

Tau-Charmers at the February workshop in Beijing.



the various charm and charmonium states. These will provide stringent tests of the Standard Model as well as providing important input for extracting physics at higher energy machines - and they may potentially reveal new physics beyond the Standard Model.

Considerable progress was made on the machine design, reflecting an especially strong group of machine physicists under the capable organization of S. Kurokawa, Y.Z. Wu and M. Tigner (who is spending the year at IHEP working on the BTCF design). The priorities for the machine performance are seen as, in order: 1) a peak luminosity of 10^{33} per cm per s at 4 GeV, and a primary energy range of about 3-5 GeV; 2) longitudinal polarization of one or both beams near 3.67 GeV (the prime energy for tau physics) and possibly at other energies; and 3) to maintain the potential for future luminosity increases and for operation with monochromator optics.

Longitudinally polarized beams are considered essential for the study of CP violation in tau decays - a programme that may be uniquely accessible at the BTCF. Longitudinal polarization is desirable at other

energies also, since symmetry violations may be uncovered in other channels and since polarization is equivalent to higher luminosity. Much attention was focused on the schemes for polarization generation and rotation, and the initial indications are encouraging. Given the physics priority, it was recommended that the necessary polarization hardware be included in the reference design and installed at the outset.

The detector groups were organized by J. Kirkby, W. Li, J.M. Ma and L. Price. The detector design benefits from the R&D programmes of the B Factory detectors and the advanced data acquisition systems pioneered by experiments at Fermilab, DESY and elsewhere. Significant advances in the detector design were made in areas such as the particle identification system (a combination of time-of-flight and aerogel counters), the superconducting solenoid (suitability of the TOPAZ solenoid), and the muon polarimeter. Informal discussions took place on the framework for international collaboration on the machine and detector. Several accelerator laboratories are interested in collaborating,

especially in challenging areas such as the superconducting radiofrequency cavities.

A large international community of physicists will be required to build and operate the detector and to analyse the physics. Representatives were present at the meeting from each of the main potential regions for international participation: Asia, Europe, North America and Russia.

The optimum timescale is a two-year period for R&D and preparation of the detailed design (1997-1998) followed by a four-year construction period (1999-2002), with the first collisions by the end of 2002. With the feasibility study due to be completed by October this year and a decision on the study expected soon after by the Chinese authorities, the high energy physics community eagerly looks forward to the "promising future" for the BTCF seen by Zhou Guang-zhao.

The meeting, organized by Z.P. Zheng and S.H. Wang, brought together a large group of theoretical physicists, experimentalists and accelerator specialists, numbering about 220 in total, including 60 from abroad.

Video conferencing

In many fields, video conferencing is becoming an increasingly popular way to do business, avoiding the need to travel long distances, and being immune to such phenomena as heavy fog and rail strikes. It is only natural that particle physics, with its large international collaborations, both in terms of numbers of people and geographical extent, should be

A few of the participants at a CMS collaboration video conference. The room they are using is equipped with a system donated to CERN by the US high energy physics community and has a capacity of 30 people.

an active player in this new communications medium.

Already widely used across the vast distances of the United States, video conferencing made its debut at CERN in October 1994, and has rapidly found favour.

There are two ways in which the physics community is exploiting video conferencing. The first uses the commercial Integrated Services Digital Network, ISDN, whilst the second runs over the internet. Both have their advantages. With ISDN, bandwidth (see box) is guaranteed, giving an assurance of reliable performance. Typical ISDN systems are designed for dedicated conference rooms although cheaper PC-based systems are available. Many desktop workstations are well equipped for informal conferencing over the internet, but the current internet bandwidth is insufficient to support unrestricted use. At CERN, internet video conferencing technology is most frequently exploited in a limited number of dedicated conference rooms.

CERN currently has two rooms equipped for ISDN video conferencing. The largest has a capacity of 30 and is equipped with a system donated by the United States physics community to facilitate communication with the growing number of American physicists working at CERN. These rooms play host to about 20 conferences each month, frequently involving physics groups on both sides of the Atlantic.

Many transatlantic conferences pass through a gateway at the Lawrence Livermore National Laboratory in California. To hold a conference with several US sites a European participant has to make a single call to Livermore which currently costs 120 Swiss francs/hour.



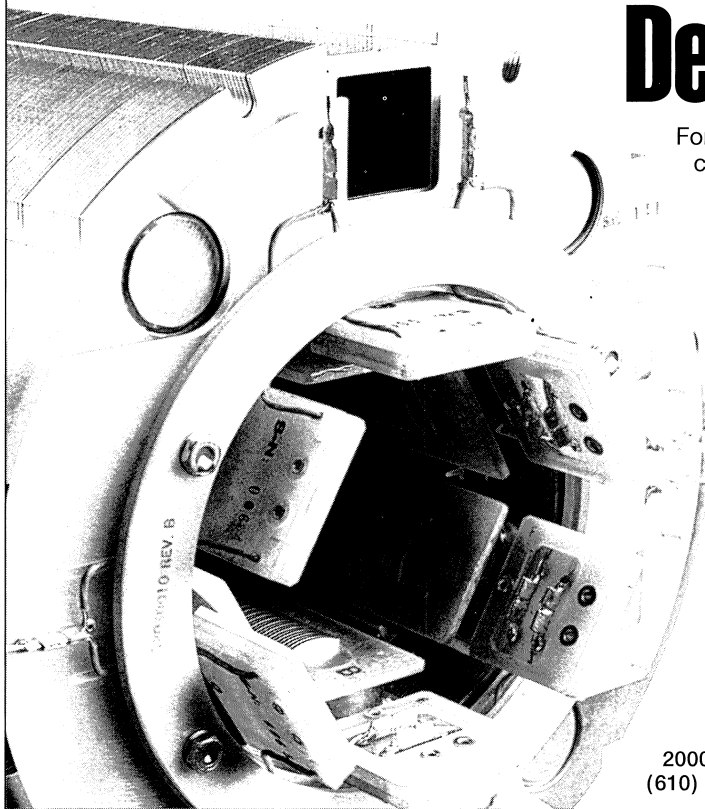
Within Europe, conferences are co-ordinated by a local machine and cost around 90 Swiss francs/hour. Charges are falling, and with European telecommunications deregulation in 1998, video conferencing should become considerably cheaper.

With over a year of ISDN experience, CERN experiments are finding video conferencing to be a valuable supplement to face-to-face meetings, rather than an alternative. One reason is the large distances involved. CMS, one of the big global experiments preparing for physics at CERN's Large Hadron Collider, holds weekly management video conferences. With participants from California to Oxfordshire taking part, finding a convenient time for everyone is not easy. Fermilab near Chicago is the CMS reference point, with conferences starting at 9 am Illinois-time. This corresponds to 7 am in California, and 4 pm in Europe. Clearly, if Japanese groups were involved, a convenient time for everyone would simply not exist.

Video conferencing also requires a strict code of conduct. Free and open discussion such as might take place in a room is not possible. Current systems are sound-activated, with attention focusing on whoever makes the most noise! There is also a slight time delay between saying something at one site, and being heard elsewhere. For these reasons, speakers have to know when they are supposed to speak, and they must leave clear pauses for other participants to comment. Background mumbling is, of course, out.

Despite these drawbacks, CMS finds the weekly conferences indispensable, and also uses the system for specific conferences as necessary. Recently, the experiment's 'parameter committee', which has the task of fine-tuning the detector design to the nearest millimetre without squashing any cables, found that video conferencing made their task considerably easier. Another use has been found by the Michigan group on the L3 experiment

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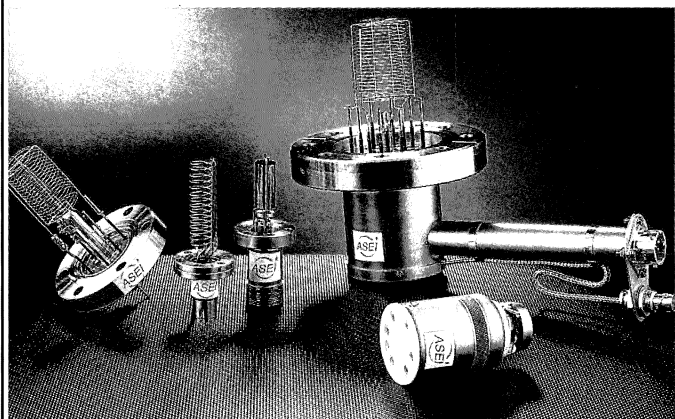
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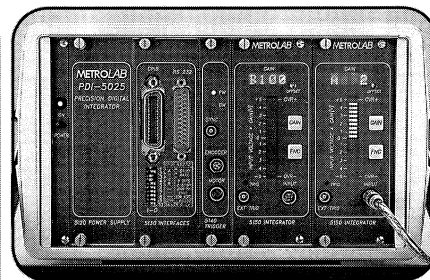
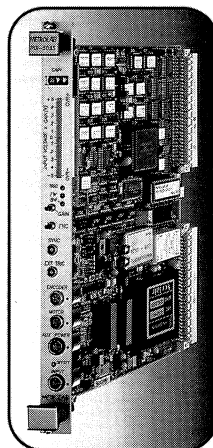
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Bandwidth

In telecommunications, bandwidth is the range of frequencies covered by a transmission. A single frequency (zero bandwidth) is just a pure note. The richer the information which has to be conveyed, then the wider the bandwidth required - for example video transmission requires a higher bandwidth than audio. Pictures require more bandwidth than text, and moving images require more bandwidth than still photographs. In more general terms, any method for transmitting information has a natural bandwidth. The natural bandwidth of the postal system, for example, is the amount of information which can be put in a letter. The average bandwidth of the CERN Courier is 44 pages per month.

at CERN's LEP electron-positron collider who use regular ISDN conferences to allow students, whilst they are at CERN, to keep in touch with their supervisors in the US.

Video over the internet is still in its infancy. Video broadcasts or video conferences with very many participants rely on a virtual network called MBONE running on top of the internet. Video conferences involving a small number of participants can use the internet directly.

MBONE is based on a series of routers which try to overcome the bandwidth problem by reducing the amount of information transmitted. For example, if a site in Europe sends a packet of information to fifty sites in the US, MBONE will send a single packet from a Europe-based

router to another in America before sending individual copies to each recipient. The internet alone would send fifty copies across the Atlantic.

MBONE has to compete for bandwidth with other internet services like FTP and the World-Wide Web, and because it needs to transmit in real-time, is at a disadvantage. With the Web, a crowded network means slow transmission; lost packets are resent later. But for video conferencing, lost packets are potentially disastrous; there is no point resending a syllable spoken 2 minutes ago.

Many people are already making use of MBONE technology. NASA broadcasts space shuttle missions in this way. But sometimes as many as 50% of packets are lost as seen from Europe, making the sound and video incomprehensible. CERN broadcasts certain important committee meetings on MBONE, and the other big LHC experiment, ATLAS, transmits its plenary meetings over the network. Although MBONE is often more congested than the underlying internet, even point-to-point video-conferences over the internet suffer from congestion and packet loss.

Nevertheless, video conferencing on a workstation has many attractive features. It is very easy to move computer-based documents into a common 'white board' which everyone can see. Here, the protocol does resend lost packets, and the full information is always transmitted. In this way, conference participants can work together on text, graphics, and computer programs. Another feature is that the whole conference can be recorded on disk and replayed later through a Web browser.

Long term solutions to the bandwidth problem may come with

an expanding internet, or with the arrival of point-to-point networking technology such as the much-touted Asynchronous Transfer Mode, ATM. But in the short term, more innovative solutions have to be found.

Scientists at CERN and the California Institute of Technology are working on a way to reserve bandwidth on the heavily used internet link between CERN and the US; Caltech will equip a conference room at CERN for use with the reserved bandwidth. Another solution is to leave the internet altogether, and run the internet video conferencing protocols over ISDN, but then commercial telecommunications charges come into play.

Video conferencing is proving to be essential for the global collaborations preparing for CERN's LHC collider. It is impossible for all collaboration members to get to plenary meetings, but anyone with access to internet video conferencing can at least follow them. However, with current bandwidth problems, broadcast information is sometimes lost, and internet based conferencing is better suited to impromptu one-to-one conferences. The ability to share computer-based documents quickly and easily coupled with the low end-user cost of conferencing over the internet make it extremely attractive. But for the time being at least, the quality of audio and video over the internet is unpredictable, and where guaranteed bandwidth for a large number of users is needed, ISDN is the safest bet.

For information on ISDN video conferencing, see:

<http://www.cern.ch/CERN/Video/Welcome.html>

<http://cmsdoc.cern.ch/teleconf.html>
The Network Research Group at

Lawrence Berkeley Laboratory has produced the majority of the internet video conferencing tools:
<http://www-nrg.ee.lbl.gov>
 For MBONE conferencing in general:
<http://www.best.com/~prince/techinfo/mbone.html>
 or at CERN:
<http://ecponion.cern.ch/multimedia/welcome.html>

Cesium iodide photocathodes come of age

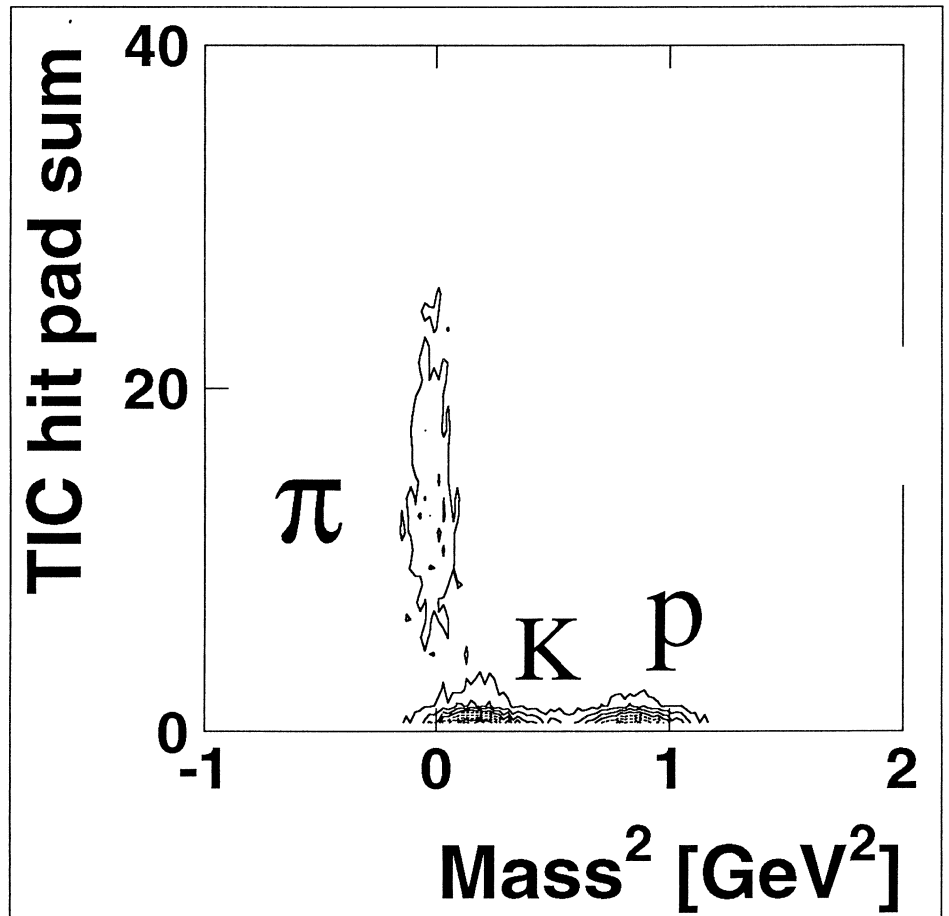
For its upgrade the NA44 heavy ion experiment at CERN has stressed the improvement of particle identification for the multiple tracks encountered in lead-lead collisions, and a novel detector based on threshold Cherenkov radiation emission has been constructed - the Threshold Imaging Cherenkov (TIC).

This is based on two-dimensional detection of Cherenkov light emitted in a metre-long isobutane gas radiator by particles with velocities above the threshold Cherenkov radiation (the optical shock wave produced when particles force their way through a medium faster than the velocity of light in the medium).

The Cherenkov photons are reflected by mirrors towards detectors outside the track acceptance region. This imaging, in conjunction with surrounding tracking

Schematic of the NA44 Threshold Imaging Cherenkov detector. For each track above emission threshold, mirrors reflect Cherenkov light onto planes of photon detectors, equipped with cesium iodide photocathodes, on the top and on the bottom of the module.

2-dimensional iso-contour plot from the NA44 Threshold Imaging Cherenkov detector. Low mass pions produce many hits, while protons and kaons, below Cherenkov threshold, produce no pad hits and are distinguished by their mass. The technique gives a good resolution between pions and kaons which would not be available from time-of-flight information alone.



TIC (Threshold Imaging Cherenkov) Detector

