30 years of PSRS - memories

15th ISSRNS 2022
programme
exemplary abstracts

News from SOLARIS

Bulletin of the Polish Synchrotron Radiation Society Vol. 22, July 2022

SYNCHROTRON RADIATION IN NATURAL SCIENCE

Dear Readers,

On behalf of the Editorial Team, it is our pleasure to deliver the jubilee issue of Synchrotron Radiation in Natural Science. Since 2002 Polish Synchrotron Radiation Society has published a journal covering recent developments in instrumentation related to the synchrotron radiation and X-ray Free Electron Laser sources. It also provides a forum for reporting the most recent achievements in fundamental and applied research, such as novel applications in physics, chemistry, materials science, biology, and medicine.

The release of the recent issue is closely connected to the 15th edition of the International Symposium on Synchrotron Radiation in Natural Science which this year will take place on 22-25 of August in Przegorzały (near Krakow) where 30 years ago, an initiative to establish a scientific society of synchrotron radiation users was born. Therefore, the issue addresses the 30th anniversary and history of the Polish Synchrotron Radiation Society, shows examples of research discussed at the conference, and delivers recent news from National Synchrotron Radiation Centre SOLARIS. We hope each reader will find interesting and inspiring materials in the present issue.

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Synchrotron Radiation in Natural Science **22** (2022)

Honorary Members of the Polish Synchrotron Radiation Society

Danuta Żymierska
PSRS Secretary in the years 2002 - 2011

The General Assembly, the highest authority of the Polish Synchrotron Radiation Society (PSRS), awarded the title of Honorary Member to the co-founders of the Society, Professors Julian Jan Auleytner of the Institute of Physics of the Polish Academy of Sciences in Warsaw (in 2003) and Andrzej Kisiel of the Jagiellonian University (in 2004) in recognition of the merits of the creation and development of the PSRS.

Both Professors organized the 1st National Symposium of Synchrotron Radiation Users (1 KSUPS) in Krakow on February 11-12, 1991. During this meeting, the participants decided to establish the Polish Synchrotron Radiation Society. The Society was registered in Krakow on May 5, 1991. Currently, the seat of PSRS is located at the Institute of Nuclear Physics of the Polish Academy of Sciences in Krakow. Professor Kisiel became the first president and prof. Auleytner, his deputy; both of them held these positions for the first two four-year terms, that is, until 1999, actively participating in the work of the Management Board and organizing committees of all international and national conferences and symposia organized by the Society, later as Honorary Chairmen.

Professors Julian Jan Auleytner and Andrzej Kisiel were outstanding scientists with enormous scientific achievements. They were open to cooperating with many research centers in the country and abroad. They both started their professional work in 1953 - the prof. Auleytner was several years older, but the second world war and persecution took a precious period of his early youth. They both worked for half a century, prof. Auleytner at the University of Warsaw and the Institute of Physics of the Polish Academy of Sciences, and prof. Kisiel at the Jagiellonian University. They attached great importance to exchange their knowledge and experience with young scientists (each promoted to over 20 doctors). Their Ph.D. students work in many scientific and research centers in Poland and abroad, on all continents. Both Professors were members of the scientific councils of several institutes. They were awarded for their scientific work individually and with their teams, including state decorations.

Since 1992, in even-numbered years, PSRS has organized consecutively numbered international schools, and symposiums called the International School and Symposium on Synchrotron Radiation in Natural Science (ISSRNS), and in odd-numbered years the National Symposia of Synchrotron Radiation Users (KSUPS).

Late prof. Auleytner had extensive experience in organizing scientific meetings. In the years 1964-1992, he organized eight international schools combined with scientific symposia on defects in crystals, which contributed to increasing the level of knowledge and skills in the field of material characterization and to the development of scientific contacts with other countries, both from the West and the East, which was of great importance in the years of the Polish People's Republic. In 1978, he was the Organizing Committee chairman of the International Congress of Crystallography in Warsaw, which was attended by as many as 1,650 participants worldwide.

Synchrotron Radiation in Natural Science **22** (2022)

Professor Auleytner published in the first issue of the PSRS Bulletin an article entitled "My comments on the history of the Polish Synchrotron Radiation Society establishment ", while Professor Kisiel wrote about the idea to initiate the Polish Synchrotron Radiation Society and its beginnings in No. 10 of the PSRS Bulletin, and several articles in the following issues, including a comprehensive calendar.

In 1999, the younger members took over the activity of the PSRS. Professor Auleytner passed away in December 2003, while Professor Kisiel continues to provide Society with knowledge, advice, and experience.

The 4th ISSRNS (1998): sitting from the left J. Bąk-Misiuk and K. Jabłońska; standing from the left: D. Nagy (Hungary), J. Auleytner, (Honorary Member of PSRS), L. Datsenko (Ukraine), M. Lefeld-Sosnowska, behind her J. Grochowski, A. Kisiel (Honorary Member of PSRS), D. Żymierska and B.V. Robouch (Italy).

The Polish Synchrotron Radiation Society from the perspective of thirty years as seen by the President

Wojciech Maria Kwiatek
PSRS Treasurer in the years 1991 - 2017
PSRS Chairman in the years 2017 - 2023

On Thursday afternoon in 1991, I met Dr. Marta Zimnal-Starnawska at the Institute of Physics of the Jagiellonian University at Reymont Street in Krakow. We knew each other from my physics studies at UJ and then we became friends at Brookhaven National Laboratory (BNL) in the USA in 1985. Marta told me about the initiative of prof. Andrzej Kisiel and prof. Julian Auleytner from the Institute of Physics of the Polish Academy of Sciences in Warsaw on the organization of the National Symposium of Users of Synchrotron Radiation. The organizers wanted to recognize the interest of a scientific community in research conducted with the use of synchrotron sources. Due to limited access to these sources in Poland, the number of researchers was low. Mainly research was carried out with the use of laboratory sources,

but it was known that the use of synchrotron radiation sources would significantly improve the research possibilities and the obtained results.

The symposium was held on February 11 and 12, 1991 at the Guest House of the Jagiellonian University in Przegorzały (currently there is the Forest Hotel). During this meeting, it was suggested that a scientific society should be established in Poland, gathering all enthusiasts of synchrotron radiation in its ranks. I was the lucky guy who had the opportunity to build the X26 beamline at BNL and perform there experiments for my doctoral dissertation, which I defended in October 1989. It was the fruit of a three-year stay at BNL. There is no need to convince anyone that the adventure with synchrotron radiation which started in 1984 had a huge impact on my scientific plans resulting from my fascination and the possibility of learning about the surrounding world, which was provided by methods using this radiation. Undoubtedly, the group of prof. Kisiel in Krakow and prof. Auleytner in Warsaw were the leaders that conducted research on synchrotrons. Those research groups were small, but their enthusiasm and fascination gave them the strength to act. I was not a member of these teams, but an outsider from Bronowice. Thanks to Marta, I got to know prof. Kisiel and his team.

The group of prof. Auleytner from Warsaw, quite a large group of Cracovians and individuals from various centers in Poland came to Symposium in Pregorzały. Prof. Kisiel and prof. Auleytner presented arguments for establishing a scientific society, the aim of which would be to popularize research with the use of synchrotrons and the organization of scientific schools during which we would learn what synchrotron radiation is, how the synchrotron works, what research and where could be carried out with the use of synchrotron radiation. Everyone agreed that such an initiative is very important for the scientific community. Society gave us a chance to establish contacts between us here in Poland and to establish international cooperation. It allowed us to significantly expand the research offer of our teams. During this meeting, we discussed the organizational and legal aspects of our activity. We established a team whose task was to write the statute, prepare a registration application to the court, and appointed a temporary Management Board. The Management Board was headed by prof. Andrzej Kisiel and prof. Julian Auleytner became the Vice-Chairman. We have also established that the seat of the Society is Krakow and the scope of activities covers the entire country. We signed the declaration of joining the Society and the attendance list at this meeting in one of the small rooms on the ground floor next to our meeting room. The declaration of joining the Society was signed by 29 participants of the meeting – Izabela Sosnowska, Julian Auleytner, Henryk Fiedorowicz, Tadeusz Pisarczyk, Józef Oleszkiewicz, Ewa Czarnecka-Such, Marta Zimnal-Starnawska, Andrzej Rodzik Andrzej Andrejczuk, Marian Surowiec, Grzegorz Kowalski, Krystyna Jabłońska, Jadwiga Bąk-Misiuk, Eugeniusz Rokita, Wojciech Kwiatek, Paweł Tomaszeski, Helena Grigoriew, Maria Lefeld-Sosnowska, Jerzy Pielaszek, Krzysztof Reubenbauer, Janusz Waliszewski, Dorota Dębowska, Marek Stankiewicz, Jacek Goniakowski, Roman Markowski, Henryk Kępa, Andrzej Kisiel, Ewa Sobczak, Jacek Grochowski. We were all very excited, we were aware that we were starting new pages in the history of the development of Polish physics. It was late but we were full of energy to act and with the hope that we would be able to meet our expectations. That night we finished the session as members of the Society - although it was still required to register the Society in the Court. Then, during the symposium in Przegorzały, we established that it was the first National Symposium of Synchrotron Radiation Users and that the next one will be held in two years.

The following days were devoted to the preparation of documents. Waiting for the registration seemed to be endless. Until the day when the letter from the Court arrived, now we were able to act as a fully-fledged Society. The first treasurer was Marta, who knew that I had some financial experience from the scouting times. Therefore she asked me to take over these duties during the first General Assembly. We had to organize such a meeting as the official Society. And so I became the treasurer, as it turned out many years later.

The main tasks of the Society were also the organization of an international school and a symposium. We called it "International School and Symposium on Synchrotron Radiation in Natural Science" - ISSSRNS and decided to organize it every two years, alternating with the National Symposium on Synchrotron Radiation Users - KSUPS. Over time, the abbreviation ISSSRNS was replaced with the shorter abbreviation ISSRNS.

The first International School (ISSSRNS) was held on May 13-21, 1992 in Jaszowiec. The chairmen became prof. Andrzej Kisiel and prof. Julian Auleytner. Many wonderful lecturers from major synchrotron centers were invited as well as guests, among them were: M.J. Cooper, P. Fratzl, R. Haensel, J. Hormes, A. Kvick, C. Malgrange, G. Margaritondo, G. Materlik, S. Mobilio, I.H. Munro, C.R. Natoli, P.-O. Nilsson, G. Rapp, R. Rosei, L. Schlapbach, G. Vogl, E. Weckert, T. Wróblewski, *et al.* and it was they who took us on a journey through the secrets of synchrotron radiation.

Thanks to the founding of the Society, we had the opportunity to get to know each other better and to teach each other about the research possibilities offered by synchrotrons. During joint meetings, conferences, and schools, not only scientific but also social relations between us strengthened. Sometimes our family members also took part in the conferences. And it is so today. The accompanying children have always given us a lot of fun. And this is when organizing a highlander dance show on a large barrel standing next to the fire, or suddenly appearing in the conference room, relieving the chairmen and announcing another lecture - "Now, my Daddy will have a talk". At that time, there was a surprise, apleasant surprise, and a smile on the face of prof. Bronek Orłowski, because he was the perpetrator of such actions. Common walks and evenings by the fire were an opportunity not only for talks but also for dancing and singing to the accompaniment of the sounds of the prof. Czesław Kapusta's guitar. Czesiu even wrote a song about us. We can safely say that we managed to create a "family" of friends, and sympathizers of synchrotron radiation.

The tradition of organizing these national and international meetings is preserved to this day. For thirty years, we are still craving new knowledge about synchrotrons and research opportunities. Not so long ago, the third-generation synchrotrons seemed to be something wonderful, which would allow for a change in the quality of the research conducted. Today we know that the fourth generation synchrotrons – free-electron lasers have significantly changed the quality of research. We can observe the kinetics and dynamics of chemical reactions, phenomena occurring in less than a picosecond, or study the structures of individual atoms.

The activities of the Society are not only conferences or schools. Appetite increases with eating. Fascinated by the possibilities of research with the use of synchrotron radiation, we wanted even more. A wonderful center has been established in Grenoble - the European Synchrotron Radiation Facility. An initiative of a consortium of which Poland was not a member. Anyone can apply for an allocation of beam time, but scientists from member countries may have more of that time, as their countries bear the costs of the activity. Therefore, among the members of the Society, the idea arose that Poland should join this consortium with at least a minimal contribution. Talks with the ministry were conducted for several years. Prof. Kisiel traveled to Warsaw many times to convince ministerial authorities of the need for such an undertaking. Many members of the Society became involved in these activities.

As the Society's Treasury, I had very frequent contact with prof. Kisiel and one day he asked me to go to Grenoble with dr. Jacek Grochowski and take part in the ESRF User's Meeting and meet with the administrative director of the ESRF to initially discuss the possibility of Poland joining the Consortium. It was a huge challenge for me. I remember sitting with Jacek in the cafeteria and discussing the strategy of the conversation. We were asking ourselves questions so as not to forget anything. We were such a for-post on this matter. Later, the initiative was taken over by the Warsaw center. Prof. Krystyna Jabłońska has great merits in this field. It is difficult to count the hours, days, and months that prof. Kisiel and prof.

Jabłońska spent to achieve this goal. And after many years of effort, it worked out. Today, Poland pays a contribution to the ESRF in the amount of 1% of the budget and we can sit on both the Consortium Council and the Administrative and Economic Panel. We have easier access to the beam.

Another important initiative before Poland joined the ESRF was an attempt to build a consortium consisting of Central European countries (Austria, the Czech Republic, Slovakia, Hungary, and Poland), which would contribute 1%. The meeting of representatives of the scientific community of these countries was held in Krakow on the initiative of prof. Kisiel at the Collegium Novum of the Jagiellonian University. We had several meetings, but unfortunately, it was not possible to build this consortium. On the other hand, the Czech Republic, Slovakia, and Hungary signed the "Centralsync" consecration agreement in 2008, becoming an associate member of the ESRF with a 1.05% contribution. On the other hand, Poland, thanks to the efforts of the Society, became an independent associate member of the ESRF with a 1% contribution, and the role of the coordinator of the project to support Polish scientists in the ESRF is performed by the Institute of Physics of the Polish Academy of Sciences in Warsaw, previously represented by prof. Krystyna Jabłońska and currently by dr. hab. Anna Wolska.

Access to the ESRF did not exhaust the appetites of the Society's members. In parallel with the efforts made to obtain Poland's participation in the ESRF, the idea of building a National Synchrotron Radiation Center was born. Initially, there was also an idea to build a synchrotron in Central Europe, which would ease the burden of requests for beam time on European synchrotrons. The talks were held jointly with representatives of the Czech Republic and Slovakia. But where to get this huge amount of money from? Were the proposals different, from structural funds, funding for science, directly from European funds? Again a few years of deliberation. Years passed, and the Presidents of the Society changed (prof. Andrzej Kisiel, prof. Bronisław Orłowski, prof. Krystyna Jabłońska, prof. Maciej Kozak), but the dreams were always the same. However, the Polish community has undertaken intensified efforts to discern whether it is possible to build a synchrotron in Poland.. The first discussions among the Society took place during the ISSRNS Conference in Jaszowiec, then in Zakopane, Szklarska Poręba, and Krakow. Work has begun on the design of the source, electron energy in the storage ring, and experimental lines. In Poland a Synchrotron Consortium was established, which included 20 research units from Poland. Initially, we dreamed of 3 GeV electron energy and a large measurement hall. There were teams designing lines. I was responsible for building a team designing an X-ray line for research using the microXRF, mikroXAS, and mikroCT techniques. The team included: prof. Marek Lankosz, prof. Czesław Kapusta, prof. Marek Pajek, prof. Andrzej Kuczumow and me. The first conference on the presentation of measurement line projects took place in Poznan. We were all very excited about these plans. We really wanted it to succeed. But as it usually happens, life writes its own scripts, and it was impossible to realize these dreams. Until one day my fellow physicists from the Jagiellonian University, constantly trying to obtain financing for the construction of a synchrotron, received proposals to submit an application to the Ministry and apply for the necessary funds. But these have been severely limited. And here a quick decision had to be made. We could build a smaller machine that would allow a series of research in the energy range still interesting for the scientific community, or we could give up. No, nobody gave up. The decision was made. “We are building a smaller synchrotron”. I admit that it initially divided the scientific environment a lot, but today, in the perspective of the years, when we can boast of a very good research tool located in Krakow at the National Synchrotron Radiation Center - Synchrotron SOLARIS, no one has any doubts that it was a good decision.

Laying the foundation stone for the construction of the synchrotron SOLARIS. From the left in the first row: prof. Marek Stankiewicz, prof. Wojciech Nowak, prof. Karol Musioł (Rector)

The cooperation between the Society and the Synchrotron SOLARIS is still tightened, as evidenced by the initiative to jointly organize the National Synchrotron Radiation Users Symposium and the SOLARIS Synchrotron Users Meeting as "JOINT MEETING OF PSRS AND SOLARIS USERS". This year, such a meeting will be held for the second time in history. It has been permanently included in the SOLARIS and the Society's calendar of events.

Thanks to the initiative of Prof. Wojciech Paszkowicz, for twenty years, we have been publishing a Bulletin containing interesting scientific articles, including abstracts from organized schools and conferences. In this way, we try to reach the widest possible scientific community not only in Poland but also abroad. There are many examples of activities undertaken by members of the Society for the development of scientific research using synchrotron radiation or free-electron lasers. Examples include the recent initiatives of the School on Free Electron Lasers (FEL) for Beginners, establishing a consortium of users of FEL sources, or an application to the Ministry of Education and Science to support Polish users of the European Free Electron Laser.

From the perspective of thirty years of the Society's activity, it should be emphasized that we are the most dynamically operating Synchrotron Society and at the same time the oldest in the world. It is thanks to determination, mutual cooperation, and understanding. Understanding the need to popularize synchrotron science, we act *pro publico bono.* None of us count the time we spend on these activities. We don't have holidays. No matter what, each of us is always available. And it doesn't matter if he/she is visiting a distant country or holding his/her little happiness in his/her hands. It doesn't matter if it's morning or evening. If there is a need for action, we simply are. This is what I want to thank my colleagues

- all members of our Society. Looking to the future, I hope that in the next thirty years Society will be able to boast of achievements in science equal to the Nobel Prize.

As the fifth President of the Polish Synchrotron Radiation Society, I would like to thank all my predecessors, and members of the Boards and Audit Committees for their selfless work, full of dedication. For initiatives aimed at improving the quality of research with the use of synchrotrons and free-electron lasers. Thank you for disseminating knowledge about research opportunities and encouraging, especially young science adepts, to thoroughly learn about the world around us thanks to the possibilities offered by interdisciplinary research using synchrotron radiation.

I would also like to thank prof. Andrzej Kisiel that he was my mentor, teacher, and still is a friend.

Thirty years jubilee of the Polish Synchrotron Radiation Society

Zbigniew Kaszkur
PSRS Secretary in the years 2011 - 2017

Thirty years is a lot of time, looking from a personal perspective. Many of us witnessing the Society time travel from the beginning feel nostalgia and ponder on values the Society brought to our lives. From a purely scientific point of view, it gathered people strongly lobbying in favor of developing our material research tools to a contemporary level and having access to such tools. We do not know whether it would be possible to support by state our access to Large Scale Research Facilities or to sponsor the building of the first Polish synchrotron without pressure from the community. But we know that nothing happens without human activity, and behind all these initiatives, there were people of the Polish Synchrotron Radiation Society.

The social context is the second, possibly more critical element of the Society's history. Meeting and talking to other time travelers continuously changes our lives, bringing new motivations and new choices. The Society during these 30 years showed outstanding and astounding activity in the organization of meetings. Each year, a national or international (interchangeably) meeting was held with its minutes printed in the Society Bulletin. Amazement comes from realizing that each time some 'sucker' has to be found, devoting a lot of his time and energy to activity having nothing to do with discovering hidden laws of nature. He/she usually makes few other dependent people do extended office work as typically, for meetings, no professional companies were employed. A self-supporting meeting requires many participants, so the submitted contributions are rarely rejected, resulting in their overall low rating. But surprisingly, the 'sucker' work brings no planned added value. When we listen to our colleagues, we often arrive at new ideas, form opinions, motivate ourselves and criticize. Besides our personal development, unnoticeably, we create SCIENTIFIC COMMUNITY - an abstract being of practical importance. We can shape our community by favoring scientific values appearing from substantive assessment and not bureaucratic measures like bibliometric factors, financial impact, ministry guidelines, or political correctness. It is something vanishing in the contemporary world but worth fighting for. Do not let money and bureaucracy ruin science for future generations. The task is increasingly difficult with broadening the scope of science and interdisciplinarity. The right referee for scientific councils or journal editorials is harder to find. Scientific evaluation often is reduced to summing the bibliometric points. It seems that the only cure can come from an active SCIENTIFIC COMMUNITY.

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During the past 30 years, the Polish Synchrotron Radiation Society gathered around itself few hundred people (including nearly 200 members and sympathizers) participating in the meetings. Among them, many ventured into organizational activity, and some were 'sucked into,' including young members. Our 30 years old jubilarian is still in good shape, and ongoing generation change runs smoothly.

The Society also has impressive financial records. The conference activities and skillful attracting of sponsors brought net positive financial results, which allowed the statutory fees to be low. They cannot pose a financial barrier even for students.

Individual perspective for most of us involves private contacts, friendships, and meeting memories. For some of us, it is a nostalgic look back to when we were young and pretty, full of energy to conquer the scientific world. Since then, indifferent time took away a few of our colleagues whom we will neither meet nor talk to. We got to know a few young colleagues sucked into organizational activities despite a common negative response to the question: "what the Society has to offer?". In a world ruled by money and commerce, seemingly, organizational activity has nothing to offer and is a waste of time. But, if we plan to be involved in science for life, contributing to the scientific community is an intangible asset worth nurturing. It is not about settling something by knowing somebody, and it is about the survival of science as a human pursuit to know the secrets of the world, not as a bazaar where we sell for the best-offered price. In the end, also remember that our colleagues evaluate scientific grants from the scientific community we attempt to shape.

My thirty years with the Polish Synchrotron Radiation Society

Krystyna Lawniczak-Jablonska
PSRS Secretary in the years 1991 - 1995, 1999 – 2002
PSRS Vice-Chairwoman in the years 2002 - 2005
PSRS Chairwoman in the years 2005 - 2011

I am one of 20 founding members of the Polish Synchrotron Radiation Society. I remember very well how the idea was born. It was the meeting in Krems town in lower Austria in the autumn of 1990. The Polish delegation was invited to discuss the Polish involvement in constructing a nuclear reactor for science. It turned out during the discussion that we not only used neutrons in our research, but many of us are already exploiting synchrotron radiation and are fascinated by the numerous possibilities offered by this tool. There were delegates from scientific institutions and universities in Krakow, Poznan, Warsaw, and Wroclaw. I do not remember all by names, but there was prof. Julian Auleytner, prof. Andrzej Kisiel and scientists from his group, prof. Izabela Sosnowska, prof. Maria Lefeld-Sosnowska, and doctors Jacek Grochowski, Jerzy Gronkowski, Ewa Sobczak, Jadwiga Bąk-Misiuk and also a few scientists from the Institute of Low Temperature and Structure Research, PAS in Wroclaw. We have been sitting in the evening with a glass of young wine and complaining about how difficult it is to get beam time at the synchrotron because we were not experienced in writing the scientific proposals at the international level. Moreover, in the case of the proposals being accepted, we had a whole new set of problems: how to get travel and accommodation money for the group working 24 hours at the experimental station? We needed support. So, at this very moment, the concept arrived of the creation of society, bringing together Polish scientists interested in using synchrotron radiation and supporting the development of research

conducted using synchrotron. At the end of the Krems meeting, we decided to meet again in Poland and look for the fastest possible way to realize our idea.

Taking advantage of the hospitality of the X-Ray group from the Institute of Experimental Physics at Warsaw University, headed at that time by Maria Lefeld-Sosnowska, we have organized a short meeting at her office. The groups from Krakow and Warsaw gathered and unanimously decided to organize a scientific seminar. Andrzej Kisiel proposed Przegorzały near Krakow as a place for this event. The first meeting of the polish synchrotron radiation users was held on 11-12 February 1991. The Polish scientists reported on the posters the results of their experiments using synchrotron radiation. Some information has been provided about available synchrotron facilities and those under construction (e.g., European Synchrotrons Radiation Facilities) and planned. Scientists from European Synchrotrons have been asked to explain the procedures for applying for beam time at different facilities and describe the experimental possibilities. During the night discussions, the concept of establishing the Polish Synchrotron Radiation Society was converted into a fundamental objective. None of us had experience with the formalities needed to register the society officially as an independent. We know the requirements now, but it was a new exercise then. Nevertheless, working together and sharing experiences (e.g., dr Paweł Tomaszewski, ILTSR, Wroclaw provided the sample statute of a society already registered in a court, Ewa Czarnecka-Such (UJ) was the contact person in court in Krakow). Finally, on 5 May 1991, the Polish Synchrotron Radiation Society was registered officially. From the idea in Krems to the creation of society passed only half a year.

The main aim of the Society was and still is a scientific and educational activity. In particular, it is crucial to support the development of scientific research using synchrotron radiation (SR) and to popularize this type of research in Poland. The PSRS field of interest currently includes free-electron lasers (FEL) besides synchrotrons. From the beginning in 1991 up to 2020, I was involved in the activities of the Management Board. First, I was the PSRS Secretary (1991-1994, 1999-2002), next Vice-president (2002-2005), and then President (2005-2011). From 2011 to 2017, I acted as a member dedicated to contacting international organizations, and then, up to 2020, I was a member of the PSRS Audit Committee. My active activity for the PSRS was 29 years altogether. The main involvements of the Society, and therefore mine, in those years, were the organization of international (ISSRNS) and national (KSUPS) meetings. Someone may ask why so complicated name (International Schools and Symposium for Synchrotron Radiation in Natural Science) was chosen for international meetings? The reason was straightforward. We wanted to use all words to ensure more accessible access to subsidies to finance conferences. It is easier to get support sometimes for schools, other times for symposiums, but it is going about science in general, not just physics.

International meetings provided us with an overview of the latest research techniques, technical solutions, and scientific achievements. We were new to the conference market. It was not easy to invite recognized scientists, so we focused on young but committed people who would come to us willingly. Now, these people are very famous and hold high positions.

National meetings enabled Polish scientists to present their achievements in synchrotron research and consolidate the research community, simply get to know each other.

I think I have attended almost all of these meetings and remember them with pleasure.

Apart from my involvement in organizing the conferences, I tried to organize dedicated, in particular, to X-ray absorption technique workshops. Below are photos from the workshop in November 2006 with the participation of Bruce Ravel, with whom many of us have established close contact. Fifty-two young scientists from 15 research centers in Poland took part in this workshop at IP PAS in Warsaw.

From the beginning, we were looking for a way to facilitate Polish scientists' access to synchrotron research. Much of my activity has focused exactly on this. First of all, since 1992, we have been making efforts to ensure Poland's participation in the consortium ESRF. Many discussions at General Meetings and Management Board Meetings concerned the strategy to convince the Ministry of Science of the need to be a member of this international research infrastructure. We considered joining alone or within a consortium of countries from the Eastern bloc. Finally, after 12 years, starting from July 2004, Poland officially became a member of ESRF, and from July 2006, an associated member with a share of 1% of the ESRF budget. The Ministry of Science pays the Polish share through a grant awarded to the Institute of Physics PAS in Warsaw. The Polish users performing an experiment at the ESRF have to acknowledge this in publications reporting the results of experiments carried out there.

From left to right: Administrative Director Helmut Krech, Prof. Jacek Kossut Director If PAN and Director General Bill Stirling signing the agreement.

From left to right: The Director General of the ESRF, Bill Stirling; the two Polish scientists at the ESRF, Maciej Lorenc and Johanna Hoszowska; and Prof. Krystyna Jablonska-Lawniczak, Prof. Bogdan Kowalski and Prof. Jacek Kossut, from the Polish Academy of Sciences

Moreover, I was a member of the Expert Group dedicated to large research infrastructures set up at the Ministry of Science for several years. One of our activity's results was funds for Poland's access to the European Free-Electron Laser Facility at DESY. On June 5, 2007, the German Federal Minister of Education and Research, Dr. Annette Schavan, officially launched the European X-ray laser facility XFEL project. The Polish Ministry of Science representative, Dr. Jacek Gierlinski, was present at the ceremony. Starting from

that year, I was actively involved as a Polish representative in the Working Group on the Scientific and Technical Issues at XFEL. I was also, up to 2012, a member of the E-XFEL Scientific Advisory Committee (SAC).

On June 5th, 2007, Dr. Annette Schavan officially launched the European X-ray laser facility XFEL project. Poland was already involved.

XFEL SAC and MAC meeting in 2010 at DESY

Visiting XFEL with SAC during construction.

With Dr. Thomas Tschentscher XFEL Scientific Director

When the PSRS celebrated its 15th anniversary in 2006, the project of the Polish National Synchrotron was already under preparation and got a green light to realize from the government. The project was finally approved in April 2010, and the synchrotron facility was erected in 2015 at the new campus of Jagiellonian University in Cracow.

It would not be justified to claim that all the achievements mentioned above are result only PSRS activity. However, I believe that the joint effort of PSRS members substantially contributes to them.

Another essential part of my activity in PSRS was working first at the European Synchrotron Radiation Society (ESRS) and next in ESUO (European Synchrotron and FEL Users Organization), where I was acting till 2021 as the vice-chair. These organizations have been created to support synchrotron radiation users at the European level. This activity resulted in the creation of European programs in the framework of FP6 (project IA-SFS) and FP7 (ELISA and CALIPSO), supporting European scientists performing research

on large facilities. On the ELISA project board, I was representing ESUO. In the CALIPSO project, I was a coordinator of transnational access activity (TAA) work packages. I am sure many of us have used these programs, which not only paid for travel and accommodation during experiments on European national synchrotrons but also paid synchrotrons part of the cost of used beamtime. Thanks to the intensive work of ESUO and lobbying through national representatives in the European Commission, it was possible to open a competition for a similar program in the frame of Horizon 2020 and obtain CALIPSO plus project, which has just ended. ESUO represents about 30 000 users of the European synchrotrons and FEL light sources. Currently, 30 European countries (including Turkey and Israel) are ESUO members and are represented by delegates. At present Agnieszka Witkowska and Ryszard Sobierajski represent Poland in ESUO. The general mission of ESUO is to coordinate the synchrotron and FEL radiation user activities in Europe and provide support to the users to access synchrotron and FEL beamlines in Europe. Trip supports to European synchrotrons has greatly helped scientists access these devices. However, the user's support is still unclear in the frame of the Horizon Europe program.

In 2006 we celebrated 15 years of PSRS in Zakopane, Geovita. In 2011 Institute of Physical Chemistry PAS in Warsaw hosted KSUPS'9, where we celebrated 20 years. In 2016 we decided again to organize the conference in Ustron-Jaszowiec. In this place, the first ISSRNS conference took place in 1992, and also a few others. In Ustron-Jaszowiec we celebrated 25 years of PSRS activity. Below are some photos to memorize these happy hours.

ISSRNS-2006. Celebration of PSRS 15 years with the executive board. Excursion to the Tatra mountains. Conference dinner.

KSUPS'9 2011. Celebration of PSRS 20 years. K. Jablonska presenting history of PSRS. G. Wrochna introducing idea of Polfel. Group photo.

ISSRNS-2016. Celebration of PSRS 25 years. Three Presidents cutting the special cake Bronisław Orłowski, Krystyna Jablonska, Maciej Kozak. Conference excursions to castle in Pszczyna and Tyskie brewery.

Finally, in these difficult times, I would like to dedicate to all of us Albert Einstein's words: "The most beautiful thing we can experience is the mysterious. It is the source of all true art and science. He to whom the emotion is a stranger, who can no longer pause to wonder and stand wrapped in awe, is as good as dead; his eyes are closed. "- don't close your eyes.

Synchrotron Radiation in Natural Science **22** (2022)

Poland at the European Synchrotron Radiation Facility: 30 years of history and future prospects

Anna Wolska
PSRS Board Member in the years 2008-2011

Wojciech Paszkowicz
PSRS Board Member in the years 2002-2020
PSRS Bulletin Editor-In-Chief in the years 2002-2017

The European Synchrotron Radiation Facility (ESRF) is a research infrastructure located in Grenoble, France (Figure 1). It is a state-of-the-art European radiation source with a wide range of radiation energy, extremely high brightness, and excellent beam stability. Construction and operation of this unique infrastructure were possible due to the creation in 1988 of the international consortium. Twelve countries took part in the construction: France, Germany, Italy, United Kingdom, Belgium*, The Netherlands*, Denmark **, Finland**, Norway**, Sweden**, Spain, and Switzerland. These countries became member states, individually or through consortia like Benesync, as indicated by *, and Nordsync, indicated by **. Starting from 2004, Poland has been one of eight associated members together with: Austria, Israel, Portugal, India, the Czech Republic, South Africa, and Hungary. Russian Federation was admitted as a new member in 2014. However, presently is suspended by the decision of the ESRF council.

Polish presence in the ESRF is ensured by the grants from the Ministry of Education and Science led by the National Consortium of Scientific Institutions Interested in the Use of the European Synchrotron Radiation Source in Grenoble represented by the Institute of Physics Polish Academy of Sciences. The current grant will expire in March 2026. More information can be found on the website: http://www.ifpan.edu.pl/esrf/Local_Publish/

Figure 1. The main entrance to the ESRF. Photo by W. Paszkowicz.

The ESRF research facility is used for fundamental and applied research in physics, materials research, chemistry, molecular biology, and other life sciences. In particular, the ESRF now offers unique capabilities for studying of the structure and its function in biological materials, the real-time course of chemical reactions, X-ray tomography of materials with the spatial resolution of single nanometers, and the properties of materials at extreme pressures and temperatures. Research techniques such as time-resolved and high-pressure diffraction as well as X-ray absorption and emission, magnetic circular polarization, Cryo-EM electron cryomicroscopy, and many others, are available to users.

The first light at the ESRF was observed in 1992. The facility was made fully available to researchers in 1994 with 15 end stations. It is noteworthy that immediately in 1994 Polish scientists published their scientific articles describing the results obtained at the ESRF[1,2].

The decision on the preparation to upgrade was taken after 20 years of activity in the frame of a roadmap aiming to keep the world leadership as a synchrotron radiation source and support the development of European science[3,4]. In 2008, the ESRF Council decided on a comprehensive upgrade to be split into two phases. The first stage, performed in 2009-2015 and described in the Purple Book[5], concerned the upgrading and allocation of research stations to prepare them to exploit the new capabilities of the X-ray source[6-9]. The described source upgrading in the Orange Book was successfully carried out in 2019-2020. Despite the obstacles caused by pandemic-related restrictions, the work was completed to replace the accumulation ring two months ahead of schedule. The new accumulation ring has virtually the same circumference as the previous one. Still, thanks to an array of innovative new magnets designed at the ESRF, it is able to guide and focus electrons so that the brightness and coherence of the X-rays are increased by a factor of 100 compared to that obtained before. What is interesting, with the new design, the machine is also much more energy-efficient which results in about a 30% reduction in electricity consumption compared to the previous one. On 25th August 2020, the beam was made available to users at almost all beamlines (except a few under construction or reconstruction), completing both phases of the ESRF upgrade. With the completion of the accumulation ring upgrade, the ESRF-EBS (EBS stands for Extremely Brilliant Source) has become the representative of the newest generation of synchrotron radiation sources.

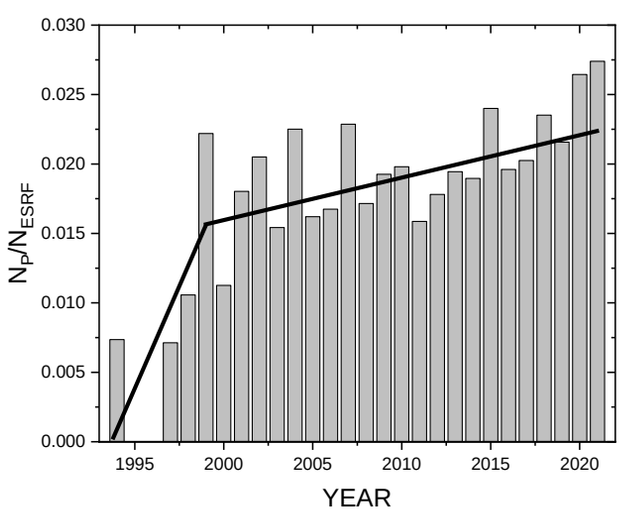

Figure 2. Fraction of publications (NP/NESRF), with the contribution of authors affiliated in Poland, referring to results of experiments performed at ESRF (NP). The NP is based on the ESRF library database, completed by extensive search in ISI and Scholar databases. NESRF corresponds to ESRF library data. The solid line is a guide to the eye showing the trend.

Four new so-called flagship beamlines were designed to take advantage of the properties of the EBS fully: EBSL1: Coherence applications – dynamics and imaging at the nanoscale; EBSL2: Hard X-ray diffraction microscopy on material complexity; EBSL3: High-throughput large-field phase-contrast tomography and EBSL8: Serial

synchrotron crystallography on macromolecular nanocrystals. They are under construction and are planned to be gradually open to users from the second half of 2022 to 2024.

Thanks to the grant of the Polish Ministry of Education and Science (decision no. 2021/WK/11), any researcher affiliated with the Polish scientific institution can submit a research project alone or in collaboration with scientists from other countries. All scientific proposals are evaluated by the International Peer Review Committee regarding the scientific merit. It is essential to realize that, according to the ESRF regulations, each member country can use only the fraction of the available beamtime equal to the contribution to the budget. What's more, in the case of collaboration with scientists from other countries, the percentage of the beamtime is divided proportionally between the countries depending on the affiliation of the scientists given as co-proposers.

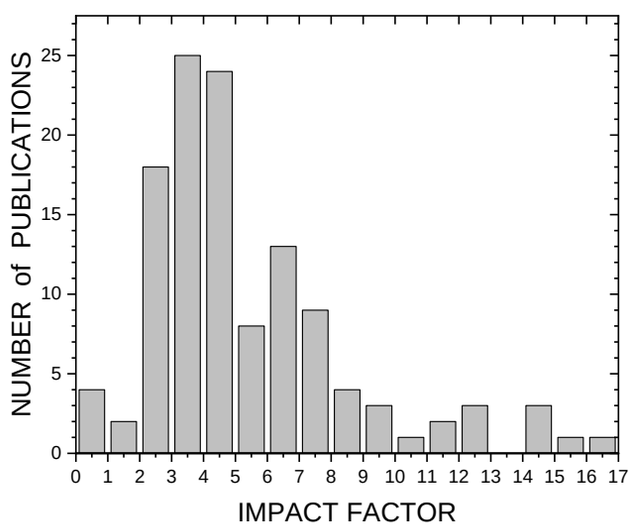

Figure 3. Number of publications from years 2019-2021, with contribution of authors affiliated in Poland in respect to the journal's Impact Factor.

The obtained results are published in scientific journals. Currently, the number of scientific articles with Polish affiliation is about 50 per year. Figure 2 displays this number (NP) as a fraction of all scientific articles produced with a contribution of the ESRF facility (NESRF) in a function of time. The fraction tends to increase with time and now is more than two times larger than the formal contribution of Poland to the ESRF budget (0.01). It shows that the Polish scientists use their beamtime with excellent efficiency. Figure 3 presents the number of publications from the years 2019-2021 in respect of the journal's Impact Factor. Most scientific articles in this period are published with the Impact Factor between 2 and 8.

For over 18 years, scientists affiliated with more than 40 scientific institutions from Poland have applied for beamtime at the ESRF. The total number of publications with Polish coauthors is more than 800 and shows a growing trend. They report the results of experiments on different types of materials and use various techniques. All this indicates how important for Polish researchers is access to the unprecedented opportunities of the ESRF beamlines.

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Monday, 22nd August 2022			
Time	**Title**	**Speaker**	**Type**
11:00	Conference Opening		
Session: X-ray research for an ecological society			
11:30 – 12:10	X-ray absorption spectroscopy to provide insight in the catalytic active site	Maarten Nachtegaal	Invited
12:10 – 12:30	Electronic structure of TiO_2 thin films for photoelectrochemical and gas sensing applications studied by XPS and XAS	Katarzyna Zakrzewska	Oral
12:30 – 12:50	Local and electronic structure study of GaN based microrods for hydrogen generation from water	Edyta Piskorska-Hommel	Oral
12:50 – 13:00	Oxygen K and titanium L23 XAS spectra of thin films applied as photoelectrodes for hydrogen generation	Katarzyna Płacheta	Short
13:00 – 14:00	Lunch break		
Session: Advances in theory, software, and data analysis & Recent trends in synchrotron instrumentation (I)			
14:00 – 14:40	Spin polarisation and dichroism effects in ARPES of 2D materials	Jan Minar	Invited
14:40 – 15:00	Pypleem- a Python framework for PEEM/LEEM data analysis	Paweł Nita	Oral
15:00 – 15:10	Detection of vacancies in FCC solid and their effect on twinning	Ilia Smirnov	Short
15:10 – 15:30	Develop of RF-plasma surface cleaning technique in the NSRC SOLARIS	Tomasz Sobol	Oral
15:30 – 15:50	SOLCRYS project at SOLARIS National Synchrotron Radiation Centre – current status	Maciej Kozak	Oral
16:00 – 16:30	Coffee break		

Session: Recent trends in synchrotron instrumentation (II)			
16:30 – 17:10	Synchrotron infrared emission: optimized collection, propagation and exploitation for new scientific opportunities	Lisa Vaccari	Invited
17:10 – 17:50	TBA	Annalisa Pastore	Invited
17:50 – 18:10	X-ray surface diffraction from solid and liquid surfaces at the ESRF ID10 beamline	Maciej Jankowski	Oral
18:10– 18:30	The PIRX beamline at SOLARIS and its technical improvements	Marcin Zając	Oral
18:30 – 18:50	PolyX: X-ray microimaging and microspectroscopy beamline under construction at SOLARIS	Paweł Korecki	Oral
19:00	Welcome party		
Tuesday, 23rd August 2022 - Monday			
Time	**Title**	**Speaker**	**Type**
Session: Material science, nanotechnology, and magnetism (I)			
9:00 – 9:40	Insight into the lithiation mechanisms in Li-ion anode materials by x-ray absorption spectroscopy	Angela Trapananti	Invited
9:40 – 10:00	Positive and negative monoclinic deformation of corundum-type trigonal crystal structures of M_2O_3 metal oxides	Radosław Przeniosło	Oral
10:00 – 10:20	Superconductivity and charge density waves in $LaTSb_2$ (T=Ag, Cu) Nodal Line Semimetals	Marcin Rosmus	Oral
10:20 – 10:40	ARPES observation of topological Lifshitz transition in Weyl semimetal NbP decorated with Pb	Bogdan Kowalski	Oral
10:40 – 10:50	Studies of pristine and dissolved Nb-doped hydroxyapatite prepared via low-temperature mechanochemical method	Wojciech Korzeniewski	Short
11:00 – 11:30	Coffee Break		
Session: Material science, nanotechnology, and magnetism (II)			
11:30– 12:10	Focused and coherent X-ray beams for advanced microscopies	Gerardina Carbone	Invited
12:10 – 12:30	Porosity and local structure studies of carbon materials using synchrotron radiation	Karolina Jurkiewicz	Oral
12:30 – 12:40	Probing nanomaterials with X-ray spectroscopy	Rafał Fanselow	Short
13:00 – 14:00	Lunch Break		
Session: Material science, nanotechnology, and magnetism (III)			
14:00 – 14:40	Memory of frozen and rotatable antiferromagnetic spins in epitaxial CoO(111)/Fe and NiO(111)/Fe bilayers	Michal Ślęzak	Invited
14:40 – 15:00	Distribution of antiferromagnetic domains in mixed nickelcobalt oxide ($Ni_xCo_{1-x}O$) thin films	Anna Mandziak	Oral
15:00	Coffee Break		

15:15	PSRS meeting		
16:30	Poster Session		
18:00	Barbecue Party		
Wednesday, 24th August 2022			
Time	**Title**	**Speaker**	**Type**
Session: XFEL application to natural science (I)			
9:00 – 9:40	Introduction to Hard X-ray Free Electron Lasers	Robert Feidenhansl	Invited
9:40 – 10:20	Probing ultrafast structural and electronic dynamics in chemical and biochemical systems using X-ray free electron lasers	Christopher Milne	Invited
10:20 – 10:40	Insight into the attosecond dynamics in matter with the concept of X-ray chronoscopy	Wojciech Błachucki	Oral
10:40 – 11:00	Split-pulse hard X-ray Fourier Transform Holography femtosecond imaging	Wojciech Roseker	Oral
11:00 – 11:30	Coffee break		
Session: XFEL application to natural science (II) & New methods and combination of techniques (I)			
11:30 – 12:10	Core-level nonlinear spectroscopy triggered by stochastic X-ray pulses	Jakub Szlachetko	Invited
12:10 – 12:30	In situ synchrotron techniques for Laser Based Additive Manufacturing	Małgorzata Makowska	Oral
12:30 – 12:50	Stability of near surface crystallographic structure of Bi_2Te_3 upon Au deposition	Marcin Sikora	Oral
13:00 – 14:00	Lunch break		
Session on-line: New methods and combination of techniques (II) &Material science, nanotechnology, and magnetism (IV)			
14:00 – 14:40	Ferromagnetic resonance detected using soft X-ray absorption, reflection and diffraction	Gerrit van der Laan	Invited
14:40 – 15:20	Application of soft X-rays in the characterization of multifunctional systems	Julio Criginski Cezar	Invited
15:20 – 16:00	TBA	Matthias Bauer	Invited
16:00	Coffee break		
16:30	Sightseeing of Krakow		
20:00	Conference Dinner in Krakow Old Town		
Thursday, 25th August 2022			
Time	**Title**	**Speaker**	**Type**
Session: Structural biology, and chemistry (I)			
9:00 – 9:40	Identification of light elements by long-wavelength crystallography	Armin Wagner	Invited

9:40 – 10:20	Next-generation Automation and Remote-access Crystallography	Aina Cohen	Invited
10:20 – 10:40	Synthesis, structural characterization and biological activity evaluation of novel Cu(II) complexes with 3-(trifluoromethyl)phenylthiourea derivatives	Aleksandra Drzewiecka-Antonik	Oral
10:40 – 10:50	Investigation of copper-phenanthroline complexes with the use of X-ray absorption spectroscopy	Wiktoria Stańczyk	Short
10:50 – 11:00	Structure of alcohols under high pressure	Joanna Grelska	Short
11:00 – 11:30	Coffee break		
Session: Structural biology, and chemistry (II)			
11:30 – 12:10	Sample delivery methods for serial protein crystallography	Michał Kępa	Invited
12:10 – 12:30	Small angle X-ray scattering studies concerning the oligomerization of human cystatin C	Daria Wojciechowska	Oral
12:30 – 12:50	The Mn(II) complex with 4-bromophenoxyacetic acid - X-ray absorption fine structure study	Anna Wolska	Oral
12:50 – 13:00	Application of laboratory-based high energy resolution X-ray spectroscopy to study the electronic structure of hybrid plasmonic-protein systems	Zofia Borowska	Short
13:00 – 14:00	Lunch break		
Session: Life science and cultural heritage			
14:00-14:40	Multiple scale length studies of cultural heritage materials and objects by synchrotron radiation X-ray methods and non-invasive spectroscopic techniques	Letizia Monico	Invited
14:40-15:20	Full-Field X-Ray Imaging with Synchrotron Radiation for Materials Research and Life Sciences - Developments and Applications at KIT	Tilo G. Baumbach	Invited
15:20	Closing Remarks		
16:00	SOLARIS synchrotron site visit		

Examples of research fields addressed during the ISSRNS 2022 conference are presented on pages 22 -26

Electronic structure of TiO_2 thin films for photoelectrochemical and gas sensing applications studied by XPS and XAS

Oral Presentation
22.08.2022, 12:10

DOI:
10.36184/SRNS.2022.22.022
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Titanium dioxide is one of the best known transition metal oxides of an exceptional importance due to a wide range of applications that include photoelectrochemistry[1] and gas sensing[2]. Determination of the electronic structure of TiO_2 is one of the main aims of the current research as it has the biggest impact on its performance in the practical devices. Thin films of TiO_2 were prepared by reactive sputtering in ultra-high-vacuum system under controlled conditions. Constant substrate temperature of 350°C, constant power density of 10 W/cm² and varied oxygen-to-argon flow ratio were applied to deposit a series of films of thickness within the range of 250-300 nm. The XPS analyses were carried out in a PHI VersaProbeII Scanning XPS system using monochromatic Al Kα (1486.6 eV) X-rays focused to a 100 µm spot and scanned over the area of 400 µm x 400 µm. The photoelectron take-off angle was 45° and the pass energy in the analyzer was set to 117.50 eV for survey scans and 46.95 eV to obtain high energy resolution spectra for the C 1s, O 1s and Ti 2p regions. All XPS spectra were charge referenced to the unfunctionalized, saturated carbon (C-C) C 1s peak at 285.0 eV. XAS studies were performed at Ti L_{23} and O K edges of TiO_2 thin films deposited on Si substrates at SOLARIS National Synchrotron Radiation Centre in Kraków, Poland. Surface-sensitive total electron yield (TEY) mode in 440-520 eV range for Ti L_{23} edge and 515-570 eV for O K edge was applied. The results of XPS performed on Ti 2p lines indicate that Ti^{4+} is mostly present at the surface of TiO_2 thin films. Oxygen XPS 1s spectrum confirms that the film is almost free from contamination as the higher energy peak is very small. XAS in TEY mode probes the properties of the near surface region of the thickness comparable to that of the XPS. Therefore, the information concerning surface electronic structure, crystal splitting and band occupancy has been provided by XAS. Correlation between these results and the performance of TiO_2 thin films in photoelectrochemical and gas sensing devices will be discussed.

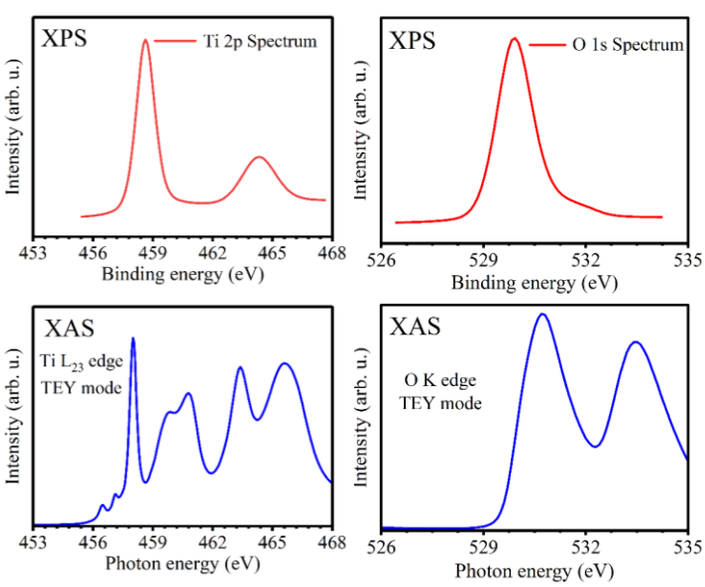

Figure 1. XPS and XAS spectra of TiO_{2-x} thin films deposited at 15% O_2 in the sputtering of Ti target

Acknowledgements: This research was financed by NCN Poland, project no. UMO-2020/37/B/ST8/02539

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PolyX: X-ray microimaging and microspectroscopy beamline under construction at SOLARIS

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Oral Presentation
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PolyX is a short bending magnet beamline that is being constructed at SOLARIS. The beamline is focused on X-ray microimaging and spectromicroscopy in 4 keV – 15 keV energy range. The name PolyX originates from polychromatic X-rays and polycapillary optics which are intended to increase the beam intensity and for an efficient focusing of X-rays. PolyX will become operational in 2023. The main experimental techniques at PolyX will be x-ray absorption and phase-contrast imaging, μCT, and spatially resolved μXRF and μXAFS. The layout of PolyX is schematically presented in Fig. 1. The beamline will operate in "high flux" mode with a double multilayer monochromator and in "high resolution" mode with a double Si(111) crystal. White beam mode will be also feasible. Installation of a vertically collimating mirror is planned for the second construction phase. Experiments will be possible in air and the beamline will be easy to reconfigure. Therefore, a dedicated area for user experiments and/or user end-station will be provided in the experimental hutch. In this Contribution, we will discuss the layout, application examples and limitations of PolyX and report the status of beamline construction.

Acknowledgements: The construction of PolyX is financed by Ministry of Polish Ministry of Science and Higher Education (6991/IA/SP/0010/2019). KMS acknowledge the support from the Foundation for Polish Science (FNP).

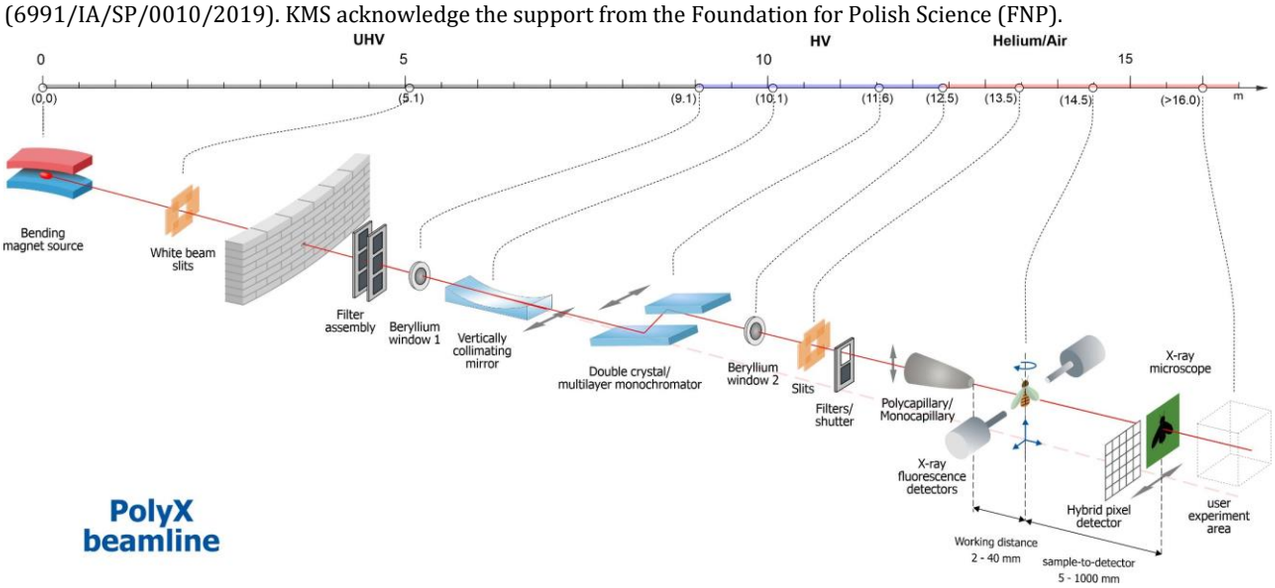

Figure 1. Layout of PolyX beamline.

Short Contribution
23.08.2022, 12:30

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Probing nanomaterials with X-ray spectroscopy

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Nowadays, nanotechnology is considered one of the most prominent fields of science with numerous potential industrial applications. Its objects of interest are nanomaterials, often referred to as structures, whose behaviour is governed by quantum mechanics. Taking full advantage of nanomaterials' unique properties requires the development of new analytical tools for their qualitative and quantitative characterization. Preferably, such instrumentation should allow examination of samples in a natural environment, for example, in form of liquid suspensions. The utilization of bulk-sensitive and element-specific methods of X-ray spectroscopy allows probing the electronic structure of the nanomaterials, providing information about the chemical state, ligand coordination, and orbital contributions of the specimen. However, analysis of nanomaterial suspensions is significantly hindered by two aspects. Firstly, due to complicated and non-scalable synthetic procedures, it is difficult to obtain sample material in the quantities necessary for optimal measurement. Secondly, nanostructures in suspensions tend to agglomerate into bigger clusters, eventually leading to particle settlement at the bottom of a sample container in a process called sedimentation. Both factors make an examination of nanomaterials in solvents challenging, in particular for experiments requiring hours of data acquisition. To address these issues, we developed a special sample setup, designed specifically to measure low volumes of nanomaterial suspensions with continuous stirring to prevent agglomeration and sedimentation processes[1].

The designed setup is based on a polyimide capillary equipped with an electrically-driven spindle that mixes nanomaterial suspensions to maintain its stability during measurements. The systems' performance was verified using ZnO nanoparticles (NPs) suspended in distilled water. A series of simultaneous Zn K-edge X-ray absorption spectroscopy (XAS) and Zn Kα X-ray emission spectroscopy (XES) measurements utilizing laboratory-based X-ray spectrometer[2] were conducted to probe the ZnO NPs concentration over 90 min of setup operation.

Acquired XAS and XES data showed a stable signal throughout the entire experiment. On the other hand, in the absence of mechanical stirring, rapid sedimentation of ZnO nanoparticles was observed, occurring a few minutes after the start of the measurements with a maximum rate of 2.5 % of concentration loss in the beam field per minute. Obtained results demonstrated that the developed setup allows the acquisition of high-quality XAS & XES of nanomaterial suspensions. Presented instrumentation could be utilized in future studies of various nanosystems based on 3d metals such as plasmonic nanoparticles or semiconductor quantum dots. Studies of nanostructures could be expanded beyond the standard X-ray spectroscopy methods toward time-dependent measurements at femtosecond time scales to follow charge dynamics induced by ultrashort optical pulses. The possible application of the newly proposed concept of X-ray chronoscopy[3] in the studies of nanomaterial systems will also be briefly discussed.

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3. Błachucki, W. *et al*. Appl. Sci., 12 (2022), 3.

In situ synchrotron techniques for Laser Based Additive Manufacturing

Oral Presentation
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Laser-based Powder Bed Fusion (LPBF) of ceramics enables the fabrication of objects with complex three-dimensional shapes otherwise challenging or even not possible to produce with conventional manufacturing routes. However, the mechanical properties of LPBF-manufactured ceramics components are poor due to the large amount of structural defects. Selected results of ex situ and in situ synchrotron studies providing deeper understanding of the mechanisms of structure and defect development will be presented, among others, operando diffraction and the first operando tomographic microscopy during LPBF, both using in-house built LPBF setups designed for usage at MS, microXAS and Tomcat beamlines of SLS. Operando diffraction measurements performed with up to 20 kHz of acquisition rate allowed for observation of the phase transformations occurring prior and after laser melting, as well as the evaluation of temperature profiles and cooling rates. Tomographic microscopy during LPBF processing was performed with a high speed tomography setup employing the gigabit fast readout system (GigaFRoST camera) and the LBPF setup allowing for the laser scanning during high-speed rotation of the sample stage. Operando 3D imaging with acquisition rate of 100 tomograms per second provided direct insight into the phenomena not accessible with other techniques, in particular, the surface roughness formation, powder denudation, meltpool dynamics and porosity formation mechanisms (Fig. 1) were investigated. The acquired information, not only provides understanding of underlying processes, but also is crucial for the development and the verification of models used for the LPBF process simulations.

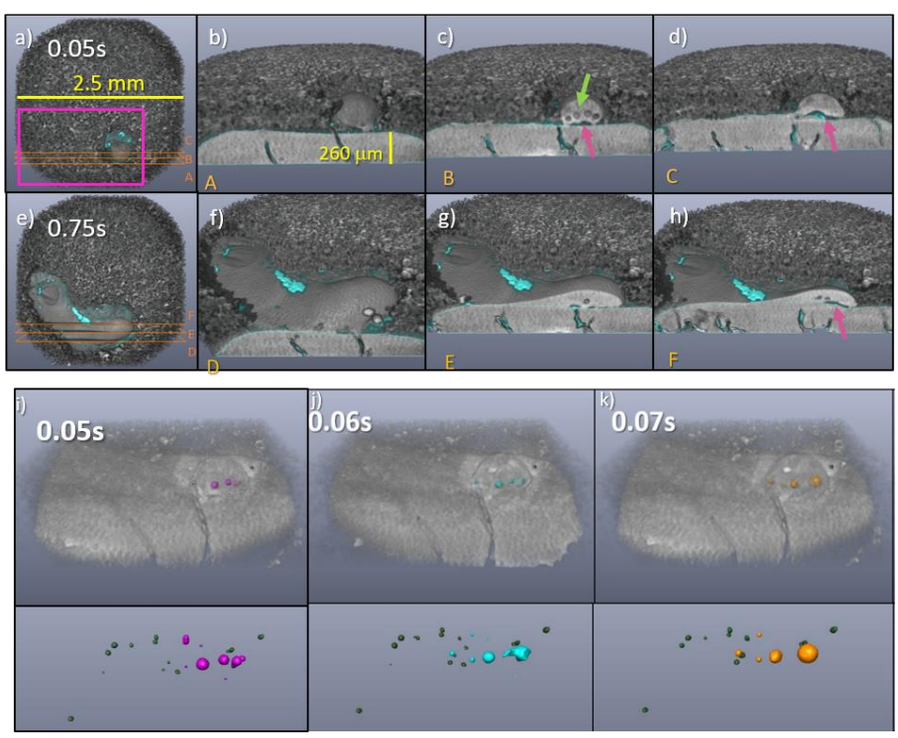

Figure 1. a)-h) Porosity due to evaporation within the liquid volume (green arrow) and due to lack of fusion with the previous layer (pink arrows) for two time frames t = 0.05 s and 0.075 s for sample processed with 15.5 W. i)-k) coalescence of gas bubbles within the molten material.

Acknowledgements: This project was financed by the Swiss National Science Foundation, grant number CRSK-2_196085.

The Mn(II) complex with 4-bromophenoxyacetic acid - X-ray absorption fine structure study

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Manganese is one of the essential elements in the living organisms. In the human body, it is absorbed from food and water and is involved in many metabolic processes. In plants, manganese is taken from the soil and translocated to the sprouts. In soil, it can exist in eleven oxidation states: from -3 to +7, however, Mn(II) species are the most soluble and available ones. This divalent manganese, present in soil and plant tissues, interacts with anions as phenoxyacetate herbicides, forming metal-organic complexes. In order to get structural information about such compounds, we have synthesized analogous complexes in the laboratory conditions[1-3].

In this research, the Mn(II) complex with 4-bromophenoxyacetic acid was studied. To describe its molecular structure the X-ray absorption and X-ray diffraction techniques were applied. The XAFS measurements for the powdered complex were performed at ELETTRA synchrotron (Trieste, Italy). The X-ray diffraction intensities for the single crystal of the complex recrystallized from N,N-dimethylformamide (DMF) were collected at 120 K on SuperNova X-ray diffractometer using the mirror-monochromatized CuKα radiation[3].

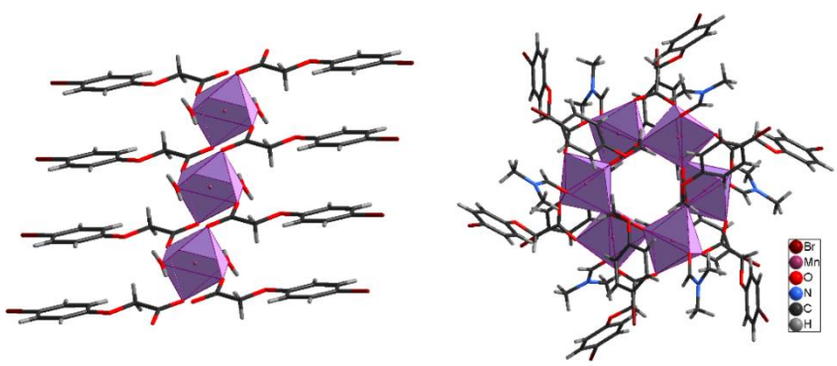

Figure 1. A polymeric structure of the complex from the XAFS analysis (left) vs. X-ray single crystal structure analysis (right).

The XAFS experiment was performed on the non-modified sample in a form of a microcrystalline powder. The analysis revealed that the complex forms a polymeric structure with 6 oxygen atoms bonded to Mn ion (see Fig.1). The oxygen atoms originate from 4 carboxylate groups and 2 water molecules. During recrystallization the coordination sphere of the metal center can be rearranged. In this case, the detachment of water molecules and attachment of the DMF molecules were observed. Due to the exchange of solvent molecules, the formation of hexanuclear manganese(II) carboxylate coordination clusters with a hydrophobic exterior was observed in the crystal.

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2. Drzewiecka-Antonik, A. *et al.* Polyhedron 165 (2019) 86.
3. Drzewiecka-Antonik, A. *et al.* Polyhedron 207 (2021) 115370.

News from SOLARIS

SOLARIS National Synchrotron Radiation Centre in 2021 - Summary

2021 was a breakthrough year for SOLARIS Synchrotron. The culmination of the efforts was obtaining funding for facility research infrastructure from the Ministry of Science and Higher Education, which will ensure the operation and further development of our Centre for the next 5 years.

Photo by Aleksander Koczur.

The aim of the project for which Jagiellonian University will receive PLN 200 million is to support scientific research and development work conducted with the use of synchrotron radiation and cryomicroscopy. These funds will ensure the maintenance of the Centre's unique instruments and free access to them for the best research groups in the years 2021-2025. The funding received already this year enabled further development of synchrotron infrastructure. On each of the constructed beamlines, works related to tenders or assembly of individual elements were moved substantially forward. One of the most important events related to the development of the synchrotron infrastructure was the installation of a monochromator on the ASTRA beamline (former SOLABS). This is exciting news for users who will be able to apply for research time on a new experimental beamline in the Spring of 2022.

The time for the SOLARIS NSRC building extension is also approaching. The area of the synchrotron hall will be significantly enlarged, which will allow for the installation of up to four new beamlines and additional space for laboratories and offices. The expanded experimental hall will also include the installation of microscopes as part of the development of the cryomicroscopy centre.

Thanks to the remote access system developed in the previous year, the ongoing pandemic did not interfere with the measurements performed on the beamlines and on the cryomicroscopes. Unfortunately, pandemic restrictions meant that most of the cyclical events and conferences that we planned for 2021 could not take place.

In two calls for applications for research time, a total of 147 applications were submitted, which is a slight decrease in the number of research groups interested in the measurements compared to the previous year. For the first time in 2021, the DEMETER beamline, has been included in the call.

Increased interest in research at the Centre and better recognition of SOLARIS among researchers in the country and abroad, transformed not only into a greater number of applications for research time, but also in an increase in the number of scientific publications of the users. Among the dozen or so new publications, the journal Science Advances deserves special attention, where the cover of its special edition has been dedicated to the research conducted on the Cryo-EM microscopes located in SOLARIS. The SOLARIS research team also worked on cutting-edge research, as a result of which the names of our scientists appeared in more than twenty publications, often in prestigious journals.

News from SOLARIS

SOLARIS NSRC and Łukasiewicz KIT join forces

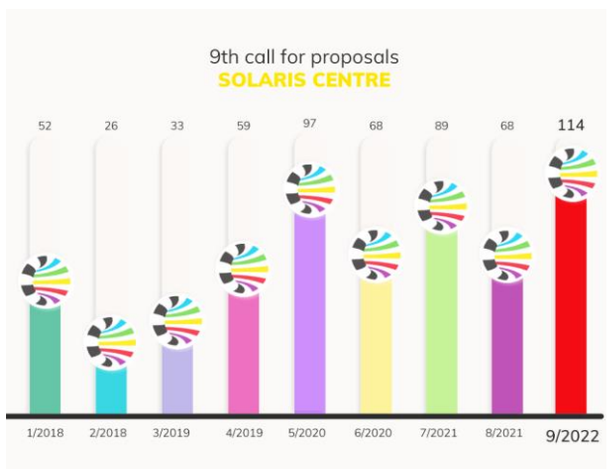
The National Synchrotron Radiation Centre SOLARIS and the Łukasiewicz Research Network - Krakow Technology Institute have started collaboration in the field of research, joint developmental projects and exchange of experiences. The agreement inaugurating the cooperation was signed in January 2022 by NSRC SOLARIS Director, Prof. Marek Stankiewicz and Dr. Michał Kwiecień, Director of Łukasiewicz - KIT. The Łukasiewicz Research Network - Krakow Institute of Technology is a renowned research centre that conducts interdisciplinary research/studies, which includes modern technologies for the production and processing of materials. This dynamically developing institute plans to open new directions of research in the near future, responding to the most pressing economic and social needs, including health, medicine, energy production, and storage.

Photo by Joanna Kowalik. In the photo: Prof. Marek Stankiewicz, Director SOLARIS Centre and dr. Michał Kwiecień, Director Kraków Institute of Technology.

Thanks to joint action and using the experience and a wide network of connections of Łukasiewicz KIT, the SOLARIS Centre will strengthen its commitment to the development of cooperation with the enterprise sector. This will bring tangible benefits in the form of a greater number of proposals for research time on the unique infrastructure of our Centre, in particular for the purposes of conducting applied and pre-implementation research.

Ninth Call for Proposals at SOLARIS NSRC

International Review Panel will have the opportunity to analyze a record number of applications, submitted for five research lines and a Cryo-EM. The applications were analyzed by external experts in terms of formalities, sample safety, and the merits of the planned research work.



In the ninth call for proposals for research time at the SOLARIS Centre, 114 applications were submitted, which is a significant increase in the number of research groups interested in measurements compared to the previous call, i.e. by as much as 67%.

For the first time in the competition procedure, the ASTRA beamline (former SOLABS), dedi-

News from SOLARIS

cated to X-ray absorption spectroscopy (XAS), was made available. 19 applications were submitted for research time on this beamline. The research beamlines PIRX (former XAS), URANOS (former UARPES), PHELIX, DEMETER and the Cryo-EM were the subject of 18, 15, 12, 20 and 30 proposals, respectively.

We remind you that it is possible to submit an application for the so-called "Rapid access" to beamlines. This mode makes it possible to check whether the planned experiment has a chance to be realized in a regular call for proposals or whether there is a need to conduct research quickly due to the potentially high scientific value.

The ASTRA beamline available to users for the first time

In January 2022 the commissioning and first measurements with friendly users (already experienced in X-ray absorption spectroscopy and willing to tolerate occasional complications of a beamline not fully commissioned yet) took place. The commissioning and development of the beamline are now in progress. Nevertheless, the beamline will be opened for the Spring 2022 Call for Proposals, giving interested users the possibility to apply for XAS measurements only in transmission mode at room temperature in the energy range 1.82 – 12 keV, covering K absorption edges of chemical elements between Si and Zn, L edges between Rb and Pt and M edges between Gd and U. We encourage our users to apply in this call mostly for experiments at K absorption edges, however, applications for measurements at L and M edges are also welcomed. The beamline staff work hardly to implement fluorescence and TEY modes for our users as soon as possible.

The ASTRA (former SOLABS) beamline was especially designed for XANES/EXAFS measurements in the tender X-ray range, i.e. at the K absorption edges of important elements such as P, S, Si, Al, and Mg. In addition, the ASTRA energy range also includes K-edges of heavier elements up to Se, L-edges of elements up to Bi, and some M-edges of elements including U, which allows the investigation of a variety of highly relevant materials.

Photo by Joanna Kowalik.

SOLARIS Industry Day - a series of meetings dedicated to commercial users

SOLARIS NSRC inaugurated a new series of elite meetings dedicated to commercial users who want to use the Centre's infrastructure. The first event, held in May, was focused on Cryo-EM technique. The workshop participants were representatives of the life sciences industry, as well as the pharmaceutical or chemical industry. The workshop covered all aspects of the cryo-electron microscopy (cryo-EM) technique, from sample preparation, measurements on the microscope, analysis of the results, and applications, to comparison with other methods, including crystallography. The participants of the meeting had the opportunity to see the microscopes, which stand in the SOLARIS

News from SOLARIS

Centre, talk directly with our operators and ask any questions concerning Cryo-EM technique. During the meeting, a significant amount of time has been reserved for networking and the exchange of experiences.

For the second time, NSRC hosted users from the industrial world in June this year. This time, the meeting focused on discussing the possibilities of conducting research and developing innovations in the industry of advanced materials and nanotechnology with the use of synchrotron radiation. Similarly to the first time, the meeting was held in the form of free, one-day workshop. The participants of the meeting were representatives of the nanotechnology and nanomaterials industry. During the workshop, research techniques available at the SOLARIS National Synchrotron Radiation Centre and at partner units, their areas of application, and access options to the centre's infrastructure were discussed.

The next and third in the series of SOLARIS Industry Day meetings is planned for October. Its main topic will be the conduct and methods of financing research and development works in the ferrous and non-ferrous metals industry.

First light on the POLYX beamline

The POLYX beamline team composed of Prof. Paweł Korecki, Dr. Katarzyna Sowa, Dr. Tomasz Kołodziej and Dr. Paweł Wróbel has been working intensively for many months to obtain the first light. In May, after passing radiological tests of the beamline, they managed to capture an X-ray beam hitting the fluorescent screen and causing strong light emission.

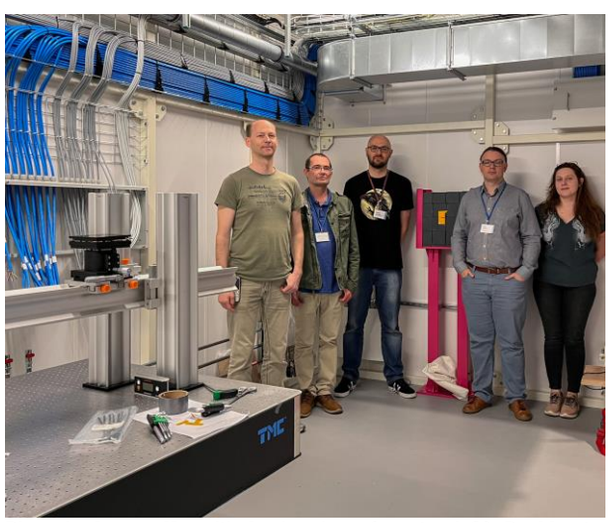


Photo by Joanna Kowalik. In the photo (starting left): Dr. Marcin Zajac, Prof. Paweł Korecki, Dr. Tomasz Kołodziej, Dr. Paweł Wrobel, Dr. Katarzyna Sowa.

The PolyX beamline uses polychromatic X-rays and achromatic polycapillary optics. Such radiation has many applications in micro-imaging and X-ray microspectroscopy. The beamline will be particularly useful to researchers in fields such as materials science, chemistry, biology and medicine, environmental and earth sciences, and artwork research.

News from SOLARIS

The construction of the POLYX line was possible thanks to the close cooperation of scientists from Jagiellonian University, AGH University of Science and Technology and Institute of Nuclear Physics of the Polish Academy of Sciences, and in consultation with scientists from all over Poland.

The construction of a new synchrotron experimental hall has started

Expansion of the experimental hall is one of the milestones in the development of SOLARIS synchrotron. The enlarged building will make it possible, first of all, to potentially install four new beamlines, including the SOLCRYS beamline, intended for structural biology research. The SOLCRYS beamline, which is already in an advanced design stage, will allow us, among other things, to analyze the structure of proteins, viruses, nucleic acids, and polymers. The National Cryo-EM Centre will also find its place in the new part of the hall. So far, two electron microscopes, Titan Krios and Glacios, stand in dedicated laboratories built in the loading dock in the older part of the building. In the new hall, there will be a cryo-EM laboratory with the potential to accommodate up to four microscopes. The project also includes a sample preparation laboratory, which will be available to all SOLARIS users. It will contain the necessary equipment for sample preparation for the beamlines, as well as for the preparation of grids for Cryo-EM measurements. The last area that will find its place in the expanded hall is workshop space and new offices for the growing SOLARIS scientific team.

During construction, the operation of linac and storage ring will be shut down for several months. The shutdown time will be used by the accelerator team for maintenance of all subsystems, installation and repair work, including the components' installation of a new infrared beamline CIRI (former SOLAIR).

The completion of construction is scheduled for mid-2023.

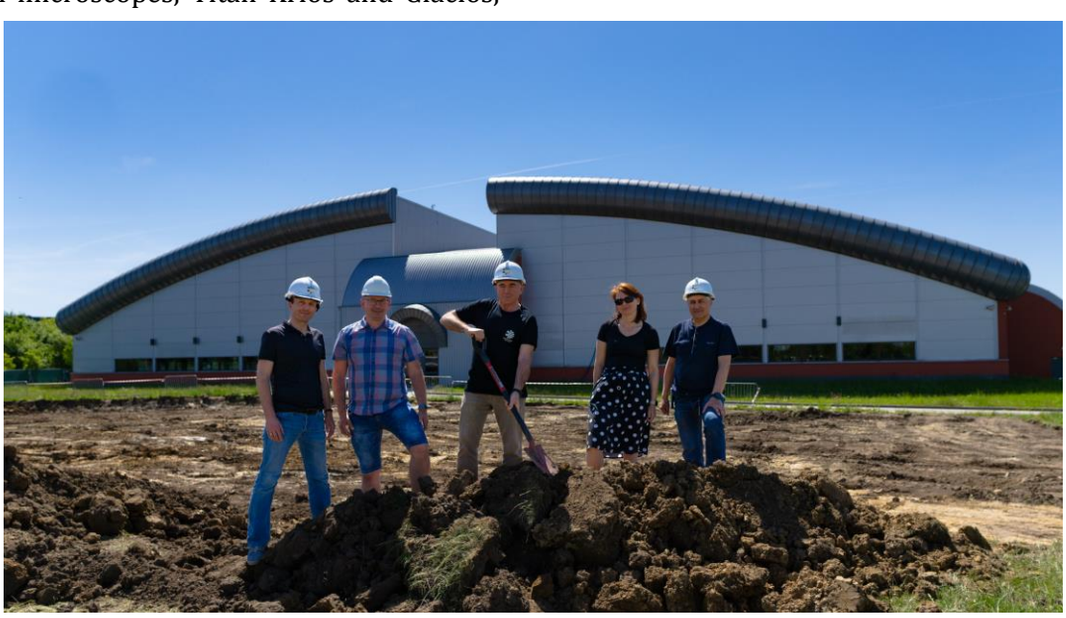


Photo by Joanna Kowalik. In the photo: Centre management (starting left): Michał Młynarczyk, Paweł Bulira, Prof. Marek Stankiewicz, Dr. Adriana Wawrzyniak, Ireneusz Zadworny.

The Polish Synchrotron Radiation Society Management Board opens the call for applications under the 4th edition of the PSRS Award competition

The competition schedule is as follows:
until September 30, 2022 - call for competition applications.
Please send your applications to the following address: **sekretarz@synchrotron.org.pl.**
The applicant will receive an e-mail confirmation of receipt of the application.

by January 31, 2023 - the decision announcement of the Award Committee.

Detailed rules of the competition can be found on the website:
http://www.synchrotron.org.pl/index.php/pl/tyszne/narzenia-ptps/nagroda-ptps-2020/109-nagroda-ptps-2

The PSRS Award is awarded for research in the area of physics, chemistry, earth sciences, materials sciences, biology, biochemistry, biophysics, and medicine performed with the use of synchrotron radiations and related work and research with the synchrotron instrumentation.

The award is granted in three categories:
Category I: for a doctoral dissertation defended at a Polish university or at a national research unit in the post-announcement period of the previous competition until the announcement of the current competition;

Category II: for a scientific or review publication published in the period after the announcement of the previous competition by the date of the current announcement competition in a peer-reviewed journal or book;

Category III: for dissemination of work related to synchrotron radiation or other development activities Polish synchrotron community.

The call for applications for the 1st and 2nd Prize categories in the 4th edition of the competition includes works from October 1, 2020, to September 30, 2022.

Information about the Winners of previous editions of the PSRS Award competition is available on the Society's website **http://www.synchrotron.org.pl/** in the Society / PTPS Award tab.

We invite you to participate in the competition. We also kindly ask you to disseminate information about the competition in your communities, and we will be grateful if you send the above information to people, teams, or research groups outside the PSRS mailing list that may be of interest in submitting applications for the award or participating in a competition.

On behalf of the Management Board of PSRS

Wojciech M. Kwiatek — President of PSRS
Edyta Piskorska-Hommel — Secretary of PSRS

Winners of the PSRS 2020 Award:

Category I:

not awarded

Category II:

for a scientific or review publication published in the period after the announcement of the previous competition by the date of the current announcement competition in a peer-reviewed journal or book;

Yves Kayser, Chris Milne, Pavle Juranić, Leonardo Sala, Joanna Czapla-Masztafiak, Rolf Follath, Matjaž Kavčič, Gregor Knopp, Jens Rehanek, Wojciech Błachucki, Mickaël G Delcey, Marcus Lundberg, Krzysztof Tyrała, Diling Zhu, Roberto Alonso-Mori, Rafael Abela, Jacinto Sá, Jakub Szlachetko,
Core-level nonlinear spectroscopy triggered by stochastic X-ray pulses
Nature Communications 10 (2019) 1
https://doi.org/10.1038/s41467-019-12717-1

Michał Ślęzak, Tomasz Ślęzak, Piotr Dróżdż, Barbara Matlak, Krzysztof Matlak, Anna Kozioł-Rachwał, Marcin Zając, Jozef Korecki
How a ferromagnet drives an antiferromagnet in exchange biased CoO/Fe(110) bilayers
Scientific Reports 9 (2019) 889
https://doi.org/10.1038/s41598-018-37110-8

Category III:

for dissemination of work related to synchrotron radiation or other development activities Polish synchrotron community.

Prof. Andrzej Kisiel

the First President of PSRS, for many years of work to popularize synchrotron research in Poland, as well as for activities for the participation of Poland in the European Synchrotron Radiation Center and the creation of the National Synchrotron Radiation Center in Krakow.

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Bulletin of the Polish Synchrotron Radiation Society

SYNCHROTRON RADIATION IN NATURAL SCIENCE