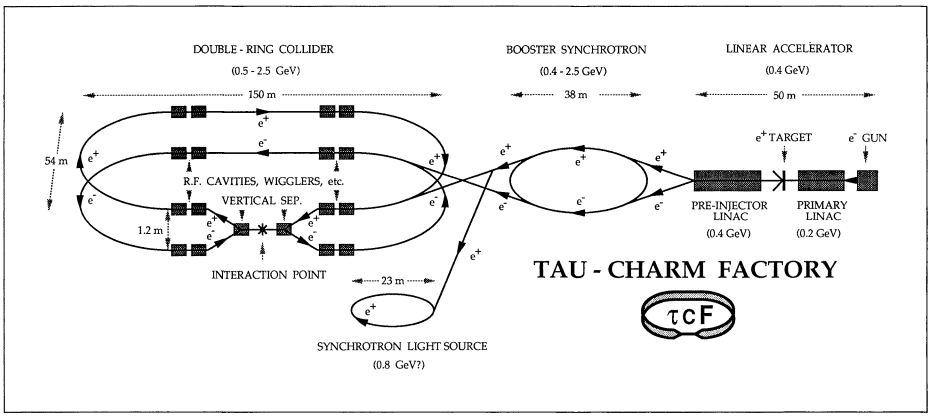
Schematic of a projected Tau-Charm Factory laboratory in Spain.

PARTICLE FACTORIES Tau-charm in the spotlight



Following earlier workshops in Stanford (1989) and in Orsay (1990), some hundred physicists from Europe and the United States met from 29 April to 2 May in Seville, Spain, to consolidate plans for a Tau-Charm Factory.

The big electron-positron colliders at CERN (LEP) and Stanford (SLC) have established that there are only three families of particles within the present Standard Model. This has stressed the importance of precise experimental studies of the presently-known particles to answer the major questions facing the Standard Model: Why there are three families? Why do they have their observed mass patterns? What lies behind the quark selection rules (Kobayashi- Maskawa matrix) and what is the origin of CP violation?

It is becoming widely accepted that, in future, progress at the 'high-precision frontier' will require dedicated machines that are optimized for specific particles. These 'particle factories' must produce selected particles copiously and with low background conditions.

The Tau-Charm Factory would collide intense beams of electrons and positrons in the region of the production thresholds of the tau lepton and the charmed quark, near 4 GeV total energy. The third-generation leptons – the tau and its associated neutrino – are an especially promising sector to search for subtle discrepancies with the Standard Model. The tau is the only lepton with a wide variety of decays – both leptonic and hadronic – of which many can be calculated with high precision. Furthermore, the sensitivity to new physics is greatly increased by the relatively high tau mass (1.8 GeV). Interest in the tau and its neutrino has grown with the recent indications of a 17 keV neutrino. If confirmed, then models are predicting lepton-flavour-violating decays of the tau which should be within the experimental sensitivity of a Tau-Charm Factory.

The advantages of a Tau-Charm Factory include not only the large data samples foreseen (10-50 million events per year of each particle) but also very low backgrounds – which can be measured experimentally – and the ability to produce taus nearly at rest. In addition, experiments can single-tag taus (as well as charmed mesons). Single-tagged data samples significantly reduce backgrounds and systematic errors (flux uncertainties, for example, are eliminated).

By generating huge samples of J/psis, (about 10^{10} per year), a Tau-Charm Factory will also answer important questions that remain at lower energies. A 'J/psi Factory' is seen as a natural future extension of present programmes exploring quark dynamics up to 3 GeV and testing symmetry principles in the decays of light mesons and baryons. In particular J/psi decays are an ideal way to study gluonium and other gluonic matter, for which the lack of experimental evidence remains as a major open problem for QCD.

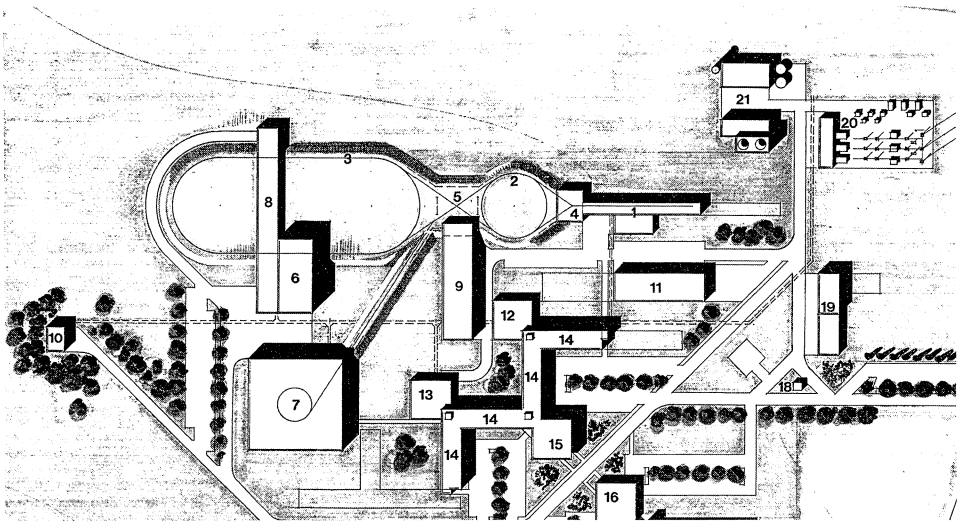
Interest in the Tau-Charm Factory has grown since the original idea by Jasper Kirkby and the first machine design by John Jowett, both at CERN. Detailed machine designs have subsequently been carried out at Stanford, Orsay, Novosibirsk and CERN – all agreeing that a luminosity of 10^{33} per sq cm per s can be achieved.

The Soviet Laboratories at Dubna (JINR) and ITEP (Moscow) are considering the possibility of a Tau-Charm Factory in collaboration with INP Novosibirsk.

In Europe, interest focuses on Spain where, following the initiative of Juan Antonio Rubio of CIEMAT (Madrid) and CERN, considerable support has grown within the scientific community as well as within industry and the central and regional governments. Among several regions that have expressed interest in the Tau-Charm Factory, Andalucia is strongly backing a site for the installation near Seville.

Following a request from the Spanish Government early last year, CERN carried out a concep-

Possible Tau-Charm Factory site layout, from a CERN design in collaboration with LAL-Orsay and Spain. 1 = Linac; 2 = Booster; 3 = Main ring; 4, 5 = Switchyards; 6, 7= Experimental halls; 8 = r.f. + exp. service hall; 9 = Machine access and service hall; 10 = Cryogenics; 11 = Workshops; 12 = Control room; 13 = Computer centre; 14, 15 = Offices and labs.



tual study, along with collaborators from LAL-Orsay and Spain, of a Tau-Charm Factory Laboratory in Spain. This study has been completed and the Spanish authorities have recently proposed considerable funds for the project. Discussions are now underway for CERN to provide the necessary technical expertise and the training of Spanish fellows and technicians.

The machine design envisages a collider and a dedicated synchrotron radiation source, both fed by an intense electron-positron injector operating at up to 2.5 GeV. The collider comprises a pair of 360-m racetrack-shaped rings, spaced vertically by 1.2 m. These are filled with up to 0.6 A positron and electron currents, at energies between 1.5 and 2.5 GeV. The beams are brought together at a single interaction point, with a second interaction region left open as a future option. With high currents and tight focusing at the interaction point, the luminosity is expected to reach 10^{33}, a hundred times that of the best current machine at these energies (BEPC, Beijing).

The Seville meeting also looked at the design of the detector for the Spanish machine. The detector is being developed by an enthusiastic team of physicists and engineers from CERN, France, Germany, Italy, Portugal, Spain, the UK and other European countries, as well as a US team led by Martin Perl of Stanford, who discovered the tau lepton in 1975.

The current ideas for the detector follow the style of CLEO II at Cornell (October 1989, page 14), with a large cesium iodide electromagnetic calorimeter, but optimized for tau-charm physics. In particular it includes a fine-grained outer hadron calorimeter/muon detector to complete the detector coverage and enable the invisible neutrinos produced in tau and charm decays to be 'seen'.

The Tau-Charm Factory is creating a lot of interest in Spain, which has never had a national centre for experimental high energy physics. As well as attracting the international physics community to Spain, the Tau-Charm Factory provides unique opportunities to breed a new generation of Spanish machine physicists and to provide a springboard for industrial spinoffs and future research projects in particle and accelerator physics. With the final decision on the project expected later this year, the first beams should collide early in 1997.

SOUTH AMERICA Looking for partners

A Regional Meeting on Fundamental Physics organized at the CIF International Physics Centre in Bogota, Colombia, in April, looked at future international collaboration possibilities for physicists from the South American Andean region in general, and from Colombia in particular.

There is a strong tradition of Latin American collaboration at Fermilab, and all the signs are that this will continue to flourish. In addition, a new collaboration agreement drawn up between CIF and the Canadian TRIUMF Laboratory in Vancouver opens up new horizons.

Cayetano Lopez of Madrid, a former Vice President of CERN Council, looked at possibilities in Europe. Spain, now playing an influential role in CERN and with plans to create a home-based accelerator centre, could provide a natural cultural bridge.

A collaboration agreement has been signed between CERN and Brazil (April 1990, page 26), and accords will soon be signed with Argentina and Chile. At the Bogota meeting Georges Charpak of CERN pointed out the usefulness of such agreements, in particular for Colombia, where CIF, founded in 1985, provides a natural base.

Apart from accelerator-based physics, countries with high mountains near the Equator provide natural advantages for observational physics.