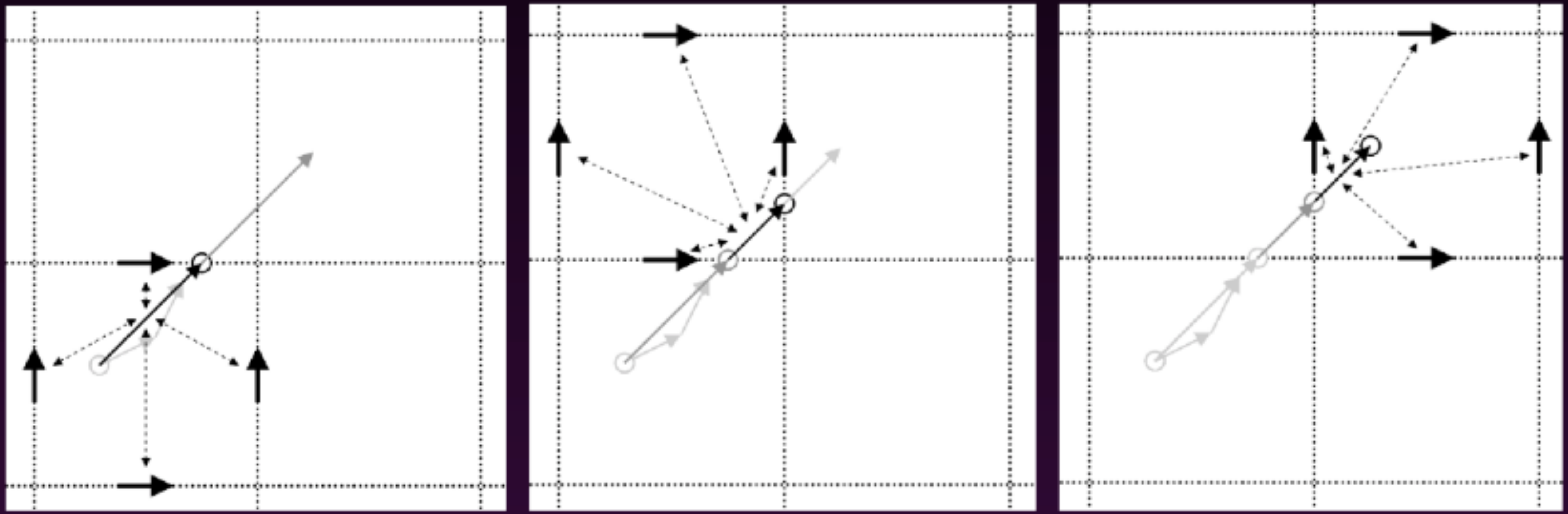
4. Deposit current on the grid

- Charge conservation is required to satisfy Poisson's equation.

$$\partial_t B = -\nabla \times E \Rightarrow \partial_t \nabla \cdot B = 0$$

$$\partial_t E = \nabla \times B - J \Rightarrow \partial_t \nabla \cdot E = -\nabla \cdot J \xrightarrow{?} \partial_t \rho$$

- The current deposition scheme needs to be charge-conserving.



- Or, a divergence-cleaning solver should be employed.

Numerical stability

- The particle granularity gives short-scale fluctuations of the electromagnetic fields, whose mean amplitude scales (Poisson-like) as $\sqrt{n}$, where n is the particle density.
- The fractional contribution of the fluctuations (over the slowly varying fields) scales as $1/\sqrt{n}$.
- This is problematic because the number of super-particles in particle-in-cell codes is $\ll$ number of real particles.
- We need to control the level of the fluctuations such that they give negligible effects over the timespan of the simulations.