Calibration of HyCal and GEM Z position

- Solving the following system of equations, for each double arm Moller, we have an analytic solution for Z:
  - $E_{beam} + m = E_1 + E_2$, where m is electron mass, E1, E2 are energy of scattered electrons
  - $P_1 \sin(\theta_1) = P_2 \sin(\theta_2)$ where P_1 and P_2 are scattered electron momenta, and theta are their polar angle in lab
  - $P_1 \cos(\theta_2) + P_2 \cos(\theta_2) = P_{beam}$
  - $\sin(\theta_1) = \frac{R_1}{\sqrt{R_1^2 + z^2}}$ and $\cos(\theta_1) = \frac{z}{\sqrt{R_1^2 + z^2}}$

  - It can be solved without neglecting electron mass:

$$z = \sqrt{(m + E_{beam}) R_1 R_2 / (2m)}$$

Condition

- Selection rules for double-arm Moller
  - Each Moller electron agree with the expected energy up to 3 sigma of HyCal energy resolution
  - | Sum of the two electron – beam energy | < 10% of beam energy
  - Polar angle > 0.8 deg
  - Delta phi angle < 5 deg

- All hits projected to HyCal (z = 5640 AWAY from the target)

Distance between Projection Plane and Vertex Z