CERN LIBRARIES, GENEVA

CM-P00100151

CERN/ECFA 66/2
2 May, 1966

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
CERN EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

EUROPEAN COMMITTEE FOR FUTURE ACCELERATORS

First Plenary Meeting

Geneva - 7 March, 1966

DRAFT MINUTES

66/526/5

DRAFT MINUTES

The Committee consisted of the following:

Chairman:	Prof. E. Amaldi	Italy
Members:	Dr. H. Koziol Dr. H. Kummer	Austria
	Prof. J. Géhéniau Prof. L. Rosenfeld	Belgium
	Prof. J.K. Bøggild Dr. K. Hansen	Denmark
	Prof. A. Citron Prof. H. Filthuth Prof. W. Jentschke Dr. U. Meyer-Berkhout Prof. C. Schmelzer Prof. A. Schoch Prof. H. Schopper Dr. H.O. Wüster	Federal Republic of Germany
	Dr. P. Falk-Vairant Dr. C. Ghesquière Dr. J. Meyer Dr. J. Parain Dr. L. Van Rossum Dr. A. Rousset Prof. J. Teillac	France
	Dr. R. Rigopoulos Dr. E.J. Sacharidis	Greece
	Prof. F. Amman Prof. G. Bernardini Dr. N. Cabibbo Dr. G. Diambrini Prof. G. Salvini Dr. G. Stoppini Prof. A. Zichichi	Italy
	Prof. D. Harting Prof. R.T. Van de Walle	Netherlands

Members: (cont'd)	Dr. E. Lillethun Dr. O. Skjeggestad	Norway
	Mr. J.A. Ruiz Dr. F. Verdaguer	Spain
	Dr. H. Atterling Prof. G. Källen Dr. S. Nilsson	Sweden
	Prof. J.P. Blaser Prof. B. Hahn Prof. R. Mermod	Switzerland
	Prof. E.H.S. Burhop Prof. C.C. Butler Prof. R.H. Dalitz Prof. J.C. Gunn Dr. L.R.L. Hobbis Prof. D.H. Perkins Prof. P.G. Murphy	United Kingdom
	Prof. J.S. Bell Dr. B. French *Dr. P. Germain *Prof. B.P. Gregory *Mr. G.H. Hampton Dr. H.G. Hereward *Dr. M.G.N. Hine *Prof. K. Johnsen *Prof. L. Kowarski *Mr. P. Mollet Dr. D.R.O. Morrison *Prof. W. Paul *Prof. Ch. Peyrou *Prof. P. Preiswerk *Dr. C.A. Ramm Dr. S. van der Meer *Prof. L. Van Hove *Dr. C.J. Zilverschoon	CERN

---

* ex officio CERN

1. INTRODUCTION AND ADOPTION OF THE AGENDA (Item 1 of the Agenda)

a) Aims, activities and conclusions of ECFA in 1963.

b) Purpose of the present ECFA and the Agenda of this meeting.

Professor AMALDI summarized the reasons for convening the initial ECFA in 1963 and the conclusions reached by that Committee (FA/WP/23/Rev.3). They had recommended the construction of a 300 GeV accelerator, intersecting storage rings (ISR) for the CERN PS at Meyrin and a range of lower-energy accelerators, spread over the Member States, referred to as the "base of the pyramid programme".

In the meantime the construction of the ISR has been authorized. Moreover, an improvement programme to raise the intensity of the CERN PS has been decided upon. On the other hand, only two of the accelerators foreseen in the base of the pyramid programme are under construction (Bonn 2.3 GeV electron synchrotron), or approved (Zürich meson factory), and the 300 GeV project is still awaiting approval.

Under these circumstances it has been thought desirable, during the course of 1965 to reconsider the question of the future high-energy physics programme for Europe, including a bringing up to date of the base of the pyramid philosophy. Accordingly, with the agreement of the Scientific Policy Committee, Professor Weisskopf had sent a letter (CERN/10.413) on 15 November 1965 suggesting that a rejuvenated ECFA be convened and proposing general terms of reference. As a result of the discussions held in the Scientific Policy Committee, he (Professor Amaldi) had sent a letter (CERN/10.501) on 16 December 1965 giving further details about the work that could be expected of ECFA, and stressing that ECFA was completely independent of CERN. A preparatory meeting had been held on 11 February 1966 with scientists representing each country, and it had been proposed that the officers of the rejuvenated ECFA should be:

Chairman, Professor Amaldi

Secretary, Professor Citron.

By acclamation Professor Amaldi was elected Chairman and Professor Citron Secretary of ECFA.

The Agenda (CERN/ECFA 66/1/Rev.1) was adopted.

c) Time-schedule and work at CERN.

Professor GREGORY said that the time-scale contemplated in document FA/WP/23/Rev.3 could no longer be held, since the necessary authorization for construction had not been obtained by the end of 1965, as originally hoped for. The time-scale proposed by CERN was therefore the following:

June 1966	First report on sites to Council Preliminary report by ECFA
June 1967	Final report on sites Final report by ECFA Convention proposals
Beginning 1968	Final choice of site Decision that construction should be started
Beginning 1969	Start of construction work
1976	Start of operation.

The cost estimates were roughly as given in Annex I, (FA/EC/9).

Although the Council of CERN would take the responsibility for presenting the project to Governments, many informal discussions would take place in the Committee of Council, which was now composed of one representative of each country. It was obvious that the 300 GeV project would succeed only if it received very wide support from European scientists, and ECFA would carry a large responsibility in the choice of the machine and of its various technical details. In this connection, the time-scale provided about one year to make changes in the specifications. Changes after that would result in obvious delays.

The question of the Convention was being considered by the Committee of Council, the Council and the Administration.

Professor SCHOCH considered that there was some inconsistency in anticipating in June 1966 some of the conclusions which could only be reached in 1967.

Professor GREGORY explained that preliminary results on a number of issues should be available by June 1966. Most governments were not very interested in precise specification of the machine, but they wanted to know whether the European scientific community in general thought that the next stage should take the form of a very large high-energy machine built in common by the European countries. Delays would be considerable if the reactions of Governments could not be tested until June 1967.

Professor BURHOP considered that it would be worth discussing whether the next stage might not be an intercontinental machine in the early 80's, in view of the slipping of the European time-table.

The CHAIRMAN said that the question might be worth exploring. However, he was much less optimistic about intercontinental co-operation since the Vienna Meeting in June 1964, when the USSR representatives were not ready to make any commitments and the U.S. scientists felt that intercontinental co-operation would not be justified for such a low energy as 300 GeV.

Dr. KOZIOL suggested that, since the 300 GeV machine could not be regarded as an intercontinental project, it would be worth encouraging a number of non-member states to co-operate in it, e.g. Poland, Czechoslovakia, Hungary and Yugoslavia.

Professor BERNARDINI supported Professor Koziol's suggestion and considered that other countries, such as Israel, might be included.

On Professor TEILLAC's proposal and after a discussion involving Professors Bernardini and Citron, Dr. Van Rossum, Professor Salvini and the Chairman, it was agreed that, in principle, certain non-member states should be kept informed of the work of ECFA and that the Chairman should write for this purpose to various laboratories in non-member states.

After a discussion involving Dr. FALK-VAIRANT, Professors GREGORY and BERNARDINI, the CHAIRMAN and Professor GUNN, it was agreed that the CERN improvement programme and ISR project would not be discussed from a scientific point of view, but reference could be made to them from the point of view of manpower and costs.

2. BASIC SPECIFICATION FOR THE EXISTING 300 GeV STUDY, THE 1964 REPORT AND SUBSEQUENT ACTIVITIES (Item 2 of the Agenda)

Professor JOHNSEN said he wanted to give a summary of 1) basic specifications and boundary conditions for the 300 GeV PS, broadly as indicated in document CERN/563, on the basis of recommendations made by ECFA (FA/WP/23 Rev.3), and 2) activities of the Study Group since the ECFA report was issued.

1) Basic Specifications and Boundary Conditions

These had to be clear before a design study could be made. They can be summarized as follows:

Energy: 300 GeV

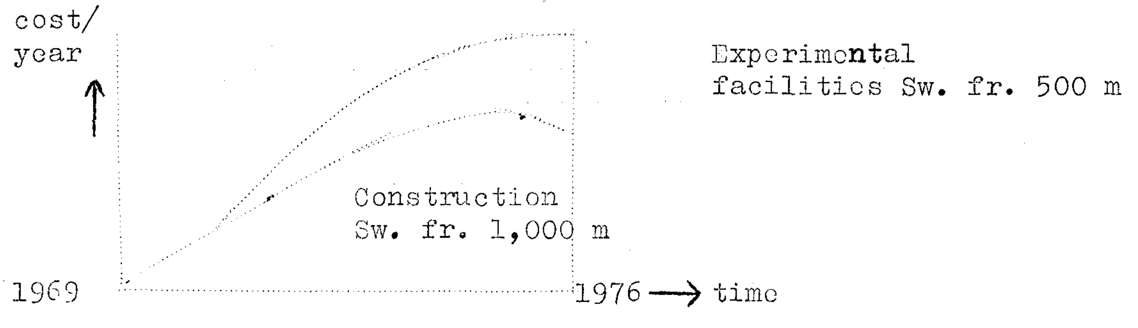
Intensity: This should be high in view of a full exploitation. 10^{13} p/sec were recommended and seem feasible without disproportionate increase in cost and difficulty. A 20% beam loss creates radiation problems that can still be handled using conventional means.

Aperture: The aperture has to be designed in order to hold the anticipated beam size (38 x 24 mm) but also the deviation of the beam core from the centre of the vacuum chamber, due to alignment and field errors (56 x 34 mm). This leads to a total aperture of 100 x 60 mm, to be compared to 150 x 70 mm for the present PS. It is seen that the two factors affecting the size of the vacuum chambers are of comparable size. Increasing intensity leads to a wider beam. When this factor starts dominating the aperture required, the cost of the magnet increases with intensity.

Exploitation Potentiality: Since the machine is supposed to be the backbone of European physics, as few limitations as possible should be built into it. A high degree of reliability has to be asked for. This affects both the choice of the site and components.

The reliability criteria together with the demand for a short construction time (about ten years) point towards the use of known principles and established technology.

Cost: A cost estimate for construction and initial exploitation based on these specifications is shown in the following graph:



Site: Strict requirements on stability, size and flatness have been imposed.

2) Activities of Study Group since the 1963 ECFA Report (FA/WP/23/Rev.3) was published

a) General Studies

i) Approach to Injection. The original design foresaw a 200 MeV linac, a fast cycling (20 Hz) 8 GeV booster, injecting 12 bursts in succession into the main ring.

Modifications under consideration are:

1. Replacement of the linac by a special 600 MeV circular injector with a 50 MeV linac (TART scheme).
2. Replacement of the fast cycling booster by a slower cycling one, adding a stacking ring, in which beam can be stored, while the particles in the large ring are being accelerated.
3. Replacement of the 8 GeV booster by a higher-energy one (60 GeV, say), in order to create a physics tool on the new site early.

ii) Approach to Utilization. Here outside help would be very welcome in order to strengthen the Group.

b) Technical Feasibility Studies

These are needed, since the new machine means an extrapolation by a factor of ten over present experience. A few points can be mentioned:

i) RF problems (two systems needing detailed studies)

ii) Linac studies (cross-bar for > 200 MeV?)

iii) Specific booster problems (particularly vacuum chamber for 20 Hz)

iv) Radiation problems: concrete
damage to insulating materials
remote handling
alignment

c) Sites

Site investigations began in 1962. Twenty-two official offers were received and reduced to about ten after study. Surveys are continuing:

List of sites offered and under active study:

Spain	1	United Kingdom	1
Greece	1	Norway	1
Austria	1	Italy	2
France	1	Germany	3

3. QUESTIONS ARISING FROM CHANGES IN THE PHYSICS SITUATION SINCE 1963 (Item 3 of the Agenda)

Professor DALITZ said that changes in particle physics having a bearing on the big accelerator project could be said to come under three headings:

1) Particle Spectrum

Richness of mesonic and baryonic states. Fast increase in the last two years, expected to be very rapid over the next five years. It is believed that these excited states are within the scope of existing accelerators, but they are not likely to be fundamental objects.

2) Building Blocks and Carrier Fields

a) Building Blocks

Hypothesis: massive quarks probably exist with fractional charges of e/3 or 2e/3. Mass not clear, but likely > 5 GeV. Recent evidence from cosmic rays shows it might be about 20 GeV. In this case ISR would allow production of quark pairs, but only for qualitative study as rate of collisions very low.

E_{cm} of 300 GeV accelerator = 25 GeV, too low for production of such massive objects, not much improved by Fermi motion in nuclei.

If quark mass = 20 GeV, accelerator needed for quark physics would be 900 GeV.

b) Carrier Fields

W-meson mass > 2 GeV, much higher energy needed to push further the search for such objects. The study of neutrino-induced reactions at high energies would be very useful. Desirable to compare μp scattering up to high momentum transfer with ep scattering, as mass differences between μ and e should be due to an interaction not yet seen.

3. High-Energy Behaviour of Cross-Sections

There has been a hope that Regge poles could explain this behaviour. Possibly Regge cuts have to be included. In any case the situation is complicated by the existence of so many mesonic states, which may all contribute. In some cases, e.g. charge exchange scattering, one pole (ρ) seems to represent the situation adequately. It is not clear from what energy up one can expect a simple "asymptotic" behaviour.

Professor CITRON observed that if a definite figure could be obtained for the quark mass in the next few months, it could lead to re-consideration of the energy of the new machine.

Professor ZICHICHI and the CHAIRMAN said that it would be very dangerous to use existing indications on quarks to argue that 300 GeV was too low, unless the quark was actually discovered.

4. CHANGES SINCE 1963 AT CERN, IN THE USA, AND IN THE USSR
(Item 4 of the Agenda)

Professor GREGORY said that the situation had developed on the following lines:

CERN : ISR and PS Improvements Programme approved.

USSR : Efforts concentrated on completing 70 GeV PS by end of 1967, so that it should be ready for physics by end of 1968.

USA : May 1963 Ramsey Report, recommending the following:

- Quick construction of 200 GeV PS at Berkeley.
- Study 600 GeV PS at Brookhaven, to start construction about 1970.
- 12.5 GeV 10^{14} p/sec for MURA.
- 10 GeV electron-synchrotron Cornell.
- Discussions on proton ISR at Brookhaven.
- Discussions on electron ISR (location not fixed).
- Improvements to AGS and ZGS.

After a series of discussions, the Report on National Policy was issued in January 1965, spelling out the policy of the USA for high-energy physics and recommending the following:

1. 200 GeV, as national facility, according to the LRL specifications, but not necessarily at Berkeley.
2. Conversion of AGS to higher intensity. Design approval mid 1965, construction approval mid 1966.

3. ZGS Improvement Programme: new experimental area, large HBC, higher-energy injector.
4. Build ISR at Stanford.
5. Support study on new accelerator (600 GeV - 1000 GeV) and new accelerator techniques.
6. Study cheaper means of constructing accelerators.

Accordingly, proton ISR left to CERN and MURA project dropped.

For 200 GeV about 200 sites offered. Pirée Committee to report on sites shortly, recommending a short list of about six, from which AEC should choose one.

US $ 2 000 000 in Government budget to finance study and promise of supplementary money when site selected. Accordingly, the machine could be completed by mid 1974.

AGS Improvement Programme = Sw. fr. 200 million compared with CERN PS Improvement Programme = about Sw. fr. 100 million.

Dr. HINE remarked that the idea of intercontinental co-operation on a 1000 GeV machine was not dead in the USA. In that case, such a machine might be for the 80's rather than for the 70's.

The meeting was adjourned at 1.20 p.m. and resumed at 2.40 p.m.

5. PRESENTATION OF A LIST OF MAIN CHANGES SINCE 1963 IN INSTRUMENTATION (Item 7 of the Agenda)

Professor SALVINI said that the main changes in instrumentation since 1963 could be classified as follows:

1. Bubble Chamber. Trend towards very big chambers with plates inside. These are only useful up to 20-30 GeV with the existing magnetic fields and can therefore only deal with particles of mass about 1 GeV. Chambers separated by a path subjected to a magnetic field are a possible development.

2. Monogaps and Isotropic Spark Chambers (Dubna). There is a tendency to replace bubble chambers by other instruments.
   - Liquid hydrogen or helium chambers (Dubna) with the possibility of seeing tracks through well-defined electric pulses 400 kV, rise times 0.1 μsec, tracks about 5 mm thick, pressure 1 atm.

- Spark chamber with pressure of 30 atm (Shoemaker, Princeton).
- Basis of all development is fast electric pulse necessary for operation; e.g. pulse by Schneider (CERN). (2 nsec rise, 5-10 nsec duration, 200 kV amplitude.)

3. Cerenkov Counters. Very difficult to distinguish p and $\bar{p}$ from K at 100 GeV. DISC developed at CERN able to separate π from μ at 11 GeV and is open line for development.

4. Solid-State Counters. New contribution from Huth et al., who succeeded in having thin layer and electric field of right shape to obtain multiplication of about 50 within the layer. Accordingly, with a counter 2 or 3 mm diameter, rise times of less than 1 nsec can be obtained. With a mosaic lay-out these counters could be in line of progress.

5. Beam Optics, Computers, Cryogenics. Great progress in beam optics and beam management owing to computer control.

   Cryogenics will soon give fields of 100 to 200 kG, and high Q cavities useful for Linacs, resonators and beam separation, e.g. cavity at 2°K, electro-coated with Pb, wavelength 10 cm, $Q = 10^8$, operated at 1.5×10^5 V/cm.

Conclusion. Improvements in techniques very significant. Accordingly, very difficult to forecast progress by 1971. It is certain that high-intensity and high-duty cycle beams will be required with considerable space around for experimental lay-outs.

Dr. MEUNIER explained that with Cerenkov counters, the higher the energy the better the beam optics match, so that the future could be contemplated with optimism.

6. CHANGES IN NATIONAL PROGRAMMES: INTRODUCTION TO FUTURE NATIONAL REPORTS FROM EACH COUNTRY (Item 5 of the Agenda)

The CHAIRMAN reviewed the situation in the various countries as described in the reports attached as Annex 2. He drew attention to the fact that, whereas about 150 physicists worked on bubble chamber data in four of the member countries, there were only 10 - 25 physicists doing this work in some of the other countries.

Professor TEILLAC observed that even if the member countries wished to send more counter groups, they would not be able to do so under the existing CERN policy.

The CHAIRMAN said that he agreed and thought that changes in this policy might be worth considering.

Professor GUNN, replying to the Chairman, said that the United Kingdom would probably refrain from making plans for a further national accelerator until a decision was taken on the 300 GeV project.

Professor SCHOPPER remarked that the question of site selection was bound to affect national programmes. Accordingly, co-operation between ECFA and the Committee of Council was essential.

The CHAIRMAN said that he agreed, and pointed out that it was arranged for the Chairman of ECFA to attend Committee of Council meetings.

7. REVIEW OF PROBLEMS ARISING IN CONNECTION WITH THE SPECIFICATION AND DESIGN OF BIG PROTON ACCELERATORS (Item 6 of the Agenda)

Professor SCHOCH said that he would give a list of problems which might be considered in more detail with the help of working groups.

1. New or old Laboratory:

   i.e. site near CERN. Assumed so far that new machine must be in new laboratory, because ground and site situation near Geneva not favourable and also because size of the CERN Laboratory should not exceed certain limits.

   Arguments for building near CERN :

   - Easier to take decision to close down CPS when base of pyramid machine makes it obsolete.
   - Existing CERN would give time for new laboratory to build up tradition to match the facilities.
   - New laboratory would benefit by imponderable capital build-up by CERN.

   Crucial question:

   Is suitable location near CERN-Meyrin feasible and, if so, what size of machine is possible on it?

2. Rates of Build-up of Laboratory

   Professor Johnsen had given as approximate break-down of investments Sw. fr. 1 000 million for construction, Sw. fr. 500 million for experimental areas and research equipment. It would undoubtedly be useful to have much equipment available at the start of operation, but the additional expenditure might be a heavy weight on balloon trying to get off ground. ECFA should therefore say whether exploitation should parallel present proportions on an enlarged scale or be more selective and purposeful in only a few directions.

3. Influence of Performance Specifications on Design and Costs

On previous occasions, the construction of the machine was timed to take advantage of some major progress in design (e.g. strong focusing). This time it is proposed to use more of the same. Saving might be looked for, e.g. by pushing strong focusing to its limit and departing from aperture, allowance made for construction tolerances, and use of more sophisticated orbit correction. It would be necessary to have some idea on costs of the reduction in aperture, assuming that orbit correction was technically feasible.

4. Two-step Laboratory

A very high-energy injector could be built to do physics early. It was unlikely, however, to be the optimum selection for injection.

5. Revised Time-scale (suggested by Dr. RAMM)

Item 1.

Dr. FALK-VAIRANT asked if there were any geological or technical difficulties in using the CERN PS as an injector.

Professor SCHOCH replied that technically it should be possible to use the CERN PS as an injector, but the intensity would be three times lower.

Professor BERNARDINI said that he would be opposed to any scheme that reduced the time available for physics with the CERN PS.

Dr. HINE pointed out that there might not be any economic advantage in this proposal since the cost of a medium-intensity injector would not be a very large proportion of the total project, and building a new ring in a place that was geologically far from ideal and far from the injector was bound to lead to additional expenditure.

Professor GREGORY said that, if Item 1 was studied, the procedure would be to look for a site and see what machine could be put on it. There would be two alternatives:

a) Looking for a site where CPS could be used as injector. Considering all the villages around, it would not be easy to build a 300 GeV machine in such an area and it would probably be necessary to restrict the energy and the experimental areas.

b) Looking for a site in the neighbourhood, independent of the CERN PS which would perhaps be easier, but would also involve a number of problems.

Professor SCHOCH said that his suggestion was made on the assumption of Professor Gregory's alternative b).

Item 2.

Professor ZICHICHI said that it would be desirable to build up exploitation facilities with the same priority as the machine, so that experimental work could start as soon as the machine was completed. Dr. Hine and Professor Salvini thought 1972 would be an appropriate date to start this activity.

Item 3.

The CHAIRMAN said that the Wilson approach might be considered in this connection.

Professor SALVINI said that two developments were relevant to the new accelerator, namely, the progress in computer control and the progress in beam optics.

Item 4.

Professor BERNARDINI remarked that, if a machine of about 150 GeV was built quickly, it would be ready fairly soon and could be used later as an injector for a much bigger machine.

The CHAIRMAN said that this idea should be kept in mind.

Dr. HINE pointed out that it would save about one year and one third of the cost to build a 150 GeV instead of a 300 GeV accelerator.

Professor AMMAN said that the argument could be reversed in favour of building a 150 GeV machine at CERN with the CPS as injector, so that the next machine could be bigger and located elsewhere.

Item 5.

Dr. RAMM pointed out that Europe should not be content to be third in the high-energy physics exploitation race and that it would be preferable to build a somewhat smaller machine which would be completed at the same time as the American one.

Professors BERNARDINI and ZICHICHI considered that the question raised by Dr. Ramm was worth discussing.

The meeting was adjourned at 5 p.m. and resumed at 5.25 p.m.

8. ESTABLISHMENT OF WORKING GROUPS TO STUDY SOME OF THE MORE IMPORTANT QUESTIONS RAISED UNDER 3) THROUGH 7) (Item 8 of the Agenda).

After a discussion it was decided to establish the following Working Groups:

Working Group 1.

To study the relations between national laboratories and international projects.

Austria Switzerland	Professor J.P. Blaser
Belgium Netherlands	Professor D. Harting (Secretary)
Denmark Norway Sweden	Dr. S. Nilsson
France	Dr. A. Rousset
Germany	Professor H. Schopper
Greece	Dr. R. Rigopoulos
Italy	Professor R. Gatto
Spain	Professor J. Catala
United Kingdom	Professor C.C. Butler
CERN	Professor L. Van Hove

Working Group 2.

To study the type of machine required and the beams and experimental facilities needed for a sound exploitation of this machine.

Austria	Dr. H. Koziol
Belgium) Netherlands)	Professor R.T. Van der Walle
Denmark	Dr. K. Hansen
France	Dr. J. Meyer Dr. J. Parrain
Germany	Professor A. Schoch Dr. H.O. Wüster
Greece	Dr. T. Ypsilantis
Italy	Professor F. Amman Professor A. Zichichi
Norway	Dr. E. Lillethun
Spain	Dr. F. Verdaguer
Sweden	Dr. H. Atterling
Switzerland	Professor B. Hahn
United Kingdom	Dr. L.R.L. Hobbis Professor D.H. Perkins (Secretary)
CERN	Dr. G. Cocconi Dr. P.M. Lapostolle

On Professor KOWARSKI's proposal it was agreed that the question of data links would be considered by both Working Groups.

On Professor CITRON's proposal, and after a discussion, it was agreed that coordinated efforts should be made by a series of groups to try to establish, if possible by June 1967, whether quarks existed and what their mass was. It was further agreed that Working Group 2 would collect the information from the groups and that the Chairman of ECFA would report to the Scientific Policy Committee about the information that came to hand.

9. DATE OF NEXT MEETING (Item 9 of the Agenda)

It was agreed that:

1) the two Working Groups would report their conclusions by 3 May;

2) the restricted ECFA would meet and consider these conclusions at 9.30 a.m. on 9 May, and

3) the plenary meeting of ECFA would be held on 23 May.

- - - - -

FA/EC/9
7 March, 1966
ANNEX I

COST FORECASTS: EUROPEAN INTERNATIONAL

HIGH-ENERGY PHYSICS FACILITIES

Million Swiss Francs at 1966 Prices

	1966	'67	'68	'69	'70	'71	'72	'73	'74	'75	'76
300 GeV PS 1)	4	6	15	48	150	215	235	235	260	270	270
CERN-Meyrin 2)	170	239	264	283	290	302					
Basic	148	167	188	206	219	229					
ISR	22	72	76	77	71	73					

Notes: 1) 300 GeV forecasts on basis of 300 GeV PS design as in CERN/563. Decision to start taken at the beginning of 1968 according to present working hypothesis: construction completed mid 1976.

2) CERN-Meyrin figures based on Council decisions for 1966-1969, forecasts for 1970-1971.

After 1971 build-up will depend on use of Improvements and ISR, and on date at which interest will transfer to 300 GeV laboratory.

M.G.N. Hine

66/391/5

CERN/ECFA 66/2
ANNEX II

PRELIMINARY REPORTS

ON HIGH-ENERGY PHYSICS

IN MEMBER STATES

66/526/5

PRELIMINARY REPORT OF AUSTRIA

Development 1963 - 1965

The group for studies of elementary particles in bubble chamber pictures, taken at CERN, which is associated with the institute of Professor Thirring (University of Vienna) continued their work in collaboration with similar groups at several other European universities. The group is equipped with scanning tables and one SOM. In 1965 preparatory work for another group of this type started at the institute of Professor Steinmaurer (University of Innsbruck).

Status 1966

With January 1st. a new institute for research in the field of high-energy physics has been established at the Austrian Academy of Sciences in Vienna (Institut für Hochenergiephysik der Österreichischen Akademie der Wissenschaften, Atominstitut, 1020 Wien, Schüttelstrasse 115). This institute by now takes over the high-energy group of Professor Thirring (5 - 7 scientists).

Plans for 1966 - 1968

Starting from summer 1966 the institute will include - besides the bubble chamber picture team - an experimental group (5 - 7 scientists) which intends to perform by 1967 high-energy experiments at CERN or possibly also at other accelerators, e.g. DESY, Hamburg, Germany. Besides a small theoretical group (3 - 4 scientists), a team for development of apparatus for high-energy experiments (4 - 6 physicists) with the necessary workshop is planned to begin work in 1968. The institute is paid by the Austrian Ministry of Education, it remains though by its construction outside the organization of the universities. However, a close collaboration is supposed to result from the fact that the council inside the Academy of Sciences which is placed over the institute, consists of those professors of the Austrian universities which are interested in the field of high-energy physics.

Difficulties

As everywhere, but especially for a small country, the main difficulties are financial. Therefore, it seems impossible to build a national accelerator of reasonable size (meson factory). It is planned to concentrate the means available on one institute which is supposed to collaborate within our narrow limitations closely with CERN.

Changes with respect to the last Amaldi report

In the 1963 ECFA Austria did not actively participate.

Collaboration with similar institutions outside Austria

As already emphasized, our institute is based on collaboration with (necessarily foreign) laboratories possessing accelerators. The main one is CERN, but contacts exist also to Germany (DESY) and to Switzerland (meson factory planned).

Computer

At present an IBM at the Mathematics Institute of the University of Technology in Vienna is used by the bubble chamber group. Due to good supplementary equipment of this computer, programme for the 7090 can be adjusted. Together with a new building, this Mathematics Institute will acquire a larger computer (not yet specified) with time-sharing, approximately in 1969. A smaller computer for scientific purposes exists in Graz (UNIVAC 490) and a number of small computers at different university institutes.

Cosmic rays

Professor Steinmaurer (Physics Institute of the University of Innsbruck) has at his disposal a small laboratory at the Hafelekar (2300 m above sea level) with meson telescopes, ionization chambers, etc.

(Wolfgang Kummer)
Director of the Institute for
High-Energy Physics at the
Austrian Academy of Sciences

Vienna, 18 February 1966

PRELIMINARY REPORT OF BELGIUM

HIGH-ENERGY PHYSICS IN BELGIUM

Works are done :

a) in bubble chamber physics (BC) at Brussels

b) in emulsion physics (Em) at the University of Brussels

c) in theory (Th) at the Universities of Liège, Louvain and Brussels, and lately at the laboratory mentioned at a).

Nearly all the scientists and technicians are members of the "Laboratoire des Hautes Energies" which is a section of the "Institut Interuniversitaire des Sciences Nucléaires".

The "emulsion laboratory" (Em) has been created around 1950. During the last years, most of the works have been done in the European K-Collaboration.

The first scientists of the "B C laboratory" have been trained up at Saclay and Berkeley (until end of 1961). The years 1962 and 1963 were a training period at Brussels (pictures from Saclay and CERN). From 1964, the Brussels group works in collaboration with a group of CERN.

Instrumentation

In the "B C Laboratory"

In 1963, 4 scanning tables (SOM, ENEDEP) for pictures of the 80 cm bc.

2 measuring machines SOM, ENETRA.

In 1964, the same.

In 1965, 2 additional scanning tables (original design) for pictures of the 2 m bc.

Needed
in 1966: 1 additional scanning table for the 2 m bc.,
a third measuring machine
1 premeasurement device for HPD.

Scientific Personnel

	1963	1964	1965	1966
B.C.	6	7	9	9
Em.	5	6	7	7
Th.	12	15	14	12
Total	23	28	30	28

	1963	1964	1965	1966
Docteurs	10	9	10	11
Licenciés	13	19	20	17

Addenda 1) There are more than 14 theorists in High-Energy Physics, perhaps 15 more, members of the Universities, not members of the "Laboratoire des Hautes Energies".

2) Moreover, two experimentalists have worked in counter physics at Saclay in 1963, 1964, 1965, 1966.

3) Numbers of Belgian scientists at CERN as "Savant visiteur" or "boursier":

in	1963	1964	1965	1966
	4	3	4	2

Publications

	1963	1964	1965
B.C.	4	6	6
Em.	9	12	12
Th.	4	9	11

- - - - - - - - - -

PRELIMINARY REPORT OF DENMARK

ON ACTIVITIES IN HIGH-ENERGY PHYSICS IN DENMARK

At the Niels Bohr Institute in Copenhagen some efforts are made to participate in the developments of high-energy particle physics.

Experimental activities are going on in two directions:

1) Bubble chamber analysis.
2) Investigations of high-energy processes in the atmospheric cosmic radiation.

The bubble chamber work is at present concerned with investigations of ~ 20 GeV/c proton-proton collisions. This work will be continued in collaboration with the groups in Oslo, Stockholm and Helsinki Universities. With broad support from all the Nordic laboratories engaged in high-energy particle physics efforts have started to get a common Nordic data centre for B.C. picture evaluation established. The aim is a centre equipped with an automatic analysis system and with access to a powerful computer.

The cosmic ray work has so far been centred on a search for heavy, stable particles, which might be produced in high-energy processes in the atmosphere. This work is being carried out in collaboration with physicists at Bergen University.

The strength of the group is to some degree reflected in the numbers of the following table:

	Equipment	Number of active physicists	Approximate financial support/year
Bubble chamber analysis	2 scantables 1 measuring projector (SOM ENETRA) free access to the Niels Bohr Institute's GIER computer and NEUCC's IBM 7090	5	100.000 SF.
Cosmic ray work	scintillators with auxilliary electronics	2	100.000 SF.

Danish Participation in Nuclear Structure Research at CERN

In 1965 CERN and the member countries France, Western Germany, Norway, Sweden and Denmark agreed upon a programme of Nuclear Structure Research based upon the use of the external proton beam of the synchro-cyclotron. The purpose is to initiate studies of nuclei far away from the region of stability, which until now have not been accessible to spectroscopic investigations. The project has been named ISOLDE, as the main experimental facility will be an electromagnetic Isotope Separator placed On Line with the proton beam, enabling the rapid separation of short-lived radioactive isotopes.

About 16 Danish scientists from three universities and from the Danish Atomic Energy Establishment are taking part in the project, and the costs in connection with the Danish participation are estimated to about 225.000 SF a year. The activity taking place at present consists partly in establishing equipment for the spectroscopic programme, partly in the construction of the isotope separator for common funds of the above participating member countries. It is expected that the installation at CERN of the main equipment can begin in 1966, and the first nuclear studies early in 1967.

\- - - - - - - - - -

PRELIMINARY REPORT

OF THE FEDERAL REPUBLIC OF GERMANY

DEVELOPMENT OF THE HIGH-ENERGY SITUATION IN GERMANY SINCE 1963 - A PRELIMINARY SURVEY

1. National Facilities and Projects

Hamburg:

DESY has started operation in 1964. It yields at present 10^{11} electrons per pulse, 50 times/sec. The energy, now 6.5 GeV, will be increased to 7.5 GeV shortly. The construction cost has been 120 Msfr. The present staff is 650, this includes 150 scientists. About 12 groups (1 foreign) work around the machine.

Budget figures are:	1965	30 Msfr.)	
	1966	42 Msfr.)	including staff.
	1967	48 Msfr.)	

It is intended to develop this facility in several ways. A new injector is planned and a 3-4 GeV storage ring is being considered.

Bonn:

The 500 MeV electron-synchrotron has continued operation (10^{12} electrons/sec) with a staff of 16 (10 scientists) plus 30 students. The budget is about 0.76 Msfr/year, excluding staff.

The 2.3 GeV alternating gradient electron-synchrotron mentioned in the Amaldi report is under construction since 1965 and is scheduled to be completed in 1967. The construction staff is 15 (10 scientists) plus 10 students, the construction cost 13.5 Msfr. including buildings and the estimated operation cost 3.8 Msfr. per year.

Both machines are operated in the framework of the Physics Institute of the University.

Mainz:

An electron linac giving 320 MeV at 0 current, 180 MeV at 70 μA operates since 1966. The staff is 45 (15 scientists) plus 6 students. The cost is 18.5 Msfr. including buildings and the operation budget 1.0 Msfr. per year.

This accelerator is the main research tool of the Physics Institute of the University. Staff figures therefore include all staff of the Institute. The research programme is aimed at both nuclear structure and pion and muon physics.

Karlsruhe:

Whereas at the time the Amaldi report was written a pion factory (synchro-cyclotron or linac) was considered, interest has shifted to a Kaon factory, i.e. a proton accelerator well above 5 GeV with a high current and duty cycle. In late 1963 it was decided to form a study group at Karlsruhe with the task of investigating what progress could be made in the design of such an accelerator by applying advanced technology. This group has started feasibility studies for a superconducting linac. In parallel with this, new aspects in the construction of circular accelerators will be studied. The staff is 30 at present and will be increased.

The group disposes of 6.5 Msfr. for investments in the three years 1966 through 1968. At the end of this period they intend to submit a detailed proposal, so that construction could start in 1969.

2. Scientific Collaboration with Research Centres inside and outside Germany

Since several groups collaborate with both DESY and CERN it is difficult to make a clear distinction between national and international collaboration.

Table I gives a very rough summary of the situation of bubble chamber evaluation groups. The data clearly are far from homogeneous. In the table all scientists working for a degree are termed as "students".

One group (Munich) also does emulsion work in collaboration with CERN.

Several institutions collaborate on counter experiments at CERN and DESY. These are:

Bonn: 2 scientists and 2 students at DESY
2 scientists and 1 student at CERN

Aachen: A group of 10 (4 scientists) is prepared to go to the CERN PS. It is backed up by a group of 12 (6 scientists) working on automatic spark chamber analysis.
Expenditure 0.4 Msfr./year.

Munich: 5 scientists work at the CERN PS. They contribute 0.3 Msfr./year.

Heidelberg University: 4 people (3 scientists) collaborate in a CERN PS experiment. Equipment for 0.2 Msfr. is contributed.

Heidelberg MPI: A group of 5 works on a CERN SC experiment in collaboration with Karlsruhe. Expenditure for this experiment about 0.3 Msfr.

Karlsruhe: A group of 5 (4 scientists) collaborate in a CERN PS experiment. 0.2 Msfr. are constributed.
A group of 5 work at DESY.

3. Technical Collaboration

Here the German contribution to the French-German CERN-study for a 5 m bubble chamber (cost estimate 66 Msfr., German contribution 1/3) has to be mentioned. Karlsruhe envisages a collaboration with CERN in the development of superconducting particle separators.

Karlsruhe, February 25, 1966

A. Citron

Table I

Bubble Chamber Evaluation Groups

Institute	Major equipment	Staff	Budget Msfr./year	Plans
Hamburg	3 m.t. now 7 end 1966, 4 o.l. PDP 7	20 (10sc.) + 25 stud.	0.55 staff 1.1 cap.	PEPR development
Bonn	2 m.t. o.l. PDP 6 1 bubble counting table IBM 7090	7 (6) + 15	0.34 staff 0.50 cap. (1966)	
Munich	1 HPD o.l. IBM 7090	54 (11) + 27 (including the counter and emulsion groups)		
Aachen	4 Frankenstein, 1 o.l. PDP 6 later 6 Fr., all o.l.	19 (10) + 12	0.5 staff) 1965 2.3 cap.)	
" for heavy liquid B.C.	m.t., o.l. PDP 7	15 (3) + 3	0.4 cap. (1966)	
Heidelberg	2 IEP 3 SMP o.l. IBM 7090 10 premeasuring t. o.l. PDP 7	70 (25)		

o.l. = on line
m.t. = measuring table

PRELIMINARY REPORT OF FRANCE

Facultés des Sciences
de Paris et d'Orsay

Institut de Physique nucléaire

Le Directeur

Orsay, le 18 Février 1966

Monsieur le Professeur AMALDI
Istituto di Fisica
"Guglielmo Marconi"
Piazzale delle Scienze
ROME

Cher Professeur Amaldi,

Cette lettre a pour but de vous faire part des projets nationaux en France comme nous en étions convenus au cours de la réunion de travail de l'E.C.F.A. qui s'est tenue sous votre présidence, le vendredi 11 février, au C.E.R.N.

Comme vous le savez sans doute une étude approfondie des projets d'investissements vient d'être faite dans notre pays à l'occasion de la préparation du 5ème plan (1966-1970); c'est à partir de ces données et de quelques estimations que je vous donne les éléments ci-dessous :

I - SOUTIEN DU PROGRAMME EUROPEEN

Il semble possible de dire que les physiciens français dans leur très grande majorité sont favorables à une entreprise correspondant à un développement de la collaboration européene. Nous considérons que le CERN est un succès et qu'une nouvelle étape doit être franchie. Une machine dans la gamme 200 à 300 Gev paraissait en 1963 une bonne solution. Il me semble que ce point de vue n'a pas varié depuis cette date.

II - ACCELERATEURS NATIONAUX

a) Machine d'intérêt national: en 1963, l'idée avait été avancée d'une machine à protons de 60 Gev. Des études ultérieures plus précises nous ont montré qu'une telle machine, pour des raisons essentiellement financières, ne nous paraissait pas pouvoir être inscrite au programme quinquennal. Nous avons alors proposé l'inscription d'une machine à électrons de l'ordre de 15 GeV, cette proposition a été retenue par les diverses commissions et une somme de 235 millions de francs a été prévue en octobre-novembre 1965 pour sa construction.

Cette machine à électrons n'avait pas la faveur unanime des physiciens français. Nous avons suivi avec beaucoup d'attention l'évolution de la physique faite avec les électrons de haute énergie sur les machines existantes et examiné quelles sont les diverses possibilités qui s'offrent avec une somme de 235 MF utilisable entre 1966 et 1970. Il apparaît que la très grande majorité des physiciens se prononce en faveur d'une machine à protons d'environ 45 Gev avec une intensité de l'ordre de 10^{12} dans sa phase initiale. En résumé :

- une somme de 235 MF a été retenue pour la construction d'une machine nationale (avec la recommandation d'une machine 15 Gev à électrons).

- des démarches sont en cours pour décider de la construction d'un 45 Gev à protons. Je considère comme très probable que cette solution soit acceptée.

On peut envisager dans une option optimiste que le terrain sera acquis cette année, et qu'un institut national sera vraissemblablement créé. La machine demanderait un temps de construction de l'ordre de 6 à 7 ans.

b) Accélérateur linéaire à électrons et anneau de collision: Des travaux sont en cours pour porter l'énergie de 1,3 Gev à 2,3 Gev, (énergie maximum à 50 cycles par sec.; cette énergie maximum sera seulement de 1,75 Gev à 150 cycles/sec.). L'anneau de collision $e^+ e^-$ est construit et des essais de remplissage sont en cours; des courants de 40 mA ont été obtenus en e^-.

c) Saturne: Une amélioration de l'accélérateur Saturne est en cours; en particulier l'injecteur actuel sera remplacé par un accélérateur linéaire de 20 Mev. On admet que l'intensité sera multipliée par un facteur 3 au moins.

III - CONSTRUCTION DE CHAMBRES A BULLES

En plus des chambres existantes, la France s'est engagée dans la construction de très grandes chambres, seule ou en collaboration avec divers pays.

Chambres en cours de fonctionnement

TB_3 (à liquide lourd) actuellement à Saclay; retournerait au CERN en 1966.

81 cm (H_2) fonctionne au CERN.

181 litres (H_2) est actuellement à Nimrod jusqu'en fin 1966 prévue pour aller au CERN ensuite.

Chambres en construction (ou projets décidés)

grande chambre à H_2 ($6m^3$) études en cours - construction décidée par le Commissariat à l'Energie Atomique.

en pourparlers pour aller à Serpukhov (70 Gev)

Gargamelle: projet commun à plusieurs laboratoires français (Ecole Polytechnique, C.E.A., Accélérateur linéaire) et au CERN, chambre cylindrique Ø 1, 92m, longueur 4,60m, volume $12m^3$ à liquide lourd (propane + fréon) champ magnétique ≃ 20 kgauss, une section est actuellement réalisée; serait terminée vers 1969.

Très grande chambre à H_2: collaboration Allemagne-CERN-France: $60m^3$ - Etude du projet.

IV - POTENTIEL POUR LE TRAVAIL EXPERIMENTAL

a) Chambres à bulles: Actuellement environ 150 physiciens travaillent sur des clichés de chambres à bulles provenant en totalité du CERN. De l'ordre 10^6 clichés ont été analysés en 1965. On peut grossièrement estimer que la puissance de mesure sera multipliée par un facteur au moins égal à 3 dans les 3 à 4 ans à venir. Projets HPD et SMP en cours de réalisation.

b) Expérimentation sur les faisceaux à l'aide de dispositifs électroniques: Actuellement des physiciens principalement au C.E.A. et à l'Institut de Physique Nucléaire effectuent ou participent à des expériences de ce type. Ce mouvement va s'accentuer, en particulier le laboratoire de l'accélérateur linéaire envisagera d'aborder des expériences avec protons de haute énergie. Si on estime à 3 le nombre actuel d'équipes purement nationales on peut penser que ce chiffre sera de 6 à 7 (de 10 physiciens) vers 1969-1970, et qu'à cette époque, sur ces équipes trois pourraient être en permanence auprès des accélérateurs du CERN.

Toutes ces estimations résultent de discussions préliminaires avec quelques collègues. Il semble qu'elles soient possibles compte tenu des prévisions d'accroissement du nombre de chercheurs et de crédits d'investissement au cours des quatre prochaines années.

Cher Professeur Amaldi, je reste à votre disposition pour tout renseignement complémentaire dont vous pourriez avoir besoin et je vous prie de croire, à mes sentiments les meilleurs.

Jean Teillac

PRELIMINARY REPORT OF ITALY

THE SITUATION IN ITALY ON ACCELERATORS AND PROGRAMMES

(a preliminary sketch)

I shall list in part 1) the experimental facilities available in Italy at present or in the foreseeable future; in part 2) the distribution of Italian groups among Italian and European accelerators will be shown.

1) - The main facility available at present is the Frascati 1.1 GeV electron-synchrotron, which is in operation since 1959.

Since February 1965 an extracted electron beam is available of energy up to 1.0 GeV and intensity of $\sim 10^{10}$ el/s.

The (1.5 + 1.5) GeV electron-positron storage ring, Adone, is now in advanced construction; it should start operation in late 1966 or early 1967.

The electron-positron linear accelerator which will be used as injector of Adone is now under test at Frascati. In the factory it has reached an energy of 400 MeV for electrons and of 350 MeV for positrons, at a peak intensity of 100 mA. This Linac will also be used directly for experiments (electron, pion, neutron beams) independently of Adone.

It should finally be mentioned that a committee has been working in the last few months at a preliminary study for the construction of a proton-synchrotron in the energy range of some tens of GeV.

2) - There are in Italy approximately 37 groups engaged in high-energy physics. The figure is approximate because of the many experiments to which members of several groups participate.

At the Frascati synchrotron 13 groups are working at present; most of them (10) use counters and spark chamber techniques, two use bubble or cloud chambers, one uses emulsions; three of these groups are mainly interested in nuclear structure.

Twenty groups use the CERN accelerators (17 the PS, two the SC); 14 of them are bubble chamber analysis groups; 5 counter and spark chamber groups; one emulsion group; one of them is working in nuclear structure studies. To these 20 groups the Italians working in the CERN internal groups should be added.

Two groups are collaborating with DESY groups at Hamburg.

One (bubble chamber) group has received film from Saclay.

Two (bubble and spark chamber) groups collaborate with American groups at AGS and CEA.

Giorgio Salvini

- - - - - - - - - -

PRELIMINARY REPORT OF THE NETHERLANDS

Prof. Dr. D. Harting February 23, 1966

Prof. E. Amaldi
Physics Department
University of Rome

Rome
Italy

Dear Professor Amaldi,

As agreed on February 11th I send you approximate figures on the number of physicists working in, and the amount of money spent on, high-energy physics in the Netherlands.

The total number of physics graduates (at least Dutch doctoral examination, but not necessarily Ph.D.) working in high-energy physics was 50 on January 1st, 1966.
Of this number, 27 were working in theoretical physics, 23 in experimental physics.

The total amount of money spent on high-energy physics, including salaries, instrumentation, rent of buildings, was approximately in millions of Swiss francs:

	Dutch groups	CERN	Total
1964	3.1	4.4	7.5
1965	4.0	6.0	10.0
1966	5.0	7.4	12.4

The heading "Dutch groups" includes the following:

1) A counter beam at CERN

3 physicists Expenditure 1965 0.2 M Sfr

2) An experimental group working on bubble chamber picture analysis at Amsterdam

14 physicists Expenditure 1965 1.3 M Sfr

3) An experimental group working on bubble chamber picture analysis at Nijmegen

6 physicists Expenditure 1965 1.3 M Sfr

4) Groups of theoretical physicists at:

Amsterdam, Groningen, Leiden, Nijmegen, Utrecht.
27 physicists Expenditure 1965 1.2 M Sfr

The heading "CERN" includes the Dutch contribution to CERN and some additional expenses, for instance some travel expenses to and from CERN.

Plans for the future

A general increase of about 10-15% per year in personnel and money is foreseen for the period 1966-1970 for the gradual expansion of the present facilities.

It is not foreseen that an accelerator will even be planned during this period. The 1 BeV proton accelerator at Delft will probably not be used for physics.

There is a project at present under consideration by the Dutch government to build a 300 MeV linear electron accelerator with long duty cycle, which would have to be finished in 1972. The budget for this machine would rise from about 5 M Sfr/year in 1968 to 7 M Sfr in 1975.

There is a further project at the same stage for a national institute for high-energy physics, where automatic analysis of bubble chamber pictures would be done and which would serve as a base for two or three Dutch counter teams. Started in 1968 on a budget of 3 M Sfr a year, this institute would run on a yearly budget of approximately 10 M Sfr after a few years.

I hope to see you again on the 7th of March.

Yours sincerely,

D. Harting

- - - - - - - - - - -

PRELIMINARY REPORT OF NORWAY

A SUMMARY OF THE EXPERIMENTAL HIGH-ENERGY PHYSICS IN NORWAY

University of Bergen

A group from the University of Bergen has for the last years taken part in collaborations working on experiments using heavy-liquid bubble chamber technique.

Earlier work

In the T8 experiment in April 1962, 200.000 pictures were taken with the Ecole Polytechnique heavy-liquid bubble chamber exposed to a beam of 1.5 GeV/c K^- mesons. The pictures were analysed by groups from CERN, Ecole Polytechnique, University College, Rutherford Laboratory and the University of Bergen. The main purpose was a study of the properties of the Ξ particles. In November the same year the Bergen group took part in the T11 experiment in the same collaboration using the CERN heavy-liquid bubble chamber exposed to a beam of 3.5 GeV/c K^- mesons. The study of the properties of Ξ particles was continued in this experiment.

Present work

For the time being the Bergen group is working on the X_2 experiment in collaboration with CERN, Ecole Polytechnique, Nijmegen, Achen, Torino, Padua and Bari. 700.000 pictures have been taken with the CERN heavy-liquid bubble chamber exposed to a beam of K^+ mesons, stopping in the chamber. In this experiment the various decay-modes of K^+ especially in connection with the CP violation will be studied.

The Bergen group is also working on an experiment in collaboration with the Ecole Polytechnique. This experiment was carried out in January - May 1965 at Saclay. The Ecole Polytechnique bubble chamber was exposed to a beam of 2.2 GeV/c π^+ mesons, giving 300.000 pictures. The purpose of the experiment is to study the neutral decay modes of the ω^0 and η^0 mesons.

Concerning experimental equipment, the group disposes of a scan-table, 1 Enetra 112 measuring device and 1 coordinatograph.

In the last year investigation has also been made with the scintillator technique searching for heavy fundamental particles using cosmic rays. This group also takes part in experiments in CERN studying small angles p-p scattering at high energy.

University of Oslo

Present work

From about 30.000 pictures taken in the Ecole Polytechnique heavy-liquid bubble chamber exposed to a beam of stopping K^-, a study has been made of Λ°-p effective mass spectrum from multi-nucleon K^- captures.

Four prongs events from 1.2 GeV/c antiprotons in the Saclay 80 cm H_2 chamber are studied in collaboration with the University of Liverpool. The events have hitherto been analyzed to study pion resonances. This work will continue.

Concerning experimental equipment the group disposes of three scan-tables, 1 Enetra 112 measuring device.

Norwegian Institute of Technology, Trondheim

This institute has hitherto not taken part in collaboration on experimental work in CERN, but in the near future an experimental group will be organized.

In the last years also several fellows from the institutes mentioned above have been attached to CERN, and several Norwegian physicists and engineers are staff members in various divisions.

PART II

Summary of physicists working on high-energy physics

Bergen:	
Experimental	6
Theoretical	0
Number of physicists on temporary leave	5
Oslo:	
Experimental	7
Theoretical	2
Number of physicists on temporary leave	2
Trondheim:	
Experimental	0
Theoretical	5
Number of physicists on temporary leave	2

In addition to the letter of February 26, the following remarks concerning the University of Oslo can be given:

An experiment by a collaboration among Scandinavian countries is scheduled at the PS in CERN. In this experiment (T82) the CERN 2 m bubble chamber will be exposed to a proton beam of momentum 19.5 GeV/c. A study of multinucleon resonances will be made.

- - - - - - - - - - -

PRELIMINARY REPORT OF SPAIN

Ministerio de Industria
Junta de Energia Nuclear

Professor E. Amaldi
CERN
1211, G e n e v a 23
S U I Z A

Madrid - February 18th 1966.

Dear Professor Amaldi,

I am writing to inform you of the work being done in our country in the field of High-Energy Physics. All experimental work is carried out in collaboration with foreign institutions.

Valencia Group

a) Emulsions

1) Interactions of 15 GeV antiprotons with the emulsion nuclei.

2) Study of fragmentation processes in heavy nuclei using emulsions under strong magnetic fields.
   i) measurement of track widths for charge discrimination.
   ii) angular and momentum spectra of fragments.
   iii) Check with results of a similar study with π^- of 17 GeV.

3) Study of the heavy fragments produced in interactions of 12 GeV protons (Experiment E 52) with complex nuclei. This study is made in collaboration with CERN and Warsaw.

4) Study of the heavy hyperfragments produced by k^- of 800 MeV/c.

5) Study of the light hyperfragments produced by k^- of 800 MeV/c and of their mesic and non-mesic decays. Comparison with the results of the Oxford Emulsion Group.

6) Study of the energy spectrum of middle-energy particles ($p<1$ GeV/c.

7) Analysis of plates from Oxford University
   i) hyperfragments produced by k^- of 6 GeV
   ii) k^- interactions at rest.
   iii) π^- absorption by carbon in emulsions loaded with carbon powder.

b) Bubble chamber

1) Collaboration with JEN Physics Division in the scanning of films taken at CERN (81 cm. hydrogen chamber, 5,7 GeV/c antiprotons) Study of the annihilation in two charged pions and the large-angle elastic scattering.

2) Statistic study of the π^- interactions of 1.18 GeV/c with pionic nuclei. This experiment was carried out with the BP 3 bubble chamber charged with heavy liquid. The films were sent by the Physics laboratory of the Ecole Polytechnique (Leprince-Ringuet).

c) Theoretical Group

1) Research work in weak interactions (Prof. Pascual and Prof. Galindo)

2) "Capture of mesons by the He^3" by Mr. Pascual de Sans.

Madrid Group

a) Experimental work

Study of the reaction $p\bar{p} \rightarrow p\bar{p}$ (large momentum transfer) and of the $p\bar{p}$ annihilation into two pions.
The films were obtained at CERN ($\bar{p}$ of 5.7 GeV/c, 81 cm. hydrogen Bubble Chamber).

b) Theory

1) Symmetry groups in weak interactions.

2) Current algebras.

3) Non compact groups.

Seville Group

1) $p\bar{p}$ elastic collisions in nuclear emulsions exposed to a beam of 3 GeV/c antiprotons (CERN).

2) Inelastic interactions of a 600 MeV proton beam with emulsion nuclei.

3) Study of the heavy ion spectrum in a stack of 30 plates exposed to cosmic radiation (Aire sur l'Adour.).

4) 200 MeV and 1.05 GeV Photon materialization.

5) Study of hyperfragments produced in nuclear emulsions exposed to high-energy protons (CERN Synchrotron).

Zaragoza Group

1) Parastatistics.
2) Applications of unitary symmetry.
3) Group extensions.
4) Non compact groups.

Thank you very much for guidance in this matter.

Yours faithfully,

J.A. Ruiz.

- - - - - - - - - -

PRELIMINARY REPORT OF SWEDEN

Physics Research in Sweden 1963-1966 using the CERN facilities

Stockholm (Institute of Physics, University of Stockholm)

Analysis of bubble chamber pictures : Three large-scale experiments have been measured and analysed. They concern 3 GeV/c $K^+ + p$ elastic and three-body inelastic final states, 10 GeV/c $p + p$ leading to strange particle production and 10 GeV/c $p + p$ high multiplicity events. There are two Enetra measuring machines in operation. One large scanning table for CERN 2m HBC film will be delivered in 1966.

Spark chamber experiments : Physicists from the Institute participate in spark chamber experiments at CERN. Spark chamber equipment has been built at the Institute.

Computers : The university institutions in the Stockholm area will be equipped with an IBM 360/M75 computer in the middle of 1967. A terminal machine CD 3200 will probably be installed at the Institute of Physics communicating with the main machine via a high-speed connection (40.8 Kbaud). The operations of the Enetra measuring machines will be computer-guided.

Stockholm (The Institute of Physics, The Royal Institute of Technology)

The Institute participates in the ISOLDE (isotope-separator-on-line) project.

Studsvik (The Swedish Research Council's Laboratory)

The laboratory participates in the ISOLDE project.

Lund (Institute of Physics, Institute of Theoretical Physics, University of Lund)

Development of the 1.2 GeV electron synchrotron laboratory :

Accelerator : The synchrotron in Lund was started up with a beam in 1963. Later studies and developments have been directed to improve the performance and to remove various shortcomings of the machine.

Intensity loss due to the acceleration in two steps at variable and constant frequency has occurred and been removed only partly. 12 MeV microtroninjector under preparation will remove need for dual acceleration system. Present max. intensity 3.10^{10} electrons/sec. at 12 p/sec. Maximum energy at this intensity 700-900 MeV. Improvements under way to allow high intensity up to design energy.

Experimental facilities : Three experimental areas of 20, 60 and 200 m^2. Two photon beams prepared from rotating target (burst length 200 μsec.). General-purpose 40 cm diameter magnet and high-precision analysing magnets with power supplies available. Helium and hydrogen cryostat under installation.

Experiments : Photoproton production in nuclei (counters, runs started).

Photoactivation of nuclei (radiochemistry, runs started).

π^0 -photoproduction (counters, spark chambers, automatic analysis by computer, under preparation).

Theory : Many aspects of theoretical elementary-particle physics and field theory are studied. Important contributions to the models of strong interaction production processes have been made.

Göteborg (Institute of Physics, and Institute of Mathematical Physics, Chalmers University of Technology; Institute of Theoretical Physics, University of Gothenburg)

Nuclear structure research : The Institute participates in the nuclear structure research carried out at the CERN SC. A large crystal diffraction spectrometer has been brought to CERN.

By measuring the x-rays from pion capture a precision determination of the pion mass and the myon-neutrino mass will be made and the pion-nucleon interaction will be studied. By measuring the x-rays from myon capture a precision measurement of the vacuum polarization will be made.

The ISOLDE project (isotope-separator-on-line) : The Institute is engaged in the ISOLDE project.

Theory : The main interest is focused on group theory, weak interactions and quantum electrodynamics.

Summary : During the period there has been a considerable increase in the experimental activity in high-energy physics and nuclear structure research carried out at the CERN SC in the three places Stockholm, Lund and Göteborg. There are strong groups in theoretical elementary-particle physics in Lund and Göteborg.

The participation in the nuclear structure research carried out at the CERN SC must be regarded as important. It will engage the nuclear structure physicists and make them acquainted with the work at CERN.

The informal Scandinavian collaboration in the past has now grown so that more organized collaboration has become necessary. Regular meetings of Scandinavian high-energy physicists have been held in Copenhagen (Nov. 1964), Stockholm (May 1965) and Spåtind, Norway (Jan. 1966). Next meeting will be held in Finland.

The bubble chamber groups in Copenhagen, Helsinki, Oslo and Stockholm will collaborate in the analysis of high-energy proton-proton interactions at 20 GeV/c in the CERN 2m HBC.

Detailed proposal for a Scandinavian 10 GeV proton synchrotron has been worked out. The project was not approved by the Swedish Atomic Research Council. Thus it will not be realized for the time being.

Detailed proposal for a Scandinavian data centre with an automatic measuring device for bubble chamber film has been put forward.

Sigward Nilsson

Genève, 22 February 1966

- - - - - - - - - -

PRELIMINARY REPORT OF SWITZERLAND

HIGH-ENERGY PHYSIC IN SWITZERLAND

I. National Accelerator Programme

Actual Situtation :

An accelerator with following specifications is in course of development by a group of ETH, Zürich :

Particles, Energy	: Protons, 500 MeV fixed.
Current	: design goal 100 A
Structure	: Two stages :
	1) Isochronous cyclotron (conventional) to 70 MeV, (possibly H^- acceleration) as injector into:
	2) Isochronous ring accelerator with 8 C-shaped magnet sectors and 4 accelerating cavities.

Status beginning 1966 : Basic orbit dynamics and 1:5 scale magnet model terminated, construction of one full-scale magnet sector begun. Experiments on RF system to reach 350 kV in full-scale cavity model in vacuum in advanced stage. Engineering of machine and planning of buildings in starting phase.

Changes since 1963; comparison to prognostics : In year 1963 type of accelerator was frozen. No significant changes since. Development slow by one year, due to delay in final fund allocation (expected in March 1966). Budget for accelerator and buildings increased to 90 Mio s.Fr. Close co-operation with industrial firm MFO is planned for construction phase.

Future plans : Accelerator to be ready in 1971/72 at a new national research facility at Villigen (close to Swiss Reactor Institute Würenlingen). Research in elementary particles (with increased collaboration with CERN), nuclear structure physics and technical and medical applications.

II. Research in High Energy

Actual Situation compared to 1963 :

As it can be seen in the attached table, the main effort comes now from Geneva and Zürich, it goes into participation with several counter groups at CERN. However, at Geneva's University this participation needs to be concentrated in one or two groups.

In B.C. picture evaluation the effort comes from the Universities of Bern, Fribourg and Neuchâtel but is mainly beginning with a total of four half-automatic measuring tables.

The emulsion technique is used by the three last Universities and the University of Lausanne, all are at the moment converting into B.C. picture evaluation.

The development since 1963 is shown by an increase of 30% in budget and 70% in scientific staff.

Future plans

Apart from the 500 MeV accelerator in Zürich there is a proposal from the Universities of Geneva, Lausanne and Neuchâtel for a common Centre of Research in High-Energy Physics. In its laboratories the equipment for visiting teams at CERN and Villigen will be built; B. Chambers pictures will be evaluated with automatic and semi-automatic tables.

The results of all experiments will be treated with a large computer of this centre as well as with small computers on line. A rough estimate of the investment in scientific permanent equipment only, for a starting period of 3 years is of 10 million s.fr. Besides a large part of the existing equipment will move in this centre.

Actual Situation in Research compared to 1963

University	Activity	Year 1965-1966		Year 1963-1964	
		Budget*	Scientific** Staff	Budget*	Scientific** Staff
Bern	Emulsions B. Chambers	36 K.s.fr.	7	32 K.s.fr.	9
Fribourg	B. Chambers	130	8	90	4
Geneva	Participation to CERN Counter Groups	650	10	330	4
Lausanne	Emulsions	53	6	32	3
Neuchâtel	Emulsions B. Chambers	40	3	30	1
ETH Zürich	Participation to CERN Counter Group	400	7	500	3
	Total	1309 K.s.fr.	41	1014 K.s.fr.	24

* Does not include salaries.
** Including about 50% post-graduate students preparing doctor degree.

PRELIMINARY REPORT OF THE UNITED KINGDOM

Notes on the U.K. High-Energy Physics programme

1. National Programme

(i) University machines

At the time of the Amaldi report the operating accelerators in the U.K. programme were -

(a) The Liverpool cyclotron.

(b) The 450 MeV Glasgow electron synchrotron.

(c) The Birmingham proton synchrotron.

These accelerators are all becoming obsolescent, and will probably close down during the next 5 years or so, in the order (c) then (b) then (a). There is no present intention of providing a new high-energy accelerator at any British University, and in the programme over the next 5 - 10 years we expect that the only University machines will be in the nuclear structure energy range (say around 100 MeV).

(ii) National Institute Machines

The main British effort is at present concentrated on the two National Institute Machines.

Rutherford Laboratory, Nimrod, 7 GeV protons,
has been in operation again since February 1, 1966,
after the alternator failure in February, 1965.

Daresbury Laboratory, Nina, 5 GeV electrons,
expected to operate in Autumn 1966.

These two machines, together with their experimental programmes, make the largest demand on the British nuclear physics budget, both in terms of money and scientific manpower. At both accelerators (prospectively for Nina) the experimental programme is largely carried on by University physicists. The numbers engaged are approximately -

Nimrod - 120 physicists
Nina - 40, growing to 60 physicists.

The total budgets are approximately -

Nimrod - £6M p.a. Nina - £3M p.a.

Over the next 5 - 10 years we hope to operate Nimrod and Nina on a slowly increasing budget. There is an improvement programme for Nimrod, but this is at present held back for lack of funds. The main developments expected at Nimrod and Nina over the next few years are relatively small, e.g. extension of experimental areas. In a fully developed state we expect that something like a total of 240 experimentalists will be basing their research work on Nimrod and Nina.

At present there are no plans in the U.K. for high-energy accelerators beyond Nimrod and Nina. It seems unlikely that any new high-energy accelerators will be proposed before 1970, and that none will be constructed until funds become available through the obsolescence of, say, Nimrod.

2. British Collaboration with CERN

Much the largest British use of CERN has been in connection with the bubble chamber programme. There are 7 major bubble chamber groups in Britain:-

Imperial College, London.
University College, London.
Oxford.
Rutherford Laboratory.
Birmingham.
Liverpool.
Glasgow.

Most of these are now moving to second generation measuring machines (SMP at Glasgow, FSD at Imperial College, PEPR at Oxford) and they are each expecting to measure 100,000 events or more per annum. There are about as many smaller groups and by 1968 we may expect there to be as many as 200 bubble chamber experimentalists in Britain.

A rough estimate is that the bubble chamber effort will be equally divided between work at CERN and at Nimrod. The present budget for support of bubble chamber activities in the British Universities is tending towards £1M p.a.

British collaboration in electronics experiments at CERN has been on a much smaller scale. At present I know only of two groups - a Rutherford Laboratory group engaged in a K° decay experiment (transferred from Harwell) and an Oxford group engaged in nuclear structure experiments with the SC. However, Hine's paper SPC/213 shows 16 British physicists among the 78 Scientific Staff and Fellows engaged in electronics experiments at CERN during 1965. This is not far out of line with expectation, but it is believed that British physicists are less numerous among the Visitors engaged in electronics experiments.

Present manpower estimates are that by 1975 there will be at least 180 post Ph.D. experimental physicists from the U.K., trained in high-energy physics and not catered for by existing accelerators, either at the national level or at CERN. These estimates probably need revision, but they provide a reasonable basis for the assertion that the U.K. should be able to take up its share both of the "improved" CERN and of a future "300 GeV" machine.

J.C. GUNN

21st February, 1966

\- - - - - - - - - -