Electron and proton beam dynamics
a
discussion

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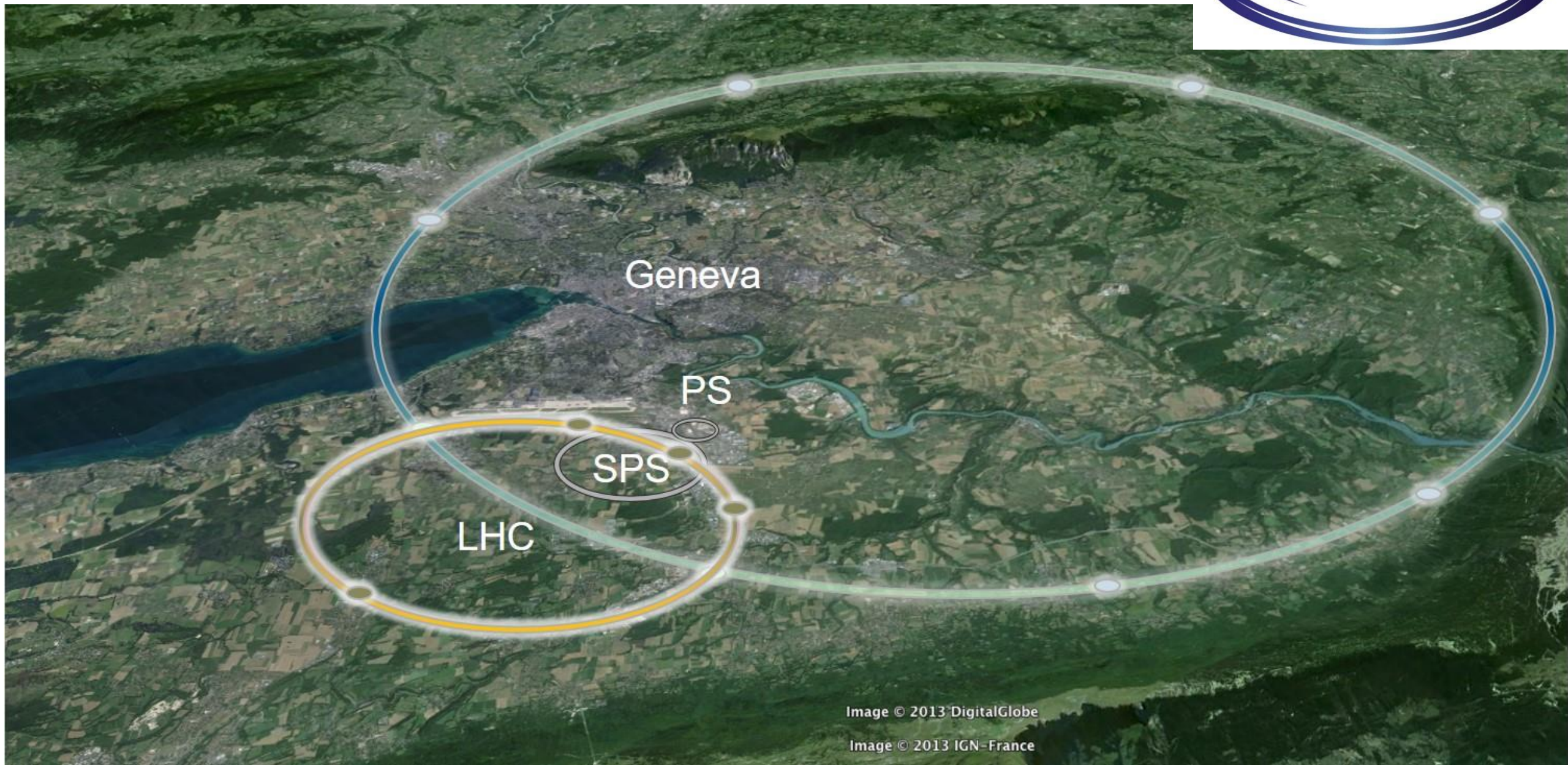
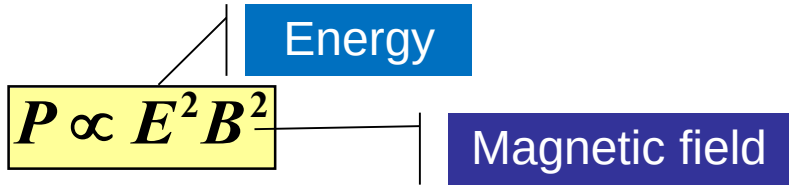
Future Circular Collider Study: 100 km, 100 TeV



Synchrotron radiation power

Power emitted is proportional to:



$$P_\gamma = \frac{cC_\gamma}{2\pi} \cdot \frac{E^4}{\rho^2}$$

$$P_\gamma = \frac{2}{3}\alpha\hbar c^2 \cdot \frac{\gamma^4}{\rho^2}$$

$$C_\gamma = \frac{4\pi}{3}\frac{r_e}{(m_e c^2)^3} = 8.858 \cdot 10^{-5}\left[\frac{\mathrm{m}}{\mathrm{GeV}^3}\right]$$

$$\alpha = \frac{1}{137}$$

$$\hbar c = 197\ \mathrm{Mev} \cdot \mathrm{fm}$$

Energy loss per turn:

$$U_0 = C_\gamma \cdot \frac{E^4}{\rho}$$

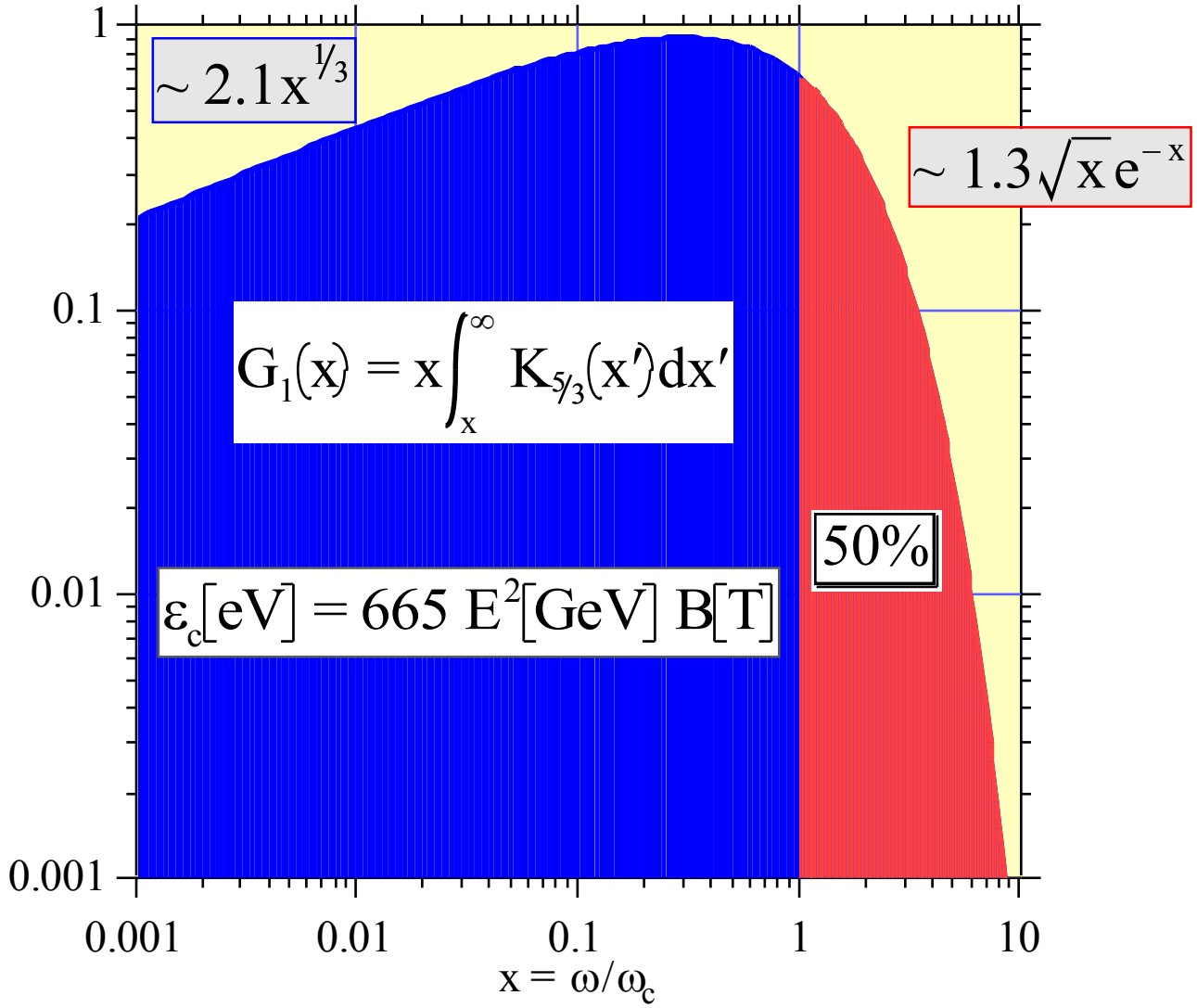
$$U_0 = \frac{4\pi}{3}\alpha\hbar c\frac{\gamma^4}{\rho}$$

$$\frac{dP}{d\omega} = \frac{P_{tot}}{\omega_c} S\left(\frac{\omega}{\omega_c}\right)$$

$$S(x) = \frac{9\sqrt{3}}{8\pi}\, x \int_x^\infty K_{5/3}(x')dx' \qquad \int_0^\infty S(x')dx' = 1$$

$$P_{tot} = \frac{2}{3}\hbar c^2 \alpha \frac{\gamma^4}{\rho^2}$$

$$\omega_c = \frac{3}{2}\frac{c\gamma^3}{\rho}$$



Some quick calculations for FCC-hh

- FCC-hh center-of-mass energy 100 TeV. Bending radius for 16 Tesla field?
- Proton Lorentz factor?
- Dipole field 16 Tesla. Critical photon energy?
- Loss per turn:
- Damping time:
- In LEP we shortened the damping time using wigglers. Could we do it here?

Some quick calculations for FCC-hh

- FCC-hh center-of-mass energy 100 TeV. Bending radius 10’400 m for 16 Tesla field
- Proton Lorentz factor? 53’300

$$U_0[MeV] \cong 6 \cdot 10^{-15} \frac{\gamma^4}{\rho[m]}$$

- Dipole field 16 Tesla. Critical photon energy? 4.3 keV
- Loss per turn: 4.6 MeV
- Damping time: 1 h (3 kHz revolution frequency)
- In LEP we shortened the damping time using wigglers. Could we do it here?