SNEWPY & sntools

Software for Studying Supernova Neutrinos

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they/them

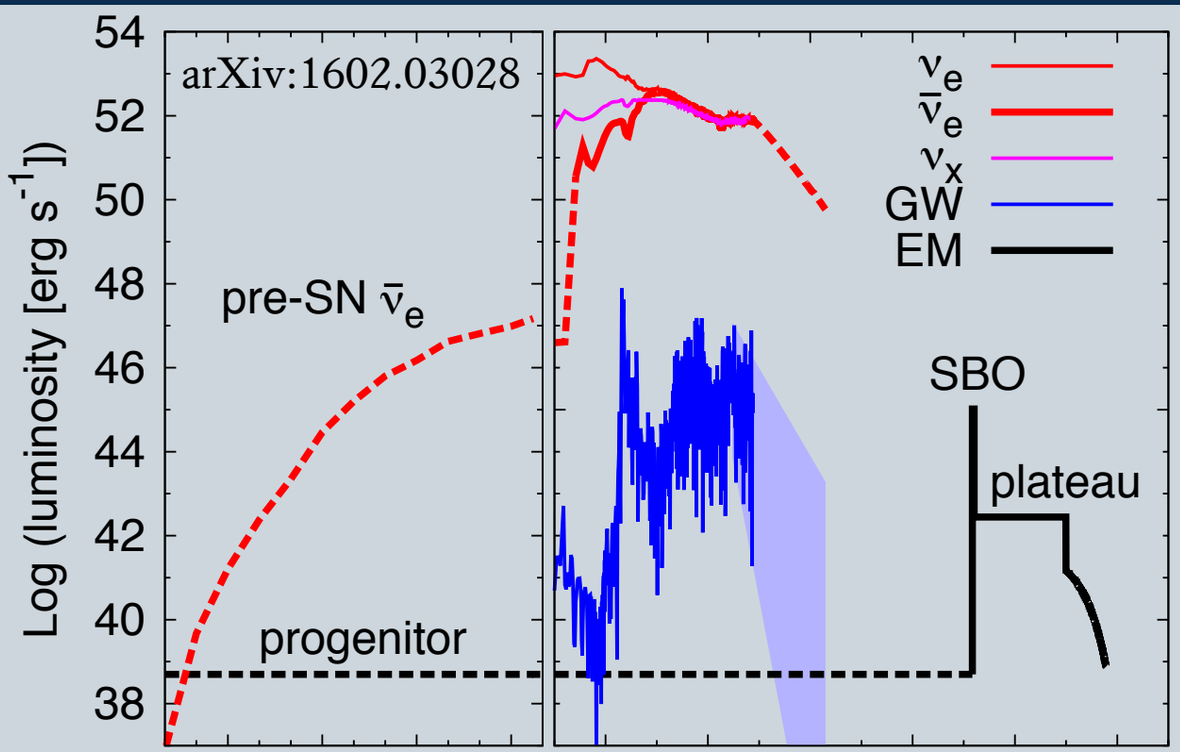
Please note: 🤒

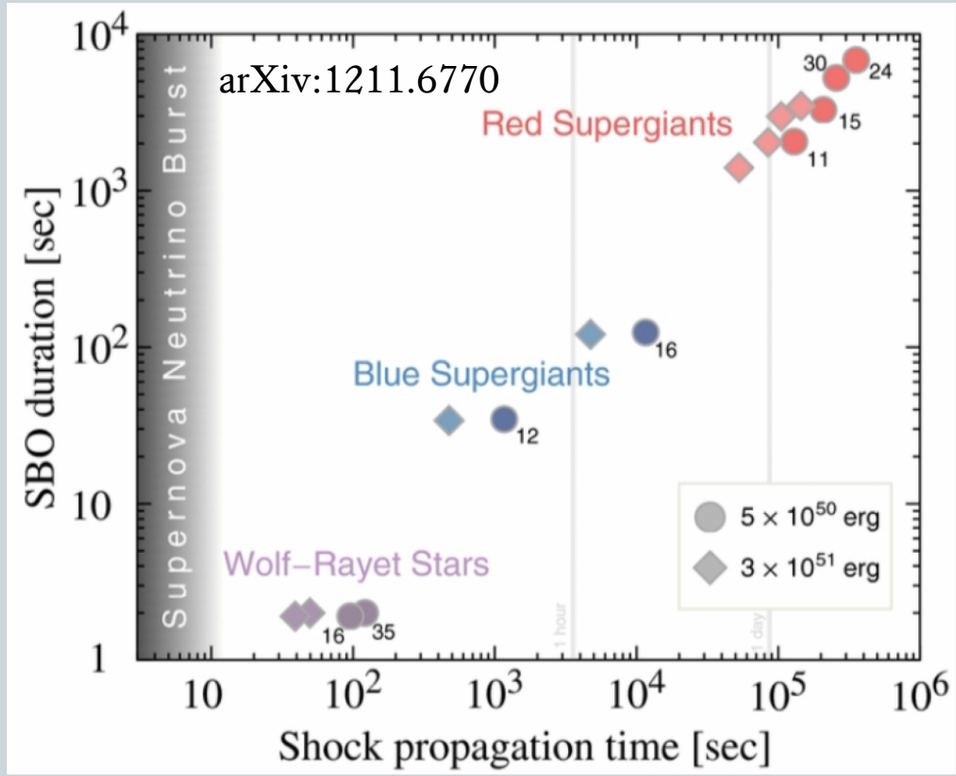
Introduction: SNEWS

- Once-in-a-lifetime event
  ➔ Extract as much multi-messenger information as possible!

- Neutrinos emitted minutes to hours before light

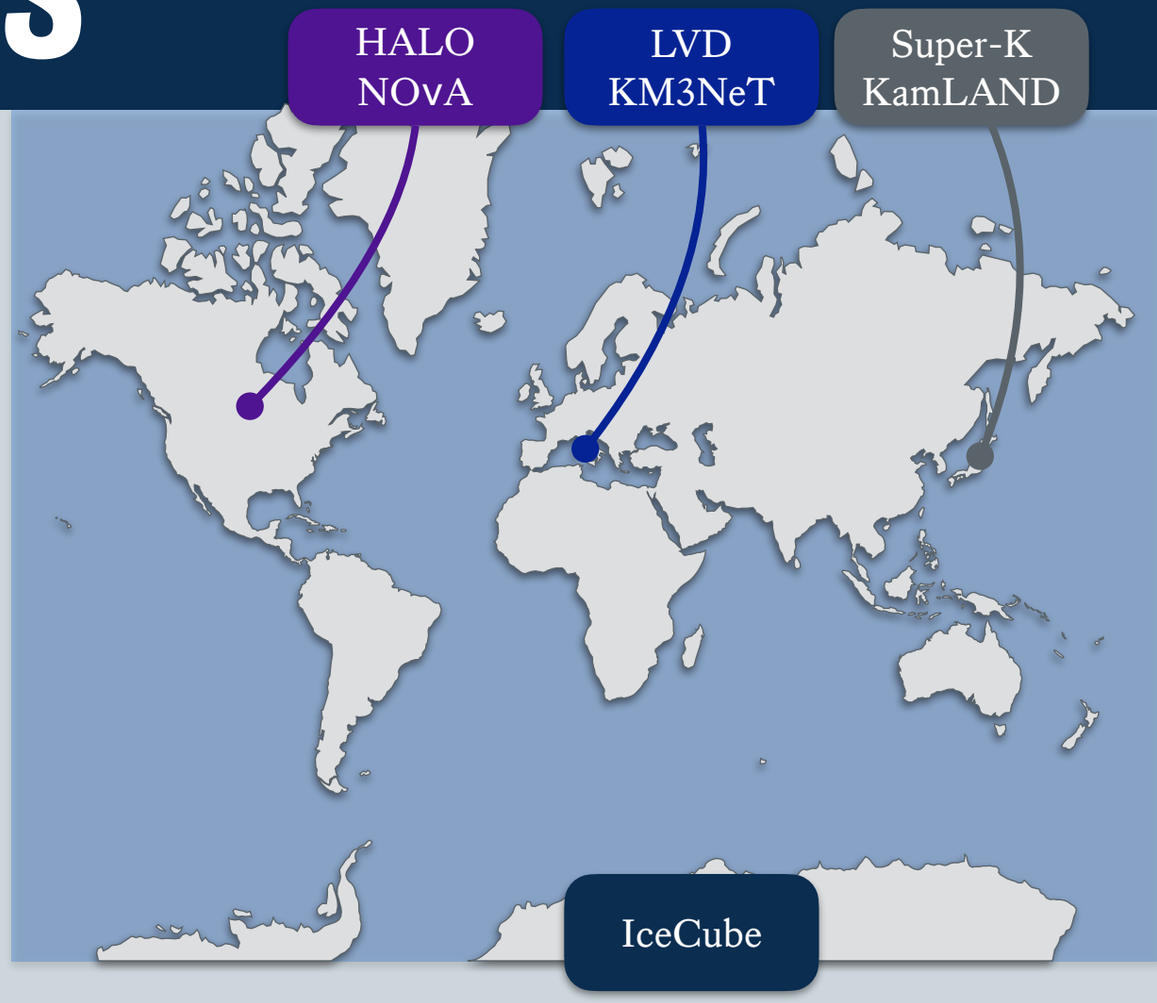
- Can build a SuperNova Early Warning System with neutrino detectors

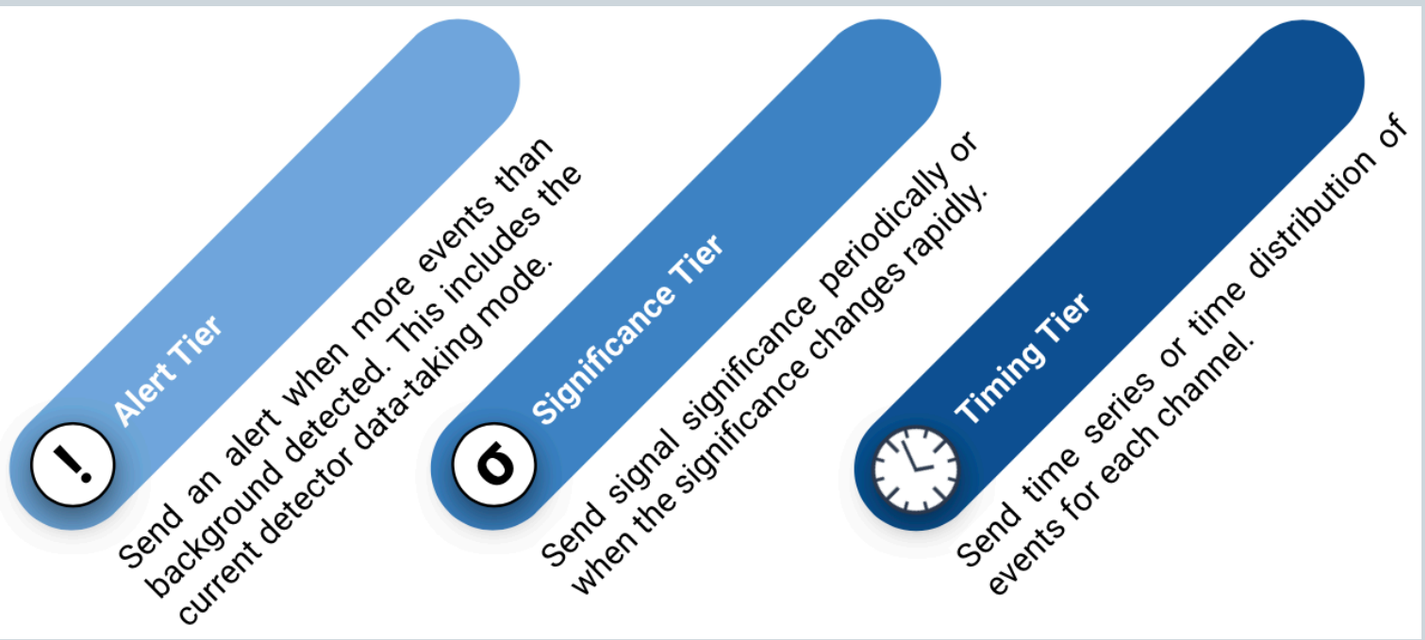




SNEWS

- Started >20 years ago, running in automated mode since 2005
- Today: 7 participating detectors ➔
- Started to re-imagine SNEWS for the age of multi-messenger astronomy
(arXiv:2011.00035 / DOI:10.1088/1367-2630/abde33)

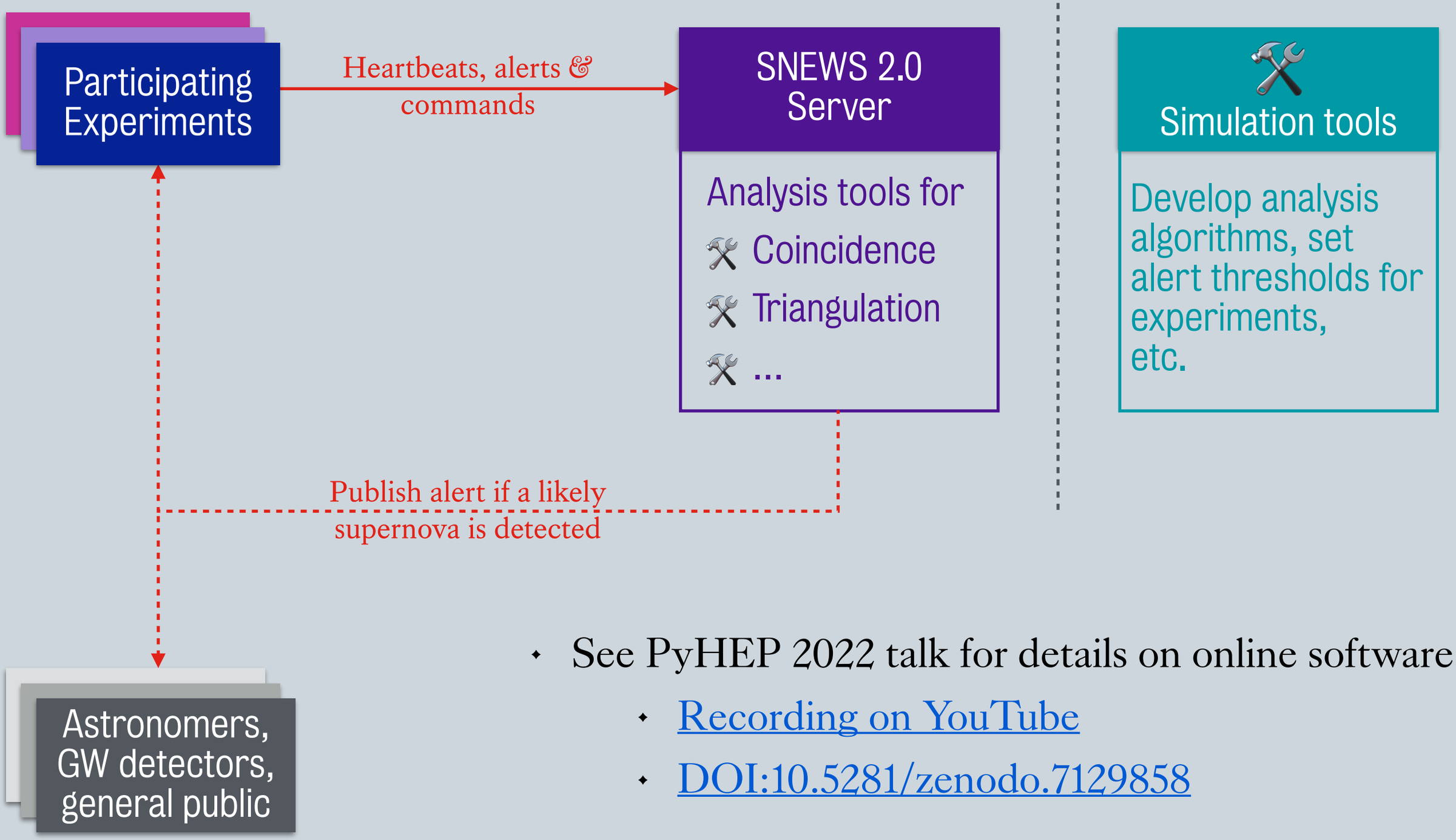




New features:

- Reduced alert threshold
- Pointing information
- Follow-up strategy
- *… and much more!*

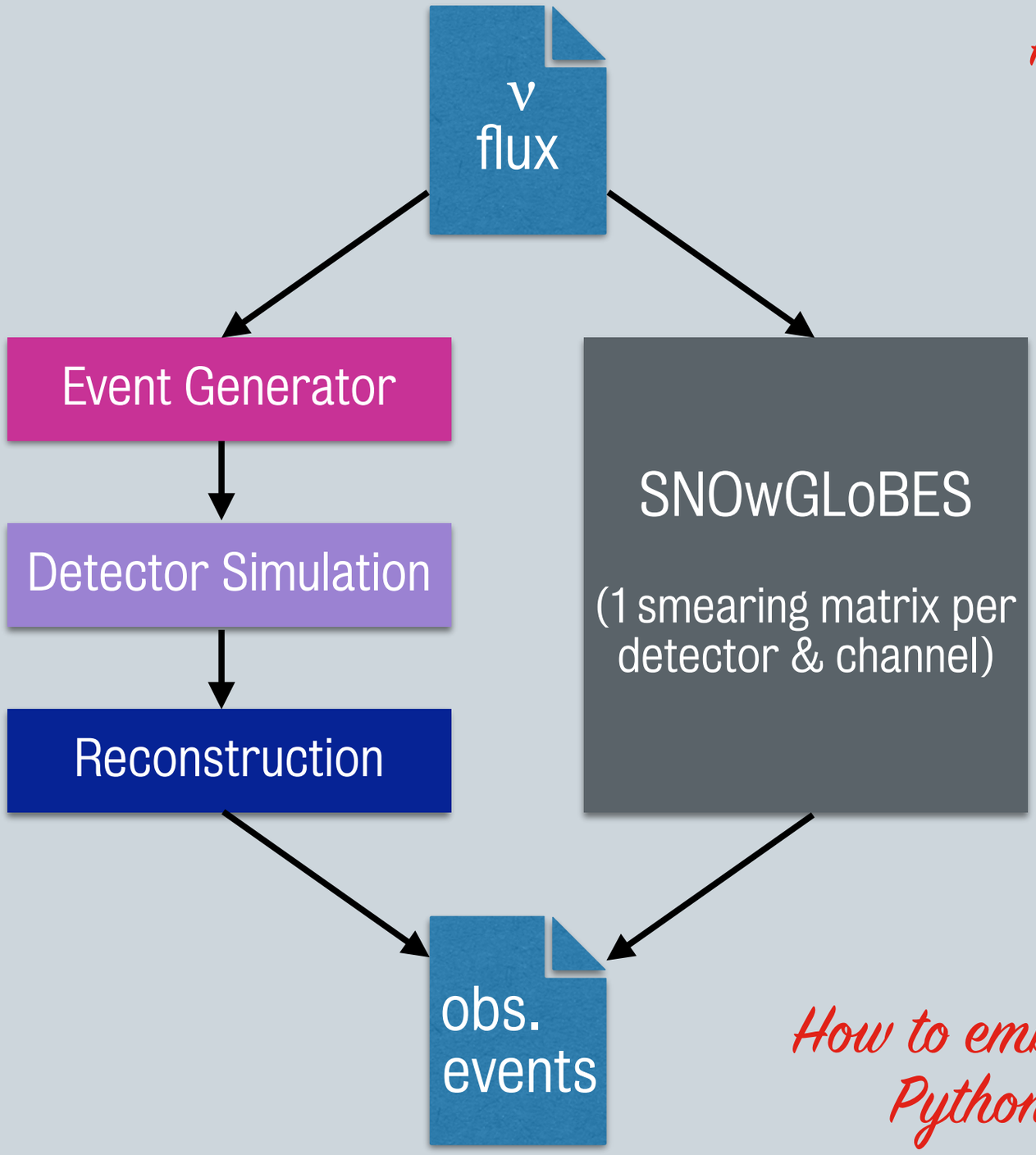
SNEWS 2.0 Software Overview



- See PyHEP 2022 talk for details on online software:
  - Recording on YouTube
  - DOI:10.5281/zenodo.7129858
- Here: Focus on simulation tools

Determining the Detector Response

Where to get fluxes from different SN models?



How to apply transformations to ν flux before reaching detector?

- github.com/SNOwGLoBES/snowglobes

- SNOwGLoBES is orders of magnitude faster & covers *most* use cases
- Still need event generator for advanced studies

How to embed SNOwGLoBES in a Python-based workflow?

SNEWPY Offers ...

Where to get fluxes from different SN models?

- ... a simple and unified interface to hundreds of supernova simulations.

Can use these in your code!

How to apply transformations to ν flux before reaching detector?

- ... a large library of flavor transformations that relate neutrino fluxes produced in the supernova to those reaching a detector on Earth.

How to embed SNOwGLoBES in a Python-based workflow?

- ... and a Python interface to SNOwGLoBES to integrate into your existing workflows.

Integrating SNEWPY in sntools

- sntools: event generator for SN neutrinos in water Cherenkov & liquid scintillator detectors
- Used by Hyper-Kamiokande, SNO+, WATCHMAN, THEIA
- Open source:
  - github.com/JostMigenda/sntools
  - JOSS paper: DOI:10.21105/joss.02877
- Integrates SN models & flavor transformations from SNEWPY
  - For devs: Save work & eliminate major source of bugs
  - For users: Smooth transition from quick initial estimates to advanced analyses

Usage of SNEWPY

github.com/SNEWS2/snewpy

- SNEWS-internally
- By other software:
  - sntools (DOI:10.21105/joss.02877)
  - ASTERIA (DOI:10.5281/zenodo.3926834)

smooth transition from quick initial estimates to advanced analyses

- In non-SNEWS papers:

Neutrino Echos following Black Hole Formation in Core-Collapse Supernovae

Samuel Gullin,[1] Evan P. O'Connor,[1] Jia-Shian Wang,[2] and Jeff Tseng[2]

[1] *The Oskar Klein Centre, Departm*
Stockholm University, AlbaNova, SE-10
[2] *Department of Physics, Oxford University, Ox*

arXiv:2109.13242

arXiv:2203.05141

Detectability of hadron-quark phase transition in neutrino signals of failing core-collapse supernova

Zidu Lin,[1] Shuai Zha,[2] Evan P. O'Connor,[3] and Andrew W. Steiner[1,4]

[1] *Department of Physics and Astronomy, University of Tennessee Knoxville*
[2] *Tsung-Dao Lee Institute, Shanghai Jiao Tong University, Shanghai 200240, China*
[3] *The Oskar Klein Centre, Department of Astronomy, Stockholm University, AlbaNova, SE-106 91 Stockholm, Sweden*
[4] *Physics Division, Oak Ridge National Laboratory*
(Dated: March 11, 2022)

SNEWPY Demo

- SNEWPY demo in Jupyter notebook

➔ Run it yourself:

- https://github.com/JostMigenda/20221201-snewpy
- Or on Binder: see link in README file (Binders are amazing! 💙💖🤍)