Bunch diagnostics with coherent IR Undulator radiation

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A new exciting instrument at FLASH…

The IR-Undulator during test measurements

Since summer 2007 a new diagnostic tool is implemented in FLASH. With the Infrared Undulator you get radiation in the wavelength range (1-200)μm.

This will give us the opportunity to characterize the longitudinal bunch profile of the short electron bunches produced by FLASH in a manner similar to other frequency-domain techniques using infrared radiation.

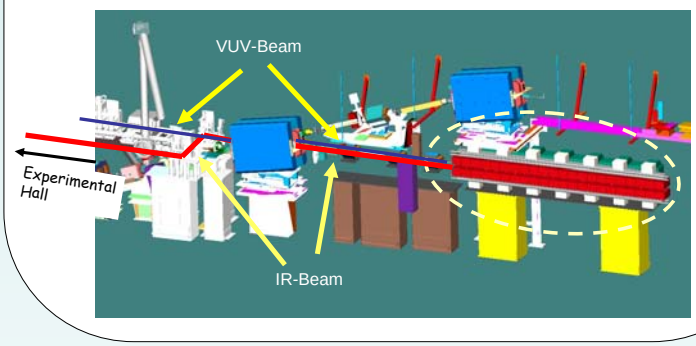
Why using the undulator instead of other techniques?

- Usual coherent diagnostics use broadband spectra
- short wavelength regime most interesting!
- **narrow band source** ⟶ Being able to tune the undulator to a certain wavelength

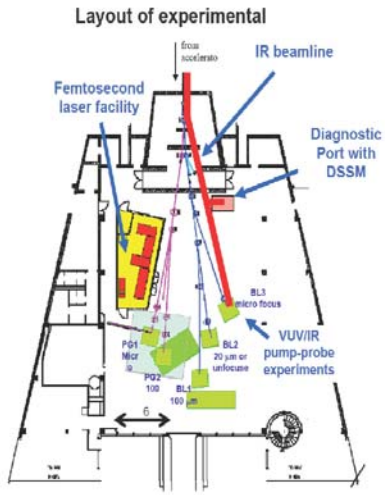
The IR-Undulator in the FLASH tunnel

Some facts…

- Undulator: electromagnetic, 40mm gap, 9 periods of 40cm, 44 poles a maximum field of 1.18T (K = 44 @500MeV)
- situated after FEL-undulator and before the electron dump
- By using the same bunch as FEL, VUV and infrared light naturally synchronized!! Opportunity for pump-probe-experiments.



- Diagnostic Port installed in experimental hall of Flash (access without restrictions)
- Set-Up flushed with nitrogen
- Dispersive Spectrometer will be in use (DSSM),covers range from 26μm to 170μm
- Aim is a better understanding of spectrum and tuning behavior
- Correlation between machine parameters and undulator Spectra
- Second step will be a prevacuum set-up
- Parasitic use of undulator under investigation



The Set-up

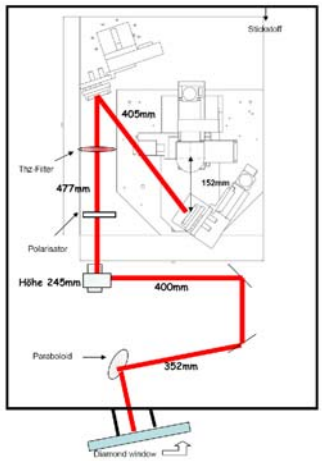
DSSM (dispersive Spectrometer)

Production of first order by reflective grating as filter, afterwards same grating in front of the mirror

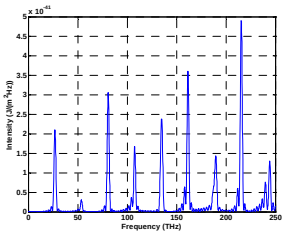
Gratings:
1. 7.9 lp/mm covers 99-166μm;
2. 20 lp/mm covers 39-65μm
3. 30 lp/mm covers 26-43μm

(change by linear movers)

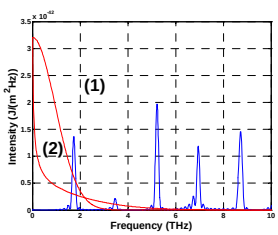
Beam will be prepared by optics not to have a diameter greater than 20mm



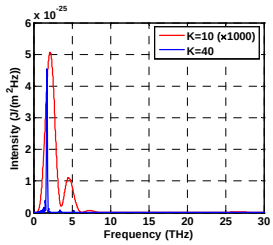
Single Particle Spectrum – Simulated spectrum for horizontal polarized component, K=10 and on-axis



Formfactor – Simulated formfactor gaussian (1) and G.Geloni et.al. [Desy 03-031 (2003)] (2), **spectrum** - K=40 and on-axis



Total spectrum- Because of special bunch shape you get an undulator spectrum in total (dominant fundamental)



Plots courtesy of Oliver Grimm

Outlook…

- Installing prevacuum set-up in experimental hall to get more accurate spectra as soon as possible
- After comissioning of new infrared beamline a port in the tunnel 10m behind the undulator will be available for intensity measurements.
  ⟶ A prevacuum set-up will be installed with a movable pyro-detector

Ideas: - characterizing the source
- after spectrum is quiet understood: scan of the formfactor by tuning the undulator through whole range of wavelengths and measuring the intensity for each. Comparing with simulated single electron spectrum you can figure the form factor ->bunch profile

References:

[1] A. Alfeev et.al., *Simulations of Hamburg University Undulator for infrared coherent source,* Dubna 2005

[2]O. Grimm et.al., *The infrared undulator project at the VUV-FEL*, proceedings of the 27th international FEL conference p. 183-186, Stanford August 2005

[3]O. Grimm et.al., *Principles of Longitudinal Beam Diagnostics with Coherent Radiation,*TESLA-FEL 2006-03, April 2006