Establishing the deformation characteristics of $^{66}\text{Ge}$

Dr. George O’Neill
University of the Western Cape
P-531
Motivation

- $^{66}$Ge expected to lie on boundary of $\gamma$-soft and triaxial shapes [1]
- Valence particles in $fpg$ shell challenge theoretical models
- Low-excitation structure not understood
- Post-accelerated beams only available at HIE-ISOLDE (July 2017)

Motivation

- $\Delta(2^+_2 - 2^+_1)$ relatively constant
- $\Delta(2^+_2 - 0^+_2)$ decreasing in energy
- Implies intruder orbital into the $\gamma$ band
- Few measurements of $0^+_2$ near N=Z with unstable nuclei
Current Situation

- Level scheme well known
- Shapes are not
- Effect of mid-shell effects outside valley of stability between N, Z=28-50 unclear

![Level Scheme Diagram](image)
Method

- Safe Coulomb excitation (4.9 MeV/u)
- De-excitations detected using MINIBALL
- Reorientation effect employed
- $^{196}$Pt (4.0 mg/cm$^2$) target for normalisation
  - No $\gamma$ rays in regions of interest
  - Well-measured B(E2) values
- CD placed 26 mm downstream (any MINIBALL chamber)

Kinematics in the lab frame for $^{68}$Ge on $^{196}$Pt at 4.9 MeV/u
Beam Production

- $^{66}$GeS can be enhanced with direct sulphur injection [1]
- Relatively clean beams with high yields extracted as molecule [2]
- Broken apart in EBIS
- $^{34}$S enriched preferred to reduce possible $^{70}$SeCO

[2] Ulli Koester, Private Communication
Previous Experiment

- $^{66}$Ge (4.395 MeV/u) data taken over 60 hours in summer 2017
- First time post-accelerated
- Intention was to perform $^{70}$Se study (IS569); little yield obtained
- Yields of $^{66}$Ge on the order of $10^3$ pps
- Decays from first $2^+$ state observed
GOSIA Calculations

2^+_1 \rightarrow 0^+_1

Per shift:
2^+_1 \rightarrow 0^+_1 = 2460
2^+_2 \rightarrow 0^+_1 = 106
2^+_2 \rightarrow 2^+_1 = 19
4^+_1 \rightarrow 2^+_1 = 186

Oblate = +10%
Prolate = -10%

2^+_2 \rightarrow 0^+_1 \geq 200 counts in each angular range to get Q_s(2^+_2)

Shifts requested: 15
Experiment Outline

- Mid-shell effects and underlying shape of $^{66}$Ge unknown
- Measurement only possible at ISOLDE
- Yields can be greatly enhanced compared to July 2017
- Production enhanced with sulphur contained within primary target
- Broken apart in EBIS
- Determination of sign & magnitude of quadrupole moment for 1$^{\text{st}}$, 2$^{\text{nd}}$, 2$^+$
- Matrix element for 1$^{\text{st}}$, 4$^+$
- Search for 2$^{\text{nd}}$, 0$^+$


<table>
<thead>
<tr>
<th>Production material</th>
<th>ZrO$_2$</th>
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<tbody>
<tr>
<td>Primary target yields</td>
<td>$5.4 \times 10^5$ ions/μC [1]</td>
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<tr>
<td>Beam energy</td>
<td>4.9 MeV/u (323.4 MeV)</td>
</tr>
<tr>
<td>Charge state</td>
<td>16+</td>
</tr>
<tr>
<td>MINIBALL rate</td>
<td>6300 pps/μC</td>
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<tr>
<td>Shifts</td>
<td>15</td>
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</tbody>
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Collaboration

G. G. O’Neill*1,2, J. N. Orce1, K. Abrahams1, E. Akakpo1, J. M. Allmond3, D. T. Doherty4, R. Dubey1,2, L. P. Gaffney5, P. Garrett1,6, D. G. Jenkins7, M. Kamil1, N. Khumalo1, S. Masango1, D. Mavela1, C. Mehl1, M. Mokgolobothe1, E. M. Montes1, C. Ngwetsheni1, S. Ntshangase8, J. Ondze1, B. Rebeiro1, B. Singh1, S. Triambak1,2, R. Wadsworth7, M. Zielińska9

1: Department of Physics, University of the Western Cape, Private Bag X17, Bellville 7535, South Africa
2: iThemba LABS, National Research Foundation, P.O. Box 722, Somerset West 7129, South Africa
3: INPA, Oak Ridge National Laboratory, Oak Ridge, Tennessee 37831, USA
4: University of Surrey, Guildford GU2 7XH, United Kingdom
5: CERN, CH-1211 Geneva 23, Switzerland
6: Department of Physics, University of Guelph, Guelph, Ontario, Canada
7: Department of Physics, University of York, York, United Kingdom
8: Department of Physics, University of Zululand, Private Bag X1001, KwaDlangezwa 3886, South Africa
9: CEA Saclay, IRFU/SPhN, Gif-sur-Yvette, France
Coulomb Excitation Parameters

- Most target particles available
- CoM angle safe until 96°
- Sommerfeld parameter $\eta = 177$ (GOSIA valid)
- Adiabacity parameter $\xi = 0.315 (2^+)$ (3 MeV excitations)
Kinematics

- Detection of forward-focused particles includes most target particles
- High-energy projectile particles detected
- Further detection of $^{66}$Ge possible by detection of target