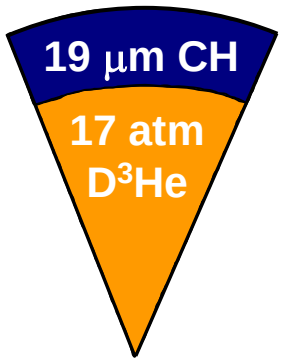
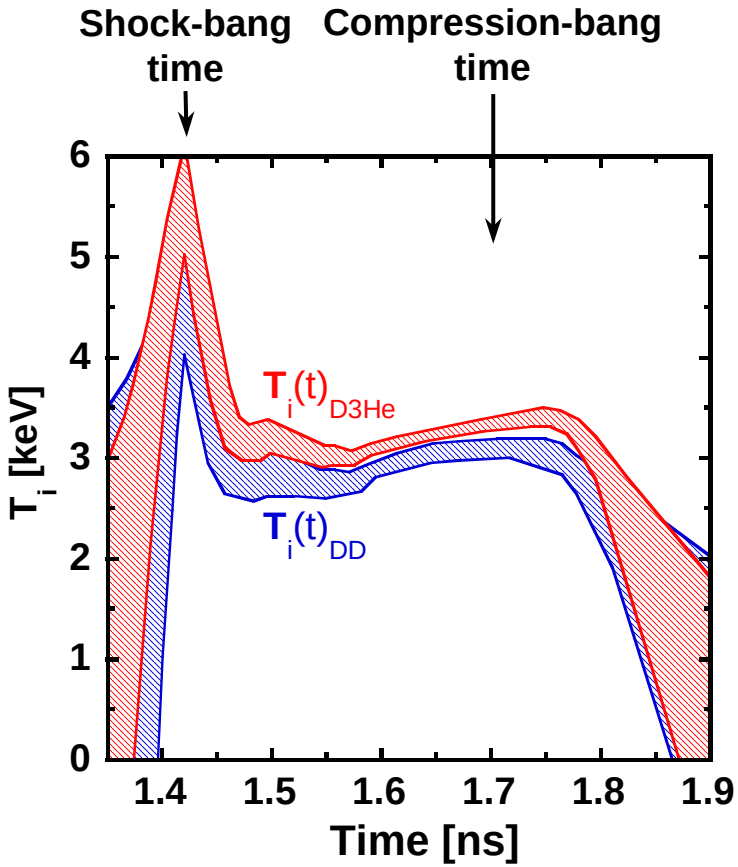
Measurements of time evolution of ion temperature in D^3He implosions at OMEGA





Johan Frenje
MIT - Plasma Science
and Fusion Center

46th Annual Meeting of the
Division of Plasma Physics
Savannah, GA
November 15-19, 2004

Collaborators

C. K. Li, F. H. Séguin, J. DeCiantis, J. R. Rygg and R. D. Petrasso*

Plasma Science and Fusion Center

Massachusetts Institute of Technology

V. Yu. Glebov, C. Stoeckl, D. D. Meyerhofer†, S. P. Regan,

T. C. Sangster and V. A. Smalyuk

Laboratory for Laser Energetics

University of Rochester

*** Also Visiting Senior Scientist at LLE**

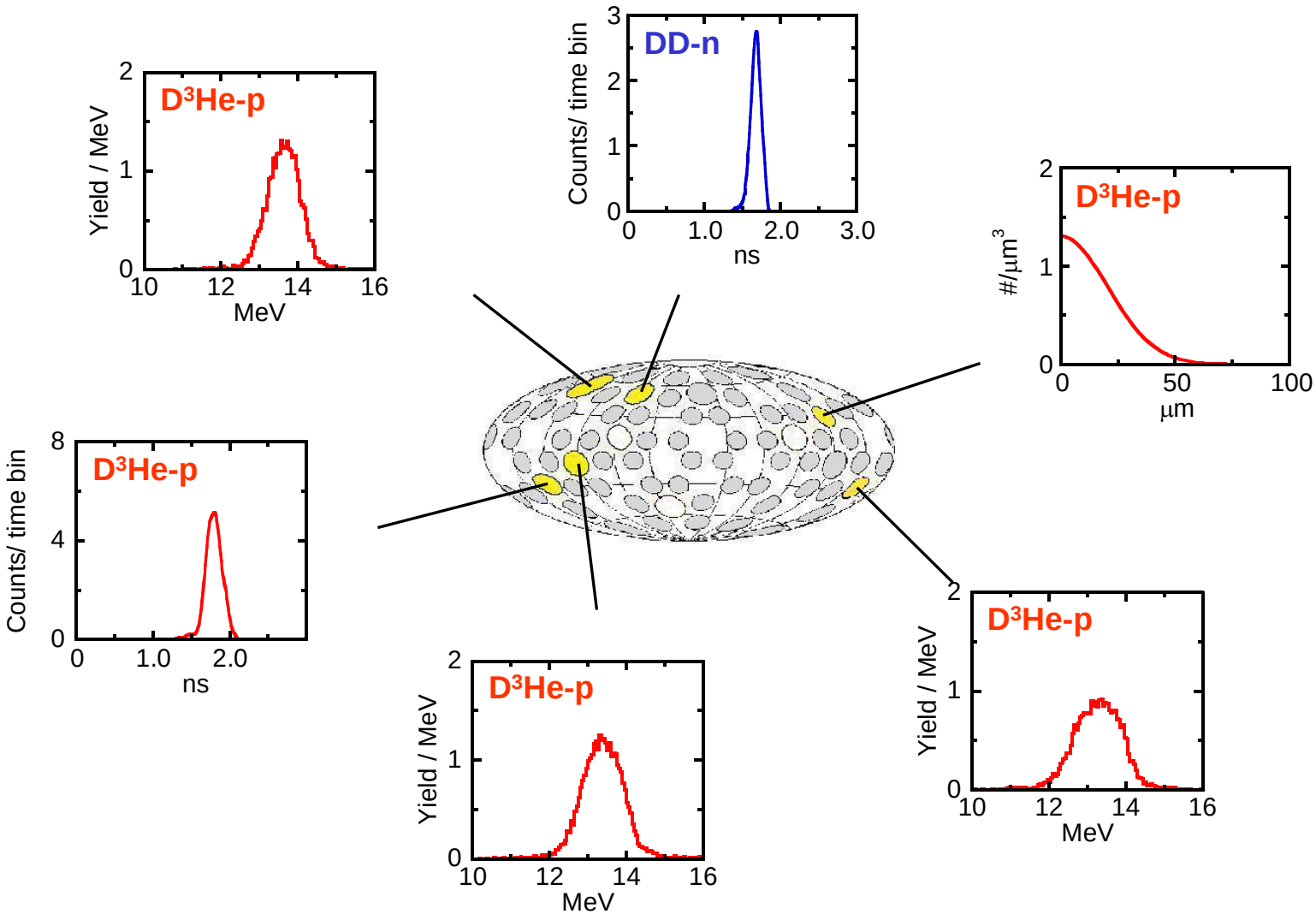
† Also Department of Mechanical Engineering, Physics and Astronomy.

Summary

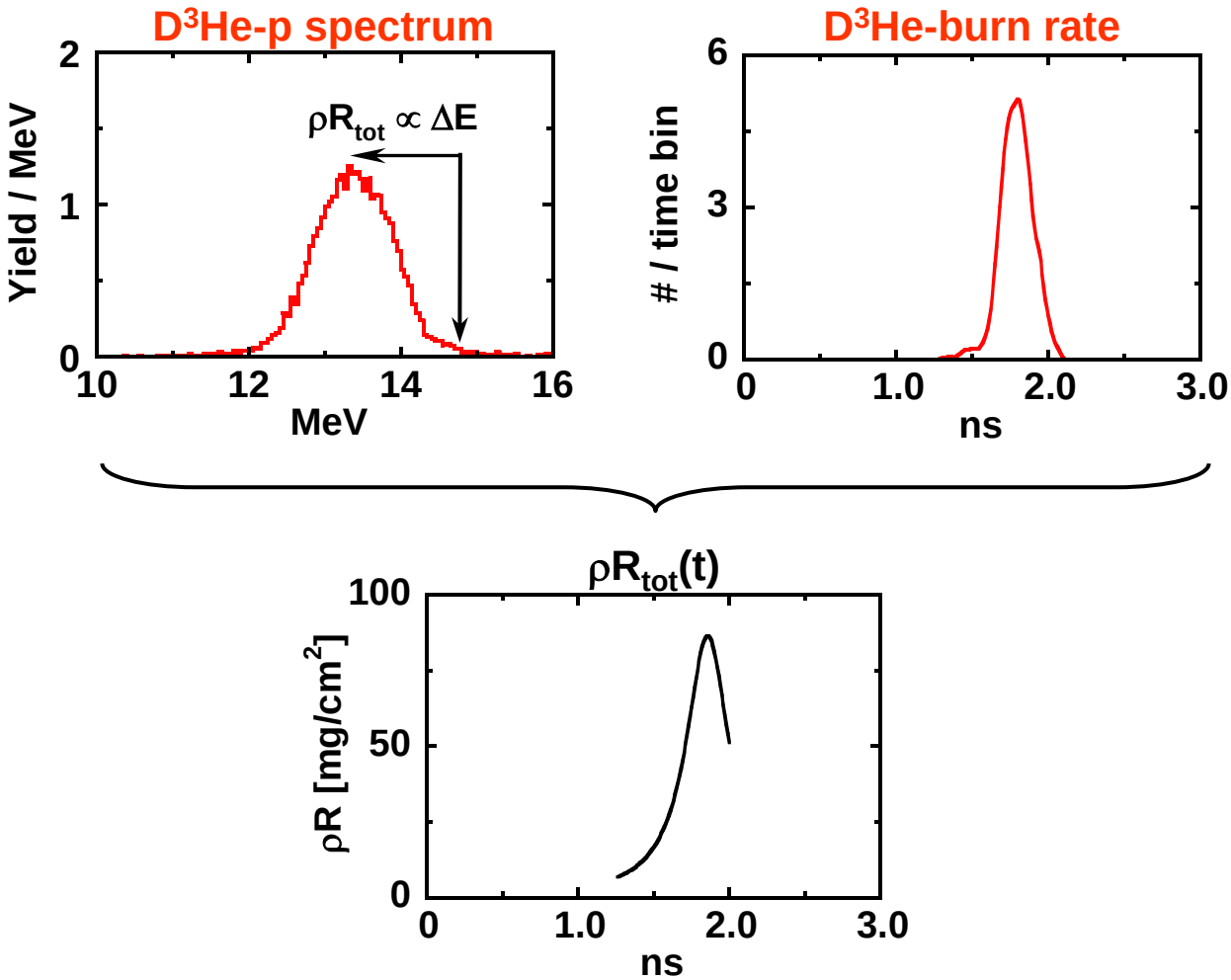
First measurements of evolution of ion temperature during shock and compression burn have been performed at OMEGA

- Spatially averaged $T_i(t)_{DD}$ is ~300 eV lower than $T_i(t)_{D3He}$.
- Shock-induced temperature is ~70% higher than the temperature during the compression.
- Size of D^3He-burn region is ~25% smaller than the DD-burn region during the shock and the compression phase.
- This work suggests that the fuel is not isobaric during shock burn and later stages of compression burn.

A large set of experimental data from one D^3He implosion is used in the analysis



$\rho R_{tot}(t)$ is inferred from D^3He-p spectrum and D^3He-burn rate



J. A. Frenje et al., Phys. Plasmas 11 (2004) 2798

Parabolic like temperature and density profiles of the fuel are used to model the experimental data

$$T_i(r,t) = T_i(0,t)\left[1-\left(\frac{r}{R(t)+\Delta R(t)}\right)^2\right]^{k_1(t)}$$

$$n_i(r,t) = n_i(0,t)\left[1-\left(\frac{r}{R(t)}\right)^2\right]^{k_2(t)}$$

- R(t) represents the position of the fuel-clean-shell interface at a certain time.
- $\Delta R(t)$ represents the thickness of the clean shell at a certain time.
- $T_i(0,t)$, $k_1(t)$, $n_i(0,t)$ and $k_2(t)$ are free fitting parameters.

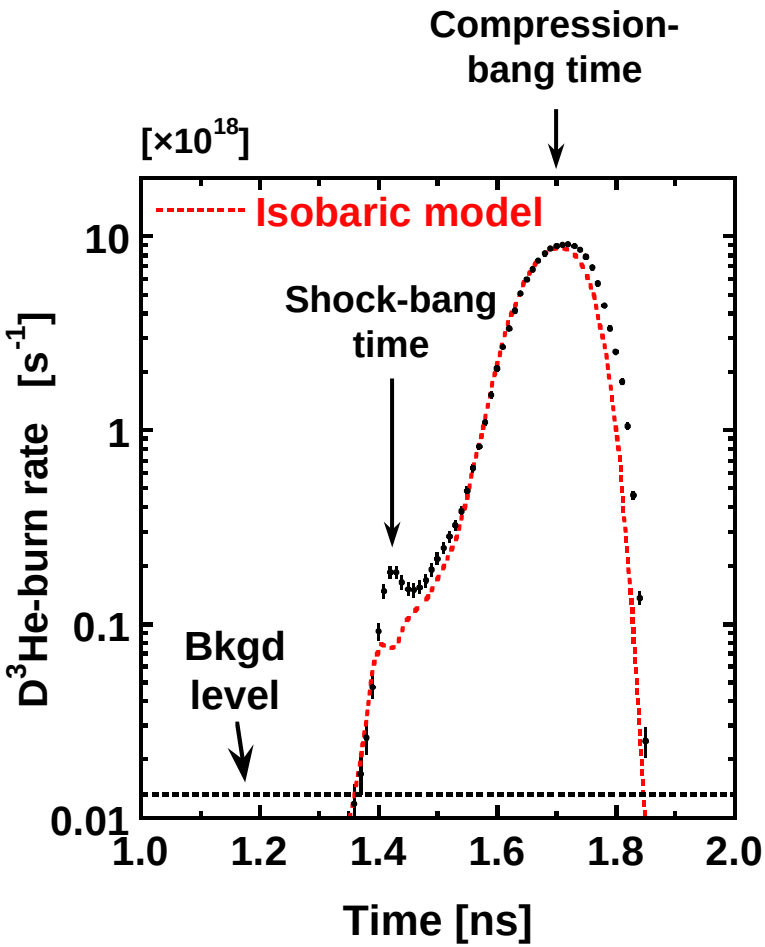
Several measurements are used as constraints in the implosion model

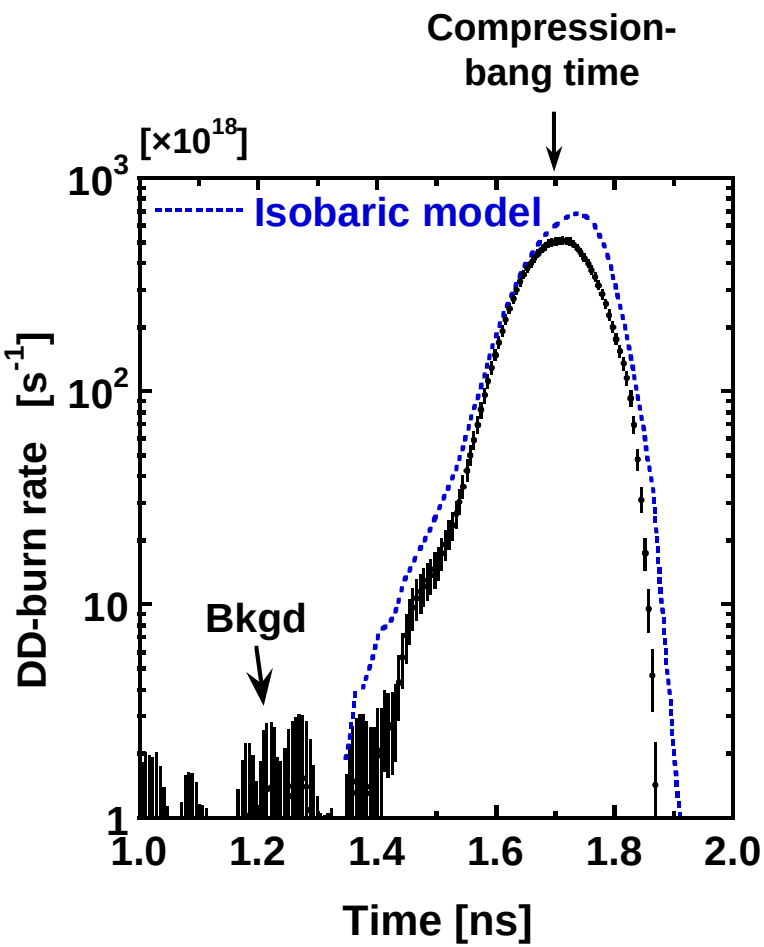
- **D^3He-burn rate**
- **DD-burn rate**
- **$\rho R_{tot}(t)$ $\Rightarrow$ Position of the fuel-clean-shell interface R(t)**

<u>Additional constraints:</u>

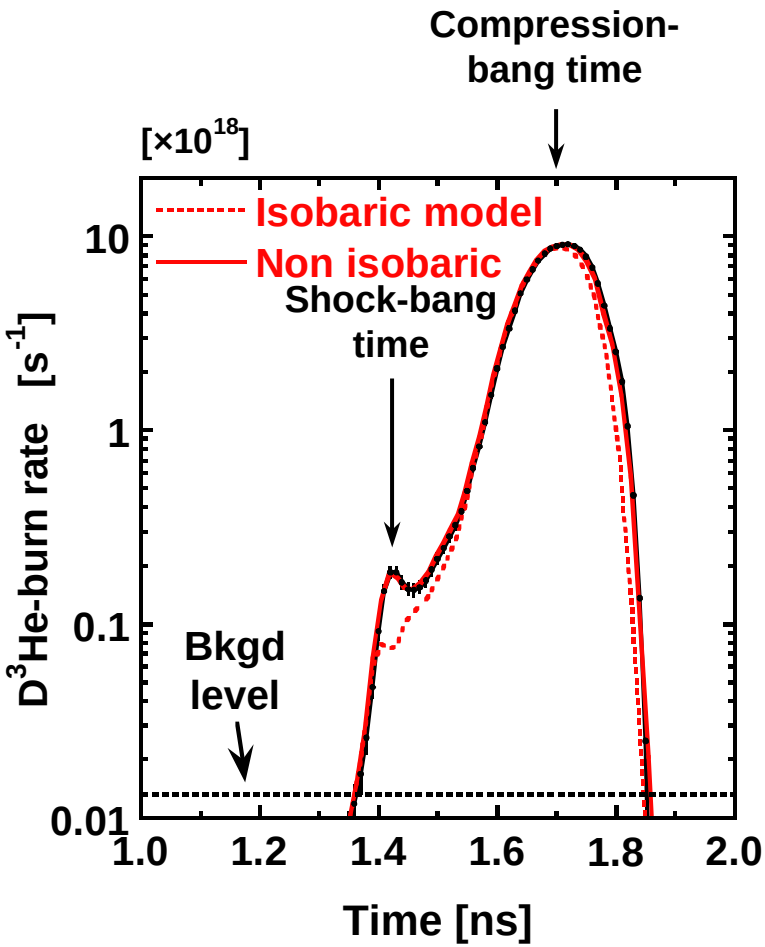
- **Conservation of fuel mass**
- **Isobaric fuel (switched on and off)**

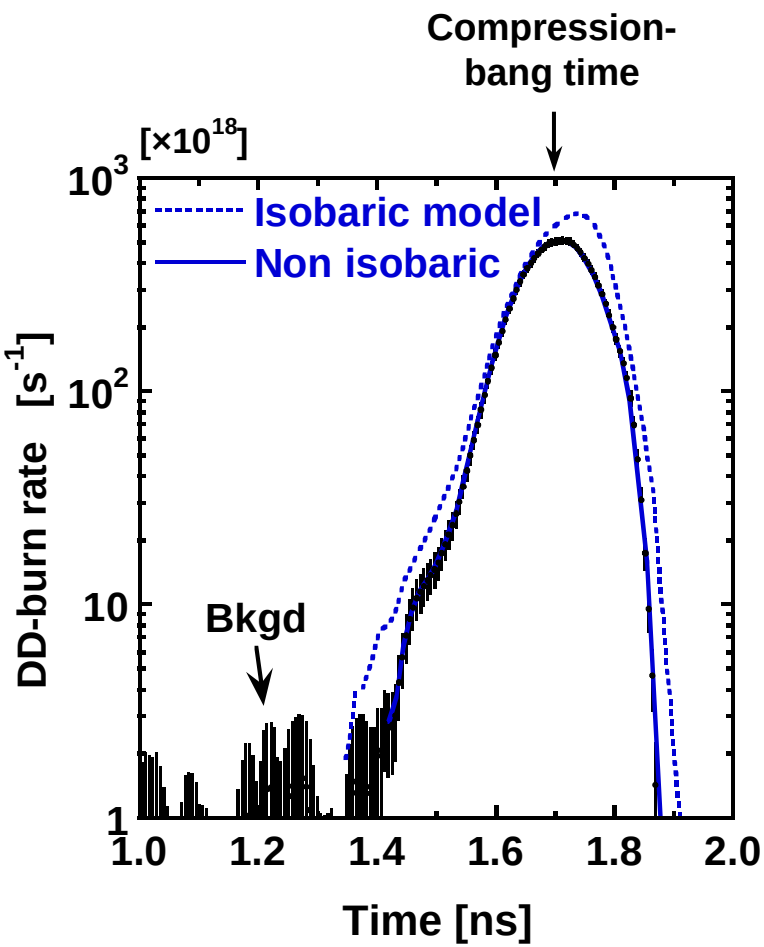
Modeled D^3He and DD-burn rates were fitted to measured data



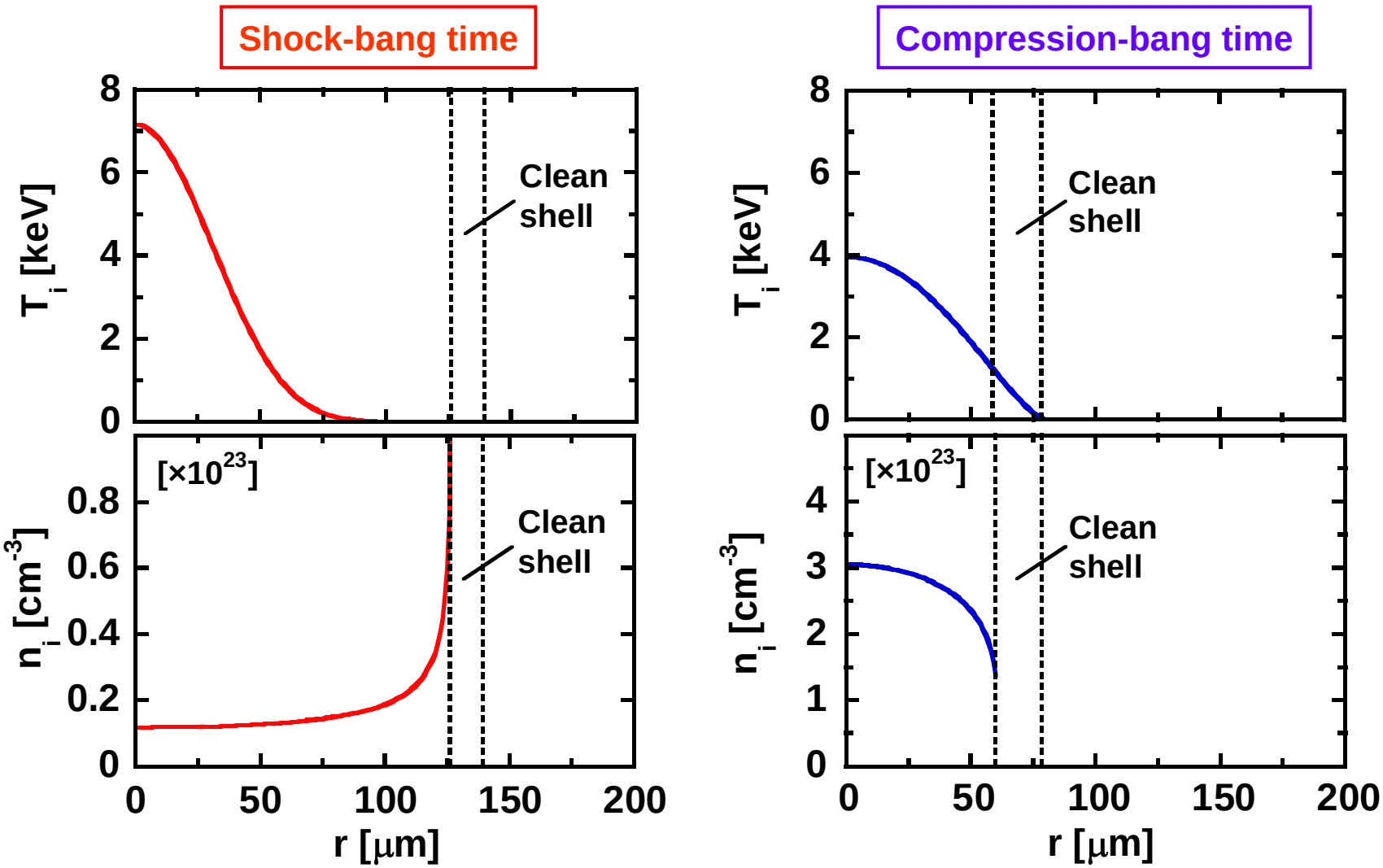


A non isobaric model describes the D^3He and DD-burn rate very well

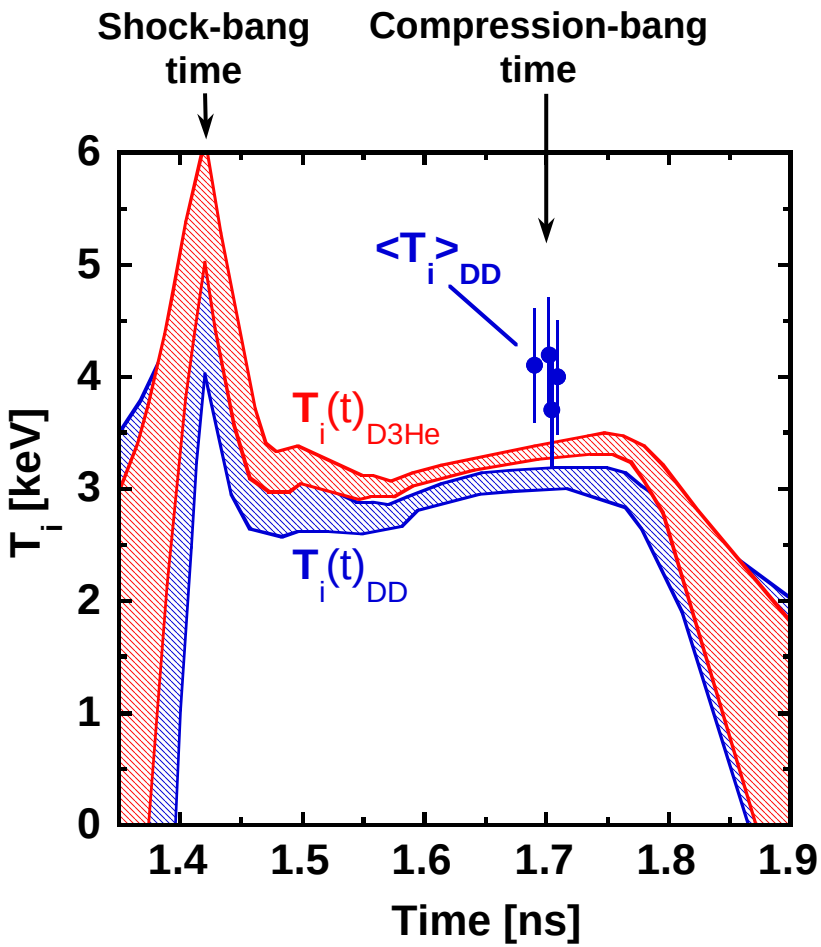




Significantly different $T_i(r)$ and $n_i(r)$ are observed at shock-bang and compression-bang time

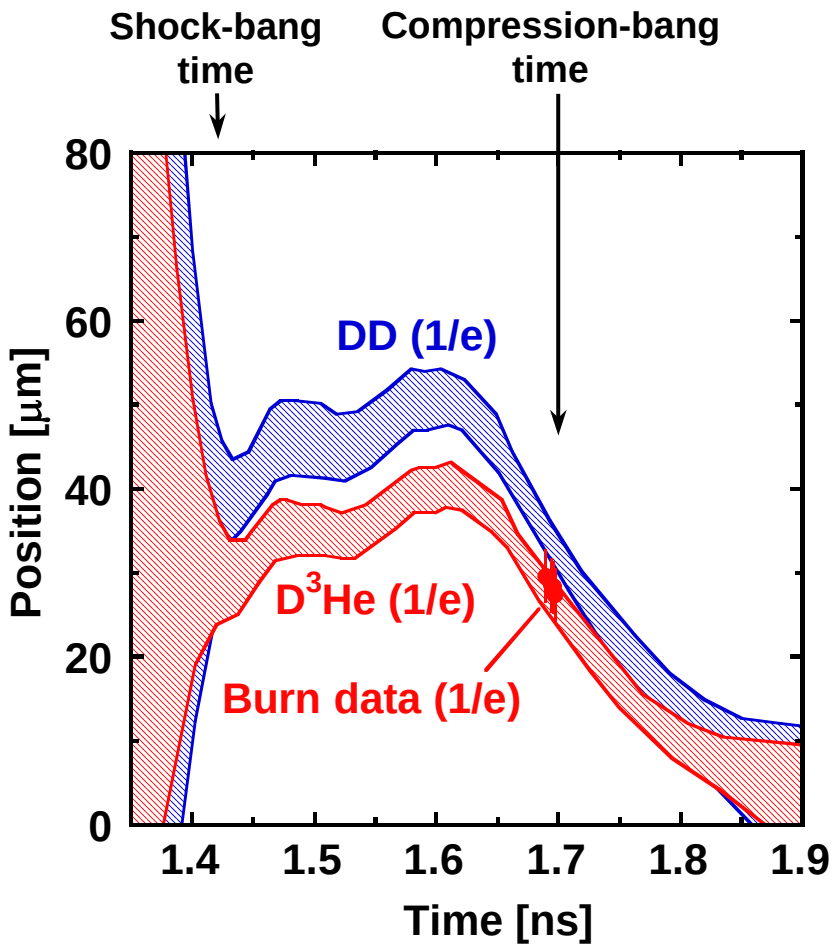


Modeled $T_i(t)_{DD}$ is ~300 eV lower than $T_i(t)_{D3He}$



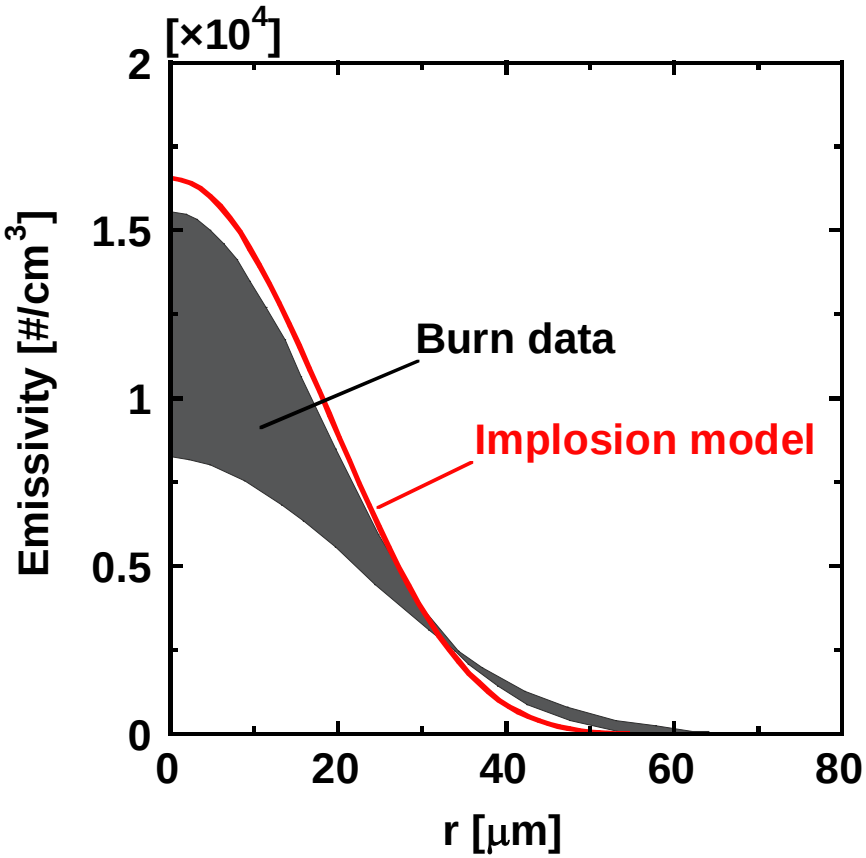
Shock-induced temperature is ~70% higher than the temperature during compression.

Size of modeled D^3He-burn region agrees with data and is ~25% smaller than the DD-burn region



J. DeCiantis et al., CO1.11
F. H. Séguin et al., CO1.12

The shape and size of modeled burn averaged D^3He-profile agrees with data



J. DeCiantis et al., CO1.11
F. H. Séguin et al., CO1.12

Summary/Conclusions

First measurements of evolution of ion temperature during shock and compression burn have been performed at OMEGA

- Spatially averaged $T_i(t)_{DD}$ is ~300 eV lower than $T_i(t)_{D3He}$.
- Shock-induced temperature is ~70% higher than the temperature during the compression.
- Size of D^3He-burn region is ~25% smaller than the DD-burn region during the shock and the compression phase.
- This work suggests that the fuel is not isobaric during shock burn and later stages of compression burn.