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Antiprotons 4 times more effective than protons for cell irradiation

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A pioneering experiment at CERN with potential future application in cancer therapy has produced its first results. Started in 2003, ACE (Antiproton Cell Experiment) is the first investigation of the biological effects of antiprotons.

"We have taken the first step towards a novel treatment for cancer. The results show that antiprotons are four times more effective than protons at terminating live cells. Although it still has to be compared with other existing methods, it is a breakthrough in this area of investigation." says Michael Doser at CERN, one of the scientists collaborating on the experiment. ACE brings together a team of experts in the fields of physics, biology, and medicine from 10 institutes around the world.

Current particle beam therapy commonly uses protons to destroy tumour cells inside a patient. The ACE experiment directly compared the effectiveness of cell irradiation using protons and antiprotons. To simulate a cross-section of tissue inside a body, tubes were filled with hamster cells suspended in gelatine. Researchers sent a beam of protons or antiprotons with a range of 2 cm depth into one end of the tube, and evaluated the fraction of surviving cells after irradiation along the path of the beam.

The results showed that antiprotons were four times more effective than protons. When comparing a beam of antiprotons with a beam of protons that cause identical damage at the entrance to the target, the experiment found the damage to cells inflicted at the end of the beam path to be four

times higher for antiprotons than for protons. Michael Holzscheiter, spokesperson of the ACE experiment, summarises: "To achieve the same level of damage to cells at the target area one needs four times fewer antiprotons than protons. This significantly reduces the damage to the cells along the entrance channel of the beam for antiprotons compared to protons. Due to the antiproton's unsurpassed ability to preserve healthy tissue while causing damage to a specific area, this type of beam could be highly valuable in treating cases of recurring cancer, where this property is vital."

Antiprotons are antimatter; they have to be produced in small amounts in a laboratory with the help of a particle accelerator. When matter and antimatter particles meet, they annihilate, or destroy each other, transforming their mass into energy. The experiment makes use of this property as the antiproton would annihilate with a part of the nucleus of an atom in a tumour cell. The fragments produced from the energy released by the annihilation would be projected into adjacent tumour cells, which are in turn destroyed.

"CERN is a unique facility for this work. It is the only place in the world where an antiproton beam of sufficiently low energy and high quality is available. This is crucial for our research. Without access to the antiproton decelerator facility, these experiments would simply not have been possible." says Niels Bassler, co-spokesperson of ACE. "This experiment is a fantastic example of how research in particle physics can generate innovative solutions with potential medical benefits."

Researchers are currently conducting more tests to irradiate cells at a greater depth (about 15cm below the surface). Experiments to compare the effectiveness of antiprotons with another form of treatment using carbon ions will begin next month at GSI (Gesellschaft für Schwerionenforschung) in Germany. Further tests are planned to fully assess the effectiveness and suitability of antiprotons for cancer therapy,

and to assure that less damage is caused to healthy tissues compared to other methods.

If all goes well, the first clinical application would still be a decade or more into the future.

Full results of the experiment are published today in *Radiotherapy and Oncology* – Journal of the European Society for Therapeutic Radiology and Oncology. Holzscheiter MH et al., The Biological Effectiveness of Antiproton Irradiation, *Radiother Oncol* (2006), doi:10.1016/j.radonc.2006.09.012

Source: CERN