TKE Release in $^{235}U(n,f)$

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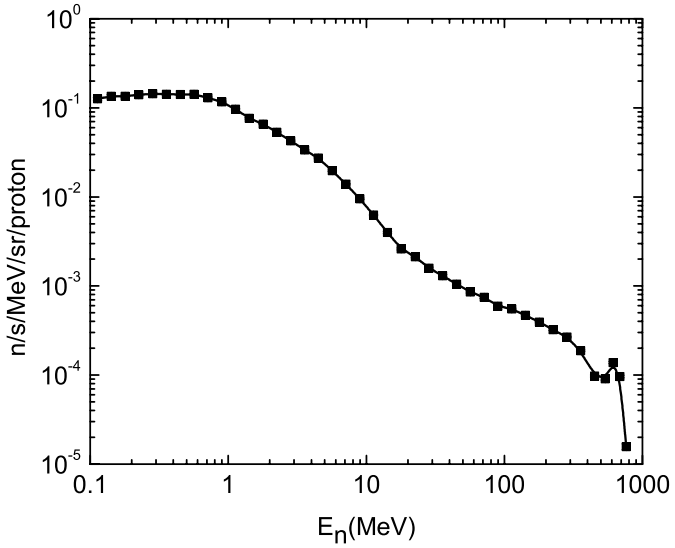
Fission Energetics (rough)

Consider $^{235}U(n_{th},f)$

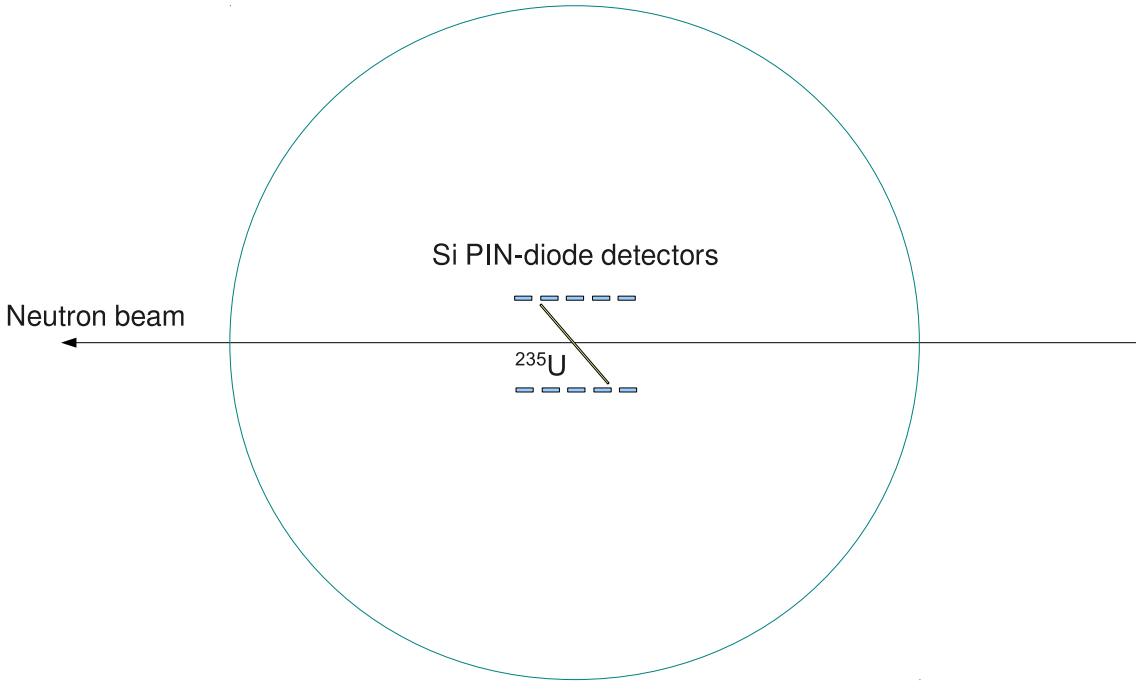
- Mass-energy release ~ 200 MeV
- TKE ~ 171 MeV (164 Coulomb, 7 pre-scission)
- TXE ~ 29 MeV
- Neutrons ~ 15 MeV, Photons~ 7 MeV, beta, etc ~ 7 MeV

Experimental Details

- Expt. was run at WNR 15R beam line with "white spectrum" neutron beams.



Experimental Details (cont.)



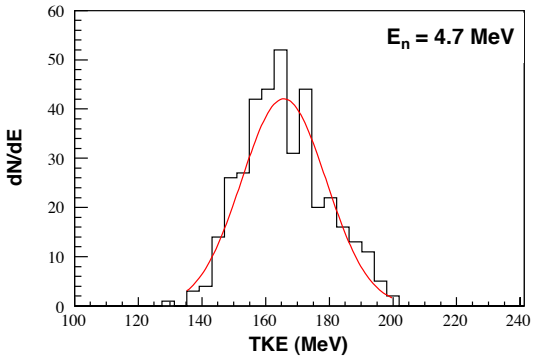
Fission fragments were detected by 5 pairs of Hamamatsu Si PIN diodes. Alpha resolution was 18 keV for 5475 keV line of ^{241}Am, timing res^{n} was 100 ps.

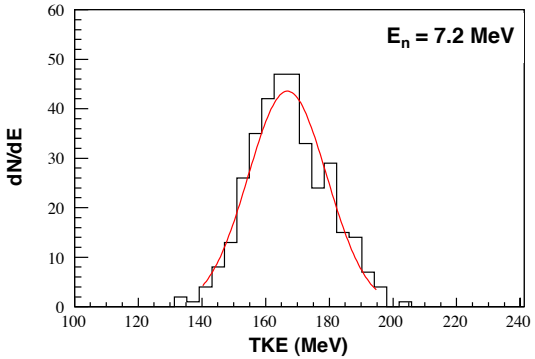
Target was $^{235}UF_4$ deposit (175.5 ug/cm^2) on 100 ug/cm^2 C. Isotopic purity of ^{235}U was 99.91%.

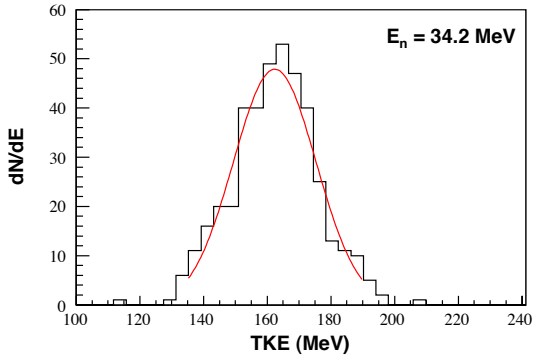
Technical details

- dE/dx of fission fragments in the target was measured using a ^{252}Cf beam (SRIM sucks)
- Schmitt method was used to correct for PhD.
- Time of flight of each neutron measured using timing pulse from PIN diode and accelerator RF. Calibration with photofission peak and known flight path geometry.

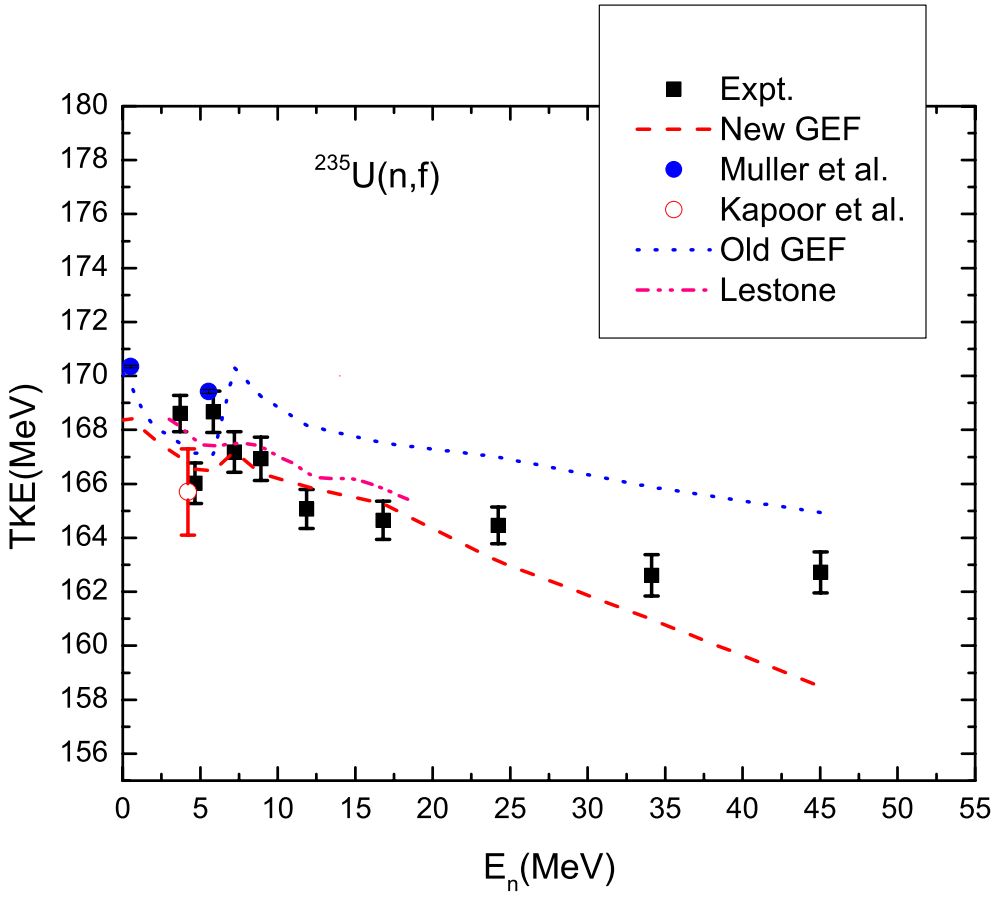
Results


E_n = 4.7 MeV
dN/dE
TKE (MeV)


E_n = 7.2 MeV
dN/dE
TKE (MeV)


E_n = 34.2 MeV
dN/dE
TKE (MeV)

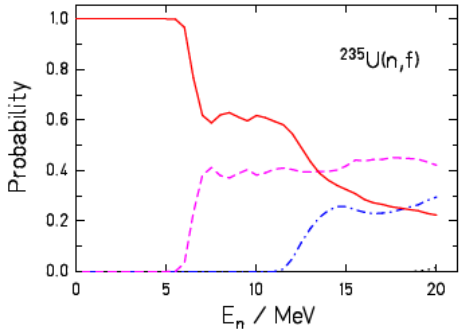
Excitation energy dependence of TKE for ^{235}U(n,f)

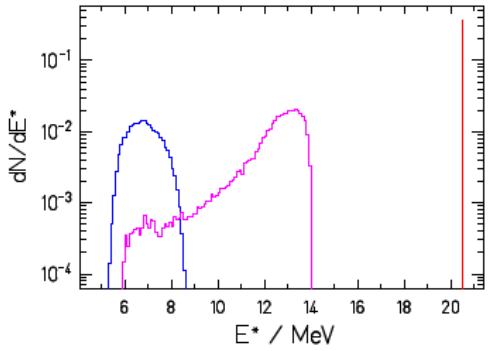


Yanez et al. PRC (Rapid Communication) 89, 051604 (R) (2014)

Aside on GEF (General Fission Model)

- Semi-empirical fission model
- K.-H. Schmidt, B. Jurado, C. Amouroux, http://hal.inp2p3.fr/in2p3=00976648
- Code is available at http://www.khs-erzhausen.de/GEF.html
- Version used is 3/25/2014
- Code understands multiple chance fission

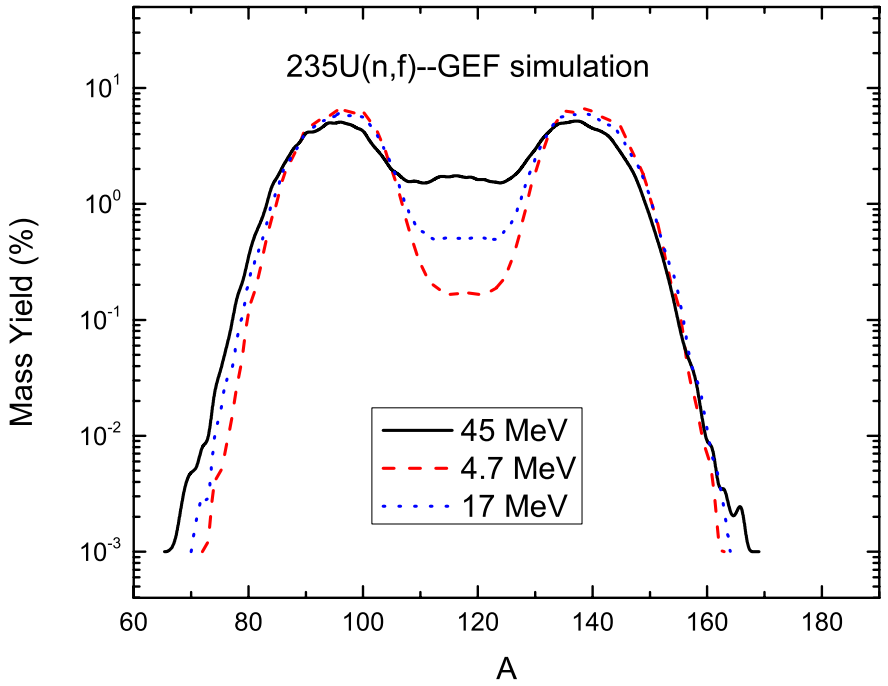




E_n=14 MeV

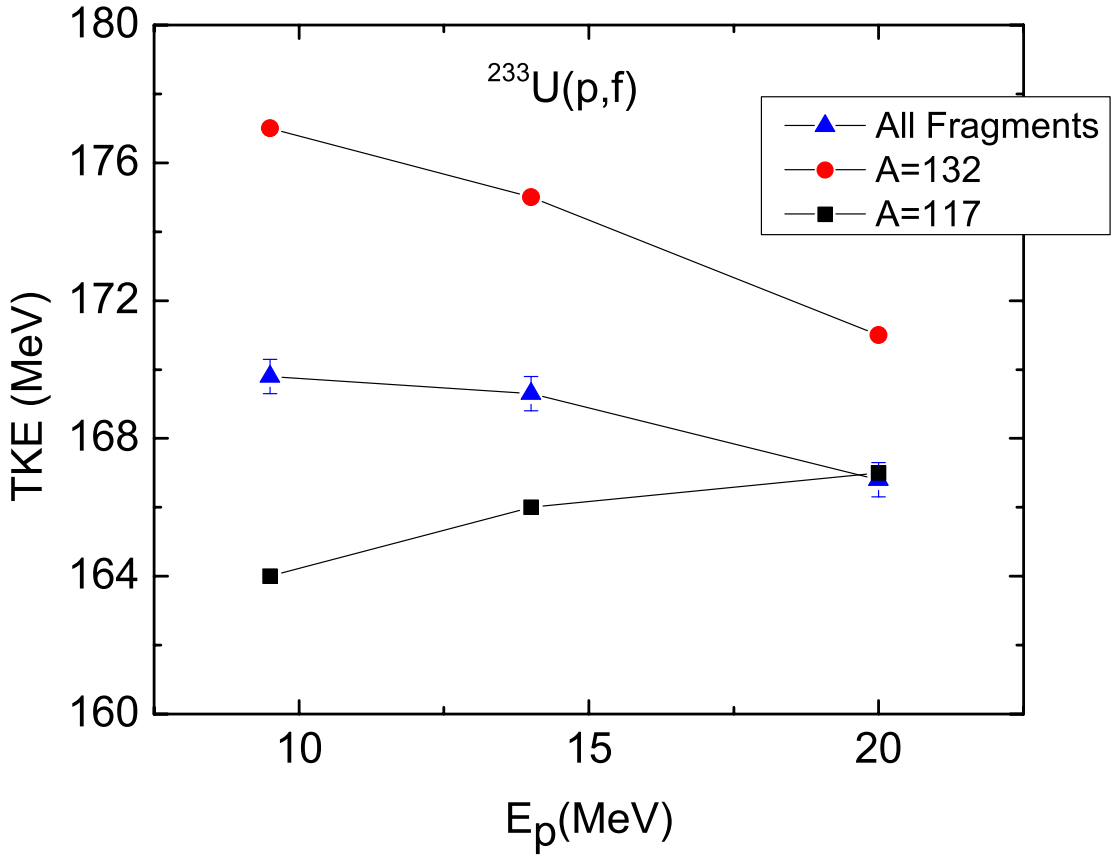
What is the physics?

- As E* increases, the mass distributions become more symmetric. Symmetric fission has a lower TKE.



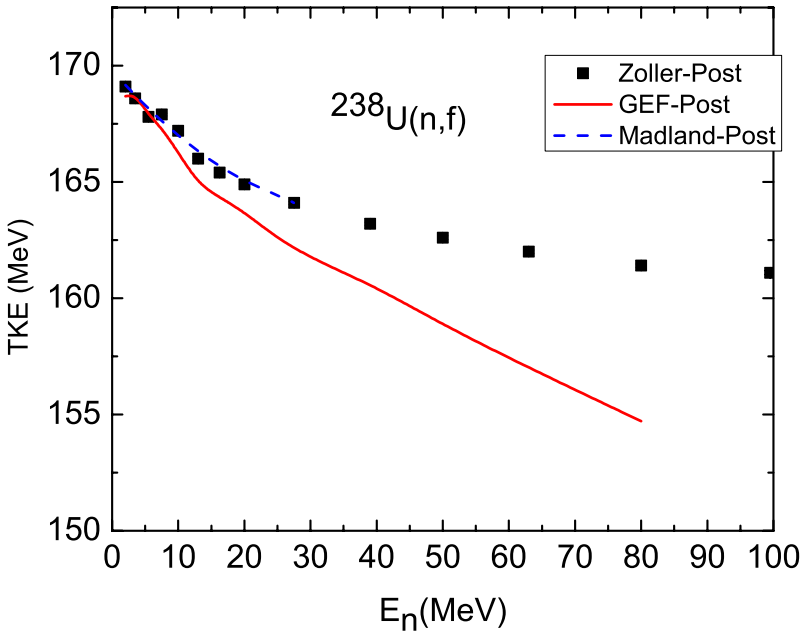
What is the physics?

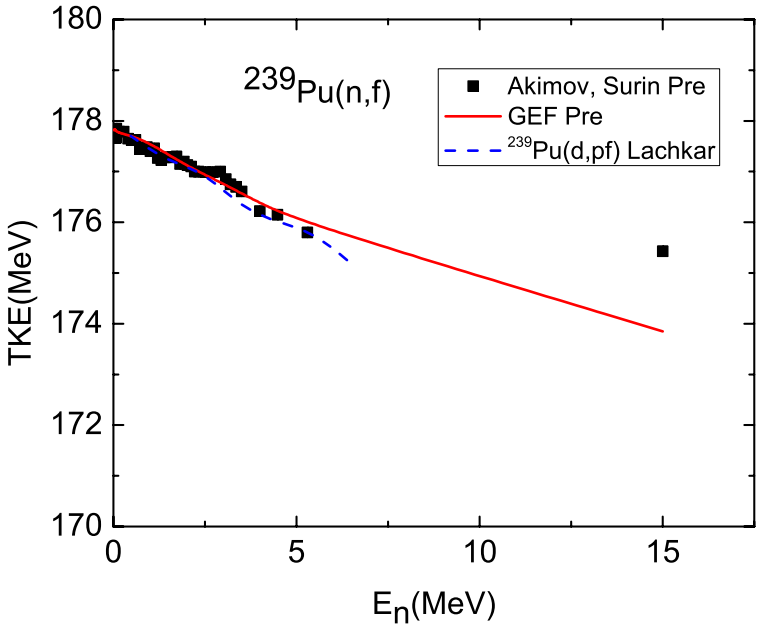
- Washing out of shell effect at *A*=132



Bishop et al., NPA, 150 129 (1970)

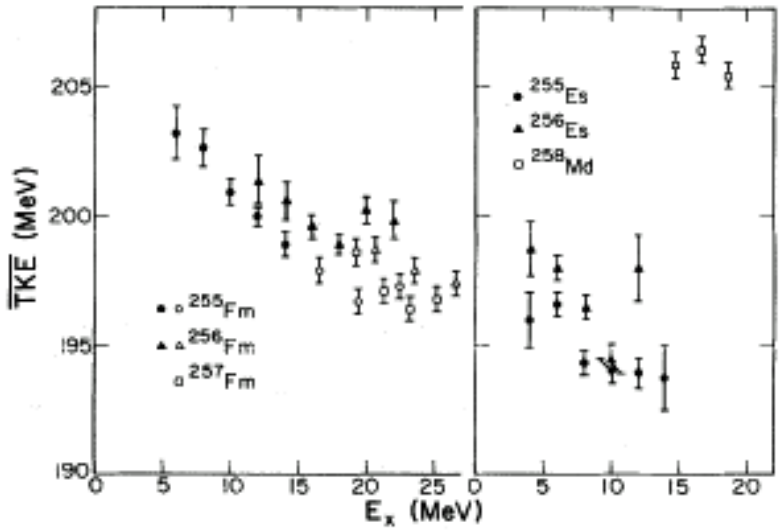
How universal are these trends? (Other systems)



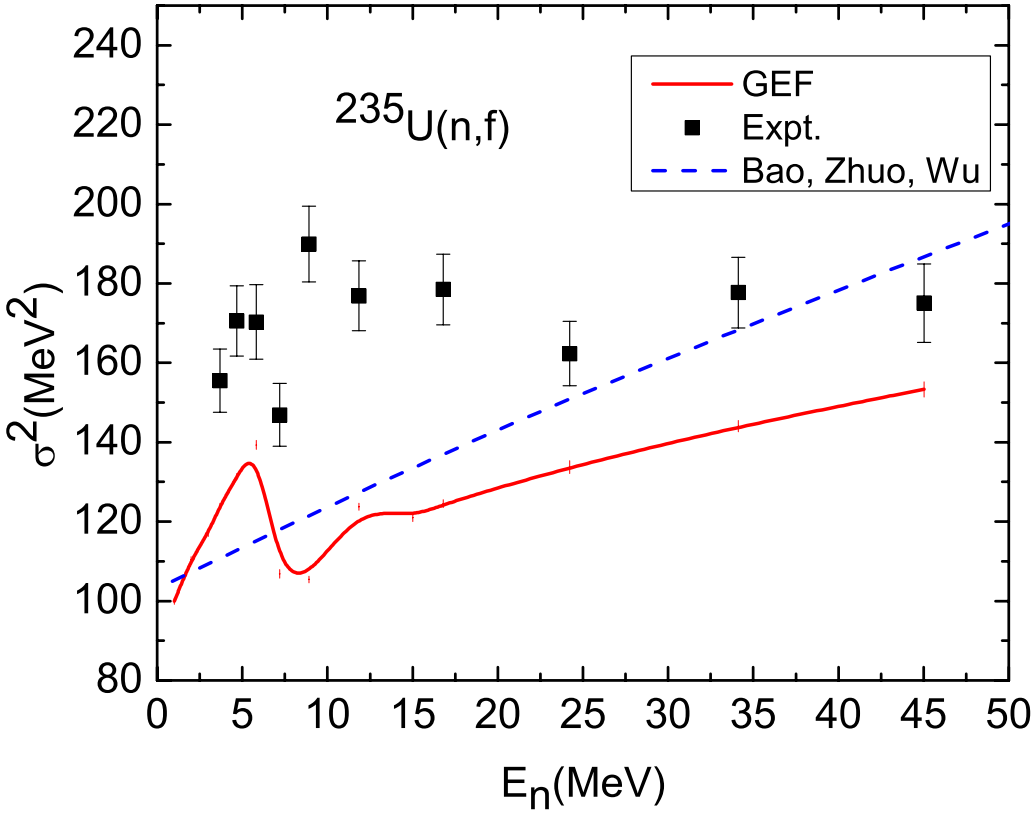


Transfer reactions

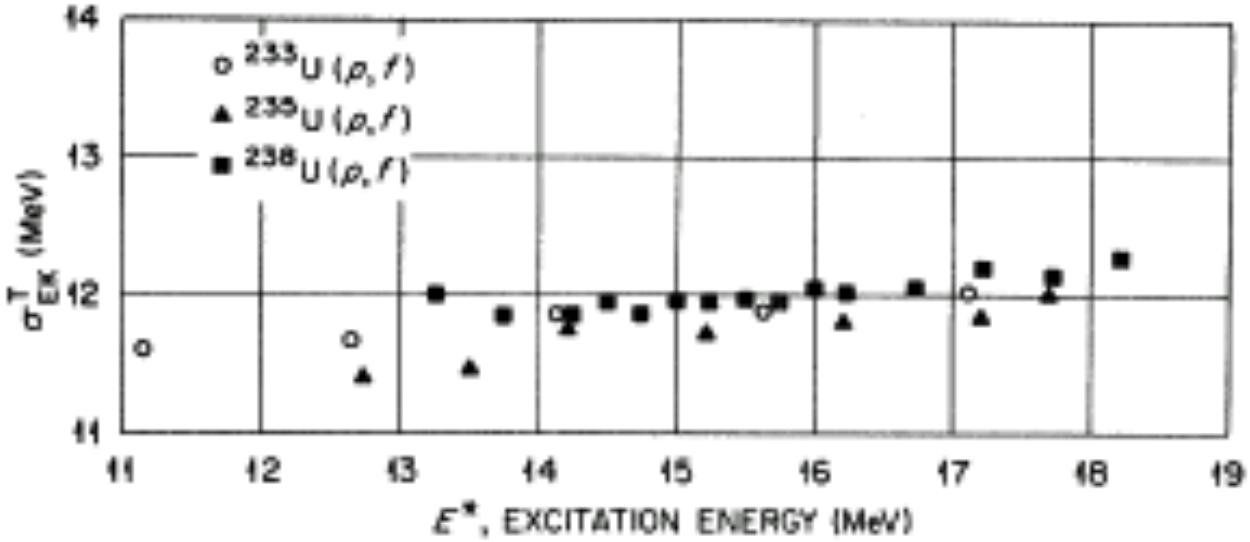
$^{254}Es(^{3}He,d)^{255}Fm$,
$^{254}Es(^{3}He,p)^{256}Fm$



Variances of TKE (E*)

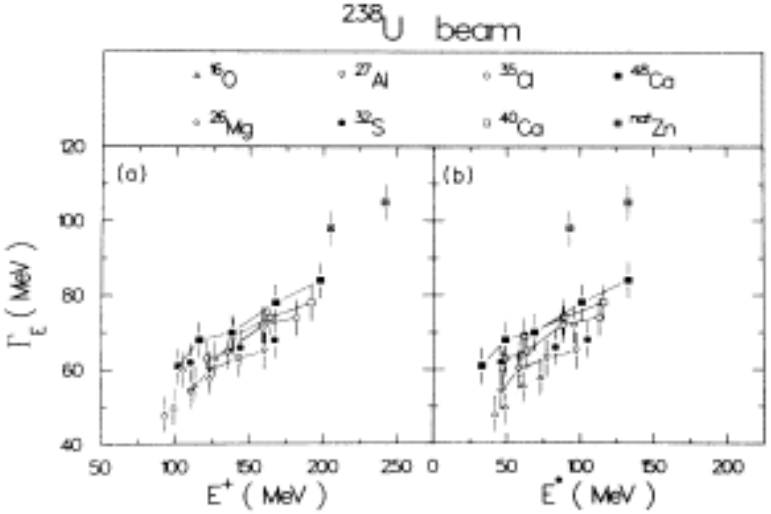


Other variance data



Ferguson et al. PRC **7** 2510 (1973)

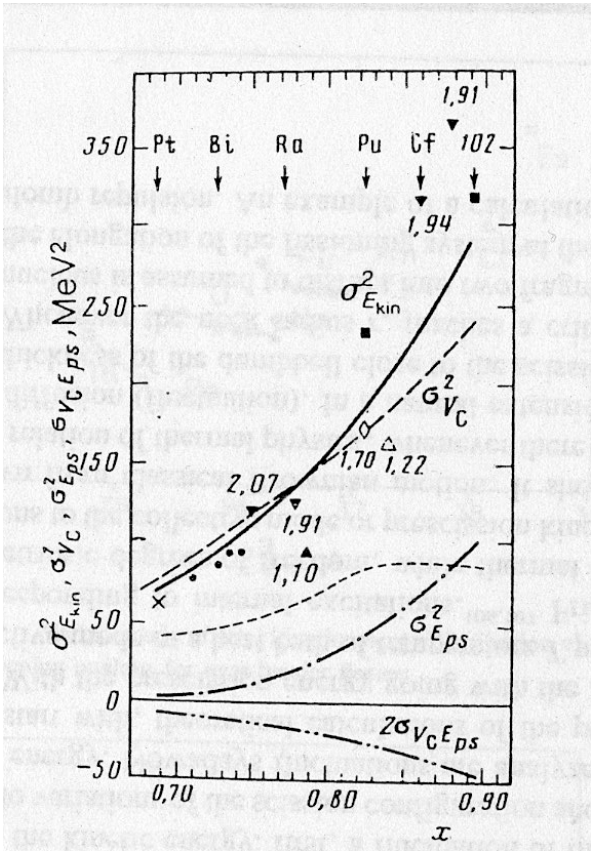
High Excitation Energies



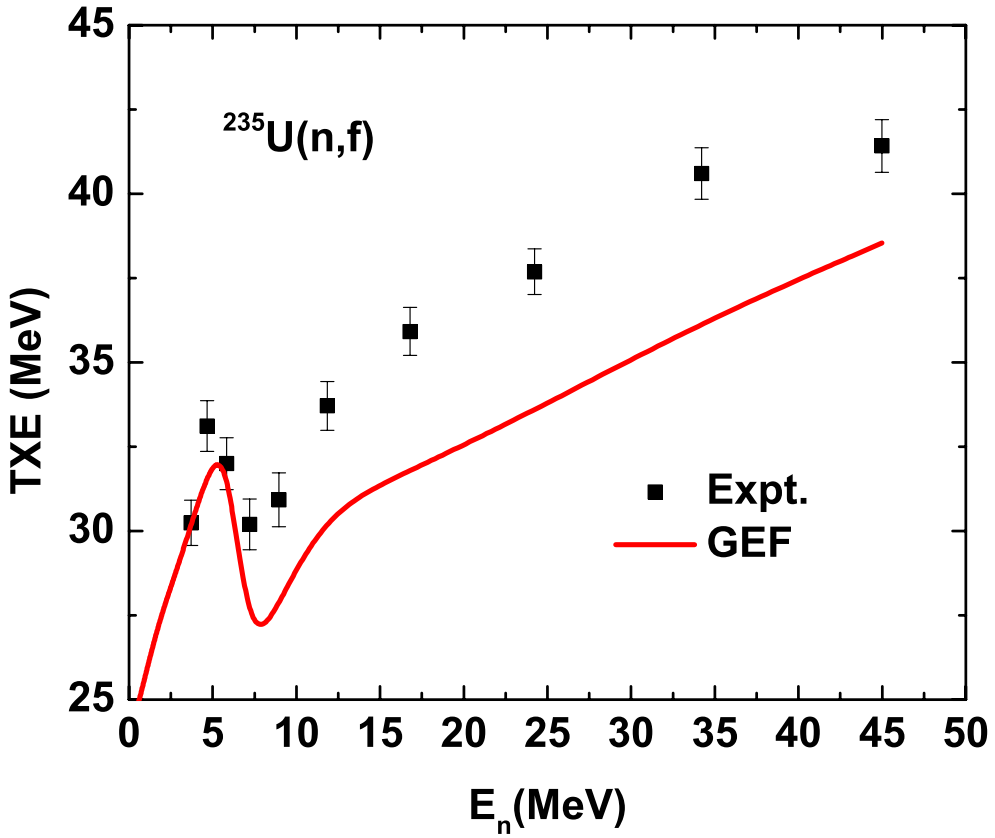
W. Q. Shen, et al., PRC **36**, 115 (1987)

Physics of variance data

$$\sigma_E^2 = \sigma_C^2 + \sigma_{PS}^2 + 2\sigma_{CPS}$$



TXE (E*)


^{235}U(n,f)
TXE (MeV)
E$_n$(MeV)
Expt.
GEF
45
40
35
30
25
0
5
10
15
20
25
30
35
40
45
50

Conclusions

- There are surprising gaps in our knowledge of TKE(E*) and its variance.
- These uncertainties propagate linearly into TXE(E*) and subsequent descriptions of neutron and photon emission.
- There are few or no Pre-Dictions of TKE. As experimentalists move forward, theory is put in the position of making Post-Dictions