

SPC report to Council

Open Session
December 14, 2012

Fabio Zwirner

Three SPC meetings since June report:

- 17-18 September 2012 (278th)
- 27 November 2012 (279th)
- 10-11 December 2012 (280th)

Will mention only three main items today:

- LHC matters
- Question from Council to the SPC
- Discussions on European strategy update

LHC matters

The SPC heard reports from:

- S.Myers (LHC machine)
- S.Bertolucci (LHC experiments & computing)
- P.Giubellino (ALICE)
- F.Gianotti (ATLAS)
- J.Incandela (CMS)
- P.Campana (LHCb)

Excellent update yesterday: LHC jamboree
(warm congratulations to all the speakers!)

The SPC congratulates LHC team, experiments,
CERN management for an exceptional year 2012

historic discovery of the Higgs boson

many other important results

impressive confirmation of the so far complete
SM description of gauge and flavour breaking

look forward to:

analyses of full 2012 data sample
design energy and higher luminosity

Question from Council to the SPC

September 2012:

The scientific significance of the observation of a particle consistent with the Standard Model Higgs boson with a mass of around 126 GeV

December 2012:

Answered in CERN/SPC/1000, CERN/3047

Summary of the main points (I):

- **The discovery of a new particle consistent with the Higgs boson postulated in the Standard Model (SM) is a triumph for science.** Many factors were crucial for making this possible: the remarkable theoretical vision and insight that went into the construction of the SM, with its minimal realisation of the Brout-Englert-Higgs (BEH) symmetry-breaking mechanism; the long-term effort to characterize the direct and indirect signals of the Higgs boson and compute the relevant backgrounds; the skill and dedication of those who have designed, built and operated the CERN LHC accelerator, its two general purpose detectors ATLAS and CMS, and the related computing infrastructures; the persistence of CERN – across many DG terms – to realize the LHC project, and the sustained support of its member states.

Summary of the main points (II):

- **Finding this new particle is just the start of a major programme of work to measure its properties with the highest possible precision, with the aim of establishing whether or not these are consistent with those expected for the SM Higgs boson.** This will require many years of operation of the LHC, accumulating the largest possible data set at the highest achievable energy, with upgraded detectors able to acquire good quality data during high luminosity operating conditions. A possible future electron-positron collider with adequate energy and luminosity would go further in this direction

Summary of the main points (III):

The wider aim of the LHC remains to explore thoroughly particle physics phenomena at the TeV energy scale and, in particular, to elucidate the nature of the mechanism of mass generation for elementary particles. The discovery of the Higgs boson is only the first milestone in this direction. To obtain a more complete picture it is essential to check whether or not the Higgs is accompanied by other particles at the TeV scale. The negative results from initial searches have already yielded important constraints on models for physics beyond the SM. However, it should be remembered that this initial phase of LHC operations is at roughly half of the design energy and represents a tiny fraction of the integrated luminosity that will ultimately be collected. Whatever the eventual outcome of these additional investigations, they will deeply affect our view of the fundamental laws and the role of symmetries in nature.

Final comment on vacuum stability:

It is remarkable that, with the measured value of the Higgs mass lying close to 126 GeV, the predictions of the SM agree with observations to an astonishing precision without the need for additional particles or forces. It is conceivable that **the SM can be extrapolated to very high scales, possibly even up to the Planck scale** of gravitational interactions; the observation of a Higgs boson with a mass of 126 GeV **may be telling us something very profound** about the laws of nature. *This extrapolation would lie close to the boundary between absolute stability and metastability of our vacuum, but in the latter case with a lifetime many orders of magnitude larger than the age of the Universe. In particular, according to the SM extrapolation, the effective Higgs self interaction could become negligibly small not far from the Planck scale; **exploring the possible meaning of such a coincidence is an area of active theoretical research.***

SPC discussions on European Strategy update

The SPC heard reports from:

- T.Nakada (progress of strategy update)
- S.Bertolucci (prospects for HL-LHC)
- S.Komamiya (Japanese Community Proposal)
- W.Chou (ICFA workshop on Higgs factories)
- C.Vallée (neutrino projects in the SPSC)

SPC consensus on the following conclusions (I):

- The SPC believes that the strategy discussion is progressing well towards its timely completion, involving wide community participation with the global landscape of the field in mind.
- The full exploitation of the LHC potential, including the high-luminosity upgrade of the machine and of the detectors in view of collecting 3 ab^{-1} until 2030 or so, should be the highest scientific priority. A strong scientific case is already in place: longitudinal vector boson scattering, Higgs self-coupling, rare Higgs decay modes, more precise measurements of the Higgs properties. This will also provide additional opportunities for the searches for new physics.

SPC consensus on the following conclusions (II):

- CERN should have a vision of its long-term future and pursue vigorous accelerator R&D, in particular towards projects at the new high-energy frontier after the LHC. To decide on the next large project at CERN, the physics output of the 2015-2017 full-energy run of the LHC is essential.
- The participation of CERN and its member states in global projects outside Europe, and of CERN non-member states in global projects at CERN, can foster new opportunities for world-class science. Such initiatives can be to the mutual benefit of all regions and will require appropriate organizational frameworks; they can help make effective use of financial and human resources and bring long-term benefits to CERN and its member states.

SPC consensus on the following conclusions (III):

- There is a strong scientific case for a lepton collider that could initially study the Higgs properties with high precision, in a way complementary to the LHC, and be later upgraded to higher energy. There is also a strong case for a long-baseline neutrino programme capable of determining the mass hierarchy, exploring a good fraction of the parameter space for CP violation in the neutrino sector and measuring more precisely the oscillation parameters. The role of European particle physics in the realization of these programs belongs to the strategy discussion.
- The SPC thinks that it would be important to reconstitute an activity in neutrino physics at CERN to provide technical expertise, support and focus to a European contribution to the next generation of accelerator neutrino experiments, wherever they are based.
- The SPC would assign lower priority to the projects that are proposed to run concurrently with the LHC (LEP₃ and LHeC).

Many thanks, on behalf of the SPC, to:

- All of you for your attention
- The Minutes and Translation Service for their excellent work
- The Council Secretariat (Brigitte, Sylvia, Claudia) for precious help in preparing the SPC meetings