Particle accelerator gets wired up

Installing the fibre-optic network for CERN's flagship particle accelerator is a project that comes with a unique and challenging set of requirements. Tami Freeman takes a closer look.

Wiring up the world's largest and most energetic particle accelerator with more than 1500 km of optical cable is no mean feat. Yet Netherlands-based cabling specialist Draka Comteq Telecom has taken the task in hand, and broken the distance record for cable-blowing along the way.

Draka is using its microduct-cable technology to install communication cables in and around the Large Hadron Collider (LHC) at CERN, the European Laboratory for Particle Physics, near Geneva. The firm's JETnet system comprises microduct cables that contain bundles of fibres, which are blown into loose tubes called microducts.

"The key factors leading to our choice of microducts and blown-microduct-cable technology for this project were its flexibility, lower initial cost and the fact that cables can be replaced easily if they are damaged by irradiation," explained Luit Koert de Jonge, head of CERN's TS/EL optical-fibres division. "Draka Comteq succeeded with a severe pilot project – blowing a 2.5 km microduct cable in one go at a minimum speed of 30 m/min in the LHC tunnel."

Going underground

The LHC accelerator ring is situated 100 m underground in a 27 km long tunnel. When it is switched on in 2007, this multibillion-euro machine will help physicists to probe the fundamental secrets of matter by smashing beams of protons and atomic nuclei together at unprecedented energies. The new fibre-optic network forms a key element of the project, enabling communication between surface buildings and within the tunnel, as well as linking up the beam instrumentation.

Draka's first challenge was to quickly and cost-effectively wire up large stretches of the tunnel, which is split into eight sections and connected to the surface via a series of shafts. Cabling an entire octant without any fibre joints required a blowing distance of at least 3.4 km. "At first, we blew in cables from both sides, from above ground through the shafts, and half-way through each section," explained Willem Griffioen, product manager at Draka Comteq Telecom. "The maximum distance needed in that situation was 2.5 km. But then they wanted to blow 3.4 km or even further to avoid sections with high radiation."

Draka met this enhanced requirement by developing (and patenting) a cable-lubricating system and using it with the blowing apparatus. Immediately after the cable has passed through the blowing equipment it travels through the lubricator, a hollow chamber filled with lubricant-saturated foam plugs, which coat the cable. The airflow needed to propel the cable bypasses this chamber.

WILLEM GRIFFIOEN

CERN PHOTO

High impact: CERN's LHC (top) will collide beams of protons at 14 TeV, as well as smashing together beams of lead nuclei with an energy of 1150 TeV. Lower image: Draka's cable-blowing equipment.

"This lubricator improved the distance that you could blow cable by a factor of four or five," said Griffioen. "We expected some improvement but were surprised by the distances that we reached." The firm's latest breakthrough involved blowing a 3.9 mm 24-fibre cable (in a 7/5.5 mm microduct) a distance of 3.474 km in a single blow. Griffioen claims this is a record distance for microduct-cable blowing, adding that the cable could have travelled further had there been anywhere else for it to go.

Another requirement for the LHC's optical network is that the fibres can cope with the extreme levels of radiation occasionally encountered around the ring. While the particle beam is generally contained within the accelerator tube by magnets, localized radiation levels can be high enough to cause radiation-induced attenuation (in the collimator and beam-cleaning areas, for example). Where this problem occurs, the microduct-cable platform will facilitate the removal of damaged cables and the blowing in of new ones.

Even so, CERN engineers were concerned that the microducts themselves might be affected by high radiation exposures. To check out this premise, Draka performed blowing tests after a radiation dose of 300 kGy – by which point the optical fibre has degraded to an unusable condition (50 dB/km attenuation). "We thought that blowing ability after high dose rates could be an issue, so we irradiated two 1 km microducts, each containing an eight-fibre microcable, with up to 300 kGy," explained de Jonge. "Afterwards, the cable could be blown out and in again at 100 m/min in a test bed."

Griffioen added: "The blowing performance was not affected by the high dose. This means that you can change the cables without going into the tunnel."

The optical installation is now well underway, with 80% of the microducts and most communication and control cables in place. Around half of the beam-instrumentation cables are blown and partially terminated. There's still a lot to do, however, including the nontrivial matter of connecting up the four LHC experiments. CERN says that these experiments will generate as much information as the entire European telecoms network does today, about 0.5–1 Tbytes/s.

"The beam-instrumentation represents half of the LHC fibre project," added de Jonge. "We are now starting the microduct and cable installations for the experiments; the total project will last for another two and a half years."