LLNL Laboratory Report

Computational Nuclear Physics

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UCRL-PRES-236285

Computational Nuclear Physics Overview

- Main conduit for communication and coordination between LLNL Programs and N Division:
  - Coordinate nuclear data related experiment and theory activities in N Division
  - Manage LLNL nuclear data infrastructure
    - Website
    - Processing codes
    - Data access libraries
    - Neutron and photon transport routines
  - Manage LLNL nuclear data libraries
    - Perform evaluations in support of LLNL program
    - Collect & disseminate other LLNL evaluations
    - Provide non-LLNL nuclear data libraries to LLNL customers
- Chair Homeland Security Nuclear Data Taskforce

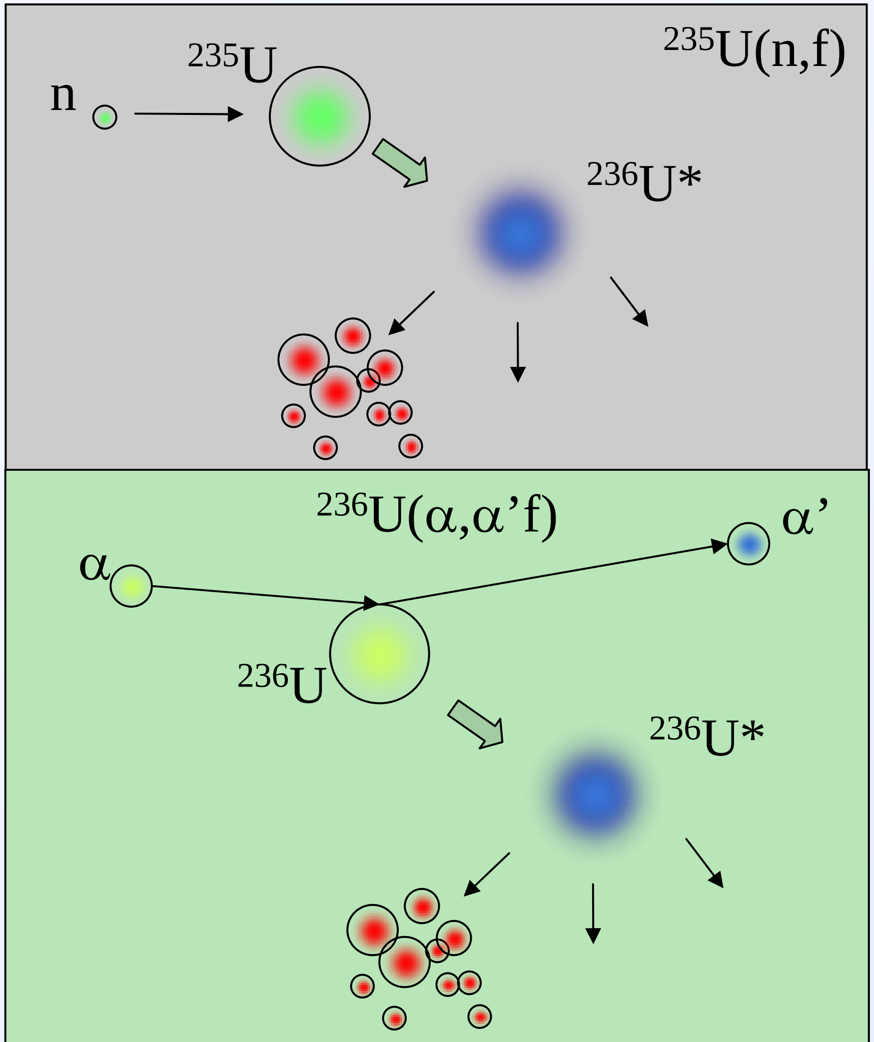
Personnel updates

- New hires in CNP Group reflect LLNL and USNDP data needs:
  - Neil Summers (Flex Term)
    - Low energy reaction theory
    - Nuclear data evaluations
    - Evaluator tool development
  - Ramona Vogt (Flex Term/Adjunct UC Davis)
    - Fission product modeling
- Collaborations
  - Ian Thompson & Petr Navratil (N Division/NTM Group)
  - Marie-Anne Descalle (AP Division)
  - Brad Sleaford (Engineering)
- Strong support fro ASC and DHS programs:
  - 0.42 FTE from USNDP (0.5 FTE in FY05 $$, last time we had increase)
  - 8.5 FTE from ASC & NHI/DNDO

N Division Highlights

- Computational Nuclear Physics
- Nuclear Theory and Modeling
- Nuclear Experiments and Technology
- High Energy Physics
- Collaborations within the laboratory
  - AP Division
  - Engineering
- And outside the laboratory
  - LBNL, LANL, INL, TUNL
  - Stockpile Stewardship Academic Alliance partners: Yale, Univ. of Richmond, Rutgers, UC Berkeley
  - many others…

LLNL continues to lead experimental and theoretical development of the surrogate reaction technique



Hauser-Feshbach (HF) for “desired” CN reaction

$$\sigma_{\alpha\chi} = \Sigma_{J,\pi}\, \sigma_{\alpha}^{CN}(E,J,\pi) \cdot G^{CN}_{\chi}(E,J,\pi)$$

Weisskopf-Ewing limit of reaction:

$$\sigma_{\alpha\chi}^{WE}(E) = \underbrace{\sigma_{\alpha}^{CN}(E)}_{\text{calculated}} \cdot \underbrace{P_{\chi}(E)}_{=N_{coinc}/N_{single}\ \text{measured}}$$

J. Burke *et al.* Phys. Rev. C **73**, 054604 (2006)

^{237}U(n,f) simulated by ^{238}U(α,α’f)

QuickTime™ and a
TIFF (LZW) decompressor
are needed to see this picture.

The surrogate technique has met with some early success, but there are difficult questions yet to settle

J. Escher, F.S. Dietrich Phys. Rev. C **74**, 054601 (2006)

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Angular-momentum mismatch between Surrogate and desired reactions affects low-energy regime.

B.F. Lyles *et al.* Phys. Rev. C **76**, 014606 (2007)

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^{236}U(n,f) simulated by ^{238}U(^{3}He,αf)

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Computational Nuclear Physics is producing many new and revised evaluations for the next ENDF release

- ^{240}Am based on surrogate work of Younes & Britt (D. Brown, N. Summers)
- ^{237}U based on LLNL surrogate work (D. Brown, N. Summers, I. Thompson (NTM), W. Younes (NTM))
- B. Sleaford (Eng.) merged EGAF data with ENDF/B-VII.0 evaluations as part of his Ph.D. in Nuclear Engineering: ^{19}F, ^{182}W,^{183}W, ^{184}W, ^{186}W, and ^{207}Pb
- Evaluations in progress:
  - Structural materials (N. Summers, I. Thompson (NTM)):
    - Fill out Mn network (54, 56, and 57)
    - Fill out Cu network (62, 64, and 66)
  - Making all 497 partial evaluations in the Hoffman Radchem library (now in ENDF/A) transport ready (N. Summers)

Humble beginning of what we hope to become a focus for Homeland Security simulation tools (D. Wright (HEP))

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- http://nuclear.llnl.gov/simulation/

Development of a Time Projection Chamber for precision ^{239}Pu(n,f) cross section measurement (M. Heffner (HEP))

TPC Capabilities:

- 3D event reconstruction
- High background rejection
- Particle identification
- Standalone or incorporate in existing detector

Possible Measurements:

- Precision ^{239}Pu(n,f) other (n,f) cross-sections (e.g. ^{235}U, ^{238}U)
- Fission fragment energy, mass and direction
- Neutron energy, direction, number (with specially designed TPC)
- Correlation with γ-rays (with γ external spectrometer)

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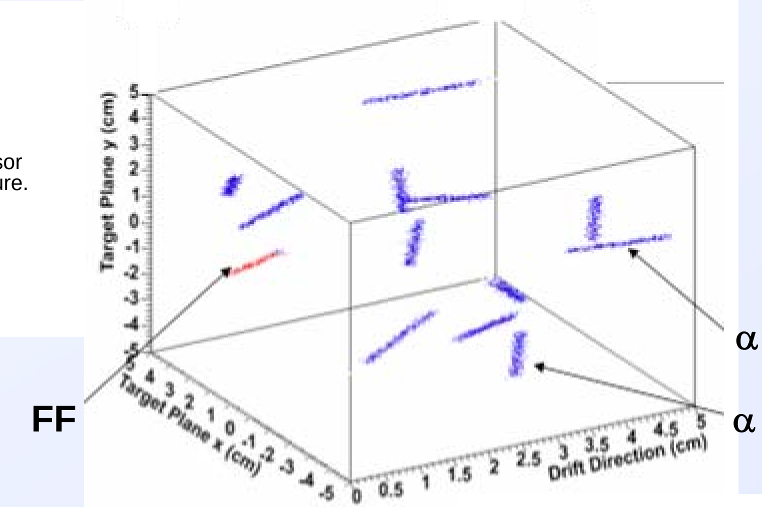

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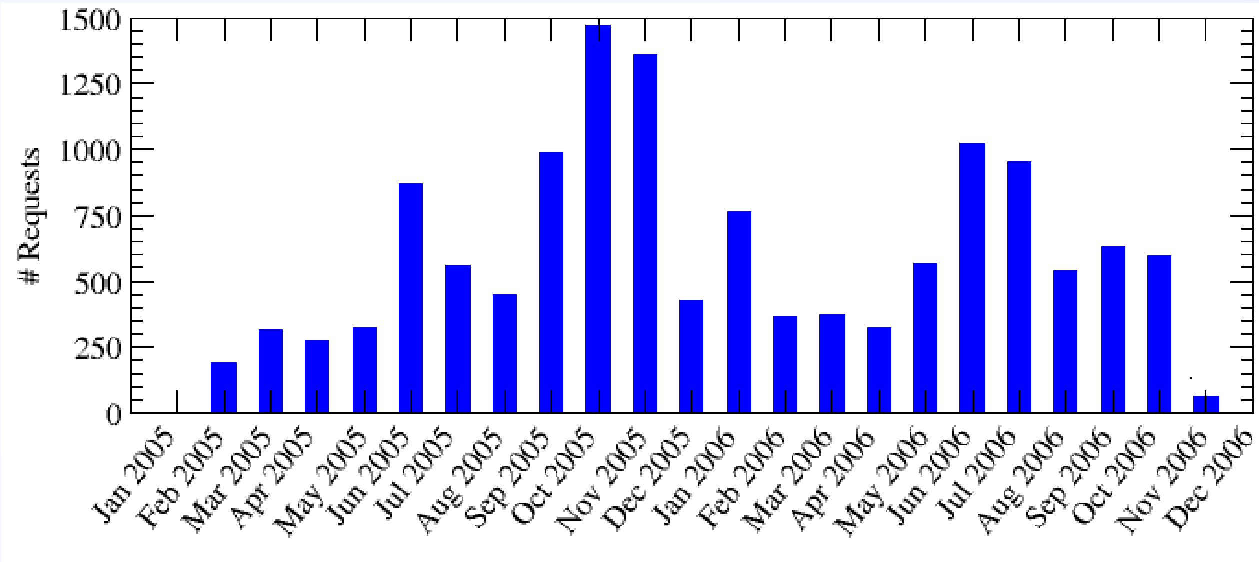
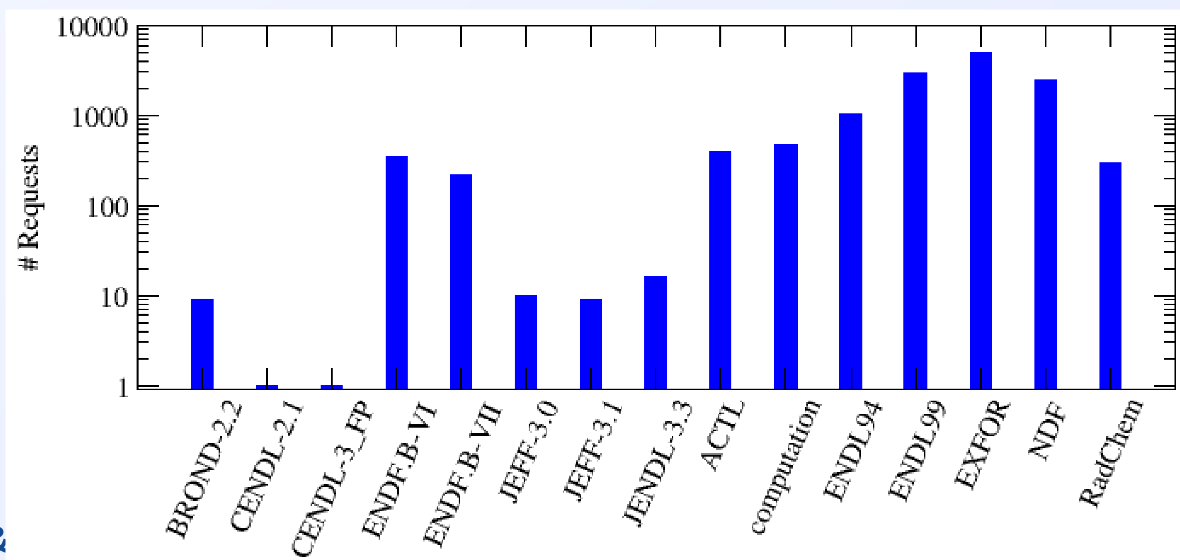
Backup Slides

LLNL’s Nuclear and Atomic Data System remains popular





P. Navratil (NTM) reviewed the gamma production data for several low-Z isotopes

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- Part of D. Brown, M. Johnson, P. Navratil, “High Energy Neutron Induced Gamma Production” UCRL-TR-235226

^{241}Am(n,2n) measurement at TUNL in excellent agreement with ENDF/B-VII.0 evaluation (C.-Y. Wu (NET))