

Run 2024:

Feedback From
Fixed Target Experiments

+

Desiderata for 2025

D. Lazic

With lots of help from

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PS215 - CLOUD

(Cosmics Leaving OUtdoor Droplets)

A Study of the Link between Cosmic Rays and Clouds with a Cloud Chamber



CLOUD inputs for Joint Accelerator Performance Workshop 2024

<https://indico.cern.ch/event/1439972>

Antti Onnela, CERN EP-DT, CLOUD EXSO and Resource coordinator



CLOUD

- CLOUD Facility at PS T11:
 - In 2024 final re-construction tasks, triggered by PS East Area Renovation, were fully completed.
- Two successful runs in 2024:
 - Technical run in May and physics run in September - December.
 - Quality and availability of beam, PS T11 3.5 GeV pions, matching CLOUD needs.
- CLOUD operations planned for 2025:
 - Equipment repairs (thermal system), modifications (gas system) and commissioning through Q1-Q2.
 - Physics run in September - December.
 - Similar beam quality and availability requested as in 2024.
- Other use of PS T11:
 - 2024: 3 weeks of P349 experiment test run in August.
 - 2025: P371 (former P349) requesting 8 weeks beam-time for summer 2025.
 - CLOUD can liberate the requested space on the main platform, which needs to be cleared back for CLOUD use within August.
 - Schedule and safety aspects (hydrogen target?) to be addressed.

ISOLDE

Isotope Separator On Line DEvice

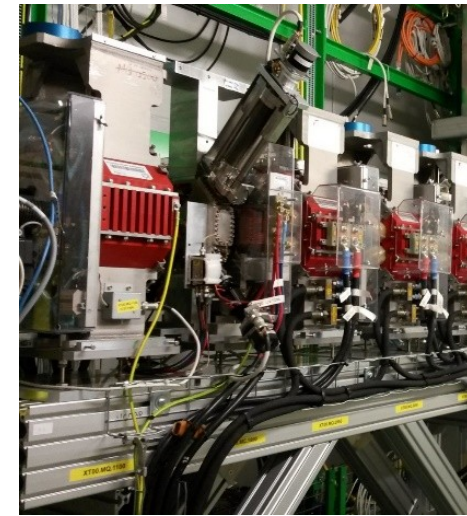
Feedback from ISOLDE users

2024 & 2025

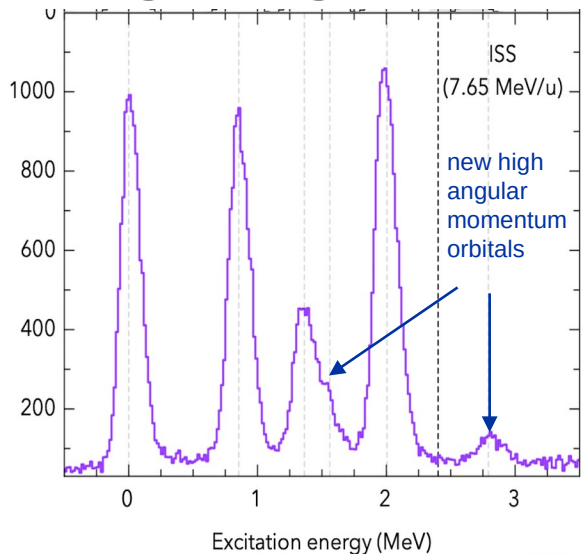
- Despite several issues encountered (see slides D. Gamba), many experiments achieved their physics goals. Thanks to the technical teams for their efforts and expertise resolving the issues quickly.
- Preferred baseline for LS3 for ISOLDE: stop operations end 2025, proceed with beam dump upgrade and other improvements of Isolde Improvement Plan (IIP). Restart as early as possible in 2028.
2025 is last year of physics before LS3

Priorities of ISOLDE users are captured in Isolde Improvement Plan (IIP)

- Increasing capacity and capability of facility while maintaining a reliable operation of an aging facility
 - ISOLDE Beam Dumps Replacement and Sustainability, BTY line upgrade for 2 GeV delivery, beam switching of central beam line, RILIS lab upgrade, ISCOOL cooler buncher, ...
- Bringing the post-accelerator back to design specifications as the current, degraded, situation is limiting the physics which can be done
 - Requires improvements on superconducting (HIE-ISOLDE) and normal conducting (REX) linac
 - Refurbishment of Cryomodule1 in 2026 is a must! Will be requested in 2025 MTP.

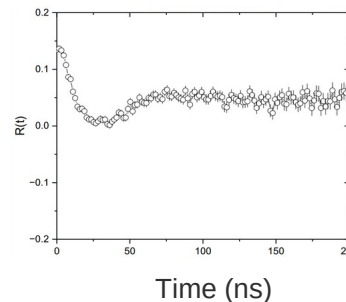
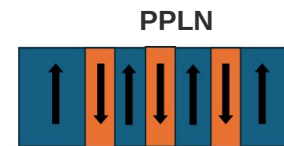


Highlights 2024

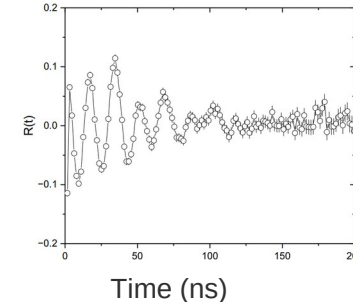
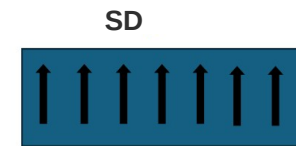


IS671 – ^{34}Mg @MIRACLs

- First collinear laser spectroscopy measurements of exotic isotopes in a MR-ToF device. This device allows to repeatedly probe the same ions during the >1000 revolutions and hence significantly increase sensitivity
- Used **1.7 GeV** protons to increase yields (2024 1st year with 1.7 GeV production runs)



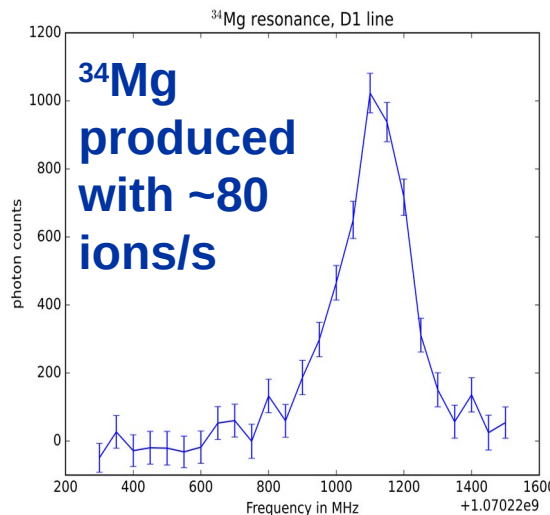
^{111}mCd probe in the domain walls



^{111}mCd probe in regular Li-sites

IS742 - $^{132}\text{Sn}(d,p)^{133}\text{Sn}$ @ISS

- The $^{132}\text{Sn}(d,p)^{133}\text{Sn}$ reaction has driven the science cases of many radioactive ion beam facilities worldwide, but **HIE-ISOLDE is unique** in having a ^{132}Sn beam with the intensity and energy, coupled to a high-resolution instrument like ISS, needed for a comprehensive study.
- The experiment obtained for first time all high angular momentum single-particle states outside double-magic ^{132}Sn .

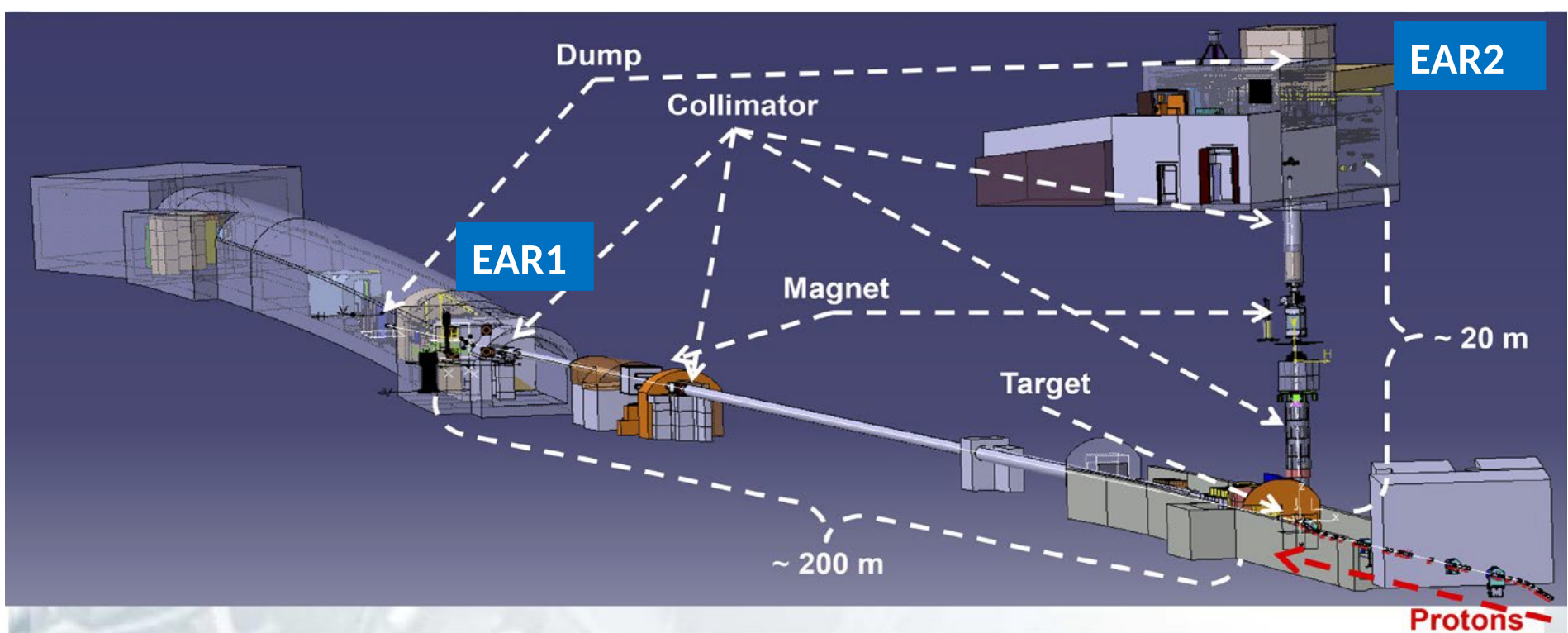


IS760 - Lithium Niobate Domain Walls

- Single domain poled (SD) and periodically poled lithium niobate (PPLN) samples were investigated using ^{111}mCd and the PAC technique.
- Significant improvement in terms of understanding the local scale phenomena important for **applications in photovoltaic and nanoelectronic devices.**

n-TOF

Neutron Time Of Flight



Three experimental areas (EAR)

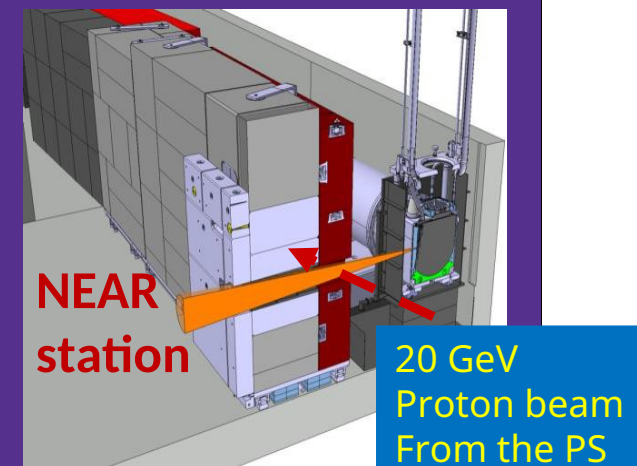
Horizontal flight path: EAR1 at 200 m

Vertical flight-path: EAR2 at 20 m

NEAR at 3m: activation/irradiation

(distances from the spallation target)

Excellent neutron energy resolution
 High instantaneous neutron flux
 Wide neutron energy range
 (from meV to GeV)



≈150 Researchers – 40 Institutions – 20 PhD students/year

THE EXCELLENT 2024 DATA TAKING CAMPAIGN
245 days of physics – 3.2E19 PoT
13 experiments performed (on 17 isotopes)
9 (n,γ), neutron capture
1 (n,f), induced fission
2 (n,lcp), light charged particles in the exit channel
1 (n,n'γ), inelastic scattering
Several detector developments

Significant increase of proton beam intensity

Expected protons/day

1.00E17 - beginning of the year

1.08E17 - May, after IEFC approval

Up to 1.70E17 - after PS increase in bunch intensity

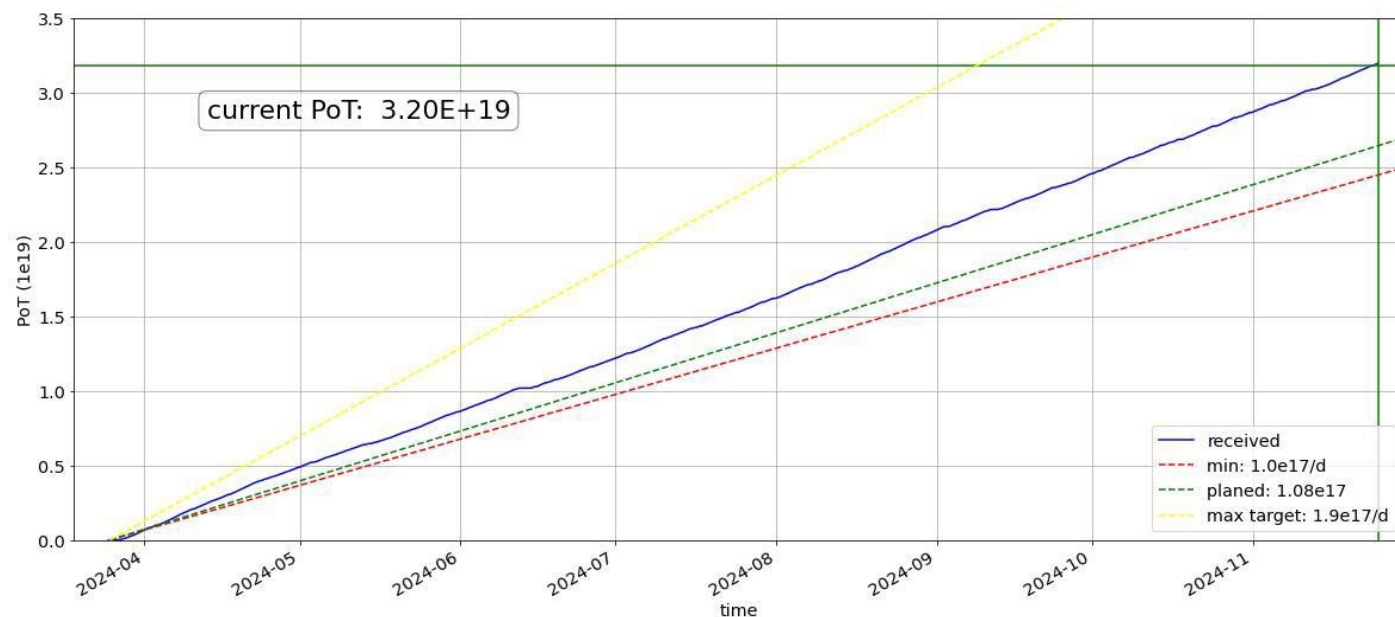
Dedicated from 800 to 900E10 ppp

Parasitic from 350 to 800E10 ppp

1.30E17 p/day received on average along 2024 run → +30% !!

If no surprises are found during Radioprotection survey of the transfer tunnel n-TOF would like to continue to work in 2025 with high-intensity bunches, just like at the end of 2024.

Another possibility that will be explored is to have two extractions to n-TOF in a single PSB cycle.



NA61 SHINE

Study of Hadron Production
in
Hadron-Nucleus and Nucleus-Nucleus Collisions

NA61/SHINE – Beam periods

- ▶ Beams
 - ▶ Summer
 - ▶ Physics with hadron beams – 3.07-30.07 (227.5M events)
 - ▶ Autumn
 - ▶ Calibration with hadron beams – 16.10-21.10
 - ▶ Physics with hadron beams – 21.10-1.11 (60M events)
 - ▶ Physics Pb@150 beam – 4.11-25.11 (245M events)
 - ▶ Physics with fragmented Pb beam – 25.11-1.12 (44M events)
- ▶ Good detector performance with very stable operation. No major issues by the side of NA61/SHINE.

NA61/SHINE – Beam delivery feedback

- ▶ During summer run: beam position was moving when users at other beamlines were changing beam of their properties. The same problem as previous year. We hope to have it improved in cooperation with BE-EA.
- ▶ Autumn runs
 - ▶ Pb@150 beam: beam very unstable in terms of intensity and spill structure, eventually solved with help of Nikos.
 - ▶ Frequent LHC fillings interrupting our data taking. It would be great to announce their starts and endings earlier, so we could plan better our time when beam is not delivered.
 - ▶ Pb fragments: we discovered that the 50 Hz from electrical network modulates the beam delivery and killing our data taking efficiency. Problem eventually solved.
 - ▶ Last weekend of data taking (29-30.11) – extremely stable beam in terms of intensity and delivery.
- ▶ Thank you for your service and help in case of problems!

NA62 - Kaon Factory

Measurements of Decay

$K^+ \rightarrow \pi^+ \nu \bar{\nu}$

NA62: Data Taking

RUN 2024 successful

	SoB (total)	Good spills recorded kaon (+dump and low intensity)	PoT (kaon)	PoT (dump)	PoT (total)
2024*	942×10^3	$566(+70) \times 10^3$	1.29×10^{18}	0.23×10^{18}	1.52×10^{18}
2023	655×10^3	$398(+50) \times 10^3$	1.17×10^{18}	0.27×10^{18}	1.44×10^{18}

- Kaon run as baseline, 15 days of dump run, 7 days of very low intensity run
- Stable run at the optimal intensity for the experiment
- Good quality of extraction: thanks to the operators for the continuous effort to maintain the spill quality
- All the detectors worked smoothly
- >90% DAQ efficiency

RUN 2025 requests

- Same conditions as in 2024

*Preliminary

NA62: 2024 Physics Highlights

2016-2022 Combined

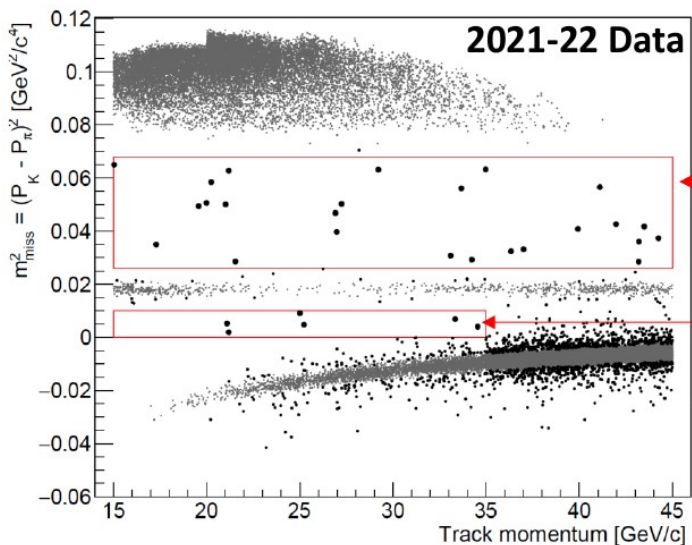
Effective number K^+ decays	$\sim 6 \times 10^{12}$
Single Event Sensitivity	$(0.42 \pm 0.02) \times 10^{-11}$
Expected SM signal	20 ± 1
Expected background	18^{+3}_{-2}
Observed candidates	51

First “5 σ ” observation of the $K^+ \rightarrow \pi^+ \nu \bar{\nu}$ decay

- New analysis: NA62 data 2021-2022
Signal yield up by 50% wrt 2016-18 analysis
Expected SM signal over background ~ 1
- Combination with result from 2016-17-18 data

b-only hyp. rejection significance: $Z = 5\sigma$

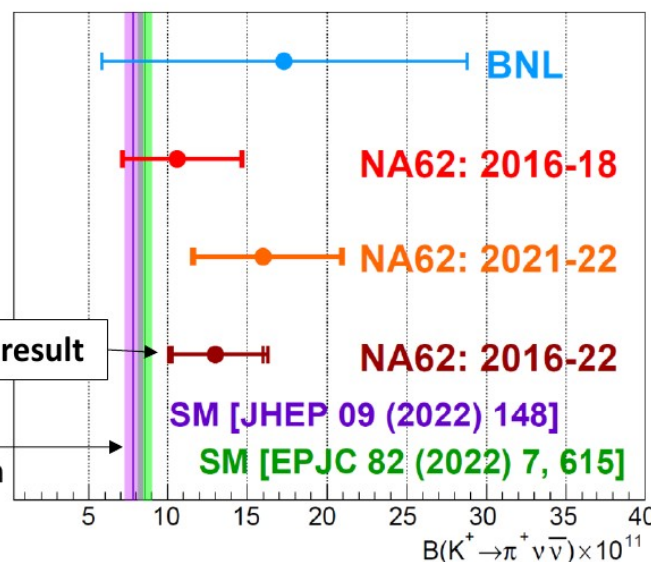
Measured branching ratio $\mathcal{B}_{\pi\nu\bar{\nu}} = \left[13.0^{(+3.0)}_{(-2.7)} \right]_{stat} \left(-1.2 \right)_{syst} \times 10^{-11}$



Signal regions

Combined result

SM prediction



Rarest meson decay ever observed at 5σ

CERN and national agencies press releases; result appeared on several media

More than $\times 2$ statistics expected from 2023+24 data

NA64

Search for dark sectors in missing energy events



NA64 status and plan for 2025

Status of NA64 run on H4 beam line SPS.

Electron beam, H4 PPE144, 24 April – 19 June 2024, 100 GeV e-.

100 GeV electrons spills $\sim 1.2 \times 10^5$; $E\sigma T \sim 5.2 \times 10^{11}$

70 GeV positrons spills $\sim 6.7 \times 10^3$; $E\sigma T \sim 2.3 \times 10^{10}$

We took data in electron beam with intensity $6-6.5 \times 10^6$ per spill with preshower in trigger and sandwich SRD (Synchrotron Radiation Detector).

The new LYSO SRD was installed and included in trigger during positron data taking, also preshower was excluded from trigger.

Two important issues were done:

1. Successful test of new fast ADCs, 250 MHz, 14 bits, Genova WB;
2. High intensity test up to 1.3×10^7 with 100 units on T2;

Beam request for 2025 --> 10 weeks on H4 from April 14, included 7-10 days for positrons and hadron.

We are plan to work with new fast 250 MHz ADC, developed in Genova group, and $1.0-1.2 \times 10^7$ intensity of 100 GeV electrons and record around 10^{12} electrons on target.

Two important modifications of PPE 144 zone are plan for winter shutdown:

- PPE144 bridge shielding modification;
- Installation of moveable platform for hadron calorimeters.



NA64 status and plan for 2025

Status of NA64 run on M2 beam line SPS.

Muon beam, M2 PPE211, 17 July – 4 September 2024, 160 GeV μ^\pm .

160 GeV muons spills $\sim 7.2 \times 10^4$; MoT $\sim 2.5 \times 10^{11}$

160 GeV muons, empty target spills $\sim 1.7 \times 10^4$; MoT $\sim 5.2 \times 10^{10}$

Main problem during run was the cooling of second magnet (we are waiting the dedicated magnetic field measurements of the magnet for the analysis).

No beam request for 2025

Beam request for 2025 -> 2 weeks on T9 October-November

Main goal: measurement of the beam parameters, response of electromagnetic and hadron calorimeters, precision of momentum reconstruction with MM and Straw tracking detectors.

Requirements from PS team:

- *particle ID*
- *small magnet*
- *moveable tables for electromagnetic and hadron calorimeters*

Measurements should be done for few energy up to 15 GeV for negative and positive beam.

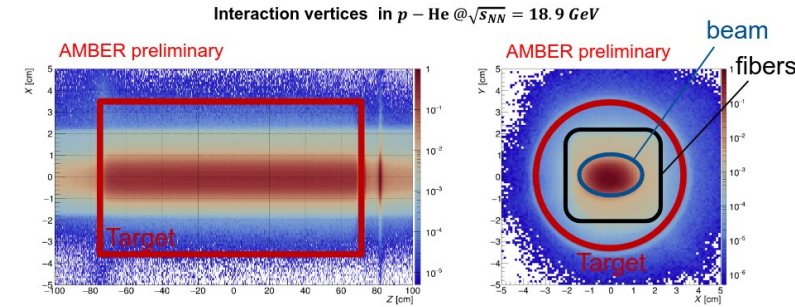
NA66 - AMBER

Apparatus for Meson and Baryon Experimental Research

User Feedback

Measurement of p-H and p-D collisions (APX) in 2024:

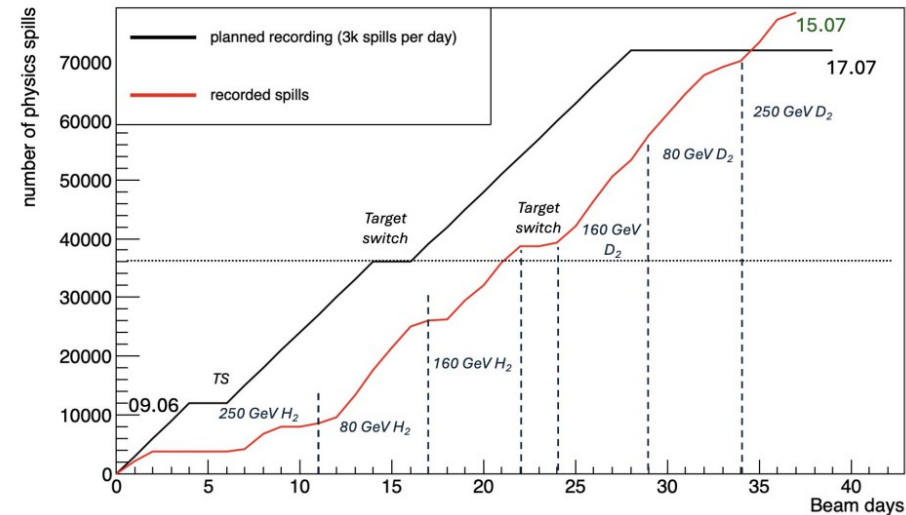
- Comparison of collision data from p-H₂ and p-D₂ to extract difference in antiproton production in proton/neutron induced flipped reactions: $p + p \rightarrow p + X$ and $p + n \rightarrow p + X$.
- Successful measurement at 3 different collision energies to study collision-energy dependence of isospin effect (80, 160, 250 GeV/c).
- We are thankful for the strong support and flexibility of the accelerator and beam groups, which helped to compensate for the safety-related delays in the construction and approval of the new cryogenic LH/LD target.



Test of beam PID for high intensity Drell-Yan (DY) in 2024

- Intensive measurement campaign to characterize CEDAR behavior in
- high intensity hadron beams (3E8 / spill)
- Issues with CEDARs during commissioning of APX and DY test which were hard to diagnose and to recover (diaphragm misalignment and gas contamination)
- → Several days of beam lost → Procedure to commission CEDARs should be established to avoid these problems in the future.
- Pressure control of CEDARs not sufficient to keep set point stable for physics.

AMBER antiproton-measurement data-taking



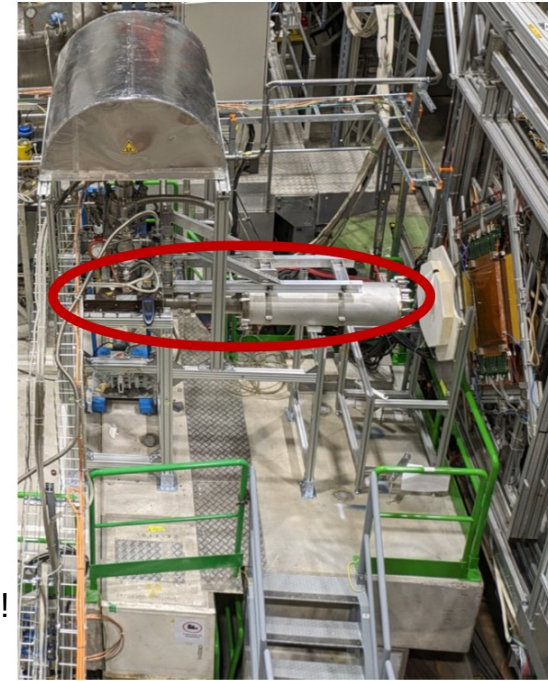
Test of Proton Radius (PRM) setup components in 2024:

- Test of new PRM detector components (Fibers, GEMs) for free running DAQ in different beam configurations.

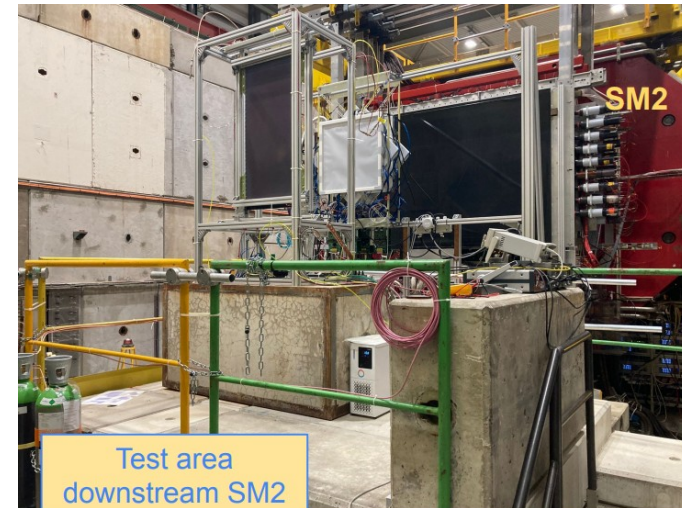
User Feedback

Upcoming in the future for AMBER:

- Dedicated Proton radius test measurement with 100GeV/c Muon beam on the new 20bar hydrogen time projection chamber starting in July 2025!
- → Final PRM data taking in 2026 (full year of beam will be requested)
- → Requires stable beam intensity and beam position at M2!
- Parasitic test of new free running DAQ system at the beginning of 2025.
- Parasitic test of new large micro megas system in the beam (2025/2026).
- More depending request on beam and beam PID coming with high intensity DY run after LS3!



New AMBER cryogenic LH/LD target



Test beams:

There were more than 90 test beam requests in 2024, asking for all kinds of beams (different particle types, energies, beam sizes and intensities)!

Common theme in their reports were:

- Very much appreciated help with installation, power, gas, cooling, movable supports, instrumentation etc etc...
- Very much appreciated the availability and competence of beam line physicists who tuned the beams to the best possible performance in the given conditions!

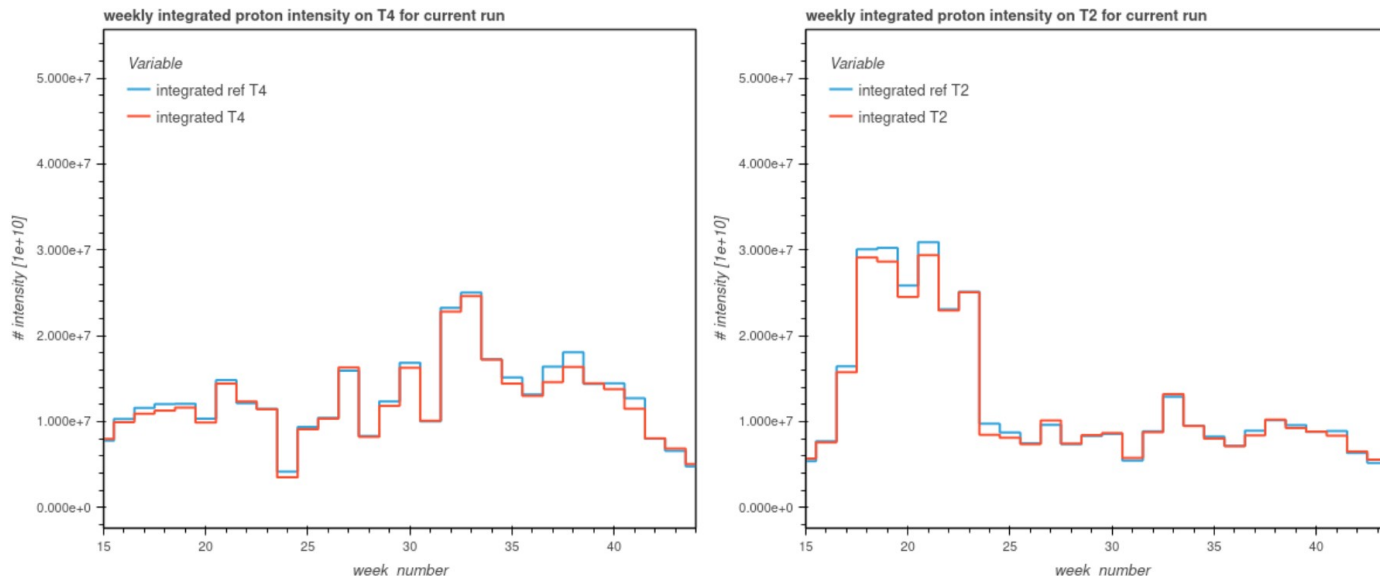
Key Performance Indicator for test beams is the beam availability, not always possible with aging accelerators!

Work(s) in progress:

Key Performance Indicators collected and some of them already available in Beam Performance Tracking pages, more to come.

Mechanisms for better feedback from the experiments about the status of their KPI during the run being worked on.

Information on SPS Page 1 very much improved! Planning is easier when you know what to expect.



More in Pablo Arutia's talk in Session 3.

Summary:

In majority of cases the message from the experiments is “so far so good, just give us more good stuff”!

There are usual issues in the areas where there are upgrades either pending or under way - being addressed as quickly as possible!

The most important point of concern - aging of the facilities and the installed equipment. Natural process that we should continue to mitigate by continuous efforts on proper maintenance and timely consolidation!

Comments? Questions?