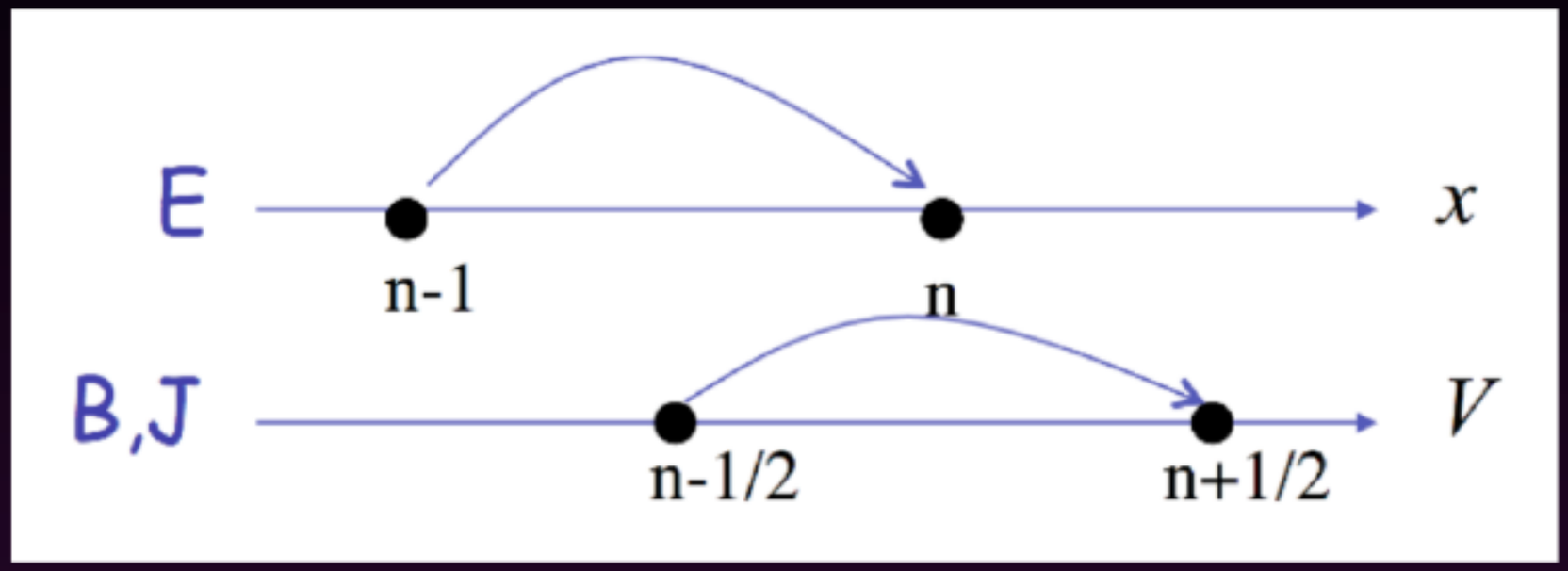
3. Push the particles

If the number of ppc is >>1, most of the computing time is spent in pushing the particles.

The BORIS pusher (leapfrog method)



advance the position

$$x^{n+1} = x^n + \frac{p^{n+1/2}}{\gamma^{n+1/2}}\Delta t$$

advance the momentum

$$\frac{p^{n+1/2} - p^{n-1/2}}{\Delta t} = \frac{q}{m}(E^n + \frac{1}{c}\frac{p^{n+1/2} + p^{n-1/2}}{2\gamma^n} \times B^n)$$

$$(B^n = \frac{B^{n+1/2} + B^{n-1/2}}{2})$$

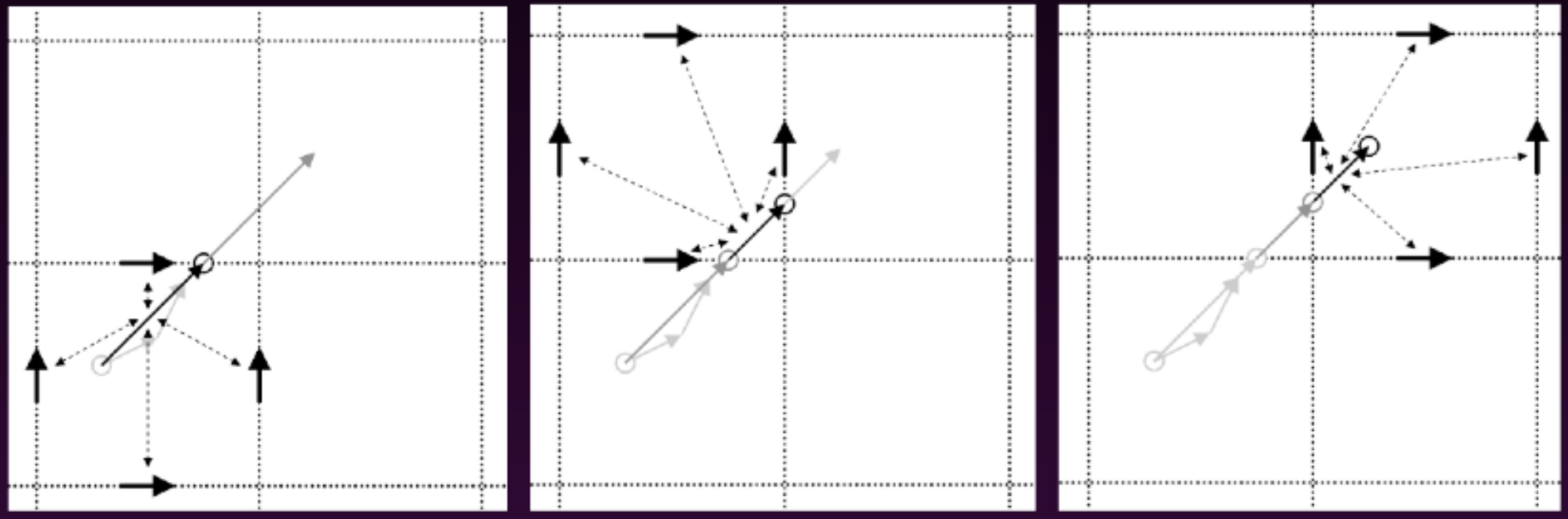
4. Deposit current on the grid

• 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.