Hand Calculations regarding the effect of changing the STAR beampipe radius from 1.5 cm to 2.0 cm

I have used the Matrix5Resolution.C macro to estimate the effect of moving the inner beam pipe radius from 1.5 to 2.0 centimeters. This change was requested by the RHIC accelerator physicists because they were concerned about the STAR beampipe becoming the limiting aperture around the ring. By expanding our BP radius to 2.0 cm, the limiting aperture is moved elsewhere around the ring.

The calculations shown in figures 1-4 are for a configuration that includes all of the proposed Si detectors for STAR. Specifically, these include the HFT, the HPD, the IST, the SSD, and the TPC. For all Si points, I have assumed that the useful resolution is three times the detector resolution.

The four figures have the same format. Pointing resolution (sigma) is shown on the vertical axis in microns. Transverse momentum is plotted on the horizontal axis and is quoted in GeV. The top line in each plot is an estimate of the pointing resolution of the TPC acting alone but with a 3 mm vertex constraint. The pointing resolution at the vertex is shwon. Note that the low momentum part of the curve goes asymptotically to 3 mm … which helps to identify the fact that a 3 mm vertex constraint is part of the fit.

The dashed line in each figure is the "ideal" hft performance, if the hits could be found by magic, and without any multiple scattering from any other detector except the HFT itself. Note that the dashed line in figures 1 and 2 is not the same as the dashed line in figure 3 and 4.

Figures 1 and 2 show the performance of the system when the HFT layers are close to the 1.5 cm radius of the BP. Figures 3 and 4 show the performance of the system when the HFT layers are moved out to accommodate the larger BP at 2.0 cm. The dashed line in the figures reflect the idealized performance of the HFT in these two different configurations.

```
#define    VtxRadius          0.0     // cm
#define    BeamPipe1Radius    2.05    // cm (2.05 large 1.50 small)
#define    Hft1Radius         2.5     // cm (2.5 large 1.55 small)
#define    Hft2Radius         7.0     // cm (7.0 large 5.00 small)
#define    BeamPipe2Radius    8.55    // cm (8.55 large 6.05 small)
#define    HpdRadius          9.2     // cm
#define    Ist1Radius         12.0    // cm
#define    Ist2Radius         17.0    // cm
#define    SsdRadius          23.0    // cm
```

Results:

The pointing resolution of the small beam pipe configuration is approximately 65 microns in the critical 500 – 600 MeV region. The pointing resolution of the larger beampipe configuration is approximately 85 microns in the 500 – 600 MeV region.

The change in resolution is real and significant. However, it needs to be put in perspective: the bottom line in each plot is the pointing resolution of the same detector systems but with the addition of a 30 micron vertex constraint. Thus, if we do a re-fit of the Si points after all the hits have been found, then it is possible to make a large improvement in the pointing resolution of the system using software … much larger than anything that can be done, or undone, with hardware. The pointing resolution of both systems, with a re-fit and a tight vertex constraint, is about 30 microns.

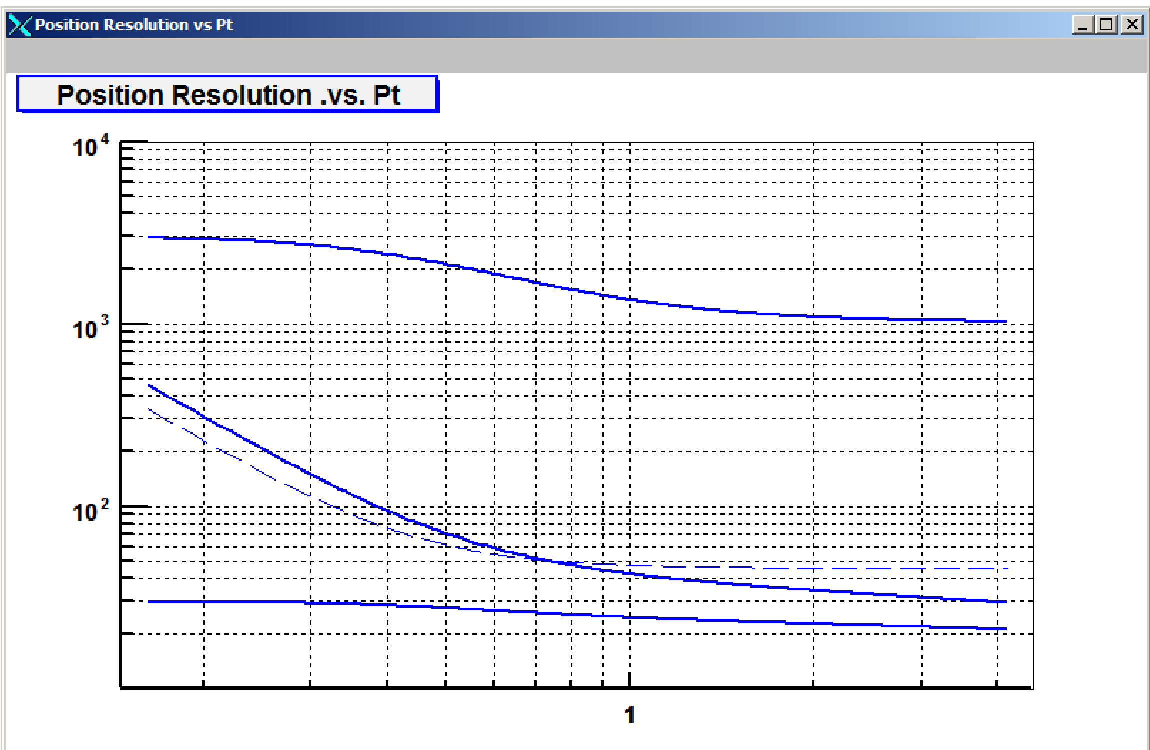

Figure 1: R-Phi Resolution for the HFT+HPD+IST+SSD+TPC with a 1.5 cm radius Beam pipe and the HFT layers moved in to take advantage of the small radius of the BP.

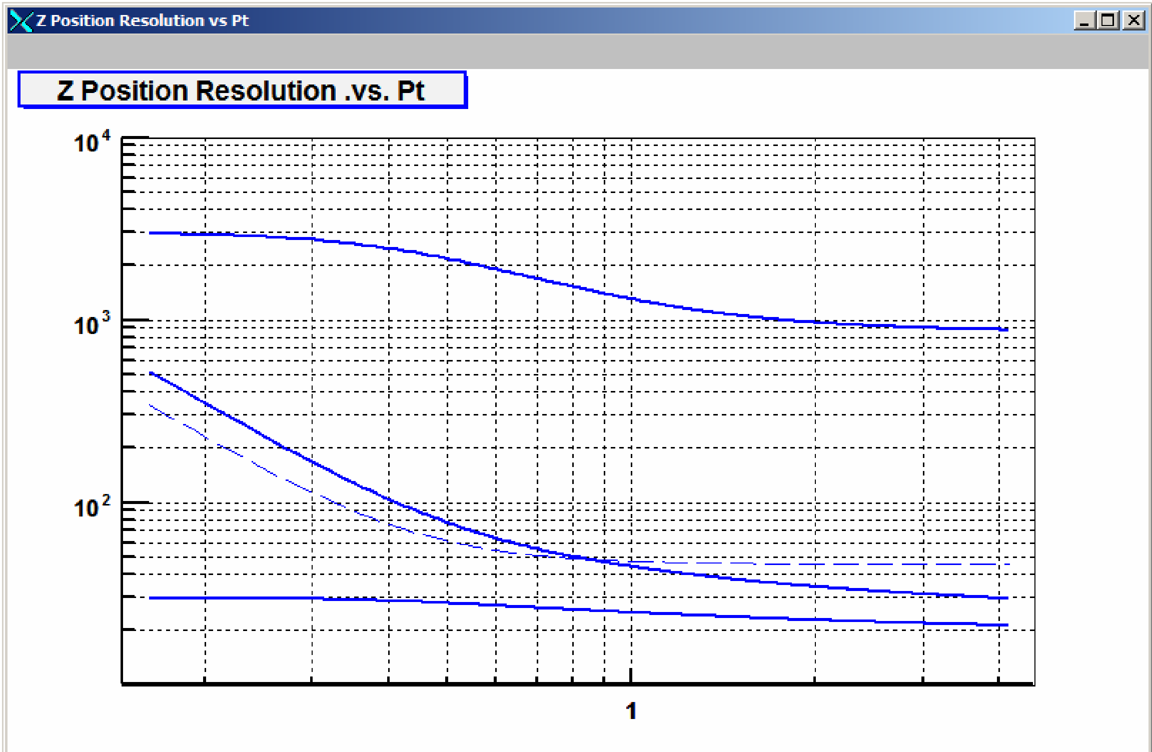

Figure 2: Z Resolution for the HFT+HPD+IST+SSD+TPC with a 1.5 cm radius BP

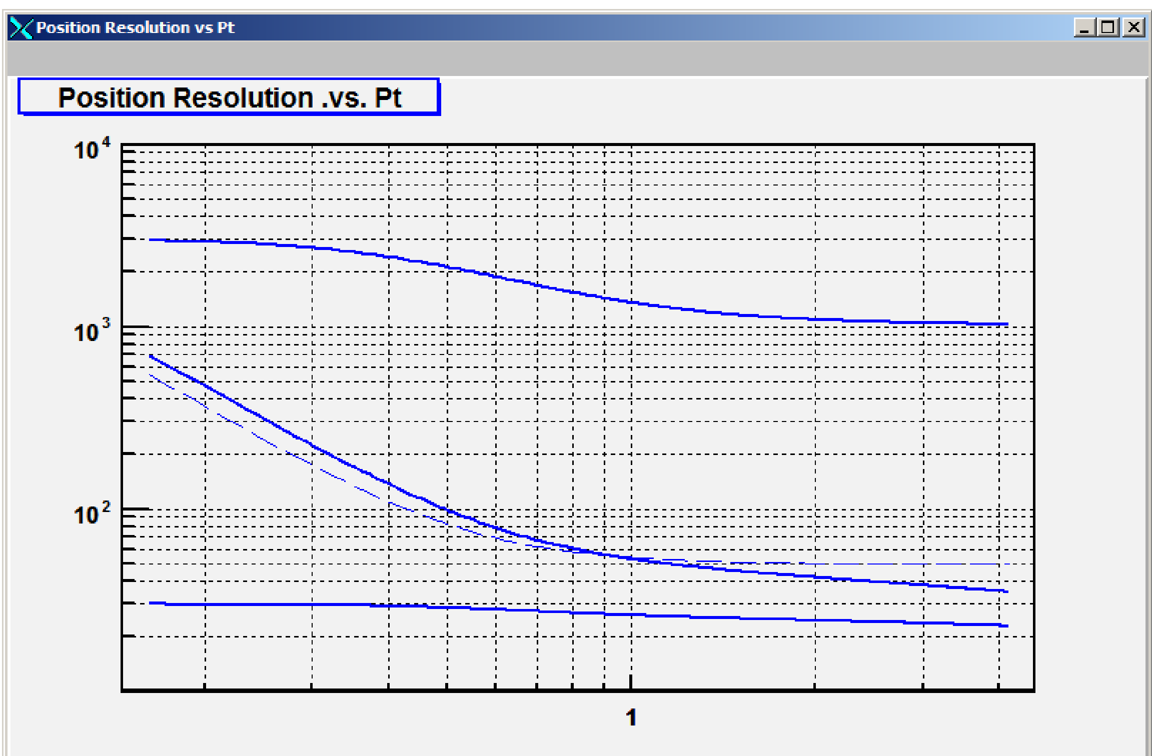

Figure 3: R-Phi Resolution for the HFT+HPD+IST+SSD+TPC with a 2.0 cm radius Beam pipe and the HFT layers moved out to stay off the BP.

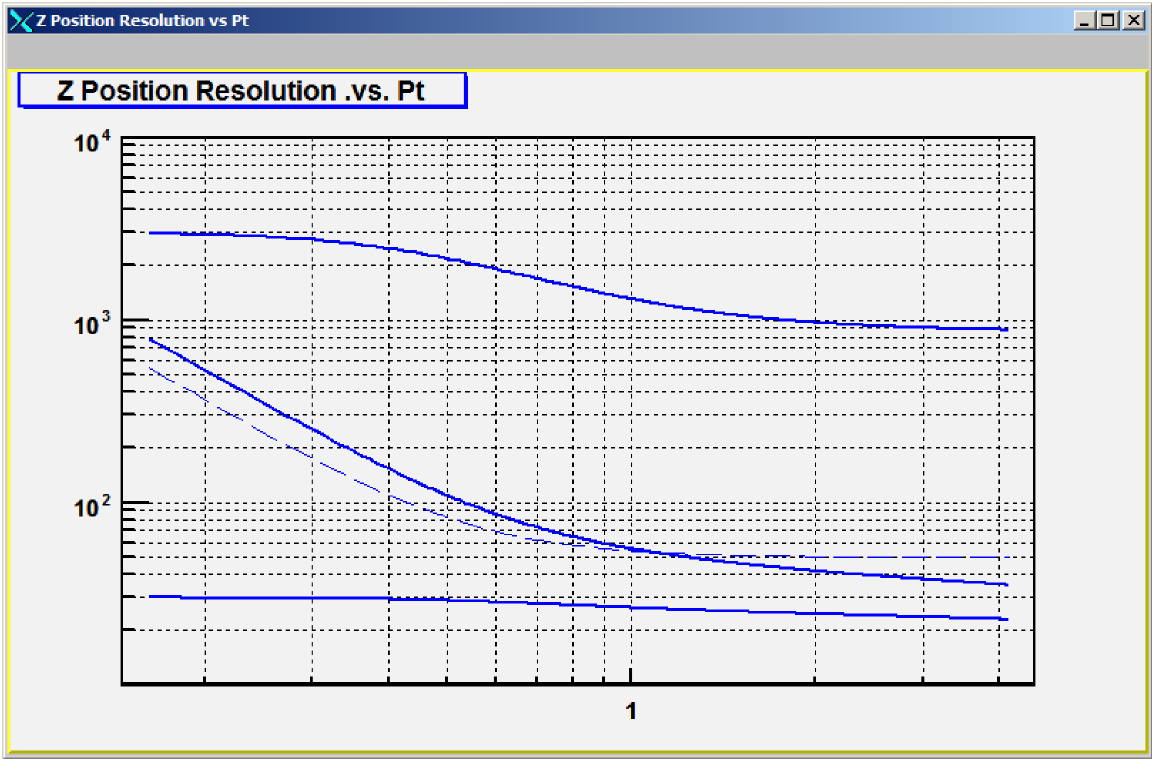

Figure 4: Z Resolution for the HFT+HPD+IST+SSD+TPC with a 2.0 cm radius BP