Minutes of the 7th PAF working group meeting

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******* DRAFT VERSION 2 *******

Participants:

R. Aymar, J. Engelen, M. Benedikt, A. Blondel, L. Camilleri, A. Ceccucci, J. Ellis, R. Garoby, M. Lindroos, M. Mangano, R. Ostojic, L. Rolandi, W. Scandale, E. Shaposhnikova, J. Wenninger,.

1) SLHC : the experimental perspective

L. Rolandi presented the experimental perspective on the LHC upgrade (SLHC) from the point of view of the physics interest as well as experimental challenges and issues.

An extensive study of the physics motivation was done in 2002 and published in Eur. Phys. J. C29, 293-333 (2005). The physics reach of SLHC for many relevant channels is clearly higher than that of the LHC. However it is difficult to say before the LHC has delivered first results whether SLHC will allow precision measurements of already discovered phenomena or whether it will provide opportunities for new discoveries. In any case the SLHC is attractive and a natural upgrade of the LHC.

Experimentation at the SLHC will be more difficult due to the increase (factor 5) of the event pile-up. The physics reach is a compromise of much larger integrated luminosity and degraded detector performance. It is important to note that the key factor is the integrated luminosity of 1000 fb^{-1}/year and not the peak luminosity of 10^{35} $cm^{-2}s^{-1}$. Both ATLAS and CMS have started a project to discuss technical aspects of the SLHC and to define an appropriate R&D programme. The main technical challenges are radiation, tracking and integration of machine elements and services. Most detector systems will continue to operate at SLHC without changes, with the exception of particle trackers, integration of machine elements, electronics (depending of the bunch spacing) and shielding.

The tracking detectors are designed to survive around 10 years at the LHC, corresponding to ≈ 300 fb^{-1}. The occupancy of the trackers becomes a new important parameter due to the increase of the event pile-up by a factor 5. Pattern recognition would suffer for some of the CMS Si Strip trackers from a large occupancy. Tracker upgrades aim for a higher granularity (≈ 1 mm^2 at R ≈ 20-50 cm) and more pixels. For ATLAS the TRT would suffer even more. Issues related to such upgrades are the power consumption, getting more cables in and out of the detectors, industrial production and transfer of present R&D efforts (RD50) to industry on a short time scale. For CMS the L1 trigger will have to include tracker information to provide sufficient rejection.

For ATLAS a major issue related to a reduction of β* is the layout in the very crowded forward region. The impact of machine elements moving closer to the IR

must be studied. A concrete example for a layout including services is required to study all implications.

A reduction of the bunch spacing is a crucial parameter of electronics upgrades for SLHC. With a spacing of 12.5 ns, which is not achievable with the present SPS RF system, most of the electronics could be kept. A bunch spacing of 10 or 15 ns, compatible with the present SPS RF system, implies major electronics changes for some sub-detectors. This issue must be quantified for each sub-detector. In addition the triggers must be changed.

L. Rolandi concluded that:

- The SLHC physics case is very interesting.
- Discussion on SLHC upgrades have started in ATLAS and CMS.
- (Inner) trackers will have to be rebuilt, but most other components of the detectors will stay usable
- Integration with machine elements must be studied with concrete cases.
- A study of the impact of reduced bunch spacing on the electronics must be performed.

Discussion:

- In answer to a question on the cost of reducing the bunch spacing, L. Rolandi answered that for 12.5 ns spacing, the cost is estimated to ~ 10% of the cost of each experiment. For 10 or 15 ns spacing, the cost is significantly higher.

- To the question of the implications of 12.5 ns on the machine, it was stated that, as a first approximation, the cost would be 30-40 MCHF higher than with 10 or 15 ns. All bunch spacing reduction schemes require upgrades of LHC beam instrumentation electronics (some MCHF). Other examples of issues are the present transverse dampers that will no longer work, and power upgrades that are required for the 400 and 800 MHz RF system.

- W. Scandale commented a slide (No. 4) presented at the last PAF meeting by F. Ruggiero. This slide details the luminosity gains of the various upgrade steps. While upgrades of the low-beta quadrupole are considered to be 'light' and not to costly (~ 50 MCHF), the price of the upgrades increases when short bunch spacing is considered, since this involves major changes of SPS and LHC beam instrumentation electronics, to the transverse feedback system and to the RF systems. Electron cloud effects may potentially prevent a reduction of the spacing. On the top end the price of a super-SPS is on the scale of 1000 MCHF. W. Scandale pointed out that a reduction of the turnaround time is crucial to take advantage of the higher luminosities, because of the reduction in beam lifetime due to 'proton burn-out'.

In terms of schedule, L. Rolandi estimates that it may take approximately one year to install the new tracking detectors.

2a) Preparation of the meeting with the Director General

Before the arrival of the Director General, R. Garoby presented the slides he intended to show to the Director General. A discussion was triggered by the last slide that presented initial findings of PAF. E. Shaposhnikova commented that the presence of bottlenecks in the SPS for ultimate LHC beam intensity is not likely as stated on the slide but certain. This point was modified by R. Garoby. W. Scandale questioned again the usefulness of LINAC4 as an optimum for the luminosity upgrade. R. Garoby replied that in any case the present 50 MeV linac is not optimal and that the studies of alternatives using FFAG or RCS was being organized. M. Benedikt and J. Wenninger wondered if a superconducting PS+ (Super-PS) was really the optimum choice (as compared to normal conducting magnets). It was pointed out that the main motivation for superconducting magnets is to increase the injection energy into the SPS. The real gain of an increased injection energy into the SPS must however still be evaluated. A new PS could also solve the present radiation issues at the PS if the new tunnel is excavated below the present tunnel, which may be performed in parallel to machine operation.

2b) Meeting with the Director General R. Aymar and with the Chief Scientific Officer J. Engelen.

R. Garoby thanked Director General R. Aymar and CSO J. Engelen to be present at this meeting and to provide direct contact with the members of the two WGs.

R. Aymar briefly presented the arguments that led to the creation of the PAF/POFPA working groups. He stated that it was not acceptable for CERN not to prepare its future. In the event of a decision on ILC/CLIC around 2010, CERN must have a scientific programme for the laboratory in case the linear collider is not sited at CERN. An assessment of the future of physics at CERN and of the necessary conditions is required. The basic process is to have a view on the physics (POFPA) and to assess the potential of present and new machines (PAF). It is important to be aware on R&D programmes in order to decide what systems must be pushed.

To a question by M. Mangano on the possibility to consider also the energy upgrade of the LHC within PAF and POFPA, R. Aymar restated what he considers to be his highest priorities for CERN, namely LHC operation, LHC upgrade, CLIC/ILC. He considers that it is not appropriate to give a too high priority to the LHC energy upgrade, but he does not object to PAF/POFPA considering this option.

R. Garoby mentioned that at the instalment meeting of PAF, staged and progressive upgrades of the accelerator complex were mentioned and highlighted, and he asked if it was possible to consider ‘dream’ scenarios. R. Aymar answered that until 2010 there are presently no resources available at CERN for new programmes. He considers that this situation is not acceptable and that CERN must go back to the member states and request resources to pursue new programmes. He considers that 80 persons and a budget of 50-100 MCHF/year between 2008 and 2010 as an adequate level of funding for such an activity. Concerning ‘dream’ scenarios, R. Aymar stated that it was up to the WGs to get their own consensus. J. Ellis proposed that POFPA provide timescales, objectives and milestones for projects and for future decisions.

The issue of the lepton options was raised by J. Ellis who wondered if somewhere at CERN similar groups study those options. R. Aymar said that presently no such group exists. J. Engelen pointed out that around 2010 a decision may be taken on ILC/CLIC. If the ILC is not sited at CERN, an event that R. Aymar considers to be very likely, then CERN will take the route proposed by PAF and POFPA for its own internal research programme. Obviously the frame is changed entirely if a linear collider would be sited at CERN.

J. Ellis also raised the issue of the relation of PAF/POFPA to the strategy group for European Particle Physics initiated by the CERN council. R. Aymar said that CERN should provide help and advice. Because of the accelerated planning of the strategy group, he asked for recommendations from PAF and POFPA at an earlier date. A first written report is needed for January 2006.

R. Garoby and J. Ellis make short presentations on the work of the WGs. R. Garoby presented the PAF members, the 'competence table' and first findings. R. Aymar was particularly interested and worried about the SPS magnet problems that were presented at the PAF meeting on 15th August 2005 by K.H. Mess. A short briefing on the situation, 7 water leaks observed in 2004 due to corrosion, was given to R. Aymar. J. Ellis described the organization of the document that POFPA plans to issue by the end of 2005. R. Aymar made positive comments after both presentations and approved the past and future plans.

A very short debriefing took place after R. Aymar and J. Engelen had left the meeting. The main points:

- The energy upgrade of the LHC can be considered by PAF/POFPA.
- In terms of budget, there is no need to auto-censure the work. It is possible to consider ambitious scenarios, but it is important that appropriate arguments be given to the Director General to request additional funds from the council.
- The work has to be accelerated to have a first document available at the beginning of 2006.

Minutes by J. Wenninger, 05.10.2005