8 July 2002

AD-HOC WORKING GROUP ON LHC EXPERIMENT-MACHINE PARAMETER AND SIGNAL EXCHANGE

Minutes of the 3rd Meeting held on 19 June 2002

Present: R. Assmann, B. Dehning, K. Eggert, N. Ellis, D. Evans, K. Gill, W. Herr, D. Macina, A. Moersch, B. Muratori, M. Placidi, A. Smith, W. Smith, B. Taylor, E. Tsesmelis

Apologies: G. Beetham, R. Jones

1. APPROVAL OF THE MINUTES

The minutes of the 2nd Meeting were approved without modification.

2. MATTERS ARISING

Werner Herr reported on the variation of the beam collision point in the transverse planes. Present estimates indicate the following:

- The maximum transverse variation during a coast is expected to be < 20% of the beam width. (The width of the LHC beams will have a σ = 15.9 μm.)
- The maximum transverse variation of the beam collision point between coasts is likely to be < $\pm$ 1 mm.
- The transverse position of the beam can be re-aligned by the machine to within $\pm$1 mm at any time (even outside machine shutdown periods).

Nick Ellis reminded the working group that ATLAS plans to monitor the transverse position by reconstructing tracks in the Inner Detector. A measurement of the collision point in the transverse planes to 10 μm accuracy can be provided within 10 s. A similar measurement can be provided by CMS. Although such measurements will follow the movement of the detectors, a potential source of error is transforming the measurements in the experiment reference frames to that of the machine.

Alasdair Smith stated that a maximum shift of $\pm$5 mm can just be allowed for in the case of LHCb.

The experiments are asked to consider the following effects that will give rise to the need for re-alignment:

- How much are the cavern floors expected to move over time from settling (down) and from hydrology of the geology (up).
- How much cavern floor movement is expected during extended access periods, during which major parts of the experiments are moved over the floor.
- How well are the detectors expected to be aligned with respect to the beam collision point, both from *in-situ* survey measurements and later from physics processes.

[Action: LHC experiment representatives]

A regular re-alignment of the machine with the experiments will be required in the case that the cavern floors move substantially and often. Note that at any given time, a re-alignment of only ±1 mm is possible by the machine. Larger scale re-alignment could be considered a few times per year during shutdowns.

3. LUMINOSITY CONSIDERATIONS FOR THE LHC

(Bruno Muratori)

Bruno Muratori reported on luminosity issues for the LHC. He summarised the results of his calculations to determine the luminous region around the IPs, taking into account the following features of the machine: number of bunches, particles per bunch, the revolution frequency, transverse and longitudinal beam sizes, the geometry of the beam crossing region (including the β^*), the beam crossing angle and the hourglass effect (whereby the transverse beam size depends on the longitudinal coordinate *s*).

Plots of the luminosity versus the distance from the IP were shown for various LHC operating modes. For the LHC nominal parameters of σ_s = 7.5 cm, $\sigma_x=\sigma_y$=15.9 μm, crossing angle φ= 300 μrad and a low-β insertion with β^*=0.5 m, 95% of the luminosity is found to within a distance *s* = ± 8 cm around the IP. Moreover, operating with φ= 300 μrad reduces the luminosity by 20% compared to the case with φ= 0 μrad. Finally, the hourglass effect does not reduce significantly the luminosity.

Given the nominal 300 μm crossing angle, the transverse collision area will not be circular and thus will not yield a cylindrical luminous region, as in the case of φ= 0 μrad, but will instead be an ellipse that is about 20% less high than it is wide for the case of vertical crossing and *vice versa* for the case of horizontal crossing.

An open issue remains the effect of the longitudinal spread of a bunch during a coast. This effect should be included in the estimation of the luminous region.

[Action: Bruno Muratori]

The experiments would like to have the plane of the crossing angle and the its value fixed, as the design of the detectors is affected by the choice. The nominal parameters are currently fixed as $\varphi = 300$ μrad and the plane being horizontal at Points 5 and 8 and vertical in Points 1 and 2.

Further details concerning this presentation may be found at

/afs/cern.ch/user/b/bmurator/public/lumi/

4. SUMMARY OF EXPERIMENT REQUIREMENTS ON BEAM MONITOR SIGNALS FROM THE LHC MACHINE

(Nick Ellis / Wesley Smith)

Nick Ellis and Wesley Smith summarised the requirements of the LHC experiments on the signals from the BPTX monitors. There will be one BPTX timing pick-up per incoming beam for IR 1, 2, 5 and 8. The BPTXs will be located about 150 m from the IP in front of the D2 magnet and will be used exclusively by the experiments. Possible technologies include a stripline coupler, button electrode and wall current monitor.

Two applications of the BPTX timing signals were identified by the experiments:

- Monitoring the phase of the clock of the two beams locally at the IRs. This will allow the experiments to determine whether the TTC system is synchronised with the actual arrival of the bunch.

- Identify the location of the gap in the LHC bunch train. This measurement is considered useful especially during the setting-up stage of the experiment.

Both these measurements would be performed by taking the sum of the BPTX quadrants.

Moreover, a separate quadrant read-out of the LHC RF pick-ups could provide an accurate measurement of the transverse collision position at the IP. This measurement would be performed by using the machine BPMs in the warm section between the TAS absorber and the Q1 quadrupole. The experiments ask that the derived signals be made available and request from the machine group information on precision of the extrapolation from the measurement to the position of the collision point.

[Action: Rhodri Jones]

The experiments request a technical liaison to be set up between the SL/BI machine group and the LHC experiments concerning the use of the pick-up detectors and the read-out electronics (amplifiers and signal processing). In particular, the experiments would like know if they can make use of electronics developed by the

machine groups and to benefit from their expertise in the use of such instrumentation.

[Action: LHC Experiment Representatives / SL / BI]

5. CMS-LHC SIGNAL EXCHANGE

(Wesley Smith)

Wesley Smith reported on a number of issues concerning to the interface between CMS and the LHC machine.

He reported on the calculations showing the matching of the CMS Tracker geometry to the luminous region. Global inefficiencies for the Inner and Outer Tracker Barrel detectors of between 0.2% and 3% were estimated after a 10h. coast, at which time the distribution of the collision point has a Gaussian distribution with σ=7.72 cm. The results indicate a good coverage of luminous region by the Tracker. A similar good match was found for the barrel and end-cap Pixel detectors and the end-cap Tracker.

In addition, Wesley summarised the proposal of CMS prepared by Joao Varela on algorithms for bunch crossing identification. The absolute synchronisation of the data is based on the identification of the LHC bunch structure. A bunch structure correlation function is proposed which requires the measurement of the individual bunch crossing relative luminosity, a sampling frequency of 1 Hz and a precision of the individual bunch intensity of 1%.

Moreover, in order to identify satellite bunches and to diagnose synchronisation problems, CMS submitted a request for a sub-ns scale time spectrum of each bunch. The spectrum should be delivered once per minute in addition to the 1 Hz of integrated bunch luminosity.

Finally, LHC and experiment information should have an absolute GPS time tag. It was noted that this time tag will be available via an antenna and cable.

Both ATLAS and CMS request the machine to provide, for example on a server accessible via the network, the individual bunch luminosities (updated frequently at a rate to be discussed), and also information on the intensity in satellite bunches.

6. NEXT MEETING

The next meeting of the working group will be held on Tuesday, 9 July at 16:00.

E. Tsesmelis