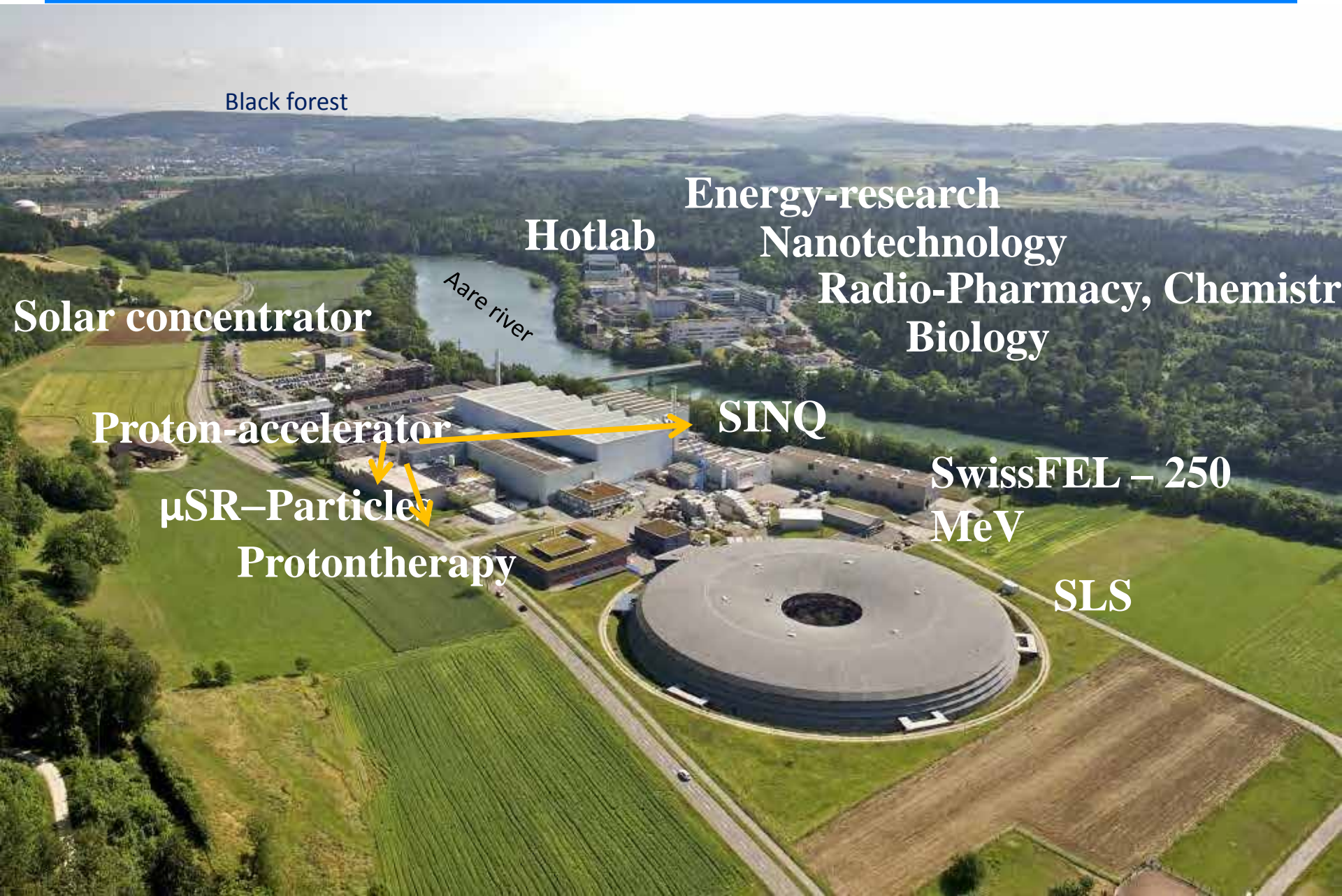


PSI and its Accelerators

February 27th, 2014

Terry Garvey



Black forest

Hotlab

Energy-research

Nanotechnology

Radio-Pharmacy, Chemistry

Biology

Solar concentrator

Aare river

Proton-accelerator

SINQ

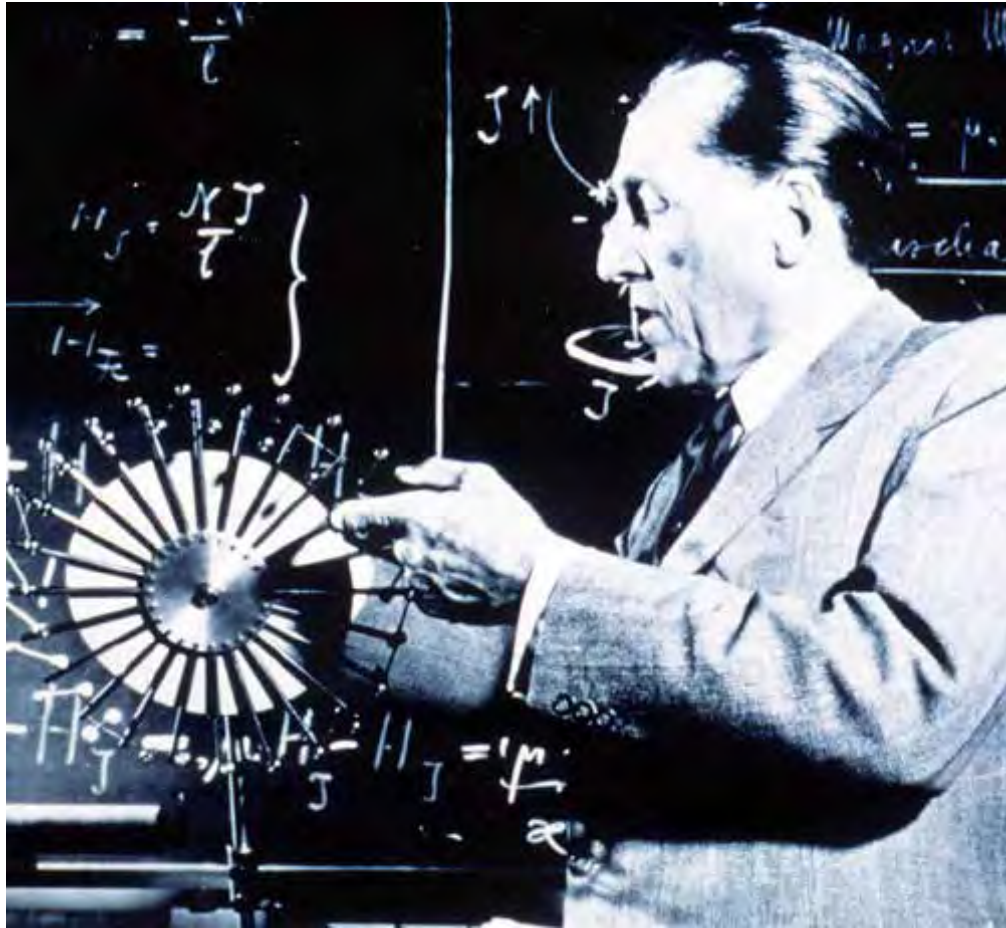
μ SR-Particle

SwissFEL – 250
MeV

Protontherapy

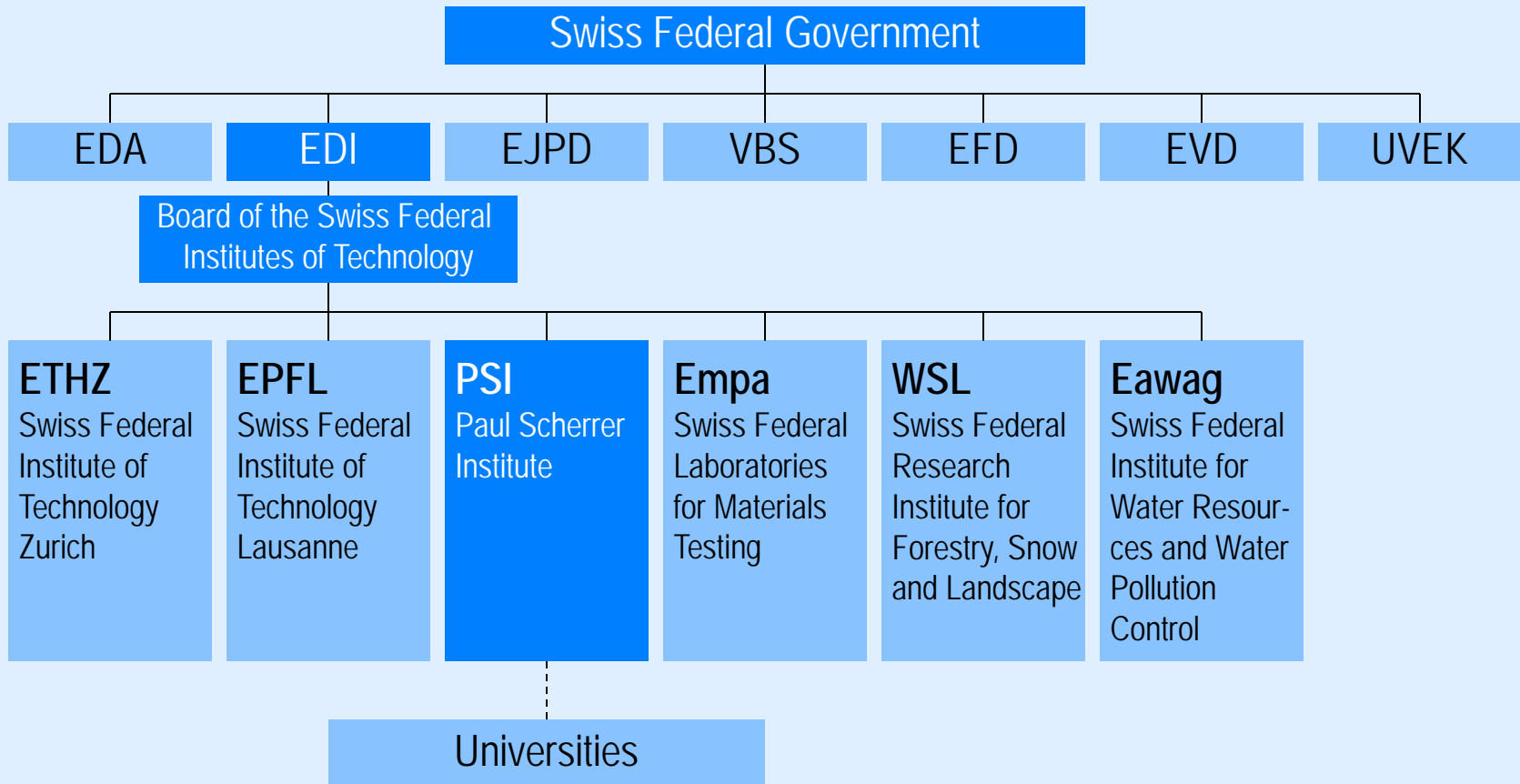
SLS

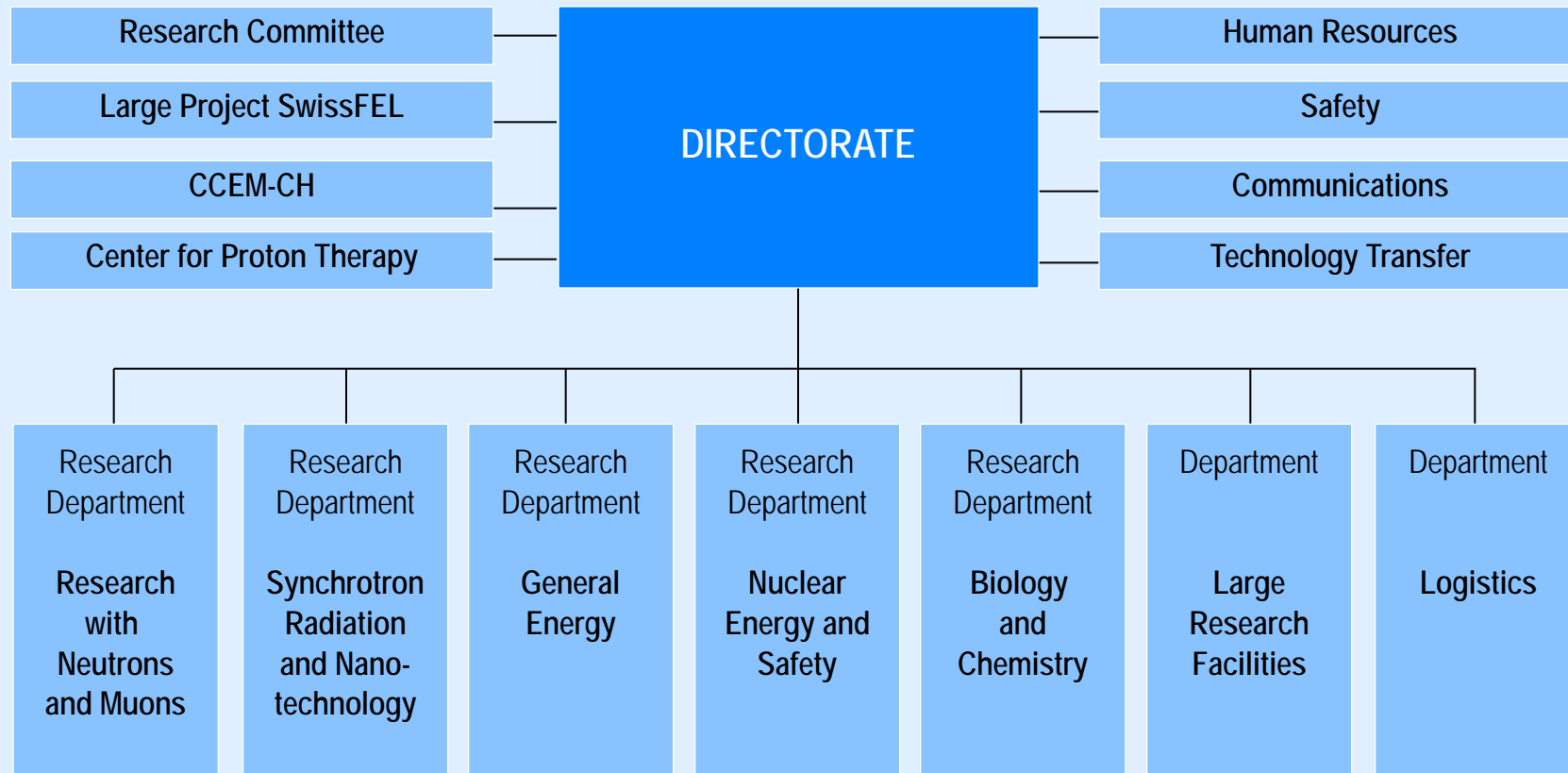
Paul Scherrer (1890 – 1969)



- Studied physics and mathematics at the Swiss Federal Institute of Technology (ETH) Zurich, in Königsberg and Göttingen in Germany
- 1920: Director of The Institute of Physics at the ETH Zurich.
- Researched X-ray scattering from crystals, liquids and gases. Later work was in nuclear physics
- 1946: President of the Swiss Study Commission on Atomic Energy
- Involved in the founding of CERN

Political embedding





Our Mission

- To play a leading role on an international level in
 - physics of condensed matter and materials sciences
 - structural biology
 - radiochemistry, radio-pharmacy and proton radiation therapy
 - particle & **accelerator physics**

@ PSI large-scale facilities
(SLS, SINQ, S μ S, particle beams)

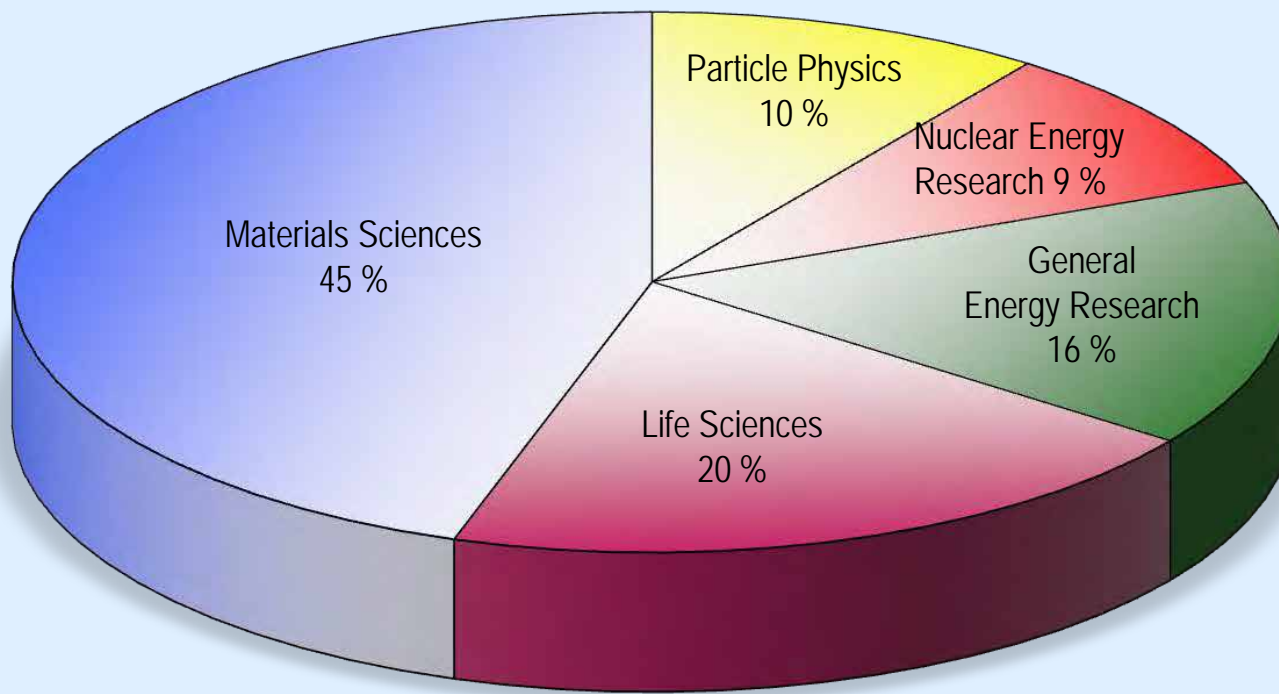
- **To be a User Lab for the external scientific community**
- Energy research, primarily using complex facilities, towards an efficient, environmentally friendly and reliable energy supply

PSI in figures

PSI funds (global budget)	250	MCHF
External funding	80	MCHF
Staff	~ 1500	PY
Of which externally financed	~ 400	PY
Doctoral students	~ 300	
Apprentices	~ 85	
External users	~ 2100	
Number of scientific publications	~ 1000	
PSI employees with teaching duties at ETH and universities	~ 100	
Visits of patients	~ 6000	

Budget

- Distribution by points of emphasis; 250 MCHF (PSI funding)



Particle beams at PSI:

protons, electrons, photons, neutrons and muons

➤ 590 MeV Proton cyclotron (40 years old):

CW proton beam of 2.2 mA
Beam power: **1.3 MW**

- neutron spallation source **SINQ**, thermal and cold neutrons
 - very high flux and brightness muon beams
-
- ### ➤ 2.4 GeV electron storage ring: Swiss Light Source (**SLS**, 12 years old)
- ### ➤ 250 MeV protons cancer therapy (**PROSCAN**)
- ### ➤ 6 GeV electron linac based X-Ray Free Electron Laser (**SwissFEL**)

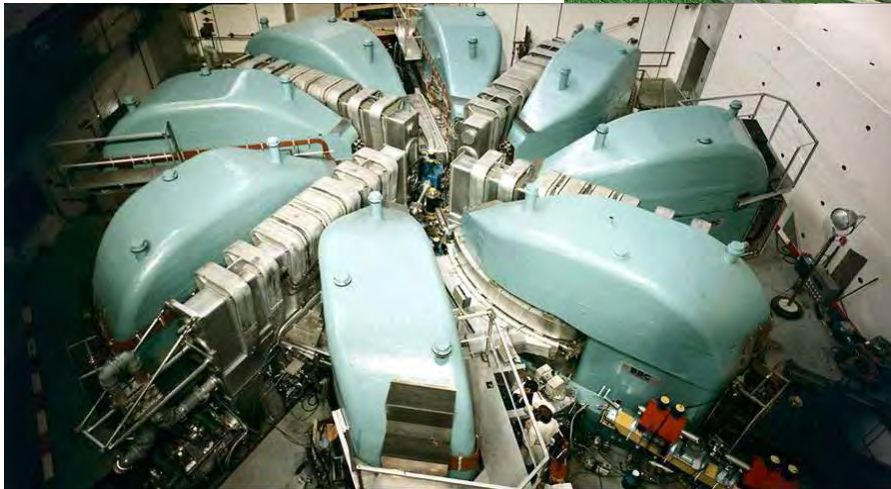
Accelerators at PSI

SwissFEL

Synchrotron Light Source



Proton Cyclotron



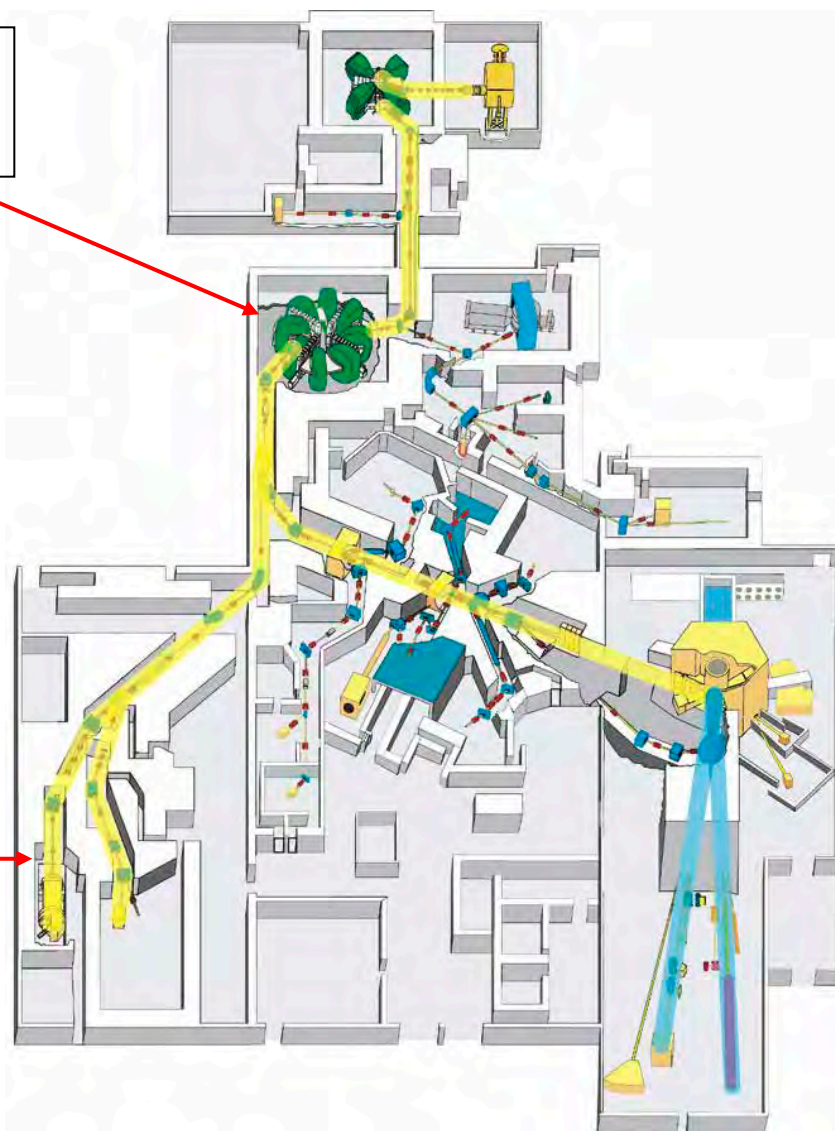
The 590 MeV Ring Cyclotron



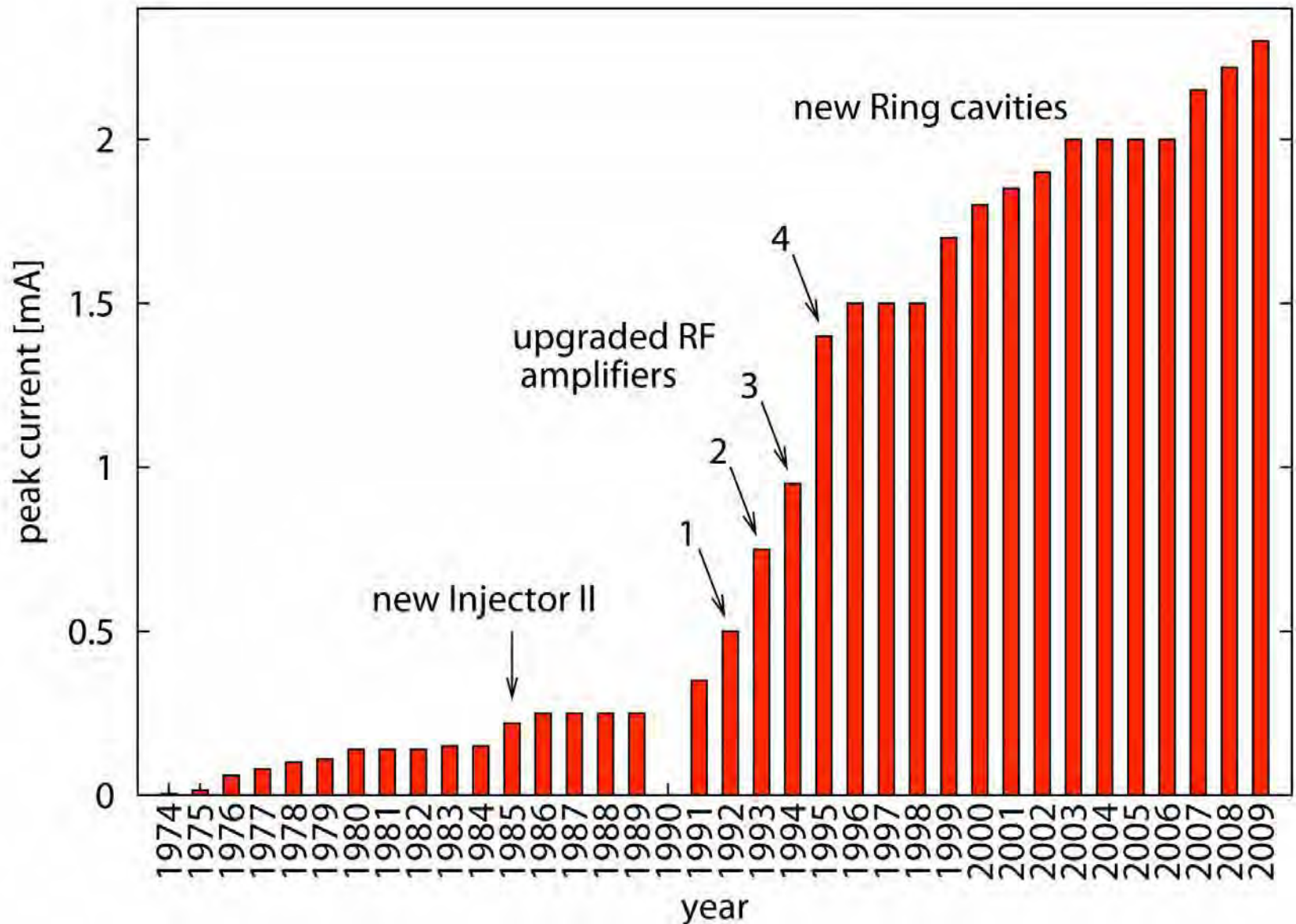
The proton facility.

Ring cyclotron
590 MeV, 2 mA

Gantry 1



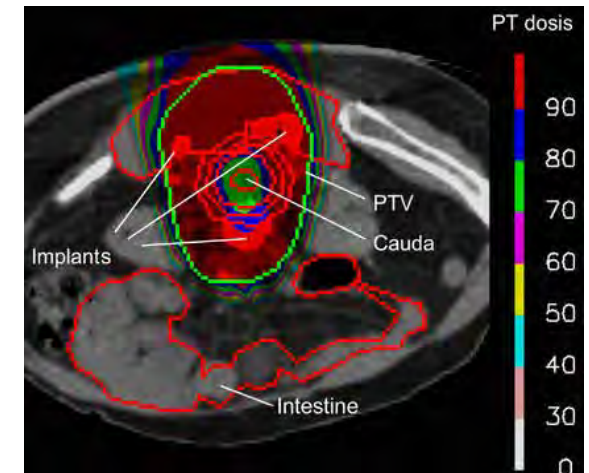
Still going strong after 40 years



Humans and health

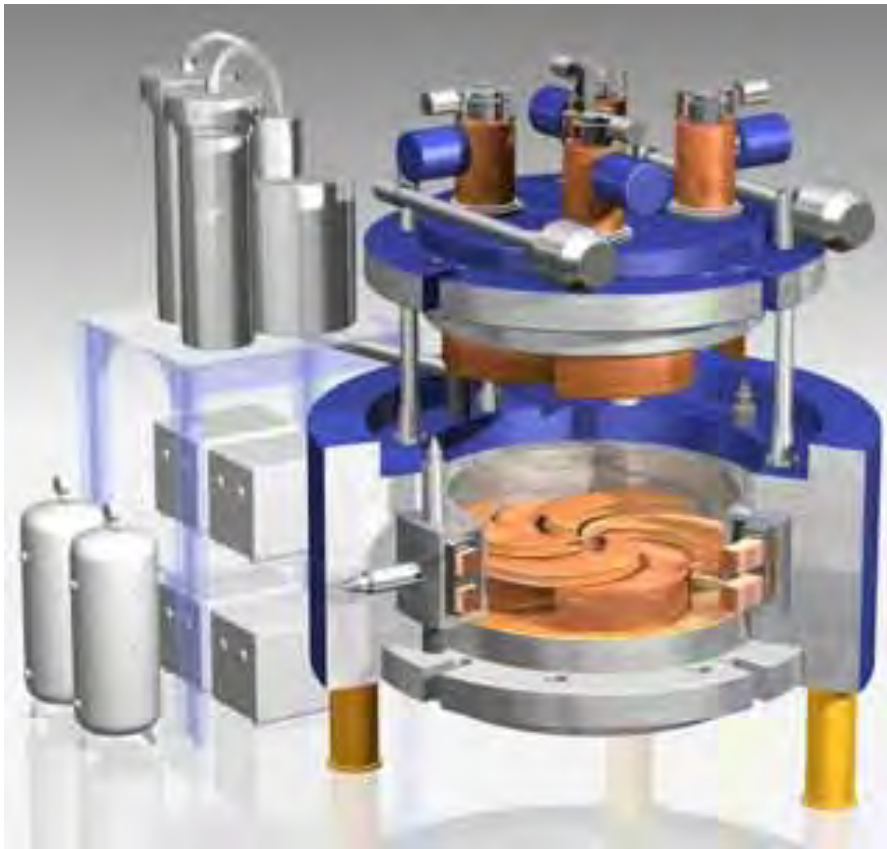


Radiation facility (Gantry) for proton therapy



Efficient spot-scanning
technique:
irradiation plan for a tumour
at the lower spine
(sparing of healthy tissue)

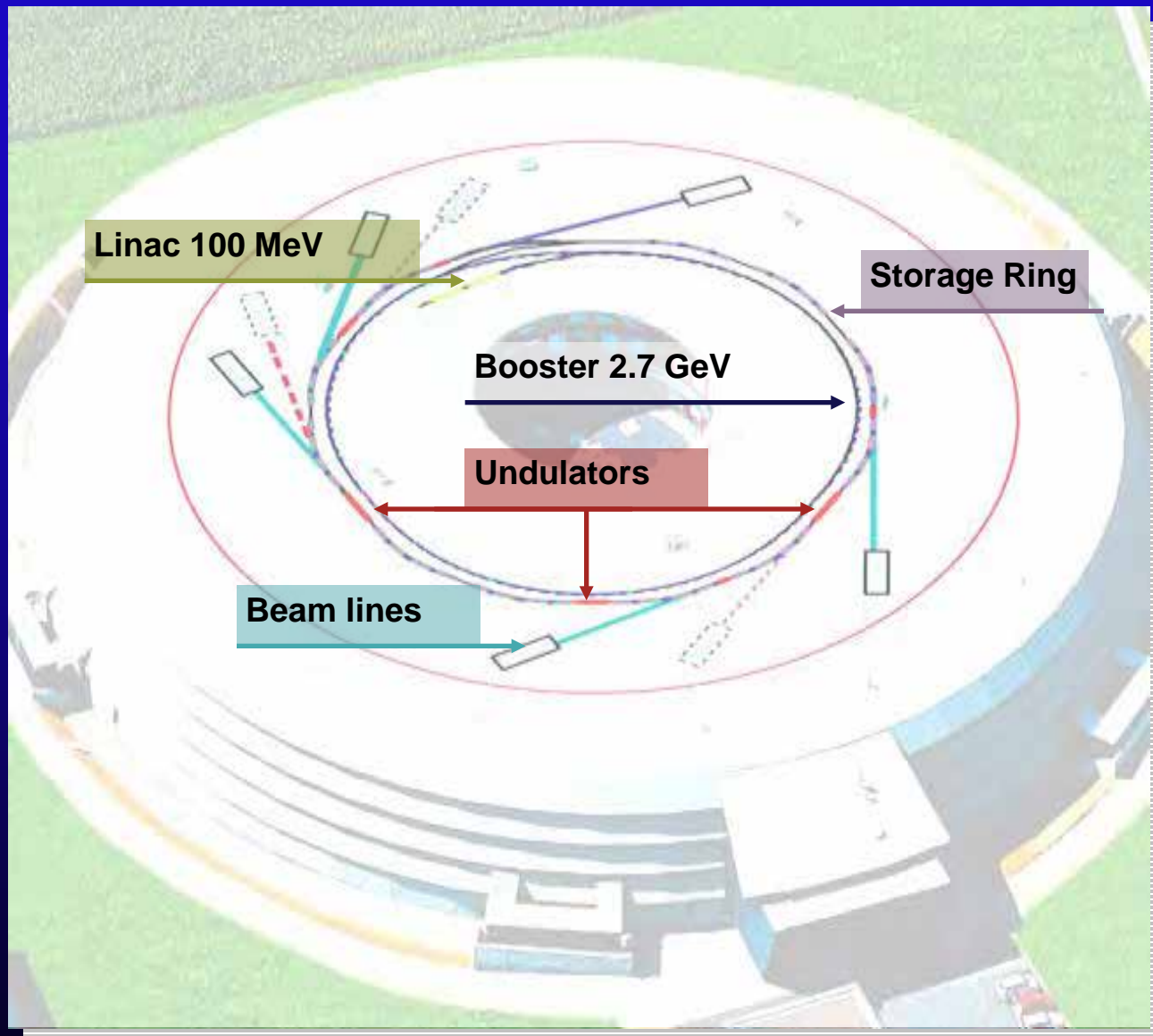
ESTABLISHED TECHNIQUE: CANCER TREATMENT WITH PROTONS
→ CYCLOTRON WITH MAXIMUM ENERGY OF 250 MeV



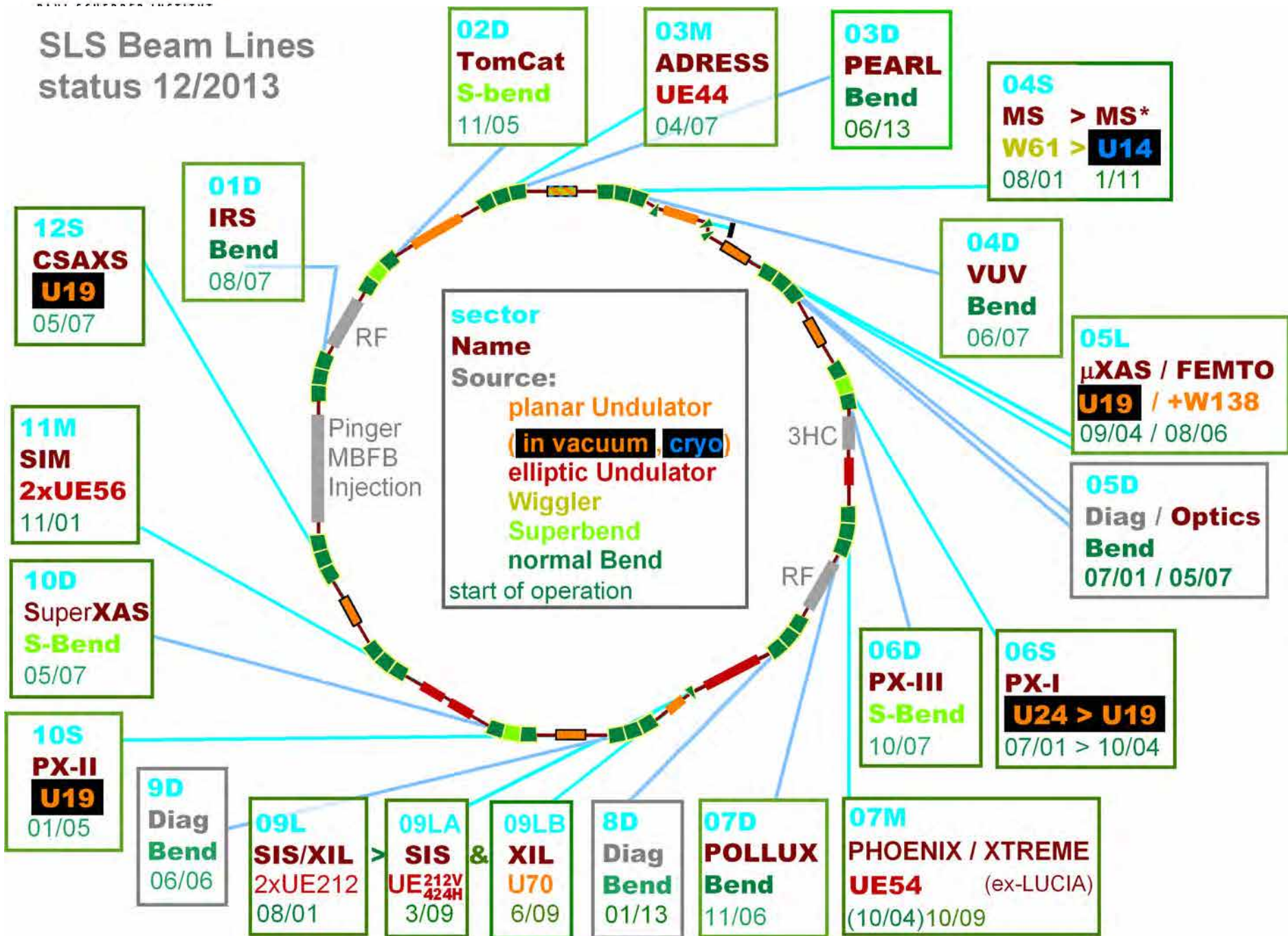
*PROSCAN
SC CYCLOTRON
ACCEL / PSI*

Swiss Light Source SLS



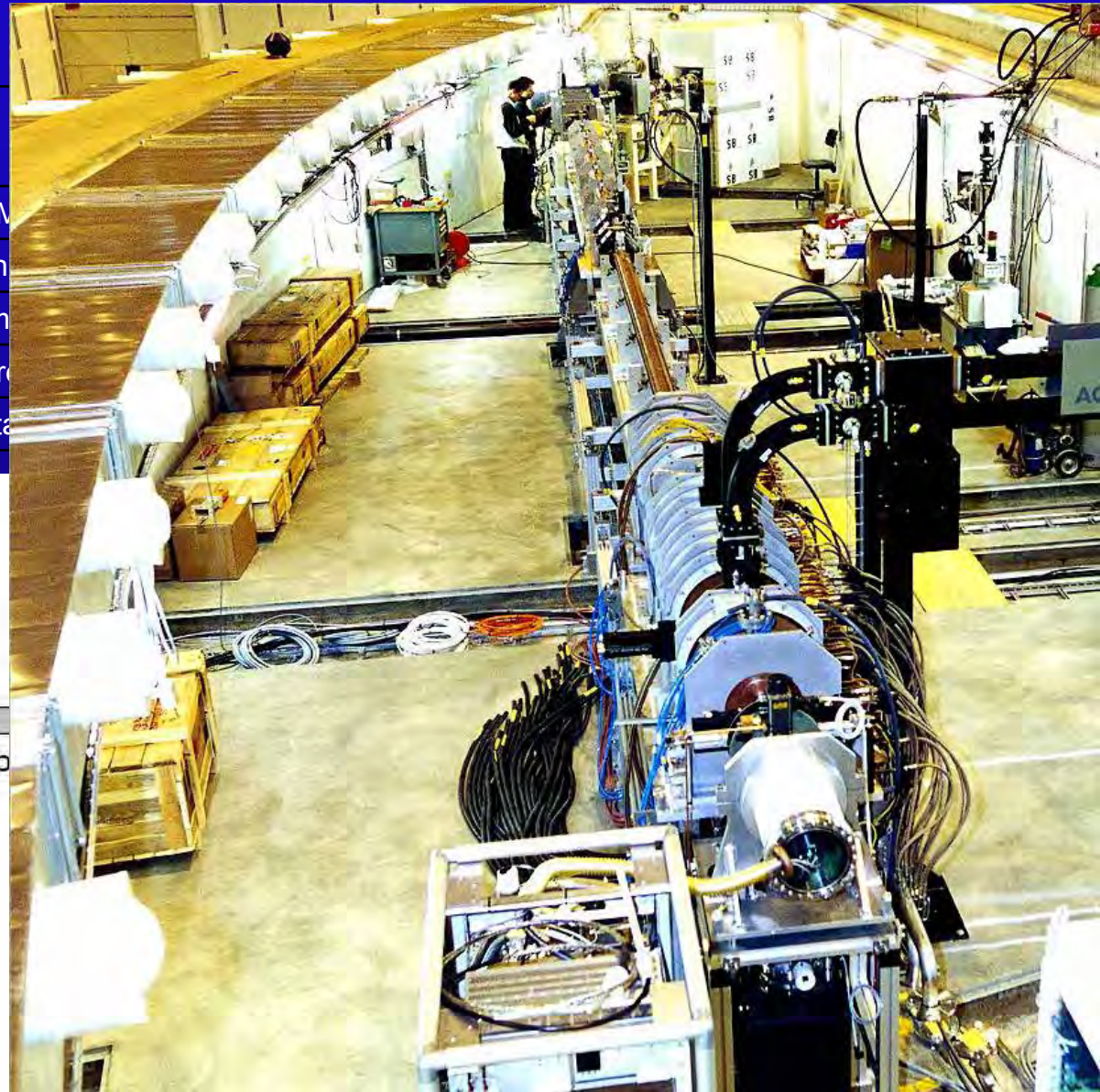
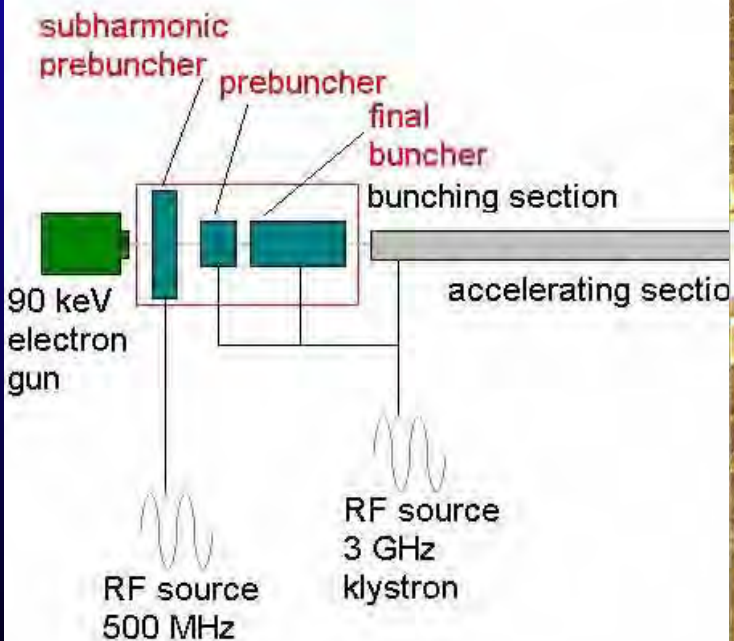


SLS Beam Lines status 12/2013



Linac

Energie [MeV]
Ladung [nC]
Norm. Em.
Energiebre.
Energiespr.



Booster

$E = 2.4 \text{ GeV}$

$C = 270 \text{ m}$

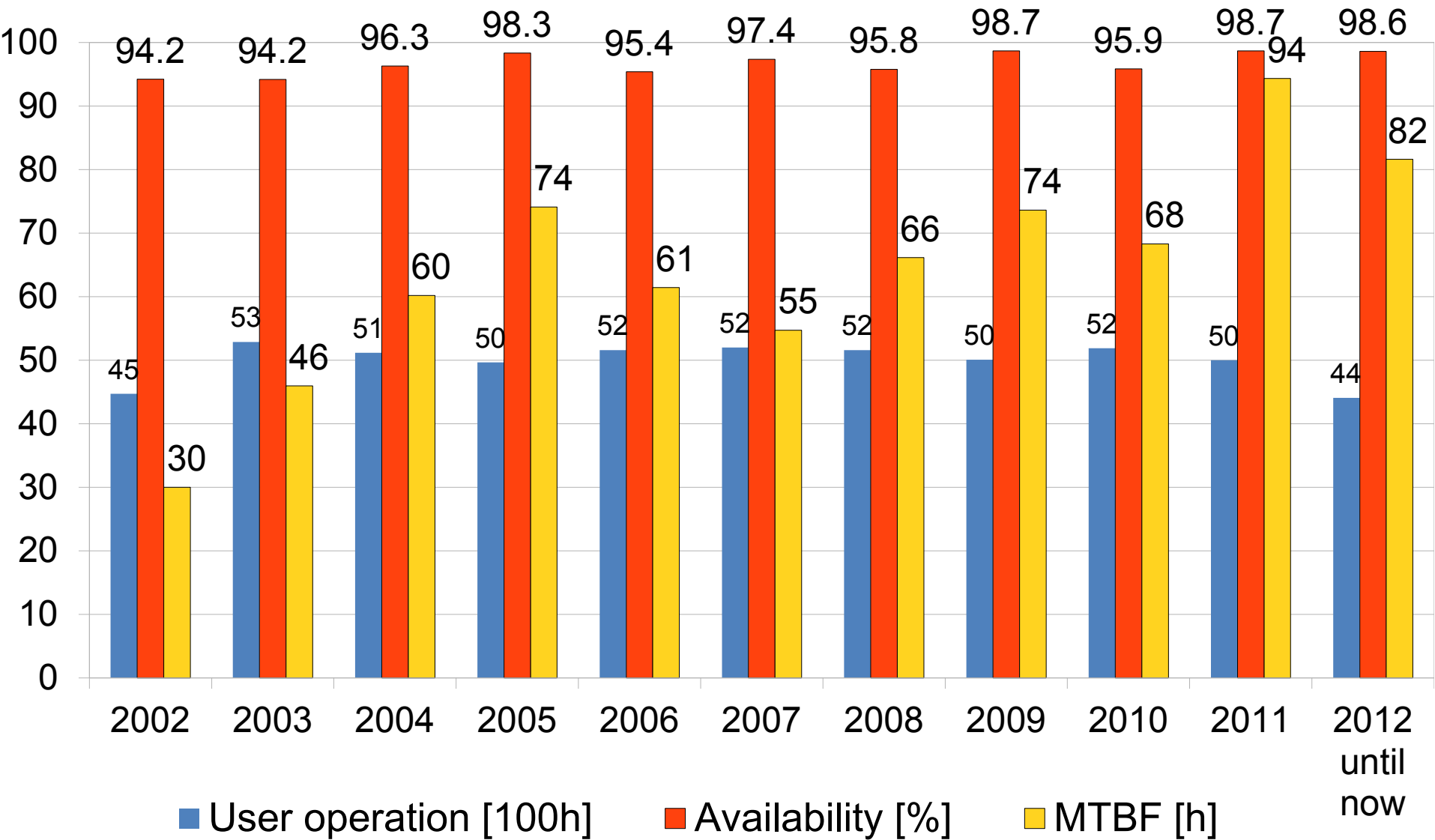
$\varepsilon = 9 \text{ nm}$





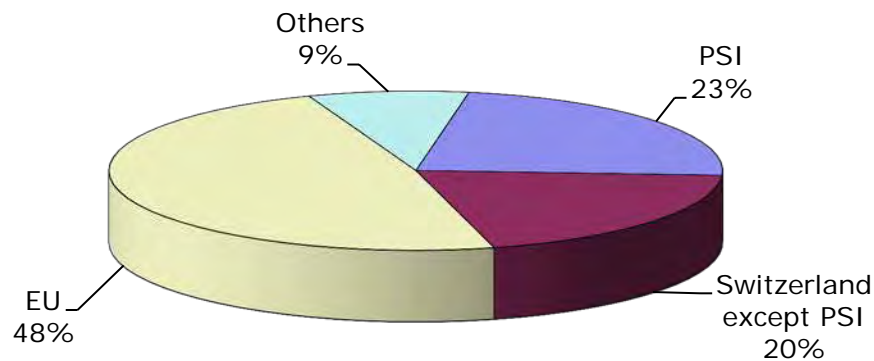
TUNNEL
WITH BOOSTER AND STORAGE RING

SLS Operation Statistics

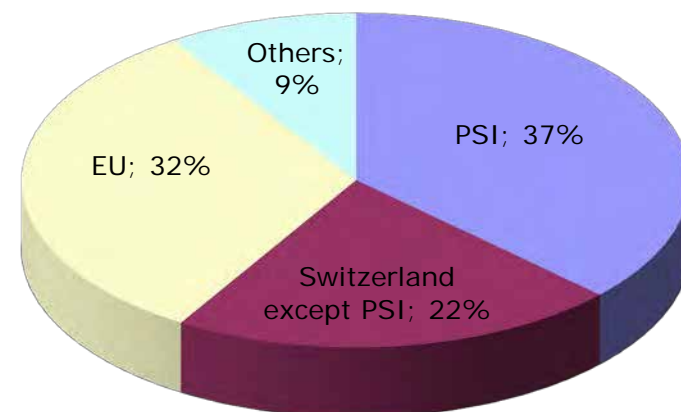


Use of facilities 2010

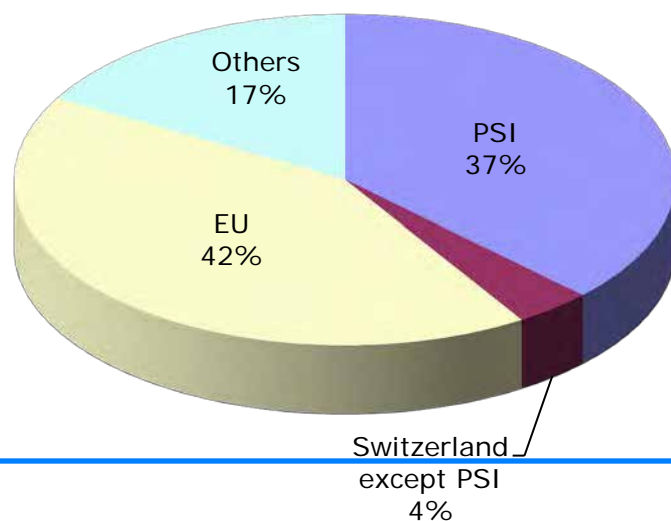
Geographic distribution **SLS** users 2010,
all beamlines



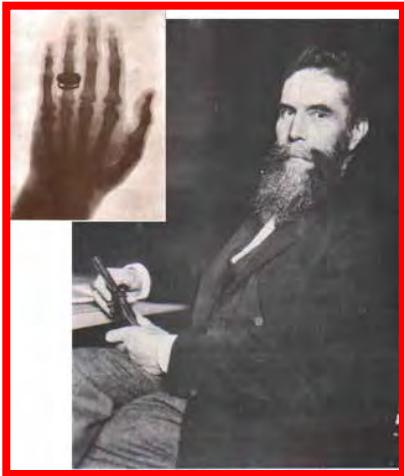
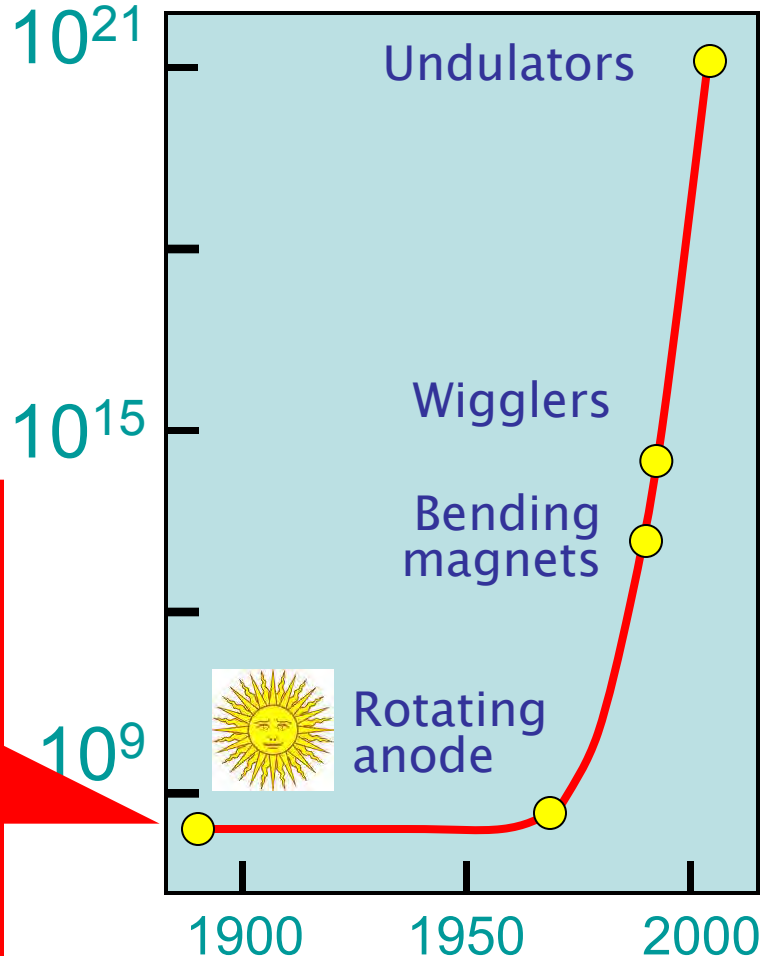
Geographic distribution of **SINQ** users



Geographic distribution of **SμS** users 2010



Steep rise in brightness



Bertha Roentgen's hand
(exposure: 20 min)

the second wave



SLS
SOLEIL (F)
DIAMOND (UK)



SPring8



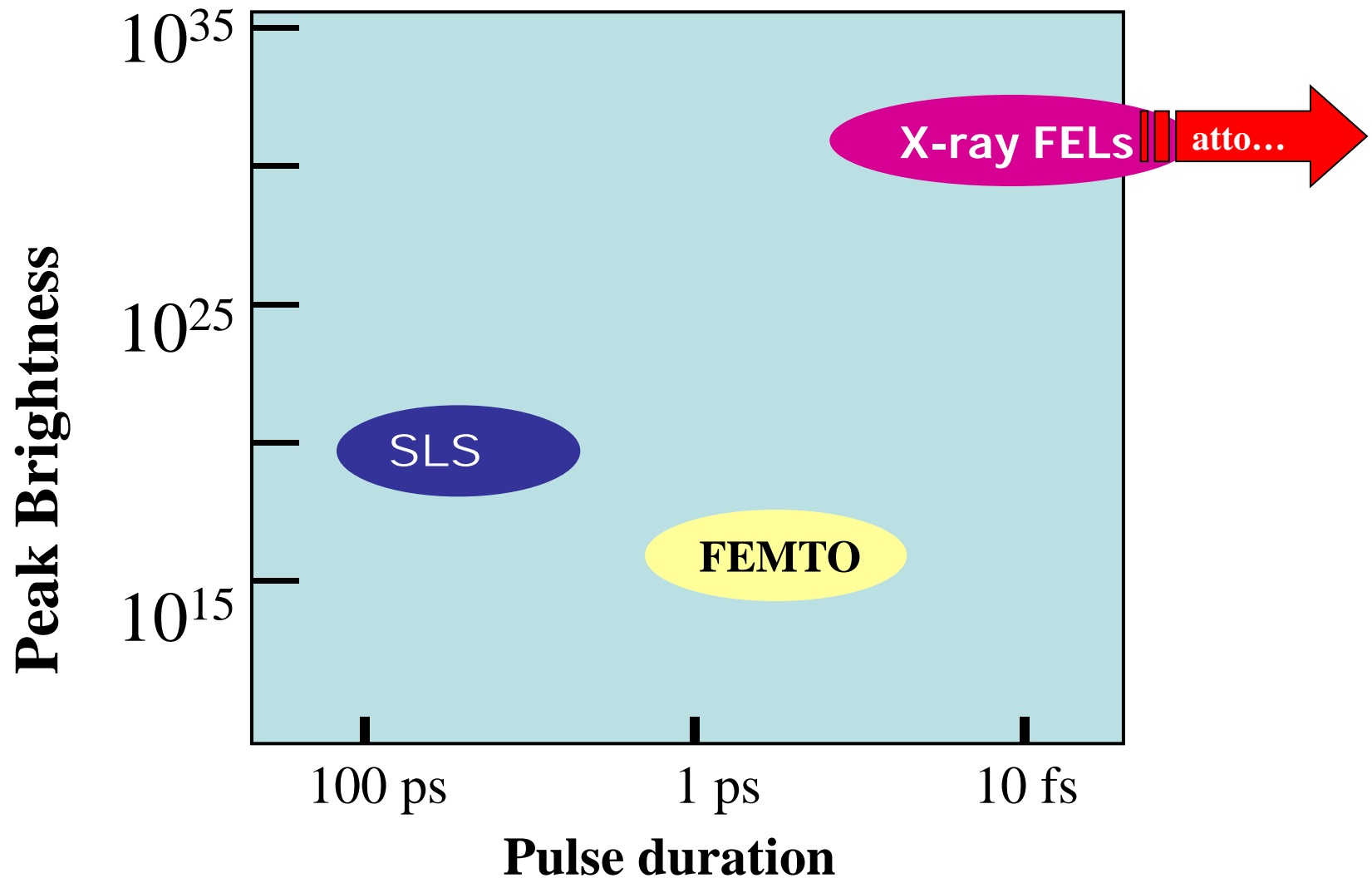
ESRF



APS

X-Ray Laser

10 ORDERS OF MAGNITUDE JUMP!



X-FEL facilities

“National”

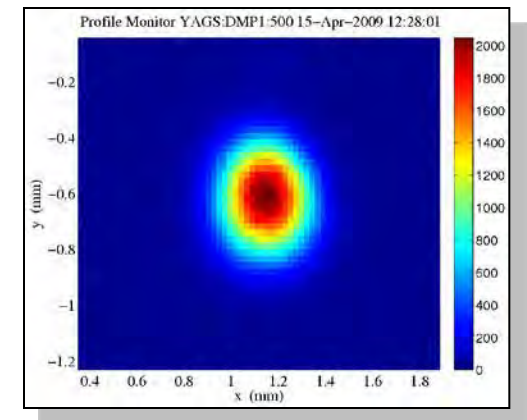
SwissFEL 2016



**USA
LCLS-SLAC
2009**

**Japan
SCSS-SPring8
2010**

**Europe
X-FEL-DESY 2014/2015**

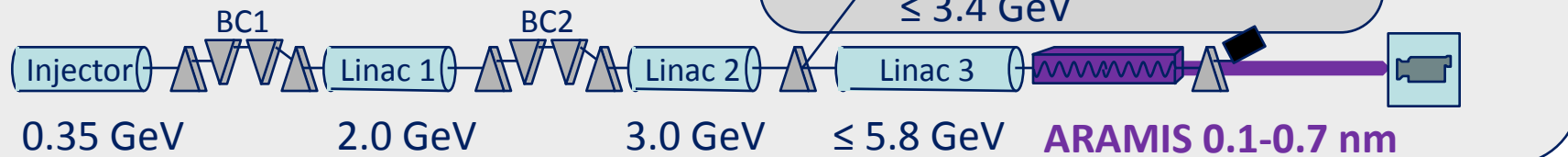


Short Pulses at PSI: SwissFEL

1st construction phase
2013-16

2nd construction phase
2018-19

ATHOS 0.7-7nm

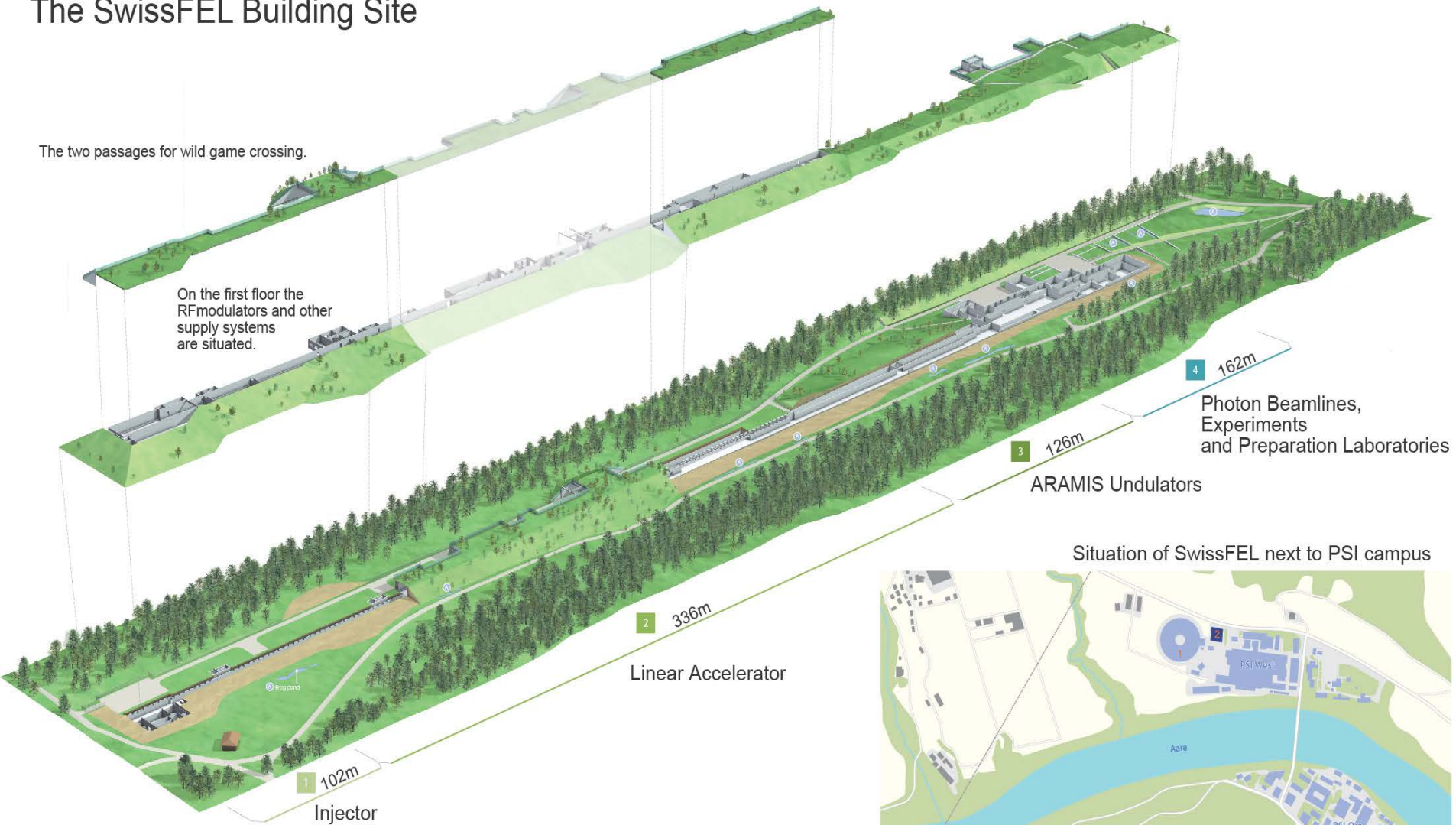


2012	2013	2014	2015	2016	2017
component procurement accelerator and ARAMIS FEL				preparation ATHOS FEL	
preparatory work	building construction		Accelerator and ARAMIS FEL installation interleaved with injector commissioning	Linac and ARAMIS commissioning	friendly users

The SwissFEL Building Site

The two passages for wild game crossing.

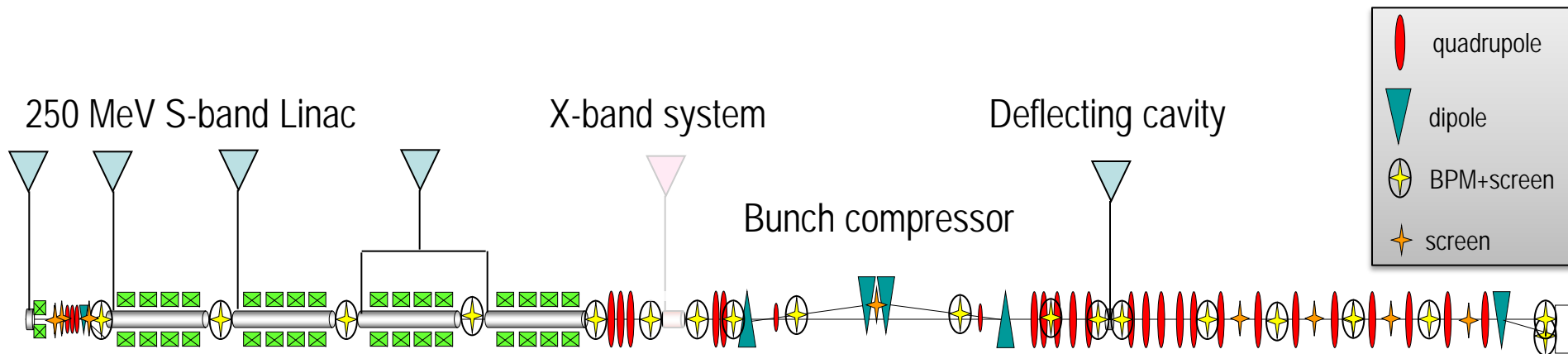
On the first floor the
RFmodulators and other
supply systems
are situated.



Situation of SwissFEL next to PSI campus



SwissFEL Development: Injector Test Facility (SITF)



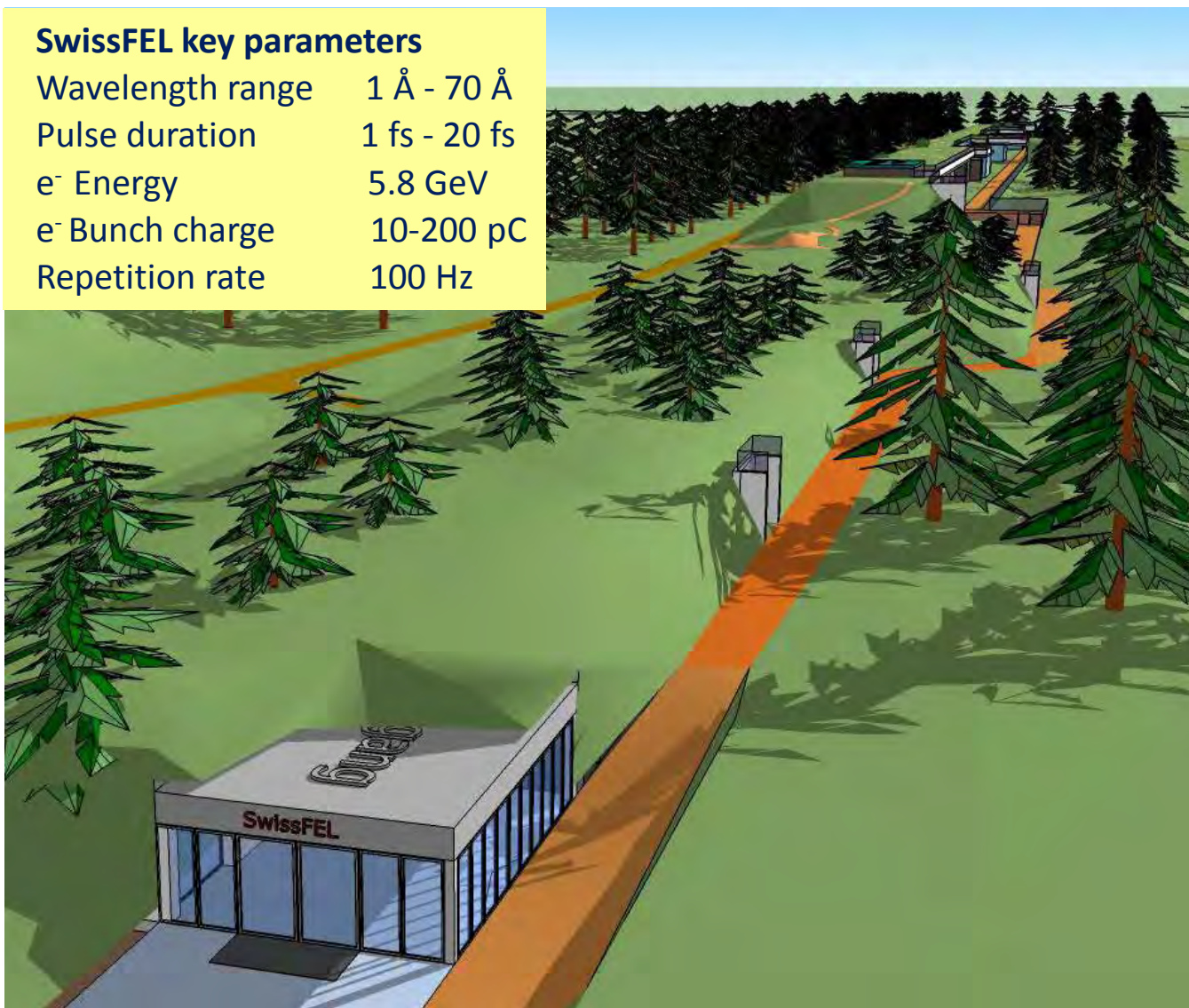
- Facility to test:
 - Electron Source: laser gun development
 - RF: low-level regulations, RF modulator development, X-band
 - Bunch compression studies
 - Diagnostics development: EO, CSR, Beam arrival
 - Controls development: beam synchronous data acquisition



SwissFEL, the next large facility at PSI

SwissFEL key parameters

Wavelength range	1 Å - 70 Å
Pulse duration	1 fs - 20 fs
e ⁻ Energy	5.8 GeV
e ⁻ Bunch charge	10-200 pC
Repetition rate	100 Hz



I wish you all an
enjoyable and
interesting visit