The Large Hadron Collider in 10'

This is one of the coldest places on Earth,
And this… is one of the coldest places in the Galaxy
This is the hottest place in the Solar System,
And this… is one of the hottest places in the Universe.

A vacuum emptier than outer space,
the largest number of “high tech” magnets ever built,
the largest, most complex electronic instrument on the planet.

It fills much of the Geneva countryside – but you can’t see it, even if you look for it. Because to find it, you have to go deep underground.

At 100 m depth, housed in a 27 km long tunnel, the Large Hadron Collider is ready to start.

[Tara Shears] Although it looks like a giant gas pipeline, this machine is the most powerful particle accelerator in the World, and in fact it uses the most sophisticated technologies available to us today.
More than 9000 magnets guide two beams of protons in a circular path through the accelerator, and then accelerate them to speeds approaching the speed of light.

And then the beams crush together with as much energy as a high speed train.
[Álvaro de Rújula] We can make two objects collide at a very high energy and make a new object, of mass which equals the energy, total of these things that I have collided, which is going to last for a very little, and you’re going to discover it by making it.

VO: Every second 2 billion protons smash against each other inside the LHC, and recreate the conditions that were present less than a billionth of a second after the Big Bang. This is when the universe started, in a massive explosion of pure primordial energy.
[Tara Shears] What’s really exciting about this is that some of these new objects, so particles, are very different to the particles we originally collided together.

In fact, they are particles that we no longer see in the world around us.

But although these new particles only lived for a short time, around the start of the Universe, they played a fundamental role in making the Universe look the way it does today.

[Álvaro de Rújula] If you want to understand the origin of the Universe, one of the ingredients that we need to understand is these particles, that lasts so little, and that you cannot find now, in mines, because they have disintegrated completely, from the origin of the Universe.

[Tara Shears] The more we study, the deeper we look into things, the more we find there is to find out. Because… there here is some very strange mysteries in the Universe.

[Brian Cox] We know that mass can turn into energy, but we don’t know how that happens.

We know that back a millionth of a second after the big bang, matter didn't exist in the form of protons and neutrons, but in a completely different state.

And we know that gravity was extremely important back in those earliest times, but we don't know exactly how it works.

But maybe the reality out there is much closer to science fiction than the real world.
VO: The LHC is like a spacecraft venturing into the unknown, looking for answers to these questions.

VO: And four major experiments, called ATLAS, ALICE, CMS and LHCb, have built gigantic detectors on the LHC ring, to capture the instant of particle collisions.

We're going to use them to find out more about the mysteries of the Universe.
[Tara Shears] On a clear night, we can see thousands of stars. But… all the stuff we can see, or detect, only accounts for 4% of the whole universe. The rest is made of… "dark matter" and "dark energy".
[Richard Jacobson] If the universe was filled with only the matter that we're familiar with, what we can see with our own eyes when we look out in the Universe, galaxies and clusters of galaxies wouldn't move, rotate and turn the way astronomers see them today.
[Ilaria Segoni] We believe that there is something else out there that is modifying their movement, but at the moment we cannot see or detect what that something else is.

[Marcos Merino] So there is a theory which could actually explain Dark Matter, and this theory is called supersymmetry. So according to supersymmetry, for each particle we see there is another particle, which is sometimes called its "supersymmetric partner".

One of these supersymmetric particles could perfectly be the particle which makes up dark matter

If these supersymmetric particles exist, then the two largest experiments, ATLAS and CMS, will find them.
But dark matter isn't the only thing we don't understand.
[Richard Jacobson] Antimatter and matter were created in equal amounts at the very birth of the Universe.

However we also know that when antimatter and matter come in contact with each other, they annihilate, we say. They destroy each other and they vanish into pure energy.

The LHCb detector is a precision instrument with which we will try and unravel the true nature of this mechanism.
[Federico Antinori] The idea here, in the ALICE experiment, is to use the LHC to recreate such high temperature conditions as were prevalent in those first instants of life of the universe, which should allow us to recreate tiny droplets of primordial matter, in order to study its properties.

[Álvaro de Rújula] The vacuum is a substance, and like any other substance, you can make it vibrate. And the vibrations of the vacuum are called Higgs particles. And that is the object we are most trying to find at the LHC.

[Álvaro de Rújula] The Higgs particle is essential to theoretical physics because it's different from any other we have discovered so far. It is the one responsible for the masses of all other particles.
[Tara Shears] These detectors have been designed to look for the Higgs particle, But… what if we don't see it?!

[Álvaro de Rújula] That would fantastic, because it would mean that we really haven't understood anything. And this is the best situation in science; the one that precedes big revolutions is when we realize that we have actually understood nothing!

[Brian Cox] It might be that reality is very different to this three dimensional view of the universe, and that would be really mind blowing.

[Marcos Merino] There is another theory, which is called the String theory, whose aim is actually to unify all these particles that we see, in a single framework. So according to string theory, all particles are different vibration modes of a single fundamental object, which is a vibrating string.
[Marcos Merino] One of the surprising consequences of the string theory is that you reach the conclusion that there have to be extra dimensions in the universe
[Álvaro de Rujula] If the LHC is lucky enough to penetrate with its very high energy inside these points that contain extra dimensions, then a complete new field opens up, of possible new discoveries.

[Tara Shears] You are looking at 12 thousand tons of metal and electronics, which have been put together with a precision of 5 microns. That' 5 thousands of a millimetre. And It's taken many companies, hundreds of universities and research institutes, and thousands of scientists and engineers to put these precision instruments together.
[Jim Virdee] The detectors like CMS and ATLAS arguably constitute the most complicated apparatus that science has ever seen.
[Tara Shears] The LHC and its detectors will produce billions of interesting events every month, but we'll need the computing power of the Grid to tell us what we have found.

[Lisa Randall] There could be some big discovery about the nature of space- time or just what's really out there, what's fundamentally there.
[Álvaro de Rújula] We could make complete series of new particles, we could make wormholes, which are little holes in space - time, in which you can go from one point in space and time, to another point in space and time, so that you could travel to another time.

[Federico Antinori] Scientific Research is an exciting trip with a fuzzy map and an unknown destination. We're a bit like old time explorers. We know there's a lot out there to discover but if we knew exactly how and when we will discover it, it wouldn't be research.

[Tara Shears] And research is the driving force behind the world we live in. Because none of the things that we enjoy would exist without the fundamental research that's gone on into electricity, into magnetism and nuclear physics over the past 2 centuries.

[Tara Shears] No amount of applied research on the candle for example, would have given us the electric light.

Science needs space for creativity and imagination, and the LHC is gonna take us onto a journey into the unknown.