



REINFORCE

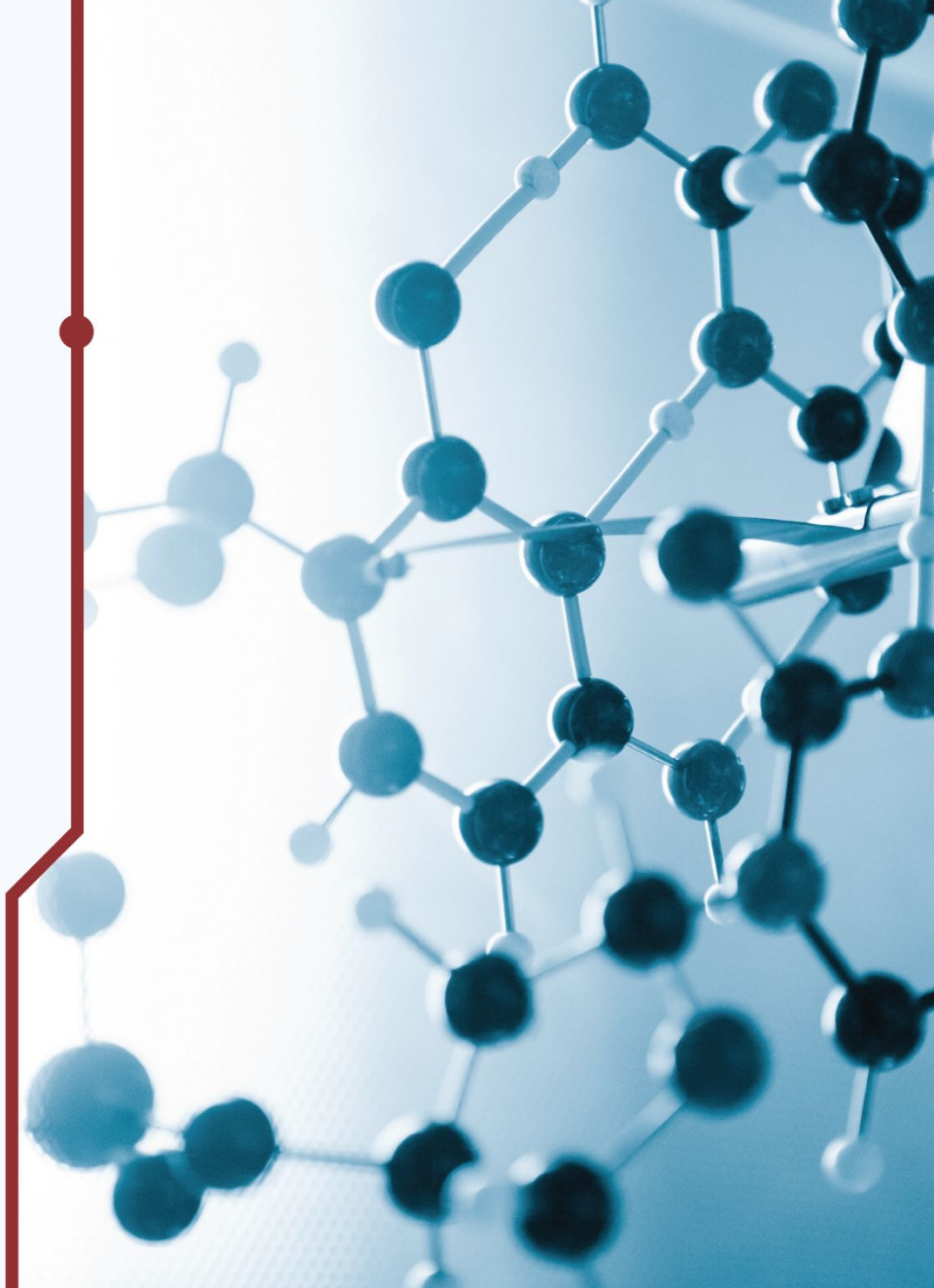
REsearch INfrastructures FOR Citizens in Europe

WP5: Search for New Particles at the LHC

Stylios Angelidakis on behalf of WP5

WEBINAR

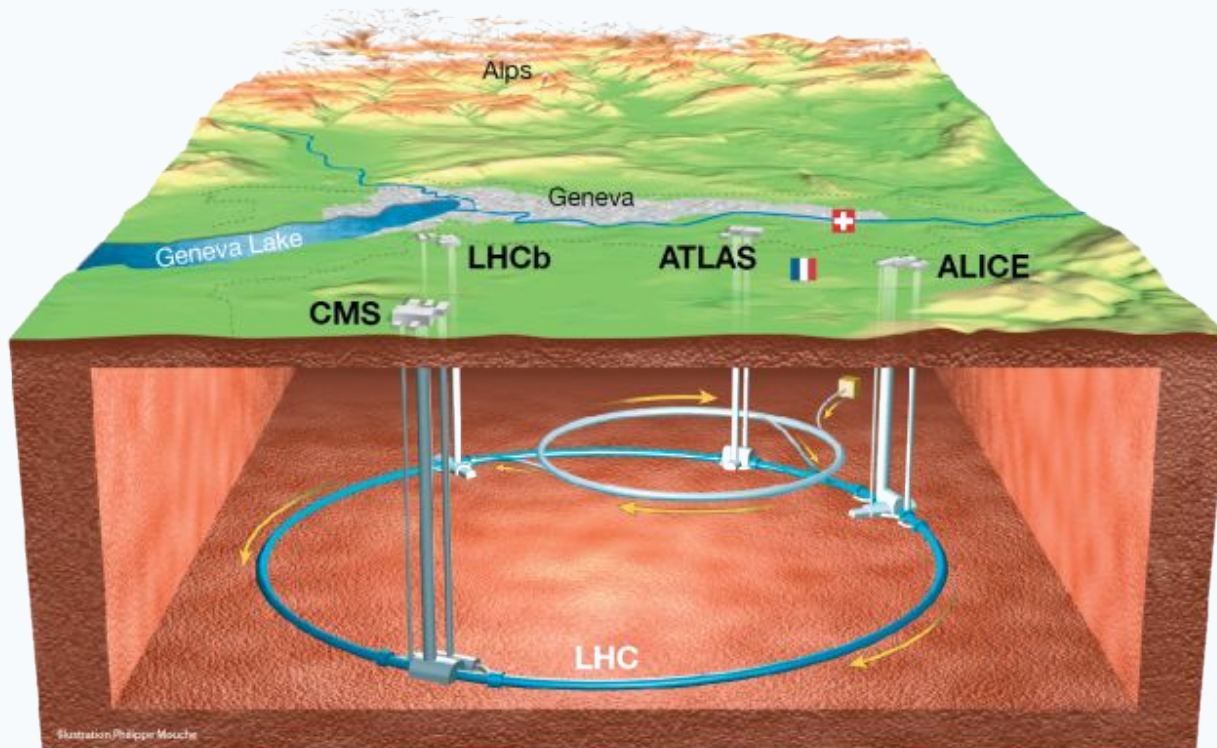
June 1, 2020, 11:00 AM CEST





Citizens will become scientists of CERN,
the largest particle-physics lab in the world.

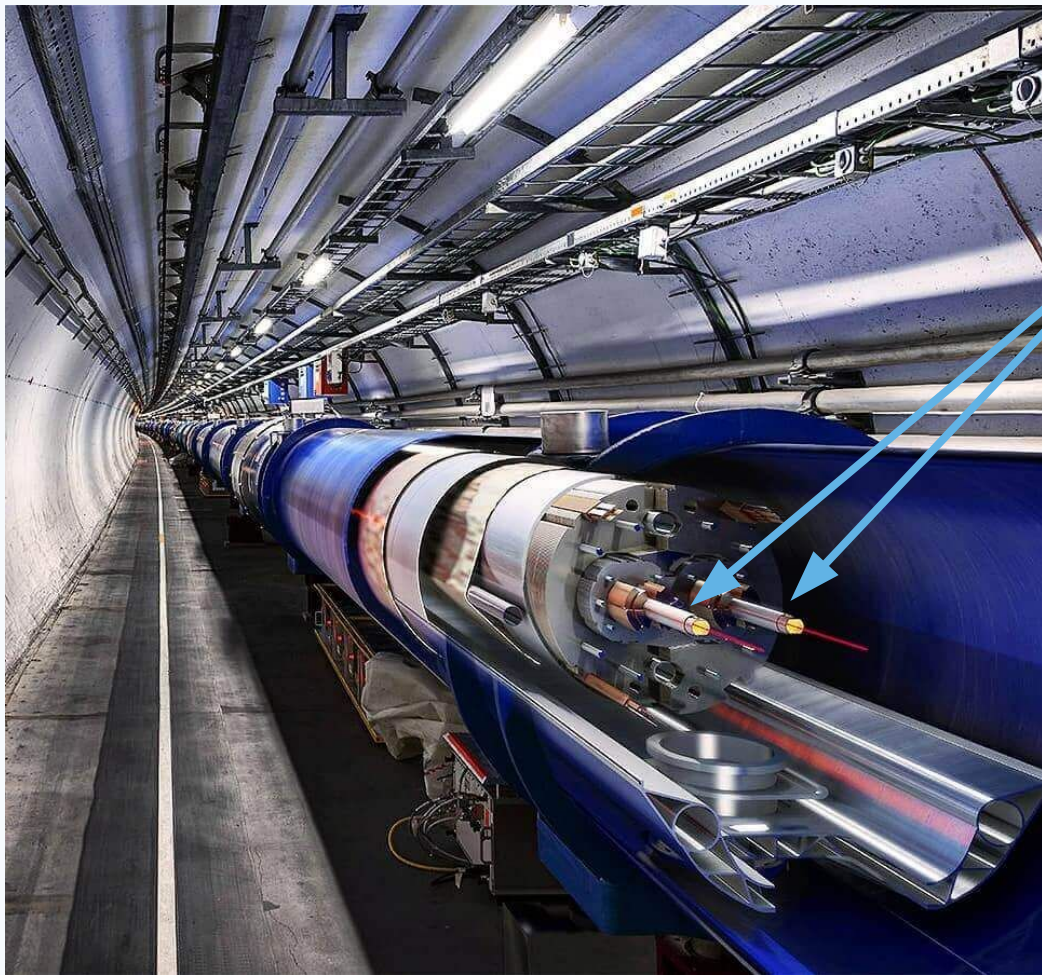
to discover New Physics with the Large Hadron
Collider (LHC), the most powerful collider ever built.



The LHC is located at the Swiss-French borders, 100m below the surface.

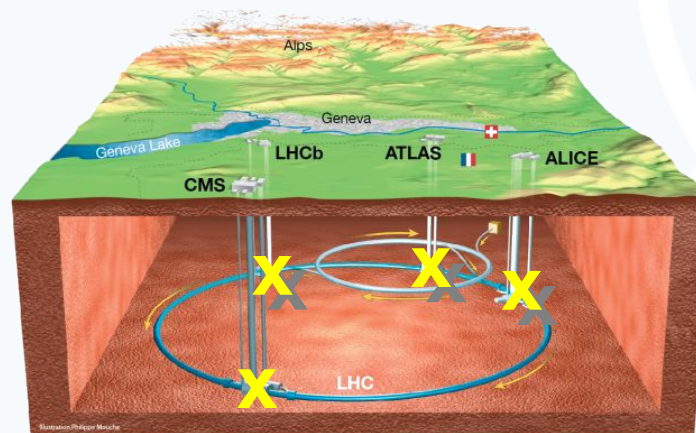
and it is a:

- Large: 27km circumference;
- Hadron: accelerates bunches of protons;
- Collider: the proton bunches collide.



Two vacuum pipes in which the proton bunches accelerate in opposite directions.

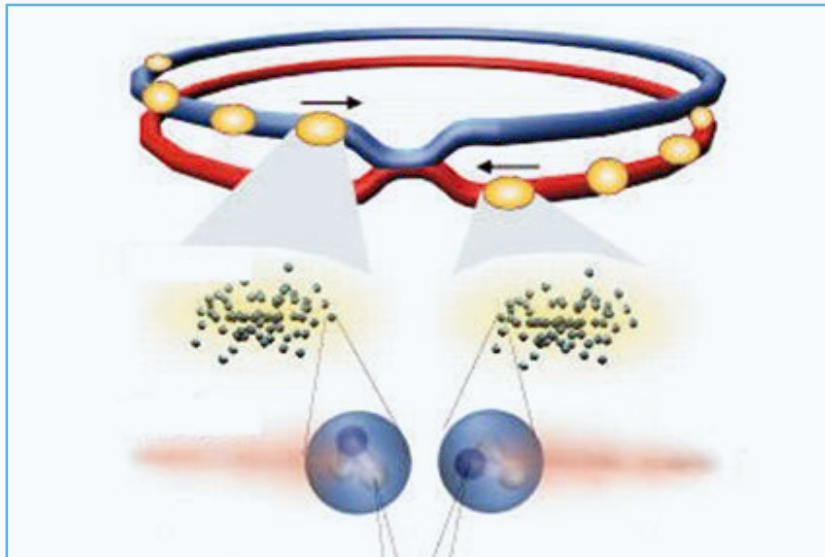
The pipes intersect at four points along the LHC circumference.



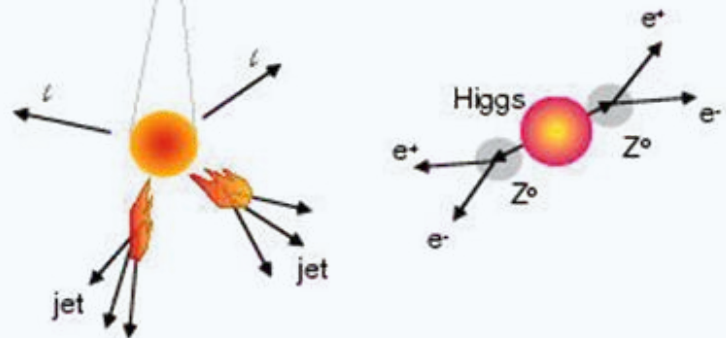
At those points, protons collide at very high energy.



Proton Collisions



(quark, gluon)



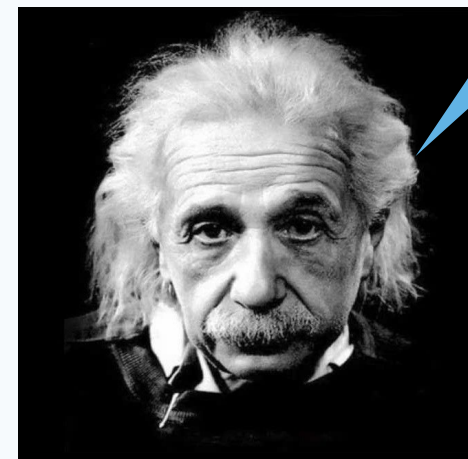
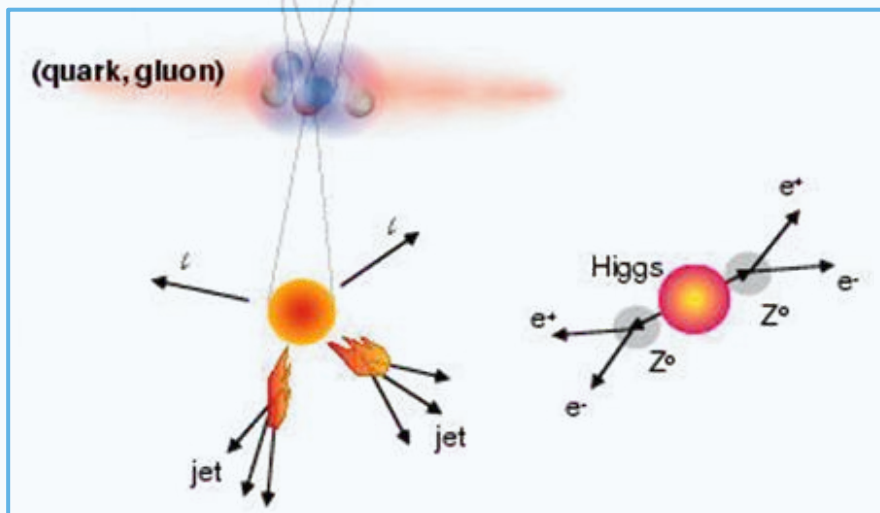
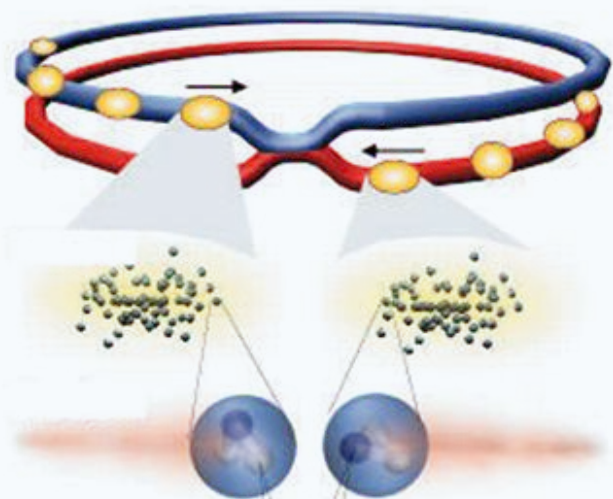
Proton bunches collide every 25ns.

Each bunch contains more than 100 billion protons.

Tens of protons interact.



Proton Collisions



$$E=mc^2$$

The collision energy is transformed into matter



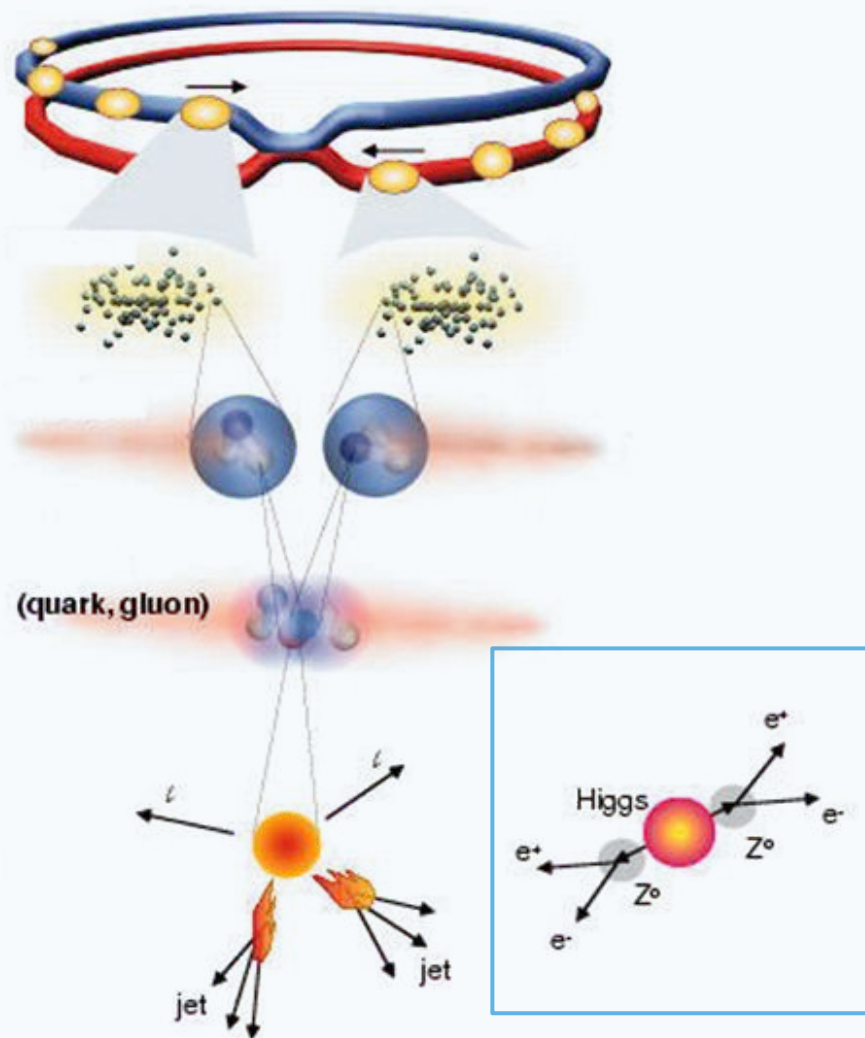
Known particles



maybe... **UNKNOWN** particles



Proton Collisions



It was among such collisions that the Higgs boson was discovered in 2012.

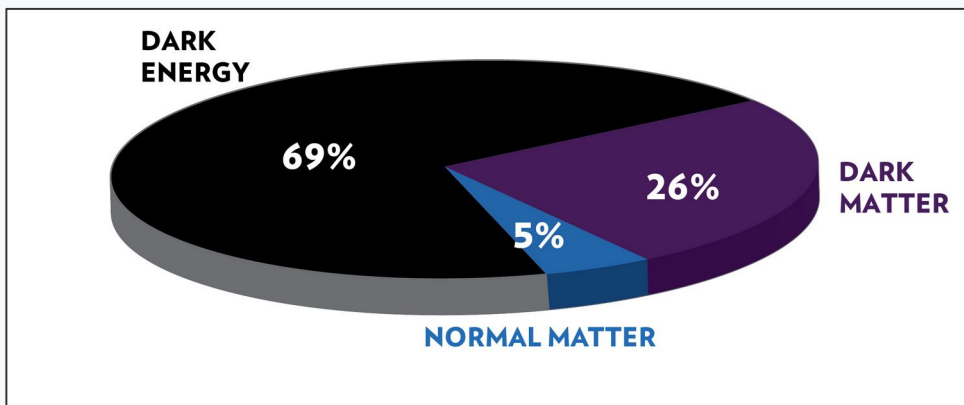


Because of the Higgs boson discovery we now understand how known elementary particles acquire mass.



Still many questions to be answered

For example:



Ordinary matter constitutes a small fraction of the energy in the Universe.

What constitutes the rest??



← masses of known particles

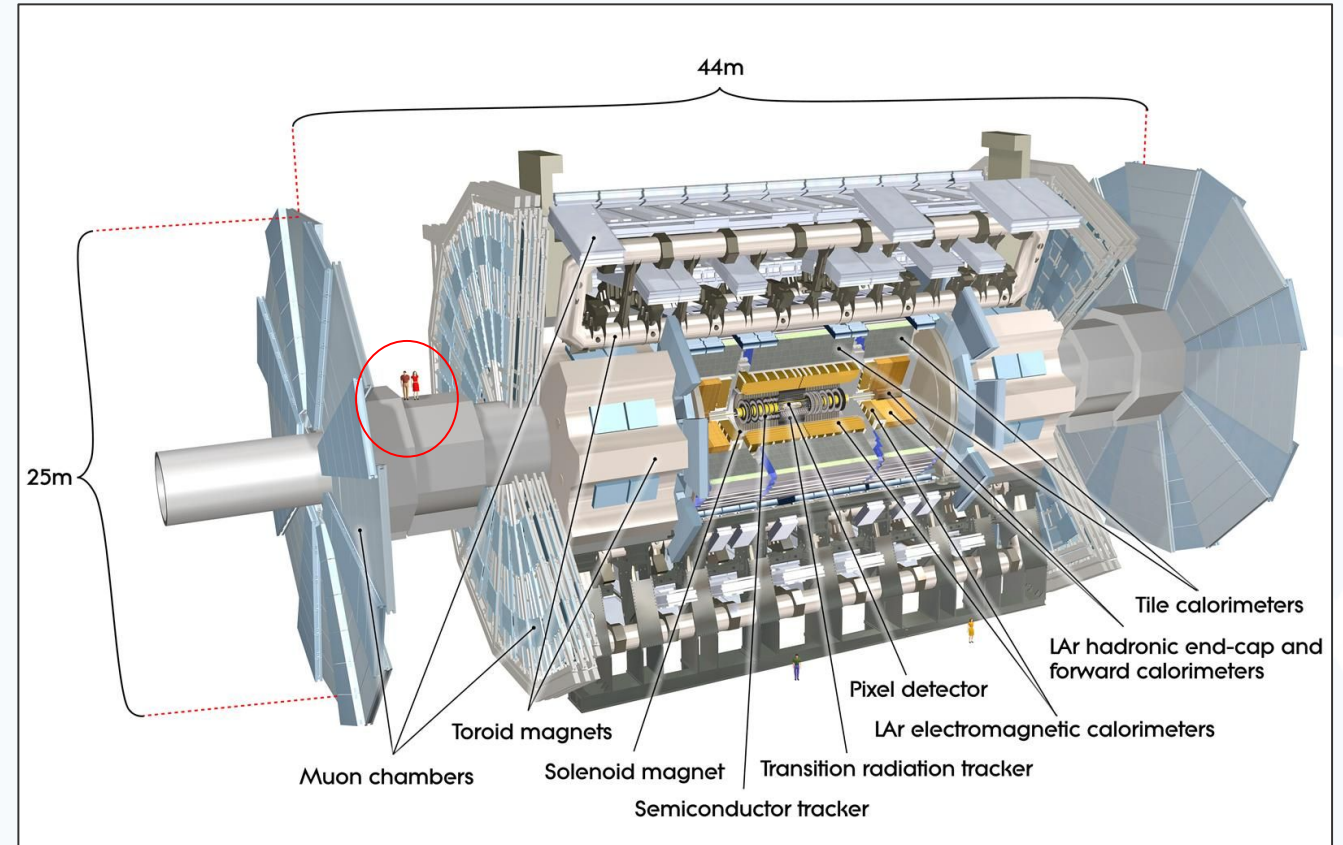
heaviest known particle:
top quark, $m_t \sim 10^2$ GeV

Planck mass
 $\sim 10^{19}$ GeV

What exists in the intermediate region??

Citizen-scientists can contribute to searches for New Physics.

We designed a multi-stage project for the study of real and simulated collision events recorded with the ATLAS detector.



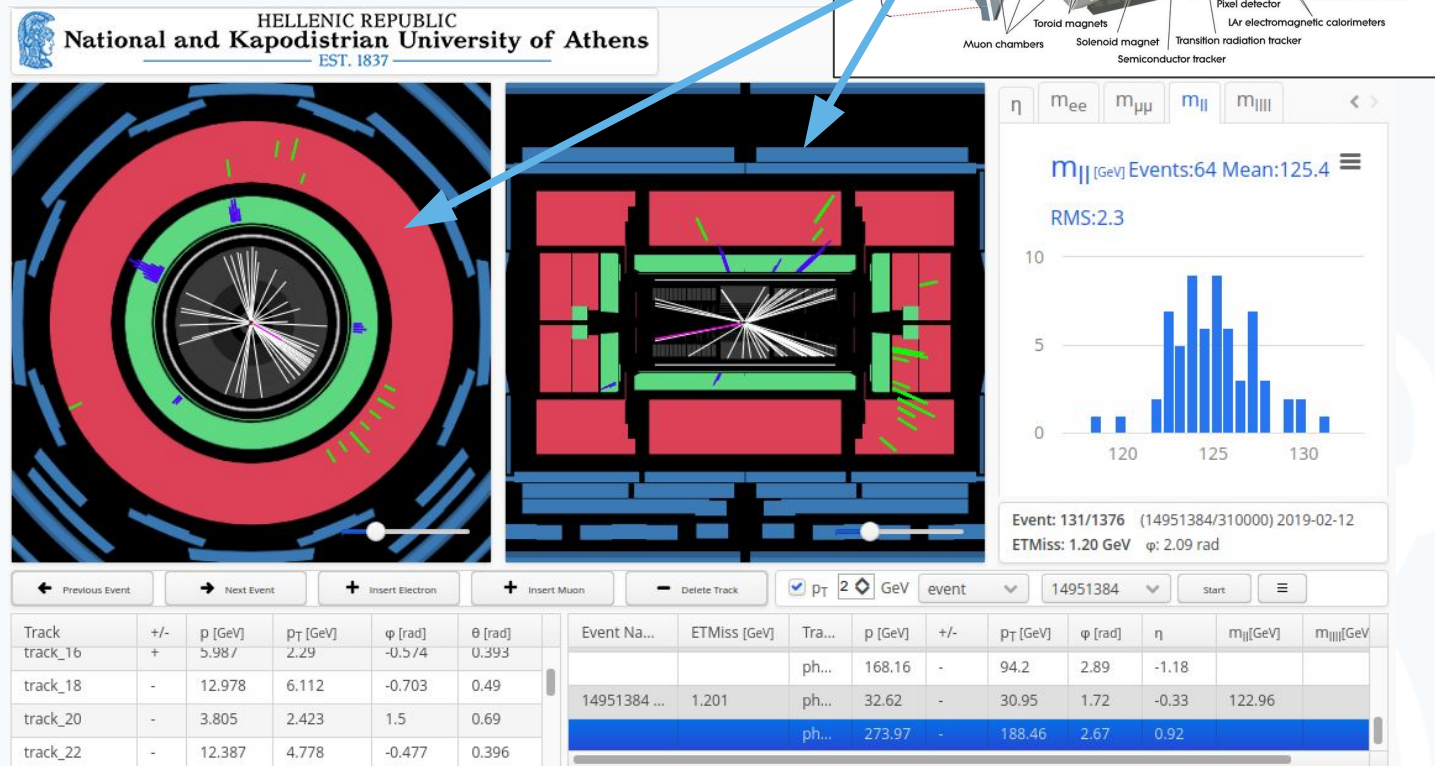
The project is based on visual (and if possible aural) representation of LHC collisions.

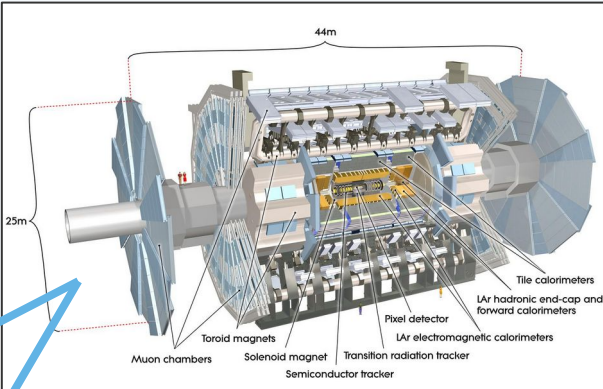
The interactive framework HYPATIA will offer different views of each collision in ATLAS.

Hosted by ZOOMIVERSE!



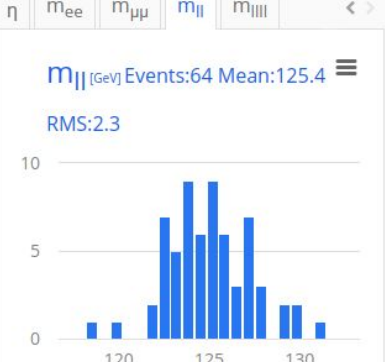
HELLENIC REPUBLIC
National and Kapodistrian University of Athens
EST. 1837





η m_{ee} $m_{\mu\mu}$ m_{ll} m_{llll}

m_{ll} [GeV] Events:64 Mean:125.4
 RMS:2.3

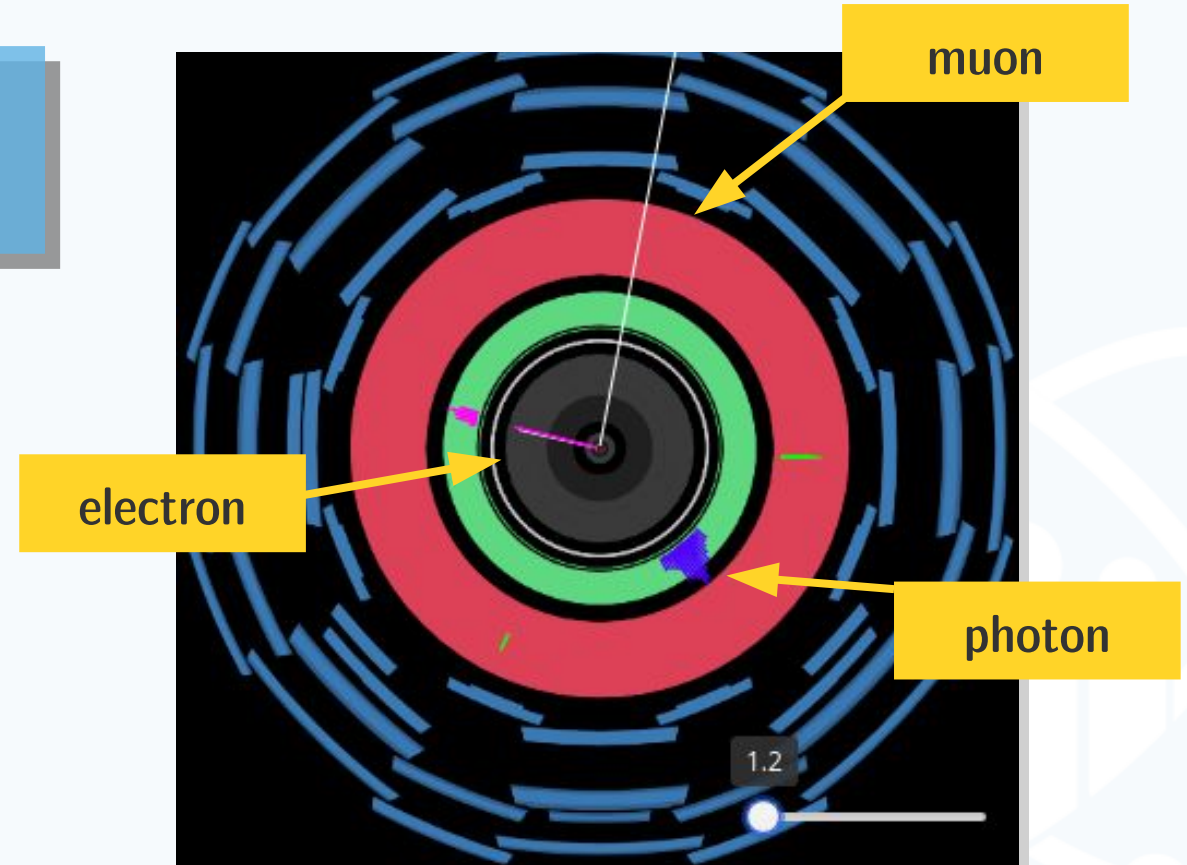


Event: 131/1376 (14951384/310000) 2019-02-12
 ETMiss: 1.20 GeV ϕ : 2.09 rad

Previous Event Next Event + Insert Electron + Insert Muon - Delete Track p_T 2 GeV event 14951384 Start

Track	+/-	p [GeV]	p_T [GeV]	ϕ [rad]	θ [rad]	Event Na...	ETMiss [GeV]	Tra...	p [GeV]	+/-	p_T [GeV]	ϕ [rad]	η	m_{ll} [GeV]	m_{llll} [GeV]
track_16	+	5.987	2.29	-0.574	0.393			ph...	168.16	-	94.2	2.89	-1.18		
track_18	-	12.978	6.112	-0.703	0.49			ph...	32.62	-	30.95	1.72	-0.33	122.96	
track_20	-	3.805	2.423	1.5	0.69	14951384 ...	1.201	ph...	273.97	-	188.46	2.67	0.92		
track_22	-	12.387	4.778	-0.477	0.396										

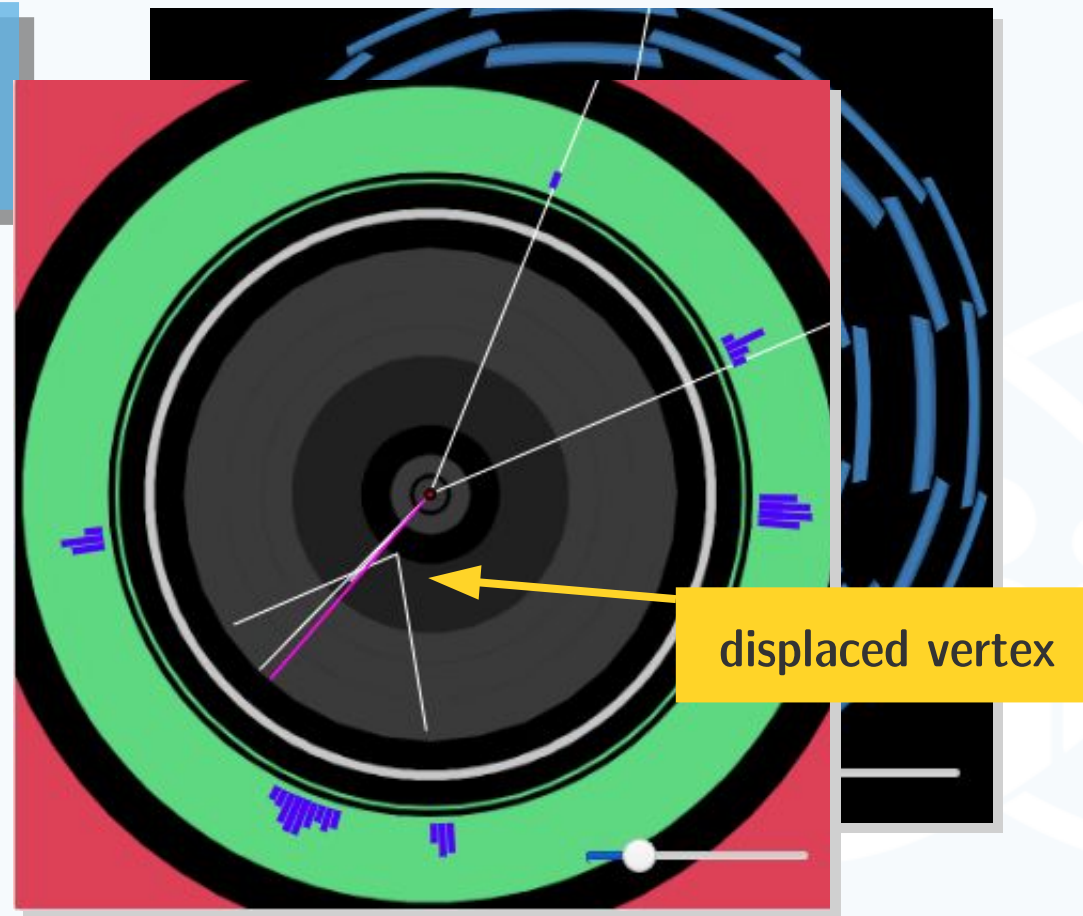
1. Learn about the different kinds of particles and identify them among collision products.





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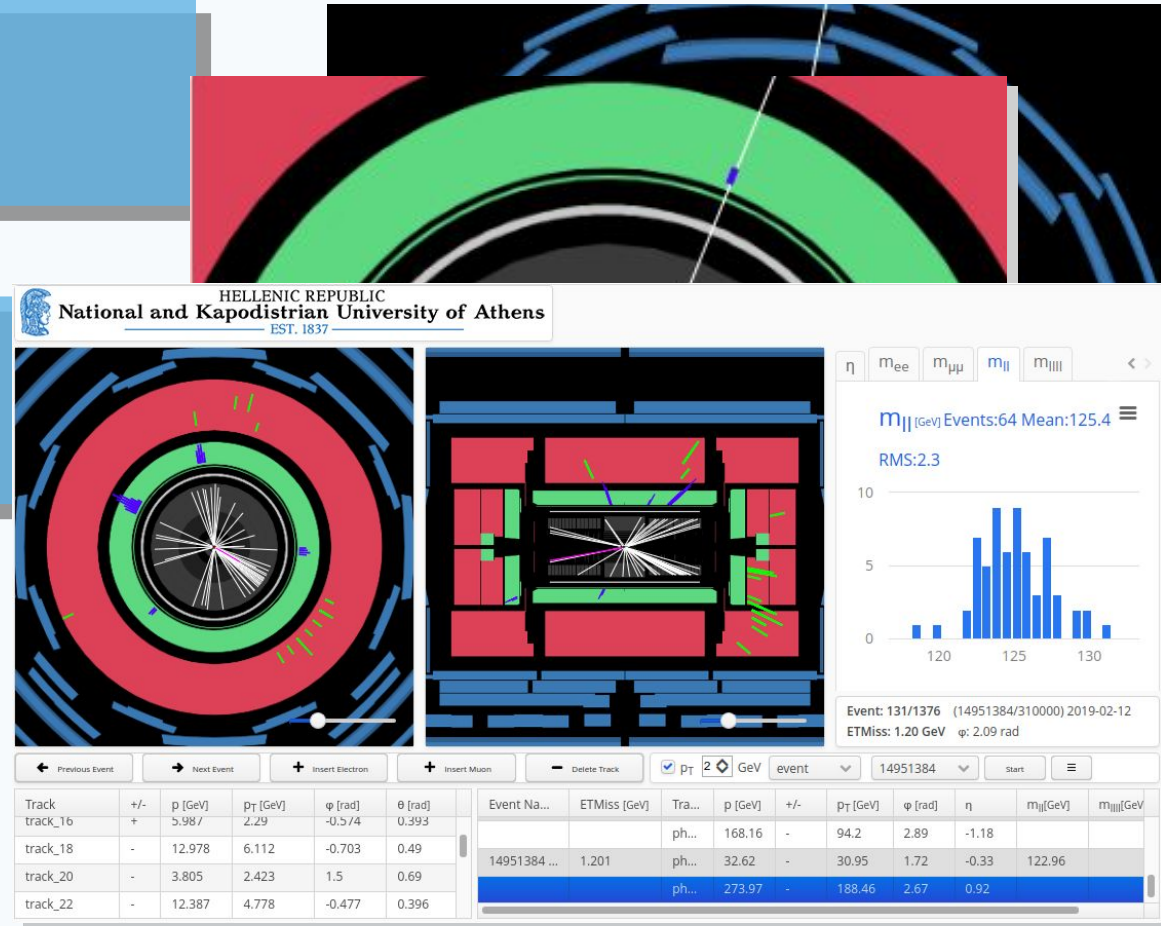
2. Learn to identify traces of new physics.



1. Learn about the different kinds of particles and identify them among collision products.

2. Learn to identify traces of new physics.

3. Scan a large sample of real data to discover new-physics signatures.



The project is expected to be running in about one year!

We invite interested citizens to learn and participate in research efforts at the LHC.

This project will also help us establish more paths, in order to bring citizen-scientists into the fundamental research of particle physics.