

Neutrino pair interactions

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Impact on early explosion mechanism and observations

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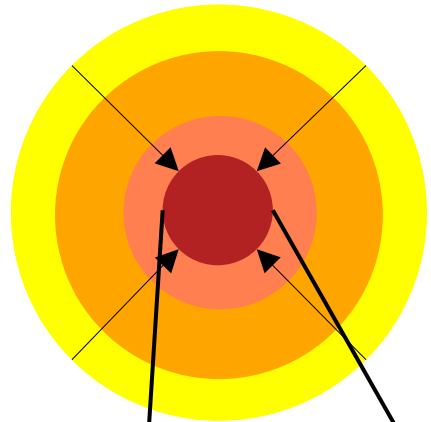


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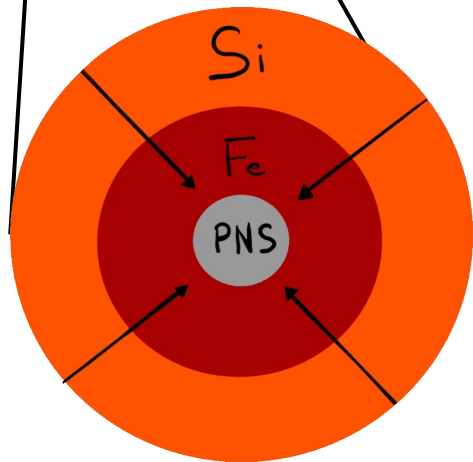


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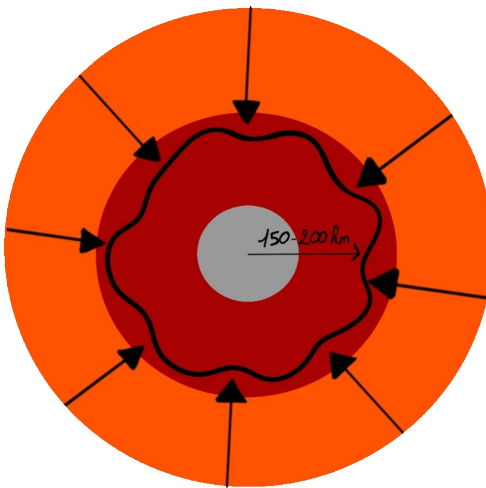
Onion shell structure



CCSN reminder

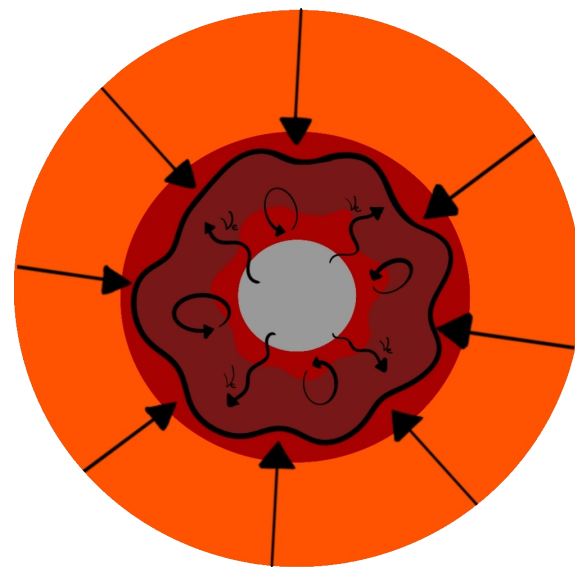


Collapse and Bounce



Shock stalling

Shock revival

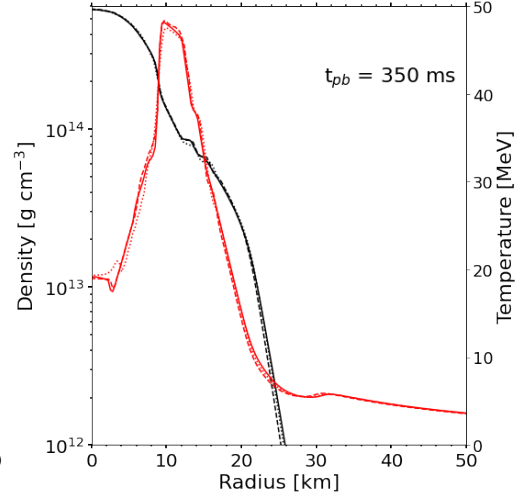
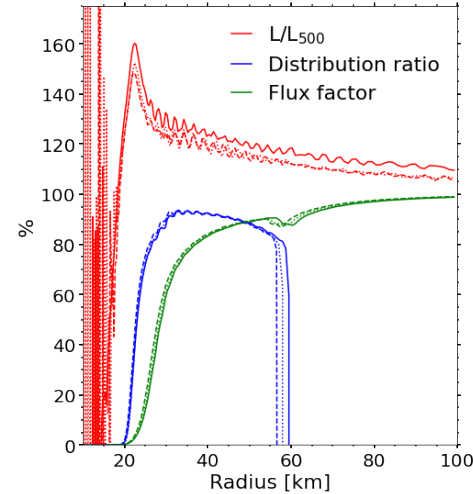
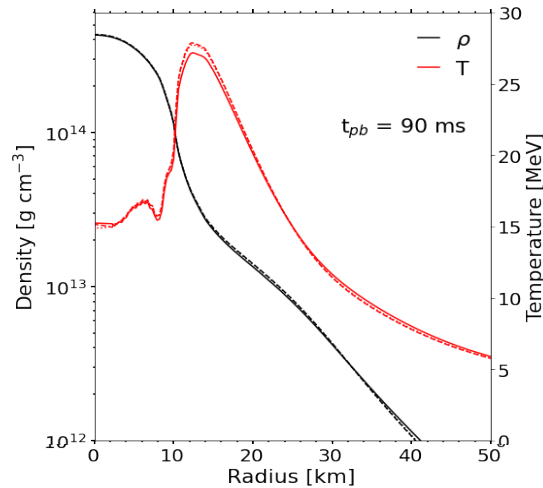
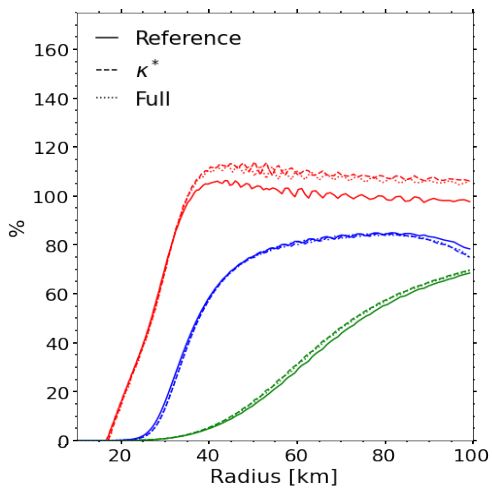


Improved approximate transport: K^*

Neutrino distribution next to the PNS is not the black body distribution but is assumed as much in the opacity calculation.

90 ms

350 ms



Pair-processes treatment: Reference, Full, Simplified (K^*)

Reference:
$$B = j(1 - f) - \frac{f}{\lambda} = \eta - f\kappa_a$$

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Full: $B = \int v'^2 dv' d\Omega' [(1 - f)(1 - \bar{f})R^{pro} - f\bar{f}R^{ann}]$

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\bar{f} is considered as a black body distribution but the real distribution is different by ~80% in the PNS outer layer













Pair-processes treatment: Reference, Full, Simplified (κ^*)

Reference:
$$B = j(1 - f) - \frac{f}{\lambda} = \eta - f\kappa_a$$

Full:
$$B = \int v'^2 dv' d\Omega' [(1 - f)(1 - \bar{f})R^{pro} - f\bar{f}R^{ann}]$$

Simplified:
$$\kappa_a^* = F\kappa_a \quad \text{with} \quad F = \min \left(1, \frac{\sum_i E_i \Delta \varepsilon_i}{\sum_i BB_i \Delta \varepsilon_i} \right)$$

1D simulations

| | SRO | | SFHo | |
|-------------------------------------|---|---|--|---|
| | OPE | T-matrix | OPE | T-matrix |
| Reference |  |  |  |  |
| Simplification (K [*]) |  |  |  |  |
| Full |  |  |  |  |

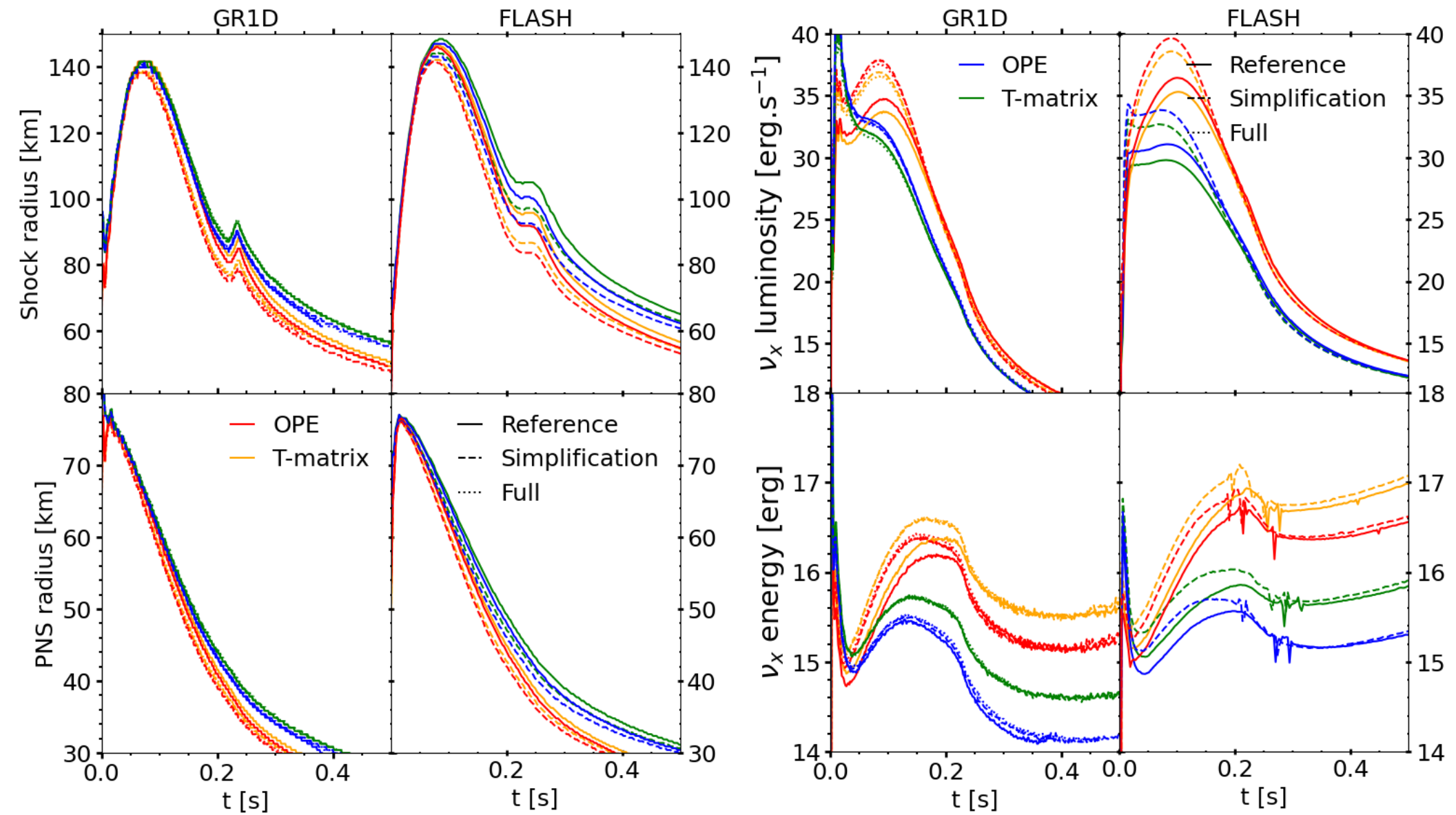
One Pion Exchange
(OPE): Hannestad &
Raffelt 98

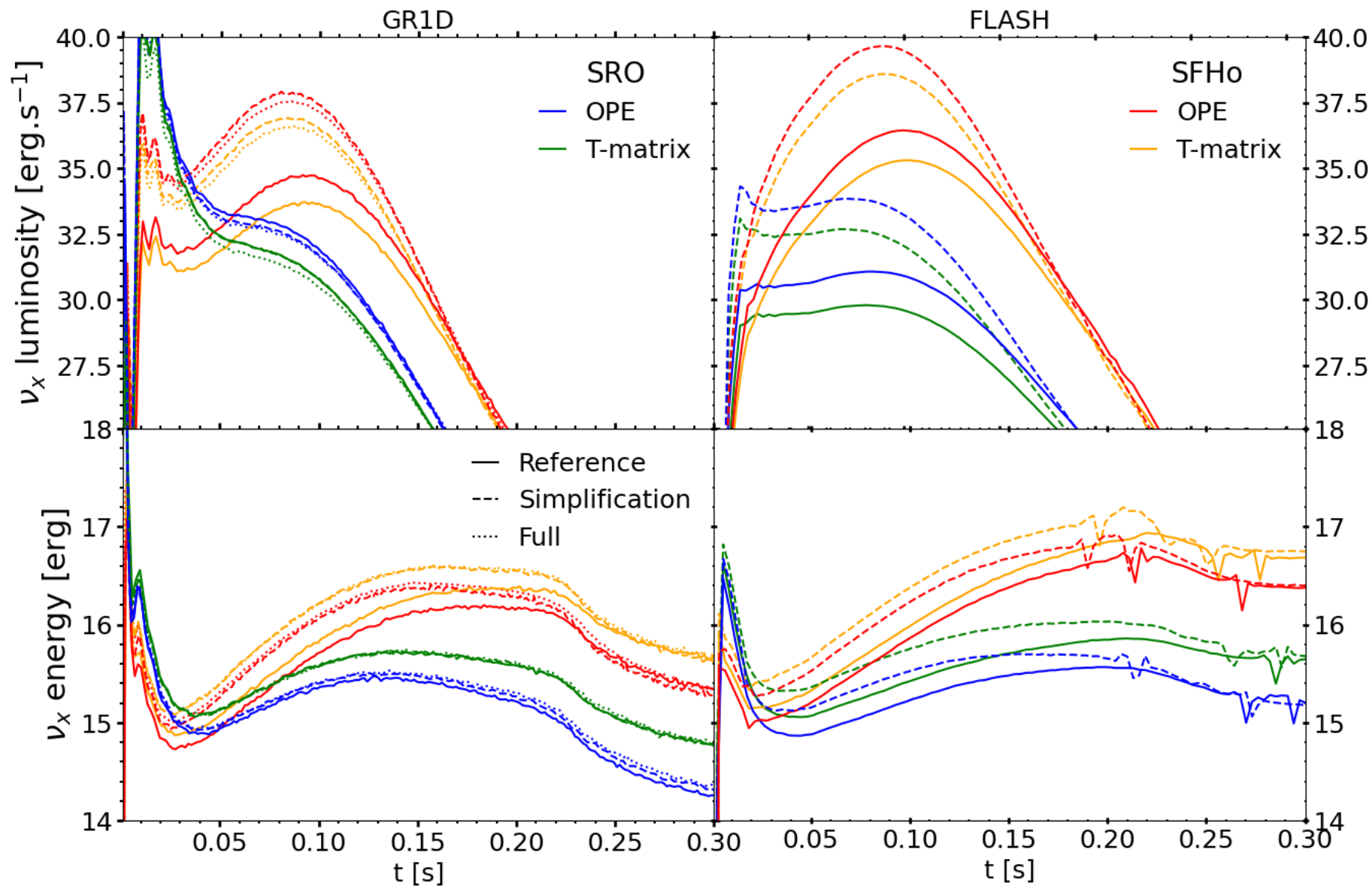
T-matrix: Guo et al. 2018

FLASH does not have the
full treatment coded in


Testing in both FLASH
and GR1D to confirm
adequate change

Both codes use M1

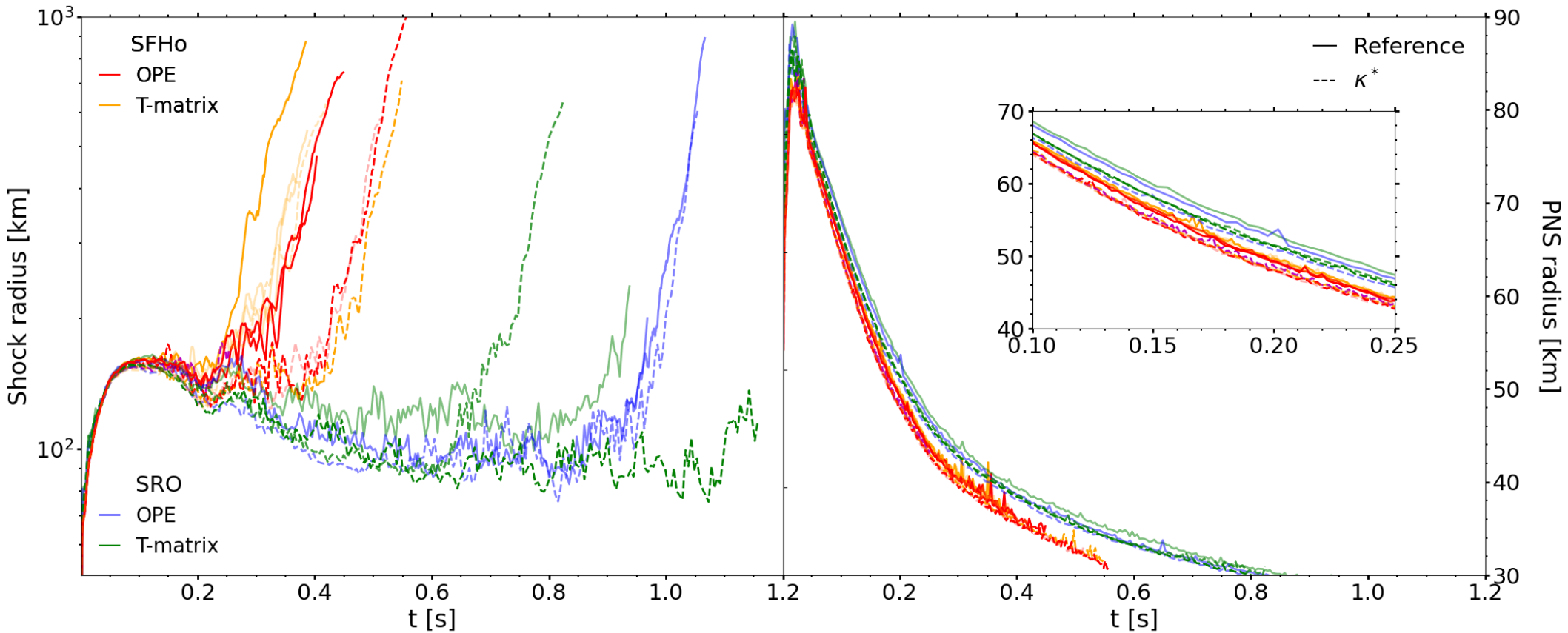




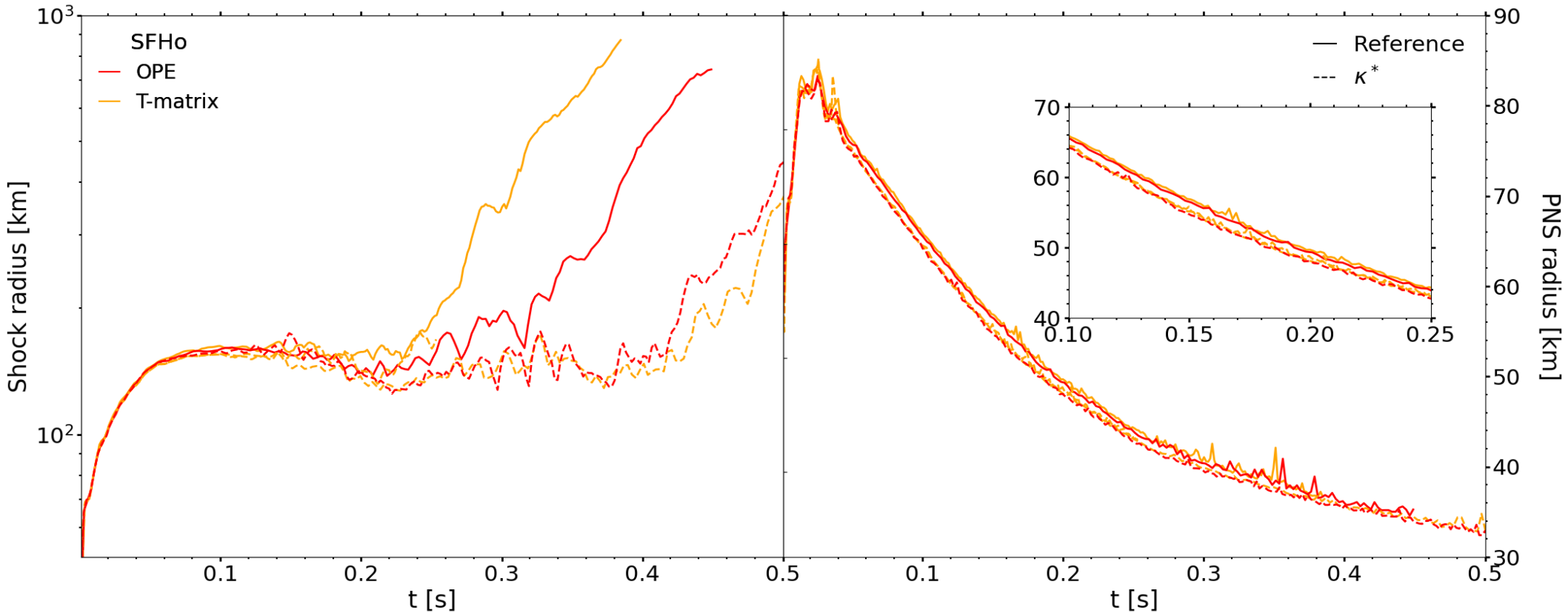
2D simulations

| | SRO | | SFHo | |
|-----------------------------|---|---|---|---|
| | OPE | T-matrix | OPE | T-matrix |
| Reference |  |  |  |  |
| Simplification (K^*) |  |  |  |  |

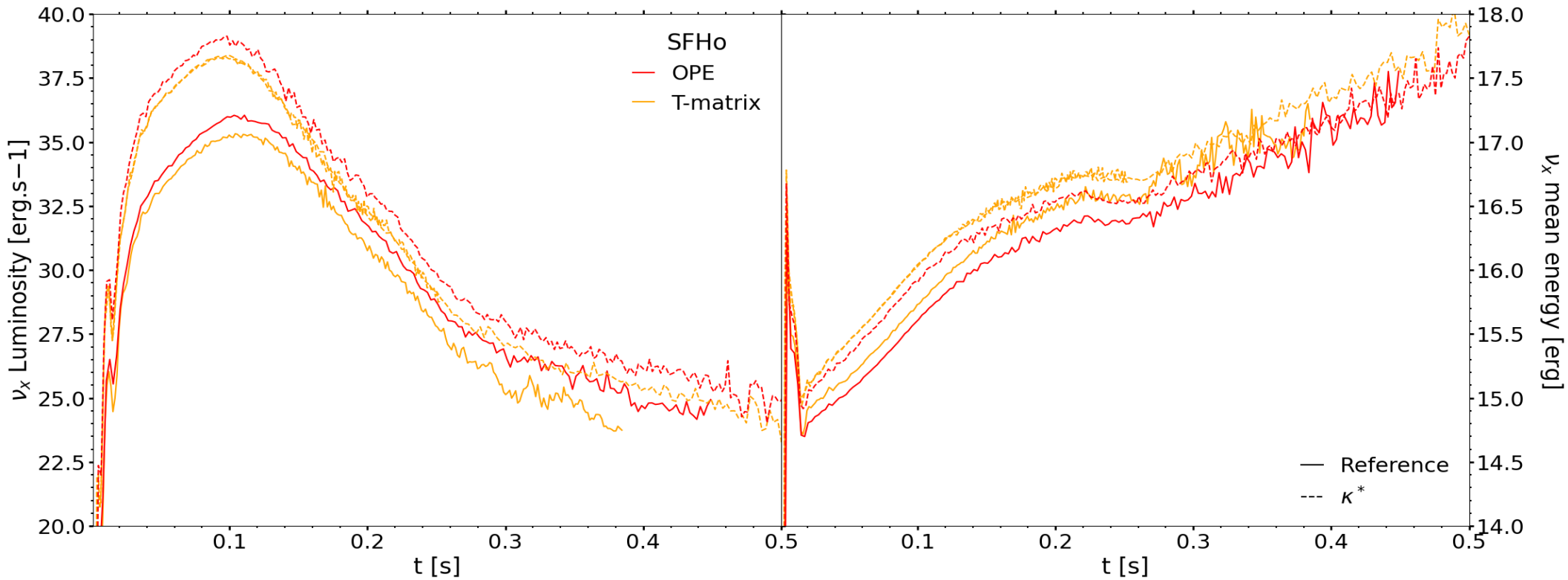
2D simulations - hydro



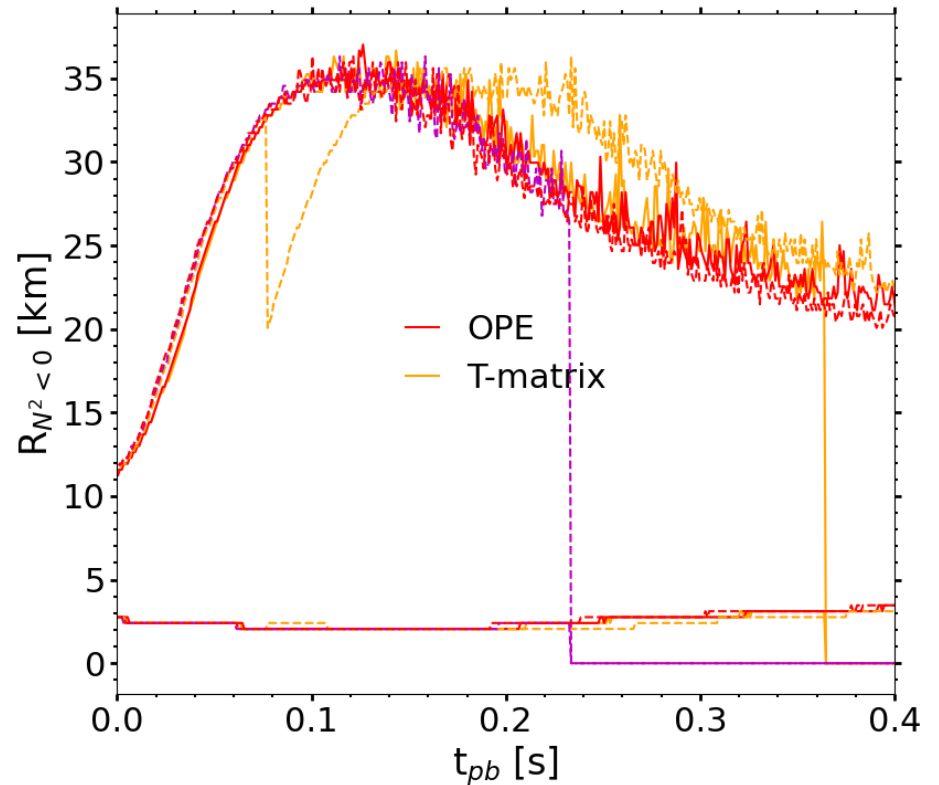
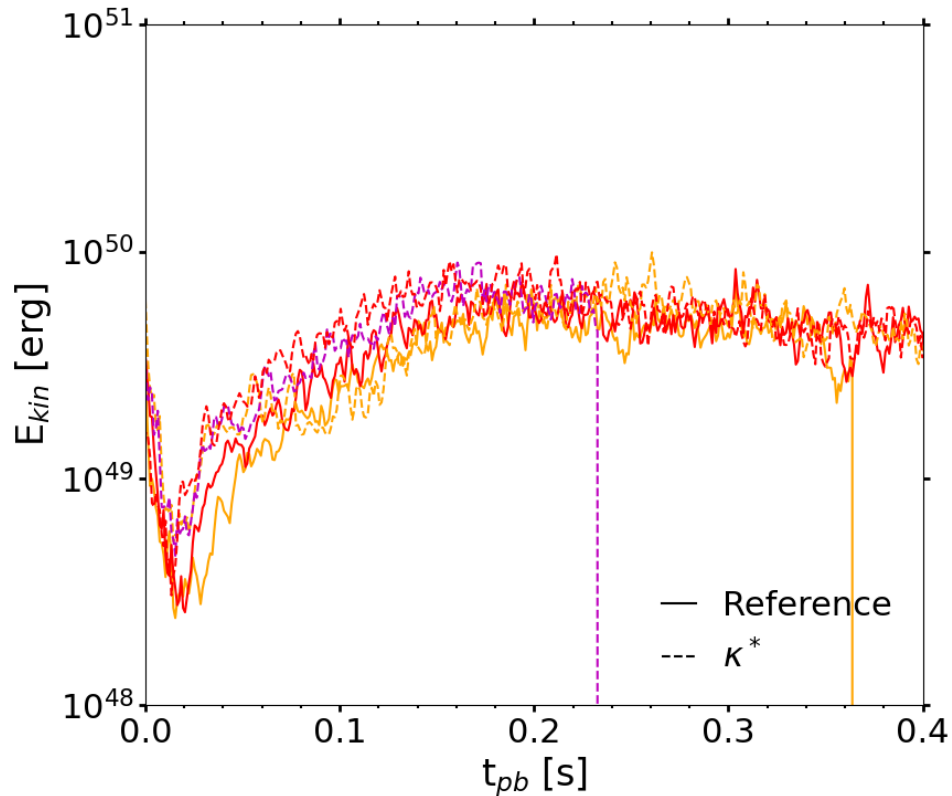
2D SFHo - hydro



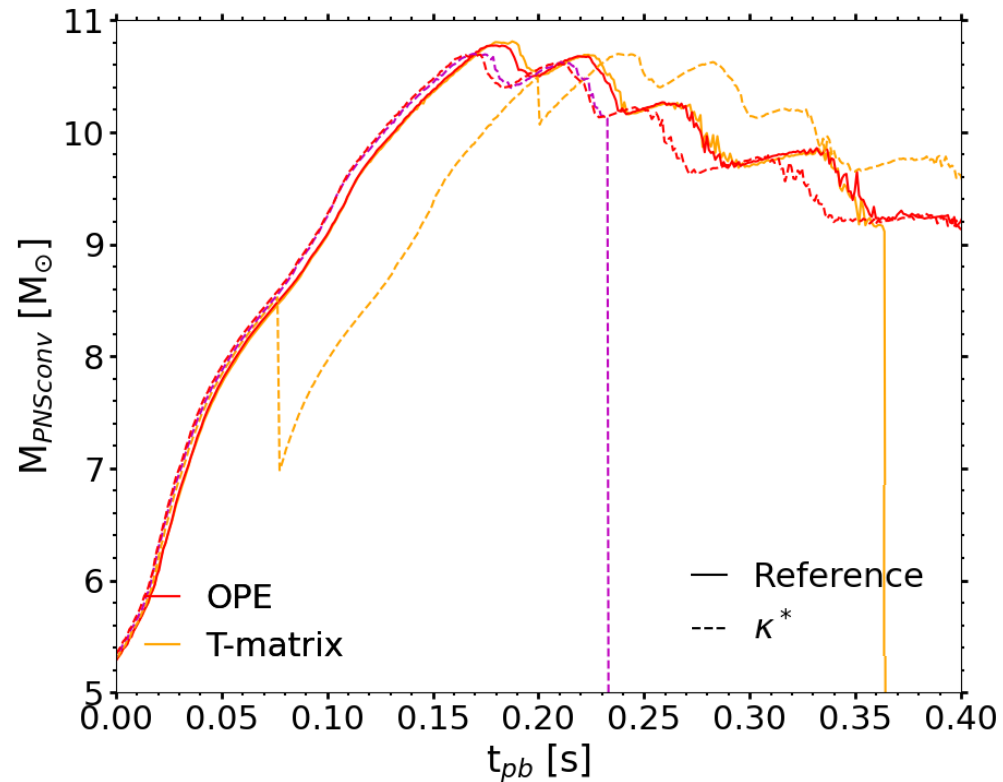
2D: SFHo - v_x



SFHo: PNS convection zone



SFH0: PNS convection zone



Conclusion

- Small effect on the PNS outer layer at early time
- Faster contraction of the PNS due to higher energy loss
- The nucleon-nucleon bremsstrahlung has little impact on the hydrodynamic
- EOS impacts the explosion time and global evolution far more

Thank you!



