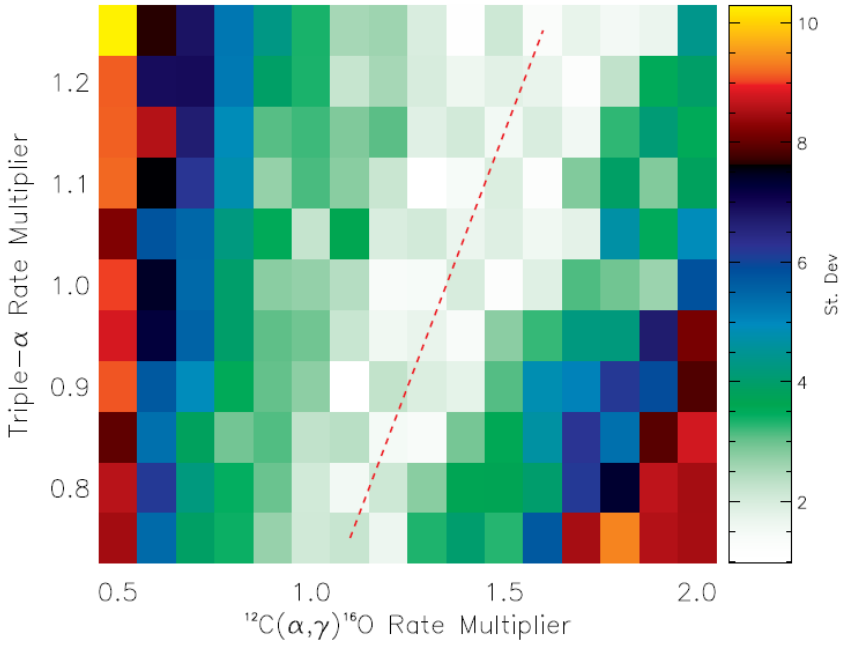
Joint Institute for Nuclear Astrophysics

Effective Helium Burning Rates in Supernovae



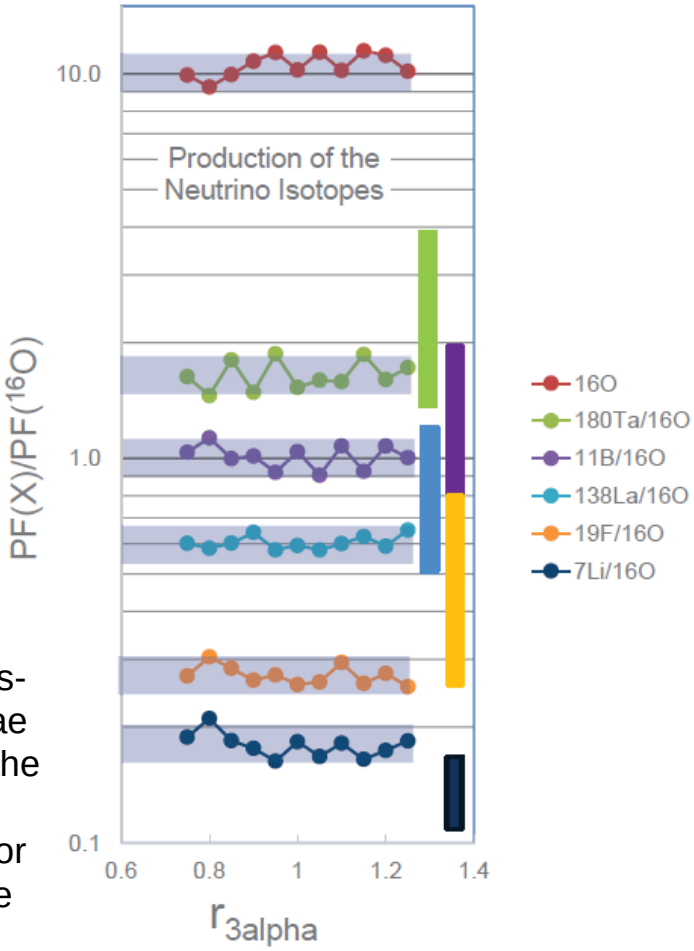


Fig.1 (Left): Standard deviations of fits to A=20-40 and s-only isotope abundances using the KEPLER supernovae code. The dashed curve, drawn through the minima, is the ERR described below.

Fig. 2 (Right): The production of the neutrino isotopes for rates along the ERR line. The bands are ±10% and the bars on the right show the uncertainties for ±2σ uncertainties in the rates from earlier results.

We have obtained *Effective Reaction Rates (ERR)* for the helium burning reactions (Triple-α and $^{12}C(\alpha, \gamma)^{16}O$). We parameterize these rates and fix the ERR parameters by fitting the abundances of A=20-40 and s-only isotopes. This allows us to treat uncertainties in the rates and approximations in the supernova code (e.g. the description of convection) in a unified way. The calculations are based on the data base of simulations (C. West et al, see publications below.) which yield the standard deviations of fits to the abundances for a ±2σ of the helium burning reactions as shown in Fig. 1. The dashed line shows the values of the Triple-α and ^{12}C (a, g) ^{16}O reaction rates that provide the best fit to A=20-40 and s-only isotopes using the KEPLER supernovae code. This line describes the ERR.

We have used the ERR values to calculate the production of the Neutrino isotopes and find that they are constant within ±10%. This is much better than found previously—see the vertical bars in Fig. 2. Other uncertainties now dominate, and can be evaluated to determine whether the 11B abundance can be used to constrain the neutrino flux from SN.

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Publications

West et al., ApJ **769**, 2 (2013),
Austin et al. PRL Mar. 2014