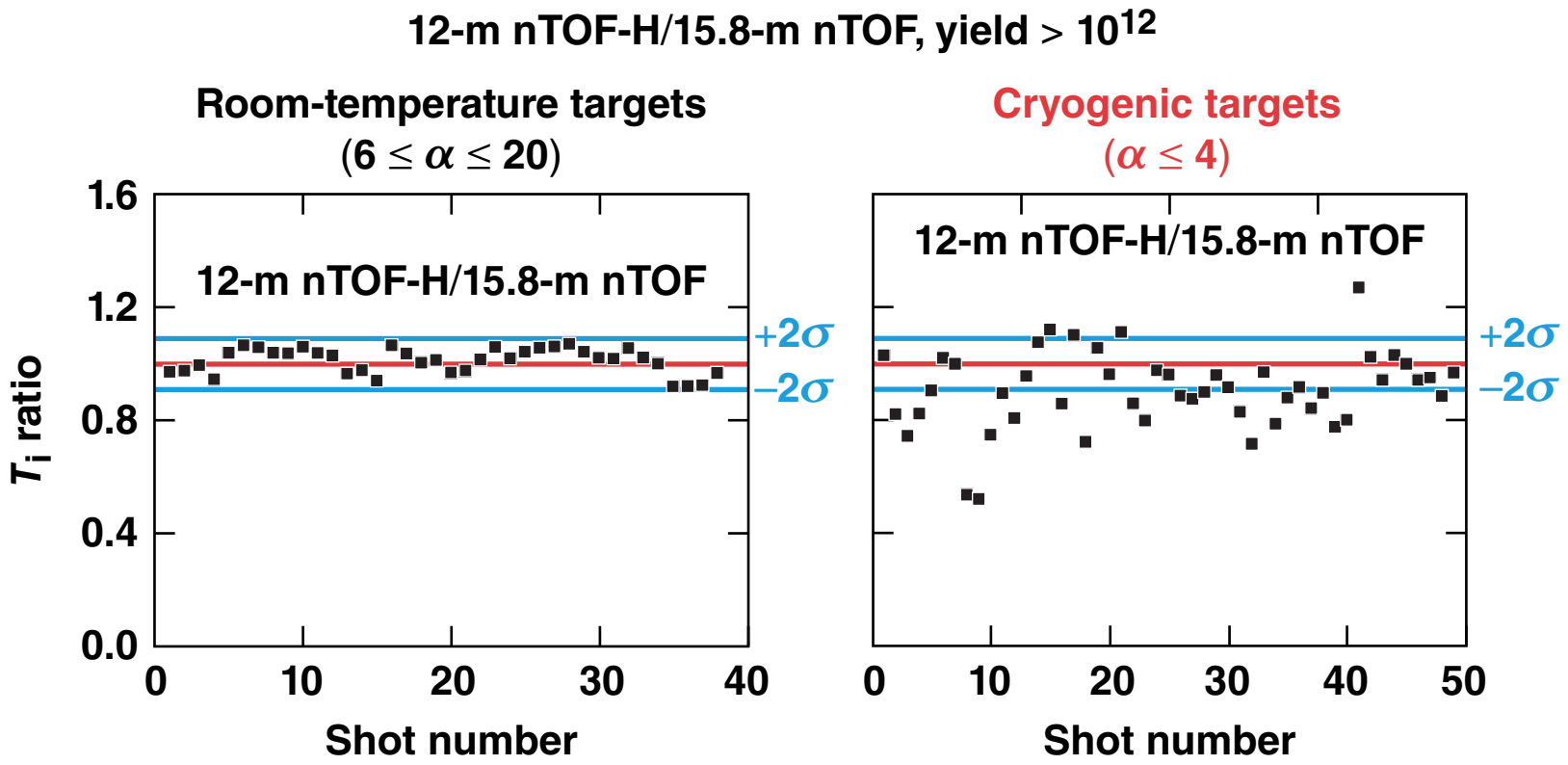
Inference of Cryogenic Fuel Motion from Ion-Temperature Measurements on OMEGA



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Summary

Ion-temperature measurements in different lines of sight (LOS) suggest that bulk fuel flows in some DT cryogenic implosions

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- Six neutron time-of-flight (nTOF) detectors with different instrumentation, sensitivity, and distance from a target are used to measure DT ion temperatures on OMEGA
- In DT cryogenic implosions, the ratio of the ion temperature measured in different LOS can vary by factor of 2
- Large differences in the ion temperature in different LOS suggests that bulk fuel flows because of perturbation growth or nonuniform drive

Collaborators

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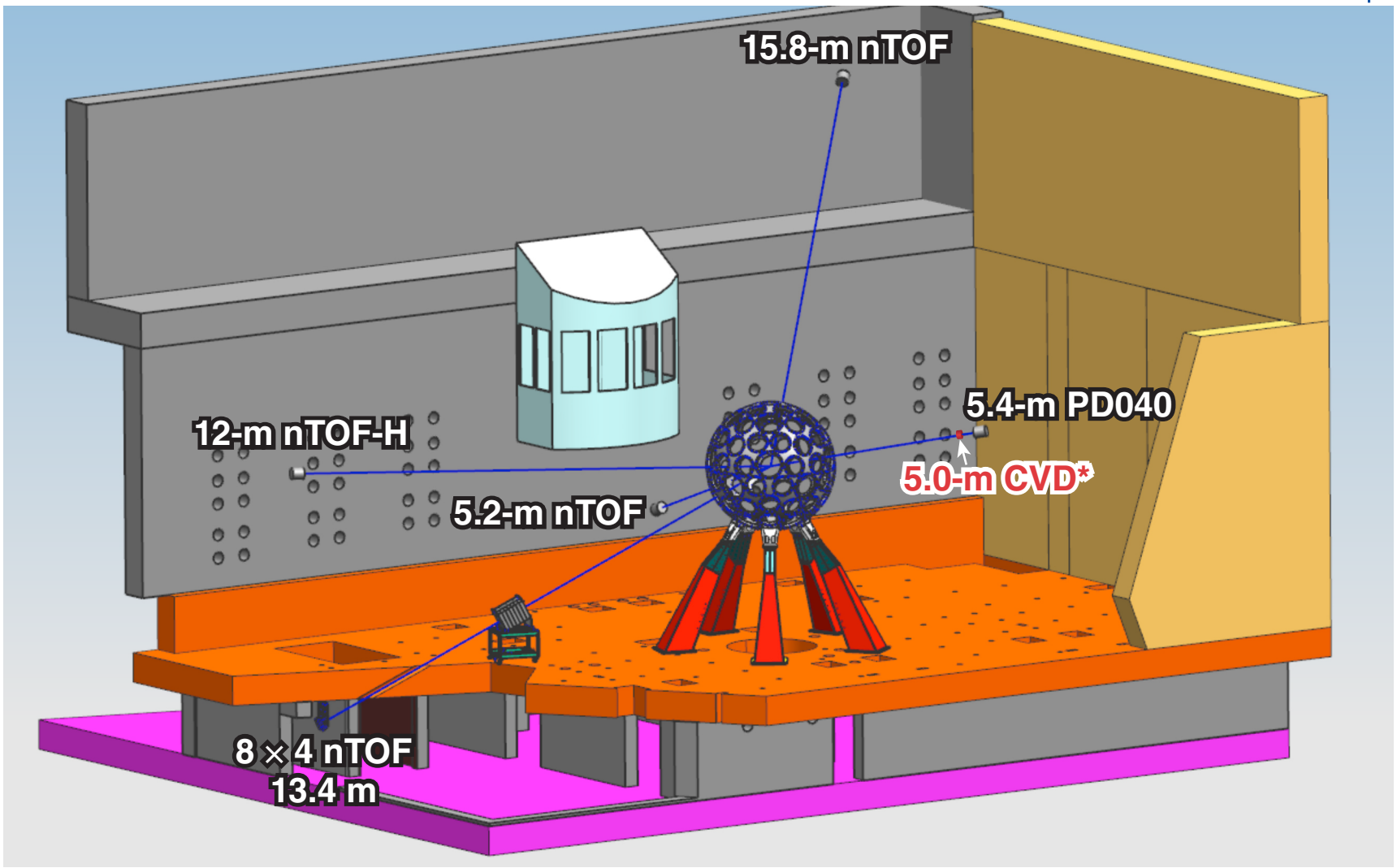
Six nTOF detectors are located on OMEGA at different lines of sight and distances



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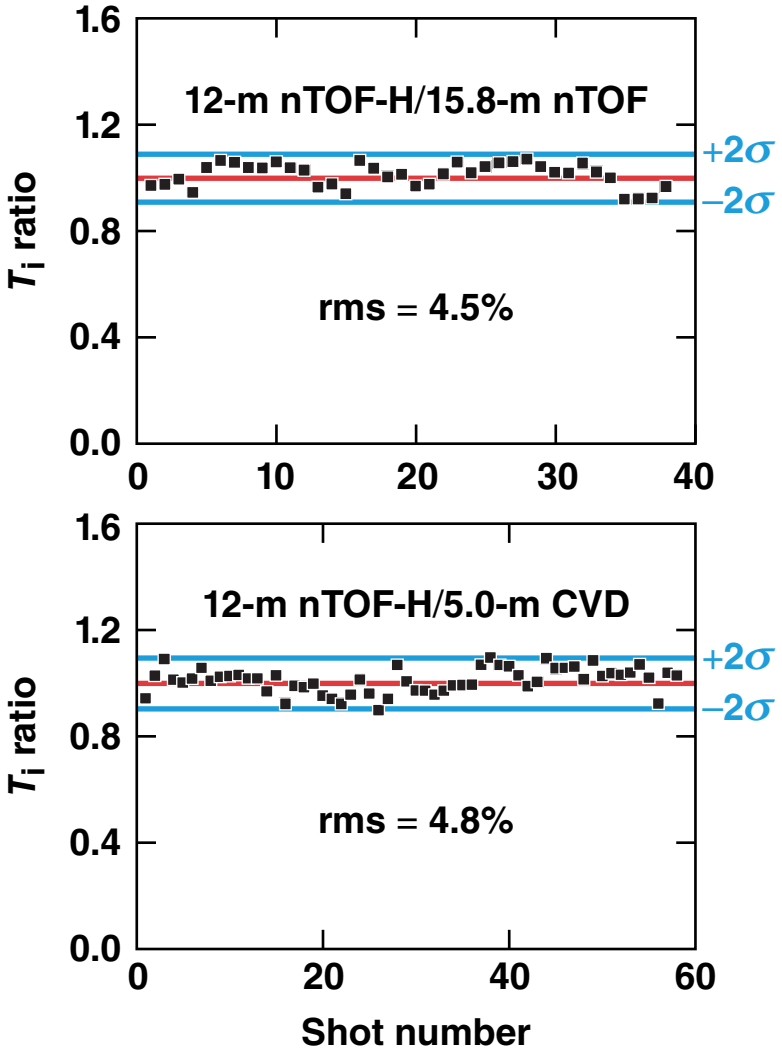
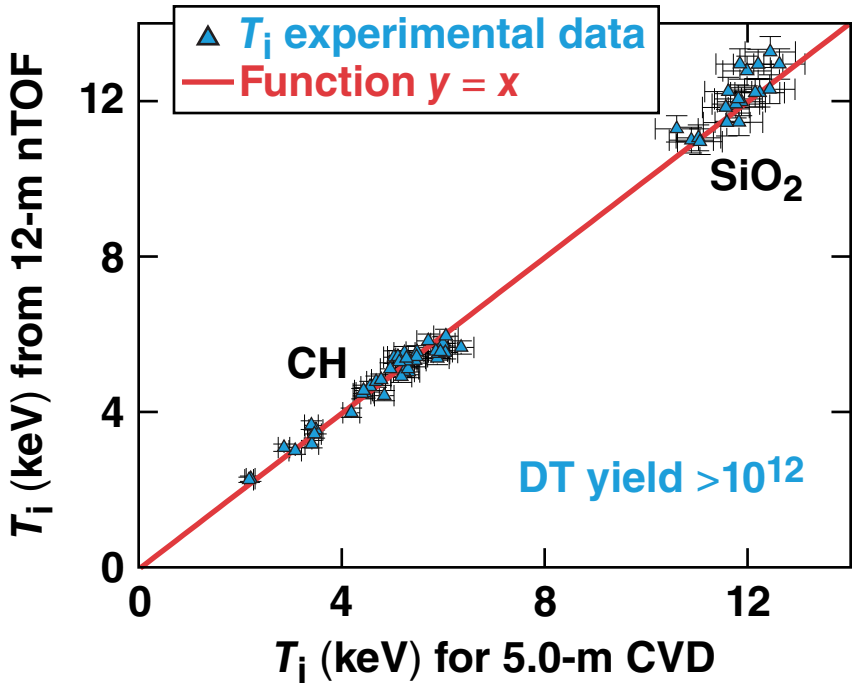
*Chemical vapor deposition

The T_i ratio in different LOS is close to one for DT room-temperature targets with high-adiabat implosions





All shots are taken with 1-ns square laser pulses with $6 \leq \alpha \leq 20$ and a convergence ratio (CR) from 4 to 11. Target offset is less than 10 μm.

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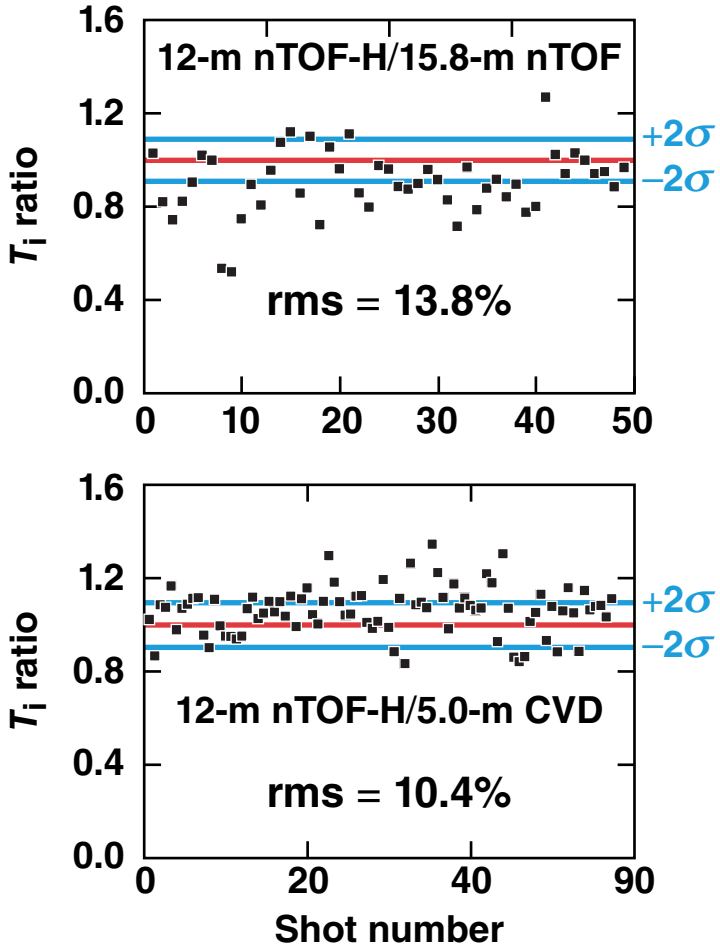
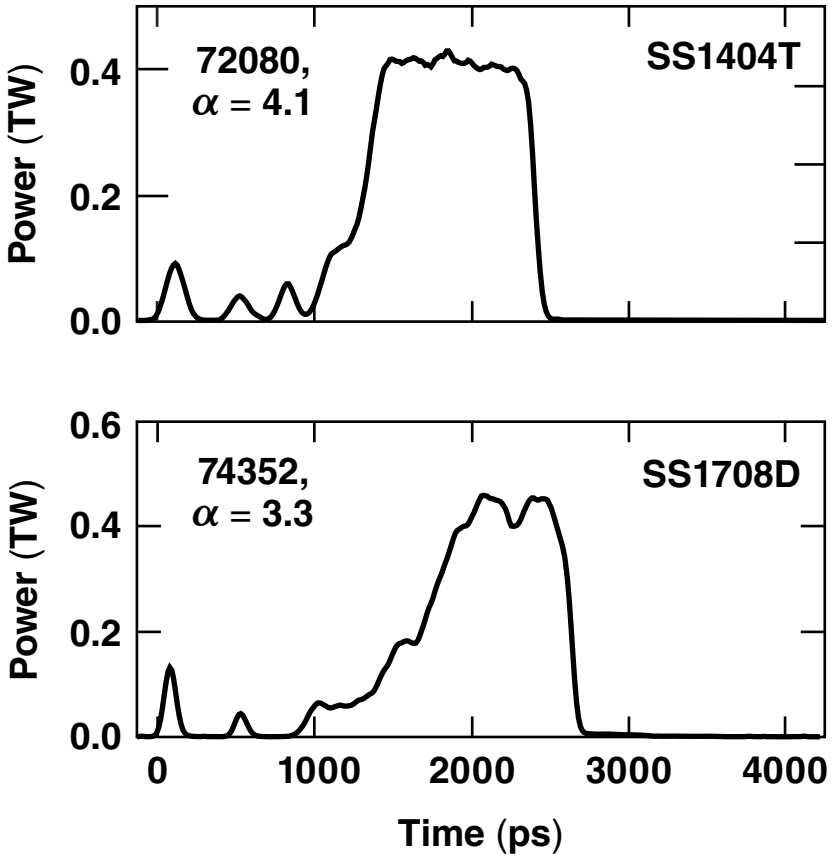
The T_i ratio in different LOS can vary by a factor of 2 in low-adiabat DT cryogenic implosions

DT yield > 10^{12}
2012 to 2014 data

CR from 14.5 to 22

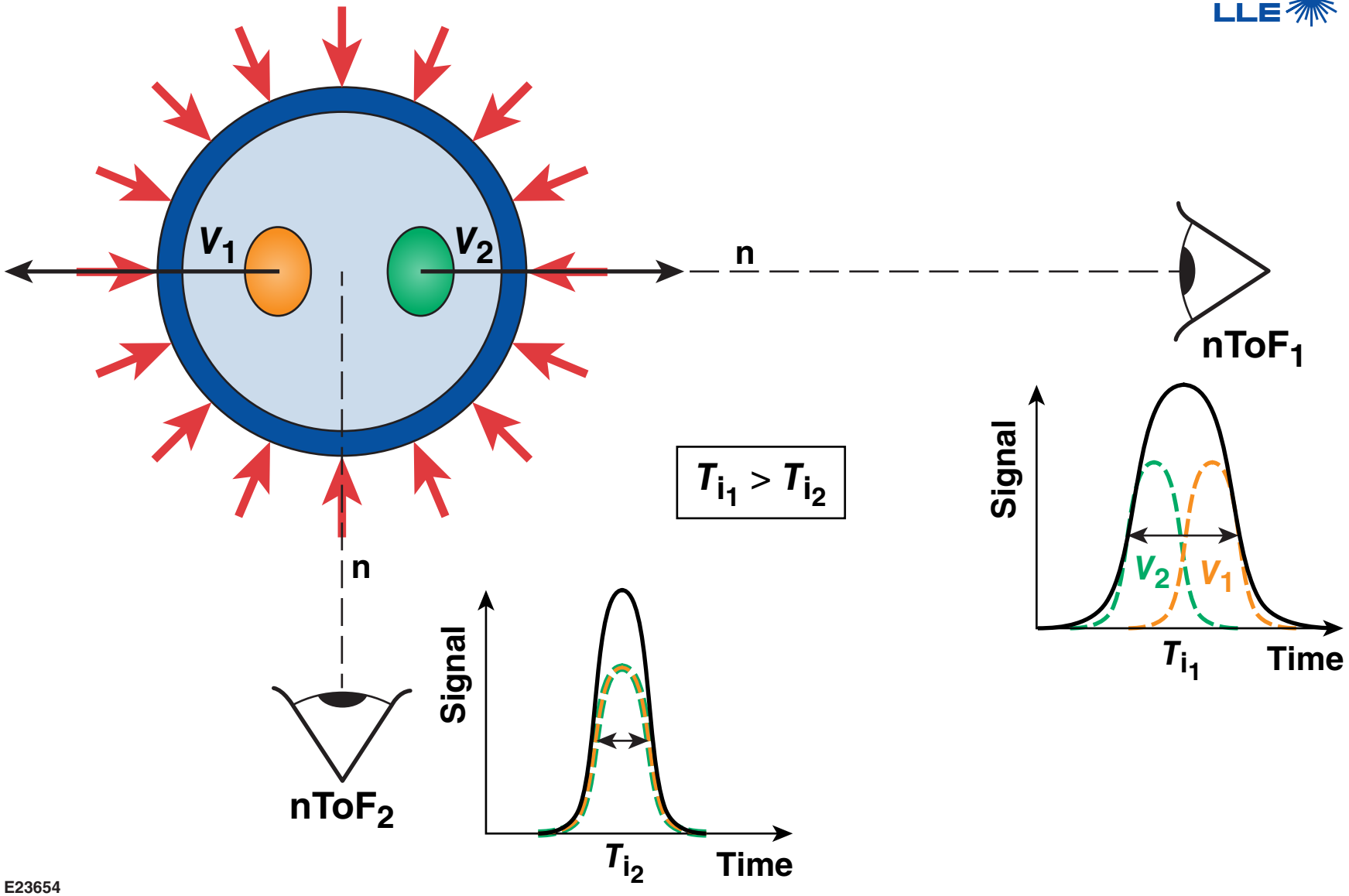


Typical pulse shapes



E23656

Bulk fuel flows during an implosion may create different T_i in different LOS



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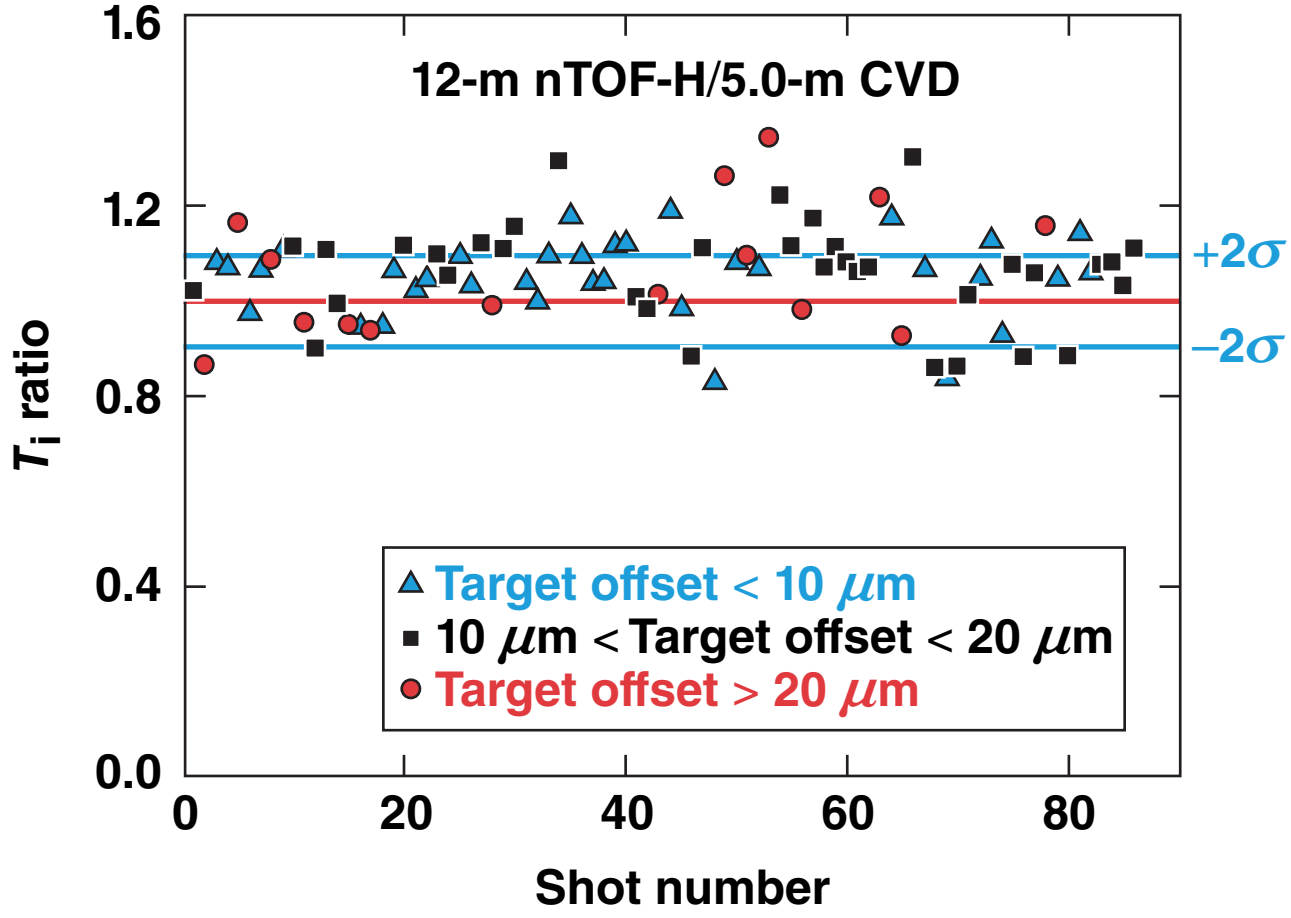
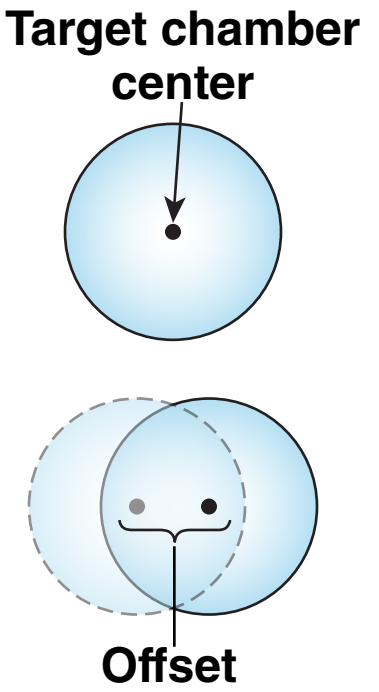
Target offset alone can not explain the different T_i ratio in different LOS





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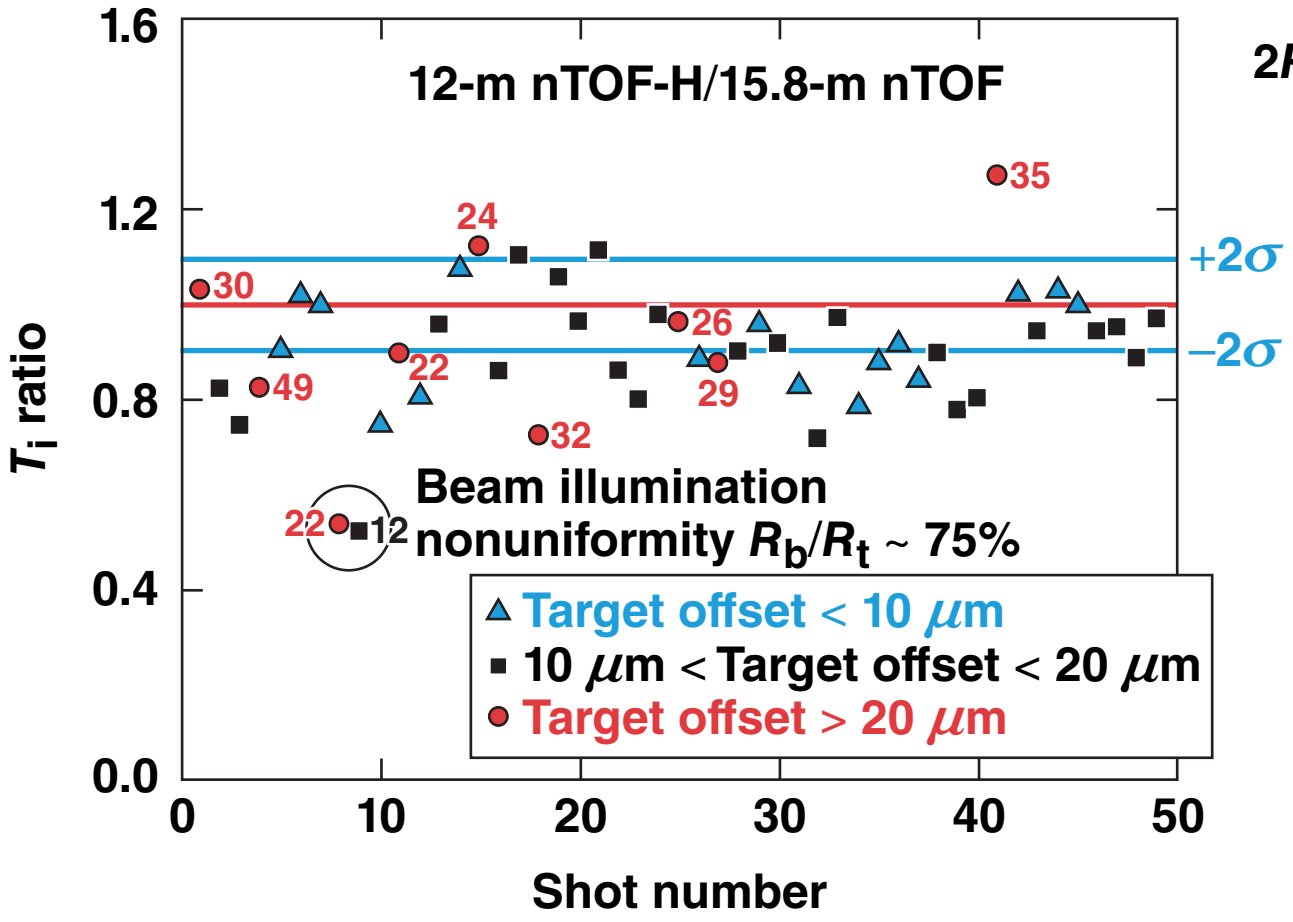
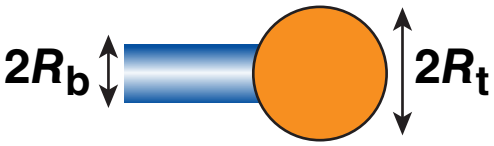
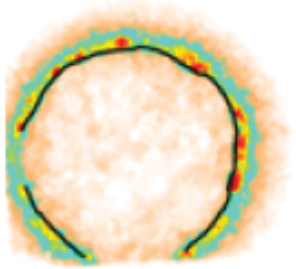
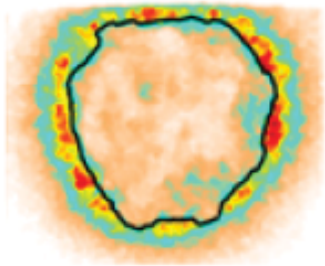
Beam illumination nonuniformity may create bulk fuel flows and different T_i in different LOS







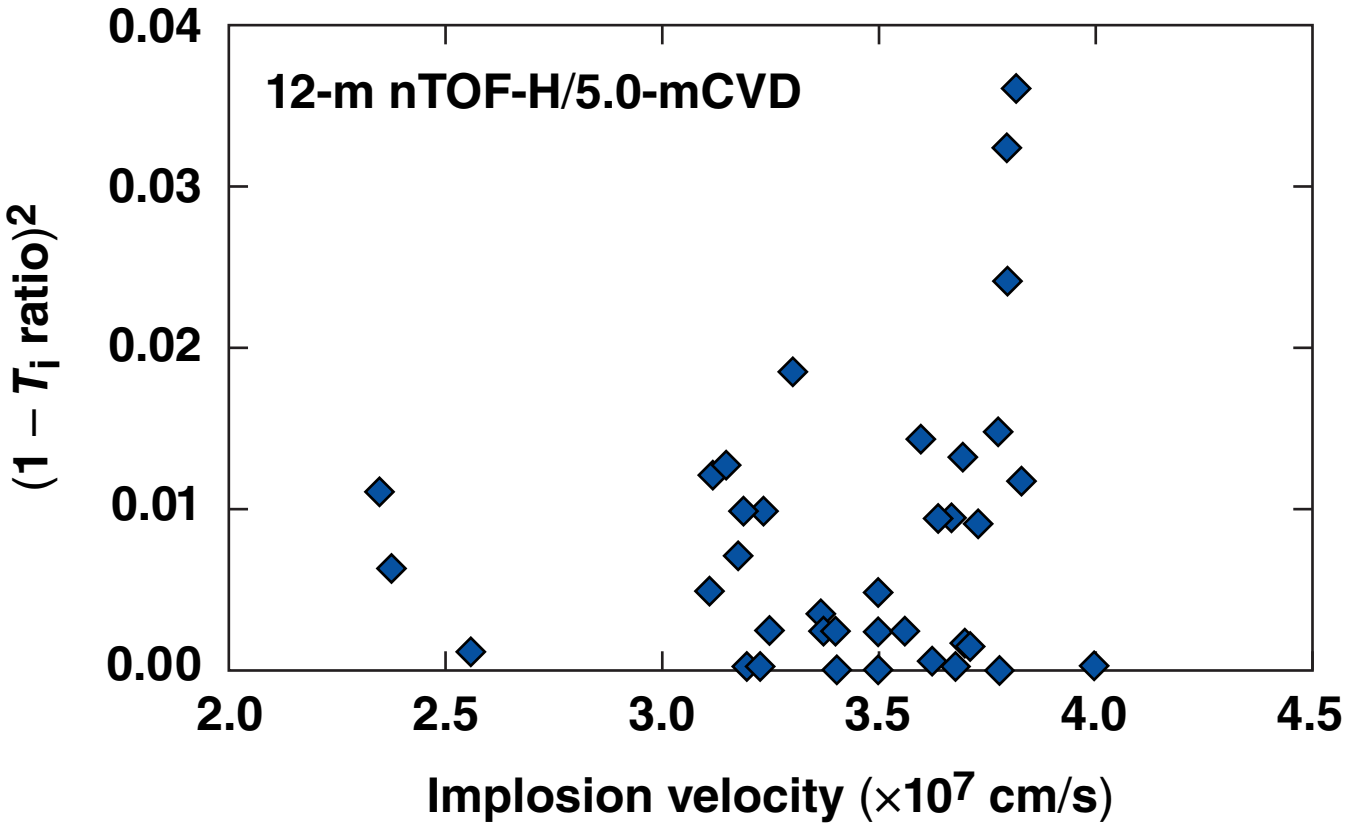
R_b/R_t = 100%



R_b/R_t = 75%

E23660

There is a correlation between implosion velocity and the deviation of the T_i ratio from 1



Flow asymmetry increases for larger shell-implosion velocities.

E23657

Summary/Conclusions

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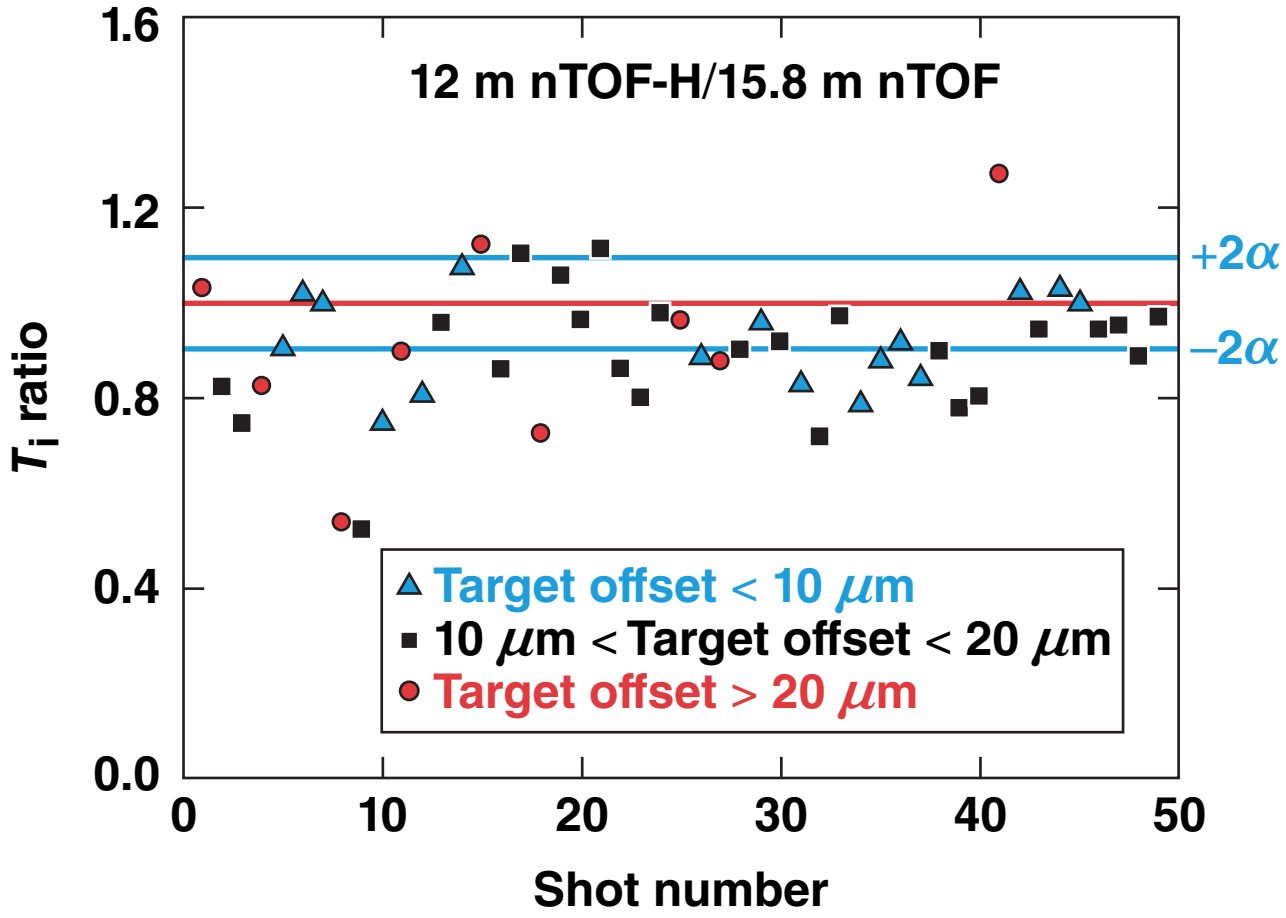

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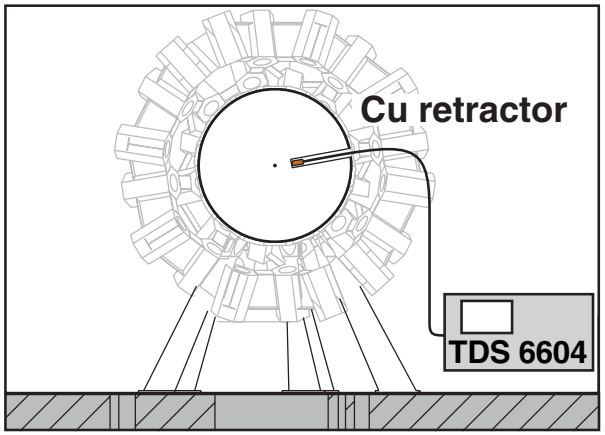
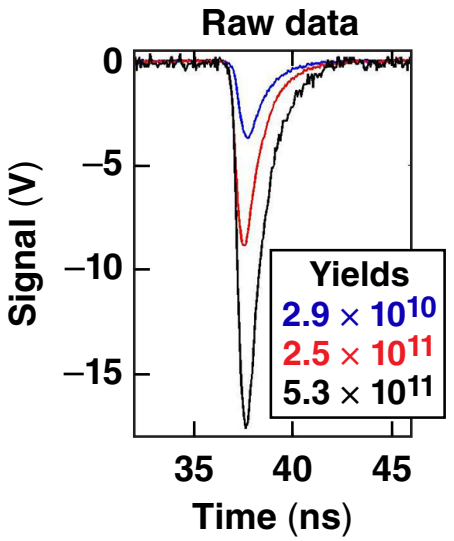
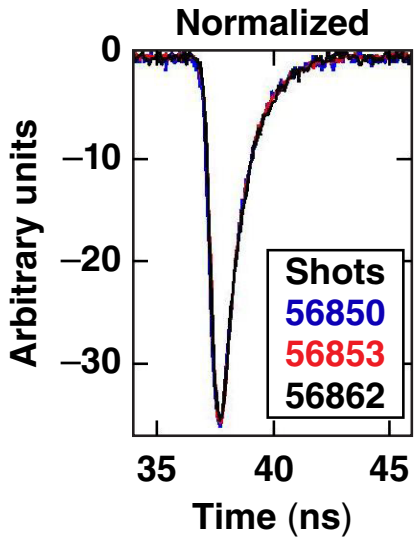
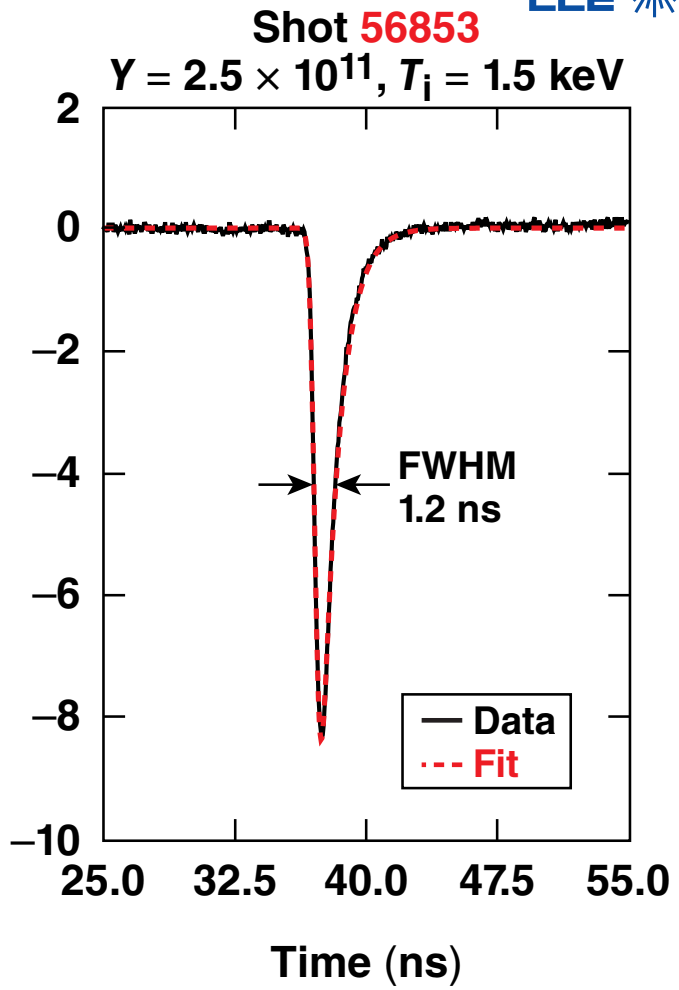
The neutron IRF of a 5.0 m CVD detector was directly measured in low T_i, low-yield DT shots at 40 cm from TCC*







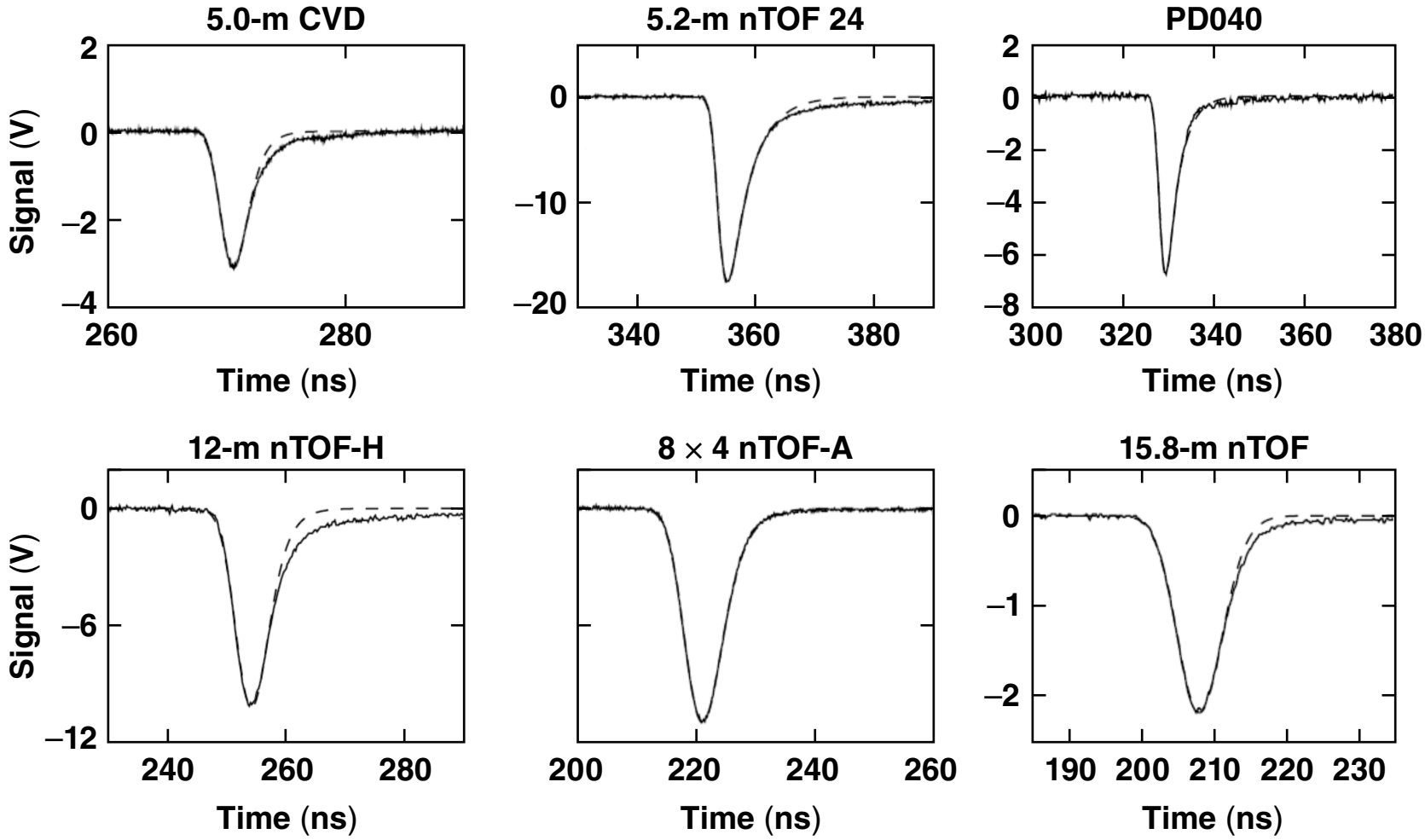


Other nTOF detectors' instrument response functions (IRF's) were adjusted to match the 5.0-m CVD.

E21711a

*Target chamber center

Example of scope traces from six detectors for ambient DT shot 72883 with a yield of 3.0×10^{13} and $\langle T_i \rangle = 12.0$ keV



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Six nTOF detectors measure ion temperature in DT implosions with yields larger than 10^{12}

N	Name	Distance from TCC	θ, ϕ	Detector
1	5.0 m CVD	5.0 m	79.30, 314.27	10 × 1 mm CVD
2	5.2 m nTOF	5.2 m	109.57, 90.00	40 × 20 mm BC422 PMT140
3	PD040	5.4 m	79.30, 314.27	40 × 10 mm BC422Q PD040
4	12 m nTOF-H	12.4 m	87.86, 161.24	40 × 20 mm BC422 PMT140
5	8 × 4 nTOF-A	13.4 m	116.57, 162.0	203 × 102 mm Xylene PMT140
6	15.8 m nTOF	15.8 m	61.32, 47.64	40 × 10 mm BC422Q PMT140