EURO-LABS SAM : HiRadMat facility – TA progress

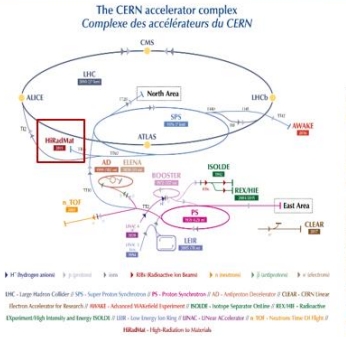
N. Charitonidis, A. Goillot, E. Andersen, V. Stergiou

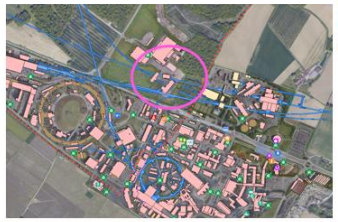
October 2023

Reminder : HiRadMat @ CERN/SPS

A "flash" overview of HiRadMat

- HiRadMat (High-Radiation to Materials) is a user facility providing high-energy, **high-intensity pulsed beams to a broad international scientific community**.
  - *https://hiradmat.web.cern.ch/*
- The facility was **comissioned in 2011** (11y ago!) and **is located in SPS Point 7**.
- Since 2011: **40 successful experiments**





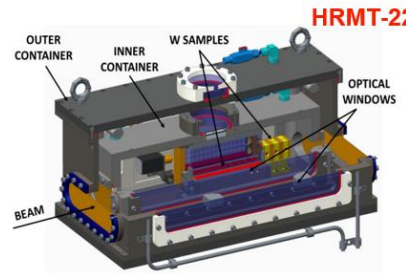
HiRadMat High-Radiation to Materials — N. Charitonidis – HiRadMat Facility – EUROLABS KOM — 2

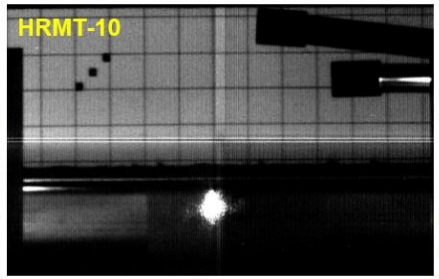
EURO-LABS KOM, Bologna 2022

EURO-LABS has been essential in supporting the facility and most importantly these users that – without this TA budget – would be impossible to do their experiment.

A CERN facility, with ~5 very complicated experiments per year, with lots of preparations and navigating (usually) via a "minefield" of issues

Impressions of HiRadMat Experiments





Experiments take long time and hard effort to prepare.

The results are unique additions to the knowledge of the beam-to-material impact

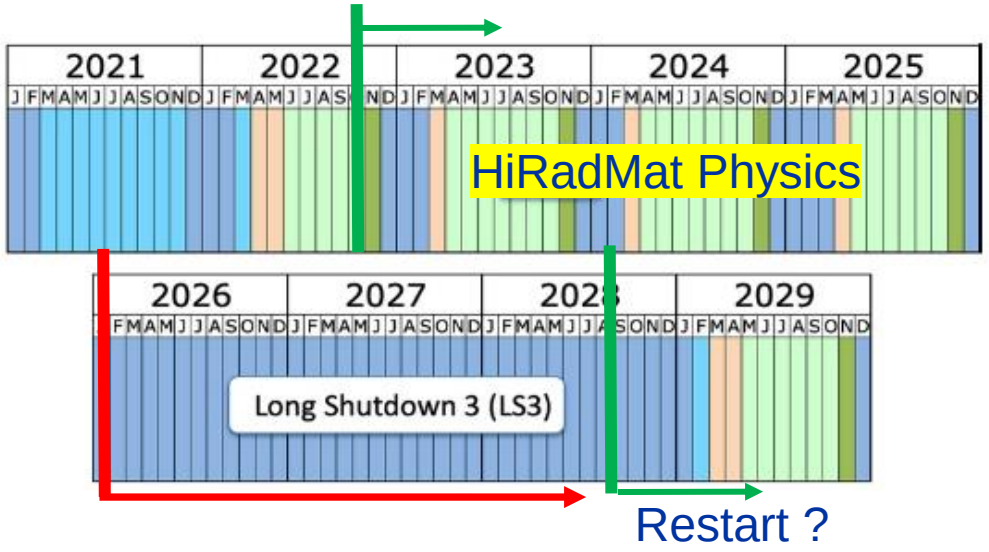
> 35 publications in peer reviewed articles and conference proceedings

HiRadMat High-Radiation to Materials — N. Charitonidis – HiRadMat Facility – EUROLABS KOM — 5

Introduction – AU Budget

- **Granted 4800 Access Units (AUs) - Project duration: 4 years**

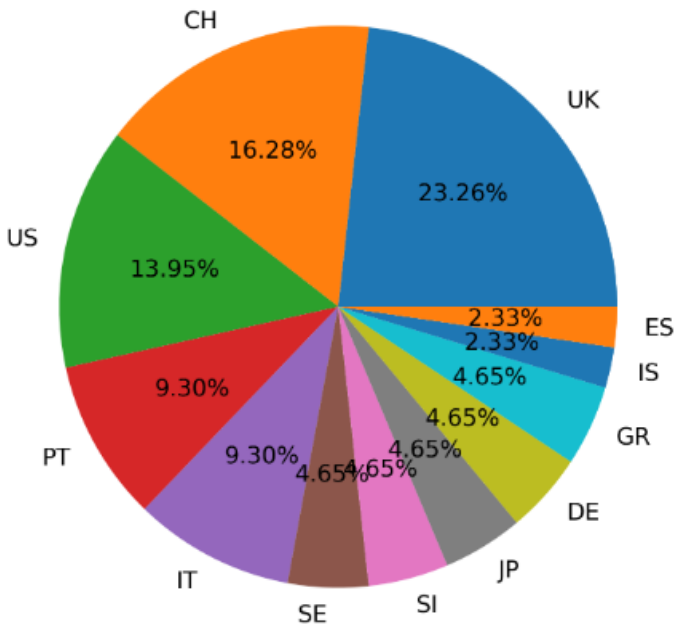
- **However:**
  - **LS3**: no beamtime at all during the last year of the project (2026)
  - **Many CERN internal experiments critical for HL-LHC operation upcoming**
  - **A "fallout" from COVID-19 :** People seem 'reluctant' to travel if something can be done on zoom....



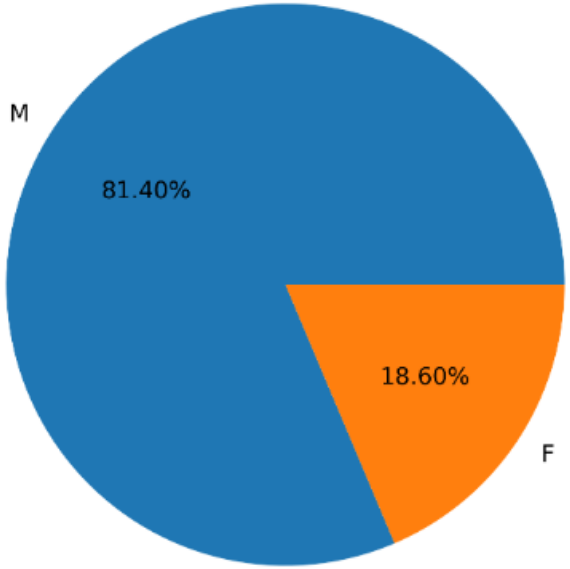
- **So, by the end of 2023 run:**
  - Delivered **1528 AUs (65.41 %) out of 2336 requested** AUs
  - Delivered **1528 AUs (31.83 %) out of total 4800 available** AUs
  - **3272 AUs for 2 more experimental seasons (2024 and 2025)**

Up to now – Declared Users and Collaborators

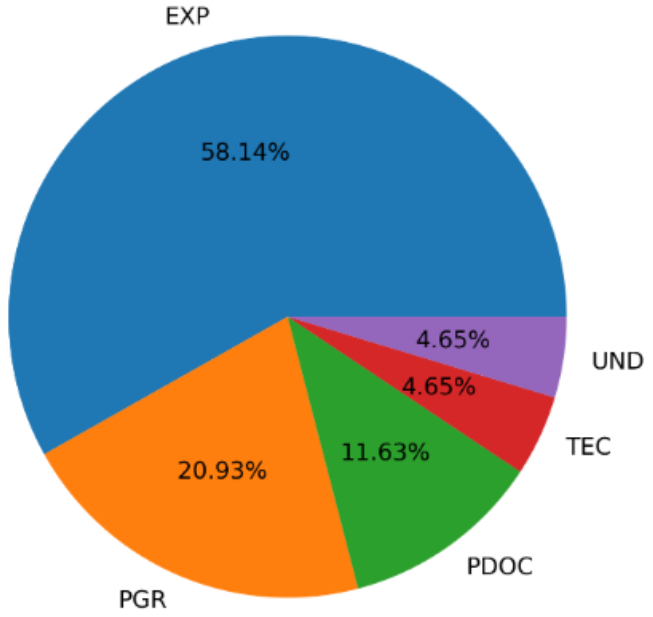
All users - Country distribution in all projects



All users - Gender distribution in all projects



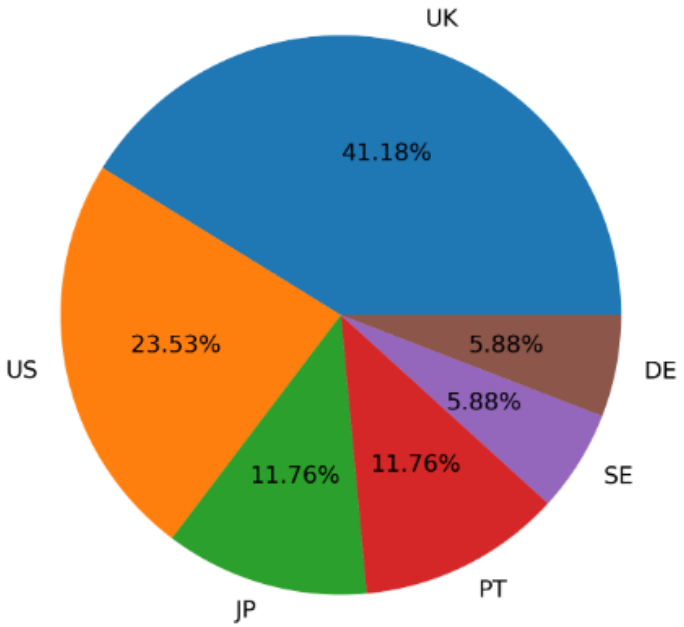
All users - Research status distribution in all projects



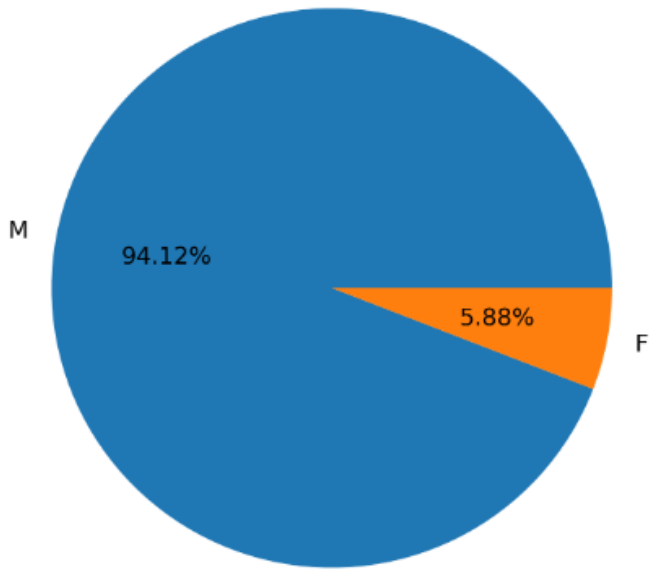
A nice breakdown of TNA users (funded & not-funded), with a slight inclination towards experienced researchers and males

Up to now – Funded Users

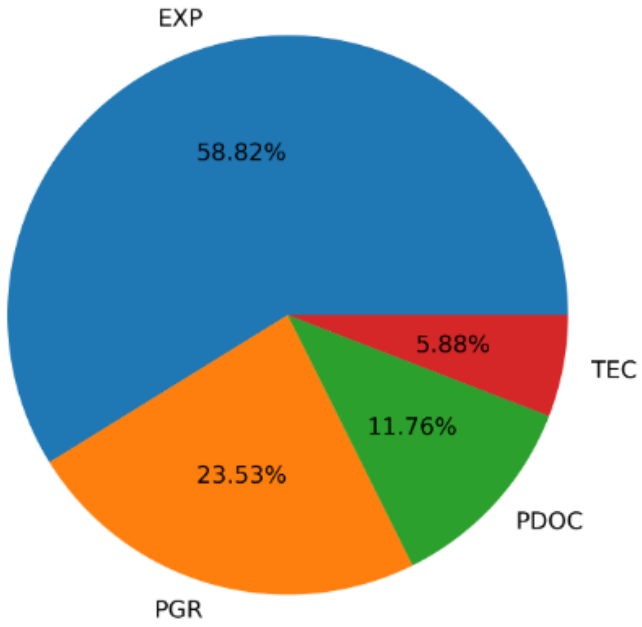
Funded users - Country distribution in all projects



Funded users - Gender distribution in all projects

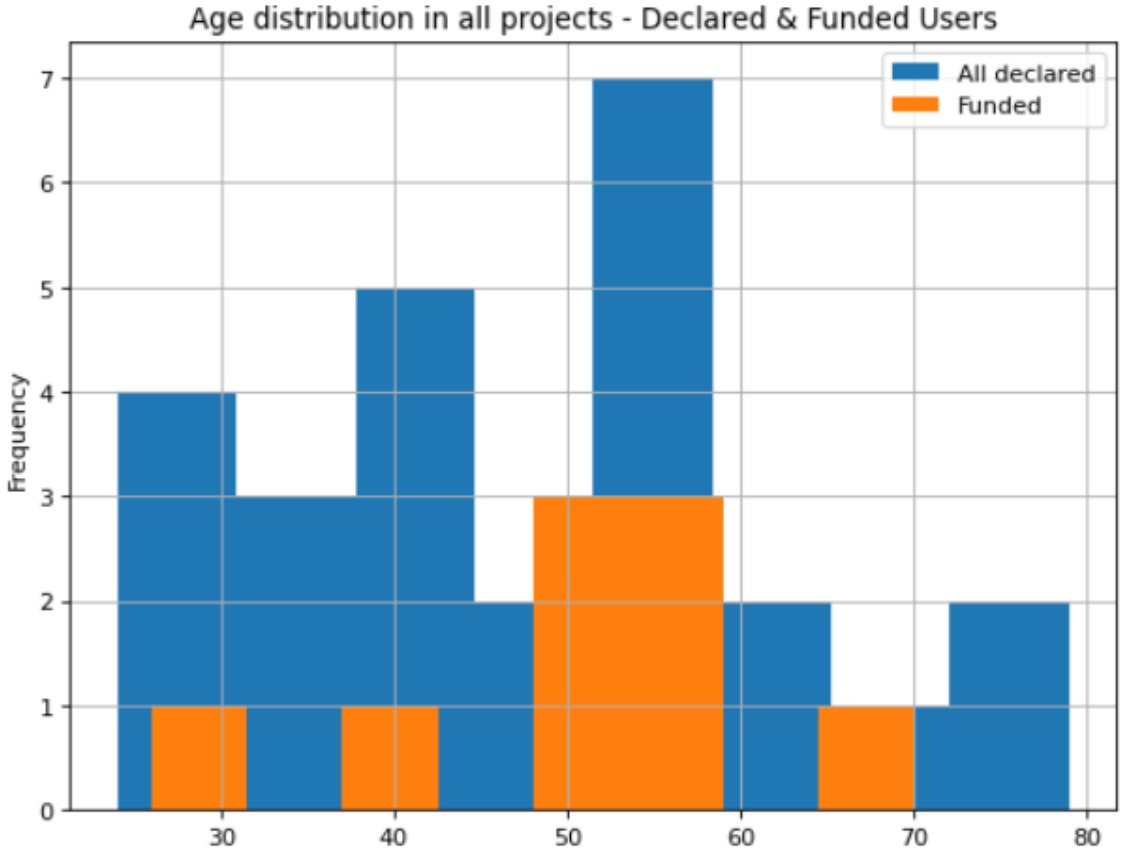


Funded users - Research status distribution in all projects

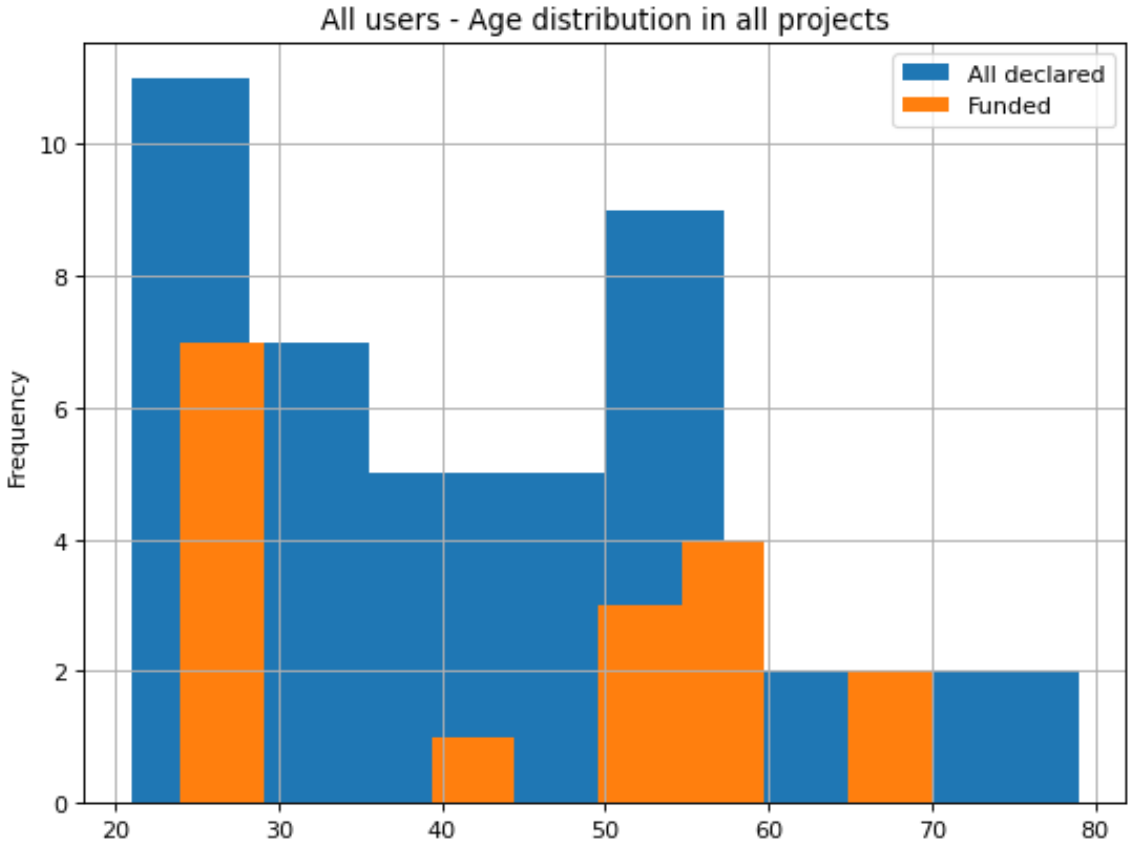


- **Due to unforeseen conditions, some visits were cancelled and access units were not used (e.g. HRMT55, HRMT58)**
- **Some collaborators could access other sources of funding (i.e their institutes covered)**

Up to now – Age distribution



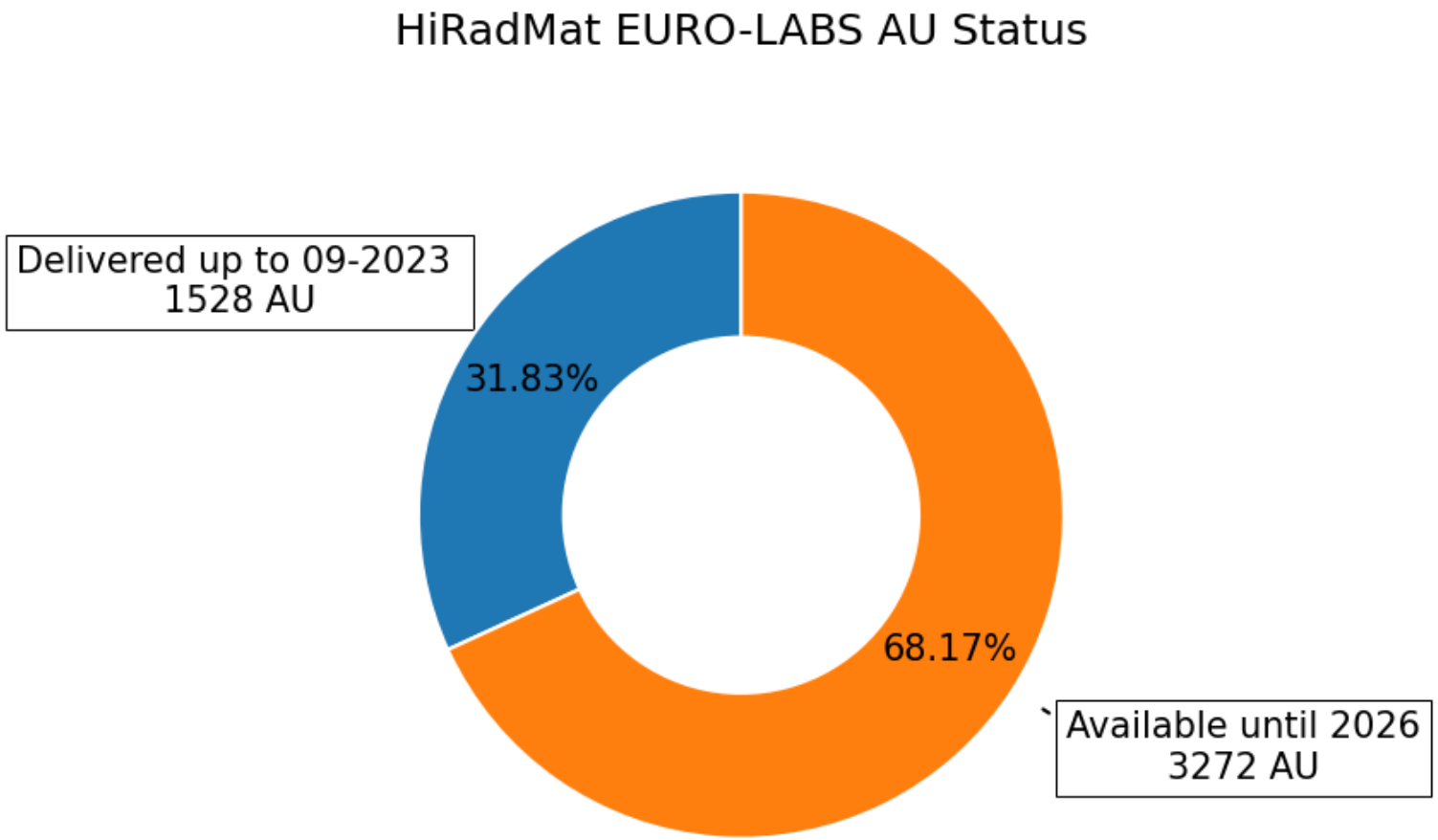
User data until 15/02/2023



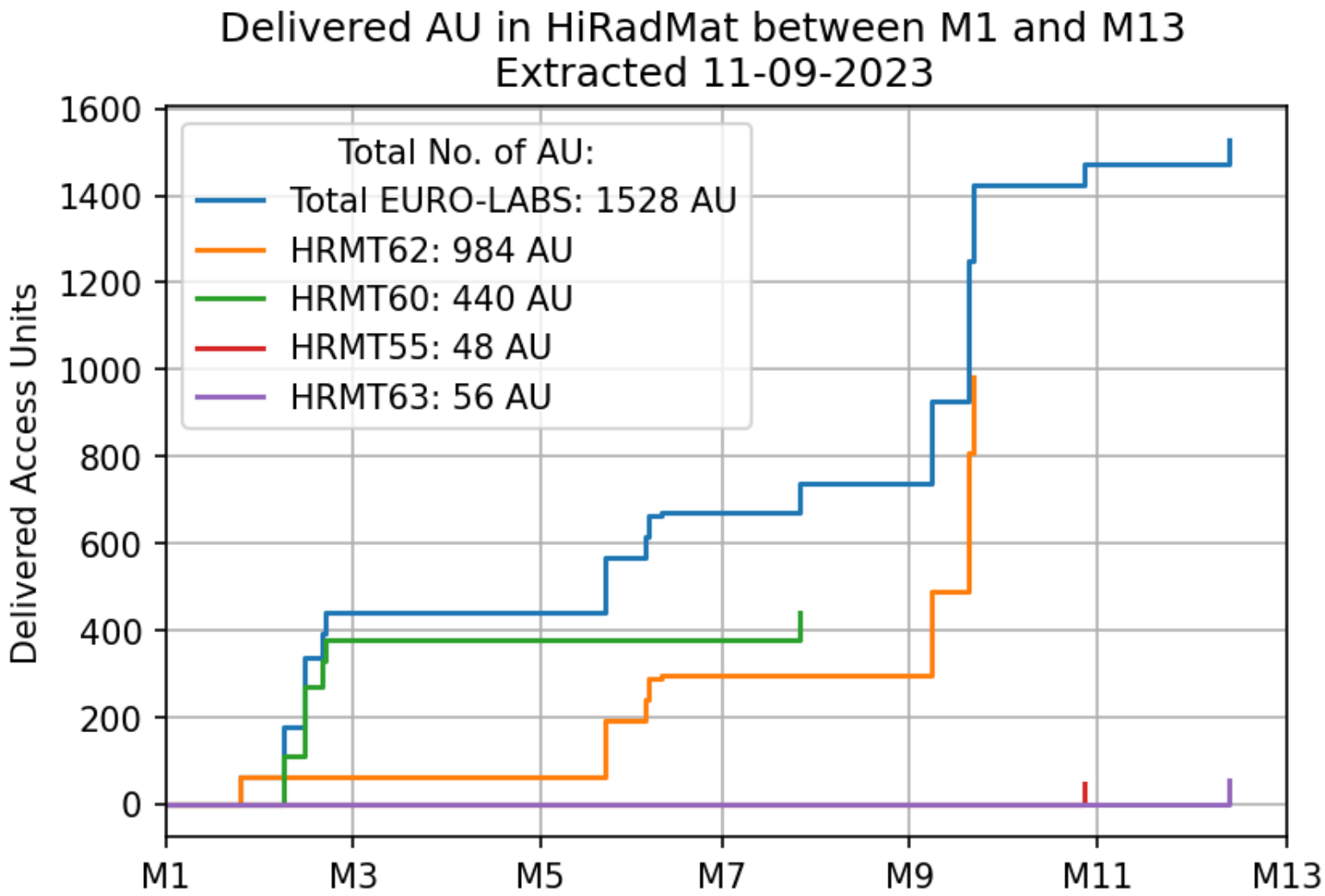
User data until 19/09/2023

We actively instructed the USPs and the proponents / applicants to motivate younger people, undergrads postdocs & females to apply.

Up to now – Access Units delivered



Up to now – Access Units delivered

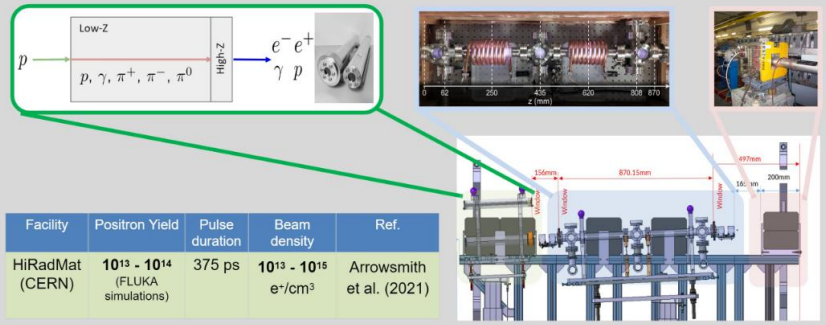


Highlights – HRMT-62

Courtesy: G. Gregori (Univ. Oxford)

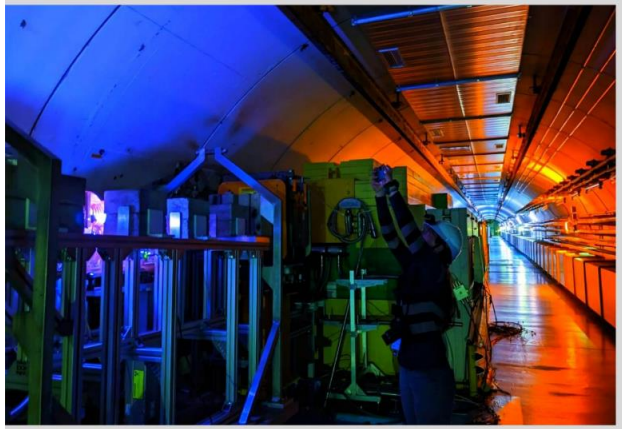
Oxford Physics

We have adopted a completely new approach using CERN SPS



Facility	Positron Yield	Pulse duration	Beam density	Ref.
HiRadMat (CERN)	10^{13} - 10^{14} (FLUKA simulations)	375 ps	10^{13} - 10^{15} e^+/cm^3	Arrowsmith et al. (2021)

- We have developed a new platform to study the propagation of quasi-neutral beam through an ambient plasma.
- 440 GeV/c protons irradiate a low-Z target, initiating a hadron cascade. Decay of neutral pions generate GeV photons that produce pairs in the high-Z target.

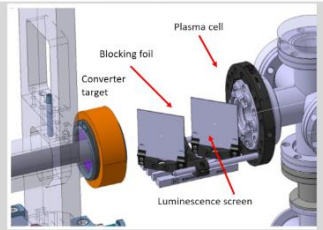


Installation completed

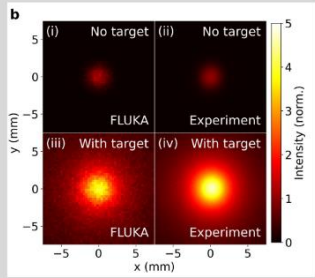
Remote operations from CERN Control Center (CCC)

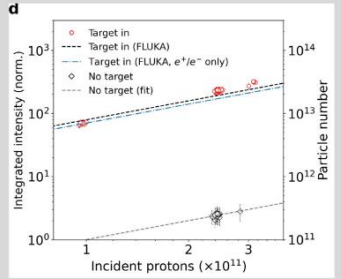
Oxford Physics

Preliminary results: evidence of high-yield pair plasma (as predicted from simulations)



- Luminescence screens show significant increase in electron/positron signal compared to proton beam only.
- Energy deposition for different species is accounted for.
- **Estimated pair number is >10^{13}** (in agreement with FLUKA simulations).





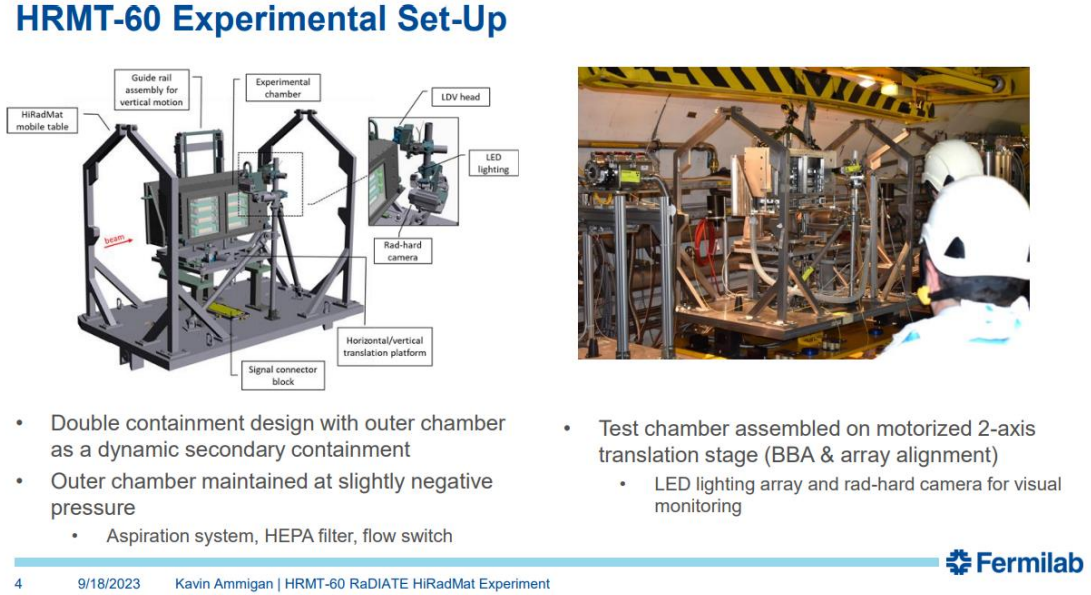
A unique experiment for laboratory astrophysics, for first time at HiRadMat

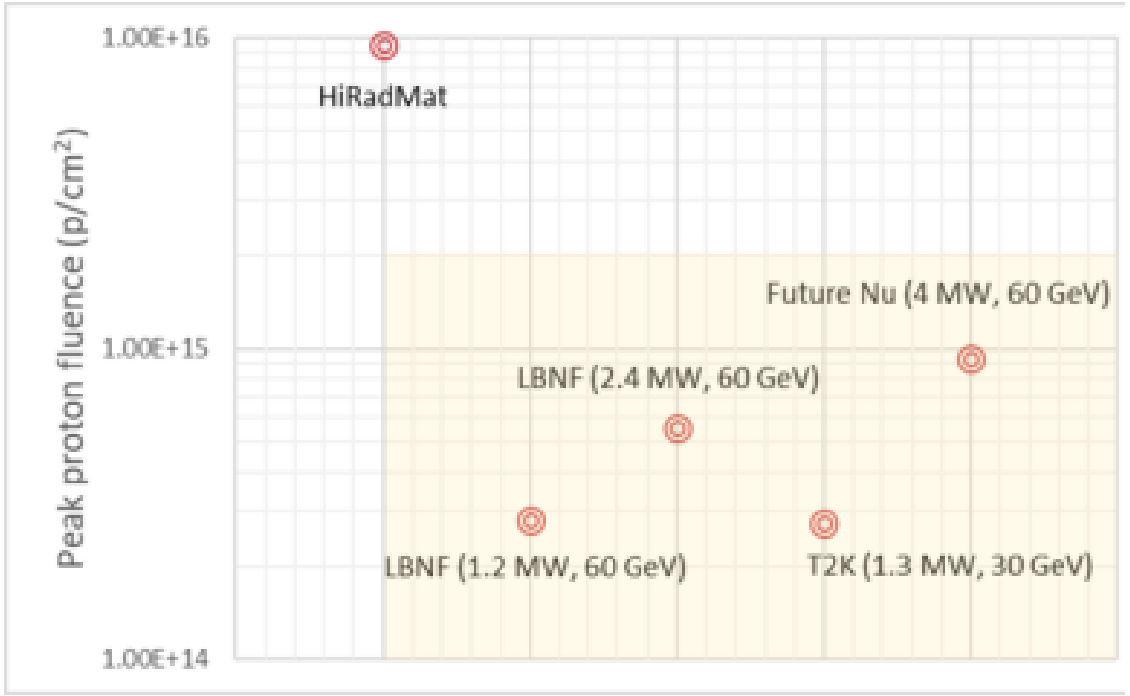
EURO-LABS is acknowledged in all publications and talks in APS physics conferences !

https://meetings.aps.org/Meeting/DPP23/Session/PP11.95 and more publications to follow.

Highlights – HRMT-60

Courtesy: K. Ammigan (Fermilab)





- A critical experiment for understanding thermal shock behaviour of beam intercepting devices
- Challenge: compare behavior of non-irradiated to pre-irradiated materials
- **EURO-LABS acknowledged to every talk / presentation given and was very important for the experiment's success.**

- Follow-on to HRMT-24 (2015) and HRMT-43 (2018)

RaDIATE Collaboration
Radiation Damage In Accelerator Target Environments
https://radiate.fnal.gov

Fermilab · KEK · Pacific Northwest National Laboratory · UKRI Science and Technology Facilities Council · Materials Research Facility · CERN · College of Engineering, University of Wisconsin-Madison · Brookhaven National Laboratory

Highlights – HRMT-55

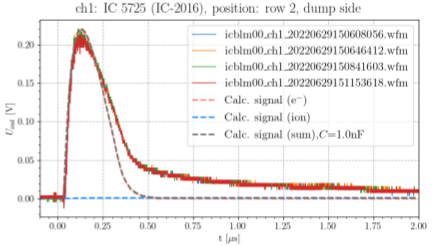
Courtesy: S. Grishin (ESS)

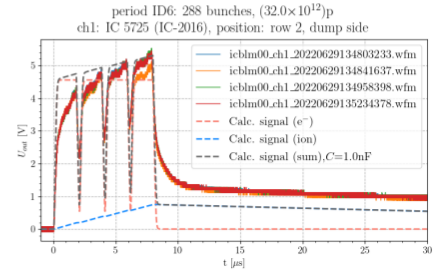
- **Development of novel BLMs, for LHC (CERN) and ESS. Project to continue expanding its scope in 2024**

IC results 2022: signal

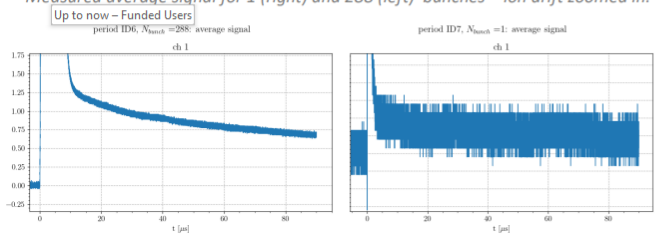
- Signal shape rather different than what is expected for a parallel plate geometry, assuming $^{+}N_2$ and e^{-} drift:
  - –Less linear for ion drift part
  - –Increased contribution from ions

Measured and calculated (dashed lines) signal for 1 (top) and 288 (bottom) bunches assuming e^{-} and $+N_2$ drift times from literature:



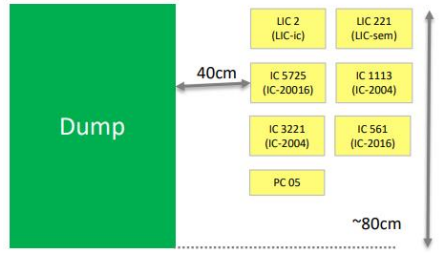


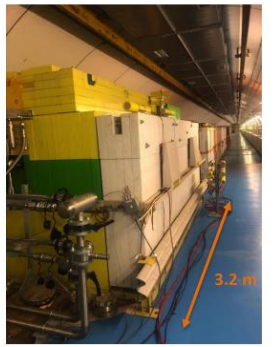
Measured average signal for 1 (right) and 288 (left) bunches – ion drift zoomed in:



Experimental setup at HiRadMat

- Detectors connected from the area of HiRadMat side of dump to the HiRadMat Control Room in BA7.
- Due to low detector current
  - Detector signal cables connected through only one patch panel
  - Signal connection not grounded.
- DAQ:
  - Signal waveforms acquired with a scope (Tektronix, MSO 5), ~3-6 waveforms per pulse/bunch
- Detector locations:





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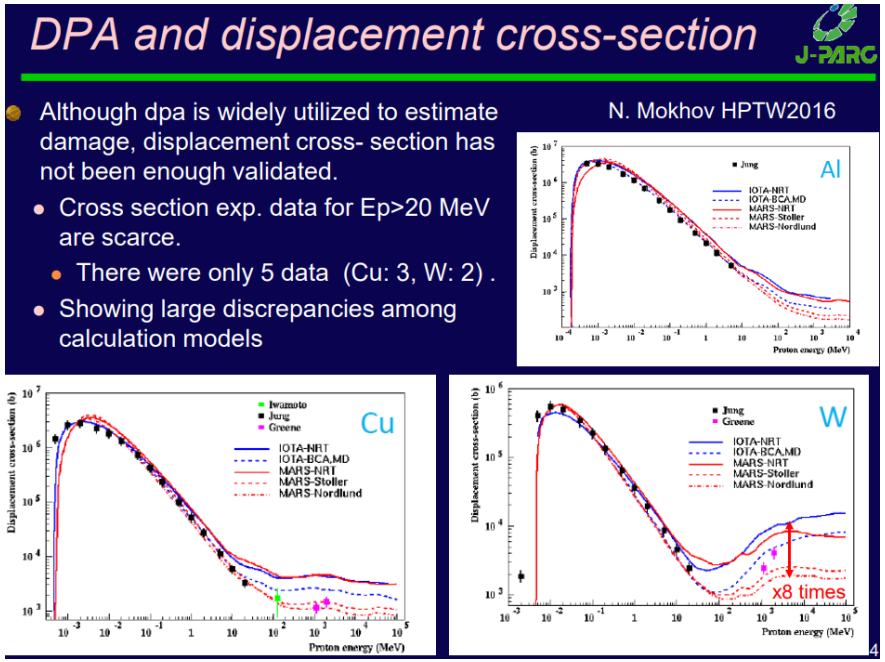
Highlights – HRMT-63

Courtesy: S. Meigo (JPARC)

- **Preparatory meetings for a JPARC related experiment to measure DPAs on superconducting wires.**
- **Quite complicated experiment, preparations have started and a broader collaboration between CERN-JPARC has "sprung-out"**
- **Partial support from EURO-LABS very helpful**



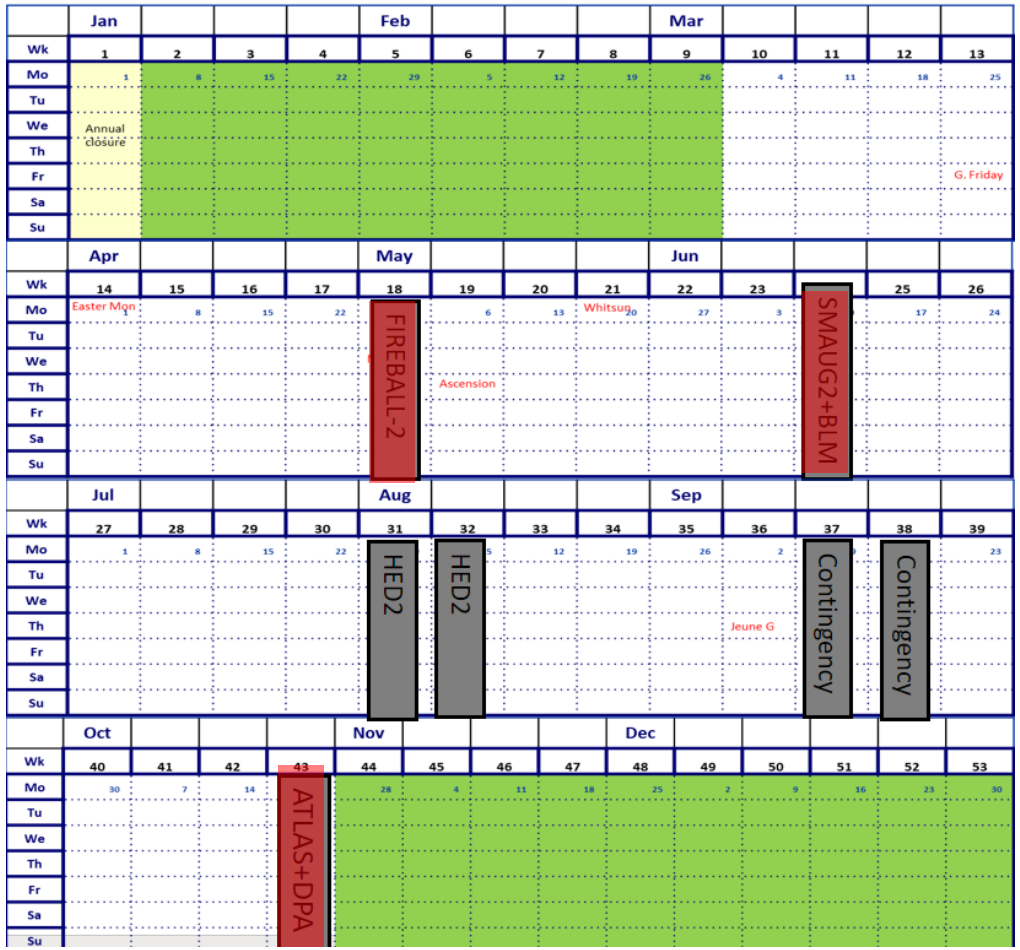
HiRadMat Service Improvements

- **Doctoral student: optimization machine learning algorithms to improve beam delivery at HiRadMat**
  - **Machine learning based calibration procedures and data processing for the SPS BPMs (ALPS system), that will improve beam stability for HiRadMat and LHC-type beams in the SPS.**
  - **Better understanding of the beam conditions for the HiRadMat beam**

- **Beginning of DOCT contract: April 2024 (estimated)**

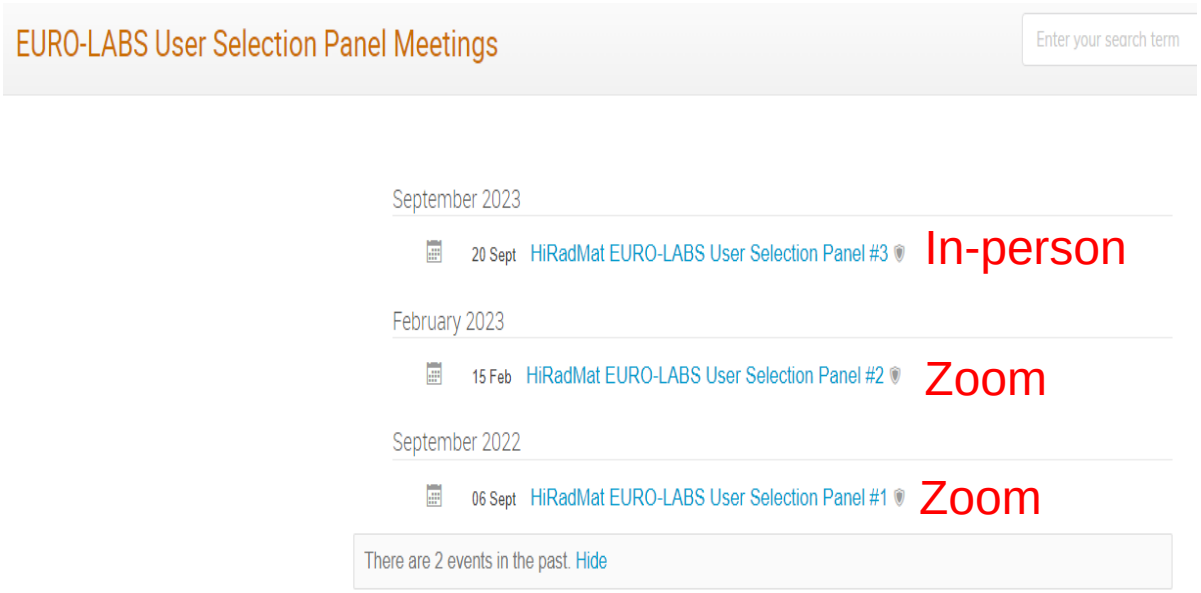
- **Preliminary results estimated by the end of 2024**

Plans for 2024



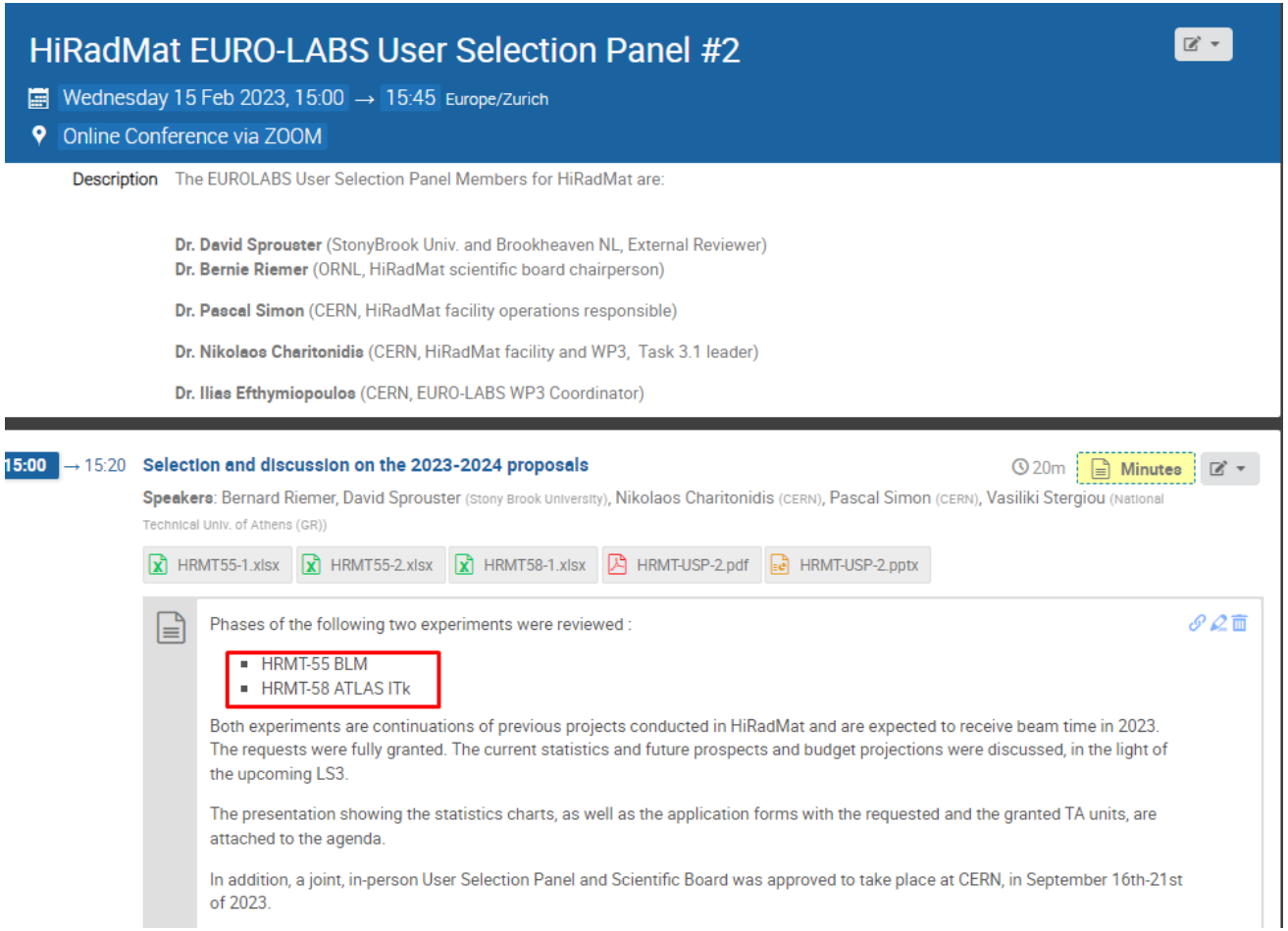
- **2024: A tight year for HiRadMat with CERN critical experiments & external users**
- **FIREBALL-II, SMAUG-2 & BLM and ATLAS-DPA expected to request TNA support**
- **Schedule for the moment not frozen.**

Events, User Selection Panels, User Days

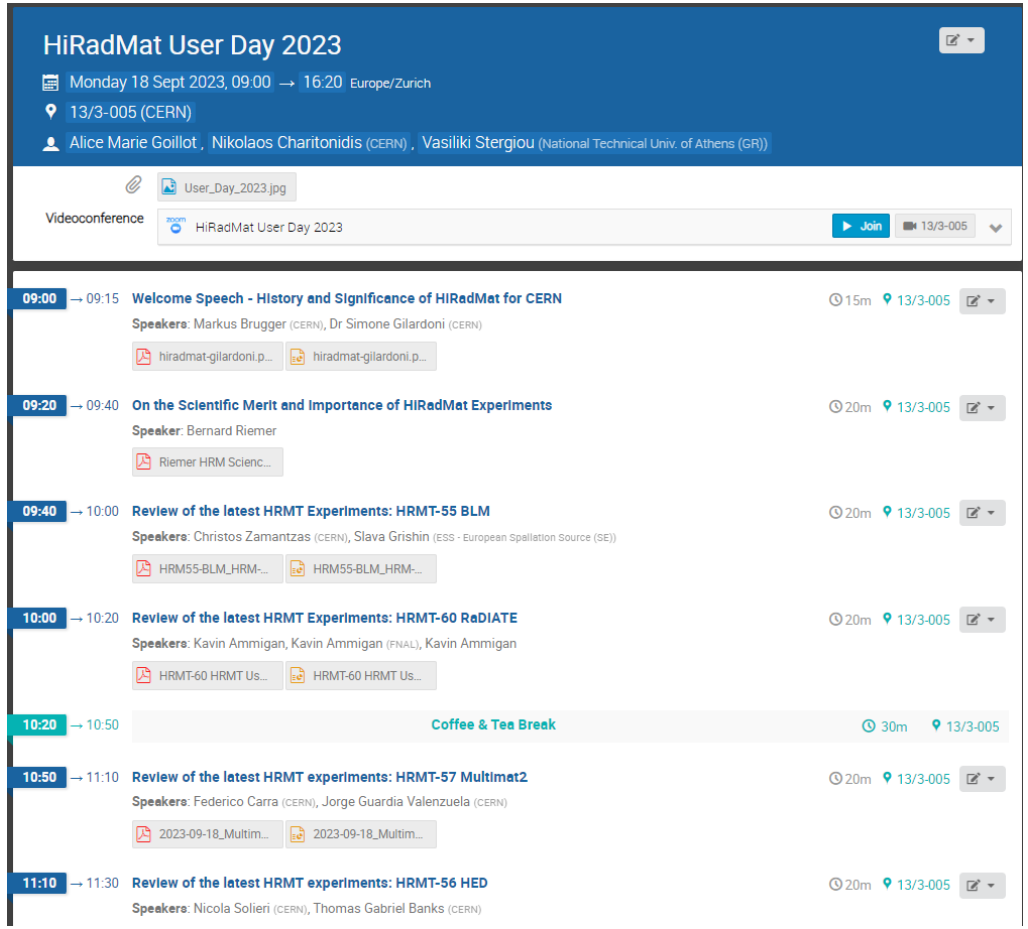


https://indico.cern.ch/category/15888/
(access restricted to the WP leader & USP members)

Next USP being planned for ~15.02.2024



Events, User Selection Panels, User Days



HiRadMat User Day 2023

Monday 18 Sept 2023, 09:00 → 16:20 Europe/Zurich

13/3-005 (CERN)

Alice Marie Goillot, Nikolaos Charitonidis (CERN), Vasiliki Stergiou (National Technical Univ. of Athens (GR))

User_Day_2023.jpg

Videoconference: HiRadMat User Day 2023 — Join — 13/3-005

09:00 → 09:15	Welcome Speech - History and Significance of HIRadMat for CERN	Speakers: Markus Brugger (CERN), Dr Simone Gilardoni (CERN)	15m	13/3-005
09:20 → 09:40	On the Scientific Merit and Importance of HiRadMat Experiments	Speaker: Bernard Riemer	20m	13/3-005
09:40 → 10:00	Review of the latest HRMT Experiments: HRMT-55 BLM	Speakers: Christos Zamantzas (CERN), Slava Grishin (ESS - European Spallation Source (SE))	20m	13/3-005
10:00 → 10:20	Review of the latest HRMT Experiments: HRMT-60 RaDIATE	Speakers: Kavin Ammigan, Kavin Ammigan (FNAL), Kavin Ammigan	20m	13/3-005
10:20 → 10:50	Coffee & Tea Break		30m	13/3-005
10:50 → 11:10	Review of the latest HRMT experiments: HRMT-57 Multimat2	Speakers: Federico Carra (CERN), Jorge Guardia Valenzuela (CERN)	20m	13/3-005
11:10 → 11:30	Review of the latest HRMT experiments: HRMT-56 HED	Speakers: Nicola Solieri (CERN), Thomas Gabriel Banks (CERN)	20m	13/3-005

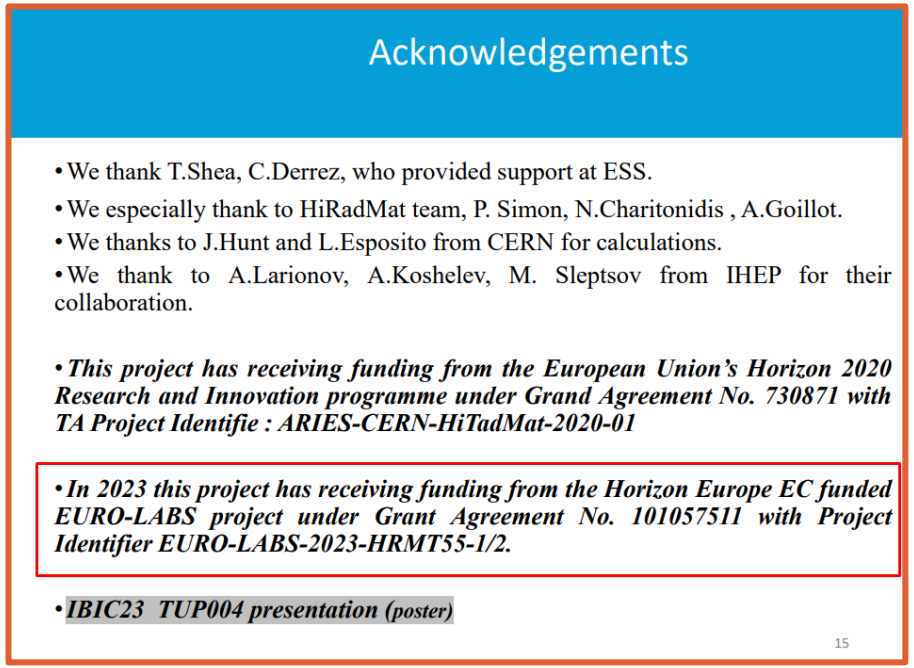
https://indico.cern.ch/event/1302657/

Many thanks to the EURO-LABS TNA support, HiRadMat team, RP team, radioactive shipping/receiving group, transport and support personnel at CERN

This project has received funding from the European Union's Horizon Europe Research and Innovation programme under Grant Agreement No 101057511 (EURO-LABS)

Fermilab

17 10/4/2023 Kavin Ammigan | HRMT-60 RaDIATE HiRadMat Experiment



Acknowledgements

- We thank T.Shea, C.Derrez, who provided support at ESS.
- We especially thank to HiRadMat team, P. Simon, N.Charitonidis , A.Goillot.
- We thanks to J.Hunt and L.Esposito from CERN for calculations.
- We thank to A.Larionov, A.Koshelev, M. Sleptsov from IHEP for their collaboration.

- ***This project has receiving funding from the European Union's Horizon 2020 Research and Innovation programme under Grand Agreement No. 730871 with TA Project Identifie : ARIES-CERN-HiTadMat-2020-01***

- ***In 2023 this project has receiving funding from the Horizon Europe EC funded EURO-LABS project under Grant Agreement No. 101057511 with Project Identifier EURO-LABS-2023-HRMT55-1/2.***

- ***IBIC23 TUP004 presentation (poster)***

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A big thank you to EURO-LABS for greatly supporting the operation of HiRadMat !

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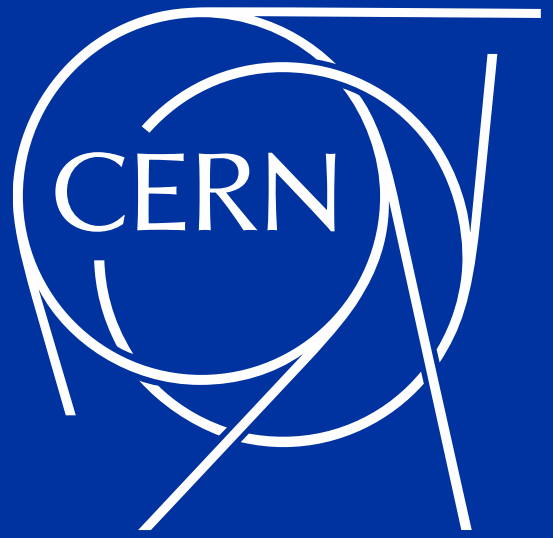
CERN