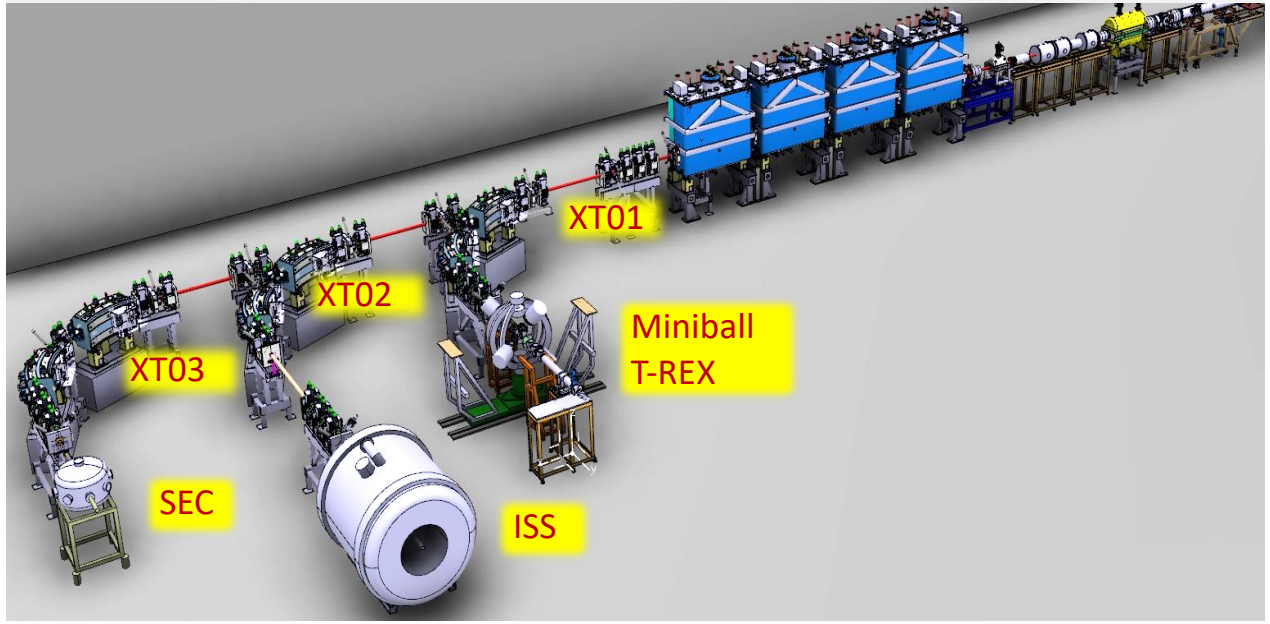
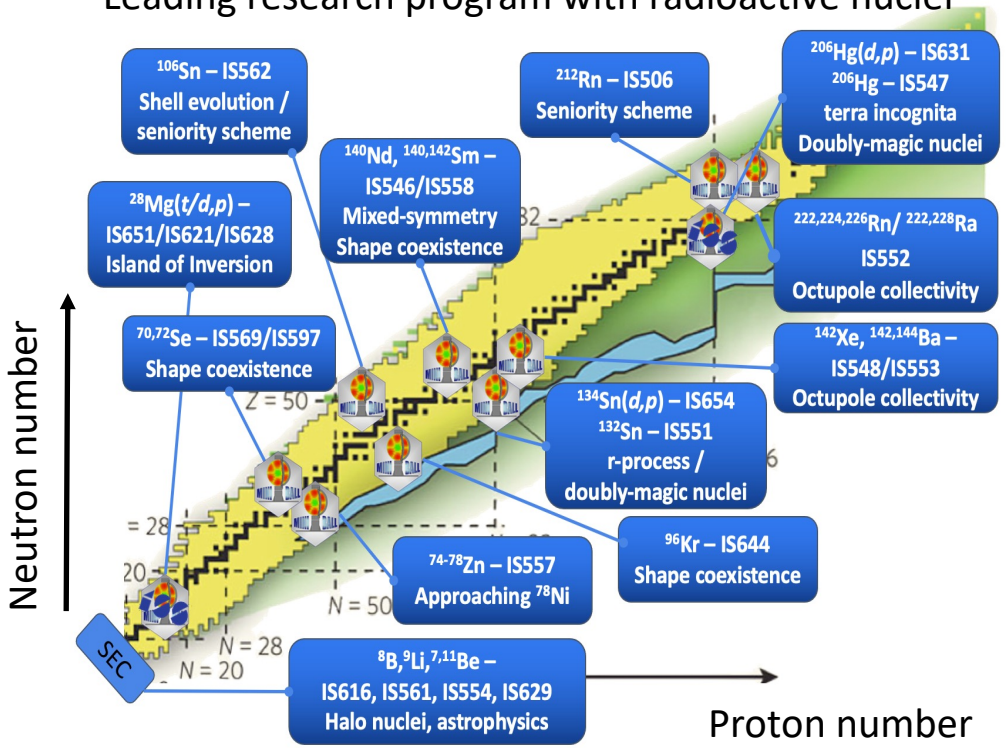
The HIE-ISOLDE facility at CERN

World-leading facility in radioisotope production and acceleration:

- Large range of radioactive beams: from ^{6}He – ^{234}Ra
- More than 1000 isotopes of about 70 elements
- Wide energy range from 0.45 to ~ 10 MeV/A



Leading research program with radioactive nuclei



Recent physics cases investigated at HIE-ISOLDE (L. Gaffney, ISOLDE EPICS Workshop 2019).

- The objective is to **carry out R&D program** to study the possibility to develop a compact fragment separator using **innovative** concepts and technologies: *(1) Mini-Storage ring, (2) CCT-Multifunction Superconducting solenoids, (3) FFAG, (4) Iron free magnets, (5) cryocooling*
- Unprecedent mass resolution, angular and momentum acceptance. Low cost.
- **Technological breakthrough for future fragment separators and mass spectrometers.**

PHYSICS OPPORTUNITIES

- ISRS as a stand-alone detector
- In coincidence with complementary detector arrays:
  - gamma- particle array Miniball + T-REX
  - Particle array GLORIA
  - Neutron array SAND
  - Multi-purpose reaction chamber SEC
  - Spectrometer ISS
  - Storage Ring

Benefit from the plans for a future extension of the HIE-ISOLDE experimental hall.

- *Coulomb dissociation* at a few MeV/u has rarely been used despite having much high cross sections
  - ✓ Core fragments ~15°
  - ✓ Coincidence with the neutrons, particles and gammas ejected in the breakup.

- *Direct transfer reactions in inverse kinematics*
  - ✓ Mainly when light outgoing particle is a neutron
  - ✓ Cone ranges from ±15° for light projectiles
  - ✓ About ±1° for heavy beams

- Nuclear structure studies around N≈82, 126
- Reactions relevant for the s, p and rp process nucleosynthesis around Z ≈ 50 and Z ≈ 82

- *Multinucleon transfer reactions*, via *deep inelastic, quasi-elastic and quasi-fission reactions*
  - ✓ Analyse individual exit channels.
  - ✓ Production of exotic nuclei and states so far unobserved
  - ✓ Coincidence with gammas and neutrons from decay.
  - ✓ Direct or inverse kinematics with light or heavy targets
  - ✓ The spectrometer should be able to rotate to cover the grazing angle

- Neutron-rich nuclei in Terra Incognita (78Ni, r-nuclei ~N=126)
- Shell-quenching and the r-process

Fusion evaporation reactions in inverse kinematics.

- Selection of fusion evaporation residues
- lifetime measurements using standard and triple foil plungers

Low energy transfer, breakup and fusion reactions.

- Reaction dynamics studies at low energies ~5 MeV/A
- Emphasize collective behaviour associated with nucleon correlations.
- Beam-like fragments in coincidence with neutrons and gammas

Physics program: we should look also for cases where nuclear physics, astrophysics and particle physics could all benefit (ie. physics BSM). Any ideas/contributions will be very welcome.

Momentum acceptance	± 10%	Solid angle	100 msr
Resolving power p/Δp	2000	Charge resolution ΔQ/Q	1/70 (FWHM)
Angular acceptance	+/- 10°	Mass resolution ΔM/M	1/250 (FWHM)
Angular resolution	0.1°	Rotation	0 - 70°

Table 1. Minimum spectrometer requirements