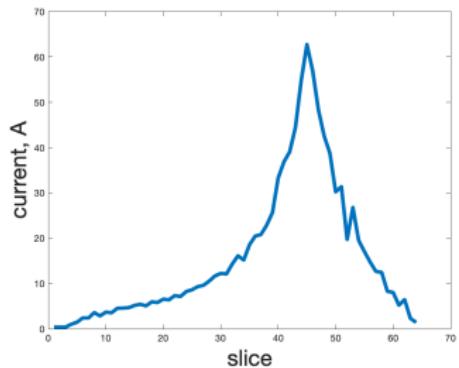


CeC Physics

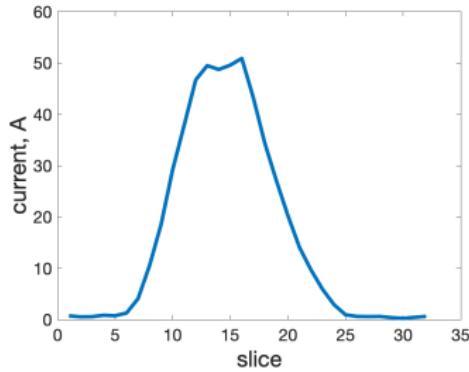
Jun Ma

Collider-Accelerator Department
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1/13/2023



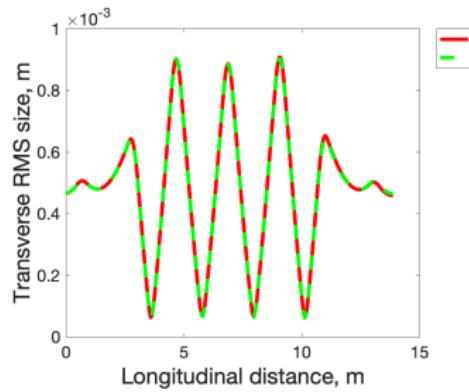
(a) Old



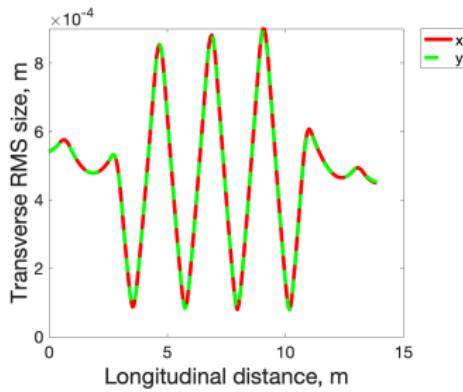
(b) New

- Old slice 45, $I = 62.76A$, $\delta E/E = 1.3e - 4$, $\varepsilon_{norm} = 1.3\mu m$, $\beta = 4.74m$, $\alpha = -0.16$, $\gamma = 28.57$
- New slice 15, $I = 49.58A$, $\delta E/E = 1.45e - 4$, $\varepsilon_{norm} = 1.72\mu m$, $\beta = 4.85m$, $\alpha = -0.22$, $\gamma = 28.5$

Beam size

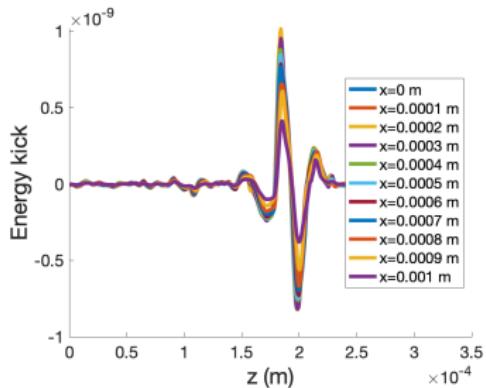


(a) Old 45

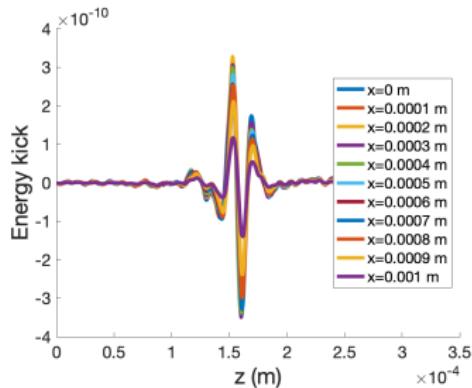


(b) New 15

Cooling



(a) Old 45



(b) New 15

Solenoid field

$$\begin{aligned}B_z(r) &= B_{z,0} - \frac{r^2}{4} B''_{z,0} + \frac{r^4}{64} B''''_{z,0} - \frac{r^6}{2304} B''''''_{z,0} \dots \\B_r(r) &= -\frac{r}{2} B'_{z,0} + \frac{r^3}{16} B'''_{z,0} - \frac{r^5}{384} B''''''_{z,0} \dots\end{aligned}$$

where $B_{z,0}$ is the longitudinal on-axis magnetic field and the primes indicate derivatives with respect to z .

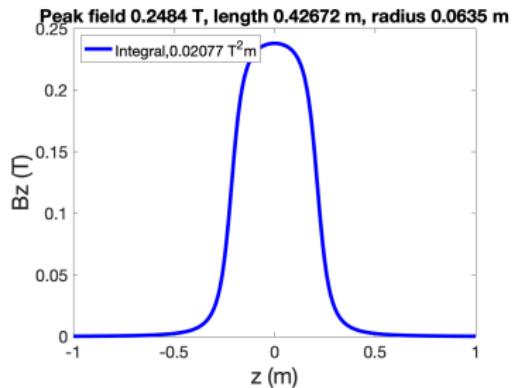
Solenoid field

In simulations, we use up to 3rd order derivative.

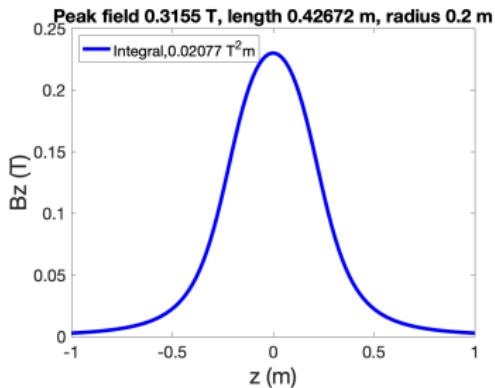
$$\begin{aligned}B_x &= -\frac{x}{2}B'_{z,0} + \frac{x(x^2 + y^2)}{16}B'''_{z,0} \\B_y &= -\frac{y}{2}B'_{z,0} + \frac{y(x^2 + y^2)}{16}B'''_{z,0} \\B_z &= B_{z,0} - \frac{x^2 + y^2}{4}B''_{z,0}\end{aligned}$$

Solenoid field

$$B_{z,0} = \frac{B_0}{2} \left(\frac{L/2 - z}{\sqrt{(z - L/2)^2 + R^2}} + \frac{L/2 + z}{\sqrt{(z + L/2)^2 + R^2}} \right)$$



(a) Sol setup 1



(b) Sol setup 2

- PCA lattice
- No space charge
 - SPACE simulation
 - Transfer matrix, thin lens

Sol setup 1

(a) SPACE

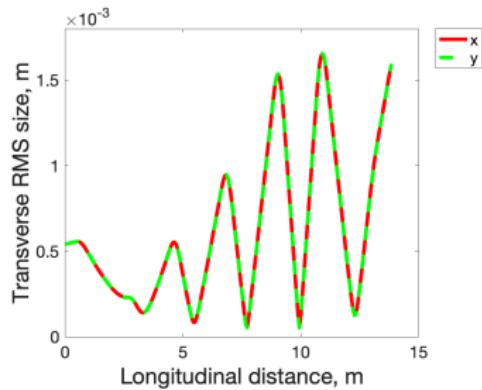
(b) Matrix

Sol setup 2

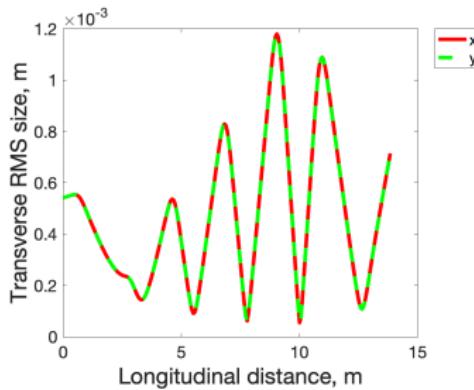
(a) SPACE

(b) Matrix

Beam size



(a) SPACE, sol setup 1



(b) SPACE, sol setup 2

- PCA lattice, no space charge
- Compare solenoid field expansion up to 3rd order / 1st order
 - 3rd order

$$\begin{aligned}B_x &= -\frac{x}{2}B'_{z,0} + \frac{x(x^2 + y^2)}{16}B'''_{z,0} \\B_y &= -\frac{y}{2}B'_{z,0} + \frac{y(x^2 + y^2)}{16}B'''_{z,0} \\B_z &= B_{z,0} - \frac{x^2 + y^2}{4}B''_{z,0}\end{aligned}$$

- 1st order

$$\begin{aligned}B_x &= -\frac{x}{2}B'_{z,0} \\B_y &= -\frac{y}{2}B'_{z,0} \\B_z &= B_{z,0}\end{aligned}$$

Sol setup 1

(a) SPACE, 3rd order

(b) SPACE, 1st order