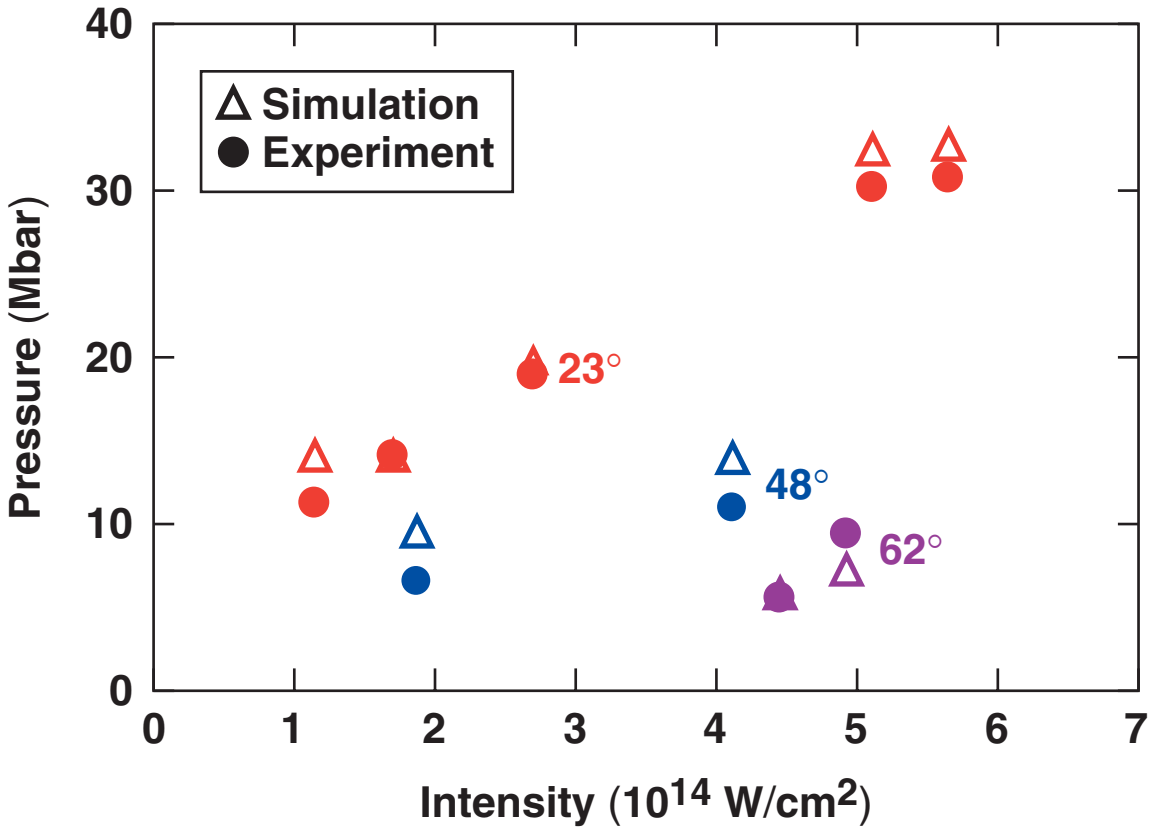
The Effect of Incidence Angle on Laser-Driven Shock Strengths



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Summary

Double-pulse experiments demonstrate that 1-D simulations with ray tracing can model the effects of oblique incidence

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- Angular dependence of laser–target coupling efficiency is important for planar and polar direct drive experiments.
- Shock strength is used as a measure for coupling efficiency by inferring pressure from the measured velocity profiles.
- Ray trace routines in one-dimensional simulations provide a good measure of angular effects.
- For short pulses, 3-D effects and lateral heat transport appear to be small.

Motivation

Planar and polar-direct-drive experiments require modeling of oblique angles of incidence

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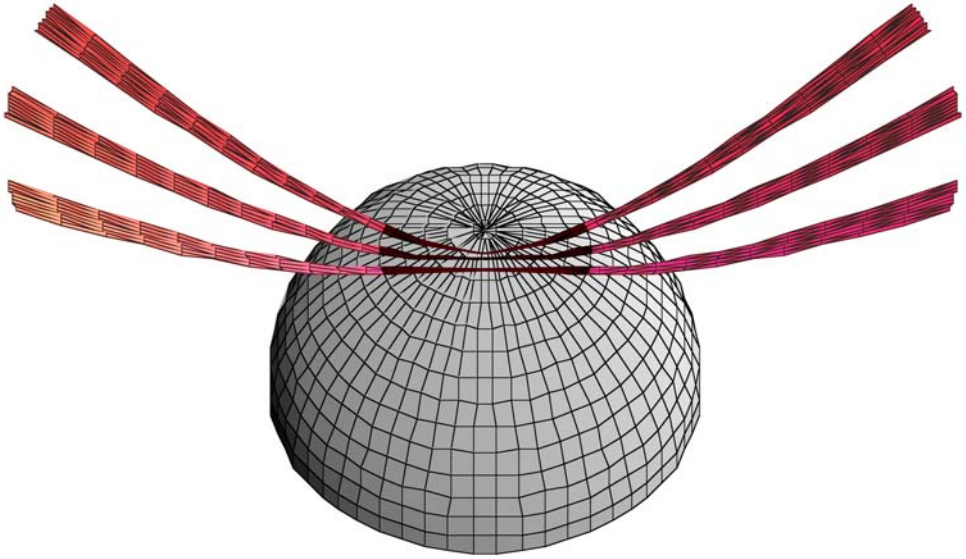
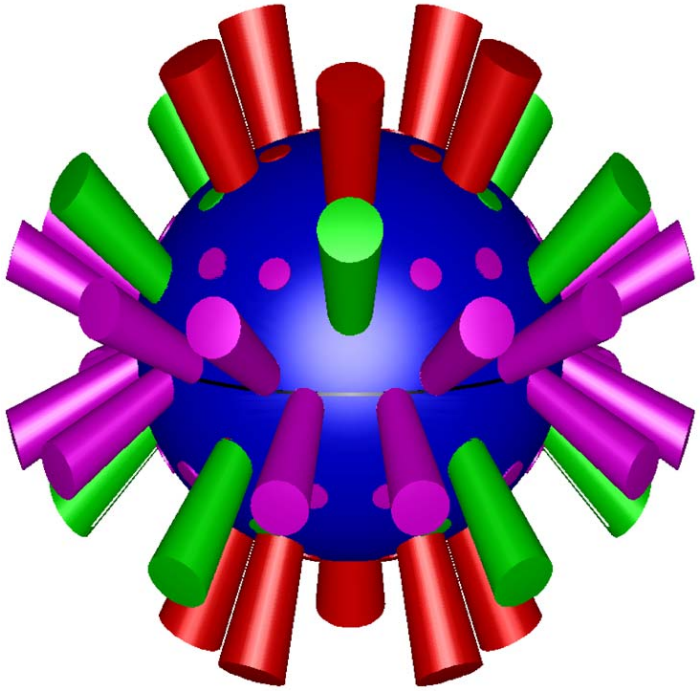
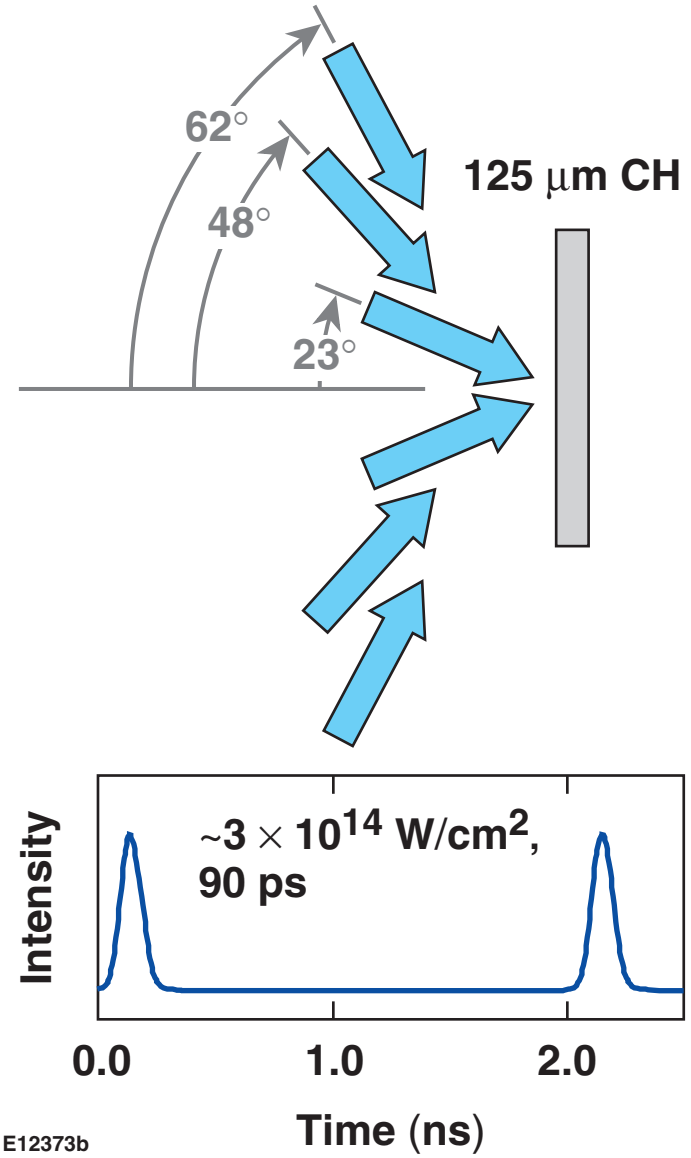


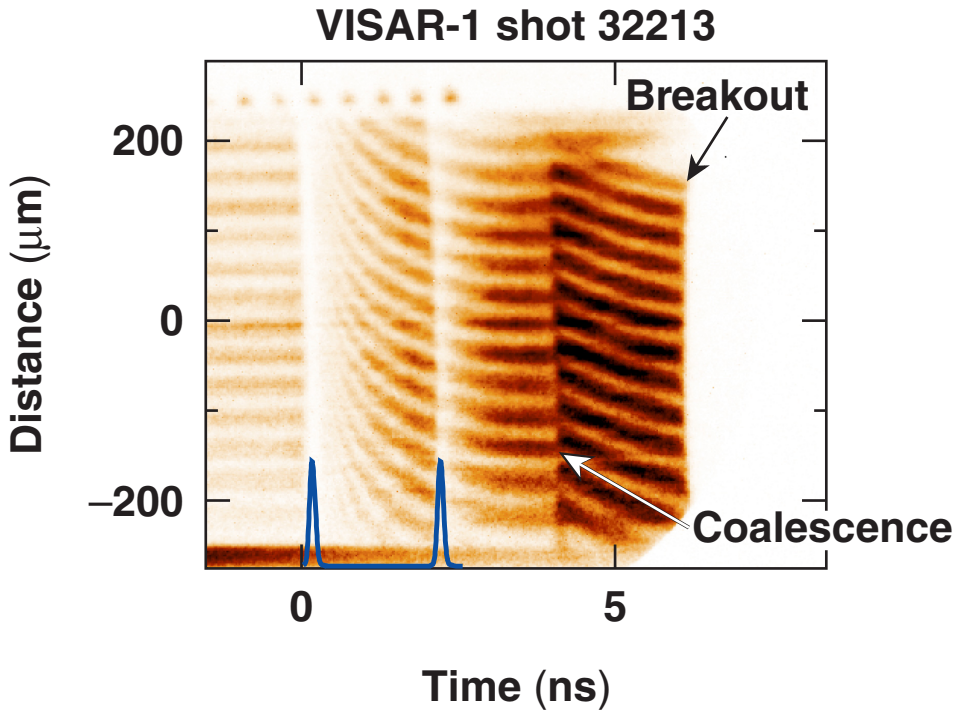
Planar experiments can involve spherical plasmas.



Polar direct drive uses nonradial drive beams.

Shock timing and coupling efficiency are studied with two pulses and different angles





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Planar experiments are affected by oblique incidence and edge effects

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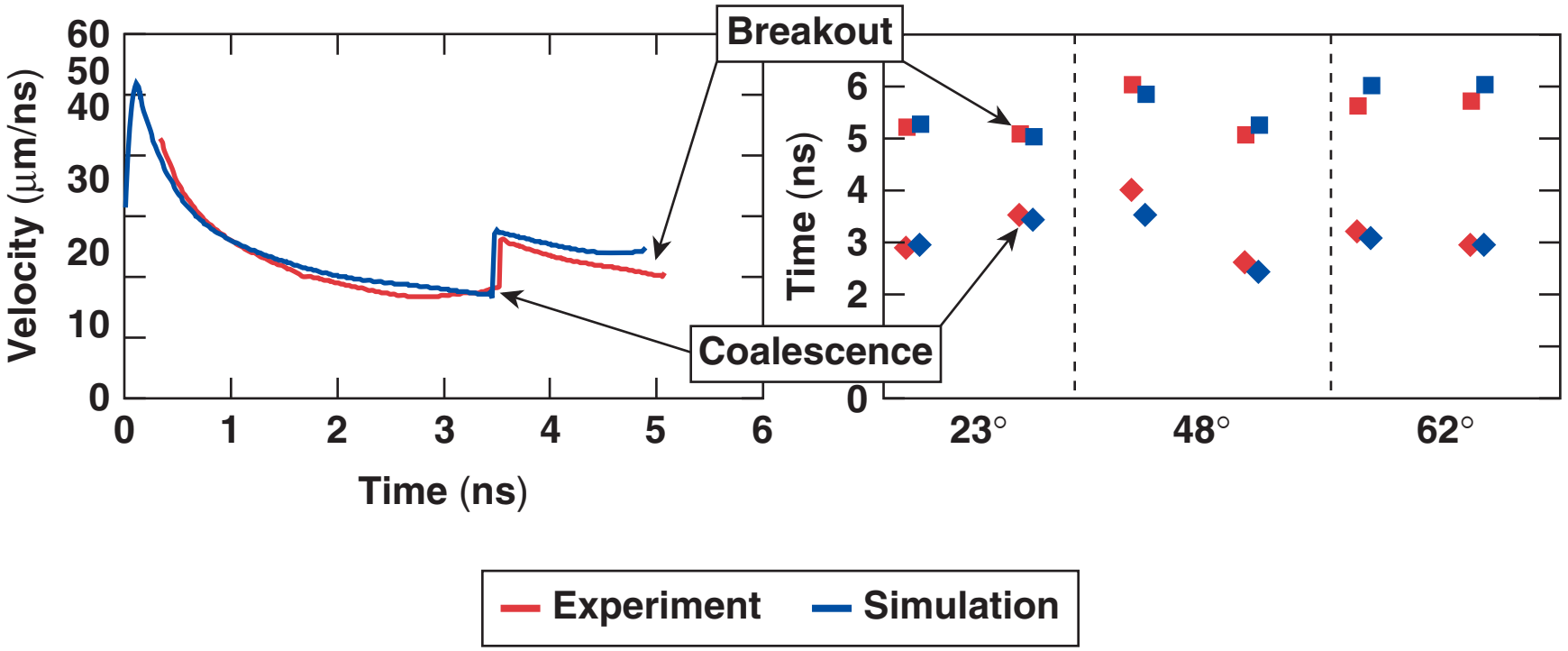
- 1-D simulations with ray-trace routines treat
  - changes in spot size and shape and
  - refraction of oblique rays altering the turning point.
- Effects not included are
  - additional loss due to refraction from 3-D plasmas and
  - lateral heat flow.
- Experiments indicate that for short pulses, the latter are small.

One-dimensional simulations with ray tracing model the experiements well



These types of experiments are used to study coupling efficiency.

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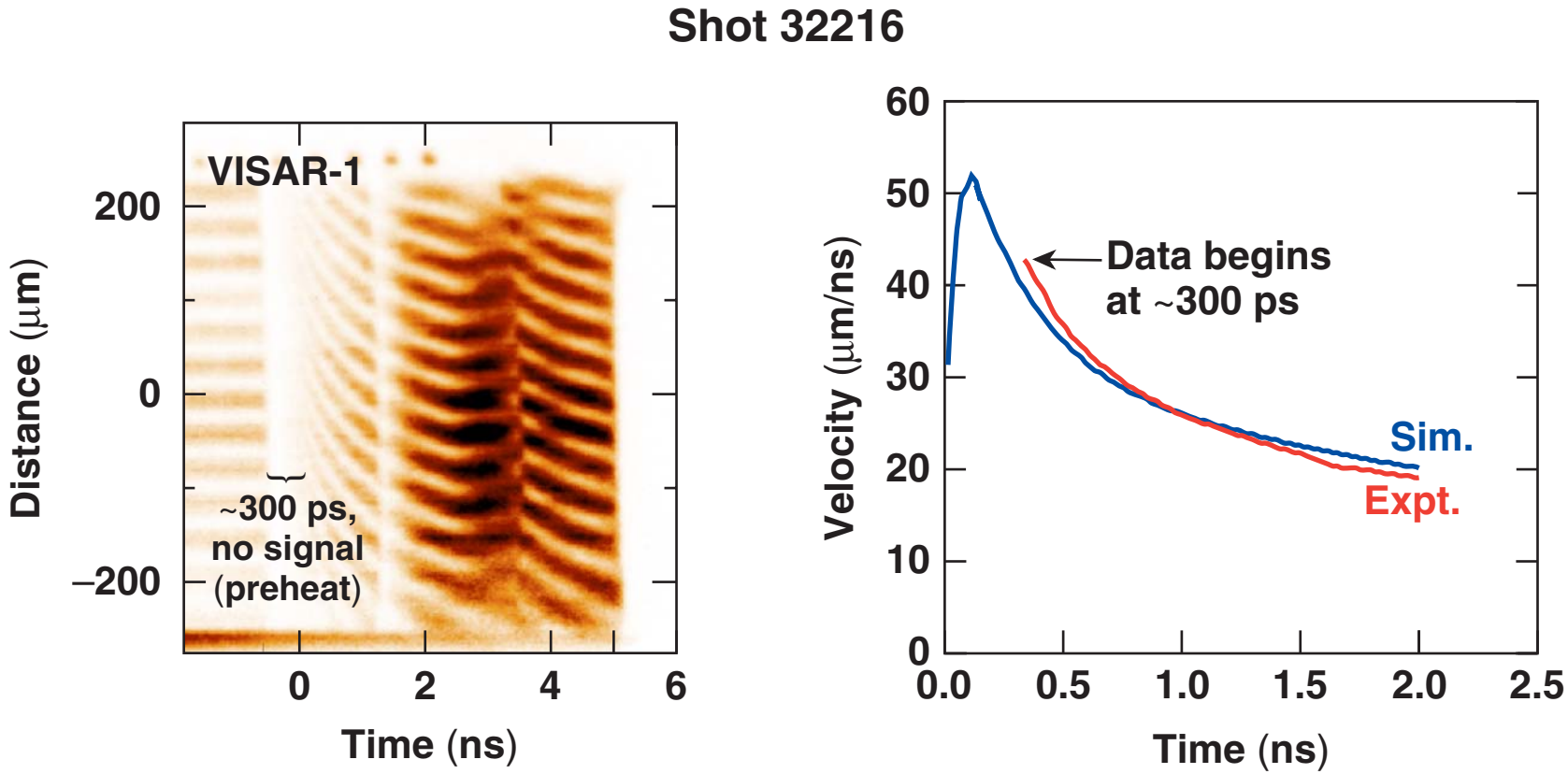
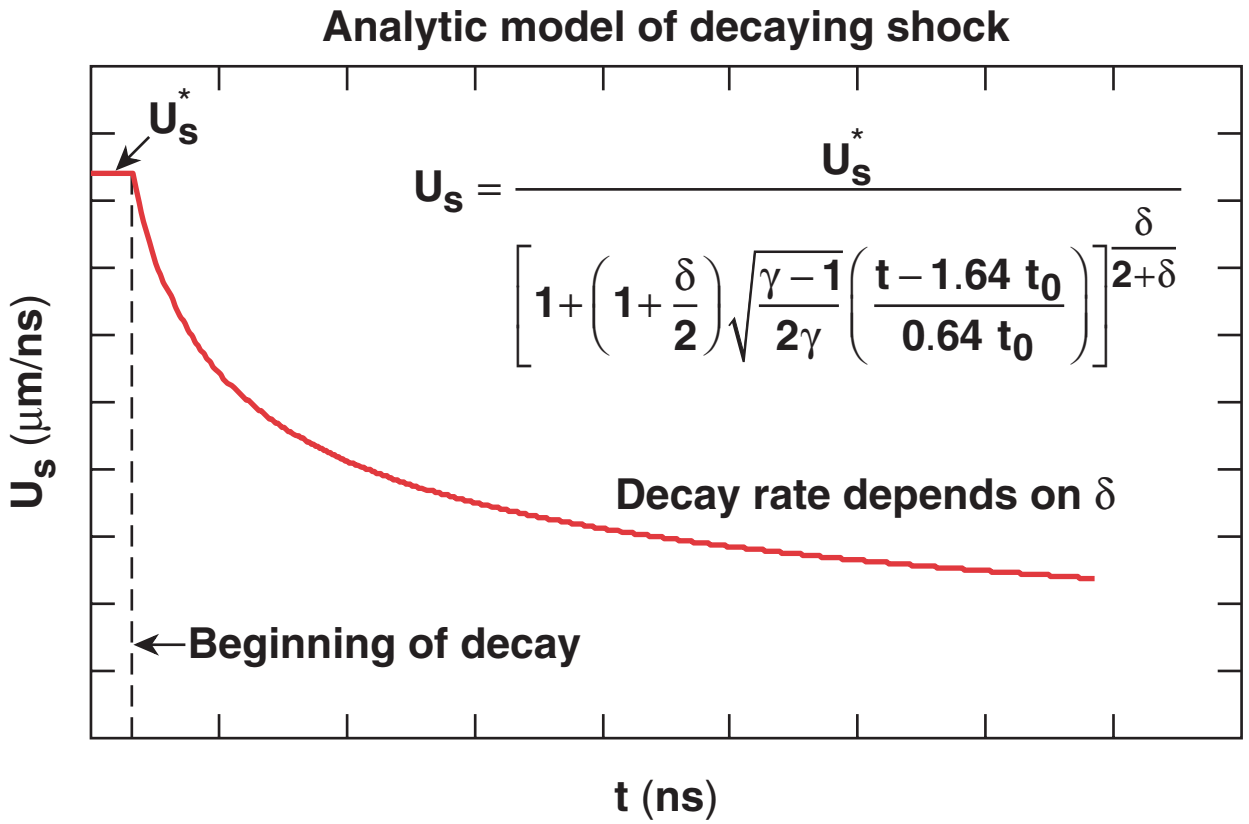
The velocity profiles are used to infer initial conditions



An analytic model[1] can be used to infer initial pressure from a measured velocity profile



U_s^* = initial shock speed

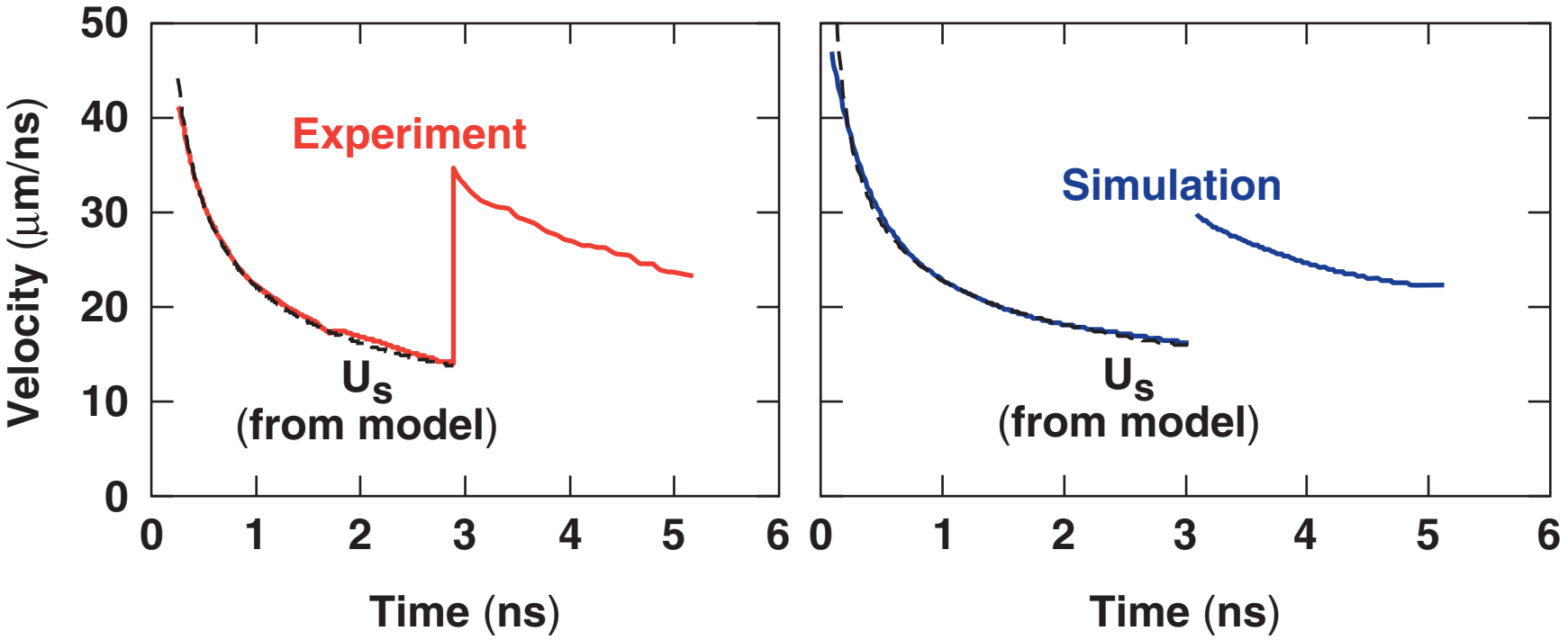
δ = material constant

t_0 = pulse length

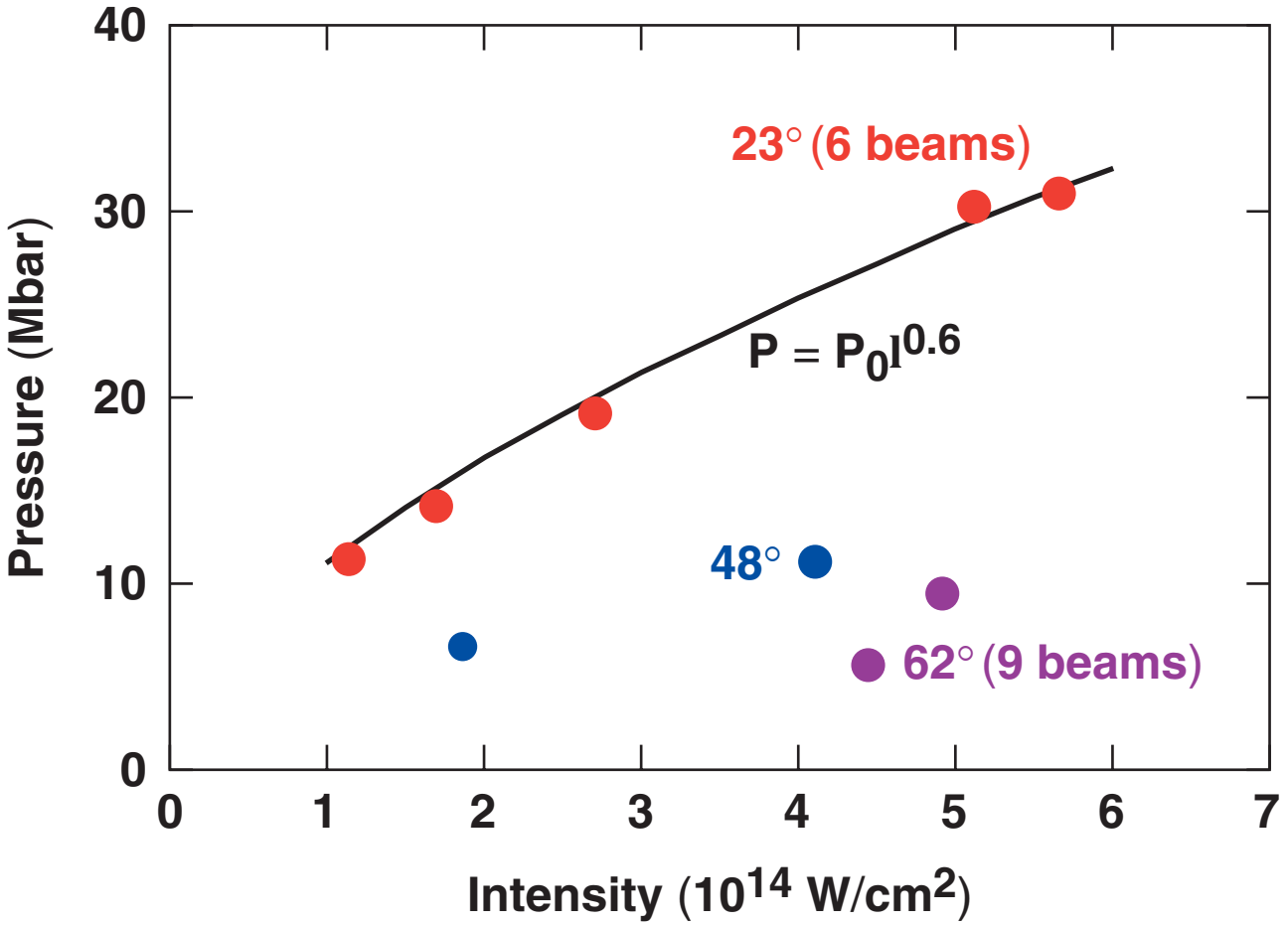
γ = material/EOS constant

[1] K. Anderson and R. Betti, Phys. Plasmas 10, 4448 (2003).

The analytic model is fit to the experimental and simulated velocity profiles



Peak pressures inferred from the velocity profiles demonstrate the effect of incidence angle on coupling efficiency



- Intensity is corrected for obliquity (cos θ).

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34914, 31543, 35790
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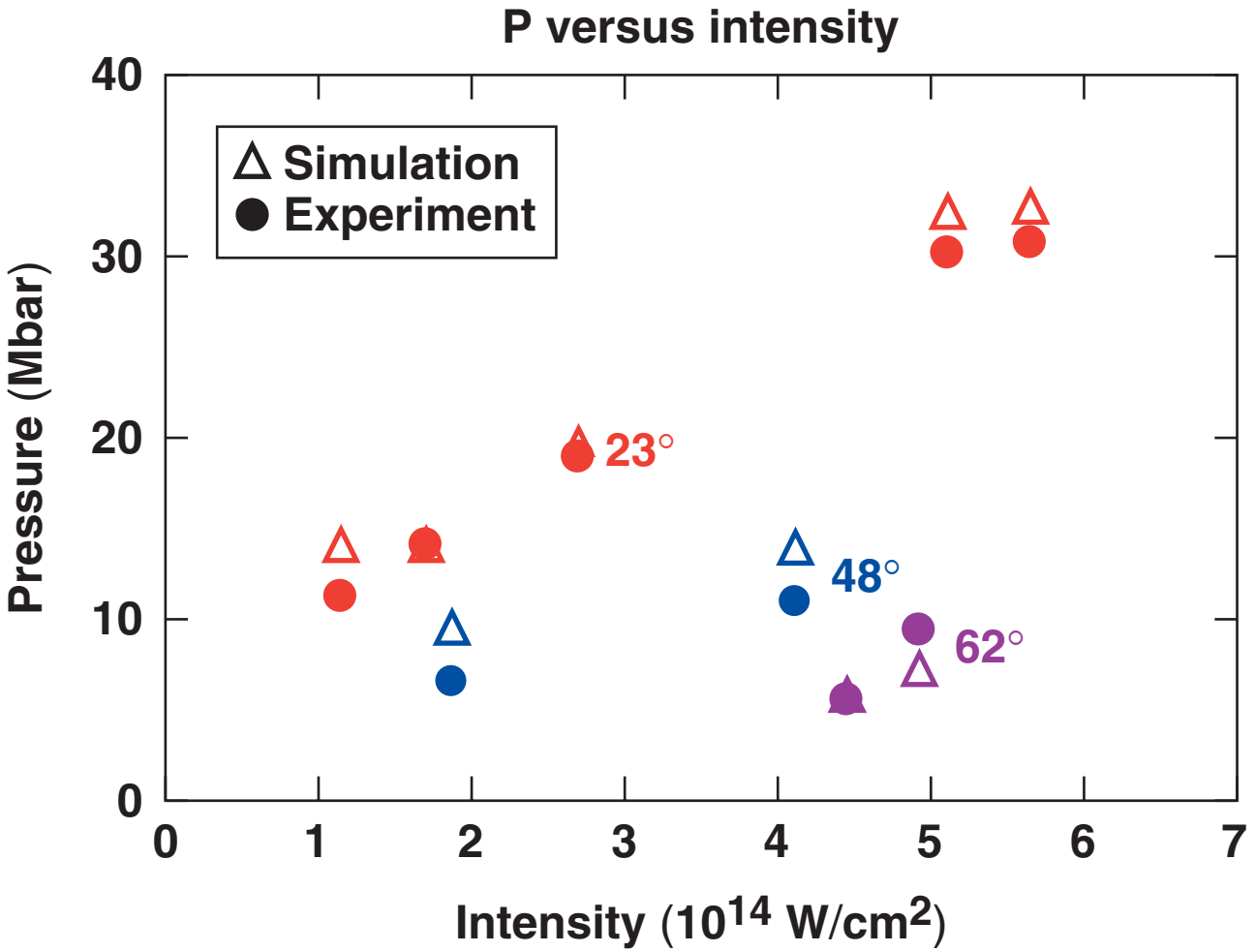
Pressures from simulations show good agreement with inferred experimental peak pressures



- Discrepancies are likely due to high-order effects.

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Summary/Conclusions

Double-pulse experiments demonstrate that 1-D simulations with ray tracing can model the effects of oblique incidence

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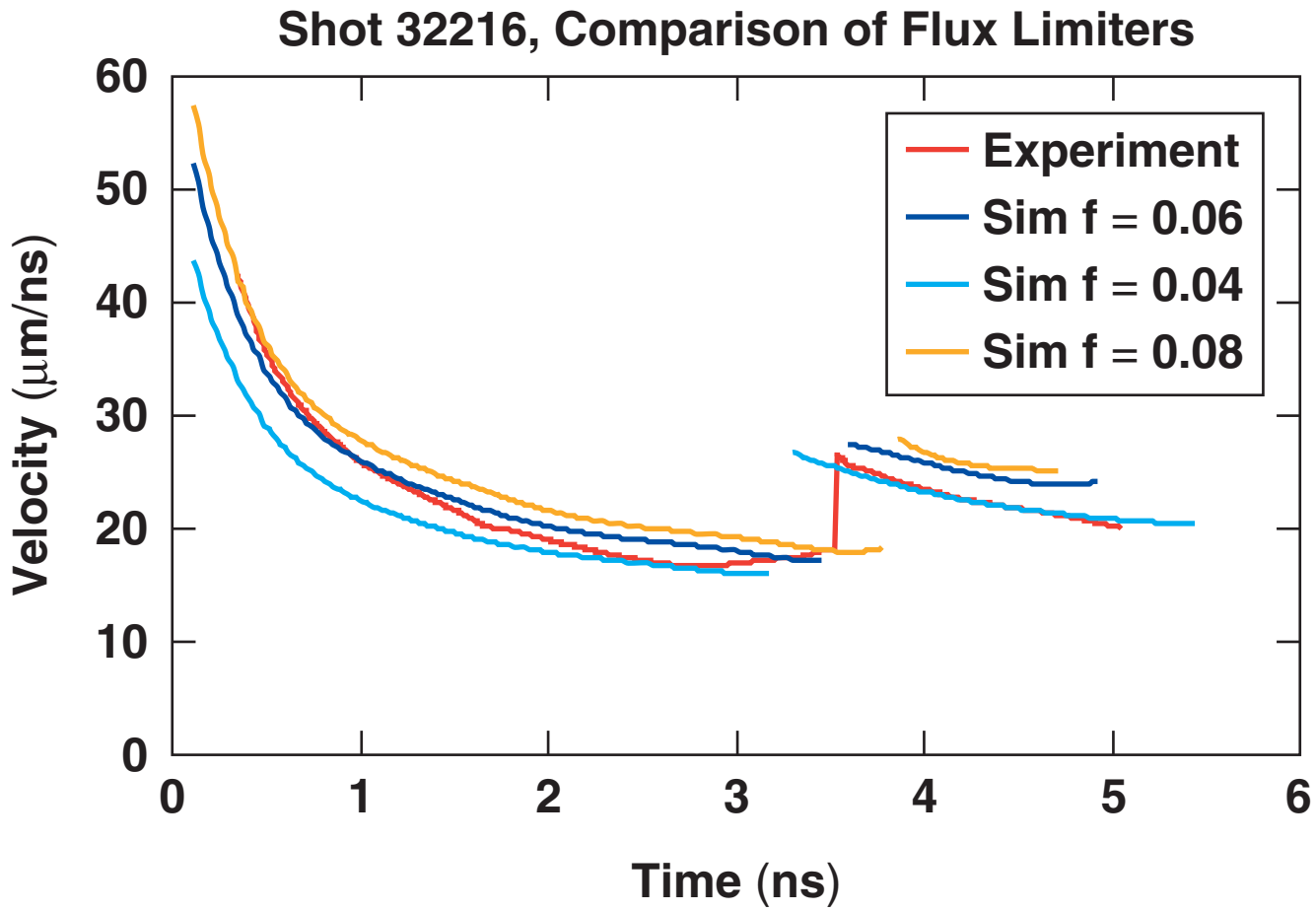
- Shock strength is used as a measure for coupling efficiency by inferring pressure from the measured velocity profiles.
- Ray trace routines in one-dimensional simulations provide a good measure of angular effects.
- For short pulses, 3-D effects and lateral heat transport appear to be small.

Measured velocity profiles are used to discern between flux limiters



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