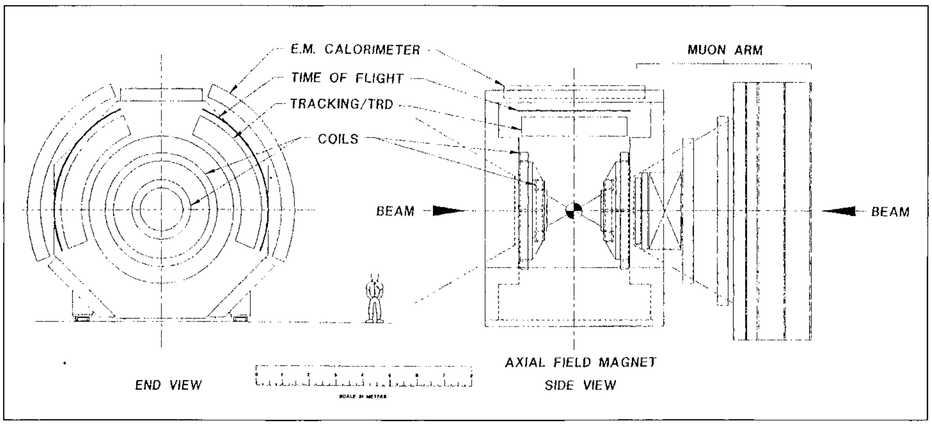
Around the Laboratories

Layout of the PHENIX detector for Brookhaven's RHIC heavy ion collider, with an axial field magnet.



BROOKHAVEN PHENIX arises

At its February meeting, Brookhaven's High Energy and Nuclear Physics Program Advisory Committee reviewed the status of the PHENIX (Photon Hadron Electron Nuclear Interaction eXperiment) proposal for the RHIC heavy ion collider.

The committee was pleased with the progress made by the collaboration and approved the preparation of a formal proposal. It is anticipated that a preliminary conceptual design report will be available for review at the September Committee meeting. This action puts PHENIX on an equal footing with the other major RHIC experiment, STAR (Solenoidal Tracking At RHIC, November 1991, page 17).

As a complement to STAR, PHENIX will focus specifically on electromagnetic signals and should be able to exploit the highest RHIC luminosities. It uses an axial field magnet and two central electron/photon/hadron spectrometers each covering 90 degrees in azimuth, where a range of detector options is being kept open. Muons would be intercepted in a forward detector arm.

The Committee also recommended that two groups which presented letters of intent for smaller experiments proceed to the preparation of proposals. A Brookhaven/Strasbourg/Beijing/NYU/Texas A&M/SSL-Berkeley collaboration will develop a Forward Angle and a Midrapidity Hadron Spectrometer; and a Brookhaven/Iowa State/INP (Krakow)/Jagellonian University (Krakow)/MIT/Illinois (Chicago)/Maryland/Wayne State collaboration will develop PHOBOS, a study of very low transverse momentum phenomena.

SACLAY Eta mesons at Saturne

Using a nuclear reaction, the new tagged eta meson facility now operating at the French Saturne National Laboratory in Saclay produces eta mesons (together with recoil helium-3 nuclei) by proton bombardment of a deuterium target. The proton beam is extracted from the Saturne synchrotron at 893 MeV, stabilized to 80 keV. This is a scant 1.5 MeV above the reaction threshold and close to the energy where eta production peaks.

The etas come out nearly monochromatic and in a narrow cone around the beam direction, facilitating the design of the eta decay detector. The recoil helium-3 emerges around the beam direction and signals the production of the eta.

The helium-3 is detected by the SPES II spectrometer which separates the ions from the unused incident proton beam. SPES II has had a distinguished career including a six year stint at CERN for investigations of hypernuclear and antiproton physics.

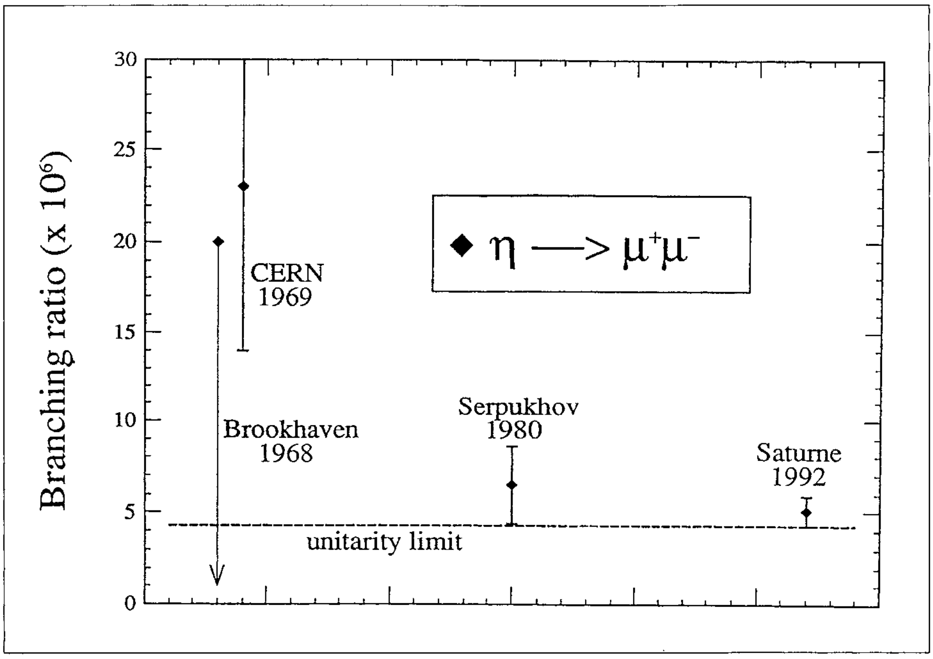
Previous work on eta decay has been carried out mainly using production by negative pions on protons at an incident pion energies well above threshold so the etas are not monochromatic. Tagging with the accompanying neutrons is not an easy task.

The new eta facility provides a 92% pure eta source and yields routinely 10^8 tagged etas per day. The possibility of a 50-fold increase of this yield has been demonstrated, although this is accompanied by a high hadronic background from the production target (the short-lived etas decay before they can leave the production target).

With the new facility, sensitive searches for rare and forbidden decays become possible. As a first experiment, a major international collaboration has made a convincing measurement of the branching ratio for the rare eta decays into two charged muons, about 5×10^{-6}. This preliminary result is close to the minimum (unitarity limit) calculated for this electromagnetic process, and is in agreement with most models.

In this first experiment at the Saclay eta facility, new upper limits were also obtained on some rare and for-

New limits on the branching ratio for the rare decay of an eta meson into a muon of charged muons measured at the French National Saturne Laboratory's new eta decay facility.



bidden eta decays, such as the muon-electron channel, which are a modest improvement over existing upper limits.

Plans are being made, though not yet funded, for a novel large acceptance spectrometer to measure many of the known and unknown eta decays to a level of 10^{-8} - 10^{-9}. For instance etas going to a neutral pion and a pair of muons or electrons test charge conjugation invariance at the level of a one-photon intermediate state; etas decaying into electron-positron pairs are an (indirect) test of the existence of leptoquarks, and eta going to a muon and an electron tests lepton family violation.

The eta factory also makes possible new and detailed measurements of the eta electromagnetic transition form factor in the decay of etas into muon pairs plus a photon, and can probe perturbation theory in measurements of eta going to a neutral pion and two photons.

Artificial intelligence

A vivid example of the growing need for frontier physics experiments to make use of frontier technology is in the field of artificial intelligence and related themes. This was reflected in the second international workshop on 'Software Engineering, Artificial Intelligence and Expert Systems in High Energy and Nuclear Physics' which took place from 13-18 January at France Telecom's Agelonde site at La Londe des Maures, Provence. It was the second in a series, the first having been held at Lyon in 1990.

Four closely related sectors were covered - software engineering, expert systems, neural networks and symbolic manipulation techniques.

The magnitude and complexity of the experiments on the horizon for the end of the century clearly calls for the application of artificial intelligence techniques. However there are common problems in different areas (high energy, nuclear and plasma physics, space, telecommunications,...), and solutions are sought through research-industry collaboration in an international collaboration framework.

From an identification of the real needs of fundamental research using large installations, this approach leads on one hand to the development of new products or techniques which will find a place in industry, and on the other to improved artificial intelligence methods.

Many experts from outside particle physics took part in the workshop, including several having made pioneer contributions to the field. Coursework covered the logic of the method components of software engineering, object-oriented languages (EIFFEL), and applications using a variety of languages.

An introduction to artificial intelligence and expert systems was followed by a description of the PROLOG III language, the possibilities for genetic algorithms, and the use of neural networks for pattern recognition, together with their application in high energy physics.

Plenary sessions summarized three days of parallel streams, including several ongoing physics projects. Relations with industry play an important role. The programme continued with results and ongoing projects in neural network applications in particle physics and related sectors.

Symbolic manipulation techniques allow algebraic evaluation of measurable quantities to be introduced into computing, avoiding the otherwise tiresome and onerous aspects of precision calculations using numerical methods, notably in Feynman diagrams and accelerator parameters. MAPLE, REDUCE, FORM, SCHOONSCHIP and ASHMEDAI were among the codes described.