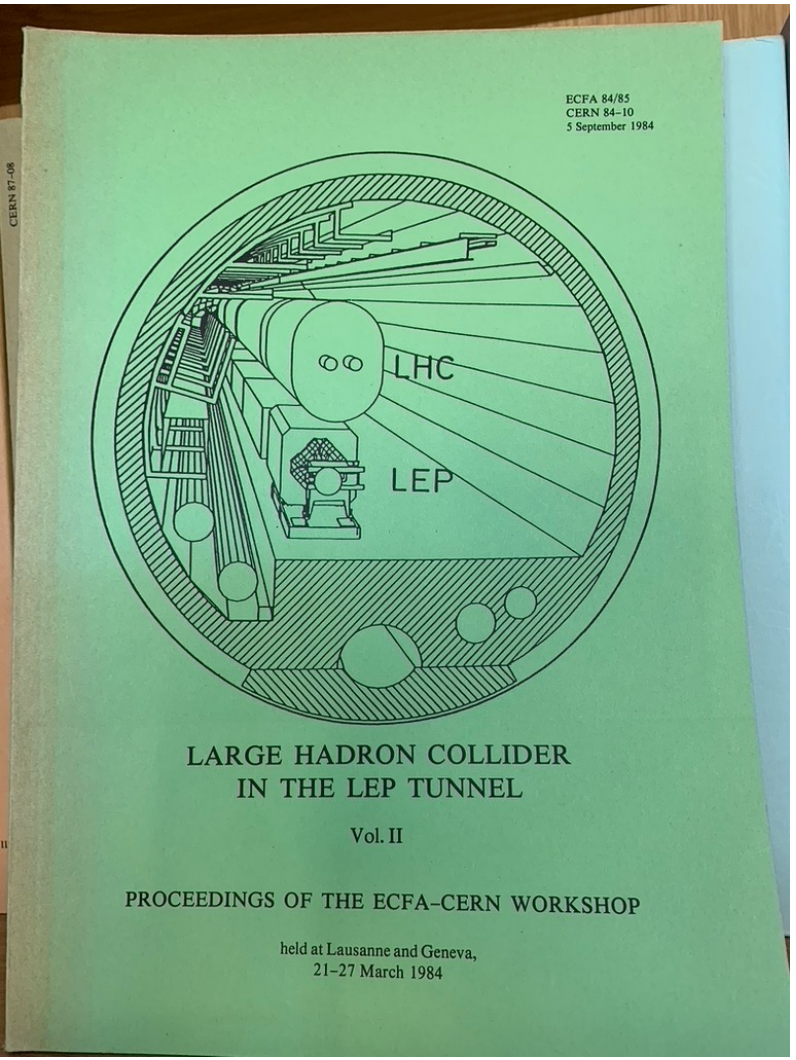
Facilitating a Future Collider Lessons from the LHC and the Funding Landscape

Andy Parker

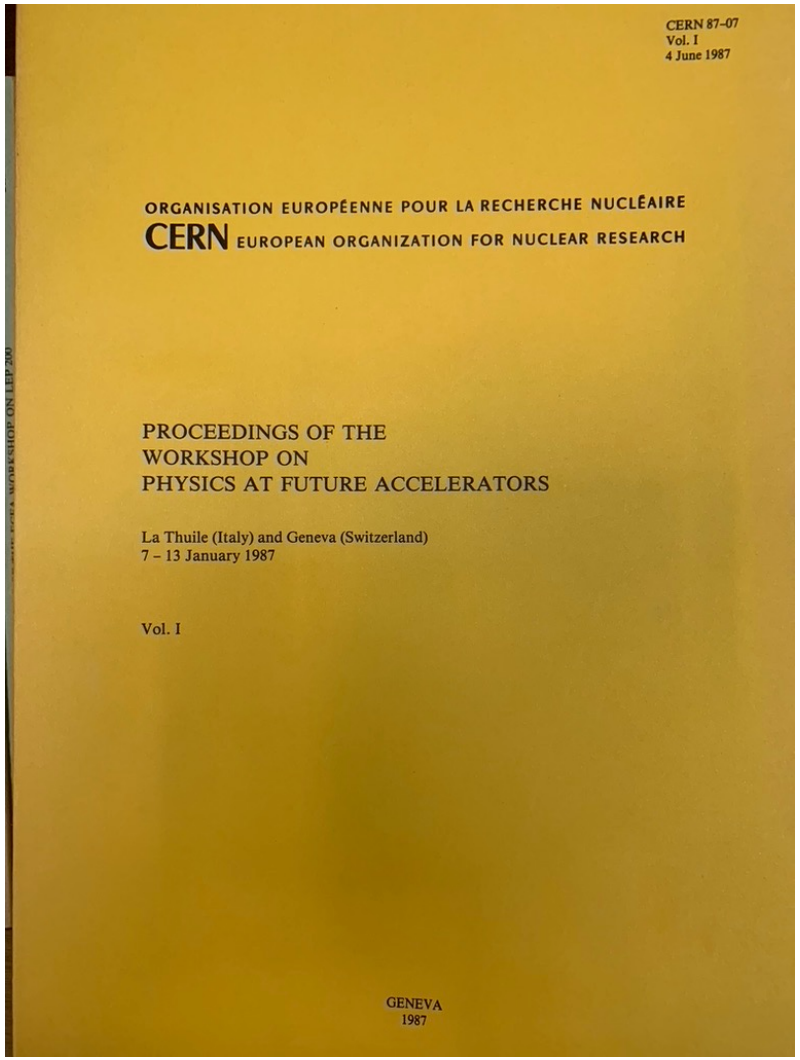
Cambridge

LHC Genesis

1984



1987



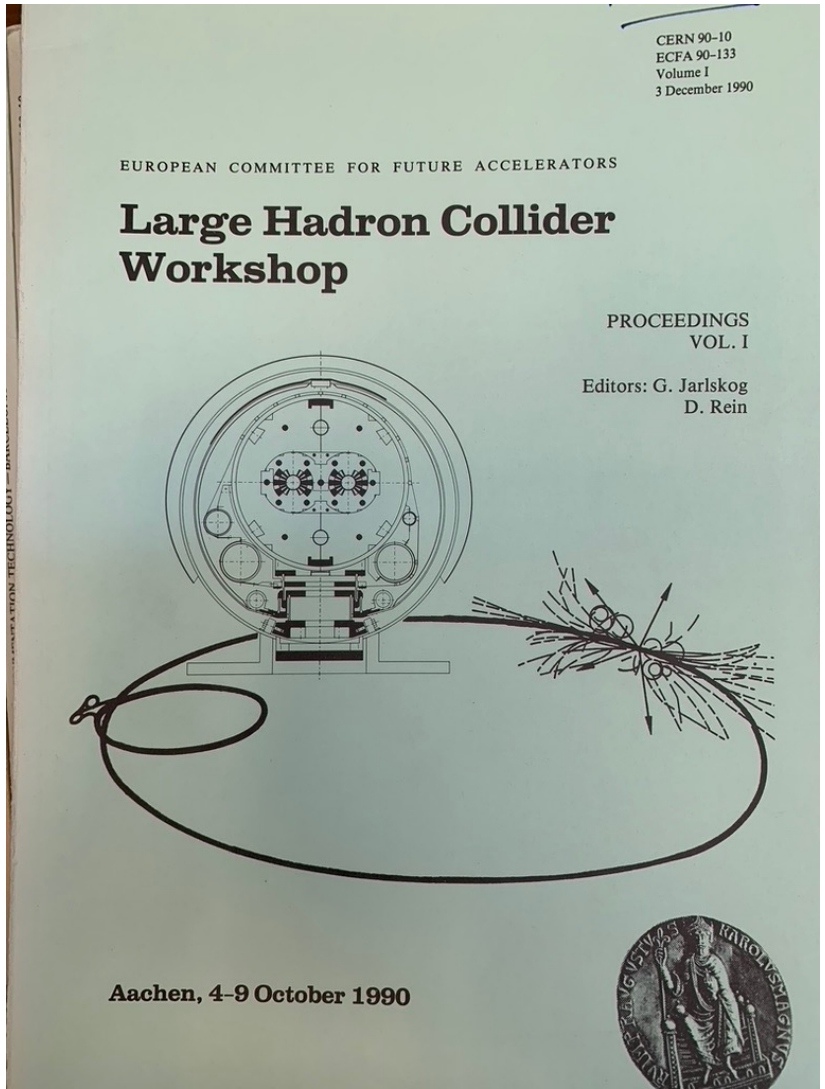
- LHC made possible by size and diameter of LEP tunnel –decision in 1981
- Strategy for machine driven by CERN via Council
- "A theoretical consensus is emerging that new phenomena will be discovered at or below 1 TeV. There is no consensus about the nature of these phenomena but it is interesting that many of the ideas which have been suggested can be tested in experiments at an LHC. Although many, if not all, of these ideas will doubtless been discarded, disproved or established by the time an LHC is built, this demonstrates the potential virtues of such a machine".

Chris Llewellyn Smith 1984

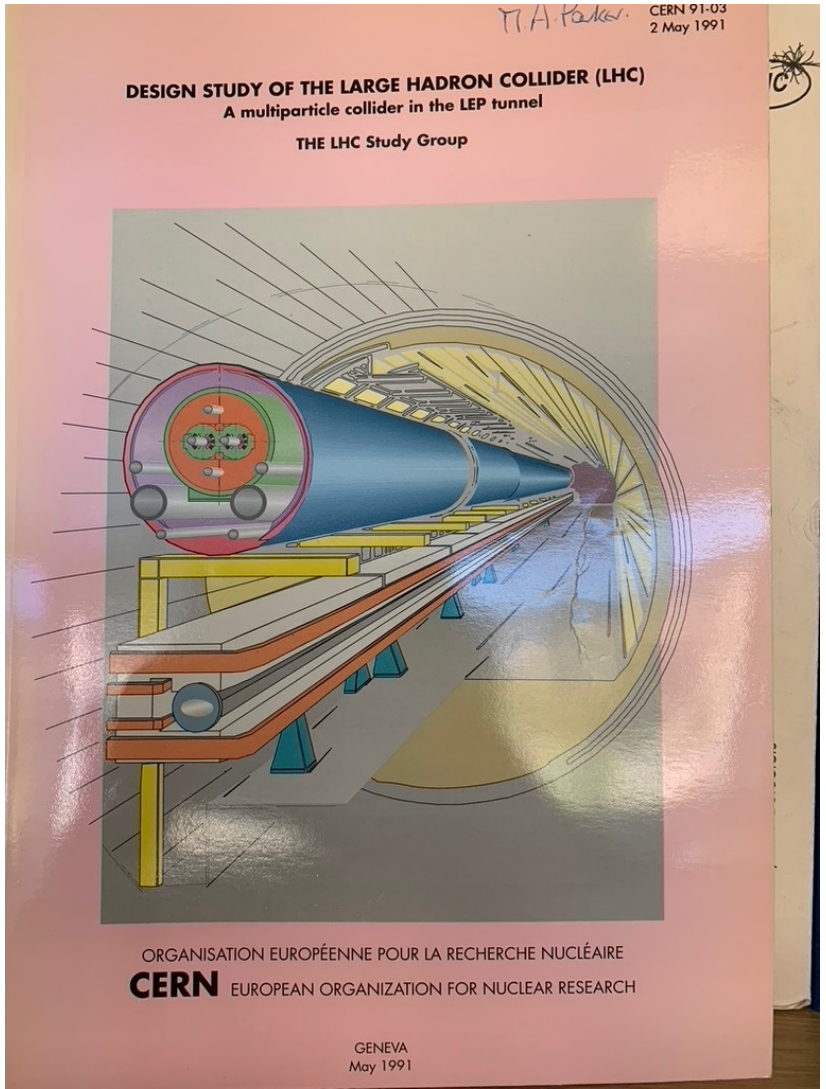
- The LHC was proposed in competition with the SSC in the USA (20 TeV)

LHC Proposal – fast track in tandem with LEP

1990



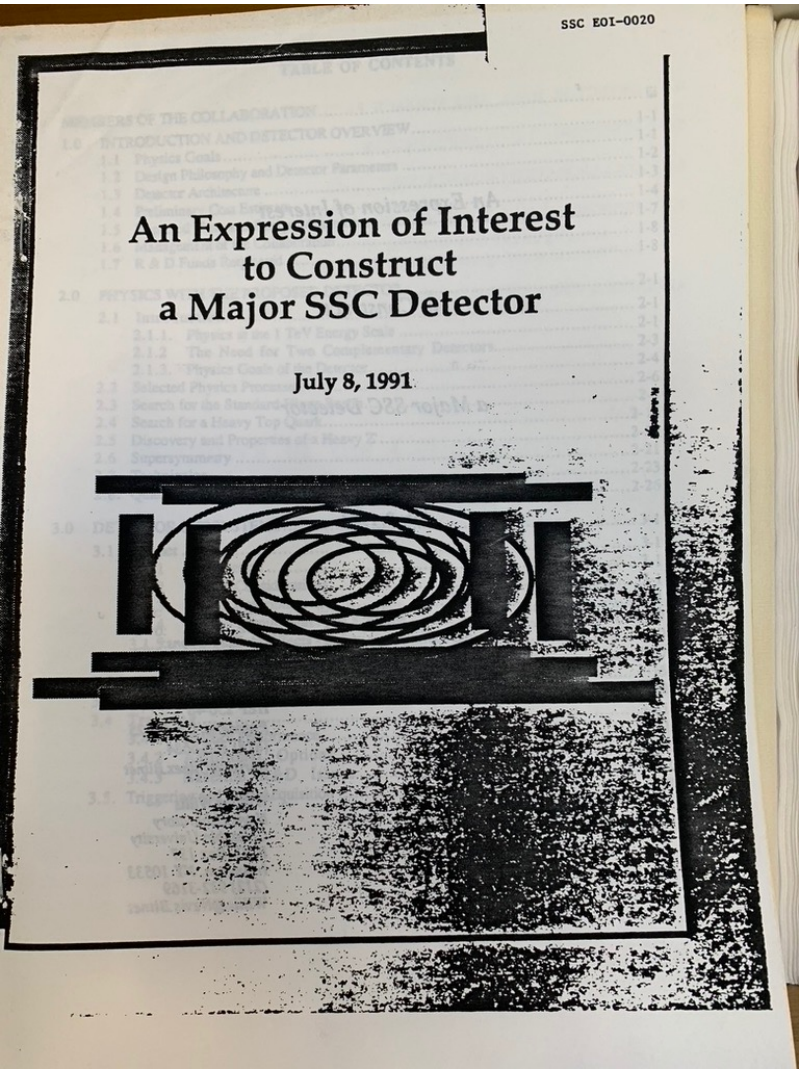
1991



- 1987 proposal for 16 TeV LHC above LEP by Carlo Rubbia
- Aim for approval in 1989 and operations in 1995.
- We all got busy…

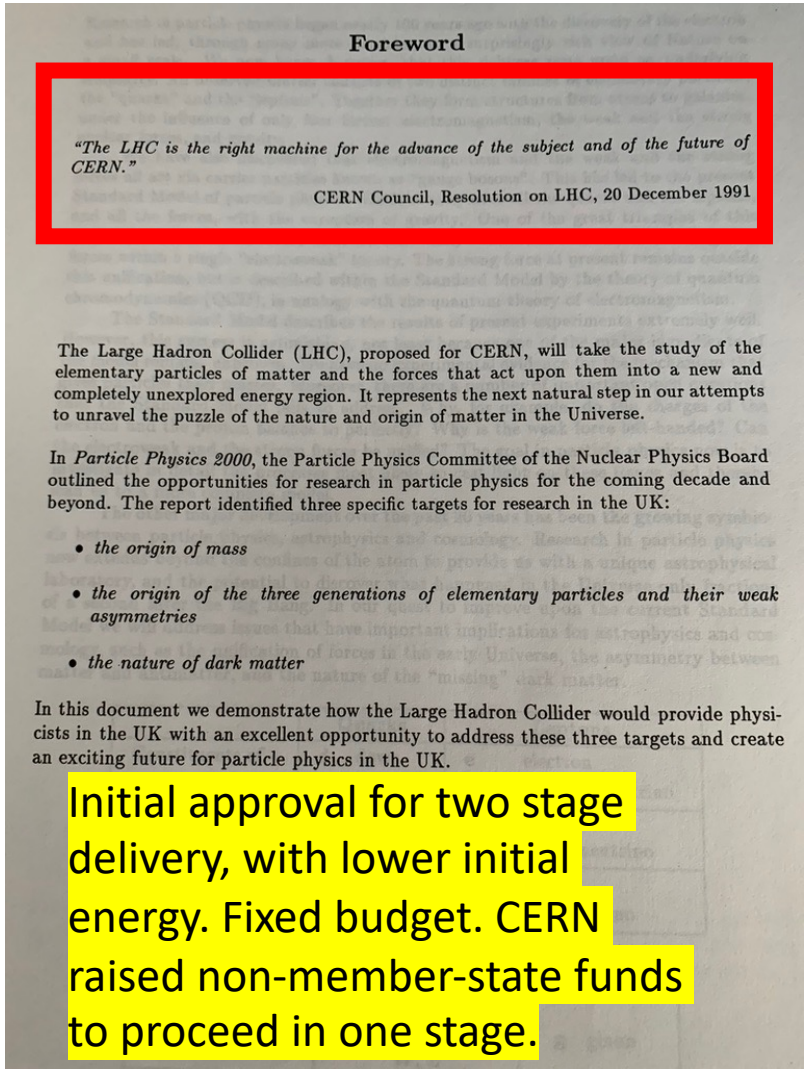
LHC vs SSC

1991


SSC EOI–0020

An Expression of Interest
to Construct
a Major SSC Detector

July 8, 1991


Foreword

"The LHC is the right machine for the advance of the subject and of the future of CERN."

CERN Council, Resolution on LHC, 20 December 1991

The Large Hadron Collider (LHC), proposed for CERN, will take the study of the elementary particles of matter and the forces that act upon them into a new and completely unexplored energy region. It represents the next natural step in our attempts to unravel the puzzle of the nature and origin of matter in the Universe.

In *Particle Physics 2000*, the Particle Physics Committee of the Nuclear Physics Board outlined the opportunities for research in particle physics for the coming decade and beyond. The report identified three specific targets for research in the UK:

- *the origin of mass*
- *the origin of the three generations of elementary particles and their weak asymmetries*
- *the nature of dark matter*

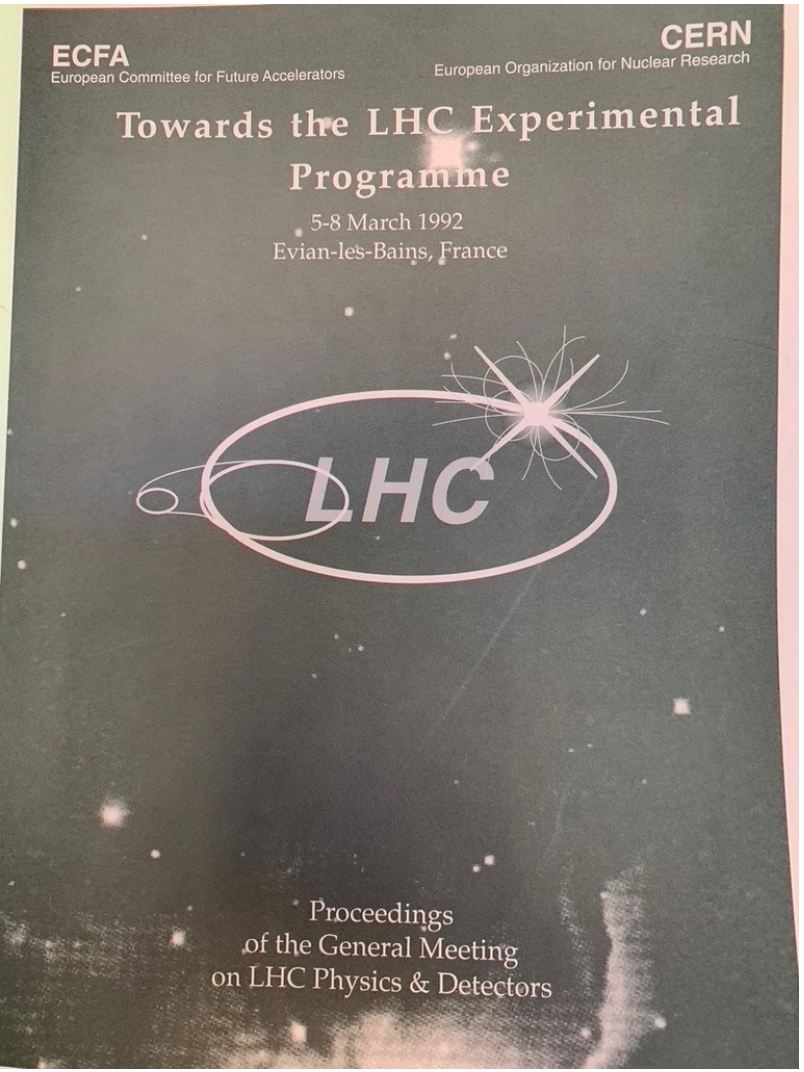
In this document we demonstrate how the Large Hadron Collider would provide physicists in the UK with an excellent opportunity to address these three targets and create an exciting future for particle physics in the UK.

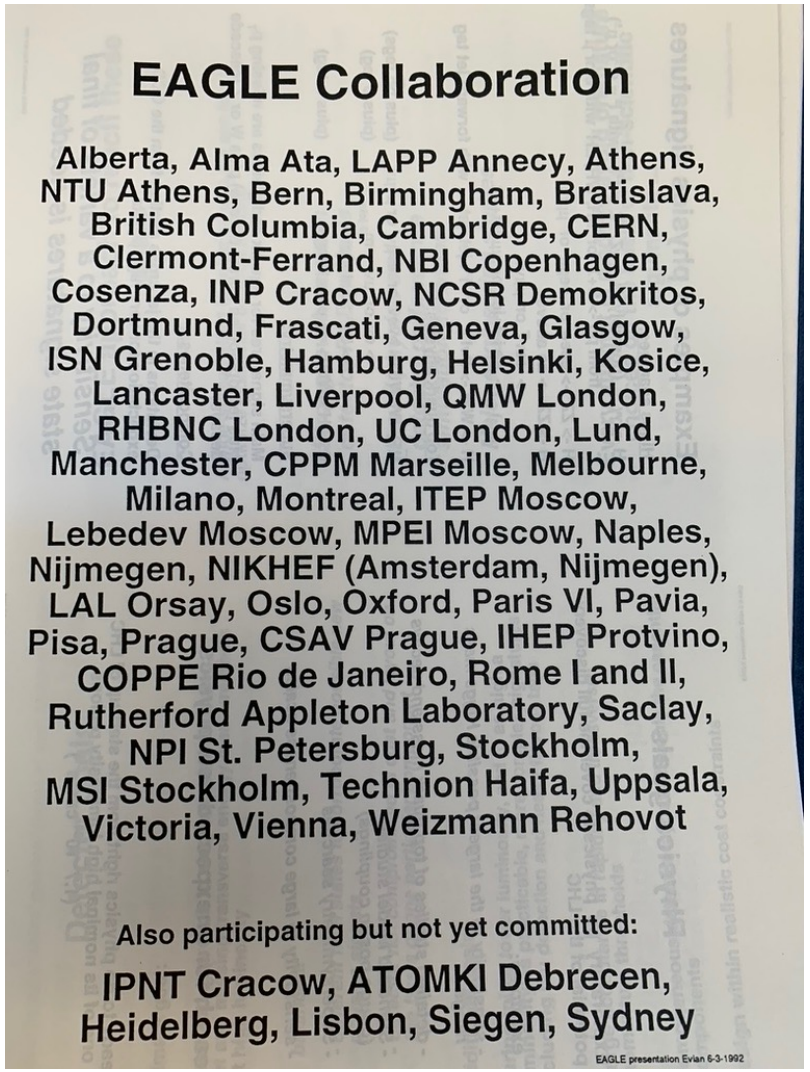
Initial approval for two stage delivery, with lower initial energy. Fixed budget. CERN raised non-member-state funds to proceed in one stage.

- SSC attempted to become an international project, but failed to give sufficient influence to partners.
- Cost overruns. Cancelled by Congress in 1993. USA joined LHC in 1994
- Experimental R&D for LHC Experiments began in 1990 (DRDC).
- Council gave amber light in 1991, and approval was gained in 1993-6 for LHC construction in one stage.
- UK was not always helpful…proposed 25% cut in CERN budget.

Detector Collaborations start to form

1992





EAGLE Collaboration

Alberta, Alma Ata, LAPP Annecy, Athens, NTU Athens, Bern, Birmingham, Bratislava, British Columbia, Cambridge, CERN, Clermont-Ferrand, NBI Copenhagen, Cosenza, INP Cracow, NCSR Demokritos, Dortmund, Frascati, Geneva, Glasgow, ISN Grenoble, Hamburg, Helsinki, Kosice, Lancaster, Liverpool, QMW London, RHBNC London, UC London, Lund, Manchester, CPPM Marseille, Melbourne, Milano, Montreal, ITEP Moscow, Lebedev Moscow, MPEI Moscow, Naples, Nijmegen, NIKHEF (Amsterdam, Nijmegen), LAL Orsay, Oslo, Oxford, Paris VI, Pavia, Pisa, Prague, CSAV Prague, IHEP Protvino, COPPE Rio de Janeiro, Rome I and II, Rutherford Appleton Laboratory, Saclay, NPI St. Petersburg, Stockholm, MSI Stockholm, Technion Haifa, Uppsala, Victoria, Vienna, Weizmann Rehovot

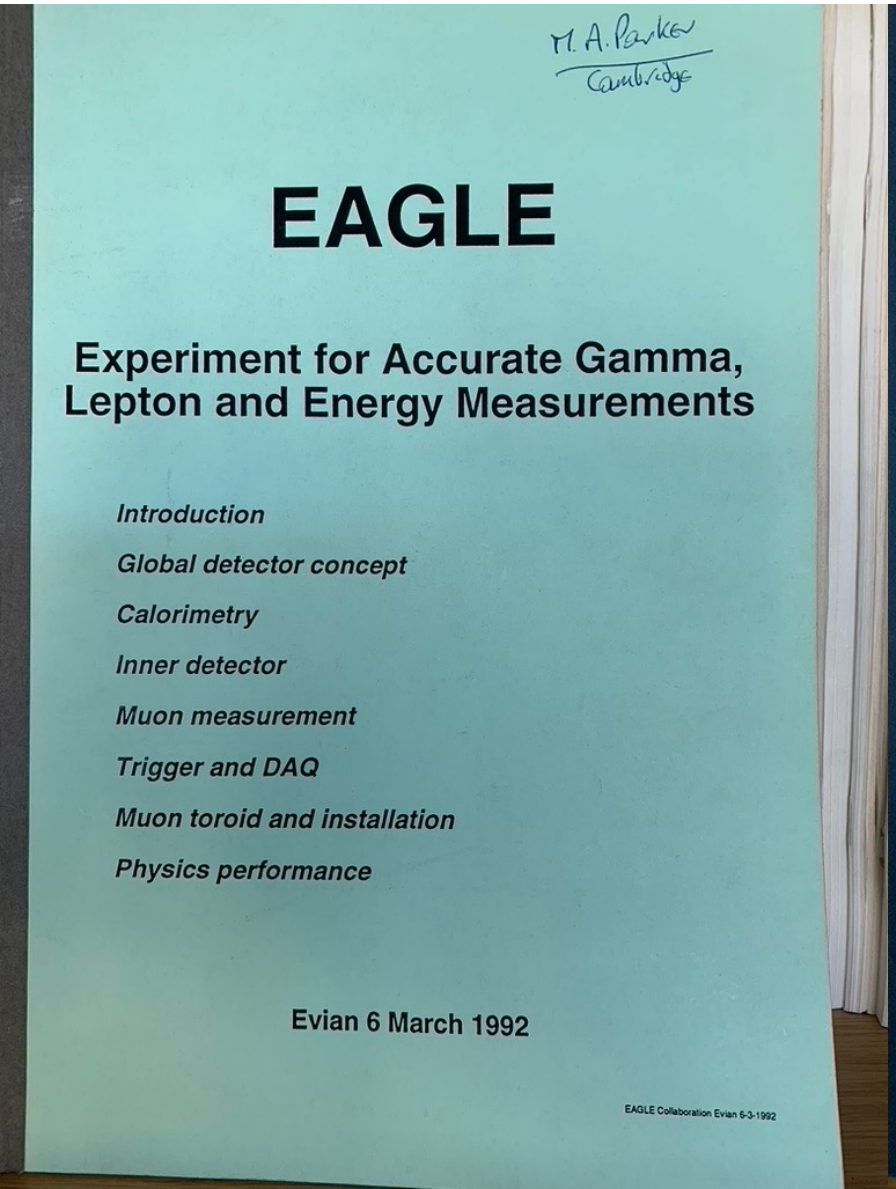
Also participating but not yet committed:

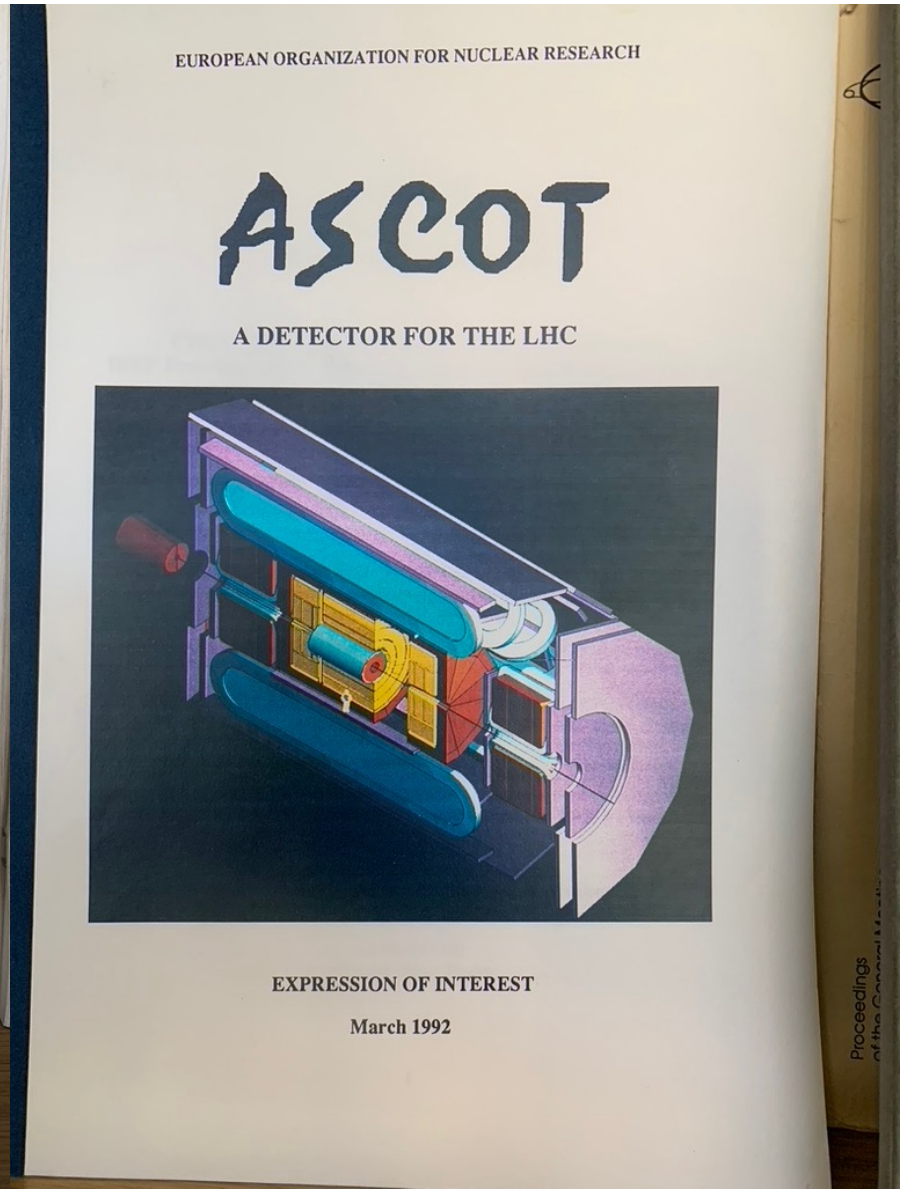
IPNT Cracow, ATOMKI Debrecen, Heidelberg, Lisbon, Siegen, Sydney

EAGLE presentation Evian 6-3-1992

- Evian 1992
- 11 UK institutes involved in EAGLE collaboration

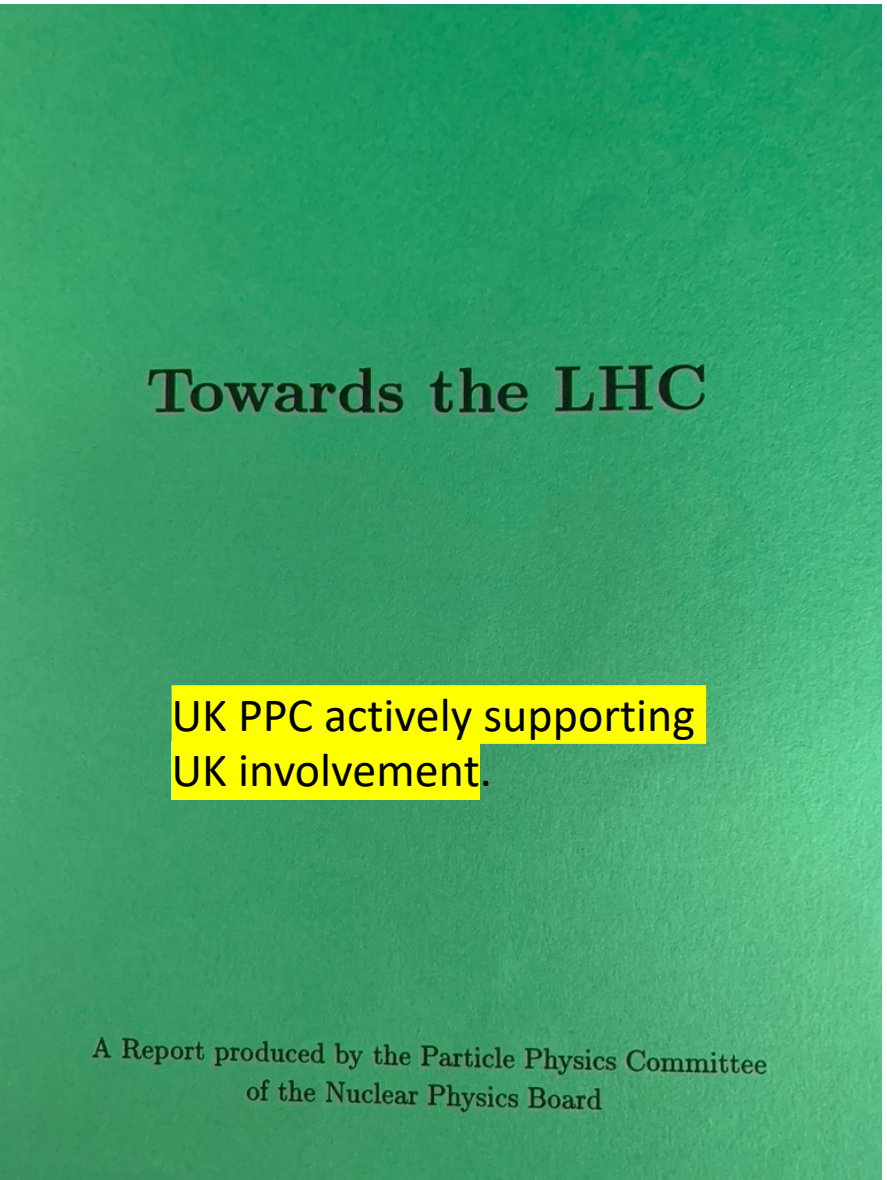
Detector Expressions of Interest

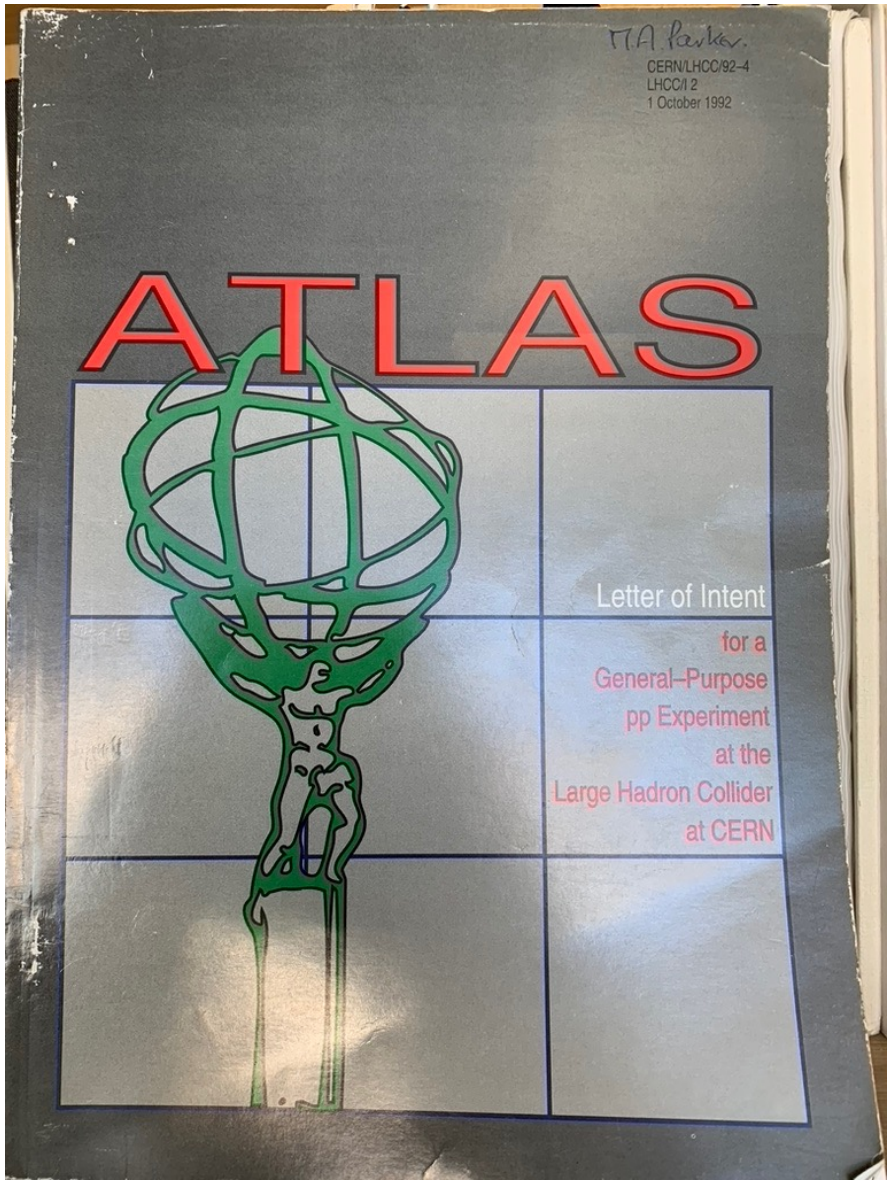




- Evian - 1992
- 4 EoIs for GPDs: ASCOT, EAGLE, CMS, L3P
- 2 Heavy Ion
- 3 CP violation/B physics
- 2 neutrino proposals and several smaller specialized measurements.

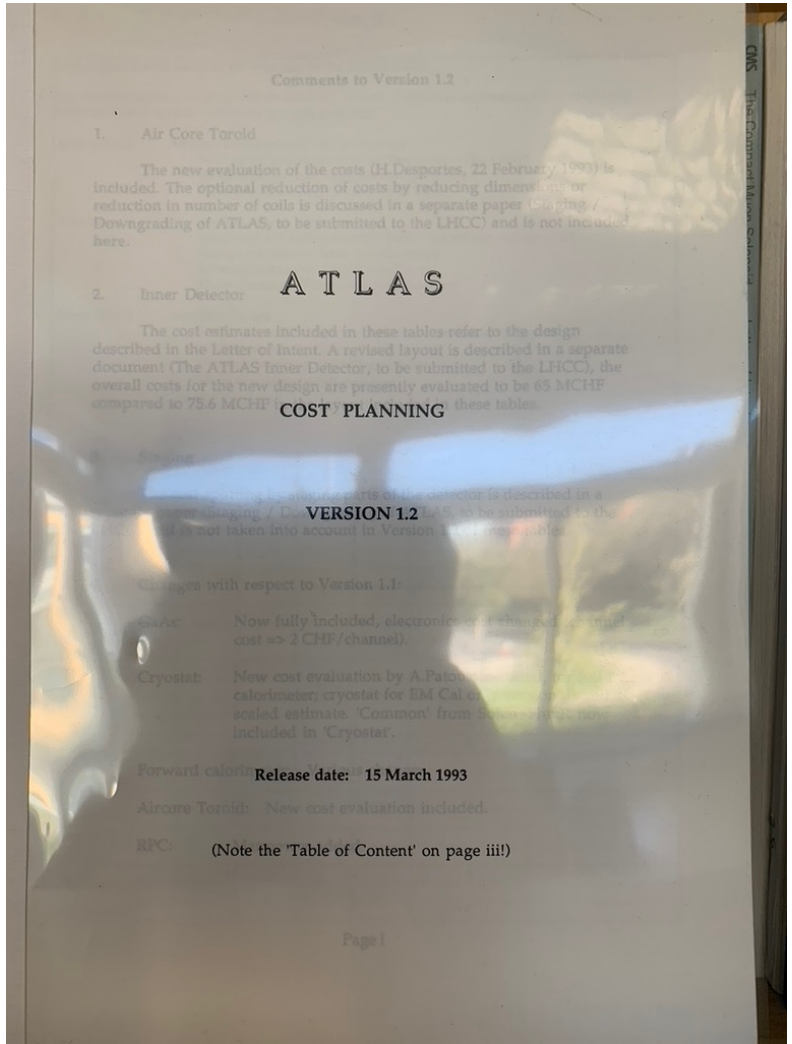
Letters of Intent





- CERN encouraged merger of EAGLE and ASCOT to form ATLAS
- 3 GDP LoIs in 1992, approval for ATLAS and CMS to prepare Technical proposals in 1993
- UK PPC supportive (David Saxon)

Cuts to budget began immediately!



Comments to Version 1.2

1. Air Core Toroid

The new evaluation of the costs (H.Desportes, 22 February 1993) is included. The optional reduction of costs by reducing dimensions or reduction in number of coils is discussed in a separate paper (Staging / Downgrading of ATLAS, to be submitted to the LHCC) and is not included here.

ATLAS

2. Inner Detector

The cost estimates included in these tables refer to the design described in the Letter of Intent. A revised layout is described in a separate document (The ATLAS Inner Detector, to be submitted to the LHCC), the overall costs for the new design are presently evaluated to be 65 MCHF compared to 75.6 MCHF

these tables.

COST PLANNING

VERSION 1.2

Changes with respect to Version 1.1:

Cryostat: New cost evaluation by A.Pa... calorimeter; cryostat for EM Cal ... scaled estimate. 'Common' from ... now included in 'Cryostat'.

Forward calori...

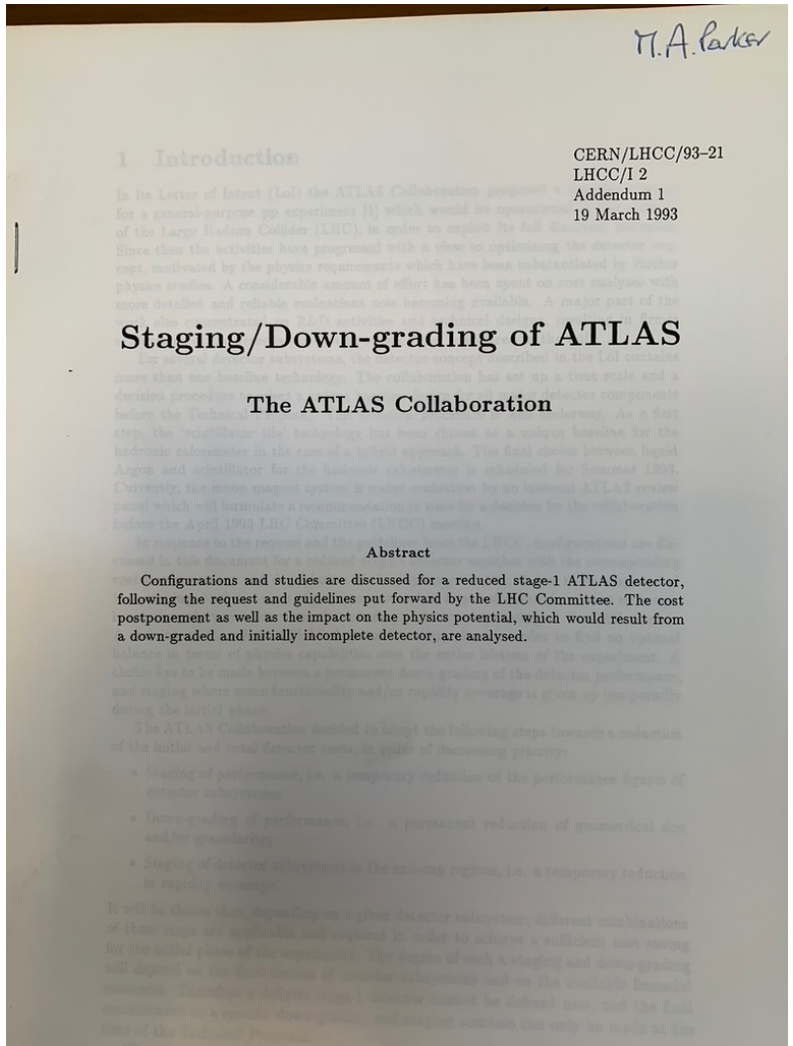
Aircore Toroid: New cost evaluation included.

RPC:

Release date: 15 March 1993

(Note the 'Table of Content' on page iii!)

Page 1



M.A. Parker

CERN/LHCC/93–21
LHCC/I 2
Addendum 1
19 March 1993

1 Introduction

Staging/Down-grading of ATLAS

The ATLAS Collaboration

Abstract

Configurations and studies are discussed for a reduced stage-1 ATLAS detector, following the request and guidelines put forward by the LHC Committee. The cost postponement as well as the impact on the physics potential, which would result from a down-graded and initially incomplete detector, are analysed.

- LHCC imposed staging and downgrading scenario requests in 1993 for “stage 1” detectors.
- Lots of physics studies to preserve essential capabilities in designs.

1994 - Technical proposals

- TPs prepared in 1994, presented in 1995.
- Approved in 1996
- Funding for construction released in 1997
- TDRs needed for each component.
- Construction complete in 2008.

Conclusions from Chris Lellewyn Smith:

Approval of the LHC depended on:

- a robust scientific case (exploration of a large new domain, with good reasons to expect discoveries);
- uniqueness;
- essentially unanimous support of the world's particle physics community;
- the technical success of CERN (throughout the approval process LEP was breaking records); and
- being able to build the LHC without a budget increase (a real terms decrease was actually imposed).

Approval of future major particle physics projects will require

- a robust scientific case;
- major discoveries at the LHC (the Higgs qualifies, but something less expected would be a tremendous boon);
- unanimous support of world's particle physics community;
- continued technical success of CERN; and
- a 'reasonable' budget envelope.

- Llewellyn Smith C. 2015 Genesis of the Large Hadron Collider. *Phil. Trans. R. Soc. A* **373**: 20140037. http://dx.doi.org/10.1098/rsta.2014.0037

Some comments:

- a robust scientific case is more difficult without a clear target for the energy range.
- CERN has site advantage from infrastructure, neutral location, reputation and skill base.
- Now is not a good time to ask for large amounts of money. Don't force a decision – you might not like what you get.
- Build case, with good PR for public, science community and decision-makers.
- Bring politicians solutions not problems. Understand their policies.
- Officials, CSAs, learned Societies can all make the case.
- Other scientists have other priorities – need them to be at least neutral.
- The Treasury Catch-22: *"if your work is excellent it doesn't need more money. If it is not excellent, it doesn't deserve more money."*
- Treasury will want to see value for money in *their* terms.