CERN-INTC-2018-
INTC-059
27 – 28 June 2018
DRAFT

ISOLDE AND NEUTRON TIME-OF-FLIGHT
EXPERIMENTS COMMITTEE

Minutes of the 59th meeting of the INTC
held on Wednesday and Thursday, June 27 – 28 2018

The chairperson of the INTC (Prof Karsten Riisager) opened the meeting by welcoming the INTC referees who were present and excusing Kristiaan Temst[1] and Andrea Jungclaus who were unable to attend. The meeting began with the facility reports followed by the presentation of the submitted proposals. Presentations from the open session may be found at the following address: https://indico.cern.ch/event/736662/

1. Facility reports during the open session

ISOLDE technical report (Richard Catherall)

Richard Catherall presented an overview of the recent technical developments currently underway at ISOLDE and also those which will be undertaken during LS2.

The start-up at ISOLDE started in earnest from 26th February upon the return of the cooling water. The cold check out lasted until 26th March with SEM grid tests straddling Easter. A number of initial beam diagnostics and controls issues were detected during this period. In addition, work was complicated due to too many co-activities, such as RFQ cooler tests and RILIS developments, taking place at the same time as the cold check out.

Tests of the new HT modulator on the HRS were carried after Easter and were successful. A second modulator will be installed during LS2. However, this will be unable to provide negative ions in 2021, only from 2022 onwards. The new ISOLDE tape station was partially tested in week 20 but many issues were encountered; tests will continue later in the year when some damaged modules are replaced.

12 targets were retrieved from the ISR before the operations period. In addition, 21 targets were either used or tested at the offline separator. 6 units were purely for development and 11 units have been irradiated at ISOLDE in the period from April – June. Two noteworthy targets from 2018 were shown: #650 for the production of ^{8}B delivered a factor of ten higher production than seen in previous units and #634 – a LIST unit – performed with excellent isobaric suppression: no ^{22}Na was seen on the desired mass of ^{22}Mg. Prototype units under production include a new neutron convertor arrangement where the W convertor is situated in the middle of an annular arrangement of Uranium Carbide and a negative ion unit for the production of At beams. The new yield database continues to progress with numerous upgrades for faster insertion of recent yield measurements. The ISOLDE laser ion source (RILIS) also has seen many upgrades with a new laser for Ti:Sa pumping and an improved cooling system to avoid chiller failures. A tender is underway for the procurement of a new laser for the MEDICIS facility. Finally, the first demonstration of Doppler-free RILIS ionisation was shown for Rb isotopes in April, this will allow for enhanced selectivity and ionisation of non-metals in the future and should allow for higher resolution laser spectroscopy for physics experiments.

[1] Kristiaan Temst was able to participate in the closed session the following day.

The long shutdown will see many activities, however three have been postponed for the foreseeable future: the re-alignment of the ISOLDE hall beamlines due to concerns about the need for this; the replacement of beamline power supplies and an upgrade to the ventilation controls due to lack of budget. Among the works foreseen, the exchange of the two ISOLDE frontends will allow for a major upgrade for the beam instrumentation, extraction electrode mechanics and replacement of many cables and beamline modifications will all be possible. Assembly of the front ends has begun with installation foreseen in Q3 2019; final commissioning will be carried out in Q3 2020.

There are many upgrades foreseen in the ISOLDE hall including the mechanical slits on the HRS; the full replacement of the compressed air lines; the refurbishment of the target and ion source gas system; the new tape station in the CA0 beamline and new beam gate controls. A full refurbishment of the beam diagnostics is also foreseen. REX and HIE-ISOLDE will see a new cooling system for the IH structure as the current system is beyond the LRF capacity along with a substantial upgrade of the LRF amplifiers. Additional diagnostic boxes and steerers have been requested for the three high energy beam lines and there will be also be a major overhaul of the cryogenic system. A repair of the newly installed cryomodule, where the RF coupler on the 3rd cavity was found to be malfunctioning, is also being planned for LS2.

Starting in October 2018, the new extension of the Class A lab to incorporate a nano-lab for the production of nano-structured actinide materials will begin. The design is currently being finalised and civil engineering will commence in November 2018 with commissioning of the extension foreseen for April 2021.

In 2020 ISOLDE expects to be able to make stable beams – from local ion sources – from August onwards. Prior to this due to the replacement of the front ends and the unavailability of resources during LS2 the facility will not produce beam.

HIE-ISOLDE status report (Yacine Kadi)

Yacine Kadi gave an overview of the status of the end of phase 2 of the HIE-ISOLDE project. Since the last INTC meeting the installation of services for the 4th cryomodule was completed the maintenance of the compressor station was completed along with maintenance on the REX RF system. A full smoothing campaign by the survey teams was carried out after the cooldown was completed.

The ISOLDE Solenoid Spectrometer (ISS) has seen a lot of installation work with the completion of the setup prior to beam and experiments later in 2018. The detector carriage, faraday cup and recoil detector have all been installed and the magnet itself has been successfully ramped up to 2.5T with beam during the HIE-ISOLDE commissioning.

The HIE-ISOLDE cryogenics plant has had essential maintenance performed during December 2017 and the 4th cryomodule was integrated in February 2018. The plant is now at the limit of its operation with the second cryomodule operating at three times its specified power. During the commissioning of the 4th cryomodule it was discovered that it was impossible to inject power into the 3rd cavity of CM4: the problem being identified due the connection of the fundamental power coupler. This cavity will not be used in 2018 and is due for repair in LS2. The performance of the cavities has also degraded slightly since 2017 with an extra case of field emission to add to the two known instances. The maximum estimated energy for 2018 is 10.172 MeV/u for A/q=3.0 and 7.7MeV/u for A/q = 4.5.

A successful beam commissioning campaign allowed REX to be tested and a machine check-out to the various high energy beamlines. The schedule for starting with physics at HIE-ISOLDE in week 28 still stands.

The spare cavities for HIE-ISOLDE were shown. There are currently three available with 2 more in the pipeline. The repair of the 4th cryomodule has been approved by the LS2C on 22nd June and this is expected to take place in May 2019 (with transport from ISOLDE during the winter of 2018/2019).

ISOLDE physics report (K. Johnston)

An overview of the physics schedule for 2018 was shown including the CERN accelerator planning. Protons are available between April 9th and November 12th with HIE-ISOLDE online from July 9. This means that the HIE-ISOLDE programme will be shorter than in 2018 due to the relatively early stop of protons. Low energy and high energy runs will be interleaved as in 2017. As there will be 4 operational cryomodules reaction studies will be possible with energies up to 10MeV/u for light masses and 7.4MeV/u for heavy to mid-masses.

In total more than 1050 shifts were requested in 2018 with 630 of these from the HIE-ISOLDE community. The physics schedule so far has allowed for 18 experiments to be performed with the delivery of 163 shifts for physics. 2018 has seen the start-up of the MEDICIS facility. Initial experience has been very positive with no impact observed on the ISOLDE physics programme. A new Technical Advisory Committee which evaluates the ISOLDE schedule has been implemented. This is in similar spirit to the TAC used for INTC proposals which allows technical aspects of forthcoming experiments to be discussed well in advance where yields and possible issues can be identified to avoid any unwanted surprises during the experiment itself.

Among the early highlights has been a successful measurement on the electron capture of ^{8}B into the highly excited states of ^{8}Be. Laser spectroscopy has successfully measured the properties of challenging Ge and Sc isotopes and also the very exotic ^{52}K. Successful experiments in solid state physics have allowed Mg to be studied for p-type nitride materials and the phase transitions of ferroelectric materials were probed using ^{111}Cd. Draft planning for the end of the year was presented indicating some of the possibilities for the Autumn for both HIE-ISOLDE and low energy physics.

Safety and ergonomic conditions around the GLM/GHM are currently being improved through a dedicated working group: a new shielded fume cupboard will soon arrive which will result in a transformation of this area which will meet modern safety requirements.

Status of nTOF (Laurent Tassan-Got)

The status of nTOF was presented. The schedule for 2018 was shown. Physics started in week 14 with 15 experiments scheduled before the end of protons in week 45. All the accepted experiments which have been approved by the INTC will be scheduled in 2018. The delivery of protons has exceeded the initial request so far in 2018, which has assisted the initial runs in EAR1 which were cut by 10% so that the busy schedule could be accommodated.

Among the initial results, the ^{68}Zn(n, γ) reaction has been measured which is the main nuclear uncertainty for the abundance of ^{68}Zn. ^{140}Ce(n, γ) addresses the problem of the natural abundance of this isotope through the s-process and has uncovered a mis-assignment in the resonance from previous data. ^{241}Am(n, f) is important for the incineration in fast reactors, initial results indicating the separation between α-particles and fission fragments were shown.

A casualty of the schedule has been ^{231}Pa(n, f) which has not been possible due to the difficult chemistry in preparing this sample. It has been replaced by tests for dosimetry, imaging, and tests focusing on the γ-flash which is an issue at nTOF and which is often 1000 times higher than the energy of the particle being detected. A test involving PPAC localisation strips has allowed pile-up beyond 200MeV to be avoided. Furthermore, a new switch – developed with HZDR, Dresden – has been inserted between the nTOF detectors and preamplifier: this is gated by the proton pulse or an ancillary detector but allows the saturation of the preamplifer to be avoided following reactions above

MeV. This has been successfully tested and allows the possibility of threshold reactions to be studied in the future.

Documents presented during the open session

1. **TAS Status Report:** Luis M Fraile (Universidad Complutense)
2. **MIRACLS Memorandum** Stephan Malbrunot-Ettenauer (CERN)
3. **PUMA Memorandum** Alexandre Obertelli (TU Darmstadt)

2. Discussions during closed session: Thursday 28th June 2018

Present:

Karsten Riisager (INTC Chair), Richard Catherall, Marek Pfutzner, Dario Vretenar, Daniela Macina, Laurent Tassan Got, Enrico Chiaveri, Thierry Stora, Gerda Neyens, Thomas Prokscha, Alessia di Pietra, Kristiaan Temst and Arjan Plompen, Antonio Moro, Iain Moore, Karl Johnston (INTC Secretary)

Excused: Andrea Jungclaus, Yacine Kadi

The INTC chair opened the meeting. Kristiaan Temst was welcomed to his first INTC closed session and François de Oliveira was thanked for his time as an INTC referee.

The minutes of the 58th meeting of the INTC were approved without further comment.

Discussion of the Facility reports:

1. ISOLDE technical report

The committee congratulated the on-time start-up of the facility in spite of the late arrival of cooling water this year with the early runs of the year not suffering from the short time available for the technical cold check-out. The progress on the new tape station was welcomed as this will be essential for all users after LS2.

2. HIE-ISOLDE status report

The completion of phase 2 at HIE-ISOLDE was congratulated by the committee: being able to reach ~10MeV/u in 2018 is a major milestone at ISOLDE. The efforts being made for the future upgrade and repair of the machine were also commended by the committee.

3. ISOLDE Physics report

The large number of shifts requested for 2018 was discussed. In spite of the difficulties in scheduling so many experiments it is also a sign of the strong community at ISOLDE and possibilities that the facility offers. The newly adopted Technical Advisory Committee was welcomed by the committee where planning of experiments are discussed well in advance of their actual running time allowing for better and more efficient planning. The minimal impact of MEDICIS on the ISOLDE physics schedule was also commended.

4. nTOF

nTOF were also congratulated on their smooth startup and being able to accommodate all the outstanding experiments in 2018 before the LS2 with the exception of the Pa experiment which will need to be re-scheduled after LS2.

Discussion and recommendations for the status report and memoranda which were presented during the open session

The chairperson introduced the discussion with a summary on the role of status reports and on the need to re-evaluate existing and long-standing experiments with regard to their continuing relevance. All experiments will be re-evaluated during LS2 in this regard. Experiments which are deemed to be no longer relevant – or if the measurement has been carried out elsewhere – will be closed; those for which the scientific goals are still of importance will remain as ISOLDE experiments. The TAS collaboration has submitted the first status report in this regard, and this will be followed by a full review of all experiments in the coming year.

SR-055 (TAS Status Report): Experiments IS440 (6 shifts remaining); IS539 (5.5 shifts remaining); IS570 (0 shifts remaining)

Progress of the experiments IS440, IS539 and IS570 has been reported. These experiments were devoted to the determination of the Gamow-Teller beta strength distributions in the decay of isotopes of Pb, Hg, Se and Ge, using the Total Absorption Spectrometer (TAS) Lucrecia.

1. IS440 (accepted in 2005)

The measurement of three isotopes ^{188,190,192}Pb was accepted. The physics goal was to determine the shapes of these nuclei. Differences in the GT beta strength distributions were predicted depending on the deformation of the parent nucleus. The experiment was performed; data have been analyzed and interpreted assuming that the parent and the daughter nuclei have the same deformation. Results on ^{190,192}Pb have been published (PRC 2015).

It is now requested to use the remaining 6 shifts to study ^{188}Pb (2 shifts at $1.7\text{x}10^{6}$ ions/µC) and ^{186}Pb (4 shifts, $4.6\text{x}10^{4}$ ions/µC) with the IDS setup during the next IDS measurement campaign in 2018, to determine with a high resolution the low lying states properties of the daughter nuclei. The investigation on ^{186}Pb, proposed in the addendum, was not approved by INTC. Two shifts for the high resolution measurement of ^{188}Pb were instead approved, however, ^{188}Pb is well known [NP356, Yoth *et al*., 26 (1981))] since it was measured with high statistics. There is a possibility for a not yet measured gamma branching ratio, but this unknown gamma BR should be lower than 7 % (from Yoth *et al.*, BR for alpha radioactivity was determined from X-rays, the sum of BR alpha + BR beta gamma is equal to 93%, only 7% missing). The impact of this 7% uncertainty on the TAS analysis was not shown.

2. IS539 (proposal submitted in 2012)

The investigation of three isotopes, $^{182, 184, 186}$Hg, has been proposed, with the objective to study shape co-existence, using the TAS technique. The study of only one Hg isotope was approved by INTC. The three isotopes were however investigated. The data on ^{186}Hg suffered from isobaric contamination and "pollution" by internal conversion, the related problem was solved and a paper is to be published. The analysis on ^{182,184}Hg is ongoing. It is proposed to use the remaining 5.5 shifts to study $^{182\text{-}184\text{-}186}$Hg at IDS with the objective to have a more complete picture of the low lying states of the daughter nuclei. The results on ^{186}Hg are about to be published, so there is no need to measure it with IDS. For ^{182}Hg and ^{184}Hg, this information is relevant for the TAS analysis, but the possible impact of the measurement was not shown.

3. IS570 (submitted in 2013, performed in 2016)

The isotopes ^{68,70}Se have been accepted by INTC. One of the motivations was astrophysics. In the rp-process, ^{68}Se is a waiting point. It was shown that the continuum electron capture rate is higher than the beta-decay rate. It is interesting to measure the decay of this nucleus to validate the astrophysical

calculations. These Se isotopes could not be measured correctly because of contamination with sulfur. Beta decay of ^{64,68}Ge was measured instead. The plan for the future is the following: finish data analysis of ^{64,68}Ge and present these new results. Then, if the SeCO beam can be produced at ISOLDE, they will submit an addendum to the proposal to measure Se isotopes.

In conclusion, it was noted that all approved experiments with the Lucrecia set-up have been performed, that they have announced an interest in performing a ^{188}Pb IDS measurement, but would argue that such an IDS experiment would need to be justified in a new proposal after LS2. The INTC suggests that the collaboration finish the writing of articles about the unpublished results, and to write a new proposal for ^{186}Pb. The INTC committee noted that the experimental setup LUCRECIA has endured technical difficulties and that the activity of the collaboration has slowed down during the last years.

The INTC recommends that the TAS experiments IS440, IS539 and IS570 having completed their programme at the TAS spectrometer, should be closed. Further plans should be presented as new proposals.

INTC-M-018 PUMA: antiprotons and radioactive nuclei

PUMA is an ambitious project which has already been presented at INTC 58. The purpose of the current memorandum was to establish the current status of this project and to evaluate the physics cases being proposed. The technical aspects of the project are within the realm of the SPSC who will consider these following the physics recommendations given by the INTC.

The committee finds that the technique is unique and will have the capacity to perform cutting-edge research. The physics topics presented in the memorandum such as those dealing with neutron skins and halos are well-motivated and would be well-suited to the first implementation of the scientific programme which is being proposed. The case of ^{6}He would be a perfect test of the method which would establish whether it can then shed light on the proposed heavier isotopes such as $^{26\text{-}31}$Ne for which precise data are not so readily available as the lighter cases. Looking forward to the more exotic cases such as hypernuclei will depend on these tests being successful.

The programme outlined in the memorandum is challenging but the individual steps appear to be realisable – although the SPSC will evaluate these for AD in more detail. The collaboration has received considerable support from its partners both in terms of personnel and funding and appears to be very well placed to carry out these experiments. There are also strong links to theory, which will be required for the analysis of the experiments.

There are some technical aspects relating to ISOLDE such as the vacuum consideration where the 10^{-17} mbar environment at PUMA is not yet compatible with the typical ISOLDE beamline vacuum level of 10^{-6} mbar. However, the committee feels that these challenges – while difficult – will be met by the collaboration.

The committee **strongly endorses** the current physics programme: although very ambitious, the outcome and impact could be significant and its future progress will be regarded with interest. The SPSC will have to separately approve the technical aspects which relate to the AD facility.

INTC-M-019 MIRACLS: the Multi Ion Reflection Apparatus for Collinear laser spectroscopy

This memorandum concerned the progress of the MIRACLS project, an ERC-supported project whose scientific case has already been endorsed by the INTC in INTC56. The scope of the present memorandum was to present the current status and future plans for this ambitious project and to evaluate their feasibility. The progress made by the project **was noted** by the committee with various

technical challenges being dealt with. The synergy of this project and the future MT-TOF for the ISOLDE facility **was also noted**.

The memorandum presented immediate plans for LS2 and these were discussed by the committee. In terms of services and resources the request is rather modest and is deemed to be achievable during this time, although close interaction with the technical teams at CERN will be required for the proposed work to be achieved. The likely location – at LA2 – which is currently occupied by the new tape station will be liberated at the end of 2018.

The INTC **took note** of the programme that is currently underway including the provision of stable beam in 2018 to measure the emittance and recommends that stable beam tests be carried out in the second half of 2020 when ISOLDE should be capable of delivering stables beams again. It **strongly supports** the request that the relevant services be available to allow the successful undertaking of these tests.

Preparation for review of uncompleted experiments unable to run before LS2.

An overview of the shifts currently on the ISOLDE books was shown. There were 1474.5 shifts outstanding as of February 2018, i.e. not including those experiments which will run this year. A breakdown by experiment type was shown. Among the low energy experiments clear priorities have been received for this year and the remaining experiments will either be closed or will present a status report in the coming year. There are a number of old experiments which have not received beam – e.g. a beam which ISOLDE has difficulty producing – and for which the scientific case has passed; these are expected to be closed during LS2. The main backlog is among the high energy experiments where 700 shifts were outstanding; 200 shifts could be expected to be delivered this year. In short, both low energy and high energy will have about 500 shifts each left after 2018.

The committee decided that no INTC meeting was required for February 2019; the preparation for the review of existing experiments will begin in 2019 with the meetings in July and November being dedicated to the presentation of status reports.

AOB:

The next meeting of the INTC will take place on 7th and 8th November 2018.

The dates for the meetings in 2019 will take place on July 2-3 and November 6-7.

The meeting was then closed.

Minutes taken by Karl Johnston