## Shrinking cylinder / helium vessel Heat exchanger tube Magnetic insert Thermal shield Superconducting coils Main dipole bus-bar Auxiliary bus-bar Bunch of 10<sup>11</sup> protons Beam 1, anti-clockwise Bunch of 10<sup>11</sup> protons Beam 2, anti-clockwise

## INGENIOUS ENGINEERING

Exploring the universe requires new technologies and ingenious engineering to build the machines that explore physics at a new frontier.

Inside the LHC, the high-energy particle beams travel at close to the speed of light through an ultra-high vacuum. Atmospheric pressure in the 27km beam-pipes is lower than that on the Moon. Particle beams are guided and focused by over 9000 magnets. The steering requires a highly stable 8.4 tesla magnetic field, over 200 000 times that of the Earth. The electric current creating the magnetic field passes through superconducting cables at up to 12 000 amps with no electrical resistance and therefore no power loss. These cables are cooled to -271.3°C, colder than outer space, by a network of superfluid-helium supply lines.