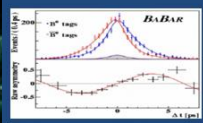
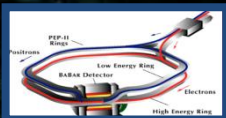




## ANTIPROTON DECELERATOR

The Antiproton Decelerator (AD) at CERN supplies other research centers with low energy antiprotons which are then examined via laser spectroscopy to determine similarities to the matter hydrogen system. The AD fires protons into heavy metal nuclei, magnetically funnels the created antiprotons into a compact stream and slows them using electron clouds, electric fields, and (hypothetically) lasers.

## BABAR EXPERIMENT



[On left] Babar records the collisions of particles in the PED-II collider. The PED-II collider circulates beams of electrons and positrons. The energies of the circulating beams are manipulated so that the new particles created contain b quarks<sup>[7]</sup>. Babar, when it records the collisions, determines the energy, momentum, and type of particle.

[On right] The graph displays the decay of tag mesons into b mesons (blue) and B-bar mesons (red) over time. The decays are different, which shows CP violation.

# ANTIMATTER

Antimatter is composed of antiparticles. These particles are, according to the standard model, supposed to behave in the same way as matter while maintaining an opposite charge. If this held true our universe would have the same amount of matter and antimatter, however this is not the case. Studying the ways in which matter and antimatter behave differently leads us to better understand the origins of our universe

## HISTORY

In 1928, physicist Paul Dirac proposed a relativistic formula for lower level electrons bonded to heavy nuclei. It predicted behavior for two particles, both travelling near the speed of light: an electron and a mysterious positively charged particle. This secondary result was dismissed at first, but was later confirmed in 1933 to be a positron..

## CHARGE PARITY VIOLATION

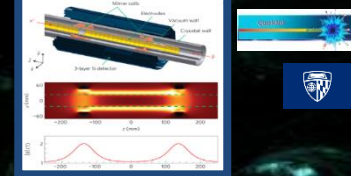
INDIRECT: This occurs when particles that oscillate between their particle and antiparticle states are measured more often as ordinary particles than antiparticles<sup>[1]</sup>. This asymmetry was first discovered by James Cronin and Val Fitch in 1964 when they experimented with kaon particle-antiparticle oscillations.  
DIRECT: This violation occurs when particles and antiparticles decay differently from each other. This was documented at Fermilab in 1999 when it was discovered that B mesons decay disproportionately.

## FURTHER RESEARCH

The extreme cost of anti-matter production restricts scientific discoveries- we plan to research possible improvements and adjustments to the antimatter creation process. We also plan on researching the potential of antiprotons for irradiating cancerous masses.

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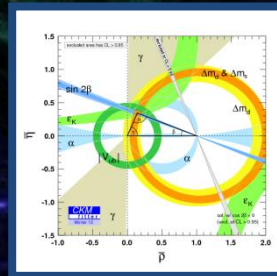
## ALPHA EXPERIMENT

The ALPHA experiment at CERN focuses on trapping antihydrogen particles, with the hopes of finding similarities between matter and antimatter. The standard model requires that hydrogen and antihydrogen have the same spectrum. CERN is working to test this requirement by performing direct spectroscopic measurements on trapped particles of antihydrogen.

### ACCOMPLISHMENTS:

- Discovered antihydrogen's charge to be 0
- Confined an antihydrogen particle for 1000 seconds, improving by 4 orders of magnitude from the previous record of 172 milliseconds<sup>[2]</sup>.

## UNITARY TRIANGLE



The Unitary Triangle is a complex plane projection of the vectors of quark mixing that are represented in the Cabibbo-Kobayashi-Maskawa Matrix. Its area, determined by the study of CP violating processes, represents the amount of CP Violation that is caused by the weak force<sup>[8]</sup>.