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Gross Nuclear Properties from $\beta$ Decay

- $P_n$ and $T_{1/2}$ from $\beta$ decay

$$T_{1/2} = \frac{1}{\sum_0^{Q_{\beta}} S_{\beta}(E_i)f(Z,R,Q_{\beta}-E_i)}$$

$$P_n = \frac{\sum_{Q_{\beta}} S_n(E_i)f(Z,R,Q_{\beta}-E_i)}{\sum_0^{Q_{\beta}} S_{\beta}(E_i)f(Z,R,Q_{\beta}-E_i)}$$

- $S_n$ is the neutron separation energy
- $f(Z,R,Q_{\beta}-E_i)$ is the Fermi function

Sensitivity of $S_\beta$ to Deformation

- Magnitude and distribution of $\beta$-decay strength changes with deformation
- Calculated $T_{1/2}$ and $P_n$ reflect changes in $S_\beta$

**Deformation in Neutron-Rich $pf$-shell Nuclei**

<table>
<thead>
<tr>
<th>Energy (MeV)</th>
<th>50</th>
<th>40</th>
<th>38</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\beta_2$</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

- **Imp. Rate $> 0.01$ s$^{-1}$**
  - Yellow

- **Prolate**
  - Blue
  - $^{64}$Fe
  - $^{65}$Fe
  - $^{66}$Fe

- **Oblate**
  - Red
  - $^{62}$Mn
  - $^{63}$Mn

References:

Calculated $P_n$ Values Along $N=40$

Data from: http://t16web.lanl.gov/Moller/publications/rspeed2002.html

Legend:
- Isotope
- $P_n$ from QRPA
- Lower Limit on $P_n$
Planar Germanium DSSD

- Ions implant into the Ge Double-Sided Strip Detector (GeDSSD)
- Detector characteristics [1]:
  - Planar geometry
  - 1 cm thick
  - 9 cm diameter
  - 5 mm $\times$ 5 mm pixels
- High $\beta$-decay detection efficiency
  - $\approx 60\%$ for 1 pixel field
  - We expect $\geq 85\%$ for 9 pixel field
- Decays correlated event-by-event

N. Larson et al. NIM A (in preparation)
Ancillary Detector Array

- Neutron and $\gamma$-ray detectors
\( \gamma \)-Ray Detection Efficiency

![Graph showing detection efficiency vs. gamma-ray energy for optimum and alternate arrays.](graph.png)
Conclusion

- First measurements of absolute $P_n$ will be made for $pf$-shell nuclei along $N=40$
- Measured $P_n$ and $T_{1/2}$ will be compared with theoretical predictions to assess the influence of deformation in this region
- An experimental array composed of electron, gamma-ray, and neutron detectors has been designed and simulations have been performed
Thank you for your attention

Questions?