CERN and the LHC - their place in global science

Ladies and Gentlemen, Good Morning.

First of all, thank you all for coming from near and far to attend this special event. We sincerely appreciate the interest that you take in the research we are doing here at CERN.

Today I declare officially that the Worldwide LHC Computing Grid is fully operational, and ready to handle the huge flow of data to be produced from the hundreds of millions of subatomic collisions expected every second inside the LHC. This data handling feat marks an essential stage in the process of enabling thousands of physicists around the world to discover new physics.

I would like to start off by putting this very important milestone in a broader perspective.

In simple terms, there are three essential components to a particle physics experiment: the accelerator, the detectors and the computing. Let me say a few words about each of these.

In the LHC, the accelerator brings two beams of subatomic particles to practically the speed of light on a circular path of 27 km, and then carefully focuses the two beams, which are travelling in opposite directions, so that they collide in a microscopic space.

The results of these collisions are identified and their characteristics measured by four large instruments, the Detectors.

The LHC detectors are built in giant underground caverns by collaborations of thousands of physicists from around the world, including Canada, China, India, Israel, Japan, Russia and the United States.

Indeed, some 80 nations are represented at CERN, and we estimate that over 10 000 scientists and engineers from around 500 academic institutes and industrial companies worldwide have contributed to the construction of the LHC and its four large detectors, ALICE, ATLAS, CMS and LHCb.

At the collision point, energy is turned into mass, according to Einstein's famous formula, E=mc2. Occasionally, this leads to new particles being produced, that are not stable in our Universe today.

These particles decay in a fraction of a second, into other, more common particles, which fly off through the detector. It is these decay products that the detector registers electronically.

The computing turns the huge flow of digital data coming out of the detectors into useful physical information about the collisions, and stores that information, which is processed in a search of those rare events where new particles were produced. This is the function of the Worldwide LHC Computing Grid. It stretches around the globe, connecting resources in hundreds of data centres in over 30 countries, to form an unprecedented computational and storage device.

At the end of the day, the net product of this huge enterprise is pure knowledge.

Knowledge about elementary particles that were around at the very start of the Universe, a tiny fraction of a second after, and their evolution towards the Universe we live in.

And knowledge that will help to clarify some of the outstanding mysteries, such as the nature of antimatter, or the mysterious dark matter that seems to pervade the universe.

As you will hear in more detail in the subsequent talks by my colleagues, the accelerator and the underground detectors used to achieve this knowledge are giant monuments to human ingenuity.

They will tell you about the technical challenges that had to be overcome to make such a Grid work, and the many spin-off benefits that this is having for other sciences and for commerce.

Here, I would like to dwell on what is in my view a less tangible but equally important benefit. That is the contribution of the Worldwide LHC Computing Grid to stimulating international collaboration.

Let me give you some historical context.

When CERN was established in 1954, it was in the wake of a war that had devastated Europe. The goal was to enable European scientists from countries previously enemies, to join and work together again on peaceful, fundamental research, and to help Europe recover from the immense intellectual losses that war on the continent had incurred.

For this reason, CERN has always had four missions.

Of course, there is the primary mission of pushing back the frontiers of our knowledge in fundamental physics, the raison d'être of CERN.

The second mission is to develop new technologies in order to pursue our scientific goals. These technologies have had many important spin-offs for society. Two examples are the world wide web and detector technology for medical scanners.

The third mission is to train young researchers and engineers, many of whom learn skills at CERN that go on to serve them well in European industry. One of the most important skills, I should add, is not technical. Rather, it is the ability to work effectively in a very international, indeed a global environment, overcoming all the cultural and language barriers that this implies. That is a survival skill at CERN!

Finally, the fourth mission of CERN is to continue to stimulate international collaboration through peaceful research. In the past fifty-four years, CERN has achieved this mission in many new ways.

During the cold war, CERN served as a place where international scientific collaboration between East and West could be peacefully pursued.

In the last two decades, CERN has been active in stimulating collaborations with researchers from many developing countries, helping to bridge the divide between North and South, which is a threat to the stability of our world today.

The reason I emphasize international collaboration here is that the Worldwide LHC Computing Grid has in many ways taken this mission a step further. It has enabled, for the first time, researchers to collaborate from their home countries, sharing resources located in their universities and national laboratories with others around the world.

Before this project, scientific data centres were essentially silos, tightly controlled by local administrators. What the Worldwide LHC Computing Grid has done is to encourage an opening up of the digital research infrastructure of science on an unprecedented scale.

We hear much in the media about the negative aspects of globalization, but I believe that projects like the Worldwide LHC Computing Grid are excellent examples of the positive benefits global thinking can bring, when used for a good cause.

I would like to end my talk by answering briefly two questions that the title of my talk raises.

First, what lies ahead for CERN and the LHC?

As I'm sure most of you have heard, the first proton beam in the LHC was successfully steered around the full 27 kilometres of the accelerator just a few weeks ago, on the morning of September 10th, to be precise.

This historic event marked a key moment in the transition from over two decades of preparation to a new era of scientific discovery.

Hundreds of media representatives from around the world were here to report on the event, which created a huge opportunity for popular interest in particle physics and fundamental science.

But this is just the first step in a long voyage. The LHC is a discovery machine, and its research programme stretches out two decades into the future.

As with any voyage of discovery, there are times when we must confront stormy weather, too.

As you no doubt also have heard, on the 19th of September, a large helium leak occurred in one of the sectors of the LHC. This was likely due to a faulty electrical connection between two of the accelerator's magnets.

I hasten to add that due to the stringent safety measures in place at CERN, no one was put at risk by this incident. Indeed, the LHC has been the subject of several independent and exhaustive safety reviews, and I am glad to say that, despite some of the science fiction scenarios of black holes reported in the press, these reviews have shown that the LHC is perfectly safe.

Before a full understanding of the recent incident can be established, however, the sector, which is cooled with liquid helium, has to be brought to room temperature and the magnets involved opened up for inspection. The time necessary for the investigation and repairs precludes a restart before the

obligatory winter maintenance period for the whole CERN facility, bringing the date for restart of the accelerator complex to early spring 2009.

Coming immediately after the very successful start of LHC operations, this is undoubtedly a psychological blow. Nevertheless, the success of the LHC's first operation with beam is testimony to years of painstaking preparation and the skill of the teams involved in building and running CERN's accelerator complex.

I have no doubt that we will overcome this setback with the same degree of rigour and application, and continue on this voyage of discovery, in which the Worldwide LHC Computing Grid will play such a vital role.

The **second question** I wish to answer is what lies ahead for global science?

I think it is clear from the reactions in the world press to the recent announcement of the LHC start-up, that Europeans can lead the rest of the world in certain areas of science, if they organize themselves to do so. This is a potent reminder that the original vision of CERN, fifty years ago, has become a reality.

CERN can now serve as a reference for new international initiatives on European soil, such as the European X-ray Free Electron Laser project in Hamburg, Germany or the international fusion reactor project ITER, based in Cadarache, in France.

Looking towards the future of particle physics, we know already that the LHC will not be able to answer all the questions about the Universe that we can imagine now, but it will surely show those which will require new tools to be answered. These new tools to be built will require a global effort.

In many ways, the LHC has already proved that such a global effort can succeed. Therefore, I believe CERN should be well-placed to provide a base for a future, global research laboratory in fundamental physics, ... if the political will is there to achieve that goal.

In ending, I would like to warmly congratulate all those involved in making the Worldwide LHC Computing Grid a success.

These include the CERN member states and the respective national funding agencies that have supported the Grid's development in their countries and at CERN.

The European Commission has also played a lead role through its early and generous funding of research and development on computing Grids, which has led to the highly successful Enabling Grids for E-SciencE project. This now represents the world's largest Grid infrastructure for science.

Thanks go also to other major multi-science Grid initiatives, in particular the Open Science Grid in the United States, which is an essential partner.

Without close technical collaboration with the many suppliers of computing infrastructure and software, the rapid progress that has been made in establishing the Grid would not have been possible.

A special thanks goes to the companies who have joined us in the CERN openlab partnership over the past six years, which include EDS, Enterasys, F-Secure, HP, IBM, Intel, Oracle and Stonesoft and which have been joined most recently by Siemens.

Their sponsorship of cutting edge technologies, and support of the young researchers who have helped to test and verify those technologies, has enabled our engineers to map out much more effectively the best technological directions for the Grid.

All that is left for me is to wish you a very pleasant and informative day at CERN. Do not hesitate to ask the speakers and other staff here any questions, and to take pictures of any equipment.

Thank you for your attention.