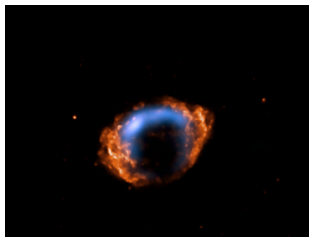
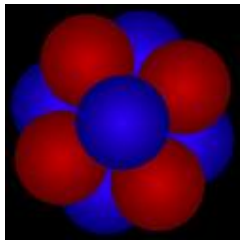
JINA goals

Astrophysics



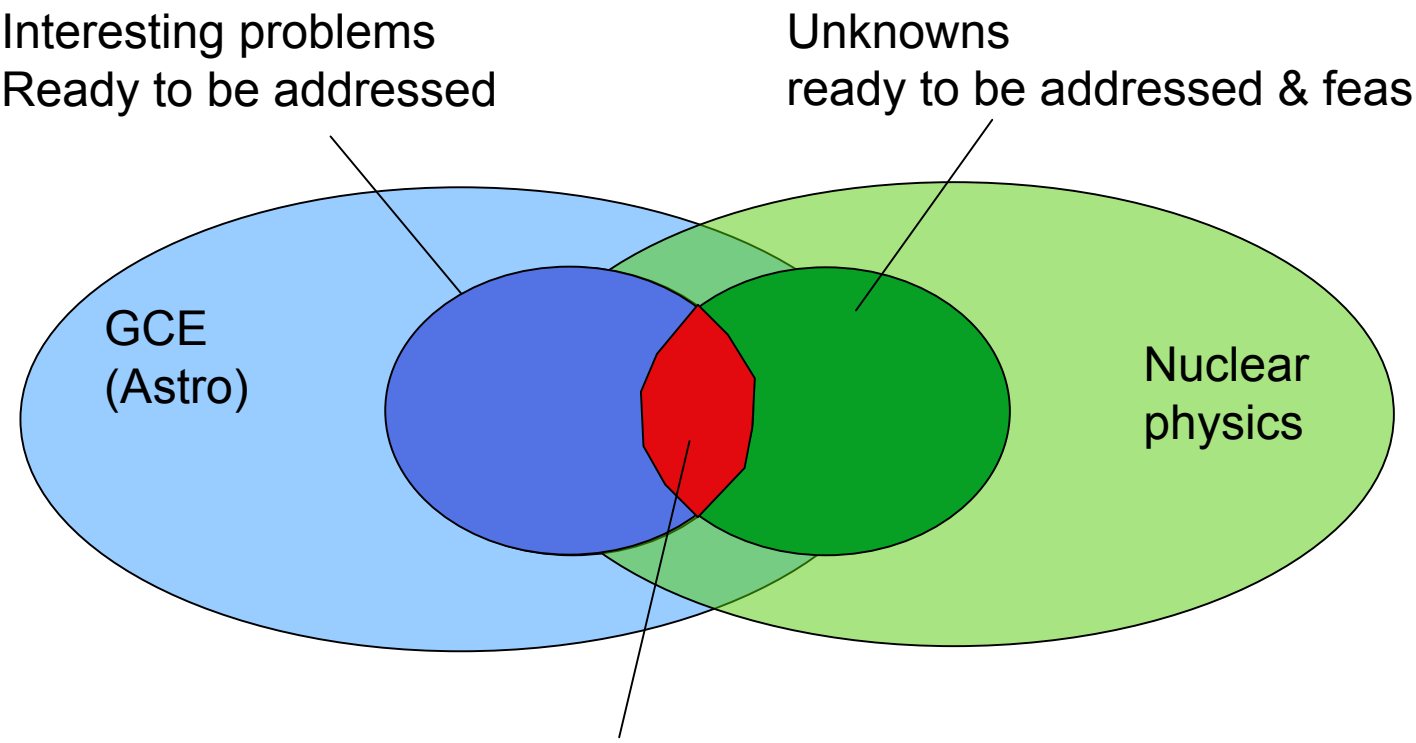
Nuclear Physics



JINA

Address open questions
by working on the nuclear physics and the astrophysics

JINA workshop goals



Identify this overlap

- Key problems in GCE ready to be addressed
- That also require work in nuclear physics

(as these would likely not be done without cross field collaboration)

How to identify nuclear - astro overlap

Approach 1:

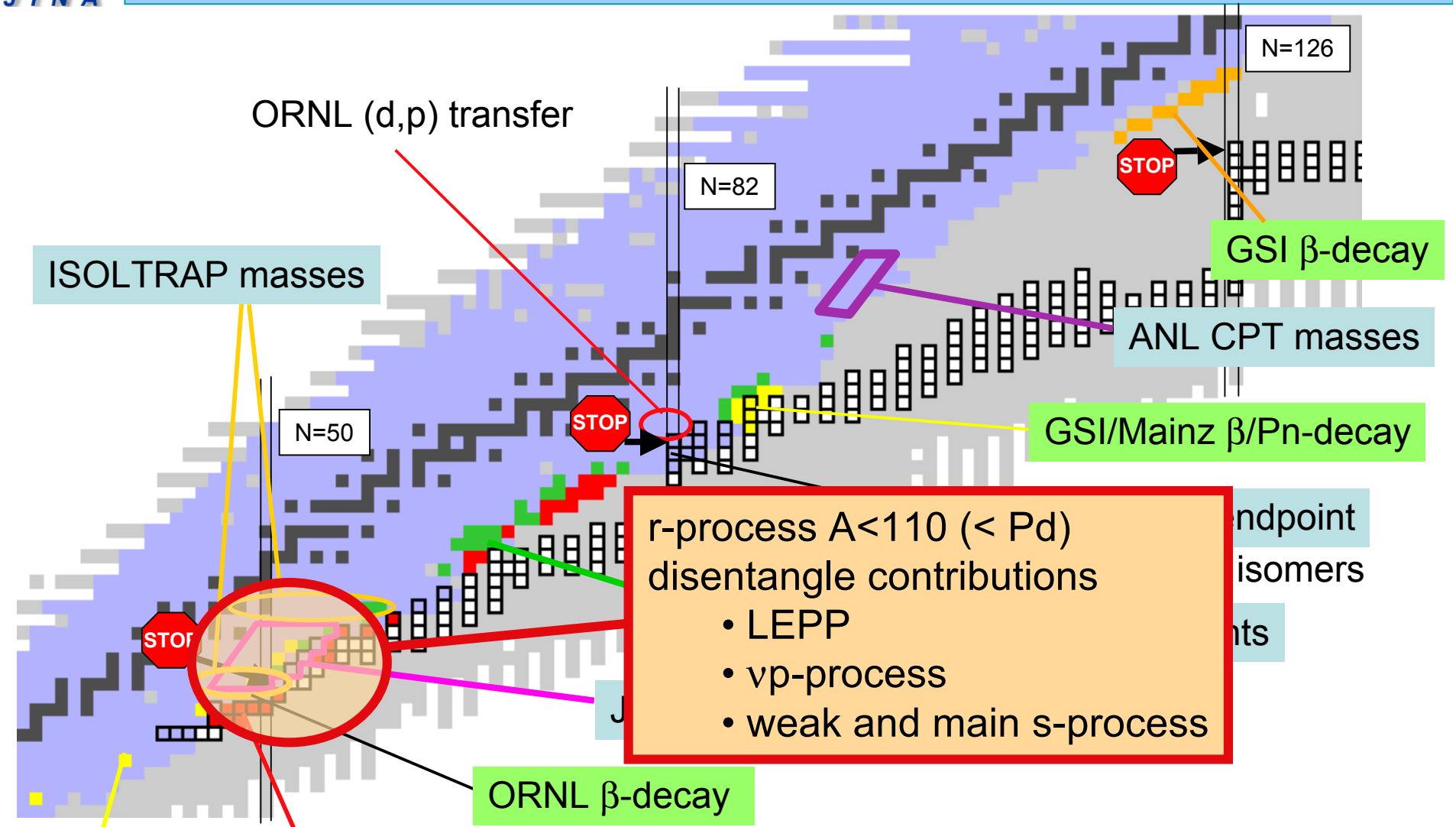
- Identify key problems in GCE
- Identify among these critical nuclear physics problems
  - Think about nuclear physics analysis/sensitivity studies
- See where nuclear physics progress would be feasible
  --> trigger new nuclear physics efforts

Approach 2:

This talk

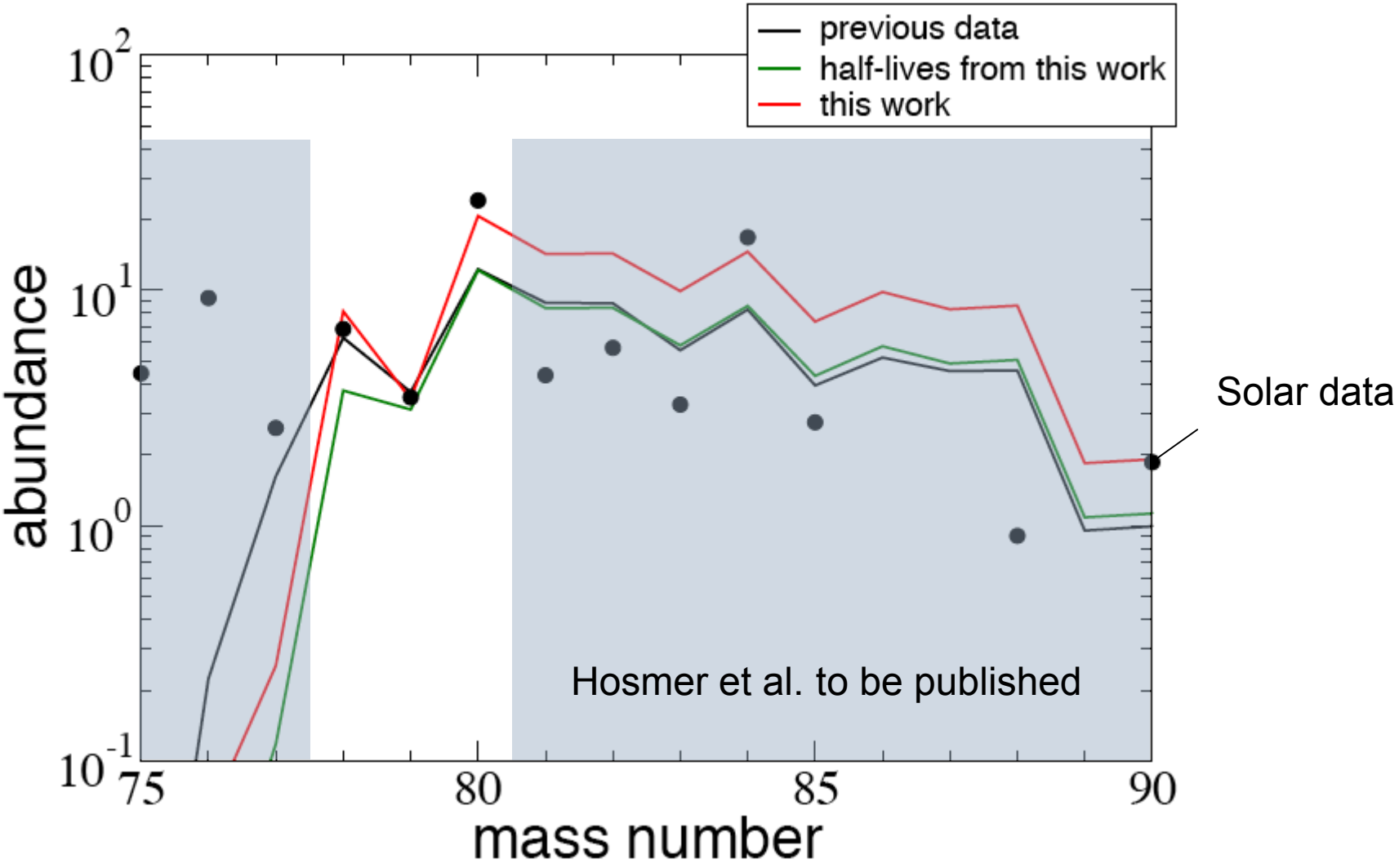
- Look at ongoing and planned nuclear physics efforts
  (which processes see advances, which nuclei are affected)
  (note that feasibility is a big factor - so what can be done likely is done)
- Identify the interesting GCE problems where one can take advantage of improvements in nuclear physics
  --> trigger new astrophysics efforts

Area 1: r-process: recent nuclear physics efforts

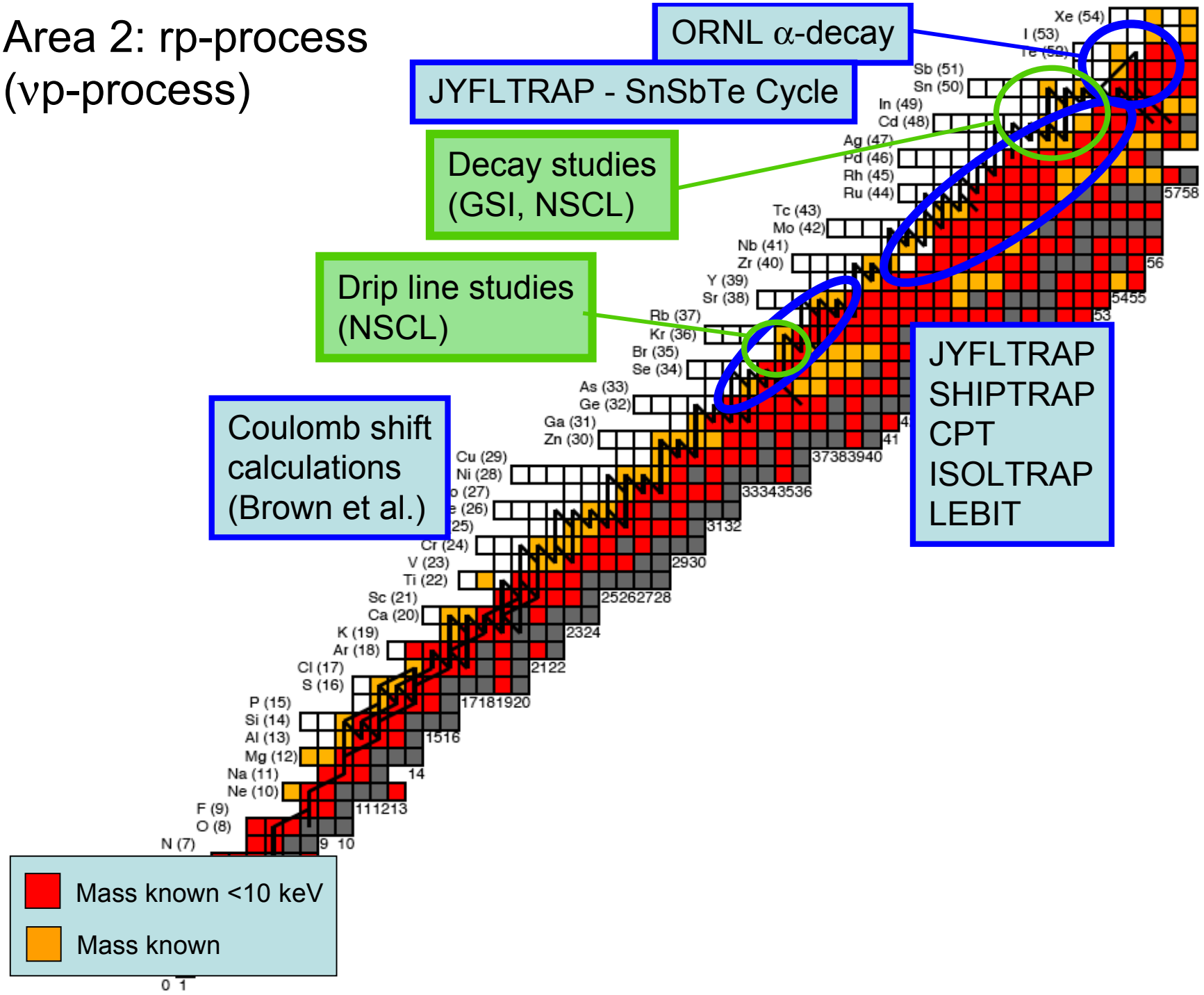


Example: impact of improved nuclear physics

Can calculate relative pattern of ^{78}Se, ^{79}Br, ^{80}Se produced in a cassical r-process based on experimental nuclear data

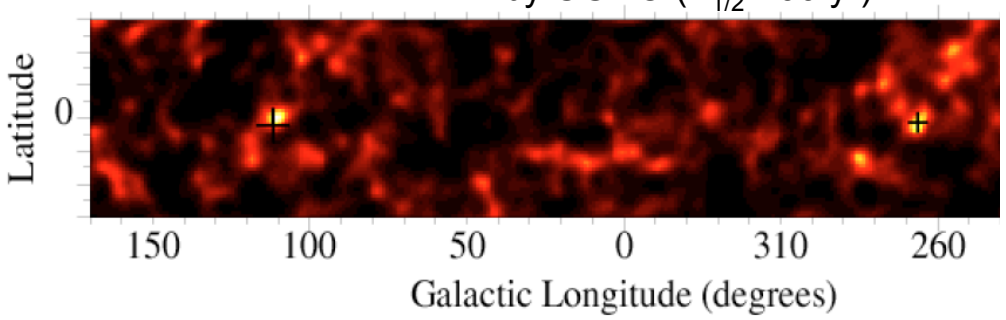


Area 2: rp-process (νp-process)

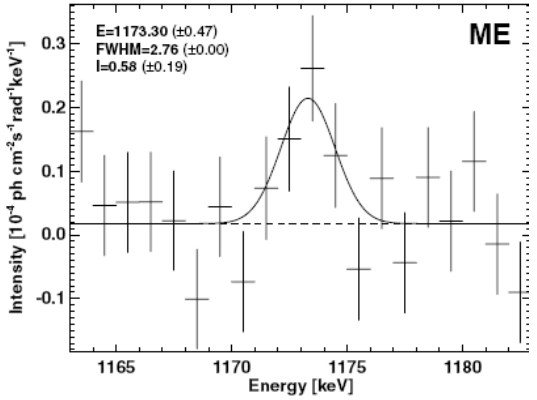


Area 3: Galactic radioactivity

^{44}Ti by CGRO ($T_{1/2}$= 60 yr)



^{60}Fe by INTEGRAL SPI
($T_{1/2}$ = 1.5 10^6 yr)

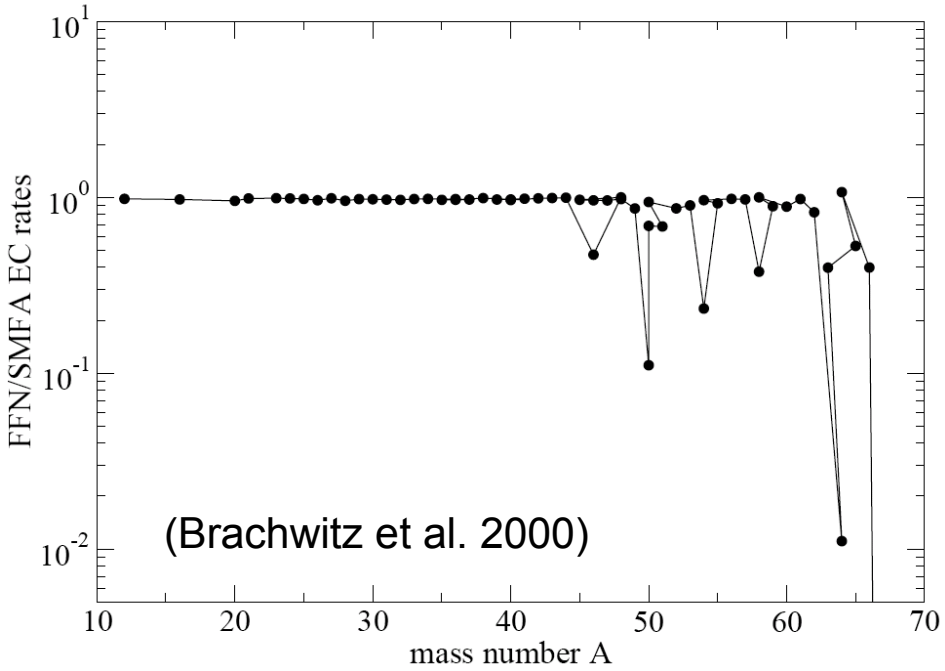


JINA Efforts (Timmes, Wiescher, et al.)

- improved reaction rates for ^{44}Ti production: ^{40}Ca(α,γ)
- improved reaction rates for ^{60}Fe production: ^{59,60}Fe(n,γ)
- supernova model calculations for ^{44}Ti and ^{60}Fe production

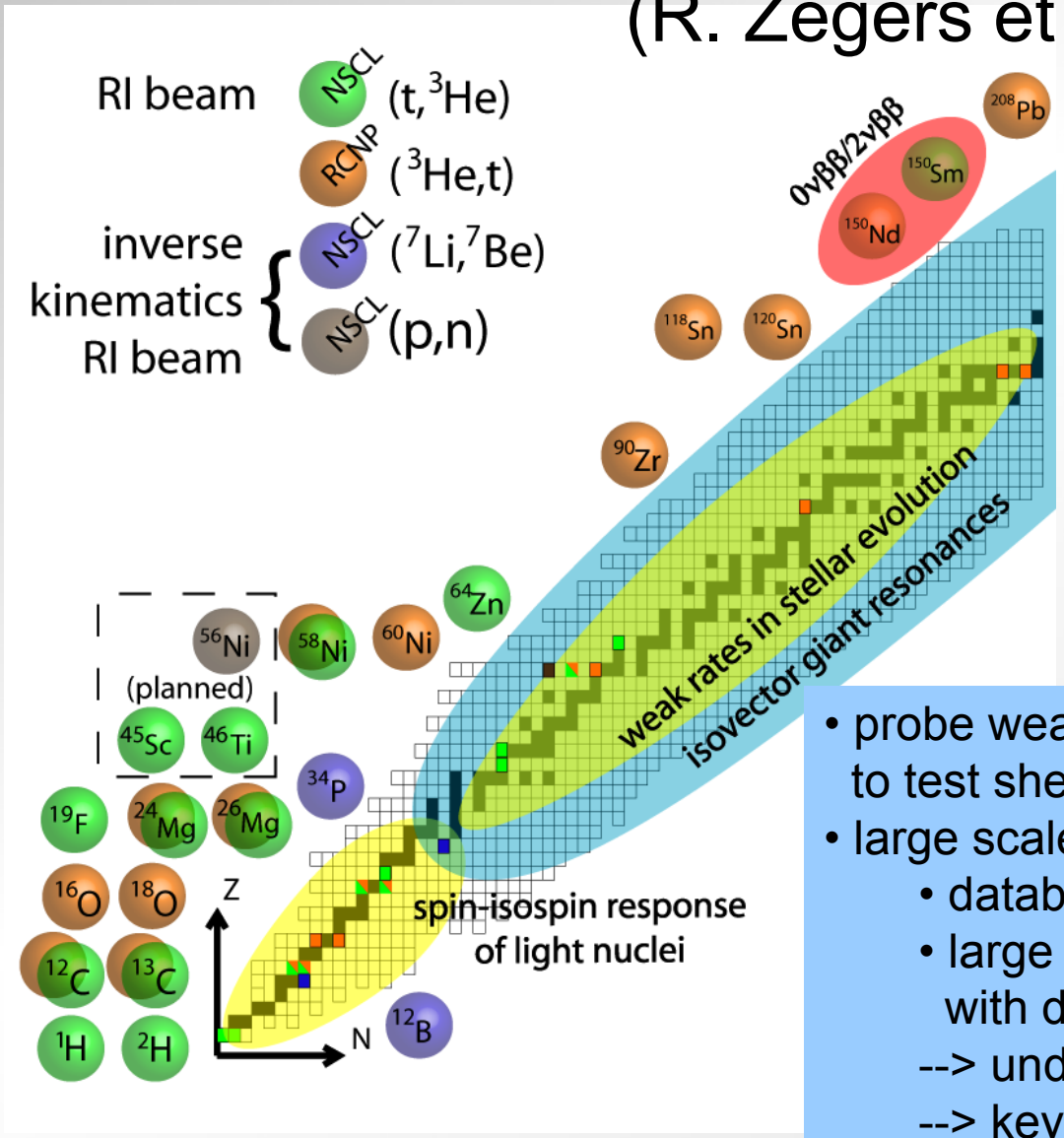
Area 4: Production of iron group isotopes in Sn Ia

Change of ejecta composition in SN Ia model when using different sets of electron capture rates



Affected are n-rich isotopes:
^{48}Ca, ^{50}Ti, ^{54}Cr, ^{54,58}Fe, and ^{58}Ni

NSCL charge-exchange program (R. Zegers et al.)



- probe weak interaction strength to test shell model
- large scale JINA project:
  - database for experimental data
  - large scale shell model calculations with different interactions

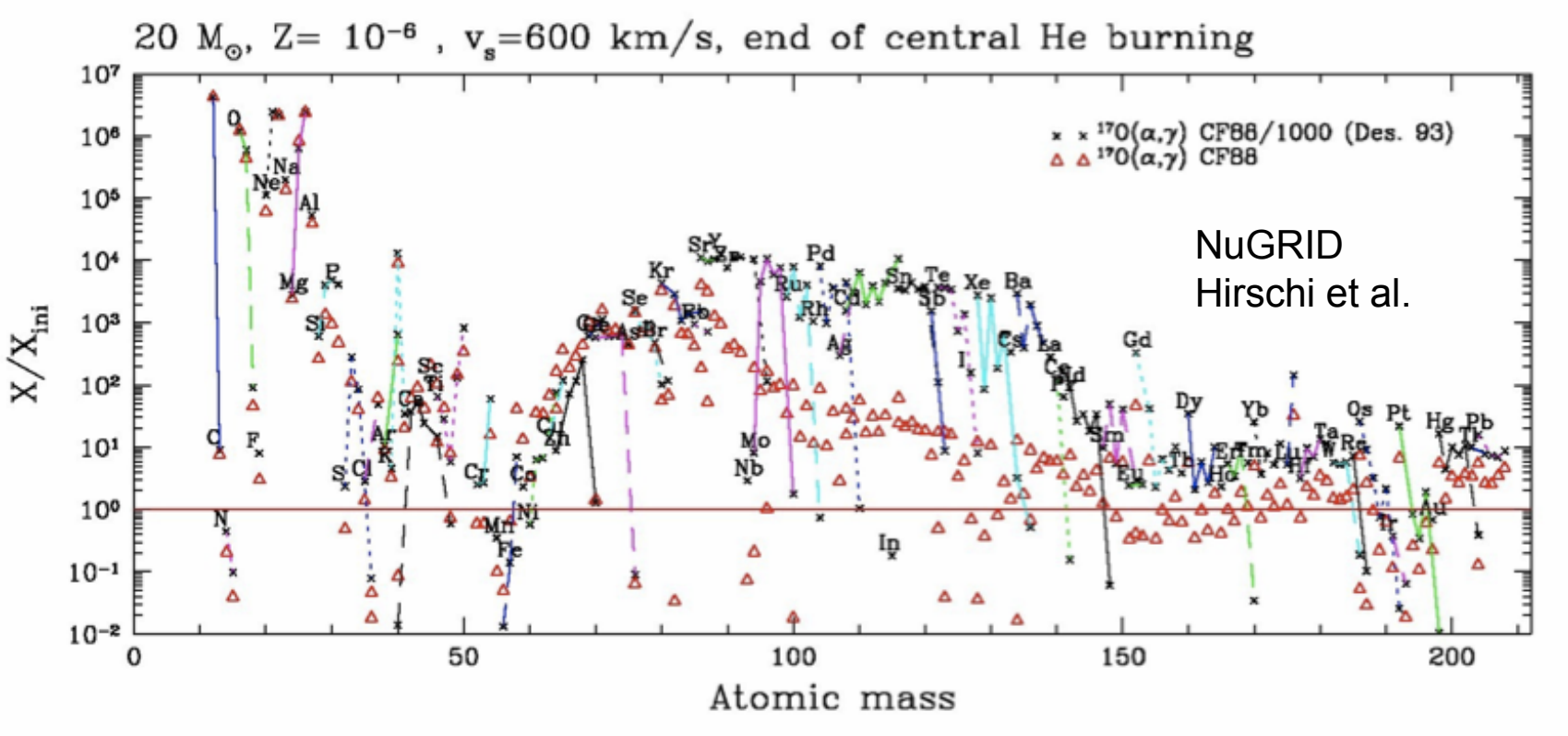
  --> understand error bars

  --> key reactions for theory improvements

  --> new astrophysical data set?

Area 5: neutron sources in the s-process

Experimental efforts (Wiescher, Best, Falahat et al.):
(α,n) rates on ^{22}Ne, ^{17}O, ^{18}O, ^{25}Mg, ^{26}Mg (and on α,γ competition)



--> main impact on weak s-process in massive stars

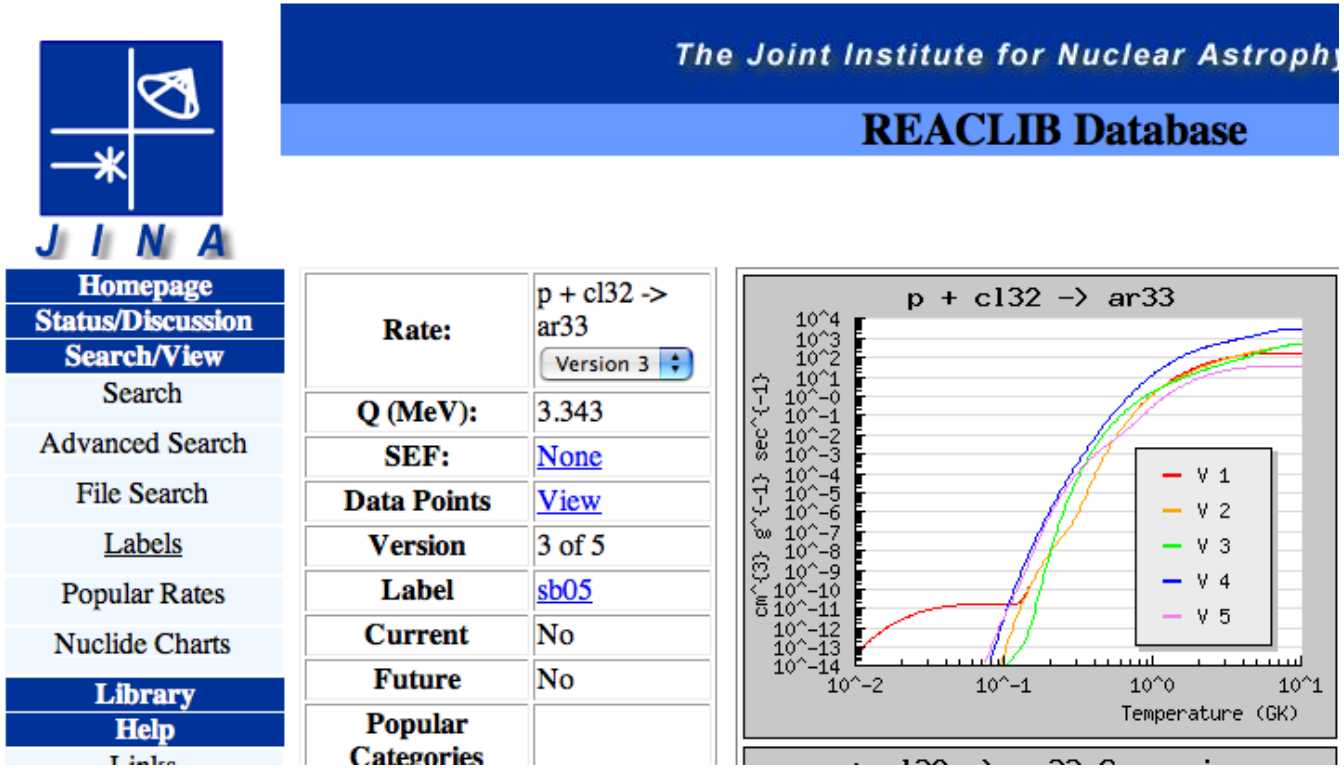
The Joint Institute for Nuclear Astrophysics

JINA reaclib database

Richard Cyburt et al.

- Reaction rates (no uncertainties)
- Goal: provide best rates available in literature at any given time
- Continuous rapid updates
- Only modest evaluation for quality control (ensure new version is improvement)
- Include published evaluations (including evaluations by reaclib group)

http://groups.nscl.msu.edu/jina/reaclib/db/



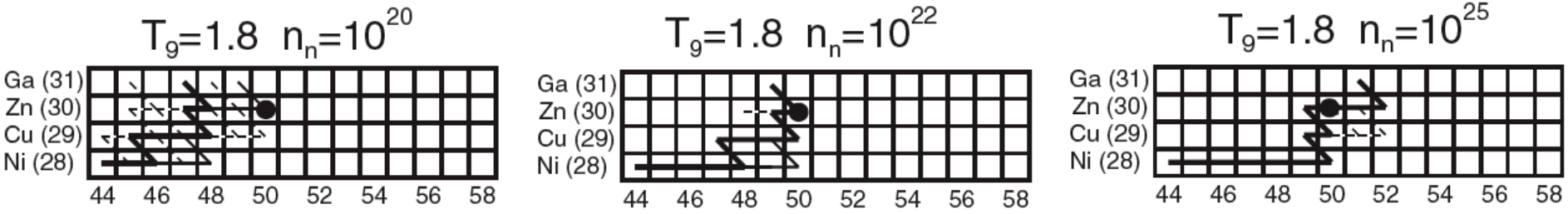
Summary: areas affected by exp nuclear work

- stellar evolution affected by 3-alpha (talk by Sam Austin)
- p-process ? (New program by Artemis Spyrou)

- r-process <Pd (LEPP, νp-process, s-process)
  and around A=130
- ^{44}Ti and ^{60}Fe
- iron group in Sn Ia (^{48}Ca, ^{50}Ti, ^{54}Cr, ^{54,58}Fe, and ^{58}Ni))
- s-process: ^{22}Ne(α,n) and weak s-process
- νp-process (n-deficient isotopes up to A~100?)

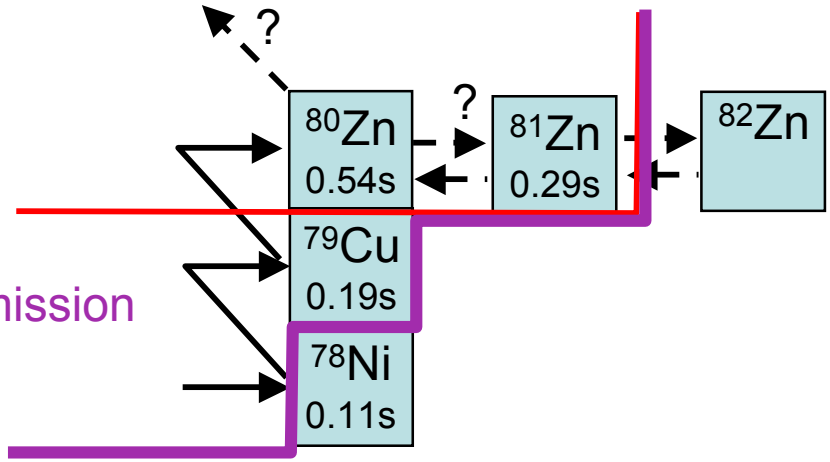
(Talk by Carla Fröhlich)

The r-process at A=80



Baruah et al. 2008

Precision masses
from ion traps (JYFLTRAP, ISOLTRAP)



known n-emission
branchings

> Unique region where main nuclear physics for the r-process is now experimentally constrained