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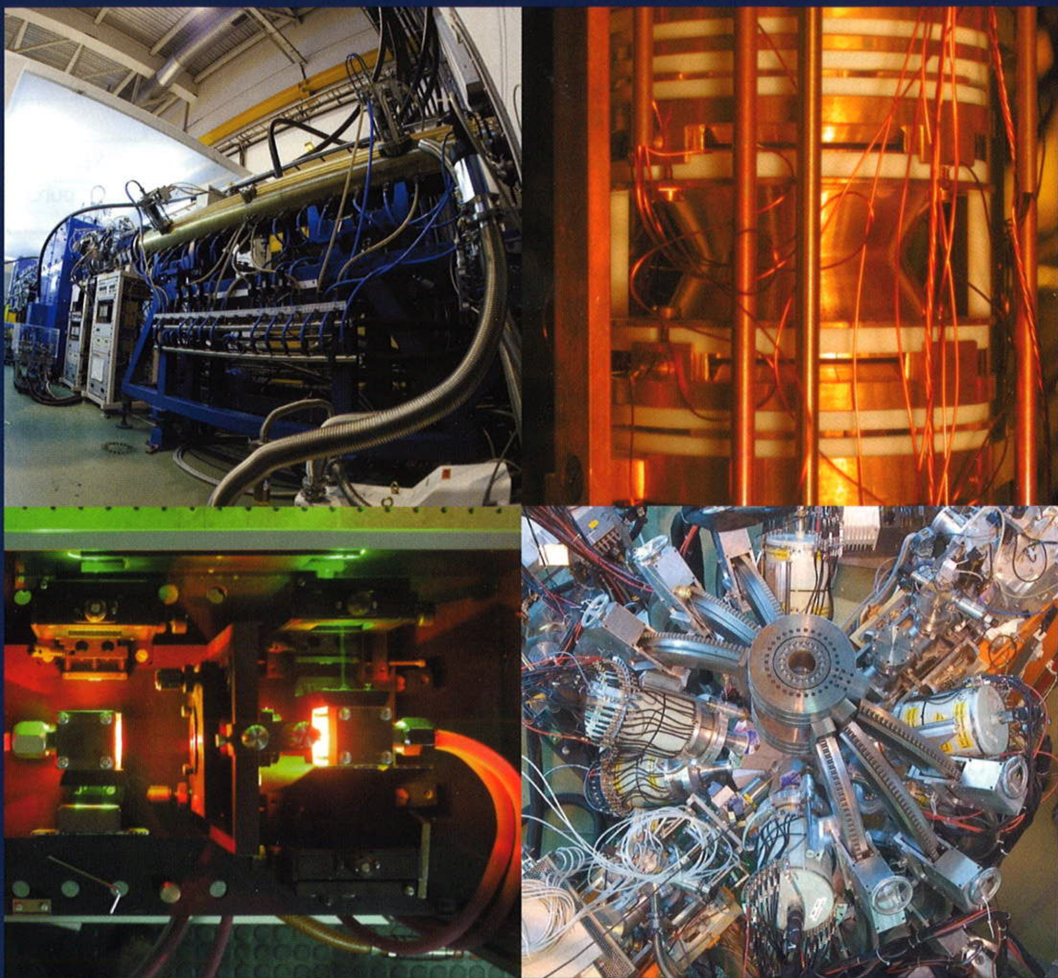

**FEATURING:**

Laboratory Portrait: The ISOLDE Facility · Weak Decay of Hypernuclei · Charmonium Spectroscopy — A Tool for Understanding the Strong Interaction


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# The ISOLDE Facility

## Introduction

The ISOLDE facility [1–3] is one of the world-leading laboratories for the production and investigation of radioactive nuclei. ISOLDE belongs to CERN's accelerator complex situated on the border between Switzerland and France (Figure 1). The facility has been in operation since its start in 1967 and is presently receiving protons from the Proton Synchrotron Booster (PSB) of CERN. The success of ISOLDE is due to the continuous development of new radioactive ion beams and improvement of the experimental conditions. With the upcoming high energy and intensity upgrade HIE-ISOLDE the possibilities for experiments with exotic nuclei will be further boosted. This laboratory portrait gives an overview of the present facility that will focus on the status of radioactive ion beam production, the operation of ISOLDE, and the main experimental equipment rather than aiming at a comprehensive summary of physics results.

## The ISOLDE Collaboration

The ISOLDE facility is run by CERN staff, mainly from the engineering and beams departments, and is an integral part of the CERN accelerator complex. The ISOLDE user community is represented by the ISOLDE Collaboration, which has an important role in shaping the science program at ISOLDE and the technical developments around it. The ISOLDE Collaboration officially holds the Memorandum of Understanding with CERN that covers legal aspects. The member states of the collaboration are Belgium, CERN, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Norway, Romania, Spain, Sweden, and the United Kingdom. Negotiations with other countries are ongoing.

## ISOLDE Experiments

In order to perform experiments at ISOLDE, proposals have to be submitted to CERN's ISOLDE and Neutron Time-of-Flight Experiments Committee (INTC). The INTC meets regularly to evaluate experiment proposals as well as letters of intent, which aim at new experimental techniques or the development of new beams. After recommendation by the INTC and approval by the CERN Research Board, experiments may request their allocated number of radioactive ion beam shifts for scheduling. In general, ISOLDE experiments are scheduled within 1–2 years after approval.

Many experiments install their own experimental equipment in the ISOLDE experimental hall, although a large fraction of approved experiments make use of permanently installed setups or common equipment already in place. In particular, for the solid state physics community, collection points are available to accumulate radioactive ions for further use in off-line experiments. Among the more permanent experimental setups are the gamma detector array MINIBALL, the mass spectrometer ISOLTRAP, the laser spectroscopy setups COLLAPS and CRIS, the $^{3}$He-$^{4}$He dilution refrigerator NICOLE, the weak interaction experiment WITCH, and the total absorption gamma spectrometer TAS. A more detailed description of these experiments is given below.

## Physics at ISOLDE

The experiments at ISOLDE focus mainly on modern nuclear structure physics. In addition, front-line studies in other fields are pursued. The energy range of the investigated radionuclides goes from $10^{-6}$ eV in the case of low-temperature nuclear orientation at NICOLE to 3 MeV per nucleon in the case of post-accelerated beams at REX-ISOLDE.

The nuclear structure is reflected in many ground state properties of nuclei, for example nuclear masses, nuclear charge radii, spins, and moments. With the investigation of excited nuclear states the evolution and behavior of shell closures can be studied. Shape evolution and coexistence in many regions of the chart of

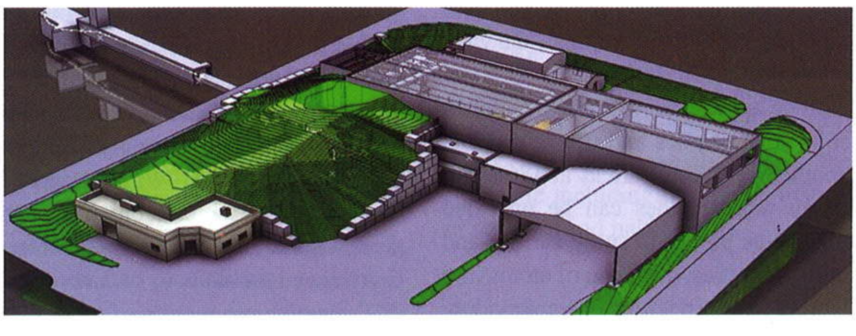

**Figure 1.** *ISOLDE facility situated on the Meyrin site of CERN across the border line between Switzerland and France.*

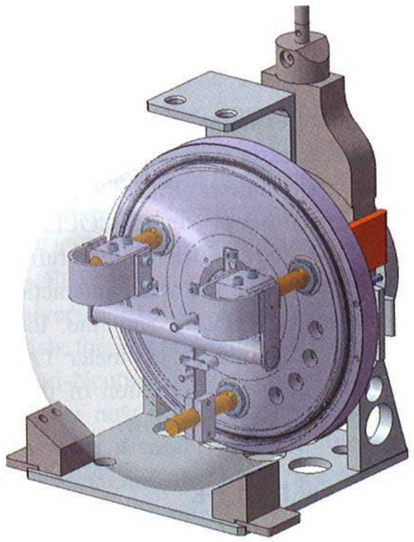

**Figure 2.** *Standard ISOLDE target unit.*

nuclides as well as properties of nuclides along the drip lines, including halo nuclei like $^{11}Li$, are of interest. Furthermore, exotic radioactive decay modes are investigated.

Another closely related field of research is nuclear astrophysics. Nuclear masses and half-lives of exotic nuclides need to be known in order to calculate nucleosynthesis processes. In addition, decay properties including beta-delayed particle emission have to be understood in order to take them into account in the theoretical models. Finally, low-energy reaction cross-sections provide valuable input for the understanding of the various processes in stars.

The application of radionuclides in solid state physics and life sciences is another very active field at ISOLDE. Many radionuclides can be provided that act as probes to study surface and bulk properties, diffusion of atoms into lattices, and properties of semiconductors. Similar experimental techniques are used for biophysics experiments, that is, radioisotopes are used to examine biomolecules and to perform *in-vivo* studies on plants. It is also planned to test radioisotopes for medical applications.

ISOLDE also hosts experiments that investigate fundamental interactions. Especially Penning trap experiments are dedicated to fundamental tests since they are able to provide very precise data that are needed to further push the limits for new physics beyond the Standard Model.

## Radionuclide Production and Operation at ISOLDE

The radioactive nuclei are produced in reactions of high-energy protons from the PS-Booster accelerator in thick targets. The typical proton energy is 1.4 GeV, which can be lowered to 1 GeV on request. Depending on the isotopes of interest and possible isobaric contamination, the target material and the subsequent ion source are chosen to match the experimental requirements (i.e., mainly production yield and purity). More than 25 different target materials are offered with uranium carbide being the most versatile and the most requested in the last years. A technical drawing of a standard ISOLDE target unit is shown in Figure 2.

In general, the target material is kept at an elevated temperature, in the case of uranium carbide at 2,000°C, so that the produced exotic atoms diffuse out of the target into an adjacent ion source. The ionization takes place in a hot plasma, on a hot surface, or by laser excitation. With a careful combination of the target material and the ion source type, a chemical selectivity may be obtained, thus resulting in a selective production of more than 70 of the chemical elements. The ion source is elevated to 30–60 kV and the exotic ions are accelerated toward and directed into an electromagnet where they are separated according to their mass.

ISOLDE provides two target stations, the GPS and the HRS front-end, named after the two adjacent mass separators. In principle, both front-ends are compatible such that targets can be mounted on either one of the target stations. However, with the high-resolution separator (HRS) a resolving power of the order of 5,000 or higher can be achieved since two electromagnets are being used. In addition, a slit system after the HRS allows one the removal of isobaric contamination if separated in the HRS but still present in the beam. The general purpose separator (GPS) can reach a resolving power of about 1,000. Nevertheless, with a special deflector geometry within the mass separator it is possible to deliver beam to three different beam-lines at the same time: while the central mass is sent to the main experimental beam-line, the ions on the lower mass and higher mass side can be send to the GLM and GHM beam-lines, respectively.

The experiments can request either the GPS or the HRS system depending on the experimental constraints. With the installation of the ISCOOL cooler and buncher right behind the HRS separator, a further constraint for ISOLDE experiments has been added. While the ISCOOL system provides a better beam emittance and the possibility of short bunches of a few microsecond length, the transmission for light ions below mass $A = 40$ can be lower than 50%. Usually, the beam requests are discussed with the ISOLDE technical group and the Physics Coordinator in order to find the most suitable front-end for the envisaged physics run.

**Target and Ion Source Development**

Throughout its existence ISOLDE has been leading developments in the production of radioactive isotopes via the ISOL (Isotope Separation On-Line) method. Many results have also emerged on specialized techniques for manipulation of (radioactive) ions and measurements performed with them. It is therefore vital to include dedicated target and ion-source development test runs in the physics on-line schedule.

The intensity of a radioactive beam depends on the intensity of the primary proton-driver beam, the target thickness, the cross section for production of the specific radioactive isotope, and on the efficiency of extracting the produced isotope from the target, purifying it, ionizing it and guiding it into the experimental setup. Many specialized targets and ion sources have been constructed over the last years in order to optimize the efficiency. However, it is still challenging to predict the behavior of a new target design in the fierce environment involving high-temperature chemistry and intense radiation.

Besides the intensity of radioactive ion beams, the amount of contamination, that is, the beam purity is of importance for the experiments. Presently, Thierry Stora from the EN-STI group at CERN is responsible for new target and ion-source developments at ISOLDE. Especially requests for new beams in approved experiment proposals and letters of intent are taken into account to prioritize the projects. Recent highlights of target and ion-source development comprise the following subjects.

*Beam Purification by Application of a Quartz*

This development aims at a reduction of contaminating ions by use of chemical selectivity, that is, the absorption on a piece of quartz that is inserted between the target container and the ion source, inside the transfer line [4]. Especially the amount of alkalis like rubidium is reduced by several orders of magnitude. For an optimal operation, the temperature of the transfer line has to be adjusted. With such a target it was possible to obtain very pure beams of neutron-rich zinc isotopes beyond the magic shell $N = 50$.

*Application of Submicron Targets*

One challenge of the thick ISOL targets is the fast release of short-lived isotopes from the target container. Especially refractory elements like vanadium are not accessible with ISOL targets. However, a recent development toward new target material showed a way to improve release times and to provide higher production yields and even new beams. This new material consists of sub-micron size grains [5] (e.g., of silicon carbide or yttrium oxide). First on-line tests and full experiment runs showed very promising results [6] and the reliability will be further tested in the future.

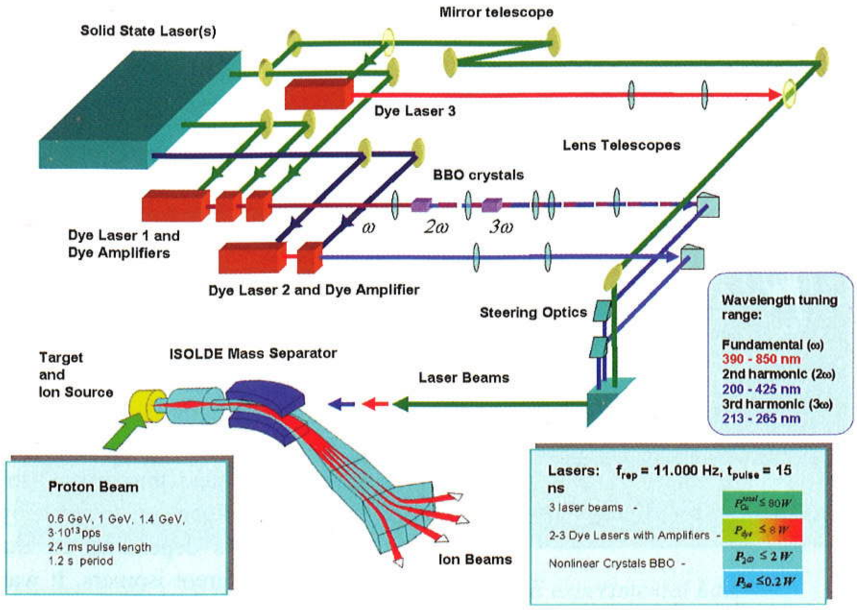


**Figure 3.** *RILIS scheme with the new solid state pump lasers.*

*A New Versatile Arc Discharge Ion Source (VADIS)*

The production yield also depends on a high ionization efficiency. A recent technical development aimed at the improvement of a plasma ion source [7]. With this new type of versatile arc discharge ion source (VADIS), the yields of noble gas isotopes have been increased by up to an order of magnitude. It was therefore possible to reach very neutron-rich isotopes of krypton and radon, especially $^{229}$Rn was investigated for the first time including the determination of its mass and half-life [8].

*RILIS Developments*

The Resonance Ionization Laser Ion Source (RILIS) [9] is very selective and

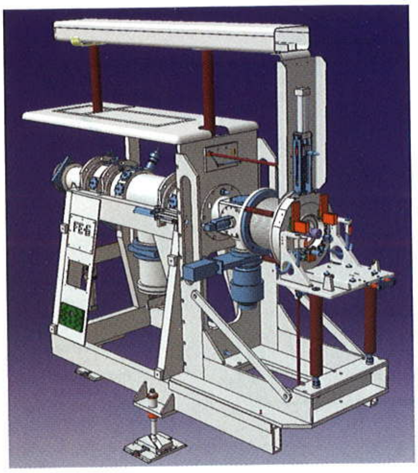

**Figure 4.** *New HRS front-end FE 6.*

operates through stepwise excitation of atoms to above the ionization threshold. It has been an important part of ISOLDE since 1992 and the technology has been transferred to many other laboratories. The RILIS group, led by Valentin Fedosseev, is continuously pushing the development and tests of new ionization schemes [10] in order to get access to new elements (e.g., gold [11]) or to improve the laser ionization efficiency for available elements.

A recent major upgrade was done in light of the HIE-ISOLDE project (see below). New solid state pump lasers (Nd:YAG) replaced the aging copper vapor lasers, which had a rather long start-up time (more than two hours) and pulse-to-pulse instabilities. In 2008 the first on-line use of Nd:YAG lasers took place and in 2009 only Nd:YAG pump lasers were used for on-line runs (see Figure 3 for the laser scheme of RILIS). The copper vapor lasers have been removed recently and a further upgrade of the pump lasers and installation of new dye lasers is ongoing. It is also planned to perform tests on Ti:Sa lasers in order to check the feasibility for a future use at ISOLDE.

Presently, 29 RILIS elements are available at ISOLDE and for other 17 elements the ionization schemes have been tested. Recent highlights of RILIS developments include a new scheme for manganese and a two times higher efficiency for gallium. In 2010 it is planned to perform an on-line test for resonant laser ionization of astatine.

Besides the broad-band excitation, it is also possible to have a narrow-band excitation in order to excite hyperfine levels and thus select isomers of an isotope of interest by tuning the lasers depending on the spins of the different isomers. It was also possible to apply the RILIS lasers for in-source laser spectroscopy [12].

In addition to the upgrade of the RILIS pump lasers, a new off-line laboratory was initiated: the LARIS laboratory at CERN. In principle, it consists of an oven to produce an atomic beam from a sample that is then crossed by laser beams for ionization. The amount of ionization is measured with a time-of-flight spectrometer with which the ions are detected and analyzed. This off-line laboratory has proven to be very useful in finding new ionization schemes especially for the application of the new Nd:YAG pump lasers at the ISOLDE RILIS.

### Recent Improvements of the Facility

The ISOLDE facility has over the last years continuously improved the conditions for experiments. The installation of the radiofrequency quadrupole cooler and buncher ISCOOL [13], as part of the HIE-ISOLDE upgrade, had a major impact on many experiments. Especially laser spectroscopy experiments can make use of the bunched beams in order to reduce background effects by orders of magnitude. For all experiments the emittance of the HRS beam has improved due to ISCOOL, which allows the experiments to have a better injection of the beam into the setups.

Recently, the HRS front-end was exchanged with a new more modular system (Figure 4) and it is planned to exchange the GPS front-end soon. Target changes and operation should be more reliable with fewer delays. For the beam diagnostics a new fast tape station is being commissioned. It will allow the ISOLDE technical group to obtain yield information of short-lived isotopes not possible with the present system. Finally, the vacuum system was completely renovated to ensure a more reliable operation.

### Experimental Installations at ISOLDE and Recent Results

This facility portrait cannot provide a complete overview of all recent ISOLDE experiments and results. In the following the major permanent installations at ISOLDE are briefly reviewed and recent examples of physics results are given.

#### *REX-ISOLDE and Post-Accelerated Beams*

The REX-ISOLDE system [14] has evolved in the last years into a facility within the ISOLDE facility (Figure 5). It is maintained by CERN staff and step-by-step the operation has improved over the last years with respect to reliability and efficiency. Isotopes as heavy as radon isotopes have been post-accelerated and efficiencies reach between 5 and 10%.

The multiply charged ions needed for efficient post-acceleration are produced in a unique way in the REX-ISOLDE low energy stage. Singly charged ions from ISOLDE are stopped, bunched, and cooled in a Penning trap (REX-TRAP), transferred to an electron beam ion source (REX-EBIS) where they are bred to mass-to-charge ratios between A/q = 3 and 4.5 before magnetic separation and acceleration. This essentially universal scheme allows post-acceleration of most of the beams produced by ISOLDE.

The technical improvements include tests of diamond detectors for a better beam diagnostics and bunched injection from the ISCOOL buncher and cooler. Furthermore, REX-TRAP has been used to improve the mass-selectivity and within the REX-EBIS charge breeder iron isotopes were produced by in-trap decay of stored manganese isotopes [15].

The main user of the post-accelerated beams is the MINIBALL gamma array [16]. MINIBALL consists of eight cryostats, each containing three individual germanium crystals that are mounted in close geometry around the target position. In case of Coulomb excitation experiments (see Refs. [17–19]) the spherical target and detection chamber is equipped with a double sided silicon strip detector (DSSSD) to detect projectile and/or target particles. The DSSSD allows one to determine the energy (velocity) and scattering angle of the detected particles, an essential ingredient for the Doppler correction of the gamma-ray spectrum. It is also possible to study nucleon transfer reactions in inverse kinematics for which dedicated detection set-ups have to be used in addition to the gamma array. One example is the T-REX system [20], which has been successfully used to investigate one or two neutron transfer reactions (see Ref. [21]). An overview of the REX-ISOLDE experimental program can be found in Ref. [22].

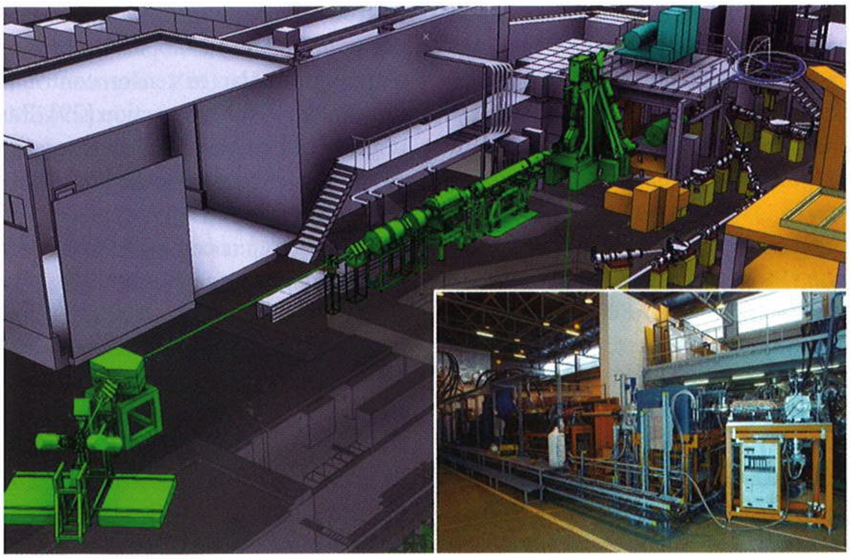

**Figure 5.** *REX-ISOLDE setup within the ISOLDE experimental hall.*

Another beam-line is connected to the REX-LINAC in order to send post-accelerated beams to dedicated experimental setups (e.g., to perform scattering experiments). It is also planned to study polarized nuclei using the tilted foils polarization technique. A test setup is presently installed at ISOLDE.

*Laser Spectroscopy at COLLAPS and CRIS*

Atomic-beam experiments with radioactive ions were pioneered at ISOLDE and still provide important and model independent information on nuclear ground state properties such as charge radius, spin, magnetic dipole moment, and electric quadrupole moment. Today most studies involve collinear laser spectroscopy where the ion (or atom) beam is overlaid with one or more laser beams. At ISOLDE, two experiments are permanently installed: COLLAPS and CRIS. While the CRIS experiment is presently commissioned and will receive its first on-line beam end of 2010, the COLLAPS experiment has a long record of measurements carried out in the last decades at ISOLDE.

COLLAPS uses different detection techniques to obtain information on hyperfine splitting or isotope shifts. The most common is the classical collinear laser spectroscopy where fluorescence light emitted by the excited atoms is detected with photomultipliers. The other methods use optical pumping, for example, into excited states with a lower ionization energy (for subsequent re-ionization) or to change the population with respect to nuclear polarization. In the latter case the beta-NMR technique is applied for the measurement of resonances (see Ref. [23]). Recent highlights comprise results on the charge radii of neutron-rich beryllium isotopes [24], on the moments of neutron-rich gallium isotopes [25], and data obtained for nuclear spins and magnetic moments of copper isotopes [26]. The CRIS setup (collinear resonant ionization spectroscopy) aims at francium isotopes with low production yields of only a few hundred atoms per pulse, which requires the application of the ISCOOL buncher, pulsed excitation lasers as well as sensitive particle detection.

*High-Precision Mass Measurements with ISOLTRAP*

The ISOLTRAP Penning trap mass spectrometer [27] aims at the precise and accurate determination of atomic masses of exotic nuclides. It is capable to study nuclides with a production yield below 100 ions per pulse and with half-lives below 100 ms. The mass determination is performed by measuring the cyclotron frequency in a strong homogeneous magnetic field of the isotope of interest and of a well-known nuclide. From the ratio of the frequencies, the mass ratio is obtained. ISOLTRAP employs meanwhile four different ion traps in order to study exotic nuclides. With a linear radiofrequency buncher and cooler the ions delivered by ISOLDE are bunched for subsequent injection into a multi-reflectron time-of-flight system. This new device has a high resolving power (several 10,000 within a few milliseconds) and preselects the ions for the first Penning trap, where an additional isobaric cleaning is performed. Finally, in the measurement Penning trap, the cyclotron frequency of—in the ideal case—only one ion is measured. With ISOLTRAP more than 400 nuclide masses have been determined in the last years, which are applied for nuclear structure physics (see Ref. [28]), nuclear astrophysics, and fundamental tests. One recent highlight is the discovery of the new isotope $^{229}$Rn of radon [8].

*The WITCH Experiment*

The WITCH experiment aims at a test of the Standard Model by probing the recoil energy spectrum after beta decay of selected isotopes in order to search for scalar or tensor contributions to the Weak Interaction [29]. For unpolarized nuclei the shape of the recoil ion energy spectrum is determined by the $\beta$–$\nu$ angular correlation. A Penning trap is employed to act as a source for the decaying nuclides. By use of a so-called MAC-E filter (retardation spectrometer), all recoiling ions are transmitted along the experiment axis and with an electrostatic barrier (retardation potential), their kinetic energy can be determined. The experiment has completed the commissioning phase and a physics run on $^{35}$Ar is planned at the end of 2010.

*Nuclear Orientation at NICOLE*

The NICOLE experiment aims at, e.g., the measurement of magnetic dipole moments by use of oriented nuclei at low temperatures and on-line $\beta$-NMR [30, 31]. The exotic nuclides from ISOLDE are deposited, for example, on a pure iron foil soldered to the cold finger of the dilution refrigerator for which the temperature can be lowered down to 10 mK. Beta detectors are placed at 0° and 180° to the orientation axis outside the setup close to the sample location in order to measure the polarization. The magnetic resonance is obtained by varying a radiofrequency excitation and observing a change of the asymmetry. One recent example is the case of $^{71}$Cu, for which the magnetic dipole moment was determined for the ground state [32].

*Spectroscopy at TAS*

Measuring beta decay strengths is notoriously difficult because of the continuous nature of the beta decay spectrum. In general, such measurements have been made with germanium detectors. They are ideal for establishing decay schemes but unfortunately have very limited detection efficiencies. As a result it is difficult to determine beta-decay strengths because of the so-called Pandemonium effect [33].

This difficulty can be overcome by the use of Total Absorption spectroscopy [34]. The technique is based on the detection of all of the gamma cascades that follow the beta decay from each level with a highly efficient device, a total absorption gamma spectrometer (TAS). Thus instead of detecting the individual gamma rays one measures directly the intensity of feeding to each level.

The TAS setup at ISOLDE has been installed by a collaboration of groups from Strasbourg, Valencia, Surrey, and Madrid. This LUCRECIA setup is one of the largest single crystal total absorption spectrometers in existence. It has a cylindrical shape with a diameter of 38 cm and a length of 38 cm. It has a longitudinal bore perpendicular to the symmetry axis. The beam-line from ISOLDE enters this hole and radioactive species can be implanted directly in the center of the TAS or can be carried there after implantation on a moving tape.

LUCRECIA has been used in studies of shape effects in the mass region A = 70. For example, it was shown [35] that $^{76}$Sr is one of the most deformed, prolate nuclei that exist in nature and it was confirmed that $^{74}$Kr has a mixed shape ground state [36]. Presently, similar studies in the lead region aim to determine the shapes of the ground states of $^{188,190,192}$Pb.

*Free Beam-Lines for Decay Spectroscopy*

ISOLDE provides two beam lines, LA1 and LA2, for a versatile use of the variety of radioactive ion beams for any short-term experiment. Usually these are decay spectroscopy setups that are put up in a few days and operate on-line up to one week before they are dismantled.

*The Solid State Physics Program at ISOLDE*

The application of radionuclides produced at ISOLDE in materials science and biophysics account for about 15% of the allocated on-line operation [37–40]. In the case of materials science, investigations focus on the study of semiconductors and oxides, with the recent additions of nanoparticles and metals, while the biophysics studies address the toxicity of metal ions in biological systems. The different experimental techniques that are used to characterize the samples are typical radioactive probe techniques such as Mössbauer spectroscopy [41], perturbed angular correlation, emission channeling, and tracer diffusion studies. In addition to these "classic" methods of nuclear solid state physics, also standard semiconductor analysis techniques such as photoluminescence or deep level transient spectroscopy profit from the application of radioactive isotopes.

Mössbauer spectroscopy yields information on the charge state and on the electric field gradients and magnetic fields to which the Mössbauer probe nucleus is exposed in a solid. With the pure and intense $^{57}$Mn beams delivered by ISOLDE, it is possible to populate the 98 ns level in $^{57}$Fe by beta decay, which is the most commonly used Mössbauer state. The intense $^{57}$Mn beams allow the experiments to do fast data taking and to record hundreds of Mössbauer spectra per day, which is not possible in any other radioactive ion beam facility. Mössbauer experiments with $^{57}$Mn/$^{57}$Fe have been undertaken in a large variety of semiconductors and oxides, for example ZnO [42]. Recently, Mössbauer spectroscopy including a measurement of the angular dependence was used to determine that the coupling in ZnO is clearly paramagnetic, therefore reducing the perspectives for ZnO:Fe to act as a true dilute magnetic semiconductor [43].

The method of perturbed angular correlation (PAC) allows one to measure the electric field gradient and the magnetic field that a suited probe nucleus experiences on its lattice site in a solid. Experiments at ISOLDE mainly concentrate on the investigation of semiconductors and metal surfaces [44] using, for example, the probes $^{111}$In, $^{111m}$Cd, and $^{111}$Ag. The general goal is to better characterize the properties of In, Cd, and Ag impurities in nitrides. PAC is also applied to study oxides, for example, for the investigation of phase transitions in manganites [45].

The principle of the emission channeling (EC) lattice location method relies on doping single crystals with radioactive probe atoms that decay by the emission of charged particles such as $\alpha$, $\beta^-$ or $\beta^+$ particles or conversion electrons, which, on their way out of the crystal, experience channeling or blocking effects along crystal directions. The resulting anisotropic particle emission yield in the vicinity of major crystallographic directions depends in a characteristic way on the lattice sites occupied by the emitter atoms and is recorded with the aid of position sensitive detectors. During the last years the EC experiments focused on the lattice location of dopants and impurities in ZnO [46], Si, GaN, AlN, and, most recently, also in Ge.

Biophysics and medical applications have a long tradition at ISOLDE. While the investigation of new radioisotopes for small-scale clinical studies is continued in the near future, biophysics studies using the PAC technique are successfully ongoing with the main probe nuclei $^{199m}$Hg and $^{111m}$Cd. The biophysics PAC experiments generally aim to identify the binding sites, ligands, and dynamic interactions of probe atoms attached to large biomolecules under specific conditions [47]. The radioisotopes are implanted in ice held at liquid nitrogen temperature. After melting the ice, the radioactive probes are directly available for biochemical processing in aqueous solution using a small chemistry lab located on-site. It is planned to extend the ISOLDE biophysics experiments to *in vivo* studies, *that is*, by introducing the PAC probes into living plants [48].

**Outlook: The HIE-ISOLDE Project**

The HIE-ISOLDE project is the next major upgrade and will boost ISOLDE to higher energies for the post-accelerated radioactive ion beams and with an increase of the intensity of the proton driver higher production yields are envisaged. Furthermore, the beam quality is subject to improvement, which is partly accomplished with the installation of the ISCOOL buncher and cooler as well as the new RILIS pump lasers as mentioned earlier.

The HIE-ISOLDE project has been approved by the CERN Research Board in December 2009 and the project has officially started in January 2010. With Yacine Kadi as Project Leader and Matteo Pasini as technical coordinator for the HIE-LINAC system the project is looking forward to the production of the first cryomodule. In June 2010 over 30 Letters of Intent for the future HIE-ISOLDE facility were evaluated by the INTC. The information gathered from the experiment proposals will be used to finalize the layout of the new HIE-ISOLDE experimental hall. It is planned to operate the low-energy ISOLDE experiments during the installation of the new superconducting HIE-LINAC accelerator and for the post-accelerated beams a staged approach is foreseen in order to give beam to, for example, MINIBALL at intermediate energies before reaching the design value of 10 MeV/u.

With the ongoing development of radionuclide beams, present experiments as well as new installations, especially for HIE-ISOLDE, the ISOLDE facility is looking forward to new discoveries and results in the next years to come.

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