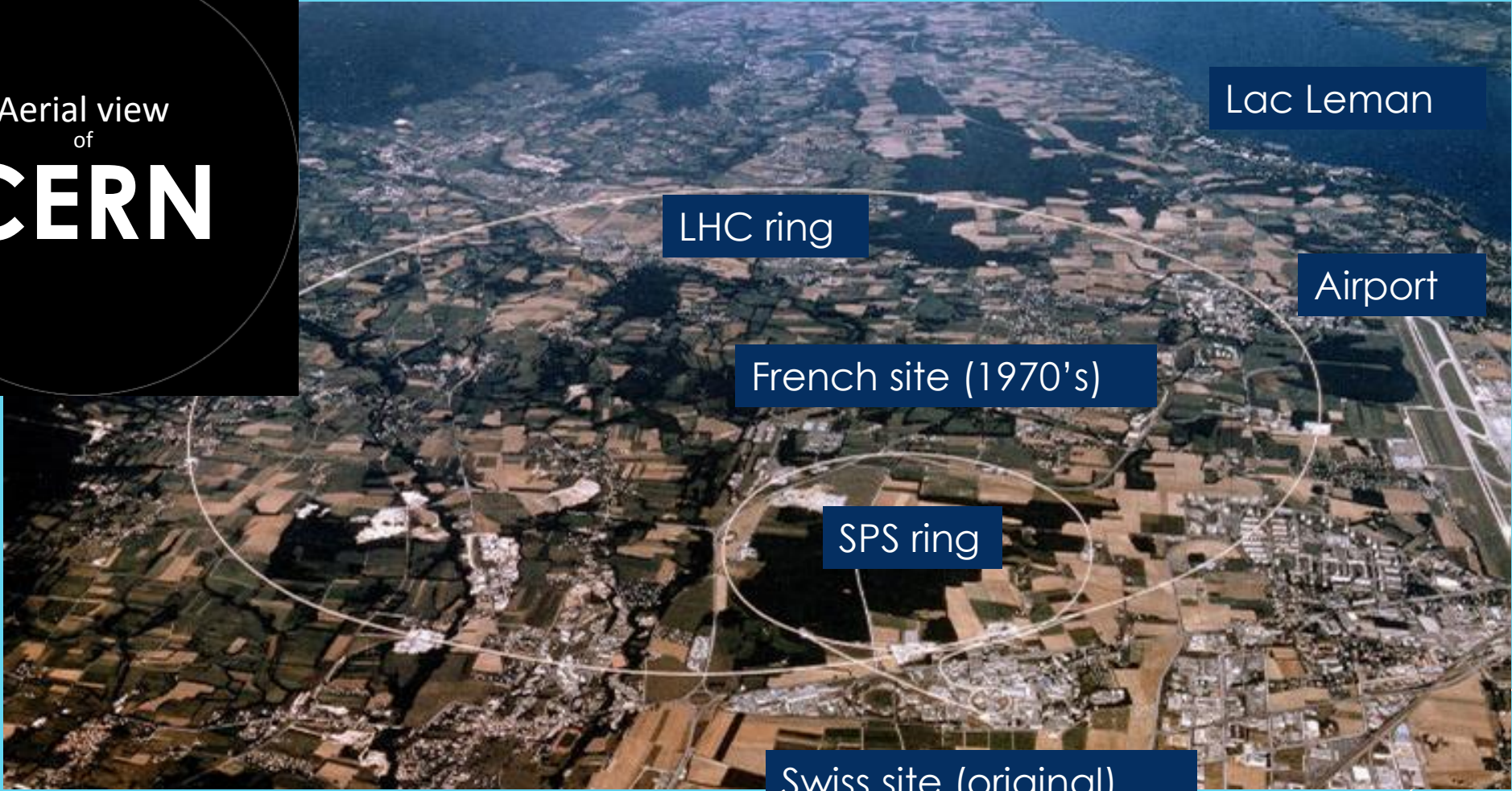


OUTLINE

- ▶ CERN seen from the sky
- ▶ Mission
- ▶ Technologies
- ▶ Accelerators (increase and decrease beam energy)
- ▶ Future projects
- ▶ Spin-off from CERN
- ▶ Jobs and competences
- ▶ Outlook and Challenges

CERN FROM THE SKY

Aerial view
of
CERN



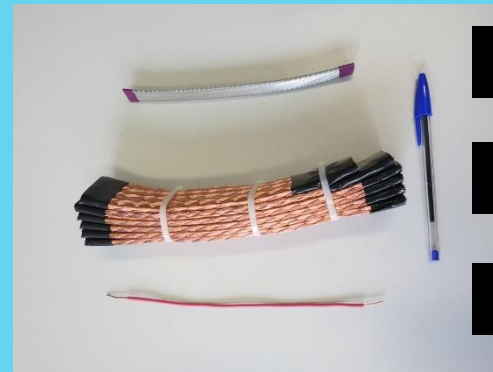


MISSION OF CERN

- ▶ Technical innovation
 - ▶ New techniques in collaboration with other institutes worldwide and industry (member states when possible)
- ▶ Training
 - ▶ Students (17-→)
 - ▶ Graduates (20+)
- ▶ Employ young(ish) people and retain the best (competences)
 - ▶ Staff (23 -→) (average age for staff = 32 years)
- ▶ Research in particle physics
 - ▶ Push frontiers of knowledge

TECHNOLOGIES USED AT CERN

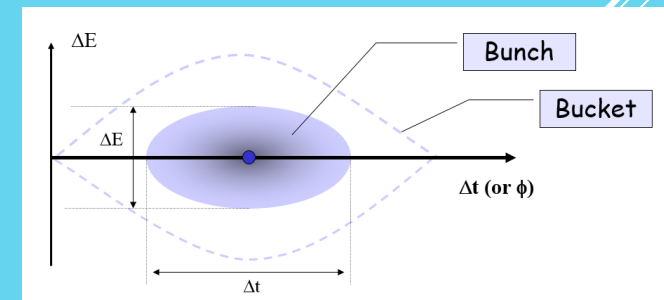
- ▶ Computing/IT (Web-technology and fast Ethernet/Wifi) (10Gb/s)
- ▶ Vacuum & cryogenics (superconductivity)
- ▶ Electronics (analogue, digital, DC and switched power)
- ▶ Electricity (400 kV -> 220 V AC)
- ▶ Magnets (normal and superconducting)
- ▶ Mechanics (detectors, supports)
- ▶ Material science (new alloys) – 3D printing
- ▶ Radiofrequency 10->3000 MHz cavities
- ▶ Control systems (Linux front-ends and servers)



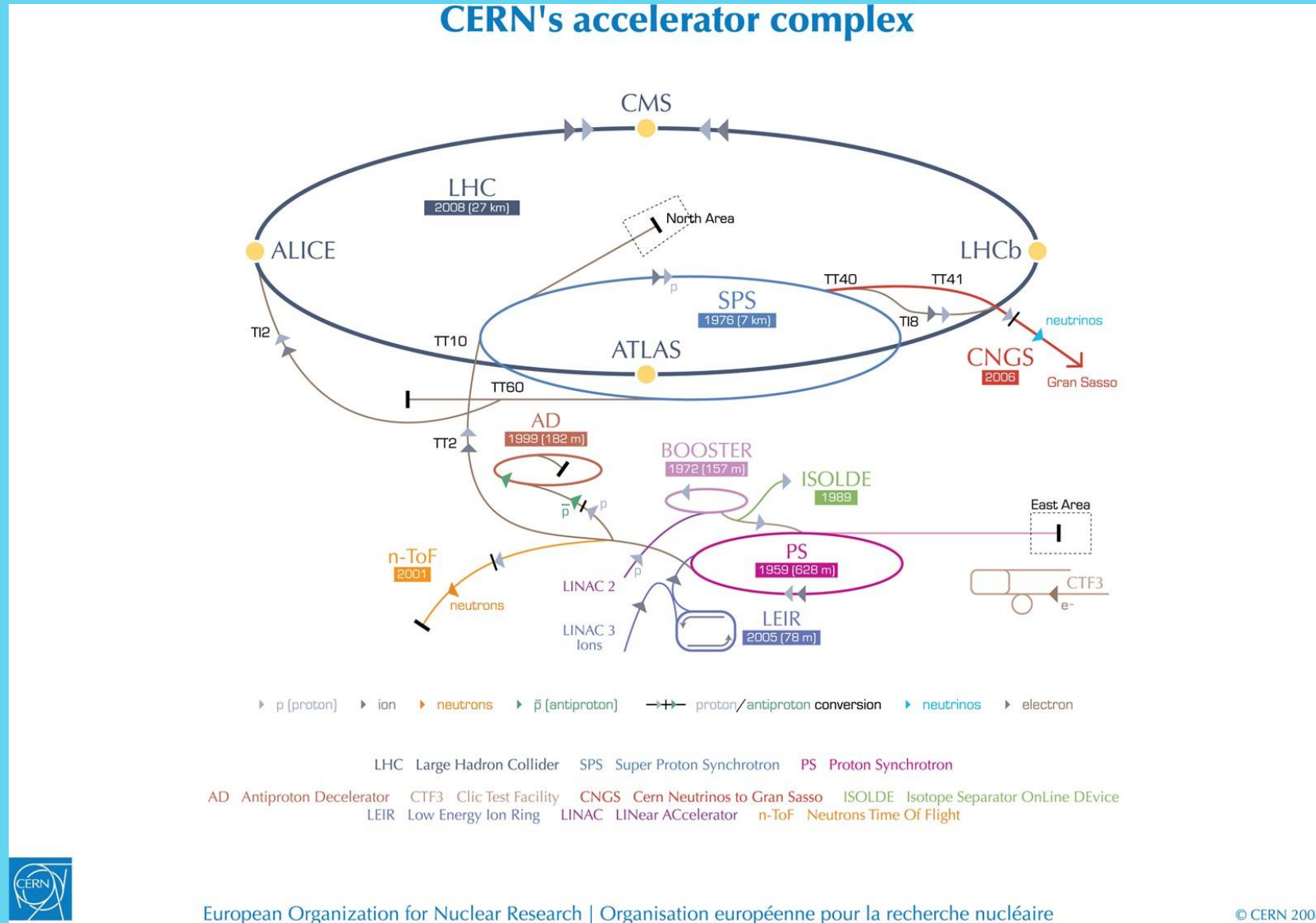
13 kAmps -270C

13 kAmps 20C

13 Amps at 20C



ACCELERATOR CHAIN

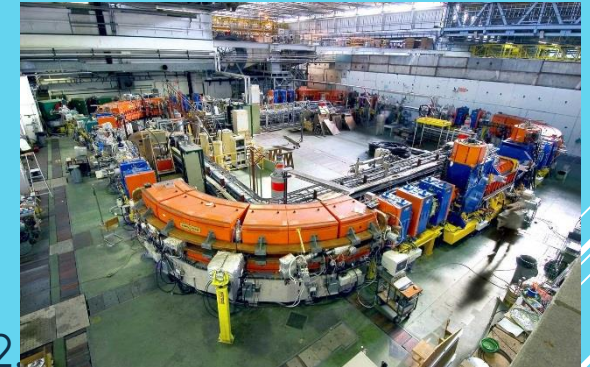


ACCELERATORS (MACHINES) #1

Chain (one machine connected to another by transfer-lines)

<https://videos.cern.ch/record/1125472>

- ▶ LINAC (~100 m long) – often used for medical applications (x-rays etc)
- ▶ Series of machines (increasing high energy physics)
 - ▶ PSB (booster – 4 rings) -> ISOLDE physics
 - ▶ LEIR (ions)
 - ▶ PS -> material and electronics radiation testing and physics
(<https://www.google.com/maps/@46.2317217,6.0476546,2a,75y,193.37h,82t/data=!3m6!1e1!3m4!1sSaCsCx-k6GaVH7lLvdXGMQ!2e0!7i13312!8i6656>)
 - ▶ SPS -> material hardness and fixed-target physics (7km circumference)
 - ▶ LHC -> collider (proton ↔ proton) (27 km circumference, superconducting)
- ▶ Special machines
 - ▶ AD and ELENA (for very low energy anti-matter physics)

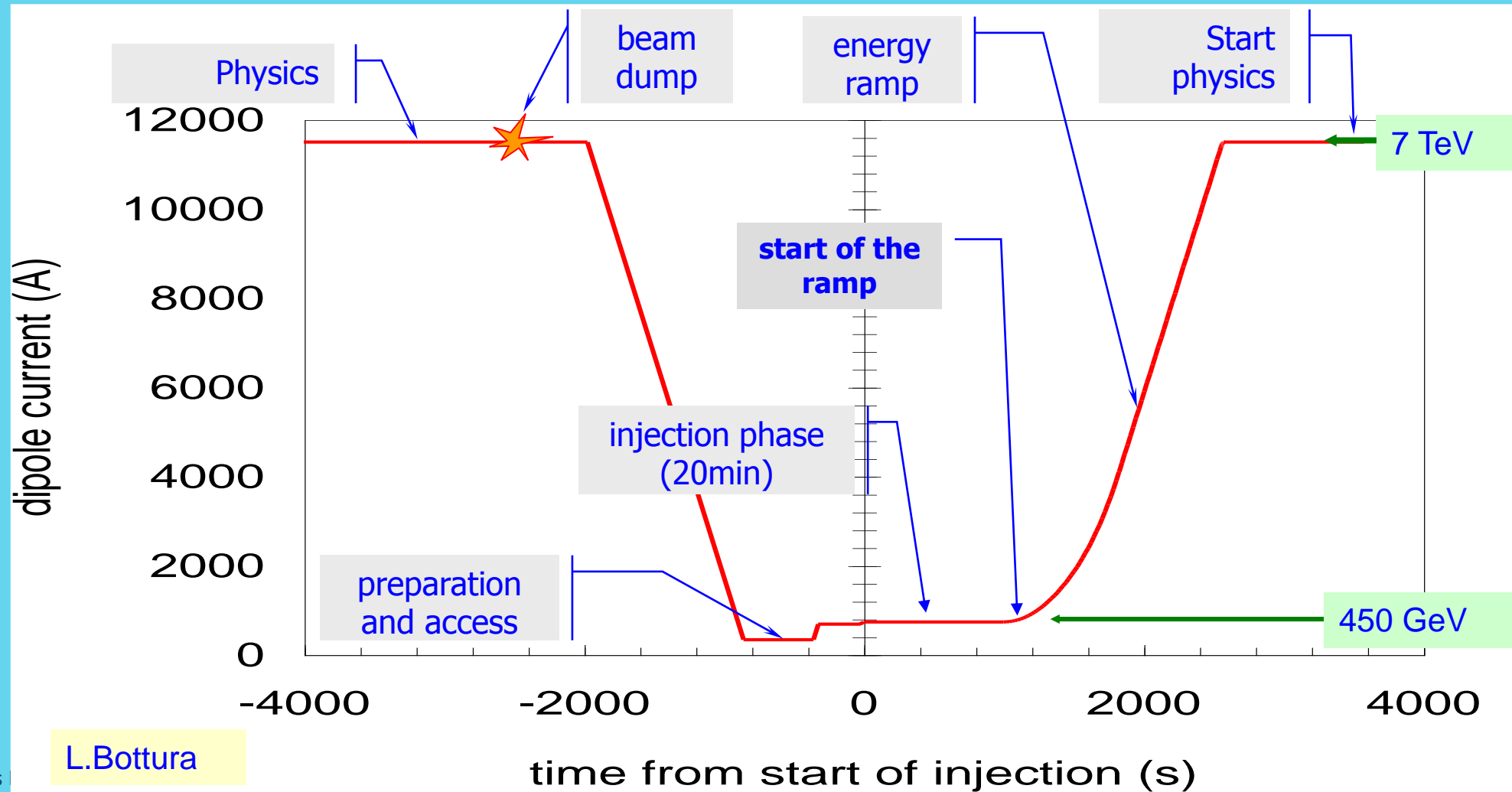


ACCELERATORS (MACHINES) #2

- ▶ Made of:
 - ▶ Electro-magnets (dipoles to bend, quadrupoles to focus ..)
 - ▶ Kickers (electrostatic) – pulsed (several kVolt / kAmp)
 - ▶ Vacuum tubes and pumps (remove air particles)
 - ▶ RF cavities to add or remove beam energy
 - ▶ Instrumentation (position, intensity, size ..)
 - ▶ Experiments (colliders, fixed-target)

LHC 'CYCLE'

The magnetic field (dipole current) is increased during the acceleration.



L.Bottura

Lars

CERN CONTROL CENTRE (VISIT LATER TODAY)

PS (Meyrin)
island (1950+)

SPS island
(1970+)



Technical
Infrastructure
island (2008+)

LHC island
(2008+)

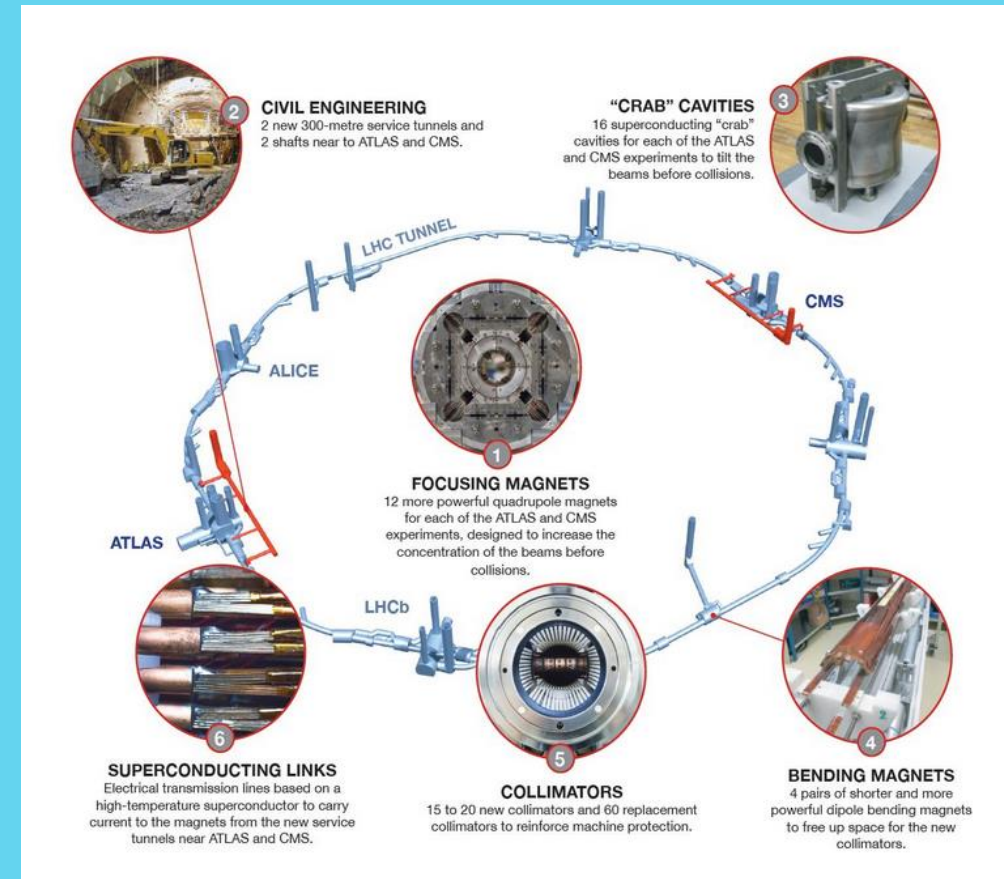
FUTURE (MAJOR) PROJECTS #1

- ▶ General ideas
 - ▶ Brighter beams:
 - ▶ Higher energy and intensity, smaller transverse dimensions
- ▶ LS2 (2019->2021) - LIU project
 - ▶ Upgrade of LINAC4, PSB, PS, SPS
 - ▶ Ultimate goal: provide beams for HL-LHC
 - ▶ Now: production and logistics phase (installation, commissioning)

FUTURE (MAJOR) PROJECTS #2

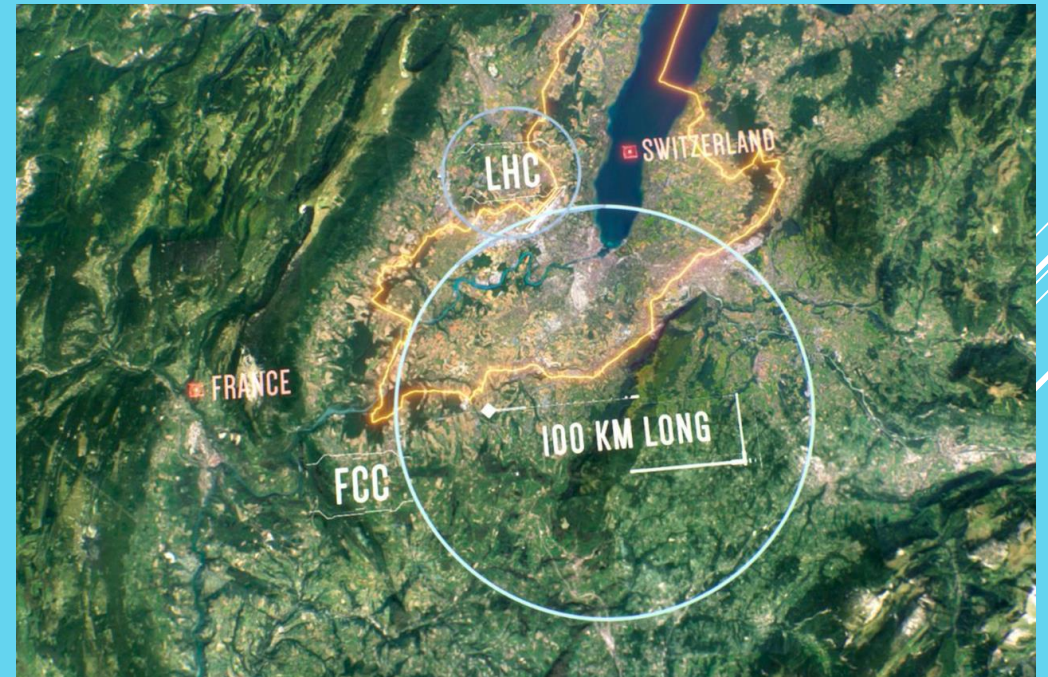
LS3 (2024->2026) HL-LHC project (upgrade of LHC + experiments)

- ▶ <https://project-hl-lhc-industry.web.cern.ch/>
- ▶ <https://bsbf2018.org>



FUTURE (MAJOR) PROJECTS #3

- ▶ Much later but preparations are well underway (ICFA/ESPP)
 - ▶ CLIC (Linear collider) – 11 km / 50km (new underground tunnel)
 - ▶ Could be ready by 2035
 - ▶ FCC (80 or 100 km circumference options)
 - ▶ <https://fcc.web.cern.ch/Pages/default.aspx>



SPIN-OFF FROM CERN #1 – MOST KNOWN!

Tim Berners-Lee, CERN March 1989

This proposal concerns the [management of general information](#) about accelerators and experiments at CERN. It discusses the problems of loss of information about complex evolving systems and derives a solution based on a **distributed hypertext system**

World Wide Web

The WorldWideWeb (W3) is a wide-area [hypermedia](#) information retrieval initiative aiming to give universal access to a large universe of documents.

Everything there is online about W3 is linked directly or indirectly to this document, including an [executive summary](#) of the project, [Mailing lists](#) , [Policy](#) , November's [W3 news](#) , [Frequently Asked Questions](#) .

[What's out there?](#)

Pointers to the world's online information, [subjects](#) , [W3 servers](#), etc.

[Help](#)

on the browser you are using

[Software Products](#)

A list of W3 project components and their current state. (e.g. [Line Mode](#) ,X11 [Viola](#) , [NeXTStep](#) , [Servers](#) , [Tools](#) , [Mail robot](#) , [Library](#))

[Technical](#)

Details of protocols, formats, program internals etc

[Bibliography](#)

Paper documentation on W3 and references.

[People](#)

A list of some people involved in the project.

[History](#)

A summary of the history of the project.

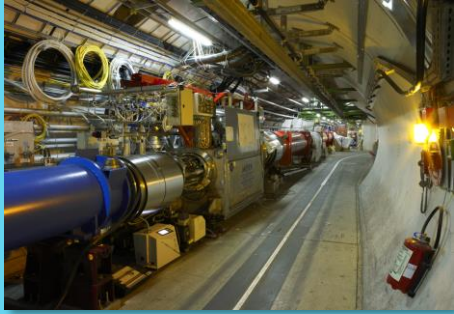
[How can I help ?](#)

If you would like to support the web..

[Getting code](#)

Getting the code by [anonymous FTP](#) , etc.

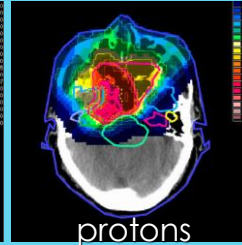
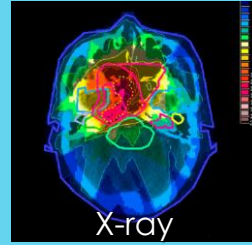
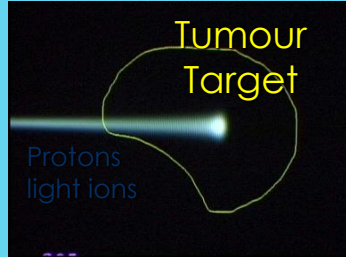
SPIN-OFF FROM CERN #2



Accelerating particle beams

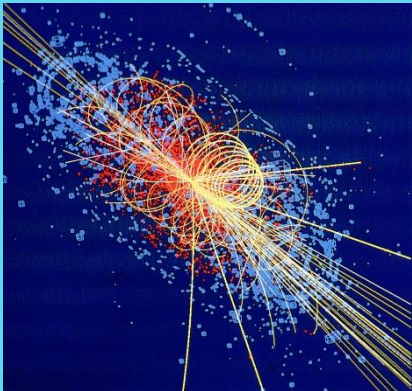
~30'000 accelerators worldwide
~17'000 used for medicine

↔ Hadron Therapy



Leadership in Ion Beam Therapy now in Europe and Japan

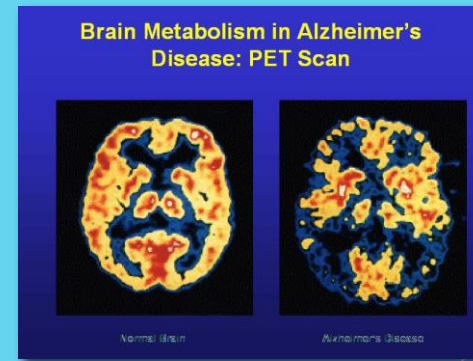
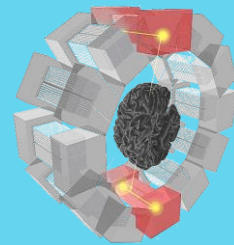
>100'000 patients treated worldwide (45 facilities)
>50'000 patients treated in Europe (14 facilities)



Detecting particles

↔ Imaging PET Scanner

Clinical trial in Portugal, France and Italy for new breast imaging system (ClearPEM)



CERN JOBS – FEW PHYSICISTS EMPLOYED

Information Officer

Administrative Assistant

Electronics
Engineer

Technical Engineer
(Electronics)

Computing Engineer

Lawyer

Vacuum Technician

Firefighter

Machine Operator

Radioprotection
Engineer

Translator

Physicist

TYPES OF POSTS

- ▶ Trainees (short-term)
- ▶ Technical students (after 3 years of study)
 - ▶ https://www.youtube.com/watch?v=_vj3a-5tefM
- ▶ PhD students (after master diploma)
- ▶ Fellows (after bachelor or master degree)
- ▶ Staff (we like people with experience and up-to-date training!)
- ▶ One-stop for all candidates: <http://cern.ch/jobs>

OUTLOOK WITH CHALLENGES

- ▶ CERN has unique position in the centre of Europe
- ▶ Large infrastructure and good-will from host states
- ▶ Several nations expressed interest in joining (observer)
 - ▶ In-kind contributions (material)
- ▶ Commitment/funded for programmes until 2035 (HL-LHC)
- ▶ New programmes being studied
- ▶ However:
 - ▶ Not cheap (infrastructure and salaries)
 - ▶ National interests
 - ▶ Personnel spread too thin since LHC (too many projects)

MANY THANKS FOR YOUR ATTENTION

▶ Questions?