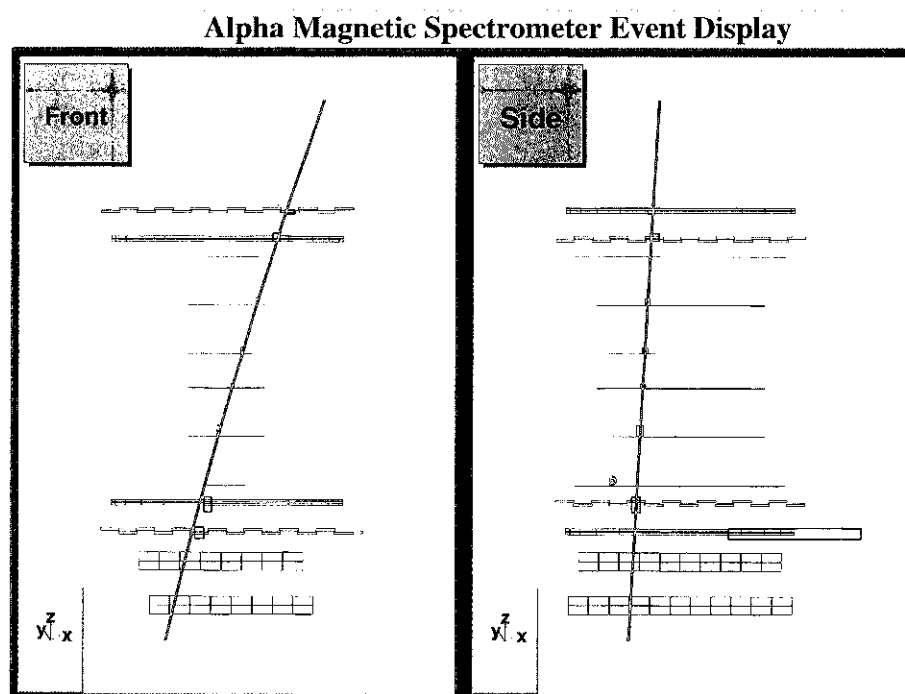


A candidate cosmic antiproton recorded by the AMS tracker.



particularly concerned for their delicate detector, and during the flight carefully monitored variations in operating temperature which might have upset their instrumentation.

As well as searching for antinuclei, AMS picks up antiprotons, whose spectra could reveal more information about the mysterious 'dark matter' which dominates the gravitational behaviour of the Universe but is otherwise invisible.

Discovery's flight crew brought the Space Shuttle into land on schedule on 12 June. Although the NASA high speed data transmission link to Earth failed during the flight, this did not affect actual AMS data taking. Resourceful NASA communications specialists were able to patch through some data via a link normally reserved for video pictures, and this 10% sample verified that the detector was functioning correctly. The valuable AMS trawl of physics from outer space will be carefully analysed over the coming months.

LEAR not here

A special symposium at CERN on 15 May highlighted the accomplishments of CERN's LEAR low energy antiproton ring. With effort and resources at CERN at a premium for its LHC collider, LEAR's experimental programme was prematurely terminated at the end of 1996, recalling how CERN's ISR Intersecting Storage Rings had been sacrificed in 1984 to liberate resources for the LEP electron-positron collider.

In the late 1970s, exciting new developments in beam cooling brought tightly controlled beams of antiprotons within reach, opening the door to high energy collider projects which only a few years before had been but a dream.

While the high energy proton-antiproton collider route offered glittering prizes, the same techniques also

pointed to the less prominently signposted route of low energy proton-antiproton collision physics. This would open up new physics domains - spectroscopy, atomic and nuclear studies, and fundamental symmetries. Profits were expected in spectroscopy, hitherto explored using limited secondary beams or via electron-positron colliders whose selection rules offer only a limited menu.

As the big push for CERN's high energy proton-antiproton collider got underway, a more modest effort also began for what became CERN's LEAR low energy antiproton ring.

Grafted onto existing infrastructure, LEAR was constructed in the existing South Hall of CERN's PS synchrotron in just 16 months, and commissioned within the following year. Using only a small fraction of CERN's precious antiprotons, it began work for physics in July 1983. Taking secondary antiprotons decelerated from 3.5 GeV to 600 MeV by the PS, it was initially equipped with stochastic cooling systems to further shape the antiproton beams, and an internal gas-jet target.

In the machine sector, LEAR became a showcase for accelerator skill and expertise. Different appetites require very different catering, and the LEAR kitchen could handle anything from fast extraction, stripping out a good fraction of the stored antiprotons, to its impressive ultra-slow extraction. In this latter development, extended (multi-minute) spills could delicately peel off just a single antiproton per turn - equivalent to having a controlled antiproton beam stretching over interplanetary dimensions. The antiproton momentum could also be changed at a few hours' notice, providing additional physics flexibility.

In 1987, LEAR entered a new

phase, with the availability of CERN's Antiproton Collector to refine the antiparticle stacking procedures, while LEAR itself was equipped with its own electron cooling to complement its original stochastic cooling.

For the future, LEAR becomes the LEIR low energy ion ring to provide nuclear particles to CERN's LHC collider now under construction (April, page 10). Also testifying to LEAR's success is its progeny of 'daughter' cooling rings - Astrid (Aarhus), IUCF-cooler (Bloomington, Indiana), ERS (Darmstadt), TSR (Heidelberg), COSY (Jülich), Cryring (Stockholm), TARN II (Tokyo), Celsius (Uppsala), - which provide regional centres with world class physics capability for a relatively modest investment.

Physics highlights

For the world at large, the most memorable moment of LEAR's career was undoubtedly the headline announcement in January 1996 that

physicists had succeeded in making the world's first atoms of antihydrogen - chemical antimatter.

LEAR had in fact been designed with the possibility of antihydrogen production in mind. Windows had been incorporated so that such neutral atoms, which escape the magnetic clutch of the antiproton orbit, could fly through the surrounding hardware and be detected. However these windows had initially been blocked by other instrumentation, while it also took time to perfect the gas jet techniques necessary to produce antihydrogen in flight.

Antimatter might be seen as the jewel in LEAR's physics crown, but many physicists would say that this 'discovery' merely confirmed what they already believed, and the real physics contributions came in other areas.

The LEAR acronym could have referred to low energy annihilation ring, for proton-antiproton annihilation was at the heart of most of its physics.

Using the Crystal Barrel, Obelix and Jetset detectors, light particle spectroscopy (mass range 1400 - 2200 MeV) became a major industry at LEAR. Notable highlights were clarification of scalar (spin zero, positive parity) meson states, with high statistics studies of many different decay channels, and the sighting of the lightest glueball (composed of gluons, rather than quarks) and exotic particles with unusual quark and gluon assignments.

LEAR also provided a new arena for CP violation, with valuable new parameters including the first evi-

dence (from the CPLEAR experiment) for the concomitant but nevertheless previously unobserved violation of time reversal symmetry. For the neutral kaons, past and future are not interchangeable.

Another LEAR speciality was synthetic 'exotic' atoms containing orbital antiprotons, providing a valuable new laboratory for making precision antiproton measurements.

As well as stopping antiprotons by capturing them in atoms, antiprotons were also captured by electromagnetic traps, enabling the proton and antiproton masses to be compared to one part in a billion.

For the future, the AD antiproton decelerator, a simpler machine providing less antiprotons and with only fast extraction (May 1997, page 1), will continue CERN's low energy antiproton tradition. The physics programme already includes trapping to 'mass produce' antihydrogen at the rate of about 1000 atoms per hour, and new precision studies of antiprotonic helium. The AD is scheduled to supply its first antiprotons next year. LEAR may be dead, but its physics tradition is still very much alive.



A special symposium at CERN on 15 May highlighted the accomplishments of CERN's LEAR low energy antiproton ring. Among those present were LEAR pioneers Dieter Möhl (left) and Ugo Gastaldi.



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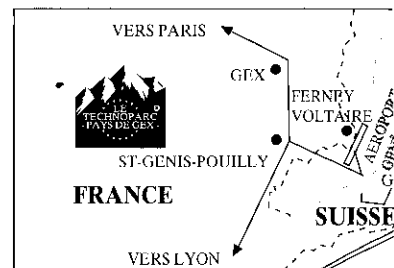
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Research Associate Positions in High Energy Physics

The Experimental High Energy Physics Group at the Blackett Laboratory, Imperial College, London, has Research Associate positions vacant.

The High Energy Physics group at Imperial is one of the largest in the UK and has teams working on the ALEPH, XEUS, BABAR, CMS, LHC-B and UK Dark Matter experiments. The group has a strong tradition in both analysis and detector, electronics and software development. The successful candidates will be expected to contribute to the work of the ALEPH, BABAR or CMS experiments and to take a leading role in the work of the group they join. In addition, the group expects to join the CDF experiment later this year for the Tevatron Run-II. When confirmed, another Research Associate position will be opened for this experiment and the group also welcomes applicants for this additional position at this time.

Appointments will be made as soon as possible and would be initially for a period up to 30 September 2000 and may be extended. Salary will be in the range £17,869 - £25,785 including London Allowance.

Applications, comprising a curriculum vitae, a list of publications and the names and addresses of two referees should be sent by September 28 to:

Professor I. Butterworth, Blackett Laboratory, Prince Consort Road, London SW7 2BZ, Great Britain Tel: (+44 171) 594 7851

Post-deadline applications will be considered until the positions are filled.

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