



# Welcome - Herzlich willkommen

Besuch des  
BRG Bruck and der Leitha  
29 März 2018

to



**Accelerating Science and Innovation**



# CERN

*What is it ?*



# What does « CERN » stand for?

European

European for la

Research

Research



# What does « CERN » stand for?

European  
Organization for  
Nuclear  
Research



# Nuclear?



European laboratory for particle physics

# CERN

*Who is it ?*



# Member states



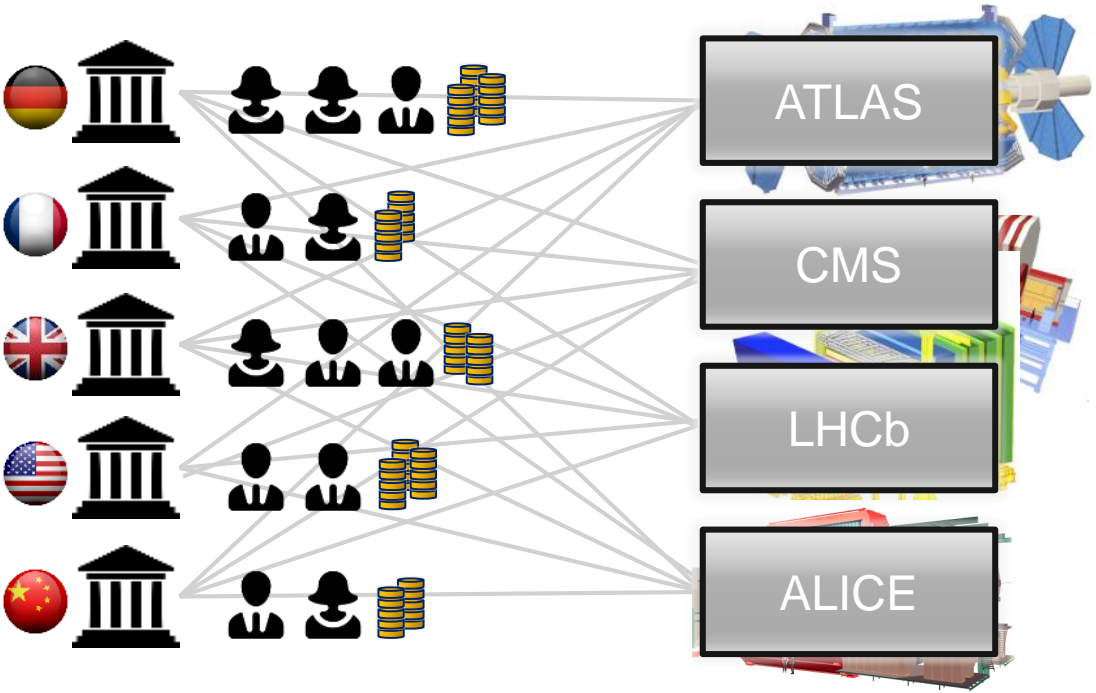
ca 1 Bn CHF



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

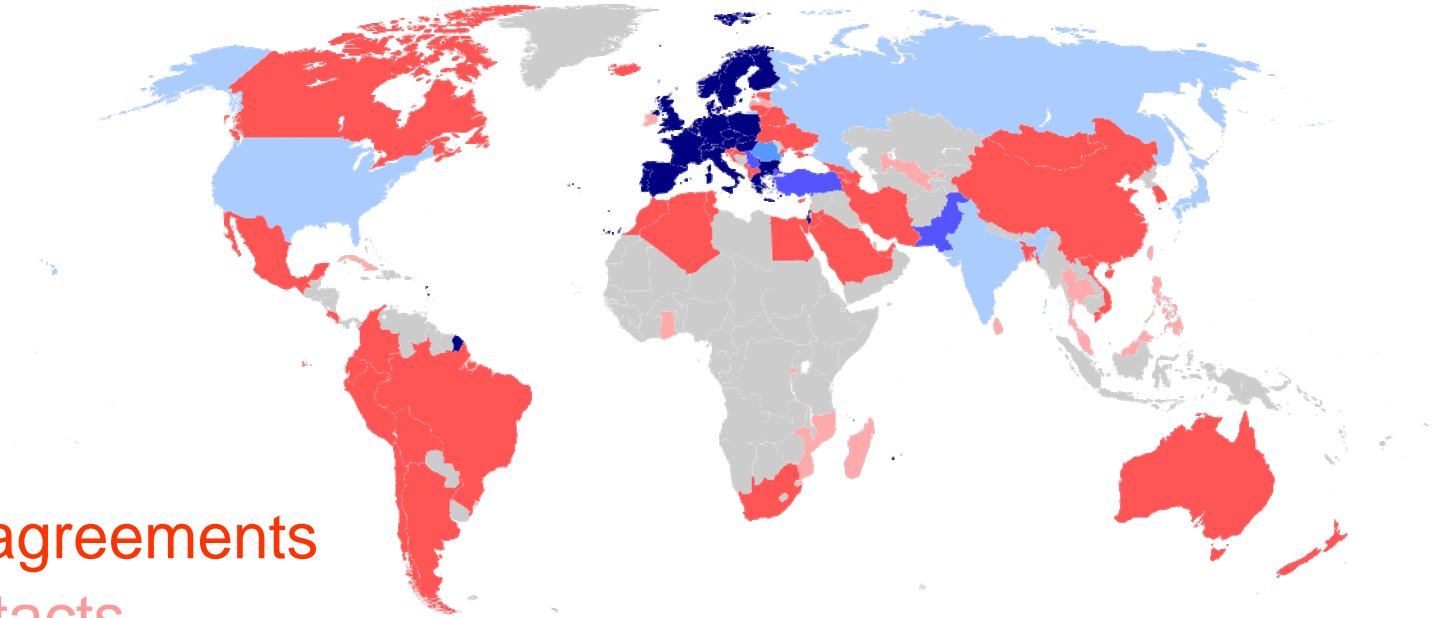
2 associates

2 candidate

Observers

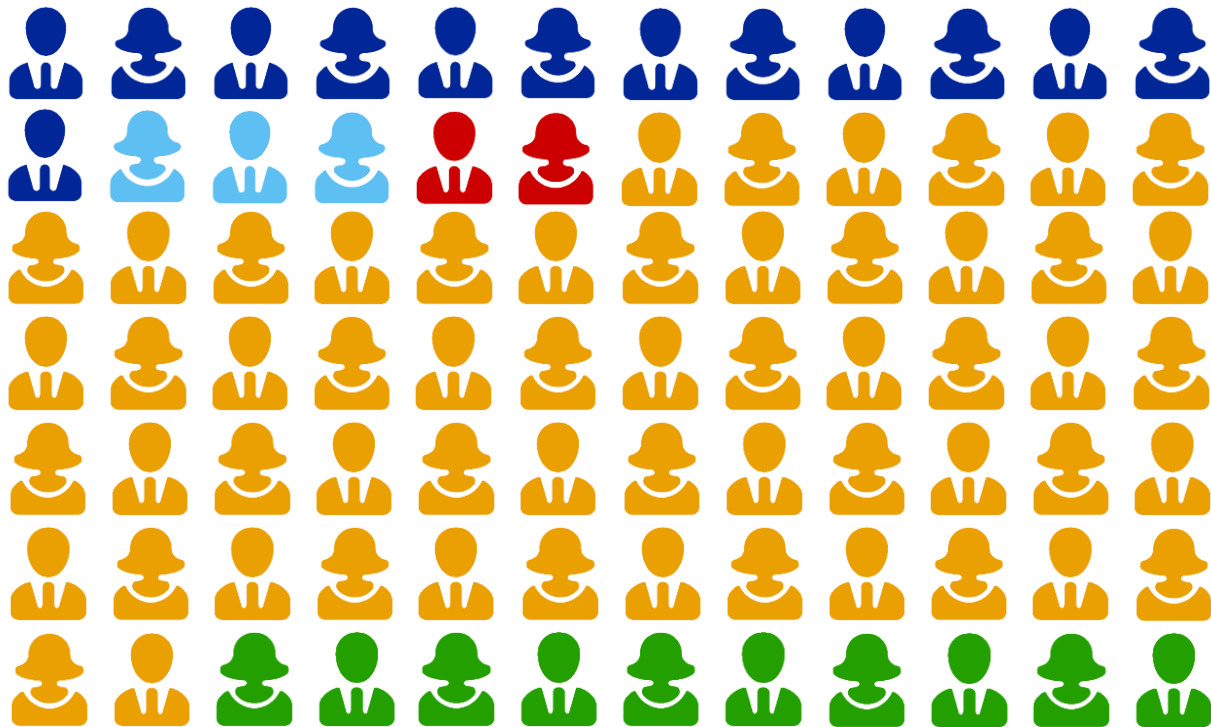
Cooperation agreements

Scientific contacts



# How many persons?

+15'000!



2'500 staff

600 fellows & apprentices

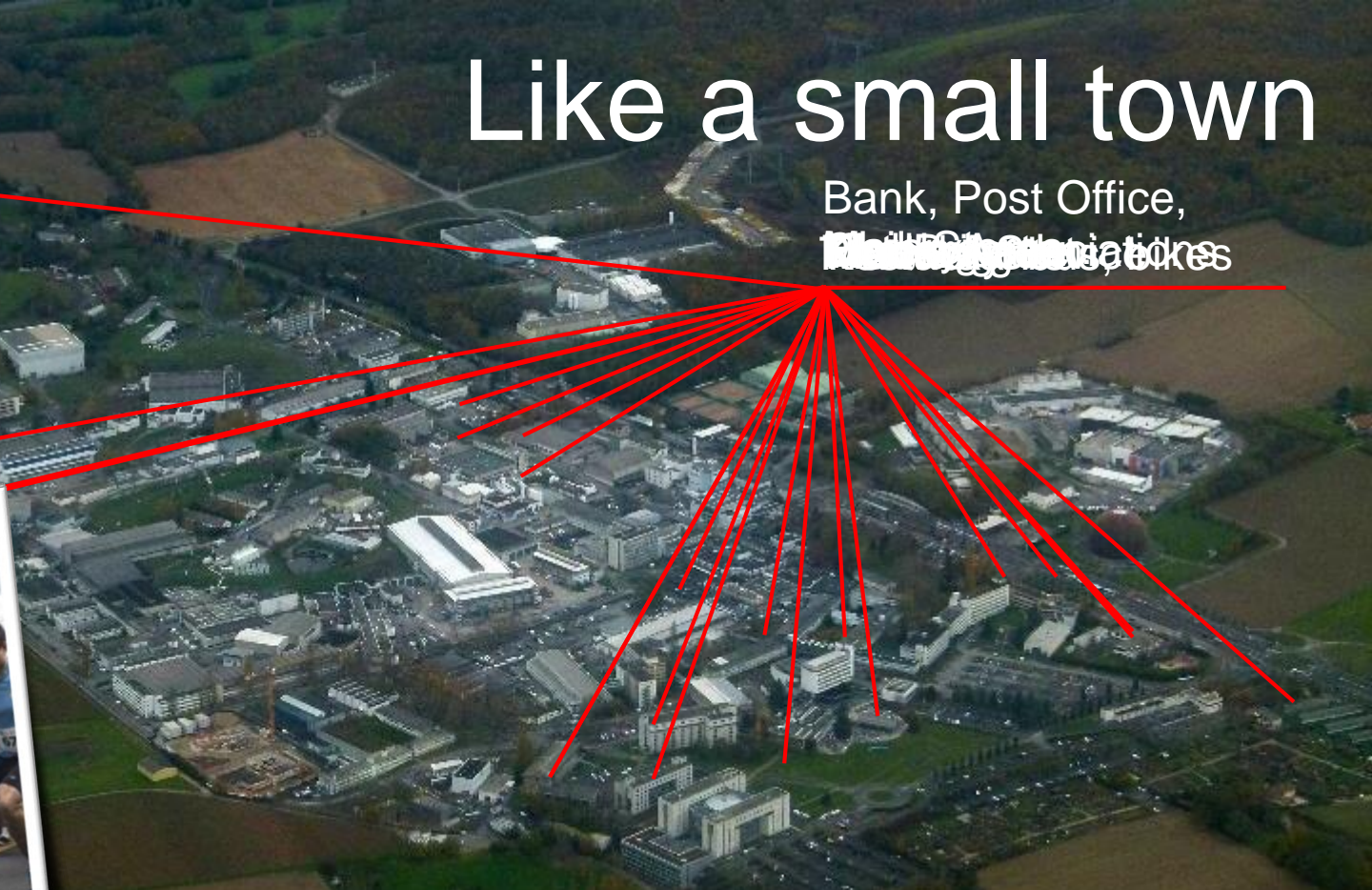
500 students

11'000 users

2'000 external companies

# Like a small town

Bank, Post Office,  
Retail, Office, etc.



# CERN

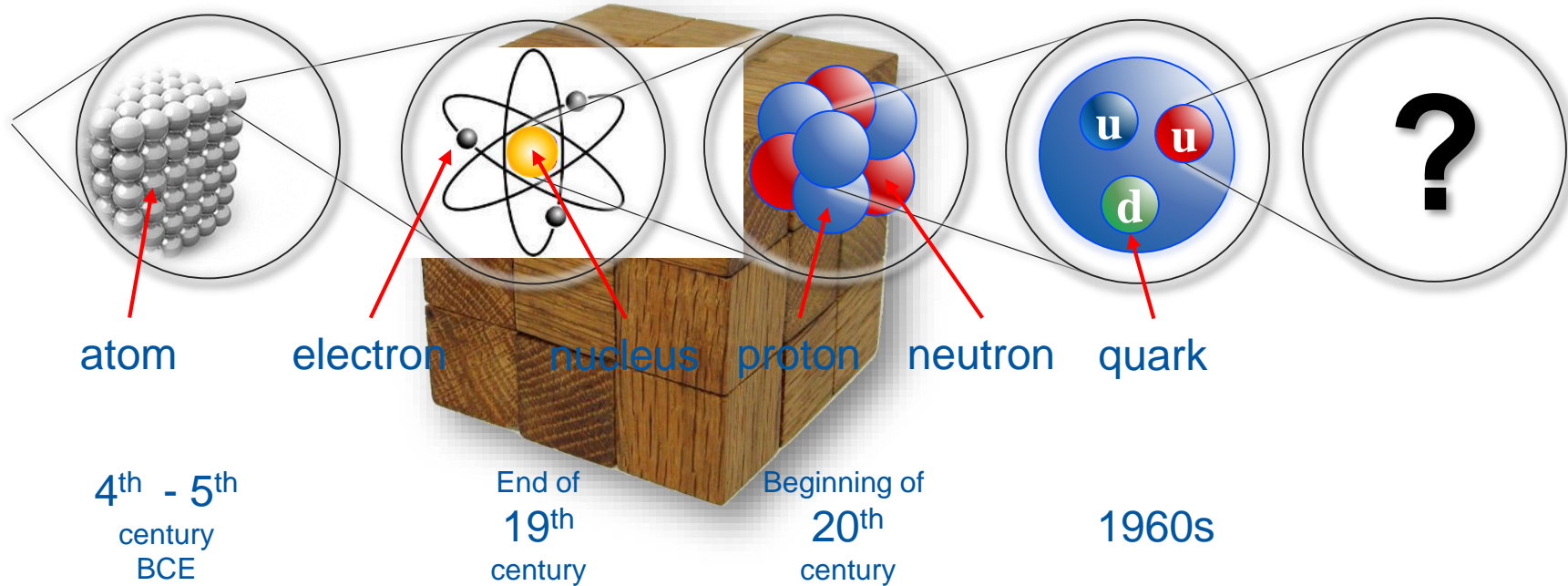
*What for ?*



# ***Fundamental research***



# What is the matter made of ?



# Standard Model

Images:  
[www.particlezoo.net](http://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



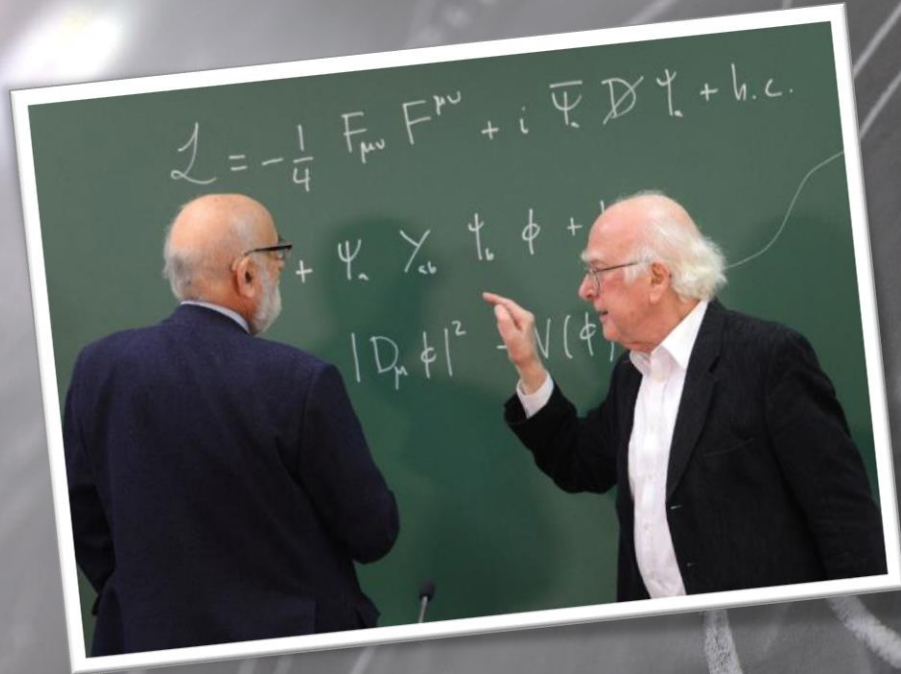


# Answering questions...



## *Antimatter ?*

# Answering questions...



Higgs

Higgs ?

# Answering questions...

*Dark matter ?*

# Collaborate



# Educate



# CERN

*How does it work ?*



# Accelerating and colliding



# Incredible levels of energy

$$-\frac{\hbar^2}{2m} \frac{d^2\psi}{dx^2} + V\psi = E\psi$$
$$\Phi_e = \frac{1}{2\pi} \int \frac{1}{r} d\Omega$$
$$k = \frac{2\pi}{\lambda}$$
$$v = \frac{\omega}{k} = \frac{1}{\mu} \frac{I_1 I_2}{2\pi d}$$
$$E_f = \frac{1}{m} E = k \frac{q_1 q_2}{r^2}$$
$$U = W_{AB} = |E_{PA} - E_{PB}| = |\varphi_A - \varphi_B|$$
$$T = \frac{4n_1 n_2}{(n_2 + n_1)^2}$$
$$F = \frac{m_1 m_2}{r^2}$$
$$\vec{B} = \mu_0 \frac{NI\sqrt{2}}{2\pi r m_e}$$
$$v = \frac{wh}{2\pi r m_e}$$
$$\varphi_E = \frac{E_c}{\varphi_0} = k \frac{\varphi}{r}$$
$$m = N \cdot m_0 = \frac{Q}{v_e} \frac{M_m}{N_A}$$
$$E = \frac{E_c}{a} \int_{-a/L}^{+a/L} \sin(\omega t + \phi) dy$$
$$R_m = \frac{c}{T} k = \pm \sqrt{\frac{2m}{\hbar^2} (E - V_0)}$$
$$k = \frac{p^2}{2m} m_0 = \frac{M_m}{N_A} = \frac{M_r \cdot 10^{-3}}{N_A}$$
$$l_t = l_0(1 + d \Delta t)$$
$$I = \frac{U_e}{R + R_i}$$
$$\omega = 2\pi f$$
$$\lambda = \frac{h}{m v}$$
$$R = \rho \frac{l}{S}$$
$$E = m c^2$$
$$\frac{\sin \alpha}{\sin \beta} = \frac{v_1}{v_2} = \frac{w_2}{w_1}$$
$$v = \frac{1}{\sqrt{\epsilon \cdot \mu}} = \frac{c}{\sqrt{\epsilon_r \mu_r}}$$
$$f_0 = \frac{1}{2\pi} \sqrt{\frac{g}{l}}$$
$$\psi(x) = \sqrt{\frac{2}{L}} \sin \frac{n\pi x}{L}$$
$$E = \frac{1}{2} \hbar \sqrt{k/m}$$
$$\beta = \frac{\Delta I c}{\phi_e} = \frac{\Delta E}{\Delta t} \frac{w_1}{x} + \frac{w_2}{x'} = \frac{w_2 - w_1}{v}$$
$$\oint \vec{B} d\vec{l} = \mu_0 \iint_S \vec{J} d\vec{S}$$
$$\vec{J} = \frac{1}{\mu_0} (\vec{E} \times \vec{B})$$
$$E_k = \frac{\hbar^2}{8mL^2}$$
$$\oint \vec{J} d\vec{S} = Q^*$$
$$v_k = \sqrt{\frac{3kT}{m_0}} = \sqrt{\frac{3kT N_A}{M_m}} = \sqrt{\frac{3R_m T}{M_r \cdot 10^{-3}}}$$
$$E = \hbar k^2$$
$$1 \text{ pc} = \frac{1 \text{ AU}}{206265}$$
$$R = \frac{U}{I}$$
$$\psi_2 = U_e I t$$

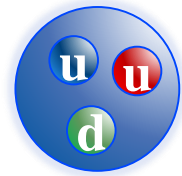
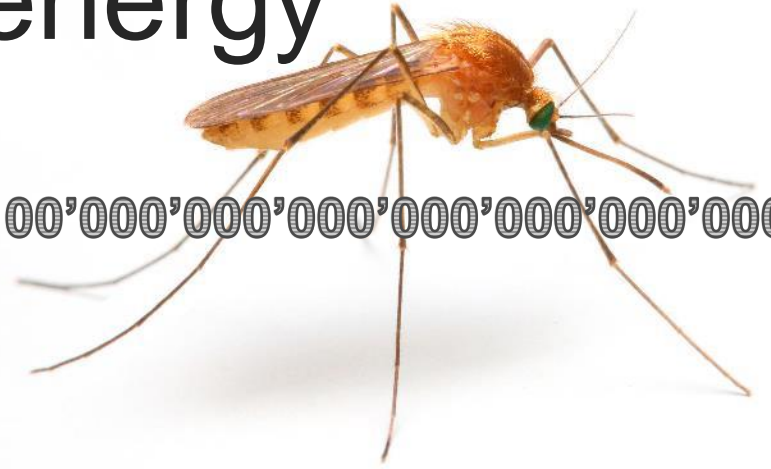




# Incredible levels of energy

7 TeV

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



# Accelerators chain

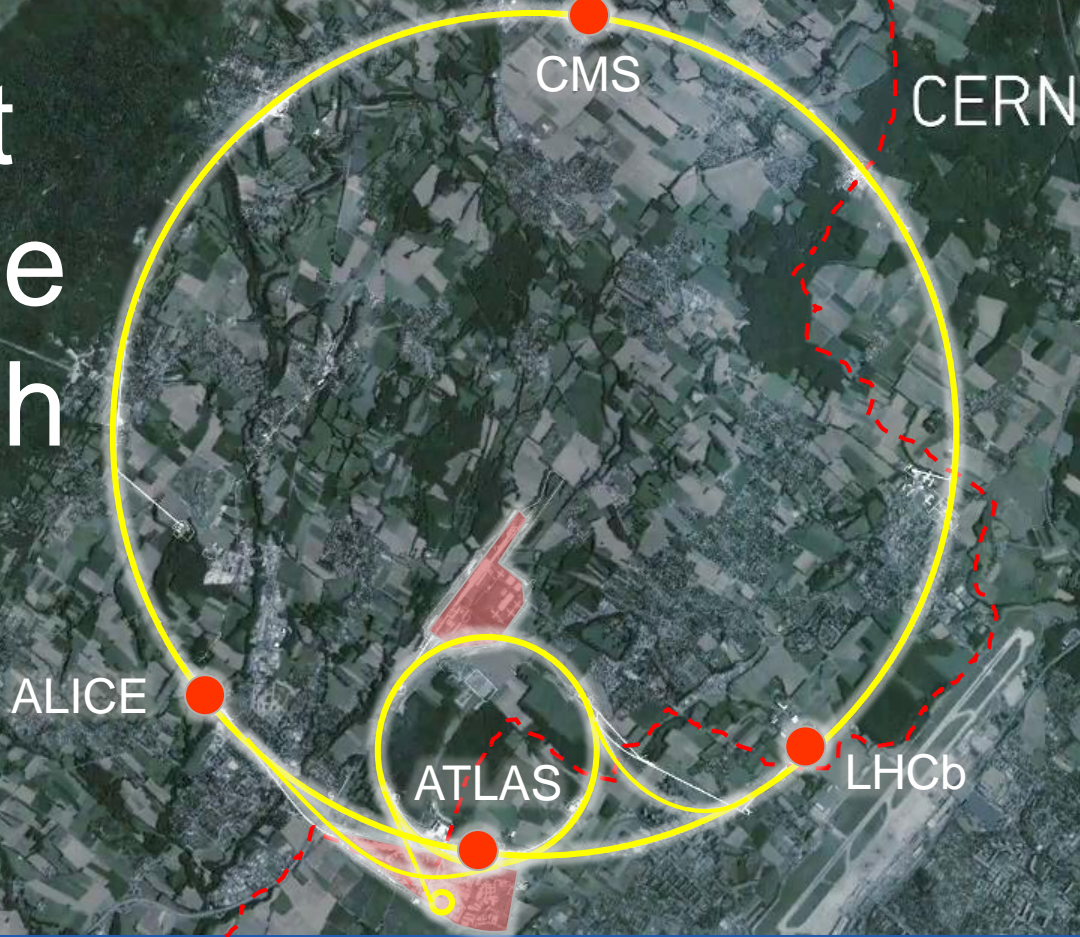


# Million of collisions

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 conical components, all rendered in a semi-transparent blue color. The background is a dark blue gradient.

25 ns bunch crossing  
25 ns entre les paquets

# Largest machine on Earth





The most  
powerful  
magnets

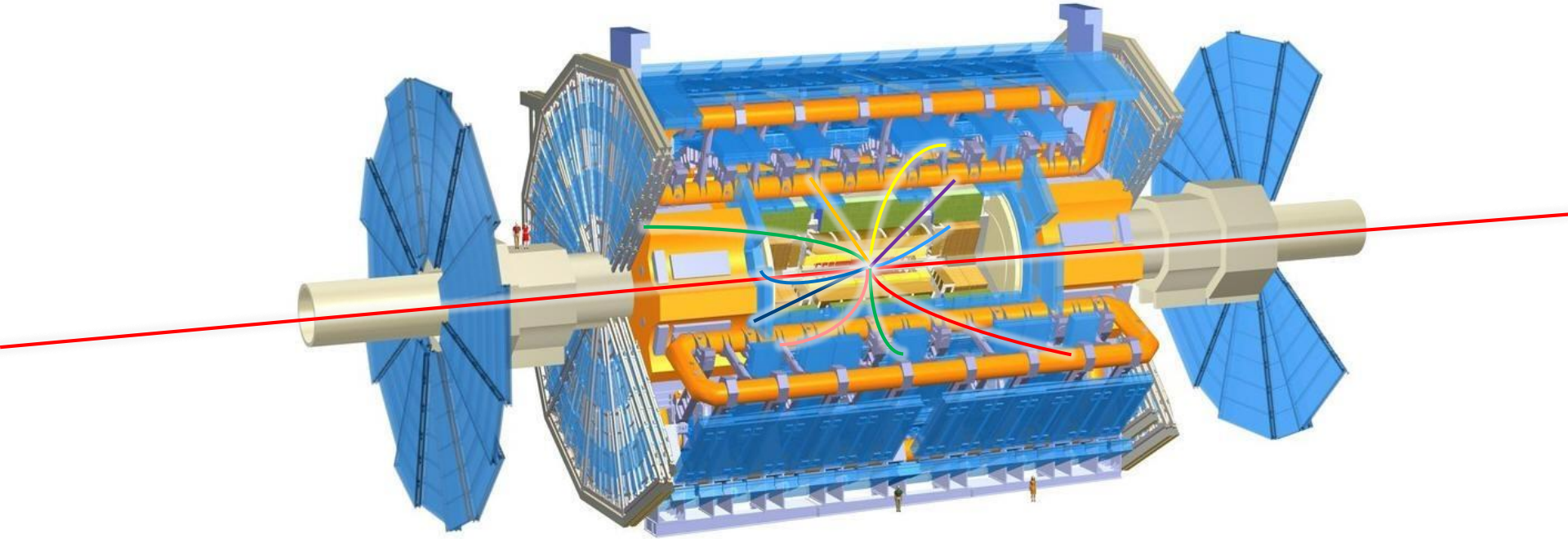


# The highest vacuum

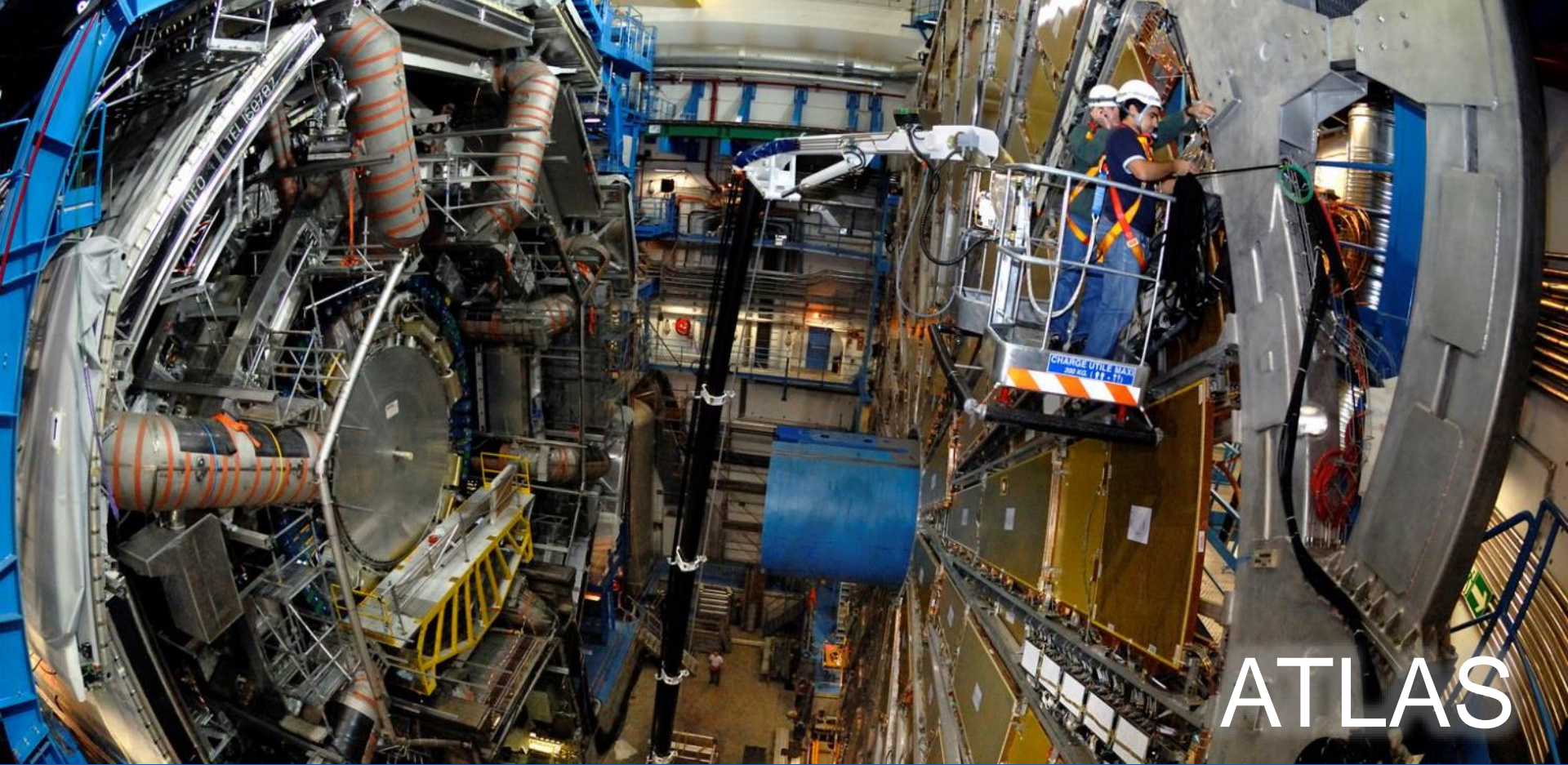


# The coldest temperature

# The largest detectors

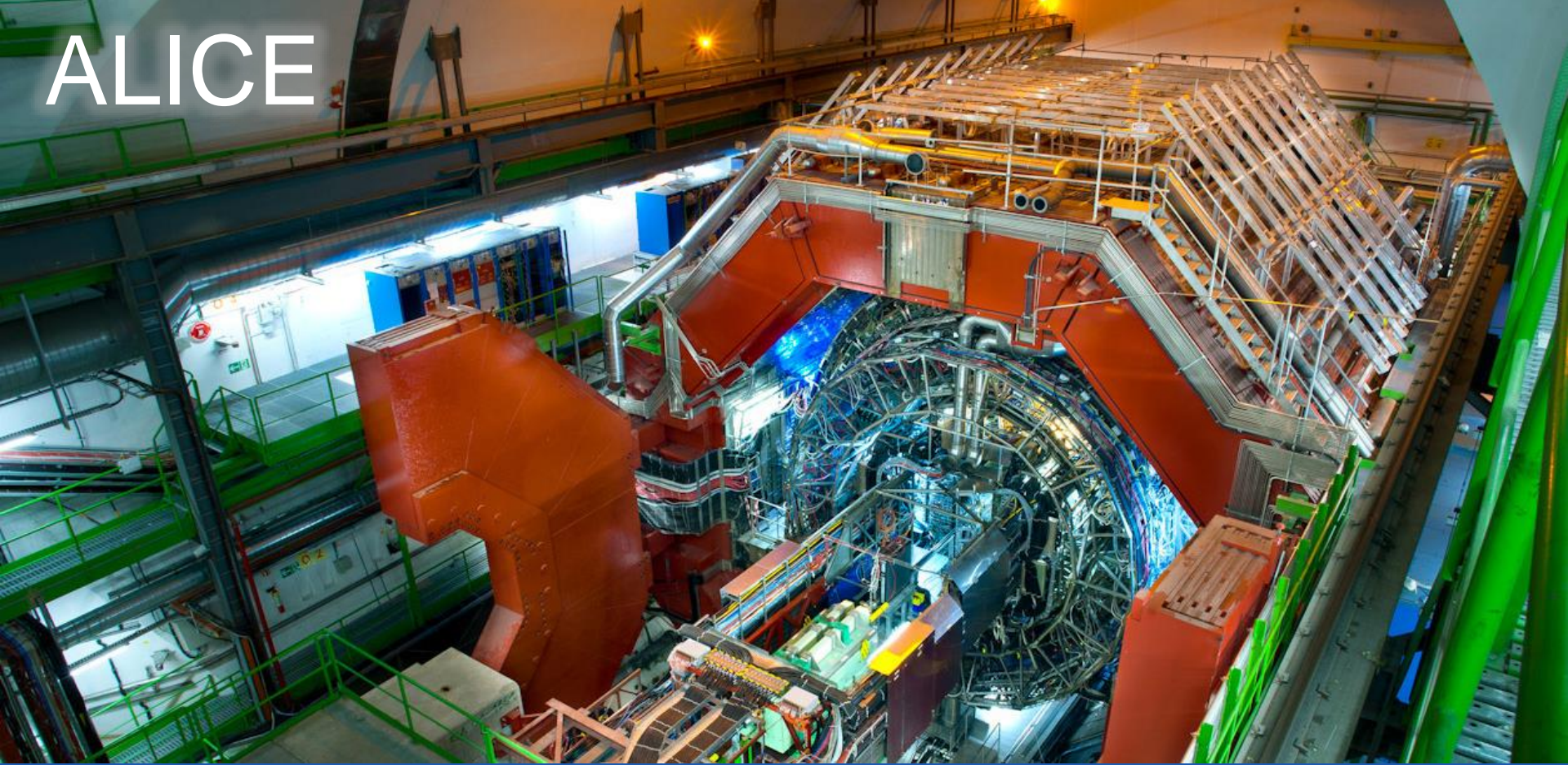






ATLAS

# ALICE



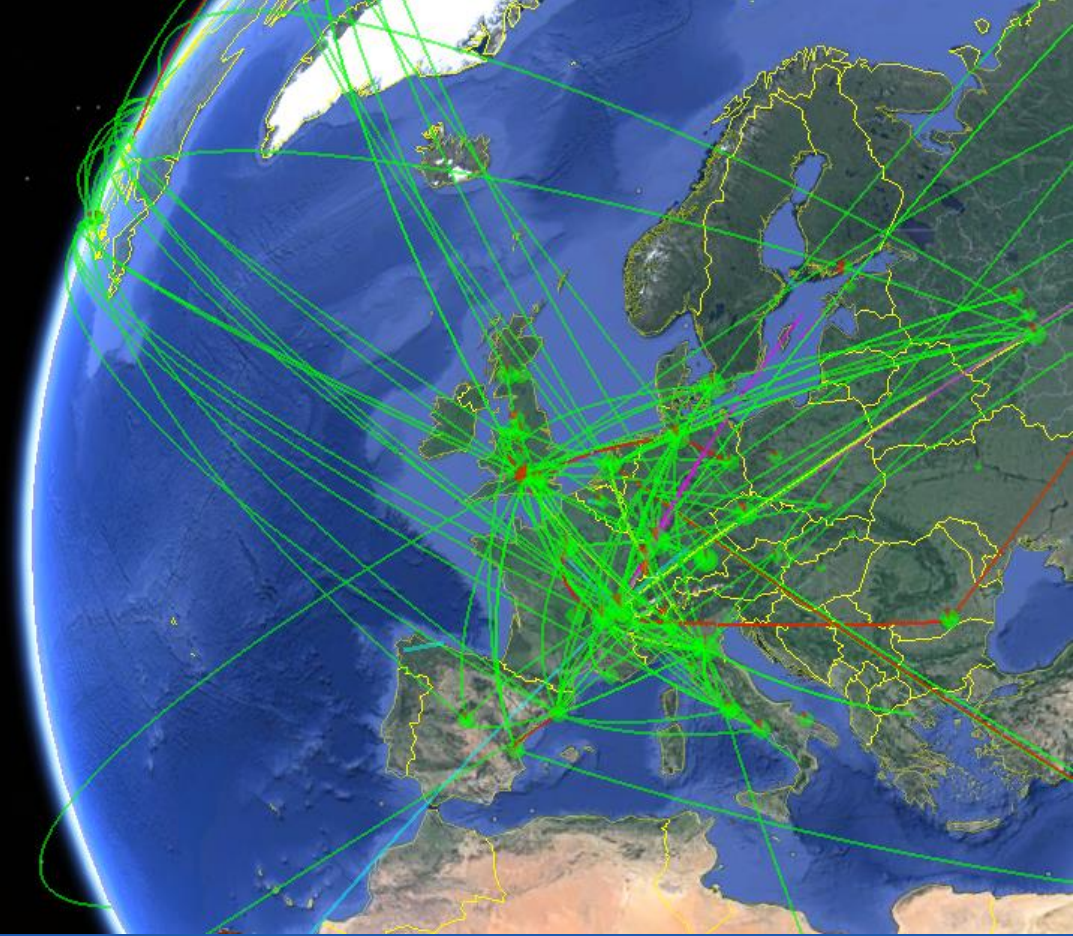
# CMS





LHCb

# The largest computing grid



# World Wide Web

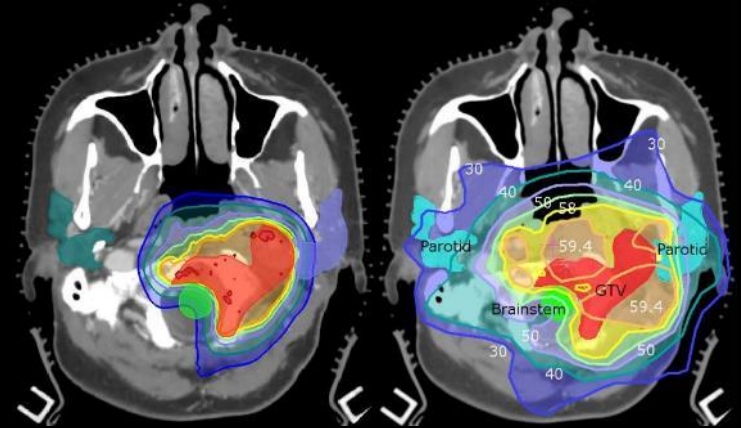
WWW



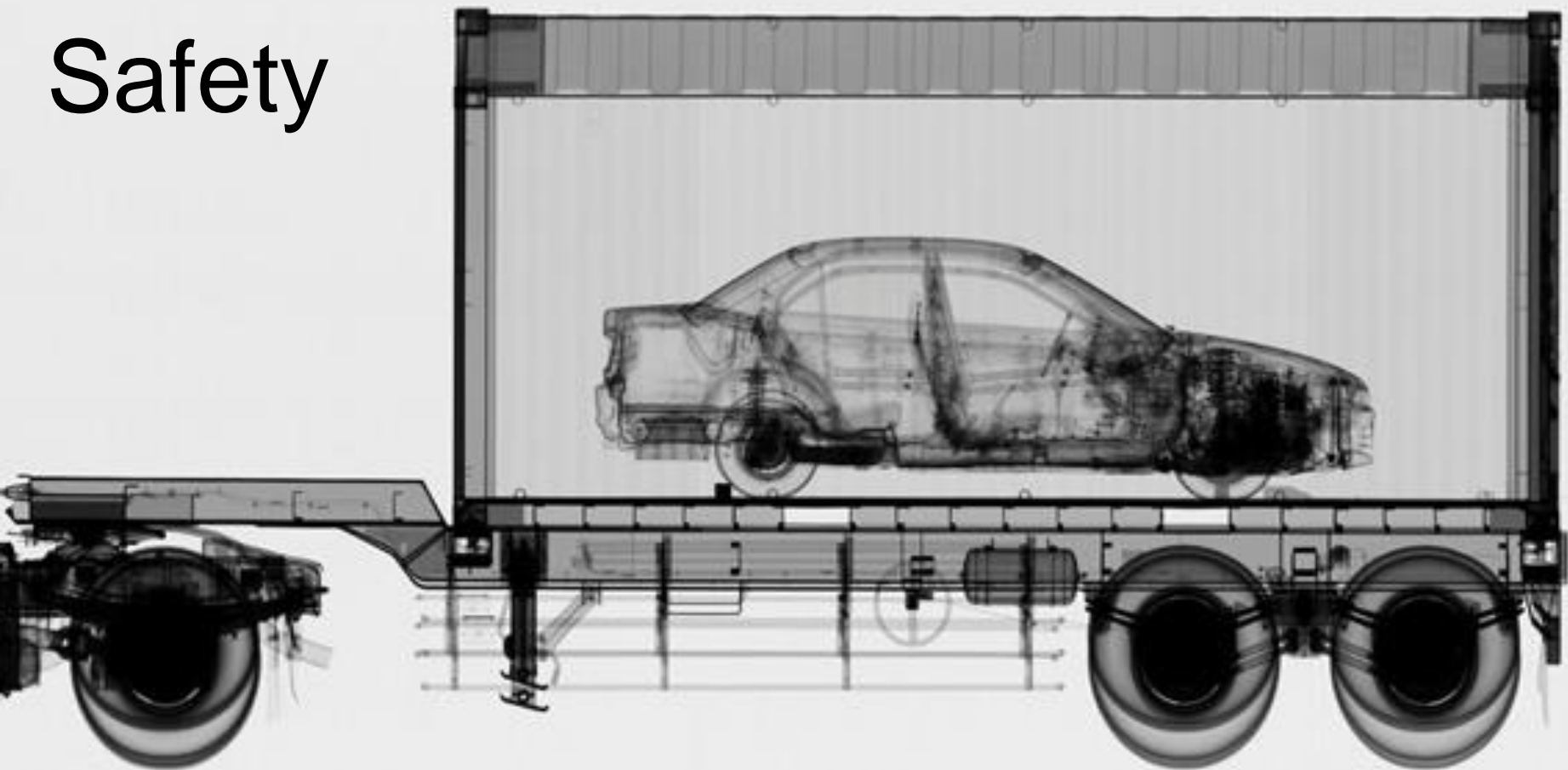
# Medical applications: MedAustron collaboration



- 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, iGeoEye, Earthstar  
Geographics, CNES/Airbus DS,  
USDA, USGS, AEX, Getmapping.

**INSET: 27 APRIL 2015**

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

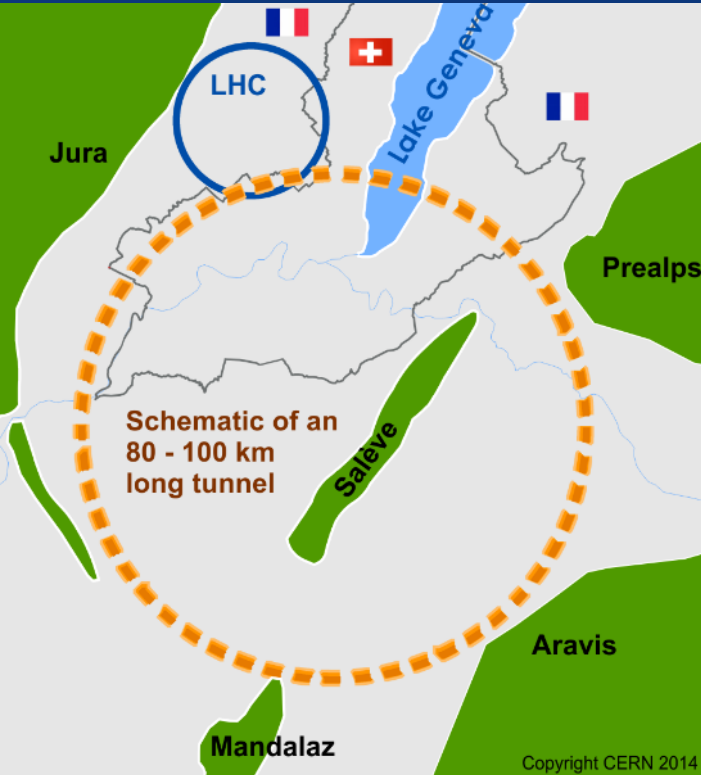
# Humanitarian

CERN

*What's next ?*

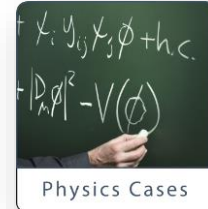


# Future Circular Collider Study

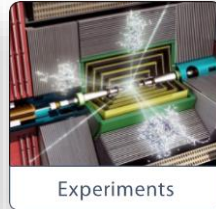


## International FCC collaboration (CERN as host lab) to study:

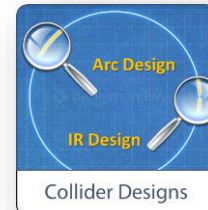
- ***pp*-collider (FCC-*hh*)**  
→ main emphasis, defining infrastructure requirements
- **~16 T ⇒ 100 TeV *pp* in 100 km**
- in Geneva area, site specific
- ***e<sup>+</sup>e<sup>-</sup>* collider (FCC-*ee*)**, as potential first step
- ***p-e* (FCC-*he*) option**, integration one IP, e from ERL
- **HE-LHC**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



Physics Cases



Experiments



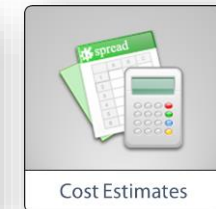
Collider Designs



R&D Programs

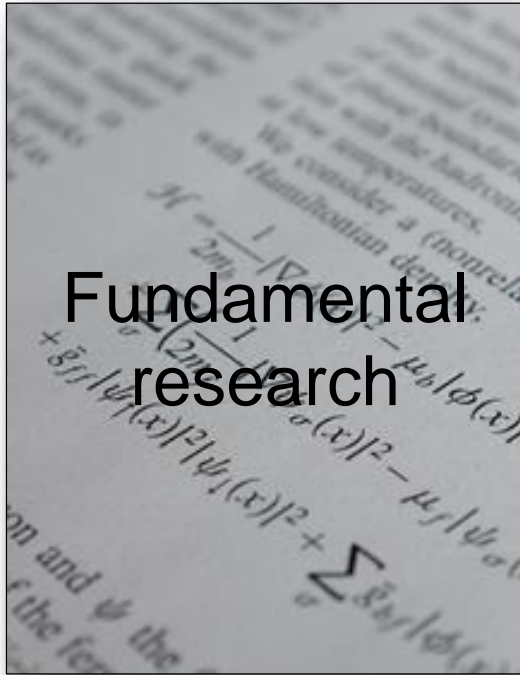


Infrastructures



Cost Estimates

# In a nutshell...



# Some links...

Information : [www.cern.ch](http://www.cern.ch)

CERN TV : [youtube.com/cern](https://youtube.com/cern)

Recruitment : [www.cern.ch/jobs](http://www.cern.ch/jobs)





[www.cern.ch](http://www.cern.ch)