.....tau and charm

The Standard Model of particle physics has six quarks, grouped in three pairs (up/down, charm/strange, top/beauty), each pair being partnered with a lepton and its corresponding neutrino - respectively electron, muon, and tau. Probing the Standard Model in depth to see what makes it work means peering into all quark/lepton corners. While B physics, with its potential at proton and electron-positron machines, is being pushed hard (see previous article), other physicists underline the need for complementary information from other sectors.

Essential experimental tools for exploring out-of-the-ordinary particles are a Tau-Charm Factory and a Beauty Factory. These machines address similar basic questions in the Standard Model, but in complementary ways: the Beauty Factory is optimized for beauty particles and CP violation in B decays; and the TCF is optimized for the tau lepton, charm particles, and the spectroscopy of hidden charm states and light hadrons.

In early June about 100 physicists - theorists, experimentalists and accelerator physicists - from Europe and beyond gathered in Marbella, Spain, for the 3rd Workshop on the Tau-Charm Factory (TCF). The workshop aimed to reassess the TCF physics potential in the light of recent progress, to develop further the designs of the machine and the detector, and to discuss the experimental programme.

At the workshop, particular emphasis was placed on the prospects for tau and charm physics at current machines and at future B Factories. Whereas both a BF and a TCF generate large tau and charm statistics (a few 10^7 events per year), the workshop indicated that the key element of future precision measurements will not be statistics but systematic errors. Here the unique environment of the TCF, with its backgrounds that are both small and experimentally measurable, is likely to prove a decisive advantage.

Among the most challenging TCF goals are: measurement of a possibly finite tau-neutrino mass with a sensitivity of about 1 MeV, measurements of CP-violation asymmetries in the decays of D (charmed) mesons and hyperons, precision measurements of the space-time structure of tau decay, and a comprehensive study of light quark, gluon and hybrid spectroscopy.

There was considerable discussion at Marbella about new calculations of direct CP-violation in D decays. Seeing CP violation with these relatively short-lived particles has traditionally been written off, but new Rome/Naples calculations suggest that this highly constrained sector should be worth investigating. The calculations indicate decay rate asymmetries at the 10^{-3} level, close to the TCF's experimental reach.

In the light meson spectroscopy sector there was a consensus among the participants that with the detail of information available from the huge data samples (more than 10^{10} J/psi decays per year), in an optimized detector, a definitive understanding of the full picture of light quark-, hybrid-, and glueball-states should be possible.

The TCF double storage ring can achieve luminosities of 10^{33} cm^{-2} s^{-1} with a fairly conservative design based on head-on collisions, reasonable beam currents, moderate heat load on vacuum chambers, etc. Ideas were explored at the workshop for reducing the bunch spacing at a later stage (with a finite crossing angle) to attain luminosities beyond 10^{33}. Another option is to reduce the collision energy spread to 0.1 MeV using a monochromator optics, which is important for resonance and threshold running. Longitudinal beam polarization is also possible for the future.

The detector concept is technically sound and incorporates broad experience from previous detectors. At the workshop, test beam results were presented from several groups which confirmed the design performance of certain novel aspects of the detector. These included the tests of the longitudinally segmented cesium iodide calorimeter by US groups and the Valencia tests of 6m-long scintillating fibre time-of-flight counters which achieve 120 ps. A detailed simulation of the detector has been prepared by the Seville group which will be used to study TCF physics performance in detail. A proto-collaboration representing about 20 institutes from 9 countries has formed to prepare by mid 1994 a proposal for the Tau-Charm Factory.

Bubbling away

Bubble chambers may have almost vanished from the front line of physics research, but the vivid memory of their intricate and sometimes beautiful patterns of particle tracks lives on, and has greatly influenced the computer graphics of track reconstruction in today's big experiments. 'Seeing' an interaction makes it more understandable.

Bubble chambers, with their big collaborations of physicists from many widely scattered research institutes, started another ball rolling. The groups formed are even now