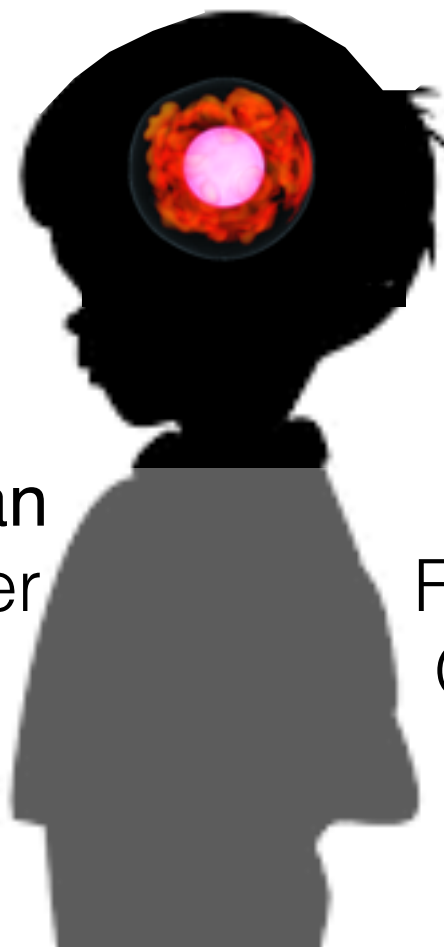


Multi-D

Core-Collapse Supernova Simulations with the IDSA for neutrino transport

The Basel Supernova Group

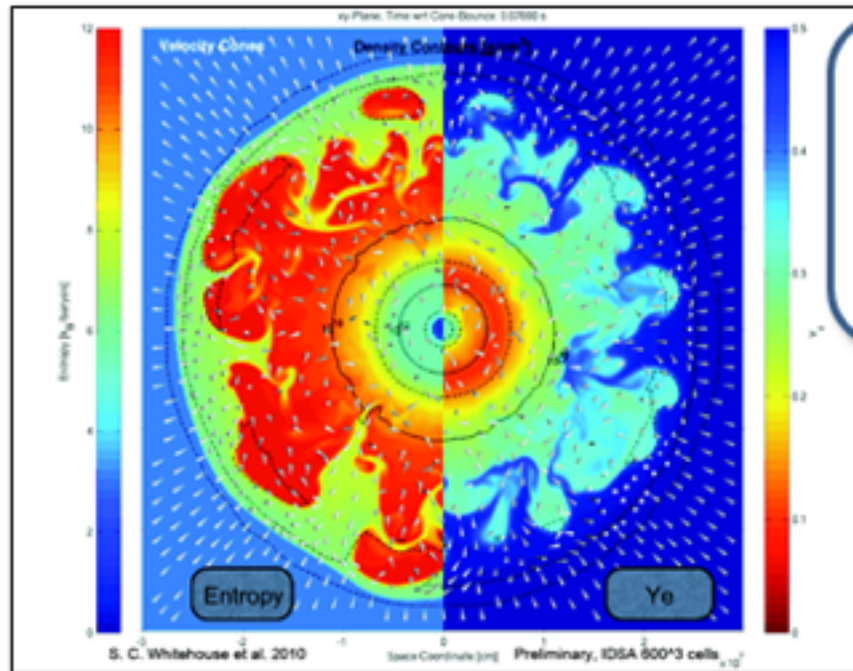
Brainstorming and fun



Kuo-Chuan Pan
Matthias Liebendörfer
Rubén Cabezón
Takami Kuroda
Matthias Hempel

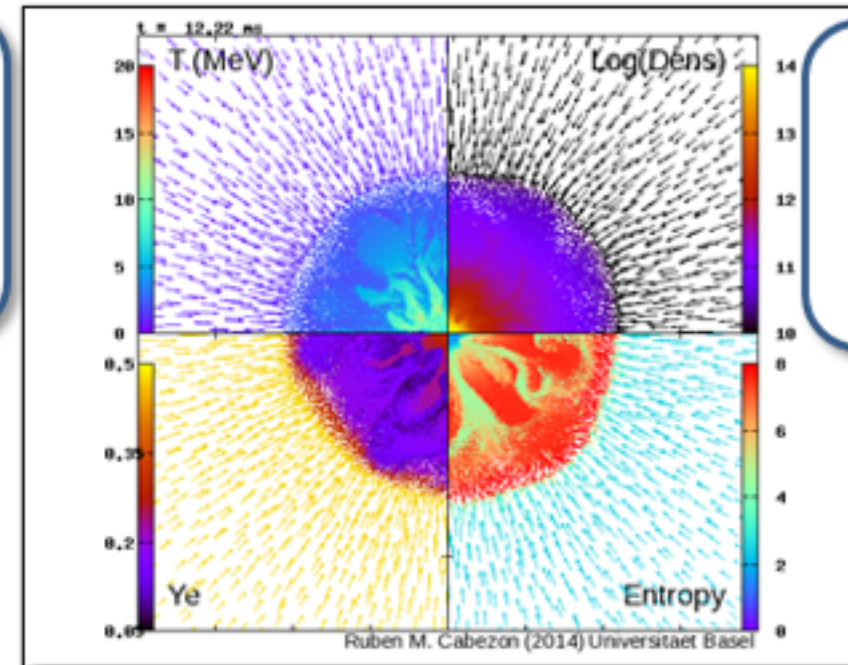
Friedrich-Karl Thielemann
Oliver Heinemann
Kevin Ebinger

Ported the IDSA in 3 different codes



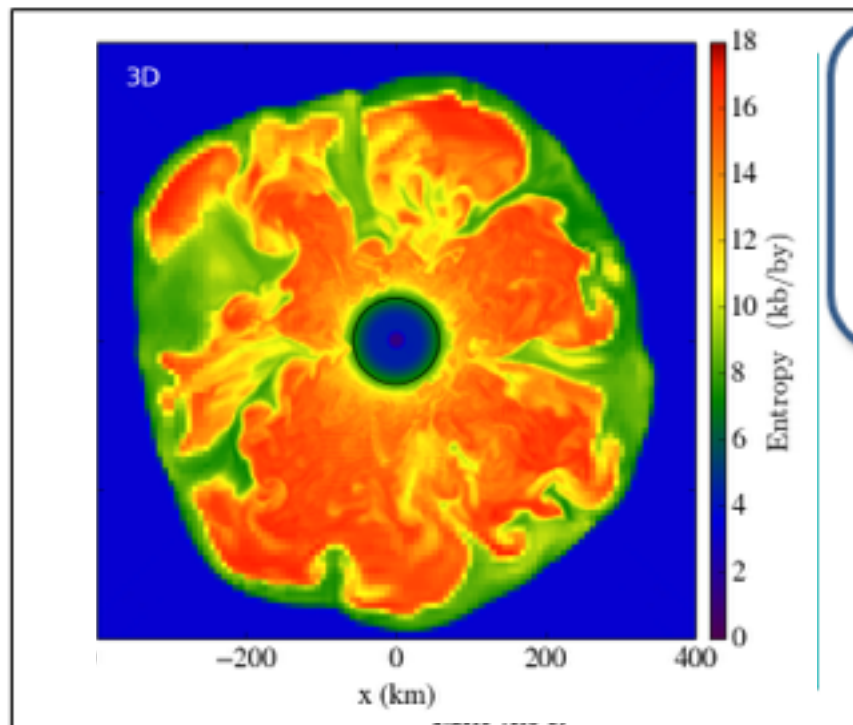
Elephant
3D IDSA
Cartesian mesh
1D GR potential

M. Liebendörfer
S. C. Whitehouse
R. Käppeli
K. Ebinger
O. Heinemann



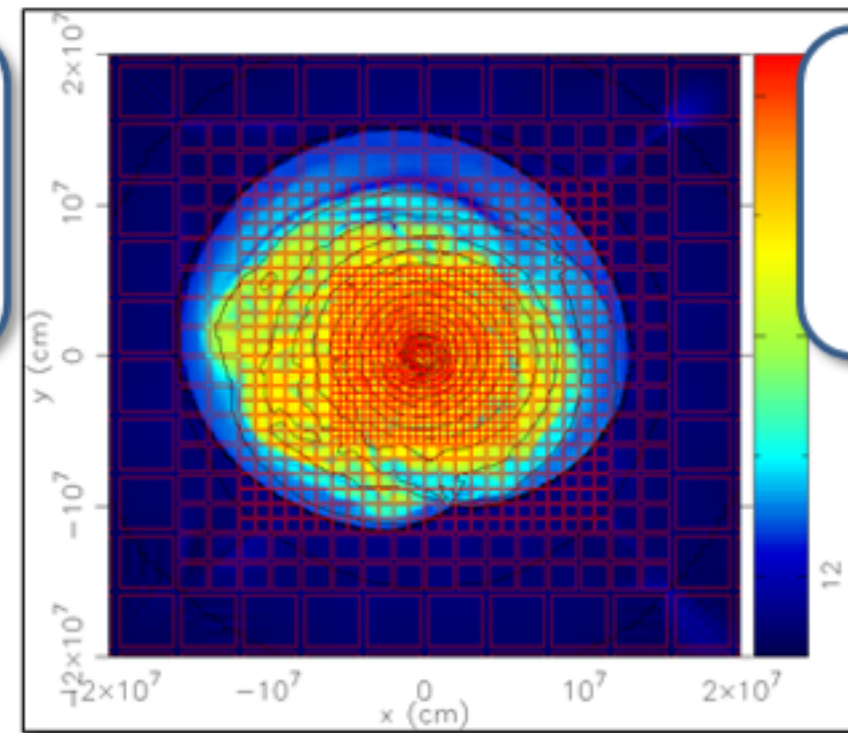
SPHYNX
ASL/IDSA
SPH
3D Newtonian

R. M. Cabezón



FLASH
1-3D IDSA
AMR
1D GR potential

K.-C. Pan



fGR_M1
M1
Nested meshes
3D full GR

T. Kuroda

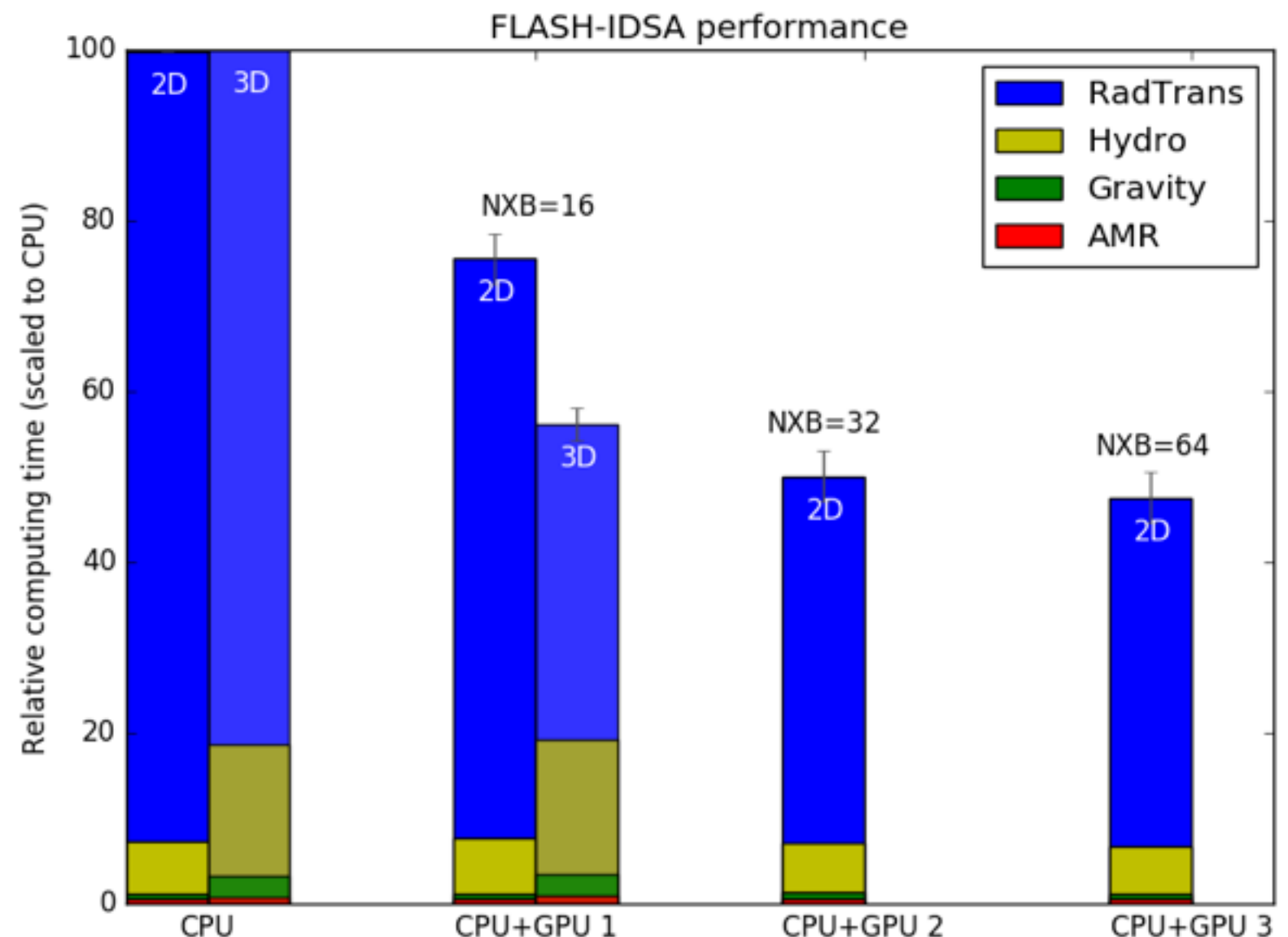
GPU acceleration

The IDSA solver is accelerated with OpenACC.
Performance tested on the Piz Daint super computer at CSCS.
Elephant gives a similar performance gain.

The diffusion equation for trapped neutrinos:

$$\begin{aligned}\frac{\partial f_v^t}{c \partial t} &= j_v - (j_v + \chi_v) f_v^t - \Sigma_v, \\ \Sigma_v &= \min \left\{ \max \left[\alpha_v + (j_v + \chi_v) \frac{1}{2} \int f_v^s d\mu, 0 \right], j_v \right\}, \\ \alpha_v &= \nabla \cdot \left(\frac{-1}{3(j_v + \chi_v + \phi_v)} \nabla f_v^t \right),\end{aligned}$$

depends largely on
neighbouring zones



GR Effective Potential

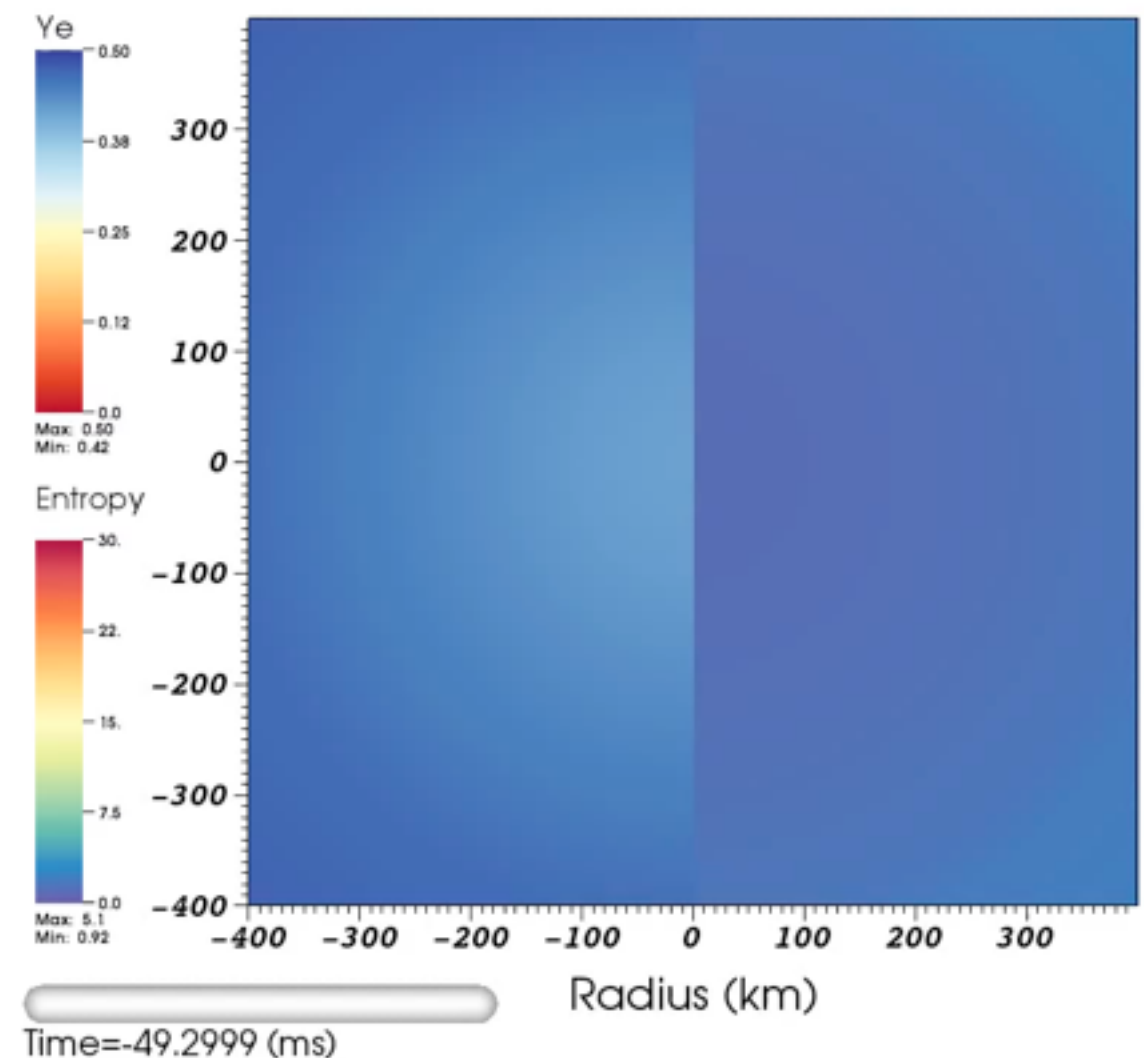
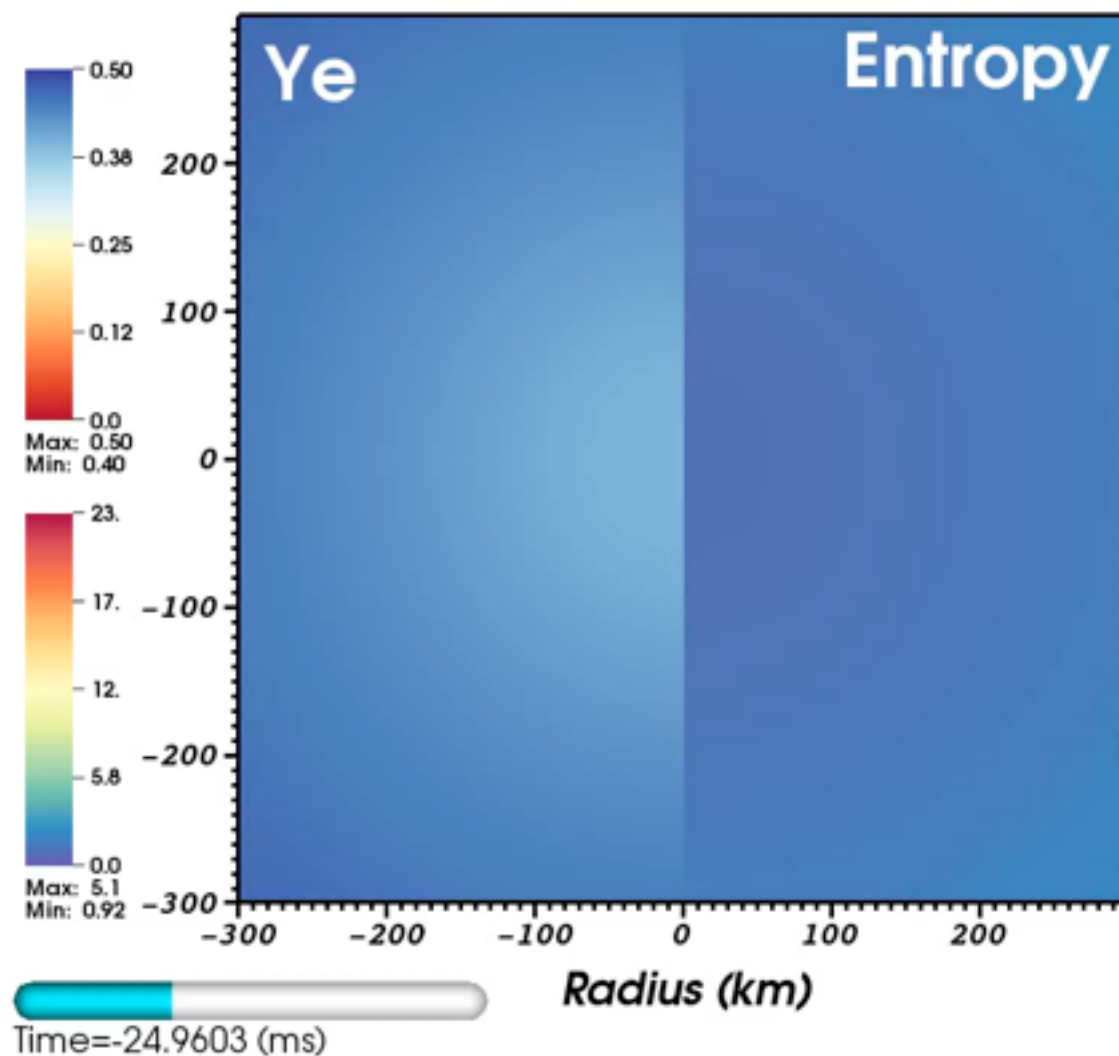
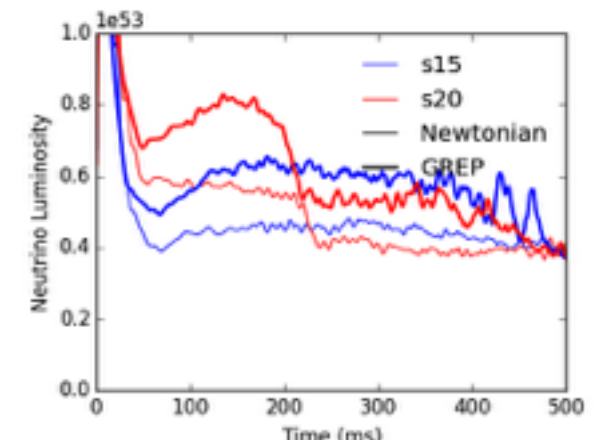
2D FLASH-IDSA simulation

GR correction from the Case A in Marek (2006)

s20 progenitor (W2007) + LS220 EoS

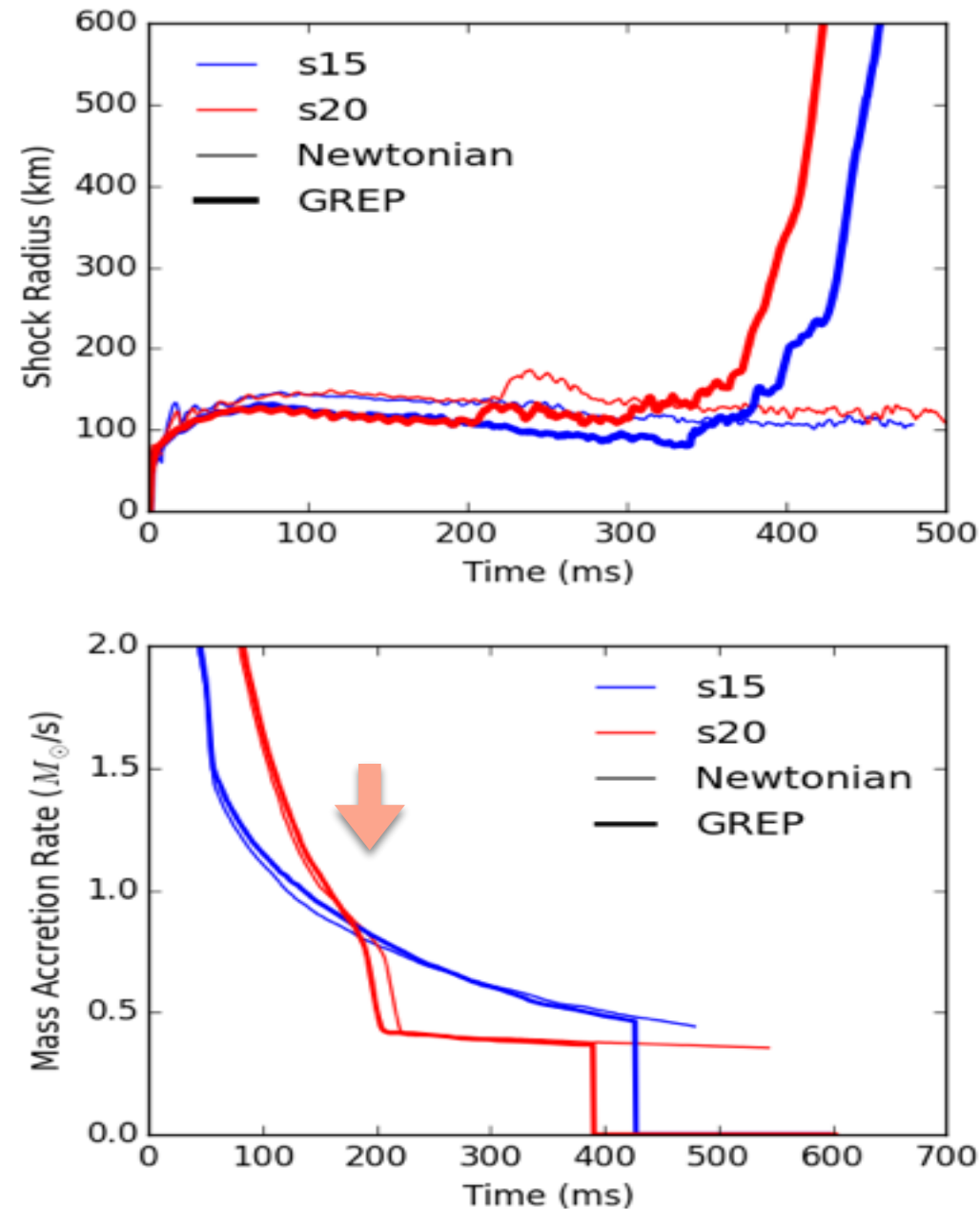
Newtonian

GR

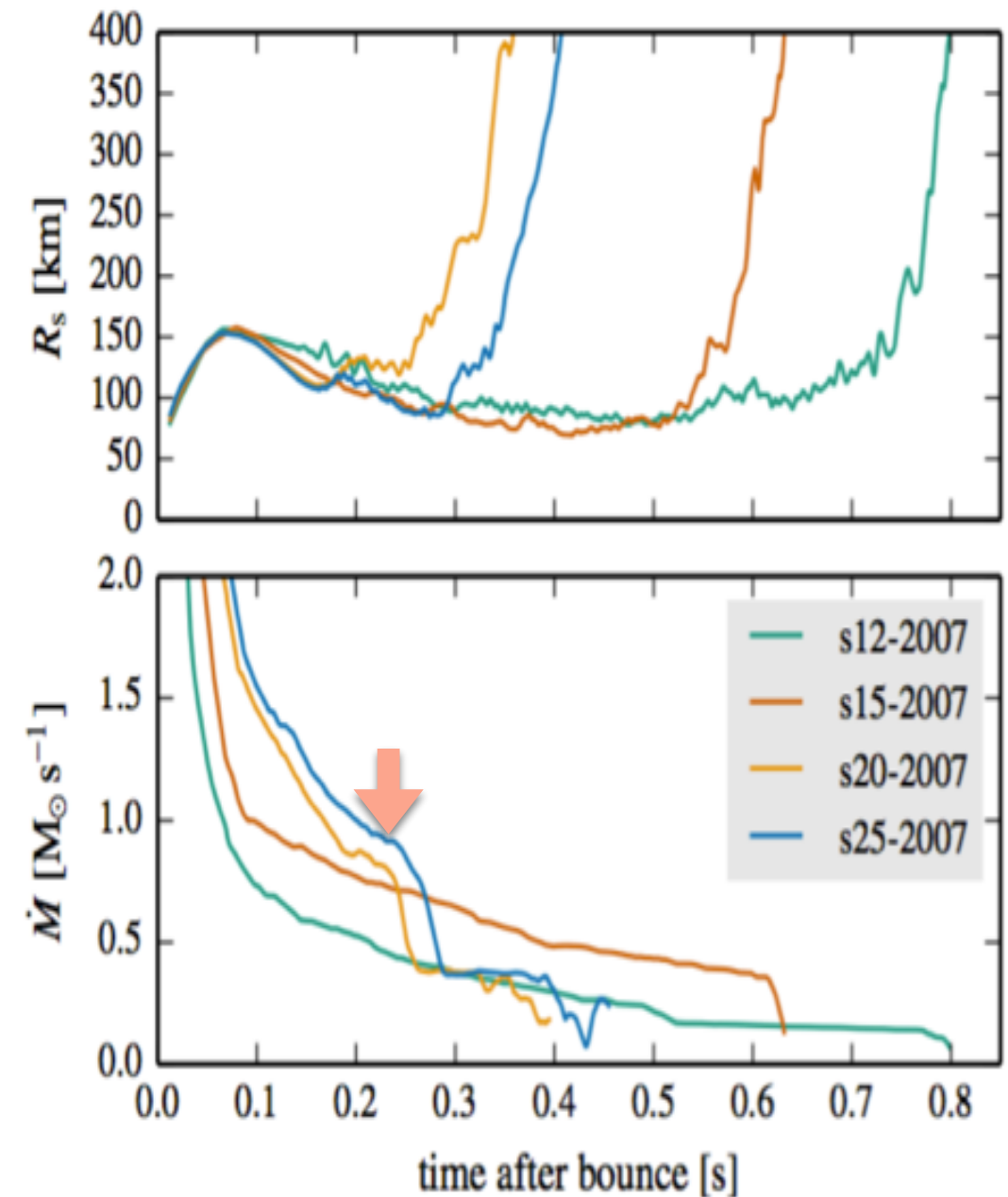


GR Effective Potential

FLASH+IDSA



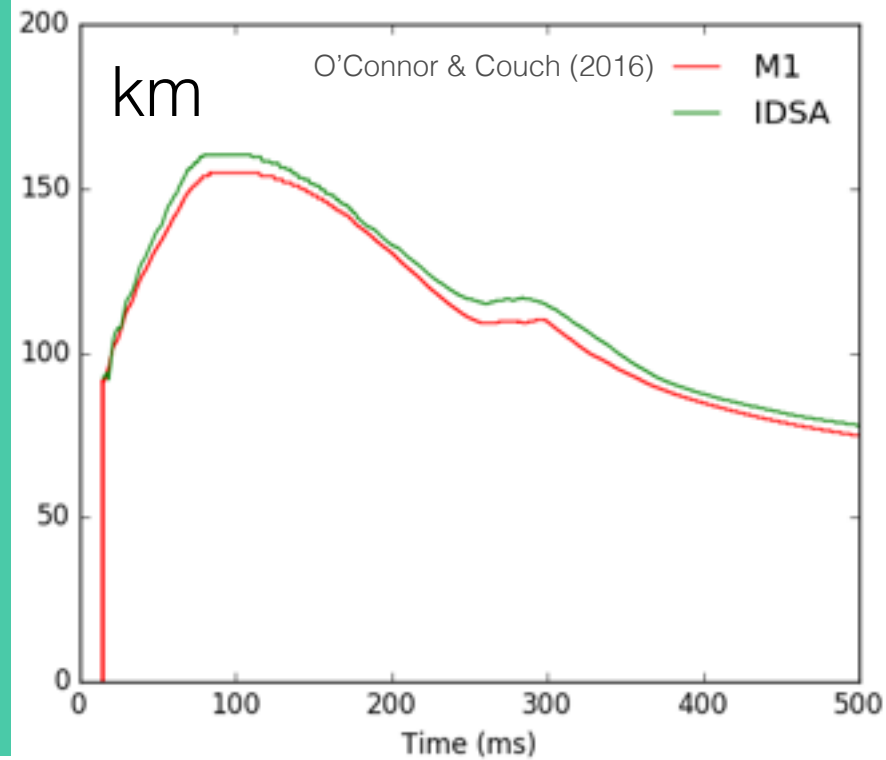
Summa+16



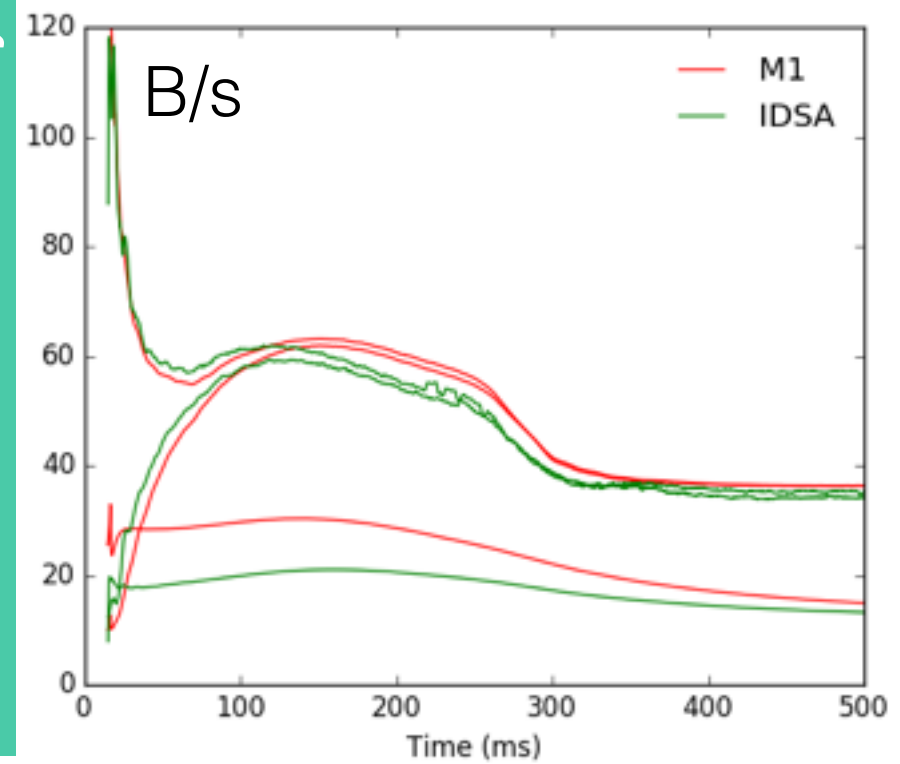
IDSA vs M1 (Newtonian)

Restart from GR1D
s20 (W2007)
LS220
Newtonian

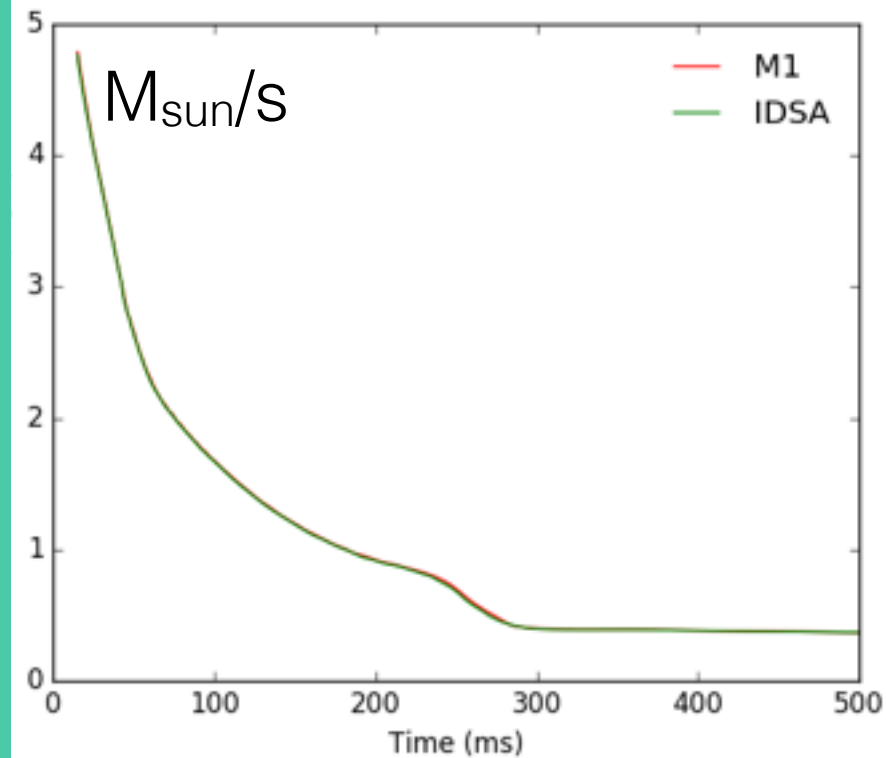
Shock Radius



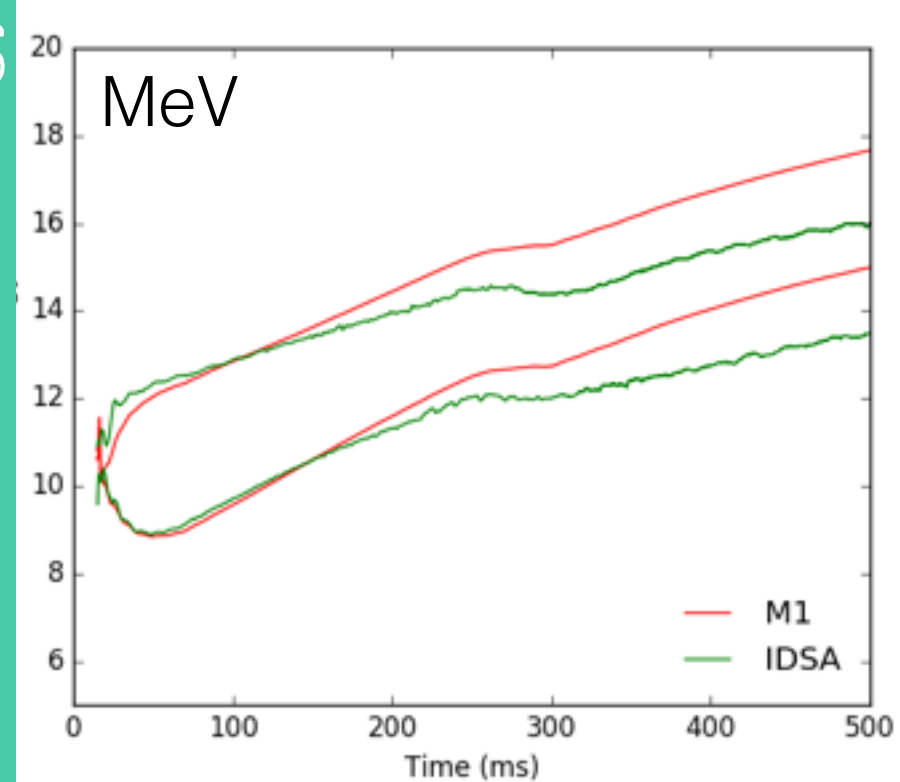
Neutrino Luminosity



Mass Accretion Rate



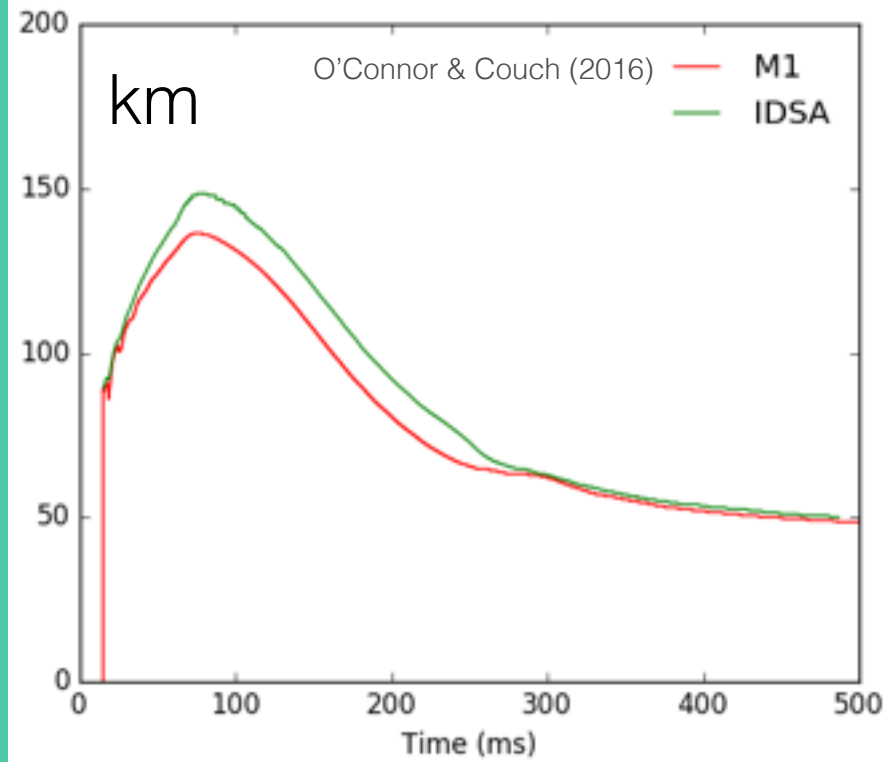
Neutrino Mean Energy



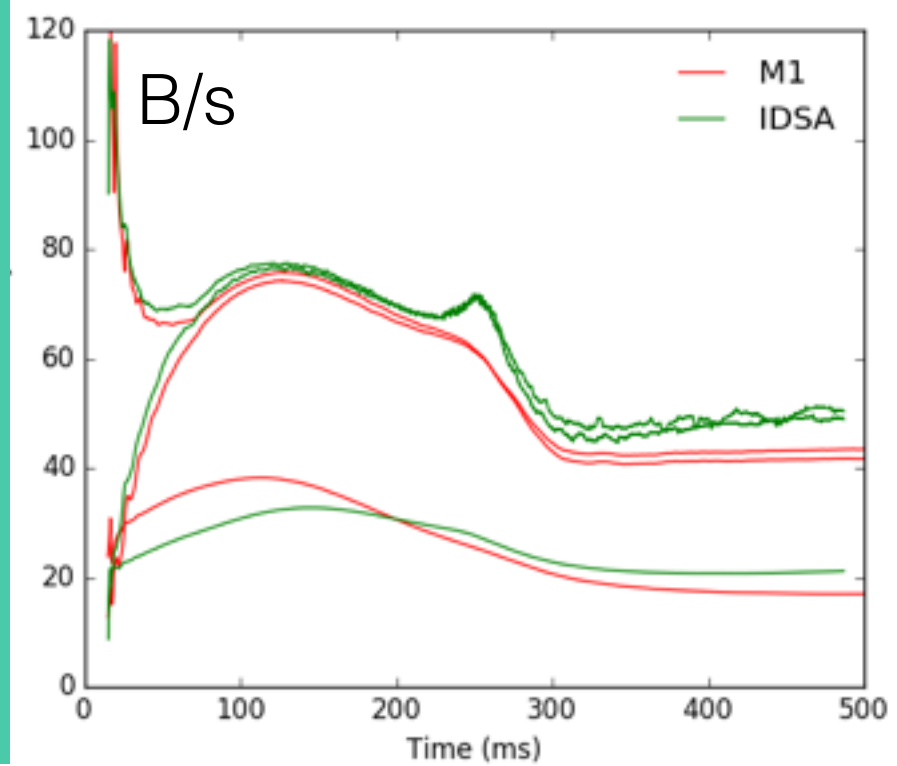
IDSA vs M1 (eff. GR)

Restart from GR1D
s20 (W2007)
LS220
GR potential

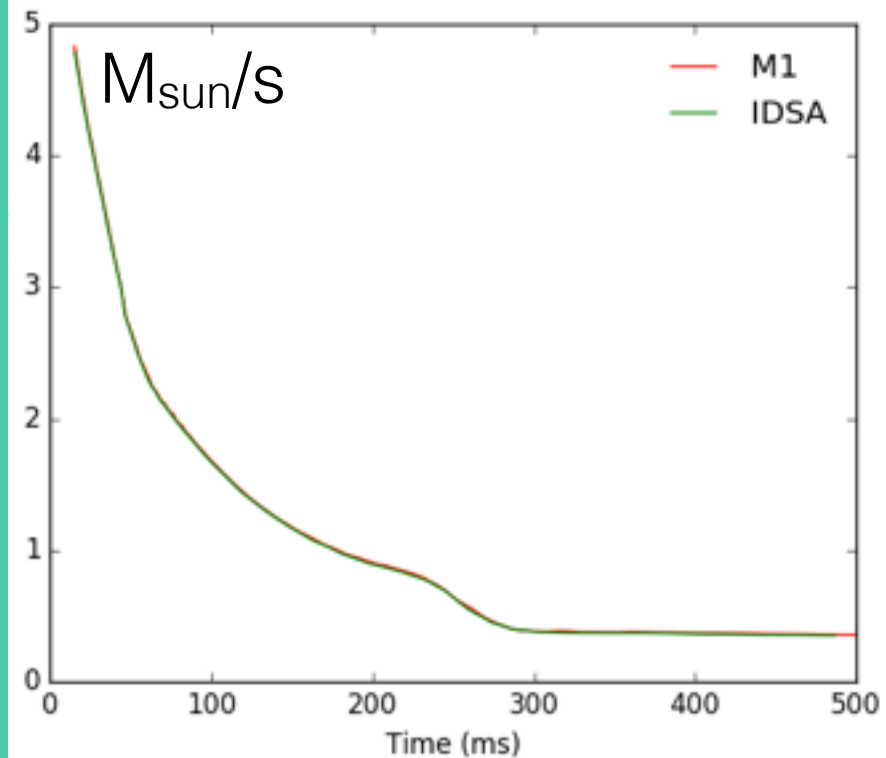
Shock Radius



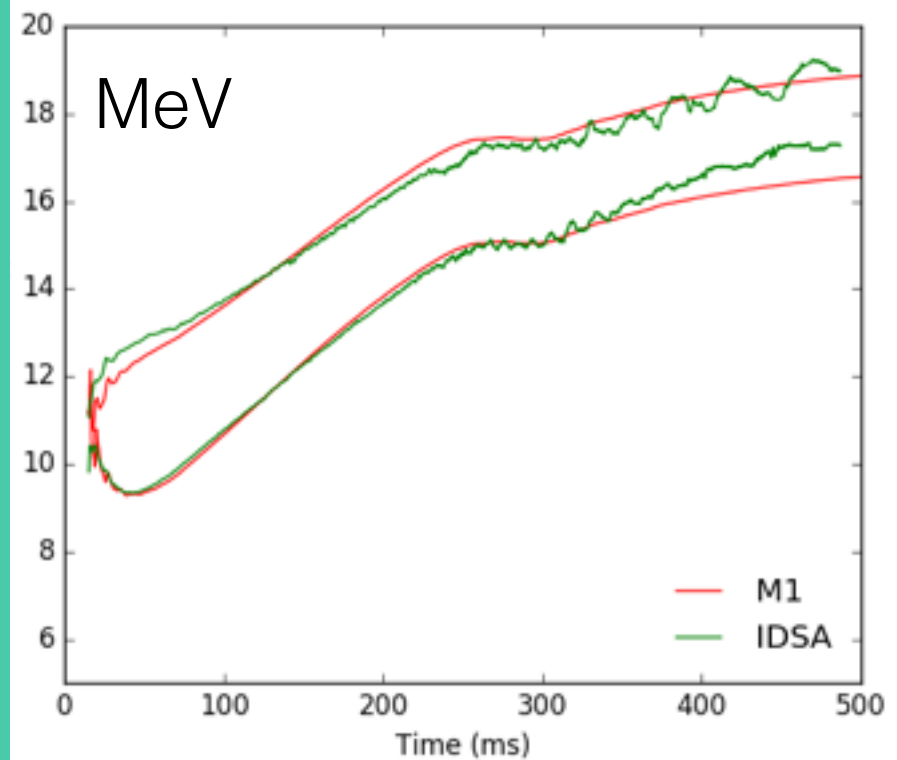
Neutrino Luminosity



Mass Accretion Rate



Neutrino Mean Energy



Black Hole Formation

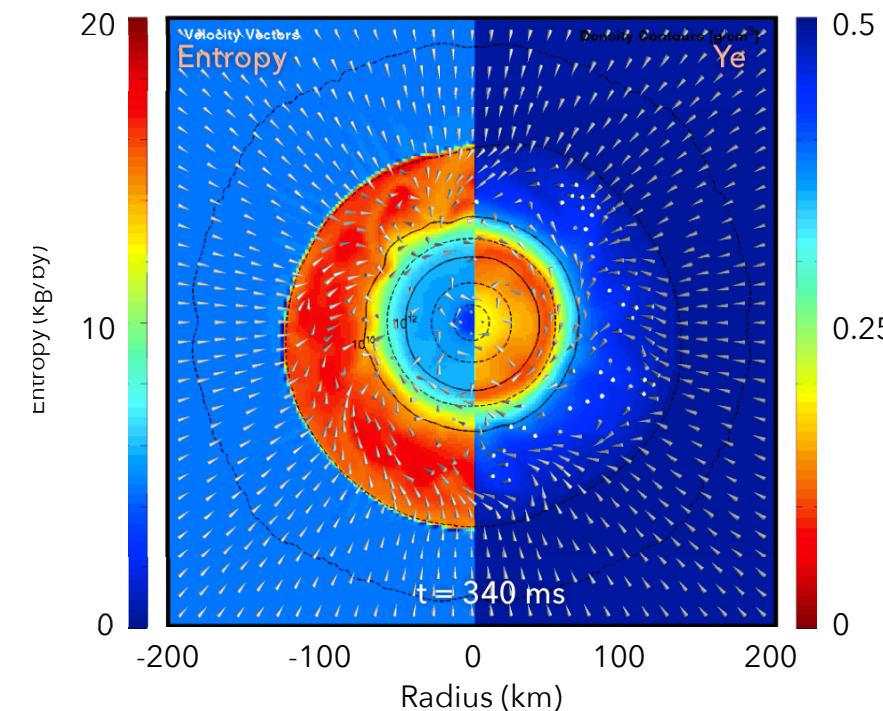
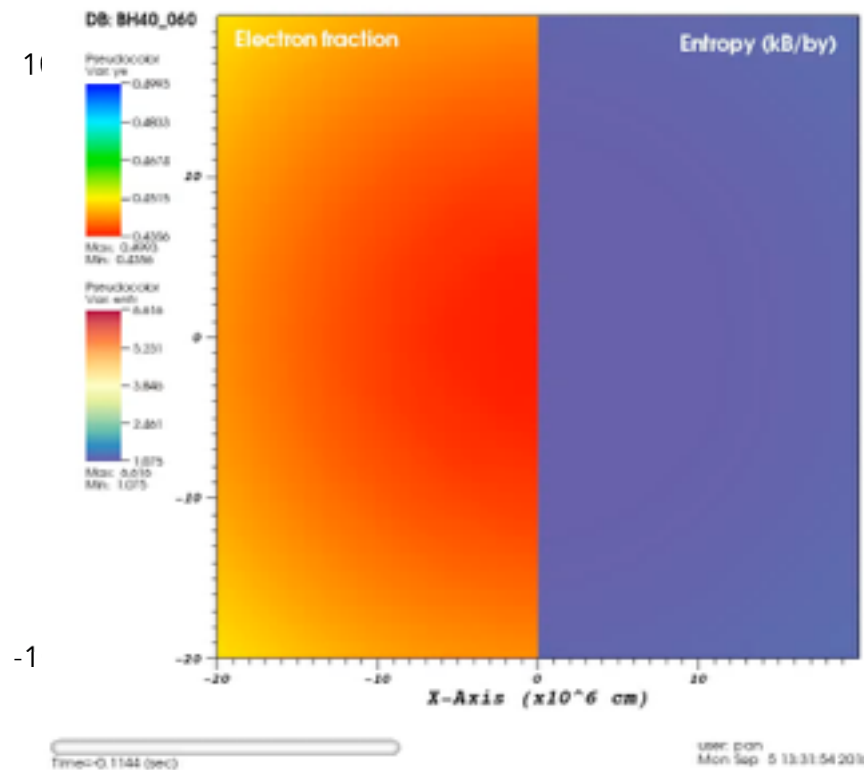
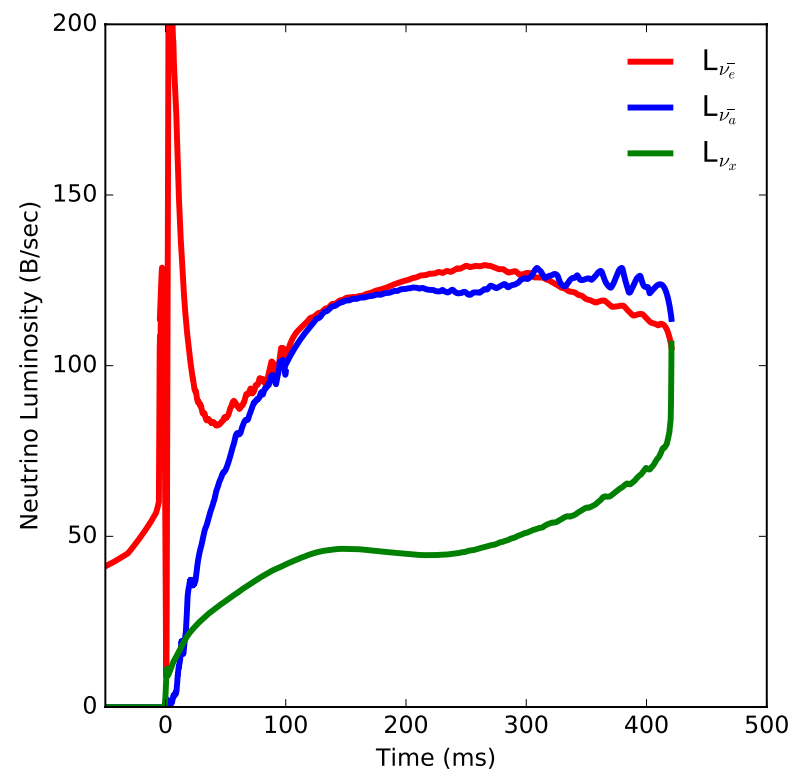
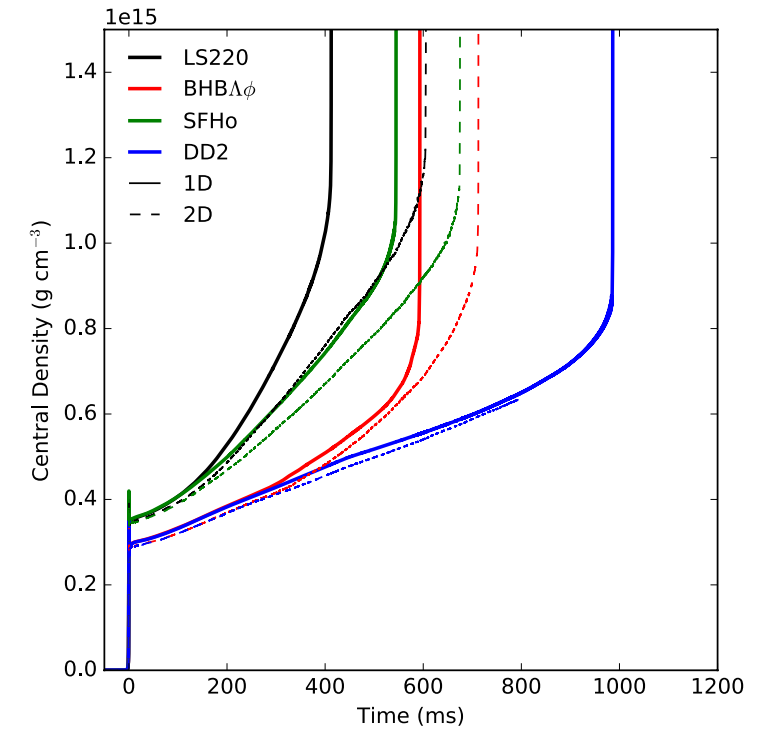
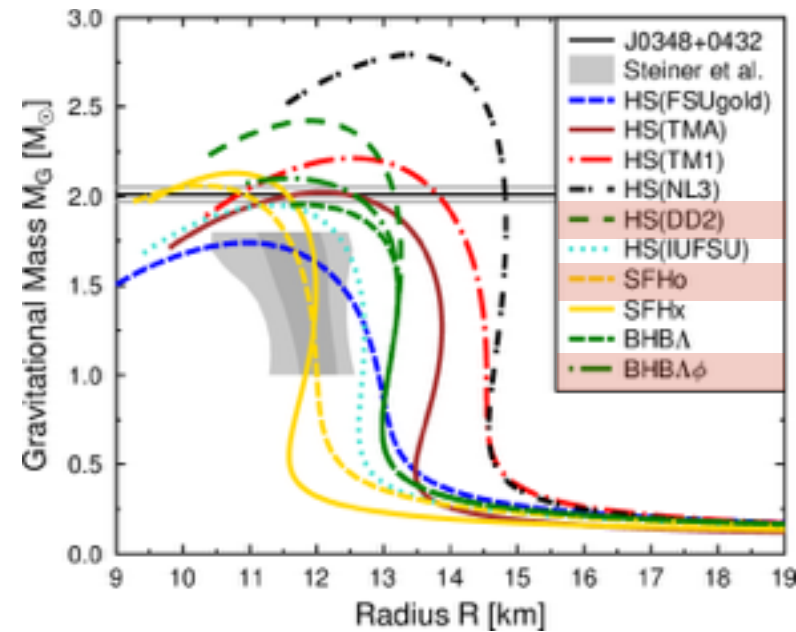
s40 progenitor (W2007)

1D FLASH + 4 EoS

2D FLASH + 4 EoS

3D Elephant + LS220

From M. Hempel's website



Black Hole Formation in 3D

3D Elephant + LS220

s40 progenitor (W2007)

simulation done by
M. Liebendörfer

movie starts from 0.326
sec postbounce to
0.505 sec postbounce

