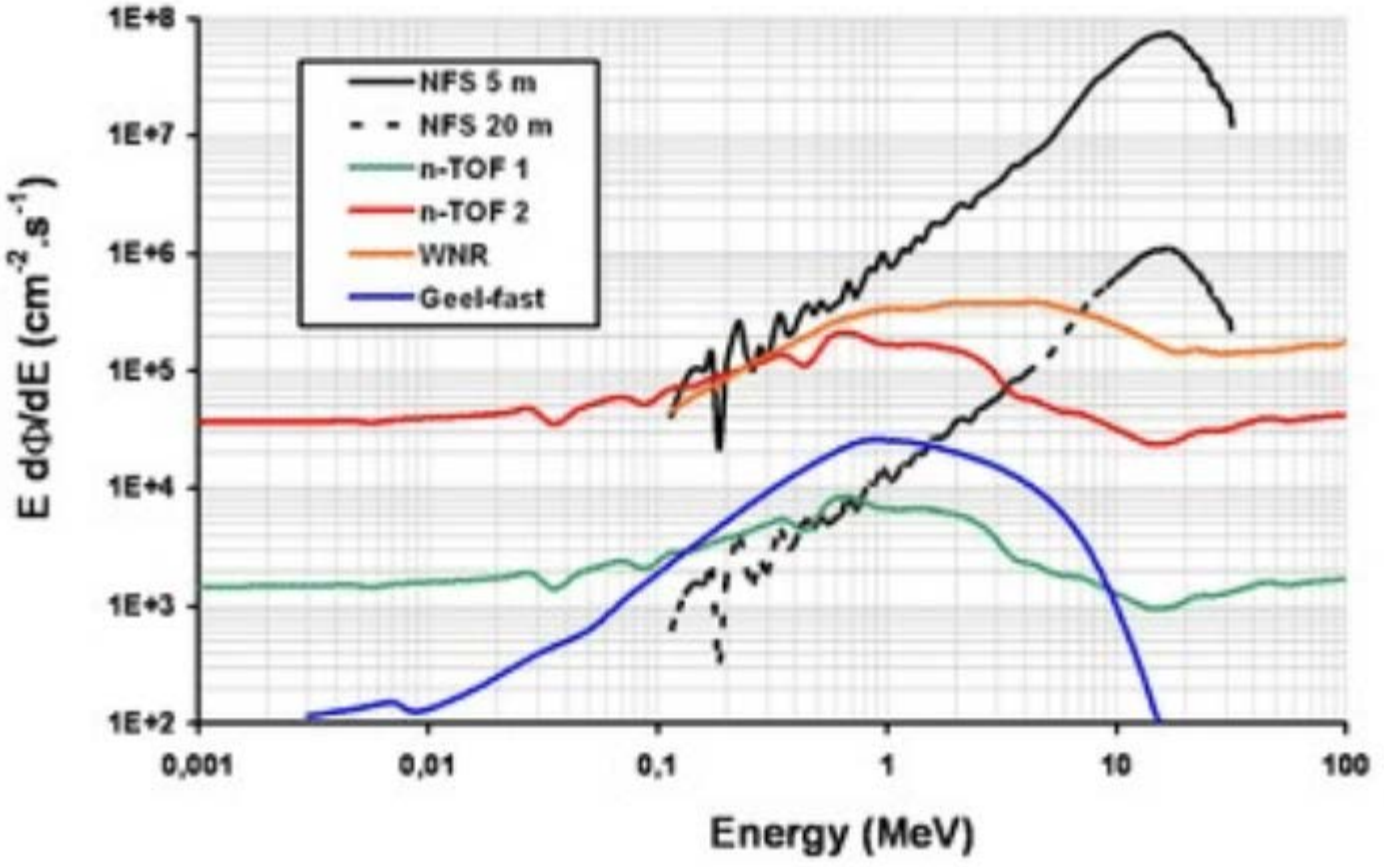
Astrophysics at NFS

René Reifarth

Goethe-Universität Frankfurt

GANIL community meeting 2022
17-21 October 2022, GANIL, Caen, France

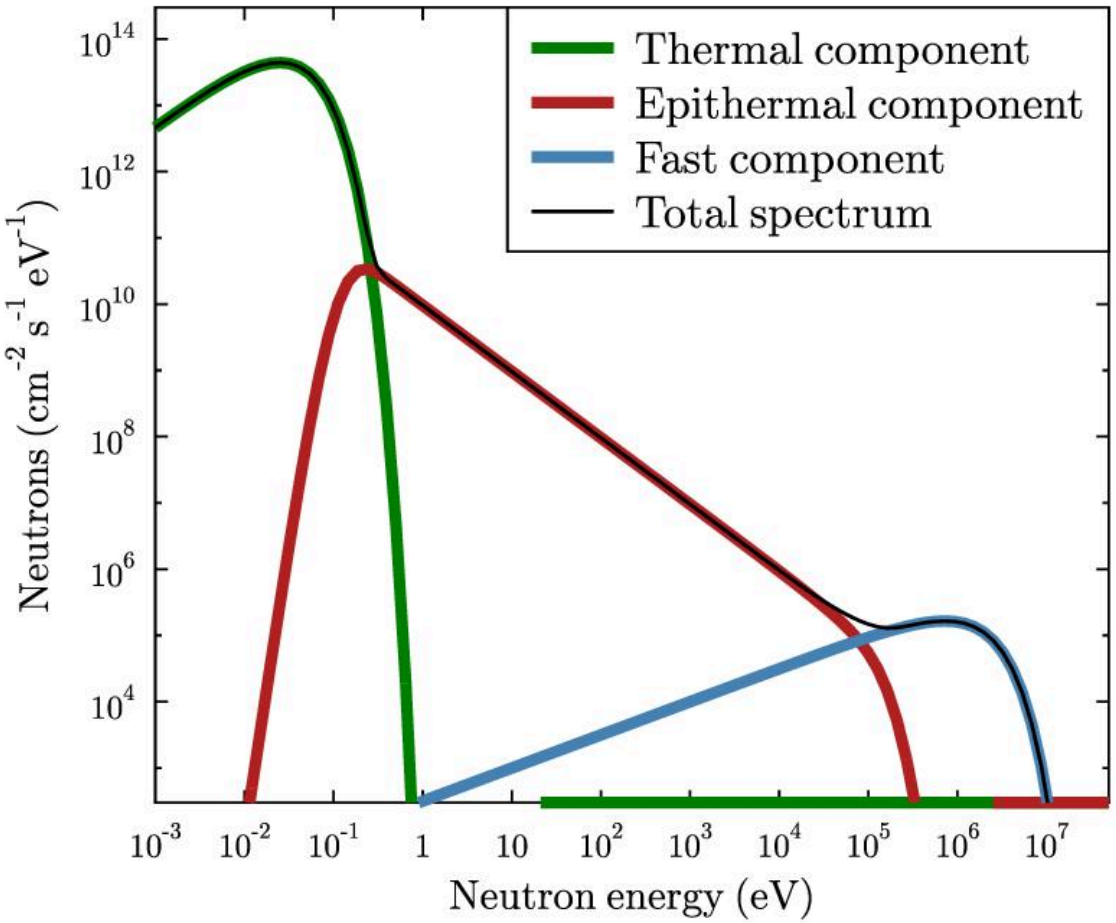
NFS vs. other facilities



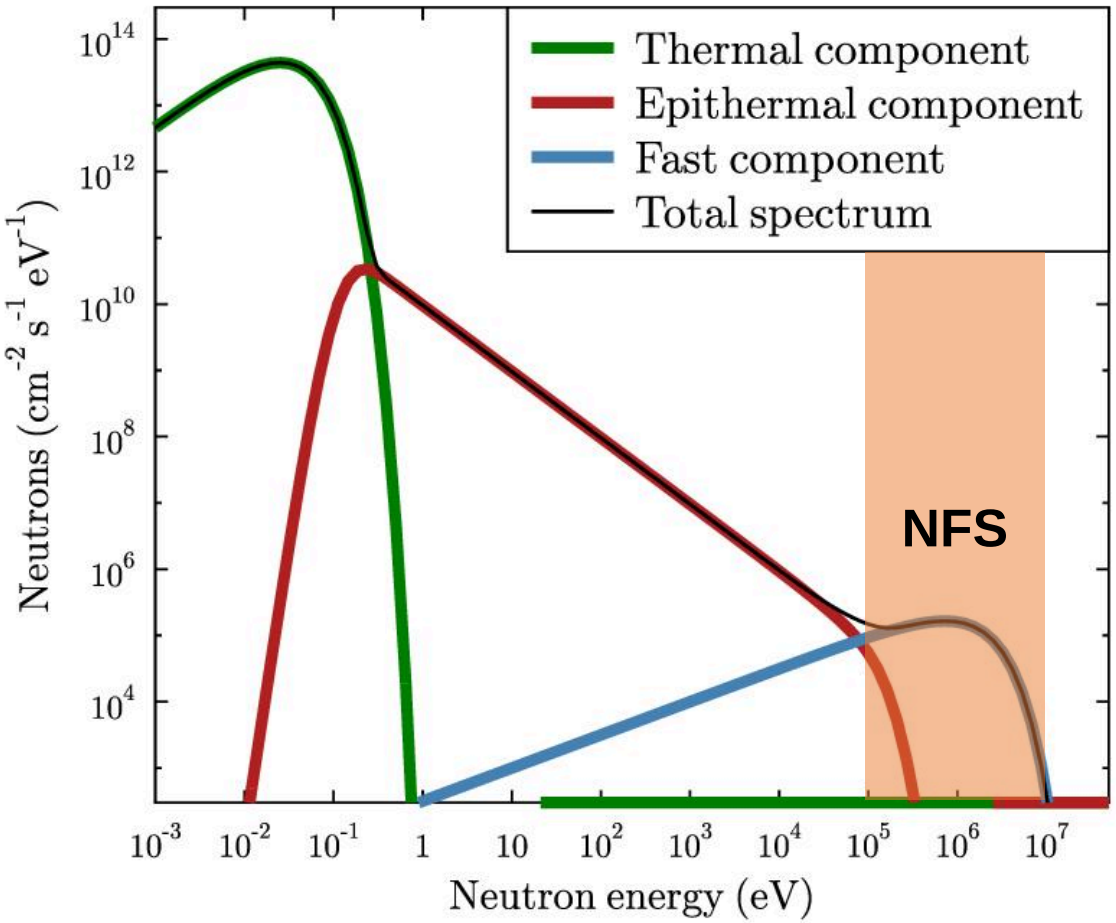
NFS

- Competitive: 100 keV - 30 MeV
- Unique: 1 MeV - 30 MeV

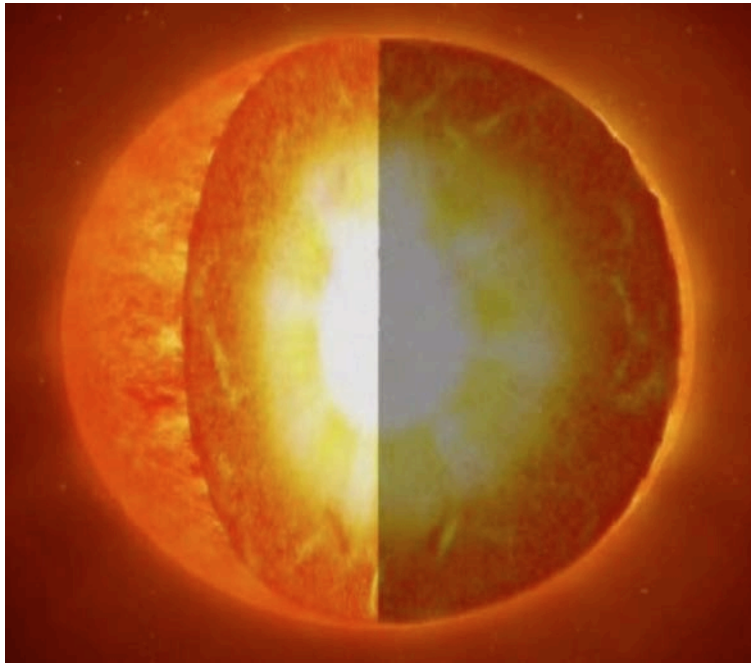
NFS for reactors



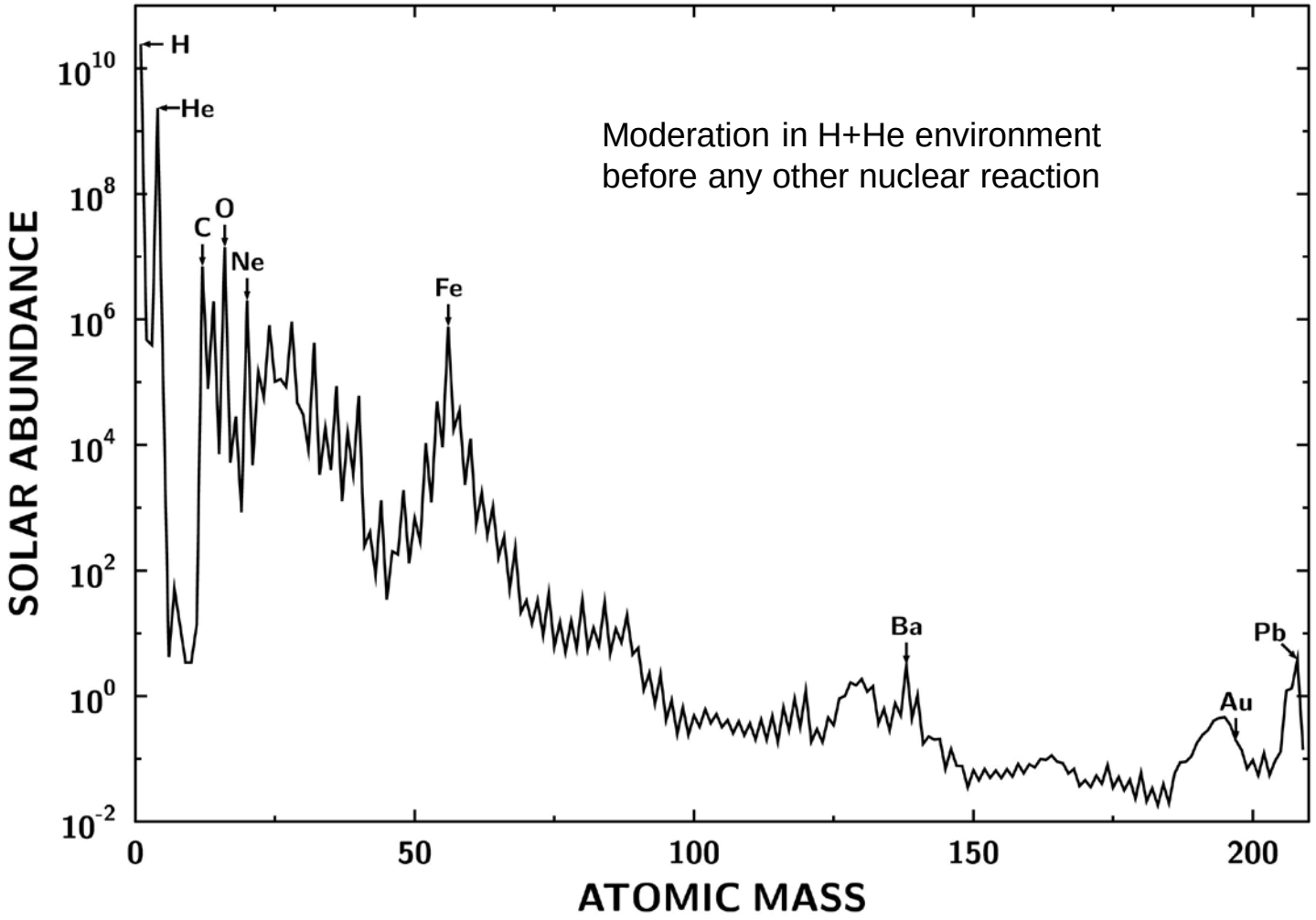
NFS for reactors



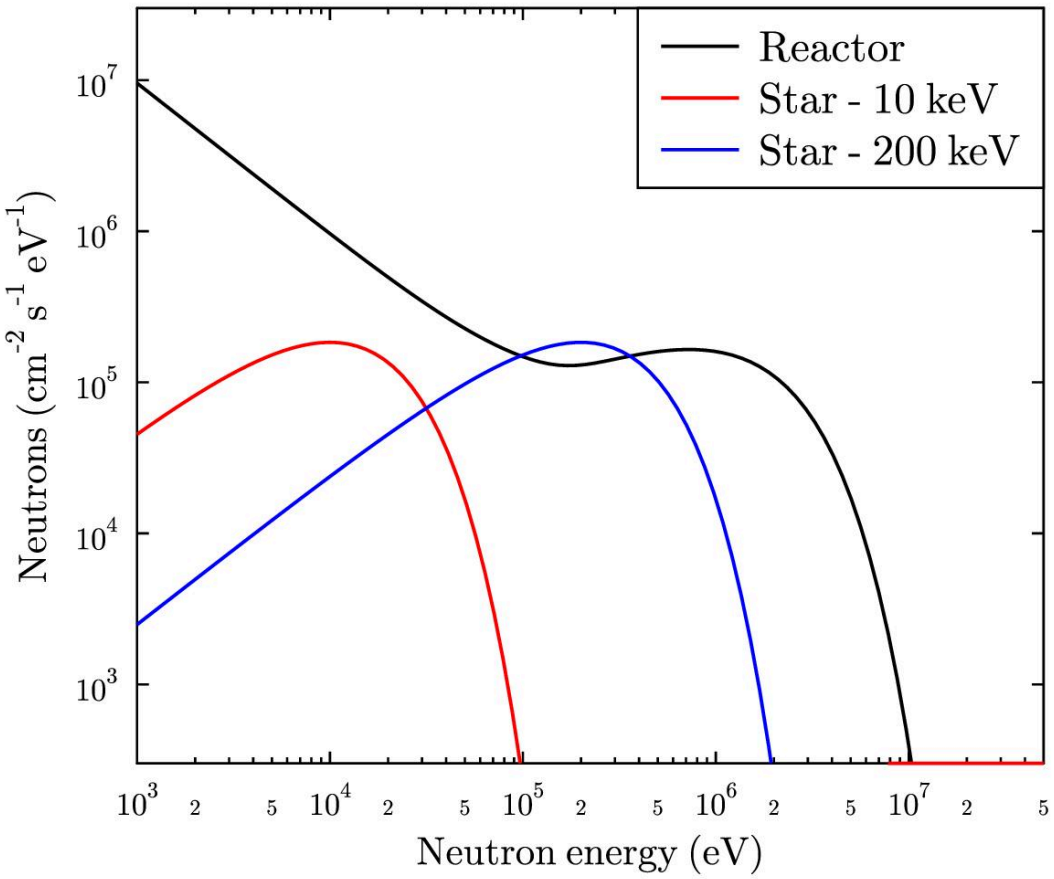
Stellar environments



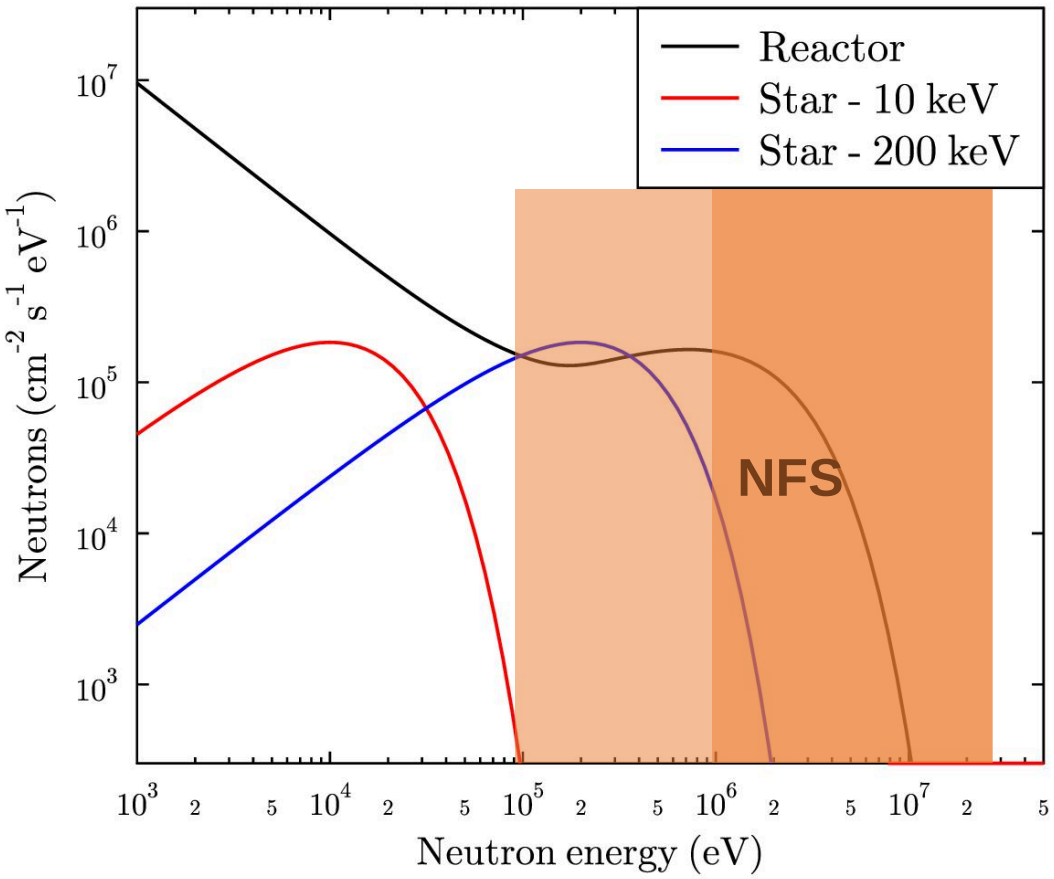
Credit: ESA



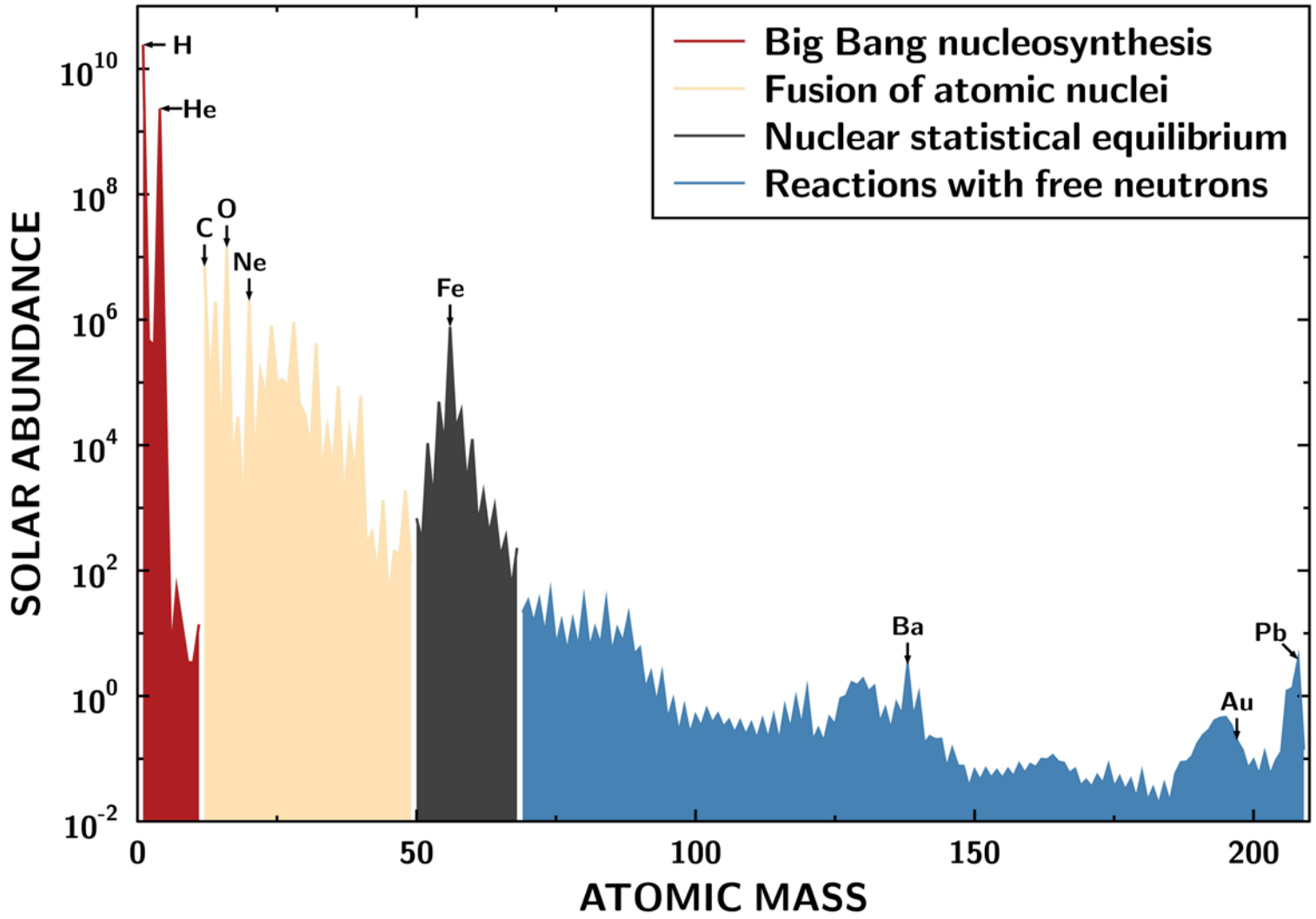
NFS for stellar nucleosynthesis



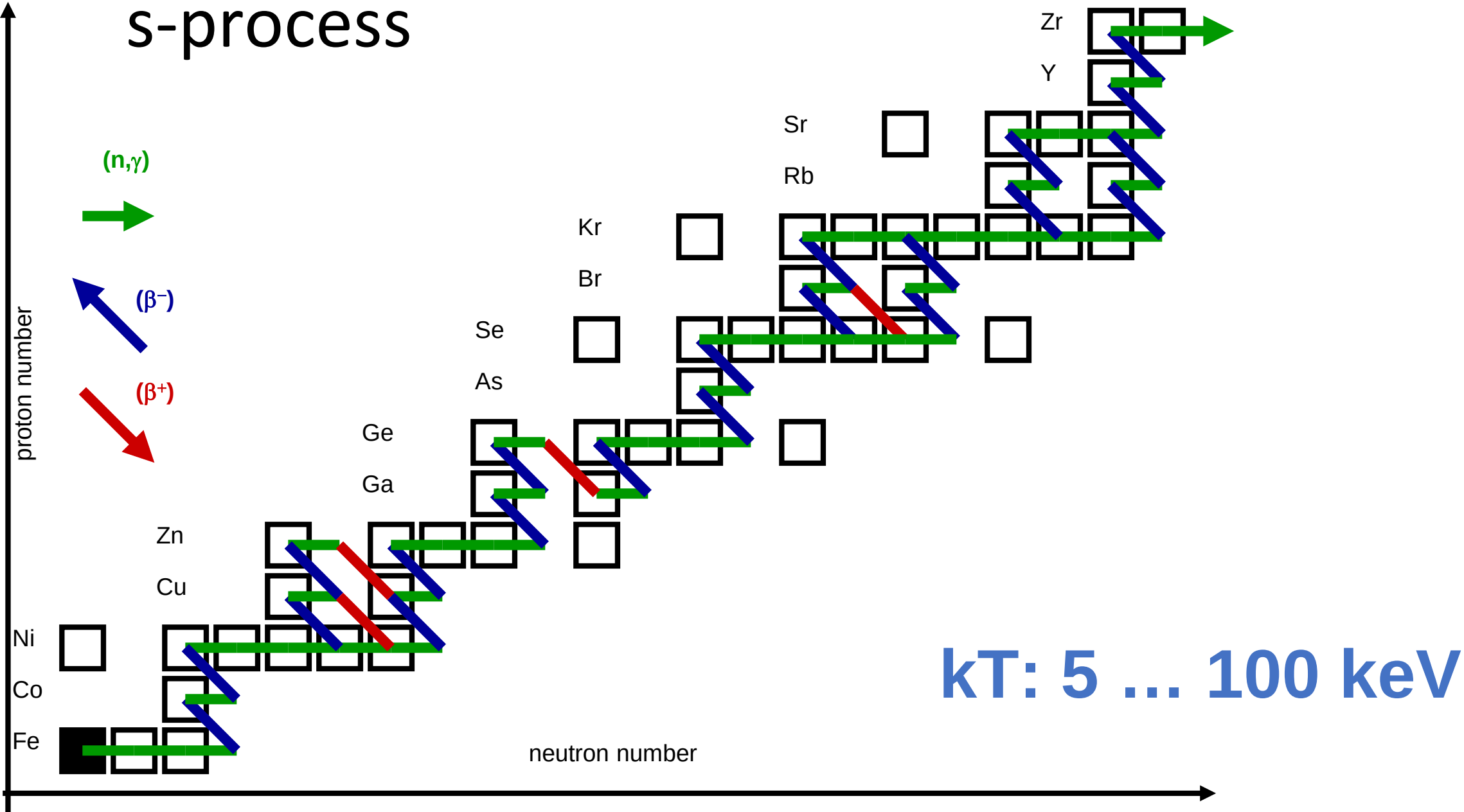
NFS for stellar nucleosynthesis



Stellar nucleosynthesis



s-process



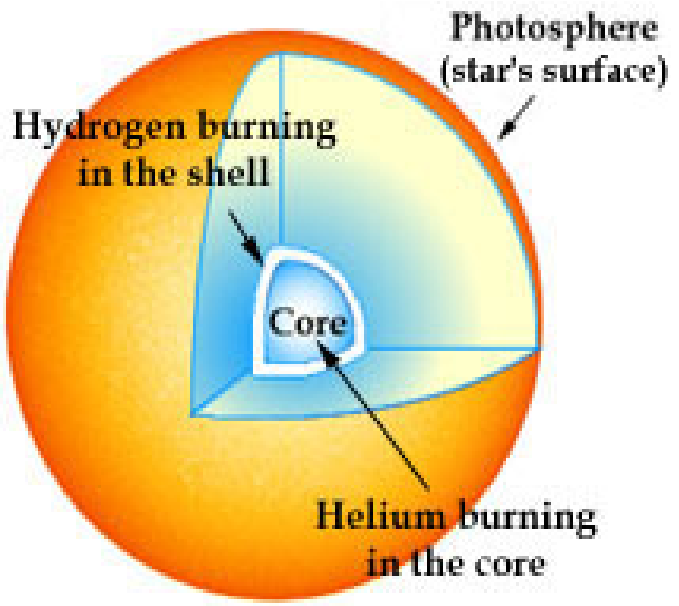
kT: 5 … 100 keV

r-process

kT: 100 … 300 keV

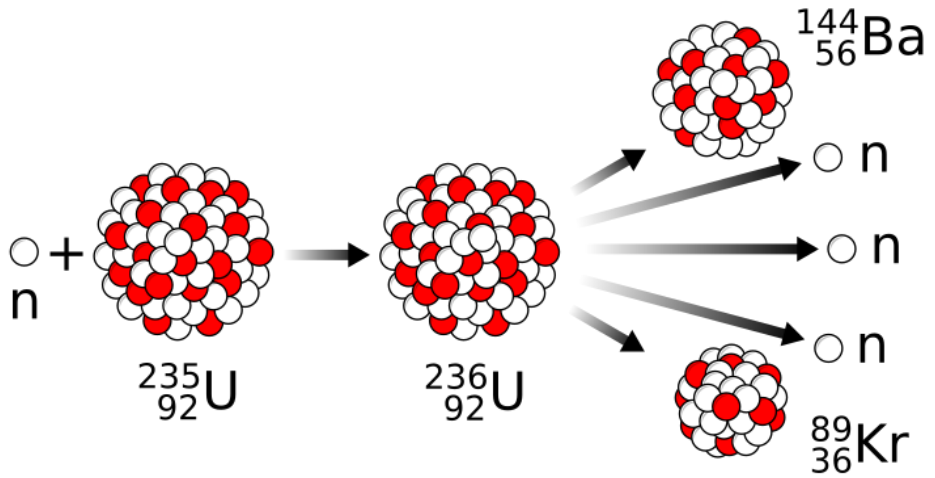
NFS – direct contribution

- **Neutron capture for hot environments**
- Weak s-process (activation or TOF)
- r-process freeze out, if short-lived isotopes become feasible (will be really difficult!!)



NFS – indirect contribution

- **Neutron-induced fission**
- Extrapolation to extreme nuclei necessary, e.g. ^{276}U, ^{282}Cf, …
- Learn as much as possible closer to „feasibility line“
- See next talk (Diane Doré)



Credit: MikeRun, wikipedia, creative commons

Determination of long half lives

PRL 103, 072502 (2009) PHYSICAL REVIEW LETTERS week ending 14 AUGUST 2009

New Measurement of the ^{60}Fe Half-Life

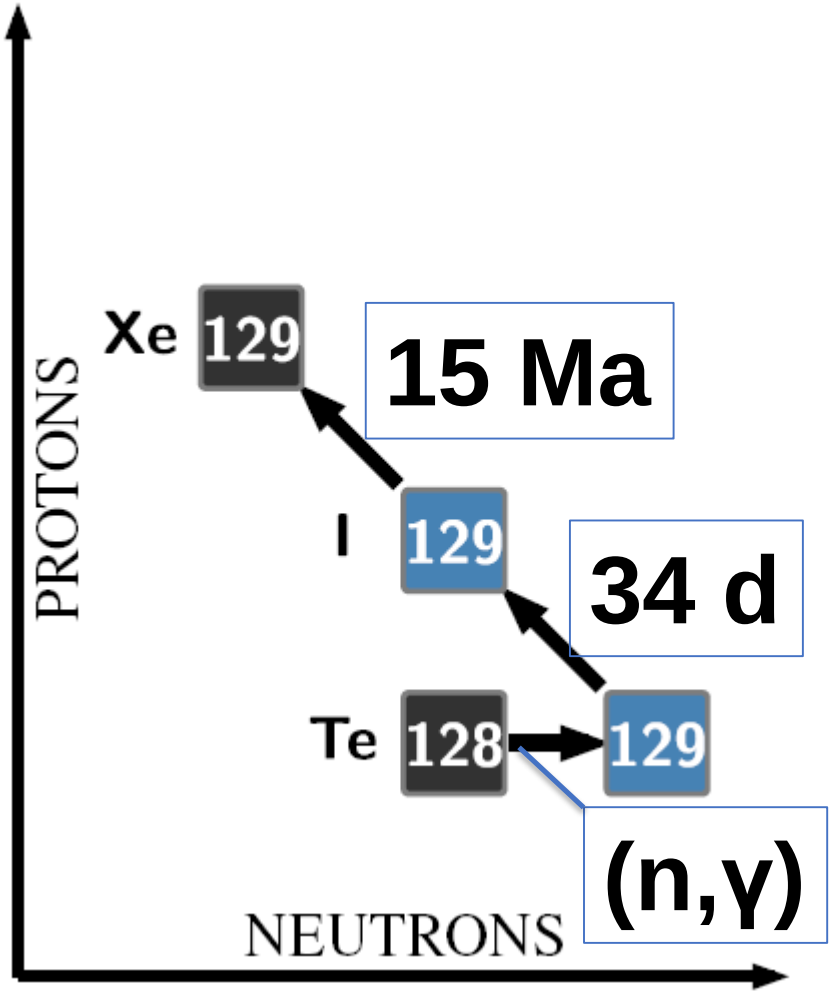
G. Rugel, T. Faestermann, K. Knie,* G. Korschinek, and M. Poutivtsev
Technische Universität München, D-85748 Garching, Germany

D. Schumann, N. Kivel, I. Günther-Leopold, R. Weinreich, and M. Wohlmuther
Paul Scherrer Institut, CH-5232 Villigen PSI, Switzerland
(Received 25 March 2009; published 14 August 2009)

We have made a new determination of the half-life of the radioactive isotope ^{60}Fe using high precision measurements of the number of ^{60}Fe atoms and their activity in a sample containing over 10^{15} ^{60}Fe atoms. Our new value for the half-life of ^{60}Fe is $(2.62 \pm 0.04) \times 10^6$ yr, significantly above the previously reported value of $(1.49 \pm 0.27) \times 10^6$ yr. Our new measurement for the lifetime of ^{60}Fe has significant implications for interpretations of galactic nucleosynthesis, for determinations of formation time scales of solids in the early Solar System, and for the interpretation of live ^{60}Fe measurements from supernova-ejecta deposits on Earth.

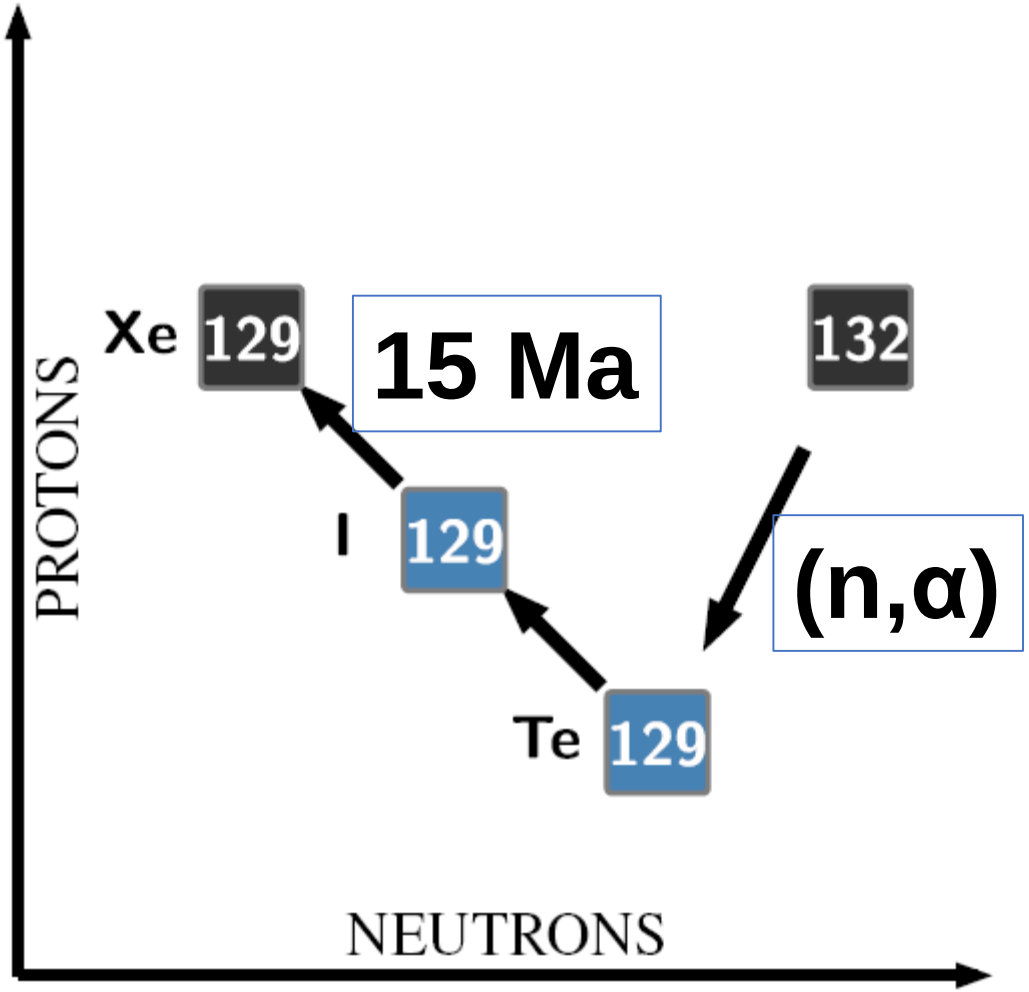
DOI: 10.1103/PhysRevLett.103.072502 PACS numbers: 21.10.Tg, 26.20.Np, 26.30.−k, 27.50.+e

NFS – isotope production: ^{129}I

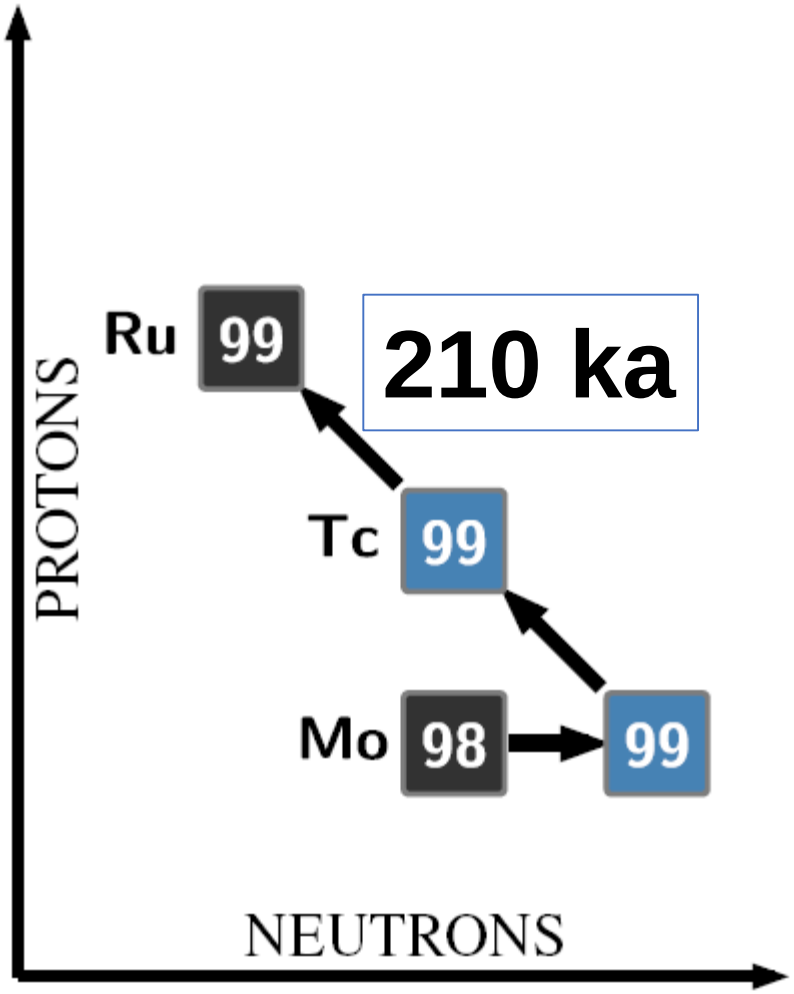


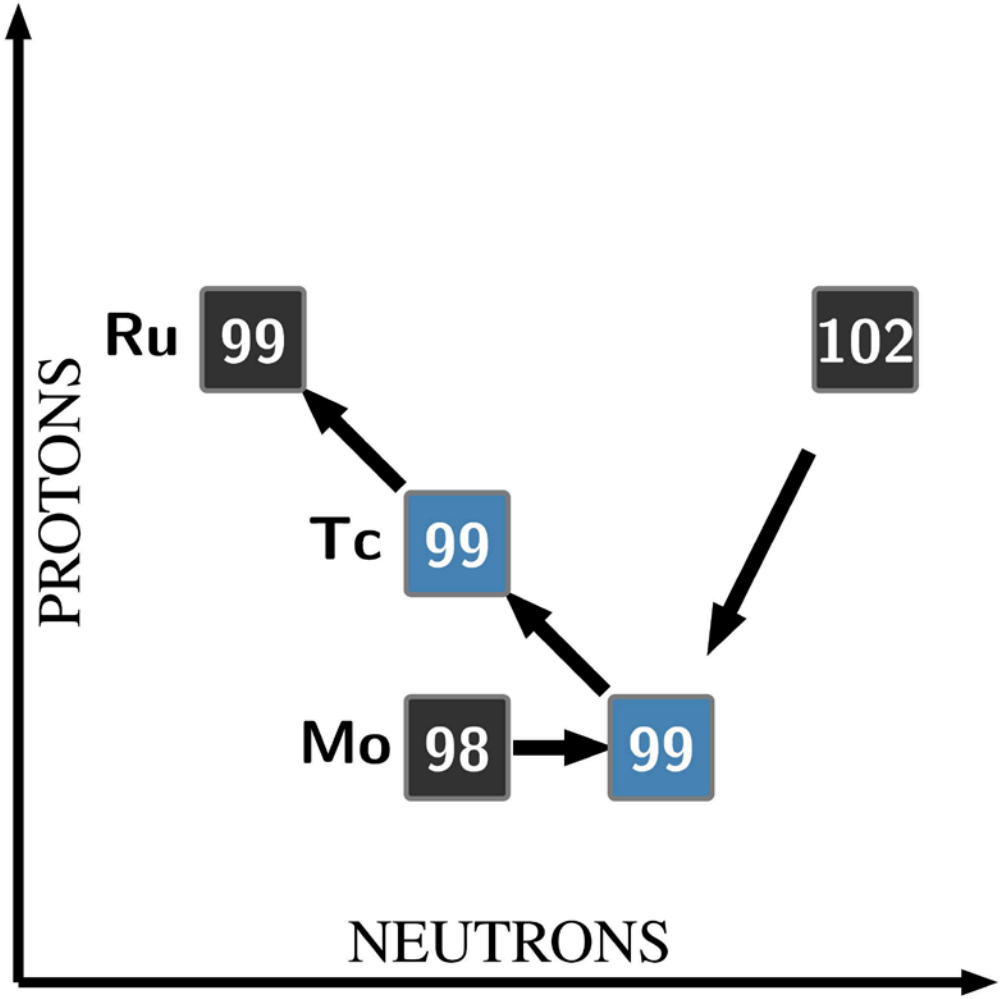
$$t^{long} = \frac{A^{short}}{A^{long}} t^{short}$$

NFS – isotope production: ^{129}I

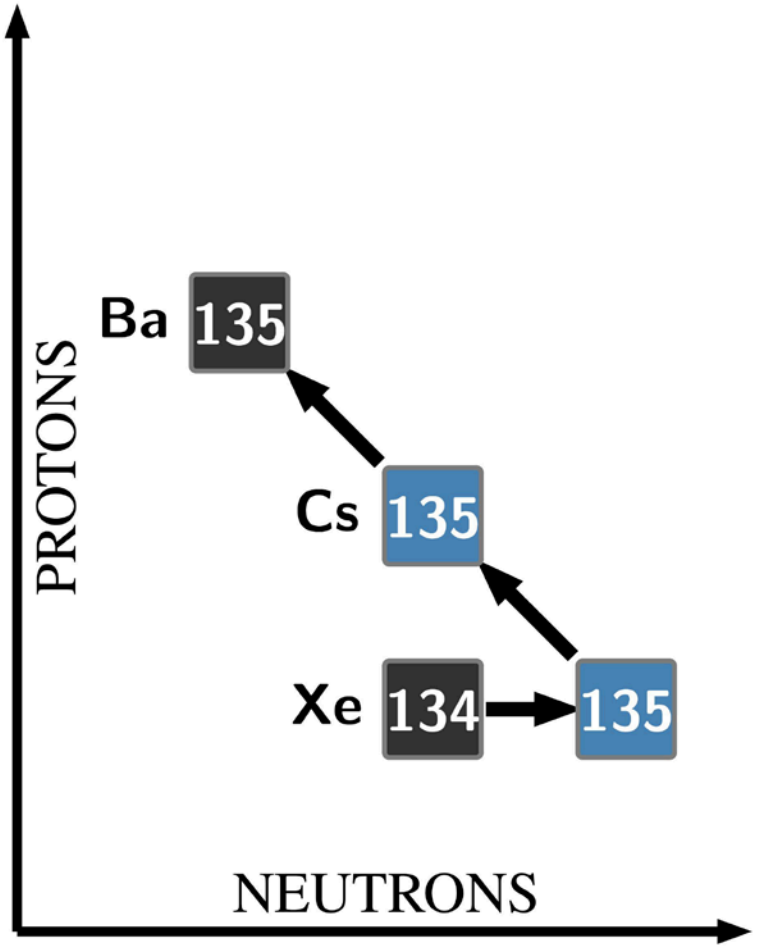


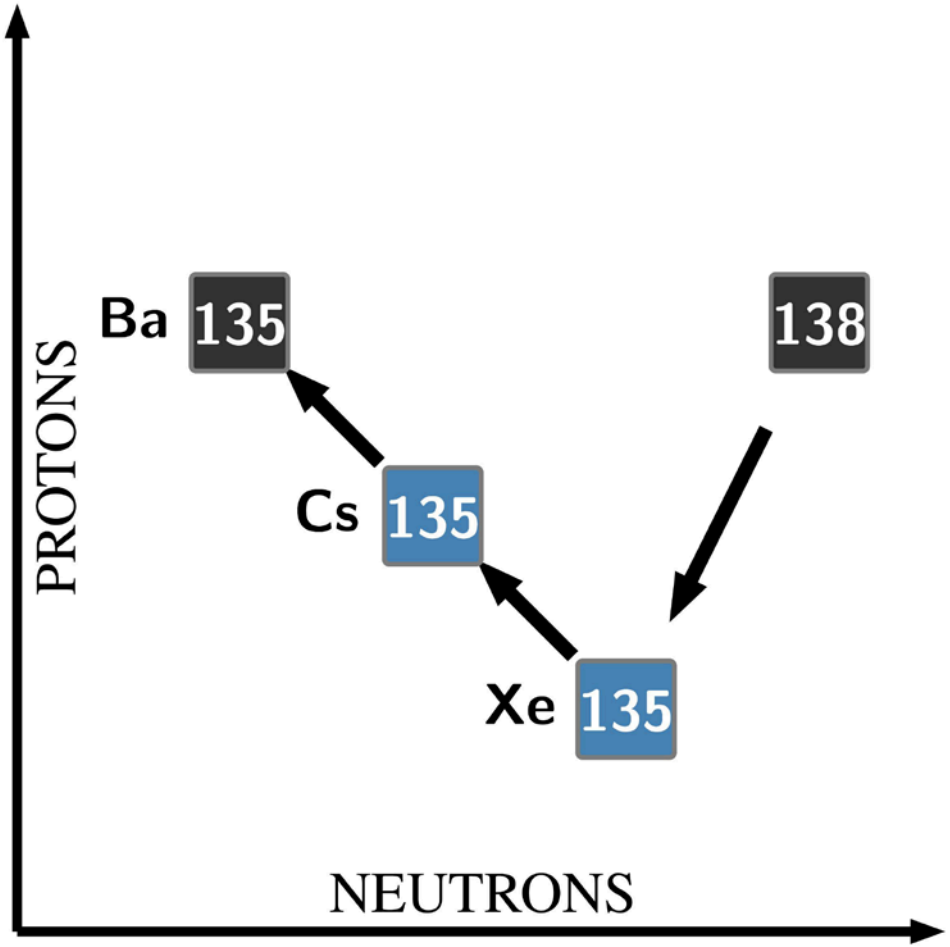
NFS – isotope production: ^{99}Tc





NFS – isotope production: ^{135}Cs



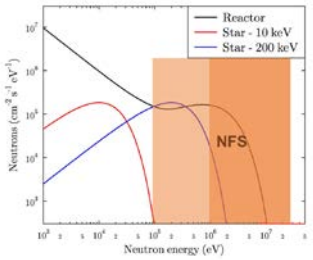


NFS – isotope production

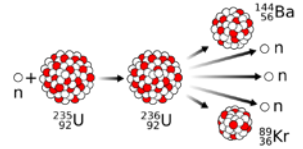
- ^{79}Se via $^{82}Se(n,\alpha)(\beta^-)(\beta^-)$
- ^{93}Zr via $^{96}Zr(n,\alpha)(\beta^-)(\beta^-)$
- ^{107}Pd via $^{110}Pd(n,\alpha)(\beta^-)(\beta^-)$

Summary

- Direct contribution to (very) hot environments



- Indirect contribution to understanding of fission



- Quantitative isotope production for half-live determinations