First results from recent BigRIPS commissioning experiments with 238U beam at 345 MeV/u: search for new isotopes

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Dec. 28th , 2006

First Beam $^{27}Al^{10+}$ 345 MeV/u at RIBF-SRC

March, 2007

12th $^{86}Kr^{31+}$ beam at 345 MeV/u several pnA.

13th First production of RI beams with ^{86}Kr beam

23rd First successful acceleration of $^{238}U^{86+}$ beam at 345 MeV/u and 0.002 pnA

27th First production of RI beams with ^{238}U beam

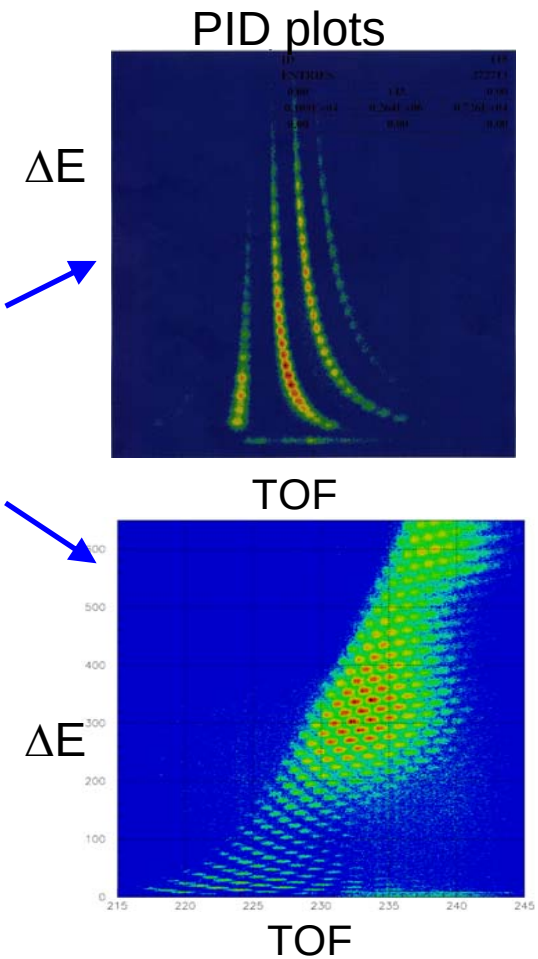
May-June, 2007

with ^{238}U beam at 345 MeV/u and 0.02 pnA max (~1x10^8 pps)

May 16th-23th BigRIPS commissioning (testing)

May 24th – June 3rd Search for new isotopes

PID plots



Particle identification (PID) scheme at BigRIPS and experimental setups

Measurement of TOF, Bρ (reconstructed), ΔE &TKE

↓ + isomeric γ-rays

Z, A/Q, A, Q

ΔE Si, I.C.

E NaI

Isomer γ-ray Ge

Bρ (reconstructed)

PPAC x2

RI beams

Second stage

F7

F5

F3

Time of flight (TOF)

Plastic scinti.

Heavy ion beams from SRC

Production target

STQ1

D1

STQ2

F1

STQ5

First stage

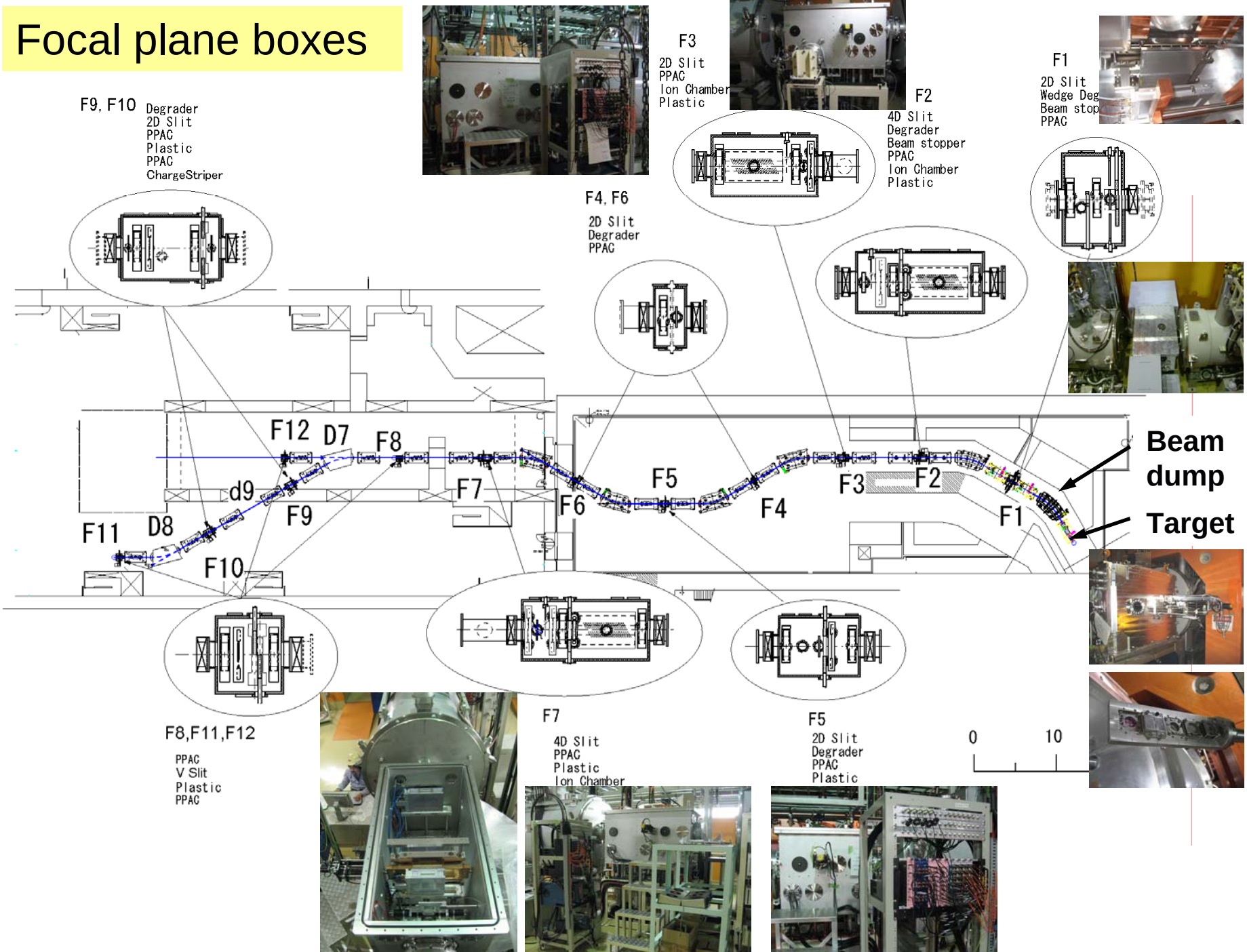
$$Z \leftarrow -dE/dx = \mathrm{f}(Z,\beta)$$

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

$$A = \frac{T_{KE}}{(\gamma-1)m_u}$$

$$Q = \frac{A}{A/Q}$$

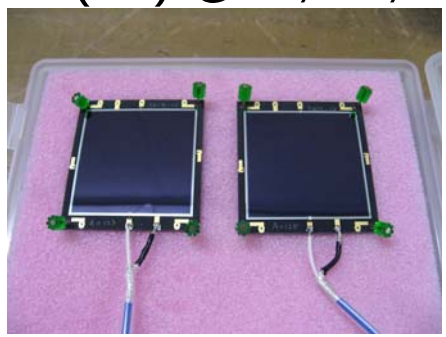
Focal plane boxes



Standard beam-line detectors at BigRIPS/ZeroDegree focuses

DL-PPAC (position) @F1-F7

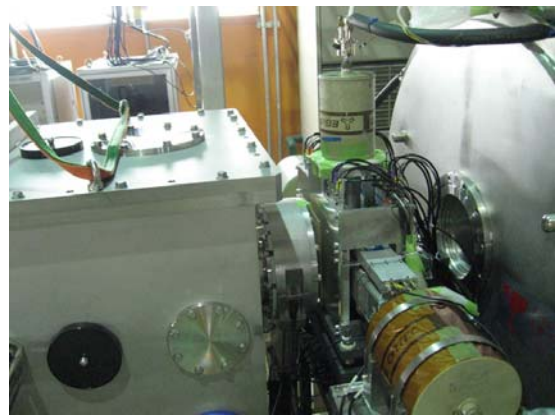
Si (ΔE) @F7, F2, F3



NaI (E) @F7

Plastic scinti. (TOF) @F2, F3, F7

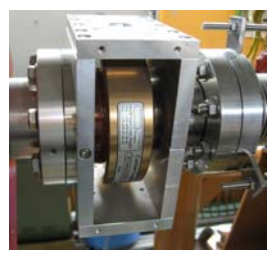
Ge @F7 for isomer γ-decay measurement (Isomer PID)



MUSIC (ΔE) @F7

To be ready soon

Intensity monitor (primary beams) @F0

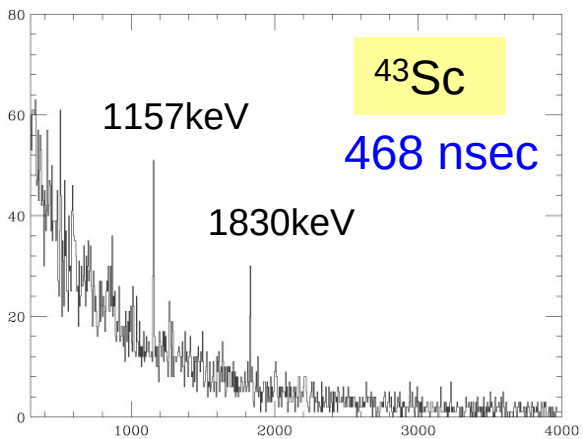


First RI-beams at BigRIPS

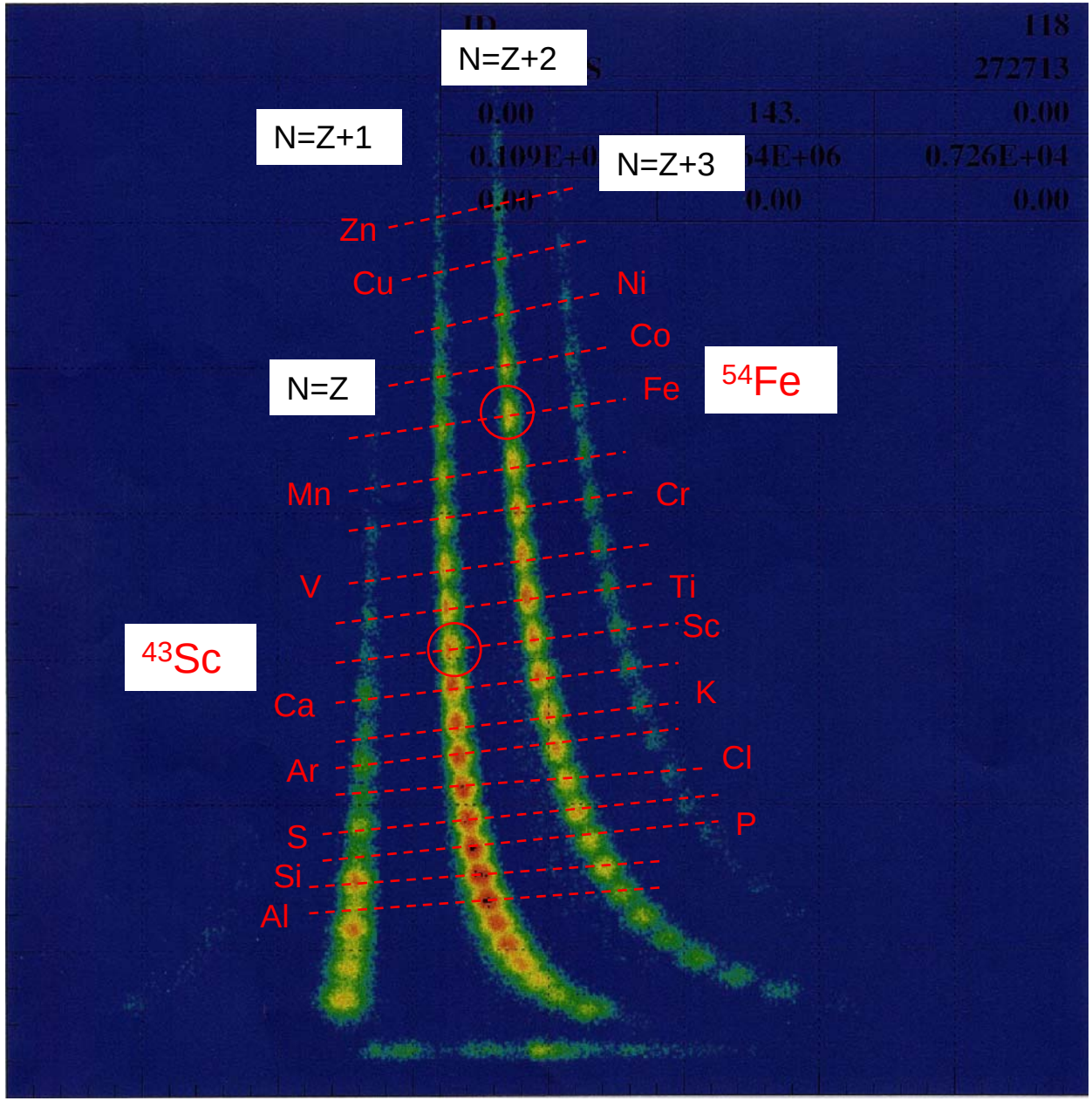
^{86}Kr + Be(2mm)
at 345 MeV/u

Bρ setting for
A/Z=2 isotopes

March 13th, 2007



γ-rays from an isomer in 43Sc



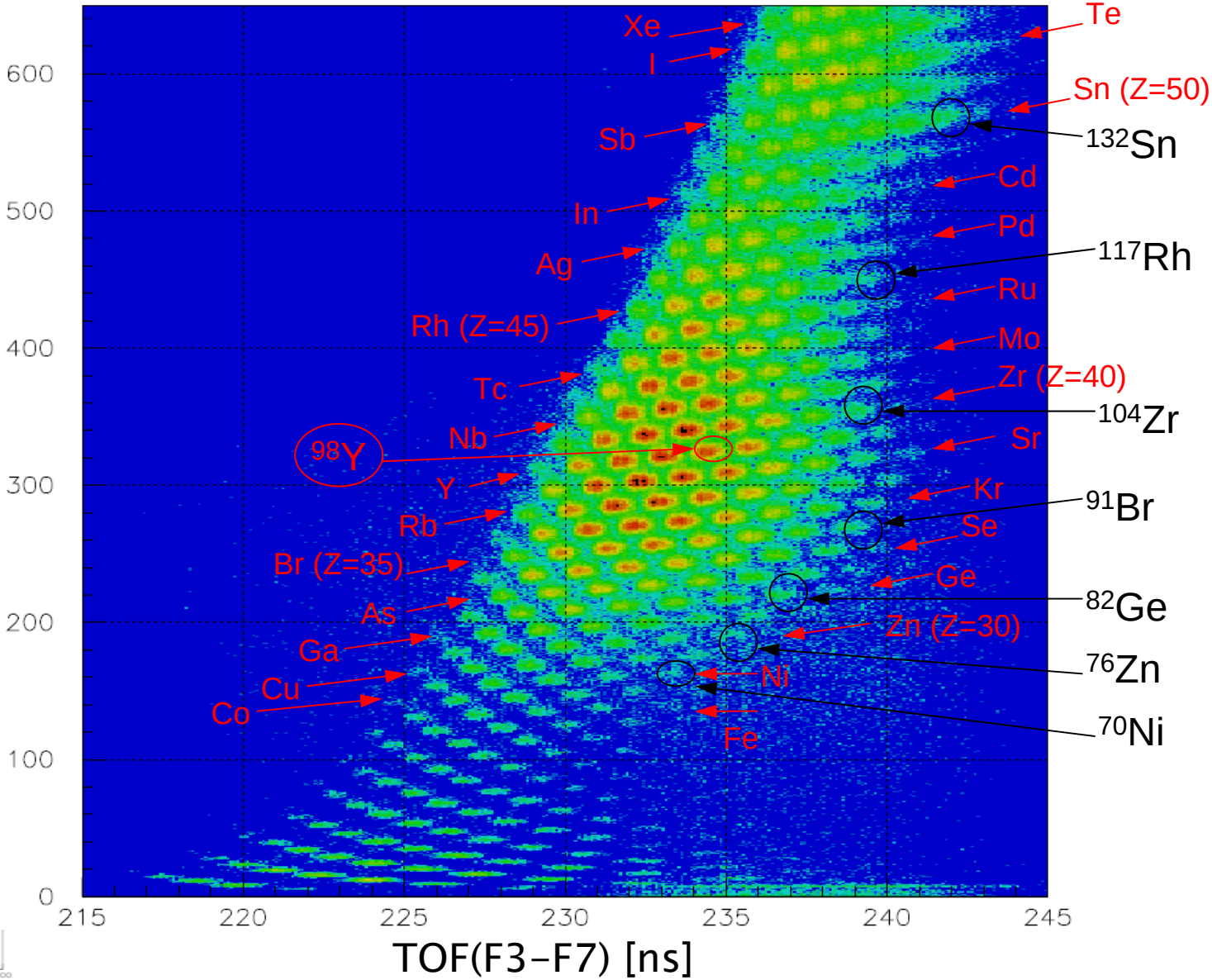
First RI beam production with U beam at BigRIPS

^{238}U + Be(5mm)
at 345 MeV/u

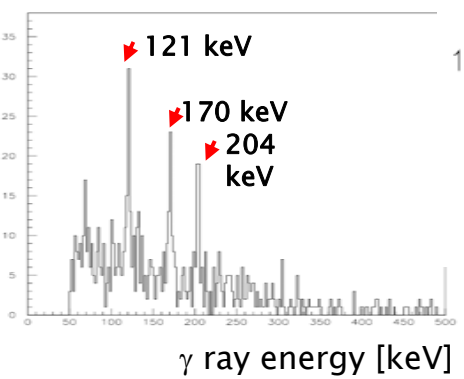
Bρ setting for
^{76}Ni isotope

F1 slit: +-2mm

Mar. 27th, '07



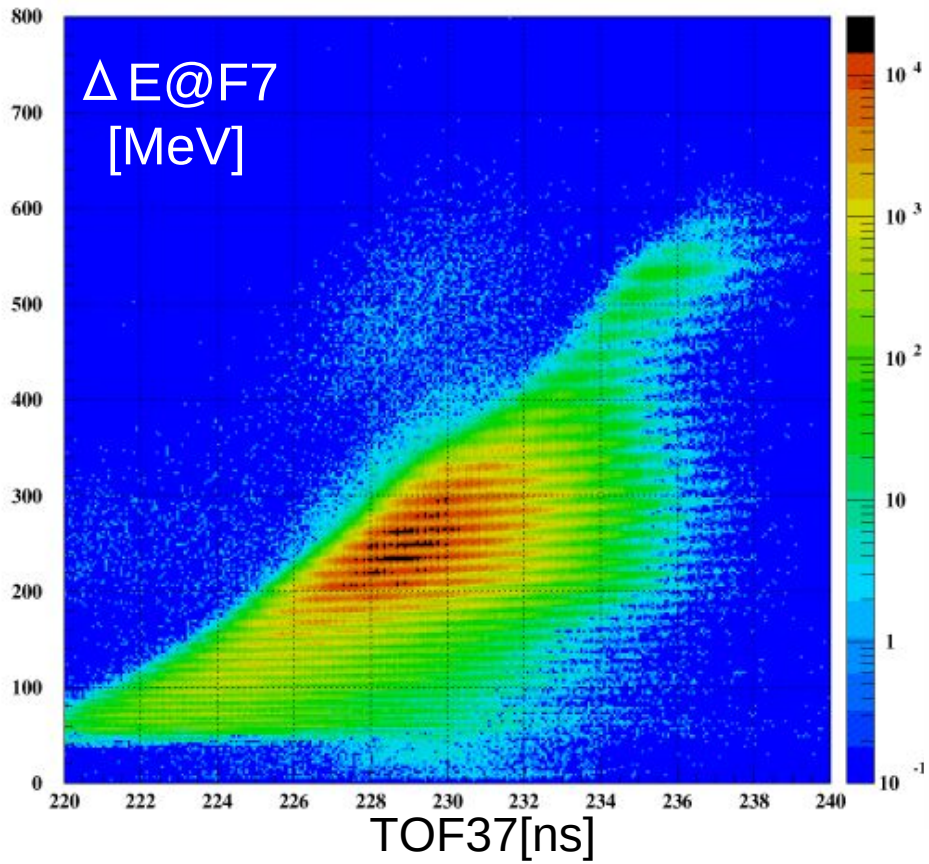
Isomeric γ-rays
from 98Y



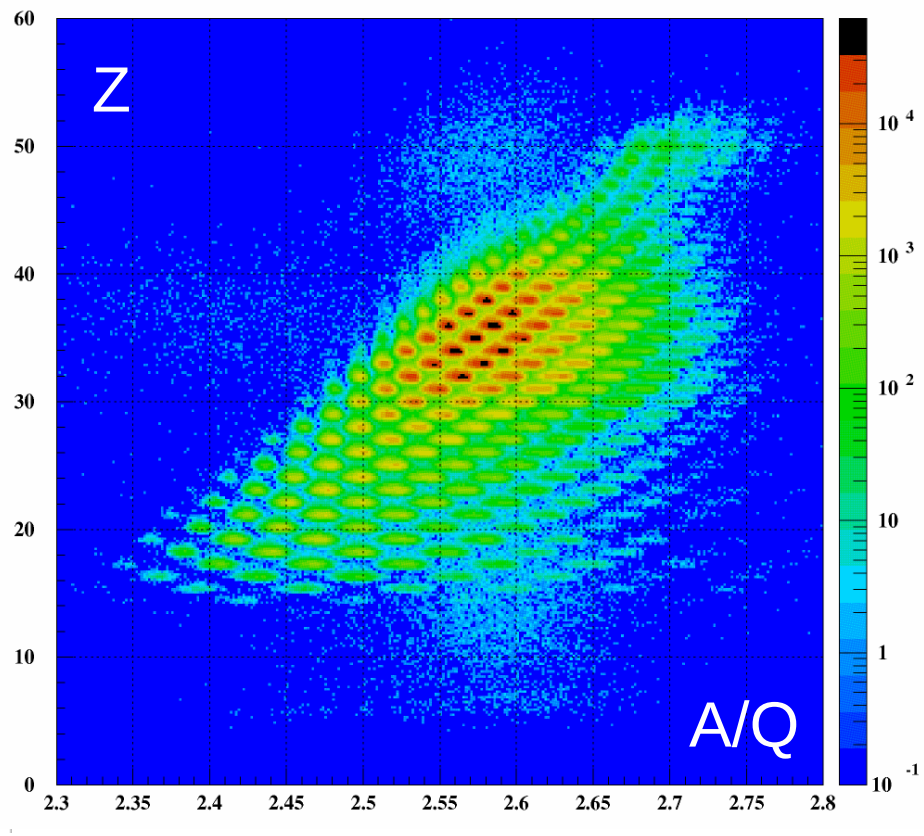
ΔE vs. TOF plot with wide momentum acceptance

^{238}U + Be(7mm) at 345 MeV/u, Bρ =7.4 Tm, Δ P = 2 %(F1 slit: +- 21mm)

ΔE vs. TOF plot



Z vs. A/Q plot
Bρ obtained just from F5 x-position



Bρ reconstruction using inverse optics matrix

4th-order matrix obtained from COSY-INFINITY calculation using field map data

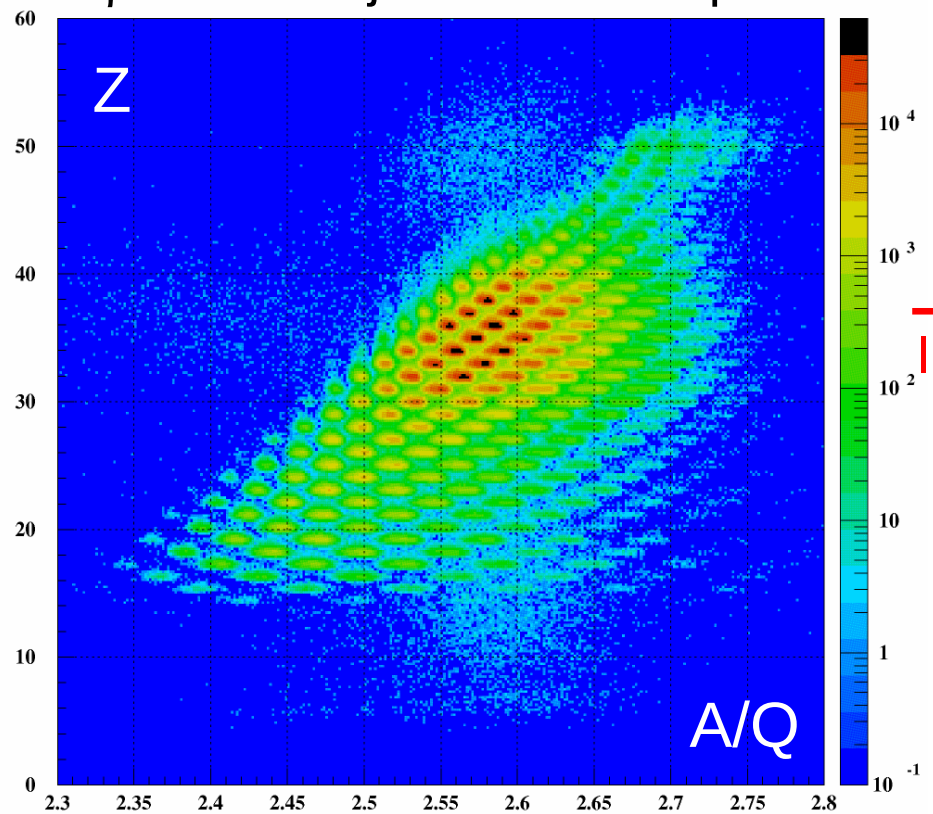
F5:x,y,θ,ϕ
F3:x
(measured)

reconstruction

Bρ (Δp)
y,θ,ϕ at F3

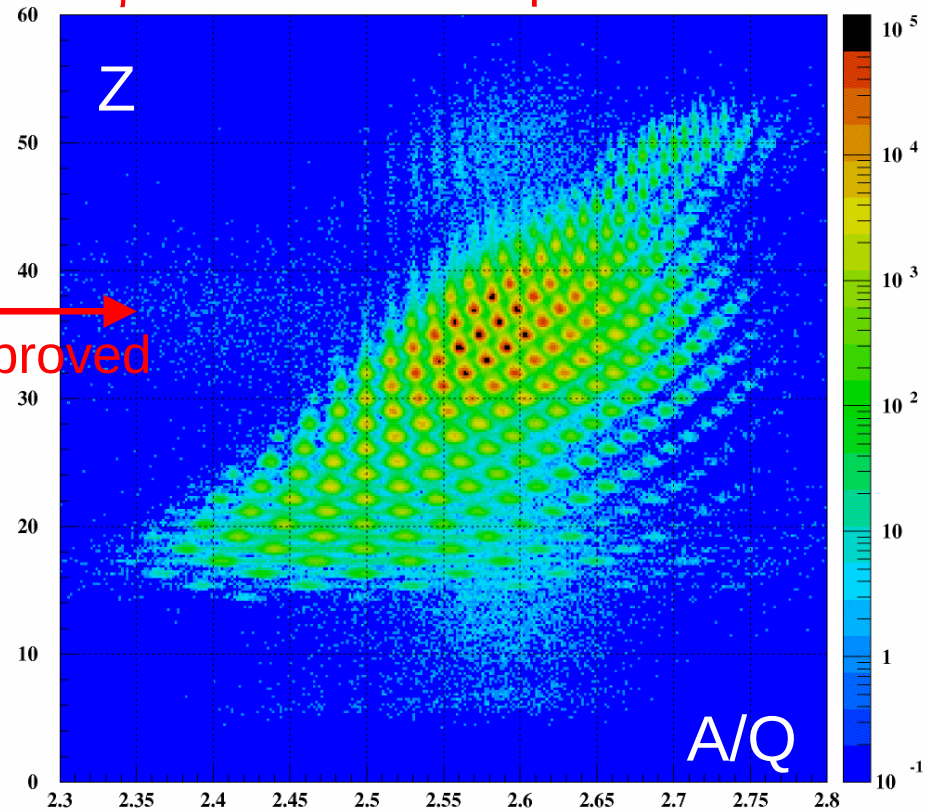
Δ L(path length diff. of TOF)

Bρ obtained just from F5 x-position



Improved

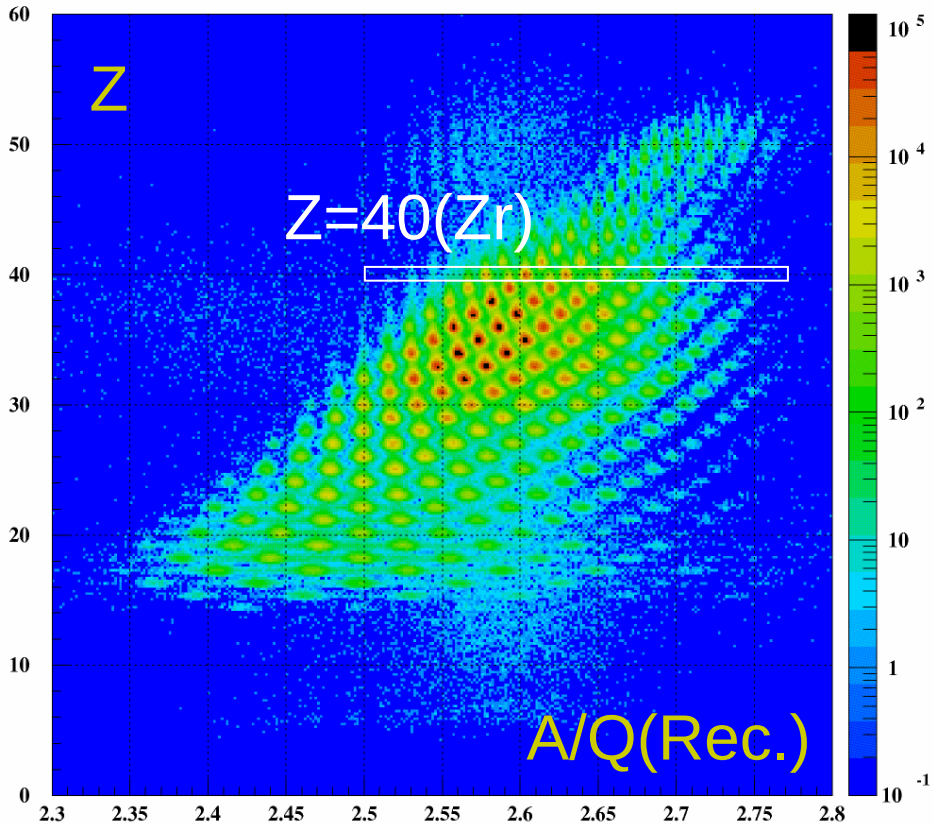
Bρ reconstructed up to 4th order

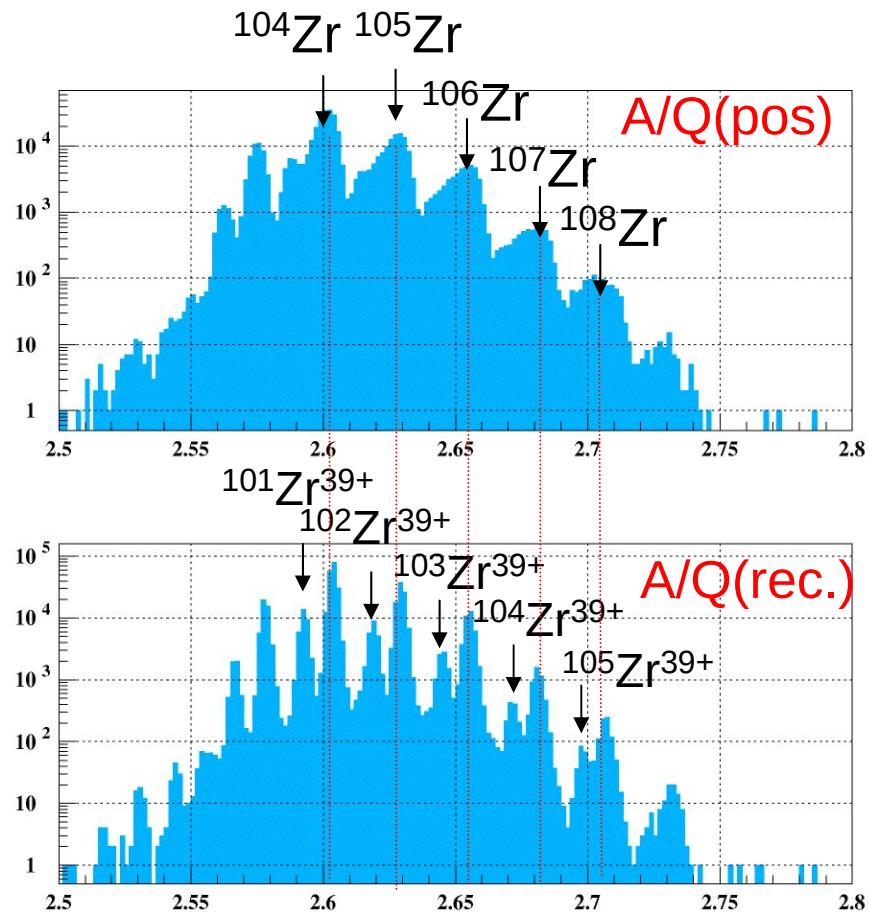


1D plot for Zr (Z=40) isotopes (an example)

Charge states are clearly resolved.

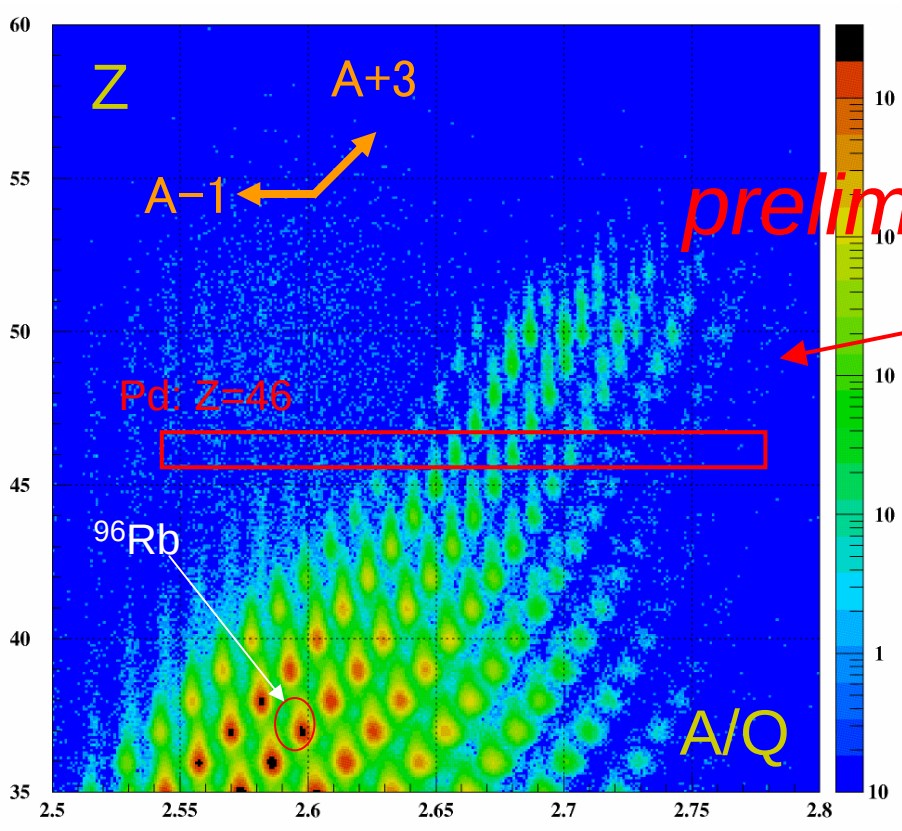
Bρ reconstructed up to 4th order

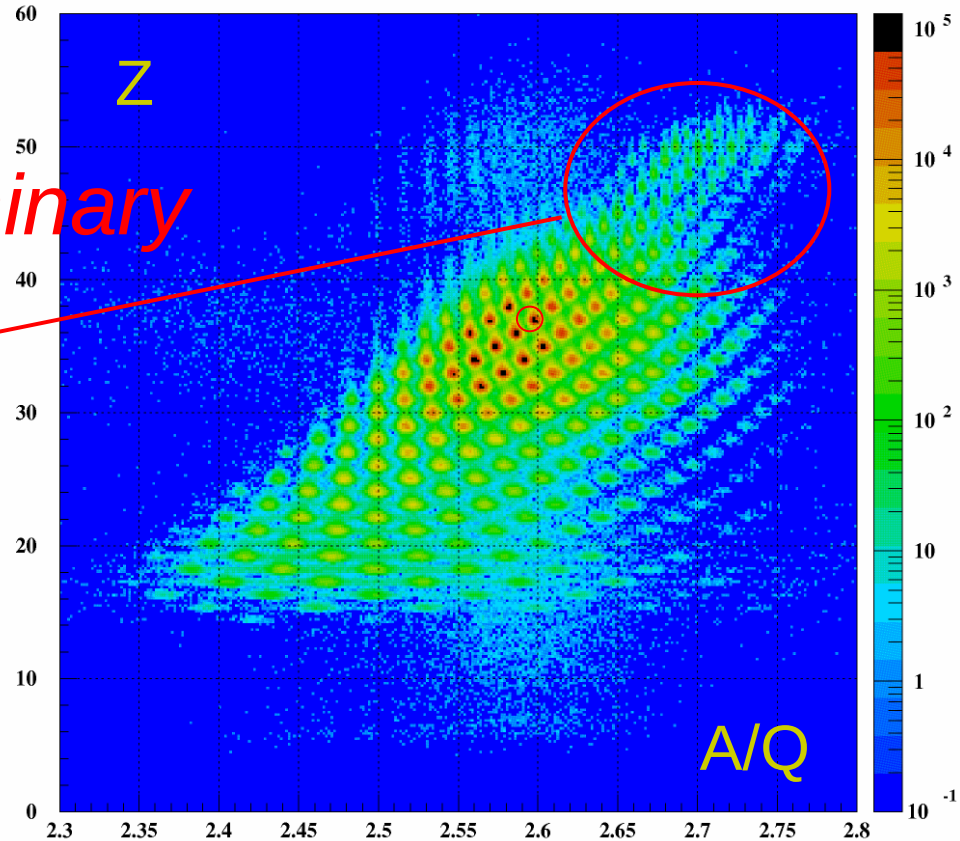




A/Q resolution(r.m.s): 0.07%

New isotope search with ^{238}U beams at 345 MeV/u





preliminary

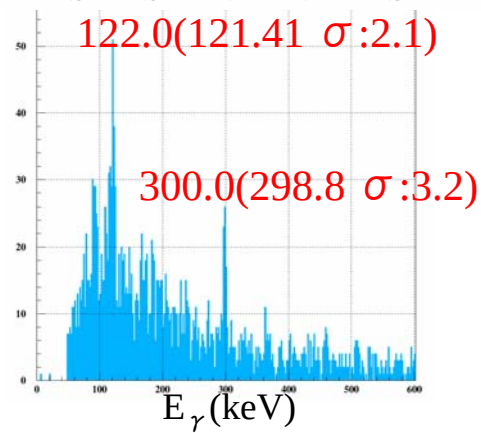
$B\rho$: 7.438 Tm, ΔP=2%

^{238}U + Be(7mm) at 345 MeV/u,

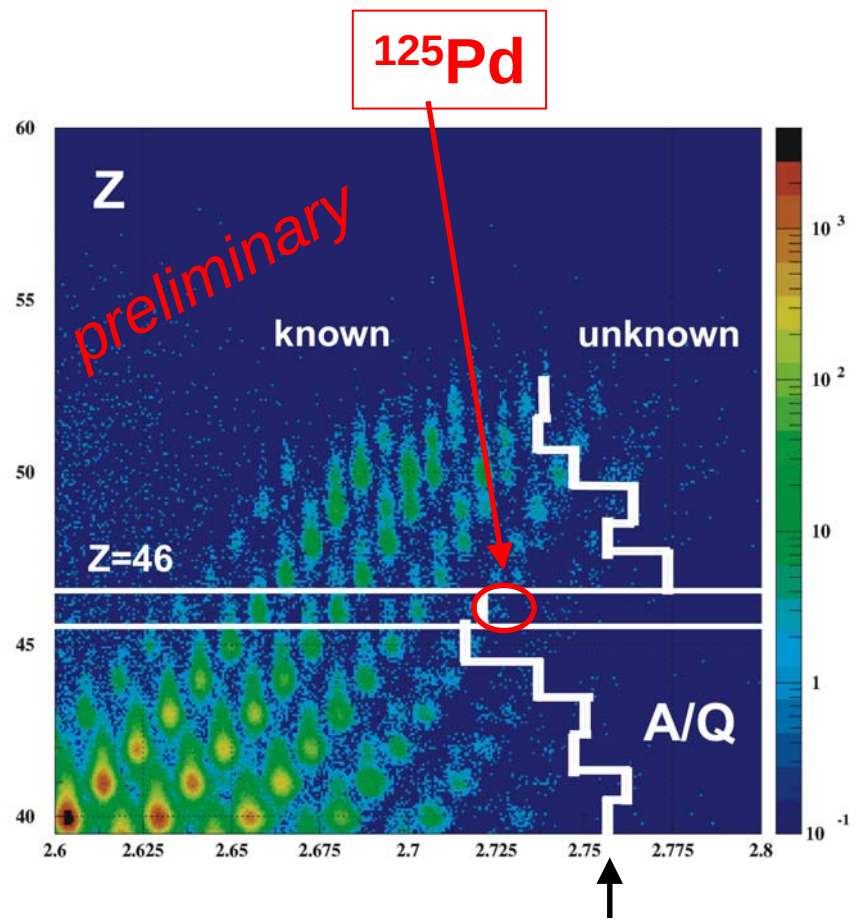
~1x10^{8} pps max.

Total dose: 6.9×10^{12}

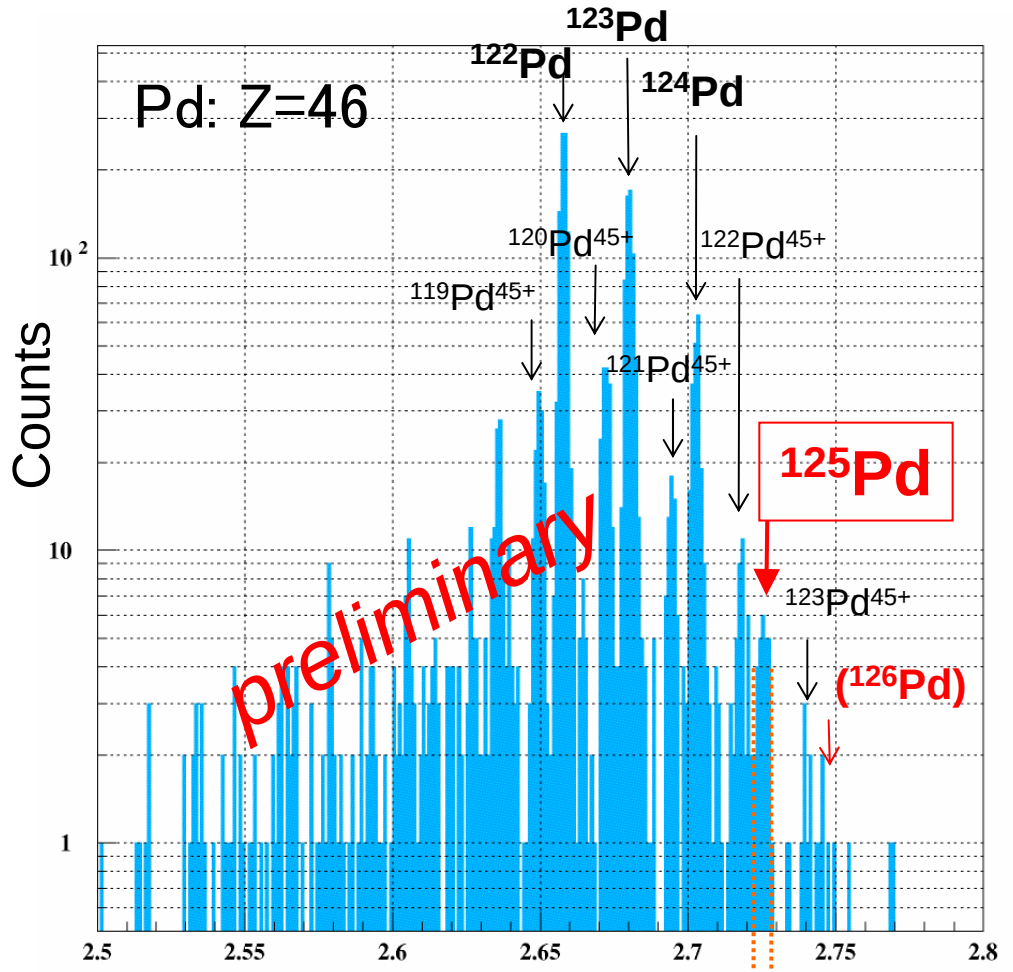
Isomeric γ-rays from ^{96}Rb



New isotope ^{125}Pd(Z=46) clearly observed!



M.Bernas et a. PLB 331(94)19;
PLB 415(97) 111 (GSI)



A/Q (reconstructed)

A/Q resolution(r.m.s): 0.07%

We could discover the new isotope ^{125}Pd(Z=46), regardless of the present U-beam intensity as low as 10^8 pps, which is 5 orders of magnitude smaller than the goal intensity !

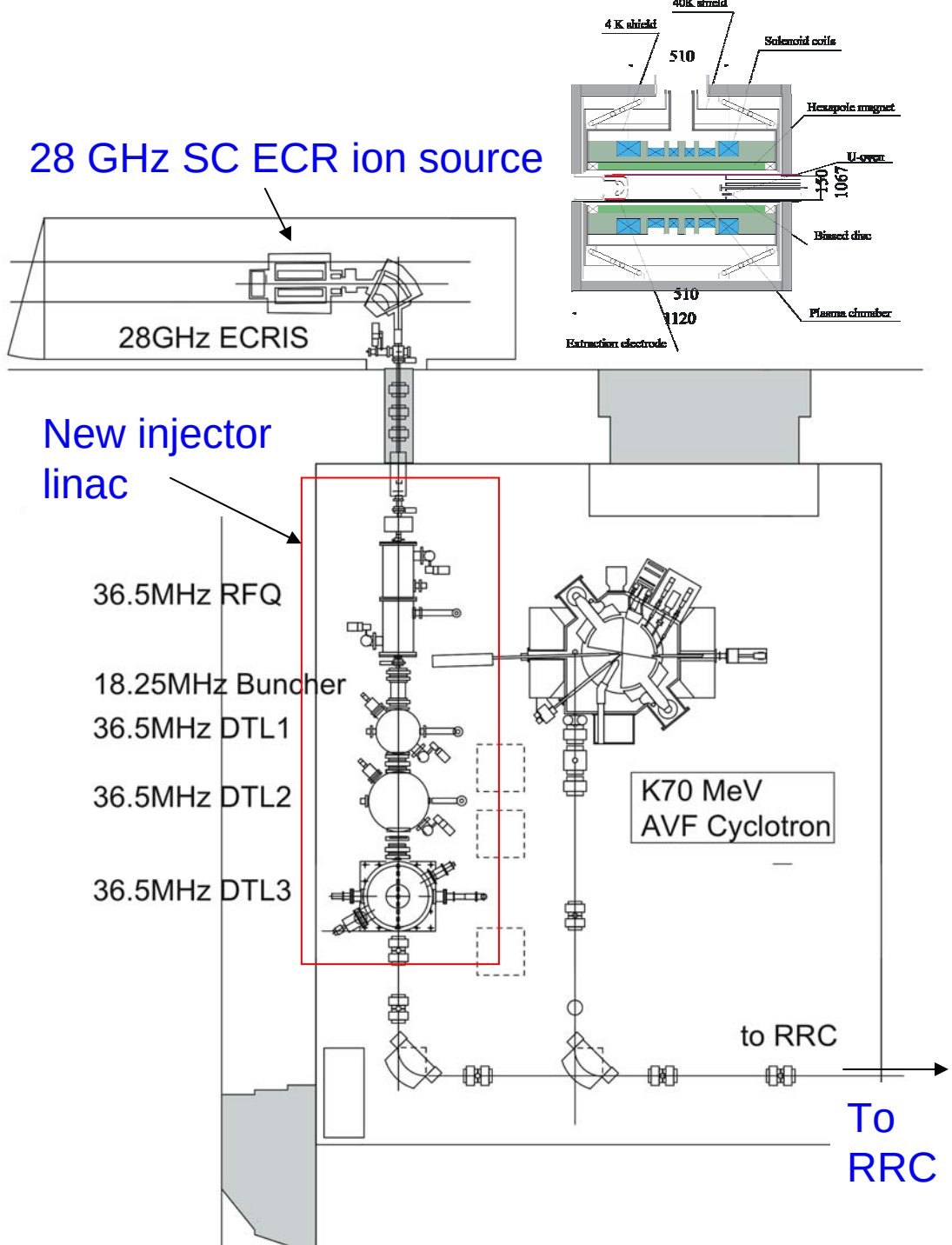
This demonstrates high performance and potentiality of the BigRIPS separator, and is a great launch to explore the nuclear world not accessible so far !

Beam-intensity upgrade project and RIBF phase-2 project

Intensity upgrade project for U beams: currently going on

Y. Yano et al

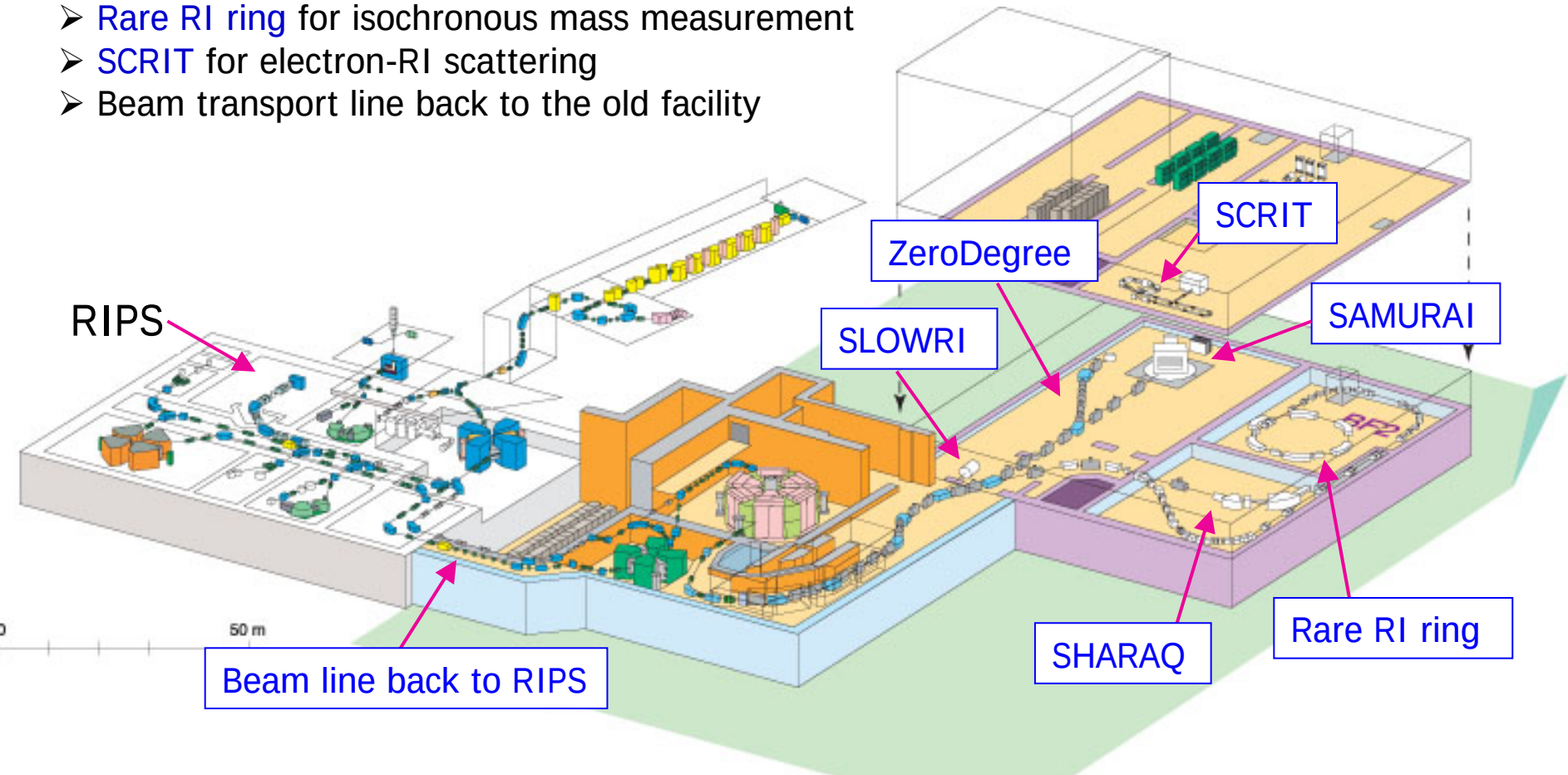
- Build a new injector linac and a new SC ECR ion source to upgrade the beam intensity.
- Acceleration of $^{238}U^{35+}$ ions
- 28 GHz superconducting ECR ion source, e.g. VENUS@LBNL
- $^{238}U^{35+}$ ions > 15 pμA (goal)
- Expected beam intensity: ~100 pnA for U
- will be operational late in 2008.



RIBF Phase-II projects: major experimental installations

- ZeroDegree: a beam-line spectrometer → Complete in Oct. 2007
- SHARAQ: high resolution spectrograph (CNS project) → Complete in 2008
- High-resolution beam line for SHARAQ
- SLOWRI (gas catcher, In-flight + ISOL+ re-accel.)
- SAMURAI: large-acceptance superconducting spectrometer
- Rare RI ring for isochronous mass measurement
- SCRIT for electron-RI scattering
- Beam transport line back to the old facility

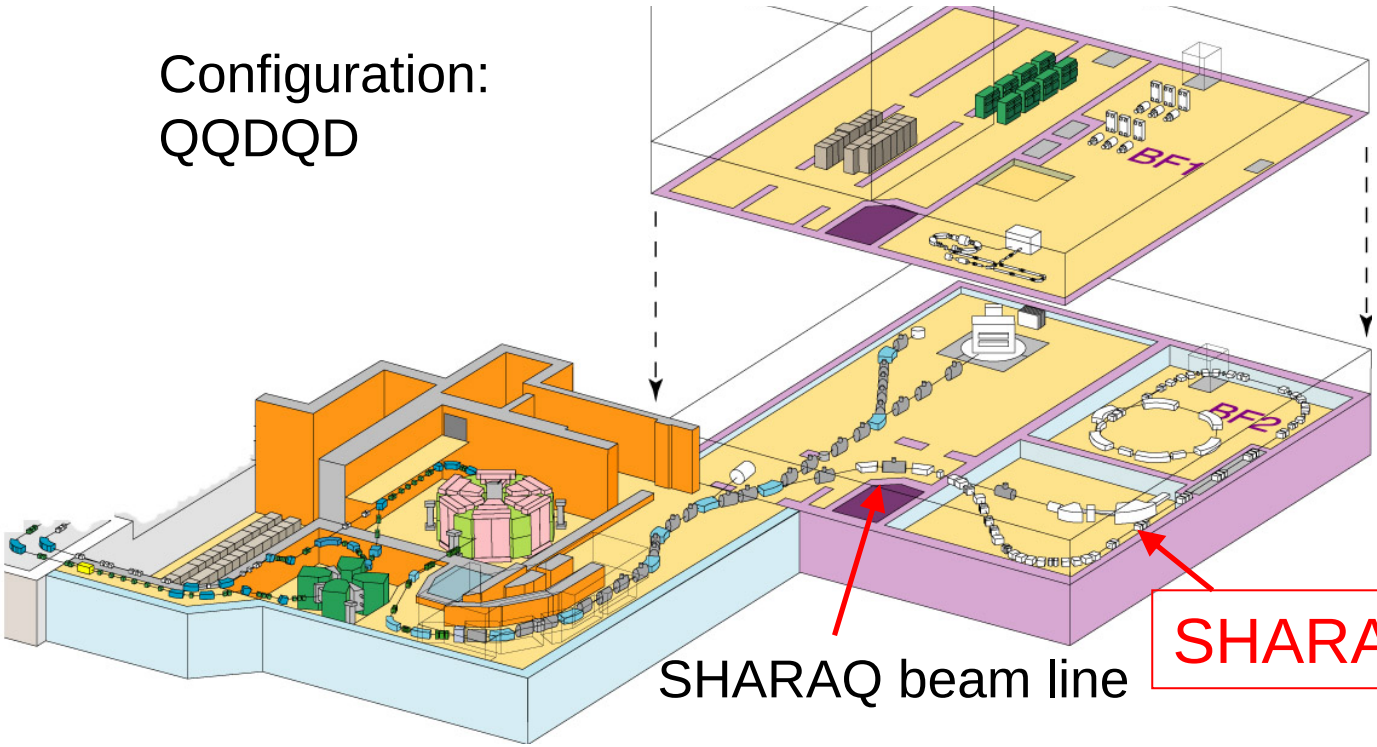
Others: being proposed.



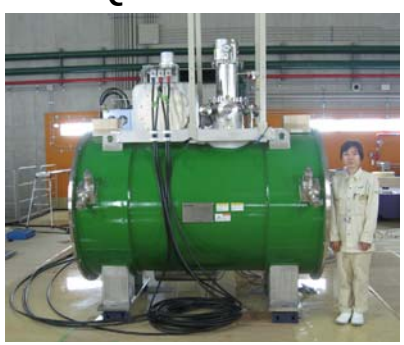
SHARAQ: high resolution spectrograph (CNS project)

High-resolution beam line for SHARAQ

Configuration:
QQDQD



SDQ



D2

Summary and conclusion

- RI beam production using in-flight separators was reviewed.
- Overview of BigRIPS in-flight separator at RIKEN RI beam factory (RIBF) was outlined, including those of the RIBF accelerators
- BigRIPS was commissioned in March, 2007 with ^{86}Kr and ^{238}U beams at 345 MeV/u, and first RI beam production was successfully made.
- A new-isotope search experiment was made in May, 2007 with ^{238}U beam after commissioning test runs. New isotope ^{125}Pd(Z=46) has been clearly observed, regardless of the U-beam intensity as low as 10^8 pps (five orders of magnitude lower than the goal intensity).
- This discovery has demonstrated high performance and potentiality of BigRIPS, and is a great launch to explore the nuclear world so far not accessible,
- Beam intensity upgrade project and phase-2 projects were also outlined.

BigRIPS

RIKEN Nishina Center

Credit

Collaborators of BigRIPS construction (BigRIPS team members)

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Together with people from companies

March, 2006

■ BigRIPS team members

Collaborators of the BigRIPS commissioning experiments

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M. Matsushita (Rikkyo U., Japan)
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A. Ozawa, T. Moriguchi, Y. Yasuda (U. Tsukuba, Japan)
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J. Nolen (ANL, USA)
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W.Mittig (GANIL, France)




International collaboration

Thank you for your attention.