

Study of coherent Smith-Purcell radiation in the far infrared/THz at the SOLEIL linac

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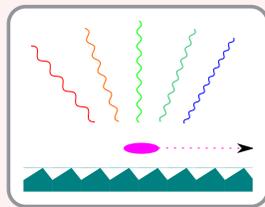
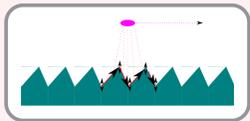
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Smith-Purcell Radiation

- Smith-Purcell radiation is produced when a bunch of charged particles passes above a grating.
- If the bunch is short with respect to the wavelength emitted, the radiation is emitted coherently.
- Coherent emission encodes the Fourier transform of the bunch longitudinal profile:

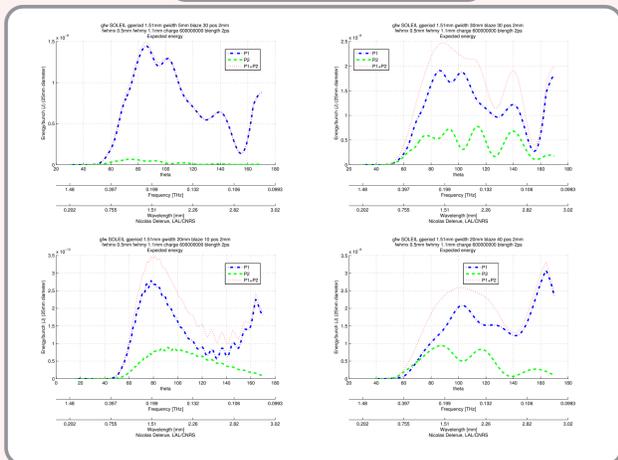
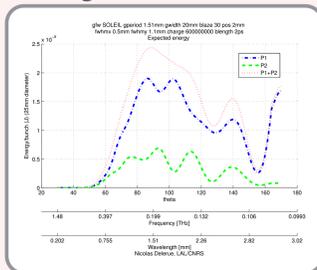
$$\left(\frac{dI}{d\Omega d\omega}\right)_{N_e} \approx \left(\frac{dI}{d\Omega d\omega}\right)_{SP} [N_e + N_e^2 |F(\omega)|^2 G(\sigma_x, \sigma_y)]$$

☞ Can be used as a diagnostic to measure the longitudinal profile of an electron bunch.



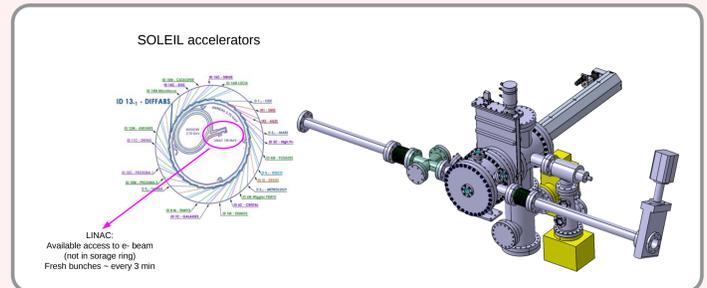
Predicted yield

- ☞ Systematic study of the effect of various gratings parameters to validate the theory.
- ☞ Radiation emitted expected to be between 0.75 mm (0.4 THz) and 3 mm (0.1 THz).
- ☞ Yield simulations using G. Doucas' code (gfw)

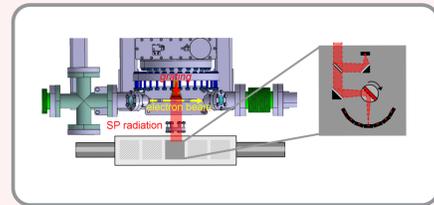


Installation in the SOLEIL LINAC

- The LINAC at SOLEIL can give 100 MeV electron bunches
- 104 x 37pC at 352MHz in multibunch mode every 2 minutes or 2 x 0.5 nC every 1.5 minutes

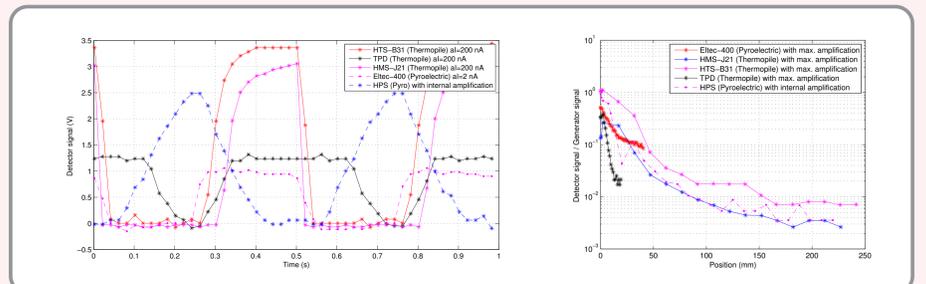


- A 5D robot (3 translations, 2 rotations) will scan the radiation emitted.
- Aim: find/validate the directions where it is possible to measure background radiation and those where it is possible to measure signal, and compare with theory.



Detectors study

- Final device is expected to use 60-100 detectors
- ☞ Can't afford so many bolometers!
- ☞ Test "cheaper" detectors.
- At the moment the study is focused on Pyroelectric detectors and Thermopiles.
- Several models studied (all without window or with window removed):
 - ☞ Thermopiles: Heimann HMS-J21, HTS-B31, Excelitas TPD-2T-0625
 - ☞ Pyroelectrics: Heimann HPS-A03E (with amplification), Eltec 400-0



Schedule

- April 2013: Installation at SOLEIL
- April-December 2013: Measurements at SOLEIL
- Early 2014: Test single shot device at SOLEIL
- 2014: Measurements and test single shot device at SPARC
- 2015: Test single shot device on a plasma accelerator

References

- Victoria Blackmore, Thesis: Determination of the Time Profile of Picosecond-Long Electron Bunches through the use of Coherent Smith-Purcell Radiation
- G. Doucas et al. First measurements of the longitudinal bunch profile of a 28.5 GeV beam using coherent Smith-Purcell radiation. Phys.Rev.ST Accel.Beams 12:032803, 2009.
- O. Grimm and P. Schmüser Principles of Longitudinal Beam Diagnostics with Coherent Radiation, TESLA FEL 2006-03