High-energy physics

Another flavour of quark?

HARD on the heels of the discovery of the Z^0 particle by the UA1 group at CERN (European Organization for Nuclear Research), rumours were rife that the group has also discovered the "top" quark — the sixth flavour in the family. This development has not been confirmed, however. The position seems to be that among its harvest of possible $W^\pm$ and Z^0 events, the UA1 group has a few events that are "consistent with" the existence of top. The difficulty is that, hitherto, the criteria used for selecting for analysis records of proton-antiproton collisions have been biased towards putative heavy-meson events. Nevertheless, the data to sustain a search for the top quark exist, but the search will not be started until the data on the W s and Z^0 have been tidied away.

Meanwhile, the UA1 group is rushing out a paper on the intermediate vector bosons giving the latest estimates of their masses as follows:

	UA1 estimate	Salam-Weinberg theory
Z	95.2 ± 2.5	94 ± 2.5
W	81 ± 2	83 ± 3

The measurements are clearly consistent with the theory. Moreover, the UA1 group has also measured the "Weinberg angle" θ_w , an essential parameter of the unified theory of electromagnetism and the weak nuclear interaction. The value quoted in the paper from the UA1 group is $\sin^2 \theta_w = 0.226 \pm 0.011$, again consistent with earlier estimates of 0.236 ± 0.030 .

Meanwhile, CERN has had success of another kind. The French Government at the end of last month gave its formal blessing to the construction of LEP, the large electron-positron collider due to be completed by 1989. Armed with the government's blessing (a *declaration d'utilité publique*, an environmental requirement for big constructions), CERN is now purchasing the land it requires around the ring for surface buildings.

There has been strong local opposition to these buildings, particularly in the village of Echevex — where villagers claim the buildings are far too close and noisy. The opposition to LEP now has no further legal line of resistance, but the legal owners of the land could have some influence by refusing to sell at the price CERN offers, when a judge would have to arbitrate. CERN officials say, however, that the farmers who own the land at Echevex are accepting the offers. Construction is now expected to begin in July, with injection of electrons and positrons beginning in late 1988 and first experiments in mid-1989.

The pace of development may, however, be affected by the interests of the UA1 physicists and others in improving the antiproton-proton collider which has pro-

duced the Z s, W s and possibly top. There is a proposal for a SF50 million (£15 million) development of the collider to improve its luminosity (production rate of events such as W s and Z s) tenfold. This would take three years and could thus be just ahead of Fermilab (see below). The snag is that the member governments of CERN are not flush with cash just now.

Even so, Dr Erwin Gabathuler, CERN's director for colliding beams, is hopeful. He argues that member states should acknowledge that the collider has wrested the lead

US particle accelerators

Fermilab poised to leapfrog

Chicago

THE Fermi National Accelerator Laboratory is jubilant over its achievement of a long-sought goal, the operation of the world's first large superconducting particle accelerator. The machine is called the energy doubler/saver, for its twin goals of doubling the maximum energy of Fermilab's proton beams to 1,000 GeV — one teravolt — and of using electrical power more efficiently. For several years, Fermilab has been able to afford power for its accelerator for only about half the year.

Beams in the superconducting ring, also called the Tevatron, were circulated at 100 GeV (1 GeV = 10^9 electron volts) for the first time this month. Experiments with the new beam are scheduled for October at 400 GeV, and beams approaching 1 TeV are expected early next year. Development of the superconducting accelerator began at Fermilab in 1972, while the conventional 400 GeV accelerator was still being broken in. The machine was the idea of Fermilab's builder and first director, Robert R. Wilson, who reasoned that the cheapest way to increase that accelerator's energy was to build a new ring of powerful superconducting magnets in the same tunnel.

The technology of superconducting magnets was not then as advanced as some had hoped. The US Government complicated matters by reducing funds for high-energy physics, which prompted Wilson's resignation in 1977. While Fermilab and another American accelerator projector, Brookhaven Laboratory's ISABELLE, were bogged down on the frontier of superconductivity, the European Organization for Nuclear Research (CERN) moved in 1979 into the different technology of colliding beams of protons and antiprotons, making available much more energy in inter-particle collisions than can be had from fixed targets.

With the 1,000 GeV Tevatron beam, only 45 GeV will be available to create new particles, far less than the 540 GeV available from CERN's 270 GeV beam, which has made possible the recent

in high-energy physics from the United States. He also says that the net cost of SF50 million could be brought down to SF20–30 million by using some of the contribution from the new member, Spain (which wished to support mostly lower energy physics at CERN). And the money would be spread over three years, he pleads.

But members are more likely to require that if the collider is to be improved, it should be within a constant CERN budget. That might entail a delay in the LEP programme — which is itself in competition with an American proposal, the SLAC linear collider. The ball thus seems likely to end up right back in the physicists' court.

Robert Walgate

discovery of the W and Z particles. Fermilab is now building the antiproton accumulator and other machinery necessary to use the Tevatron as a collider, but it is not expected to operate until 1985–86.

According to Chris Quigg, head of the theory group at Fermilab, intense beams of secondary particles such as neutrinos and muons produced by the Tevatron will be ideally suited to study the quark structure of nucleons. The fixed-target accelerator will also be unsurpassed for studying short-lived particles that contain charmed and bottom quarks. The tau neutrino, expected as a companion of the tau lepton, is also a candidate for discovery.

But Quigg says that qualitatively new physics is expected to appear at Fermilab in 1985, when the Tevatron is first used as a collider. If all goes as planned, the machine will produce collisions four times as energetic as CERN's and with as much as ten times the luminosity. One prize in contention between Fermilab and CERN will be the top quark, the sixth and perhaps the last quark flavour (see above), as well as a determination of the total number of neutrino species in the Universe (by measurements of the energy width of the Z) and the mechanism of the rare Centauro events hitherto seen only in cosmic rays.

Of CERN's recent successes, Quigg says, "The European strength in high-energy physics is healthy for the field as long as we keep up our end of it. In two years it will be our turn again. As long as we keep alternating the big new machines this way, the competition between CERN and Fermilab will be a good thing". By 1986, Fermilab's 2TeV collider will be the most powerful of its kind". But in 1989, CERN hopes to commission LEP, the most powerful electron-positron accelerator. Whether the United States will then be able to look forward to its next turn depends in large part on the recommendations to be made this month by physicists meeting at Woods Hole, Massachusetts, to discuss the next generation of US accelerators.

Larry Arbeiter