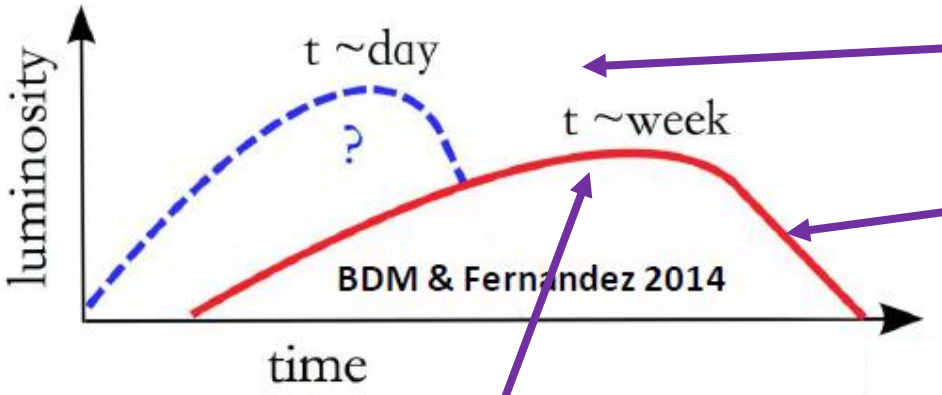
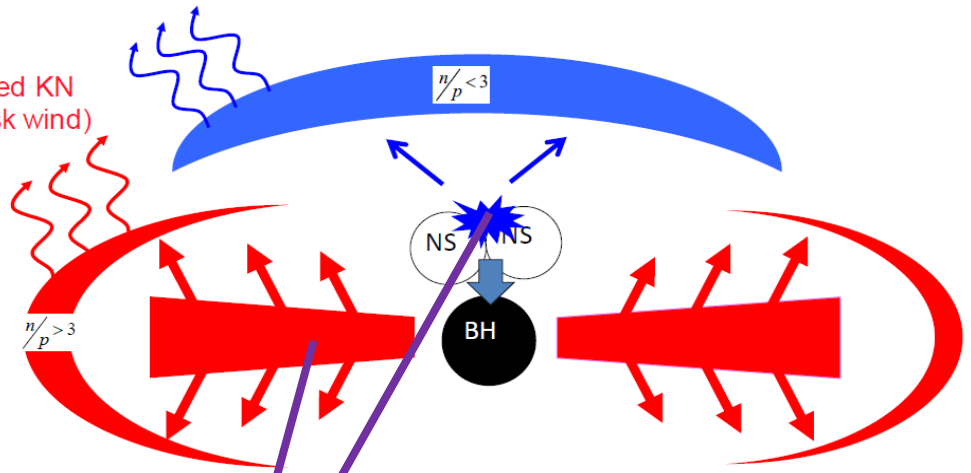
Observables: link to nuclear physics

"direct" observable: luminosity curves from decay heating



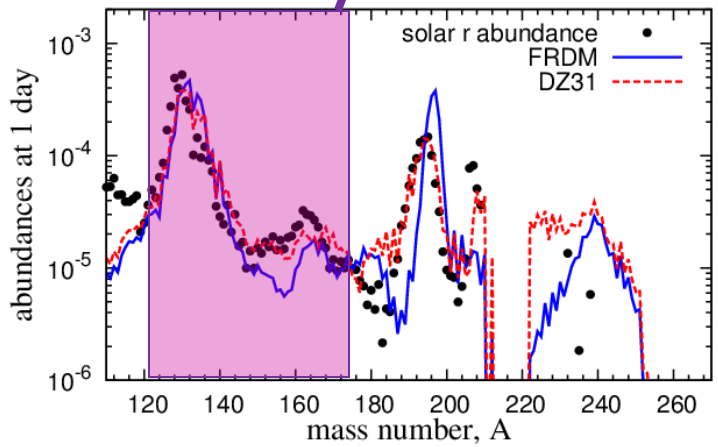
Blue KN (polar dynamical ejecta)

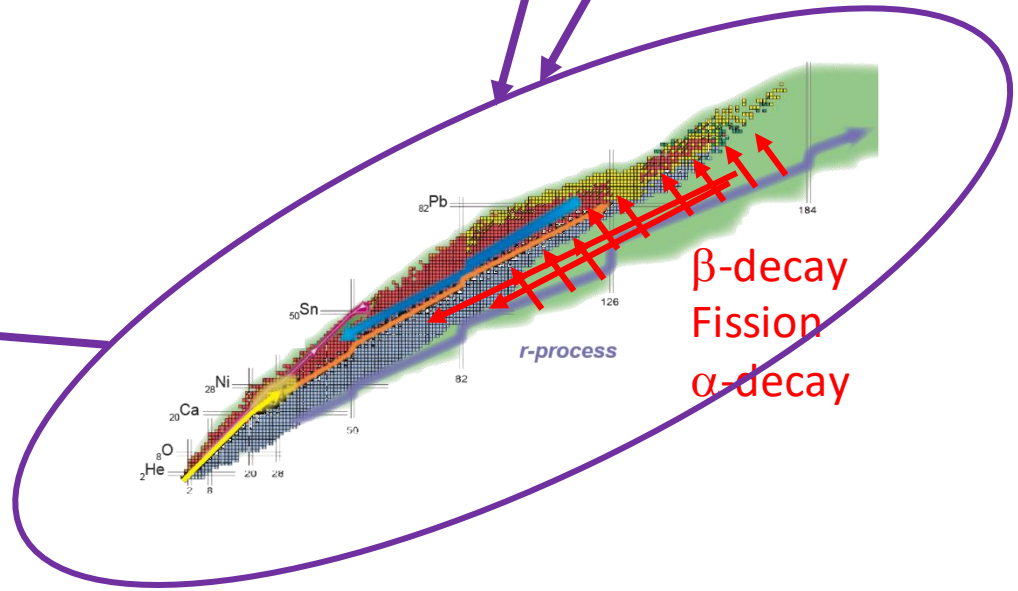
Red KN
(disk wind)



Lanthanides-Opacity "Filter"

"indirect" observable: r-process SS abundances





Key Questions related to Experimental Nuclear Physics & Kilonova:

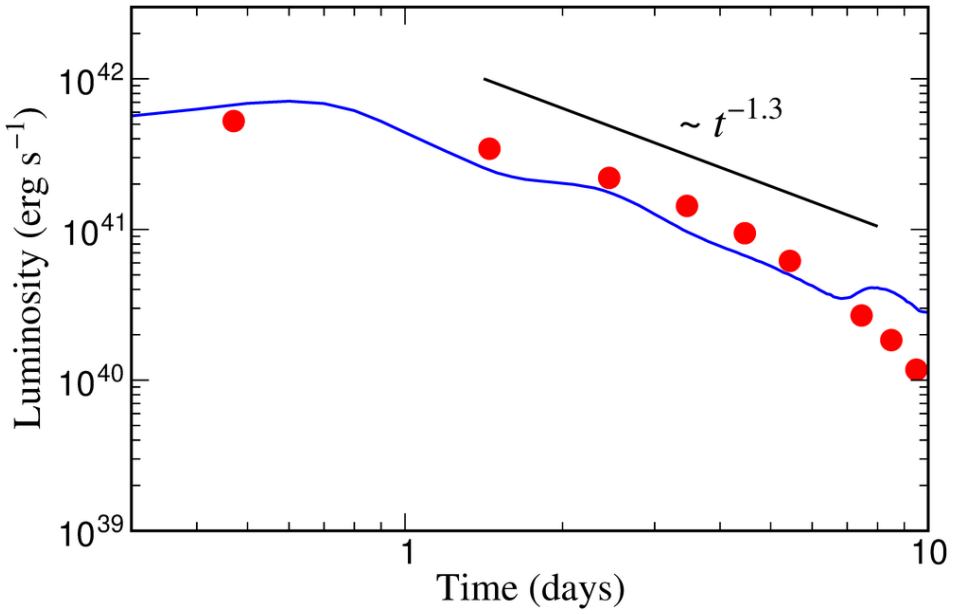
- How much do nuclear physics (masses, b-decays, fission) impact the Kilonova observables?
  - Nucleosynthesis-wise?
  - Luminosity-wise?

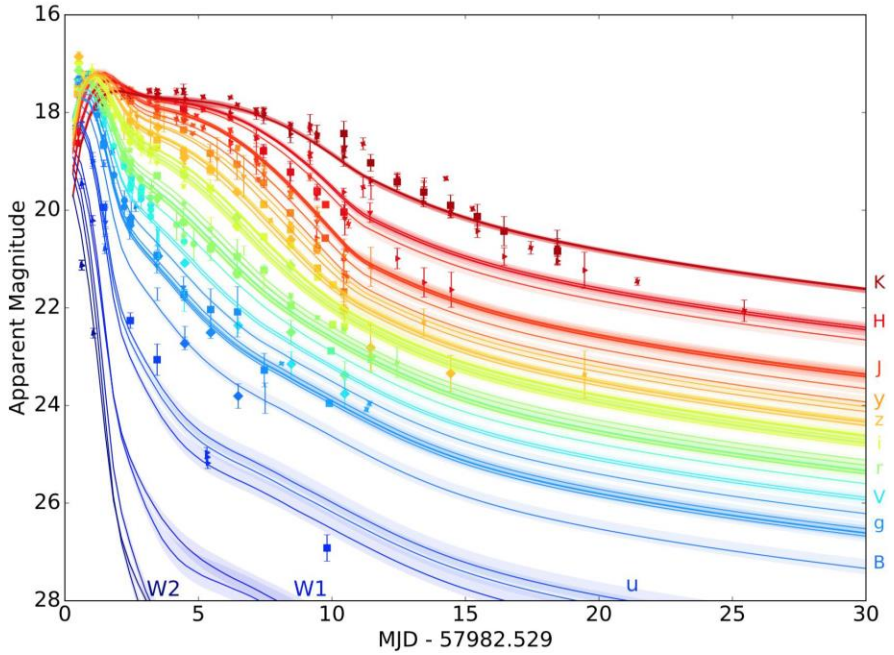
- Are there specific nuclear properties and/or nuclei or regions of the nuclear chart which are particularly relevant to KNs … or just measure “everything you can”?

- What properties and which nuclei will be accesible in the next years at present or new RIB facilities? And which will remain out-of-Access still for a long time (theory)?

- How will the theoretically-based properties/uncertainties improve on the light of the new available data?

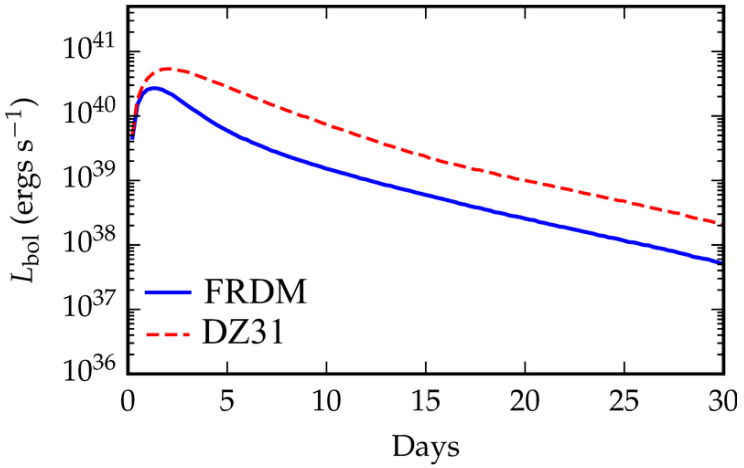
Direct observable: light curves

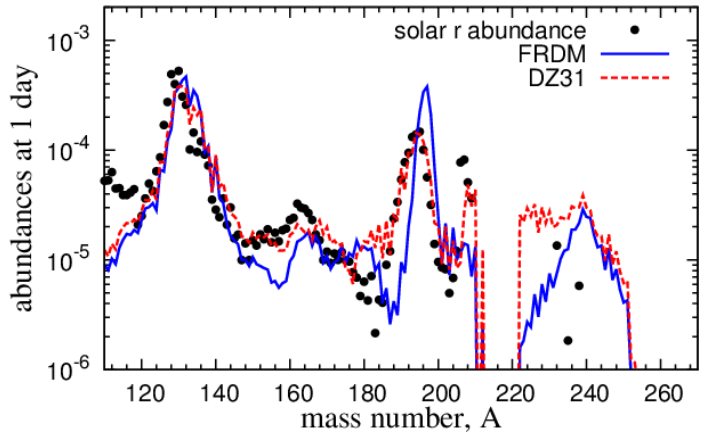




- Are the discrepancies to be ascribed to the Nuclear Physics? To Models? To opacities/atomic physics? To which extent?
- Can we try to reproduce better the data by improving the NP input?
- What can we learn when we improve the agreement?
- Need to measure masses? Beta-decay half-lives? Beta and gamma-spectra? Fission? Alpha-decay?, etc, etc

Barnes, Kasen, Wu, GMP, ApJ 829, 110 (2016)





→Masses impact luminosity curves → Mass ejecta estimates

Key Questions related to Experimental Nuclear Physics & Kilonova:

- How much do nuclear physics (masses, b-decays, fission) impact the Kilonova observables?
  - Nucleosynthesis-wise?
  - Luminosity-wise?

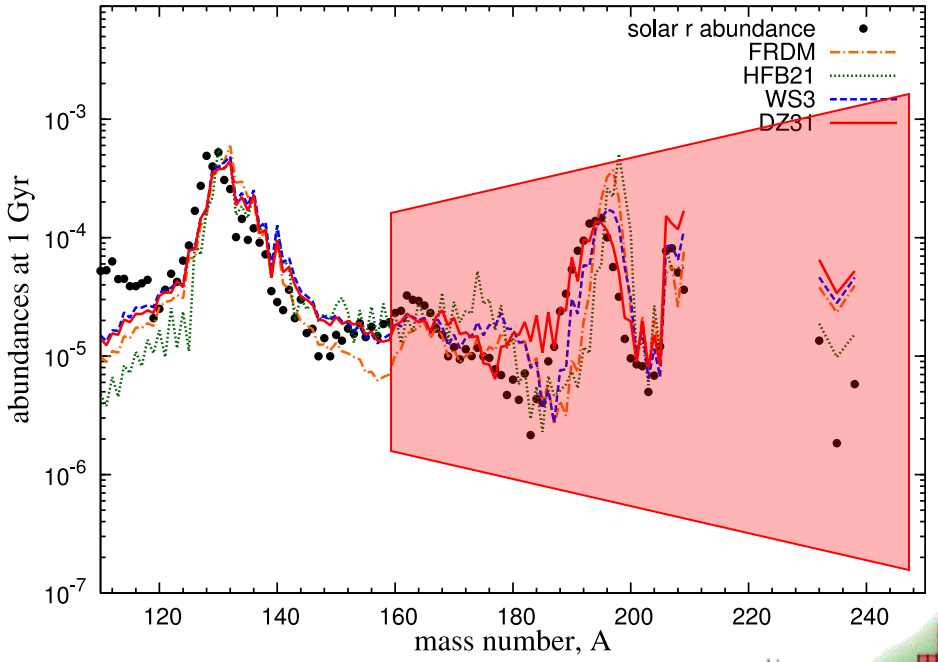
- Are there specific nuclear properties and/or nuclei or regions of the nuclear chart which are particularly relevant to KNs … or just measure “everything you can”? Are the n-Shell closure as relevant as they were?

- What properties and which nuclei will be accesible in the next years at present or new RIB facilities? And which will remain out-of-access still for a long time (theory)?

- How will the theoretically-based properties/uncertainties improve on the light of the new available data?

What to measure?

Mendoza-Temis, et al, PRC 92, 055805 (2015)



r-process

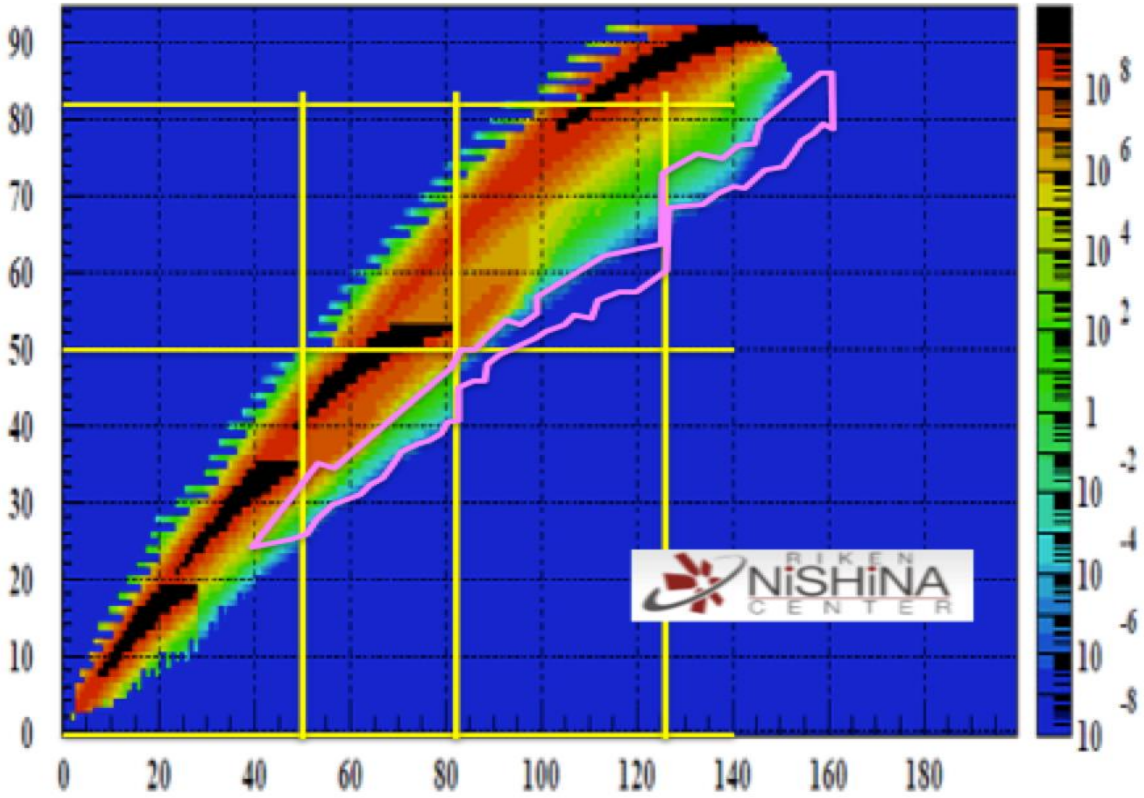
Ye

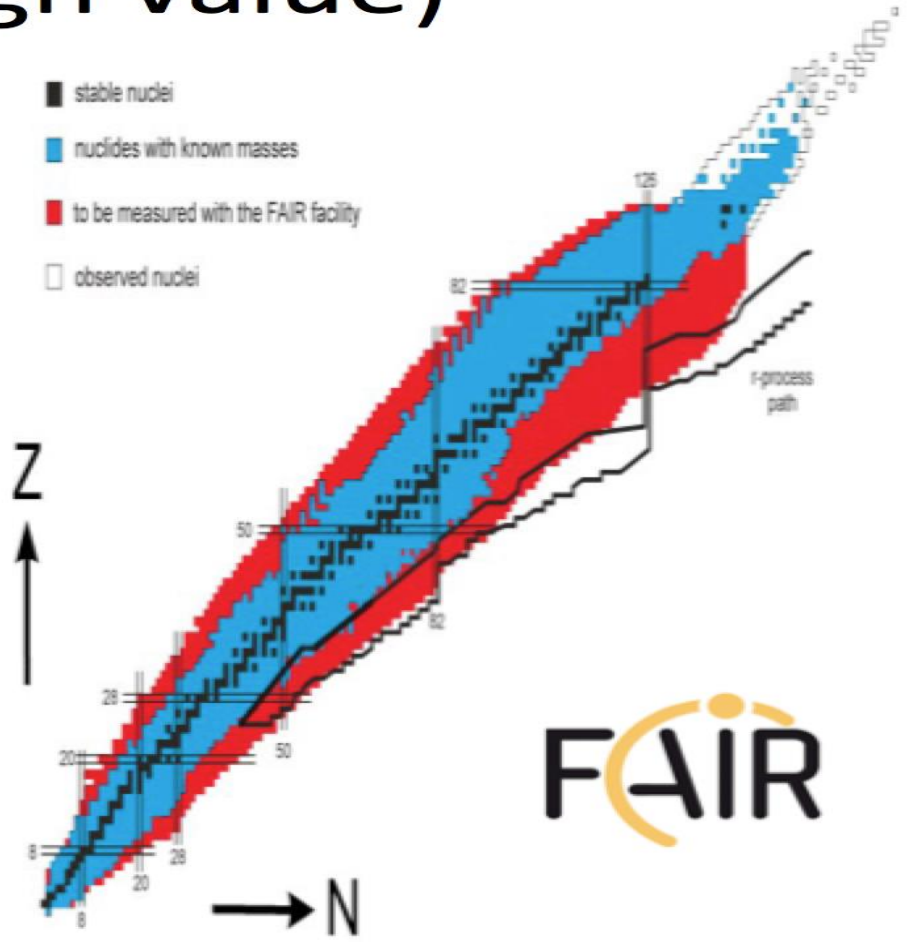
Nuclear Physics Relevance

"Ignorance" curve

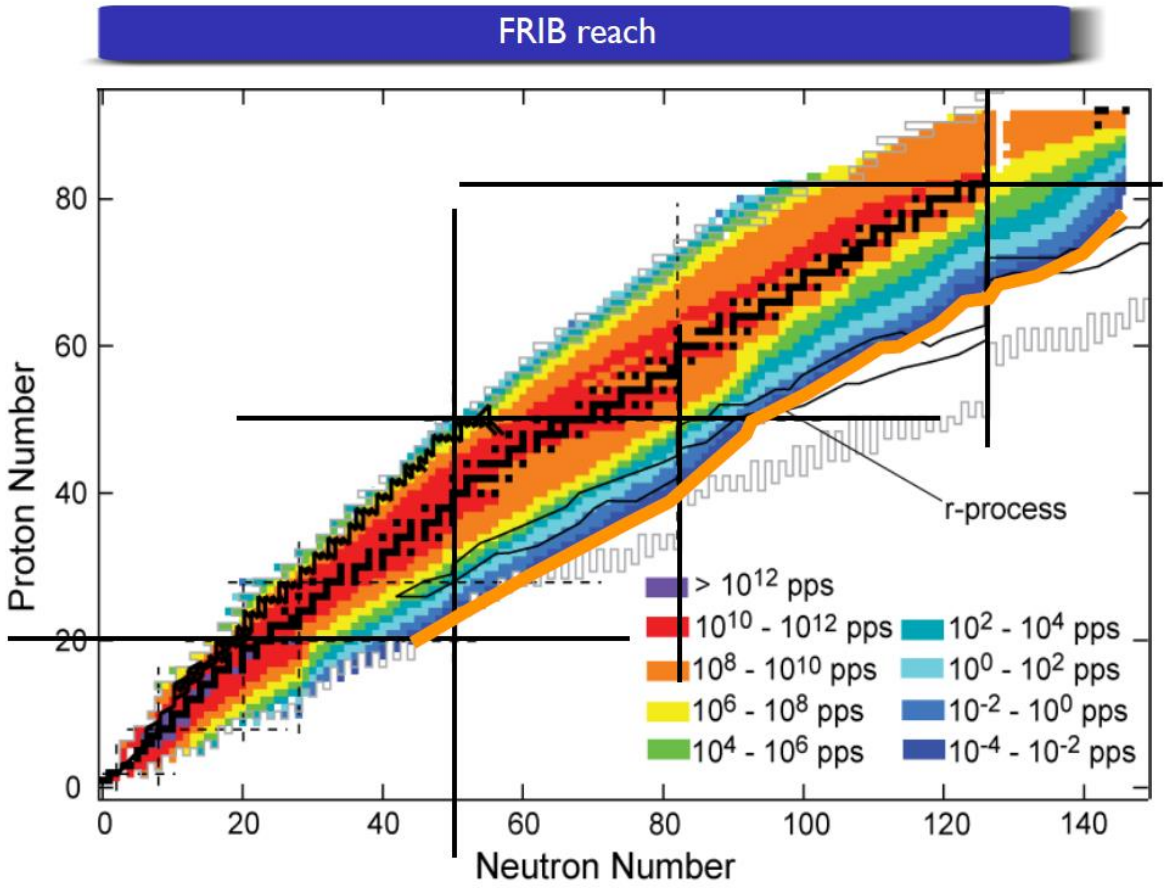
RI Production (Design value)

RIBF (1000 pnA) … current int. = 60 pnA



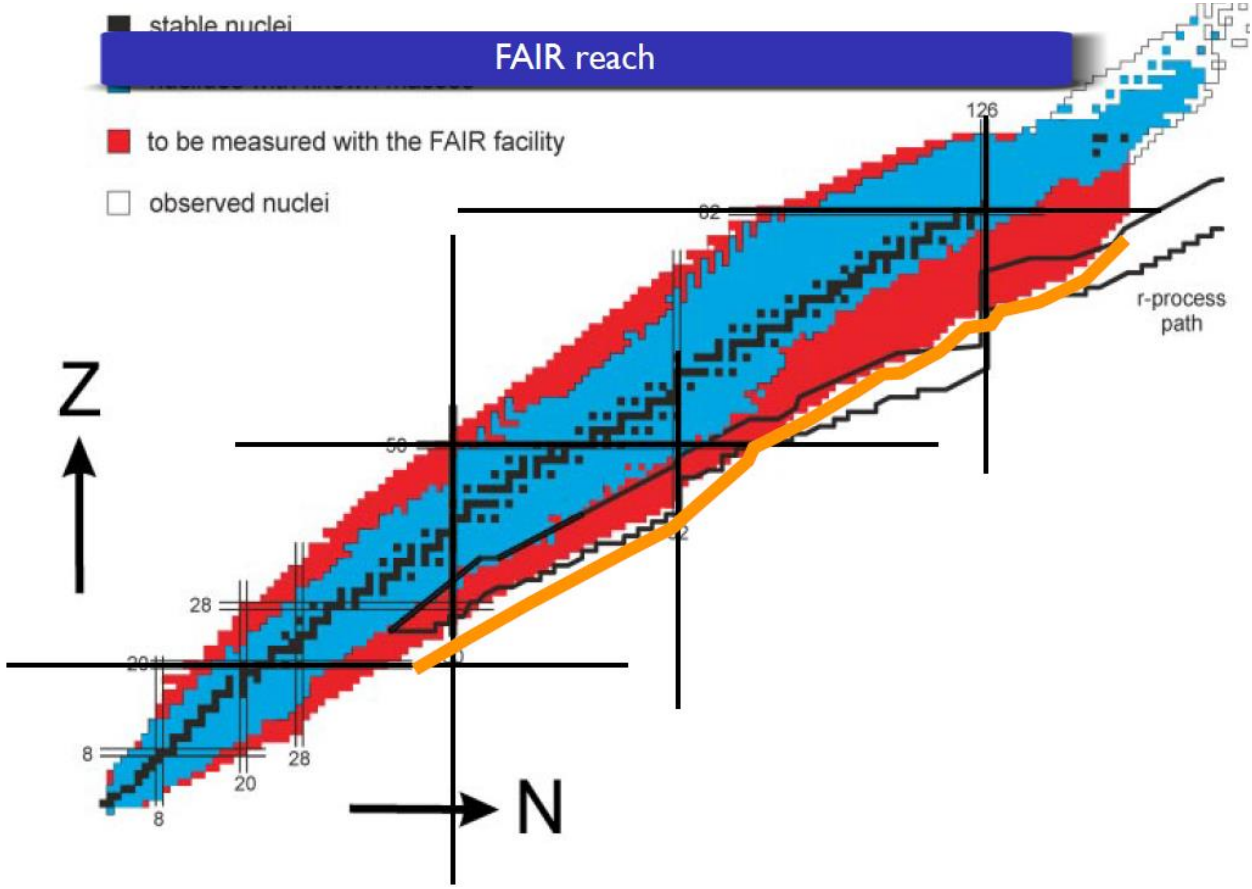


FRIB reach



Official completion date: June **2022**
Possible early completion date October 2021

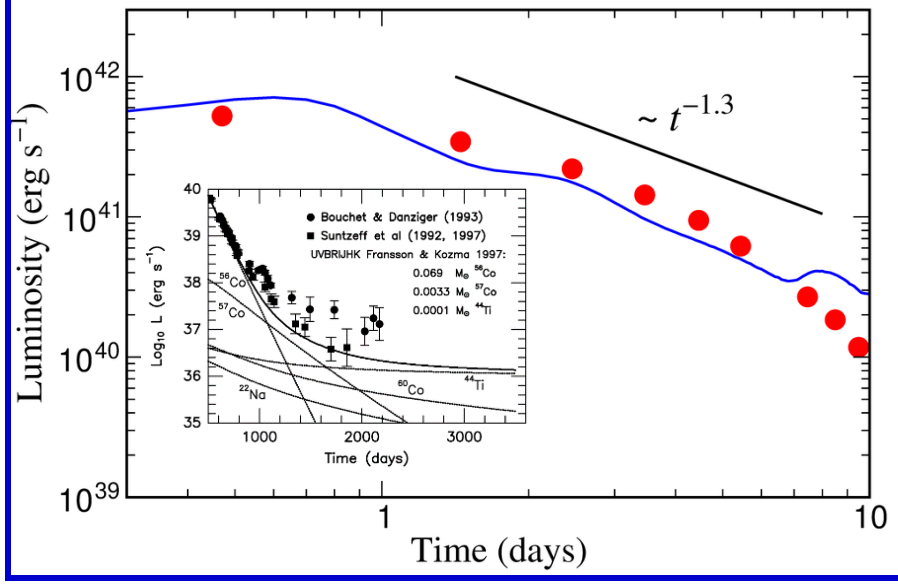
FAIR reach



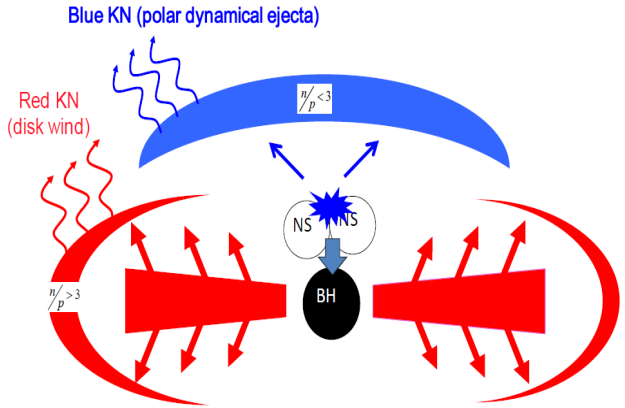
Official completion date **2024** (?)

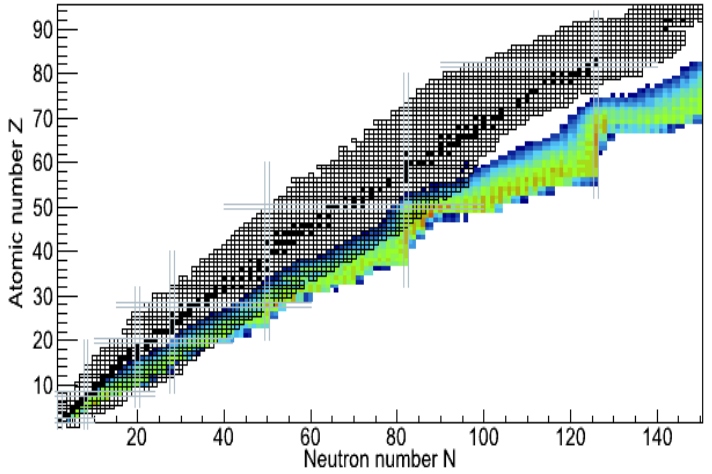
Slides by F. Montes

Direct observable: light curves

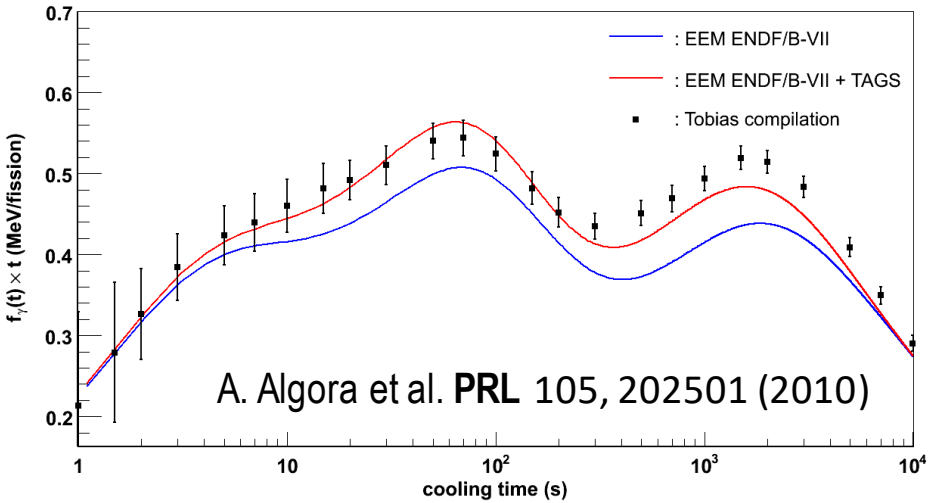


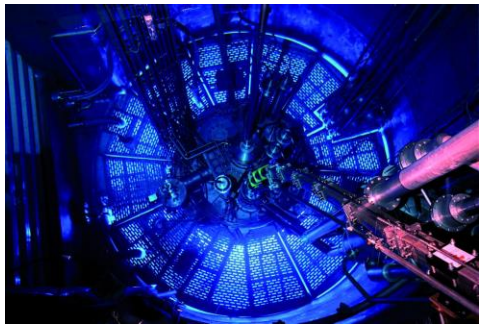
γ-rays→ Gas heating → Observable photons





Residual decay heat in a reactor (due to radioactive decay of long-lived fission-products, not to fission)



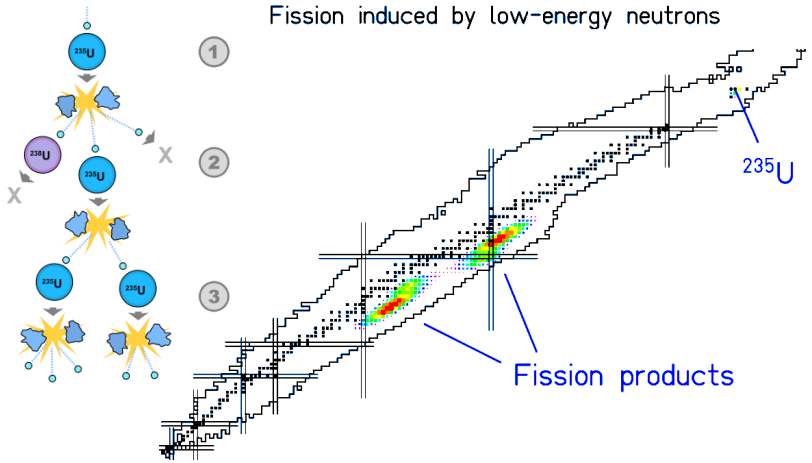


$$f(t) = \sum_i E_i \lambda_i N_i(t)$$

E_i energía media

λ_i const. desint.

N_i número de isot.



SUMMARY

- Presently a wealth of new nuclear input data (masses, half-lives, b-decay properties) has been measured/is being measured worldwide, particularly a lot of data has been made available at RIKEN thanks to their very high beam intensities.
- New detection techniques and instruments are being developed, both at RIKEN (talks by S.Nishimura, J.L.Tain) and also at GSI/FAIR (talk by T.Dickel) and NSCL-MSU (F. Montes).
- An enormous amount of –very exotic netron rich- nuclei, relevant for the Kilonova will be produced and properties measured at the new generation of facilities, namely FAIR and FRIB, and also with upgrades at RIKEN.