

Low Energy Physics Working Group Meeting

Mass ordering studies with ternary diagrams

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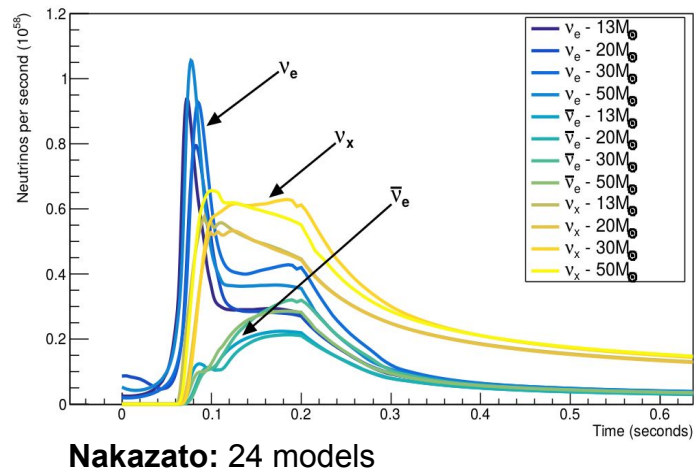
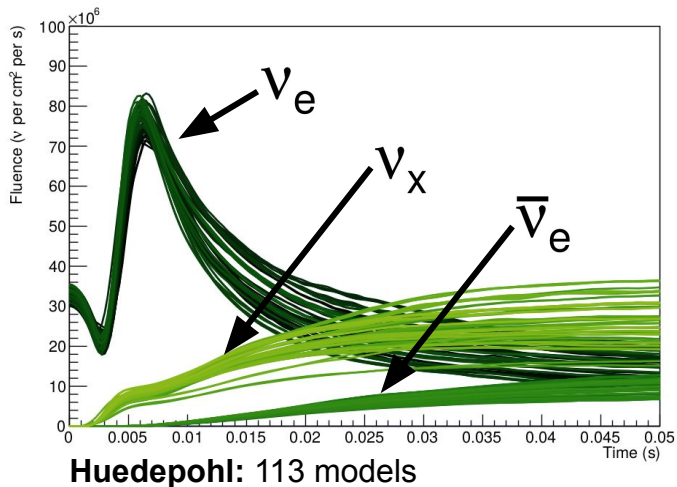
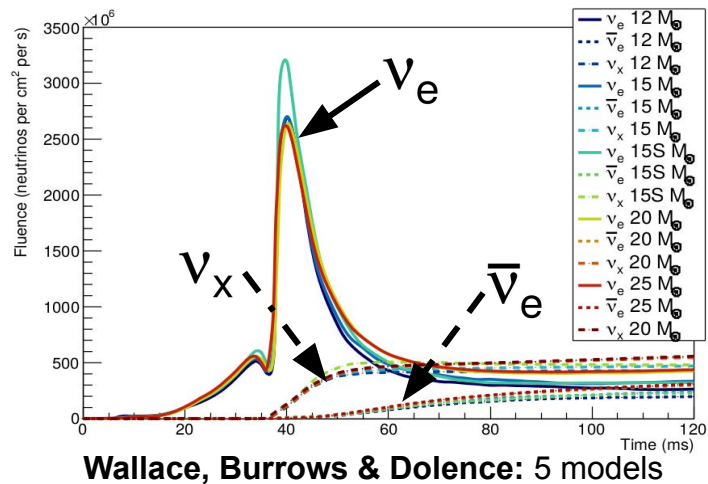
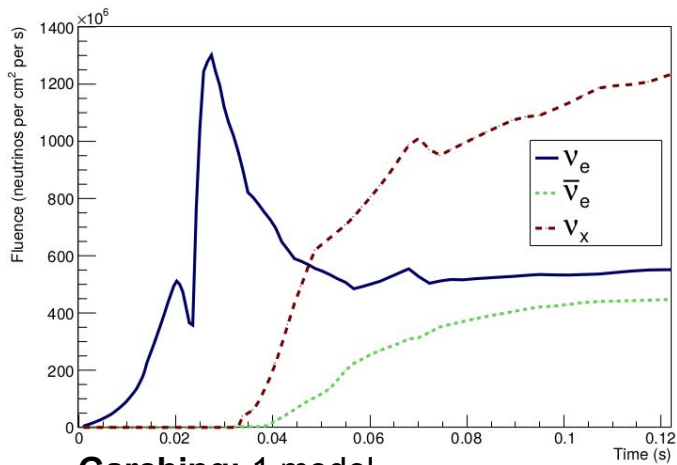
Jul 28, 2021



Introduction

- We are analyzing 4 SN neutrino databases with different neutrino signatures, searching for MO discriminators
 - Garching: 1 model
 - Wallace, Burrows & Dolence: 5 models
 - Nakazato: 24 models
 - Huedepohl: 113 models
- ~~MH discrimination using the neutronization burst looks to be model dependent.~~ (Need to redo analysis)

SN Databases



Ternary diagrams

- Represent 3D data on 2D plane
- Events proportional to a constant in ternary data

$$\text{Event (A, B, C)} \rightarrow \text{Ternary (A/T, B/T, C/T)}$$
$$T = A + B + C$$

- Strategy based on Rishi Gundakaram's report and codes
<https://github.com/rishigundakaram/SURF2020>

Ternary Diagrams for Supernova Neutrino Emission
Visualization

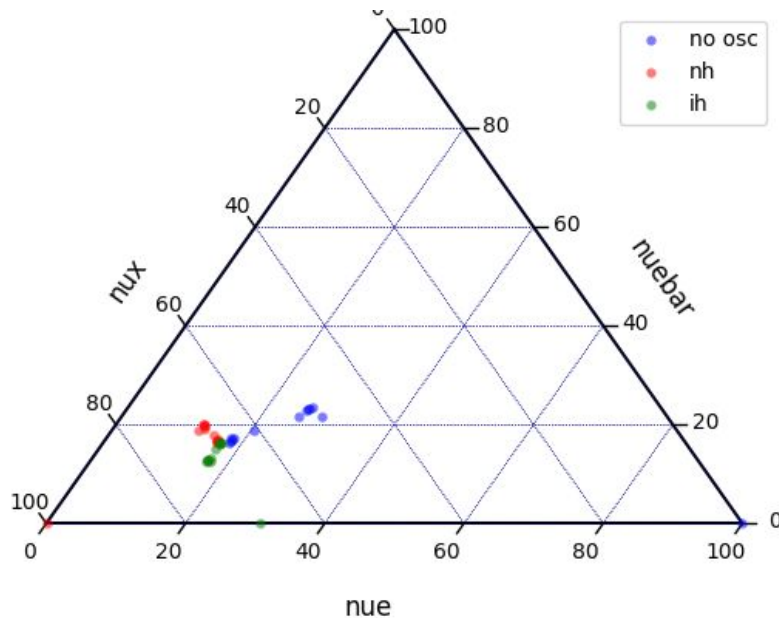
Rishi Gundakaram, Mentor: Dr. Kate Scholberg

Ternary diagrams

python-ternary lib

Marc Harper et al. (2015). `python-ternary`: Ternary Plots in Python. Zenodo. [10.5281/zenodo.594435](https://zenodo.org/record/594435)

- Sum of data pieces = 100%

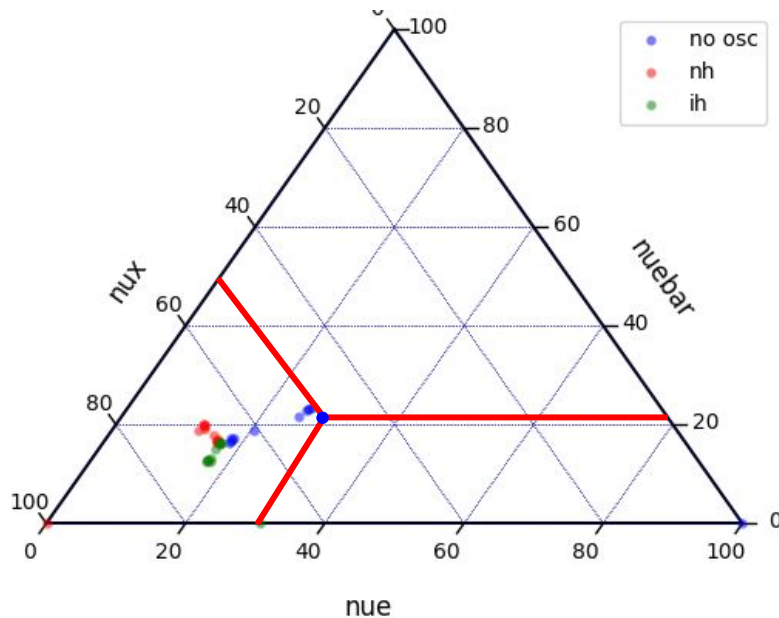


Ternary diagrams

python-ternary lib

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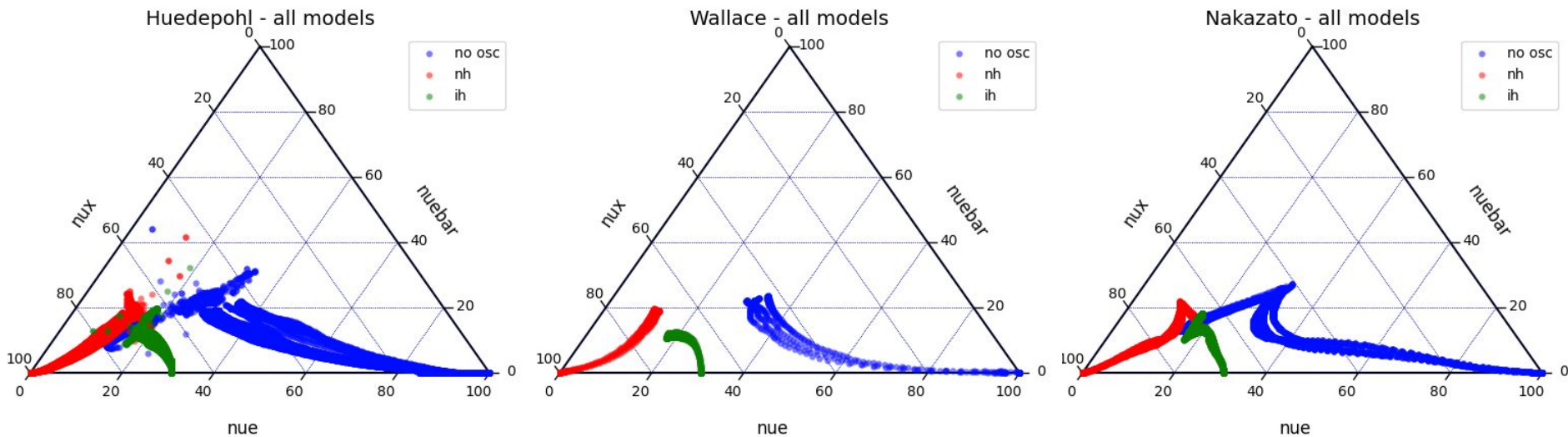


Ternary diagrams - proposed analysis

- Combine data from argon, water, and scintillator detectors to obtain total events from ν_e CC+ES, IBD, and NC
- Relate interaction channels with neutrino content (ν_e , $\bar{\nu}_e$, ν_x)
- From time-dependent detected events reconstruct neutrino fluxes

Ternary diagrams - preliminary results

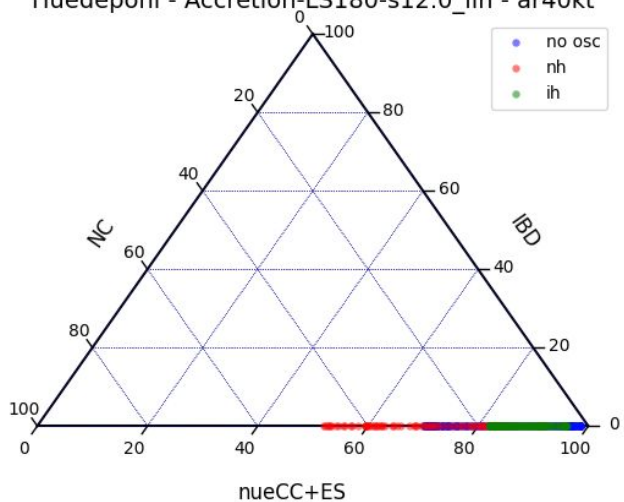
SN neutrino fluxes - similar across databases



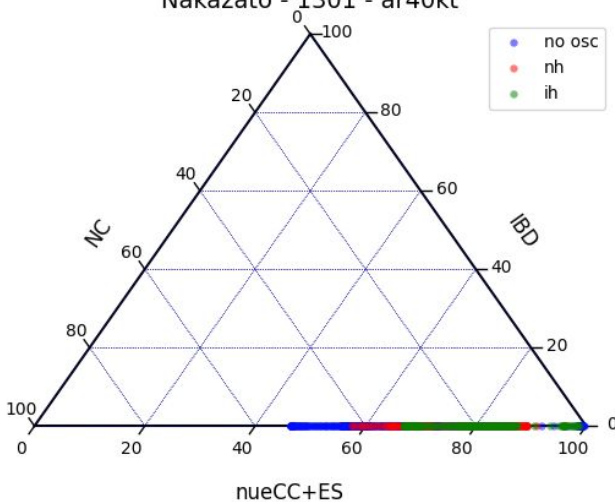
Ternary diagrams - preliminary results

Interaction channels - ar40kt

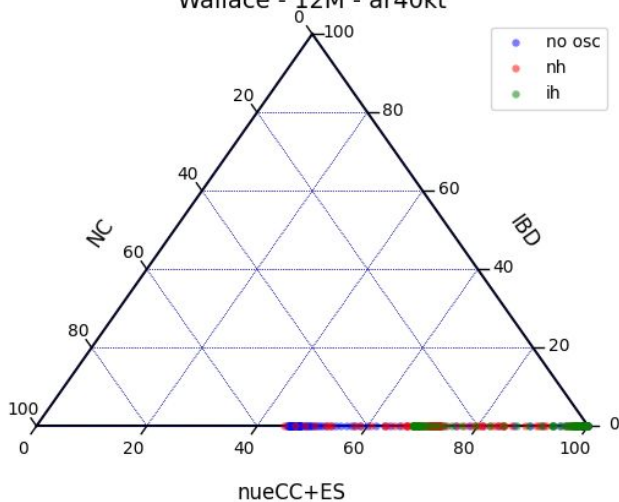
Huedepohl - Accretion-LS180-s12.0_lin - ar40kt



Nakazato - 1301 - ar40kt



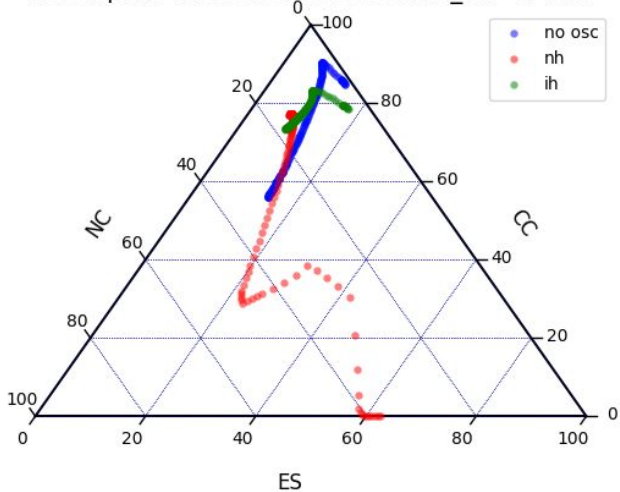
Wallace - 12M - ar40kt



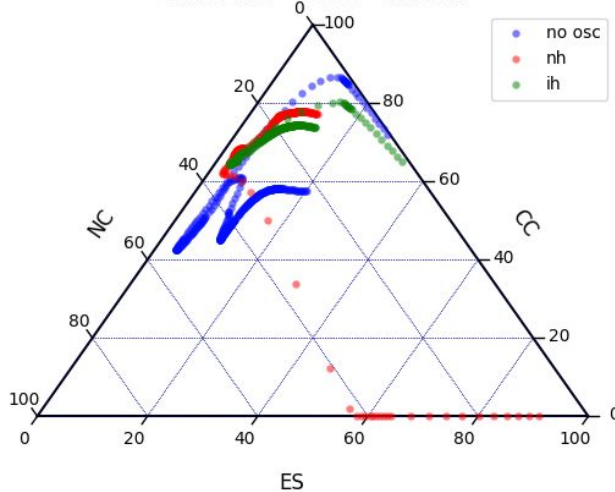
Ternary diagrams - preliminary results

Interaction channels - ar40kt
No IBD data

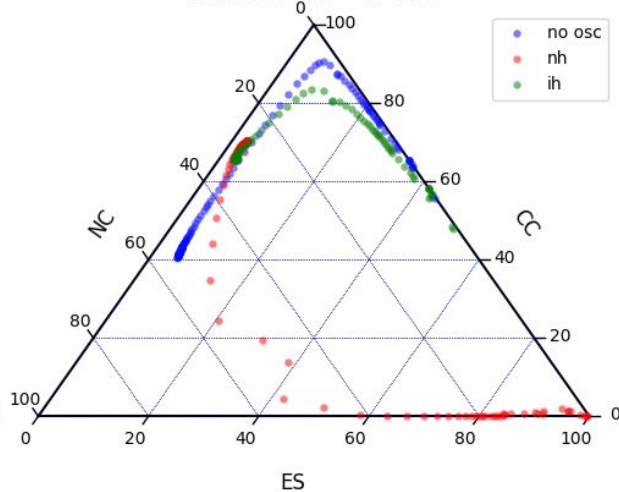
Huedepohl - Accretion-LS180-s12.0_lin - ar40kt



Nakazato - 1301 - ar40kt



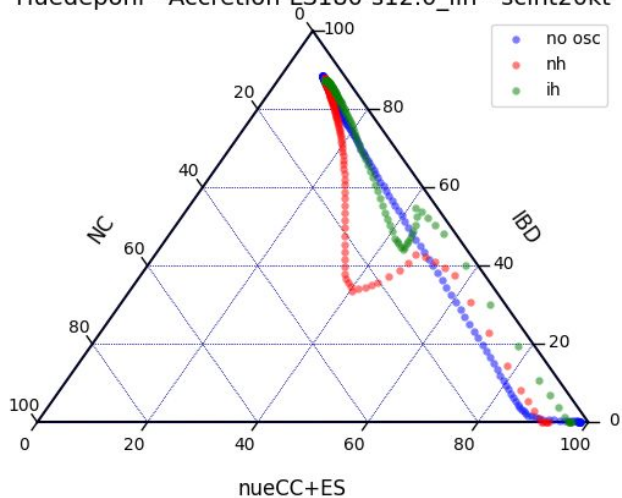
Wallace - 12 - ar40kt



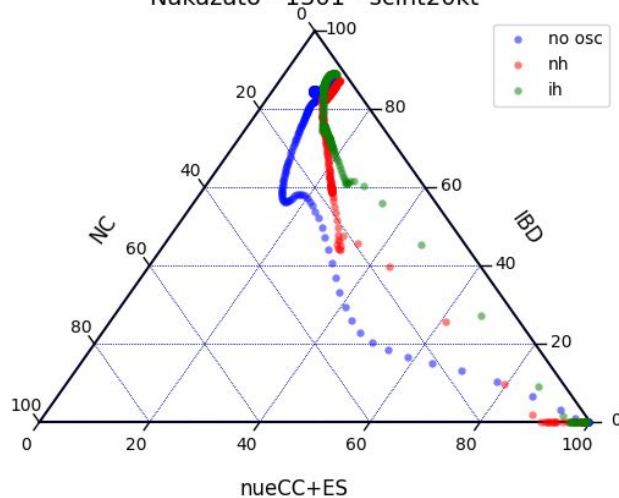
Ternary diagrams - preliminary results

Interaction channels - scint20kt

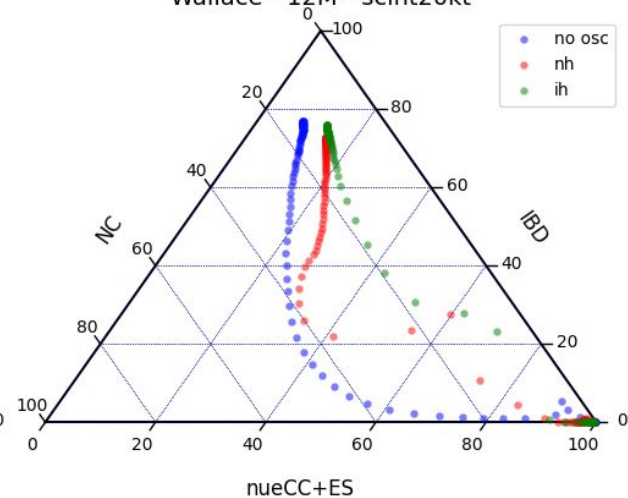
Huedepohl - Accretion-LS180-s12.0_lin - scint20kt



Nakazato - 1301 - scint20kt



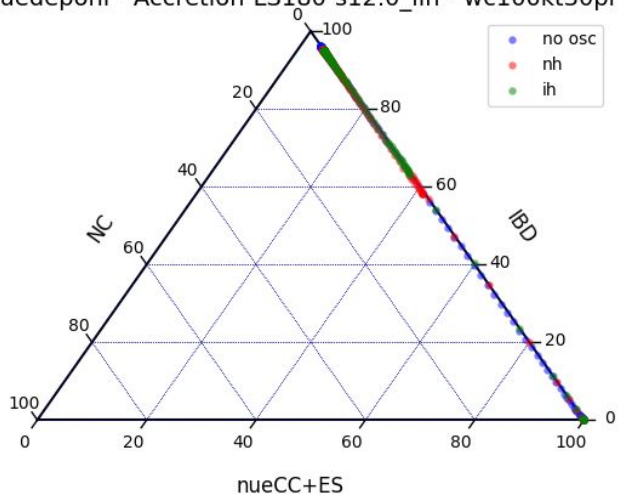
Wallace - 12M - scint20kt



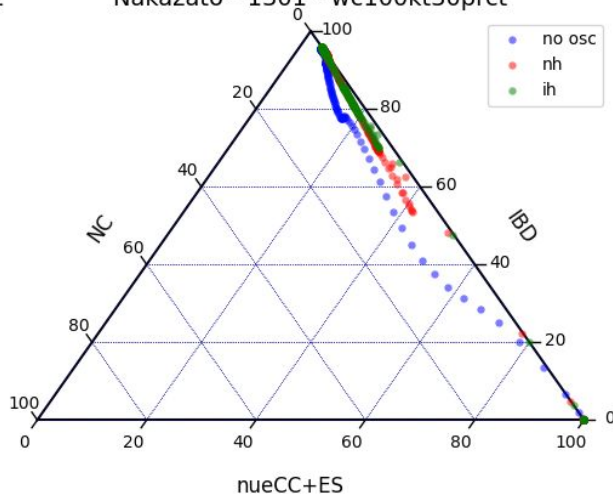
Ternary diagrams - preliminary results

Interaction channels - wc100kt30prct

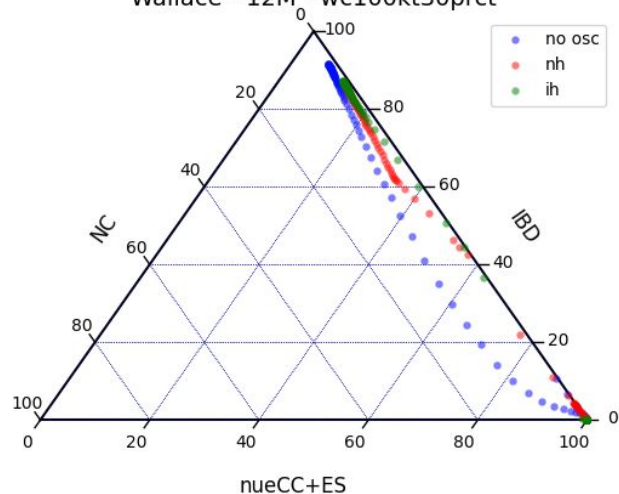
Huedepohl - Accretion-LS180-s12.0_lin - wc100kt30prct



Nakazato - 1301 - wc100kt30prct



Wallace - 12M - wc100kt30prct

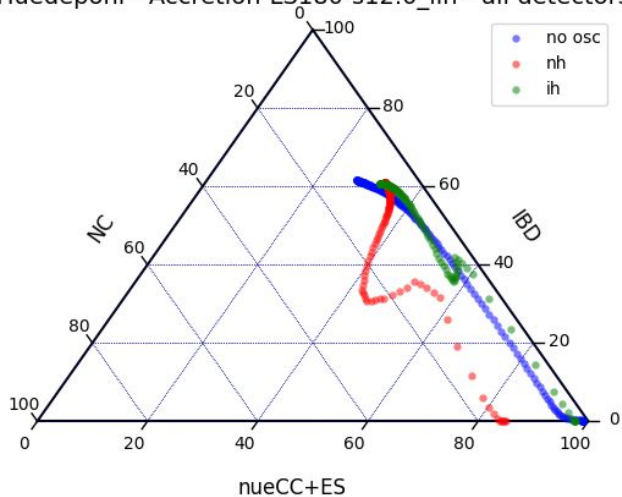


Ternary diagrams - preliminary results

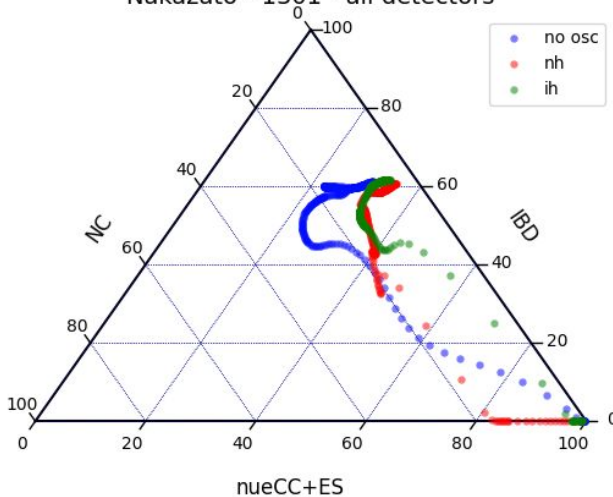
Combined detectors - ar40kt + scint20kt + wc100kt30prct

Different trajectories for NH and IH

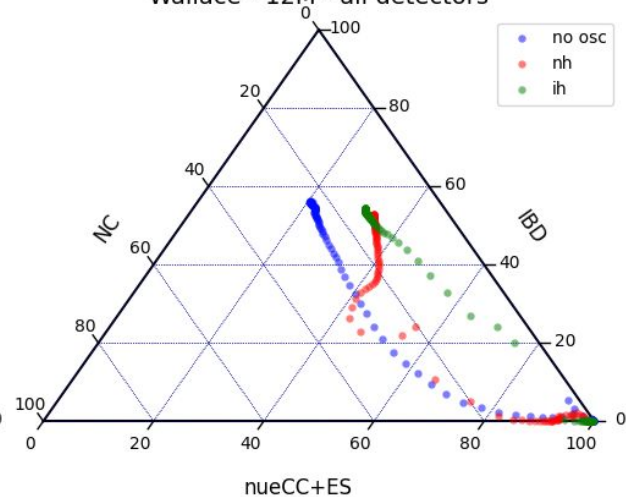
Huedepohl - Accretion-LS180-s12.0_lin - all detectors



Nakazato - 1301 - all detectors



Wallace - 12M - all detectors



Ternary diagrams - next steps

- Compare the results for all models in each database (Garching, Huedepohl, Nakazato and Wallace, Burrows & Dolence)
- Statistical analysis for MO trajectories in detected channels
- Estimate total flux from detected events, considering xscs and number of targets

Thanks!

Thanks to Rishi Gundakaram for ternary diagram codes!