Closing remarks

C. Rubbia (CERN)
Towards the LHC Experimental Programme
General Meeting on LHC Physics & Detectors

Closing Remarks

C. Rubbia

8 March, 1992
Evian-les-Bains, France

MEMBER STATES RESPONSE TO THE LHC PROJECT

☐ A two step procedure toward LHC has been proposed by the CERN management, namely

(1) an "Approval in Principle" of LHC as the right and next project for CERN, pending a number of further clearly defined conditions and

(2) the Final Approval with the consequent starting of construction and final approval of the experimental programmes.

☐ For optimum progress of the project, the Approval in Principle was requested for not later than June 1992 and – provided that all conditions can indeed be met – a final LHC approval should be given during the second half of 1993, namely in about two years from today."

☐ Step (1) has already been completed: CERN Council, on 20 December 1991 adopted unanimously a resolution (see transp) endorsing the management's and SPC recommendations.
A two step procedure toward LHC is proposed, namely (1) an "Approval in Principle" of LHC as the right and next project for CERN, pending a number of further clearly defined conditions and (2) the Final Approval with the consequent starting of construction and final approval of the experimental programmes. For optimum progress of the project, the Approval in Principle should be reached not later than June 1992 and — provided that all conditions can indeed be met — a final LHC approval should be given during the second half of 1993, namely in about two years from today.

- The Director-General has been asked to provide before the end of 1993 a detailed information on the costs, the involvement of the Member and non-Member States and on the factors set out in 2.2 of Document CERN/CC/1891, so that Council may move towards a decision on the LHC;

- In particular, information is required on the following aspects:
  
a) the technical feasibility of the project;

  b) the best estimate of the final cost of the machine, the sources of funding and the delivery schedule of the components, including the possible participation of non-Member States according to the so-called "HERA Model";

  c) a definition of the experimental programme, its goals and its direct costs to CERN as well as the indirect costs to be sustained by the Funding Agencies of the main participating institutions".

- This meeting is the first consequent step in defining the experimental programme of the LHC, as requested by Council.
COUNCIL RESOLUTION ON LHC

COUNCIL,

Following presentations of both the needs of the science and of the nature of the proposed machine done at its Session on 19 December 1991, as well as of the preliminary indication of costs,

Agrees:

1. that in all these respects, the LHC is the right machine for the advance of the subject and of the future of CERN;

2. that the Director-General be asked to provide before the end of 1993 detailed information on the costs, the involvement of Member and non-Member States and on the factors set out in 2.2 of Document CERN/CC/1891, so that Council may move towards a decision on the LHC;

3. In particular, information is required on the following aspects:
   a. the technical feasibility of the project;
   b. the best estimate of the final cost of the machine, the sources of funding and the delivery schedule of the components, including the possible participation of non-Member States according to the so called "HERA Model";
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We operate under the initial assumption that the initial programme for the LHC consists of:

- 1 or 2 general purpose detector(s) to study proton-proton collisions. In case of >1 detector, "complementarity" must be ensured
- 1 dedicated heavy-ion facility + parasitic use of the other detectors
- 1 or 2 non-mainstream experiments (beauty, neutrino, ...)

This guide-line has been endorsed by the SPC and constitutes:
- a broad and competitive programme fully exploiting the diverse physics opportunities of the LHC, while
- taking into account the inevitable limitations in manpower and financial resources, which exclude unnecessary duplication of experimental efforts.

It is assumed that a possible electron-proton option will only be considered at a later stage and on the basis of the results of HERA.

Evian, March 8, 1992
The spirit in which these activities are organized is to cover all aspects of instrumentation in a LHC detector in a first approximation, irrespective of a link to a specific LHC (proto)-collaboration. This has actually worked out, as demonstrated by the EOI in Evian, which rely to a large extent on common R&D projects.

It is important to encourage and continue a strong detector R&D programme in order to assure the success of a project as ambitious and complex as the LHC. The technical expertise embodied in the DRDC and the experimental responsibility of the future LHCC will have to be merged to maintain proper guidance for the development of the LHC, at least for the next few years. The DRDC will therefore have to be involved in the choice of experimental projects.

There is the risk that the "technology clock" will stop soon after the approval has crystallized proposals and this must be avoided.

Before embarking in the mass production of the detector elements, the equivalent of the so-called "full string test" for the machine is necessary, with the corresponding need of large amount of test beams and R&D.
50. Users from Member States in DRDC proposals (September 1991).
CONCLUSIONS

- Participation is intense & enthusiastic. Progress impressive: host of the 1st year goals have been achieved, in some cases faster or better than planned.

- Several new powerful detectors are already available for less demanding applications.

- However further progress is needed for LHC.

- Visible influence of Protocollaboration positive aspect: better focussing on realistic goals. Negative aspects should be minimized (a hope...)

GENERAL REMARKS

☐ The interest shown by the large number of participants at the Evian meeting and the impressive number of institutions indicating their interest in joining the experimental programme demonstrates that indeed the LHC is the right machine for the future of CERN.

☐ The physics case since Aachen has been confirmed and strengthened both on the theory front and on the feasibility front in all areas, as obvious for instance from the presentations of Expression of Interest:

- proton-proton
  => complementarity, more than one detector,
  => highest luminosity, how high?
  => general purpose vs “specialized”
  => matching detector vs. machine parameters (one bunch crossing?)
  => cost & construction time: evolutionary approach
SUMMARY OF EXPRESSIONS OF INTEREST

• **PP :** a) Main Detectors
  - ASCOT
  - CMS
  - EAGLE
  - L3+1
  P. Norton
  M. Della Negra
  J.C. Lottin
  P. Jenni
  S.C.C. Ting

b) B Physics
  - CP Violation in B (forward spectrometer in collider mode)
  P. Schlein
  - CP Violation in B (extracted beam FT)
  G. Carboni
  - CP violation in B (GAS JET FT)
  T. Nakada

• **Heavy ions :**
  - Dedicated general purpose detector
    J. Schukraft
  - DELPHI
    G. Jarlskog
  - CMS
    L. Ramello

• **Neutrinos :**
  K. Winter
  L. Vannucci

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**B physics :**
- LHC is competitive and complementary to dedicated B factories
- how to extract the beam vs internal target option?
- it must be done (CP)

**Heavy ions**
- very fundamental physics (QCD & vacuum phase transitions: hydrogen atom vs solid state)
- LHC has a clear advantage over RHIC and SSC is not interested
- detector occupancy very high, but not so much higher than high luminosity pp + pileup
- low event rate, time-multiplexed data acquisition (TPC)
- Second generation studies with not so spectacular signatures: muons, strange particles, J/ψ etc
The large interest for the LHC programme can be judged by the impressive amount of work which was done in the past two years and by the open and frank discussions which followed each presentation. However, much work is still to be done to fully exploit the broad physics potential of LHC and to optimize resources. Let me offer some remarks on this subject:

- There is a need to confirm that there is an optimal match between the machine and the detectors.

- There is some lack of focus in the detector approach resulting in compromised detector performance. Generally speaking, lack of definition grows going from the outside to the inside:
  - muon detection
  - hadron calorimeter
  - e.m. calorimeter
  - tracking

- There is a need to optimize detector cost versus detector performance.

(a number of interesting ideas but need a lot of DRDC type of work. One cannot invest 50-100 MSF without accurate testing and pilot prototypes

Can one do it all in less than two years? When shall we
  - be ready with a final design and give "approval"?
  - have the programme fully defined and prices known with precision?

Experiments will obviously be approved in the first place on their physics merits. However, financial considerations have to play an important role from the start and will be an important element in the approval process. An optimum has to be found for the ratio of physics potential to costs, with "de-scoping" iterations to be avoided.

Evolutionary vs. "all the way" approach to the detector construction. Strong temptation in view of money constraints. Easy ("light" (<300 GeV)H⁰,Z',top) vs. second generation, sophisticated physics (heavy H⁰,H±,strongly inter. W&Z, SUSY)

While the size of the LHC detectors is partly dictated by the physics needs, big is not necessarily beautiful and "megalomania" should be suppressed.
Theoretical Determination of the Masses of
the Higgs Boson and the Top Quark in the Standard Model

Per Osland
Department of Physics, University of Bergen, Allégri. 55
N-5007 Bergen, Norway

and

Tai Tsun Wu
Gordon McKay Laboratory, Harvard University
Cambridge, Massachusetts 02138, U.S.A.

ABSTRACT
By purely theoretical arguments involving the absence of certain divergences in the
Standard Model, the masses of the Higgs and the top quark have been found to be

\[ m_H = 190 \text{ GeV} \quad \text{and} \quad m_t = 120 \text{ GeV}. \]

This value of \( m_t \) is within the range favored by existing phenomenology. The Higgs of this
mass has a width of 1 GeV, with the major branching ratios of 77%, 22% and 1% into
\( W^+W^- \), \( ZZ \) and \( b\bar{b} \), and is quite easy to detect at SSC and LHC even without enhanced
luminosity.

* Work supported in part by the Norwegian Research Council for Science and the Hu-
manities.

§ Work supported in part by the U.S. Department of Energy under Grant DE-FG02-
84ER40158.
The process leading to the definition of the LHC experimental programme should be concluded by the end of 1993, in order to be synchronized with the intended formal approval of the LHC.

This implies the following tentative timetable:

- Letters of intent (L.o.I.) to be submitted by 1 August 1992
- Open presentations of L.o.I. in September 1992
- Selection of projects toward of a full technical proposal by the end of 1992
- Final approval of experiments by end of 1993, depending on Council decision

An LHC Committee (LHCC) will be established in the next few months to organize this programme according to the standard practices of the CERN experimental committees.
The approval procedure for experiments is not "scale invariant". A 400 MSF project cannot follow the same procedure for say, a 400 kSF experiment. The CERN Management, National Laboratories and Funding Agencies must actively participate in the process. But the Management will try to preserve the peer review mechanism that we are accustomed to in our field.
NON MEMBER STATES PARTICIPATION

- The LHC will be a unique facility offered by CERN to the particle physics community and it is confirmed that indeed the LHC is the right machine for the future of CERN.

- It is good to see that the enthusiasm for the LHC extends, as is the case for other elements of the CERN programme, to a large number of groups from non-Member States. The LHC will therefore continue CERN's tradition of offering frontline facilities to a large world-wide community.

- The LHC will be CERN's most ambitious project requiring an unparalleled effort in both the realization of the machine and, together with the users, of the detectors. It is obvious that in providing these physics opportunities CERN is expecting the many non-Member States intending to participate in the LHC programme to make a substantial effort in making the project feasible thus assuming their responsibility in making the LHC a success.

CONCLUSION

- LHC is a project of a new magnitude for CERN and for the entire international High Energy Physics community.

- The CERN management has to be closely associated not only to the construction of the facility (the LHC accelerator complex) but also to the experimental programme. At the same time it is important to preserve the peer review mechanism that we are accustomed to in our field.

- The LHC programme has an extraordinary scientific potential. It is very much a project for the young generation of physicists which will certainly find in LHC a tremendous challenge and a new frontier.
EOIs for LHC Experiments - March 1992

Total No. of Institutions: 249
(Including 90 Institutions (36%) from Non-MS)

- Member States
- CERN
- Non-Member States
- USA
- CIS (former USSR)
- others

EOIs - LHC pp collider option - March 1992

Total No. of Institutions: 197
(Including 90 Institutions (46%) from Non-MS)

Contr. to CERN budget in %
scaled rel. to No. of Persons from MS

- ASCOT
- CMS
- EAGLE
- L3+1
- Beauty

No. of Institutions in %

Austria Belgium Czechoslovakia Denmark Finland France Germany Greece Italy Netherlands Norway Poland Portugal Spain Sweden Switzerland UK CERN Non-MS