SOLARIS
CENTRE

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SOLARIS Status Update

SOLEIL, 38th Tango Community Meeting 28-30.05.2024

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SOLARIS National Synchrotron Radiation Centre

NSRC SOLARIS

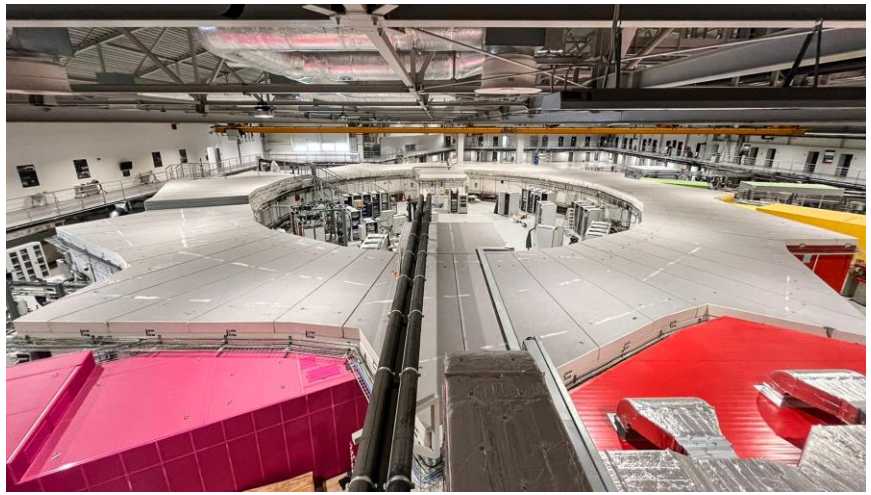
Fot. Aleksander Koczur

NSRC SOLARIS

- Third generation light source.
- Designed by MAX-lab team (Mikael Eriksson).
- Constructed 2010 - 2015 in Krakow, Poland.
- Between 2015 and 2018 the synchrotron as well as two beamlines (PIRX and URANOS) were commissioned.
- Since **October 2018** Solaris has been in the user operation mode.

1.5GeV Storage ring

- 12 DBA Cells – 96 m circumference.
- Space for ID's (10 sections) ~ 3.5 m.
- 100 MHz RF system.
- 300 MHz Landau Cavities.
- Injection dipole kicker.
- Ramping mode.
- In operation since May 2015.



600MeV Linac

- RF Thermionic Gun.
- 6 S-band 2998.5 MHz accelerating structures.
- Accelerating gradient 20 MeV/m.
- 3 RF Units & SLED cavities.
- Dog-leg vertical transfer line.
- In operation since Dec. 2014.
- Linac upgrade design is being contucted to match the ring energy (top up injection scheme).

SOLARIS research infrastructure

Available and in user operation

Starting up, availabe for fall call

Project accepted, in construction, available in 2026

Project application submitted (decision in July 2024)

Available space for 4-5 beamlines

+

CryoEm centre

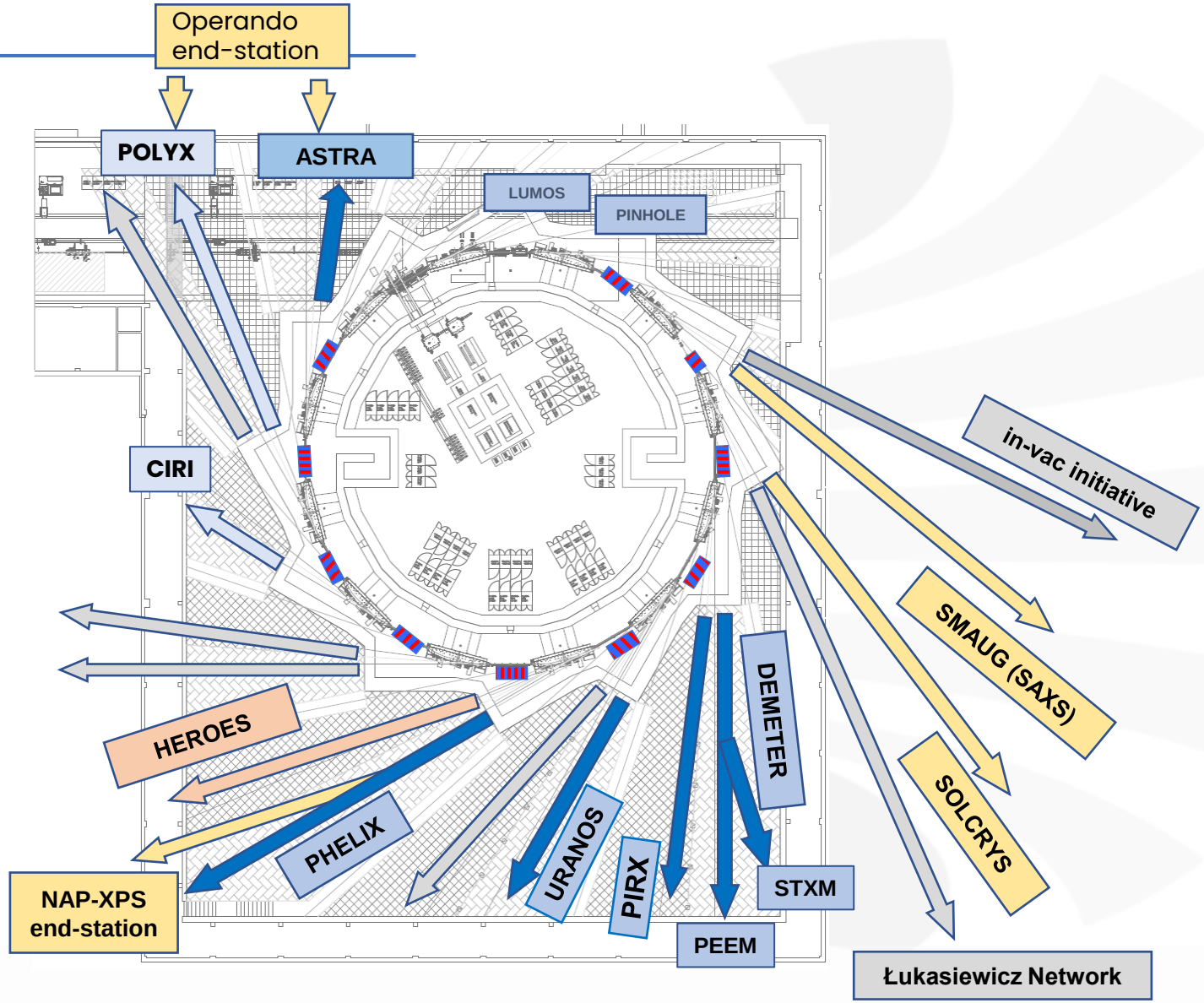
Structural Biology Core Facility

Krios

Glacios

Neutron-lab
(in construction)

RESEARCH UNIVERSITY EXCELLENCE INITIATIVE



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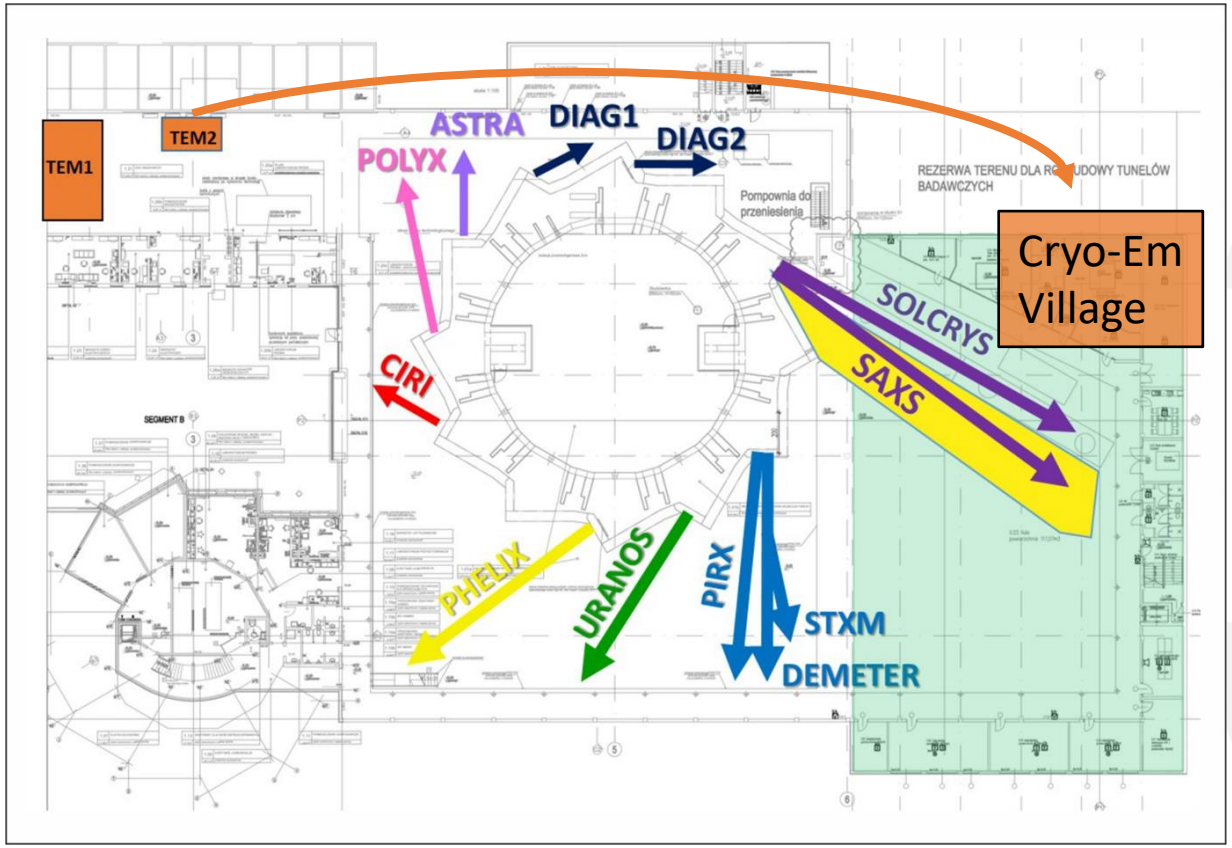
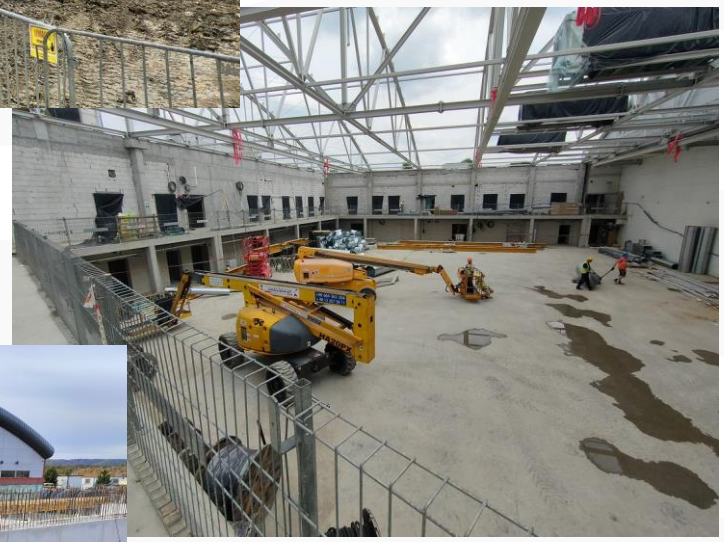
Beamline name	Photon energy range	Research method	Sample environment	Photon spot size
DEMETER	100 - 2000 eV	absorption & photoelectron spectroscopy (**PEEM, STXM, XPS, XPD**)	STXM: gas atmosphere PEEM - UVH	STXM – 0.03 x 0.03 μm^2 PEEM – 40 x 30 μm^2
PIRX	100 - 2000 eV	absorption spectroscopy (**XANES, XMCD, XMLD**)	UHV, HV	250 x 40 μm^2
URANOS	8 - 150 eV	photoelectron spectroscopy (**ARPES**)	UHV	60 x 150 μm^2
PHELIX	50 - 1500 eV	absorption & photoelectron spectroscopy (**XANES, ARPES, S-ARPES, XPS, NAP-XPS** end of 2026)	UHV	80 × 30 μm^2
CIRI	12,5 - 500 meV	absorption spectroscopy (**FT-IR, s-SNOM/AFM-IR**)	low/atmospheric pressure	10 µm
POLYX	5 - 15 keV	absorption microspectroscopy, microimaging (**µXRF, µXAS, µXRD, µCT, Operando** end of 2026)	atmospheric pressure	from 40 x 40 μm^2 to 1 x 1 μm^2
ASTRA	1 - 15 keV	absorption spectroscopy (**EXAFS, XANES, Operando** end of 2026)	atmospheric pressure	10 x 1 mm^2
SMAUG	6-15 keV	small angle X-ray scattering (end of 2026) (**bioSAXS, SEC-SAXS, static SAXS, liquid SAXS in HP**)	atmospheric pressure	200 x 200 μm^2
SOLCRYS	4-16 keV	single crystal diffraction (end of 2026)	atmospheric pressure	200 x 200 μm^2

SOLARIS experimental hall extension

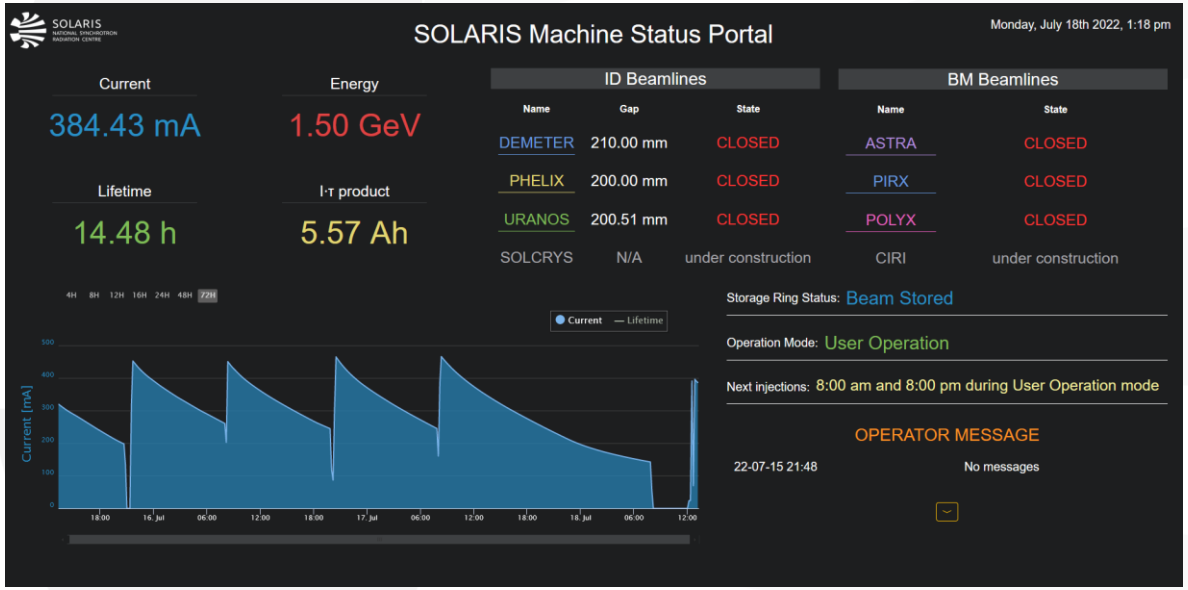




- Done in Q3 2022-Q1 2024

SOLARIS Operation

- 2 Shifts from Monday to Saturday (8:00-16:00; 14:00-22:00).
- On call support to 2:00 am from Tuesday-Saturday.
- 2 operators per shift.
- Monday – machine days, maintenance.
- User operation 5 days/week (Tue-Sat).
- Sunday – no injection, or injection upon request.
- Injection twice/day: 8:00 am and 8 pm.
- One operation mode (uniform filling pattern).
- Singe bunch operation mode under development.
- Operation in the decay mode.



Control System in NSRC SOLARIS

- Accelerators and beamlines for control system use PLC (BMS, MPS, PSS) and TANGO (high level, mostly python, sometimes C++).
- OS: CentOS 6, **7 (mainly),** 8, Windows 10, 11 + some embedded custom Linux and 1 Fedora (old one) **=> Alma9**
- Python versions: 2.7 (GUIs), **3.6 (devices and GUIs),** 3.7 (some web), **=> 3.9 (Alma 9 during first deployment).**
- Tango versions: 9.4.2, **9.3.5 (mainly) and 9.3.6**, 9.2.5 (few systems left), 9.1 (embedded) and some 8 (e.g. old archiving).
- Taurus versions: 3.7 (virtual env), 4.1 (accelerators), 4.4 (virtual env), **4.5 (beamlines), 4.7 , 5.X**
- Additionally, some projects use Vue.js, Tango GQL and Taranta (for authentication).
- Archiving: hdb++ + MySQL InnoDB
- Migrated to **Sardana 3.4**
- No big difference between machine and beamlines - same software stack
- running on VMs
- Ansible, AWX

- Cryomicroscopes are fully independent and are based on manufacturer software

Control System upgrade – goal for 2024

- We decided to go for Alma9
- For now – python3.9
- First step – migrate non-Tango machines (infrastructure, services…)
- Started repo and CI/CD refactoring – to support two OS
- Building main Tango packages and dependencies
- All new DS deployments should already be on Alma9 VMs
- Slowly migrating existing Tango VMs
- Finally migrating workstation machines
- Migration Windows machines to Windows 11 – mainly IT

Prepare tests for archiving + Zordon

Zordon is service to run automatic system tests in SOLARIS

Reasons to add archiving to Zordon

- Check if data is continuously collected (based on archive period events)
- Check health of databases
- Check health of Event Subscribers
- Check storage left on the VMs

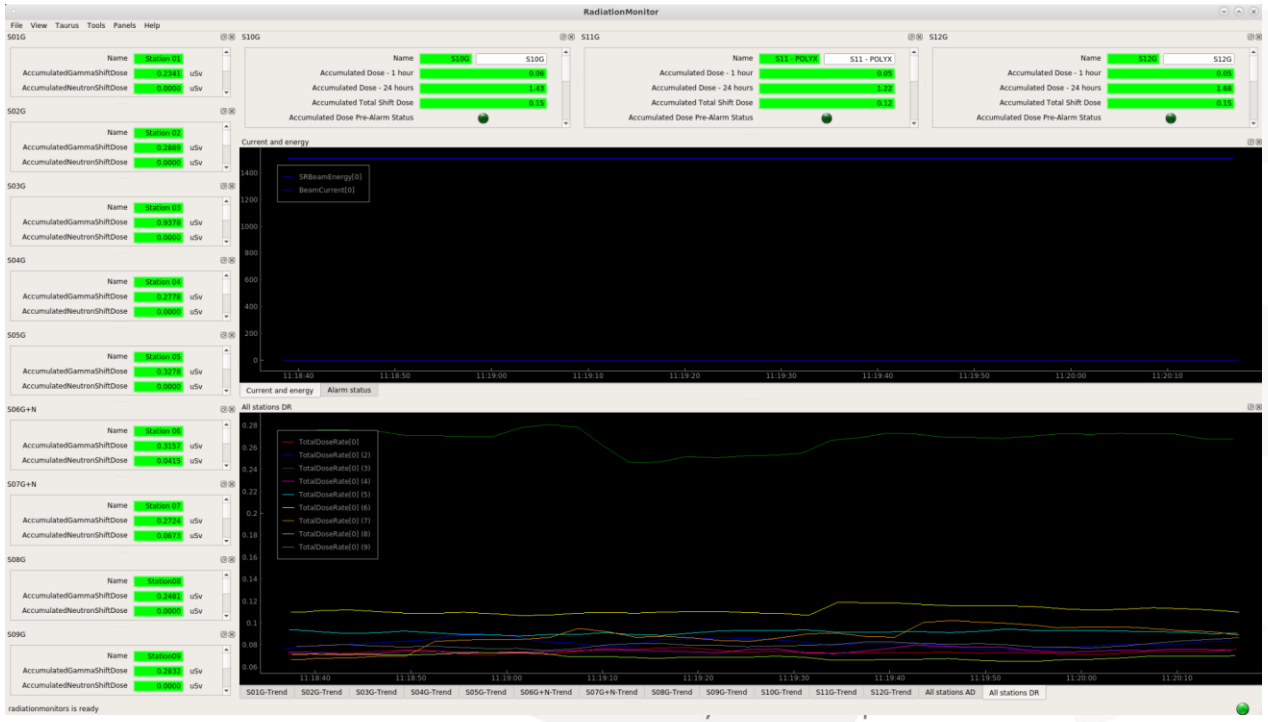
Move apps to web

Already deployed:

- Web Panic (machine)
- Interlocks (machine)
- Radiation monitor

Future applications:

- State Grid (during development – see Joanna Wajda presentation tomorrow)
- Overview of the system (state of valves, shutters, vacuum subsystem, temperatures
- Interlocks (beamlines)
- Web Panic (beamlines)



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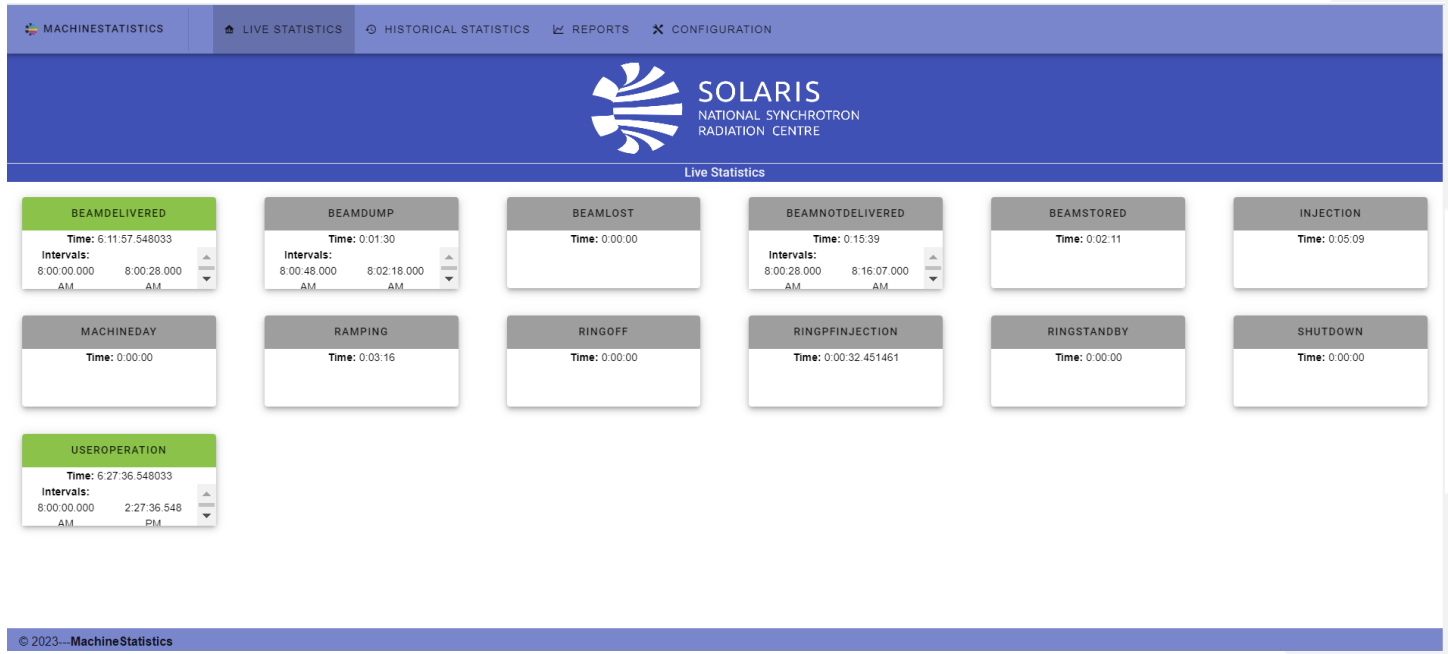
Machine Statistics

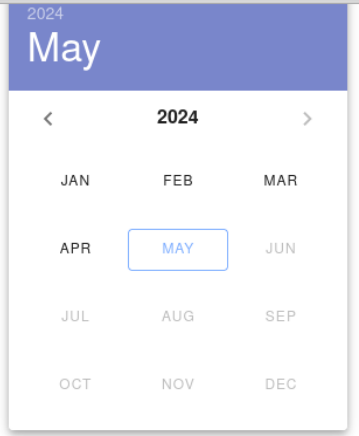


- Web Application to automatically calculate statistics of the machine (e.g. failures)
- Based on the archiving, facadedevice, FastAPI, Vue.js, Celery and PostgreSQL
- Deployed to production on May
- Older data are acquired from archiving only
- Current data are acquired both from archiving and facadedevice and cross-validation is being made
- Users can modify statistics by hand
- In latest release there was operation calendar added (mostly for operators convienience but in the future it should be used by SUN<DUO> and new statistics calculation)

Machine Statistics

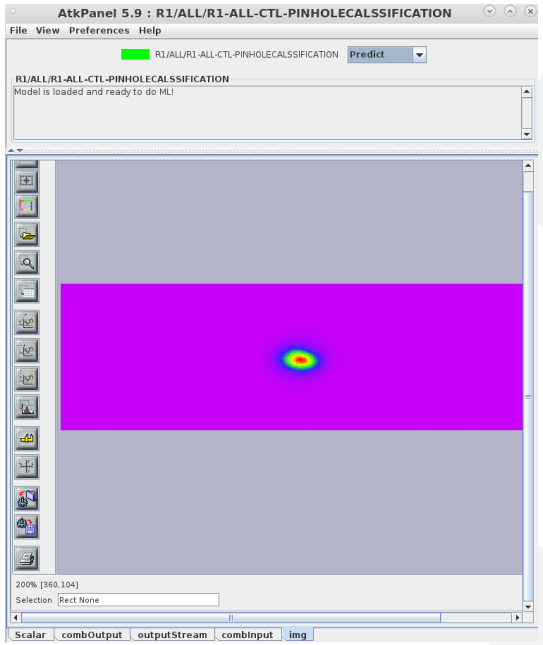
NUMBER OF DAYS	7	SCHEDULED TIME	7 days 0h 00min 00s
MACHINE FAILS TOTAL	5	MACHINE FAILS WITH BEAM LOST	5
FAILURES DOWN TIME	3 days 15h 29min 22s	TOTAL DOWNTIME	3 days 20h 13min 39s
EXTRA DURATION	5h 15min 35s	MTBF	1 day 9h 36min 00s
MTTR	17h 29min 52s	DAILY FAILS	0.71
UPTIME	47.92%	FAIL TIME TO TOTAL DOWNTIME	94.86%

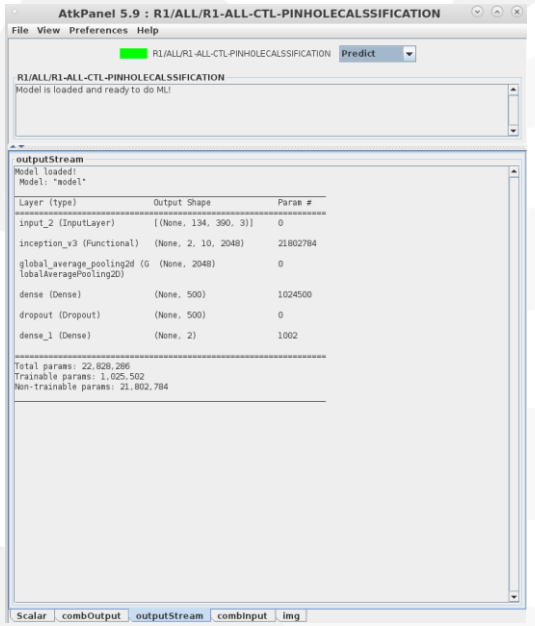
RECALCULATE

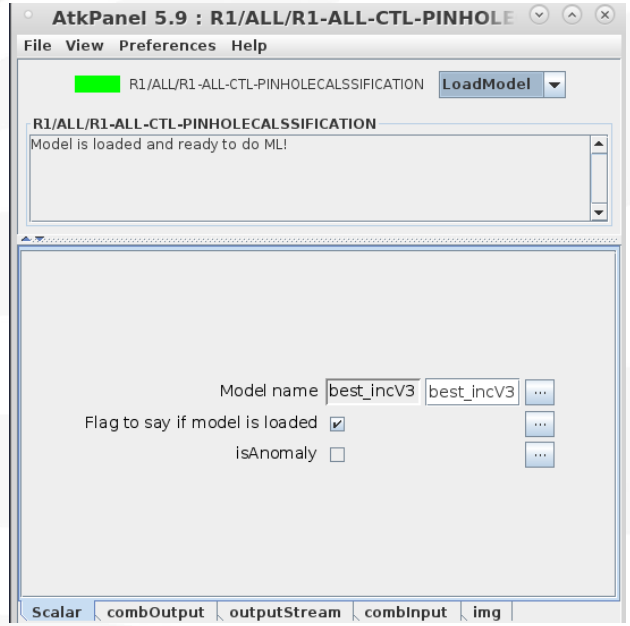


MLWorker - PoC

- PoC of generic DS to run ML models
- Supports TF models saved in hdf5
- MLWorker Class implementing basic interface
- Two instances:
  - Pinhole anomaly prediction
  - ID correction tables generation
- TODO
  - Pytorch
  - Online training







Device properties [R1/ALL/R1-ALL-MLIDCORR05ID]

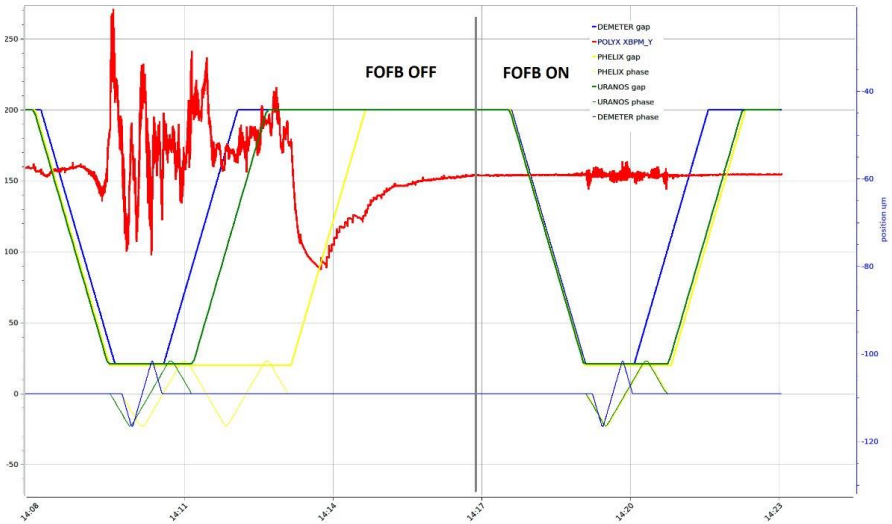
Property name	Value
idcou_device	
InputAttributes	R1-05S/MAG/R1-05S-MAG-IDU1/CC1_Current R1-05S/MAG/R1-05S-MAG-IDU1/CC2_Current R1-05S/MAG/R1-05S-MAG-IDU1/CC3_Current R1-05S/MAG/R1-05S-MAG-IDU1/CC4_Current
input_len_prop	4000
log_len	1000
model_location	/opt/mlworker/models
save_location	/opt/mlworker/outputs

```
@command
def Predict(self) -> None:
    """
    **MLWorker API**. Override is MANDATORY!
    Called to predict on the model.
    Default implementation raises :exc:`NotImplementedError`
    """
    raise NotImplementedError("Predict must be defined!")
```

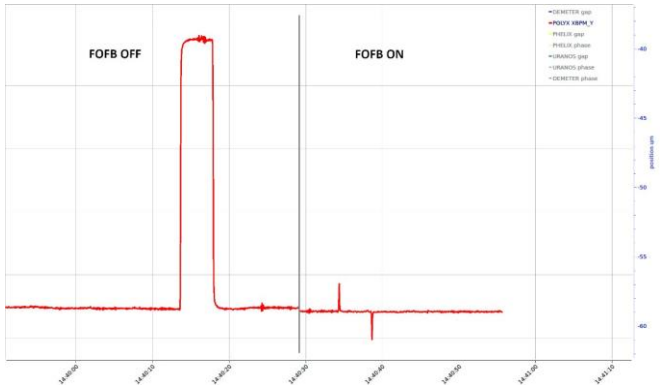
Orbit Correction Upgrade

- Performed in cooperation with Operators and with help of MAX IV Team (big thanks especially to Áureo Freitas and Magnus Sjöström!)
- New SlowOrbitFeedback (Tango DS) redesigned and runs 10x faster
- FastOrbitFeedback (i-Tech Libera) fine-tuned (PI coefficients, setpoint update (golden orbit), …)
- An offloading procedure was introduced and fine-tuned to eliminate the mutual conflict between both correction systems
- Introduced RF compensation, some enhancements like correction deadband, auto off, etc.
- A significant improvement in the stability of the electron beam was achieved

Orbit Correction Upgrade

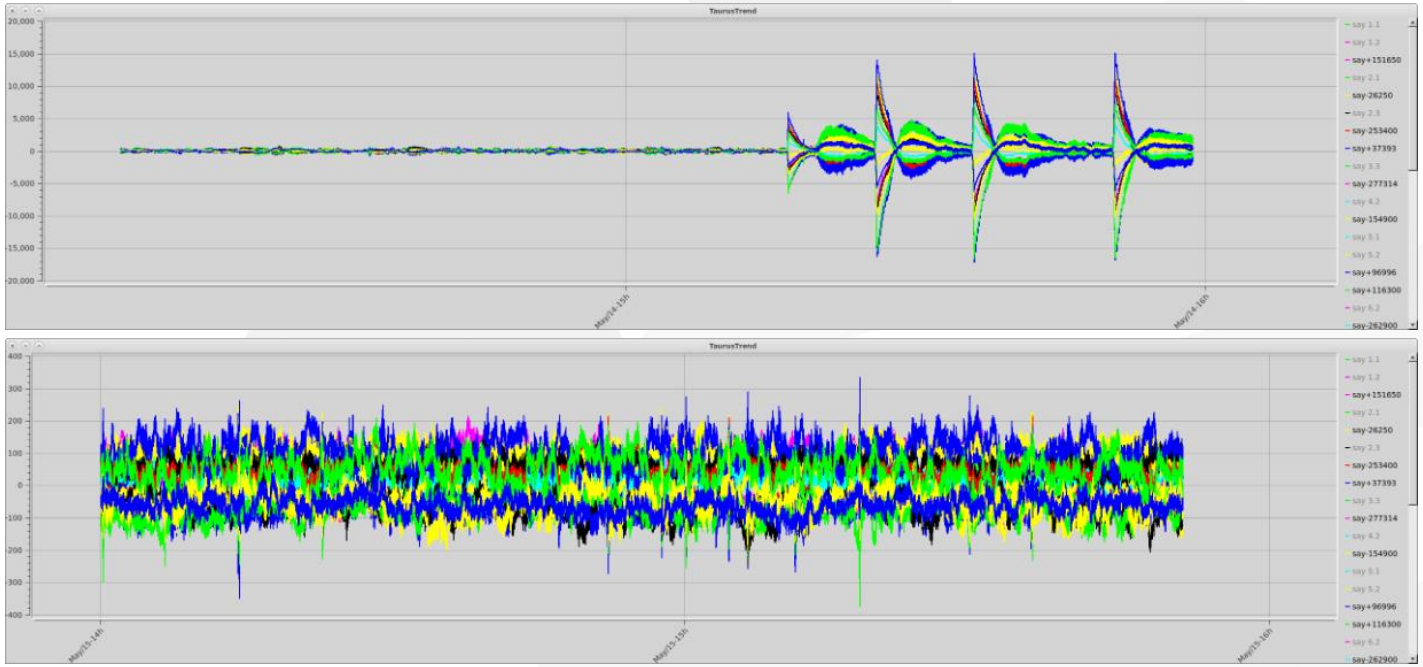


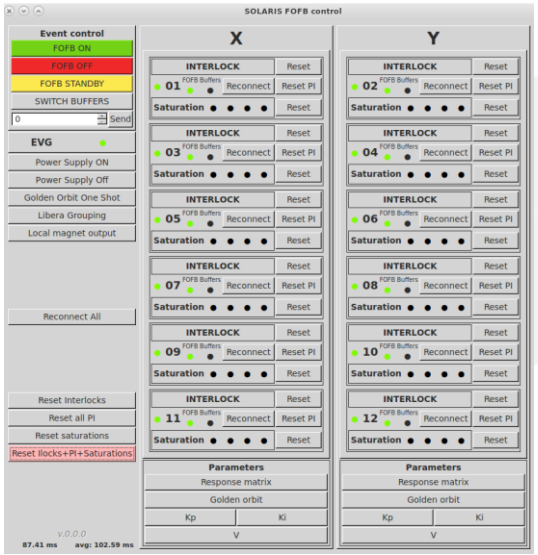
ID's impact compensation

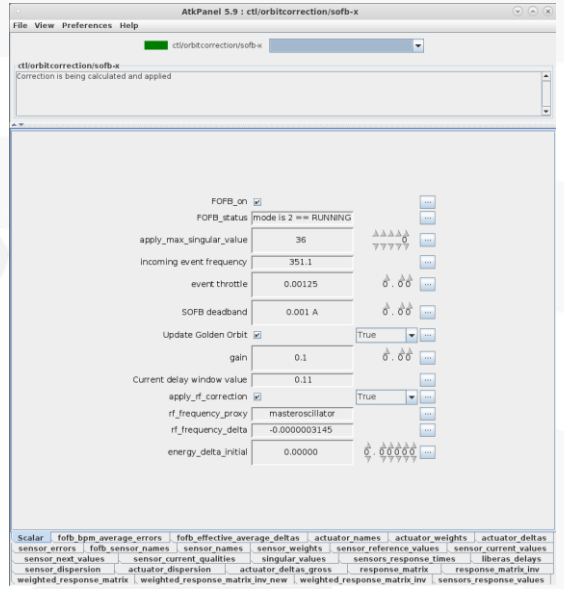


FOFB OFF/ON response for corrector kick

BPMs signals FOFB OFF and ON (below) (scale in nm)

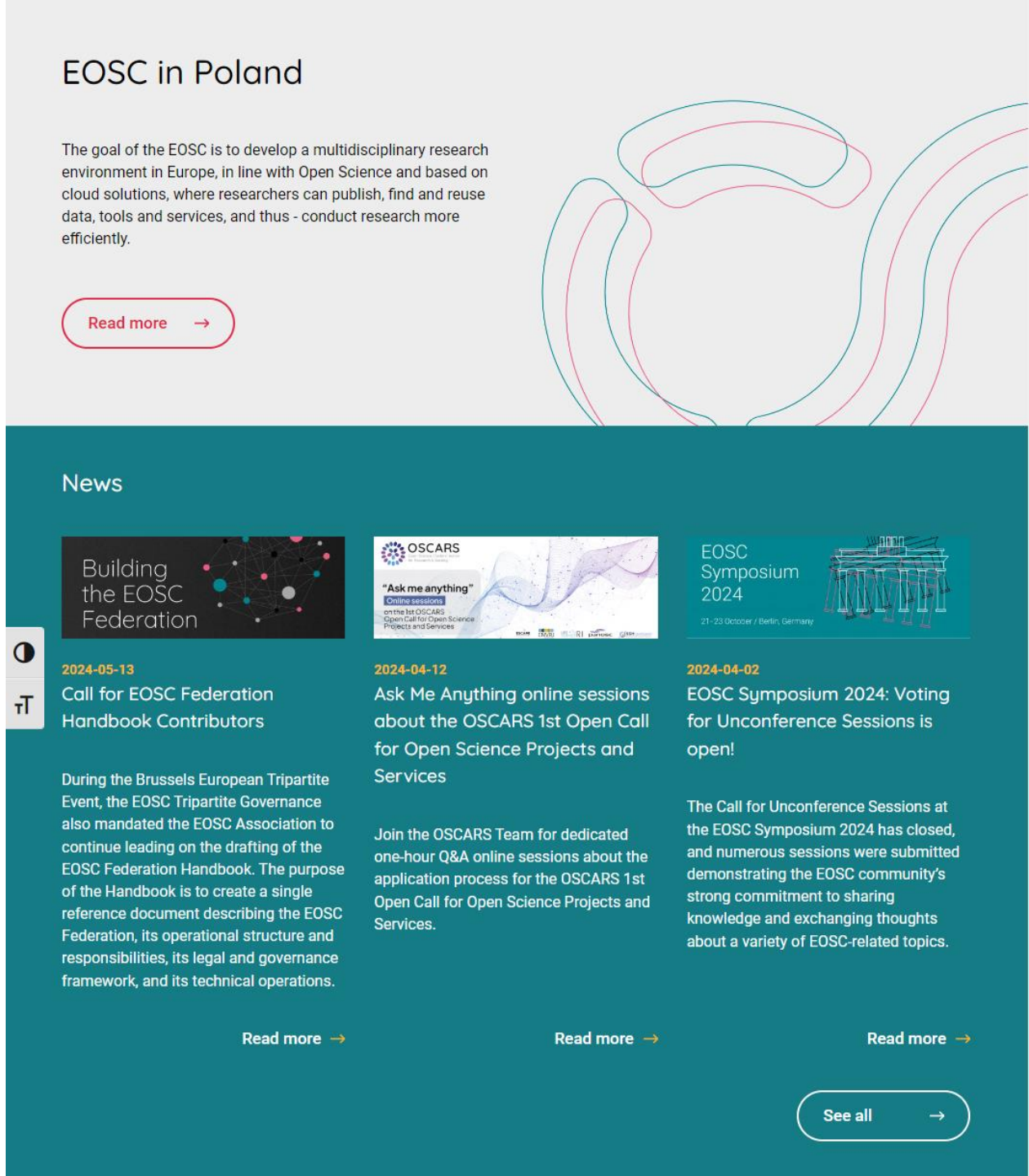


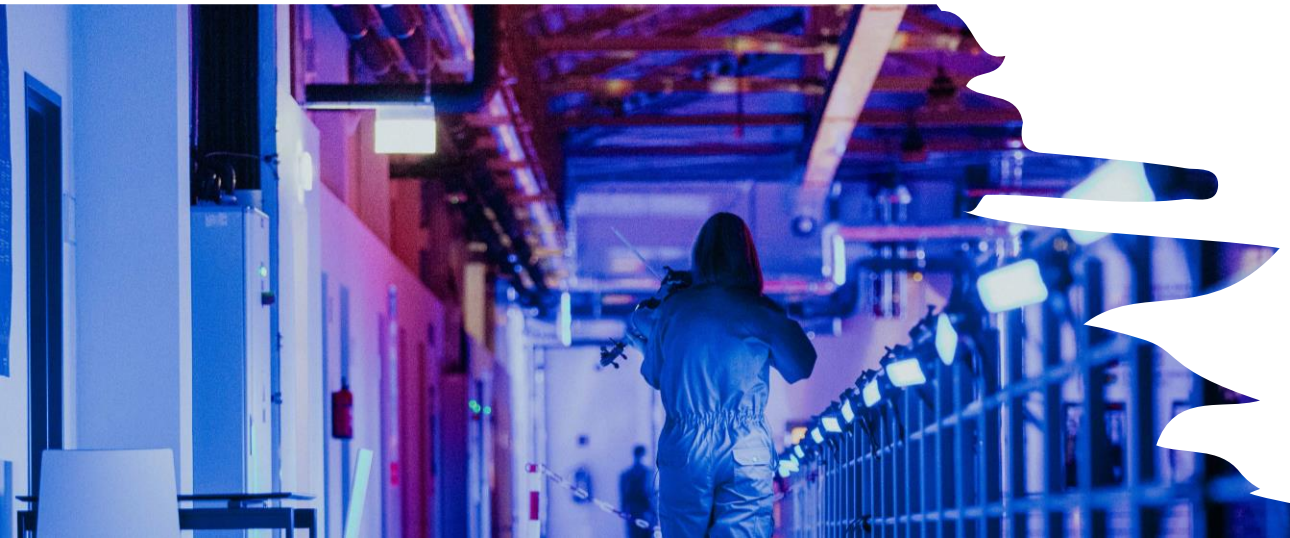




Data Management/ Open Data

- Jagiellonian University has implemented an open data policy for its employees
- SOLARIS users rely solely on the regulations of their research centers or universities – no open data policy for them
- no open source policy for JU employees and SOLARIS users
- preparation to implement open data policy at SOLARIS
- just applied for OSCARS funding
- plans: gain knowledge, create policies, train users, prepare resources for data long-term storage, hire a data steward responsible for proper data management





Fun Fact: SOLARIS by Stary Theater in Kraków

Thank you!

Questions?