

Charged pion precision measurements, instrumentation frontier, and early-career effort in PIONEER

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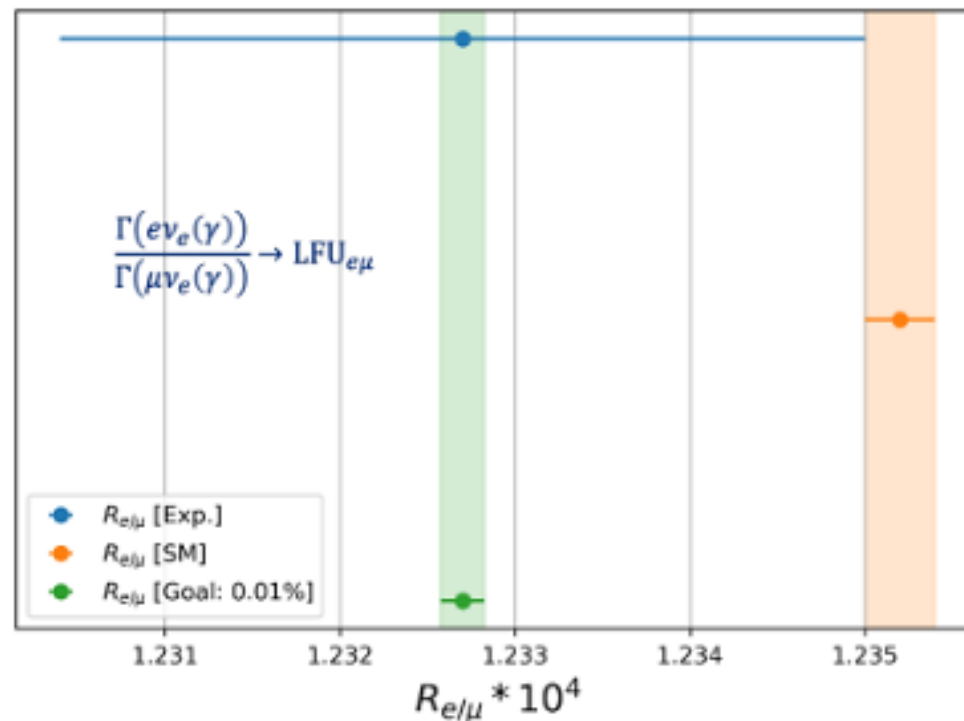
P5 Town Hall

27 June 2023

$$R_{e/\mu} = \frac{\Gamma(\pi^+ \rightarrow e^+(\gamma))}{\Gamma(\pi^+ \rightarrow \mu^+(\gamma))}$$

Lepton flavor universality → charged lepton flavor violation?

SM prediction ca. 15x more precise than experiment!



Intensity Frontier

Phase 1

$$R_{e/\mu} = \frac{\Gamma(\pi^+ \rightarrow e^+(\gamma))}{\Gamma(\pi^+ \rightarrow \mu^+(\gamma))}$$

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SM prediction ca. 15x more precise than experiment!

Phase 2 (3)

$$\pi^+ \rightarrow \pi^0 e^+(\gamma)$$

Intensity Frontier

CKM unitarity

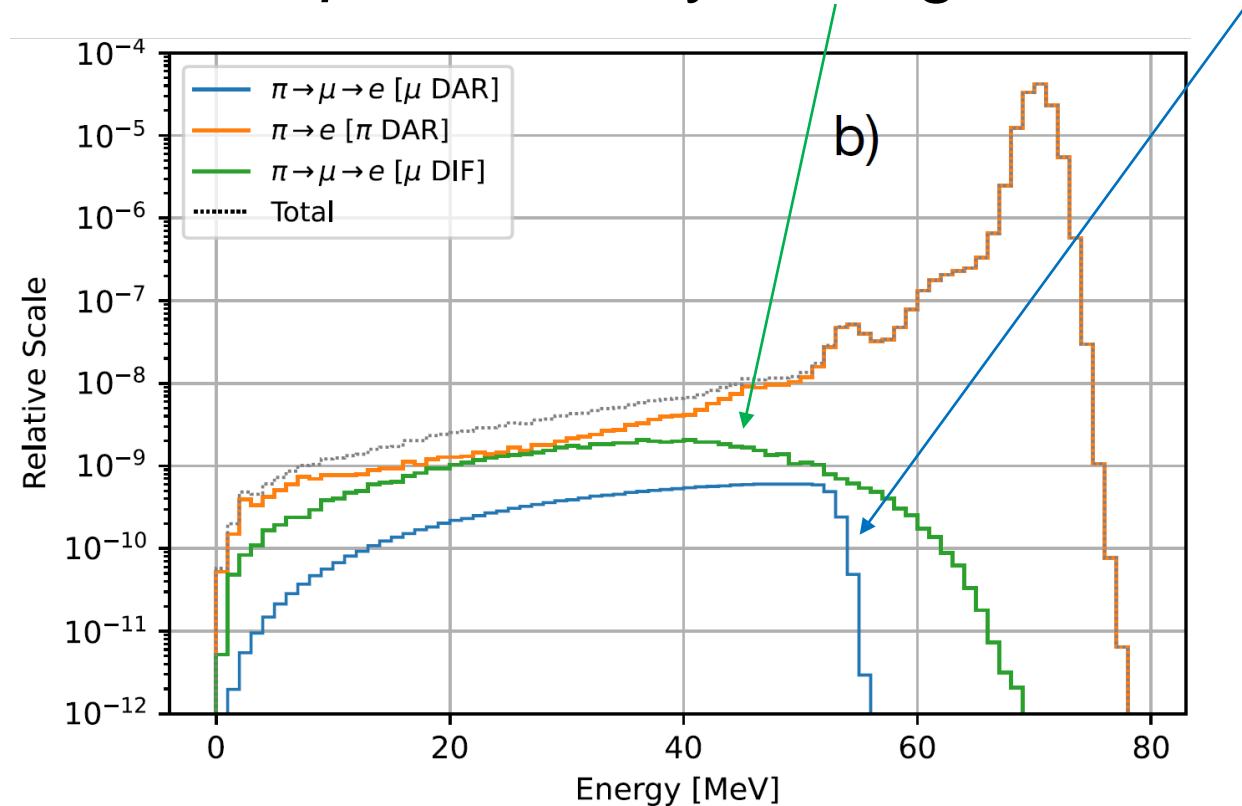
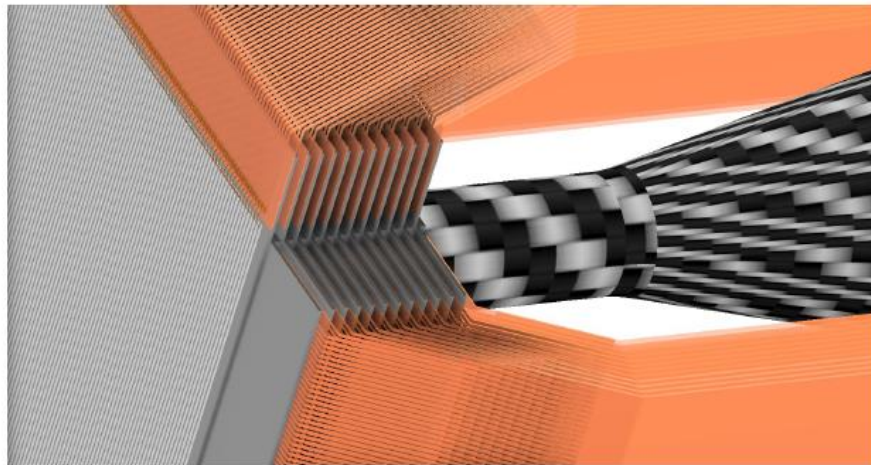
$$|V_{ud}|$$

Heavy neutrinos; *light New Physics* \rightarrow *previous talk!*

Towards 4D (5D) tracking: Active TARget detector



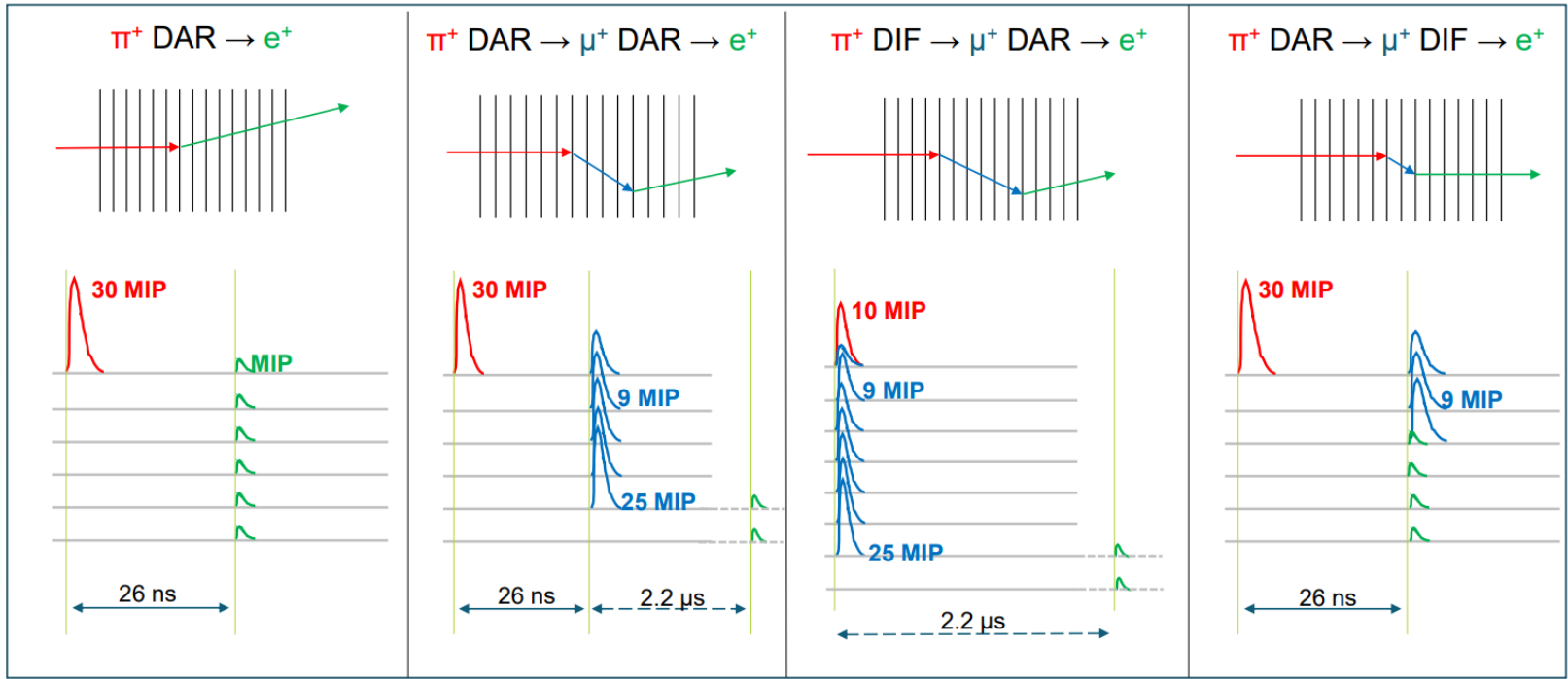
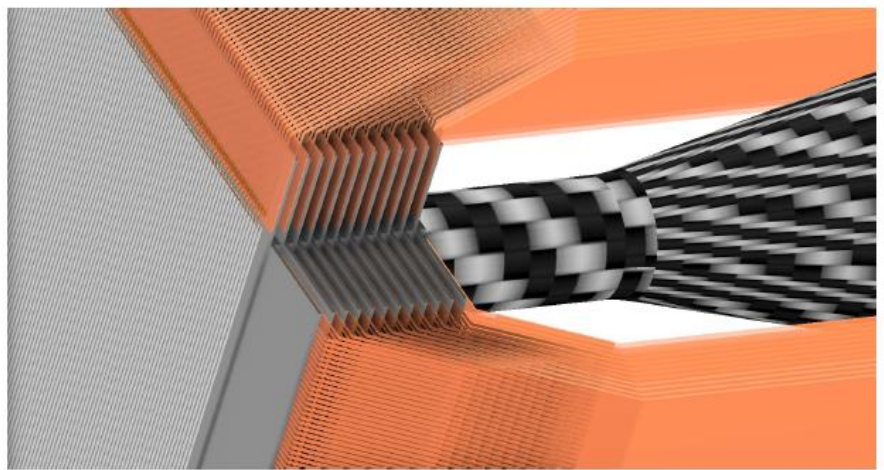
Crucial to separate low-energy tail of $\pi \rightarrow e$ events from $\pi \rightarrow \mu \rightarrow e$ decays in-flight and at-rest



Towards 4D (5D) tracking: Active TARget detector

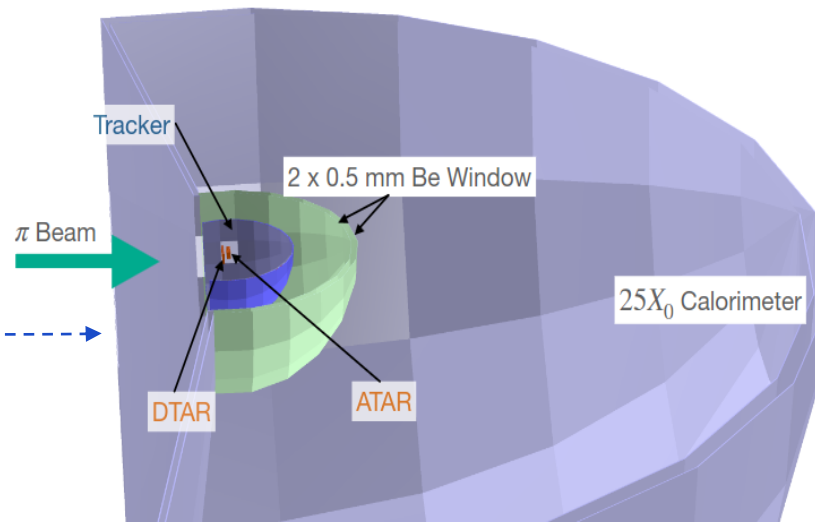
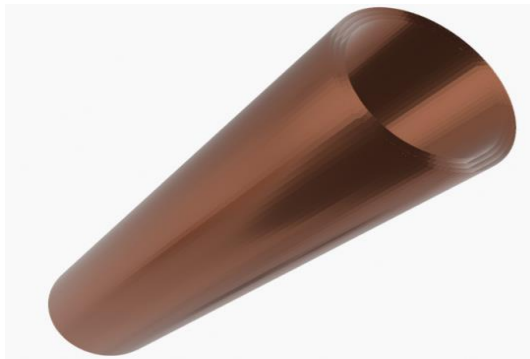
Sensor baseline: AC-LGADs

→ solid-state precision timing and tracking



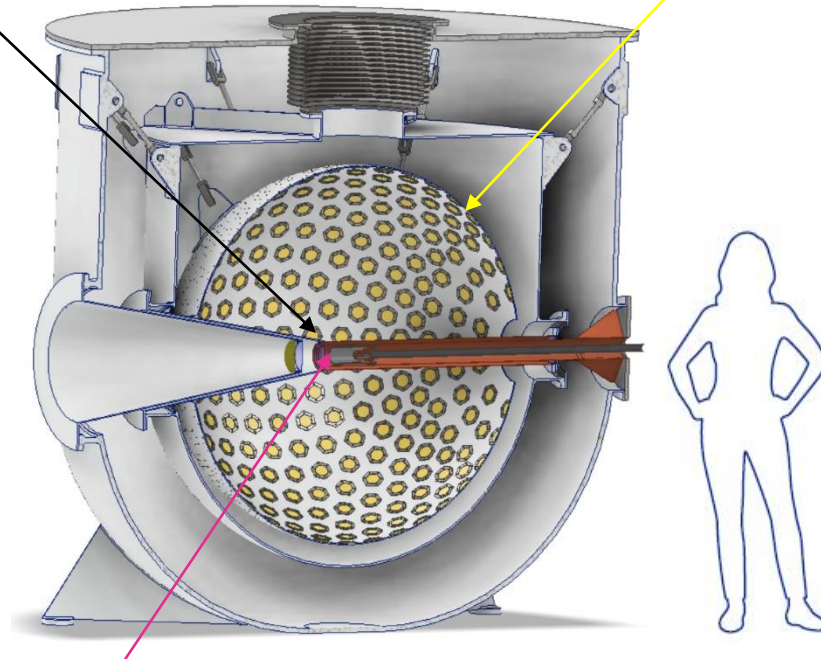
Tracker μ -RWELL

- Nominal design: homogeneous, cylindrical tracker
- Optimized experiment geometry: bullet-shaped or spherical?



3π calorimeter 7t LXe

- Dense, uniform
- Fast response, excellent energy resolution
- Challenges: photosensors, cost, photonuclear effects



ATAR

Early-career contributions

- Currently: 25 institutes, ~80 collaborators
- Graduate students, postdocs, junior scientists and junior faculty are **heavily involved in all aspects of the experiment and haven't taken leading roles**
 - Simulations: P. Schwendimann, J. LaBounty (UW)
 - ATAR: S.M. Mazza, J. Ott (UCSC)
 - Beamline & beam tests: A. Soter (ETH Zurich)
 - Tracker: J. Datta, P. Garg et al (Stony Brook)

and many others!
- First beams scheduled for 2028 – we have a chance to participate in the whole life cycle of the experiment from proposal, design, construction, active operations and exciting physics analyses!