Bend Magnet Heat Loads & Out of Orbit Scenarios

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Challenge

- Accelerated electrons emit radiation.
- This radiation can heat up materials.
- True electron paths contain errors.
- How do these errors effect the power distribution?

Tasks

1. Calculate the ideal path an electron travels through a given bend magnet.
2. Determine sets of alternative paths the electron may take due to orbital errors.
3. Create ray traces of photons emitted from the electrons.
4. Calculate the power distributions on the surfaces impacted by the photons.
5. Verify data with SynRad simulations

Process

Lattice files from Elegant → **Ideal Particle Trajectory**

Lattice files from Elegant → **Missteering (orbital errors)**

Ideal Particle Trajectory → **Missteering (orbital errors)**

Missteering (orbital errors) → **Ray Tracing**

Ray Tracing → **Power Distributions**

Power Distributions → **Optimization**

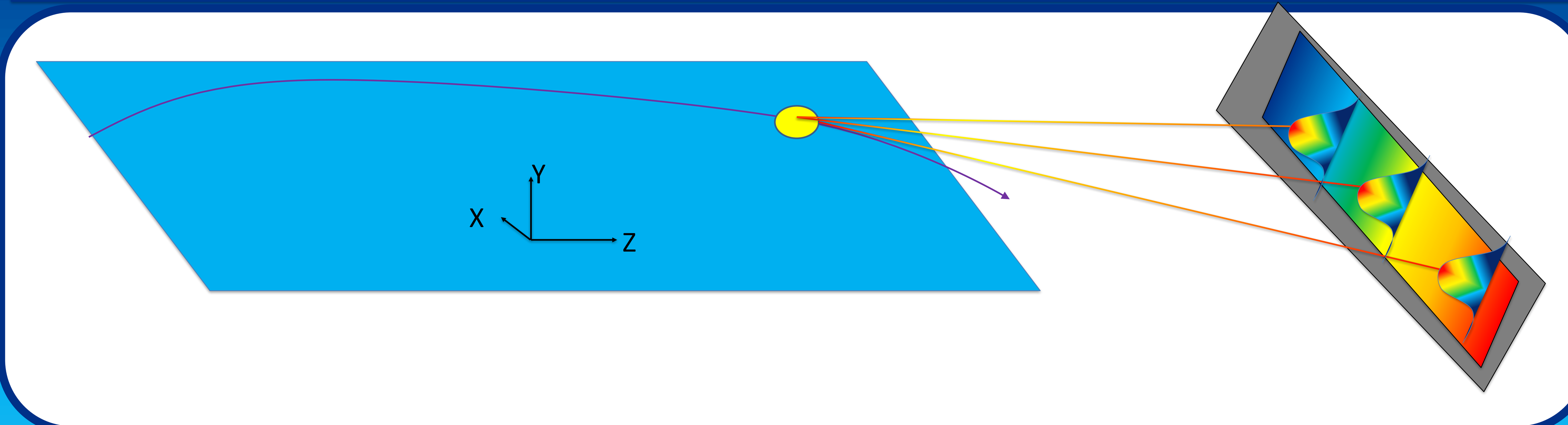
Accomplishments

- ☑ Task 1: Solved for any ideal path
- ☑ Task 2: Code finds desired off orbit paths
- ☑ Task 3: Can ray trace from any trajectory
- ☑ Task 4: Calculates heat map on any plane
- ☑ Task 5: Data closely matches SynRad

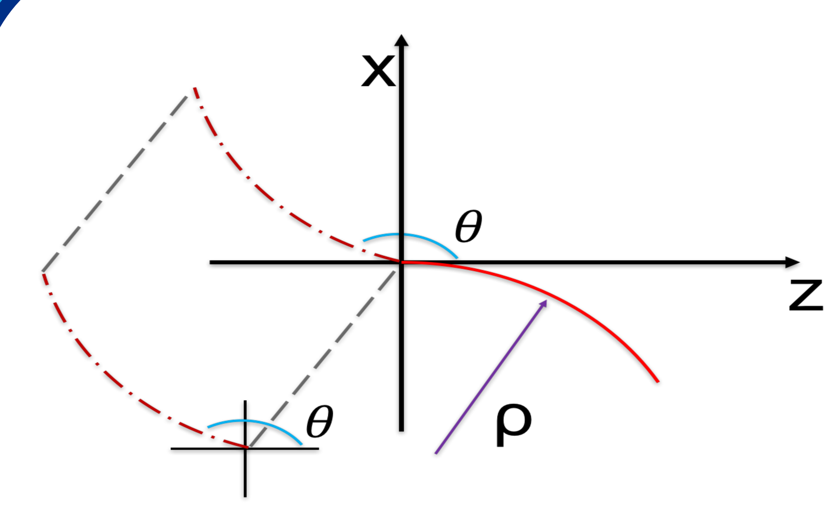
Future Work

- A more friendly UI
- Deeper COMSOL Integration
- More geometries of absorbers
- Insertion device analogs

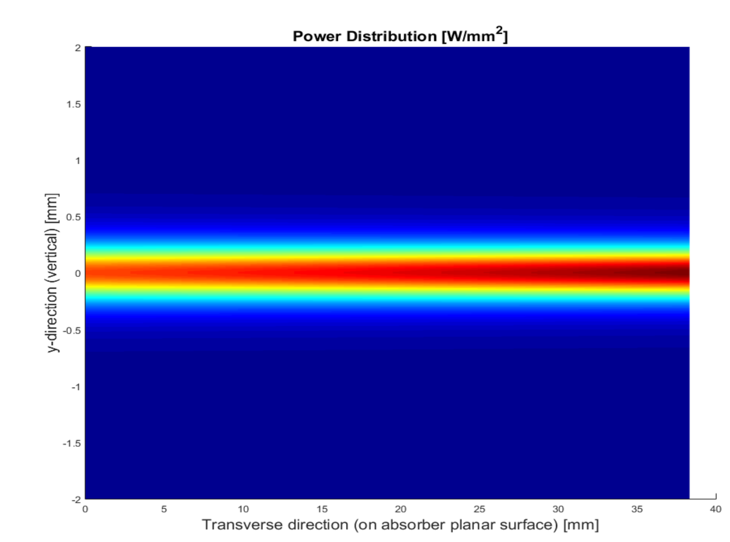
Geometry



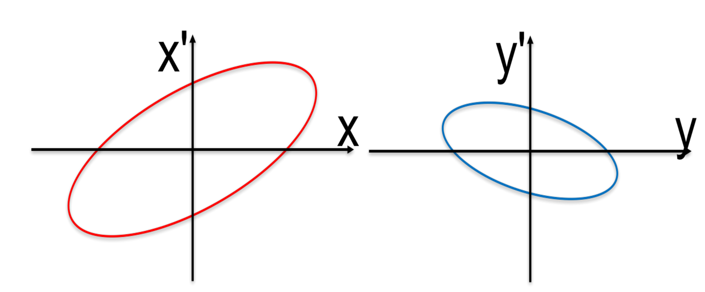
Theory



$$\mathcal{A}_u = \gamma_x x^2 + \alpha_x x x' + \beta_x x'^2$$
$$\mathcal{A}_u = \gamma_y y^2 + \alpha_y y y + \beta_y y'^2$$



$$\begin{bmatrix} z(t) \\ x(t) \\ y(t) \end{bmatrix} = \bar{\bar{R}}(\theta)\begin{bmatrix} \rho\sin(\omega t) \\ \rho(\cos(\omega t)-1) \\ 0 \end{bmatrix} + \bar{r}_0$$

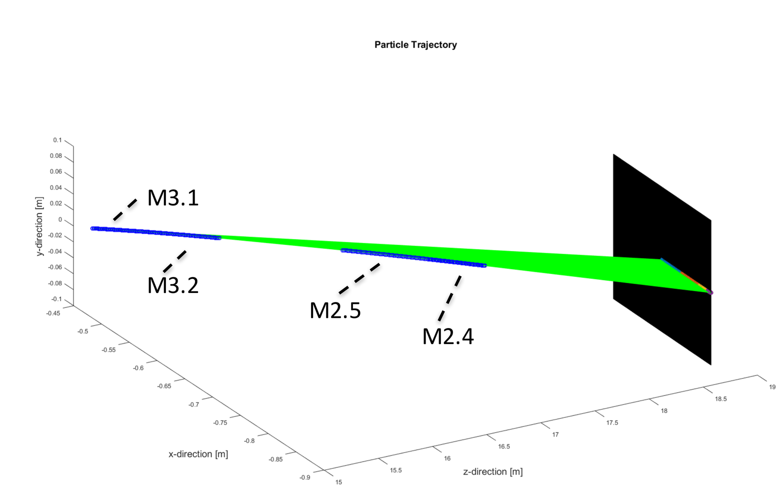


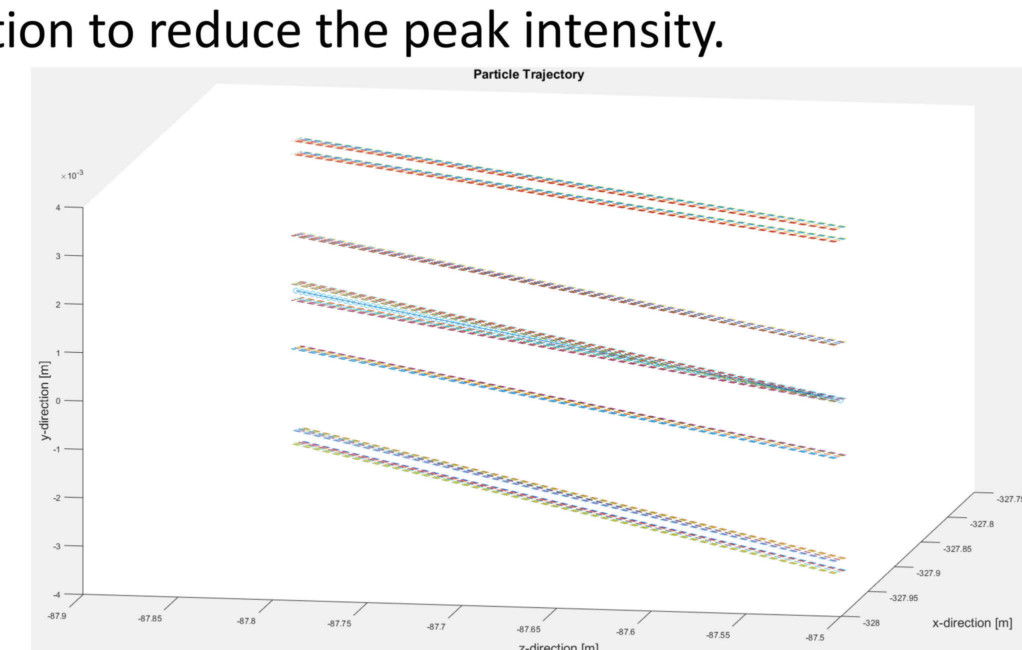
$$\frac{\partial^2 P}{\partial\theta\partial\psi} = P_0\frac{1}{(1+X^2)^{5/2}}\left[1+\frac{5}{7}\frac{X^2}{1+X^2}\right], \qquad X = \gamma\theta$$

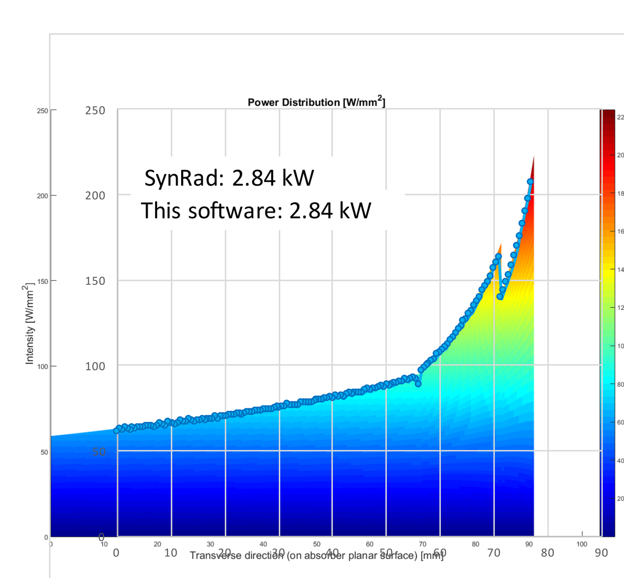
$$P_0\left(W/_{mrad^2}\right) = 5.421 * E^4(GeV) * I(A) * B(T)$$

Performance & Discussion

- Data matches SynRad to high degrees of accuracy and yet doesn't contain the noise.
- Can be used to determine what the heat load is on an absorbing surface of a specific material.
- One can run an optimization process by changing the absorber position and orientation to reduce the peak intensity.
- Analytical solutions allow easy coupling with other programs such as COMSOL.







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