



Scientific evaluation at KIT

Evaluation panel

Chair:

Rolf Heuer

MT-DTS reviewer:

Philip Patrick Allport, chair ECFA detector panel

In the MT parallel session:

Angeles Faus-Golfe, Rhodri Jones, Ubaldo Iriso,
Lia Merminga,

Pascale Ehrenfreund (only MT-ARD),

Jodi Cooley, Phil Allport (both only MT-DTS)

Chair of the panel

First name	Family name	Affiliation	Country
Rolf	Heuer	CERN - European Organization for Nuclear Research	Switzerland

Members of the panel

First name	Family name	Affiliation	Country
Pascale	Ehrenfreund*	International Space University	France
Johanna	Stachel*	Ruprecht-Karls-Universität Heidelberg	Germany
Philip Patrick	Allport	University of Birmingham	UK
Amber	Boehnlein	Thomas Jefferson National Accelerator Facility	USA
Jodi	Cooley	SNOLAB	Canada
Jorgen	D'Hondt	Vrije Universiteit Brussel	Belgium
Angeles	Faus-Golfe	CNRS - Centre National de la Recherche /IN2P3 à IJCLab	France
Ubaldo	Iriso	ALBA Synchrotron	Spain
Rhodri	Jones	CERN - European Organization for Nuclear Research	Switzerland
Sarah	Köster	Georg-August-Universität Göttingen	Germany
Michael	Krisch	European Synchrotron Radiation Facility (ESRF)	France
Nikolitsa	Merminga	Fermi National Accelerator Laboratory	USA
Alexander	Moewes	University of Saskatchewan	Canada
Jan-Erik	Rubensson	Uppsala Universitet	Sweden
Anthony	Van Buuren	Lawrence Livermore National Laboratory	USA
Carlos E. M.	Wagner**	University of Chicago	USA

Agenda

Monday 24.02., day 1

14:00 – 15:15

MT plenary session

- *MT-DTS*, Andreas Kopmann 15 + 15 min

17:45 – 19:15

Strategic topics

- *Talent management and diversity*,
with Andreas Kopmann
- *Cooperations, technology + knowledge transfer*,
with Frank Simon, as LHCC chair
- *Digitization and sustainability*

Tuesday 25.02., day 2

09:00 – 12:30

Visit of research infrastructures

- *MT show & tell*

14:00 – 17:30

MT parallel session

- *Semiconductor sensors, ASICs and interconnects*,
Ivan Peric 7 + 7 min
- *Quantum sensors and readout of cryogenic sensors*,
Sebastian Kempf 7 + 7 min
- *High-performance DAQ systems*,
Timo Muscheid 7 + 7 min
- *Impact and strategy*, Frank Simon 10 + 10 min

Evaluation results

- Selected slides from the evaluation, annotated with review results and verbal feedback
- Recommendations
- Grading

"... the creation of new scientific knowledge ... is crucial for Europe ..."

"The development of enabling technologies has been recognized as an overarching theme at KIT" (initial notification)

"Collaboration between the programs is visible at KIT" (initial notification)

Competences at KIT

Semiconductor sensors, ASICs and packaging

- HVMAPS
- Scouting technologies
- Silicon photonics

→ Ivan Peric
MT parallel session

"Impressive"
"Most promising technology"
"strengthen microelectronics
in Germany"



HVMAPS prototype for the
Mu3e pixel detector

Quantum sensors and readout of cryogenic devices

- Metallic Magnetic Calorimeter (MMC), design and production
- Scalable readout

→ Sebastian Kempf
MT parallel session

"World-leading"
"Scalability remarkable"
"Disruptive technology"
"Establish foundry-like
services"



MMC detector: world record in
energy resolution of 1 eV

Scalable high-performance DAQ systems

- Programmable electronics (FPGA)
- Fast links
- Parallel programming for CPU and GPU
- Trigger and signal processing

→ Timo Muscheid
MT parallel session

"Essential"
"Key strength"
"Attract engineers early in
their careers"



Serenity boards:
Tb/s data processing

Science systems for

- High-energy physics
- Astroparticle physics
- Beam physics
- Photon science



ECHO readout system for 800 MMCs

High-tech infrastructures – new capabilities

"Great facilities"
"Detector innovation platform
is needed, excellent review,
win for Helmholtz and academia"

Clean-room facilities for

- quantum sensors and readout
- electronics packaging

operation 2025

1 out of 2 production
centers for CBM/STS

KIT clean room
center KCOP

operation 2026

- 50 MEUR invest
- 2 detector technology clusters

**Excellent research facilities for
unique detector systems**

Detector technology clusters in 2025



Competence Center for
High-resolution Super-
conducting Sensors (HSS)



Electronic Interconnect &
Packaging Center (AVT)



KIT ASIC and Detector
Laboratory (KIT-ADL)

Further laboratories for:



Cryogenic
readout systems



Silicon photonics



Ultrasound
tomography



Proton
irradiation

Training excellent scientists

Doctoral school KSETA

- Training physics and technology experts



International training:

- Scientific collaborations
- Double degree program with UNSAM, Argentina

Results (21-23):

- 18 doctoral researcher finished
- 118 publications

MT-DTS attracts the best talents

Helmholtz Doctoral Award 2022



Nick Karcher
**Readout
superconducting
sensors**

Richard Gebauer
**Qubit control
RF Information**

both now in industry

2023



Martin Angerer
**Electronics
packaging**
Helmholtz Enterprise
Field study fellowship

Postdoc
U British Columbia

"Link between physics and
technology is crucial"
"Attract engineers early in their
careers"
"Helmholtz university is a unique
selling point"



now in industry

2023 UNSAM Engineering School Award



Luciano Ferreyro
**Readout super-
conducting
sensors**

Postdoc
Argentina

Collaborations

Our research is embedded in a broad international network

Member of international scientific collaborations

- Focus: technologies and design
- KATRIN, CMS, LHCb, CBM, ...



ECFA detector R&D roadmap

- Leading roles in definition and implementation
- Broad activities in *semiconductor detectors, quantum sensors, calorimetry, electronics and on-detector processing*



"Internationally highly visible"
"Effective support of interdisciplinary science"
"Aligned well with relevant international detector roadmaps"

Collaborating with DESY and GSI

- Common developments, Helmholtz Innovation Pool projects



Strategic partnership with
U Heidelberg, ITeDA / UNSAM Argentina

Embedded in the KIT center KCETA

Transfer activities with industry
Network for quantum technologies

- e.g. qSolid - 25 German institutions from science and industry working on a quantum computer



Findings and recommendations

The scientific **productivity and international recognition** of the group is **very high** and the programme breadth is remarkable given the stated staff and budgetary resources.”

“The detector development and facilities together provide **key enabling technologies** for the MU projects.”

“Environments where radiation hardness is critical, the technology used by ALICE has significant limitations and **HVCMOS** [...] is widely seen as the **most promising technology** to address these”

“The design of cutting-edge high-bandwidth and low-latency **data acquisition systems** in support of KATRIN, KARA (including beamlines), CMS and other experiments, is another **key strength** at Helmholtz and KIT”

Recommendations:

- “Contribute with liquid Xenon + photodetectors to DRD2 + 4”
- “HSS is world-leading - broad scoping exercise of more potential application areas is proposed”
- “Special attention should be made to staffing levels in the areas of microelectronics design and DAQ development”
- “Early interactions between experimental particle physicists, detector physicists, engineers and assembly technical experts are particularly important”

Recommendation in executive summary:

- Set up a ‘**Detector Innovation Platform**’ in Helmholtz in the near future, supporting groups from different centres working on innovative detector development (eg microelectronics, quantum sensors, cryogenic sensors, etc).

Grades MT-DTS

"Support the ranking numbers by short statements"

Rating contribution to the topic Detector Technologies and Systems (DTS)

Scientific achievements and impact

X Outstanding ☐ Excellent ☐ Very good ☐ Good ☐ Fair

Originality and innovative potential

X Outstanding ☐ Excellent ☐ Very good ☐ Good ☐ Fair

International standing and competitiveness

X Outstanding ☐ Excellent ☐ Very good ☐ Good ☐ Fair

Explanations

Scientific achievements and impact

- The **detector capabilities and internationally recognised expertise** in a broad range of sensor and microelectronics design, interconnect technology, array construction and advanced read-out system development are **truly internationally leading**.

Originality and innovative potential:

- The R&D on **HV-CMOS and high-resolution superconducting quantum sensors are world-class** with a large range of opportunities for further potential applications, including possible commercial exploitation.

International standing and competitiveness:

- The group has very strong participation in a number of the **world's most ambitious** particle/astro-particle **physics experiments, clear leadership** within many of the **international R&D collaborations** addressing the particle physics detector roadmap recommendations.