University of Victoria

CaNPAN

On possible observational signatures of *i*-process nucleosynthesis in pre-solar dust grains

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NUGRID

MESA

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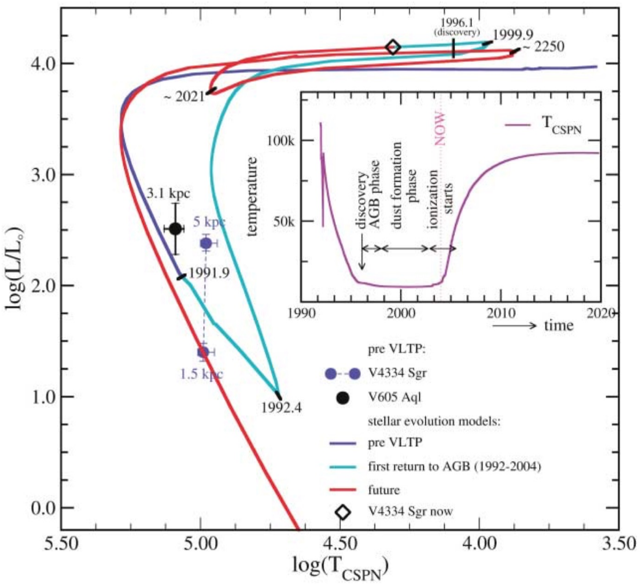
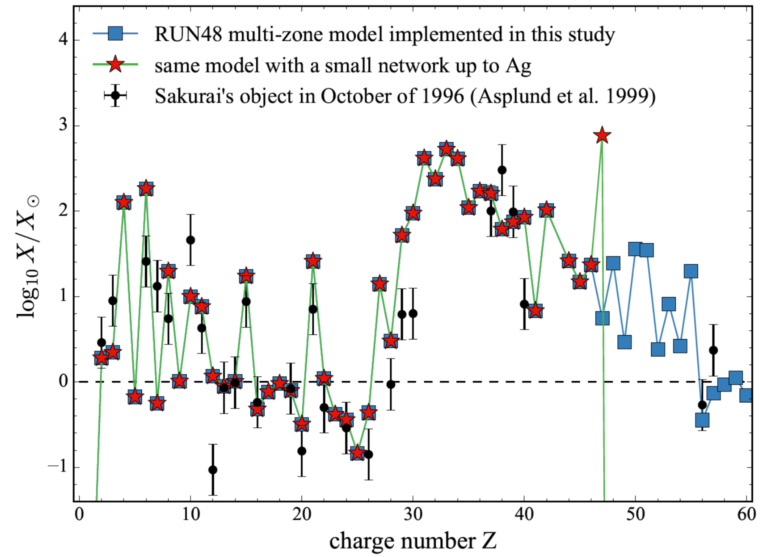
Multi-zone *i*-process nucleosynthesis models at [Fe/H] ≅ 0: He-shell flashes in the post-AGB Sakurai's object and rapidly-accreting white dwarfs (RAWDs)





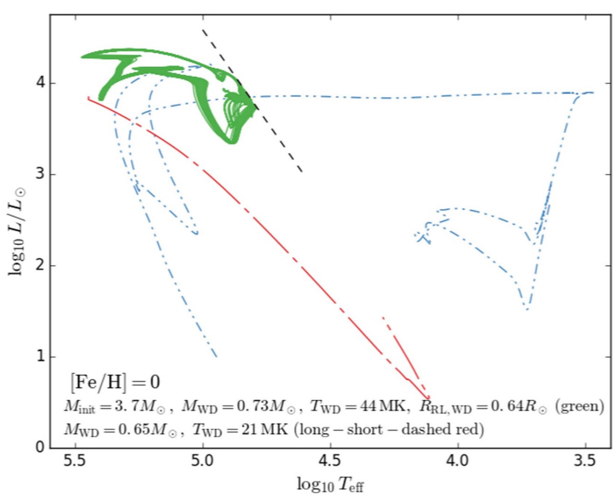


Figure 1. Tracks of progenitor and post-AGB evolution of 0.73 $M_\odot$ WD (double-dot–short-dashed blue line; see text for details) and multiple He-shell flashes with H-ingestion cycles in model B (green line). The flash causes the star to expand to the WD Roche-lobe radius (dashed black line) and lose the accreted material via the Roche-lobe overflow. The short–long-dashed red curve is a fragment of the track of model A during its second He-shell flash.

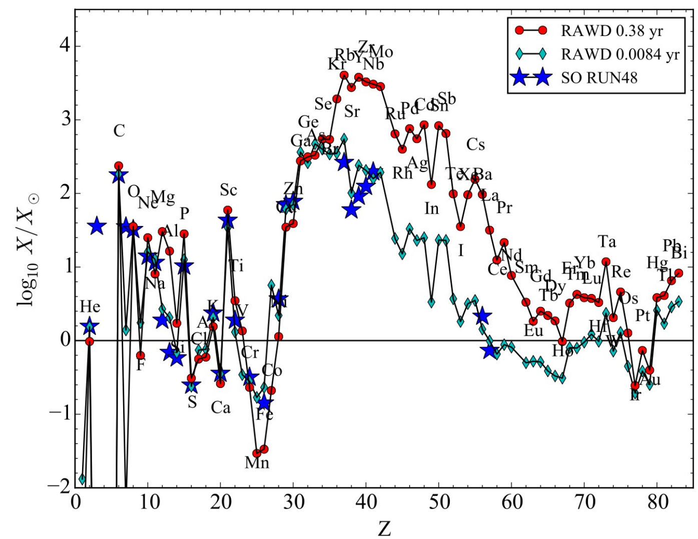
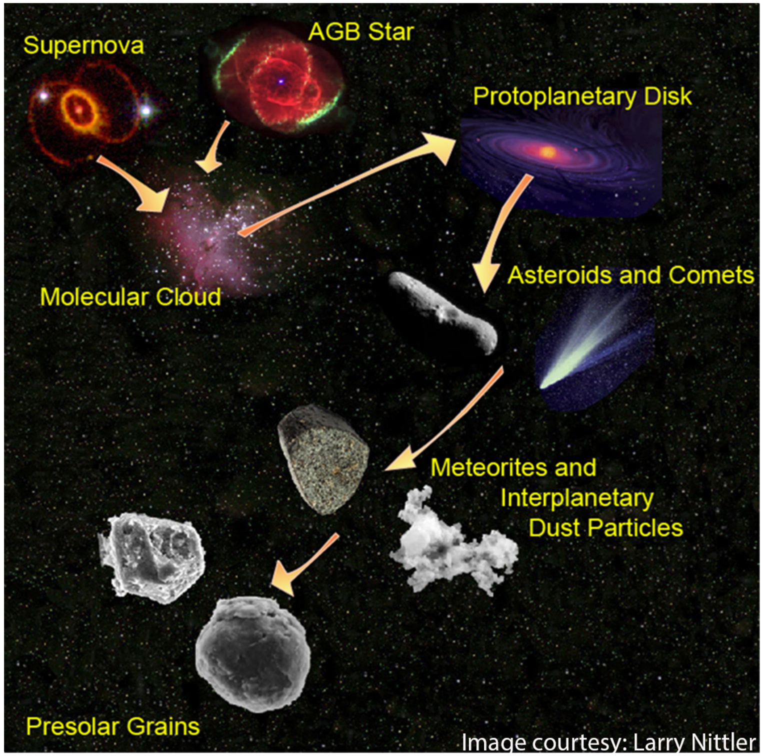
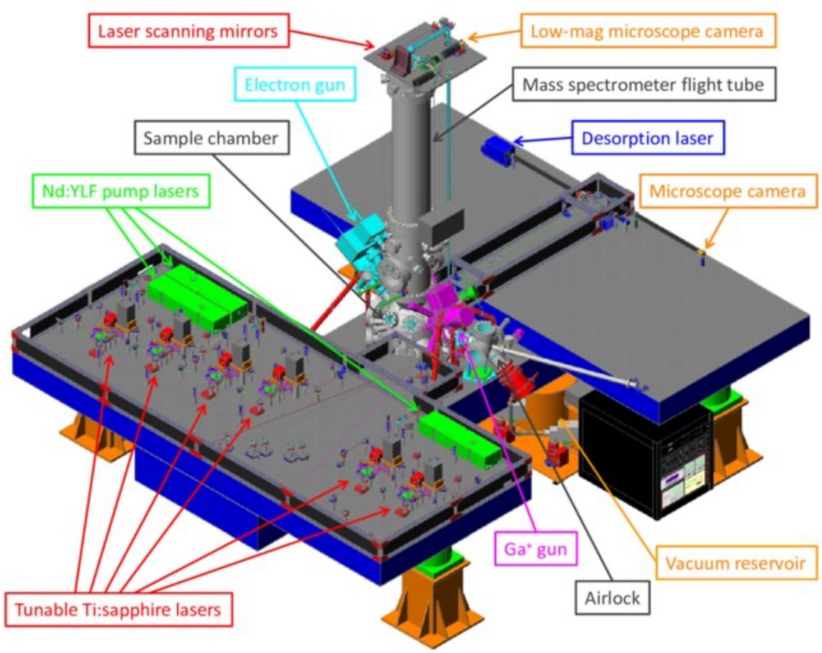


Figure 4. Abundance distributions in the RAWD model A, after the second He flash, with $M_{\rm WD} = 0.65\ M_\odot$ and $T_{\rm WD} = 21$ MK (teal diamonds, solid lines), and for comparison the model RUN48 (blue stars) from Herwig et al. (2011) that matches the observed abundances of Sakurai's object.

Pre-solar dust grain data from http://presolar.wustl.edu/PGD/Presolar_Grain_Database.html

(K. M. Hynes and F. Gyngard, 2009, Lunar Planet Sci. 40, Abstract # 1198; T. Stephan et al., 2024, ApJS, 270, 27 for SiC grains only)





Davis A. M., Stephan T., Boehnke P., Pellin M., Trappitsch R., and Liu N. (2018) Cosmochemistry with CHILI (abstract). *Goldschmidt Abstracts* **2018**, 529.

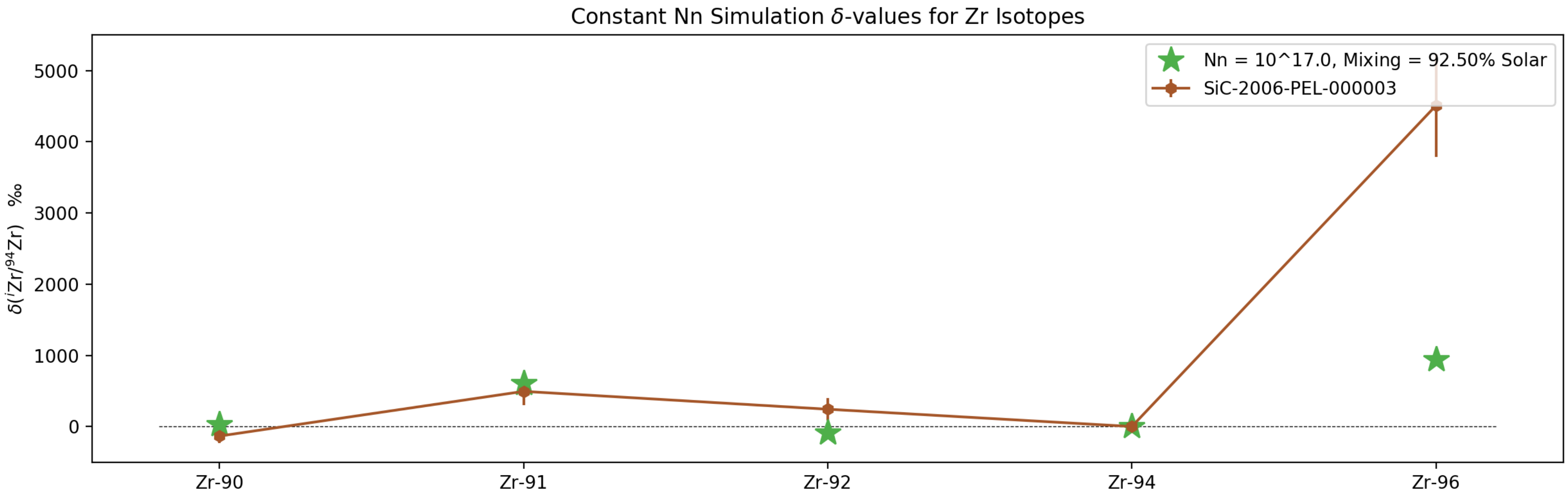
According to https://iniabu.readthedocs.io/en/latest/background.html,

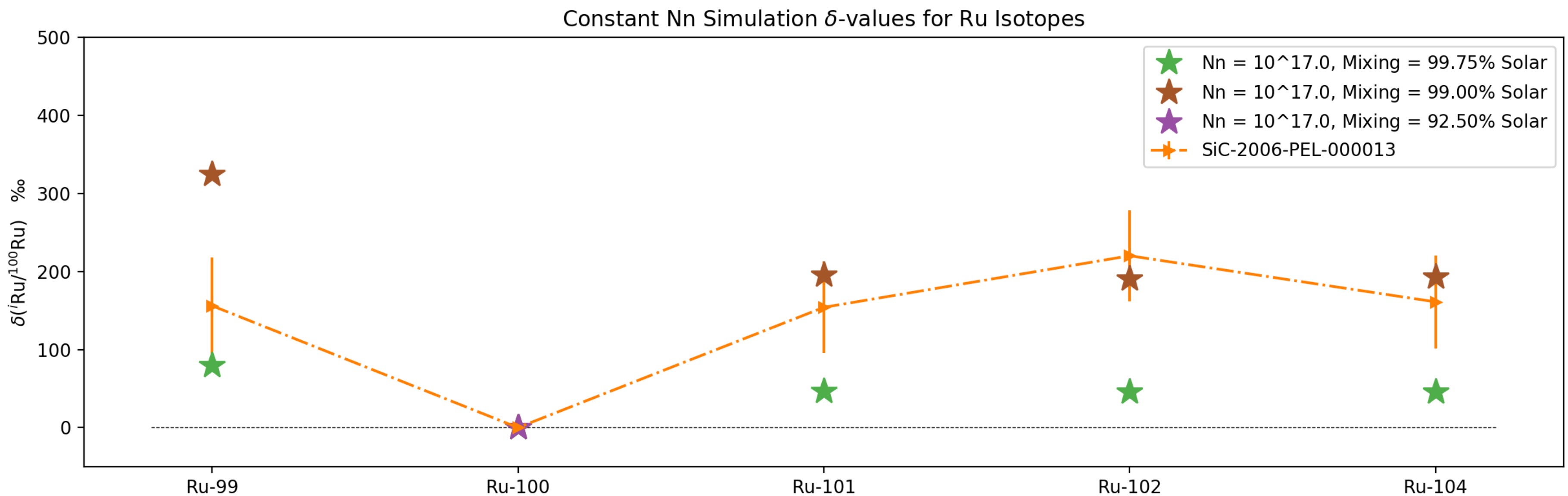
$$\delta\left(\frac{{}^iX}{{}^jX}\right) = \left(\frac{\left(\frac{{}^iX}{{}^jX}\right)_{\text{measured}}}{\left(\frac{{}^iX}{{}^jX}\right)_{\text{solar}}} - 1\right) \times f,$$

where $f = 1000$.

If the "measured" abundances represent a mixture of d-fraction of i-process and $(1-d)$-fraction of solar abundances, where d is the dilution coefficient, then ${}^{i,j}X_{\text{measured}} = d\,{}^{i,j}X_{\text{i-process}} + (1-d)\,{}^{i,j}X_{\text{solar}}$, and

Comparison of one-zone simulations of *i*-process nucleosynthesis with pre-solar dust grain data





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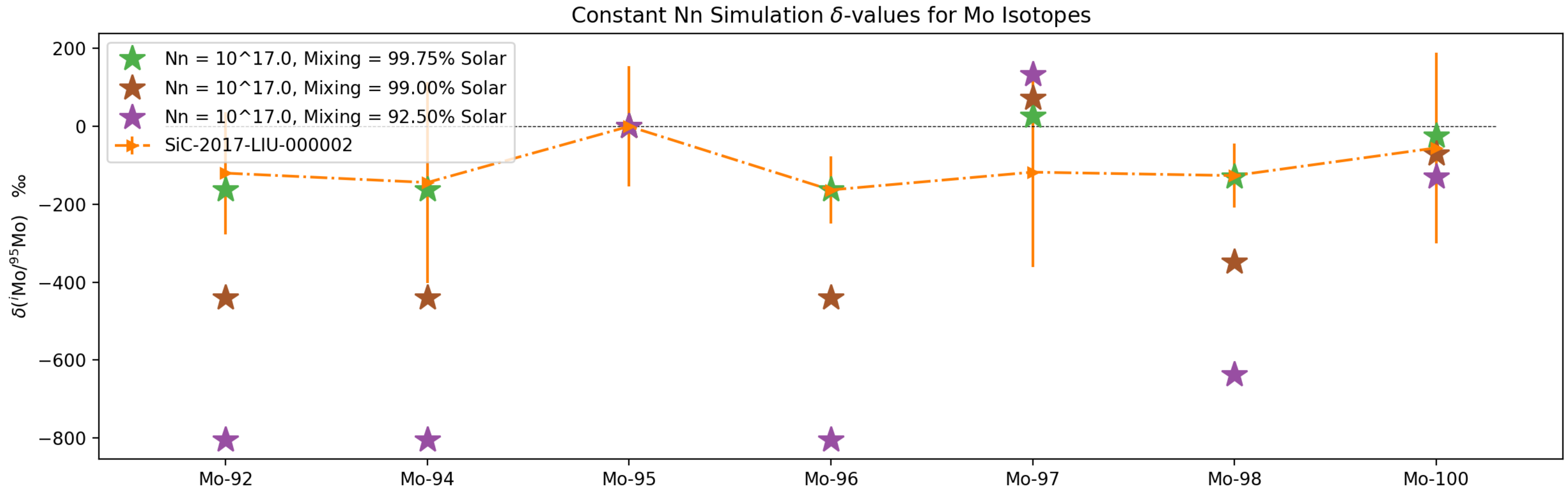

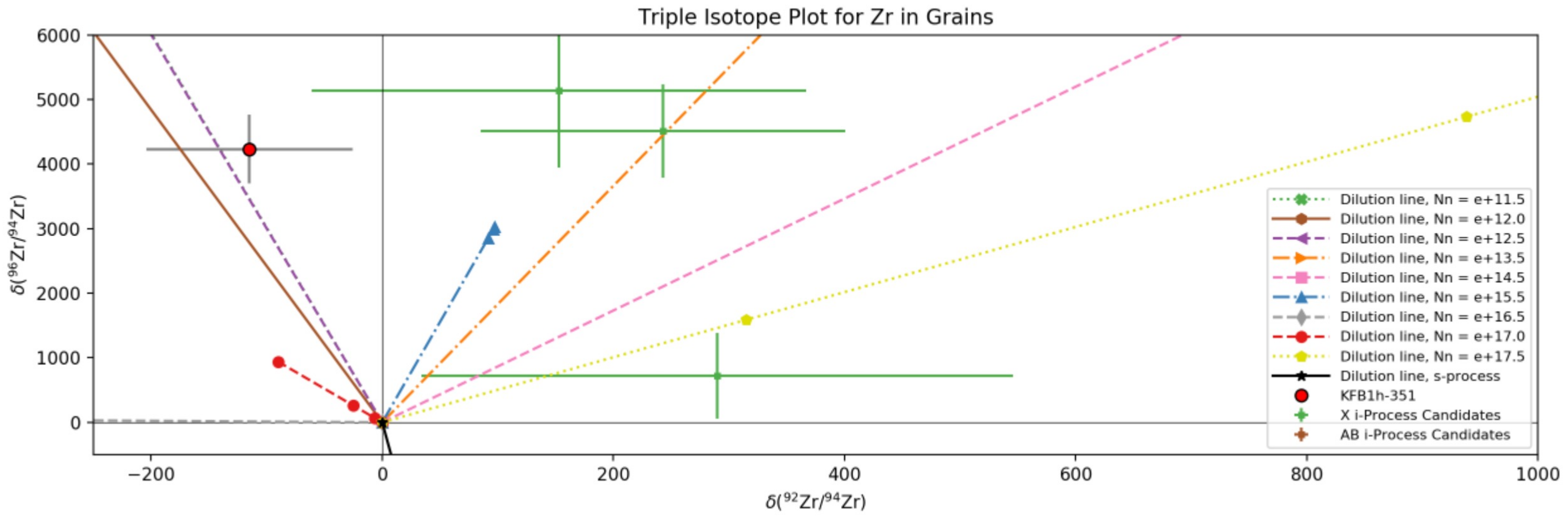

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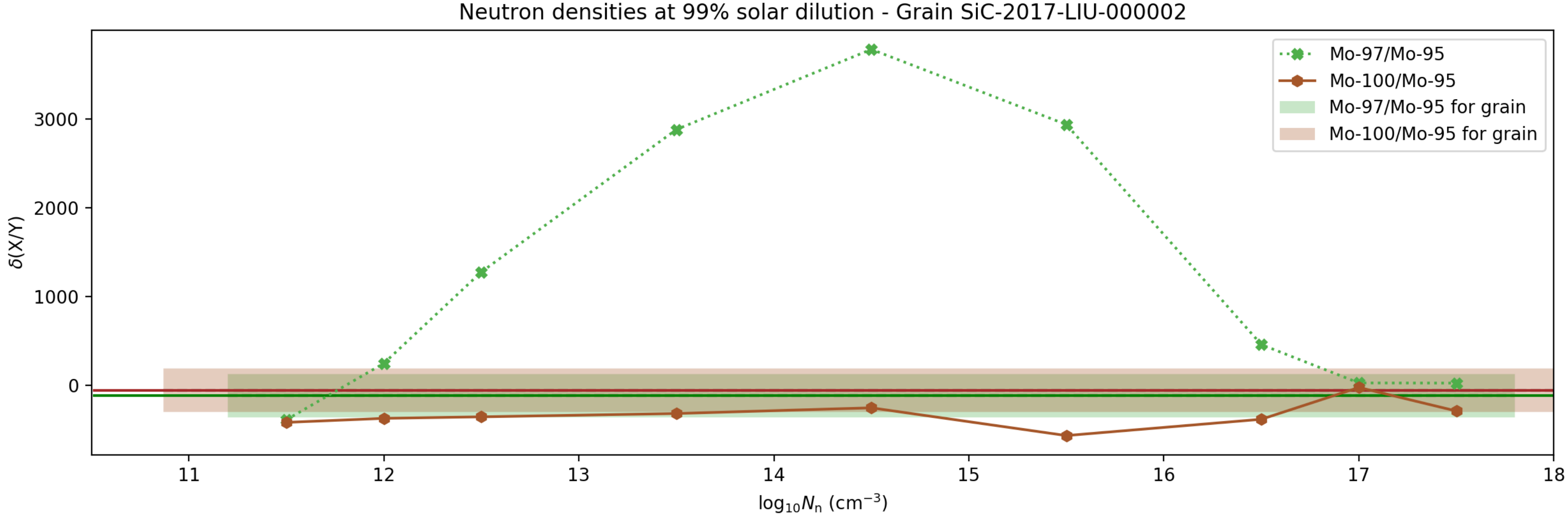

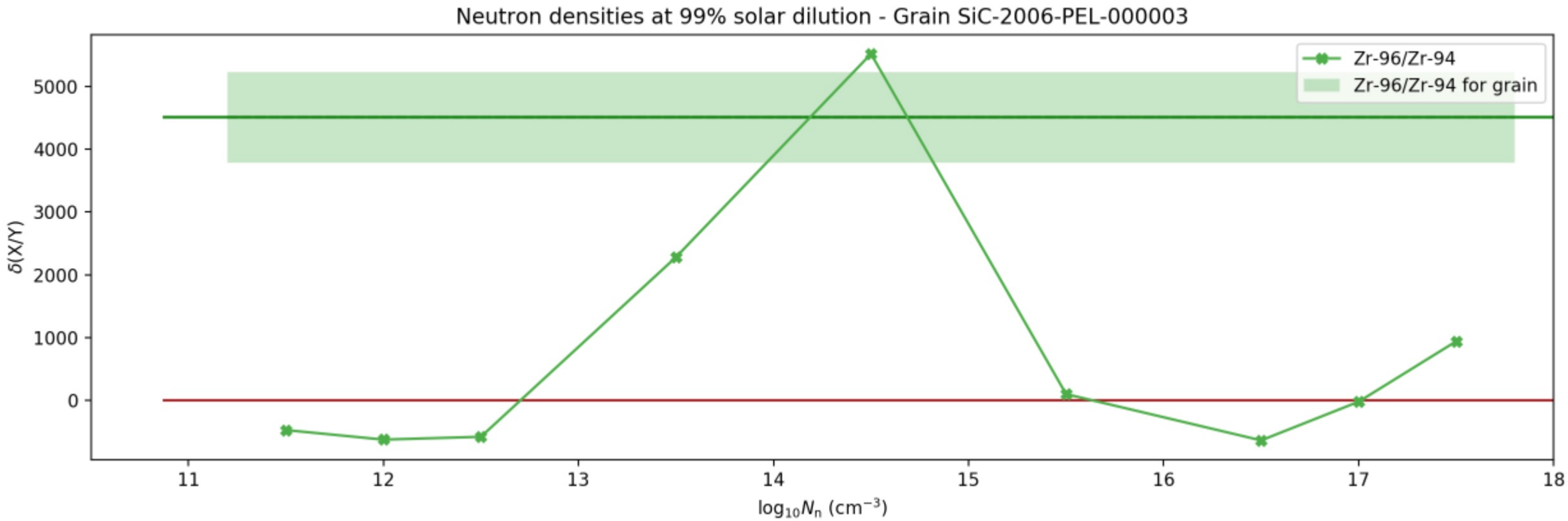

CONCLUSIONS

- Ru, Mo, and Zr isotopic abundance ratios in some of pre-solar dust grains may be interpreted as signatures of *i*-process nucleosynthesis.
- The peak neutron densities characteristic for the n-capture processes, signatures of which are seen in those grains, lie between 10^{12} and 10^{17} cm^{-3}.
- Unlike RAWD and Sakurai's object models, the low-mass AGB models do not predict an activation of *i*-process at nearly solar metallicities.