The Split-and-Delay Unit for the HED Instrument

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Requirements

- wide photon energy range (5 keV – 24 keV)
- high transmission (~ 30% - 60 %)
- transmission of the whole beam profile
- maximum delays on the order of picoseconds
- sub-100 as resolution ($t_{coh} \sim 200$ as)
- variable splitting ratio
- two-color pump/probe experiments with fundamental and third harmonic radiation
Optical Concept

- point symmetrical concept in one plane
- multilayer mirrors enable steeper reflection angles
- Bragg-angle depends on the photon energy
- mirrors move along the separated beams
- odd number of reflections (beam profile turned by 180°)
- Bragg-angle of BS and RC twice as large compared to the other mirrors
- variation of the splitting ratio: horizontal motion of BS
- all components are mounted inside the optical bench
- octagonal structure – increased sturdyness
- mirrors move along guiding rails
- motion of $L = 10 \mu m \Rightarrow t = 13$ as (at $0.56^\circ$, 20 keV)
Mechanical Layout
- Mo/B₄C multilayer coating on silicon substrates
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- acceptance delay mirrors: 141 µrad
- acceptance BS and RC: 33 µrad
Two-color pump/probe experiments

- two-color pump/probe experiments with fundamental and third harmonic
- fundamental in one beam path, third harmonic in the other

- mirror S1 and S8 have to reflect both photon energies at the same Bragg angle
Two-color pump/probe experiments

- two-color pump/probe experiments with fundamental and third harmonic
- fundamental in one beam path, third harmonic in the other

- mirror S1 and S8 have to reflect both photon energies at the same Bragg angle
- novel two-color multilayer coating
Two-color pump/probe experiments

- third coating (two-color) on S1 and S8
- two coatings on top of each other
- **fundamental** (5 keV – 6.6 keV) is reflected by 4 layers of Ni/B$_4$C (d = 11.85 nm)
- **third harmonic** (15 keV – 20 keV) passes the Ni/B$_4$C system and is reflected by 120 layers of Mo/B$_4$C (d = 3.2 nm)
Two-color pump/probe experiments

- measurement performed at BM05 at ESRF
- both, fundamental and third harmonic are reflected at the same angle
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Mirror Re-Adjustment

- non-ideal motion along guide rails
- parasitic angle $\theta$
- overlap of both beams has to be guaranteed
Mirror Re-Adjustment

- CRL1: f=141 m
- CRL2 sample: f=84 m
- SDU: 846 m
Mirror Re-Adjustment

\[ \theta = 100 \text{ mrad} \quad y = 0.9 \text{ \(\mu\)m} \]
Mirror Re-Adjustment

- 3-axis interferometer
- feedback loop
- piezo actuator for correction of angle $\theta$
Mirror Re-Adjustment

Distance [mm]

angle [μrad]

Time [s]

re-adjustment active
Mirror Re-Adjustment

800 mm

angle [μrad]

Time [s]
Mirror Re-Adjustment

\[ \bar{\theta} = -16.9 \text{ nrad} \]

\[ \sigma = 29.5 \text{ nrad} \]

\[ \bar{\theta} = -20.2 \text{ nrad} \]

\[ \sigma = 47.9 \text{ nrad} \]
Work to be done

- limit switches
- set up clean-room tent
- installation
- commissioning
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Thank you for your attention!