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

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LANSCE

- LANSCE 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 15º left beamline, 21.5 m from the tungsten target.
Chi-Nu

Neutron detection:
Li Glass Scintillator Array
- 40 cm distance
- 21 $^6$Li Glass detectors
- 1 $^7$Li 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
- 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)
$^{240}$Pu$(n,f)$ PFNS data analysis is complete and a publication has been prepared.
$^{240}\text{Pu}(n,f)$ PFNS

![Graph showing PFNS ratios for different energy levels and models.](image)
$^{240}\text{Pu}(n,f), \ 239\text{Pu}(n,f)$ comparison
CEA $^{240}$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 $^{240}$Pu(n,f) measurement in September.
- NA-22 funding for even-even Pu(sf) measurements, NA-113 OES funding to support new CEA $^{240}$Pu(n,f) measurements.
Contributors

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Questions?
Prompt fission neutron spectra (PFNS)

- Ratio of the PFNS to a Maxwellian $v E_{inc}$ and $E_{out}$
- Major actinide ($^{235,238}$U and $^{239}$Pu) PFNS have been measured at Chi-Nu for incident neutrons from 0.7 to 20 MeV
- Also $^{240}$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)