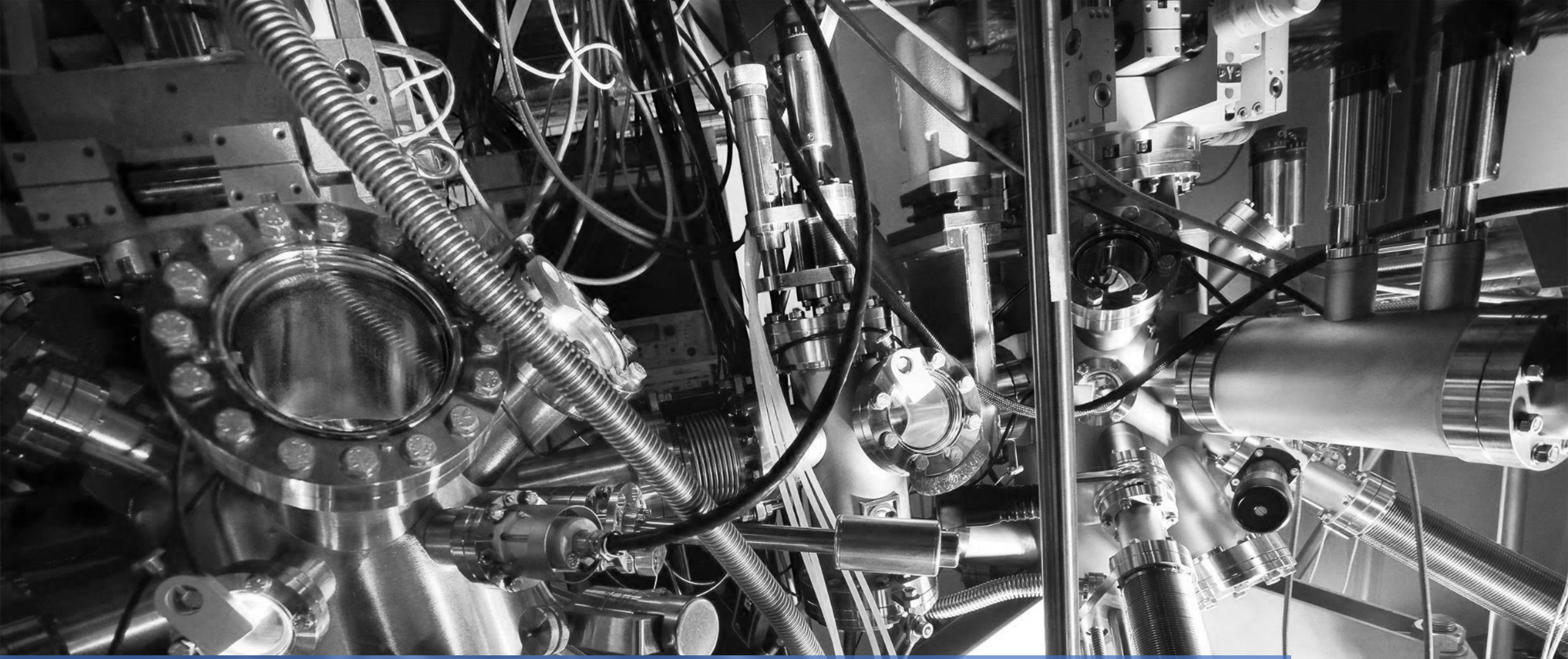


Synchrotron SOLARIS – when dreams come true

Marek Stankiewicz - on behalf of SOLARIS Team

Vist to ALBA, 13/05/2026

UNIWERSYTET JAGIELLOŃSKI W KRAKOWIE

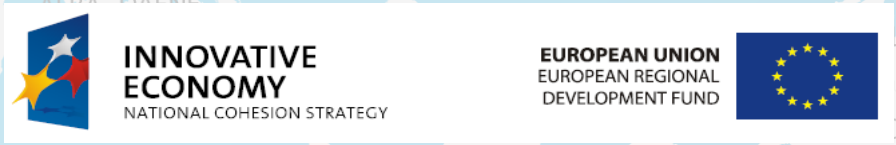
SOLARIS
NARODOWE CENTRUM PROMIENIOWANIA SYNCHROTRONOWEGO

Short history of SOLARIS

SHORT HISTORY OF SOLARIS

- Community of SR users in PL - since the advent of synchrotron sources
- **1991** Polish Synchrotron Radiation Users Society (PTPS)
- Polish Synchrotron Consortium – 36 members

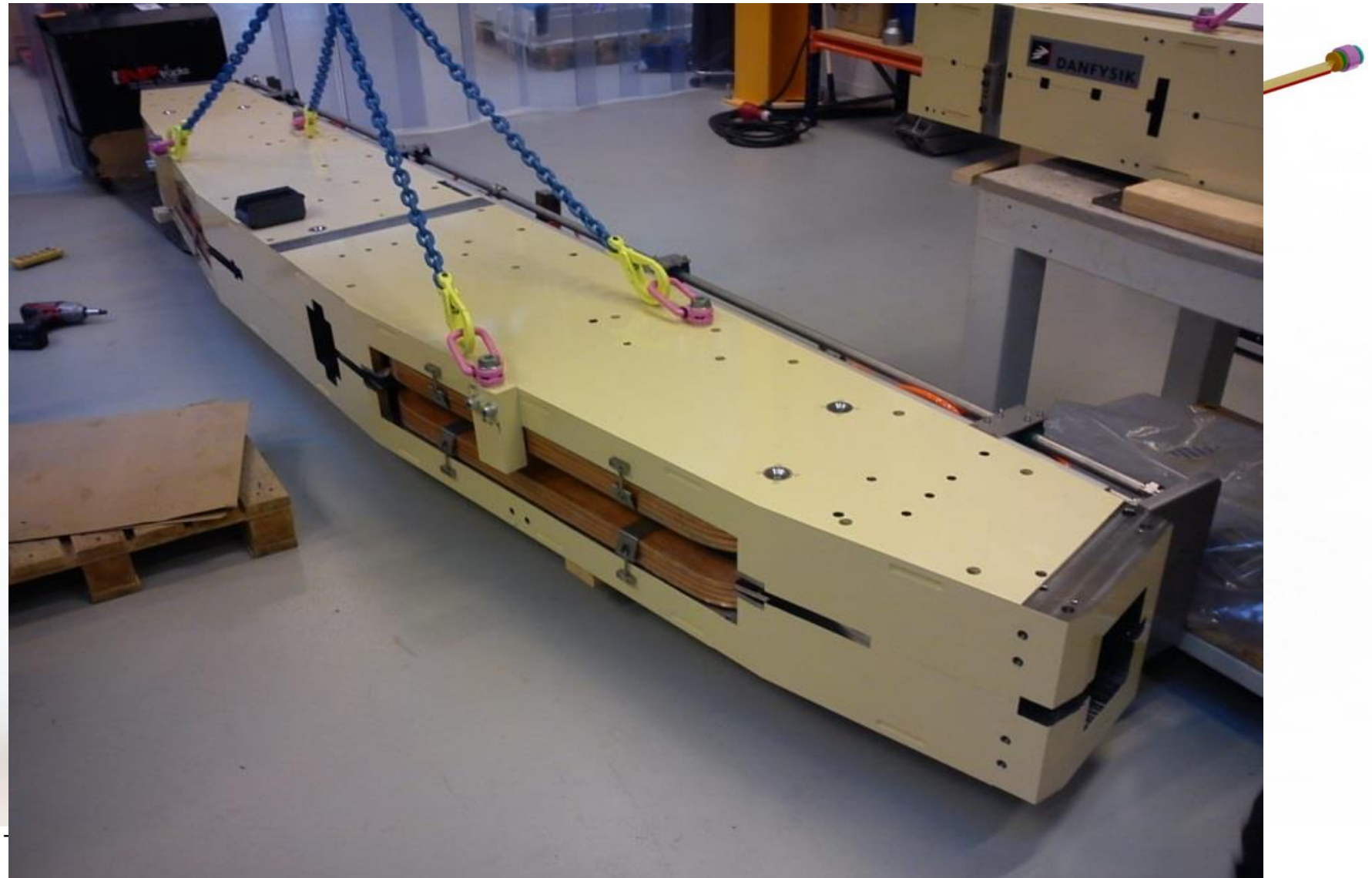
  ==➔ Long lasting initiative to built a SR source in PL – user driven initiative
- Jagiellonian University management support
- 2009 money allocated (40 MEUR) ==➔



- Feasibilty ???
  - ✓ brain storms
  - ✓ **correlation with MAX-IV project and decision by Max-II lab management**
- Decision taken by JU => SOLARIS as JU unit – but available for all researchers at no cost

==➔ 2010 contract signed – green field project started

SOLARIS 1.5 GeV ring design - MAX-lab accelerator team - Mikael Eriksson



SOLARIS – MAX IV synergy – challenges

- Replica of MAX-IV 1.5 GeV ring – but:
  - Different building
    - Different storage ring tunnel
    - Different building infrastructure
  - Different injection – linac but not full energy
  - Ramping

- Uniqueness (first such facility in PL)
  - There are no commercially available synchrotrons
  - Tailored made design
  - Tailored made equipment

- Challenges - *terra incognita*:
  - For the SOLARIS team
    - no team, no expertise (employment of Carlo Bocchetta)
  - For the Polish contractors
    - e.g. building, technological infrastructure……..
  - For the Administration
    - *Difficult money – public procurments – EU restrictions*

- Tight collaboration with MAX-lab and other SR facilities critical for success of the project

Building SOLARIS – challanges

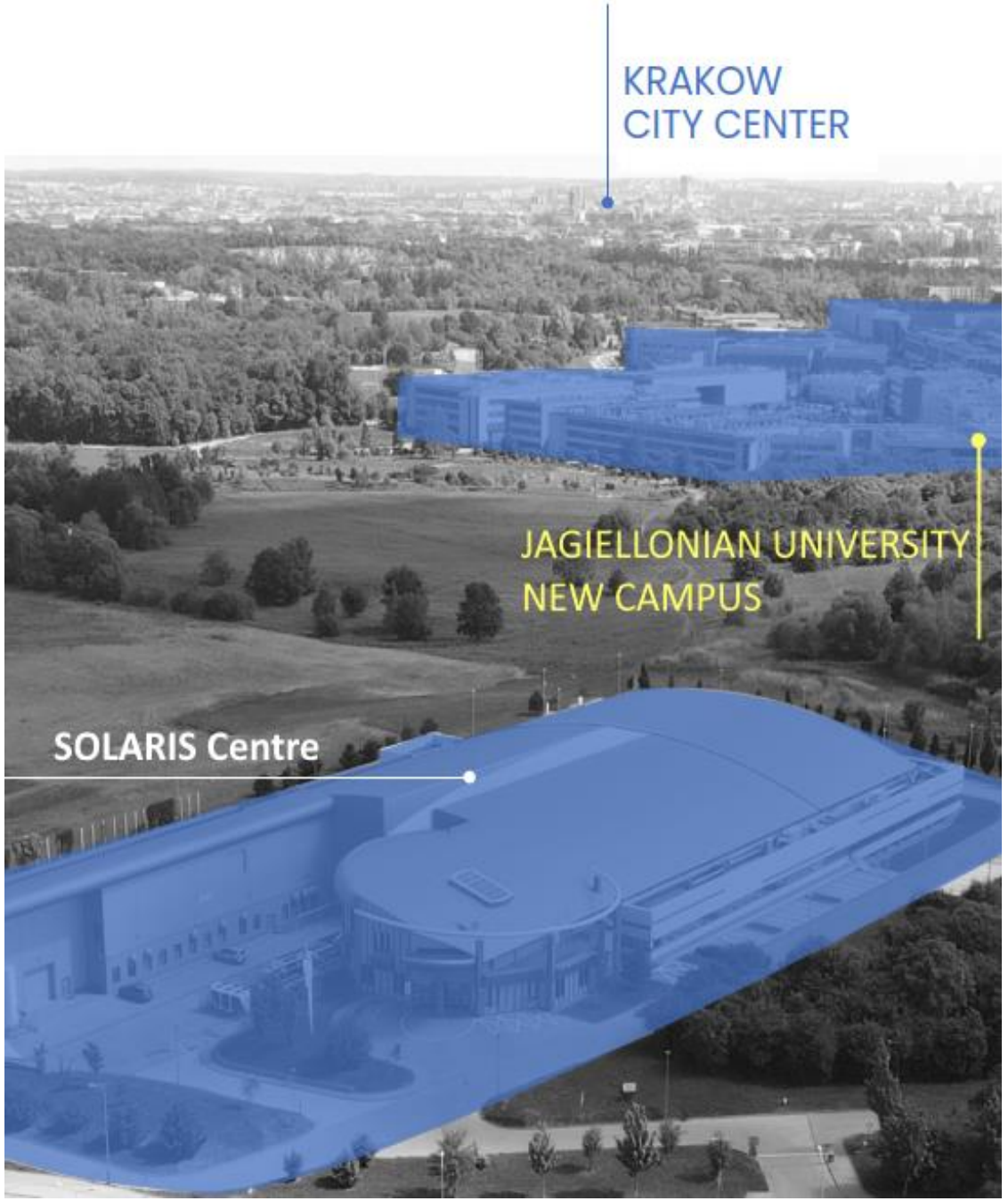
DELIVERABLES:

- Building
- Linac
- Storage ring
- Beamline
- **TEAM**

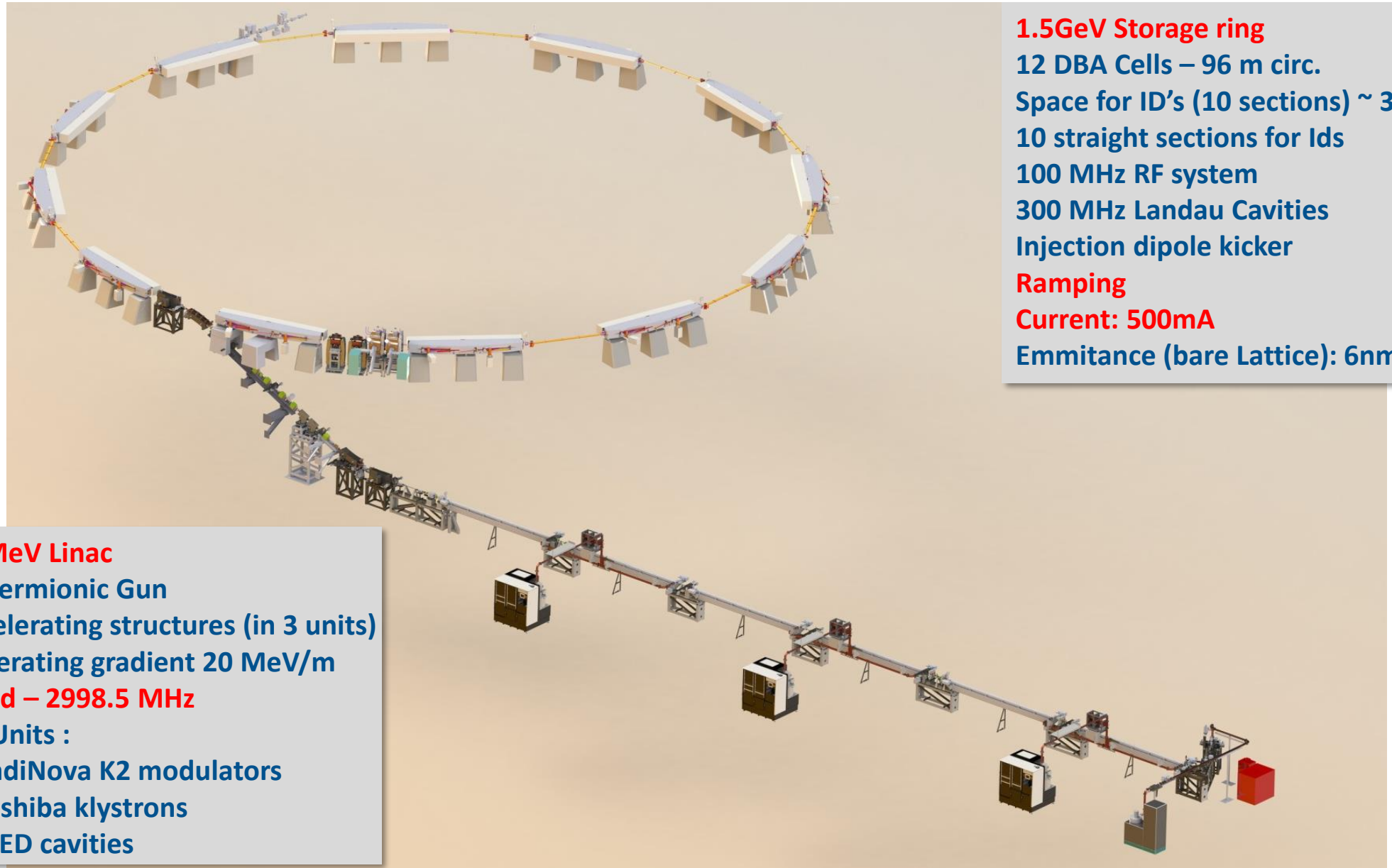
GREEN FIELD PROJECT

National Synchrotron Radiation Centre SOLARIS

- 3rd generation **synchrotron lightsource** constructed from 2010 to 2015
- Seed funding from EU Regional Development Fund
- Commissioned between 2016 and 2018



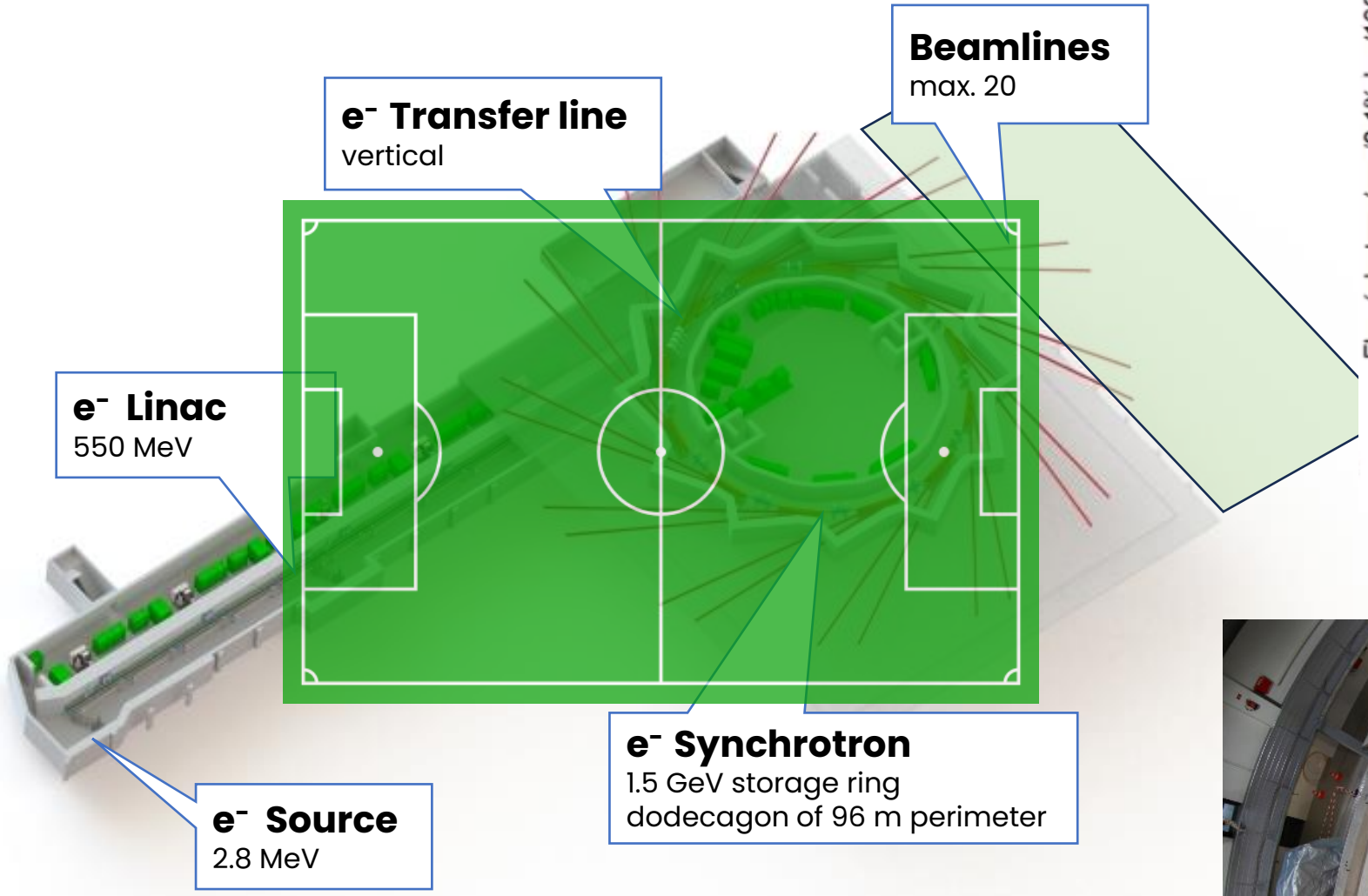
SOLARIS accelerators

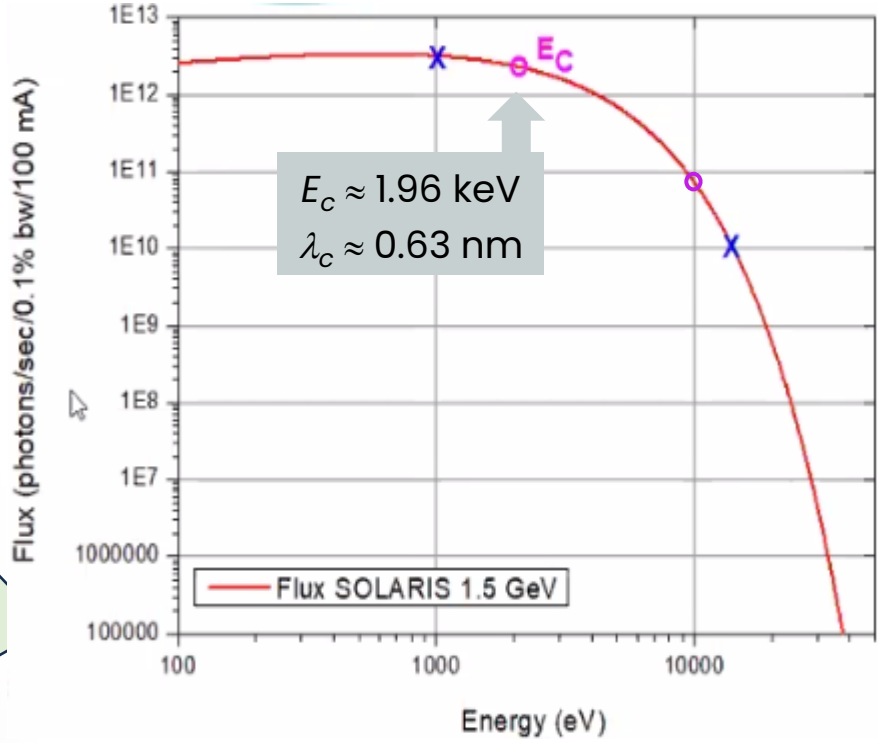


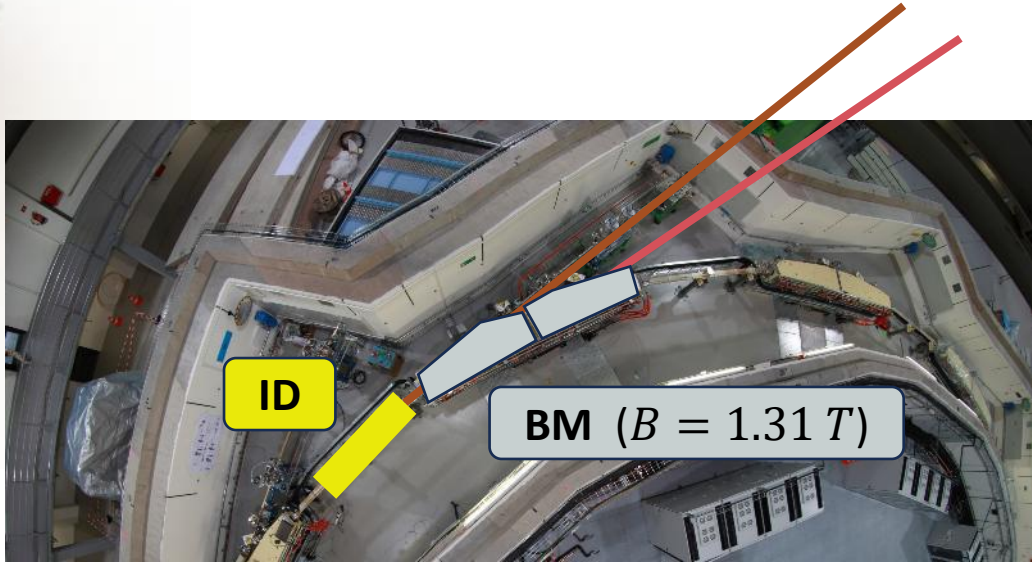
1.5GeV Storage ring
12 DBA Cells – 96 m circ.
Space for ID's (10 sections) ~ 3.5 m
10 straight sections for Ids
100 MHz RF system
300 MHz Landau Cavities
Injection dipole kicker
Ramping
Current: 500mA
Emmitance (bare Lattice): 6nmrad

600 MeV Linac
RF Thermionic Gun
6 accelerating structures (in 3 units)
Accelerating gradient 20 MeV/m
S-band – 2998.5 MHz
3 RF Units :
- ScandiNova K2 modulators
- Toshiba klystrons
- SLED cavities

SOLARIS infrastructure







December 2015 - Project completed
Commissioning
2018 first call – 2 Beamlines (PIRX & URANOS) - first users

Development and operation pillars at SOLARIS

Due to the very limted budget serious compromizes had to be made - To utilize the full potential of the infrastructure further investment has been needed

1. **Synergy** between SOLARIS & research centers
   a. Addressing expectations of research groups
   b. Addressing new research ideas and challenges

2. **Integration** of research groups

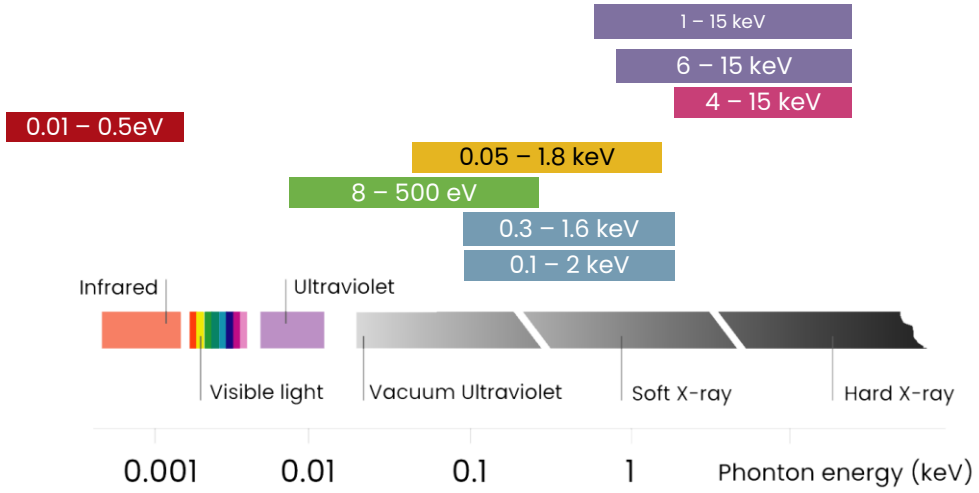
3. **User driven** development:
   1. users + SAC => ROAD to new research infrastructure
   2. “beamline consortia” – development of new beamlines - result of initiatives of external groups

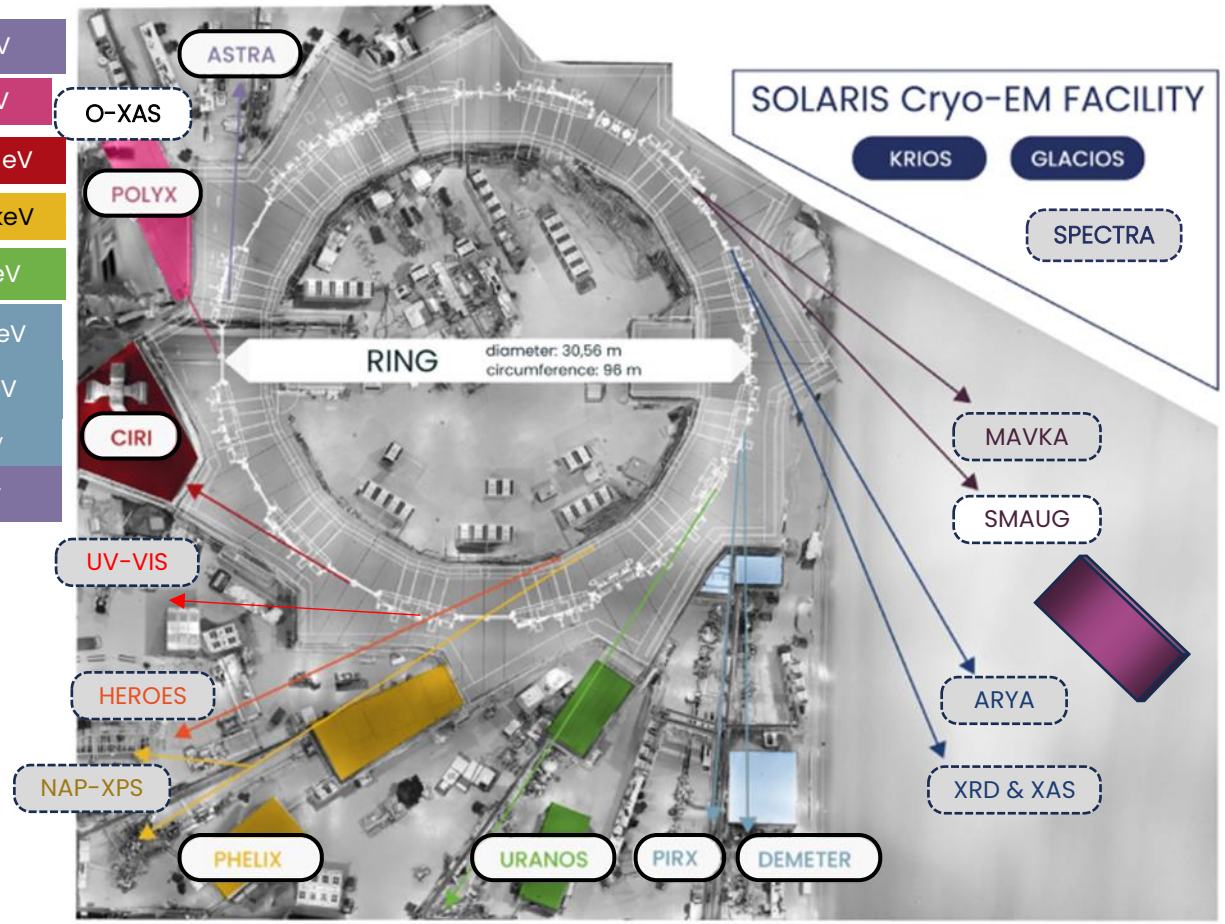
4. **User-driven** operation: operation of each beamline is backed up by “beamline consortia”

Beamlines and cryo-microscopes

	SAMPLE ENVIRONMENT	*MAIN TECHNIQUES*	
ASTRA	AMBIENT, OPERANDO	EXAFS, XANES	1 – 15 keV
POLYX	AMBIENT	TOMOGRAPHY, uXAS, uXRF	4 – 15 keV
CIRI	AMBIENT	FT-IR, sSNOM/AFM-IR, O-PTIR	0.01 – 0.12 eV
PHELIX	UHV, VTI	XPS, ARPES, XAS, XLD	0.05 – 1.8 keV
URANOS	UHV, VTI	ARPES	8 – 500 eV
PIRX	LV(He)-UHV, VTI, B	NEXAFS, XLD, XMCD	0.3 – 1.6 keV
DEMETER	UHV, VTI, B, E, I	X-PEEM	0.1 – 2 keV
	LV(He), LIQUID CELL	STXM	0.1 – 2 keV
SMAUG*	LIQUID CELL	SAXS	6 – 15 keV

Krios G3i	300 kV	SPA & MED
Glacios	200 kV	SPA screening Cryo-tomography





AVAILABLE FOR USERS

UNDER CONSTRUCTION / PROJECTS

Status of the research infrastructure

Instruments available for users (13)

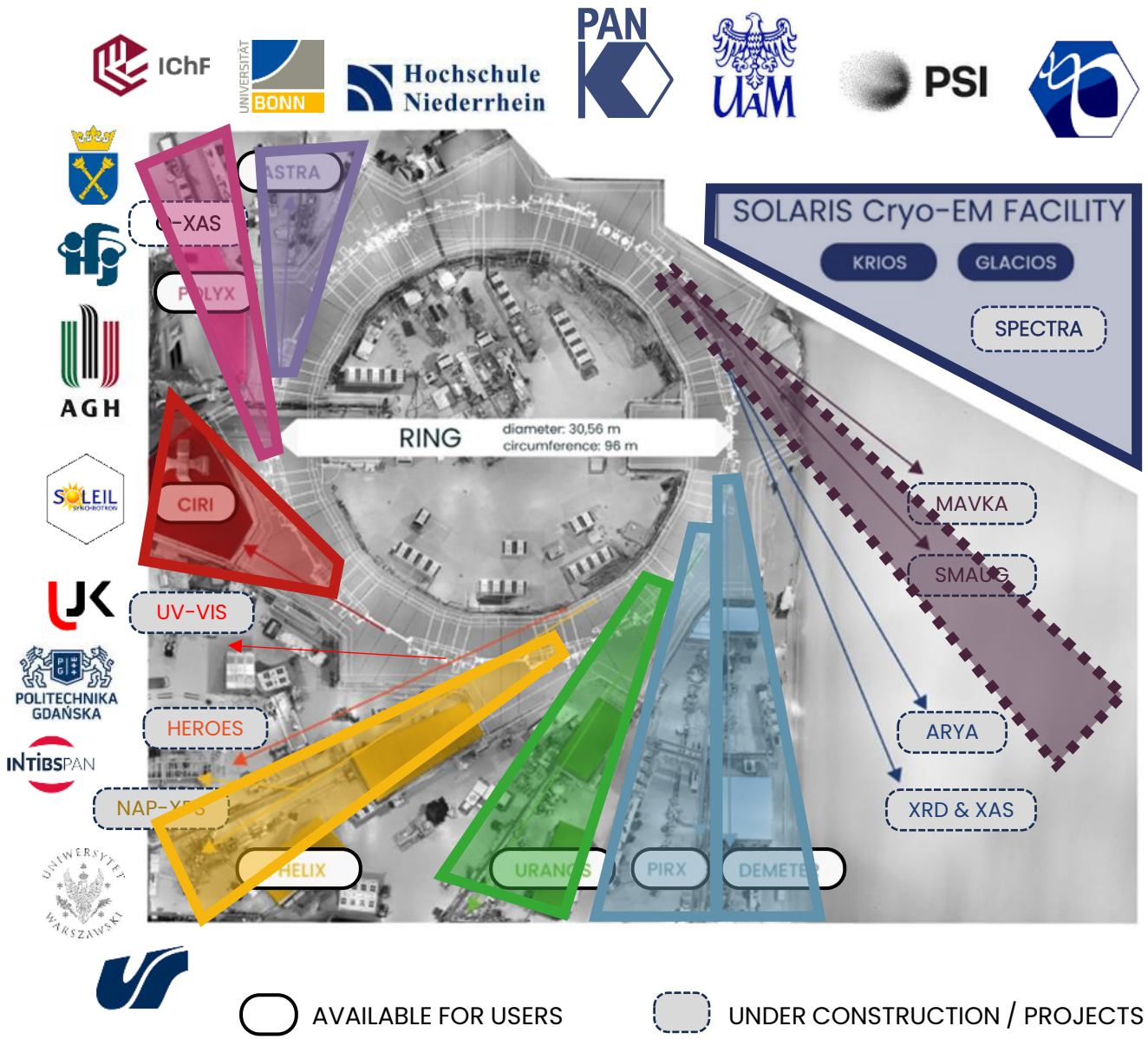
- IR microspectroscopy at **CIRI** (3)
- VUV spectroscopy at **URANOS**
- soft X-ray spectroscopy at **PIRX** and **PHELIX** (2)
- soft X-ray microscopy at **DEMETER** (2)
- tender & hard X-ray spectroscopy at **ASTRA**
- hard X-ray microscopy & tomography at **POLYX**
- 200kV (GLACIOS) and 300kV (KRIOS) **Cryo-EM** (2)
- small angle X-ray scattering at **SMAUG**

Instruments under construction (4)

- NAP-XPS end-station at **PHELIX**
- MX at **ARYA**
- soft - tender - hard X-ray spectroscopy at **MAVKA**
- universal operando end-station **O-XAS**

Projects (5)

- AP-HAXPES end-station at **MAVKA**
- operando RXES beamline (**HEROES**)
- **XRD & XAS** beamline with surface scattering end-station
- next generation 300kV (SPECTRA) **Cryo-EM**
- **UV-VIS** beamline



New Beamlines Development: ARYA

Technical Design Report of ARYA Beamline

Saga of ARYA...

2019 – Superconducting Wiggler SCW (Budker Institute of Nuclear Physics)

2021 – SCW - Design Study (FMB) modification of the storage ring

2022 – SCW – Final Design Report (Budker Institute of Nuclear Physics)

2023 – New source 3 Pole Wiggler (3PW) from KYMA ordered

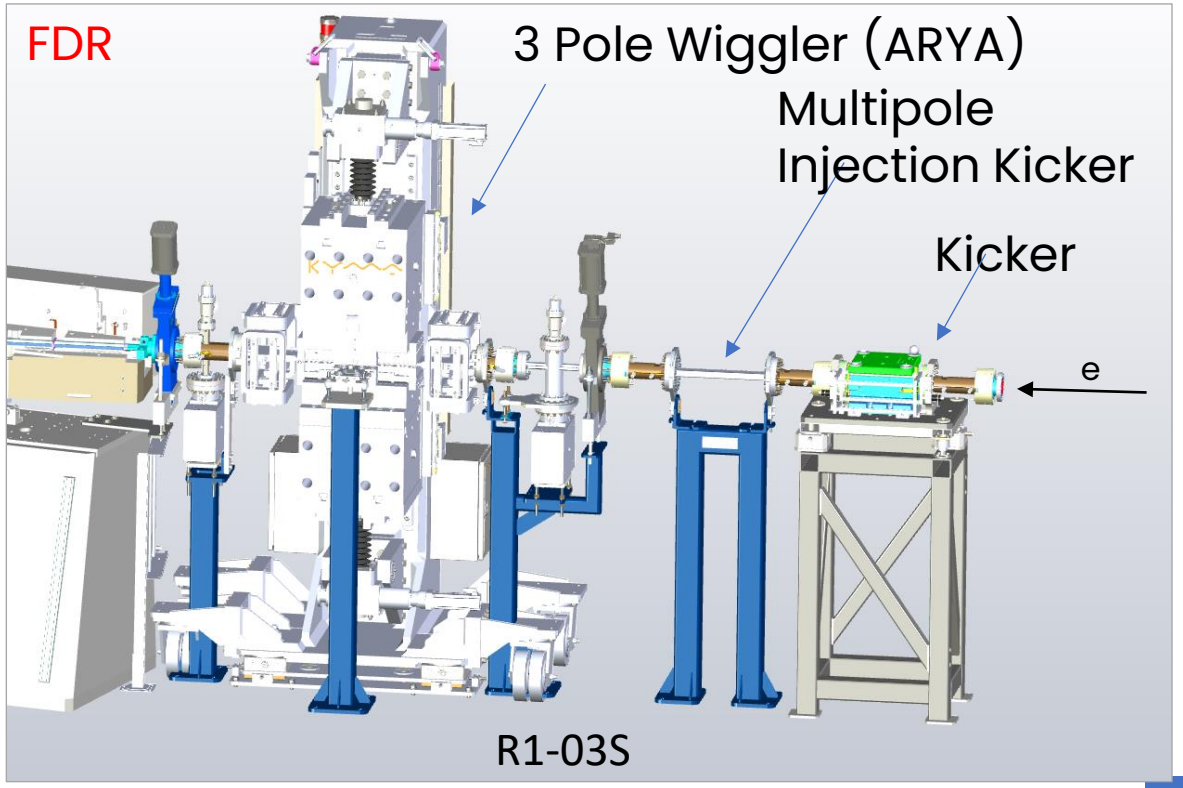
2023 – 3PW - Design Study (FMB) modification of the storage ring straight section

2024 – Straight section Conceptual Design Report (CDR)

2025 –Delivery of the 3PW(KYMA) Straight Section Preliminary Design Review (PDR)

2025 – Straight section (FMB) Final Design Review (FDR)

2026 – FAT, SAT, Delivery of straight section components



New Beamlines Development: ARYA

ARYA - under construction

The ARYA (mAcromolecular x-RaY crystAllography) is an advanced research infrastructure designed to utilize high-energy synchrotron radiation for structural analysis of proteins, nucleic acids, and small molecules. Its primary goal is to support research in structural biology, chemistry, and pharmaceutical sciences.

The MX end station has been designed for maximum flexibility and precision. It will enable:

- wavelength selection for MAD (Multiwavelength Anomalous Diffraction) experiments,
- high-flux operation for routine diffraction data collection from protein crystals.

Start of user experiments are planned for late 2027.

Beamline parameters

PARAMETERS	VALUE
Source	**3-pole wiggler**
Available energy range	4-22 keV
Energy resolution ΔE/E	DCM 1 x10^{-4}; DMM 1 x10^{-2}
Beam size at sample (H x V)	260 x 80 µm
Photon flux at sample	~10^{12} ph/s
End station	MX

New Beamlines Development: SMAUG

SMAUG beamline (Small Angle X-ray Scattering)
bending magnet based beamline delivering hard X-rays in the range of 6 to 14 keV.

The planned research capabilities of the end station will offer measurement capabilities in the following techniques:

- bioSAXS (studies of biological systems in solutions)
- SEC-SAXS (combined SAXS studies with simultaneous chromatographic separation),
- SAXS static measurements (including tests at low and high temperatures, magnetic or electric field)
- and SAXS liquid measurements at high pressures.

Beamline parameters

PARAMETER	VALUE
Source	Bending magnet
Available energy range	6-14 keV
Beamline Energy Resolution	~ 1.5 x 10^{-4} (DCM)
Beam size at sample (H x V)	200 x 200 µm
Photon flux at sample	5-6 x 10^{10} ph/s (DCM), 1 x 10^{12} ph/s (DMM)
End station	SAXS
Spot Size On Sample Vert	200 µm
Divergence Hor	160 µrad
Divergence Vert	80 µrad

New Beamlines Development: MAVKA

MAVKA beamline is being constructed within the Light for Ukraine (L4U) project initiated by League of European Accelerator-based Photon Sources (LEAPS) and aimed to expand opportunities for the Ukrainian scientific community and reinforce scientific collaborations with Europe.

The broad energy range, from soft to hard X-rays, available at MAVKA beamline will be applied to different types of spectroscopic techniques, including photoemission, absorption and fluorescence spectroscopies of solid and liquid samples at various experimental conditions.

Construction of the MAVKA beamline is co-financed by the Paul Scherrer Institute (PSI) within SERI/SNSF (State Secretariat for Education, Research and Innovation / Swiss National Science Foundation) grant and via the in-kind contributions.

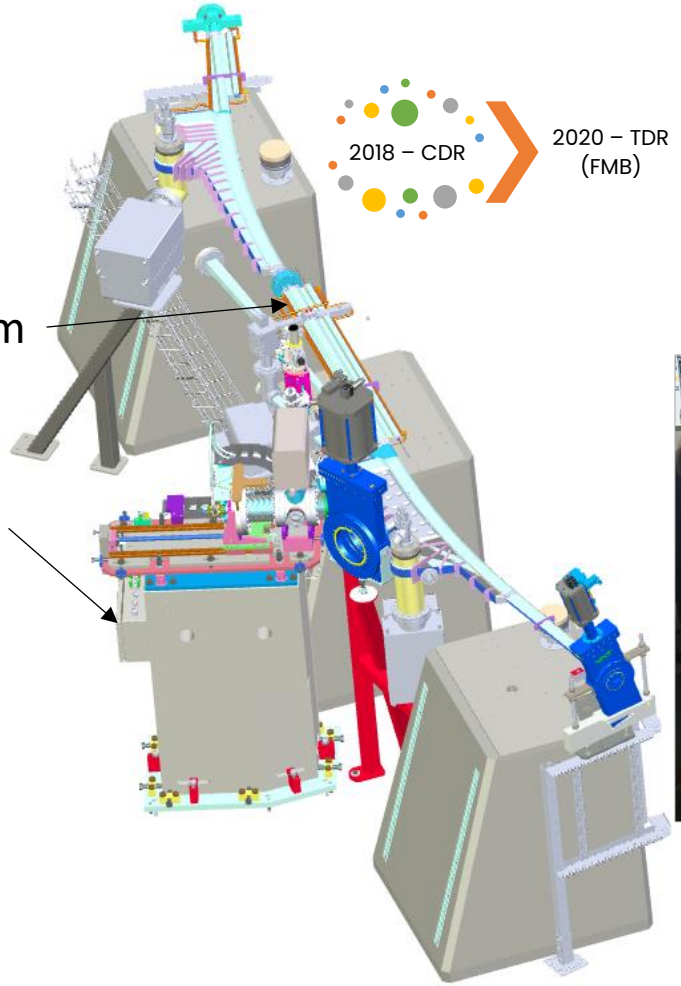
Beamline parameters

PARAMETERS	VALUE
Source	Planar in-vacuum undulator U19 (PSI)
Available energy range	0.5 – 9.0 keV
Energy resolution ΔE/E	2×10^{-4} (DCM)
Beam size at sample (H x V)	< 10 µm (TBD)
Photon flux at sample	~ 1011 ph/s
Polarization	Linear (horizontal)
Endstation XPS/XAS	Research techniques: Micro – X-ray photoemission spectroscopy (µ-XPS) Micro – X-ray absorption spectroscopy (µ-XAS) Micro – X-ray fluorescence spectroscopy (µ-XRF)
Endstation AP-HAXPES	Research techniques: Ambient pressure hard X-ray photoelectron spectroscopy (AP-HAXPES)

New Beamlines Development: CIRI

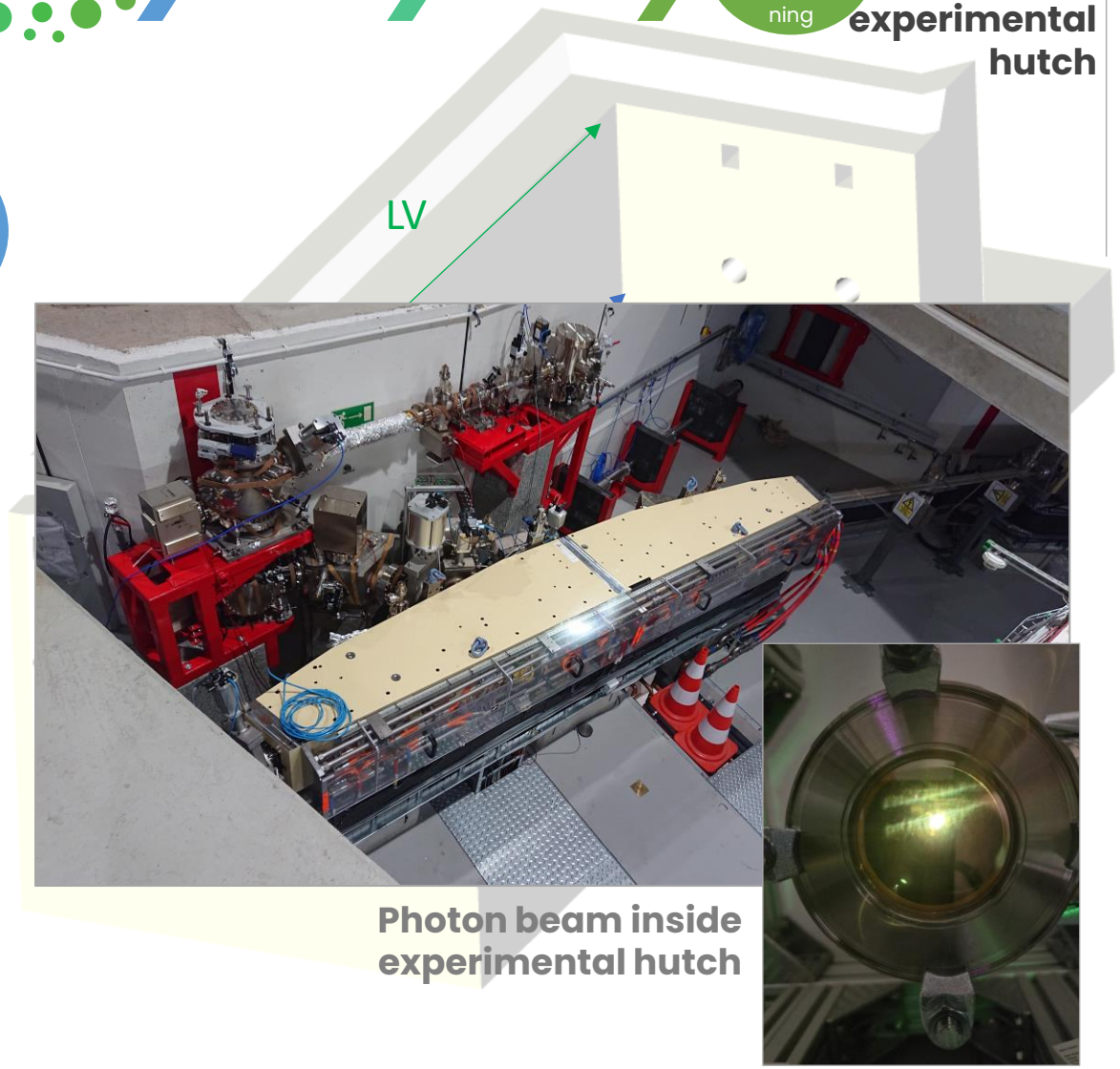
Installation and Commissioning of the CIRI Beamline

2018 – CDR → 2020 – TDR (FMB) → 2021 – Manufacture (FMB) → 2023 – Installation & Commissioning



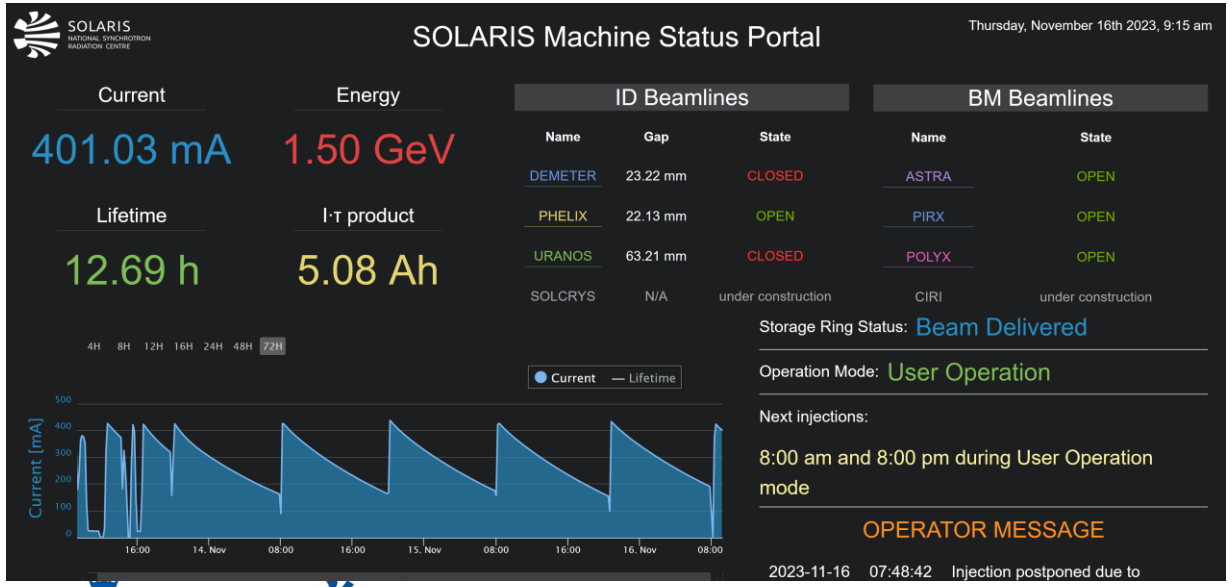
2021 – CDR → 2022 – TDR (SOLARIS) → 2023 – Manufacture → 2024 – Installation & Commissioning

experimental hutch



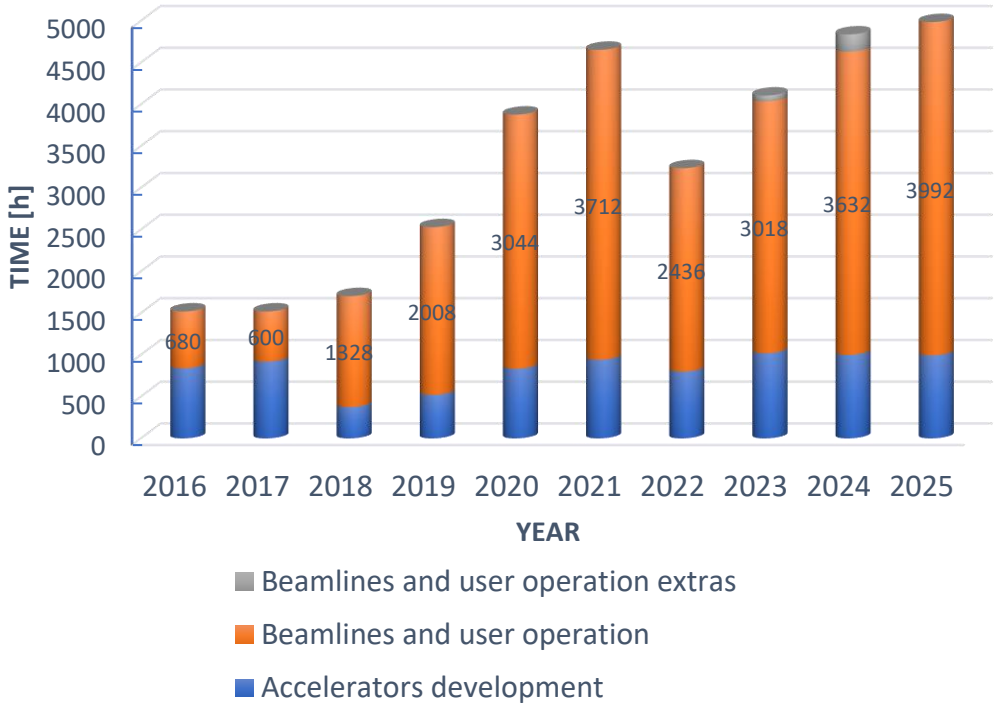
Photon beam inside experimental hutch

SOLARIS OPERATION



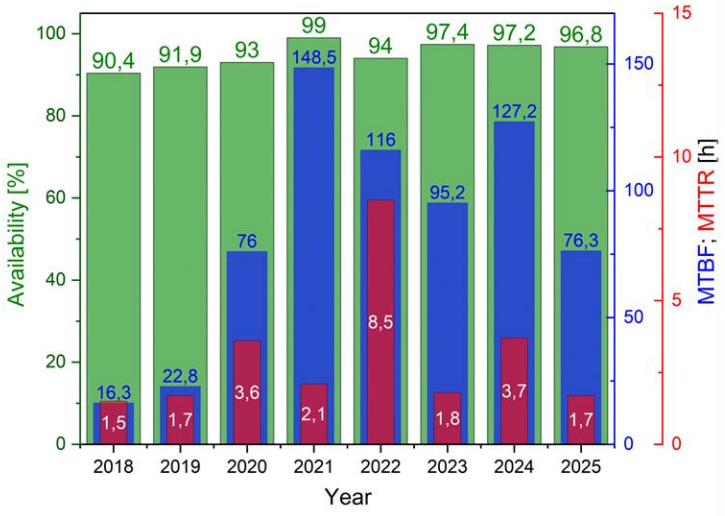
STANDRAD OPERATION 24/7 since 2025r.

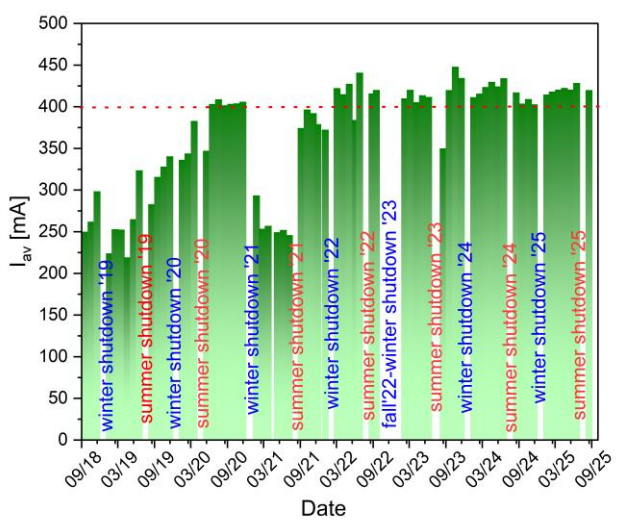
- 2 shifts (8:00-16:00; 14:00-22:00),
- Mondays (from 8:00 am) for machine studies, developments and maintenance
- Tue-Mon (until 8:00 am) –User Operation
- On-call duties 22:00-2:00
- Operation in decay mode, full filling pattern
- 2 injections/day

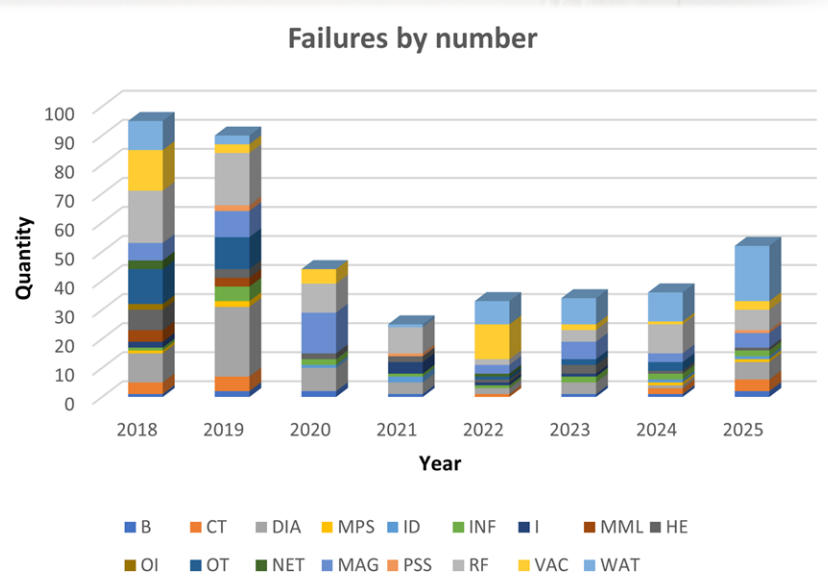


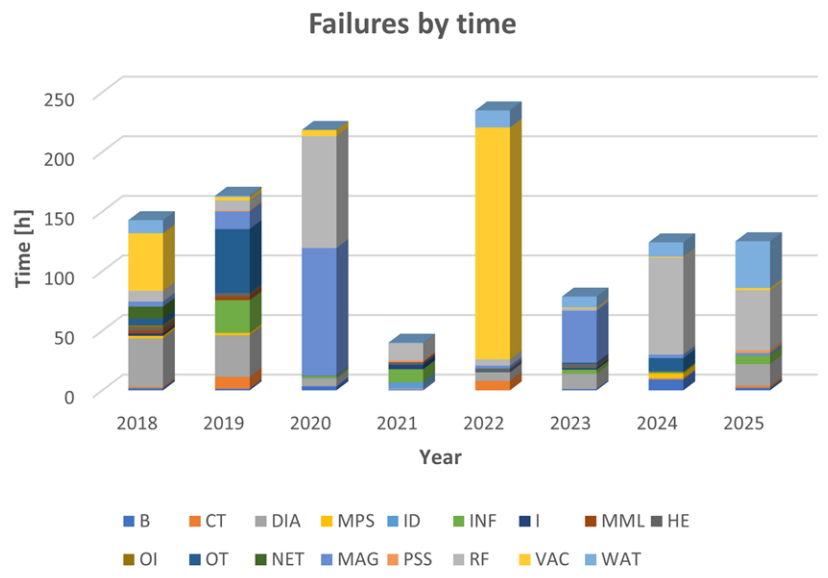
SOLARIS OPERATION: STATISTICS

User time	Availability	MTBF	MTTR
3970h	96.8%	76.3h	1.7h

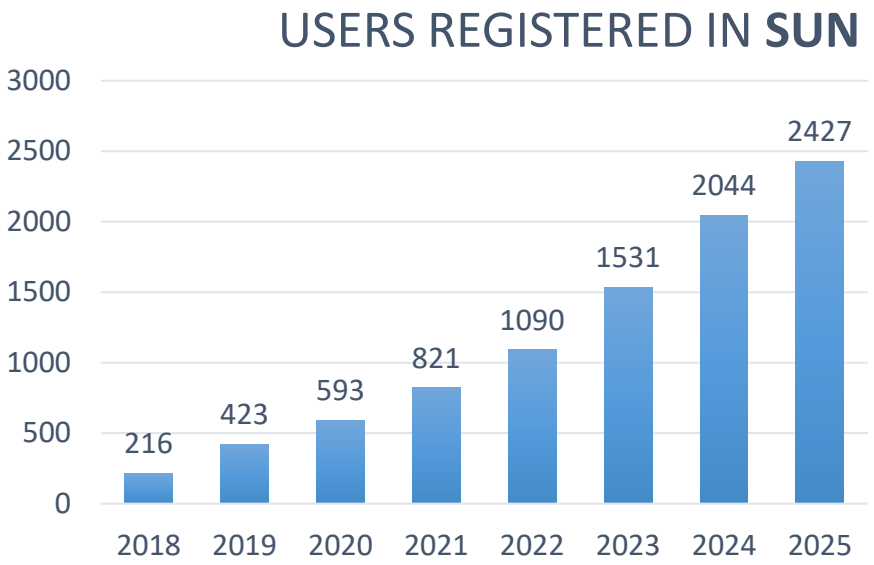


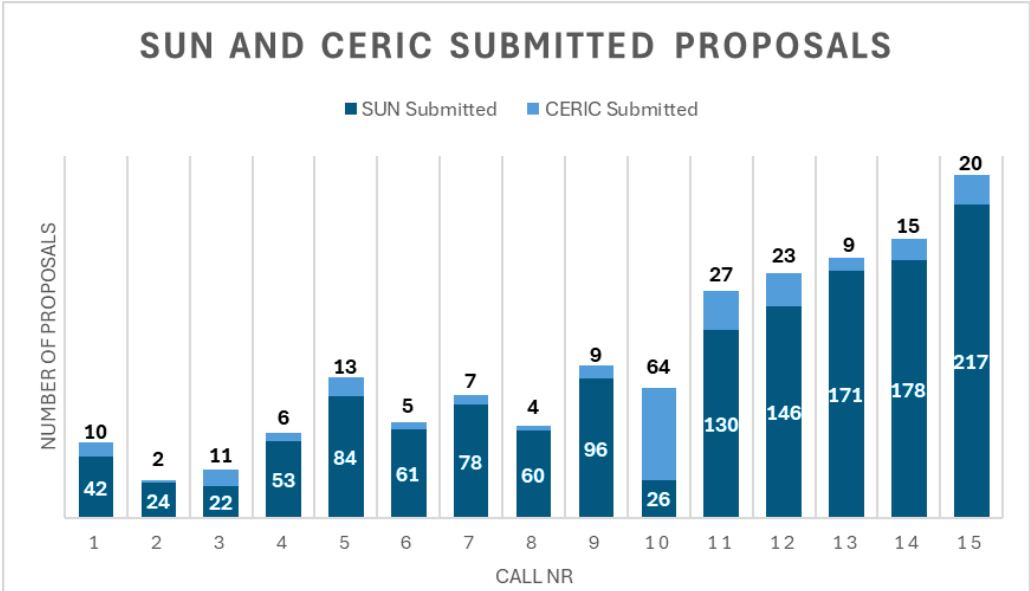


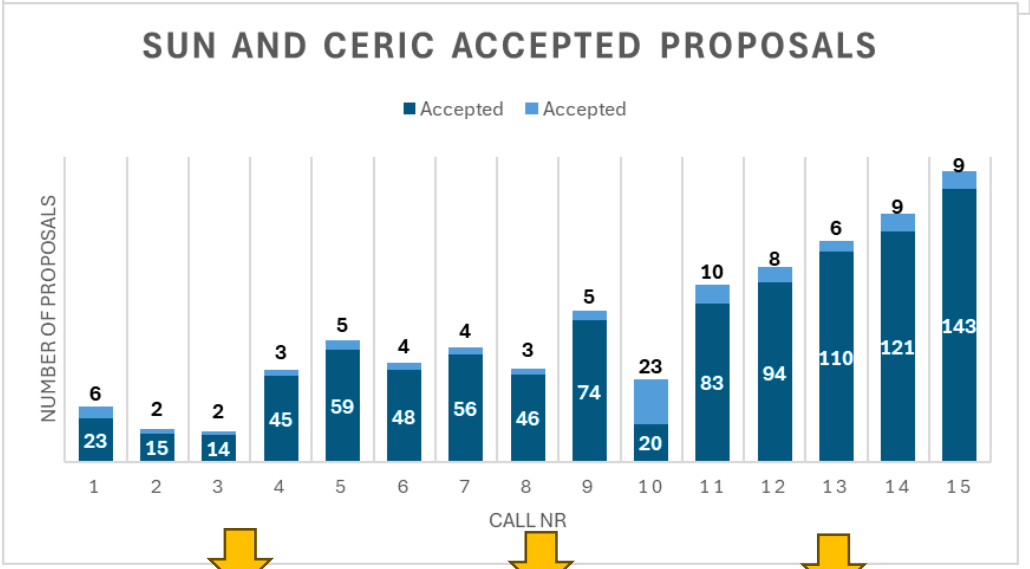




SOLARIS users – statistics







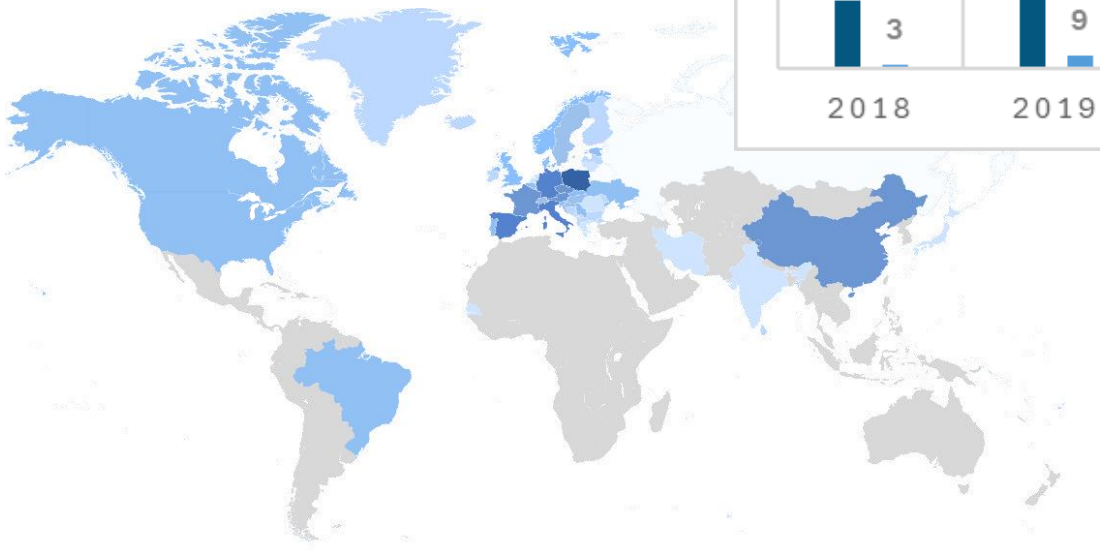
- **Free of charge** (for non-proprietary research)
- **Regular calls** for proposals **twice a year**
- **Peer reviewed** (5 PRPs)

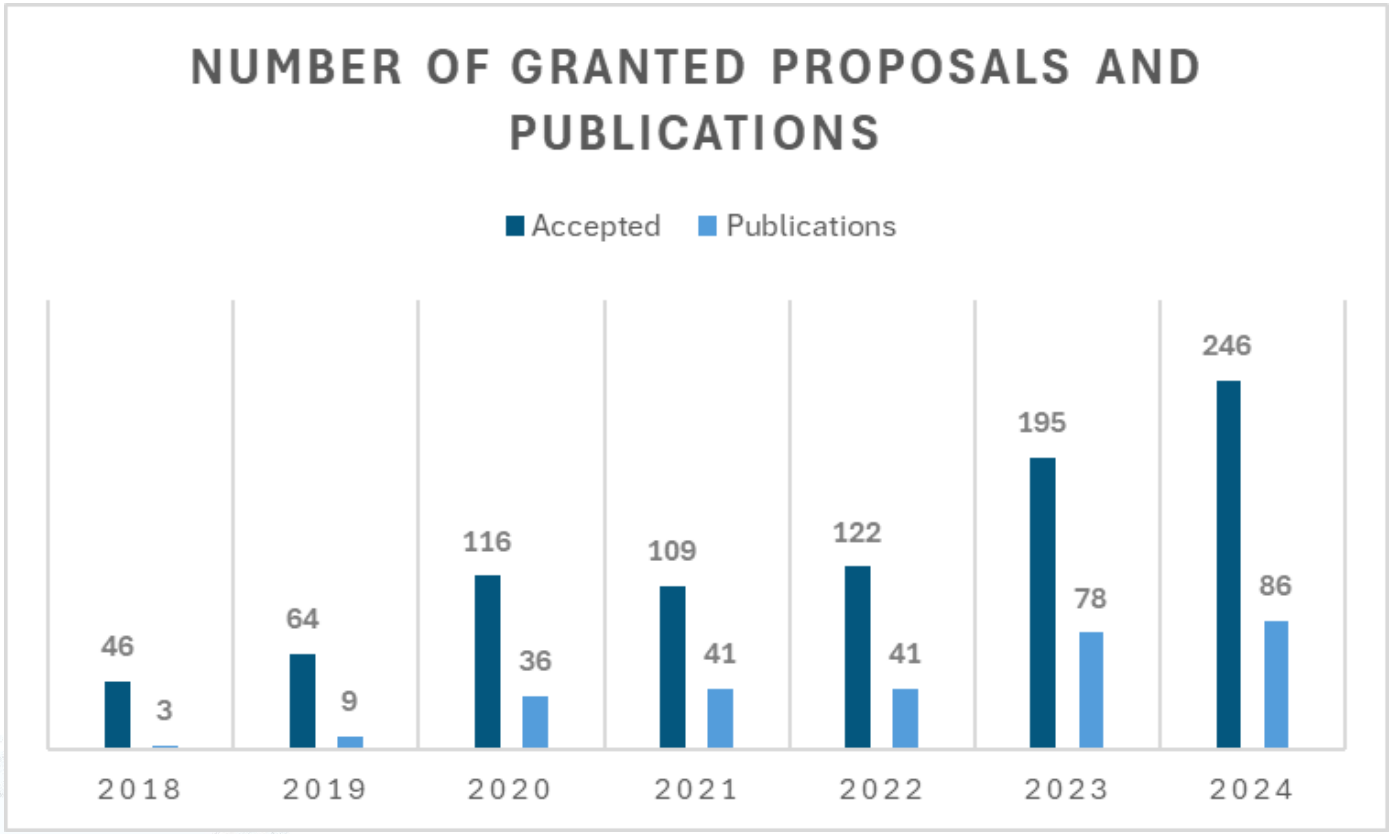
- **Rolling call** for rapid access
- **mail-in** or **remote** experiments @ selected instruments

Last call - 2026

	PIRX	STXM	PEEM	CIRI	URANOS	PHELIX	ASTRA	POLYX	Cryo-EM	Total
SUN Proposals	18	6	15	24	40	26	48	23	48	248
CERIC Proposals	5	3	1	0	1	6	8	4	4	32
										280

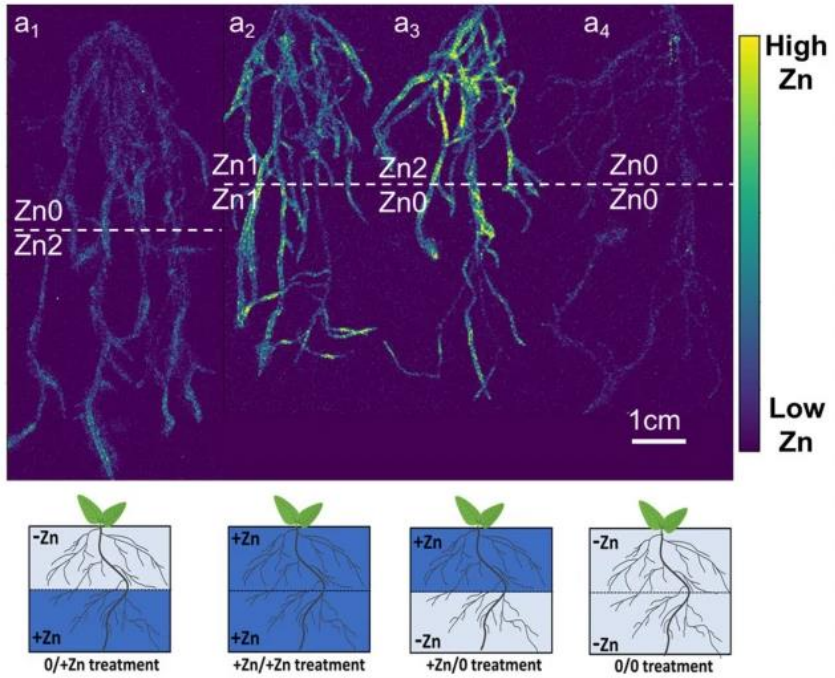
Publications of SOLARIS users





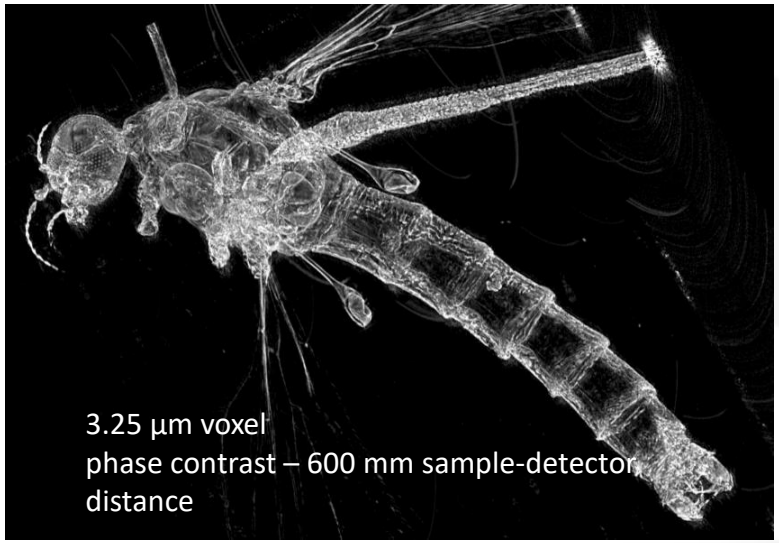
Results @ POLYX beamline

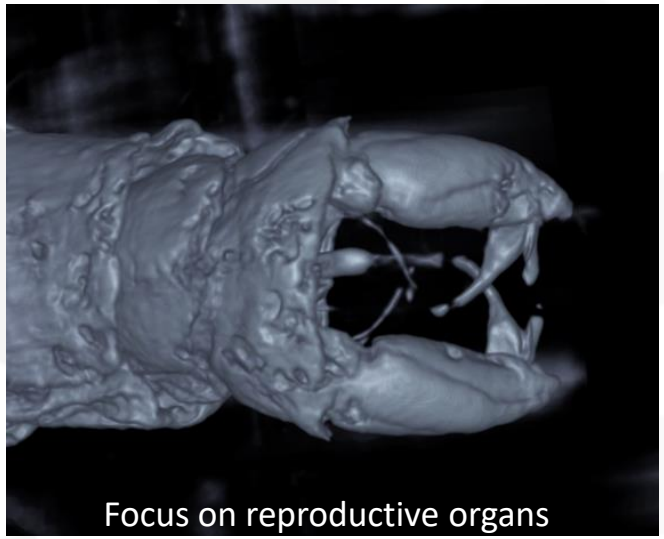
Microimaging of metal distribution at POLYX



Magdalena Pypka *et al., Zinc translocation from Zn-sufficient to Zn-deficient roots as an adaptation to heterogeneous Zn availability*, BMC Plant Biology (2025) 25:1341

Zn transport in plant roots





Crane fly in 40 MYears Baltic amber

Much more @ : https://synchrotron.uj.edu.pl/en_GB/start

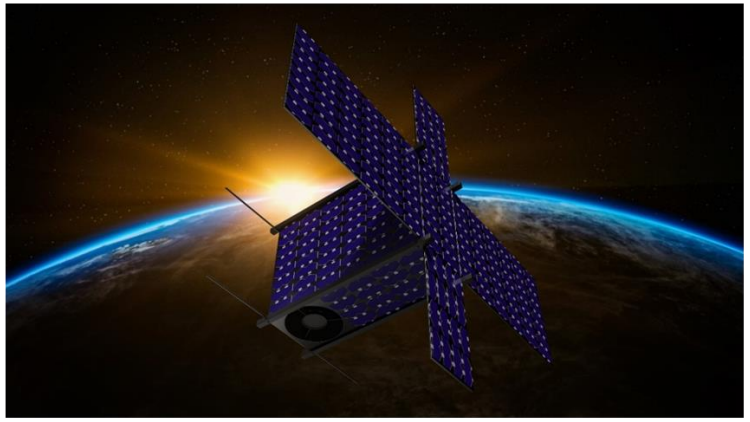
URANOS beamline (8-100 eV, 270 x 30 μm^2)

Support of national Horizon and ERC projects

HYADES critically needs **SOLARIS** as a strong source of Lyman-alpha radiation for the development of the tunable filter and tests & calibration of the satellite's science instrument

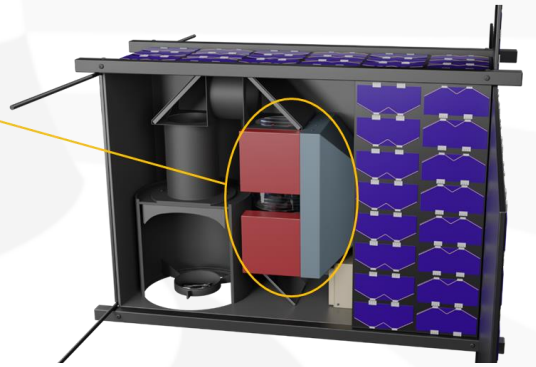
HYADES
(HYdrogen **A**nd **DE**uterium **S**urveyor of comets & asteroids)

A small **space mission** with three **big goals**:



- Explain the **origin of water** on our planet
- Search for **new reservoirs of water** in our Solar System
- Search for **water** tracers around **interstellar** objects

- Inexpensive off-the-shelf CubeSat platform in Low Earth Orbit
- Sensitive to Lyman-alpha radiation of hydrogen (switchable between H and D) at 121.6 nm
- Innovative tunable filter
- Excellent sensitivity thanks to:
  - Long ionisation lifetime of hydrogen
  - Extreme brightness in Ly α
  - Large imaging field of view
  - Reduced sky background



Lider projektu ERC: Michal Darhus, michal.drahus@uj.edu.pl
Zespół: Piotrek Guzik i Mikołaj Sabat (OA UJ) oraz Tomasz Kawalec (IF UJ)

SOLARIS partnerships

CERIC

SOLARIS contributes 10% of research time to the Central European Research Infrastructure Consortium, which gathers unique research facilities in 8 countries of the region

Open access to NMR, Mass Spectroscopy, Neutrons, Photons, Ions, Microscopy, Nanolabs, Laser science, Testing, etc.

LEAPS

Member of the League of European Accelerator bases Photon Sources, which is formed by 16 organizations representing 19 light source facilities in Europe

SOLARIS partnerships

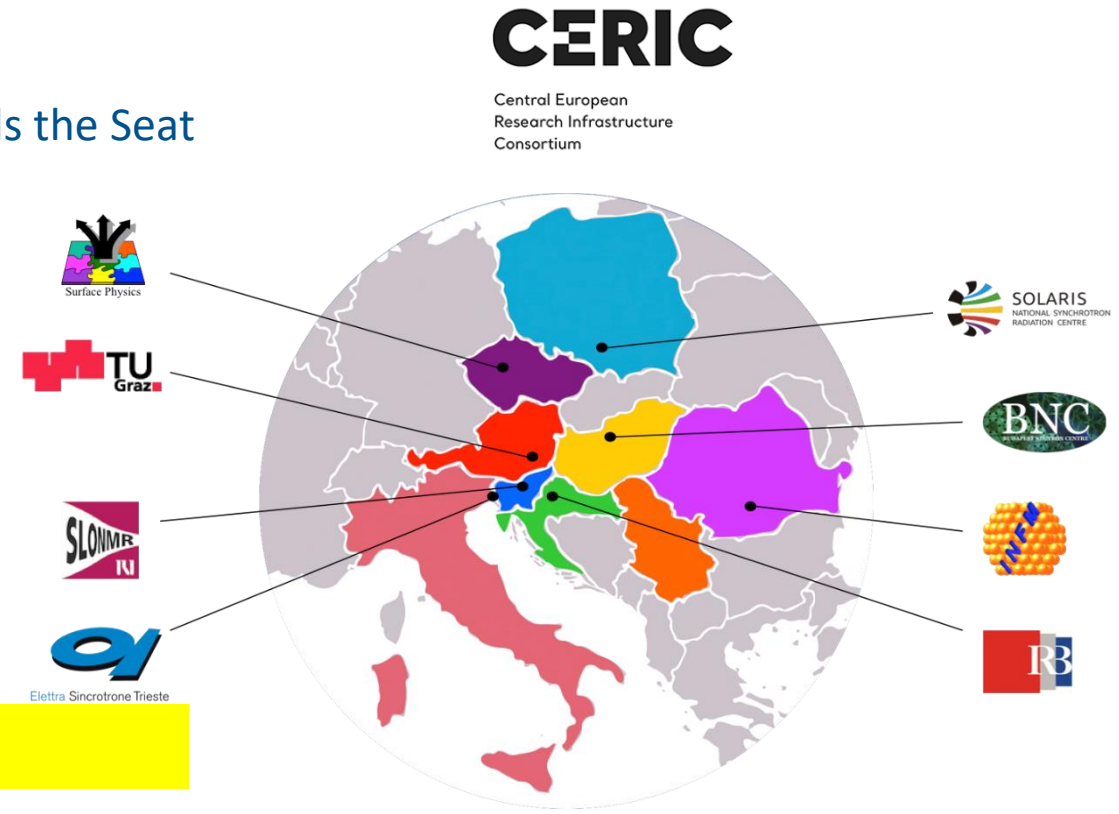
SOLARIS – part of Central European Research Infrastructure Concortium CERIC-ERIC

CERIC-ERIC: a unique distributed research facility in 8 countries

Number of infrastructures (Partner Facilities), one from each member countries made available to member countries for free

- ***no transfer of money***, but transfer and share of values, IT funds the Seat
- ***single entry point***, offering over 40 available techniques;
- ***peer evaluation system*** to select the best proposals;
- ***free and open access*** by quality selection only;

STRUCTURE:
Participating Country (member)
Representing Entity
Partner Facilities



PROVIDING ENVIRONMENT FOR MULTITECHNIQUE RESEARCH

SOLARIS partnerships

LEAPS - the League of European Accelerator-based Photon Sources - is a strategic consortium initiated by the Directors of the Synchrotron Radiation and Free Electron Laser (FEL) user facilities in Europe. Its primary goal is to actively and constructively ensure and promote the quality and impact of the fundamental, applied and industrial research carried out at their respective facility to the greater benefit of European science and society.

LEAPS members will produce a road map for the development of the next-generation light sources and instrument technologies, advocate for its funding and together address the big data challenge.
LEAPS will also:

- Play to the strengths of individual facilities through smart specialisation, recognising strengths in a more coordinated way to better serve the future needs of the user community
- Strengthen and expand services to industry to trigger innovation more widely and efffectively
- Standardise and improve access modes for users, capture and map socio-economic impact, enhance training and outreach programmes
- Strengthen scientific integration, both across Europe and globally

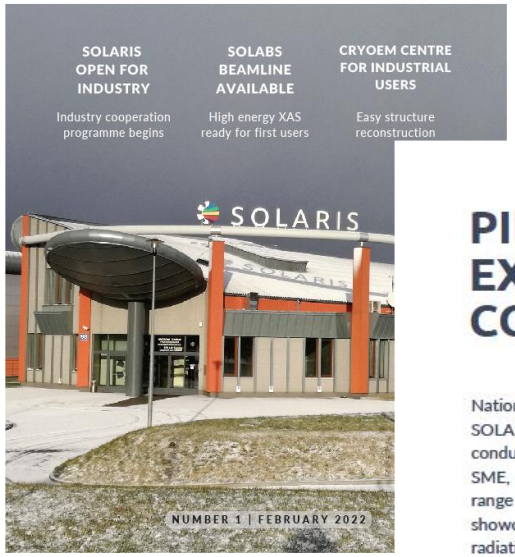
Project

Project Sylinda (Synchrotron Light Industry Applications) aims at boosting R&D capabilities of the National Synchrotron Radiation Centre SOLARIS, located in Kraków, Poland, through the cooperation with experienced project partners: ALBA Synchrotron, Hochschule Niederrhein and University of Bonn.

In order to boost the industrial research programme at Solaris, efficient cooperation structures have been organized, centered around Industrial Liaison Office and supported by the industry-focused beamline scientist and a dedicated funding officer. The staff involved in these activities have been enrolled in the twinning and advanced training programmes at the facilities of the project partners, in order to gain necessary expertise. A special emphasis has been placed on enhancing industry research project management, proposal preparation and administration skills.

The X-ray Absorption Spectroscopy (XAS) beamline, upgraded with a high resolution spectrometer, is attractive for academic and industrial users dealing with the studies of low-Z elements (atomic number Z down to Z=11). This opens new cooperation avenues with the pharmaceutical, rubber, agricultural, biological, chemical and cosmetic industry sectors.

Various communication and dissemination activities included a summer school focused on science management and the specifics of industrial research projects, dedicated for early stage researches and an industrial workshop, organized at Solaris. These activities enhanced the visibility of Solaris in the European synchrotron community and ensure the sustainability of the Sylinda project. The network established with the experienced partners lead to the future collaborations with other European and worldwide research institutions and to the future R&D projects with both academic and industrial partners.



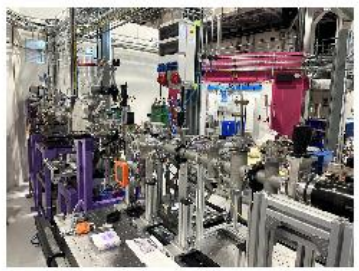
PILOT EXPERIMENT COMPLETED

National Synchrotron Radiation Centre SOLARIS has completed a pilot experiment conducted in cooperation with a Polish SME, Vis Plantis, a producer of a wide range of cosmetics. The experiment showcases the strengths of synchrotron radiation - based methods in solving key issues of the cosmetics sector and fostering development of innovative products

The experiment focused on studying the mechanism of action of a newly developed product, aimed at protecting hair from the negative effects of high - temperature treatments. Applied methods included X-ray absorption spectroscopy in the tender energy range at the ASTRA beamline, IR spectroscopy at the CIRI beamline, optical microscopy (OM), scanning electron microscopy (SEM) and atomic force microscopy (AFM).

The studies have indicated potential protective mechanisms of the substance and will serve as a basis for future cooperation with the cosmetics sector.

a)



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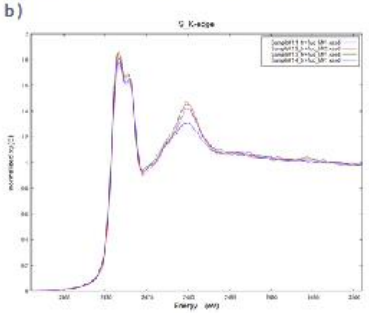

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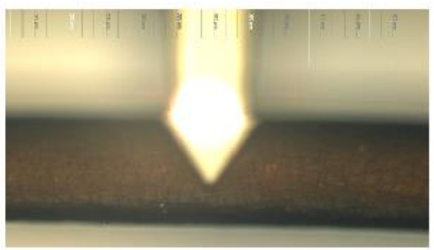


(a) ASTRA beamline during the measurements; (b) Sulphur K-edge XAS spectra of the hair samples, which have undergone various treatments; (c) AFM measurements of a hair sample

ASTRA BEAMLINE OPENING

After numerous safety and performance tests and optimization of key parameters, on June 29th, ASTRA beamline (formerly known as SOLABS beamline), has been officially opened. The beamline is the joint project of SOLARIS with Hochschule Niederrhein (Germany), Synchrotron Light Research Institute (Thailand) and University of Bonn (Germany). ASTRA beamline was specifically designed for XAS (X-ray absorption spectroscopy) measurements in the tender energy range, however hard X-ray measurements are also possible.

The opening ceremony of the beamline was attended by many distinguished guests: German Consul General Dr. Michael Groß, Rector of Hochschule Niederrhein, Dr. Thomas Grünewald, Director of the SOLARIS National Synchrotron Radiation Center, Prof. Marek Stankiewicz, Vice-President of Hochschule Niederrhein, prof. Alexander Prange, the representative of Jagiellonian University, Prof. Stanislaw Kistryn and the representative of the University of Bonn, prof. Josef Hormes.

Research conducted on the beamline will contribute to developments in fields such as materials science, physics, chemistry, biomedicine, and environmental studies. The beamline opens up opportunities for cooperation with the rubber, agricultural, chemical, and cosmetic industries.

Opening ceremony of the ASTRA beamline (photo: Agnieszka Cudek)

SYLINDA INDUSTRY WORKSHOP

Between 14.06.2023 and 15.06.2023 the first Sylinda Industry Workshop was held at the SOLARIS National Synchrotron Radiation Centre in Kraków, Poland. The event attracted over 50 participants and speakers from industry and academia and was focused on two main industry sectors: (1) chemical & materials and (2) agriculture & biotechnology.

In addition to numerous presentations of world-class scientists, agenda of the event also included talks given by industry leaders, such as Harry Zumaque from Lanxess, or Kang Wei Chou from Henkel. Topics covered both the scientific basis of advanced measurements, offered by synchrotron radiation facilities and their applications in solving real-life problems faced by the companies.

Early stage researchers, from the partner institutions of the Sylinda project, had the chance to present their industry-relevant research during poster sessions. 14 posters were presented, which described themes ranging from functional, selenium - enriched foods studied by X-ray absorption spectroscopy to the analysis of how synchrotrons can help startups and industry.

Numerus fruitful discussions were held during the meeting and several collaborations have already been initiated. The event was highly rated by the participants and will undoubtely lead to enhancing the potential of the SOLARIS Centre, and the whole Sylinda project consortium, in applied and industrial research and attracting industrial users to the facilities.

PHOTO: PIOTR CIOCHON

PHOTO: JOANNA KOWALIK

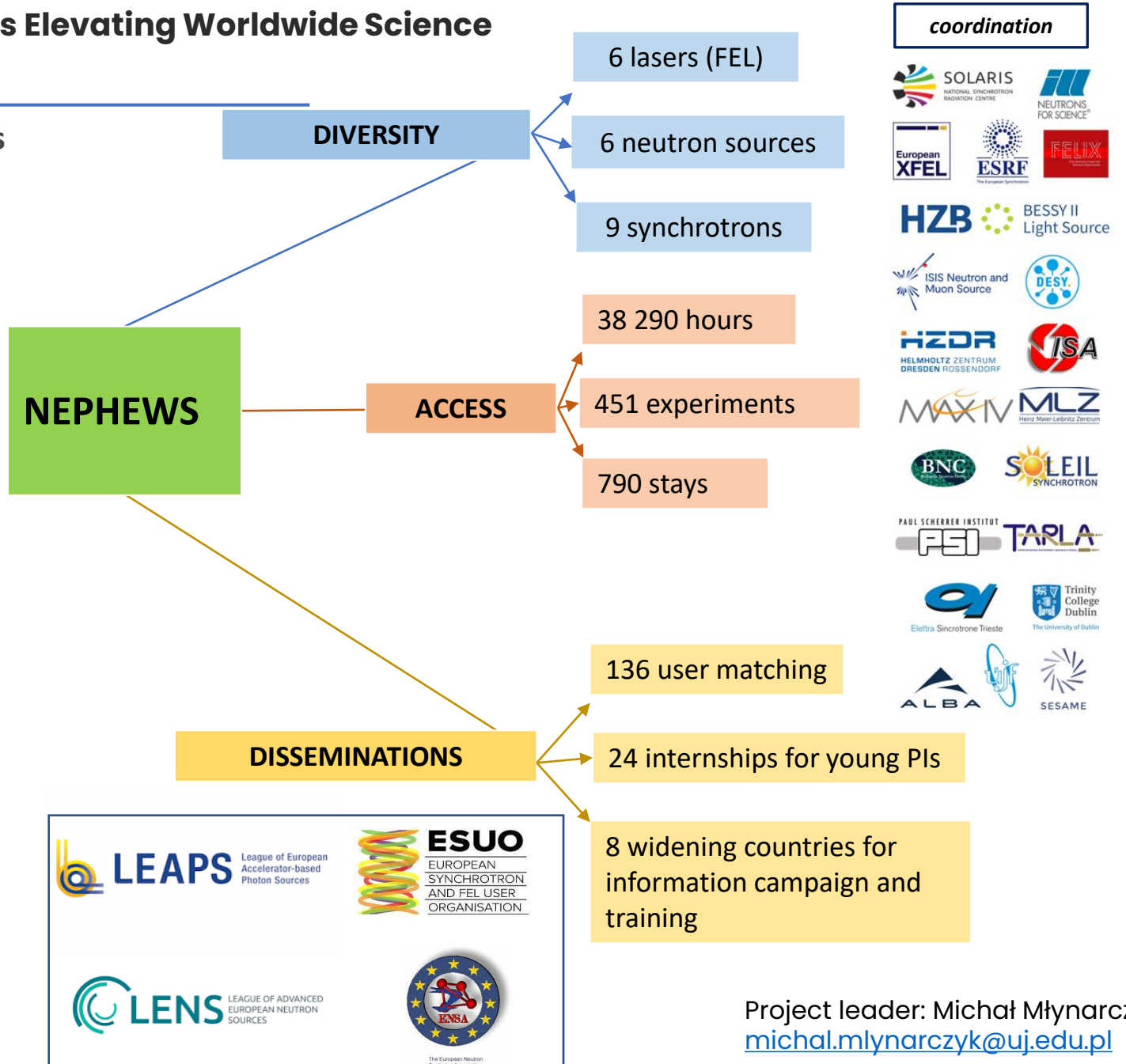
PHOTO: JOANNA KOWALIK

Horizon project: NEPHEWS -Neutrons and Photons Elevating Worldwide Science

The project primary objective is to grant researchers access to cutting-edge European photon sources (LEAPS - League of European Accelerator-based Photon Sources) and neutron source (LENS- League of advanced European Neutron Sources). This access aims to enhance collaboration with User communities in supported countries and foster research excellence.

Close cooperation with ESUO (European Synchrotron and Free Electron Laser User Organization) and ENSA (European Neutron Scattering Association) representing over 40 thousand Users, underscore the project's commitment to meeting the specific needs of these communities throughout their scientific career development. Geographically, the NEPHEWS project prioritizes European developing countries (Widening countries), Ukraine, and Africa.

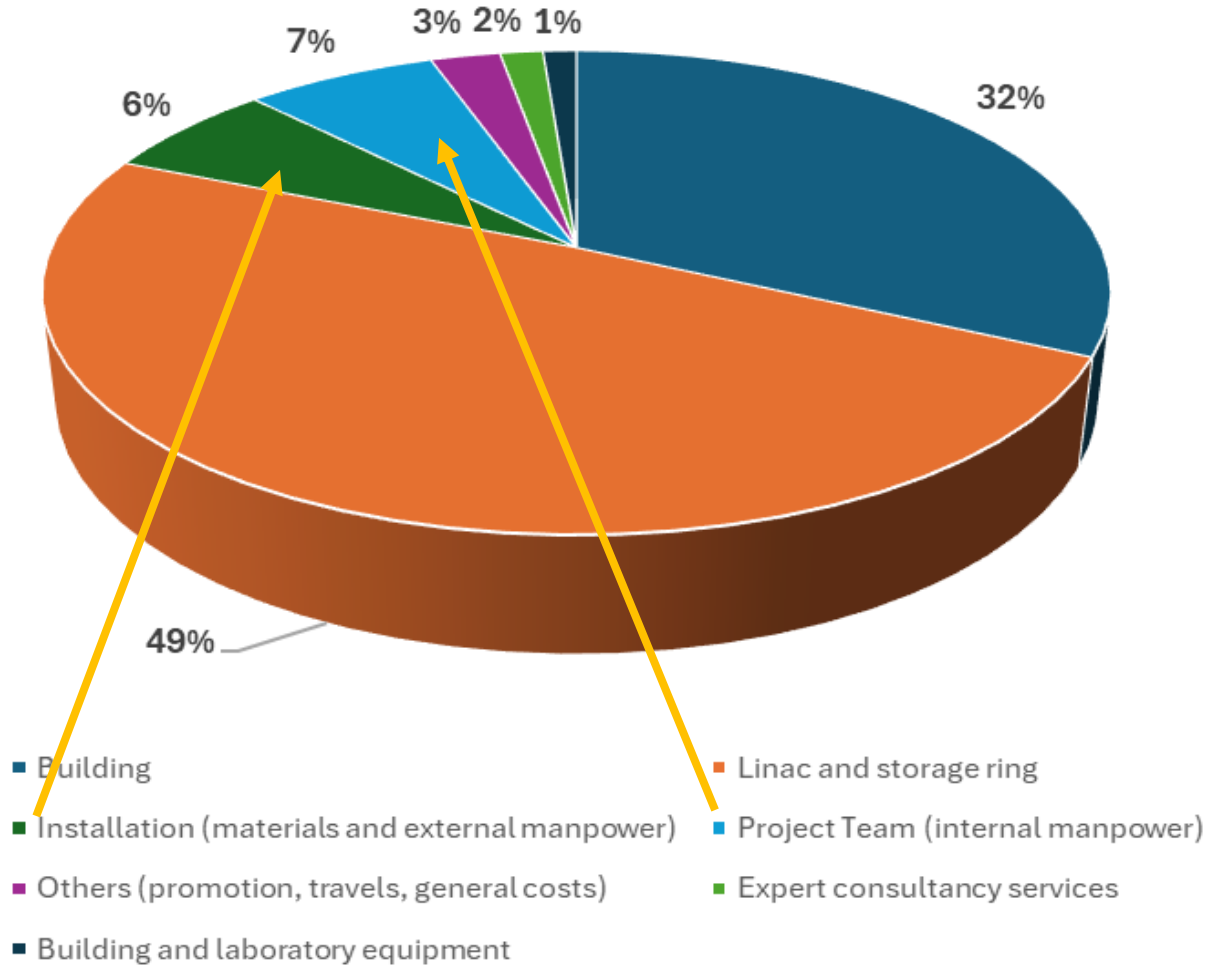
The project employs a bottom-up, User-centered approach to create an integrated landscape of photon and neutron research infrastructures and their European User communities. This approach is unprecedented in the scale of European collaborative networks.



Project leader: Michał Młynarczyk
michal.mlynarczyk@uj.edu.pl

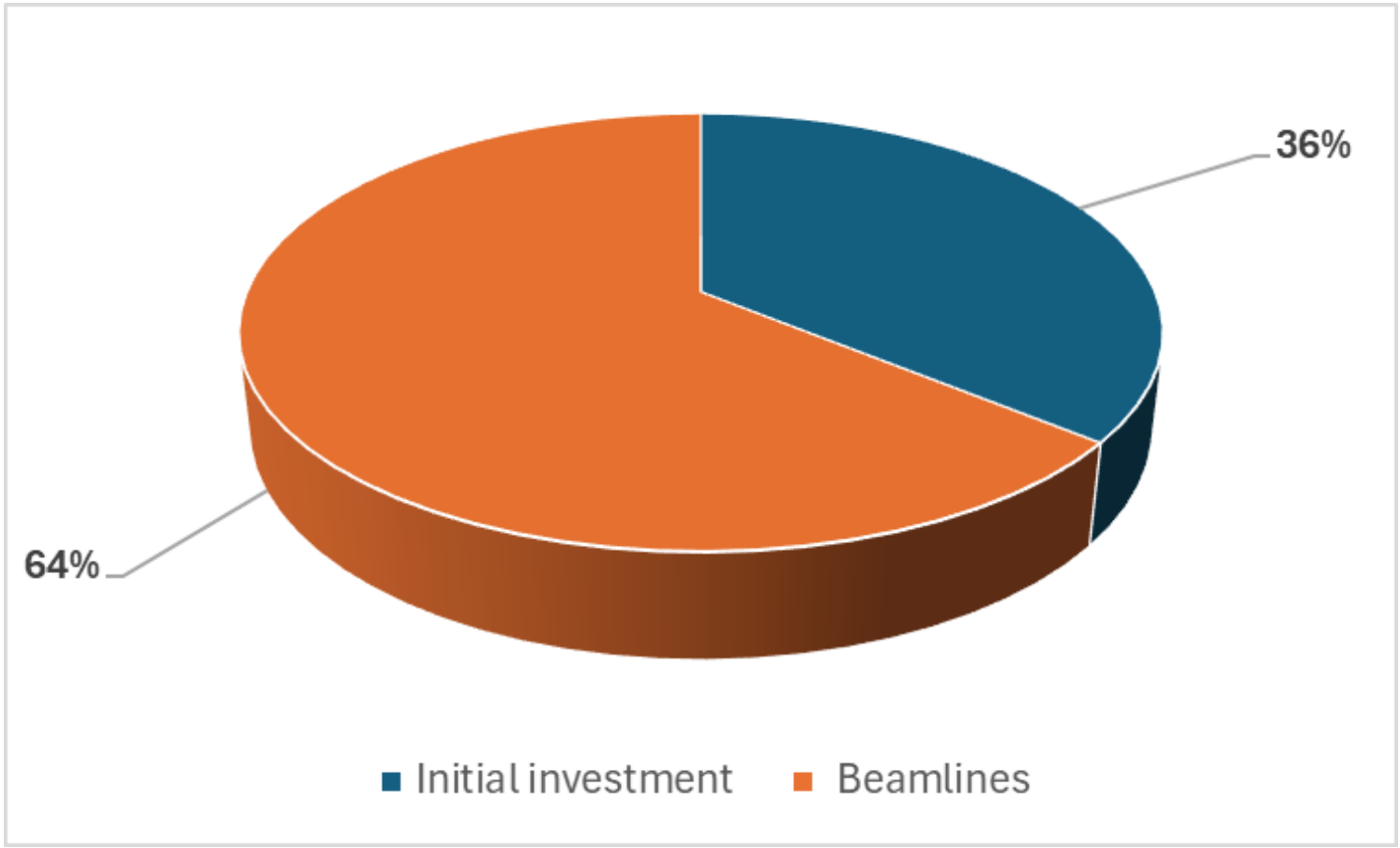
Budget – Initial Investment (No Beamlines)

Category	EUR
Building	11 703 670
Linac and storage ring	17 947 634
Installation (materials and external manpower)	2 340 878
Project Team (internal manpower)	2 534 884
Others (promotion, travels, general costs)	918 605
Expert consultancy services	566 317
Building and laboratory equipment	441 860
TOTAL	36 453 848



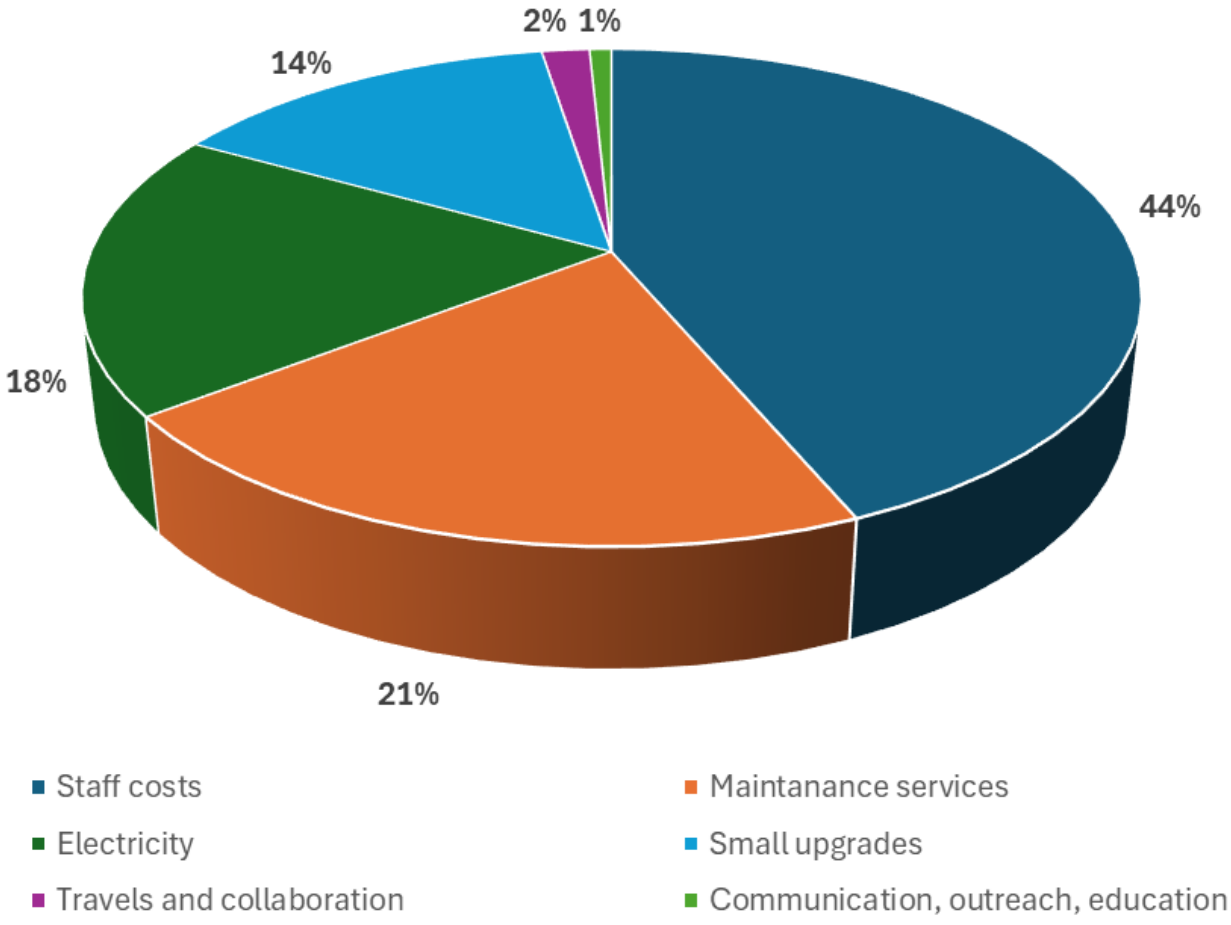
Budget – Total Investment With Beamlines (So Far)

Category	EUR
Initial investment	36 453 848
ARYA	21 000 000
ASTRA	2 857 143
CIRI	2 354 762
Cryomicroscopy	9 480 633
DEMETER	3 526 667
NAP-XPS	2 015 231
PHELIX	5 761 905
PIRX	1 943 721
POLYX	2 852 857
SMAUG	8 320 000
URANOS	5 069 767
TOTAL	101 636 534



Budget – Annual Operation

Category	EUR
Staff costs	5 070 929
Maintenance services	2 430 952
Electricity	2 160 000
Small upgrades	1 666 667
Travels and collaboration	202 381
Communication, outreach, education	92 857
TOTAL	11 623 786



Operational budget = 10% of investment

Large infrastructure cost

SOLARIS future

- **SOLARIS - further development:**
  - **Full set of beamlines**
  - **Full energy (1.5 GeV) linac: C-band min (X-band?) => top up**
  - **Short Pulse facility**
- **SOLARIS 2.0 – IV generation**

Acknowlegements

- **Project success relied on exceptional transnational collaborations**
- **FOREMOST - The freely given design of the MAX IV 1.5 GeV ring and its injector technology by MAX-lab**
- **MAX IV – Solaris Collaboration:**

  Training and exchange of personnel

  Exchange of ideas and requirements

  Collaboration in procurements and contract specifications: Procurements for Solaris were as options in MAX IV tenders

  Provision of state-of-the-art components: Gun System, Landau cavities, modifications to vacuum chambers and magnets

  Technical support with industrial follow-up and FATs

  Maximised return for cash by allowing industry to plan for double purchase orders

Acknowlegements

Elettra-Sincrotrone Trieste - Expert advice, contracts for PSS, design of transfer line, vacuum chamber components, beamline and front-end, EPU insertion device

Swiss Light Source - Expert advice, training, Bake-out oven and control

Diamond - Expert advice

Soleil - Expert advice, commissioning software

ALBA - Expert advice, commissioning software, training

ESRF - Expert Advice, IcePAP motion controllers

Machine Advisory Committee – Expert advice of 5 world class experts from Diamond, Soleil, PSI

National Centre for Nuclear Research, Świerk - Vacuum system installation inclusive of linac, storage ring and RF cavities.

Polish Synchrotron Consortium (36 universities and institutes)

Polish Synchrotron Radiation Society

Polish Physical Society

PL-Grid

Institute of Catalysis and Surface Chemistry PAS – PEEM End Station

Cracow University of Technology

SOLARIS
NARODOWE CENTRUM
PROMIENIOWANIA
SYNCHROTRONOWEGO

Welcome to SOLARIS

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thank you
danke
謝謝
ngiyabonga
شكراً جزيلاً
рахмат
teşekkür ederim
Баярлалаа
спасибо
faafetai lava
dank je
gracias
tapadh leat
vinaka
спасибі
blagodaram
misaotra
matondo
paldies
grazzi
mahalo
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nanni
nandri
bayarlalaa
gràcie
köszönöm
akun
dankon
aëiù
obrigada
tenki
murakoze
enkosi
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