The Tools of the Trade

**Synchrotron = Swiss Army Knife of Science**
- Education
- Research
- Innovation
- Imaging
- Spectroscopy
- Diffraction
- Atoms
- Electrons
- Spins

**FEL = Lightsaber of Science**
- Attack the most challenging issues!
- Drill through any material!
- Comes in different colors
- Unique owing to builder

Wikipedia:
1. “This is the weapon of a Jedi Knight. Not as clumsy or as random as a blaster. An elegant weapon... for a more civilized age”
2. The lightsaber’s energy blade can cut, burn, and melt through most substances with little resistance.
3. Each lightsaber is unique, though some may bear resemblance to others, especially if there is a connection between the builders.
The international scene
League of European Accelerator Based Photon Sources

Joining forces to master the challenges of the next decades

Grand Challenges
↓
Science question
↓
Technology

Users
International Colleagues
National Funders
Public
EU Funders
Industry
Grand Challenges ⇒ Science Questions ⇒ Technology

Example: Health

<table>
<thead>
<tr>
<th>The challenges</th>
<th>Drug resistance and age-related illnesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>The answers</td>
<td>Mechanistic understanding, new drugs and personalised medicine</td>
</tr>
<tr>
<td>LEAPS role</td>
<td>Leveraging advances in brightness, automation &amp; computation to drive biomedical discovery</td>
</tr>
<tr>
<td>LEAPS impact</td>
<td>Standardised databases allowing Europe-wide integration of massive volumes of atomic to tissue level data for machine learning</td>
</tr>
</tbody>
</table>
League of European Accelerator Based Photon Sources

6 permanent Working groups

- Education & Training
- Beamline Technology
- Photon Sources
- User Services & Impact
- Industry & Innovation
- Information Technology

- Pilot projects (2019)
  - Detectors
  - Optics & gratings
  - Software
  - Industry involvement

Working on application for major funding via Horizon Europe!

Horizon Europe:
2021 – 2027, suggested 94.1 B€ (50 % above current Horizon 2020)
The European Landscape
How does the international community see LCLS?
The early success of LCLS was a breakthrough for accelerator and X-ray sciences and opened the new world of studying matter on atomic space and time scales.

A message to LCLS staff & users for the next decade?

Stay at the forefront of the X-ray revolution, keep the open spirit of collaboration in a competitive world, and continue training, inspiring young people.
The most important contribution of LCLS?

LCLS has *pioneered ultrafast science* using *uncommon boldness and perseverance*. This has boosted the interest of the international scientific community in exploiting the unique features of Free Electron Lasers.

A message to LCLS staff & users for the next decade?

*LCLSII is the ultimate ultrafast facility*: the coming years will see realized the dream of looking at matter with new eyes!
The circumstances at the time of the creation of LCLS were exceptional: excellent accelerator scientist and engineers looking for new challenges, visionary leaders searching for new frontiers in research and a healthy competition between USA, Japan and Europe to put into operation an X-Ray FEL facility.

LCLS has fulfilled three of the most important goals of any research infrastructure:

- it has open new research capabilities, paving the way and setting new standards,
- it has contributed in educating a young generation and
- it has disseminated - through close collaborations - the scientific and technological knowledge worldwide, shaping a new phase: many facilities are now in operation, while LCLS is involved in an ambitious upgrade.

PSI wants to congratulate SLAC and - in special - the management and the outstanding staff members of LCLS for the great achievements in the “first ten years”.

SwissFEL (Switzerland)
The most important contribution of LCLS?

- **LCLS staff are very generous and open-minded in sharing** their valuable experiences and skills such as
  - Lattice design: P. Emma, Z. Huang
  - X-band linearizer RF system: E. Jongewaard, M. Fazio
  - BBA & other analysis program: H. Loss, J. Wu, D. Ratner, Y. Ding, T. Raubenheimer, A. Lutman, F. Decker

A message to LCLS staff & users for the next decade?

- **Continue the collaboration** for both sides to get more benefit (PAL-XFEL contributes a new design of cavity BPM for LCLS-II).
- **FELs are valuable resources for the world.** Let’s think of efficient use of beamtime.
Congratulations on the 10th anniversary of LCLS.

We admire your strong leadership, excellent foresight, and great success.

We hope LCLS continues to take the lead of XFEL community in the world.
The International Knights of FEL

10th Hard X-ray Collaboration Meeting
Date: 12 - 14 March, 2019
Location: Quail Lodge, Monterey, CA
Hosted by the LCLS of SLAC National Accelerator Laboratory
What will LCLS be like in its 20th year?

It's hard to make predictions, especially about the future.

Alternative sources: Karl Kristian Steincke, Samuel Goldwyn, Robert Storm Petersen, Yogi Berra, Mark Twain, Nostradamus, …?
LCLS in 2029?

- A vibrant & innovative impactful research facility
- Attractive employer for young scientists
- Close to “perfect” FEL
  - Seeding, multi-pulse, attosecond, non-linear spectroscopy, hard X-rays, …
  - Close to perfect all the way: endstation, detectors, …
- More capacity / beamlines!
- Close coordination (complementarity) with SSRL
- Member of (informal) international FEL network

- Pushing for wake-field user facility in 2040?