Leibniz Gemeinschaft

Der Senat

4. Juli 2023

Stellungnahme zum Leibniz-Institut für Sonnenphysik, Freiburg (KIS)

Inhaltsverzeichnis

Vorbemerkung

Die Einrichtungen der Forschung und der wissenschaftlichen Infrastruktur, die sich in der Leibniz-Gemeinschaft zusammengeschlossen haben, werden von Bund und Ländern wegen ihrer überregionalen Bedeutung und eines gesamtstaatlichen wissenschaftspolitischen Interesses gemeinsam außerhalb einer Hochschule gefördert. Turnusmäßig, spätestens alle sieben Jahre, überprüfen Bund und Länder, ob die Voraussetzungen für die gemeinsame Förderung einer Leibniz-Einrichtung noch erfüllt sind.[1]

Die wesentliche Grundlage für die Überprüfung in der Gemeinsamen Wissenschaftskonferenz ist regelmäßig eine unabhängige Evaluierung durch den Senat der Leibniz-Gemeinschaft. Die Stellungnahmen des Senats bereitet der Senatsausschuss Evaluierung vor. Für die Bewertung einer Einrichtung setzt der Ausschuss Bewertungsgruppen mit unabhängigen, fachlich einschlägigen Sachverständigen ein.

Vor diesem Hintergrund besuchte eine Bewertungsgruppe am 22. und 23. September 2022 das KIS in Freiburg. Ihr stand eine vom KIS erstellte Evaluierungsunterlage zur Verfügung. Die wesentlichen Aussagen dieser Unterlage sind in der Darstellung (Anlage A dieser Stellungnahme) zusammengefasst. Die Bewertungsgruppe erstellte im Anschluss an den Besuch den Bewertungsbericht (Anlage B). Das KIS nahm dazu Stellung (Anlage C). Der Senat der Leibniz-Gemeinschaft verabschiedete am 4. Juli 2023 auf dieser Grundlage die vorliegende Stellungnahme. Der Senat dankt den Mitgliedern der Bewertungsgruppe und des Senatsausschusses Evaluierung für ihre Arbeit.

1. Beurteilung und Empfehlungen

Das Leibniz-Institut für Sonnenphysik (KIS)[2] hat den Satzungsauftrag, „Grundlagenforschung in der Astronomie und Astrophysik mit besonderem Schwerpunkt in der Sonnenphysik zu betreiben. Unter anderem betreibt es hierzu selbst und zusammen mit Dritten Beobachtungseinrichtungen für eigene und fremde Forschungsarbeiten." Dementsprechend gliedert sich das KIS in eine Abteilung, in der überwiegend geforscht wird, und eine Abteilung, die vor allem hochkomplexe Instrumente entwickelt und deren Betrieb an großen Observatorien im Ausland verantwortet. Die Beobachtungsdaten werden in einer weiteren Arbeitseinheit aufbereitet und verfügbar gemacht.

I.

In der **Abteilung „Solare und Stellare Astrophysik"** (Programme Area/PA 1) wurden in den letzten Jahren wichtige Ergebnisse u. a. zu den Magnetfeldern der Sonne und anderer Sterne erarbeitet. Außerdem wurde zu Exoplaneten und in der Astrobiologie geforscht. Bereits bei der vergangenen Evaluierung war darauf hingewiesen worden, dass einige dieser Arbeiten sich nur schwer in den Kernauftrag des KIS einpassen lassen. Die thematische Ausweitung wurde aber akzeptiert, weil sie größtenteils über einen ERC-*Advanced*

[1] Ausführungsvereinbarung zum GWK-Abkommen über die gemeinsame Förderung der Mitgliedseinrichtungen der Wissenschaftsgemeinschaft Gottfried Wilhelm Leibniz e. V.

[2] Bis November 2018 „Kiepenheuer-Institut für Sonnenphysik". Das Akronym KIS wurde nach der Namensänderung beibehalten.

Grant finanziert werden konnte. Diese Förderung und ebenso ein ERC-*Starting Grant* endeten 2017. Die Drittmittel und das Personal in der Abteilung verringerten sich daraufhin. Es wurde anschließend keine Strategie entwickelt, wie mit den nun vorhandenen Ressourcen die sonnenbezogene Forschung in den Mittelpunkt gerückt wird. Nachdem die Arbeiten vor sieben Jahren noch als „sehr gut bis exzellent" eingeschätzt wurden, werden sie nun lediglich als „gut bis sehr gut" bewertet.

Die Leistungen der **Abteilung „Observatorien und Instrumente"** (PA 2) sind demgegenüber deutlich besser und werden wie bei der vorigen Evaluierung als „sehr gut bis exzellent" bewertet. Zwei Aufgaben standen in den vergangenen Jahren im Mittelpunkt: Zum einen verantwortet die Abteilung den Betrieb und die kontinuierliche Weiterentwicklung des Sonnenteleskops GREGOR. Es wurde von mehreren deutschen Forschungsinstituten gemeinsam gebaut und wird seit 2013 am Teide-Observatorium auf Teneriffa eingesetzt. Zum anderen entwickelte PA 2 seit 2010 mit dem *Visible Tunable Filter* (VTF) ein hochmodernes Instrument für das neue *Daniel K. Inouye Solar Telescope* (DKIST) auf Hawaii und betreut nun dessen Instandhaltung und Weiterentwicklung. In der Abteilung wurden außerdem sehr gute technologische Beiträge zu anderen Beobachtungsprojekten unter anderem der ESA geleistet.

Mit dem Aufbau eines *Science Data Centre* (SDC), das zunächst die auf Teneriffa gewonnenen Daten zugänglich machen soll, wurde bereits 2012 begonnen. Unterstützt durch eine Erhöhung des Kernhaushalts ab 2021 konnte das Datenzentrum weiter ausgebaut werden. Das KIS verfolgt das ambitionierte Ziel, im SDC nutzungsoptimierte Daten aller großen erdgebundenen Sonnenobservatorien bereitzustellen. Dabei sollen u. a. auch die mit DKIST auf Hawaii gewonnenen Daten einbezogen werden.

II.

Die Planungen für die Zukunft lassen zentrale Fragen der **wissenschaftlichen Strategie** offen:

- Das KIS hat Zugang zu exzeptionellen Daten, die es selbst und andere Institute an den international bedeutendsten Sonnenobservatorien erheben. Die damit gegebenen Möglichkeiten werden jedoch nicht hinreichend ausgeschöpft. Es ist keine übergreifende Forschungsstrategie zu erkennen, die wie bereits vor sieben Jahren empfohlen klar definiert, welche wissenschaftlichen Fragestellungen bearbeitet werden sollen.
- Damit fehlt eine Grundlage für strategisch begründete Entscheidungen zur weiteren Entwicklung der Instrumentierung. Dies erklärt, warum neben der Weiterentwicklung von GREGOR und dem VTF keine ausreichenden neuen Perspektiven entwickelt wurden. Stattdessen konzentriert sich das KIS weiterhin auf den Aufbau eines *European Solar Telescope* (EST) als Nachfolger zu GREGOR. Dieses von nationalen Finanzierungen abhängige europäische Projekt wird bereits seit 2008 verfolgt. Die Realisierung wäre frühestens 2030 zu erwarten, steht nun aber grundlegend infrage. In Deutschland wurde das EST vor vier Jahren nicht auf die *Nationale Roadmap für Forschungsinfrastrukturen* aufgenommen.
- In Bezug auf das *Science Data Centre* ist unklar, wie mit DKIST als dem derzeit weltweit größten Sonnenteleskop in klar definierten Strukturen zusammengearbeitet werden

soll. Ob das SDC wie avisiert auch als Datenzentrum für das EST dienen kann, ist nicht abzusehen (s. o.).

Insgesamt sank die Zahl der **wissenschaftlich Beschäftigten** seit der letzten Evaluierung durch den Rückgang von Drittmitteln, Wechsel an andere Einrichtungen und Eintritte in den Ruhestand von 40 auf 26 Personen. Sie blieb im Infrastrukturbereich mit derzeit 25 Personen stabil und wuchs in der Administration von 12 auf 17. Ähnlich wie vor sieben Jahren wurden im Zeitraum 2019–2021 vier Promotionen abgeschlossen, allerdings sank die Zahl der Promovierenden von 12 zum Zeitpunkt der letzten Evaluierung auf nun vier. Eine stringente Personalstrategie, mit der auf die geschilderten Veränderungen reagiert wird, ist nicht zu erkennen.

Seit der Begehung wurden die Leitungen der beiden **Forschungsgruppen** in PA 1 mit externen Wissenschaftlern neu besetzt. In einem Fall wurde damit ein laufendes Verfahren nach dem Wechsel eines ausgewiesenen Gruppenleiters auf eine Professur in Jena abgeschlossen. Im anderen Fall reagierte das KIS darauf, dass die Abteilungsleiterin von PA 1 ihre Gruppenleitung Ende Februar 2023 aufgab. Sie wird im Herbst in die Schweiz wechseln (s. u.). Mit seiner zügigen Reaktion kehrte das KIS vom bisherigen Grundsatz ab, dass die Abteilungsleitungen gleichzeitig auch eine Gruppe leiten. Es ist nicht zu erkennen, dass die langfristige Rückwirkung auf die Leitungsstruktur des Instituts bedacht wurde.

Die Erträge aus **Drittmitteln** lagen mit im Schnitt 26 % (2019–2021) ähnlich hoch wie bei der letzten Evaluierung. Sie gingen jedoch in den Jahren 2019–2021 stetig zurück. 60 % dieser Drittmittel wurden im Wettbewerb eingeworben, insbesondere im Rahmen des EU-Netzwerks SOLARNET, dessen Förderung in diesem Jahr endet. Knapp 40 % wurden vom Sitzland und vom BMBF zur Fertigstellung des Teleskop-Filters für DKIST/Hawaii aufgewendet. Insgesamt ging die Zahl der geförderten Vorhaben deutlich zurück. Zwar veröffentlichte der ERC im Januar 2023, dass eine in der Schweiz tätige Wissenschaftlerin einen *Consolidator Grant* am KIS bearbeiten werde, ihre definitive Entscheidung über die Gastinstitution steht aber aus.

Der **Wissenschaftliche Beirat** hat in seinem Audit von 2021 eine Reihe von kritischen Hinweisen gegeben, die allerdings nicht hinreichend umgesetzt wurden, wie im Bewertungsbericht festgehalten. Bereits bei der letzten Evaluierung war die schleppende Umsetzung von Beiratshinweisen moniert worden. Im Aufsichtsgremium wurden wesentliche Weichenstellungen versäumt, auch wenn anzuerkennen ist, dass die seit vielen Jahren kritisierte Raumsituation mit einem für dieses Jahr vorgesehenen Umzug in einen Neubau gelöst wurde.

III.

Die beiden **Abteilungsleitungen** und ein administratives Mitglied bilden den Vorstand des KIS. Im April 2022 trat der langjährige Leiter der Instrumentierung (PA 2) in den Ruhestand ein. Wie das Institut inzwischen mitteilte, wechselt außerdem im September 2023 die Leiterin der Forschungsabteilung (PA 1) in die Schweiz, wo sie seit Mai 2022 bereits im Nebenamt tätig war.

Die Führungsvakanzen belasten die strategisch schwierige Situation des KIS zusätzlich in erheblichem Maße: Für die Behebung der oben beschriebenen Defizite ist ein enges

Zusammenwirken beider Abteilungsleitungen erforderlich. Im April 2023 wurde zwar ein Ruf für die Leitung von PA 2 erteilt. Es ist aber nicht abzusehen, bis wann beide Positionen wieder besetzt sein werden und ein gemeinsam getragenes Konzept für das KIS entwickelt werden kann.

IV.

Vor dem Hintergrund der geschilderten Gesamtsituation des Instituts sieht der Senat die Anforderungen, die an eine Einrichtung von überregionaler Bedeutung und gesamtstaatlichem wissenschaftspolitischem Interesse zu stellen sind, nicht mehr in hinreichendem Maße erfüllt.

2. Zur Stellungnahme des KIS

Das KIS hat zum Bewertungsbericht Stellung genommen (Anlage C). Das KIS nimmt zu einzelnen Hinweisen aus dem Bewertungsbericht Stellung und weist auf verschiedene personelle Entwicklungen hin. Die grundlegende Kritik des Senats wird damit jedoch nicht aufgehoben.

3. Förderempfehlung

Der Senat der Leibniz-Gemeinschaft empfiehlt Bund und Ländern, die gemeinsame Förderung des KIS auf der Grundlage der Ausführungsvereinbarung WGL als Einrichtung der Forschung und der wissenschaftlichen Infrastruktur zu beenden.

7 September 2022

Annex A: Status report

Leibniz Institute for Solar Physics, Freiburg (KIS)

Contents

1. Key data, structure and tasks

Key data

Year established:	1943
Admission to joint funding by Federal and *Länder* Governments:	1950s
Admission to the Leibniz Association:	1991 (founding member)
Last statement by the Leibniz Senate:	2016
Legal form:	Foundation under public law
Responsible department at *Länder* level:	Ministry of Science, Research and the Arts of Baden-Wurttemberg (MWK)
Responsible department at Federal level:	Federal Ministry of Education and Research (BMBF)

Total budget (2021)

€ 6.49m institutional funding

€ 1.08m revenue from project grants

€ 0 revenue from services

Number of staff (2021)

26 individuals in research and scientific services

25 individuals in service sector

17 individuals in administration and management

Mission and structure

Mission according to statutes

"The purpose of the Foundation shall be to conduct basic research in astronomy and astrophysics with a special focus on solar physics. For this purpose and among other activities, the Foundation shall, both on its own and jointly with third parties, operate observation facilities for its own research activities and those of others."

Organisation

The science programme of the institute is organized in two Program Areas (PA), each headed by a director. Both Program Areas are further divided into research groups:

PA 1: Solar and Stellar Astrophysics

Research groups: - Solar Photosphere and Interior
- Solar-Stellar Connections
- Science Data Centre

PA 2: Observatory and Instrumentation

Research groups: - Solar Telescopes
- Scientific Instrumentation

2. Overall concept and core results

Overall concept and activities

The Leibniz-Institut für Sonnenphysik (KIS) conducts basic research in astronomy and astrophysics with particular emphasis on solar physics. Main issues to be solved by solar physics are (a) origin, structure and evolution of the Sun's magnetic field, (b) magneto-hydrodynamic structure of the solar interior, operation of the magnetic dynamo and understanding the Sun as a star, c) heating of the outer atmosphere, and (d) influence of the solar variability on Earth and other planets.

To address these questions, KIS has defined in its current 5-year research plan (2018–2022) three research foci (RF) with magnetic fields forming the common thread:

- RF I: "Dynamic Solar Atmosphere" aims at understanding magnetic structure formation and magneto-convection processes in the photosphere, the structure and dynamics of the chromosphere as well as heating processes in the outer atmosphere.
- RF II: "The Sun among Stars" deals with the origin, evolution, and energetics of magnetic fields in the Sun and other stars, the hydrodynamic structure of solar and stellar interiors, and the influence of stellar radiation and activity on planets.
- RF III: "Instruments, Techniques, Data Analysis and Data Dissemination" aims at the development of high resolution and high sensitivity techniques and analysis methods for imaging, spectroscopy and polarimetry of the Sun and other stars. Another issue of this research focus is to unify data formatting, processing, archiving, and dissemination with the aim to offer solar ground-based data from various observational facilities.

KIS develops and operates two research infrastructures. The institute is responsible for the German solar telescopes at the Observatory del Teide, Tenerife (OT): the 1.5m GREGOR telescope and the 0.7m *Vacuum Tower Telescope* VTT), which serve the German, European and world-wide solar physics communities. From 2021, a new strategic research data infrastructure, the *Science Data Centre* (SDC), is being developed to offer observational data from ground-based solar telescopes (GREGOR, VTT, DKIST and others) to the national and international communities. KIS expects that SDC will become the central node of the *European Solar Telescope* (EST) Data Centre. For the establishment of the SDC, at total of € 1.4m p.a. are spent (see chapter 3).

Besides, KIS developed the *Visible Tunable Filter* (VTF) for the 4m *Daniel K. Inouye Solar Telescope* (DKIST) on the Hawaiian island Maui, the *Correlating Wavefront Sensor* (CWS) for the 1m balloon-borne telescope SUNRISE, the *Image Stabilization System* (ISS) for the *Solar Orbiter* space mission), and the *GREGOR Planet Polarimeter* (GPP) (see below for details). Furthermore, the institute participates in international consortia to construct instrumentation in order to secure prime access to telescopes for high-resolution observations and stellar astrophysics studies, e.g.: the 4m *European Solar Telescope* (EST, in planning), the synoptic telescope network SPRING (*Solar Physics Research Integrated Network Group*; in planning the high-sensitivity polarimeters DIPOL-2 and DIPOL-UF (deployed) and the instrumentation for the 1.85m telescope PLANETS (under construction).

To ensure knowledge transfer, KIS scientists serve on science policy committees and contribute to reports to governmental and research funding agencies. Technology transfer occurs through participation in instrumentation projects.

Results

Research

In 2019–2021, KIS published on an average 29 articles p.a. in peer-reviewed journals, 0.3 articles in other journals, 7 individual contributions to edited volumes as well as 32.3 working and discussion papers. In addition, the institute had the editorship of one collective volume during this period.

Within the three research foci the following results were achieved (see chapter 7 for details). In RF I "Dynamic Solar Atmosphere", the institute highlights e.g.

- understandings of fundamental processes driving dynamic small-scale magnetic fields in the photosphere and their impact on the chromosphere,
- conclusions concerning the inhibition of umbral convection in sunspot umbrae if magnetic fields exceed a strength of 2.8 kG,
- new insights on the structure of, and energy transport in, sunspots, especially the finding of an invariant vertical component of the magnetic field as an empirical law of the umbra-penumbra boundary in stable sunspots,
- a study of temporal fluctuations of small-scale magnetic fields in the solar quiet photosphere using approaches of stochastic thermodynamics,
- an observational confirmation of small-scale magnetic flux sheets emerging in the quiet Sun, formerly only found in simulations, and first observation of a flux cancellation,
- a novel approach to obtain vector magnetic field in the solar corona.

Among other projects in RF 2 "The Sun among Stars", KIS

- used analytical concepts of wave mechanics and perturbation theory for calculations concerning the interaction of helioseismic waves with large-scale flow components, and the Lorentz force resulting from various magnetic field components in the solar and stellar interiors,
- gained insights on the inference of both the Sun's internal meridional flow and the differential rotation for the northern and southern hemisphere independently,
- made a direct detection of a strong 5 kG magnetic field on the surface of an active brown dwarf,
- revealed the high complexity of magnetic fields on red dwarfs using an advanced spectropolarimetric analysis of molecular and atomic lines.

Results of RF 3 "Instruments, Techniques, Data Analysis and Data Dissemination" include

- new techniques for helioseismology: 1) Eigenfunction perturbation analysis for measuring large-scale flows in the solar interior; 2) Spherical Time-Distance Helioseismology for obtaining 3D maps of the solar interior at great depths.
- an inversion code FIRTEZ to interpret spectro-polarimetric observations and infer physical parameters (temperature, magnetic field, etc.) consistent with the 3Dmagnetohydrostatic equations and Maxwell's equations.
- several numerical codes for: 1) simulations of molecular polarization from exoplanets and protoplanets, 2) inversions of photometric and polarimetric observations of exoplanets, 3) molecule formation and cloud diagnostics in planetary atmospheres, 4) multiple scattering in stellar and planetary atmospheres, 5) stellar limb polarization during planetary transits, 6) effect of starspots on transit photometry and polarization,
- the development of an inversion technique to indirectly image exoplanet surfaces using observed unresolved reflected light variations over the course of the exoplanet's orbital and axial rotation,
- reduction, analysis and visualization tools for spectroscopic and spectropolarimetric solar data, several (semi-)automatic pipelines, instrument data curation involving the calibration, reduction, post-processing of raw data as well as archiving.

Research Infrastructure

With regard to the achievements in the development and operation of research infrastructures, KIS highlights the following activities and achievements:

KIS is engaged in the operation of three solar telescopes on Tenerife:

- *GREGOR* is the largest (1.5 m) solar telescope in Europe, and it will remain the main KIS observing facility until at least 2030. Since 2015, GREGOR has been in science operation. It is equipped with an adaptive-optics (AO) system, a narrow and broad-band imager, an infrared spectro-polarimeter, and imaging polarimeters for solar and nighttime operations. It has been improved and updated in many ways. Important developments concern GREGOR's new secondary mirror M2 (2018), made of Zerodur, new slit-jaw system for the GREGOR long-slit spectrograph (2018). Furthermore, the new capability to do remote observing and observing assistance with GREGOR by opening the Remote Observing Center (ROC) at KIS in Freiburg (2018) was established. A newly developed GREGOR Graphical User Interface (GUI, 2019) simplifies and increases the efficiency of observations by reducing the number of required GUIs from about ten to one. The redesign of the GREGOR relay optics including AO (2020) has improved the image quality. Near-term goal is to build the new 2D spectropolarimeter Large EtAlon Polarimeter for GREGOR (LEAP) in cooperation with external partners for studying rapid evolution of solar magnetic fields.
- The *Vacuum Tower Telescope* (VTT, 0.7 m) was the major observing facility at KIS until 2014. A new fast camera system for the spectrograph (AIP) and the 2D spectropolarimeter IBIS (INAF, Italy) are to be installed in 2022–2024.

- The *Chromospheric Telescope* (ChroTel, 10 cm) acquires semi-automatically full-Sun images in three spectral lines with high cadence starting from 2008. Data are archived and made available to the world-wide community through the KIS SDC and Virtual Solar Observatory. Current Sun images are shown on the KIS website when available. Due to the COVID-19 pandemic, ChroTel has not been maintained since 2019 and can probably only resume operation in 2023.

Further achievements in the development and operation of research infrastructure are:

- KIS contributes the *Visible Tunable Filter* as a first-generation post-focus instrument to the world's largest solar telescope DKIST. KIS will be granted guaranteed observing time at DKIST equivalent to about 90 observing days in total as compensation for contributing the VTF. At the end of 2021, the VTF data pipeline, designed to generate fully calibrated science ready data, was delivered to the DKIST Data Centre. Besides, VTF needs two etalons (Fabry-Pérot-Interferometer). The one-etalon instrument is currently being assembled in a laboratory at KIS, observations starting in 2023.
- Preparations for a third flight of the 1m balloon-borne stratospheric telescope SUNRISE started in 2017. The optical and mechanical setup has been completely redesigned. The science instrumentation has been expanded. The launch took place in 2022 but had to be terminated prematurely due to mechanical damages incurred at launch. A new launch in 2023 may be possible.
- KIS contributed to the *Polarimetric and Helioseismic Imager* (PHI) instrument of the ESA's *Solar Orbiter* space mission launched in February 2020. KIS has developed and constructed the *Image Stabilization System* (ISS) in collaboration with the University of Barcelona. After the launch, KIS has been involved in the commissioning, calibration and operation of the instrument, and will continue to be involved until the end of the mission (2029). KIS scientists have early access to the PHI science data from the beginning of the mission.
- With its 4m mirror, the *European Solar Telescope* (EST) will look at fundamental solar processes at their smallest scales. The development of EST is organized by the European Association for Solar Telescopes (EAST; currently 18 countries engaged). Since the beginning of the EST project, KIS is contributing to advance EST on all different levels, including the formulation of the scientific requirements, towards a design of multi-wavelength spectropolarimetric post-focus instrumentation. The EST Science Advisory Group has been chaired by KIS since 2017, the EST Board of Directors by KIS since 2020. The goal is to establish an *European Research Infrastructure Consortium* (ERIC) to build and operate EST.

With the *Science Data Centre* (SDC), KIS established a third strategic pillar, complementary to the research and observatory operation. For the establishment and operation of the SDC KIS receives additional institutional funding of € 1.25m and invests own funding of € 0.15 m (total € 1.4 m) p.a. since 2021. The SDC shall strengthen the bridge between theoretical and observational research, streamline the observational data handling and increase KIS' visibility. It is an open platform for archiving and distributing data and derived science-

ready data products from data of the observatory on Tenerife as well as data of other facilities and stellar and solar simulations. It will allow statistical analyses and enable new results based on machine learning and artificial intelligence. Current estimates assume a yearly data ingress of approximately 1 PByte (including mirroring all DKIST science-ready data). Its web interface (http://archive.sdc.leibniz-kis.de) allows browsing, downloading, and filtering the data based on parameters like instrument, wavelength, date, heliocentric angle and provides context information from the HMI instrument on the SDO satellite.

Knowledge and technology transfer

KIS scientists contributed i.a. to the *International Scientific Committee* (CCI), which oversees the operation of the astronomical observatories on the Canary Islands, to the *Association of Universities for Research in Astronomy* (AURA), which operates several large observatories in the US (among them DKIST), or to the *Rat Deutscher Sternwarten* (RDS).

Concerning technology transfer, KIS plans to consider patenting and licensing options to properly transfer know-how acquired with public funds to businesses.

3. Changes and planning

Development since the previous evaluation

The head of PA 2 “Observatory and Instrumentation” and the group “Scientific Instrumentation” retired as of 1.4.2022. From 1997 till 2017 he was also the Scientific Director of KIS. In view of his upcoming retirement, the previous Deputy Director took over the position of Scientific Director in 2017. The structure of the KIS was changed in 2021 so that there are now two Scientific Directors, and a third director as Head of Administration and Technical Services who has financial responsibility. In addition to the new leadership structure, several more changes in the management structure have been established (see chapter 4).

The new second Scientific Director and head of PA 2 will again be appointed jointly with the University of Freiburg. The tender for this ended in February 2021. After the hearings in March and July 2022, it is expected that contract negotiations can start 2023.

The head of the "Solar Photosphere and Interior” group focused on solar physics (PA1) took up a professorship at the University of Jena in April 2022. The group will be replaced by a group “Solar Magnetism”, as soon as a new head is found. The position of its head is currently being filled through a competitive search.

A significant strategic development was the establishment of the Science Data Centre (SDC, see chapter 2).

Strategic work planning for the coming years

In the next few years, the following appointments will be made at the management level:

- second Scientific Director as head of PA 2 and the "Scientific Instrumentation" group

- head of the new group "Solar Magnetism" (replacing "Solar Photosphere and Interior" group, position was advertised in 04/2022).
- Succession to the leadership of the "Solar Telescopes" group (retirement likely 2026)

KIS' work in the coming years will be guided by the "Strategic Plan 2020–2030". Five fundamental strategic goals have been identified:

1. Advances in knowledge about the Sun, especially in understanding the formation and decay of magnetic structures, developing realistic numerical models of solar magnetic activity at high resolution, obtaining robust information on subsurface structures and flows, understanding the magnetic and non-magnetic coupling in the solar atmosphere and the interior as well as expanding knowledge on processes leading to energetic events in the solar atmosphere.

   This goal shall be achieved by exploiting the new scientific instrumentation (especially DKIST and VTF). Besides, *Solar Orbiter* provides chances for high-resolution observations of the Sun and for probing the interior.

2. Understanding the Sun among other Stars by understanding stellar magnetic activity across the Hertzsprung-Russell-diagram, expanding and analysing long-term records of solar and stellar activity cycles, revealing relations between the interior structure and magnetic activity as well as understanding space environment and planetary atmospheres weathered by stellar activity.

   This goal shall be achieved by applying to stellar data various theoretical and experimental techniques developed in the framework of solar physics. The instrumentation developed at KIS will be exploited at various telescopes (e.g. DIPOL polarimeters) and in cooperation of space missions such as the *Transiting Exoplanet Survey Satellite* TESS. Observations of DKIST and SUNRISE will be exploited.

3. Development of advanced astrophysical instrumentation by building instruments for major solar telescopes (e.g. GREGOR), by contributing to instruments for solar space and stratospheric missions, by expanding development and deployment of solar high-resolution techniques and developing innovations for high-precision polarimetry.

   Operating the Observatory of Tenerife (OT) on behalf of the German partners will remain an unchanged service duty in the coming decade. Research and development of observing techniques as well as the advancement of instrumentation at GREGOR will continue. The VTT is currently in the category of small ground-based facilities. Its future will be determined in cooperation with the partners of the OT, possibly towards a large-field-of-view facility (as compared to GREGOR, DKIST and EST) focused on extended and synoptic programs for linking small and large-scale processes on the Sun.

   The operation of both GREGOR and VTT may be terminated or repurposed when the European Solar Telescope (EST) will begin operations. This will be a subject of detailed planning for the 2030s when the EST is finalized. EST is the major facility for which KIS will contribute a first-generation instrument. In the first phase (2022/23) and at institutional level, KIS will join the EST legal entity (in preparation) whose goal is to prepare the EST ERIC agreement and secure national funding.

As an auxiliary complementary facility for DKIST and EST, the international solar community will develop a network of small ground-based telescopes SPRING for full-disk synoptic observations of the Sun with the focus on large-scale magnetic phenomena and space weather. The development of this network is part of the new Astronet Infrastructure and Science Roadmap. SPRING development will be transferred to the University of Jena, as the former head of KIS' "Solar Physics" group accepted there a professorship in April 2022.

4. Operation of the *Science Data Centre* by providing high-quality solar data for the solar physics community and related disciplines.

   Short term plans include i.a. curating and offering standardized solar data from the Observatory of Tenerife (OT) and other sites, higher-level data products, as well as expert and non-expert tools to evaluate and correlate these data sets. KIS also plans to establish an European data mirror of all science-ready data from DKIST, offering the same user experience as DKIST-DC and building and offering complementary and novel data products through SDC.

   To further support the SDC project, collaborations are being developed within the framework of the National Research Data Infrastructure (NFDI) and the Steinbuch Centre for Computing (SCC) of the Karlsruhe Institute of Technology (KIT), the DKIST Data Centre and consortia within the European Open Science Cloud (EOSC).

5. Education and inspiration of students and the public. This strategic goal will be achieved by continuing the cooperation with the professors of physics at the University of Freiburg and in the framework of the European Campus EUCOR with the University of Strasbourg. Students of physics and applied physics bachelor and master programs participate in the frontier research taking place at KIS and work on their theses.

4. Controlling and quality management

Facilities, equipment and funding

Funding

In 2021, the institutional funding totalled € 6,5m.

Between 2019–2021, revenue from project grants totalled Ø € 2m p.a., corresponding to 26 % of the overall budget. Thereof, Ø € 856k p.a. were raised from the EU, Ø € 782k p.a. from Federal and *Länder* governments, Ø € 167k p.a. from the Leibniz Association (competitive procedure) and Ø € 156k from the DFG. From services, the institute did not generate any revenue.

Accomodation of the Institute

The institute is housed in three buildings in a residential area on the slopes of the Schlossberg close to downtown Freiburg. During the evaluations in 2007 and 2015 the Senate of the Leibniz Association recommended to improve the accommodation capacities. In order to bridge time until a sustainable solution could be found, the institute received additional funding to rent additional 650 m^2 of office and laboratory space in a building about 500

m apart from the other three buildings as of spring 2015. This space is still being rented and it includes the integration laboratories for the development of DKIST/VTF and the Solar Orbiter PHI/ISS instruments.

In 2017 KIS received funding about € 20.3m for construction of a new building on the basis of the already existing space requirement plan. A completion of the construction is envisaged in the first half of 2023, so relocation and merging from all current sites in Freiburg is expected to take place in the second half of 2023.

Observatories and Telescopes

The Schauinsland Observatory operated by KIS in the Freiburg region is a historical observatory consisting of a lecture building, a 35 cm Maksutov telescope and a 45 cm Coelostat solar telescope. This facility is used for student education as part of the university curriculum. The observatory also greatly contributes to KIS public outreach.

KIS leads the operation of the German solar telescopes GREGOR and VTT on Tenerife and coordinates the cooperation with the German partner institutes (*Leibniz Institute for Astrophysics Potsdam* (AIP) and the *Max Planck Institute for Solar System Research* (MPS, Göttingen). KIS plans and implements the work required for the operation and the development of the post-focus instrumentation in its workshops in Freiburg. Additional post-focus instruments are provided by the partner institutes.

The operation of the observatory is a long-term commitment which defines the service function of the institute's activities. About one quarter of the KIS base resources in terms of budget and manpower (~1.5 M€) are allocated for the observatory operation, including administration, maintenance, and observing scientist support. The financial resources currently contributed by the partners, AIP and MPS, to the operations budget amount to about 200,000 € per year and are managed by KIS. The partners also contribute to instrumentation at the observatory from their own funds.

IT infrastructure

The main IT resources at KIS used for data reduction, simulation and development currently consist of eight multi-socket servers, with 64–128 cores each, and 512GB–1TB RAM. At OT there is presently one such server with four CPUs and 64 cores. At KIS these resources are also available for batch processing via Condor.

In 2017, KIS replaced all bulk network storage at both sites by horizontally scaling NAS clusters. At the beginning of 2021, this amounted to 750 TB (distributed over six nodes) at KIS, and 200 TB at the OT (spread over six nodes). Old disks are still used for backup and disaster recovery of essential data.

All data-intensive components (network-attached storage (NAS), servers) are connected via redundant 10 Gbit links. The interconnects between buildings at KIS and telescopes at OT are 40 at Gbit/s bandwidth. All other internal connections and the respective connections to the outside world at both sites are 1 Gbit/s.

Remote observations are becoming increasingly important. As a consequence, nowadays data are mainly transported between OT and KIS using the network instead of using tapes

or portable disks. Meanwhile, data output of the telescopes has increased to several TB/day. Therefore, KIS is currently in the process of implementing a low-latency dedicated 10 Gbit/s network-connection (Lambda) between OT and KIS.

At the instigation of the University of Freiburg, KIS as an independent legal entity could no longer remain part of the university network and is now an independent direct customer of the local provider *Belwü* and of a significant number of commercial businesses providing IT-services and software licenses.

The IT team has joined the SDC group to curate and implement its technical aspects. To foster direct and documented collaboration and communication, IT has introduced infrastructure services such as a ticket-system.

Organisational and operational structure

The institute is headed by the Executive Scientific Director together with the Deputy Scientific Director and the Director of Administration and Technical Services forming the Board of Directors (BoD). The two Programme Areas, which consist of research groups are each headed by a Scientific Director.

The department Administration and Technical Services fulfills administrative, managerial and technical tasks to assure a seamless operation of the institute and to assist the operation and development of existing and new astrophysical instrumentation.

In 2021 the management structure of KIS was reorganized (see chapter 3) including changes on the research group level. Small research and technical groups were combined and are now managed by new group leaders that report directly to the department heads. Three scientific group leader positions were advertised and filled internally as a result of organizational changes. Together with the BoD the five research group leaders and two administrative and technical group leaders now form a new, intermediate management level of stake holders, the body referred to as management committee ('Management-Komitee'), which meets weekly and advises on important decisions such as staff appointments and strategic developments. In connection with larger, temporary projects (e.g., instrumentation projects for large observation facilities or externally funded projects), project teams may be set up for a limited duration of the project. Every project team consists of a project leader (principal investigator) and other members, if applicable, according to the project plan.

In order to improve information flow within the institute, a Coordination Group ('Koordinierungsrunde'; KR) has been established including all group, team and project leaders. The KR holds monthly meetings and the minutes are published on the internal network. Besides, a new budgeting system was introduced that allows all group and project leaders (KR members) to submit annually their requests for internal funding of activities of their groups.

The BoD is further assisted and advised in specific matters by the Board Office, the Budget Committee and the Worktime Committee. The largest participation forum is the Staff Assembly, called for by or in coordination with the BoD to discuss various aspects of work at KIS.

Quality Management

KIS follows the recommendations for good scientific practice as developed by the DFG and adopted by the Leibniz Association. KIS has an ombudsperson.

The yearly publication target is defined in the Program Budget submitted to the Foundation Council (see below) for approval. The quality control measure for publications is computed as a total weighted number of publications with different weights for refereed publications (1.0), non-refereed conference papers (0.6), and openly published technical reports (0.5). It has been discussed with the Scientific Advisory Committee (see below) whether additional factors should be considered to evaluate the scientific performance of the institute, such as perhaps citation index, impact factor of journals or number of observing runs. Several KIS staff members participate in immaterial technology transfer through expert reports provided to government and research funding agencies produced by the international committees of which they are members. Internal knowledge transfer concerning technology and technical processes is practiced through meticulous documentation of such in technical reports, thereby actively contributing to the quality management concerning technical procedures.

Quality management of research infrastructures, in particular at the Tenerife Observatory (OT), was improved during the past years. The instruments were subjected to a critical review and appropriate measures were initiated. The new regulation of the OT operation approved by the Board has resulted in overall optimization of resources and, especially, in a decrease of the accumulated extra hours ("overtime") by factor of 10 at the observatory.

The research data management is currently undergoing a major professionalization due to the establishment of the SDC. Open access to observational data, with a time-limited embargo agreed upon by the OT partners a few years ago, is becoming the standard for all data, and SDC offers the platform to efficiently serve the data to interested scientists in a suitable standardized format.

The change management coaching started at the end of 2019 has been a key element of the organizational quality management. Several structural changes have been initiated (see above).

Quality management by advisory boards and supervisory board

The Scientific Advisory Committee (SAC) consists of six to eight scientists with expertise in the scientific and technical research fields of KIS. The SAC meets regularly once per year. The members are appointed by the Foundation Council (see below) and advise both the Board of Directors and the Foundation Council on matters of strategic and financial interest. In between the regular evaluations, the SAC performs an audit. The last audit took place as a virtual meeting in 2021. As a general rule, members shall be appointed for a period of four years. Appointments may be renewed once and for consecutive terms only.

KIS' supervisory committee is the Foundation Council ("*Stiftungsrat*"), which is composed of representatives of the *Land Baden-Württemberg* and the Federal Ministry of Education

and Research (BMBF), the rector of the University of Freiburg, an elected representative of KIS, and the chairman of the Scientific Advisory Committee. It appoints and oversees the Board of Directors as well as SAC members and decides on fundamental issues of scientific, financial or legal nature.

5. Human Resources

As of 31 December 2021, KIS had 68 employees (without trainees, see appendix 4). 26 persons worked in research and scientific services. Furthermore, 25 persons were occupied in science-supporting service positions and 17 in science-supporting administrative positions.

Leading scientific and administrative positions

KIS fills the positions of scientific directors by joint professorial appointments with the University of Freiburg.

At the moment the position of the Deputy Director is being refilled. The Director of Administration and Technical Services was appointed in 2021. The appointment procedure followed the standards of the Leibniz Association.

Since the last evaluation, group leaders had been selected internally to map important organizational restructuring as a result of the change management. Within the newly established institute organization, group leader positions are advertised internationally. The typical initial appointment is for two to five years. One year before the appointment expires, a review procedure is initiated by the Management Committee involving external experts. Currently, the tender process to fill the position of the leader for the group “Solar Magnetism” is underway.

Staff with a doctoral degree

At KIS, staff with a doctoral degree (i.e. postdocs) are employees on fixed-term positions. Within the next five years, several base funded staff positions will become vacant due to retirements. As has been the case in the past, such key positions will be openly advertised and reappointments will be made through a tenure track process.

The BoD encourages young scientists at KIS and outside to fund their own research positions at KIS through external grants. KIS offers attractive infrastructure, and theoretical and experimental collaborations. Several such applications have been successful, including PhD students, postdocs and junior group leaders. Until the end of 2021, the QUEST group has been funded through a competitive funding program of the Leibniz Association.

Doctoral candidates

As of 31 December 2021, there were four doctoral candidates employed at KIS (see appendix 4). Between 2019 and 2021 four doctoral researchers completed their work. On average it takes 4.6 years to complete a doctoral degree at KIS. The institute supports the doctoral candidates with a part-time scientist position for 3-4 years, occasionally longer. Typically, the salary is 50 % TV-L 13 in the first year, and 65 % TV-L 13 thereafter. Most

theses are financed through third-party funding; base funding is used as needed during initial phases of a thesis or during the final phase if third-party funding has expired.

Each doctoral candidate is supervised by a professor at KIS and when necessary has also an assigned advisor with whom the candidate collaborates on a daily basis. Doctoral candidates are required to present their work to the institute's members during regular staff reports.

PhD students are encouraged to enroll in the University's graduate program which provides soft skill courses. They often take over responsibilities in teaching support and public relations work. KIS supports students and doctoral candidates interested in a research stay at solar physics institutes abroad. Doctoral candidates are encouraged to participate in summer or winter schools and to regularly use international conferences as a platform to present their work. Students receive travel support from the institute's budget as needed. If possible, doctoral students receive a full (post-doc) position after finishing the thesis. KIS has organized trainings for young researchers in preparing their job and grant applications.

Science supporting staff

KIS participates in vocational training and education programs for non-academic staff. There are currently four apprenticeship positions; two in the mechanics workshop, and two in the technical IT group. The trainees obtain degrees as precision engineering technician (*Feinwerkmechaniker/in)* or electronics technician (*Elektroniker/in)*. In the past three years, two trainees have successfully completed an apprenticeship. In addition, one student of the Baden-Wuerttemberg Cooperative State University (*Duale Hochschule Baden-Württemberg / DHBW*), a higher education institution that combines on-the-job training and academic studies, obtained a degree and was subsequently hired by KIS in the IT department.

KIS encourages the non-academic staff to participate in various training and education programs related to their job, e. g. language courses, or to obtain an academic degree if they fulfil the requirements. KIS supports them by fully or partly financing the courses or by offering a flexible working time model.

Equal opportunities and work-life balance

Equal opportunities

As of 31 December 2021, out of 26 employees in research and scientific services at KIS 4 were female (15 %). The Executive Scientific Director was female and the Deputy Director was male. Out of the 15 scientists in non-executive positions, 1 was female (7 %) and out of the 4 doctoral candidates 1 was female (25 %).

KIS has been defining and tracking the flexible target quota in the sense of the cascade model of research-oriented equality standards of the DFG and anchored them in the program budget. Active recruitment and internal promotions are used to increase the number of women in leadership positions.

In 2022 KIS will start a coaching program for group leaders addressing both the general culture in research institutions and the complex field of human diversity.

Work-life balance

KIS staff members can opt to work from home, can use a parent- and-child office, flexible working time arrangements and apply for childcare allowances. Parental leave models are fully implemented at KIS.

In 2018 and 2021, KIS has been re-certified by the audit „berufundfamilie". In addition, KIS is a member of the Freiburg network of family-oriented companies (*Freiburger Netzwerk Familienbewusste Unternehmen*) as well as of the regional dual career network and has signed a cooperation agreement with Freiburg University.

6. Cooperation and environment

Cooperation with universities

The cooperation with the Albert Ludwig University of Freiburg is regulated on the basis of cooperation agreements for each joint appointment. At the moment, the scientific director and head of Program Area 1 is jointly appointed as full professor (W3) and associated to the Institute of Physics within the research focus "Atomic, Molecular and Optical Physics". The joint appointment enables KIS scientists lecturing of students, supervision of theses at all three education levels (i.e. Bachelor, Master and PhD). During the stay at KIS the students are integrated into the research groups.

Activities with further academic partners

- The *Observatoire de Strasbourg at the Université de Strasbourg (France)* offers galactic and extragalactic astrophysics as well as high-energy astrophysics and data management courses. This collaboration makes use of the European Campus EUCOR which combines five French, Swiss and German universities.
- Partnership with the *University of Turku (UTU, Finland)* in theoretical and instrumental projects related to high-precision polarimetry, which has resulted in the design and construction of a high-sensitivity broad-band polarimeter DIPOL-2.
- Cooperation with the *University of Hawaii (UH, USA)* in design and construction of the advanced instrumentation for polarimetric studies of the Sun, stars and exoplanets. The collaboration offers access to the astronomical facilities at the Mauna Kea and Haleakala Observatories. The current managing director of KIS has been a long-term visiting scientist at UH and co-supervised a PhD-student.
- The *New Jersey Institute of Technology (NJIT, USA)* operates the Big Bear Solar Observatory (BBSO, CA) with the 1.6 m Goode Solar Telescope (GST). NJIT is a Co-PI institution of DKIST. KIS, NJIT and the National Solar Observatory (NSO) have been collaborating for more than a decade on the development of adaptive optics technologies for solar telescopes.

- A partnership with the *Stellar Astrophysics Centre* at Aarhus University (SAC, Denmark) exploits the potential of stellar research for the interdisciplinary area of astrobiology and includes stellar and exoplanetary studies. Through this association with SAC, KIS has gained access to the SONG (Stellar Observation Network Group) facility.

National collaboration for operation of the solar facility on Tenerife (OT)

The German Solar facilities on the Canary Island of Tenerife were constructed by a German consortium in the 1980s and went into operation by the end of that decade. The legal framework consists of a set of international treaties at government level and at the level of the individual institutions. In 2016 the legal representation was transferred to a consortium of institutes (AIP, IAC, MPG represented by MPS) led by KIS that can use 75 % of the observing time. The partners agreed to their shares of 60 % KIS / 20 % AIP/ 20 % MPS, respectively. Spanish astronomers receive 20% of the science time of each telescope, while another 5% is allocated to researchers world-wide as "international time". An international scientific committee composed of representatives of all second level member institutions (Comité Científico Internacional, CCI) provides oversight to the operation of the observatories and decides on the admission of new facilities.

Collaborations in programs and projects funded by the EU

- "High-resolution Solar Physics Network" (SOLARNET) (2013–2017 and under coordination of KIS 2019–2022). The consortium consists of 35 research institutes, companies, and partners from industry.
- EST Preparatory Phase (PRE-EST) (2017-2021) funded by the EU as a *European Strategy Forum on Research Infrastructure* (ESFRI) project. The consortium is formed by 23 research institutions from 16 European countries.

KIS indicates the following further projects that received EU funding:

- ERC Advanced Grant project *HotMol* (2012-2017) led by the Executive Scientific Director of KIS
- ERC Starting Grant project *ORIGIN* (2012-2017) was led by the former head of "Solar Physics" group (PA2)

Further Networks

- European Association for Solar Telescopes (EAST), founded in 2006 consisting of 26 institutes. EAST promotes the development, construction and operation of a next-generation large aperture European Solar Telescope (EST) in the Canary Islands. Furthermore, EAST coordinates the operation and scientific use of existing high-resolution optical solar telescopes on the ground in Europe, channeling efforts of its members to participate in other solar facilities such as DKIST. EAST has initiated major projects in solar physics.
- European Helio- and Asteroseismology Network (HELAS) (24 partner institutions).
- Stellar Observing Network Group (SONG) (8 research sites with 1-meter-class telescope with a suitable geographical distribution).

Collaboration in the framework of the Science Data Centre

The KIS Science Data Centre (KIS SDC) is engaged in a number of national and international collaborations related to data curation, data analysis, data dissemination and scientific exploitation:

- representation of EST within the group of European Data Experts (GEDE-RDA)
- coordination of a H2020 SOLARNET work package (15 partner institutions)
- partner of the H2020 ASTERICS project (28 partner institutions)
- representation of EST in the H2020 ESCAPE project (31 partner institutions)
- partner of the PUNCH4NFDI project (29 partner institutions).

Institution's status in the specialist environment

In Germany KIS names the *Leibniz Institute for Astrophysics Potsdam* (AIP) and the *Max Planck Institute for Solar System Research* (MPS, Göttingen) as institutions with a comparable research focus. Within Europe the institute indicates the *Instituto de Astrofísica de Canarias* (IAC), Spain, *the Observatoire de Paris – Meudon* (OPM), France and the *Institute for Solar Physics* (ISP, Stockholm, Sweden) as leading institutes in its scientific environment. According to KIS further important research institutions are the *National Solar Observatory* (NSO) and the *High Altitude Observatory* (HAO), both in Boulder, USA, the *Institute for Astrophysics* (IIA), Bangalore, India, the *National Astronomical Observatories* (Beijing, China) as well as the Yunnan Astronomical Observatory, Kunming, China.

7. Program Areas of KIS

Program Area 1: Solar and Stellar Astrophysics

[20.4 FTE, thereof 12.3 FTE Research and scientific services, 2.3 FTE Doctoral candidates, and 5.8 FTE Service staff]

The Program Area 1 contributes to all three research foci (see chapter 2) and comprises three research groups:

- The *Solar Photosphere and Interior* group performs research in solar photospheric magnetism and helio- (astero)seismology. From 2023, it is to be replaced with the group "Solar Magnetism" with the focus on magnetism within the entire solar atmosphere (position was announced in 04/2022).
- The *Solar-Stellar Connections* group carries out research in solar-stellar magnetism and activity, as well as near-stellar environment, including solar system and exoplanetary systems.
- The *Science Data Centre* conducts research in big data and develops tools for big data handling. The SDC is also one of the strategic infrastructures of KIS currently under development, with the goal to service German and European solar physics community.

The main objectives of the Program Area 1 are to carry out fundamental research focused on understanding both small- and large-scale processes on the Sun and other stars and

their environment, operating and further developing the Science Data Centre, and establishing broad cooperation in Europe and beyond for solar and stellar astrophysics, including participation in and contribution to the EST.

Scientific results obtained by PA1 include the detailed investigation of magnetic processes in the solar atmosphere to large-scale and global phenomena in the solar interior. Results from solar research could be transferred and new phenomena were discovered and were solved on other stars. Novel applications for exoplanets and astrobiology based on high-precision polarimetry motivated instrumentation development for solar physics.

The Science Data Centre has been realized as a major strategic pillar of the institute. It provides access to ground-based solar data and their dissemination to a broader scientific community within the German and European astrophysics and particle physics networks (PUNCH4NFDI, ESCAPE) and in general within the EOSC infrastructure. On a long-term, KIS aims and is being prepared to lead the EST Data Centre (EST DC).

Between 2019 and 2021 PA1 published on an average 23 articles p.a. in peer-reviewed journals, 6.3 work and discussion papers and 6 individual contributions to edited volumes. The revenue from project grants totalled approx. € 1.3m (Ø € 434k p. a.). € 502k (Ø € 167k p. a.) thereof were obtained from the Leibniz Association (competitive procedure), € 469k (Ø € 156k p. a.) from the DFG and € 374k (Ø € 125k p. a.) from the EU. In the three-year period, 4 doctoral degrees and 21 academic degrees leading to doctoral work were completed.

Program Area 2: Observatory and Instrumentation

[25.4 FTE, thereof 7.8 FTE Research and scientific services and 17.6 FTE Service staff]

Program Area 2 contributes to the research foci RF I and RF III and comprises two research groups:

- *The Solar Telescopes* group conducts research in observational solar physics, i.e. the study of dynamic eruptive events in the upper solar atmosphere in collaboration with PA1 and develops optical telescopes and instrumentation for the Teide Observatory (OT), which is also a major strategic infrastructure at KIS, servicing the German and European solar physics community.
- *The Scientific Instrumentation* group carries out research in instrumentation for various astronomical facilities, which KIS scientists can employ in their research. Currently, the group works exclusively on the Visible Tunable Filter (VTF) project before beginning other projects after completion.

The main objectives of the PA are the operation of the solar telescopes at the Observatory on Tenerife (OT), the development of post-focus instruments, and the establishment of the next-generation solar telescope EST as European counterpart of the DKIST telescope with complementary capabilities.

In recent years at OT efforts and resources have been focused on making the telescope GREGOR one of the leading solar facilities in Europe. After replacing all Cesic mirrors and a complete redesign of the post-focus optical setup in 2020 the telescope now delivers

diffraction-limited optical performance. KIS and its partners at OT continue to upgrade existing post-focus instruments and develop new instruments for GREGOR. As the most important development in the near future, KIS plans to build the new 2D spectropolarimeter Large EtAlon Polarimeter (LEAP) in cooperation with external partners.

The Vacuum Tower Telescope (VTT, 0.7 m) was the major observing facility at KIS until 2014. It is over 30 years old and the strategy for a major technical refurbishment and repurposing to regain competitiveness is under development. VTT currently features two unique post-focus instruments and two more are being developed by external partners.

The image stabilization unit (ISS) of the PHI instrument aboard the Solar Orbiter space mission was developed under leadership of KIS and successfully launched in 2020. The ISS makes high-precision polarimetric measurements with PHI possible. KIS also provides technical and scientific support throughout the scientific phase.

The 1m balloon-borne telescope SUNRISE III has been built by a consortium with MPS as leading institute. SUNRISE had two successful flights in 2009 and 2013, for which KIS provided the imagine stabilization system. In total these flights have led to more than 100 publications, with KIS scientists taking part in in the science data analysis. KIS also developed the new correlating wavefront sensor for the current mission, which is considered to be relaunched from Kiruna (Sweden) in 2023 or later.

KIS was invited by the DKIST consortium to contribute a Visible Tunable Filter (VTF) as a first-generation post focus instrument for this telescope as the only European institution. KIS received additional funding from its funding agencies, increased the own contributions from base funding and was able to recruit the MPS (Göttingen) and IRSOL (Locarno, Switzerland) as partners, contributing funding and in-kind contributions. In addition, DKIST provided funding for hardware. As the instrument is 5 m in height, a special lab was prepared. It is the biggest and most demanding instrumentation project at KIS that is in the testing phase at the moment.

Between 2019 and 2021 PA2 published on an average 8.3 articles in peer-reviewed journals p.a., 26.3 work and discussion papers and 1.7 individual contributions to edited volumes. The revenue from project grants totalled approx. € 4.7m (Ø € 1.6m p.a.). € 2.3m (Ø € 767k p.a.) thereof were obtained from federal and *Länder* governments, € 2.2m (Ø € 733k p.a.) from the EU and € 161k (Ø € 53.7k p.a.) from other sponsors. In the three-year period, 0 doctoral degrees were completed.

8. Handling of recommendations from the previous evaluation

KIS responded as follows to the six recommendations of the last external evaluation (highlighted in italics, see also statement of the Senate of the Leibniz Association issued on 13 July 2016, pages B-2/B-3):

*1) "Plans to further develop the "Center for Advanced Solar Spectro-Polarimetric Data Analysis" (CASSDA, founded in 2012) into a "**GREGOR Science and Data Center**" are endorsed. KIS*

rightly recognises such a centre as an important prerequisite for the comprehensive management, provision and exploitation of KIS' data. Proper implementation of this centre would, however, necessitate an increase in the number of IT staff. KIS is thus encouraged to drive its plans to secure funding in order to bring the centre to life."

Through networking activities and collaborations at the national and international level, the horizon of the Science Data Centre to be established has been widened to that of the European gateway to solar data from ground-based telescopes in general (not only GREGOR), including data management and processing pipelines. Its goal has been formulated as curating, processing, archiving, and delivering solar data and processing pipelines and software to the solar physics community in Europe and beyond. In an environment where it is becoming ever more challenging for a single institute or even an entire country to operate a competitive solar telescope of its own, KIS recognized the need to establish the SDC as the third strategic pillar of the institute. Irrespective of the uncertainty when the EST will start operating, through agreements with the current data-providing telescope operators SDC will be able to provide state-of-the-art calibrated science-ready solar data.

2) "In order to maintain its status of a leading institution in the field, KIS needs to align its range of current scientific and technological projects with its ***long-term strategic planning****. As already pointed out by the Scientific Advisory Committee, the latter is still too general. Hence, KIS should prioritise its projects in accordance with specific goals and milestones against the backdrop of the resources at its disposal. In this context, the institute should not lose sight of its main tasks in the field of solar physics."*

KIS sees its core mission in solar physics. To this end, during the last three years KIS has undertaken a serious effort to strengthen its major tools (GREGOR, the VTF and the Science Data Centre) towards a successful operation in this field.

3) "KIS must drive its efforts to acquire ***DFG funding*** *at least in the amount of its annual DFG fees."*

In the reporting period (2019–2021) the average amount of raised DFG funds amounted to Ø € 156k p.a. (see chapter 4, "funding") and the annual DFG fee totalled € 137k.

4) "Given that both the findings of the last evaluation (2008) and the audit conducted by the Scientific Advisory Committee (2012) drew attention to the space problems of ***accommodating KIS*** *satisfactorily, a solution must now be found urgently. In order to be able to uphold its scientific performance and remain internationally competitive the institute requires, in particular, appropriate workshop facilities."*

See chapter 4, "Accommodation of the Institute".

5) "According to the 2016 programme budget, there is still a ***binding staffing appointment plan*** *(verbindlicher Stellenplan) for 80 % of KIS' personnel. KIS' funding agency (State Ministry of Baden-Wuerttemberg for Sciences, Research and Arts), however, is expected to act in accordance with the Administrative Agreement between the Federal and Länder Governments with regard to the joint funding of member institutions of the Leibniz Association (AV-WGL)*

and to completely abolish this plan. It should be replaced by criteria which allow the workforce to be managed globally."

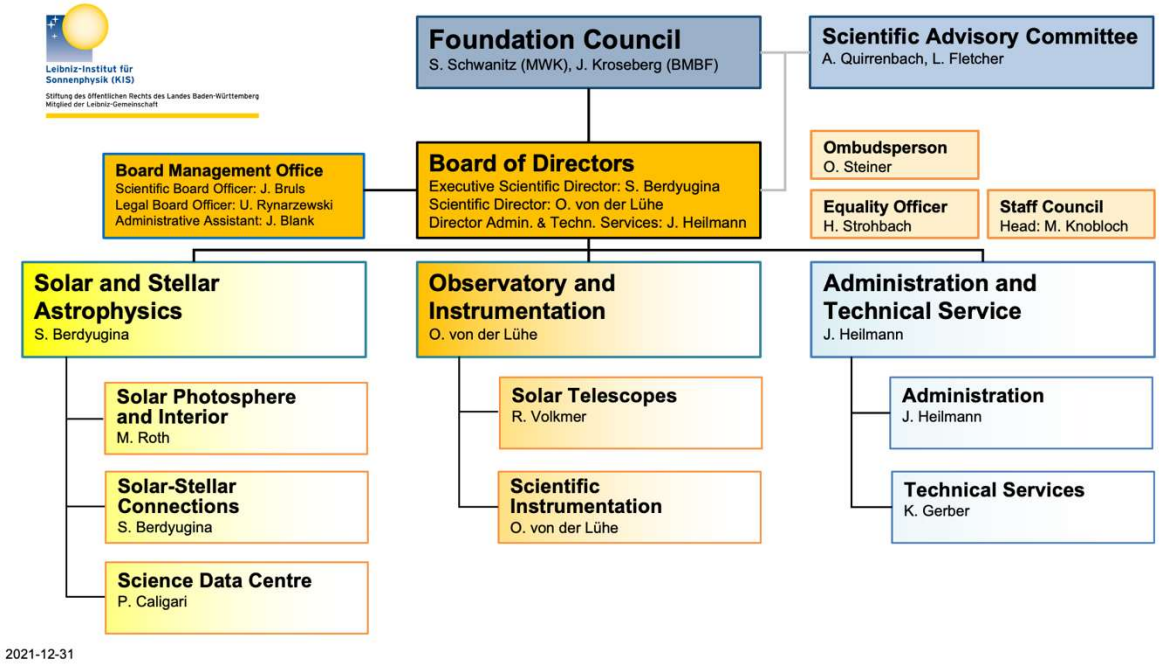
According to the programme budget 2022, the ministry formally abolished the staffing appointment plan.

*6) "In order to further improve the **promotion of junior researchers** and to raise standards, KIS should follow the "Career guidelines of the Leibniz Association" more closely."*

KIS follows the guidelines and uses the opportunities offered by the Leibniz Association (e.g., the SAW funding programs for junior group leaders and professors). A personnel development plan has been drafted and is subject of a discussion process to further develop it. Career training (e.g., writing grant and job applications) and individual mentoring for (PhD) students and postdocs have been intensified.

Appendix 1

Organisational Chart



Appendix 2

Publications

	Period		
	2019	**2020**	**2021**
Individual contributions to edited volumes	15	4	2
Articles in peer-reviewed journals	24	36	27
Articles in other journals	1	0	0
Working and discussion papers	30	28	39
Editorship of edited volumes	1	0	0

Appendix 3

Revenue and Expenditure

Revenue		2019			2020			2021		
		k€	%	%	k€	%	%	k€	%	%
Total revenue (sum of I., II. and III.; excluding DFG fees)		**10.116,4**			**10.547**			**12.967,3**		
I.	**Revenue (sum of I.1., I.2. and I.3)**	**8.268**	**100**		**7.097**	**100**		**7.569**	**100**	
1.	INSTITUTIONAL FUNDING (EXCLUDING CONSTRUCTION PROJECTS AND ACQUISITION OF PROPERTY)	5.150	62		5.252	74		6.486	86	
1.1	Institutional funding (excluding construction projects and acquisition of property) by Federal and *Länder* governments according to AV-WGL	5.150			5.252			6.486		
1.2	Institutional funding (excluding construction projects and acquisition of property) not received in accordance with AV-WGL									
2.	REVENUE FROM PROJECT GRANTS	3.118	38	100	1.845	26	100	1.083	14	100
2.1	DFG	232		7	119		6	118		11
2.2	Leibniz Association (competitive procedure)	156		5	188		10	158		15
2.3	Federal, *Länder* governments	910		29	766		42	669		62
2.4	EU	1.729		55	702		38	138		13
2.7	Other sponsors	91		3	70		4	0		0
3.	REVENUE FROM SERVICES	0	0		0	0		0	0	
3.1	Revenue from commissioned work	0			0			0		
3.2	Revenue from publications	0			0			0		
3.3	Revenue from exploitation of intellectual property for which the institution holds industrial property rights (patents, utility models etc.)	0			0			0		
3.4	Revenue from exploitation of intellectual property without industrial property rights	0			0			0		
II.	**Miscellaneous revenue** (e.g. membership fees, donations, rental income, funds drawn from reserves)	188,4			125			398,3		
III.	**Revenue for construction projects** (institutional funding by Federal and *Länder* governments, EU structural funds, etc.)	1.660			3.325			5.000		

Expenditures		k€	k€	k€
Expenditures (excluding DFG fees)		**8.306,1**	**7.773,9**	**11.461,4**
1.	Personnel	4.970,4	5.009	5.086
2.	Material expenses			
2.1	*Proportion of these expenditures used for registering industrial property rights (patents, utility models etc.)*	0	0	0
3.	Equipment investments	560,9	655,6	1.240
4.	Construction projects, acquisition of property	947,5	673,3	3.763,4
5.	Other operating expenses	1.827,3	1.436	1.372
DFG fees (if paid for the institution – 2.5% of revenue from institutional funding)		125	127,7	158,4

Appendix 4

Staff

(Basic financing and third-party funding / proportion of women (as of: 31/12/2021)

	Full time equivalents		Employees		Female employees		foreign-ers
	Total	on third-party funding	Total	on tem-porary contracts	Total	on tem-porary contracts	Total
	Number	Percent	Number	Percent	Number	Percent	Number
Research and scientific services	**22,4**	**47**	**26**	**53,8**	**4**	**50**	**10**
1st level (scientific directors)	1,7	-	2	-	1	-	1
2nd level (department leaders or equi.)	-	-	-	-	-	-	-
3rd level (group leaders or equi.)	3	18,3	3	-	-	-	-
Junior research group leaders (if applicable)	2	35	2	50	1	100	-
Scientists in non-executive positions (A13, A14, E13, E14 or equivalent)	13,4	59,3	15	60	1	0	7
Doctoral candidates (A13, E13, E13/2 or equi.)	2,3	57,3	4	100	1	100	2
Science supporting staff (technical support, Library, IT etc.)	**23,4**	**29**	**25**				
3rd level (group leader Technical Services)	1	-	1				
Technical Support (from E13, senior service)	1	-	1				
Technical Support (E9 to E12, upper-mid-level service	16,3	30,7	17				
Technical Support (E5 to E8, mid-level service)	2	50	2				
Library (E9 to E12, upper-mid-level service)	0,1	-	1				
Information technology - IT (E9 to E12, upper-mid-level service)	3	26,6	3				
Science supporting staff (administration)	**15,5**	**12,8**	**17**				
1st level (Administrative-technical director)	1	0	1				
Staff positions (from E13, senior service)	2,8	35,7	3				
Staff positions (E9 to E12, upper-mid-level service)	0,6	-	1				
Internal administration (financial administration, personnel etc.) (from E13, senior service)	7,8	12,8	8				
Internal administration (financial administration, personnel etc.) (E9 to E12, upper-mid-level service)	1,6	-	2				
Building service (E1 to E4)	1,8	-	2				
Trainees	**4**	-	**4**				

17 March 2023

Annex B: Evaluation Report

Leibniz Institute for Solar Physics, Freiburg (KIS)

Contents

1. Summary and main recommendations

The Leibniz Institute for Solar Physics (KIS) carries out basic research in observational and theoretical astrophysics with a particular emphasis on solar physics. For its experimental studies, it develops high-quality instruments and contributes them to important solar telescope infrastructure in international collaborations. The data obtained through these telescopes are made available online. KIS is divided into two Programme Areas (PAs): PA1 “Solar and Stellar Astrophysics” and PA2 “Observatory and Instrumentation”.

An essential task of the institute is the development and improvement of instruments, which are the basis for KIS’s own research as well as for external scientists. This technical work is done in PA2 “Observatory and Instrumentation”, which comprises two groups and is the larger PA in terms of staff. PA2 is rated as “very good to excellent”. One of its key tasks is to maintain and operate the three telescopes at the German Solar Observatory on Tenerife (GREGOR, VTT and ChroTel), to which KIS dedicates a significant proportion of its core budget (€1.5m p. a.). PA2 has made important improvements to optical instruments in recent years, particularly for GREGOR, which has been operating since 2015. The review board notes with satisfaction that it has developed a remote observing capability. Another, outstanding result is the Visible Tunable Filter (VTF), a world-class instrument that PA2 has been building for the Daniel K. Inouye Solar Telescope (DKIST) on Hawaii since 2010. Through its substantial contribution, KIS has also secured significant observation time on DKIST, which started operating in 2022 and is currently the world’s largest solar telescope. The institute has also developed complex instruments for airborne and space-based observatories, e. g. ESA's Solar Orbiter space mission and the balloon-borne SUNRISE mission. In the coming years, important tasks lie ahead in the maintenance and further development of existing instruments like those at the German Solar Observatory on Tenerife and the VTF at the DKIST. A long-term project for the future is the realization of the European Solar Telescope (EST), which KIS actively promotes.

PA1 “Solar and Stellar Astrophysics”, which has three research groups, is mainly responsible for basic research. It is rated as “good to very good”. As a result of large-scale projects with third-party funding (including two ERC grants), the personnel capacity of PA1 doubled temporarily between 2012 and 2017. This made it possible, on the one hand, to carry out very successful research work that was directly related to the sun, but also, on the other, to research solar-stellar connections. However, it is not expected that this temporary, unusually high level of third-party funding will be achieved again in the next few years. PA1 therefore urgently needs to define a comprehensive strategy that takes this into account. It should return to a stronger focus on topics directly linked to the sun.

An important new development is the further expansion of the KIS Science Data Centre (SDC), which will provide science-ready data from all the major ground-based solar observatories, and also data analysis tools. KIS is receiving permanent additional funding of €1.25m p. a. from 2021 onwards for this purpose. It is also good to see that the institute will move into a new building in the immediate vicinity of the university in 2023. This will resolve the long-standing problem of a lack of space in the four small buildings it uses at present.

KIS is currently in a transition phase where staffing is concerned. One of the two Scientific Directors, who was also head of PA2, retired in April 2022. He had made a significant impact on the institute since he took up the post of Managing Director in 1997. The joint appointment procedure with the University of Freiburg to fill this position was instigated in 2020, but is not yet complete. In view of the impending retirement, the Supervisory Board appointed the long-standing Deputy Director and head of PA1 to the position of Managing Director back in 2017, as recommended by the Scientific Advisory Board.

Another leading scientist from PA1 left the KIS in April 2022 to take up a professorship in Jena. The procedure to fill this position is underway as well. The institute's plan to give this research group a new focus on Solar Magnetism makes sense. The number of scientific staff on the other levels of the hierarchy also declined, due to third-party funded projects coming to an end, and staff moving to other institutions or retiring. More positions will become vacant in the coming years because of staff retiring.

Special consideration should be given to the following main recommendations in the evaluation report (highlighted in **bold face** in the text):

Changes and planning (chapter 3)

1. The institute's privileged access to the DKIST but also to data from other infrastructure like the German Solar Observatory on Tenerife and the Solar Orbiter mission, offers KIS outstanding opportunities to make important new findings in the field of solar physics. To take full advantage of this, KIS must now develop an **overarching research strategy** that decisively puts solar science at centre. The future development of instrumentation (see below) should be inferred from the scientific questions that KIS wants to answer within this strategy.

   Regarding the **development of new instruments**, KIS very actively promotes establishing the European Solar Telescope (EST) as a successor to GREGOR. It has been pursuing the development of the EST since 2008 together with other institutions within the European Association for Solar Telescopes (EAST). KIS's efforts are very commendable, however, it was decided in 2019 not to include the EST in the BMBF's National Roadmap of Research Infrastructures, and it remains uncertain whether the EST can actually be realised. Moreover, the project would not be likely to start until 2030 at the earliest. Therefore, it is welcomed that KIS participates in developing a new network of small ground-based telescopes (SPRING) as an auxiliary complementary facility. While further promoting the EST, KIS should continue to look for alternatives. The future development of instruments should always be driven by scientific questions.

   The **Science Data Centre (SDC)** processes the measurement data and makes them available for research projects at KIS but also for external users. The further development of the SDC as a scientific infrastructure should be done in close cooperation with scientists, using the data provided by the SDC. The institute should document both internal and external use of the data from the start, particularly in the case of data collected using instruments developed by KIS. The SDC's position within the organisation should reflect the fact that it takes on overarching tasks for both

programme areas. Its current position, as a group within PA1, should therefore be reviewed.

2. In view of these fundamental strategic challenges, it is of key importance that **leaders** are appointed without delay for **PA2** (whose head will also be second Director) and the **Solar Magnetism group in PA1**. Subsequently, an important task will be to fill vacant scientific positions and to develop a medium-term human resource planning concept for the coming years in the scientific and technical area.

Controlling and quality management (chapter 4)

3. In 2019–2021, KIS generated an average of around €2m p. a. from **third-party funding**, corresponding to 26% p. a. of its budget. This is about the same level as previously (24% on average in 2012–2014). However, since there has been a decline over the last three years, the institute should now aim to increase it again, particularly in PA1. KIS should ensure that in future applications for external funding, proposed projects are always aligned with its strategic core. As already recommended at the time of the last evaluation, KIS should secure more funds from the DFG, so that they are at least equal to the DFG fee.
4. In addition to the structural and organisational streamlining carried out at KIS in 2021, the upcoming staff replacements and strategic clarifications are likely to lead to further adjustments. In shaping these developments, it is important to **support and integrate all groups of employees** (scientific, technical and administrative staff). It is therefore necessary to on the one hand strengthen communication channels from staff to management. On the other hand, management should pay greater attention to fostering a collective spirit in the various groups and to communicating clearly and transparently. Furthermore, KIS should extend the measures to support the career development of staff at all levels within KIS as well as for career paths outside of KIS.
5. The **Scientific Advisory Committee** (SAC) is extremely committed and analytical in its support. As recommended in the previous evaluation, KIS and its supervisory body should take a more targeted approach in the future to conscientiously implementing the SAC's recommendations.

Human resources (chapter 5)

6. In 2019–2021, four doctorates were completed at KIS. At 31 December 2021, there were four **doctoral students** employed at the institute (compared to 12 in 2014). The institute must once again significantly increase the number of doctoral students. Furthermore, KIS should aim to reduce the average duration of 4.5 years for completing a thesis.
7. The outstanding results in the field of instrument development would not be possible without the high level of expertise of the **technical staff**. In view of the upcoming retirements among the technical staff, KIS needs to ensure that it retains the relevant expertise. In the case of projects that are coming to an end, a decision should be taken as soon as possible regarding the technical staff involved in them, as to which subsequent projects they will be employed on. KIS should also offer more permanent positions for excellent technical staff members (in analogy to tenure track positions for

scientists) in order to be able to adequately support the growing instrument projects (in size and complexity) and to provide the necessary continuity during long-term projects and from one project to the next.

8. The proportion of women among the scientific staff has dropped since the last evaluation from 17.5% in 2014 (7 out of 40 scientific employees) to 15.4% at 31 December 2021 (4 out of 26 scientific employees). The institute should ensure that the gender imbalance is countered by actively approaching excellent female scientists for future appointments. In addition to the recruitment KIS should also strengthen the measures to ensure **equal opportunities** in the progression and development of staff.

2. Overall concept, activities and results

The Leibniz Institute for Solar Physics (KIS) carries out basic research in observational and theoretical astrophysics with a particular emphasis on solar physics. For its experimental studies, it develops high-quality instruments and contributes them to important solar telescope infrastructure in international collaborations. The data obtained through these telescopes are made available online.

KIS is divided into two Programme Areas (PAs). PA1 “Solar and Stellar Astrophysics” consists of three groups and is mainly responsible for basic research. PA2 “Observatory and Instrumentation” consists of two groups and is mainly responsible for the development and improvement of technologies and instruments (see chapter 7 for details).

Results

Instrumentation

A central KIS task involves operating the three German solar telescopes at the Teide Observatory on Tenerife (GREGOR, VTT and ChroTel) on behalf of the two German partners – the Leibniz Institute for Astrophysics (AIP) and the Max Planck Institute for Solar System Research – and in cooperation with the Instituto de Astrofísica de Canarias (IAC) in Spain. A significant proportion of the institute’s core budget is dedicated to their administration, maintenance and scientist support (€1.5m p. a.). KIS has made important improvements to optical instruments, particularly for GREGOR (operating since 2015), e. g. the GREGOR Planet Polarimeter. A near-term goal for the future is to build the new 2D spectropolarimeter Large EtAlon Polarimeter (LEAP) for GREGOR in cooperation with external partners. For the VTT, a new camera system and a 2D spectropolarimeter are to be installed in 2022–2024.

Another, outstanding result is the Visible Tunable Filter (VTF), a world-class instrument that KIS has been building since 2010 for the Daniel K. Inouye Solar Telescope (DKIST) on Hawaii, which started operating in 2022. Initially, this work was funded by temporary additional institutional funding (2011–2018). To complete the work, the institute is receiving third-party funding from the federal government and the state of Baden-Württemberg until 2022. In 2023, the single-etalon instrument of the VTF will be shipped to the DKIST and reassembled there, with observations starting in 2023. The second

etalon will be assembled at KIS and shipped to the DKIST after the single-etalon VTF has been commissioned. KIS is the most important foreign partner of the DKIST. Through its substantial contribution, it has secured significant observation time on this, the world's largest solar telescope.

KIS has also developed complex instruments for airborne or space-based observatories. For ESA's Solar Orbiter space mission, KIS built the Polarimetric and Helioseismic Imager and, for the balloon-borne SUNRISE mission, the Correlating Wavefront Sensor.

Research

KIS's varying research activities concern fundamental physics, the sun in the context of other stars, and solar-terrestrial relations. New research results have been achieved in the field of solar magnetism and helioseismology especially. KIS regularly publishes in peer-reviewed journals and its results are internationally well received. This also includes contributions on technological developments in instrumentation. A positive development is, that the average number of articles in peer-reviewed journals (see status report appendix 2) per FTE in Research and Scientific Services (appendix 4) has risen from 0.9 p. a. (2012–2014) to 1.3 p. a. (2019–2021).

Science Data Centre (SDC)

An important new development is the further expansion of the KIS Science Data Centre (SDC). KIS began establishing a *Centre for Advanced Solar Spectro-Polarimetric Data Analysis* (CASSDA) back in 2012 within the framework of a Leibniz young researcher group that was funded until 2017, also in preparation for the commissioning of GREGOR. At the last evaluation in 2016, the Senate recommended putting this important work at KIS on a more permanent footing. Initially, KIS used limited funding from the core budget and from third-party funded projects to continue this work. For example, it took over the leadership of the H2020 SOLARNET (2019–2022) work package 5 "Towards a European Solar Data Centre", involving 15 European solar institutions. Important developments in recent years have included setting up a Remote Observing Centre (ROC) at KIS in 2018 and the establishment of a direct 10 Gbit connection between the German solar telescope on Tenerife and KIS in 2022 to automatically transmit data from the telescopes to Freiburg on a daily basis.

In view of the ever increasing data output from the telescopes on Tenerife, KIS plans to expand the SDC further. It has been receiving permanent additional funding of €1.25m p. a. for this purpose since 2021. The aim is to provide science-ready, ground-based data online for the scientific community worldwide. In addition, there are plans to offer state-of-the-art data analysis tools and services employing machine learning and artificial intelligence. KIS also plans to provide external data within the SDC, e. g. as a European data mirror for DKIST data. If the European Solar Telescope (EST) is realised (see below), the SDC will serve as a *European Solar Data Centre*. It is welcomed that KIS, with the SDC, is participating in PUNCH4NFDI (Particles, Universe, NuClei, and Hadrons for the NFDI), the consortium of particle, astro-, astroparticle, hadron and nuclear physics within the German *National Research Data Infrastructure* (NFDI) programme.

Knowledge transfer

The primary facility for outreach activities is the observatory on the Schauinsland mountain. This historical facility is used for public observatory tours and open days, which attract more than 1500 visitors yearly. Furthermore, the facility is still equipped with instruments which are used for testing parts of new instruments as well as for practical exercises by university students within their bachelor and master studies. It is good to see that KIS plans to renovate some of the buildings in order to run a series of summer and winter schools.

3. Changes and planning

Development since the previous evaluation

KIS is currently in a transition phase where staffing is concerned. One of the two Scientific Directors, who was also head of PA2, retired in April 2022. He had made a significant impact on the institute since he took up the post of Managing Director in 1997. The joint appointment procedure with the University of Freiburg to fill this position was instigated in 2020, but is not yet complete. In view of the impending retirement, the Supervisory Board appointed the long-standing Deputy Director and head of PA1 to the position of Managing Director back in 2017, following a recommendation by the Scientific Advisory Board.

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Strategic work planning for the coming years

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In the coming years, important tasks lie ahead in the maintenance and further development of existing instruments like those at the German Solar Observatory on Tenerife and the VTF at the DKIST**. Regarding the development of new instruments, KIS very actively promotes establishing the European Solar Telescope (EST) as a successor to GREGOR. It has been pursuing the development of the EST since 2008 together with other institutions within the European Association for Solar Telescopes (EAST). KIS's efforts are very commendable, however, it was decided in 2019 not to include the EST in the BMBF's National Roadmap of Research**

Infrastructures, and it remains uncertain whether the EST can actually be realised. Moreover, the project would not be likely to start until 2030 at the earliest. Therefore, it is welcomed that KIS participates in developing a new network of small ground-based telescopes (SPRING) as an auxiliary complementary facility. While further promoting the EST, KIS should continue to look for alternatives. The future development of instruments should always be driven by scientific questions.

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4. Controlling and quality management

Funding, facilities and equipment

Funding

KIS is adequately endowed with institutional funding for its current tasks. In 2019–2021, KIS received an average of €5.6m p. a. (including for 2021 the permanent increase of institutional funding of €1.25m for operating and expanding the SDC, see chapter 2).

In 2019–2021, KIS generated an average of around €2m p. a. from third-party funding, corresponding to 26% p. a. of its budget. This is about the same level as previously (24% on average in 2012–2014). However, since there has been a decline over the last three years, the institute should now aim to increase it again, particularly in PA1. KIS should ensure that in future applications for external funding, proposed projects are always aligned with its strategic core. As already recommended at the time of the last evaluation, KIS should secure more funds from the DFG, so that they are at least equal to the DFG fee.

Facilities and equipment

The review board is satisfied that KIS will move into a new building in the immediate vicinity of the university in 2023. This will resolve the long-standing problem of a lack of space in the four small buildings it uses at present. This new building is funded by the federal and state governments to the tune of €20.3m.

KIS is in charge of operating the German solar telescopes GREGOR and VTT on Tenerife and coordinates the cooperation of the German partner institutes. A significant proportion (€1.5m p. a.) of KIS's core budget is allocated for the observatory's operation, including administration, maintenance, and support for observing scientists.

Organisational and operational structure

As a result of external change management coaching, KIS adjusted its organisational structure in 2021. It is good to see that the Board of Directors (BoD) now has a Director of Administration and Technical Services, as well as the two Scientific Directors, and that the responsibilities have been equally distributed among all three members in line with a principle of collective responsibility. An experienced scientific manager was recruited for the position of Administrative Director in 2021.

The reorganisation also included changes at research group level. The 15 smaller groups and teams were combined into five research groups, whose heads now have administrative as well as scientific responsibility. Two groups are led by the directors; the other three group head positions were advertised and filled internally. **In addition to the structural and organisational streamlining carried out at KIS in 2021, the upcoming staff replacements and strategic clarifications are likely to lead to further adjustments. In shaping these developments, it is important to support and integrate all groups of employees (scientific, technical and administrative staff). It is therefore necessary to on the one hand strengthen communication channels from staff to management. On the other hand, management should pay greater attention to fostering a collective spirit in the various groups and to communicating clearly and transparently. Furthermore, KIS should extend the measures to support the career development of staff at all levels within KIS as well as for career paths outside of KIS.**

Quality management

The institute's quality management is well aligned with the established standards. KIS follows the recommendations for good scientific practice as developed by the German Research Foundation (DFG) and adopted by the Leibniz Association. KIS has an ombudsperson. Quality management regarding publications and research infrastructures, in particular at the Tenerife Observatory, is adequate. Research data management is undergoing further professionalisation due to the upgrading of the SDC.

Quality management by Foundation Council and Scientific Advisory Committee

The Scientific Advisory Committee (SAC) is extremely committed and analytical in its support. As recommended in the previous evaluation, KIS and its supervisory body (Foundation Council) **should take a more targeted approach in the future to conscientiously implementing the SAC's recommendations.**

5. Human Resources

The number of employees in Research and Scientific Services reduced from 40 (at 31 December 2014) to 26 (at 31 December 2021). This reduction is especially due to the number of doctoral researchers, which fell from twelve to four.

At 31 December 2021, KIS employed 25 science support staff in technical support and 17 in administrative support, and four trainees (cf. Status Report, Annex 4).

Leading scientific and administrative positions

The two Scientific Directors are jointly appointed with the University of Freiburg to W3 professorships. The appointment procedure for the second director and head of PA2 is currently in progress. In 2021, a new Director of Administration and Technical Services was appointed.

Early Career Researchers

In 2019–2021, four doctorates were completed at KIS. At 31 December 2021, there were four doctoral students employed at the institute (compared to 12 in 2014). The institute must once again significantly increase the number of doctoral students. Furthermore, KIS should aim to reduce the average duration of 4.5 years for completing a thesis. PhD students have the possibility to enrol in the university's graduate programme offering courses on non-disciplinary skills. In addition, KIS provides in-house workshops and practical training. It is good to see that PhD students are also involved in teaching activities and public relations work. Once the number of doctoral students has been increased again, KIS should look at whether it can set up its own structured doctoral programme. All PhD students should be enrolled in a graduate program.

KIS is very committed to offering suitable tenure perspectives to highly qualified scientific staff. Since the last evaluation several fixed-term positions have been tenured (e. g. the head of the Leibniz-Junior Research Group CASSDA running 2013–2017). The criteria for tenure evaluations should be communicated to the whole staff in written form in order to make the procedure as transparent as possible.

Early career scientists from KIS have also managed to secure external positions. For instance, the head of the QUEST Leibniz-Junior Research Group (2018–2021) took up a position at the DKIST (USA). Another KIS scientist became an assistant professor at the University of Geneva in Switzerland

Scientific support staff

The outstanding results in the field of instrument development would not be possible without the high level of expertise of the technical staff. It is welcomed that technical staff also have the possibility to participate in training and education programmes related to their job and that KIS supports them by fully or partly financing the courses. **In view of the upcoming retirements among the technical staff, KIS needs to ensure that it retains the relevant expertise. In the case of projects that are coming to an end, a decision should be taken as soon as possible regarding the**

technical staff involved in them, as to which subsequent projects they will be employed on. KIS should also offer more permanent positions for excellent technical staff members (in analogy to tenure track positions for scientists) in order to be able to adequately support the growing instrument projects (in size and complexity) and to provide the necessary continuity during long-term projects and from one project to the next.

KIS successfully participates in vocational training for non-academic staff. There are currently four apprenticeship positions: two in the mechanics workshop, and two in the technical IT group. In the past three years, two trainees have successfully completed an apprenticeship.

Equal opportunities and work-life balance

The proportion of women among the scientific staff has dropped since the last evaluation from 17.5% in 2014 (7 out of 40 scientific employees) to 15.4% at 31 December 2021 (4 out of 26 scientific employees). The institute should ensure that the gender imbalance is countered by actively approaching excellent female scientists for future appointments. In addition to the recruitment KIS should also strengthen the measures to ensure equal opportunities in the progression and development of staff. Furthermore, it should be considered how to incorporate other dimensions of staff diversity into the measures of equal opportunities.

KIS offers adequate work-life options such as working from home and flexible working time arrangements. Since 2014, KIS has been certified by the "berufundfamilie" audit.

6. Cooperation and environment

University of Freiburg

A close partnership exists with the University of Freiburg, with which the two Scientific Directors are jointly appointed. Two former adjunct professors at the University of Freiburg left KIS – one due to retirement, the other to take up a professorship in Jena. KIS scientists supervise bachelor and master students, who are integrated into the research groups at KIS.

Teaching activities are not only provided at the University of Freiburg, but also at the University of Strasbourg (both universities are members of *EUCOR – The European Campus*, a tri-national confederation of Upper-Rhine universities for shared teaching and research).

Other collaborations

In Germany, there is close cooperation with the Leibniz Institute for Astrophysics in Potsdam (AIP) and the Max Planck Institute for Solar System Research. Together with these two institutes, KIS operates the German solar telescope infrastructure on Tenerife (see chapter 2). KIS also collaborates with the Max Planck Institute on other projects, including the SUNRISE mission. Relationships also exist with various Fraunhofer

Institutes, including those based in Freiburg such as the Fraunhofer Institute for High Speed Dynamics.

At European level, KIS collaborates with the *Instituto de Astrofísica de Canarias*, Tenerife, including on the instrumentation for GREGOR and the development of the EST. KIS also established collaborations with the Aarhus University (Denmark) for research in astrobiology, and in order to gain access to the facility of the Stellar Observation Network Group. Furthermore, KIS collaborates with the University of Turku (Finland) mainly for instrument development in polarimetry.

Promising collaborations also followed the launch of the SDC. For example, KIS took over the leadership of the H2020 SOLARNET (2019–2022) work package 5 "Towards a European Solar Data Centre", involving 15 European solar institutions.

At the international level, the most important partnership is with the National Solar Observatory in the USA and its DKIST telescope on Hawaii. Furthermore, it is good to see that KIS is using its collaboration with the New Jersey Institute of Technology for synergies in the field of adaptive optics and access to the Big Bear Solar Observatory.

7. Programme Areas of KIS

Programme Area 1: Solar and Stellar Astrophysics

[20.4 FTE, of whom 12.3 FTE research and scientific services staff, 2.3 FTE doctoral candidates, and 5.8 FTE service staff]

The Programme Area is divided into three research groups:

- Solar-Stellar Connections
- Solar Photosphere and Interior
- Science Data Centre

The PA conducts basic research focussing on both small- and large-scale processes on the sun and other stars and their environment. New findings have been achieved in the field of solar magnetism and helioseismology in particular. The research results are regularly published in peer-reviewed journals and are internationally well received. Additionally, the results also include innovative instruments for experimental studies, e. g. the dual Fabry-Pérot etalon instrument HELLRIDE used on the Vacuum Tower Telescope (VTT) to track waves in the solar atmosphere. Moreover, since KIS was restructured in 2021, the Science Data Centre has been part of PA1 (see chapter 2).

At the time of the last evaluation, PA1 had access to unusually high levels of third-party funding (including two ERC grants and one Leibniz-Junior Research Group). This led to the number of staff in PA1 almost doubling from 2012 to 2017 and made it possible, on the one hand, to carry out very successful research directly related to the sun, but also, on the other, to research solar-stellar connections. For instance, as part of the ERC Advanced Grant secured by the Director of KIS for "Hot Molecules in Exoplanets and Inner Disks" (HotMol, 2012–2017), research was conducted on the theory of polarized radiative transfer in astrophysical atmospheres. The ERC Starting Grant for "The Origin of Solar

Activity" (ORIGIN, 2012–2017), secured by the leader of the research group on Solar Photosphere and Interior, led to very good results on processes in the solar dynamo. In view of these achievements, PA1's performance was rated "very good to excellent" at the last evaluation.

Since then, the situation has changed, which is also reflected in a number of indicators. Third-party funding fell from an average of €1m p. a. (2012–2014) to €450,000 p. a. (2019–2021). Staff numbers in research fell from 28 FTE (2014) to 14.6 FTE (2021) and the number of peer-reviewed articles fell from a total of 80 in 2012–2014 to 69 for 2019–2021. In addition, the head of the Solar Photosphere and Interior research group left in 2022 to take up a professorship at the University of Jena. It is commendable that KIS managed to set up another Leibniz-Junior Research Group in 2018 (QUEST, 2018–2021), whose leader found a position at the DKIST (USA) following completion of the research.

The procedure to replace the head of the Solar Photosphere and Interior group now needs to be completed without delay. It makes sense to give this research group a new focus on Solar Magnetism. Since it is not expected that PA1 will match the unusually high temporary level of third-party funding again in the next few years, it is vital to define a comprehensive strategy for the PA that takes this situation into account. PA1 should return to a stronger focus on topics directly linked to the sun.

The Programme Area "Solar and Stellar Astrophysics" is rated as "good to very good".

Programme Area 2: Observatory and Instrumentation

[25.4 FTE, of whom 7.8 FTE research and scientific services staff and 17.6 FTE service staff]

The Programme Area is divided into two research groups:

- Solar Telescopes
- Scientific Instrumentation

A central task of KIS involves operating the three German solar telescopes at the Teide Observatory on Tenerife (GREGOR, VTT and ChroTel). KIS has made important improvements to optical instruments, particularly for GREGOR (operating since 2015), e. g. the GREGOR Planet Polarimeter. Further important developments have included setting up a Remote Observing Centre (ROC) at KIS in 2018 and establishing a direct 10 Gbit connection between the German solar telescope on Tenerife and KIS in 2022 to automatically transmit data from the telescopes to Freiburg on a daily basis. A near-term goal for the future is to build the new 2D spectropolarimeter Large EtAlon Polarimeter (LEAP) for GREGOR in cooperation with external partners. For the VTT, a new camera system and a 2D spectropolarimeter are to be installed in 2022–2024.

Another, outstanding result is the Visible Tunable Filter (VTF), a world-class instrument that KIS has been building for the Daniel K. Inouye Solar Telescope (DKIST) on Hawaii since 2010. This makes KIS the most important foreign partner of the DKIST. Through its substantial contribution, KIS has secured significant observation time on DKIST, which started operating in 2022 and is currently the world's largest solar telescope. In 2023, the

single-etalon instrument of the VTF will be shipped to the DKIST and reassembled there, with observations starting in 2023. The second etalon will be assembled at KIS and shipped to the DKIST after the single-etalon VTF has been commissioned. The work on the VTF was initially carried out using temporary additional institutional funding (2011–2018). To complete the work, KIS is receiving third-party funding from the federal government and from the state of Baden-Württemberg until 2022.

In collaboration with the Max Planck Institute for Solar System Research, KIS has also developed complex instruments for airborne or space-based observatories. These include the Polarimetric and Helioseismic Imager for ESA's Solar Orbiter space mission and the Correlating Wavefront Sensor for the balloon-borne solar telescope SUNRISE.

The PA has managed to increase its third-party funding since the last evaluation from an average of €700,000 p. a. (2012–2014) to €1.6m p. a. (2019–2021). The number of publications also rose from a total of 16 in the 2012–2014 period to 25 in 2019–2021. Further important instrumentation projects are in the pipeline for the next few years, especially in relation to the German Solar Observatory on Tenerife and the VTF at the DKIST. It is therefore vital that the position of head of PA2 is filled without delay.

The Programme Area “Observatory and Instrumentation” is rated as “very good to excellent”.

8. Handling of recommendations of the last external evaluation

KIS addressed the recommendations made by the Leibniz Association Senate in 2016 (see Status Report, p. A-19f). The last evaluation recommended keeping a close eye on KIS’s strategic focus, in view of the unusually high increase in third-party funded projects for the years 2012 to 2017. This recommendation is reiterated here (recommendation 2). The recommendation concerning DFG funding (recommendation 3) still applies.

Appendix

1. Review Board

Chair (Member of the Leibniz Senate Evaluation Committee)

Ulrike **Woggon**	Institute of Optics and Atomic Physics, Technical University Berlin

Deputy Chair (Member of the Leibniz Senate Evaluation Committee)

Andreas **Weber**	Plant Biochemistry, University of Düsseldorf

Reviewers

Bernhard R. **Brandl**	Leiden University, Leiden Observatory, NL
Philippa **Browning**	Professor of Astrophysics, University of Manchester, UK
William **Chaplin**	School of Physics and Astronomy, University of Birmingham, UK
Manuel **Güdel**	Department of Astrophysics, University of Vienna, AT
Bernd **Heber**	Institute of Experimental and Applied Physics, University of Kiel
Valery **Nakariakov**	Centre for Fusion, Space and Astrophysics, University of Warwick, UK
Merav **Opher**	Department of Astronomy, Boston University, US
Göran **Scharmer**	Institute for Astronomy, Stockholm University, SE

Representative of the federal government

No participation

Representative of the Länder *governments (member of the Leibniz Senate Evaluation Committee)*

Marc **Brüser**	Ministry of Science and Health of Rhineland-Palatinate, Mainz

27 April 2023

Annex C: Statement of the Institution on the Evaluation Report

Leibniz Institute for Solar Physics, Freiburg (KIS)

The Leibniz Institute of Solar Physics (KIS), Freiburg, would like to thank the review panel for having conducted a comprehensive and constructive evaluation of the institute. We are grateful that the evaluation report recognises the institute's scientific and technological achievements and motivates to continuously develop and further advance its expertise in both fields in the upcoming years.

KIS wants to stress that the existing strategy is based on further exploiting the unique opportunities that are offered by the access to the German solar observatory on Tenerife (OT), including the existing and eventually newly designed post-focus instrumentation, as well as the Solar Orbiter space mission. The deployment of the VTF-instrument at DKIST on Maui (Hawaii) will provide KIS unique access to the world's largest solar telescope and will offer unprecedented opportunities for observations and data collection to gain new discoveries and insights in solar physics. The data exploitation of these instrumentation is an important part of the current KIS research and strategic plans which will be further updated following the panel's recommendations.

Another important pillar of the current scientific strategy of KIS is the strategic expansion of the Program Area 1 (PA1) with the Science Data Centre (SDC) that had been initiated and developed under the lead of PA1 scientific director as a new research infrastructure funded on a permanent basis by a strategic extraordinary item of expenditure (*kleiner strategischer Sondertatbestand*) from 2021. In less than a year, the SDC started providing open access to data of the German solar telescopes for national and international solar, astro- and particle physics communities, well aligned with the FAIR requirements and in cooperation with EOSC-driven consortia in Germany and EU.

Since the Sun and solar data are crucial for understanding astrophysical plasma processes, space weather and climate change, these interdisciplinary connections and dissemination of science data will be further advanced at KIS to ensure its future as a key solar physics knowledge and data hub. Fostering the development of the SDC may even lead to an important role of SDC as a partner for DKIST and a leading role for the EST data centre in terms of data calibration, processing (including machine learning techniques), and dissemination. Depending on the scale of the actual developments and the benefits of SDC for both existing program areas of KIS, the institute's organisational structure and research links to universities and other research institutions may be further developed along the lines indicated by the review panel.

Apart from that, on a longer time-scale, new opportunities will eventually be opened by the current activity to establish the EST, a possible construction of a second-generation instrument for DKIST or other observational solar large-scale facilities (e.g., Sunrise, SPRING, solar space missions, etc.). All instrumentation activities will be developed together with the hopefully soon appointed new director of Program Area 2 (PA2).

It is also essential to point out that scientists of both scientific departments work closely together in many projects and jointly contribute to the success of both the PA1 and PA2. In particular, the PA1 scientific director and scientists have led and contributed to the GREGOR instrument GPP, polarimetric unit for VTF and data reduction/analysis pipe-

lines for BBI, GRIS, VTF, as well as the establishment of the remote observing center. The PA2 scientists have contributed to research topics and projects (e.g., SOLARNET, SDC) that are developed and led in PA1. The scientific directors also substitute each other during their absences and take full responsibility for both PA1 and PA2 especially during prolonged unavailability of one director, as was the case in PA2 during the reporting period. KIS is determined to recognize its leaders and members with excellent performance, prevent discrimination, support equity and strengthen the cooperation between the two program areas. This greatly motivates employees to aim at higher achievements.

Concerning the staffing issues addressed in the report, KIS can already state here that in the meantime the process of appointing a new scientific director of PA2 has made substantial progress with decisions by the Foundation Council and the Senate of Freiburg University. Furthermore, in PA1, KIS successfully hired new and renowned scientists as leaders of the two groups Solar Magnetism (to replace Prof. Roth) and Solar-Stellar Connections, who contribute with their complementary expertise to new developments and strengthening of the KIS scientific strategic directions. In addition, one tenure-track and two postdoctoral positions have been filled with internationally experienced young researchers, one of them female. Also, in PA2, a recently hired experienced tenure-track scientist has been appointed as the head of the OT and group Solar Telescopes, and two experienced staff members with high-level technical and science-supporting skills have been permanently employed within the OT and instrumentation groups. A search for two additional postdoc positions in both PA1 and PA2 is ongoing.

As a new development, the current scientific director of PA1, after 15 years of the successful leadership and research work and six years of demanding service as managing director of KIS, accepted to take over the full directorship of the solar institute IRSOL in Locarno and professorship at the USI university in Lugano (Switzerland), which had been exercised in part-time since 2022. This transfer of an accomplished leader and researcher to a long-term partner institute of KIS will strengthen the existing institutional cooperation as well as the solar physics community in Europe. Both institutes have jointly contributed to the construction of VTF for DKIST and instrumentation at GREGOR and are partners within the European consortia for EST. Even though this transfer is a loss for KIS, it gives way for developing new directions at KIS, especially with respect to the now and in the near future available telescopes and instrumentation within an international network.

Concerning third-party funding, the institute has set up a procedure to encourage and support KIS scientists in their applications for grants from national and international funding agencies. The procedure contains a comprehensive check of the proposals' alignment with the institute's strategy and resources, as well as competitive elements that have a monetary impact on both the applicant and the working group (performance-oriented allocation of funds). At the time of writing, in PA1, one DFG proposal has been accepted, a proposal in the funding line of Competitive Excellence within the Leibniz Competition and a new EU Horizon Europe cooperation proposal have been submitted and several additional proposals are planned by the new scientists together with

their group members and across groups. In PA2, a follow-up proposal to DLR to support the Solar Orbiter mission has also been submitted. Successful applications for third party funding, combined with new lecture courses offered at Freiburg University by newly hired scientists, several of them having solid to profound teaching experience, will help increasing the number of PhD-students as well as master and bachelor candidates.

The Board of Directors and the group leaders are well aware of the age distribution and the skills of the employees, whether on the scientific, technical or administrative level. To discuss these and also general institute's matters, the Management Committee, which was established within the new organizational structure, meets weekly and offers room for exchange and discussions. Another format already presented to the Foundation Council, a Staff Forum involving employees at all levels of expertise and experience, is planned to be set up to arrange discussion and exchange of knowledge and ideas with a broader participation. Beyond that, a management development process that had been started in 2019 will be continued from mid-2023 with renewed support of experts in communication training and change management, focusing especially on the professional communication, ethics, and interactions between employees.

KIS has also intensified its activities to promote a non-discriminating, inclusive environment by introducing gender-sensible trainings for leading staff, as well as in coming months for all staff members. Other aspects that receive particular attention are improving visibly on the institute culture as well as outreach activities. All these developments are in accord with the high goals that KIS is devoted to following the standards on integrity, equal opportunities and gender equality as well as leadership culture of the Leibniz Association[1].

Two new scientific directors, two and in due time other new group leaders will strengthen opportunities for KIS to further actively develop into a Europe's leading solar physics institute. New staff positions due to upcoming retirements in technical and scientific areas, successful acquisition of third-party funds to support innovative projects, an attractive and functional new institute's building with modern labs, workshops and work spaces and a highly supporting Scientific Advisory Committee will assure a continuous and favorable development.

[1] https://www.leibniz-gemeinschaft.de/en/about-us/leibniz-integrity/