

## 4-stage single-shot spectrometer.

Stephan Wesch<sup>1</sup>   Christopher Behrens<sup>1</sup>   Bernhard Schmidt<sup>1</sup>   Peter Schmüser<sup>2</sup>

<sup>1</sup>Deutsches Elektronen-Synchrotron, Hamburg

<sup>2</sup>Institut für Experimentalphysik, Universität Hamburg

IRUVX WP3 Longitudinal Diagnostic Meeting, 27th – 28th October 2009



## Motivation.

### Goal:

Diagnose longitudinal properties of electron bunch for better FEL performance!

### One possible way is spectroscopy of coherent radiation:

$$\left. \frac{dU}{d\omega d\Omega} \right|_{\text{bunch}} \approx \left. \frac{dU}{d\omega d\Omega} \right|_e \cdot N^2 \cdot \left| F(\omega, \vec{k}_\perp) \right|^2$$

- not intrinsically limited in resolution
- not a priori a destructive method
- not a direct measurement of current profile

### Examples of applications:

- 1 Bunch compression monitor
- 2 Substructures (e.g. Microbunching Instability)
- 3 Profile reconstruction (?)

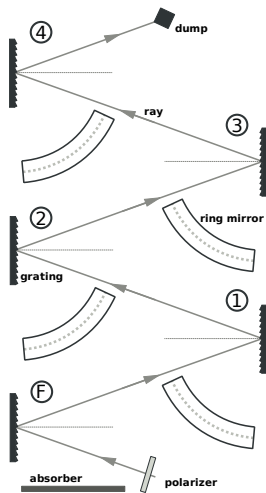
### Request:

Record spectra with wide wavelength coverage for each bunch in macropulse!

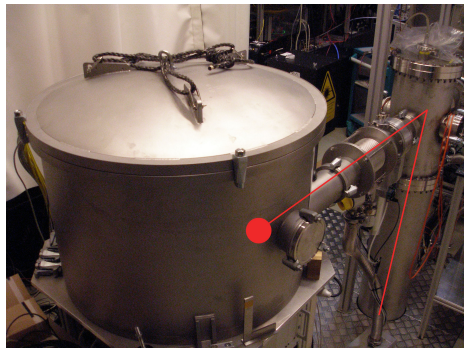
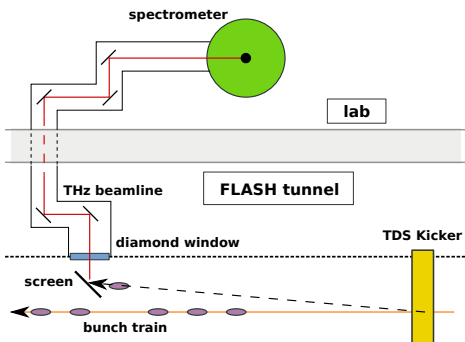
# Principle\*

\* developed by Hossein Delsim-Hashemi

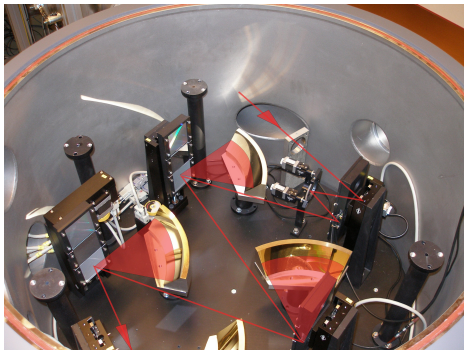
- I. dispersive device — reflective blazed gratings
  - high reflectance in 1<sup>st</sup> order at certain configuration
  - act like a mirror for a specific  $\lambda$  – grating period ratio
  - staging dispersive elements (large spectral coverage)
  
- II. focussing — special ring mirror
  - single mirror per stage (large dispersive angle of 60 deg)
  - focussing without geometric distortion
  
- III. detector — pyro electric elements
  - wavelength range from 1  $\mu\text{m}$  up to several 100  $\mu\text{m}$ 's
  - 30 single elements per stage
  - see Bernhard's talk
  
- IV. readout electronics
  - amplifier chain (up to 1 MHz readout rate)
  - ADC for each detector element (sampling rate 9 MHz)



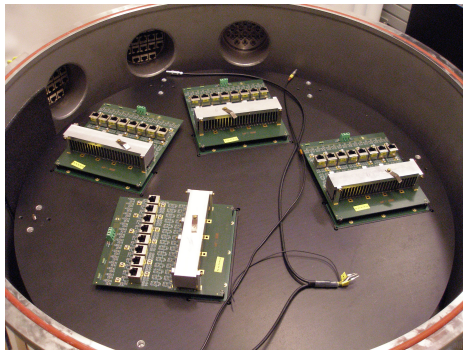
# 4 Stage Spectrometer I.



## 4 Stage Spectrometer II.

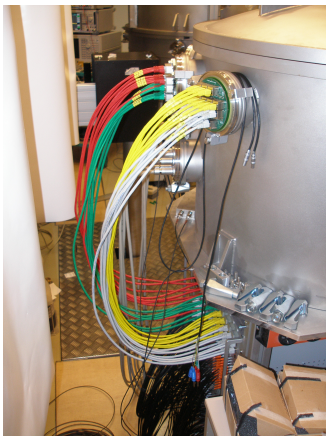


grating plane



detector plane

## 4 Stage Spectrometer III.

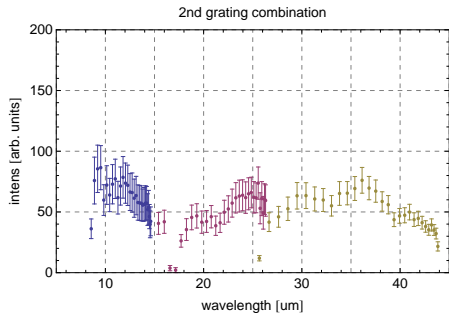
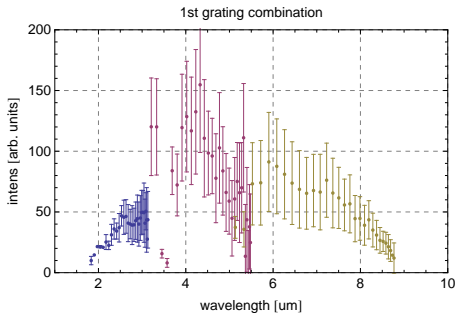


signal feedthrough



electronic rack

# Test Spectrum.



- test spectra under FEL condition
- spectra with 3 stages - uncorrected data
- errorbars show shot-to-shot fluctuation bandwidth
- 4<sup>th</sup> stage equipped with transmission grating (not in operation)

## Two installations at FLASH.

### After last acceleration module:

- a. TR station off/on-axis screens
- b. spectrometer outside tunnel
- good accessibility (for testing)
- measure spectra of mostly full compressed bunch (dogleg missing)

### In front of SASE undulators:

- a. TR screen off-axis / DR screen
- b. spectrometer inside tunnel
- monitor capability
- measure spectra of 'undulator' bunches (after collimator, ORS and sFLASH)

### Correlation of both spectrometers:

- i. bunch spectra evolution
- ii. 'cross check' of spectrometer behavior



Thank you for your attention!

