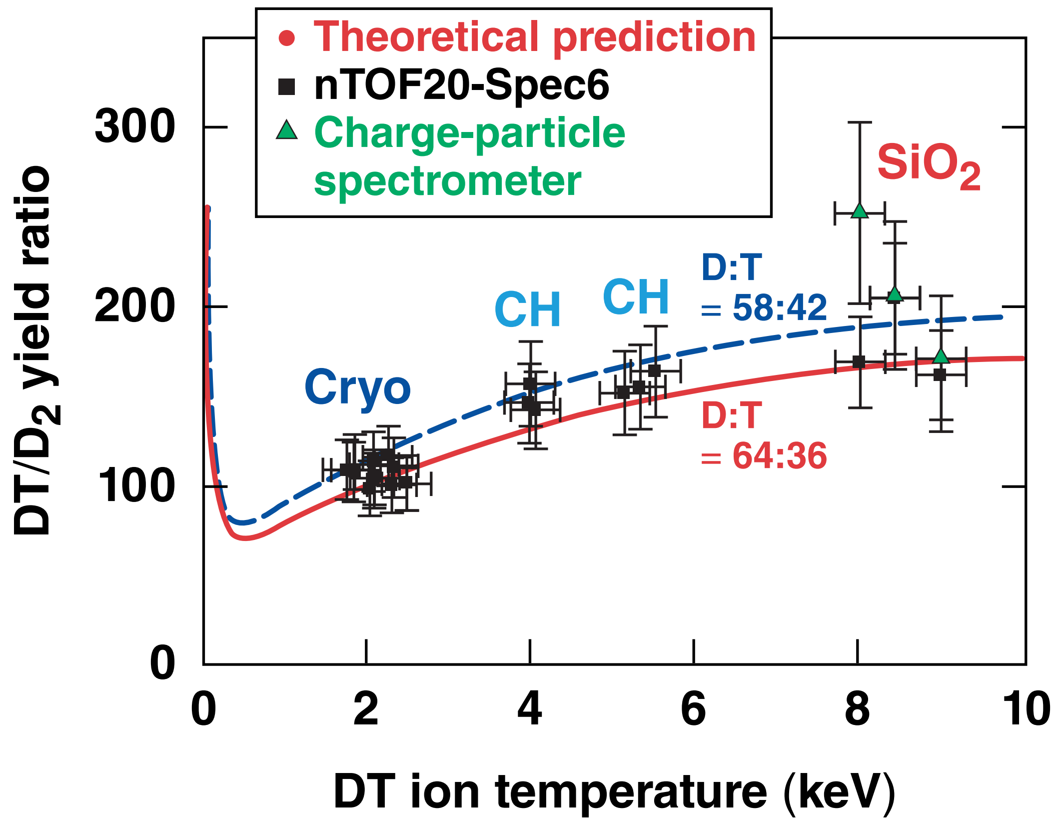
Measurements of D_2 Neutron Yield and Ion Temperature in DT Implosions on OMEGA



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Summary

The D_2 neutron yield and ion temperature in DT implosions have been measured on OMEGA

- A dedicated neutron time-of-flight (nTOF) detector and a collimated line of sight were developed on OMEGA to measure D_2 neutron yield and ion temperature in DT implosions

- The independently measured DT and D_2 ion temperatures are consistent with a single thermal source

- The experimentally measured ratio of DT to D_2 neutron yields is in good agreement with *LILAC* simulations of DT cryogenic implosions, and somewhat higher than the prediction of an ice-block model

Related talks: N06.00004, N13.00005

Collaborators

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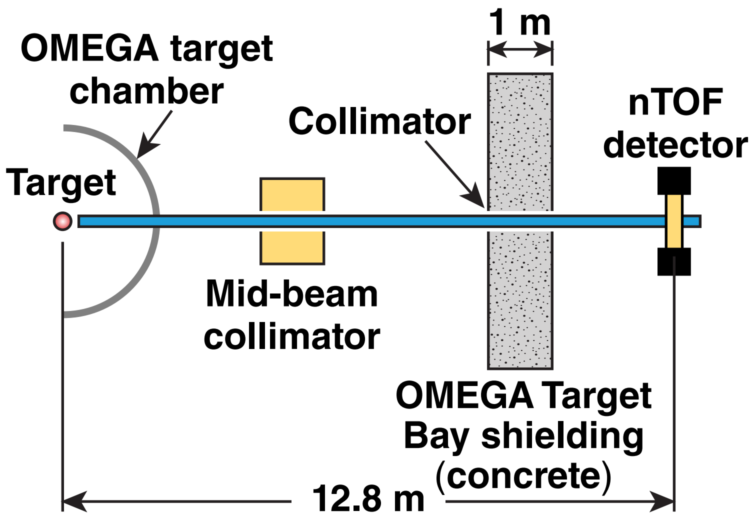
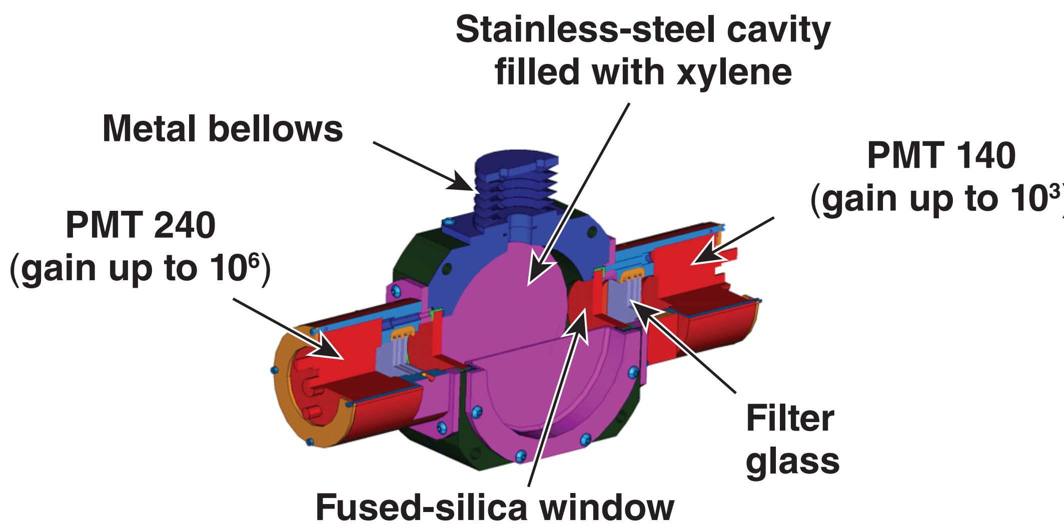
The measurement of D_2 yield and T_i in DT implosions required a new detector and a collimated line of sight

- To record a small D_2 signal after a DT signal that is 350 to 1000× higher, the following requirements must be satisfied:
  - the nTOF detector has a gated PMT to eliminate the DT peak and avoid photomultiplier tube (PMT) saturation
  - the time separation between DT and D_2 peaks is larger than the PMT gate recovery time
  - low-afterglow scintillators like oxygenated xylene[1], EJ-399-17 ("Liquid A")[2], and bibenzyl crystal[3] are used

[1] C. Stoeckl *et al.*, Rev. Sci. Instrum 81, 10D302 (2010).
[2] www.eljentechnology.com
[3] N. Zaitseva *et al.*, LLNL-JRNL-414904 (2009).

The nTOF20-Spec6 detector* filled with oxygenated xylene is being used for DT/D_2 ratio measurements





- Gated PMT 240 records the D_2 neutron signal
- Ungated PMT 140 records the DT neutron signal

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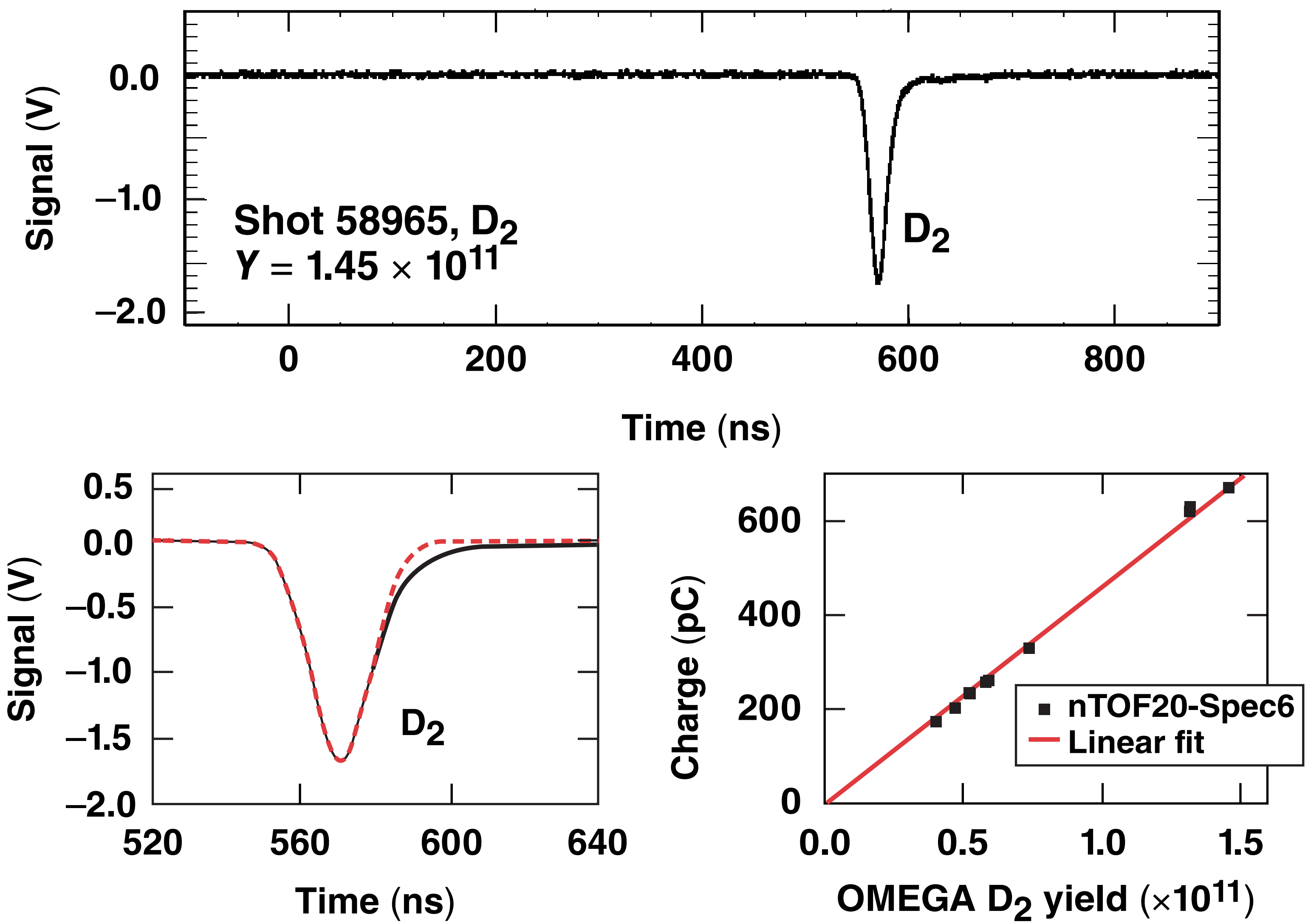
*V. Yu. Glebov *et al.*, Rev. Sci. Instrum 81, 10D325 (2010).

The nTOF20-Spec6 detector was calibrated *in-situ* in D_2 shots on OMEGA with the same gate as in DT shots



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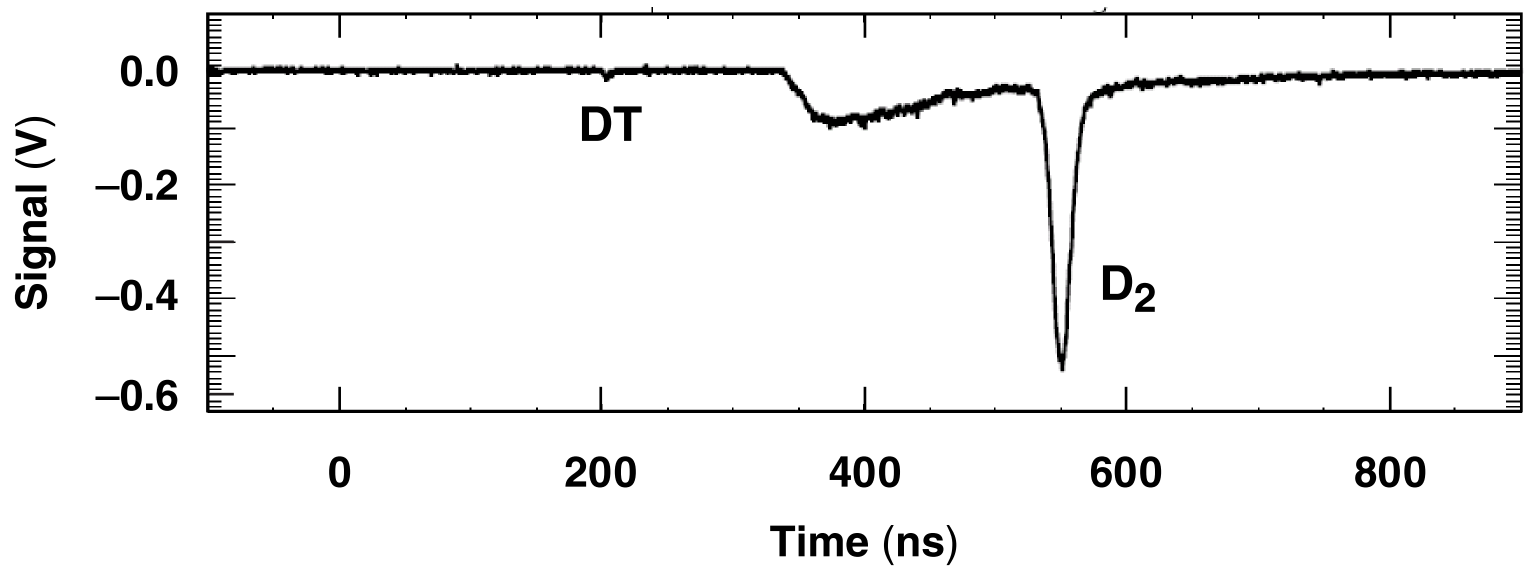
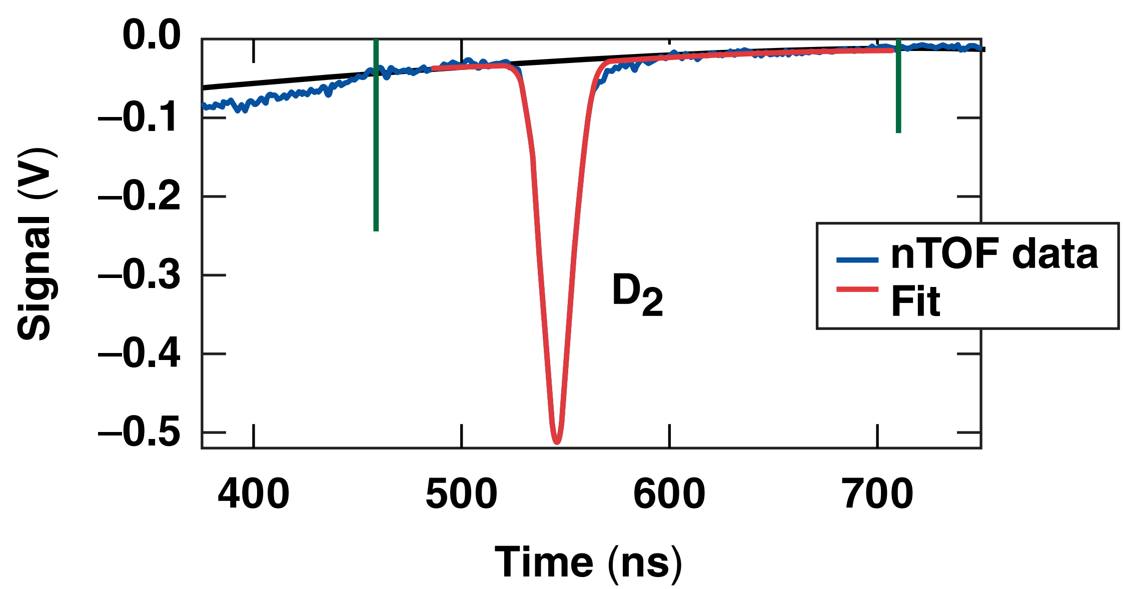
A typical scope trace from the gated PMT-240 in a DT implosion clearly shows the D_2 neutron peak



Shot 63659
$Y_{DT} = 3.7 \times 10^{12}$
$Y_{D_2} = 2.6 \times 10^{10}$
$T_i = 2.2$ keV



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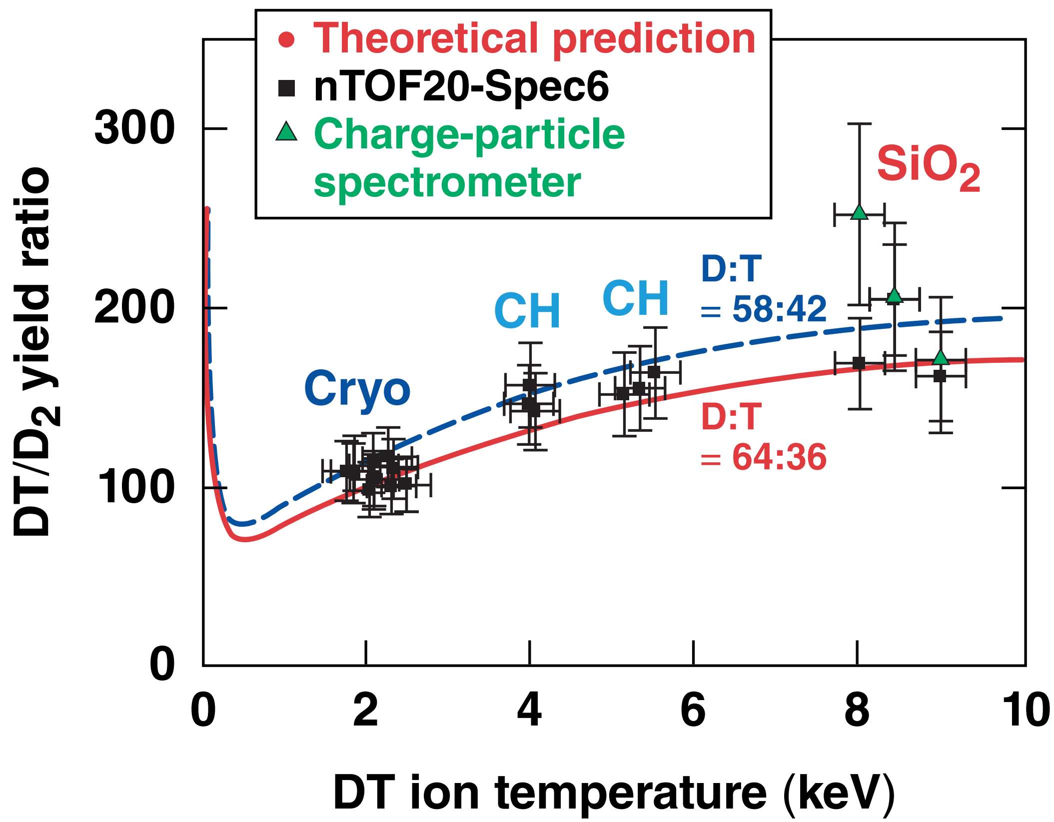
The measured DT/D_2 yield ratios are somewhat higher than the prediction of an ice-block model



- 36% T is a recent measurement
- Value to be confirmed by LLNL experts
- Systematic error now being determined
- 10% systematic error in T fraction is possible

An ice-block model assumes constant n_d, n_t, T_i, and a fixed D to T ratio in the fuel.

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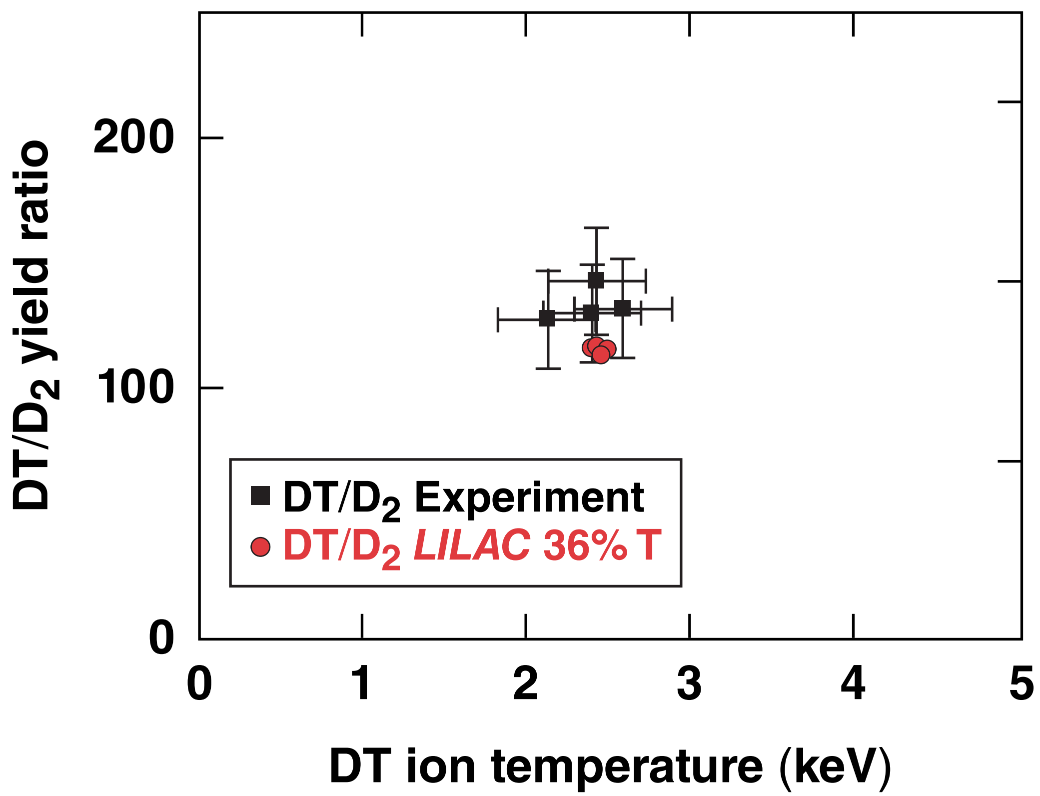
There is good agreement between data and *LILAC* simulations of the DT/D_2 yield ratio in cryogenic shots



Only recent shots with 25-μm target offsets are shown.

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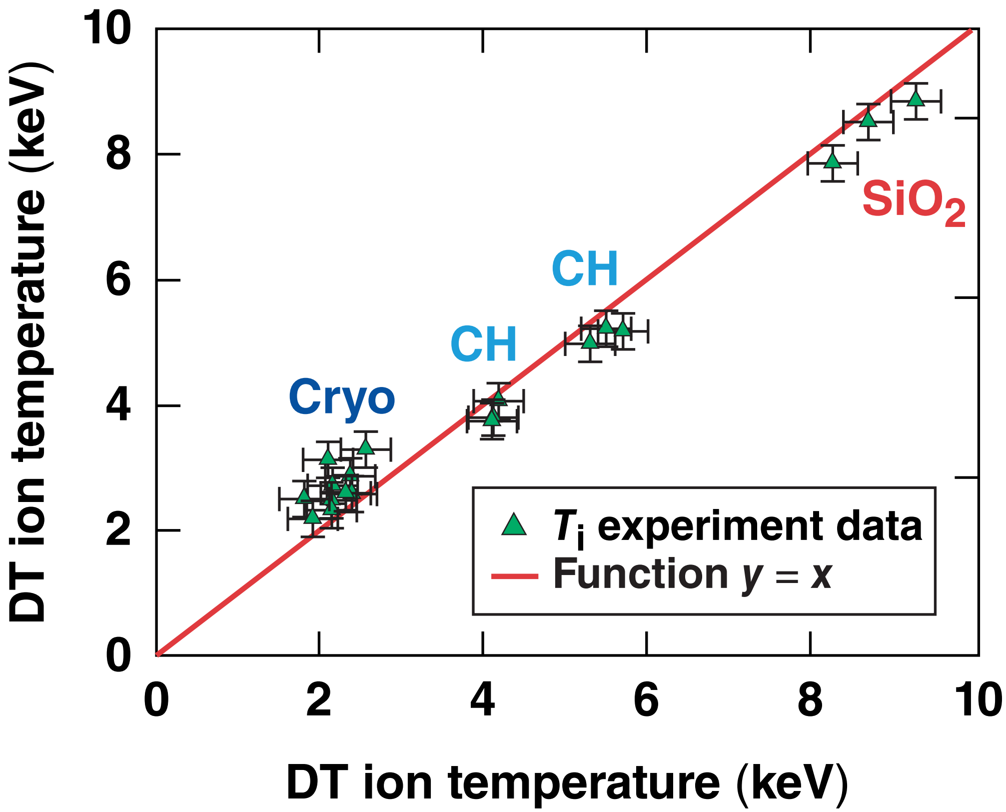
The independently measured DT and D_2 ion temperatures are consistent with a single thermal source



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Summary/Conclusions

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