The LHCb movie

Something that will change our view of reality.

The first particle collisions in the Large Hadron Collider were recorded by all of its experiments.

That was an incredible event that starts now that we really got beams colliding for the first time.

You can say that the honeymoon ended a little bit abruptly last year with the beam we got, that never got to the point of collisions

So we say this year is a great moment of celebration because now we've seen the first protons really colliding in our experiment.

To me it's the perfect proof that we have a working detector, we have a beautiful collaboration, which is necessary to make "Beauty" physics.

This is a main proof to me.

Each one of these experiments is looking for something, with a different method, a different strategy.

Each one is trying to understand a different aspect of our Universe.

We will look at one of these in particular, the one on the quest to study Antimatter

LHCb, "the Beauty experiment"

It's taken 20 years to design and build this facility.

It's taken thousands of scientists and engineers to build this machine to let us look back towards the beginning of time, when things were very very different to the way they are now.

It's the structure of reality itself that has changed.

The Universe was very different when it had just been born.

There were no stars, no planets, no water and no gases.

There was no matter, or light, in the way that we're familiar with today.

Just a massive explosion of pure radiation: the Big Bang.

When matter and antimatter met, in the early Universe they annihilated, to release pure energy, and this energy in turn could make new pairs of matter and antimatter particles that could also meet and annihilate.

And this process continued as the Universe expanded.

However, as the Universe expanded, so it also cooled, and after about a minute, there was no longer energy to make new pairs of matter and antimatter particles, and the process stopped.

And what remains now in the Universe, is a consequence of a very tiny difference.

No more that one part in a billion between the amount of matter and antimatter that existed at that time.

We don’t know why there was a difference but we wouldn’t be here if there wasn’t one.

This difference is a mystery, but it’s given birth to everything we see around us

So if we really want to understand the Universe, and why it looks the way it does, we need to understand Antimatter, and why it behaves that little bit differently.

In fact antimatter is like normal matter, except that everything has the opposite charge.

For example the electrical charge is opposite.

If we look at antiatoms, they are made of a negative proton and a positive electron.

So if I was made of antimatter,

I would be like a mirror image of myself, with opposite charges.

The tricky thing is that if matter and antimatter meet, they annihilate, disappearing in a flash of energy.

In 1928 a young physicist by the name of Paul Dirac wrote an equation that revolutionized our understanding of the Universe.

Note that this equation has four solutions.

The first two clearly refer to the electron.

The other two…

Although Dirac ignored its real meaning at the time, this equation stated that each particle has an antiparticle twin.

That is, another particle exactly identical, but with opposite charge.

So for protons there are antiprotons, for electrons there are anti-electrons, which we call positrons, for neutrons there are anti-neutrons and so on.

And at the bottom of this there are quarks, and their antimatter equivalent, the anti-quarks.

Dirac described the positron as being symmetric and opposite to the electron.

It was like its mirror image, and the levels of Physics would work in exactly the same way as they would for the electron.

In other words, matter and antimatter should behave in a perfectly symmetrical pattern.

It took 30 years to find out that this assumption was wrong.

In 1964, the American physicists James Cronin and Val Fitch discovered, by examining the decay of a particle called the kaon, that its matter and antimatter versions do not always behave in the same way.

For the first time, the symmetry between matter and antimatter was seen to be broken.

40 years later, we built an instrument that can help understand this, and this instrument is right here.

It's in a cavern 100 metres underneath the ground, and it's the combination of years of planning and construction by an international collaboration called LHCb.

Now, "b" stands for "beauty", or the "beauty quark", because if this instrument can track and study the beauty quark and its antimatter twin, this could help us understand much more about the difference between them, because we think that the difference between matter and antimatter will be easiest to see in these particular particles.

So how does this work?

Here we are, 100 metres underground, where the Large Hadron Collider enters the experiment cavern of the LHCb project.

This is really where the LHCb collaboration peers back at the early Universe.

Now you would think that this is best done with telescopes, but in fact here at CERN we do it by recreating the hot conditions of the actual first moments after the Big Bang.

Let's go and see how this is done, and where it is done.

The protons circulating in the collider, come via this beam pipe, meeting up with the opposite beam inside this box.

Now very much like the heat you feel when you clap your hands, we recreate those hot conditions after the Big Bang by smashing those protons together at the highest energy ever achieved in a lab.

Very often we may achieve temperatures which are a billion times the temperature in the centre of the sun, and this takes us back to a fraction of a second after the birth of the entire Universe.

Now with the help of a collider, we can do this 40 million times per second, at hours of length.

We study these collisions by registering them with this 4 and a half thousand ton LHCb detectorthat we see next to me here.

Forty million times a second it registers information about the particles coming out of the little Big Bangs.

This detector is composed of many small parts over a length of 20 meters, performing different tasks.

We are interested in knowing the shape of the collisions by using so called "particle tracking detectors".

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We also measure the individual energies of each particle, and of course we would like to know the identities, so there are special detectors dedicated to that.

All the information from the particle detector is first collected here, and then sent up on the surface, to the computers hundred metres above us.

Later on it is distributed all around the World to many hundreds of physicists making the physics analysis.

These experiments will produce as much data each year as you can store on 400, 000 compact disks.

And that's only after storing the interesting stuff.

Then we have to analyse this much data if we want to understand antimatter better, but to do so with a normal computer it would be just impossible.

We can't even analyse it with all the 10, 000 computersin CERN's computing centre.

Instead, particle physicists worldwide have connected their computing resources togetherto form the GRID.

A worldwide supercomputer that is powerful enough to do the job for us.

The huge amount of data that are collected from the experiments have to be analysed on this supercomputer, on this "GRID", and these collaborations are formed from scientists from all over the world, with different nationalities, with different cultures, with different religions and different political ideas, but still in LHCb, like in any other CERN experiment, we share our knowledge our experience and our efforts, and we have one common aim: to discover and better understand Nature.

The LHC started production, colliding protons 40 millions times a second at an energy of 7 Tera electron-volts.

Three and a half times higher than anything seen before.

Each proton collision produces matter and antimatter particles.

LHCb will study how these particles and antiparticles behave, to try and uncover why there is a difference between them.

We've come a long way since Galileo and Copernicus, but we've realised that the more we discover, the less we actually know, and the less we know, the more there is to find out.

And it's this endless quest to understand more about the Universe around us, this desire to journey into the unknown that's driven us to become who we are today,

and to build these fantastic experiments to explore with.

We are trying to take the energy of the LHC to 7 Tera electron volt, to get collisions at 7 Tera electron volt.

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This is the first attempt in history, today March the 30th 2010.

Beams are going to be aligned, and I'm expecting a huge surge of applause everywhere, in the 5 control rooms.

The two beams are getting closer and closer.

Finally we managed to see collisions and the detector registered properly.

Are you continuing recording collisions?

Sure, sure, I mean, we are recording very well.

OK, good luck with your hunt for the "beauty particle".

Fundamental research is at a turning point today.

We're at the dawn of a new era, where the unexpected may be discovered, and the unimaginable could become possible.

The "LHC beauty" experiment has started its journey of discovery, and it's taking us on an adventure that could uncover the mysterious differences

between our world, and the anti-world.