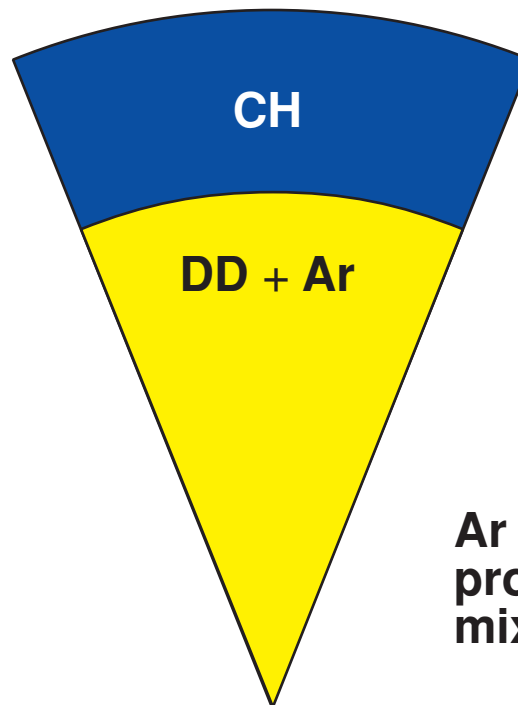
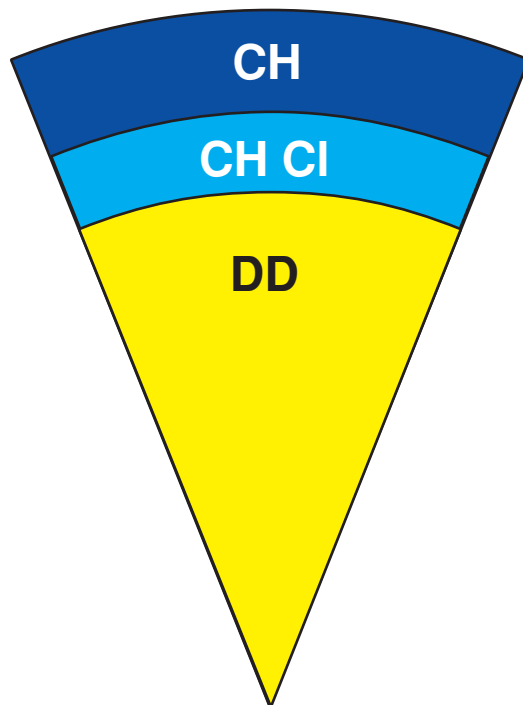


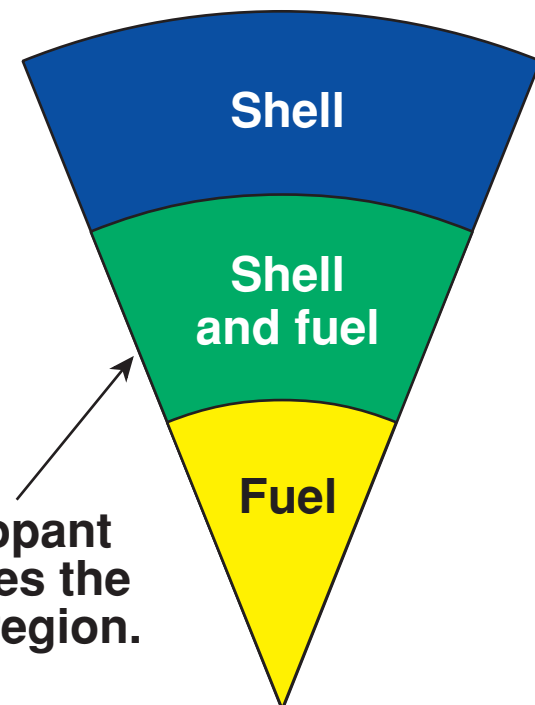
# Diagnosing Shell Mix in Direct-Drive ICF with Time-Resolved X-Ray Spectroscopy



Initial Targets



Compressed Core



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Division of Plasma Physics  
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# Collaborators

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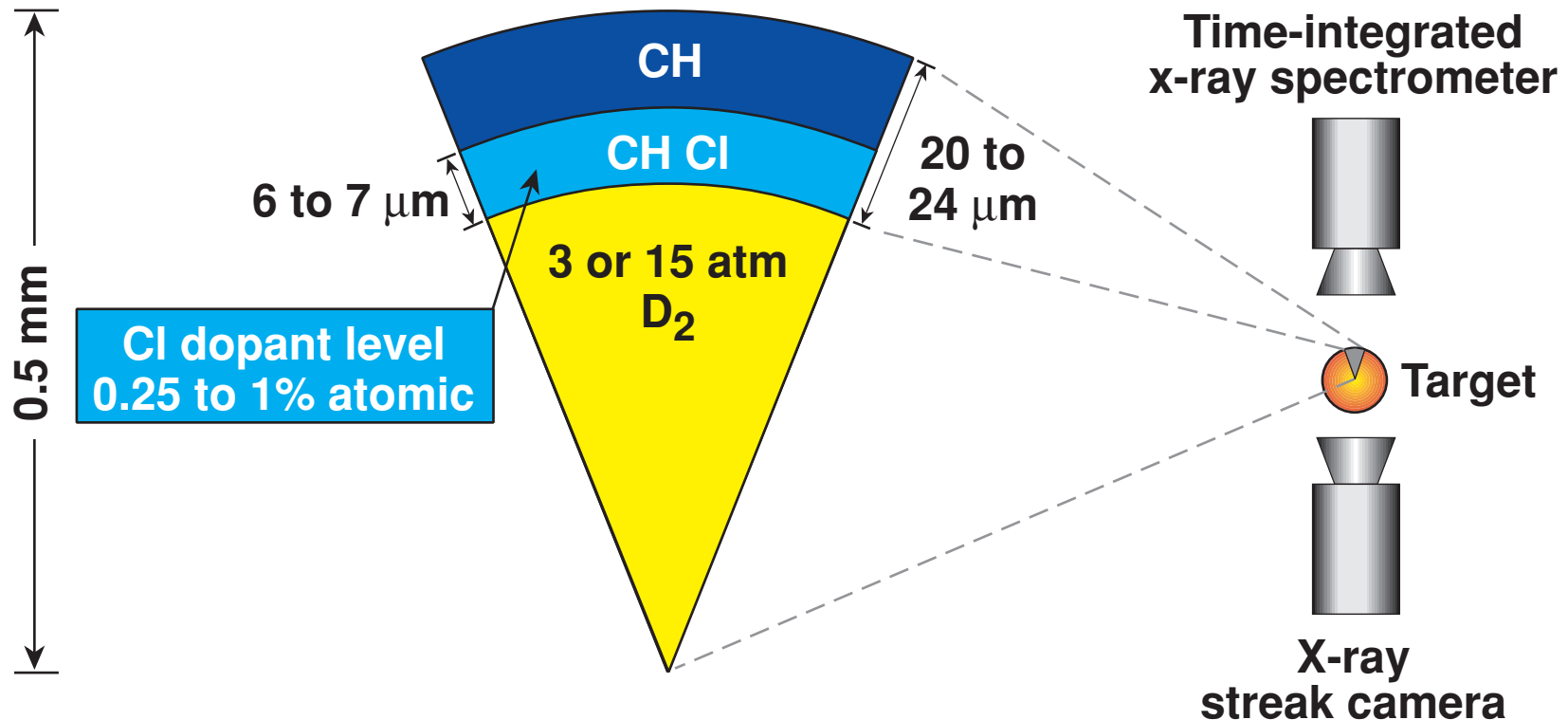
## Summary

# The shell electron densities inferred from time-resolved x-ray spectroscopy are close to 1-D hydrocode predictions



- Spherical  $D_2$ -filled plastic shells with a Cl-doped inner surface were imploded on the 60-beam OMEGA laser system, and the spectral line shapes were analyzed to infer emissivity-averaged  $n_e$  and  $T_e$ .
- The Cl dopant probes a region with similar  $n_e$ , but slightly lower  $T_e$  than the Ar dopant in the mix region.
- Emissivity-averaged  $n_e$  and  $T_e$  measurements could be localized to the mix region by using thinner Cl-doped inner layers with a higher Cl concentration.

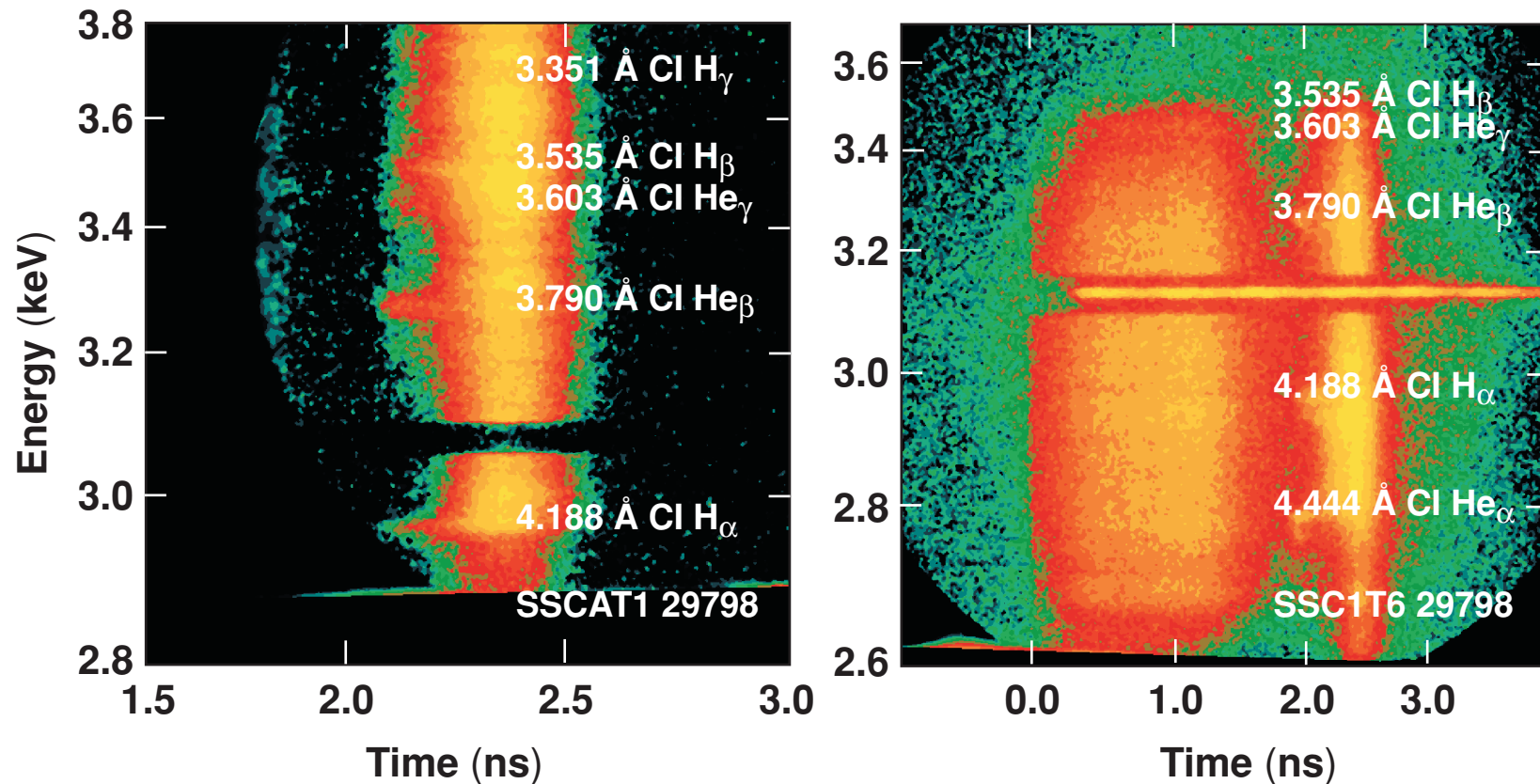
# Spherical plastic-shell targets were imploded with a 23-kJ, 1-ns square laser pulse



- Predicted convergence ratios ranged from 13 to 40.
- Laser irradiation with 1-THz SSD, PS, and on-target beam-to-beam power imbalance < 5% rms.

# Streaked x-ray spectroscopy is used to measure time-dependent Cl *K*-shell spectral line shapes

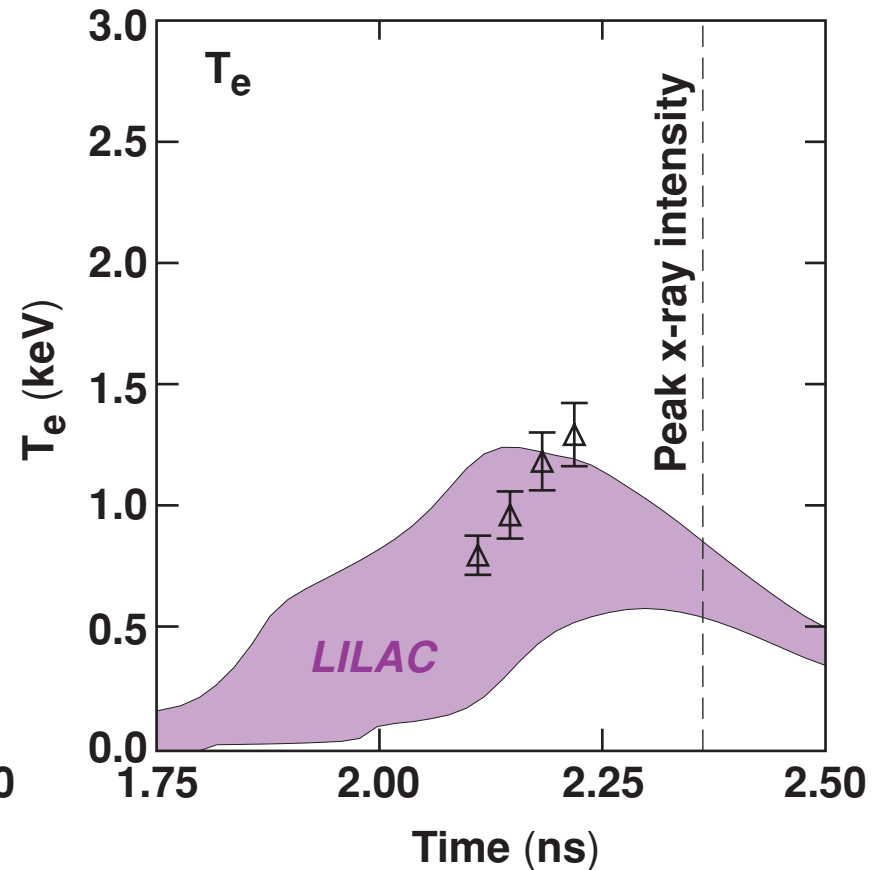
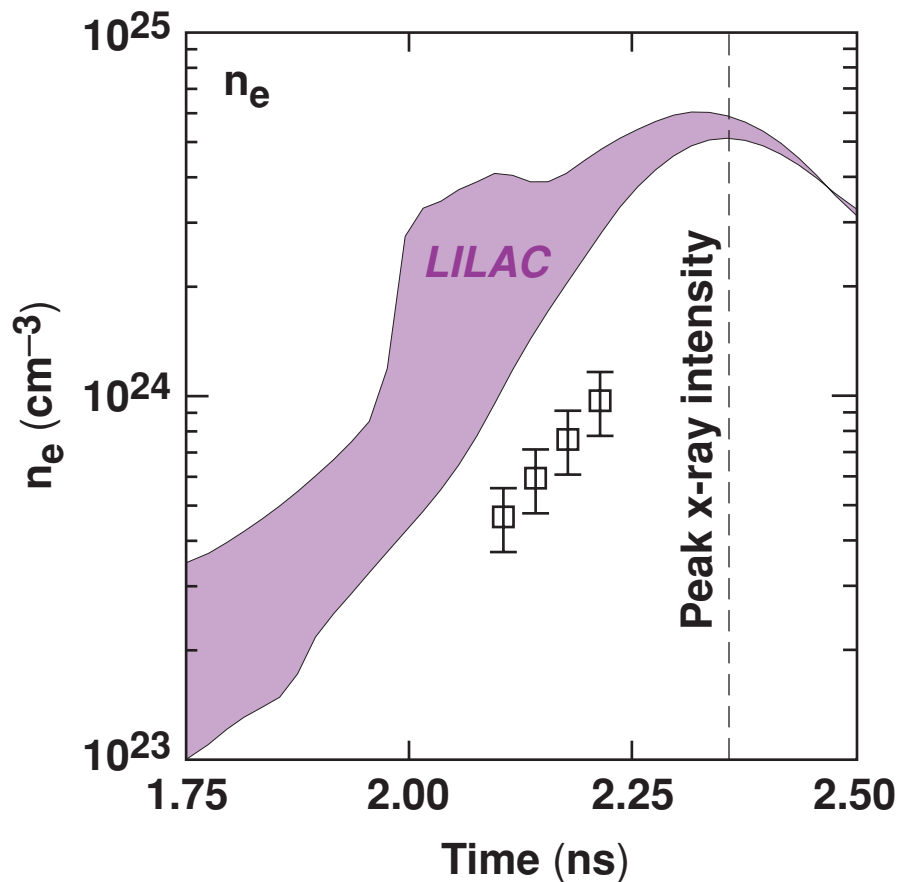
Shot #29798: D<sub>2</sub> (15 atm), CH Cl [5.9 μm, 1%], CH [18 μm]



- Spectral line shapes of Cl He<sub>β</sub>, Cl He<sub>γ</sub>, and Cl Ly<sub>β</sub> are analyzed to infer the time history of emissivity-averaged  $n_e$  and  $T_e$ .

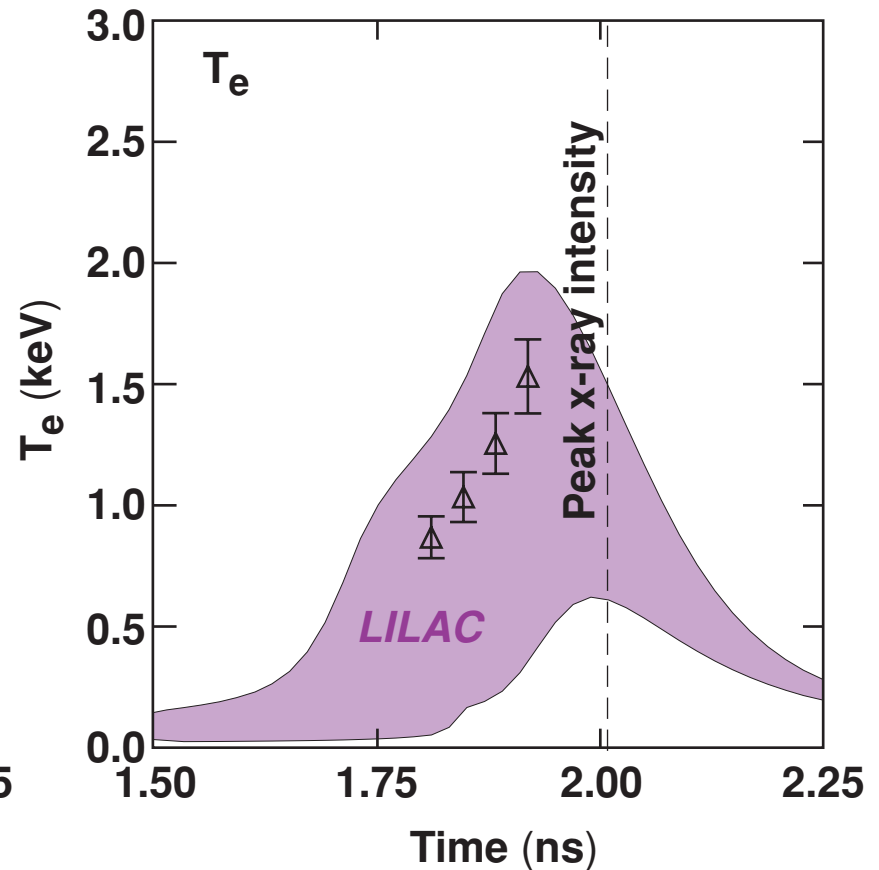
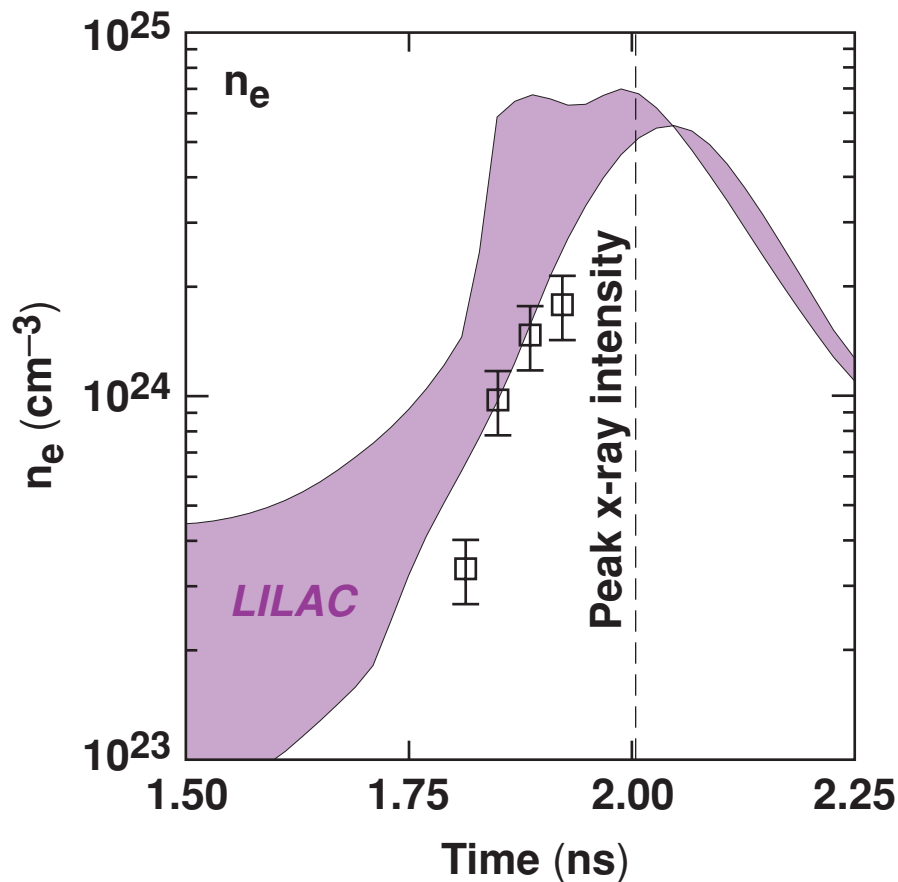
# The shell electron densities are lower than 1-D hydrocode predictions for the 24- $\mu\text{m}$ -shell target

Shot #29798: D<sub>2</sub> (15 atm), CH Cl [5.9  $\mu\text{m}$ , 1%], CH [18  $\mu\text{m}$ ]



# $n_e$ close to 1-D hydrocode predictions is observed for a 20- $\mu\text{m}$ -shell target

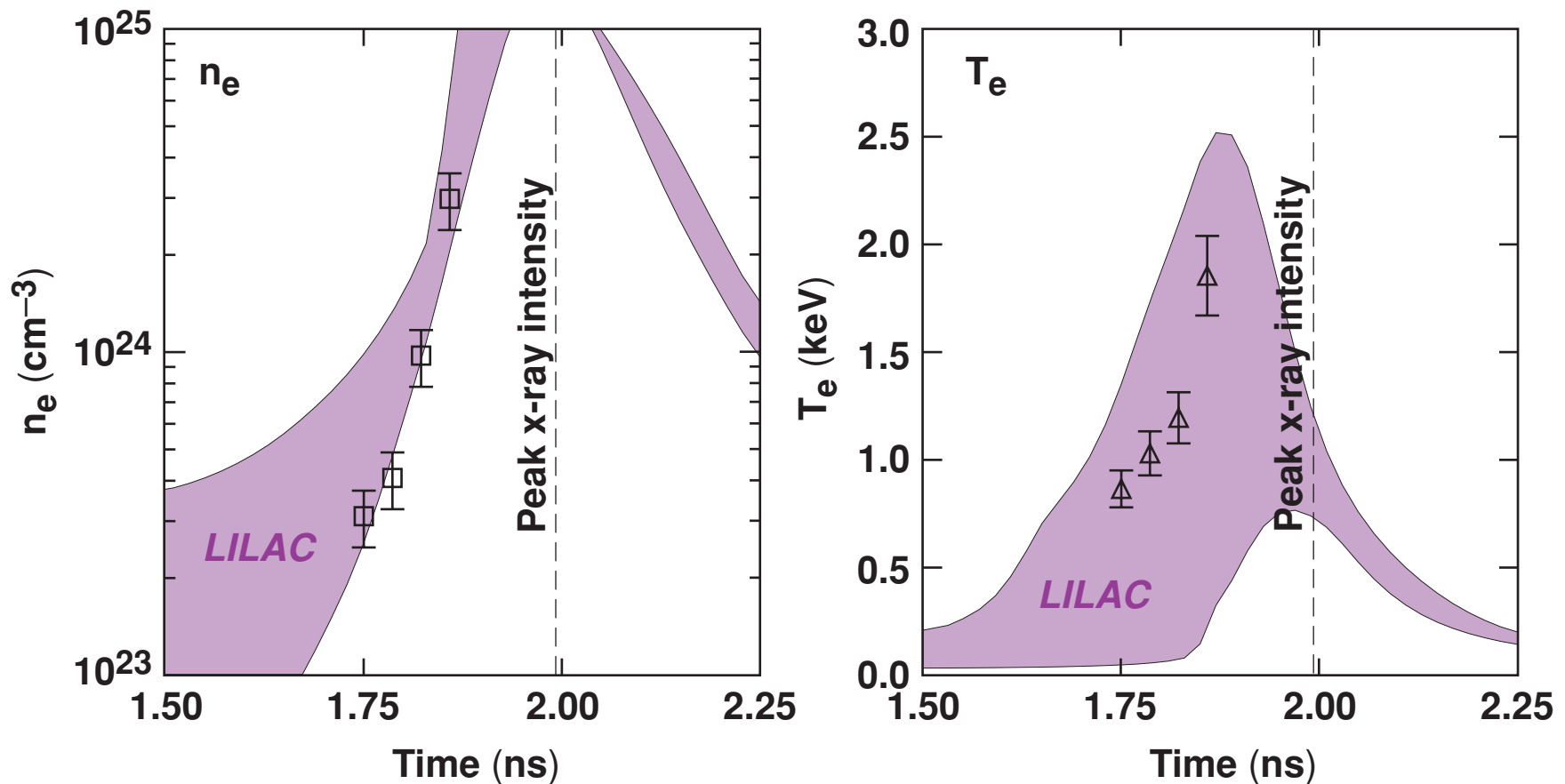
Shot #29794:  $\text{D}_2$  (15 atm), CH Cl [7  $\mu\text{m}$ , 0.25%], CH [12.4  $\mu\text{m}$ ]



# $n_e$ close to 1-D hydrocode predictions is observed for implosions with higher predicted convergence ratio

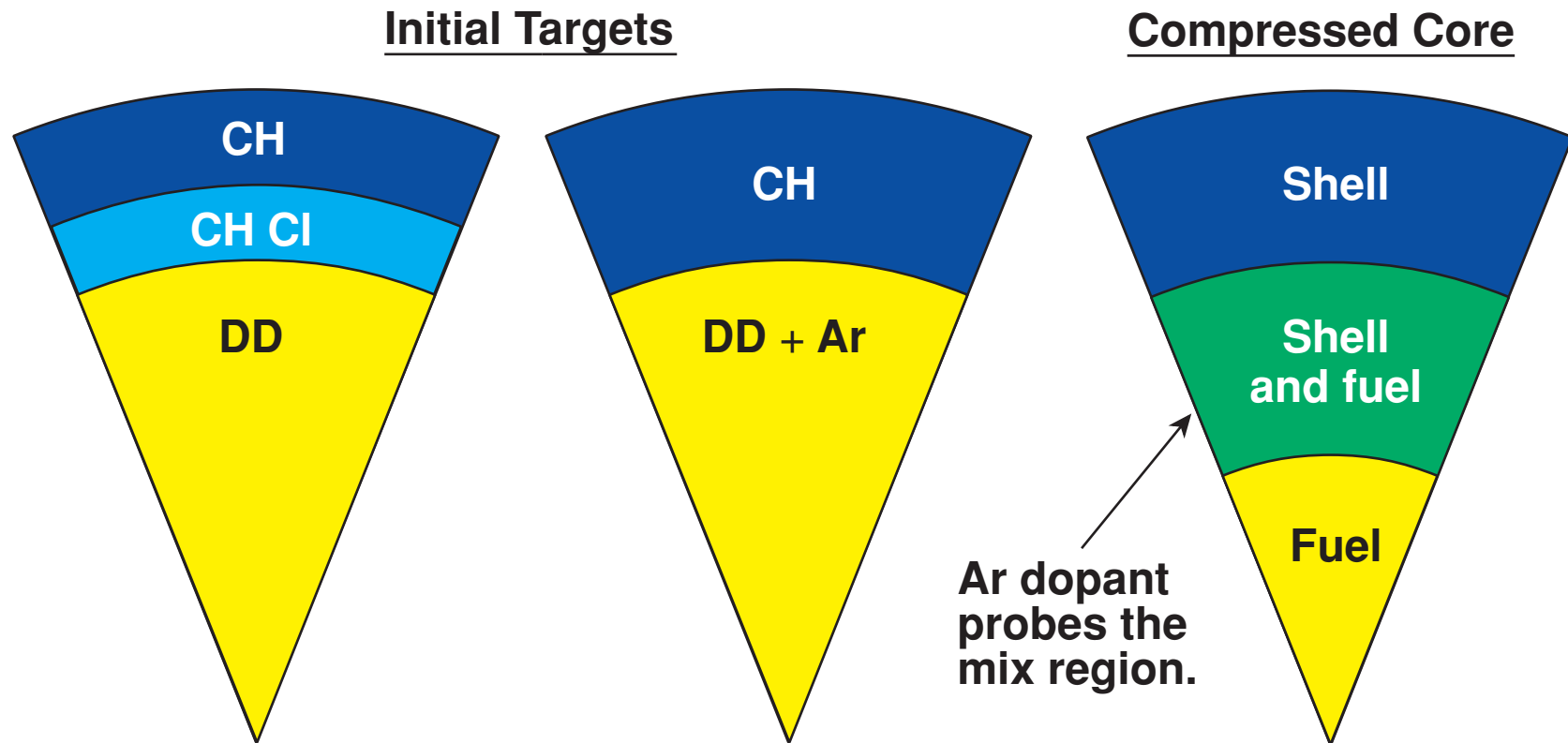


Shot #29792: D<sub>2</sub> (3 atm), CH Cl [7 μm, 0.25%], CH [12.4 μm]



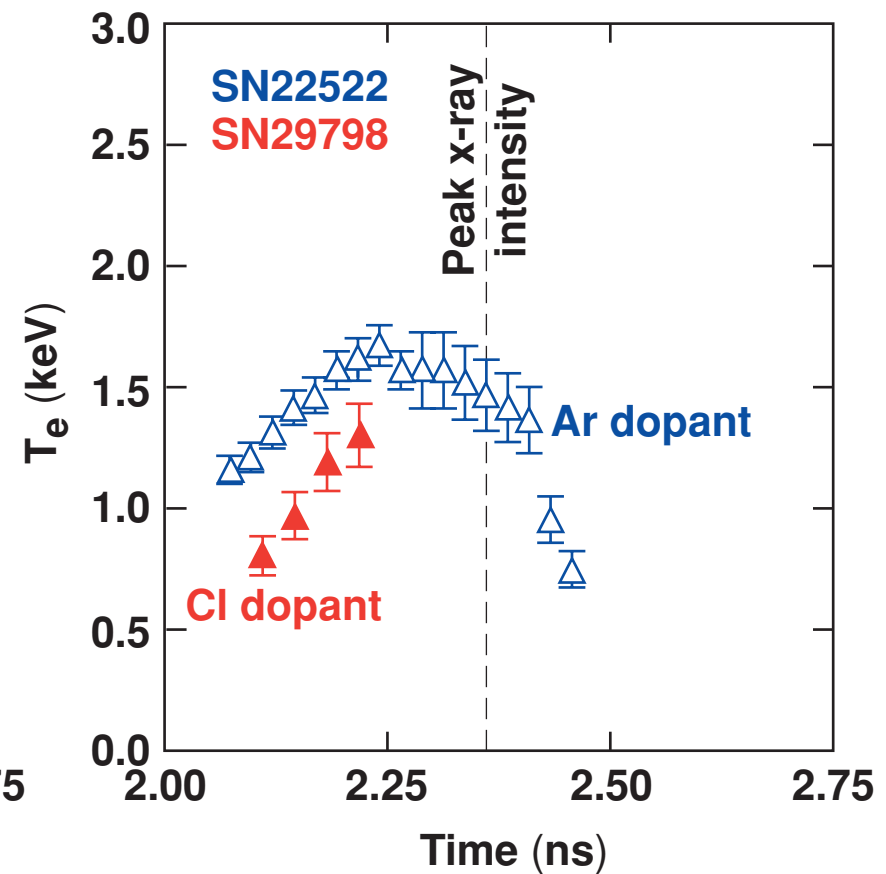
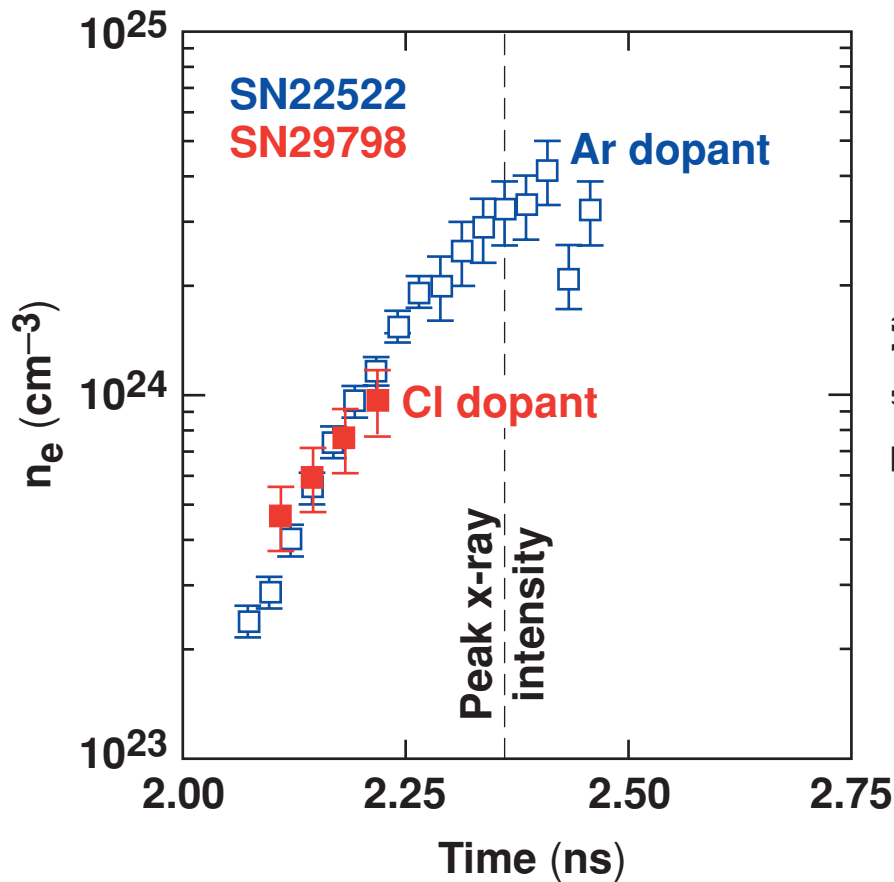


# Emissivity-averaged $n_e$ and $T_e$ inferred from Cl dopant are compared with those inferred from Ar dopant<sup>1</sup>



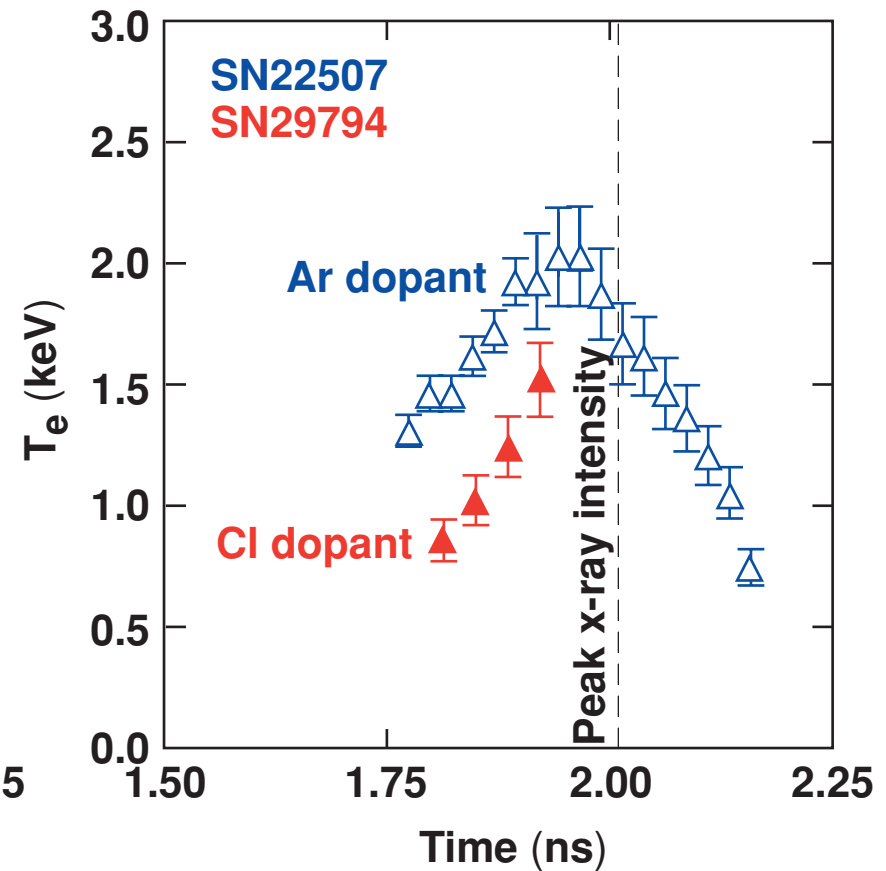
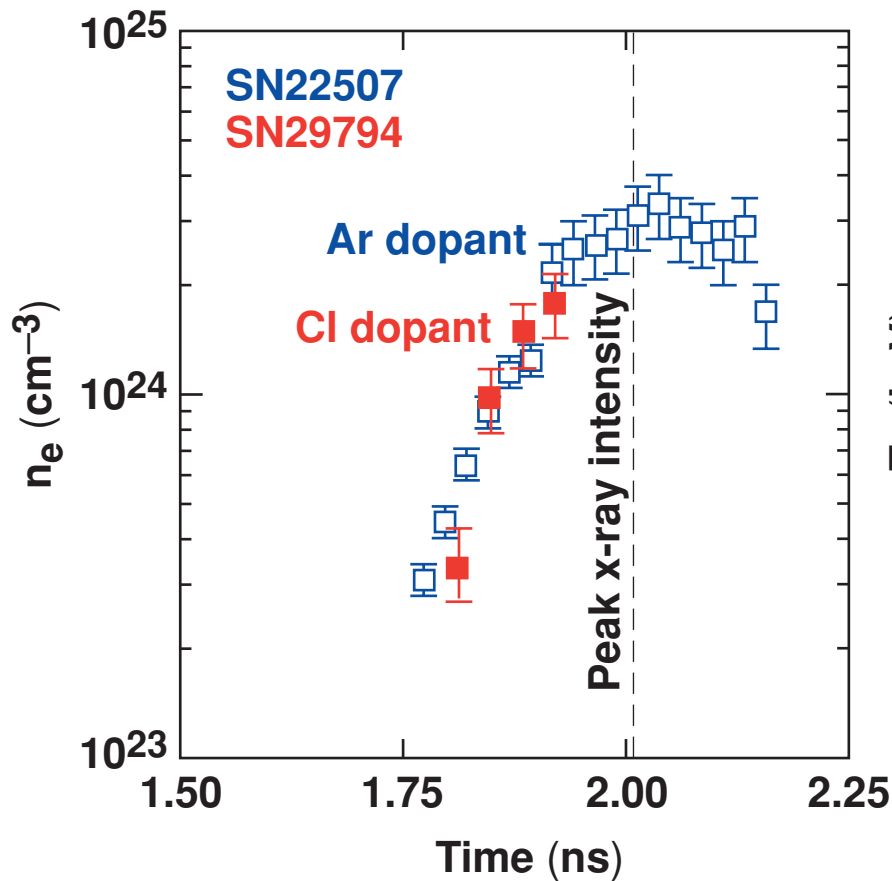
Compared with the Ar dopant, the Cl dopant probes a region of similar  $n_e$  but slightly lower  $T_e$

D<sub>2</sub> (15 atm), CH Cl [5.9 μm, 1%], CH [18 μm]



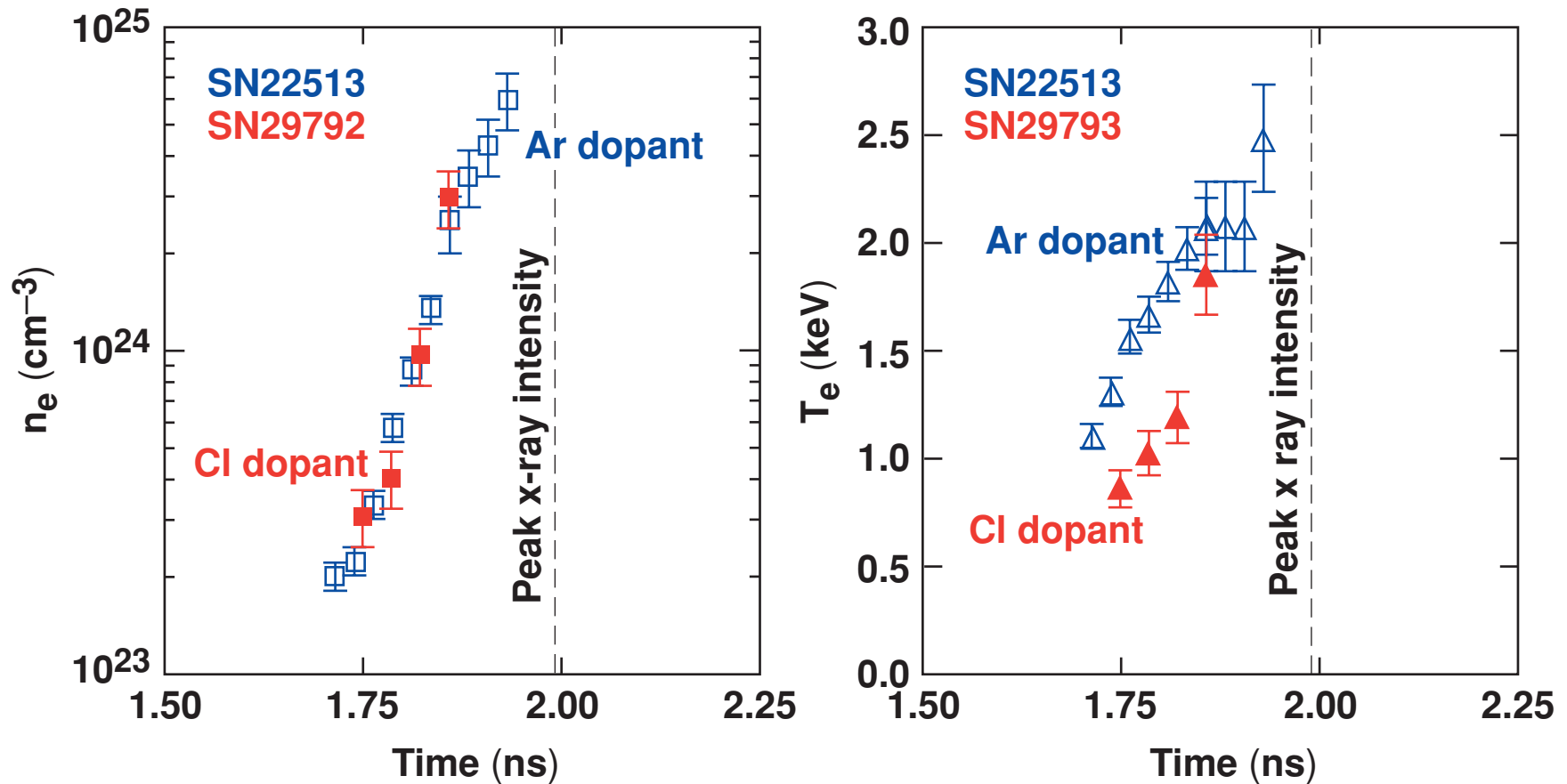
# The Cl dopant probes a region of similar $n_e$ but slightly lower $T_e$ for the 20- $\mu\text{m}$ -shell target

$\text{D}_2$  (15 atm), CH Cl [7  $\mu\text{m}$ , 0.25%], CH [12.4  $\mu\text{m}$ ]



The Cl dopant probes a region of similar  $n_e$  but slightly lower  $T_e$  for the implosion with the higher predicted convergence ratio

$D_2$  (3 atm), CH Cl [7  $\mu\text{m}$ , 0.25%], CH [12.4  $\mu\text{m}$ ]



## Summary/Conclusions

# The shell electron densities inferred from time-resolved x-ray spectroscopy are close to 1-D hydrocode predictions



- Spherical D<sub>2</sub>-filled plastic shells with a Cl-doped inner surface were imploded on the 60-beam OMEGA laser system, and the spectral line shapes were analyzed to infer emissivity-averaged  $n_e$  and  $T_e$ .
- The Cl dopant probes a region with similar  $n_e$ , but slightly lower  $T_e$  than the Ar dopant in the mix region.
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