

# INFRA- STRUCTURE

# 3

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# 3.1 SCIENTIFIC AND TECHNICAL INFRASTRUCTURE

*Aerial view of the institute's campus in fall. In the background the city of Heidelberg.*

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## Campus

The institute campus is situated in the forest 200 m above the city of Heidelberg. The main buildings are the Walther Bothe and the Wolfgang Gentner Laboratories providing office and laboratory space. The library building with a lecture hall and a seminar room suitable for small conferences lies at the centre of the campus. Other significant buildings are the experimental hall complex, the electronic and mechanical workshop buildings, the kindergarten and guest houses. The neighbour to the south is the European Molecular Biology Laboratory (EMBL). See page 58 for a map of the site.

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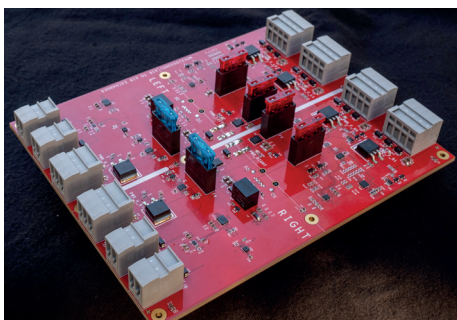
## Central IT Services

The central IT infrastructure provides computing power and storage space. A Linux cluster and several special-purpose servers with about 7000 processor cores are available for processing batch jobs. Data is stored on hard disks with a total capacity of over 17 Petabytes. For fast access, most of the data space is organised as a parallel file system. A central tape library is used as a backup system to assure data safety and as a long-term archive. All servers and file systems are attached with up to 100 Gigabit Ethernet connections to the network. The cluster mainly serves for data storage, data analysis and simulations in gamma-ray astronomy as well as for time-consuming calculations in theoretical quantum dynamics. Further, the IT group operates mail and web servers, supports users with desktop hardware and software, and maintains the technical infrastructure in the lecture hall and seminar rooms.



*Four water-cooled racks containing servers.*

## Electronics



Fan control board for the air-to-air heat exchanger for the proposed SWGO electronics cabinet.

Electronics to control experiments and for data acquisition are developed and produced in the central electronics shop and the apprentices' shop, since in many cases the experimental requirements cannot be fulfilled by commercial devices. A new electronic circuit design is transferred to the layout of a respective board, which is then usually produced externally and tested before its integration into an experiment. The central electronics group has specialist expertise in areas of critical importance to the institute, for example in the precise voltage systems needed for ion traps, and the digitisation systems needed to capture the data from many experiments. Maintenance and repair of electronic devices is also performed. Some of the electronic technicians are permanently engaged in specific experiments.

## Precision Mechanics and Engineering Design

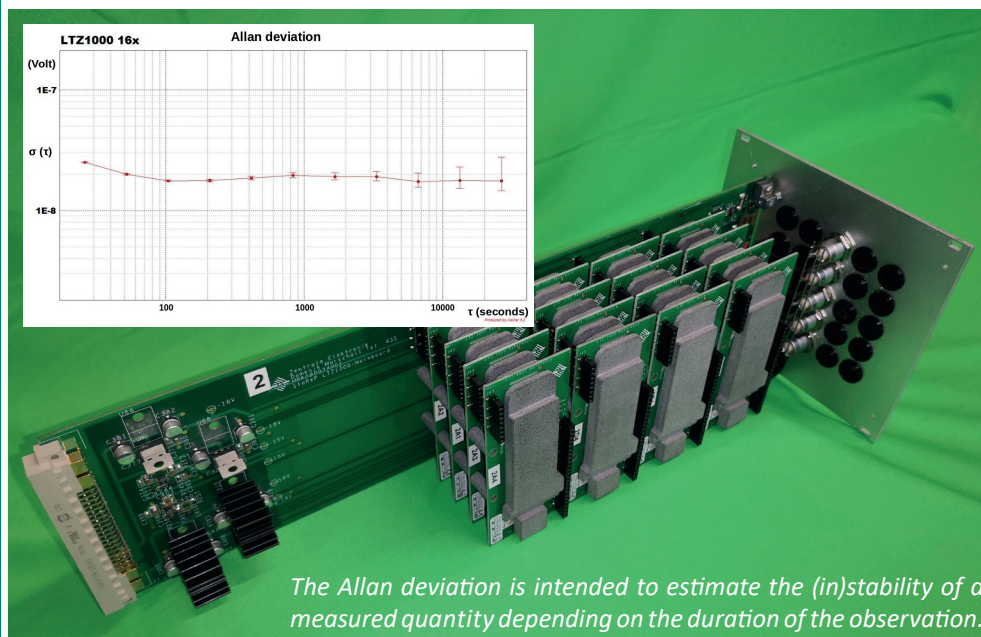


Vacuum chamber, designed and built in the institute's engineering design office and precision mechanics shop.

Both the central precision mechanics shop and the apprentices' shop are equipped with modern CNC-controlled as well as conventional milling and turning machines. Further, a number of welding and soldering techniques are applied to produce vacuum components. Among the treated materials are steel, copper, titanium, tantalum, molybdenum as well as ceramics and plastics. The precision of the workpieces is checked with a high-resolution 3D measuring device. Several specialised mechanics shops are in charge of some large-scale experiments.

Many of the components for scientific instruments that are built in the mechanics shops are developed in the engineering design office based on a 3D-CAD system. It delivers three-dimensional views that can be rotated on the screen, technical drawings for the manufacturing process, data to directly control the CNC machines and lists of the required materials. The software package includes a numerical simulation tool to test the components beforehand.

### The STAREP voltage reference cluster



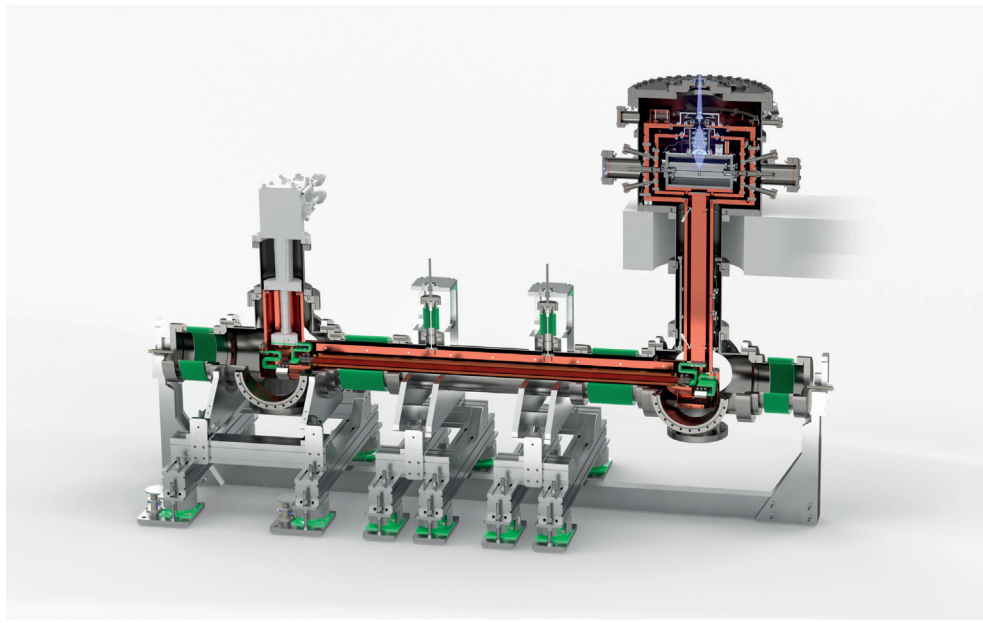
Ion traps offer many opportunities to measure fundamental physics properties of matter. The Penning ion traps at MPIK allow for highest precision measurements of atomic and nuclear states and masses by observing the frequencies of ion motion in strong magnetic fields. Loading, unloading and placement of the ions inside the trap is controlled by several electrical potentials. In order to allow for highest precision measurements, those voltages have to be precise and very stable in time because any voltage variation dilutes the frequency measurements.

In the current STAREP (STABLE Reference for Penning traps) system, all channel potentials are derived from a central reference voltage source that is based on very stable commercial reference ICs (Linear Technologies LTZ1000). In addition, the ICs are electrically and thermally decoupled from the ambient by dedicated pcb layout techniques and 3D-printed housings. To further reduce the voltage noise, sixteen LTZ1000 are combined to make up a STAREP voltage reference module. With this setup, voltage variations of less than 30 nanovolts over measurement intervals ranging from 10 seconds to about 10 000 seconds can be achieved as illustrated by the measurement of the so-called Allan deviation. The achieved stability is very close to the stability of the best standard available, the Josephson voltage standard.

### CryPTEx 2: cryogenic Paul trap experiment

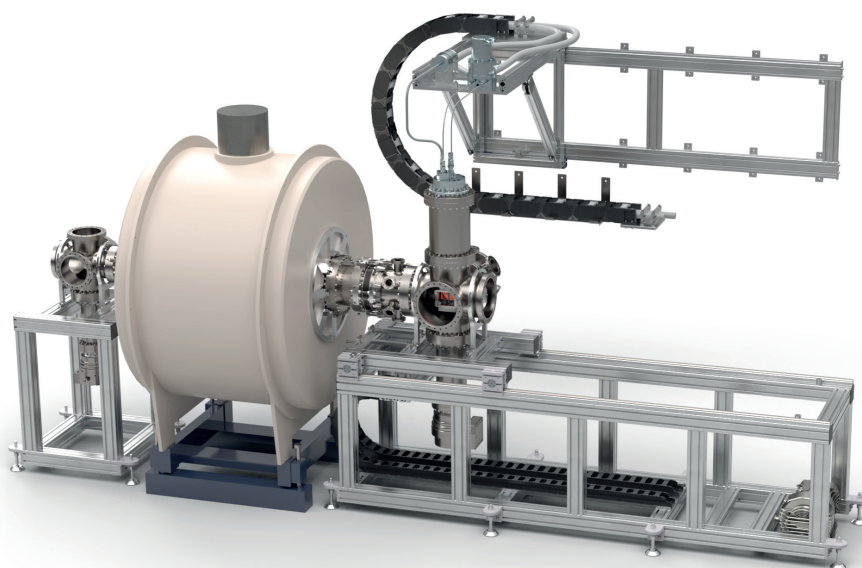
A novel, quasi-monolithic and superconducting radio-frequency trap made of high-purity niobium for the storage and laser spectroscopy of highly charged ions was designed in close collaboration between scientists and the engineering design office and built in the central precision mechanics shop. After the niobium ingot resonator was assembled and aligned, it was electron-beam welded at several points. Optomechanics were also developed and manufactured for the detection of the stored ions.

Complementary to this worldwide unique concept, a vibration-decoupled, cryogenic feed line made of high-purity copper was designed and manufactured. A second, improved version of the entire experiment is currently being manufactured as part of a BMBF-funded project in engineering design and precision mechanics.

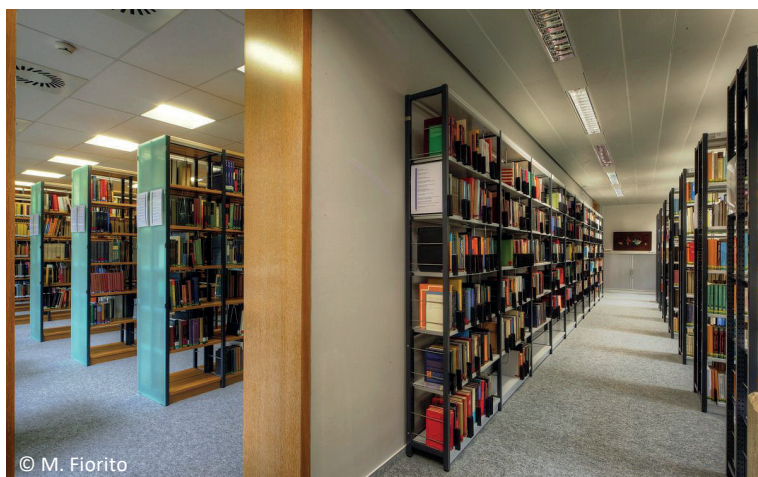


### ELCOTRAP: an experiment to explore novel methods for cooling single ions

The continuously advancing precision of Penning trap experiments requires increasingly sophisticated techniques for cooling ions. A novel cooling technique, where highly charged ions are cooled down to sub-millikelvin temperatures by coupling them to a cold electron plasma, is expected to further increase precision. The ELCOTRAP (Electron Cooling Trap) experiment was designed to realise this technique. The experiment chamber in the centre of a superconducting magnet is cooled to 4 K, with special attention paid to the best possible thermal conductivity while minimising mechanical vibrations. By designing special bearings and suspensions, the experimental chamber can be pulled out sideways within a few minutes, thus enabling fast iteration cycles. For this purpose, the engineering design office constructed, among other things, a mechanical joint that can be opened without tools and that establishes optimal conductivity during operation by thermal contraction. Using FEM simulations, the cryogenic structure was optimised for the necessary mechanical stiffness. Subsequently, the entire structure was manufactured and pre-assembled in the central precision mechanics shop.



## Scientific Information Service



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View into the MPIK library.

The institute's library presently holds about 26 200 monographs, book series, conference proceedings, theses prepared at the MPIK and about 6 200 journal volumes. Via the Max Planck Society, the library provides access to e-books, online dictionaries, databases and more than 40 000 e-journals. MPIK actively participates in the Max Planck Society's open access activities via the Max Planck digital library. The publication management system PuRe offers the opportunity to publish papers and supplementary material and to prepare individual publication lists.

## Public Relations

It is a high priority of the MPIK that major research results are communicated well beyond the scientific community, to the public at large. A dedicated publication relations team writes press releases about selected results which are published via the institute's homepage and internet services. Detailed information about the research at MPIK is kept up to date both online and as printed matter. Groups of visitors are welcome for guided institute tours; for school students, we provide the "Saturday morning physics" events.

### Open Day celebrating the 20<sup>th</sup> anniversary of the inauguration of the H.E.S.S. telescopes

In 2002, the first of now five telescopes of the High Energy Stereoscopic System H.E.S.S. was inaugurated on Farm Goellschau, about 120 km south-west of Windhoek in Namibia.

To date, H.E.S.S. is the largest and most sensitive telescope array exploring the Universe at the highest energies of the electromagnetic spectrum. In the last 20 years, the H.E.S.S. Collaboration has published over 250 articles in high-impact scientific journals and contributed to close to 1 000 student thesis projects; the Collaboration and its members have been awarded many prestigious prizes, and independent surveys ranked H.E.S.S. among the most influential observatories worldwide.

In order to celebrate these achievements, the H.E.S.S. Collaboration hosted an Open Day for the public on the H.E.S.S. site in Namibia, organised by the Collaboration and MPIK. On Sunday, October 23<sup>rd</sup>, over 500 guests came to the remote location to have a look at this unique research facility. Besides numerous tours to the telescopes given by members of the H.E.S.S. Collaboration, several activities and showcases had been prepared to highlight the science of H.E.S.S.



Visitors could experience a show in a portable planetarium provided by the University of Namibia, UNAM, where the southern sky was presented. A poster presentation of over 50 newly designed posters explained the H.E.S.S. telescopes, their function and scientific discoveries. Younger guests were invited to test their skills in eliminating unwanted signals from their gamma-ray counterparts in a specifically designed video game. Two technicians from MPIK, who have been supporting the construction and maintenance of the telescopes for the last 20 years, provided an extensive display of tools that have been used in construction of the telescopes as well as crucial parts as a hands-on experience.



As the site of the telescopes is only accessible by an hour-long drive from Namibia's capital Windhoek, free public transportation was organised. As a result, several school classes were among the visitors, as well as many local residents from Windhoek and nearby villages, allowing them a glimpse into Namibia's forefront research facility and the importance of gamma-ray astronomy. As tour organisers were notified of the event beforehand, a number of tourists from all over the world attended the Open Day as well.

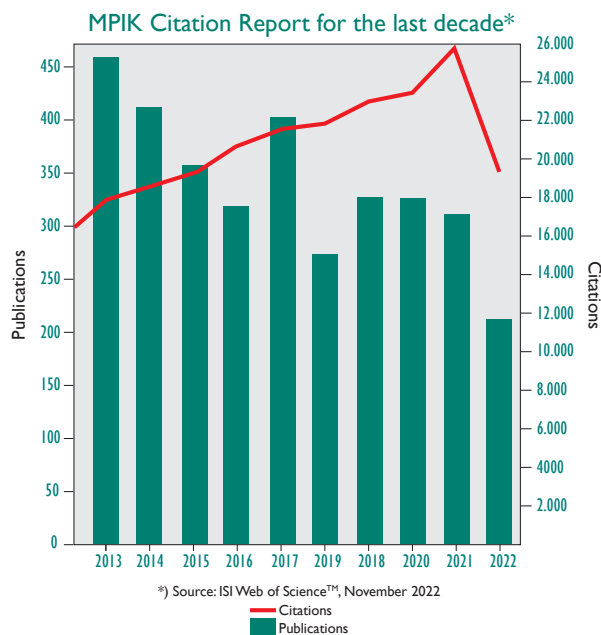
### Publication statistics

The publication output of the MPIK is documented via the Max Planck wide publication repository PuRe (<https://pubman.mpg.de/>), which presently contains about 9 100 datasets related to the MPIK. 1 010 entries have been added in the years 2020-2022, of which 429 contain the full text and 392 provide a link to the full text of the publication.

While the total number of publications has fluctuated over the years, the yearly number of citations to all publications ever published by MPIK scientists continues to increase. In the years 2020-2022, overall 52 papers were regarded as being of interest for the general public and therefore accompanied by a press release. Two papers by MPIK scientists were among the finalists for “Breakthrough of the Year 2021“

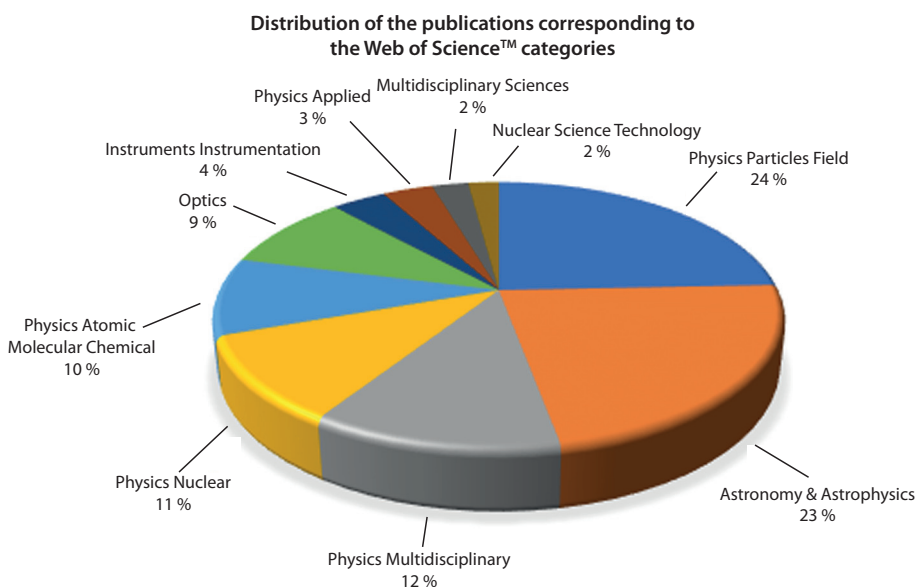
The following table lists the most favoured journals during the years 2020 to 2022 together with the numbers of papers published therein. The second table indicates the number of theses of various types completed at MPIK over the three years.

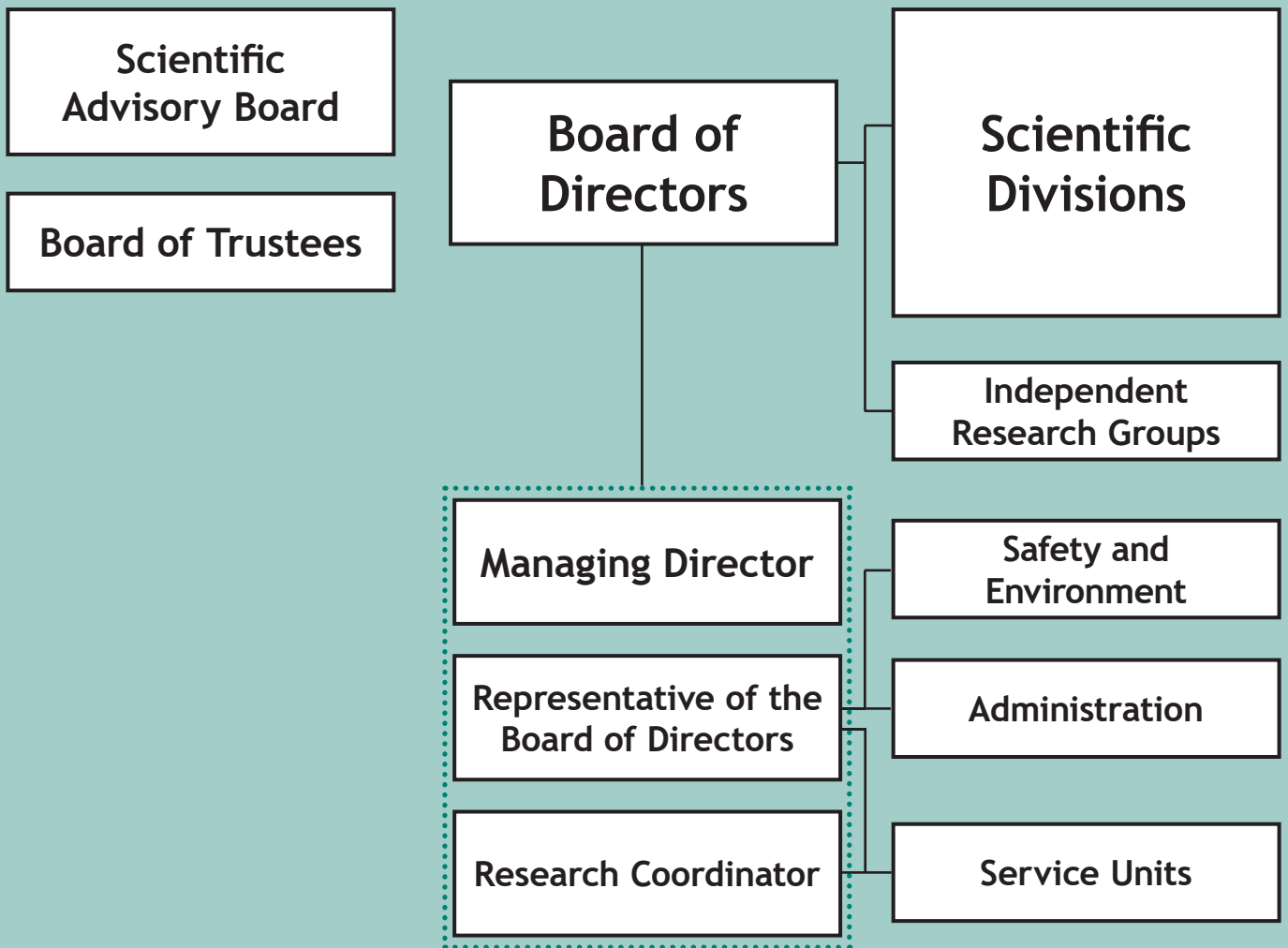
Journal	Papers
Physical Review D	92
Physical Review Letters	88
Journal of High Energy Physics	76
Physical Review C	46
Physical Review A	45
European Physical Journal C	42
Astrophysical Journal	34
Astronomy & Astrophysics	27
Physical Review Research	25
Journal of Cosmology and Astroparticle Physics	24
Nature	13
Nature Physics	9
Nature Communications	5
Nature Astronomy	4
Science	4
Nature Chemistry	1



The data for 2022 are still incomplete; the full numbers will be available in spring 2023.

	2020	2021	2022
Bachelor theses	13	9	9
Master theses	14	12	13
Dissertations	24	19	11
Habilitations	1	1	1





## 3.2 PERSONNEL



*Organisational diagram of the institute.*

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### Distinctions to MPIK Members

Prof. Dr. Klaus Blaum: Lise Meitner Prize of the European Physical Society and Otto-Hahn-Preis der Stadt Frankfurt am Main, der GDCh und der DPG and Member of the Heidelberger Akademie der Wissenschaften

Prof. Dr. Dr. h.c. Manfred Lindner: Fellow of the American Association for the Advancement of Science (AAAS)

Prof. Dr. Heinrich Völk: Honorary Doctorate of the Sibirian Branch of the Russian Academy of Sciences

Prof. Dr. Eberhard Grün: Ehrendoktorwürde der Universität Stuttgart

Prof. Achim Schwenk: Advanced Grant of the European Research Council (ERC)

Apl. Prof. Dr. Andreas Wolf: Dieter-Möhl-Medal 2021 of CERN

Apl. Prof. Dr. José R. Crespo López-Urrutia: Fellow of the American Physical Society

Dr. Jonas Karthein: Wilhelm und Else Heraeus-Dissertationspreis 2020 and Dissertationspreis der DPG

Dr. Peter Micke: Dissertationspreis der DPG

Dr. Frederik Depta: Best Paper Award des Exzellenzclusters „Quantum Universe“

Zheng Gong: Matter at Extremes Young Investigator Award

Stefan Dickopf: Otto-Haxel-Preis der Fakultät für Physik und Astronomie für die beste experimentelle Masterarbeit

Jason Mather: Kammersieger im Leistungswettbewerb des deutschen Handwerks and Azubipreis der MPG 2020

Maximilian Bruder, Vincent Gahn and Lukas Heckmann: Urkunden für sehr gute bzw. gute Leistungen in der Gesellenprüfung

Maximilian Bruder: 1. Kammersieger und 2. Landessieger im Leistungswettbewerb des deutschen Handwerks 2022

Lukas Heckmann: 2. Kammersieger im Leistungswettbewerb des deutschen Handwerks 2022

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### Appointments of MPIK Scientists

PD Dr. Antonino Di Piazza: Full professor, University of Rochester (NY) and distinguished scientist, Laboratory for Laser Energetics

Dr. Yuanbin Wu: Full professor at Nankai University, China

PD Dr. Adriana Pálffy-Buß: W2-Professur für Theoretische Quanteninformation und Quantenoptik, Universität Würzburg

Dr. Yun Jiang: Associate Professor, Sun Yat-sen University, China

Dr. Giorgio Busoni: Assistant Professor, Australian National University

PD Dr. José R. Crespo López-Urrutia: außerplanmäßiger Professor, Universität Heidelberg

Dr. Anne Harth: Professur für Computational Optics, Hochschule Aalen

Dr. Tommi Alanne: Lecturer, University of Liverpool, UK

Dr. Oliver Fischer: Lecturer, University of Liverpool, UK

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Prof. Dr. Eckart Würzner, Heidelberg  
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Theoretical Quantum Dynamics and  
Quantum Electrodynamics  
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Particle and Astroparticle Physics  
Prof. Dr. Thomas Pfeifer –  
Quantum Dynamics and Control

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Prof. Dr. Werner Hofmann  
Prof. Dr. Konrad Mauersberger  
Prof. Dr. Bogdan Povh  
Prof. Dr. Heinrich J. Völk  
Prof. Dr. Hans-Arwed Weidenmüller

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Prof. Dr. Rudolf M. Bock, Darmstadt  
Prof. Dr. Stanley J. Brodsky, Stanford  
Prof. Dr. Lorenz S. Cederbaum, Heidelberg  
Prof. Dr. Gisbert Frhr. zu Putlitz, Heidelberg  
Prof. Dr. Gerd Röpke, Rostock  
Prof. Dr. Volker Soergel†, Heidelberg  
Prof. Dr. Joachim H. Ullrich, Braunschweig  
Prof. Dr. Christof Wetterich, Heidelberg  
Prof. Dr. Daniel Zajfman, Rehovot

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### Managing Director

Prof. Dr. Thomas Pfeifer, until 31.12.2020  
Prof. Dr. Jim A. Hinton, from 01.01.2021

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### Institute Management

PD Dr. Günter Sparn, Representative of the  
Board of Directors  
PD Dr. Werner Rodejohann, Research  
Coordinator from 01.03.2022

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### Max Planck Fellow

Prof. Achim Schwenk

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### Max Planck Research Group Leaders

Dr. Laura Cattaneo, from 01.05.2020  
Dr. Florian Goertz  
PD Dr. Holger Kreckel, until 31.08.2021  
Dr. Brian Reville

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### Elected Representative to the CPTS

Dr. Bernhard Schwingenheuer

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Dr. Christian Bauer  
PD Dr. Konrad Bernlöhr  
Dr. Christian Buck  
Apl. Prof. Dr. José R. Crespo López-Urrutia  
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 Dr. Richard White  
 Apl. Prof. Dr. Andreas Wolf

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## International Max Planck Research Schools

The MPIK is involved in three International Max Planck Research Schools (IMPRS). Two of them are coordinated by the institute, while the third one is coordinated by the MPI for Astronomy (MPIA). The IMPRS are part of the Heidelberg Graduate School for Physics (HGSFP) at Heidelberg University.

### IMPRS-QD: Quantum Dynamics in Physics, Chemistry and Biology

Spokesperson: Christoph H. Keitel

Coordinator: Jörg Evers

Institutions: MPIK, Heidelberg University, German Cancer Research Center, MPI for Medical Research, GSI Helmholtzzentrum für Schwerionenforschung (Darmstadt)

	2020	2021	2022
PhD students	41	42	44
female	11	10	12
from foreign countries	26	27	26
funded by IMPRS-QD	10	7	10
graduations	6	8	10

### IMPRS-PTFS: Precision Tests of Fundamental Symmetries

Spokespersons: Manfred Lindner and Klaus Blaum

Coordinator: Werner Rodejohann

Institutions: MPIK, Heidelberg University

	2020	2021	2022
PhD students	20	21	22
female	6	6	10
from foreign countries	6	7	5
funded by IMPRS-PTFS	8	7	11
graduations	6	2	5

### IMPRS-HD: Astronomy and Cosmic Physics @ MPIA

During the reporting period, 14 PhD students (of which 7 female, 9 from foreign countries, 0 funded by IMPRS-HD, 6 graduations) were working at the MPIK.

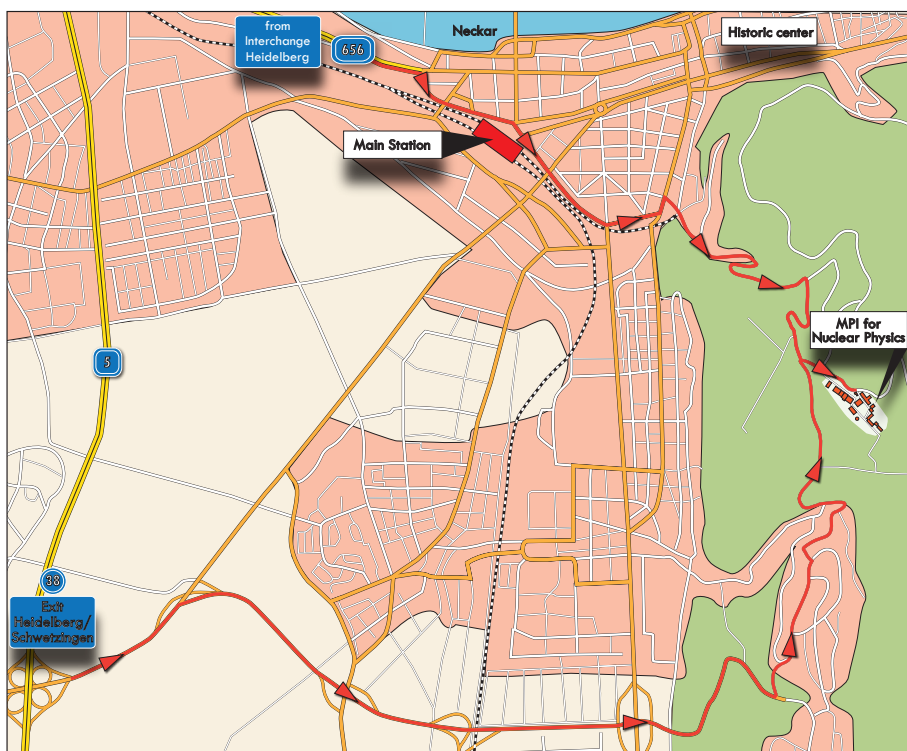
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## Electronic Annex

The electronic annex provides lists of publications, theses, invited talks at conferences and symposia or at other institutes, teaching activities, jointly organised conferences and workshops, as well as institutional collaborations. Both the annex and the report itself can be downloaded from MPIK's web pages:

[www.mpi-hd.mpg.de/mpi/en/public-relations/reports-and-information-material](http://www.mpi-hd.mpg.de/mpi/en/public-relations/reports-and-information-material)

## How to Reach the Institute



**By car:** Autobahn A5 from the north until Autobahnkreuz Heidelberg, turn to A656 direction Heidelberg; at the end of the Autobahn turn right (direction „Zentrum, Altstadt, Schloss“) and at the main station turn right again, stay on the four-lane road (underbridge), at the traffic light half left, then straight ahead, take third exit in the roundabout (‘left’), at the next traffic light turn right into Steigerweg, and follow the direction signs „Max-Planck-Institut für Kernphysik“ about 2.5 km uphill.

From the south leave A5 at the exit Heidelberg/Schwetzingen, turn on B535 direction Heidelberg/Leimen, then right direction Leimen and keep straight ahead for about 4.5 km (at last uphill) to the Aral station, there turn left to Boxberg and follow the direction signs „Max-Planck-Institut für Kernphysik“.

**By train:** Arriving at the main station Heidelberg Hauptbahnhof which can be reached either directly by long-distance trains or via Mannheim and S-Bahn, take a taxi to the institute, or bus 39 direction Königstuhl until the stop „MPI Kernphysik“ or bus 39A until the stop „Bierhelderhof/Ehrenfriedhof“ (about 15 min). Alternatively with S1, S2, S5 to Heidelberg Weststadt/Südstadt, then walk (3 min) to Alois-Link-Platz and take bus 39 or 39A.

**By plane:** Airport Frankfurt/Main; take either an express train (ICE, IC) at Flughafen Fernbahnhof via Mannheim or the Lufthansa Airport Bus to Heidelberg. Continue with a taxi.

**By taxi:** Taxis are available outside the main station or can be called: +49 6221 302030. Please tell the taxi driver MPI für Kernphysik, Saupfercheckweg, as there are three other MPIs in Heidelberg.

## Site Map of the MPIK

