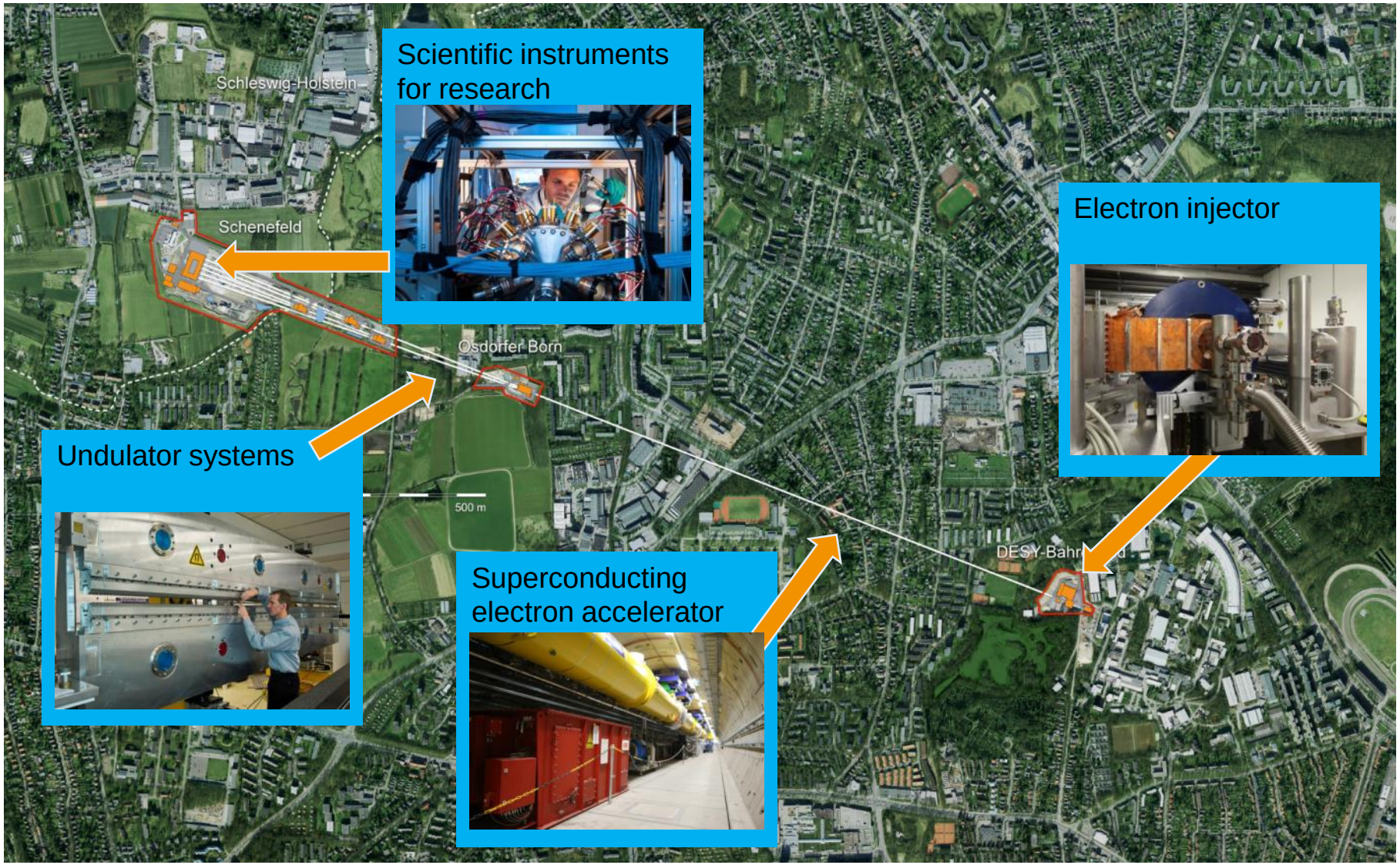
HED /HIBEF satellite meeting
Welcome

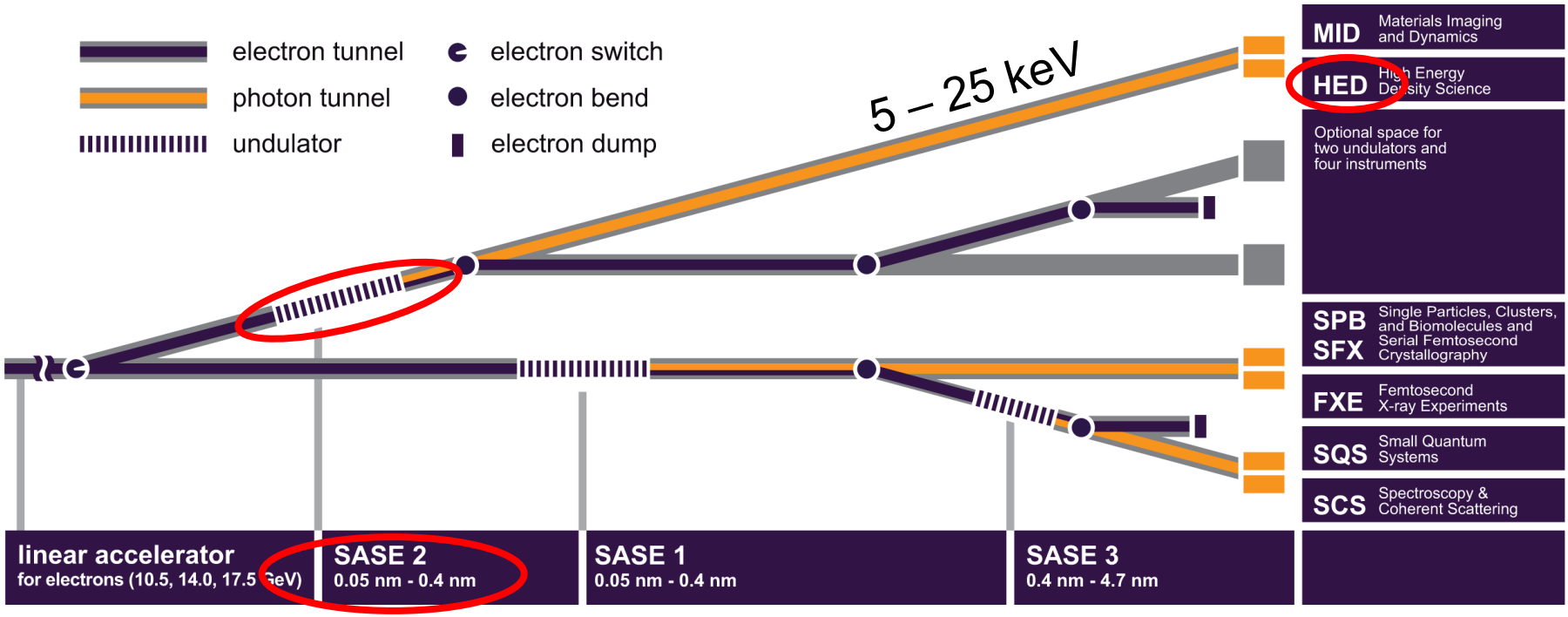
Ulf Zastrau
Group Head
HED science instrument at the European XFEL

HED-HiBEF satellite meeting to the EuXFEL/DESY UM 2021
January 20th, 2021, EuXFEL, Germany

European XFEL: a closer look at the facility



European XFEL: beamlines and instruments



- 8 keV lasing in SASE1 with up to 1 mJ — May 2017
- First experiments at SASE1 — Sept. 2017
- First experiments at HED — May 2019

Unique capabilities arise when:

Couple XFEL beam to powerful drivers

- Diamond Anvil Cells (available)
  dynamic DAC; pulsed laser heated DAC; double-stage DAC
- Powerful optical lasers (2020-2021)
  100 J 15 ns 10 Hz; 400 TW 30 fs 10 Hz
- XFEL split&delay line (2021)
  x-ray pump-probe, 0-20 ps delay
- 60 T pulsed magnetic field coil (2021)
  cryogenic sample environment, superconductivity

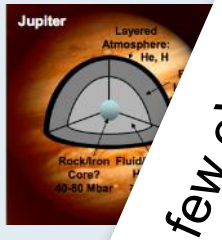
HED – research at extremes

high density $\rho > \rho_0$, T < few eV

solid density $\rho = \rho_0$, T up to keV

Laser Compression

Shock & ramp compr



XRD, IX

Long-p laser

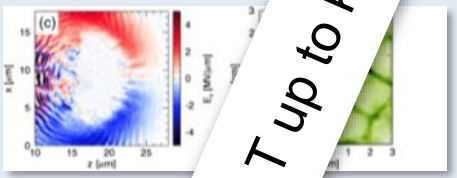
Relativistic Laser-Plasmas

Electron transpor

Instabilities and filam

Particle acceler

High EM fi



Multi-10 laser

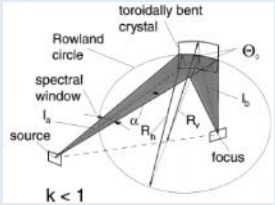
Advanced methods

Spectrometers

Advanced focusing

IXS, SAXS

Phase contrast imaging



Diam vil Cells

Fast piezo DAC

Puls heated DAC

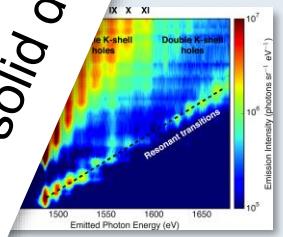
stage DAC

18 to 25 keV

Isochor excitation

Tra roperties,

H oms, rates



XES, IXS, XRD

Tight focusing

Further projects

Isobaric heating

Cryogenic jet targets

High-rep solids targets

EMP-hard X-ray detectors

High-purity polarimetry

…

First publications appear…

SCIENTIFIC REPORTS
natureresearch
Check for updates

An approach for the measurement of the bulk temperature of single crystal diamond using an X-ray free electron laser

A. Descamps[1,2], B. K. Ofori-Okai[1], K. Appel[3], V. Cerantola[3], A. Comley[4], J. H. Eggert[5], L. B. Fletcher[1], D. O. Gericke[6], S. Göde[3], O. Humphries[7], O. Karnbach[7], A. Lazicki[5], R. Loetzsch[8,9], D. McGonegle[4,7], C. A. J. Palmer[10], C. Plueckthun[3], T. R. Preston[3], R. Redmer[11], D. G. Senesky[2], C. Strohm[3,12], I. Uschmann[8,9], T. G. White[13], L. Wollenweber[3], G. Monaco[14], J. S. Wark[7], J. B. Hastings[1], U. Zastrau[3], G. Gregori[7], S. H. Glenzer[1] & E. E. McBride[1]

Review of Scientific Instruments ARTICLE scitation.org/journal/rsi

High-resolution inelastic x-ray scattering at the high energy density scientific instrument at the European X-Ray Free-Electron Laser

Cite as: Rev. Sci. Instrum. 92, 013101 (2021); doi: 10.1063/5.0022886
Submitted: 24 July 2020 • Accepted: 12 December 2020 •
Published Online: 4 January 2021 • Publisher Error Corrected: 7 January 2021
View Online Export Citation CrossMark

L. Wollenweber,[1,a)] T. R. Preston,[1] A. Descamps,[2,3] V. Cerantola,[1] A. Comley,[4] J. H. Eggert,[5] L. B. Fletcher,[2] G. Geloni,[1] D. O. Gericke,[6] S. H. Glenzer,[2] S. Göde,[1] J. Hastings,[2] O. S. Humphries,[7] A. Jenei,[5] O. Karnbach,[7] Z. Konopkova,[1] R. Loetzsch,[8] B. Marx-Glowna,[8] E. E. McBride,[2] D. McGonegle,[7] G. Monaco,[9] B. K. Ofori-Okai,[2] C. A. J. Palmer,[10] C. Plückthun,[1] R. Redmer,[11] C. Strohm,[1,12] I. Thorpe,[1] T. Tschentscher,[1] I. Uschmann,[8,13] J. S. Wark,[7] T. G. White,[14] K. Appel,[1] G. Gregori,[7] and U. Zastrau[1]

Mirror to measure small angle x-ray scattering signal in high energy density experiments

Cite as: Rev. Sci. Instrum. 91, 123501 (2020); doi: 10.1063/5.0021691
Submitted: 13 July 2020 • Accepted: 6 November 2020 •
Published Online: 2 December 2020
View Online Export Citation CrossMark

M. Šmíd,[1,a)] C. Baehtz,[1] A. Pelka,[1] A. Laso García,[1] S. Göde,[2] J. Grenzer,[1] T. Kluge,[1] Z. Konopkova,[2] M. Makita,[2] I. Prencipe,[1] T. R. Preston,[2] M. Rödel,[1] and T. E. Cowan[1]

We had ambitious plans for 2021…

- In 2020, we were able to schedule 2 user experiments
  - Kraus → later. Nakatsutsumi →plenary.
- 2021: 7-Eleven scheme (7am – 11pm) – no 12h/12h switching

Calendar 2021, Run7

January	February	March	April	May	June
1 Fr	1 Mo 14 GeV 5	1 Mo 14 GeV 9	1 Th XANES CNRS	1 Sa	1 Tu 7.49 keV seeded 50 bunches
2 Sa	2 Tu	2 Tu 12.9 keV (seeded) 100 bunch	2 Fr XANES CNRS	2 Su	2 We seeding, hrMONO, pp laser
3 Su	3 We	3 We seeding setup	3 Sa X-ray heating (Williams/Fajardo)	3 Mo 16 GeV long RF window	3 Th crystal optics polarization control
4 Mo 1	4 Th setup IC1 for TW laser expt	4 Th mono setup	4 Su Williams/Fajardo #2586	4 Tu 18 keV 2.2 MHz 352 bunches	4 Fr Wollenweber/Gregori hrIXS
5 Tu	5 Fr compatible with Polarimetry	5 Fr Polarimetry (Schlenvoigt)	5 Mo Williams/Fajardo 14	5 We AGIPD MH recommissioning	5 Sa Wollenweber/Gregori #2656
6 We	6 Sa	6 Sa Polarimetry #2452	6 Tu 16 GeV	6 Th dDAC commissioning	6 Su Wollenweber/Gregori
7 Th	7 Su	7 Su Polarimetry LC: CB; SG	7 We	7 Fr dDAC commissioning	7 Mo 23
8 Fr	8 Mo 14 GeV 6	8 Mo 14 GeV 10	8 Th	8 Sa Jenei/Liermann: dDAC	8 Tu
9 Sa	9 Tu 8 keV, 10 bunches	9 Tu	9 Fr setup nanofocus for Lee	9 Su Jenei/Liermann #2592	9 We
10 Su	10 We beamline setup	10 We	10 Sa keep CNRS spectrometer?	10 Mo 16 GeV 19	10 Th
11 Mo 2	11 Th decector commiss	11 Th change to Be lenses in IC1	11 Su	11 Tu IC2: change dDAC to LH setup	11 Fr
12 Tu	12 Fr PCI commissioning	12 Fr	12 Mo 7	12 We	12 Sa
13 We	13 Sa PCI commissioning	13 Sa	13 Tu 7	13 Th IC1:	13 Su
14 Th	14 Su mono edges, cryo	14 Su	14 We 16 GeV	14 Fr pp-laser setup with laser interlock	14 Mo 24
15 Fr	15 Mo 7	15 Mo 14 GeV 11	15 Th 9 keV, 1 bunch	15 Sa	15 Tu
16 Sa	16 Tu	16 Tu 8.15 keV 1 bunch	16 Fr align nanofocus	16 Su	16 We
17 Su	17 We	17 We Pulse-on-demand tests	17 Sa Ge220 spectrometer tests	17 Mo 16 GeV 20	17 Th
18 Mo 3	18 Th	18 Th PoD / TW laser Toncian	18 Su Lee #2353	18 Tu 18 keV 2.2 MHz 200 bunches	18 Fr
19 Tu	19 Fr	19 Fr TW laser SAXS/PCI (Toncian)	19 Mo Lee #2353 16	19 We Prescher/Morard: LH DAC	19 Sa
20 We	20 Sa	20 Sa TW laser Toncian #2621	20 Tu Lee #2353 LC: JPS	20 Th Prescher/Morard #2605 LC: ZK ?	20 Su
21 Th	21 Su	21 Su TW laser Toncian	21 We dismantle CNRS XANES spectrmeter	21 Fr buffer / setup change - 15 keV	21 Mo 25
22 Fr	22 Mo 14 GeV 8	22 Mo 12	22 Th remove nanofocus from IC1	22 Sa Husband/McMahon: low-Z DAC	22 Tu
23 Sa	23 Tu	23 Tu 11 GeV	23 Fr start mount diced analyzers IC1	23 Su Husband/McMahon #2590- 15 keV	23 We
24 Su	24 We	24 We remove SAXS setup behind IC1	24 Sa move IC2 into the beam	24 Mo 11 GeV 21	24 Th
25 Mo 4	25 Th change to SU8 lenses	25 Th	25 Su	25 Tu	25 Fr
26 Tu	26 Fr	26 Fr setup for spectrometers in IC1	26 Mo 16 GeV 17	26 We	26 Sa
27 We	27 Sa	27 Sa and XANES CNRS spectrometer	27 Tu	27 Th pp-laser setup with laser interlock	27 Su
28 Th	28 Su	28 Su	28 We	28 Fr	28 Mo 26
29 Fr		29 Mo 13	29 Th start bring pp laser to IC1	29 Sa	29 Tu
30 Sa		30 Tu 11 GeV	30 Fr	30 Su	30 We
31 Su		31 We 5.0 and 7.8 keV, 1 bunch		31 Mo 11 GeV 22	

Shutdown
Facility Development
Tuning and setup

X-ray Operation (7-Eleven)
USERS
X-ray at MID

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12 Tu	12 Fr PCI commissioning	12	Mo 7	12 We	12 Sa
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20 We	20 Sa	20 laser Toncian #2621	Tu Lee #2353 LC: JPS	20 Th Prescher/Morard #2605 LC: ZK ?	20 Su
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- We planned to conduct 8 user experiments in 8 weeks – but then the lockdown came

Special modes – seeding and two-color

7th EuXFEL Call for Proposals (Allocation: July– December 2021)	
SASE FEL	SASE 1/SASE 2
Photon energy [keV]*	5 – 24
Max. mean pulse energy **[mJ]	0.5 – 4
Bunch duration [rms fs]	10 – 25
Max. intra-train frequency [MHz]	4.5
Typ. number of pulses***	400

„Regular“ operation

- **Hard X-ray Self Seeding**

  7-14.4 keV, few 100 uJ pulse energy. Tested at 9 keV and 12.9 keV

- **two-color two pulse mode**

  few 100 uJ (or 10s uJ), max delay 400 fs, depending on electron energy

  has not yet been tested at SASE2 and HED and the performance is unknown.

  Cross talk between delay, intensity ratio, pointing, …

  Interested proposers contactws HED staff with a specific request, following discussion with experts (FEL Physics team).

7th call for proposals (opens Nov 5, closes Dec 16, 2020)

- **We offer on a regular basis – X-RAY parameters:**
  - 5-24 keV x-ray photon energy SASE spectrum (about 0.2% bandwidth), usually about 1-2 mJ Pulse energy in ~20-40 eV
  - Seeded x-rays between 8-14 keV (~0.8 eV spectral width), few 100 µJ

  - Single pulses/trains on demand, or 10 Hz continuous
  - pulse trains of 2.25 MHz (440 ns) or up with 4.5 MHz rep. rate (220 ns) and max. 200 µs window

  - 4-bounce monochromator (1 eV bandwidth) at 10 Hz between 5-18 keV
  - High res-mono@7.49 keV (about 40 meV bandwidth) at 10 Hz

  - full focusing capability CRL 1,2,3,4
    any focus from parallel beam (few µrad divergence) down to sub-µm foci, however with partly strong absorption in the Be lenses.

  - "HIREX2" spectrometer in the SASE2 branch (before the separation into MID and HED) for monitoring the incident SASE / seeded spectrum

Scientific drivers (contributed by HIBEF UC):

- Isochoric heating (using the focused intense XFEL pulse to create a plasma)
- Diamond anvil cells
- Pump-probe laser (PP)
- TW laser RE.LA.X
- DiPOLE laser (only in a single community proposal (McMahon/Appel)

We still have to exclude:

- Split-Delay-Line (installation planned for 2021/2022)
- Pulsed magnetic fields (installation in 2021)
- 1M AGIPD (this “full scale” AGIPD detector is delayed to unknown time due to necessary redesign of the cooling system)

Proposals must be submitted through UPEX (https://in.xfel.eu/upex)

The joint HED and HIBEF team at European XFEL

Great thanks to

HIBEF Team at DESY

HED group at HZDR