Elastic and Inelastic Scattering at Residual Gas in IOTA

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Measurements

- At small intensity
  - Beam lifetime is set by gas scattering (no Touschek)
  - Vertical emittance is set by
    - Elastic gas scattering (Coulomb, Rutherford) and
    - by quantum nature of SR due to coupling of vertical and horizontal motion
- Comparison of beam lifetime and emittances showed large discrepancy if only Coulomb scattering is accounted
  ⇨Bremsstrahlung has to be added

Analysis

Inelastic (Bremsstrahlung) Scattering Lifetime

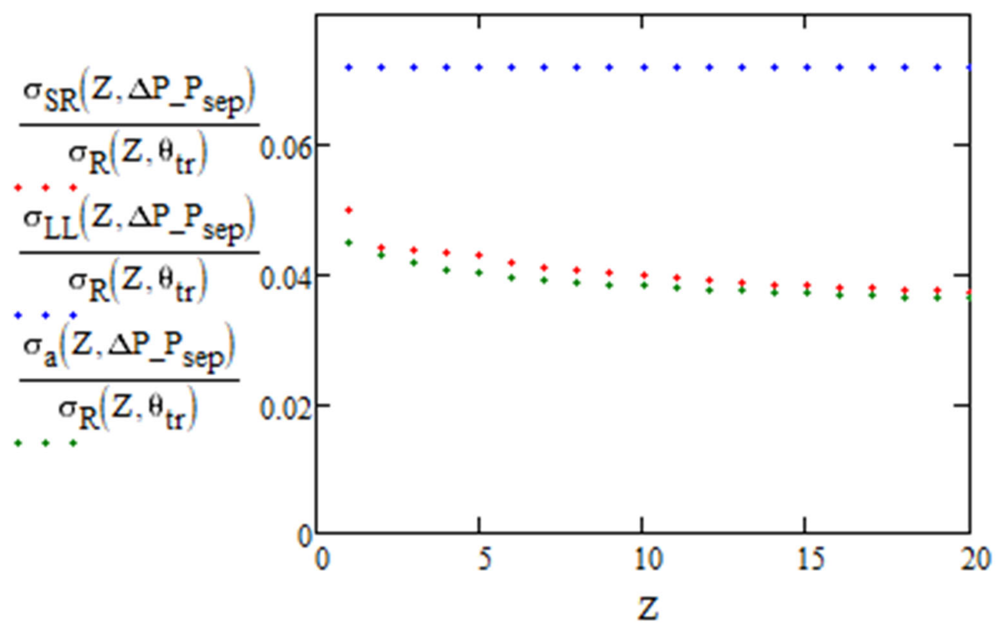
- Usage standard formulas showed that bremsstrahlung can add only 5-10% and does not allow to match ends

$$\frac{1}{\tau_{brem}(h)} = 2.42\times10^{-3} L\left(\delta^E_{acc}\right)\ln\left(\frac{183}{\sqrt[3]{Z}}\right)\frac{P[nTorr]}{T[K]}\sum_i^n Z_i^2 N_i f_i$$

Where, $L\left(\delta^E_{acc}\right) = \frac{4}{3}\left(\ln\frac{1}{\delta^E_{acc}} - \frac{5}{8}\right)$

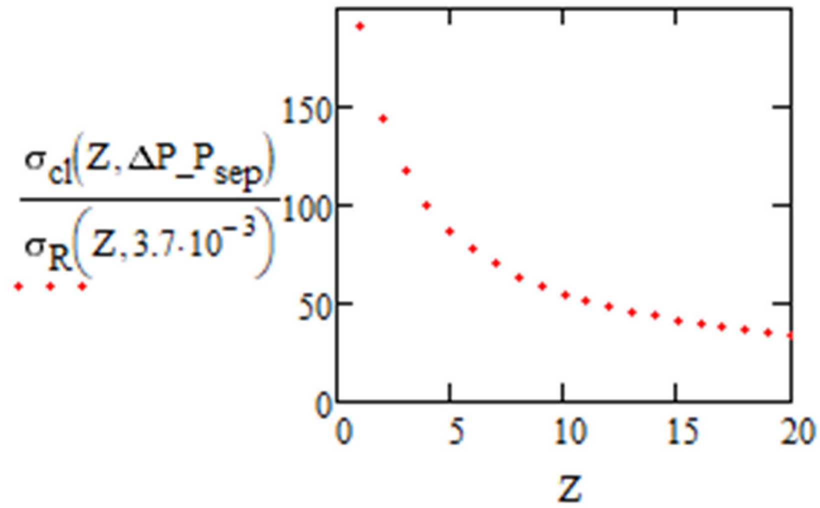
and δ^E_{acc} is energy acceptance (%) of the ring. The Bremsstrahlung lifetime has similar dependence on residual gas properties (Z and N), but a weak dependence on relative energy acceptance.

- Scattering at atomic electrons is also too weak to help



Analysis (2)

- The problem is that the standard formula is not applicable to IOTA
  - It looks at probability to generate a single photon with given energy
- While we need a probability to lose energy above certain value
- Classical estimate allows us to match ends
  - Its usage is justified by small energy of photons: $\omega < m_e$



$$\sigma_{cl}(Z,\theta_s) := \pi \cdot r_e^{\,2} \cdot \left(\frac{\pi}{4}\cdot\frac{\gamma}{\theta_s}\right)^{\frac{2}{3}} \cdot \left(Z + Z^{\frac{4}{3}}\right)$$