The RISING Project

Technical Details for Fast Beam Proposals

RISING Collaboration

January 2003
**Experiment #1**

P. Mayet et al.:  
*Shape evolution in light n-rich nuclei*

Nucleus of interest: $^{34}\text{Mg}$ (2 step fragmentation + lifetime)

Primary beam: $^{48}\text{Ca}$  $10^9$ pps  400 MeV/u
Production target: $^9\text{Be}$  4 g/cm$^2$  

**First step $^{48}\text{Ca} \rightarrow ^{36}\text{Si}$:**

Secondary beam: $^{36}\text{Si}$  312 MeV/u
Yield of $^{36}\text{Si}$ / incident $^{48}\text{Ca}$:  $1.2 \cdot 10^{-5}$ (6.7 $\cdot 10^{-2}$ mb)
Charge states after production target: fully stripped

Al degrader at S1: -  
Al degrader at S2: 8500 mg/cm$^2$  
Charge states after degraders: fully stripped

Energy at reaction target (S4): 160 MeV/u
Charge states at reaction target (S4): fully stripped

Slits:
S1 ± 10 cm (open)  
S2 ± 10 cm (open)  
S3 ± 10 cm (open)

Transmission of $^{36}\text{Si}$:  
Yield / incident particle:
At S1 after slits: 72 % 8.7 $\cdot 10^{-6}$
At S2 after slits: 16 % 1.9 $\cdot 10^{-6}$
Total at S4: ($\sigma_x^{^{36}\text{Si}} = 1.6$ cm) 15 % 1.8 $\cdot 10^{-6}$

Yield of $^{36}\text{Si}$ at S4 / all fragments: 0.5

Yield of $^{36}\text{Si}$ at S4 / incident $^{48}\text{Ca}$: 1.8 $\cdot 10^{-6}$ (1800 pps)

**Second step $^{36}\text{Si} \rightarrow ^{34}\text{Mg}$:**

Reaction target at S4: $^{27}\text{Al}$  1.2 g/cm$^2$  d/R= 0.4

Energy of $^{34}\text{Mg}$ behind the reaction target: 135 MeV/u

Yield of $^{34}\text{Mg}$ / incident $^{36}\text{Si}$: 2.7 $\cdot 10^{-5}$ (1.0 mb, 5 $\cdot 10^{-2}$ pps)
Yield of $^{34}\text{Mg}$ / all nuclei: 1 $\cdot 10^{-3}$ (without $^{36}\text{Si}$)
Yield of $^{34}\text{Mg}$ / isotopes of Mg: 9 $\cdot 10^{-3}$

Estimated p$\gamma$ rate for $^{34}\text{Mg}$ (3% $\gamma$ efficiency, 100% state population): 130 per day
Some additional information

Relative yield of Mg isotopes:

<table>
<thead>
<tr>
<th></th>
<th>$^{30}\text{Mg}$</th>
<th>$^{31}\text{Mg}$</th>
<th>$^{32}\text{Mg}$</th>
<th>$^{33}\text{Mg}$</th>
<th>$^{34}\text{Mg}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield</td>
<td>12</td>
<td>7</td>
<td>4</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Slits:
S1 ± 10cm
S2 ± 10cm
S3 ± 10cm

Reaction target ± 3.5cm

Yield of all fragments / incident $^{48}\text{Ca}$ after S1 slits: $1 \cdot 10^{-3}$ ($1 \cdot 10^{6}$ pps)
Yield of all fragments / incident $^{48}\text{Ca}$ before SC21: $3 \cdot 10^{-4}$ ($3 \cdot 10^{5}$ pps)
Yield of all fragments / incident $^{48}\text{Ca}$ before MUSIC at S4: $4 \cdot 10^{-6}$ ($4 \cdot 10^{3}$ pps)
Yield of all fragments / incident $^{48}\text{Ca}$ behind the reaction target: $3 \cdot 10^{-6}$ ($3 \cdot 10^{3}$ pps)

$B_p(D1) = 7.2083$ Tm
$B_p(D2) = 7.2084$ Tm
$B_p(D3) = 5.0638$ Tm
$B_p(D4) = 5.0677$ Tm
Yield(pps/cm)

$X$ at $S4$(cm)

$^{37}\text{P}$

$^{36}\text{Si}$

$^{35}\text{Al}$
$\Delta E$ vs $\text{TOF(S}_2\text{S}_4)/Z$ for $^{36}\text{Si}$
Experiment #2

M. Bentley et al.:  
*Isospin Symmetry and Coulomb Effects Towards the Proton Drip Line*

Nucleus of interest: $^{45}$Cr (2 step fragmentation)

Primary beam: $^{58}$Ni 10$^9$ pps 600 MeV/u  
Production target: $^9$Be 6.3 g/cm$^2$ d/R=0.45

First step $^{58}$Ni $\rightarrow$ $^{46}$Cr:

Secondary beam: $^{46}$Cr 410 MeV/u  
Yield of $^{46}$Cr / incident $^{58}$Ni: 3.1 $\cdot$ 10$^{-6}$ (0.014 mb)  
Charge states after production target: fully stripped

Al degrader at S1: -  
Al degrader at S2: 5800 mg/cm$^2$ 190 MeV/u } d/R= 0.6

Charge states after degraders: fully stripped

Energy at reaction target (S4): 164 MeV/u

Charge states at reaction target (S4): fully stripped

Slits:  
S1 $\pm$ 10cm (open)  
S2 $\pm$ 10cm (open)  
S3 $\pm$ 10cm (open)

Transmission of $^{46}$Cr:  
Yield / incident particle:
At S1 after slits: 91 % 2.9 $\cdot$ 10$^{-6}$  
At S2 after slits: 46 % 1.5 $\cdot$ 10$^{-6}$  
Total at S4: ($\sigma_x(^{46}$Cr) = 1.9 cm) 32 % 1.0 $\cdot$ 10$^{-6}$

Yield of $^{46}$Cr at S4 / all fragments: 0.2

Yield of $^{46}$Cr at S4/ incident $^{58}$Ni: 1.0 $\cdot$ 10$^{-6}$ (1000 pps)

Second step $^{46}$Cr $\rightarrow$ $^{45}$Cr:

Reaction target at S4: $^9$Be 700 mg/cm$^2$ d/R= 0.3

Energy of $^{45}$Cr behind the reaction target: 123 MeV/u

Yield of $^{45}$Cr / incident $^{46}$Cr: 1.7 $\cdot$ 10$^{-4}$ (3.55 mb, 0.17 pps)  
Yield of $^{45}$Cr / all nuclei: 4.4 $\cdot$ 10$^{-3}$ (without $^{46}$Cr)  
Yield of $^{45}$Cr / isotopes of Cr: 0.98 (without $^{46}$Cr)

Estimated p$\gamma$ rate for $^{45}$Cr (3% $\gamma$ efficiency, 100% state population): 18 per hour
Some additional information

<table>
<thead>
<tr>
<th>Nucleus of interest</th>
<th>Intermediate fragment</th>
<th>Yield of intermediate fragment at S4 / incident $^{58}$Ni</th>
<th>Beam intensity of $^{58}$Ni (limited by rate on detectors)</th>
<th>Estimated $p\gamma$ rate (3% $\gamma$ efficiency, 100% state population)</th>
</tr>
</thead>
<tbody>
<tr>
<td>$^{45}$Cr</td>
<td>$^{46}$Cr</td>
<td>$1 \cdot 10^{-6}$</td>
<td>$1 \cdot 10^9$ pps</td>
<td>18 / h</td>
</tr>
<tr>
<td>$^{45}$Sc</td>
<td>$^{46}$Ti</td>
<td>$8 \cdot 10^{-4}$</td>
<td>$2.5 \cdot 10^6$ pps</td>
<td>440 / h</td>
</tr>
<tr>
<td>$^{53}$Ni</td>
<td>$^{54}$Ni</td>
<td>$8 \cdot 10^{-7}$</td>
<td>$1 \cdot 10^9$ pps</td>
<td>10 / h</td>
</tr>
<tr>
<td>$^{53}$Mn</td>
<td>$^{54}$Fe</td>
<td>$3 \cdot 10^{-3}$</td>
<td>$6.3 \cdot 10^5$ pps</td>
<td>580 / h</td>
</tr>
</tbody>
</table>

Slits:
S1 ± 10cm
S2 ± 10cm
S3 ± 10cm

Reaction target ± 3.5cm

Yield of all fragments / incident $^{58}$Ni after S1 slits: $3.2 \cdot 10^{-3}$ ($3.2 \cdot 10^6$ pps)
Yield of all fragments / incident $^{58}$Ni before SC21: $2.9 \cdot 10^{-3}$ ($2.9 \cdot 10^6$ pps)
Yield of all fragments / incident $^{58}$Ni before MUSIC at S4: $5.4 \cdot 10^6$ ($5.4 \cdot 10^3$ pps)
Yield of all fragments / incident $^{58}$Ni behind the reaction target: $5.0 \cdot 10^{-6}$ ($5.0 \cdot 10^3$ pps)

$Bp(D1) = 6.1711$ Tm
$Bp(D2) = 6.1717$ Tm
$Bp(D3) = 3.9892$ Tm
$Bp(D4) = 3.9899$ Tm
\[ \text{TOF(S2−S4)/Z} \]

\[ ^{46} \text{Cr} \]
Experiment No. 3

A. Bracco et al.
Gamma-decay of the GDR in the exotic nucleus $^{68}$Ni via Coulomb excitation

<table>
<thead>
<tr>
<th>Nucleus of interest:</th>
<th>$^{68}$Ni (GDR via Coullex)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primary beam:</td>
<td>$^{86}$Kr $10^{10}$ pps</td>
</tr>
<tr>
<td>Production target:</td>
<td>$^9$Be 4 g/cm$^2$</td>
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<tr>
<td></td>
<td>$d \over R$ = 0.26</td>
</tr>
</tbody>
</table>

**First stage $^{86}$Kr $\rightarrow$ $^{68}$Ni:**

| Secondary beam:     | $^{68}$Ni                     |
|                     | 584.0 MeV/u                   |
| Yield of $^{68}$Ni/incident $^{86}$Kr | 9.5·$10^{-6}$               |
| Charge states after prod. target | fully stripped               |

| Al degrader at S1   | 6167.8 mg/cm$^2$ |
| Al degrader at S2   | 415.3 MeV/u      |
| Charge states after degrader | fully stripped |

| Energy at reaction target (S4) | 400.2 MeV/u |
| Charge states at target        | fully stripped |

| Slits:                     |
| S1 = ± 1.5 cm              |
| S2 = ± 6 cm                |
| S3 = ± 1.6 cm              |

| Transmission of $^{68}$Ni: |
| At S1, after slits | 40.1 %       |
| At S2, after slits | 26.2 %       |
| At reaction target($\sigma_x(^{68}$Ni) = 0.70 cm) | 24.5 % |

| Yield of $^{68}$Ni at S4/all fragments: | 0.22 |

| Yield of $^{68}$Ni at S4/incident $^{86}$Kr | 2.3·$10^{-6}$ (2.3·$10^{4}$ pps) |

**Second stage $^{68}$Ni $\rightarrow$ $^{68}$Ni*:**

| Reaction target at S4 $^{208}$Pb | 2 g/cm$^2$ |
| Energy of $^{68}$Ni behind the reaction target: | 362.0 MeV/u |
| Yield of $^{68}$Ni*(Coullex)/incident $^{68}$Ni | 3.5·$10^{-3}$ (high energy part: 600 mb, 81 pps) |
|                                         | 8.7·$10^{-4}$ (region of pygmy: 150 mb, 20 pps) |

Estimated $p\gamma$ rate in BaF$_2$ detectors (5 - 13 MeV Energy, (1.1 % $\gamma$ eff. at 10 MeV)) : 64 hr.$^{-1}$

Estimated $p\gamma$ rate in Ge detectors (15 - 17 MeV Energy, (0.4 % $\gamma$ eff. at 15 MeV)) : 6 hr.$^{-1}$
Some additional information for FRS setting

Slits:
S1 = ± 1.5 cm
S2 = ± 6 cm
S3 = ± 1.6 cm

Reaction target = ± 3.5 cm (max.)

Yield of all fragments / incident particle before SC21: 5.1·10^{-4} (5.1·10^{6})
Yield of all fragments / incident particle before MUSIC at S4: 1.0·10^{-5} (1.0·10^{5})

B\rho(D1) = 9.6691 Tm
B\rho(D2) = 9.6746 Tm
B\rho(D3) = 7.8722 Tm
B\rho(D4) = 7.8716 Tm
Figure 1: Position spectrum at S4 for $^{68}$Ni setting

Figure 2: Time-of-flight vs Position plot for $^{68}$Ni setting
Experiment #4

H. Grawe et al.:  
Relativistic Coulex in N=28-34 and N=40-50 nuclei

Nucleus of interest: $^{50}$Ca

Primary beam: $^{82}$Se  $10^8$ pps  400 MeV/u  
Production target: $^9$Be  2 g/cm$^2$  d/R=0.3

First step $^{82}$Se → $^{50}$Ca:  
Secondary beam: $^{50}$Ca  330 MeV/u  
Yield of $^{50}$Ca / incident particle: $5 \cdot 10^{-7}$ (4.8 $10^{-3}$ mb) 
Charge states after production target: fully stripped

Al degrader at S1: - 
Al degrader at S2: 7200 mg/cm$^2$  130 MeV/u  
Charge states after degraders: fully stripped

Energy at reaction target (S4): 108 MeV/u  
Charge states at reaction target (S4): fully stripped

Slits:  
S1 ± 10cm (open) 
S2 ± 10cm (open) 
S3 ± 10cm (open)

Transmission of $^{50}$Ca:  
Yield / incident particle: 
At S1 after slits: 67 %  $3.5 \cdot 10^{-7}$ 
At S2 after slits: 25 %  $1.3 \cdot 10^{-7}$ 
At reaction target: ($\sigma_x^{(50}\text{Ca}) = 2$ cm) 14 %  $7.4 \cdot 10^{-8}$

Yield of $^{50}$Ca at S4 / all fragments: 0.19

Yield of $^{50}$Ca at S4/ incident particle  $7.4 \cdot 10^{-8}$ (74 pps)

Second step $^{50}$Ca → $^{50}$Ca(2$^+$):  
Reaction target at S4: $^{208}$Pb  1000 mg/cm$^2$  d/R= 0.5

Energy of $^{50}$Ca behind the reaction target: 78 MeV/u

Yield of $^{50}$Ca(2$^+$) / incident $^{50}$Ca:  $5 \cdot 10^{-4}$ (250 mb, 0.04 pps) 
Yield of $^{50}$Ca(2$^+$) / isotopes of Ca (products of $^{50}$Ca+$^{208}$Pb reaction): 0.43

Estimated $\gamma$ rate for $^{50}$Ca(2$^+$) (3% $\gamma$ efficiency at 1.3 MeV): 4 /h
Some additional information for FRS setting

Slits:
S1 ± 10cm
S2 ± 10cm
S3 ± 10cm

Reaction target ± 3.5cm

Yield of all fragments / incident particle before SC21: \( 5 \cdot 10^{-5} \) (5 \( \times \) 10^4 pps)
Yield of all fragments / incident particle before MUSIC at S4: \( 4 \cdot 10^{-7} \) (4 \( \times \) 10^2 pps)

\[ B_p(D1) = 7.0840 \text{ Tm} \]
\[ B_p(D2) = 7.0888 \text{ Tm} \]
\[ B_p(D3) = 4.2318 \text{ Tm} \]
\[ B_p(D4) = 4.2313 \text{ Tm} \]
400 MeV/u $^{82}\text{Se}$ on 2g/cm$^2$ $^{9}\text{Be}$

$^{50}\text{Ca}$ - setting $D/R = 0.78$
400 MeV/u $^{82}$Se on 2g/cm$^2$ $^9$Be

$^{50}$Ca – setting D/R = 0.78

TOF (S2-S4) vs Z

$48$Ar

$49$K

$^{50}$Ca

$^{51}$Sc

$^{52}$Ti
Experiment #4

H. Grawe et al.:  
**Relativistic Coulex in N=28-34 and N=40-50 nuclei**

Nucleus of interest: $^{66}\text{Fe}$

Primary beam: $^{82}\text{Se}$ 10$^9$ pps 400 MeV/u
Production target: $^{9}\text{Be}$ 2 g/cm$^2$ d/R=0.3

First step $^{82}\text{Se}\rightarrow^{66}\text{Fe}$:

Secondary beam: $^{66}\text{Fe}$ 331 MeV/u
Yield of $^{66}\text{Fe}$ / incident particle 3·10$^{-7}$ (3.0·10$^{-3}$ mb)
Charge states after production target: fully stripped

Al degrader at S1: -
Al degrader at S2: 5000 mg/cm$^2$ 154 MeV/u d/R=0.70
Charge states after degraders: fully stripped

Energy at reaction target (S4): 130 MeV/u
Charge states at reaction target (S4): fully stripped

Slits:
S1 ± 10cm (open)
S2 ± 10cm (open)
S3 ± 10cm (open)

Transmission of $^{66}\text{Fe}$:
At S1 after slits: 94 % 3.0·10$^{-7}$
At S2 after slits: 47 % 1.5·10$^{-7}$
At reaction target: ($\sigma_x(^{66}\text{Fe}) = 1.7$ cm) 34 % 1.1·10$^{-7}$

Yield of $^{66}\text{Fe}$ at S4 / all fragments: 0.23

Yield of $^{66}\text{Fe}$ at S4 / incident particle 1.1·10$^{-7}$ (110 pps)

Second step $^{66}\text{Fe} \rightarrow^{66}\text{Fe}(2^+)$:

Reaction target at S4: $^{208}\text{Pb}$ 1000 mg/cm$^2$ d/R= 0.4

Energy of $^{50}\text{Ca}$ behind the reaction target: 96 MeV/u

Yield of $^{66}\text{Fe}(2^+)$ behind the reaction target / incident $^{66}\text{Fe}$: 1.7·10$^{-3}$ (580 mb, 0.19 pps)
Yield of $^{66}\text{Fe}$ / isotopes of Fe (products of $^{66}\text{Fe}+^{208}\text{Pb}$ reaction): 0.55

Estimated $\gamma$ rate for $^{66}\text{Fe}$ (3% $\gamma$ efficiency): 21 /h
Some additional information for FRS setting

Reaction target ± 3.5cm  

Yield / incident particle  
Yield of all fragments before SC21: \(4 \cdot 10^{-5}\) (4 x10⁴ pps)  
Yield of all fragments before MUSIC at S4: \(4 \cdot 10^{-7}\) (4 x10² pps)

\[ B_{\rho}(D1) = 7.2085 \text{ Tm} \]
\[ B_{\rho}(D2) = 7.2098 \text{ Tm} \]
\[ B_{\rho}(D3) = 4.7232 \text{ Tm} \]
\[ B_{\rho}(D4) = 4.7248 \text{ Tm} \]

\[ 6\text{Fe} \text{ setting} \]
\[ \text{Se} 400 \text{ MeV/u on } ^{2}\text{Be} 2\text{g/cm}^2, \text{S2 Deg. } 5\text{g/cm}^2 \text{ D/R} = 0.75, \text{slits open} \]
Experiment #4

H. Grawe et al.:  
Relativistic Coulex in N=28-34 and N=40-50 nuclei

Nucleus of interest: $^{82}\text{Ge}$

Primary beam: $^{86}\text{Kr}$  $10^9$ pps  450 MeV/u  
Production target: $^9\text{Be}$  2 g/cm²  

First step $^{86}\text{Kr}\rightarrow^{82}\text{Ge}$:

Secondary beam: $^{82}\text{Ge}$  380 MeV/u  
Yield of $^{82}\text{Ge}$ / incident particle  $1 \cdot 10^{-7}$  ($1 \cdot 10^{-3}$ mb)  
Charge states after production target: fully stripped

Al degrader at S1:  - 
Al degrader at S2:  5375 mg/cm²  162 MeV/u  
Charge states after degraders: fully stripped

Energy at reaction target (S4):  133 MeV/u  
Charge states at reaction target (S4): fully stripped

Slits:
S1 ± 10cm (open)  
S2 ± 10cm (open)  
S3 ± 10cm (open)

Transmission of $^{82}\text{Ge}$:  
At S1 after slits:  100 %  
Yield / incident particle:  $1.0 \cdot 10^{-7}$
At S2 after slits:  68 %  
Yield / incident particle:  $7.2 \cdot 10^{-8}$
At reaction target: ($\sigma_x^{82}\text{Ge} = 1.6$ cm)  59 %  
Yield / incident particle:  $6.2 \cdot 10^{-8}$

Yield of $^{82}\text{Ge}$ at S4 / all fragments:  0.15

Yield of $^{82}\text{Ge}$ at S4/ incident particle  $6.2 \cdot 10^{-8}$  (62 pps)

Second step $^{82}\text{Ge} \rightarrow^{82}\text{Ge}(2^+)$:

Reaction target at S4: $^{208}\text{Pb}$  200 mg/cm²  
Energy of $^{82}\text{Ge}$ behind the reaction target:  91 MeV/u

Yield of $^{82}\text{Ge}(2^+)$ / incident $^{82}\text{Ge}$:  $8 \cdot 10^{-4}$  (290 mb, 0.05 pps)  
Yield of $^{82}\text{Ge}(2^+)$ / isotopes of Ge (products of $^{82}\text{Ge}+^{208}\text{Pb}$ reaction):  0.38

Estimated $\gamma$ rate for $^{82}\text{Ge}(2^+)$ (3% $\gamma$ efficiency at 1.3 MeV):  5 /h
Some additional information for FRS setting

Slits:
S1 ± 10cm
S2 ± 10cm
S3 ± 10cm

Reaction target ± 3.5cm

Yield of all fragments / incident particle before SC21: $5 \cdot 10^{-6}$ (5 $10^3$ pps)
Yield of all fragments / incident particle before MUSIC at S4: $4 \cdot 10^{-7}$ (4 $10^2$ pps)

$B_{\rho}(D1) = 7.8910$ Tm
$B_{\rho}(D2) = 7.8910$ Tm
$B_{\rho}(D3) = 4.9000$ Tm
$B_{\rho}(D4) = 4.9000$ Tm
450 MeV/u $^{86}$Kr on 2g/cm$^2$ $^9$Be
$^{82}$Ge — setting  D/R = 0.73
450 MeV/u $^{86}$Kr on 2 g/cm² $^9$Be

$^{82}$Ge - setting      D/R = 0.73
Experiment #5

D. Tonev et al.: Investigation of the origin of mixed-symmetry states using relativistic COULEX of N=52 isotones

Nucleus of interest: $^{88}$Kr (fission, Coulomb excitation)

Primary beam: $^{238}$U 10$^9$ pps 750 MeV/u
Production target: $^9$Be 1416 mg/cm$^2$

First step $^{238}$U → $^{88}$Kr:
Secondary beam: $^{88}$Kr 744 MeV/u
Yield of $^{88}$Kr / incident $^{238}$U: 2.1 · 10$^{-3}$ (26 mb)
Charge states after production target: fully stripped

Al degrader at S1: 7500 mg/cm$^2$
Al degrader at S2: 8000 mg/cm$^2$
173 MeV/u
Charge states after degraders: fully stripped

Energy at reaction target (S4): 140 MeV/u
Charge states at reaction target (S4): fully stripped

Slits:
S1 ± 10 cm (open)
S2 ± 10 cm (open)
S3 ± 10 cm (open)

Transmission of $^{88}$Kr:
At S1 after degrader: 3.8 % 8.0 · 10$^{-5}$
At S2 after degrader: 0.39 % 8.2 · 10$^{-6}$
Total at S4: (σ($^{88}$Kr) = 2.1 cm) 0.27 % 5.7 · 10$^{-6}$

Yield of $^{88}$Kr at S4 / all fragments: 0.36

Yield of $^{88}$Kr at S4 / incident $^{238}$U: 5.7 · 10$^{-6}$ (5700 pps)

Second step $^{88}$Kr → $^{88}$Kr(2$^+$):
Reaction target at S4: $^{208}$Pb 400 mg/cm$^2$
Energy of $^{88}$Kr behind the reaction target: 122 MeV/u

Yield of $^{88}$Kr(2$^+$) / incident $^{88}$Kr: 3.2 · 10$^{-4}$ (200 mb, 1.8 pps)
Yield of $^{88}$Kr(2$^+$) / incident $^{88}$Kr: 8.0 · 10$^{-5}$ (50 mb, 0.46 pps)

Estimated $\gamma$ rate (3% $\gamma$ efficiency):
for $^{88}$Kr(2$^+$) 194 per hour
for $^{88}$Kr(2$^+$) 50 per hour
Some additional information

The fission cross section for $^{86}$Se is 0.910 mb compared to 26 mb for $^{88}$Kr.

Slits:
S1 ± 10cm
S2 ± 10cm
S3 ± 10cm

Reaction target ± 3.5cm

Yield of all fragments / incident $^{238}$U after S1 degrader: $6.1 \cdot 10^{-3}$ ($6.1 \cdot 10^6$ pps)
Yield of all fragments / incident $^{238}$U before SC21: $8.8 \cdot 10^{-4}$ ($8.8 \cdot 10^5$ pps)
Yield of all fragments / incident $^{238}$U before MUSIC at S4: $2.6 \cdot 10^{-5}$ ($2.6 \cdot 10^4$ pps)
Yield of all fragments / incident $^{238}$U behind the reaction target: $2.5 \cdot 10^{-5}$ ($2.5 \cdot 10^4$ pps)

$B_p(D1) = 10.648$ Tm
$B_p(D2) = 8.9225$ Tm
$B_p(D3) = 4.8265$ Tm
$B_p(D4) = 4.8251$ Tm
Experiment #6

C. Fahlander et al.:  
**Relativistic Coulomb excitation of nuclei near \(^{100}\text{Sn}\)**

Nucleus of interest: \(^{104}\text{Sn}\)

Primary beam: \(^{124}\text{Xe}\) 10\(^9\) pps 550 MeV/u  
Production target: \(^9\text{Be}\) 4 g/cm\(^2\) d/R=0.56

**First step \(^{124}\text{Xe} \rightarrow \^{104}\text{Sn}\):**

Secondary beam: \(^{104}\text{Sn}\) 309 MeV/u  
Yield of \(^{104}\text{Sn}\) / incident particle 6.8 \cdot 10\(^{-7}\) (4.5 \cdot 10\(^{-3}\) mb)  
Charge states after production target: fully stripped

Al degrader at S1: -  
Al degrader at S2: 1560 mg/cm\(^2\) 155 MeV/u  
Charge states after degraders: fully stripped  
\{ d/R = 0.55 \}

Energy at reaction target (S4): 95 MeV/u  
Charge states at reaction target (S4): fully stripped

Slits:  
S1 ± 3cm  
S2 ± 10cm (open)  
S3 (-2;2.5)

Transmission of \(^{104}\text{Sn}\):  
At S1 after slits: 87 % 6.0 \cdot 10\(^{-7}\)  
At S2 after slits: 73 % 5.0 \cdot 10\(^{-7}\)  
At reaction target: (\(\sigma_x\)\(^{104}\text{Sn}\) = 1.7 cm) 55 % 3.7 \cdot 10\(^{-7}\)

Yield of \(^{104}\text{Sn}\) at S4 / all fragments: 0.06

Yield of \(^{104}\text{Sn}\) at S4 / incident particle 3.7 \cdot 10\(^{-7}\) (370 pps)

**Second step \(^{104}\text{Sn} \rightarrow \^{104}\text{Sn}(2^+)\):**

Reaction target at S4: \(^{208}\text{Pb}\) 200 mg/cm\(^2\) d/R= 0.26

Energy of \(^{104}\text{Sn}\) behind the reaction target: 77 MeV/u

Yield of \(^{104}\text{Sn}(2^+)\) / incident \(^{104}\text{Sn}\): 8 \cdot 10\(^{-5}\) (200 mb, 0.03 pps)  
Yield of \(^{104}\text{Sn}(2^+)\) / isotopes of Sn (products of \(^{104}\text{Sn}+^{208}\text{Pb}\) reaction): 0.92

Estimated \(\gamma\) rate for \(^{104}\text{Sn}(2^+)\) (3\% \(\gamma\) efficiency at 1.3 MeV): 3 /h
Some additional information for FRS setting

Slits:
S1 ± 3 cm
S2 ± 10 cm
S3 (-2;2.5) cm

Reaction target ± 3.5cm

Yield of all fragments / incident particle before SC21: $1.5 \cdot 10^{-4} (1.5 \times 10^5 \text{ pps})$
Yield of all fragments / incident particle before MUSIC at S4: $6.4 \cdot 10^{-6} (6.4 \times 10^3 \text{ pps})$

Yield with slits open (all frag./ip before SC21): $1.7 \cdot 10^{-4} (1.7 \cdot 10^5)$
Yield with slits open (all frag./ip before MUSIC at S4): $1.2 \cdot 10^{-5} (1.2 \cdot 10^4)$
Transmission of $^{104}\text{Sn}$ with open slits: 63%

$Bp(D1) = 5.6856 \text{ Tm}$
$Bp(D2) = 5.6875 \text{ Tm}$
$Bp(D3) = 3.8845 \text{ Tm}$
$Bp(D4) = 3.8842 \text{ Tm}$
550 MeV/u $^{124}$Xe on 4g/cm$^2$ $^9$Be
$^{104}$Sn – setting D/R = 0.55
$550 \text{ MeV/u } ^{124}\text{Xe on } 4\text{g/cm}^2 \ ^9\text{Be}$

$^{104}\text{Sn} - \text{setting}$

$D/R = 0.55$

$\text{TOF (S2-S4) vs Z}$
# Experiment #6

C. Fahlander et al.:  
*Relativistic Coulomb excitation of nuclei near $^{108}$Sn*

Nucleus of interest: $^{108}$Sn  
Primary beam: $^{124}$Xe 10⁹ pps 600 MeV/u  
Production target: $^9$Be 4 g/cm²  

**First step $^{124}$Xe $\rightarrow$ $^{108}$Sn:**  
Secondary beam: $^{108}$Sn 377 MeV/u  
Yield of $^{108}$Sn / incident particle: $5.0 \times 10^{-4}$ (3 mb)  
Charge states after production target: fully stripped  
Al degrader at S1: 1770 mg/cm² 263 MeV/u  
Al degrader at S2: 930 mg/cm² 158 MeV/u  
Charge states after degraders: fully stripped  
Energy at reaction target (S4): 101 MeV/u  
Charge states at reaction target (S4): fully stripped  

Slits:  
S1 ± 0.4 cm  
S2 ± 3.0 cm  
S3 ± 10 cm (open)  

Transmission of $^{108}$Sn:  
At S1 after slits: 24 % 1.2 $\times$ 10⁻⁴  
At S2 after slits: 9 % 4.4 $\times$ 10⁻⁵  
At reaction target ($\sigma_x(^{108}$Sn) = 1.7 cm): 8 % 4.0 $\times$ 10⁻⁵  

Yield of $^{108}$Sn at S4 / all fragments: 0.57

<table>
<thead>
<tr>
<th>Yield of $^{108}$Sn at S4/ incident particle</th>
<th>4.0 $\times$ 10⁻⁵</th>
<th>(4 $\times$ 10⁴ pps)</th>
</tr>
</thead>
</table>

**Second step $^{108}$Sn $\rightarrow$ $^{108}$Sn(2⁺):**  
Reaction target at S4: $^{208}$Pb 200 mg/cm²  
Energy of $^{108}$Sn behind the reaction target: 85 MeV/u  

Yield of $^{108}$Sn(2⁺) / incident $^{108}$Sn:  $1 \times 10^{-4}$ (200 mb, 4.6 pps)  
Yield of $^{108}$Sn(2⁺) / isotopes of Sn (products of $^{108}$Sn+$^{208}$Pb reaction): 0.87

**Estimated $\gamma$ rate for $^{108}$Sn(2⁺) (3% $\gamma$ efficiency at 1.3 MeV): 490 /h**
Some additional information for FRS setting

Slits:
S1 ± 0.4 cm
S2 ± 3.0 cm
S3 ± 10 cm (open)

Reaction target ± 3.5cm

Yield of all fragments / incident particle before SC21: \(5 \cdot 10^{-4} (5 \times 10^5 \text{ pps})\)
Yield of all fragments / incident particle before MUSIC at S4: \(7 \cdot 10^{-5} (7 \times 10^4 \text{ pps})\)

Yield with slits open (all frag./ip before SC21): \(6 \cdot 10^{-3} (6 \times 10^6)\)
Yield with slits open (all frag./ip before MUSIC at S4): \(10^{-3} (10^6)\)
Transmission of \(^{108}\text{Sn}\) with open slits: 40%

\[B_p(D1) = 6.6177 \text{ Tm}\]
\[B_p(D2) = 5.3945 \text{ Tm}\]
\[B_p(D3) = 4.0742 \text{ Tm}\]
\[B_p(D4) = 4.0742 \text{ Tm}\]
600 MeV/u $^{124}$Xe on 4g/cm$^2$ $^9$Be

$^{108}$Sn – setting

D/R = 0.67
600 MeV/u $^{124}$Xe on 4g/cm$^2$ $^9$Be $^{108}$Sn –setting  D/R = 0.67
Experiment No. 7

G. de Angelis et al.
Nuclear magicity at Z \sim 50 N \sim 82 investigated through knock-out reaction of $^{132}$Sn

Nucleus of interest: $^{132}$Sn (Fission fragment, knock-out)
Primary beam: $^{238}$U $1 \times 10^8$ pps 700 MeV/u \( \frac{Q}{R} = 0.15 \)
Production target: $^{208}$Pb 1.5 g/cm$^2$

First stage $^{238}$U $\rightarrow$ $^{132}$Sn:

Secondary beam: $^{132}$Sn 596.5 MeV/u
Yield of $^{132}$Sn/incident $^{238}$U 6.8 $\times$ 10$^{-5}$ fully stripped 15.4 mb (lit.)
Charge states after prod. target

Al degrader at S1
Al degrader at S2 6183.9 mg/cm$^2$ 300.5 MeV/u \( \frac{Q}{R} = 0.65 \)
Charge states after degrader fully stripped

Energy at reaction target (S4)
Charge states at target 270.9 MeV/u fully stripped

Slits:
S1 = \pm 2 cm
S2 = \pm 3 cm
S3 = \pm 10 cm

Transmission of $^{132}$Sn:
At S1, after slits 5.9 \% 4.2 $\times$ 10$^{-6}$
At S2, after slits 1.6 \% 1.1 $\times$ 10$^{-6}$
At reaction target (\( \sigma_x^{132}\text{Sn} = 0.92 \text{ cm} \)) 1.2 \% 8.8 $\times$ 10$^{-7}$

Yield of $^{132}$Sn at S4/all fragments: 0.05 (transmission only)

| Yield of $^{132}$Sn at S4/incident $^{238}$U | $8.8 \times 10^{-7}$ | ($8.8 \times 10^1$ pps) |

Second stage $^{132}$Sn $\rightarrow$ $^{131}$Sn$^+$:

Reaction target at S4 $^9$Be 1 g/cm$^2$ 270.8 MeV/u \( \frac{Q}{R} = 0.34 \)
Energy of $^{131}$Sn behind the reaction target: 264.8 MeV/u

Yield of $^{131}$Sn/incident $^{132}$Sn 6.7 $\times$ 10$^{-3}$ 100 mb, 0.59 pps
Yield of $^{131}$Sn$^+$(l=2, 3S$^+_4$)/incident $^{132}$Sn 6.0 $\times$ 10$^{-4}$ 9 mb, 0.05 pps

Estimated p\(\gamma\) rate for $^{131}$Sn (2.7 \% \(\gamma\) eff. at 1.3 MeV)) : 57 hr.$^{-1}$
Estimated p\(\gamma\) rate for $^{131}$Sn (l=2, 3S$^+_4$) (2.7 \% \(\gamma\) eff. at 1.3 MeV)) : 10 hr.$^{-1}$
Some additional information for FRS setting

Slits:
S1 = ± 2.0 cm
S2 = ± 3.0 cm
S3 = ±10.0 cm

Reaction target = ± 3.5 cm (max.)

Yield of all fragments / incident particle before SC21 : 5.1·10^{-4} (5.1·10^6)
Yield of all fragments / incident particle before MUSIC at S4 : 1.0·10^{-5} (1.0·10^5)

B_\rho(D1) = 10.6867 Tm
B_\rho(D2) = 10.6839 Tm
B_\rho(D3) = 7.0973 Tm
B_\rho(D4) = 7.0974 Tm
Figure 1: Position spectrum at S4 for $^{132}$Sn setting (only transmission).

Figure 2: Mass vs $z$ plot for $^{132}$Sn setting (only transmission).
Experiment No. 8

A. Maj et al.
Coulomb excitation at intermediate energies - Angular distribution and particle - $\gamma$ angular correlation measurement

Nucleus of interest: $^{132}$Xe (Coulex)
Primary beam: $^{132}$Xe 10$^5$ pps 160 MeV/u
Production target: None

First stage $^{132}$Xe $\rightarrow$ $^{132}$Xe:

Secondary beam: $^{132}$Xe 158.8 MeV/u
Yield of $^{132}$Xe/incident $^{132}$Xe
Charge states after prod. target Not applicable
Al degrader at S1 none
Al degrader at S2 none
Charge states after degrader not applicable
Energy at reaction target (S4) 105.3 MeV/u
Charge states after target fully stripped

Slits:
S1 = $\pm$ 10 cm
S2 = $\pm$ 10 cm
S3 = $\pm$ 10 cm

Transmission of $^{68}$Ni:
At S1, after slits 99.9 %
At S2, after slits 99.9 %
At reaction target ($\sigma_x$($^{132}$Xe) = 1.1 cm) 99.5 % $\sigma_n$ = 5.0 mrad

Yield/incident particle:

Yield of $^{132}$Xe at S4/incident $^{132}$Xe $\sim 1$ (10$^5$ pps)

Second stage $^{132}$Xe $\rightarrow$ $^{132}$Xe$^*$:

Reaction target at S4 $^{208}$Pb 50 mg/cm$^2$ 105.3 MeV/u $\frac{d}{R} = 0.05$
Energy of $^{132}$Xe behind the reaction target: 97.2 MeV/u
Yield of $^{132}$Xe$^*(2^+)/$incident $^{132}$Xe 7.2$\cdot$10$^{-5}$ (500 mb, 7 pps )

Estimated $p\gamma$ rate for $^{132}$Xe (2.7 % $\gamma$ eff. at 1.3 MeV) : 703 hr.$^{-1}$
Some additional information for FRS setting

Slits :
S1 = ± 10 cm
S2 = ± 10 cm
S3 = ± 10 cm

Reaction target = ± 3.5 cm (max.)

Yield of all fragments / incident particle before SC21 : 1 (1.10^5)
Yield of all fragments / incident particle before MUSIC at S4 : 1(1.0·10^5)

B_ρ(D1) = 4.6174 Tm
B_ρ(D2) = 4.6174 Tm
B_ρ(D3) = 4.6174 Tm
B_ρ(D4) = 4.6174 Tm
Figure 1: Position spectrum at S4 for $^{132}$Xe Primary beam
Experiment No. 9

K.-H. Speidel et al.
Magnetic moments of Xenon and tellurium isotopes near doubly-magic \(^{132}\)Sn at relativistic beam energies.

Nucleus of interest: \(^{134}\)Te (Coulex)
Primary beam: \(^{136}\)Xe \(1 \times 10^9\) pps
Production target: \(^9\)Be 2.5 g/cm\(^2\)
\[\frac{d}{R} = 0.37\]

First stage \(^{136}\)Xe \(\rightarrow\) \(^{134}\)Te:

Secondary beam: \(^{134}\)Te 370.7 MeV/u
Yield of \(^{134}\)Te/incident \(^{136}\)Xe \(4.5 \times 10^{-5}\)
Charge states after prod. target fully stripped
Al degrader at S1
Al degrader at S2 3121.9 mg/cm\(^2\) 150.6 MeV/u \(\frac{d}{R} = 0.75\)
Charge states after degrader \(Q_2 = 0.85\)
\(Q_1 = 0.14\)
Energy at reaction target (S4)
Charge states at reaction target 100.0 MeV/u
\(Q_2 = 0.85\)

Slits:
\(S1 = \pm 1\) cm
\(S2 = \pm 3\) cm
\(S3 = \pm 10\) cm

Transmission of \(^{134}\)Te:
At S1, after slits 67.8 %
At S2, after slits 48.2 %
At reaction target (\(\sigma^{(134}\)Te) = 1.5 cm) 45.0 %

Yield of \(^{134}\)Te at S4/all fragments: 0.91

| Yield of \(^{134}\)Te at S4/incident \(^{136}\)Xe | \(2.0 \times 10^{-5}\) | \((2.0 \times 10^4\) pps) |

Second stage \(^{134}\)Te \(\rightarrow\) \(^{134}\)Te\(^+\):

Reaction target at S4 \(^{208}\)Pb 50 mg/cm\(^2\)
Energy of \(^{134}\)Te behind the reaction target: 96.6 MeV/u \(\frac{d}{R} = 0.05\)
Yield of \(^{134}\)Te\(^+\)(\(^2\)+)/incident \(^{134}\)Te \(4.3 \times 10^{-5}\)
Yield of \(^{134}\)Te\(^+\)(\(^2\)+)/incident \(^{134}\)Te \(300\) mb, 0.9 pps

**Estimated \(p\gamma\) rate for \(^{134}\)Te (\(^2\)+) (3.0 % \(\gamma\) eff. at 1.3 MeV)) : 94 hr.\(^{-1}\)**
Some additional information for FRS setting

Slits:
S1 = ± 1 cm  
S2 = ± 3 cm  
S3 = ±10 cm

Reaction target = ± 3.5 cm (max.)

Yield of all fragments / incident particle before SC21 : 7.9·10⁻⁵ (7.9·10⁴)
Yield of all fragments / incident particle before MUSIC at S4 : 2.8·10⁻⁵ (2.8·10⁴)

\[ B\rho(D1) = 7.8165 \text{ Tm} \]
\[ B\rho(D2) = 7.8165 \text{ Tm} \]
\[ B\rho(D3) = 4.7314 \text{ Tm} \]
\[ B\rho(D4) = 4.7314 \text{ Tm} \]

Additional information for g-factor measurement

Ferromagnetic material : Gadolinium (50 mg/cm²)
External magnetic field : ~ 0.08 Tesla
Expected Transient magnetic Field (TF) : 23 kTesla (p₁₃=0.03, q₁₃=0.5)
Expected precession angle (\(\Phi_{exp}(2^+)\)) : 240 mrad
Count rate for both field direction (Up/Dn) : 10 hr⁻¹ (1.0 % γ eff.)
Figure 1: Position spectrum at Si for $^{134}\text{Te}$ setting

Figure 2: Time-of-flight vs energy loss in Music plot for $^{134}\text{Te}$ setting
Experiment No. 10

S. Mandal et al.
Search for stable octupole deformation in neutron-rich of $^{142-144}$Ba using relativistic Coulomb excitation.

Nucleus of interest: $^{142}$Ba (Coul ex)
Primary beam: $^{150}$Nd, $5 \times 10^8$ pps
Production target: $^9$Be, 4.0 g/cm$^2$

First stage $^{150}$Nd $\rightarrow$ $^{142}$Ba:

<table>
<thead>
<tr>
<th>Secondary beam:</th>
<th>$^{142}$Ba</th>
<th>382.9 MeV/u</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield of $^{142}$Ba/incident $^{150}$Nd</td>
<td>$7.7 \times 10^{-6}$</td>
<td>0.06 mb (EPAX2)</td>
</tr>
<tr>
<td>Charge states after prod. target</td>
<td>fully stripped</td>
<td></td>
</tr>
<tr>
<td>Al degrader at S1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Al degrader at S2</td>
<td>2450.0 mg/cm$^2$</td>
<td>198.0 MeV/u</td>
</tr>
<tr>
<td>Charge states after degrader</td>
<td>$\frac{d}{R} = 0.63$</td>
<td></td>
</tr>
<tr>
<td>Energy at reaction target (S4)</td>
<td>153.0 MeV/u</td>
<td></td>
</tr>
<tr>
<td>Charge states at reaction target</td>
<td>$Q_e=0.86$</td>
<td></td>
</tr>
</tbody>
</table>

Slits:
- S1 = -1.0, +2 cm
- S2 = ± 3.5 cm
- S3 = -2.7, +2.4 cm

Transmission of $^{142}$Ba:
- At S1, after slits: 44.7 %
- At S2, after slits: 24.8 %
- At reaction target ($\sigma_x(^{142}$Ba) = 1.1 cm): 23.4 %

Yield of $^{142}$Ba at S4/all fragments: 0.12

<table>
<thead>
<tr>
<th>Yield of $^{142}$Ba at S4/incident $^{150}$Nd</th>
<th>$1.8 \times 10^{-6}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield/incident particle:</td>
<td>$3.5 \times 10^{-6}$</td>
</tr>
</tbody>
</table>

Second stage $^{142}$Ba $\rightarrow$ $^{142}$Ba$^*$:

<table>
<thead>
<tr>
<th>Reaction target at S4</th>
<th>$^{208}$Pb</th>
<th>300 mg/cm$^2$</th>
<th>153.0 MeV/u</th>
<th>$\frac{d}{R} = 0.17$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy of $^{142}$Ba behind the reaction target</td>
<td></td>
<td></td>
<td>134.8 MeV/u</td>
<td></td>
</tr>
<tr>
<td>Yield of $^{142}$Ba$^*(3^-)$/incident $^{142}$Ba</td>
<td>$6.1 \times 10^{-6}$</td>
<td>7.0 mb, 0.06 pps</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Estimated p$\gamma$ rate for $^{142}$Ba (3$^-$) (3.0 % $\gamma$ eff. at 1.3 MeV)): 6 hr.$^{-1}$
Some additional information for FRS setting

Slits:
S1 = -1,+2 cm
S2 = ± 3.5 cm
S3 = -2.7,+2.4 cm

Reaction target = ± 3.5 cm (max.)

Yield of all fragments / incident particle before SC21 : \(1.4 \times 10^{-4} \ (7.1 \times 10^5)\)
Yield of all fragments / incident particle before MUSIC at S4 : \(1.7 \times 10^{-5} \ (8.7 \times 10^4)\)

\[B\rho(D1) = 7.8391 \text{ Tm}\]
\[B\rho(D2) = 7.8391 \text{ Tm}\]
\[B\rho(D3) = 5.4024 \text{ Tm}\]
\[B\rho(D4) = 5.4023 \text{ Tm}\]
Figure 1: Position spectrum at S4 for $^{142}$Ba setting

Figure 2: Time-of-flight vs energy loss in MUSIC plot for $^{142}$Ba setting
Experiment #11

Zs. Podolyak, et al.:  
**Prompt gamma spectroscopy and isomer tagging.**  
**Deformation of five-quasiparticle states in the A≈180 mass region**

Nucleus of interest: $^{179}$W

Primary beam: $^{208}$Pb  $10^8$ pps  1GeV/u  
Production target: $^9$Be  1.6g/cm$^2$  d/R=0.13

Secondary beam $^{179}$W  897 MeV/u  
Yield of $^{179}$W / incident $^{208}$Pb  $4.23 \cdot 10^{-6}$ (0.952mb)(EPAXII:0.893 mb)  
Charge states after prod. target  fully stripped:74+(57.1%)  
73+(33.5%)  
72+( 6.4%)

Al degrader at S1  -  
Al degrader at S2  8500 mg/cm$^2$  293.5  MeV/u  d/R=0.76
Charge states after degraders  fully stripped:74+(65.8%)  
73+(30.6%)  
72+( 3.6%)

Energy at reaction target (S4)  234.5  MeV/u (74+)  
Charge states at reaction target (S4)  fully stripped:74+(100%)

Slits:  
S1 $\pm$ 15mm(open for $^{179}$W)  
S2 $\pm$ 40mm(open for $^{179}$W)  
S3 $\pm$ 15mm(open for $^{179}$W)

Transmission of $^{179}$W(fully stripped):  
Yield / incident particle:  
At S1 after slits  93.5 %  3.96 $\cdot$ 10^{-5}  
At S2 after slits  36.4 %  1.02 $\cdot$ 10^{-5}  
At S4  ($\sigma_{x}(^{179}$W) = 1.5 cm)  32.5 %  0.85 $\cdot$ 10^{-5}

Yield of $^{179}$W at S4 / all fragments  0.23

Yield of $^{179}$W at S4 / incident $^{208}$Pb  8.5 $\cdot$ 10^{-6}  (8.5 $\cdot$ 10^2 pps)

Yield of I=35/2- isomer at S4(2.7%)  23.0/s

Second step: coulomb excitation

Reaction target at S4 $^{208}$Pb (300 mg/cm$^2$)  d/R=0.12
Energy of $^{179}$W behind the reaction target:  215.2 MeV/u
Yield of $^{179}$W(37/2-)/incident $^{179}$W(35/2-):  $2'10^{-3}$ (2327mb)
Yield of $^{179}$W(39/2-)/incident $^{179}$W(35/2-):  $1'10^{-4}$ ( 123mb)
Estimated p $\gamma$ rate for $^{179}$W(37/2-)(3% $\gamma$ efficiency &10% tagging efficiency):  0.5/h
Estimated p $\gamma$ rate for $^{179}$W(39/2-)(3% $\gamma$ efficiency &10% tagging efficiency):  2.5 $\cdot$ 10^{-2}/h
Some additional information for FRS setting

Slits:
S1    ± 15mm
S2    ± 40mm
S3    ± 15mm

Reaction target ± 35mm

Yield of all fragments/ incident $^{208}$Pb after S1 slits: 2.9 · $10^5$
Yield of all fragments/ incident $^{208}$Pb before SC21: 2.9 · $10^5$
Yield of all fragments/ incident $^{208}$Pb before MUSIC at S4: 3.6 · $10^3$
Yield of all fragments/ incident $^{208}$Pb behind the reaction target: 2.5 · $10^3$

$B_p(D1) = 12.7$ Tm
$B_p(D2) = 12.7$ Tm
$B_p(D3) = 6.4$ Tm
$B_p(D4) = 6.4$ Tm
$^{208}\text{Pb} 1000.0 \text{ MeV/u} + \text{Be} (1600 \text{ mg/cm}^2)$; Settings on $^{179}\text{W}$ $^{74+}^{74+}^{74+}^{74+}$; Config: DSWMDMMVVWVSDMDSMMSMMS

$\text{dp/p}=1.24\%$; Wedges: 0, Al (8500 mg/cm$^2$), 0, 0, 0; Brho(Tm): 12.7396, 12.7396, 6.5086, 6.5086

All charge states
X distribution before coulomb excitation target
Experiment No. 12

J. Gerl et al.
Investigation of the structure and deformation of $^{185-187}$Pb by $\gamma$-spectroscopy and lifetime measurements.

Nucleus of interest: $^{186}$Pb (2 step fragmentation)
Primary beam: $^{238}$U $5 \cdot 10^8$ pps 600 MeV/u
Production target: $^9$Be 1.6 g/cm$^2$ \( \frac{d}{R} = 0.3 \)

First stage $^{238}$U $\rightarrow$ $^{200}$Rn:

Secondary beam: $^{200}$Rn 443.0 MeV/u
Yield of $^{200}$Rn/incident $^{238}$U 1.6 $\cdot$ 10$^{-4}$ 2.06 mb (EPAX2)
Charge states after prod. target $Q_1$=0.56, $Q_2$=0.36, $Q_3$=0.07
Al degrader at S1 986.6 mg/cm$^2$ 442.9 MeV/u
Al degrader at S2 807.2 mg/cm$^2$ 359.2 MeV/u \( \frac{d}{R} = 0.63 \)
Charge states after degrader $Q_1$=0.16, $Q_2$=0.46, $Q_3$=0.37
Energy at reaction target (S4) 153.8 MeV/u
Charge states after reaction target $Q_3$=0.04

Slits:
S1 = $\pm$ 1.0 cm
S2 = $\pm$ 3.0 cm
S3 = $\pm$ 10. cm

Transmission of $^{200}$Rn:
At S1, after slits 32.6 %
At S2, after slits 3.5 %
At reaction target ($\sigma_{\gamma}(^{200}$Rn) = 1.1 cm) 3.3 %
Yield/incident particle: 5.2 $\cdot$ 10$^{-5}$
Yield/incident particle: 5.4 $\cdot$ 10$^{-6}$
Yield/incident particle: 5.3 $\cdot$ 10$^{-6}$

Yield of $^{200}$Rn at S4/all fragments: 0.02

Yield of $^{200}$Rn at S1/incident $^{238}$U 5.3 $\cdot$ 10$^{-6}$ (2.6 $\cdot$ 10$^3$ pps)

Second stage $^{200}$Rn $\rightarrow$ $^{186}$Pb:

Reaction target at S4 $^{27}$Al 500 mg/cm$^2$ 153.0 MeV/u \( \frac{d}{R} = 0.67 \)
Energy of $^{200}$Rn behind the reaction target:
Yield of $^{186}$Pb/incident $^{200}$Rn 3.1 $\cdot$ 10$^{-5}$ 67.8 MeV/u 2.9 mb, 0.08 pps
Yield of $^{186}$Pb/all nuclei 1.3 $\cdot$ 10$^{-1}$
Yield of $^{186}$Pb/isotopes of Pb 2.0 $\cdot$ 10$^{-2}$

Estimated $\gamma$ rate for $^{186}$Pb (3.0 % $\gamma$ eff. at 1.3 MeV)) : 9 hr.$^{-1}$
Some additional information

Yield of $^{185}$Pb/incident $^{200}$Rn: $1.3 \times 10^{-5}$, 1.2 mb, 0.03 pps

Estimated $p\gamma$ rate for $^{185}$Pb (3.0 % $\gamma$ eff. at 1.3 MeV): 4 hr.$^{-1}$

Yield of $^{187}$Pb/incident $^{200}$Rn: $6.2 \times 10^{-5}$, 5.9 mb, 0.16 pps

Estimated $p\gamma$ rate for $^{186}$Pb (3.0 % $\gamma$ eff. at 1.3 MeV): 18 hr.$^{-1}$

Slits:
- S1 = $\pm$ 1.0 cm
- S2 = $\pm$ 3.0 cm
- S3 = $\pm$ 10. cm

Reaction target = $\pm$ 3.5 cm (max.)

Yield of all fragments / incident particle before SC21: $1.6 \times 10^{-3}$ (8.1 $\times 10^{5}$)

Yield of all fragments / incident particle before MUSIC at S4: $3.2 \times 10^{-4}$ (1.7 $\times 10^{5}$)

$B\rho$(D1) = 7.8395 Tm
$B\rho$(D2) = 6.8409 Tm
$B\rho$(D3) = 5.2980 Tm
$B\rho$(D4) = 5.2979 Tm
Figure 1: Position spectrum at S4 for $^{200}$Rn setting

Figure 2: Time-of-flight vs Position plot for $^{200}$Rn setting.