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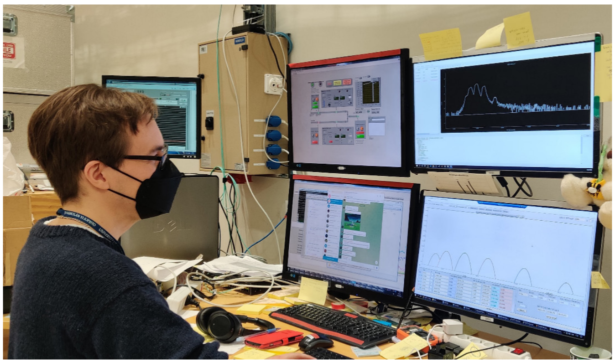
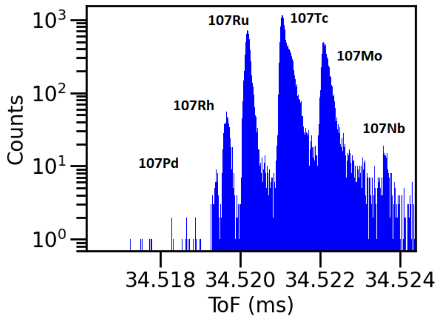
JYFL Accelerator News

– Accelerator Laboratory, Department of Physics University of Jyväskylä, Finland –

Multi-Reflection Time-of-Flight Mass Separator at IGISOL: first on-line mass separation of exotic ions



PhD student Ville Virtanen obtaining the first on-line mass spectrum with MR-TOF.



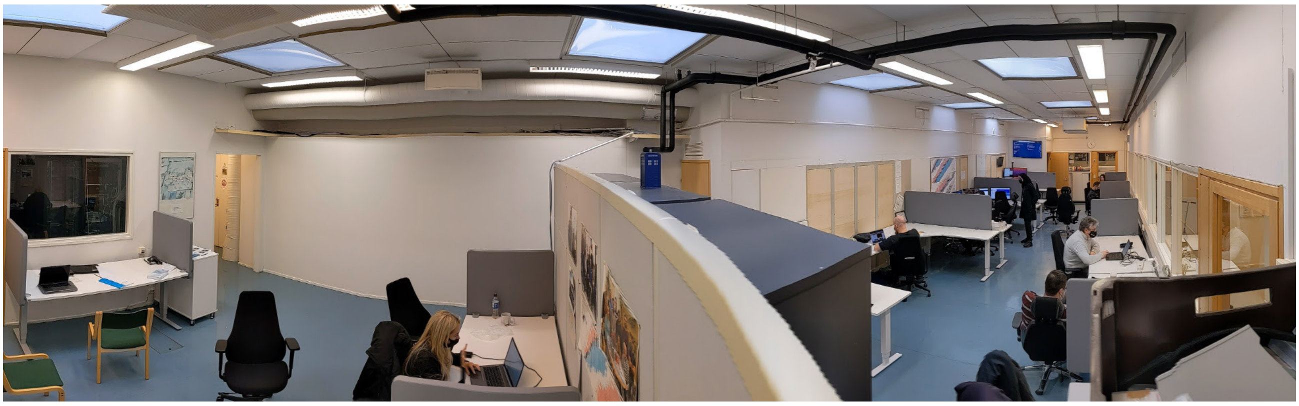
The separation of isobars at mass A=107.

The very first mass separation of on-line produced exotic ions was achieved with the multi-reflection time-of-flight (MR-TOF) mass separator at IGISOL in early February 2022. The ions were produced in proton-induced fission reactions and mass number A=107 was chosen as one of the isobaric chains to be measured. With the achieved mass resolving power of 1.7×10^5, the fission-produced isobars could be readily separated and identified by their mass (see Figure). The kinetic energy of the ion beam was increased to 2 keV to allow efficient injection into MR-TOF and subsequent transfer further, for example to the JYFLTRAP Penning trap spectrometer.

MR-TOF is now ready to be used as a mass filter or spectrometer. Mass measurements will be extended to nuclei beyond the sensitivity of JYFLTRAP. Especially mass measurements of neutron-rich fission fragments along the astrophysical r-process path are of high priority.

NEWS

Something old, something new, something borrowed and something blue



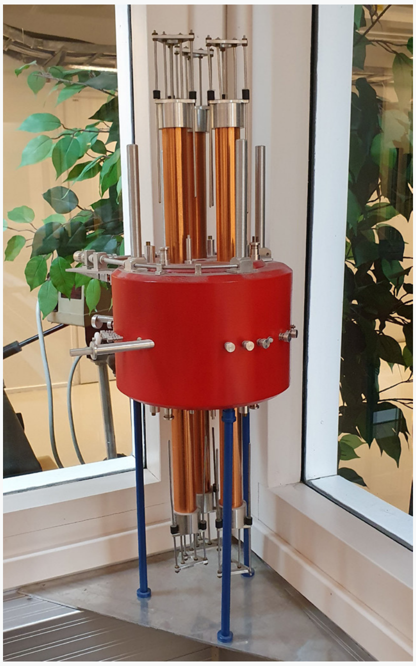
The good old JYFL measurement room awaits post-pandemic visitors eagerly. Since the long promised complete renovation of the Ylistö campus has been again postponed further into the future, a minor refurbishment has occured. Second hand furniture from the University Digi-services has been combined with few brand new pieces to create a cozy atmosphere for 24/7 experimenting. All humans in the photo are on loan from collaborating institutes. Floor is still blue.

30 years of accelerated particles from the K130 cyclotron - How did it all begin?

The K130 cyclotron with Arto Lassila and Jani Hyvönen (2002)

On Friday, January 28th, at 14:20, it was exactly 30 years since the first particle beam from the K130 cyclotron was extracted. The first particle beam was He^{+} at an energy of 6 MeV/u. The intensity was 120 nA which was increased to 300 nA by 16:00. Since the experimental hall was still under construction, no nuclear physics experiments were done. Ar^{10+} was the first heavy ion beam extracted in May 14th, 1992. The first nuclear physics experiments in the new target hall with the RITU gas filled separator, in the spring 1993, led to the discovery of two new isotopes ^{207}Ac and ^{208}Ac.

A lot of things had happened before the first operation of the K130 cyclotron. The MC20-cyclotron made by Scanditronix AB, Uppsala, Sweden, had served the Department of Physics since the mid-70´s. In the early 80´s, an idea of getting a K800 superconducting cyclotron was initiated with a detailed plan and cost analysis. The final report/proposal was submitted to the Ministry of Education in March 1984. It was successful until the very last phase of the Ministry budget handling when it was turned down, mainly due to cost and the need of new permanent positions for technical staff. Very soon, a new plan was initiated. Instead of a technically demanding superconducting technology, we chose a normal conducting cyclotron with a smaller beam energy. As a result, a proposal to get a "MC106" cyclotron was written and published in March, 1986. This proposal was successful, and the approval text by the Ministry of Education included a chapter where a new laboratory building was mentioned. During the tendering process the K-value (specific maximum energy) of the cyclotron was increased to 130 MeV.



Miniature model of the K800 superconducting cyclotron

The contract to get the K130 cyclotron was signed with SCX (Scanditronix). It included also major local effort, mainly the magnet design together with the Scanditronix staff. The method to calculate the cyclotron magnetic field was developed with one SCX cyclotron and tested with a bigger existing SCX cyclotron. The result was accurate enough, and the design of the K130 magnet could begin.

The contract with SCX included just the cyclotron and its power supplies. The vacuum pumps, ion sources, injection line, central region of the cyclotron, the beamlines from the cyclotron to experimental stations and the control system belonged to JYFL's responsibility.

The cyclotron project was successfully led by Esko Liukkonen. Pauli Heikkinen was responsible for the magnet design including the geometrical design of extraction elements, and ion optical design of the beam lines together with Teuvo Poikolainen who was also responsible for the vacuum system. Matti Rinta-Nikkola designed the central region with the help of his own developed computer codes. Juha Ärje, Hannu Koivisto and Matti Nurmia were initially responsible for the ion source development. Jukka Lampinen and Arto Lassila took care of the control system implementation and development. The installation (and maintenance) work would not have been possible without the total engagement of both mechanical and electric workshops, led by Alpo Lyhty and Väinö Hänninen, respectively.

Since the first extracted beam, the cyclotron has been used more than 178'000 hours until February 15, 2022. The annual use stabilized to around 6000 hours/year in 1996, the maximum being 7629 hours in 2006 and the average since 1996 being 6430 hours/year. This would not have been possible without student operators who mainly operate the cyclotron during nights and weekends. More than 100 students have been trained during the years. They typically work 2 – 4 years as uphold operators, depending on the phase of their studies. Many thanks to them all!

In addition to extensive scientific work with the cyclotron beams, industrial applications, originally led by Ari Virtanen, have been a vital part of our activity. In the first phase, medical radioisotopes were produced with MAP Medical Technologies. Jaana Kumpulainen was the key person in this collaboration. Later, after Teuvo Poikolainen, she worked as the Radiation Safety Officer of JYFL, having worked also for MAP for many years. Today, radiation effects testing for space electronics and micro filter production (irradiation) are the main industrial/commercial applications.

Second call for RADMEP studies resulted in 124 applications

The second application round for students in the Erasmus Mundus Joint Master Degree (EMJMD) programme, RADiation and its effects on MicroElectronics and Photonics technologies (RADMEP) was due in February 8th 2022. The total number of applications this time was 124 from 32 different countries. The evaluation is ongoing.

The call for applications for RADMEP MSc studies for 2023-2025 will open later in the fall of 2022. More information on the programme, and the exact application dates can be found at

https://master-radmep.org/

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NEWS

RADNEXT - RADiation facility Network for the EXploration of effects for indusTry and research

RADNEXT is an H2020 INFRAIA-02-2020 infrastructure project with the objective of creating a network of facilities and related irradiation methodology for responding to the emerging needs of electronics component and system irradiation; as well as combining different irradiation and simulation techniques for optimizing the radiation hardness assurance for systems, focusing on the related risk assessment.

Detailed information on the project can be found at https://radnext.web.cern.ch/

Transnational Access

Transnational Access to irradiation facilities is the cornerstone of the RADNEXT project. More than 6000 beam time hours are awarded during the four years of the project, in more than 20 different facilities in Europe and beyond. One of which is the RADEF facility at the JYFL Accelerator Laboratory.

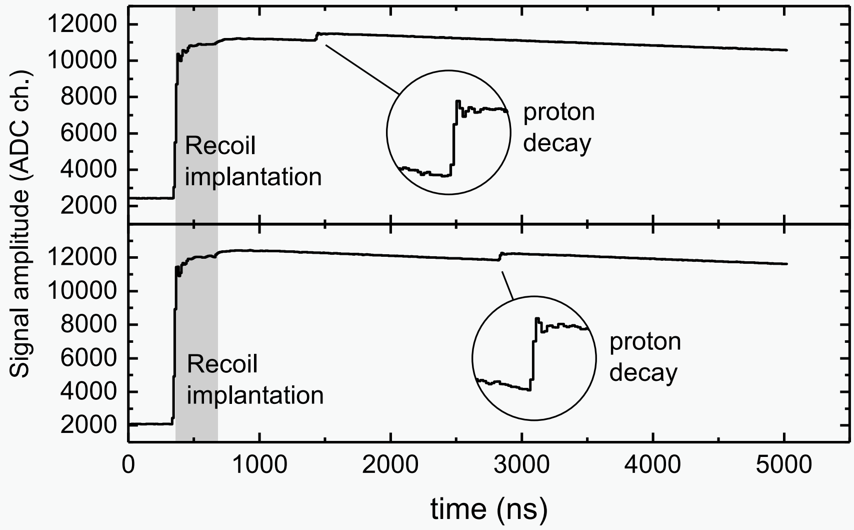
Both academic and industrial groups are eligible for beam time as potential RADNEXT users, and in particular small and medium-sized enterprises (SMEs) are strongly encouraged to submit their proposals. Beam time awarded for RADNEXT users is free of charge, funded by EU European Union's Horizon 2020 research and innovation programme under grant agreement No 101008126.

More information on the Transnational Access scheme and the quarterly call for proposals can be found at https://radnext.web.cern.ch/transnational-access/

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101008126

Strongly oblate ^{149}Lu radiates protons with record setting rate

Proton emission is a rare nuclear decay mode. A new atomic nucleus 149-Lutetium, consisting of 71 protons and 78 neutrons, has been synthesized in an experiment performed with the MARA separator. The new isotope was found among products of fusion of 58Ni beam particles and 96Ru target atoms at the focal-plane detector setup of MARA. 149Lu was observed to decay into 148Yb via spontaneous proton emission, and its decay properties were measured to be exceptional; It has the highest proton-decay energy of 1920(20) keV and the shortest directly measured half-life of 450(+170-100) ns of any ground-state proton emitter known to date. Observation of the swift decay was possible due to recorded traces, see the figure for a few examples. Furthermore, it was found via comparison to non-adiabatic quasiparticle calculations that it is the most oblate deformed ("pumpkin shaped") proton emitter. This is the first instance when the models of proton emission are tested against such a strong oblate deformation. These observations will help to develop the theory of proton emission as well as the atomic mass models for the most exotic isotopes. The results of this study have been accepted for publication in [Physical Review Letters.](#)



Two examples of a wave form recorded for the fast proton decay of ^{149}Lu.

NEWS

/ Next Call for Proposals Deadline: March 15, 2022

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