superconducting coils arranged symmetrically around the beam beamline will generate CLAS' magnetic field.

The $6.54 million contract went to Oxford Instruments of the UK. Eight experiments for CLAS have been approved, with another six conditionally approved.

Equipment procurement is also advancing for the other two CEBAF halls, one to have a pair of high resolution spectrometers, the other a high momentum spectrometer with complementary instrumentation. The halls themselves are half finished.

BROOKHAVEN RHIC intent

With construction of the Relativistic Heavy Ion Collider (RHIC) imminent and its physics programme expected to start in 1997, a call for Letters of Intent for experiments was issued last year.

Nine letters were submitted by collaborations from over fifty universities and research centres, represented by over 300 researchers from the US and abroad. The proposed detectors varied in their scope and physics focus, but all were designed with high segmentation to cope with the 10,000 or so secondary particles expected from each collision of gold nuclei at 100 GeV per nucleon per beam.

Such segmentation, and bunch crossings every 114 nanoseconds, put high demands on the density and speed of the readout electronics. The detectors also aim to utilize RHIC's flexibility to accelerate ions ranging from the light (protons) at 250 GeV to the heavy (gold) at 100 GeV per nucleon, and colliding different beams at several energies.

These detectors will provide the first look at the new domain of extreme nuclear densities that is RHIC's hallmark. Each is designed to focus on multiple indicators of the formation of the long-awaited quark-gluon plasma (QGP) and the liberation of quarks from their confinement inside hadrons. These heavy ion collisions are expected to approximate to the conditions of the microsecond following the Big Bang, thus providing a new link between particle physics and cosmology.

The Letters can be grouped in three broad categories – electron and photon detectors augmented with tracking for hadron identification, tracking detectors that stress particle production spectra, and one muon detector.

Three letters belong to the first category. TALES, proposed by a Japanese-led collaboration, plans a two-arm photon and hadron spectrometer with two conventional dipoles for momentum analysis, time projection chambers for tracking, electromagnetic calorimetry for photon and electron detection, and ring-imaging Cherenkov counters augmented by time-of flight counters for particle identification. The detector aims to pick up electron pairs, a good probe of the quark-gluon plasma since they are not prone to final state strong interactions.

The OASIS letter, submitted by a collaboration led by Columbia and Brookhaven, proposes a very large axial field spectrometer, possibly utilizing recycled magnet iron from the Gatchina cyclotron in Leningrad. The ambitious programme attempts to identify several quark-gluon plasma signatures simultaneously: a high resolution liquid argon calorimeter of novel design for electron and photon detection; transition radiation trackers, time-of-flight scintillators and Cherenkov counters for hadron identification and studies of jet production; and finally silicon strip as well as silicon drift detectors for vertexing and global event characterization. The detector is tailored to measure low mass electron pairs and high transverse momentum direct photons as well as jets.

The third letter in this category comes from a Stony Brook-led collaboration that uses a six-coil superconducting air toroid configuration with cesium iodide and lead-glass calorimetry of varying levels of energy and spatial resolution for electron and photon measurements augmented by transition radiation tracking detectors for electron and hadronic tracking, and silicon strip detectors for vertexing and multiplicity detectors. The emphasis again is on jet physics, direct photons and electron pairs at high transverse momenta.

The next group of letters emphasize hadron tracking and particle production spectra in both transverse momentum and angular distribution. A forward, variable angle spectrometer is proposed by a Brookhaven group, with septum dipoles, a time projection chamber for tracking, and Cherenkov counters to measure particle yields. The projected coverage extends from the very forward baryon-rich region well into the baryon-free region expected from quark-gluon plasma formation. The sought-for signatures are particle/antiparticle ratios as well as the relative yields of various quark flavours, such as kaon to pion ratios.

A complementary experiment, MARS, led by a group from MIT,

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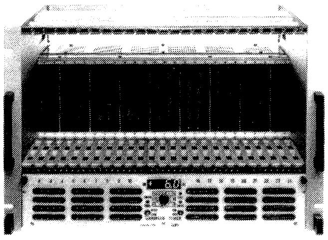

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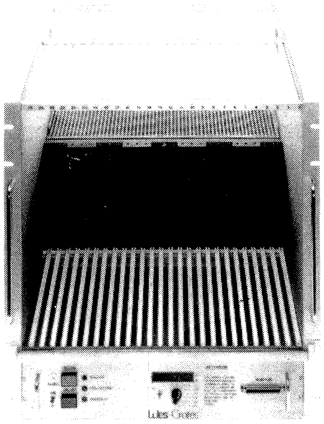

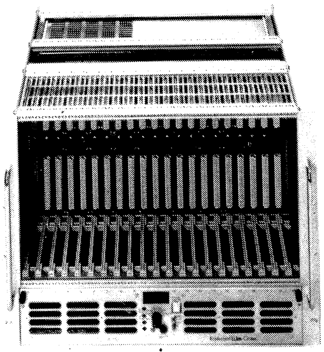

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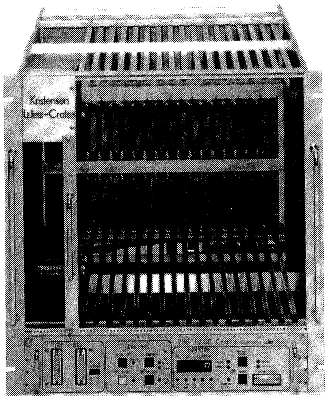

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chose a superconducting axial magnetic field with a full ring of 'straw' drift tube tracking and time-of-flight counters to measure particle yields in the central region. The design stresses modular construction with a potential for expansion should the physics warrant it.

Two large tracking detectors propose measuring particle yields using the time projection chamber technique. A Berkeley-led collaboration chose a superconducting solenoid surrounding a time protection chamber to measure particle spectra, hard jet processes, and meson production as well as two-particle correlations indicating the size of the QGP interaction volume. The time projection chamber would be augmented by a silicon strip detector to handle vertexing and multiplicities, and an electromagnetic calorimeter for photon detection in addition to a time-of-flight system.

The second time projection chamber, from users of the Brookhaven AGS multiparticle spectrometer, chose a dipole magnet with nearly complete solid-angle coverage in tracking, and time-of-flight systems in the forward directions. The detector is designed to provide full event characterization, as QGP formation will produce remarkably different particle spectra to those of normal hadronic interactions.

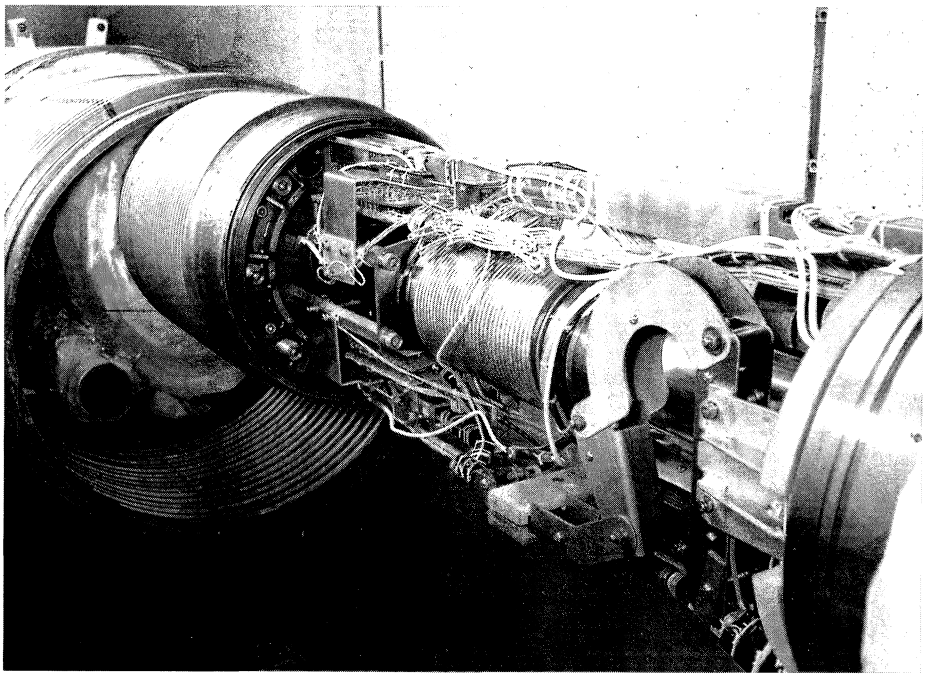
Finally, a detector proposed by a collaboration led by a group from Oak Ridge will concentrate on muon pair detection. The design utilizes superconducting toroids in the central as well as the end-cap regions filled with steel and alumina absorbers to stop hadrons and provide a clean sample of muons. The heavy detector is segmented into a central system and two end-caps. A small 'port spectrometer' has no absorber and is equipped with tracking and calorimetry to study hadronic as well as direct photon production at high transverse momenta. Silicon strips provide vertexing as well as tracking in the port spectrometer.

The physics programme for all these detectors involves studies of proton-proton, proton-nucleus and nucleus-nucleus collisions to study the evolution of QGP signatures with increasing nuclear density.

The RHIC project is funding research and development in readout electronics, triggering and data acquisition, silicon strip detectors, time-of flight systems, photon calorimeters, and hadron absorbers.

In addition to the plans for heavy ion experiments, a letter submitted by a Brookhaven-led collaboration proposes to use the colliding proton option to study proton-proton reaction rates at collision energies up to 500 GeV. While proton-antiproton reaction rates have been measured elsewhere at collision energies up to 1.8 TeV, proton-proton rates have only been studied at much lower energies, and RHIC can fill this gap. The proposal calls for scintillator fibre detectors a few millimetres from the beam to measure scattered protons at the lowest possible momentum transfer.

Two or more medium/large detectors would be the ideal RHIC scenario, but final decisions have to be matched to the resources available. After looking at the letters of intent, Brookhaven management is looking for a consolidation of effort to achieve as many physics objectives as possible with the initial detector complement allowed by the available funding. A meeting at Brookhaven on 19-20 April explored these possibilities.



Interconnection between dipole magnet (right) and quadrupole/sextupole assembly for the RHIC high energy ion collider to be constructed at Brookhaven.

RHIC magnets

The first prototype superconducting magnets for Brookhaven's RHIC Relativistic Heavy Ion Collider have successfully passed initial performance tests. RHIC will use 1600 such magnets, some 400 of which will be built by Brookhaven, the remainder coming from industry, but based on the Laboratory's prototypes.

A ceremony on 12 April marked the beginning of RHIC construction. Keynote speaker was Presidential Science Advisor D. Allan Bromley.