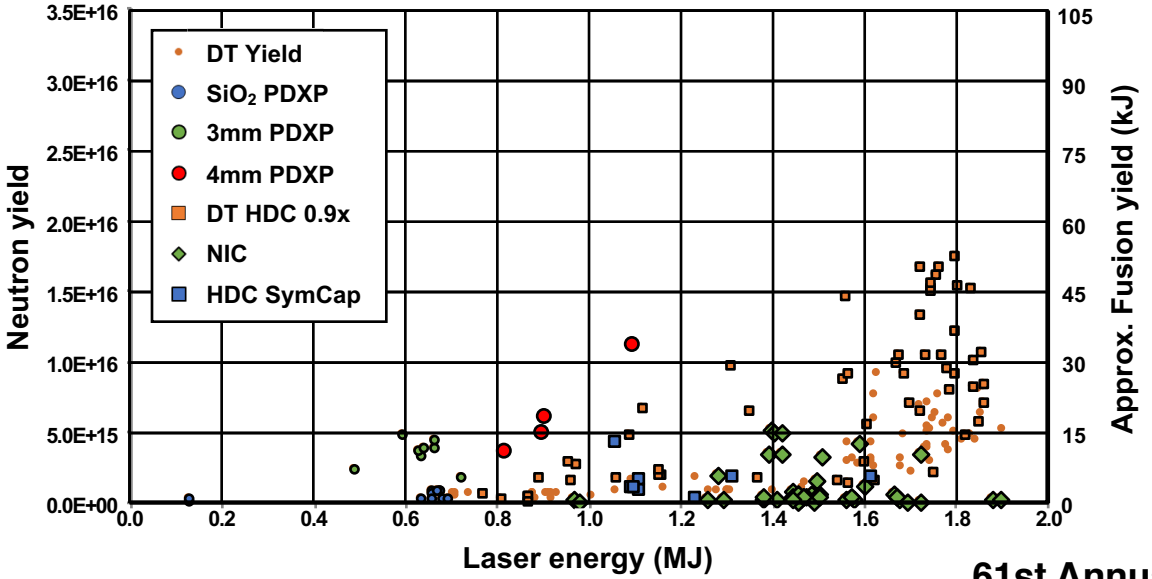
# Evaluation of Ablator-Shell Contouring to Enhance the Performance of NIF Polar-Drive High Yield Source Experiments





P. W. McKenty
University of Rochester
Laboratory for Laser Energetics



61st Annual Meeting of the
American Physical Society
Division of Plasma Physics
Fort Lauderdale FL
21-25 October, 2019

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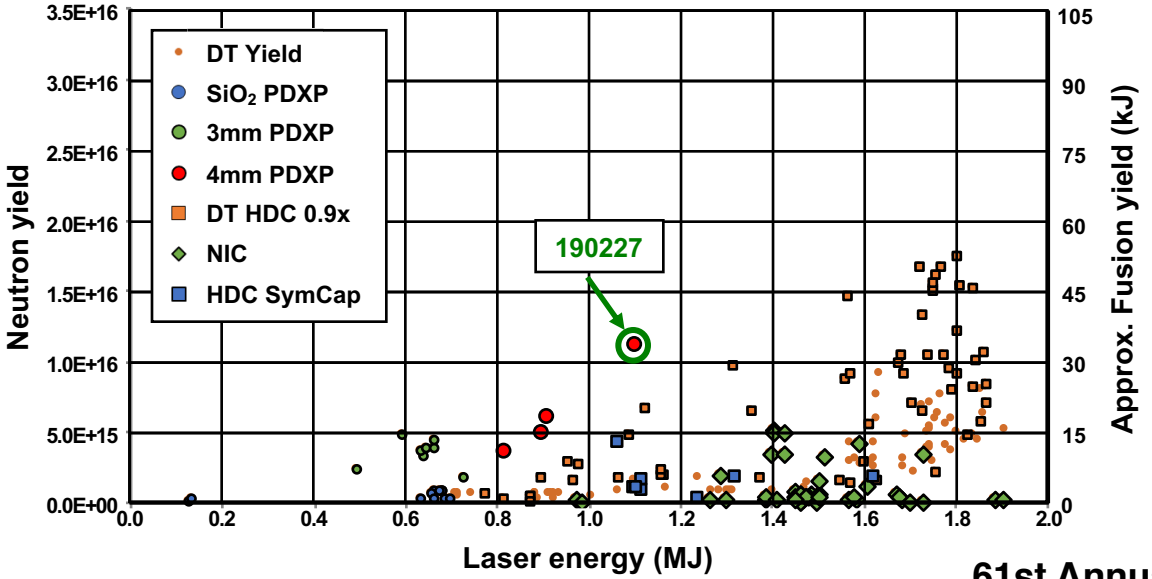



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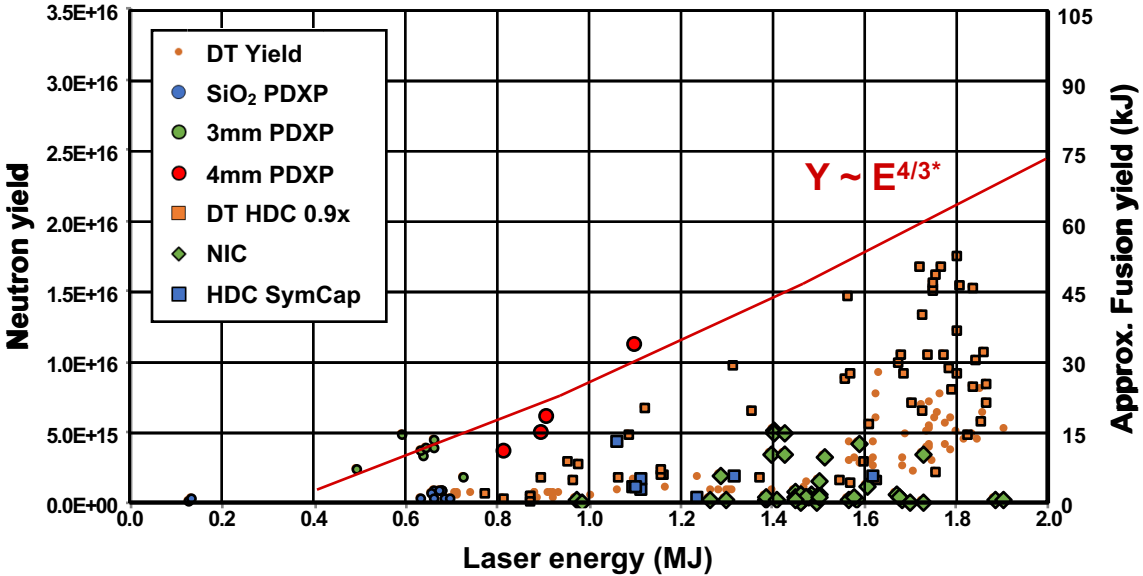


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* A. Cok, R. S. Craxton, and P. McKenty, Phys. Plasmas 15, 082705 (2008).
J. Alverez et al., Physics Procedia 00 (2013) 1-10

Summary

# Contoured shells help mitigate inflight shell nonuniformities inherent with the use of Polar-drive illumination

UR LLE

- Current goal of the Neutron Source Working Group (NSWG) is to produce routine neutron yields in excess of 100 kJ
- Polar-drive experiments on OMEGA clearly indicate the benefit of contoured shells in improving target performance
- New contour profiles have been developed using inflight density perturbations taken from 2D Draco simulations
- Contoured-shell simulations indicate more than a factor of 2 increase in performance compared to same simulations without contour.

# Collaborators

**F.J. Marshall, D. R. Harding, R. S. Craxton, M. Rosenberg, J. A. Marozas, T. J. B. Collins, R. Bahukutumbi, and E. M. Campbell**

**University of Rochester**

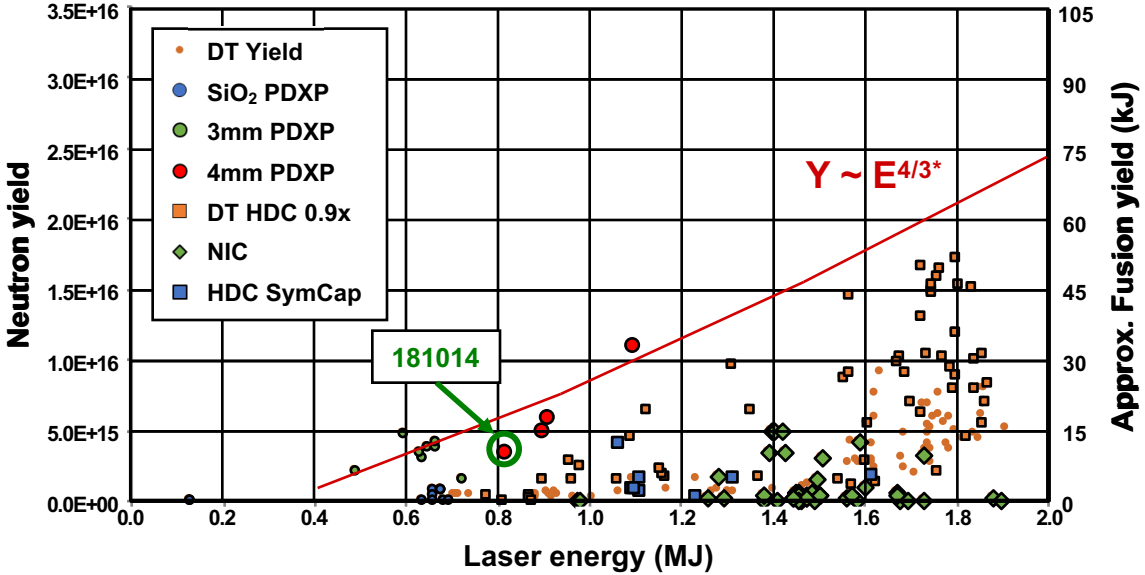
**B. Blue, C. Yeamans, and W. Hsing**

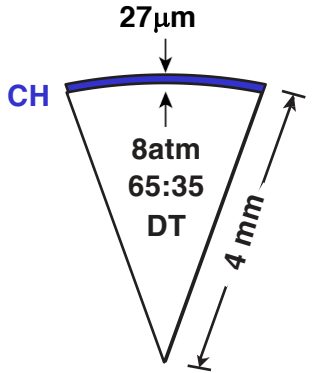
**Lawrence Livermore National Laboratory**

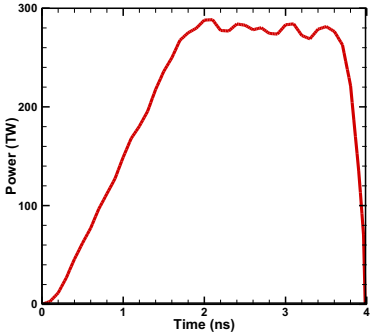
**M. Farrell**

**General Atomics**

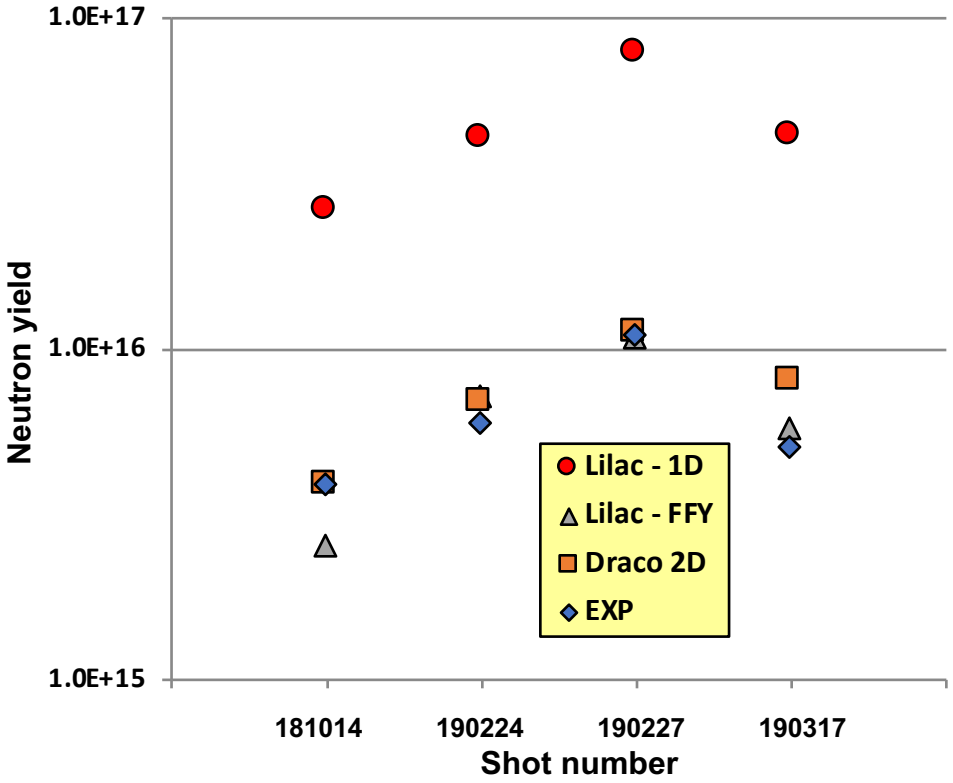
# Initial NIF shell-contour studies will concentrate on 4mm-shells with sub-MJ energies to limit laser damage exceptions

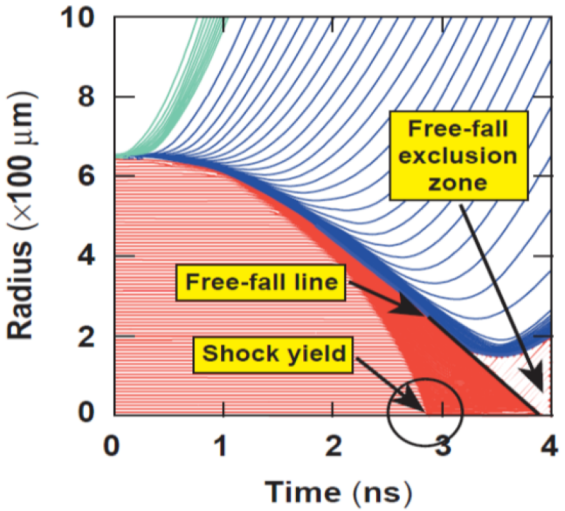


# Lilac free-fall and Draco CBET simulations do an excellent job in predicting the performance of NIF 4mm DDXPs

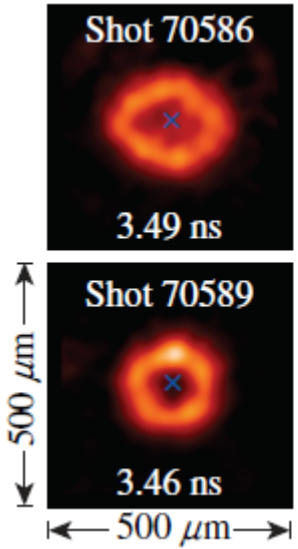


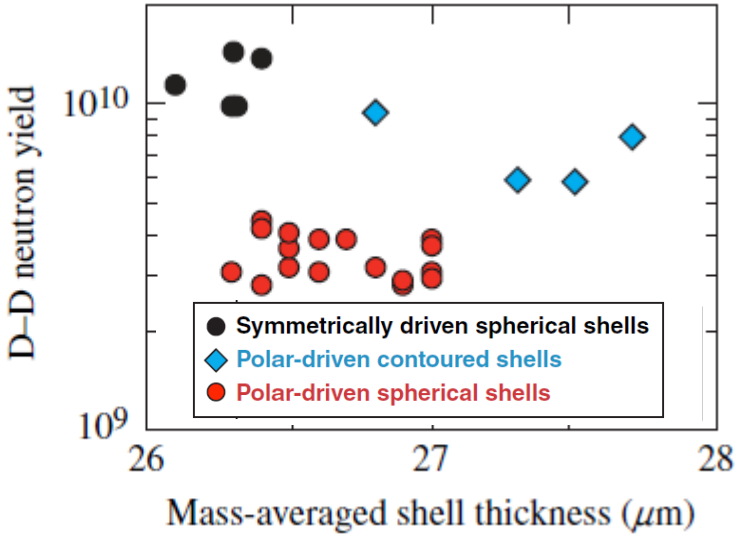



# The use of contoured shells to affect core shape and improve PDD neutron yield was clearly demonstrated in Omega implosions*

Spherical-target radiograph

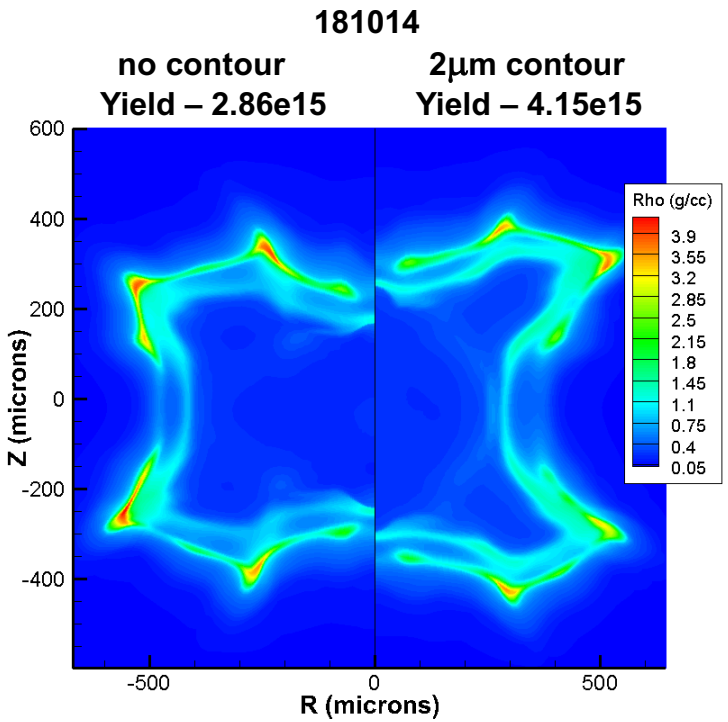
Contoured-target radiograph

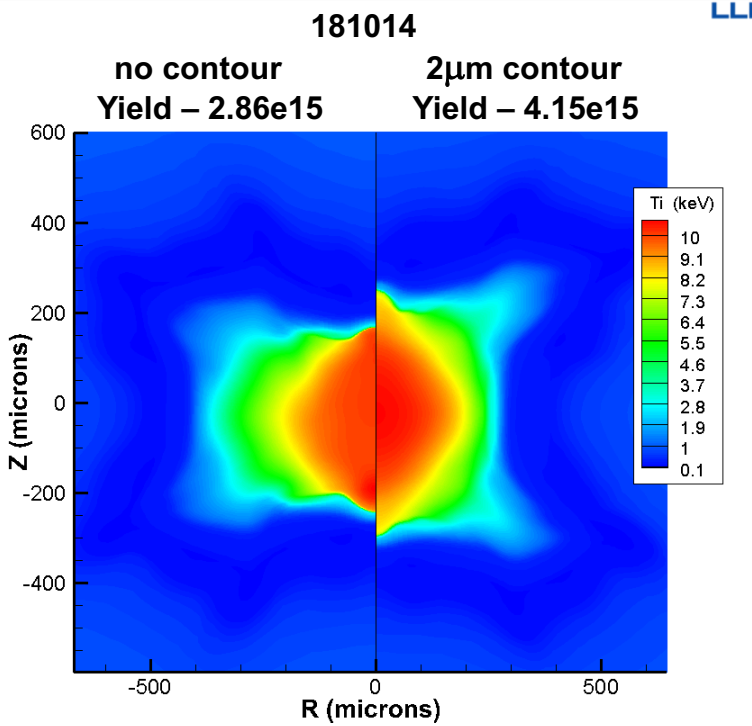



* F. J. Marshall et al., Phys. Plasmas 23, 012771 (2016).

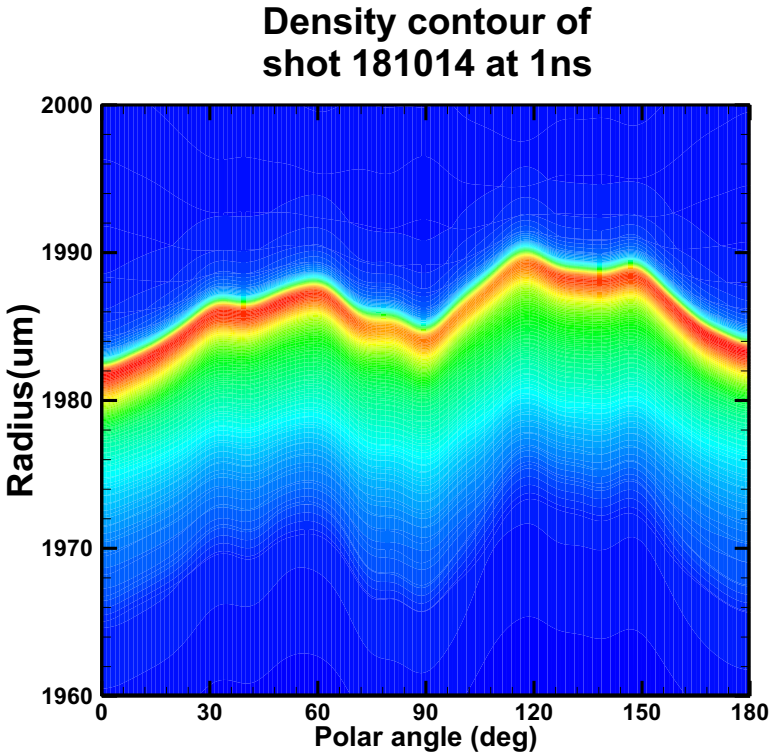
# Simulation of NIF shot 181014, implementing a ~2μm (p:v) contour taken from OMEGA experiments*, indicates ~50% increase in yield

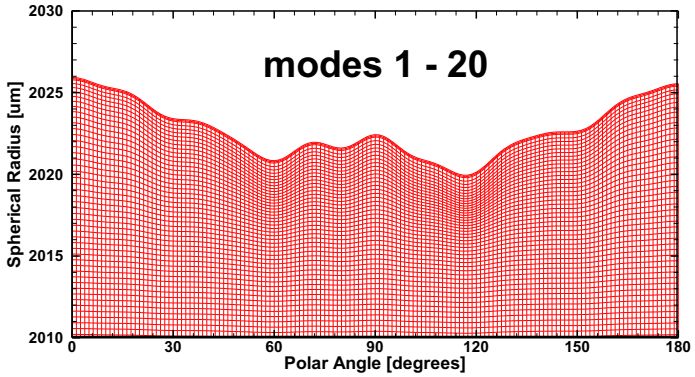


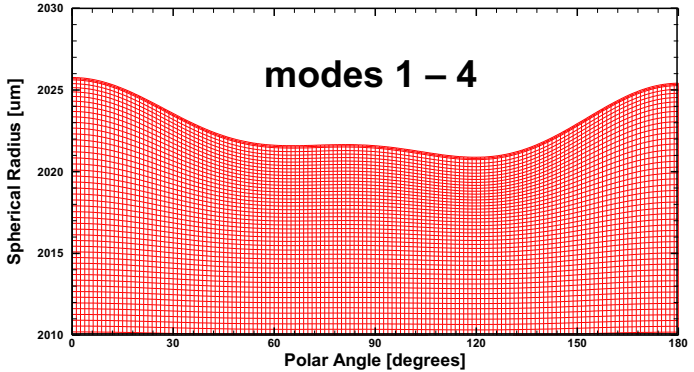




* F. J. Marshall et al., Phys. Plasmas 23, 012771 (2016).

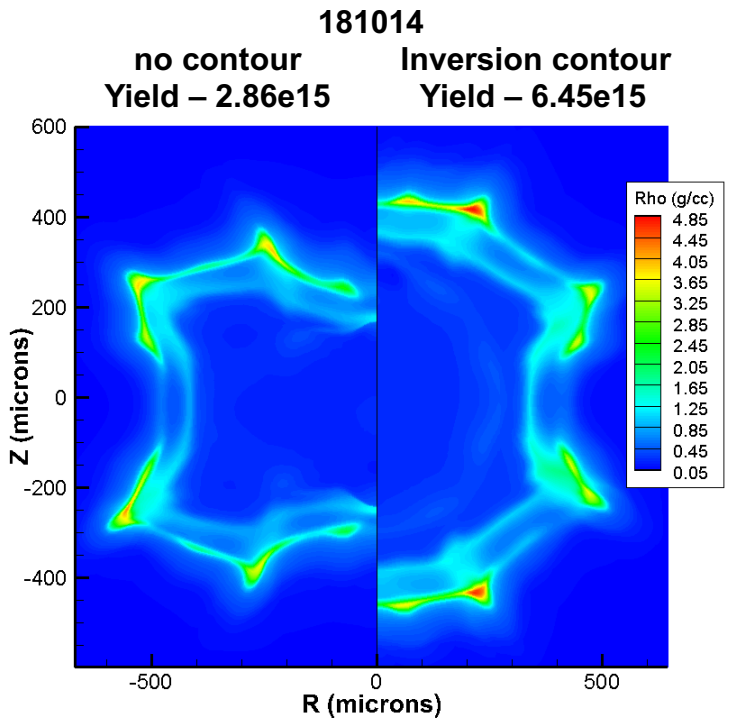
# A new contour has been designed using the inverse modal constituents of shell perturbations taken at 1ns into the implosion

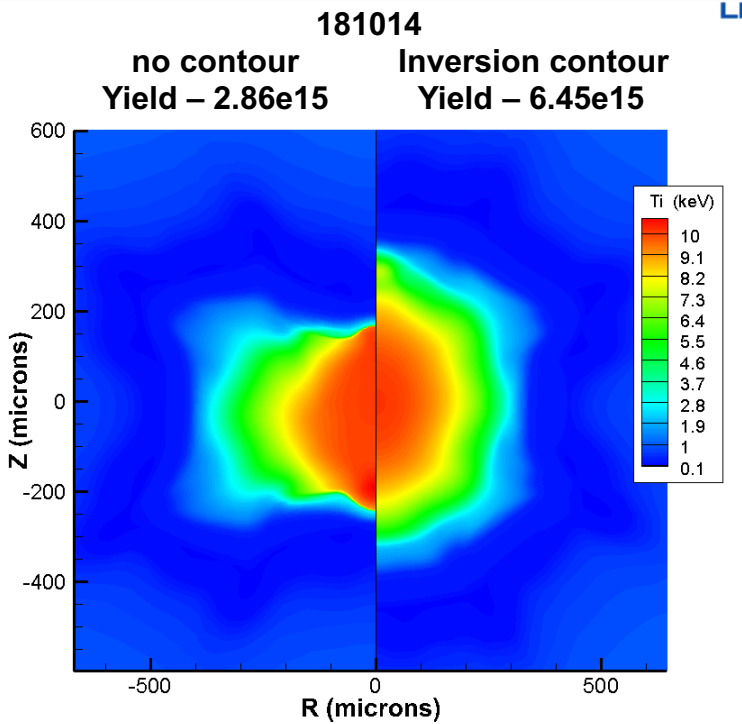


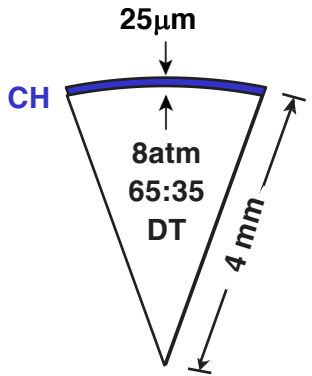
# Using an inversion contour as the initial outer surface for shot 181014 results in a factor of 2.25 increase in primary DT yield

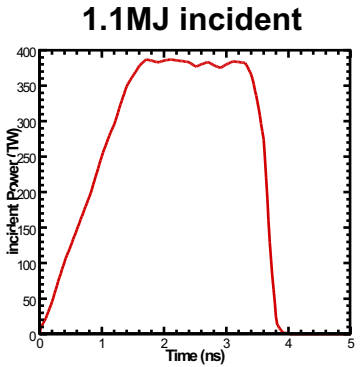


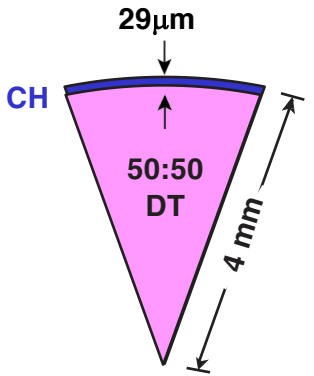



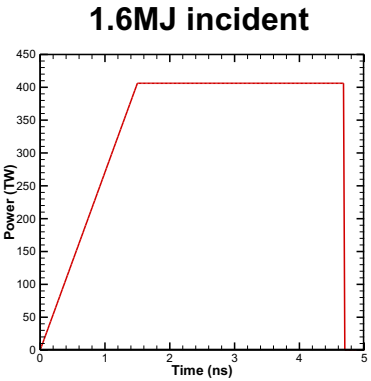

**These contoured shells will be tested on NIF in Q3FY20**

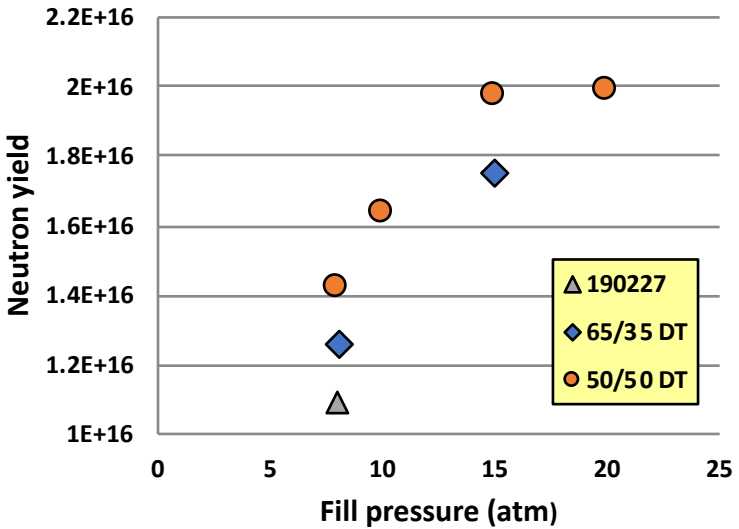
# Moving forward we have optimized 190227 using higher fuel pressures to produce a free fall yield of 2.0e16 at 1.6 MJ



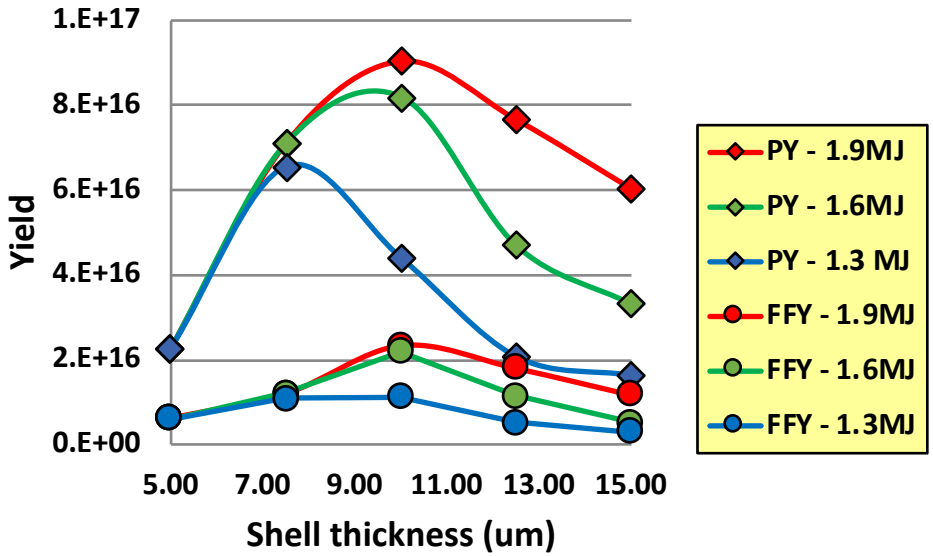



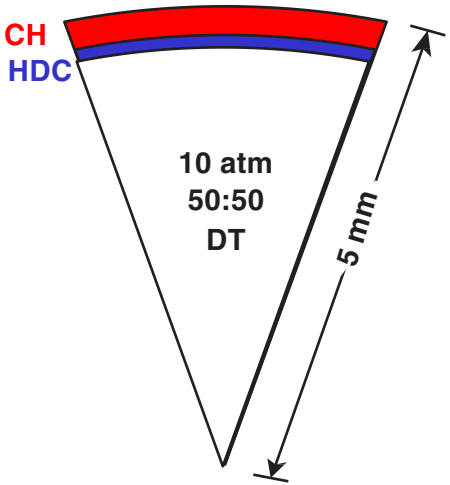



# An HDC ablator, with its higher burst pressure, also provides a viable path to higher yields on the NIF

**5-mm OD HDC, 10atm (50/50) fill, 1500 ps rise, 410 TW pulse**




**A CH overcoat will enable fielding a contoured HDC capsule**

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# Related talks

YO6.00007 K. Humbird, ***Machine learning design and prediction of polar direct drive experiments at the National Ignition Facility***.

YO6.00014 G. E. Kemp, ***Development of high-efficiency, non-cryogenic, direct-drive neutron sources on the National Ignition Facility laser***.

YO5.00009 P. B. Radha, ***Robust Direct-Drive Implosions on OMEGA Scaled from Polar-Direct-Drive National Ignition Facility Implosions.***

YO5.00010 J. A. Marozas, ***NIF Polar-Drive High DT-Yield Exploder-Pusher Designs Modeled Using Pump-Depletion in DRACO***