September 25, 2012

Run-13 Au+Au : The HFT perspective

1. Introduction

STAR management has proposed that the second priority in Run-13 be a low-energy point - proposed 14.6 GeV - instead of a 200 GeV engineering run for HFT. This decision is mainly driven by the desire to fill in another low energy point for BES. This is not our preferred action. We present a short position paper on the HFT point of view: how this would affect our capability and what we can learn, and argue for a Au+Au run at full 200 GeV energy.

2. Impact on the Engineering Run Goals

The HFT group is planning and preparing to install several fully instrumented PIXEL sectors in the experiment for the next run, Run-13, which is the only available opportunity for an engineering test before full system installation next year. The main goal for this run is system verification and correction; this includes the study of the collision environment, detector response, backgrounds, operational experience and first look at basics detector performance. At the same time, assuming good performance and data integrity, we could be able to attempt the extraction of some charm physics as several simulation studies have shown. As it becomes immediately obvious, most of these goals will be compromised by a low energy run. Below we list our argument in no particular order:

- We will not be able to test the sensors in the high multiplicity environment of Au+Au 200 GeV collisions. The PIXEL sensors and readout system will not have the chance to 'see' the full load anticipated at 200 GeV. This includes the hits from the primary collision but also the hits from pileup collisions and spiraling, background electrons from Ultra-Peripheral AuAu Collisions (UPC). In order to experience this we will have to wait for full system installation and operation in Run-14, the run that HFT is supposed to accumulate large, high quality data samples for precision physics measurements. A major system test in the real environment of Au+Au collisions at 200 GeV is thus compromised.

- We will not be able to study the background radiation at our working position (only a couple of centimeters from the beam line center). This includes Halo but also the UPC electrons. Dark current (radiation) and hit density studies again will have to wait for the full system installation and operation next year. The engineering run was also a way to test for vulnerability to wakefield generated noise (or other unanticipated noise source). We don't expect this to be an issue with our detector design, but if the engineering run exposes a problem then RF shielding would be implemented.
- Most collisions will be not useful due to poor beam properties at low energy and definitely outside +-10 cm useful PIXEL acceptance due to anticipated poor vertex position trigger performance at very low multiplicities. This coupled to poor delivered luminosities, the large beam diamond at the detector and the increased backgrounds from upstream interactions will render most of these data of little or no use. Figures 1, 2 and 3 demonstrate these points.

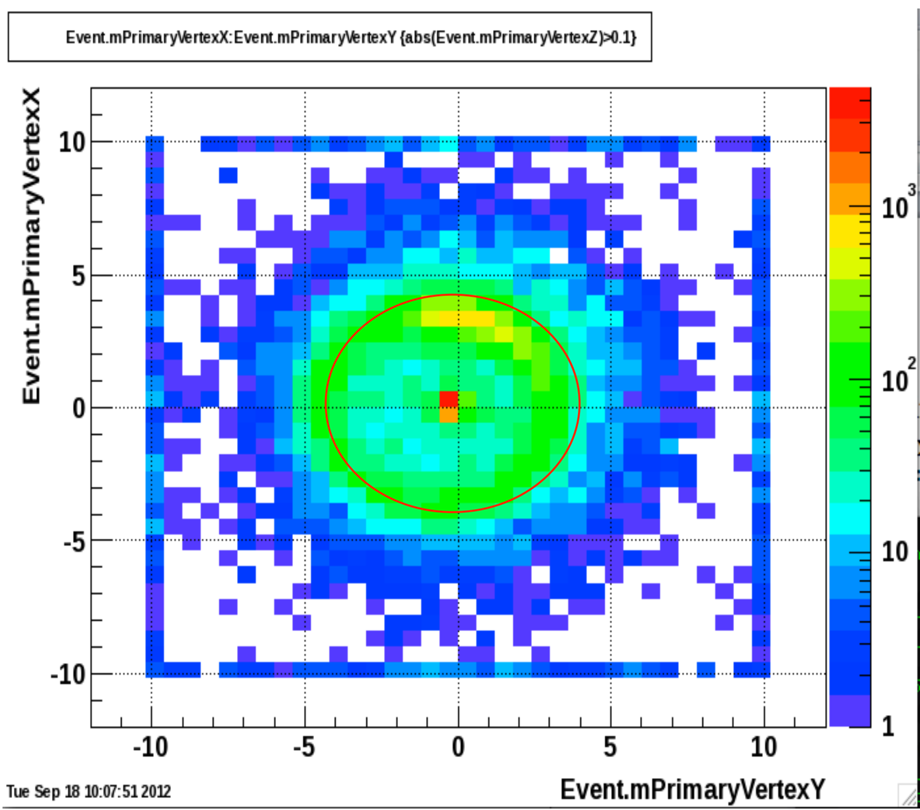


Figure 1 Primary vertex position in the transverse plane for Au+Au collisions at 11.5 GeV/c. The red circle denotes the position of the beam pipe (radius of 4 cm).

Figure 1 is real data from Run-10 where we recorded about 55 million interactions of Au+Au collisions at 11.5 GeV, an energy close to the proposed one. What is shown is the event vertex position in the transverse plane (X-Y) for valid/triggered minimum bias events. Besides the good events near the origin one can easily see the outline of halo events near the position of the beam pipe (which is shown as a red circle at 4cm). Figure 2 shows the X position of these vertices vs the Z position (beam direction).

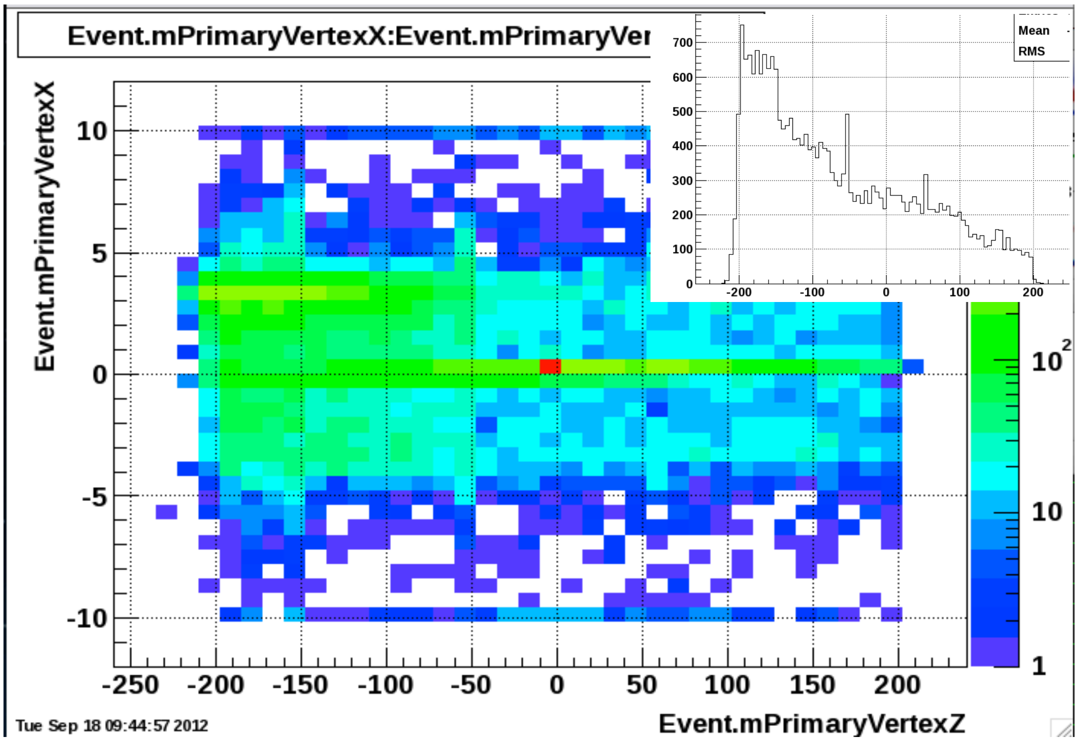


Figure 2 Event vertex position in the X-Z plane (side view). The insert is the profile histogram along the beam (Z) direction.

The insert is the histogram profile along the Z-direction. One observes that most of the ‘beam scrapping’ events happen upstream but they appear as valid events at the edge of the TPC. This significant halo is going to hit the first PIXEL layer sensors, which will be in the vicinity of 2.5 to 3.5 cm from the beam pipe center, marginally useful event sample for any studies. All this assumes that at the proposed run the beam characteristics are going to be similar to those in Run-10 Au+Au 11.5 GeV. In the Appendix we present the same distributions for Au+Au collisions at 19.6 GeV. We also present the distributions for zero-bias events at both energies. We observe that all distributions show similar characteristics; the beam scrapping events are the majority of the samples, they are present at both energies and are independent of the trigger conditions.

- At the same time the TPC - determined event vertex will have about four times worse resolution at 14.6 GeV than at 200 GeV thus the reconstruction parameters, in terms of rates and resolution, and their study will rapidly deteriorate. This is also due to several other factors like the partial angular coverage of the PIXELS, the absence of both intermediate trackers (SSD and IST) and in general the challenging tracking environment is these conditions.

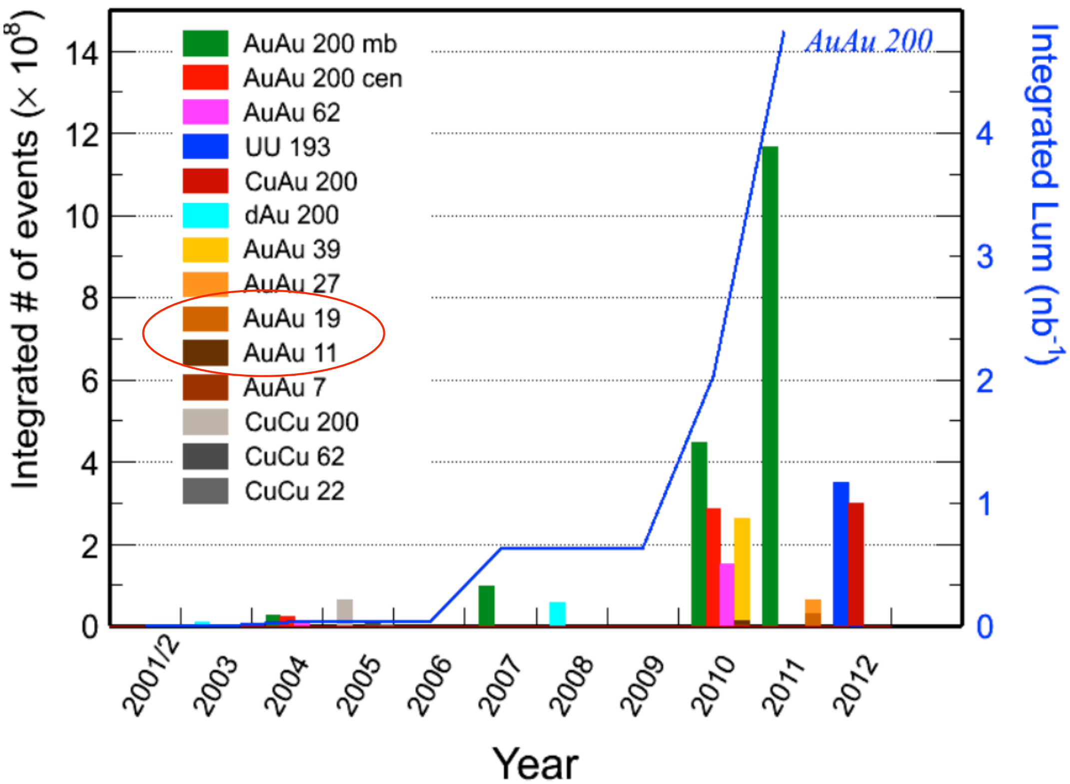
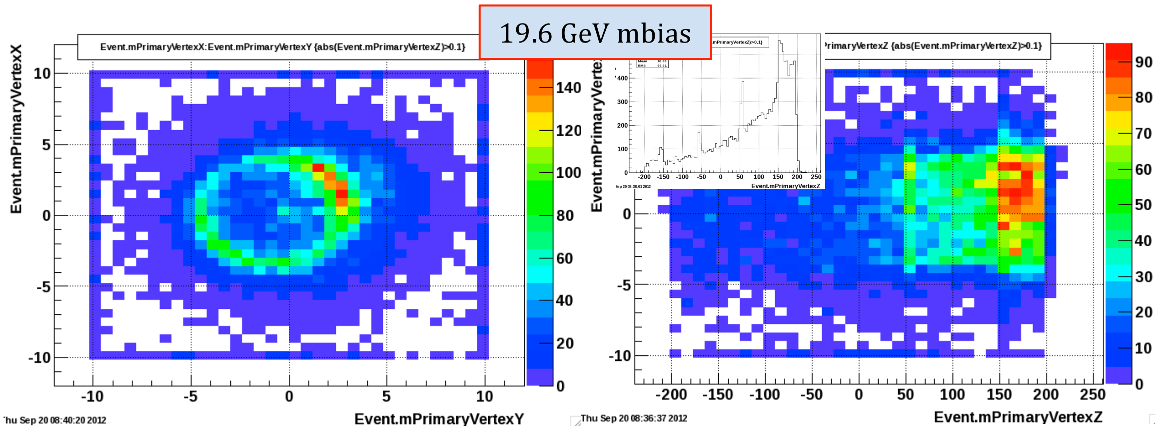


Figure 3 Integrated number of events (left vertical axis) or Luminosity (right vertical axis) for various beam configurations and run periods.

In summary: Performing the engineering run with low energy Au+Au collisions will reduce a good fraction of the benefits anticipated from a run with full energy Au+Au collisions and will increase the risk for encountering unanticipated problems during Run-14 that might impact the physics readiness of the HFT. This increases the risk for delays in delivering the Physics of HFT in a highly competitive environment at RHIC and CERN.

APPENDIX

Same as figures 1,2 but for 19.6 GeV/c. Both energies have identical characteristics.



Below we see the same figures, at both energies, but for random triggers (zerobias events). We observe the same features as in regular triggers.