Neutron Scattering Cross Sections: (n,n') (n,γ) (n,n'γ)

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Current Team Members

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Univ Dallas
Sally Hicks, prof

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US Naval Academy
Bijan Nichols, undergrad
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- Lab Overview
- Where we are today
- Primary Projects
- Secondary Projects

Special thanks to Anthony Ramirez, currently @ LLNL.

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University of Kentucky Accelerator Laboratory (UKAL)

- 7-MV single-ended Van de Graaff accelerator
- p, d, ^{3}He and α beams
- pulsed and bunched beam:
  - f = 1.875 MHz and Δt ~1 ns
- primarily conducts neutron-induced reactions and scattering experiments

Basic Nuclear Science

- Nuclear structure via (n,n'γ)

  - Level Schemes and Transitions
  - Spectroscopic Information
  - DSAM Lifetimes

Applied Nuclear Science

- Cross section measurements

  - (n,n') - Elastic and inelastic cross sections

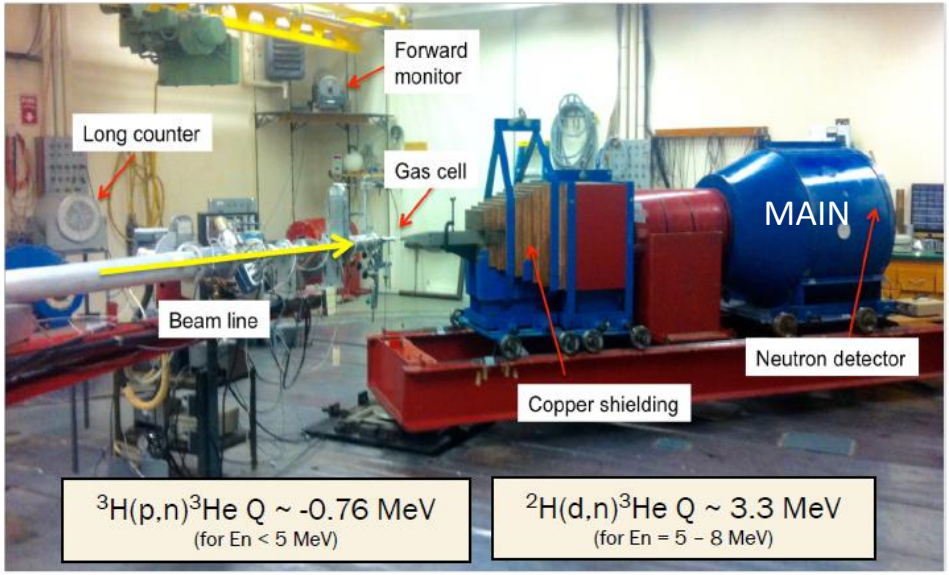
    ^{23}Na, ^{56}Fe, ^{54}Fe, ^{12}C, ^{nat}Si, ^{nat}Li

  - (n,n'γ) - γ-ray production cross sections

    Level cross sections

- Detector development

UKAL Experimental Hall

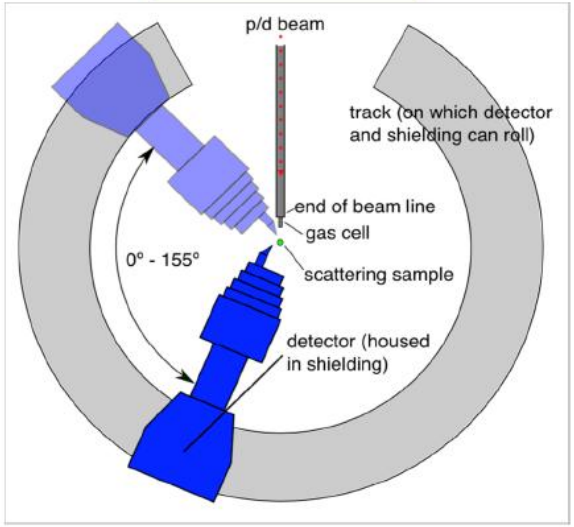


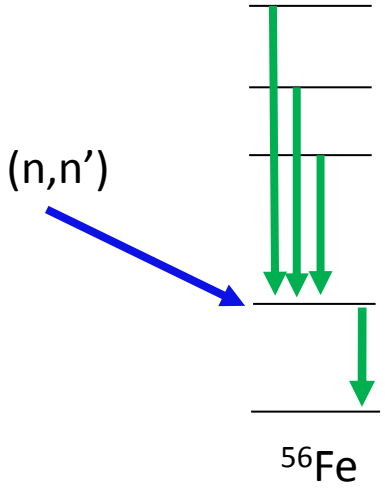
- Neutron and γ-ray detection

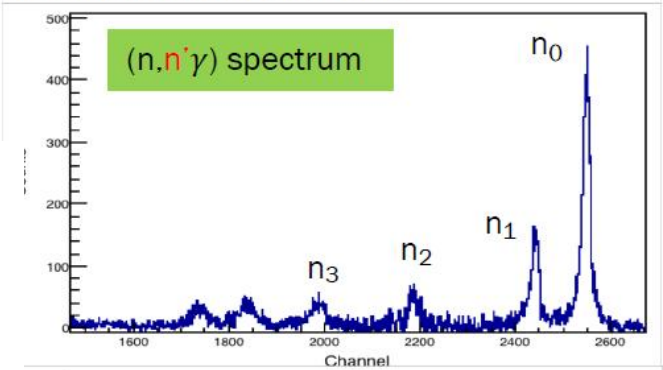
- time-of-flight (TOF) method to extract neutron energy spectrum
- TOF gating also employed to reduce background neutrons and γ-rays

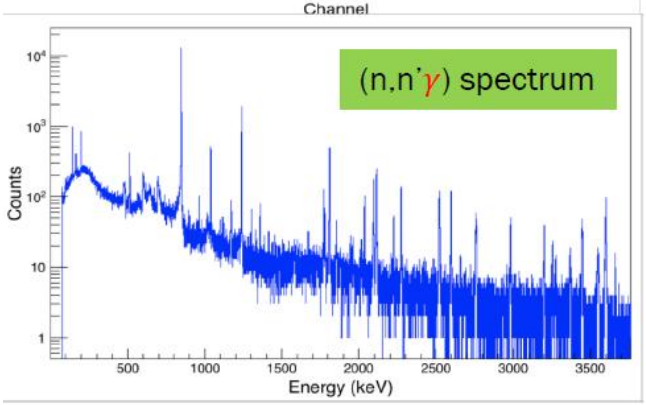
- Angular distribution and excitation function measurements

Schematic view









Today's Status

- DE-FOA-0002114 NDIAWG (2019)
  - Collaboration is holding weekly mtgs
  - New DAQ quotes -- ready to order
  - COVID restrictions prevent major runs

SC		Start	Funds Functional	Duration
21243	Univ Dallas	1 Sep 2020	Oct 2020	3 yr
21175	Mississippi State	1 Sep 2020	Oct 2020	1 yr resubmit for 2 & 3
00056	US Naval Acad	1 Sep 2020	Jan 2021	3yr
21424	Univ Kentucky	1 Dec 2020	waiting	1 yr resubmit for 2 & 3

New data acq system

today: Learning how detectors & DAQ work.

- Hired postdoc Yongchi Xiao
  - Hired from other funds (started 1 Oct)
  - Learning/developing γ-ray data analysis procedures in ROOT for UnivKY DSAM style data
  - Responsible for on-site project mgmt & daq system

n-capture expts

- Recruited Students
  - Undergrad: Bijan Nichols
  - Gradstudents: Kofi Assumin-Gyimah, Stephan Vajdic

- ^{110,111,112,114}Cd(n,γ) measurements at DANCE completed !

- Lee Bernstein, LBL
  - Perhaps sending students to help during summer.

today: GEANT & MCNP simulations

Primary Projects

$^{12}C(n,n')$

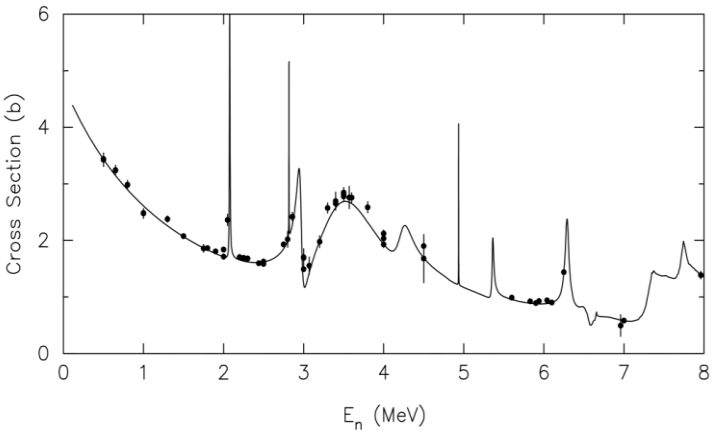


Fig. 1. The ENDF8 [11] angle-integrated $^{12}C(n,n)$ cross sections; data are from previous UKAL measure

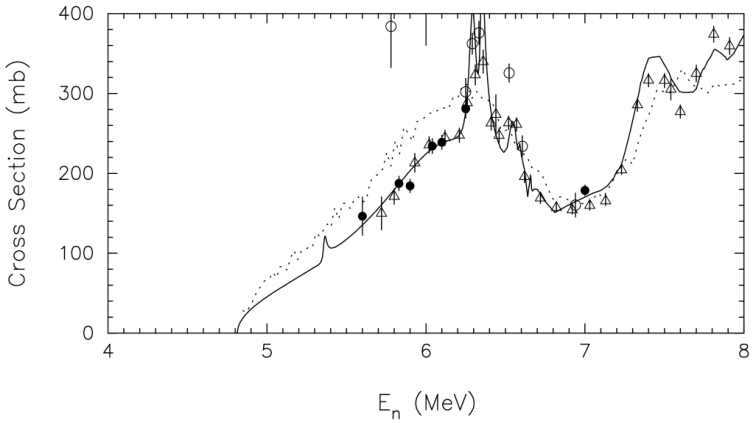
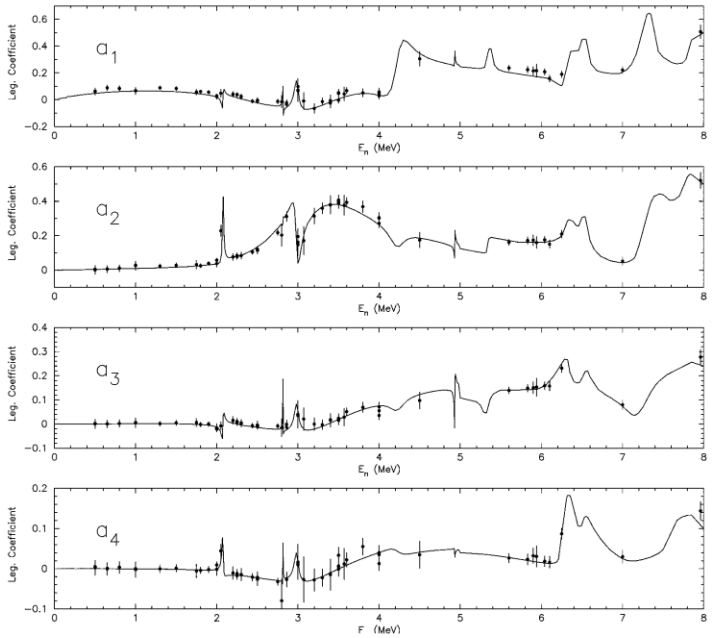


Fig. 2. The ENDF8 angle-integrated $^{12}C(n,n_1)$ cross section annotated with previous experimental measurements found in EXFOR. UKAL data are given by blackened circles.

4-6 additional angular distribution measurements are needed in the range 5-8 MeV to assist with resonance parameter analysis.

Angular distribution Legendre Analysis



→ Elastic agreement is very satisfying.

→ Describing (n,n_1) is difficult

Primary Projects

$^{7}Li(n,n_k)$ and $(n,n'\gamma)$

We need isotopic samples to generate useful information.

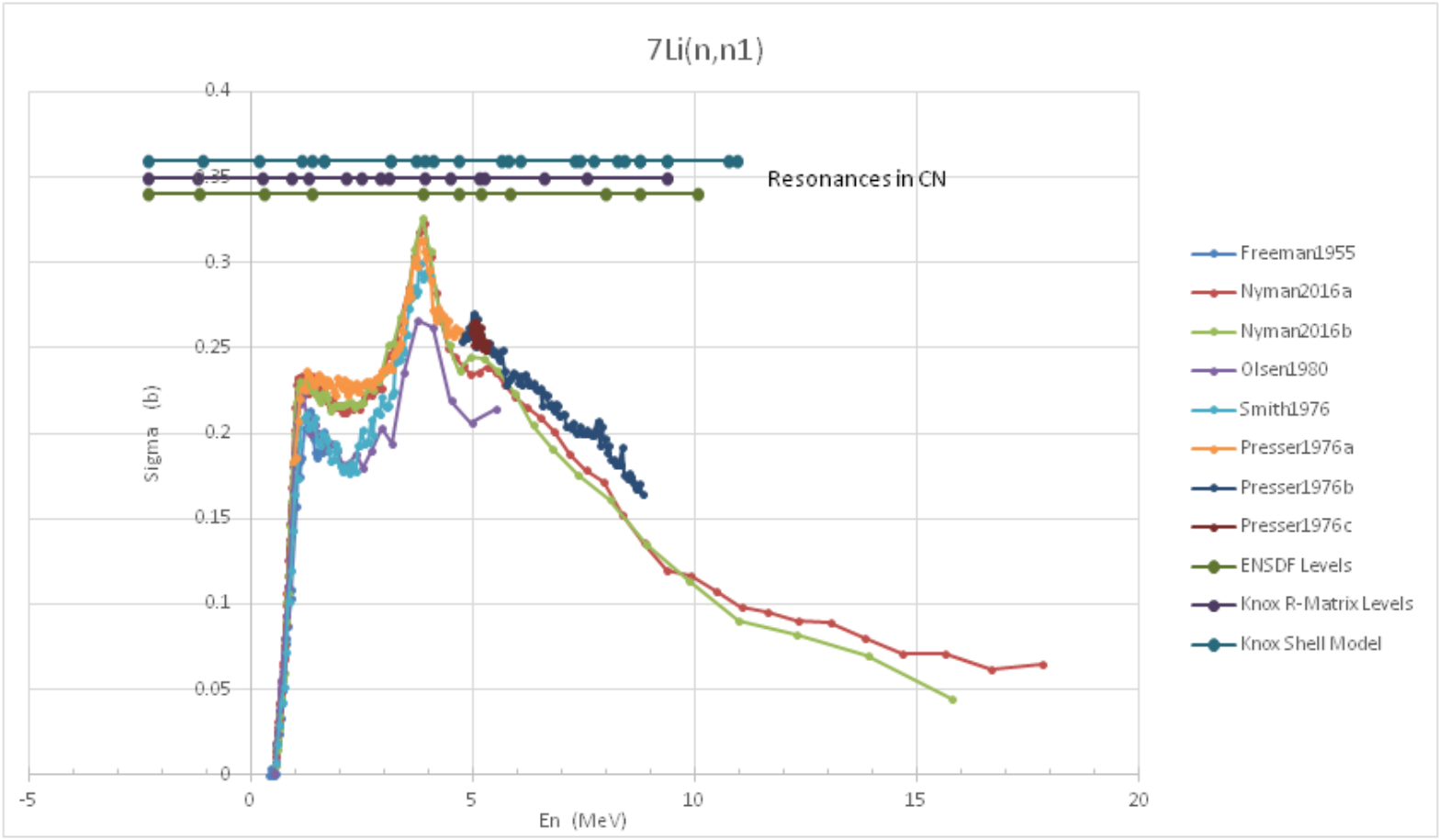
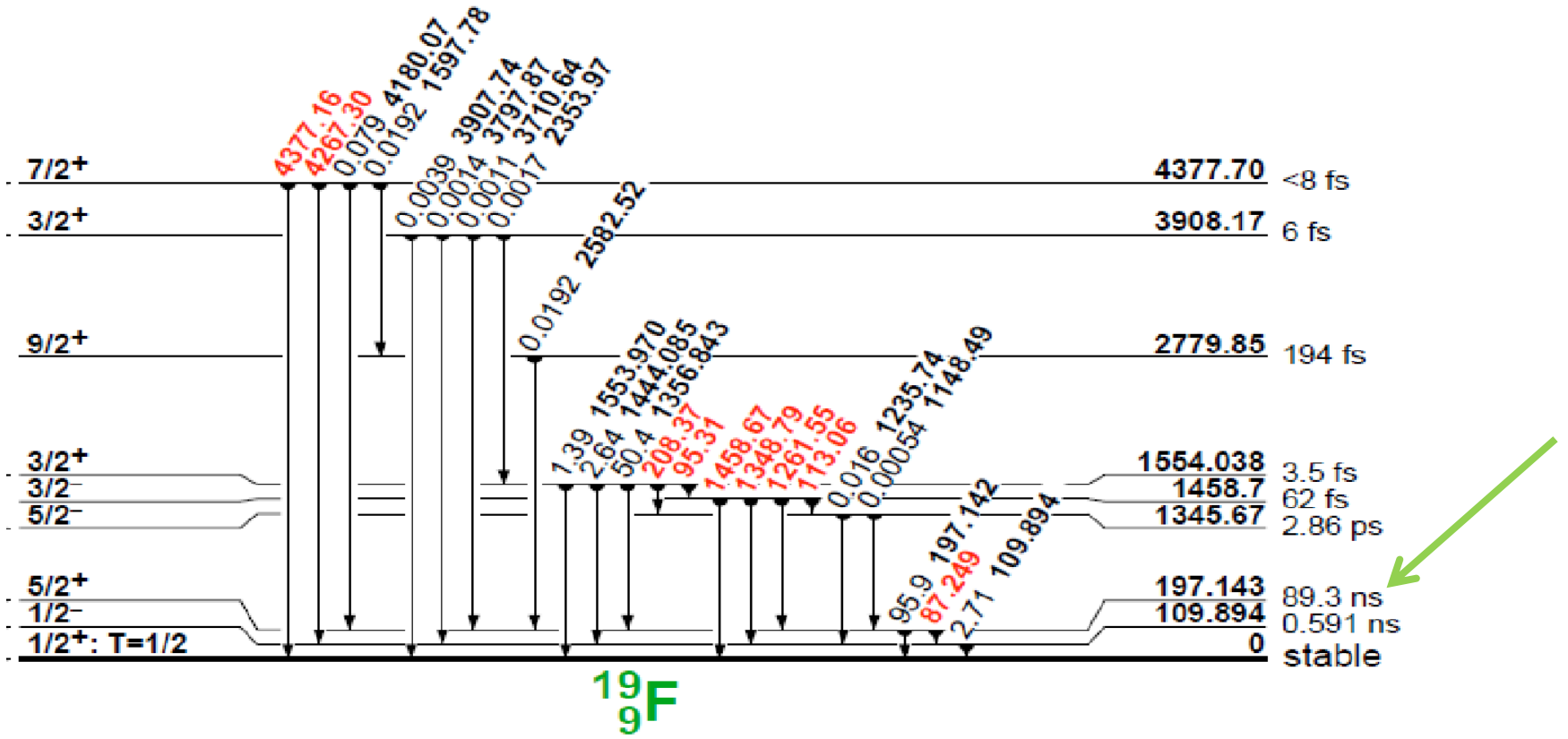


Fig. 3. Measured / inferred $^{7}Li(n,n_1)$ cross sections from EXFOR compared to two R-matrix calculations. The position of the resonances are indicated along with the adopted levels of the ^{8}Li compound nucleus from ENSDF.

Primary Projects

$^{19}F(n,n'\gamma)$

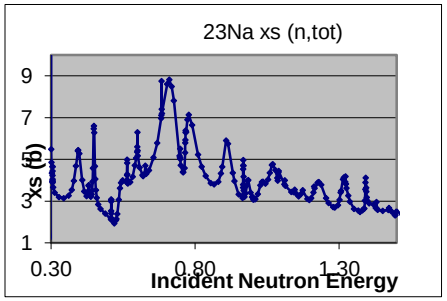
Surprisingly few detailed neutron scattering data exist for 19F. Industrial manufacturers of compact molten salt reactors employ FLiBe as a base material and have called for an increased understanding of its properties.



The 89 ns isomer causes a lot of trouble for cross section measurements.

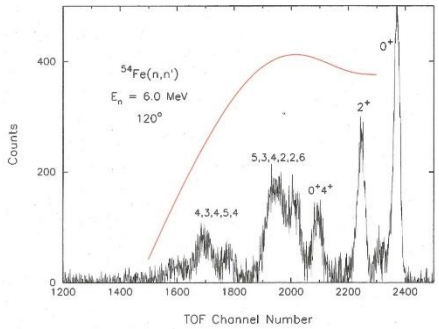
Secondary Projects (if we have time)

Sodium-23 is a component in …..
Measurements below 1.3 MeV.
More ang distrib for resonance information

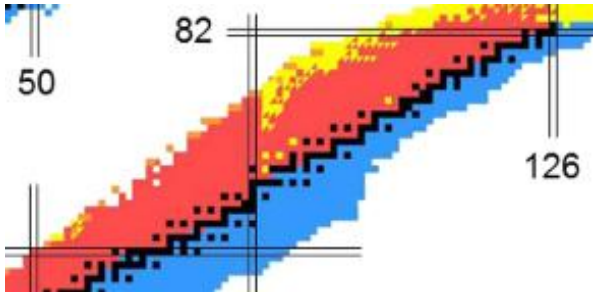


Magnesium-24 is a component in …..
More ang distrib for resonance information

Iron-56, one of the most ubiquitous materials, ….
Possible addn'l measurements upon request.
Conversion of existing HE data to neutron emission spectra.



Conversion of Previously Measured Angular Distribution Data to Differential Cross Sections.
The list includes most major stable isotopes of the elements
Na, Fe, Ge, Se, Zr, Mo, Ru, Pd, Cd, Sn, Te, I, Xe, Ba, Ce, Nd, Sm, Gd, Dy,



Neutron capture.
DANCE @ LANL: pulsed n beam w BaF detectors – total emission energy
130,132,134,136Xe proposed
FIPPS @ ILL: continuous n beam w HPGe – detailed γ-ray emissions btw levels
CdTe(n,γ) -- scheduled for Feb 2021
100Ru(n,γ) -- awaiting rescheduling

SUMMARY:

Much to do.

Have identified the students.

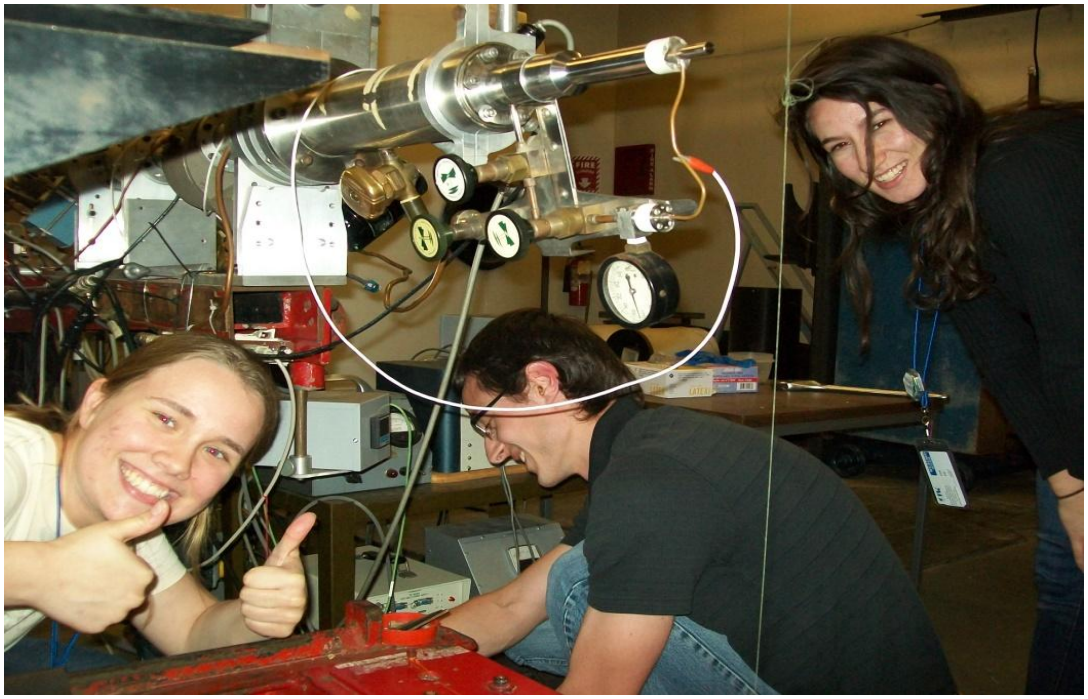
Waiting for UnivKY funds to arrive

in order to pay postdoc & purchase DAQ.

Must travel to take data and efficiently collaborate.

Have completed proposed Cd measurements at LANL-DANCE.

END



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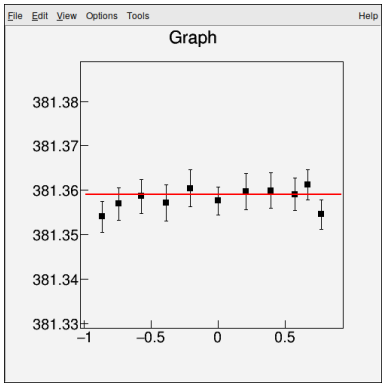
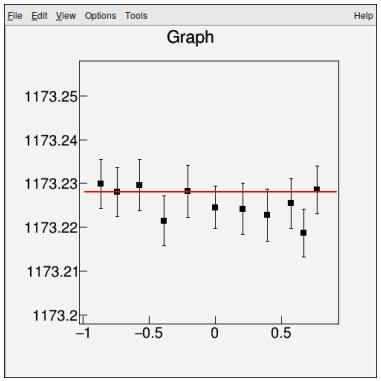
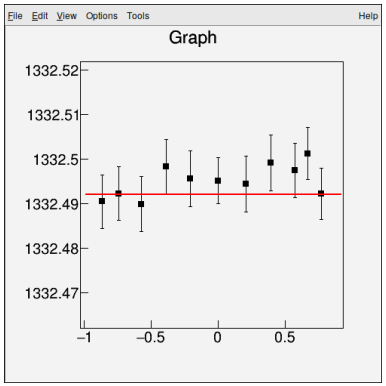
New Postdoc, New Data Acquisition System

Yongchi

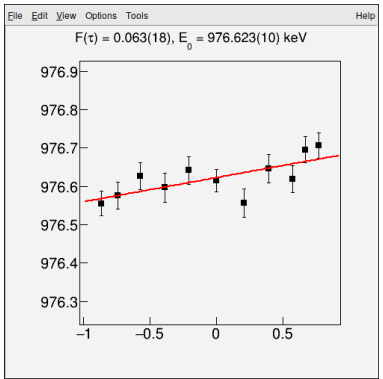
Calibration Lines

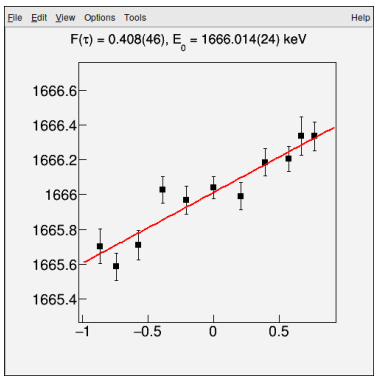


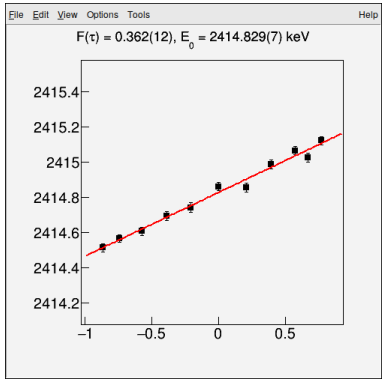




Xe Lines w Doppler Shifts

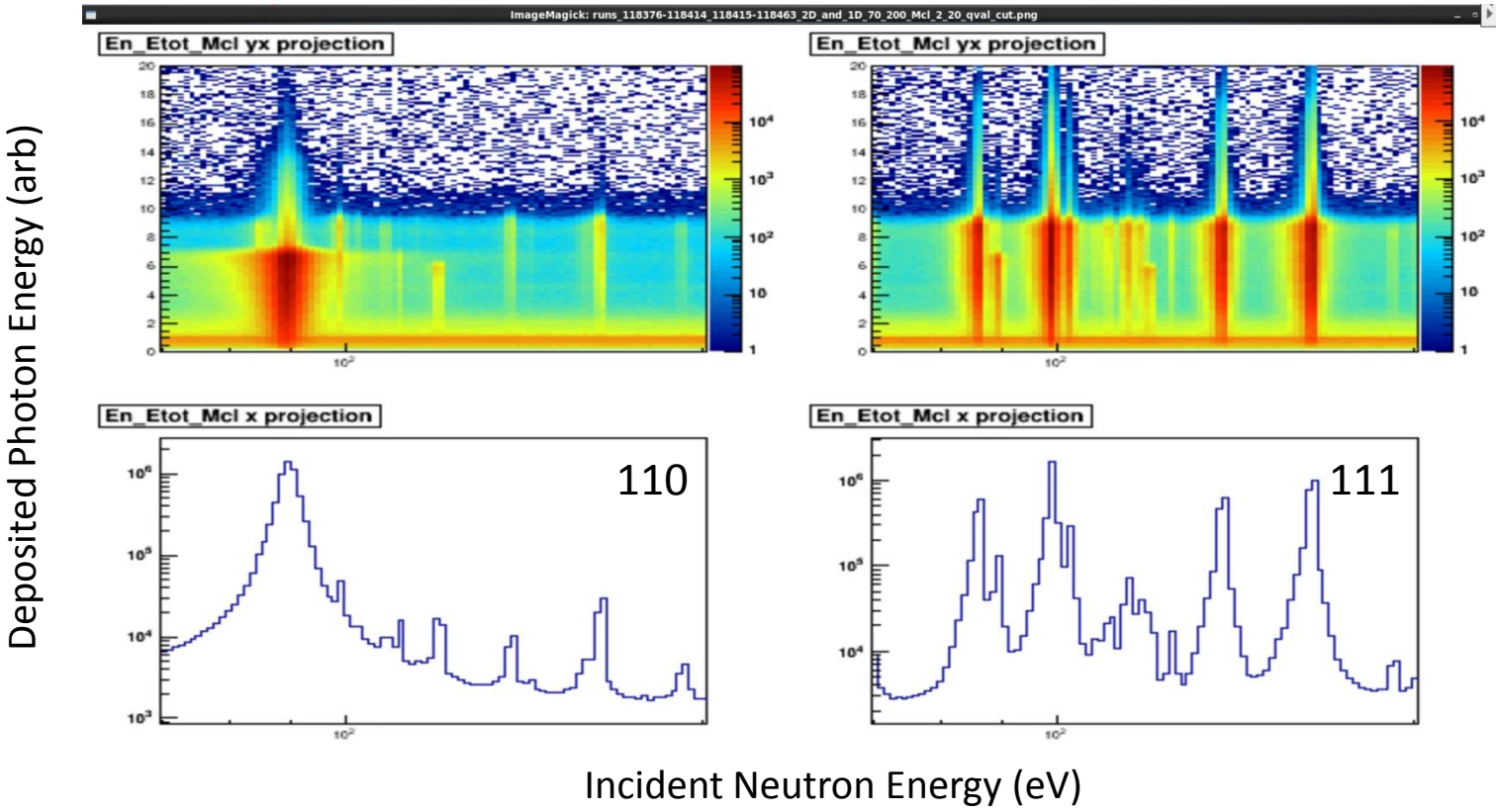






Until the DAQ system arrives, YX trying to use ROOT to fit “Kentucky data”

^{110,111}Cd(n,γ) @ DANCE 14days in Sept2020



Step 0: Develop all corrections specific to the measurement.

Step 1: Convert to XS

Step 2: Extract γ-ray strength function


Kofi


Stephan