LITTLE POSTER OF LITTLE BIG BANGS

Science and Technology Facilities Council

WHY DO WE SMASH ATOMS?

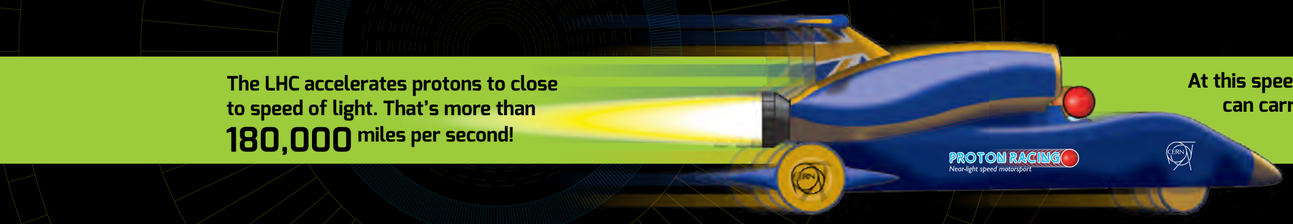
Imagine you have a model made of plastic building bricks (in this case a model particle) and you want to build another one, but you don't have the instructions.

The only way to find out what sort of pieces the model is made of is to take it apart and see what's inside. This is what particle accelerators like the Large Hadron Collider are made to do.

They take particles of matter and fire them into each other at such huge speeds that the particles are smashed to pieces.

Scientists can then look at what comes out to figure out what particles are made from and even what particles were made in the Big Bang!

The LHC accelerates protons to close to speed of light. That's more than **180,000** miles per second!



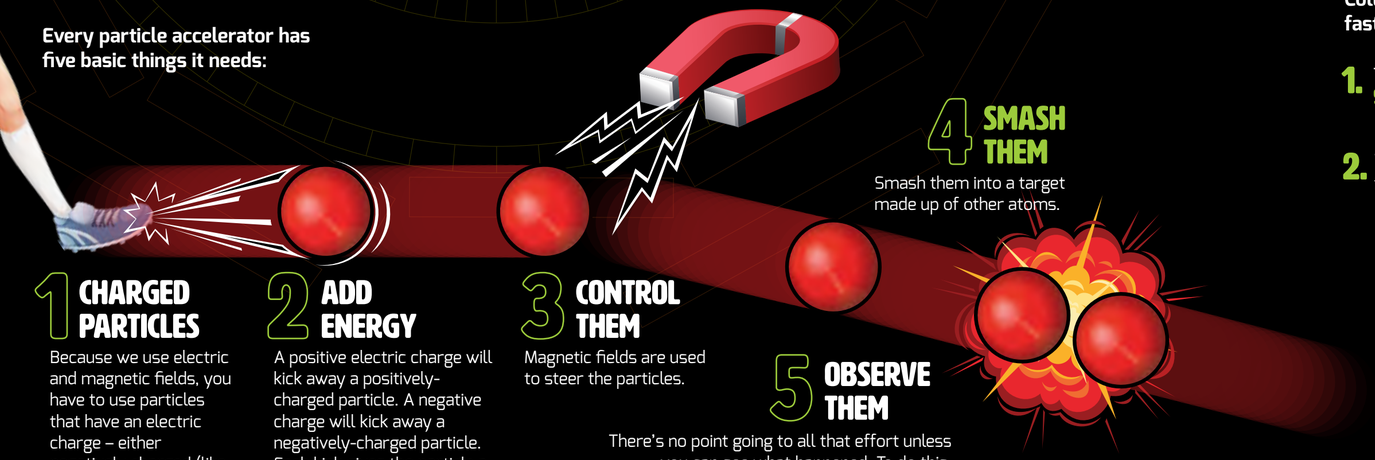
At this speed, even something as small as proton can carry as much energy as car travelling at **1,000** miles per hour!

WHAT IS A PARTICLE ACCELERATOR?

Most simply, a particle accelerator is a machine that is designed to take particles and give them energy to increase their speed (accelerate).

Particle accelerators can be huge (the Large Hadron Collider is 27 km long) or they can be small enough to fit in your living room (old-fashioned CRT televisions were simple electron accelerators).

Every particle accelerator has five basic things it needs:



1 CHARGED PARTICLES

Because we use electric and magnetic fields, you have to use particles that have an electric charge – either negatively charged (like an electron) or positively charged (like a proton).

2 ADD ENERGY

A positive electric charge will kick away a positively-charged particle. A negative charge will kick away a negatively-charged particle. Each kick gives the particle a little more energy and makes it go faster and faster.

3 CONTROL THEM

Magnetic fields are used to steer the particles.

4 SMASH THEM

Smash them into a target made up of other atoms.

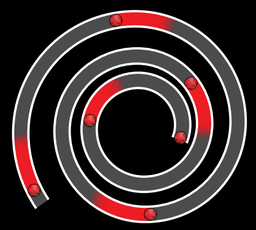
5 OBSERVE THEM

There's no point going to all that effort unless you can see what happened. To do this, accelerators have special detectors that act a bit like super-sensitive cameras.

TYPES OF ACCELERATORS

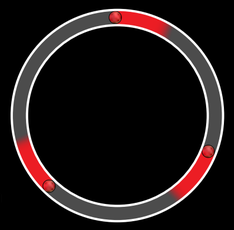
LINEAR

Linear accelerators accelerate particles in a straight line – rather like a bullet in the barrel of a gun. Accelerators like this are used in radiotherapy in hospitals to accelerate electrons to create X-rays, which are used for cancer treatment.



CYCLOTRON

Cyclotrons are like linear accelerators that have been coiled up like snail shells. They accelerate particles from the centre outwards. The coil means you have a much longer accelerator that takes up less space.



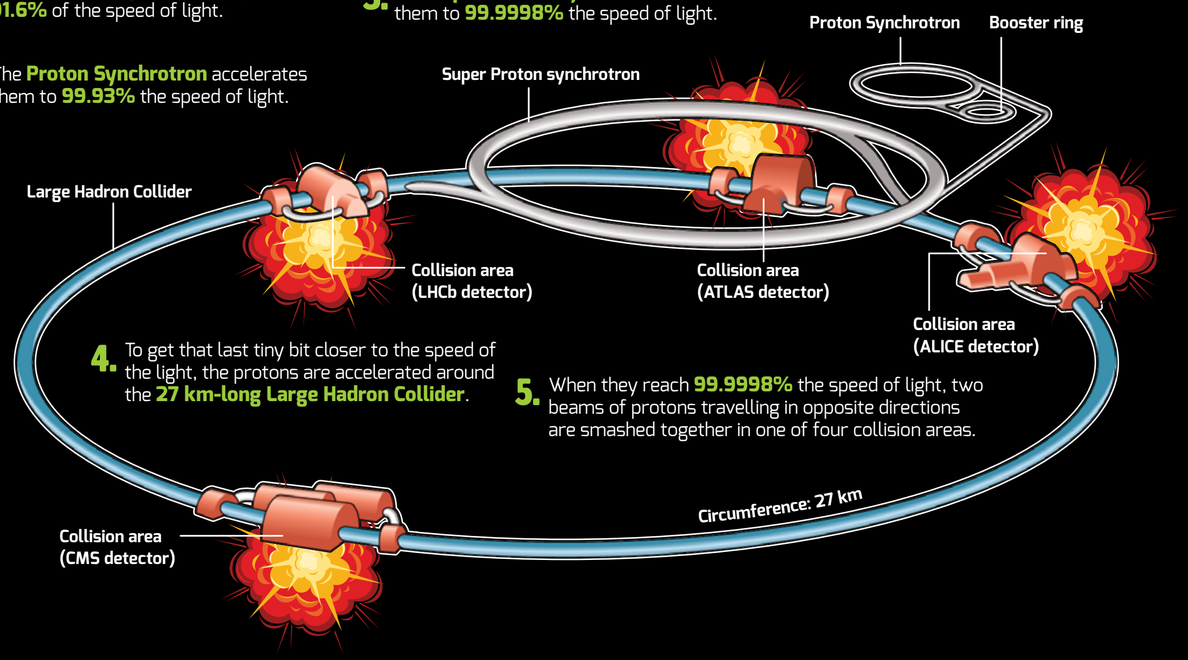
SYNCHROTRON

They accelerate particles round and round in circles thousands of times at nearly the speed of light. They are called synchrotrons because the electric and magnetic fields used to accelerate the bend the particles have to be perfectly synchronised. The LHC is a synchrotron.

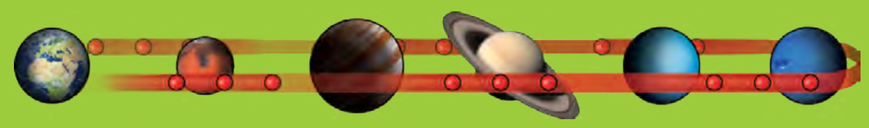
MEET THE LHC THE ULTIMATE PARTICLE ACCELERATOR

The faster you can make a particle go, the more energy it has and the better the little big bang you will get. The Large Hadron Collider is actually made up of lots of synchrotron accelerators - each one adds more energy to the particles to make them go faster and faster and faster...

1. The **booster ring** accelerates protons to **91.6%** of the speed of light.
2. The **Proton Synchrotron** accelerates them to **99.93%** the speed of light.
3. The **Super Proton Synchrotron** accelerates them to **99.9998%** the speed of light.
4. To get that last tiny bit closer to the speed of the light, the protons are accelerated around the **27 km-long Large Hadron Collider**.
5. When they reach **99.9998%** the speed of light, two beams of protons travelling in opposite directions are smashed together in one of four collision areas.



A proton in the LHC can travel more than **6.2 billion** miles.



That's far enough to get to **Neptune** and back again!