# Implosions with different tritium mixtures for Plasma Nuclear Science, nuclear astrophysics and ICF

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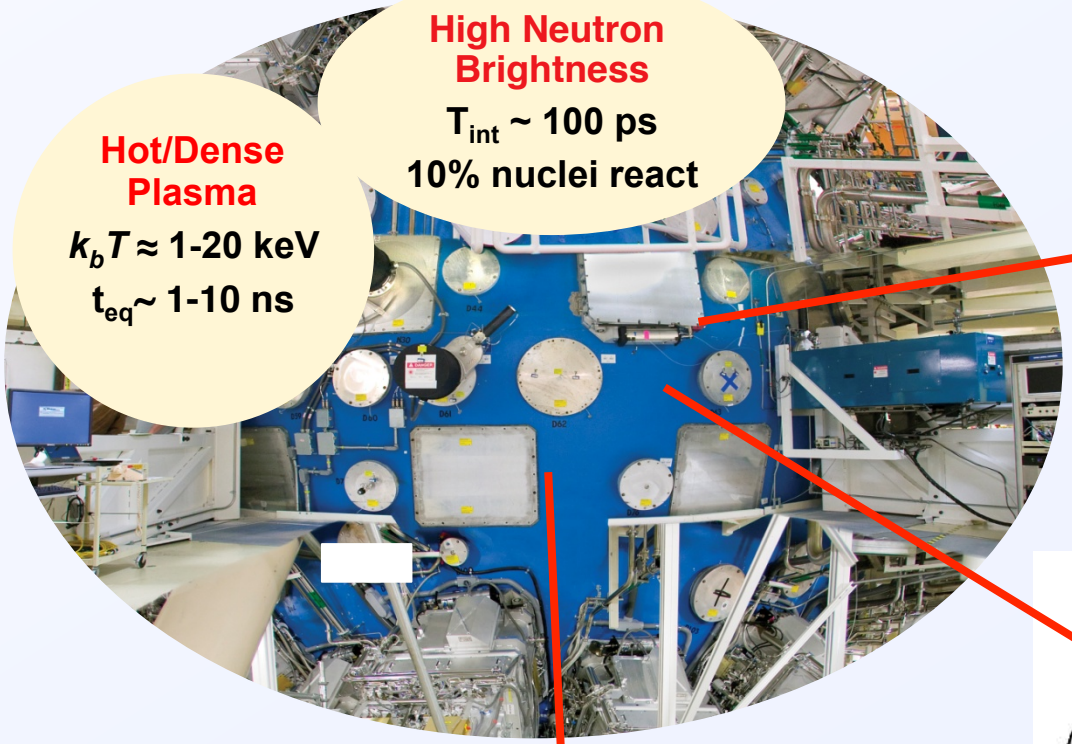
# Plasma Nuclear Science: Probing new degrees of freedom in nuclear reactions and nuclear-atomic interactions using plasmas



**High Neutron Brightness**

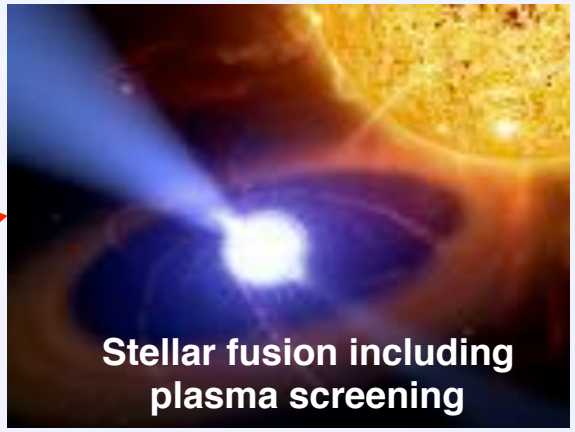
$T_{int}$ ~ 100 ps

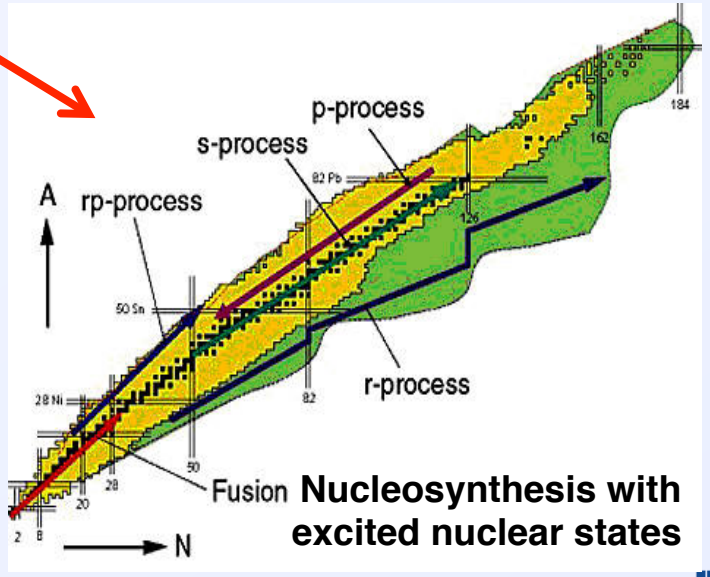
10% nuclei react

**Hot/Dense Plasma**

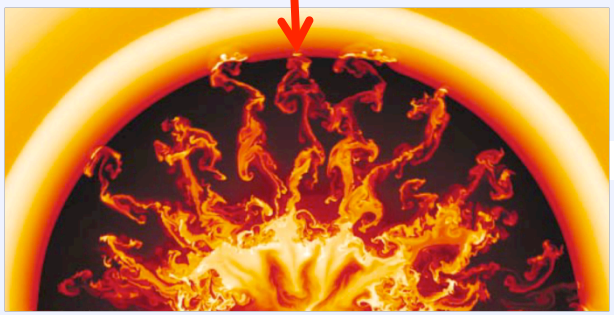
$k_bT \approx$ 1-20 keV

$t_{eq}$~ 1-10 ns




Nuclear probes of burning plasma conditions



Kifonidis et al., AA. 408, 621 (2003)

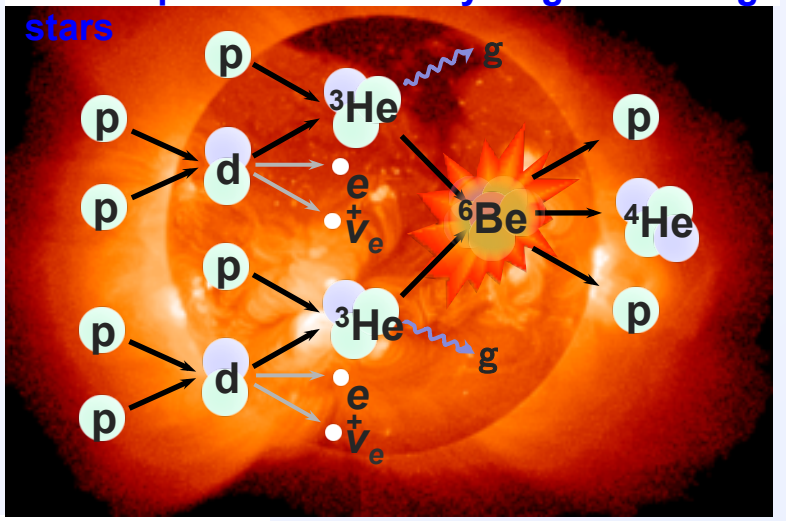
# Plasma Nuclear Science – nuclear reactions that have been, that are and that will be studied using high-energy-density/implosion plasmas at OMEGA

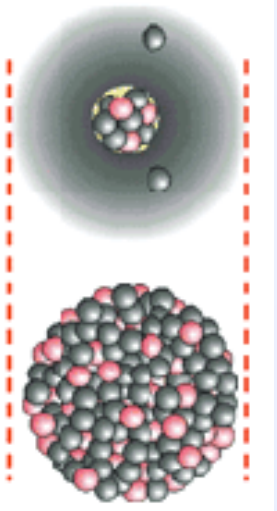
- Elastic scattering (n-T,n-D,…) …Frenje et, PRL11
- g-branching ratios of DT, D$^3$He (Herrmann – GRH)
- T+T (Gatu Johnson – LENS; Zylstra– TP)
- T+$^3$He
- $^3$He+$^3$He (Zylstra – CPS3)
- $^{15}$N+p
- $^{11}$B+p
- H+D
- $^6$Li+p and $^7$Li+p
- $^7$Be+d and $^7$Be+t

Basic nuclear physics

Nuclear astrophysics

Proton-proton chain in hydrogen-burning stars



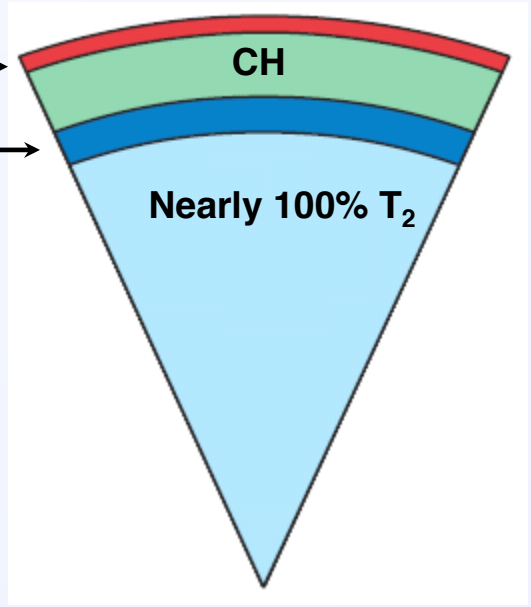
$^{11}$Li

Understanding halo nuclei & 3-body continuum states

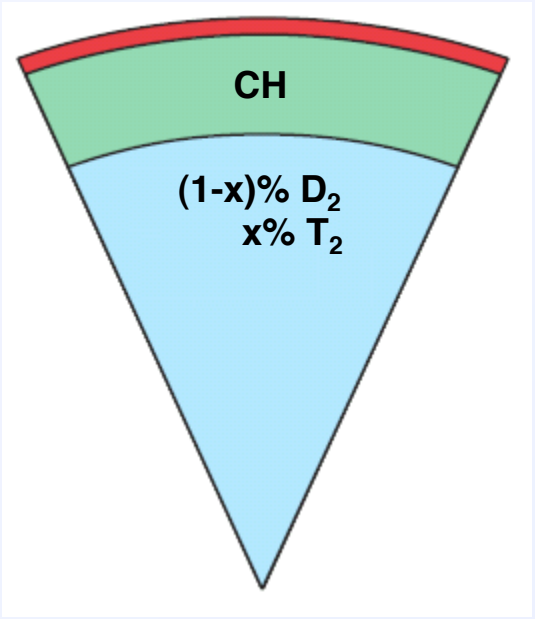
$^{208}$Pb

# Pure $T_2$-gas-fill capability will allow studies of fuel-shell mix and fuel stratification, which are important in the context of ICF and astrophysics

**Fuel-shell mix study**




**Fuel-stratification study**





D.C Wilson *et al.*, "Nearly pure tritium filled capsule implosions to measure the time dependence of mix", bull. Am. Phys. Soc. 50, 312 (2005).

V. Yu Glebov *et al.*, "Measurements of the neutron energy spectrum in T-T inertial confinement fusion", Am. Phys. Soc. 51, 107 (2006).

# Substantial progress has been made by LLE on developing flexible tritium fill capabilities, and possibilities also exist at LLNL.

- Isotope separation (update from Walt Shmayda)
  - Agreements and funding in place with Savanah River
  - Relevant NNSA program managers are talking
  - Functioning system (in Houston, TX) may be ready by June
    - Could be used to make tritium to ship to LLE before qualifying system for use at LLE

- LLNL has a very flexible system: can do admixtures of D, T, $^3$He up to 15 atm

- Would need furnace (from LLE or other) to keep capsules at temperature during fill