Fragmentation measurements of ^{86}Kr at Riken

Betty Tsang, Riken PAC meeting, Dec 18, 2003

US-Japan Collaboration

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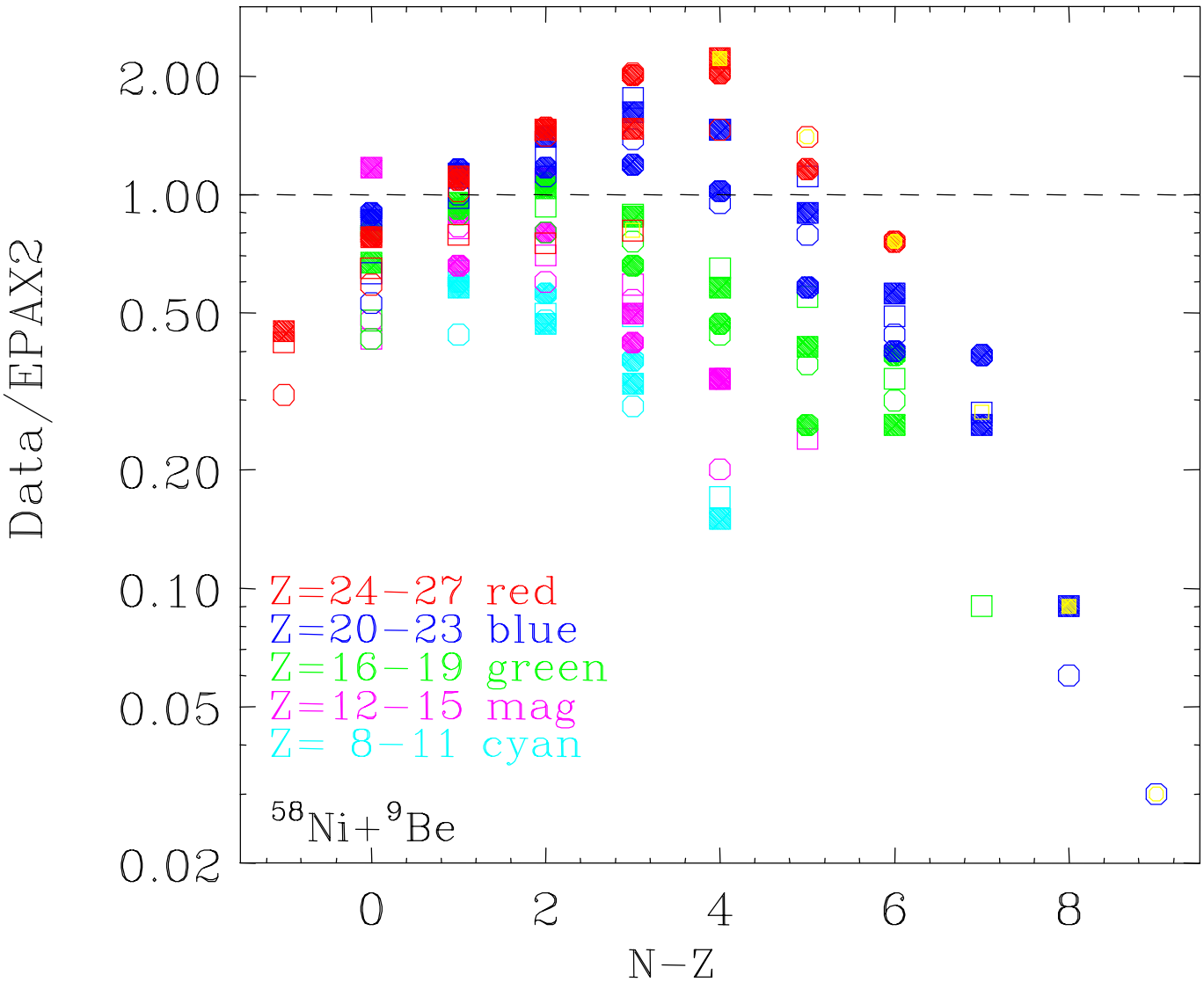
Projectile Fragmentation experiments

- **Experimental objectives:**
  - ***To understand rare isotope production in fragmentation reactions.***
  - ***extract systematics for fragment cross-section measurements, charge state distributions, momentum distributions,***
    - ***operations of current facilities, aide in experimental design, R&D for RIA, HI radiation therapy, space exploration etc.***

Epax Parameterizations

- Limiting fragmentation
  - *Independent of beam energy*
  - *Geometrical dependence on targets*
- Empirical parameterizations
  - *Used in fragment production rate estimates*
  - *Incorporated into LISE*
  - *Widely used in designing experiments*
- Problems:
  - *Based on limited data sets at E/A=500 MeV*
  - *No physics insights*
  - *Observed deviations in producing nuclei far from stability*

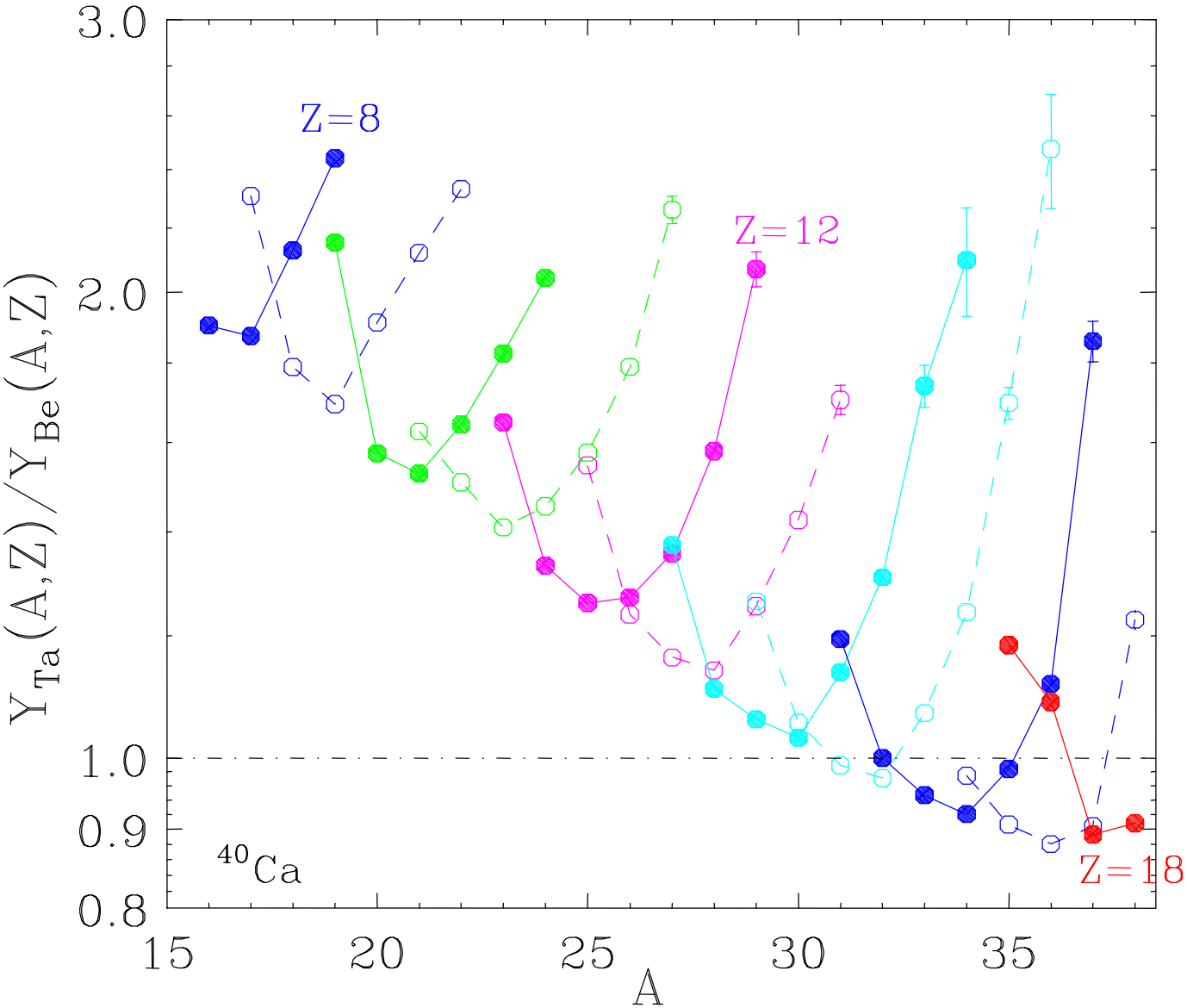
Comparison of Epax-predicted and experimental cross-sections



Most ratios are less than 1

Ratios decrease with decreasing charge and increasing N-Z

Fragmentation of ^{40}Ca -- Be and Ta target comparison



Constant enhancement is predicted by EPAX

Data may shed insights to the role of targets in production of fragments far away from stability

Important to get data on Be & Ta targets

Proposed Experiment

Need high quality and comprehensive data

- ***to explore energy and target dependence of fragmentation mechanisms***
- ***to provide better parameterizations than EPAX especially for nuclei far from stability***

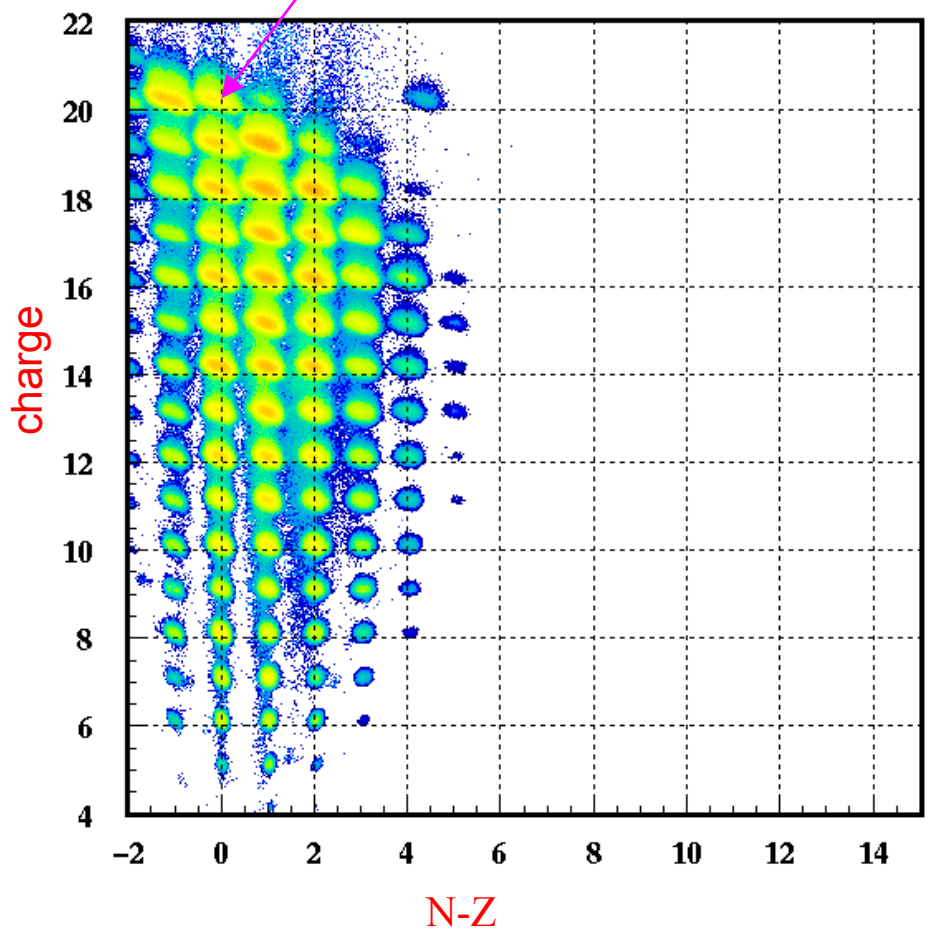
– crucial in development of fragmentation models to understand rare isotope production.

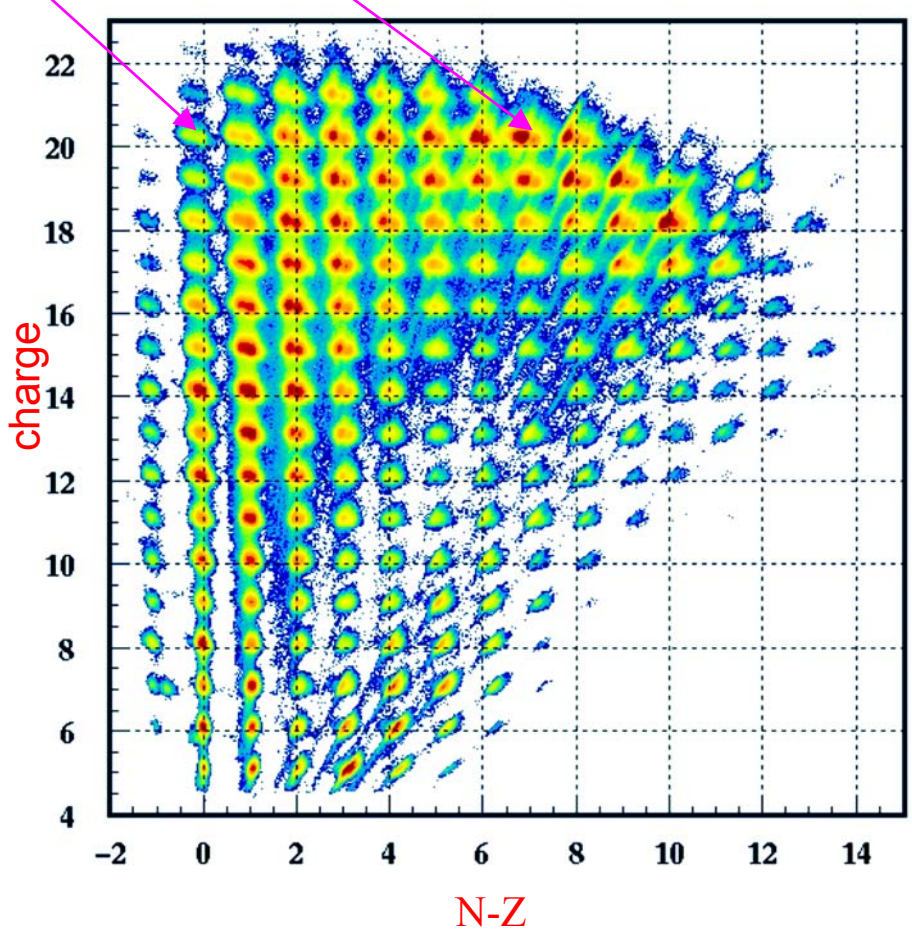
- **Primary beam:**
  - *^{86}Kr; 65MeV/u, intensity ≈ 1-80 pnA*
- **Targets:**
  - *^{9}Be (100 mg/cm^2) and ^{181}Ta (200 mg/cm^2)*

Comparison of Fragmentation of ^{40}Ca and ^{48}Ca

$^{40}Ca + {}^{9}Be$

$^{48}Ca + {}^{9}Be$





Projectile Fragmentation experiments

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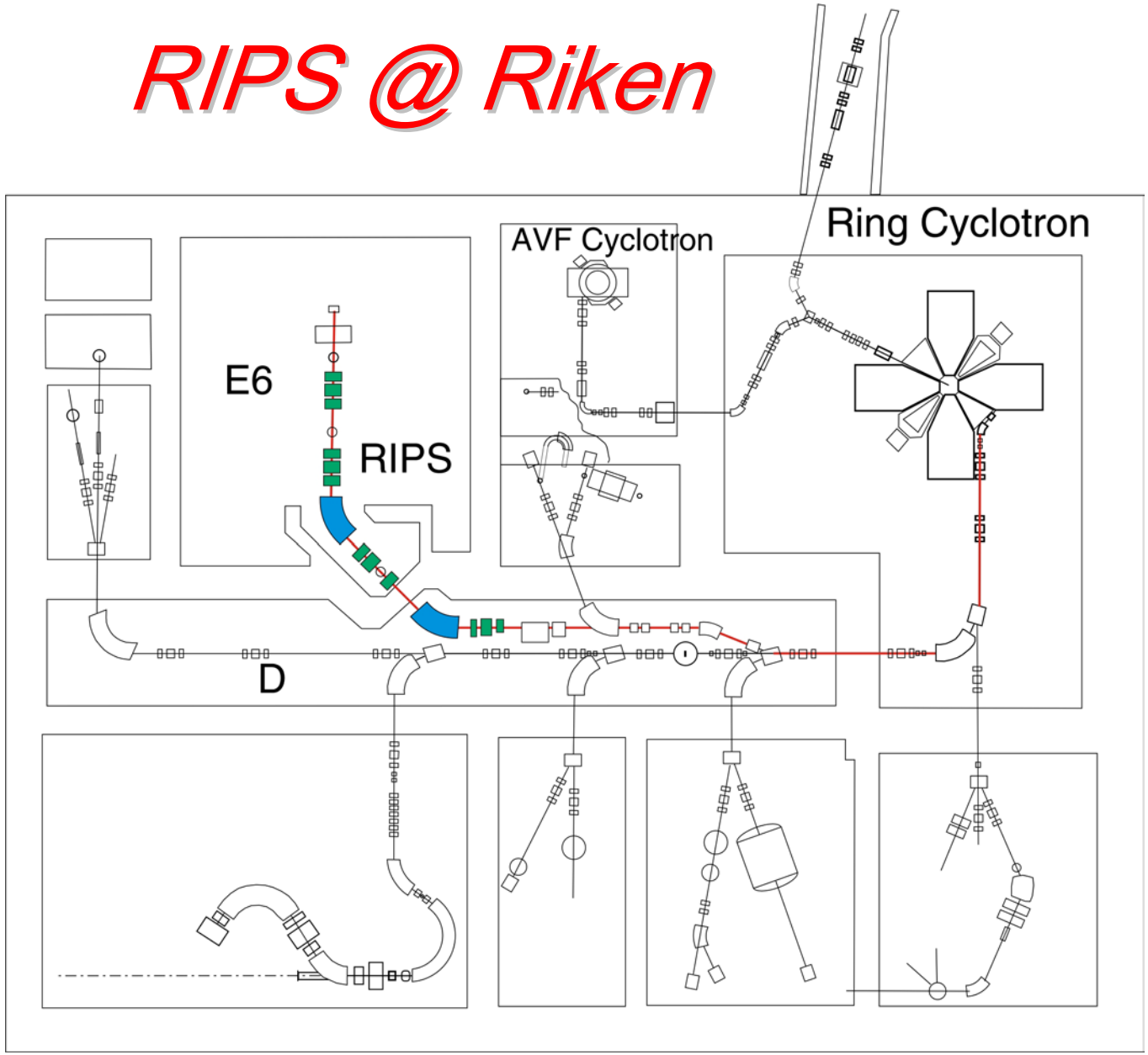
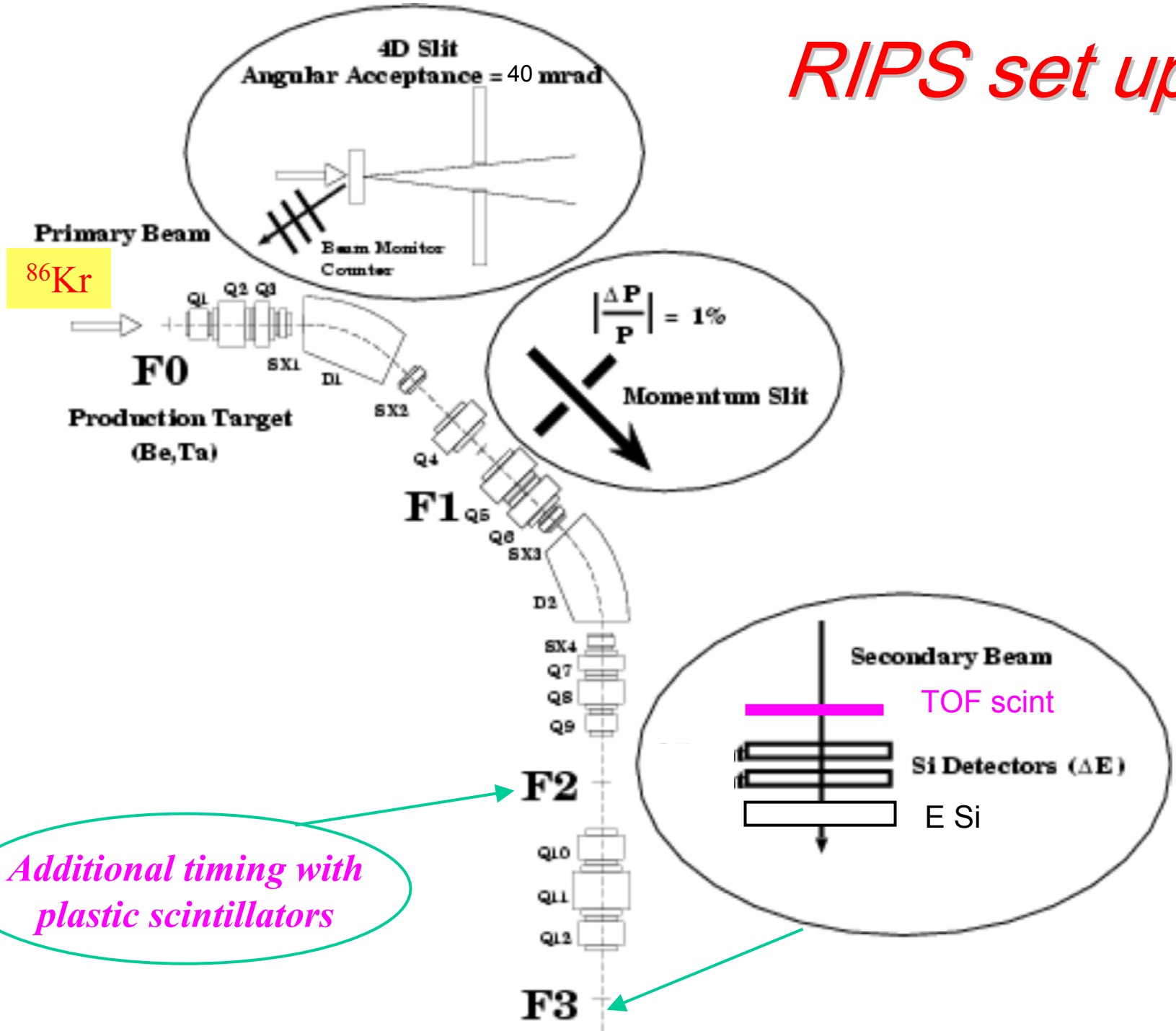
Experimental objectives:

- ❖ *Comprehensive cross-section measurements for ^{86}Kr fragmentation: data base from 25-500 MeV/u*
- ❖ *Deviation from EPAX*
  - ➢ *target effects*
  - ➢ *Dependence on Incident energy*
- ❖ *Production mechanism for n-rich isotopes in the p-removal chain.*
- ❖ *…*

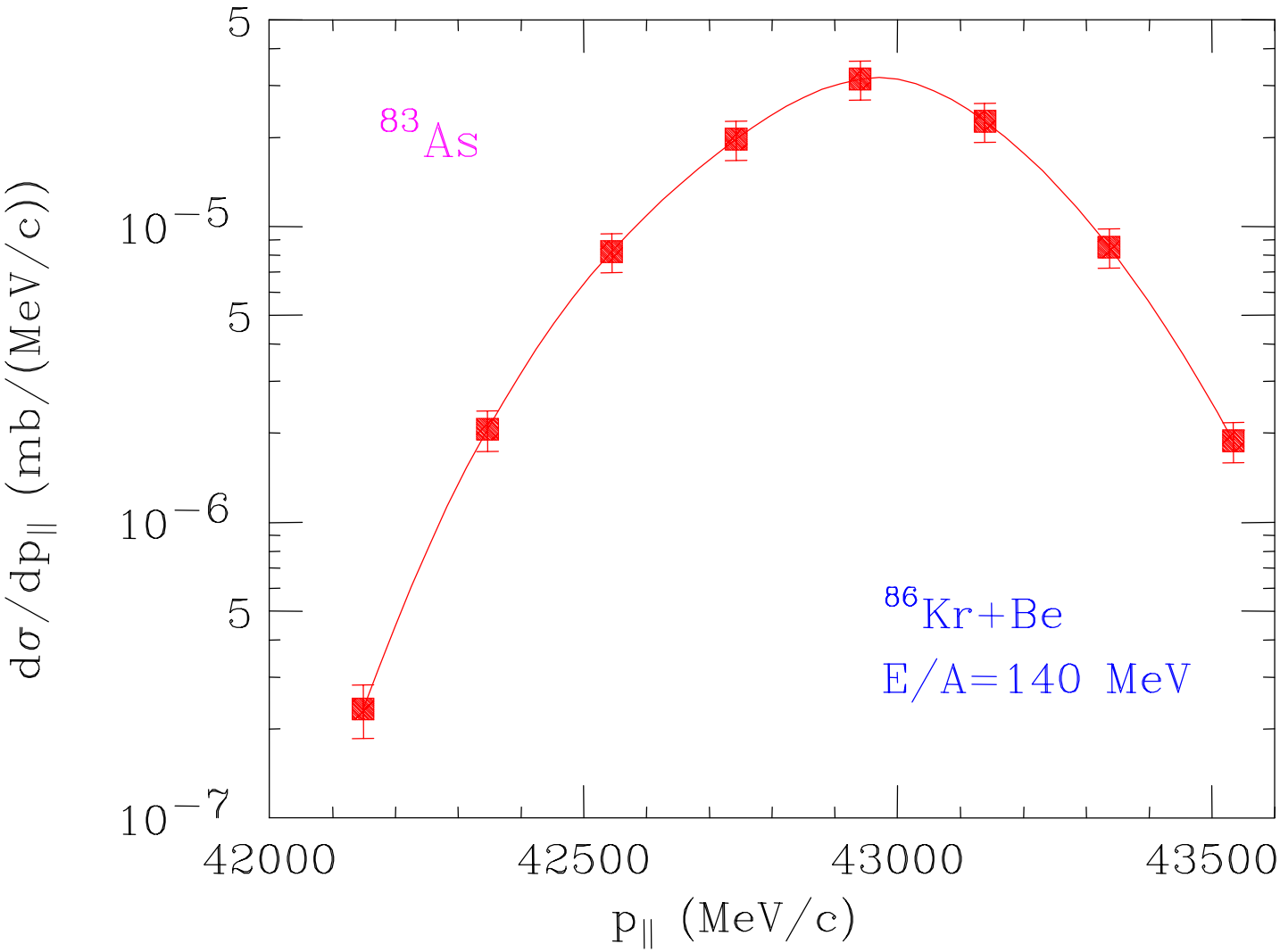
RIPS @ Riken



RIPS set up

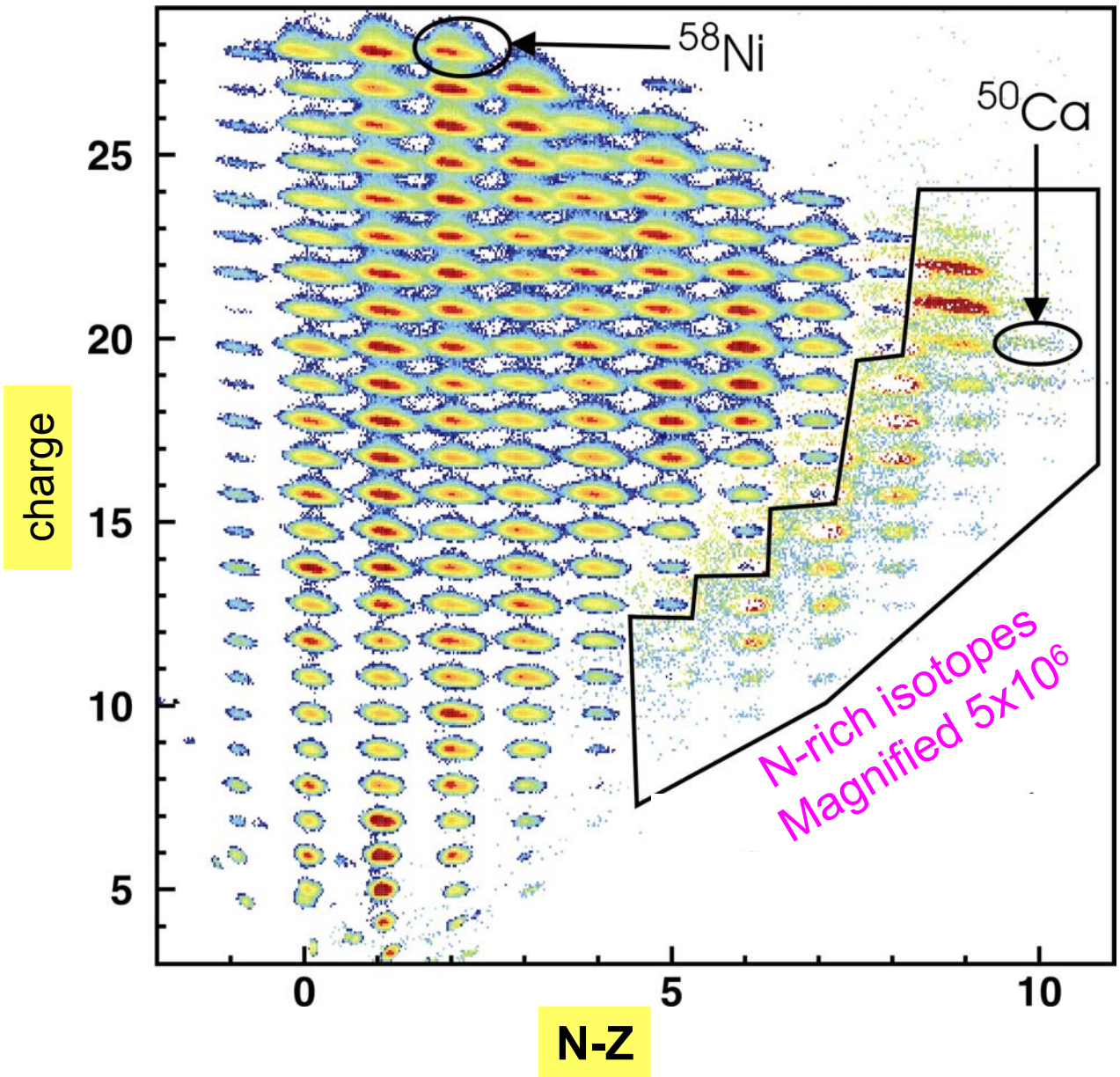

4D Slit
Angular Acceptance = 40 mrad
Beam Monitor Counter
Primary Beam
86Kr
Q1 Q2 Q3
F0
SX1
D1
Production Target
(Be,Ta)
SX2
Q4
|ΔP/P| = 1%
Momentum Slit
F1
Q5
Q6
SX3
D2
SX4
Q7
Q8
Q9
F2
Q10
Q11
Q12
F3
Secondary Beam
TOF scint
Si Detectors (ΔE)
E Si
Additional timing with plastic scintillators

Momentum Distributions



- ***Extraction of cross-sections***
- ***Tail with low momentum constitutes background for n-deficient isotopes***

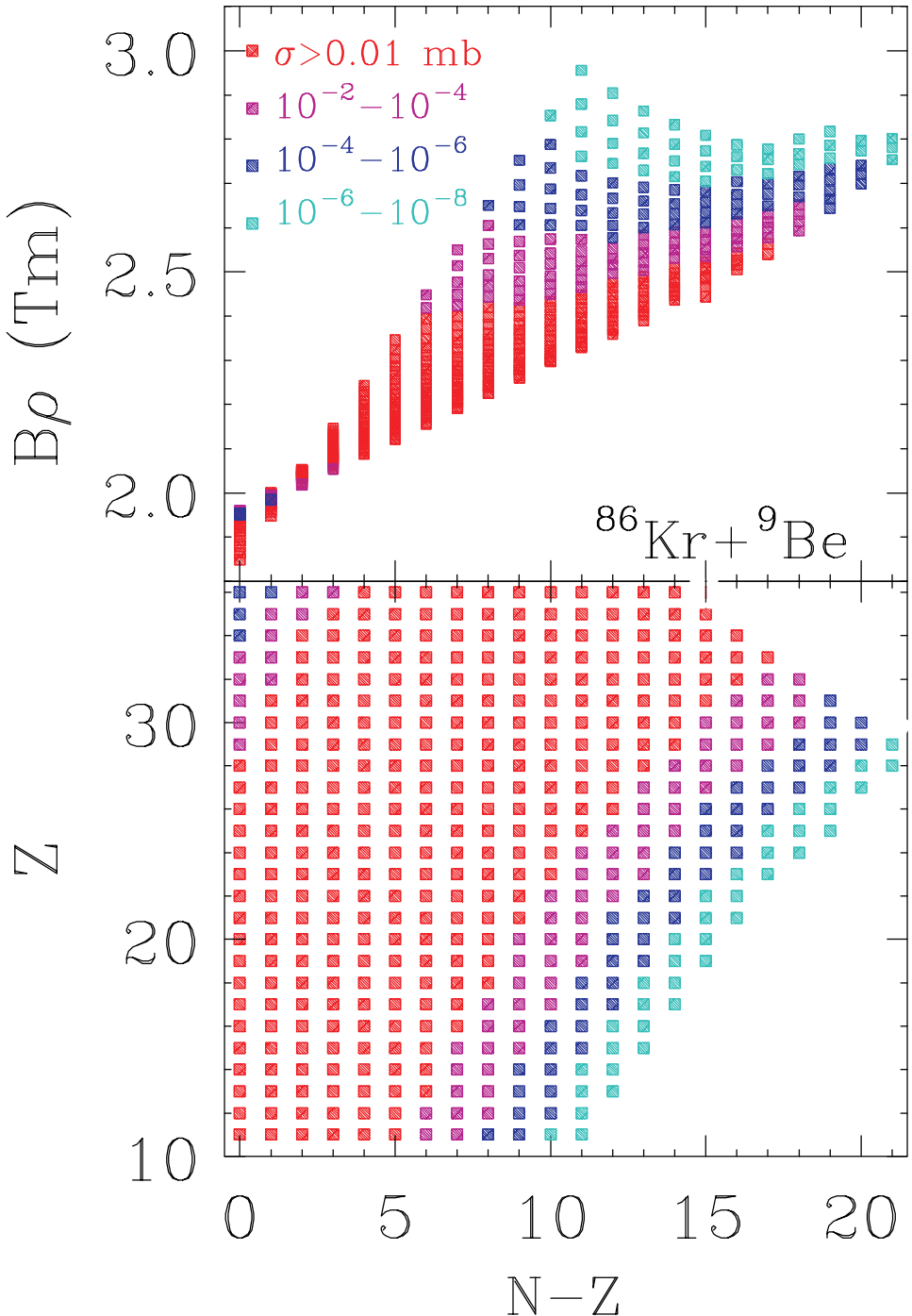
Example: *Fragmentation of 58Ni at MSU*



Measured:

>200 isotopes

9 orders of magnitude of cross-sections



Proposed run plans

I. σ>0.01 mb ; 40 hr.

II. $10^{-2} < \sigma < 10^{-4}$ mb; 40 hr.

III. $10^{-4} < \sigma < 10^{-6}$ mb; 30 hr.

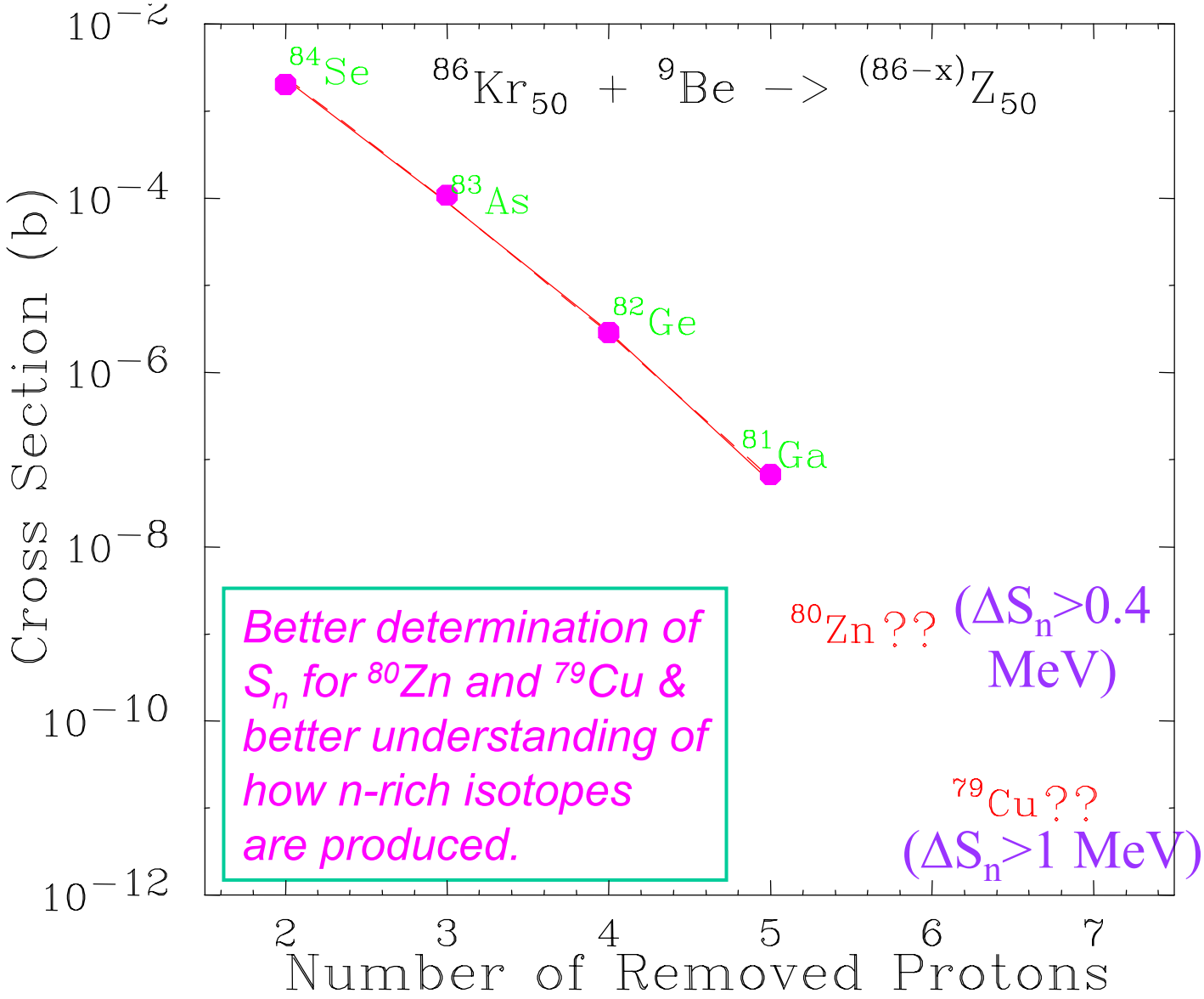
IV. $10^{-6} < \sigma < 10^{-8}$ mb; 30 hr.

Include 6 & 7 p-removal

V. Setup & calibrations; 24

p-removal chain

^{86}Kr
↓
$p+^{85}Br$
↓
$p+^{84}Se$
↓
$p+^{83}As$
↓
$p+^{82}Ge$
↓
$p+^{81}Ga$
↓
$p+^{80}Zn^{*}$
↓
$p+^{79}Cu^{**}$



Better determination of S_n for ^{80}Zn and ^{79}Cu & better understanding of how n-rich isotopes are produced.

^{80}Zn ?? (ΔS_n>0.4 MeV)

^{79}Cu ??
(ΔS_n>1 MeV)

Summary

- We are requesting 7 days of beam Time
- *To obtain comprehensive isotope cross-sections from the fragmentation of ^{86}Kr on ^{9}Be and ^{181}Ta targets with particular attention to measure the p-removal chain up to ^{79}Cu.*

Happy Holidays