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 $^{40}\text{Ca} -- \text{Be and Ta target comparison}$

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 $\approx$ 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**

- **Primary beam:**
  - $^{86}$Kr; 65MeV/u, intensity $\approx 1-80$ pnA

- **Targets:**
  - $^9$Be (100 mg/cm$^2$) and $^{181}$Ta (200 mg/cm$^2$)

**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 set up

Additional timing with plastic scintillators

$^{86}$Kr

$|\Delta P / P| = 1\%$

Momentum Slit

Secondary Beam

TOF scint

Si Detectors ($\Delta E$)

E Si
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

N-rich isotopes
Magnified $5 \times 10^6$
Proposed run plans

I. $\sigma > 0.01$ 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.

V. Setup & calibrations; 24 hr.

*Include 6 & 7 p-removal*
Better determination of $S_n$ for $^{80}\text{Zn}$ and $^{79}\text{Cu}$ & better understanding of how n-rich isotopes are produced.
Summary

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

Happy Holidays