Precision measurement on $^{16}O(n,\alpha)$ reaction cross section for nuclear applications

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1. **We have performed a benchmark measurement on $^{16}O(n,\alpha)$ reaction in 2015, to reduce the systematic uncertainties by optimizing experimental configurations**
2. **We plan to take a production run in Sept. 2016 in order to make an impact on ongoing evaluation efforts**

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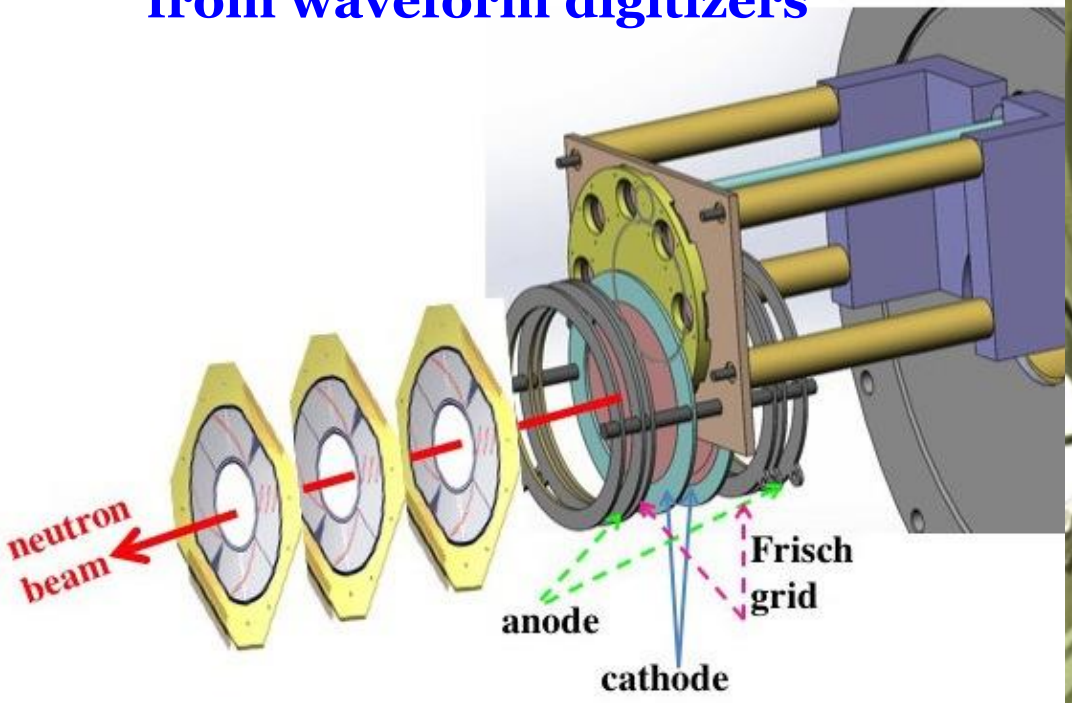
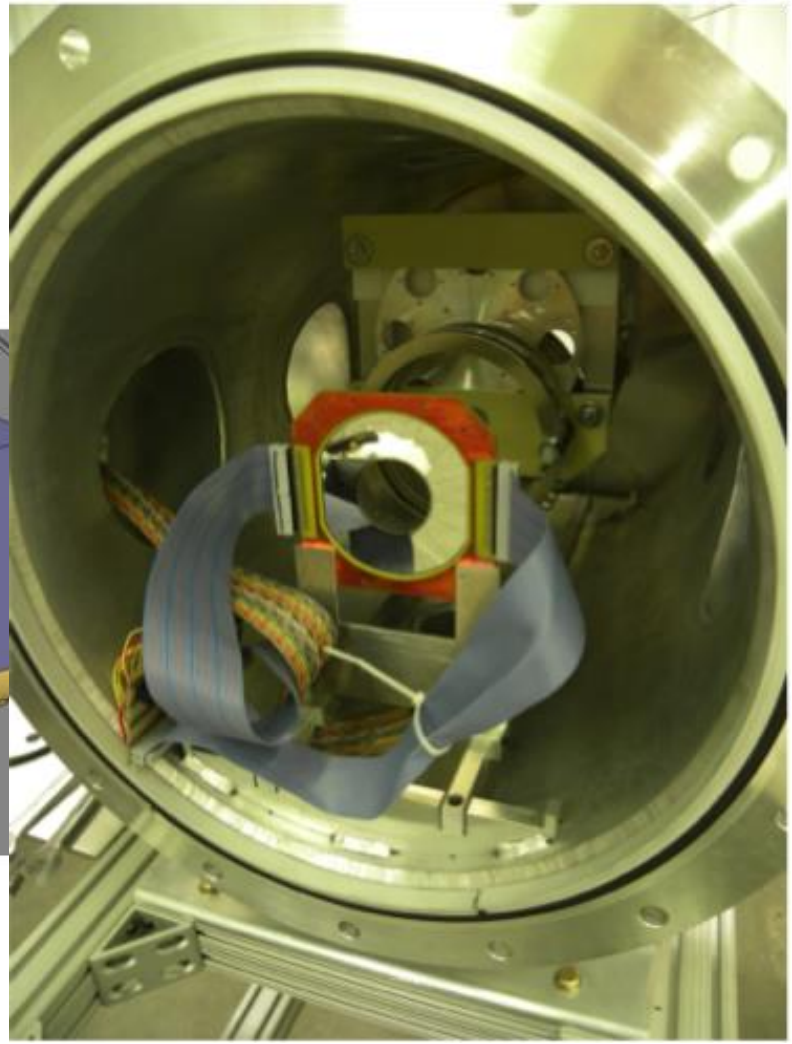
Measurements on (n,α) cross section using LENZ

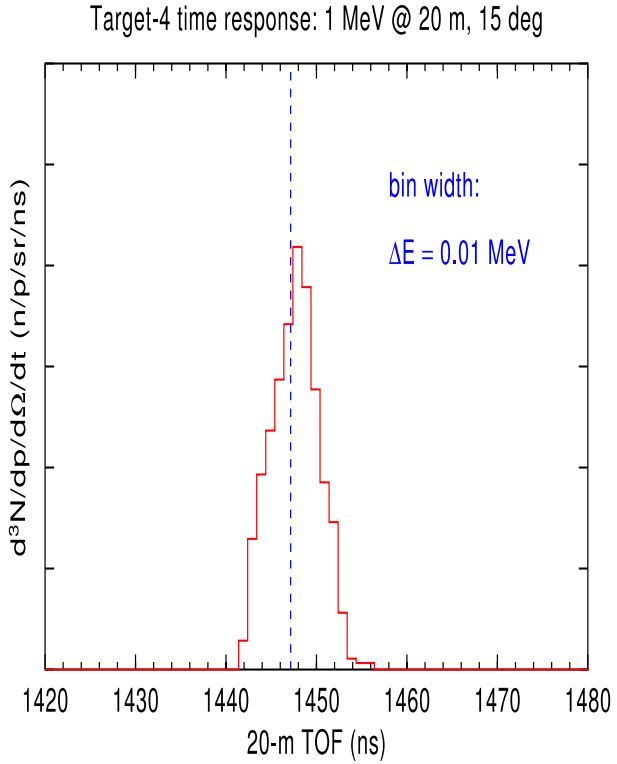
Key improvements for (n,α) study at LANSCE :

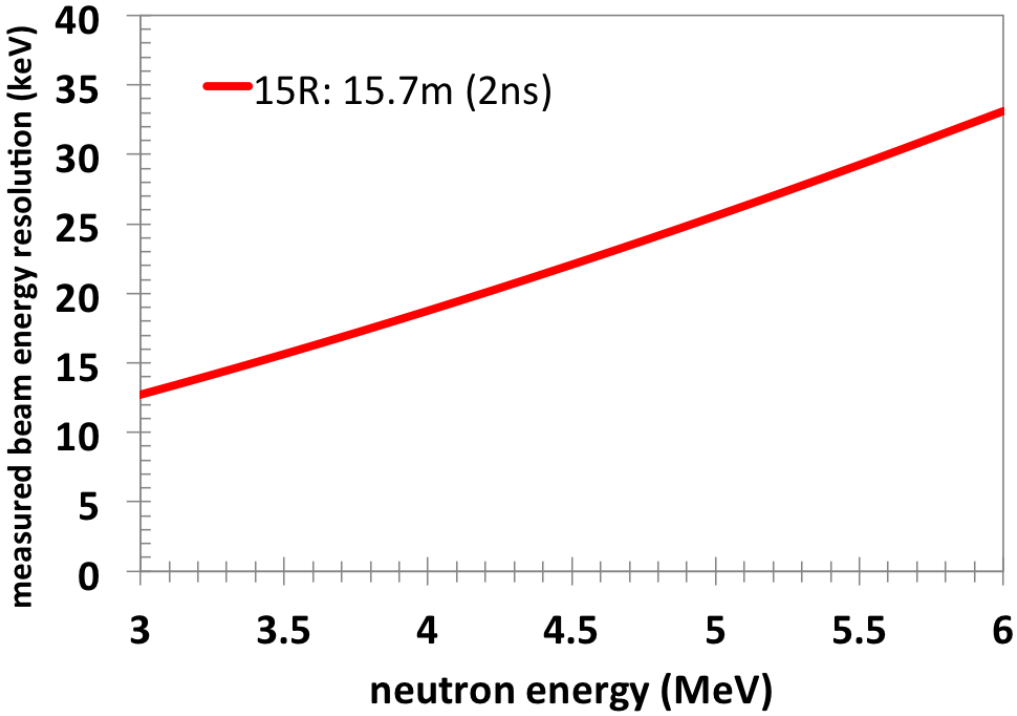
Solid angle coverage
Signal-to-noise ratio for low-energy α's
Energy resolution
Measured angular distribution
Redundant information
from waveform digitizers





Neutron beam energy resolution estimation at LANSCE





- Estimated timing uncertainty from MCNP at 15R flight path with 20-m length, translates into a path length uncertainty of $\Delta L \sim 4$ cm, instead of 7.6 cm of W target physical length
- Neutron beam energy resolution in TOF method is estimated using 4 cm of path length uncertainty and 2 ns of detector timing resolution

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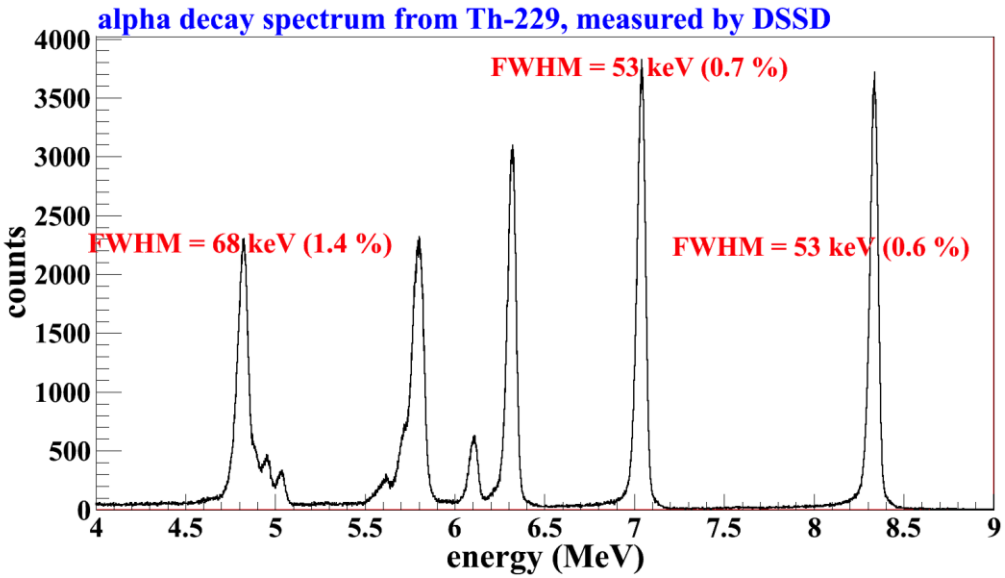
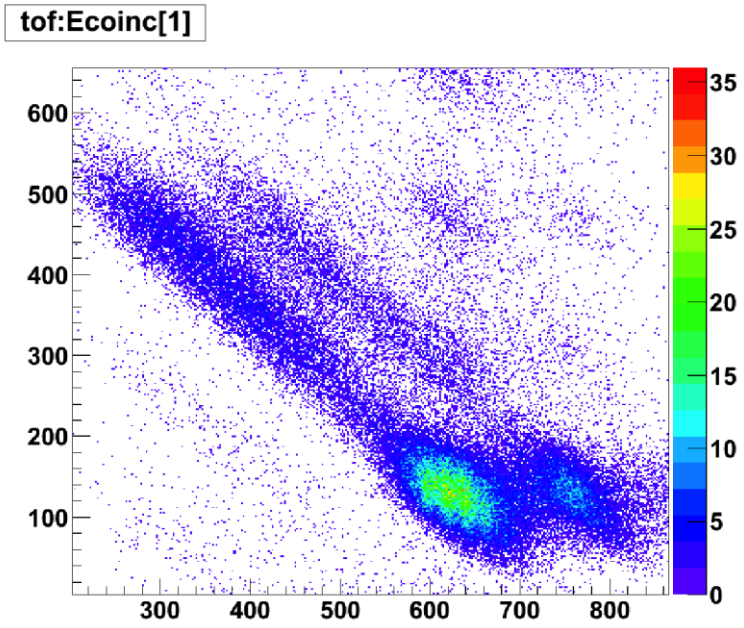
LENZ performance : energy and timing resolutions



Energy resolution (~ 50 keV) measured with Double-sided Silicon Strip Detector (DSSD), 1000 micron thick

2d plot of TOFs betweenTo-cathode and DSSD-cathode, demonstrating different charged particle groups, taken the measurement of $^{59}Co(n,p/\alpha)$ reaction at LANSCE



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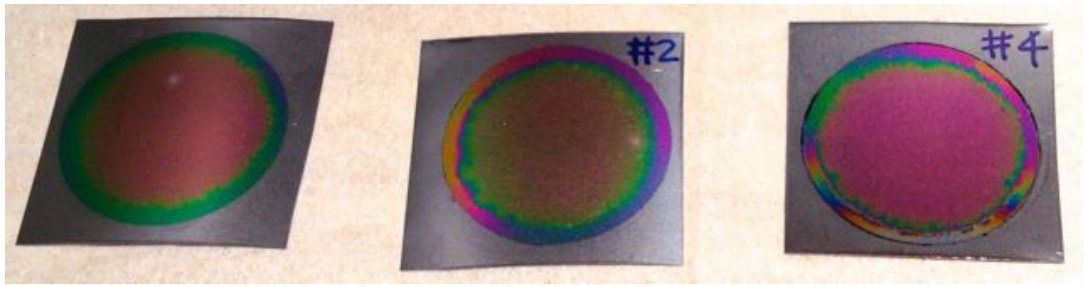
Summary of Run Cycle 2015

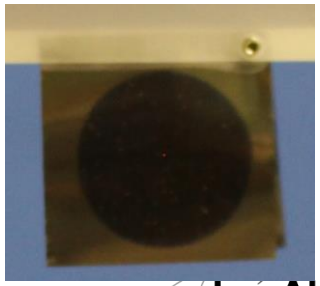
Optimization of detector configuration for $^{16}O(n,\alpha)$ measurement

1. Ionization chamber (ΔE) coupled with Silicon Strip Detectors (E) at 300 Torr. of P10 gas
2. Only Twin Frisch-grid Ionization chamber (fully stopped E) at 300 Torr. of P10 gas
3. Only Two Silicon Strip Detectors (fully stopped E) at 1 mTorr. of vacuum

Fabricated two types of solid oxygen targets :

1. Ta_2O_5 by anodizing method : ~ 4000 Å corresponds to 2 X 10^{18} oxygen atoms (left 3 targets)
2. Li_2CO_3 by evaporation method for the ratio measurement : retention rate of lithium carbonate is observed to be unreliable (one most right target)





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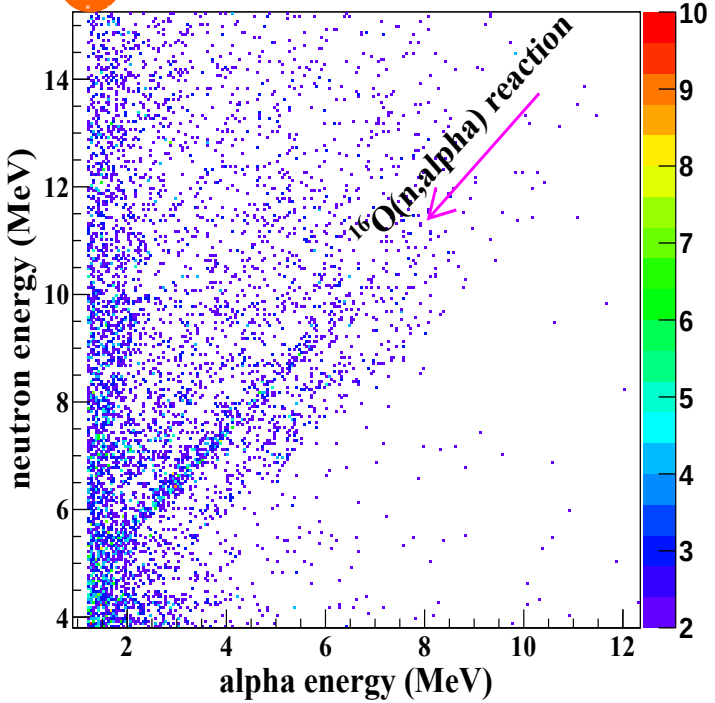
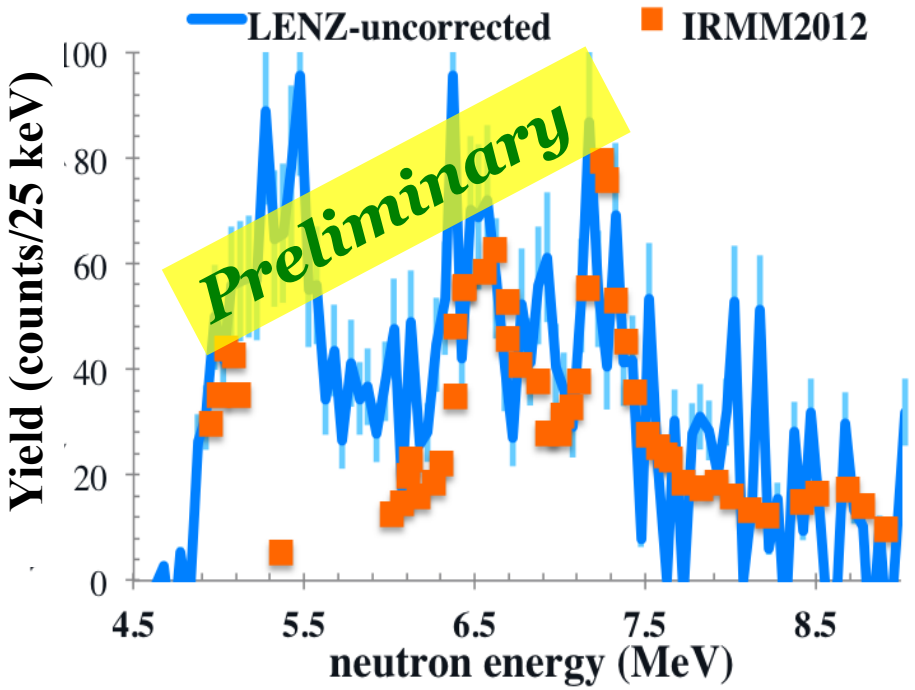
LENZ preliminary $^{16}O(n,\alpha)$ yield, taken from configuration 3 & target 1





This kinematics line shows the reaction Q-value (~2.2 MeV) relation between neutron beam energy and detected alpha energy

The preliminary $^{16}O(n,\alpha)$ yield is extracted by projecting the diagonal line onto the neutron energy axis. This is a subset (at θ = 40 deg) of the detected angle range, and *proper background subtractions and angular corrections are not performed yet.*

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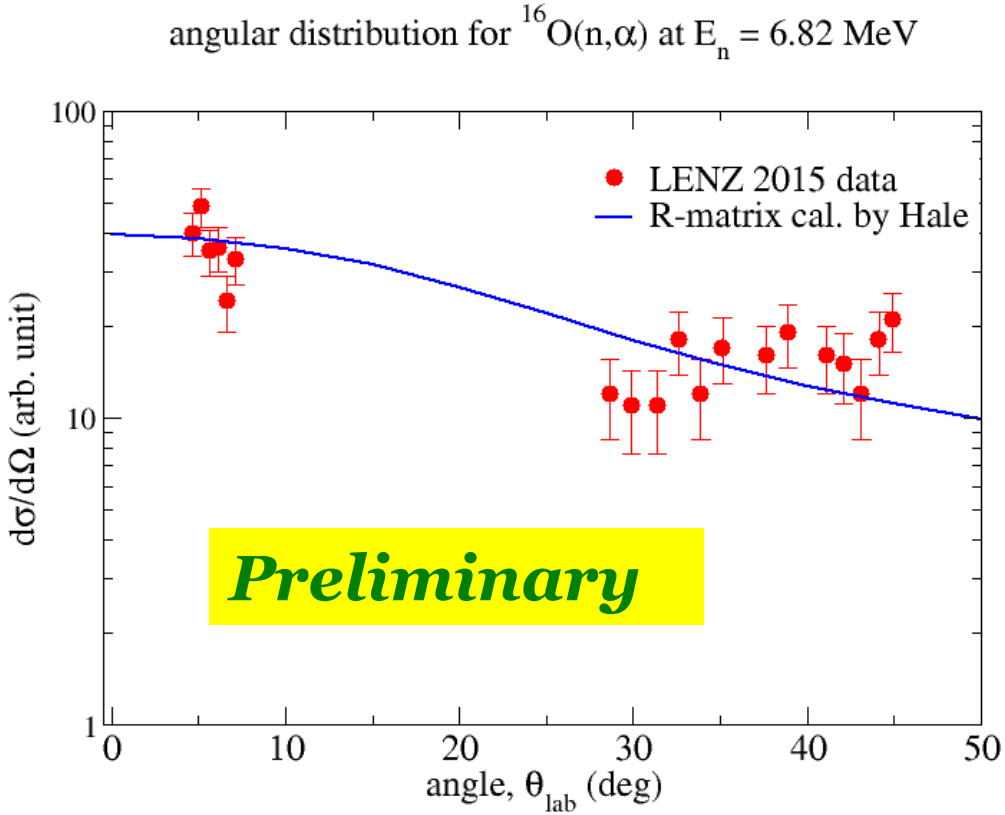
LENZ $^{16}O(n,\alpha)$: forward propagating analysis

Plan to implement R-matrix driven double-differential cross sections as a Monte Carlo input for simulating the LENZ data, a yield, not the final cross section. This allows us to have an independent method to determine a normalization, besides determining it from a conventional way of applying beam flux and a number of target atom.



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Outlook for $^{16}O(n,\alpha)$ cross section study

- In the 2015 run cycle, we optimized the newly developed LENZ instrumentation for measuring the $^{16}O(n,\alpha)$ reaction cross section with reduced systematic uncertainty, using good neutron energy resolution and solid oxygen targets
- Solid oxygen target characterization is scheduled in Summer 2016 to improve systematic uncertainty
- The normalization of this cross section, with our current knowledge on a beam flux and a number target atoms at LANSCE, could be determined within 15 % uncertainty

- We plan to perform a "timely" production measurement in Sept 2016 including fast analysis result, in order to contribute to the next release of the CIELO/ENDF evaluations.

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