

ISOLDE AND NEUTRON TIME OF FLIGHT
EXPERIMENTS COMMITTEE

Minutes of the twenty-seventh meeting of the INTC
Held on Monday 30 and Tuesday 31 October 2006

OPEN SESSION

Monday 30 October 2006 at 13:30 h, Council Chamber

Apologies were received from the Chairman of the INTC, Mark Huyse, who could not attend the meeting. The discussion was lead by the ISOLDE Physics group leader, Karsten Riisager.

ISOLDE Technical Report

The ISOLDE Technical Coordinator, Mats Lindroos, reported on the technical activities at ISOLDE. REX-ISOLDE has been running with good total efficiency up to 10%. The post-acceleration of ions with low A/q has allowed the achievement of the record energy 3.15 MeV/u for ${}^8\text{Li}^{3+}$. A slow extraction scheme from the EBIS has been implemented; this allows extending the beam pulse from the standard value of 50 μs to 400 μs FWHM without loss in efficiency. The charge breeding of heavy beams (up to $A\sim 200$) has been successfully tested. A new operator working 50% of the time for REX-ISOLDE has joined the team.

Concerning the ISOLDE resonant ionization laser ion source (RILIS), it has operated smoothly for about 15 runs. A market survey for solid state lasers is underway and the laboratory for atomic resonance spectroscopy (LARIS) is making good progress.

The research and development on targets and ion sources has continued during 2006. The major highlights are the new version of the quartz transfer line with a new temperature range, the off-line test of negative ion source prototypes and the design and construction of a target unit with two transfer lines.

The new installations in the hall were then discussed. The move of the experimental stations after REX-ISOLDE into the extension of the ISOLDE hall is progressing well. The installation will take place in two phases: in December 2006 the end of the beam line including the bending magnet and the two experimental beamlines will be dismantled and placed in their final position. The final alignment and installation will take place in January 2007.

The RFQ cooler tests are doing good progress concerning transmission, beam cooling and emittance. For the 2006 shutdown the installation of the high-voltage cage and the vacuum modifications are foreseen. The installation of the RFQ cooler in the ISOLDE hall and the integration of the control and vacuum systems will be discussed based on the outcome of the ongoing tests.

ISOLDE Physics Report

The ISOLDE Physics Coordinator, Luis M Fraile, presented a compilation of the radioactive ion beams delivered by REX-ISOLDE on the occasion of the 5th anniversary of the first radioactive beam post-accelerated at the facility. Forty-five radioactive species of 17 elements have been post-accelerated and used for physics experiments until now.

The last part of the ISOLDE Physics schedule for 2006 and the latest modifications of the accelerator schedule affecting ISOLDE were discussed. The planned offline activities at the end of the online period were also reported.

The draft accelerator schedule for 2007 was then presented. The PS Booster will start operations with beam on 10 April 2007. Protons will be delivered to ISOLDE on 16 April 2007, and Physics can start at ISOLDE as of 23 April. The stop of protons delivered to ISOLDE is planned for 12 November 2007, thus adding up to a total of 29 weeks for ISOLDE Physics. The MERIT experiment (nTOF-11) is scheduled from 3 to 17 July 2007. The n_TOF facility is planned to resume operations on 13 August 2007, subject to the completion of the target and agreement on resources.

n_TOF Technical Report

The n_TOF technical coordinator, Paolo Cennini, reported on the ongoing technical activities aiming at resuming the operations at the n_TOF facility. Actions have been taken in order to remove the old irradiated target. The shielding has been removed and measurements of the radioactivity in the access pit have been performed in order to compare with the simulations of the activation of the target. A procedure for the removal of the target has been devised. The upgrade of the infrastructure in the TT2-A tunnel, including the ventilation system and radiation monitoring is also planned.

The conceptual design of the new spallation target, fulfilling the requests of the SC has been finished and the detailed technical design has started. The new unit is a lead target with reduced dimensions weighting about 1.3 tons, instead of 4.7, and clad with an aluminium alloy. The use of steel for the cladding and for the target support is avoided in order to minimize the activation of the target assembly. The moderation over a thickness of 5 cm can be done with water or heavy water, exchangeable during the run. A possible orthogonal flight-path is foreseen in the design. The installation can be accomplished via the access shaft. The fine positioning of the target unit and the replacement of the moderator can be remotely controlled from the service gallery. This design has been agreed by the n_TOF Collaboration Board.

The following proposals and addendum were then presented:

1. **CERN-INTC-2006-032** and **INTC-P-215**, *Diffusion of ^{56}Co in GaAs, ZnO and $\text{Si}_{1-x}\text{Ge}_x$ systems*, Jyrki Räsänen
2. **CERN-INTC-2006-033** and **INTC-P-216**, *Shape coexistence in neutron-rich Sr isotopes: Coulomb excitation of ^{96}Sr* , Emmanuel Clement
3. **CERN-INTC-2006-034** and **INTC-P-217**, *Measurements of shape co-existence in $^{182,184}\text{Hg}$ using Coulomb excitation*, Peter Butler
4. **CERN-INTC-2006-035** and **INTC-P-218**, *Emission channelling lattice location experiments with short-lived isotopes*, Ulrich Wahl
5. **CERN-INTC-2006-036** and **INTC-P-219**, *Study of single particle properties of nuclei in the region of the "island of inversion" by means of neutron-transfer reactions*, Thorsten Kröll
6. **CERN-INTC-2006-041** and **INTC-P-220**, *Investigation of alpha-decay rates of ^{221}Fr , ^{224}Ra and ^{226}Ra in different environments*, Henrik Jeppesen
7. **CERN-INTC-2006-042** and **INTC-P-223**, *Exploring the X(5) characteristic in the mass $A\sim 80$ region: Coulomb excitation of ^{78}Sr nucleus*, Dipa Bandyopadhyay
8. **CERN-INTC-2006-040** and **INTC-P-160-Add.1**, *High-precision Mass Measurements of Exotic Nuclei with the Triple-Trap Mass Spectrometer ISOLTRAP (IS413)*, Alexander Herlert.

CLOSED SESSION

Tuesday 31 October 2006

Present: T. Butz, J.-P. Delahaye (part-time), L.M. Fraile (Secretary), M. Lewitowicz, M. Lindroos, L. Linssen, G. Neyens, C. Rembser (part-time), K. Riisager (chairing this meeting), M. Streit-Bianchi (part-time), V. Vlachoudis, Ph. Woods.

Apologies: S. Åberg, H. Börner, H. Doubre, J. Engelen, M. Huyse (Chairman), R. Krücken, F. Priolo.

1. INTRODUCTORY REMARKS

Apologies were received by the INTC Chairman, Mark Huyse, who could not attend the meeting. The session was chaired by Karsten Riisager.

2. MINUTES OF THE LAST MEETING

The minutes of the twenty-sixth INTC meeting held on 20 and 21 May 2006 were approved without amendments.

3. STATUS OF ISOLDE

The Committee acknowledged the achievements during the 2006 campaign and took note of the future installations.

The Committee was informed that the AB department is organizing an Accelerator Technical and Operation Review (ATC/ABOC Days), which will be held from 22 to 24 January 2007. Half a day is devoted to ISOLDE. The INTC requested a report on the outcome of the meeting after the approval by the AB Management Board.

4. STATUS OF N_TOF

The Committee regarded with satisfaction the progress in the design of the new target for n_TOF and expressed its support for the restart of the physics programme at the facility. The Committee took note of the letter addressed by the n_TOF collaboration to the INTC reporting about the status of activities. The Committee was informed that a draft of the new Memorandum of Understanding between CERN and the n_TOF Collaboration has been discussed with the CERN management. A final version is expected by the end of the year.

5. HIE-ISOLDE PROPOSAL

Karsten Riisager reported on the status of the HIE-ISOLDE proposal. The Research Board had requested a detailed plan for the upgrade of the facility. A meeting of the CERN Director-General and the Chief Scientific Officer with the Chairman of the ISOLDE Collaboration, the Chairman of the INTC, the spokesperson of the ISOLDE Collaboration and the ISOLDE physics coordinator was held on 30 June 2006. CERN expects major contributions towards HIE-ISOLDE from the external sources, of the order of half of the total costs, before CERN can commit funds for the upgrade. The Standing Group for the Upgrade of ISOLDE met on 5 October 2006. The SGUI followed the technical solutions proposed in the HIE-ISOLDE yellow report but clearly defined the stages in order to best fit the CERN requests. Stage 1 of HIE-ISOLDE contains the REX-ISOLDE energy upgrade to 5.5 MeV/u, the consolidation of

the infrastructure, radioprotection upgrades and key issues on beam improvement (RILIS and RFQ cooler) with a total of 12 MCHF capital cost. Stage 2 includes the REX-ISOLDE energy upgrade to 10 MeV. Stage 3 refers to the intensity upgrade.

The Committee was informed that a white paper has been presented by the CERN Director-General to the CERN Council concerning future research programmes, with a request for additional funds. The HIE-ISOLDE project is explicitly mentioned in the fourth theme. The white paper will lead to a green paper in March 2007 that will be discussed during the year together with the mid term plan and the budget issues.

6. DISCUSSION ON THE OPEN SESSION AND ON LETTERS OF INTENT

The presentations of the proposals and the addendum made during the open session, and the letters of intent submitted to the INTC were then discussed. The discussion on the clarification letter (**CERN-INTC-2006-039/CLL-002** *Clarification letter: Coulomb Excitation of a ^{94}Kr Beam - Deformation Changes in the Neutron-Rich Isotope Chain*) was postponed until the next meeting.

CERN-INTC-2006-032/P-215, *Diffusion of ^{56}Co in GaAs, ZnO and $\text{Si}_{1-x}\text{Ge}_x$ systems*

The proposed experiment intends to study the diffusion mechanism of Co in different materials by means of the so-called modified radiotracer technique with ^{56}Co ions. The information on diffusion coefficients of cobalt in GaAs, ZnO and $\text{Si}_{1-x}\text{Ge}_x$ is very scarce. The Committee found the proposed investigation of great interest as a first step to understand the diffusion processes of Co, although the amounts of Co diffused in the material would be minute, far from technological applications. The Committee found the collaboration well equipped for this type of experiments and the long half-life of ^{56}Co suitable for an efficient use of the beam time. The characterization of materials, key to the understanding of the diffusion processes, has been properly taken into account. The Committee decided to **recommend 6 shifts** for approval by the Research Board.

CERN-INTC-2006-033/P-216, *Shape coexistence in neutron-rich Sr isotopes: Coulomb excitation of ^{96}Sr*

The aim of the experiment is the study of the properties of the neutron-rich nucleus ^{96}Sr ($Z=38$, $N=58$) by means of Coulomb excitation at “safe” energies with REX-ISOLDE and the Miniball detector array. By using the reorientation effect in a differential CoulEx experiment both transitional and diagonal matrix elements for transitions connecting low-lying states in ^{96}Sr can be determined, thus providing a complete description of the transition strengths and quadrupole moments, in particular for the second and third 0^+ states. The Committee found the physics case very convincing and underlined the opportunity provided by the REX-ISOLDE postaccelerator and the Miniball detector array for this type of experiments. The results will provide insight into the shape co-existence in ^{96}Sr and the shape evolution in the mass region. The SrF^+ beam is routinely used at ISOLDE, but it has never been post-accelerated at REX-ISOLDE. Therefore the Committee recommended that the trapping of SrF^+ molecules, break-up, charge breeding of ^{96}Sr and post-acceleration be tested prior to the experiment. With the provision, **24 radioactive ion beam shifts**, including 3 shifts for beam development, **were recommended** for approval by the Research Board.

CERN-INTC-2006-042/P-221, *Exploring the X(5) characteristic in the mass A~80 region: Coulomb excitation of ^{78}Sr nucleus*

The experiment proposes to measure the transition matrix elements for transitions in ^{78}Sr by means of Coulomb excitation, with the aim of investigating whether this nucleus shows a phase transitional behaviour with X(5) symmetry. The Committee judged the case of interest, and ^{78}Sr as the best suited candidate to search for X(5) features in this mass region. In order to obtain conclusive data both the energy ratio between the 4^+ and 2^+ levels in the yrast band, and the interband and intraband transition probabilities need to be measured. This sets a stringent requirement on the amount of beam time required for a successful run. The Committee judged the experiment to be in the limit of feasibility within the requested 30 shifts, and decided to provisionally accept the physics case but defer the decision on a possible recommendation to the Research Board, subject to successful test of SrF^+ beams at REX-ISOLDE. The proponents are encouraged to join forces with the proponents of P-216 for this test.

CERN-INTC-2006-034/P-217, *Measurements of shape co-existence in $^{182,184}\text{Hg}$ using Coulomb excitation*

The experiment proposes to measure the transition and diagonal matrix elements for the E2 transitions between the lowest-lying states in $^{182,184}\text{Hg}$ by means of Coulomb excitation at REX-ISOLDE with the Miniball array. The aim is to obtain quantitative information about the nature of the shape coexistence in these nuclei. The Committee found the experiment of the highest interest, with a technique already developed and applied here to mid-shell Hg nuclei where the prolate configurations lie closest to the oblate ground state. This region of the nuclear chart is now available for experiments at REX-ISOLDE and calls for thorough exploration. The experiment was regarded as the best approach to obtain the sign of the diagonal quadrupole matrix element and distinguish between prolate and oblate excitations. The degree of mixing between oblate and prolate structures can then be determined from the transition matrix elements. The beam test requested by the proponents was judged of crucial importance by the Committee. The proponents are encouraged to discuss with the REX-ISOLDE team. It was thought that no special risk is posed by the long-lived daughter activities, but this should be taken into account when the beam time is scheduled. The Committee decided to **recommend 24 shifts** (including 3 for beam development) for approval by the Research Board.

CERN-INTC-2006-035/P-218, *Emission channelling lattice location experiments with short-lived isotopes*

The experiment proposes an extension of the emission channelling measurements with position-sensitive detectors to isotopes with shorter half lives and lower electron energies. The technique is routinely used at ISOLDE for studies of lattice location of radioactive impurities implanted into single crystals, and can now be broadened due to the availability of new on-line emission channelling setups and faster readout systems. The Committee judged the proposal as a step forward in terms of instrumentation, and considered the first planned applications of interest. Special emphasis was given to the investigation of lattice location of transition metals in semiconductors, for which emission channelling is ideally suited, in order to understand the physics of ferromagnetism in semiconductors. The application of Auger electrons for channelling studies is very demanding and its advantages are not obvious, hence the feasibility

of this technique should be demonstrated first with a selected case. With this provision, the Committee decided to **recommend** for approval by the Research Board a total of **20 shifts** for a 2 year period, after which the proponents should report on the achievements with special emphasis on the online measurements. The possible technological applications of this project were underlined.

CERN-INTC-2006-036/P-219 *Study of single particle properties of nuclei in the region of the 'island of inversion' by means of neutron-transfer reactions*

The proposal aims at the investigation of single particle properties of neutron-rich nuclei in the “island of inversion” around Mg by means of transfer reactions at 3 MeV/u at REX-ISOLDE. The detection of gamma rays in the Miniball array in coincidence with a high efficiency segmented Si detector array will allow determining cross sections and extracting relative spectroscopic factors, in order to pin down the particle configuration and the influence of intruder states. The first experiment focuses on one-neutron transfer on a deuterated target with a ^{30}Mg beam in order to populate states in ^{31}Mg . The Committee found the physics case of the highest relevance, and underlined the challenges of this type of experiments at the present REX-ISOLDE energies. Whether the achieved precision in the obtained spectroscopic factors will be enough for a meaningful comparison to existing models remains a question. The experiment was regarded as a starting point for this type of studies at REX-ISOLDE. The Committee **recommended 24 radioactive beam shifts** (including 3 for beam preparation) for approval by the Research Board.

CERN-INTC-2006-041/P-220 *Investigation of alpha-decay rates of ^{221}Fr , ^{224}Ra and ^{226}Ra in different environments*

and

CERN-INTC-2006-043/I-068 *Temperature effects on alpha radioactivity of ^{223}Ra*

The proposal P220 intends to investigate the effect of surrounding host materials in alpha decay half lives. Recent publications suggest that the rate of low energy nuclear reactions depend on whether they occur on a metallic or insulating environment. It is argued that the electron screening in metals plays a key role in this effect and, although no quantitative description is available, the Drude-Debye model is used for a parameterization of the available data. The same model is used to explain the modification of lifetime in EC and β^+ decays; alpha decays might be affected in a similar manner.

The proposal P220 addresses this issue by investigating the activity of long-lived isotopes at different temperatures and by directly measuring the half-lives of shorter lived isotopes in different materials. The Committee found the proposal very timely to test the controversial effects described above. The application of the Drude-Debye model has a strong dependence on the temperature that would lead to dramatic modifications of the half-lives, never observed to date. ISOLDE provides an excellent framework to perform an independent verification of this effect. The Committee found the proposal well detailed and aware of the possible difficulties concerning beam purity, total activity of the samples and simultaneous investigation of different host materials.

The letter of intent I68 addresses the same matter in a much less detailed manner, and plans temperature dependent half-life measurements of ^{223}Ra and also (although not stated in the title) ^{226}Ra after implantation in gold foils at ISOLDE.

The Committee decided to **recommend 12 shifts for Proposal P220** to be approved by the Research Board, and to **endorse the Letter of Intent I68**. The Committee called for a parallel development of both projects when it comes to offline activity measurements in Mainz (LoI68) and Bochum (P220). Sources should be prepared in exactly the same conditions and simultaneously delivered to both laboratories.

CERN-INTC-2006-040/P-160-Add-1 (IS413) *High-precision Mass Measurements of Exotic Nuclei with the Triple-Trap Mass Spectrometer ISOLTRAP*

During 2006 ISOLTRAP has continued its successful programme to measure a significant number of precise masses of exotic nuclei. The physics topics addressed include halo nuclei, tests of the unitarity of the CKM matrix, evolution of shell structure, and structure of r-process nuclei in the vicinity of ^{132}Sn and ^{208}Pb . The addendum intends the continuation of these experiments in the coming two years. The collaboration is preparing a new proposal to be defended in 2007 with overlapping measurement period. The Committee regarded with interest the continuation of the measurements, especially those requested with higher priority for the 2007 campaign, but had reservations about the physics priorities and the overlap with the upcoming proposal. The estimated precision in the measurement of light nuclei and the interaction with the MISTRAL measurements was also questioned. The Committee decided to **recommend the approval by the Research Board of 22 shifts** for the 2007 campaign. The proponents are asked to pursue the necessary developments for the rest of the experiments and to provide a revised prioritization of all measurements when the new proposal is presented to the INTC.

CERN-INTC-2006-023/I-066 *(n,p) emission channeling measurements on ion-implanted beryllium*

The letter of intent aims at using the emission channelling technique in samples implanted with beryllium in order to identify sites in the crystal lattice of the hosts. The ion implantation is done with ^7Be and the charged particles for channelling are obtained by exposing the implanted samples to a high neutron flux in order to produce protons via the $^7\text{Be}(n,p)$ reaction, whose cross section is very high. The Committee judged positively the high potential of the proposed method, and specifically the cases of lattice location of Be in GaN and II-VI semiconductors, but considered that clarification is needed concerning the chosen reaction and the feasibility of the study. The proponents are encouraged to come up with a complete proposal where these issues are addressed and more experimental details are provided.

Out of the 199 radioactive beam shifts requested to the INTC a total of 132 have been recommended for approval by the Research Board.

7. DATES OF NEXT MEETINGS

The next INTC meeting will take place on **Thursday 15 and Friday 16 February 2007**. The deadline for submission of proposals is **Wednesday 17 January 2007**.

The dates of the other two INTC meetings in 2007 are fixed at Monday, 21 and Tuesday, 22 May 2007, and Monday, 12 and Tuesday, 13 November 2007.

8. A.O.B.

On behalf of the INTC the chairman thanked the outgoing members, T. Butz, H. Doubre, M. Lewitowicz, and F. Priolo, expressing his gratitude to their contributions to the Committee.

A report from the Standing Group for the Upgrade of ISOLDE (SGUI) on research and development on target and ion sources will be delivered in the next meeting of the INTC.

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