DISCUSSION OF SESSION 1: EXPERIENCE AND RECOMENDATIONS FROM TEVATRON, HERA AND RHIC

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Mike Lamont chaired this session devoted to review the experience from TEVATRON, HERA and RHIC, both from machine perspective and detectors point of view, in order to get an idea about what we could expect and optimise from the machine side and from the LHC experiments side. The session consisted of five talks and a series of discussions after each one. The main points raised during the discussions are collected in this document.

TEVATRON SOURCES AND CURES OF BACKGROUND – MACHINE AND EXPERIMENTS PERSPECTIVE (SPEAKER: R. TESAREK)

Abort Gap: DC beams in the abort gap are observed since Run II. There was some discussion about the nature of this abort gap beam. R. Tesarek explained that this beam was originated from RF noise. The beam was diffusing to neighbouring RF buckets. Elena Chapochnikova said that there are two types of beam in the Tevatron abort gap:

1. uncaptured, which moves along the abort gap staying longer between buckets due to small velocity at this place;
2. captured, most probably created in the main injector (MR), injected into Tevatron and then captured at the beginning of the acceleration. This beam doesn't move with time.

Another remark was made about the origin of uncaptured beam during the coast. Elena said that publications (e.g. V. Lebedev EPAC'03) exist which show from comparison of simulations with measurements that Intra Beam Scattering (IBS) is the main source for this beam loss. However, the speaker said that he doesn't fully agree with this explanation.

Is uneven bunch intensity distribution within a bunch train a source of background? (Answer from J. Annala) The uneven bunch intensities can be a source of high background for the opposite beam. Unequal bunches were common in the Tevatron back when the Protons were much stronger than the Pbars. Although nowadays the Proton beam sees very strong effects from the Pbar beam since the Pbars are more intense and can have very small emittances, Tevatron gets a fairly even intensity distribution in the Pbar bunches and, therefore, there are no Proton background problems anymore

What are the Lifetimes during Collider Run II?: Below there is the answer from J. Annala:

If we go back several years (2004), when Tevatron top Luminosity was $100x10^{30}$ we had particle and luminosity lifetimes at the beginning of the stores in the range of:

	Real (hours)	Optimum* (hours)
Protons	30-200	200
Pbars	15-30	40
Luminosity	6-15	30

(*every particle ends up in a collision, i.e. no particle loss and no emittance growth)

These lifetimes depended not only on how well we had everything tuned up to reduce backgrounds, but also on the initial luminosity. We could have a large variation in the number of Pbars available, so the initial luminosity could vary a lot as well.

If we look at our best store recently (initial luminosity of $315x10^{30}$) we had lifetimes of:

	Real (hours)	Optimum* (hours)
Protons	15	70
Pbars	15	23
Luminosity	4	17

(*every particle ends up in a collision, i.e. no particle loss and no emittance growth)

At the present time, our Pbar lifetime is very close to the optimum (luminous) lifetime because we have very small emittances. Also, the backgrounds are now very close to where they were in 2004, although the instrumentation ages. We actually lose more Protons now that in 2004, but we do a better job of keeping the background down. We do this with better placement of collimators, careful tuning, and positioning the beam within the aperture better.

Background rejection: during the discussion R. Tesarek made clear that the track reconstruction in the Tevatron experiments is very demanding and, therefore, the physics background rejection is very efficient. The experiments have also put in place a three dimensional track reconstruction technique to improve off-line background rejection. At the on-line level, Tevatron is able to reduce the amount of triggered backgrounds by reducing the diffused halo of particles surrounding the core of the beam. This reduction came about by:

- improving the vacuum;
- commissioning collimators and routinely using them to scrape the halo surrounding the beam core away.

According to R. Tesarek these two improvements were mostly responsible for the 40% reduction in trigger rates that he reports in his talk, but he does not completely rule out that:

- magnet unrolls (quadrupole unrolls)

- Tevatron dipole coil shimming to reduce skew quadrupole component of the field

helped to reduce horizontal/vertical coupling of the beam and allowed for better understanding of orbits.

HERA SOURCES AND CURES OF BACKGROUND – MACHINE PERSPECTIVE (SPEAKER: B. HOLZER)

Collimators: B. Holzer clarified that the ratio secondary/primary collimator positions had to be calibrated from time to time.

What was the orbit stability at HERA? ½ mm in the arcs; at HERA there was not a feedback system to help with the orbit correction. At the experiments the correction was local. Global corrections were considered too dangerous.

Tune: at HERA the tune optimization was done at the level of single bits at the power supply controller, because the available phase space was very small, just 600 Hz. The optimal tune was placed within a very small triangle. This triggered the question if HERA operators ever tried to jump into a bigger triangle. B. Holzer answered that yes but that was not successful.

How did experiments protect against background? the experiments were protected by the BLM system; high losses dumped the beam. The experiments themselves did not have a direct input into the beam dump system.

Is uneven bunch intensity distribution within a bunch train a source of background? B. Holzer answered that strong differences in the bunch intensity can indeed make problems with background as it will not be easy to find a place in the tune working diagram that is good for every bunch. Therefore one should always try to fill all bunches equally. At HERA they always checked the equal density distribution over the bunches for every fill and before the ramp.

Chromaticity measurement during luminosity runs: B. Holzer explained that chromaticity measurements were done shifting the momentum with the RF system and observing the tune change. Nevertheless, looking at the tune working diagram one can see there is basically just enough space in the working diagram to survive. Any tune change will, therefore, cause a lot of lifetime breakdowns, background events and drift chamber trips in the detectors. So he advised not to modify the tune during luminosity runs.

HERA SOURCES AND CURES OF BACKGROUND – EXPERIMENTS PERSPECTIVE (SPEAKER: C. NIEBUHR)

Vacuum quality inside the detectors: The beam pipe at the insertion regions of the HERA machine is quite complex since it has to accommodate three different beam types: electrons, protons and photons (see slide 9). This triggered the question how one can guarantee a good vacuum inside the detectors given the complex topology of the beam pipe. C. Niebuhr answered that there is a pump inside the detector, but on the other hand, the vacuum quality in this region was never an issue. What was an issue is the vacuum quality in the regions before and after the detectors. Many efforts were conducted to solve the problems in those regions. R. Tesarek commented that in Tevatron the warm sections were a source of pressure problems and as a consequence the beam was scattered and after ten revolutions, on average, went into the detector.

BACKGROUND IN RHIC (SPEAKER: W. FISCHER)

Does background quench the inner triplets?: W. Fischer answered that at the beginning it happened from time to time. To cure this they installed shielding and now it happens very rarely.

EXPECTED SOURCES OF BACKGROUND IN LHC OPERATION (SPEAKER: M. LAMONT)

What is the cleaning efficiency of the momentum collimators at the start of the ramp?: R. Assman did not provide with a concrete number for the cleaning efficiency but replied that we believe that the system will be able to cope with the expected loss rates.

Is there background cross-talk between experiments?: according to simulations background cross-talk between CMS and ATLAS may exist. B. Holzer added that in HERA they also had this problem.