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Studies of Deuteron Beam Tracking

- Steep learning curve, but coming along.
- Have a program (in c) which uses the betatron equations to describe the orbits of deuterons:

$$y = \sqrt{\varepsilon_y \beta_y}\,\cos\left(\frac{s}{\beta_y} + \phi_y\right)$$

$$x = \sqrt{\varepsilon_x \beta_x}\,\cos\left(\frac{s}{\beta_x} + \phi_x\right)$$

- Random initial selection of ϕ_x and ϕ_y .
- Use various step sizes, in preparation for including multiple scattering and dE/dx from a gas.
- Each step re-calculates the betatron parameters from x, dx/ds, y, dy/ds.

- First, propagate in vacuum, eliminate floating error "walk":
  - Define s to be "long double".
  - Define π to about 20 places.
  - Before evaluating sin/cos, take s/β modulo 2π, convert result to "double" (normal), add ϕ.
  - The betatron parameters remain stable for step sizes from 1 cm to 100 m (at least), for durations of 80 seconds and more. No floating-point-error problems.
- Next (in progress), put in effects of gas, find how long a population of deuterons remain in the beam without exceeding the aperture. It is somewhat problematic to do multiple-scattering in such a way that is independent of step size.