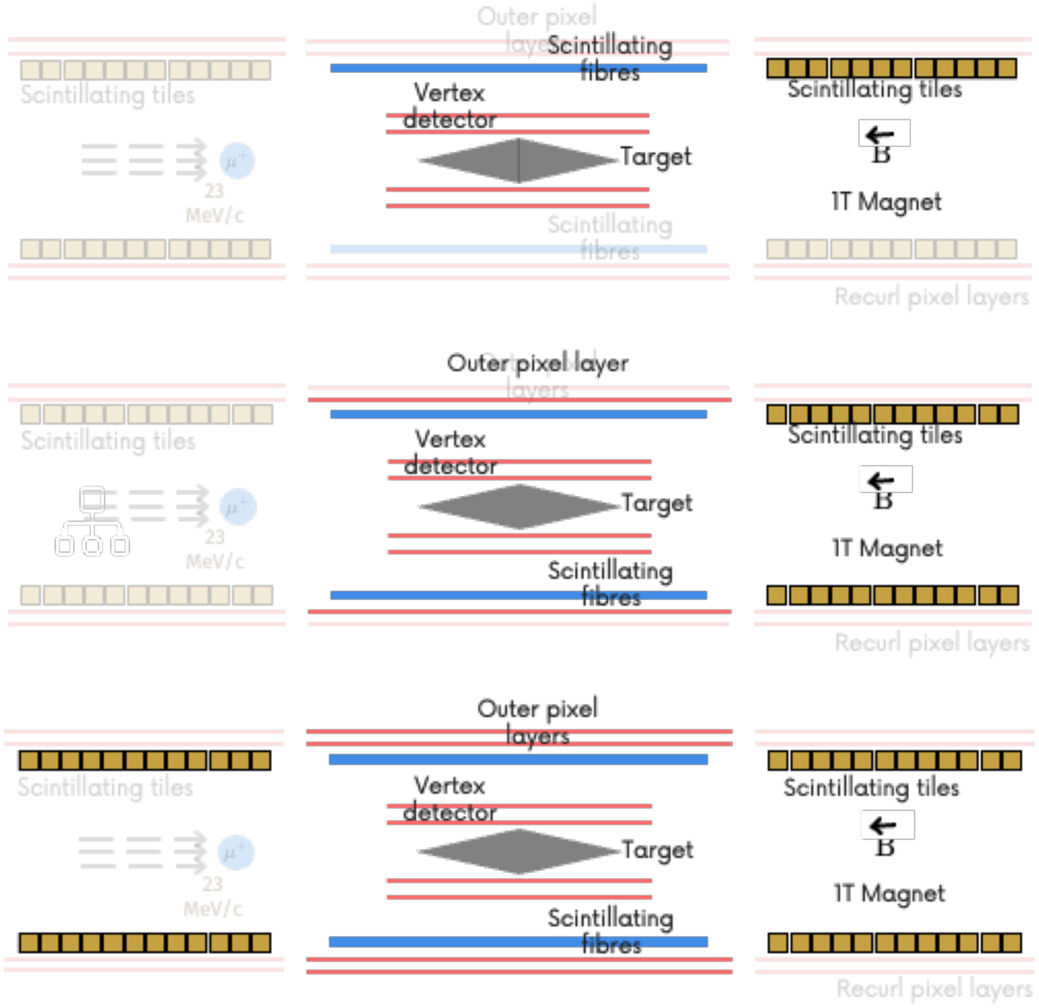
>2028

Jan 2028: HIMB Shutdown
Outer Pixel Recurl Station
Prodution, HW & SW Consolidation

> Mid 2029: First Beam for HIMB
Phase I data taking
Phase I goal: $\mathcal{O}(10^{-15})$

>2031:
Phase II
Phase II goal: $\mathcal{O}(10^{-16})$

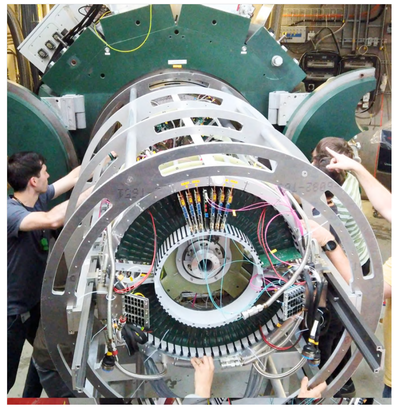
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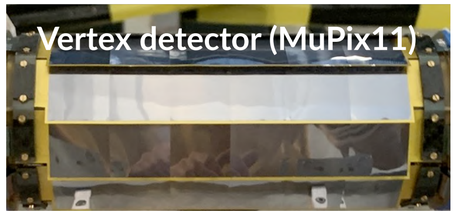


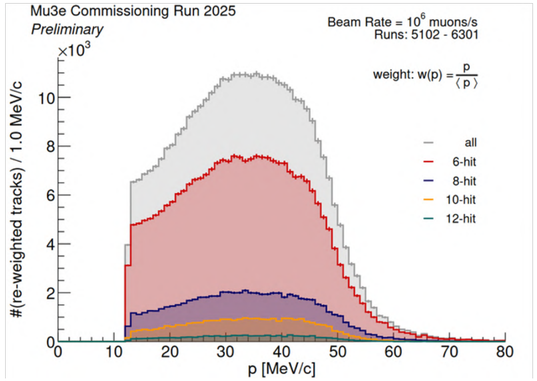
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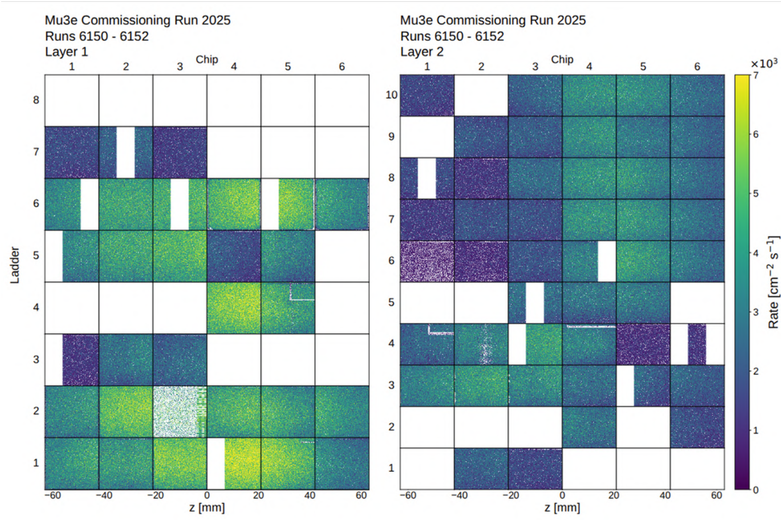
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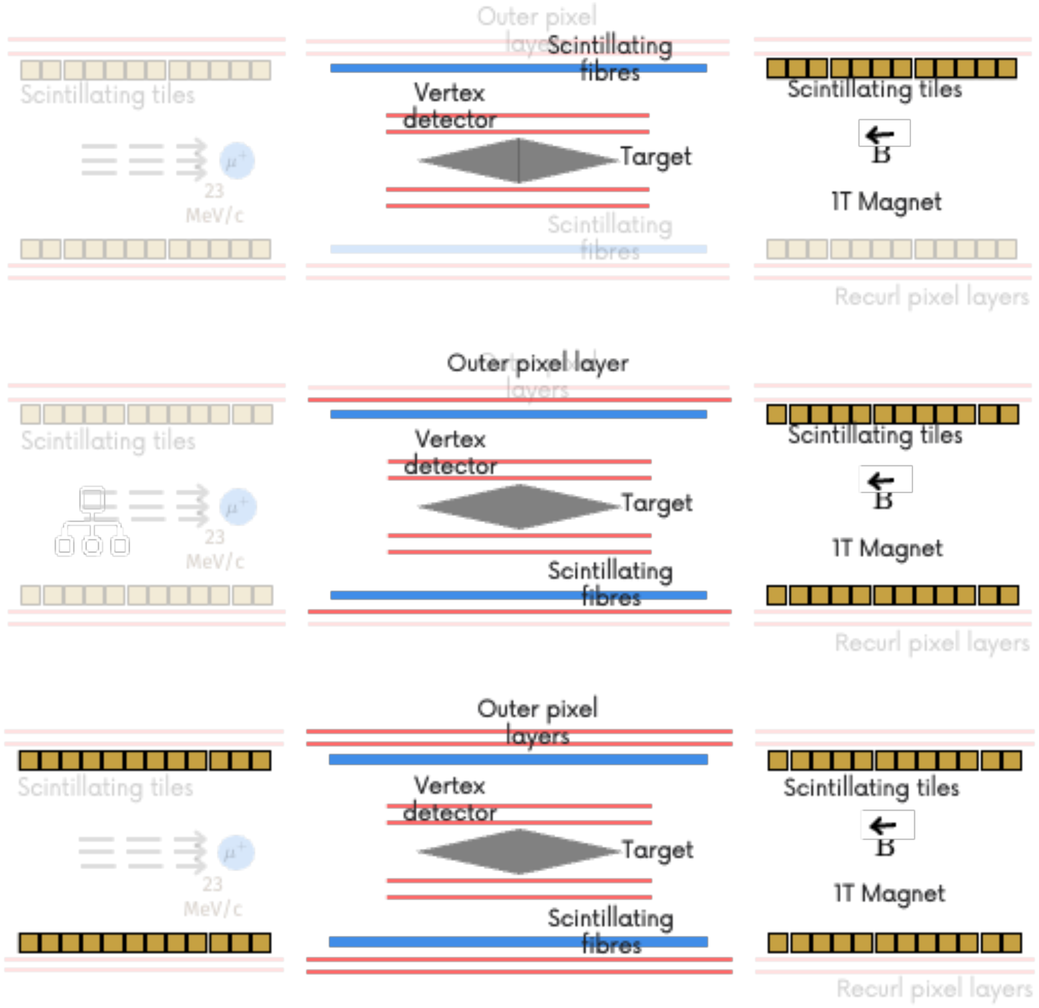


Vertex detector hit maps



Some chips didn't work, but a lot learned!

Mu3e :Timeline



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Phase II
Phase II goal: $\mathcal{O}(10^{-16})$

$\mu^- N \to e^- N$

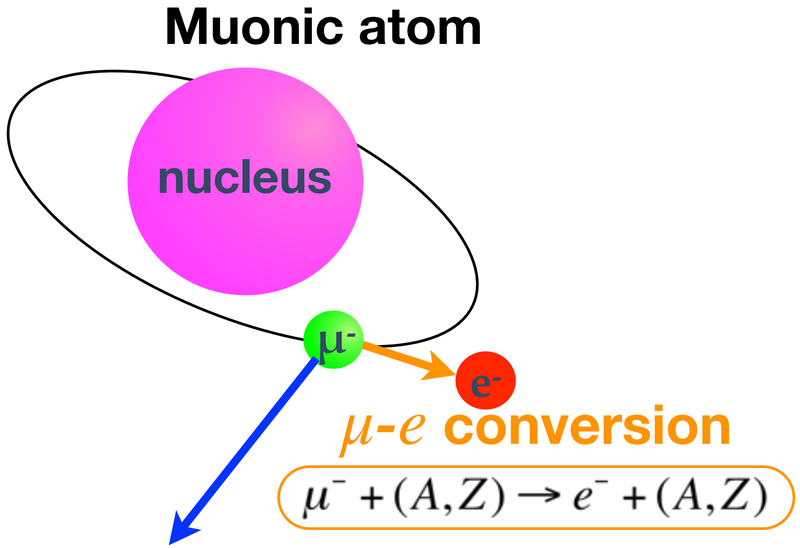
Signal

- **Monoenergetic electron from muonic atom**
  - $E_e = m_\mu - B_\mu - E_{\text{recoil}} \sim 105\,\text{MeV}$ (Al atom)
  - Muon lifetime $1\,\mu\text{s}$ in a muonic atom: (Al atom)

  ⇒ delayed measurement is possible

Background

- Decay In Orbit (DIO)
- Beam-related
  - Radiative Pion Capture (RPC)
  - Decay in Flight (DIF)
  - Beam electrons/antiprotons
- Cosmic rays



Standard Model

Decay in orbit

$\mu^- \to e^- \bar{\nu}_e \nu_\mu$

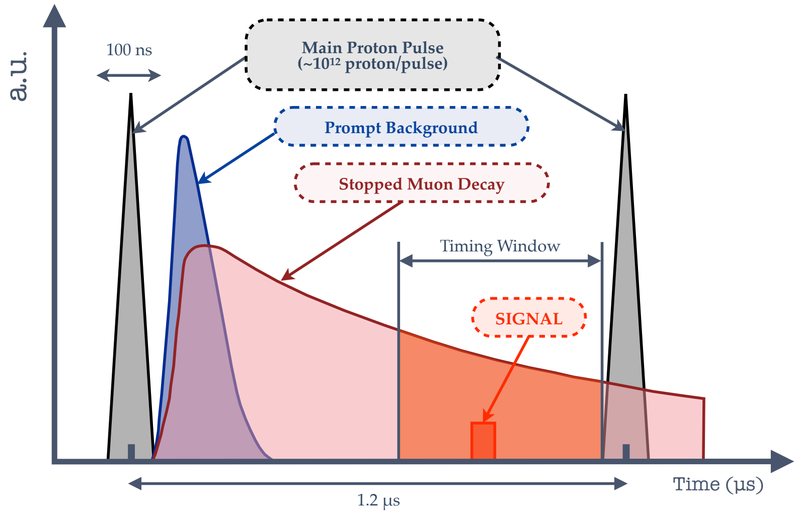
Nuclear capture

$\mu^- + (A,Z) \to \nu_\mu + (A,Z-1)$

- **Challenges**
  - A single energetic electron as the only signal signature

    → No coincidence measurement possible
- **Key concepts**
  - Delayed measurement requires excellent extinction

    ($< 10^{-10}$) to suppress out-of-time beam particles
  - Curved solenoids for background suppression
- **Upcoming experiments based on similar concepts**
  - COMET@J-PARC
  - Mu2e@Fermilab



COMET@J-PARC



- Target sensitivity : 2×10^{-17} (SES)

  $(R(\mu N \rightarrow eN) < 7 \times 10^{-13}$ (N=Au) SINDRUM II (2006))
- $8\,\mathrm{GeV}$ Proton beam at a power of 56kW
- Background suppression using a long muon transport solenoid

~50 kW, 8 GeV proton beam

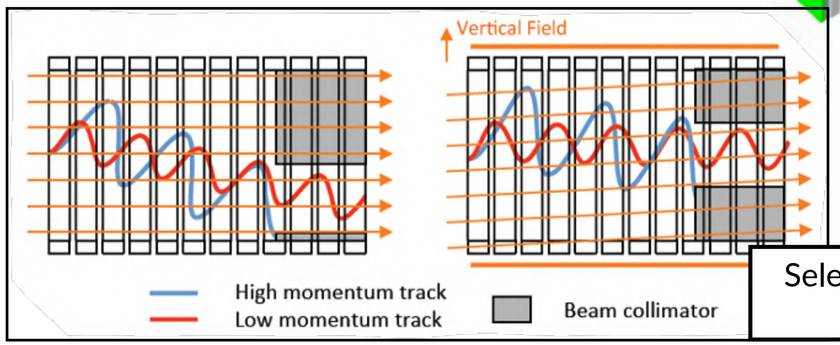
Pion production target + capture solenoid (max 5 T)

Muon stopping target

Electron transport spectrometer ~1 T

Curved muon transport solenoid
Max 3 T + dipole ~0.05 T

Detectors + Solenoid ~1 T
+ Cosmic-ray veto

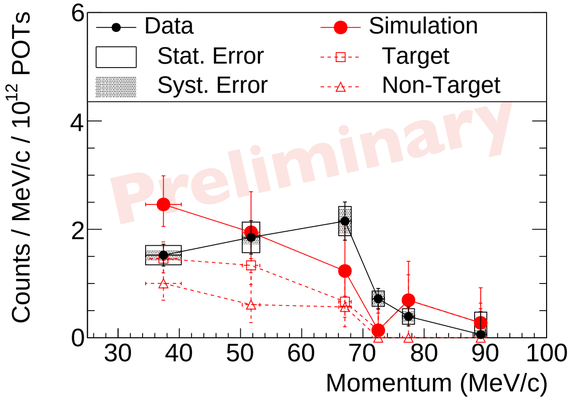


Select low-momentum negative muons with curvature drift

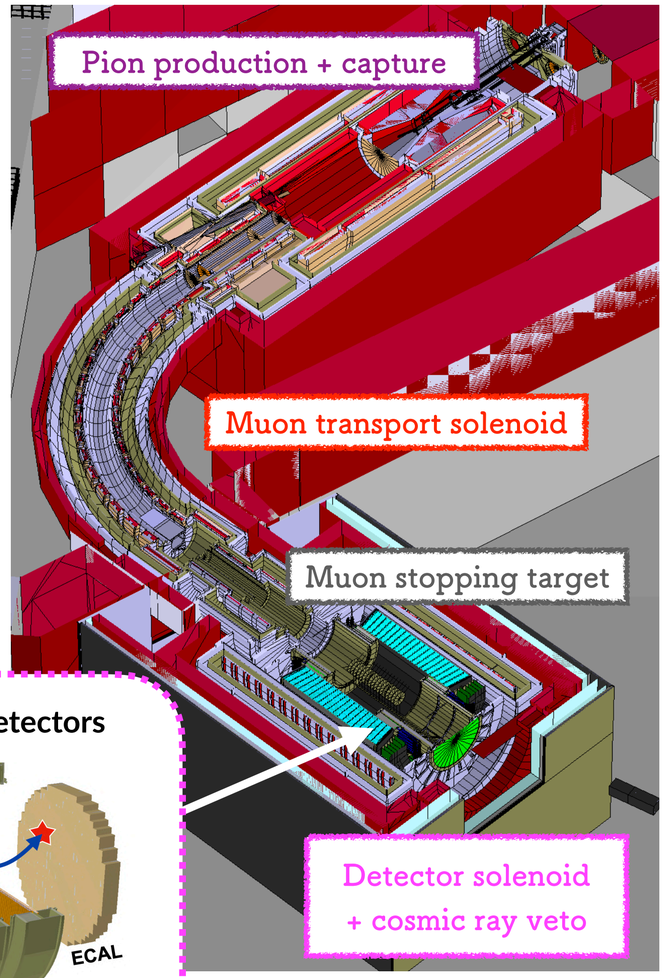
COMET : Staged Implementation

Phase-α (done in 2023)

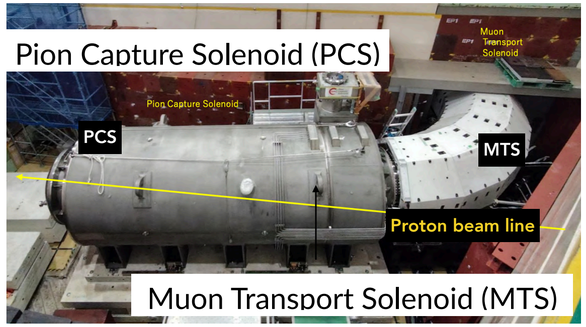
- First proton beam injection with reduced beam power of 260W
- Muons successfully transported by the muon transport solenoid



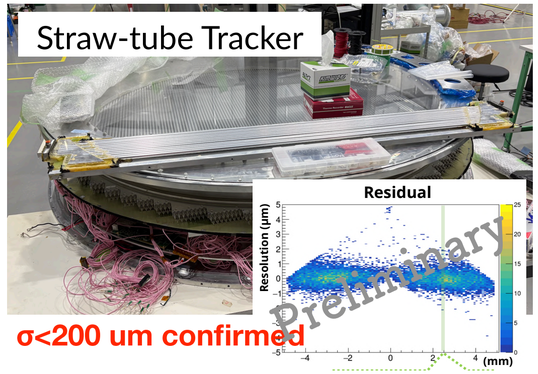
Phase-I (2028-)

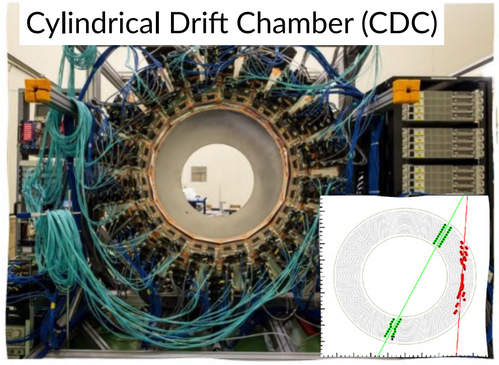


- **Target sensitivity**：3×10^{-15} (SES)
- **Proton beam power**: 3.2kW (Phase-I design goal)
  - **Commissinoing (1/100 intensity, in 2028) → Low-intensity running (1/10, 2029) → Full-intensity running (2029-)**
- **Muon transport solenoid**: 90° bend (half of the Phase-II configuration)
- **Pion production target**：Graphite
- **Physics goals:** Background measurements＋physics data taking

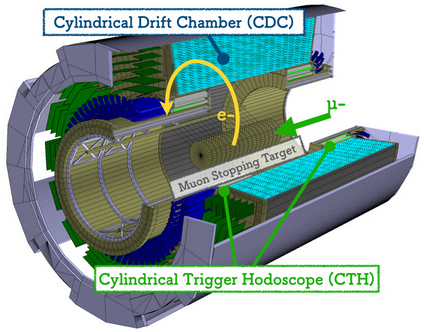




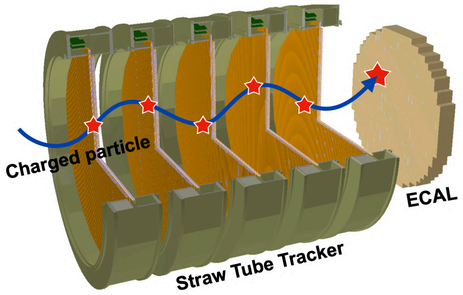




CyDet for physics DAQ



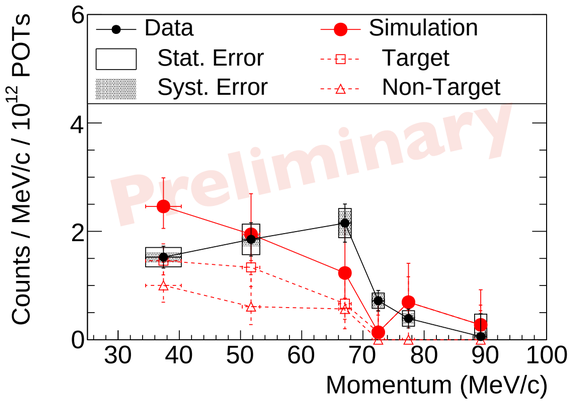
Beam measurement detectors



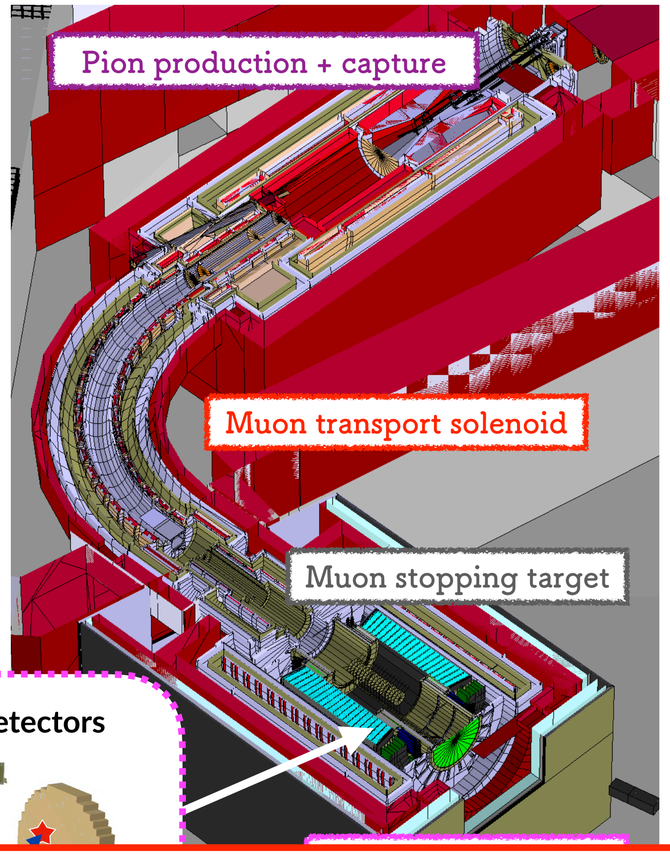
COMET : Staged Implementation

Phase-α (done in 2023)

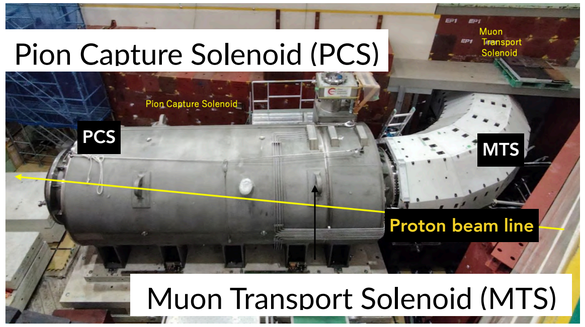
- First proton beam injection with reduced beam power of 260W
- Muons successfully transported by the muon transport solenoid



Phase-I (2028-)

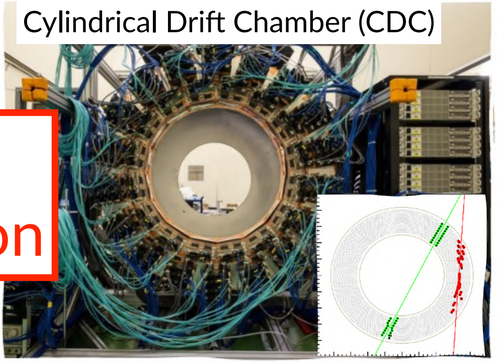


- **Target sensitivity**：3×10^{-15} (SES)
- **Proton beam power**: 3.2kW (Phase-I design goal)
  - **Commissinoing (1/100 intensity, in 2028) → Low-intensity running (1/10, 2029) → Full-intensity running (2029-)**
- **Muon transport solenoid**: 90° bend (half of the Phase-II configuration)
- **Pion production target**：Graphite
- **Physics goals:** Background measurements＋physics data taking

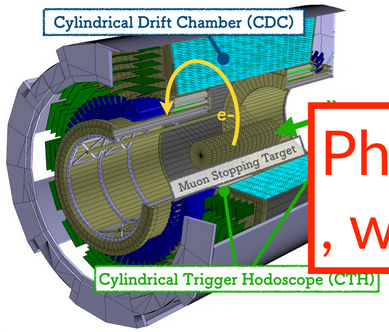




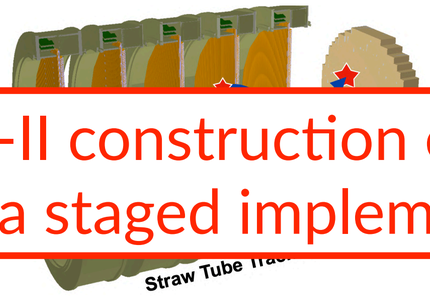




CyDet for physics DAQ



Beam measurement detectors

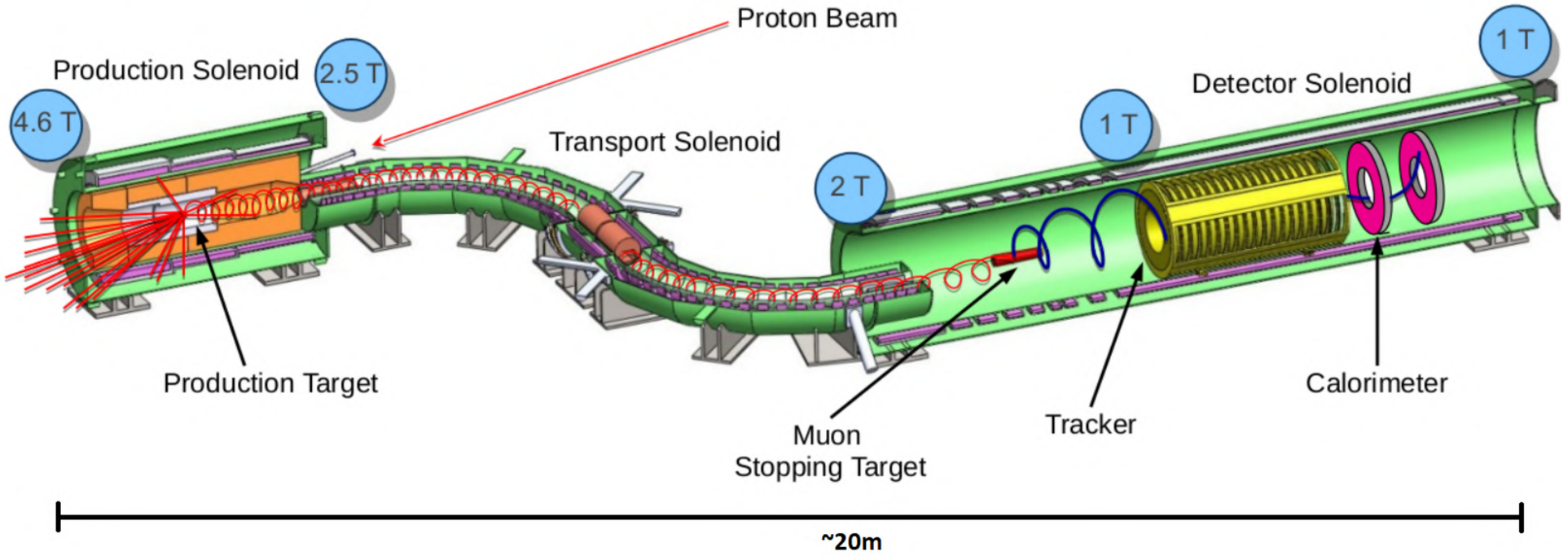




Phase-II construction expected to take ~3 years after Phase-I , with a staged implementation scenario also under consideration

Mu2e@Fermilab



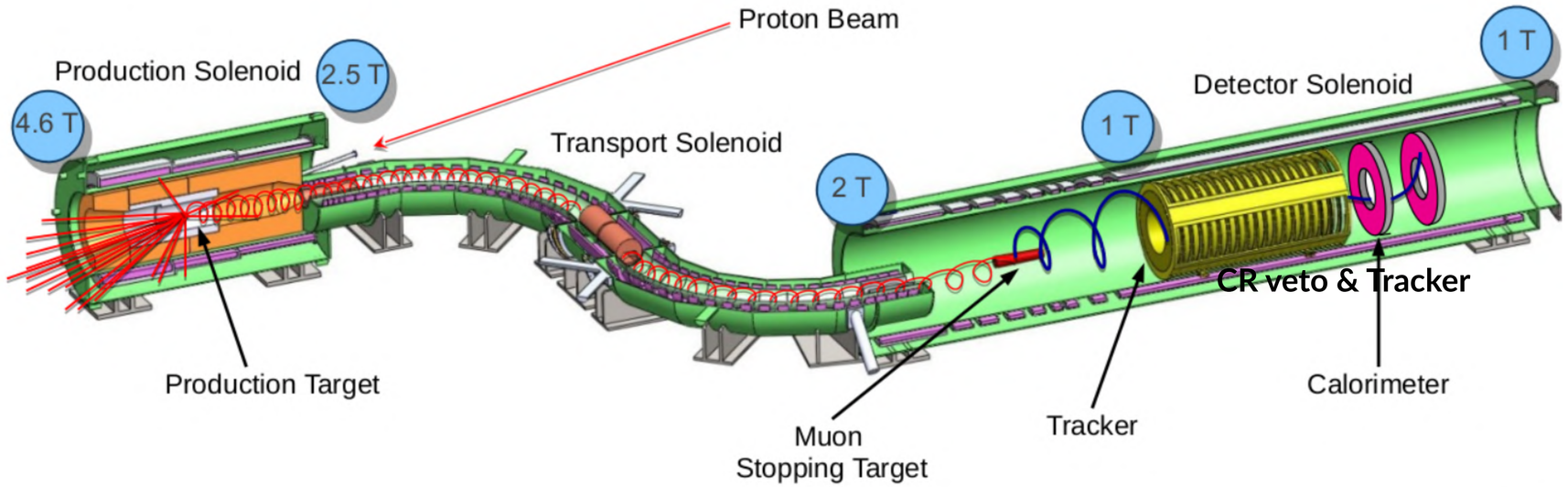


Mu2e@Fermilab

- Mu2e reuses Fermilab's existing accelerator infrastructure.
- 8GeV proton beam pulses every 1695ns
- Beam power: 7.7kW

- **A complementary approach to COMET**, pursuing comparable sensitivity
  - **Full detector configuration from the outset**, with a gradual ramp-up of beam power
  - **S-shaped muon transport solenoid** (vs. C-shaped in COMET)
  - **Straight detector solenoid** without a separate electron transport section (unlike COMET Phase-II)
- **High sensitivity despite lower proton beam power**
  - **Higher overall signal efficiency**
  - **Longer data-taking period**, enabled by operation alongside other experiments

Mu2e@Fermilab



Production Solenoid (PS)

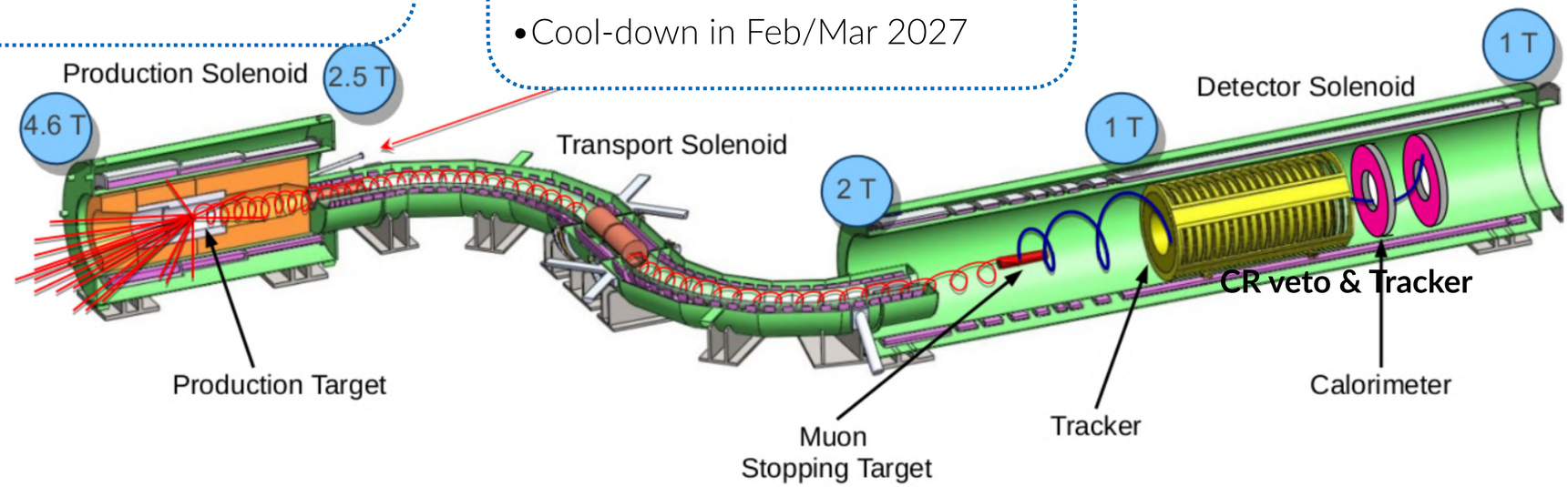


- Installed in 2025
- Cool-down in end 2026
- Endcap and ext. shielding installed in early 2027

Transport Solenoid (TS)



- Installation & assembly completed
- Cryogenic connections in progress
- Cool-down in Feb/Mar 2027



Production Solenoid (PS)



- Installed in 2025
- Cool-down in end 2026
- Endcap and ext. shielding installed in early 2027

Transport Solenoid (TS)



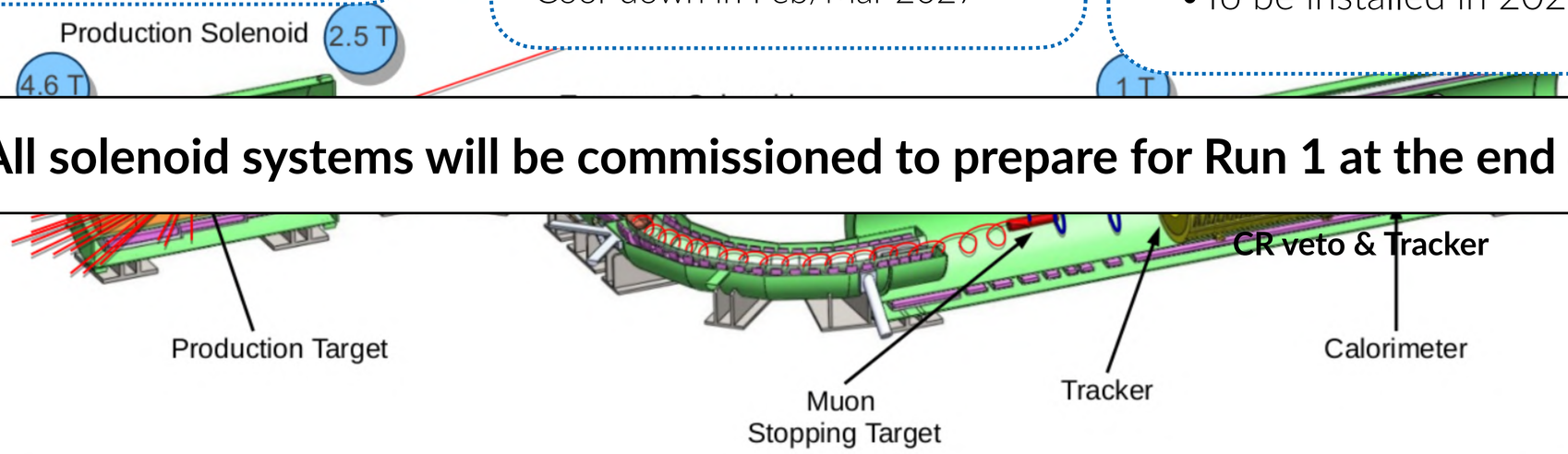
- Installation & assembly completed
- Cryogenic connections in progress
- Cool-down in Feb/Mar 2027

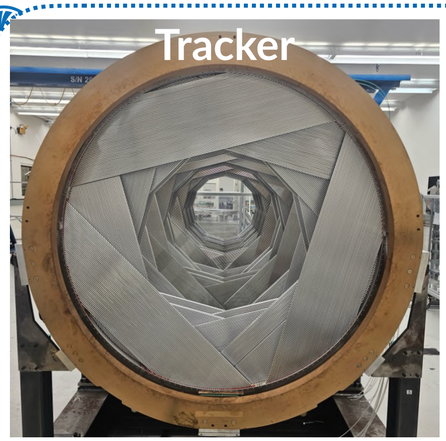
Detector Solenoid (DS)



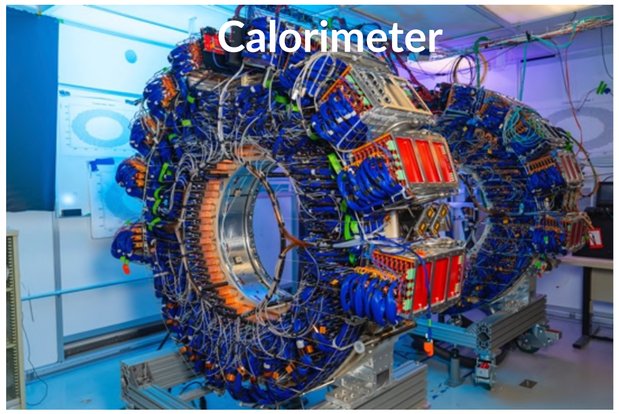
- **Has been delivered!**
- To be installed in 2027

All solenoid systems will be commissioned to prepare for Run 1 at the end of 2027!

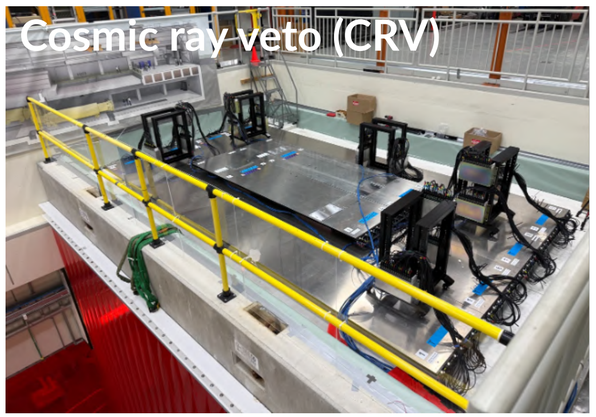




- Low-mass straw-tube tracker
- Mom resolution $\sim 180\,\mathrm{keV}/c$
- Assembly completed and installed in 2025



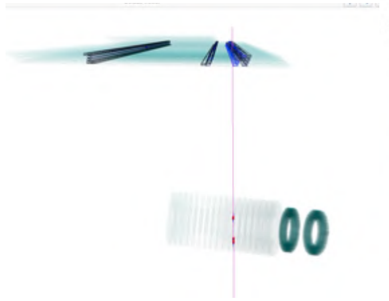
- CsI crystals readout by SiPMs
- Energy resolution: $< 10\,\%$, time resolution: $<500\,\mathrm{ps}$
- Assembly completed and installed in 2025



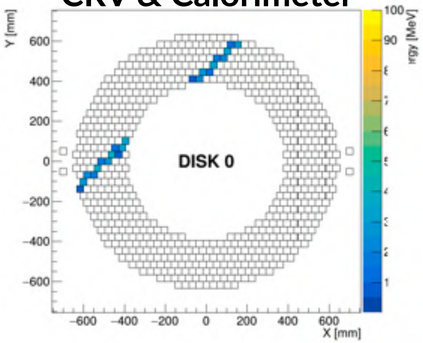
- Four layers of plastic scintillator with WLS fibres
- All CRV modules fabricated, under commissioning



CRV & Tracker



CRV & Calorimeter



Detectors extensively tested with cosmic rays and performing as expected — ready for beam!

2026	2027	2028	2029	2030	2031	2032	2033	2034

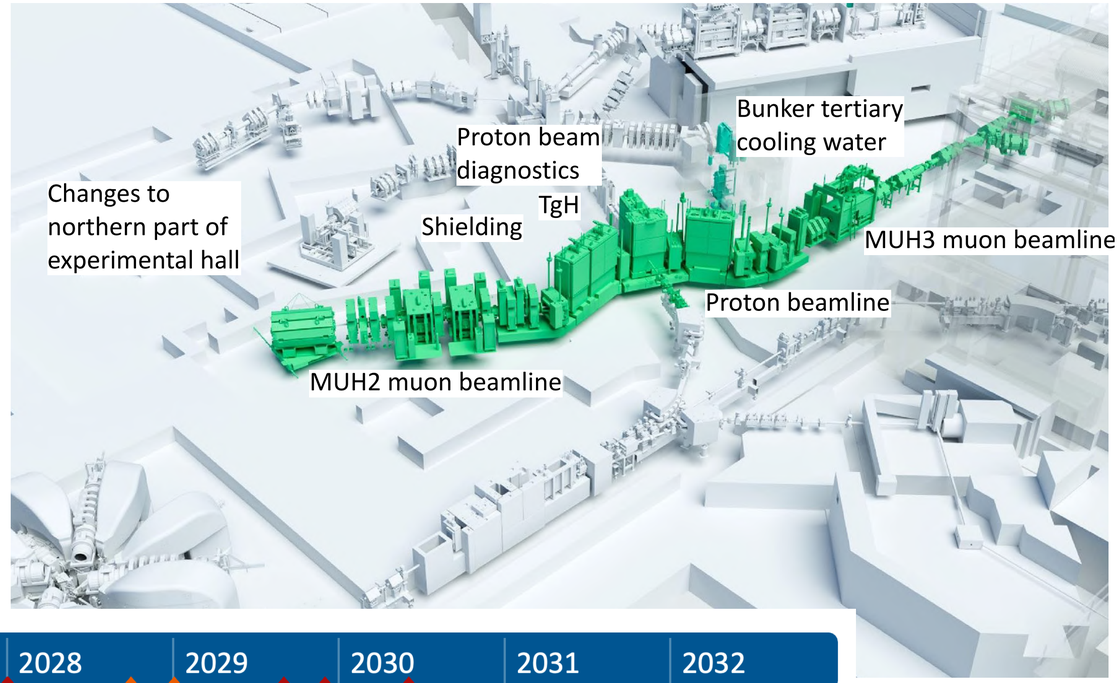
Run1 | Accelerator shutdown (PIP-II) | Run2

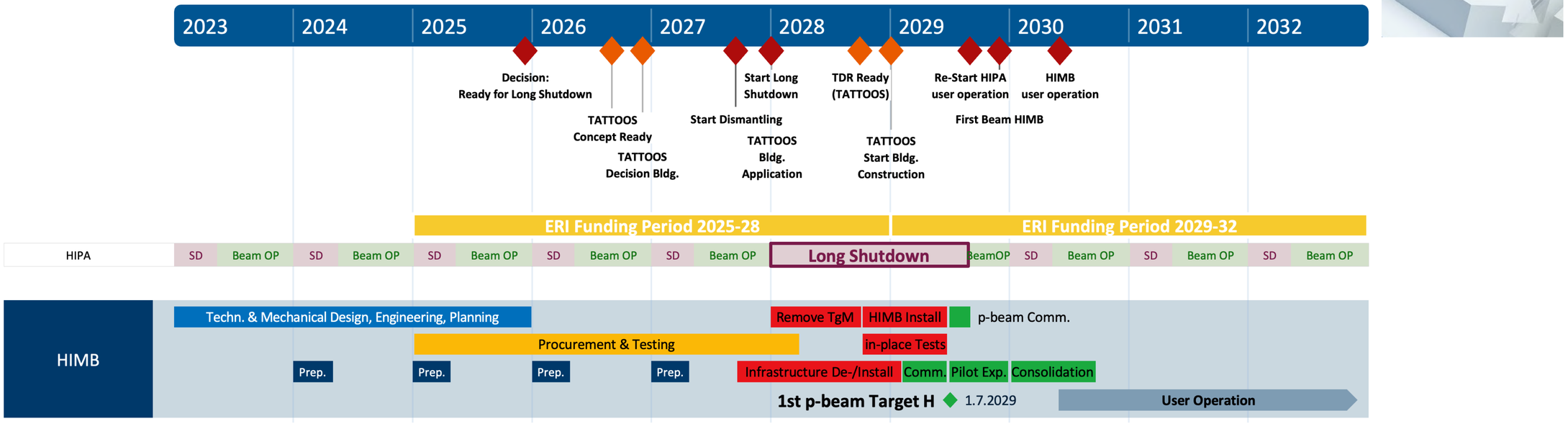
Path to Run1

- Commissioning of solenoid (PS/TS/DS), detector (with cosmic rays), and beamline
- AC dipole commissioning and verification of extinction at the 10^{-10} level
- **Run 1 in 2027**
  - **3-month beam time incl. $3.84\,\mathrm{kW}$ (50% nominal) 1-month physics run**
  - Physics target: **Improve the SINDRUM II limit by a factor of 10**

High-Intensity Muon Beam (HIMB) at PSI

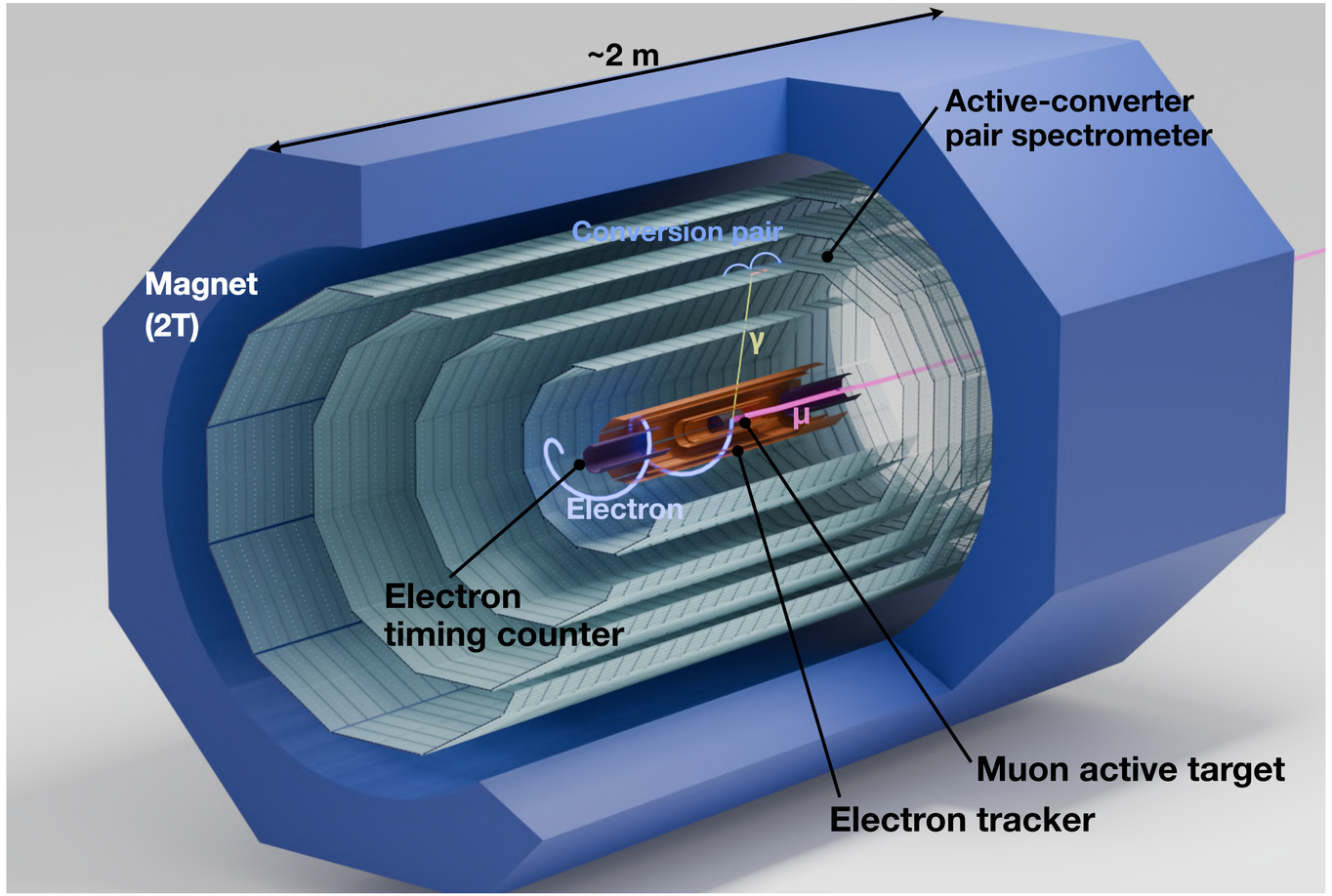
- New muon beam line at PSI with $\times 100$ intensity
  - $\mathcal{O}(10^8)\,\mu^+/\mathrm{sec} \;\Rightarrow\; \boldsymbol{\mathcal{O}(10^{10})\,\mu^+/\mathrm{sec}}$
  - Installed in **2028-2029**
  - **User operation in 2030**
- HIMB will provide new opportunities for rare muon decay experiments





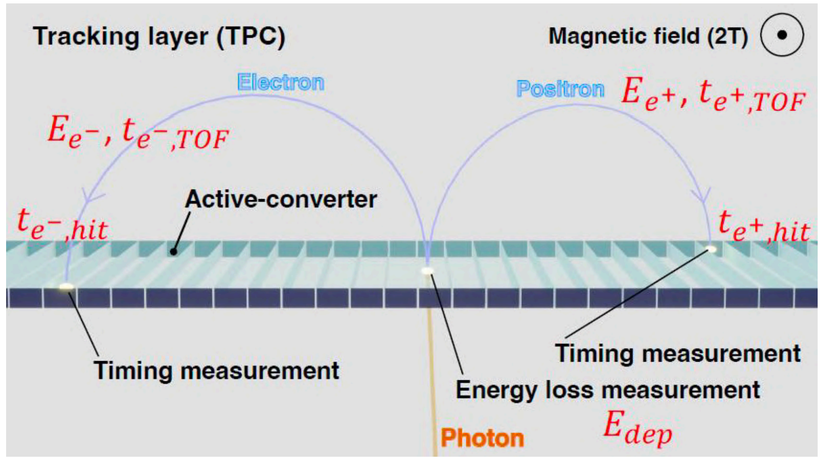
Future $\mu^+ \to e^+\gamma$ Experiment at HIMB

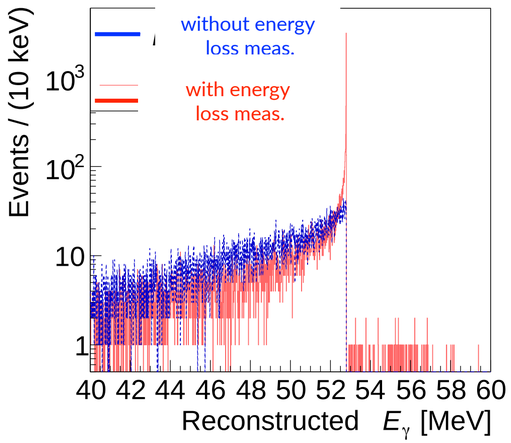
- **Target BR sensitivity $\mathcal{O}(10^{-15})$ achieved with HIMB and new detector concepts and technologies**
- Letter of Intent (LoI) submitted to PSI in Jan. 2026 by an international study group (arXiv:2504.18831)
- Proposed experimental concept
  - **Photon spectrometer with active converter** (⇔ LXe calorimeter at MEG II)
  - **Positron spectrometer based on Si pixel sensors** (à la Mu3e) (⇔ CDCH at MEG II)
  - **Long/separate active targets**
  - **Significantly increased acceptance**
  - **Broader physics programme, including searches for $\mu^+ \to e^+e^+e^-$ and exotic particles**



Future $\mu^+ \to e^+\gamma$ Experiment : Key Technologies

Pair spectrometer with active converter





- **Excellent energy and position resolution** by tracking the conversion pair
- **Active converter**
  - Measure the conversion pair energy loss and timing
  - Candidate material: **LYSO**
  - Multi-layer to compensate for low detection efficiency
- Conversion pair tracker: **Radial TPC** with cylindrical MPGD readout
- **Photon direction can be measured** → Further BG suppression

Electron tracker

- **Ultra-thin silicon pixel tracker** with HV-MAPS ($50\,\mu$m) as a primary candidate.
- **Mu3e-like silicon tracker would allow us to search for $\mu \to eee$**
- **R&D for even thinner MAPS** to further improve tracking performance

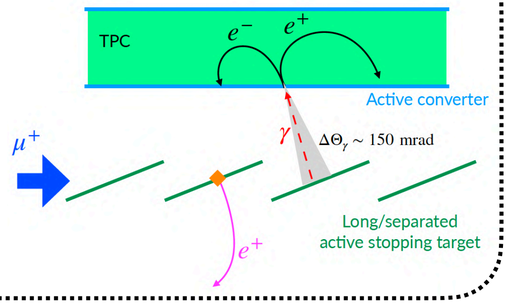


Electron timing detector

- Candidate technology: Scintillator+SiPM
- LGAD, Fast MAPS, SiGe BiCMOS as a future possibility

Active target

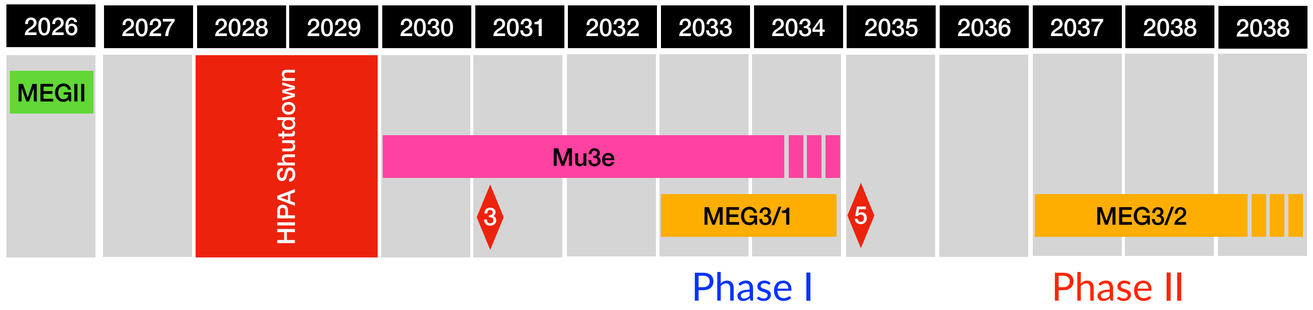
- **Long/separated active target** with **photon direction measurement** by pair spectrometer to reduce accidental BG



Future $\mu^+ \to e^+\gamma$ Experiment : Status and Prospects

- Currently in R&D phase toward a proposal to PSI
  - Beam test with TPC prototype in Oct 2026
  - Beam test with LYSO active converter + MEG II drift chamber to demonstrate the active converter concept early next year

Timeline

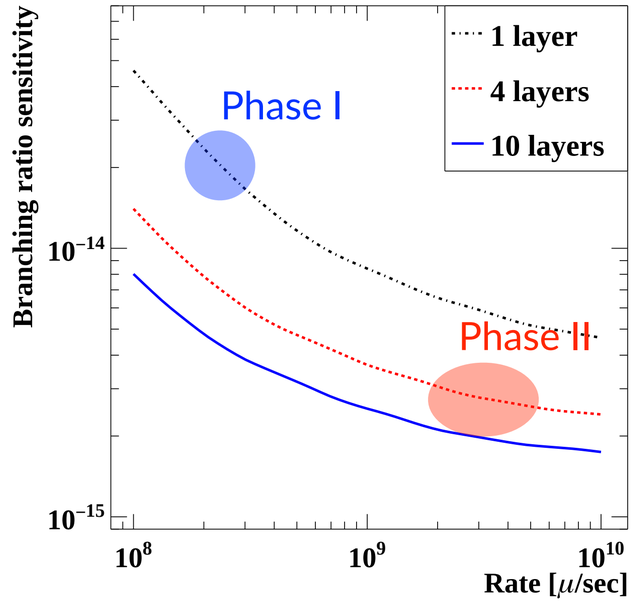


Target performance

	Resolutions/efficiencies
Photon energy	200 keV
Photon position	200 μm
Photon timing	30 ps
Photon angle	150 mrad
Photon detection efficiency (4 layers)	6 %
Positron energy	100 keV
Positron angle	6 mrad
Positron timing	30 ps
Positron detection efficiency	70 %
Geometrical acceptance	85 %

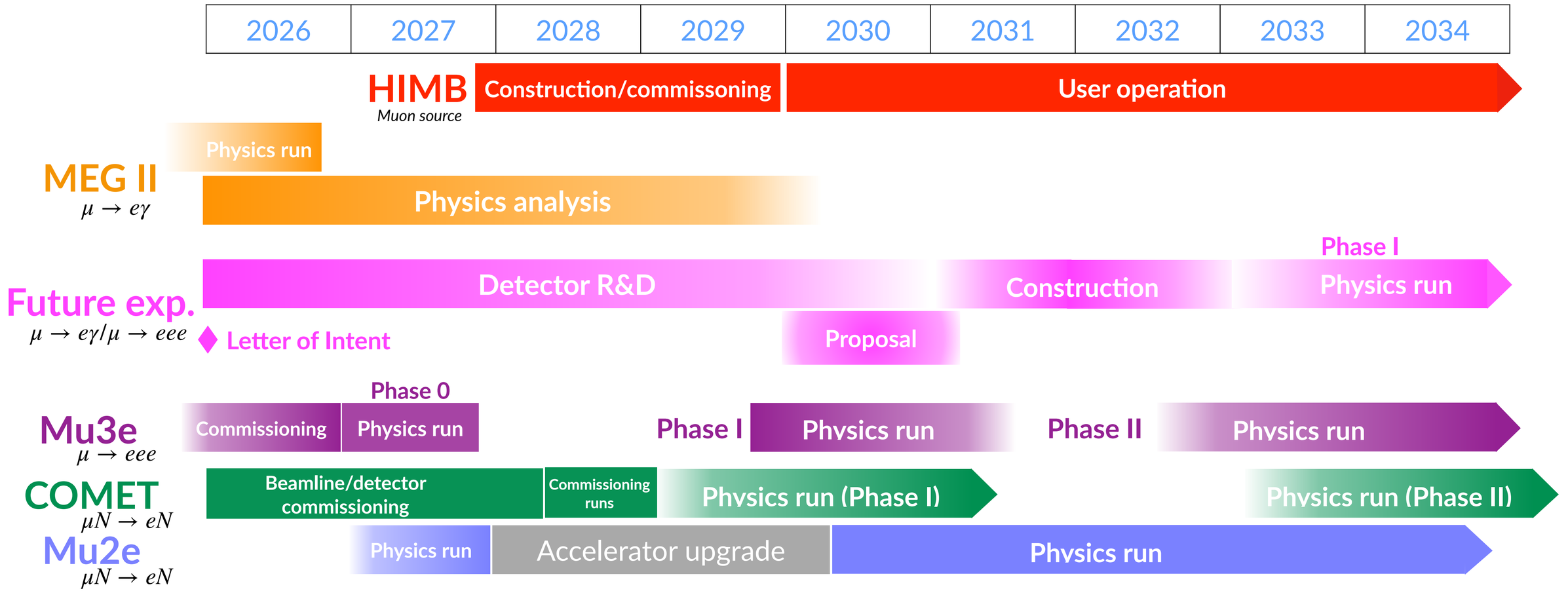
- Phase I (2033-)
  - Target sensitivity: $\sim 10^{-14}$
  - Moderate beam above $\sim 10^8\,\mu/\mathrm{s}$
  - **1-2 conversion layers for pair spectrometer**
  - **Gaseous tracker (**in COBRA magnet of MEG II?)
- Phase II (2037-)
  - Target sensitivity: $(2-3)\times 10^{-15}$
  - Higher beam intensity at HIMB
  - **Full-layer conversion spectrometer**
  - **Silicon pixel tracker**

Projected Sensitivity



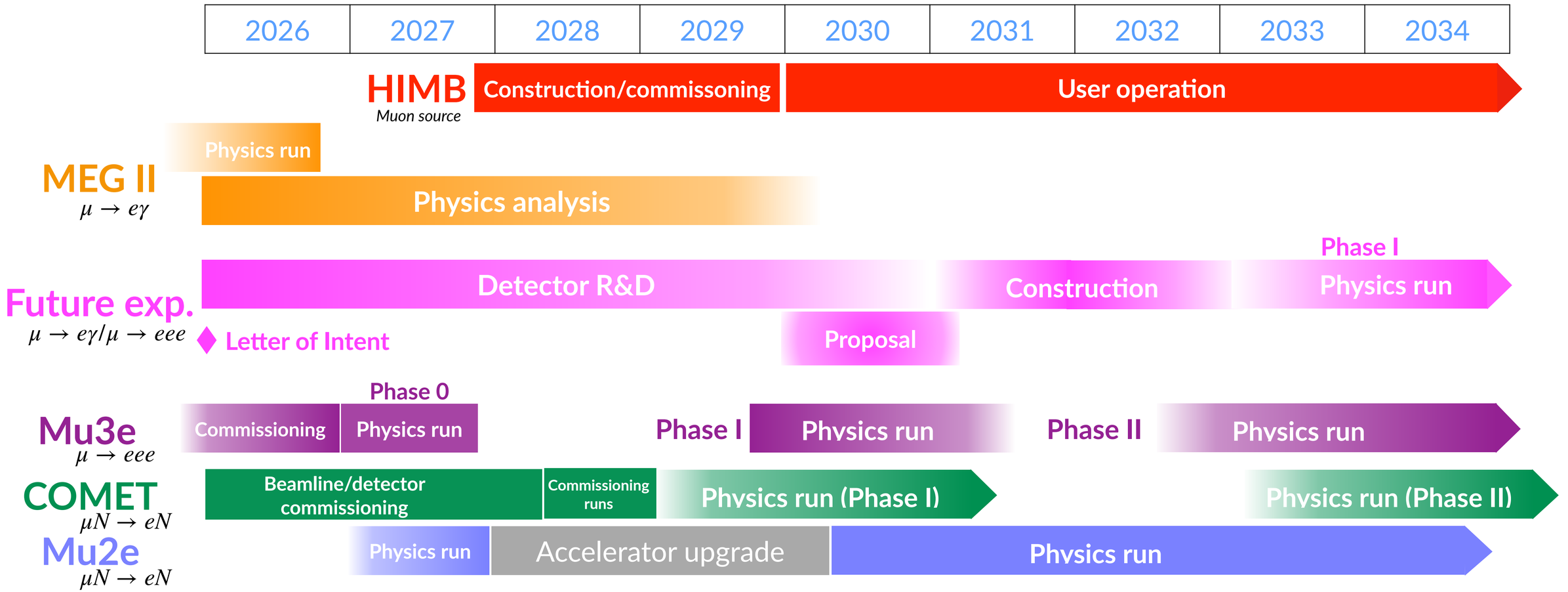
Muon LFV Experiment Timeline

N.B. Indicative timeline — my personal compilation



Muon LFV Experiment Timeline

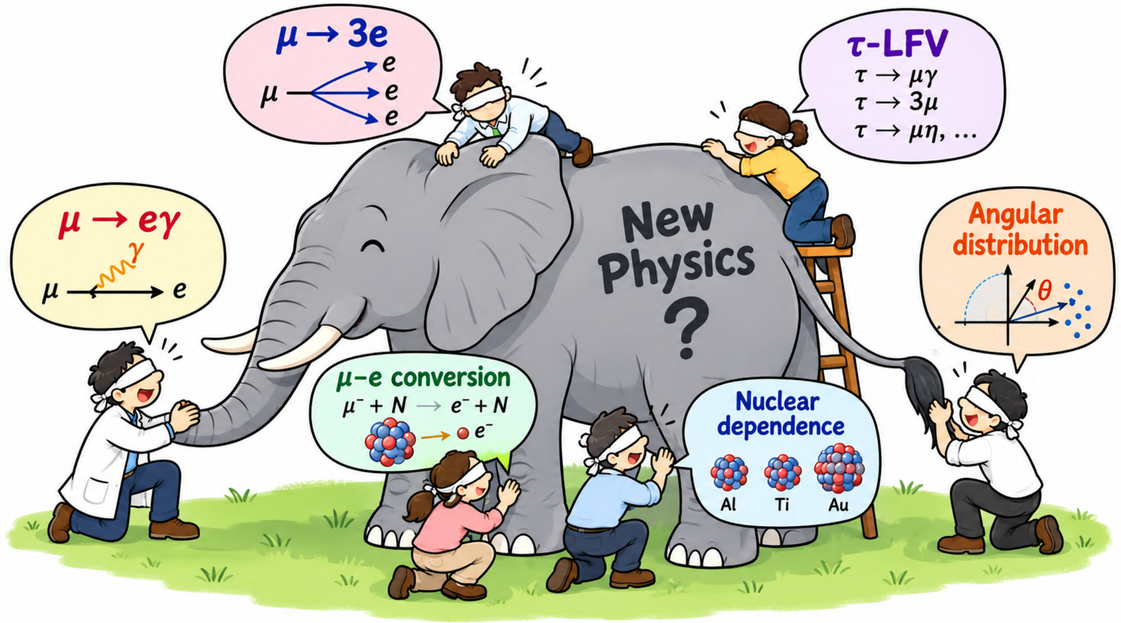
N.B. Indicative timeline — my personal compilation



Exciting years ahead for muon LFV!

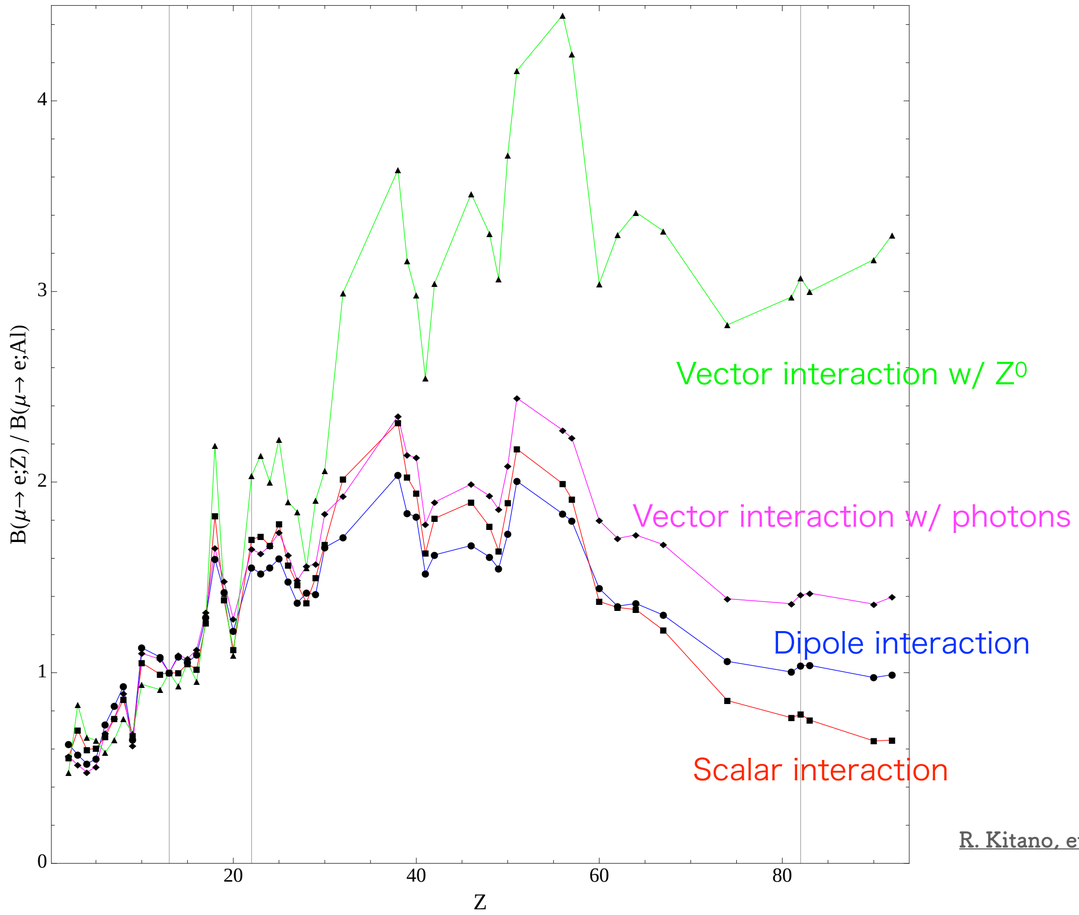
Summary

- **LFV provides a unique opportunity to probe BSM physics at very high energy scales**
  - Beyond that, **strong complementarity among different LFV channels offers powerful tools to explore the underlying new physics**
- **MEG II will soon no longer be the only LFV experiment exploring BSM physics**
  - With MEG II data analysis continuing and Mu3e, COMET, and Mu2e preparing for physics runs, **exciting new results are expected in the coming years — hopefully including a discovery!**
  - **We are entering a new era of powerful BSM tests, exploiting the complementarity among different LFV channels**
- **Next-generation high-intensity muon beams such as HIMB at PSI will offer new opportunities to push the sensitivity frontier even further**



Backup

$\mu^- N \to e^- N$: Target Atom Dependence



R. Kitano, et.al., PRD 66, 096002 (2002)

After the discovery of $\mu N \to eN$, the dependence of the process rate on the target atom will be studied ⇒ leading to the identification of the new physics behind.

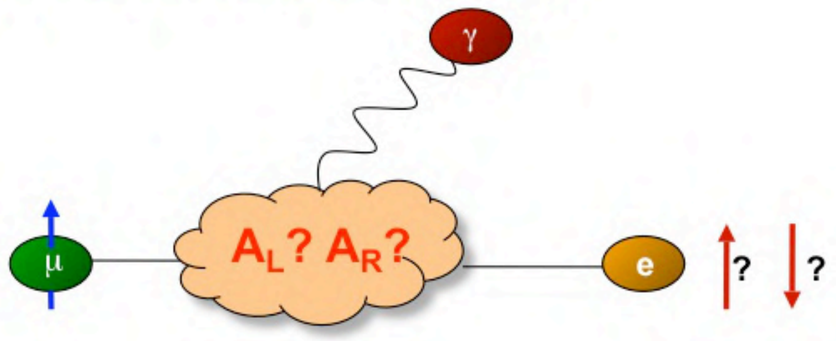
Future $\mu^+ \to e^+\gamma$ Experiment : Enhanced Acceptance

Zenith-angle acceptance significantly improved w.r.t. MEG II

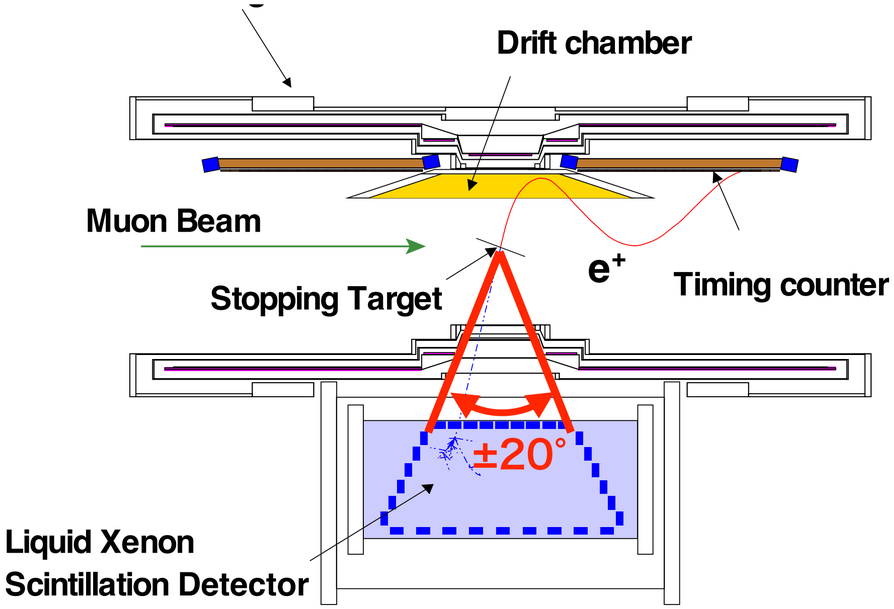
→ After $\mu \to e\gamma$ discovery, angular distribution can be measured with a polarised muon beam ($P_\mu = -0.86$ @MEG)

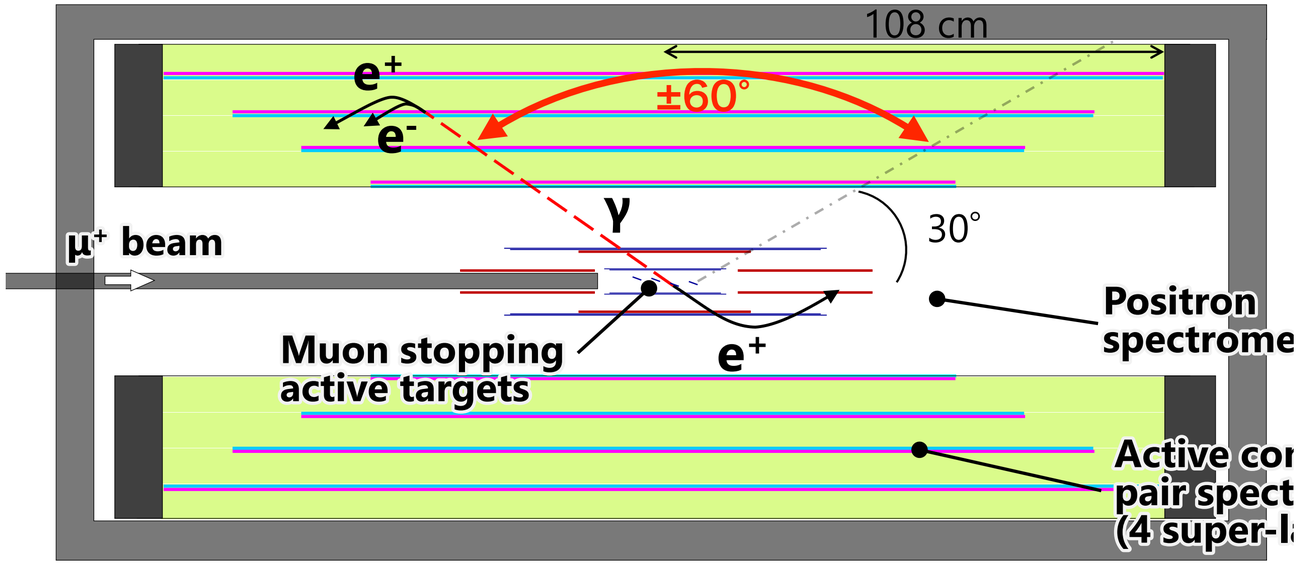
→ Pin-down underlying new physics

- e.g. SU(5) SUSY-GUT: $A_L \neq 0, A_R = 0$
- e.g. SO(10) SUSY-GUT: $A_L \simeq A_R$
- e.g. Non-unified SUSY with ν_R: $A_L = 0, A_R \neq 0$



$$\frac{dB(\mu^+ \to e^+\gamma)}{d\cos\theta_e} \propto |A_R|^2(1 - P_\mu \cos\theta_e) + |A_L|^2(1 + P_\mu \cos\theta_e)$$



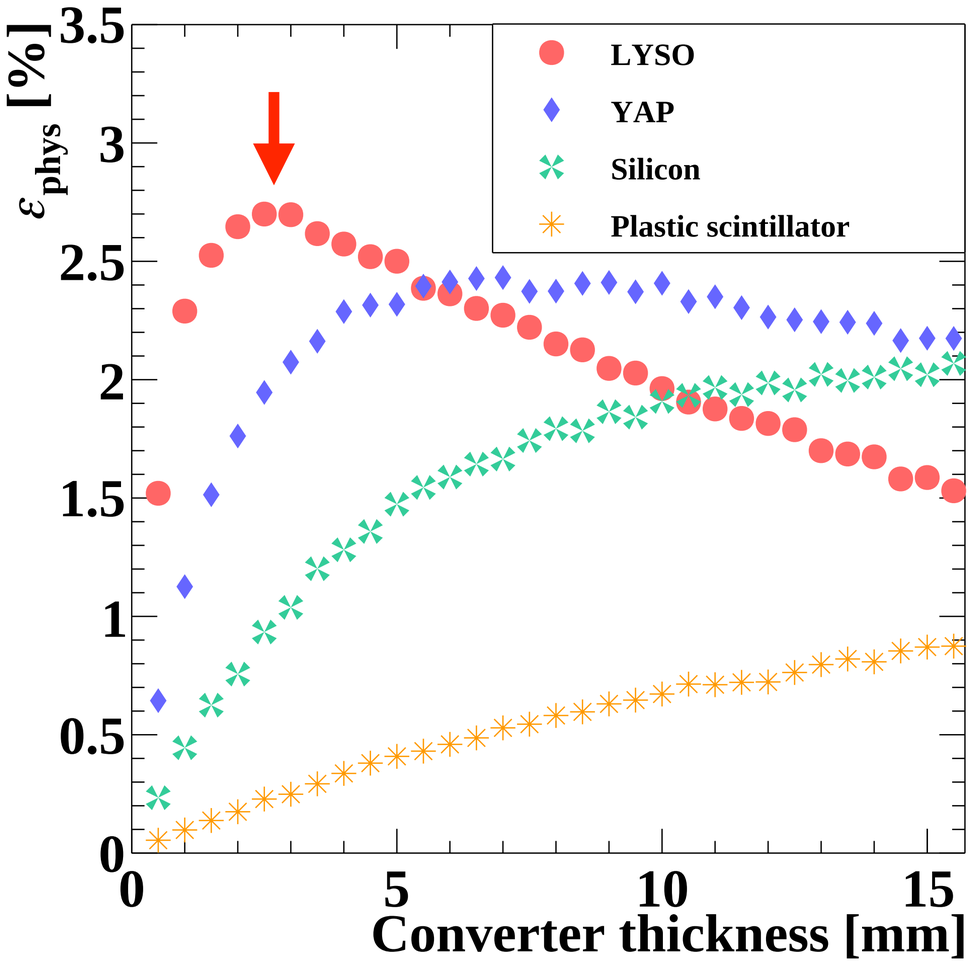


Future $\mu^+ \to e^+\gamma$ Experiment : Active Converter

Material Choice

- Material choice and optimal thickness
  - Trade-off between conversion probability and energy escape by bremsstrahlung

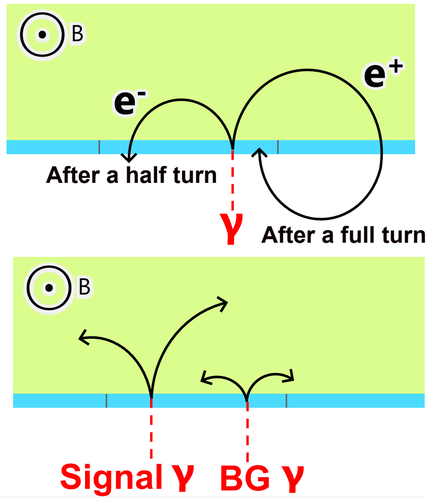
    →optimise thickness for the highest signal efficiency
- LYSO with a few mm thickness is the best candidate
  - High light yield → energy resolution
  - Short decay time → high rate capability, timing resolution
  - Short Radiation length → detection efficiency



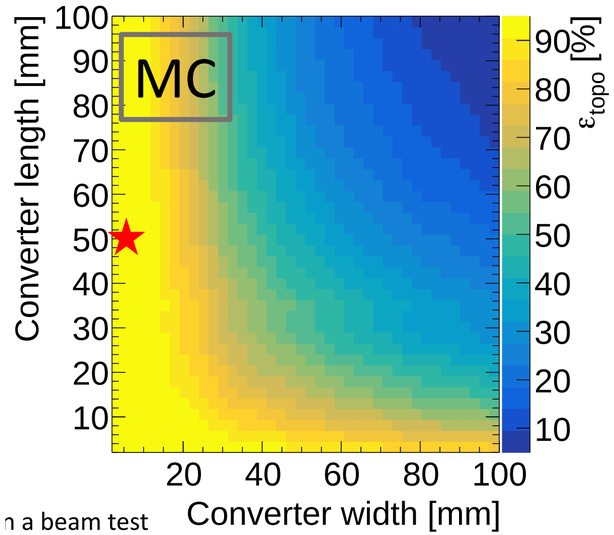
Future $\mu^+ \to e^+\gamma$ Experiment : Active Converter

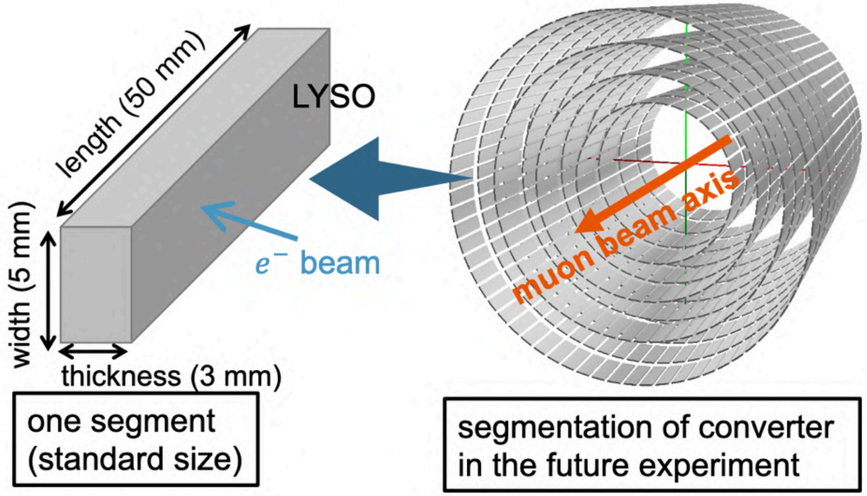
Segmentation

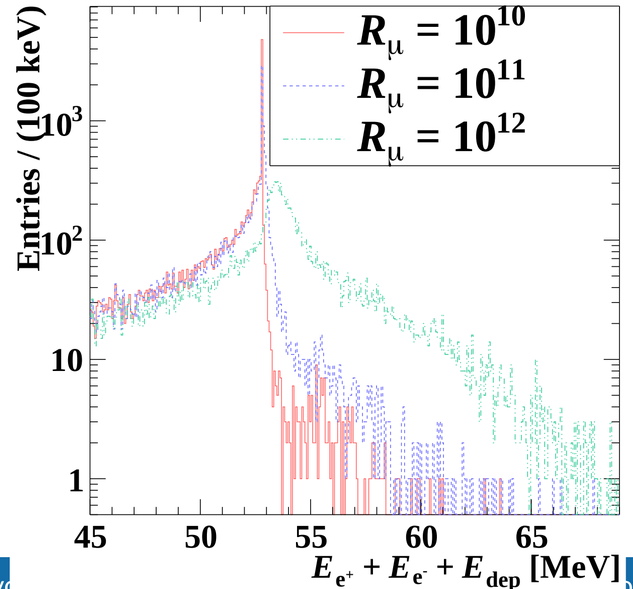
- Energy loss measurement can be ruined by
  - Hits in the same segment by the returning conversion pair
  - BG photon pileup hits
    - → **segmentation needed**
- Optimal segmentation: LYSO 50mm(//B) × 5mm(⊥B)



Segmentation

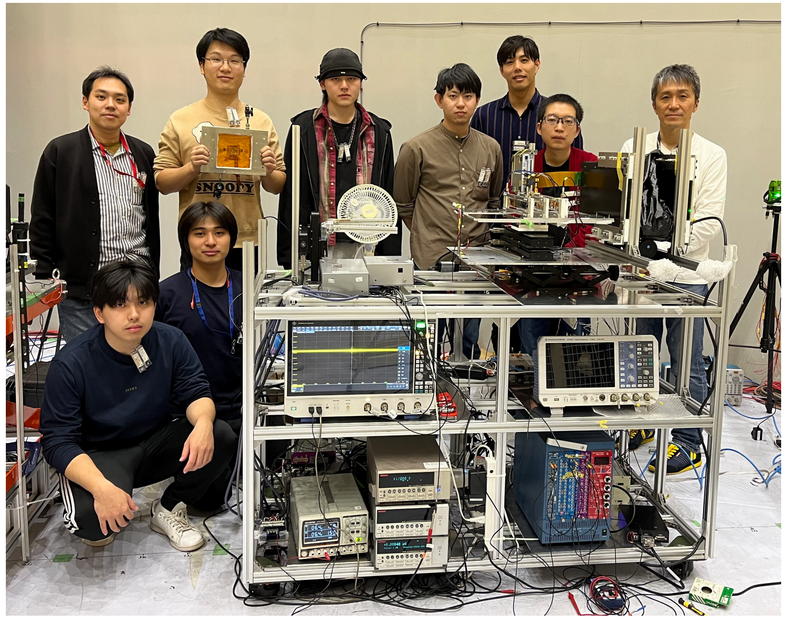




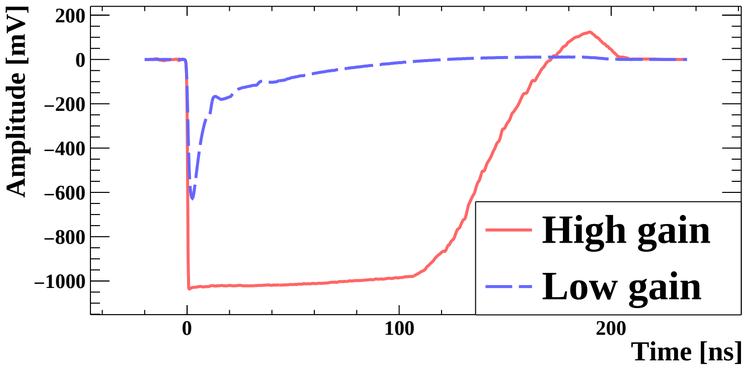


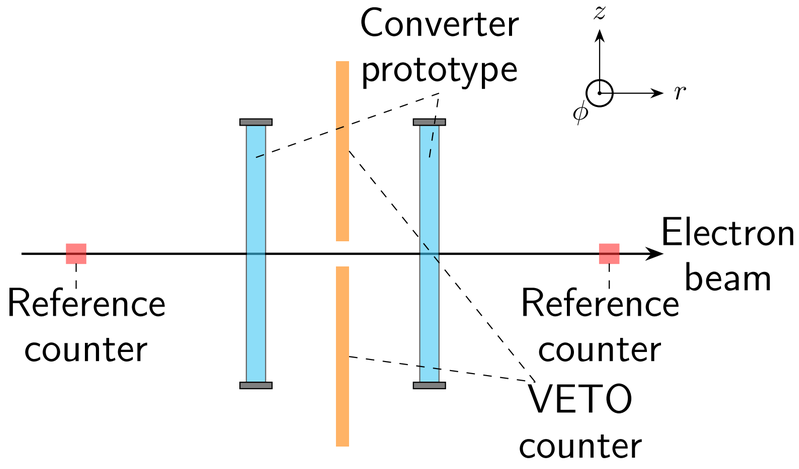
Future $\mu^+ \to e^+\gamma$ Experiment : Active Converter

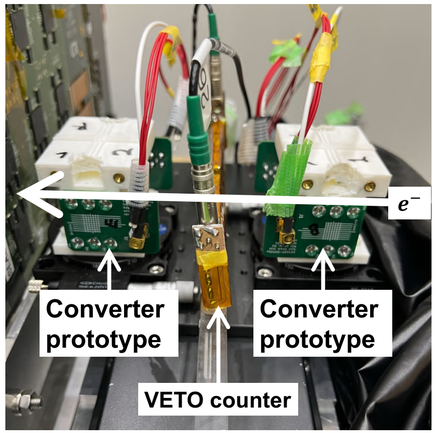
Prototype Beam Test



- Beam test to measure MIP response of LYSO active converter prototype
  - $3\ \mathrm{GeV}$ electron beam at KEK PF-AR test beam line
  - Overall rate: $4.5\ \mathrm{kHz}$
- Prototype
  - LYSO strips ($5\ \mathrm{mm} \times 50\ \mathrm{mm} \times 3\ \mathrm{mm}$, $5\ \mathrm{mm} \times 50\ \mathrm{mm} \times 1.5\ \mathrm{mm}$)
  - 3×MPPC(S14160-3015HS, connected in series) at both ends
- Readout electronics
  - WaveDREAM (DRS4 waveform digitiser chips), 4-5GPS
  - Split signals recorded with two gain modes
    - Low gain: charge measurement
    - High gain: timing measurement







Special thanks to the KEK PF-AR test beamline team for their excellent support

Future $\mu^+ \to e^+\gamma$ Experiment : Active Converter

Prototype Beam Test

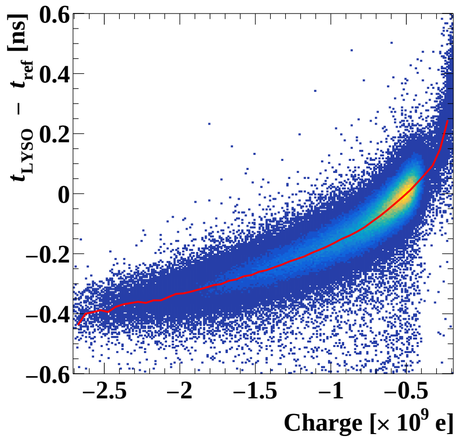
- Analysis
  - Event cleaning to remove multi-particle events
  - Leading-edge timing in the waveform
  - Time walk correction
  - Threshold optimisation (leading edge and TOT)

$$\sigma(t_{\text{US LYSO}} - t_{\text{ref}}) = \sqrt{\sigma^2_{t_{\text{US LYSO}}} + \sigma^2_{t_{\text{ref}}}},$$

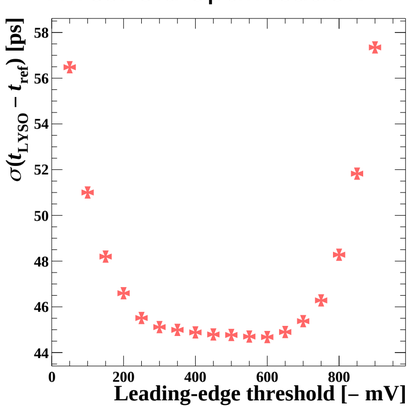
$$\sigma(t_{\text{DS LYSO}} - t_{\text{ref}}) = \sqrt{\sigma^2_{t_{\text{DS LYSO}}} + \sigma^2_{t_{\text{ref}}}},$$

$$\sigma(t_{\text{US LYSO}} - t_{\text{DS LYSO}}) = \sqrt{\sigma^2_{t_{\text{US LYSO}}} + \sigma^2_{t_{\text{DS LYSO}}}}$$

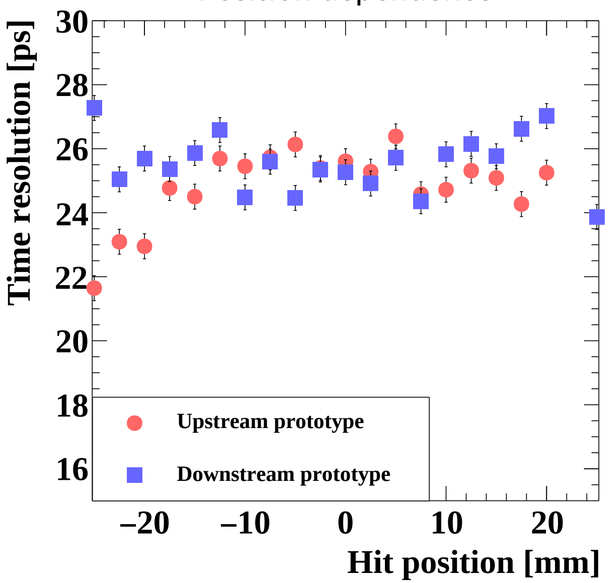
Time walk correction



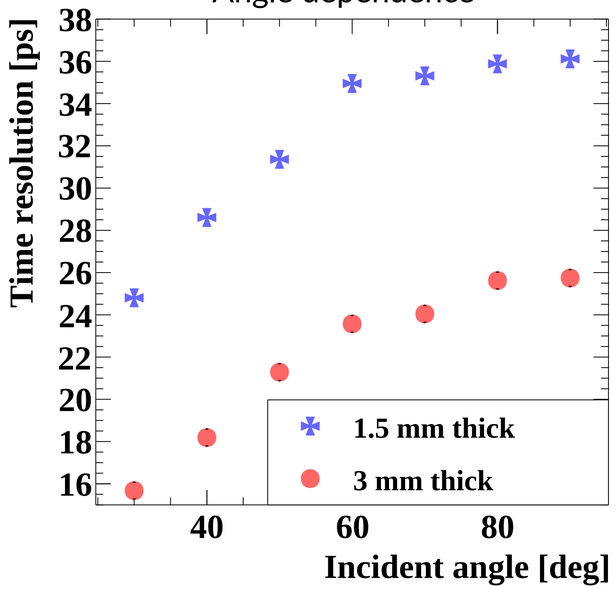
Threshold optimisation



Position dependence



Angle dependence



MIP timing resolution $\sim$ 25 ps achieved ⇒ much better than target 40 ps

Future $\mu^+ \to e^+\gamma$ Experiment : Sensitivity Reach

- Sensitivity projections for three scenarios of # conversion layers (four layers as a baseline)
  - Expected performance of detectors
  - Five separated stopping targets to further reduce acc. BG using the photon angles measured by the conversion pair
- Sensitivity $(2-3)\times10^{-15}$ reacheable with a multi-conversion-layers at $>10^9\,\mu^+/\mathrm{sec}$

MEG II

Resolutions	Achieved
E_{e^+} (keV)	89
ϕ_{e^+} [a], θ_{e^+} (mrad)	4.1/7.2
y_{e^+}, z_{e^+} (mm)	0.74/2.0
E_γ(%) (w<2 cm)/(w>2 cm)	2.0/1.8
$u_\gamma, v_\gamma, w_\gamma$ (mm)	2.5/2.5/5.0
$t_{e^+\gamma}$ (ps)	78
Efficiency (%)	
ε_γ	62
ε_{e^+}	67
ε_{TRG}	80

Future Experiment

	Resolutions/efficiencies
Photon energy	200 keV
Photon position	200 μm
Photon timing	30 ps
Photon angle	150 mrad
Photon detection efficiency (4 layers)	6 %
Positron energy	100 keV
Positron angle	6 mrad
Positron timing	30 ps
Positron detection efficiency	70 %
Geometrical acceptance	85 %

Projected Sensitivity

