



# Diagnostics for the micro-bunching instability at KARA

**Benjamin Kehrer, M. Brosi, E. Bründermann, S. Funkner, M. J. Nasse  
G. Niehues, M. M. Patil, J. L. Steinmann, A.-S. Müller**

LAS Laboratory for Applications of Synchrotron Radiation

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Gudrun Niehues, Meghana M. Patil, Johannes L. Steinmann<sup>1</sup>, Anke-Susanne Müller  
Karlsruhe Institute of Technology, Karlsruhe, Germany  
<sup>1</sup> now at APS, Argonne, USA

Long term goal → Reconstruction

Energy profile →  $\sigma_x = \sqrt{\beta_2} \sigma_0 + (D_0 \sigma_0)^2$  → Energy vs. Time

KALYPSO → EOSD → Temporal profile → CSR → Synchronous measurements

Synchronisation → Multiple detector systems at different locations → Pulse distribution requires synchronous measurements → Trigger distribution by hardware synchronisation scheme → Taking inherent setup delays into account

Time-scales

- Turn-by-turn
- Bunch-by-bunch
- KARA
- $T_{\text{rf}} = 368 \text{ ns}$
- $T_{\text{gap}} = 2 \text{ ns}$
- Stringent requirements

KARATUNE

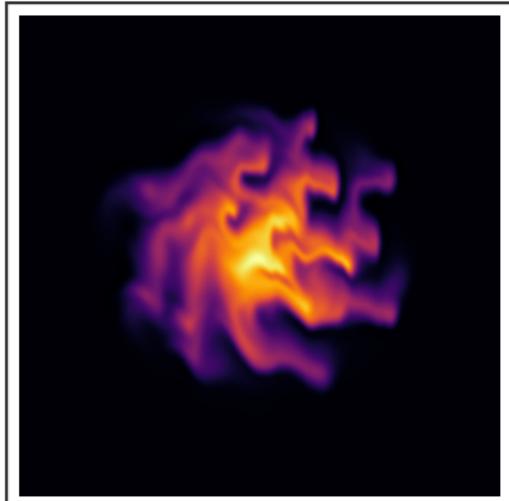
- Ultra-fast DQO system
- Developed at KIT
- Up to 8 channels with 500 MHz sampling rate
- Fast spectrometer

Plots: Energy profile (Kehrer et al., IPAC'18 (DEPP0010)), Temporal profile (Niehues et al., IPAC'18 (DEPP0012)), CSR (Steinmann et al., Phys. Rev. Accel. Beams 21, 101002), Synchronous measurements (Kehrer et al., IPAC'18 (DEPP0013))

Plots: Onset of CSR burst coupled to occurrence of substructures on the longitudinal bunch profile (Kehrer et al., IPAC'18 (DEPP0014)), Different bunches (Kehrer et al., IPAC'18 (DEPP0015)), Different energy spread (Kehrer et al., IPAC'18 (DEPP0016)), Different synchronization radiations (Kehrer et al., IPAC'18 (DEPP0017))

# Diagnostics for the micro-bunching instability at KARA

- Investigation of the longitudinal phase space



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**Long term goal → Reconstruction**

Energy profile

$$\sigma_x = \sqrt{\beta_2} \alpha_2 + (D_0 \alpha_0)^2$$

KALYPSO

- Ultralow noise array
- Microstrip detector with feedback loop
- Max. frame rate > 10 Mfps

EOSD

Temporal profile

Energy vs Time

Longitudinal phase space studies

Time-scales

- Turn-by-turn
- Bunch-by-bunch
- KARA
- $T_{\text{bunch}} = 368 \text{ ns}$
- $T_{\text{CSR}} = 2 \text{ ns}$
- Stringent requirements

KARATUNE

- Ultra-fast DQO system
- Developed at KIT
- Up to 8 channels with 500 MHz sampling rate
- Fast spectrometer

Temporal profile

CSR

Synchronisation

- Multiple detector systems at different locations
- Phase measurement requires synchronous measurements
- Trigger distribution by hardware synchronisation scheme
  - Taking inherent setup delays into account

Onset of CSR burst coupled to occurrence of substructures on the longitudinal bunch profile

Horizontal bunch profile

Vertical energy spread monitoring

Horizontal spread of de-tuned

Enhanced synchronization radiation

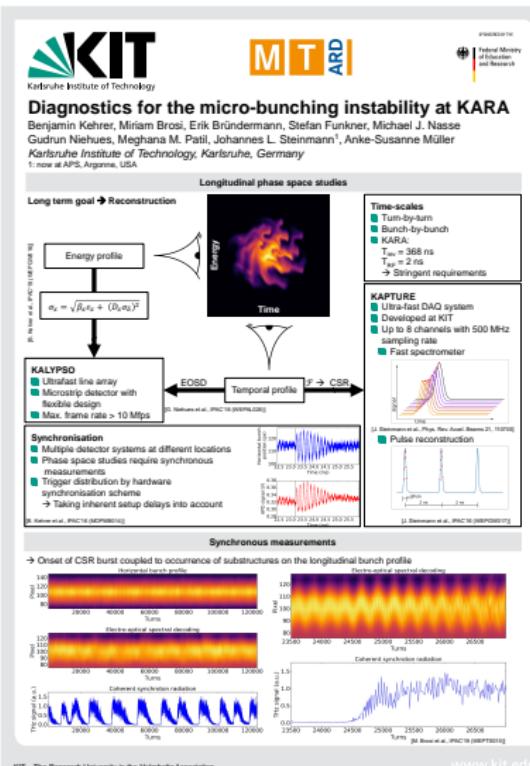
Enhanced synchronization radiation

www.kit.edu

KIT – The Research University in the Helmholtz Association

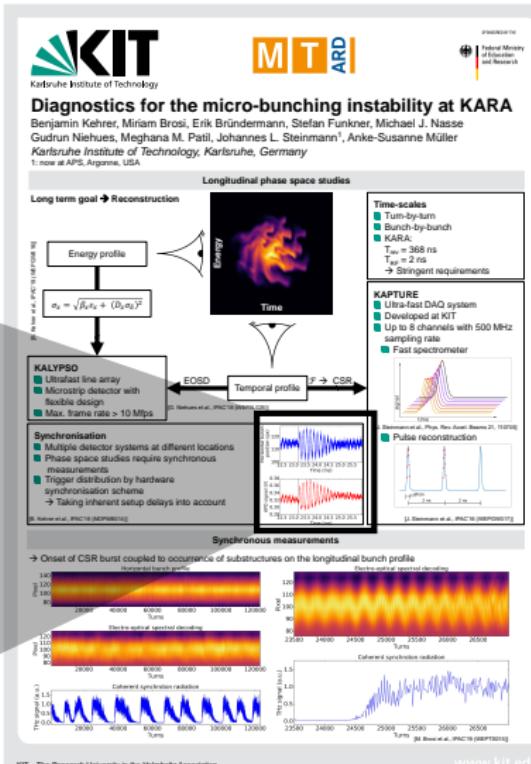
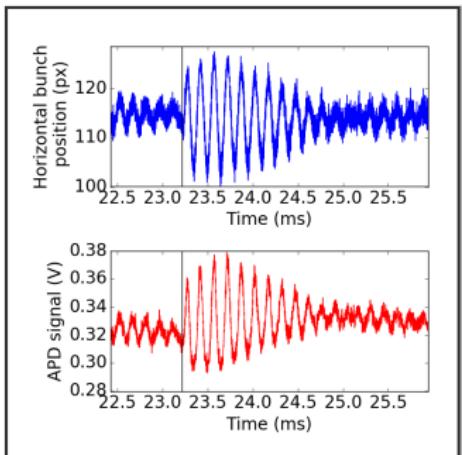
# Diagnostics for the micro-bunching instability at KARA

- Investigation of the longitudinal phase space
- Detector systems
  - KAPTURE + Schottky diodes
  - KALYPSO: EOSD + hor. imaging



# Diagnostics for the micro-bunching instability at KARA

- Investigation of the longitudinal phase space
- Detector systems
- Synchronized



# Diagnostics for the micro-bunching instability at KARA

- Investigation of the longitudinal phase space
- Detector systems
- Detailed studies of the micro-bunching instability

