PIONEER
CFI IF 2025

Lead Institution
UBC
Team Leader: D. Bryman, Team co-leader: C. Malbrunot

Collaborating Institutions
McGill U.
TRIUMF
BNL
Cornell University
University of Tokyo
University of Washington
ETH Zürich

NEXT-GENERATION RARE PION DECAY EXP.

Builds on TRIUMF leadership

in previous pion experiments

Strong international partners from diverse backgrounds

- PIENU
- PEN/PiBeta
- MEG/MEGII
- Rare kaon decays
- low-energy stopped muon experiments
- g − 2
- high energy collider physics,
- neutrino physics

https://pioneer.triumf.ca

BROAD PHYSICS REACH

Lepton Flavour Universality test

$$R^{\pi}_{e/\mu} = \frac{\pi \to e\nu(\gamma)}{\pi \to \mu\nu(\gamma)}$$

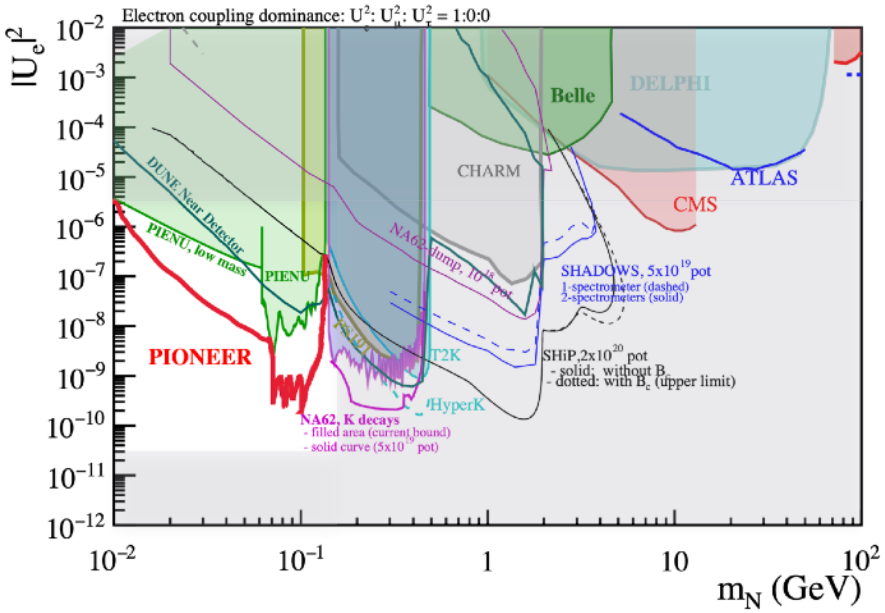
one of the most precisely known observable involving quarks in the SM

$$= (1.23534 \pm 0.00015) \times 10^{-4} \quad (\pm 0.012\%) \quad \text{(SM)}$$

$$= (1.2327 \pm 0.0023) \times 10^{-4} \quad (\pm 0.187\%) \quad \text{(exp.)}$$

x 15

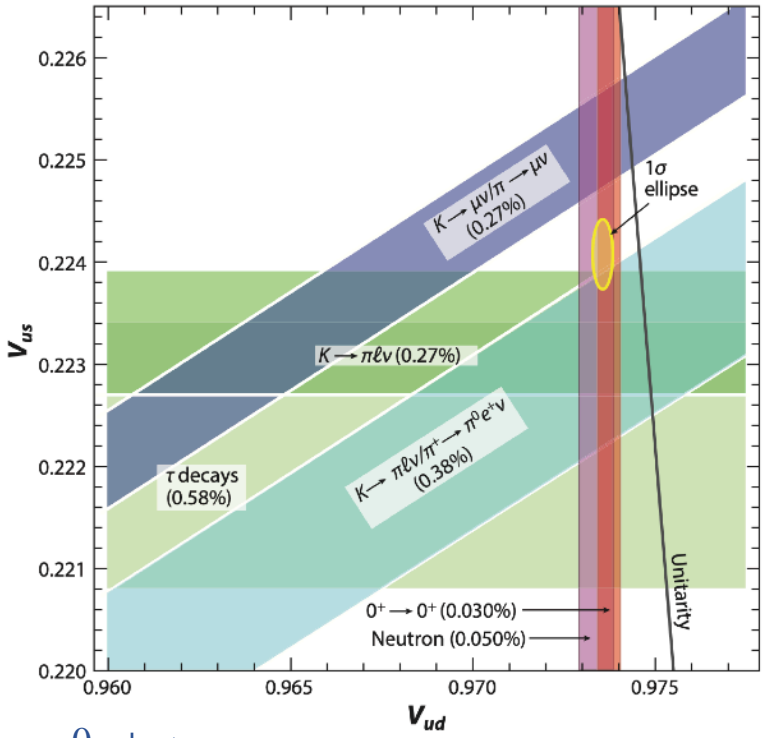
Heavy sterile neutrinos searches



Sensitivity to New Physics at very high mass scales

New Pseudoscalar and scalar currents
Leptoquarks
etc

CKM Unitarity test



Improve $B(\pi^+ \to \pi^0 e^+ \nu)$ precision by an order of magnitude

CANADIAN INVOLVEMENT

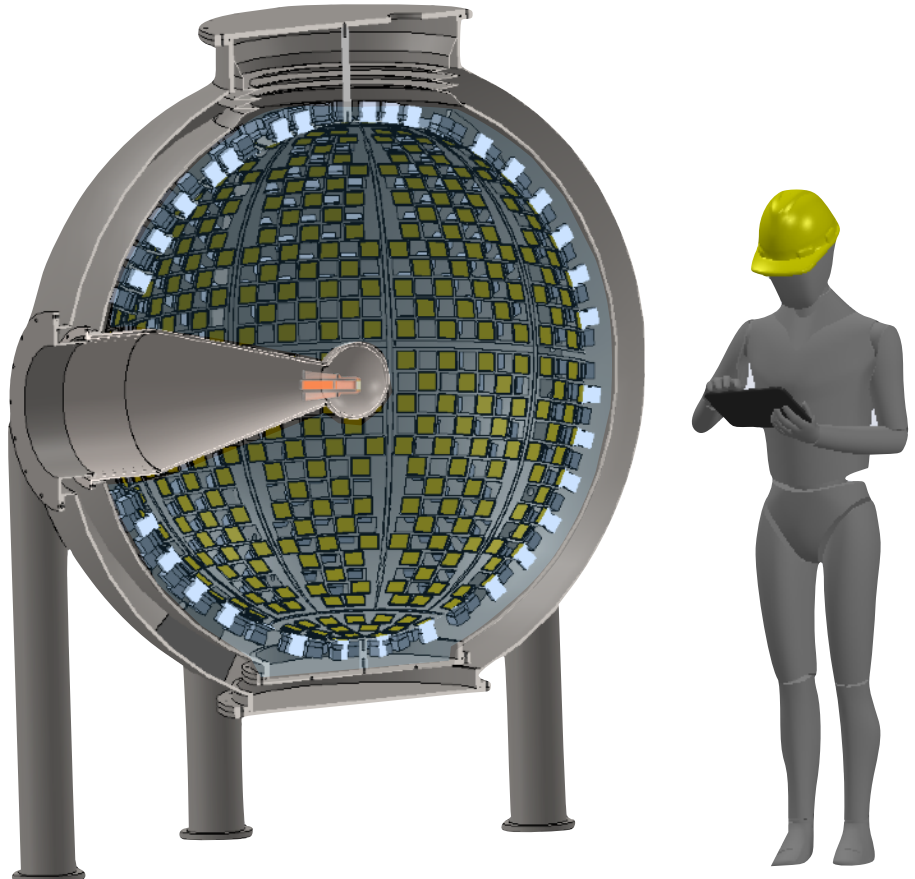
Canadian group initiated the PIONEER project - approved with high priority at PSI in 2022

D.Bryman: former co-spokesperson
C. Malbrunot: deputy spokesperson

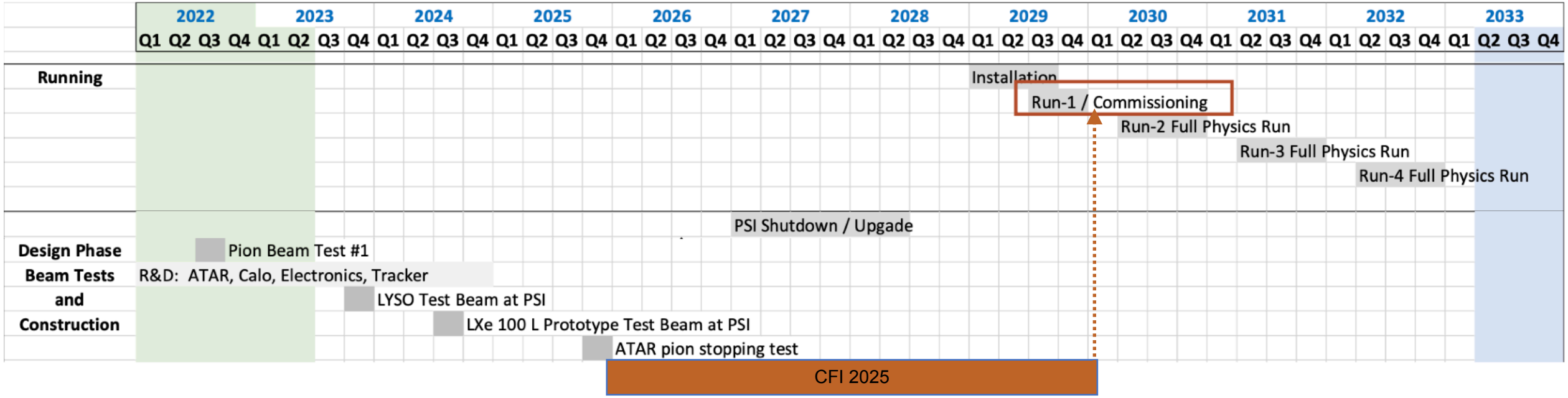
With experiment taking place at PSI, the Canadian group should provide intellectual leadership on detectors, simulation and data analysis.

Canadian group has taken on the “LXe calorimeter thread” (with participation of international collaborator, including Japanese colleagues from MEG - providing the in-kind)

The funds requested as part of CFI IF 2025 would provide crucial infrastructure for the construction of the PIONEER calorimeter - strong synergy with other TRIUMF-supported Nobel liquid experiments



PIONEER TIMELINE



<u>CFI 2025: Timely opportunity</u> (the only one that is inline with the current PIONEER timeline).

Funding for the calorimeter construction is needed to sustain our involvement and leadership in the experiment.

The funds are required to start conceptualization and construction of the detector within the next 2 years. Not submitting this year may put PIONEER in jeopardy

IMPACT ON TRIUMF RESOURCES & INFRASTRUCTURE

(1) **Budget request to CFI <u>includes cost for all</u> technical personnel**

As indicated in the Proj. Init. Sheet**:** *The TRIUMF person-power and the materials resources would be fully funded from the CFI grant; if TRIUMF staff are unavailable, new people would be hired or contracted to complete the tasks.*

No in-kind contribution requested from TRIUMF

Electronics Engineer - Mechanical/Cryo Engineer - Mechanical Technologist- Electronics Technologist - Mechanical Designer

(2) **<u>Infrastructure footprint</u>**

Existing lab in MOB #149 will be used for prototyping and tests

Large TRIUMF MHESA cleanroom for cryo-system assembly and testing

The cryostat will be assembled at TRIUMF

Gas system will be built at McGill

Commissioning and Operation will be done at PSI

IMPACT OF THE DIFFERENT 5YP SCENARIOS

PIONEER is not foreseen to be impacted by the choice of scenario - unless scenario 2 (extended shutdown) has a major impact on Sci-tech availability

The timeline for the pion lifetime measurement will be impacted - no time-criticality that would justify favouring a specific scenario