

Son of CAMAC

model and measurements of pion-proton and kaon-proton total cross sections.

Adding charm to this picture produces noticeable effects as charm channels cut in. Some plausible arguments indicate that the onset of charm could lead to an increase of the order of 2% for the total cross section. A precise experiment, with statistics better than 1%, was required to resolve this question. The recent experiment not only extended the measurements to a new high energy but did so with much greater precision than achieved before.

Most photon interactions in a hydrogen target are not hadronic but involve electromagnetic processes that are highly collimated in the forward direction, which means that a transmission measurement of the total cross section is not satisfactory. Instead, the detector collected all the hadronic products outside of a narrow forward cone (just slightly smaller than the rho opening angle). This region is covered with both charged and neutral hadron detectors. Behind the central hole, an electromagnetic shower counter measured electromagnetic energy and helped to veto pair events. Detectors were arranged so that they could be moved along the beam to scale for different energy ranges.

Photons were produced by bombarding a thin radiator with an electron beam of known energy. The electrons bremsstrahlunged to produce forward going photons with part of the incident energy, while electrons that radiated proceeded with the remaining energy. A magnet just after the radiator deflected the electrons into a series of shower counters which measured their energy so that it was possible to tag the energy of the photon.

This system functioned well both in determining the energy of the photons and in establishing their flux with remarkable precision. To cross check operation of the beam, the experiment

ran at several different electron energies up to 200 GeV and it was possible to measure the photon total cross section on hydrogen from 18 to 185 GeV.

The results show a total cross section of about 115 microbarns rising linearly by about 2 microbarns per 100 GeV. The errors are less than 1%. This data seems to connect with much of the lower energy data and the energy dependence is in agreement with earlier models which relate the cross section to vector-meson production. However, the net cross section is several microbarns higher than would be expected if charm is not taken into account.

Data was also taken using heavy nuclei targets to study the energy and A dependence of nuclear shadowing, which is yet another manifestation of the hadronic nature of the photon. Preliminary results on carbon and copper in the 45 to 90 GeV range indicate that the shadowing effect has, if anything, increased over that at lower energies.

One of the big spin-off successes in high energy physics has been in the field of fast electronics with the development of the standard CAMAC interface techniques which enable data collection and control systems to be developed for all types of applications and for use with a wide range of different computer equipment and electronics. Without CAMAC, or similar standards, data acquisition systems would have to cope afresh with the exact hardware and software requirements of each application.

As well as being a worldwide standard for high energy physics and nuclear physics experiments, CAMAC is also used in a wide range of other laboratory environments, and even further afield in industry wherever there is a large scale requirement for data acquisition or telemetry.

However, the fast rate of development in data processing techniques and electronics has been generally interpreted as limiting the useful life of CAMAC in its present form, and it is realised that sooner or later a replacement or complementary interface method will be required to offer increased speed, scope and flexibility.

In 1975, formal representations were made to the Nuclear Instrumentation (NIM) and CAMAC committees in the USA, suggesting that future experiments designed to take data at very high rates would find themselves hampered by the present CAMAC maximum speed of 1 MHz per 24 bit transfer, and by other limitations, pointing to a need for a long term replacement system.

An investigatory group was set up, which recommended that a formal Advanced Systems Study Group should be established to examine, in detail, the requirements for data collection rates in future experiments, the future trends in minicomputer speeds and design, and the increasing use of 'distributed intelligence' in which processing power is dispersed through

A typical CAMAC set-up. CAMAC has been one of the big spin-off successes in high energy physics and is now used in a wide range of different data acquisition and computer control applications. But the fast development taking place in this field means that a replacement or complementary interface technique will soon be required.

(Photo CERN 130.12.72)

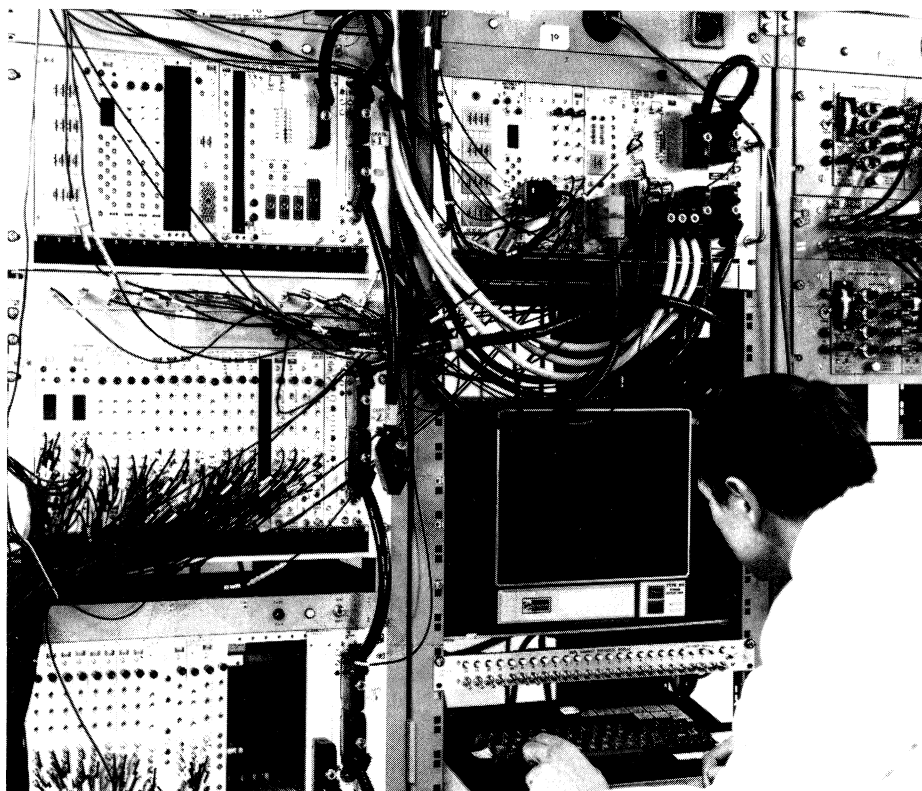
a system rather than being centred in one place. The Study Group was to put forward its conclusions on the requirements for a 'next generation' of interface systems. Its terms of reference said that, while compatibility with existing CAMAC techniques should be a subject for study, it was not necessarily a binding commitment.

In its report, published earlier this year, the Study Group concluded that CAMAC has some general shortcomings which would severely limit its usefulness for future experiments using new data acquisition and processing techniques. While CAMAC might be able to work with these problems for a long time to come, a long term replacement system is clearly needed. These objectives are now being incorporated into preliminary designs for the new system. Final specifications should be complete by the middle of 1979, with production models ready soon after.

At the same time, the ESONE collaboration responsible for the maintenance of CAMAC standards in Europe has acknowledged the need to investigate the long term future of CAMAC and has its own Study Group. Although not directly involved in the new USA design work, CERN is closely monitoring progress and has observers at the regular NIM meetings.

Some of the future needs identified by the USA Study Group included block transfer requirements involving the high speed transfer of blocks of data words (for example, between different buffers); the increasing use of preprocessing and parallel processing techniques (for example, using micro-processors to select data as early as possible, reducing the volume of data to be transmitted), and the handling of 'sparse data' in large arrays of detector elements, only a few of which would contain relevant information.

Control and data acquisition software requirements are taken into account at the outset of the new



specification, while provision is being made for parallel processing and multiprocessing, including the required communications protocols. Other general requirements which have been identified include the need to read and write individual registers, to initiate activities (such as interrupts) remotely, and to enable the status of the whole system to be changed by a single signal.

To fulfil these requirements, the new interface standard will need to operate at a speed at least ten times that of CAMAC (that is, more than 10 MHz) and be able to operate in two transfer modes — a 'handshake' mode involving exchange of signals between two devices and another mode where blocks of data could be transmitted without necessarily having to wait for a response. It should be able to handle 'sparse data' as a matter of routine. The Study Group also had reservations about CAMAC's addressability and its

compatibility with distributed processing techniques.

The limitations of CAMAC can also be illustrated by the relatively large number of ad hoc electronic systems which have been developed in recent years for special applications. Each of these systems overcomes one or two of the major CAMAC problems, but none of them can really be regarded as forming a basis for general development.

Whatever the outcome of the new design work, CAMAC will probably still be with us for many years to come. Far from disappearing from the scene when the new systems emerge, CAMAC could well obtain an extra lease of life.