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University of Tartu activities at CERN: CLIC and CCC collaborations

Marco Kirm
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3rd Baltic Group meeting 29.01.2019, Tallinn

Institute of Physics and Crystal Clear Collaboration (RD-18) at CERN:

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The CCC 70. annual meeting - Baltic cooperation

30.11.2018 CERN

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CCC collaboration membership since 2012, when MoU signed between CERN and University of Tartu

But the research collaboration with the CCC members actually dates back to:

- V. Mürk, M. Nikl, E. Mihokova, K. Nitsch, *„A study of electron excitations in $CaWO_4$ and $PbWO_4$ single crystals“ J. Phys. Cond. Matter 9 (1997) 249-256.*
- *1997 …2017 - tens of joint papers*
- S.I. Omelkov, V. Nagirnyi, S. Gundacker, D.A. Spassky, E. Auffray, P. Lecoq, M. Kirm, *Scintillation yield of hot intraband luminescence*, J. of Luminescence **198** (2018) 260-271.

- *DRIVEN BY A NEED FOR FASTER SCINTILLATORS*

- FUTURE CIRCULAR COLLIDER

- MEDICAL APPLICATIONS

- free electron lasers

- other novel applications ☺?!

Band structure engineering – facilitating ultrafast emissions

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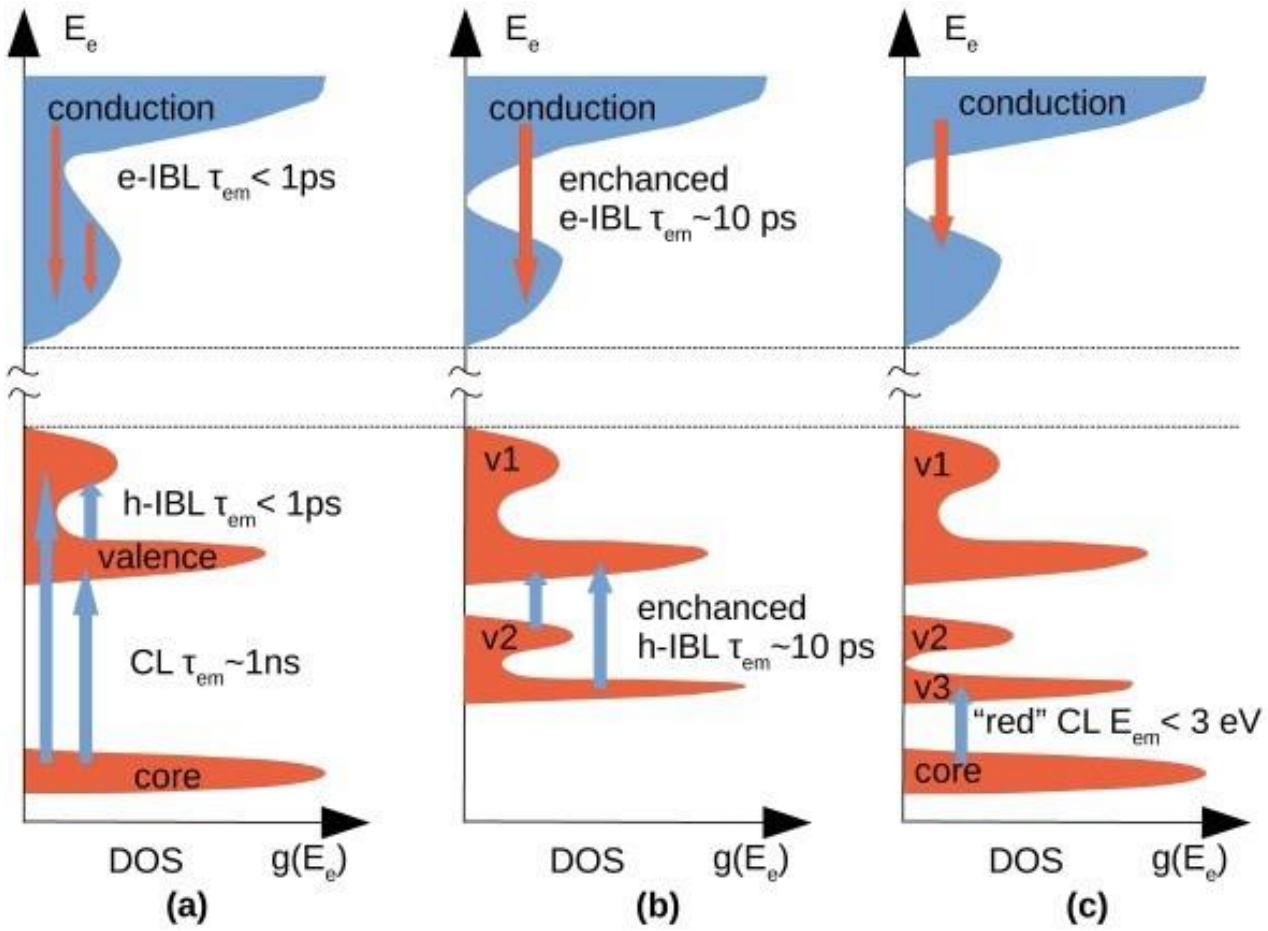
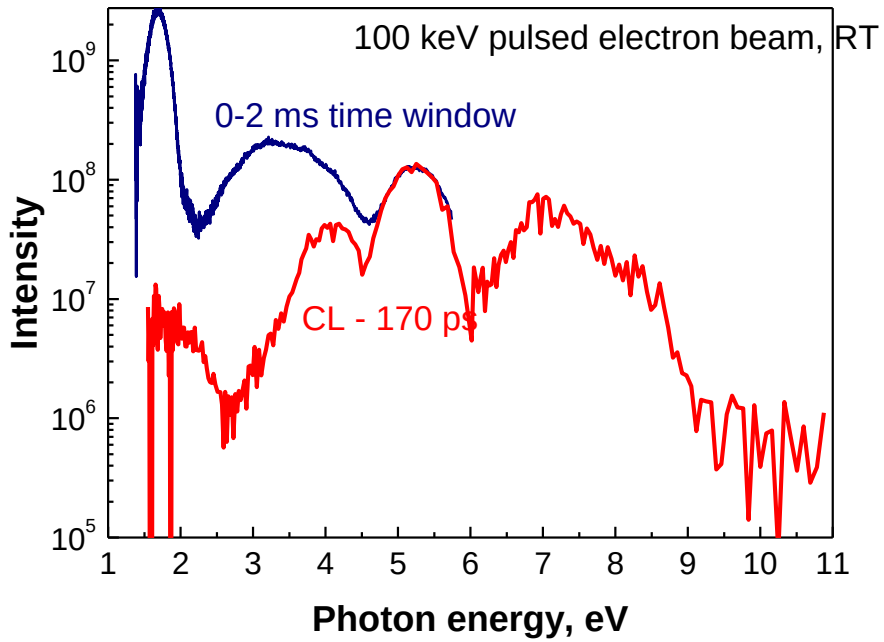


CL and IBL in the multication material K_2SiF_6



Joint Research Projects

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"Fast Advanced Scintillator Timing "(FAST) TD1401 COST Action 2014-2018

The Attract H2020 proposal „ Development of novel **C**L-**IBL** mat**ER**ials for ultrafast scintillation applications (**CIBLER)** „ - UT is a lead partner, status submitted.

MCurie ITN network „ Light engineering materials and devices "
UT is a lead partner, status in preparation.

National Funding

National Center of Excellence TK141 „"Advanced materials and high-technology devices for sustainable energetics, sensorics and nanoelectronics" 2023
Estonian Research Council IUT2-26 „ Transformation of electronic excitations into luminescence and radiation defects in wide-gap functional materials" 2018
Estonian Research Council PUT-RG111 „ Interrelations between the properties of impurities and hosts in novel optical materials: fundamental and applied aspects" 2022

CLIC collaboration and Institute of Technology

Vahur Zadin, Simon Vigonski, Robert Aare, Kristian Kuppart, Alvo Aabloo

- **MoU with University of Tartu signed in 2013**
- **IMS Lab, http://www.ims.ut.ee, Institute of Technology, University of Tartu, Estonia**
- **Department of Physics and Helsinki Institute of Physics**

National Funding for CLIC cooperation

- **PUT 57** “Multiscale simulations of dislocation generation in rf electric fields in the linear accelerator design” **288 000 EUR**. Project duration 01.01.2013-31.12.2016
- **PUT 1372** “Mechanisms of vacuum arching in high electric field systems” **206 400 EUR**. Project duration 01.01.2017-31.12.2020

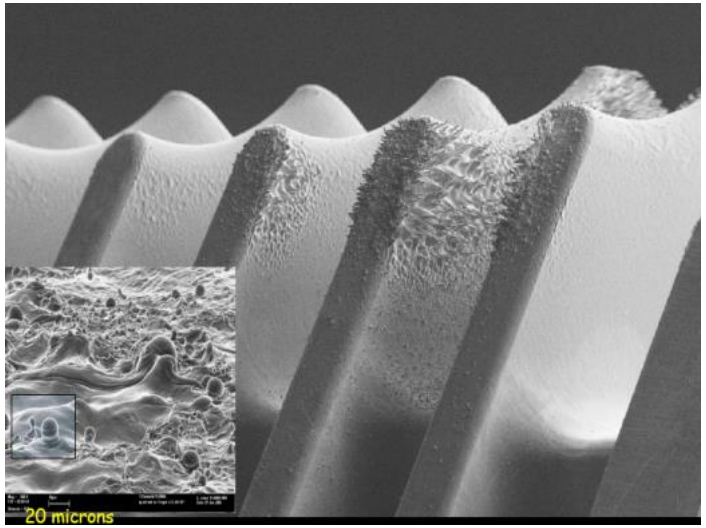
Current collaboration:
CLIC – Compact Linear Collider

Applications:

- **CLIC collider in CERN**
- vacuum switches
- novel nanofabrication applications
- x-ray sources
- medical linear accelerators
- RF components for microwave devices

CLIC:

- collision energies 0.5-5 TeV
- Proposed length 50 km requires E ~ 100 MV/m causing vacuum breakdowns
- $p_{required} < 3 \cdot 10^{-7} \frac{\#}{pulse \cdot m}$ → Breakdown mechanisms must be understood



Surface damage in CLIC accelerating structures after the breakdown

Collaboration network

- **CLIC & UT MoU signed in 2013**
  - Renewal currently in progress

- Main Research Focus:
  - Simulations of conditions and reasons leading to electrical breakdowns in CLIC accelerating structures

- Funded from Estonian National Research grants
- Main collaboration network:
  - University of Helsinki (Flyura Djurabekova)
  - CLIC RF studies (Walter Wuensch)
  - Hebrew University of Jerusalem (Yinon Ashkenazy)
  - Uppsala University (Marek Jacewicz)
  - Ludwig-Maximilians-University of Munich (Hirofumi Yanagisawa)

Involved research staff and students from Tartu:

Vahur Zadin
Alvo Aabloo
Simon Vigonski
Artur Tamm
Robert Aare
Tarvo Metspalu
Mihkel Veske
Kristjan Eimre
Kristian Kuppart

Flyura Djurabekova - UH

Walter Wuensch - CLIC RF

Kai Nordlund - UH

Marek Jacewicz - UU

Hirofumi Yanagisawa - LMU of Munich

Yinon Ashkenazy – HU of Jerusalem

UNIVERSITY OF HELSINKI REPORT SERIES IN PHYSICS

HU-P-D263

ATOMISTIC STUDY OF SURFACE EFFECTS IN METALS

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ACADEMIC DISSERTATION

To be presented with the permission of the Faculty of Science of University of Helsinki, for public criticism in auditorium A110 of the Department of Chemistry (Chemicum), on January 4th, 2019, at 11 o'clock.

HELSINKI 2018

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I. S. Vigonski, F. Djurabekova, M. Veske, A. Aabloo, V. Zadin, Molecular dynamics simulations of near-surface Fe precipitates in Cu under high electric fields, Modelling Simul. Mater. Sci. Eng. 23 (2015) 025009. doi:10.1088/0965-0393/23/2/025009.

II. V. Zadin, M. Veske, S. Vigonski, V. Jansson, J. Muszinsky, S. Parviainen, A. Aabloo, F. Djurabekova, Simulations of surface stress effects in nanoscale single crystals, Modelling Simul. Mater. Sci. Eng. 26 (2018) 035006. doi:10.1088/1361-651X/aaa928.

III. S. Vigonski, M. Veske, A. Aabloo, F. Djurabekova, V. Zadin, Verification of a multiscale surface stress model near voids in copper under the load induced by external high electric field, Applied Mathematics and Computation. 267 (2015) 476–486. doi:10.1016/j.amc.2015.01.102.

IV. E. Baibuz, S. Vigonski, J. Lahtinen, J. Zhao, V. Jansson, V. Zadin, F. Djurabekova, Migration barriers for surface diffusion on a rigid lattice: challenges and solutions, Computational Materials Science. 146 (2017) 287–302. doi: 10.1016/j.commatsci.2017.12.054.

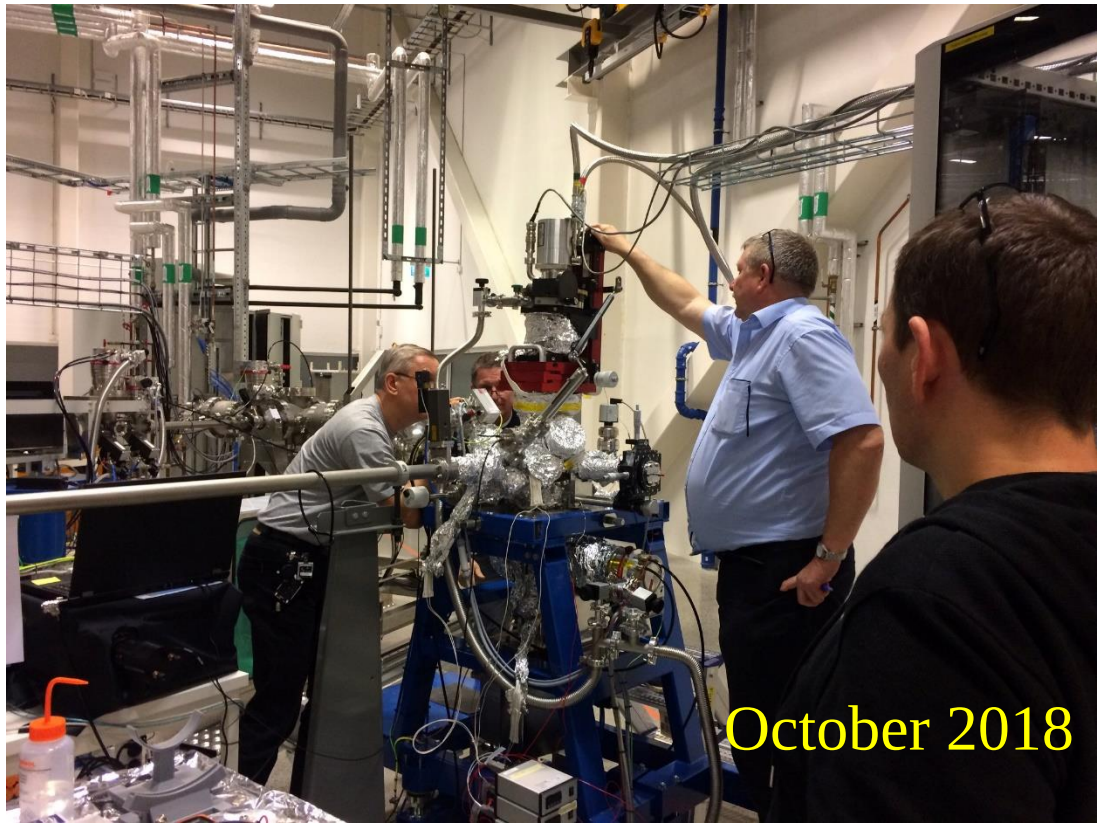
IV.a. E. Baibuz, S. Vigonski, J. Lahtinen, J. Zhao, V. Jansson, V. Zadin, F. Djurabekova, Data sets of migration barriers for atomistic Kinetic Monte Carlo simulations of Cu self-diffusion via first nearest neighbour atomic jumps, Data in Brief. 17 (2018) 739–743. doi:10.1016/j.dib.2018.01.066.

IV.b. E. Baibuz, S. Vigonski, J. Lahtinen, J. Zhao, V. Jansson, V. Zadin, F. Djurabekova, Data sets of migration barriers for atomistic Kinetic Monte Carlo simulations of Fe self-diffusion, Data in Brief. 19 (2018) 564–569. doi:10.1016/j.dib.2018.04.060.

V. S. Vigonski, V. Jansson, S. Vlassov, B. Polyakov, E. Baibuz, S. Oras, A. Aabloo, F. Djurabekova, V. Zadin, Au nanowire junction breakup through surface atom diffusion, Nanotechnology. 29 (2018) 015704. doi:10.1088/1361-6528/aa9a1b.

Thank You – AITÄH !

NEW HORIZONS for time-resolved low temperature VUV-XUV spectroscopy at FinEstBeAMS at MAX IV !



Photos by Antti Kivimäki and Ivo Romet