Nanoflare on Kinetic Scale: Spectra for the smallest scales

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Problems with Large Scale Simulations

- Each cell in the simulation represents an "average" of the behavior of the cell.
- The physics on the smallest grid scale is governed by numeric.
  - Even when the smallest scales are covered by the theoretical models your numerical method will have limitations.
  - More complex with adaptive griding.
- For MHD there is no smallest scale from the mathematical view, you cannot expect grid convergence.

A Scale Too Small?

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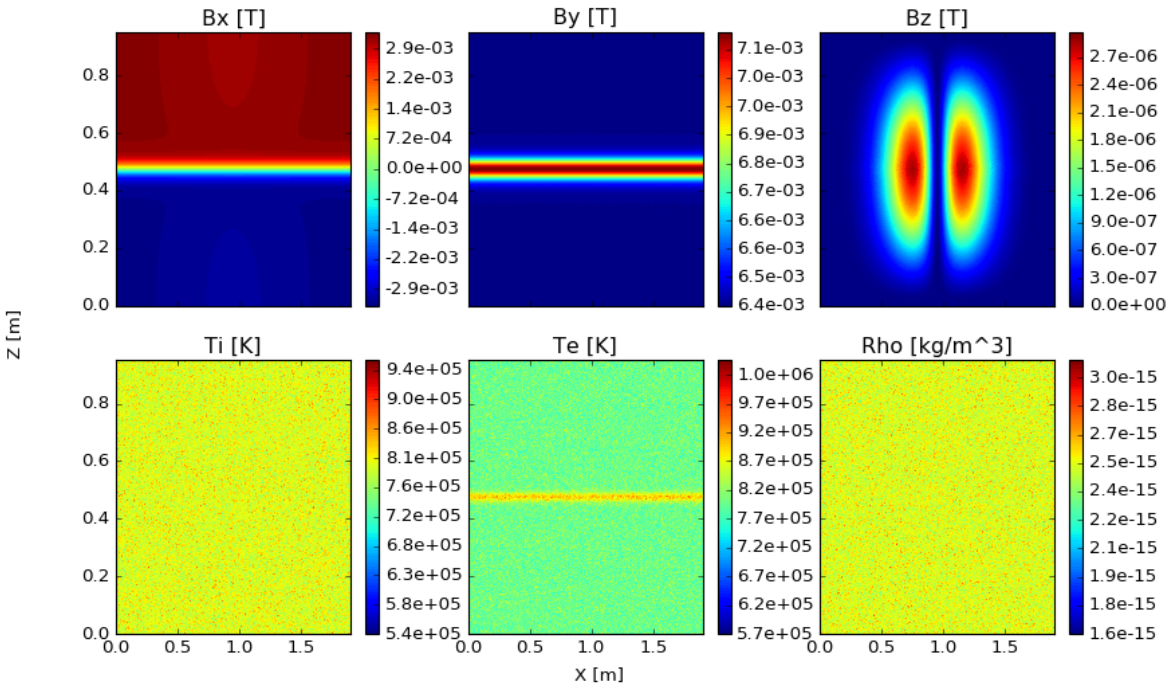
- Sub-grid or parameterized models will not govern all the physics on the smallest scale.
- On the smallest scale we can get the physics correct.
- When we understand what to expect on the smallest scale we can go to larger scales step by step to understand what to expect for sub grid structures in large scale simulations

PIC Simulation Parameters

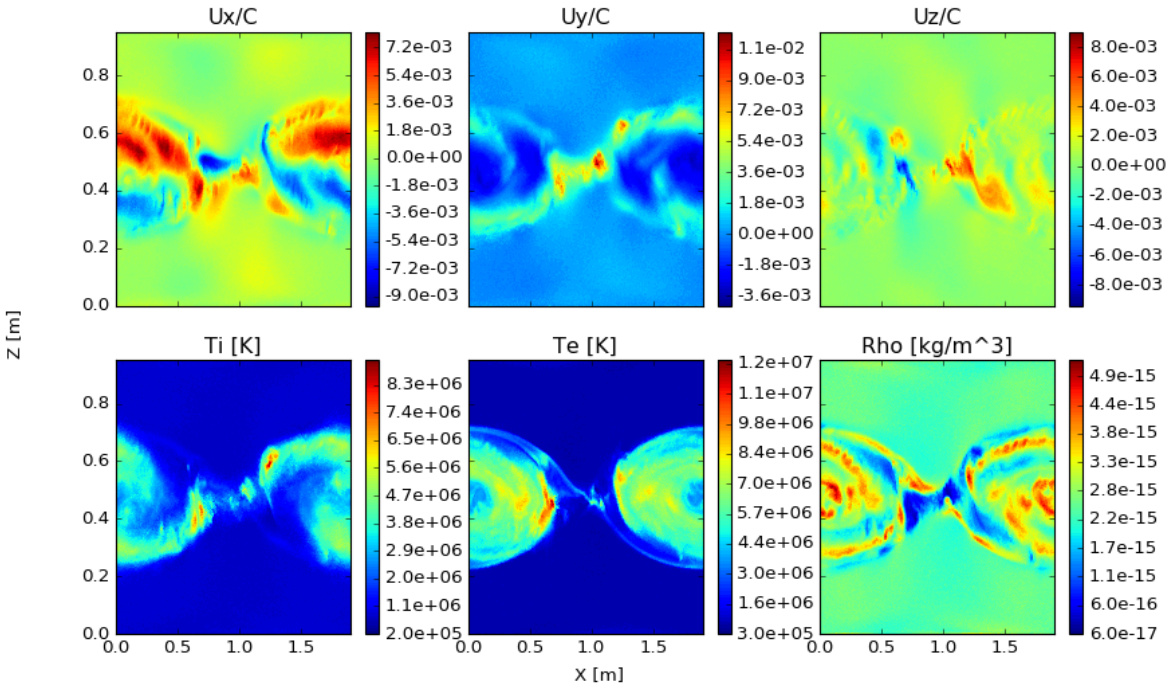
- T = 8e5 K
- rho = 2.5e-15 kg/m^3 = 2.5e-18 g/cm^3
- n_e = 1.5e6 cm^{-3}
- B_{shear} = 2.9e-3 Tesla = 29 G
- B_{guide} = 6.4e-3 Tesla = 64 G
- B_{tot} = 7.0e-3 Tesla = 70 G
- Θ = 48 degrees (total rotation across sheet)
- Box dimension = 1.9m x 0.95m
- Current sheet half width = 10 cm
- 1024x124 cells with 100 particles per species per cell

PIC Simulation t=0



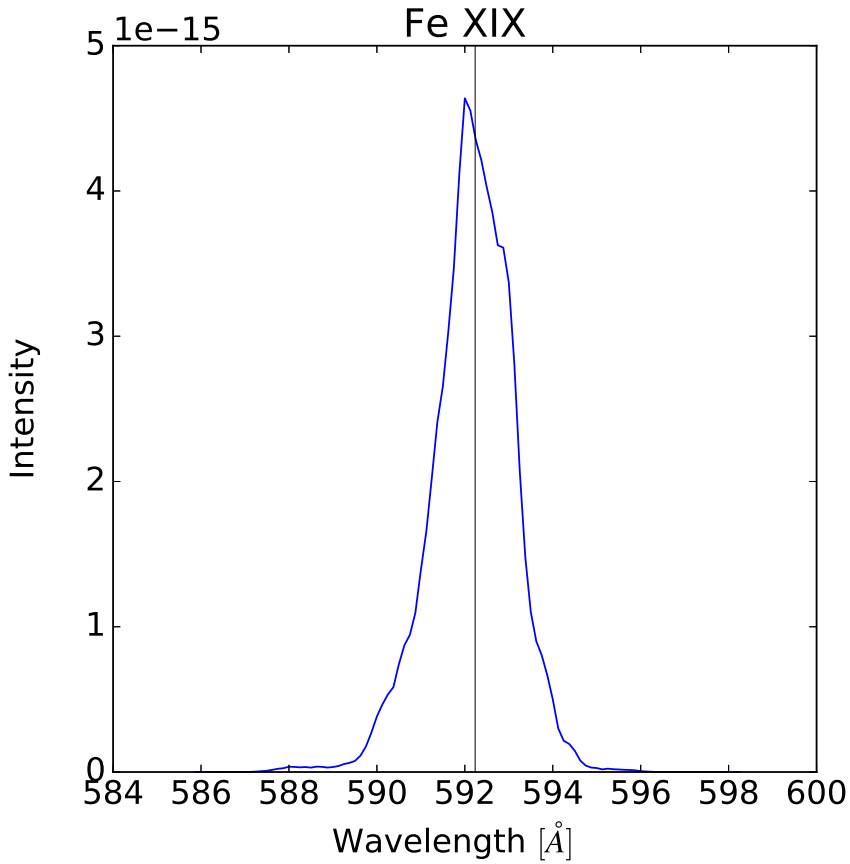
- Coronal conditions, SI units
- Initial perturbation in B_z

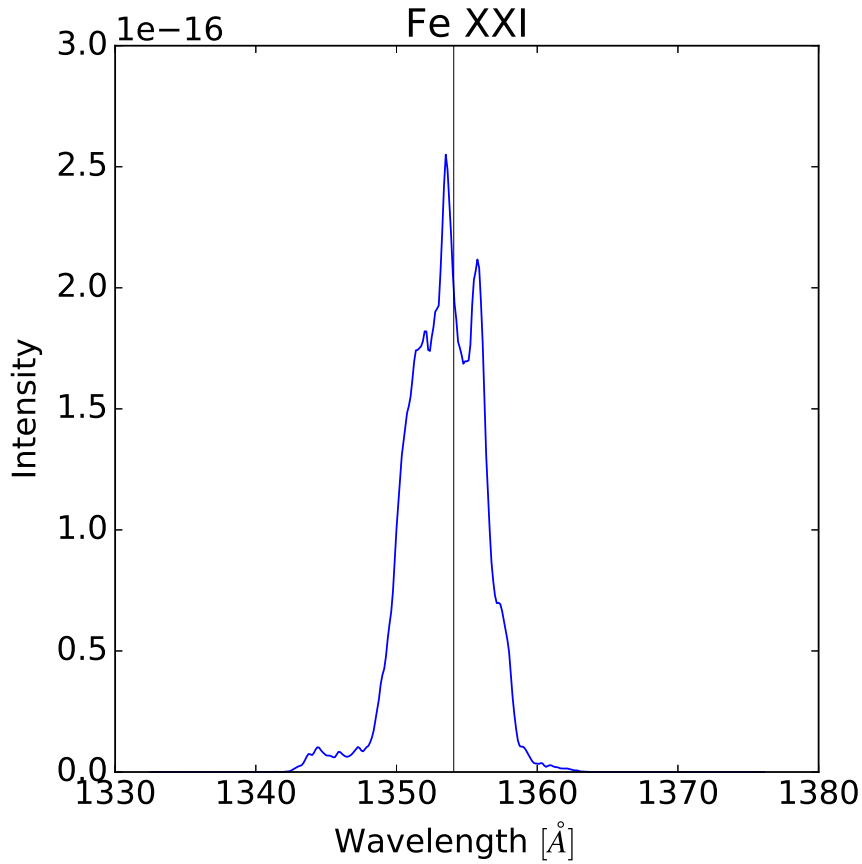
PIC Simulation t=90μs



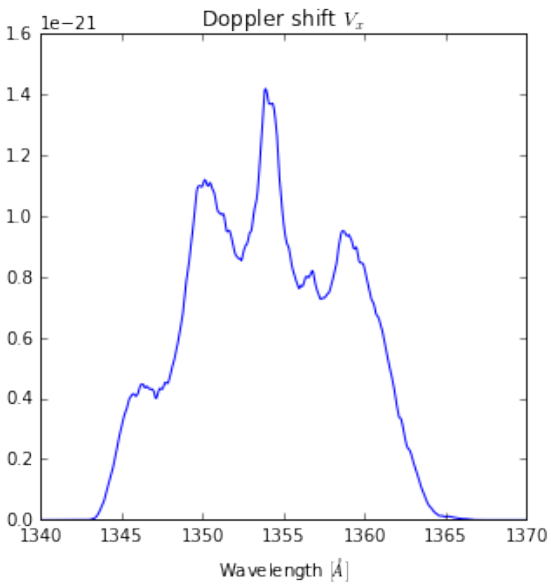
- Highly dynamic
- time = 18 electron cyclotron periods (90μs)

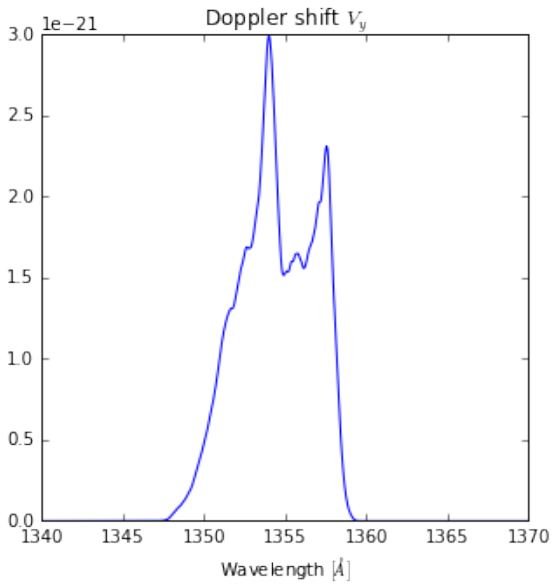
Fe XIX and XXI Spectra

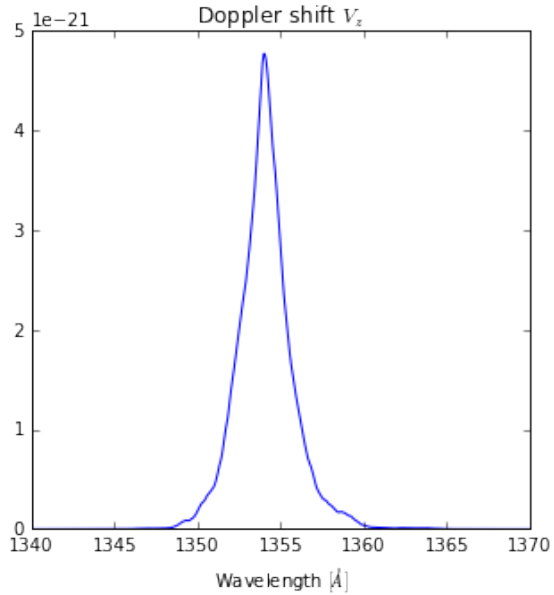




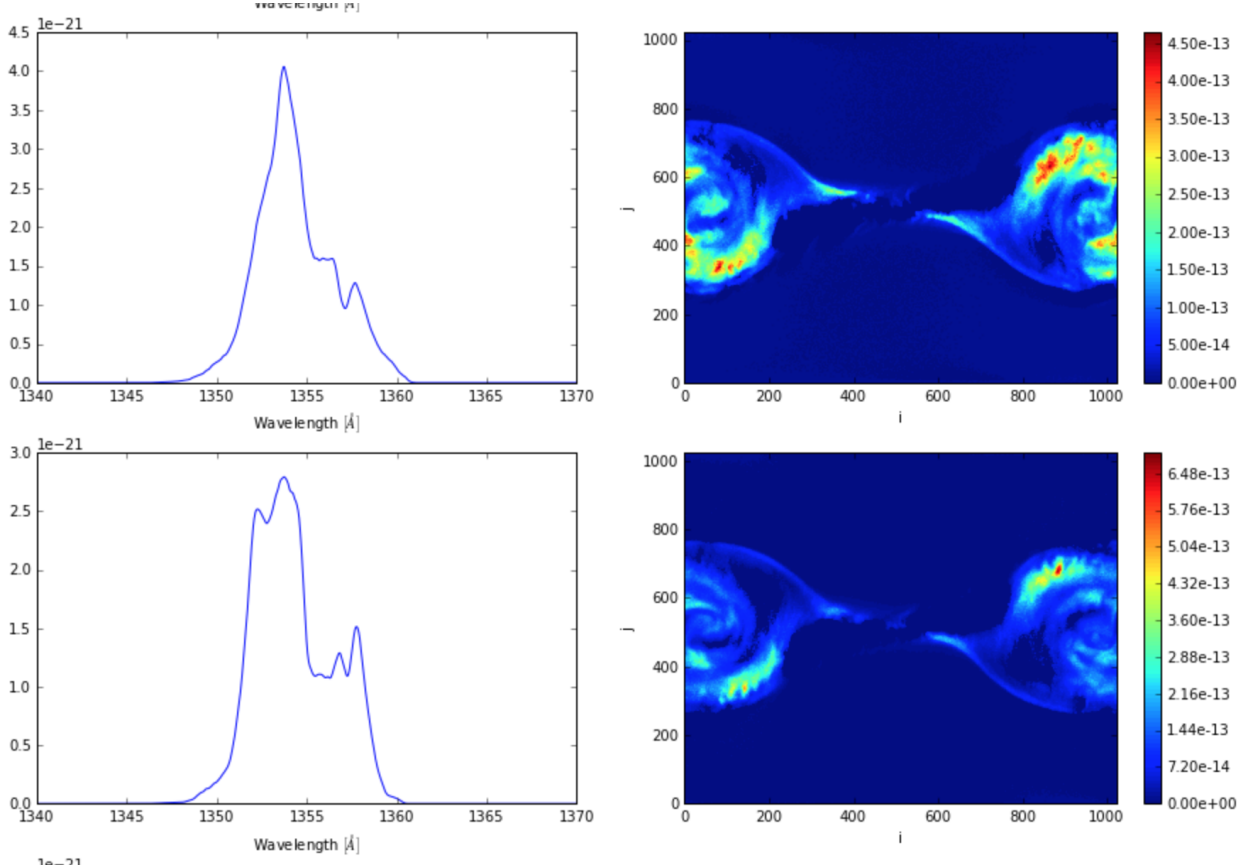
Fe XXI and Doppler effect, Ui_x, Ui_y, Ui_z







Fe XXI Intensity Time Variation



- Highly dynamic in time
- One electron cyclotron period time difference
- Normelized units

Future Work

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- What plasma densities/temperatures can we reach? Its distribution?
- What is the particle distribution? (seed population for particle tracing in large scale simulations)
- Make prediction for sub gird scale spectra for large scale simulations.