Description of the THz FEL

The main goal of the envisioned light source is to provide the Swedish research community with a first domestic THz FEL combined with an X-ray source. This will present a unique opportunity for time-resolved pump(THz)-probe(X-ray) measurements and make it an advanced instrument for multi-disciplinary research in physics, chemistry and bio-medicine.

A preliminary sketch of the light source is presented in Fig. 1. Electron bunches are accelerated in the RF linac to an energy of 10-20 MeV and compressed to a pulse length of 1-10 ps. These bunches are then used for generation of soft X-ray pulses, before they are sent through a bending arc and finally to the THz FEL oscillator, which is located on top of the RF linac in order to make the system more compact.

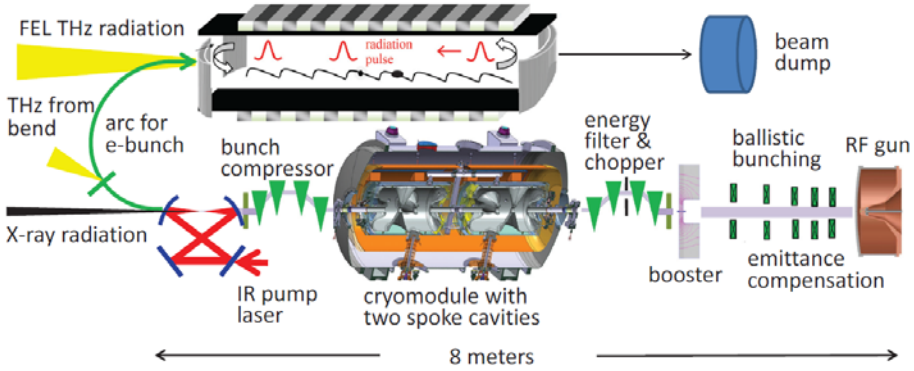

Figure 1. Schematic of the THz FEL complemented with an X-ray source.

The X-rays can be generated by a number of different techniques of which one is inverse Compton scattering. This technique involves up-conversion of low-frequency (typically IR) radiation into X-rays. The high repetition rate provided by the superconducting accelerators (176 MHz) will translate into a high average brightness soft X-ray source comparable to a second generation synchrotron radiation source.

The THz FEL oscillator can produce both narrow bandwidth pulses of the order of $\Delta E/E=10^{-4}$, and short pulses with a few cycles in duration. The frequency will be tunable from about 0.3 THz (1 mm) to 6 THz (50 μm) with a pulse energy of 1-20 μJ. The temporal structure of the train of radiation pulses will reproduce the structure of the electron beam presented in Fig. 2. For applications demanding a low repetition rate, a part of the THz pulses can be extracted by inserting a mirror with variable reflectivity in the THz transport line.

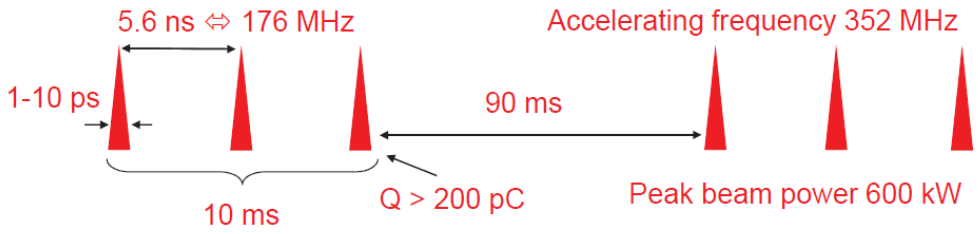

Figure 2. Proposed time structure of the electron beam at the end of the RF linac.

By running the RF linac in a low-charge mode, one can generate short electron bunches. This provides the possibility of generating broadband THz pulses in a dipole installed in the bending arc.

More information about the light source can be found in references [1]-[4].

[1] V. Goryashko, V. Zhaunerchyk, Uppsala University, Diva Database, (2013): http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-213793.

[2] A. Opanasenko, V. Zhaunerchyk, V. Goryashko, Uppsala University, Diva Database, (2013): http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-213799.

[3] R. Chulkov, V. Goryashko, V. Zhaunerchyk, Uppsala University, Diva Database, (2014): http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-219365.

[4] V. Goryashko, A. Opanasenko, V. Zhaunerchyk, Uppsala University, Diva Database, (2014): http://urn.kb.se/resolve?urn=urn:nbn:se:uu:diva-221151.