cLFV report

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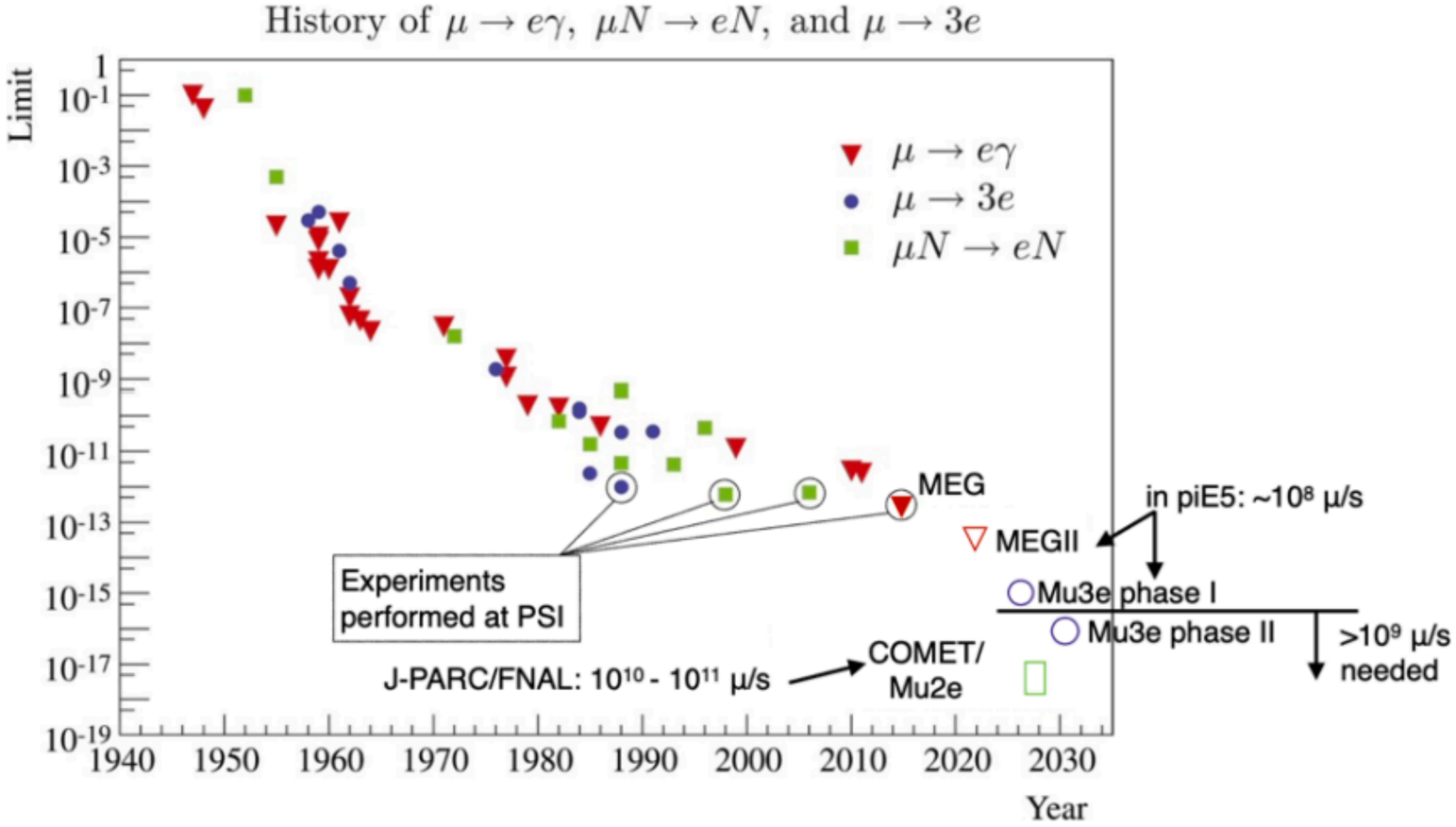
February 27th 2024
PROBES meeting

Future muon cLFV experiments

- Neutrinoless muon decays are one of the most sensitive probes for new physics
  - $\mu^+ \rightarrow e^+ \gamma$ and $\mu^+ \rightarrow e^+ e^+ e^-$ only possible at DC, high-intensity machines, such as HIPA
    - New project (HIMB) for muon experiments with unique sensitivities
  - $\mu^- \rightarrow e^-$ conversion in nuclei strongly enhanced at pulsed beams, such Fermilab/JParc



The MEGII experiment at PSI

- The MEGII experiment aims at searching for $\mu^+ \rightarrow e^+ \gamma$ with a sensitivity of ~ **$6\ 10^{-14}$**
- Best upper limit on the BR ($\mu^+ \rightarrow e^+ \gamma$) set by the MEG experiment (**$4.2\ 10^{-13}$** @90% C.L.)
- Five observables **(E_g, E_e, t_{eg}, ϑ_{eg}, ϕ_{eg})** to identify $\mu^+ \rightarrow e^+ \gamma$ events

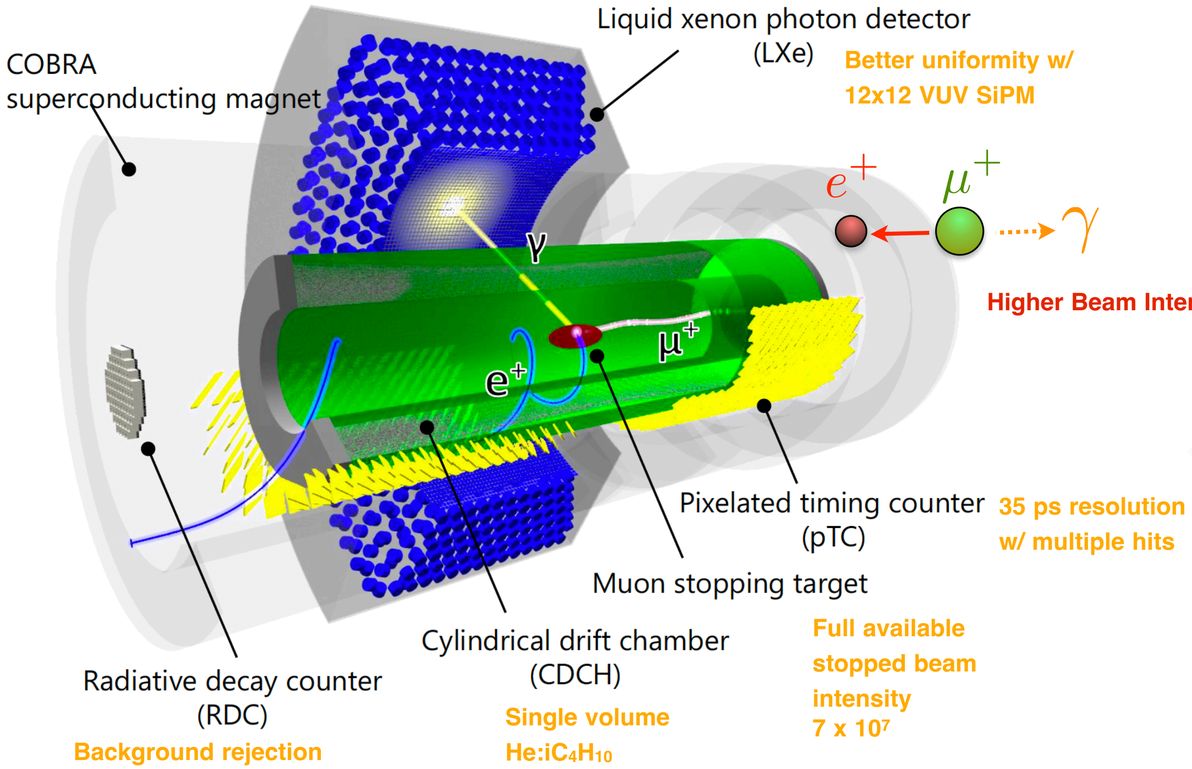
New electronics:
WaveDAQ

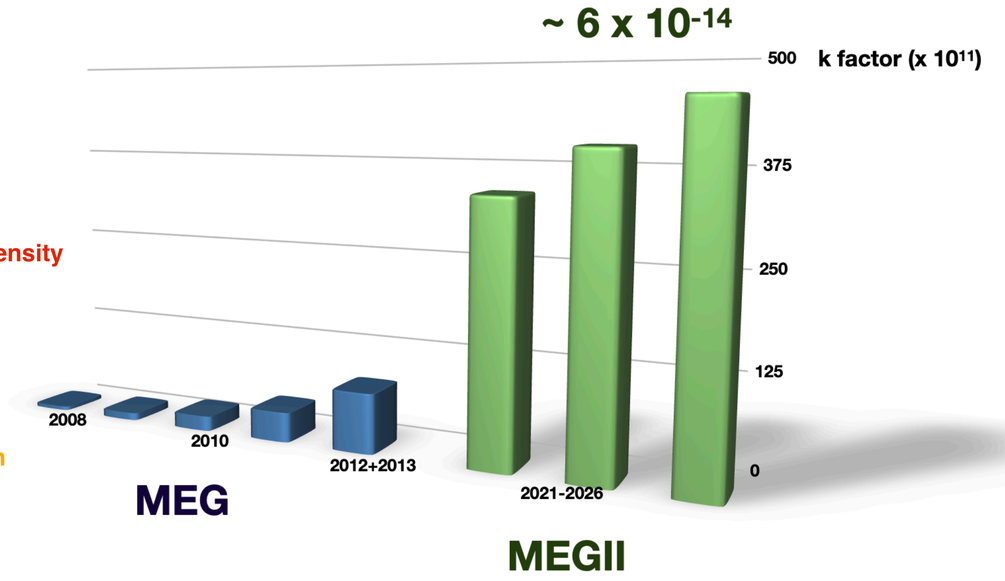
~9000 channels at 5GSPS

2x Resolution everywhere

Updated and new Calibration methods

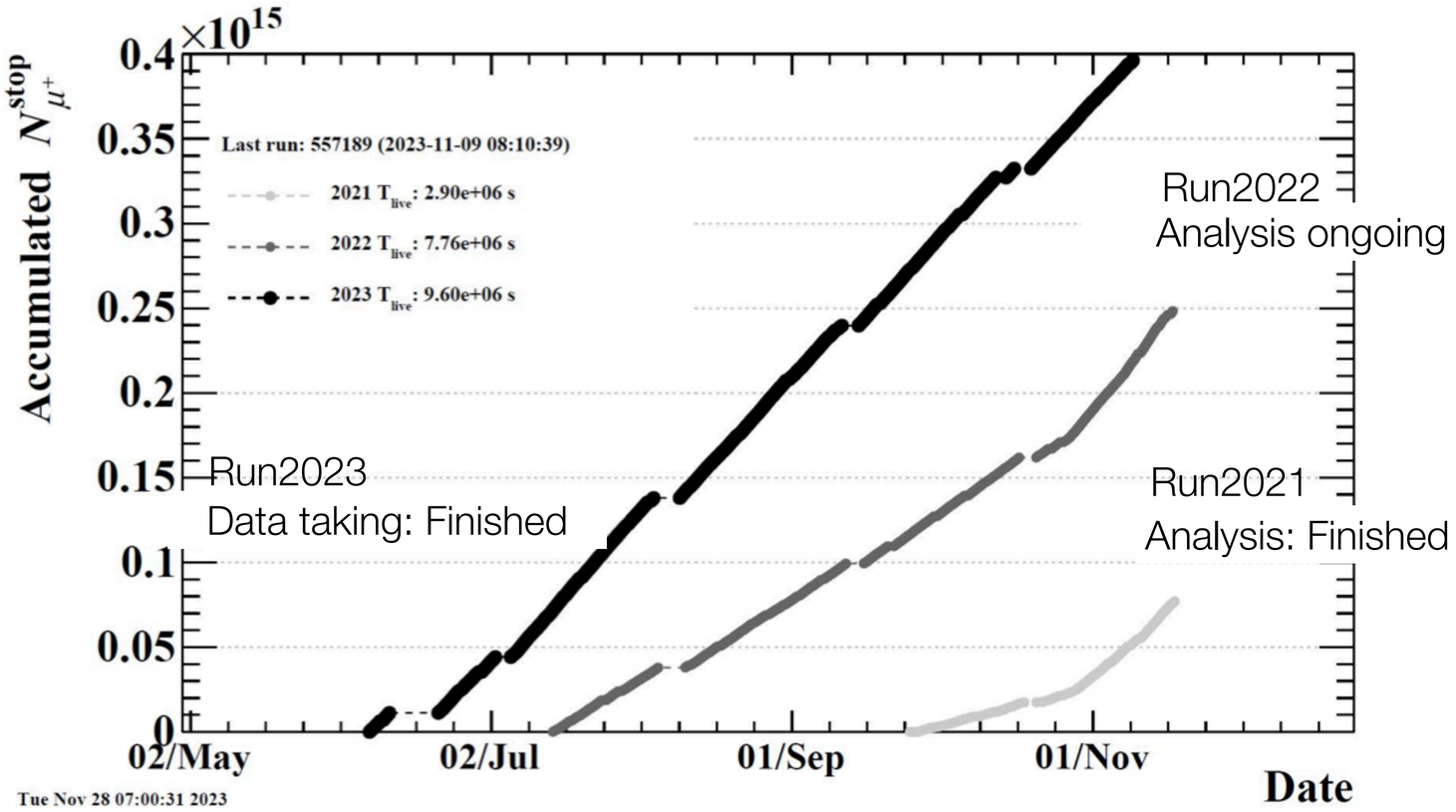
Quasi mono-chromatic positron beam



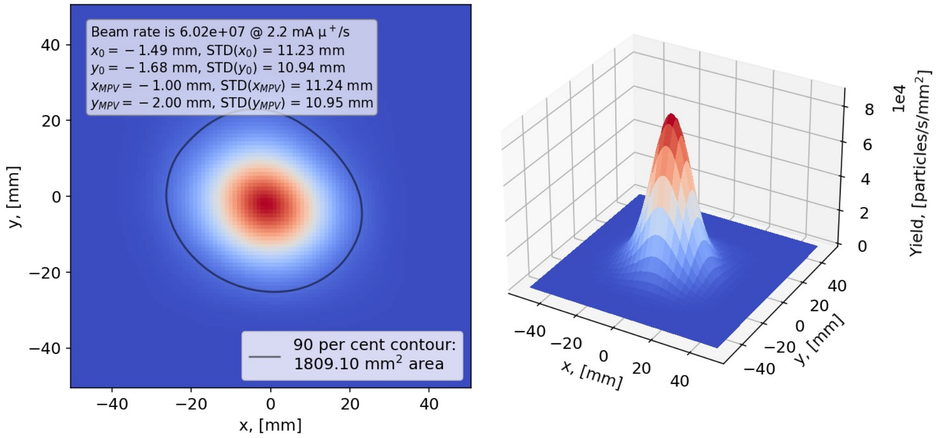


How is ongoing…Physics run 2023: completed

- Very successful data taking period!



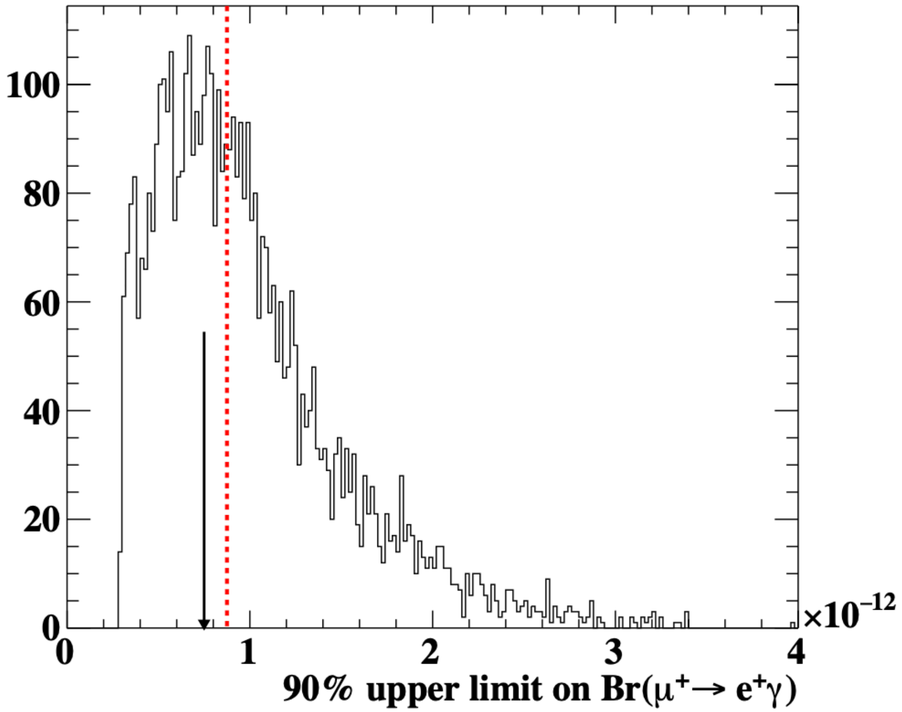
With a beam intensity =
4.27e7 mu/s@1.76 mA

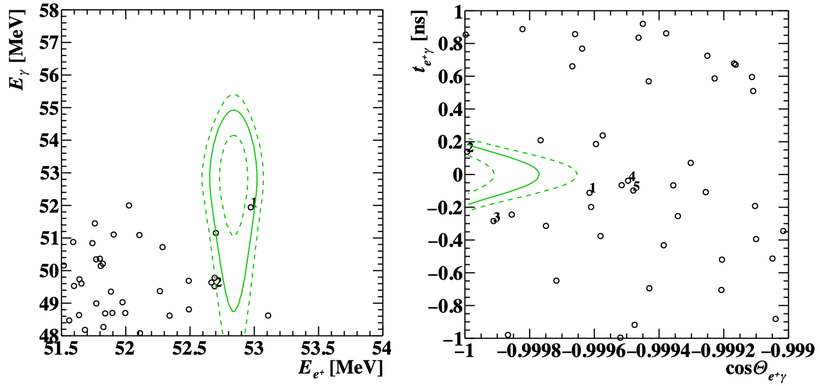


First MEGII results - data sample “Run2021” and MEG combination

https://arxiv.org/pdf/2310.12614.pdf

https://arxiv.org/pdf/2310.11902.pdf





- Distribution of the 90% C.L. upper limits computed for an ensemble of pseudo-experiments with a null-signal hypothesis
- The sensitivity is indicated by a red dashed line while the upper limit observed (Run 2021) in the analysis region with a solid black arrow

- Upper limit on the BR ($\mu^+ \rightarrow e^+ \gamma$) set by the MEGII experiment **Run2021** (**7.5 10^{-13}** @90% C.L.)

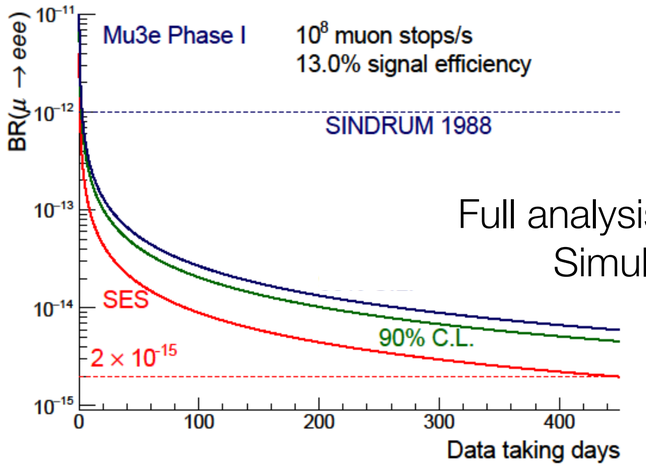
- When **combined** with the final result of MEG, we obtain the most stringent limit up to date, BR ($\mu^+ \rightarrow e^+ \gamma$) < **3.1 10^{-13}** @90% C.L.

- The final goal (by 2026) is to reach a sensitivity to the $\mu^+ \rightarrow e^+ \gamma$ decay of $S_{90} \sim 6\ 10^{-14}$

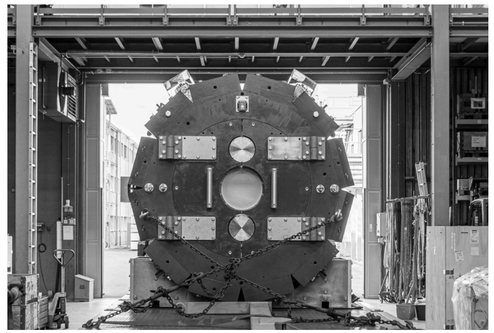
Mu3e: Latest news and currents status

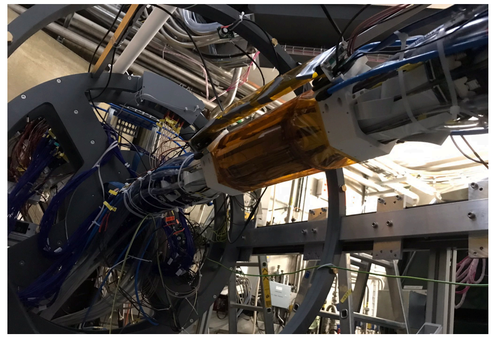
- The Mu3e experiment aims to search for $\mu^+ \rightarrow e^+ e^+ e^-$ with a sensitivity of ~10^{-15} (Phase I) up to down ~10^{-16} (Phase II)
  - Previous upper limit BR($\mu^+ \rightarrow e^+ e^+ e^-$) ≤ 1 x 10^{-12} @90 C.L. by SINDRUM experiment)

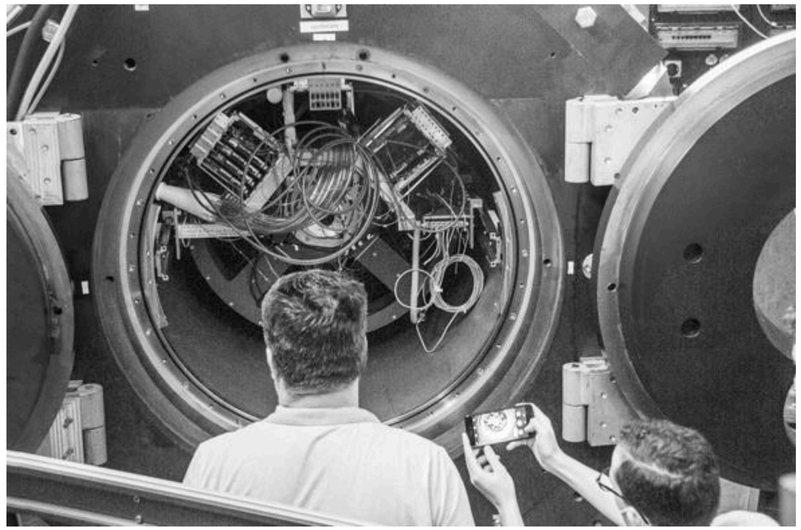
- **Detector concept validated during the Integration run 2021**
- **Full beam line commissioned during the beam time 2022 - fine tuning and further studies ongoing during the beam time 2023 [new record of transported muons at the collimator]**
- Very successful: TDR promised values **matched!**
  - **1.02e10^8 mu/s @2.4 mA** (Mu3e magnet) [run2022]

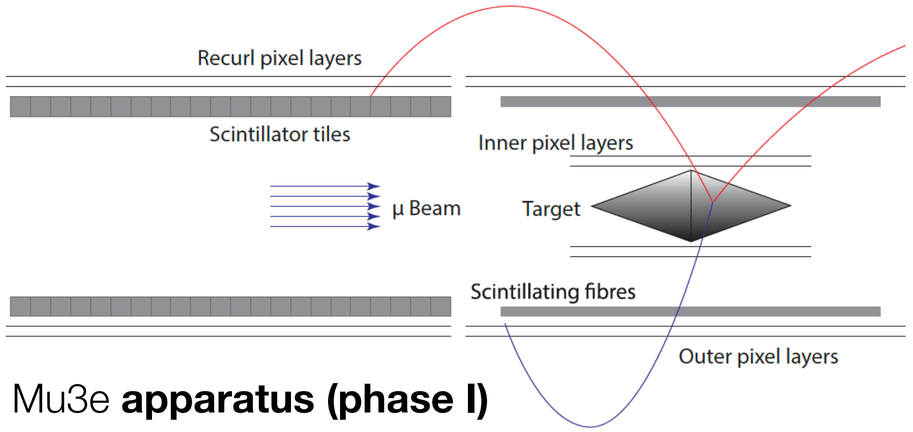


Full analysis performed on Simulated data

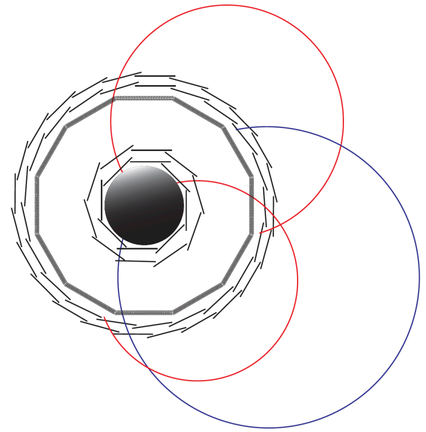








Mu3e **apparatus (phase I)**



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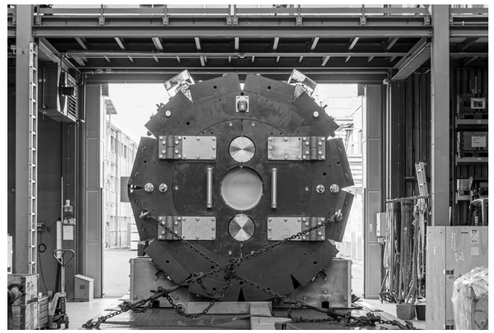

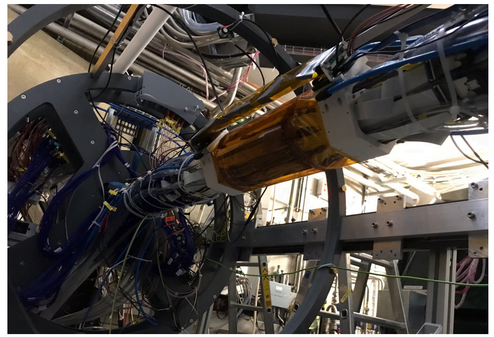

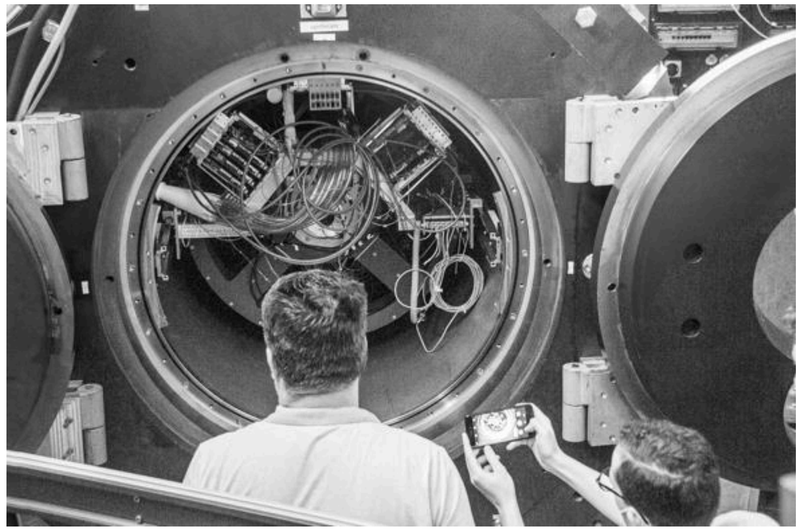

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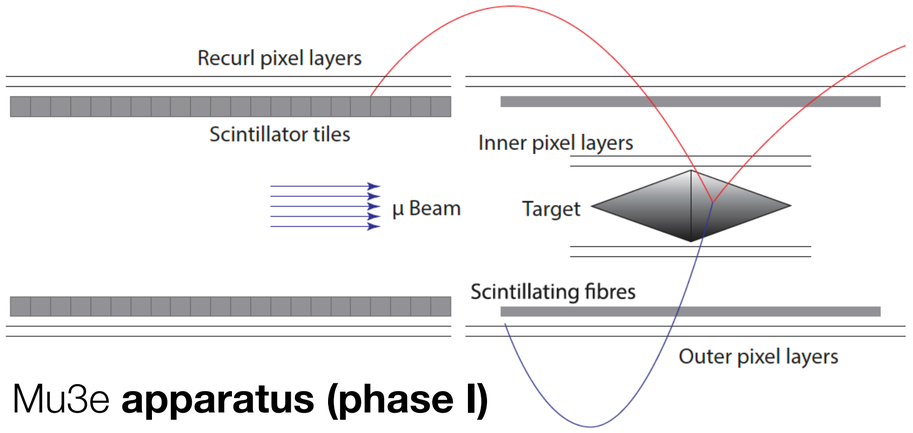
Time line phase I (exploiting current beamline intensity)

- Engineering run: 2025
- First physics run: 2026

Phase II: It requires 10^9 mu/s —> **HiMB**



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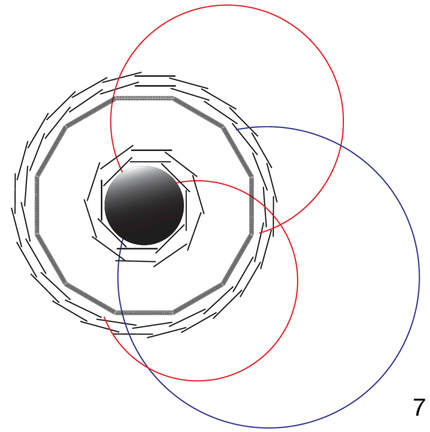
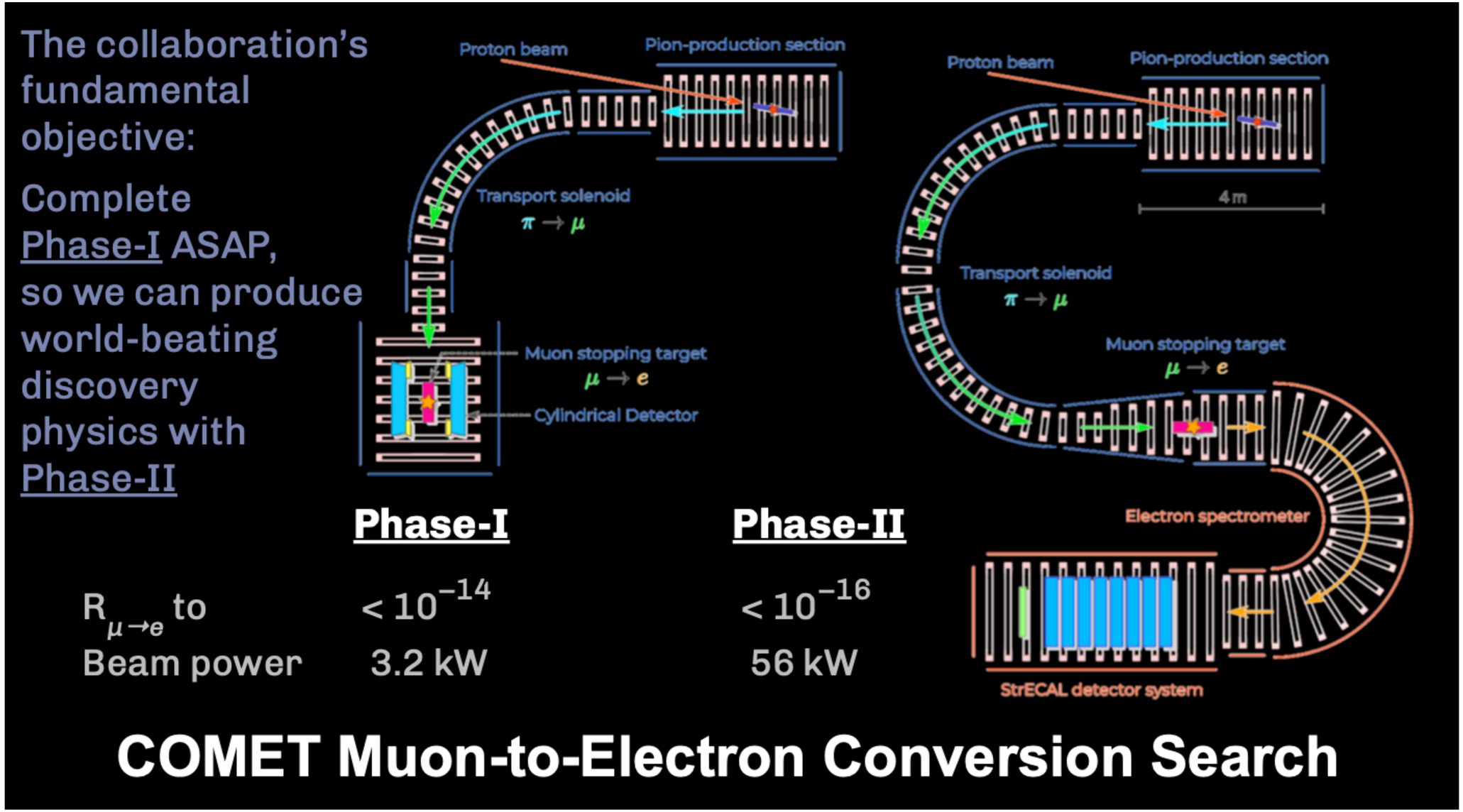


COMET: Latest news and currents status



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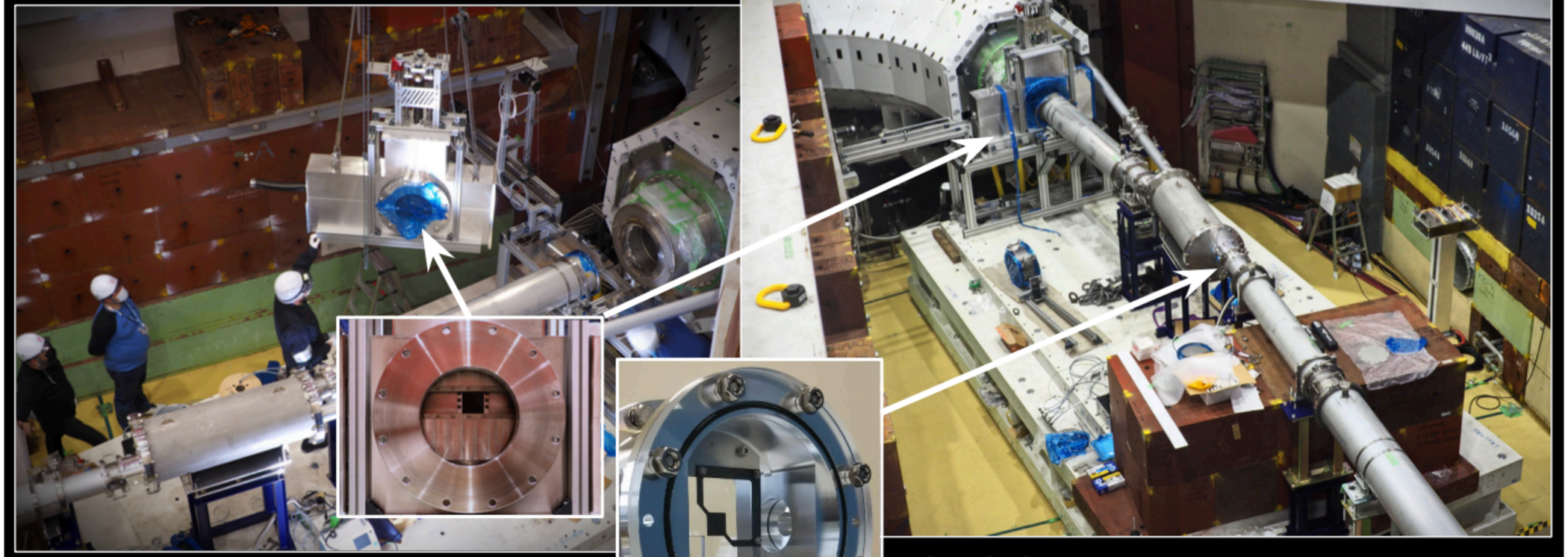
- Early 2023: saw first beam in the new proton beam linec —> COMET Phase-α

COMET Phase-α: Beam



Beam-masking system

Simple beam target, no pion capture solenoid

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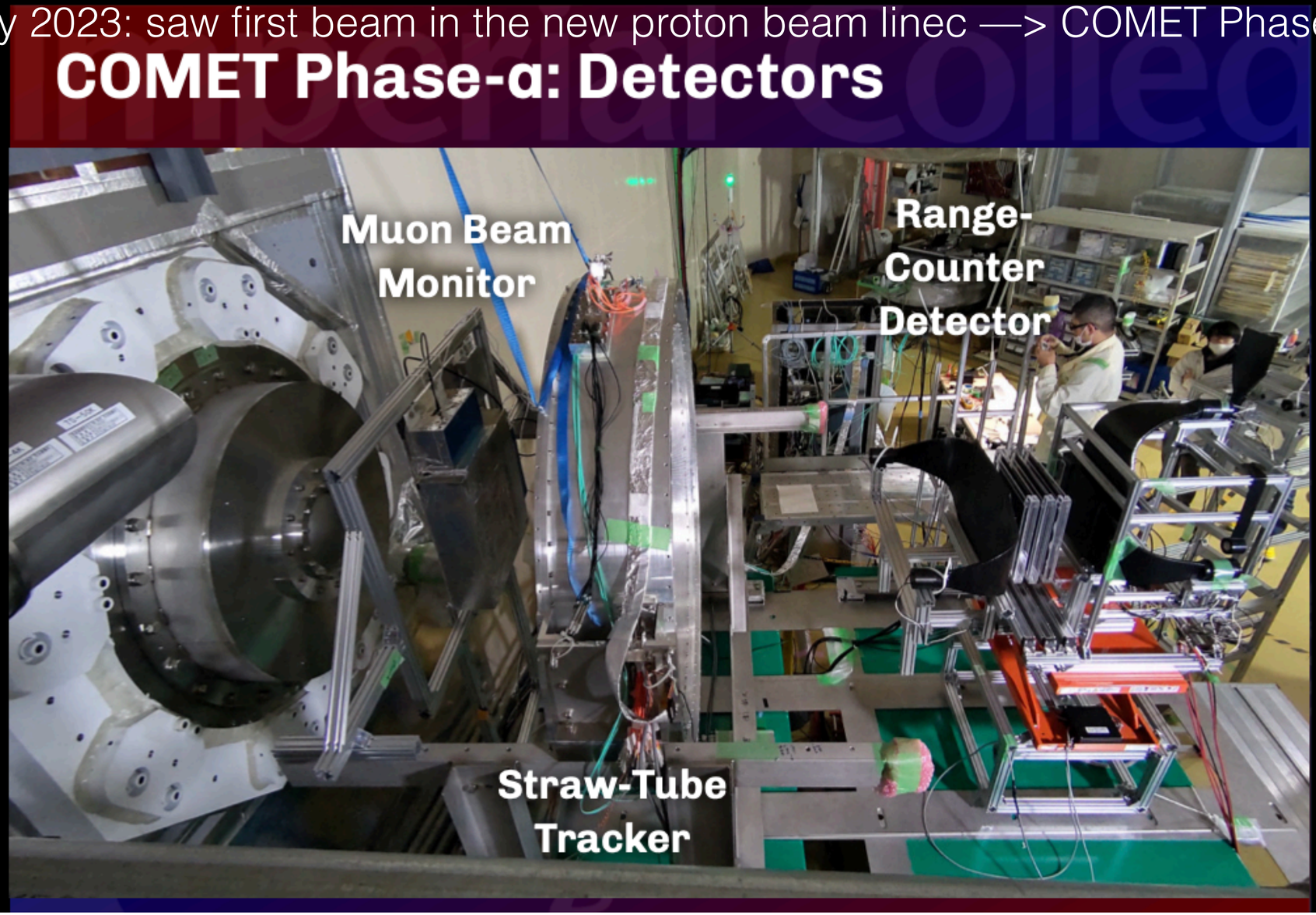

COMET: Latest news and currents status

Test Beam Runs at PSI: CTH

- Scintillator planes mounted on actual support structure
- Response tested with electrons, muons and pions