method being considered for producing collimated, high energy neutrino beams is the use of a cesium gas jet traversing one of the circulating proton beams. A neutrino experiment could also be placed behind the LHC beam dump.

Soft hadron detectors

The three EOI received after the deadline for the Evian meeting last March present the obvious case for measuring total cross-section, elastic scattering and diffraction dissociation in pp interactions.

Future Steps

An important factor contributing to the progress made by the experimental community in understanding how to cope with the experimental challenge posed by the LHC is the Detector Research and Development programme under the aegis of CERN's Detector R. & D. Committee (DRDC). About 1000 physicists from both CERN Member States and elsewhere are involved in the more than 25 projects presently approved and institutions from some 20 non-Member States collaborated in the EOI. This widespread interest in the LHC programme confirms CERN's rôle as a leading accelerator facility.

The procedure for approving experiments has been set in motion following the presentation of the EOI's in Evian. It has to reflect the fact that the LHC is primarily a discovery machine charting completely new physics territory. This is markedly different from the situation with LEP where the physics goals were clearly defined and the experimental solutions, although far from trivial, were well understood at the Letter of Intent stage.

The main lines towards the LHC experimental programme are therefore set. The intention is to establish within the next few months a LHC Committee (LHCC) to supervise the transition from the EOI's to Letters of Intent and, eventually, to technical proposals. The timetable is determined by the approval procedure of the LHC machine itself which, according to last December's CERN Council resolution, requires the definition as well as the costing of the basic programme by the end of 1993. Meanwhile, discussions are taking place within the two pairs of proto-collaborations involved in the large pp detectors (CERN has proposed two such experiments for LHC [3]). Building upon the fact that they share a common magnet geometry, *i.e.*, toroids, ASCOT and EAGLE have agreed to submit a common Letter of Intent. CMS and L3+1 are expected to do the same for solenoids.

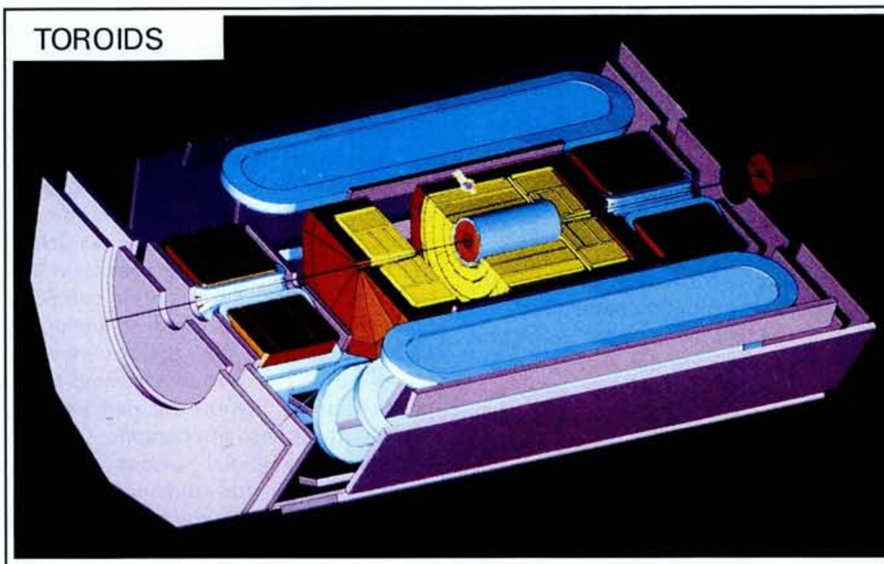
[1] *Proc. Large Hadron Collider Workshop*, Aachen; Eds G. Jarlskog and D. Rein, CERN Report **90-10** (1990).
[2] *Proc. General Meeting on LHC Physics & Detectors*, Evian-les-Bains (CERN) 1992.
[3] *Design Study of the Large Hadron Collider*, CERN Report **91-03** (1991).

LHC's Proton-Proton Detectors

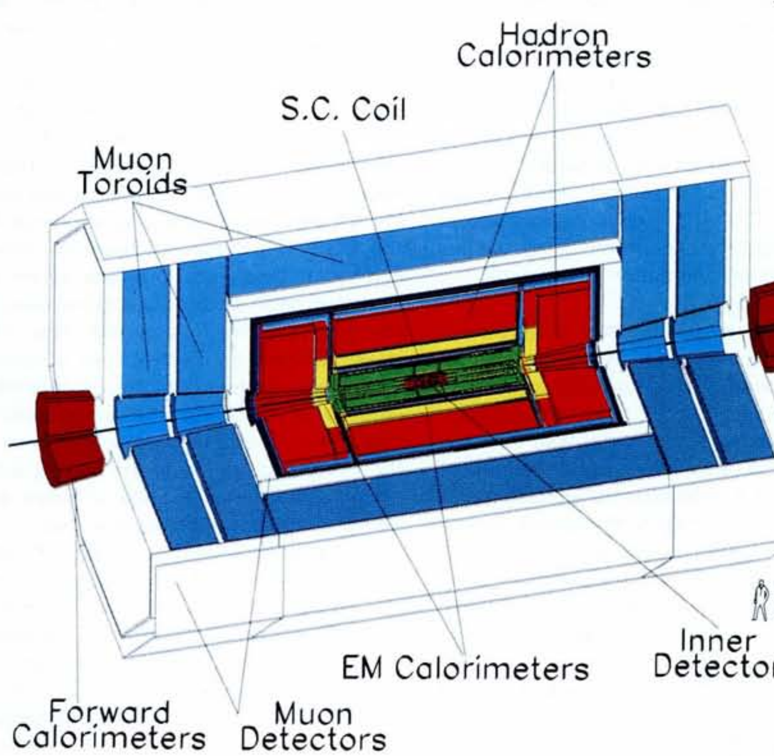
Four high luminosity proton-proton collider detectors were presented as Expressions of Interest at the CERN/European Committee for Future Accelerators (ECFA) meeting in Evian-les-Bains in March 1992. ASCOT (Apparatus with SuperCOnducting Toroids) and EAGLE (Experiment for Accurate Gamma, Lepton and Energy Measurements) propose large magnetic toroids for the muon measurements; CMS (Compact Muon Solenoid) and L3+1 (a modified version of the existing L3 detector at LEP) seek large solenoids.

ASCOT

ASCOT (Apparatus with SuperCOnducting Toroids) has as first priority the precise measurement of muon momenta over a large range of solid angles without relying on central tracking. The magnet system consists of a superconducting air-cored toroid in the central region together with smaller iron-cored superconducting toroids in the forward regions. The toroids are instrumented with pressurised drift tubes with 100 micron resolution, resulting in a muon momentum resolution of 2% at 100 GeV and 14% at 1 TeV in the central region. Second priority is given to the uniformity and response stability of the electromagnetic calorimeter. The segmentation of the calorimeter aims to achieve the best possible identification of electrons and photons in a background dominated by hadrons. It is proposed to build a lead/liquid argon electromagnetic calorimeter with emphasis on lateral and



ASCOT



EAGLE

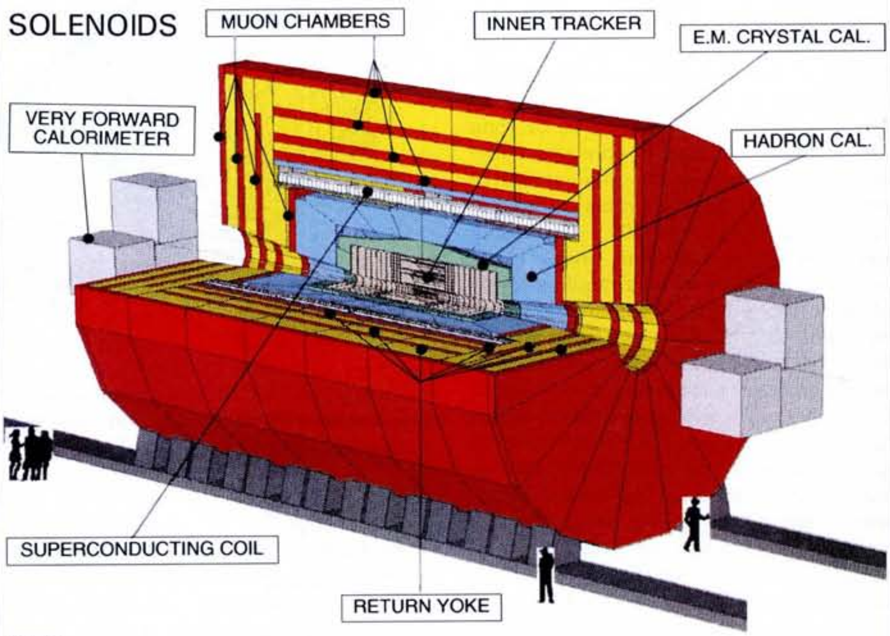
longitudinal granularity and an iron/liquid argon hadron calorimeter, augmented by an outer layer of instrumented warm iron serving as both a magnetic flux return and a structural element. A 1.5 T superconducting solenoid in front of the electromagnetic calorimeter measures the sign of the electron charge.

EAGLE

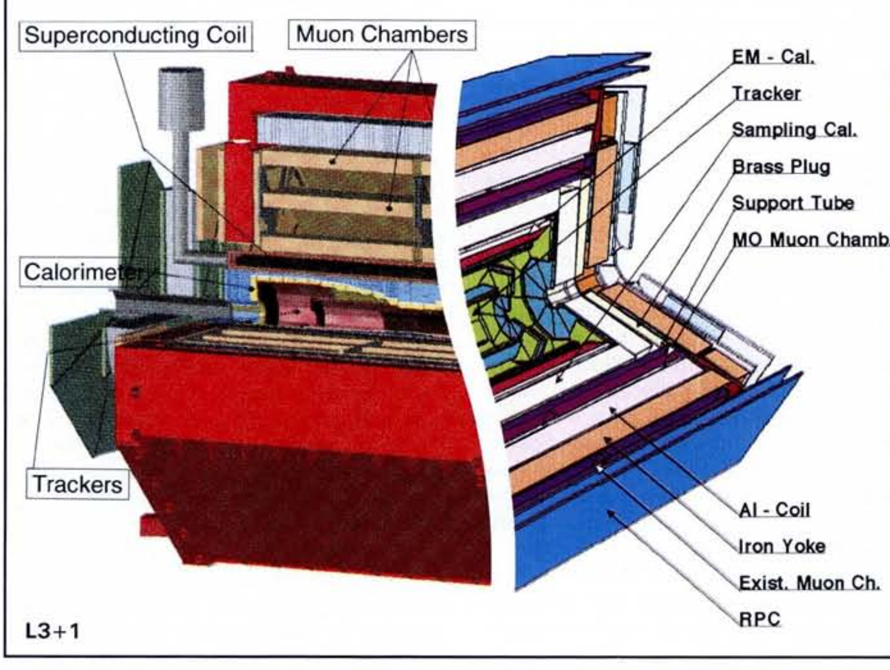
The EAGLE detector (Experiment for Accurate Gamma, Lepton and Energy measurements) aims for a balanced approach to electron, gamma, muon, jet, and missing transverse energy signatures so that different final states will be used to corroborate possible new physics signals. At lower luminosities, the experiment will look for more complex signatures including tau detection and heavy flavour tags. A powerful inner detector in a 2 T central superconducting solenoidal field aims to provide accurate momentum measurements over a large solid angle for isolated leptons, and to enhance the electron identification. High quality electromagnetic sampling calorimetry is combined with fine granularity detection for electron and photon measurements, and is followed by hermetic hadron calorimetry for jet and missing transverse energy measurements. Several options, including liquid argon (or liquid argon accordion) and scintillating fibre calorimeters for the electromagnetic part and liquid argon or scintillators (fibres or tiles) for the hadronic part, are under study. The outer shell of the experiment is a warm iron toroid muon spectrometer with large acceptance for muon identification and stand-alone momentum measurements.

CMS

CMS (Compact Muon Solenoid) emphasises the identification and precise measurement of muons, photons and electrons. Momentum and energy resolutions of <1% at 100 GeV can be achieved for all these particles. At the core of the detector is a large superconducting solenoid which generates a uniform field of 4 T within a 15 m long cylinder of 3 m inner radius. The magnetic flux is returned *via* a 2 m thick saturated iron yoke, instrumented with muon chambers. This choice of a strong solenoidal magnetic field leads to a compact design for the muon spectrometer without compromising the momentum resolution. The strong bending in the transverse plane facilitates the task of triggering on muons with large momenta. There are three independent muon measurements (in the flux return, after the coil and inside the tracking volume). In the inner free volume, silicon (or gallium arsenide) detectors and microstrip gas chambers with high granularity and accuracy will measure all high momentum particles. At the outer tracker shell, the pattern recognition is simplified since low momentum particles are trapped inside the tracking volume. A high resolution electromagnetic calorimeter (*e.g.*, a crystal calorimeter), designed to detect the two photon decay of the Higgs, and a hadron calorimeter are placed before the coil. The CMS detector is also suited for low luminosity studies such as top, beauty and tau physics, as well as for important aspects of the heavy ion programme (the subject of a separate proposal).



CMS



L3+1

L3+1

When the L3 experiment for LEP was proposed in 1983, compatibility with a future proton collider in the LEP tunnel was acknowledged. This is reflected in the large L3 experimental hall, the large magnet and the extensive and precise muon coverage. For LHC operation, the L3 magnet with all its detectors will have to be lifted from its present position in the LEP beam to the LHC beam level about a metre above, hence the name L3+1.

Two possible approaches for LHC physics are considered: both retain the existing magnet and muon chambers. The first alternative concentrates on the measurement of muons and electrons. In a first - low luminosity - stage, a new electromagnetic calorimeter, muon filter and inner detectors will be installed. In a second stage, the muon filter would be replaced by a strong (6 T) superconducting solenoidal coil to sweep away low transverse momentum tracks of uninteresting background events so as to allow operation at the highest possible luminosities. The second alternative aims at the precise measurement of muons, electrons and gammas. A two-stage approach is again proposed. In the first stage, the existing muon chambers are rearranged and new trackers and a simple sampling electromagnetic calorimeter will be used. The latter would be replaced in the second phase by high resolution crystals in order to primarily look for decays of Higgs particles into pairs of photons.