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PAR LE DIRECTEUR GENERAL
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I. RESEARCH DIVISIONS

- Theoretical Physics Division
- Experimental Physics Division
- Experimental Physics Facilities Division
- Data Handling Division
THEORETICAL PHYSICS DIVISION

The main themes in the work of the Theory Division, in the first half of 1985, remain the physics emerging from the CERN collider, the quest for unification, lattice QCD, and quantum field theory in general.

New successes have been obtained in the interpretation of the bulk of the collider data in terms of the standard model. However particular attention has been given to the apparent persistence in the data of the unexpected "monojet" events. It has been argued that previous discussions had underestimated the importance of some standard-model backgrounds. But it is still not excluded that there is a pointer here beyond the standard model. The very vigourous interaction between theorists and experimenters on this matter has prepared both very well to deal with new data expected soon.

The Division participated in study groups reevaluating LEP physics prospects in the light of recent developments. Among the ideas to emerge is that the toponium system may be close in mass to the Z, leading to interesting interference effects.

In pursuing unification beyond the standard model, supersymmetry remains a central idea. Significant contributions have been made to the understanding of strong coupling phenomena which could be relevant for composite models or dynamical supersymmetry breaking. Superstring theories have been given increased attention. These have become prominent because of their exceptional finiteness properties. In this context new results have been obtained as regards the consistency of compactification schemes in which redundant spacetime symmetries are transformed into internal symmetries. Attempts to relate superstring theories with the observed particles and forces lead back, on the phenomenological level, towards symmetry breaking and supergravity models already proposed in the Division on purely phenomenological grounds.

The lattice QCD work in this period has been concerned especially with the finite temperature transition with dynamical fermions, the topological charge in SU(3) gauge theory, and the hadron spectrum with quenched Kogut-Susskind fermions. Most of this work has been done with computer time available outside CERN. The new results with fermions are in good agreement with those obtained previously without fermions, and with the actual hadron spectrum. They support the existence of a deconfining phase transition at finite temperature. They also reveal large finite lattice size effects with dynamical fermions.
In quantum field theory new results have been obtained on anomalies, on hidden symmetry in d=11 supergravity, on Nicolai mapping, on instantons, and on stochastic quantization of chiral theories.

This year, until May 13, 90 preprints have been registered in the Division. Only a fraction of the work could be mentioned above.
1. Collider Physics

After its major discoveries the collider has entered a period of consolidation of its physics. The 1984 data taking has provided about 2.5 times more integrated luminosity than previously obtained.

Other decay modes of the intermediate vector bosons have been observed by UA1: \( Z_0 \rightarrow \mu^+ \mu^- \) (9 candidates), \( Z_0 \rightarrow \tau^+ \tau^- \) (a few possible candidates in 1984 data) and \( W \rightarrow \tau \nu \) with \( \tau^+ \rightarrow \pi^+ (\pi^0) \nu \) (therefore a charged high \( p_T \) and some missing energy).

The production properties of the Intermediate Vector Bosons (IVB), in particular their transverse momentum distributions, and the jet activity produced in association with them are in fair agreement with the QCD improved parton model.

About the top quark, the rate of candidates in UA1 from the 1984 run is compatible with what has been previously observed. Work on the evaluation of the corresponding background is being pursued.

Much work has been done on jet physics by UA1 and UA2. The jet cross section has been measured and its scaling properties (taking advantage of the higher \( \sqrt{s} \) value in 1984) agree with QCD predictions. In UA1 studies of jet fragmentation into charged particles suggest differences between quark (q) and gluon (g) jets; the latter are broader and present a larger scaling violation. The jet charge is experimentally compatible with zero in the case of gluon jets, positive (negative) for u (u) quarks.

In addition more complicated (>2 jets) configurations have been quantitatively studied. The ratio of 3 jet/2 jet gives a reasonable value for \( \alpha_s \).

Both UA1 and UA2 have measured dileptons with masses below the \( Z_0 \). UA2 has produced 10 events (\( e^+e^- \)) with \( 12 < M < 26 \) GeV/c\(^2\). Combining 1983 and 1984 data UA1 has observed 67 muon pairs. Most of those events are interpreted in terms of Drell-Yan, \( J/\psi \) or \( \Upsilon \) production and heavy flavour processes. However 7 UA1 events with isolated like sign muons cannot be explained at present in terms of trivial background or heavy flavour processes.

UA1 has measured a substantial yield of inclusive \( D^* \) inside jets of \( p_T > 20 \) GeV/c which could be a manifestation of the rich charm content of gluon jets.

The UA5 experiment, studying the general features of \( pp \) collisions at the collider, has in particular demonstrated the violation of the KNO scaling law, an observation which prompted much theoretical thinking. The fact that such a scaling was observed in the 10-62 GeV CM energy range seems to have been accidental.

The UA4 experiment results on \( \sigma_{\text{tot}} \) and small angle scattering give a picture of the proton which can be summarized by saying that when \( \sqrt{s} \) gets larger the proton size grows up and its opacity in the central region increases. The geometrical scaling behaviour found at the ISR should be considered as a transient feature. More light will be shed by the measurement of the real part which is sensitive to the derivative of \( \sigma_{\text{tot}} \).

The UA6 experiment using a hydrogen cluster jet target (\( \sqrt{s} = 25 \) GeV), after taking preliminary data in 1984, will provide a comparison of \( pp \) and pp data with high integrated luminosities, the accent being on direct \( \gamma, \gamma \) pairs, Drell-Yan e\(^+\)e\(^-\).
2. Fixed Target

A rich program of fixed target has been going on. From neutrino physics one is on the verge of reaching an experimental accuracy of ± 0.005 on sin² θ. This will come from the measurements by CDHS and CHARM (1984 data) of the ratio R_ν of the neutral current over charged current total cross sections. The study of the y distribution of ν scattering can also bring such an information.

To obtain a similar experimental accuracy with less theoretical uncertainty, CHARM 2 will, in 1986, measure with high statistics the ratio of νμe and νμe scattering: it is presently under active preparation.

The results of the CERN 1982 beam dump experiment confirm the presence of prompt ν fluxes, with equality of ν_e and ν_μ fluxes at least in two experiments and an e^+/e^- event rate ratio (BEBC) which differs significantly from the σν/σν̅ cross section ratio. This indicates that the source of prompt ν and ν̅ might not only be DD production but possibly associated production of A_∓D.

The search for possible heavy neutrino decays has also been actively pursued in particular by PS 191.

A new QCD analysis of the charged current ν data has given for A\NS:

\[ A_{\NS} = 310 \pm 140 \text{ (stat)} \pm 70 \text{ (syst)} \text{ MeV}. \]

The evolution of nucleon structure functions from ν data up to 10000 GeV^2 gives results which are qualitatively confirmed by experiments at present collider energies.

The muon experiments have also finalized their QCD analysis of structure functions. For instance EMC gives

\[ A_{\mu NS} = 105 \pm 55 \pm 85 \text{ MeV}. \]

from data with 0.02 < x < 0.8 and 3 < Q^2 < 190 GeV/c^2. EMC has also provided an exhaustive study of the properties of the hadronic final state of muon-production.

Both experiments (EMC and NA4) have been active on the EMC effect which is now firmly established. Through ν virtual photoproduction EMC has shown that the gluon distribution at small x seems to vary with the nucleus atomic number.

The high statistics NA10 dimuon experiment has contributed to show that the Drell-Yan process is more complex and richer than first expected: anomalous scaling violation at large x, higher twist effects have been observed. An accurate distribution of the dimuon transverse momenta is providing an excellent input to theoretical investigation.

Spectroscopy of heavy flavours is under way. Several silicon microvertices detectors following the pioneering work of NA1 and NA11 are now in operation. After the constrained F events of NA32, the charmed strange baryons A^+ and T^0 from WA62, let us quote the remarkable observation by WA75 of a pair B^-B^- in a 350 GeV ω^- interaction. Both beauty mesons decay into charmed particles the decay of which is seen in the emulsion. Flight times of (0.8 ± 0.1) 10^{-13} sec and (5 ± 3) 10^{-13} sec are quoted.

Two experiments (NA10 and NA3) have given very stringent limits on BB hadronic production (a few nb/nucleon, rather model dependent) which however do not contradict the previous observation.
Detailed properties of $\Upsilon$ hadroproduction and $\psi$ elastic and inelastic photoproduction have been given by NA10 and NA14 respectively.

Prompt $\gamma$ physics has been another active field. WA70, NA24 and NA3 have measured hadroproduced prompt photons. The comparison of $\pi^+$ and $\pi^-$ induced data allows in principle to separate the respective contributions of the Compton and annihilation processes. The results agree with QCD expectations.

The NA14 photoproduction experiment, due to its very high sensitivity, has measured the QED Compton effect (elastic scattering of a high energy real photon on a quark) in a kinematical domain which allows a meaningful comparison with theory. Gauged integer charge quark models are ruled out; the agreement with the QCD corrected elementary QED process is good. Quantitative agreement with QCD predictions are also obtained by NA14 from $\pi^0$ and $\pi^+$ hard photoproduction.

The multiparticle spectrometer GAMS (NA12) is well suited to the study of reactions producing many gammas. After observations like rare $\eta$ modes ($\eta \rightarrow \pi^0\gamma\gamma$) they have found and studied an isoscalar $0^{++}$ meson at 1590 MeV (in $\eta\eta$ and $\eta'\eta$) called the G and which is a serious candidate for a glueball.

3. ISR Physics

Physics results still come out from the closed ISR by exploiting existing data.

The ABCDHW (Split Field) group has been pursuing its program of jet tagging. After providing evidence for gluon tagging through a high $p_T$ kaon ($K^-$), they have for instance given an interpretation of the large yield of high $p_T$ protons at the ISR. Whereas models based exclusively on quark and gluon scattering fail to describe the data, the hypothesis of diquark scattering provides a quantitative understanding of the observations.

The CMOR Collaboration (R110) has obtained 58 $e^+e^-$ pairs with $M > 11$ GeV/c$^2$ at $\sqrt{s} = 62.3$ GeV. The data are consistent with the scaling hypothesis when compared to lower $\sqrt{s}$. The mean $p_T$ is quite high and this large value indicated contributions from higher order diagrams than Drell—Yan. The increase of the mean $p_T$ with $\sqrt{s}$ at given $\tau$ predicted by QCD is observed.

The AFS (Axial Field) group has confirmed the existence of a large yield of prompt $e^+$ at small $p_T$ : it is six times higher than expectation from known sources and this stays as a mystery. This group has also observed Bose Einstein correlations between kaons in $\alpha\alpha$, $pp$, $p\bar{p}$ collisions : the average radial extension of the $K$ emitting region is $2.4 \pm 0.9$ fermi.

Jet studies at the ISR have their specific interest since larger $x$ than at the collider are involved. CMOR and AFS groups have provided excellent data on jet properties, in particular their fragmentation function.

The R704 experiment working with an internal gas jet target has given data on charmonium states, formed by $pp$ annihilation. In spite of a limited statistics they got very precise values of the masses of $\chi$ states.
Finally PS188 has pursued in 1984 its study of channeling. Upper limits are one order of magnitude below the prediction. They have found no evidence for resonant or bound quasi nuclear p states in °Li. At pg = 600 MeV/c, PS184 has explored the energy region corresponding to the S (1936) and has set an upper limit on the intensity of a narrow resonance in this region which contradicts some previous positive observations. PS192 has explored the energy region corresponding to the S (1936) and has set an upper limit on the intensity of a narrow resonance in this region which contradicts some previous positive observations.

Other groups are measuring pp cross sections: PS173 has recently given the real to imaginary ratio of the pp forward elastic amplitude between 180 and 590 MeV/c. Otot is obtained through the optical theorem. PS192 has explored the energy region corresponding to the S (1936) and has set an upper limit on the intensity of a narrow resonance in this region which contradicts some previous positive observations.

PS170 has obtained preliminary results on the reaction pp → e⁺e⁻ (0–300 MeV/c). 300 events allowed to give the branching ratio of this channel (a few 10⁻⁷) and the value of |GE| = |GH| = 0.62 ± 0.06. The analysis of data taken at 600 MeV/c is under way.

PS185 studying the annihilation pp → AA has preliminary results for incident momenta of 1.48 and 1.51 GeV/c. About 500 AA have been extracted from the raw data at each energy. A strong l > 0 contribution seems to be present.

PS184 and PS179 use nuclei as targets. Some results from both have already been reported last year. At p̅p = 600 MeV/c, PS184 has found no evidence for resonant or bound quasi nuclear p̅ states in °Li and ¹²C. Upper limits are one order of magnitude below the prediction. Finally PS188 has pursued in 1984 its study of channeling.
1. **SPS Experiments**

From 1st March to 4 April, the SPS was operated in pulsed collider mode at 450 + 450 GeV energy. EF staff participated in the operation of experiments UA1 and UA5. UA1 recorded about 400,000 events, while UA5 took 115,000 streamer chamber pictures.

Since 18 April, the SPS is operating in fixed target mode. Omega has restarted taking data for experiment WA70 (direct photons in hadronic collisions). The new kaon experiment NA31 has started operation. The heart of this experiment, a liquid argon calorimeter measuring photons (and electrons) from neutral pion decay, was installed in the beam in April. Preliminary results available less than 24 hours after cooldown and argon filling indicate that the overall performance is close to the design figures: energy resolution approximately 8 % GeV⁻¹; spatial resolution a few millimeters.

Technical work continued for the Omega experiments WA69, WA71, and WA77, which will resume data taking later this year, and for the new experiment NA34 (hadronic production of leptons), which is in preparation, and for which EF Division is building three special drift chambers for vertex reconstruction and isochronous collection of primary ionization. A silicon detector with pad geometry for this experiment, which will work as part of the prompt electron trigger to eliminate electrons produced in pairs, has been developed in collaboration with Brookhaven National Laboratory.

2. **Preparation of LEP experiments**

ALEPH passed the last 'milestone', consisting in Monte-Carlo simulations of the performance of the combined electromagnetic and hadronic calorimeters. Orders have been placed for the equipment of the electronics barracks (air-conditioning units, racks and so on). The production of the iron yoke modules of the magnet proceeds as foreseen; 12 out of the 24 units of the barrel part have been completed. The material for the winding of the TPC field cage has been delivered, and the winding equipment is essentially assembled.

OPAL passed its last 'milestone' when successfully testing simultaneously the Jet and Z chambers of the central detector. The design of this detector is now complete. Four final modules for the electromagnetic calorimeter have been assembled and are being tested and calibrated. Series production of components and subunits of the entire OPAL detector is under way in industry and in laboratories outside CERN. A Monte-Carlo simulation of the hadron shower resolution of the combined electromagnetic and hadronic calorimeters confirmed predictions of the original Technical Proposal.
Experiment L3 has placed a contract for the supply of 4000 BGO crystals with the Institute of Ceramics in Shanghai. The first 100 crystals have been inspected and tested using a spectrophotometer designed and built by CERN. Several spectrophotometers of the same type have since been ordered by outside institutions. Beam tests are being prepared for a 10 x 10 BGO matrix followed by four final-version calorimeter modules. Design of support and transport mechanisms for the detectors is being finalised. The 'torque tubes' of the muon chambers are now considered as part of the main detector support tube with technical responsibility also given to CERN. About 50% of the magnet half-turns have been completed in the CERN 'factory'.

DELPHI activities have fallen mainly into three areas. After the achievement of the barrel-RICH 'milestone' in obtaining ring images from pions with both gas and liquid radiators, design of the final detector is now under way. The HPC milestone prototype was tested successfully with cosmic rays; beam tests with a magnetic field have commenced. The TPC group has begun the production of the MWPC end plates. Handling devices for the magnet yoke have been prepared and the movable support structure has been ordered by EP Division.

The requirements for heavy cranes, common to the four experiments, have been finalized, and the main contract for the supply of this equipment is now being placed by the LEP Division. Using a 1/5 scale model the disposition of the mobile radiation shielding in the forward regions of the experiments ALEPH, DELPHI and OPAL has been studied in detail.

3. Technical support for the construction of the LEP machine

Technical support for the construction of the LEP machine continued. Activities concerned vacuum equipment, field mapping of dipole magnets, and instrumentation. A superconducting four-cell accelerating cavity operating at the LEP frequency of 350 MHz has achieved an accelerating field of 5 MV/m and a quality factor of $3.3 \times 10^9$, the design values for LEP.

4. Detector developments

Work to determine and improve the reliability of microstrip detectors continues, and development of a CCD readout strip for use in collider experiments is well under way. A low noise hybrid preamplifier has been tested extensively and is now in production.
DATA HANDLING DIVISION

Computer Centre

During the Christmas shutdown the Siemens 7880 computer was replaced by a 7890-S dual processor. This machine has four times the capacity of its predecessor and its introduction has doubled the power of the IBM compatible machines in the Computer Centre. With an availability of 100%, the machine passed the acceptance tests and so far not a single hardware failure has occurred in the CPU. Peripheral storage has been increased with the installation of 50 Gbytes of disks. The base implementation of VM/CMS is complete and the service is now open to anyone wanting to make use of it. Approximately 450 users have registered. Rutherford-Appleton Laboratory, IN2P3 at Saclay and CERN have formed the HEP-VM group, with the objective to provide a common base implementation in these -and possibly other- laboratories, allowing particle physicists to easily transport their programs.

Also during the Christmas shutdown, the 3081 Enhancement Feature was installed, giving an increase of 9% CPU power in this IBM machine.

The CDC 875 continues to give a stable service, with a 3 1/2 month period with no hardware failure and record-breaking CPU utilisation: 297 hours in one week. Supermux, which used old HP2100s, is gradually replaced by CDC 2550 communications controllers, providing standard terminal access.

In March a DEC VAX 8600 was installed. This was the first delivery of a 8600 to a customer site in Europe. Introduction of a user service, mainly aimed at providing interactive program development facilities for the LEP collaborations, went very smoothly and the service proves to be very popular (already 350 registered users). The other DEC systems for LEP Data Bases and for mechanics CAD/CAM were upgraded: 3 VAX 11/780s were changed to 11/785s and a 11/750 was installed.

The RIOS replacement programme is well underway: 5 3362s and a DEC 1200 lines per minute printer were installed.

General Services

An all-points addressable laser printer service, allowing a mixture of multi-font text and graphics was released and CERNPAPER revised to make use of the added facilities. The Program Library now exists in versions for MVS, VM/CMS, VMS, CDC and Apollo. The CERN benchmark suite has been extended to comprise IBM's 3090 and 4381 and DEC's VAX 8600, 11/780 and 750.
An Oracle data-base service has been introduced on the VAX 8600 and a few pilot projects with LEP collaborations have started. Oracle will be made available as a general service on the IBM machines.

After extensive evaluation of Personal Work Stations, support activities are now being set up. This concerns Apollo machines, of which 8 have now been installed. Other types of PWSs are being evaluated: a Symbolics 3640 (for algebraic manipulation), 2 VAX Station-1, 2 SUN and 1 HP9000. A terminal emulator for VM/CMS and other systems has been installed and PIONS has been adapted for Apollo. The Division is considering organising support for personal computers, much along the lines of its support for PWSs. An evaluation of small UNIX systems, is underway, with a view to making the PRIAM cross-software suite available on PCs and PWSs.

In the frame of the PRIAM project, 20 G64-based 6809 systems have been acquired from European industry. The development of front-ends for Fortran77 and C compilers continues and the cross-software suite is being enhanced to include support for the Motorola 68020 (32-bit processor) and 68881 (floating-point attachment). In the project, DD plays a major role in the collection and dissemination of information, although the main users of microprocessor systems are in the experiments and the accelerator Divisions.

**Data Communications**

A global common policy for CERN's data communications has been elaborated and proposed to Management. The CERNET service continues on a stable level. A CERNET transport manager for VM/CMS has been produced. The technical requirements for the new backbone network have been defined and a task force set up. Ethernet installations for the North and West Areas have started and the first Ethernet-CERNET Frigate gateway has gone into service. J-NET and TCP/IP protocols have been implemented on VAX.

An internal X-25 network (called EXCITE) has entered service and a direct X-25 connection into the IBM machines, bypassing INDEX, has been established. The GIFT file gateway went into experimental service. It provides a limited interchange between CERNET, Coloured Books and DECNET. The COMICS study on electronic mail was completed and proposals have been made for implementation.

The European Academic Network EARN has continued to expand and in association with BITNET it now consists of some 500 nodes spread over Europe and North America.

The backlog of INDEX and terminal installation work, caused by shortage of personnel, has taken disquieting proportions. Also other areas of data communications are severely hampered by shortage of personnel.
Data Handling

The GEANT-3 program has been successfully interfaced to EGS-4, an electron shower simulation program from SLAC. The memory management part of Zebra is already in use and the complete Zebra package will be available soon. Full implementations of the international graphics standard GKS to run under VM/CMS and VMS are almost completed; a reduced (miniGKS) version for mini- and microcomputers, written at CERN is available on NORD and Apollo computers.

The CERN Fastbus interface CFI has been installed in several LEP test beams and successfully integrated with the VAX data acquisition system. Standard routines for the Fast Diagnostic Sequencer interface and the LeCroy 1821 Segment Manager are near to completion. A direct Unibus to Fastbus interface has been successfully completed, and help was given to the development of a NORD to Fastbus interface.

Existing on-line software has been further developed to meet the needs of LEP experiments in test beams. Support to these and other experiments has continued (10 new on-line VAXes installed). The general problems of data acquisition for LEP experiments are now being attacked. Close contacts with the LEP collaborations are maintained in order to define those areas where standard packages can be used by several collaborations.

First deliveries have been made of the VME-based test system VALET-PLUS, which uses a Macintosh or other personal computer for the user interface.

The prototype 3081/E emulator has been extensively and successfully tested. Nine machines are now under construction and the first will be delivered soon. Work on an off-line farm of 3081/Es has started, using an IBM 4361. The prototype of the very fast processor XOP has also been successfully tested and two machines have been delivered to L3 for use in their trigger. The pre-amplifiers for the prototype Time Expansion Chamber of L3 have been produced in quantity. The Division collaborates with EF in the setting-up of a micro-electronics test laboratory. Three Daisy systems, running on IBM PC-AT have been acquired for schematic capture in automated electronics design.

In view of the growing importance of Fastbus and the VMEbus, conferences on Fastbus software and on "VMEbus in physics" are organized for autumn. In the areas of experiments and of accelerator operation, interest in Expert Systems is growing. An Interest Group (ESSIG) has been formed with the active participation of the Division.

The LEP collaborations have all planned considerable computing facilities for their experiments and in recent discussions on computing in the LEP Committee it was realized that many problems still need to be solved. In order to coordinate the different activities and to minimize effort by identifying common problem areas and recommending common solutions for implementation, it was decided to form a Committee with representatives from the four collaborations and from DD and EP Divisions.
II TECHNICAL DIVISIONS

- LEP Main Ring Division
- Proton Synchroton Division
- Super Proton Synchroton Division
- Technical Services and Buildings Division
LEP MAIN RING DIVISION

LEP Construction

Despite the problems faced on the work sites owing to the long periods of severe weather in January, progress with the civil engineering work has been almost normal over the first six months.

Concerning the underground work in the plain, the delays in excavating the shafts and cavities at point 8 led to a decision by the contractor to lower the first boring machine at point 1 (PGC 1) and tunnel towards PA 2. The main tunnel is now being excavated by this machine on schedule. The highest rate of boring reached has been 36 metres per day, with rates of up to 15 metres per eight-hour shift, giving hopes of good performance with some making up of lost time.

The main tunnel excavations beneath the Jura are proceeding well (30 metres per week, with the preliminary flooring slab concreted as boring progresses). Exploratory drillings are regularly being made every other week-end, and no major geological accidents have been encountered. It is hoped that a length of some 1.5 km will have been bored by the end of the half-year. The Crozet emergency shaft PA3 has been completed and fitted out.

The tunnelling work described above has required continuous geodetic support and, in particular, gyroscopic steering of the excavations. In addition, tests on the geodetic surface network using the NAVSTAR satellites, and its linkage to the underground network, have continued.

Nine of the sixteen LIL accelerating sections have been installed while the first high-power modulator of the klystron gallery is ready for pulsing. The high-current electron source, after being tested at LAL, has been delivered to CERN.

Theoretical studies on the main ring have included a review of the correction of the optical functions and progress on the analytical derivation of the dynamical aperture. On the practical side a major event has been the construction of a complete RF unit. This consists of two 2 MW klystrons and 16 storage and accelerating cavities complete with low-power and control systems and testing of the assembly has now started. Magnet work continues according to schedule notably with the placing of a contract for the weak-field dipole cores which have the original features of an auxiliary gap and "flux throttling" in the return yoke. Several auxiliary components for the main dipoles such as supports, clamps and hydraulic connections for
the excitation bars have also been ordered. Similarly the delivery of vacuum components continues while manufacture of the chambers is still at the pre-series stage in order to optimize the final details. The two 6 MVA transformers for the pre-production klystron power converters have been delivered while the final specifications of all power converters are being prepared.

Progress on the machine infrastructure has also continued. A contract for the ventilation pipes for zone 1 and PM 15 has been placed and a cooling plant delivered and commissioned. The shielding requirements of access points and alcoves have been specified together with the access control system and associated radiation protection equipment.
PROTON SYNCHROTRON DIVISION

During the customary long shutdown at the beginning of the year, a major undertaking was the move of Linac I. By shifting the whole machine backwards some 12 metres, it became possible to reinforce the PS Ring radiation shielding, hitherto a perennial nuisance because of its weakness in this critical area. Another big job was the successful implementation of full central computer control for the various PS r.f. systems. Thanks to the adoption of a modular structure and standardisation of both hardware and software, very few problems were encountered in commissioning this large new addition to the controls system. In addition to numerous lesser maintenance tasks, the 44-ton filter of the main magnet power supply had to be completely reconditioned, its windings having suffered from the severe winter cold. Some changes in the beam optics of the 50 MeV transport line from Linac II resulted in an appreciable increase in the intensity supplied to the Booster, and should also significantly reduce the hazard due to radioactivity in this crowded area. The start-up of the accelerator complex was delayed by three days, partly in order to finish the filter repair, but mostly owing to the necessity, at the last minute, of replacing a unit of the PS main magnet owing to an insulation breakdown. Subsequently, operation was seriously disturbed by mains power failures and numerous changes of programme needed to cope with the "critical days" imposed by CERN's contract with EdF. Some 30 hours of machine development time were temporarily sacrificed in compensation, and will have to be recovered later in the year. Despite all this, the SPS was shortly being supplied with protons and antiprotons for the successful tests of collider operation in the pulsed mode, and later received its standard 14 GeV/c high intensity proton beam. LEAR users had a full week of experimental physics at 300 MeV/c in March, after setting up the machine as economically as possible since only precious protons were available for the purpose, and later on, in May, another week at various energies. One of the East Hall beams was already running in March, earlier than scheduled, and the remainder came into service in April, providing test facilities for a good deal of experimental equipment. The efficiency of multiple operations was improved by decoupling the extraction processes serving the East Hall and the SPS, which had suffered from mutual interference when sharing a supercycle, and by speeding up the changeover of antiproton supply between LEAR and the SPS. In the field of machine studies, the major item concerned injection of protons to the PS at 1 GeV instead of the usual 800 MeV. One of the four Booster rings was made to accelerate up to 1 GeV at the full intensity of 1012 protons per pulse, normal operation continuing on the other cycles in the supercycle. Pushing some of the beam transport line power supplies to their limit (and beyond), the 1 GeV beam was injected into the PS and accelerated. As expected, the beam occupied a smaller space in the Q1 - Q3 diagram; however losses at low energy did not diminish, and consequently there was no increase in
accelerated beam intensity. Investigation of this phenomenon continues. Also under study was the modification of the momentum compaction factor \( \alpha_m \) for fast ejection, in order to extract beams with a larger momentum spread, thus using a bigger slice of the antiproton stack. During March and April, whilst the AA was supplying antiprotons for LEAR and SPS, some experiments were also carried out aimed at improving the \( p \) yield and the machine tune. These did not result in appreciably better performance, but the experiments with pulsed current in the target confirmed theoretical predictions that the biggest technical difficulty would be design of a target containment structure able to withstand the shock of intense pulses of protons and 100 kA currents simultaneously. Shimming certain groups of quadrupoles improved the machine tune to the extent that, apart from a few lower-order non-linear difference modes, the momentum aperture was free of resonances up to the 15th order. This should lead to better accumulation at high stack intensities.

Design work continued on the new vacuum chamber and figure-of-eight winding for the PS magnet, and on the modifications, mainly concerned with handling low intensity beams, which will enable the Booster to accelerate oxygen ions. The last step was taken in the rejuvenation of the Booster main magnet power supply, all five rectifier-inverter units being upgraded with new thyristors. The controls for the LEP Preinjector were keeping in step as the process itself took shape; up to the end of the year, all commissioning will be done using autonomous units based on the Macintosh personal computer. Delivery began of quadrupoles for ACOL, and numerous other items were out to tender; a prototype injection septum was successfully tested, and prototype solid-state amplifiers for the 1—3 GHz frequency range were developed. The second PS internal dump target was moved to a location with more efficient radiation shielding. The project for renovation of the access control system has been more thoroughly studied, and its financial profile revised in the light of delays in the development of CERN-wide standards.

The Synchro-Cyclotron light-ion experimental programme was dramatically halted after only one day, when, in a repetition of the 1981 incident, a turbopump underneath the rotary capacitor (Rotco) exploded. Although no permanent damage was done, considerable effort was required to clear out debris from inside the Rotco and vacuum system, and two weeks were lost. The pump was returned to its manufacturer for investigation. During the March shutdown, advantage was taken of the relatively low level of radioactivity after an ion-acceleration period to correct errors in the mechanical alignment of the r.f. vacuum system, which have plagued Rotco and transmission line changes for some years. Also, considerable progress was made in preparations for the installation of ISOLDE 3. After starting up again (with protons), the Rotco performed badly, and this was at first thought to be due to the unusually long period it had been open to air. However, things got worse rather than better, and the other Rotco had to be installed. When the misbehaving unit was stripped down, a large quantity of oil was found inside and it was clear that this had been the real cause of the trouble The source of the contamination is under investigation.
Apart from the usual hectic activity for maintenance and many smaller modifications, the major tasks which were carried out during the winter shutdown were:

i) The civil engineering for the junctions with the $e^+$ and $e^-$ transfer tunnels towards LEP.

ii) The installation of the complete infrastructure, i.e. cables, cooling, supports etc. for the upstream half of the standing wave cavity system for electron acceleration.

Period 1 was devoted to pulsed collider operation for the experiments UA1 and UA5. In this operation mode the SPS is cycled between 450 GeV and 100 GeV, while maintaining the same counter-rotating beams consisting of two bunches of protons and one bunch of antiprotons for several hours. The flat top duration at 450 GeV was 4.0 s, with a repetition time of 21.6 s, resulting in a duty cycle at the record centre of mass energy of 900 GeV of 19%. An important contribution to the success was the development of tune measurement and adjustment techniques which kept the tunes of the beams constant to $^\pm .002$ during the continuous ramping up and down between 100 and 450 GeV. In these conditions the beam lifetimes were longer than 4 hours and were limited by longitudinal effects.

The initial luminosity of a coast was $3 \times 10^{26}$, with a luminosity lifetime of 2 hours. Beam intensities were $6 \times 10^{10}$ protons per bunch and up to $10^{10}$ antiprotons per bunch.

After Easter the SPS started up for the usual spring and summer periods of fixed target physics.
DIVISION DES SERVICES TECHNIQUES ET BATIMENTS

1. **Etudes, travaux neufs et modifications**

Au cours du premier semestre 1985, divers travaux ont été mis à l'étude, en chantier ou réalisés: outre les activités du Département Génie civil LEP, rapportées dans la partie du rapport consacrée à ce projet, les bâtiments 32 (Bâtiment des Physiciens) et 33 (Réception) sont en cours de réalisation; la construction de l'ATS II (Atelier de traitement de surfaces polyvalent) sera terminée le 15 juillet, l'équipement technique suivra; un pavillon de bureaux, de 150 m, pour la Division DD a été mis en service; le pavillon 601 et l'aménagement du bâtiment 115 seront terminés à la fin du semestre (Div. EP); les pavillons 587 et 588 (750 m) ont été livrés à la Division PS; un hall de stockage de matériels radioactifs, de 400 m, a été livré au Centre Anneau PS; et les travaux de transformation des anciens bâtiments et tunnels ISR destinés au LEP sont terminés.

Ont été mis à l'étude, pour réalisation au second semestre: un bâtiment de 1000 m, une aire de stockage de 5000 m pour le LEP sur le site de Prévessin, un bâtiment de stockage de matériels radioactifs d'une surface de 800 m, ainsi qu'une extension du bâtiment 366 dans le cadre du projet ACOL.

Le montant des demandes de travaux, qui était très important en 1984, se maintient au même niveau pour le premier semestre de 1985.

2 **Entretien et exploitation - transport et manutention**

Les travaux de maintenance programmés tant pour les bâtiments que pour les installations techniques ont été réalisés en diminuant les fréquences, à cause des contraintes budgétaires.

Le parc de véhicules comprend maintenant 1388 unités (voitures, camionnettes, camions, engins de transport et de manutention spéciaux, véломoteurs).

L'exploitation normale des halls de stockage et d'expériences s'est poursuivie. Les travaux de démontage des zones expérimentales ISR et de l'accélérateur se sont terminés.

3 **Ateliers centraux**

Les Ateliers Centraux ont vu leur charge moyenne très soutenue pendant ce semestre, avec prédominance des travaux pour la Division LEP et pour les activités des autres Divisions liées au projet LEP. Les travaux les plus marquants ont porté sur: le stack core cooling system; le programme supraconducteur niobium RF LEP; la
lentille à lithium du PS avec ses composants; des éléments prototypes des expériences LEP; les composants des cavités LEP RF en cuivre, y compris le dopage en surface des séries de céramiques; l'assistance technique dans les domaines de traitements de surface, traitements thermiques (brasages) et contrôle qualité auprès des fournisseurs des composants de l'accélérateur LEP; le contrôle dimensionnel des séries de composants pour les systèmes d'aimants et de vide du LEP; et une demande très importante en circuits multicouches haute technologie pour l'ensemble du CERN (un type différent par jour).
III ADMINISTRATION

- Documentation Department
- Finance Department
- Management Information Department
- Personnel Department
The workload in the printshop has remained high but the continued use of a second high-speed photocopier has helped considerably. The financial situation is not helped by very large increases in paper costs after a long period of stable prices. A new phototypesetter has considerably reduced turn-around time and increased productivity in the Scientific Reports Typing Section. Nevertheless, demand for the services of the Section continues to exceed capacity; a study has been made of the implications of sending some work outside the Laboratory. Users have communicated their need for this service and their appreciation of the quality of the work provided. The use of the NOTIS office automation system has continued to extend and has outstripped present capacity. Demand for databases, such as address lists, has grown and there has been increased interest in transferring files between various systems.

Space has again become a major preoccupation in the Library and less-used holdings are being moved to enlarged basement storage areas. The latest version of the ISIS computer system for Library holdings has been installed; a new database to handle book acquisitions is being implemented as well as a major update of the "corporate authors" database. Several collections of documents from long-standing staff members of CERN have been made available to the CERN archives and have been inventoried in an abbreviated way so as to be of use to the Study Team for CERN History. The team is writing up, on the basis of the reports already produced, the first volume of the history, covering the period from 1949 to 1954, which will be published early next year.

A wide range of material has been handled by the Translation and Minutes Section. Translation of the Annual Report put a big burden on the French translators in the first months of 1985 but the deadlines were met. Other important translations included agreements between CERN and Member States, the Users Guide and the report on "economic utility". Minute writing called for increased effort from the English translators because of the additional work related to the Tripartite Working Group on Pensions. In view of the progress with computerized translation techniques, their possible usefulness to the work of the Section is being studied. The Publications Section now publishes the "Images" house journal as a separate publication. "CERN Courier" continues to make strong headway; following tender-action the printing of the journal is to be undertaken in England in the second half of this year. The Scientific Reports Section continued to face a heavy workload including the editing of numerous papers for LEAR, Collider Workshops and an Accelerator School Symposium.
The exhibition team prepared CERN exhibits for a joint stand with "Arbeitsgemeinschaft der Großforschungseinrichtungen" at the Hannover Fair. Much of the preliminary work for the major 1985 exhibitions in Scandinavia (Stockholm, Trondheim and Lund) has been done. The team is also helping with plans to improve the visits circuit on the CERN site. The Mail Office is studying the implications of CERNwide computerized address lists which can be accessed from the mail expedition room.
**DEPARTEMENT DES FINANCES**

**Situation financière**

La hausse des taux d'intérêts s'est poursuivie depuis le début de l'année jusqu'à la mi-mars; depuis lors, on a d'abord assisté à une stabilisation, puis à une tendance à la baisse de ces taux.

Etant donné que la plupart des Etats Membres ont payé les deux premiers tiers de leurs contributions dans les délais réglementaires, on atteindra, voire dépassera les recettes réelles prévues dans le budget de l'année 1985. Il est à noter, cependant, qu'à la fin avril 1985, une somme de 19 669 028 francs suisses, représentant le solde des contributions des années 1983 et 1984, n'a pas été réglée par deux Etats membres.

Pendant les premiers mois de l'année, le franc suisse a continué à s'affaiblir par rapport au dollar et à la plupart des monnaies.

Au 30 avril de cette année, on a constaté une augmentation des dépenses de quelque 33 millions de francs suisses par rapport à la même date de l'année passée. Les provisions pour engagements non échus constituées à la fin avril ne sont plus que de 52 millions, par rapport à 70 millions de francs suisses au 1er janvier 1985.

A ce jour, l'Organisation a reçu de la FIPOL, pour le contrat de prêt couvrant les bâtiments 32 et 33, des versements de 2,5 millions de francs (7,5 millions sont prévus pour cette année).

**Services Financier et Comptables**

Durant cette période, une bonne partie de l'activité a été consacrée aux opérations de clôture et à la préparation des comptes annuels de 1984.

**Service des Achats**

Depuis le début de mai, toutes les commandes sont traitées par ordinateur, avec des résultats tout à fait concluants. En conséquence de cela, il est possible de procéder à une standardisation croissante de tous les textes utilisés. Les études en cours laissent désormais entrevoir une réduction notable du temps nécessaire au traitement des informations et une expédition plus rapide des affaires. Ainsi sera-t-il possible de faire face, dans ce domaine, à l'intense activité actuelle, malgré le manque d'effectifs.
Service des Magasins

La valeur des sorties de matériel standardisé a augmenté, durant le premier trimestre de 1985, de 17,5% par rapport à la même période de l'année précédente.

Le contrôle de qualité des gaz, effectué par la Section Technique, est désormais opérationnel.

Un accord relatif aux arrangements fiscaux et douaniers pour la période de la construction du LEP a été conclu avec les autorités suisses.
Le coordinateur de l'appui industriel a pris une série d'initiatives qui se sont traduites entre autres par: la renégociation d'un grand nombre de contrats afin d'infléchir les effets inflationnistes engendrés par l'application annuelle des indices de prix, et l'organisation de séminaires d'information à l'intention du personnel.

**Groupe Prévisions et Statistiques**


**Groupe Traitement des Données**

Ce groupe, conformément aux engagements pris, a mis en place dès avril, le progiciel de gestion du personnel. Ce système est actuellement utilisé en parallèle avec l'ancien, par le Département du Personnel et par la Division EP. L'application 'SALAIRES' est en cours de développement.

La base de données financières de l'Organisation a été constituée; la production des états comptables et la mise en place d'un système d'interrogation sont en cours de réalisation.

Le système de gestion informatisée du service des achats développé en coopération étroite avec celui-ci, est maintenant complètement opérationnel.

Ce groupe, en vue de fournir aux utilisateurs un plus large accès au centre de traitement des données administratives via le réseau Index, a procédé à l'installation d'un 'concentrateur intelligent'.

85/59/5
Groupe Support Technique

Outre ses activités habituelles dans les domaines de la gestion prévisionnelle du personnel, des procédures administratives, du support aux usagers de la micro-informatique et de la gestion du bureau d'appui industriel, ce groupe vient de mettre en place une procédure informatisée visant à gérer les droits de signature et à entreprendre de rédiger un recueil des procédures et règlements à l'usage des 'superviseurs'. Ce groupe a également été sollicité pour la mise en place informatique du projet PAYPER; la constitution d'un répertoire des contacts de l'Organisation avec les administrations des Etats hôtes ainsi qu'une analyse concernant la présentation des budgets.
PERSONNEL DEPARTMENT

The five-yearly review of the Fellows, Associates and Students Programmes, which analyzes the development during the last period and makes proposals for the next five years, was prepared for consideration by the Scientific Policy Committee, Finance Committee and Council.

Applications for employment were received at the rate of over 200 per month; during the first semester 160 candidates were invited to 30 selection boards.

Several documents were prepared and presented through the Standing Concertation Committee to the tripartite Consultative Committee on Employment Conditions, notably concerning the review of CERN salaries, annual salary adjustment methods, the revision of the Staff Rules and Regulations texts, education grant.

Members of Personnel Department participated in several working groups concerned with such subjects as the introduction of a new personnel data base for administrative data processing; alcohol abuse; periodic review discussions; the registration procedures for personnel; and a computerized booking system for the CERN hostel.

As agreed by the Housing Fund Committee, a project has been started for the renovation of 20 of the CERN furnished apartments; others will be undertaken in due course.

The Education Services drew up a training programme to prepare for the introduction of the "Periodic Review" scheme that was approved by the Director-General in March 1985.

The second CERN Utility Study, which was coordinated by a member of Personnel Department, was completed and published. It attracted a considerable amount of attention in the news media in the Member States.
IV DIRECTOR-GENERAL

- Office and Services of the Director-General
- Technical Inspection and Safety Commission
- CERN Staff Insurance Scheme
L'Audit interne a procédé à la vérification des Comptes 1984 de l'Organisation et de la Caisse des Pensions. Dans le cadre de ce audit, des investigations spécifiques ont été également effectuées à la demande des Commissaires aux Comptes. En dehors de cette activité principale liée aux comptes 1984, l'Audit interne a poursuivi ses travaux et enquêtes prévus à son programme annuel.

Les activités du Service des Relations publiques ont été marquées par un notable accroissement du nombre des visiteurs; un appel a été lancé aux physiciens pour qu'ils participent davantage à la présentation du CERN; des propositions sont également à l'étude pour améliorer le parcours de la visite.

Les contacts avec les médias continuent de se renforcer; le CERN a invité une douzaine de journalistes britanniques pour une visite de deux jours en mars; les expositions du CERN à l'étranger permettent également de développer les contacts avec les médias des Etats Membres.

Le Service juridique a assuré sa fonction de conseil de l'Organisation; il a préparé les documents et donné les avis juridiques demandés par le Directeur général et le Directoire. Il a entretenu, sur le plan juridique, les relations nécessaires avec les autorités des Etats Membres et des Etats-hôtes. Il a participé aux travaux du Conseil et de ses Comités.

Il a pris une part active à l'élaboration des documents relatifs au projet LEP, à la coopération entre le CERN et les Communautés européennes, à l'adhésion du Portugal. Par ailleurs, il a contribué à la mise en place du cadre juridique concernant l'importation et l'exportation d'uranium sur le territoire de ses Etats-hôtes, traité les questions relatives au statut de l'Organisation en Suisse au regard du droit social et préparé les recours en justice qui s'y rapportent. Il a pris part à divers comités (notamment le Comité pour la Politique de Sécurité, Groupe des Pensions), groupes de travail et enquêtes.

Au plan du contentieux, il a défendu les intérêts de l'Organisation devant les juridictions nationales, géré les assurances de celle-ci, veillé à la récupération des sommes dues à l'Organisation par des débiteurs extérieurs, contribué au règlement de litiges de caractère commercial.

Il a dispensé aux membres du personnel, notamment aux attachés, l'aide juridique nécessaire (droit de famille, fiscalité, nationalité, résidence ...).
Le Service des Relations avec les Etats-hôtes a traité de nombreux problèmes avec les services publics français et suisses ainsi qu'avec les élus locaux à tous les niveaux.

Un effort important a été consacré, d'une part à la recherche d'hébergements provisoires en prévision de la venue d'effectifs importants pour l'installation du LEP. D'autre part, les préparatifs ont été menés très activement pour la définition des liaisons électriques et optiques en câbles du projet et pour le lancement de cette importance opération.

Enfin, la régularisation des mises à disposition des terrains pour ce même projet a été poursuivie, tant avec les autorités françaises qu'avec les propriétaires.

Les autres services, à savoir le Secrétariat du Conseil et le Secrétariat des Conférences scientifiques, ont poursuivi leurs activités habituelles.
Chemistry has been much at the forefront amongst the questions presented to TIS in recent months. Non-conventional liquids are envisaged for new types of particle detectors and basic data had to be found and confirmed describing the properties of these liquids. In the LEP project concern for inflammable material such as cables and other plastic components in the underground installations lead to the definition of flame-retardant and halogen-free cables.

Mechanical problems have arisen in all four LEP experiments and assistance in design and choice of material has been frequent for detector lay-out, cryogenic equipment and solenoids, vacuum and pressure vessels.

The Radiation Protection Group inaugurated a new storage hall for radioactive equipment permitting cool-down before reuse or disposal. In order to cope with the increasing amount of material to be kept in store, the construction of another hall on the Prévessin site was authorized.

The Emergency and Fire Services are still being solicited to a considerable extent by the neighbouring region and by personnel of firms working for CERN. The Fire Prevention Service has been called upon to advise many groups of the LEP Project but also the existing installations have been inspected on a more systematic basis than in the past.

The Electricity and General Safety Group have been continuing their regular safety inspections on the CERN site, but unfortunately, have not been able to carry out the full programme as planned, due to health problems amongst several members of the group.

The Medical Service has prepared a new Medical Code which is being processed through the various competent bodies before approval by the Director-General.

Generally speaking, all groups report of a positive working atmosphere in their interactions with divisions throughout CERN.
The Annual report of the Staff Insurance Scheme is submitted separately to the Council (CERN/1567 – CERN/FC/2845).

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