D 2.4

Reports of min. 5 (young) researchers of HN at SOLARIS

Project acronym: Sylinda

Project full title: Synchrotron Light Industry Applications

Grant agreement no.: 952148

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Due Date of Deliverable: 31.08.2023

Completion Date of Deliverable: 29.10.2024

Lead partner for deliverable: HSNR

Project funded by the European Commission within the Horizon 2020 program		
Dissemination Level		
PU	Public	V
PP	Restricted to other programme participants (including the Commission Services)	
RE	Restricted to a group specified by the consortium (including Commission Services)	
CO	Confidential, only for members of the consortium (including Commission Services)	

Document History

Issue Date	Version	Changes Made / Reason for this Issue	Author
24.04.2023	1.0	Initial draft	Dr Susanna v. Ameln and young researchers
03.05.2023	1.1	Final version approval	Dr Susanna v. Ameln and young researchers
16.10.2024	2.0	Additional justification at the request of the Project Officer	Magdalena Żychowska
29.10.2024	2.1	Final approval	Michał Młynarczyk

The purpose of the short-term internships foreseen under this deliverable was to deepen knowledge about the daily work at large-scale research facilities such as the SOLARIS synchrotron.

Three of the five researchers from HN travelling to SOLARIS within the SYLINDA short term staff exchange obtained their doctoral degree recently (Jessica Frieß, PhD in 2021) or did not start their PhD studies yet (Lasse Wagner, Niklas Büll). These early stage researchers were already trained by the research and transfer department at HN, however, they had never worked at a synchrotron and therefore lacked hands-on experience in the capabilities and limitations of an X-ray spectroscopy beamline in the field of applied research. Consequently, and in accordance with task 2.4, instead of being educated in science management their visits at SOLARIS were primarily focused on acquiring knowledge about daily practices in a synchrotron laboratory, gaining insights into synchrotron based research techniques and the operation of a large research facility, working with beamline scientists, interacting with the industry liaison officer, getting first practical experience, and understanding access policies and other aspects of the facilities' activities, such as technology transfer.

Besides these young researchers, two more experienced scientists from HN were included in the staff exchange: Henning Lichtenberg has been working at synchrotron beamlines for a long time, however, mostly with an academic background. Despite being trained in science and cooperation management at HN, attracting beamline users from outside the academic synchrotron user community he mostly worked with so far still remains a major challenge for him. Making a beamline more attractive for industrial users often requires technical modifications, e.g. for surface sensitive measurements under grazing incidence or for enhancing the energy resolution in order to distinguish between neighbouring X-ray emission lines, e.g. from a catalyst´s active element and its support. In this context, participating in the installation of a high energy resolution fluorescence spectrometer was a unique opportunity for him to learn how to upgrade and advertise a beamline for the specific needs of application oriented and industrial users – an experience he will share with new German academic and industrial collaboration partners as well as young students and researchers at HN in order to recruit them as future beamline users. Ralph Radmacher, a further experienced lecturer from HN, has worked for the industry himself and interacted with students working in a company in parallel to their education at HN for several years. However, he first needed to learn about the operation of synchrotron beamlines within the SYLINDA project. By sharing his experience in interacting with the industry he significantly contributed to increasing the ASTRA beamline´s attractiveness for industrial users and making its commissioning, technical upgrades and

operation more time efficient, e.g. by using 3d printed prototypes of optical elements, which several young scientists from SOLARIS greatly benefitted from.

In conclusion, these experienced scientists who have many years of scientific experience can play the role of a facilitator for a young scientists at the home institution. Their participation in short-term internships ensures the sustainability of the project's results even after its finalization.

Summaries of the visits are attached below:

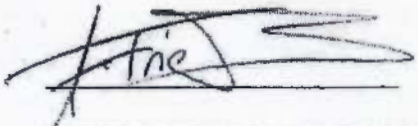
Name	Affiliation:	Destination:	Dates:
Dr. Jessica Frieß	HSNR	SOLARIS	March 2, 2023

I visited the SOLARIS synchrotron facilities on March 2, 2023. The day started with a hybrid group meeting between the German and Polish Sylinda project partner where the current progression of the Sylinda Project was presented. The focus was on the planning of the Industrial Meeting in 2023. Furthermore, I actively took part in the discussion of further potential common research activities, where sychrotron radiation techniques could be used to solve urgent problems in agriculture and food. There we discussed the following three synchrotron radiation techniques: "X-ray absorption spectroscopy (XAS)", "Element specific X-ray tomography" and "Fourier transform IR spectroscopy (FTIR)". XAS and FTIR can be operated with and without spatial resolution, which offers the possibilities to investigate a variety of research tasks. The Sylinda project members want to focus on the detection of elements heavier than carbon – these elements can be both a blessing and a curse. Potential research questions could focus on "Heavy elements in soil", "Plants and heavy elements: uptake, biochemistry, storage" as well as "Micronutrients for humans and animals". In my role as a research funding officer at Hochschule Niederrhein, I evaluated these research ideas regarding their potential to fit to certain open and upcoming calls within the Horizon Europe program, especially Cluster 6 "Food, Bioeconomy, Natural Resources, Agriculture and Environment" and the calls of "Farm2Fork".

After that, I met with a beamline scientist, who showed me the overall Synchrotron facilities of SOLARIS with their different beamlines. As the synchrotron was currently in power mode, it was not possible to have a look at the inner ring. The beamline scientist also showed me the setup of the ASTRA beamline, which is specially equipment to use the low energy range of the radiation, i.e 1–15 keV. As a material scientist myself, I am well acquainted with basic different characterization techniques of microstructures. So far, my focus during my own bachelor, master, PhD as well as postdoc studies were on metallic microstructures. The beamline scientist explained me the obstacles and specifics when investigating lighter materials. I enjoyed the possibilities to have a detailed look at the overall ASTRA setup with its different components, e.g. the monochromator and the beam control. This short research visit gave me the chance to broaden my knowledge about the possibilities of synchrotron characterization techniques. So far, I knew the technique mostly for research questions in the fields of material science and

physics. Furthermore I got to see in real how to a single is experiment is prepared, i.e. what needs to be considered when planning and which steps to take to run the experiments.

Thus, I was able to expand my theoretical knowledge of synchrotron radiation techniques with practical insights.



Signature of Dr. Jessica Frieß

Date: April 14, 2023

Name	Affiliation:	Destination:	Dates:
Lasse Wagner	HSNR	SOLARIS	November 20-26, 2021

Topic: Visit to SOLARIS within the cooperation between HSNR and SOLARIS
Activity: Installation of a novel signal processing chain for the beamline under construction; Exchange with beamline operators/scientists.

Content:

In the period 2021-11-20 to 2021-11-26, I visited the SOLARIS Synchrotron facility in the context of the cooperation between SOLARIS and Hochschule Niederrhein University of Applied Sciences (HSNR) in order to carry out installation work at the joint beamline under construction.

The construction of the beamline is an interdisciplinary collaboration between HSNR and SOLARIS, involving various disciplines such as electrical engineering, computer science, physics and mechanical engineering.

The aim of the visit was to install the remaining vacuum components and ionization chambers, and to install and commission the electronics for the new signal processing chain, which we previously assembled and tested in Krefeld.

For this purpose, there was already a permanent exchange between HSNR and SOLARIS during the planning phase. The special feature of the newly installed signal processing chain is that it does not require the classic Vtf converters, thus reducing installation costs.

In addition, the setup makes it possible to record/sample signals with different sampling rates and filter options.

The goal was to make the setup as compact as possible and keep the commissioning time short in order to quickly make the beamline available for use by academic and industrial users.

In this context, the software was modified through close cooperation with the experts at SOLARIS so that a first spectrum could be successfully measured during this commissioning phase.

In addition to the installation of the hardware, there was also an intensive exchange about the specific requirements of potential users of the beamline.

Here, one focus was on adapting the software to the needs of the users. After the visit to SOLARIS, the software was thoroughly revised by a member of the SOLARIS team so that it is now ready for use.

In addition to the technical work, there was an intensive exchange on how the beamline can also benefit users of the high-throughput plant in Krefeld.

Here, we cooperate with companies from the paints and coatings sector (surface coating materials). Thus, we are highly interested in possibilities to perform a more detailed structural analysis of these materials at SOLARIS and thus to offer new services.

14.04.2023,

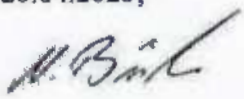
Lasse Wagner

Name	Affiliation:	Destination:	Dates:
Niklas Büll	HSNR	SOLARIS	March 11-17, 2023

In September 2022 and March 2023 I had the opportunity to visit the SOLARIS synchrotron in Krakow (Poland) for one week of beamtime at ASTRA, a beamline for X-ray spectroscopy and related techniques. For these experiments I brought a new experimental set-up for grazing incidence X-ray absorption spectroscopy (GIXAS), which I had previously tested 'off-line' (i.e. without synchrotron light) at Hochschule Niederrhein University of Applied Sciences in Krefeld (Germany), where I am currently working on my master's thesis. The capability to perform X-ray spectroscopy at grazing incidence angles allows to specifically analyze the structure of surfaces and interfaces on an atomic scale. Such surface- and interface-sensitive measurements are especially interesting for industrial collaborations, since many industrially relevant processes take place at surfaces and interfaces, especially in combination with Niederrhein University's strong activities and long-time expertise in the field of coating technology and functional surfaces. Implementing the hard- and software for the GIXAS experiment, including a motorized sample positioning unit and several motorized optical slits, was both a challenging and fascinating task for me , and I am happy that I could contribute to this new set-up with my background in electrical engineering and automation. As far as possible, I included automated processes in the control system, which will make the beamline more user friendly especially for industrial collaboration partners. One spatial feature of the new GIXAS set-up is the large vacuum chamber accommodating the sample positioning unit, which allows to pump down the set-up in order to minimize the absorption of low energy photons. This will further strengthen the beamline's unique capabilities, since ASTRA was especially designed for X-ray spectroscopy at low energies (down to ca. 1 keV) to investigate 'light' chemical elements such as Mg, Al, Si, and P. During my visits at SOLARIS I was strongly supported by the local researchers and technicians, particularly by the beamline scientist at ASTRA. At the end of my second beamtime at ASTRA we tested the GIXAS set-up by recording X-ray fluorescence samples of metal coated silicon wafers as model samples. Since the results of these test measurements are promising, I am optimistic that the new set-up can be used for analyzing application relevant samples very soon. These visits also gave me an opportunity to learn more about synchrotron light sources and beamlines in general and to gain hands-on experience in operating such experimental stations. We also discussed future developments and technical challenges at the synchrotron light source.

In summary, I regard these exchange activities between SOLARIS and Hochschule Niederrhein within the SYLINDA project as highly beneficial for both sides. I am confident that I could make a strong contribution to the implementation of an additional experimental technique at ASTRA which will strengthen both SOLARIS' and Hochschule Niederrhein's research capabilities especially in view of future collaborations with industrial partners. On the other hand was given the opportunity to broaden my knowledge by gaining an insight in state of the art analytical techniques at a synchrotron light source.

20.04.2023,



Niklas Büll

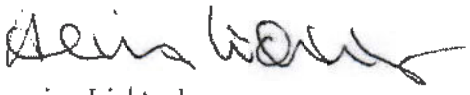
Name	Affiliation:	Destination:	Dates:
Dr. Henning Lichtenberg	HSNR	SOLARIS	Feb 27- Mar 17, 2023

In February/March 2023 I spent about 2 weeks at the SOLARIS synchrotron in Krakow (Poland) in order to work together with beamline scientists and the technical support group on a spectrometer for high-energy-resolution fluorescence detection. This device was installed at the ASTRA beamline within the SYLINDA project and has the potential to take the experimental capabilities at this station to a new level. In conventional X-ray absorption spectroscopy, as performed at ASTRA in routine operation, the photon energy of the incoming radiation is scanned with an X-ray monochromator, while either the intensity transmitted through the sample or the intensity of a selected fluorescence line emitted by the sample is measured. Additionally, X-ray fluorescence analysis at fixed excitation energy is possible. However, the resolution of the semiconductor detectors used for these measurements is quite low, and therefore certain features in the fine structure of the recorded spectra are not resolved. The new spectrometer at ASTRA will improve the energy resolution for fluorescence measurements by 1-2 orders of magnitude. This enhanced sensitivity will enable researchers to retrieve additional structural information about their samples. One example for the application of the spectrometer is catalysis research, where sometimes the fluorescence lines of chemical elements in the – low concentrated - catalytically active phase and in the support overlap when a conventional detection system is used. The new fluorescence spectrometer at ASTRA will be able to distinguish between these emission lines, and therefore allow to extract additional structural information about the catalytically active component. Since these advantages apply to functional materials in general, the new spectrometer has the potential to bring both basic and applied research at ASTRA to a higher level and help to attract especially industrial partners to the beamline within the SYLINDA project.

For me as a scientist who never worked with such a device, it was highly interesting to see how the new spectrometer was installed at ASTRA with the advanced techniques (including laser tracking) used by SOLARIS´s alignment specialists. Since the spectrometer is a very sensitive instrument, the alignment process is very challenging, and I am very grateful that during my visit at SOLARIS I could gain some hands-on experience in adjusting this device and learn about the data it provides and how it can be analyzed. I also discussed with the ASTRA beamline scientist how to make the alignment process more time efficient and user friendly

(since user beamtime at a synchrotron is quite expensive). For my part, I hope that I could contribute to bring this new device into routine user operation soon.

24.04.2023,



Henning Lichtenberg

Name	Affiliation:	Destination:	Dates:
Ralph Radmacher	HSNR	SOLARIS	....

During the last 2-3 years, I frequently exchanged design ideas and test results with scientists and technicians at the SOLARIS synchrotron in Krakow (Poland). Unfortunately, during that time I could not personally visit SOLARIS due to the Corona outbreak and my tight working schedule at our university. Instead, several on-line meetings were organized. This cooperation was intensified at the time when we were working on the X-ray monochromator for SOLARIS' ASTRA beamline in our laboratory at Hochschule Niederrhein University of Applied Sciences in Krefeld (Germany). After assembling the main parts of the monochromator we decided to test and optimize it as far as possible 'off-line' by simulating the synchrotron beam path with a HeNe laser before transferring the device to Poland. Naturally, these activities needed to be coordinated with our project partners in Krakow, and during one of our on-line meetings we discussed the advantages of developing a test bench for integration of system parts for the SOLARIS beamline. Since user beamtime at synchrotron light sources is very expensive, testing as many new components as possible 'off-line' is a very time and cost efficient way to further develop a beamline and improve user operation. Prototyping mechanical parts by 3D printing can save valuable time and costs as well, since they can be made in a short time and at low cost in our laboratory before - after several iterations of testing and optimization – sending the best design to a mechanical workshop for manufacturing the final, e.g. stainless steel, version. As a result, several prototypes of a modified fixed cam for the ASTRA monochromator were made by laser cutting and tested at our test bench. These cams are important to keep the incoming X-ray beam at ASTRA stationary during spectroscopic measurements, and therefore for obtaining reliable and reproducible data. We also printed alignment aids for helping the beamline staff to optically adjust the beamline within a short time. I hope that with our activities we could contribute to make ASTRA a more attractive, user friendly and efficient beamline for both academic researchers and industrial customers. Our interaction with SOLARIS also broadened my knowledge, e.g. when our Polish project partners shared their expertise in efficiently aligning beamline components at SOLARIS by using state of the art optical technologies like laser tracking with us. Therefore, I believe that both SOLARIS and Hochschule Niederrhein did greatly benefit from this exchange of expertise and experience within the SYLINDA project.

22.04.2023,

Ralph Radmacher

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 952148.