SCIENCE CAMPUS
PHOSPHORUS RESEARCH
ROSTOCK

Activity Report 2016

Katalysis LIKAT Leibniz-Institut für Katalyse e.V.
INP Greifswald
Leibniz Institute for Baltic Sea Research Warnemünde IOW
IPK Gatersleben
FBN Leibniz Institute for Farm Animal Biology
Universität Rostock Traditio et Innovatio

WISSENSCHAFTSCAMPUS PHOSPHORFORSCHUNG ROSTOCK

Content

1 Development of the Leibniz ScienceCampus Phosphorus Research Rostock (Introduction)

The Leibniz ScienceCampus Phosphorus Research Rostock focuses on three main areas in the support of phosphorus research by its members: intensifying **networking** and strengthening the **internationalization** of the ScienceCampus and **supporting young scientists** in phosphorus research.

In 2016, a major focus was the organization and realization of the **8th International Phosphorus Workshop (IPW8)**, held in Rostock from September 12th to 16th. IPWs are held every 3 years in a different European country and are among the most important events in the field of phosphorus research in Europe. In 2016, for the first time, Germany was the host. The record 230 participants from 30 countries presented and discussed their phosphorus research in 48 presentations, 144 posters, and 122 poster slam presentations. The members of the ScienceCampus Rostock contributed with 11 oral, 33 poster, and 13 poster slam presentations. All posters and poster slam presentations were independently evaluated by a committee and by all participants. The seven best posters and six best poster slam contributions were awarded, with six awards going to members of the ScienceCampus Rostock.

During five excursions, phosphorus research and related topics in Rostock and its surrounding area were descriptively highlighted by our members. The local organizational committee consisted of 12 members from different partner institutions of the ScienceCampus Rostock. The Scientific Advisory Board consisted of 23 international, renowned scientists. The International Advisory Council of the ScienceCampus Rostock was also invited to the IPW8 and involved in several aspects. In eight keynote talks, outstanding scientists presented their current work. A final panel discussion summarized the results of the conference, placing them in a larger context. The IPW8 was co-funded by the Deutsche Forschungsgemeinschaft (DFG).

For the ScienceCampus, the conference led to a better international perception of its research activities. The conference proceedings are permanently available under a DOI. The conclusions of the IPW8 were summarized and published as a press release (see Appendix), in addition to being distributed by the Deutsche Phosphor-Plattform e.V. (DPP) and the European Sustainable Phosphorus Platform (ESPP).

A special issue within the international journal *Ambio – A Journal of the Human Environment* with the topics of the IPW8 was developed and approved. Members of the ScienceCampus Rostock are serving as a guest editorial board to manage – together with the Coordination Office – the review of all submitted manuscripts as well as their preparation for publication in *Ambio*.

The organization and realization of the IPW8 significantly advanced the ScienceCampus Rostock's efforts at **networking, internationalization**, and **graduate education**. However, there were also many other important activities at the ScienceCampus in 2016.

Numerous events of different formats were carried out by the ScienceCampus Rostock to promote **networking** at all levels. The internal meetings and workshops served to intensify both the networking of scientists at the ScienceCampus Rostock and scientific cooperation/exchange among them. In addition to events for PhD students of the interdisciplinary Phosphorus Graduate School and other doctoral students in the field of phosphorus research, regular meetings of various groups of the ScienceCampus Rostock took

place. In two "Ideas Workshops," the members of the Campus discussed the further thematic development of the ScienceCampus and presented new ideas/proposals for large and small projects, discussed them, and decided on their funding or integration into project proposals. In the winter semester 2016/2017, a second lecture series was held at the University of Rostock. A 2nd Campus symposium, in March 2016, was an internal networking event for all members of the ScienceCampus Rostock. It was linked to a regional conference "New future-proof approaches to phosphorus management in Northern Germany," which met in Rostock together with the DPP. The ScienceCampus Rostock is an active member of the DPP and of the ESPP. Prof. P. Leinweber, a member of the ScienceCampus Rostock, is on the DPP board. Other cross-linking activities include the involvement of some 20 doctoral students from partner institutes conducting phosphorus-related research with various sources of funding.

In terms of **internationalization**, the IPW8 was a milestone for the ScienceCampus Rostock and an excellent addition to the other international activities of our members. The ScienceCampus Rostock has contributed to the financial support of young scientists in their international activities, such as for research stays at Uppsala University, for work at the Synchrotron in Saskatoon/Canada and at the Synchrotron Light Research Institute of Thailand, and for conference attendance in Norway and the Czech Republic. This support has allowed doctoral students to conduct the measurements and analyses essential to their research and to travel abroad, none of which would have been possible otherwise.

The Graduate School Phosphorus Research is the core of the **graduate concept** of the ScienceCampus Rostock. Its overarching goal is the provision of an excellent graduate education. Thematic training and the lively exchange of information among doctoral students are supported by workshops, professional training, informal meetings, etc.

In 2016, a number of new, important, third-party-funded projects thematically related to the ScienceCampus Rostock were started (Table 1). Many of them are only partially concerned with phosphorus and reflect the close connection of phosphorus to other elements or the role that it plays in so many different areas. Others have phosphorus as their main focus. Three of these new projects can be highlighted:

(1) *Research into the characteristics and effects of glyphosate in soil* (Scholarship of the federal state of Mecklenburg-Vorpommern), (2) *Phosphorus from source to sea – integrated phosphorus and water resources management for sustainable water protection* (PhosWaM; BMBF), and (3) *SPP1685: Studies on understanding the phosphorus cycle in forest ecosystems at the molecular level* (DFG).

Significant publications, as examples of productive research in 2016, were:

The publication "*Towards improved phosphorus efficiency in monogastrics - Interplay of serum, minerals, bone and immune system after divergent dietary phosphorus supply in swine*," by Oster et al., was honoured as publication of the year by the ScienceCampus Rostock (see List of publications, Sect. 3.4). The article, co-authored by members of the ScienceCampus Rostock from two different partner organizations (FBN, UoR) and published in the American Journal of Physiology (impact factor 3.26, open access), presents the results of a study of the phosphorus utilization efficiency of pigs.

A phosphates information sheet providing basic information on phosphates was prepared by several members of the ScienceCampus Rostock (UoR and FBN; Leinweber et al., 2016) and published in the Wiley publication "Soil Hazardous Substances: Assessment -

Substance Data - Ecotoxicology - Reconstruction" (eds. Litz et al.). The latter describes, inter alia, phosphate analysis in different media, essential emission paths, and phosphate contents and transformations in soils.

Several scientists from the ScienceCampus Rostock (Eichler-Löbermann et al., Ekardt et al.) contributed to the book "*Phosphorus in Agriculture: 100% Zero. Summary of current state of the art in the area of agricultural phosphorus research*" (eds. Schnug & De Kok). This Springer publication deals with the prerequisites and legal framework needed to achieve balanced phosphorus fertilization in agriculture. Among its conclusions are that only fertilizers containing the nutrient in a fully available form should be used. The book identifies knowledge gaps and shortcomings in translating research into practice.

Within the **research clusters**, "Cluster III" has been broadened and adapted to current developments.

The public relations work of the ScienceCampus Rostock in 2016 included, but was not limited to, text writing and publishing, presentations and maintenance of the website, and representation of the ScienceCampus Rostock by an information stand at the University of Rostock during the Long Night of Sciences.

2 Goals and concept

The overarching goal of interdisciplinary cooperation at the Leibniz ScienceCampus Phosphorus Research Rostock is, through a thematically oriented integrated network, to explore options for the more sustainable management of phosphorus. Further focuses of the ScienceCampus, in addition to the sufficient and efficient use and recycling and recovery of phosphorus, are phosphorus cycles and fluxes in the environment and the environmental problems, in particular in aquatic systems, caused by inefficient phosphorus use or a lack of phosphorus recycling. Expertise in various aspects of research into the essential and irreplaceable element phosphorus, diverse phosphorus-containing chemical compounds, and specific modes of action of phosphorus in agricultural and environmental systems as well as in technical and industrial processes are brought together at the ScienceCampus Rostock. Cooperation and research are intensified and strong national and international networks established.

The following institutes are partners of the ScienceCampus Rostock:

- Leibniz Institute for Catalysis (LIKAT) at the University of Rostock
- Leibniz Institute for Farm Animal Biology (FBN), Dummerstorf
- Leibniz Institute for Baltic Sea Research Warnemünde (IOW)
- Leibniz Institute for Plant Genetics and Crop Plant Research (IPK), Satellite Collections North, Groß Lüsewitz
- Leibniz Institute for Plasma Research and Technology (INP), Greifswald
- University of Rostock (UoR; Faculty of Agricultural and Environmental Sciences, Interdisciplinary Faculty, Faculty of Law, Faculty of Mathematics and Natural Sciences, Rostock University Medical Centre)

3 Research

3.1 Research foci

The research foci of the ScienceCampus Rostock are:

- Cluster I: Phosphorus cycles and fluxes in the environment
- Cluster II: Sufficiency and efficiency of phosphorus utilisation, phosphorus recycling
- Cluster III: Syntheses of and with Phosphorus-Containing Compounds (former: Phosphorus as an element in and as result of catalytic processes)
- Cross-cutting activity: The development of advanced phosphorus analysis methods

3.1.1 Cluster I: Phosphorus cycles and fluxes in the environment

Phosphorus ends up in the environment through open-ended industrial cycles and along river flows, reaching the sea. The aim is a better understanding of P fluxes and cycles in the environment in order, on the one hand, to analyze the effects of high P inputs and, on the other, to enable discussion of protection and/or rehabilitation measures. This starts at the "sources", for example with the application of fertilizer on agricultural land and the effects of artificial drainage (drain systems), but also at the river outlets of small and large wastewater treatment plants. And it continues through phosphorus fluxes in different ecosystems, from special soil crusts to coastal waters and into the large Baltic Sea basin. Methodological approaches in Cluster I include measurements on the smallest scale up to the Baltic Sea ecosystem modelling over a wide range of scales and instrumentation.

3.1.2 Cluster II: Sufficiency and efficiency of P utilization, P recycling

The goal is to formulate a scientific basis with which to derive the necessary legal framework and policy recommendations for the sustainable management of regional and global closed P-fluxes in accordance with the principles of sufficiency and efficiency. Sufficiency means to limit the application rates of P for the production of plant and animal foods to the level actually required. This requires critical evaluations of existing P-fertilization and feed recommendations with the aim of reducing P-use in agriculture. Research to improve P-efficiency includes:
(1) Elucidation of the genetic basis of P-efficiency (uptake and utilization efficiency)
(2) Unlocking the accumulated but not available or not used P-stores in topsoil and the subsoil
(3) Utilization of alternative P sources and development / refinement of practice-relevant P-recovery technologies including research into the properties and potential of alternative P sources and technically recovered phosphates and extending to recommendations for practical applications.
The interdisciplinary nature of the Cluster, which covers all sub-areas of the agricultural P cycle (soil, plant, animal, water, process engineering ...), enables a realistic assessment of the portion of the P application rates that in the future are replaceable with renewable P sources.

3.1.3 Cluster III: Syntheses of and with phosphorus-containing compounds

This cluster was expanded in 2016 and thus adapted to the content and edited topics (former: Phosphorus as an element in and as result of catalytic processes).
This cluster is primarily concerned with research into underlying structural and reactive properties as well as theoretical issues in phosphorus chemistry. This reflects the formally possible oxidation states, which for phosphorus range from −3 to +5, the extraordinarily high structural diversity of phosphorus compounds. As a central element in achiral and chiral ligands for organometallic and coordination chemistry catalytic processes, phos-

phorus plays a unique role in catalysis research and as a reagent in organic syntheses. This is also true for some areas of industrial chemistry, mainly in the manufacture of fine chemicals, which often have a high added value. In addition, phosphorus-based organo-catalysts are gaining increasing importance.

3.1.4 Cross-cutting activity: The development of improved P analysis methods

The cross-cutting activity (Cluster: Q) has as its focus on the provision and development of diverse methods needed for carrying out the main areas of research of the entire Phosphorus Campus. On the other hand, it is the objective of this Cluster to approach the question of relevant phosphorus compounds in the environment and their dynamics through its own projects. The spectrum of available methods includes the most modern chemical analytical methods, such as coupled gas (GC-MS) and liquid chromatography (HPLC-MS/MS) and colourimetric methods. In addition, at the IOW, with its CAMECA NanoSIMS 50L, a secondary ion mass spectrometer is available with which the elementary and isotopic composition of the smallest particles and single cells can be investigated. P metabolism by microorganisms from the Baltic Sea and soil have already been analyzed here and the presence of P-storage vacuoles in cyanobacteria depicted.

3.2 Research projects

Within the research clusters, 30 disciplinary and interdisciplinary, externally funded projects were thematically assigned to the ScienceCampus Rostock in 2016 (Table 1). Nine of them were new and three were approved for a second period. The Graduate School of the ScienceCampus Rostock, funded by the Leibniz Association and partner institutions of the ScienceCampus, conducts research in 11 thematically affiliated individual projects (Table 2).

Table 1. Research projects thematically assigned to the ScienceCampus Rostock (status as of December 2016; *italics: phosphorus not a subject of the total project*)

Project name	Term	Sponsor	Participating Partners of the ScienceCampus	Cluster
BACOSA: Baltic Coastal System Analysis and Status Evaluation	04/13 - 03/16	BMBF	Universität Rostock (MNF, AUF)	I
BACOSA: Baltic Coastal System Analysis and Status Evaluation	04/16 - 03/19	BMBF	Universität Rostock (MNF, AUF)	I
BaltCoast: A Systems Approach Framework for Coastal Research and Management in the Baltic	04/15 - 03/18	EU-Bonus	IOW	I
Baltic Transcoast	01/16 - 06/20	DFG	Universität Rostock (AUF, MNF), IOW	I
BioAcid III: Biological Impacts Of Ocean Acidification	10/15 - 09/17	BMBF	Universität Rostock (MNF), IOW	I
Biomasse-Asche-Monitoring (BAM), Teilvorhaben 2: Agronomische Bewertung	11/16-10/19	BMELV	Universität Rostock (AUF)	II
BMP Glyphosat: Best Management Praktiken und Nachhaltige Anwendung von Glyphosatprodukten	10/13-05/17	BMEL	Universität Rostock (AUF)	II
CRUSTFUNCTION	02/14 - 01/17	DFG	Universität Rostock (AUF, MNF)	I
Dach-KüNO: Wissens- und Datentransfer in der Küstenmeerforschung	04/14 - 09/16	BMBF	IOW	I

Project name	Term	Sponsor	Participating Partners of the ScienceCampus	Cluster
Durchführung einer Studie zu den Perspektiven für die deutsche Aquakultur im internationalen Wettbewerb	06/16 - 07/17	BLE	Universität Rostock (AUF)	II
ECO-FCE: A whole-systems approach to optimising feed efficiency and reducing the ecological footprint of monogastrics	02/13 - 01/17	EU - FP7	FBN	II
Graduiertenschule Leibniz-WissenschaftsCampus Phosphorforschung Rostock	04/15 - 03/19	WGL	FBN, INP, IPK, IOW, LIKAT, Universität Rostock	I, II, III, Q
InnoAquaTech: Cross-border development and transfer of innovative and sustainable aquaculture technologies in the South Baltic area	07/16 - 06/19	Interreg South Baltic	Universität Rostock	II
InnoSoilPhos	03/15 -02/18	BMBF	Universität Rostock (AUF)	I, II, Q
KataPlasma: Hydoformulierung mit homogenen Katalysatoren geträgert auf Plasma funktionalisierten Materialien	06/16 - 05/19	BMBF	INP, LIKAT	III
Kogge - Kommunale Gewässer gemeinschaftlich entwickeln im urbanen Raum	04/15 - 03/18	BMBF	Universität Rostock (AUF)	I
Langzeitmonitoring Nährstoffe in der Darß-Zingster Boddenkette	seit 1980	LUNG, Universität Rostock	Universität Rostock (MNF)	I
Mephor: Cellular mechanisms of phosphorus regulation in filamentous cyanobacteria	05/15 - 04/18	Forschungsstiftung Ostsee	IOW	I
Mischfruchtanbau mit Leguminosen: Effiziente Nutzung von Wachstumsfaktoren als Beitrag zum Ressourcen- und Gewässerschutz	07/12 - 06/16	FNR	Universität Rostock (AUF)	II
MOSSCO II: Modular System for Shelves and Coasts	04/16 - 03/19	BMBF	IOW	I
MOSSCO: Modular System for Shelves and Coasts	04/13 - 03/16	BMBF	IOW	I
Optimierung der Düngewirkung von Reststoffen aus Biomassekonversionsanlagen - Ein Beitrag zum Ressourcen- und Umweltschutz	05/16 - 11/16	BMBF	Universität Rostock (AUF)	II
Phosphor-Deposition: Entwicklung ausgewählter Indikatoren und Bewertungssätze für die Meeresumwelt im Rahmen der Umsetzung der Meeresstrategie-Rahmenrichtlinie	09/15 - 12/17	Umweltbundesamt	IOW	I, Q
PhosWaM: Phosphor von der Quelle bis ins Meer - Integriertes Phosphor- und Wasserressourcenmanagement für nachhaltigen Gewässerschutz	03/16 - 02/19	BMBF	IOW, Universität Rostock (AUF)	I, II
POLARCRUST - Biological soil crust algae in polar regions	02/14 - 01/17	DFG	Universität Rostock (MNF)	I
P-Recycling aus organischen Abfällen und Reststoffen – Stand, Potenziale und Perspektiven in M-V	01/12 - 12/16	Universität Rostock	Universität Rostock (AUF)	II

Project name	Term	Sponsor	Participating Partners of the ScienceCampus	Cluster
PRODIVA - Crop diversification and weed management	01/15 - 01/18	ERA-net Core Organic Plus, für D: BMEL über BLE	Universität Rostock (AUF)	II
P-Schadstoff-Wechselwirkungen infolge Applikation von Knochenkohle	09/13 - 08/16	Land MV (Stipendium)	Universität Rostock (AUF), LIKAT	II
Role of phosphorus as a key component for managing grasslands N-yield and phytodiversity in organic farming	09/13 - 12/16	BÖLN	Universität Rostock (AUF)	II
SECOS II: The Service of Sediments in German Coastal Seas	04/16 - 03/19	BMBF	IOW	I
SECOS: The Service of Sediments in German Coastal Seas	04/13 - 03/16	BMBF	IOW	I
Untersuchungen der Eigenschaften und Wirkungsweisen von Glyphosat im Boden	02/16 - 01/19	Land MV (Stipendium)	Universität Rostock (AUF)	I, II, Q
Untersuchungen zum Verständnis des Phosphorzyklus in Wald-Ökosystemen auf molekularer Ebene	11/16 - 10/19	DFG	Universität Rostock (MNF)	I

Table 2: Subprojects of the Graduate School Phosphorus Research Rostock (financed by the Leibniz Association and partners of the ScienceCampus Rostock): 2015–2018

Project	Participating Partners of the ScienceCampus	Research focus
Quality, quantity and transformation of P losses from diffuse sources to the Baltic Sea	IOW, Universität Rostock	I
Phosphatases – Development of new quantitative assays along terrestrial-aquatic gradients	Universität Rostock, IOW	I
Natural and anthropogenic organic P compounds – inositol-phosphates, phospholipids and glyphosate	IOW, Universität Rostock	I, II, Q
Mechanisms of P mobilization in the rhizosphere involving weeds and crop plants	Universität Rostock, IPK	II
Genetic regulation of phosphatase production and activity to increase P uptake from deficient soils	Universität Rostock, IPK	II
Genetic and nutritional effects on the efficiency of P use of monogastric animals	FBN, Universität Rostock	II
The P cycle and its application in land-based integrated aquaculture systems	Universität Rostock, FBN	II
Political-legal P governance by means of certificate markets and charges	Universität Rostock, IOW	II
Processing of alternative P sources for fertilization in agriculture	INP, Universität Rostock	II, III
Synthesis of new heterocyclic ring systems containing P	LIKAT, Universität Rostock	III
Large scale application of P based organocatalysts in batch and flow for the synthesis of fatty acid derived cyclic carbonates	LIKAT, Universität Rostock	III

3.3 Graduate Concept/Graduate School Phosphorus Research

The structured training concept of the ScienceCampus Rostock (see Figure 1) is realized by graduate studies at the Graduate School of Phosphorus Research and the involvement of other young scientists (BSc and MSc students, doctoral students, and postdocs) whose thesis or project concerns phosphorus research. All relevant information is provided to young scientific members of the ScienceCampus. In addition to their inclusion in events involving the ScienceCampus Rostock and in scientific and thematic networks, for example, those of the DPP and ESPP, they can apply to the Campus for grants and for financial support for internationalization (travel, publications, and visiting scientists, including longer stays).

Figure 1: Graduate concept of the Leibniz ScienceCampus Phosphorus Research Rostock

The Graduate School of Phosphorus Research is the core of the graduate concept of the ScienceCampus Rostock. Its overall objective is to provide excellent graduate education, to encourage new and innovative phosphorus research topics, and to foster networking among partners. The 11 currently ongoing doctoral projects cover important areas of knowledge and research (Table 2). BSc and MSc thesis topics in phosphorus research have also been developed.

All doctoral students are supervised by a committee of scientists from at least two partner organizations of the ScienceCampus (e.g., the Leibniz Institute for Baltic Sea Research and the University of Rostock). In 2016, the students presented their work at the annual ScienceCampus Rostock Symposium, held in March, and at the IPW8. Lively exchanges of information between doctoral students are promoted through various events, such as workshops and the regularly held "Phosphorus Breakfast" (see Section 5). Positive support for these activities has come from opening up the events to other doctoral students with thesis topics in phosphorus-related research.

3.4 Publications

Adam, R., Alberico, E., Baumann, W., Drexler, H.-J., Jackstell, R., Junge, H., Beller, M. (2016): NNP-type pincer imidazolylphosphine ruthenium complexes: Efficient Base-Free Hydrogenation of Aromatic and Aliphatic Nitriles under Mild Conditions. Chemistry - A European Journal 22: 4991-5002, DOI: 10.1002/chem.201504709

Adam, R., Bheeter, C.B., Jackstell, R., Beller, M. (2016): A Mild and Base-Free Protocol for the Ruthenium- Catalyzed Hydrogenation of Aliphatic and Aromatic Nitriles with

Tridentate Phosphine Ligands. ChemCatChem 8: 1329-1334, DOI: 10.1002/cctc.201501367

Bachmann, S., Uptmoor, R., Eichler-Löbermann, B. (2016): Phosphorus distribution and availability in untreated and mechanically separated biogas digestates. Scientia Agricola 73: 9-17, DOI: 10.1590/0103-9016-2015-0069

Bauwe, A., Kahle, P., Lennartz, B. (2016): Hydrologic evaluation of the curve number and Green and Ampt infiltration methods by applying Hooghoudt and Kirkham tile drain equations using SWAT. Journal of Hydology 537: 311-321.

Bläsing, K., Ellinger, S., Harloff, J., Schulz, A., Sievert, K., Täschler, C., Villinger, A., Zur Täschler, C. (2016): Lewis Acid Catalyzed Synthesis of Cyanidophosphates. Chemistry - A European Journal 22 (12: 4175–4188, DOI: 10.1002/chem.201504523

Bresien, J., Faust, K., Hering-Junghans, C., Rothe, J., Schulz, A., Villinger A. (2016): Synthetic strategies to bicyclic tetraphosphanes using P1, P2 and P4 building blocks. Dalton Transactions - The international journal for inorganic, organometallic and bio-inorganic chemistry 05/2016, DOI: 10.1039/C5DT02757H

Büttner, H., Steinbauer, J., Wulf, C., Dindaroglu, M., Schmalz, H.-G., Werner, T. (2016): Organocatalyzed Synthesis of Oleochemical Carbonates from CO2 and Renewables. ChemSusChem, DOI: 10.1002/cssc.201601163

Cramer, M., Koegst, T., Tränckner, J. (2016): Cost-efficient Phosphorus removal in rural WWTPs. In: Proceedings of the 13th IWA Specialized Conference on Small Water and Wastewater Systems., Athens, Greece.

Eichler-Löbermann, B., Bachmann, S., Busch, S., Schiemenz, K., Krey, T., Pfahler, V., Uptmoor, R. (2016): Management options for an efficient utilization of phosphorus in agroecosystems. In: Schnug, E. and De Kok, L.: Phosphorus in Agriculture: 100% Zero. Springer (ISBN: 978-94-017-7611-0)

Eichler-Löbermann, B., Stahn, P., Busch, S., Miegel, K., Peter, M., Uptmoor, R. (2016): Phosphorus utilization in mixed cropping systems with legumes. In: 24th International Symposium of the International Scientific Centre of Fertilizers, Coimbra (Portugal). Julius-Kühn-Institut, Bundesforschungsinstitut für Kulturpflanzen (ISSN: 1866-590X)

Ekardt, F. (2016): Justice and Sustainability: Normative Criteria for the Use of Phosphorus. In: Schnug, E. and De Kok, L.: Phosphorus in Agriculture: 100% Zero. Springer: 317-330. (ISBN: 978-94-017-7611-0)

Ekardt, F. (2016): Theorie der Nachhaltigkeit, 3. Aufl., Nomos Verlag.

Ekardt, F., Garske, B., Stubenrauch, J., Wieding, J. (2016): Governance Instruments for Phosphorus Supply Security. In: Schnug, E., De Kok, L.: Phosphorus in Agriculture: 100% Zero. Springer: 331-347. (ISBN: 978-94-017-7611-0)

Guckenberger, L.-M., Bredenkamp, D., Borgelt, L., Kieckhäven, S., Wolf, P. (2016): Effect of varying phosphorous levels in diets of weaned piglets on the bacterial microbiome in colon and faeces. In: Proceedings of the Society of Nutrition Physiology 25. (ISBN: 978-3-7690-4109-5)

Hinz, A., Kuzora, R., Rölke, A.-K., Schulz, A., Villinger, A., Wustrack, R. (2016): Synthesis of a Silylated Phosphorus Biradicaloid and Its Utilization in the Activation of Small Molecules. European Journal of Inorganic Chemistry, DOI: 10.1002/ejic.201600321

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Hupfauf, S., Bachmann, S., Fernández-Delgado Juárez, M., Insam, H., Eichler-Löbermann, B. (2016): Biogas digestates affect crop P uptake and soil microbial community composition. Science of the Total Environment 542: 1144-1154, DOI: 10.1016/j.scitotenv.2015.09.025

Jungk, P., Täufer, T., Thiel, I., Hapke, M. (2016): Synthesis of Chiral Indenylcobalt(I) Complexes and Their Evaluation in Asymmetric [2+2+2] Cycloaddition Reactions. Synthesis 48 [13]: 2026-2035, DOI: 10.1055/s-0035-1560433

Kahle, P., Zimmer, D., Baum, C. (2016): Beitrag von Ockerflocken zum P-Austrag gedränter Standorte in Nordostdeutschland. Hydrologie und Wasserbewirtschaftung 60 [5]: 294-302, DOI: 10.5675/HyWa_2016,5_1

Karstens, S., Buczko, U., Jurasinski, G., Peticzka, R., Glatzel, S. (2016): Impact of adjacent land use on coastal wetland sediments. Science of the Total Environment 550: 337–348, DOI: doi.org/10.1016/j.scitotenv.2016.01.079

Klehr, W., Koegst, T., Tränckner, J. (2016): BOOT-Monitoring - räumlich hochaufgelöste chemische und physikalische Zustandsbewertung von Fließgewässern. In: 10. Rostocker Abwassertagung - Wege und Werkzeuge für diene zukunftsfähige Wasserwirtschaft im norddeutschen Tiefland. Schriftenreihe Umweltingenieurwesen der AUF/Universität Rostock: 43-57. (ISBN: 978-3-96009-449-5)

Koch, S., Kahle, P., Lennartz, B. (2016): Visualization of Colloid Transport Pathways in Mineral Soils Using Titanium(IV) Oxide as a Tracer. Journal of Environmental Quality 45[6]: 2053-2059, DOI: 10.2134/jeq2016.04.0131

Koegst, T., Noack, D., Kotzbauer, U., Tränckner, J. (2016): Niederschlagswasser auf Biogasanlagen - Belastung und Behandlung. In: 10. Rostocker Abwassertagung - Wege und Werkzeuge für diene zukunftsfähige Wasserwirtschaft im norddeutschen Tiefland. Schriftenreihe Umweltingenieurwesen der AUF/Universität Rostock: 77-90. (ISBN: 978-3-96009-449-5)

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Zimmer, D., Leinweber, P. (2016): Phosphateinträge in die Vorfluter senken. dlz Agrarmagazin 4: 58-63.

3.5 Theses

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Bresien, Jonas (2016): Synthesis and characterisation of cyclic polyphosphanes. Dissertation an der Universität Rostock. Betreuer: Prof. Dr. Axel Schulz (Universität Rostock)

Tiedt, L. (2016): Membranverfahren zur Aufarbeitung von Meerwasser-Größenfraktionierung von DOP. Bachelorarbeit an der Universität Rostock. Betreuer: Prof. U. Kragl (Universität Rostock)

4 Networking

Besides interactions among its individual scientists and research groups, the ScienceCampus Rostock is a member of the ESPP and DPP. Prof. P. Leinweber (ScienceCampus Rostock) is an elected member of the Executive Committee of the DPP. In addition, the ScienceCampus Rostock is connected with other Leibniz ScienceCampi as well as through its scientists and their thematic networks.

5 Events

Different kind of events were held, e.g. to promote networking and interdisciplinary cooperation within the ScienceCampus Rostock but also with external scientists, authorities, and the general public.

5.1 Public events

Lecture Series Phosphorus Research „Interdisziplinäre Herangehensweise an ein lebenswichtiges Element": WS15/16 with 13 presentations at the University of Rostock by members of the ScienceCampus Rostock and one guest lecturer (Dr. Steve Robinson, University of Reading; program attached in the Appendix)

Lecture Series Phosphorus Research "Interdisziplinäre Herangehensweise an ein lebenswichtiges Element:" WS16/17 with nine presentations at the University of Rostock by members of the ScienceCampus Rostock and by four guest lecturers (program attached in the Appendix)

Colloquium Dr. Alexander Bachor "Langzeitbeobachtungen zur Entwicklung der Nährstoffe in Fließ- und Küstengewässern Mecklenburg-Vorpommerns", 01.03.2016 Leibniz-Instituts für Ostseeforschung Warnemünde

8th International Phosphor Workshop (IPW8), Universität Rostock, 12.–16.09.2016, Rostock

Colloquium of the Institute for Chemistry and the „GDCh-Ortsverbands Rostock": 21.1.2016: Prof. Müller, FU Berlin (member of the SAC of the ScienceCampus) "Low-Coordinate Phosphorus Hetero-cycles: From Molecular Design to Applications"

Within the lecture series "Küstensysteme im Umbruch" (25.1.2016, Universität Rostock): Prof. B. Eichler-Löbermann (Universität Rostock Rostock), Prof. S. Haneklaus (JKI Braunschweig) **"**Gesunde Ostsee und Landwirtschaft – (k)ein Widerspruch?**"**

Regional conference of the German Phosphorus Platform „Neue zukunftssichere Ansätze zum Phosphor-Management in Norddeutschland" at the department „Life, Light & Matter" of the University of Rostock, 09.03.2016

10. Rostocker Abwassertagung 2016: Wege und Werkzeuge für eine zukunftsfähige Wasserwirtschaft im Norddeutschen Tiefland. 08.11.2016. Organisiert und durchgeführt vom Lehrstuhl für Wasserwirtschaft (Universität Rostock).

5.2 Internal meetings and workshops

Internal meetings and workshops facilitate intensive networking and thematic exchanges between scientists of the ScienceCampus. In addition to various events for graduate/doctoral students, an annual campus-symposium is held in which all scientists introduce their new projects, present their work, and discuss the results. The Steering Group of the ScienceCampus meets roughly every 3 months to discuss overarching issues as well as the strategic orientation and further development of the ScienceCampus.

R-Workshop (basics) for doctoral students of the Phosphorus Graduate School 1.-3.06.2016

2nd Symposium of the ScienceCampus Phosphorus Research Rostock, Department "Life, Light & Matters", University of Rostock, 10.03.2016

Workshop for doctoral students "Conference presentations," Leibniz-Institute for Baltic Sea Research Warnemünde, 31.08.2016

2nd Phosphorus-Analytics-Workshop for members of the ScienceCampus Rostock, Leibniz-Institute for Baltic Sea Research Warnemünde, 27.–29.09.2016

1st Idea Workshop 2016 of the ScienceCampus Phosphorus Research Rostock, Leibniz-Institute for Catalysis, 05.10.2016

2nd Idea Workshop 2016 of the ScienceCampus Phosphorus Research Rostock, Leibniz-Institute for Farm Animal Biology Dummerstorf, 18.11.2016

The Steering Committee of the ScienceCampus Rostock met four times (18.02., 19.05., 01.09., 02.11.2016) during the reporting period, each time at a different partner insti-

tute. At these meetings, the thematic development of the ScienceCampus and overarching decisions were deliberated.

In 2016, a series of organizational meetings (26.02., 13.04., 19.05., 24.06., 13.07., 05.08., 25.08., 01.09., 06.09.2016) were held in preparation for IPW8, organized by the ScienceCampus Rostock and held in Rostock September 12–16, 2016.

To promote exchanges among PhD students working on phosphorus-related issues within the ScienceCampus Rostock, two "Phosphorus Breakfast" gatherings took place at different partner institutes, during which phosphorus research and related updates were presented and discussed: 12.02.2016 (University of Rostock, MNF), and 09.06.2016 (University of Rostock, AUF).

6 Public relations

The ScienceCampus Rostock and the research of its members have been introduced to external research groups, politicians, government, and the general public. A selection of the related events is provided below.

6.1 Oral presentations (selection)

Berthold, M., Schumann, R.: How the catchment area prevents the "good ecological state" of a shallow estuary. A case study in the coastal water bodies of the southern Baltic Sea. IPW8, Rostock, 14.09.2016

Buczko, van Laak: Re-evaluation of Phosphorus fertilizer recommendations based on metaanalyses of long-term field experiments. IPW8, Rostock, 14.09.2016

Douhaire, Stubenrauch: EU regulatory and policy objectives relevant to sustainable agricultural land and phosphorus use. IPW8, Rostock, 16.09.2016

Eichler-Löbermann, Busch, Brand, Stahn, Miegel, Uptmoor: Phosphorus utilization in mixed cropping systems. IPW8, Rostock, 13.09.2016

Garske, Wieding: Changing animal food consumption as part of phosphorus regulation? IPW8, Rostock, 16.09.2016

Gros, Ahmed, Kühn, Leinweber: Glyphosate binding in soil as revealed by sorption experiments, mass spectometry and quantum-chemical modeling. IPW8, Rostock, 15.09.2016

Nausch, Nausch, Leipe, Neumann: Phosphorus in the Baltic Sea – measured since decades, but really unterstood? IPW8, Rostock, 14.09.2016

Oster, Just, Büsing, Muráni, Polley, Vollmar, Wolf, Ponsuksili, Wimmers: Elucidating the biodiversity of P homeostasis towards improved P efficiency in pigs. IPW8, Rostock, 13.09.2016

Schaub, Iris: Effect of prolonged darkness and temperature on the lipid metabolism in the benthic diatom Navicula perminuta from the arctic. 16. Scientific Conference of the Phycologal Section of the German Botanical Society, Leipzig, 06.-09.03.2016

Steinbauer, Büttner, Werner: CO2 valorization utilizing new P-based catalysts. IPW8, Rostock, 15.09.2016

Strauch, S.: Aquaponics - The German Experience. Rendez-vous de Concarneau, 29.-30.09.2016

Strauch, Palm, Knaus, Bischoff-Lang: Proportional Up Scaling of African Catfish recirculation aquaculture systems disproportionally affects nutrient dynamics. European Aquaculture Society, Edingburgh, 20.-23.09.2016

Tränckner, Beetz, Koegst, Cramer: Cost-efficient phosphorus removal in rural waste water treatment plants (WWTP). IPW8, Rostock, 13.09.2016

Täufer, Hapke, Schulz: P-NCompounds as synthons in cyclisation reactions. IPW8, Rostock, 15.09.2016

Zacher, A.: P-Mobilisierung in der Rhizosphäre von Unkräutern und Kulturpflanzen. Öffentliches Kolloquium der Professuren Phytomedizin & Grünland und Futterbauwissenschaften, Universität Rostock, 07.01.2016

Zacher, A.: Mechanisms of P mobilization in the rhizosphere involving weeds and crop plants. 7. International Weed Science Congress, Prag, 19.-25.06.2016

Zacher, A.: Potenzielle Wirkung von Unkräutern auf die P-Mobilisierung unter Mais. 59. Tagung der Gesellschaft für Pflanzenbauwissenschaften, Gießen, 27.-29.09.2016

6.2 Posters (selection)

Ahmed, A.A., Leinweber, P., Kühn, O.: Molecular Level Investigation of P-related Reaction Mechanisms at Soil Mineral Surfaces. IPW8, 12.-16.09.2016, Rostock

Baum, C., Prüfer, D., Eickmeyer, F.: Intraspecific diversity of the rhizodeposition of Lupinus angustifolius L. regarding the phosphorus mobilization in the soil. IPW8, 12.-16.09.2016, Rostock

Baumann, K., Glaser, K., Karsten, U., Leinweber, P.: The role of biological soil crusts in P-cycling. IPW8, 12.-16.09.2016, Rostock

Berthold, M., Karstens, S., Buczko, U., Schumann, R.: Phosphorus budgets of the land-water transitional zones in a cold temperate lagoon. IPW8, 12.-16.09.2016, Rostock

Böttcher, M.E., Schmiedinger, I., Wacker, U., Conrad, A.C., Grathoff, G., Schmidt, B., Bahlo, R., Gehlken, P.-L., Fiebig, J.: Synthesis of carbonate-bearing hydroxyl apatite (CHAP) via calcite transformation: Calibration of stable isotope (C, O) and monovalent cation partitioning. IPW8, 12.-16.09.2016, Rostock

Braun, P., Schulz-Vogt, H., Siebers, M., Dörmann, P., Nausch, M.: Cellular structures of filamentous cyanobacteria affected by phosphate availability. IPW8, 12.-16.09.2016, Rostock

Friedland, R., Buer, A.-L., Dahlke, S., Grov, M., Meyers, L., Schernewski, G., Schulze-Böttcher, K., Stybel, N.: On the potential of mussel farms as nutrient retention measure in a eutrophied lagoon. IPW8, 12.-16.09.2016, Rostock

Glaser, K., Schulz, K., Mikhailyuk, T., Leinweber, P., Karsten, U.: Biodiversity of biological soil crusts from sand dunes and their functional role in the P and C biogeochemistry (CRUSTFUNCTION). IPW8, 12.-16.09.2016, Rostock

Goers, M., Baum, C., Grafe, M., Schulz, S., Schloter, M., Leinweber, P.: Effects of long-term fertilisation management on microbial P mobilisation and community structure in the crop rhizosphere. IPW8, 12.-16.09.2016, Rostock

Gropp, T., Uptmoor, R., Eichler-Löbermann, B.: Agronomic effectiveness of P resources. IPW8, 12.-16.09.2016, Rostock

Habedank, F., Abraham, M., Schulz-Bull, D.: A Microextraction Method for the Simultaneous Determination of 20 Organo Phosporous Pesticides from Marine Water Samples. IPW8, 12.-16.09.2016, Rostock

Jahn, S., Kahle, P., Schulz-Vogt, H., Lennartz, B., Nausch, M.: Quality, quantity and transformation of P losses from diffuse sources to the Baltic Sea. IPW8, 12.-16.09.2016, Rostock

Just, F., Oster, M., Büsing, K., Muráni, E., Ponsuksili, S., Polley, C., Vollmar, B., Wolf, P., Wimmers, K.: Impact of dietary phosphorus on hormone balance and gene expression in kidney and its implications on immune status of weaned piglets. IPW8, 12.-16.09.2016, Rostock

Karstens, S., Buczko, U., Jurasinski, G., Glatzel. S: Phosphorus storage and mobilization in coastal Phragmites wetlands: Influence of local-scale hydrodynamics. IPW8, 12.-16.09.2016, Rostock

Koch, S., Kahle, P., Lennartz, B.: Phosphorus dynamics in agricultural used lowland catchments in NE-Germany. IPW8, 12.-16.09.2016, Rostock

Koch, S., Kahle, P., Lennartz, B.: Visualization of colloid transport pathways in mineral soils. IPW8, 12.-16.09.2016, Rostock

Koch, M., Kruse, J., Eichler-Löbermann, B., Zimmer, D., Willbold, S., Leinweber, P., Siebers, N.: Phosphorus stocks and speciation in top- and subsoils of a long-term fertilization experiment: evidence from sequential fractionation, 31P-NMR, and P K-edge XANES spectroscopy. IPW8, 12.-16.09.2016, Rostock

Koegst, T., Lennartz, B.: Low-cost recyclable filter media for phosphate elimination. IPW8, 12.-16.09.2016, Rostock

Krämer, I., Nausch, G., Börner, R., Mehl, D., Lennartz, B.: Phosphorus from source to sea – Integrated phosphorus and water resources management for sustainable water protection (PhosWaM). IPW8, 12.-16.09.2016, Rostock

Kunz, F., Hiller, A., Lipka, M., Böttcher, M. E., Schernewski, G., Bathmann, U.: Phosphorus-related Services of Sediments in German Coastal Seas - Aspects of the SECOS Project. IPW8, 12.-16.09.2016, Rostock

Leinweber, P.: InnoSoilPhos – a new long-term research program in Germany. IPW8, 12.-16.09.2016, Rostock

Mahnke, B.: The effect of soil P on legume distribution and biodiversity on small spatial scales. European Grassland Federation (EGF2016), 04.-10.09.2016, Trondheim, Norwegen

Mahnke, B., Müller, J., Wrage-Mönnig, N: Effect of soil phosphorus availability on legume distribution and phytodiversity. IPW8, 12.-16.09.2016, Rostock

Meissner, R., Leinweber, P.: Phosphorus fertilisation and – leaching: new insights from long-term lysimeter studies. IPW8, 12.-16.09.2016, Rostock

Nausch, M., Achterberg, E., Bach, L., Goldstein, J., Hellemann, D., Czerny, J., Schulz, K., Riebesell, U.: Phosphorus cycling within a low productive plankton community in the Gulf of Finland (Northern Baltic Sea). IPW8, 12.-16.09.2016, Rostock

Nausch, M., Woelk, J., Kahl, P., Nausch, G., Leipe, T., Lennartz, B.: Elemental composition of particulate inorganic phosphorus in discharges from an artificially drained lowland catchment. IPW8, 12.-16.09.2016, Rostock

Recknagel, C., Sjöberg, P., Abraham, M., Schulz-Bull, D.: Determination of Inositol Phosphates in Aquatic Systems of the German Baltic Coastal Area. IPW8, 12.-16.09.2016, Rostock

Schaub, I., Schumann, R., Karsten, U.: Phosphorus demand in phytoplankton communities - alkaline phosphatase activity as a proxy? IPW8, 12.-16.09.2016, Rostock

Schumann, R., Berthold, M., Zimmer, D.: Phosphorus extraction from various environmental and biological materials. IPW8, 12.-16.09.2016, Rostock

Skeff, W., Recknagel, C., Schulz-Bull, D.: Development and Validation of an Analytical Method for the Determination of Glyphosate, Glufosinate, AMPA and 2-AEP in Seawaters. IPW8, 12.-16.09.2016, Rostock

Steinbauer, J., Büttner, H., Werner, T.: Bifunctional phosphonium salts for the conversion of CO2 with terminal and internal oxiranes. 49. Jahrestreffen deutscher Katalytiker, 16.-18.03.2016, Weimar

Strauch, S., Knaus, U., Bischoff, A.A., Palm, H.W.: Phosphorus limited aquaponics – causes and consequences. IPW8, 12.-16.09.2016, Rostock

van Laak, M., Buczko, U.: The equivalence of the CAL and DL extraction method to assess the amount of plant available phosphorus in soils. IPW8, 12.-16.09.2016, Rostock

Wacker, K., Dehmer, K. J., Eichler-Löbermann, B., Uptmoor, R.: Genetic regulation of phosphatase production and activity to increase P uptake from deficient soils. IPW8, 12.-16.09.2016, Rostock

Zacher, A., Baum, C., Gerowitt, B., de Mol, F., Dehmer, K. J.: Mechanisms of P mobilization in the rhizosphere involving weeds and crop plants. IPW8, 12.-16.09.2016, Rostock

Zimmer, D., Panten, K., Leinweber, P.: Bone char as novel alternative phosphorus fertilizer: from submicroscopic characterization to fertilization experiments. IPW8, 12.-16.09.2016, Rostock

6.3 Press

Zukunftsfähige Nutztierhaltung, Artikel in Leibniz Nordost, Dezember 2016 (S.10/11)

FBN, INP, IOW, LIKAT: IPW8-Konferenz zu Phosphor-Problematik, Artikel in Leibniz Nordost, Dezember 2016 (S. 16)

Dünger lässt sich recyclen, Artikel in den Salzburger Nachrichten, 16.11.2016 (S. 19)

Internationaler Phosphorworkshop, Artikel in der wwt wasserwirtschaft-wassertechnik 10/2016.

Neues aus der Phosphorforschung: 8. International Phosphorus Workshop (IPW8) vom 12.-16.9.2016 in Rostock - Artikel auf www.deutsche-phosphor-plattform.de, 07.10.2016.

Challenges of phosphorus: International IPW8 Conference, Rostock, identifies solutions - Artikel auf www.phosphorusplatform.eu, Oktober 2016

Lösung für Überdüngung gesucht - Phosphorkongress nimmt Tierhaltung ins Visier - Artikel in Norddeutsche Neueste Nachrichten, 13.09.2016

Kongress: Immer noch zu hoher Phosphorverbrauch - Artikel in der Ostseezeitung, 13. September 2016

Wird der Phosphor knapp? - Interview mit Ulrich Bathmann auf Deutschlandfunk, 12.09.2016

Rostocker Kongress: Immer noch zu hoher Phosphorverbrauch - Artikel auf bild.de, 12. September 2016

Die Phosphorquellen ergründen: Phosphorprojekt an der Warnow - Artikel auf svz.de, 28. Juli 2016

Ritterschlag für Rostocker Uni-Chemiker - Artikel auf idw-online.de, 01.04.2016

Backhaus: Reform der Düngeverordnung muss kommen – Chance für den Innovationsstandort MV - Ministerium für Landwirtschaft, Umwelt und Verbraucherschutz Artikel Nr.036/2016, 28.01.2016

Aufbruch nach Chile: Rostocker Forscher erkunden Biologische Bodenkrusten - Artikel auf das-ist-rostock.de, 11.01.2016

Aktenzeichen P - Artikel auf bestewelten.de, 03.01.2016

Ritterschlag für Rostocker Uni-Chemiker: Rostocker Chemiker punkten volle Zahl mit dem Element Phosphor. Pressemeldung der Universität Rostock vom 19.04.2016. Würdigung der Phosphorforschung vom Lehrstuhl für Anorganische Chemie in Zusammenarbeit mit Wissenschaftlern des LIKATS. (s. Anhang)

6.4 Websites

Leibniz-WissenschaftsCampus Phosphorforschung Rostock: www.wissenschaftscampus-rostock.de (www.sciencecampus-rostock.de; www.p-campus-rostock.de) → inter alia 13 news (2016)

Leibniz-Association/ScienceCampi: https://www.leibniz-gemeinschaft.de/en/research/leibniz-sciencecampi/phosphorous-research/

University of Rostock/Interdisciplinary Faculty/Maritime Systems: http://www.inf.uni-rostock.de/mts/wissenschaftscampus-rostock-phosphorforschung/ (not available from 2017 on because of a new structure)

6.5 Others

PANEL DISCUSSION "Handling the phosphorus paradox in agriculture and natural ecosystems: scarcity, necessity and burden of P". 8th International Phosphorus Workshop, Rostock, 16.09.2016 (U. Bathmann, F. Ekardt)

Excursion "A trip to the coast: The Leibniz Institute for Baltic Sea Research and the `Hütelmoor fen' (Responsible: M. Nausch, Leibniz Institute for Baltic Sea Research Warnemünde), within the IPW8, 14.09.2016, Rostock

Excursion "Energy from biomass: Visit experimental and industrial energy production plants" (Responsible: B. Eichler-Löbermann, University of Rostock) within the IPW8, 14.09.2016, Rostock

Excursion "Extremely fertile soils in the Baltic coast region: natural phenomena or anthropo-/pedogenesis?" (Responsible: P. Leinweber, University of Rostock) within the IPW8, 14.09.2016, Rostock

Excursion „Full scale P-recycling from dairy-industry wastewater" (Responsible: J. Tränckner, University of Rostock) within the IPW8, 14.09.2016, Rostock

Excursion "Phosphorus analytics" (Responsible: W. Baumann, Leibniz Institute for Catalysis and D. Schulz-Bull, Leibniz Institute for Baltic Sea Research Warrnemünde) within the IPW8, 14.09.2016, Rostock

Science Night, University of Rostock. Information desk of the Leibniz ScienceCampus Phosphorus Research Rostock. K. Heide, S. Jahn, C. Recknagel, J. Schneider, I. Krämer. 28.04.2016.

7 Structure and committees

7.1 Structure

The ScienceCampus Phosphorus Research Rostock is assigned to the University of Rostock's Interdisciplinary Faculty (INF), Department of Maritime Systems.

The organisation of the ScienceCampus Phosphorus Research Rostock is as follows: The **Directorship** is made up of the Directors of the participating Leibniz Institutes and the Rector of the University of Rostock. They can be represented by members of their institutions. Through the **Steering Committee** representatives of the Leibniz Institutes and the University of Rostock assume direct leadership of the ScienceCampus. They are represented by a **Spokesperson**. Direct **coordination** is carried out by a staff scientist, supported by a secretary. An international **Scientific Advisory Council** oversees the ScienceCampus Phosphorus Research and in addition to advising has the task of evaluating the scientific work of the ScienceCampus. Currently, more than 70 scientists and 12 PhD students from 45 Working Groups are **Members** (see Partners and Members) of the ScienceCampus Rostock.

The Institute for Baltic Sea Research Warnemünde acts as beneficiaries and provides the coordination office.

Abb.2: Structure of the ScienceCampus Rostock

7.2 Committes

7.2.1 Scientific Advisory Council

Prof. Dr. Emmanuel Frossard, ETH Zürich
Prof. Dr. Ellery D. Ingall, Georgia Institute of Technology
Prof. Dr. Christian Müller, FU Berlin
Prof. Dr. Hisao Ohtake, Osaka University Japan
Prof. Dr. Paul Withers, Prifysgol, Bangor University/UK

7.2.2 Directorship

Prof. Dr. Ulrich Bathmann, IOW
Prof. Dr. Matthias Beller, LIKAT
Prof. Dr. Andreas Graner, IPK
Prof. Dr. Wolfgang Schareck, UoR
Prof. Dr. Klaus-Dieter Weltmann, INP
Prof. Dr. Klaus Wimmers, FBN

7.2.3 Spokesperson

Prof. Dr. Ulrich Bathmann, IOW

7.2.4 Steering committee

Prof. Dr. Ulrich Bathmann, IOW
Dr. Volker Brüser, INP
Dr. Klaus Dehmer, IPK
Prof. Dr. Ulf Karsten, UoR
Dr. Inga Krämer
Prof. Dr. Udo Kragl, UoR
Prof. Dr. Peter Leinweber, UoR (spokesperson UoR)
Prof. Dr. Detlef Schulz-Bull, IOW
Dr. Thomas Werner, LIKAT
Prof. Dr. Klaus Wimmers, FBN

Vertretungen:
PD Dr. Tom Goldammer, FBN
Dr. Stephan Reuter, INP

Prof. Dr. Axel Schulz, UoR/LIKAT
Prof. Dr. Marko Hapke, LIKAT
Evelin Willner, IPK

7.2.5 Coordination office

(Work and tasks 2016: see Appendix)
Dr. Inga Krämer
Daniela Derlet-Eichler (Secretary, in parental leave until 04/2016)
Julia Schneider (Secretary, during parental leave of D. Derlet-Eichler, until 04/2016)

7.2.6 Members

(Status: Updated during 2016)

Leibniz Institute for Catalysis (LIKAT) at the University of Rostock

Prof. Dr. Matthias Beller	Applied Homogeneous Catalysis	Cluster III
Prof. Dr. Armin Börner	Asymmetric Catalysis	Cluster III
Hendrik Büttner	Organocatalysis	Cluster III
Dr. Marko Hapke	Cycloadditions and Transition Metal Catalysis	Cluster III
Dr. Dirk Michalik	Analytical Service	Cluster III
Prof. Dr. Uwe Rosenthal	Coordination Chemistry and Catalysis	Cluster III
Johannes Steinbauer	Organocatalysis	Cluster III
Tobias Täufer	Cycloadditions and Transition Metal Catalysis	Cluster III
Dr. Thomas Werner	Organocatalysis	Cluster III

Leibniz Institute for Farm Animal Biology (FBN), Dummerstorf

Christian Gerlinger	Genome Biology	Cluster II
PD Dr. Tom Goldammer	Genome Biology	Cluster II
Franziska Just	Genome Biology	Cluster II
Dr. Michael Oster	Genome Biology	Cluster II
Prof. Dr. Klaus Wimmers	Genome Biology / Director	Cluster II

Leibniz-Institut für Ostseeforschung Warnemünde (IOW)

<u>Directorate</u>		
Prof. Dr. Ulrich Bathmann	Director	Cluster I
Dr. Inga Krämer	Coordination Office	
<u>Department Biological Oceanography</u>		
Franziska Bitschofsky	Microbial Processes and Phosphorus Cycle	Cluster I
Philipp Braun	Microbial Processes and Phosphorus Cycle	Cluster I
Sandra Jahn	Microbial Processes and Phosphorus Cycle	Cluster I
Dr. Monika Nausch	Microbial Processes and Phosphorus Cycle	Cluster I
Dr. Angela Vogts	NanoSIMS Lab	Q
<u>Department Marine Geology</u>		
Prof. Dr. Michael Böttcher	Geochemistry and Stable Isotope Biogeochemistry	Cluster I, Q
Dr. Thomas Leipe	Microanalysis	Cluster I, Q
Marko Lipka	Geochemistry and Stable Isotope Biogeochemistry	Cluster I, Q

Department Marine Chemistry

Dr. Marion Abraham	Organic Contaminants	Cluster I, Q
Dr. Günther Nausch	General Marine Chemistry	Cluster I, Q
Constantin Recknagel	Organic Contaminants	Cluster I, Q
Dr. Oliver Schmale	Biogeochemistry Trace Gases	Cluster I, Q
Prof. Dr. Detlef Schulz-Bull	Organic Contaminants	Cluster I, Q
Dr. Wael Skeff	Organic Contaminants	Cluster I, Q

Department Physical Oceanography and Instrumentation

Dr. René Friedland	Baltic Sea system dynamics	Cluster I
Dr. Thomas Neumann	Baltic Sea system dynamics	Cluster I
Dr. Hagen Radtke	Baltic Sea system dynamics	Cluster I

Leibniz Institute for Plant Genetics and Crop Plant Research (IPK), Satellite Collec-tions North, Groß Lüsewitz

Dr. Klaus Dehmer	Genebank, Satellite Collections North	Cluster II
Prof. Dr. Andreas Graner	Director	Cluster II
Evelin Willner	Genebank, Satellite Collections North	Cluster II

Leibniz Institute for Plasma Research and Technology (INP), Greifswald

Dr. Volker Brüser	Catalytic Materials	Cluster II
Sina Jahanbakhsh	Catalytic Materials	Cluster II
Dr. Stephan Reuter	Plasma Medicine/Decontamination	Cluster II
Prof. Dr. Klaus-Dieter Weltmann	Director	

University of Rostock

Faculty of Agricultural and Environmental Sciences

PD Dr. Christel Baum	Soil Science	Cluster II
Dr. Karen Baumann	Soil Science	Cluster II
Dr. Adrian Bischoff-Lang	Aquaculture and Sea-Ranching	Cluster I, II
Dr. Luisa Borgelt	Nutrient Physiology and Animal Nutrition	Cluster II
Dr. Uwe Buczko	Landscape Ecology and Site Evaluation	Cluster I
Dr. Jörg Burgstaler	Agricultural Technology and Process Engineering	Cluster II
Michael Cramer	Water Resources Management	Cluster II
apl. Prof. Dr. Bettina Eich-ler-Löbermann	Agronomy	Cluster II
Beatrice Garske	Research Unit Sustainability and Climate Policy	Cluster II
Prof. Dr. Bärbel Gerowitt	Crop Health	Cluster II
Dr. Manuela Görs	Soil Science	Cluster II
Theresa Gropp	Agronomy	Cluster II
Peter Gros	Soil Science	Cluster II
Jennifer Grünes	Waste Management and Material Flow	Cluster II
Dr. Petra Kahle	Soil Physics	Cluster I, II

Prof. Dr. Norbert Kanswohl	Agricultural Technology and Process Engineering	Cluster II
Svenja Karstens	Landscape Ecology and Site Evaluation	Cluster I
Dipl. Agr.-Ing. Ulrich Knaus	Aquaculture and Sea-Ranching	Cluster I, II
Stefan Koch	Soil Physics	Cluster I
Prof. Dr. Peter Leinweber	Soil Science	Cluster II,Q
Prof. Dr. Bernd Lennartz	Soil Physics	Cluster I, II
Barbara Mahnke	Grassland and Fodder Sciences	Cluster I
Dr. Gert Morscheck	Waste Management and Material Flow	Cluster II
Mohsen Morshedizad	Soil Science	Cluster II
Dr. Jürgen Müller	Landscape Ecology and Site Evaluation	Cluster I
Prof. Dr. Michael Nelles	Waste Management and Material Flow	Cluster II
Prof. Dr. Harry Palm	Aquaculture and Sea-Ranching	Cluster I, II
Sebastian Strauch	Aquaculture and Sea-Ranching	Cluster I, II
Jessica Stubenrauch	Research Unit Sustainability and Climate Policy	Cluster II
Prof. Dr. Jens Tränckner	Water Resources Management	Cluster II
Prof. Dr. Ralf Uptmoor	Agronomy	Cluster II
Michael van Laak	Landscape Ecology and Site Evaluation	Cluster II
Telse Vogel	Agronomy	Cluster II
Kathrin Wacker	Agronomy	Cluster II
Jutta Wieding	Research Unit Sustainability and Climate Policy	Cluster II
Dr. Denny Wiedow	Agricultural Technology and Process Engineering	Cluster II
Prof. Dr. Petra Wolf	Nutrient Physiology and Animal Nutrition	Cluster II
Prof. Dr. Nicole Wrage-Mönnig	Grassland and Fodder Sciences	Cluster II
Annika Zacher	Soil Science	Cluster II
Dr. Dana Zimmer	Soil Science	Cluster II
Faculty of Law		
Caroline Douhaire	Research Unit Sustainability and Climate Policy	Cluster II
Prof. Felix Ekardt	Research Unit Sustainability and Climate Policy	Cluster II
Faculty of Mathematics and Natural Sciences		
Dr. Ashour Ahmed	Institute of Physics, Molecular Quantum Dynamics	Cluster Q
Maximilian Berthold	Institute for Biological Sciences, Applied Ecology & Phycology	Cluster I, Q
Dr. Jonas Bresien	Institute for Chemistry, Anorganic Chemistry	Cluster III
PD Dr. Stefan Forster	Institute for Biological Sciences, Marine Biology	Cluster I
Prof. Ulf Karsten	Institute for Biological Sciences, Applied Ecology & Phycology	Cluster I, II
Prof. Udo Kragl	Institute for Chemistry, Analytical & Technical Chemistry; Technical Chemistry	Cluster III
Prof. Oliver Kühn	Institute of Physics, Molecular Quantum	Q

	Dynamics	
Iris Schaub	Institute for Biological Sciences, Applied Ecology & Phycology	Cluster I
Prof. Dr. Axel Schulz	Institute for Chemistry, Anorganic Chemistry	Cluster III
PD Dr. Rhena Schumann	Institute for Biological Sciences, Applied Ecology & Phycology, Biological Station Zingst	Cluster I, Q
Rostock University Medical Center		
Prof. Brigitte Vollmar	Institute for Experimental Surgery, University Medicine Rostock	Cluster II

8 Funding

In 2016, the ScienceCampus Rostock was funded by the Ministry of Agriculture, Environment, and Consumer Protection Mecklenburg-Vorpommern and by the Leibniz Association. Substantial contributions also came from the participating Leibniz Institutes and the University of Rostock. External funding by third parties for phosphorus research at the ScienceCampus Rostock was obtained as well (see Table 1).

Funds from the Ministry of Agriculture, Environment, and Consumer Protection Mecklenburg-Vorpommern (€85,000 in 2016) were mainly used to finance the Coordination Office of the ScienceCampus Rostock. Since 2014, the Coordination Office, located at the IOW, has consisted of two employees: a scientist and a secretary.

In 2015, the ScienceCampus Rostock was awarded a total of €1.2 million to be distributed over a period of 4 years to partially fund 11 interdisciplinary PhD projects.

APPENDIX

WISSENSCHAFTSCAMPUS
PHOSPHORFORSCHUNG
ROSTOCK

Program of the
8th International Phosphorus Workshop IPW8
(12.-16.09.2016)

Monday, September 12, 2016

14:00	Registration
16:00 - 16:40	**Opening remarks**
16:40 - 17:20	***Keynote talk:*** **Jarvie:** Back to the future: Historical phosphorus fluxes, legacies, and water-quality management
17:20	***Keynote talk:*** **Kaasinen:** Towards sustainable phosphorus management in the Baltic Sea region
18:00 - 22:00	**Welcome reception**

Tuesday, September 13, 2016

Theme 2 Sufficiency and Efficiency of Phosphorus Utilization		Theme 3 Phosphorus Recycling - Technologies and Product Applications	
09:00 - 09:40	***KEYNOTE* Frossard:** How much phosphorus do our agro-ecosystems really need?	09:00 - 09:40	***KEYNOTE* Kabbe:** Circular economy - challenges and opportunities for phosphorus recycling
09:40 - 10:00	**Eichler-Löbermann, Busch, Brand, Stahn, Miegel, Uptmoor:** Phosphorus utilization in mixed cropping systems	09:40 - 10:00	**Folberth, Binder:** Global flows of nitrogen and phosphorus embedded in agricultural products and recycling potential
10:00 - 10:20	**McLaren, Simpson, McLaughlin, McBeath, Smernik, Guppy, Richardson:** The fertilizer phosphorus use efficiency of leguminous-based pastures under different management in the high rainfall zone of south eastern Australia	10:00 - 10:20	**Bünemann, Symanczik, Koller, Menold, Oelmann, Stemann:** Evaluation of pyrolysis chars from sewage sludge as phosphorus fertilizers
10:20 - 10:40	**Meyer, Bünemann, Frossard, Maurhofer, Mäder, Oberson:** Can inoculation with *Pseudomonas protegens* CHA0 enhance the mobilization of scarcely soluble phosphorus from soil and uptake by *Lolium multiflorum?*	10:20 - 10:40	**Herzel, Adam, Stemann, Hermann:** A thermochemical process for P-fertilizer production from sewage sludge ashes investigated from lab to industrial scale
10:40 – 11:10 Coffee Break			
11:10 - 11:30	**Bruun, Harmer, Bekiaris, Christel, Zuin, Hu, Jensen, Lombi:** The effect of P speciation on soil availability of P in biochar produced from solid fraction of manure at different pyrolysis temperatures	11:10 - 11:30	**Amann, Egle, Zoboli, Rechberger, Zessner:** Impact of co-incineration of refuse derived fuels (RDF) on sewage sludge ash quality with focus on P-recovery
11:30 - 11:50	**Rodehutscord:** Possibilities and perspectives to improve P efficiency in livestock feeding	11:30 - 11:50	**Herr, Mocker, Mayer:** Phosphorus recycling in the mineral fertilizer industry - co-processing of sewage sludge ash during chemical wet phosphoric acid production
11:50 - 12:10	**Oster, Just, Büsing, Muráni, Polley, Vollmar, Wolf, Ponsuksili, Wimmers:** Elucidating the biodiversity of P homeostasis towards improved P efficiency in pigs	11:50 - 12:10	**Ohtake, Okano, Kunisada, Takano, Masuda:** Innovatively simple technology for phosphate recovery using a bifunctional adsorption- aggregation agent
12:10 - 12:30	**Zhang, Hao, Tan, Welacky, Wang, Hao, Hong:** Long-term cumulative contribution of phosphorus-based swine manure application to soil test phosphorus under corn-soybean rotation	12:10 - 12:30	**Tränckner, Beetz, Koegst, Cramer:** Cost-efficient phosphorus removal in rural waste water treatment plants (WWTP)
12:30 – 13:30 Lunch Break			
13:30 – 15:00 Poster Presentations (‚Slam') Theme 2, 3			
15:00 – 15:30 Coffee Break			
15:30 – 17:00 Poster Presentations			
17:30 – 19:00 Guided City Walk			

Wednesday, September 14, 2016

Theme 1 Phosphorus Cycles and Fluxes in the Environment		Theme 7 Phosphorus: Characterization and Use Efficiency	
09:00 - 09:40	***KEYNOTE* Ingall:** Nature and dynamics of marine dissolved organic phosphorus	09:00 - 09:20	**Rydin, Sjöberg, Kumblad, Ek:** Organic phosphorus forms in Baltic Sea sediments
		09:20 - 09:40	**Hupfer, Herzog, Jordan, Rothe, Kleeberg:** The long-term storage of phosphorus via vivianite formation in iron rich surface sediments is prevented by nitrate
09:40 - 10:00	**Mellander, Jordan, Bechmann, Shore, McDonald, Fovet, Gacuel-Odoux:** Weather amplifications as overriding drivers of P loss in Western Europe	09:40 - 10:00	**Richardson, McLaren, McBeath, McLaughlin, Smernik, Guppy, Moore, Simpson:** Inefficiencies associ-ated with phosphorus fertilization of a grazed pasture system
10:00 - 10:20	**Zilla, Angulo-Schipper, Carlos Méndez, Dippold, Kuzyakov, Spielvogel:** Effects of spatial P heterogeneity on microbial P uptake and community structure in forest soils	10:00 - 10:20	**Duboc, Santner, Golestani Fard, Tacconi, Zehetner, Wenzel:** A complementary set of methods to characterize P availability from fertilizers of varying origin and solubility
10:20 - 10:40	**Ulén, Stenberg, Wesström:** Using a waterflow flashiness index as predictor for phosphorus losses from subsurface drains on a Swedish farm with clay soils	10:20 - 10:40	**Nawara, van Dael, Amery, Warrinier, Vermeiren, Plevoets, Elsen, Odeurs, Vandendriessche, Roisin, McGrath, Jouany, Pellerin, Denoroy, Eichler-Löbermann, Börjesson, Merckx, Smolders:** Soil phosphorus tests compared on established European long-term trials: which test is the winner?
10:40 – 11:10 Coffee Break			
11:10 - 11:30	**Shore, Melland, Mellander, Jordan:** The relative and combined impacts of storm and low-flow phosphorus pressures on stream ecology in agricultural catchments: a five year study	11:10 - 11:30	**Nkebiwe, Weinmann, Bar-Tal, Müller:** Placement of P and N to improve crop nutrient acquisition and yield: a meta-analysis
11:30 - 11:50	**Gruau, Gu, Dupas, Gascuel-Odoux, Rumpel:** Complex inter-play of soil characteristics, groundwater dynamics and biogeochemical processes on the release of dissolved phosphorus from riparian vegetated buffer strips	11:30 - 11:50	**Buczko, van Laak:** Re-evaluation of Phosphorus fertilizer recommendations based on meta-analyses of long-term field experiments
11:50 - 12:10	**Berthold, Schumann:** How the catchment area prevents the "good ecological state" of a shallow estuary. A case study in the coastal water bodies of the southern Baltic Sea	11:50 - 12:10	**Gu, Gruau, Dupas, Gascuel-Odoux, Rivard, Marcel:** Distribution of Phosphorus-containing colloids in shallow groundwater from a small agricultural catchment as revealed by the combination of ultrafiltration, ultracentrifugation, ICP-MS and XANES data
12:10 - 12:30	**Nausch, Nausch, Leipe, Neumann:** Phosphorus in the Baltic Sea – measured since decades, but really understood?	12:10 - 12:30	**Polain, Guppy, Knox, Wilson, Siebers:** Delta18O-P as a marker for depth resolved microbial turnover of phosphorus in native and cropped Australian Vertisols
12:30 – 13:30 Lunch Break			
Excursions (starting times see p. 15)			

Thursday, September 15, 2016

Theme 4 Syntheses of and with Phosphorus-Containing Compounds		Theme 5 The Development of Advanced Phosphorus Analysis Methods	
09:00 - 09:40	***KEYNOTE* Müller:** Recent Developments in the chemistry of low-coordinate phosphorus heterocycles	09:00 - 09:40	***KEYNOTE* Cade-Menun:** Phosphorus research and 31P-NMR spectroscopy: Current knowledge and future directions
09:40 - 10:00	**Zhang, Jiao, Michalik, Selent, Franke, Börner:** Hydrolysis stability of bidentate phosphites utilized as modifying ligands in the Rh-catalyzed n-regioselective hydroformylation of internal olefins	09:40 - 10:00	**Gros, Ahmed, Kühn, Leinweber:** Glyphosate binding in soil as revealed by sorption experiments, mass spectometry and quantum-chemical modeling
10:00 - 10:20	**Holz, Rumpel, Börner:** A new strategy for the synthesis of P-chiral ligands for asymmetric catalysis	10:00 - 10:20	**Gamble, Northrup, Sparks:** Novel spectroscopic techniques to examine soil phosphorous speciation
10:20 - 10:40	**König, Heller:** Rhodium diphosphine complexes in homogeneous catalysis – How to use the catalysts more efficiently?	10:20 - 10:40	**Kubis, König, Selent, Ludwig, Franke, Börner:** In situ-IR-spectroscopy for the study of kinetic and mechanistic aspects of alkene hydroformylation with metal catalysts modified by phosphorus(III) ligands
10:40 – 11:10 Coffee Break			
11:10 - 11:30	**Steinbauer, Büttner, Werner:** CO_2 valorization utilizing new P-based catalysts	11:10 - 11:30	**Oelmann, Sorkau:** Quantification of enzyme-mediated hydrolysis by means of the oxygen isotope ratio of phosphate in grassland and forest soils
11:30 - 11:50	**Grandane, Schirmer, Suna, Werner:** Phosphorus-based organocatalysts for base free catalytic Wittig reaction	11:30 - 11:50	**Sjöberg, Thelin, Rydin:** Separation of inositol phosphate isomers in environmental samples by ion-exchange chromatography coupled with electrospray ionization tandem mass spectrometry
11:50 - 12:10	**Täufer, Hapke, Schulz:** P-N-Compounds as synthons in cyclisation reactions	11:50 - 12:10	**McIntyre, Evershed, Johnes, Arthur, Lloyd:** Application of high resolution mass spectrometry to the characterisation of organic phosphorus in environmental matrices
12:10 - 12:30	**Rabeah, Brückner:** Highly tunable organic-inorganic hybrid materials based on the utility of vanadium organophosphonate clusters	12:10 - 12:30	**von Sperber, Lewandowski, Tamburini, Bernasconi, Frossard, Amelung:** Real-time monitoring of oxygen isotope exchange between phosphate and water using Raman spectrometry
12:30 – 13:30 Lunch Break			
13:30 – 15:00 Poster Presentations (‚Slam') Theme 1, 4, 5, 6			
15:00 – 15:30 Coffee Break			
15:30 – 17:00 Poster Presentations			
18:30 Conference Dinner			

Friday, September 16, 2016

Theme 6
From Knowledge to Action: P-Related Issues in Politics and Society

08:30 - 09:10	***KEYNOTE* Stoll-Kleemann:** Meat consumption, human behaviour and phosphorus
09:10 - 09:30	**Douhaire, Stubenrauch:** EU regulatory and policy objectives relevant to sustainable agricultural land and phosphorus use
09:30 - 09:50	**Garske, Wieding:** Changing animal food consumption as part of phosphorus regulation?
09:50 - 10:10	**Buckley, McDonald, Leach:** What influences the achievement of optimal soil P status at farm level?
10:10 – 10:30 Coffee Break	
10:30 - 10:50	**Klages, Osterburg:** German fertiliser legislation: current and future rules on phosphorus
10:50 – 11:10	**Wang:** Strategies for mitigating China's phosphorus resource crisis
11:10 - 13:00	**PANEL DISCUSSION "Handling the phosphorus paradox in agriculture and natural ecosystems: scarcity, necessity and burden of P" Moderation: Sonja van Renssen**

13:00 End

WISSENSCHAFTSCAMPUS PHOSPHORFORSCHUNG ROSTOCK

Press Release: Latest news from phosphorus research

28.09.2016

Latest news from phosphorus research

The challenges of phosphorus — International IPW8 Conference in Rostock identifies solutions

From September 12 to 16, 2016, the 8th International Phosphorus Workshop (IPW8), entitled "Phosphorus 2020: Challenges for synthesis, agriculture, and ecosystems", took place in Rostock. 230 scientists from around the world discussed possible solutions arising from their latest research regarding the responsible use of this finite raw material. The aim is to avoid serious damage to the environment, such as the eutrophication of water bodies, and to ensure that, through its sustainable use, there will be enough phosphorus to maintain the world's food supply in the future.

According to IPW8 participants, the most important **results** of phosphorus research in recent years include those related to the following aspects:

1. *Phosphate fertilizers and inputs into water bodies:* The latest research continues to show that large amounts of phosphorus still end up in water. The binding water protection objectives set by various guidelines will therefore not be reached. As an important reason, the researchers cited the persisting inefficient use of phosphorus in intensive farming and the inability of traditional agricultural soil testing of plant-available phosphorus to adequately assess the risk of phosphorus seepage. In addition, it was demonstrated that established water protection measures (for example buffer strips, reduced fertilization) have yet to show success because of the long delays until the phosphorus is transported from the soil into water. It was also demonstrated that more extreme precipitation events due to climate change promote the mobilization and leaching of phosphorus.
2. *Improved investigation methods:* In recent years, the refinement of numerous analytical methods has allowed environmental monitoring of the presence of a large number of phosphorus compounds, for example, the weed-killer glyphosate, and their reaction products. Research methods already include the use of very sophisticated isotope and spectroscopic techniques, e.g. synchroton-based X-ray absorption, to carry out very detailed investigations of phosphorus compounds and their transformations.
3. *Phosphorus recycling and synthesis:* For the first time, the various technologies for phosphorus recycling and phosphorus-based chemical catalysis, as forward-looking strategies for the sustainable use of phosphorus, were discussed in the context of an IPW. Both fundamental, new reaction pathways and connections as well as a variety of mature technologies were presented, with phosphorus recovery from sewage sludge, slaughterhouse waste or biogas digestate as important targets.
4. Genetic research approaches: As our understanding of the genetic basis of phosphorus utilization by microorganisms, plants, and animals continually improves, new possibilities and processes related to phosphorus uptake, utilization, and dispersion are open-

ing up. Examples are the identification of gene variants for the breeding of pigs such that they utilize the phosphorus in their feed more effectively, or new feed supplements and feeding regimes that increase the digestibility and utilization of P compounds by animals.

Important **research goals and call for action** identified by the IPW8 participants were:

1. *Integrated system-based research:* So far too little is known about the similarities and differences exhibited by phosphorus transformation processes in various environmental systems, such as in water or on land, and how they are coupled with Earth's other biogeochemical cycles, including those of carbon and nitrogen. In addition, there is little integrated research into the relationship between phosphorus reactions at different size scales, from individual cells to organisms to entire ecosystems. This is important because most ecosystems processes are coupled and can therefore be properly understood only through a holistic approach.
2. *The translation of innovative methodologies into applications:* Both in the area of phosphorus recovery as well as with respect to analytical methods for the detection of plant-available phosphorus in agricultural soils — both of which are important prerequisites for the efficient use of fertilizers — major scientific and technological progress has been made. Yet so far widespread practical application of these technologies is lacking. Among the many different reasons are that either the practical application stage has yet to reach maturity or there are legal obstacles, such as those related to guidelines and regulations, that did not foresee the use of certain procedures. The problems partly lie in the unclear political conditions, such as revision of the Sewage Sludge Ordinance in Germany and European requirements for the recycling of manure. Here the IPW8 researchers recognize the need for action in research as well as in politics.
3. Encourage an awareness and a constant rethinking of problems: A new perspective for the IPW was the inclusion of ethical as well as legal- and political-environmental issues affecting the use of phosphorus. Various aspects, such as the benefits of a balanced diet in the light of phosphorus availability and load or the ability to effectively control phosphorus use through incentives or bans were lively topics of discussion at the conference. It became clear that the biological and agricultural research approaches pursued almost exclusively thus far must now be complemented by social science approaches aimed at making the sustainable use and recovery of phosphorus, via its more environmentally mindful utilization, an accepted practice.

Conclusion: The participants agreed that only a wide range of individual measures implemented "in concert," such as advances in breeding methods, improved agricultural analyses and management measures, new techniques and technologies for the conservation and recovery of phosphorus, new societal norms, greater consumer awareness and complementary policy programs can solve the phosphorus problem. This joint strategy requires the development of new academic structures, such as the Leibniz ScienceCampi, that support the transfer of technologies, methodologies, and ideas.

The **International Phosphorus Workshop (IPW)** takes place every three years in different European countries and is one of the most important events in the field of phosphorus research in Europe. This year, for the first time, Germany was the host and

was able to welcome a record number of participants. The workshop organizer was the Leibniz ScienceCampus Phosphorus Research Rostock, a consortium of five Leibniz institutes, and the University of Rostock.

IPW Chairs:

Prof. Dr. Ulrich Bathmann, Spokesman for the Leibniz ScienceCampus Phosphorus Research Rostock

Prof. Dr. Peter Leinweber, University Spokesman for the Leibniz ScienceCampus Phosphorus Research Rostock

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Leibniz ScienceCampus Phosphorus Research Rostock

Because of the central importance of phosphorus in many production and environmental systems, an interdisciplinary research approach is necessary. Therefore, five Leibniz Institutes and the University of Rostock have joined to form a network to intensify joint research and other forms of cooperation regarding this essential element and its sustainable management. The Leibniz ScienceCampus Phosphorus Research Rostock promotes, as part of its strategic research, interdisciplinarity in its topics, projects and methods. Established fields of expertise in various aspects of the exploration of the essential element P, its different chemical compounds and reactions, and its specific modes of action in agricultural and environmental systems as well as in technical and industrial processes are combined at the ScienceCampus. The ScienceCampus is funded by the Leibniz Association and the Ministry of Agriculture, Environment, and Consumer Protection Mecklenburg-Vorpommern.

PM: Ritterschlag für Rostocker Uni-Chemiker

Ingrid Rieck* Presse- und Kommunikationsstelle *Universität Rostock

Forscher unter Labor-Bedingungen „kleine Künstler"

Paukenschlag für die Rostocker Uni-Chemie: Im neusten Trendbericht der Gesellschaft Deutscher Chemiker (GDCh), in dem jährlich der weltweite Fortschritt des vergangenen Jahres beschrieben wird, wurden fünf Publikationen des Lehrstuhls für Anorganische Chemie der Universität Rostock besonders gewürdigt und hervorgehoben.

„Das ist ein Ritterschlag für die anorganische Chemie in Rostock", sagt der geschäftsführende Direktor des Instituts für Chemie, Professor Axel Schulz. Das Papier verweist auf innovative, kreative und zukunftsweisende Forschungen. Und die Rostocker Chemiker punkten volle Zahl mit dem Element Phosphor. Das ist eins der großen Forschungsthemen an der ältesten Universität im Ostseeraum.

Die Chemiker um Prof. Schulz ziehen unter Laborbedingungen alle Register, tricksen das Element Phosphor bei Versuchen aus, um beispielsweise neue Erkenntnisse über das Nährelement zu erreichen. Wie das geht? „Im Düngerphosphat ist Phosphor zufrieden, also stabil", sagt Prof. Schulz. Unter Laborbedingungen stellen die Rostocker Chemiker hochreaktive Phosphor-Verbindungen her, die, wenn man so will, unzufrieden mit ihrer Situation sind. Die Folge? Stabile Moleküle wie Kohlendioxid können mit diesen Phosphor-Verbindungen reagieren und neue, beziehungsweise wiederverwertbare Verbindungen bilden.

Phosphor, Symbol P, an dem in Rostock so intensiv geforscht wird, ist für alle Lebewesen essentiell. Wenn ein erwachsener Mensch beispielsweise über längere Zeit weniger als 0,7 g Phosphat pro Tag zu sich nimmt, entwickelt er Mangelerscheinungen wie Müdigkeit, Gewichtsverlust, Probleme bei der Knochen- und Zahnbildung und Wachstumsstörungen.

„Wir Chemiker sind aber auch im Sinne einer nachhaltigen Chemie an geschlossenen Stoffkreisläufen interessiert", sagt Prof. Schulz. Ein Beispiel: durch Verbrennungsprozesse entsteht das Treibhausgas Kohlenstoffdioxid (CO2), welches dann im Labor-Versuch durch Reaktionen mit Phosphor-Verbindungen in verwertbare Chemikalien umgewandelt wird. „Unsere Wissenschaftler sind in ihrer experimentellen Forschung unter Laborbedingungen kleine Künstler", ist Prof. Schulz stolz. „Unzufriedener Phosphor" reagiere schon mit Spuren von Luft und Wasser. Das bedeutet, dass in der Forschung alle Experimente unter Ausschluss von Luft erfolgen. Das erfordert spezielle Arbeitstechniken wie z. B. das Arbeiten in Handschuhboxen unter Edelgasatmosphäre.

Eine geringe Effizienz der P-Nutzung, nicht geschlossene Stoffkreisläufe und daraus resultierende Umweltbelastungen stellen aktuell ein Hauptproblem in der gesamtwirtschaftlichen Nutzung von Phosphor und seinen Verbindungen dar. Gelangen große ungenutzte P-Mengen in die Stoffkreisläufe von Ökosystemen, kann dies zu Überdüngung führen, die das ganze System aus dem Gleichgewicht bringt. Ein Beispiel für die Effekte hoher P-Einträge sind die sommerlichen „Blaualgenblüten" in der Ostsee.

Deshalb erforschen die Rostocker Chemiker, insbesondere mit dem Leibniz-Institut für Katalyse (Prof. Matthias Beller, Prof. Marko Hapke und Prof. Uwe Rosenthal) Methoden eines effizienteren Phosphor-Einsatzes. Übergeordnetes Ziel ist darüber hinaus die interdisziplinäre Zusammenarbeit im Leibniz-WissenschaftsCampus Rostock. Die Uni arbeitet mit fünf Leibniz-Instituten an einem nachhaltigen P-Management. „Wir haben dabei die verschiedensten Aspekte der Erforschung des essentiellen Elementes Phosphor, seiner

vielfältigen chemischen Verbindungen und spezifischen Wirkungsweisen in Agrar- und Umweltsystemen wie auch in technischen und industriellen Prozessen im Auge", sagt Prof. Schulz. Text: Wolfgang Thiel

Doktoranden aus Rostock weltweit gefragt

An der herausragenden Rostocker Phosphor-Forschung der Universität Rostock sind junge Doktoranden beteiligt, die bereits weltweit gefragt sind. Dr. Alexander Hinz hat nach seiner Promotion sofort ein dreijähriges Postdoc-Stipendium von der Universität Oxford erhalten. „Für meine jetzige Position als wissenschaftlicher Mitarbeiter in Oxford wurden die Grundlagen in Rostock geschaffen", sagt der junge Forscher. „Das gewisse Etwas, das mich von anderen Bewerbern unterschied, ist der Erfolg der vorangegangenen Forschung, und der baut im Wesentlichen auf der exzellenten Spezialausbildung in der Gruppe von Prof. Axel Schulz auf". Diese erstrecke sich auf alle Aspekte der modernen anorganischen Molekülchemie von der Handhabung extrem empfindlicher Substanzen über Methoden der Charakterisierung bis hin zu bindungstheoretischen Betrachtungen. Durch Fleiß und Kreativität, so Alexander Hinz, sowie einer Portion Glück sei es der Gruppe gelungen, über Jahre hinweg herausragende Resultate zu erzielen, was sich eben auch in den „Nachrichten" widerspiegele.

Jonas Bresien hat für die Forschungen bei Prof. Schulz ein FCI-Stipendium (Fond der chemischen Chemie) erhalten, das Beste in der Chemie, das vergeben wird. Und Katharina Sievert wurde schon vor der Promotionsprüfung von einem großen chemischen Unternehmen abgeworben.

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Program of the lecture series Phosphorus Research winter term 15/16

WISSENSCHAFTSCAMPUS
PHOSPHORFORSCHUNG
ROSTOCK

Ringvorlesung

Phosphorforschung

Interdisziplinäre Herangehensweise an ein lebenswichtiges Element

Zeit: Wintersemester 2015/2016, mittwochs 17:00-18:30 Uhr
Ort: Hörsaal 001 „Hans Spemann", A.-Einstein-Str. 3

Datum	Vortragsthema	Referent
14.10.2015	Phosphorus mirabilis	Prof. Dr. Axel Schulz, Anorganische und Elementorganische Chemie, Universität Rostock
21.10.2015	Phosphor: Ein wichtiger Baustein in Katalyse und Chemie	Dr. habil. Marko Hapke, Cycloadditionen und Übergangsmetallkatalyse, Leibniz-Institut für Katalyse (LIKAT)
28.10.2015	Der marine Phosphor-Kreislauf	Prof. Dr. Detlef Schulz-Bull, Meereschemie/ Organische Fremdstoffe, Leibniz-Institut für Ostseeforschung Warnemünde (IOW)
04.11.2015	Phosphorus – a critical element in wetland conservation and restoration	Dr. Steve Robinson, Geography and Environmental Science, University of Reading (UK)
11.11.2015	Nährstoffe in den deutschen Küstengewässern und in der Ostsee	Dr. Günther Nausch, Meereschemie, Leibniz-Institut für Ostseeforschung Warnemünde (IOW)
18.11.2015	Leibniz-WissenschaftsCampi und weitere universitäre Forschungsinitiativen	Prof. Dr. Ulrich Bathmann, Direktor Leibniz-Institut für Ostseeforschung Warnemünde (IOW), Sprecher WissenschaftsCampus
25.11.2015	Der Phosphorzyklus und seine Anwendung in landbasierten Aquaponiksystemen	Prof. Dr. Harry Palm, Aquakultur und Sea-Ranching, Universität Rostock
02.12.2015	Wofür und wie effektiv nutzen Tiere Phosphor – Neue Einblicke aus „omics-Studien"	Prof. Dr. Klaus Wimmers, Genombiologie, Leibniz-Institut für Nutztierbiologie (FBN)
09.12.2015	Eutrophierung flacher Küstengewässer durch Phosphor: Was nun?	PD Dr. Rhena Schumann, Angewandte Ökologie, Universität Rostock
16.12.2015	Phosphor im Abwasser: Emission, Reduzierung, Recycling	Prof. Dr. Jens Tränckner, Wasserwirtschaft, Universität Rostock
06.01.2016	Beitrag der Kreislaufwirtschaft zur Phosphor-Versorgung - Grundlagen, Technologien & Grenzen	Prof. Dr. Michael Nelles, Abfall- und Stoffstromwirtschaft, Universität Rostock
13.01.2016	Knochenkohle - ein interessantes Recyclingmaterial mit Düngewirkung	Prof. Dr. Peter Leinweber, Bodenkunde, Universität Rostock
20.01.2016	Phosphor-Versorgung im Pflanzenbau mit Beispielen aus der internationalen Agrarforschung	Prof. Dr. Bettina Eichler-Löbermann, Pflanzenbau, Universität Rostock
27.01.2016	Nachhaltiges Phosphor-Management: Gesellschaftliche, politische und rechtliche Aspekte	Prof. Dr. Felix Ekardt, Forschungsstelle Nachhaltigkeit und Klimapolitik & Universität Rostock

WISSENSCHAFTSCAMPUS PHOSPHORFORSCHUNG ROSTOCK

Program of the lecture series Phosphorus Research winter term 16/17

WISSENSCHAFTSCAMPUS PHOSPHORFORSCHUNG ROSTOCK

Ringvorlesung Phosphorforschung

Interdisziplinäre Herangehensweise an ein lebenswichtiges Element

Zeit: Wintersemester 2016/2017, donnerstags 15:00-16:30 Uhr
Ort: Hörsaal 002 „Karl von Frisch" (Biowiss.), A.-Einstein-Str. 3, 18059 Rostock

Datum	Vortragsthema	Referent
03.11.2016	Phosphorversorgung und Phosphordüngung landwirtschaftlich genutzter Böden	Dr. Hans-Eberhard Kape, LMS Agrarberatung – Landwirtschaftliche Fachbehörde
10.11.2016	Einfluss variierender Phosphorgehalte im Futter auf die Knochendichte und -zusammensetzung beim wachsenden Ferkel	Prof. Dr. Petra Wolf, Ernährungs-physiologie und Tierernährung, Universität Rostock
17.11.2016	Die Rolle biologischer Bodenkrusten im Phosphorkreislauf	Dr. Karen Baumann, Bodenkunde, Universität Rostock
24.11.2016	Phosphatmagelanpassung bei Cyanobakterien - Molekulare Grundlagen und die Anpassung des Ostseecyanobakteriums Nodularia spumigena CCY9414	Prof. Dr. Martin Hagemann, Pflanzenphysiologie, Universität Rostock
01.12.2016	Phosphaternährung der Pflanzen im ökologischen Landbau. Der Beitrag der chemischen Phosphatmobilisierung	PD Dr. Jörg Gerke, Landwirt
08.12.2016	Landseitige Phosphoreinträge in die Ostsee - Entwicklung, Herkunft und Reduzierungsansätze	Dr. Clemens Engelke & Franka Koch, Landesamt für Umwelt, Naturschutz und Geologie MV
15.12.2016	Phosphor-Austragspfade und -Muster in landwirtschaftlich genutzten Tieflandeinzugsgebieten	Prof. Dr. Bernd Lennartz, Ressourcenschutz und Bodenphysik, Universität Rostock
05.01.2017	Phosphorhaltige Verbindungen in der organischen Synthese und Katalyse	Dr. Thomas Werner, Organokatalyse, Leibniz-Institut für Katalyse (LIKAT)
12.01.2017	Membranen als Phosphatspeicher - Wie Pflanzen auf Phosphatmangel reagieren	Dr. Meike Siebers, Institut für Molekulare Physiologie und Biotechnologie der Pflanzen (IMBIO), Universität Bonn
19.01.2017	Das P-Dilemma ökologisch bewirtschafteter Grünlandstandorte - Phytodiversität versus Produktionsfunktion?	Dr. Jürgen Müller, Grünland und Futterbauwissenschaften, Universität Rostock
26.01.2017	Glyphosat - Anwendungen in der Landwirtschaft und Auswirkungen auf Ackerunkräuter	Prof. Dr. Bärbel Gerowitt, Phytomedizin, Universität Rostock
02.02.2017	Phosphorus as a key element in cellular signaling and biological energy transductions	Prof. Dr. Inna Sokolova, Marine Biologie, Universität Rostock
Verschiebung	Polyphosphat-speichernde Bakterien im Meer	Prof. Dr. Heide Schulz-Vogt, Leibniz-Institut für Ostseeforschung Warnemünde
16.02.2017	Technologisches Potential von Niedertemperaturplasmen beim Phosphor-Recycling	Dr. Volker Brüser, Katalytische Materialien, Leibniz-Institut für Plasmaforschung und Technologie

WISSENSCHAFTSCAMPUS PHOSPHORFORSCHUNG ROSTOCK

Leibniz ScienceCampus Phosphorus Research Rostock

Tasks of the Coordination Office 2016 (report to the Ministry of Agriculture, Environment and Consumer Protection MV)

The Leibniz ScienceCampus Phosphorus Research Rostock links the research of 90 scientists from six research institutions who are active in many different disciplines and involved in externally funded projects, with a total volume of more than €15 million. This linkage is accomplished by the Coordination Office, financed by the Ministry of Agriculture, Environment, and Consumer Protection Mecklenburg-Vorpommern. Without the Office's efforts, neither the close networking of scientists nor a successful external presentation of the ScienceCampus or its structural developments would be feasible. Moreover, the Coordination Office has enabled the acquisition of funds in the amount of €1.35 million from the Leibniz Association in support of graduate education, networking, and the internationalization of the ScienceCampus. In addition, the Coordination Office organizes numerous internal and public events, such as the 8th International Phosphorus Workshop to promote the national and international networking of the ScienceCampus.

In the following, the activities and thematic foci of the Coordination Office of the Leibniz ScienceCampus Phosphorus Research Rostock that dominated in 2016 are described. The Office is staffed by a scientific coordinator (Dr. Inga Krämer) and an administrative assistant (Daniela Derlet-Eichler; represented during her parental leave until 29.5.2016 by Julia Schneider).

The focus of the Coordination Office's work is the coordination of the research foci and projects of both the partner institutions of the ScienceCampus Phosphorus Research and its individual members. In 2016, the central task was the organization and implementation of the IPW8. Among its other tasks were the external representation of the ScienceCampus, the preparation of reports and e-mails providing information to interested parties, the organization of other events of different formats, and, together with the Financial Department of the IOW, financial management. The work was carried out in close coordination with the spokesperson and the Steering Group of the ScienceCampus.

In the following, the priorities of the Coordination Office, including its function as a contact point, provider of support in the development of research project proposals, coordinator of the graduate school, and event organizer, as well as its public relations tasks are described in detail.

Contact point

The Coordination Office of the ScienceCampus is the linchpin for networking, both within the ScienceCampus and externally, at the national and international levels. In 2016, the Coordination Office continued to serve as a contact for all members of the ScienceCampus, handled external inquiries, and forwarded targeted information to the relevant members/member groups. By mediating both internal and external contacts, the office supported networking among scientists. Contacts with external research institutes, ministries, and authorities were regularly maintained, and those

with other networks were intensified, for example, to the Interdisciplinary Faculty (INF) of the University of Rostock and the DFG's graduate program Baltic Transcoast (University of Rostock). Membership and participation in meetings of the ESPP and DPP as well as contact with other Leibniz ScienceCampi were also promoted.

Research topics and initiatives

The ScienceCampus thrives on the continuous initiatives of its scientists in developing research themes and ideas and in considering proposals for their realization.

Through the Coordination Office, relevant funding calls and proposals regarding the acquisition of external research funds for scientists of the ScienceCampus are evaluated. In addition, the office coordinates projects supported by seed financing from the Leibniz Association, from the project approval stage to the final report.

In preparation for the follow-up application for Leibniz Association funding, preliminary concepts and start-up projects were developed in workshops held in 2016.

Structured graduate support

As young scientists are a significant part of the ScienceCampus network, a structured framework for their support and encouragement is offered by the ScienceCampus.

The Coordinator is responsible for the coordination and administration of the Graduate School, which in 2016 included the organization of several events (e.g., workshops) and networking opportunities of interest to graduate students.

Event organization

The events organized and guided by the Coordination Office are an important basis not only for networking but also for the internal and external representation of the ScienceCampus.

Among the regular activities that took place in 2016 were the organization of meetings of the Steering Group of the ScienceCampus, which addressed current developments, record keeping, etc., and of breakfast gatherings of PhD students of the ScienceCampus, which promoted mutual exchanges. The Coordination Office also organized (program creation, invitation, catering, etc.) the annual, this time internal, Symposium of the ScienceCampus, the 2nd Phosphorus Research Lecture Series at the University of Rostock (in which state authorities were also actively involved), and several colloquia (see the ScienceCampus' Annual Report of 2016).

In addition, the Coordination Office assumed the bulk of the responsibility for the planning of IPW8 and coordinating its Organizing Committee (consisting of 11 scientists of the ScienceCampus). For its first meeting held in Germany, the International Phosphorus Workshops was hosted by the ScienceCampus Rostock, in September 2016. The Coordination Office was responsible for the preparation and servicing of the official conference website as well as the organization of planning meetings, the venue, and the meals. It also assisted the Organizing Committee in the planning and technical implementation of the IPW8's program and accompanying activities, including excursions. In conjunction with the IPW8, the Office is overseeing the publication of a conference special issue in the journal *Ambio*, including several editorial tasks (contact among guest editorial board, authors, Ambio editors, editing, etc.). The publication of this special volume enables further networking at an international lev-

el, the presentation of the ScienceCampus, and the publication of numerous works by its scientists.

Public relations

The Leibniz ScienceCampus is a prominent research network among six partner institutions in Mecklenburg-Vorpommern and is represented not only regionally but also nationally and internationally.

The Coordination Office is responsible for the presentation of the Leibniz ScienceCampus Phosphorus Research Rostock at various events, in the media (articles, interviews), and by developing information (handouts, posters, presentations) about the ScienceCampus (for a list, see the Annual Report of the ScienceCampus). This entails, among other tasks, providing scientists of the Leibniz ScienceCampus Phosphorus Research Rostock with relevant material for presentation and distribution at events (conferences, workshops etc.) of thematic interest. The Coordination Office offers support related to introducing the ScienceCampus to external scientific groups, policy makers, authorities, and the general public through visual presentations, such as research posters. Together with its PhD students, the ScienceCampus actively participated in the Long Night of Sciences at the University of Rostock. The Coordination Office also organized the 2nd Phosphorus Research Lecture Series, held at the University of Rostock.

Another important task was the design of the website of the Leibniz ScienceCampus Phosphorus Research Rostock, including content development, in coordination with relevant scientists. The website is updated continuously with new information from the ScienceCampus. The Coordinator also compiles texts and information that allow the presentation of the ScienceCampus on other websites (for example, those of the DPP and the ESPP).

WISSENSCHAFTSCAMPUS
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Imprint

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Rostock, October 2017


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