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HiLumi LHC
FP7 High Luminosity Large Hadron Collider Design Study
Newsletter

HiLumi, at CERN the biggest particle physics project over the next decade

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INTERVIEW

HILUMI, AT CERN THE BIGGEST PARTICLE PHYSICS PROJECT OVER THE NEXT DECADE

Interview with Lucio Rossi, High Luminosity LHC project coordinator

High Luminosity (HiLumi) LHC is the name of the ongoing project to make the Large Hadron Collider at CERN even more powerful. The aim is to extend the discovery potential of the LHC and its experiments. To do this, scientists are working to increase its luminosity to make it capable of producing even more collisions per second. HiLumi also represents a technological challenge and the project will take at least ten years to complete. We spoke about it with Lucio Rossi, the project manager.

What is HiLumi LHC?

The project consists of upgrading the LHC. Its aim is to increase the peak luminosity, in other words, the number of events produced per second, by a factor of 5, and its integrated luminosity, meaning the total amount of data obtained by the experiments, by a factor of 10. In technical terms, the machine and detectors are designed to produce 300 inverse femtobarns (the unit of measurement of integrated luminosity). With HiLumi we will produce 3000. This cannot be achieved simply by upgrading the machine. The experiments will also need to be greatly improved. You cannot observe something merely by producing light. The eyes must be efficient too, otherwise it's like when someone shines a torch straight in your face: you can't see anything. We are therefore working on a substantial upgrade of both the accelerator and the detectors.
Most of the work on the accelerator will be funded by CERN. The cost of upgrading the experiments will mainly be borne by associated bodies, such as the INFN, although CERN will also contribute to these.

What stage is the project at now and what are the next steps?

The design study is almost complete and will be ready by the end of this year. It was approved in 2011 and partially financed by the EU: HiLumi is in fact named after the European project. As well as the technical work to complete the design study, we have also started to produce the first prototypes. From now until 2017 we will work on the hardware, especially on the prototypes of the new 12 TeV magnets: these Niobium-3-

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Tin superconducting magnets will allow us to improve the LHC magnet performance by 40-50% around the collision point. Along with the magnets, another important component are the so-called crab cavities: superconducting cavities that are very special because they manipulate the beam in the transverse plane and, with the magnets, make it possible to increase the luminosity. A third fundamental element is the new generation of collimators, similar to those currently used but made of new materials. These innovative devices may also use electron beams to collimate the LHC's primary proton beam halo. Lastly, another important component are the superconducting links: high amperage superconducting cables carrying up to 100 kA so that the magnet power converters can be moved away from the tunnel to avoid radiation damage.

Will the structure of the accelerator ring and underground experimental halls remain unchanged?
Certainly not. HiLumi is not just a huge technological enterprise, it is also an important civil engineering project. New tunnels and new underground halls will have to be built near the ATLAS and CMS experiments. The increased use of cryogenics will require new infrastructure to house more cryogenic equipment. The new side tunnels will be about 300 metres long and will house the cryogenic systems as well as the electric and power supply plants. To give you an idea of the scale of the work involved, the civil engineering work for HiLumi amounts to 25% of that for the LHC project. These factors. considered as a whole, make HiLumi LHC the biggest particle physics project over the next decade.

What will be the overall cost of HiLumi?
CERN approved the project in 2014 and integrated it into the Medium Term Plan, although only three-quarters of the budget was covered. Now, in the new Medium Term Plan for 2016-2020, published in 2015, the project has been fully funded up until 2020 and the remaining funding to complete the project in 2026 has been specified. In September CERN is expected to approve the structure of the funding of the whole HiLumi project, in its five-year plan.
The total cost of the project is CHF 958 million (just over EUR 900 million). This has been calculated based on European rather than American parameters, which means the cost of materials is included but not staff expenditure (approx. 1600 man-years). The costs of the HiLumi project have been validated by a panel of auditors: in March an international board of independent reviewers accountable to CERN, not to the project management team, conducted an in-depth review of the costs and planning. The remarks we received, based on this review, have been taken on board and incorporated into the Medium Term Plan.

What is Italy's contribution to HiLumi?
The INFN has made an important contribution to the magnet design study, in particular through the LASA Laboratory in Milan. Scientists at the INFN Frascati National Laboratory have also contributed to the physics of the machine. The INFN and CERN have signed agreements for the new corrector magnets, the realization

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of wich is being undertaken in collaboration with the LASA Laboratory. INFN-Genoa has signed an agreement to carry out design and prototyping on the D2 dipole magnet, which is a particularly complex component to develop. Other forms of collaboration are currently being discussed.
Italian industries have also made a significant contribution, especially two companies based in Genoa, ASG Superconductors and Columbus. Columbus is in pole position to build the superconducting links, which will use a new superconducting material, magnesium diboride (MgB2). It is the only company capable of producing this material on an adequate scale to meet our requirements. ASG is already involved in the construction of the new magnet technology, in partnership with other companies: engineers and technicians at ASG are working at CERN laboratories in order to learn about the technology (and in turn contribute with their important know-how). This will allow them to acquire the necessary skills in order to take part in tenders. Then there is Tosti, based at Castel del Piano near Grosseto, which supplies specially profiled composite materials for use in the construction of the magnets. Tosti is also investing in new technologies for superconducting radio-frequency cavities. Several other firms are on track to build other components of HiLumi.
Italy is the third-largest contributor, after the UK, which did not take part in the LHC project, and France. The UK has invested a great deal in the HiLumi design study, which has seen the participation of five British universities. When research institutes commit resources to a project, industry always follows close behind. The INFN is a good example of this mechanism. The INFN is regarded as a major partner in the development of both the detectors and the accelerator: having facilities spread across the country, as in the case of the INFN, fosters differentiation, and this is the real strength of the INFN.

What does the future hold for HiLumi?
HiLumi has two goals: one physical, and one technological. In other words it is a project to exploit the full capacity of the LHC: in practice, it will extend its life with expenditure accounting for 25% of the LHC budget. The second goal of a project like HiLumi is to develop new technologies. The LHC has completed the technological developments initiated by the Tevatron programme. In HiLumi, we are using Niobium-3-Tin something new and never used so far in accelerators: we need to build 40 large magnets, which will represent 2-3% of all the LHC's magnets and will be about one kilometre long. Unlike the LHC, which was a large-scale project, this one is medium-sized, leaving us room to "experiment" (always within margins of safety, as with any machine that must "produce"): with HiLumi we hope to achieve a technological leap forward.
The new components will be installed in 2024 and it will take two years to complete the work: then HiLumi LHC will work for about ten years, until the mid 2030s and will probably continue to be operational until 2040. It is a perfect bridge-project, conceived to last 25 years, until we have built the big new next-generation accelerator, which we have already been discussing for some time. Short-sightedness gets you nowhere in this sector. We have to be far-sighted. These are the timescales involved in high-energy physics, major basic research projects of the type that eventually revolutionise science and technology. ■