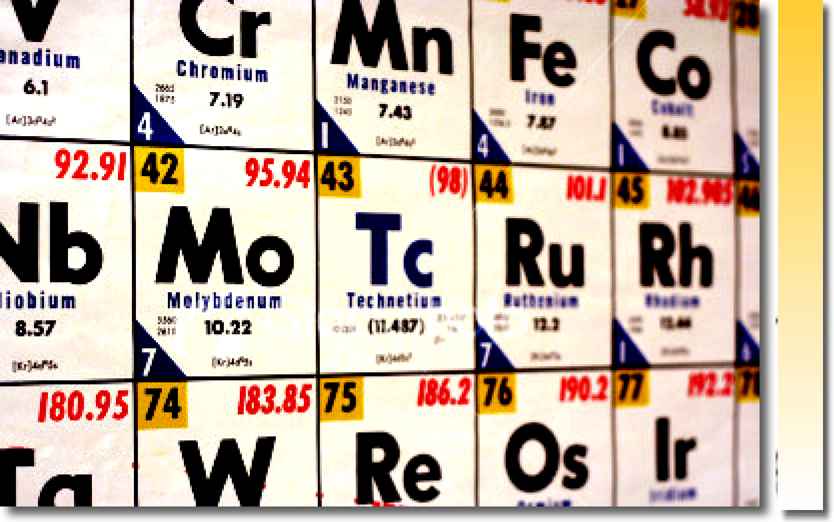
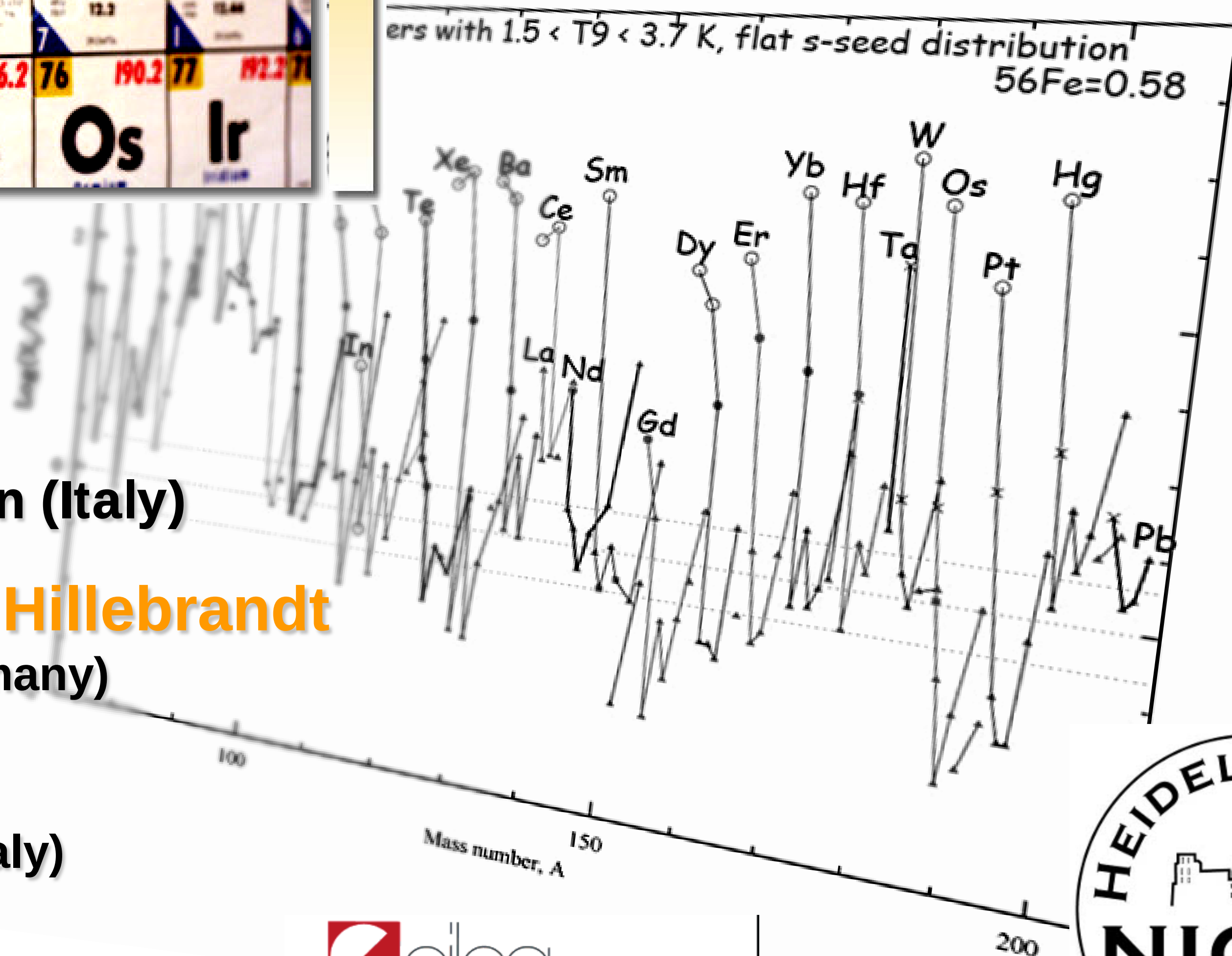


p-process in multi-D SNIa



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UniversityTurin (Italy)

Computer resources thanks to

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CALCOLO ALTE PRESTAZIONI
TECNOLOGIE DELL'INFORMAZIONE E DELLA COMUNICAZIONE

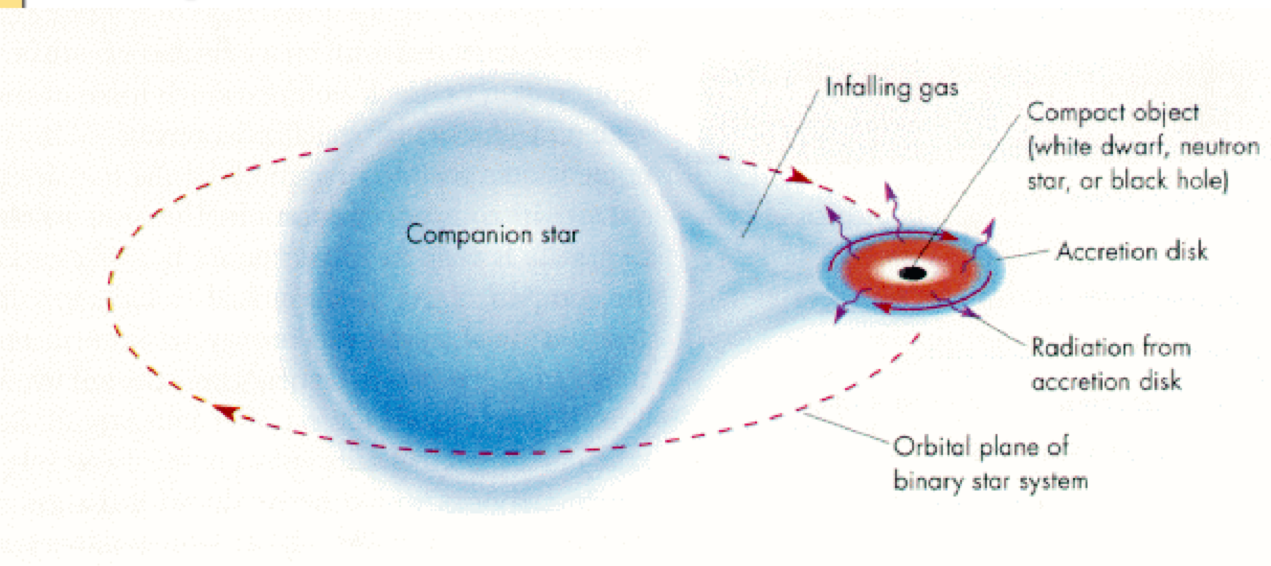
B2FH
Ricerca per l'Astrofisica Nucleare

HEIDELBERG
NIC XI
JULY 19 - 23, 2010

Who studied this problem:

Howard, Meyer, Woosley 199* ;
Arnould, Prantzos 199*;
Goriely et al. 200*;
Kusakabe, Iwamoto, Nomoto 201*

s-process in accreted mass



"Accreting white dwarfs as an alternate or additional source of s-process isotopes" (Iben, ApJ 243, 1981)

Hydrogen-accreting CO white dwarf

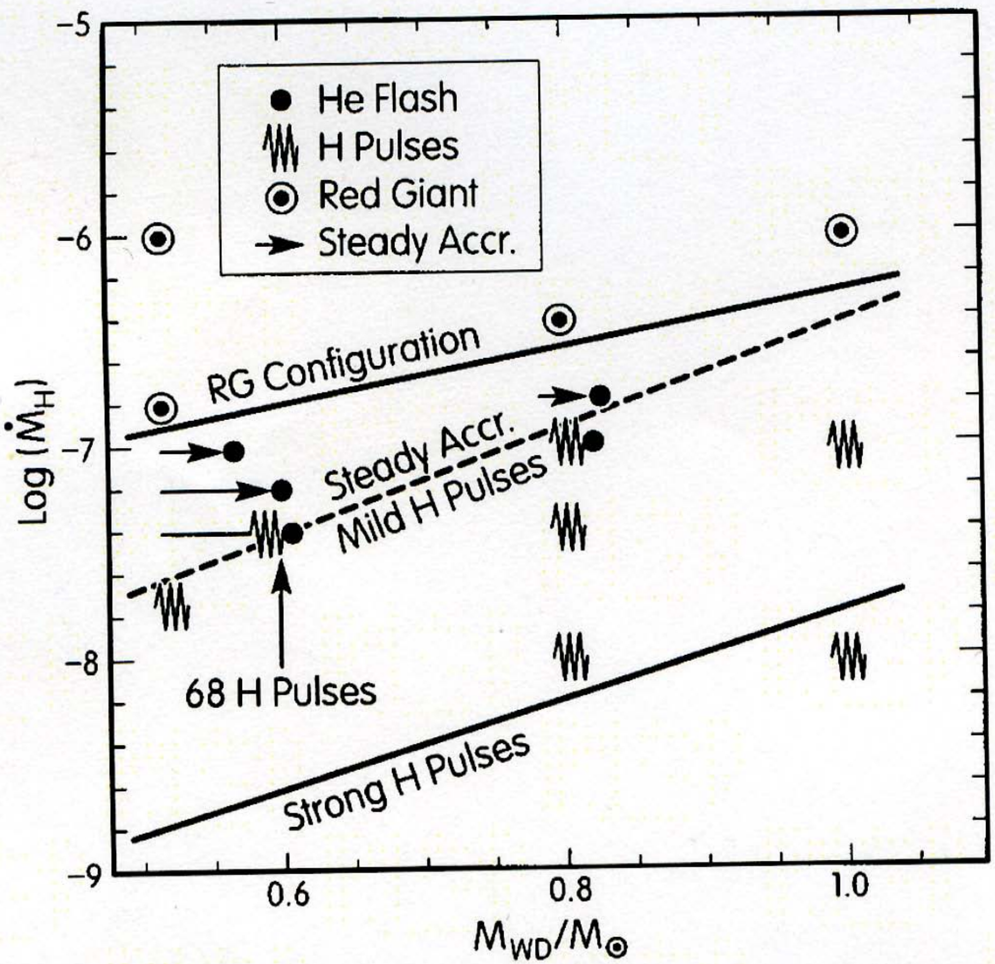


FIG. 10.—Parameter space in the $\dot{M}$-M_{WD} plane explored in the present work. Various symbols mark the different outcomes experienced by the various computed models, depending on initial white dwarf mass and accretion rate (see the text for symbol meanings). The results of accretion experiments performed by Livio et al. (1989) with a 1 $M_\odot$ WD are also shown at the right in the figure.

Cassisi, Iben, Tornambe' 1998, ApJ, 496, 376

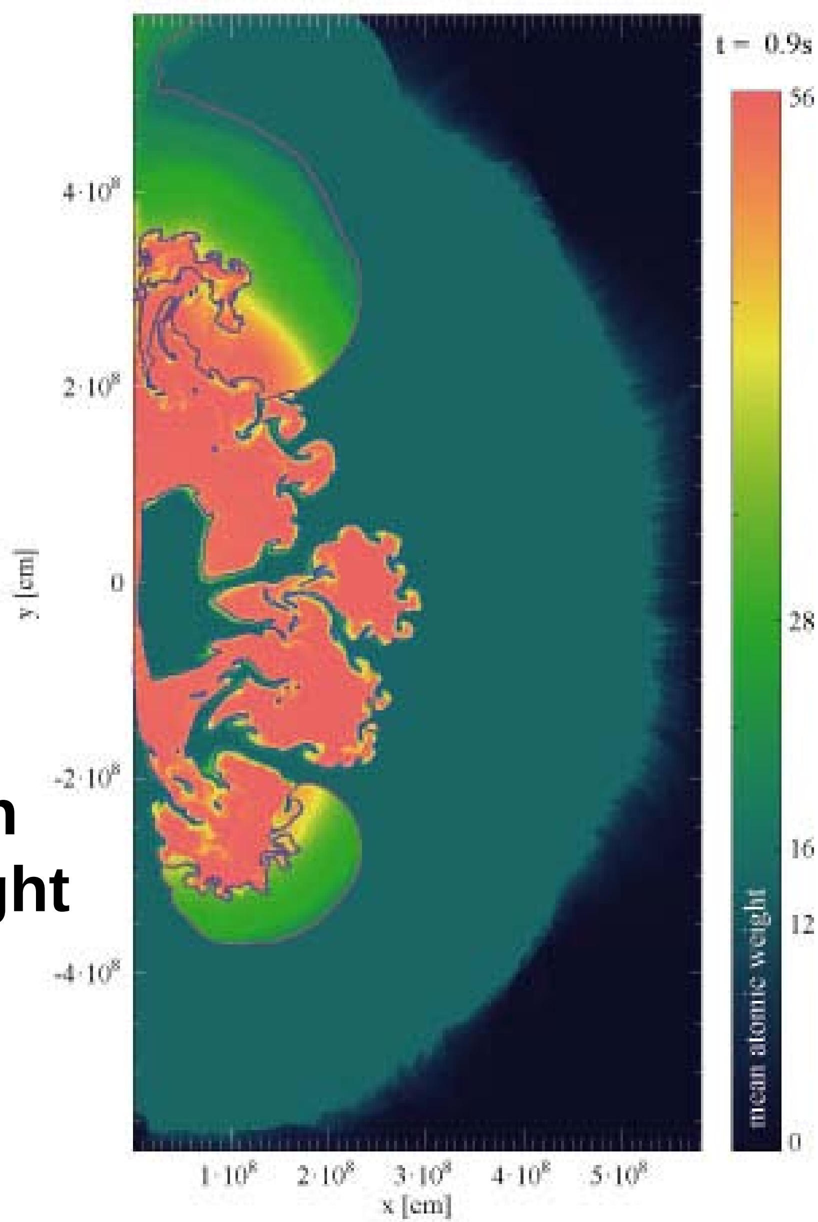
Piersanti, Cassisi, Iben, Tornambe' 2000, ApJ, 535, 932

Type Ia models: 2D

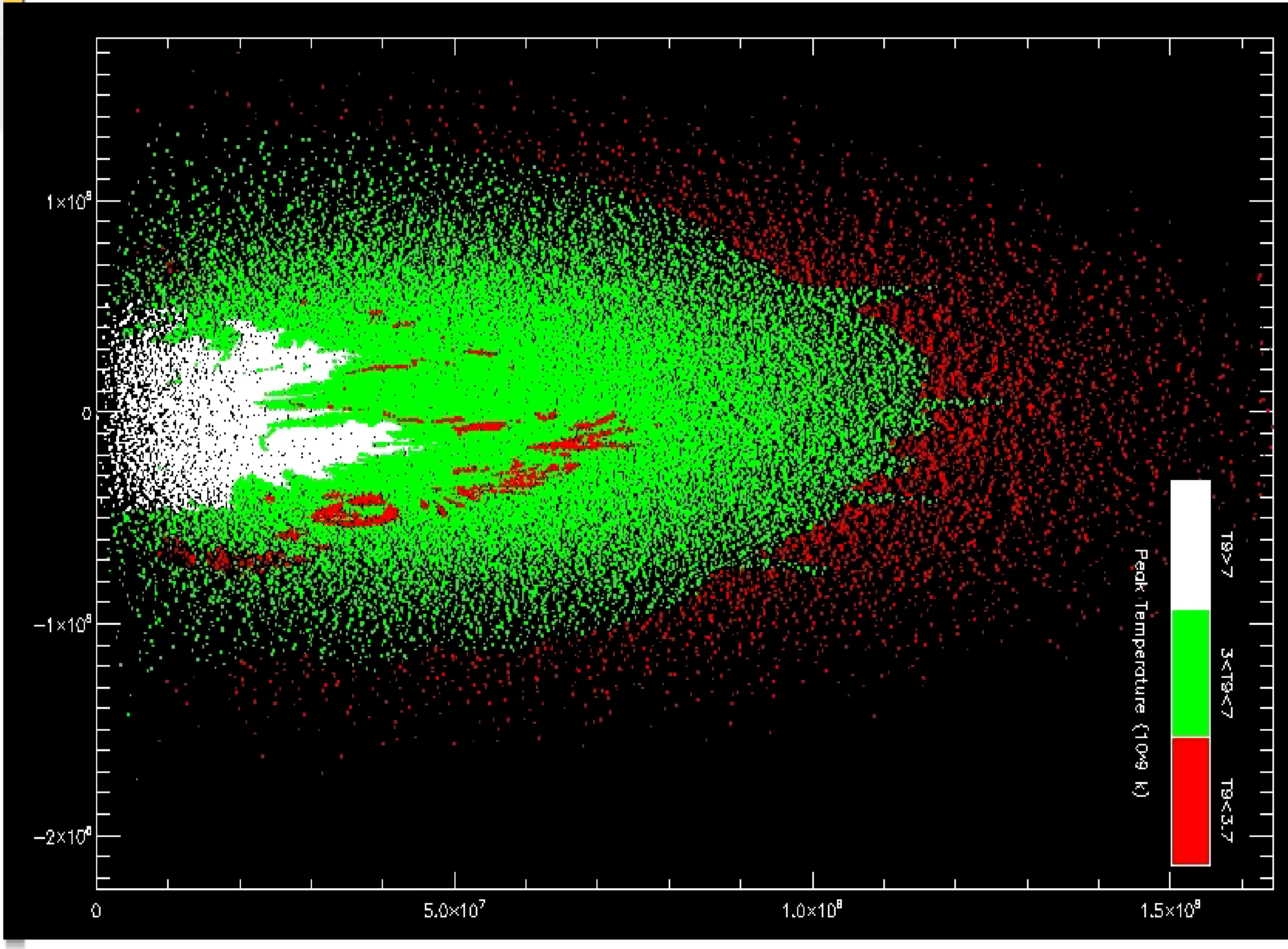
(simulation done by F. Ropke)

We tested different SNIa models:

- **pure deflagration**
- **delayed detonation with different strenght**



Tracer particles in SNIa models



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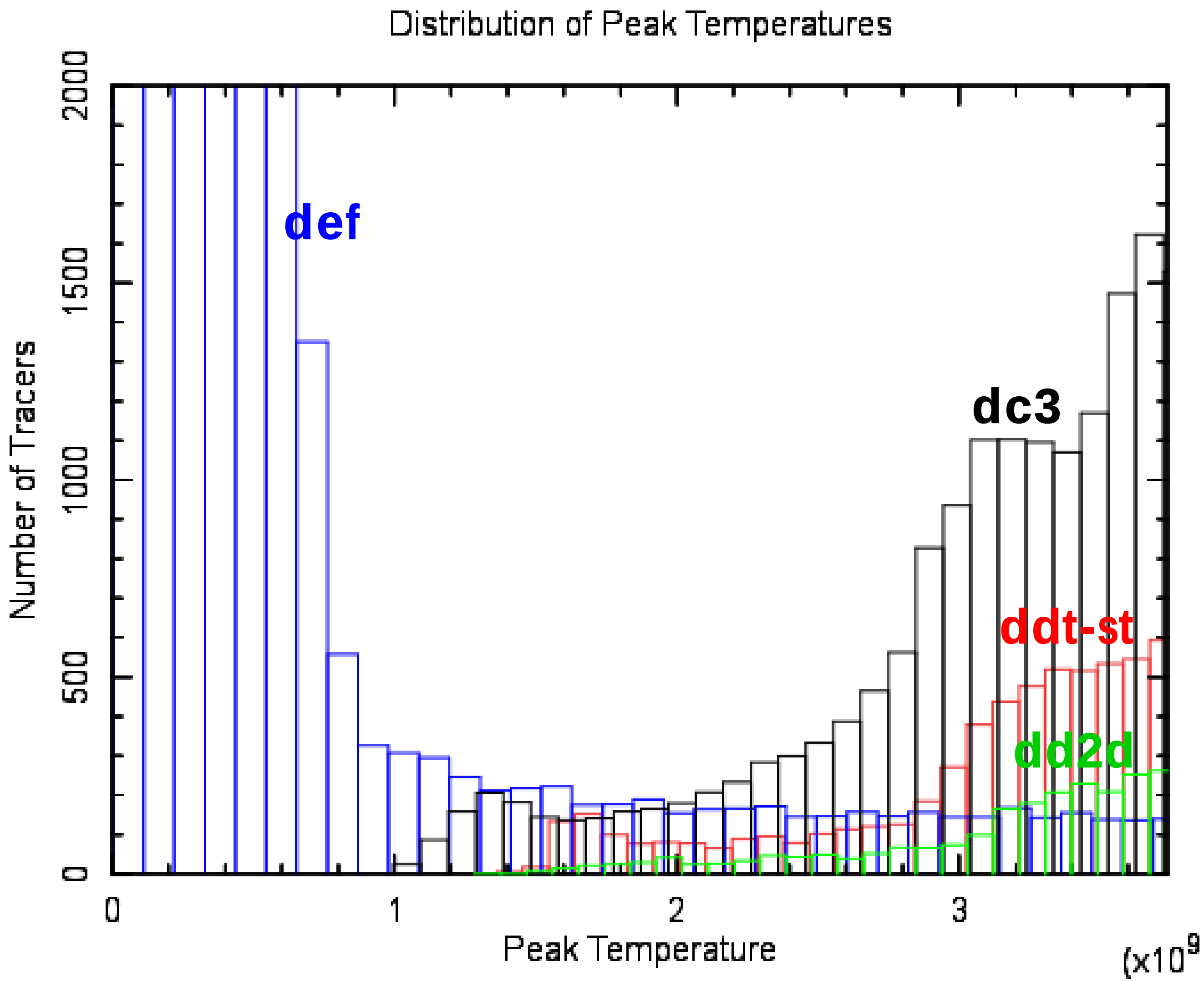
Distribution of tracers

def = deflagration
ddt-st = standard del. det.

dc3 = weaker del. det.
dd2d = stronger del. det.



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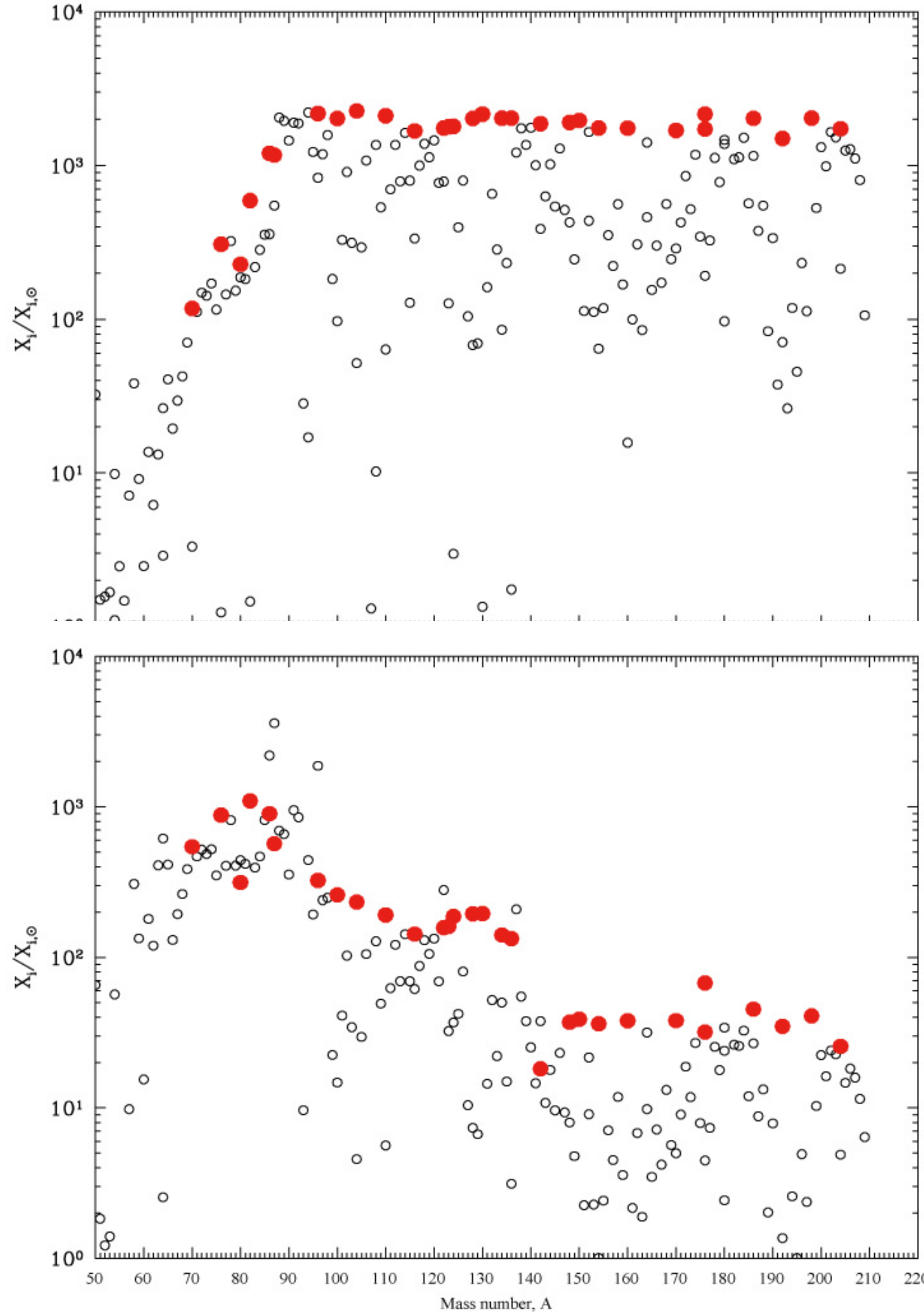
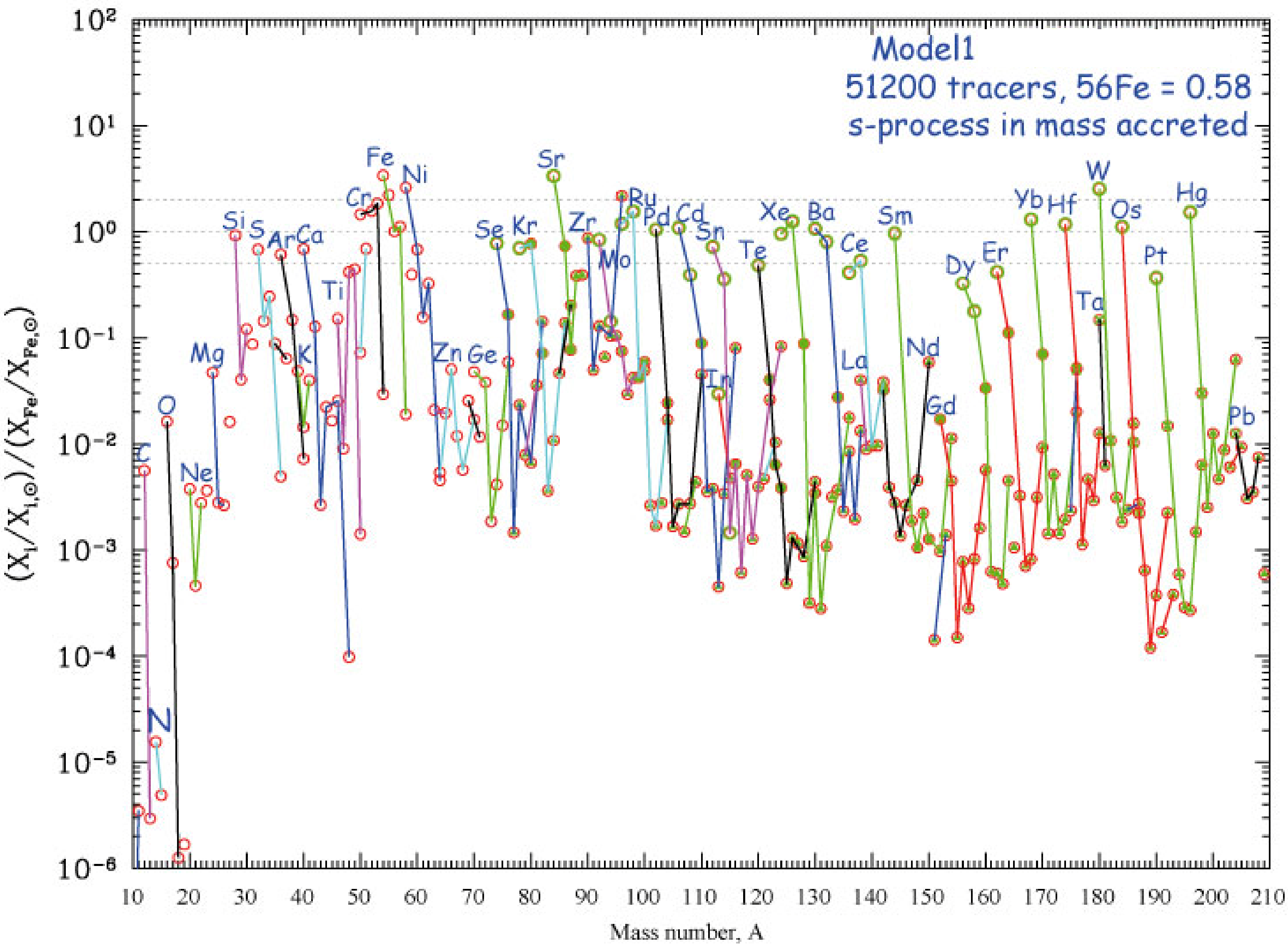
s-process seeds

Preliminary s-process tests in a close binary system during the secondary companion MS/giant accreting on a WD

(Cristallo, Piersanti et al. in progress)



Results: solar metallicity



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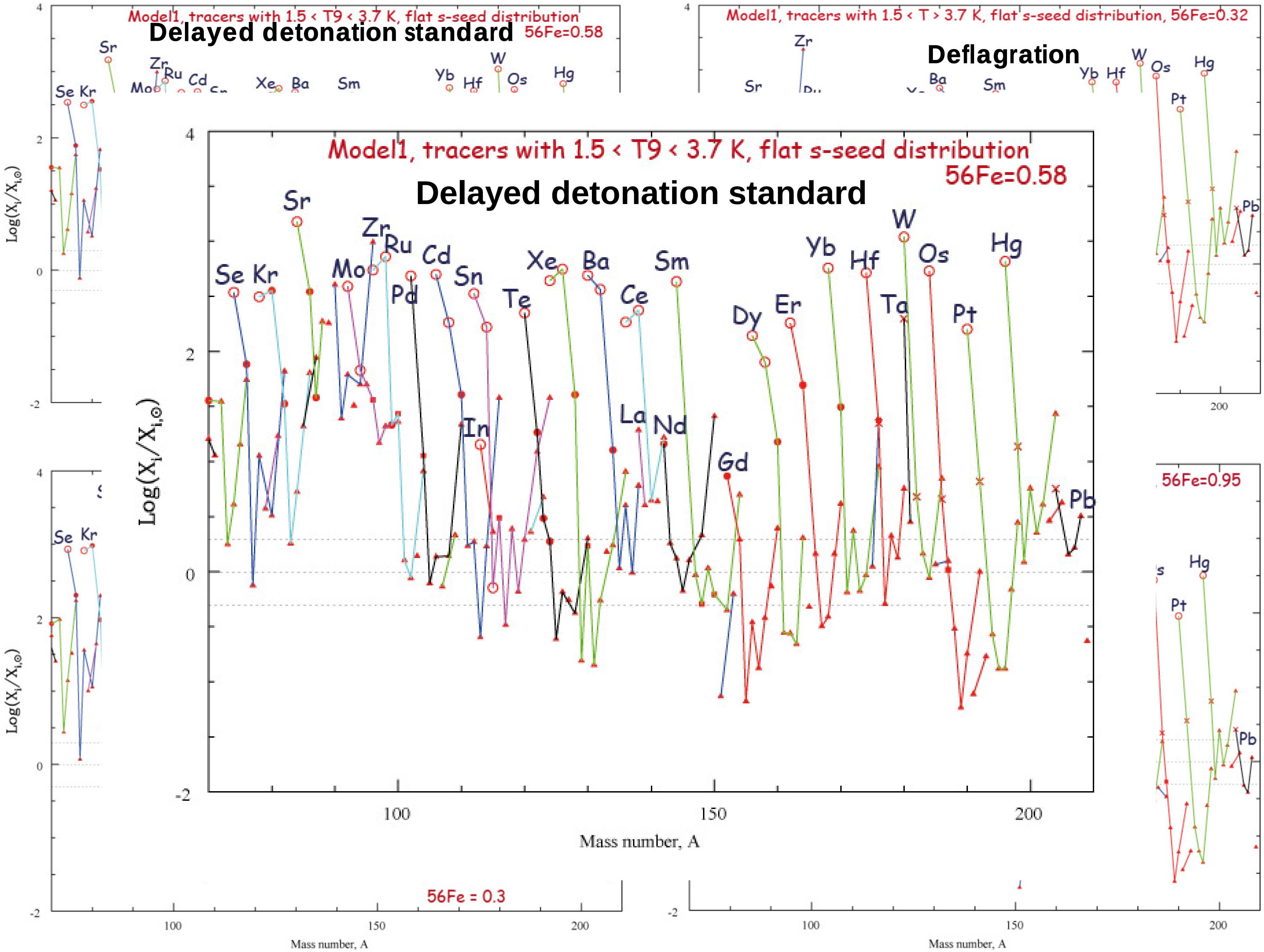
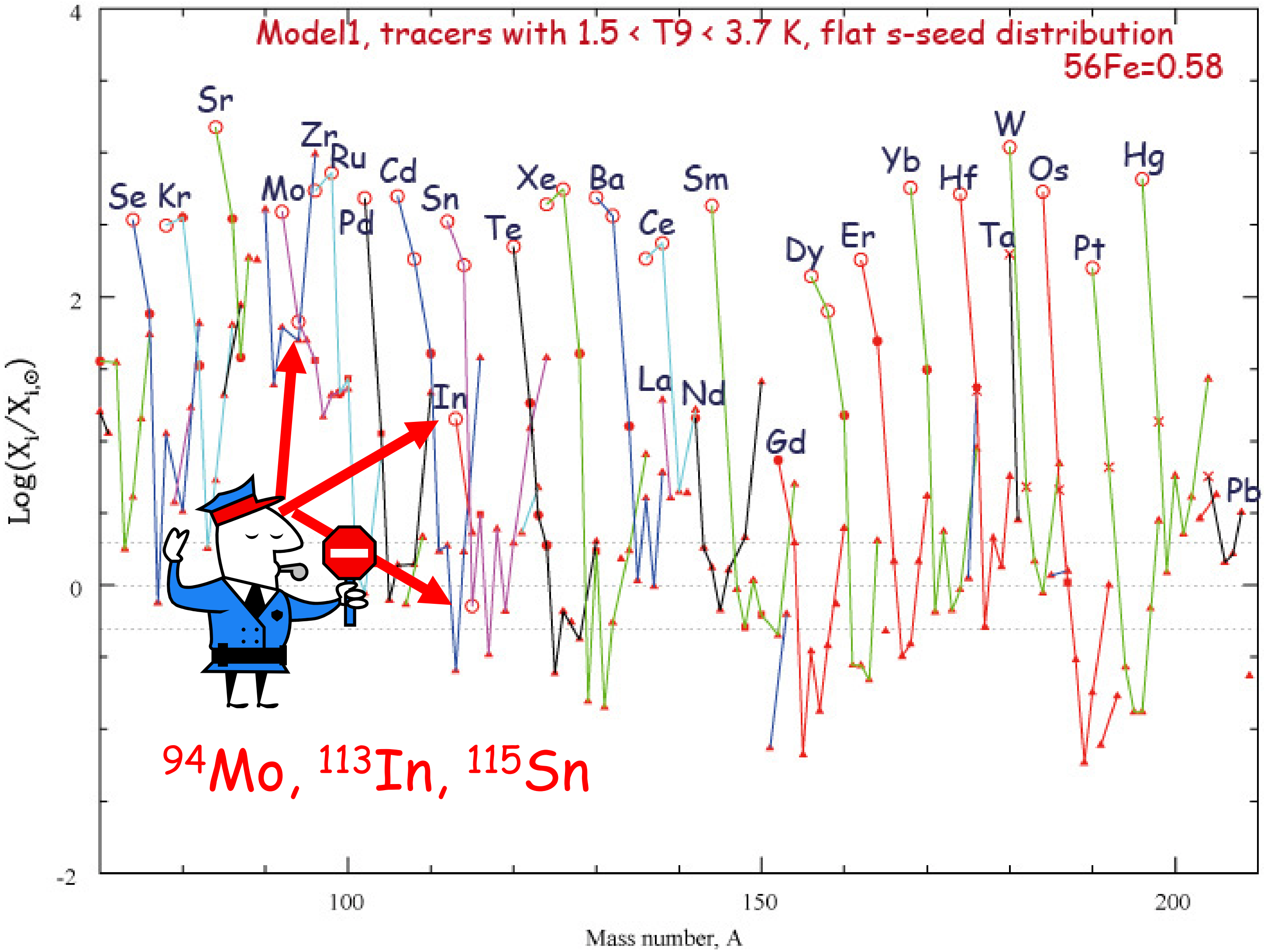


Model1, tracers with 1.5 ‹ T9 ‹ 3.7 K, flat s-seed distribution
Delayed detonation standard
56Fe=0.58
Model1, tracers with 1.5 ‹ T › 3.7 K, flat s-seed distribution, 56Fe=0.32
Deflagration
56Fe=0.95
56Fe = 0.3
Se
Kr
Sr
Zr
Mo
Ru
Pd
Cd
Sn
In
Te
Xe
Ba
La
Ce
Nd
Sm
Gd
Dy
Er
Yb
Hf
Ta
W
Os
Pt
Hg
Pb
Log(Xi/Xi,⊙)
Mass number, A



^{94}Mo, ^{113}In, ^{115}Sn

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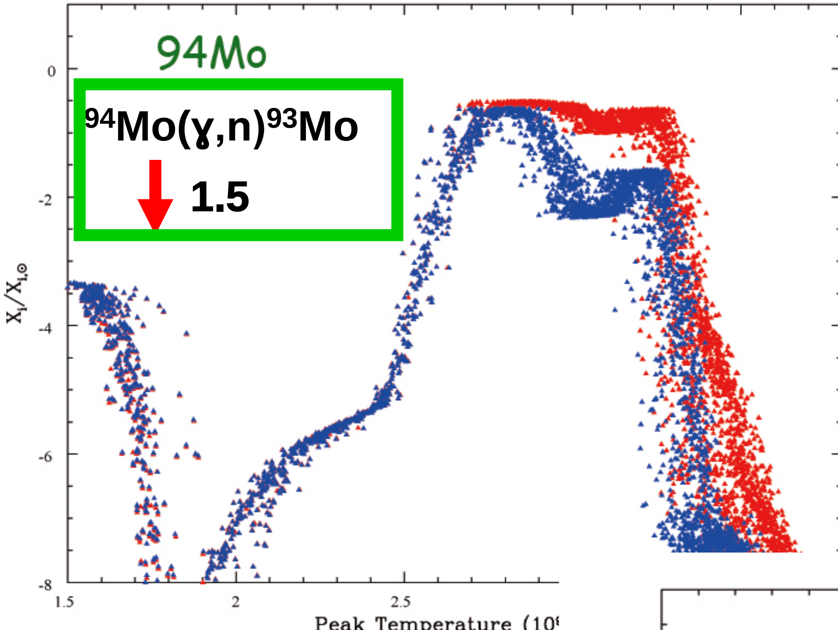

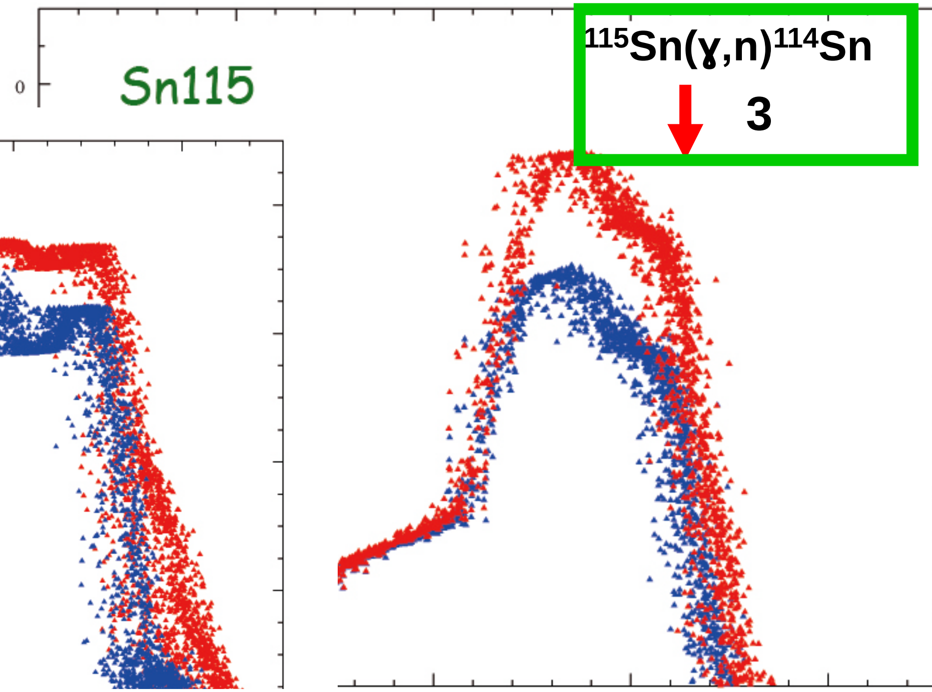

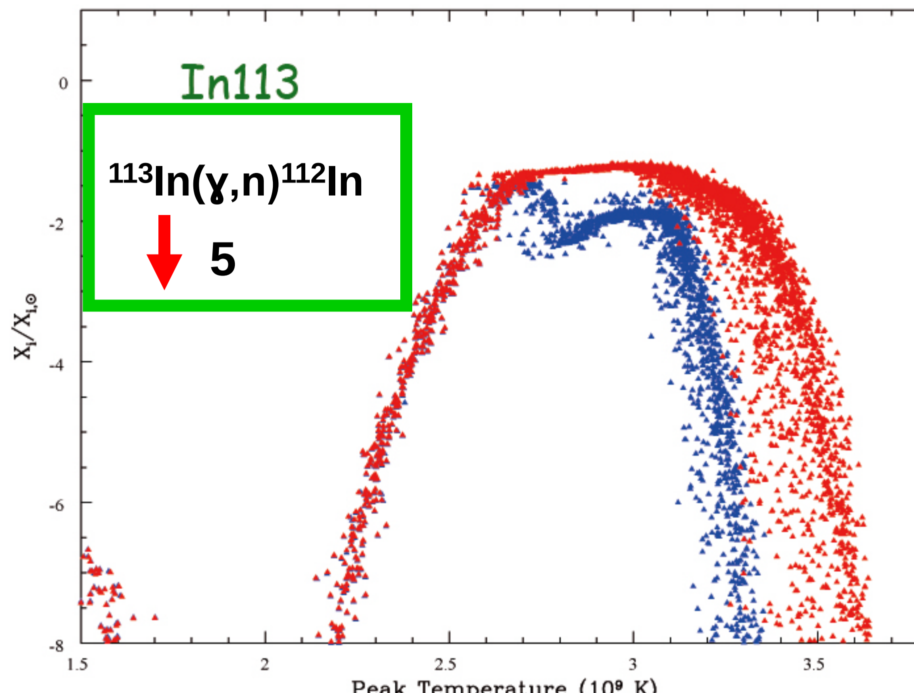

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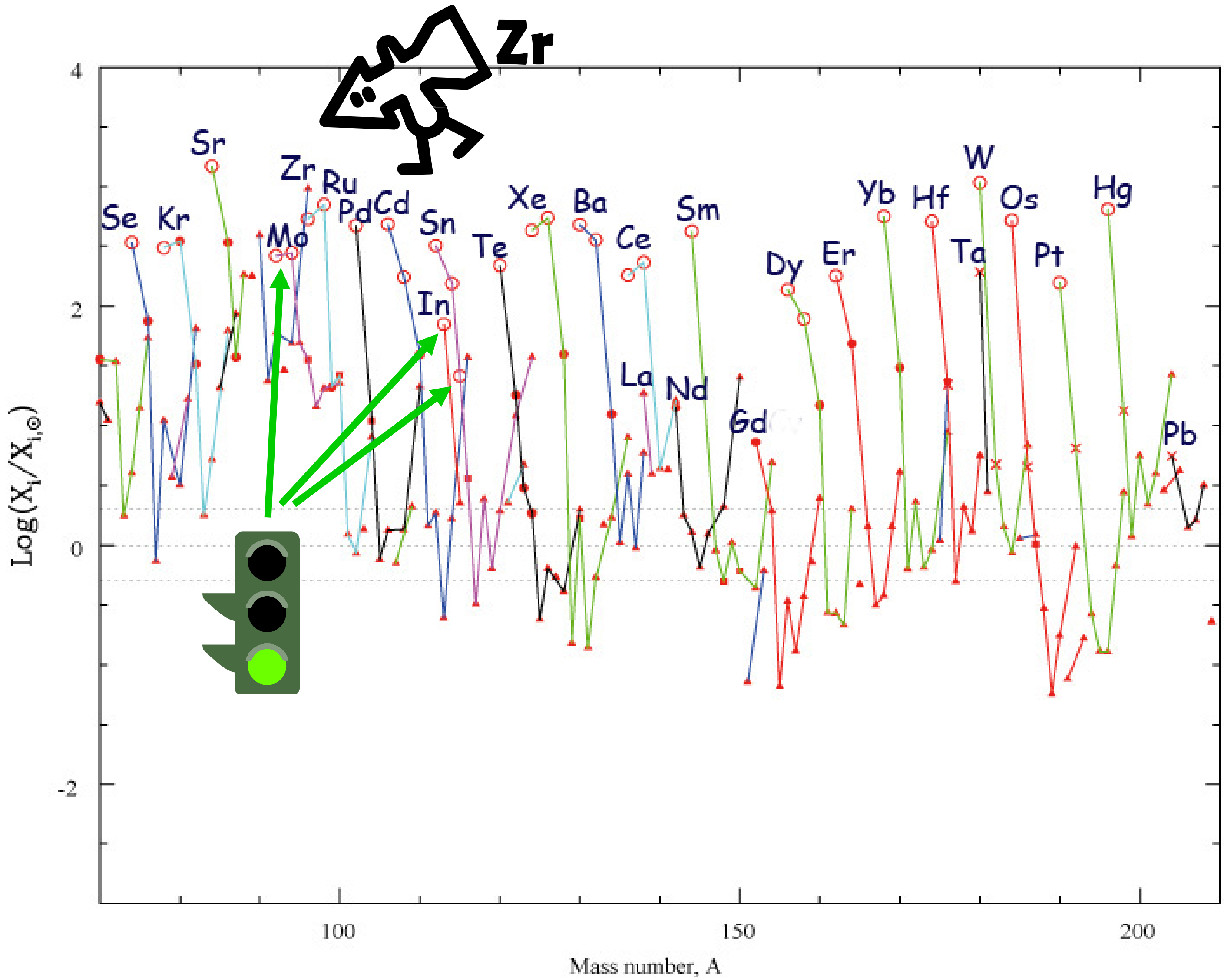
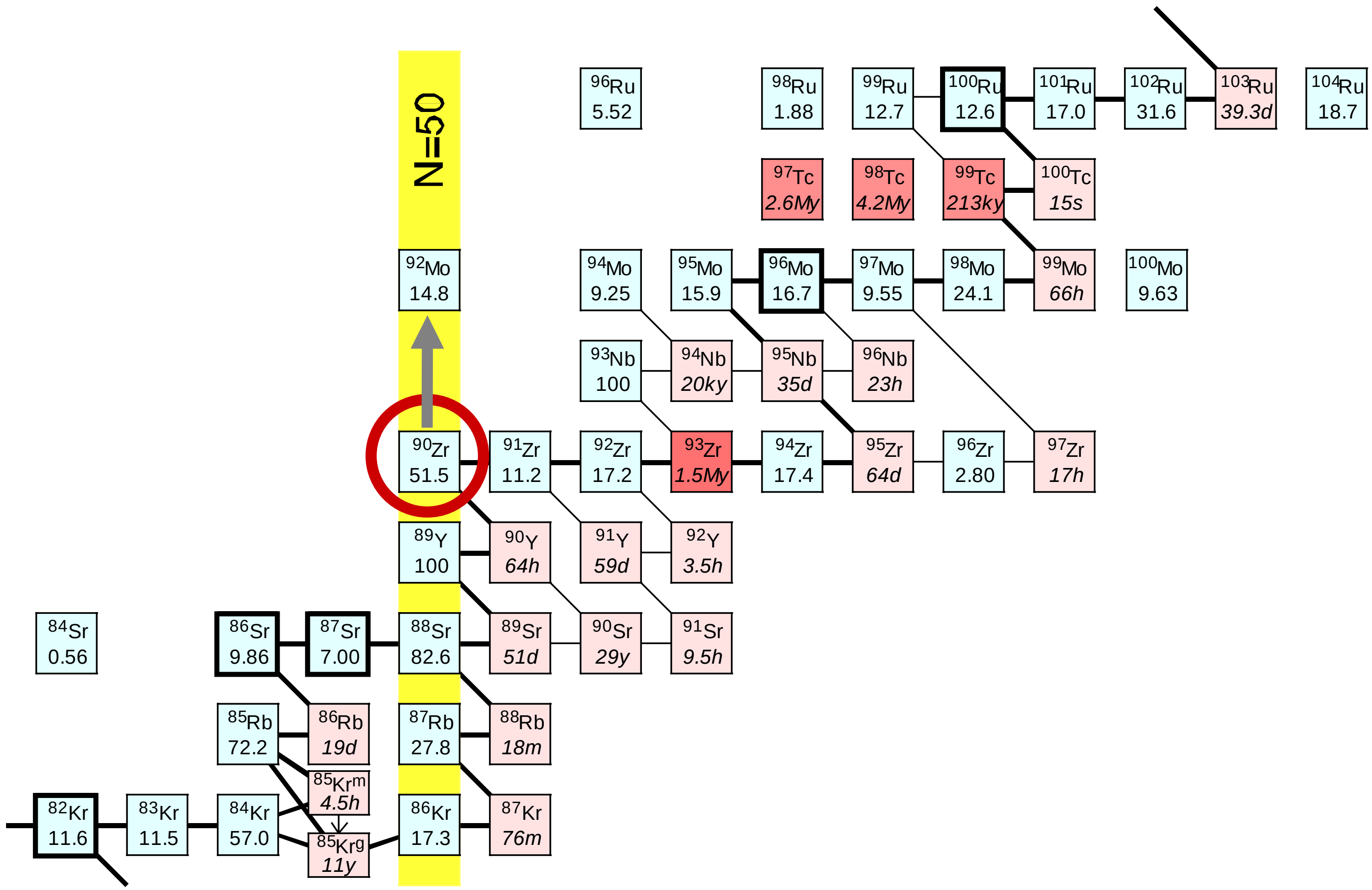


^{113}In, ^{115}Sn are p-only isotopes?

r-process contribution ***(Dillmann et al. 2008, Nemeth et al. 1994)*****?**

^{90}Zr 60% from GCE of s-process

Travaglio et al. 2004; Serminato et al. 2009



+ p-process contribution from SNIa to be taken into account

Future

Nucleosynthesis in accreted mass

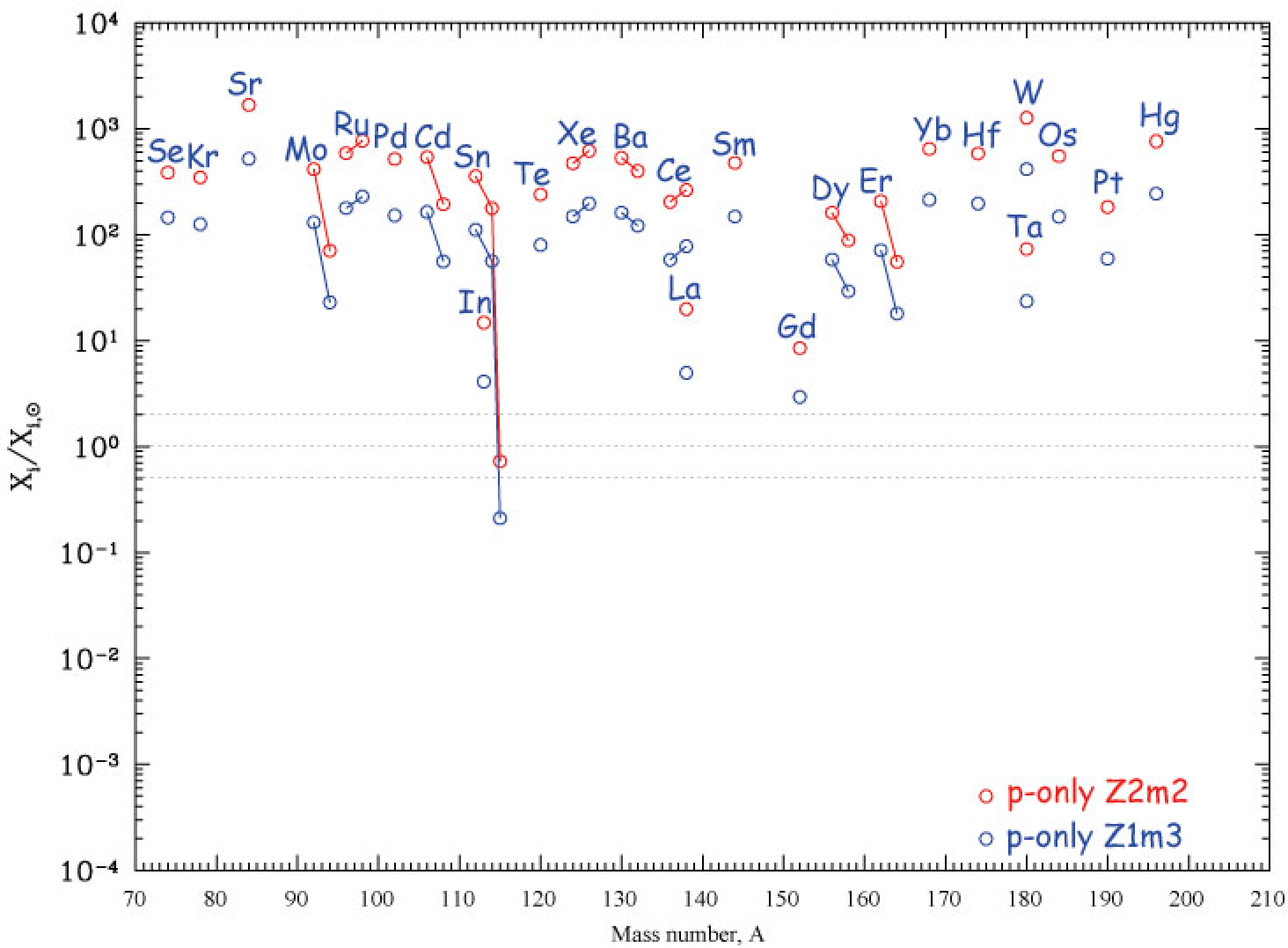
(Cristallo, Piersanti et al. in progress)

Sub-Chandrasekhar models

(Roepke et al. at MPA)

Chemical evolution

Metallicity study



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p-process in SNII:

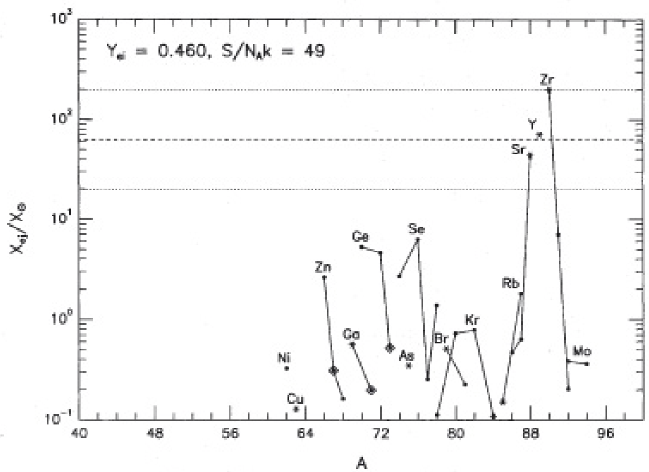

FIG. 2a

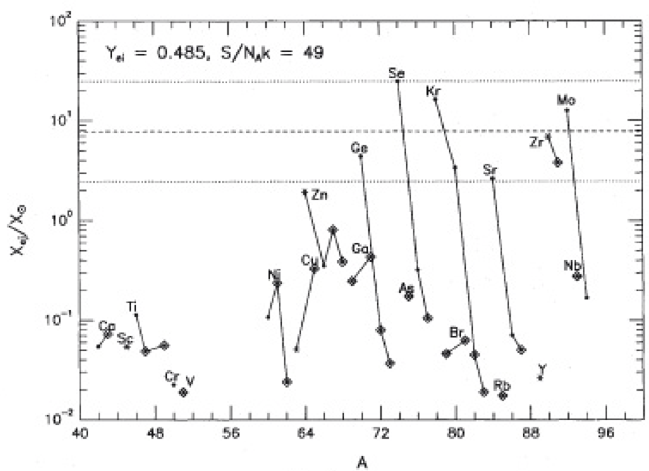

FIG. 2b

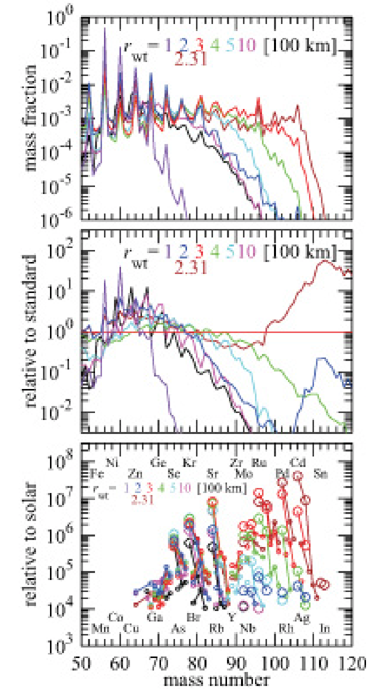

FIG. 2.— Comparison of the nucleosynthetic results for various wind-termination radii r_{wt}. The mass fractions (top) and their ratios relative to those for the standard model (middle) are shown as a function of atomic mass number. The bottom panel shows the abundances of isotopes (connected by a line for a given element) relative to their solar values, where those lower than 10^4 are omitted. The color coding corresponds to different values of r_{wt} as indicated in each panel (red is the standard model). The result for the outflow without wind termination is shown in black. In the bottom panel, the names of elements are specified in the upper (even Z) and lower (odd Z) sides at their lightest mass numbers.

This condition continues until the end of their commu-

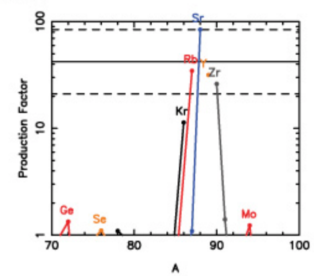

Figure 7. Isotopic production factors from the NDW model employing the neutrino luminosities from Woosley et al. (1994) with the anti-electron neutrino temperature reduced by 15%. The production factors are calculated assuming that 18.4 $M_{\odot}$ of material was ejected in the supernova in addition to the wind. The horizontal lines are similar to those in figure 5.

Figure 9. Isotopic production factors from the NDW model when the neutrino luminosities from Woosley et al. (1994) are used and an external boundary pressure is specified as described in the text, which results in a wind termination shock. The production factors are calculated assuming that 18.4 $M_{\odot}$ of material was ejected in the supernova in addition to the wind. The horizontal lines are similar to those in figure 5.

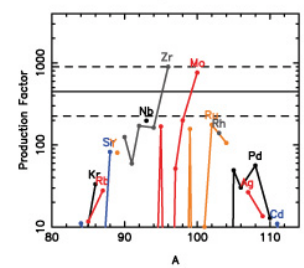

Figure 8. Isotopic production factors from the NDW model employing the neutrino luminosities from Woosley et al. (1994) with weak magnetism corrections turned off. The production factors are calculated assuming that 18.4 $M_{\odot}$ of material was ejected in the supernova in addition to the wind. The horizontal lines are similar to those in figure 5.

which r-process nucleosynthesis is expected, but spends a significant amount of time making nuclei in the N = 50 closed shell isotones.

4.1.1. *Variations in Neutrino Properties*

Since the neutrino temperatures from the original model were uncertain, several other models were calculated. One had a reduced (by 15%) electron antineutrino temperature; another had the weak magnetism corrections to the neutrino interaction rates turned off. A smaller antineutrino temperature is more in line with recent calculations of PNS cooling (Pons et al. 1999; Keil et al. 2003). Because the model of Woosley et al. (1994) did not include weak magnetism corrections, our model with weak magnetism corrections turned off is more consistent with the original supernova model.

The production factors for the model with a reduced electron antineutrino temperature are shown in figure 7. The yield of ^{88}Sr is reduced by almost a factor of ten from the base case, while the production factors of ^{89}Y and ^{90}Zr are reduced by a factor of three. In this case, the wind also produces the proton-rich isotopes ^{74}Se, ^{78}Kr, and ^{84}Sr. The coproduction line for lighter elements like oxygen in a $20 M_{\odot}$ supernova at solar metallicity is around 18, so the wind could contribute to the total nucleosynthesis if the antineutrino temperature was

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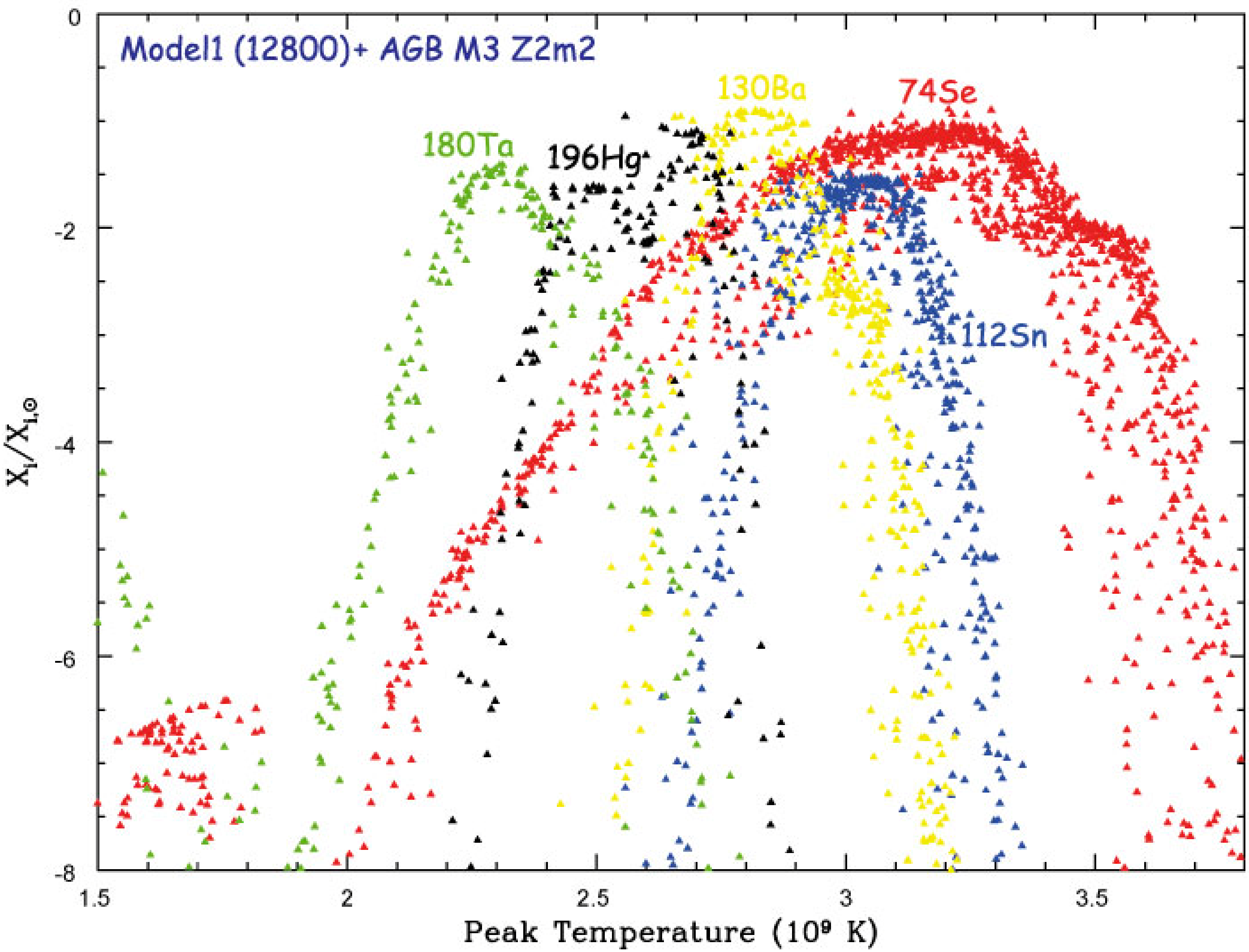
At which T p-process formed?



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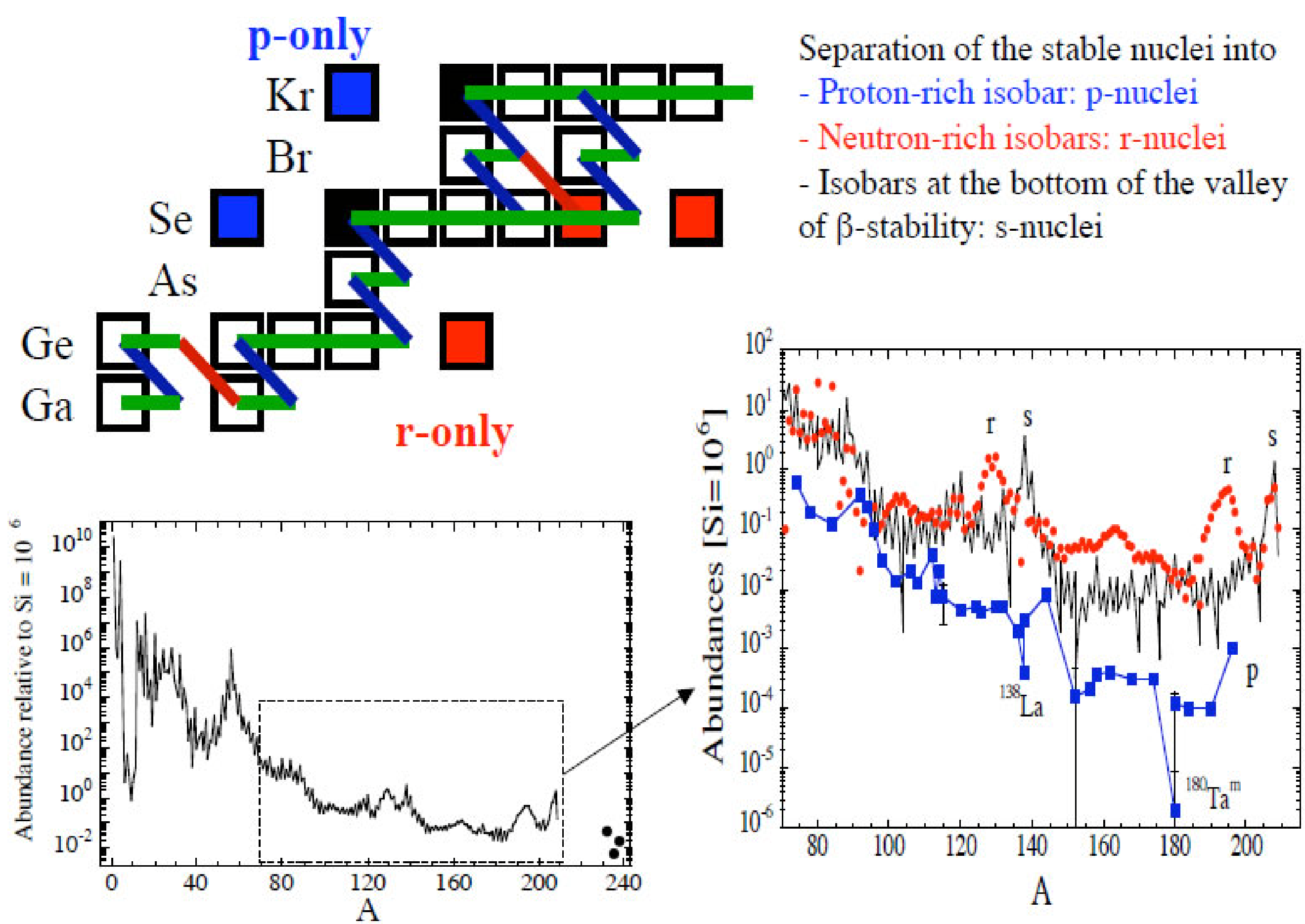
Solar composition

In nature 35 nuclei can be found on the neutron-deficient side of the valley of stability ranging from ^{74}Se and ^{196}Hg, which are shielded against production by n-capture processes.



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Thielemann et al., 2010

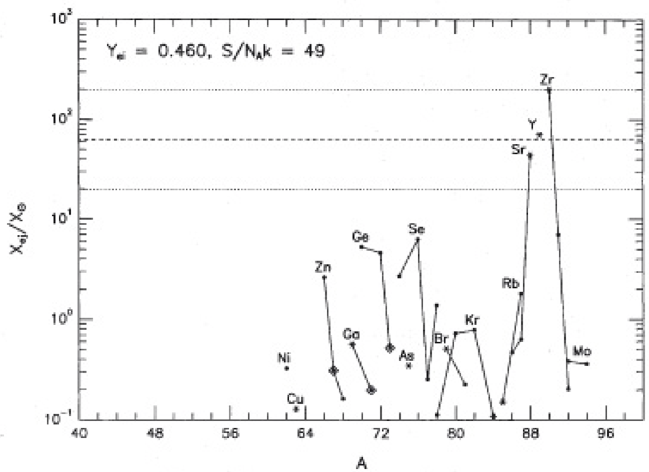


FIG. 2a

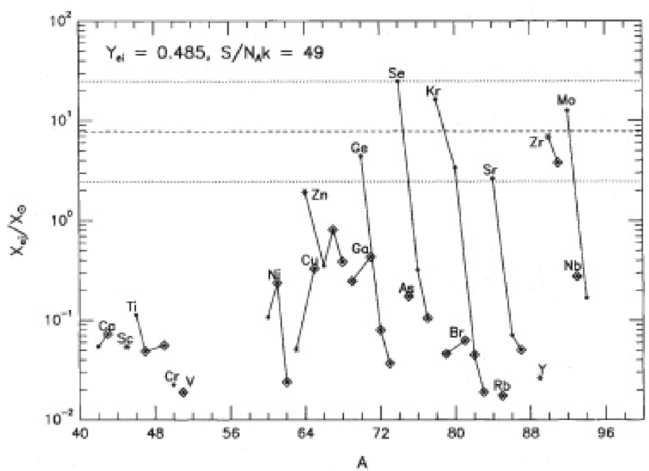
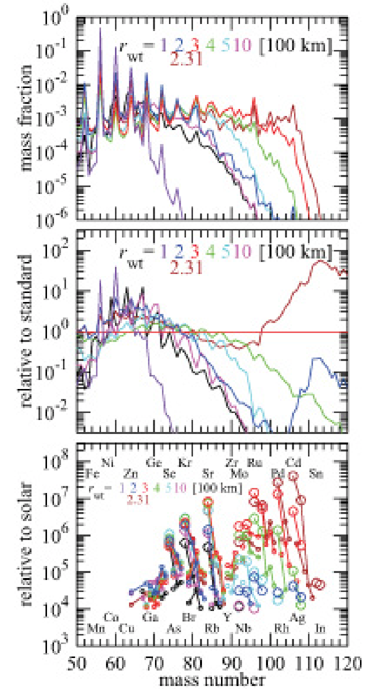


FIG. 2b

Wanajo, Janka, Kubono, ApJ submitted



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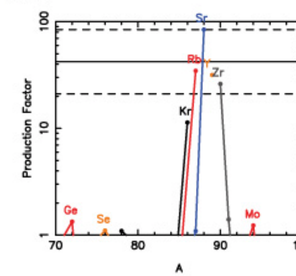
This condition continues until the end of their compu-

Roberts, Woosley, Hoffman, ApJ Submitted

Figure 7. Isotopic production factors from the NDW model employing the neutrino luminosities from Woosley et al. (1994) with the anti-electron neutrino temperature reduced by 15%. The production factors are calculated assuming that 18.4 $M_\odot$ of material was ejected in the supernova in addition to the wind. The horizontal lines are similar to those in figure 5.

rts et al.



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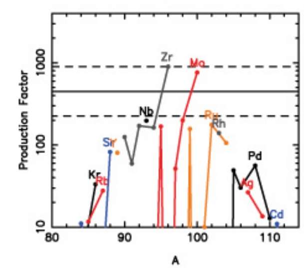

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