Implementation of Boosted frame capability in OSIRIS

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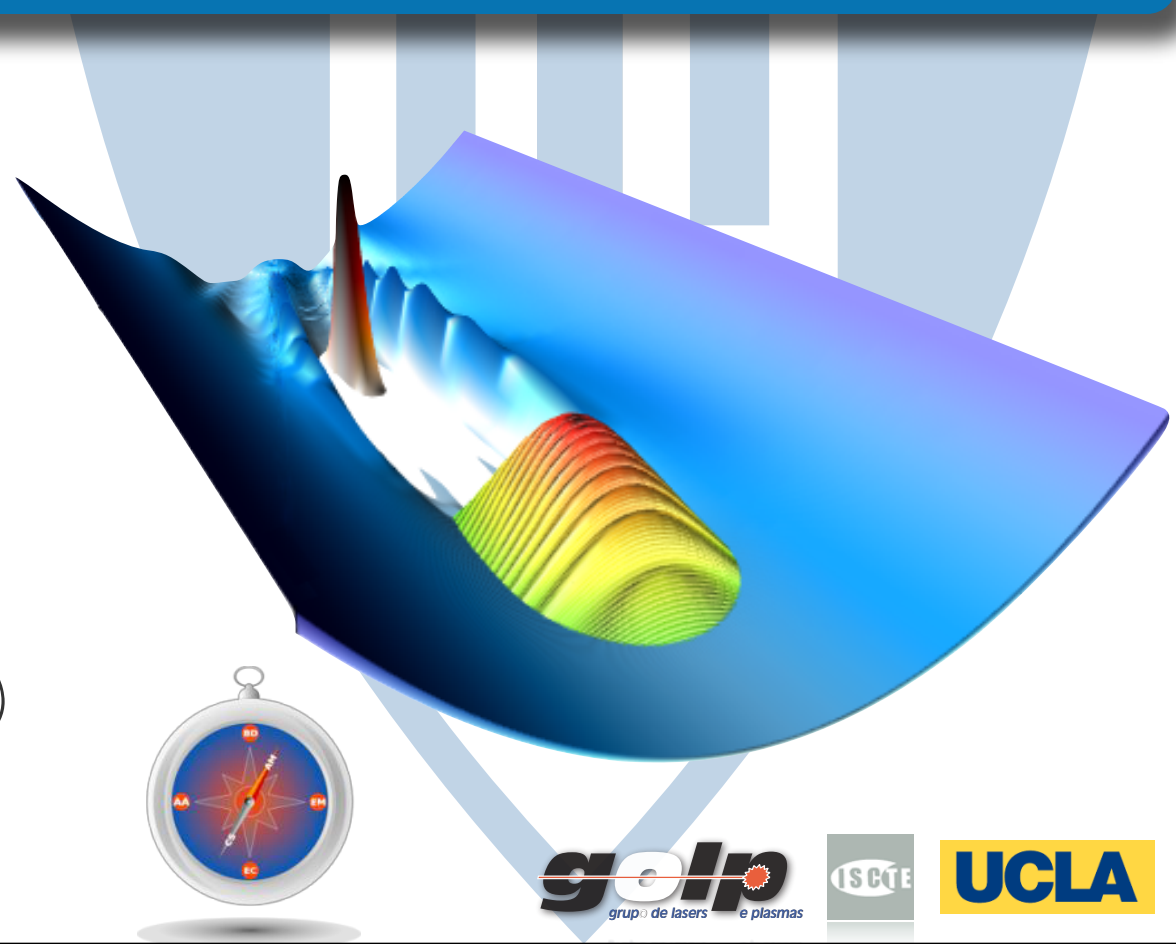

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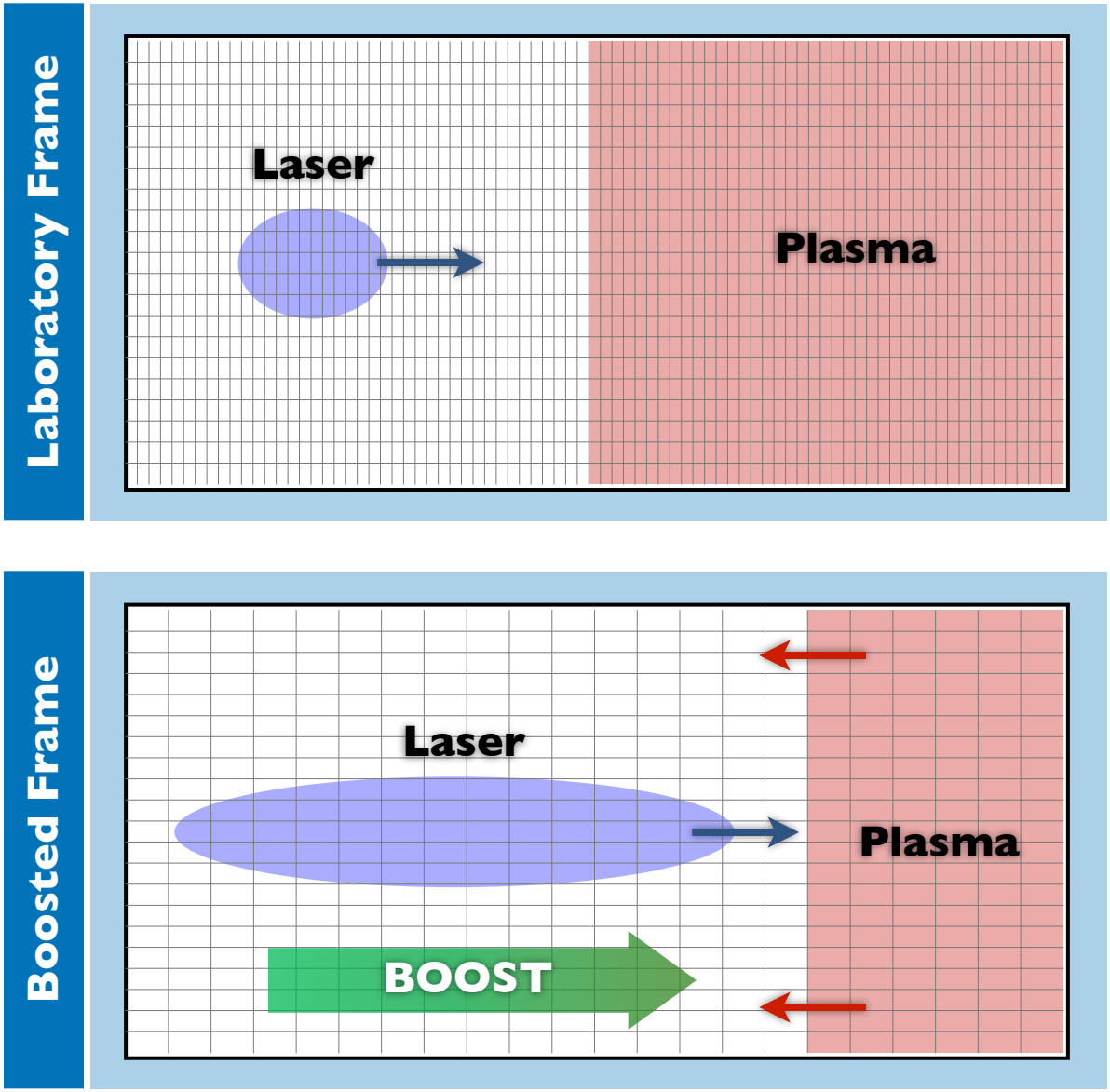
Boosted Frames in LWFA simulations



Resolution gains

Particles

- Resolution: $\beta)$
- Plasma contribution: γ

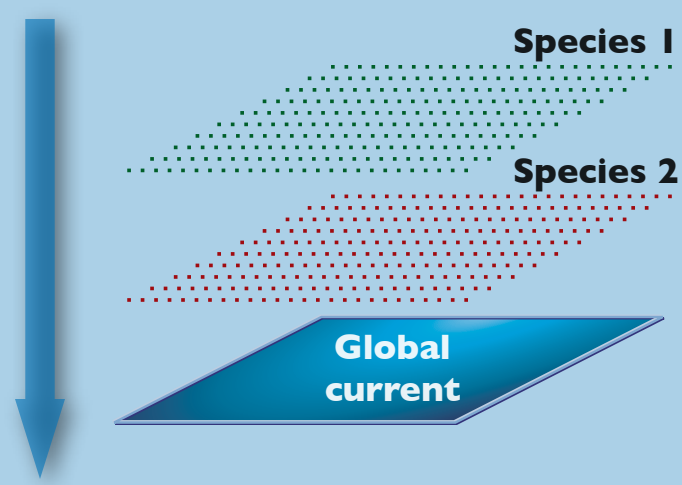
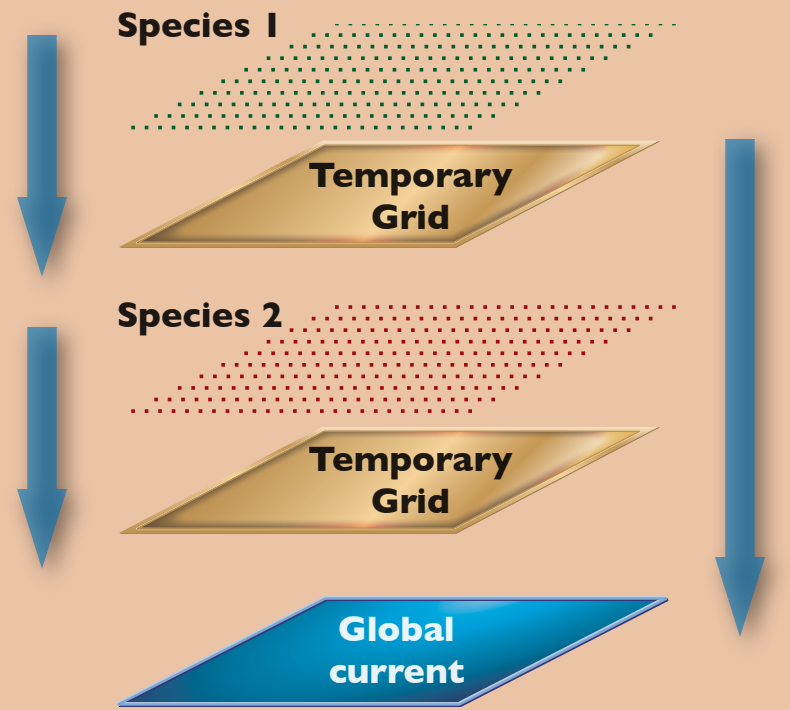
Moving window in Lab Frame

Time steps

- Time step: $\gamma(1+\beta)$
- Total time: $\gamma(1+\beta)$

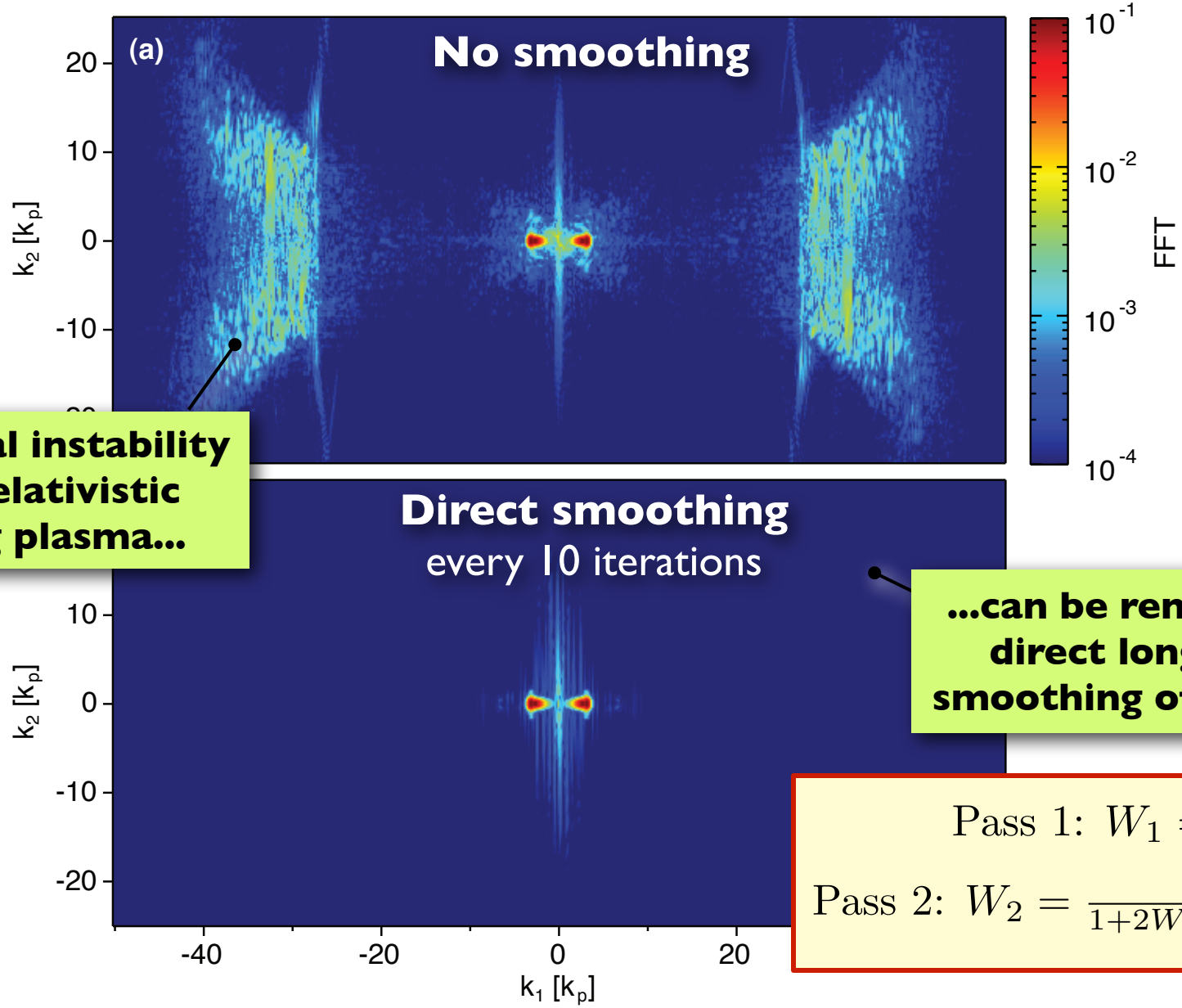
Total: $\gamma^2(1+\beta)^2$

Moving plasma and neutrality

	Default	"Clean addition"
Current deposition scheme		
Method	All particles consequently deposited onto global current grid	Species deposited in a new grid before adding onto global current grid
Comments	Possible precision issues for overall null current	Overall precision increase

Removing the numerical instability

FFT of the electric field in the laser polarization direction



Numerical instability from relativistic moving plasma...

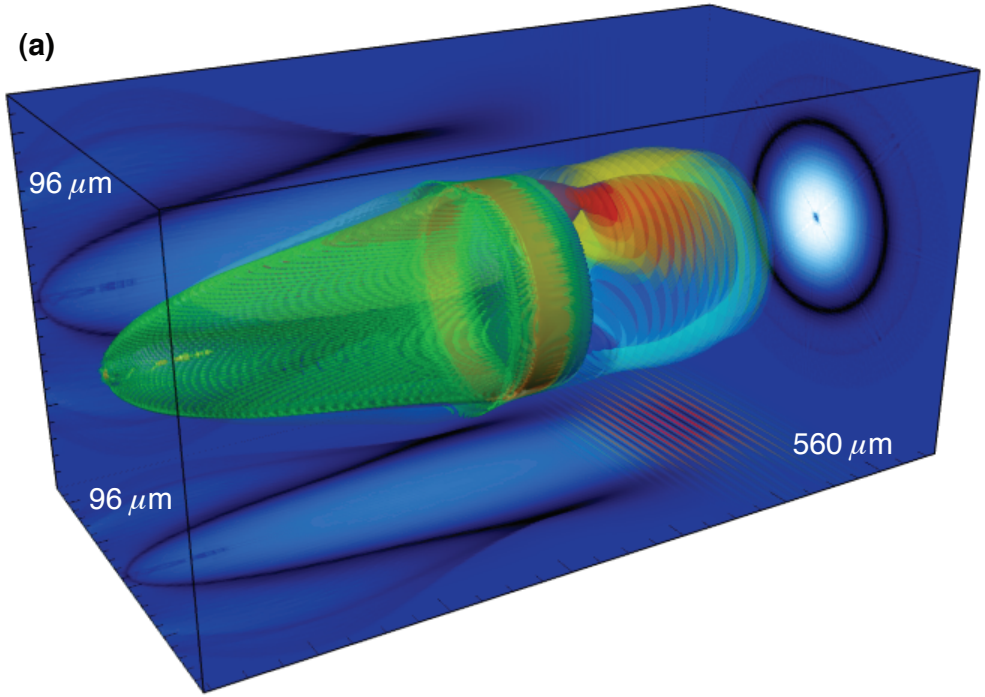
...can be removed with direct longitudinal smoothing of E&B fields

$$\text{Pass 1: } W_1 = 1/2$$

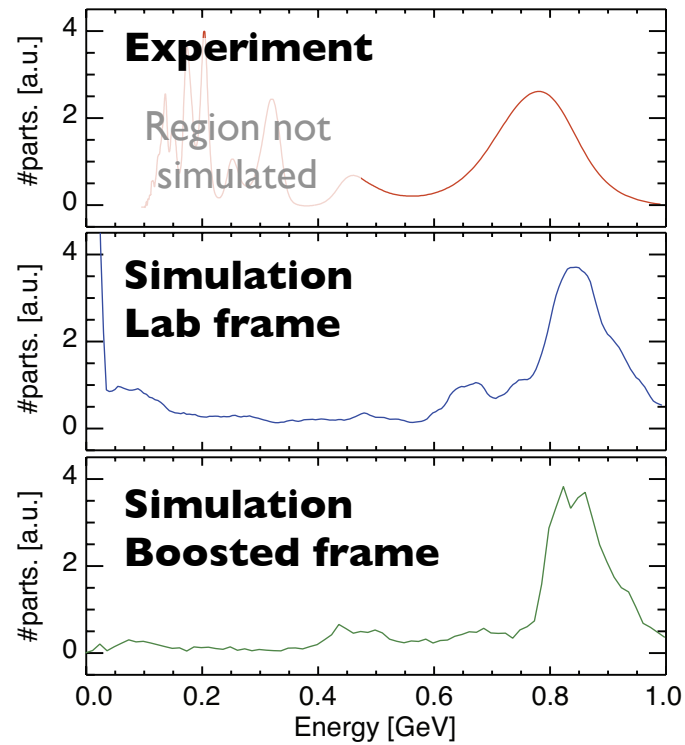
$$\text{Pass 2: } W_2 = \frac{-W_1}{1+2W_1[1+\cos(k_l \Delta x)]}$$

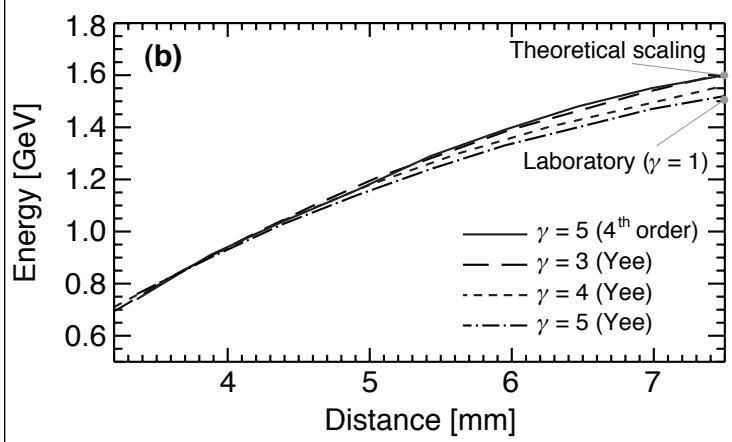
Boosted Frames benchmarks

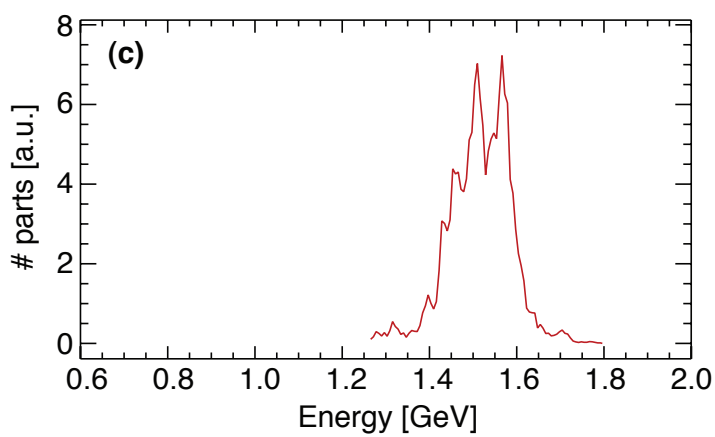
Self-injection of 1.5GeV beam



Experiment/Lab/Boost

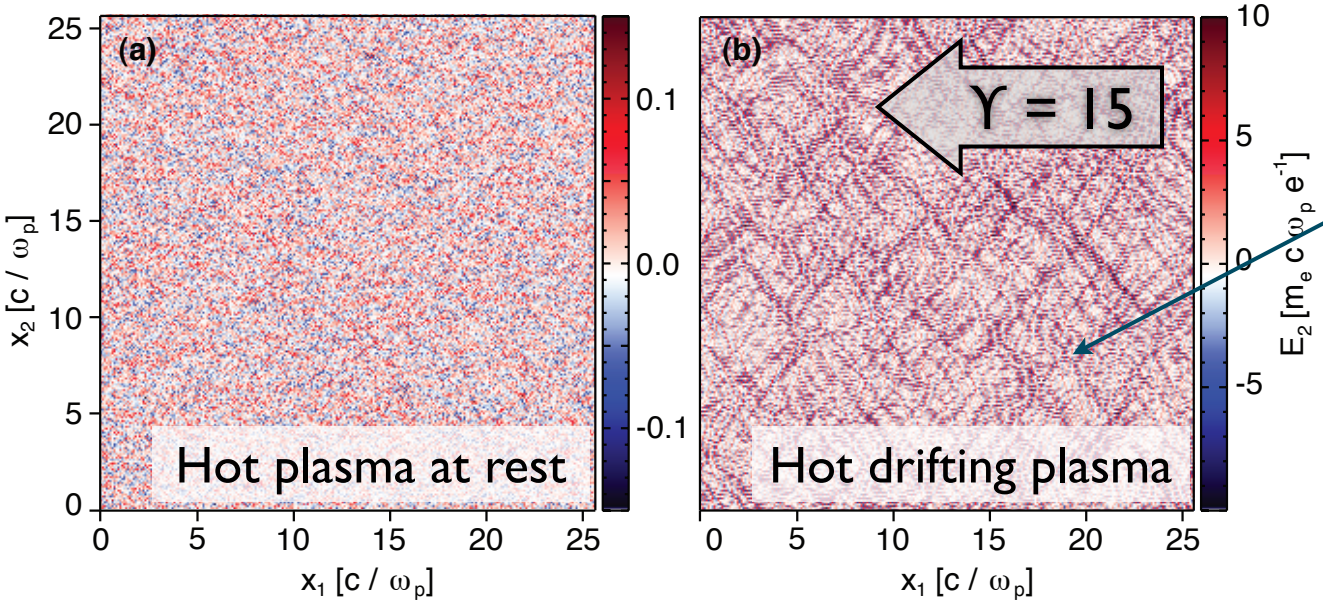




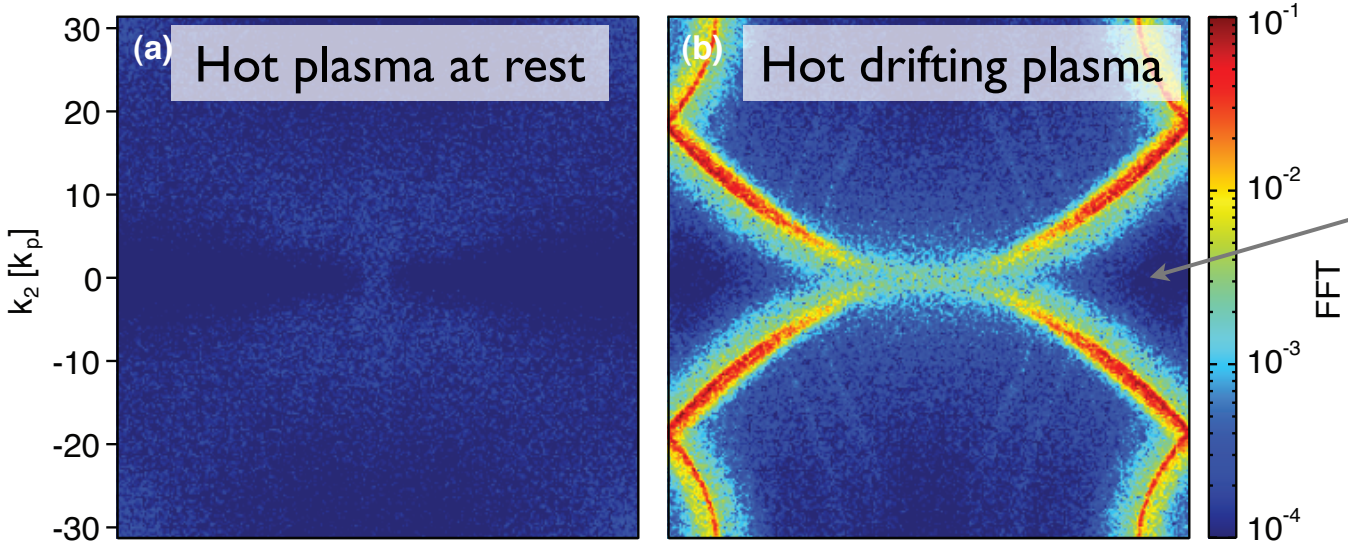


~20x faster
than lab simulation

Relativistic plasmas flows



Noise pattern in fields & densities

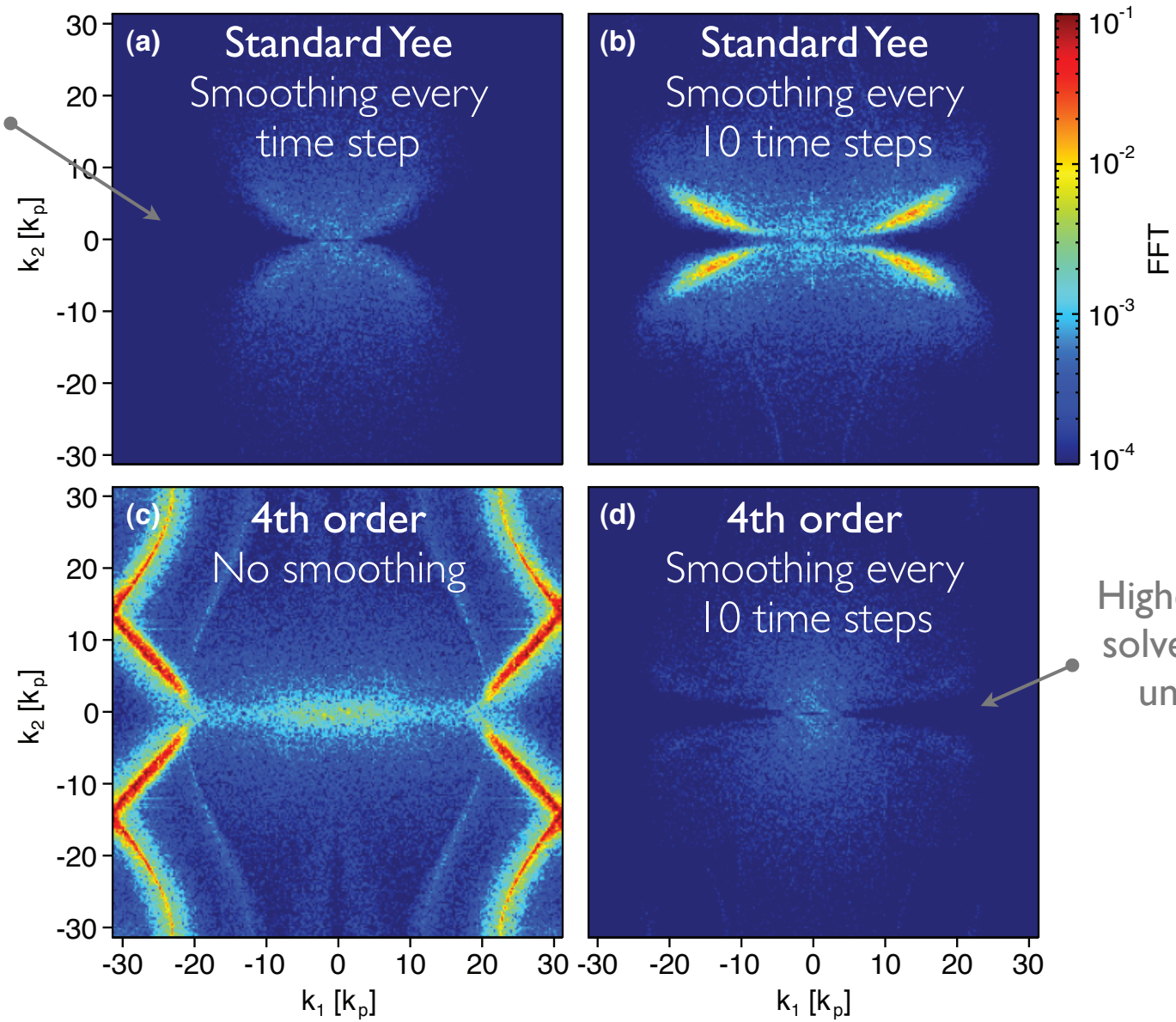


Noise with broad wavelength components

Advanced digital filtering

FFT of Electric field (E_2) with different field solvers

Digital filtering removes noise



Higher order solver is less unstable