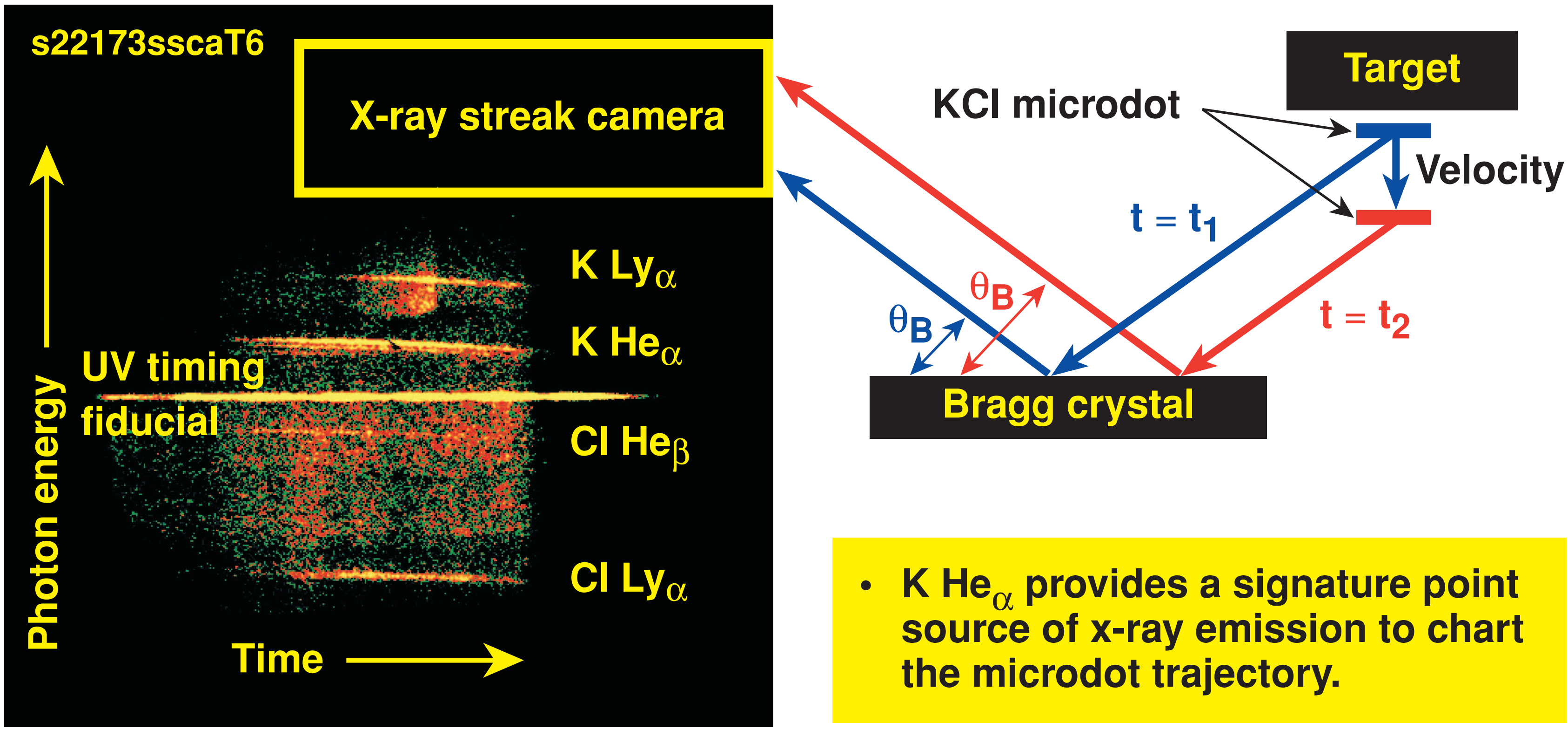
Experimental Investigation of Expansion Velocity and Gradients in Long-Scale-Length Plasmas on OMEGA



- K He$_\alpha$ provides a signature point source of x-ray emission to chart the microdot trajectory.

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Collaborators

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Summary

Bragg reflection geometry is exploited to record the trajectory of a microdot tracer layer ablated into the blowoff plasma

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- Long-scale-length plasmas relevant to direct-drive ICF target designs for the NIF are generated on the 60-beam OMEGA laser system to study the laser–plasma instabilities associated with multiple interaction beams.
- Time-resolved x-ray spectroscopy of microdot tracer layers is used to characterize the plasma conditions created with massive, solid-density plastic targets.
- The measured trajectories of ablated microdots are compared with the predictions of the 2-D hydrodynamics code *SAGE*.
- The electron temperature and density profiles are diagnosed with the measured line ratios of the *K*-shell emissions from the microdot.
- The predicted line ratios are calculated with *SAGE* and the time-dependent *FLY* atomic physics code and compared with the experimental results.

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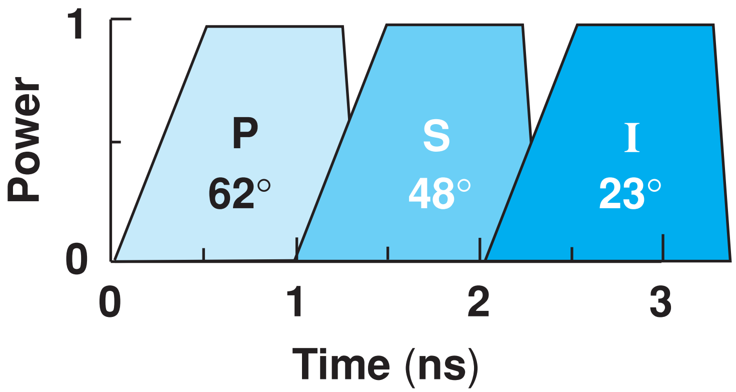
Outline

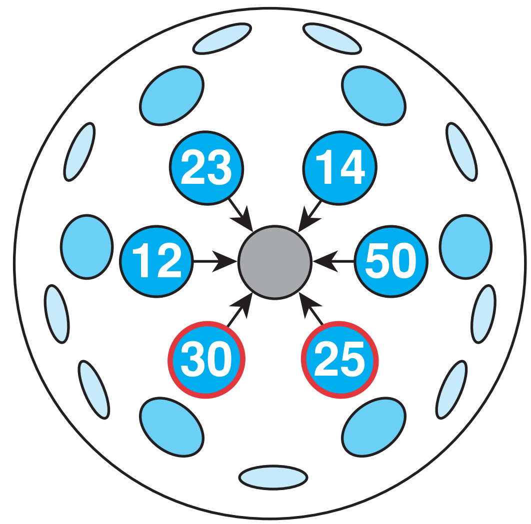
Experimental investigation of expansion velocity and gradients in long-scale-length plasmas on OMEGA

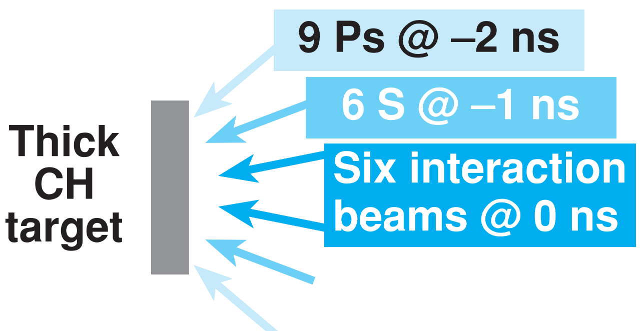
- Long-scale-length plasmas on OMEGA
- Time-resolved *K*-shell spectroscopy
- Measured microdot trajectory
- 2-D hydrodynamics code predictions
- Microdot time history of electron temperature and density
- Line ratios
- Conclusions

Multiple-beam SBS interaction experiments used three sets of delayed beams, six of them interaction beams



BL	25	30	12	23	14	50	
I_{14}	4	16	4	8	16	8	(W/cm^2)

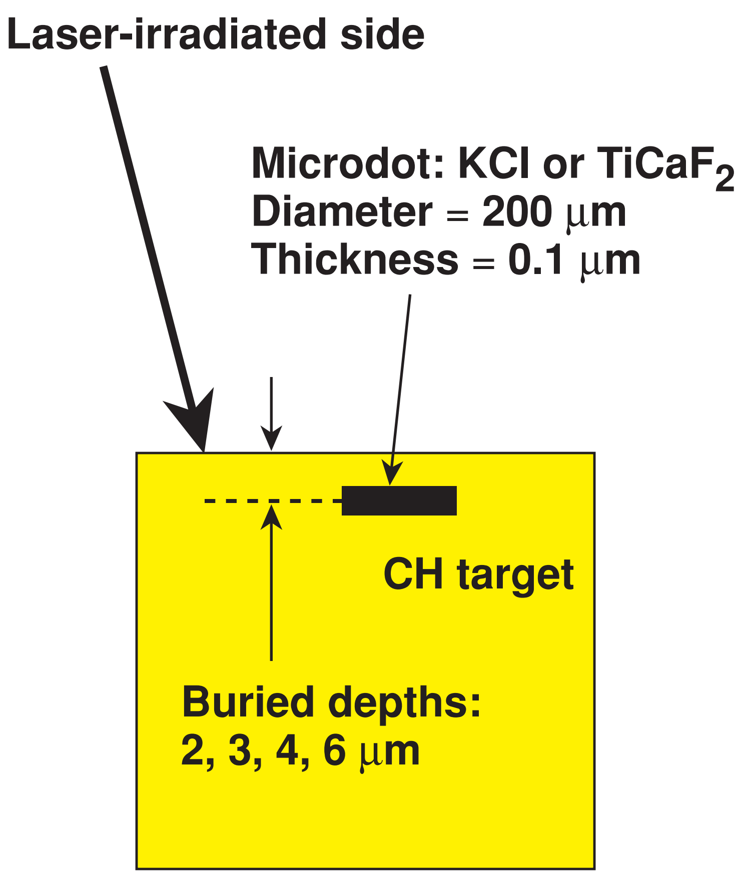


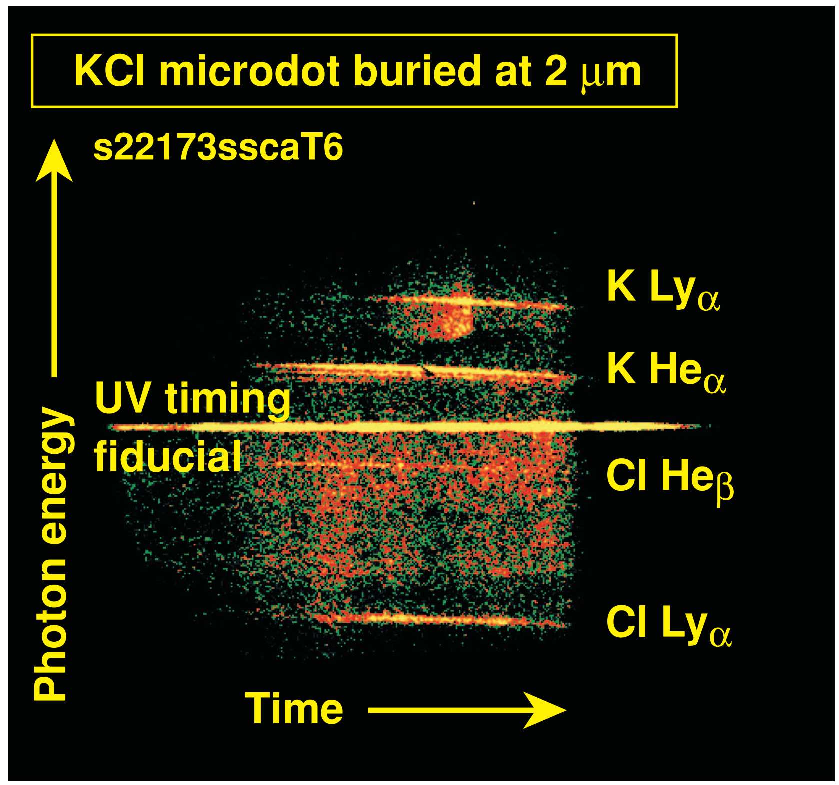


Intensities are varied with phase plates; energies are kept constant.

- Plasma density scale lengths and T_e roughly correspond to NIF direct-drive conditions.
- Full-beam smoothing (1-THz 2-D SSD and polarization smoothing)
- SBS and SRS with and without time resolution in two beams

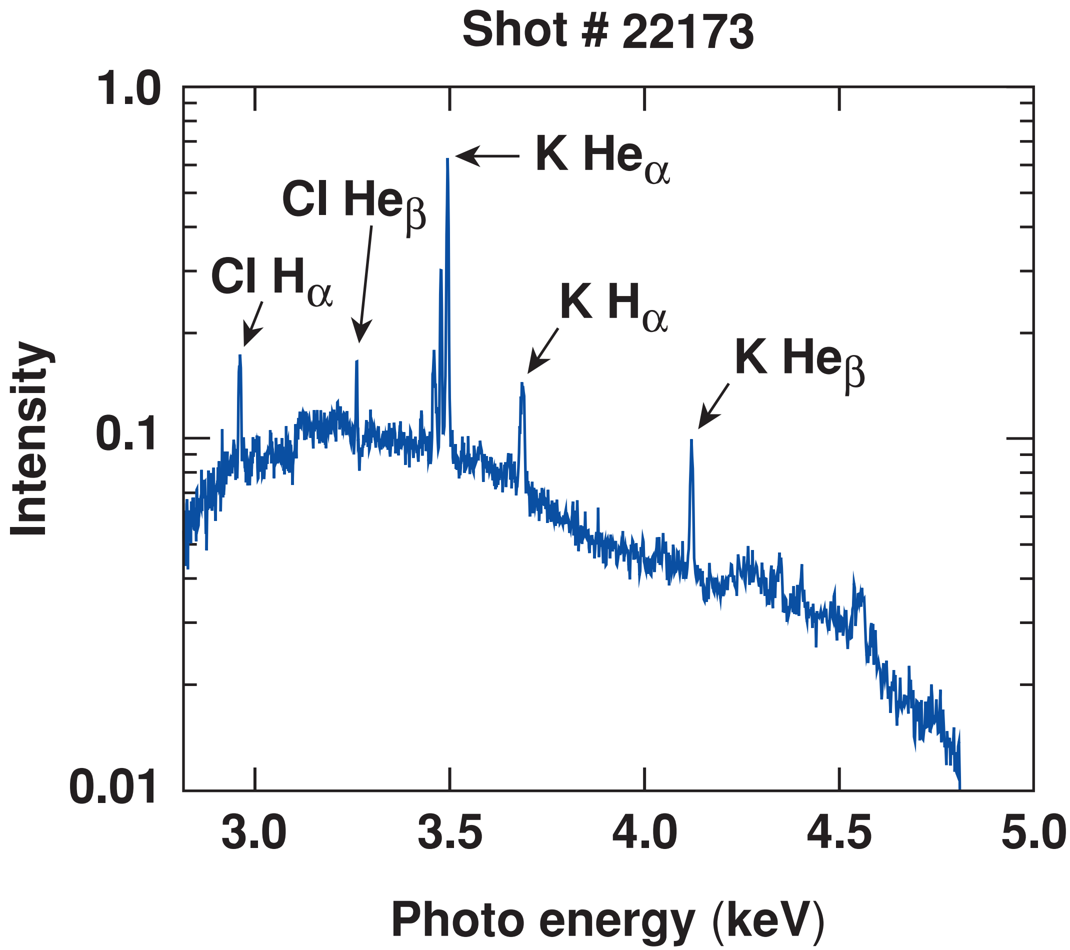
Plasma conditions are diagnosed with time-resolved *K*-shell spectroscopy of microdot tracer layer





Time-integrated x-ray spectrum is recorded to photometrically calibrate streaked spectrum

KCl microdot buried at 2 μm



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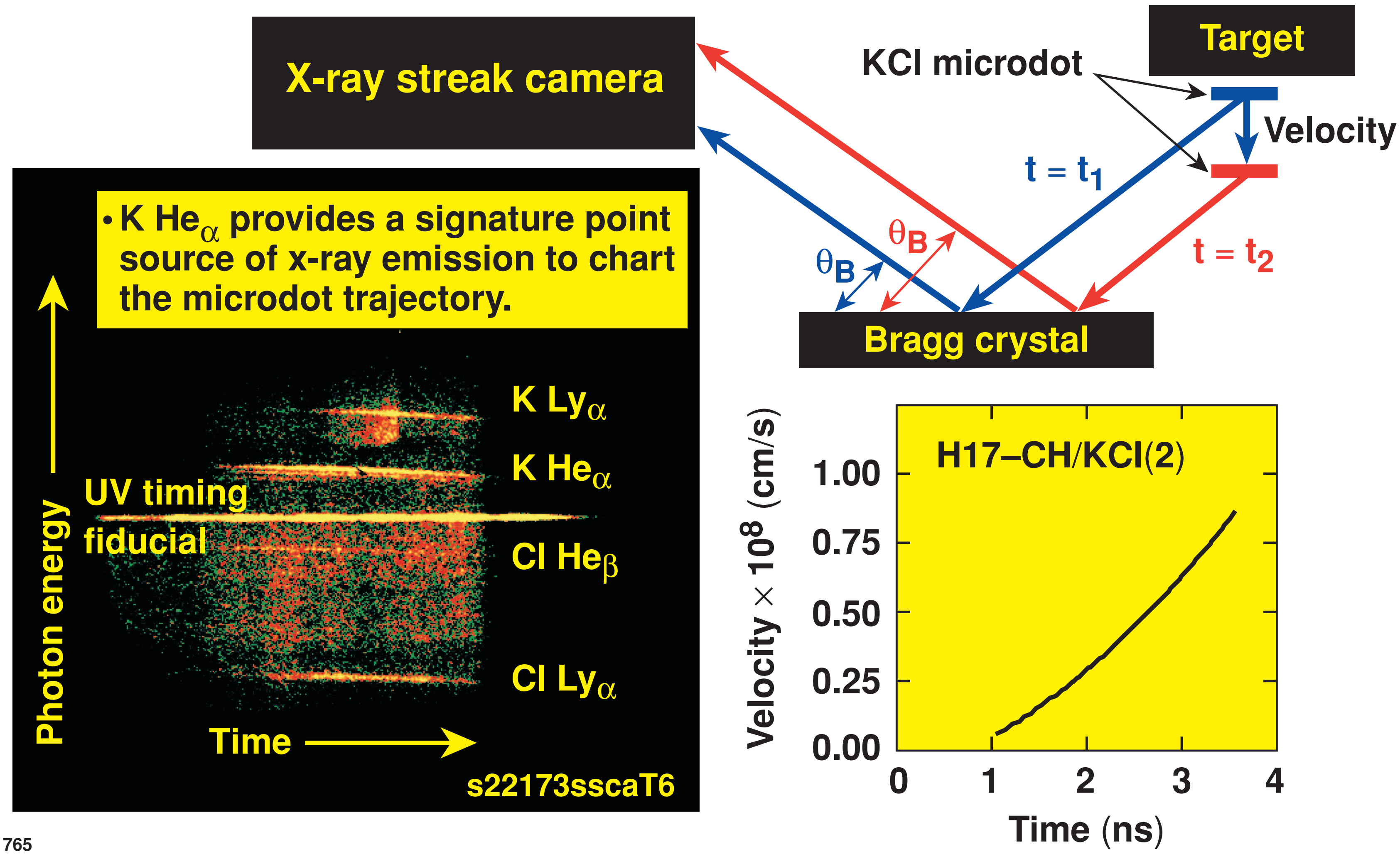
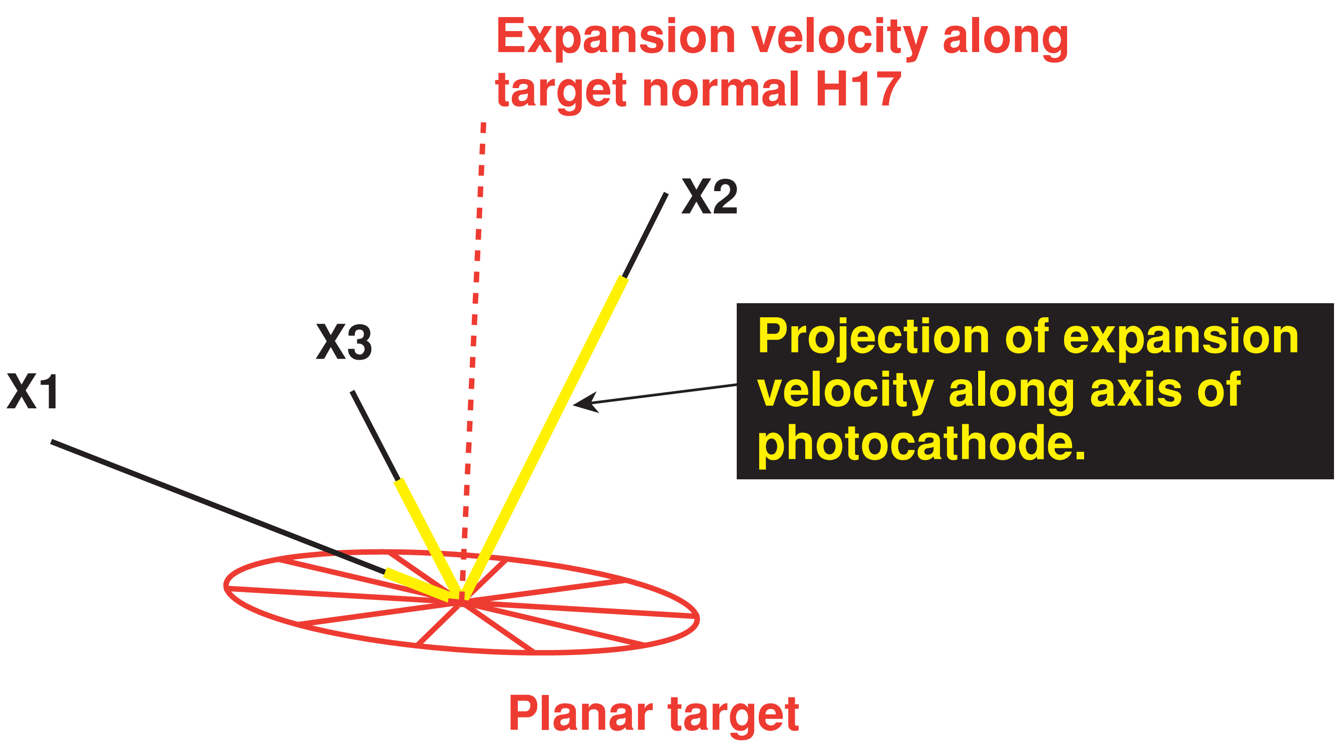
Trajectory of KCl microdot recorded with time-resolved x-ray spectroscopy is used to measure expansion velocity of long-scale-length plasmas on OMEGA



Projection of the expansion velocity along the axis of the photocathode is recorded

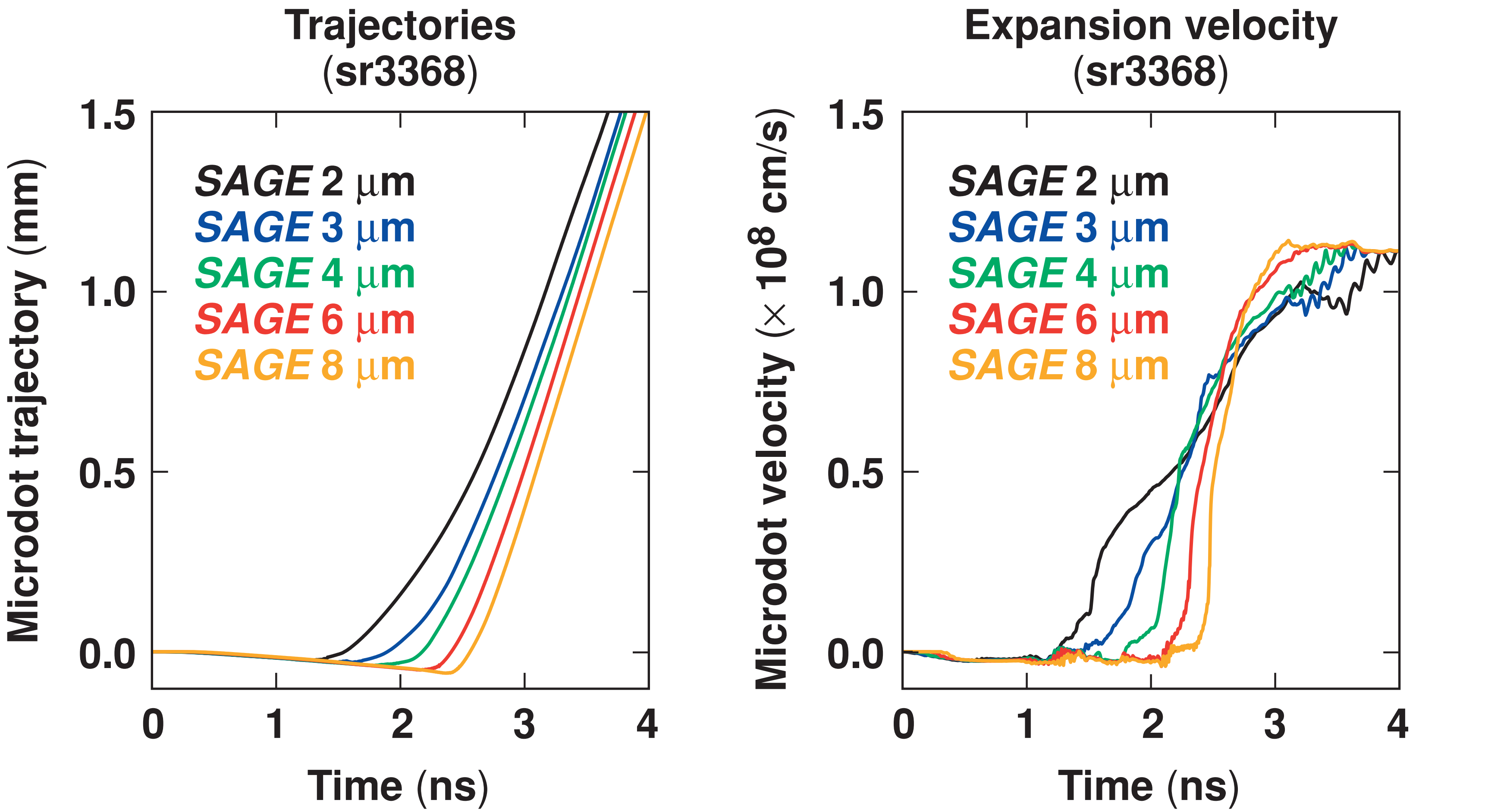


X1: diagnostic view (TIM 6)

X2: axis of photocathode

X3: normal to the plane of incidence

Microdot trajectories and blowoff velocities are predicted with the 2-D hydrodynamics code *SAGE*



- **Microdots buried at deeper depths are ablated at later times.**

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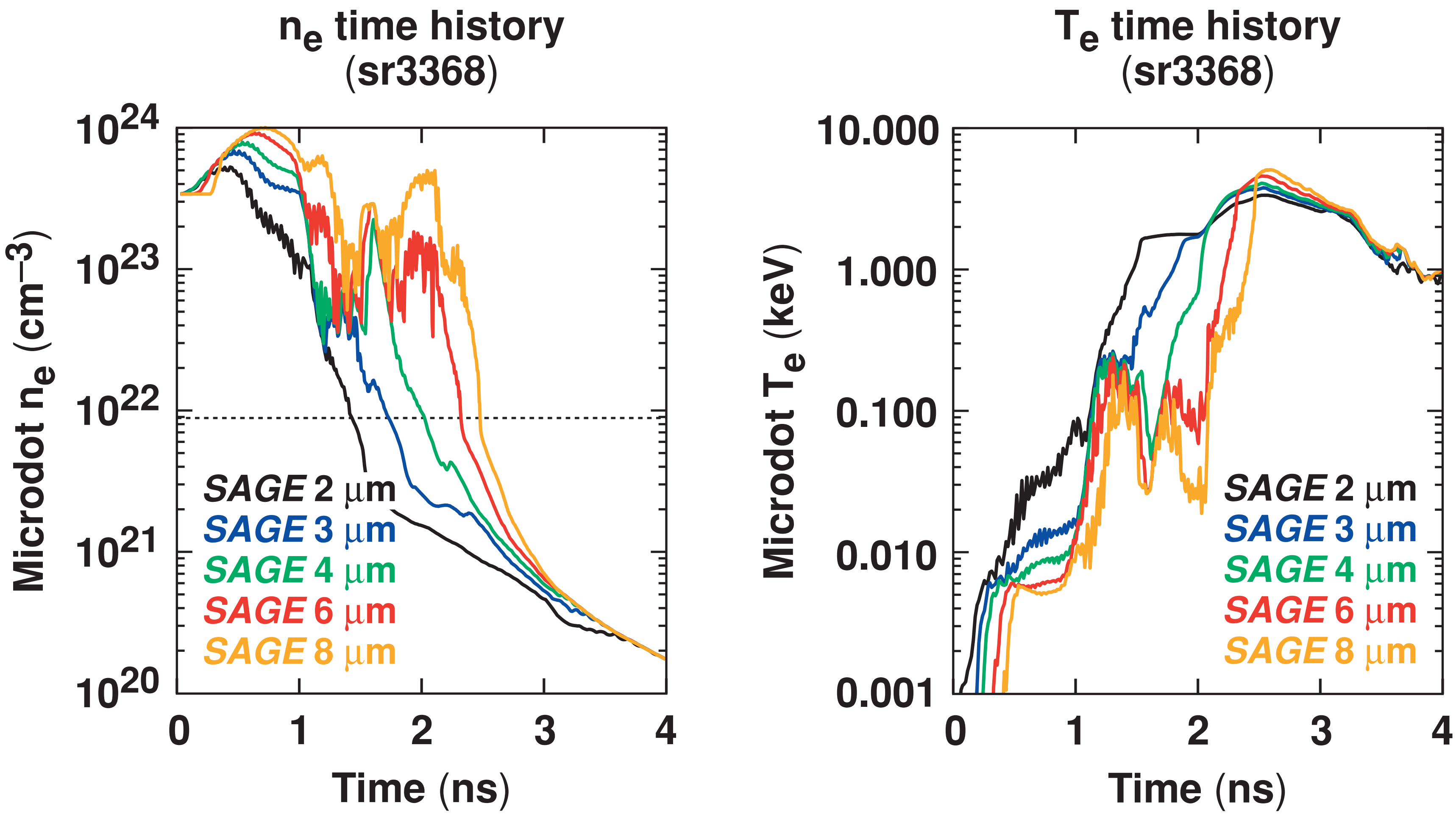
Microdot time histories of n_e and T_e are predicted with the 2-D hydrodynamics code *SAGE*



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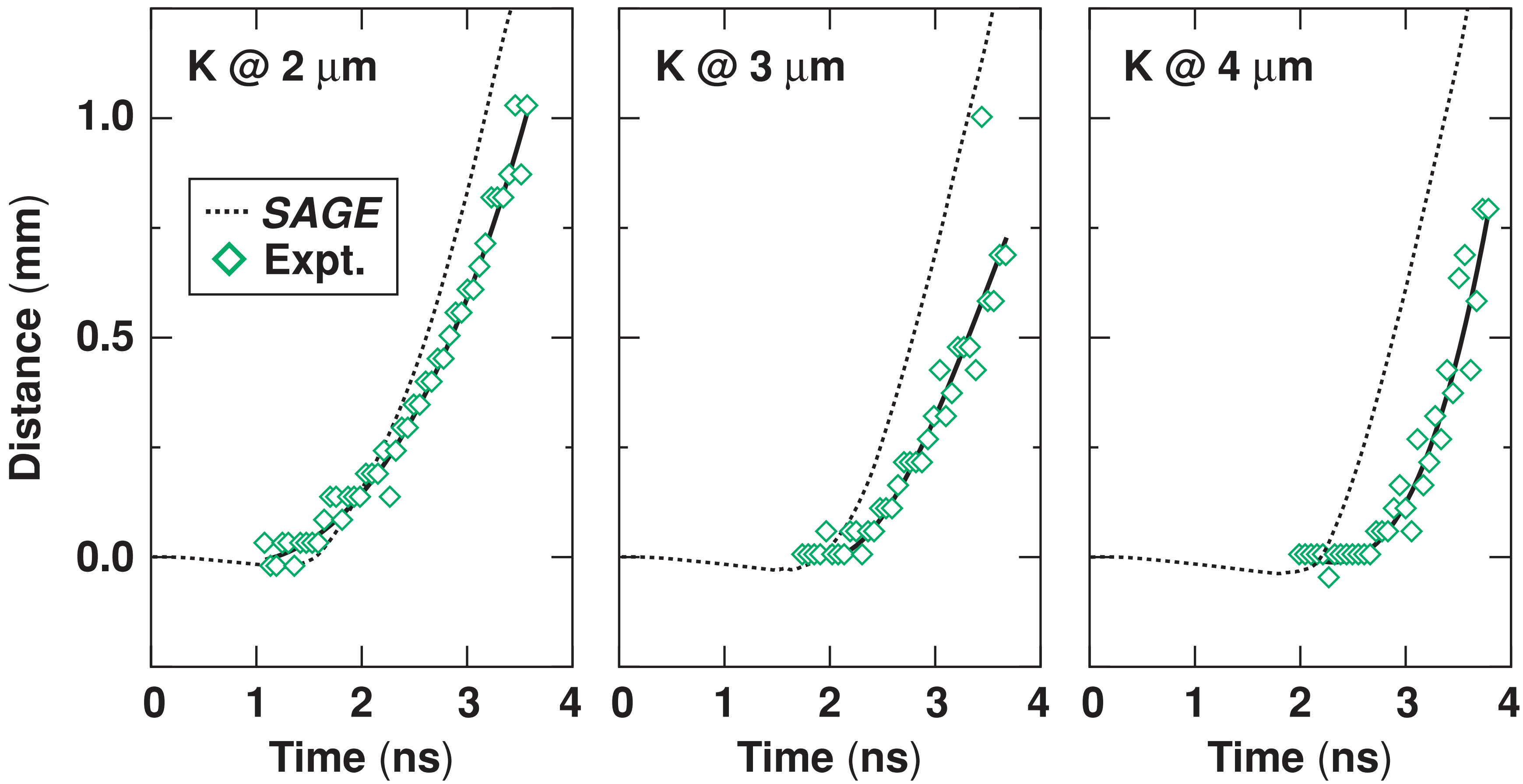
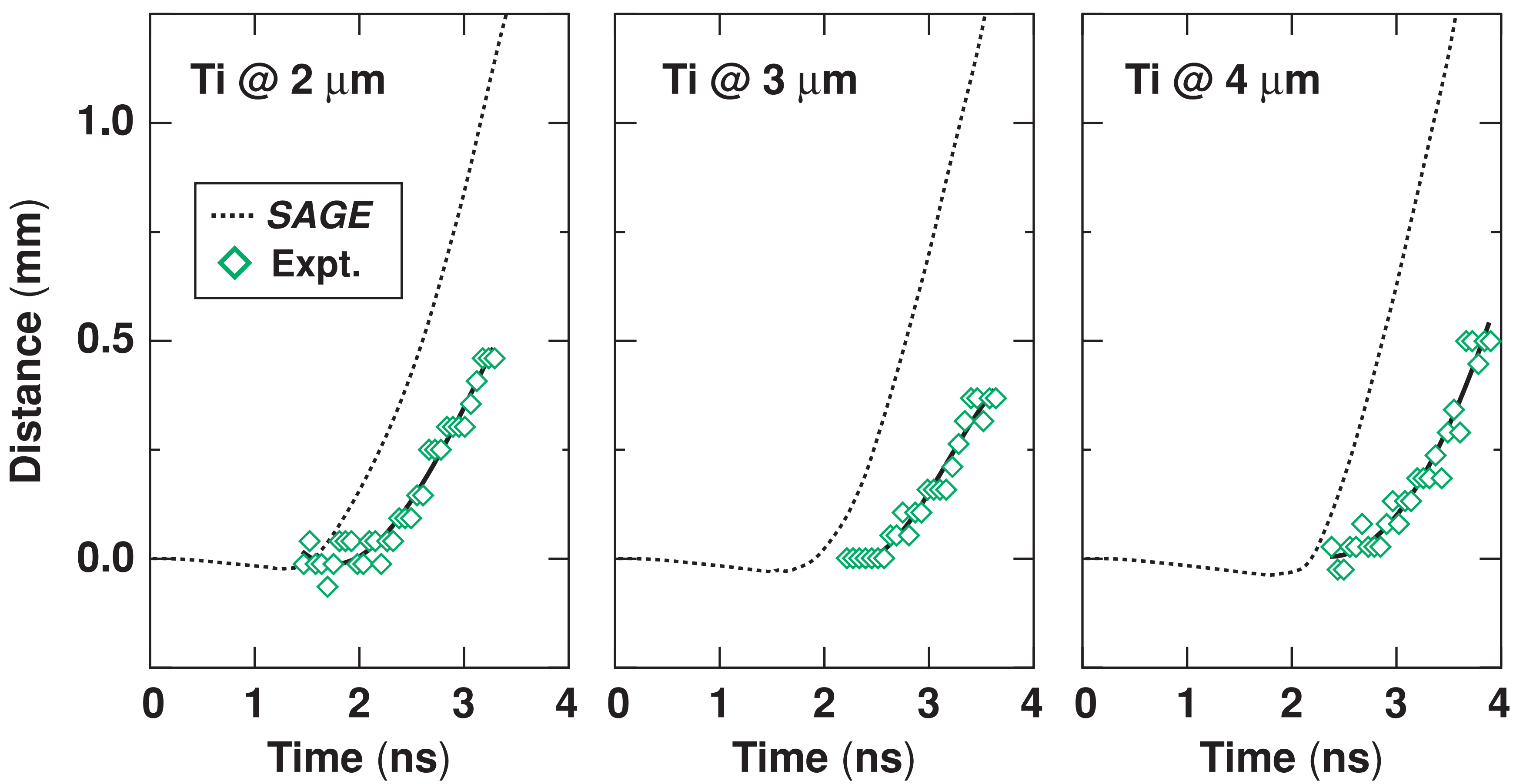
Discrepancy is observed between measured micordot trajectory and predicted trajectory for CH plasma



A larger discrepancy is observed between the predicted trajectory and the one measured for the Ti microdot



- Experiments are planned to record simultaneously the trajectories of Ti and K.

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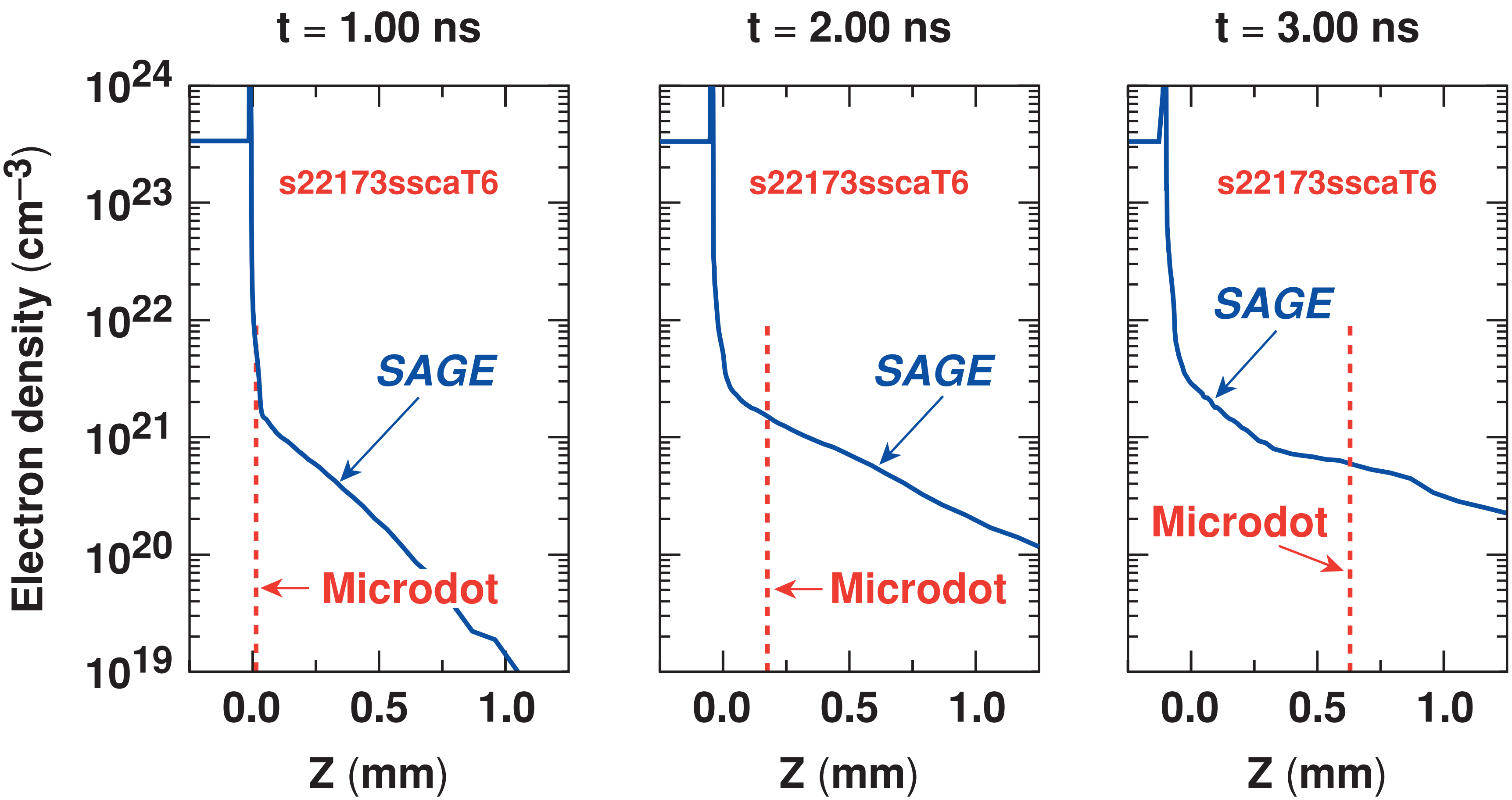
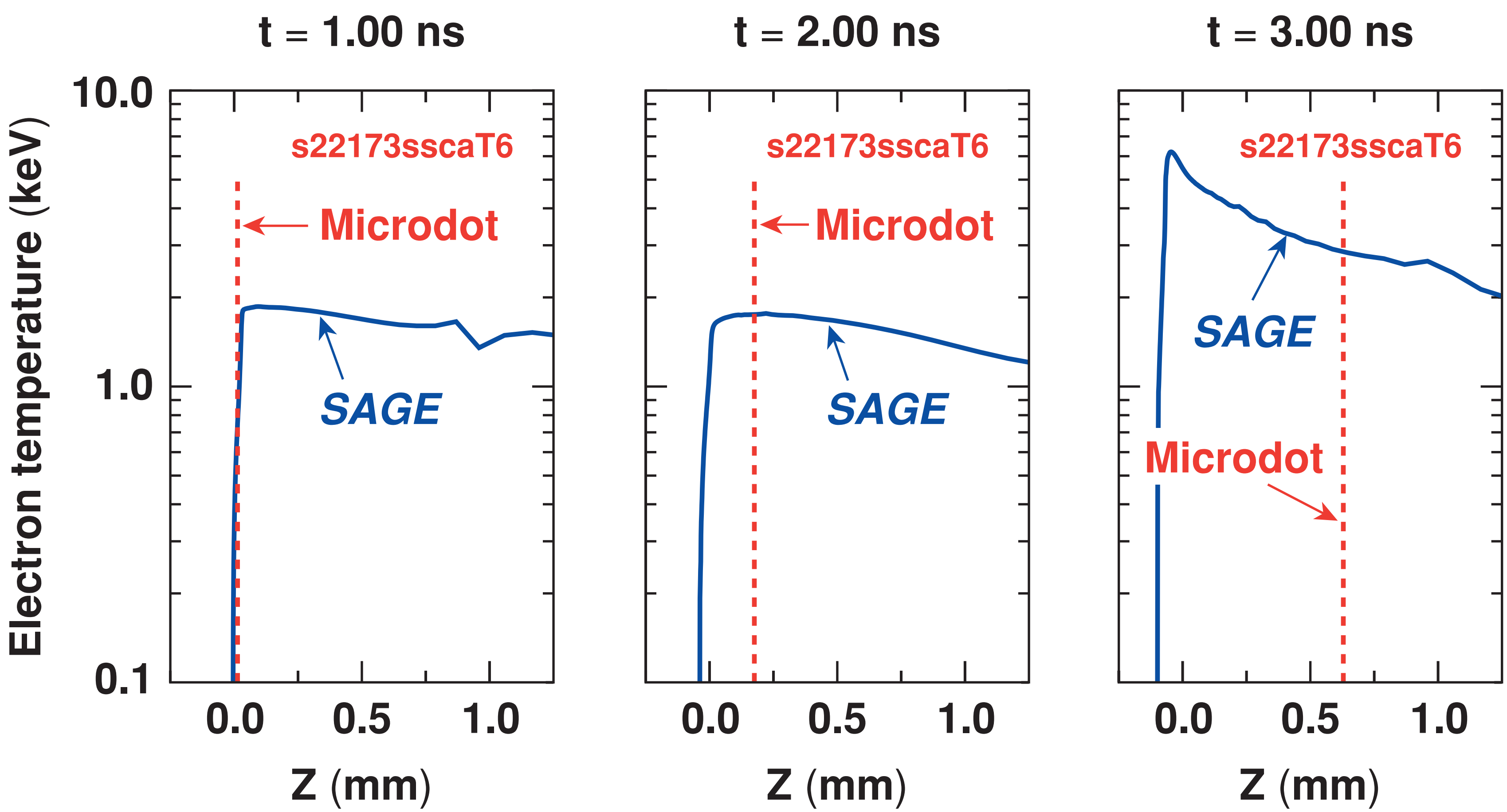
Microdot time history of electron density is predicted with *SAGE* profiles and measured microdot trajectory

KCl microdot buried at 2 μm



Microdot time history of electron temperature is predicted with *SAGE* profiles and measured microdot trajectory

KCl microdot buried at 2 μm



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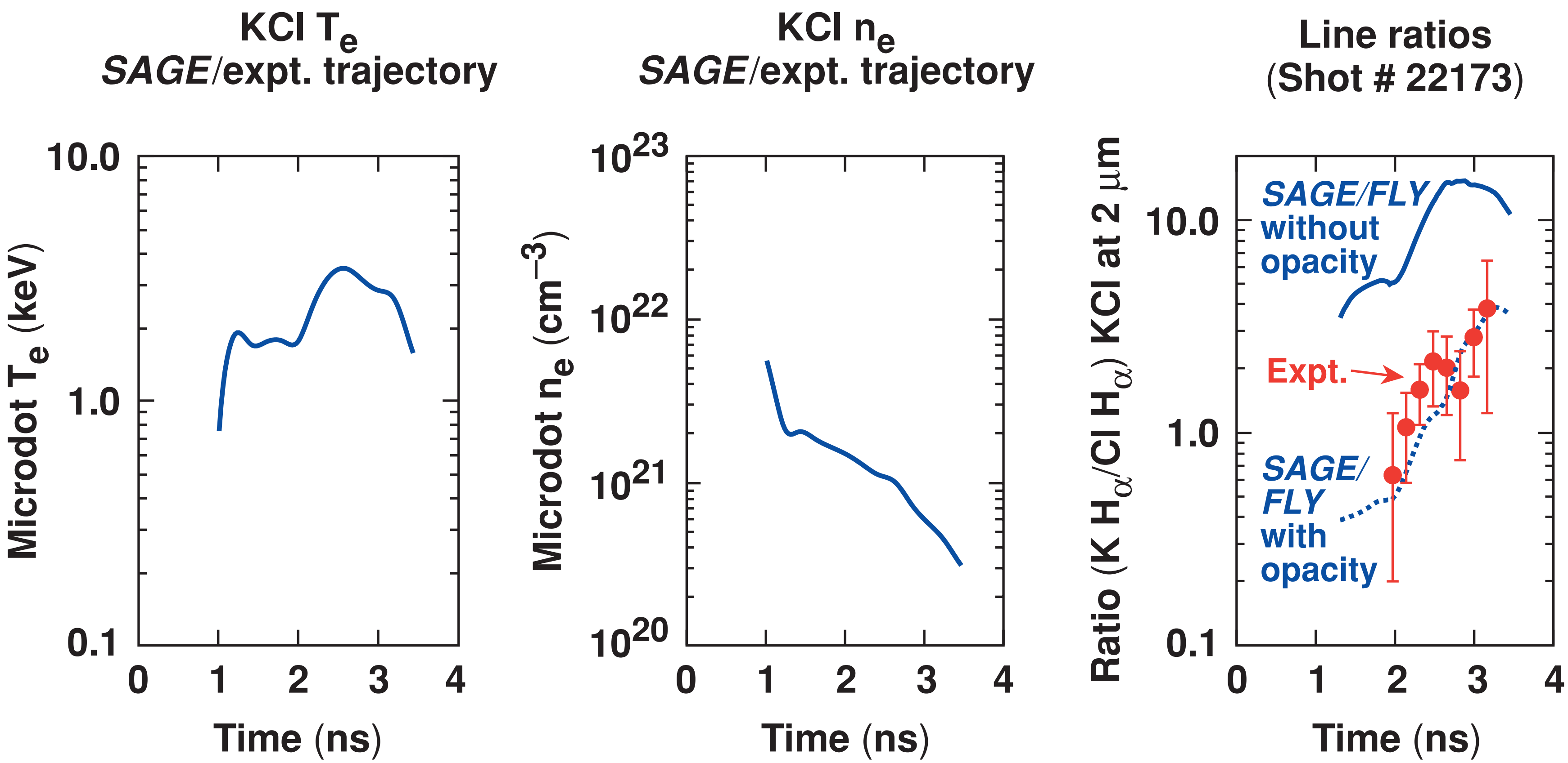
Good agreement is observed between *SAGE/FLY* predictions and measured results when line opacitites are included

KCl microdot buried at 2 μm



- Side-on view for microdot trajectory measurement
- Normal-incidence view for line ratio measurement

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Summary/Conclusions

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- Long-scale-length plasmas relevant to direct-drive ICF target designs for the NIF are generated on the 60-beam OMEGA laser system to study the laser–plasma instabilities associated with multiple interaction beams.

- Time-resolved x-ray spectroscopy of microdot tracer layers is used to characterize the plasma conditions created with massive, solid-density plastic targets.

- A discrepancy is observed between the measured microdot trajectory and the predicted trajectory of a CH plasma (calculated with the 2-D hydrodynamics code *SAGE*.)

- The electron temperature and density profiles are diagnosed with the measured line ratios of the *K*-shell emissions from the microdot.

- Good agreement is observed between *SAGE*/*FLY* predictions (using the measured microdot trajectory) and the measured line ratios when the line opacities are included.

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