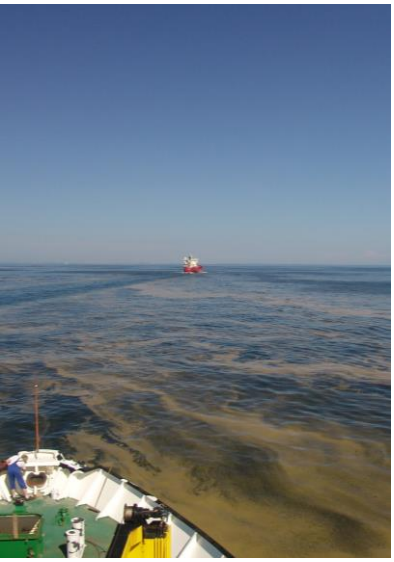
SCIENCE CAMPUS
PHOSPHORUS RESEARCH
ROSTOCK




# Activity Report 2013–2014

Leibniz-Institut für Katalyse e.V. LIKAT
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

# Contents

# 1 Development of the Leibniz ScienceCampus Phosphorus Research Rostock

In 2013, the Leibniz ScienceCampus Phosphorus Research Rostock (hereinafter: ScienceCampus Rostock) received support and initial funding by the Leibniz Association. This permitted not only financial support of phosphorus research topics through five research projects (listed in tab. 1) but also increased networking among partners and enhanced discussions on relevant research themes up to project applications. In addition, the necessary structures for a Leibniz ScienceCampus were created, including e.g. the steering committee. Furthermore, the members were compiled and information on thematically assigned projects and publications collected. In addition to creating the logo and the website, a demand plan was developed and a cooperation agreement designed. Information about the ScienceCampus Rostock has been prepared such as posters, presentation slides, hand-outs and website references. Relevant networks were, if not yet done, contacted.

In 2014, the structures of the ScienceCampus Rostock were consolidated. The steering committee met regularly to discuss the latest developments. The members of the Scientific Advisory Council were identified and invited to an international symposium of the ScienceCampus Rostock (March 2015). The scientific results such as publications are presented in chapter 3. In several workshops joint project proposals were developed and finally submitted to funding agencies. A great success was the raising of funds for a graduate school as a strategic measure in the context of the recent advancements in the Leibniz Association (start: spring 2015). Another important milestone was the signature of the cooperation agreement between the Leibniz Association, the Ministry of Agriculture, Environment and Consumer Protection Mecklenburg-Vorpommern, the Ministry of Education, Science and Culture of Mecklenburg-Vorpommern, the University of Rostock and the participating Leibniz Institutes. For this purpose, a press conference was performed in August 2014. In addition, the website has been released and is now regularly informing about news from the ScienceCampus Rostock as well as from the entire field of research. Further material for publicity of the ScienceCampus Rostock was prepared (roll-ups, posters etc.).

# 2 Goals and concept

The ScienceCampus Rostock focuses on the exploration of the essential and irreplaceable element phosphorus and its diverse chemical compounds. The overall aim of the interdisciplinary collaboration in the ScienceCampus Rostock is to explore options for a more sustainable management of phosphorus by means of focused thematic networking. We investigate specific modes of action in agricultural and environmental systems as well as in technical and industrial processes. In addition to basic and applied research, development and transfer of technologies shall contribute to economic development. Furthermore, cooperation and research regarding this essential element will be intensified and strong national and international networks shall be established.

**The following research institutions are partners in 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 ScienceCampus Phosphorus Research is divided into four areas of research (clusters):

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

### 3.1.1 Cluster 1: Phosphorus cycles and fluxes in the environment

Cluster I of the ScienceCampus Rostock has as its focus phosphorus fluxes and cycles 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 analyse 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 2: Sufficiency and efficiency of P utilisation, 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-fertilisation 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 utilisation efficiency)

(2) Unlocking the accumulated but not available or not used P-stores in topsoil and the subsoil

(3) Utilisation of alternative P sources and development / refinement of practice-relevant P-recovery technologies including research into the properties and potential of alter-

native 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 3: 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, phosphorus 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 organocatalysts are gaining increasing importance.

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

This cross-sectional task focuses on the improvement and development of methods to address the number of research questions within the ScienceCampus. Moreover, this cluster holds a number of projects to answer the question of relevant phosphorus compounds and their dynamics in the environment.

The methodological spectrum available in this cluster includes *state-of-the-art* analytical technology as liquid and gas chromatography coupled to mass spectrometric detection (GC-MS, LC-MS/MS).

In particular, the Institute for Baltic Sea Research Warnemünde maintains the Secondary Ion Mass Spectrometer CAMECA NanoSIMS 50 L for elementary and isotopic compositional analyses of smallest particles and single cells. Thus, detailed investigations on the P metabolism of Baltic Sea and soil microorganisms could depict the presence of P-storage vacuoles in cyanobacteria.

## 3.2 Research projects

Currently already around 30 disciplinary and interdisciplinary projects are thematically assigned to the ScienceCampus Rostock (Tab. 1). Furthermore, funding for several projects was applied and some of these applications already approved. For example, the Leibniz Association approved the proposal of the ScienceCampus Rostock for a graduate school. This graduate school consists of 11 PhD projects which will start in spring 2015.

**Tab. 1. Currently running research projects which are thematically assigned to the ScienceCampus Rostock (status of December 2014)**

| Project | Project duration and funding | Participating partners of the ScienceCampus | Research focus |
|---|---|---|---|
| Aquaponik | 12/2011-10/2015 (UoR) | UoR | I, II |
| BACOSA: Baltic Coastal System Analysis and Status Evaluation | 04/2013-03/2016 (BMBF) | UoR | I |
| BALTIC IMTA - Integrated multitrophic Aquaculture in the Baltic Sea | 09/2013-10/2015 (European Fisheries Fund, MV) | UoR | I, II |
| Best Management-Praktiken und Nachhaltige Anwendung von Glyphosatprodukten (BMP-Glyphosat) | 10/2013-2017 (BMEL) | UoR | II |
| BioAcid II: Biological Impacts Of Ocean Acidification | 09/2012-08/2015 (BMBF) | UoR, IOW | I |
| CRUSTFUNCTION | 2014-2016 (DFG) | UoR | I |
| DIP, POP and DOP analytics in the Baltic Sea and river inputs | Running project (IOW) | IOW | I, Q |
| ECO-FCE: A whole-systems approach to optimising feed efficiency and reducing the ecological footprint of monogastrics | 2013-2017 (EU-FP7) | FBN | II |
| Evaluation of different P-digestion methods for diverse environmental materials (EvaPhoN) | 2014 (ScienceCampus) | UoR | I, Q |
| EXCALIBOR: Empirical and experimental calibration of the clumped isotope (paleo)thermometer for bioapatites | 04/2014-06/2015 (DFG) | IOW | I, Q |
| Fischglashaus: Modulares Gewächshausanbausystem zur aquaponischen Produktion von Warmwasserfischarten unter minimalem Ressourcenverbrauch in Mecklenburg-Vorpommern – Eine Innovationsinitiative zur energie- und nährstoffeffizienten Nahrungsmittelproduktion | 06/2013-01/2015 (European Fisheries Fund) | UoR | I, II |
| Genetic and nutritional effects on the efficiency of P use of monogastric animals (P-Eff-Mo) | 2014 (ScienceCampus) | FBN, UoR, LIKAT | II |
| GENUS Geochemistry and Ecology of the Namibian Upwelling System | 05/2012-04/2015 (BMBF) | IOW | I |
| GLYPHOSAT: Method Development for the Determination of particulate Glyphosate in Marine Water; Bioavailability of Glyphosate | 2014 (ScienceCampus) | IOW, UoR | I, Q |
| Hohe Phosphor-Ausnutzung aus Gärresten unter Berücksichtigung der Fest-Flüssig-Trennung – ein Beitrag zum Förderschwerpunkt<br>Humus- und Nährstoffwirkung organischer Reststoffe aus Biomassekonversionsanlagen | 08/2012-07/2015 (FNR) | UoR, LIKAT | II |

| Project | Project duration and funding | Participating partners of the Science-Campus | Research focus |
|---|---|---|---|
| Langzeitmonitoring Nährstoffe in der Darß-Zingster Boddenkette | Running since 1980 (LUNG, UoR) | UoR | I |
| Microbial phosphorus mobilisation by plant growth promoting fungi in cropping systems | 2013-2014 (DAAD) | UoR | II |
| Mischfruchtanbau mit Leguminosen: Effiziente Nutzung von Wachstumsfaktoren als Beitrag zum Ressourcen- und Gewässerschutz | 2012-2015 (FNR) | UoR | |
| MOSSCO: Modular System for Shelves and Coasts | 04/2013-03/2016 (BMBF) | IOW | I |
| Nachhaltiges Landmanagement Norddeutsches Tiefland (NaLaMa-nT) | 09/2010-08/2015 (BMBF) | UoR | II |
| Neue Organokatalysatoren und kooperative Katalysatorsysteme für die stoffliche Nutzung von CO2 | 2010-2015 (BMBF) | LIKAT | III |
| Optimierung der Düngewirkung von Reststoffen aus Biomassekonversionsanlagen – Ein Beitrag zum Ressourcen- und Umweltschutz | 06/2014-05/2015 (BMBF) | UoR | II |
| Optimierung des Nährstoffaustrags und biologisches Nährstoffrecycling für Aquakulturen in Brackwasser | 06/2013-10/2015 (EU FIAF, LFA-MV) | UoR | I, II |
| P-Recycling aus organischen Abfällen und Reststoffen – Stand, Potenziale und Perspektiven in M-V | 2012-2015 (Scholarship) | UoR | II |
| P-Schadstoff-Wechselwirkungen infolge Applikation von Knochenkohle | 09/2013-08/2016 (Scholarship MV) | UoR, LIKAT | |
| Phenotypic and molecular characterization of P utilization and uptake efficiency of *Solanum tuberosum* (P-NUE) | 2014 (Science-Campus) | UoR, IPK | II |
| Phosphite als Liganden für Hydroformylierungen | Until 2014 (Evonik) | LIKAT | III |
| Recycling of phosphorus based organocatalysts through nanofiltration (RON) | 2014 (ScienceCampus) | LIKAT, UoR | III |
| Role of phosphorus as a key component for managing grasslands N-yield and phytodiversity in organic farming | 09/2013-12/2016 (BÖLN) | UoR | II |
| SECOS: The Service of Sediments in German Coastal Seas | 04/2013-03/2016 (BMBF) | UoR, IOW | I |
| Selektive Oligomerisierung von Ethylen mit P-N-Liganden-Systemen | 2006-2015 (SABIC/Linde AG) | LIKAT | III |

Abbreviations: BMBF: Bundesministerium für Bildung und Forschung (Federal Ministry of Education and Research); BMEL: Bundesministerium für Ernährung und Landwirtschaft (Federal Ministry of Food and Agriculture); BÖLN: Bundesprogramm Ökologischer Landbau und andere Formen nachhaltiger Landwirtschaft (Federal Organic Farming Programme); DAAD: Deutscher Akademischer Austauschdienst (German Academic Exchange Service); DFG: Deutsche Forschungsgemeinschaft (German Research Foundation); EU-FP7: Seventh Framework Programme for Research and Technological Development; FIAF: Finanzinstrument für die Ausrichtung der Fischerei (Financial Instru-

ment for Fisheries Guidance); FNR: Fachagentur Nachwachsende Rohstoffe (Agency of Renewable Ressources); LUNG: Landesamt für Umwelt, Naturschutz und Geologie Mecklenburg-Vorpommern (State Agency for the Environment, Nature Conservation and Geology Mecklenburg-Vorpommern); MV: Land Mecklenburg-Vorpommern

## 3.3 Publications

### 2013

Almethyeb, M., Ruppel, S., Paulsen, HM, Vassilev, N. & B. Eichler-Löbermann (2013): Single and combined applications of arbuscular mycorrhizal fungi and *Enterobacter radicincitans* affect nutrient uptake of faba bean and soil biological characteristics. Appl. Agric. Forestry Res. 63, 229-234

Behn, C., Janssen, M., Geda Adela, Y. & B. Lennartz (2013): Phosphorus contents and phosphorous sorption in soils of the Gilgel Gibe catchment, SW Ethiopia. EGU General Assembly 2013, Geophysical Research Abstracts 15, EGU2013-8308

Busch, S., Brandt, C. & B. Eichler-Löbermann (2013): Phosphorus status of agricultural soils in Germany. Baltic Manure WP4 Standardisation of manure types with focus on Phosphorus. http://balticmanure.eu/download/Reports/pstatus_in_germanyend_web.pdf

Helm, B., Terekhanova, T., Tränckner, J., Venohr, M. & P. Krebs (2013): Attributiveness of a mass flow analysis model for integrated water resources assessment under data-scarce conditions. Water Science and Technology 67 (2), 261-270

Krey, T., Baum, C., Ruppel, S., Seydel, M. & B. Eichler-Löbermann (2013): Organic and inorganic P sources interacting with applied rhizosphere bacteria and their effects on growth and P supply of maize. Comm. Soil Sci. Plant Anal. 44, 3205-3215

Krey, T., Vassilev, N., Baum, C. & B. Eichler-Löbermann (2013): Effects of long-term phosphorus application and plant growth promoting rhizobacteria on maize phosphorus nutrition under field conditions. Europ. J. Soil Biol. 55, 124-130

Siebers, N. & P. Leinweber (2013): Bone char – a clean and renewable phosphorus fertilizer with cadmium immobilization capability. J. Environ. Qual. 42, 405-411

Siebers, N., Kruse, J. & P. Leinweber (2013): Speciation of phosphorus and cadmium in a contaminated soil amended with bone char: Sequential fractionations and XANES spectroscopy. Water Air Soil Pollut. 224, 1564-1577

Terekhanova, T., Berezina, O., Tränckner, J., Dvinskih, S. & P. Krebs (in press, 2013): IWRM for meso-scale ungauged river basins in Russia. Water Science and Technology, doi:10.2166/ws.2013.186

Unger, J., Endres, S., Wannicke, N., Engel, A., Voss, M., Nausch, G. & M. Nausch (2013): Response of *Nodularia spumigena* to $pCO_2$ – Part 3: Turnover of phosphorus compounds. Biogeosciences 10, 1483-1499

### 2014

Bachmann, S., Gropp, M. & B. Eichler-Löbermann (2014): Gärreste – Phosphor und Kalium gut verfügbar. Land & Forst 33, 32-33

Bachmann, S., Gropp, M. & B. Eichler-Löbermann (2014): Phosphorus availability and soil microbial activity in a 3 year field experiment amended with digested dairy slurry. Biomass Bioenergy 70, 429-439

Banerjee, D., Junge, K. & M. Beller (2014): Cooperative calatysis by palladium and a chiral phosphoric acid: enantioselective amination of racemic allylic alcohols. Chem. Int. Ed. 53: 13049-13053. doi: 10.1002/anie.201405511

Cruz, M., Gómez, M., Moreno, C. & B. Eichler-Löbermann (2014): Strains of Trichoderma sp. and their capacity to mobilise phosphorus. In: Bridging the gap between increasing knowledge and decreasing resources, Tropentag 2014 in Prague (ISBN: 978-80-213-2481-7), 78

Grünes, J., Xu, A. & M. Nelles (2014): Verwertung von Phosphor aus organischen Abfällen und Reststoffen. Müll und Abfall 06/14, 323-329, ISSN 0027-2957

Grünes, J. & M. Nelles (2014): Recycling of phosphorus from organic waste and residues in Germany. In: Nelles, M., Wu, K., Cai, J. & J. Cheng (Hrsg.): Proceedings of the 5th International Conference on Environmental Technology and Knowledge Transfer, Hefei Mai 15-16 (P.R. China), ISBN 978-3-86009-411-2

Grünes, J. & M. Nelles (2014): Recycling von Phosphor aus biogenen Abfällen und Reststoffen. In: Nelles, M. (Hrsg.): 16. DIALOG Abfallwirtschaft MV – Aktuelle Entwicklungen in der Abfallwirtschaft, Tagungsband, Schriftenreihe UIW Bd. 44, 159-173, ISBN 978-3-86009-410-5

Hinz, A., Kuzora, R., Rosenthal, U., Schulz, A. & A. Villinger (2014): Activation of small molecules by phosphorus biradicaloids. Chem. Eur. J. 20: 14659–14673. doi: 10.1002/chem.201403964

López, D., Mendes, G., Eichler-Löbermann, B., Vassilev, N. & M. Vassileva (2014): Effect of abiotic stress factors on phosphate solubilisation by Aspergillus niger in submerged and solid-state fermentations. Industrial, medical and environmental applications of microorganisms - Current status and trends (ed. A. Méndez-Vilas), ISBN 978-90-8686-243-6

Mahnke, B. & J. Müller (2014): Rolle des Phosphors als Steuerungsgröße des Stickstoffertrages und der Phytodiversität ökologisch bewirtschafteter Dauergrünlandbestände. Tagungsbeitrag zur 58. Jahrestagung der Arbeitsgemeinschaft Grünland und Futterbau der Gesellschaft für Pflanzenbauwissenschaften e.V. in Arnstadt 28.-30.08.2014, 55-60

Nausch, G., Naumann, M., Umlauf, L., Mohrholz, V. & H. Siegel (2014): Hydrographisch-hydrochemische Zustandseinschätzung der Ostsee 2013. Meereswiss. Ber. Warnemünde 93, 1-104

Nausch, M. & G. Nausch (2014): Phosphorus speciation and transformation along transects in the Benguela upwelling region. J. Mar. Syst. 140, Part B, Special issue: Upwelling Ecosystem Succession: 111-122

Nausch, G., Nausch, M., Steinrücken, P., Balke, J. & J. Woelk (2014): Dissolved organic phosphorus in the Baltic Sea – temporal variability and utilization. EGU General Assembly, Geophysical Research Abstracts 16, EGU2014-4951

Palm, H., Bissa, K. & U. Knaus (2014): Significant factors affecting the economic sustainability of closed aquaponic systems. Part II: fish and plant growth. AACL Bioflux, Vol. 7, Issue 3

Palm, H., Seidemann, R., Wehofsky, S. & U. Knaus (2014): Significant factors affecting the economic sustainability of closed aquaponic systems. Part I: system design, chemo-physical parameters and general aspects. AACL Bioflux, Vol. 7, Issue 1

Pérez-Garloba, L., Fundora, O., Ramallo, Y., Lugo, I., Gómez, M., Moreno, C. & B. Eichler-Löbermann (2014): Application of poultry manure with zeolite reduces the use of commercial fertilisers and improves the soil fertility in organic sugar cane production. Bridging the gap between increasing knowledge and decreasing resources, Tropentag 2014 in Prague (ISBN: 978-80-213-2481-7), p. 81

Pyhäla, M., Fleming-Lehtinen, V., Laamanen, M., Lysiak-Pastuszak, E., Carstens, M., Leppänen, J.-M., Leujak, W., Nausch, G., Murray, C. & J. Andersen (2014): Eutrophication status of the Baltic Sea 2007-2011 – A concise assessment. Balt. Sea Environ. Proc. 143, 1-41. www.helcom.fi/Lists/Publications/BSEP143.pdf

Requejo, M. & B. Eichler-Löbermann (2014): Organic and inorganic phosphorus forms in soil as affected by long-term application of organic amendments. Nutr. Cycl. Agroecosyst. 100, 245-255

Romano, S., Dittmar, T., Bondarev, V., Weber, R.J.M., Viant, M.R. & H.N. Schulz-Vogt (2014): Exo-Metabolome of Pseudovibrio sp. FO-BEG1 Analyzed by Ultra-High Resolution Mass Spectrometry and the Effect of Phosphate Limitation. PLos ONE 9(5): e96038

Siebers, N., Godlinski, F. & P. Leinweber (2014): Bone char as phosphorus fertilizer involved in Cd immobilization in lettuce, wheat, and potato cropping. Journal of Plant Nutrition and Soil Science 177, 75-83

Vágó, I., Sipos, M., Tolner, L., Eichler-Löbermann, B. & I. Czinkota (2014): Dynamics of dry matter production and potassium uptake of maize in a long-term field experiment on chernozem soil. Agrokémia es Talajtan 63, 149-158

Vassilev, N., Eichler-Löbermann, B., Martos, V. & M. Vassileva (2014): Solubilization of animal bone char by Yarrowia lipolytica on medium containing glycerol. New Biotechn. 33, doi.org/10.1016/j.nbt.2014.05.989

Wasmund, N. & G. Nausch (2014): Phytoplankton succession in an isolated upwelled Benguela water body in dependence of nutrient conditions. J. Mar. Syst. 140, 163-174

Werner, T. & H. Büttner (2014): Phosphorous based bifunctional organocatalysts for the addition of carbon dioxide and epoxides. ChemSusChem 7(12): 3268-71. doi: 10.1002/cssc.201402477

Werner, T. & M. Hoffmann (2014): First Enantioselective Catalytic Wittig Reaction. Eur. J. Org. Chem. 2014: 6630–6633. doi: 10.1002/ejoc.201402941

Werner, T., Hoffmann, M. & S. Deshmukh (2014): First Microwave Assisted Catalytic Wittig Reaction. Eur. J. Org. Chem. 2014: 6873–6876. doi: 10.1002/ejoc.201403113

## 3.4 Theses

### 2013

Bachmann, S. (2013): Phosphorausnutzung aus Biogasgüllen. Ein Beitrag zur Sicherung einer nachhaltigen Bioenergieproduktion. PhD, Supervisor: PD Dr. B. Eichler-Löbermann.

Behn, C. (2013): Phosphorgehalte und -sorption in Böden des Gilgel-Gibe-Einzugsgebiets, Äthiopien: Einfluss von Hangposition, Landnutzung und Ausgangsmaterial. MSc, Supervisor: Dr. M. Janssen.

Berthold, M. (2013): Phosphorverfügbarkeit für Phytoplankton in der Darß-Zingster Boddenkette. MSc, Supervisor: PD Dr. R. Schumann.

Bissa, K. (2013): Das Wachstum von afrikanischen Buntbarschen und afrikanischen Welsen in einem ressourcenminimierten Aquaponiksystem. BSc, Supervisor: Prof. Dr. S. Glatzel, Prof. Dr. H. Palm.

Brandt, C. (2013): Wechselseitiger Einfluss des Wassergehaltes des Bodens und der Phytin-Zufuhr auf die Phosphor-Ernährung von Pflanzen. PhD, Supervisor: PD Dr. B. Eichler-Löbermann.

Felgentreu, L. (2013): Phosphorbindungsformen im schlickigen Sediment der Darß-Zingster Boddenkette. BSc, Supervisor: PD Dr. R. Schumann.

Fritzsche, E. (2013): Bestimmung von organischen Spurenstoffen in der Ostsee mit modernen Massenspektrometrischen Verfahren. MSc, Supervisor: Prof. Dr. Schulz-Bull.

Nievel, M. (2013): Räumliche Verteilung des Pflanzennährstoffs Phosphor (Orthophosphat) in einem Ebbe-Flut-Aggregatsystem einer Warmwasser-Aquaponikanlage. BSc, Supervisor: Prof. Dr. S. Glatzel, Prof. Dr. H. Palm.

Rieche, K. (2013): Analyse der Trophieverhältnisse von beweidetem Extensivgrünland im Übergangsbereich Niedermoor-Mineralboden und Konsequenzen für den Boden- und Gewässerschutz am Beispiel des Peenetals. MSc, Supervisor: Dr. J. Müller.

### 2014

Almethyeb, M. (2014): The Influence of Singular and Combined Applications of Arbuscular Mycorrhizal Fungi and Enterobacter radicincitans on Growth and Nutrition of Plants. PhD, Supervisor: PD Dr. B. Eichler-Löbermann.

Deich, C. (2014): Entwicklung einer Methode zur Bestimmung von an Partikeln gebundenem Glyphosat in der marinen Umwelt. BSc, Supervisor: Dr. M. Abraham.

Diehl, N. (2014): Zusammensetzung der Biomasse submerser Makrophyten. BSc, Supervisor: PD Dr. R. Schumann.

Korpat, D. (2014): Phosphor im ökologisch bewirtschafteten Grünland - P-Einfluss auf Vorkommen und Leistung kleinkörniger Leguminosen sowie auf korrespondierende Phytodiversität. MSc, Supervisor: Dr. J. Müller.

Krey, T. (2014): Contribution of selected plant growth promoting rhizobacteria to maize phosphorus nutrition as influenced by organic matter management. PhD, Supervisor: PD Dr. B. Eichler-Löbermann.

Linge, J. (2014): Phosphatnutzung durch das Phytoplankton innerer Küstengewässer der Ostsee. BSc, Supervisor: PD Dr. R. Schumann.

Nguyen, H. N. (2014): Effekte unterschiedlicher Phosphorgehalte im Futter auf Leistungsparameter und Diarrhoegeschehen bei Absetzferkeln. BSc, Supervisor: Prof. K. Wimmers, Dr. K. Büsing.

# 4 Networking

In addition to numerous interactions between individual scientists and research groups, the ScienceCampus Rostock is also a member of the European Sustainable Phosphorus Platform (ESPP) and has participated in events organized by the German Phosphorus Platform (DPP).

# 5 Events

The ScienceCampus Rostock has organized a number of external and internal events that are listed below.

## 5.1 Public events

Symposium ScienceCampus Phosphorus Research Rostock at Leibniz Institute for Baltic Sea Research Warnemünde, 16.5.2013

Official signature of the cooperation agreement with all partner institutions (Leibniz-Institutes, University of Rostock) and the Ministries, incl. press conference and poster presentation, 20.08.2014

## 5.2 Internal meetings and workshops

To promote networking and interdisciplinary cooperation within the ScienceCampus Rostock various working meetings were carried out, such as within individual research foci. For the application of the ScienceCampus Rostock as part of the new funding line 'strategic networking' of the Leibniz Association, several workshops took place (11/2013, 03/2014, 04/2014, 05/2014), in which, inter alia, the overall concept and the subprojects were discussed and selected. Also for other project applications, working meetings were carried out (e.g. within the BMBF funding programme REWAM).

The steering committee of the ScienceCampus Rostock met five times during the reporting period (08/2013, 11/2013, 02/2014, 09/2014, 12/2014), each time at a different partner institute, to discuss the thematic development of the ScienceCampus and overarching decisions.

In 2014, already two organizational meetings in preparation for the 8$^{th}$ International Phosphorus Workshop IPW8 took place (09/2014, 10/2014). The IPW8 will be carried out by the ScienceCampus Rostock 12$^{th}$-16$^{th}$ September 2016.

For crosslinking of the PhD students who are working on phosphorus-related issues within the ScienceCampus Rostock, the first joint 'phosphorus breakfast' took place at IOW in October 2014. This meeting will be carried out regularly in future.

### 5.3 Lectures

In addition to the regular lectures of numerous members of the ScienceCampus Rostock, the following courses were carried out:

Phosphor als endliche Ressource: woher kommt er, wohin geht er? (UN-Dekadethema „Mobilität"). Komplexe Nachhaltigkeitsprobleme (Seminar), WS2013/2014 (I. Krämer)

Session within the KüNO Summer School: role play „Die Zukunft der Darß-Zingster Boddenkette (DZBK) - Sanierungsstrategien für dieses eutrophe Gewässer", 19.9.2014 (R. Schumann, T. Leipe, F. Schmacka)

School project Musikgymnasium Rostock Käthe Kollwitz, Wirksamkeit des Phosphorrückhalts verschiedener Filtermaterialien für Dränauslässe, September 2014 – February 2015 (F. Schmacka)

### 5.4 Others

Networking Cruises with the Research Vessel Elisabeth Mann Borgese, HanseSail, including also members of the ScienceCampus Rostock, 10.8.2013 and 9.8.2014

Böden – Lebensgrundlage und Verantwortung. Jahrestagung der Deutschen Bodenkundlichen Gesellschaft in Rostock, 7.-12.9.2013

## 6 Presentation to the public

The ScienceCampus Rostock has been presented to external research groups, politics, government and the general public. Below a selection of the presentations is listed.

### 6.1 Oral presentations

Küstenforschung, Küstennutzung und Küstenschutz, Handelskammer Hamburg, 4.-6.3.2013 (U. Bathmann)

Parlamentarischer Informationsabend der Leibniz-Institute in Schwerin, 16.4.2013 (U. Bathmann)

Workshop der WissenschaftsCampi in der Geschäftsstelle der Leibniz-Gemeinschaft Berlin, 18.7.2013 (U. Bathmann, P. Leinweber)

Böden ohne Grenzen – Landnutzung und Bodenschutz als Herausforderungen im baltischen Raum. acatech, UoR and DBG, 12.9.2013 (U. Bathmann, P. Leinweber)

Gewässersymposium am Landesamt für Umwelt, Naturschutz und Geologie, 20.11.2013 (presented by B. Lennartz)

IFAT – Weltleitmesse für Wasser-, Abwasser-, Abfall- & Rohstoffwirtschaft München, 5.-9.5.2014 (J. Tränckner)

Workshop „Phosphor für die Landwirtschaft – Strategien für eine endliche Ressource", ATB Potsdam Bornim, 11.6.2014 (presented by B. Eichler-Löbermann)

8. Rostocker Bioenergieforum 19./20.06.2014 (presented by B. Eichler-Löbermann)

9th International Symposium AgroEnviron, 03.-07.08.2014, Goiania, Brasilien (presented by B. Eichler-Löbermann)

13. Congress of the European Society for Agronomy (ESA), 25.-29.08.2014, Debrecen, Ungarn (presented by B. Eichler-Löbermann)

15th Global Conference on Environmental Taxation, Kopenhagen, 24.-26.9.2014 (presented by F. Ekardt)

SusChem 2014 in Erlangen-Nürnberg, 28.-30.9.2014 (presented by H. Büttner)

World Fertilizer Congress, Rio de Janiero, Brasilien, 20.-24.10.2014 (presented by B. Eichler-Löbermann)

Forum der DPP „Wie kritisch ist die Versorgung mit dem „Lebensmittel" Phosphor, Berlin, 21.11.2014 (presented by P. Leinweber)

1st International Conference on Sustainable Phosphorus Chemistry, Florenz, Italien, 4.-5.12.2014 (presented by T. Werner)

## 6.2 Posters

ScienceCampus "Phosphorus Research Rostock" - A new multidisciplinary research platform in Northeast Germany. Konferenz: *A Greener Agriculture for a Bluer Baltic Sea* in Helsinki, 27.-28.8.2013 (presented by B. Eichler-Löbermann)

ScienceCampus "Phosphorus Research Rostock" - A new multidisciplinary research platform in Northeast Germany. *7th International Phosphorus Workshop* in Uppsala (IWP7), 9.-13.9.2013 (presented by B. Eichler-Löbermann, M. Nausch)

WissenschaftsCampus Phosphorforschung Rostock. F² - Forschung trifft Forschung Forschungscamp, Prorektorin für Forschung und Forschungsausbildung und Zentrum für Projektkonzeption und Projektmanagement (UoR), 7.11.2013 (presented by I. Krämer, J. Kruse)

WissenschaftsCampus Phosphorforschung Rostock. 18. Gewässersymposium – Landwirtschaft und Gewässerschutz am Landesamt für Umwelt, Naturschutz und Geologie, 20.11.2013 (presented by I. Krämer)

ScienceCampus "Phosphorus Research Rostock", PSP5 (Phosphorus in Soils and Plants) in Montpellier, 26.-29.8.2014 (presented by B. Lennartz)

ScienceCampus "Phosphorus Research Rostock", 4th Sustainable Phosphorus Summit (SPS4) in Montpellier, 1.-3.9.2014

Leibniz WissenschaftsCampus Phosphorforschung Rostock. 19. Gewässersymposium – Landwirtschaft und Gewässerschutz am Landesamt für Umwelt, Naturschutz und Geologie, 19.11.2014 (presented by F. Schmacka)

Leibniz-WissenschaftsCampus Phosphorforschung Rostock, Forum der DPP „Wie kritisch ist die Versorgung mit dem „Lebensmittel" Phosphor, Berlin, 21.11.2014 (presented by F. Schmacka)

## 6.3 Press

Gold aus Gülle und Knochen. Der Spiegel 37/2013, p. 122-123.

Land fördert Wissenschaftscampus langfristig mit über einer halben Million Euro. Pressemitteilung Nr. 386/13, 16.12.2013, Ministry for Agriculture, Environment and Consumer Protection

Wenn Phosphor knapp wird. Interview with Dr. Inga Krämer, 24.1.14, WGL-online (www.leibniz-gemeinschaft.de/forschung/junge-leibniz-wissenschaftler-im-interview/phosphor/)

Knappe Ressource. Von I. Krämer. Leibniz Nordost, Journal der Leibniz-Institute MV, Mai 2014, S. 17

Gründung des Leibniz-WissenschaftsCampus Phosphorforschung Rostock. Press release Nr. 108-14, 20.08.2014, Ministry for Education, Science and Culture Mecklenburg-Vorpommern

Neue Wege der Phosphornutzung - Leibniz-WissenschaftsCampus Rostock gegründet. Press release of the Leibniz Association, 22.08.2014

PHOSPHOR – Eine endliche Ressource? Interview with Dr. Inga Krämer. ke:onda – Die Jugendzeitung der Naturfreundejugend Deutschlands 02/2014

## 6.4 Websites

Leibniz-ScienceCampus Phosphorus Research Rostock: www.wissenschaftscampus-rostock.de (www.sciencecampus-rostock.de; www.p-campus-rostock.de)

Leibniz Association/ScienceCampi: www.leibniz-gemeinschaft.de/en/research/cooperation-with-universities/leibniz-sciencecampi/rostock/

University Rostock/Interdisciplinary Faculty/Maritime Systems: www.inf.uni-rostock.de/mts/projekte/projekte-des-departments/wissenschaftscampus-rostock-phosphorforschung/

## 6.5 Input in Programming Processes, EU-Consultation

BMBF Agenda Process: Online questionnaire for Horizon 2020, Challenge 5 – Climate Action, Resource Efficiency and Raw Materials. 28.3.2013

Interreg/Baltic Sea Region Programme, Riga, 3.-4.9.2013

Program planning 2nd European Sustainable Phosphorus Conference, Berlin and Brussels

EU Consultative Communication on the Sustainable Use of Phosphorus: Statement of the ScienceCampus Rostock (1.12.2013)

# 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 institu-

tions. 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 72 scientists and 8 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. 1: Structure of the ScienceCampus Rostock**

## 7.2 Committees

### 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. Manfred Schwerin, FBN
Prof. Dr. Klaus-Dieter Weltmann, INP

### 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
Dr. Marko Hapke, LIKAT
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
Prof. Dr. Klaus Wimmers, FBN

**Representatives:**
PD Dr. Tom Goldammer, FBN
Dr. Stephan Reuter, INP
Prof. Dr. Axel Schulz, UoR/LIKAT
Evelin Willner, IPK

### 7.2.5 Coordination office

Dr. Inga Krämer, Dr. Franziska Schmacka (May-Dec 2014 during parental leave of I. Krämer)
Daniela Derlet-Eichler (Secretariat)

### 7.2.6 Members

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

| | | |
|---|---|---|
| Prof. Dr. Matthias Beller | Applied Homogeneous Catalysis | Cluster III |
| Hendrik Büttner | Organocatalysis | Cluster III |
| Prof. Dr. Armin Börner | Asymmetric Catalysis | 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 |
| Dr. Thomas Werner | Organocatalysis | Cluster III |

**Leibniz Institute for Farm Animal Biology (FBN), Dummerstorf**

| | | |
|---|---|---|
| PD Dr. Tom Goldammer | Genome Biology | Cluster II |
| Dr. Michael Oster | Genome Biology | Cluster II |
| Franziska Just | Genome Biology | Cluster II |
| Prof. Dr. Manfred Schwerin | Director | Cluster II |
| Prof. Dr. Klaus Wimmers | Genome Biology | Cluster II |

**Leibniz Institute for Baltic Sea Research Warnemünde (IOW)**

<u>Directorate</u>

| | | |
|---|---|---|
| Prof. Dr. Ulrich Bathmann | Director | Cluster I |
| Dr. Inga Krämer | Coordination Office | |

| | | |
|---|---|---|
| Department Biological Oceanography | | |
| PD Dr. Matthias Labrenz | Environmental Microbiology | Cluster I |
| Dr. Monika Nausch | Microbial Processes and Phosphorus Cycle | Cluster I |
| PD Dr. Gerald Schernewski | Coastal & Marine Management | Cluster I |
| Prof. Dr. Heide Schulz-Vogt | Microbial Ecophysiology | Cluster I |
| Juliane Unger | Microbial Processes and Phosphorus Cycle | Cluster I |
| Dr. Angela Vogts | NanoSIMS Lab | Q |
| PD Dr. Maren Voß | Marine Nitrogen Cycle | Cluster I |
| Department Marine Geology | | |
| Prof. Dr. Helge Arz | Paleoceanography - Sedimentology | Cluster I, Q |
| Prof. Dr. Michael Böttcher | Geochemistry and Stable Isotope Biogeochemistry | Cluster I, Q |
| Dr. Olaf Dellwig | 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 |
| Prof. Dr. Gregor Rehder | Trace Gases | Cluster I, Q |
| Dr. Oliver Schmale | Trace Gases | Cluster I, Q |
| Prof. Dr. Detlef Schulz-Bull | Marine Chemistry | Cluster I, Q |
| Department Physical Oceanography and Instrumentation | | |
| Prof. Dr. Hans Burchard | Coastal ocean process modelling | Cluster I |
| Dr. Anja Eggert | Regional Oceanography | Cluster I |
| 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 |
| Dr. Martin Schmidt | Regional Oceanography | Cluster I |

**Leibniz Institute for Plant Genetics and Crop Plant Research (IPK), Satellite Collections North, Groß Lüsewitz**

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

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

| | | |
|---|---|---|
| Dr. Volker Brüser | 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. Adrian Bischoff-Lang | Aquaculture and Sea-Ranching | Cluster I, II |
| Dr. Uwe Buczko | Landscape Ecology and Site Evaluation | Cluster I |
| Dr. Jörg Burgstaler | Agricultural Technology and Process Engineering | Cluster II |
| Dr. Kirsten Büsing | Nutrient Physiology and Animal Nutrition | Cluster II |
| Dr. Friederike de Mol | Crop Health | Cluster II |
| PD Dr. Bettina Eichler-Löbermann | Agronomy | Cluster II |
| Prof. Dr. Bärbel Gerowitt | Crop Health | Cluster II |
| Jennifer Grünes | Waste Management and Material Flow | Cluster II |
| Dr. Petra Kahle | Soil Physics and Environmental Resources Conservation | 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 |
| Prof. Dr. Peter Leinweber | Soil Science | Cluster II,Q |
| Prof. Dr. Bernd Lennartz | Soil Physics and Environmental Resources Conservation | Cluster I, II |
| Barbara Mahnke | Grassland and Fodder Sciences | Cluster I |
| Dr. Gert Morscheck | Waste Management and Material Flow | Cluster II |
| Dr. Jürgen Müller | Landscape Ecology and Site Evaluation | Cluster I |
| Franziska Müther | Water Resources Management | Cluster II |
| Prof. Dr. Michael Nelles | Waste Management and Material Flow | Cluster II |
| Prof. Dr. Harry Palm | Aquaculture and Sea-Ranching | Cluster I, II |
| Prof. Dr. Jens Tränckner | Water Resources Management | Cluster II |
| Prof. Dr. Ralf Uptmoor | Agronomy | Cluster II |
| Telse Vogel | Agronomy | Cluster II |
| Dr. Denny Wiedow | Agricultural Technology and Process Engineering | Cluster II |
| Prof. Dr. Nicole Wrage-Mönnig | Grassland and Fodder Sciences | Cluster II |
| Dr. Dana Zimmer | Soil Science | Cluster II |

| | | |
|---|---|---|
| Faculty of Law | | |
| Prof. Felix Ekardt | Research Unit Sustainability and Climate Policy | Cluster II |
| Faculty of Mathematics and Natural Sciences | | |
| Maximilian Berthold | Institute for Biological Sciences, Applied Ecology & Phycology | Cluster I, Q |
| Franziska Bitschofsky | Institute for Biological Sciences, Marine Biology | Cluster I |
| 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 Dynamics | Q |
| Dr. Arne Schoor | Institute for Biological Sciences, Ecology | 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 |
| Dr. Martin Sklorz | Institute for Chemistry, Analytical & Technical Chemistry; Analytical Chemistry | Cluster III |
| Prof. Ralf Zimmermann | Institute for Chemistry, Analytical & Technical Chemistry; Analytical Chemistry | Q |
| Rostock University Medical Center | | |
| Prof. Brigitte Vollmar | Institute for Experimental Surgery, University Medicine Rostock | Cluster II |

# 8 Funding

In 2013 and 2014, the ScienceCampus Rostock was funded by the Ministry of Agriculture, Environment and Consumer Protection Mecklenburg-Vorpommern and by the Leibniz Association.

The funds by the Ministry of Agriculture, Environment and Consumer Protection Mecklenburg-Vorpommern (85,000 € in 2013 and 2014 each) were used for financing the coordination office of the ScienceCampus Rostock. Since 2014, the coordination office at the IOW consists of two employees, a scientist and a secretary.

The initial funding of the Leibniz Association (150,000 €) was mainly used to establish the structures of the ScienceCampus und to finance five interdisciplinary projects, which were accompanied by scientists from at least two partner institutions of the ScienceCampus.

**Imprint**

Leibniz ScienceCampus Phosphorus Research Rostock

c/o Leibniz Institute for Baltic Sea Research Warnemünde

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