

A next generation rare pion decay experiment



# PIONEER conference committee report

Jennifer Ott (UC Santa Cruz)

Chloé Malbrunot (TRIUMF & McGill U.)

Patrick Schwendimann (U. Washington)

Toshiyuki Iwamoto (U. Tokyo)

***Looking for a new European member!***

PIONEER Collaboration Meeting, UW, June 19-21, 2024

# Objectives

- **Identify relevant conferences and workshops – anyone can point out conferences!**
- **Submit abstracts on behalf of the collaboration to conferences**
- **Assign speakers – self-nominations common**
  
- **Maintain list of conferences and speakers**
  
- **Review abstracts submitted by other collaborators**
- **Review proceedings / articles before journal submission**

# Recent conference presentations

## The PIONEER Experiment

Testing Lepton Flavour Universality in a Next-Generation Precision Pion Decay Experiment Located at PSI

Kolja Frahm\* on behalf of the PIONEER Collaboration [1]

\*kfrahm@phys.ethz.ch, ETH Zurich, 8093 Zürich, Switzerland

## Searching for new physics with low-energy pions

Chloé Malbrunot  
cmalbrunot@triumf.ca

TRIUMF  
McGill University, University of British Columbia



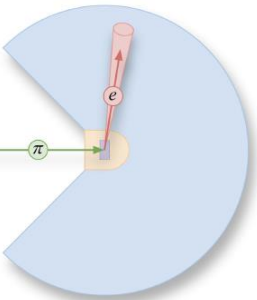
(non-official logo)

ETH zürich



## Beam tests for the PIONEER Experiment

A Next-Generation Rare Pion Decay Experiment Located at PSI



Beam Telescopes and Test Beams Workshop  
Stefan Hochrein on behalf of the PIONEER collaboration  
Edinburgh, 17.04.2024

Brookhaven National Laboratory



May 2024

CAP 2024 - London

## Measurements of a LYSO Crystal Array for a Rare Pion Decay Experiment (PIONEER)

David Hertzog; University of Washington



- Physics Goals
- Lepton Flavor Universality (e vs  $\mu$  to  $<10^{-4}$  in BR)
  - Cabibbo Angle Anomaly ( $v_{ud}$ ) pion beta decay
  - Sterile neutrinos and exotic decays:

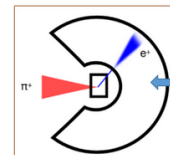
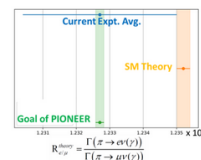
$$R_{e/\mu}^{theory} = \frac{\Gamma(\pi \rightarrow e\nu(\gamma))}{\Gamma(\pi \rightarrow \mu\nu(\gamma))}$$

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

$$\pi \rightarrow e\nu_H, \pi \rightarrow \mu\nu_H, \pi \rightarrow e\nu_X$$

illustrate challenge with this channel

All of these involve high-resolution calorimetry in the (unusual) "below 100 MeV" range



What is this?  
• LXe?  
• LYSO?

2D cartoon of experiment



Dr. Ben Davis-Purcell, TRIUMF  
2024 CAP Congress  
May 30, 2024



### 0 Motivation

Hints of Lepton Flavour Universality Violation

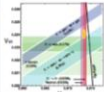
- Deviating branching ratios ( $R(D^{(*)})$  with  $3\sigma$  and  $R(K^{(*)})$  with  $4\sigma$ )

Measure branching ratio of  $\pi^+$  (Phase I)

- Bridge gap between theoretical and experimental precision: improve precision by 15
- perhaps most precisely calculated weak interaction observable involving quarks
- New physics up to the PeV scale may be revealed

Cabibbo Angle Anomaly

- test CKM unitarity



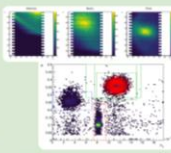
Study pion beta decay (Phase II/III)

- Improve branching ratio by
  - a factor of three (Phase II)
  - order of magnitude (Phase III)
- theoretically cleanest extraction of  $|V_{ud}|$  at 0.02% level
- comparable to deduction from superallowed beta decays
- lift 3 $\sigma$  tension of  $V_{ud}$

### 2 Momentum bite analysis of beam

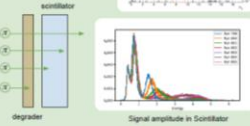
Time of flight analysis

- Cut out pions in time-Energy-space
- calculate  $\Delta t$  and use it to get a rough estimate of  $\Delta p/p$



With degraders

- pion energy signal changes with different degraders
- use peak position to identify momentum bite
- compare with simulation



### 3 Calorimeter

## PIONEER: a next-generation rare pion decay experiment

Yousen Zhang on behalf of PIONEER collaboration

13 May 2024

## Simulating a high-rate liquid xenon calorimeter for the PIONEER Experiment

# Internal conference list on Twiki



TWiki.org





Tags:  [create new tag](#) [view all tags](#)

## Upcoming conferences for PIONEER

Below are tables with upcoming conferences and workshops (second table) and additional information. Please feel free to edit to add new conferences or to propose speakers.

Conference Name	Date	Location	Abstract sub. deadline	Topic	Potential or confirmed presenter
<b>2024</b>					
<a href="#">Physics beyond the Standard Model in Leptonic and Hadronic Processes and Relevant Computing Tools</a>	Feb 26 - March 1	Athens, Greece	February 19		
<a href="#">APS April meeting</a>	3-6 April	Sacramento, CA, USA	?	PIONEER talk in CLFV mini-symposium session	Should have submitted abstract. Perhaps otherwise registered participant can cover, e.g. Stefania Gori?
<a href="#">Beam Telescopes and Test Beams</a>	15-19 April	Edinburgh, Scotland	January 26	Test beams for PIONEER	Abstract submitted (JO)  Accepted for talk  Speaker: <b>Stefan Hochrein (ETH Zurich)</b>
<a href="#">American Physical Society DPF-PHENO 2024</a>	13-17 May	Pittsburgh, PA, USA	April 1	PIONEER Experiment (invited, in CLFV mini-session)  PIONEER LYSO calorimeter tests	Speaker: <b>Yousen Zhang (BNL)</b>  Speaker: <b>David Hertzog (UW)</b>
<a href="#">Pisa Meeting on Advanced Detectors</a>	26 May - 1 June	La Biodola, Elba, Italy	January 28	Instrumentation / PIONEER detectors and test beams	Abstract submitted (JO)  Accepted as poster  <b>Presenter: Kolja Frahm (ETH Zurich)</b>
<a href="#">CAP Congress / Congrès de l'ACP 2024</a>	26-31 May	London, Ontario, Canada		PIONEER Experiment (invited, C. Malbrunot)  LXe Calo simulation	<b>Speaker: C. Malbrunot (TRIUMF/McGill)</b>  <b>Speaker: B. Davis-Purcell (TRIUMF)</b>

<https://pioneer.npl.washington.edu/do/view/Internal/UpcomingConferences>

J. Ott, Conference committee, PIONEER 2024

# Internal conference list on Twiki

- TWiki page listing conference (with link), date and place, topic, abstract deadline; **also used to track status of contribution and presenter candidates – internal use**
- **Added now a ‘wait list’ to keep track of collaborators who would/should soon present**
- **Next conferences: ICHEP (T. Iwamoto), Latin American HEP Symposium (S. Cuen-Rochin), 13<sup>th</sup> International Conference on New Frontiers in Physics (ICNFP 2024), 26 August to 4 September 2024, OAC, Kolymbari, Crete, Greece – anyone?**

We are pleased to invite the PIONEER Experiment to present talks and posters at the

[XIII International Conference on New Frontiers in Physics \(ICNFP 2024\)](#),

which will take place from **26 August to 4 September 2024 in the Orthodox Academy of Crete (OAC), Kolymbari, Crete, Greece.**

The conference invites oral and poster presentations, which can be presented physically at the conference venue on Crete, or online via zoom.

The following presentations are invited from your Collaboration:

- One or two highlight talks on the results of your collaboration, with a duration of 25+5 minutes.
- Overview talks from every working group (physics, software, trigger/DAQ, detectors, and other) with a duration of 20+5 minutes, or 25+5 minutes in selected cases.
- One or more talks on upgrades and future plans, including one review of 25+5 minutes, and others with a duration of 20+5 or 15+5 minutes.
- Topical oral presentations on specific topics that you would like to propose, with a duration of 15+5 minutes, and 20+5 minutes in selected cases.

We also encourage you to submit abstracts for poster presentations on specific topics that you would like to propose. Poster presenters can also publish a paper in the proceedings of the conference.

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<https://pioneer.npl.washington.edu/do/view/Internal/UpcomingConferences>

J. Ott, Conference committee, PIONEER 2024

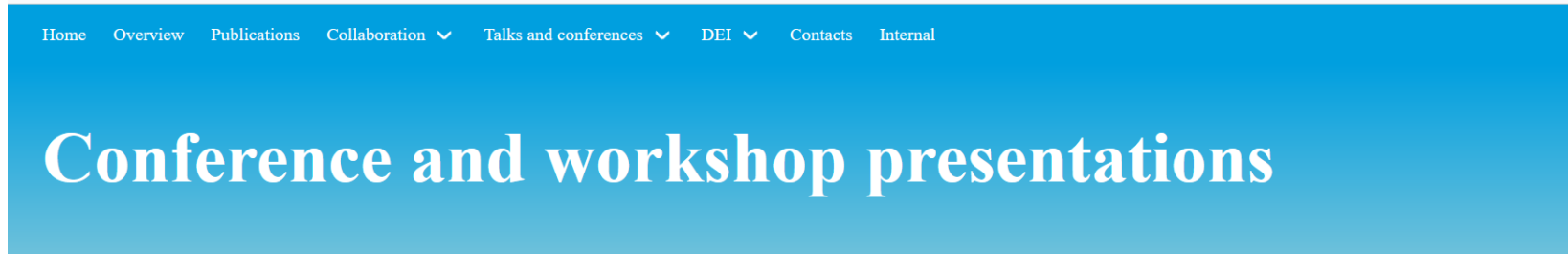
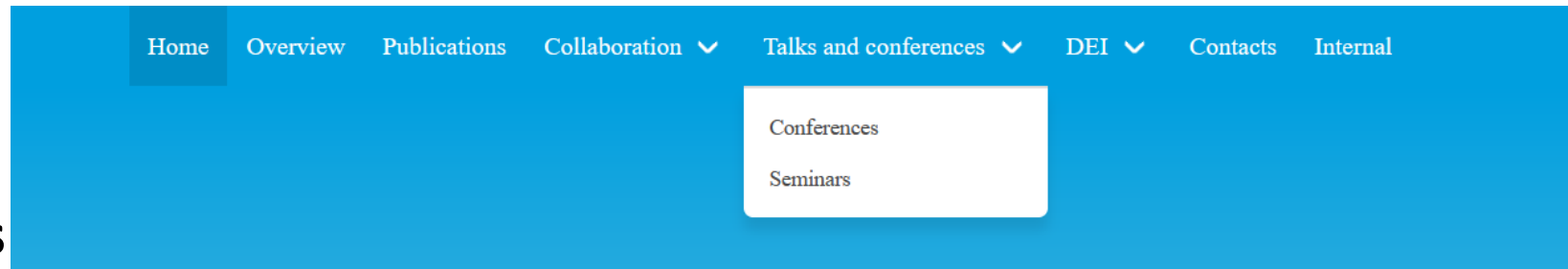


# Webpage

<https://pioneer.triumf.ca/>

## List of conferences with links to the final presentations (most are public) is included on PIONEER webpage!

- Easy to find and access for the interested community, including possible new collaborators 😊
- Update frequency sparse, random-ish
- Change to storing pdf files directly, instead of Indico links?



### Conference presentations in 2024

- **Detector development for the PIONEER Experiment** (16th Pisa Meeting on Advanced Detectors, 26 May-1 June 2024, La Biodola, Elba, Italy) *PIONEER Collaboration • K. Frahm*
- **PIONEER: a next generation pion decay experiment** (2024 CAP Congress / Congrès de l'ACP 2024, 26-31 May 2024, London, Ontario, Canada) *PIONEER Collaboration • C. Malbrunot*
- **Simulating a high-rate liquid xenon calorimeter for the PIONEER experiment** (2024 CAP Congress / Congrès de l'ACP 2024, 26-31 May 2024, London, Ontario, Canada) *PIONEER Collaboration • B. Davis-Purcell*
- **Measurements of a LYSO Crystal Array for a Rare Pion Decay Experiment** (American Physical Society Division of Particles & Fields Meeting, Phenomenology Symposium (DPF-PHENO 2024), 13-17 May 2024, Pittsburgh, PA, USA) *PIONEER Collaboration • D. Hertzog*
- **PIONEER: a next-generation rare pion decay experiment** (American Physical Society Division of Particles & Fields Meeting, Phenomenology Symposium (DPF-PHENO 2024), 13-17 May 2024, Pittsburgh, PA, USA) *PIONEER Collaboration • Y. Zhang*
- **Beam tests for the PIONEER Experiment** (12th Beam Telescopes and Test Beams Workshop, 15-19 April 2024, Edinburgh, Scotland ) *PIONEER Collaboration • S. Hochrein*

### Conference presentations in 2023

- **Testing Lepton Universality in Pion Decay / PIONEER: next-generation rare pion decay experiment** (Muons in Minneapolis workshop, 6-8 December 2023, Minneapolis, MN, USA) *PIONEER Collaboration • D. Bryman*

# Webpage

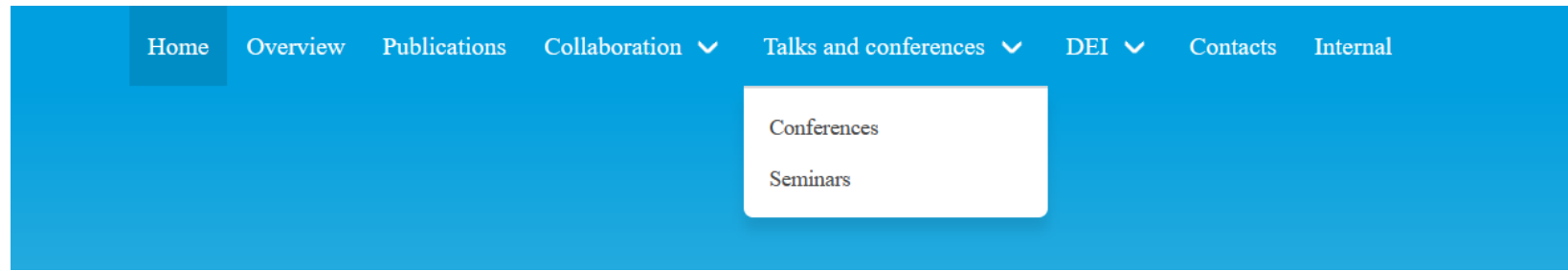
<https://pioneer.triumf.ca/>

## List of seminars also displayed on PIONEER webpage

- Currently links to internal repositories, such as Google Drive and DocDB – need to change to storing files directly

## Collection of seminar information via [Google form](#): not very intense usage

- Some seminar talks still missing?



## Seminars

- **PIONEER: a next generation pion experiment** (Colloquium, 1 March 2024, University of Manitoba, Canada) *Chloé Malbrunot (TRIUMF/McGill)*
- **PIONEER: a next generation pion experiment** (Seminar, 14 February 2024, Sherbrooke University, Canada) *Chloé Malbrunot (TRIUMF/McGill)*
- **PIONEER: a next generation pion experiment** (Seminar, 20 November 2023, University of Milan, Italy) *Simone M. Mazza (UC Santa Cruz)*
- **PIONEER: a next generation pion experiment** (Experimental nuclear physics seminar, 23 August 2023, Argonne National Laboratory) *Xin Qian (Brookhaven National Laboratory)*
- **PIONEER: a next generation pion experiment** (Colloquium, 30 March 2023, Subatech Nantes, France) *Chloé Malbrunot (TRIUMF/McGill)*
- **PIONEER: a next generation pion experiment** (Colloquium, 28 March 2023, IJCLab Paris, France) *Chloé Malbrunot (TRIUMF/McGill)*
- **PIONEER: a next generation pion experiment** (Seminar, 9 March 2023, McGill University, Canada) *Chloé Malbrunot (TRIUMF/McGill)*
- **PIONEER: a next generation pion experiment** (Seminar, 13 June 2022, EPFL Lausanne, Switzerland) *Chloé Malbrunot (TRIUMF/McGill)*
- **PIONEER: a next generation pion experiment** (Seminar, 11 April 2022, SUNY Stony Brook, USA) *Chloé Malbrunot (TRIUMF/McGill)*
- **The PIONEER Experiment** (Colloquium, 2022, UC Santa Cruz, USA) *Simone M. Mazza (UC Santa Cruz)*

# Overview of conference presentations, 2022-2024

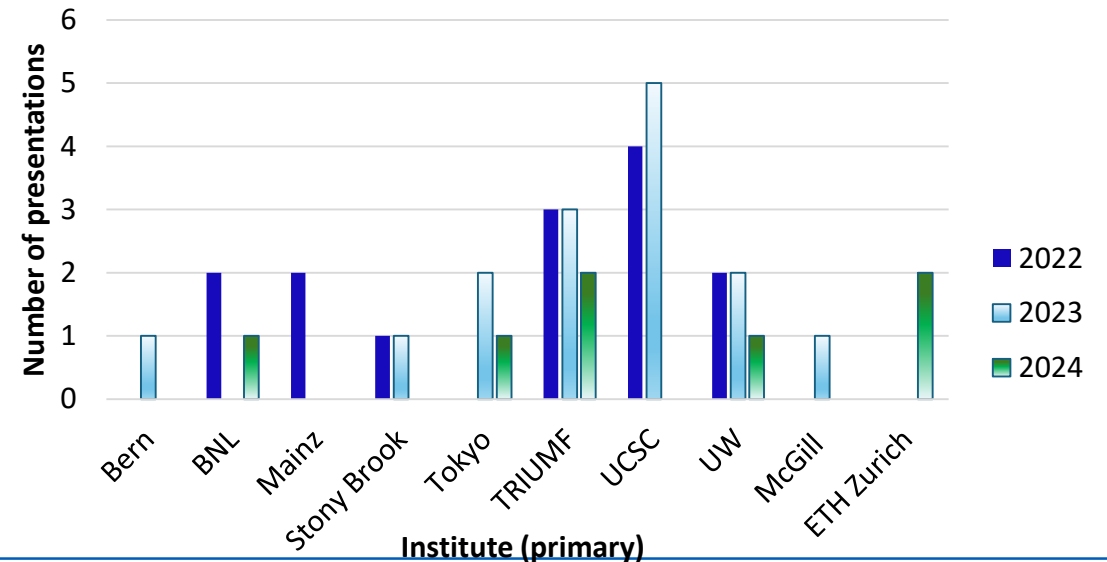
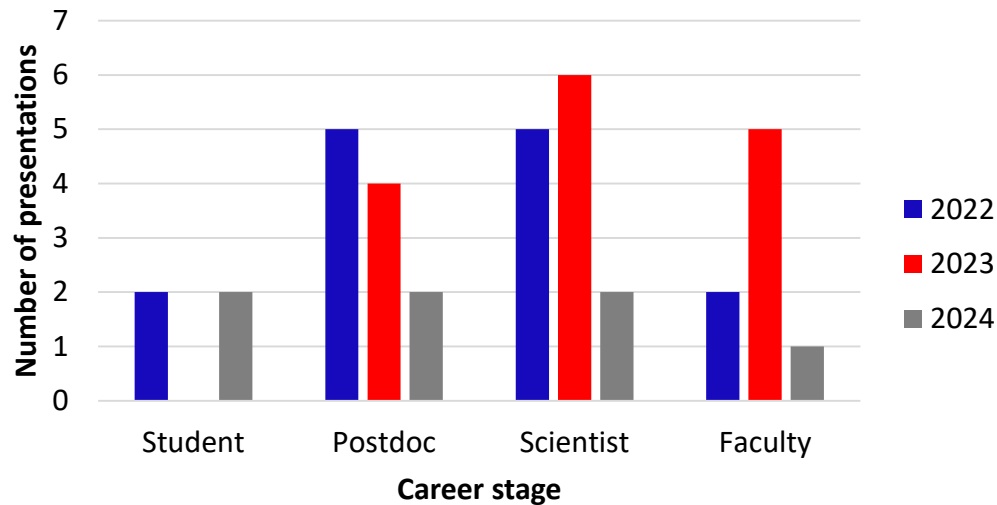
**2022: 14 presentations (10 talk, 4 poster), 2023: 15 presentations, 2024 (so far & confirmed): 7 presentations (6 talks, 1 poster)**

- Good (?) number for an experiment in the design phase

**Display of presentations by institute represents the most active groups quite well**

**Distribution by career stage varies:**

- 2022: favored postdocs and scientists (“scientists” may include large spread of seniority)
- 2023: leaning towards scientists and faculty
- 2024: very evenly distributed so far





# Author lists

**Publications have mostly been conference proceedings of a specific topic with a short PIONEER introduction and overview, e.g. *An LGAD-based Active Target Detector for the PIONEER Experiment***

- Main author / active team has decided named authors, list is displayed as *A. Author, B. B-author, C. C-author... on behalf of the PIONEER Collaboration*
  - Has worked well in practice, reflects active contribution to a degree, “nobody has complained”
  - Current situation: include everyone in the original PSI proposal author list with additions over time, nobody has been removed unless explicitly retreated themselves
  - Latex author list maintained ~manually by Patrick
- **Authorship definition updated by Institutional Board: to be implemented**

# Proceedings

- M. Hoferichter on behalf of PIONEER: from 2023 CKM conference, on arXiv
- **Coming up - Pisa Meeting proceedings**

arXiv:submit/5499346 [hep-ex] 27 Mar 2024

12th Workshop on the CKM Unitarity Triangle  
Santiago de Compostela, 18-22 September 2023

## Prospects for PIONEER

Martin Hoferichter\* on behalf of the PIONEER collaboration<sup>1</sup>

<sup>1</sup>Albert Einstein Center for Fundamental Physics,  
Institute for Theoretical Physics, University of Bern,  
Sidlerstrasse 5, 3012 Bern, Switzerland

### Abstract

Pion  $\beta$  decay,  $\pi^+ \rightarrow \pi^0 e^+ \nu_e$ , offers a pristine way to measure the CKM matrix element  $V_{ud}$  in a purely mesonic system, with excellent control over the hadronic matrix elements. We review the physics goals and current status of the PIONEER experiment, which aims at major improvements in the branching fractions for the  $\pi^+ \rightarrow e^+ \nu_e$  decay in Phase I and for pion  $\beta$  decay in Phases II and III of its experimental program, potentially leading to a measurement of  $V_{ud}$  competitive with determinations from  $\beta$  decays involving nucleons.

## 1 Introduction

PIONEER is a next-generation rare pion decay experiment at PSI [1,2]. Its main physics goals include the test of lepton flavor universality in the ratio

$$R_{e/\mu} = \frac{\Gamma[\pi^+ \rightarrow e^+ \nu_e(\gamma)]}{\Gamma[\pi^+ \rightarrow \mu^+ \nu_\mu(\gamma)]} \quad (1.1)$$

# Repositories and list of talks: materials

**Speakers, especially when not experts in a specific area, are often looking for the newest updated models or plots to include in talks and PIONEER overviews**

**No dedicated area so far for keeping and distributing such presentation materials**

- DocDB is not convenient for storing materials in a structured way, hard to navigate especially if one does not know to detail what to look for, does not have integrated viewer
- eLog is meant for logging active work, not for being a repository for polished results

**Suggestion: expand subgroup pages in Twiki, and/or create pages for most recent status and 'approved plots' with useful material and related documentation**

- Easy way to store and navigate materials for use in talks, but not directly post for public access

# Committee operations updates

**Visibility at conferences and workshops is important for the collaboration, and also for the individuals, particularly early-career scientists**

- We have included a section on the Conference Committee in the DEI/Climate survey – please give us feedback! (of course, also possible in-person or by email)

[pioneer-public@lists.triumf.ca](mailto:pioneer-public@lists.triumf.ca)

**Dieter is occupied with his new position at PSI – it would be good to have a new committee member, ideally from a European institution**