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Formulas for synchrotron radiation from FELs

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SASE FEL ρ parameter (1 dimensional theory):

$$\rho = (\frac{k^2 \cdot r_e \cdot n_b \cdot \lambda_u^2 \cdot JJ^2(k)}{32\pi \cdot \gamma^3})^{1/3}$$

$$n_b = \frac{n}{\sqrt{2\pi}^3 \cdot \sigma_r^2 \cdot \sigma_s}$$

$$\frac{\epsilon_n}{\gamma} < \frac{\lambda_{phot}}{4\pi}$$

$$\sigma_e < \frac{\rho}{2}$$

$(Example:\ \rho = 0.00222;\ k = 1.266;\ n_b = 3.17 \cdot 10^{21} m^{-3};$
$\lambda_u = 2.73cm;\ JJ(k) = 0.877;\ E = 1GeV;\ n = 6.24 \cdot 10^9;$
$\sigma_r = 50\mu m;\ \sigma_s = 50\mu m;\ \epsilon_n = 1\pi mm \cdot mrad;$
$\lambda_{phot} = 6.24nm;\ \sigma_e = 0.001)$

Saturation length of SASE FEL (1 dimensional theory):

$$L_s = \lambda_u / \rho$$

$(Example:\ L_s = 12.3m;\ \lambda_u = 2.73cm;\ \rho = 0.00222)$

Photon peak power of SASE FEL (1 dimensional theory):

$$P_e = \frac{c \cdot n \cdot E_e}{\sqrt{2\pi} \cdot \sigma_s}$$

$(Example:\ P_e = 2.4TW;\ n = 6.24 \cdot 10^9;\ E_e = 1GeV;\ \sigma_s = 50\mu m)$

$$P_{phot} = \rho \cdot P_e$$

$(Example:\ P_{phot} = 5.3GW;\ \rho = 0.00222;\ P_e = 2.4TW)$