PAUL SCHERRER INSTITUT

PSI and its Accelerators

March 1st, 2012

Terry Garvey

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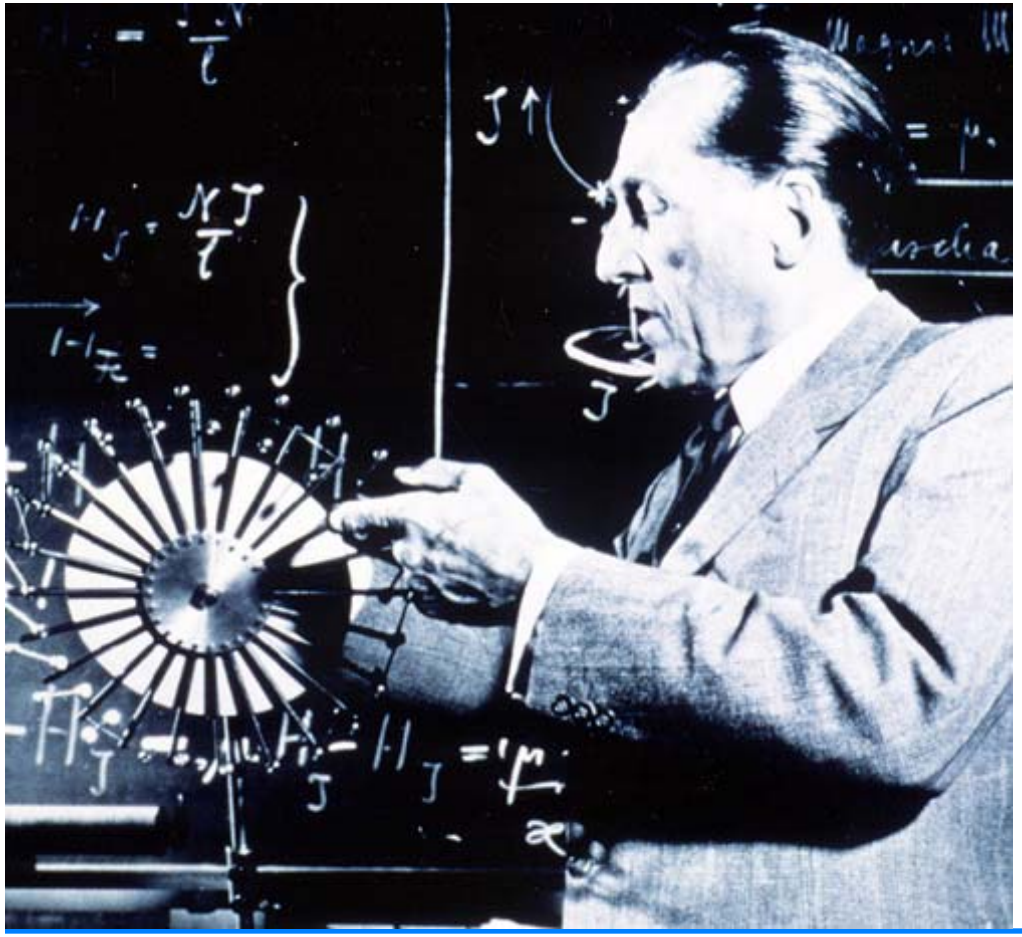
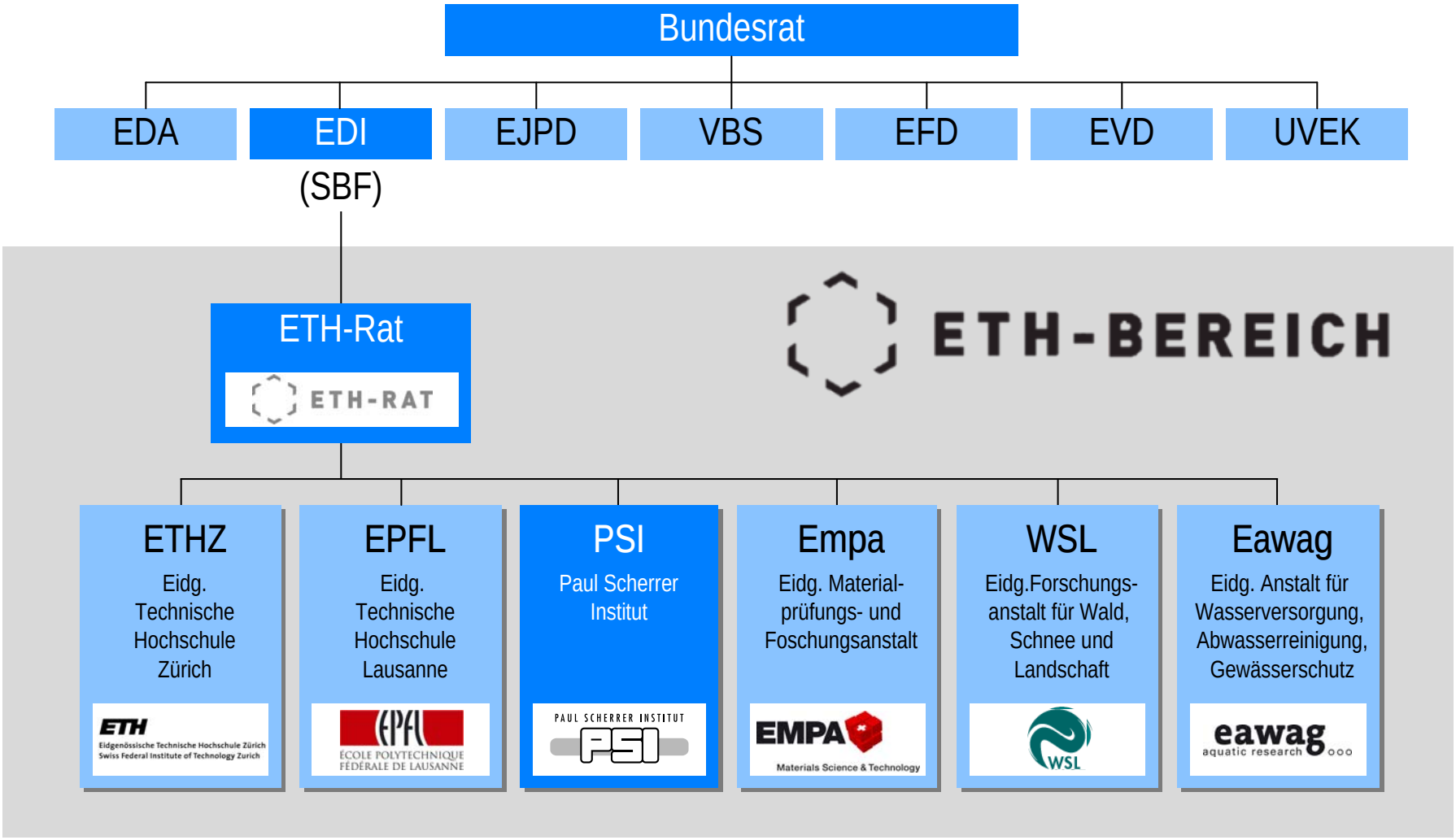
Paul Scherrer (1890 – 1969)



- 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

Der ETH-Bereich



PAUL SCHERRER INSTITUT

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, SμS, particle beams)

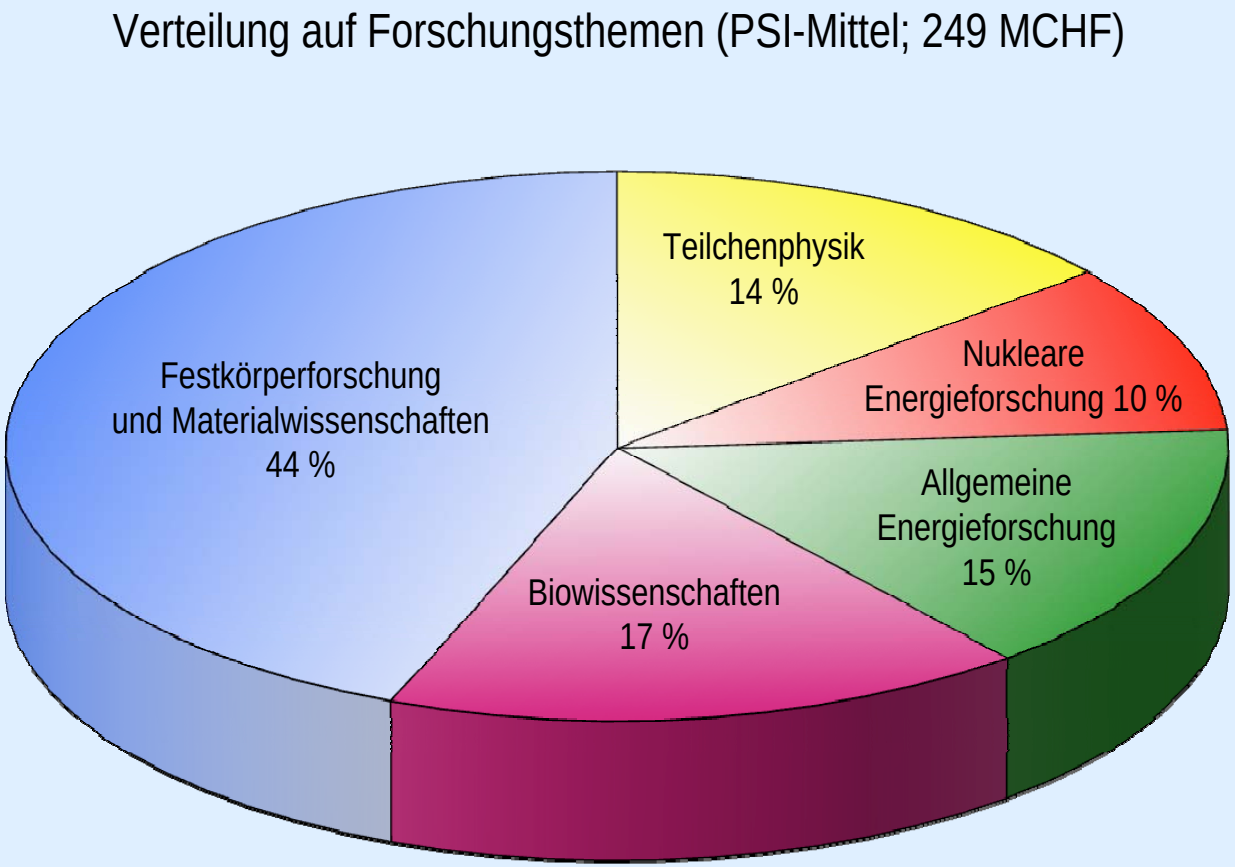
- To be a User Lab for the external scientific community

- Energy research, primarily using complex facilities, towards an efficient, environmentally friendly and reliable energy supply

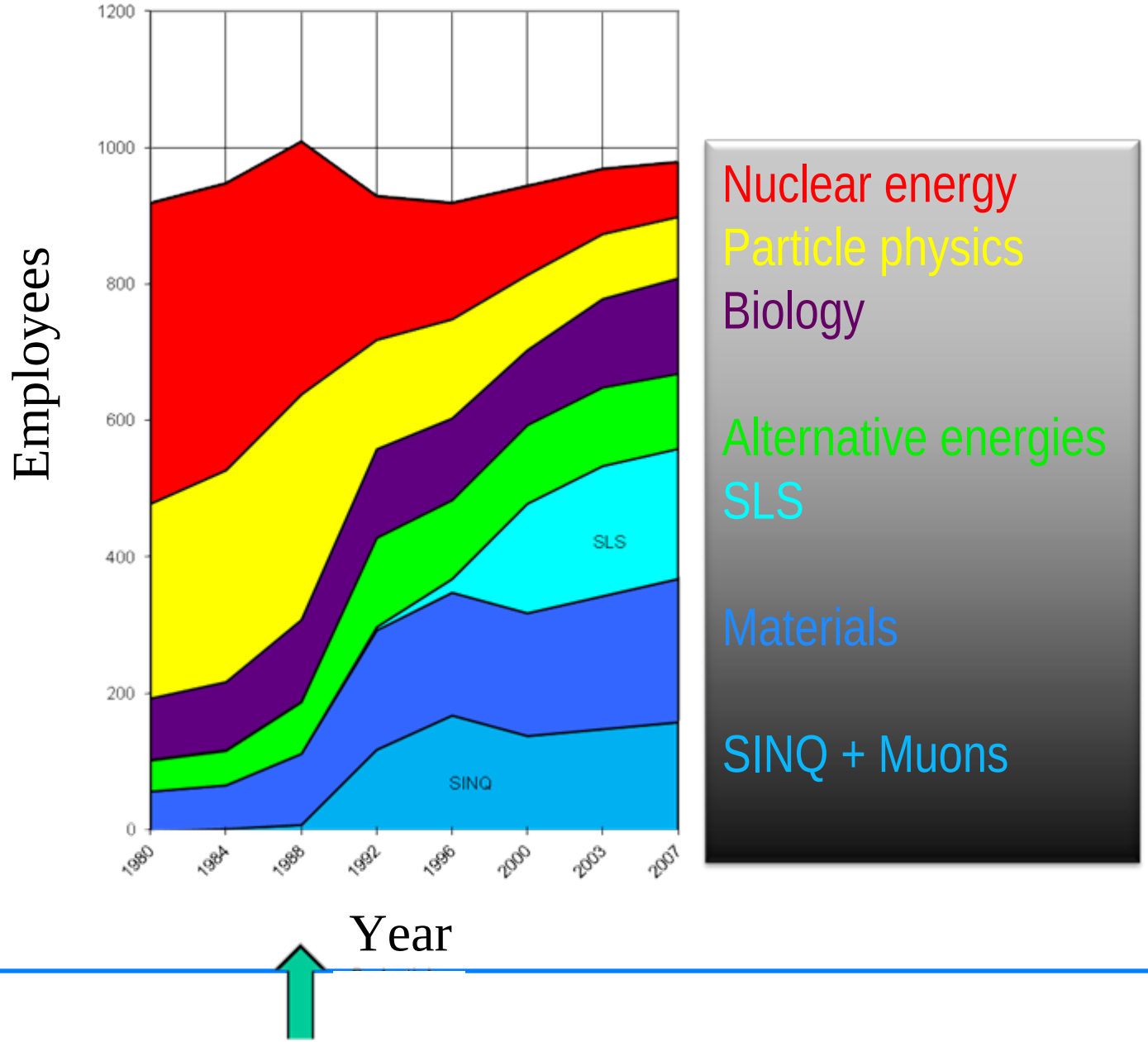
PSI in figures

PSI-Mittel (Globalbudget)		249	MCHF
Drittmittel		60	MCHF
Anzahl Mitarbeitende	~	1400	PJ
davon finanziert aus Drittmitteln	~	370	PJ
Doktoranden/-innen	~	300	
Lehrlinge		80	
Externe Benutzer/-innen	~	2000	
Anzahl wissenschaftliche Publikationen	~	900	
PSI-Mitarbeitende mit Lehrverpflichtungen an HS/FH	~	80	

Budget distribution



Evolution of PSI personnel



Particle beams at PSI:
protons, electrons, photons, neutrons and muons

- 590 MeV Proton cyclotron (35 years old):
  - neutron spallation source SINQ, thermal and cold neutrons
  - very high flux and brightness muon beams

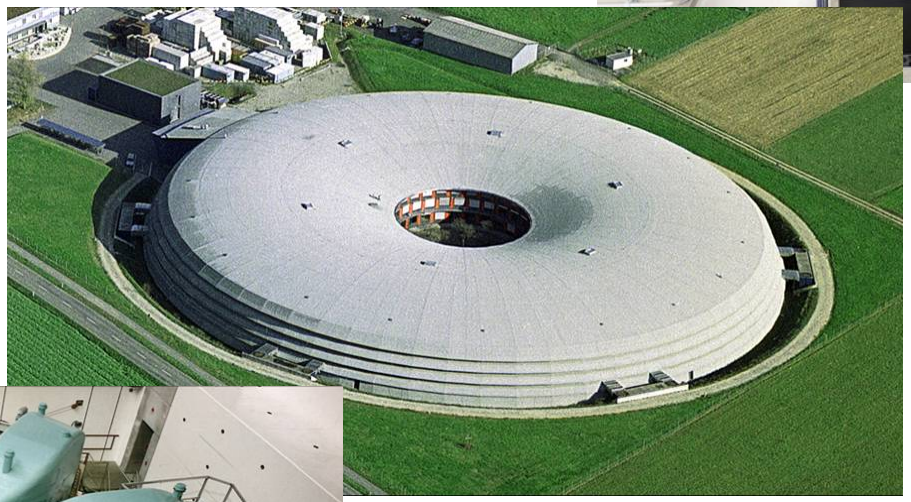
CW proton beam of 2.2 mA
Beam power: **1.3 MW**

- 2.4 GeV electron storage ring: Swiss Light Source (SLS, 10 years old)
- 250 MeV protons cancer therapy (PROSCAN)
- 6 GeV electron linac based X-Ray Free Electron Laser (SwissFEL)

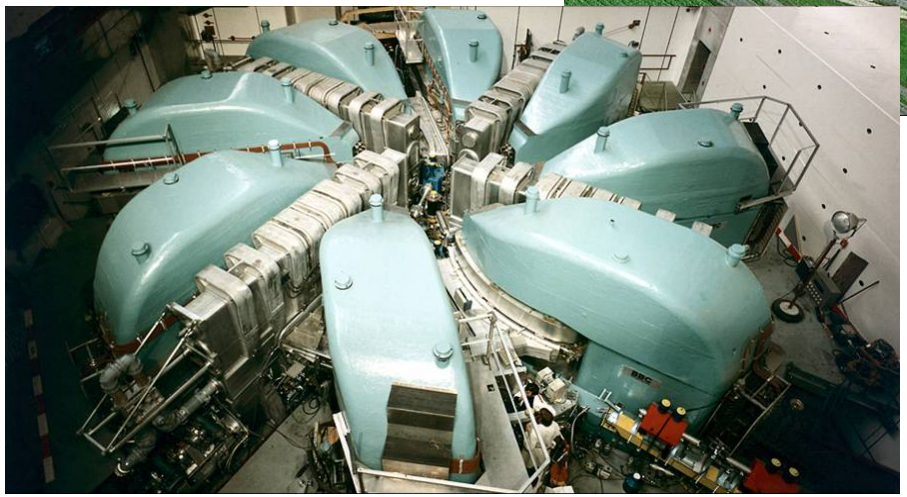
Accelerators at PSI

SwissFEL

Synchrotron Light Source



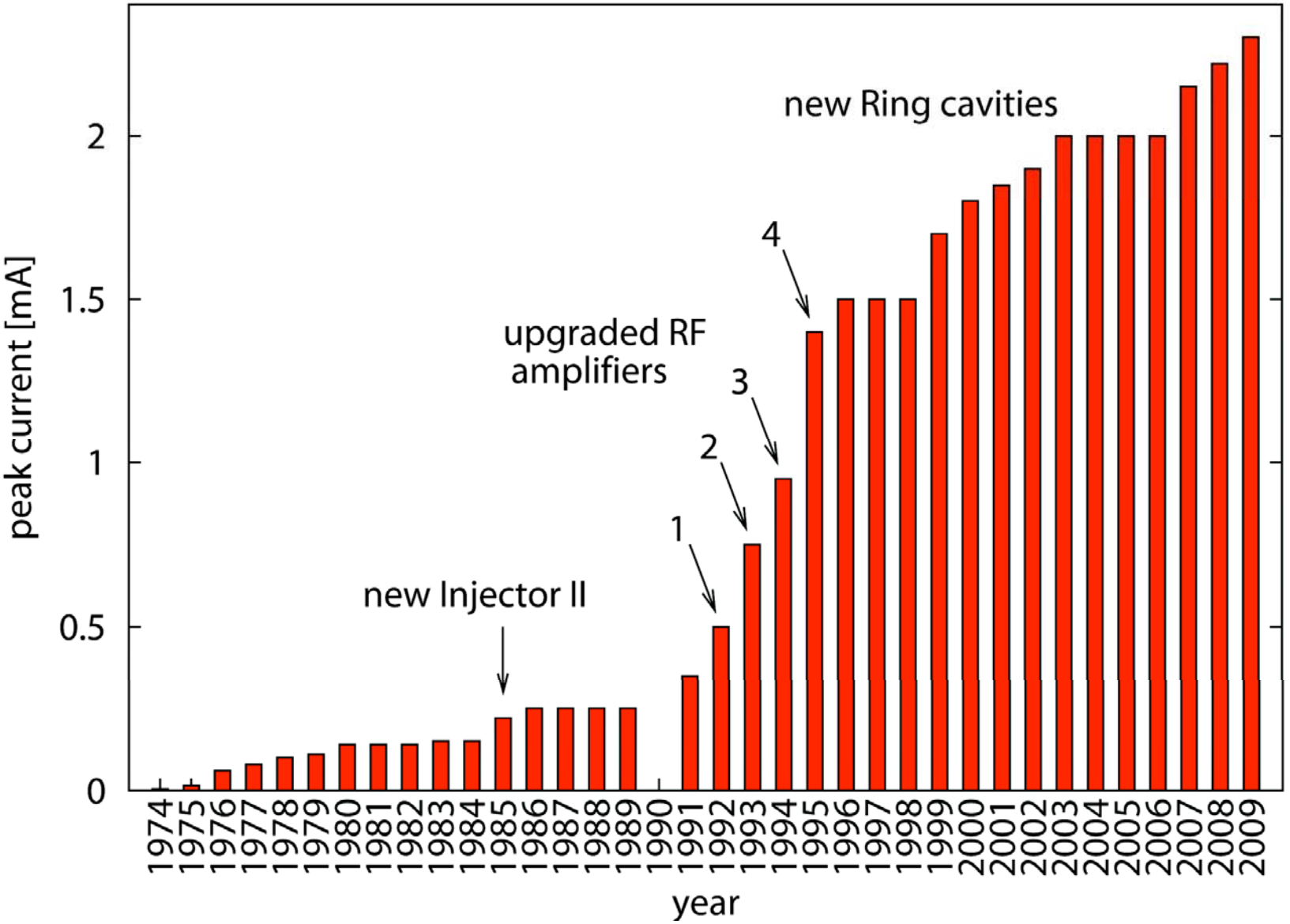
Proton Cyclotron



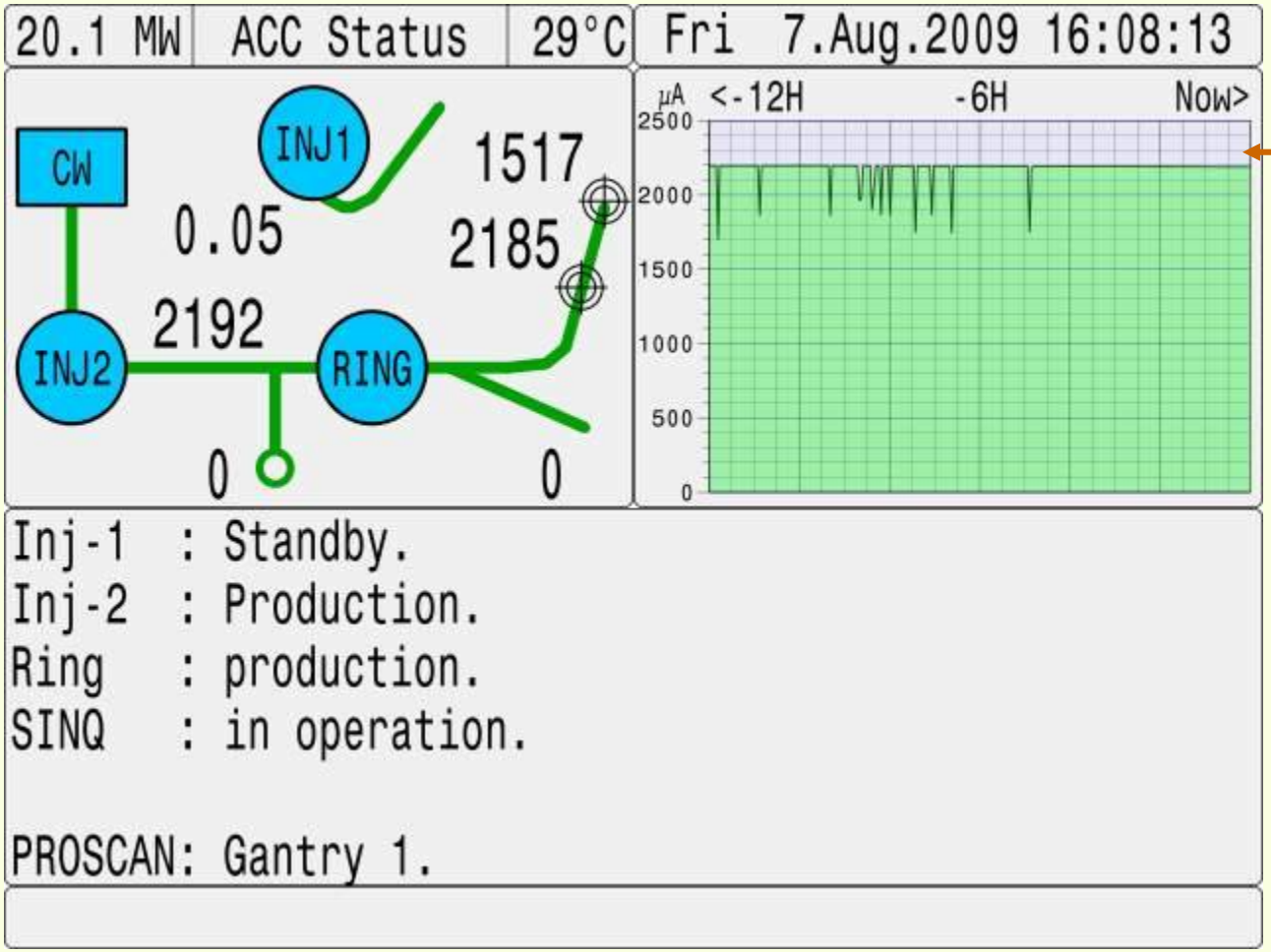
The 590 MeV Ringcyclotron at PSI

2.2 mA, 1.3 MW proton beam on target

Still going strong after 36 years



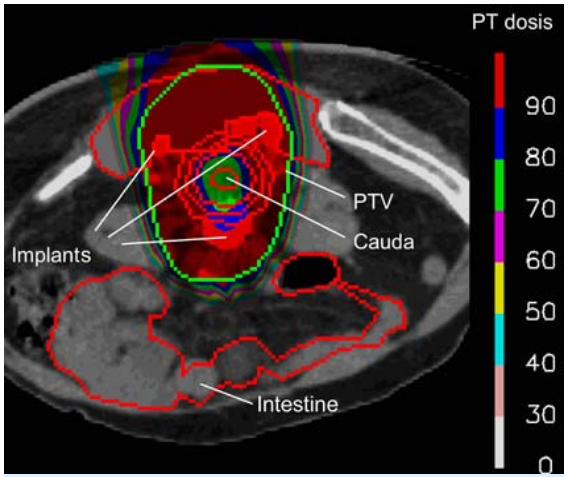
1.3 MW proton beam



2.3mA on 19.8.2009

Humans and health

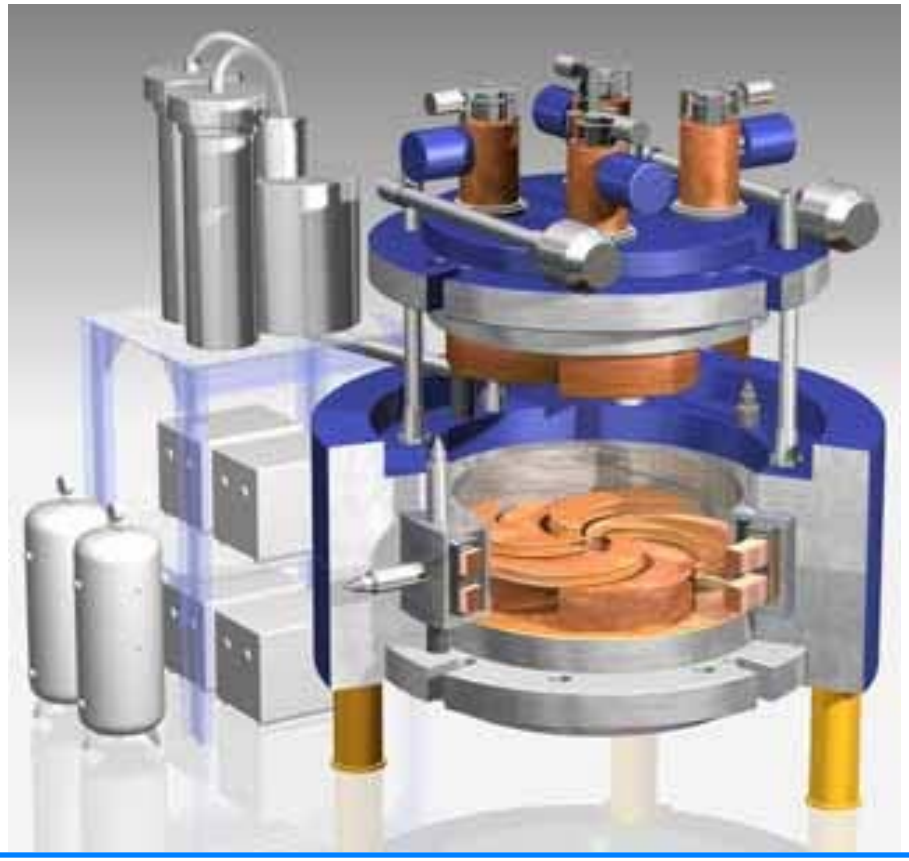
Radiation facility (Gantry) for proton therapy



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

MEDICAL THERAPY

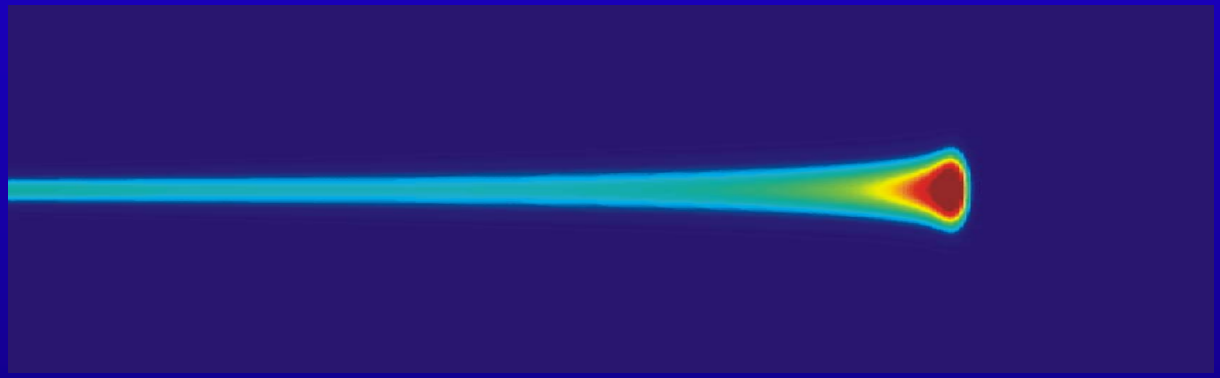
ESTABLISHED TECHNIQUE = CANCER TREATMENT WITH PROTONS
→ CYCLOTRON WITH MAXIMUM ENERGY OF 250 MeV

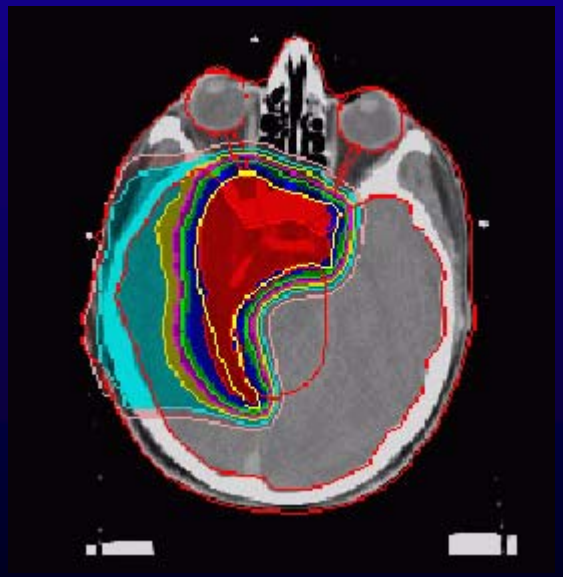


PROSCAN
SC CYCLOTRON
ACCEL / PSI

BRAGG PEAK

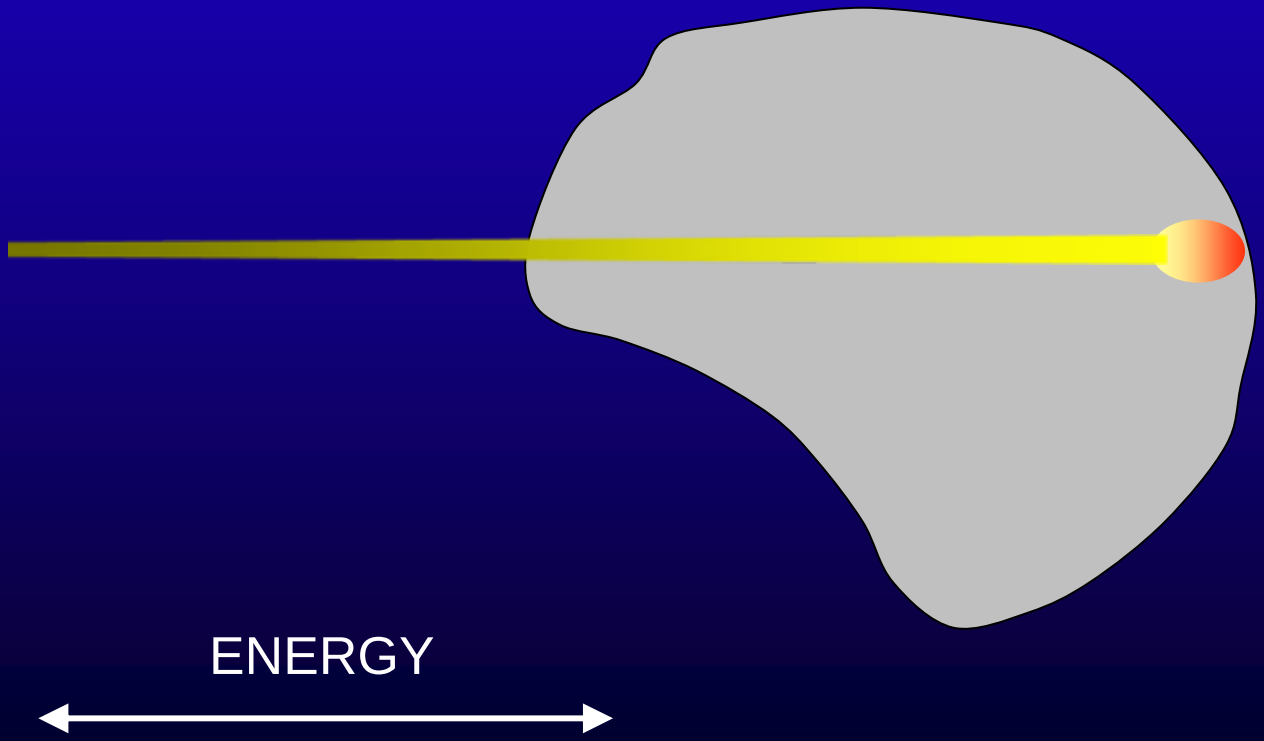
PROTON BEAM →





… ALLOWS THE TREATMENT OF DEEP LYING TUMORS WITH BEST PROTECTION OF THE SURROUNDINGS

SPOT SCANNING



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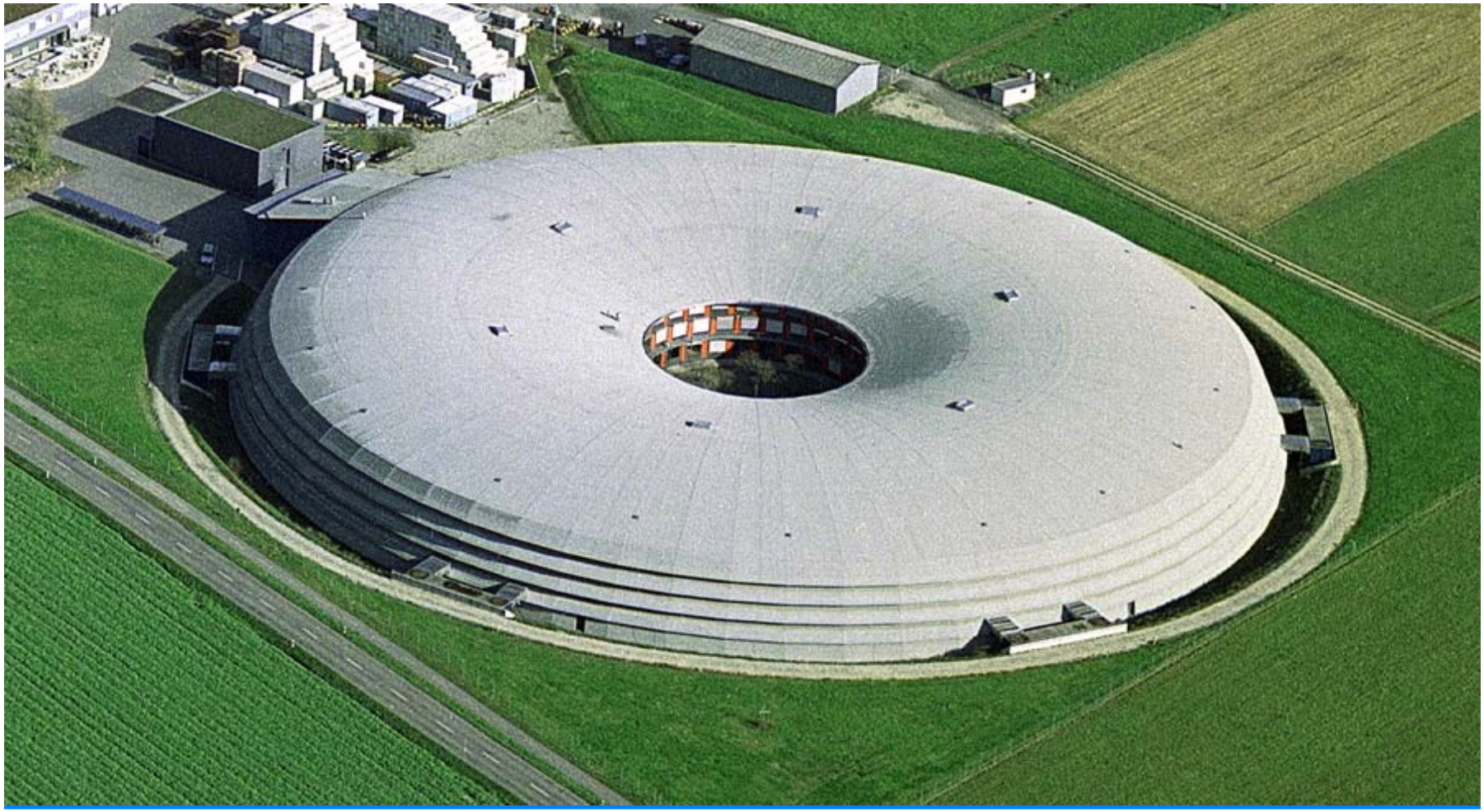
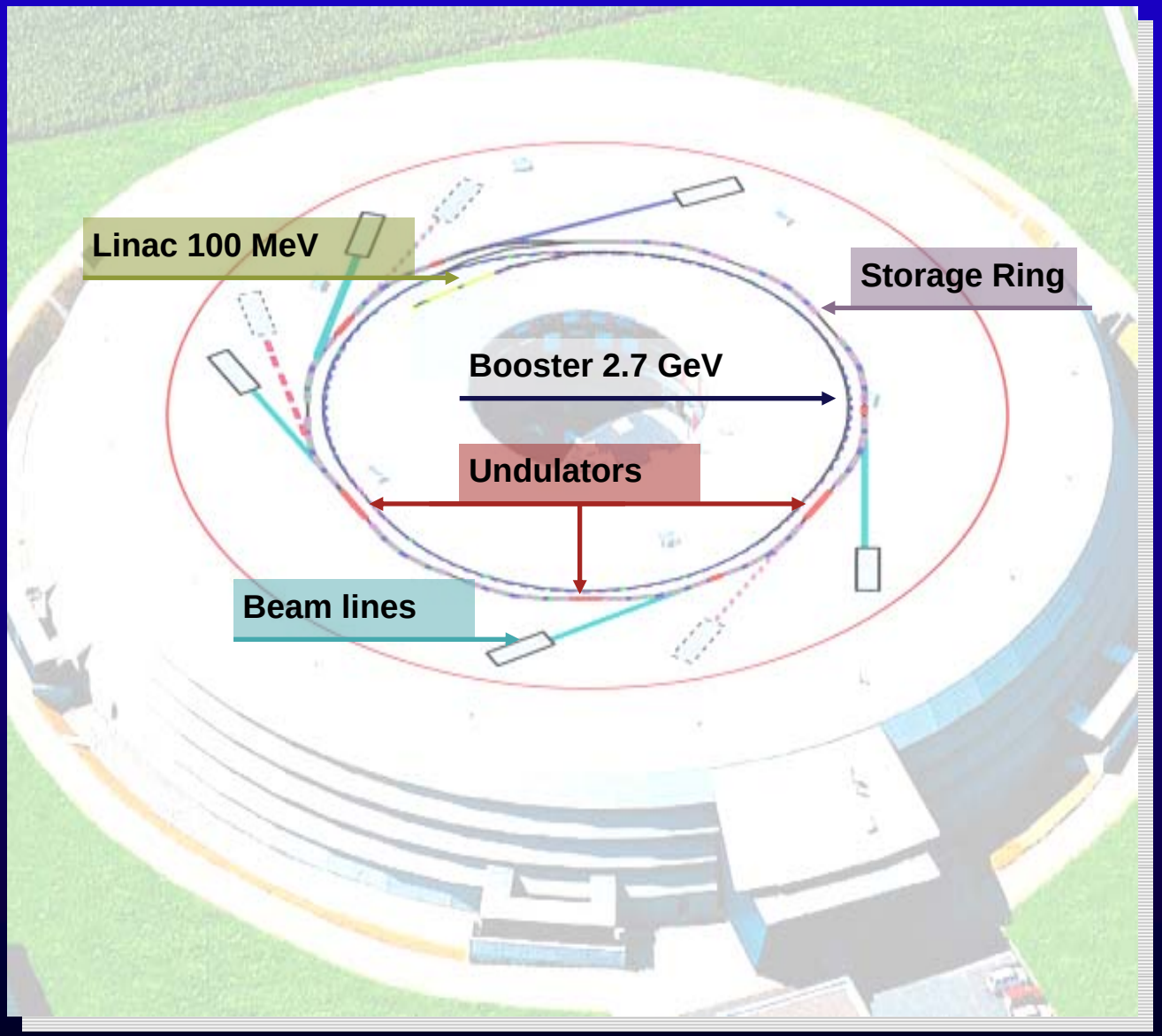
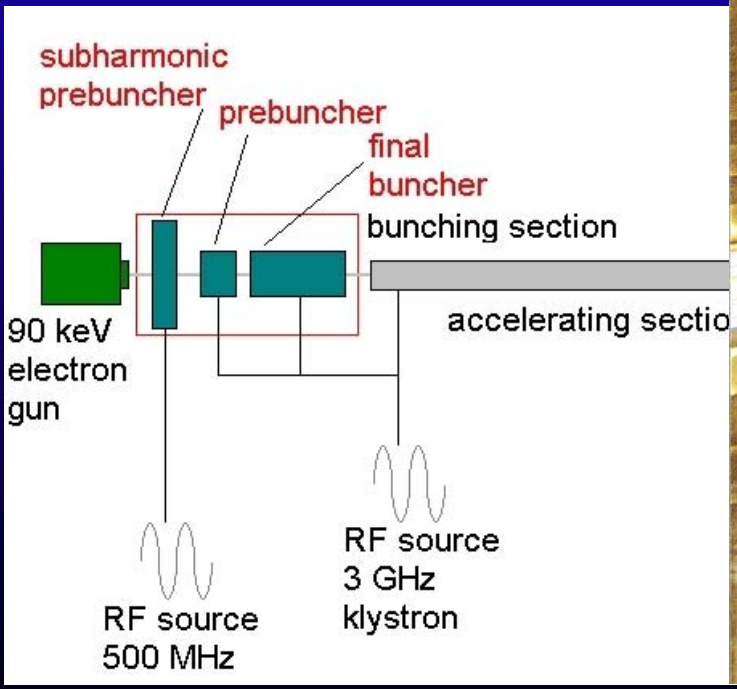
Swiss Light Source SLS

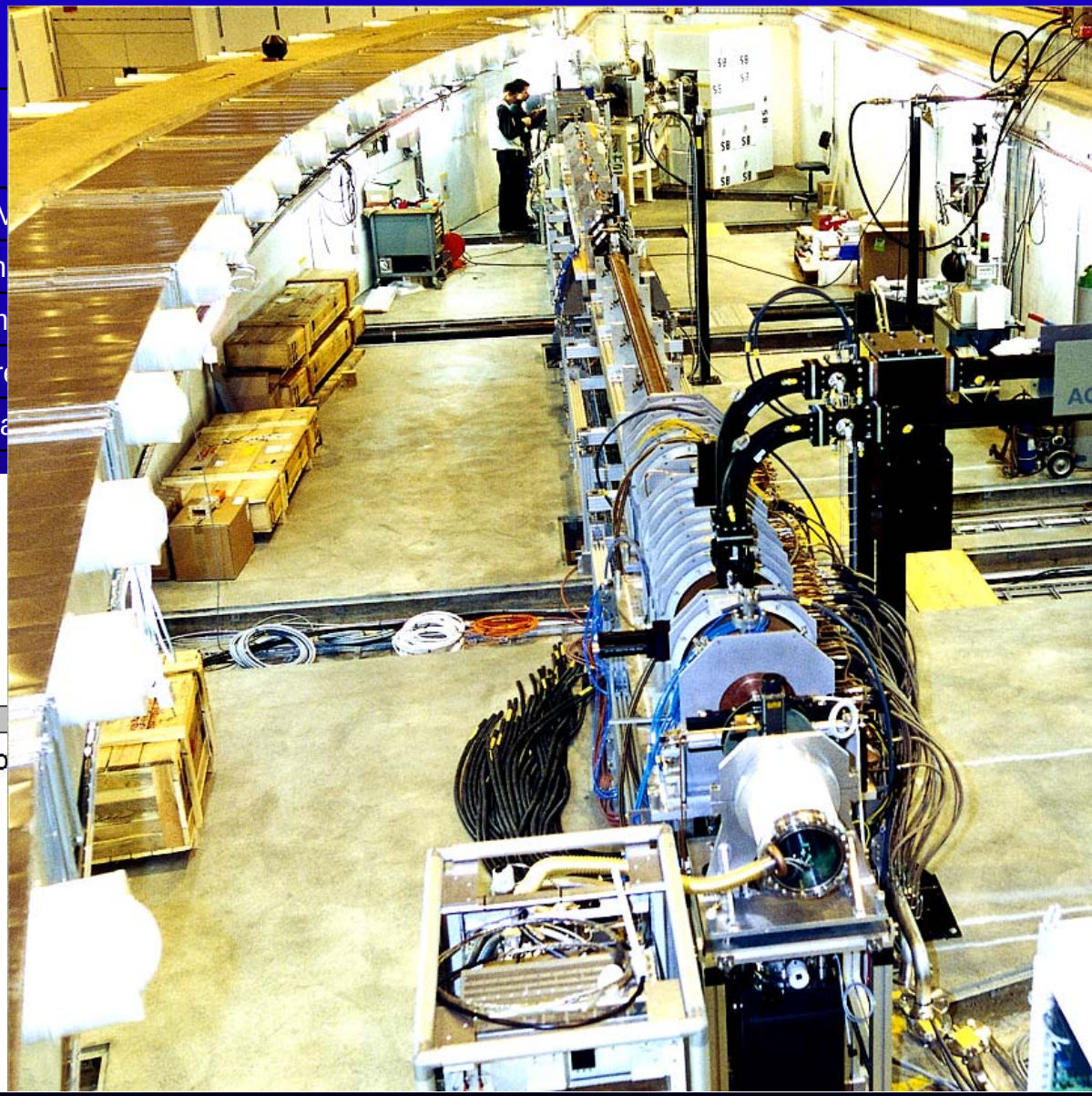



Linac 100 MeV
Storage Ring
Booster 2.7 GeV
Undulators
Beam lines

Linac

Energie [M
Ladung [n
Norm. Em
Energiebr
Energiesta





Booster

E = 2.4 GeV

C = 270 m

ε = 9 nm

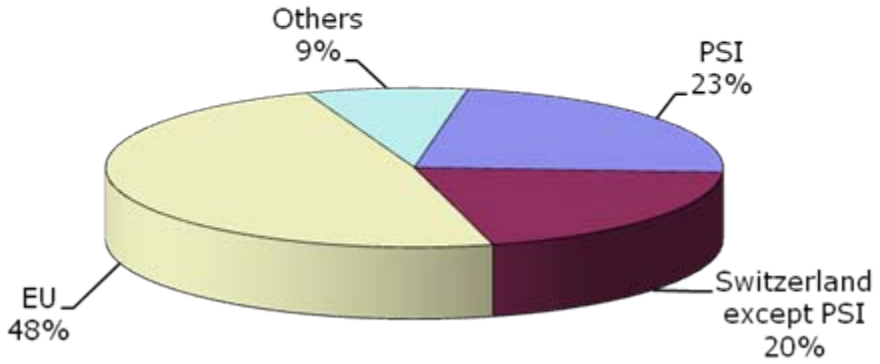
TUNNEL
WITH BOOSTER AND STORAGE RING

SLS: Operation Statistics

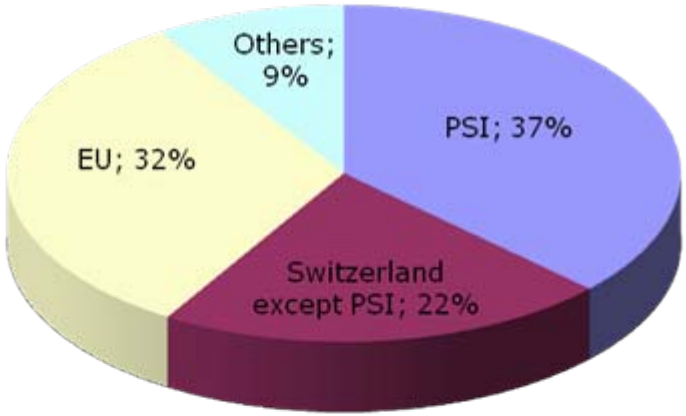
	2003	2004	2005	2006	2007	2008	2009
User operation [h]	5288	5116	4967	5160	5200	5160	5008
Available [%]	94.2	96.3	98.3	95.4	97.3	95.8	98.7
Mean Time Between Failures [h]	46	60	74	61	55	66	81

Use of facilities 2010

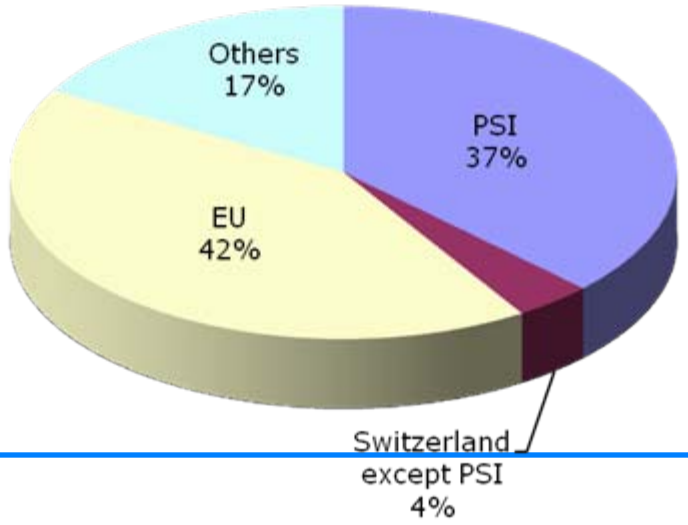
Geographic distribution **SLS users 2010, all beamlines**



Geographic distribution of **SINQ users 2010**



Geographic distribution of **SμS users 2010**



the second wave

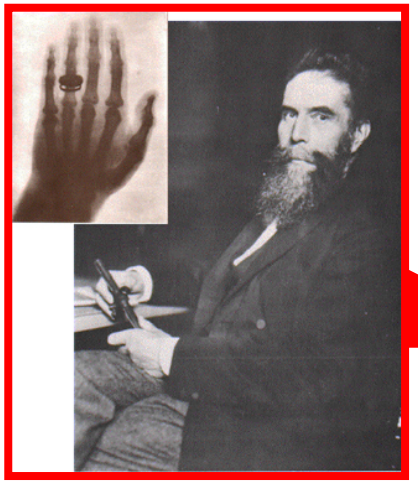
Steep rise in brightness

SLS
SOLEIL (F)
DIAMOND (UK)
…

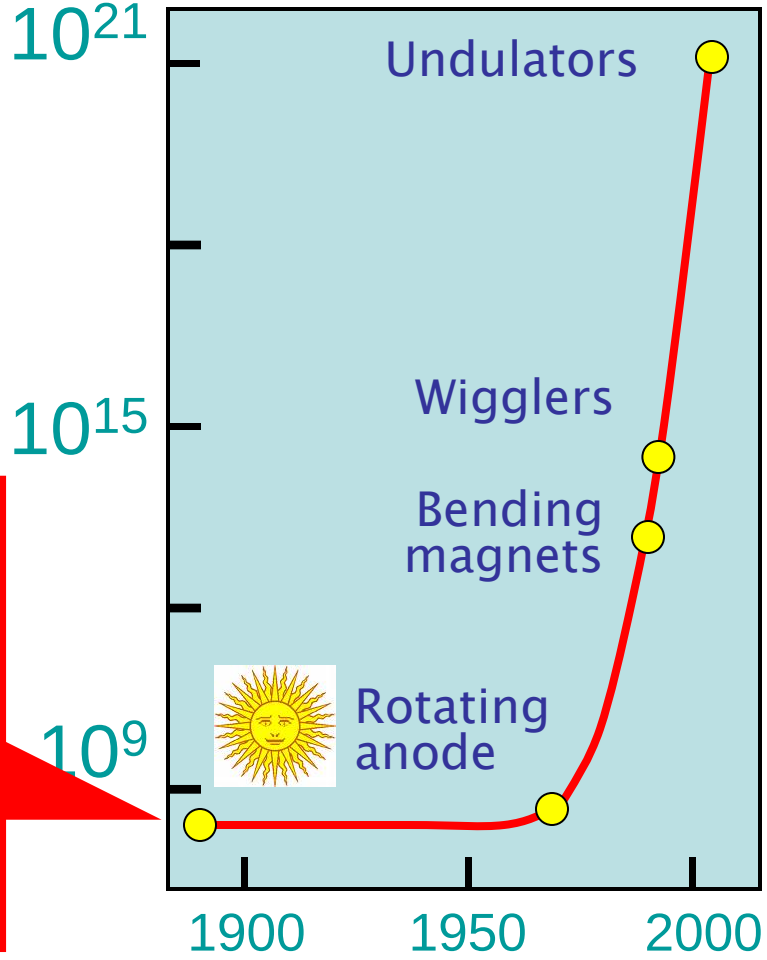
ESRF

SPring8

APS

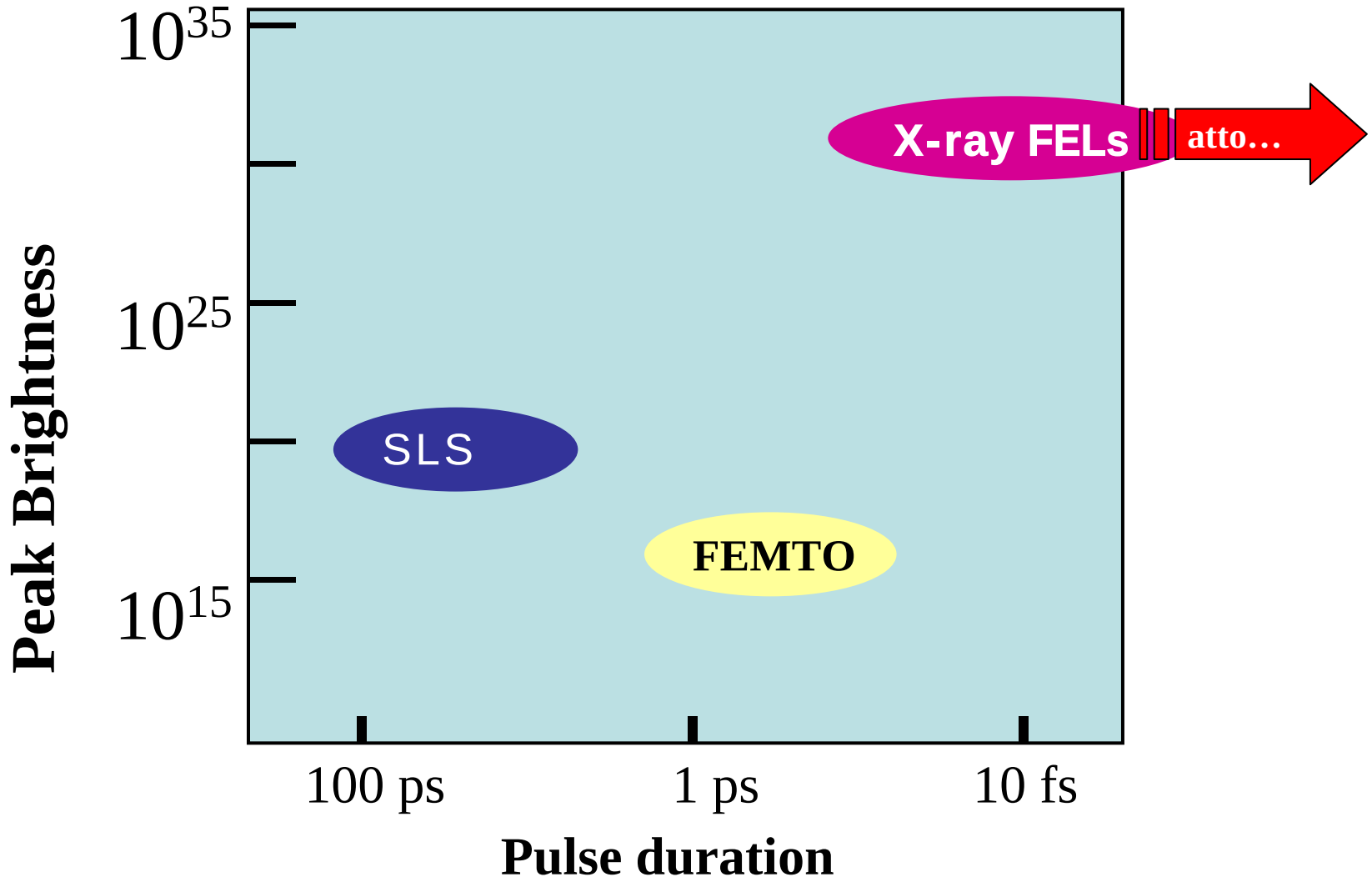


Bertha Roentgen's hand
(exposure: 20 min)



X-Ray Laser

10 ORDERS OF MAGNITUDE JUMP!

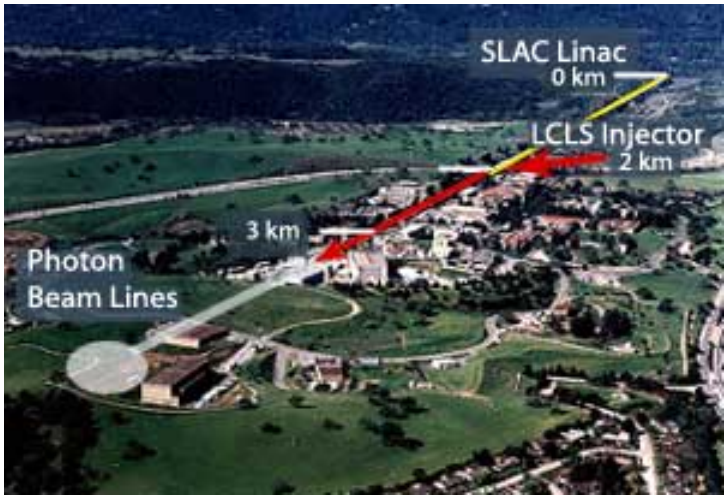


X-FEL facilities

"National"

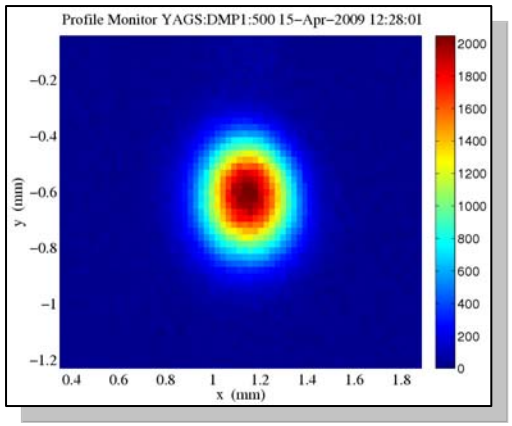
SwissFEL 2016

"Continental"



USA
LCLS-SLAC
2009

Japan
SCSS-SPring8
2010

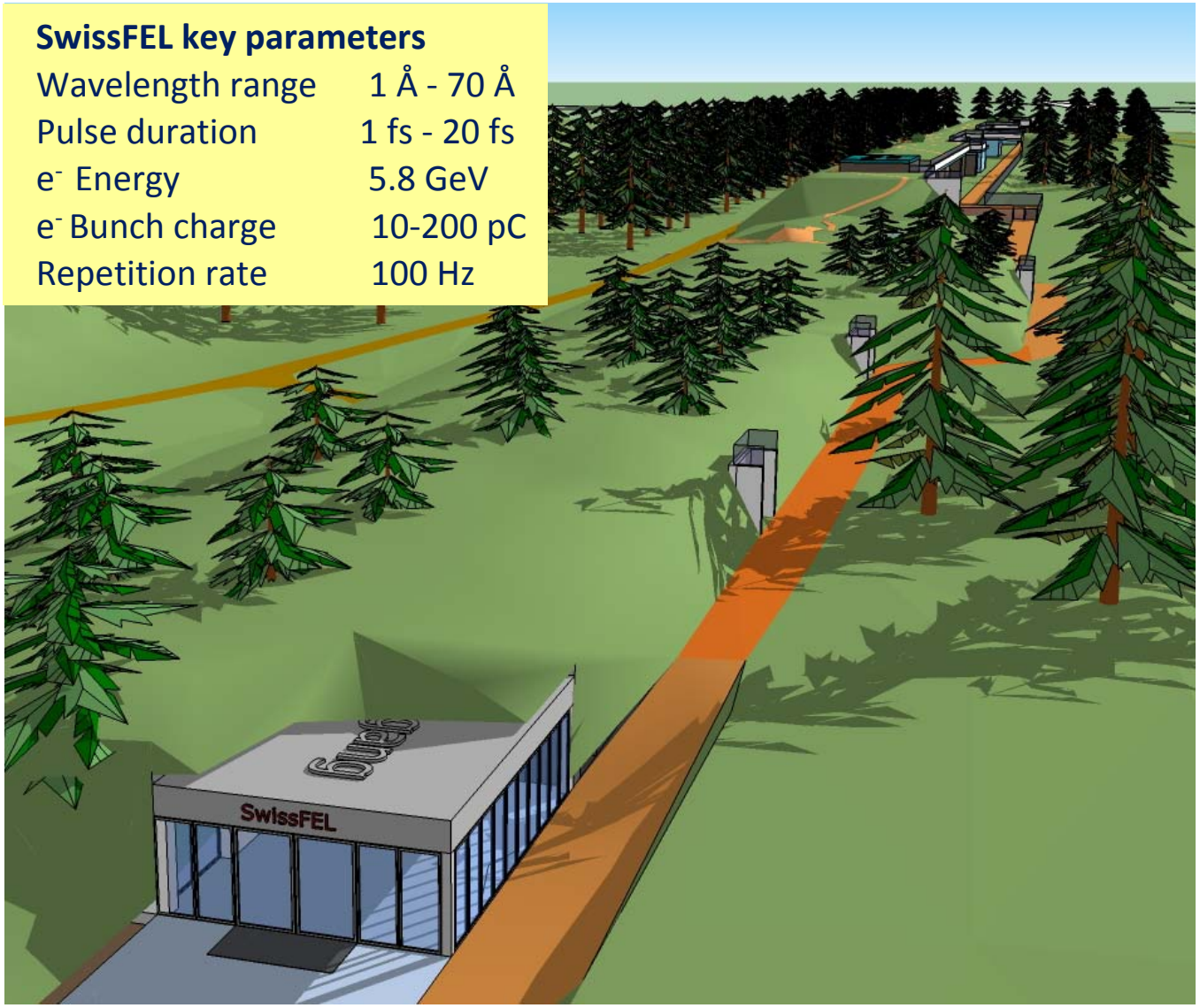


Europe
X-FEL-DESY 2014/2015

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



SwissFEL site and situation

I wish you all an enjoyable and interesting visit