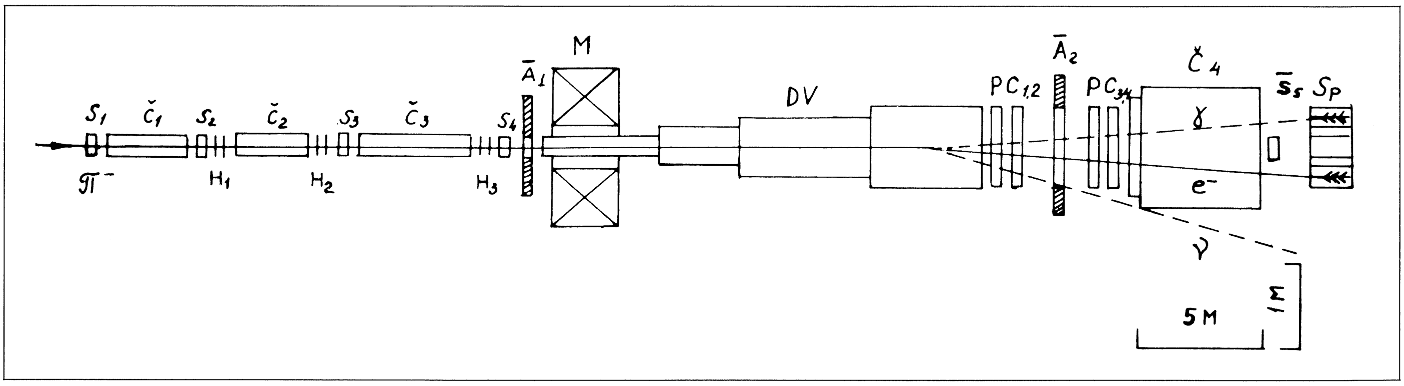


The ISTRA apparatus used by an Institute for Nuclear Research, Moscow, team working at the 70 GeV proton synchrotron at the Institute of High Energy Physics, Protvino, Serpukhov, to study rare decays of pions and kaons. S denotes scintillation counters, and C Cherenkov counters with photomultiplier readout developed at IHEP. Decay products in the vacuum volume DV were detected by proportional chambers (PC), a wide-aperture Cherenkov (C_4), and the Sp total absorption spectrometer containing 480 lead-glass elements.

MeV per nucleon for krypton 30+. With these beams Saturne provides a useful window for the study of nuclear matter.

During the krypton run, extraction attained 20 per cent, allowing 5×10^7 charges per burst at 1 Hz for physics. Machine setting was carried out in two phases, with an initial dense nitrogen 5+ pilot beam being used to tune the two synchrotrons.

The beam intensity and reliability provided excellent experimental conditions. A team using the SPES IV spectrometer is studying the role of the incident ion energy in peripheral collisions. The results will show whether, at 200 MeV per nucleon, pure fragmentation – breakup of projectiles and target without deposition of energy – is dominant, or whether there is still room for the energy dissipation seen below 100 MeV per nucleon.

MOSCOW Looking at rare decays

The first stage of a new study of some rare decays of negatively-charged pions and kaons has been completed by scientists of the Institute for Nuclear Research of the Soviet Academy of Sciences, Moscow. The experiment used the ISTRA apparatus to take data from 1984-8 using a secondary beam of the 70 GeV proton synchrotron at the Institute for High Energy Physics, Protvino, Serpukhov.

In the decay of a pion into an electron, a neutrino and a photon the structure of the quantum mechanical amplitude includes the two currents (vector and axial vector) of the weak nuclear interaction. The structure of this amplitude is essential for other meson radiative decays (such as a kaon into two pions and a photon).

Theoretical arguments (conserved vector current) link the vector current contribution to the decay of a neutral pion into two photons, but the axial vector part needs input.

In the Moscow experiment, the decay products of negatively charged pions and kaons of momenta 17 and 25 GeV/c respectively were analysed over a wide angular range. The ratio of axial vector to vector contributions was obtained as 0.41 ± 0.23, excluding a negative value reported in previous experiments, and an independent estimate obtained for the vector coupling of the pion. The branching ratio (relative decay probability) for this type of pion decay was measured as $1.61 \pm 0.23 \times 10^{-7}$. Branching ratios were also measured for a range of kaon decays.

Additional elements (magnet spectrometer, hadron calorimeter and muon identifier) have been added to the ISTRA setup, and the new ISTRA-M version will go on to make further investigations of rare kaon decays.

CONFERENCE Elastic and diffractive scattering

Elastic scattering, when particles appear to 'bounce' off each other, and the related phenomena of diffractive scattering are currently less fashionable than the study of hard scattering processes. However this could change rapidly if unexpected results from the UA4 experiment at the CERN Collider (January/February 1988, page 32) are confirmed and their implications tested.

These questions were highlighted at the third 'Blois Workshop' on Elastic and Diffractive Scattering, held early in May on the Evanston campus of Northwestern University, near Chicago. (The title

Some members of the Moscow Institute for Nuclear Research team near the ISTRA lead-glass spectrometer (see page 18) – left to right, O.M. Isakova, V.V. Isakov, V.A. Lebedev, V.N. Marin, A.A. Poblaguev, V.E. Postoev, and experiment leader V.N. Bolotov.

stems from the inaugural meeting held four years ago at the Château de Blois.)

The theme of this year's workshop was the interface of 'soft' and 'hard' processes in quantum chromodynamics (QCD, the candidate theory of quark dynamics – in this context soft and hard respectively mean small and large transverse momenta, according to whether the interactions occur on the surface or deep inside the struck protons).

Improved understanding of QCD has motivated ambitious theorists to look at the elastic and diffractive arena. At present this translates into a variety of claims (and counter-claims) that calculations based on QCD can explain a variety of effects. Summarizing the meeting, P. Landshoff declared that there was 'much more dynamics than at Blois in 1985' – a trend he found very encouraging.

Opening the meeting, André Martin reviewed the status of elastic scattering, emphasizing the importance of continuing experiments. Many important ideas can be tested, even though precise predictions are not always available. The measurement of the total cross-section (reaction rate) at Fermilab's Tevatron Collider by experiment E710 has been eagerly awaited following the excitement generated by the CERN result. If the CERN result (a large real part of the scattering amplitude) anticipates a 'new threshold' then a large cross-section is expected at Fermilab energies.

R. Rubinstein presented preliminary E710 results for the total cross-section of colliding 900 GeV proton and antiproton beams – 85.5 millibarns (± 6.4) compared with 56.1 mb (±4.7) for 150 GeV beams. Since the errors at the two energies are correlated (with the luminosity) and the lower energy value fits well with other results, the central value of 85.5 mb could have more significance than the large error implies. It is consistent with the new threshold interpretation of the UA4 result but is not large enough to unambiguously resolve the issue. The systematic error due to the luminosity is soon expected to come down.

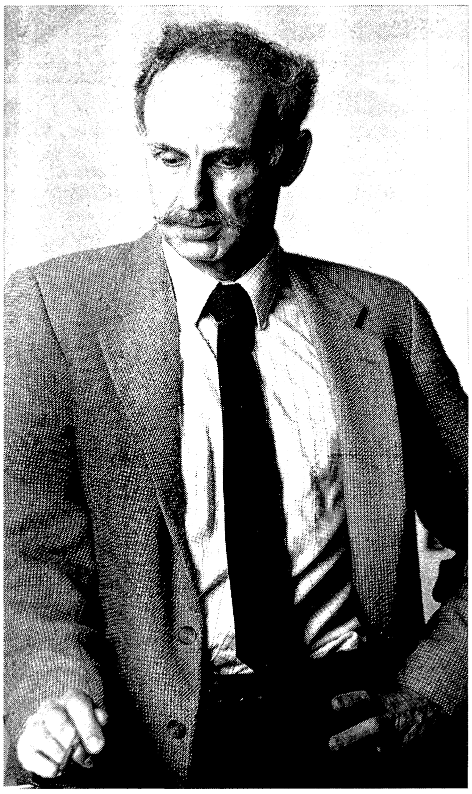
Theorists arguing that the rising total cross-section reflects an increased production of 'jets' – narrow sprays of particles due to 'hard' constituent quark interactions – included B. Margolis, M. Ryskin, N. Nikolaev, F. Halzen, I. Sarcevic, L. Durand, and P. Kluit. Ryskin described the 'Leningrad Programme', claiming that perturbative QCD is indeed 'valid for large cross-section processes at high energy because the characteristic transverse momenta of gluons (quarks) increase with energy'. Halzen appealed to cosmic rays to argue that above total collision energies of 4 TeV (4000 GeV), all events have jets.

Theorists arguing that the dominant contribution to the rising cross-section is a 'soft' mechanism (the Pomeron) included P. Landshoff, C. Tan, A. Capella and J. Tran Thanh Van. A. White argued that within QCD, jets may be dominant over some energy range but new particle states might appear at higher transverse momenta.

M. Schub reviewed results from the CDF detector at Fermilab, pointing out that the increase in transverse momentum with energy is due mainly to the production of low transverse momentum particles. N. Morgan described related results from E735, an experiment searching for evidence of quark-gluon plasma.

T. Meyer reviewed the extensive programme of (double Pomeron) studies from CERN's Intersecting

Roy Rubinstein – preliminary results for the elastic scattering of 900 GeV protons and antiprotons.



Storage Rings, where virtual states intrinsically present in the vacuum are 'kicked' into reality when two protons glance past each other. M. Albrow outlined possible extensions of these experiments using multi-TeV proton beams at proposed new colliders. C. Peroni described additional diffractive physics – Pomeron-photon collisions – at the HERA electron-proton collider now being built at the German DESY Laboratory in Hamburg.

Cosmic ray results were reviewed by T. Gaisser who emphasized the model dependence involved in extracting the proton-proton cross-section from the proton-air data. G. Yodh looked at exotic cosmic ray events, in particular the excess muons produced by what are apparently high energy photons.

K. Goulianos gave a general review of diffraction. Although it was disappointing to have no new experimental results on diffractive production processes, although the UA8 experiment at CERN was not represented at the meeting and although the CDF collaboration is still deep in analysis, this did not seem to hinder theoretical speculations.

From Alan White

CERN
Real cool antiprotons

CERN and Fermilab are the world's two major sources of antiprotons for physics experiments. At CERN's antiproton complex, operational since 1981, the particles have been taken as high as 450 GeV per beam. At Fermilab, where first antiproton beams appeared in 1985, the energies are regularly ramped to 800 GeV.

However CERN has several strings to its antiproton bow. The LEAR low energy antiproton ring takes the particles down to kinetic energies of 5.9 MeV for a unique range of experiments. For the special physics objectives of a Harvard/Mainz/Washington team – to slow down antiprotons as much as possible to measure their static properties – even these subdued energies are far too high.

Ultra-low energy charged particles are usually caught and stored in Penning traps, where an electrostatic quadrupole field locks the normal cyclotron magnetic field revolutions. Using such a trap, a lone electron was once kept for ten months!

The thermal vibration of trapped particles is often suppressed by a cold 'buffer' gas, however this technique is unsuitable for antiprotons, which quickly annihilate with the protons and neutrons of ordinary nuclei. Instead, a gas of electrons at cryogenic temperatures (4.2K) surrounds the antiprotons and absorbs their thermal energy.

Robert Tjoelker (Harvard) exults at achieving cryogenic antiprotons in an experiment at CERN's LEAR low energy antiproton ring.