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Langevin Meeting

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Problem: Upwards Trend of the Emittance

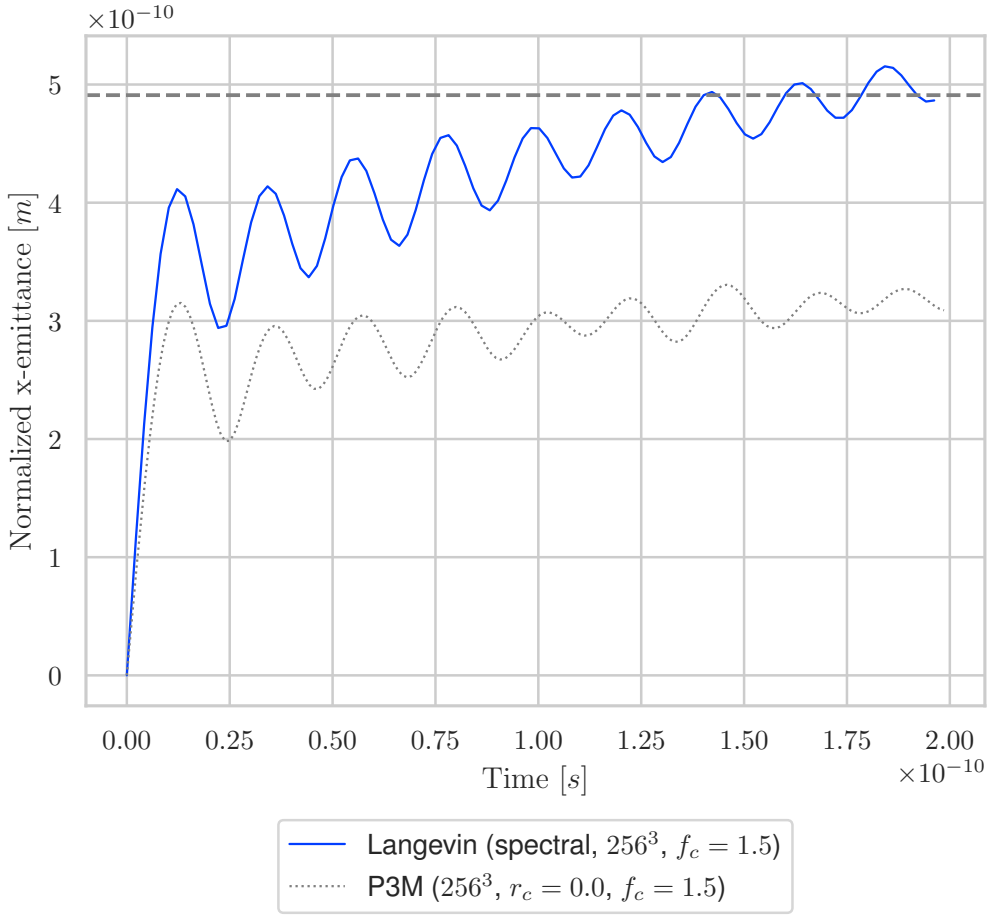

Figure 1: Increasing normalized x-emittance.

Summary of explored causes

- Time integration not identical ☑
- Check γ-factor ☑
- Check focusing strength ☑
- Check initial conditions ☑
- Prefactor in E-field computation (stems from different definition of Green's function) ☑

Unit Mismatch

- Ulmer : $[cm/s]$
- Langevin : $[cm/ms]$
- Contradiction in Coulomb constant suggests that Ulmer simulated a sphere which is 100$\times$ larger)
- Running Langevin with $r_{new} = 100 \times r_{old}$ doesn't reduce the increase in emittance; adapted `dt` due to smaller plasma frequency w_p

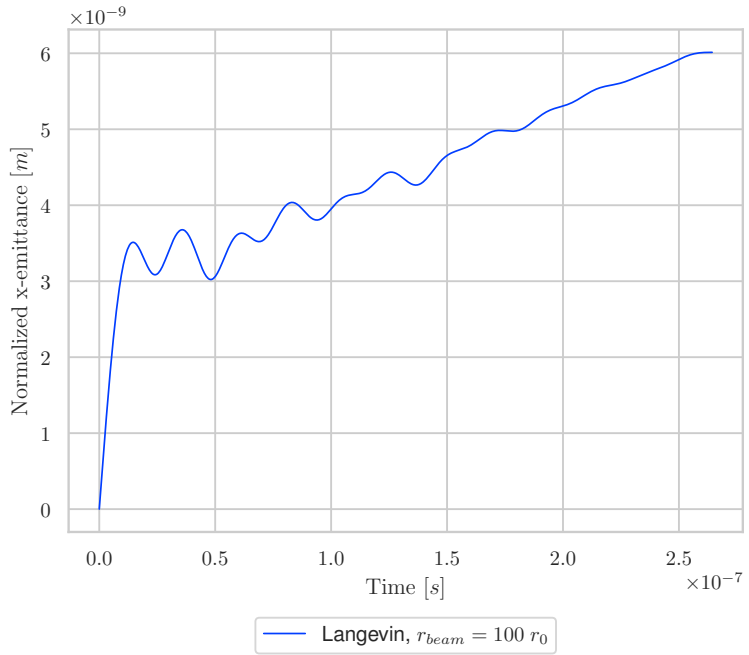

Figure 2: Increasing radius of the initial sphere. Different magnitudes!

Starting from Scratch

- Time Integration works as expected and are identical between the two codes
- Initial E-Field exhibits mismatch

Version	Comment	AvgEF (cm/ms)
Ulmer	-	(1.18018e-07 , 7.73926e-08 , 3.70959e+8)
Langevin	-	(1.56462e-08 , 8.19564e-09 , 5.17575e+08)
Langevin	radius und box length x10	(1.70257e-10 , 3.91447e-10 , 5.00394e+06)

Figure 3: Mismatch in E-field at $t = 0$ (corrected units).

Ulmer on a smaller grid?

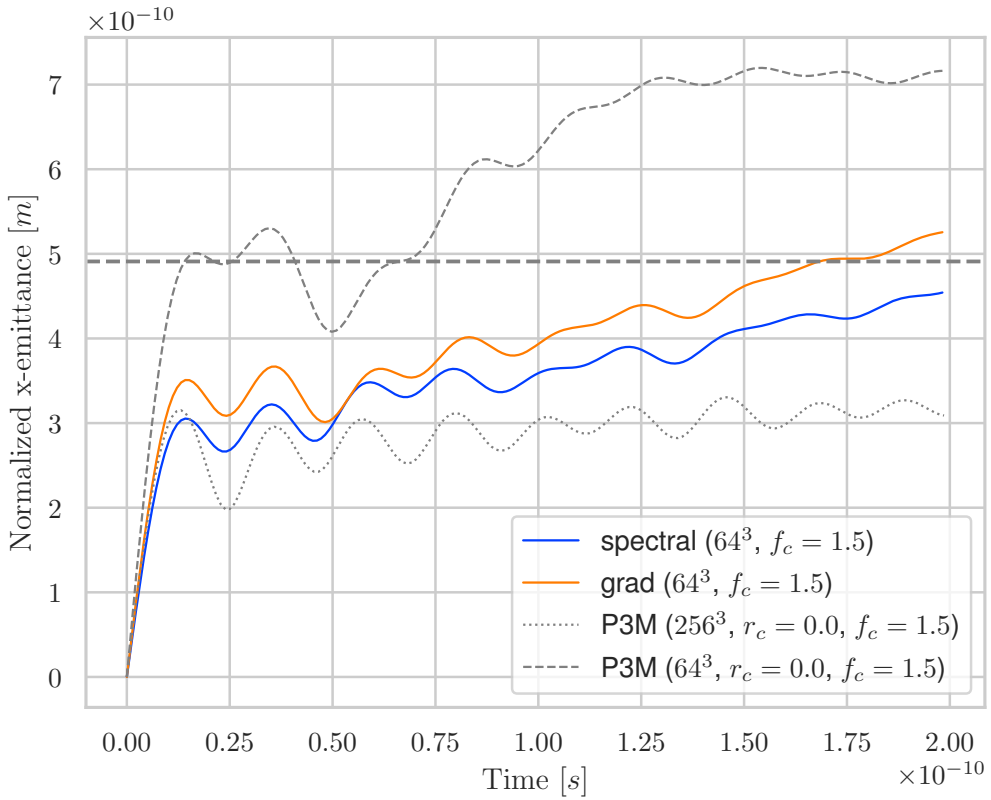

Figure 4: Heating is also disturbed in Ulmer's case if mesh smaller than 256^3.

FFT solve for $\phi(\vec{x})$ and Compute $\texttt{grad}(\phi(\vec{x}))$ on a 256^3 grid

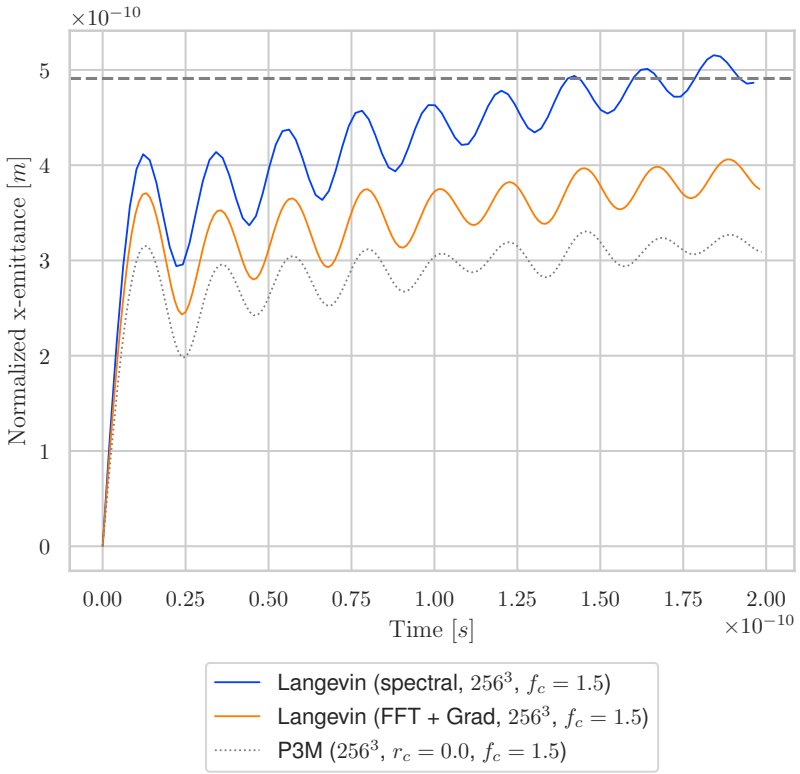

Figure 5: Solve on a larger grid (same order of solver).

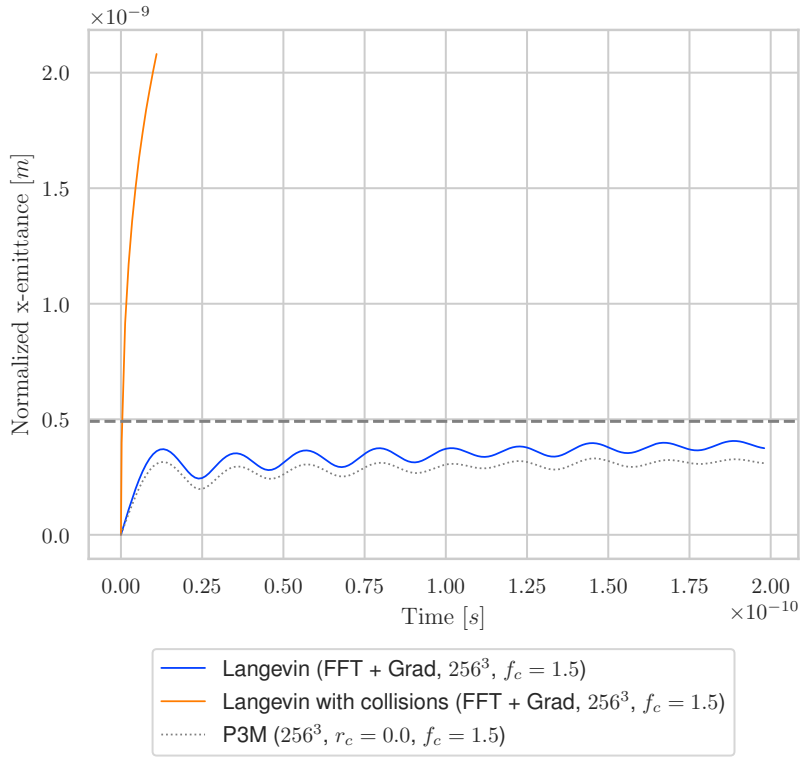

Figure 6: With Drag & Diffusion turned on too expensive (100x slower). Scaling factors as Severin suggested.

Conclusion and Outlook

Conclusion:

- Spectral solver might not work well for this problem.
- Particle density per cell could be kept constant for changing grid size (then we might be able to run on a smaller grid)
- Regular FFT solver has lower order of convergence, but exhibits smaller increase in emittance.
  - Hypothesis: Numerical errors accumulate in grad computation of the potential in Fourier space

Options:

- Further analyse why spectral solver performs worse in this case
- Continue with regular FFT solver (analyse why turning on collisions crashes the simulation)
- Explore a topic related to this but can be done separately