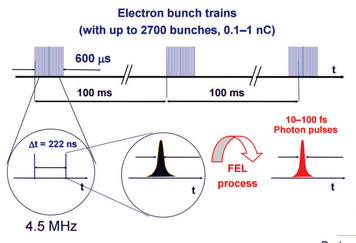
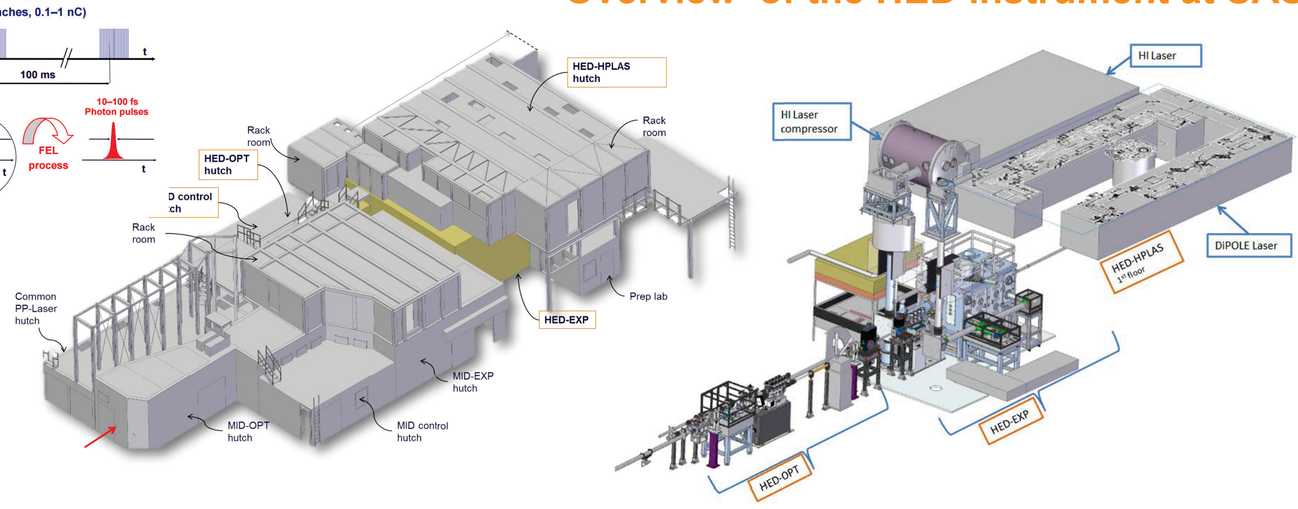
Realisation of the Infrastructure to fulfil the Scientific Requirements of the HED instrument

A. Schmidt, E. Boyd, K. Appel, S. Cunis, M. Nakatsutsumi, G. Priebe, I. Thorpe, G. Wellenreuther, U. Zastrau
European XFEL GmbH, Schenefeld, Germany
C. Baehtz, A. Ferrari
Helmholtz-Zentrum Dresden-Rossendorf, Germany

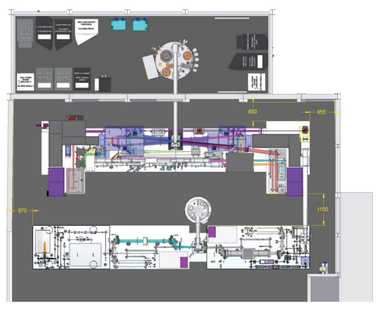
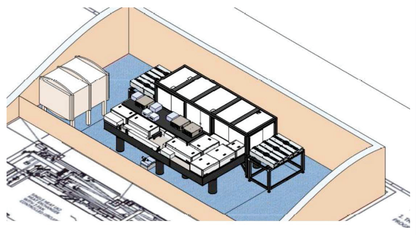
Abstract The High Energy Density (HED) instrument is one out of six end-stations currently being constructed at the European XFEL GmbH. One of the scientific fields is the investigation of extreme high energy density states driven by high-energy and high-intensity lasers at a repetition rate of up to 10 Hz.
To operate the laser systems and align the laser pulses with the X-ray pulses strong requirements to the environment like temperature stability and low vibrations are requested. The laser induced radiation requires heavy concrete shielding and also has influences to the layout of the interaction chamber.
A second interaction area is prepared for further scientific set-ups that cannot be hosted in the main interaction chamber provided by external scientific groups e.g. the HIBEF user consortium.

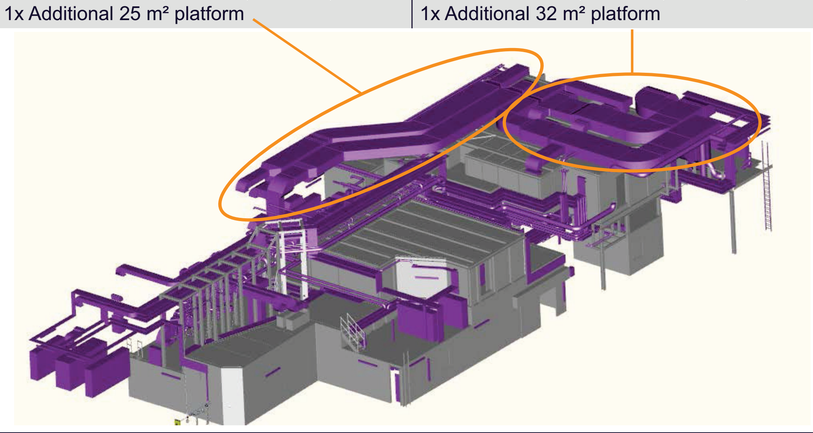
Overview of the HED instrument at SASE2





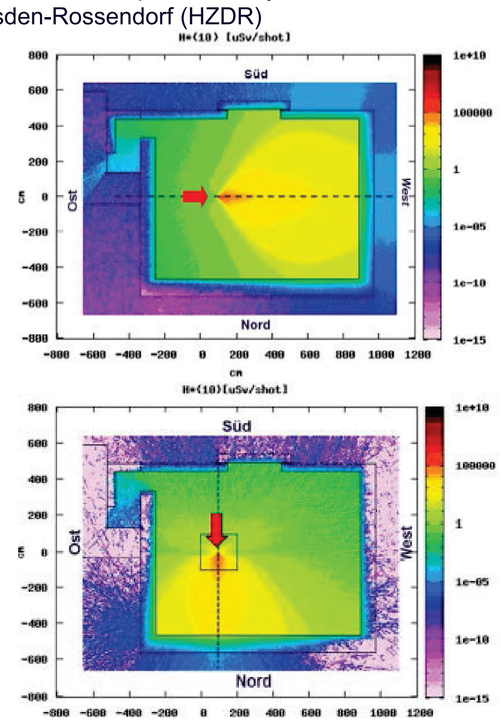
Laser Systems: (HIBEF contribution)

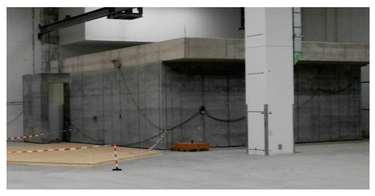
DiPOLE 100 J long-pulse laser (HE)	Short-pulse laser (HI)
100J; 2-20 ns; 10 Hz Requirements to environment: - Clean room standard ISO6 - Temperature stability better than +/- 0,1 K - Humidity 50% +/- 2,5% - Heat load 10KW	Multi 100 Tera -Watt; 10J; 25fs; 10Hz Requirements to environment: - Clean room standard ISO7 - Temperature stability better than +/- 0,1 K - Humidity 50 % +/- 2,5 % - Heat load 5 KW
	
Air condition solution: Air speed: 0,25 m/s Air change: 22.500 m³/h Air ducts: 1,6m x 0,65m 2 x AC device W:2,1m x H:2,2m x D:0,85m 1x Additional 25 m² platform	Air condition solution: Air speed: 0,25 m/s Air change: 36.000 m³/h Air ducts: 2m x 0,8m 2 x AC device W:2,4m x H:2,3m x D:1,1m 1x Additional 32 m² platform



Experimental hutch:

1 m thick heavy concrete wall are required to keep the radiation level outside the hutch <0,5 µSv/h. Taking into account up to 5 MeV electrons generated by the short pulse laser.
Fluka calculation performed by Helmholtz-Zentrum Dresden-Rossendorf (HZDR)





Vibration monitoring:

To achieve Nano-E on hall floor and VC-E at the HED enclosure roof vibration-insulation or mass baseplate are requested for:
- Main water pumps
- Vacuum Roughing pumps
- Air condition devices
- …

Comparison of possible noises in the hall
1. Light working
2. Digger pulling a steel container
3. Crane operation

Predicted vibration on top of HED enclosure roof

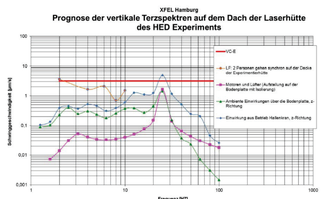


Abbildung 5-11: 1. Vertikale Terzspektren auf dem Dache der HED Experimentierhütte

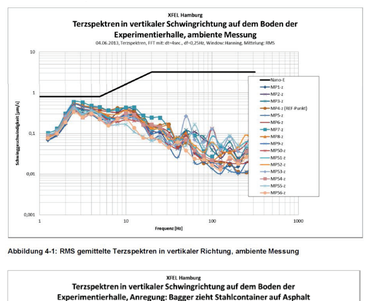
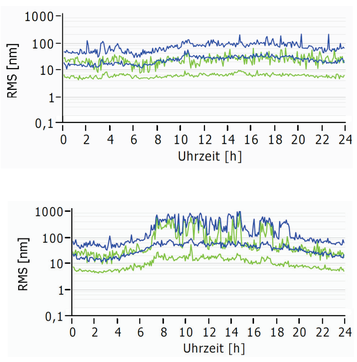


Abbildung 4-1: RMS gemittelte Terzspektren in vertikaler Richtung, ambiente Messung

Comparison of measurements Sunday and working day



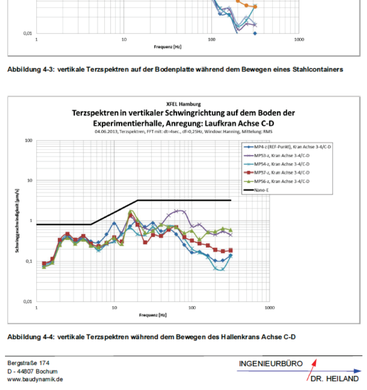


Abbildung 4-3: vertikale Terzspektren auf der Bodenplatte während dem Bewegen eines Stahlcontainers

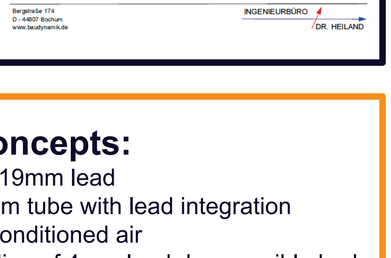


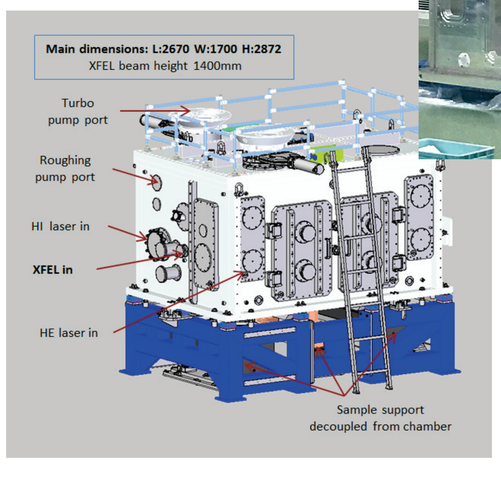
Abbildung 4-4: vertikale Terzspektren während dem Bewegen des Hallenkrans Achse C-D

Bergstraße 174
D - 44807 Bochum
www.baudynamik.de

INGENIEURBÜRO DR. HEILAND

Interaction chamber 1:

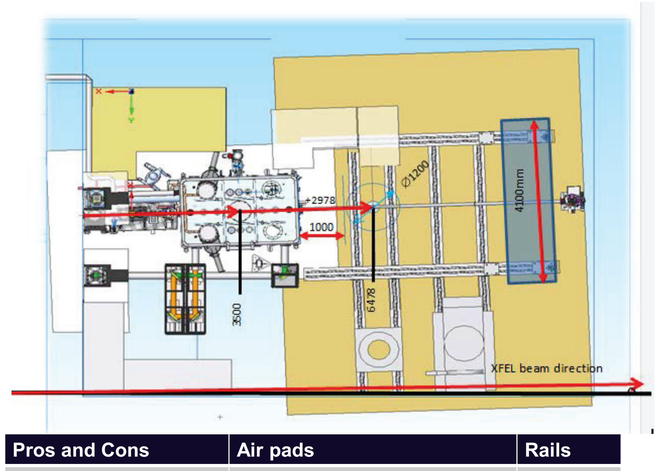
Avoid dense material which can be activated by the laser induced radiation
E.g.: Iron, Nickel, Vanadium, …
60mm plates with big reinforcements ribs are needed to achieve <0,5mm deformation



Pros and Cons	Aluminum	Steel
Stiffness	Bad	Good
Machining	Good	Good
Weldability	Limited due to wall thickness (EBW)	Good
Activating	Good	Bad
Decay time	Good	Bad

Interaction area 2 (HIBEF contribution)

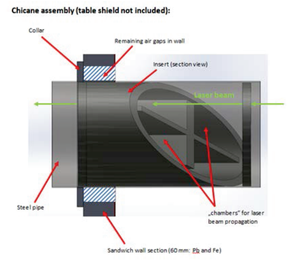
Flexible setups of different instrument set ups in limited space
-Diamond anvil cell
-Pulsed magnet
-Detector bench

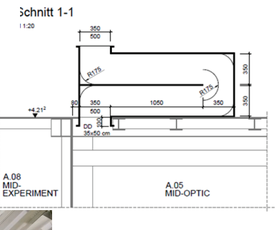


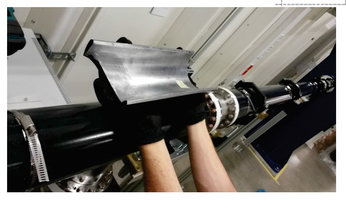
Pros and Cons	Air pads	Rails
Flexibility	Fully flexible parking positions	Limited
Precision	Kinematic mounts needed	Good
Dust	Bad	Good
Noise	Bad	Good
Movement during measurement possible	No	yes

Shielding concepts:

- Hutches 4mm to 19mm lead
- Special laser beam tube with lead integration
- Air chicanes for conditioned air
- Beam tube shielding of 4mm lead due possible bad vacuum (10E-3 mbar)







MEDSI 2016
MECHANICAL ENGINEERING DESIGN OF SYNCHROTRON RADIATION EQUIPMENT AND INSTRUMENTATION

DESY
HELMHOLTZ ASSOCIATION