

Physics monitor

system of eight very small "harmonic" vertical beam bumps strategically placed in the ring arcs.

This technique to reduce 'spin diffusion' was developed at DESY and has been further refined in recent years. Computer simulations have also led to improved understanding. Specialists think there is a good chance of maintaining these high polarizations in realistic running conditions. However several potential

trouble spots remain to be ironed out, such as the effect of the crossing proton beam, and the spin rotation needed to establish longitudinal polarization at the collision points.

The system of eight beam bumps used at the HERA electron ring at DESY to correct the average tilt of the equilibrium polarization axis. This compensates for magnet imperfections and substantially improves the final polarization.

10 years of Ws

Ten years ago, on 25 January 1983, the discovery of the W particle at CERN's proton-antiproton collider was announced to the world. The W, the electrically charged carrier of the weak nuclear force, had been predicted 24 years earlier in the classic formulations of modern weak interaction theory by Feynman and Gell-Mann and by Marshak and Sudarshan, and went on to play an important role in the subsequent electroweak unification of electromagnetism and the weak nuclear force.

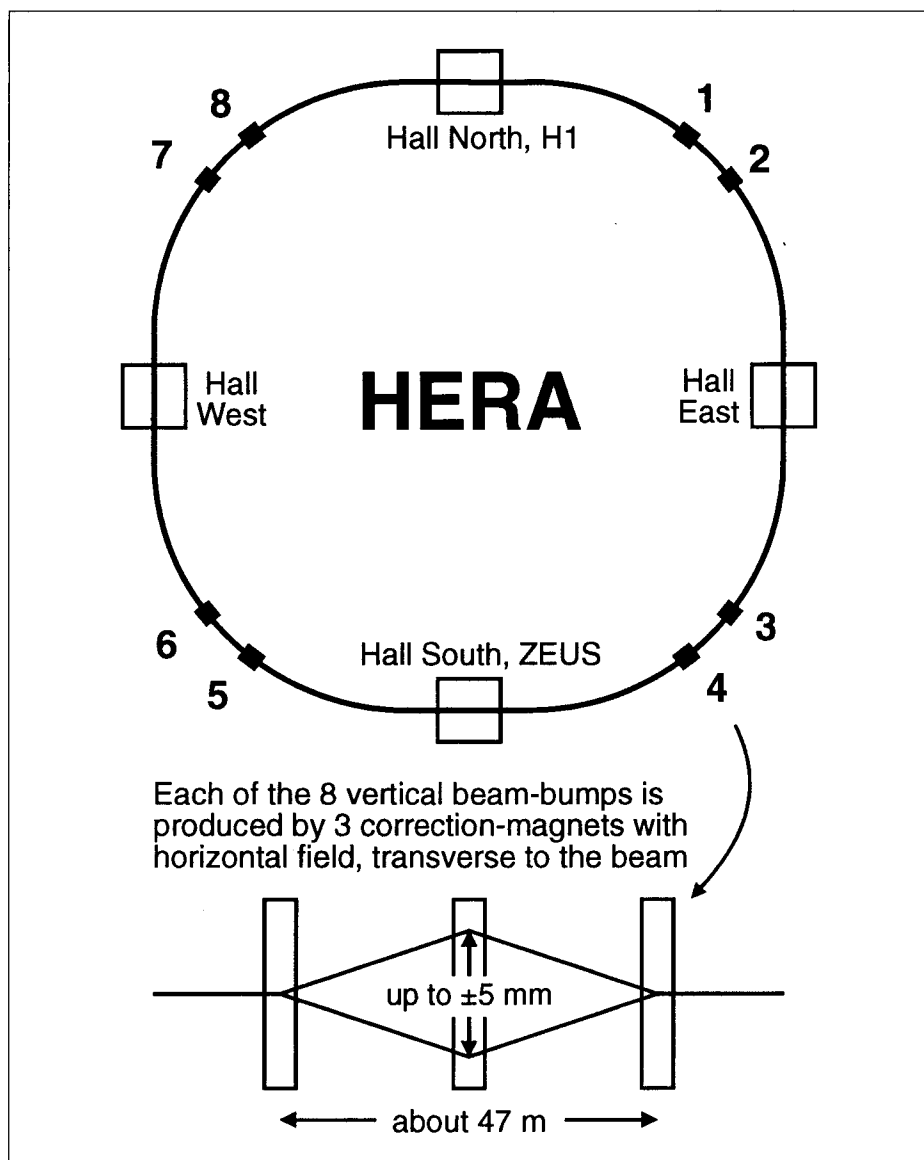
Following the discovery of the neutral current at CERN in 1973, it became clear that the W was an extremely heavy particle, some 80 times heavier than the proton, too heavy to be detected by any accelerator in operation at the time. Pushed by Carlo Rubbia, the CERN proton-antiproton collider was built to find the W and its electrically neutral companion, the Z.

Collider operations at CERN in 1982 had been compressed into a two month run, from October to December. The teams at the big UA1 and UA2 experiments eagerly sifting through their 1982 data noticed the first signs of Ws. The initial candidate W events were announced in CERN seminars by Carlo Rubbia, for UA1, on 20 January 1983*, and the following day by Luigi Di Lella for UA2.

As well as new science, these two seminars also set a trend for packing the CERN auditorium to overflowing.

Several days later, the growing weight of evidence had tilted the scales, and the 'candidate' qualifier was dropped. The W had arrived.

It was a triumph for CERN's antiproton project and for the experi-



Ten years ago, on 25 January 1983, a press conference announced the discovery of the W particle at CERN's proton-antiproton collider. Herwig Schopper, CERN's Director General at the time, holds up a copy of the CERN Courier showing the characteristic tracks recorded in the UA1 detector. Around him, left to right, are

Carlo Rubbia and Simon van der Meer, who went on to receive the Nobel Physics Prize in 1984, CERN Research Director at the time Erwin Gabathuler, and Pierre Darriulat of the UA2 experiment.

(Photo CERN 245.1.83)



ments which finally saw it. It set the stage for the masterstroke discovery of the Z several months later, and for the award of the Nobel Physics Prize the following year to Carlo Rubbia and to Simon van der Meer, the inventor of the stochastic cooling technique which made antiprotons tractable.

Over the years, the UA1 experiment at CERN went on to collect 625 W s (273 decaying into a muon and a neutrino, 323 decaying into an electron and a neutrino, and 29 examples with the rare tau lepton and its neutrino), while UA2, which could not see muons but ran for longer, saw 3559 W s, including about 170 producing tau leptons.

The W hunt was joined later by Fermilab, where the ongoing CDF and D0 experiments at the Tevatron proton-antiproton collider together have details on nearly thirty thousand W s*. Proton-antiproton annihilation was for several years the only source of W s and Z s, but this Z market dried up with the arrival of CERN's LEP electron-positron collider in 1989, which has gone on to provide Z s by

the million.

However until the LEP energy upgrade (January, page 1) is ready for physics in 1995, proton-antiproton collisions remain the sole source of W particles. The 1990 precision W mass measurement by UA2 was crucial input to the consistency calculations supporting the Standard Model. These have reached an impressive level of accuracy, particularly with LEP's energy now being known to 20 parts in a million.

CERN's proton-antiproton collider is no longer operational, but Fermilab's collider experiments continue to compile valuable W data. Probing deep into the electroweak picture to prise out information on the 'Higgs mechanism', the vital but obscure spontaneous symmetry breaking at the heart of the electroweak picture, needs a fix on the missing sixth ('top') quark from Fermilab's collider, and a still more accurate measurement of the W mass.

(*By an odd coincidence, the tenth anniversary of Carlo Rubbia's historic W seminar at CERN was 'marked' by another memorable presentation, this

*Fermilab W s

After registering 22 W s in 1987, CDF went on to log 6,380 in the 1988-9 Tevatron collider run - 4,800 in the electron channel, 1,400 in the muon channel and 180 accompanied by tau leptons. In the current run, CDF has seen 9,700 and 4,400 in the electron and muon channels respectively, while D0's initial W sample has 6,700 with electrons, 600 with muons.

time from the most recent physics Nobel, Georges Charpak.)

More spinoff from spin

Despite playing a major role in today's Standard Model, spin - the intrinsic angular momentum carried by particles - is sometimes dismissed as an inessential complication. However several major spin questions with important implications for the Standard Model remain unanswered, and recent results and new technological developments made the 10th International Symposium on High Energy Spin Physics, held in Nagoya, Japan, in November, highly topical.

The symposium covered a wide range of physics, reflecting the diversity of spin effects, however four main themes were - the spin content of the nucleon, tests of symmetries and physics beyond standard models, intermediate energy physics, and spin technologies.

Opening the meeting, T. Kinoshita reviewed the status of measurements of the anomalous magnetic moment ($g-2$) of the electron and the muon. The forthcoming experiment at Brookhaven (September 1991, page 23) will probe beyond the energy ranges open to existing electron-positron colliders. For example muon substructure will be opened up to 5 TeV and W s to 2 TeV.

R.L. Jaffe classified quark-parton distributions in terms of their spin dependence, pointing out their left-right attributes, and emphasized the importance of measuring transverse spin distributions through lepton pair production.

The intensive efforts to resolve the proton spin content were extensively