Sensitivity studies for 1/2 MJ target

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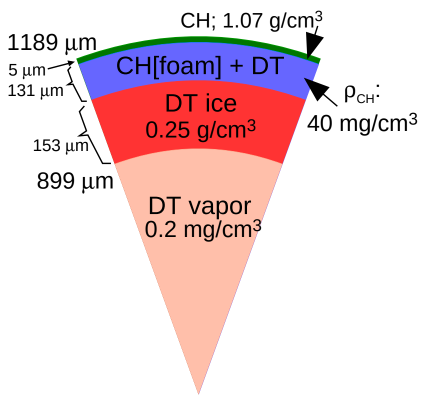
Outline

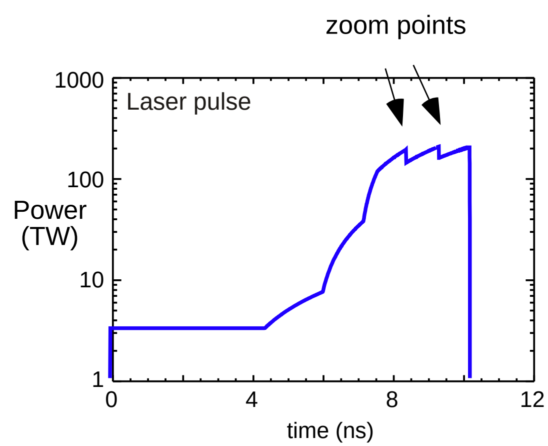
- ❑ Sensitivity studies (1D results)
- ❑ Design with 10 μm CH overcoat
- ❑ One example of 2D stability results

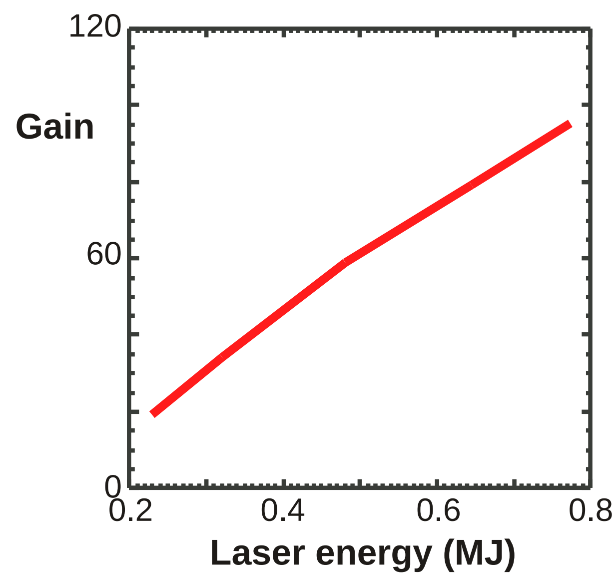
Examples of targets in the sub-MJ range

targets are low-aspect ratio, designed for high pressure drive



480 kJ target





Sensitivity studies of 1D design

- How robust are the designs ?
- What are the most sensitive parameters?

Sensitivity studies of 1D design

(based on 480 kJ design w/o spike)
Gain = 59

- Sensitivity both in laser pulse shape and target dimensions

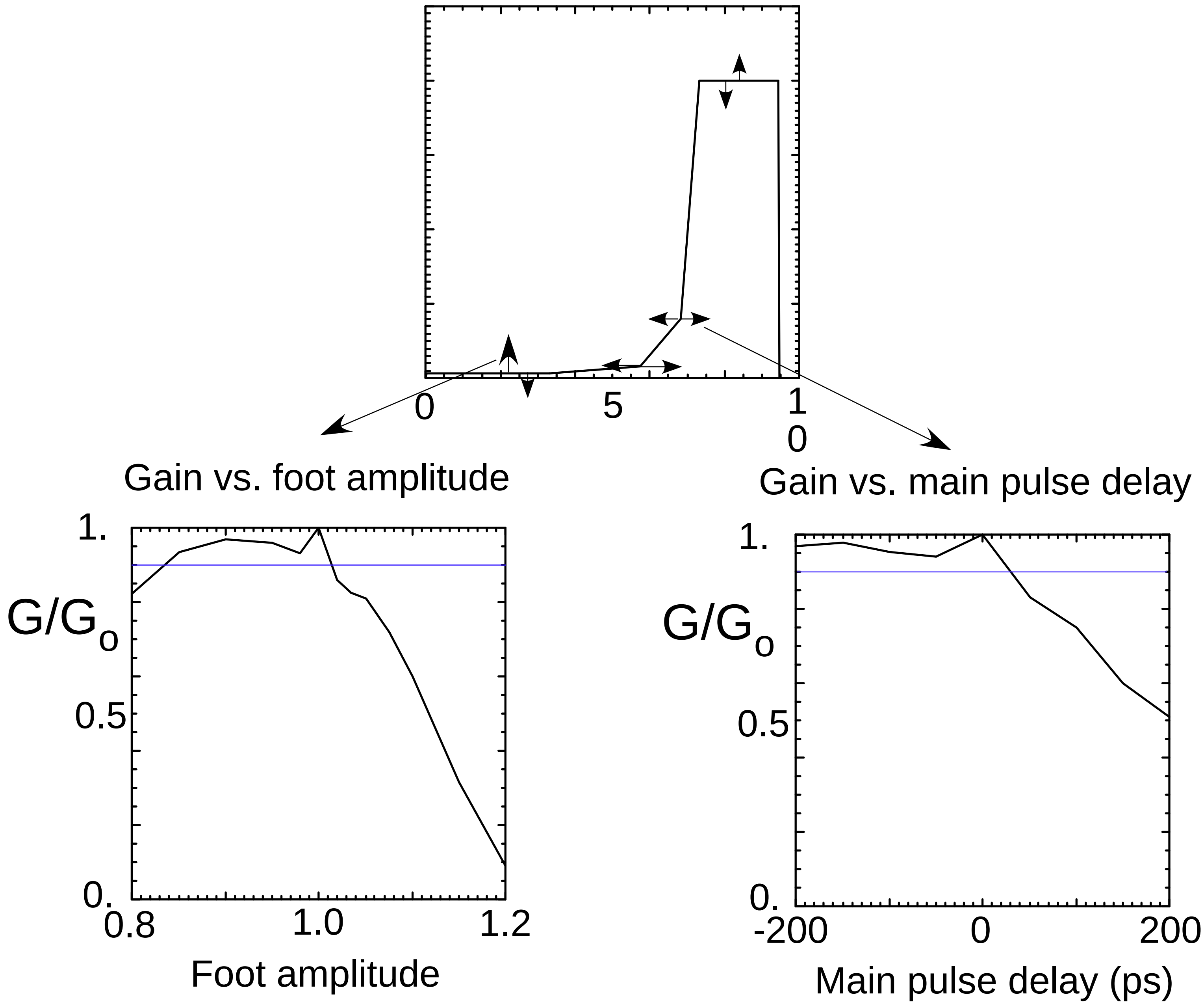
  in order to simplify no spike is included, also target composition remains the same

- Sensitivity studied for one change at a time

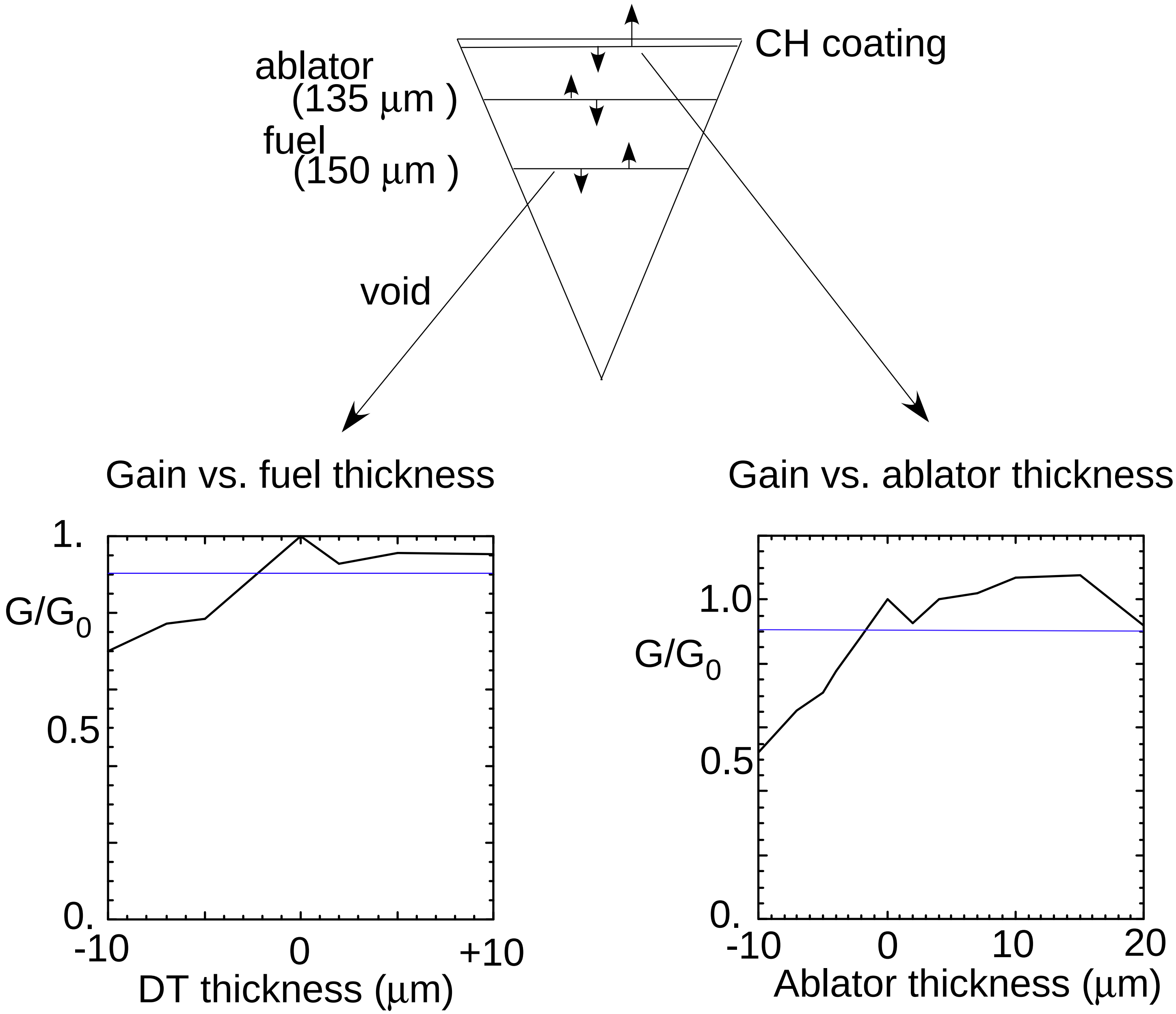
  does not include combination of changes which are most likely to occur

- Figure of merit used is gain only but should be gain AND stability

Increasing foot amplitude, delaying main pulse most sensitive

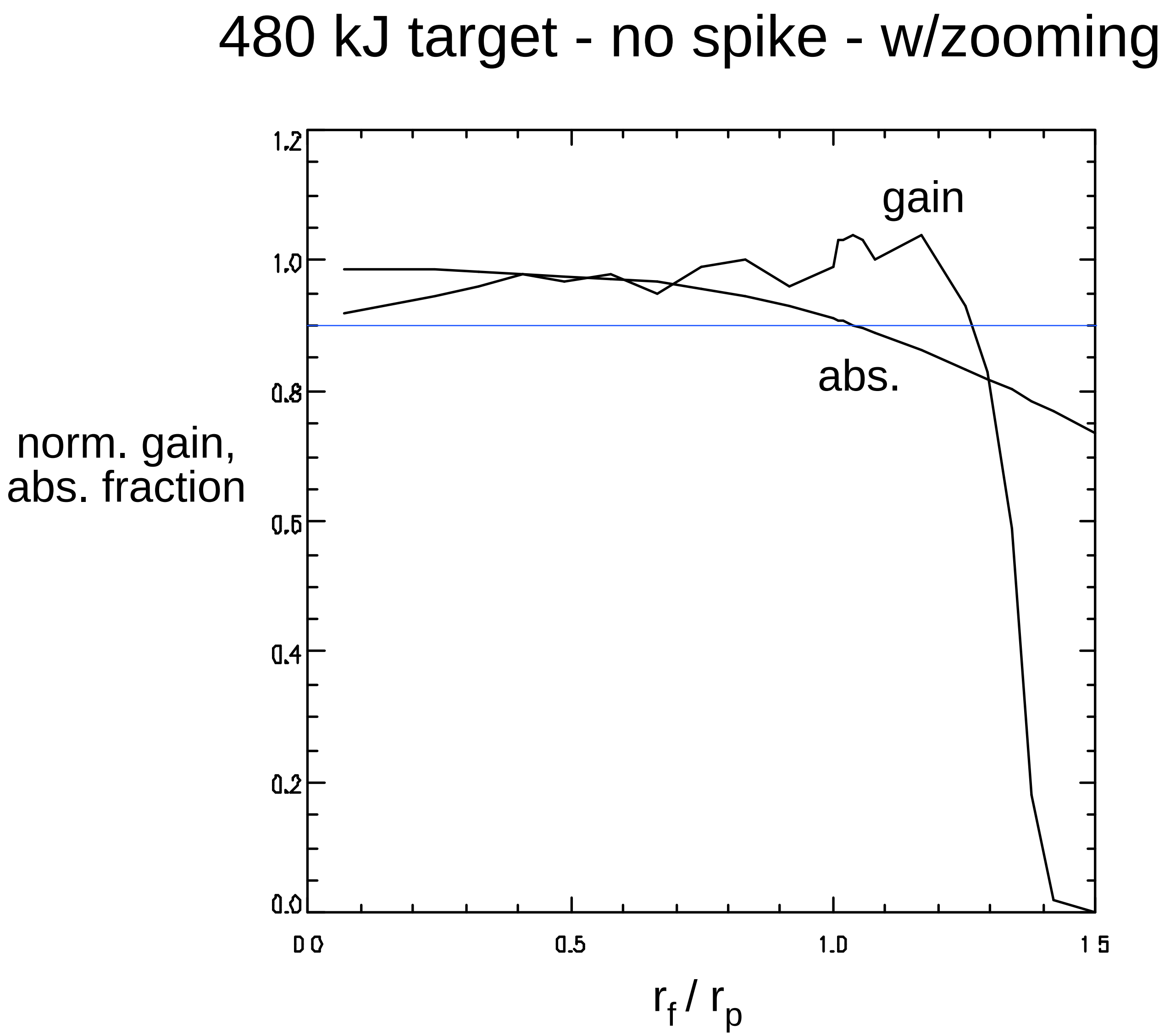


Decreasing fuel or ablator thickness most sensitive



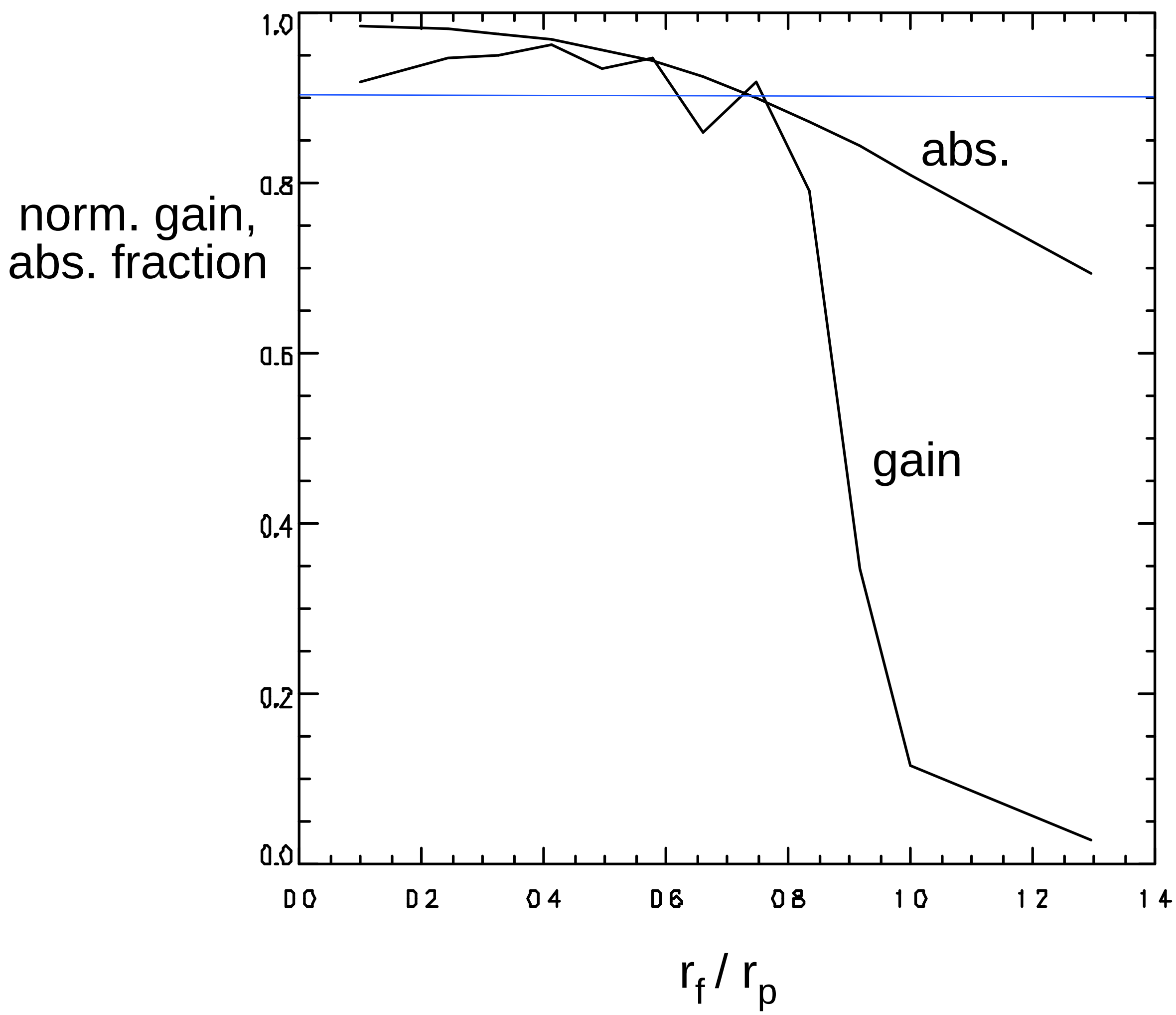
Sensitivity to focal spot radius (with zooming)

NRL



Sensitivity to focal spot radius (no zooming)

480 kJ target - no spike - no zooming

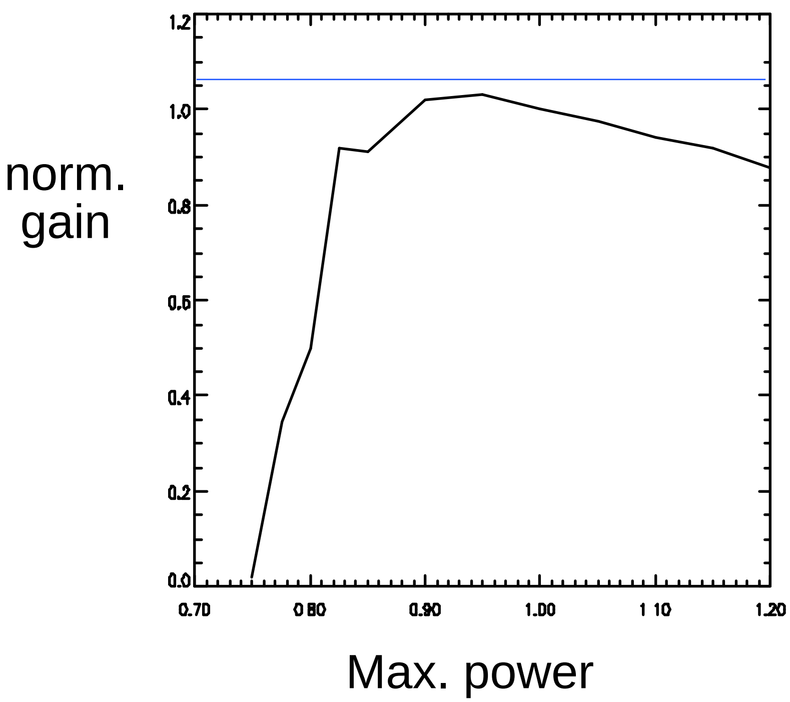


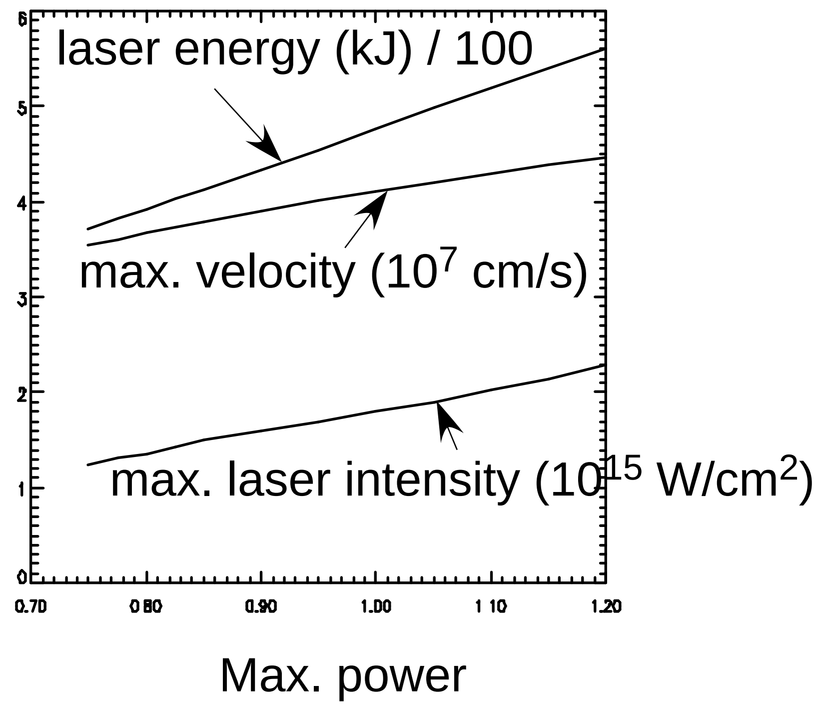
Conclusion: no zooming necessary if $r_{focal\ spot} < (0.6\text{-}0.7)\ r_{pellet}$

(penalty in gain loss ~ 10%)

Sensitivity to max. power, max. laser intensity, max. velocity

1/2 MJ target - no spike - with zooming





Sensitivity to CH thickness

- CH is 4x denser than foam, so effects on timing are amplified compared to change in foam/fuel thickness

- CH standard thickness is 5.11 μm

- If thickness is decreased by 0.27 μm (5%), gain drops by 17%

- If thickness increases by 0.34 μm (6.7%), gain drops by 7%

This is a guess...

- Concentricity of CH more sensitive than foam/fuel concentricity because of higher CH density

Design with 10 μm CH (instead of 5 μm)

- In order to get similar gain (57.9 vs. 58.4), increase the energy by ~ 30 kJ

- The reason for the extra energy is the decrease in hydrodynamic efficiency (10.56% vs. 11.21%)

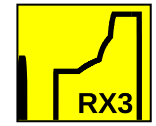
- More carbon does not change appreciably the absorption efficiency (91.9% vs. 91.7%)

- A slight advantage seems to be that the target is slightly more stable (from 1D dispersion relation) (4.7 e-folds vs. 4.95 for fastest RT growing mode)

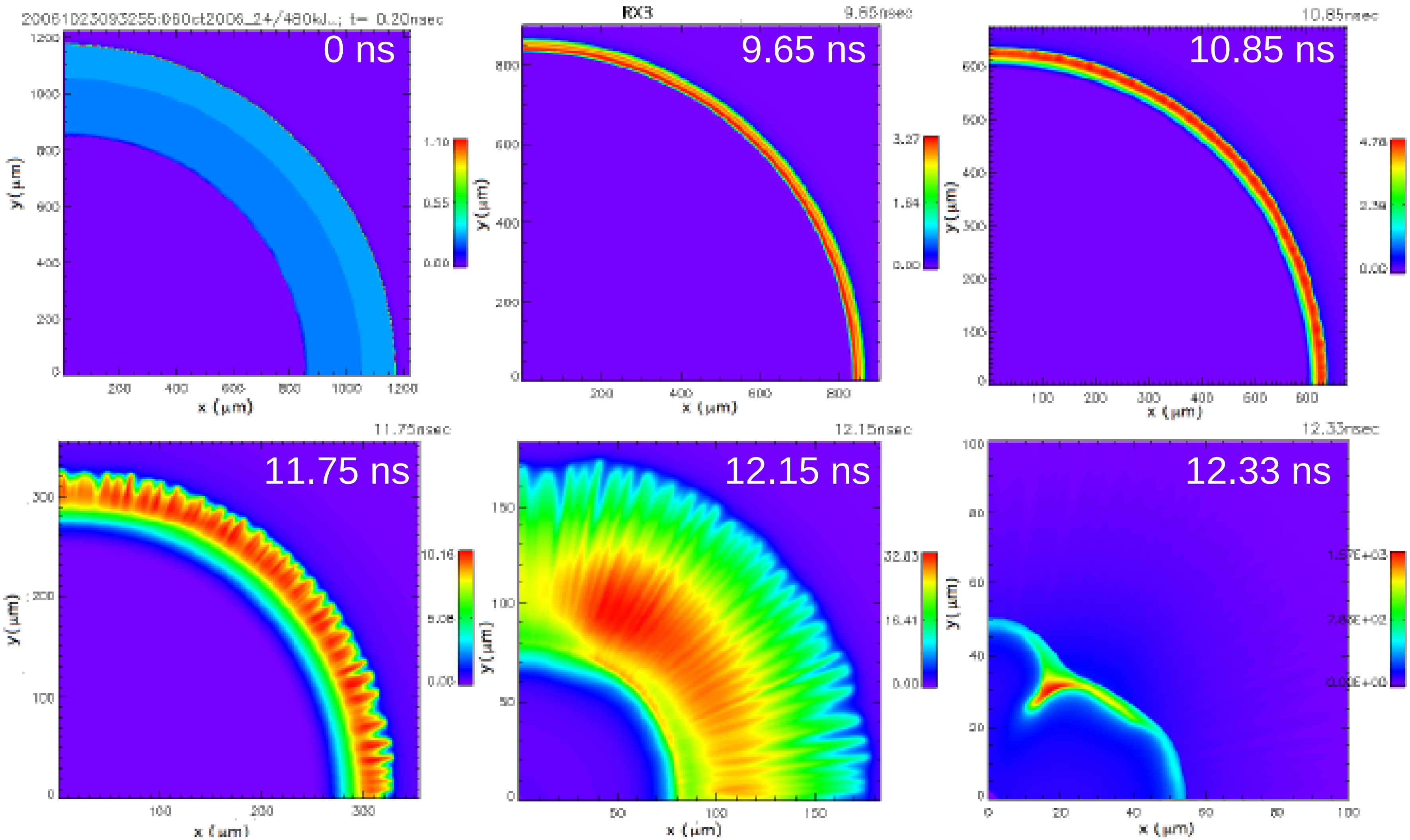
High-resolution 2D simulations with realistic perturbations predict some gain degradation.

NRL

Result: With NIF-spec.-equivalent outer surface finish, the RX3 pulse gives a yield of 27 MJ, ~90% of clean-1D yield



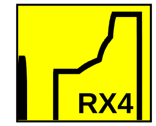
Simulations have 660 pts (r) X 2048 pts (θ) over a half sphere, and can resolve modes from 2-512.



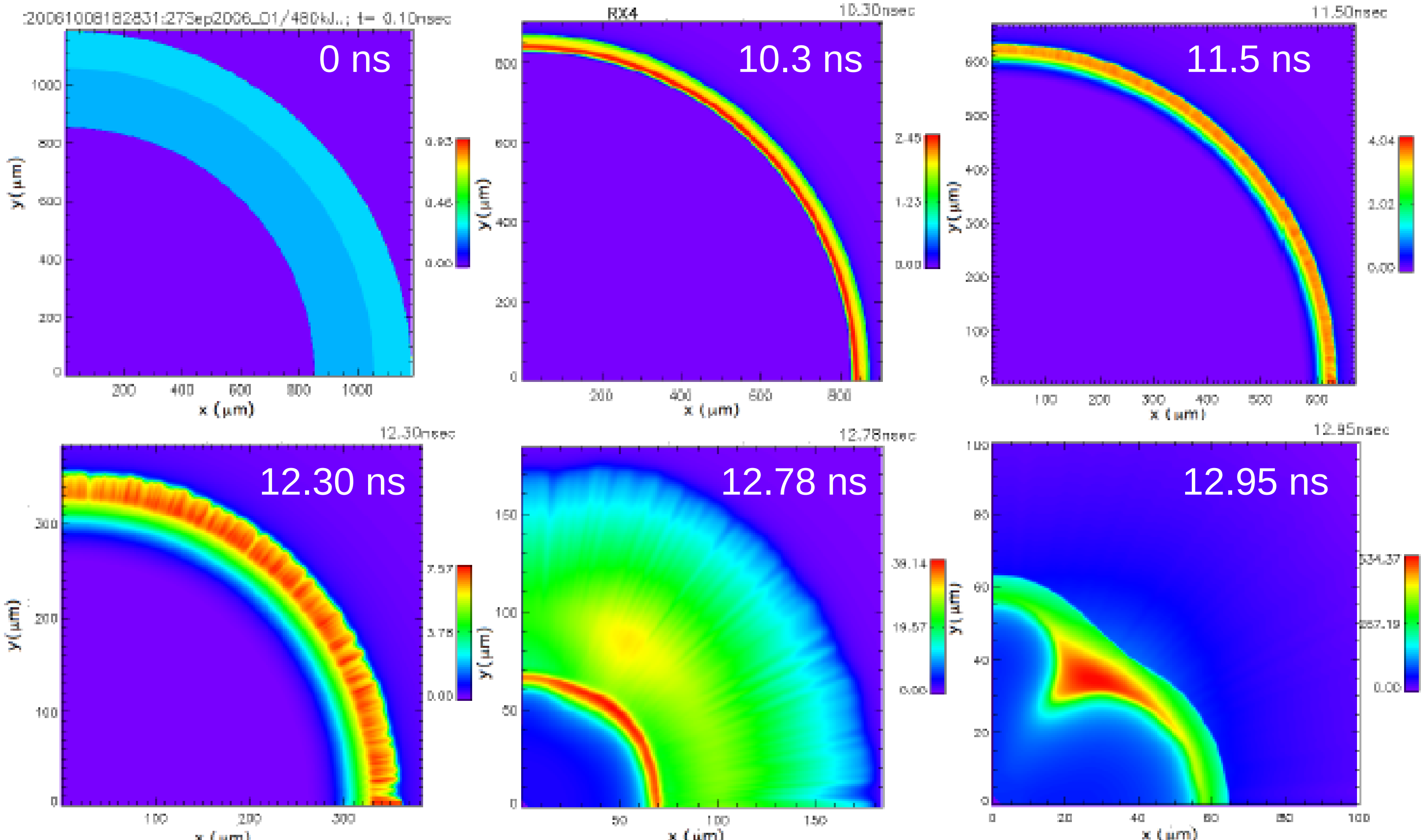
0.478 µm rms surface finish on DT/CHfoam

High-resolution 2D simulations with realistic perturbations predict more adiabat shaping can give worse results.

Result: With NIF-spec.-equivalent outer surface finish, the RX4 pulse gives a yield of 0.4 MJ, ~5% of clean-1D yield



Simulations have 660 pts (r) X 2048 pts (θ) over a half sphere, and can resolve modes from 2-512.



0.478 μm rms surface finish on DT/CHfoam

Summary and future plans

- We have shown an example of a 1/2 MJ target
  with gain ~ 57 (90 % clean) and stability ~ 1000x

- Continue target design development :

  Include more sources for seeding instability

  Add new physics package (non-local e^- transport -1D)

- Experimental testing and confirmation