<u>Goal:</u> Physics measurements with neutron-rich RIBS

- **Gamma spectroscopy**
  - **Coulomb excitation; B(E2) measurements**
  - **Fusion-evaporation; ?? coincidences**
- **Transfer reactions**
  - ***e.g.*** **(d,p)**

<u>Problems:</u>

- **Beams are radioactive**
  - **Stopped/scattered beam can give huge background**
- **Beams are weak**
  - **?, ?? rates comparable to room background**
- **Beams are isobar cocktails, *i.e.* contaminated**
  - **A real problem for transfer studies**
  - **May be less serious for ?-ray experiments**
- **Require light targets, inverse kinematics**
  - **Large recoil velocity, gives Doppler broadening**

Solutions:

- **Good tandem beam quality, careful tuning, low-intensity beam diagnostics**
  - **Reduces stopped / scattered beam**

- **Trigger to reject background**
  - **Coulex: Hyball to detect target knock-outs**
  - **Fusion-evaporation: MCP detector for recoils (and beam)**

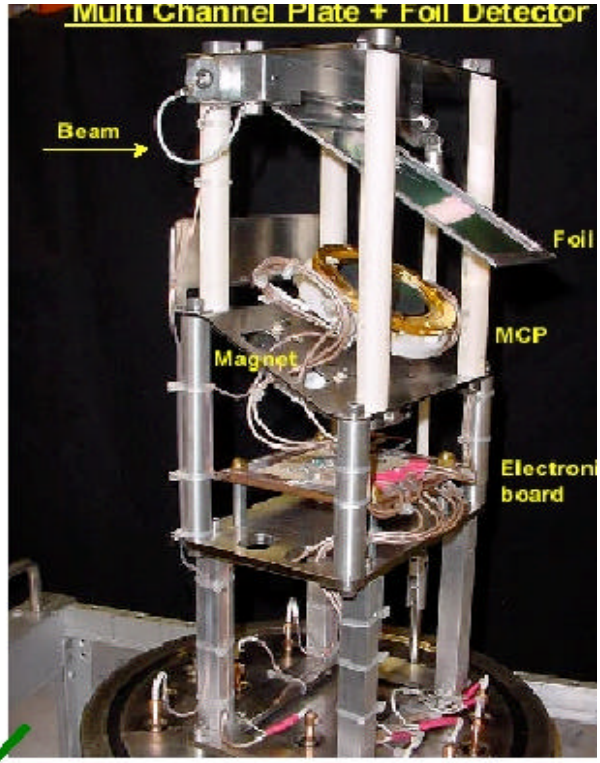
- **Segmented clover ?-ray detectors**
  - **Provide good Doppler correction for high recoil velocity**

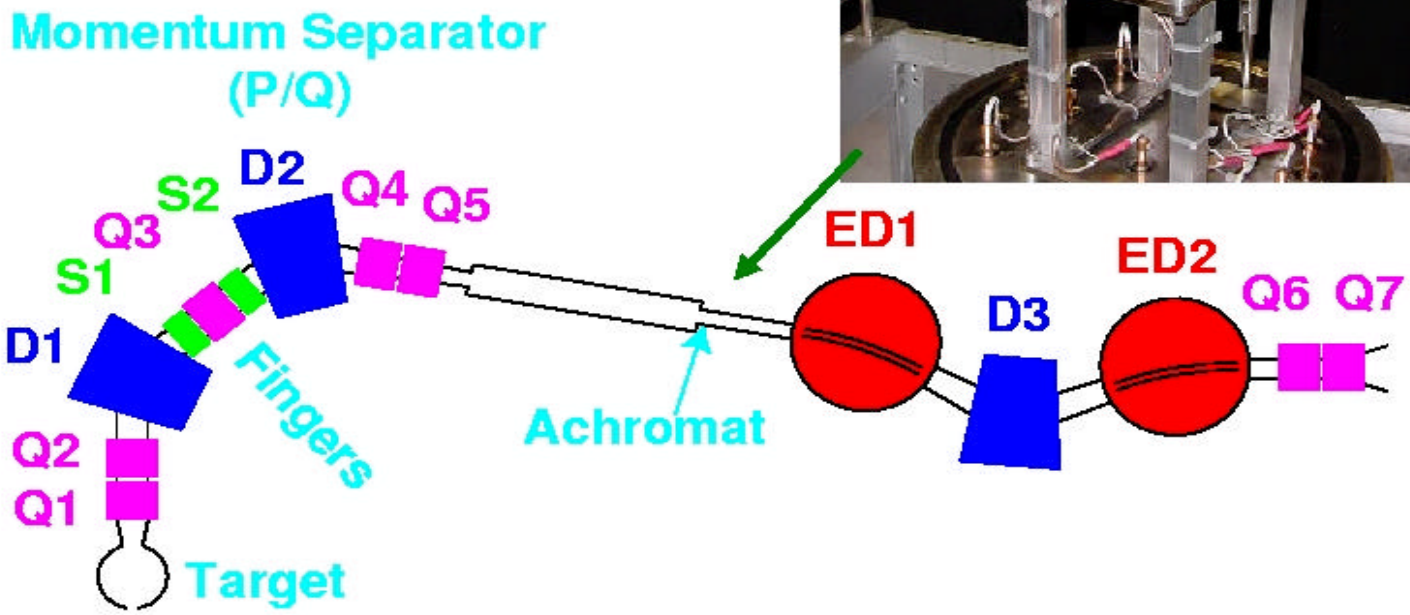
But:

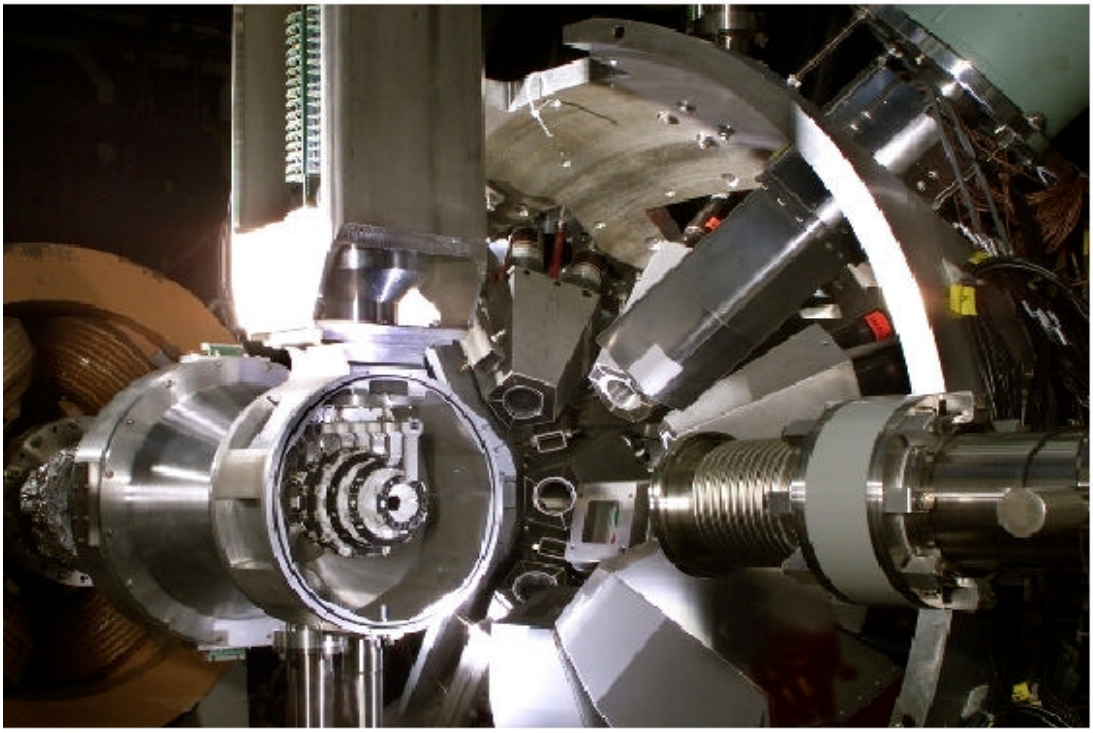
- **Transfer reaction studies require further development and tests.**

Setup for n–rich RIB test experiment

Recoil Detector
Foil plus Multichannel plate positioned at RMS Achromat







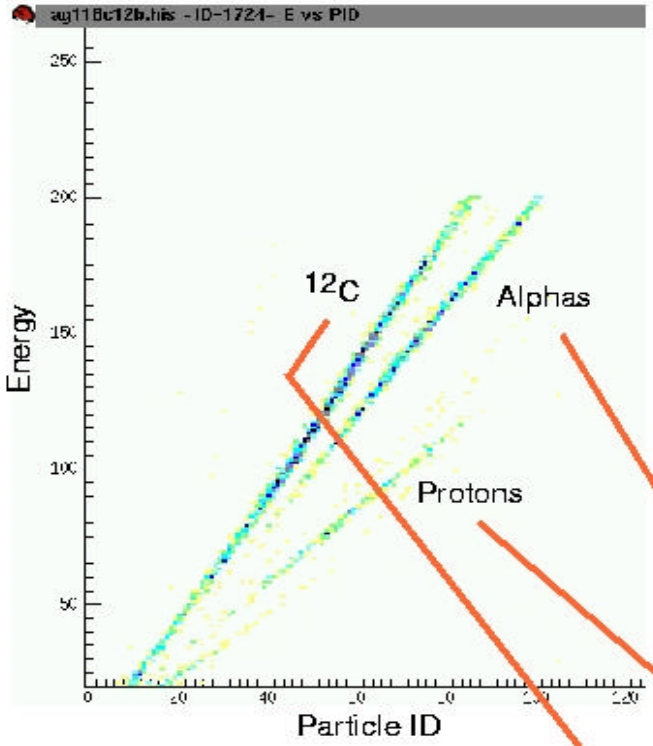
CLARION:
11 segmented clover Ge detectors
10 small Ge detectors

Hyball:
95 CsI detectors with photodiodes

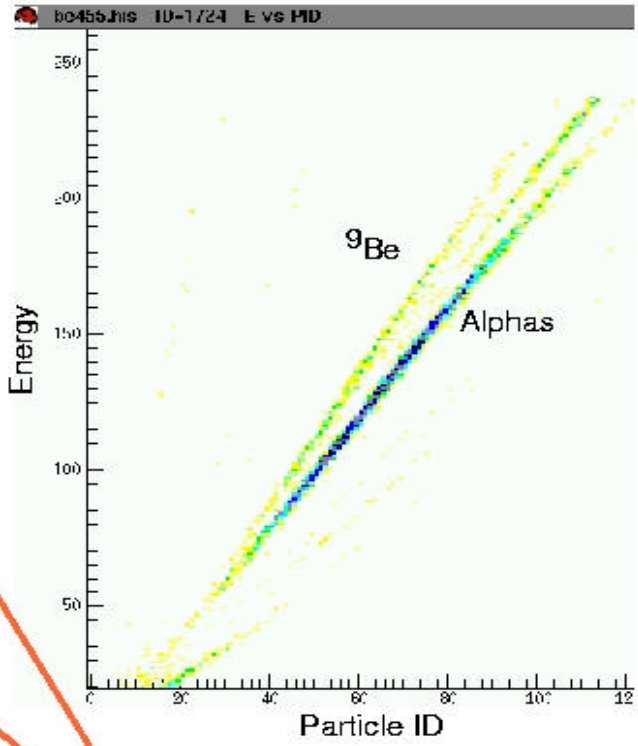
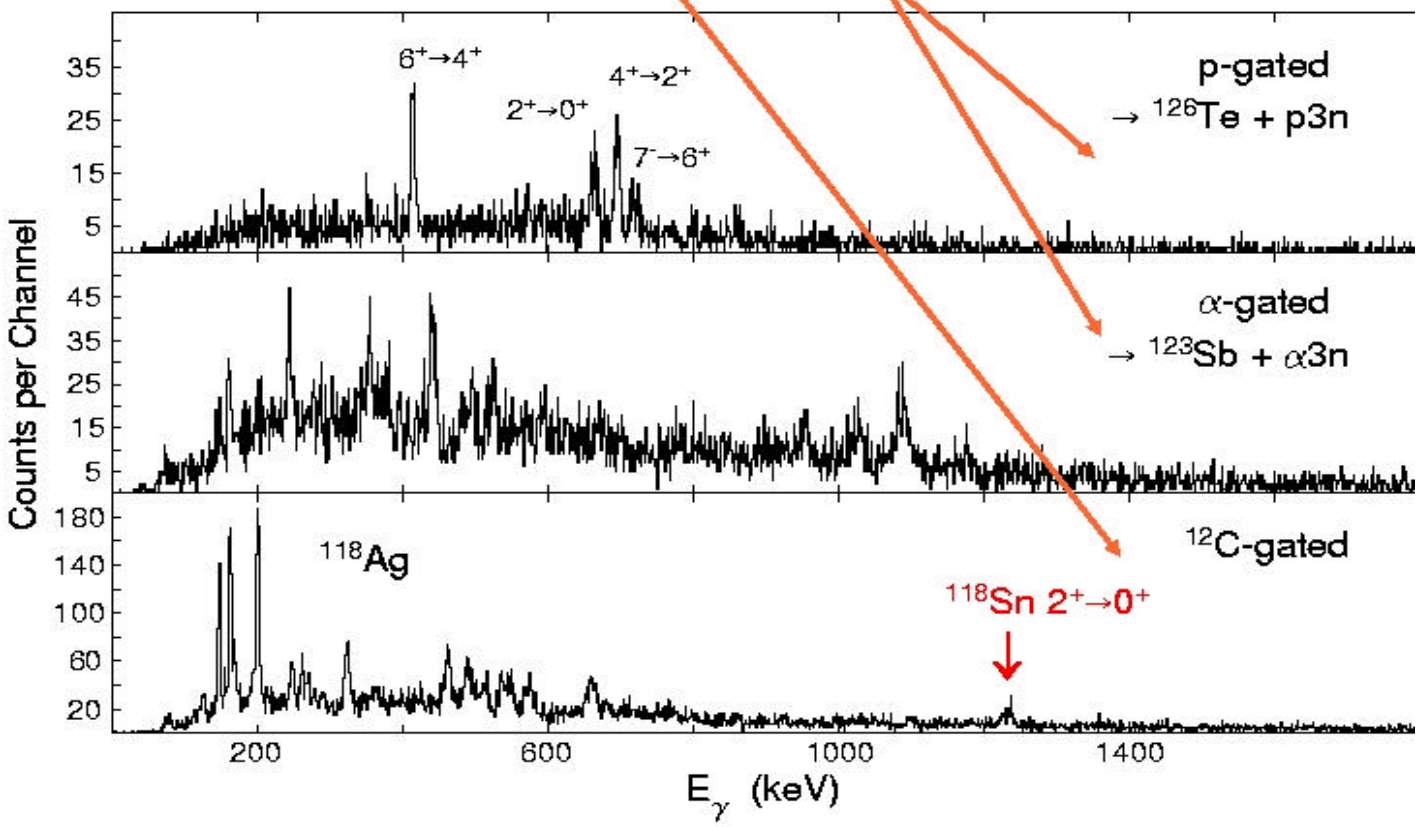
Coulomb excitation of neutron–rich beams

HyBall particle ID spectra:

500 MeV ^{118}Sn on ^{12}C



455 MeV ^{118}Sn on ^{9}Be



Gammas gated by charged particles: