Longitudinal Diagnostics with THz Radiation

May 16th 2006

H. Delsim-Hashemi
O. Grimm, B. Schmidt, P. Schmueser
FLASH layout and infrared radiation beam-lines

Terahertz and Optical SYnchrotron radiation LABoratory

CTR140

Bunch compressors
Coherent radiation

**Spectral energy density**

\[
\frac{dU}{d\omega} = C \cdot N^2 |F_{\text{long}}(\omega)|^2 T(\omega, \gamma, r_b, \theta, \text{source})
\]

- **Integral intensity**
  - 'compression factor', effective bunch length

- **Spectral resolved intensity**
  - + bunch structure, 'longitudinal fingerprint'

**Normalized charge density**

\[
F_{\text{long}}(\omega) = \int_{-\infty}^{\infty} \bar{\rho}(t) \exp(-i\omega t) dt
\]
Wavelength range of relevance

Wavelength spectra

200 µm

Wavelength spectra

double-spike structures

spectroscopic fingerprint
Rotating mirror spectrometer-transmission grating
(~1.5 m air)

30 bunches, slit diffraction radiator, standard pyroelectric detectors

![Graph showing intensity vs. wavelength for different TG series (TG 400, TG1000, TG2000).](image)
Using flat response Golay-cell detectors, it is shown that in order to study short wavelengths part of the spectra CTR has to be used.
Rotating mirror spectrometer-reflectance grating
Rotating mirror spectrometer-reflectance grating

(~1.5 m air)
Rotating mirror spectrometer-reflectance grating

(~1.5 m air)
Rotating mirror spectrometer-reflectance grating
(short wavelengths in vacuum)
Rotating mirror spectrometer-reflectance grating (short wavelengths in vacuum)
Rotating mirror spectrometer-reflectance grating (short wavelengths in vacuum)
Rotating mirror spectrometer-reflectance grating
(short wavelengths in vacuum)
BC2 compression monitor

- compression (BC2) fluctuates from 'under' to 'over' compressed

SASE optimum

No SASE

factor 2
Correlations SASE - short wavelengths - I

- 65 µm
- 69 µm
- 73 µm
- 77 µm
- 81 µm
- 85 µm
- 89 µm

0. Order long wavelength
Correlations SASE - short wavelengths - II

0. Order long wavelength
Outlook

SASE correlation to shortest wavelengths that more correspond to the spike

The circuit which makes it possible to readout from 30 pyro-detectors and has amplifiers all in one unit

Set-up the spectrograph stages based on the new designed mirror and readout
Outlook

SASE correlation to shortest wavelengths

The circuit which makes it possible to readout from 30 pyro-detectors and has amplifiers all in one unit

Set-up the spectrograph stages
The wavelength calibration of the spectrometers is checked with THz filters. The effects of crystalline-quartz, LD-PE and diamond window transmission are clearly observed.

The suppression of short wavelengths with diffraction radiator is clearly seen, for most interesting part of the spectra, short wavelengths, transition radiation should be used.

Pyro-electric detectors could be used as detectors.

Already first measurements in vacuum show very short structures in the FLASH electron bunch.