Investigation of stellar proton capture reactions on proton-rich nuclei using Coulomb dissociation

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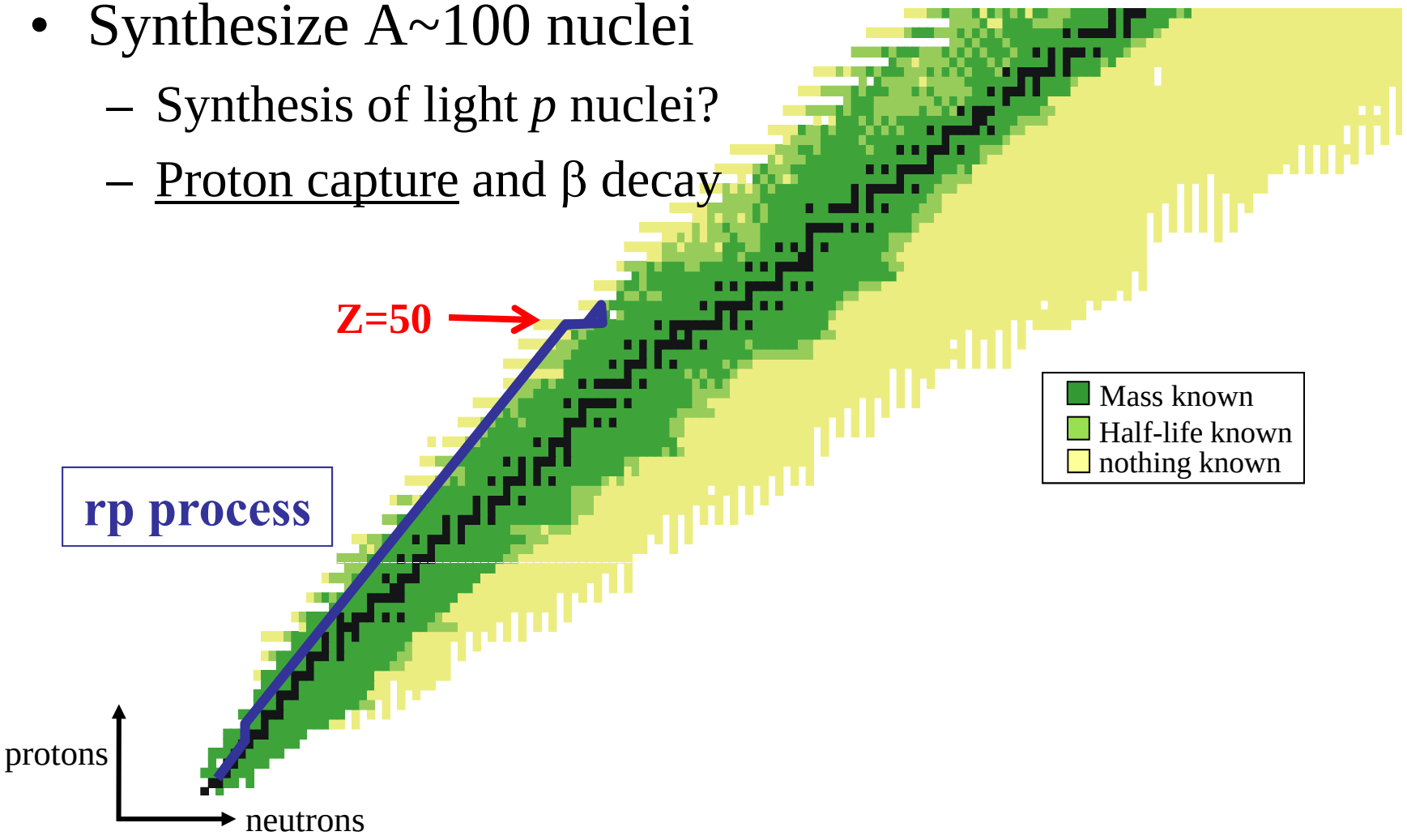
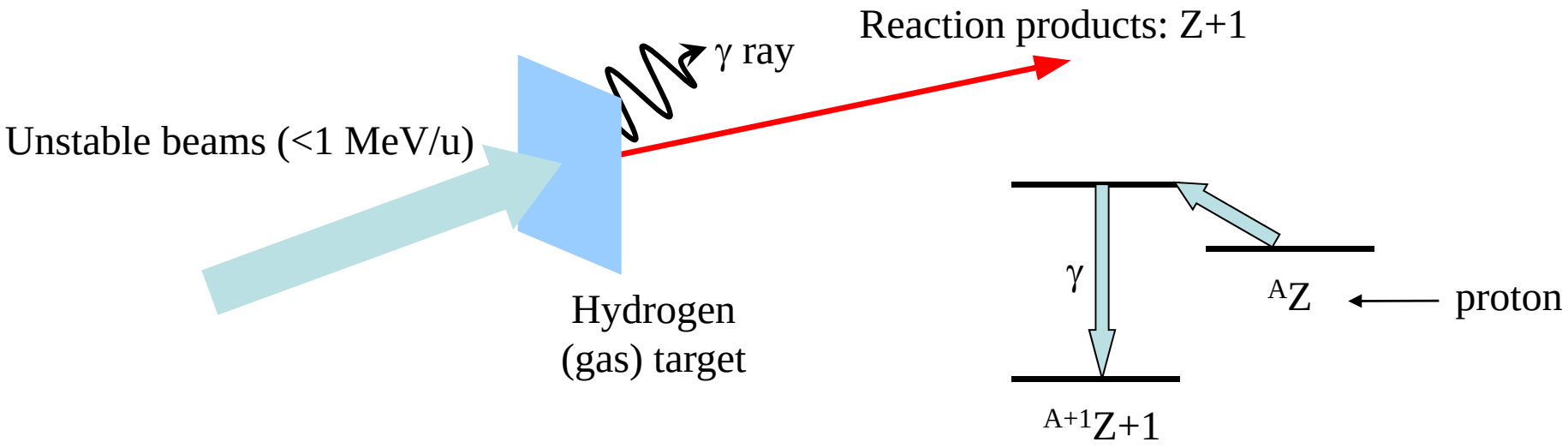
Rapid proton capture (*rp*) process

- Accreting neutron stars
- Synthesize A~100 nuclei
  - Synthesis of light *p* nuclei?
  - Proton capture and β decay



Measurement of (p,γ) reaction



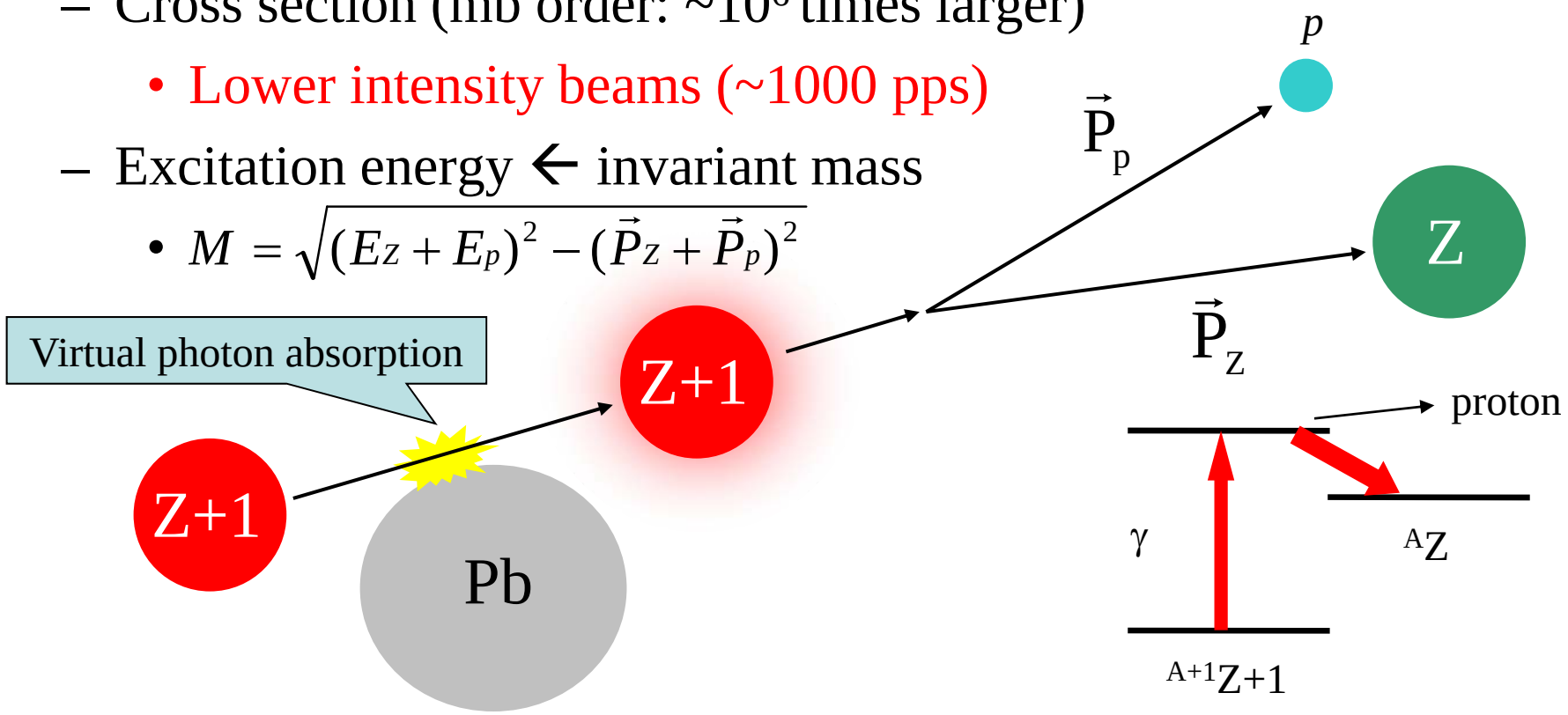
- Direct measurement is difficult
  - Small cross section (~nb order)

  → Intense low energy beam: ~10^9 pps, <1 MeV/u

Not available for present facilities

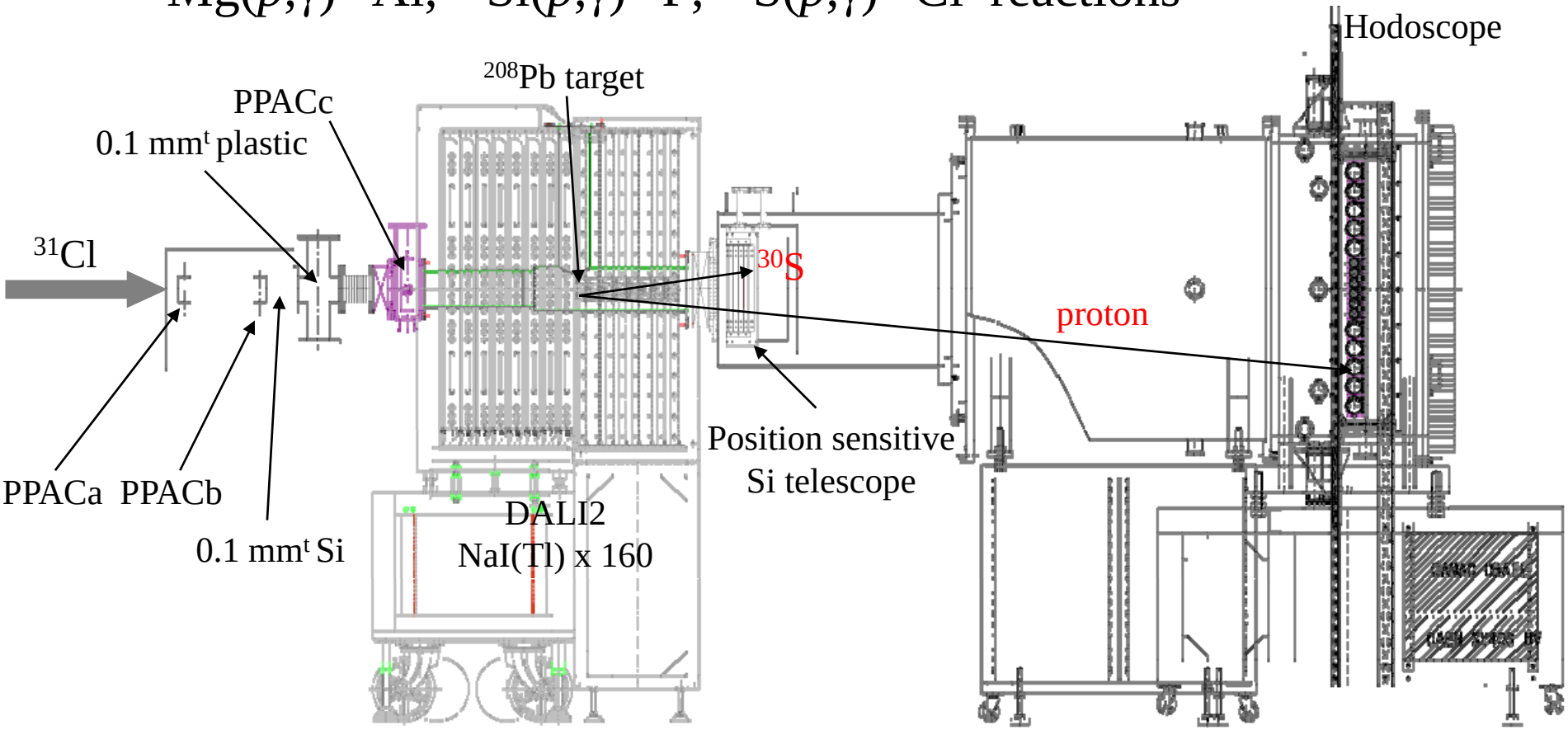
Coulomb dissociation

- (γ,p) reaction by virtual photons
  - Virtual photons: EM interaction between beam and target
  - Detailed balance: (γ,p) → (p,γ)
  - Cross section (mb order: ~10^6 times larger)
    - Lower intensity beams (~1000 pps)
  - Excitation energy ← invariant mass
    - $M = \sqrt{(Ez + E_p)^2 - (\vec{P}z + \vec{P}_p)^2}$



Studies related to waiting points

- Coulomb dissociation of ^{23}Al, ^{27}P, ^{31}Cl
  - Beam energies: ~50 MeV/u
  - ^{22}Mg(p,γ)^{23}Al, ^{26}Si(p,γ)^{27}P, ^{30}S(p,γ)^{31}Cl reactions

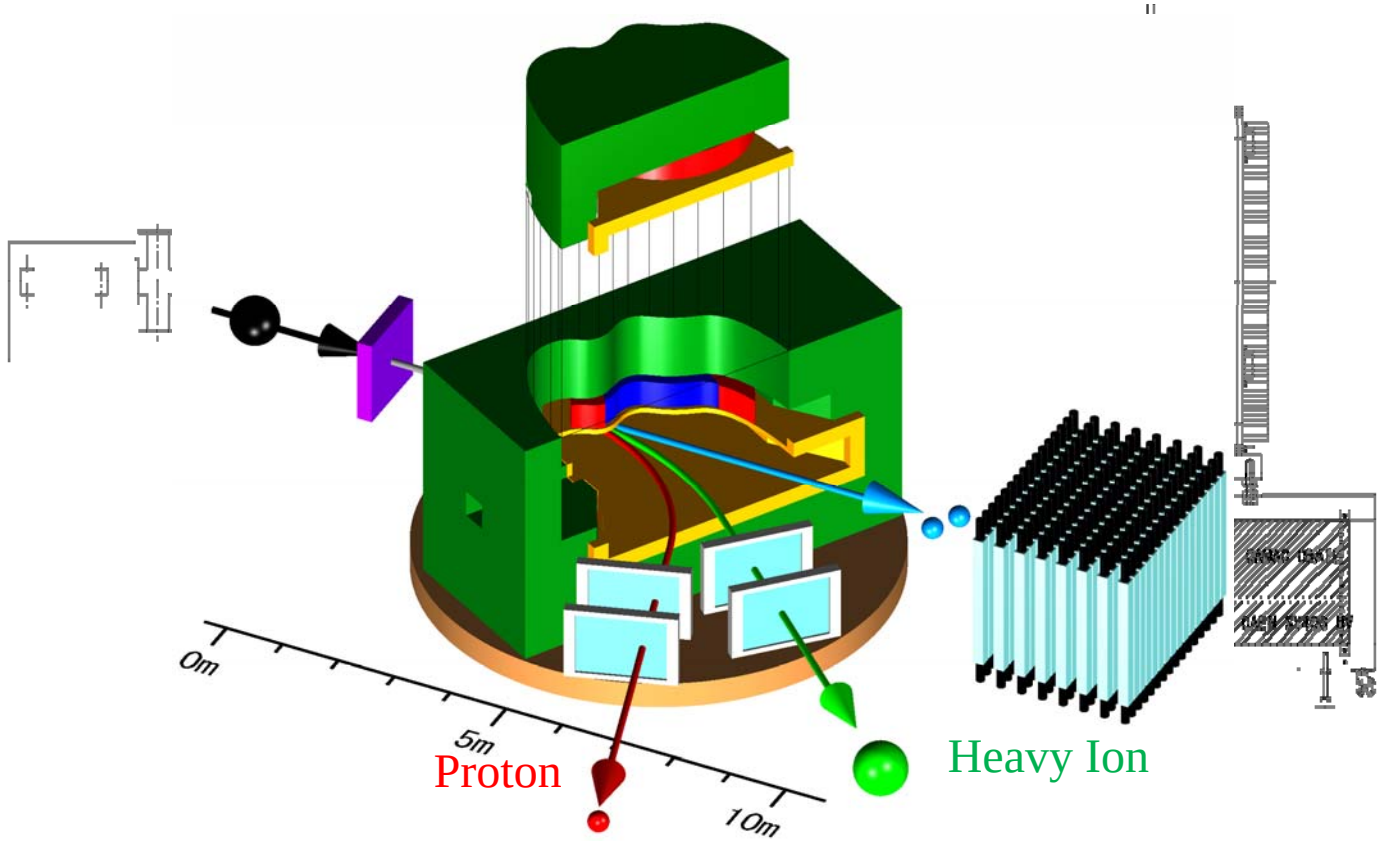


CD of ^{27}P for ^{26}Si(p,γ)^{27}P reaction

- Coulomb dissociation of ^{27}P
  - Extract the reaction rate through the resonance

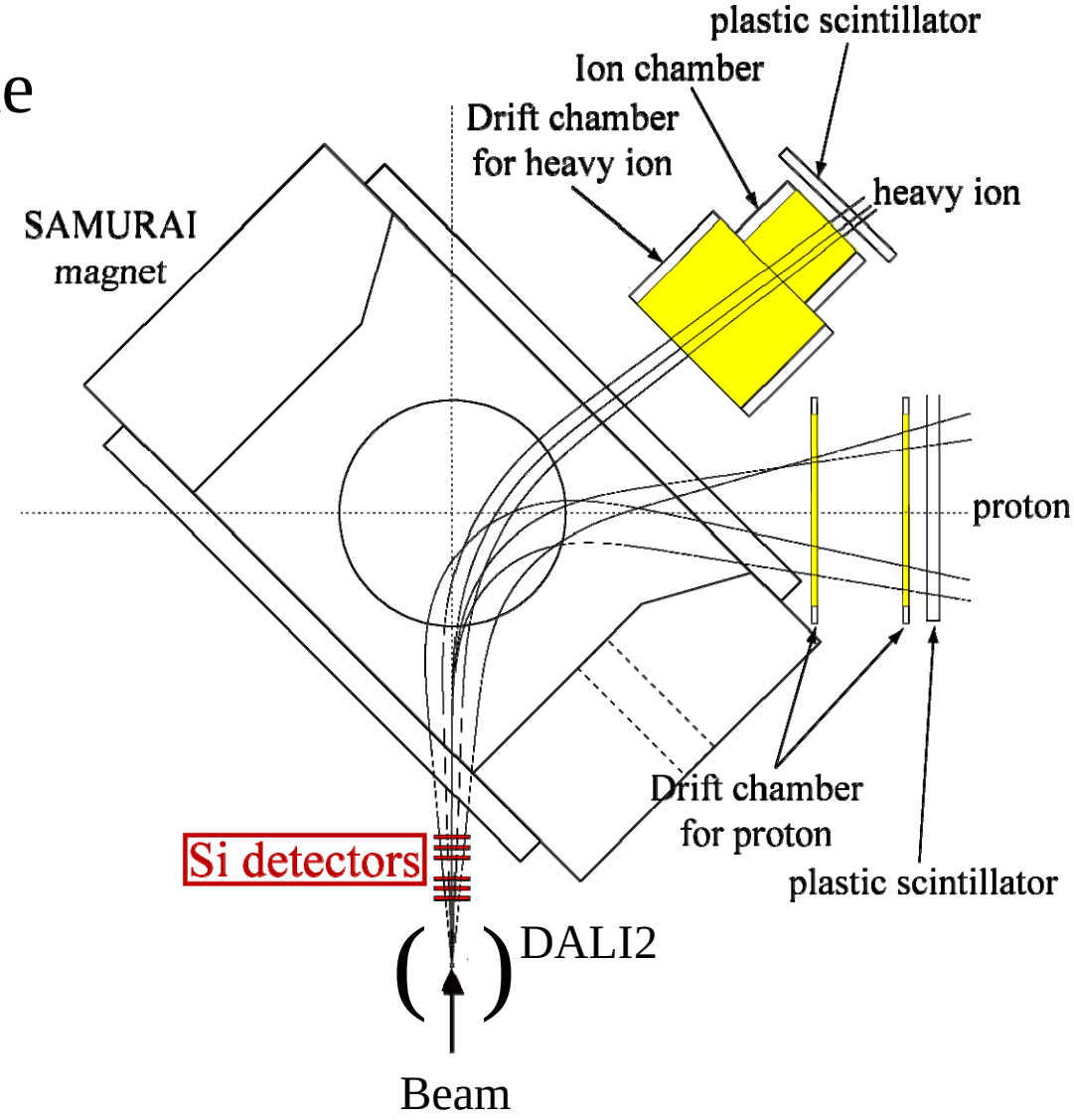
Improvement needed

- Better resolution, more beams



Setup with SAMURAI

- Large Acceptance mode
- weaker magnetic field
  - ~Half of max. field



Summary and future prospect

- Proton capture reactions in *rp* process will be studied with SAMURAI.
- Coulomb dissociation method will be employed.
  - Efficient to measure the radiative capture cross sections.
- First experiment (2013~)