

Letters of intent

beam energy from 45 GeV towards 90 GeV (see page 1), some conventional cavities could eventually become redundant. Removing them should improve single beam conditions, at the same time liberating valuable additional klystron power for LEP200. Increasing the LEP injection energy from the current 20 GeV level delivered by the SPS should also help.

Beam-beam limitations are ascribed to insufficient beam separation as the beams get larger, to subtle differences between electron and positron behaviour, and possible orbit influence from the electrostatic separators. Beam current could also be pushed higher by increasing the beam emittance, but this would also increase the level of unwelcome background photons seen by the detectors.

The 'pretzel' scheme for eight bunch operation was first used for physics in August, but became routine in October, hopefully for the remainder of LEP's career. In principle doubling the effective electron-positron collision rate, its introduction briefly slowed the Z scoring rate as the crews had to learn new tricks, but the break-even point was soon quickly passed.

One unwelcome detail is that electron-positron differences are accentuated in pretzel mode, and additional sextupoles are being installed to compensate. Eight-bunch operation could be further optimized if it became standard right through the complicated LEP injector chain.

One disappointment this year has been the absence of polarized beams from the 90° optics. Significant polarization (spin orientation) had been seen last year (November 1991, page 12) using the old 60° optics, and opened the door to valuable precision measurements of

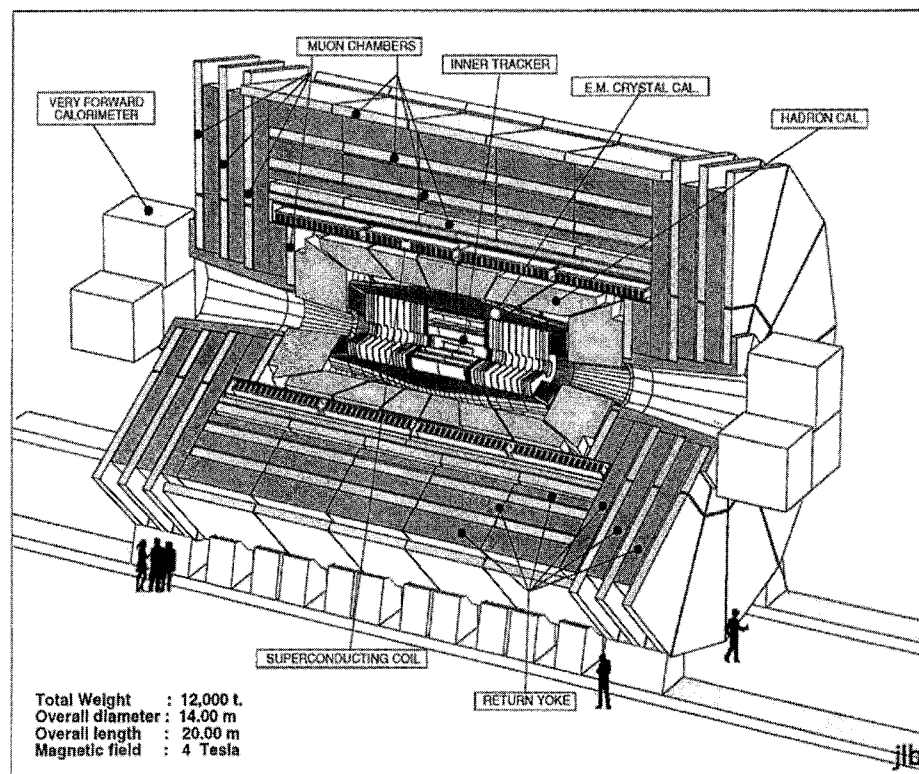
the beam energy. To retain this capability, a 90°/60° horizontal/vertical split could be tried, and a recent pretzel test gave encouraging results.

Thursday 5 November was another major milestone en route to the establishment of the experimental programme for CERN's LHC proton-proton collider to be built in the 27-kilometre LEP tunnel.

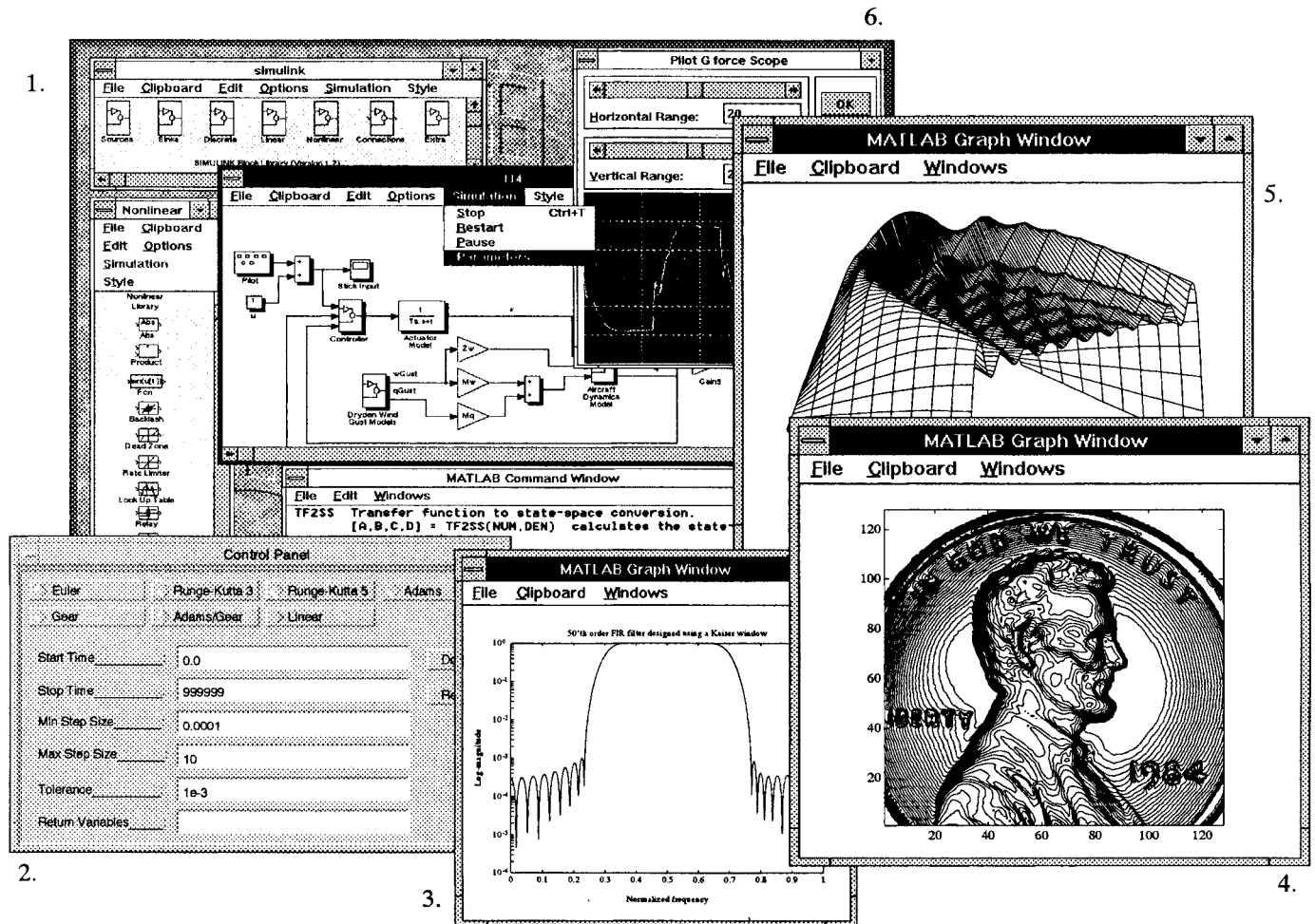
After initial discussions of 'Expressions of Interest' at the specially-arranged meeting at Evian-les-Bains, France, earlier this year (May, page 1), three Letters of Intent have emerged, together involving nearly 2000 physicists from research institutes all over the world. As well as these researchers listed on the documents, the plans in fact involve many additional technical specialists who work behind the scenes.

It was a historic moment as these three detector proposals were aired at the first open meeting of the new LHC Experiments Committee. CERN's main auditorium and a large overflow room receiving relayed video pictures were both packed.

The compact CMS design



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3. Filterdesign using Signal Processing Toolbox.
4. Contourplot of a penny. Data courtesy of NIST.
5. Family of frequency responses.
6. Use the Scope-block to see the "real-time" response of this f14 model during simulation.

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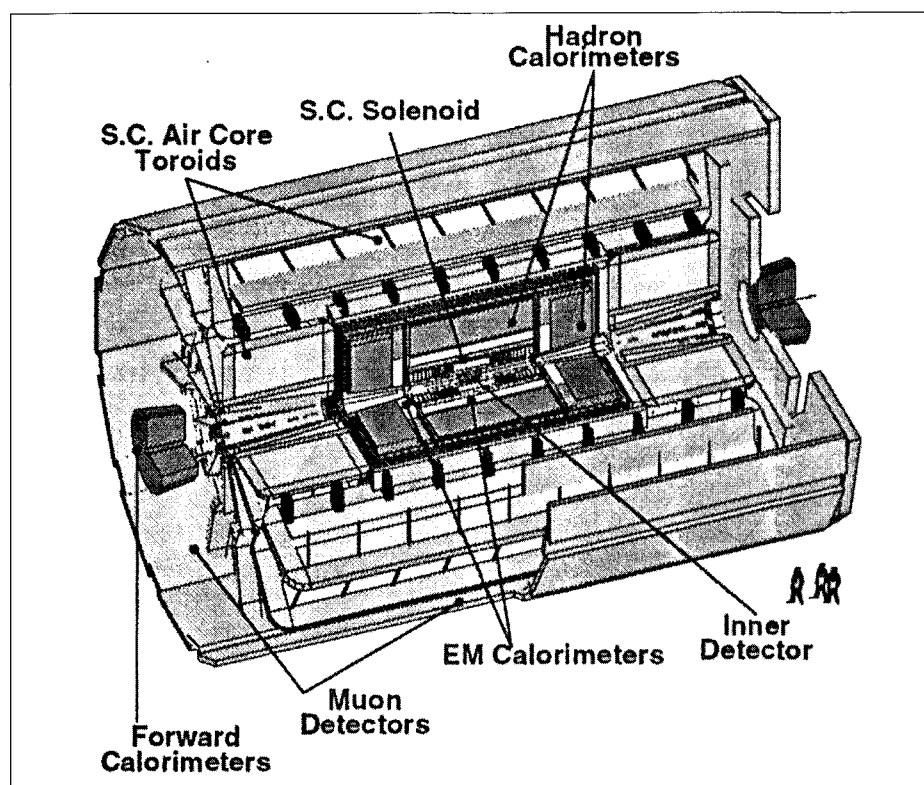
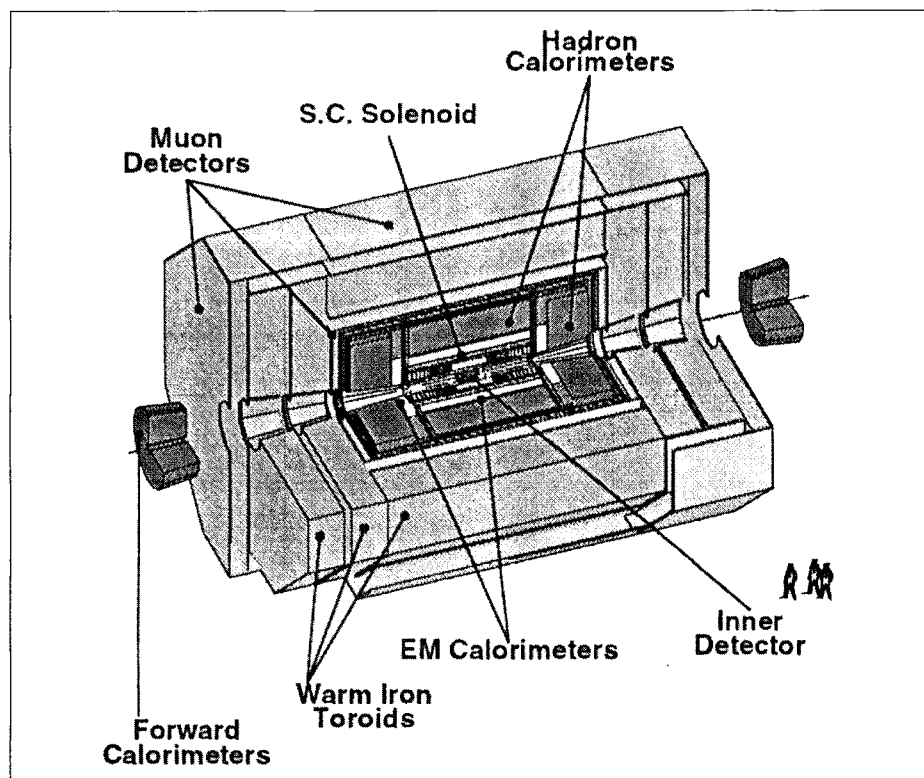
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The ATLAS scheme for an LHC detector has two options: a conventional iron-core magnet (top), and a superconducting air-core (below).



From these three schemes – ATLAS, CMS and L3P – and the first reactions to their letters of intent, eventually two projects will emerge, for which full technical proposals will be prepared, including construction plans and credible costings.

In this early phase exact specification of the detector elements is in many cases left open, pending the outcome of the vigorous ongoing detector R&D programme for generic systems to handle LHC extremely high event rates. The detector plans also reflect the potential to carry out unique and ambitious physics with initial LHC luminosities of about 10^{32} per sq cm per s before the machine is cranked up to its design goal above 10^{34} .

ATLAS, described at the CERN meeting by Peter Jenni, is a merger between the ASCOT and EAGLE schemes launched earlier this year at Evian and brings together some 850 researchers from 88 institutes in 24 countries. The aim is to exploit the full LHC discovery potential, with full coverage of photon, electron, muon and hadron jets, together with 'missing energy' indicative of invisible particle such as neutrinos, over a wide range of LHC luminosities, and with 'robust' muon and electron coverage at the very highest collision rates.

ATLAS proposes an outer 26 metre-long toroid magnet for muon measurements, with an inner 2T superconducting solenoid. The former could be superconducting air core or conventional iron core, or a combination of the two, with a superconducting barrel and warm iron for the end-cap regions.

The toroidal magnet muon detector would allow triggering and identification outside all calorimetry, with substantial thicknesses of absorber, without using the inner detector. The

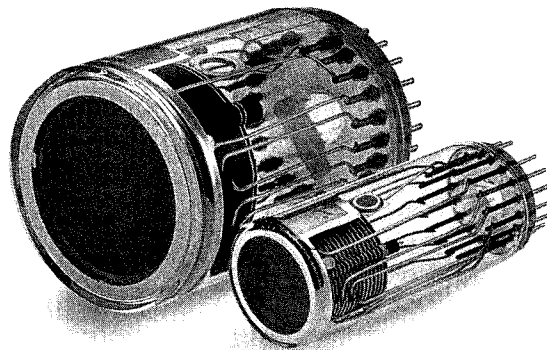
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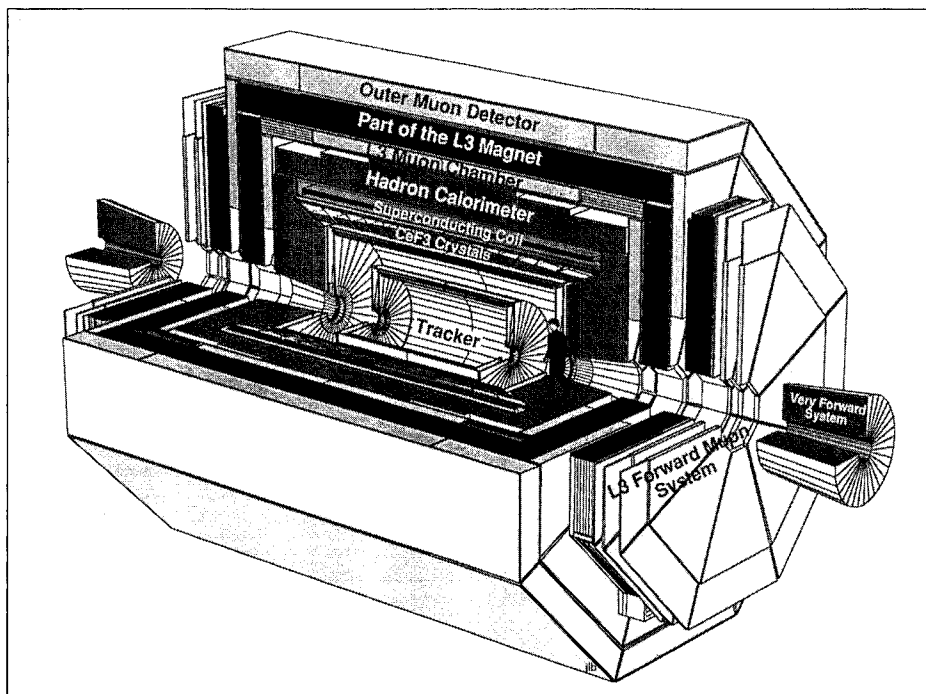
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The L3P scheme would inherit part of the infrastructure from the existing L3 detector at LEP.



superconducting solution would provide better physics capability.

Inside the muon system, calorimetry would use a highly granular lead/liquid argon approach for the electromagnetic part, and iron absorbers for the hadron part, where the active medium could be liquid argon or scintillating tiles or fibres.

At the heart of the detector, the interaction region would be surrounded by silicon and gallium arsenide microstrip and pixel detectors to provide a precision initial track segment, with supplementary instrumentation farther out for the bulk of pattern recognition, tracking, momentum measurement and identification.

While ATLAS has several options open at this stage, the vigorous ongoing R&D programme should result in many of these positions being closed by the time the full technical proposal is presented.

CMS – Compact Muon Solenoid – includes over 400 collaborators from some 60 institutes in 23 countries,

including a sizeable Russian contingent and representation from all the Baltic states. As well as proton-proton collisions, CMS is also designed to look at aspects of the alternative LHC diet of heavy ion collisions.

Spokesman Michel Della Negra pointed out how the CMS design for a compact, minimal cost detector starts with the magnet, which influences the rest of the design. The 14-metre CMS superconducting solenoid would provide 4T inside a radius of 2.9 metres. Muon momentum would be measured several times, both outside the coil and in the inner tracking volume. The magnet would be covered with several planes of drift chambers for muon identification and measurement.

Inside the magnet, the powerful field would give high momentum precision. Solid state and gas microstrip techniques would be able to provide the required level of tracking performance. Calorimetry

would be mainly inside the magnet coil, with the electromagnetic part using either cerium fluoride or a lead/scintillator 'Shashlik' design being developed in Russia, while hadron energy would be handled by copper absorber with scintillating tiles.

L3P – Lepton and Photon Precision Physics – is the LHC reincarnation of the L3 experiment at the LEP electron-positron collider, and nearly all the contributors to the L3P letter of intent have participated in L3.

L3P is designed to complement other detectors, both at LHC and at the SSC Superconducting Supercollider in the US. Sam Ting's presentation at CERN recalled past and sometimes painful experience with experiments using high intensity beams, and went on to explain how detectors relatively far from the target/interaction point with a lot of magnetic power could provide an optimal solution.

L3P would be phased with LHC progress. Detector R&D work has benefited from work in the framework of CERN's detector R&D programme.

The detector, at Point 2 in the ring, would use part of the L3 infrastructure, muon chambers and magnet frame. With its goal of precision electron, muon and photon measurements, elements are placed far from the beam intersection. Most inner central tracking, with proportional chambers, drift tubes and gas microstrip detectors would be at least 1.65 m from the proton beam. The entire tracker could be removed and a new one fitted for specialized LHC research topics.

Outside the tracker will be the electromagnetic calorimeter, made of cerium fluoride crystals. Like the BGO crystals used in L3, these would include a significant Chinese effort.

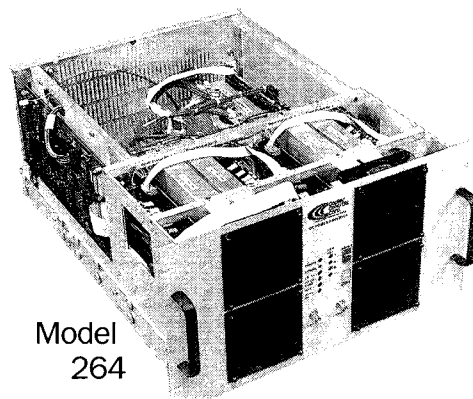
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GUIDE TO RADIATION AND RADIOACTIVITY LEVELS AROUND HIGH ENERGY PARTICLE ACCELERATORS

A. H. Sullivan

European Laboratory for Particle Physics, CERN

Contents

- Chapter 1 High energy Particle Interactions
- Chapter 2 Shielding for High Energy Particle Accelerators
- Chapter 3 High Energy Electron Machines
- Chapter 4 Induced Radioactivity

Scope The purpose of this guide is to bring together basic data and methods that have been found useful in assessing radiation situations around accelerators and to provide straightforward means of arriving at radiation and induced radioactivity levels that can occur under a wide range of situations, particularly where the basic physics is too complicated to make meaningful absolute calculations.

Readership Researchers, lecturers and scientists in the field of high energy physics; researchers, designers and operators of high energy particle accelerators.

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Physics monitor

next element would be a superconducting solenoid, where several designs are under study. The hadron calorimeter with iron absorber and gas active medium would surround the magnet.

Muons would be measured by an outer layer of drift tubes, by the existing L3 muon chambers outside the hadron calorimeter and by the central tracker, with its ultimate resolution of 3.6 parts in a thousand.

With the LHC Experiments Committee now in business, the overall goal is to present a fairly detailed description of the LHC experimental programme, including machine, detectors and the relation to the rest of CERN's experimental programme, to CERN's governing body, the Council, at the end of 1993. Council would then be in a position to start the approval procedure for the whole LHC project. However the broad outline should be clear enough for a preliminary report on the emerging plans for the experimental programme early this year.

DPF Big One

At its latest venue at Fermilab from 10-14 November, the American Physical Society's Division of Particles and Fields meeting entered a new dimension. These regular meetings, which allow younger researchers to communicate with their peers, have been gaining popularity over the years (this was the seventh in the series), but nobody had expected almost a thousand participants and nearly 500 requests to give talks.

Thus Fermilab's 800-seat auditorium had to be supplemented with another room with a video hookup, while the parallel sessions were organized into nine bewildering streams covering fourteen major physics topics.

With the conventionality of the Standard Model virtually unchallenged, physics does not move fast these days. While most of the physics results had already been covered in principle at the International

Conference on High Energy Physics held in Dallas in August (October, page 1), the Fermilab DPF meeting had a very different atmosphere.

Major international meetings like Dallas attract big names from far and wide, and it is difficult in such an august atmosphere for young researchers to find a receptive audience. This was not the case at the DPF parallel sessions. The meeting also adopted a novel approach, with the parallels sandwiched between an initial day of plenaries to set the scene, and a final day of summaries.

With the whole world waiting for the sixth ('top') quark to be discovered at Fermilab's Tevatron proton-antiproton collider, the meeting began with updates from Avi Yagil and Ronald Madaras from the big detectors, CDF and D0 respectively. Although rumours flew thick and fast, the Tevatron has not yet reached the top, although Yagil could show one intriguing event of a type expected from the heaviest quark.

Frank Sciulli of Columbia presented initial results from the HERA electron-proton collider at DESY Ham-



At Fermilab in November, the American Physical Society's Division of Particles and Fields meeting attracted about a thousand scientists.