Research Infrastructures through energy crisis

Mirjam van Daalen
PSI/LEAPS

https://leaps-initiative.eu/
LEAPS is the largest consortium of accelerator based photon sources worldwide and further expanding its service to an interdisciplinary European user community

19 facilities - 16 institutions - 10 countries

> 300 operating End Stations
> 1,000,000 h beamtime /year
> 5,000 publications/year
> 15 spin off companies
> 35,000 users from all EU & beyond researchers from all research area

Construction and Operation (~ 800 M€/year) through national funding
Instruments development: 400 years of discoveries with “telescopes” and “microscopes”

« Le seul véritable voyage ... ce ne serait pas d'aller vers de nouveaux paysages, mais d'avoir d'autres yeux, de voir l'univers avec les yeux d'un autre, de cent autres, de voir les cent univers que chacun d'eux voit, que chacun d'eux est. » Marcel Proust

“The real voyage of discovery consists not in seeking new landscapes but in having new eyes”

Marcel Proust

Galileo Galilei

Zacharias Janssen
Accelerator driven applications to meet the needs of society

- Advanced instruments for basic and applied science
- Analysis of physical, chemical and biological materials
- Modification of physical, chemical and biological properties of matter
- Medical: diagnostics, treatment and targeted drug design
- Security: cargo scanning, IT hardware
- Environmental research
- Energy research
Imaging things on all length and time scales using accelerators,
e.g. latest X-Ray and computational technologies (developed at accelerators)

*ESRF-Extremely Bright Source*

European Synchrotron Radiation Facility (ESRF)
Caterina Biscari, director of the ALBA synchrotron in Spain told Science|Business the facility’s electricity bill has increased by 60% in 2022 compared to 2021. The price hike is despite ALBA negotiating a discount deal with its energy provider.

<table>
<thead>
<tr>
<th>Facility</th>
<th>Energy [GWh/year]</th>
<th>Operating time reduction</th>
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<tbody>
<tr>
<td>CERN LHC</td>
<td>1300 (2200 with FCC)</td>
<td>- 20% in 2022, 2023 (C-free energy)</td>
</tr>
<tr>
<td>DESY</td>
<td>153</td>
<td></td>
</tr>
<tr>
<td>PSI</td>
<td>125</td>
<td>- 20%</td>
</tr>
<tr>
<td>~ all LEAPS RIs</td>
<td>~ 1050</td>
<td></td>
</tr>
</tbody>
</table>

Total: 510’000
SNCF: 7’000
Total: 277’000
RENFE: 2’600
Total: 58’000
SBB: 3’000
SLS 2.0: upscaling Swiss Light Source

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

DECEMBER 2020

Start of construction. Dark period 15 months

OCTOBER 2023

Restart of User Operation

JULY 2025

HUMAN HAIR (0.017 millimeters)

Beam profile: less emittance and more photons

2021
2022
2023
2024
2025
2026

SLS
SLS 2.0

\( \mathcal{B} = \frac{\text{flux}}{\text{emittance}} \)

Circumference [m]

\( x \times 35 \)
During darktime SLS building roof will be refurbished
More radiated X-ray power for users
Less electricity consumption

**SLS → SLS2.0**

- \( E_e^- = 2.4 \text{ GeV} \rightarrow 2.7 \text{ GeV} \)
- \( P_{SR} = 310 \text{ kW} \rightarrow 365 \text{ kW} \)
- \( W_{elec}/y = 24 \text{ GWh} \rightarrow 17 \text{ GWh} \)
- \( W_{elec}-W_{PV}/y = 17 \text{ GWh} \rightarrow 15.5 \text{ GWh} \)

**Key savings:**
- Electromagnets → permanent magnets
- Klystrons → solid state amplifiers
- Standard pumps → regulated pumps for cooling
- Tar paper roof → PV cladded roof

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

- **≈ -30%**
- **≈ -35%**

\( E_e^- \) and \( P_{SR} \) are increased by 13% and 18%, respectively.

\( W_{elec}/y \) decreases by 22%.

\( W_{elec}-W_{PV}/y \) decreases by 8%.

The key saving is the replacement of electromagnets with permanent magnets, which also reduces the number of Klystrons and the use of standard pumps for cooling.
Example: LEAPS Facilities Investment Plans 2022-2026

- Given the initial investment, cutting operation time, we give up on our primary task of being the engine of innovation and progress.

- Do we re-balance the weight of science and what it contributes to society? RIs are integral part of the solution for the challenges ahead.

<table>
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<tr>
<th>Activity (2022-2026)</th>
<th>Approximate numbers</th>
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<tbody>
<tr>
<td>No. of new beamlines being constructed or refurbished</td>
<td>70</td>
</tr>
<tr>
<td>Yearly/Total operational budget</td>
<td>800/4000 M€</td>
</tr>
<tr>
<td>Budget for investments</td>
<td>450 M€</td>
</tr>
<tr>
<td>Budget for the upgrade programs (partly already funded)</td>
<td>550 M€</td>
</tr>
</tbody>
</table>

Our instruments are oversubscribed: delays and cost increases due to supply chain problems, inflation etc. will result in cancellation of projects, harming careers of PhDs and early career researchers.
WHAT SHOULD BE DONE?

Stabilize the energy supply: RIs need long-term planning

✓ Sustainable, affordable, predictable

✓ Regulated tariff mechanism?

✓ Fluctuations in energy cost makes the planning unrealistic and hampers the scientific progress on challenges the society is facing, including energy production

Leonid Rivkin, chair of LEAPS, said member organisations are still debating a course of action but they would welcome the European Commission becoming part of the talks. “The energy prices situation is too volatile for a longer-term planning, but it of course would be useful to discuss with the Commission an inclusive solution,” said Rivkin.
“The strength of LEAPS lies in its staff and users, hailing from all European countries, beyond those which host the facilities.”

https://leaps-initiative.eu
Innovation – Permanentmagnete für SLS 2.0

permanent magnet technology results in 425kW power savings of SLS 2.0 vs. SLS

+ zero power consumption
+ compact design
+ no cooling, no vibrations
- no remote tunability

NdFeB + NiFe wrapping

2.9GWh/y = 2.3% of PSI

Unterstützt durch Pro-Kilowatt
Grid Energy demand at PSI is high but falling

PSI’s energy consumption is dominated by the operation of the large-scale research facilities. The PSI accelerators are already among the most efficient in the world.

Peak power: 22.5 MW (all hydro power)
Energy Consumption PSI

FACILITY CONSUMPTION

- Proton Accelerator: 45%
- Labs & Office: 15%
- SULTAN (s.c. tests): 4%
- Proton Therapy: 4%
- SwissFEL: 13%
- Swiss Light Source: 19%

**total:** \( \approx 125 \text{ GWh/y} \)
## Innovation – Photovoltaik & Wärmerückgewinnung

<table>
<thead>
<tr>
<th>Photovoltaik (aktuell 5'500 m²)</th>
<th>Wärmerückgewinnung</th>
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<tbody>
<tr>
<td>installed peak power entire PSI</td>
<td>total heating energy PSI 12.9 GWh/y</td>
</tr>
<tr>
<td>energy generated</td>
<td>recovered heat from facilities 6.5 GWh/y</td>
</tr>
<tr>
<td>fraction of PSI consumption</td>
<td>= fraction of needed energy 50 %</td>
</tr>
<tr>
<td></td>
<td>energy cost saved 415 kCHF/y</td>
</tr>
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</table>

### Photovoltaik

- **installed peak power entire PSI**: 580 kW
- **energy generated**: 0.56 GWh
- **fraction of PSI consumption**: 0.4 %

**Potential:**
- + 40’000 m², + 4.5 MW peak, + 3.5 %
- 10 Mio CHF investment

- Solar panels on a lab building @ PSI
- HIPA cooling circuit with recovery