

KSETA — Our Past Five Years

Ulrich Nierste, Scientific Coordinator

28 Oct 2022



Karlsruhe **S**chool of **E**lementary **P**article and **A**stroparticle Physics:
Science and **T**echnology

or

Karlsruher **G**raduierten**S**chule für **E**lementar**T**eilchen- und
Astroteilchenphysik: **W**issenschaft und **T**echnologie

KSETA is the doctoral school of the **KIT** Center **KCETA**.

KSETA has been inaugurated on November 1, 2012.

- Founding Scientific Coordinator (Spokesperson):

Johannes Blümer



- Initial **DFG** funding **11/2012–10/2017** from German Excellence Initiative, extended to **10/2019**.
- Since **11/2019** funded by local ministry (MWK) and KIT.
- Additional funding by **German Academic Exchange Service (DAAD)** through Graduate School Scholarship Programme (GSSP) **since 2017**.



KSETA's distinguishing feature is the joint doctoral research of young physicists and engineers on thesis topics centered around large-scale projects of particle and astroparticle physics.

Three categories of KSETA courses:

- **DEEPER:** scientific specialization in the doctoral researchers' field
- **BROADER:** wider professional education in (astro-)particle physics, engineering and computing
- **BETTER:** key competences, soft skills



Connect

- physicists with engineers, computer scientists
- particle physics with astroparticle physics and cosmology
- theory with experiment

Statistics

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October 2022:

compare to October 2017:

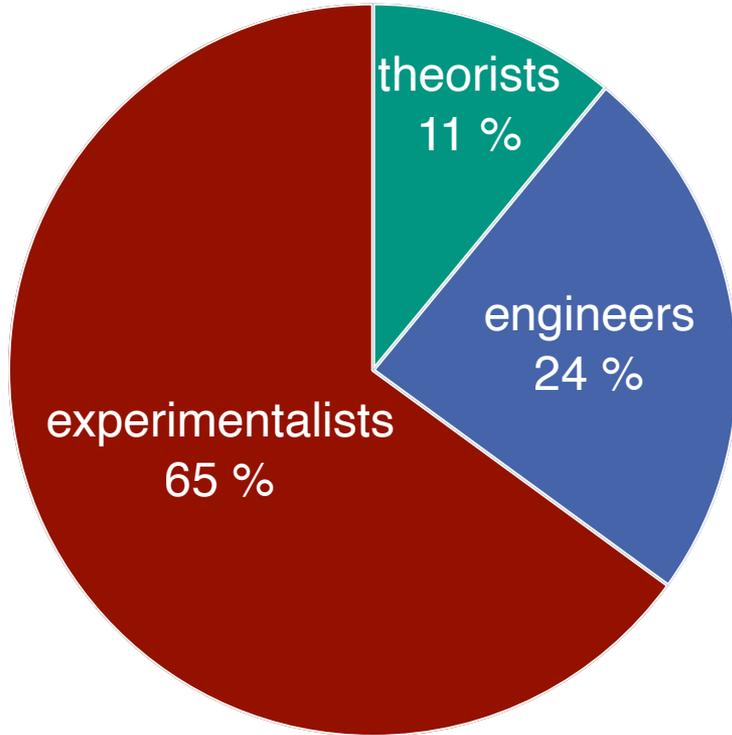
■ All KSETA Fellows	117	116
■ Directly paid by KSETA	7	
■ DAAD:	8	
■ International:	45 %	31%
■ Female:	23 %	20%
■ Theses 2017-2022:	135	Theses 2012-2017: 125

Participating institutes:

TTP, ITP, ETP, IAP, ITEP, ITIV, IMS, SCC, IPE, ITTK, IBPT

Distribution of Doctoral Fellows

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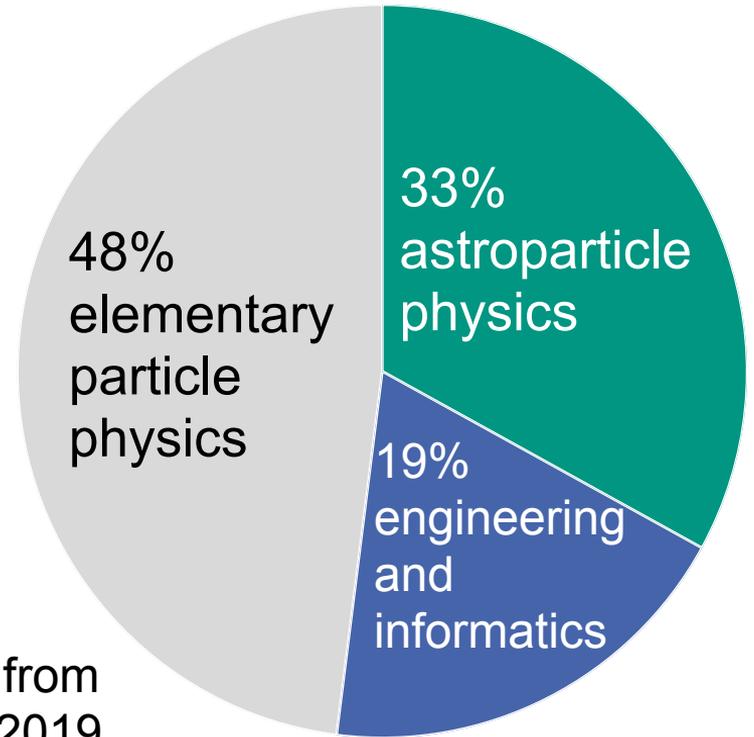


supervised by 43
Principal Investigators

Profile

Participating KIT Departments:

- physics
- electrical engineering and information technology
- chemical engineering and process engineering
- informatics



data from
Nov 2019

Training program: Plenary Workshop

KSETA

- annual event in Durbach, Black Forest
- attended by **Doctoral Fellows** and **Principal Investigators** (PhD supervisors)
- main annual event with **lectures by external scientists**, **talks** and **poster presentations** by Doctoral Fellows

March 2022:



Interns from IIT Bombay

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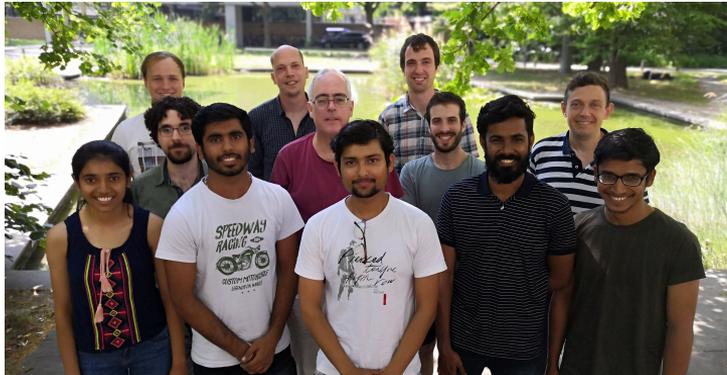
2022:



2021:



2019:



2018:

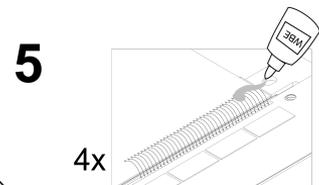
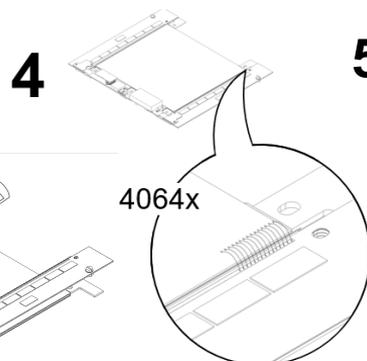
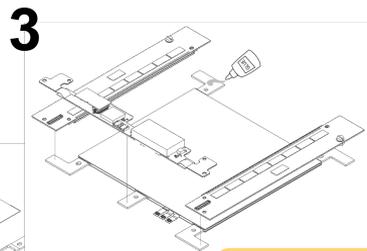
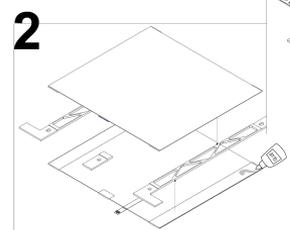
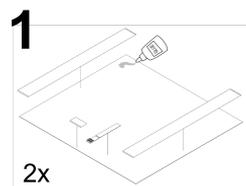
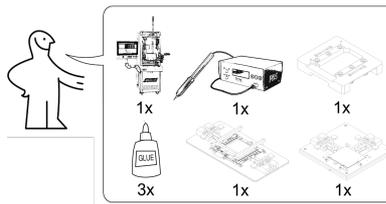
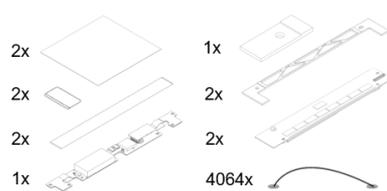
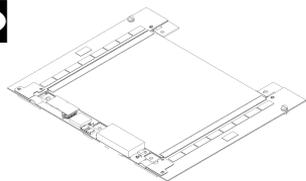


Highlights of PhD theses 2017-2022

KSETA

- Stefan Maier (ETP), CMS
- Sebastian Wozniowski (ETP), CMS
- Ana Laura Müller (IAP), double-degree programme with UNSAM
- Nick Karcher (IPE)
- Martin Angerer (IPE)
- Nils Braun (ETP), Belle
- Mustafa Tabet (TTP) T
- Matthias Linster (TTP)
- Dominic Hinz (IAP), KATRIN
- Andreas Pargner (IAP)

2S MODULÖ



How to build silicon detector modules for the CMS Phase-2 Upgrade



Stefan Maier
s.maier@kit.edu

- Procedures and systems in CMS 2S module assembly and qualification
- Development of a high-rate test stand for the module readout chain
- CMS Detector Award 2019
- Now: Postdoc at KIT



PhD Thesis of Sebastian Wozniewski

ETP-KA/2020-27

arXiv:2204.12957 [hep-ex], accepted by EPJC

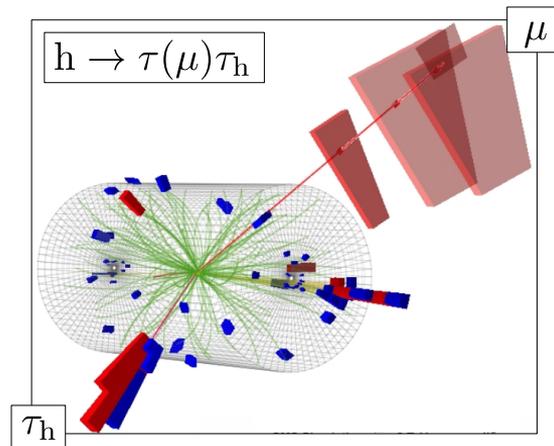
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■ Precision tests of Higgs couplings with $h \rightarrow \tau\tau$ decays:

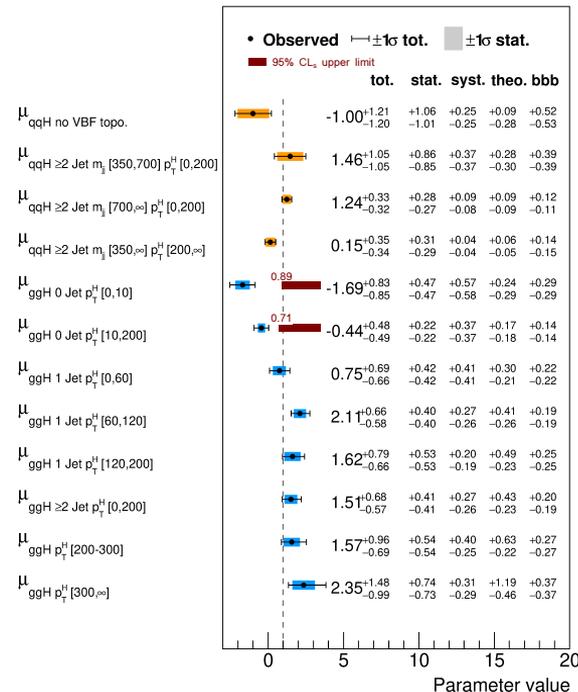
■ Multiclassification with neural networks for signal extraction

■ Differential measurement (12 bins)

■ Now: Postdoc at the University of Göttingen

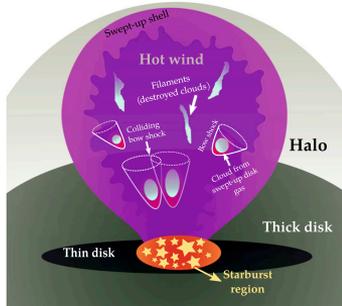
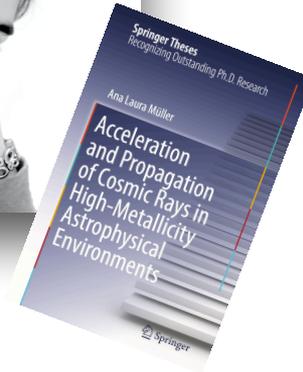


CMS *work in progress* 137.2 fb⁻¹ (13 TeV)

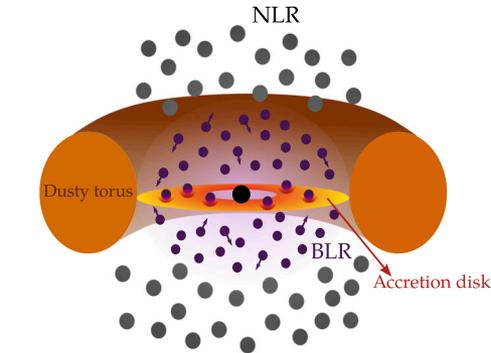
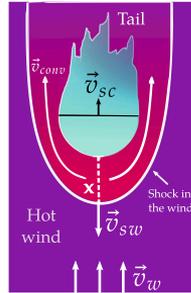


PhD thesis of Ana Laura Müller

Acceleration and Propagation of Cosmic Rays in High-Metallicity Astrophysical Environments



Particle Acceleration in
starburst galaxies



Particle Acceleration in the
Broad-Line Region
of Active Galactic Nuclei (AGNs)

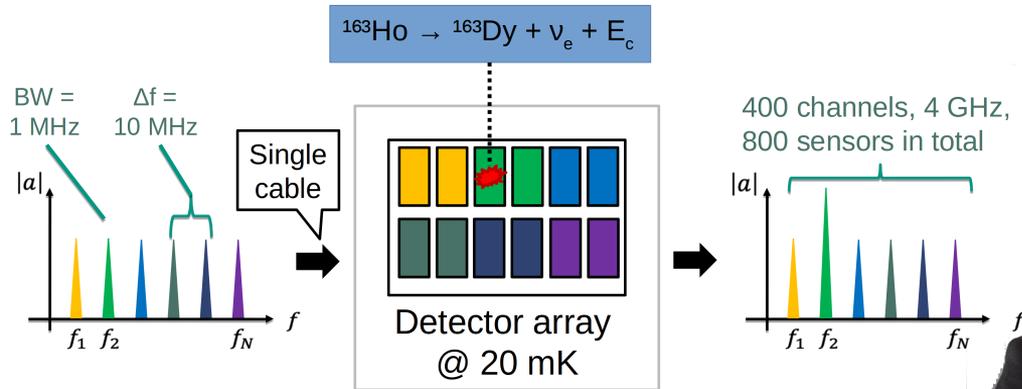
Aim: Theoretical understanding of particle acceleration to the highest energies

Nick Karcher: How to readout magnetic microcalorimeters at cryogenic temperatures?

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- Development of a scalable readout system for 800 MMC sensors
- Transfer line with 4 GHz bandwidth and a single cable to the cryostat

Selected by ECHO neutrino mass experiment



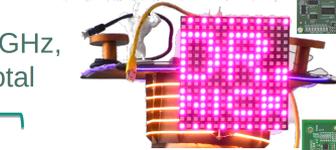
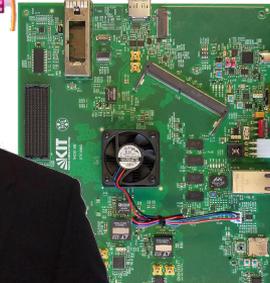
RF-Frontend



Converter board



FPGA board



Martin Angerer: Transfer detector technologies to realize novel medical imaging methods

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Goal

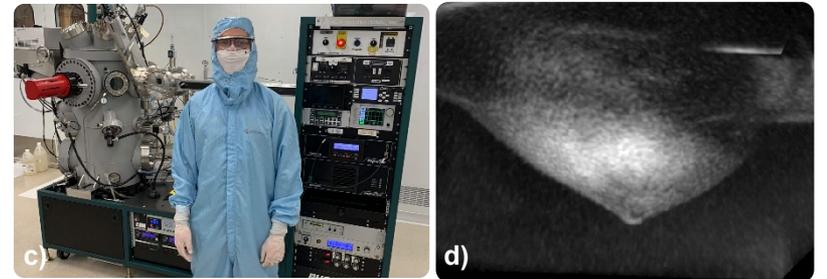
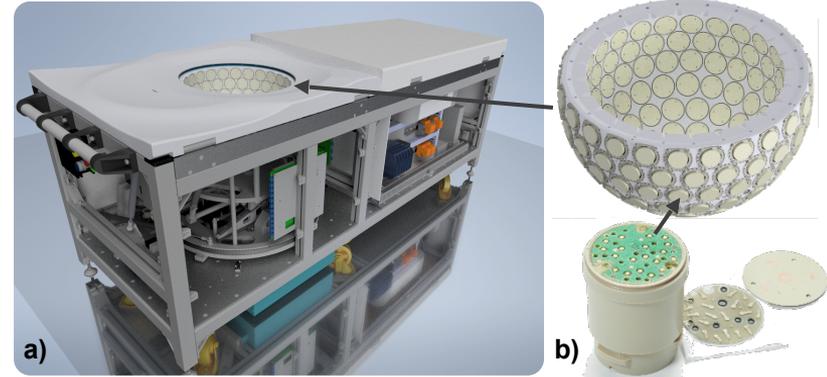
Realization of new ultrasound emitter/receiver arrays for next generation 3D ultrasound computer tomography (USCT) for early breast cancer diagnosis

Methods

- Design and automated production of arrays
- Accurate acoustic field characterization
- Design optimization via advanced modeling
- Exploration of alternative technologies such as single-crystal piezos and micromachined transducers

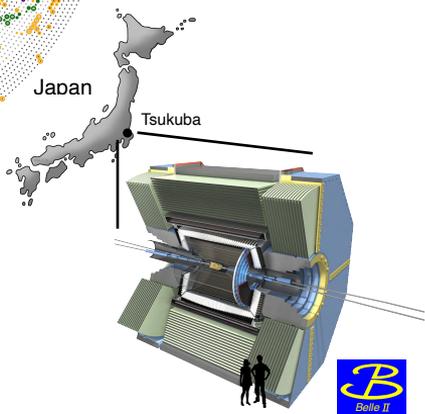
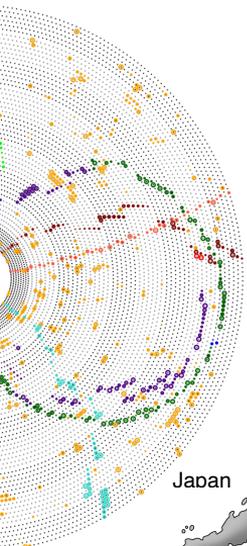
Results

- Arrays for two 3D USCT systems produced
- Reliable and repeatable ultrasound performance
- First clinical tests show promising results



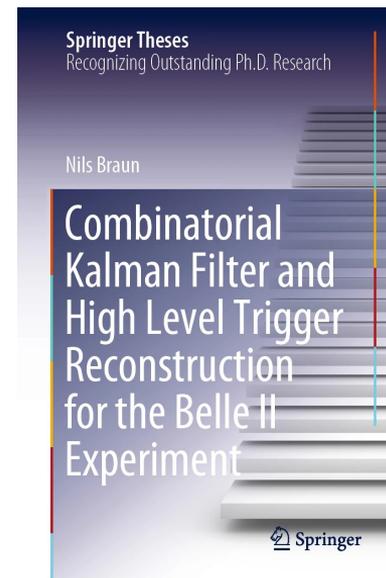
New 3D USCT system (a); measurement vessel with 128 transducer arrays (b); exploration of new technologies at UBC Vancouver (c); first clinical images with the new 3D USCT system (d)

PhD Thesis of Nils Braun



- Implementation of a Combinatorial Kalman Filter for Belle II.
- Novel data transport scheme for the High Level Trigger reconstruction.
- Optimization of online reconstruction code.
- Core part of the Belle II tracking paper.

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Computer Physics
Communications
Volume 259, February 2021, 107610



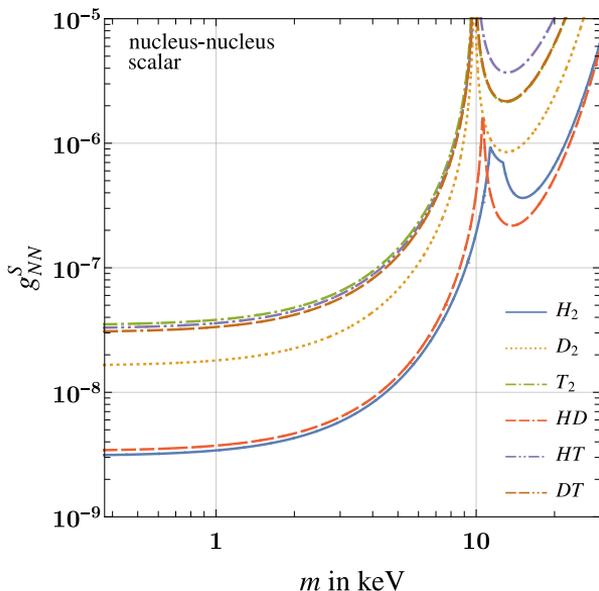
Track finding at Belle II ☆

Ulrich Nierste

PhD theses of Mustafa Tabet and Matthias Linster KSETA

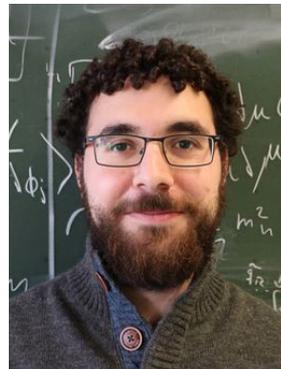
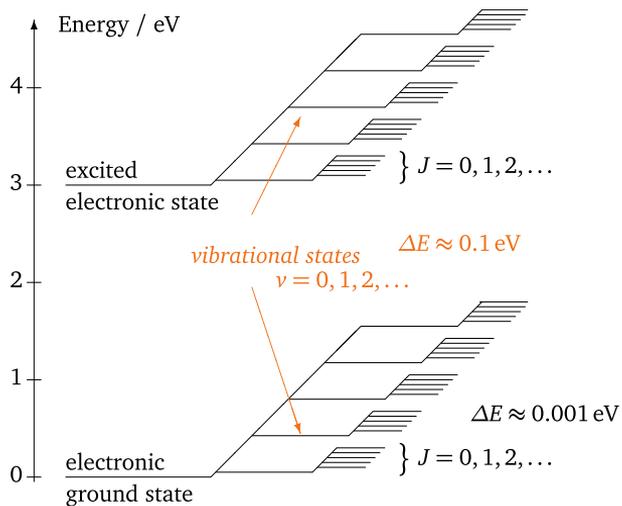
Ro-Vibrational spectroscopy of Hydrogen Isotopologues
(= molecules $H_2, HD, D_2, \dots T_2$ of hydrogen isotopes)

➔ Information on hypothetical new particles
with masses in the keV range



■ Study suggested by Magnus Schlösser (TLK)

■ Constraints on nucleus-nucleus interaction mediated by a new scalar particle



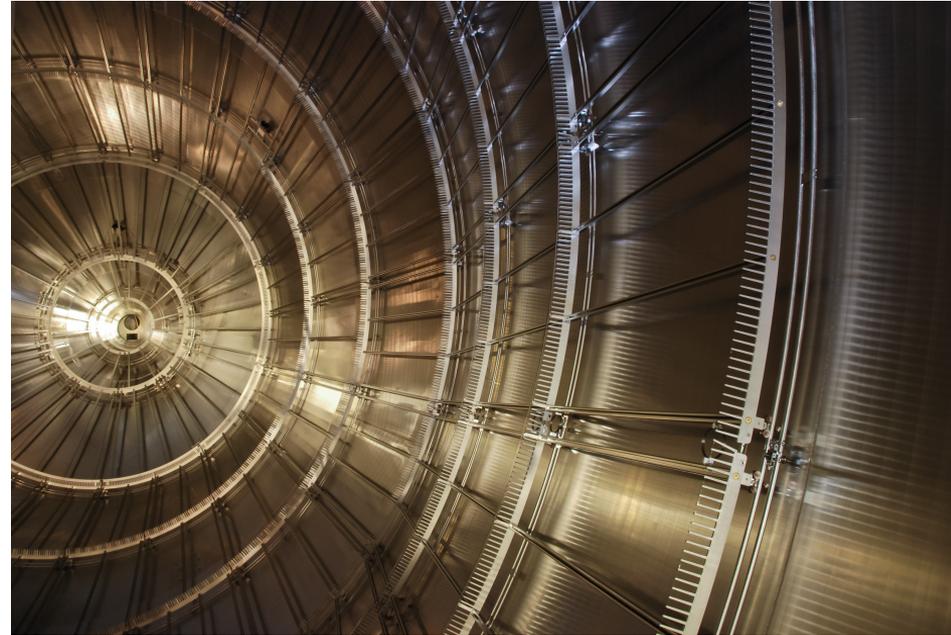
KSETA PhD Thesis: Dominic Hinz

Background systematics and extensions to the KATRIN background model

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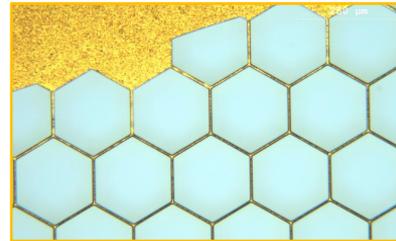
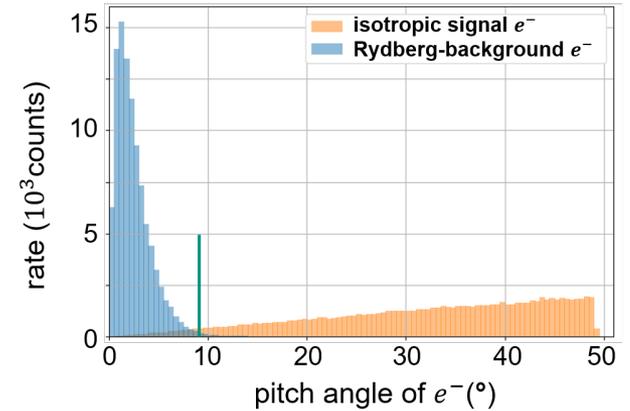


- KATRIN is the world-leading direct neutrino mass experiment
- its sensitivity to the neutrino mass is limited by rare background processes in the large spectrometer
- despite a quasi-perfect electro-magnetic shielding, a background of unknown origin filled the volume

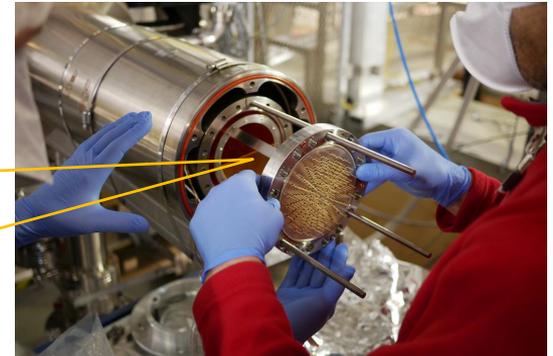


KSETA PhD Thesis: Dominic Hinz Background systematics and extensions to the KATRIN background model

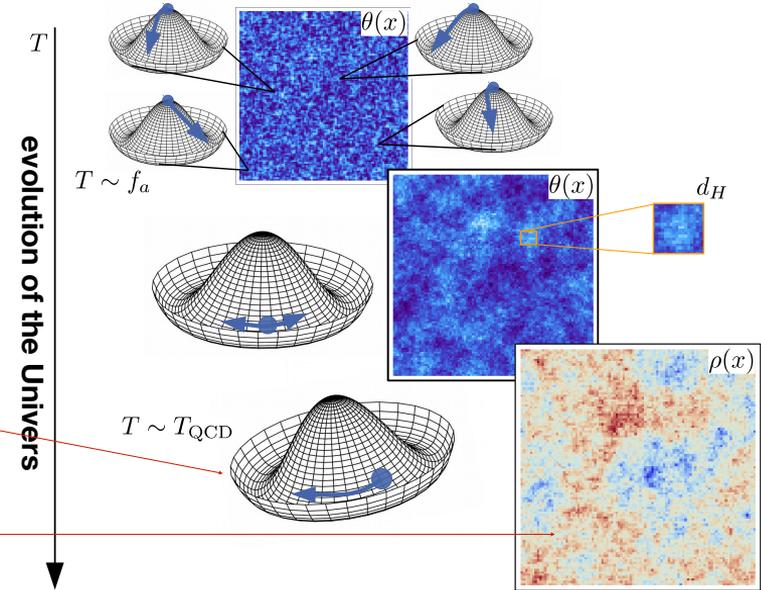
- In his thesis, Dominic Hinz performed a series of measurements with novel micro-structured units to determine the origin and energy scale of the background



pTEF-unit



- Axion is an attractive candidate for DM
- The DM energy density is provided by coherent oscillations of the axion field in its potential
- large fluctuations in the DM density can arise, leading to the formation of „axion mini-cluster“



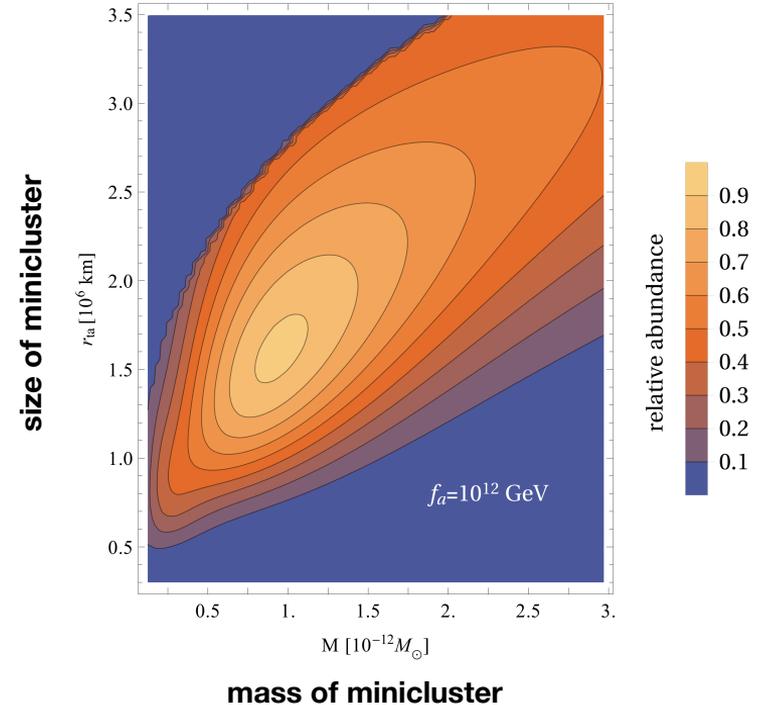
KSETA PhD Thesis: Andreas Pargner Phenomenology of Axion Dark Matter

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- In his thesis, Andreas Pargner could predict the mass and size distribution of axion mini-cluster



Enander, Pargner, Schwetz,
JCAP 1712 (2017) 038



Team

KSETA



Prof. Dr. Ulrich Nierste

Spokesperson KSETA



Prof. Dr. Günter Quast

Deputy Spokesperson
KSETA



**Prof. Dr. Steffen
Grohmann**

Deputy Spokesperson
KSETA



Dr. Irmgard Langbein

Managing Director

Administrative assistant: Barbara Lepold 2012-2022
Raquel Lujan since 2022

Fellow representatives: Kathrin Bismark, Lucas Kunz, Federico Bontempo, Robert Gartmann

Equal-opportunity officer: Gudrun Heinrich

Happy 10th birthday, KSETA!

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