RF deflector system for proton-rich RI beams in RIKEN

(RI beam purifier for present facility)

Kazunari Yamada

Department of Physics, Rikkyo University

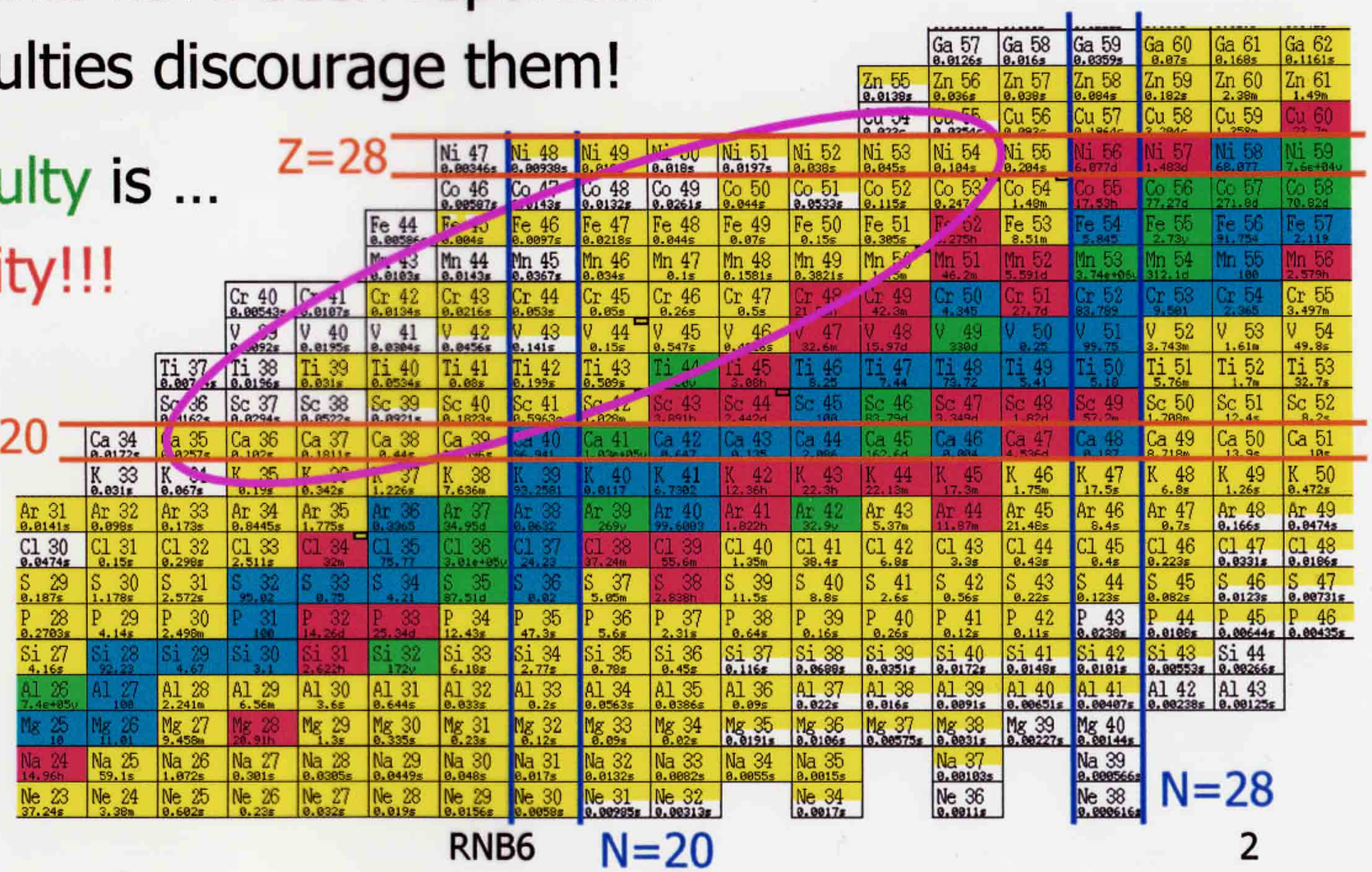
- Introduction
- Construction of the system
- Example for application
- Summary

Proton-rich RI beams

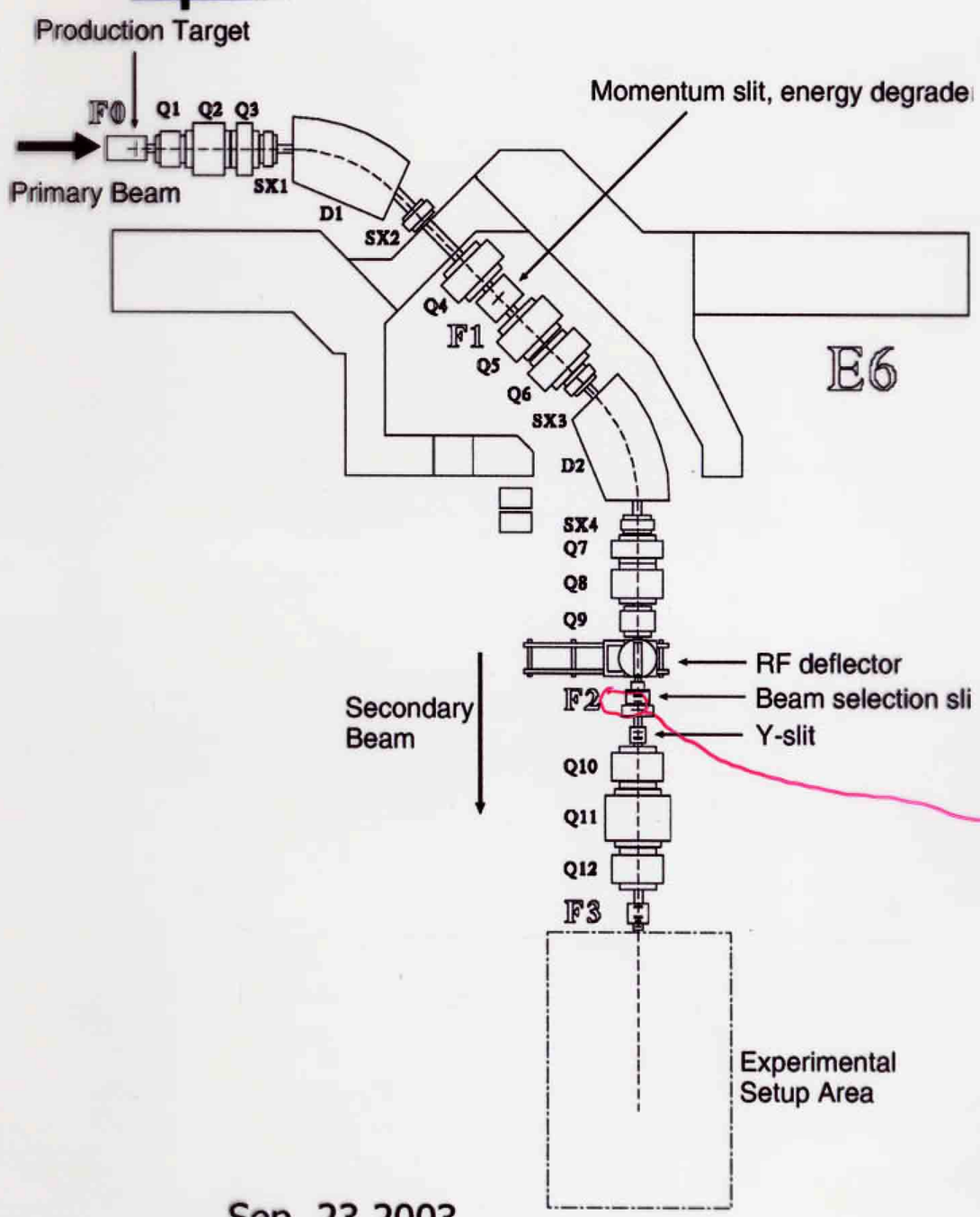
- Proton-rich RI beams around A < several tens.
  - ➪Possible to produce in the present facilities. (enough intensities)
- Few experiments have been reported.
  - ➪Some difficulties discourage them!
- A major difficulty is …

  Very Low Purity!!!

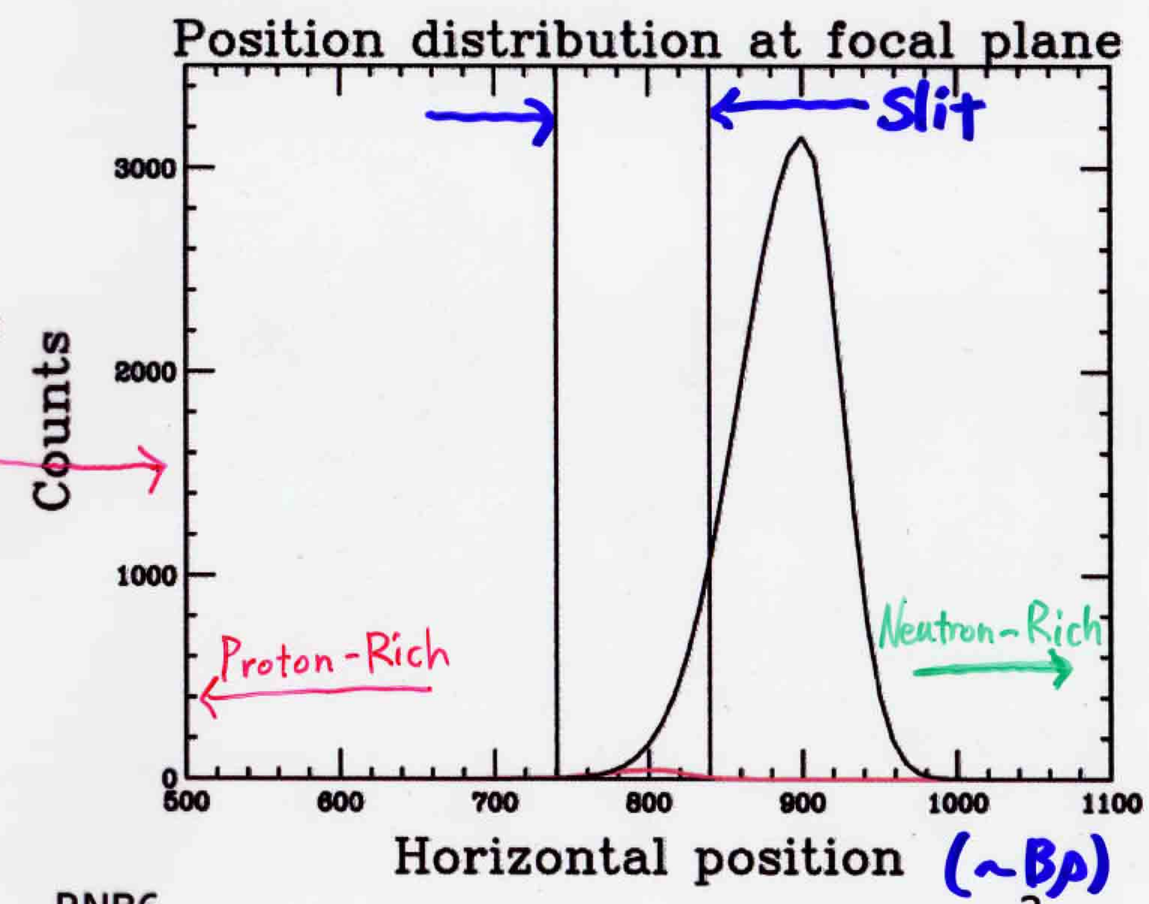
  (~10^{-3}~$^{-5}$)



Cause of "Very Low Purity"

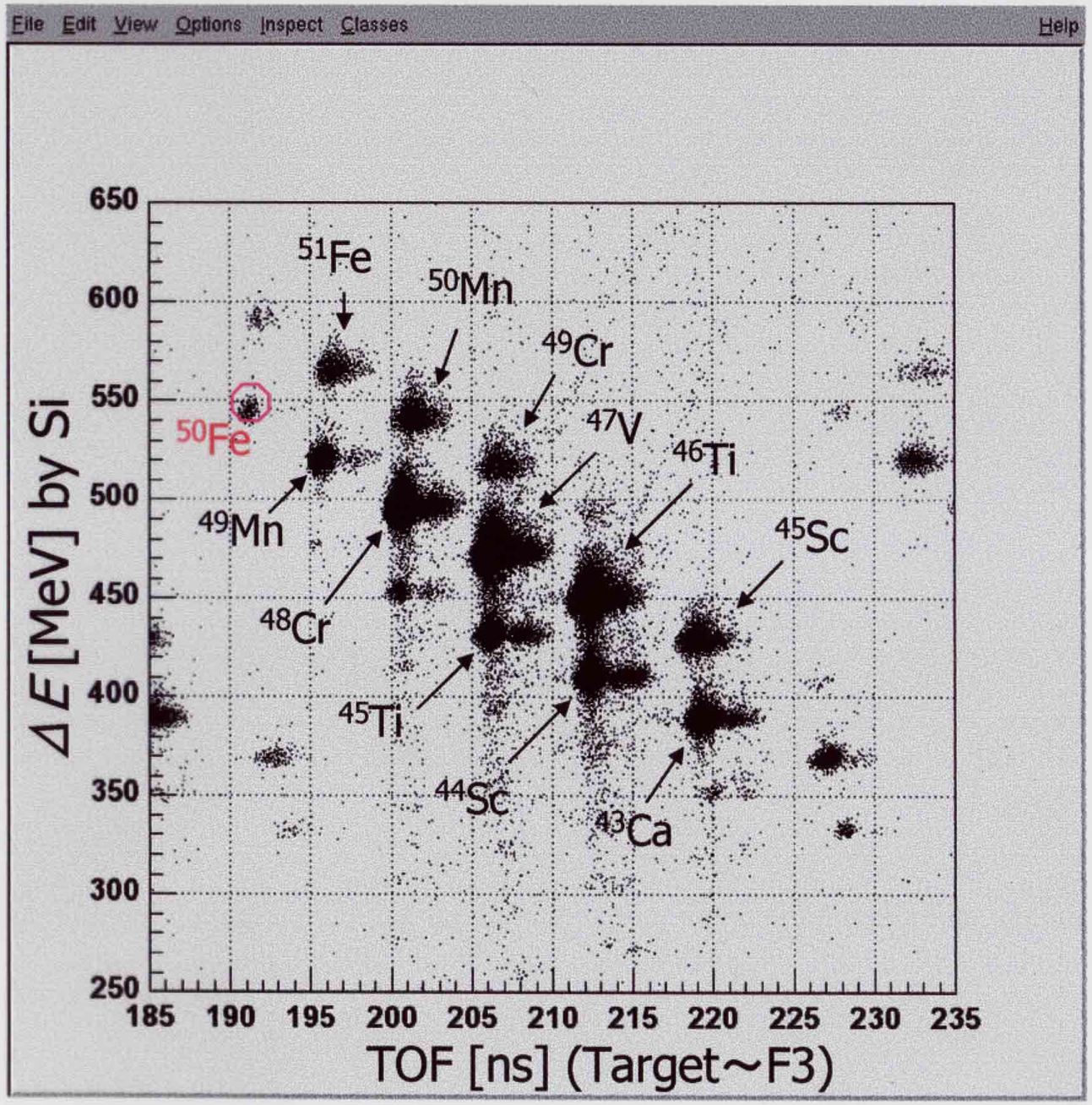


- Momentum distributions of fragments
  ➪Tail for lower side.
- This component of less proton-rich species
  ➪Override on the beam.



Example for proton-rich RI beam

- TOF-ΔE(Si) plot for ^{50}Fe.
- Produced from ^{58}Ni beam and Ni target.
- Purity of ^{50}Fe is about 0.05%.



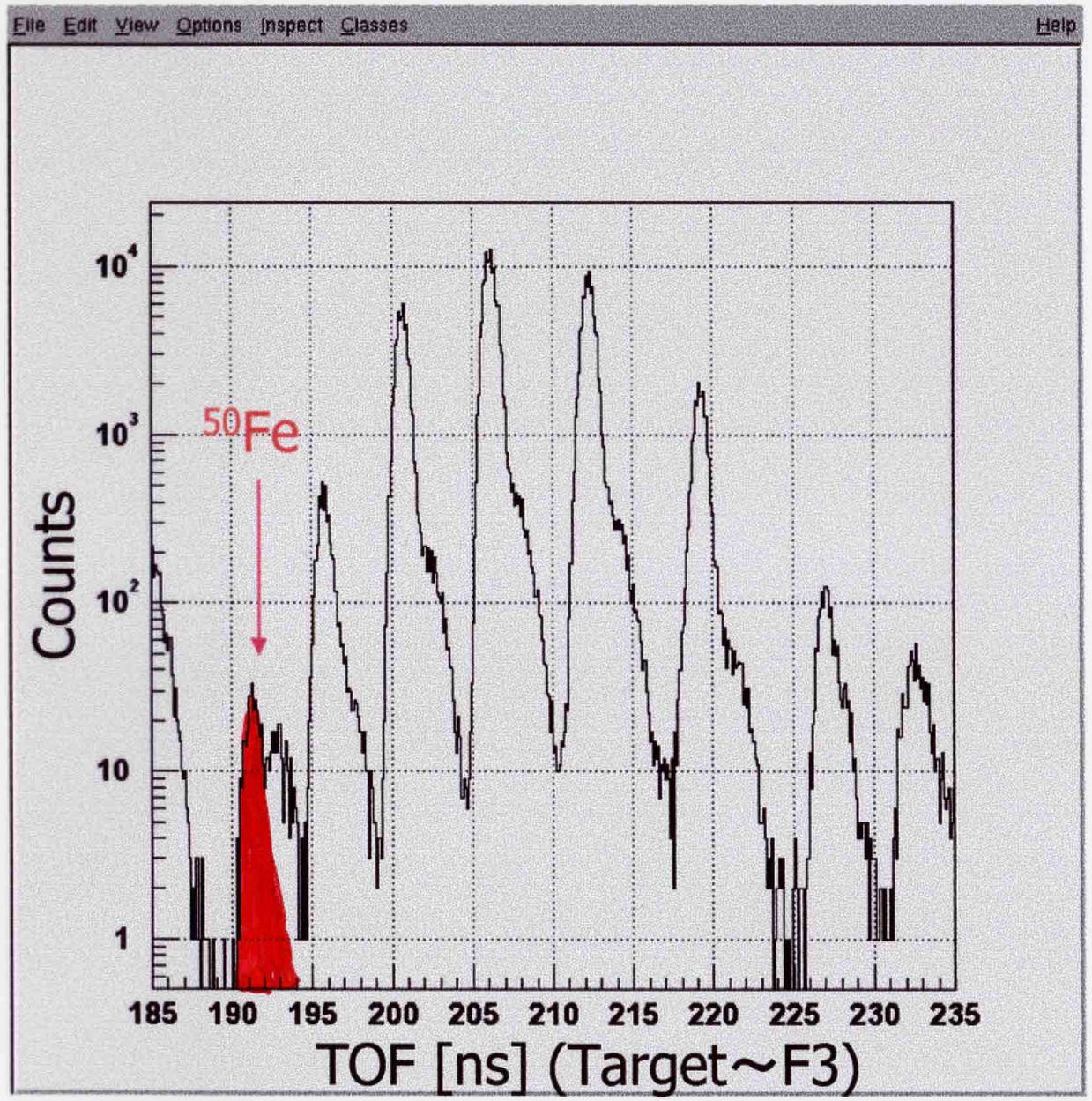
Velocity difference

- Velocity measurement (by TOF) is useful.
  - ➪Particle identification

However, …

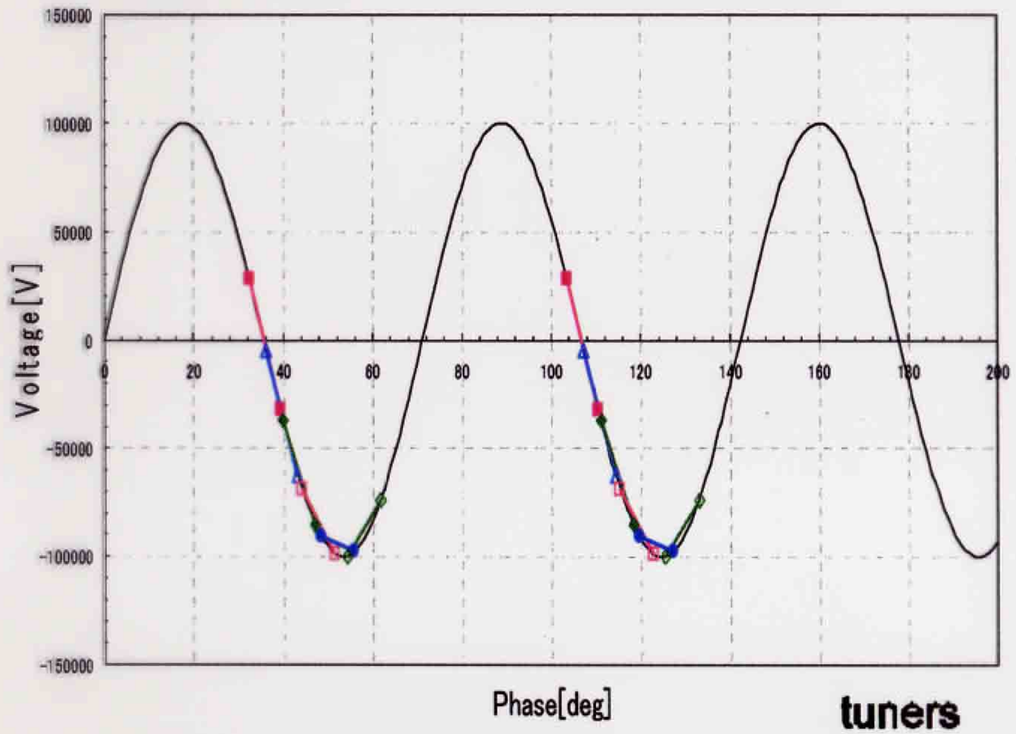
  - ➪Total beam intensity is limited by detectors.

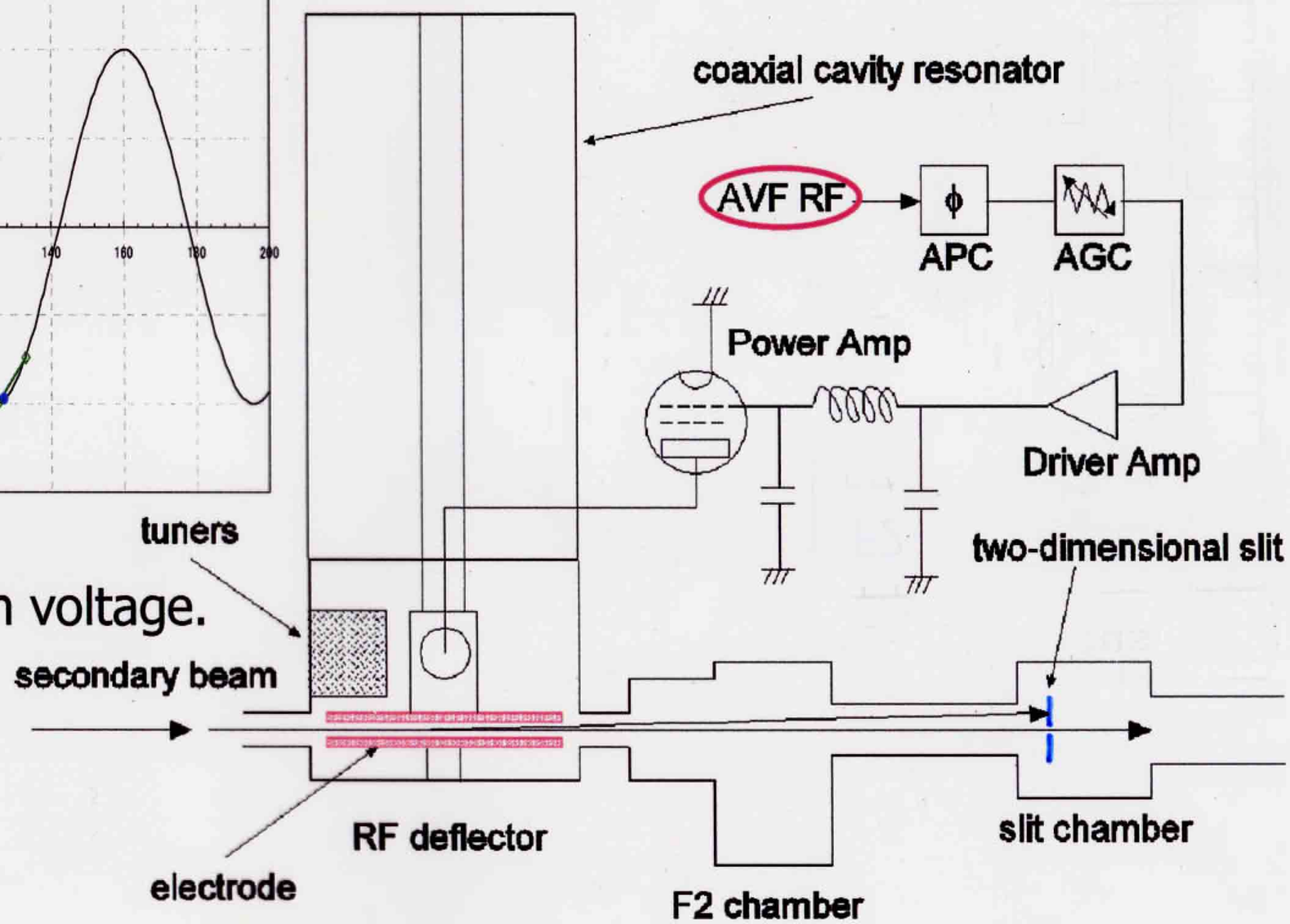
- Increase of ^{50}Fe fraction is crucial for efficient experiment.



RF deflector system

Injection timing of fragments with 14.05MHz sin wave.





- Apply sinusoidal high voltage.
- Vertical deflection.
- Adjusting phase.
- Stopped by a slit.

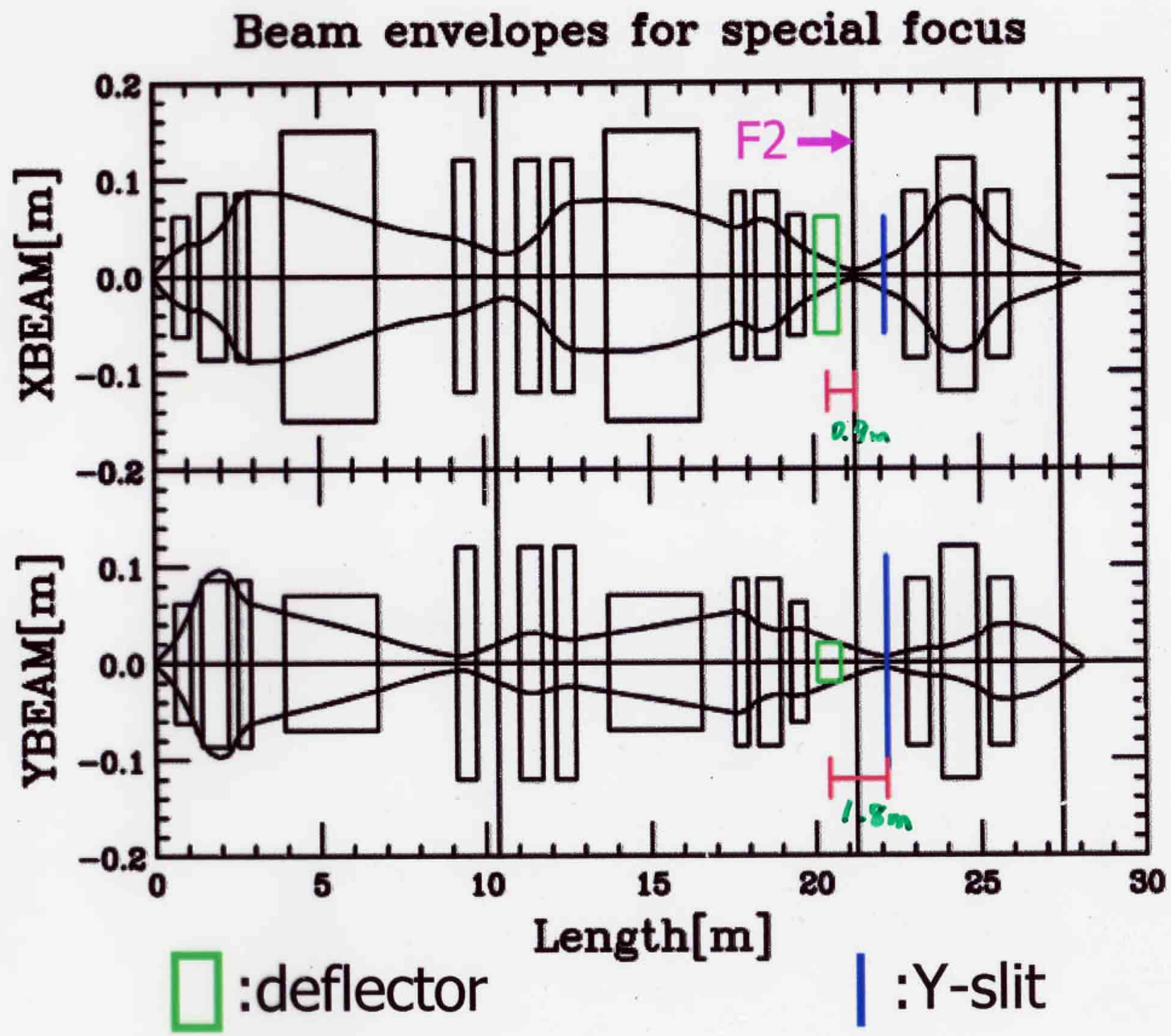
Focusing property in RIPS

- Non-standard focus

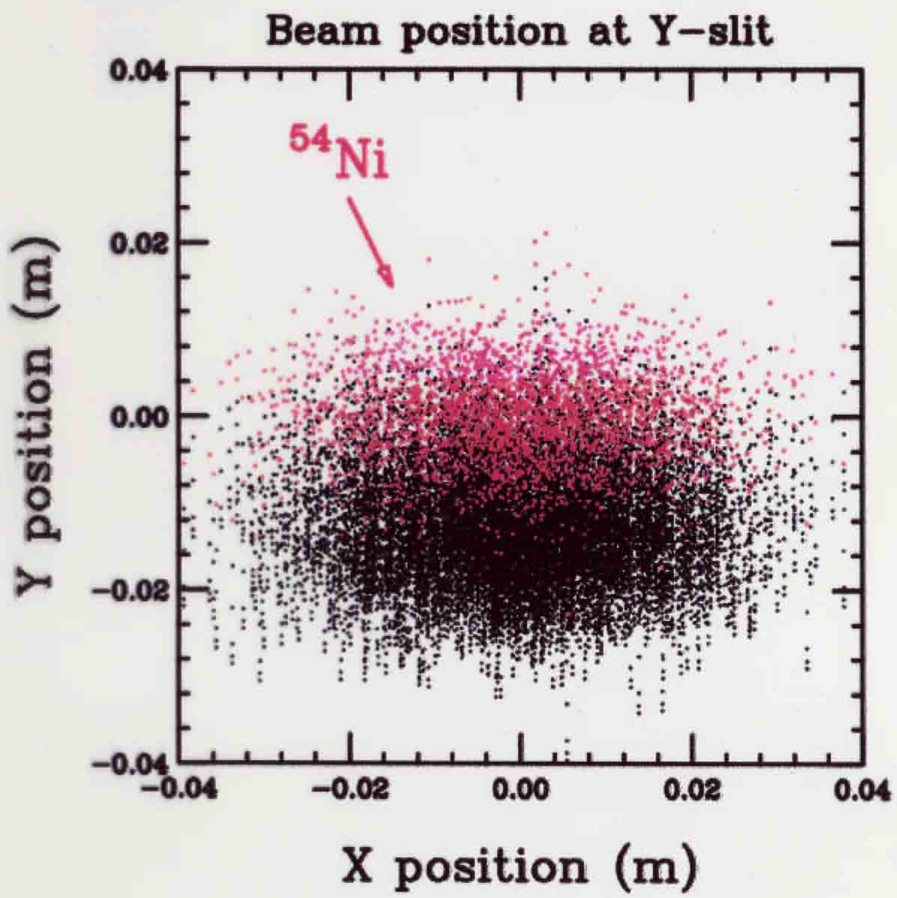
➪Focus on F2 in the horizontal direction (standard).

➪Focus on the Y-slit in the vertical direction (flight path is doubly extended).

➪Better separation



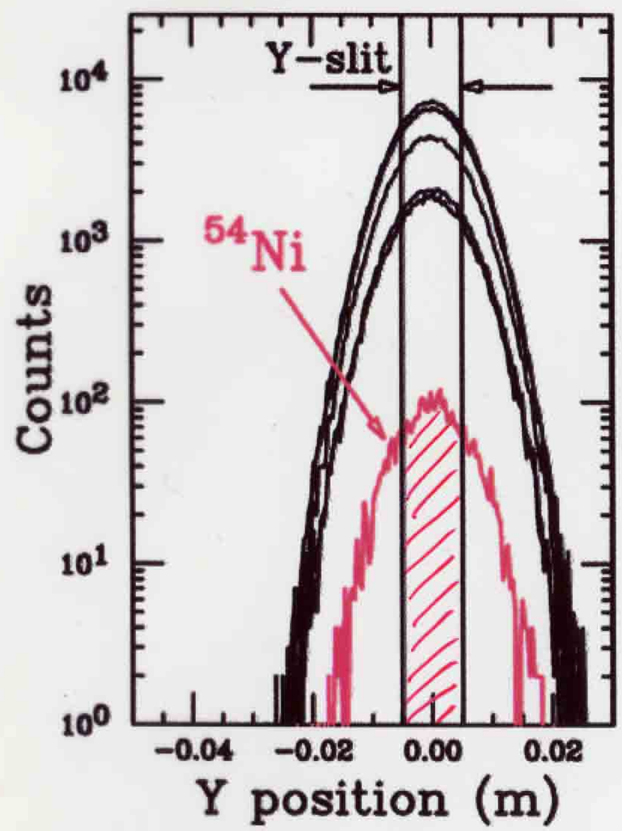
Simulated performance



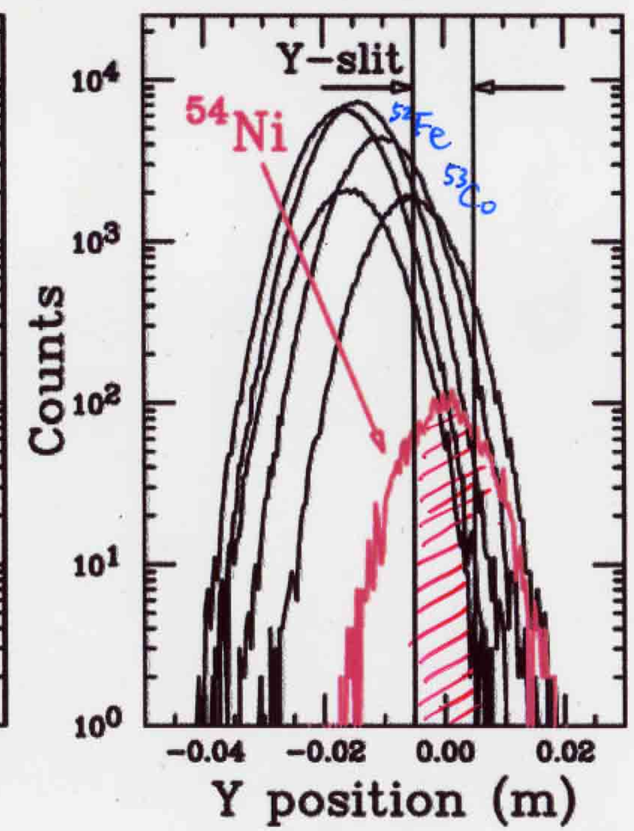
- Position distribution on the slit evaluated by first-order beam optics.

Y-slit

Deflector off



Deflector on



- Purity of ^{54}Ni :

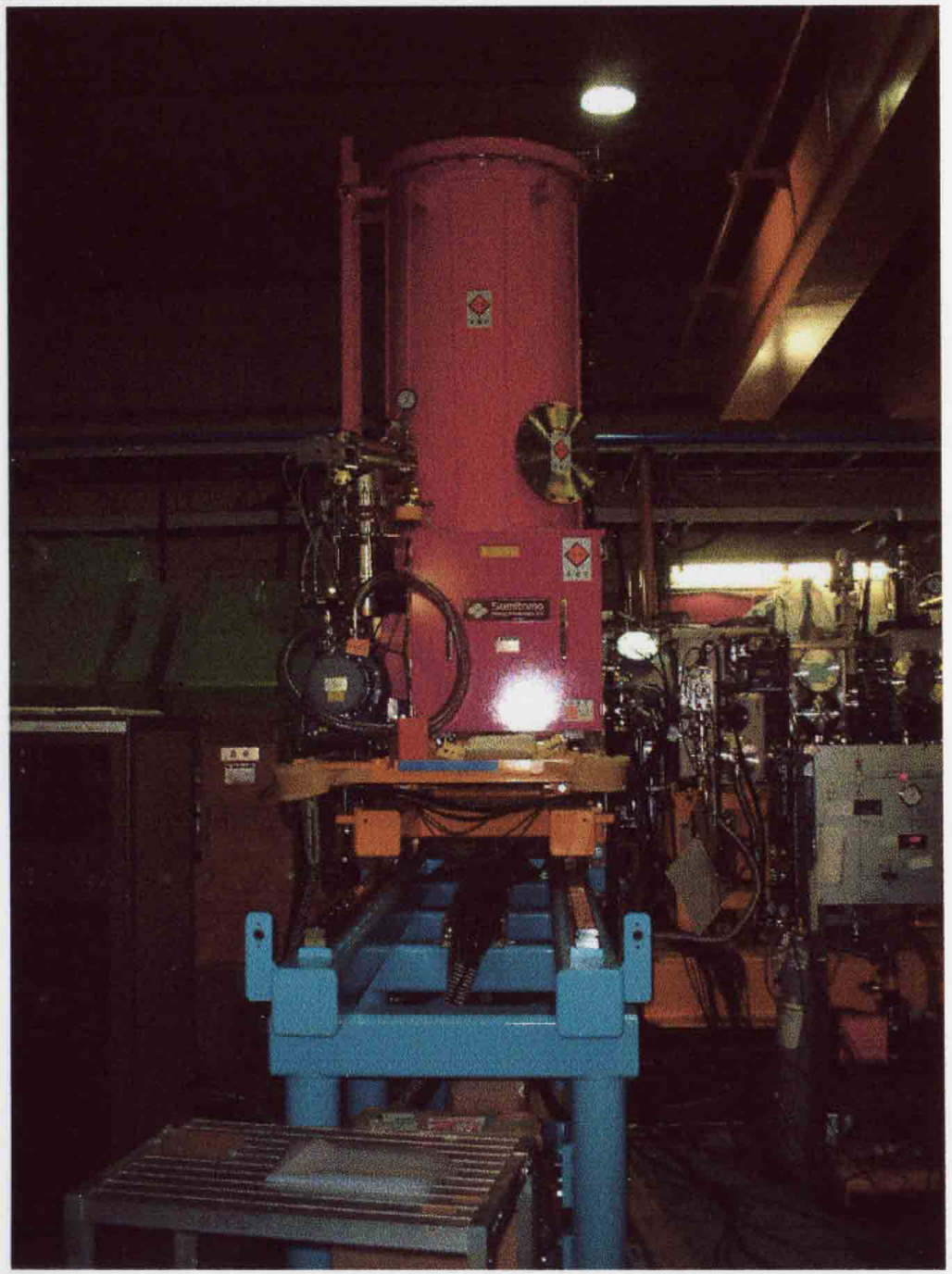
  10～20 times enhanced!!

Specification of RF deflector system

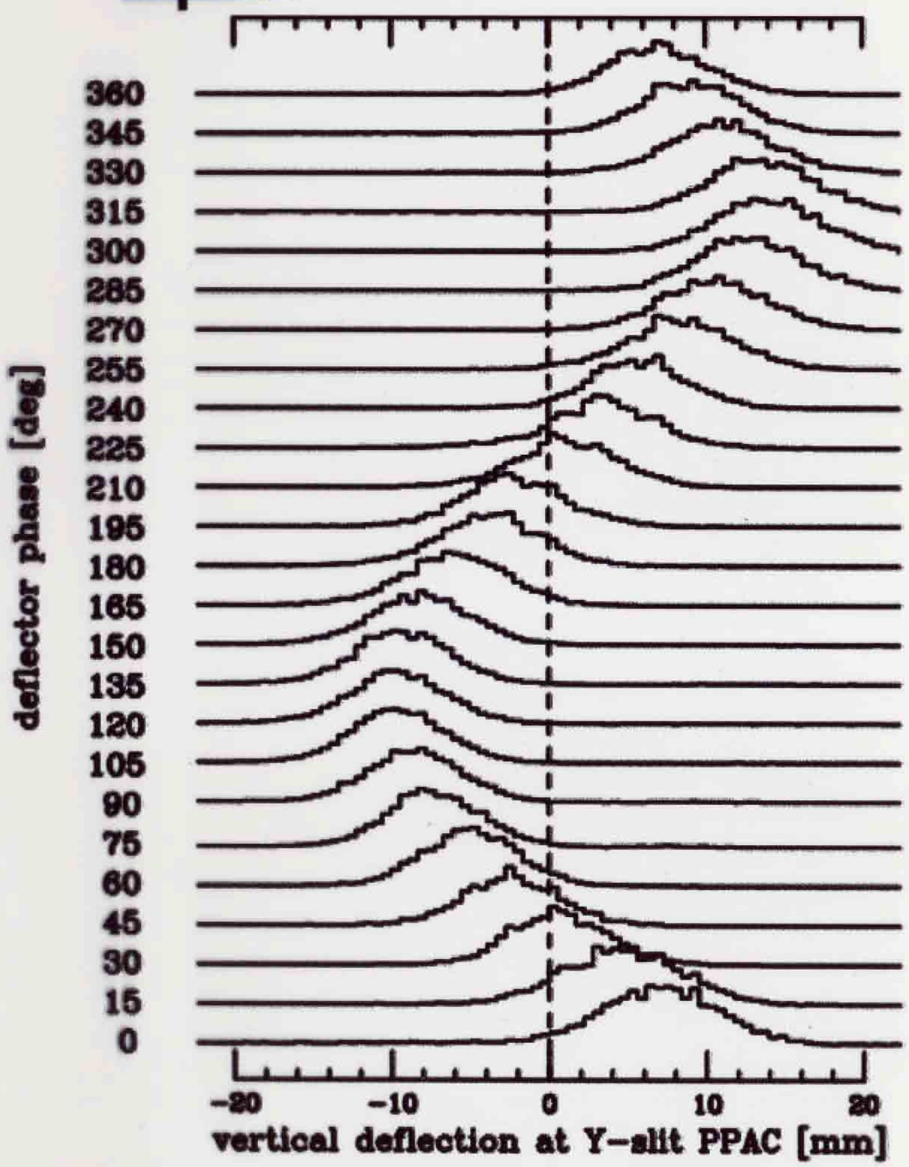
QW

- Coaxial cavity resonator with cylindrical shape, fixed-length structure, two tuners.
- Transmission is 70～80% for full emittance of RIPS.

- Maximum voltage: >100kV
- Frequency range: 12～18MHz
- Length of electrode: 700mm
- Width of electrode: 120mm
- Gap size of electrode: 40mm
- Y-slit: Copper 25mm thick
- Distance between center of electrode and slit: 1.8m

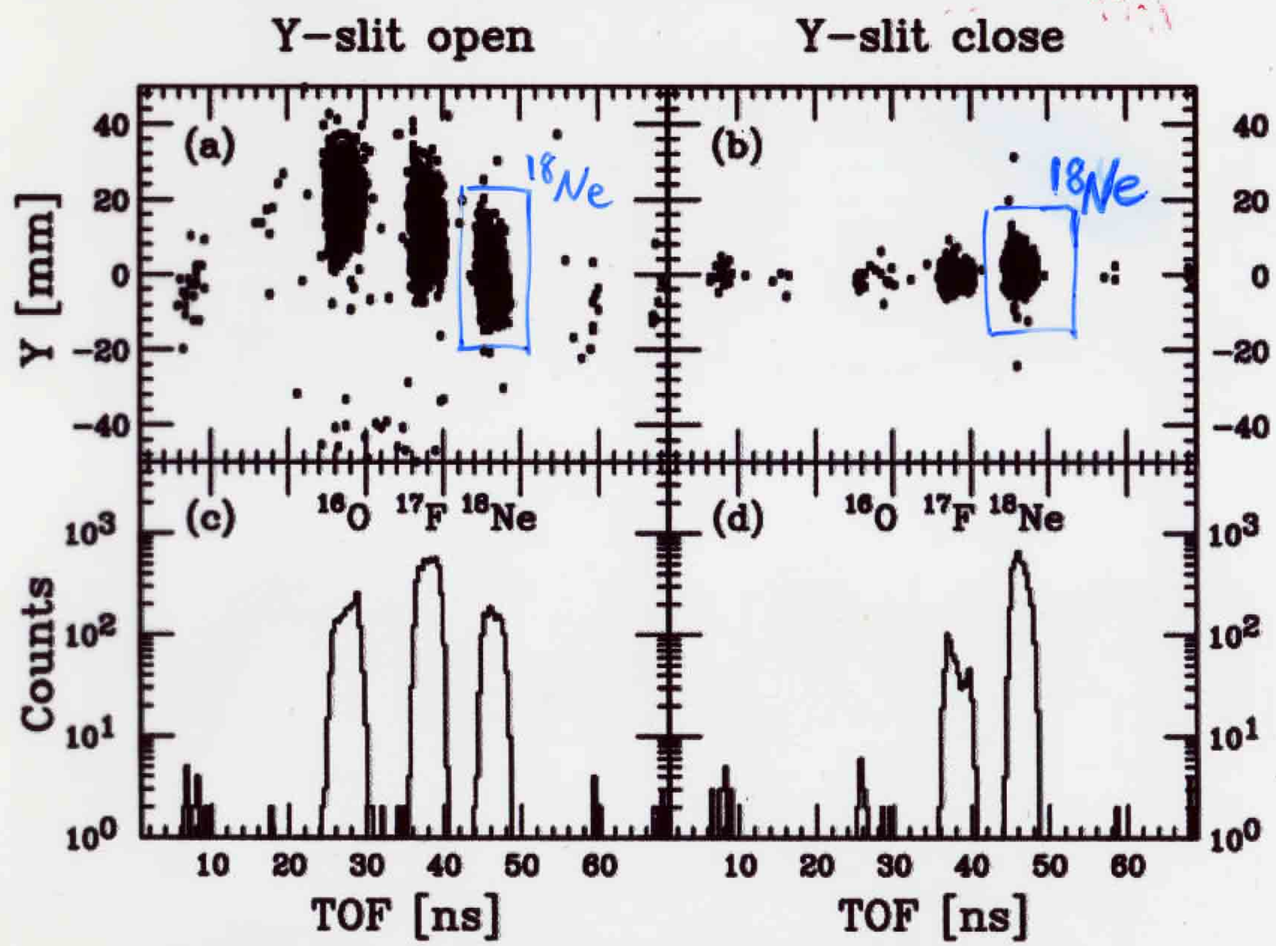


Results of a performance test



Primary beam of ^{20}Ne 82MeV/nucleon

- Voltage of deflector : 100kV
- Frequency of deflector : 16.3MHz

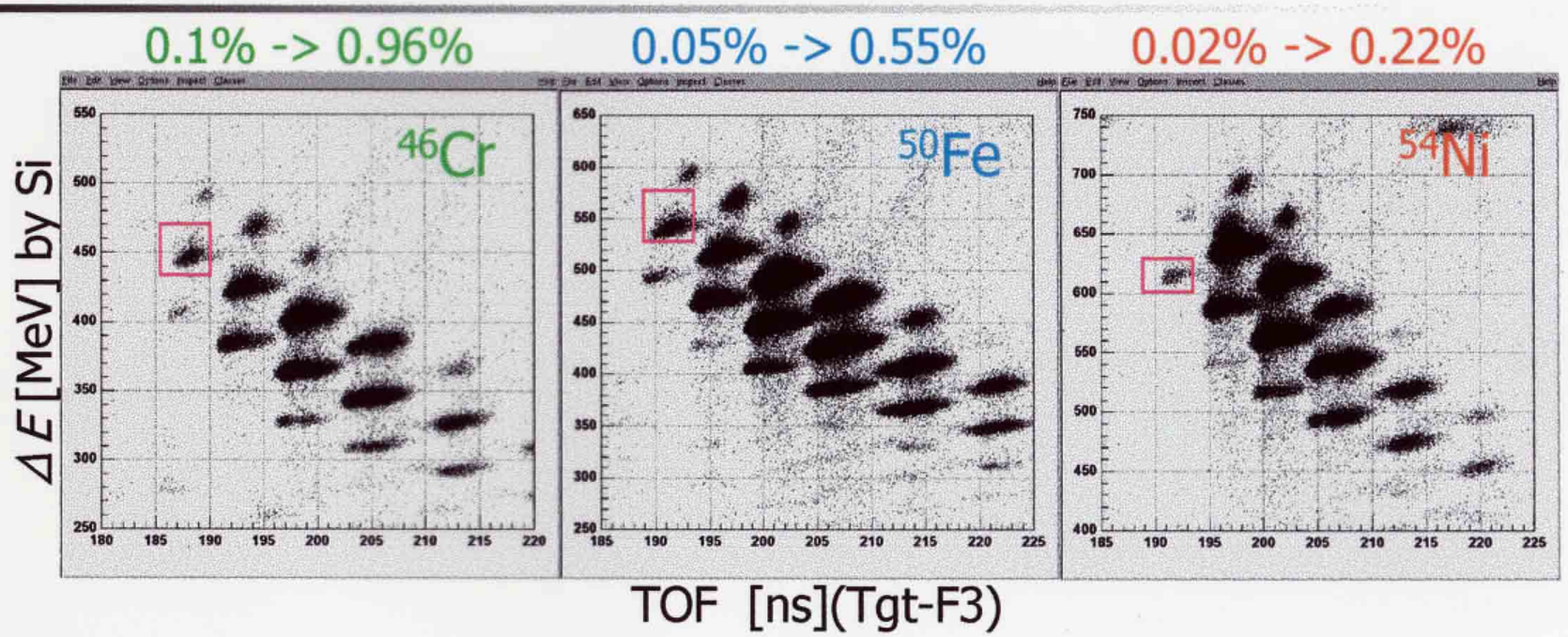


^{18}Ne 60MeV/nucleon produced by ^{20}Ne.
(+^{17}F + ^{16}O)
Purity improvement : 17% -> 86%(MAX)

Coulomb excitation of ^{46}Cr, ^{50}Fe, and ^{54}Ni

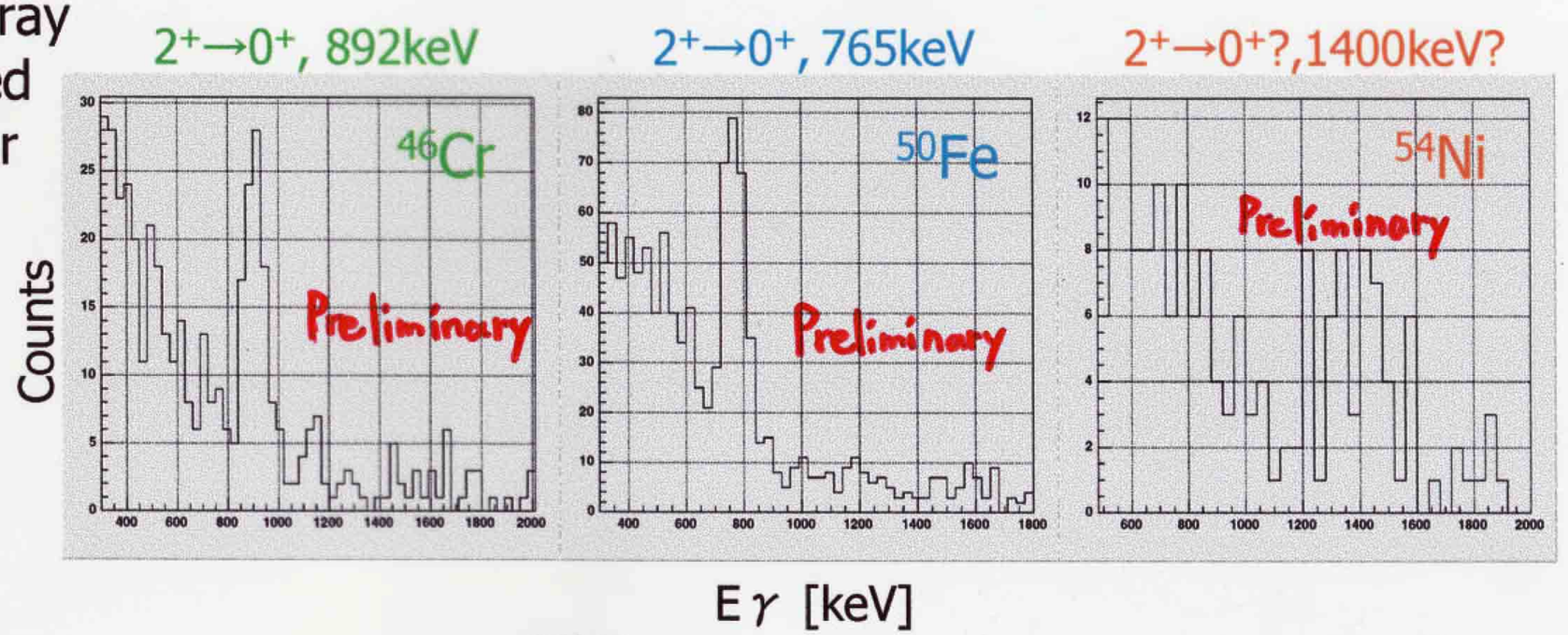
Beam purity:

About 10 times improved!



Doppler corrected γ-ray spectrum measured by NaI(Tl) detector array.

Background is not subtracted.



Summary

- RF deflector system was constructed in order to improve the purity of proton-rich RI beams.
- The performance was examined by using the primary beam of ^{20}Ne and the secondary beam of ^{18}Ne.
- The system was successfully commissioned and used in an experiment with proton-rich ^{46}Cr, ^{50}Fe, and ^{54}Ni beams.
- The purity was enhanced about 10 times, which is consistent with simulated performance.
- New experiments using RF deflector system is planned.