



Welcome - Herzlich willkommen

Besuch der
HTL Mössingerstraße
1 – 2 Februar 2018

to



Accelerating Science and Innovation



CERN

What is it ?



What does « CERN » stand for?

European

Organisation for the

Research

Centre



What does « CERN » stand for?

European
Organization for
Nuclear
Research



Nuclear?



European laboratory for particle physics

CERN

Who is it ?













































Member states

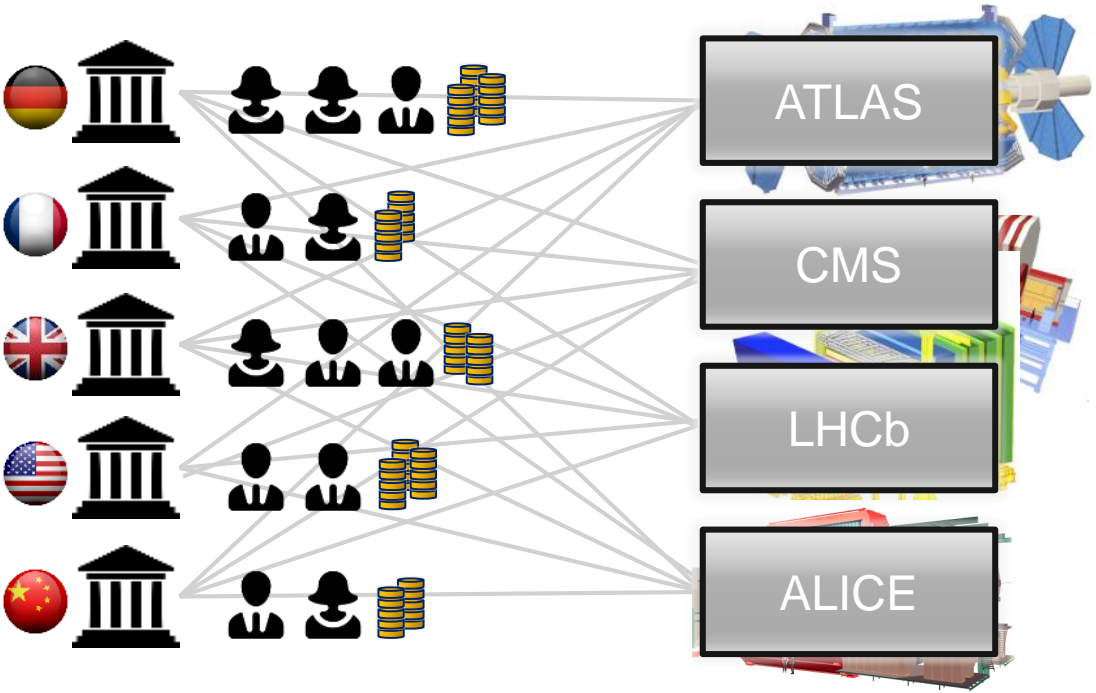


ca 1 Bn CHF



Germany		20.27%	
France		15.39%	
United Kingdom		13.88%	
Italy		11.48%	
Spain		8.28%	
Netherlands		4.60%	
Switzerland		3.64%	
Belgium		2.78%	
Poland		2.66%	
Sweden		2.61%	
Norway		2.55%	
Austria		2.22%	
Denmark		1.76%	
Greece		1.64%	
Finland		1.39%	
Portugal		1.20%	
Israel		1.19%	
Czech Republic		1.03%	
Hungary		0.65%	
Slovakia		0.50%	
Bulgaria		0.28%	

Collaborations



A world collaboration

22 members

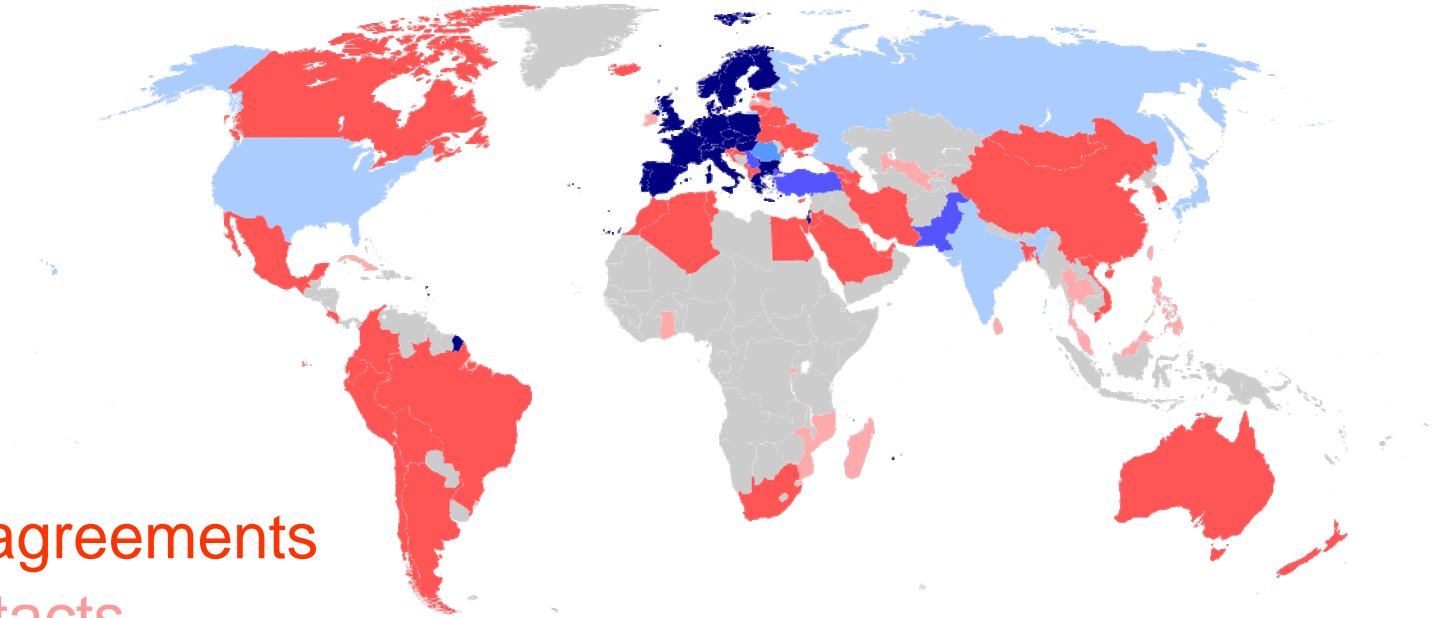
2 associates

2 candidate

Observers

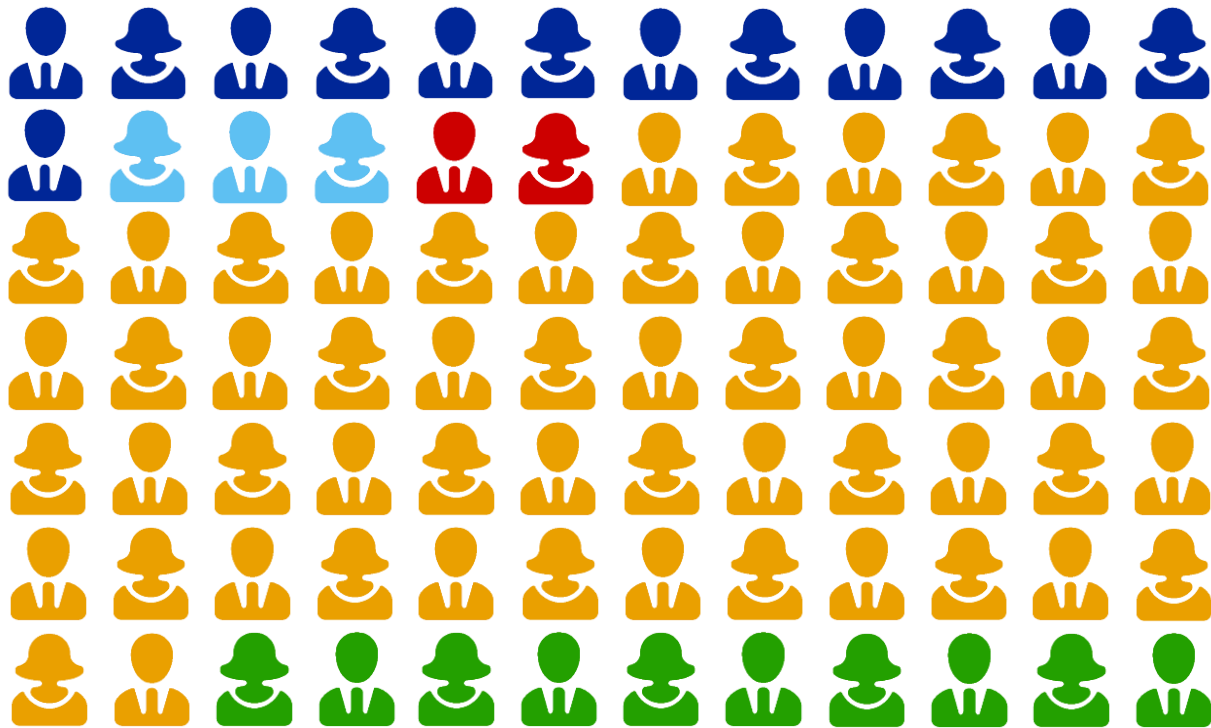
Cooperation agreements

Scientific contacts



How many persons?

+15'000!



2'500 staff

600 fellows & apprentices

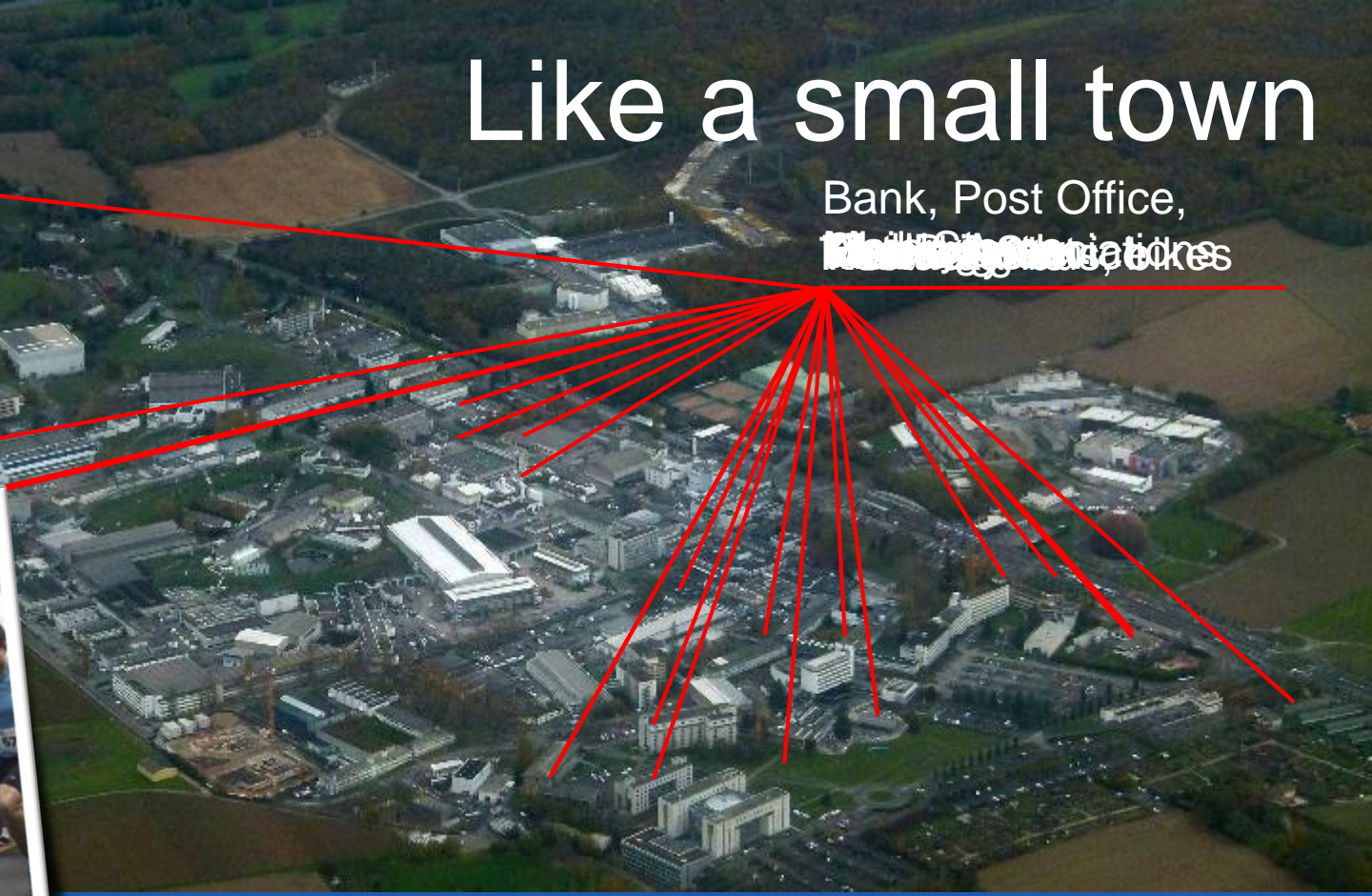
500 students

11'000 users

2'000 external companies

Like a small town

Bank, Post Office,
Retail, Office, etc.



CERN

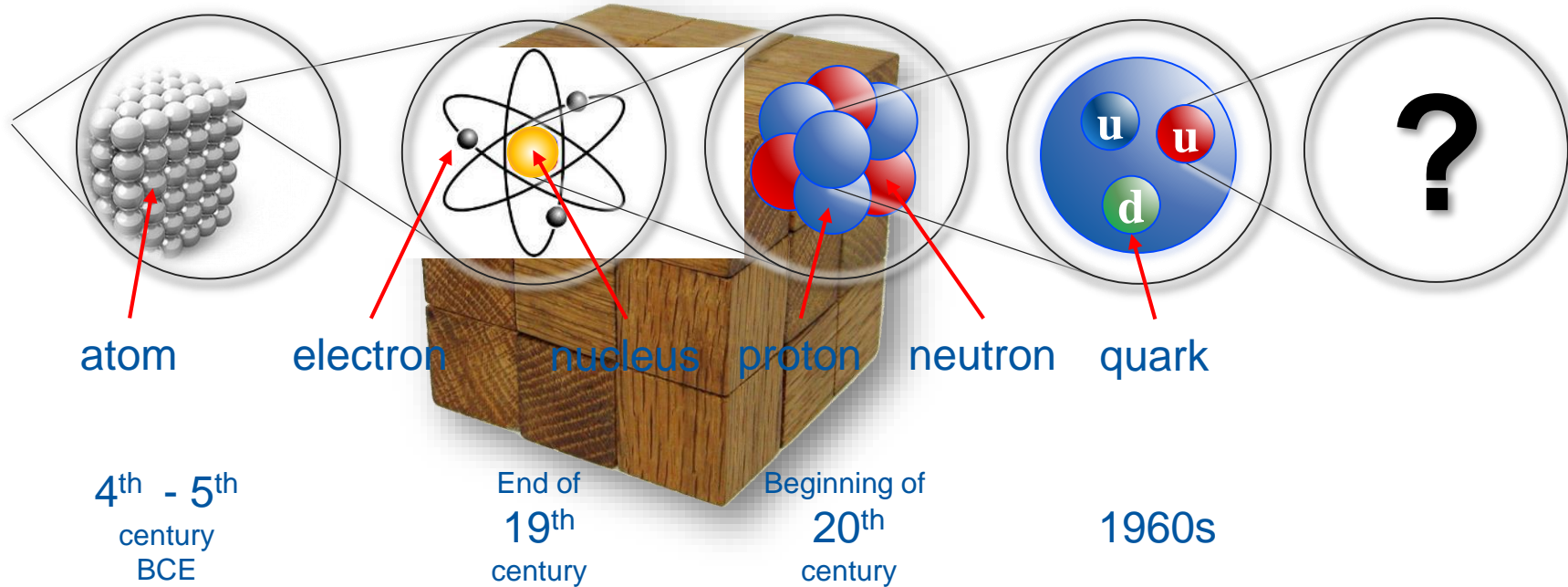
What for ?



Fundamental research



What is the matter made of ?



Standard Model

Images:
www.particlezoo.net

LEPTONS

QUARKS

ORDINARY
MATTER



POSITRON



ANTIPROTON



ANTINEUTRON



ANTIMUON



ANTITAU



ANTI-UP
QUARK



ANTI-DOWN
QUARK



ANTI-STRANGE
QUARK



ANTI-CHARM
QUARK



ANTI-BOTTOM
QUARK



ANTI-TOP
QUARK

Strong force

Electro-magnetic force

Weak force

Gravity

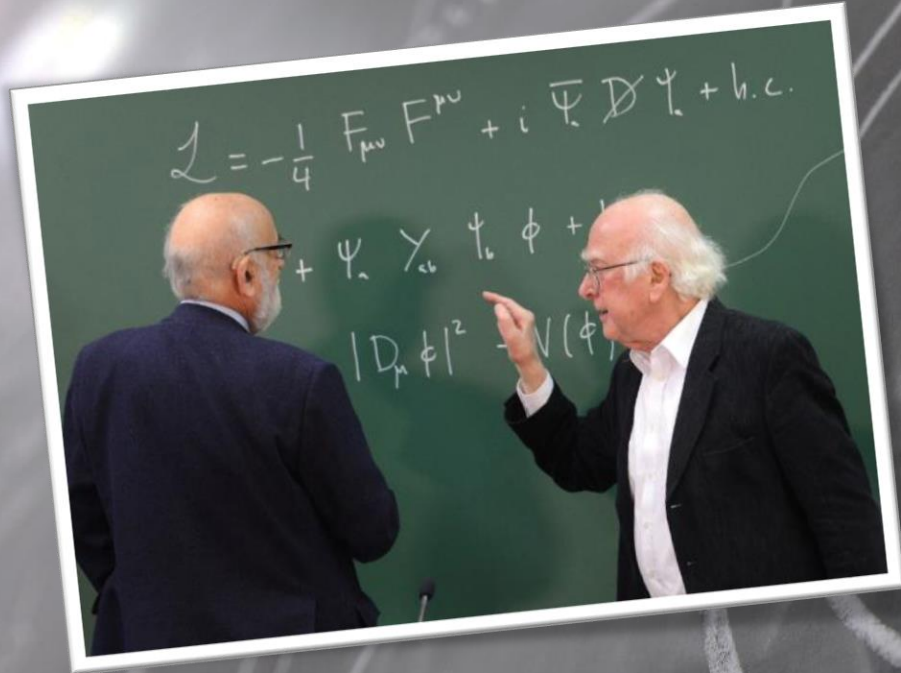


Answering questions...



Antimatter ?

Answering questions...



Higgs

Higgs ?

Answering questions...

Dark matter ?

Collaborate



Educate



CERN

How does it work ?



Accelerating and colliding



Incredible levels of energy

$$-\frac{\hbar^2}{2m} \frac{d^2\psi}{dx^2} + V\psi = E\psi$$

$$E_f = \frac{m}{m_0} E_0$$

$$U = W_{AB} = |E_{PA} - E_{PB}| = |\varphi_A - \varphi_B|$$

$$v = \frac{wh}{2\pi r m_e}$$

$$\varphi_E = \frac{E_c}{\varphi_0} = k \frac{\varphi}{r}$$

$$m = N \cdot m_0 = \frac{Q}{v_e} \frac{M_m}{N_A}$$

$$E = \frac{E_c}{a} \int_{-a/L}^{+a/L} \sin(\omega t + \phi) dy$$

$$R_m = \frac{C}{T} k = \pm \sqrt{\frac{2m}{\hbar^2} (E - V_0)}$$

$$\omega = 2\pi f$$

$$E = mc^2$$

$$\beta = \frac{\Delta I c}{\phi_e} = \frac{\Delta E}{\Delta t} \frac{m_1}{X} + \frac{m_2}{X'} = \frac{m_2 - m_1}{v}$$

$$\vec{S} = \frac{1}{\mu_0} (\vec{E} \times \vec{B})$$

$$E_k = \frac{\hbar^2 k^2}{2m}$$

$$E = \hbar k^2 \cdot 1 \text{ pc} = \frac{1 \text{ AU}}{c}$$

$$\oint \vec{D} \cdot d\vec{S} = Q^*$$

$$v_k = \sqrt{\frac{3kT}{m_0}} = \sqrt{\frac{3kT N_A}{M_m}} = \sqrt{\frac{3R_m T}{M_r \cdot 10^{-3}}}$$

$$\vec{B} = \mu_0 \frac{NI}{\sqrt{2}}$$

$$k = \frac{p^2}{2m}$$

$$\lambda = \frac{h}{m v}$$

$$f_0 = \frac{1}{2\pi} \sqrt{\frac{g}{l}}$$

$$\psi(x) = \sqrt{\frac{2}{L}} \sin \frac{n\pi x}{L}$$

$$\oint \vec{B} \cdot d\vec{l} = \mu_0 \iint_S \vec{J} \cdot d\vec{S}$$

$$C(s)$$

$$E = \frac{1}{2} \hbar \sqrt{k/m}$$

$$\phi = \frac{2\pi \sin^2 \theta}{\lambda}$$

$$R = \frac{U}{I}$$

$$\psi_2 = U_e I t$$

$$F_m = \vec{B} I l = \frac{\mu I_1 I_2}{2\pi d} l$$

$$T = \frac{4 n_1 n_2}{(n_2 + n_1)^2}$$

$$g = \frac{m_1 m_2}{r^2}$$

$$v = \frac{1}{\sqrt{\epsilon \cdot \mu}} = \frac{c}{\sqrt{\epsilon_r \mu_r}}$$

$$F_x = \frac{1}{2} C_x \rho \beta^2$$

$$E = \frac{1}{2} \hbar \sqrt{k/m}$$

$$E = \frac{1}{2} \hbar \sqrt{k/m}$$

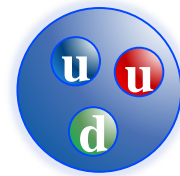
$$E = \frac{1}{2} \hbar \sqrt{k/m}$$



Incredible levels of energy

7 TeV

100'000'000'000'000'000'000'000'000



Accelerators chain

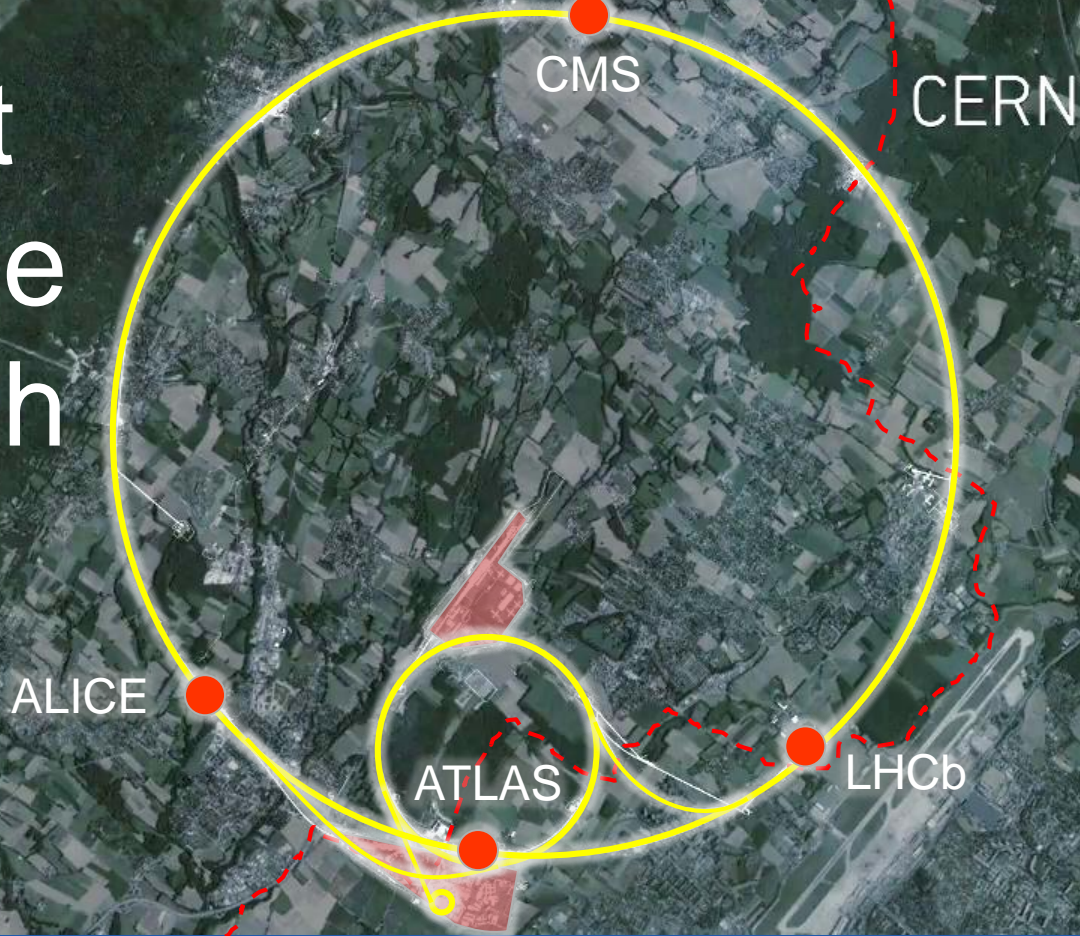


Million of collisions

A 3D rendering of a particle accelerator tunnel. Two red laser beams travel from opposite ends towards the center, where they collide, creating a bright yellow spark. The tunnel is composed of various cylindrical and rectangular components, some of which are semi-transparent, revealing internal structures. The overall color scheme is a deep blue.

25 ns bunch crossing
25 ns entre les paquets

Largest machine on Earth





The most
powerful
magnets

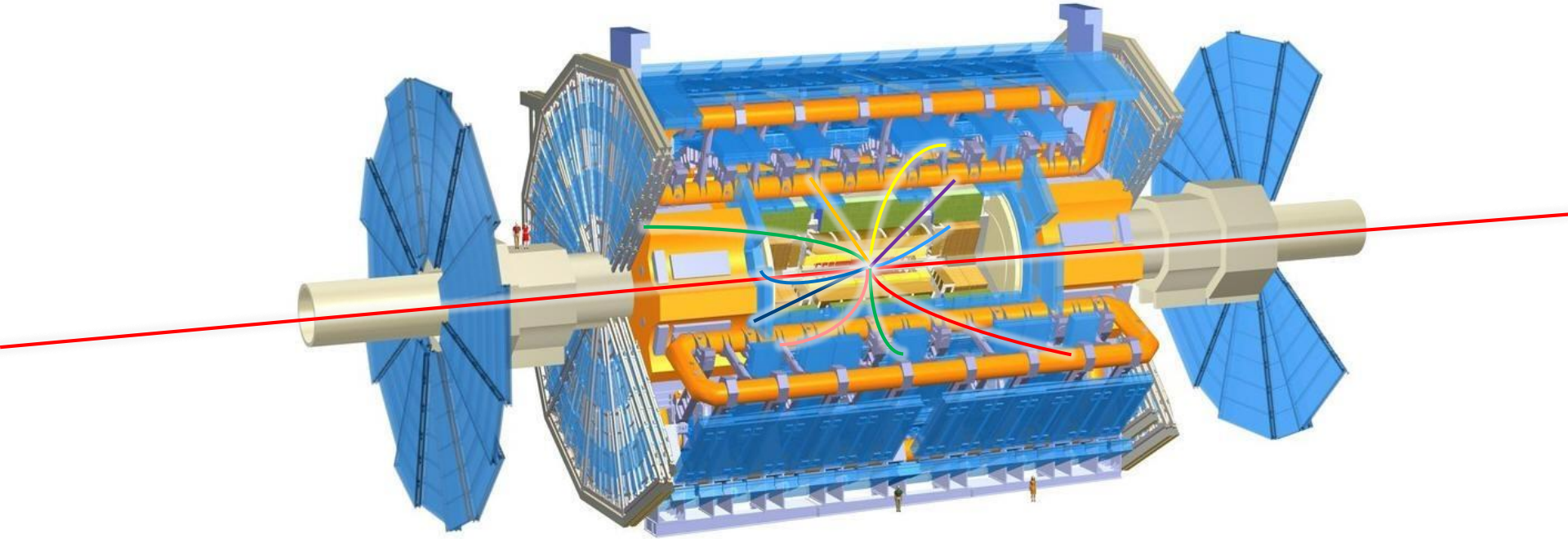


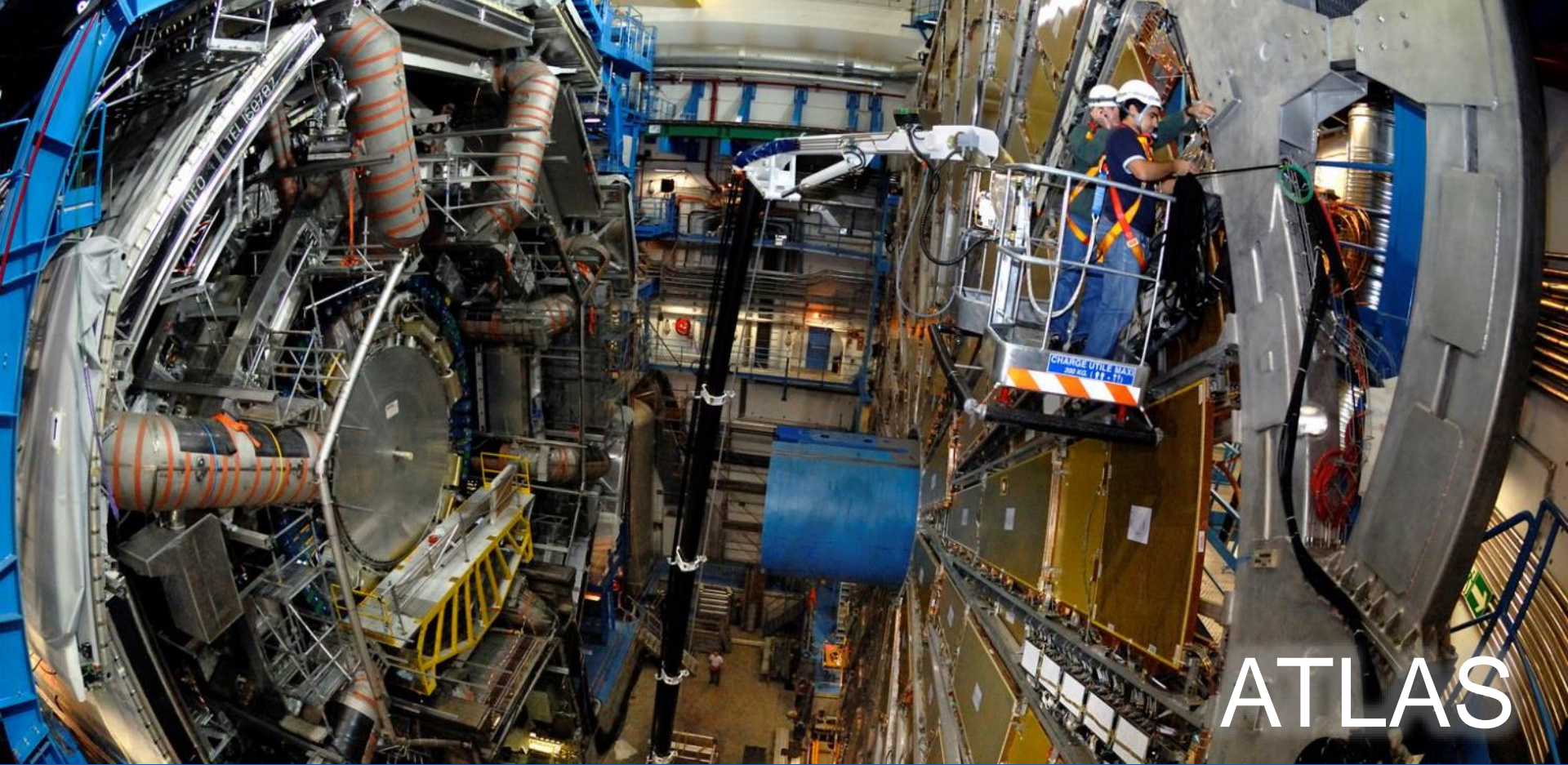
The highest vacuum



The coldest temperature

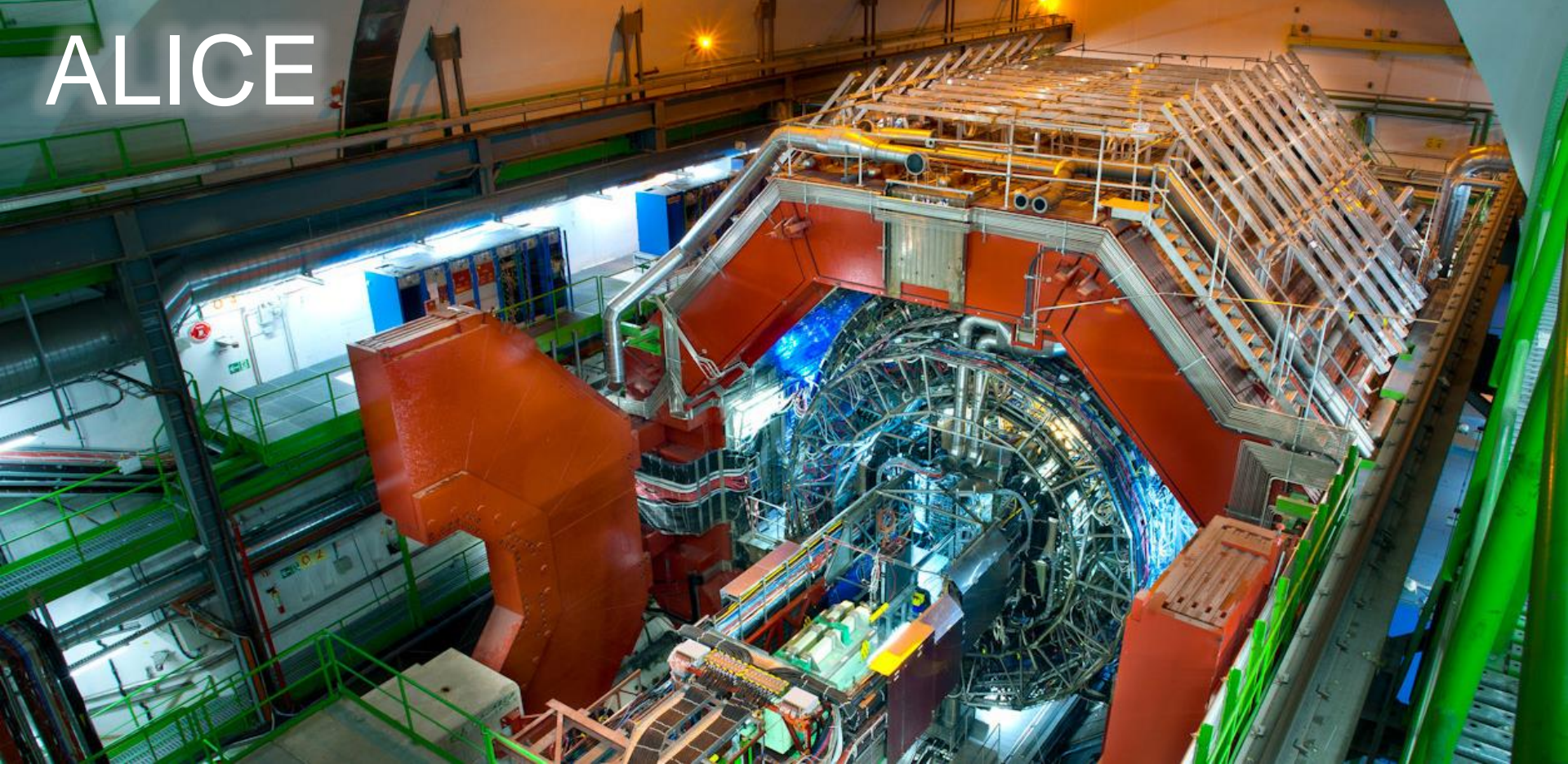
The largest detectors





ATLAS

ALICE



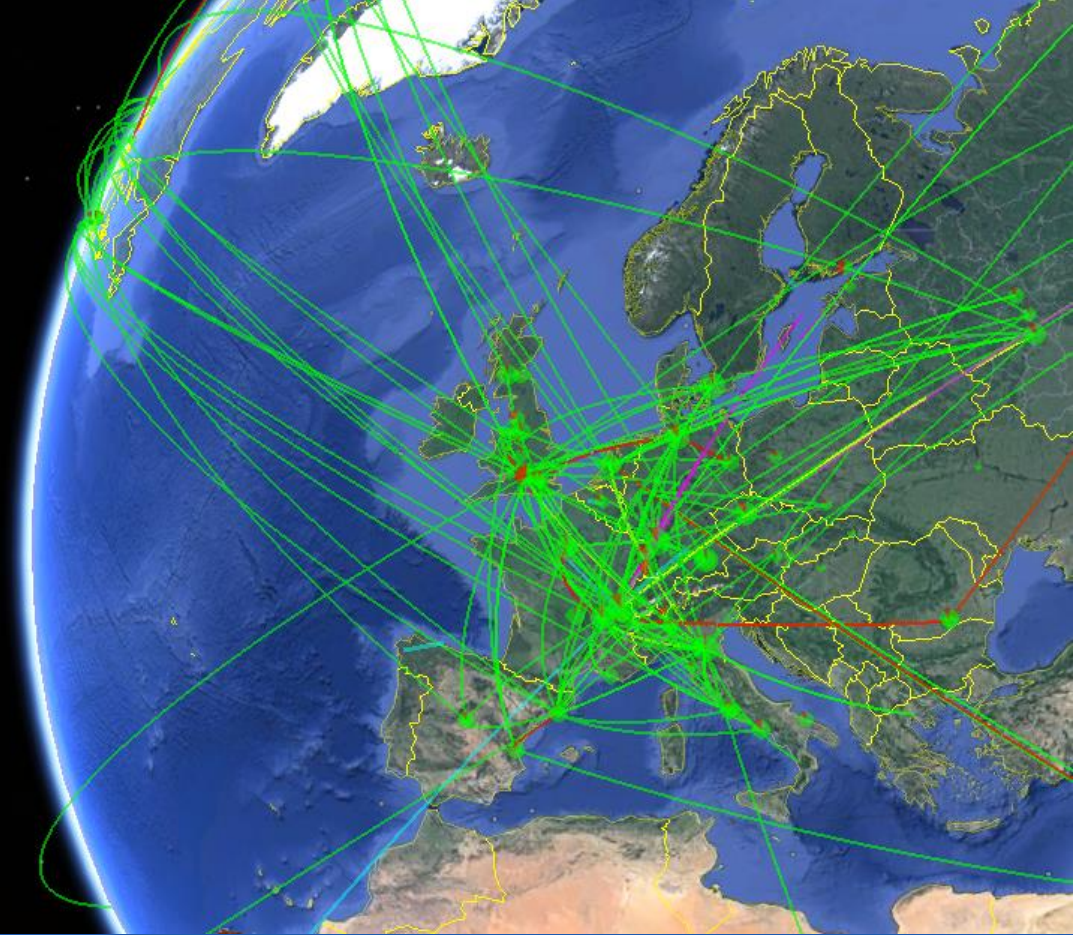
CMS





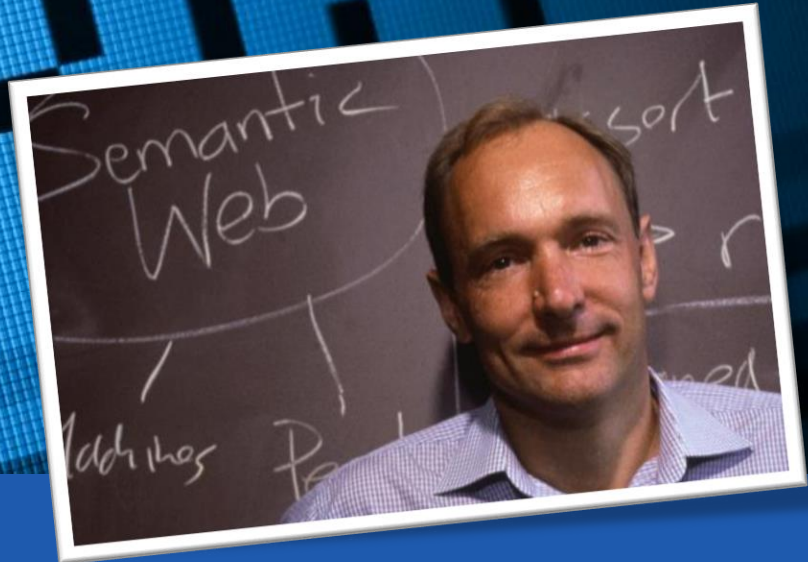
LHCb

The largest computing grid



World Wide Web

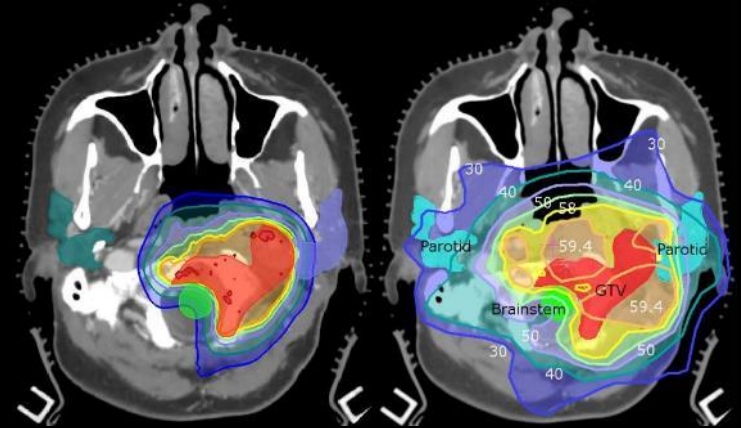
WWW



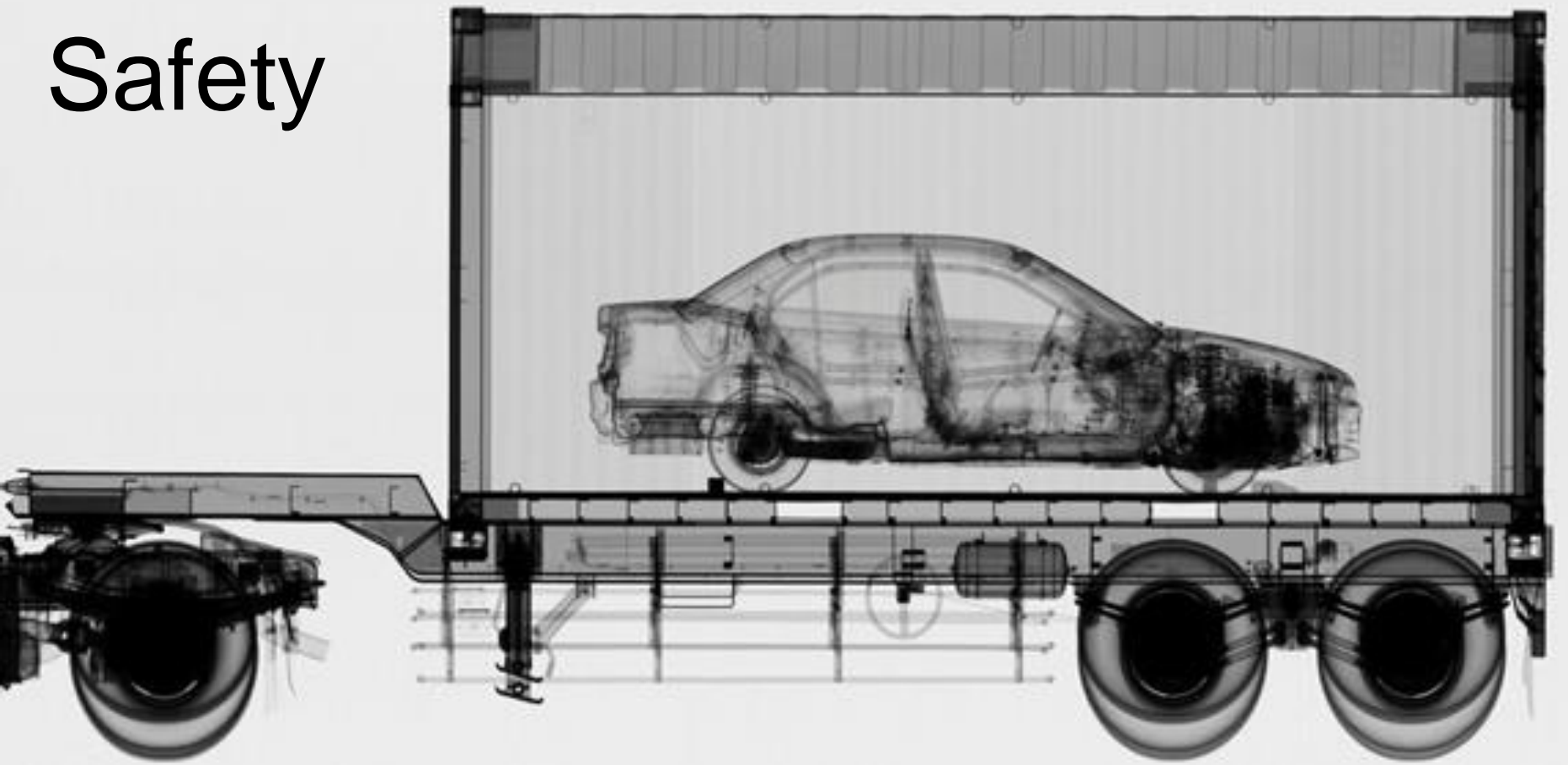
Medical applications: MedAustron collaboration



- Knowledge and technology transfer are central CERN activities.
- Realisation of the MedAustron ion therapy accelerator in Wiener Neustadt



Safety

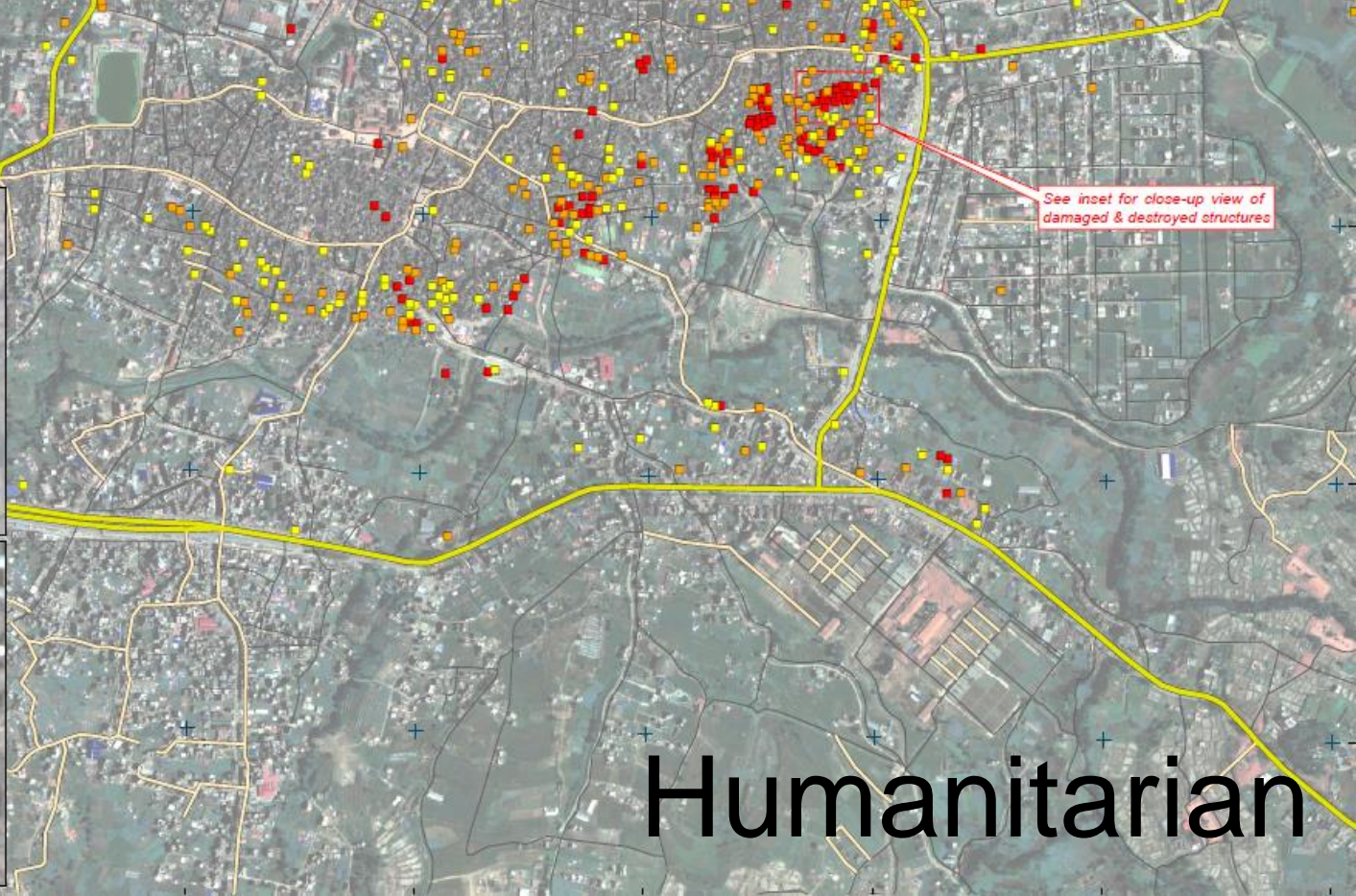


INSET: PRE-CRISIS



Source: Esri, DigitalGlobe,
GeoEye, iPlanet, Earthstar
Geographics, CNES/Airbus DS,
USDA, USGS, AEX, Getmapping.

INSET: 27 APRIL 2015



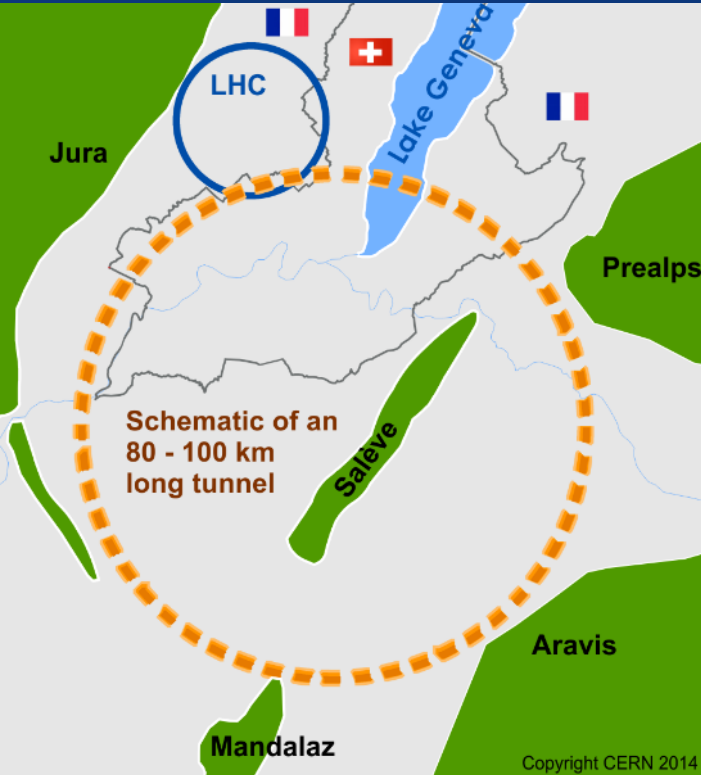
See inset for close-up view of
damaged & destroyed structures

Humanitarian

CERN

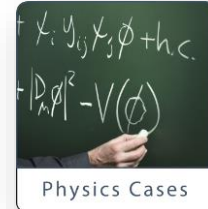
What's next ?



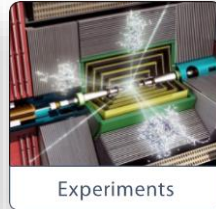


International FCC collaboration (CERN as host lab) to study:

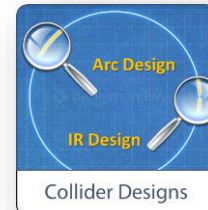
- ***pp*-collider (FCC-*hh*)**
→ main emphasis, defining infrastructure requirements
- **~16 T ⇒ 100 TeV *pp* in 100 km**
- in Geneva area, site specific
- ***e⁺e⁻* collider (FCC-*ee*)**, as potential first step
- ***p-e* (FCC-*he*) option**, integration one IP, e from ERL
- **HE-LHC** with *FCC-hh* technology
- **CDR for end 2018**



Physics Cases



Experiments



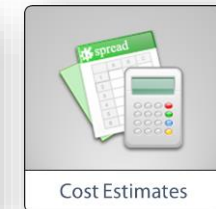
Collider Designs



R&D Programs

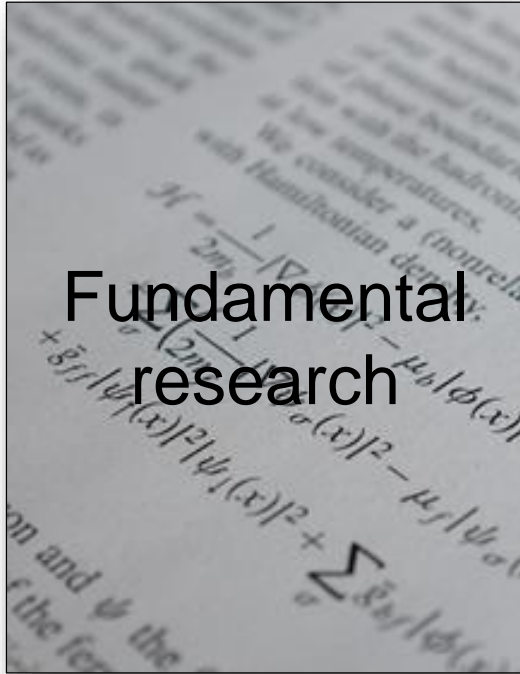


Infrastructures



Cost Estimates

In a nutshell...



Some links...

Information : www.cern.ch

CERN TV : youtube.com/cern

Recruitment : www.cern.ch/jobs





www.cern.ch