CERN

PASSEPORT
BigBang

A journey through the French and Swiss countryside
in search of the origins of matter and the Universe

PASSEPORT
BigBang

Martin
Computer scientist

Peter
LHC operator

The Passport to the Big Bang map (attached) describes the cycle routes that connect the ten points of the circuit.

Natasha
Physicist

At each stage, solve the puzzles, write down your activation code and tick the last page!

clip
clip

Tom
Age 15

Chloé
Age 9

If you want to know what happens at each of CERN's sites, follow us!

Get ready to explore the world of particles in the Pays de Gex and the Canton of Geneva. A journey in ten stages.

The ten stages of the Passport to the Big Bang are located at various points around the countryside of Geneva and neighbouring France above the tunnel of the LHC, the biggest particle accelerator ever built.

The LHC has been shut down.
We need your help: Your mission, if you choose to accept it, is to restart the particle accelerator.

To do this, you need to collect ten activation codes, one for each stage of the Passport to the Big Bang. These codes are unique to you.

You can visit the stages in any order.

You don't have to do the whole circuit in one day: you can note the codes in your passport as you go along and complete your mission at your own pace.
Once you have all the codes, visit **cern.ch/passeport-big-bang** to restart the LHC!

cern.ch/passeport-big-bang

ATLAS, the colossus of physics

What is our Universe really made of? What is dark matter? Do hidden dimensions exist? These are some of the questions the physicists at ATLAS hope to answer with their enormous underground experiment.

After looking around the ATLAS platform, has dark matter become any clearer to you?

Children's puzzle

Why is dark matter given this name?

a) *because it is thick, opaque and sticky*

b) *because it comes from the dark side of the Universe*

c) *because when we look for it with telescopes, we can't see it*

Family puzzle

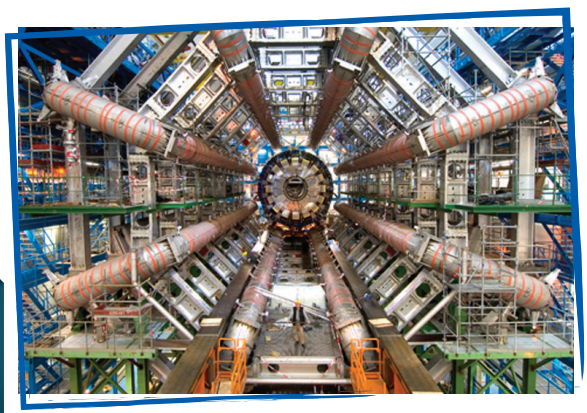
Some of the particles that could make up dark matter have a strange name. What is it?

a) *superhysterical particles*

b) *supersymmetric particles*

c) *supertypical particles*

Answers on page 15.
No cheating!



ATLAS Stage
Access card verification

Write down your personal activation code here.

Your personal activation code

At the controls of the accelerators

In the CERN Control Centre, operators work in shifts 24 hours a day to control a network of particle accelerators like no other in the world.

Take the controls and hold on tight before answering these questions.

Children's puzzle

Which of these particles circulate in the LHC?

a) *simpletons*

b) *protons*

c) *croutons*

Family puzzle

Why is the LHC circular?

a) *because centrifugal force makes the particles go faster*

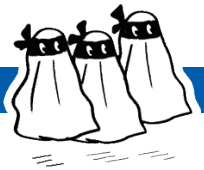
b) *so that the cows in the Pays de Gex don't get bored and can watch the particles going past*

c) *because each time they go around, the particles receive a pulse, which gives them more energy*

Control Centre Stage
Checking the LHC safety chain

Write down your personal activation code here.

Your personal activation code



The journey of the phantom particles

The physicists who worked on the CNGS experiment successfully improved their understanding of the elusive and mysterious neutrinos. How? By shooting them off on a super-fast journey through the Alps.

Try to find out more about these elusive particles.

Children's puzzle

What do we call the transformation that neutrinos undergo during their journey?

a) *metamorphosis*

b) *vibration*

c) *oscillation*

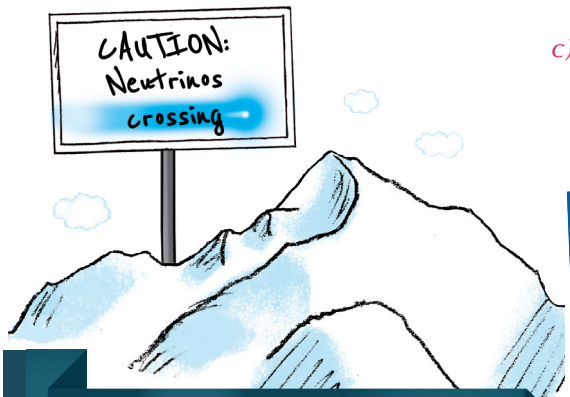
Family puzzle

Why were neutrinos sent through the Earth's crust to a Laboratory so far from CERN, 732 km away to be precise?

a) *so that they could change from one type of neutrino to another*

b) *so that they could lose enough energy*

c) *so that they could be detected to test a new anti-mole system*



Neutrinos Stage
Checking the accelerator chain

Write down your personal activation code here.

Your personal activation code

In ALICE's Wonderland

Going underground and finding yourself at the very start of the history of our Universe… A dream? No. The daily life of physicists at ALICE.

Have a go and separate true from false.

Children's puzzle

What is the nickname we give to the state of matter that physicists are trying to reproduce at ALICE?

a) *initial stew*

b) *infernal broth*

c) *primordial soup*

Family puzzle

ALICE is studying a state of matter that existed at the very start of the Universe and in which the quarks:

a) *are completely free to move around. Later on, they will be closely bound together to form protons or neutrons*

b) *have yet to appear. They will appear later on, at the same time as the protons or the neutrons*

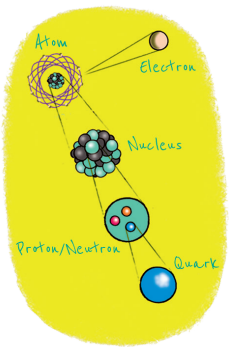
c) *are not yet fully cooked. The temperature needs to rise a bit more*

ALICE Stage

Eye recognition system

Write down your personal activation code here.

Your personal activation code



The matter present in the Universe today is composed of a set of particles nested inside each other like Russian dolls.

When energy creates matter

What passes under your feet over 11,000 times per second?
The particles in the LHC!

Get your neurons working:

Children's puzzle

What speed are the particles accelerated to in the LHC?

a) *50 km/h, like a moped*

b) *almost the speed of light (300,000 km/s)*

c) *36,000 km/h, like a rocket*

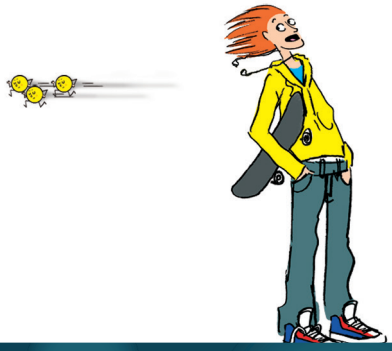
Family puzzle

Why do we accelerate particles at CERN?

a) *so that the particles cross the finish line as quickly as possible*

b) *to produce enough energy to make the superconducting magnets work*

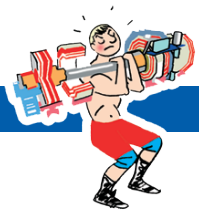
c) *to make collisions with enough energy to produce particles that are interesting to study*



Acceleration Stage
An acceleration specialist talks to you

Write down your personal activation code here.

Your personal activation code



CMS, the heavyweight of physics

CMS : does it stand for Concentration of a Mass of Science? No, but it could do, as this experiment is one of the two - with ATLAS - that discovered the Higgs boson, the particle which helps explain how fundamental particles get mass.

Will you be able to match up to the physicists by finding answers to these heavyweight questions?

Children's puzzle

What is one of the CMS calorimeters made from?

a) *super-transparent, super-heavy crystals*

b) *super-hard, super-shiny metals*

c) *super-elastic, super-practical plastic*

Family puzzle

What are sub-detectors used for?

a) *to put supra-detectors on*

b) *recording certain characteristics of the particles produced during collisions in the LHC*

c) *directly detecting where the Higgs boson has gone*

CMS Stage

Presence check at the access point

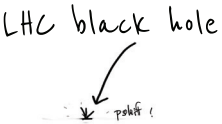
Write down your personal activation code here.

Your personal activation code

Ten questions about the LHC

A unique machine like the LHC inspires lots of questions. Separate the truth from all the rumours.

Are you green enough to answer these questions?



Children's puzzle

What are cosmic rays?

a) *aliens who shoot at us with their lasers*

b) *particles from outer space that are constantly showering us*

c) *sun rays*

Family puzzle

Why do we say that if black holes appeared in the LHC, they would be completely insignificant?

a) *because, if they did appear, they would have the energy of a mosquito in flight. They would be so tiny that they would disappear again immediately*

b) *because physicists often have holes in their socks, jumpers and T-shirts, so they see holes everywhere*

c) *because if black holes appeared, they would not have much room to grow in the beam pipes of the LHC*

Environment Stage
Dosimeter detection

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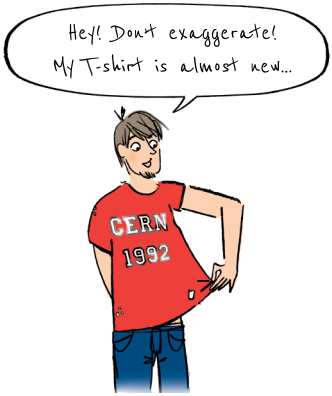
Your personal activation code



Cryogenics, the ice genie

Another amazing fact about the LHC? It's also the biggest and most powerful freezer in the world.

Don't get cold feet about these questions!

Children's puzzle

What makes the magnets in the LHC so special?

a) *they are disruptive*

b) *they don't stick to the refrigerator*

c) *they are superconducting*

Family puzzle

What is superconductivity?

a) *it's the code of conduct at CERN*

b) *it's the property of materials that conduct current with no resistance*

c) *it's the property of materials that guide particles in exactly the right direction*

Cryogenics Stage

A cryogenics specialist talks to you

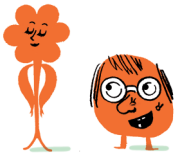
Write down your personal activation code here.

Your personal activation code

LHCb: the explorers of antimatter

Something unsuspected about physicists: they are obsessed with beauty. To unravel the mysteries of antimatter, they are hunting for what we call beauty particles.

Here are some matters worth thinking about:



Children's puzzle

What happens when matter and antimatter meet?

a) *they destroy each other and leave nothing behind except energy*

b) *they duplicate themselves*

c) *they mix together to form supermatter*

Family puzzle

Why are the quarks studied by LHCb called beauty quarks?

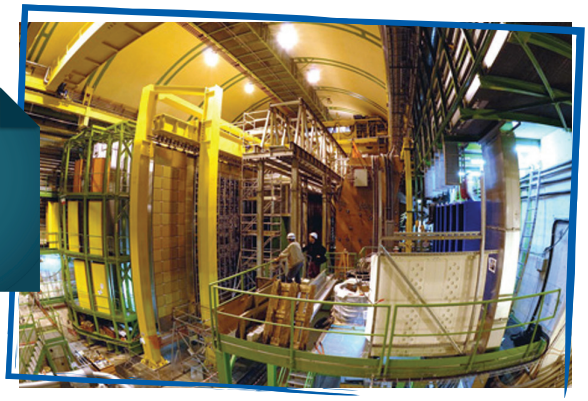
a) *because they are good-looking particles, as physicists have been able to observe*

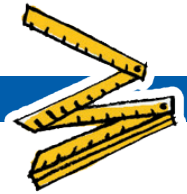
b) *it's just a name chosen by physicists*

c) *because physicists discovered them just before the ugly quarks*

LHCb Stage
Equipment check
Write down your personal activation code here.

Your personal activation code





LHC
MEYRIN
Switzerland

Scientific giants, devilish precision

The huge research instruments at CERN need to achieve outstanding precision and also need experts who measure up to them.

Are you sure you measure up?

Children's puzzle

Why are triangulation points essential for CERN?

a) *because if you join them up on the map, they form the CERN logo*

b) *because they stop scientists getting lost*

c) *because they enabled the CERN installations to be built to millimetre precision*

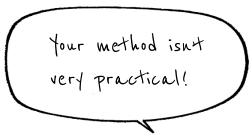
Family puzzle

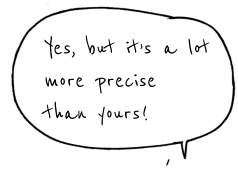
CERN has a knowledge- and technology-transfer policy to:

a) *allow society to benefit from CERN's innovations*

b) *exchange computer data between laboratories more quickly*

c) *create synergy between energy, electrical and technological transfers*





Precision Stage
Measurements to the millimetre

Write down your personal activation code here.

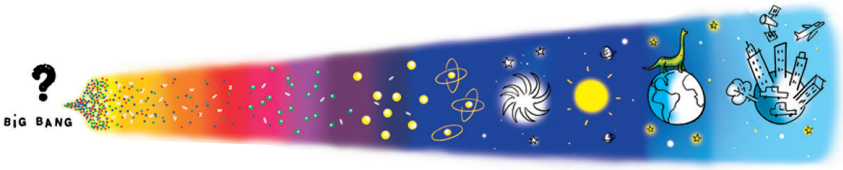
Your personal activation code

Glossary

Particle accelerator
A machine that accelerates tiny pieces of matter, i.e. particles, to bring them up to very high energies.

Antimatter
For every particle of matter, there is an antimatter particle that is almost identical, except that it has an opposite electrical charge.

Atom
An atom is a component of matter. It is made up of a nucleus surrounded by a cloud of electrons. The nucleus is composed of protons and neutrons, themselves made up of three quarks each. (see illustration on p.7)



Big Bang
The phenomenon at the origin of our Universe, 13.7 billion years ago. We can think of it as an extremely dense and hot point that experienced a sudden and gigantic expansion.

Higgs boson
A particle which physicists eventually found after decades of hunting. Particles acquire their mass by the Brout-Englert-Higgs mechanism, as proven by the discovery of the Higgs boson.

Particle detector
Device used to measure the properties of the particles that pass through it. It is formed of different sub-detectors, each designed to record a specific property of the particles.

Fundamental forces
There are four forces in Nature. The most well-known is gravity, which revolves the Earth around the Sun and keeps us on the Earth. The force responsible for electrical and magnetic phenomena is the electromagnetic force. The other two forces, the strong force and the weak force, act on the nucleus of the atom.

Gluon
The particle which carries the strong force, one of the four fundamental forces. In protons and neutrons, gluons are what allow the quarks to remain stuck together.

Hadron
Family of particles including neutrons and protons, constituents of ordinary matter.

Ion
An atom with one or more electrons removed or added, so it has a net electrical charge .

Matter
For physicists, matter is what we and everything around us are made from: this passport, your eyes, but also the air you breathe, the Sun and the billions of galaxies in our Universe…

Standard Model
A theory that describes fundamental particles and three of the forces that act between them.

Neutrino
Neutral particle that only interacts very weakly with matter.

Particle
Elementary constituent of matter.

Quark
One of the fundamental particles of matter known today.

Routes info

- The whole circuit is 54 km long.
- The times indicated on the attached map are for a one-way trip only;
- The platforms are freely accessible to the public.
- Some sections of the route follow busy roads, be careful!

Maintenance

Some platforms are sometimes unavailable due to maintenance.
Check **cern.ch/passeport-big-bang** before you leave.

Equipment

- Mountain bikes are the most appropriate kind of bike for this route, because some parts of the trail are gravelly or can be muddy.
- Remember to bring valid identity papers as the route crosses the Franco-Swiss border.

Bike rental

Éco-corner Meyrinroule
1 Avenue de Vaudagne, Meyrin
Open 7 days a week, all year
www.geneveroule.ch

Minimum age

The content of the information boards is aimed at everyone aged 8 and up, but minors should be accompanied by adults.

Public transport

All the stages except for the Acceleration stage can be reached by public transport. To plan your itinerary, visit **www.tpg.ch**

The detailed map of cycling routes between each stage is also available on **cern.ch/passeport-big-bang**

Solutions: **ATLAS Stage**-Children's puzzle: c), Family puzzle: b) | **Control Centre Stage**-Children's puzzle: b), Family puzzle: c) **Neutrinos Stage**-Children's puzzle: c), Family puzzle e: a) | **ALICE Stage**-Children's puzzle: c), Family puzzle: a) | **Acceleration stage**-Children's puzzle: b), Enigme en famille: c) | **CMS Stage**-Children's puzzle: a), Family puzzle: b) | **Environment Stage**-Children's puzzle: b), Family puzzle: a) | **Cryogenic Stage**-Children's puzzle: c), Family puzzle: b) | **LHCb stage**-Children's puzzle: a), Family puzzle: b) | **Precision Stage**-Children's puzzle: c), Family puzzle: a).

Remember to tick each stage of the Passport to the Big Bang you visit!

		**ATLAS Stage** *ATLAS, the colossus of physics* MEYRIN, Switzerland
		**Control Centre Stage** *At the controls of the accelerators* *PRÉVESSIN-MOËNS, France*
		**Neutrinos Stage** *The journey of the phantom particles* *PRÉVESSIN-MOËNS, France*
		**ALICE Stage** *In ALICE's Wonderland* *SERGY / SAINT-GENIS-POUILLY, France*
		**Acceleration Stage** *When energy creates matter* *ÉCHENEVEX, France*
		**CMS Stage** *CMS, the heavyweight of physics* *CESSY, France*
		**Environment Stage** *10 questions about the LHC* *VERSONNEX, France*
		**Cryogenics Stage** *Cryogenics, the ice genie* *ORNEX, France*
		**LHCb Stage** *LHCb, the explorers of antimatter* *FERNEY-VOLTAIRE, France*
		**Precision Stage** *Scientific giants, devilish precision* *MEYRIN, Switzerland*

CERN would like to warmly thank its partners, whose involvement and support have made the Passport to the Big Bang possible.

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Interreg FRANCE-SUISSE

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POST TENEBRAS LUX

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