A1900 fragment separator and selected NSCL control applications

Mini-lecture series for HiRA group
By Michal Mocko
Part I

• A1900 overview (what it consists of…)
• A1900 detectors
• Particle identification in the A1900
• Method of separation using the A1900
Coupled Cyclotron Facility

Beam list:
$^{40}\text{Ca} - 15\text{pnA}$
$^{48}\text{Ca} - 15\text{pnA}$
$^{58}\text{Ni} - 5\text{pnA}$
$^{64}\text{Ni} - 7\text{pnA}$
$^{86}\text{Kr} - 15\text{pnA}$

etc.

At 140MeV/u
A1900 – fragment separator

- Magnetic spectrometer
- Filter of projectile fragmentation products
- Five image planes
- Mirror symmetry about I2

Selected properties:
- Length 37m
- 4x 45° dipoles
- 24 quadrupoles
- \( \delta = 59\text{mm}/\% \)
- \( d\Omega = 8\text{msr} \)
- \( B_{\rho_{\text{max}}} = 6\text{Tm} \)
A1900 - overview

• **Image 1:**
  – Wedge
  – Slit (remote)

• **Image 2:**
  – Slit
  – PPACs (2x)
  – Wedge (3x)
  – Scintillator (ToF)

• **Image 3:**
  – Slit system (remote)

• **Focal plane:**
  – PPACs (2x)
  – dE detector (PIN diode)
  – Scintillator (ToF)
Particle identification (PID)

- Method: $B\rho$-ToF-dE

\[ B\rho = \frac{p}{Q} \quad dE \approx \frac{z^2}{v^2} \]

\[ ToF \approx v \]

- Assuming $Q=Z$

- $dE$ versus ToF is a simple PID plot

\[ ^{40}\text{Ca}+^{9}\text{Be} \]
Fragment separation

$^{78}\text{Kr}$ (12 MeV/u)

$^{78}\text{Kr}$ (140 MeV/u)
Fragment separation

\[ \text{Fragment separation} \]

\[ \text{78}^{\text{Kr}} \text{ (12MeV/u)} \]

\[ \text{78}^{\text{Kr}} \text{ (140MeV/u)} \]

- K1200
- K500
- Coupling line
- Stripping foil
- Production target
- Image 1
- Image 2
- Momentum slit
- Wedge

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Fragment separation

$^{78}\text{Kr}$

(12MeV/u)

$^{78}\text{Kr}$

(140MeV/u)

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Part II

• Control system - Barney
• Controlling A1900
• Barney printout
• What to look for during an experiment
Barney main page

Summary of Barney states:

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A1900 main page

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A1900 main page
A1900 main page
A1900 main page
A1900 main page
A1900 main page
Beam Line to S800

[Diagram of Beam Line to S800 Controls]
S800 main page
Printout generation
Barney printout

Run title

| Expt: 03031 'Fragmentation of Ni-68 [Betty Tsang] Line: S800 [8] |
| Beam: 76 Ge 12+ 11.59 MeV/nuc (K500) 30+ 130.00 MeV/nuc (K1200) |
| K500 a,b: 0 A, 0 A K1200: 0 A, 0 A RF: 22.49300 MHz |

<p>| A1900 optics: G1953v13_30x20Focus60x30.data |</p>
<table>
<thead>
<tr>
<th>Rigidity</th>
<th>Field</th>
<th>Radius (live)</th>
<th>Difference (Field*Radius)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seg 0:</td>
<td>4.32100 Tm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seg 1:</td>
<td>3.83030 Tm 1.23568 T 3.09882 m 3.09974 m 0.02983 % (3.82916 Tm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seg 2:</td>
<td>3.83030 Tm 1.23520 T 3.10148 m 3.10095 m -0.00127 % (3.83096 Tm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seg 3:</td>
<td>3.52600 Tm 1.13931 T 3.09502 m 3.09487 m -0.00483 % (3.52617 Tm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seg 4:</td>
<td>3.52600 Tm 1.13832 T 3.09382 m 3.09700 m 0.03794 % (3.52646 Tm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seg 5:</td>
<td>3.50350 Tm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seg 6:</td>
<td>3.46338 Tm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seg 7:</td>
<td>3.45510 Tm</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seg 8:</td>
<td>2.60000 Tm</td>
<td></td>
<td></td>
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Z108DS 0.50040 T 7.04675 m 7.04918 m 0.03449 %
D140DS 0.00145 T 2282.62069 m 2416.20690 m 5.85232 %
D165DS 0.37016 T 9.46362 m 9.46477 m 0.01219 %
I200DS 1.10232 T 3.14194 m 3.14190 m -0.00125 %
I205DS 1.10223 T 3.14204 m 3.14216 m 0.00373 %
I223DS 1.11579 T 3.09708 m 3.09655 m -0.01710 %
I226DS 1.08990 T 3.17011 m 3.17011 m -0.00734 %
I265DS 0.93431 T 2.80280 m 2.78280 m 0.01739 %
I266DS 0.92819 T 2.80280 m 2.80113 m -0.05883 %

Z001TL: out, Z013TL: out, Z014TL OUT
Z015TL: OUT, Z016TL OUT
Z030BC Beam Stop: -126.22 mm
Z037L,R: -4.70, 9.35 mm; Z037DC: *out*
Z057MS: out, Z061MS: out
Z056DC: out, Z062SC: out, Z037TL:
Z082 X,C,G,YG: 0.16, 203.50, 201.37 mm Z082Deg: out
Z101DC: in, Z102DC: out, Z103DC: out, Z105SC: out
B110 Cent,Gap: -0.09, -0.04 mm; D110 -3.01, 10.00 mm F110 0.15, 0.69 mm
B110DC: out, D110DC: out, D111DC: 5 ml BC=404, F110DC: out
S111S: I18I X,C,G,YC,G: 0.79, 98.98, -0.00, 98.39
I187: [3']obj Scint, I188: [0'] out, I189: , I190: [0'] out
I1213: [0'] out, I1214: [0'] out, I1215: [0'] out, I1216: [0'] out
I214DC Detector Drive: _PPAC_
Extra Drive: Z059TL.VAL = *out*
<table>
<thead>
<tr>
<th>Experiment name and beam</th>
<th>Barney printout</th>
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```
A1900 "Print18May05_13h30.txt" Wednesday 13:30:58 2005-05-18 A1900

Expt: 03031 "Fragmentation of Ni-68" [Betty Tsang] Line: S800 [8]
Beam: 76 Ge 12+ 11.59 Mev/nuc (K500) 30+ 130.00 Mev/nuc (K1200)

K500 a,b: 0 A, 0 A K1200: 0 A, 0 A RF: 22.49300 MHz

A1900 optics: G1953v13_30x2Focus60x30.data

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<td>Seg 4: 3.52600 T</td>
<td>3.09882 m</td>
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<td>0.00182 %</td>
<td>3.09700 m</td>
</tr>
<tr>
<td>Seg 5: 3.50350 T</td>
<td>3.09882 m</td>
<td>3.09700 m</td>
<td>0.00182 %</td>
<td>3.09700 m</td>
</tr>
<tr>
<td>Seg 6: 3.46338 T</td>
<td>3.09882 m</td>
<td>3.09700 m</td>
<td>0.00182 %</td>
<td>3.09700 m</td>
</tr>
<tr>
<td>Seg 7: 3.45510 T</td>
<td>3.09882 m</td>
<td>3.09700 m</td>
<td>0.00182 %</td>
<td>3.09700 m</td>
</tr>
<tr>
<td>Seg 8: 2.60000 T</td>
<td>3.09882 m</td>
<td>3.09700 m</td>
<td>0.00182 %</td>
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B110DC: out, D110DC: out, D111DC: 5 mil BC-404, F110DC: out
S113: i181 X,G,Y,G: 0.79, 98.98; -0.00, 98.39
I214DC Detector Drive: _PPAC_
Extra Drive: Z059TL.VAL = *out*
```
**Barney printout**

<table>
<thead>
<tr>
<th>A1900 segments</th>
<th>B(\rho) settings of Segments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Seg 0:</strong> 4.32100 Tm</td>
<td><strong>Very important!</strong></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Seq 5:</strong> 3.50350 Tm</td>
<td></td>
</tr>
</tbody>
</table>

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Barney printout

Target drives
Z015TL is the TGT position
Barney printout

Image 1 drives
Z037L,R = I1 slit

Z030BC Beam Stop: -126.22 mm
Z037L,R:  97.2 mm
Z037R:  97.2 mm
Z037DC: *out*
Z037TL: Out, Z037R: Out
Z037L,R:  97.2 mm
Z037R:  97.2 mm
Z037DC: *out*
Z037TL: Out, Z037R: Out
Barney printout

Image 2 drives

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Barney printout

Image 3 drives

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Barney printout

Focal plane drives

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Conclusion

• Part I:
  – A1900 layout presented
  – Principle of particle identification
  – Separation of fragmentation products showed

• Part II
  – Control system (Barney) introduced
  – Control pages for A1900, S800 presented
  – Barney printout explained