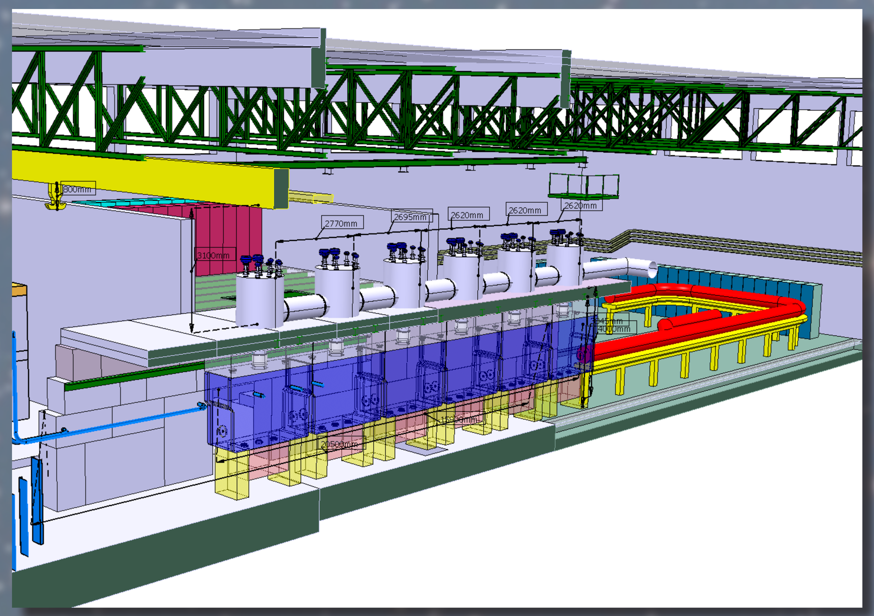
# HIE-ISOLDE

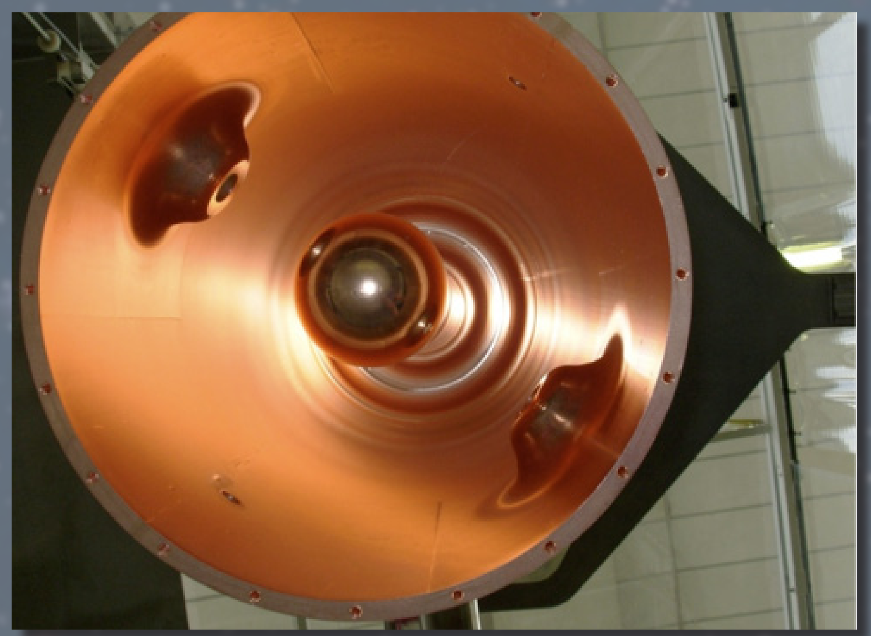
## The future of ISOLDE

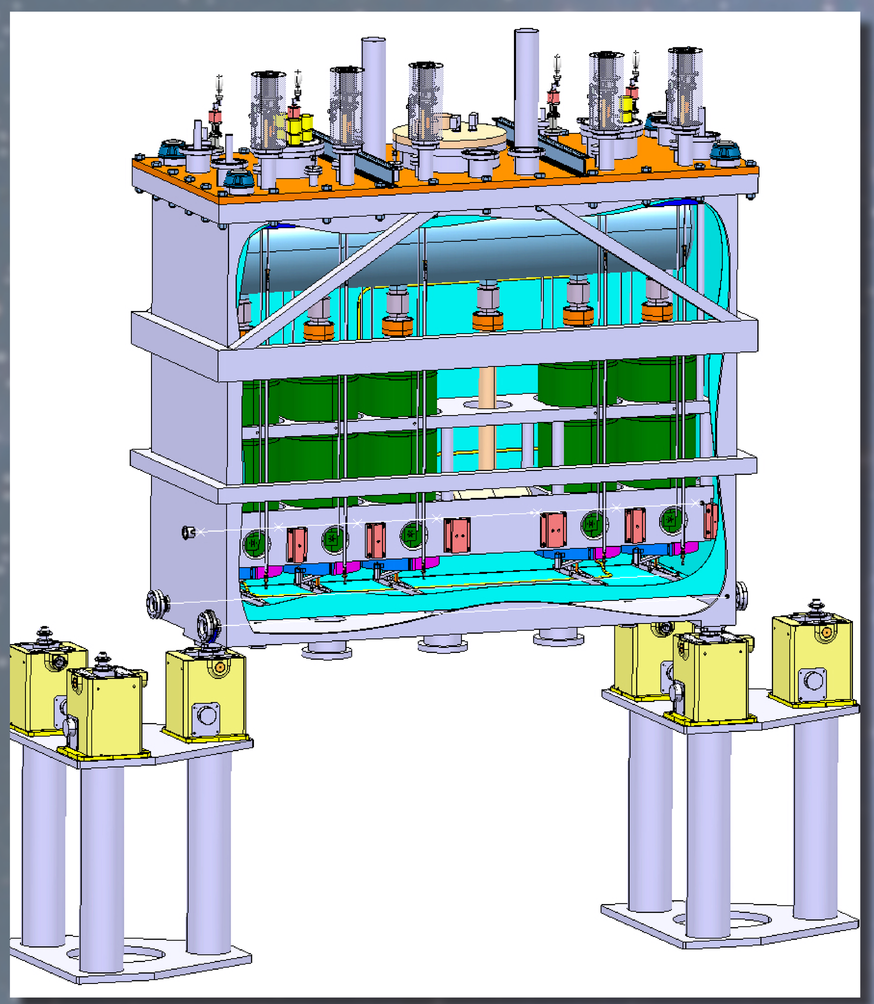
*The HIE-ISOLDE (High Intensity Energy-ISOLDE) Project is a major upgrade of the ISOLDE facility which will increase the energy, intensity and quality of the beams delivered to ISOLDE Users. It consists in the construction of a new superconducting linear accelerator for the energy increase and a Design Study for the intensity and quality improvements. HIE-ISOLDE will be part of a European network of new Radioactive Ion Beam facilities using the ISOL (Isotope Separation On Line) technique which also includes SPIRAL2 in Caen, France and SPES in Legnaro, Italy. The experience gained with these facilities is expected to lead to the construction of the ultimate ISOL facility for Europe named EURISOL.*
*HIE-ISOLDE contributes to the training of young scientists and engineers for Europe through the CATHI (Cryogenics, Accelerators and Targets for HIE-ISOLDE) contract between CERN and the European Commission. CATHI funds 20 young people to work on the HIE-ISOLDE project and enhance their knowledge by attending schools and conferences and spending time at partner institutes.*

### Energy Upgrade

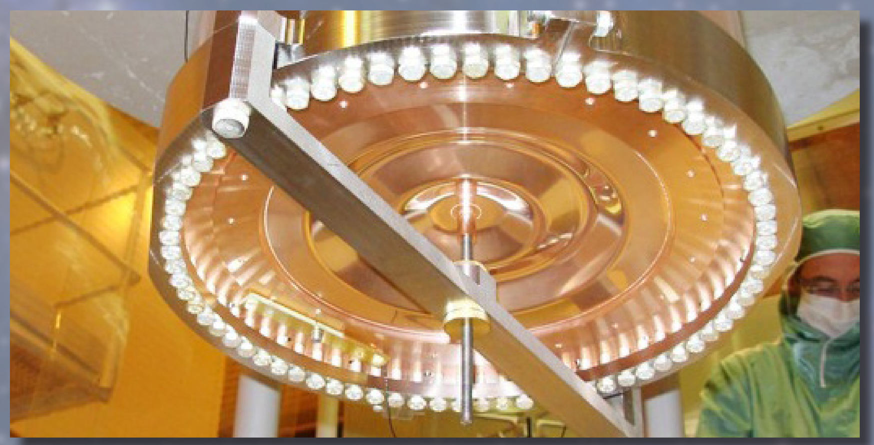
A new superconducting linear accelerator (LINAC) consisting of six cryomodules containing sputtered acceleration cavities will be built and installed. The energy of the beams delivered will then reach 10 MeV per nucleon for all the nuclei available, as compared to 3 MeV per nucleon today with the current REX post-accelerator. Nuclear reactions such as transfer and fusion reactions will become accessible for the first time for many exotic nuclear species. Users are expected to design and build new instrumentation to make best use of these beams.

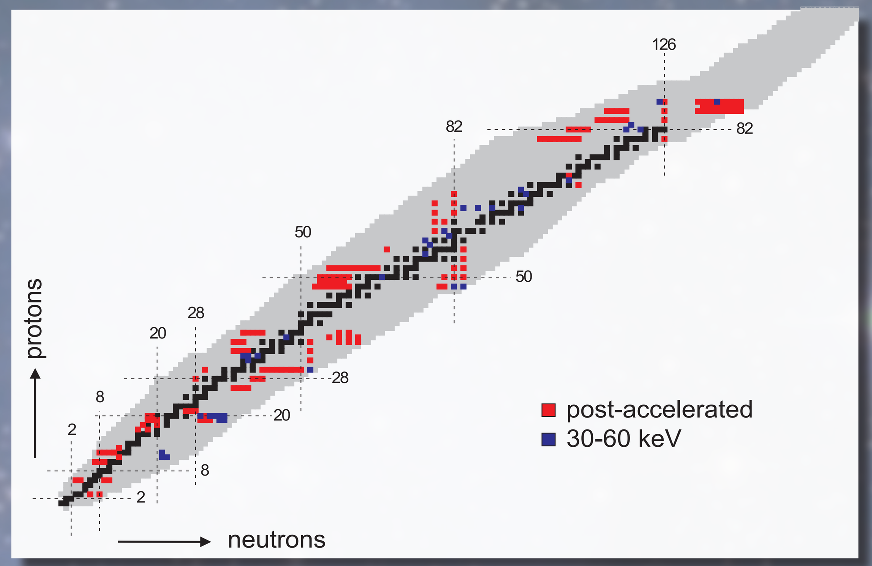

*View of the HIE-ISOLDE accelerator with the new beamlines occupying the hall extension.*


*Inside of the accelerating cavity, made from copper and later to be sputtered with a thin nyobium layer*


*HIE-ISOLDE cryostat with 5 superconducting cavities inside*


*Testing a cavity*

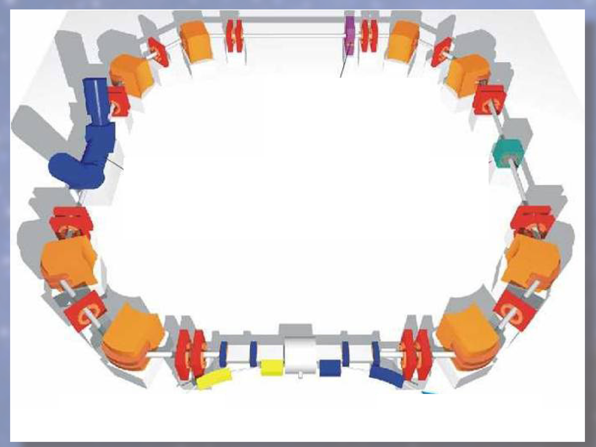

*A bottom view of one of the cavities*

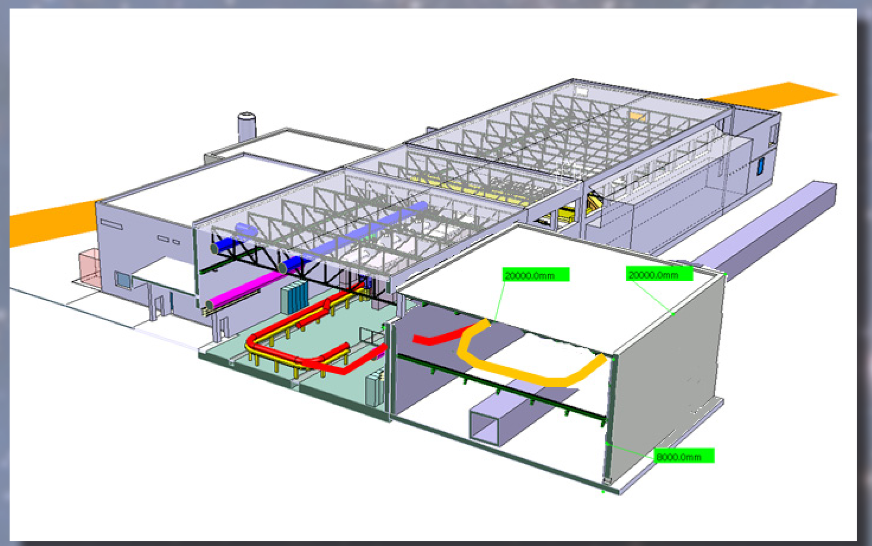


*Various radionuclides requested in the Letters of Intent for HIE-ISOLDE experiments.*

### Experiments at HIE-ISOLDE

Close to 300 scientists from 75 laboratories in 22 countries signed 35 Letters of Intent to perform experiments with HIE-ISOLDE. A large variety of beams was requested, spanning all regions of the nuclear chart. The workhorse set-up will be the MINIBALL gamma ray detector associated with an upgraded version of its light particle detector T-REX, which will be permanently installed on one of the beam lines. A second beam line will be constructed to house travelling experimental installations which can be shared between different radioactive beam facilities. For the longer term, physicists are designing a magnetic spectrometer which will complement the MINIBALL set up by identifying the scattered heavy nuclei. Another project is to move a storage ring for heavy nuclei, currently in operation at the Max Plank Institute in Heidelberg, to ISOLDE. A new building will be required to install the first storage ring to operate at an ISOL facility, which will allow unique atomic and nuclear physics experiments to be performed.


*The TSR storage ring which is planned to be installed at HIE-ISOLDE*


*Future of ISOLDE hall, including the additional space for the storage ring (RIGHT)*

### Intensity and Quality Upgrade

The new LINAC4 injector installed for the LHC combined with the upgraded PS booster will increase the energy and intensity of the proton beams impinging on the ISOLDE production target. To make best use of these improvements for the production of beams at ISOLDE, and ensure containment of the increased radiation, a redesign of the target area and of the targets themselves will be undertaken. Improvements to ion sources and magnetic separators will also enhance the quality and purity of the beams delivered to the scientists.

### Targets and Ion Sources

The higher intensity of the proton beam will have an influence on the ISOLDE targets and the target area. The present target materials will be checked for resistance to radiation and new materials will be tested. The target geometry and ion-source shape may also be modified. The energy deposition and heat transfer will be verified.

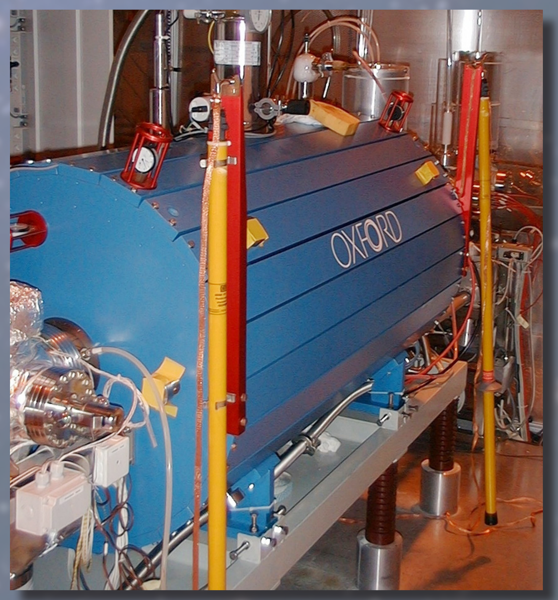

*Material evolution of sub-micron SiC target after proton irradiation*

### Separator Upgrade

Better separation of the beam of interest from disturbing isobars can be provided with upgraded separators. An improved high-resolution separator magnet will provide better beam quality and will be integrated into the existing infrastructure, while pre-mass separator will contain unwanted isotopes within shielded target area with a Wien Filter.

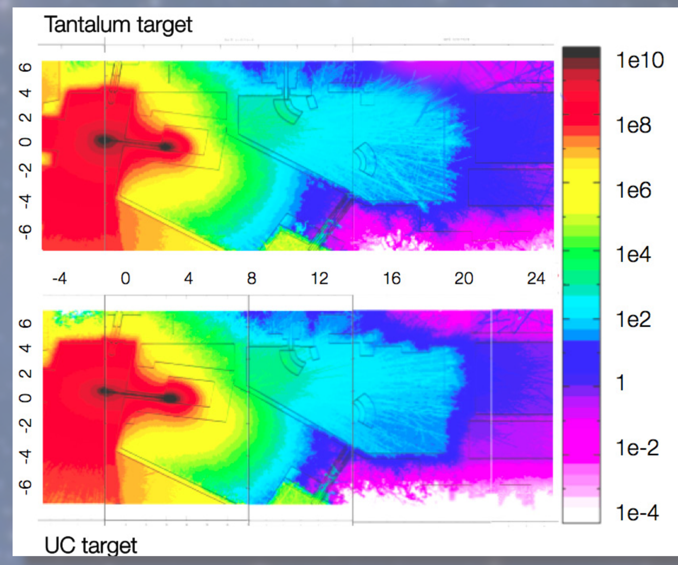
### REX-Ebis Upgrade

Evaluation of EBIS charge breeder options for HIE-ISOLDE and design of an upgrade of the REX-EBIS breeder are under way in order to increase the intensity and duty cycle of the manipulated ion beam.


*The present ISOLDE charge breeder*

### Safety

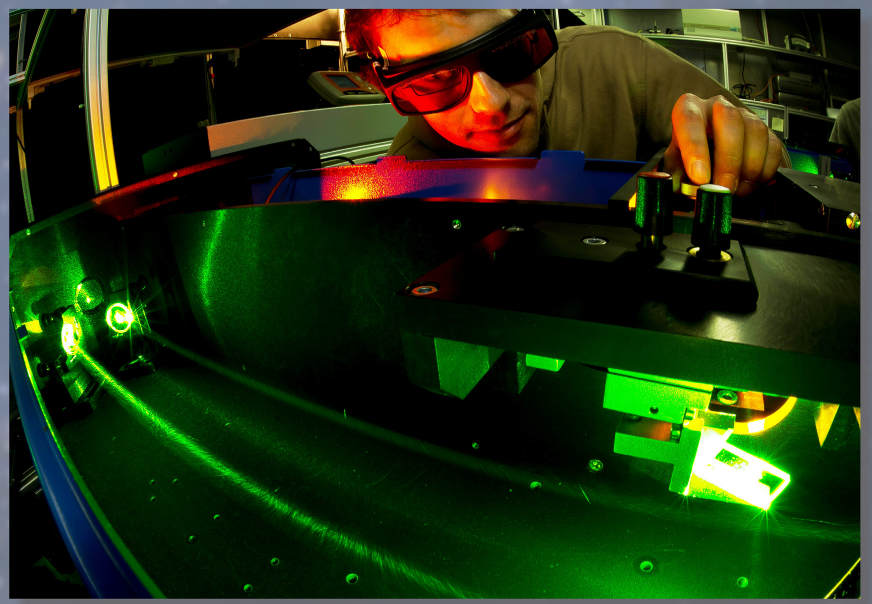
A study of radiation levels and its impact on existing and new facilities is under way. Official radioprotection limits have to be respected, which will have an impact on existing shielding and access control.



*Fluka simulations of the radiation level inside the target area and behind the shielding for the upgraded proton intensity*

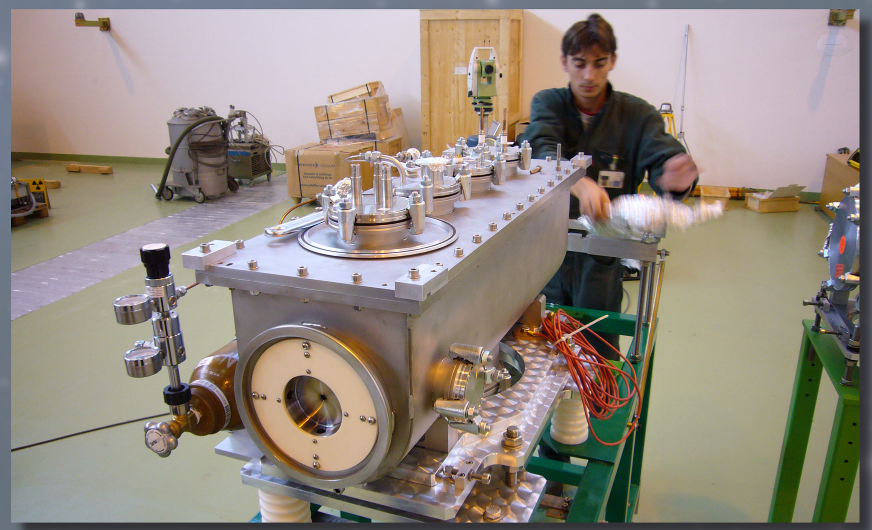
### RILIS Upgrade

The quality of the delivered beams depends to large extent on the ion source. The resonant ionisation laser ion source (RILIS) undergoes an upgrade that will allow providing more intense, stable in time, and more versatile beams with close to automatic operation. Two pump lasers, new dye lasers, and additional solid-state Ti:Sa constitute the upgrade.


*Part of the upgraded RILIS system*

### RFQ Cooler

The planned ion cooler will be located upstream from the magnet and will provide better emittance before entry into the magnet.


*The present ISOLDE rfq cooler-buncher before installation*

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