Fast Neutron Spectroscopy
with a Novel C$^7$LYC array

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University of Massachusetts Lowell

NS2016, Knoxville, July 26, 2016

Supported by the NNSA-SSAA
Grant DE-NA00013008, U.S. Department of Energy
Cs$_2$LiYCl$_6$:Ce (CLYC) Scintillator

- dual neutron-gamma response
- n-$\gamma$ discrimination via pulse shapes
- thermal neutrons via $^6$Li(n,\(\alpha\))t
- Developed by RMD Inc., MA
- DOE-SBIR partner with UML

N. D’Olympia et al., NIM A694,140(2012)

W1/W2 vs Total Area

Thermal Neutron Response

UML 1 MW research reactor

Chowdhury NS2016, Knoxville July 26, 2016
CLYC: fast neutron response

N. D’Olympia et al., NIM A714, 121 (2013)
Small CLYC Array for Neutron Spectroscopy

SCANS

Chowdhury
NS2016, Knoxville
July 26, 2016
Small CLYC Array for Neutron Spectroscopy

VME System
Struck digitizers
16 Channel
250 MS/s
14-bit ADC

7Li-enriched
1" x 1"
16-element
C$^7$LYC array

SCANS

Chowdhury
NS2016, Knoxville
July 26, 2016
$^{7}$LYC: high energy response

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<tr>
<th>Energy (MeV)</th>
<th>Counts [arb. unit]</th>
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<tr>
<td>0.52</td>
<td>5000</td>
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<tr>
<td>0.82</td>
<td>4000</td>
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<tr>
<td>1.19</td>
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<tr>
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Energy [keVee]
C$^7$LYC: light output

N. D’Olympia et al., NIM A763, 433 (2014)
Test experiments with SCANS

Elastic/inelastic neutron scattering cross-sections ($^{56}$Fe and $^{238}$U) at Los Alamos Neutron Science Center (LANSCE)

- TOF from neutron production target to CLYC (18 m flight path) provides $E_{\text{incident}}$
- Pulse height in CLYC provides $E_{\text{scattered}}$
- Plot $E_{\text{scattered}}$ vs $E_{\text{incident}}$
Fe (PRELIMINARY)

- Entries: 137141
- Mean x: 3576
- Mean y: 2660
- RMS x: 1772
- RMS y: 1097

- elastic $E_{out} = E_{in}$
- inelastic $E_{out} < E_{in}$

Pulse Height (scattered energy)

TOF energy (incident energy)

thermal
SCANS at LANSCE

Fe (PRELIMINARY)

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TOF energy + Pulse Height

TOF energy – Pulse Height
SCANS at LANSCE

Fe (PRELIMINARY)

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<tr>
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<td>RMS</td>
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Counts

TOF energy – Pulse Height

0.85 MeV

0+ GS band

\[ ^{56}_{26}\text{Fe} \]
β-delayed Neutrons at CARIBU

X-Array Super clover (70mm x 70mm crystals)

X-Array Clover 60mm x 60mm crystals

$^{94}$Rb test case: analysis in progress (poster by Gemma Wilson)
The first 3” x 3” C$^7$LYC
Summary

Ongoing
Analysis of LANSCE test data on $^{56}$Fe and $^{238}$U
Analysis of CARIBU expt ($\beta$-delayed neutrons: $^{94}$Rb decay)
(poster by Gemma Wilson)

New 3-year science proposal funded by NNSA-SSAA

Plans
Characterize and test new 3” x 3” C$^7$LYC crystal
Second ($n,n'$) experiment at LANSCE (Fall 2016)
Measure and simulate efficiency
Investigate $n-\gamma$ coincidences in SCANS
Measure low energy response of C$^7$LYC
Teams

**LANSCE**
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Alan Mitchell
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Michael Carpenter
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