JYFL Accelerator News

Accelerator Laboratory, Department of Physics
University of Jyväskylä, Finland

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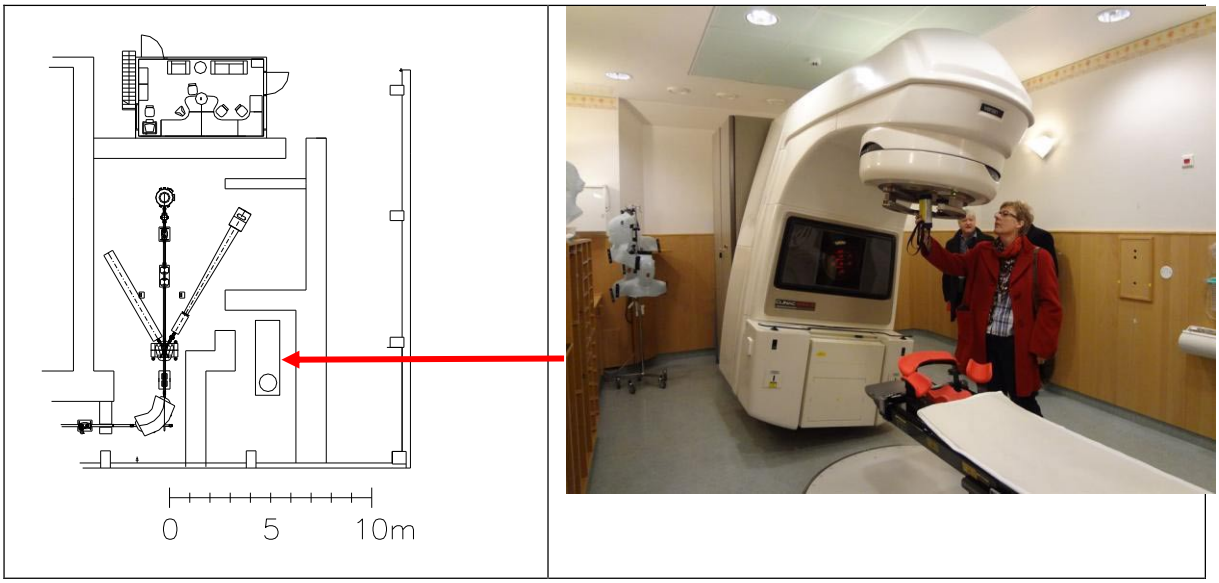
New accelerator to Jyväskylä, now for RADEF group



The construction of the new RADEF cave (left). Director of radiation safety, Jaana Kumpulainen, is checking a LINAC, similar to the machine we will have in Jyväskylä (right). Location of the accelerator in the cave is indicated with a red arrow.

The RADEF group got a chance to have an accelerator when Kuopio University Hospital replaced their 14 years old Varian Clinac 2100CD radiation therapy accelerator. The machine can provide very intense electron and x-ray beams up to 20 MeV and 15 MeV, respectively. The accelerator will have its own place inside the RADEF cave. It will be installed during the next cave construction work hopefully right after summer. The scheme of the future RADEF cave is shown in the figure.

The accelerator will be mainly used for irradiation studies of semiconductor materials and devices, but is also available for other applications. It nicely expands the selection of heavy ion and proton beams available at RADEF with electron and x-ray radiation. Among the future irradiation studies, we foresee the next large-scale satellite mission of ESA, JUICE = Jupiter Icy moon Explorer, which is aimed to be launched in 2022. The data measured in previous missions to the Jovian system indicate an extremely severe radiation environment, particularly in terms of electron fluxes and consequent bremsstrahlung dose.

IGISOL workshop in June 2013

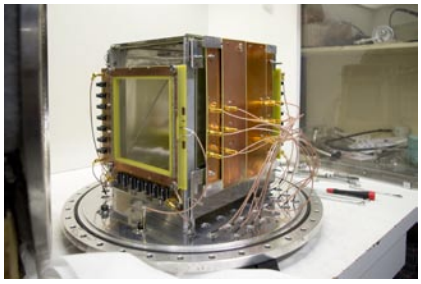
The 11th IGISOL Workshop (Conference on Stopping and Manipulation of Ions, SMI-13) will be organized in Jyväskylä 11-13 June 2013. The Workshop is the 11th in the series that started in Konnevesi, Finland, in 1986. Since then, the meetings have taken place in France, Belgium, Poland, Japan, Russia, Germany, USA, and the Netherlands.

The scope of these meetings has been in the development of the techniques related to the stopping of energetic ions in noble gases and the use of noble gases to manipulate ions and atoms. Since this work has mostly taken place in connection with research of exotic nuclei, reporting of related nuclear physics studies has been an important aspect of the workshops. The invited speakers cover the major gas catcher facilities and include Georg Bollen from FRIB (speaker not confirmed), Guy Savard from CARIBU at ANL, Michiharu Wada from RIKEN and Sivaji Purushothaman from GSI/FAIR. For the complete list of invited contributions, you are welcome to visit at the workshop home pages **https://www.jyu.fi/fysiikka/en/research/accelerator/igisol/igisolws**.

Other contributions to the workshop are welcome. The dead line for abstract submission is 19 April 2013 and for registration 17 May 2013. Both registering for the workshop and submission of abstracts are done through the workshop home pages.

There is a conference fee of 180 € (students 90 €). Travel support for eligible participants is available from the ENSAR transnational access program.

Discovery of a new asymmetry in ternary fission induced by polarized neutrons



Photograph of the detector system used during the 2012 run at ILL.

The experiments on fission induced by polarized neutrons conducted over the past years by the Darmstadt-Dubna-Gatchina-JYFL-Tübingen collaboration at the High Flux Reactor of the Institut Laue-Langevin have provided new, interesting results. The yields and angular distributions of ternary α-particles for the fissile isotopes ^{233}U, ^{235}U, ^{239}Pu and ^{241}Pu were scrutinized as a function of the polarization direction of the neutron-inducing fission. During the 2012 experiment on ^{241}Pu, in addition to ROT and TRI revealed already previously with the spin-flip technique, an unexpected and fascinating new result was obtained. A completely new and so far unexplored technique was employed. Instead of the conventional spin-flip method, where the spin of the neutrons is periodically switched by 180° e.g. from parallel to anti-parallel to the neutron beam, a spin-tilt method was introduced. Thereby the neutron polarization is tilted by 90° from parallel to perpendicular with respect to the beam direction. The spin-tilt method revealed a new asymmetry in the intensity of ternary particles. The size of this asymmetry is about 0.3% for the difference in yields when ternary particles are emitted either perpendicular or parallel to the polarization of the fissioning nucleus. We have named the new asymmetry CEF as we think that it might be connected to the additional CEntriFugal force for ejecting ternary particles in the rotational plane of the nucleus polarized perpendicular to the emission direction of ternary particles.

Developments to the Recoil-Beta Tagging technique

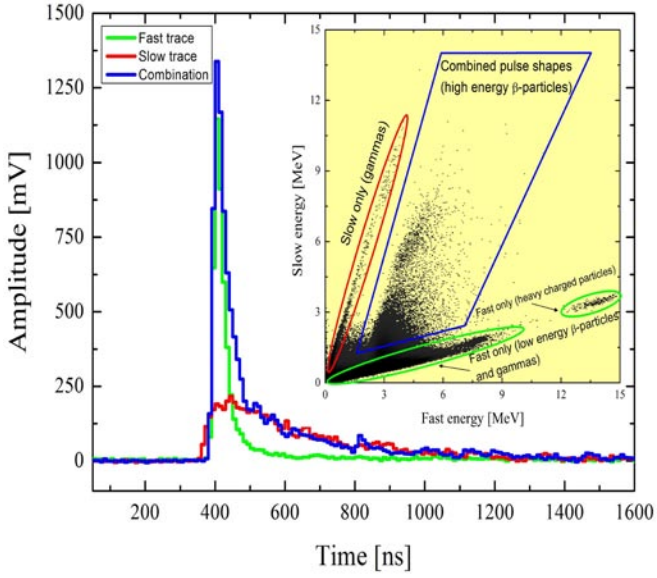


Figure 1. Pulse shapes ("traces") recorded from the phoswich scintillator with the Lyrtech ADCs. Fast signal corresponds to the interaction of a low energy beta-particle in the "fast" scintillation material. Combined pulse shape originates from a high energy beta-particle penetrating through the "fast" layer to the "slow" material. The inset illustrates a delta E - E matrix formed from the pulse shapes. This can be used to select relevant beta-particles to serve as a tag for prompt gamma-ray transitions detected at JUROGAM II.

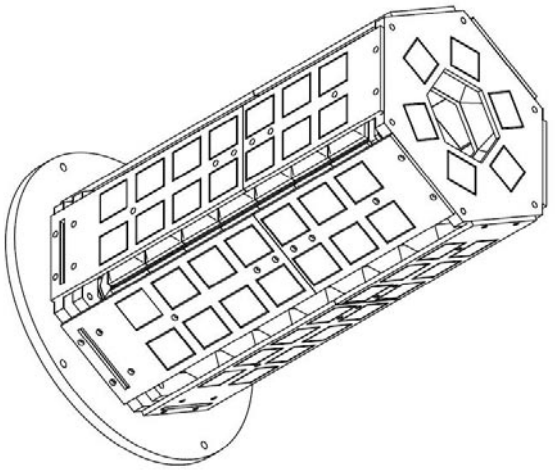


Figure 2. The redesign of the veto-detector increases the solid angle coverage but reduces the gaps between CsI crystals which hampered the geometrical detection efficiency in the previous design. By introducing the end-caps, the opening angles at the ends of the tube are also reduced. These modifications take the solid angle detector coverage to 82%. This is further improved when one takes into account the asymmetric emission of the evaporating particles in the laboratory frame, resulting in detector coverage of ~93% of emissions.

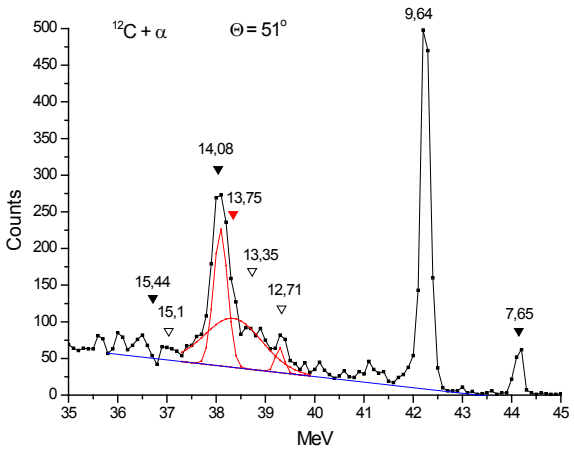
In recent years, tagging with beta-particles has successfully been employed to study several A~70 proton rich nuclei around the N=Z line at JYFL. In order to gain access to even more exotic cases, increase in the detection sensitivity is desired. Three new pieces of apparatus have been installed and tested recently. These are; a finely pixelated DSSD, a phoswich detector and a charged particle veto-detector, the UoYtube. The fine segmentation of the DSSD allows for higher beam intensities to be used without resulting in too strong prohibitive false correlations. The phoswich device consists of "fast" and "slow" plastic scintillation materials enabling an effective discrimination between the low and high energy beta-particles (see Fig. 1.). This is achieved by recently upgraded digital signal processing instrumentation which allow for pulse shapes from different detector channels to be recorded. The UoYtube houses 96 CsI crystals around the JUROGAM II target position to detect charged particles emitted in the fusion evaporation process. The recoils produced via xp channels can be vetoed allowing for cleaner tagging conditions for the exotic pure neutron evaporation channels.

The new devices have been tested and were found to improve the sensitivity of the set-up. Further improvements are currently under way, with a revised version of the veto-detector (see Fig. 2.). All these improvements will be combined in an upcoming experiment to study excited states in the proton rich nucleus ^{70}Kr.

ERINDA workshop

The second ERINDA (http://www.erinda.org) workshop was held in Jyväskylä from 8 till 11 January 2013. The European Research Infrastructures for Nuclear Data Applications aims to coordinate European efforts to exploit up-to-date neutron beam technology for novel research on advanced concepts for nuclear fission reactors, the transmutation of radioactive waste and to foster the communication and dissemination of the results. The workshop attracted 40 participants representing 12 European countries. The Rector of the University of Jyväskylä – Prof. Matti Manninen – delivered the opening talk. The visitors had the opportunity to tour the accelerator lab and see all the experimental facilities. The conference dinner was combined with a visit to Nyrölä Observatory – one of the finest observation places in Finland, equipped with two Meade LX200 telescopes (16-inch and 10-inch) and an ST-8XE CCD camera. The observatory, operated by a group of local enthusiasts, includes a modern planetarium, a meeting room, and a restaurant all located in the cavern excavated under the hill holding the telescopes, just 25 km from downtown Jyväskylä. After a spectacular display of Aurora Borealis at the planetarium the evening was completed with a fine meal of reindeer meat and other local specialties.

Participants of the ERINDA workshop at the entrance to the Rock Planetarium under the Nyrölä Observatory.

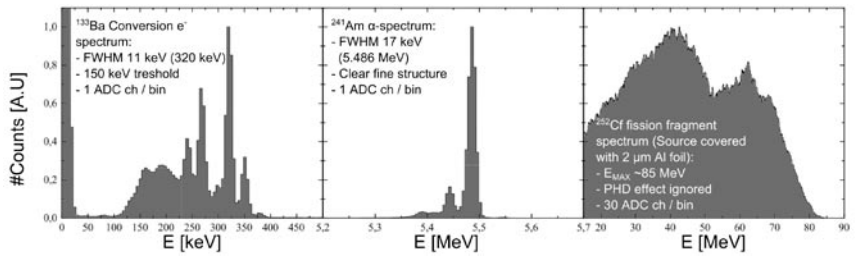


A sample spectrum of α-particles from the inelastic ^{12}C + α scattering at 65 MeV

Evidence for a new rotational band based on the Hoyle state in ^{12}C

Systematic studies of exotic cluster states with enhanced radii carried out by the Nucear Rainbow Collaboration (Dubna-JYFL-Kazakhstan-Kurchatov-Radium Institute) have yielded new results. Our 2012 measurements were focused on the famous Hoyle state (0^+_2, E* = 7.65 MeV) in ^{12}C. Different modern theories predict this state to be an alpha particle "gas-like" state. A long-standing problem is whether there are excitations based on the Hoyle state and, if so, what is their structure. Our 2012 spectra of inelastic scattering of α particles on ^{12}C at E(α) = 65 MeV show a broad (Γ = 1.4 MeV) group corresponding to the excitation energy 13.75 MeV. Angular distributions indicate that the spin-parity assignment of this new state is 4^+. With high probability, together with the recently discovered 2^+_2 state at E* ≈ 9.8 MeV, this 4^+ level belongs to the new rotational band based on the Hoyle state. The corresponding moment of inertia is about twice that of the ground state rotational band. The radius of the solid rotator extracted from the moment of inertia (R = 2.7 fm) is in good agreement with those of the Hoyle and 2^+_2 states obtained from the scattering analysis. This newly discovered rotational nature of the Hoyle state and the measured radii of the band members contradict the popular model of alpha particle condensation.

Gain Switch Rendered Obsolete?



The spectra above were measured with a Micron DSSD connected to a Mesytech MPRT-16 preamp and Lyrtec/Nutaq digital electronics. All the measurements were made with the same settings, only varying the source. The full range, quoted as '150 MeV', is ~130 MeV. This is quite a feat for a preamp residing outside the vacuum chamber. Time will tell how it'll perform in the MARA focal plane setup.

Next Call for Proposals
Deadline: March 15, 2013

The next deadline for submission of proposals and letters of intent is March 15, 2013. **Proposals should include an abstract/summary**. A justification of the beam time requested, based on cross-sections, detector efficiencies, etc. should be given. If a proposal is the continuation of an existing experimental program at the JYFL Accelerator Laboratory, a summary of the status of the project should be included. Proposals and letters of intent should be sent (preferably as a postscript or pdf file) to the Program Advisory Committee secretary Mikael Sandzelius (address: see below) and include the Proposal Summary Sheet mailed with this Newsletter. This form is also available from the JYFL WWW-pages. You are encouraged to contact anyone in the Contact List at the end of this Newsletter for more information.

From 1st September 2010, the JYFL Accelerator Laboratory is one of the EU-FP7-IA-ENSAR-Infrastructures offering a certain amount of supported access to the users from the EU and associated countries.

Requests for such support (travel and living expenses during experiments) should be attached to the scientific proposal.

All publications resulting from work done at the Accelerator Laboratory should also contain the following acknowledgement:

This work has been supported by the EU 7th framework programme "Integrating Activities - Transnational Access", project number: 262010 (ENSAR) and by the Academy of Finland under the Finnish Centre of Excellence Programme 2012-2017 (Nuclear and Accelerator Based Physics Research at JYFL).

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