Gravitational waves and Nucleosynthesis in Binary Neutron-stars simulations

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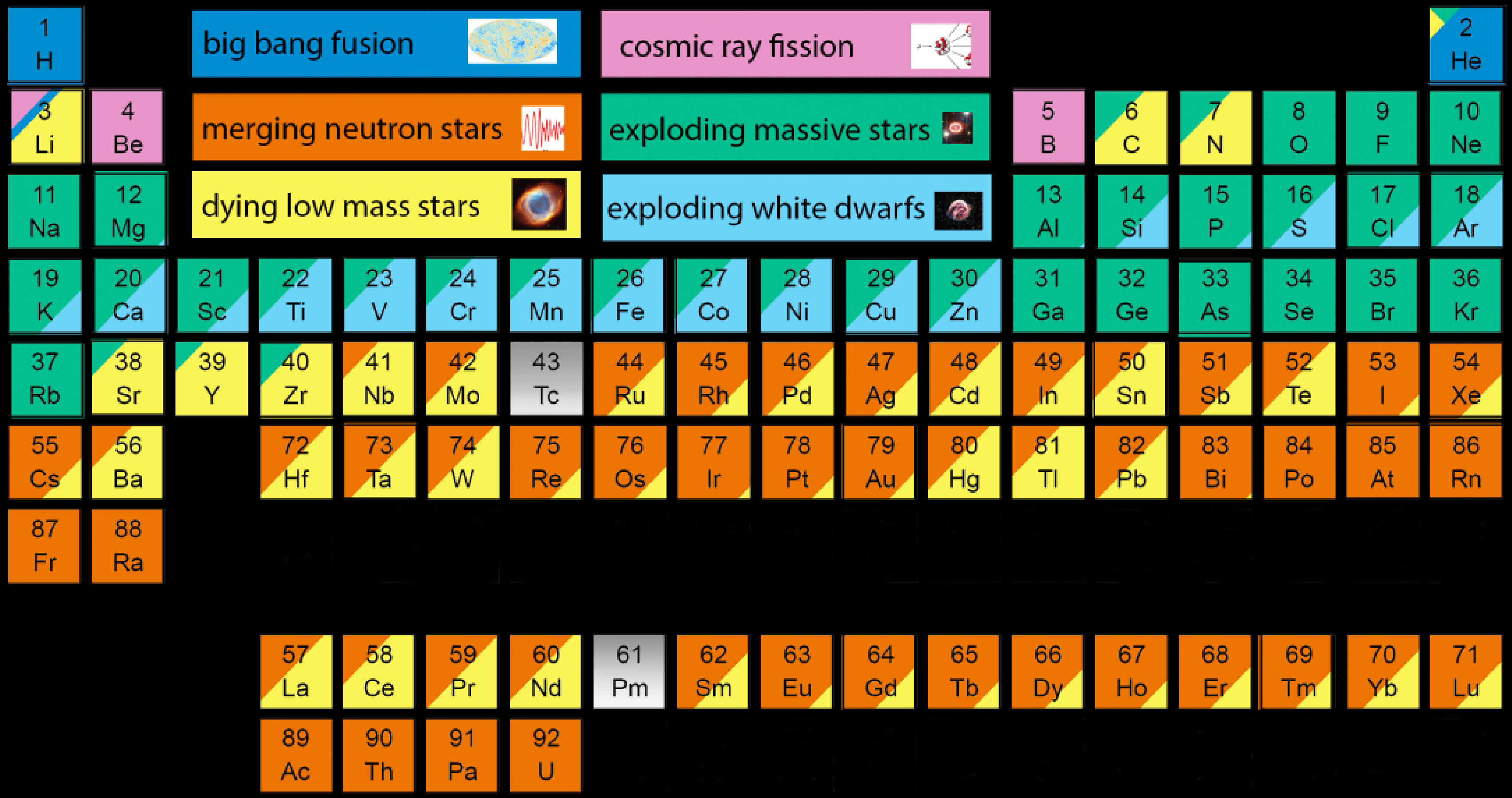
WHY NEUTRON STARS MERGER?



GRAPHIC BY JENNIFER JOHNSON

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WHY NEUTRON STARS MERGER?

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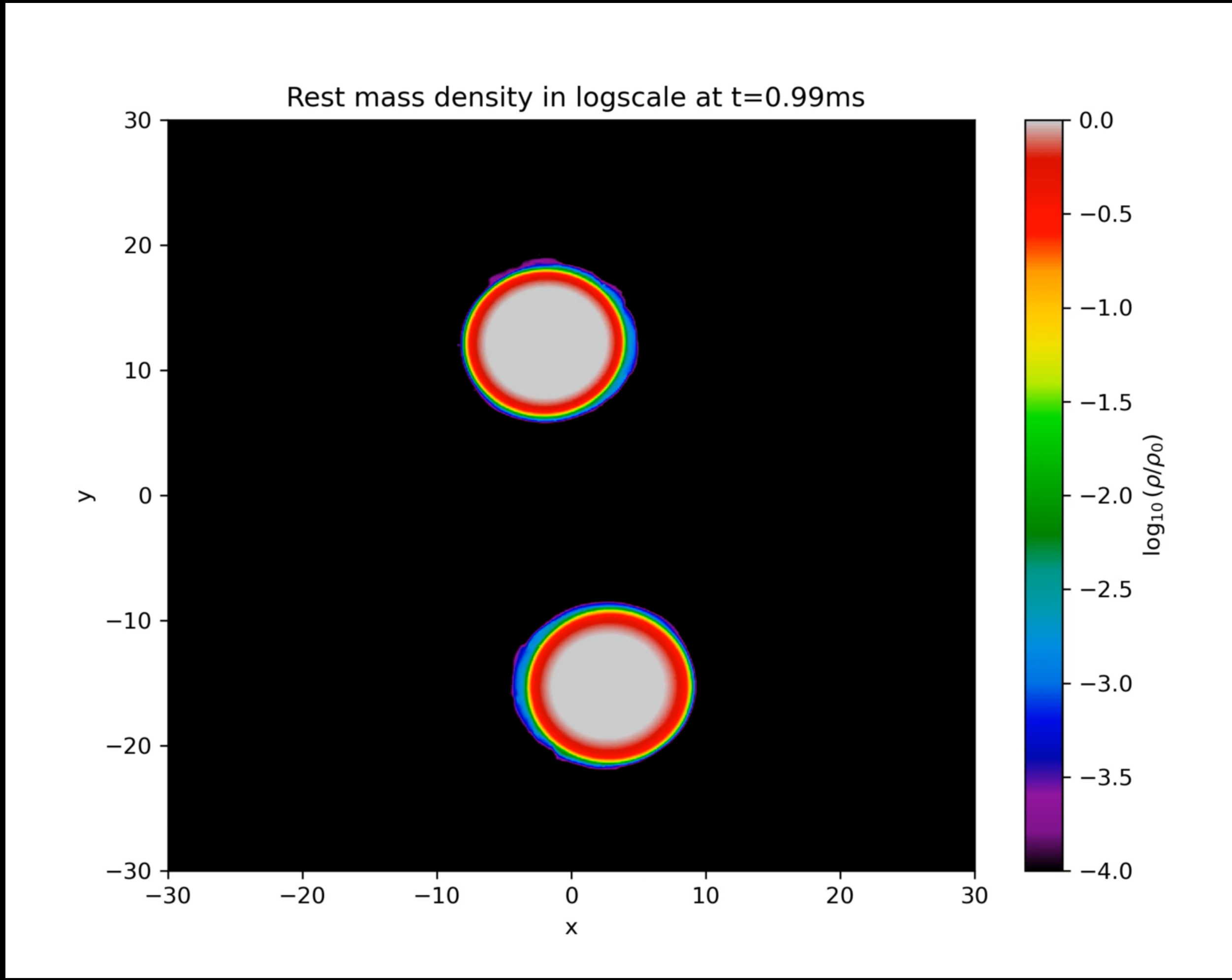
MERGER PHASES

- **Inspiral**
- **Merger**
- **Post merger phase/Collapse**
- **Stable NS/Collapse**



Venturi, GR et al. (in prep)

MERGER PHASES

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- Merger
- Post merger phase/Collapse
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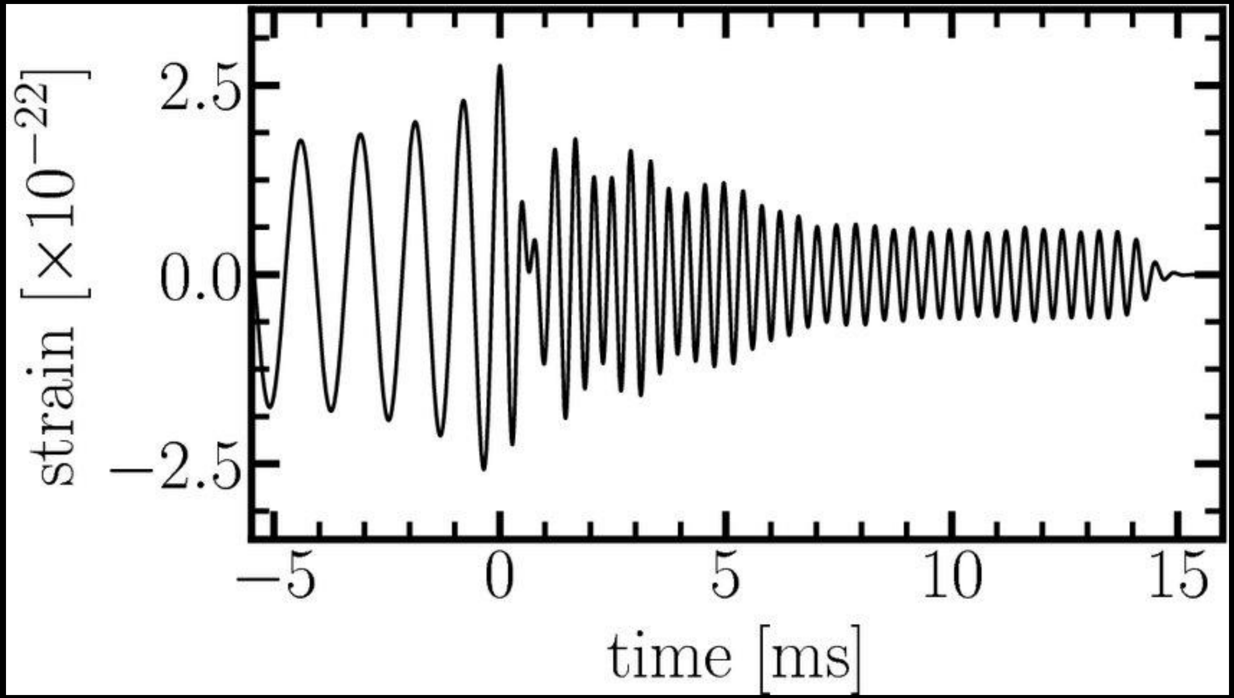

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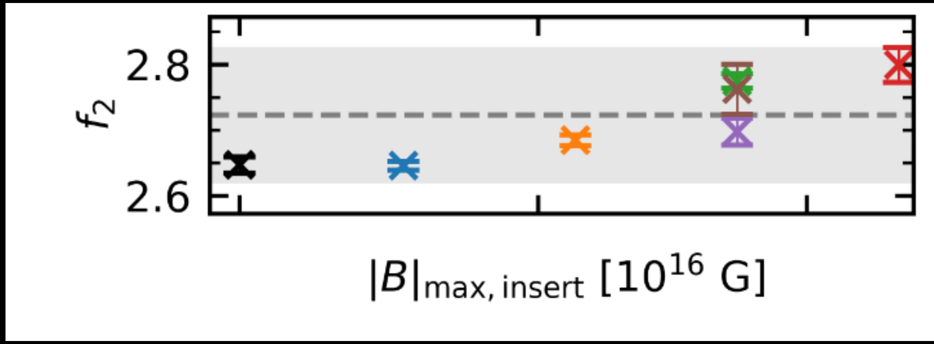
B-FIELD IN BNS

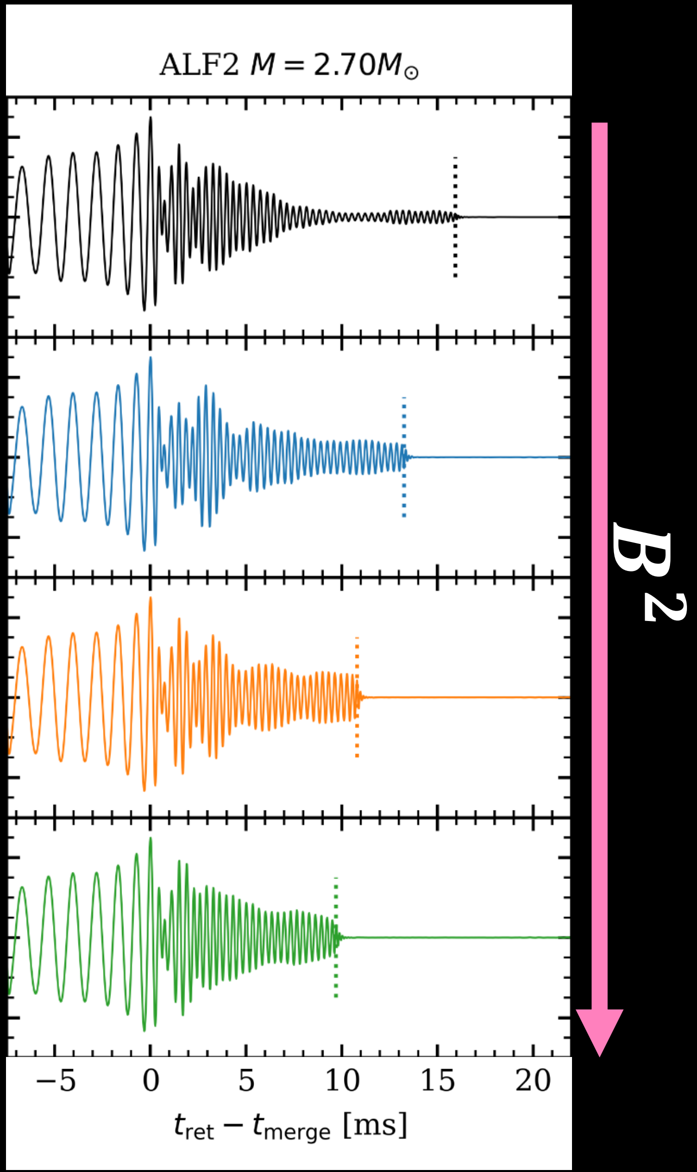


- Faster collapse to black hole

- Frequency shift in GWs

Other references about B-field and nucleosynthesis:

- De Haas et al. (2025), 10.1093/mnras/stad2931
- Kelsey A. Lund *et al* 2024 *ApJ* 964 111



BAMBER ET AL. (2025), PhysRevD.111.044038

OUR SETUP

- EoSs:
  - SFHo (soft) $q = 1{,}25$
  - DD2 (intermediate) $q = 1{,}25$
  - HShen (stiff) $q = 1$

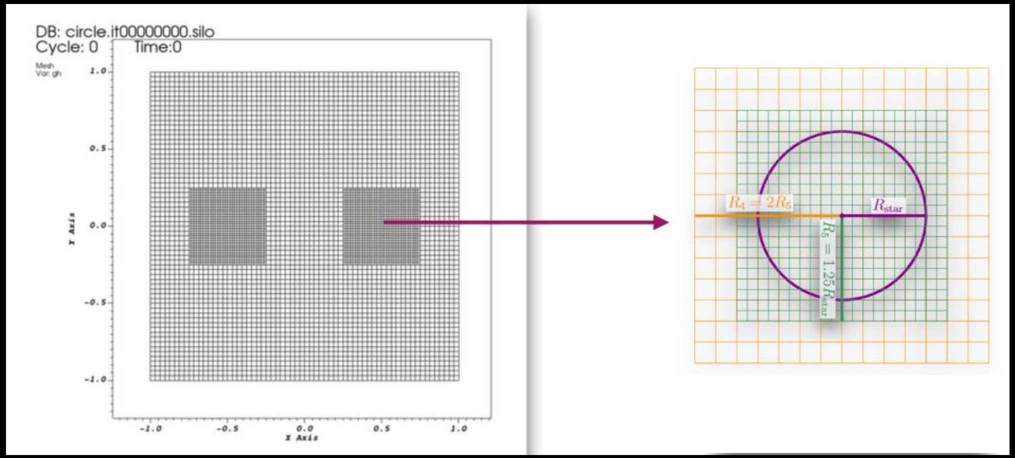
Toroidal

Poloidal

Venturi, GR et al. (in prep)

OUR SETUP

- BNS simulation using:
  Einstein Toolkit + IllinoidGRMHD
  adding tracer particles evolution
  (up to 40 ms after merger)



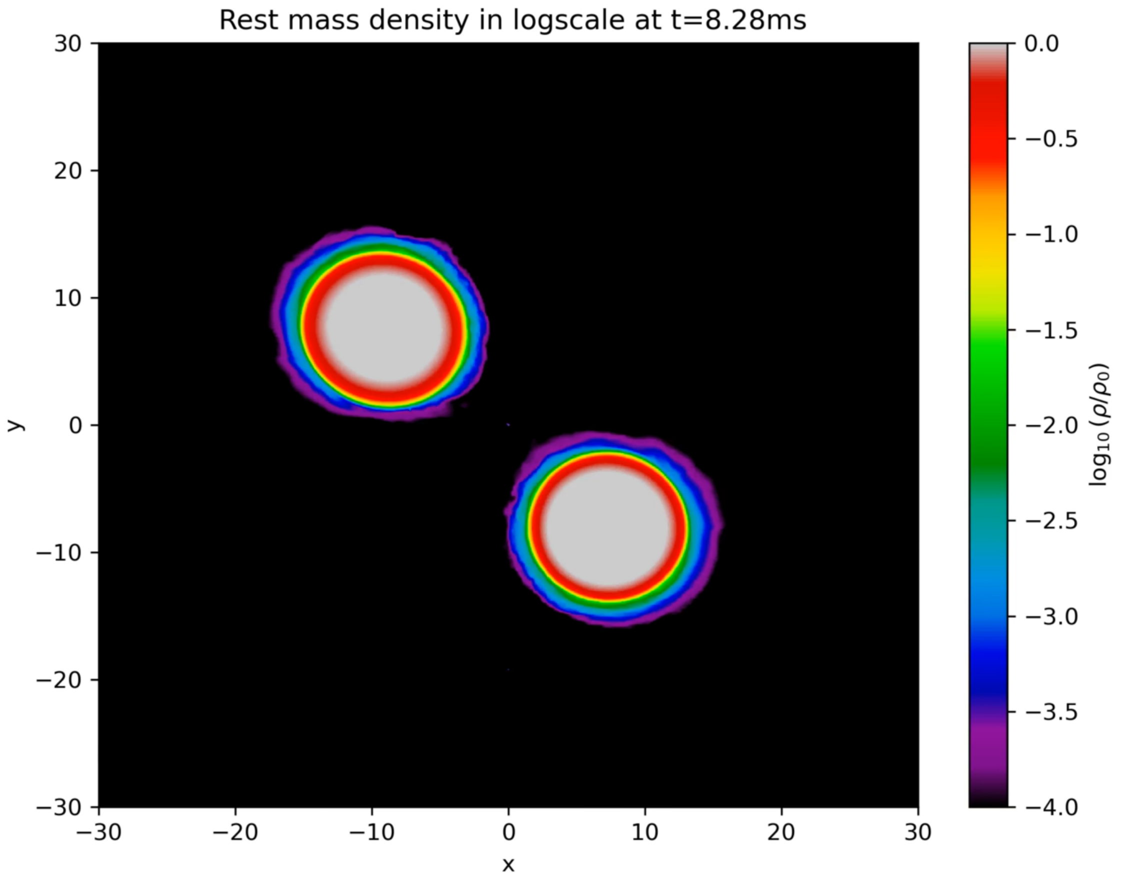
www.einsteintoolkit.org
www.illinoisgrmhd.net

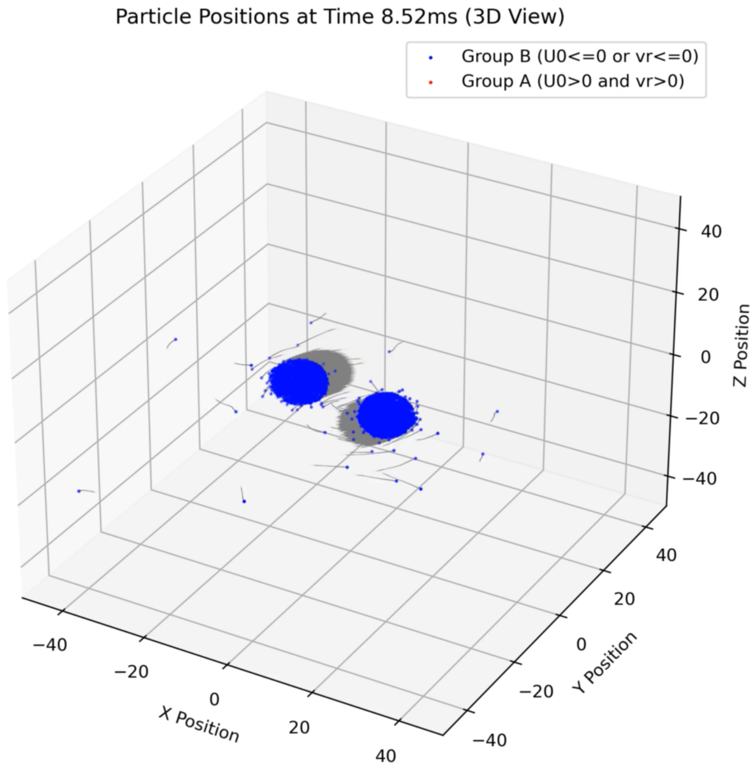
- Nucleosynthesis using WinNet
  Of the ejected tracers

WinNet

nuc-astro.github.io/WinNet/

OUR SETUP

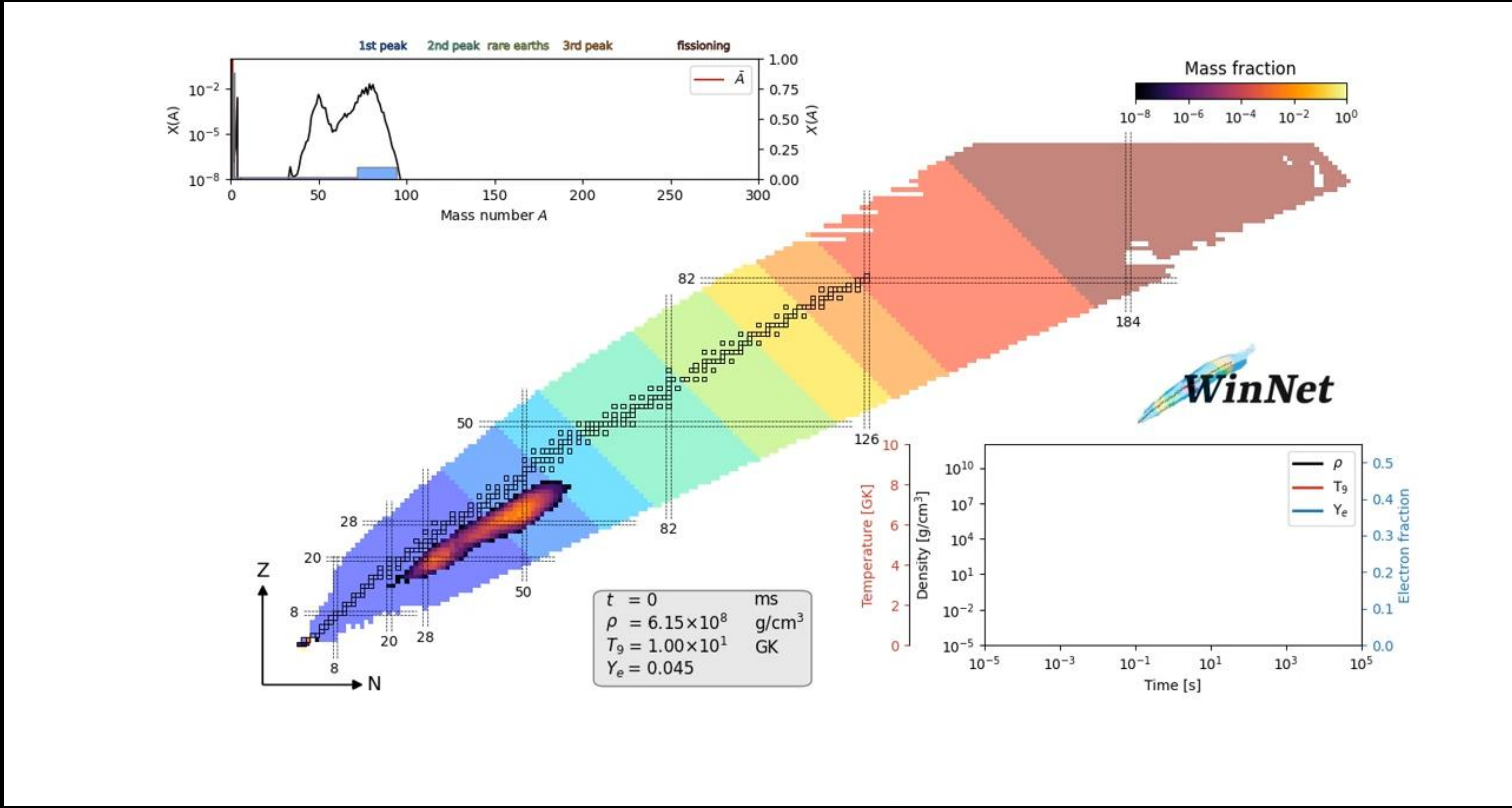




Venturi, GR et al. (in prep)

OUR SETUP

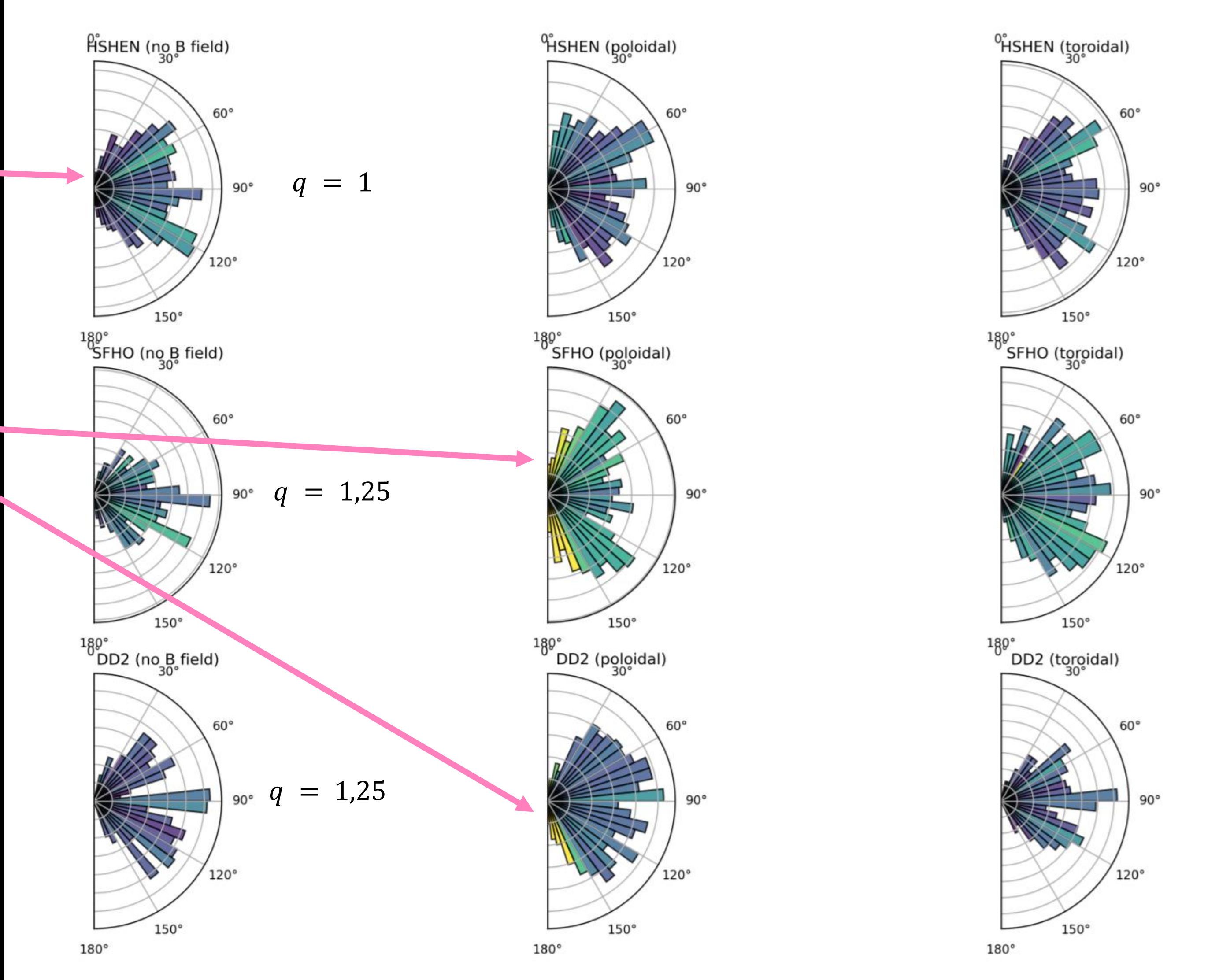
Venturi, GR et al. (in prep)



EJECTA PROPERTIES

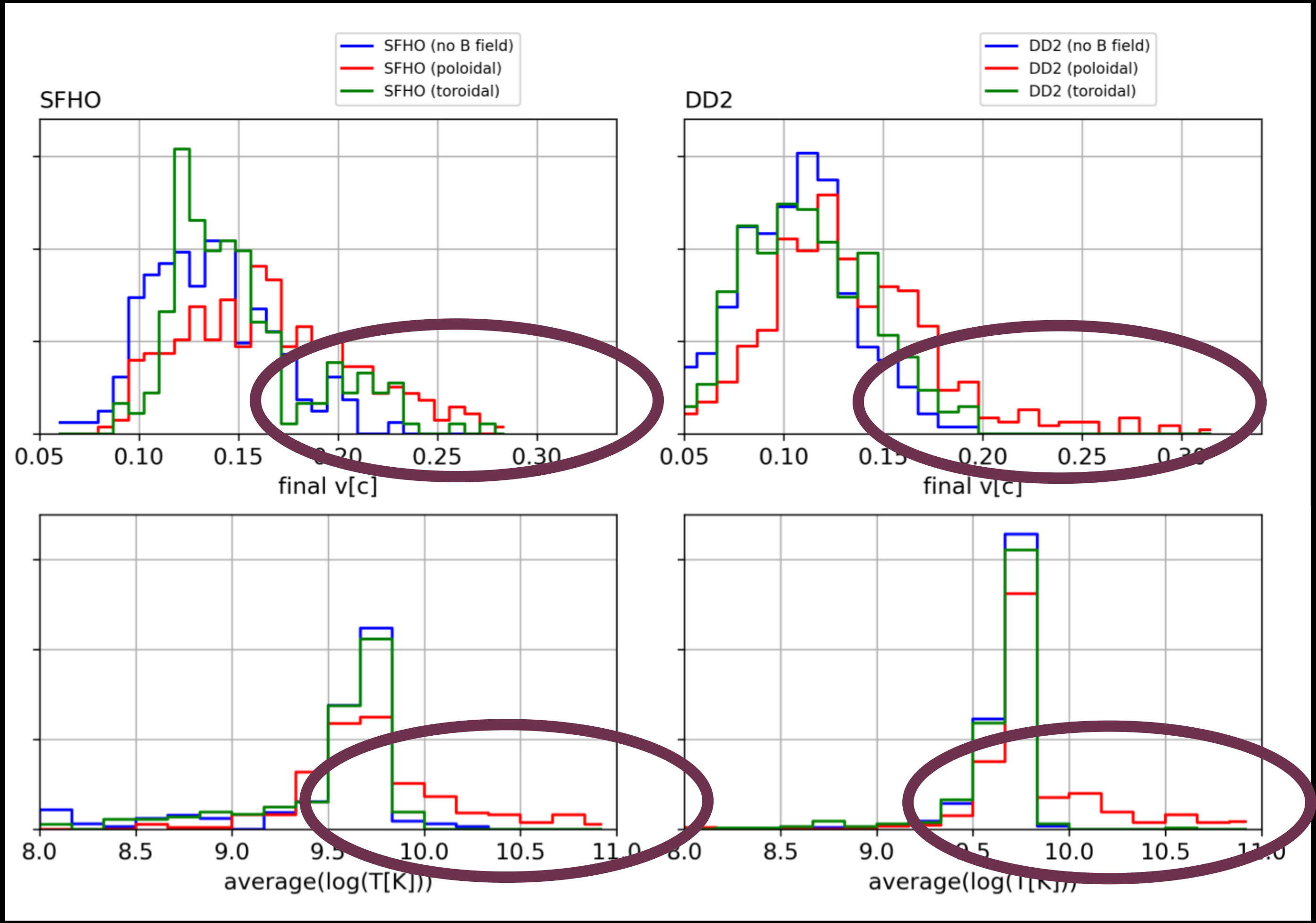
Venturi, GR et al. (in prep)

- $q = 1$ seems not affected!
- $q = 1{,}25$ Poloidal shows fast ejection at the poles!
- $q = 1{,}25$ Toroidal is not affected!



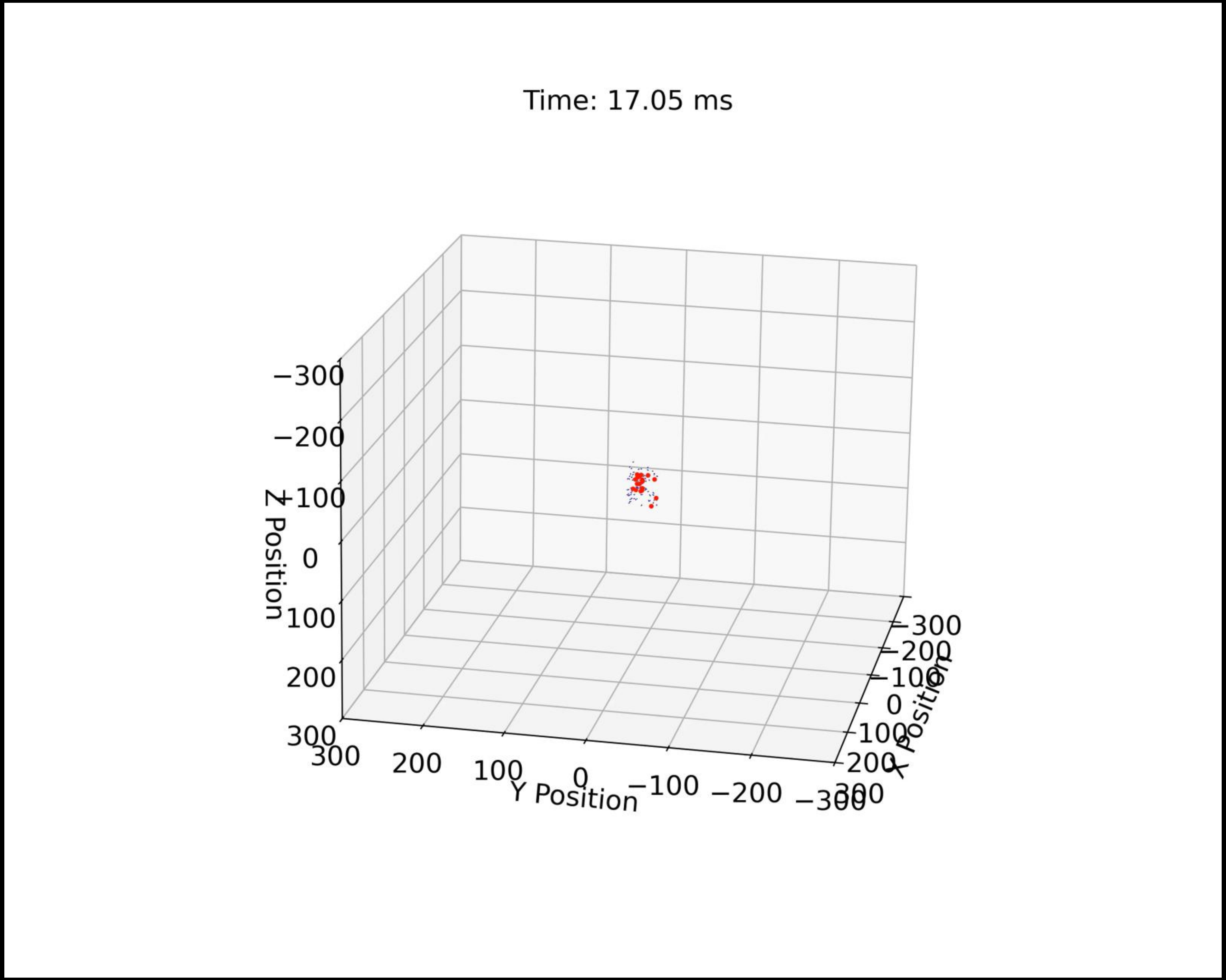
EJECTA PROPERTIES

Higher Velocities and Temperature for Poloidal and Unequal Masses



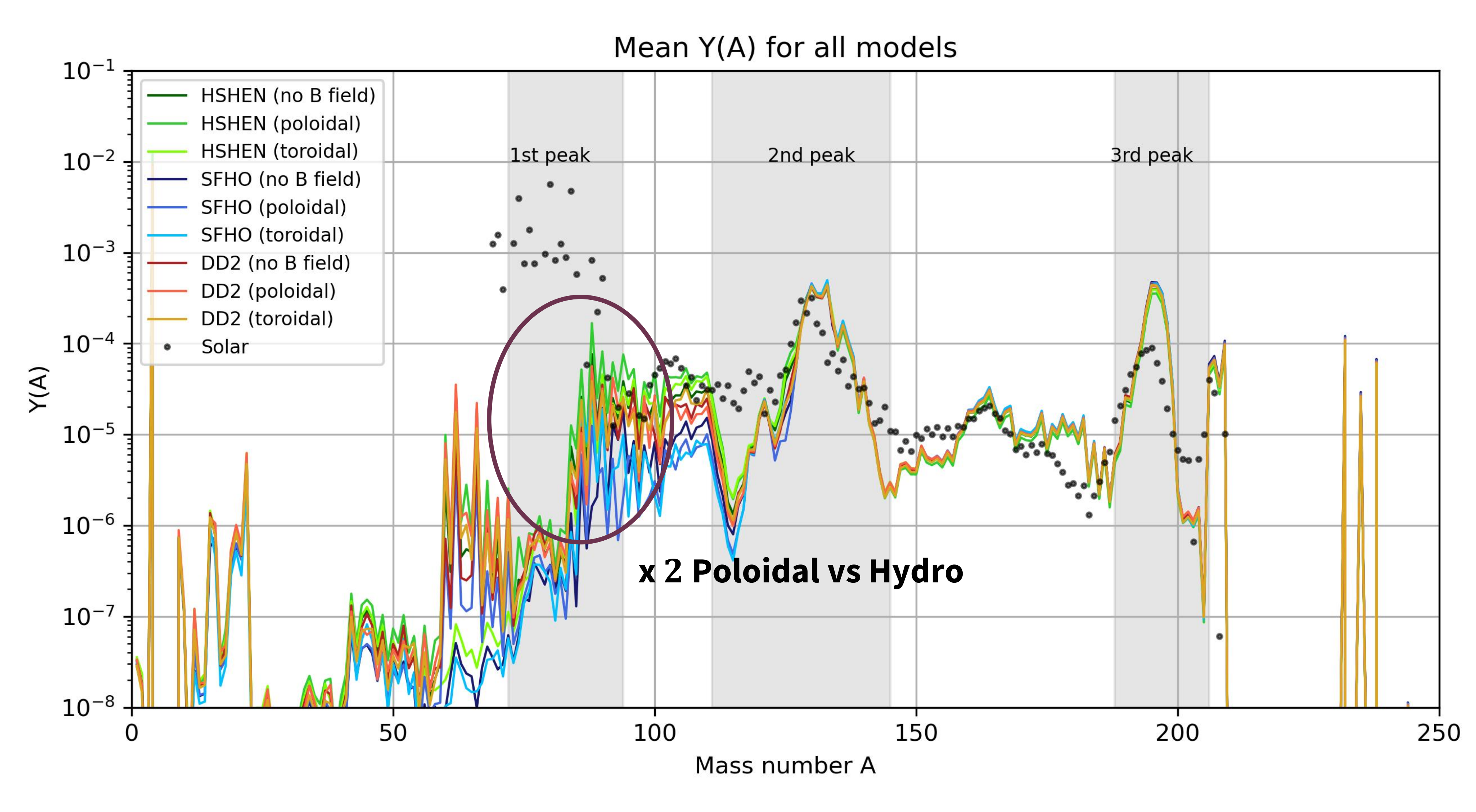
Venturi, GR et al. (in prep)

EJECTA PROPERTIES: JET?



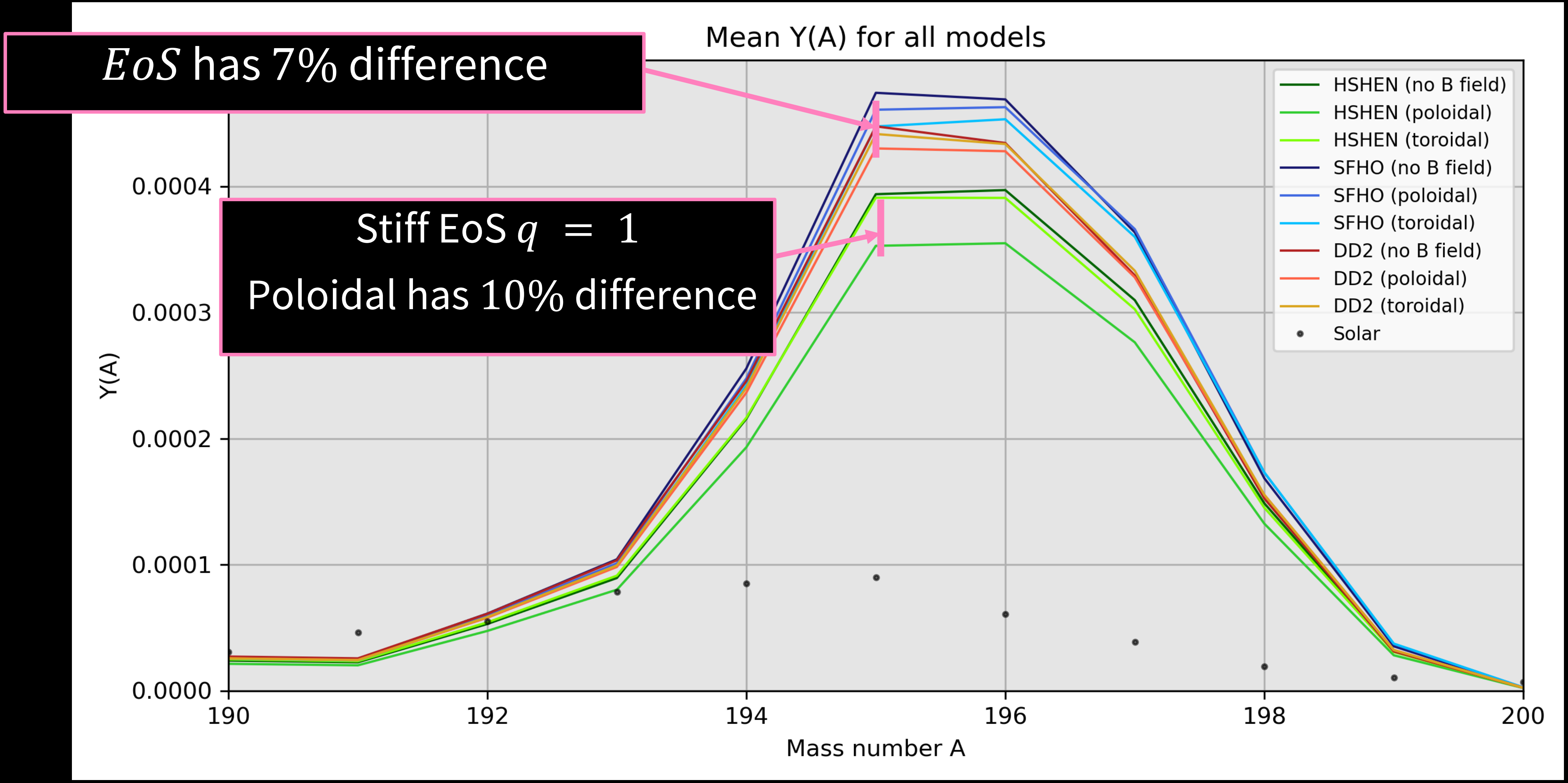
Venturi, GR et al. (in prep)

NUCLEOSYNTHESIS



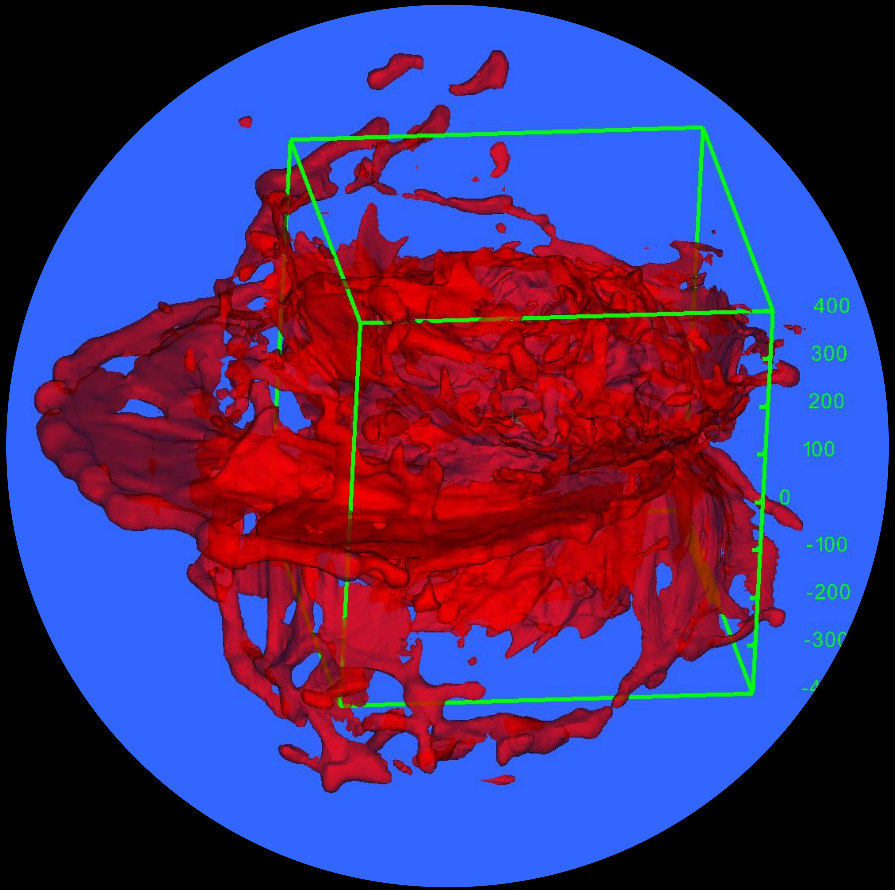
Venturi, GR et al. (in prep)

NUCLEOSYNTHESIS: 3rd Peak

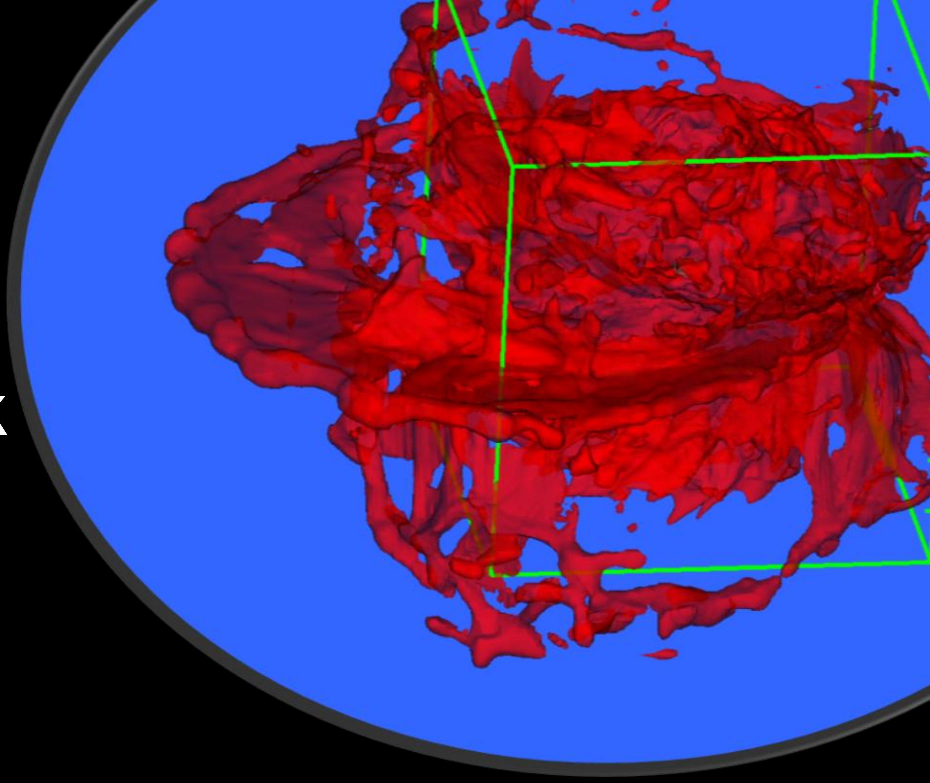


Venturi, GR et al. (in prep)

Conclusion



Conclusion &
Future Prospective



Venturi, GR et al. (in prep)

- Poloidal Magnetic field suppress the 3rd peak
- Effect comparable to EoS contribution
- Enhanced ejection in the pole
  - Nucleosynthesis in the "Jet"/Angular distribution
- Post-processing code to extract tracer data!

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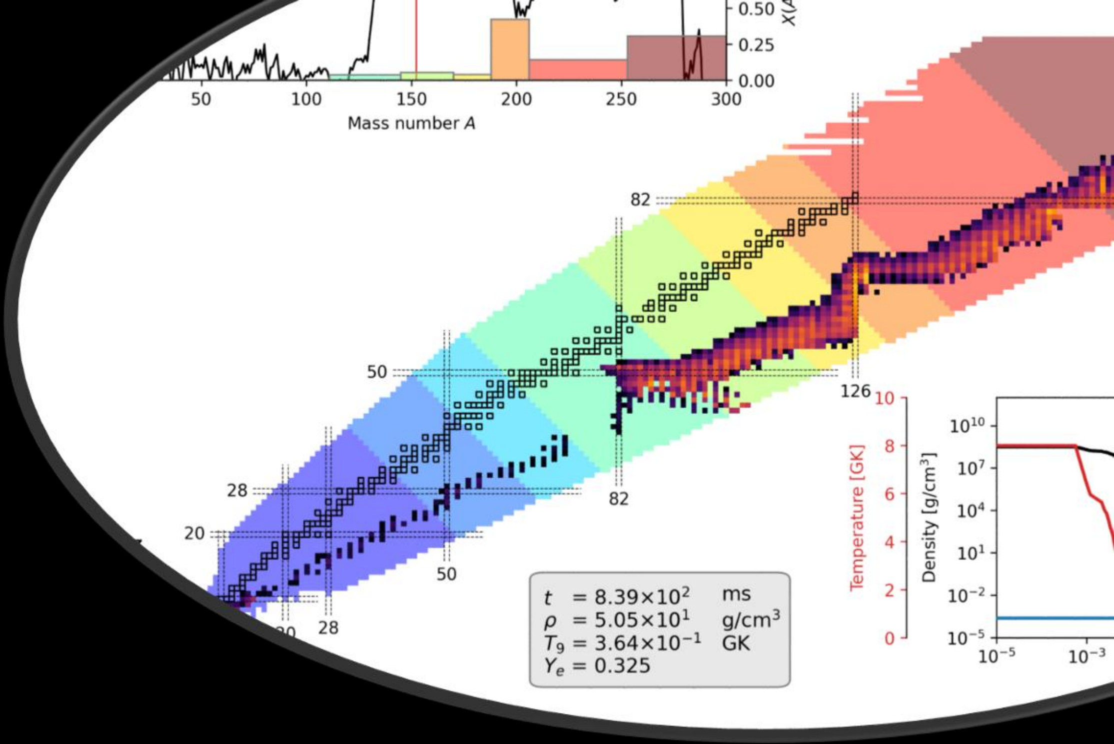

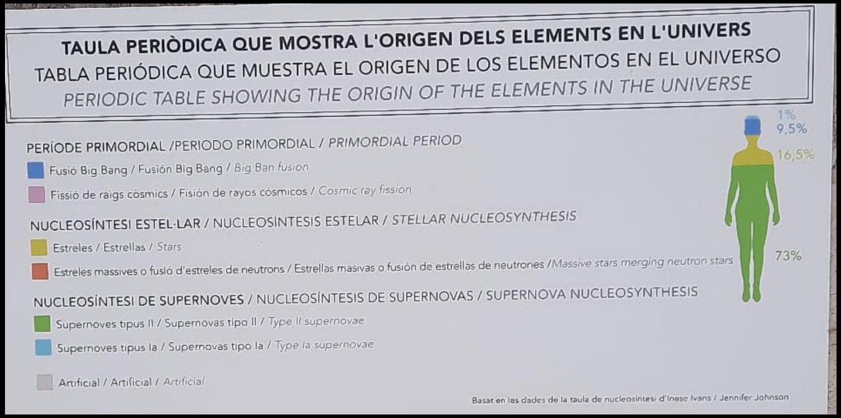

Thanks!

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