

# Simulated and Measured Electron Thermal Transport with Varying Stochasticity

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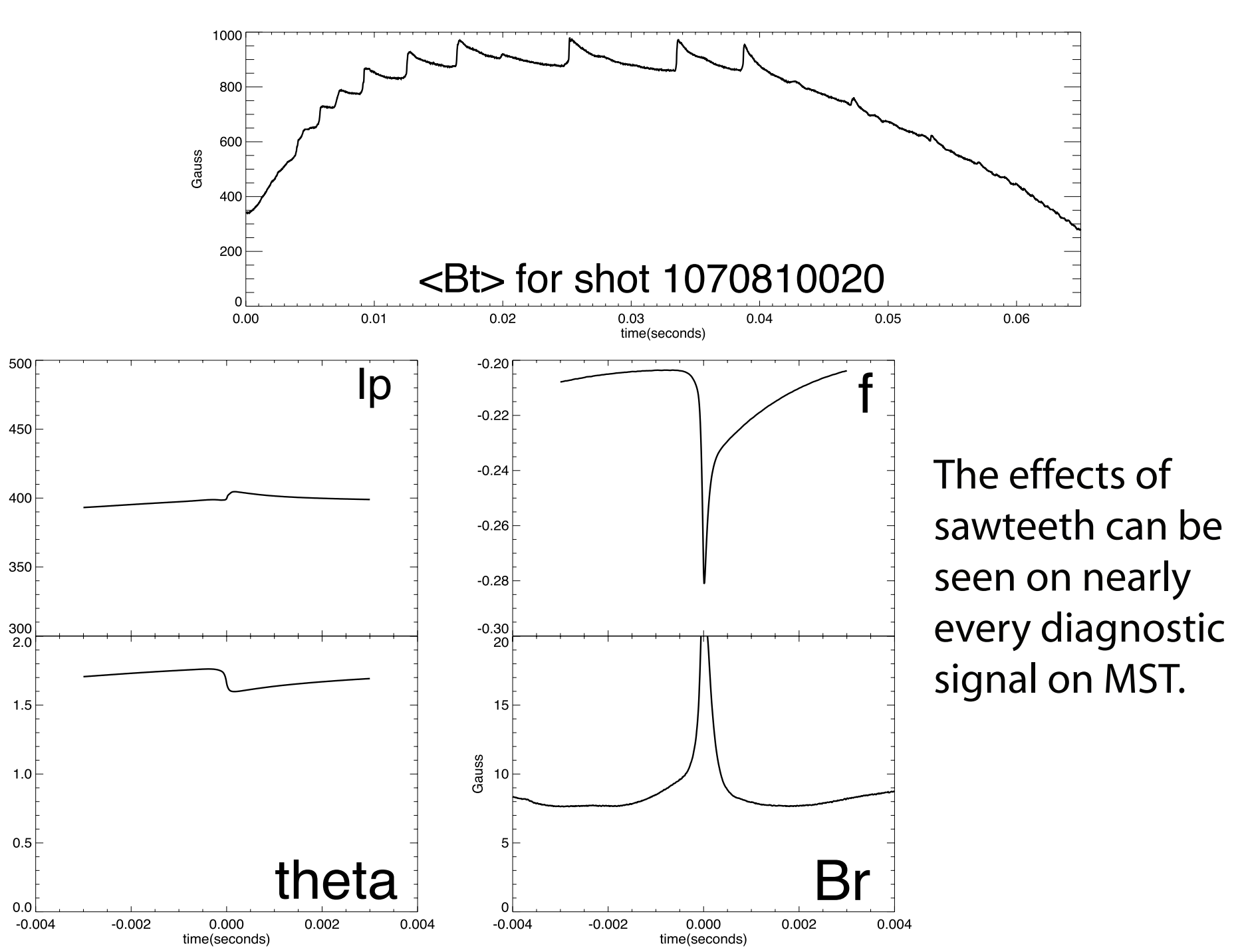
## Sawteeth in MST

### Outline

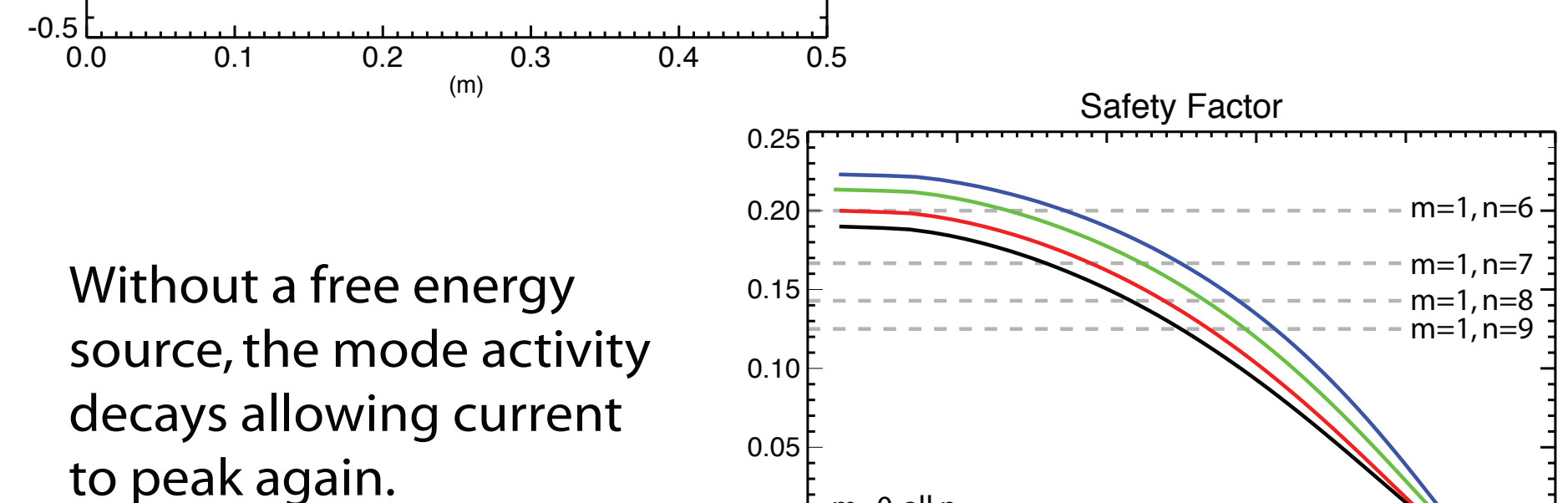
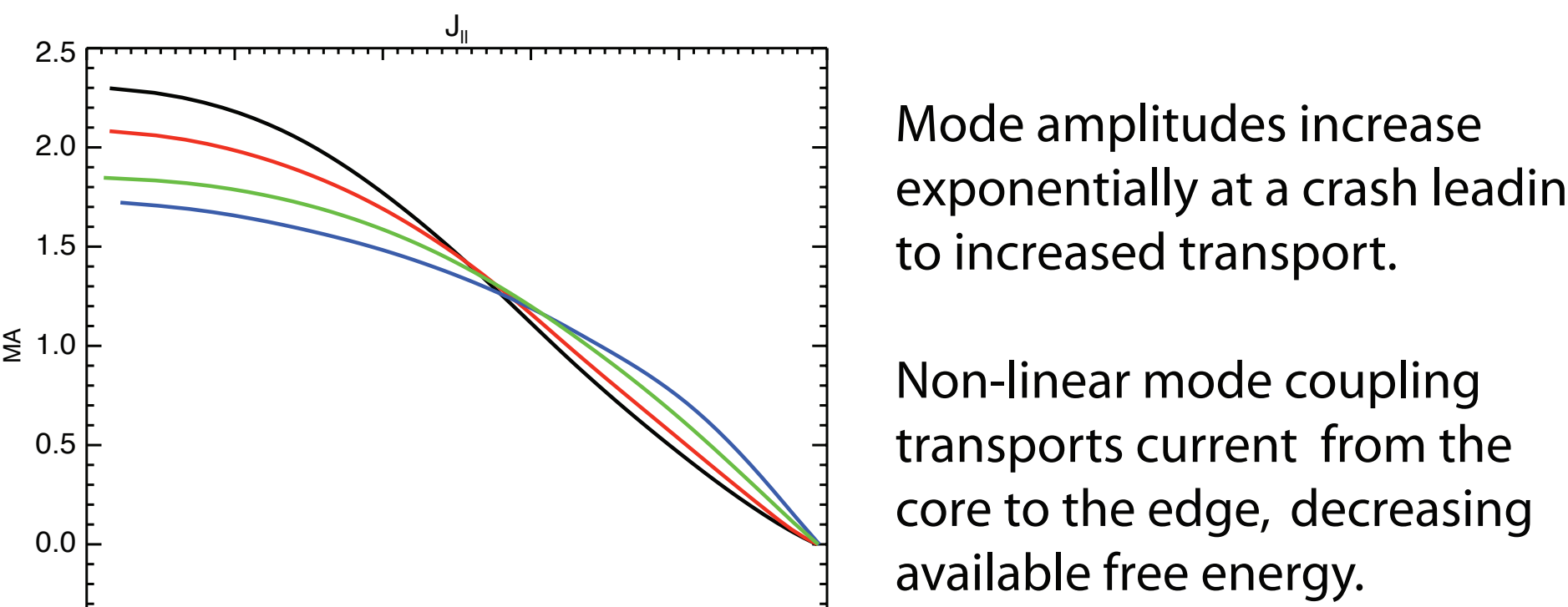
- Introduction to a sawtooth event in MST
  - The basic MST sawtooth
  - The effect of the dynamo
- Comparison of the experiment to Debs for two different fixed resistivity profiles
  - Introduction to Debs
  - Sawtooth evolution of equilibrium quantities of interest
- Comparison of experiment to Debs mode behavior
  - Mode spectra before, during, and after the crash
  - Comparison of time evolution of modes
- Comparison simulated to measured electron thermal diffusion
- Summary and Future Work

### Review of Sawteeth in MST

A dynamo electric field is needed to maintain the RFP equilibrium against resistive decay. Sawteeth in MST are discrete dynamo events that sustain the toroidal magnetic field.



The sawtooth even effects the gap voltages, changing the sign of the poloidal loop voltage implying power is actually coming out of that circuit.

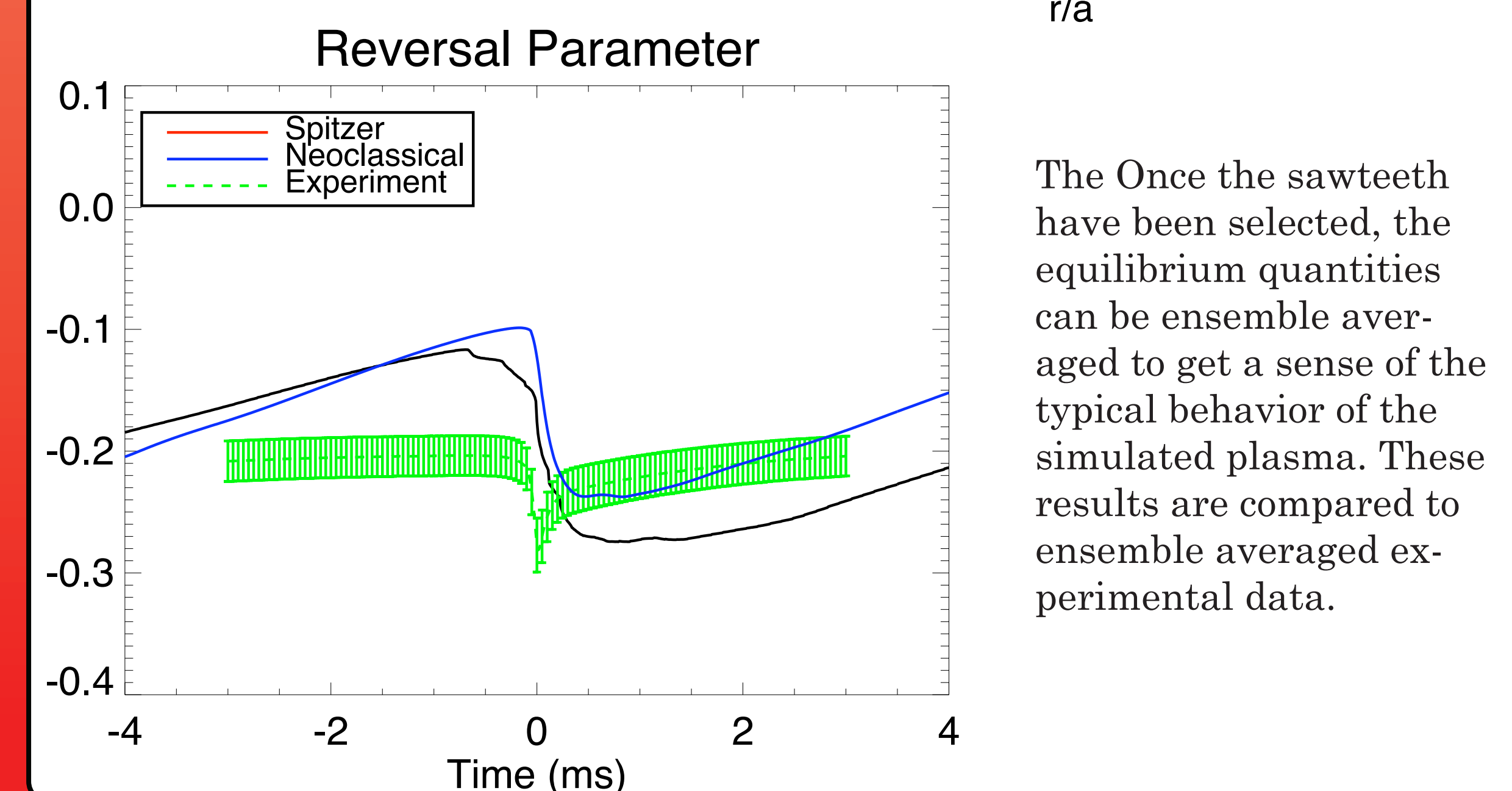
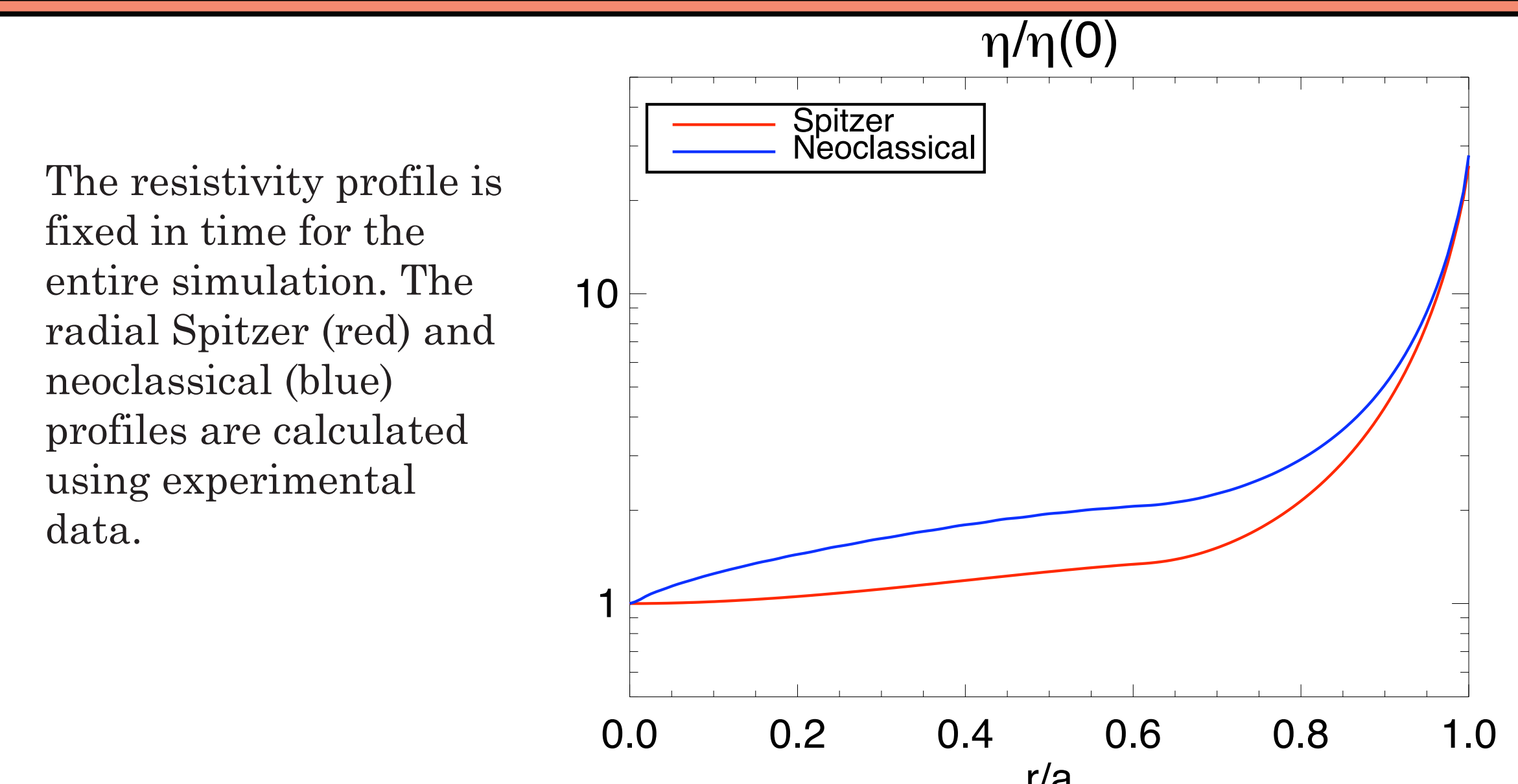
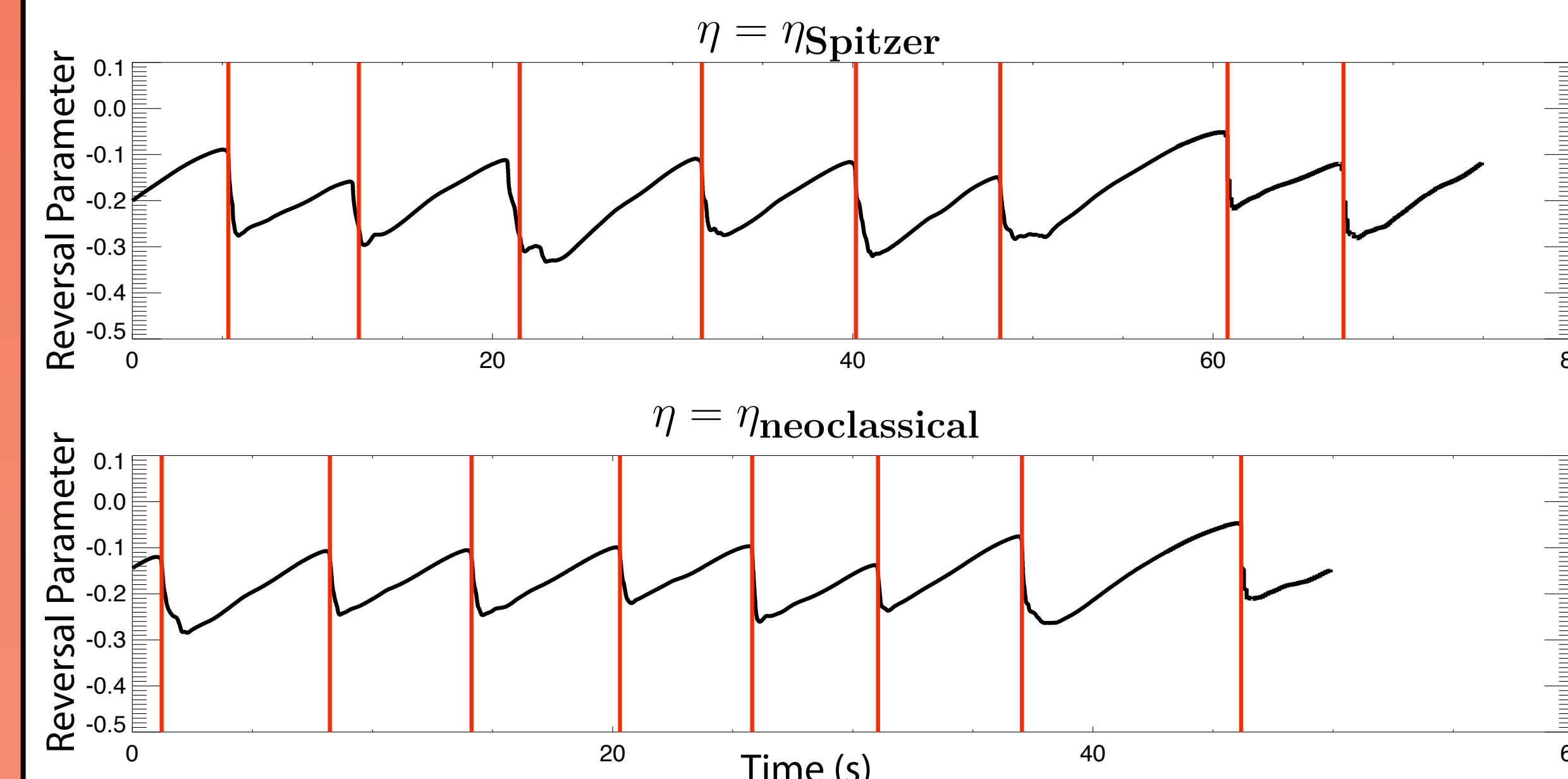


Without a free energy source, the mode activity decays allowing current to peak again.

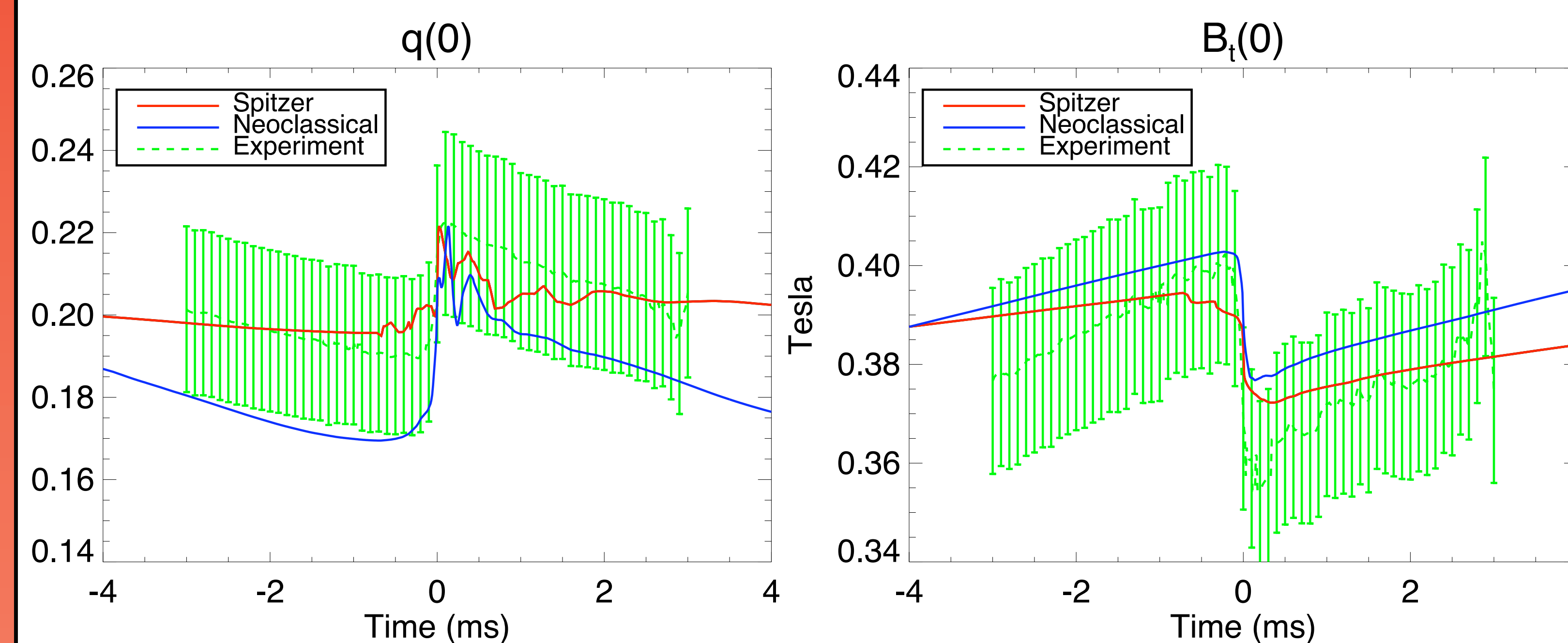
## Sawteeth in Debs at $S=3.8 \times 10^6$

- Debs is a 3-D resistive MHD code.
- Two resistivity profiles were used
  - A Spitzer resistivity calculated from experimental data
  - A neoclassical resistivity from experimental data
- A Lundquist number of  $3.8 \times 10^6$  and Prandtl number of 100 were used
- The simulation is run until many sawteeth are observed
  - The sawteeth are ensembled
  - The ensemble averaged quantities are compared to a sawtooth ensemble of experimental data
- The Rechester-Rosenbluth electron thermal diffusion is calculated using  $\chi_{eRR} = \pi V_{th} L_{eff} f_{\theta}^2 / B^2$  and compared to the thermal diffusion found in experiment

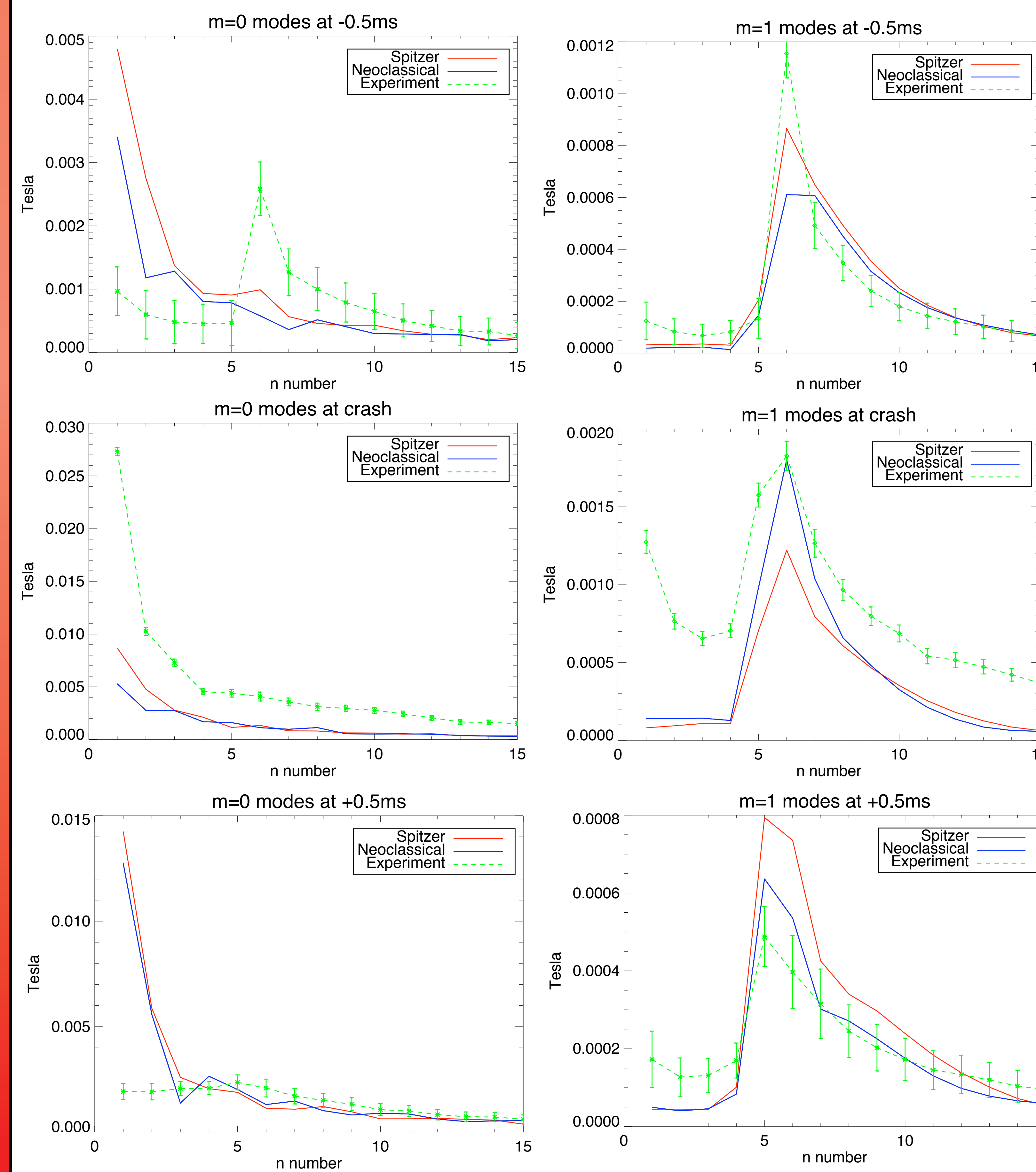
### Ensembled Sawteeth from Debs



### Comparison of Equilibrium Evolution

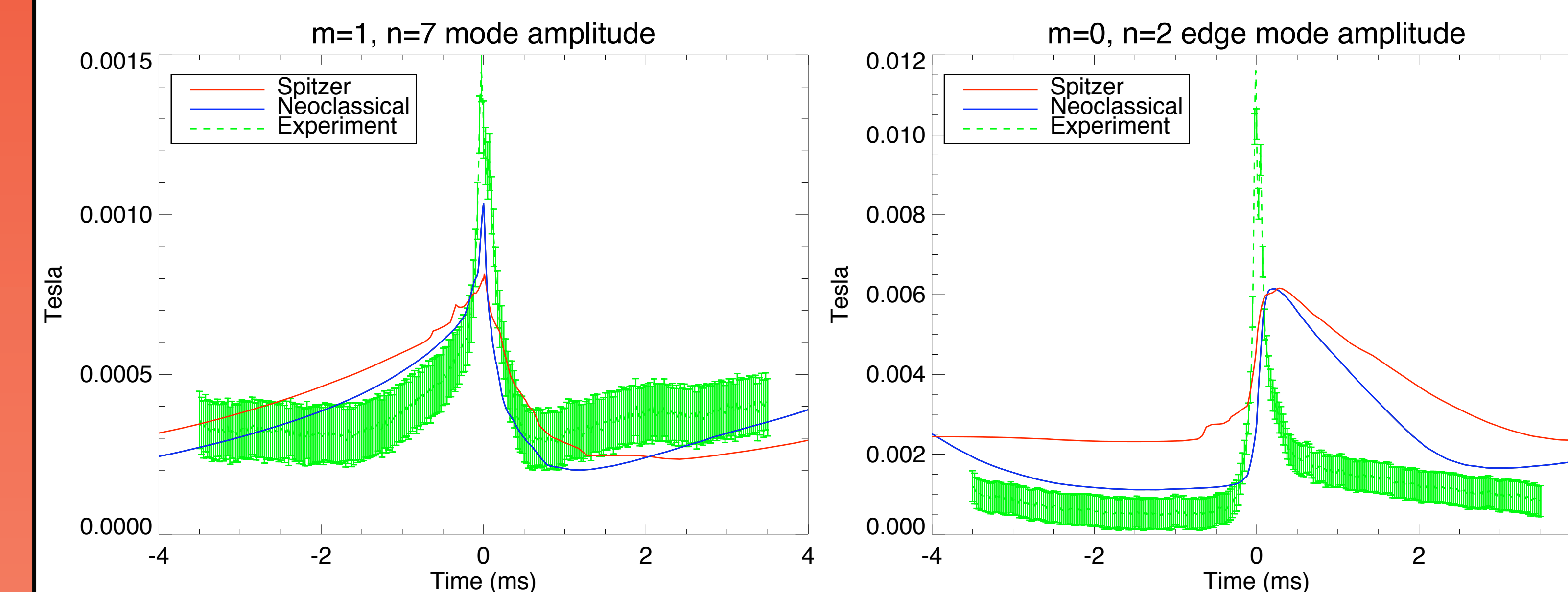


### Mode Spectra Comparison



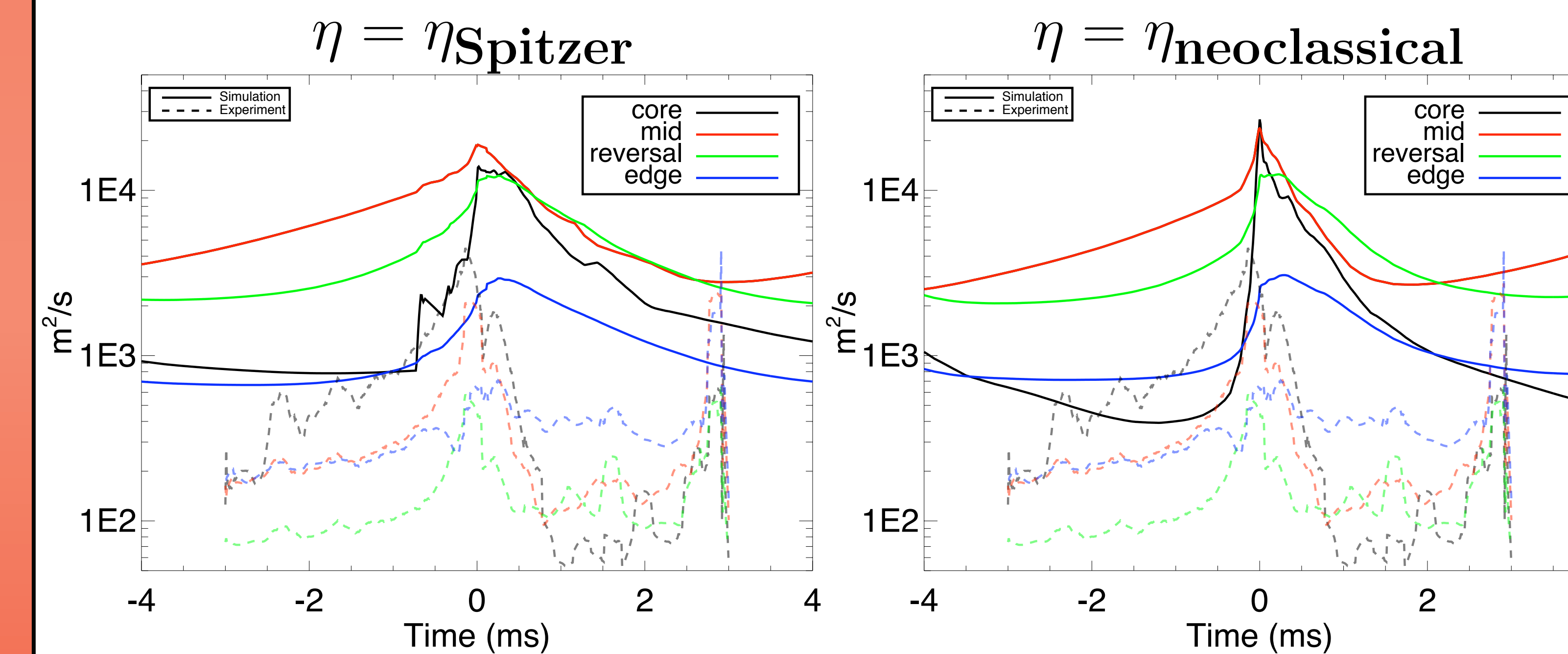
### Sawtooth Evolution of Modes

- Edge measurements of  $m=1$  mode amplitudes are well reproduced.
- Edge measurements of  $m=0$  mode amplitudes are significantly higher in simulation than in experiment except right at the sawtooth crash.



### Sawtooth Evolution of Thermal Diffusion

- Assuming a fully stochastic magnetic field, the thermal diffusion can be approximated by the Rechester-Rosenbluth thermal diffusion  $\chi_{eRR} = \pi V_{th} L_{eff} f_{\theta}^2 / B^2$
- This approximation overestimates the measured thermal diffusion (found via power balance) with the exception of near the sawtooth crash in the plasma core.



### Conclusions

- Debs has been run at Lundquist numbers matching those of the MST RFP with both a Spitzer and a neoclassical resistivity
- The neoclassical resistivity profile best reproduces the global behavior seen in experiment
- In general the mode behavior of MST is well reproduced by both simulations with the exception of the low  $m, n=0$  modes which are consistently overestimated
- The Rechester-Rosenbluth model overestimates the thermal transport in all cases

### Future Work

- Use the field line tracing code MAgnetic Lines to find the thermal diffusion to parallel loss along diffusing field lines  $\chi_{e,par}^{total} = V_{th} D_{mag}$
- Look more closely at the  $\chi_{eRR}$  calculation to determine what is causing it to be so far off from previous results

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