

CERN Plans and Perspectives for the Future



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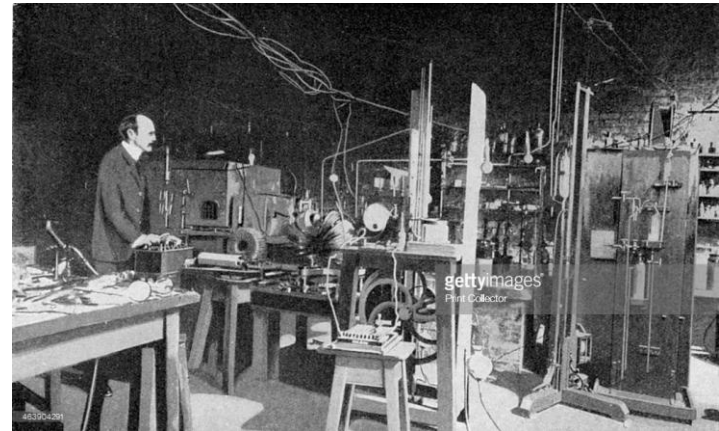
11 January 2019

INTRODUCTION

PHYSICS AND COLLIDERS

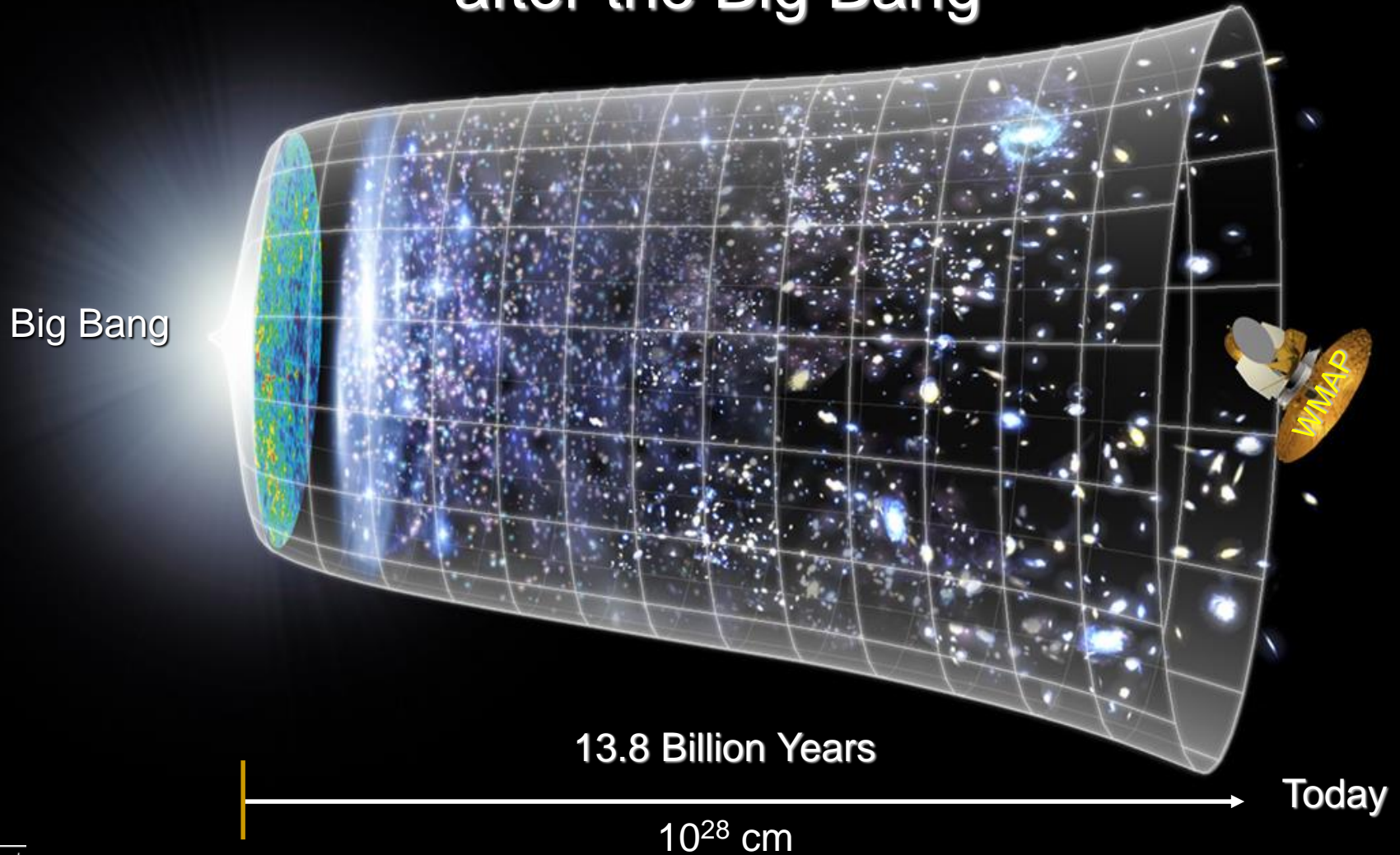
Accelerator Development

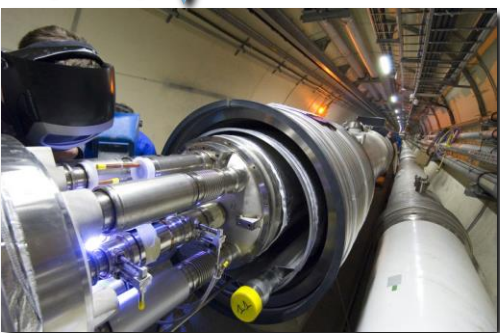
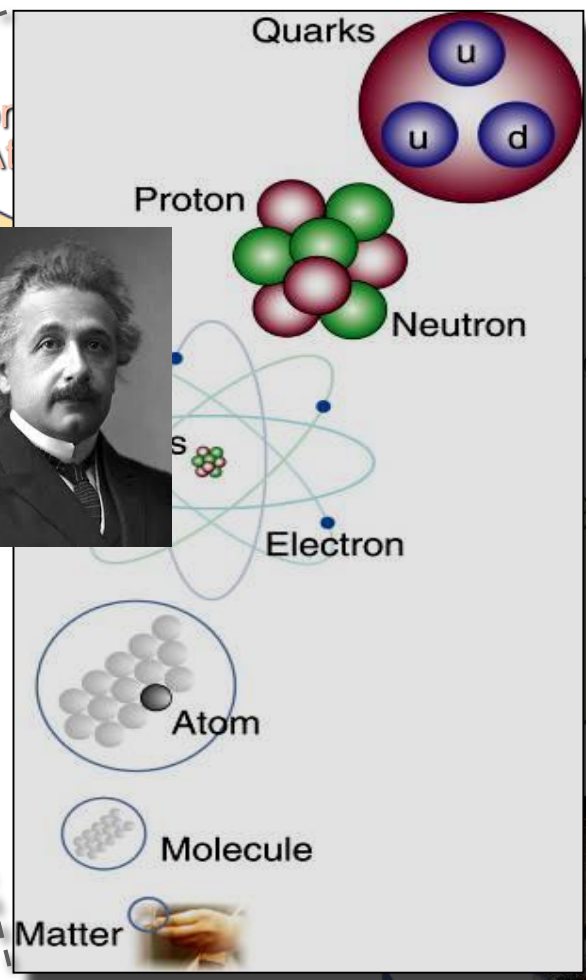
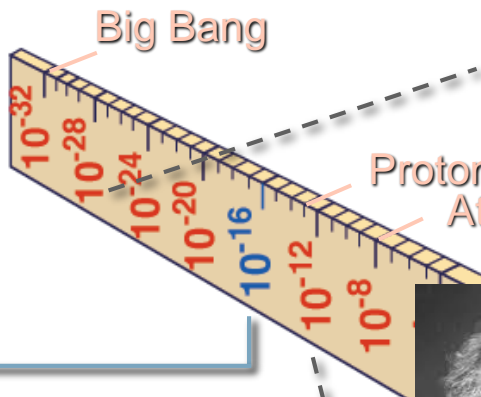
- Characterised by rapid progress for over a century.
 - From cathode-ray tubes to the LHC.
 - From the discovery of the electron to the discovery of the Higgs boson.
- Advances in accelerators require corresponding advances in accelerator technologies
 - Magnets, vacuum systems, RF systems, diagnostics,...
- But timelines becoming long, requiring:
 - Long-term planning.
 - Long-term resources.
 - Global collaboration.



Scientific Challenge:

to understand the very first moments of our Universe
after the Big Bang



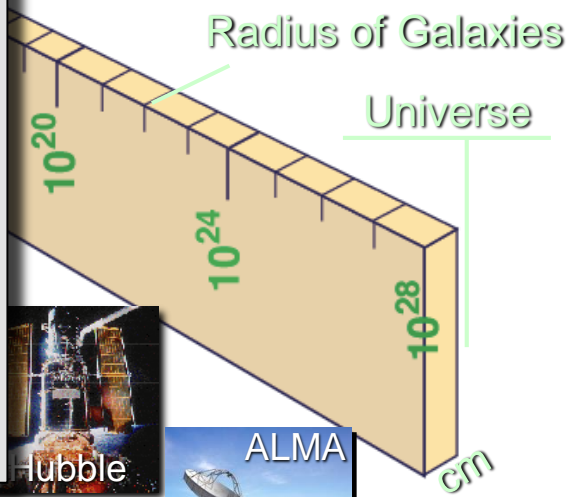


Super-Microscope

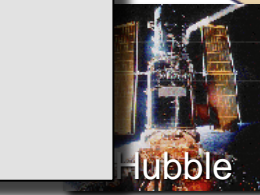


Reproducing conditions

LHC

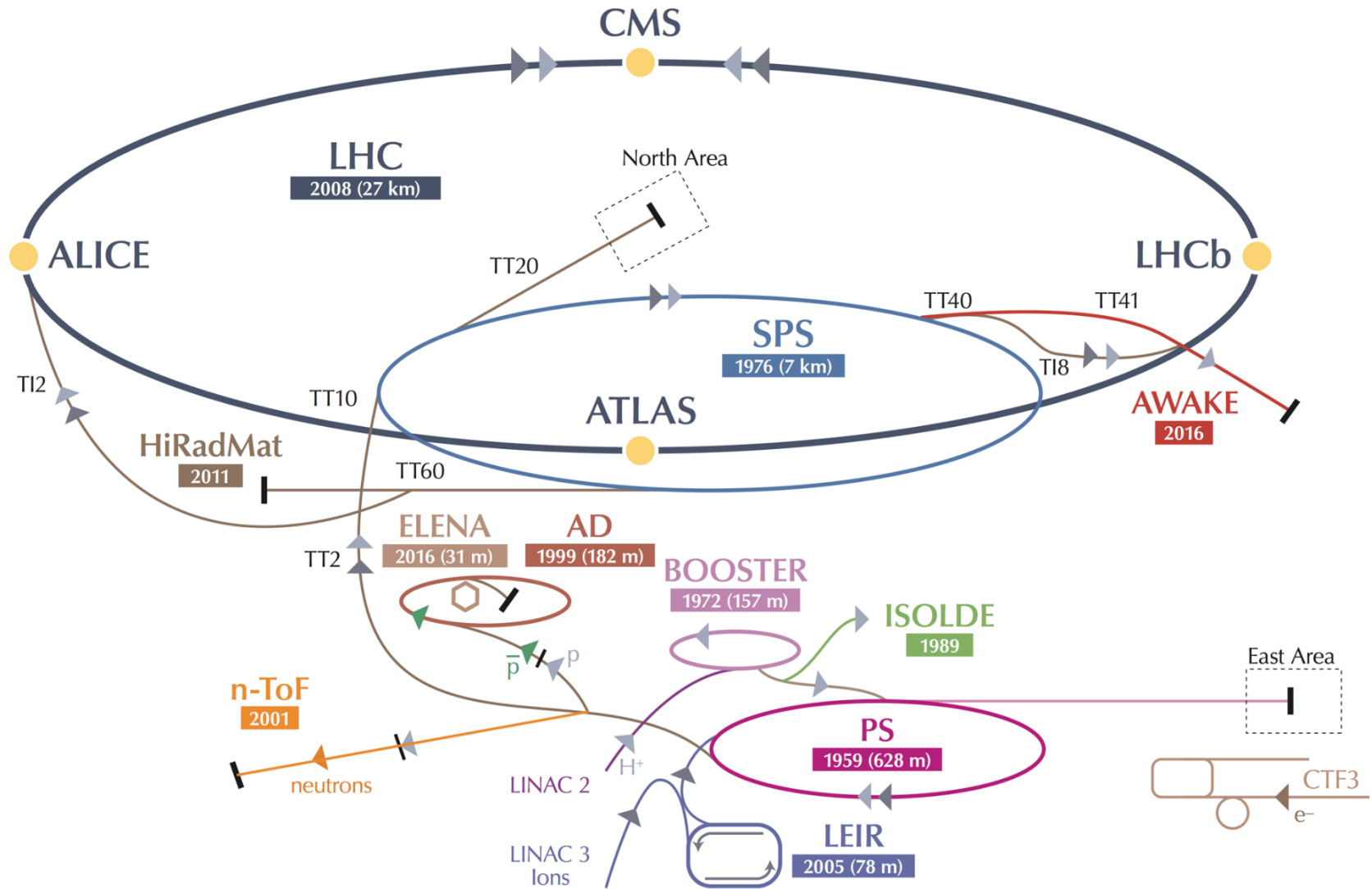


Looking back

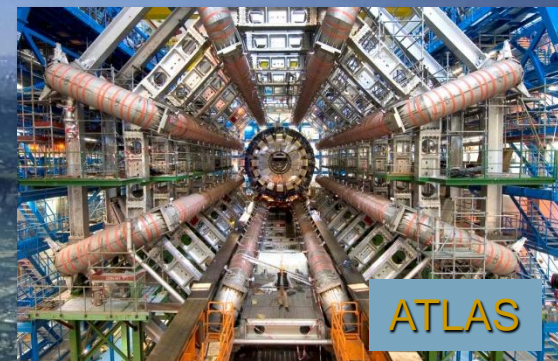


CIRCULAR COLLIDERS

CERN Accelerator Complex



A New Era in Fundamental Science

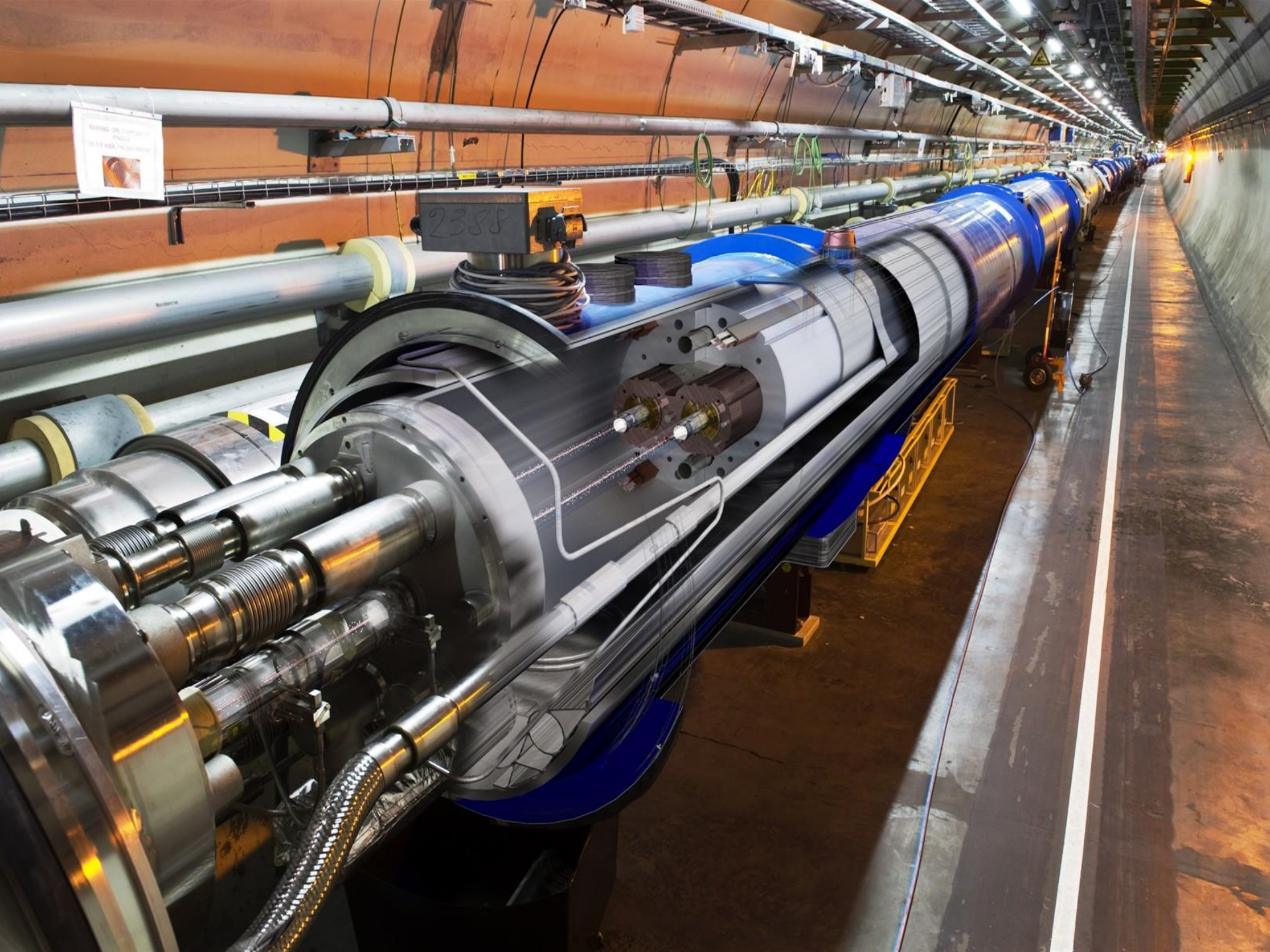


Exploration of a new energy frontier
in p-p, Pb-Pb and p-Pb collisions





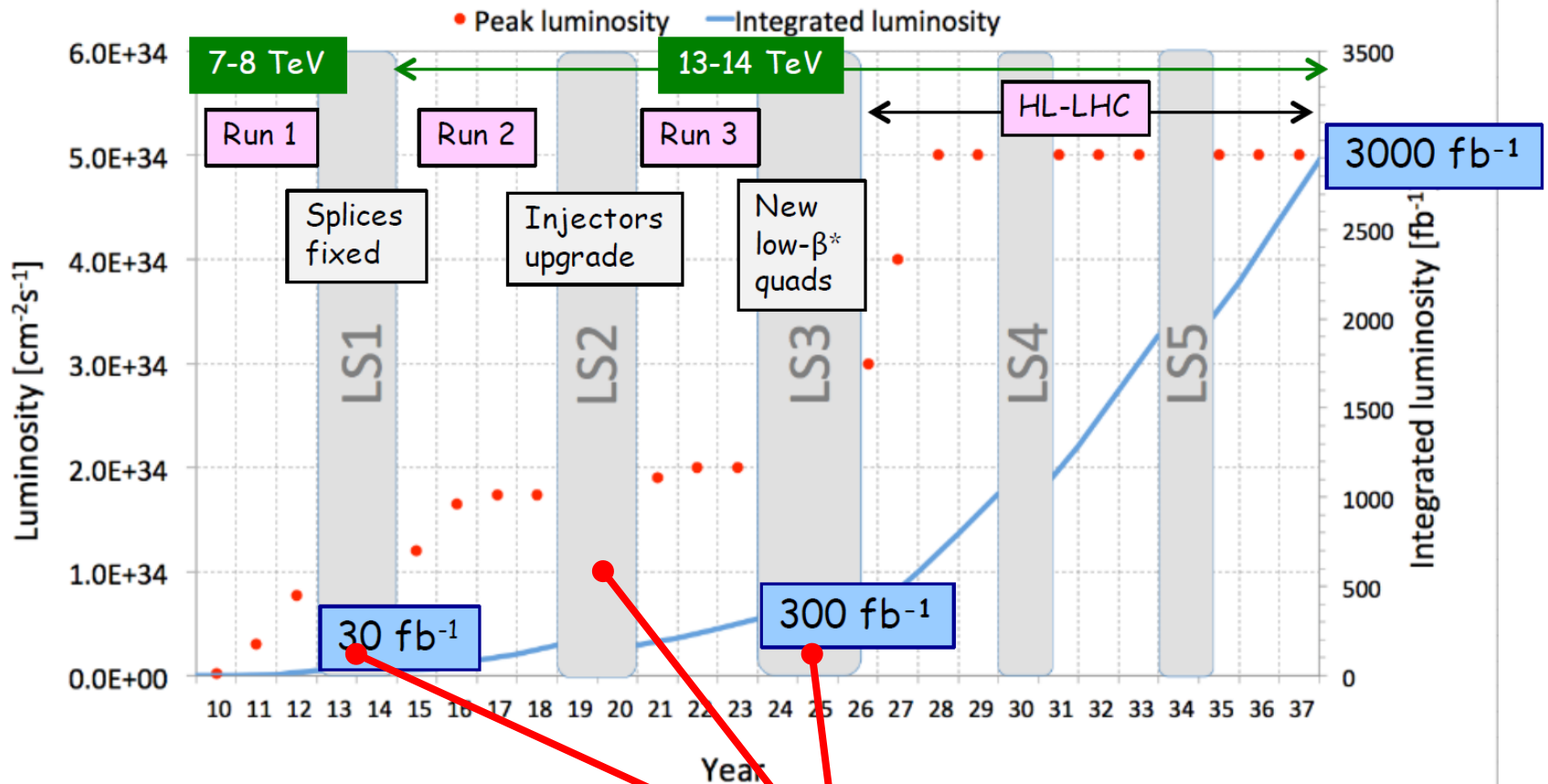
The LHC Arcs



WARNING: DO NOT TOUCH
ELECTRIC PARTS
OR YOU WILL BE SHOCKED

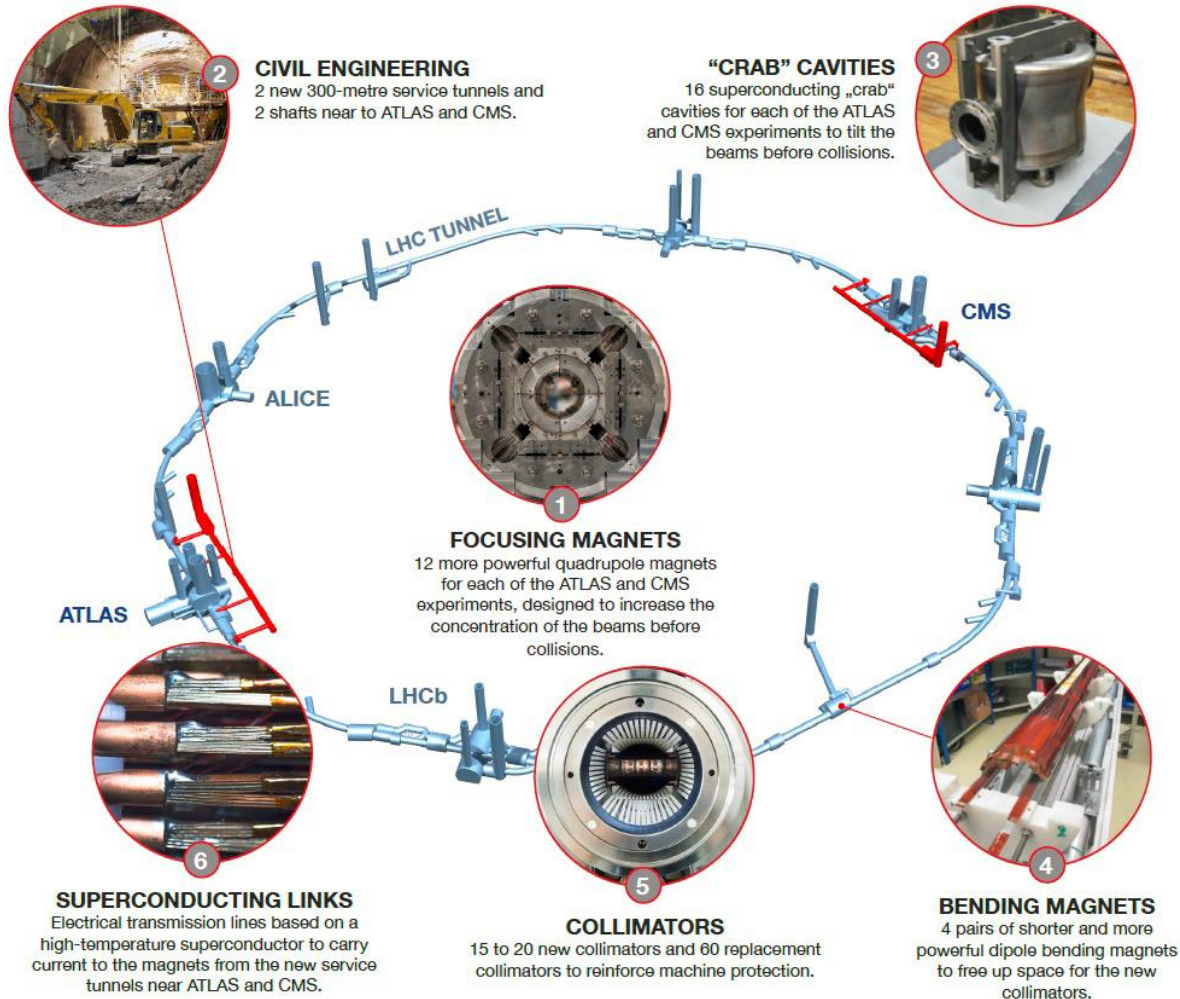
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The LHC – Next Steps

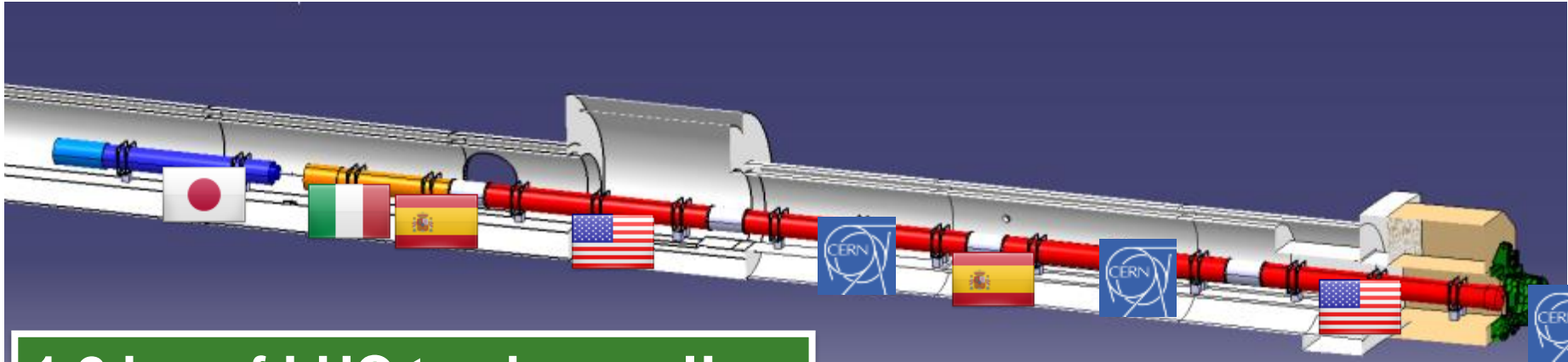


High Luminosity LHC (HL-LHC) upgrade project

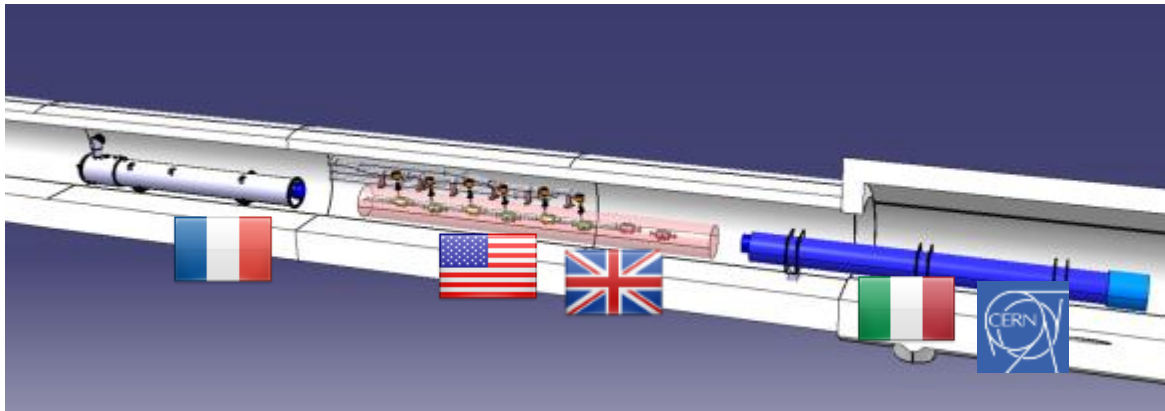
High Luminosity LHC (HL-LHC) Project



HL-LHC: In-kind Contribution and Collaboration



1.2 km of LHC to change !!



Q1-Q3 : R&D, Design, Prototypes
in-kind **USA**

D1 : R&D, Design, Prototypes and in-kind **JP**

MCBX : Design and Prototype **ES**

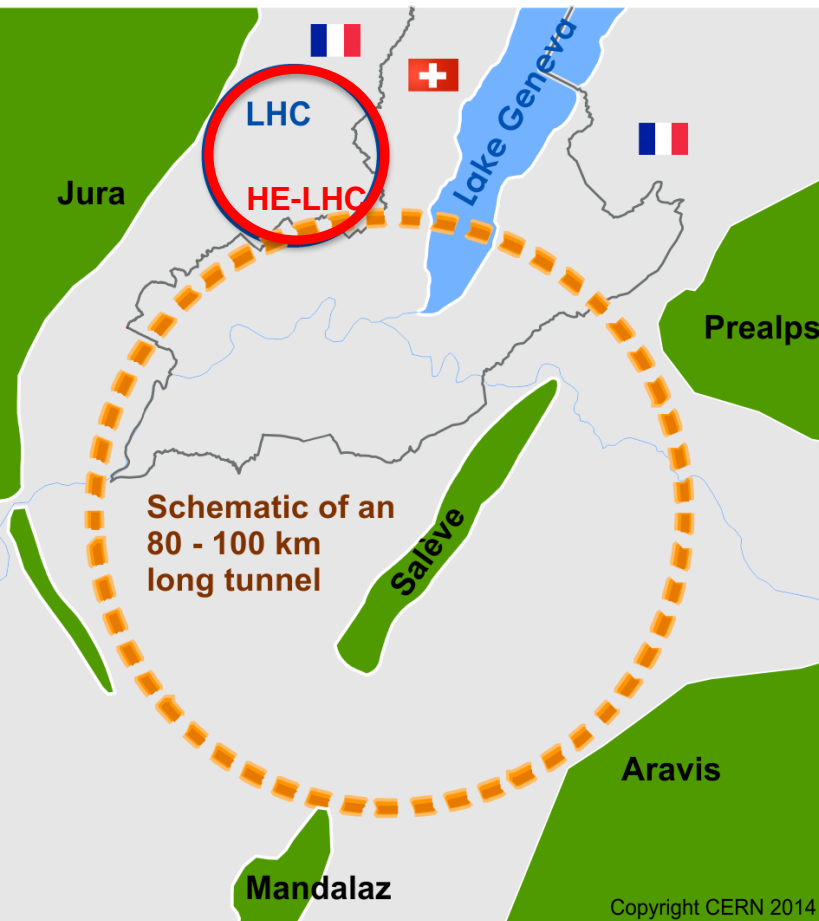
HO Correctors: Design and Prototypes **IT**

Q4 : Design and Prototype **FR**

ATLAS
CMS

CC : R&D, Design and in-kind **USA**

CC : R&D and Design **UK**

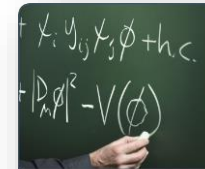


International FCC collaboration (CERN as host lab) to study:

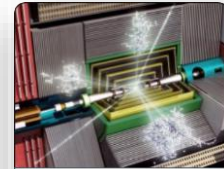
- **pp -collider (*FCC-hh*)**
→ main emphasis, defining infrastructure requirements

~16 T ⇒ 100 TeV pp in 100 km

- **~100 km tunnel infrastructure** in Geneva area, site specific
- **e^+e^- collider (*FCC-ee*)**, as potential first step
- **HE-LHC** with *FCC-hh* technology
- **$p-e$ (*FCC-he*) option**, IP integration, e^- from ERL



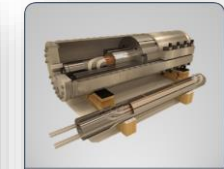
Physics Cases



Experiments



Collider Designs



R&D Programs



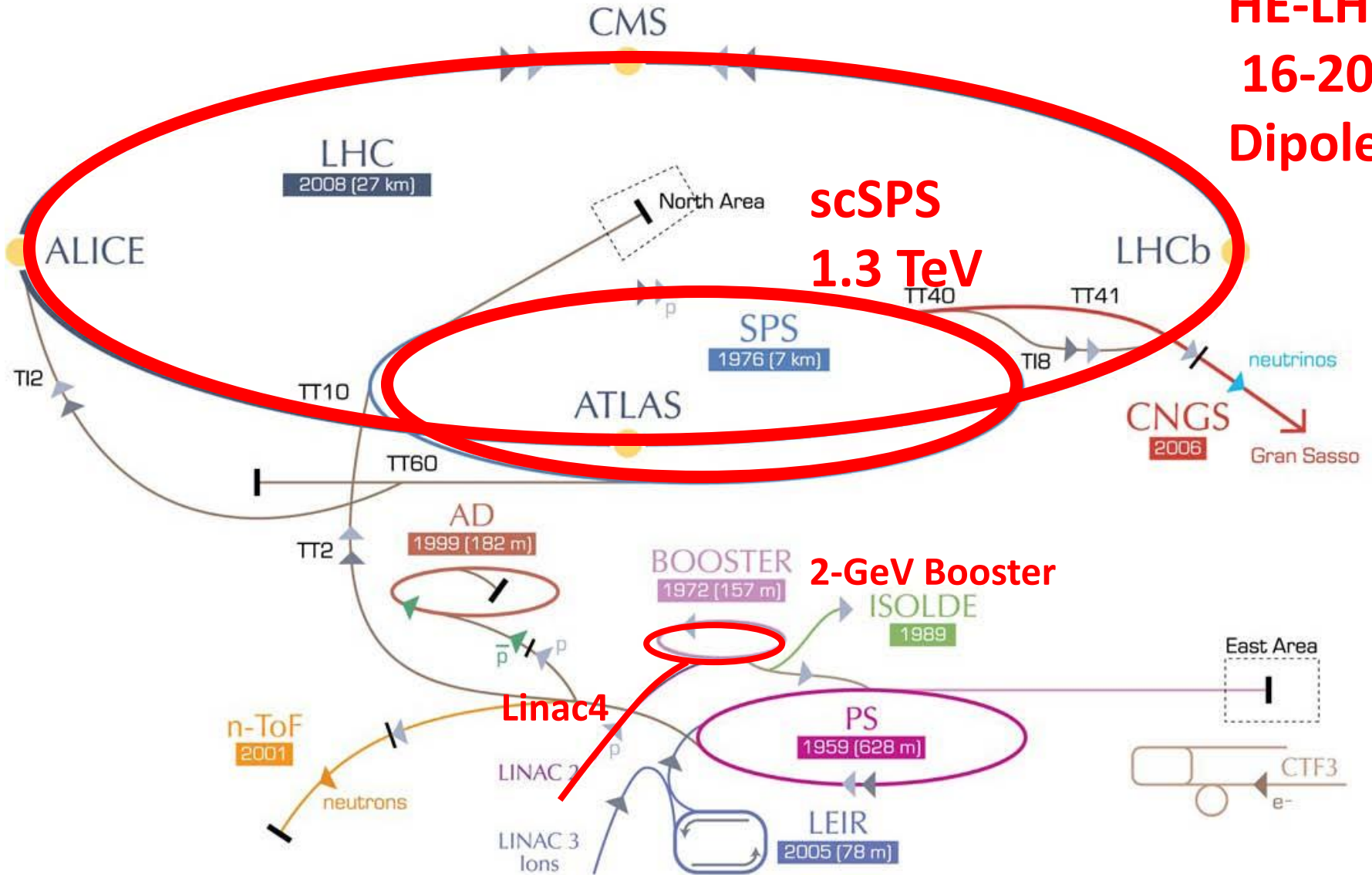
Infrastructures



Cost Estimates

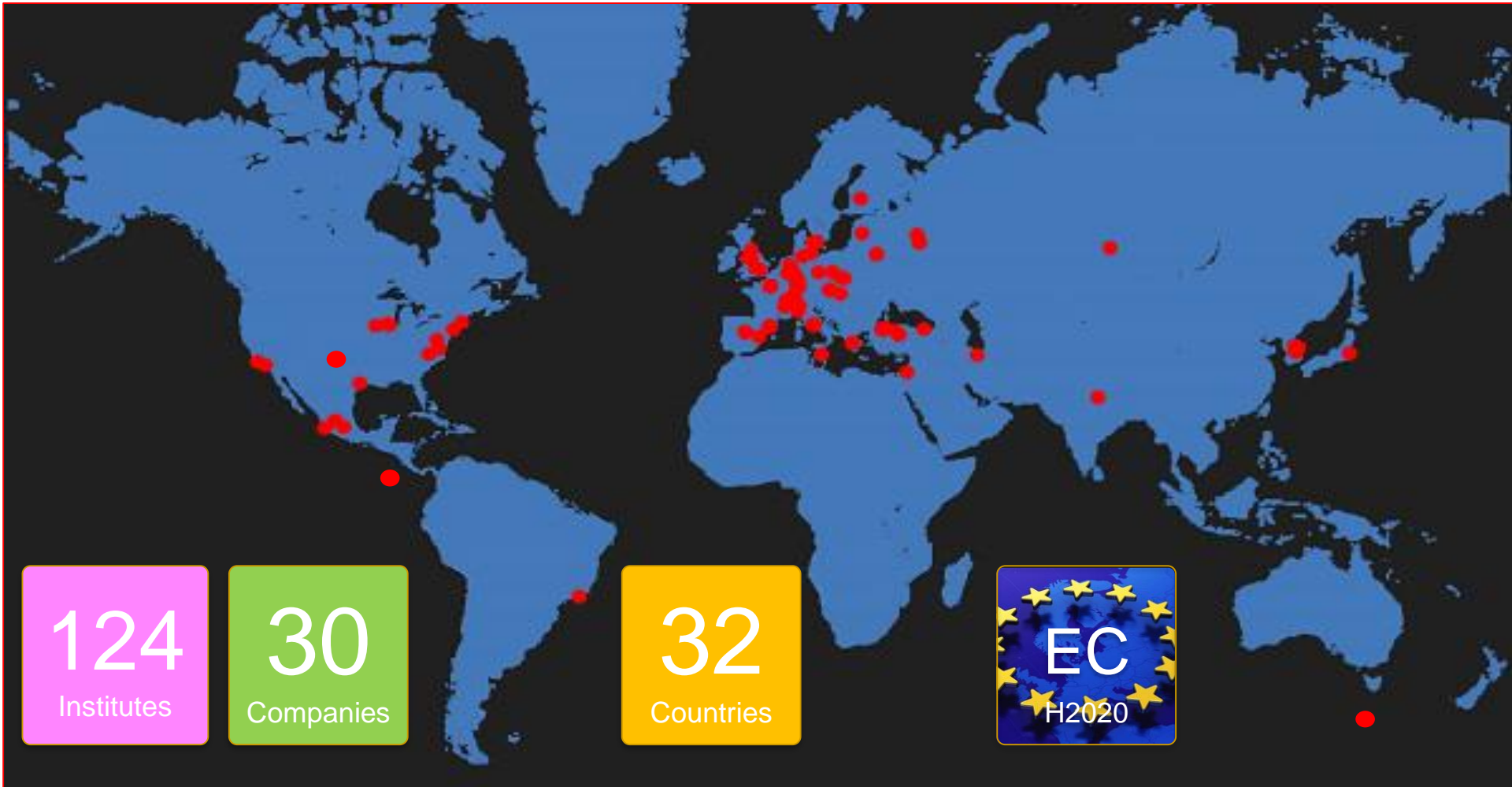
High-Energy LHC (HE-LHC)

HE-LHC
16-20T
Dipoles



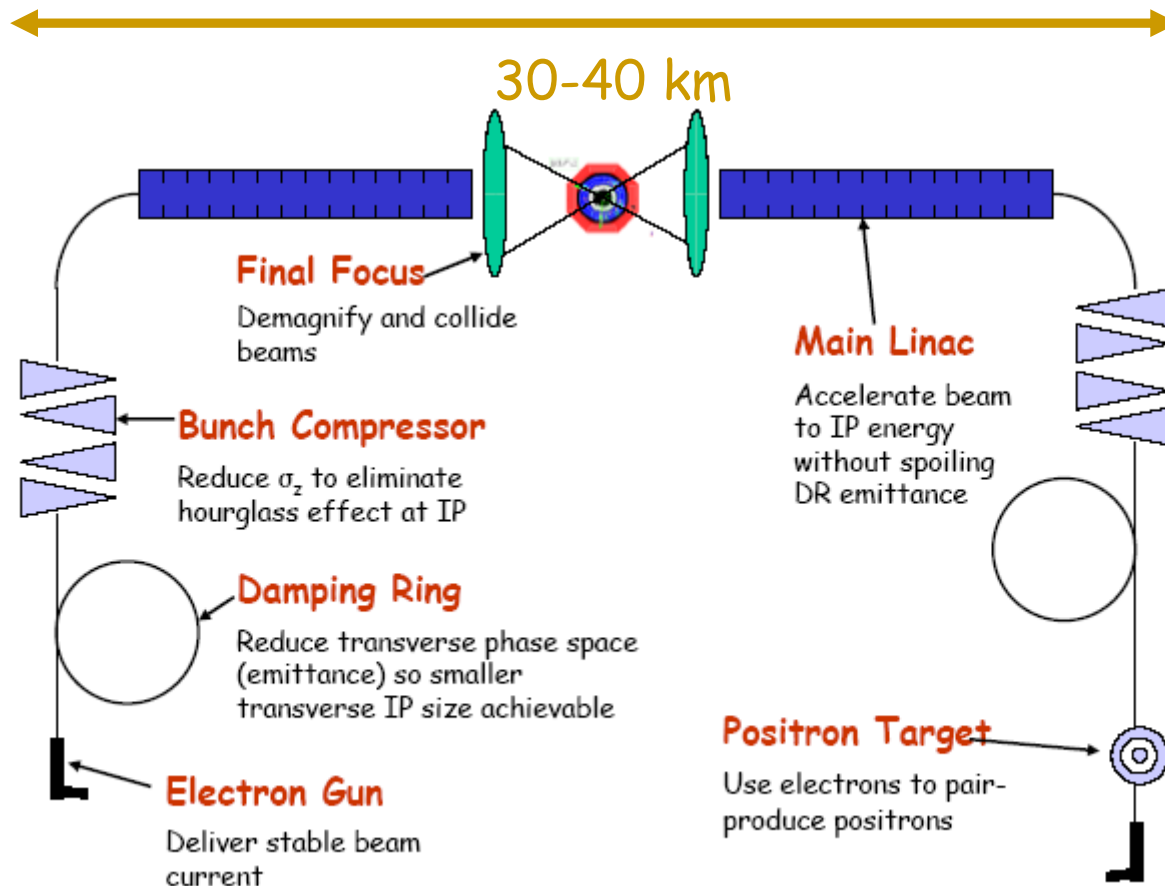


Collaboration & Industry Relations



LINEAR COLLIDERS

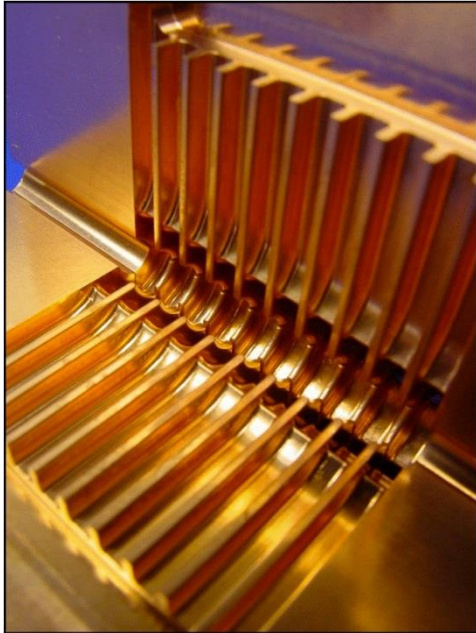
A Generic Linear Collider



The machine which will complement and extend the LHC best, and is closest to be realized, is a Linear e^+e^- Collider.

Linear Colliders

CLIC Compact Linear Collider

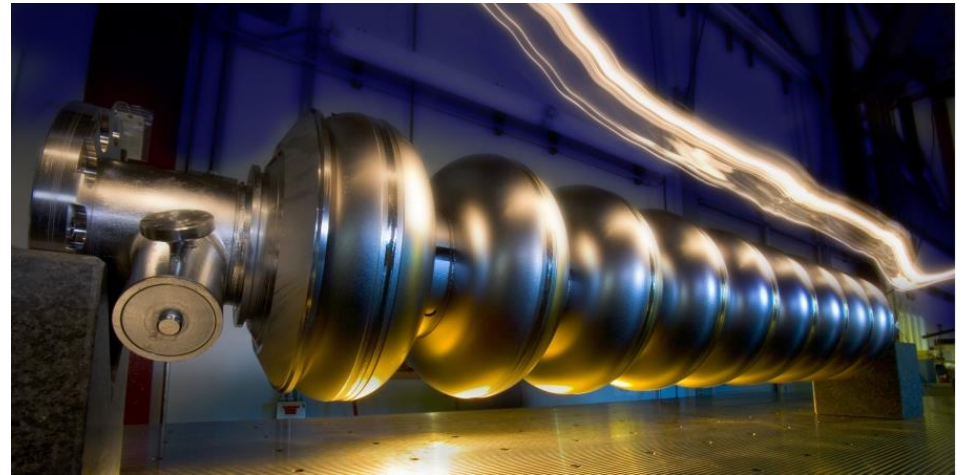


- 2-beam acceleration scheme at room temperature
- Gradient 100 MV/m
- \sqrt{s} up to 3 TeV
- Physics + Detector studies for 380 GeV - 3 TeV

Linear e^+e^- colliders

Luminosities: few 10^{34} $\text{cm}^{-2}\text{s}^{-1}$

ILC International Linear Collider

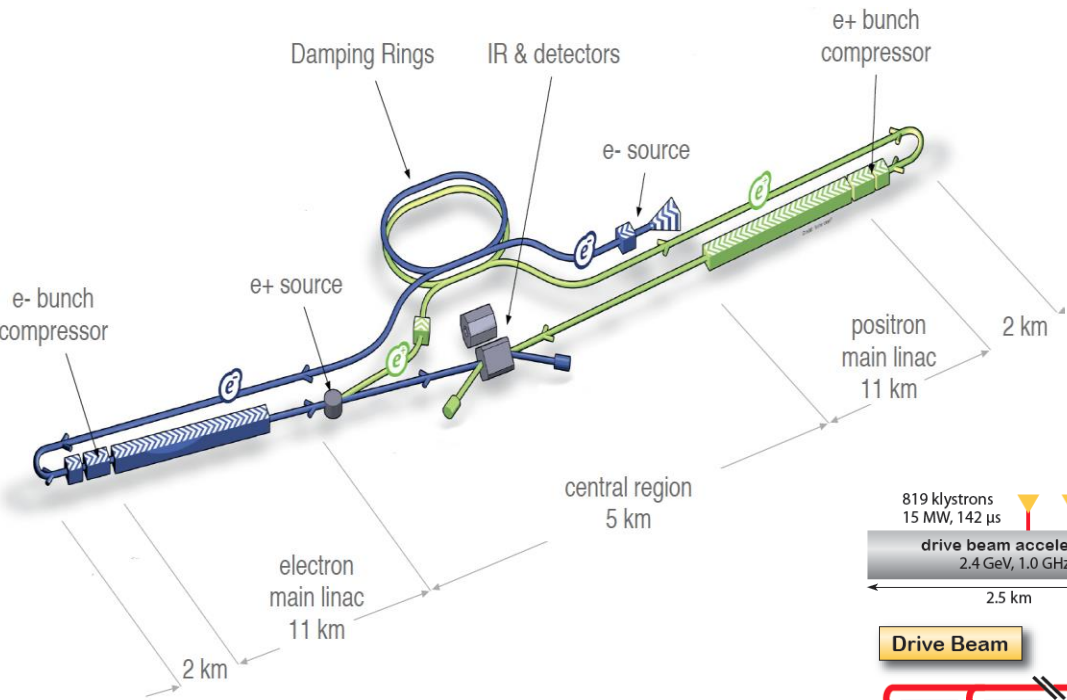


- Superconducting RF cavities (like XFEL)
- Gradient 32 MV/m
- $\sqrt{s} \leq 500$ GeV (1 TeV upgrade option)
- Focus on ≤ 500 GeV, physics studies also for 1 TeV

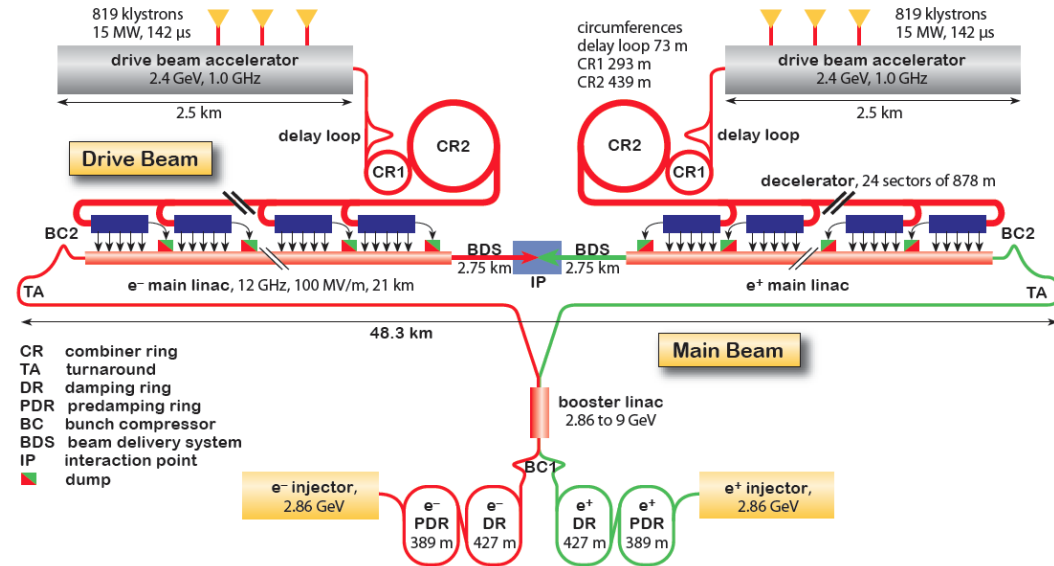
CLIC and ILC

ILC

0.5 TeV CM, upgradable to 1 TeV
 SC RF industrialized
 mature design (TDR in 2012)
 Possibility of hosting is evaluated by Japanese government

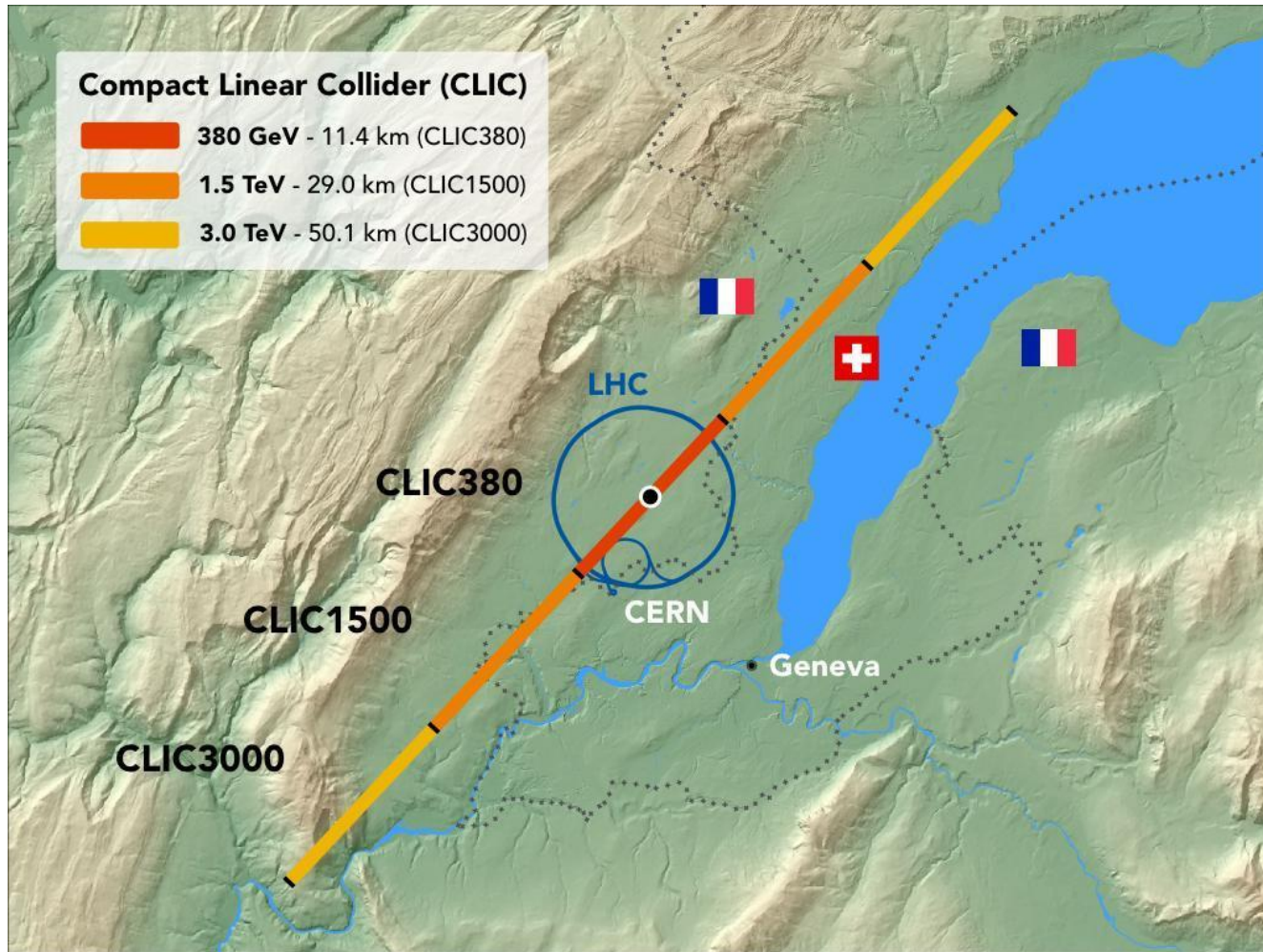


CLIC
 Two-beam scheme, 1-3 TeV CM
 Option for 380 GeV explored (klystrons)
 CTF3 facility – key R&D done
 Ready for demonstrator project



- CR combiner ring
- TA turnaround
- DR damping ring
- PDR predamping ring
- BC bunch compressor
- BDS beam delivery system
- IP interaction point
- dump

CLIC Site Near Geneva



PARTICLE PHYSICS ROADMAPS

European Strategy for Particle Physics 2013

- Scale of facilities required by particle physics is resulting in **globalisation** of the field.
 - Europe's top priority should be exploitation of full potential of the **LHC**, including the **HL-LHC** machine and detectors with view to collecting 10x more data than in initial design, by around 2030.
 - This upgrade programme will also provide further exciting opportunities for study of flavour physics & quark-gluon plasma.
 - CERN should undertake design studies for accelerator projects in a global context, with emphasis on **proton-proton** and **electron-positron** HE frontier machines.
 - These design studies should be coupled to vigorous accelerator R&D programme, including **high-field magnets** and **high-gradient accelerating structures**, in collaboration with national institutes, laboratories and universities worldwide.
-

European Strategy for Particle Physics 2013

- The initiative from the Japanese particle physics community to host the **ILC** in Japan is most welcome, and European groups are eager to participate.
 - Europe looks forward to a proposal from Japan to discuss a possible participation.
- CERN should develop a **neutrino programme** to pave way for substantial European role in future long-baseline experiments.
 - Europe should explore possibility of major participation in leading long-baseline neutrino projects in US & Japan.

Next update of European Strategy for Particle Physics has commenced and is to be finalised in 2020.



Thank You!

CMS

LHCb

ATLAS

CERN Meyrin

CERN Prévessin

SPS 7 km

ALICE

LHC 27 km

SUISSE
FRANCE