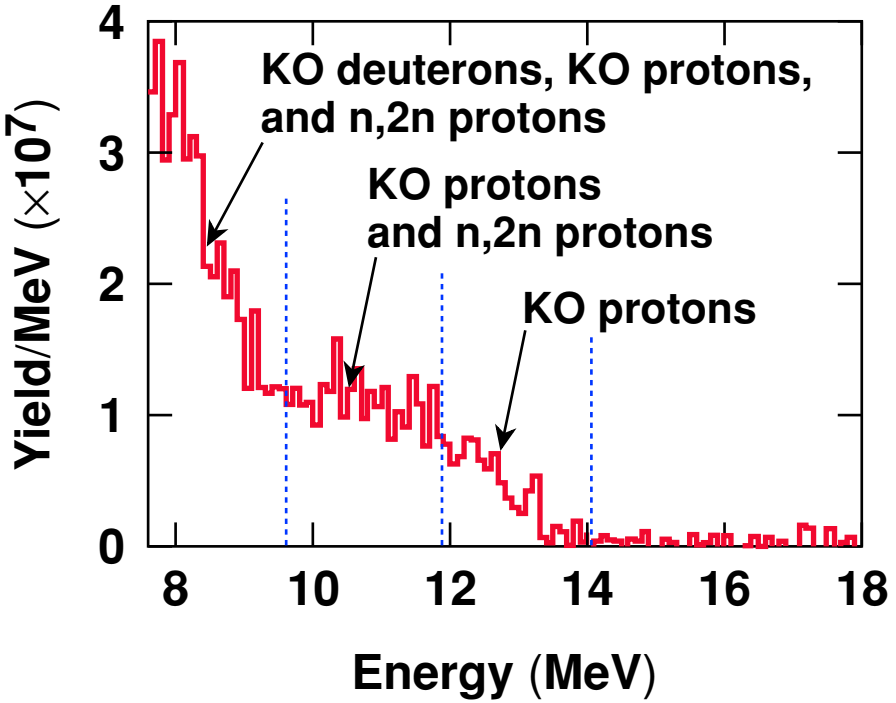
Measurements of Fuel and Shell Areal Densities of Imploded DT-doped H_2-Gas-Filled CD Capsules Using Scattered Protons on OMEGA



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Collaborators

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Summary

Knock-on protons from DT-doped H_2 fuel are used to infer ρR_{fuel} and ρR_{shell} in several directions

- A ρR_{fuel} of ~ 6.5 mg/cm^2 was determined indicating the same compression as standard 15-atm DT implosions* (Cr ~ 10 was measured at bang time in both cases).
- The ρR_{fuel} of DT-doped H_2 implosions is ~60% of 1-D prediction while standard 15-atm DT implosions are ~80% of 1-D prediction.
- An asymmetry in the ρR_{shell} between 55 and 75 mg/cm^2 is observed for DT-doped H_2 implosions.

*See next talk by C. K. Li

Motivation

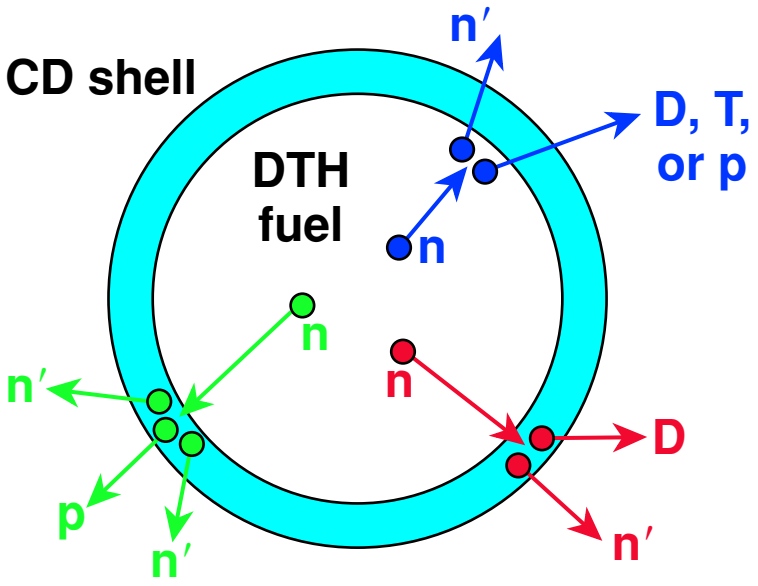
- **Study compression performance (ρR_{fuel} and Cr) using DT-doped H_2 fuel.**
- **Measure directional ρR_{shell} in several directions.**
- **Investigate the potential of using energetic deuteron breakup protons as diagnostic for high-ρR DT cryogenic implosions.**
- **Check knock-on deuteron data from standard DT implosions.**

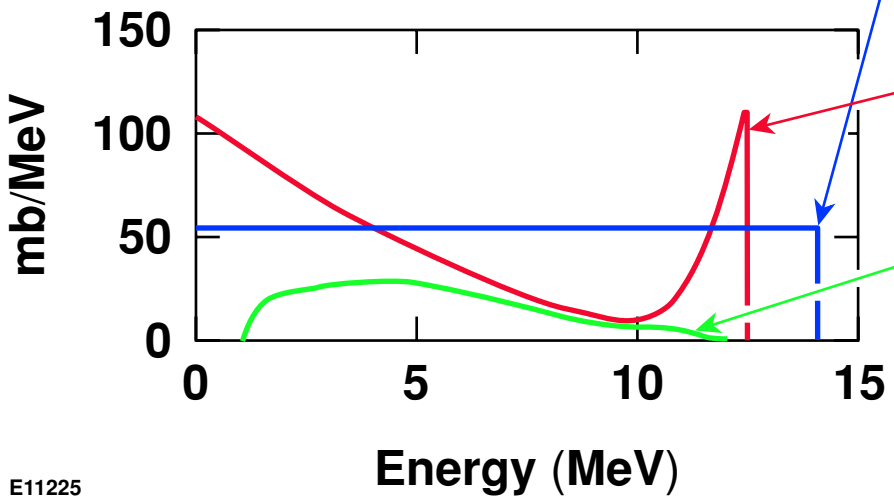
Outline

Measurements of ρR_{fuel} and ρR_{shell} knock-on protons from DT-doped H_2 fuel

- Principles of using knock-on protons for measurements of ρR_{fuel} and ρR_{shell}
- Experimental data
- Conclusions

Knock-on protons, knock-on deuterons, and n,2n protons are considered in these measurements





- DT fusion reaction:

  $D + T \rightarrow {}^{4}He + n(14.1\ MeV)$

- Neutrons elastically scatter in fuel:

  $n + p \rightarrow n' + p\ (0–14.1\ MeV)$

- Neutrons elastically scatter in shell:

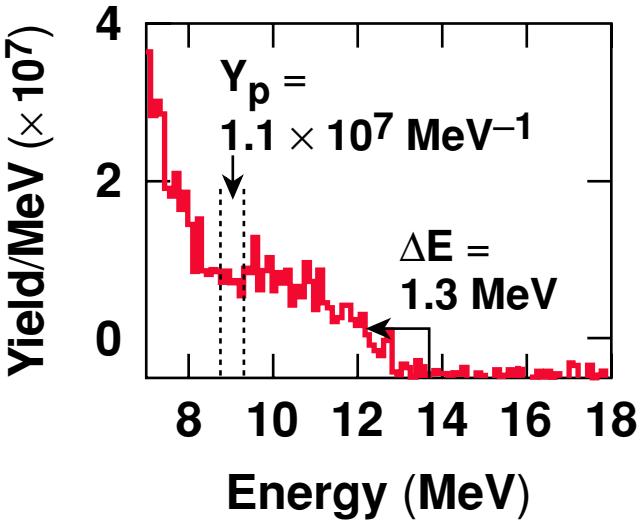
  $n + D \rightarrow n' + D'(0–12.5\ MeV)$

- n,2n reactions in shell:

  $n + D \rightarrow n' + n' + p(0–11.8\ MeV)$

E11225

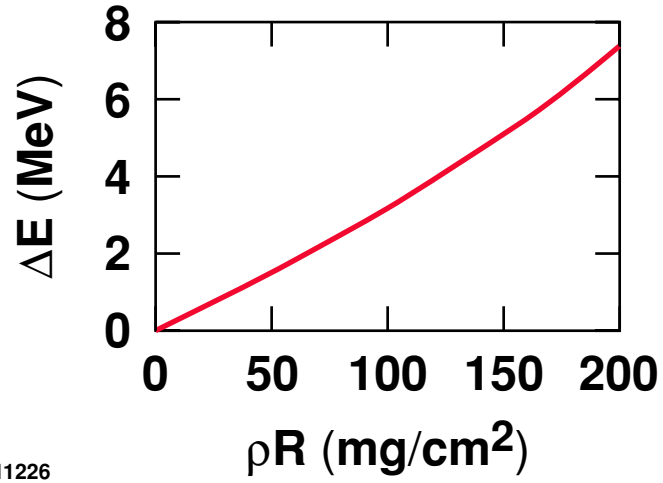
Spectral measurements of knock-on protons from DT-doped H_2 fuel are used to infer ρR_{fuel} and ρR_{shell}



- The proton yield, in a certain energy range:

$$Y_p \approx \frac{27\sigma_{np}^{eff}}{46m_p}\langle\rho R\rangle_{fuel} + \frac{\sigma_{n2n}^{eff}}{7m_d}\langle\rho R\rangle_{shell}$$

~10%



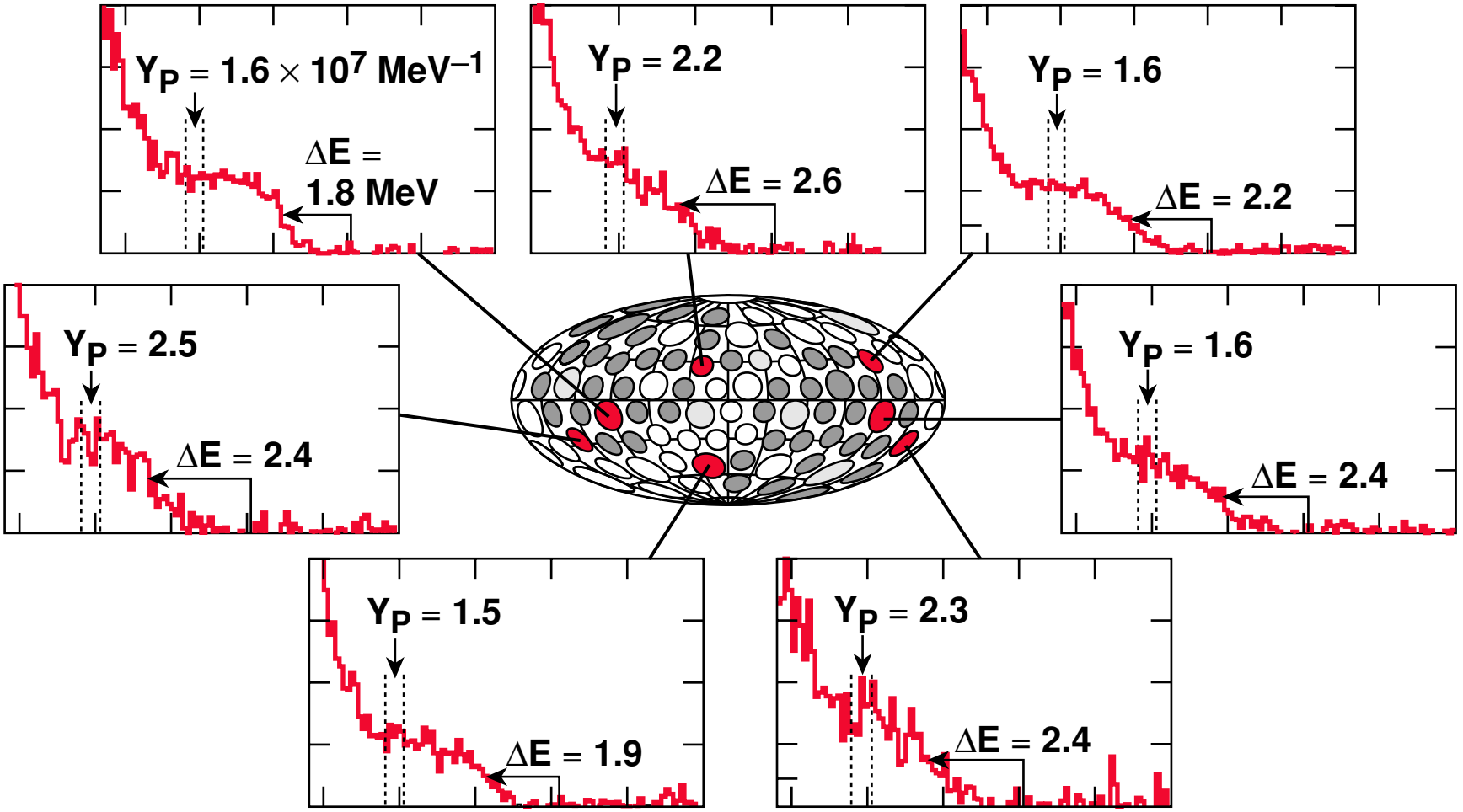
- Energy downshift of the knock-on proton spectrum:

$$\langle\rho R\rangle_{total} = \langle\rho R\rangle_{shell} + \langle\rho R\rangle_{fuel}$$

~10%

E11226

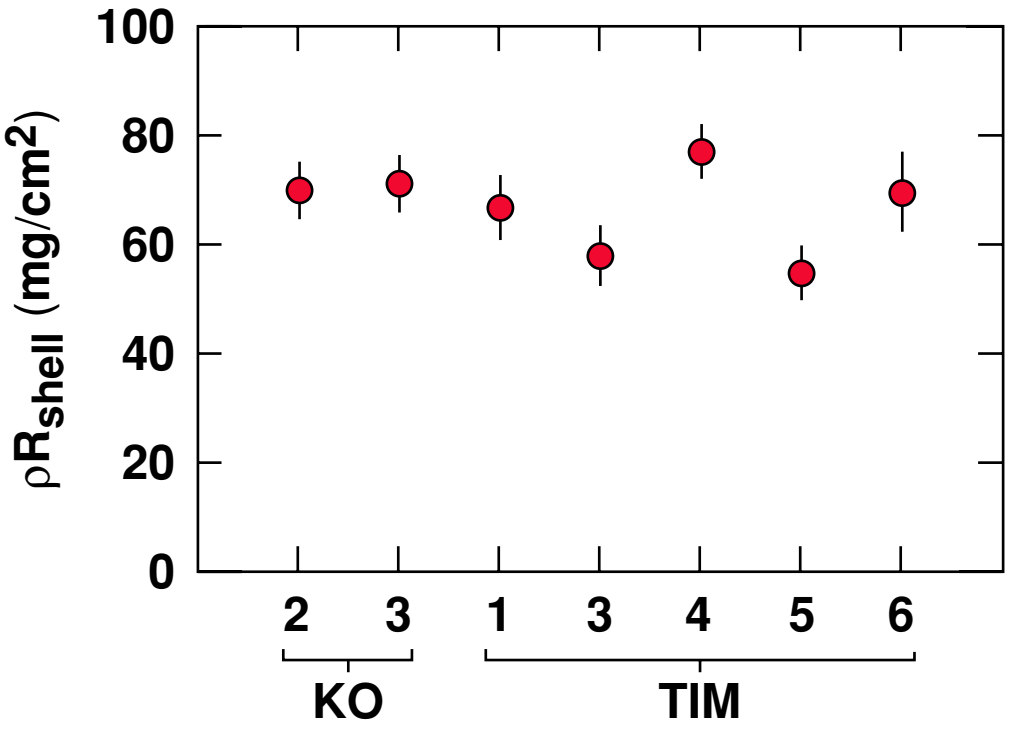
Spectral measurements of knock-on protons were performed in several directions during shot 23471



E11227

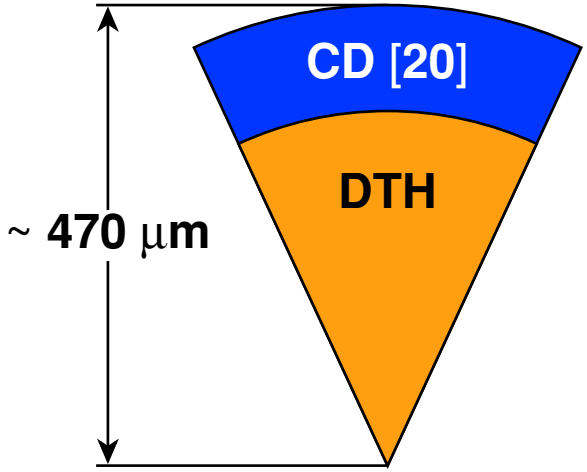
Inferred ρR_{fuel} and directional ρR_{shell} for a DT-doped H_2 implosion

- A ρR_{fuel} of ~6.5 mg/cm^2 was determined on the basis of the knock-on proton yields.
- An asymmetry in the ρR_{shell} between 55 and 75 mg/cm^2 is observed for DT-doped H_2 implosions.

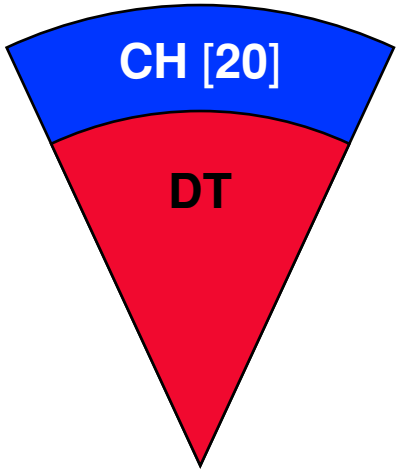


*See talk by F. H. Séguin

Comparison with 15-atm standard DT implosions indicates the same compression performance



Density correction



ρR_{fuel} ~ 6.5 mg/cm^2

ρR_{fuel} ~ 14 mg/cm^2

Cr ~ 10
~70% of 1-D prediction

$$Cr = \sqrt{\frac{\rho R_{bangtime}}{\rho R_{initial}}}$$

Cr ~ 10
~90% of 1-D prediction

C. K. Li *et al.*, Phys. Plasmas 8, 4902 (2001).

Summary/Conclusions

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