Possible Neutrino Signature of Hadron-quark Phase Transition in Failing Core-collapse Supernovae

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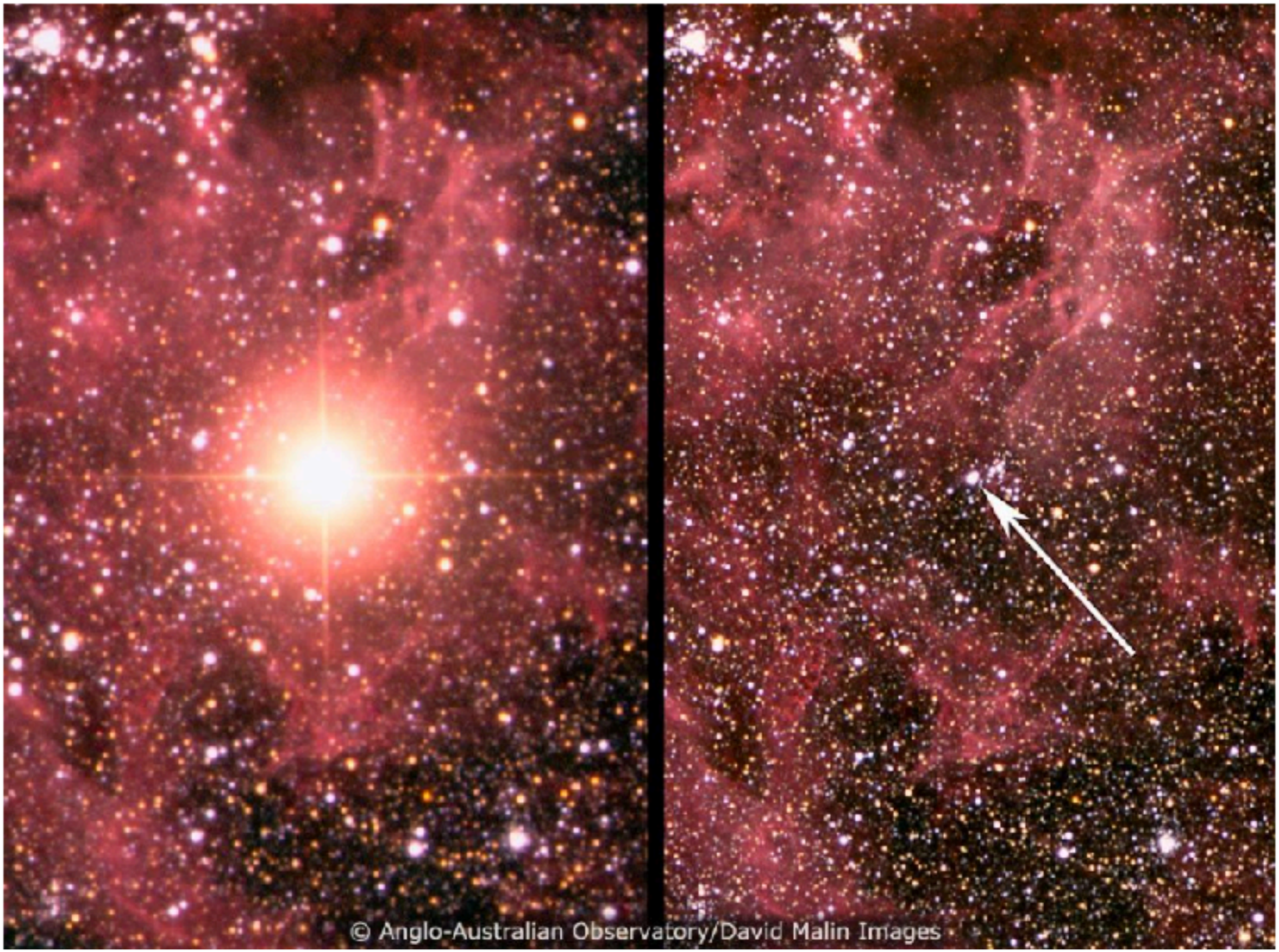
20201123

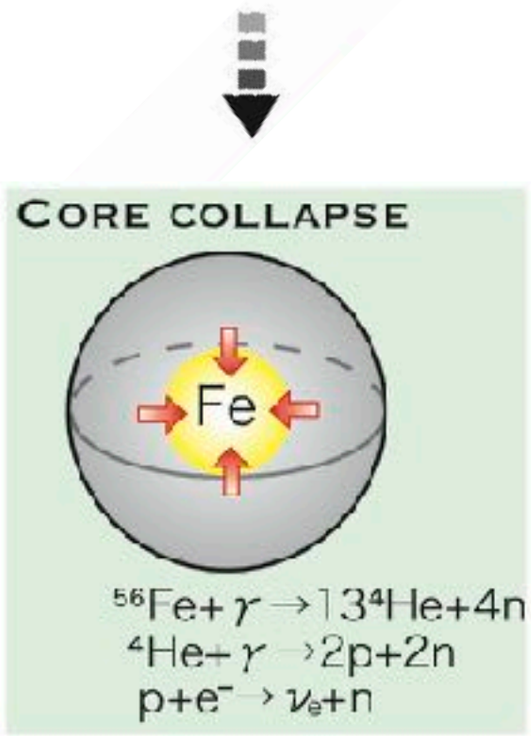
Supernova: an example

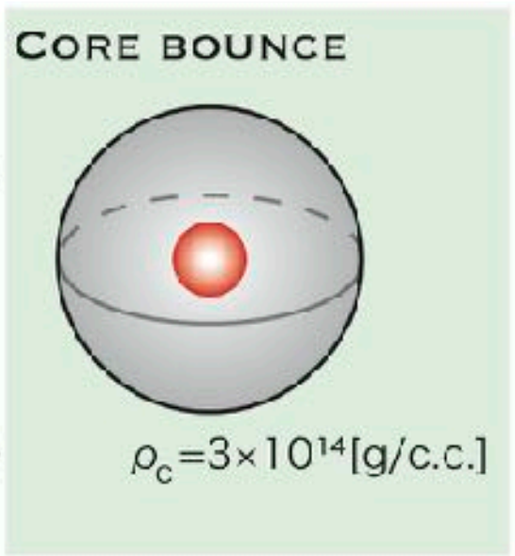
SN 1987A at Large Magellanic Cloud, ~160,000 light years away

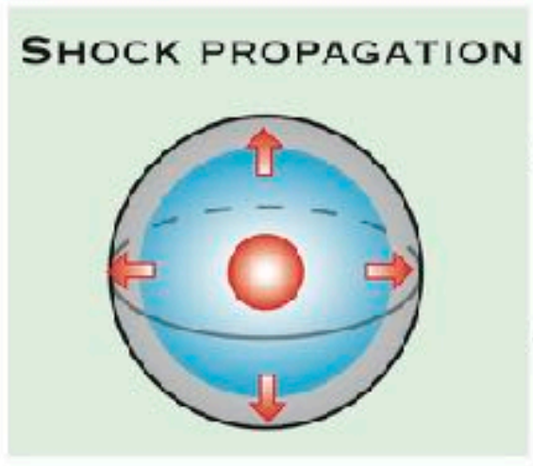


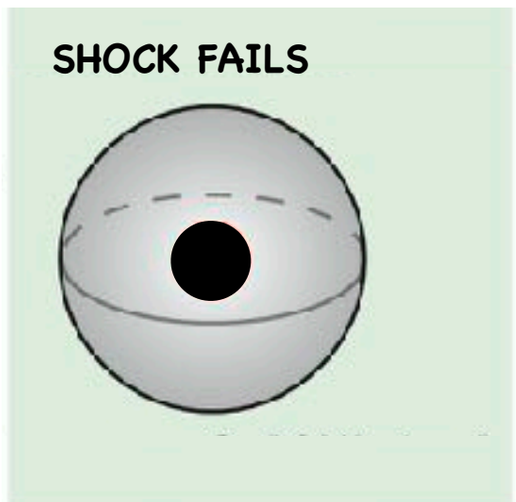
Core-collapse Supernova (CCSN)

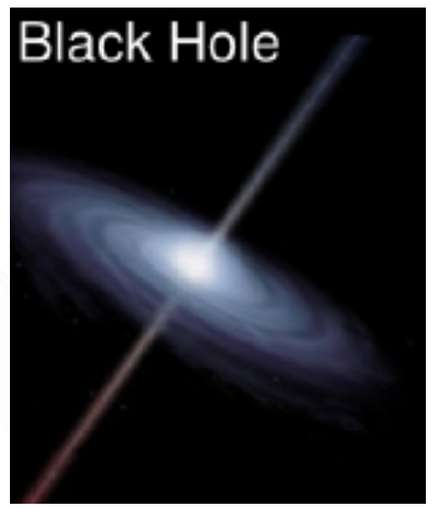
Massive star
~8-100 $M_\odot$











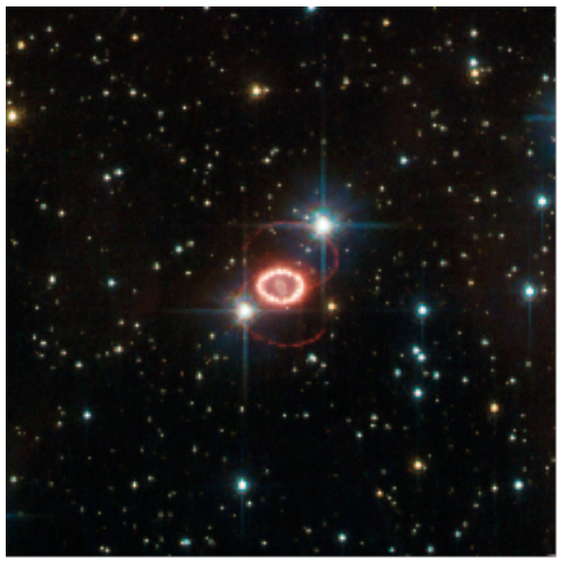
Failing CCSN

Source: A. Suzuki

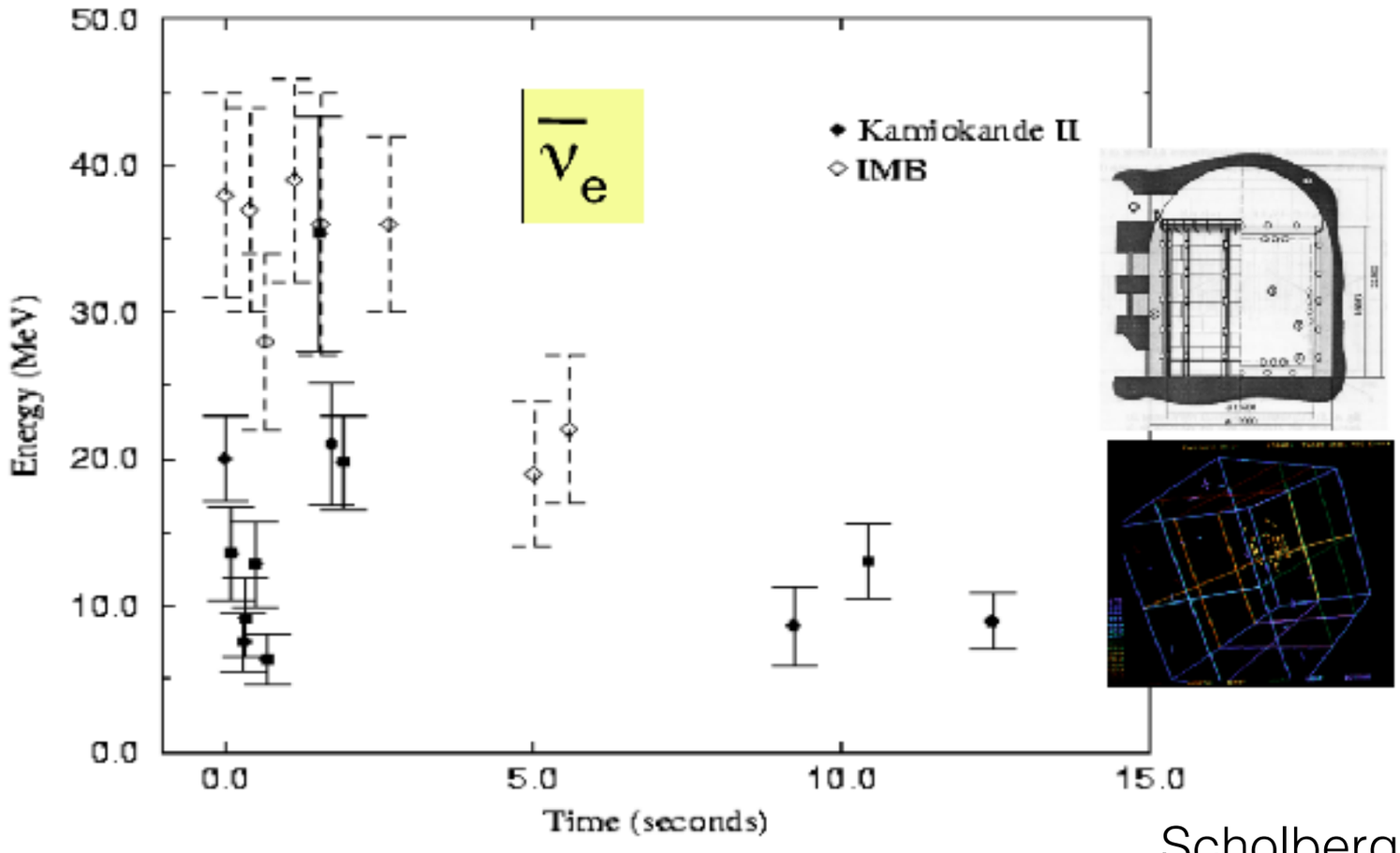
Neutrino signal of CCSN

A stellar collapse releases ~10^{53}erg gravitational energy

- ~99% is carried away by neutrinos
- SN explosion energy ~10^{51} erg



SN1987A (*ESA/Hubble)*

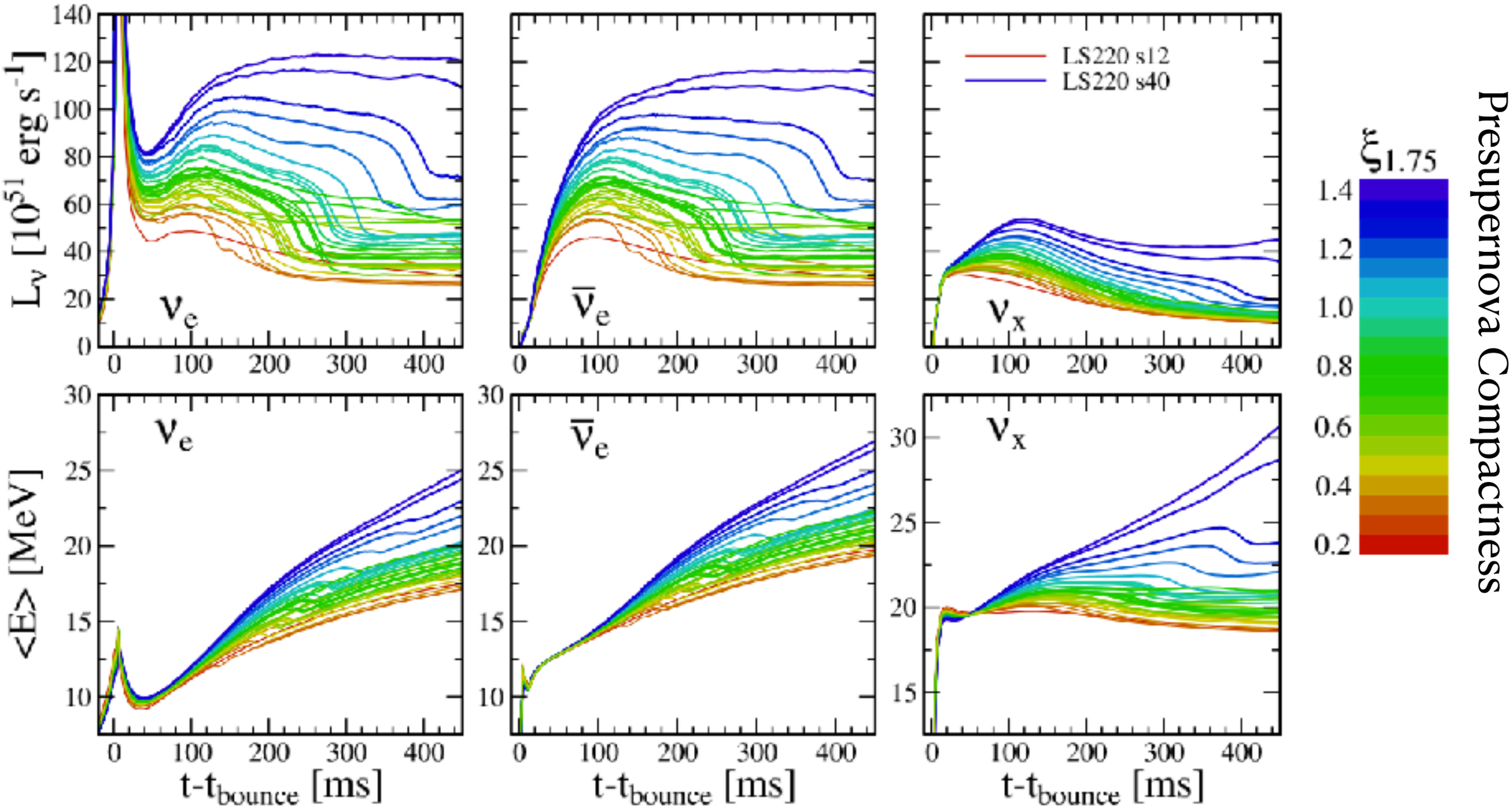


Scholberg 2017

- Confirmed baseline model, i.e., SN II -> core-collapse to a proto-NS
- Better statistics needed to probe progenitor properties,

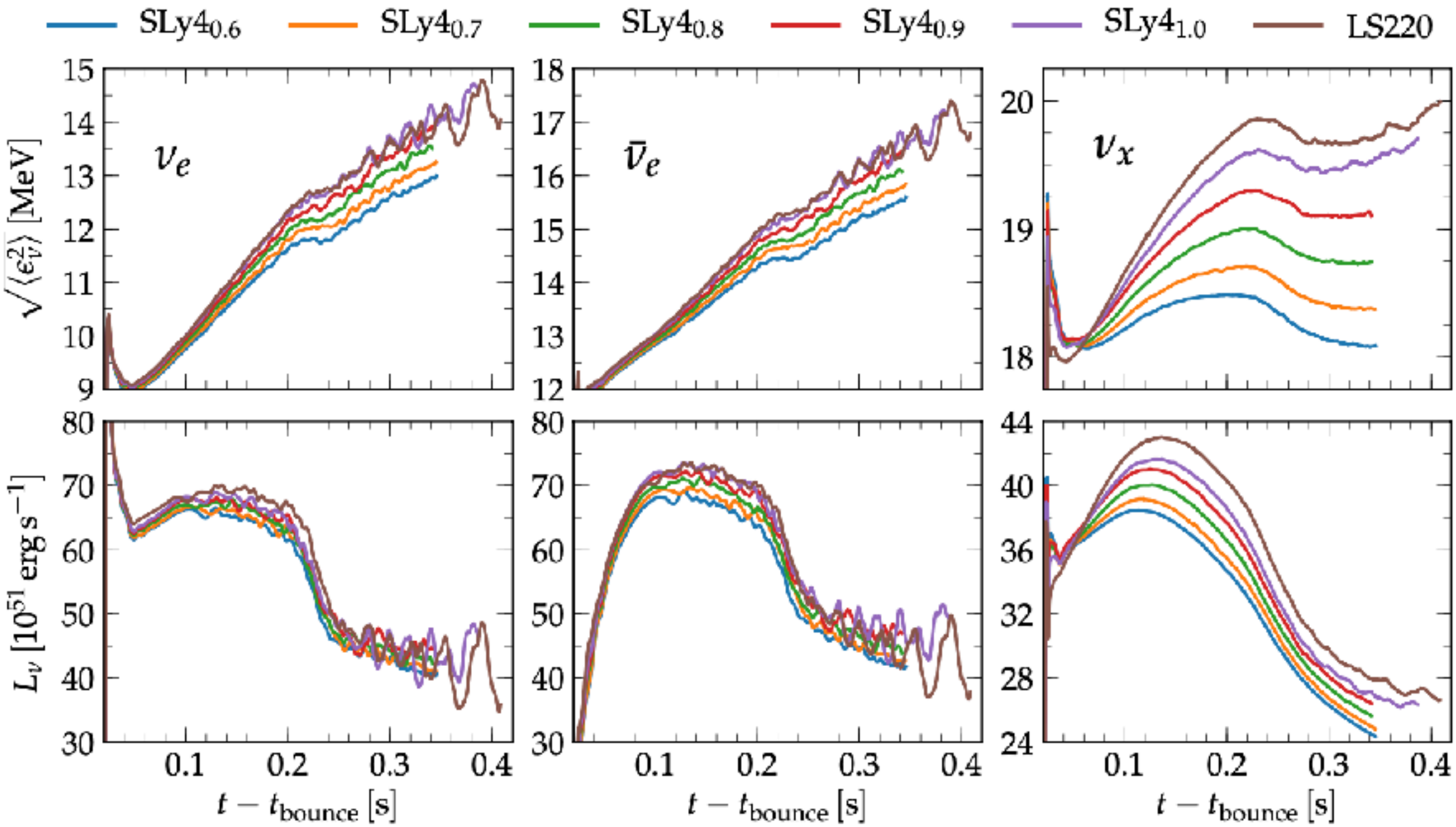
validate explosion mechanism, constrain neutrino properties, etc.

Dependence on progenitor star



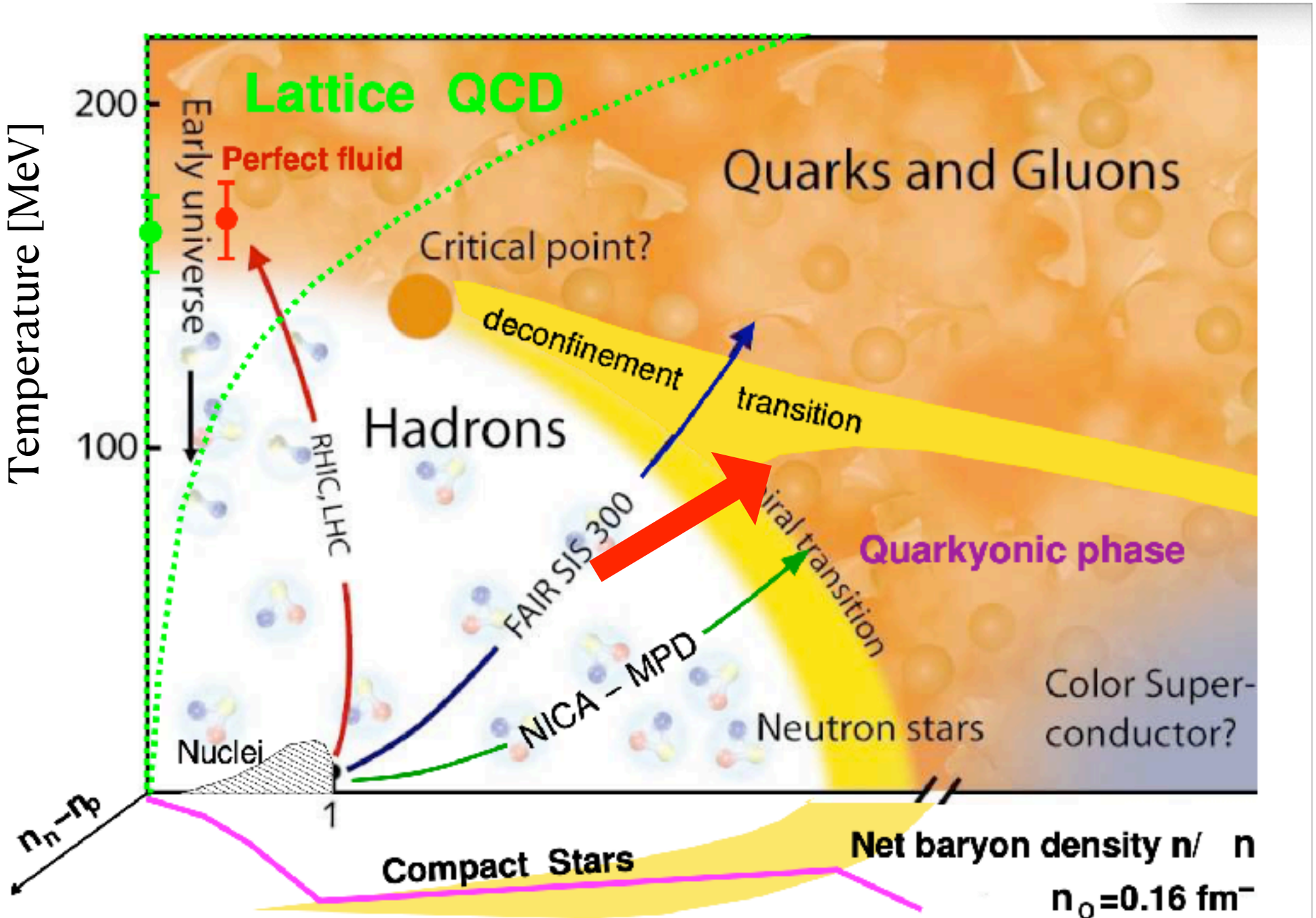
O'Connor&Ott 2012

Dependence on Equation of State (EoS)

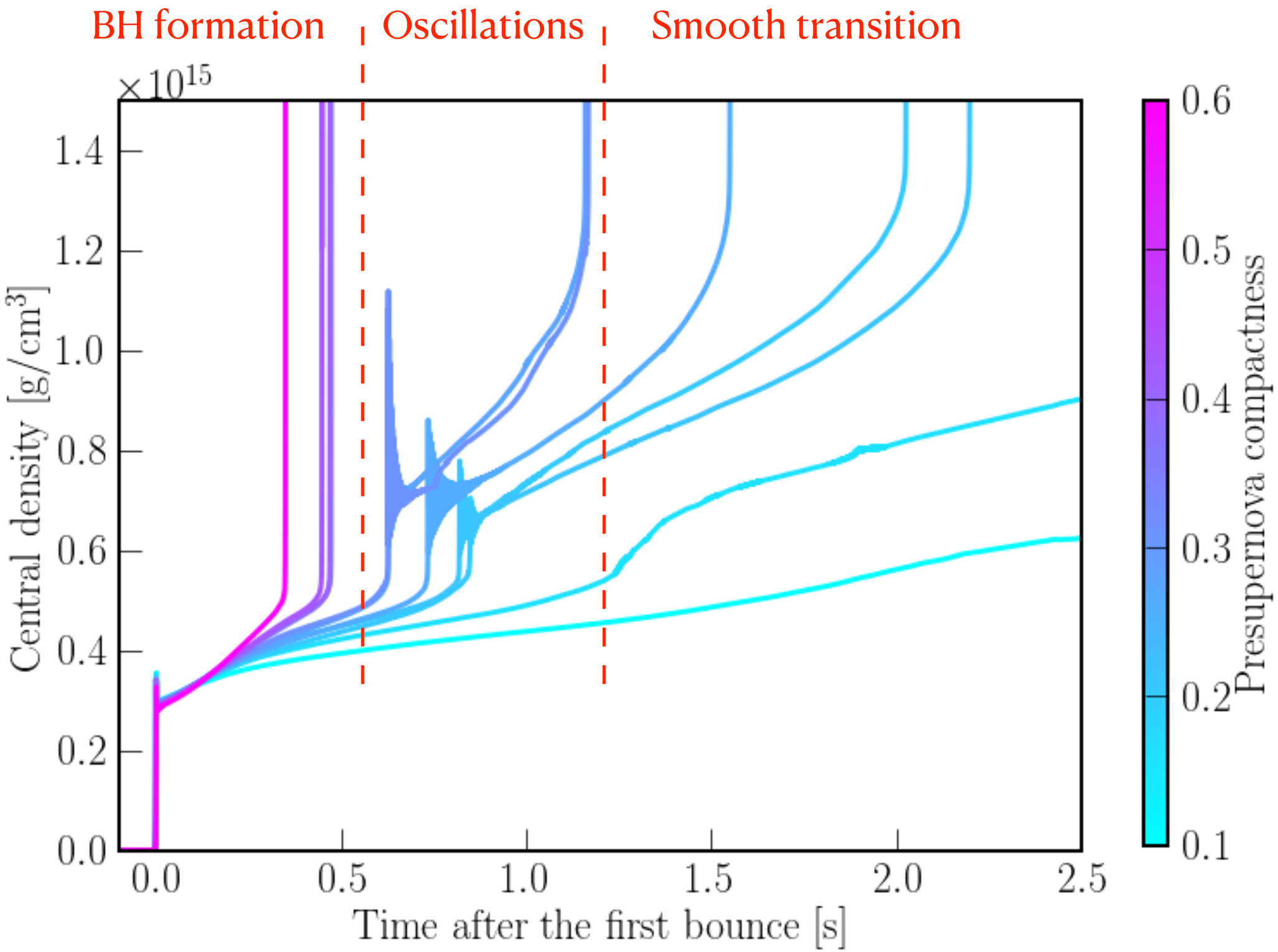


Schneider+2019

Hadron-quark phase transition



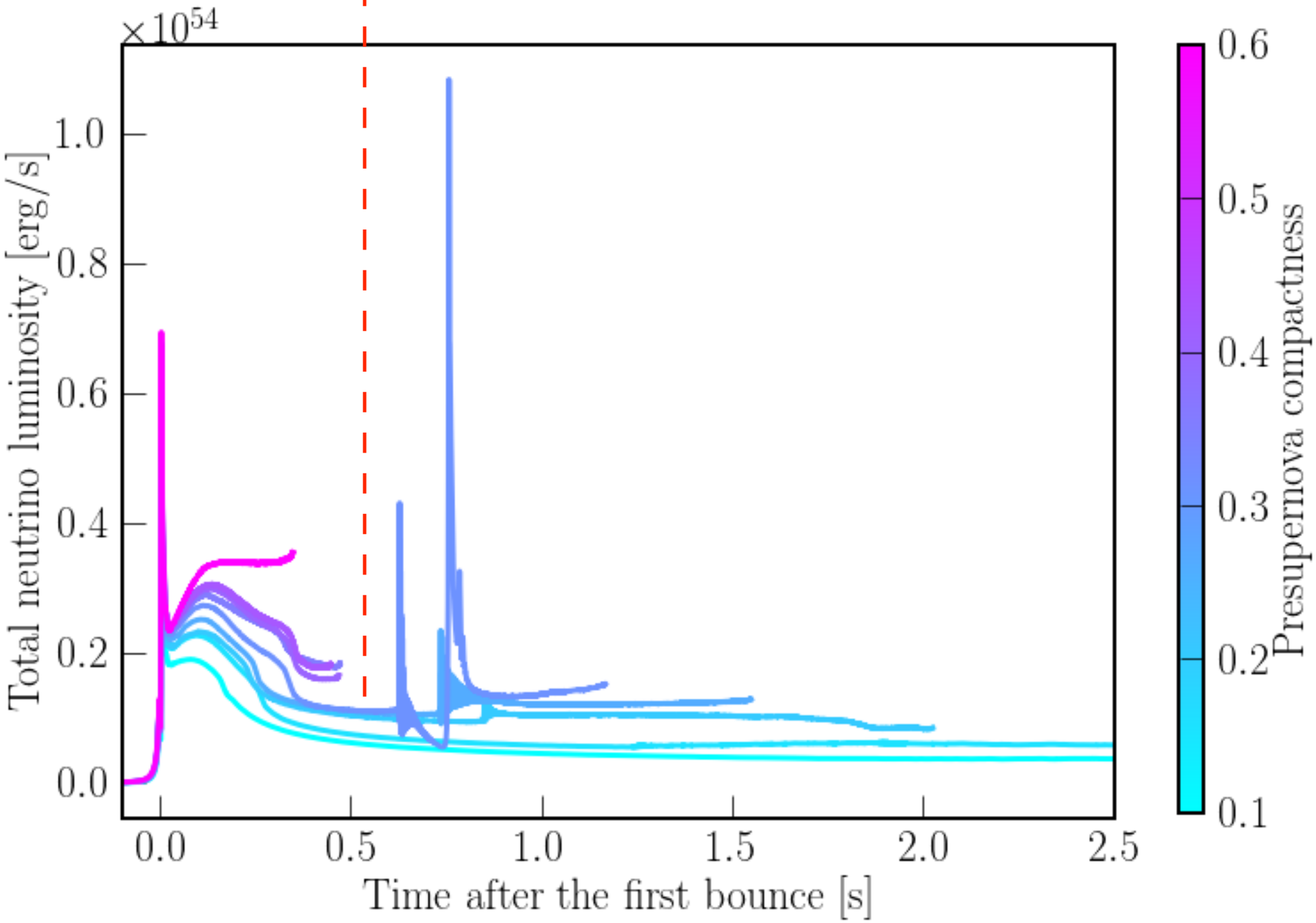
Consequence of phase transition in CCSN



Neutrino signal

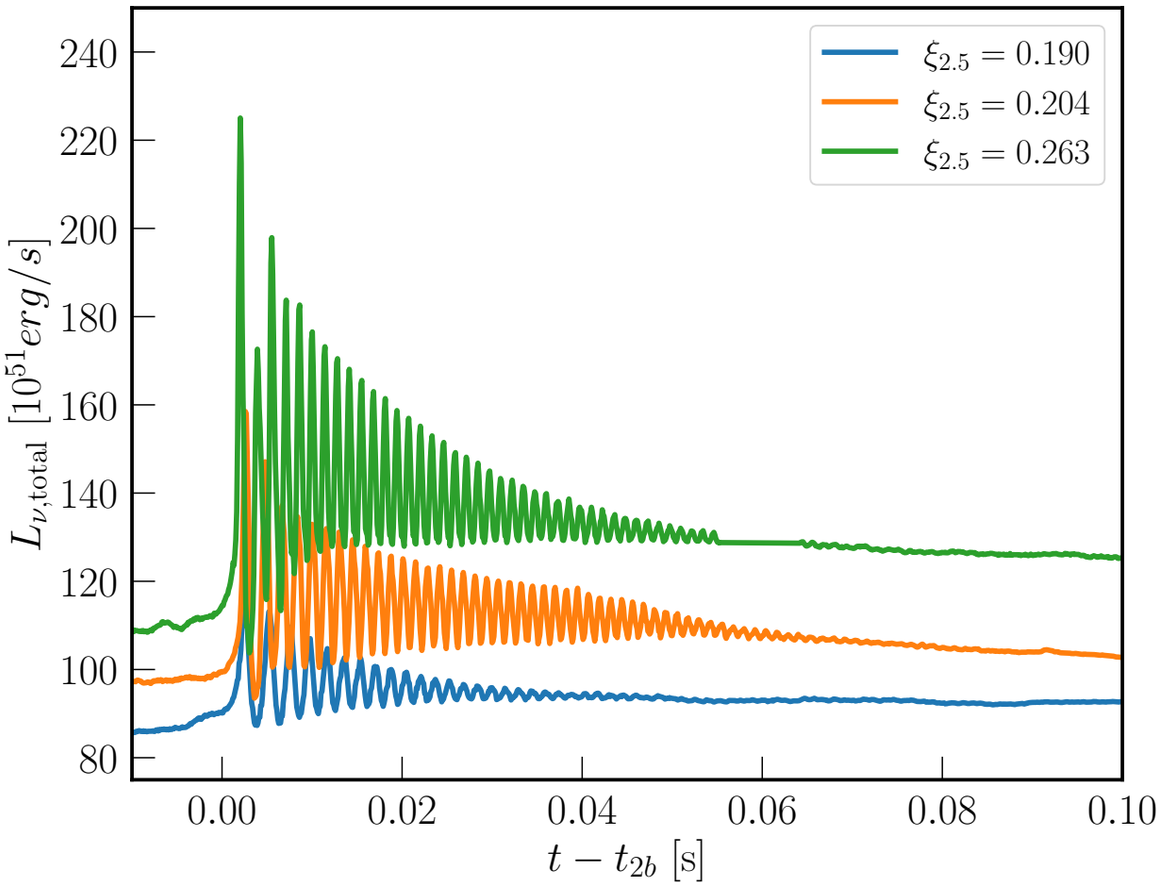
Shut off at BH formation

Oscillations after 2nd collapse



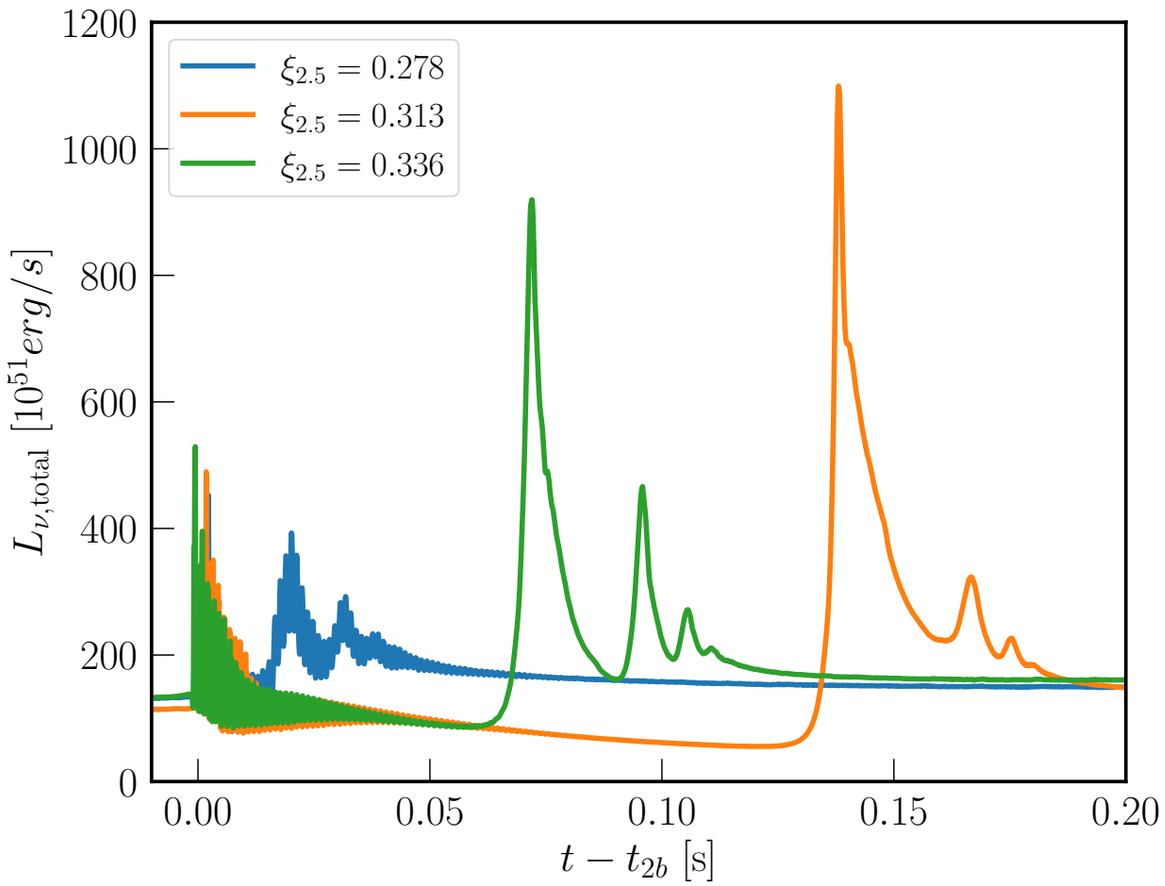
Two classes

Less compact



~ 1 ms period, last for ~50 ms

More compact



+ secondary bursts

Summary

- Hadron-quark phase transition leads to collapse of protoneutron star in core-collapse supernovae.

- The collapse and oscillations of protoneutron star emit oscillatory neutrino signal with ~1 ms period.

Thank you!
Tack!