Particle identification at BigRIPS

ΔE-TOF-Bρ method with track reconstruction → Improve Bρ and TOF resolution

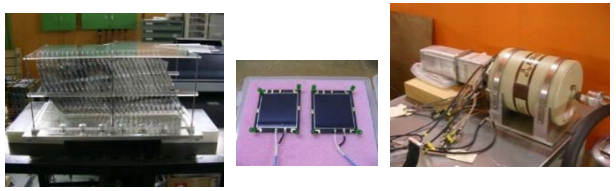
Measure ΔE,TOF, Bρ @ 2nd stage

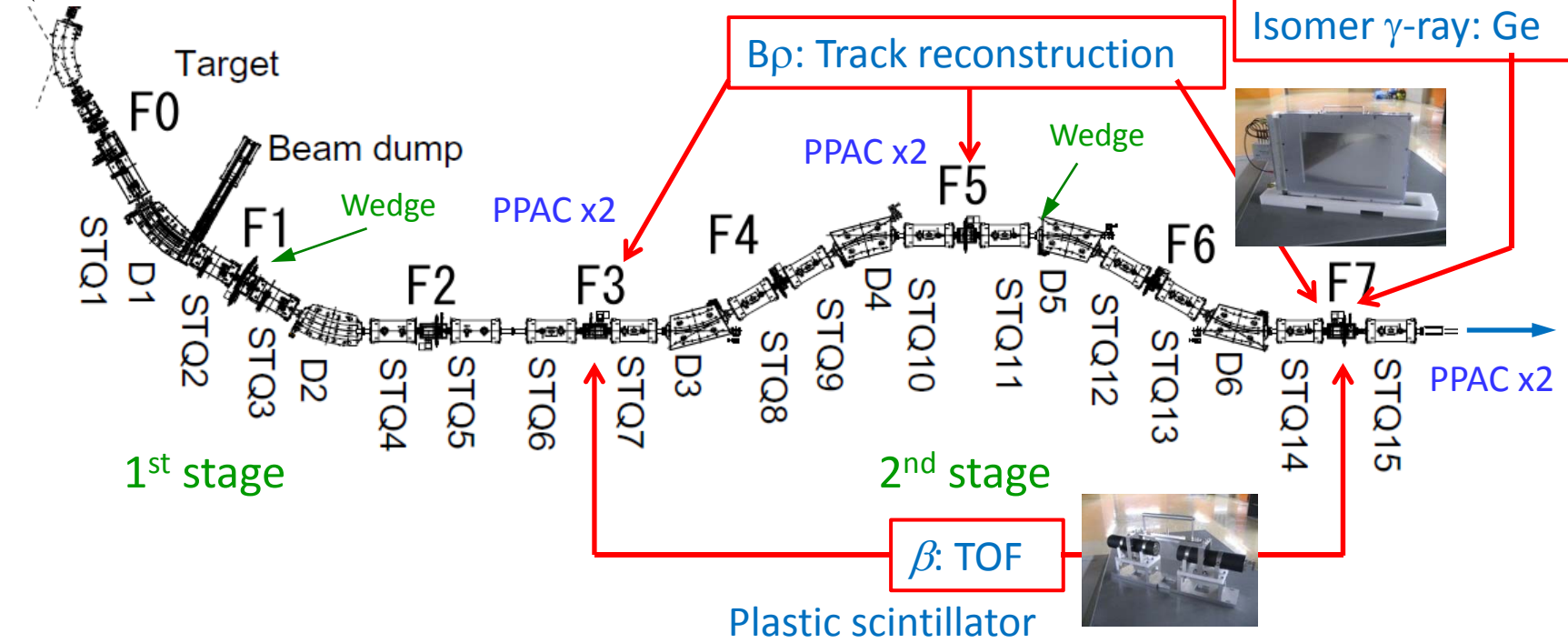
+ isomeric γ-ray

$Z \leftarrow -dE/dx = \mathrm{f}(Z, \beta)$

Z, A/Q

$$A/Q = \frac{B\rho}{\gamma\beta m_u}$$





Key point in particle identification

- ✓ $B\rho$ measurement is made by trajectory reconstruction at the 2nd stage.
- ✓ Velocity β of RI beams are derived from TOF(F3-F7) in combination with Twofold measurement of $B\rho_{35}$ and $B\rho_{57}$ in order to include energy loss in F5 materials, which provides high accuracy in β determination.

$$\begin{cases} \dfrac{B\rho_{35}}{B\rho_{57}} = \dfrac{(\gamma\beta)_{35}}{(\gamma\beta)_{57}} \\ TOF_{37} = \dfrac{L_{35}}{\beta_{35}c} + \dfrac{L_{57}}{\beta_{57}c} \end{cases} \qquad \frac{A}{Q} = \frac{B\rho_0(1+\delta_{57})}{(\gamma\beta)_{57}} \cdot \frac{c}{m_u}, \quad m_u = 931.49432\ \mathrm{MeV/c^2}$$

- ✓ The *A/Q* resolution is high enough to identify both *A* and *Q* without measuring total kinetic energy.
- ✓ Nuclear charge *Z* is derived from ΔE measured at F7 and β_{57}.

$$\Delta E \propto \frac{4\pi e^4 Z^2}{m_e v_{57}^2} Nz \left[\ln \frac{2m_e v_{57}}{I} - \ln\left(1-\beta_{57}^2\right) - \beta_{57}^2 \right], \quad v_{57} = \beta_{57} c$$

- ✓ PID is confirmed by detecting delayed γ-rays emitted from short-lived isomeric states of the fragments.

Track reconstruction

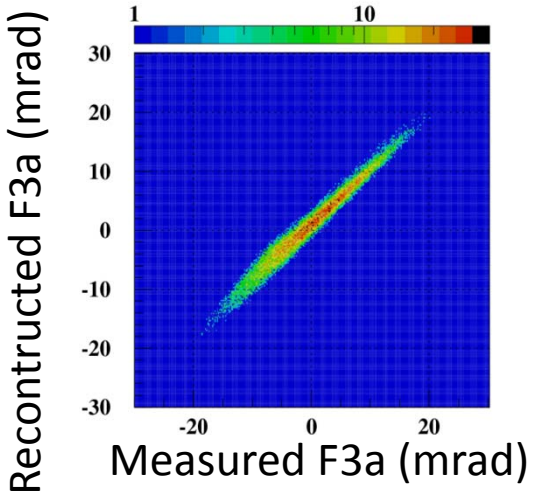
by using the position and angle measured at the focuses (such as F5x, F5a, F3x) and the experimentally determined transfer matrices as follows:

$$F5x = (x|x)F3x + (x|a)F3a + (x|\delta)\delta$$

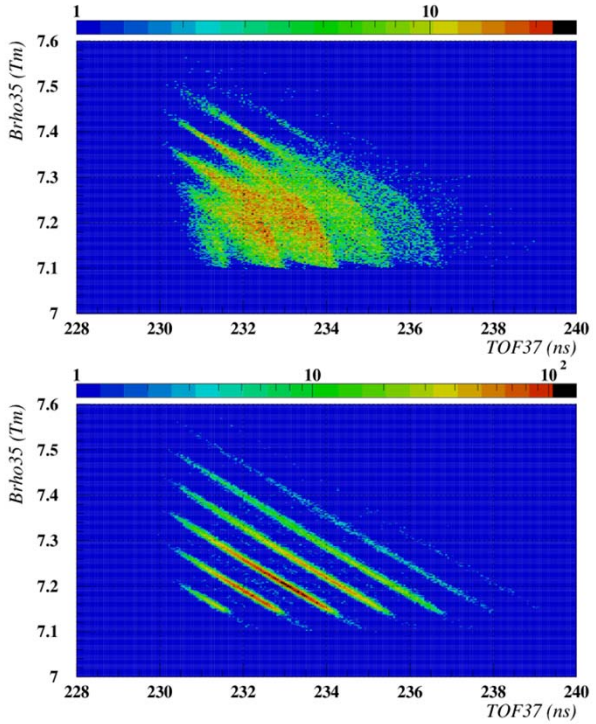
$$F5a = (a|x)F3x + (a|a)F3a + (a|\delta)\delta$$

$$B\rho = B\rho_0(1+\delta)$$

Measured F5x, F5a, F3x
→ deduce δ, F3a



For Z = 50 isotopes produced by in-flight fission of a ^{238}U beam at 345 MeV/u.
$\Delta p/p$ = 6%



Without track reconstruction
(from the position at dispersive focus)

With track reconstruction