



Prompt Fission Neutron Spectra Measurements at LANSCÉ: ^{240}Pu and $^{233}\text{U}(n,f)$

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LANSCCE



- LANSCCE is an 800 MeV proton LINAC, and produces fast neutrons by spallation on tungsten at WNR.
- This broad spectrum of neutrons, from below 1 MeV to over 700 MeV, is used for neutron-induced reaction measurements.
- Chi-Nu operates on the 15° left beamline, 21.5 m from the tungsten target.

Chi-Nu

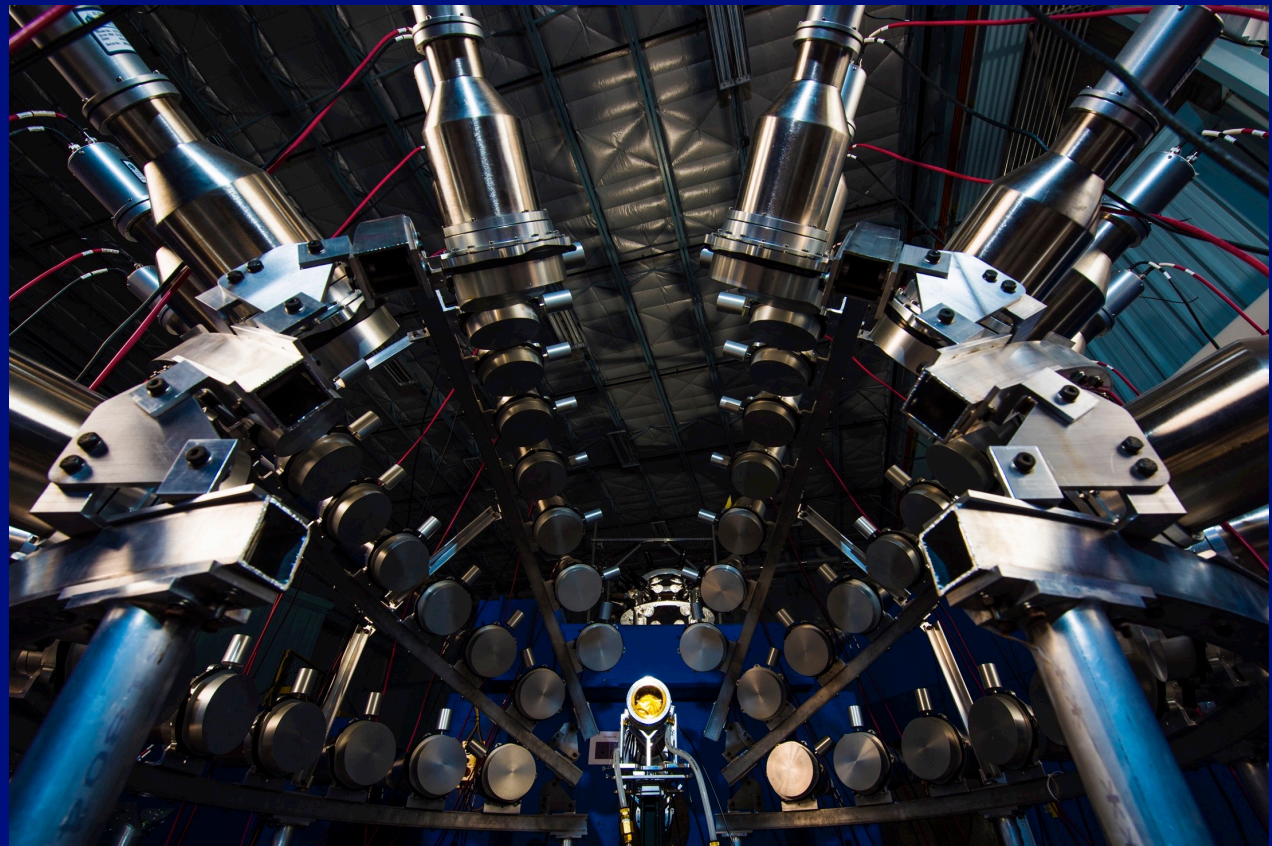
Neutron detection:
Li Glass Scintillator
Array

- 40 cm distance
- 21 ^6Li Glass detectors
- 1 ^7Li Glass Detector

EJ309 Liquid Scintillator
Array

- 1 m distance
- 54 detectors

Fission detection:
10-cell PPAC built at
LLNL for each actinide



Chi-Nu Liquid Scintillator Detector Array

Chi-Nu prompt fission data taken to date

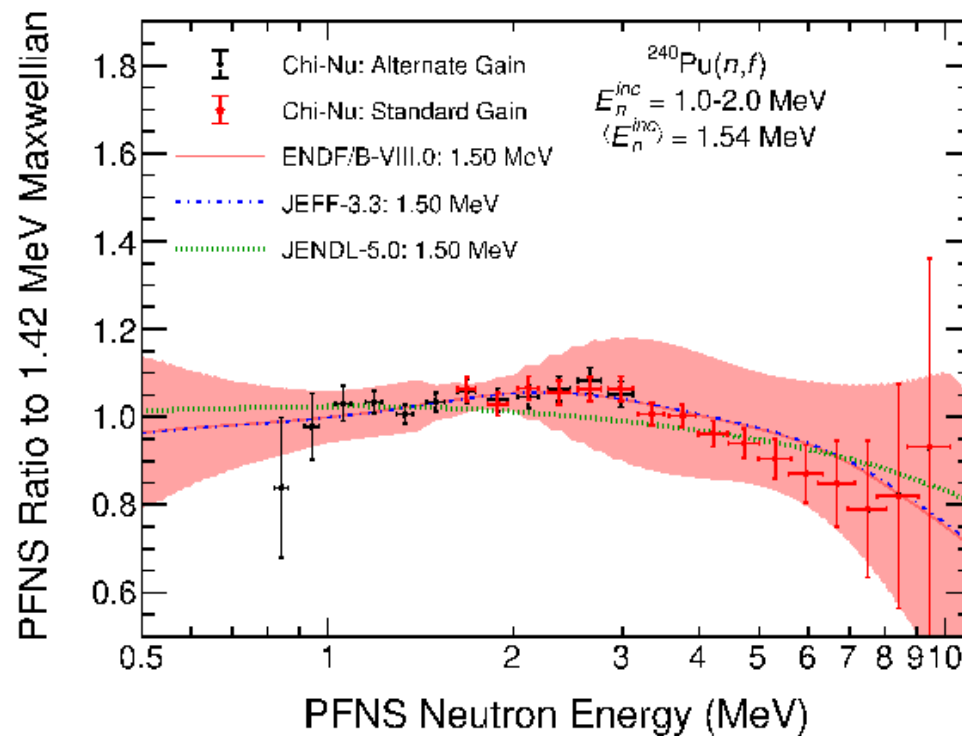
- $^{239}\text{Pu}(n,f)$ – KJ Kelly, JA Gomez, M Devlin et al., *PRC* **102**, 034615 (2020) and *PRL* **122**, 072503 (2019); and N Giha, S Marin et al., *PRC* **107**, 014612 (2023)
- $^{235}\text{U}(n,f)$ – KJ Kelly, JA Gomez, M Devlin et al., *PRC* **105**, 044615 (2022)
- $^{238}\text{U}(n,f)$ – KJ Kelly, M Devlin, JM O'Donnell et al., *PRC* **108**, 024603 (2023)
- $^{242}\text{Pu}(sf)$ – S Marin, CA Bravo, et al., LA-UR-21-26999 (2021) and INMM
- $^{240}\text{Pu}(sf)$ and $^{240}\text{Pu}(n,f)$ – paper in preparation
- $^{252}\text{Cf}(sf)$ – MJ Marcath, RC Haight, et al., *PRC* **97**, 044622 (2018) + others
- Also work with the CEA:
 - $^{239}\text{Pu}(n,f)$ – P Marini, J Taieb et al., *PRC* **101**, 044614 (2020) and P Marini, J Taieb, et al., *PLB* **835**, 137513 (2022)
 - $^{235}\text{U}(n,f)$ – B Mauss, J Taieb et al., *EPJ WoC* **284**, 01006 (2023)
 - $^{238}\text{U}(n,f)$ – P Marini, B Laurent, et al., *EPJ WoC* **193**, 03002 (2018)
 - CEA/Chi-Nu $^{239}\text{Pu}(n,f)$ PFNS comparison: KJ Kelly, P Marini, et al., *NDS* **173**, 42 (2021)

$^{240}\text{Pu}(n,f)$ PFNS data analysis is complete and a publication has been prepared

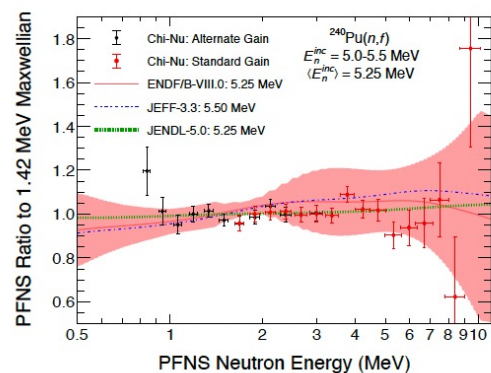
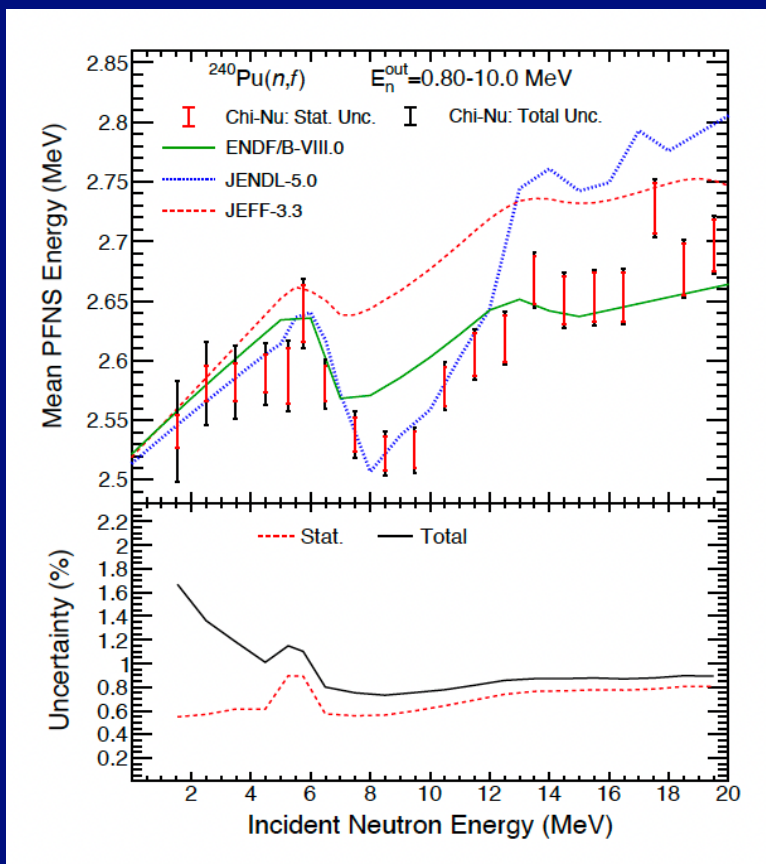
Measurement of the Prompt Fission Neutron Spectrum from 800 keV to 10 MeV for $^{240}\text{Pu}(sf)$ and for the $^{240}\text{Pu}(n,f)$ Reaction Induced by Neutrons of Energy from 1–20 MeV

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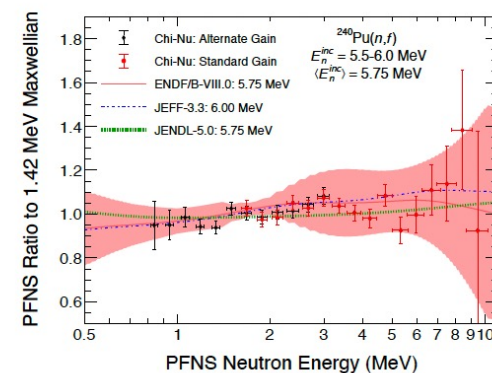
¹Los Alamos National Laboratory, Los Alamos, NM 87545, USA and
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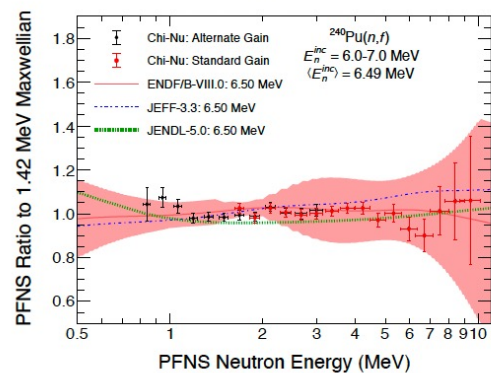
$^{240}\text{Pu}(n,f)$ PFNS



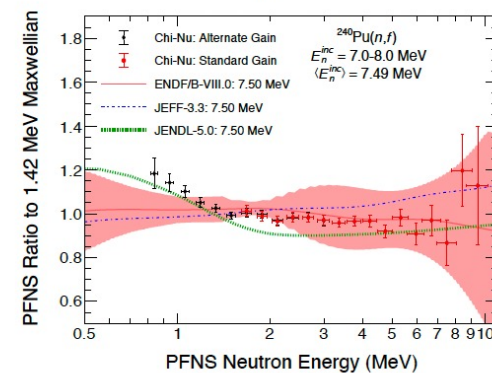
(a)



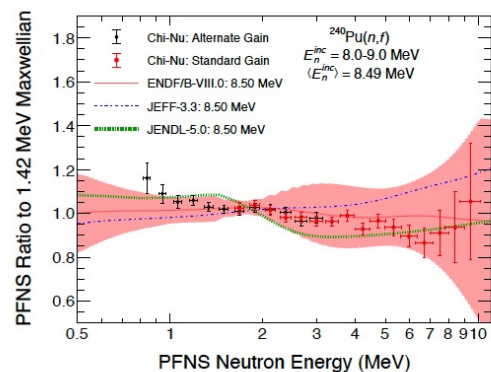
(b)



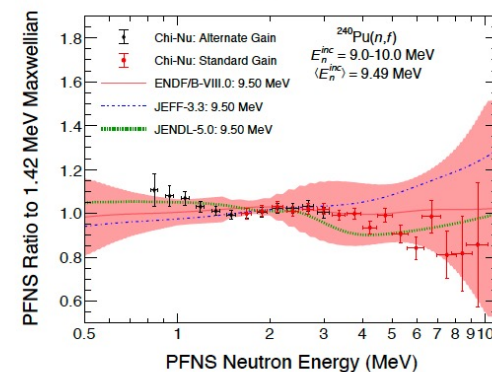
(c)



(d)

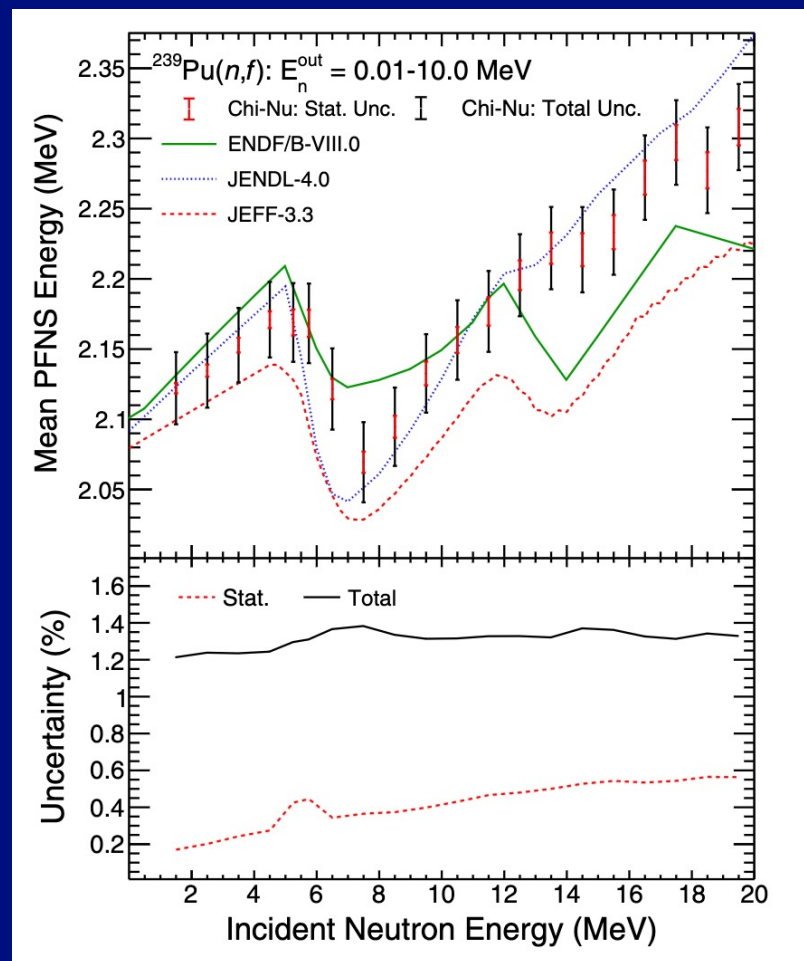
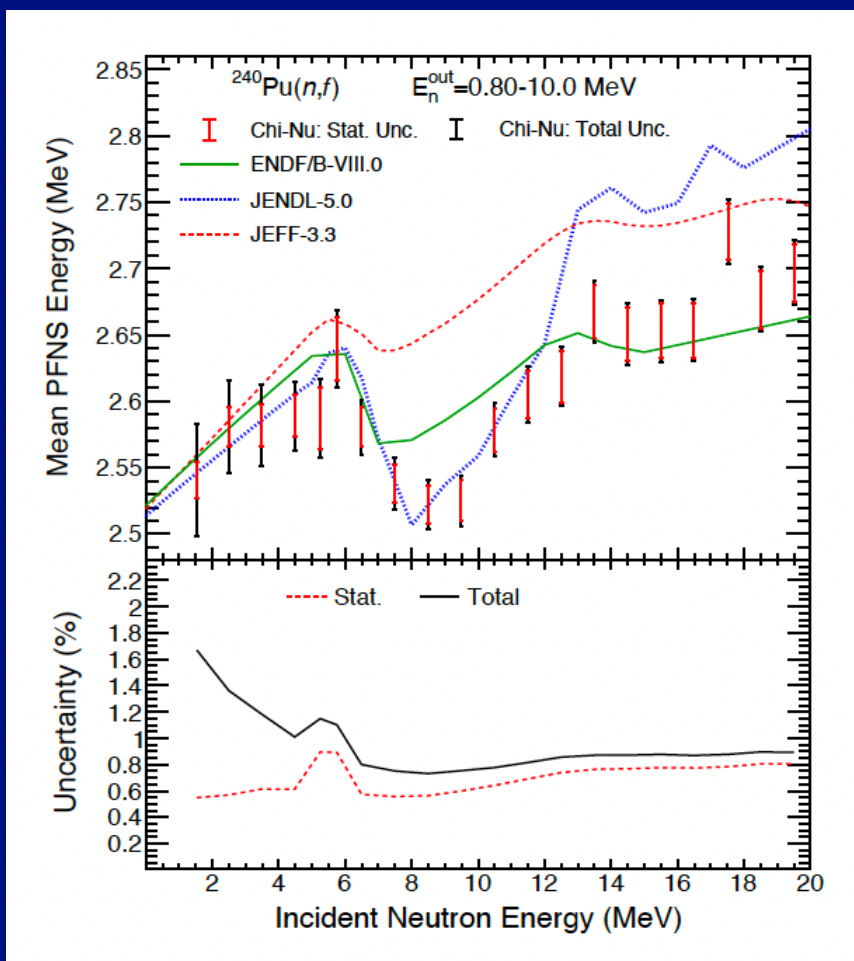


(e)



(f)

$^{240}\text{Pu}(n,f)$, $^{239}\text{Pu}(n,f)$ comparison



CEA $^{240}\text{Pu}(n,f)$ PFNS and nubar Proposed Measurement

- Proposed in 2023, unable to schedule
- Fission chamber with 15mg of ^{240}Pu (high purity) on 22 foils arrived at LANSCE in early January; Pu foils made at JRC/Geel
- Uses the new VENDETA array
- Hope to set up in May for a separate spontaneous fission measurement and continue into an in-beam $^{240}\text{Pu}(n,f)$ measurement in September.
- NA-22 funding for even-even Pu(sf) measurements, NA-113 OES funding to support new CEA $^{240}\text{Pu}(n,f)$ measurements.

Contributors

Keegan Kelly

LANL

Jamie Gomez

John O'Donnell

Robert Haight

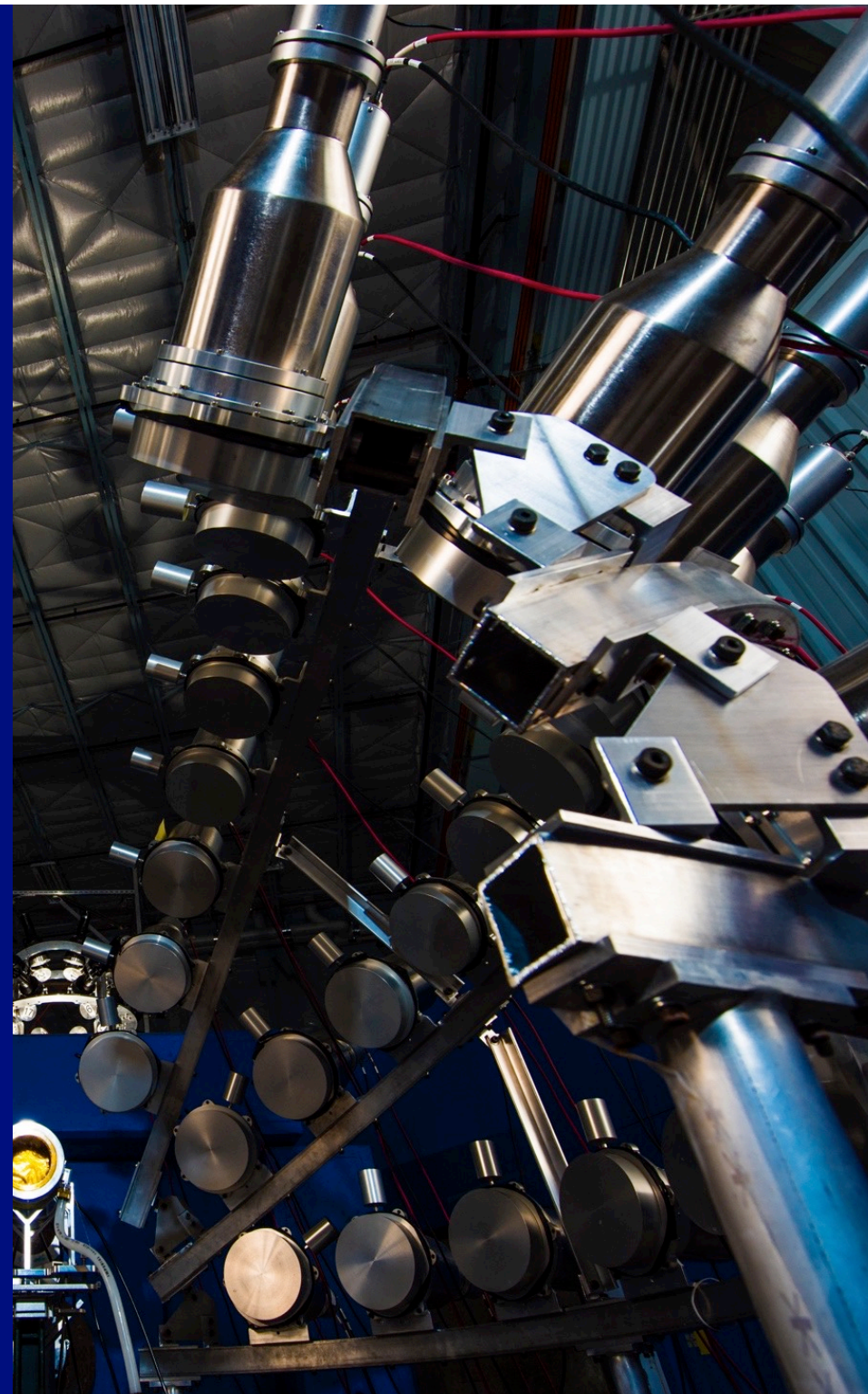
and others

Ching-Yen Wu

LLNL

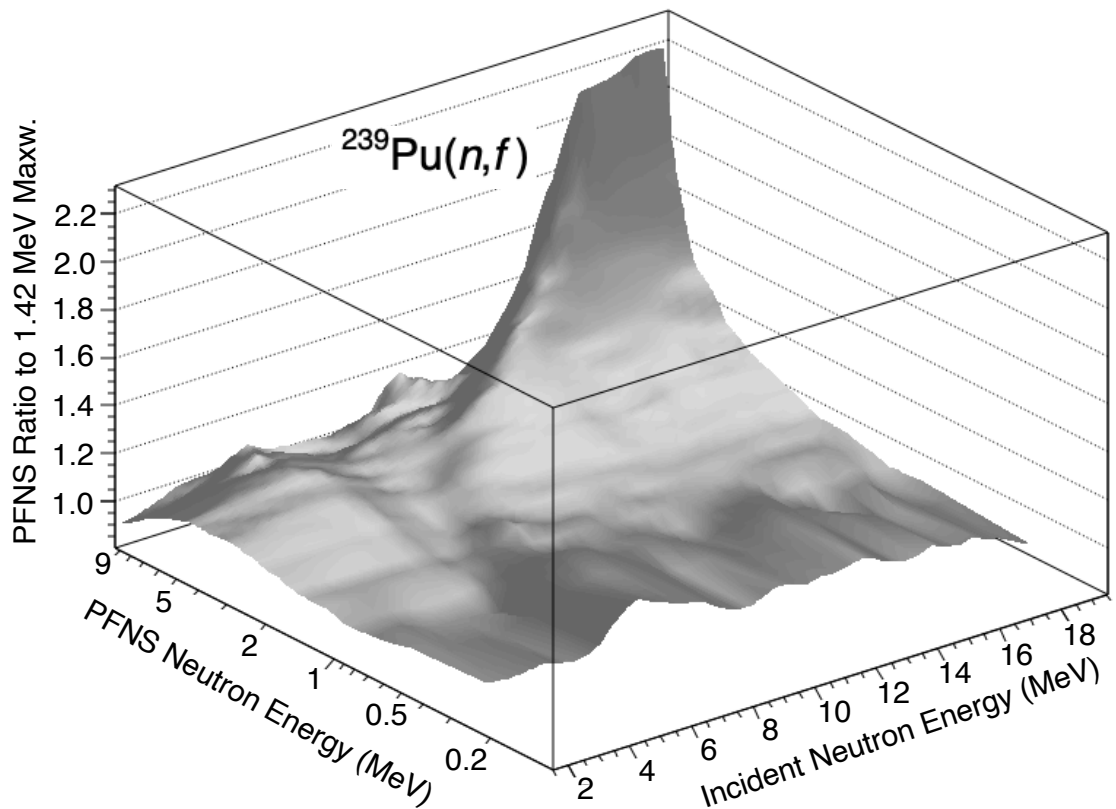
Roger Henderson

and others



Questions?

Prompt fission neutron spectra (PFNS)



- Ratio of the PFNS to a Maxwellian $\propto E_{\text{inc}}$ and E_{out}
- Major actinide ($^{235,238}\text{U}$ and ^{239}Pu) PFNS have been measured at Chi-Nu for incident neutrons from 0.7 to 20 MeV
- Also $^{240}\text{Pu}(n,f)$
- Other data on ^{252}Cf , ^{240}Pu and ^{242}Pu spontaneous fission
- LANSCE also hosts a CEA/DAM/DIF set of PFNS measurements

Data from KJ Kelly, et al., *PRC* 102, 034615 (2020)