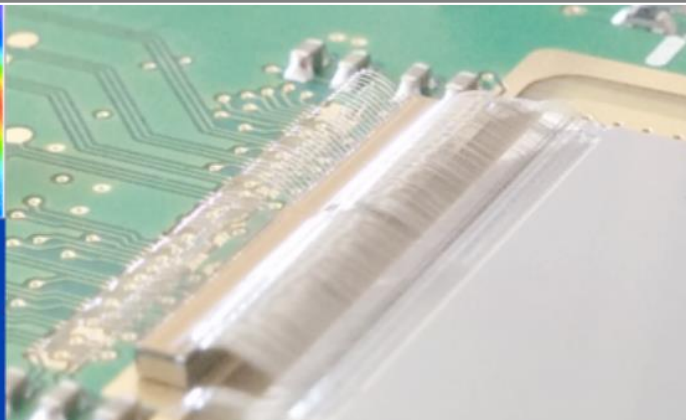
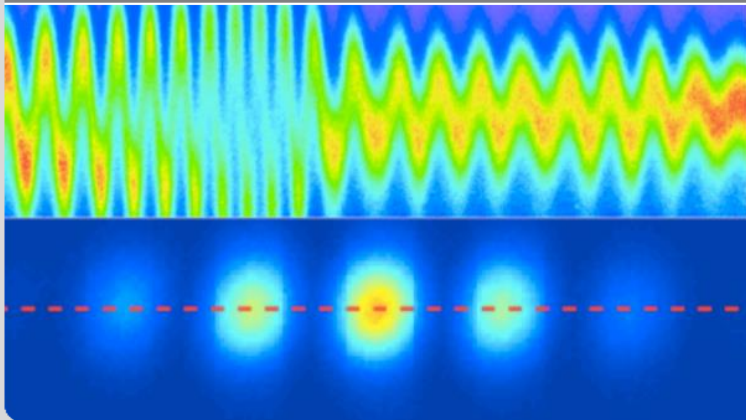


## BMBF-Verbundforschung and beyond

**Erik Bründermann**

presented on 18 October 2019 at MT-ARD-ST3 Annual Meeting

INSTITUTE FOR BEAM PHYSICS AND TECHNOLOGY



## Funding schemes in the framework programme

### „Erforschung von Universum und Materie – ErUM“

- „Physik der kleinsten Teilchen“, deadline 01/11/17, [07/18 – 06/21]
  - Includes recommendations of Committees for Elementary Particle Physics, Hadron and Nuclear Physics and Accelerator Physics
- Naturwissenschaftliche Grundlagenforschung auf dem Gebiet „Erforschung der Materie an Großgeräten“, deadline 01/11/18, [07/19 – 06/22]
  - Purpose of this measure
    - Strengthen the supra-regional cooperation of university groups in conjunction with large-scale equipment
    - Ensure the qualified use of large-scale facilities through the acquisition and training of young scientists

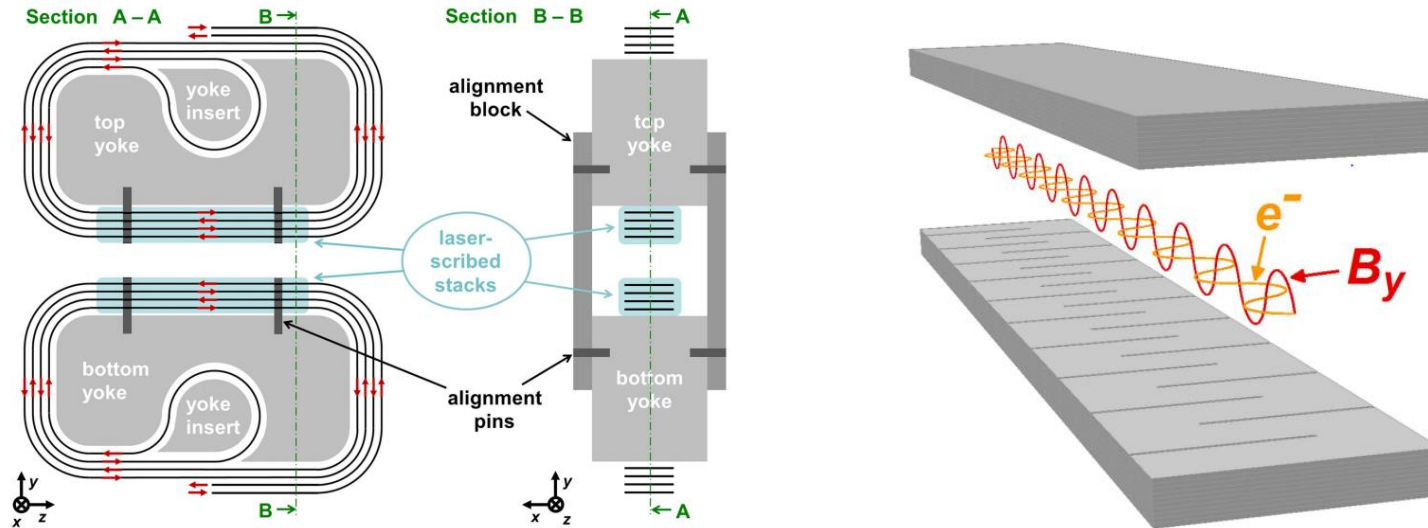
# BMBF-Verbundforschung 05K2019: 07/2019-06/2022

Projekt	Beschreibung
	Kompakte Quellen für kurze Elektronenpulse mit hoher RepetitionsrateErzeugung ultrakurzer spinpolarisierter Elektronenpulse und Messung der erreichten Pulslängen mittels Smith Purcell-Strahlung.
Advanced-BAM	Entwicklung eines neuen Ankunftszeitmonitors mit sehr hoher Bandbreite für sehr geringe Ladungen als Teil der optischen Synchronisationssysteme von XFEL, FLASH und ELBE.
BETH	Hochbrillianten Elektronenstrahlen generiert durch neuartige thermisch widerstandsfähige Photokathoden.
DLA-e-prep	Dielektrische Laser-Beschleunigung zur Elektronen-Strahl-Präparation.
E-CUBE	Elektronenstrahlen mit extremer Emittanz - Realisierung des "Trojan Horse"-Injektorkonzepts und Simulation von Beschleunigung mit ultra-kleiner Emittanz.
HTSSCU	Strukturierter Hochtemperatur-Supraleiter-Band-Undulator.
LADIAG	Neue Diagnostiken für Hoch-Intensitätslaser.
optics4XI	Entwicklung von Spezial-Röntgenoptiken für biomedizinische Bildgebung mittels Röntgenfluoreszenz für Synchrotron- wie laser-basierte Röntgenquellen.
PlasmaFEL	Laser-Plasma-Beschleuniger getriebene FEL - Erste Demonstration und fortschrittlicher Strahltransport.
SCUXFEL	Supraleitende Undulatoren für den Europäischen XFEL.
SMART	SIS Mehrschichtsysteme für Anwendungen in der supraleitenden Hochfrequenztechnik.
STAR	Moderne Seeding-Methoden für Strahlung im XUV- und Angström-Bereich.
STARTRAC	Fortgeschrittene Terahertz-Diagnostik für die Beschleunigerforschung.
TiMo	Timing-Modi für fortschrittliche Synchrotronstrahlungsquellen.
ULFI	Ultraschnelle Bildgebung in Plasmen.

[https://foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=searchmask\\_05K2019\\*](https://foerderportal.bund.de/foekat/jsp/SucheAction.do?actionMode=searchmask_05K2019*), information linked to/provided by PT-DESY

# HTSSCU: Structured High Temperature Superconductor Band Undulator

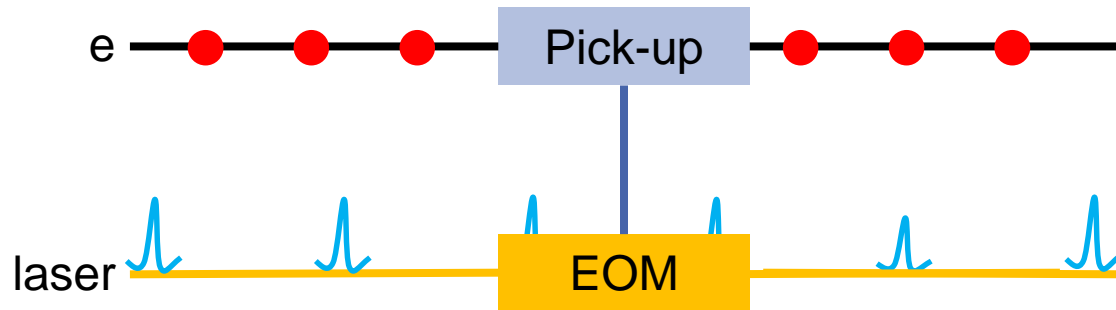
■ KIT ITTK&LAS (coordinator), TU Darmstadt (TEMF)



Images also in “A novel concept of high temperature superconducting undulator”, Holubek, T.; Casalbuoni, S.; Gerstl, S.; Glamann, N.; Grau, A.; Meuter, C.; De Jauregui, D. S.; Nast, R.; Goldacker, W., 2017. Superconductor science and technology, 30 (11), Art.Nr.: 115002. doi: <https://doi.org/10.1088/1361-6668/aa87f1>

# Advanced-BAM: Development of a novel high-bandwidth arrival time monitor for very low charges as a part of the all-optical synchronization systems at XFEL, FLASH, and ELBE

- TH Mittelhessen (coordinator), TU Darmstadt (TEMF), KIT IPQ&LAS
- DESY, HZDR



- HZB/Berlin (coordinator), KIT IAR&LAS, TU Dortmund
  - TRIBs Injection - Injection into a Two-Orbit Machine
  - Timing-Modes such as VSR, TRIBs and low- $\alpha$  in DLSRs
  - Micro-Bunching Control
  - Fundamental Studies of TRIBs
  - EEHG for BESSY II and DLSRs



DLSR: diffraction-limited storage rings  
EEHG: echo-enabled harmonic generation  
TRIBs: transverse resonance island buckets  
VSR: variable pulse length storage ring

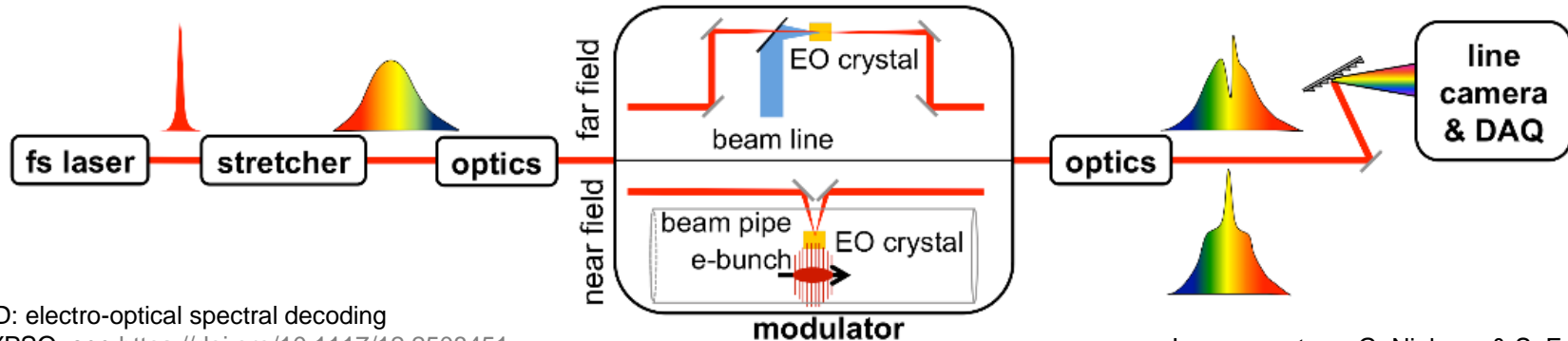
Image credit: TRIBs at BESSY II - Populating the two orbits  
[https://www.youtube.com/watch?v=FRq9pT\\_sETQ](https://www.youtube.com/watch?v=FRq9pT_sETQ)

# STARTRAC: Sophisticated Tools for Accelerator Research using Terahertz RADIATION Characteristics

- KIT LAS (coordinator), TU Dortmund
- Combining advanced ultra-fast beam diagnostic methods for systematic studies (KARA)
- Studies of beam dynamics with terahertz detection methods (DELTA)

Longitudinal bunchprofile (near-field EOSD + KALYPSO)  
+ energy spread, dispersive section (optical + KALYPSO)  
+ terahertz radiation (far-field EOSD + KALYPSO)

Explore: move from  
1050-nm laser to  
1550-nm technology



EOSD: electro-optical spectral decoding

KALYPSO: see <https://doi.org/10.1117/12.2508451>

Image courtesy: G. Niehues & S. Funkner/KIT

# ... and beyond



# 2019/2020 – Innovationspool

Two projects approved by the BMBF for the Innovationspool originating within the “Matter and Technologies” (MT) programme:

## **AMALEA**

### **Accelerating machine learning for physics**

- Project Leader: Frank Gaede/DESY
- Involved Centers: DESY, HZB, HZDR, KIT

## **PLASMED X**

### **Plasma and laser-based medical imaging diagnostic with X-rays**

- Project Leader: Jens Osterhoff/DESY
- Involved Centers: DESY, HMGU, HZDR, KIT

Source: <https://confluence.desy.de/display/DTS/Innovationspool>

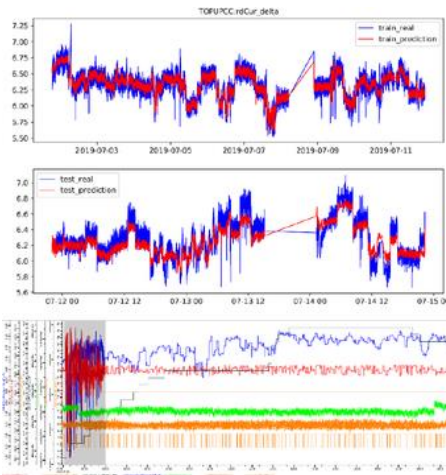
# AMALEA – Accelerating machine learning for physics

## Helmholtz Innovation Pool Project (2019/2020)

Application of machine learning to **challenging projects** in HEP, photon science and accelerators

- Creation of a **sustainable infrastructure** (distributed ML-Lab) with dedicated hardware (multi-core, GPU, FPGA) and software tools
- Development of
  - **Fast simulation and reconstruction for 3D images** of novel detectors, e.g. imaging calorimeters and cameras in photon science
  - **Ultra-fast feedback algorithm for data reduction, compression and classification** of data from current and future light sources
  - **Fast diagnosis and control systems** for the optimization of optics, emittance and beam dynamics of “future accelerators” such as PETRA-IV or BESSY III

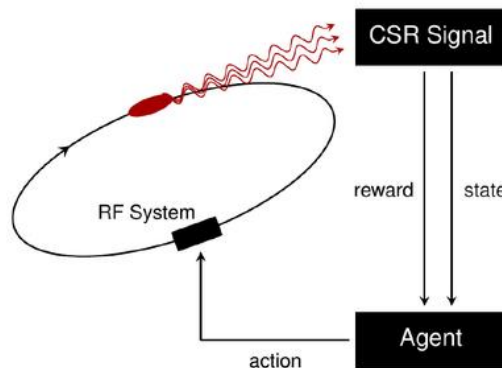
# AMALEA – Overview of ongoing ML projects



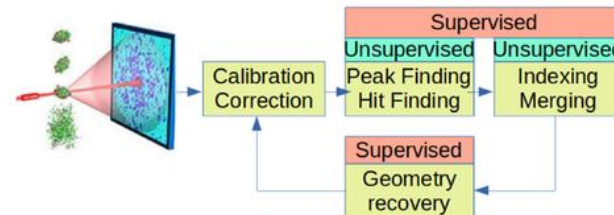
Beam lifetime prediction +  
RL for booster current optimization  
@BESSY II (HZB)



ML for reconstruction of scatter problems +  
partial differential equations +  
direct feature extraction from Fourier space images  
@HZDR



Feedback Design for Control of the  
Micro-Bunching Instability based on  
Reinforcement Learning  
@KIT

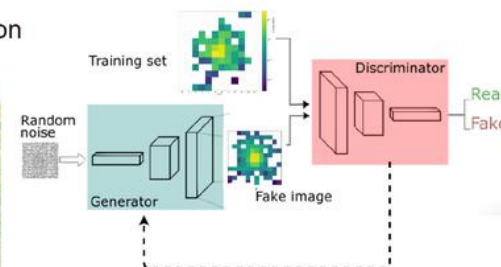


FEL experiments: feedback and data reduction

@DESY  
ML-based automation  
for PETRA IV



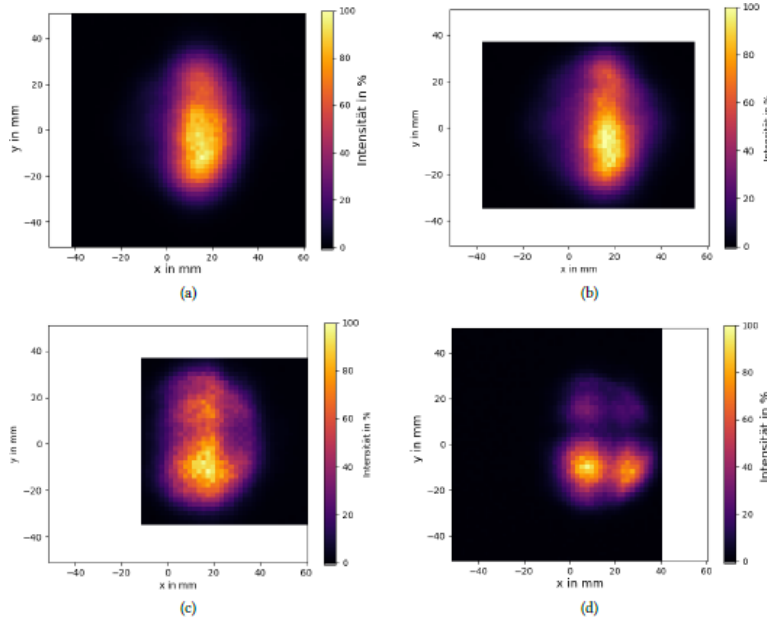
Fast shower simulation in highly  
granular calorimeters with GANs



presented at ICALEPCS2019, source: [http://icalepcs2019.vrws.de/talks/tucpl06\\_talk.pdf](http://icalepcs2019.vrws.de/talks/tucpl06_talk.pdf), see also: <http://icalepcs2019.vrws.de/papers/tucpl06.pdf>

# Imaging with different THz Schottky diodes\*

## ■ Different spatial intensity distribution at different THz frequencies\*



THz imaging at KARA at 86 mm from synchrotron radiation port with Schottky diodes for different bands

- (a) 90-140 GHz
- (b) 140-220 GHz
- (c) 220-325 GHz
- (d) 325-500 GHz

\* Images from Bachelor Thesis: Carl Sax, Nov 2017, KIT, Advisors: J.L. Steinmann, E. Bründermann, A.-S. Müller  
See also: J.L. Steinmann, Dissertation, 2019, pp. 67-72, doi: <https://dx.doi.org/10.5445/KSP/1000090017>  
See also: M. Caselle, <https://indico.desy.de/indico/event/23131/session/2/contribution/31>