

ISOLDE AND NEUTRON TIME-OF-FLIGHT
EXPERIMENTS COMMITTEE

Minutes of the 34th meeting of the INTC
Held on Monday 18 and Tuesday 19 May 2009

OPEN SESSION

Monday 18 May 2009 at 14:00 h, Council Chamber

The Chairman of the INTC, Peter Butler, opened the meeting and announced the agenda. He informed the Committee on the outcome of the recent discussion on the number of protons to be delivered to ISOLDE and nTOF during the 2009 running period. ISOLDE will receive 40-43% of the proton pulses of the PS Booster supercycle and nTOF a total of 7×10^{18} protons on its target. He continued with a remark on the recent workshop on "new opportunities in the physics landscape at CERN" and summarized that ISOLDE was presented very well. He then announced that this will be the last INTC meeting for Mats Lindroos as EN-representative for the INTC and that Richard Catherall will take over afterwards.

ISOLDE Technical Report

The EN-representative for the INTC, Mats Lindroos, summarized the technical activities since the last meeting. The main modifications and repairs in the target zone comprised a modification of the cooling water system, which will allow a better start up, a major overhaul of the ventilation system, the repair of the rabbit irradiation system, and an improvement of the target zone cameras.

For REX-ISOLDE a new Micro-Channel-Plate detector was installed in the beam line to REX-TRAP, which will serve as an additional diagnostic tool, and a tilted foil holder was installed for the investigation of polarized beams. The low-energy part of REX-ISOLDE has been started up and first mass-resolving tests have been performed off-line. In addition, poly- and single-crystalline diamond detectors have been installed behind REX-LINAC for current, profile, and energy measurements related to HIE-ISOLDE. Furthermore, four days of operator training have been implemented in the schedule. It was noted that the consolidation of the REX-TRAP system has been presented to the Injectors and Experimental Facilities Committee (IEFC).

For the high-energy part of REX-ISOLDE the water cooling of the rf amplifiers has been investigated and a heat-exchanger prototype has been installed and tested. The modification of the existing water cooling circuit is under study. Furthermore, the matching between the amplifiers and the cavities has been improved to maximize the output power and the consolidation of the 7-gap cavity tuner is ongoing. The first phase of the REX-LINAC concrete shielding has been completed (side walls and roof) and the optics downstream of the LINAC is being improved.

For the RFQ cooler and buncher ISCOOL a new and more robust rf amplifier has been installed and the vacuum controls are being integrated into the existing control system. The PS Booster Vistar application has been modified and new information has been added, for example the proton beam intensity, an alarm in case of a wrong focus, and the proton beam position. Concerning future modifications of the target area, new drawings within the Catia program package have been created. Additional information from laser scans was included to ensure up-to-date information.

During the off-line period, a scheduled RILIS test for a new Mn ionization scheme could not be done due to a failure of a front-end piston. After these start-up difficulties, the SEM-grid tests were done as scheduled and the first target test was very successful. A target with BeO as target material was used to produce an intense ^6He beam. During this target test the new tape station has also been tested by measuring the release of ^8He out of the BeO target. The calibration against the old tape station is ongoing. After this successful start of the on-line running period, the two stepping motor controllers broke down within one week (15 years old without spare) and blocked both front-ends for about one week. Both cards could be repaired thanks to an intervention by EN-STI-ECE.

Mats Lindroos concluded his report with an overview on the status of the HIE-ISOLDE activities, which cover the three main objectives: (i) a higher energy for the REX-ISOLDE system and an increase of the current capacity, (ii) a better quality of the ISOLDE radioactive ion beams, and (iii) a higher intensity of the delivered beams by increasing the proton driver beam intensity. It is planned to have a two-staged implementation: HIE-ISOLDE1 will include the R&D for the HIE-LINAC, the test of the first superconducting cavities, an ongoing beam quality development with the RFQ cooler and RILIS, and the construction of the superconducting LINAC as well as a design study of a new target area. HIE-ISOLDE2 will cover the construction of a new target area, the super-HRS for an improved mass separation, and the upgrade to the LINAC4 and later LP-SPL.

The present design of the Nb-sputtered superconducting cavities and the cryomodules has been shown, as well as the layout of the new infrastructure needed for the HIE-LINAC. Concerning the RILIS upgrade the first successfully tested ionization schemes with the new solid state lasers were reviewed and a road map for the further RILIS upgrade was given including the installation of new dye lasers, further pump lasers, and a second laser system to allow a quick switch from one RILIS element to another. Part of the RILIS upgrade is the off-line investigation of new RILIS schemes with the LARIS laboratory at CERN and a recent result was obtained for the element Mn which will be tested on-line this year.

ISOLDE Physics Report

The ISOLDE Physics Coordinator, Alexander Herlert, gave an overview on the present status of active ISOLDE experiments, summarized the beam requests for 2009 and presented the schedule for the 2009 running period. At the February INTC meeting, 10 new experiments had been recommended for approval and further 363 RIB shifts had been allocated for new experiments, addenda, and letters of intent. Out of 83 active experiments, 11 were declared completed (IS358, IS390, IS393, IS397, IS398, IS399, IS400, IS424, IS434, IS444, and IS458) and 72 were considered as active for the schedule of the running period 2009.

The schedule for the CERN accelerator complex for 2009, as approved by the Research Board on December 5, 2008, foresees a running period of about 31 weeks for ISOLDE, starting on April 14, 2009 and delivery of the last protons in the morning of November 23, 2009. 627 RIB shifts were requested by 51 of the 72 active experiments, which is again an increase as

compared to the previous year. Especially uranium-carbide targets and RILIS ion sources were highly requested with 460 RIB shifts and 359 RIB shifts, respectively. Also REX-ISOLDE experiments with requested 273 RIB shifts and about 30 RIB shifts requested for target and ion source development as well as RIB shifts for letters of intent and off-line machine development runs were considered for the 2009 schedule.

After taking into account various constraints of resources and user availability, the present schedule comprises in total 450 RIB shifts for 39 experiments and 63 different beams, i.e. 12 experiments could not be scheduled. It is foreseen to have 235 RIB shifts with RILIS operation and 282 RIB shifts with UC targets. For REX-ISOLDE 8 runs are planned for 9 experiments with in total 171 RIB shifts. For the scheduled experiments, 27 target units will be used with 4 units from last year and 12 new UC targets. Three target units are dedicated for target tests, e.g. one BeO target for the production of ^6He , a new UC target material for a test in collaboration with INFN, and a ThO target with a low work-function cavity to suppress surface ionization. The latter will also make use of RILIS, which will be employed for in total 15 runs (including one off-line run on Be) and with an operation time of more than 2300 hours in 2009.

It was noted that the ISOLDE maintenance and the cold-checkout was finished almost on time and only the ISCOOL RFQ buncher and cooler was slightly delayed, especially the new rf amplifier was not ready for the off-line tests on bunched Be beams for the COLLAPS experiment. Although shorter than planned, this off-line test gave valuable data for future on-line experiments. Otherwise, the operators encountered the usual start-up problems with the control system and vacuum, however, much less than in the previous years. REX-ISOLDE was also up and running very early and first off-line tests, e.g. mass-resolution tests and diamond detectors tests, could be carried out.

The main problems so far include a short power glitch on Sunday, April 26, which only caused a delay of a few hours for proton delivery from the PS booster, and two broken cards for the PISOMOVE piston and stepper motor control system. Due to the latter problem, one target change was delayed by one day, but no significant beam time was lost. However, just before the INTC meeting, the injection septum of the PS booster showed a water leak, which is a major failure, and the length of the intervention as well as the impact on the ISOLDE schedule was at that moment unclear. Luckily, the COLLAPS run on neutron-rich Ga isotopes could be finished successfully.

nTOF Technical Report

The representative of the n_TOF Collaboration, Vasilis Vlachoudis, summarized the situation at the nTOF facility and the startup for the 2009 running period. He reviewed the first running phase of nTOF and the failure as well as the removal and investigation of the broken target, which led to a new target design for the second phase of nTOF. The old target unit was removed in September 2007 and after a second external panel review in February 2008 a decision was made to construct a new target which was ready for a first short commissioning in November 2008, which was done with reduced power (max. 3kW) as only limited cooling was available and no ventilation. After the installation of a new cooling system for the ventilation of the primary area, the new target will be fully commissioned end of May or beginning of June 2009.

The following proposals and status reports were then presented:

1. **CERN-INTC-2009-025 and INTC-P-269**, *Neutron capture cross section measurements of ^{238}U , ^{241}Am and ^{243}Am at nTOF*, Daniel Cano Ott
2. **CERN-INTC-2009-027 and INTC-SR-013**, *Scientific highlights and future plans at the ISOLTRAP setup*, Klaus Blaum
3. **CERN-INTC-2009-028 and INTC-SR-014**, *Status report and future plans for the "light exotics" collaboration*, Hans Fynbo
4. **CERN-INTC-2009-029 and INTC-SR-015**, *Recent results and outlook for the MINIBALL experiment at REX-ISOLDE*, Jarno Van De Walle
5. **CERN-INTC-2009-030 and INTC-SR-016**, *Status report about COLLAPS experiments and output (period 2006-2008)*, Gerda Neyens
6. **CERN-INTC-2009-031 and INTC-SR-017**, *Status of solid state physics May 2009*, Karl Johnston

CLOSED SESSION

Tuesday 19 May 2009 at 8:30 h, room 60-6-002

Present: J. Billowes, Y. Blumenfeld, H. Breuker, P. Butler (Chairman), R. Catherall, M. Doser, P.-H. Heenen, A. Herlert (Secretary), M. Huyse (Chairman), R. Julin, H. Leeb, M. Lindroos, N. Orr, E. Rondio, P. Roussel Chomaz, Ch. Scheidenberger, V. Vlachoudis, U. Wahl

Apologies: P. Collier

1. INTRODUCTORY REMARKS

The Chairman informed the Committee that Ulrich Wahl and Helmut Leeb agreed to stay as members of the INTC. He also introduced Richard Catherall, the ISOLDE technical coordinator, who will replace Mats Lindroos as ex-officio member of the INTC as representative of the EN department. He thanked Mats Lindroos for all the development work done for ISOLDE in the past and wished him all the best for the next two years at the ESS project. He continued that there was a discussion on the number of protons to be delivered from the PS Booster to ISOLDE and n_TOF, which had to be newly defined due to the operation of LHC and other fixed target programmes at CERN, e.g. CNGS and DIRAC. In a meeting with CERN management it was decided to deliver about 43% of the PSB protons to ISOLDE and n_TOF will receive 7×10^{18} protons on its target in 2009. It was pointed out that this discussion will continue in the upcoming years until the start of LINAC4 in 2013.

2. MINUTES OF THE LAST INTC MEETING

The minutes of the 33rd INTC meeting held on 16 and 17 February 2009 were approved without amendments.

3. STATUS OF ISOLDE

The Committee requested further information on the situation for the ISOLDE piston control system (PISOMOVE): The technical coordinator summarized that the two cards broke down after 15 years of operation and that they could be repaired. Two spare cards could be recuperated in the meantime and in order to avoid a similar problem in the future, it is foreseen to modify the system and motors outside the shielded area. Especially for the stepping motor system at the GLM collection point a new solution has to be found. The situation for the front-ends is more complicated, as access is difficult and the new front-end FE6, which will replace one of the two existing systems, has compressed air controls.

The Committee then showed concern about the situation of the ISCOOL buncher and cooler, especially if refurbishment is needed to improve the running conditions, e.g., the installation of a pressure gauge to monitor the amount of He gas to avoid delays during a run. It was also not clear who is in charge of the ISCOOL system. The technical coordinator clarified, that the ISCOOL is part of the ISOLDE technical group and that it is a dynamic project which involves many people working on different parts of the device. The radiofrequency amplifier was newly built and improved (including a spare) and the gas and vacuum parts are being implemented in the present ISOLDE control system. It was pointed out that the consumption of He gas with about one bottle per 4 weeks is more than anticipated. It was also noted that the laser spectroscopy groups, e.g. COLLAPS, requested a check of the ISCOOL high-voltage power supply and asked to install a new voltage divider with a much better precision and stability.

Concerning the HIE-ISOLDE activities, the Committee was curious on the fact that the off-line test of the new Nb-sputtered cavities will take place at TRIUMF. Mats Lindroos explained that all possibilities to perform tests at a European lab were exhausted without success. In addition,

TRIUMF employs Nb-bulk cavities and therefore this gives a good opportunity to compare the performance of sputtered with the one of bulk Nb cavities.

4. STATUS OF N_TOF

The Committee showed concern on the backlog of n_TOF experiments waiting for protons. At the moment there are three approved experiments: nTOF12, nTOF13, and nTOF14. The commissioning run, nTOF12, will be the first one to be scheduled in 2009. However, with the maximum amount of protons this year, the programme for nTOF13 cannot be finished and together with nTOF14 the programme of next year is more than full.

5. WORKSHOP ON NEW OPPORTUNITIES IN THE PHYSICS LANDSCAPE AT CERN

The Chairman briefly reviewed the workshop on "new opportunities in the physics landscape at CERN" held in the week before. It was pointed out that CERN has to have a look at future research programmes and had invited the various collaborations to submit abstracts in order to give new ideas for new physics programmes to ensure a variety also in the future. There was an enthusiastic response to the call for ISOLDE and 31 abstracts were received; many proposals showed the future prospects for physics with HIE-ISOLDE. The discussion and evaluation of the different research programmes at CERN and the new ideas will continue in the next months. This issue will be also discussed in the next INTC meetings.

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

The proposals presented during the open session as well as status reports were then discussed:

CERN-INTC-2009-025/P-269, *Neutron capture cross section measurements of ^{238}U , ^{241}Am and ^{243}Am at nTOF*

With this proposal it is planned to measure neutron capture in ^{238}U and $^{241,243}\text{Am}$ at the nTOF facility. The main motivation is to obtain nuclear data not available so far. The proposal combines the efforts of more than 10 laboratories and the envisaged isotopes are on a high-priority list and are of high importance for future nuclear-reactor fuels and waste management. Some of the planned measurements are part of the EURATOM programme. In addition, the data are needed for simulation codes and safety issues related to the design of future nuclear reactors. The proposal is therefore essential for the nuclear industry and is thus very much supported.

In the case of ^{238}U very precise data are required with an uncertainty of less than 3%. $^{241,243}\text{Am}$ are considered as minor actinides which may act as negative sources with respect to (n, γ) reactions. Each measurement will be an improvement of the knowledge in this mass region. The expected resonances are also of importance for nuclear physics as the resonance position and width together with other data can give a spin assignment and data for parity violation. Two types of measurements are planned: one with a total absorption gamma spectrometer, which is limited in energy, and a complementary measurement with C_6D_6 detectors. It was noted that transmission experiments cannot be done at nTOF. Both types of measurements were successfully performed in previous runs.

Concerning the number of requested protons, the statistics must be extremely good to reach the envisaged precision, especially in the case of ^{238}U . Together with the reference and background measurements, the requested number of protons is of the same order as compared to a previous campaign at nTOF. The Committee stressed that both measurements are highly demanded. It was pointed out, that the $^{241,243}\text{Am}$ measurements are part of the IP-EUROTRANS activity and funding ends in 2010. As the nTOF target area has no class-A laboratory classification, the

amount of target material is very much limited, i.e. longer measurement campaigns are needed. Larger amounts of target material could be stored in a closed container. However, this would hamper the measurements and is therefore not an option. It was noted that there is an ongoing request to obtain the class-A laboratory classification, especially due to the fact that n_TOF is dedicated to radioactive samples.

The number of allocated protons for nTOF in 2009 is 7.3×10^{18} protons on target (p.o.t.). For the already approved experiment nTOF13 a total of 1.8×10^{19} p.o.t. has been allocated which cannot be scheduled in 2009. Together with the commissioning run nTOF12 and the third approved experiment nTOF14, the present proposal with a request of 1.4×10^{19} p.o.t. is unlikely to be scheduled in 2010 as the total number of protons to nTOF in 2010 will not be significantly different to the number in 2009. As both physics cases are of similar importance, the Committee could not give a priority with respect to the physics case. Nevertheless, the Am measurements seem less stringent regarding the required precision and as funding is available only until 2010, it was decided to only **recommend** for approval by the Research Board the requested number of protons for the $^{241,243}\text{Am}$ and the required calibration and background measurements with in total **8×10^{18} protons on target**. The Committee requested that the nTOF Collaboration should discuss the scheduling of all approved experiments in order to allow data taking for all approved experiments. In addition, it was strongly suggested to look into the possibility to obtain a classification as a class-A laboratory, in order to increase the amount of target material and thus reduce the amount of required protons to achieve the precision needed. The proponents were asked to come forward to the Committee with a status report after having finished the first part of the run or if the situation with respect to the class-A lab classification has changed.

CERN-INTC-2009-026/CLL-005, *Measurements of competing structures in neutron-deficient Pb isotopes by employing Coulomb excitation: Letter of Clarification for the proposal P-260*

This letter of clarification gives additional information regarding the contamination of the requested neutron-deficient Pb beams, $^{190,192}\text{Pb}$, of the proposal P260 and the influence on the measurements at MINIBALL. The Committee was very much satisfied with the explanation given in the letter. The envisaged laser on-off measurements seem to be sufficient to have a measure of the Tl admixture in the Pb beam. The Committee thus decided to **recommend** for approval by the Research Board **21 shifts**.

CERN-INTC-2009-027/SR-013, *Scientific highlights and future plans at the ISOLTRAP setup*

The highlights of recent results obtained by the ISOLTRAP Collaboration were clearly presented and give a broad picture of the application of precise nuclear masses: Data on the proton-halo candidate ^{17}Ne and other nuclides can act as benchmarks for theoretical models, mass measurements on ^{26}Al and ^{38}Ca contribute to fundamental studies, data on neutron-rich Sn and Zn isotopes are relevant for astrophysics, and of course the first discovery of the new isotope ^{229}Rn in a Penning trap shows future possibilities at ISOLDE. The impressive list of publications is of high quality, including many Phys. Rev. Letters in the last years, and also many PhD theses have emerged from the ISOLTRAP physics programme. The Collaboration and the experimental setup are both in excellent shape. Also the funding for the operation and investment for new developments seems to be safe for the future. As postdocs and PhD students are permanently stationed at ISOLDE, the development of the experimental setup is ongoing and many valuable spin-off developments like the Ramsey technique have been done. With trap-assisted spectroscopy and a new ion trap for fast isobaric purification new projects are underway. The physics programme is diverse and of highest quality and is one of the forefront projects at ISOLDE. The Committee acknowledged the successful programme at ISOLTRAP

but also noted that technical development and mass measurements with Penning trap experiments are also done at other facilities. The Committee concluded that ISOLTRAP is capable of exploring all beams available at ISOLDE with the only restriction on the half-life and production yields. One way to circumvent the latter limitation might be direct detection of single ions in the Penning trap which could be a new technique in the future. The Committee also recommended that the future physics programme of ISOLTRAP should continue to exploit ISOLDE's unique capabilities.

CERN-INTC-2009-028/SR-014, *Status report and future plans for the "light exotics" collaboration*

This status report summarizes the results of a long standing collaboration for the study of light-exotic nuclei and it is clear that the work done belongs to the best worldwide. The Committee encouraged the researchers to carry on with their successful work and suggested to improve the detection of neutrons. However, the question was raised as to how the work on transfer reactions competes with similar experiments carried out at other facilities, as it is clear that these experiments need the higher energies and intensities that will be available from HIE-ISOLDE. The Committee noted the problem of theoretical support in this mass region. Mean-field techniques cannot be applied and the main problem is the presence of both 2- and 3-body interactions. The situation for reactions is worse as it is very difficult to calculate reaction channels and bound states. Nevertheless, the 2-proton-type correlation measurements are very much of interest. The Committee concluded the discussion with the suggestion to concentrate on those isotopes which are unique at ISOLDE.

CERN-INTC-2009-029/SR-015, *Recent results and outlook for the MINIBALL experiment at REX-ISOLDE*

The number of publications from the MINIBALL collaboration, especially Phys. Rev. Letters, shows the importance and the pioneering work in this field. So far the experimental programme has exploited mostly Coulomb excitation (but also some transfer reaction studies), covering light nuclides for the investigation of the island of inversion, the investigation of shell closures, (e.g. neutron-deficient Sn nuclides which show $B(E2)$ values that do not follow the expected trend), and the investigation of shape coexistence (e.g. for Hg and Rn nuclides). Also measurements with respect to reactions relevant for astrophysics had been performed. The experiments are of high quality and the results belong to the forefront of nuclear structure physics. The Committee acknowledged that other techniques besides Coulomb excitation are done with MINIBALL, e.g. transfer reactions that will exploit the TREX setup. For the long term perspective it was suggested to look into the possibility of collaborating with groups studying light exotic nuclei. It was also pointed out that beams beyond Pb are only available at ISOLDE and the single particle structure in that mass region should be explored in the future, i.e. a research programme which would be unique for ISOLDE. Finally, the Committee pointed out that the programme will profit from an energy upgrade with HIE-ISOLDE.

CERN-INTC-2009-030/SR-016, *Status report about COLLAPS experiments and output (period 2006-2008)*

The COLLAPS experiment has shown a large variety of measurements on ground state properties, e.g., spins, quadrupole moments and charge radii, especially in the region of the island of inversion. Recent results have been obtained for Cu isotopes, ^{11}Be , and neutron rich Ga isotopes. COLLAPS is one of the pillars of the ISOLDE physics programme with an impressive publication record including four Phys. Rev. Letters in the last years and many PhD theses. It

was shown that laser spectroscopy is a powerful tool and with the COLLAPS setup many different experiments can be done. The experimental setup is in excellent shape and will profit from the ISCOOL RFQ buncher and cooler as stable conditions and background suppression are an issue for future measurements. The Committee also stressed that much more can be done with ISCOOL as will be explored with the new CRIS experiment. COLLAPS is an established collaboration which is embedded in an international network doing also experiments at GANIL and TRIUMF. The experiments also benefit from interaction between COLLAPS and the RILIS group at ISOLDE with respect to beam purity and isomeric selection. It is expected that COLLAPS will continue to play a very important role in the future research programme at ISOLDE.

CERN-INTC-2009-031/SR-017, Status of solid state physics May 2009

The solid state physics programme at ISOLDE covers a very diverse field with a large and productive user community including groups working in biophysics. In general, the different research groups do about 20% of their research at ISOLDE, i.e., ISOLDE is one of many tools to investigate the various physics cases. At ISOLDE the users make use of a very well established experimental infrastructure. The publications record with contributions in refereed journals is very large and of high quality. Many of the presented experiments are in their last stage and will be finished soon, others have recently been approved and new proposals will be submitted in the future. Overall, there are only a few inactive experiments. There have been new technical developments, e.g., a new on-line diffusion experiment to be installed very soon, or an on-line emission channelling experiment that employs detectors which were developed at CERN. Sometimes the experiments are limited by the beam properties, e.g. spot size, however, the application of the ISCOOL RFQ cooler and buncher might help. Other new setups are a digital perturbed angular correlation setup or a new beta-NMR setup, which might open a new research field with polarized beams. The Committee noted some weak points: While the facility is attracting new users from Denmark, Qatar and the UK, some users have left the community and a transition in the research field is expected, especially in Germany. A meeting is planned in Saarbrücken in order to discuss future involvement and funding from German groups. It was pointed out that the present Solid State physics coordinator position and the investments for the infrastructure were mainly coming from German funds, which are available until end of June 2010. The question was raised if other groups outside Germany may contribute to the cost of this post. The Committee underlined the importance, for the entire solid state and radiobiology program, of having a Solid State physics coordinator stationed full time at CERN.

7. A.O.B.

The Chairman suggested moving the meeting dates from Monday/Tuesday to later weekdays in the future, starting in 2010.

8. DATES OF NEXT MEETING

The next INTC meeting will take place on **Monday 16 and Tuesday 17 November 2009**. The deadline for submission of proposals is **Monday 19 October 2009**. The November INTC meeting will be followed by the ISOLDE Workshop and User meeting (November 18-20).

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