

ISOLDE AND NEUTRON TIME OF FLIGHT
EXPERIMENTS COMMITTEE

Minutes of the twenty-sixth meeting of the INTC
Held on Monday 22 and Tuesday 23 May 2006

OPEN SESSION

Monday 22 May 2006 at 13:30 h, Council Chamber

The Chairman of the INTC, Mark Huyse, opened the meeting and announced the agenda. He stated that 184 radioactive beam shifts for twelve ISOLDE experiments recommended by the INTC in its previous meeting were approved by the Research Board. The approval of the three n_TOF experiments with a total of $2.15 \cdot 10^{19}$ protons on target recommended by the INTC is pending, subject to the implementation of the safety measures and the formalization of a memorandum of understanding between the n_TOF collaboration and CERN.

ISOLDE Technical Report

The AB/ATB group leader, Jacques Lettry, reported on the technical activities at the ISOLDE facility during the shutdown and the complicated start-up. Maintenance work on all main ISOLDE subsystems has been performed, but one third of the lowest priority tasks remain to be done. The work was particularly delayed in the case of vacuum systems and front-ends. A large part of the work has been the completion and commissioning of the class A laboratory for target handling, though its installation was running late due to interruptions for other shutdown work. The UC_x targets are now synthesized in this laboratory which is not yet equipped with an offline separator and thus there is no off-line mass scan for the UC_x targets during the 2006 campaign. The GPS and HRS separator areas have become primary zone and airtight doors were installed for this purpose. A new HRS beam gate and its attached electronics have been set up to allow for the installation of the RFQ cooler and buncher during next shutdown. The GPS switchyard diverting the beam to the central beamline and the short beamlines (GLM, GHM) has been repaired during the shutdown. After re-installation a shortcut appeared, causing the scheduled off-line runs on GPS to be cancelled. The problem was solved, but a collimator at the exit of the switchyard was inadvertently bent during the re-installation of the GLM deflector plates. This was severely limiting the transmission to the experimental setups and was only found and repaired during the first GPS online physics run. It has been found that aluminium oxide powder from the air drying unit has accidentally leaked into the compressed air system at ISOLDE. In spite of having purged the circuits, the diagnostics instruments and vacuum parts could not be cleaned due to lack of

resources at service groups. Unfortunately this might have serious consequences during the running period.

The technical maintenance and upgrades at REX-ISOLDE include the replacement of the REX-EBIS cathode, the modification of the amplifier for the REX-LINAC 9-gap resonator and new controls for the LINAC power supplies and amplifiers. The slow extraction scheme from REX-EBIS has been tested off-line.

A new RILIS ionization scheme for Au has been developed. The lower limit for the ionization efficiency is measured to be 3%. The RILIS ionization efficiency for Hg has also been measured off-line to be 0.1%. The polarity of the GPS line voltage was reversed for the negative ion source tests at the end of 2005 and was not put back to normal polarity for the first run. The GPS yields and release of RILIS ionized isotopes were affected. This was not noticed until after the first two on-line experiments took place. The target and ion source development programme continues, in particular concerning the operation of a MiniMono ECR ion source, the modification and operation of a Kinetic-Ejection Negative Ion Source (KENIS) for light halogen beams, the prototyping of a bivalve target, the development of new mass markers for alkalis and the measurement of effective surface of targets materials. Six new physicists (EURISOL-DS and Marie Curie fellows) have been trained and they will participate in the ISOLDE target test and prototyping.

The planned period for offline experiments and development runs was strongly reduced due to the delays and aforementioned problems. The re-installation of the GPS switchyard forced cancelling the offline running on the GPS and only a few off-line tests could be actually performed on the HRS. The first three physics only runs were unsuccessful. The first one suffered from the low transmission at GPS and the reversed line voltage polarity. The coupling and heating of the target with closed valve caused the failure of the ion-source and lead to the cancellation of the second run. The third run was affected by the inverted polarity in the line and by problems in the CERN Linac2.

The shortage of radioprotection staff is one of the reasons for the delays of shutdown work. Most of the work in the target and separator areas and on open beamlines need to be supervised by a radioprotection technician and on single person cannot perform all the required tasks in many different locations. Another complication during the shutdown has been the fact that the ISOLDE primary zones (separator target areas) can only be accessed after the ISOLDE machine supervisor completes the security chain with a key stored at the new CERN Control Centre. This key needs to be fetched in the Preveessin site and returned back. There is also a shortage of manpower since the former ATB-IF section leader, appointed group leader, has not been replaced. The lack of personnel in the AB-OP-IS section will be mitigated with a new machine supervisor who will join in the autumn 2006.

The missing staff, the radioprotection procedures and the work planning need to be addressed shortly to improve the performance of the ISOLDE facility. Manpower difficulties are expected for the 2006-2007 shutdown due to the extra tasks of the move of Miniball experimental location into the new extension of the ISOLDE hall, and to the installation of the RFQ cooler and buncher.

ISOLDE Physics Report

The ISOLDE Physics Coordinator, Luis M Fraile, presented an evaluation of the experiments during the 2004 and 2005 campaigns, focusing on unsuccessful runs. During 2004, 34 scheduled experiments took beam in 56 separate beam times grouped in 28 blocks. Four beam times were either cancelled or stopped prematurely. Three more beam times had to be rescheduled. A few other experiments suffered from lower yields than expected or from a delayed start of their beam time. In the year 2005 30 scheduled experiments took beam in 51 different beam times grouped in 27 blocks. Five beam times were either cancelled or stopped. Two more beam times had to be rescheduled after failures. A few other runs suffered from smaller difficulties.

With respect to the 2006 campaign, protons were delivered to ISOLDE from 18 April 2006 and the physics experiments started on 24 April 2006, but were largely unsuccessful due to the abovementioned technical problems. The end of the on-line operation for ISOLDE was originally planned for 6 November 2006 but, in view of the existing problems with power supplies in the PS/SPS accelerator complex, the schedule is being revised and an extension of up to two weeks is possible. There were 503.5 remaining shifts for approved experiments from 2005, and further 184 shifts were approved during the February 2006 INTC meeting. The user requests for 2006 amount to 481 shifts. Apart from the nonflexible user requests, the main constraints for the schedule are *(i)* the limitation to a maximum of 10 UC_x targets that can be made available during 2006 by the AB-ATB-IF group [265 shifts requested by users] *(ii)* the operation of the RILIS [230 shifts requested by users] *(iii)* the integration of the research and development activities and *(iv)* the REX-ISOLDE operation [175 shifts requested by users]. The schedule in its present status was then presented. The rest of the schedule will be published once stable operation is assured.

Some practical matters were then addressed. The experimental programme and external users are suffering from a decreased level of support from the SC/RP group. The RP shipping services have degraded, with repeated problems to export samples appearing at the end of 2005, and continuing during the beginning of 2006. The radioactive sources service only opens every second week, and the opening time of the dosimeter service has been reduced to only morning hours. The users were reminded of the separation of the general purpose computer network (GPN) and the Technical computer Network (TN) in force as of 1 January 2006 in order to improve network security at CERN. The ISOLDE controls have been moved to the TN and the experiment computers are connected to the GPN. Should the experiments require access to the ISOLDE controls, dedicated servers and computers are allowed to communicate with both networks. Finally the upgrade of the INTC submission interface was presented. The main new features include a single submission screen in which all required information for each proposal is collected, and which allows for the direct transfer of the file. The reference numbers are obtained automatically and stamped into the transferred document.

n_TOF Technical Report

The n_TOF technical coordinator, Paolo Cennini, reported on the technical activities at the n_TOF facility. A Memorandum of understanding between CERN and the n_TOF collaboration

is in progress. No beam has been taken since November 2004. The safety requirements to be fulfilled when the operations are resumed have been defined by SC/RP. The ventilation and filtering of the air at the primary zone needs to be improved, and the radioactivity in the target cooling circuit should be reduced. With this aim a new spallation target is being designed. Two different designs are considered, namely a clad lead target cooled with the existing cooling system, or a completely new design. In both cases the neutron flux features will be maintained, the possibility of different moderators is kept open and the design takes into account the second flight-path orthogonal to the proton beam. A proposal for the two solutions will be submitted to the collaboration. After the design study, next phases will entitle the construction and installation of the new target and the storage and subsequent elimination of the old target.

The following proposals, addenda and status reports were then presented:

1. **CERN-INTC-2006-019** and **INTC-P-210**, *Coulomb excitation of ^{94}Kr beam – Deformation changes in the neutron-rich isotope chain*, Jędrzej Iwanicki
2. **CERN-INTC-2006-020** and **INTC-P-211**, *Investigation of the $^8\text{Li}(^2\text{H},p)^9\text{Li}$ reaction at REX-ISOLDE*, Henrik Jeppesen
3. **CERN-INTC-2006-021** and **INTC-P-212**, *Along the $N=126$ closed shell: study of ^{205}Au through its $\pi h_{11/2}^{-1}$ isomeric decay*, Zsolt Podolyak
4. **CERN-INTC-2006-022** and **INTC-P-213**, *Pb(II) and Hg(II) binding to de novo designed proteins studied by $^{204\text{m}}\text{Pb}$ - and $^{199\text{m}}\text{Hg}$ -Perturbed Angular Correlation of γ -rays (PAC) spectroscopy: Clues to heavy metal toxicity*, Lars Hemmingsen
5. **CERN-INTC-2006-024** and **INTC-P-214**, *Nuclear Charge Radius Measurements of Radioactive Beryllium Isotopes*, Wilfried Nörtershäuser
6. **CERN-INTC-2006-025** and **INTC-P-183-Add.1**, *Nuclear moments and charge radii of magnesium isotopes from $N=8$ up to $N=20$ (and beyond)*, Klaus Blaum

CLOSED SESSION

Monday 22 and Tuesday 23 May 2006

Present: S. Åberg, H. Börner, T. Butz, P. Cennini (part time), J.-P. Delahaye (part time), L.M. Fraile (Secretary), M. Huyse (Chairman), J. Lettry (part time), M. Lindroos (part time), L. Linssen, G. Neyens, K. Riisager, Ph. Woods.

Apologies: H. Doubre, J. Engelen, R. Krücken, M. Lewitowicz, F. Priolo, C. Rembser, M. Streit-Bianchi, V. Vlachoudis.

1. MINUTES OF THE LAST MEETING

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

2. STATUS OF ISOLDE

The problematic start-up of the ISOLDE facility was regarded with deep concern by the Committee, who expressed the need to straighten out the performance for the present campaign. The Committee encouraged the undertaking of a detailed analysis of the underlying reasons for the failures and to put forward a more optimized planning for the next shutdown. The lack of manpower in key areas of the facility was found worrying. The analysis of failed runs in years 2004 and 2005 did not show a particularly severe situation but a more reliable operation of the facility is considered necessary. The committee took note of the problems encountered by ISOLDE experiments to export irradiated samples and to access other RP services, and encouraged that they are addressed within CERN.

3. STATUS OF N_TOF

The two alternatives for the new n_TOF spallation target were discussed by the Committee. The goal is to keep the performance without compromising safety. Cladding the existing Pb target is one of the options to avoid the leakage of spallation products into the filters of the cooling system. The second option is a new construction of the neutron spallation target. The estimated time frame for both options is similar, with the aim of having a target ready and installed by June 2007. The possibility of replacing the water by deuterated water is kept open in both designs. After the cooling time of 2 years since the target has not been irradiated it is possible to access it without too elevated doses and therefore a new irradiation with protons in 2006 is not adequate. No additional information can be obtained from this target with respect to safety. Preparatory work for the nTOF-11 (MERIT) experiment continues in the n_TOF tunnel; the experiment will run in 2007.

4. HIE-ISOLDE PROPOSAL

The Chairman of the INTC, Mark Huyse, summarized the status of the HIE-ISOLDE proposal. In its meeting of 1 December 2005 the Research Board endorsed the Physics case for the continuation of the ISOLDE facility and its upgrades (HIE-ISOLDE project), and requested a complete report on the upgrade prepared by the AB department in consultation with the ISOLDE collaboration, and with input from the TS, PH and AT departments. It will be presented to the Research Board in its meeting of 7 June 2006.

The ISOLDE technical coordinator, Mats Lindroos, presented this study and the resource estimate for HIE-ISOLDE project from the AB department. The report had already been presented to the AB and AT Management Boards on 15 May for discussion. It includes the three main lines of upgrade, namely the REX-ISOLDE energy upgrade, the proton driver intensity upgrade and the beam quality improvement. The alternatives for the REX-ISOLDE energy upgrade have recently been addressed by an International Advisory Panel. Their recommendation is to use superconducting technology for the extension of the REX-LINAC. The major delay will be defined by the time needed for R&D on the superconducting cavities. The intensity upgrade needs to be discussed in the context of the CERN accelerators. The upgrades in beam quality are essential for the success of the facility and are already more than 50% funded by the ISOLDE Collaboration. The Committee stressed that the time scale of the project is a crucial factor for the success of the proposal in the international context

5. DISCUSSION ON THE OPEN SESSION

The presentations of the proposals and the addendum made during the open session were then discussed.

CERN-INTC-2006-019/P-210, *Coulomb excitation of ^{94}Kr beam – Deformation changes in the neutron-rich isotope chain*

The proposal intends the measurement of the B(E2) transition probability from the 0^+ ground state to the first excited 2^+ state in ^{94}Kr by means of Coulomb excitation of a ^{94}Kr beam onto a ^{108}Pd target. The nucleus ^{94}Kr is located in a region of the nuclei chart where two deformation minima (prolate and oblate) exist. The quadrupole deformation of the ground state, and its sign in particular, is a question of interest. The E2 transition from the ground state to the first 2^+ excited state can provide indirect information on this issue. The proposal was seen by the Committee as a starting point for Coulomb Excitation measurements in this region of nuclei, but found that the possible determination of the sign of the deformation was not properly addressed in the proposal.

The Committee decided to ask the proponents to explore the possibilities of measuring the sign within a reasonable time frame with the present REX-ISOLDE energy and intensity. The proponents should report to the Committee before a decision on the recommendation of this proposal can be taken.

CERN-INTC-2006-020 and INTC-P-211, *Investigation of the $^8\text{Li}(^2\text{H},p)^9\text{Li}$ reaction at REX-ISOLDE*

This experiment aims at the extraction of the spectroscopic factors (S-factors) for the $^8\text{Li}(d,p)^9\text{Li}$ reaction in inverse kinematics at 3 MeV/u REX-ISOLDE energies. The Committee regarded the study of S-factors as an important topic, but cast doubts on the suitability of the method with light nuclei at these particular energies, considering that the influence of the energy on the interpretation of S-factors (typical measurements are now around or above 5 MeV/u) is still under discussion. Nevertheless the proposal was seen with interest in the framework of pioneering studies of this type of reactions with light nuclei at the REX-ISOLDE energies. The experiment will probably not solve the discrepancies between S-factors obtained in different transfer reactions, but contribute to the interpretation of previous measurements.

The experimental approach was found appropriate although it was thought that the importance of experimental data at background angles could only be judged on-line. Therefore the Committee agreed to **recommend** a total 13 radioactive shifts for the study of the $^8\text{Li}(d,p)^9\text{Li}$ reaction at 3 MeV/u and 1 stable beam shift for the investigation of the ^{16}O background.

CERN-INTC-2006-021 and **INTC-P-212**, *Along the N=126 closed shell: study of ^{205}Au through its $\pi h_{11/2}^{-1}$ isomeric decay*

This proposal intends to take advantage of the newly developed Au beams at ISOLDE to perform spectroscopy studies of excited states in $^{201,203,205}\text{Au}$ following the decay of high-spin isomeric states, with special focus on the nucleus ^{205}Au at the N=126 shell closure. The experiment will obtain information on the shell structure configuration around N=126, providing the ingredients for an extension of the tests of the stability of this shell closure far away from stability. The Committee found this challenging experiment of interest. The half-life estimates of the isomeric states set them within reach for a decay study at ISOLDE. However, the committee cast doubts on the effect of $5/2^+$ neutron state on the half-lives, as such state is present in $^{197,199}\text{Au}$ and it could be therefore present in $^{201,203}\text{Au}$. This could reduce the isomeric half-life to below the second level, which strong decay loses as consequence. Since the beta-decay half-lives of the nuclei produced are significantly longer the proposed method to remove the activity with a tape system seems feasible. Nevertheless, as the hyperfine splitting for the $11/2^+$ isomer and the $3/2^+$ ground state will be very different, the Committee judged that an in-source selection of the states in the RILIS can be performed, and encouraged the proponents to fully explore this opportunity.

The Committee decided to **recommend 9 shifts** for the measurement of ^{205}Au for approval by the Research Board, and 2 additional shifts for the measurement of release properties and yields of Au and for a narrow band RILIS scan. The committee supported the development of Ir beam for a future extension of this study to the N=126 nucleus ^{203}Ir .

CERN-INTC-2006-022 and **INTC-P-213**, *Pb(II) and Hg(II) binding to de novo designed proteins studied by ^{204m}Pb - and ^{199m}Hg -Perturbed Angular Correlation of γ -rays (PAC) spectroscopy: Clues to heavy metal toxicity*

The aim of the experiment is the investigation of the binding properties of Pb(II) and Hg(II) to proteins by means of Perturbed Angular Correlation (PAC). The Committee judged the proposal of the highest interest in view of the toxic effects of heavy metal binding to proteins. The proposed technique was also seen as appropriate, and complementary to other methods. The case of Pb was thought to be challenging, given the fact that the binding site of Pb in proteins has not been clearly established, and therefore it was suggested that the studies start with the Hg probe. The Committee appreciated the resurgence of life sciences at ISOLDE and thought that the groups involved possess the required expertise in the different aspects of the experiment. The proponents are encouraged to optimize the number and operation of PAC spectrometers at ISOLDE in order to take full advantage from the beamtime. The Committee **recommended 24 shifts** for approval by the Research Board.

CERN-INTC-2006-024 and **INTC-P-214**, *Nuclear Charge Radius Measurements of Radioactive Beryllium Isotopes*

The proposal aims at a model-independent measurement of the charge radius of several Be isotopes including the one-neutron halo nucleus ^{11}Be . The measurement combines on one hand precision laser spectroscopy of cooled Be ions in a Paul trap for the determination of isotope shifts and on the other hand state-of-the-art atomic calculations. The Committee regarded the proposal as extremely challenging and very significant for atomic, nuclear and astrophysics.

The role of systematic errors and the theoretical calculations in the final precision of the measurements was discussed. The Committee appreciated the planned study of systematic effects in the measurement, as those induced by the laser power or the number of ions in the cloud. Concerning the theoretical calculations, they are similar to those performed for Li atoms since the experiment is performed in Be^+ ions. Such calculations have been experimentally verified with the data on ^6Li and ^7Li , and their relative uncertainty estimated. They are thus expected to be valid for Be^+ and to yield results with similar precision.

Therefore the Committee thought that the experiment will be able to achieve the required level of precision. The Committee resolved to **recommend** the allocation of 8 stable beam shifts for the optimization of the setup with ^9Be and **18 radioactive beam shifts** for the on-line measurements of the $^{7,9,10}\text{Be}$ isotopes subject to a **Status Report** to be presented to the INTC before the 2008 beamtime.

CERN-INTC-2006-025 and **INTC-P-183-Add.1 (IS427)**, *Nuclear moments and charge radii of magnesium isotopes from $N=8$ up to (and beyond) $N=20$*

The addendum proposes the continuation of the measurements of nuclear moments and charge radii of magnesium isotopes at COLLAPS. The Committee had very positively evaluated the original proposal, and stressed once more the relevance of this systematic study of the long isotopic Mg chain where information on the evolution of moments and single-particle properties can be obtained. The study has already yielded important results as for instance the ground state spin and parity of ^{31}Mg . The addendum aims at the extension of the charge radii measurements on the n-rich isotopes by an improved optical detection technique, and to the experimental determination of g-factor and quadrupole moments in the neutron deficient $^{21,23}\text{Mg}$. The production of ^{21}Mg with sufficient yield and purity remains an issue and therefore a production test is requested. Therefore the Committee decided to **recommend** to the Research Board the approval a total of **14 shifts**: 8 shifts for the completion of the measurement of neutron rich Mg isotopes and 6 shifts for the development of neutron deficient Mg isotopes with the possibility of measuring ^{23}Mg . The proponents are asked to report to the INTC after the test.

Out of the 100 radioactive beam shifts requested to the INTC a total of 78 have been recommended for approval by the Research Board. Nine of the 12 requested stable beam shifts have been also recommended for approval.

6. LETTERS OF INTENT

CERN-INTC-2006-023 and **INTC-I-066** *Measurement of shape co-existence in heavy nuclei using Coulomb excitation*

The letter of intent addresses the issue of shape coexistence at low excitation energies in neutron mid-shell nuclei near the $Z = 82$ shell closure and focuses on n-deficient Hg isotopes, in particular on $^{182,184}\text{Hg}$. The application of Coulomb excitation to these nuclei will allow distinguishing between the prolate and oblate contributions and determining the degree of mixing by the measurement of the transition matrix elements. The measurements will require the development of post-accelerated Hg beams and a prerequisite is the demonstration 43^+ state can be achieved at REX-EBIS with sufficient efficiency. The Committee **took note** of this letter of intent, appreciated the case as an approach to heavier post-accelerated beams at REX-ISOLDE and **endorsed** the development of Hg beams.

7. DATES OF NEXT MEETINGS

The next INTC meeting will take place on **Monday 30 and Tuesday 31 October 2006**. The deadline for submission of proposals is **Friday 29 September 2006**.

Luis M. Fraile
Tel. 73809 – 160985
Luis.Fraile@cern.ch