EBSS: Hands-on Activity #8

Operation of an electromagnetic isotope separator (EMIS)

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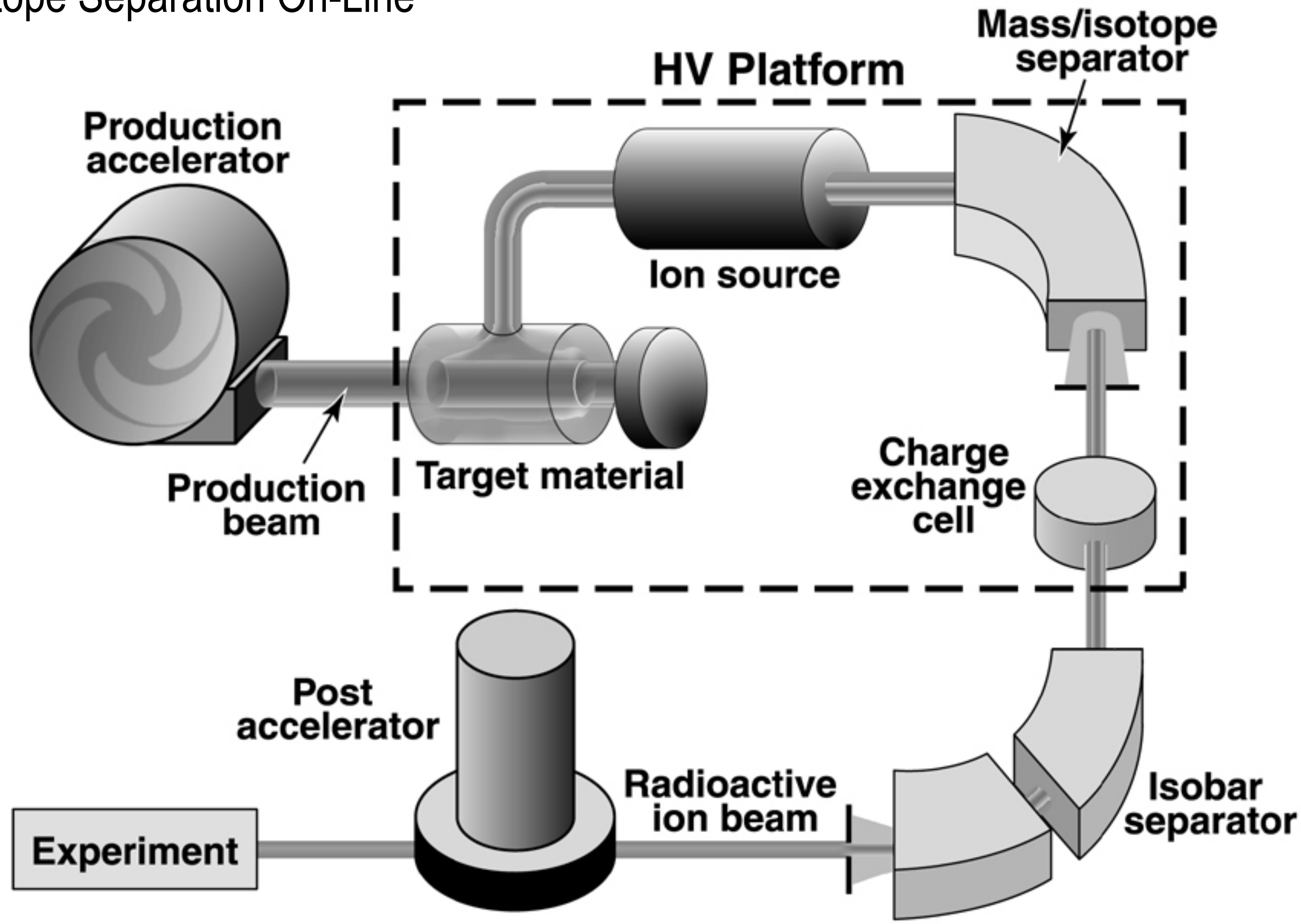
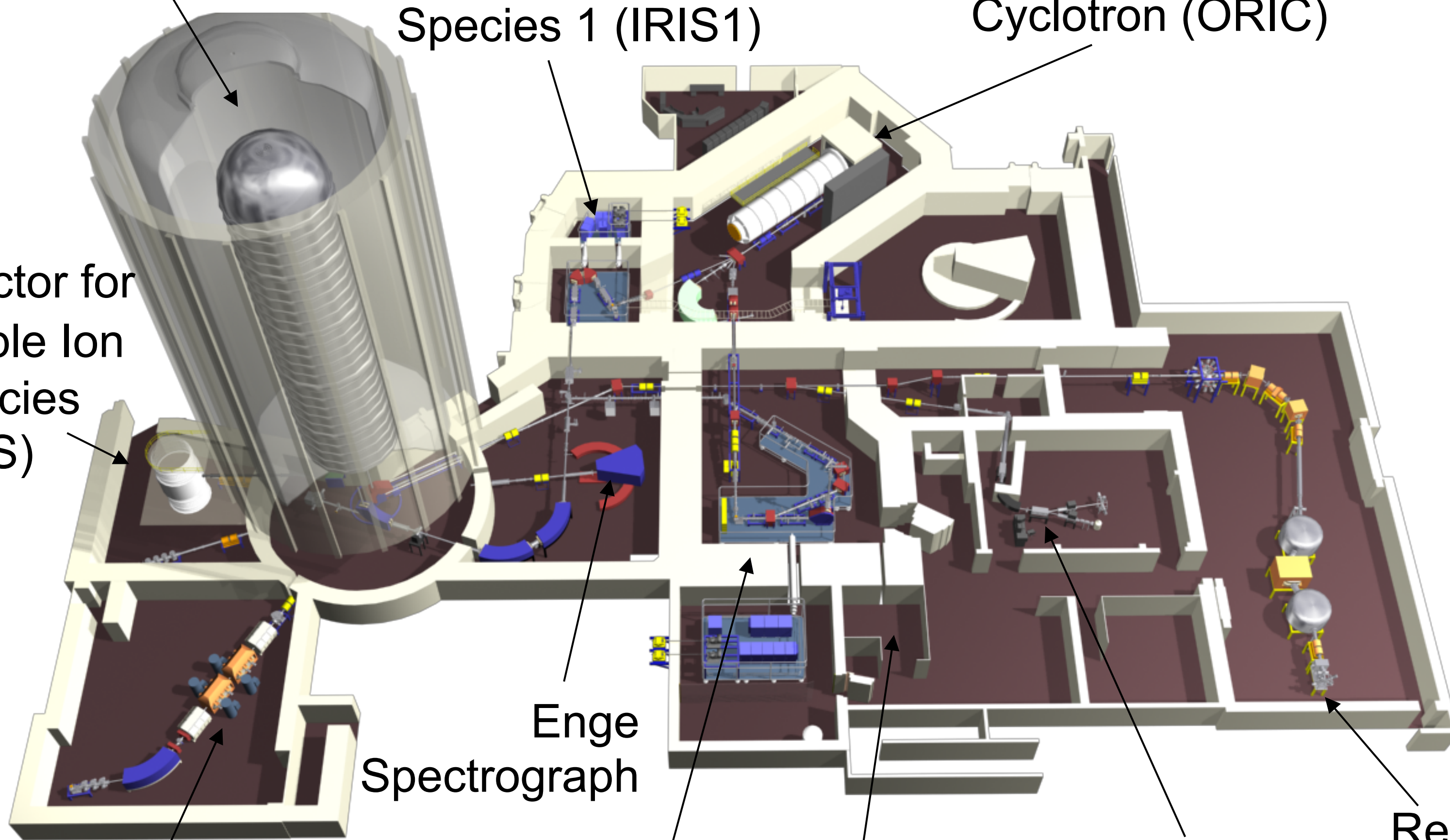
Schematic of RIB Production at the HRIBF

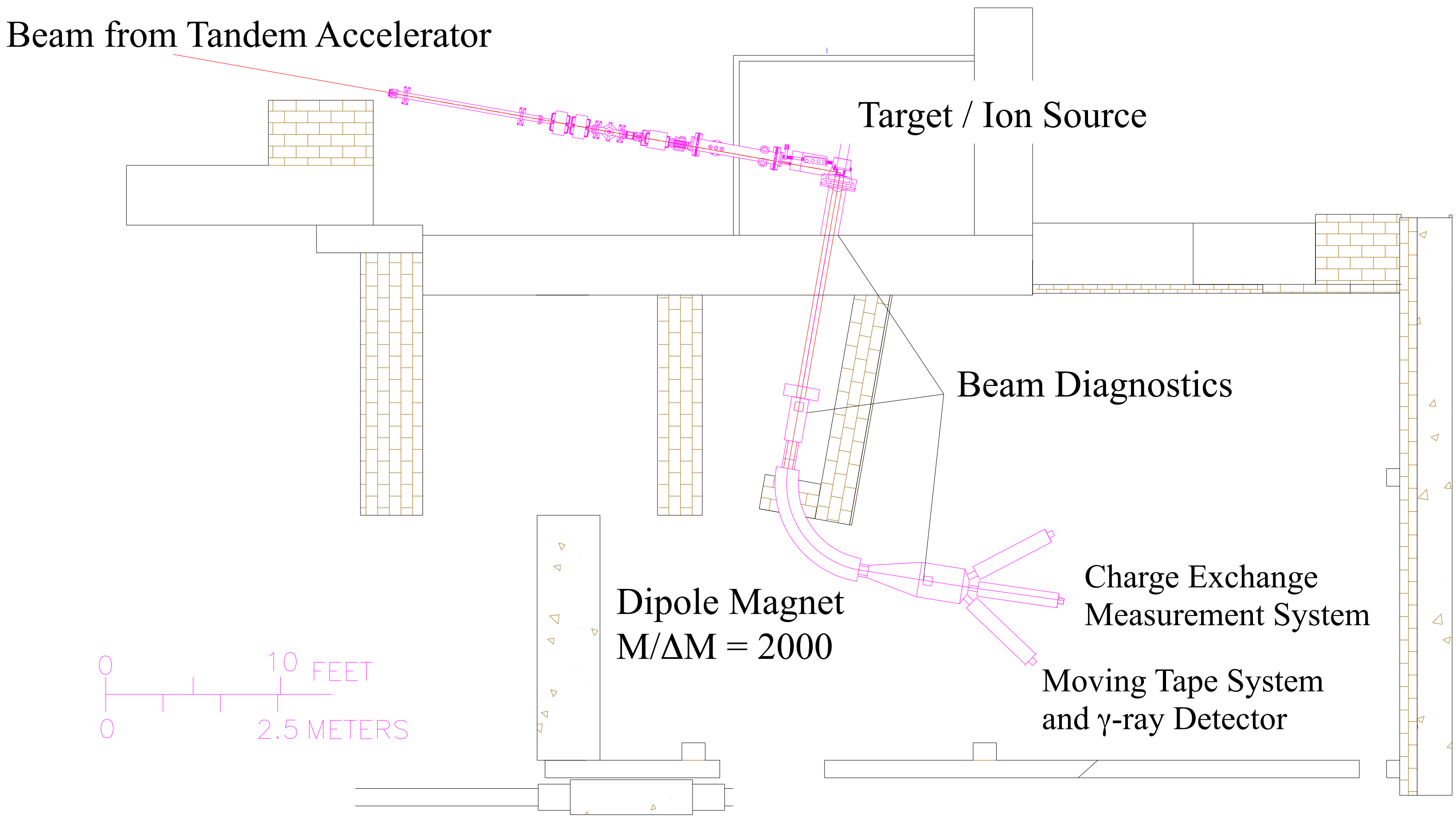
ISOL: Isotope Separation On-Line



HRIBF Layout



On-Line Target and Ion Source Testing Facility
(low intensity (<50 nA) tests of RIB production targets)



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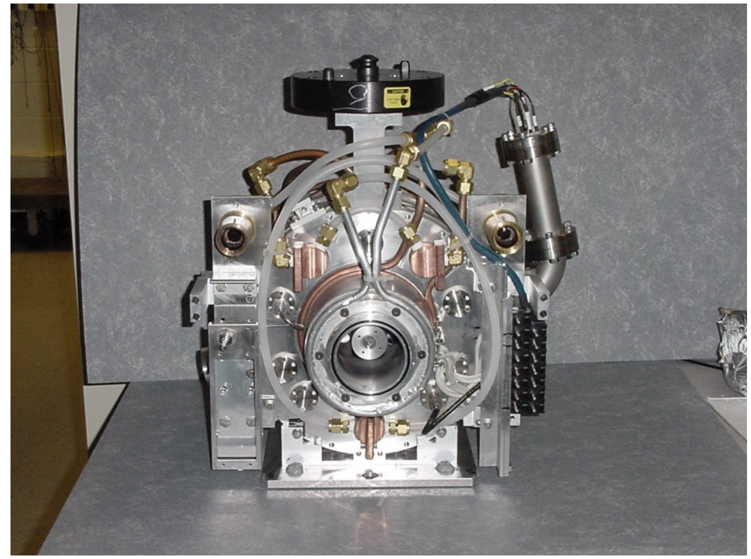
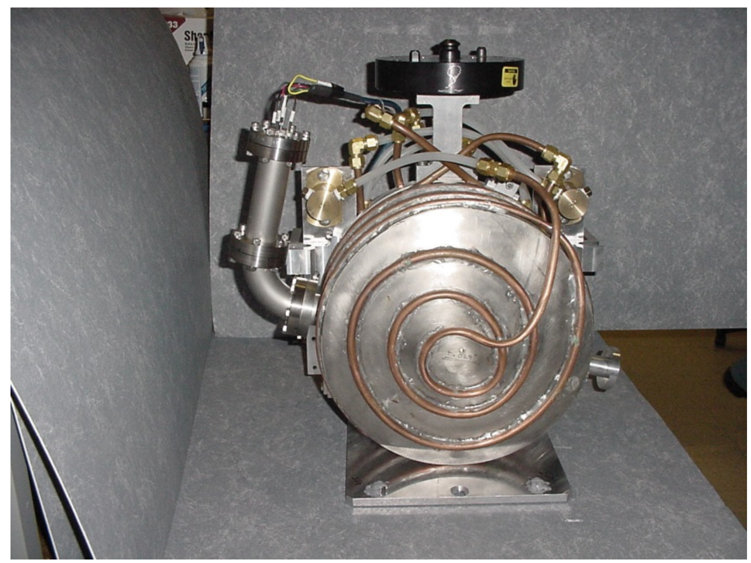
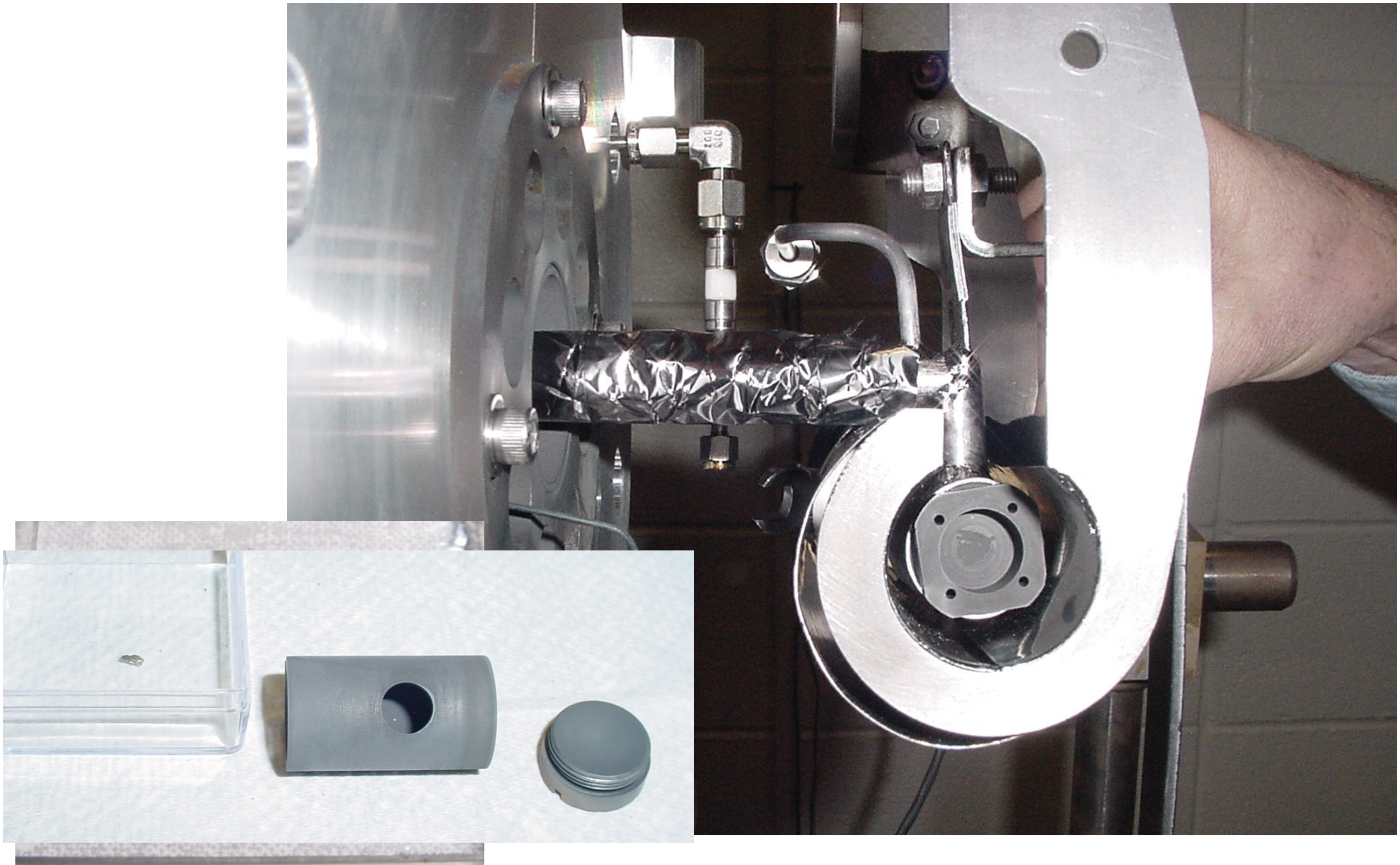
Target and Ion Source Enclosure

- A complete assembly that can be manipulated by a remote handling system
- Assembled off-line and then moved to the RIB production platform
- Holds the target and the ion source
- The target/ion source temperatures can be varied independently
- All TIS connections must be fed through vacuum-tight fittings
- Couples to both the light-ion beam line and the separator beam line





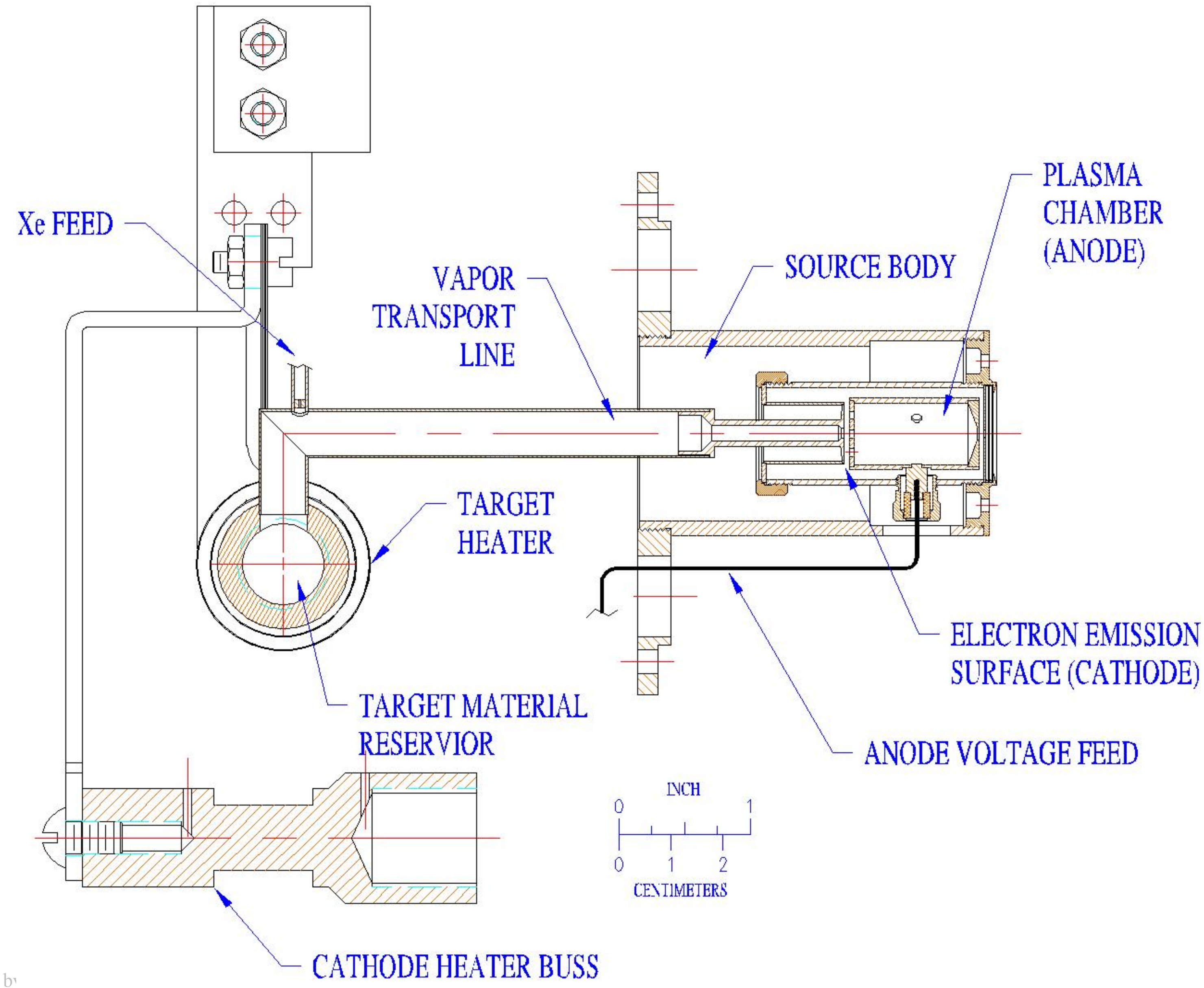
Target holder and transfer line to ion source



RIB Production Ion Sources at HRIBF

- Electron Beam Plasma Ion Source (EBPIS)
  - presently used to produce n-rich beams from UC target
  - high positive ionization efficiency for many elements
  - followed by Cs-vapor charge exchange cell (neg. ions)
  - >12000 μA-hours lifetime with up to 15 μA of 50 MeV protons on target
- Kinetic Ejection Negative Ion Source (KENIS)
  - produces negative ions
  - used for production of ^{17,18}F beams
  - may also be used for production of ^{33,34}Cl beams
  - >1200 hrs (3000 μAh) mean lifetime in beam (44 MeV ^{2}H)
- Multi-sample, Cs-sputter ion source for ^{7}Be, ^{10}Be, ^{26g}Al, and ^{82}Sr beams
  - produces negative ions
  - useful for long-lived activity
  - the radioactive atoms are produced elsewhere, extracted from the target material, and inserted into the ion source

Electron-Beam-Plasma (EBP) Ion Source



RIB Production Targets

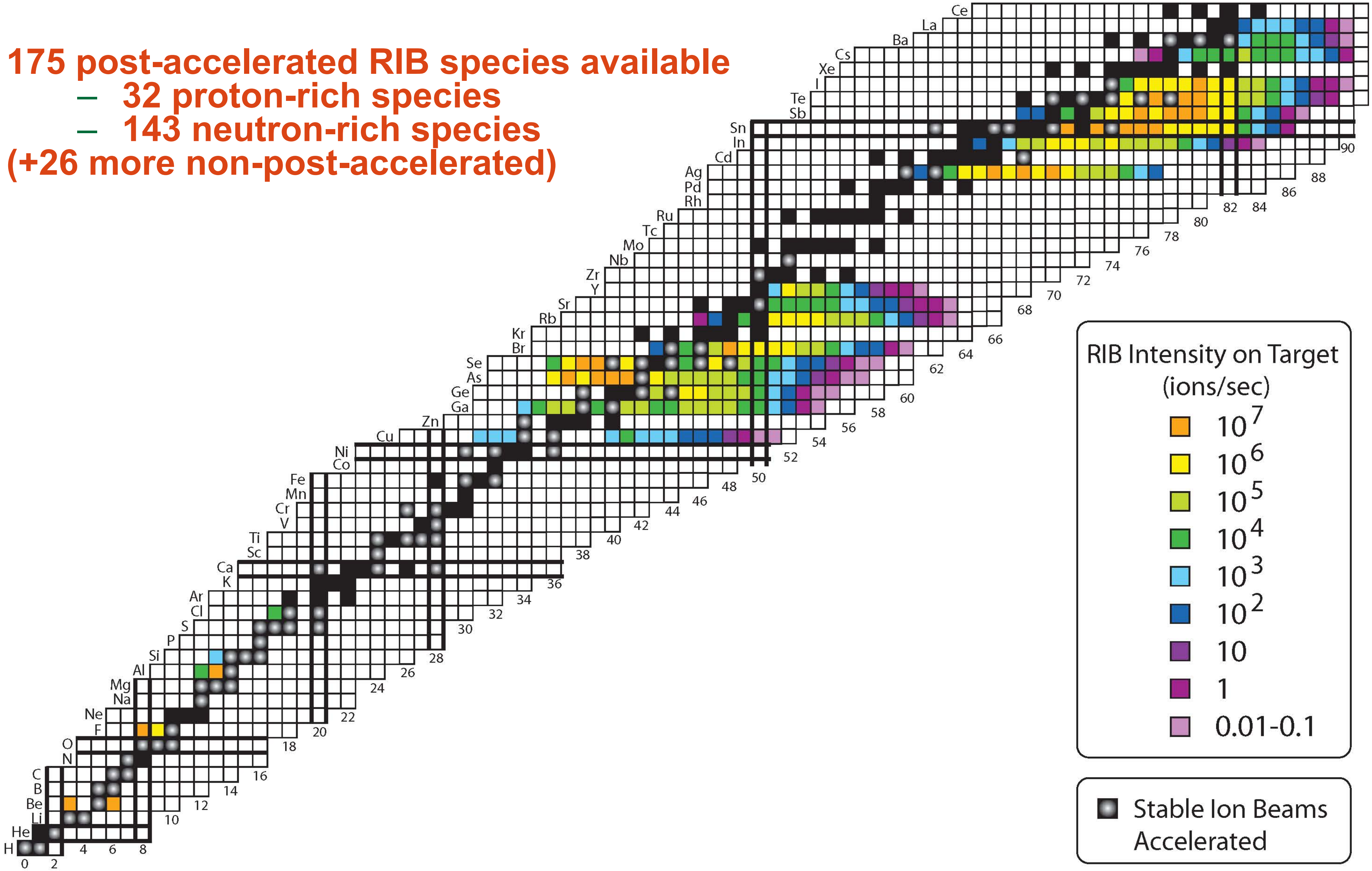
- **HfO_2 fibers** (production of ^{17}F and ^{18}F)
- **Uranium carbide** (production of n-rich beams via proton-induced fission)
- **Molten metals**
  - germanium for production of As, Ga, and Se isotopes
  - nickel for production of Cu isotopes
- **Ni pellets** (^{56}Ni via (p,p2n) reaction – ^{56}Co contamination)
- **Cerium sulfide** (production of ^{33}Cl and ^{34}Cl)
  - thin layers deposited on W-coated carbon matrix
- **Silicon carbide** (production of ^{25}Al and ^{26}Al)
  - fibers (15 μm), powder (1 μm), thin layers on carbon matrix, solid discs
  - also developing metal silicides (e.g. Nb_5Si_3 disks)
- **Aluminum oxide** (production of ^{26}Si and ^{27}Si)
  - thin fibers (6μm) with sulfur added for transport
- **^{7}Be, ^{10}Be, ^{26g}Al, ^{82}Sr** sputter targets
  - mixed with copper, silver, or niobium powders

HRIBF Beams

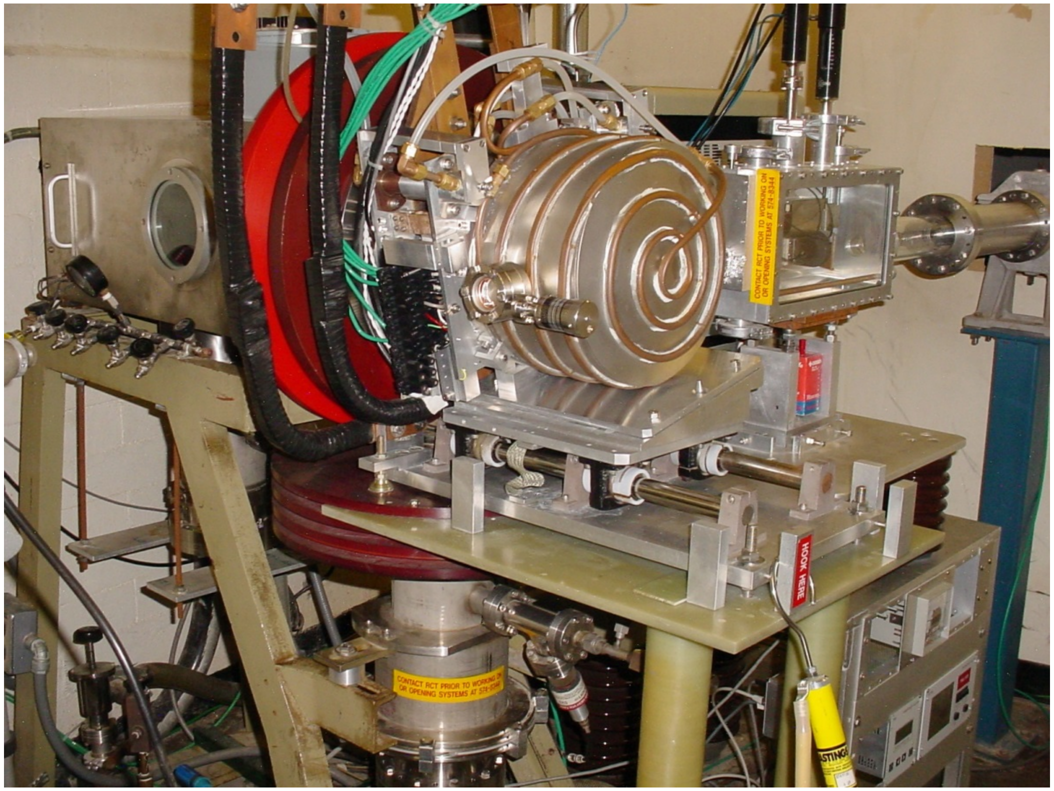
175 post-accelerated RIB species available

- **32 proton-rich species**
- **143 neutron-rich species**

(+26 more non-post-accelerated)



Safety Issues – Radiological and Electrical



There are electrical hazards (e.g. high current and high voltage) around the TIS enclosure platform.

Electrical equipment is used at the separator console. Use this equipment as intended and don't remove access panels.

Internal vacuum system is radiologically contaminated from years of testing targets and ion sources for RIB production (some areas of the target room are off-limits)

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Safety Issues – High Voltage

The ion source platform and the power supply platform will be operated at 50kV for this experiment.

Before entering the room

- make sure the HV power supply is OFF (if red lights are on, the HV power supply might be on)
- place the discharge hooks appropriately.

Activities to be performed

- Tour the separator
- Measure the target temperature
- Secure the HV rooms and turn on power supplies
- Extract a beam and tune a mass-separated beam to a Faraday cup
- Optimize the tune using noble gases (Kr and Xe)
- Perform a mass scan up to 220 amu (by varying the magnetic field in the dipole magnet)
- Identify peaks observed in the mass spectrum
- Determine isotopic ratios of a sample, which is already inserted but may vary during the week (e.g. Ge, Sn, Sm, …)