QS4Physics

InnoPool Kickoff Meeting

Steven Worm

QS4Physics InnoPool Kickoff Meeting
November 20, 2025

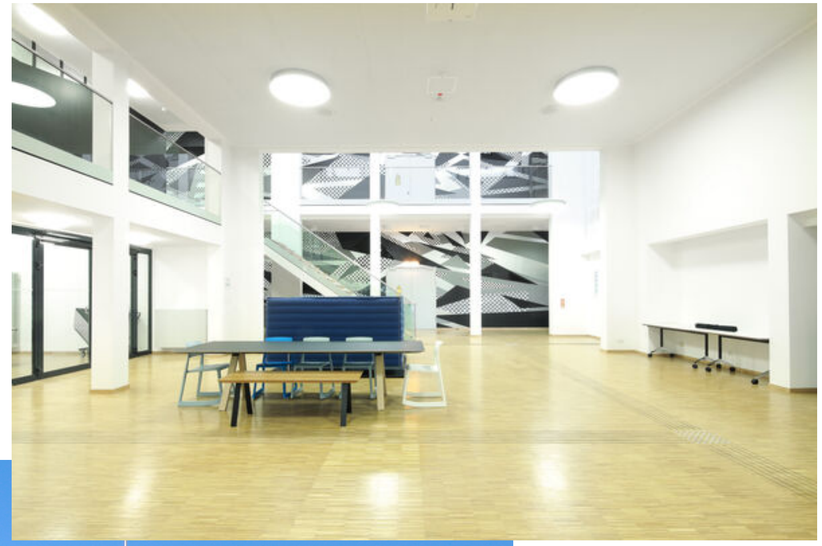
HELMHOLTZ RESEARCH FOR GRAND CHALLENGES

DESY.

Outline

- Welcome!
- Agenda and plans for the meeting
- Goals for the meeting, and for QS4Physics
- Collaboration business
- Collaborative opportunities

Welcome to HI-Mainz



- …and thanks to Dima, Arne and Hendrik!

QS4Physics Proposal & Goals

- QS4Physics Proposal Highlights
  - Supports and links Helmholtz Institutes in quantum sensing activities
  - Largest of the InnoPool grants
  - €2.9M (€1.25M new) budget
  - Spans MU, MT, MML & 7 Helmholtz Institutes
  - Funds ~9 people

- QS4Physics Goals:
  - Advance our projects / work packages
  - Work together and create a Helmholtz quantum sensing community
  - Support a cohort of young researchers
  - Create grant opportunities
  - Have a nice meeting ~once a year

Projektantrag für eine Förderung aus dem Innovationspool des Forschungsbereichs Materie

Titel des Projekts	Quantum Sensing for Fundamental Physics
Akronym des Projekts	QS4Physics
Förderzeitraum des Projekts	01.01.2025 – 31.12.2027
Schlagworte	Quantum sensors, color centers, magnetometry, cryogenic detectors, cryogenic infrastructures, dark matter, neutrino mass, simulations, synchrotron/FEL, high-precision analysis, precision spectroscopy, ion traps, ion implantation, fundamental physics
Beteiligte Programme und Topics	MU-FPF, MT-DTS, MML
Beteiligte Zentren des Forschungsbereichs Materie	DESY, GSI, HI-Jena, HI-Mainz, HZDR, KIT
Optional: beteiligte Zentren anderer Forschungsbereiche bzw. externe Kooperationspartner	
Kontaktdaten der Projektleitung	Prof. Dr. Steven Worm (DESY)
Weitere PIs des Projekts	**DESY:** Elina Fuchs, Friederike Januschek, Axel Lindner, Kai Rossnagel **GSI:** Peter Micke, Ralf Röhlsberger, Thomas Stöhlker **HI-Jena:** Sonja Bernitt, Oliver Herdrich, Peter Micke, Ralf Röhlsberger, Thomas Stöhlker, Günter Weber **HI-Mainz:** Hendrik Bekker, Dmitry Budker, Arne Wickenbrock **HZB:** Boris Naydenov **HZDR:** Georgy Astakhov **KIT:** Clemens Heske, Sebastian Kempf, Andreas Kopmann, Frank Simon, Markus Steidl, Kathrin Valerius, Marc Weber

QS4Physics — Projects

1. Precision spectroscopy of highly charged ions (HCI) to investigate variations in the fine structure constant	DESY, with HIM, HIJ
2. Expansion of the search for light dark matter using cryogenic sensors	DESY, with KIT
3. Use of magnetic microcalorimeter detectors (MMC) in conjunction with electron beam ion traps at ultra-brilliant radiation sources for modeling stellar plasmas	HIJ, with KIT, GSI, HZB, DESY/EuXFEL
4. High-resolution spectroscopy for investigating the quantum electrodynamic and nuclear structure of highly charged ions	GSI, with HIJ, DESY, HIM
5. Generation and characterization of quantum defects in various 2D and 3D materials and optimization with a view to improved sensor technology	HZDR, with HIM, HZB, DESY
6. Development of new quantum sensors for the investigation of superconducting phenomena	HIM, with HZB, HZDR, DESY
7. Investigation of MMC detectors for electron detection and optimization for applications in neutrino mass measurement or microscopy	KIT, with HIJ, DESY
8. Development of quantum sensor technology for synchrotron applications	KIT, with GSI, HIJ, DESY
9. Development of cryosensors for data acquisition and readout	KIT, with GSI, HIJ, DESY

QS4Physics — Projects

1. Präzisionsspektroskopie von hochgeladenen Ionen (HCI) zur Untersuchung der Variation der Feinstruktur-konstante	DESY, mit HIM, HIJ
2. Ausweitung der Suche nach leichter Dunkler Materie mit kryogenen Sensoren	DESY, mit KIT
3. Verwendung von Magnetischen Mikrokalorimeter-Detektoren (MMC) in Verbindung mit Elektronenstrahl-Ionenfallen an ultrabrillianten Strahlungsquellen zur Modellierung von stellaren Plasmen	HIJ, mit KIT, GSI, HZB, DESY/EuXFEL
4. Hochauflösende Spektroskopie zur Untersuchung der quantenelektrodynamischen und nuklearen Struktur hochgeladener Ionen	GSI, mit HIJ, DESY, HIM
5. Erzeugung und Charakterisierung der Quantendefekte in verschiedenen 2D- und 3D-Materialien und Optimierung mit Hinblick auf eine verbesserte Sensorik	HZDR, mit HIM, HZB, DESY
6. Entwicklung neuer Quantensensoren für die Untersuchung supraleitender Phänomene	HIM, mit HZB, HZDR, DESY
7. Untersuchung von MMC-Detektoren für die Elektronendetektion und Optimierung für Anwendungen in der Neutrinomassenmessung oder Mikroskopie	KIT, mit HIJ, DESY
8. Entwicklung der Quantensensorik für Synchrotronanwendungen	KIT, mit GSI, HIJ, DESY
9. Entwicklung von Kryosensoren für Datenerfassung und Auslese	KIT, mit GSI, HIJ, DESY

Agenda

9:50 → 10:10	Precision spectroscopy of highly charged ions	Steve Worm, DESY)
10:10 → 10:30	Expanding the search for light dark matter with cryogenic sensors	José Alejandro Rubiera Gimeno, DESY)
10:30 → 11:00	coffee!	
11:00 → 11:20	Use of magnetic microcalorimeter detectors (MMC) in conjunction with electron beam ion traps at ultra-bright radiation sources and ion storage rings	Günter Weber, Sonja Bernitt (HI-Jena)
11:20 → 11:40	Precision spectroscopy of highly charge ions and exotic nuclei using the ion trapping facility HITRAP	Peter Micke (GSI, HI-Jena, FSU Jena)
11:40 → 12:00	Creation and characterization of quantum defects	Georgy Astakhov (HZDR)
12:00 → 12:20	Development of new quantum sensors for the investigation of superconducting phenomena	Omkar Dhungel (HIM)
12:20 → 1:20	Lunch & Posters	
1:20 → 1:40	Investigation of MMC detectors for electron detection	Sebastian Kempf (KIT)
1:40 → 2:00	Development of quantum sensor technology for synchrotron applications	Clemens Heske, Lothar Weinhardt (KIT)
2:00 → 2:20	Enabling Large-Scale Cryogenic Detector Arrays through Advanced Trigger and DAQ Systems	Luis Ardila, Timo Muscheid (KIT)
2:20 → 3:00	Discussion & Closeout	(all)
3:00 → 3:20	more coffee!	
3:20 → 4:40	Lab tours	

Link: https://indico.him.uni-mainz.de/event/254/

Helmholtz InnoPool Programme

- 2 million euro / year for all programmes (plus matching), internal to Helmholtz
- Three years, from 2025—2027 (nominal start of January 2025)
- Administered separately for each institute—no formal *Zuwendungsbescheid*
- Amounts based on existing LK1 funding, balanced across MU, MT, MML

	Zuwendung vom BMBF für Innovationspool des FB Materie	Minimaler Eigenanteil der Zentren (jährliche Steigerung entsprechend LK I-Aufwuchs)			Summe für Projekte (mind. 1% LK I)		
	2025-2027	**2025**	**2026**	**2027**	**2025**	**2026**	**2027**
DESY	807	291	315	339	1,098	1,122	1,146
FZJ	119	39	42	44	158	161	163
GSI	282	70	70	70	352	352	352
Hereon	20	7	8	8	27	28	28
HZB	151	54	58	62	205	209	213
HZDR	223	76	81	86	299	304	309
KIT	398	138	148	159	536	546	557
Summe	**2,000**	**675**	**722**	**768**	**2,675**	**2,722**	**2,768**

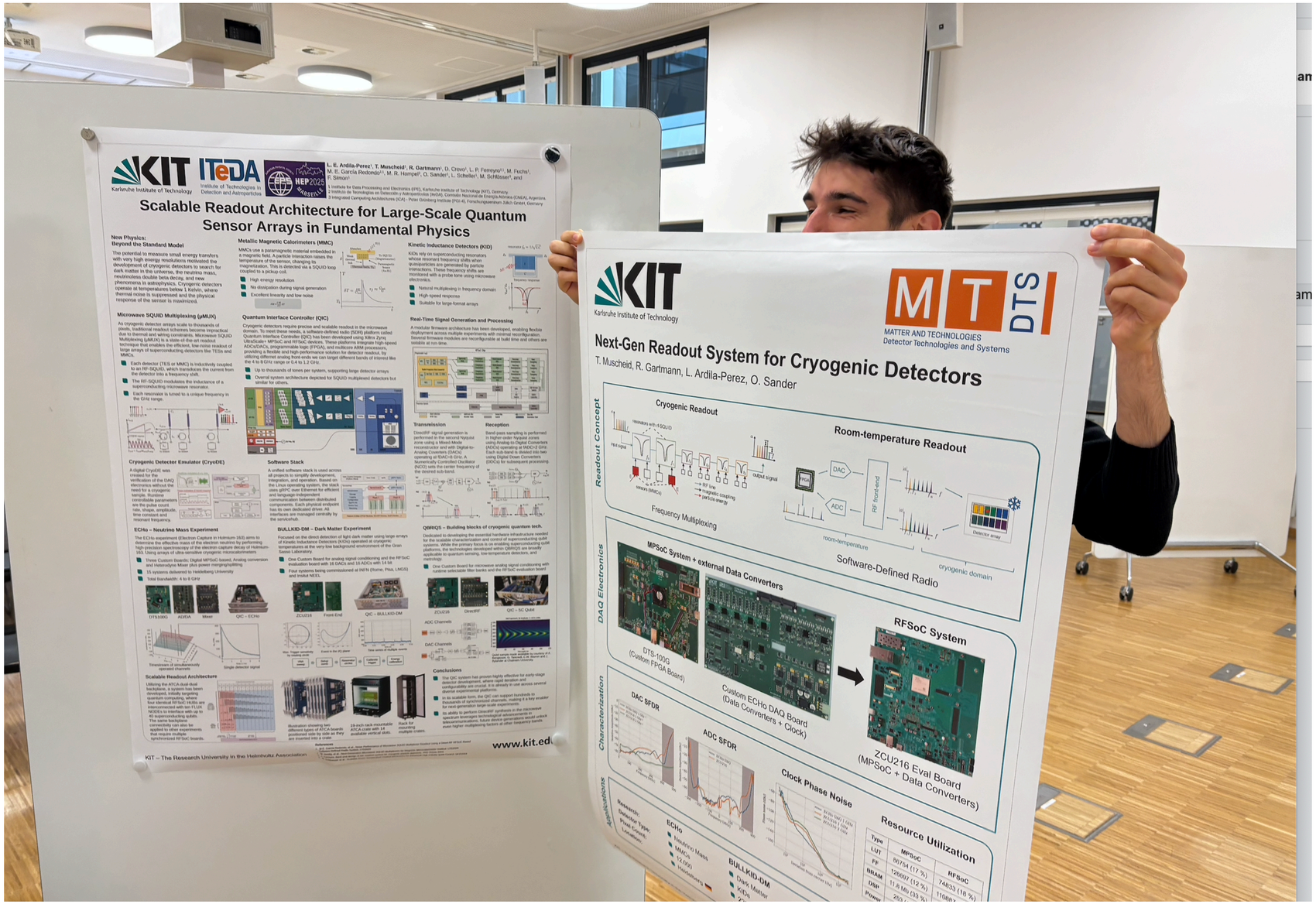
Alle Werte in TEUR

QS4Physics Collaboration

	DESY kEUR		GSI - HIJ - HIM kEUR		kEUR		kEUR		HZDR kEUR		KIT kEUR		Sum (kEUR)	
	Anteil BMBF-Geld	Eigenanteil von 1% LK I	Anteil BMBF-Geld	Eigenanteil von 1% LK I	Anteil BMBF-Geld	Eigenanteil von 1% LK I	Anteil BMBF-Geld	Eigenanteil von 1% LK I	Anteil BMBF-Geld	Eigenanteil von 1% LK I	Anteil BMBF-Geld	Eigenanteil von 1% LK I	Anteil BMBF-Geld	Eigenanteil von 1% LK I

- Started in early 2025
- Mailing list qs4physics@desy.de; please subscribe (https://lists.desy.de/sympa/home)
- No formal reporting or oversight, but expect that we (I) will be asked to report at the end. Track milestones!
- Please acknowledge your funding, e.g.: "This work was supported via ... and project Quantum Sensing for Fundamental Physics (QS4Physics) from the Innovation pool of the research field Helmholtz Matter of the Helmholtz Association." (thanks Georgy)

Posters!


KIT
Karlsruhe Institute of Technology
ITeDA
Institute of Technologies in Detection and Astroparticles
HEP2025
Scalable Readout Architecture for Large-Scale Quantum Sensor Arrays in Fundamental Physics
KIT – The Research University in the Helmholtz Association
www.kit.edu
KIT
Karlsruhe Institute of Technology
MT
DTS
MATTER AND TECHNOLOGIES
Detector Technologies and Systems
Next-Gen Readout System for Cryogenic Detectors
T. Muscheid, R. Gartmann, L. Ardila-Perez, O. Sander
Readout Concept
Cryogenic Readout
Room-temperature Readout
Frequency Multiplexing
Software-Defined Radio
DAQ Electronics
MPSoC System + external Data Converters
DTS-100G
(Custom FPGA Board)
Custom ECHo DAQ Board
(Data Converters + Clock)
RFSoC System
ZCU216 Eval Board
(MPSoC + Data Converters)
Characterization
DAC SFDR
ADC SFDR
Clock Phase Noise
Resource Utilization
Applications

Collaborative (Funding) Opportunities

- BMFTR Quantum Enabling Technologies
- BMFTR Quantum Future Professionals
- EU Horizon Europe
- QuantERA (https://quantera.eu/)
- ErUM Pro
- ERC, EIC
- Hightech Agenda Deutschland
- EU Quantum Act
- Helmholtz Quantum
- …?

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Horizon Europe cluster 5 draft WP 2026/27:

Call ID / Name	Focus Area	Type of Action	Budget / Funding	Strategic Objectives
HORIZON-CL4-2026-04-DIGITAL-EMERGING-11	Quantum Sensors for Inertial Navigation	CSA (Coordination & Support Action)	€2M (project: €0.5–2M)	EU autonomy, quantum sensor market, including SME/startup access
HORIZON-CL4-2026-04-DIGITAL-EMERGING-12	Standards for Quantum Technologies	CSA	€1M	Development of standards (hardware/software interfaces, protocols, benchmarking), EU leadership in global quantum standardisation
HORIZON-CL4-2026-04-DIGITAL-EMERGING-18	Large-Scale Photonic Quantum Computing Platform Technologies	RIA (Research & Innovation Action)	€10M	Photonic quantum computing platform, integration with HPC/cloud, industry-focused demonstration, modular scalable systems
Quantum Top-Up to InvestEU	Technology Scaling & Bankability	Indirectly managed, Venture Debt	€100M (2026), €28M (2027)	Market-ready quantum solutions, start-up/SME support, integration with existing industry, reinforcing EU technological sovereignty

Calls under framework agreements:

Trapped-Ion Quantum Computing (SGA for FPA)	Trapped-Ion Platform	SGA	€20M	Large-scale ion-trap computers (>1000 qubits), standards, modularity, error correction, industry/science applications
Quantum Computing (OpenSuperQPlus FPA)	Superconducting Quantum Computing	SGA	€20M	Modular, scalable superconducting quantum computers (1000 qubits+), industrial use cases, EU supply chain & certification
Quantum Computing Simulation (PASQuanS2 FPA)	Neutral-Atom Quantum Computing & Simulation	SGA	€20M	Scalable neutral-atom simulators/computers, cloud access, new real-world applications, benchmarking/classical validation

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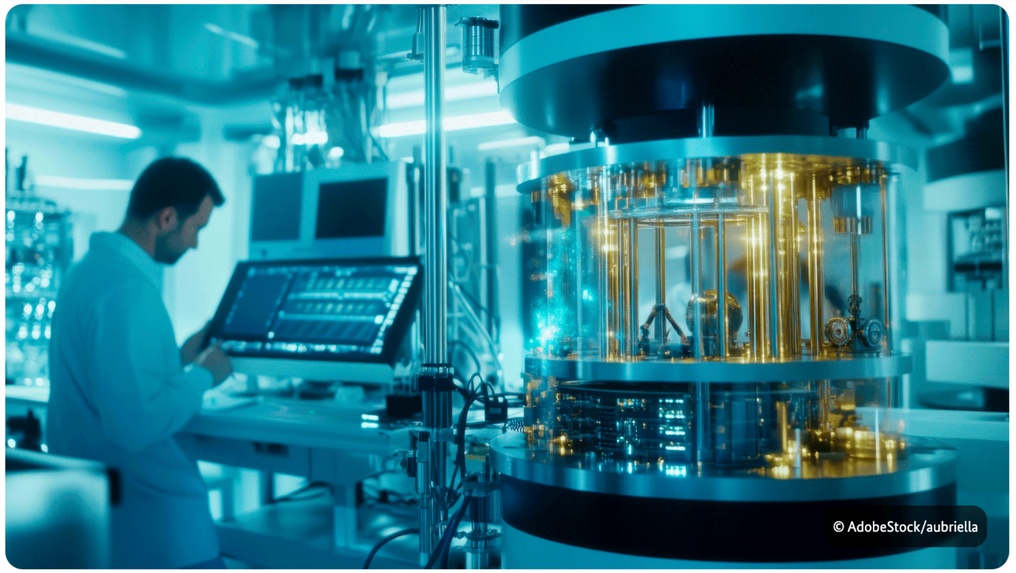
Hightech Agenda DEUTSCHLAND

Bundesministerium für Forschung, Technologie und Raumfahrt

Agenda Aktuelles Schlüsseltechnologien



Quantentechnologien

Quantentechnologien nutzen die besonderen Gesetze der Quantenphysik, um völlig neue Möglichkeiten in Datenverarbeitung, Sensorik, Medizin und Kommunikation zu erschließen. So sind sie eine große Chance für unser Land – wirtschaftlich, wissenschaftlich und gesellschaftlich. Die Hightech Agenda Deutschland legt den Grundstein für eine gezielte Förderung von Forschung und Anwendung, um unser Land als führenden Standort für Quanteninnovationen zu positionieren.

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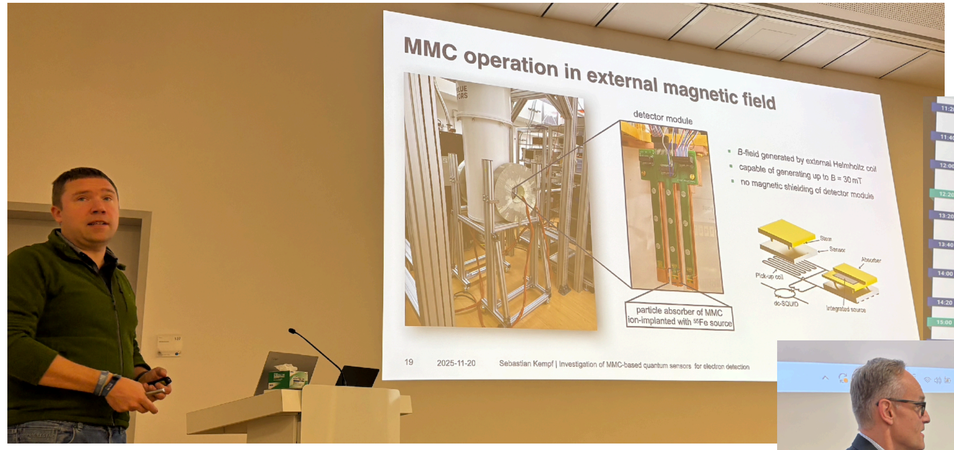

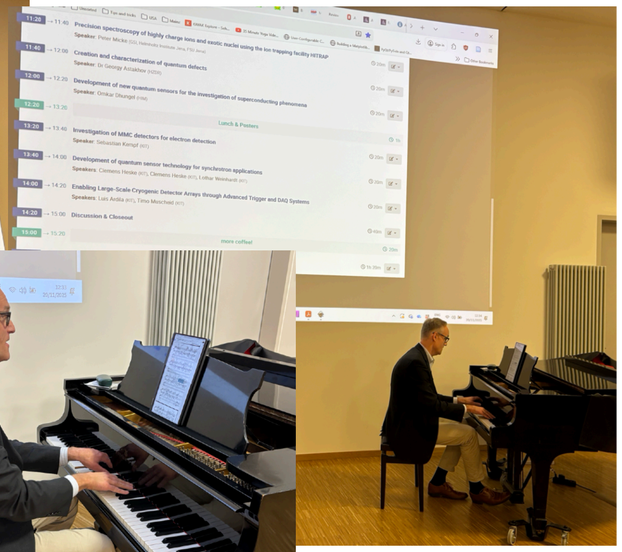

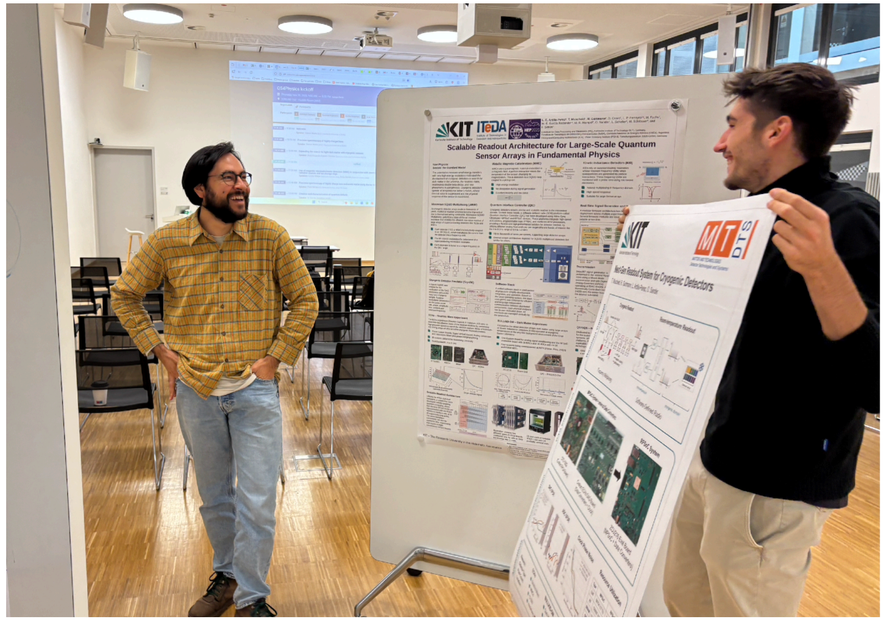

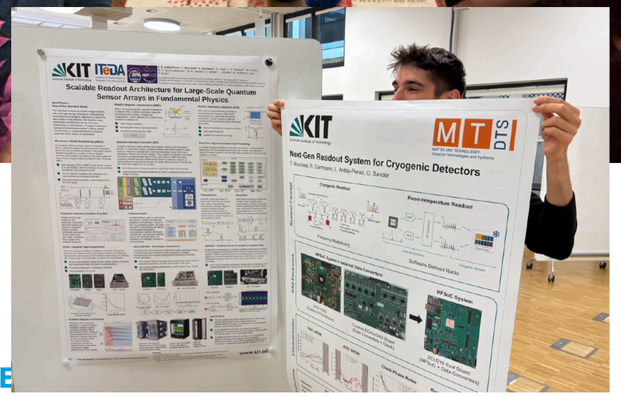

Thanks for a successful QS4Physics Kickoff!