JYFL Accelerator News

Acclerator Laboratory,
Department of Physics, University of Jyväskylä,
Finland

In this newsletter:

You are reading the 32nd volume of the JYFL Accelerator News which has gone through a revision. The previous editor in chief Pauli Heikkinen has retired and the editorial responsibility now rests on our shoulders. An overview of the career of Pauli Heikkinen is given in this issue.

We, the new editors, are staff scientists in the Accelerator Laboratory and we both started our physics studies in the University of Jyväskylä in the year 2000. We have been involved in Accelerator Laboratory projects for 20 years. Jan Sarén works in Nuclear spectroscopy and IGISOL research groups and Taneli Kalvas is responsible for the workshops and accelerator technology as well as many safety and infrastructure related duties.

For a long time the Accelerator News was a printed leaflet mailed to recipients all over the world. More recently the publication has taken electronic form. As new editors we decided to continue with the typeset format which draws attention when you find a printed copy on a coffee table.

This JYFL Accelerator News is written for our fantastic community including the local personnel, students, scientific and commercial visitors around the world and all other people interested in our laboratory. This newsletter will portray snapshots of the important events also in the future.

— Taneli Kalvas and Jan Sarén

JYFL Accelerator Laboratory: https://www.jyu.fi/en/science/accelerator-laboratory

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50 years of accelerators at JYFL

JYFL has housed accelerators already for half a century! The very first accelerator, MC-20, arrived in JYFL 50 years ago. In the local newspaper photo below, associate professor Jorma Hattula and docent Esko Liukkonen are receiving the last parts for the "particle accelerator apparatus".

Today we have two cyclotrons, the K130 and the MCC30, and a linear 1.7 MV tandem accelerator for production of high energy ions. Additionally, there is a cLINAC for production of 15 MeV photons and 20 MeV electrons.

Perjantaina 21. 12. 1973

Jyväskylän yliopiston fysikanlaitokselle saatiin perjantaina viimeiset hiukkaskiihdytinlaitteistoon kuuluvat osat. Vieläsaavat kuitenkin apulaisprofessori Jorma Hattula (vas.) ja dosentti Esko Liukkonen työskennellä kovasti ennenkuin 23 tonnin magneetti on oikealla paikalla ja koko laitteisto toimintakunnossa.

Fysiikanlaitos sai hiukkaskiihdyttimen

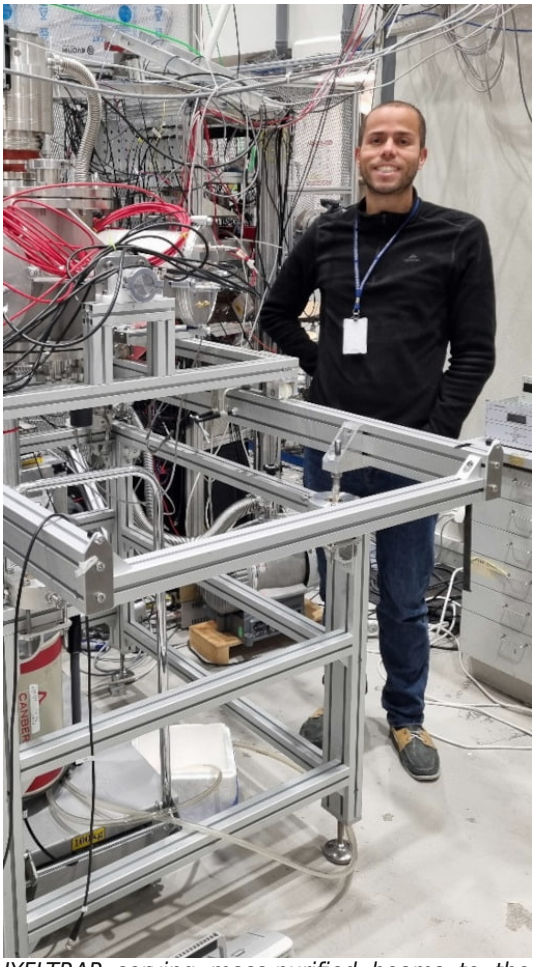
(Keski-Suomalainen, 21st of December, 1973)

Penning trap-assisted beta decay studies supporting neutrino physics

Iain Moore, IGISOL

In an ongoing collaboration between Nantes-Valencia-Surrey and Jyväskylä, JYFLTRAP has been used to purify selected fission fragment beams produced at the IGISOL facility for precision measurements of the shape of beta-particle spectra. The interest in such measurements stems from how well we understand the measured antineutrino spectrum from reactors which has attracted considerable attention in recent years in relation to neutrino oscillation experiments. Measurements of the most relevant decays using the pure beams from IGISOL after JYFLTRAP and the total absorption technique (TAGS) have contributed to dramatically improving the summation method for calculating the spectrum [1-3]. Those results have provided complementary evidence that questions the mere existence of the reactor neutrino anomaly [2].

In 2022 and 2023, new experiments were performed, both with the TAGS technique as well as with a new DE-E setup to measure the shape of the beta transitions relevant to the reactor antineutrino spectrum. The latest experiment with the beta spectrometer, performed in December 2023, was a resounding success. Both IGISOL and JYFLTRAP performed like well-oiled machines, delivering around 14 cases of interest, with 1 TB of data collected. This was enough data to satisfy future generations of researchers. Spokesperson Alejandro Algora of Valencia was quoted as saying, “this is simply the best facility to do our experiments!”.



JYFLTRAP serving mass-purified beams to the beta spectrometer of the Nantes-Valencia-Surry-Jyväskylä collaboration. Gustavo proudly overseeing the installation.

[1] M. Fallot et al., Phys. Rev. Lett. 109, 202504 (2012)
[2] M. Estienne et al., Phys. Rev. Lett. 123, 022502 (2019)
[3] A. Algora et al., Review Article in Eur. Phys. J. A 57, 85 (2021)

MORA : A steady progression towards our fundamental objectives

Pierre Delahaye (MORA spkesperson) and Luis Miguel Motilla

The Matter Origin from RadioActivity (MORA) experiment is looking for a sign of CP violation in the beta decay of laser polarized and trapped ^{23}Mg and ^{39}Ca ions. CP violation is one of the ingredients that is missing to explain the matter – antimatter imbalance in the Universe (Fig.1), that could manifest itself as an asymmetry in the angular distribution that MORA is measuring.

MORA has been installed in the IGISOL hall in 2 steps, the injection beam line in November 2021 and the trap in January 2022, after a shipping incident (see Fig. 2 and 3). Then the commissioning was done during a few on-line periods. A very nice efficiency for the trapping of ions of 10 % could be obtained. A laser power of >100 mW was also achieved, while essentially 50mW would suffice for the polarization. The main challenge that MORA is presently facing is the ^{23}Na contamination from the IGISOL gas cell, which floods the IGISOL cooler buncher and therefore limits the number of $^{23}Mg^{+}$ ion trapped by MORA. Since 2023, we have been fighting over orders of magnitude: until recently the ratio ^{23}Na:^{23}Mg was of the order of 1000:1. Recent progresses have been made thanks to chemistry. Reactive gases are injected in the gas cell, either to produce carrier molecules such as MgF^{+}, shifting Mg away by 19 mass units from the Na “troublemaker”, or to suppress the formation of atomic ions of Na^{+}. The trap efficiency has attained record values of 30 % with fixing some long-standing issues with the deceleration and capture of ions in the trap. Impressive trapping times over 1 min have been achieved. The combination of these results increased the number of Mg trapped by more than an order of magnitude. The remaining two orders of magnitude to reach the objectives of MORA will be tackled one after the other.

The installation of MORA in the IGISOL hall.

MORA benefits from a solid collaboration, gathering GANIL and LPC both at Caen, France which developed the apparatus, and the ACCLAB at Jyväskylä which hosts the experiment. Experts from KUL (Belgium) and IJCLab (France) are joining for their expertise in laser manipulation and in Effective Field Theory respectively. IGISOL provides MORA with a unique environment for starting this ambitious experimental program in the best manner, with a very welcoming team (see Fig. 5). After 2027, MORA should continue its experimental campaign at GANIL-SPIRAL 2.

High school students performing experiments at the JYFL ACCLAB

Annika Sairanen and Janne Pakarinen

High-school teams and their tutors in front of K130. (photo Annika Sairanen)

On the 12th of January, high school students from Jyväskylä Lyseo, Lahti Lyseo and Keminmaa high school experienced how research is conducted at the JYFL Accelerator Laboratory. “Kiihdytin hiukkasen”-contest provides students an opportunity to learn scientific practises and to get their hands-on with state-of-the-art instruments. Each group had prepared a research plan from a topic of their own interest and implemented the proposed experiment. During the long, yet efficient day, students showed great enthusiasm towards research.

Research topics spanned from fundamental to applied physics. Lahden Lyseo studied the decay properties of platinum-172 nucleus. The nuclei of interest were produced using beam from the K130 cyclotron and fusion products were identified at the MARA-separator. Group from Jyväskylä Lyseo simulated radiation in space employing the electron C-linac aiming to understand how that could affect the function of photoactive bacteria. After radiation, long term effects will be examined by growing a new bacterium from radiated and non-radiated samples. Keminmaa high school team examined skiing waxes, in particular assessing if their fluoride compound concentrations were as claimed, at Pelletron.

Groups will analyse their data in February and present them in a press conference at the Department of Physics on the 8th of March. “Kiihdytin hiukkasen”-contest is extremely educational, and students have a unique opportunity to became a researcher for a day in a world-class research environment.

Taneli kalvas explaining the working principle of the K130 cyclotron.

Pauli Heikkinen retired

Rauno Julin

Pauli started his academic career at JYFL in 1982 as an assistant, then continued as a researcher from 1985, senior assistant from 1987, senior research scientist from 1991 and finally as chief engineer from 2004, in which position he took over the technical directorship of JYFL-ACCLAB from Esko Liukkonen.

Pauli's interest in accelerators was awakened already at school when his teacher told about JYFL's first MC20 cyclotron project. His career as an expert of magnetic fields and ion optics began in 80’s as the designer of the superconducting magnet of a spectrometer devised by Juhani Kantele. Immediately after this he joined Esko Liukkonen's group to calculate the magnetic fields of the superconducting cyclotron ment to be built for the future JYFL-ACCLAB.

In 1984-85, at AFI in Stockholm, Pauli designed the ‘35-meter’ version of the CRYRING storage ring, which was the topic of his high-quality licentiate's thesis, which, almost as such, was approved as his doctoral thesis in 1987. Today, CRYRING forms a part of the in-kind contribution of Sweden in the FAIR project.

Pauli played an important role in the design work of the K130 cyclotron of JYFL-ACCLAB built by Scanditronix AB. Instead of an expensive model magnet, Pauli employed his semi-3D method in designing the magnetic field structures of the K130. Based on Scanditronix's plans, Pauli also designed the K130 extraction elements. With energy consumption in mind, Pauli's wish of a iron yoke larger than Scanditronix originally designed, was realised. This has borne fruit today during the high price of electricity. Combined with the powerful ECR ion sources, the K130 cyclotron has proven to be a reliable heavy-ion accelerator, providing 6000 hours of beam time annually since 1996.

Pauli's responsibilities also include ion optics calculations and equipment design of the JYFL-ACCLAB beam lines and the RITU separator at JYFL-ACCLAB. He also continued projects with Scanditronix AB, which include e.g. a PET cyclotron magnet design.

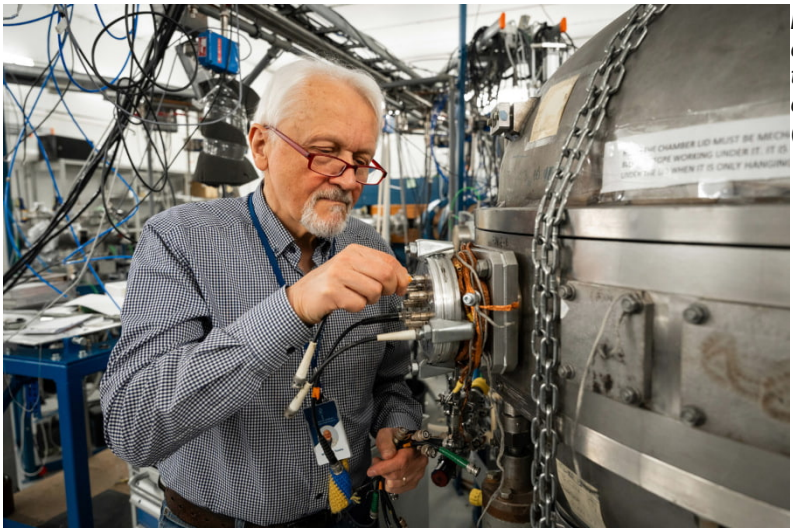
Pauli has trained young accelerator experts and operators by teaching various accelerator physics courses at JYFL since 1986, teaching accelerator physics in the CERN accelerator school and many summer schools. He lectured JYFL's basic course in electromagnetism for ten years.

Pauli was a member of the Organising Committee of the International Conference on Cyclotrons and Their Applications since 2004.

In retirement, Pauli continues his ‘extreme’ hobbies with skiing, climbing, kayaking and geocaching.

Emeritus Wladek Trzaska

Rauno Julin



Emeritus Wladek Trzaska connecting a signal cable to the large scattering chamber.
(photo: Timo Sassi)

In 2023, Wladek reached retirement age and became the new ACCLAB Emeritus. Wladek joined the JYFL group of Juhani Kantele in 1980, shortly after graduating from Warsaw University. His passion has been developing new instruments and methods for nuclear, particle, and astroparticle physics. In addition to significant contributions to the JYFL electron spectroscopy, HENDES, IGISOL, RITU, and applied physics groups, Wladek designed and built electron spectrometers at Argonne National Lab and Texas A&M University. The former solved the 17 keV neutrino puzzle, while the latter helped disprove the erroneous electron-positron peaks reported by GSI groups.

From 1992, in the new JYFL-ACCLAB, he was responsible for data acquisition systems and became the leader of the nuclear reaction program. For three decades, he has been the liaison in all experiments conducted at HENDES and the large scattering chamber.

In November 1997, Wladek joined the ALICE Collaboration at CERN. He became the project leader of T0 - the fast timing and trigger detector he helped design. In 2006, Wladek became the scientific advisor of the Center for Underground Studies in Pyhäsalmi. At that time, the European neutrino physicists envisioned a giant new-generation neutrino observatory there. However, the 2013 European Strategy for Particle Physics pushed the community to the USA-based DUNE and the Chinese-based JUNO experiment. Wladek contributes to both projects. In 2013, he developed the new Fast Interaction Trigger (FIT), which will serve ALICE till the end of the LHC Run 4 in 2032. Wladek is also the chair of the Warsaw PAC (since 2018), represents all forward detectors in the ALICE management board (since 2019), continues leading the FIT project, and is the spokesperson for the NEMESIS dark matter experiment. With over 850 co-authored papers and an H-index of 98, Wladek is #1 in the University of Jyväskylä ranking.

New faces at the LAB

My research includes different projects related to the enhancement of detection and response in different nuclear-security incidents and other events. Right now, I am testing and evaluating different methods to measure and analyze air filters containing radioactive particles.
— Philson-Amanda "Viltsu" Aden

I started in June 2023 in the Nuclear Spectroscopy group. I am interested in spectroscopy of neutron deficient At, Fr, and Ac nuclei. Quite often you can find me at the focal planes of MARA and RITU or building MARA-LEB setup upstairs.
— Henna Kokkonen

I am a PhD student working on a novel neutron detector for real-time beam monitoring during BNCT treatments.
— Jaana Tiainen

I am a visiting doctoral student from the University of Liverpool and interested in superheavy element research.
— Jamie Chadderton

I'm a PhD student in the Pelletron group, currently working on a permanent-magnet based negative helium ion source with microwave-driven plasma production.
The project is motivated by the demands of modern technology and materials research. High-intensity ion beams are essential in implanter facilities and nanolithography, and also by several characterization methods (RBS, PIXE) to reveal the elemental and structural composition of the sample.
— Rebecca Nagy

I am Zhuang Ge, a "newcomer" to the IGISOL group. I started as an Academy Research Fellow position. My project will employ diverse methods such as Penning trap, MR-TOF, storage ring, and Bro-TOF mass spectrometry for high-precision mass measurements of exotic N=Z nuclei up to ^{100}Sn and the vicinity, to tackle long-standing problems in nuclear structure and nuclear astrophysics.
— Zhuang Ge

News

The JUROGAM 3 array back in full operation

In August 2023, the Clover detectors came back to their homebase at JYFL after the second NUBALL campaign in Orsay, France. Meanwhile, the Nuclear Spectroscopy group performed in-beam experiments with 15 Phase1 detectors in the backward angles to measure lifetimes of excited states with the recently commissioned APPA plunger device. The break was also exploited to complete the renaissance of the automatic liquid nitrogen filling system now based on programmable logic controllers.

Forthcoming international conferences at JYFL

European Cyclotron Progress Meeting, ECPM2024, is hosted by University of Jyväskylä on May 27-29, 2024. The meeting is devoted to the physics and technology of cyclotrons, their applications in science, medicine and industry, and to related topics. Status reports on existing facilities as well as innovative developments and progress reports on evolving projects are welcome. The meeting is organized in person at the Physics Department premises. The abstract submission is open until 31 March 2024.

More information on website at https://www.jyu.fi/en/events/ecpm2024

Jyväskylä will be hosting the upcoming PLATAN-2024 meeting, June 9th to 14th, 2024. This conference series follows the merger between the Poznan meeting on Lasers and Trapping Devices in Atomic Nuclei Research and the International Conference on Laser Probing. As in previous conferences, PLATAN-2024 will serves as a forum for exchange between experimental and theoretical researchers in research areas including high-precision mass spectrometry, precision laser spectroscopy, trace analysis, cooling and trapping techniques, tests of fundamental interactions and symmetries using lasers and traps. Registration is now open, closing 1st May.

More information on website at https://indico.cern.ch/event/1345837/overview