KEK B factory plans

To boost the study of B mesons (carrying the heavy b quark), the Japanese KEK Laboratory is looking to construct a B-meson 'factory'.

B-mesons have revealed unexpected and important quark physics. Well-known examples are the long lifetime of the B-mesons, indicating a large gap between the third and second quark generation (compared to that between the second and the first), and relatively large mixing of the neutral B-meson and its antiparticle, now interpreted as being due to a heavy sixth ('top') quark (see page 5).

However the potential richness of B-meson physics has not been fully explored. In particular a large violation of CP symmetry (combined left-right reflection and particle-antiparticle reversal) is expected with B-mesons. (The only CP violation observed so far, in the neutral kaon sector, is a small effect.) A long-standing mystery, CP violation might have played an essential role in the formation of the present matter (rather than antimatter) universe. Also quark generation mixing reflecting possible new physics can be examined at the deepest level through B-meson decays. Thus a variety of B-meson physics projects are being discussed worldwide (June 1990, page 10).

The particle physics programme at KEK aims for a clean and detailed study of quark-lepton physics with electron-positron collisions. While R and D work is rapidly gaining momentum for the Japan Linear Collider (JLC), which will attack the TeV energy scale, B meson physics can be started earlier by making full use of the existing TRISTAN complex.

The current plan for the KEK B-Factory is a double-ring collider of unequal energies, to be installed in a newly constructed tunnel 1.2km in circumference. The TRISTAN Main Ring is also a possibility. The beam energies, 8 GeV on 3.5 GeV, are optimized for CP studies at the upsilon 4S peak. More asymmetric collisions, 12 GeV on 2.5 GeV, may also be required for the measurement of rapid oscillation between the neutral B_s meson (containing the strange- and b-quarks) and its antiparticle. This is also accommodated in the design.

The beams would be supplied from the upgraded 2.5 GeV Linac, stored and accelerated in the TRISTAN Accumulation Ring, and then injected into the storage rings. The design luminosity at the first stage is 2×10^{33} per sq cm per s, with 400 bunches colliding head-on, eventually reaching 10^{34} with 2000 bunches colliding at an angle.

To appraise the present design, an International Workshop on Asymmetric B-Factory Accelerators was held at KEK from 4-6 October. Thirty experts from abroad and forty from Japan participated in four working groups – lattice design, beam-beam interaction, hardware issues and the interaction region. The KEK design employs a small beta compression, small bunch spacing and a high tune-shift limit as well as a large dynamic aperture. No serious problem has been identified.

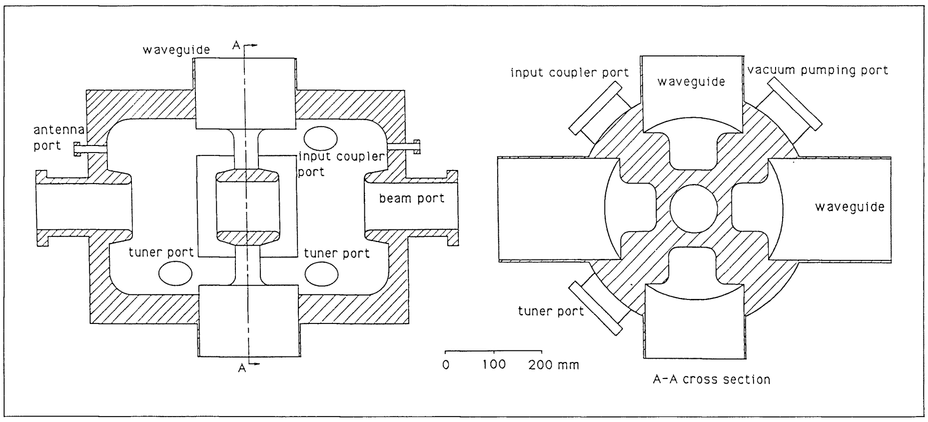
However, any high event rate factory-type accelerator is full of technical challenges. In particular closely spaced particle bunches are susceptible to coupled-bunch instabilities in accelerating cavities. Damped cavities under investigation at KEK (Palmer-type) and at Cornell (superconducting single-cell) are both viable, but need to be fully investigated. A feedback system will also be necessary to suppress the instabilities. There is a practical design for high vacuum, but ideas are needed for cooling a beam pipe at the collision point.

The next steps are to identify critical beam experiments possible at existing storage rings, and to initiate international collaboration on important items such as cavities, a feedback system, beam ducts and the beam pipe at the collision point.

Detector construction would benefit from TRISTAN experience. Tracking chambers and electromagnetic calorimeters can be based on presently available techniques. A large superconducting solenoid of 1 Tesla class and an iron structure currently operating in the TRISTAN experiments will also become available.

However there are special requirements for a detector at an asymmetric B factory. Excellent vertex resolution, better than 100 microns, in the beam direction is necessary to separate the decays of 'moving Bs', and a double-sided silicon-strip detector is under intensive study. Fast readout electronics is another requirement, resulting from a short beam-crossing interval and a high event rate. VLSI technology will be fully incorporated. Finally, the detector should be able to fully reconstruct as many individual B decays as possible, requiring ingenious combinations of detector techniques, either existing or shortly to become available.

Funding negotiations with the Japanese government project have begun. If everything goes well, construction will start next year and finish by the end of 1995, with most of the work done while TRIS-



When a storage ring is operated with multiple beam bunches, even distant bunches can interact with each other through resonating accelerator components, such as radiofrequency cavities. This can produce unwanted cavity fields, giving coupled-bunch instabilities and poor performance.
In the damped cavity design for the proposed B-factory at the Japanese KEK Laboratory, harmful field components are minimized.

TAN continues to run.

An International Workshop on Physics and Detectors for the KEK Asymmetric B-Factory will be held from 15-18 April to give the final polish to the experimental plan and to discuss ongoing international collaboration. Further information from F.Takasaki (Fax 0298-64-2580, Bitnet TAKASAKI at JPNKEKVM).

SUPERCOLLIDER Preparing initial experiments

The Superconducting Supercollider (SSC) Laboratory in Ellis County, Texas, has taken an important step toward its scientific programme.

While three letters of intent for large detectors had been invited, only two could be considered due to funding limitations. Two letters were received from existing collaborations (SDC and L*) and one from a merger of (EMPACT and TEXAS).

The SSC Laboratory has decided that the SDC collaboration will have support for a full technical proposal. The Laboratory will carry out a detailed cost review of the proposed L* detector. EMPACT/TEXAS was not approved and the Laboratory will help these physicists participate in the programme.

In the current financial year, SSC funding from federal sources amounts to $267M ($243M of new money plus $24M of 1990 construction money held over) compared to the $318M requested, but the State of Texas has compensated with an additional $60M to give $149M, hence total funding of $416M, including $7M for Department of Energy management.

High energy electrons for probing nuclei

It is becoming increasingly clear that the quarks hidden deep inside the proton and neutron constituents of nuclei can play an important role in nuclear behaviour.

With quark field theory (quantum chromodynamics – QCD) one of the twin pillars of today's Standard Model, the implications of this physics at the nuclear level are being widely investigated.

This new emphasis has been marked by the migration of hundreds of nuclear physicists to new research pastures at high energy Laboratories – CERN's LEAR antiproton ring, and ion beams at CERN and Brookhaven.

In addition, medium energy electron machines (around 1 GeV) have demonstrated their usefulness in probing details of nuclear structure, and in the US, the CEBAF Continuous Electron Beam Accelerator Facility being built at Newport News, Virginia, to provide energies up to 4 GeV will open up new nuclear physics horizons.

In France, a report published last year (May 1990, page 17) underlined the importance of setting up an essentially European project to provide nuclear physicists with electron beams of even higher energies, beyond 10 GeV

To push this message home, a workshop was organized late last year at Dourdan, France, attended by some 200 participants, including many young researchers.

Pushing for European nuclear physics – Ingo Sick of Basle, left, with Bernard Frois of Saclay.

(Photo Maurice Jacob)