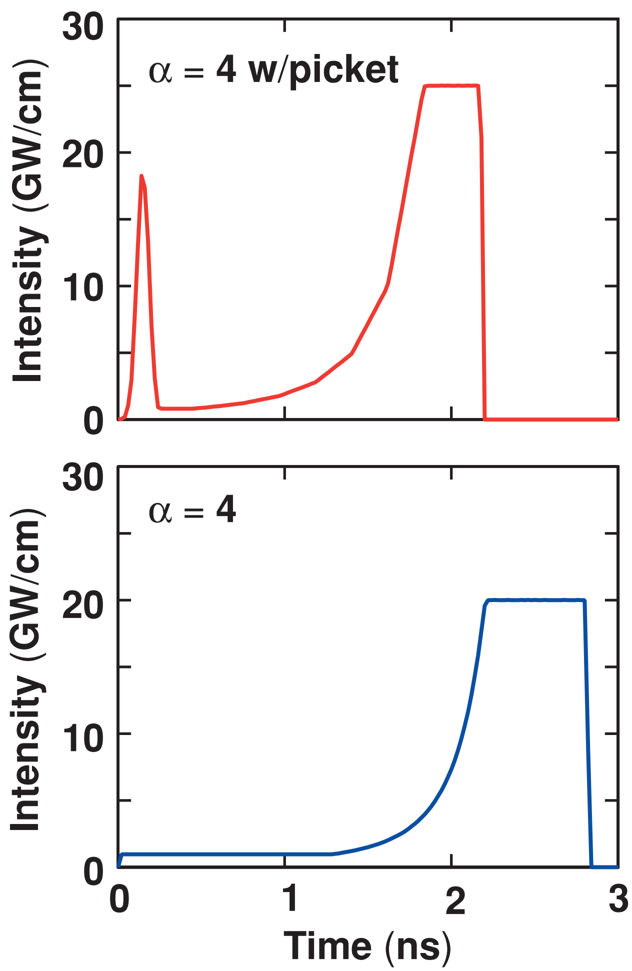
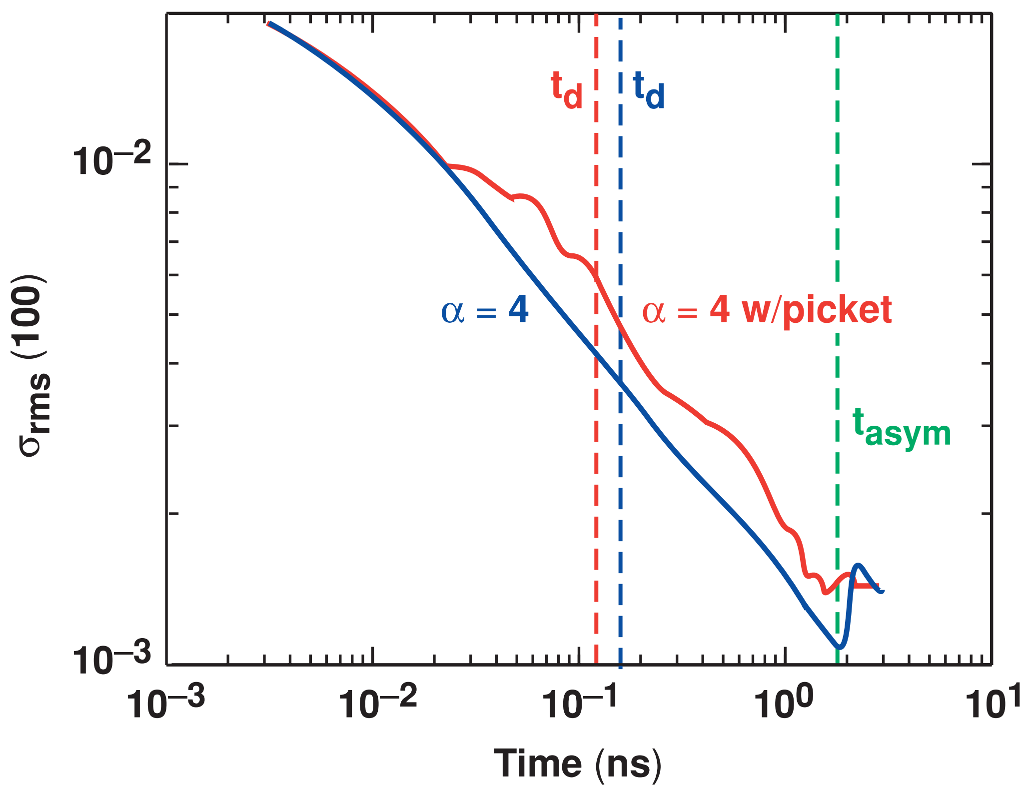
2-D SSD Model for Arbitrary Pulse Shapes Used in the Multidimensional Hydrodynamic Code *DRACO*





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Summary

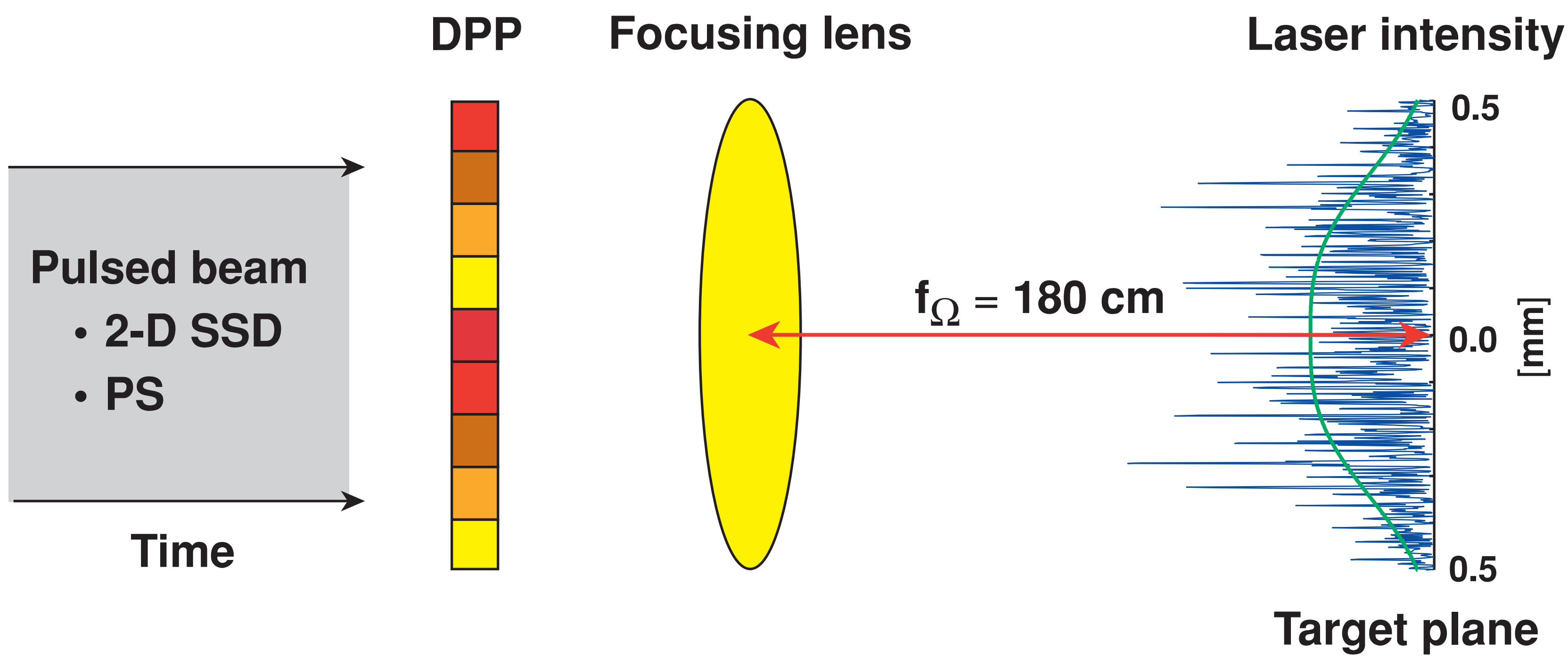
The pulse shape affects the laser nonuniformity on target

- A continuous model for 2-D SSD that accurately calculates the nonuniformity for arbitrary pulse shapes was developed.
- The model is deterministic; no need to average many runs.
- The nonuniformity predicted by the new model closely matches far-field simulations.

Outline

- Derivation of the new 2-D SSD model
- Comparison of the model with far-field simulations
- Comparison of the model with a stochastic model

SSD smoothes laser nonuniformities because the hydrodynamic response time is longer than the coherence time of the laser



- At every instant in time a speckle pattern is produced in the far-field.
- The speckle evolves continuously in time, but the pattern is statistically unique every coherence time.
- The long hydrodynamic response time causes the laser speckle field to be integrated and results in a smooth profile on target over time.

TC6093

The instantaneous nonuniformity of the laser intensity does not change in time

UR LLE

- The intensity perturbations have a fixed amplitude, but with modes that continuously change phase due to 2-D SSD:

$$I(\theta, t) = I_0(t) + \sum_{\ell} a_{\ell} \cos\left[\theta + \phi_{\ell}(t)\right]$$

$$\sigma^2_{rms}(\ell, t) = f\left(\cos\left[\theta + \phi_{\ell}(t)\right]\right)$$

- The boundary conditions in 2-D ALE codes do not readily permit this behavior.

An auxillary model for laser intensity perturbations is used for *DRACO*

- **The phases are fixed to satisfy boundary conditions while the amplitudes vary:**

$$\hat{I}(\theta,t) = I_0(t) + \sum_{\ell} \hat{a}_{\ell}(t)\cos[\theta + \phi_{\ell}]$$

$$\hat{\sigma}^2_{rms}(\ell,t) \propto \left| \int_0^t \hat{a}_{\ell}(t)dt \right|^2$$

- **A physical connection between the two laser intensity perturbation models is made by forcing the time evolution of the power spectra to match:**

$$\sigma^2_{rms}(\ell,t) \equiv \hat{\sigma}^2_{rms}(\ell,t)$$

The time evolution of the power spectrum for any ℓ-mode is related to the near-field autocorrelation

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$$\sigma_{rms}^2(\ell, t) \propto \left| \int_0^t \left(NF^* \star NF \right) dt \right|^2$$

- The near-field term NF includes a random phase plate and 2-D SSD + PS.
- Bessel function expansions are used to simplify the correlation integral.
- The pulse is linearly interpolated.
  - An exact evaluation of the correlation integral within each linear section is possible.
- The exact solution of σ_{rms}^2 is then used to solve for the amplitudes of the auxillary model $\hat{a}_\ell(t)$.

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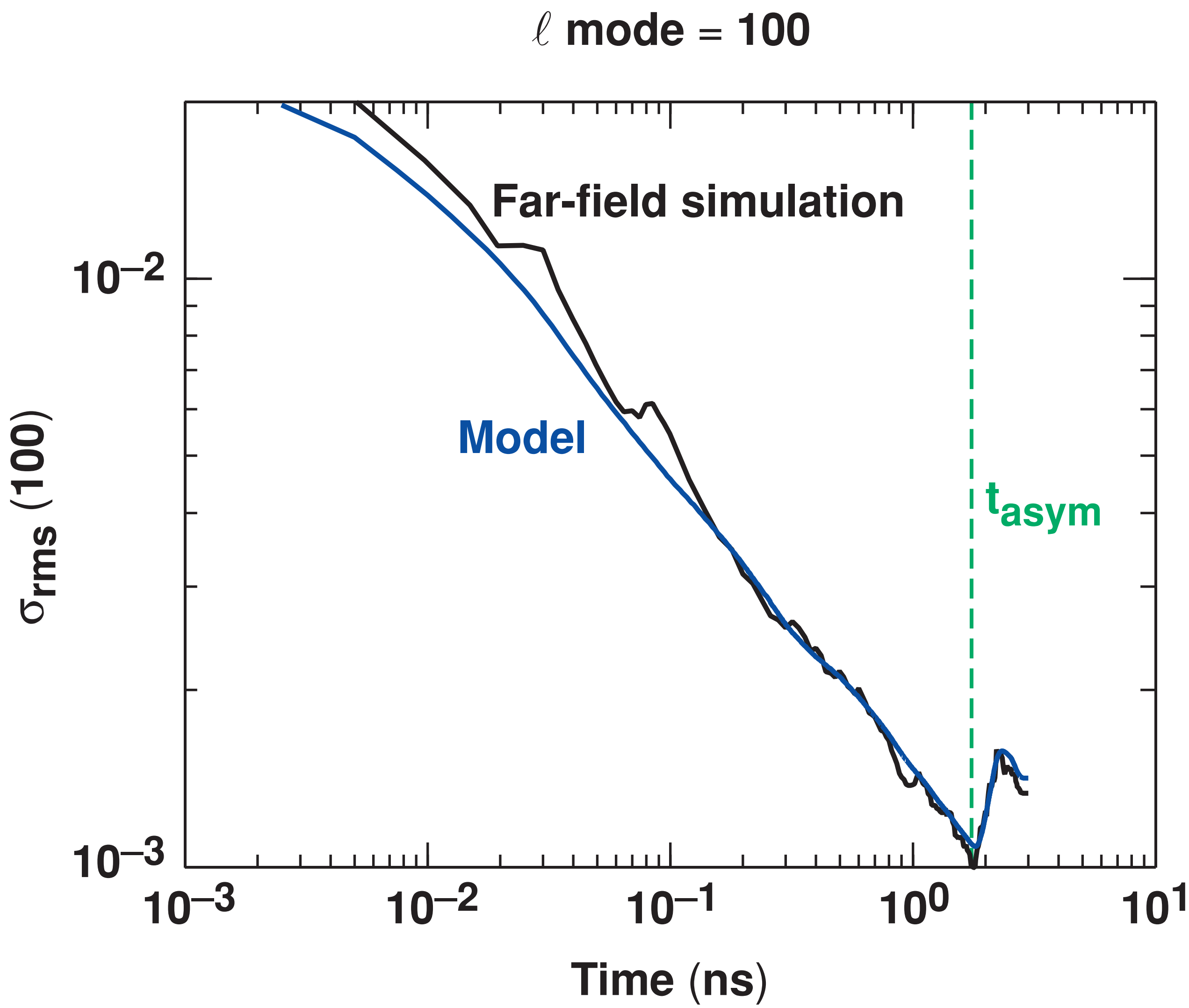
There are many advantages to the new 2-D SSD model

- Avoids the requirement of averaging multiple runs when using a flipping model.
- Continuously describes the mode amplitudes.
- Can model arbitrary pulse shapes.
- Explicitly uses the 2-D SSD parameters; not just phenomenological behavior.
- Accounts for the 2-D distribution of bandwidth.
- Much faster than calculating the mode amplitudes with a full far-field simulation.

The new 2-D SSD model matches the results of a far-field simulation of an α = 4 pulse



t_{asym} = time when asymptotic level is reached.

Far-field simulation ⇒ 10 h

Model ⇒ 1 min

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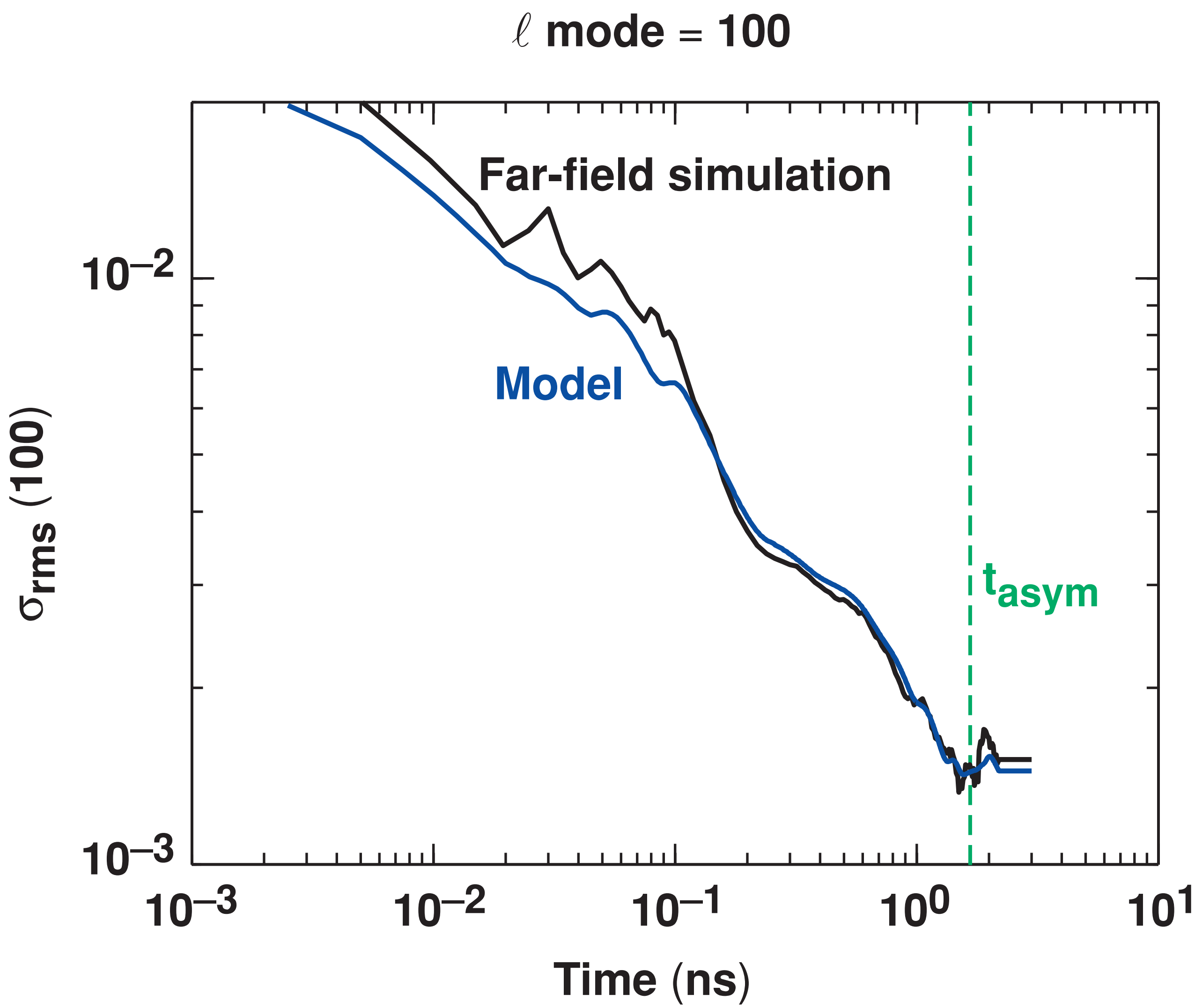
The new 2-D SSD model matches the results of a far-field simulation of an $\alpha = 4$ with a picket pulse*



t_{asym} = time when asymptotic level is reached.

TC6098

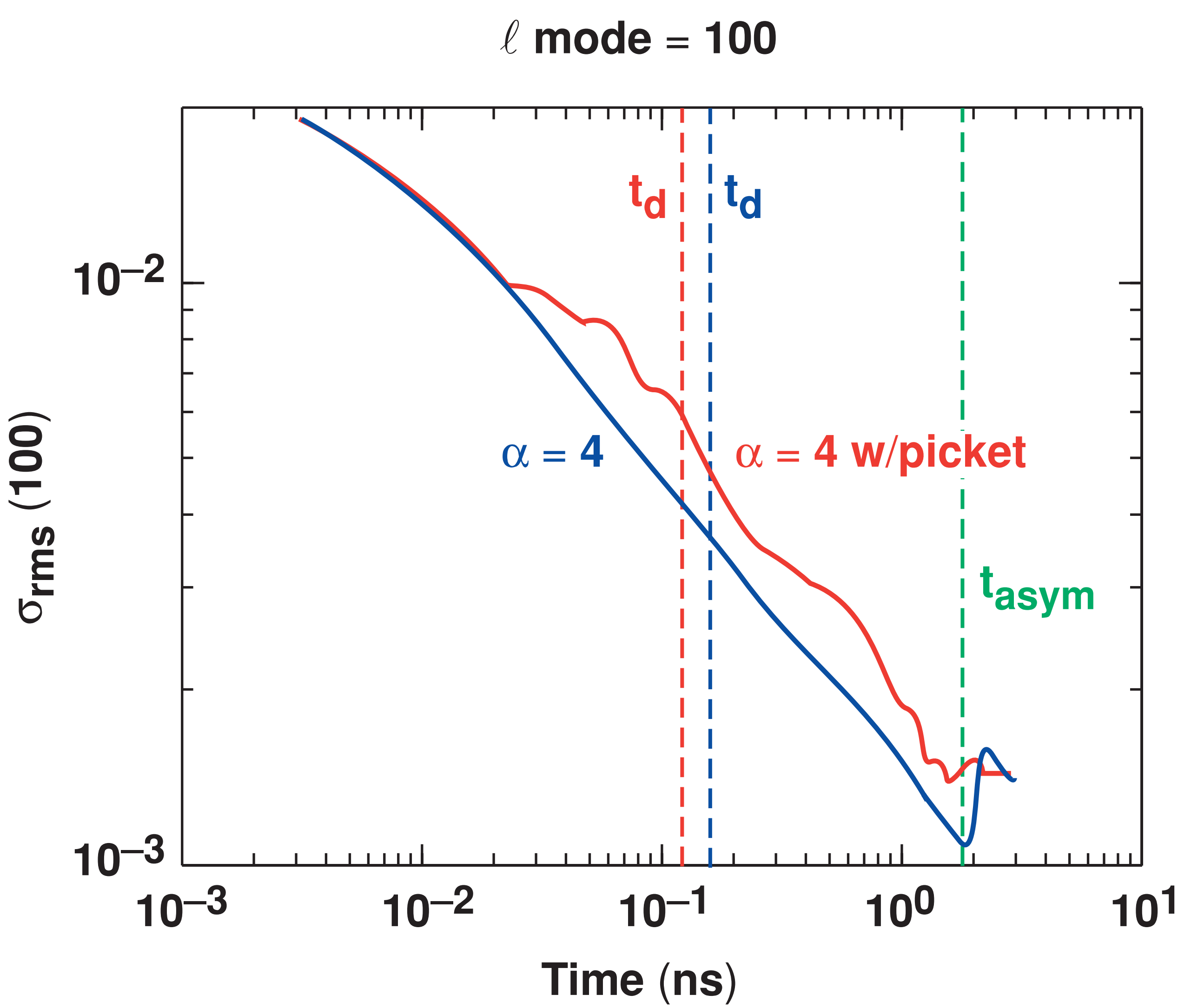
* V. Goncharov, RI1.004

The pulse shape's effect on nonuniformity can have a negative impact near the decoupling time

The fast-rising edge of the picket competes with the smoothing effect of SSD.

t_{asym} = time when asymptotic level is reached

t_d = laser decoupling time



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A random flipping model in *DRACO* compares with the new model if enough trials are averaged

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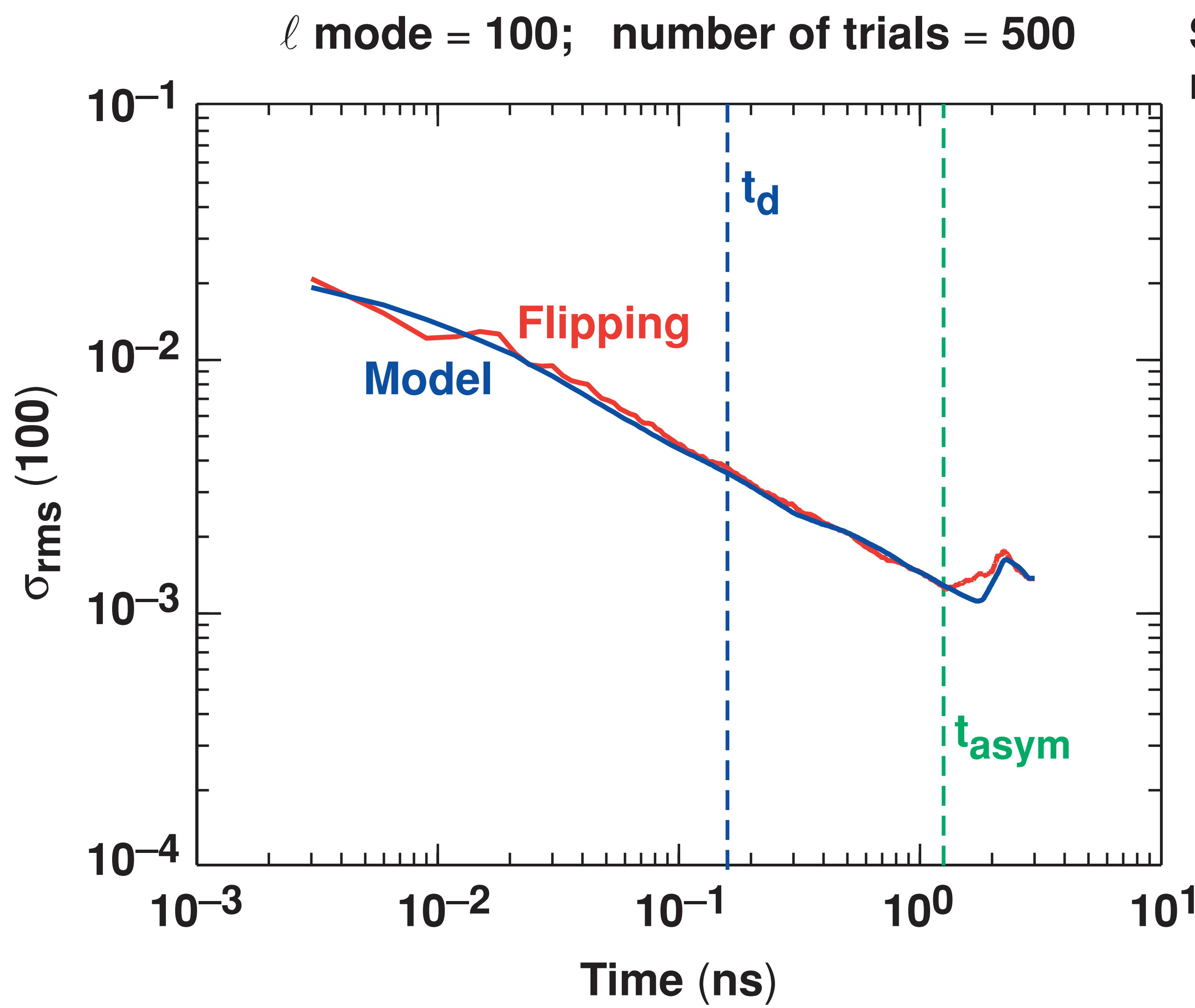

Stochastic flipping model:

- The phase is flipped every coherence time.
- The phase has flipped ~ 40 times by the decoupling time t_d.

t_{asym} = time when asymptotic level is reached

t_d = laser decoupling time

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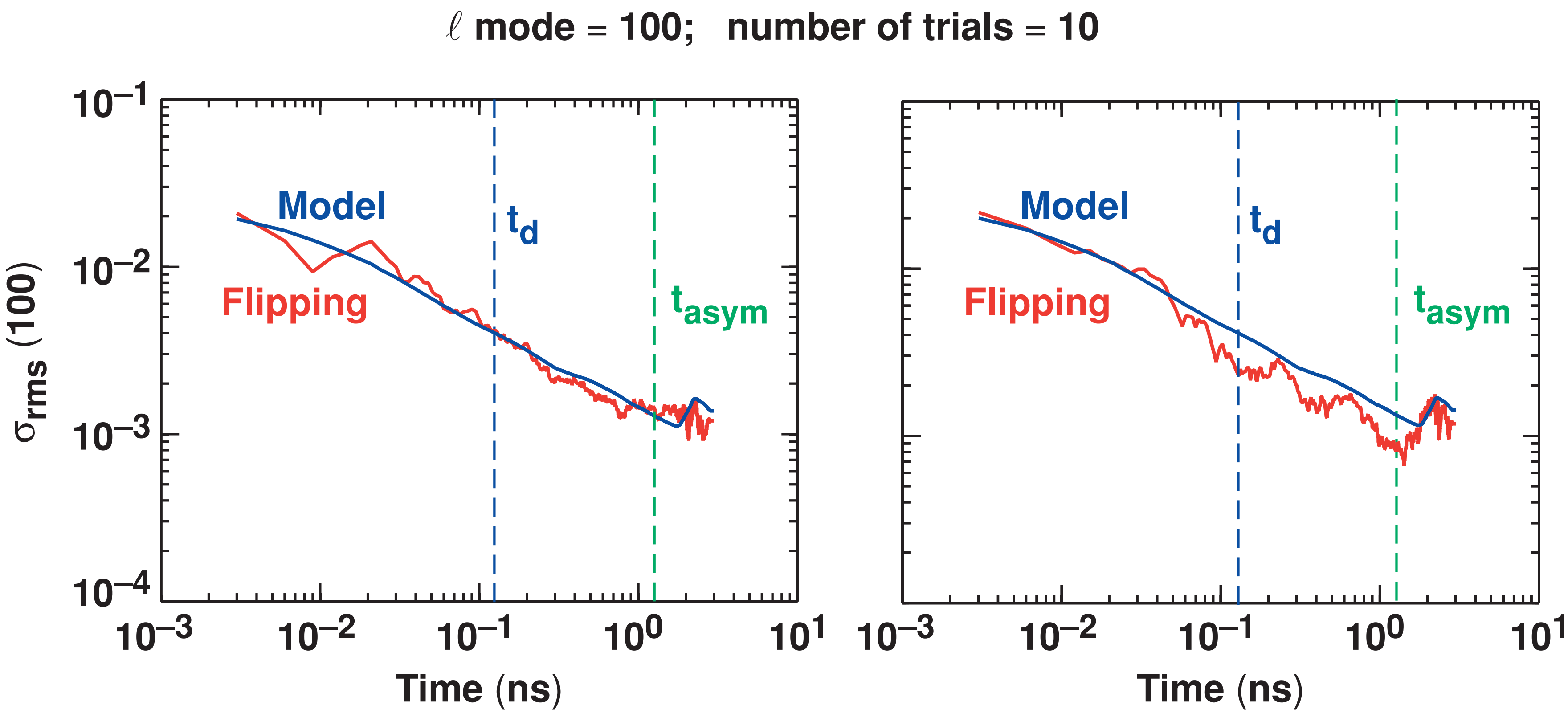
Unpredictable results occur if only ten trials are used



- Some sets of random trials can yield erroneous nonuniformity levels near the decoupling time t_d.

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Summary/Conclusions

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