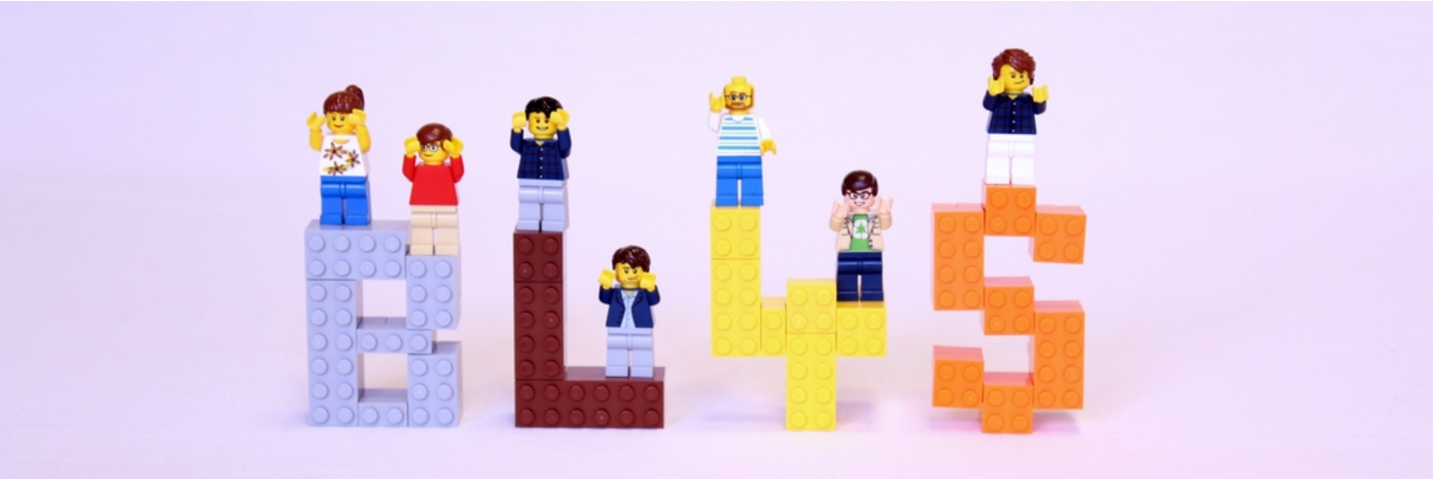
Matter or Antimatter
in cancer therapy:
does it matter?

The Doesn't Matter Team



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Why we want to come to CERN & What we hope to gain from the experience

We are a team of five united high school students who are fond of particle physics. For two years we have been spending our free time working together at the physics club of our high school where we can use a muon detector and our homemade cloud chamber. We have also been to the GANIL several times and even last year we were given the opportunity to participate in an international masterclass at the LAL (Laboratoire de l'Accélerateur Linéaire, Orsay). All these activities have made us eager to learn more about particle physics.

Now let us see what we hope to gain from this experience. First of all it would be great if we could make our project come true: our classmates would share our passion and our experience at the CERN laboratory. Indeed we would like to make our data analysis accessible to any high school student and help them for instance become aware of the usefulness of a particle accelerator. Moreover it would also be enriching for us to discover what it is like to work with high-skilled scientists, to improve our linguistic skills and work on a project that could be immediately used in the medical sector.

Preamble

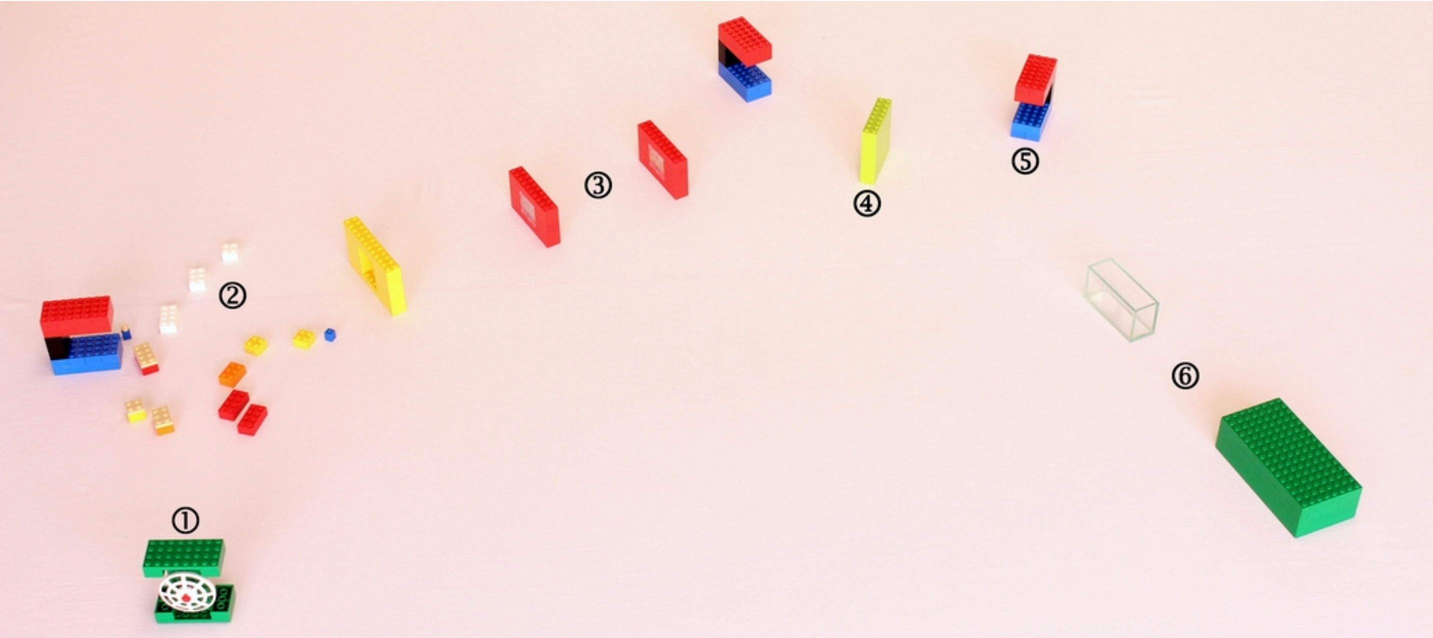
Basic research in particle physics is fascinating but may be abstruse for the uninitiated. And yet this research work can lead to practical and useful applications for anybody, in cancer therapy for instance.
Moreover our region is taking part in the ARCHADE project, Advanced Resource Centre for HADrontherapy in Europe, whose purpose is to create a unique centre in Europe for research and development focusing on cancer therapy.

Some GeV for anti-protons, a giant leap for mankind.

Our experimental proposal

The T9 beam line can be used to produce an anti-proton beam or a proton beam in order to compare the efficiency of antimatter or matter in cancer therapy. We can compare the Bragg peaks generated by the slowdown of anti-particles and particles of the same energy to see if the Bragg peaks are located at the same depth and if the spatial distribution of the deposited energy is the same.

Here we only describe the experimental device with anti-protons (the experimental device with protons is similar).



For technical reasons of framing and visibility of the different parts, we have had no other choice but to place the second magnet before the absorber and not before the Cherenkov detectors. In practice the absorber is lined up with the Cherenkov detectors.

① The incoming 24 GeV/c primary proton beam collides into the target, which provides a variety of particles: positive, negative and neutral ones.

② With the help of a collimator and bending magnets, we set up the secondary beam line to deliver a negative beam with an energy of 4 GeV. For this given energy, not only does the beam contain the largest number of anti-protons but it also seems that the proportion of anti-protons in the beam does not depend on the energy of this one.

③ All the particles have the same momentum but different weights and velocities. The use of Cherenkov detectors and/or scintillators allows us to know their velocities and thus to distinguish anti-protons from electrons, pions and kaons.

④ The absorber slows down all the particles except the anti-protons.

⑤ All the particles have a different momentum and the MNP17 enables to separate them because of their different particle rigidity.

⑥ The calorimeter measures the energy of the anti-protons emerging from the tank of water. Then as we know their energy before and behind the tank, we can therefore guess the energy deposited by the anti-protons in water. By varying the thickness of water they travel through, we can build the Bragg peak.

Then we conduct the same experiment with protons.

Further comments

A few points have not been dealt with. Indeed some questions remain unanswered, which prevents us from being more precise as to the procedure and the feasibility of our experiment.

For a negative beam with an energy of 4 GeV, each burst of particles approximately contains only 300 anti-protons but 10,000 electrons and kaons and around 100,000 pions. This proportion of anti-protons in the beam is really low: will we therefore manage to get significant data?

Moreover the decay of the pions and kaons into muons is still a problem. It is unlikely that these muons have the right momentum and carry on with the next selections. However, in comparison with the number of anti-protons, the number of pions and kaons (and therefore the number of muons after the decay) is so high that it would be difficult to distinguish the anti-protons from the background, which might distort the results.

The comparison between the two experiments, anti-protons versus protons is also left open. The number as well as the proportion of anti-protons and protons in the beams are very different (300 anti-protons versus 100,000 protons). As a result, the influence of the background is not the same in both experiments. Will we manage to compare the results as easily as we simply think?

Acknowledgements

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“Sciences à l'École” for lending us a muon detector and making us fall into the cauldron of particle physics and get hooked.
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The Doesn't Matter Team

The students

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