

Is particle research useful?

Particles for medicine: cancer therapy and much more . . .



Today, there are estimated to be around 17 000 particle accelerators in the world, over half of them used in medicine and only a few in fundamental research. In medicine, accelerators are used in two ways: imaging and therapy.

Imaging

While X-rays have provided invaluable information for doctors for nearly 100 years, a more recent and complementary form of diagnosis uses radiopharmaceuticals, radioactive substances that can be safely injected into the patient. Once inside the human body, they fix only to definite tissues or organs. As they decay, the particles emitted are detected and analysed, giving information about the body's function and metabolism.

A radiopharmaceutical is a substance that contains radioactive atoms within its structure but meets specific requirements that allow it to be safely used in humans.

Radiopharmaceuticals are made in various ways to target different organs of the body. The radiation emitted from the radiopharmaceuticals is detected externally giving rise to static or dynamic images that enable nuclear physicians to evaluate the functional and/or morphological characteristics of the organs under examination.

Radiopharmaceuticals are made using high-intensity proton beams from a particle accelerator. They have a short life span, so they must be produced close to where they are used.

About 20 million people each year undergo diagnosis using radiopharmaceuticals. A well known form of it is the Positron Emission Tomography, or PET scan, whose development owes much to CERN and the Geneva Cantonal Hospital. The forerunners of the detectors used in many PET scanners, for instance, were developed as particle detectors for experiments at CERN.

Therapy

Radiotherapy is a common treatment applied to over half of all cancer patients. It is a form of biological surgery where the scalpel is replaced by a tiny particle capable of sterilizing malignant cells by cutting out the DNA that causes them to multiply.

The most common forms of radiotherapy use X-rays, electrons, neutrons and - in the most recent developments - hadrons.

X-ray and electron beams come from linear accelerators similar to the ones at CERN (but much smaller!). The beams are targeted on the tumour with a precisely tuned energy so that they reach just far enough to hit the cancer cells.

Neutrons lose energy in a different pattern than X-rays or electrons, making them better suited for treating certain tumours. Circular accelerators called cyclotrons are used to make neutrons by accelerating protons into targets of beryllium. Neutron therapy is more expensive than X-ray or electron therapy, but it has the bonus that cyclotrons can also be used to make radiopharmaceuticals.

In recent developments, proton accelerators are being adopted for hadrontherapy. The advantage of protons is that they deposit all their energy in the same place, making them ideal for treating tumours near to delicate organs. Already, at many physics laboratories, patients are being successfully treated with hadrontherapy using accelerators whose main role is pure research.

CERN is currently involved in two projects related to hadrontherapy:

- the design of a dedicated medical accelerator for protons and carbon ions, known as PIMMS for Proton Ion Medical Machine Study.
- the test of a linear accelerator (LInear BOoster, or LIBO) able to deliver a proton beam with energy up to 200 MeV (hospitals use proton energies of 60-70 MeV), sufficient to treat deep seated tumors.