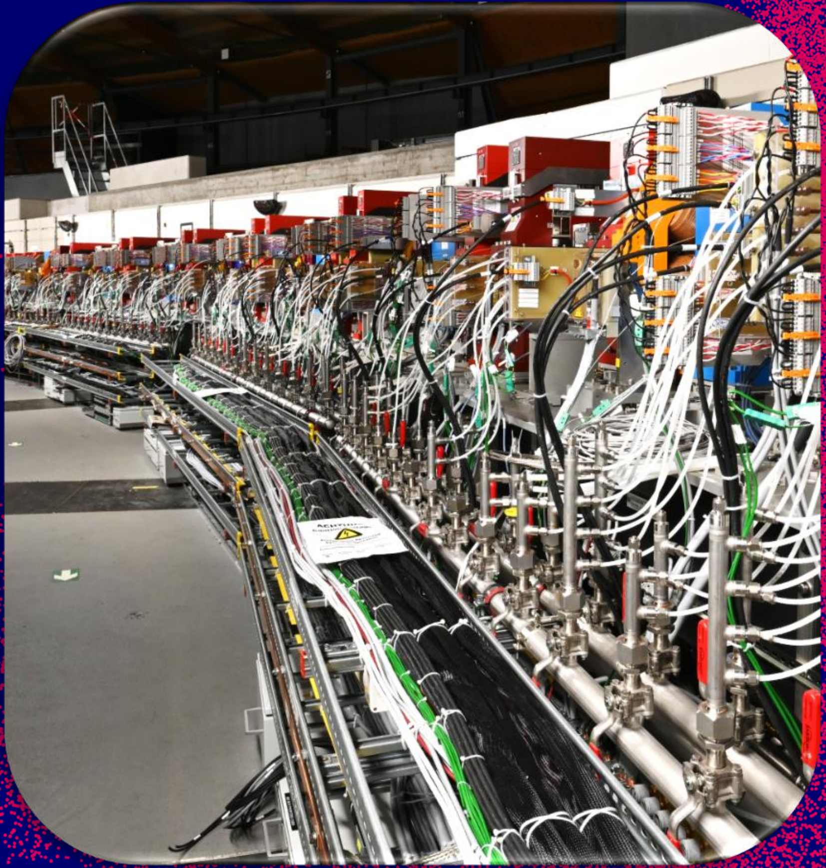
Welcome to PSI

23^{rd} IMMW Workshop
9.10.2024



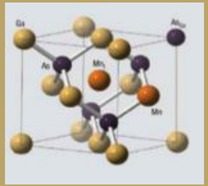
- Hans-H. Braun

Paul Scherrer Institut

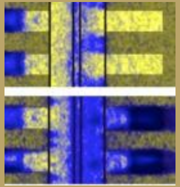
Paul Scherrer Institut – Mission

PAUL SCHERRER INSTITUT PSI

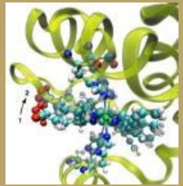
Matter and materials



Energy and environment



Human health



Development
Construction
Operation

Large research facilities

Swiss and foreign users from academia and industry

more that 2400 external users/year (38 beamports)

Knowledge & expertise

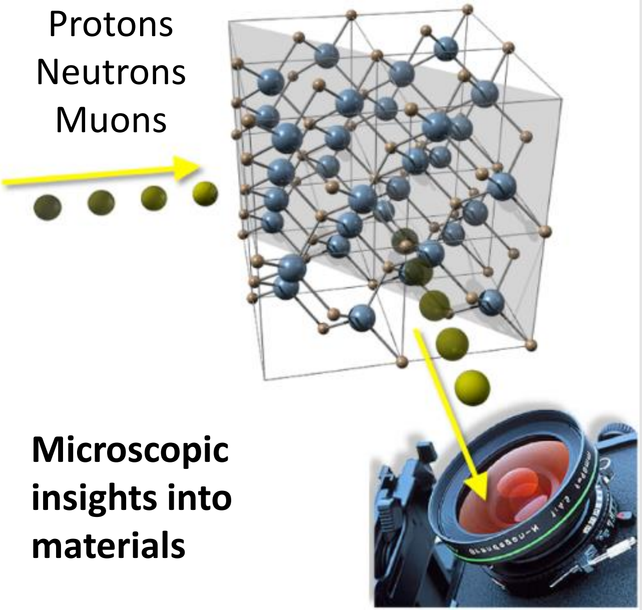
Education

Technology transfer

Large Research Facilities at PSI

Research at large facilities

Photons
Protons
Neutrons
Muons



Microscopic insights into materials

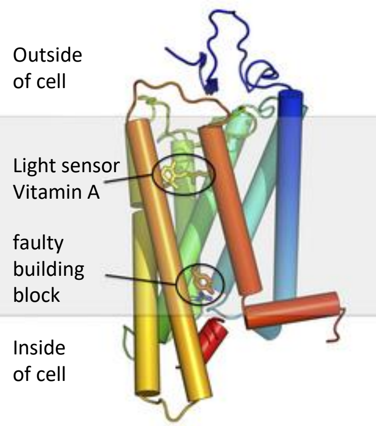
Synchrotron Light Source SLS

Spallation Neutron Source SINQ

Muon Source SμS

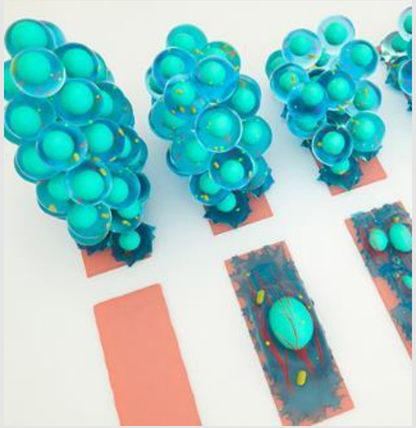
Free Electron Laser SwissFEL

Biology and Health at PSI



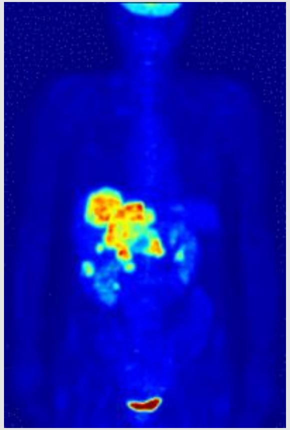
Structure of Proteins for the targeted development of new drugs
Prof. G. Schertler
Prof. M. Steinmetz

⇒ Accelerators: SwissFEL, SLS



Nanoscale biology of molecular structure and dynamics in the living cell
Prof. G. Shivashankar,
Prof. J.P. Abrahams

⇒ Detectors: EM



Radio Pharmaceuticals for the diagnosis and therapy of tumours
Prof. R. Schibli, Dr. R. Eichler

⇒ Accelerators: HIPA, SINQ
⇒ Isotopes, Radiochemistry, CRS

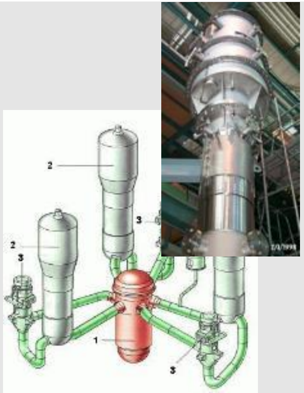
Proton Therapy for destruction of tumours and protection of healthy tissue
Prof. D. Weber

⇒ Accelerators: COMET

Energy research

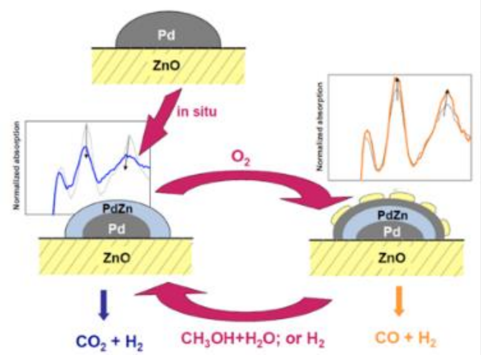
Nuclear safety

Understanding processes, monitoring materials ageing

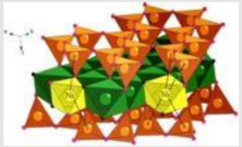


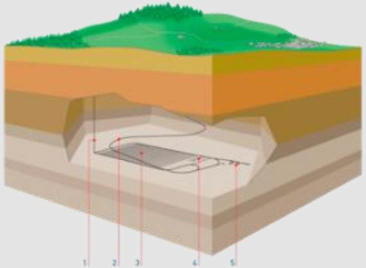
Catalysis

Understanding and better use of catalytical reactions



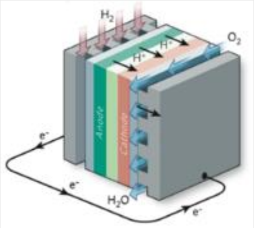
Deep geological disposal



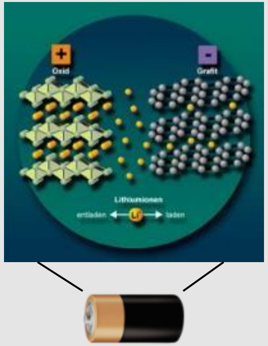


Understanding of interactions radionuclides and rocks/minerals

Electrochemistry



Fuel cells



More efficient batteries

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Scientific Computing, Theory, and Data and Quantum Technologies

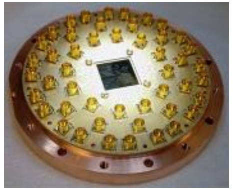
New research division of PSI since 2021

Large-scale simulations, modeling, and data science became an integral part of nearly all fundamental and applied science projects.

- **Computational material science, chemistry and biology are a huge opportunity** and Switzerland is leading in these areas.
- **Data infrastructure** and (open) **data management** are key to science success.
- **Machine Learning/AI** and **Quantum Computing** are new, disruptive technologies.

EPFL

ETH zürich



SDSC

CSCS

MARVEL

NATIONAL CENTRE OF COMPETENCE IN RESEARCH

Switzerland Innovation Network

SWITZERLAND INNOVATION
PARK INNOVAARE

Park Innovaare Residents Today

PSI · anaxam · RENAISSANCE FUSION · pic · XRnanotech · Universallab · SENSIC · nami · ASTRA · EXPOSE · Datalystica · leadxpro · HEIQ · esa · VDL · Excelsus Structural Solutions · GRATXRAY · PiBond · cross-ING

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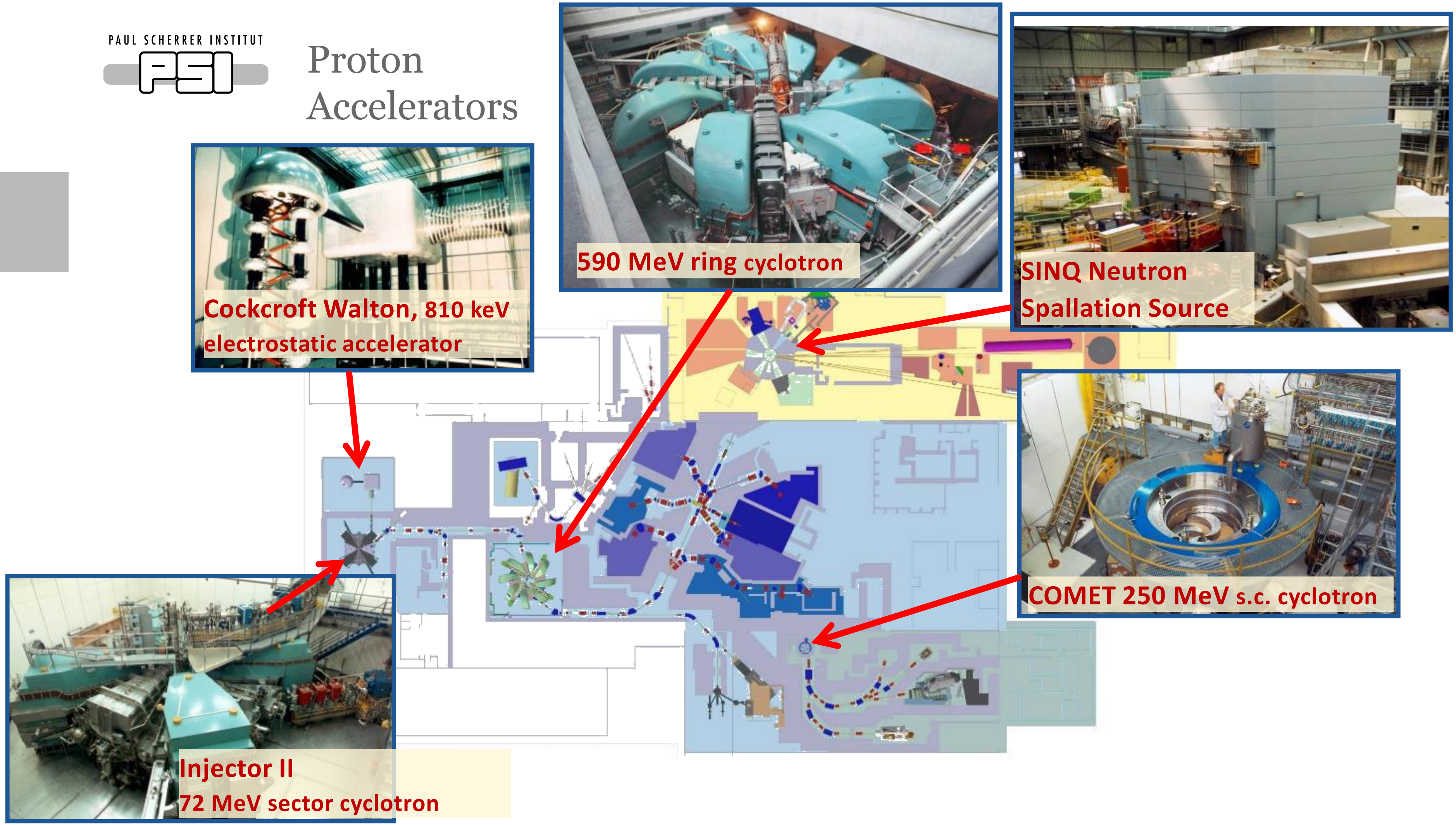
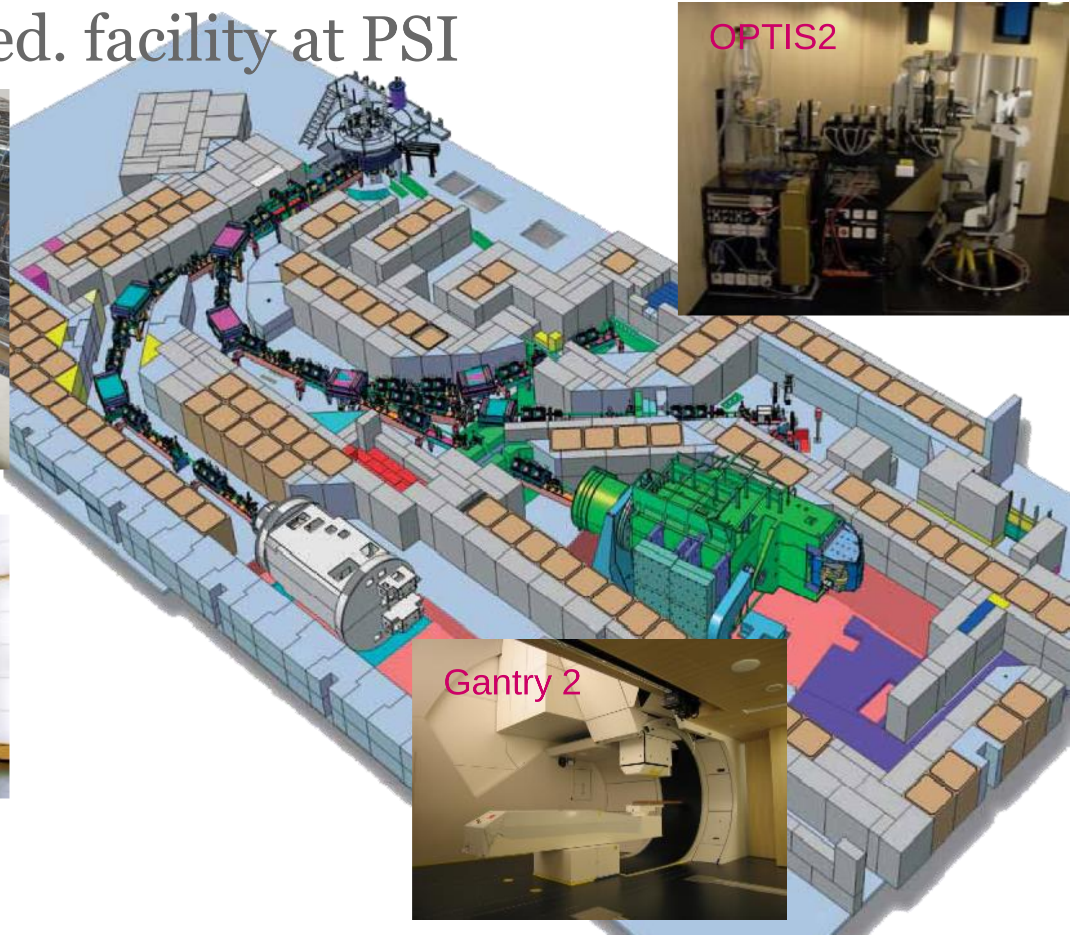
PSI

Proton Accelerators

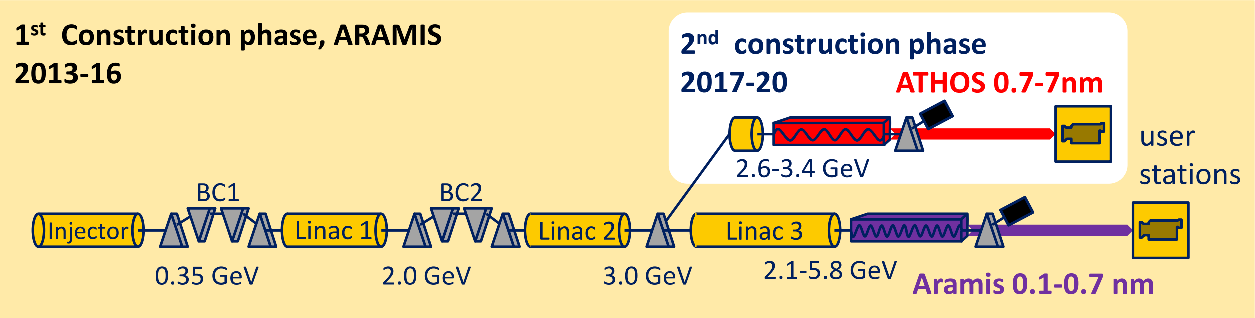


PROScan med. facility at PSI



SwissFEL

SwissFEL in a nutshell



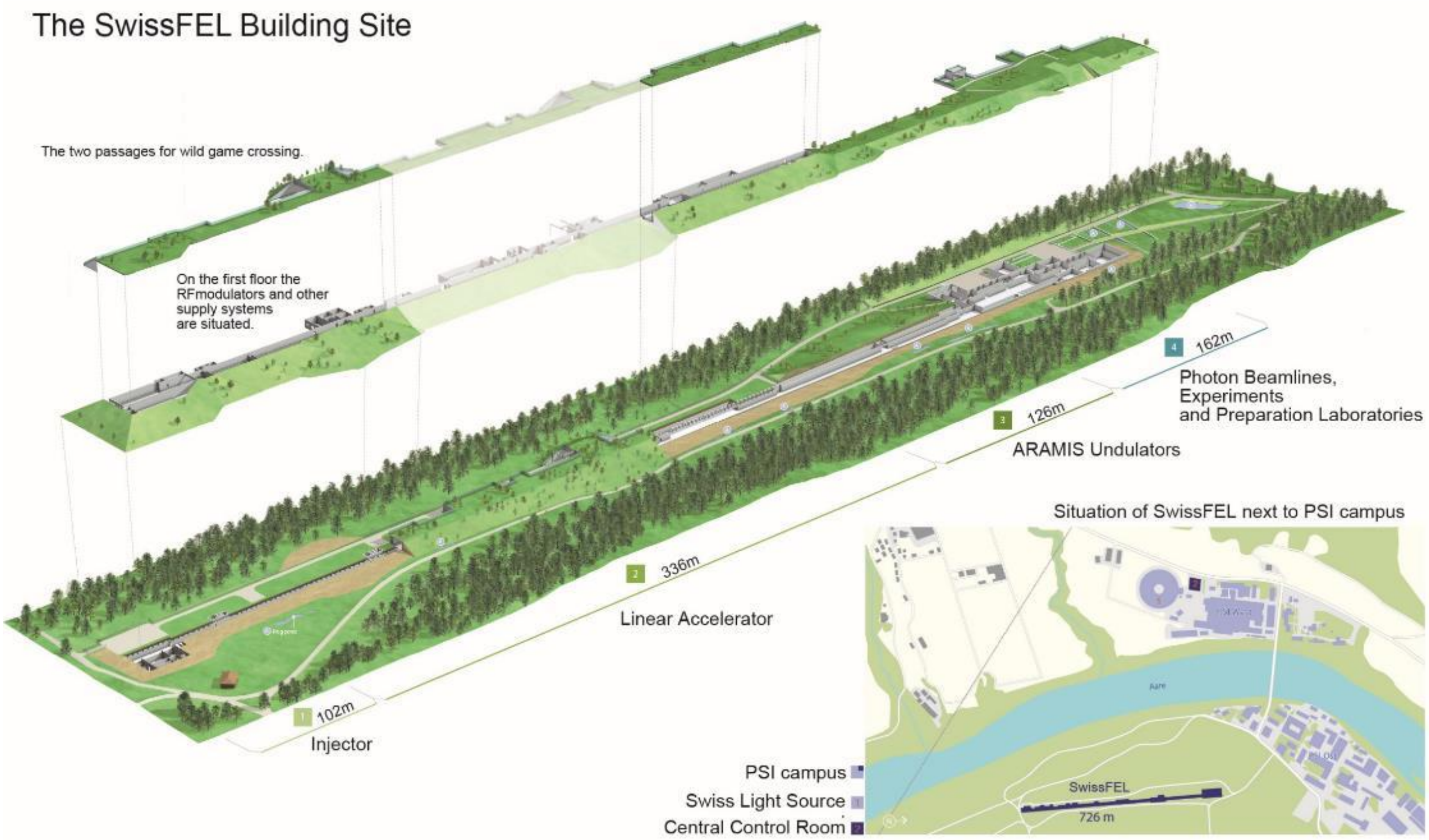
ARAMIS
Hard X-ray FEL, λ = 0.1-0.7 nm
Linear polarization, variable gap, in-vacuum undulators
First users 2017

ATHOS
Soft X-ray FEL, λ = 0.7-7.0 nm
Variable polarization, Apple II undulators
First users 2020

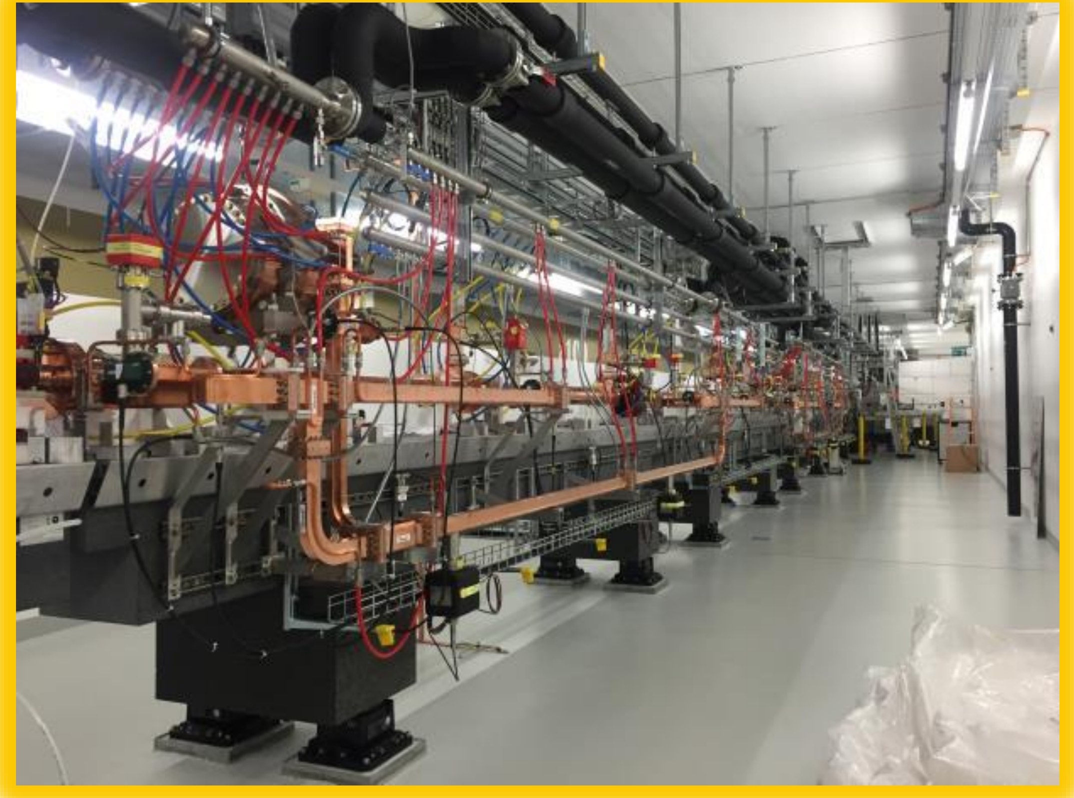
Main parameters

Wavelength from	1 Å - 70 Å
Photon energy	0.2-12 keV
Pulse duration	1 fs - 20 fs
e^- Energy	5.8 GeV
e^- Bunch charge	10-200 pC
Repetition rate	100 Hz

SwissFEL


The SwissFEL Building Site
The two passages for wild game crossing.
On the first floor the RFmodulators and other supply systems are situated.
4 162m
Photon Beamlines, Experiments and Preparation Laboratories
3 126m
ARAMIS Undulators
2 336m
Linear Accelerator
1 102m
Injector
Situation of SwissFEL next to PSI campus
PSI campus
Swiss Light Source
Central Control Room
SwissFEL
726 m

SwissFEL 6 GeV Linac



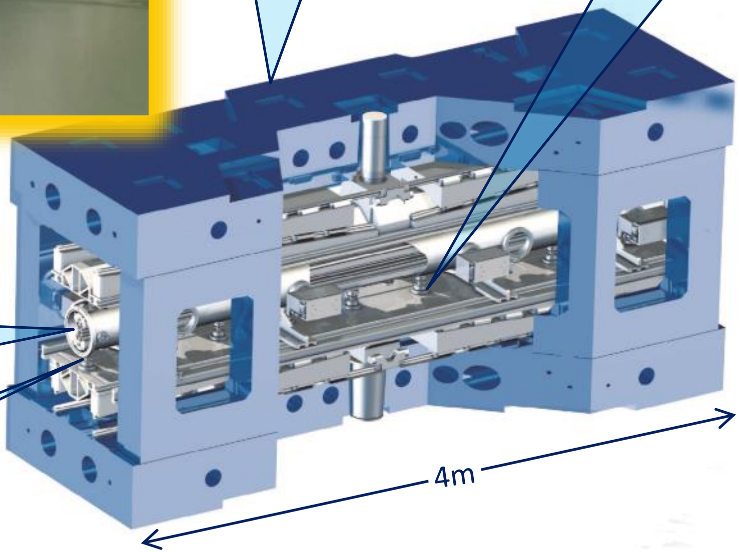
SwissFEL ARAMIS

U15 undulator

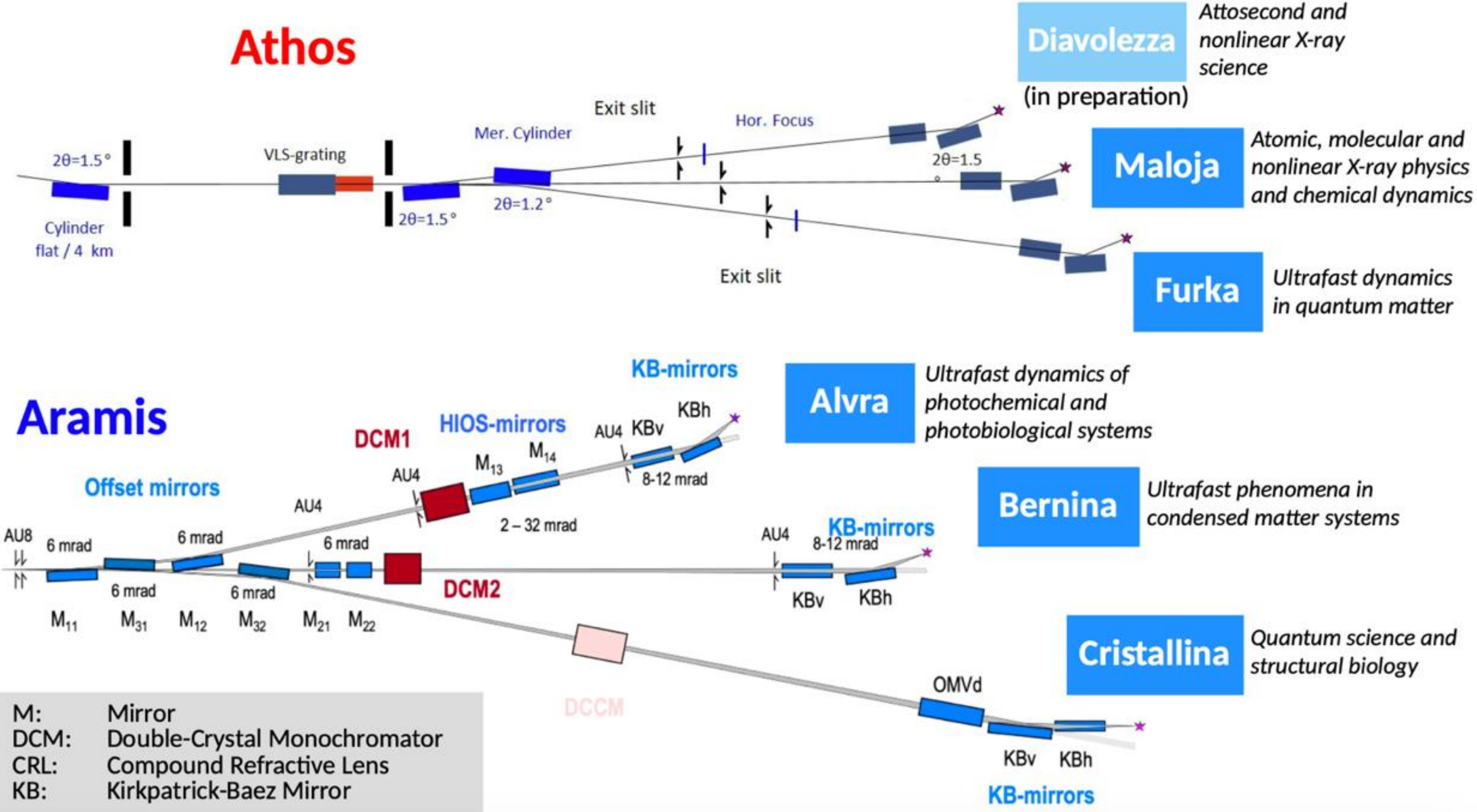
nominal working point

- λ_U=15 mm
- K=1.2
- g=4.5mm

ARAMIS FEL consists of 13 x U15



SwissFEL beamlines



M:	Mirror
DCM:	Double-Crystal Monochromator
CRL:	Compound Refractive Lens
KB:	Kirkpatrick-Baez Mirror

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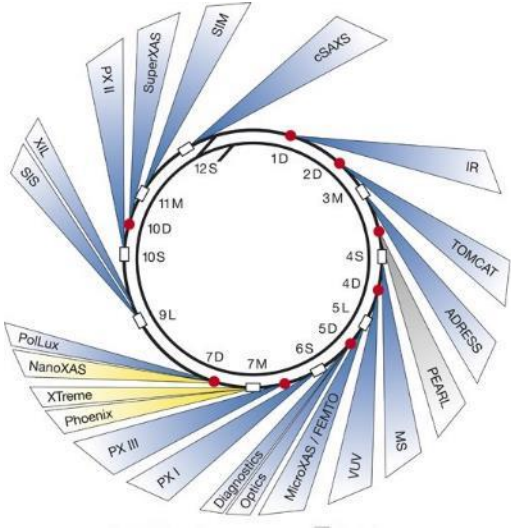
SLS

Swiss Light Source, SLS

Since 2000 in operation as synchrotron radiation source for 18 user beamlines

Now SLS → SLS 2.0

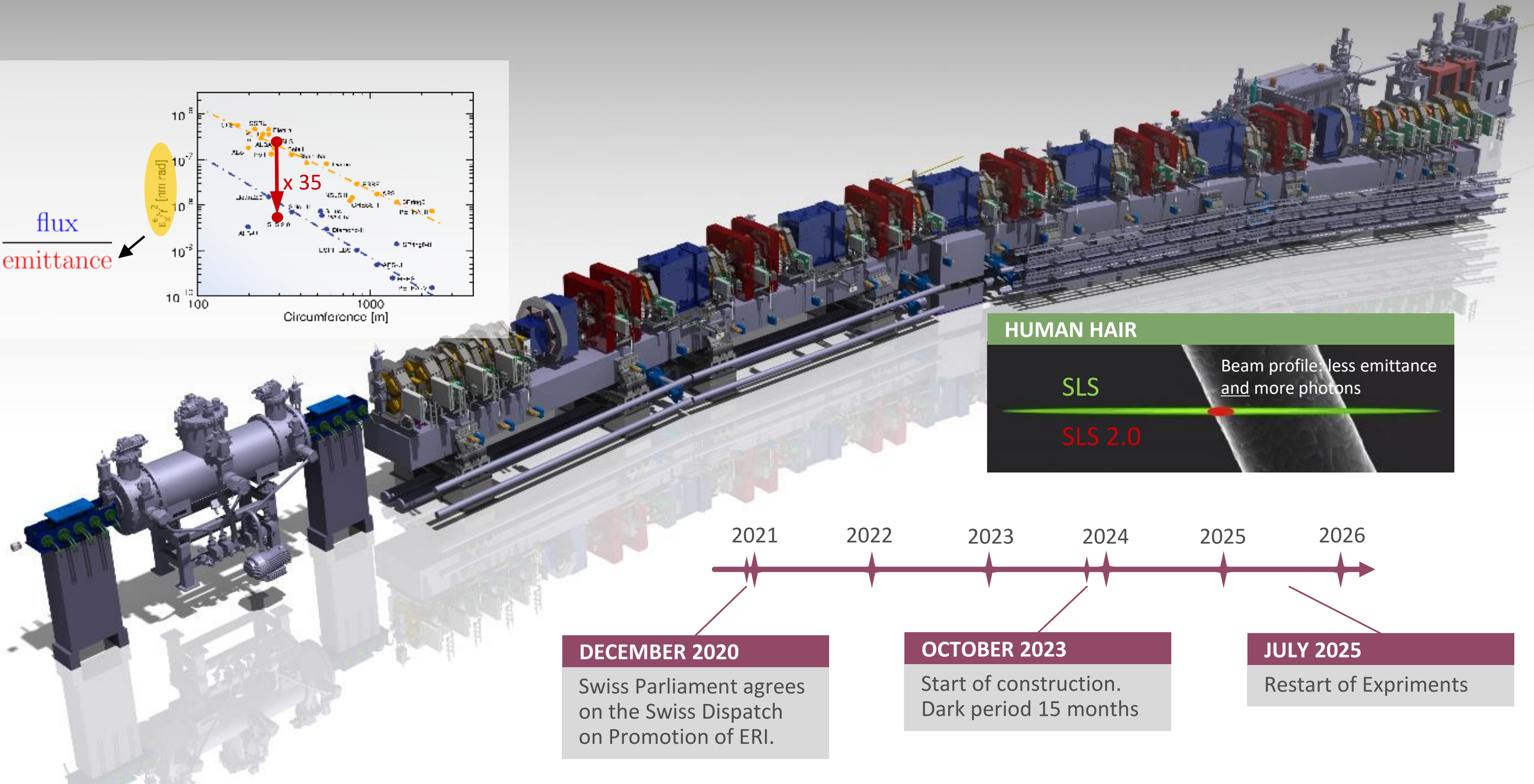


SLS 2.0: The success story continues

PSI

$$\mathcal{B} = \frac{\text{flux}}{\text{emittance}}$$

Brilliance



2021 | 2022 | 2023 | 2024 | 2025 | 2026

DECEMBER 2020

Swiss Parliament agrees on the Swiss Dispatch on Promotion of ERI.

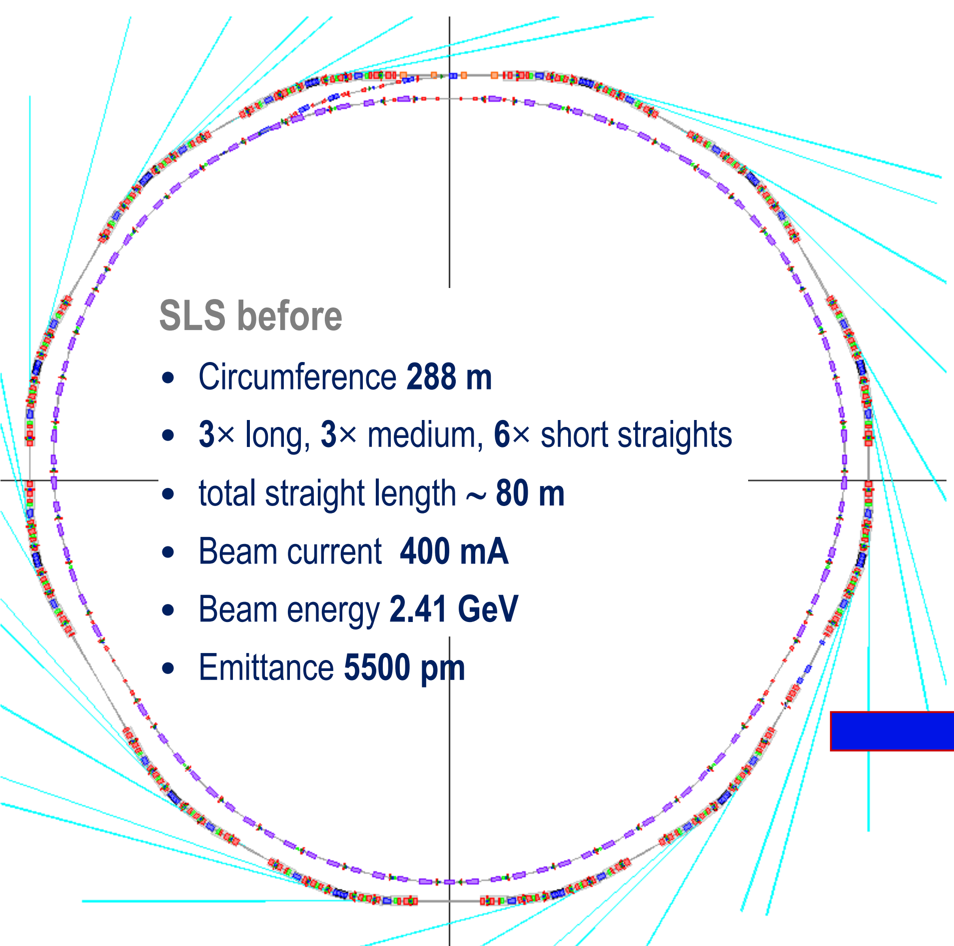
OCTOBER 2023

Start of construction. Dark period 15 months

JULY 2025

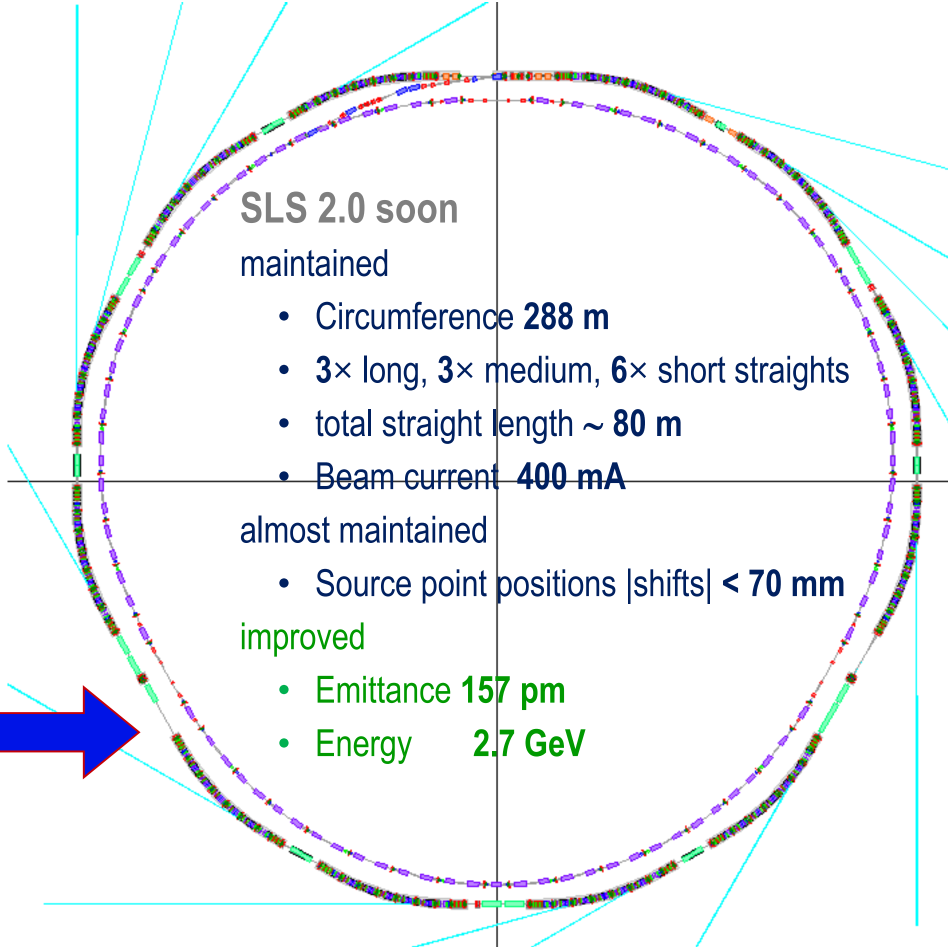
Restart of Expriments

SLS → SLS 2.0



SLS before

- Circumference **288 m**
- **3**× long, **3**× medium, **6**× short straights
- total straight length ~ **80 m**
- Beam current **400 mA**
- Beam energy **2.41 GeV**
- Emittance **5500 pm**



SLS 2.0 soon

maintained

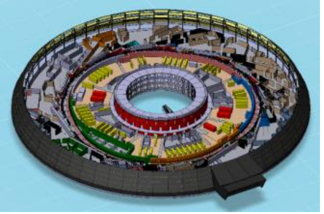
- Circumference **288 m**
- **3**× long, **3**× medium, **6**× short straights
- total straight length ~ **80 m**
- Beam current **400 mA**

almost maintained

- Source point positions |shifts| **< 70 mm**

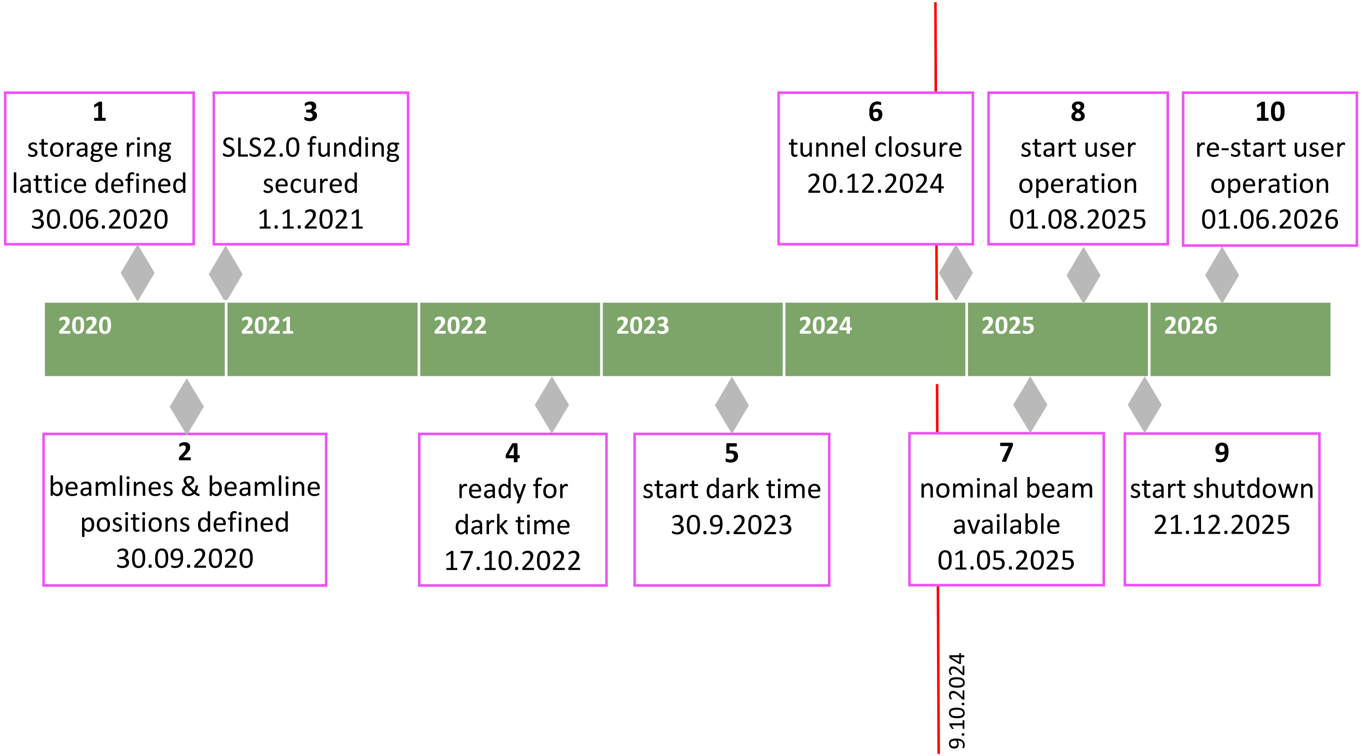
improved

- Emittance **157 pm**
- Energy **2.7 GeV**



SLS 2.0 – Milestones

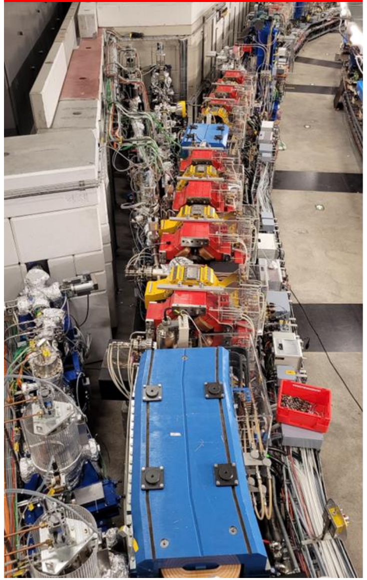
PSI



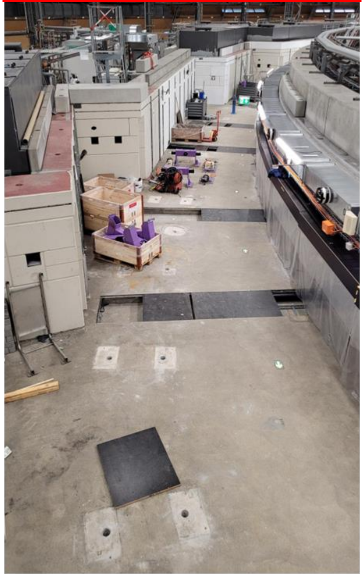
Evolution of SLS → SLS 2.0

PSI

3.10.2023



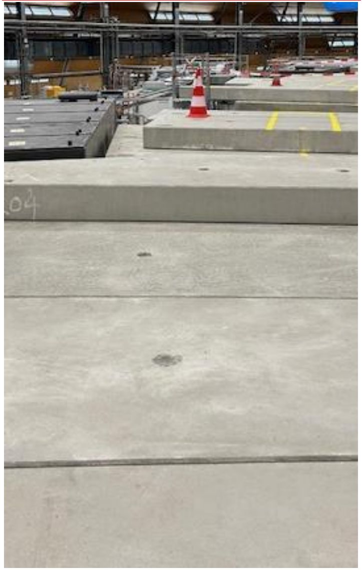
28.11.2023



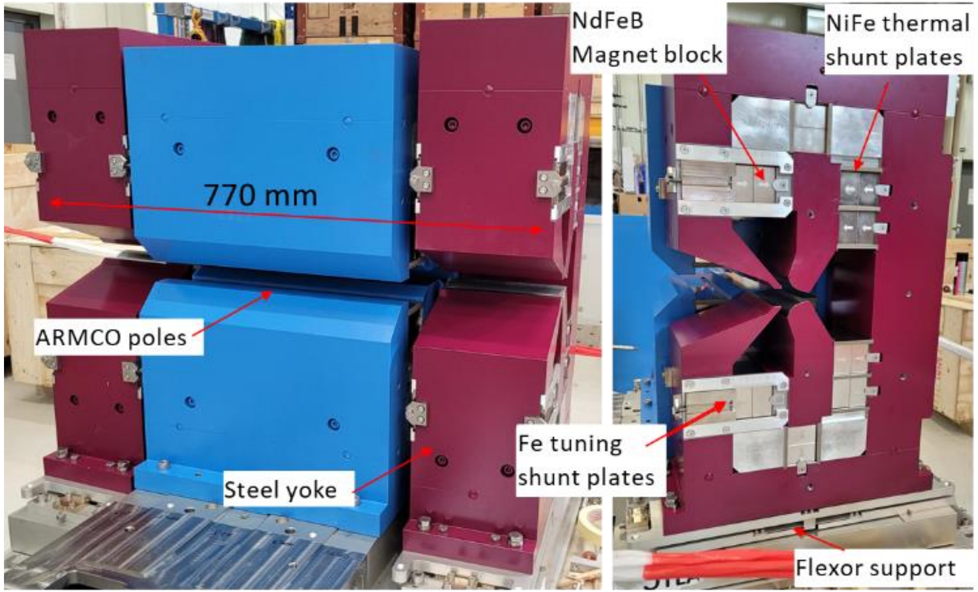
7.3.2024

1.7.2024

3.9.2024



SLS2.0 Triplet-Magnet VB-BN-VB



Central bend of MBA cell
60 in total, B_{center} = 1.35 T

Permanent Magnet

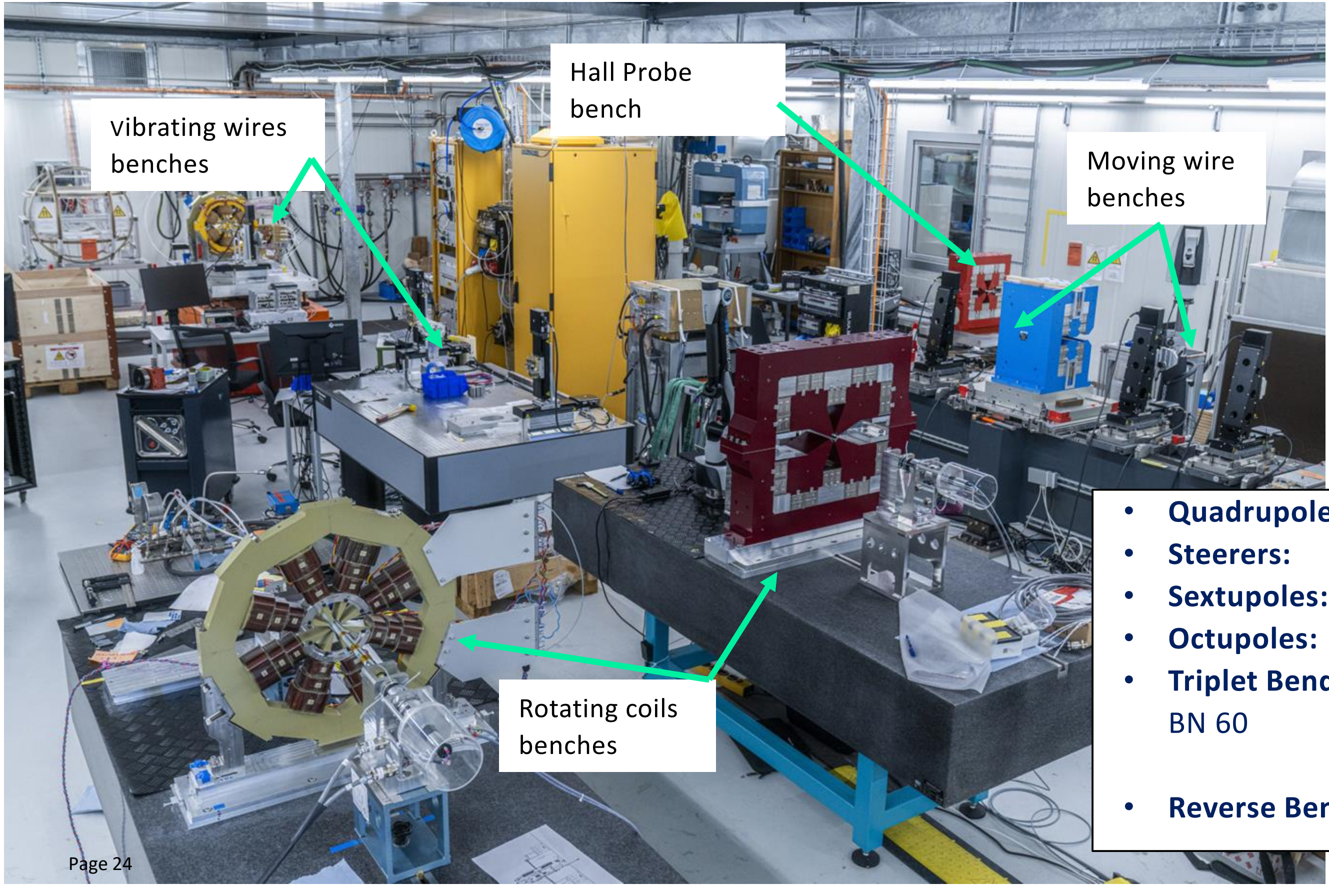
Pro and con

+ No power consumption
+ No power supply
+ No cooling water
+ Compact

– Field **AND** geometry to be measured and corrected with great precision
  B better 0.2 % , x,y,z better 20 µm
  at well defined temperature of 25°C

– No tuning knob in operation
  → ***No mistakes allowed!***

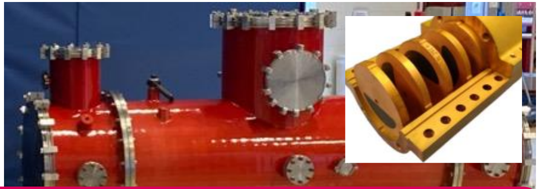
Magnet measurements



- **Quadrupole Series: 112**
- **Steerers: 117**
- **Sextupoles: 270**
- **Octupoles: 268**
- **Triplet Bending magnet: 60**
  BN 60 VB 120
- **Reverse Bends: 150 ready**

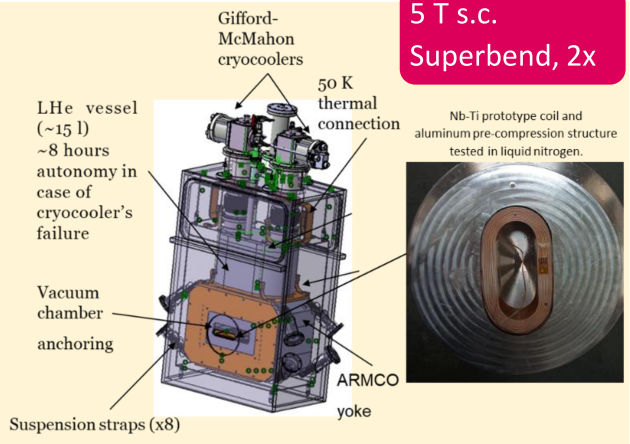
Undulators und Superbends, the SR sources

New developments
For optimum use of
SLS 2.0 beam

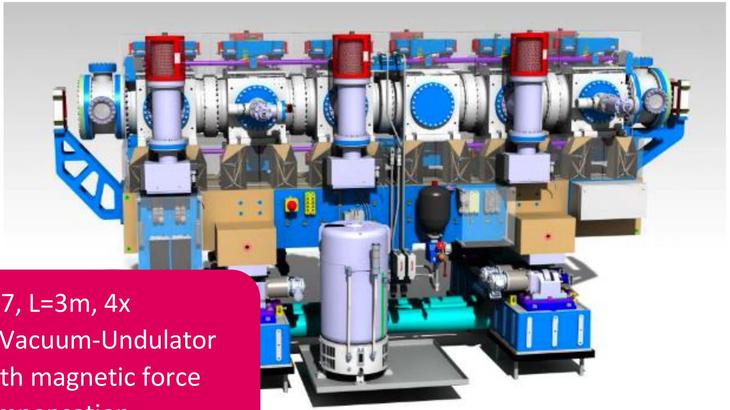


U10 HTS, B_{axis}=2 T, 4mm gap, L=1 m, 1x

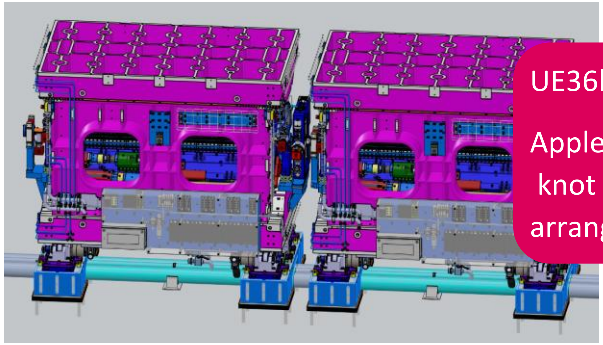
High Temperatur Bulk Superconductor



5 T s.c.
Superbend, 2x



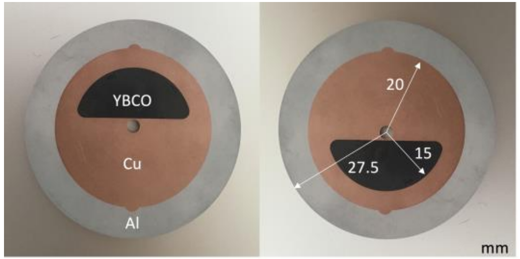
U17, L=3m, 4x
In-Vacuum-Undulator
With magnetic force
compensation

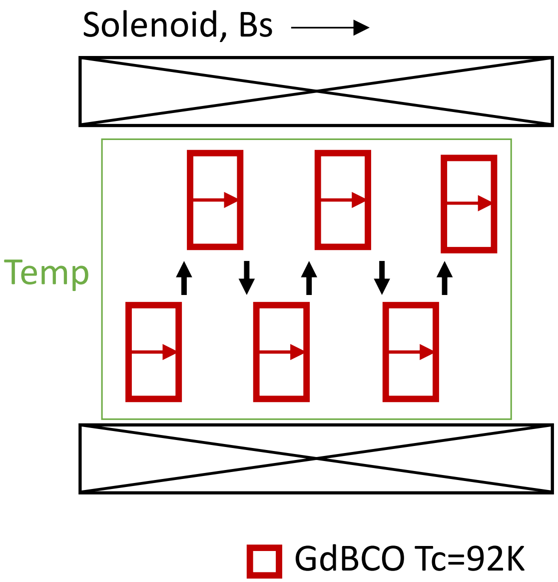


UE36kn, L=2 m

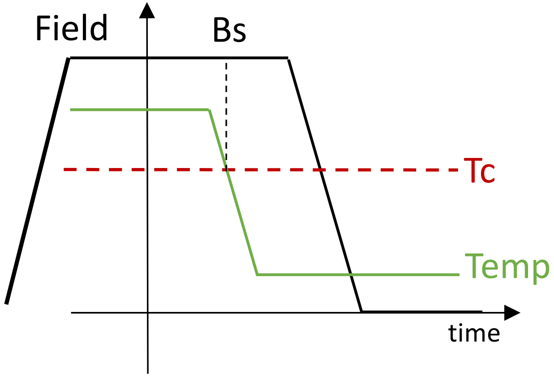
Apple-X, with
knot magnet
arrangement

U10HTS, Superconducting Staggered Array Undulator

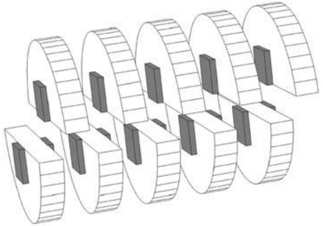




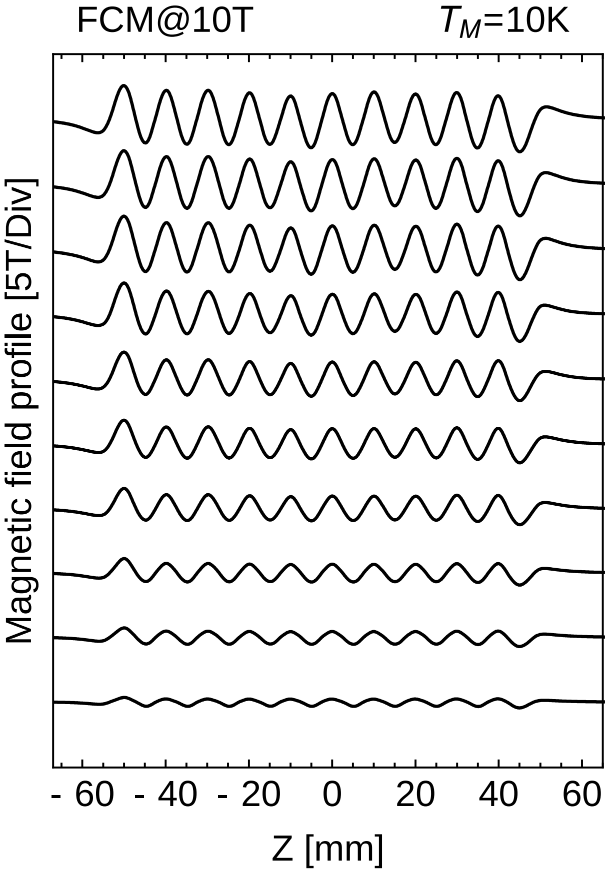
Example of *field cooling* magnetisation



T. Kii et al. AIP Conference Proceedings 1234, 539 (2010)



HTSPlanar Hybrid with CAN-HTS Blocks



SLS 2.0 Roof Renewal and Solar Panels

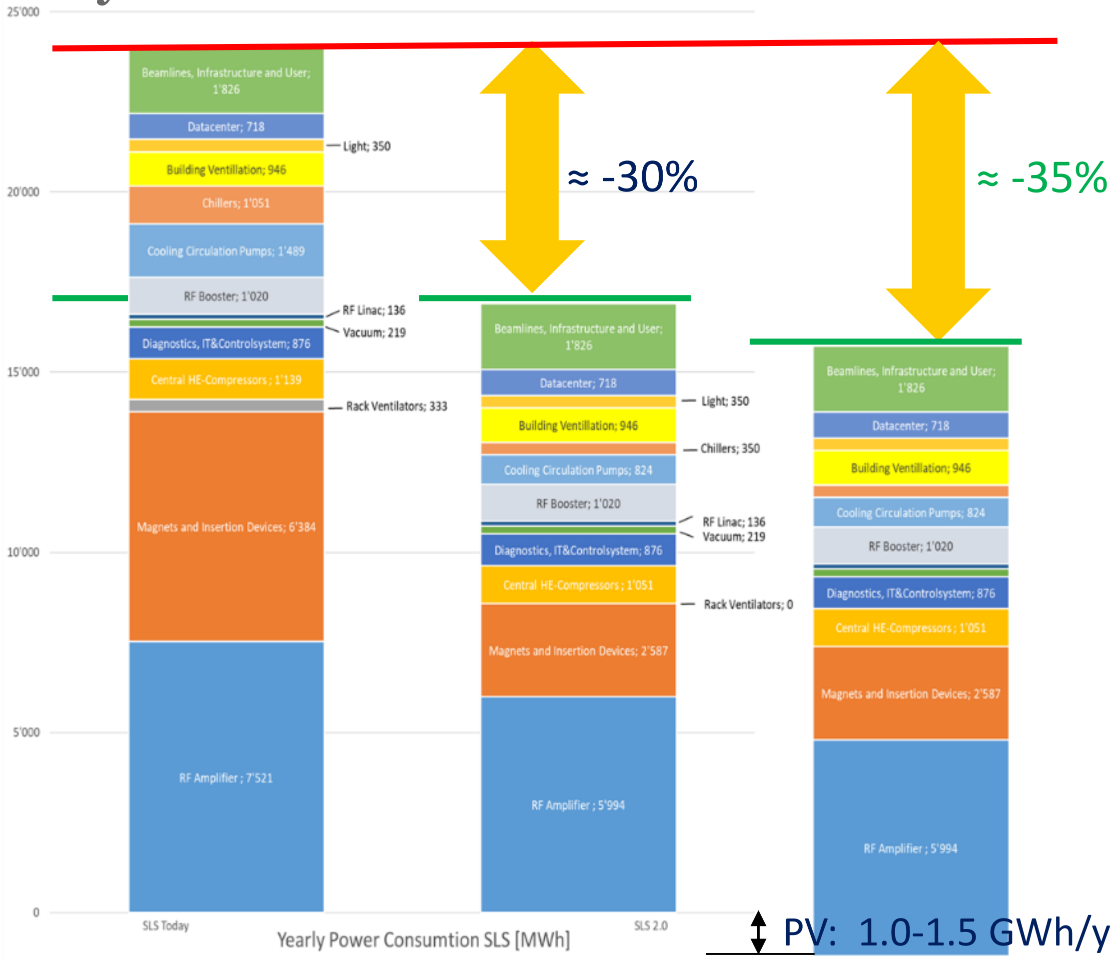
Power economy SLS2.0 vs. SLS incl. PV roof

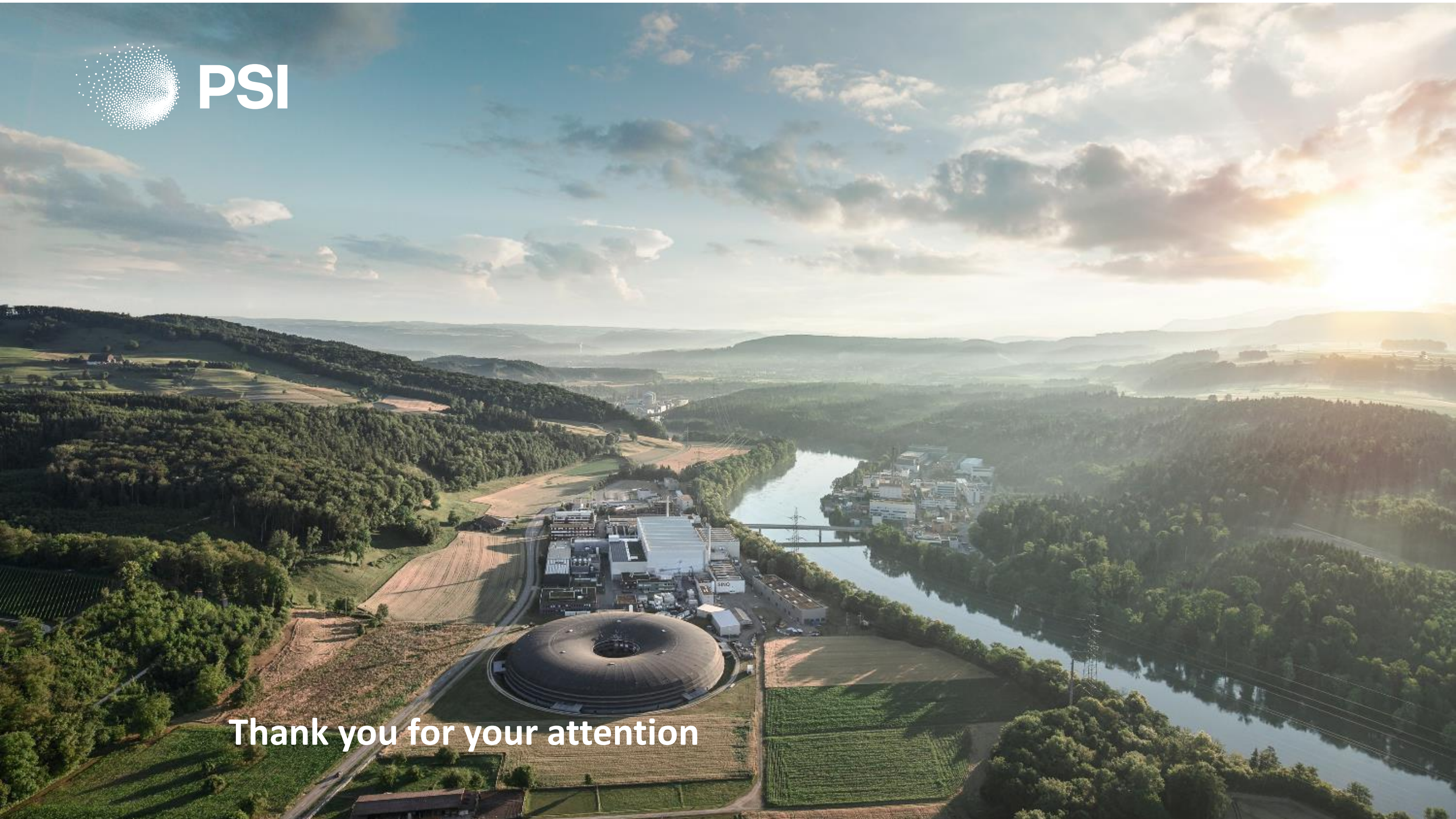
More radiated X-ray power for users
Less electricity consumption

	SLS → SLS2.0
E_{e^-}	2.4 GeV → 2.7 GeV
P_{SR}	310 kW → 365 kW
W_{elec}/y	24 GWh → 17 GWh
$W_{elec}-W_{PV}/y$	17 GWh → 15.5 GWh

Key savings:

Electromagnets → permanent magnets
Klystrons → solid state amplifiers
Standard pumps → regulated pumps for cooling
Tar paper roof → PV cladded roof





Thank you for your attention