Calculating the Performance of an IST3 Configuration

The DAC review committee asked us to consider the merits of building an additional layer of Si strips as a replacement for the SSD.

For this study, the baseline detector is HFT1+HFT2 + IST$^{\frac{1}{2}}$ + IST2+IST2$^{\perp}$+ SSD + TPC where IST$^{\frac{1}{2}}$ is a detector built with 60 µm x 2 cm strips (aka ½ length strips), and IST2$^{\perp}$ is a layer of strips rotated by 90 degrees to the other IST2 layer.

The question is whether to build the IST2$^{\perp}$ layer and put it at 17 cm radius, near the other IST2 layer, or to remove the SSD and put IST2$^{\perp}$ at 23 cm radius.

1.) IST2$^{\perp}$ at 17 cm radius and keep the SSD
2.) IST2$^{\perp}$ at 23 cm radius and delete the SSD

In principle, the pointing resolution of these two configurations should be about the same because they are both based on thin strips (60 µm strips in the IST and 95 µm strips in the SSD … however, the SSD has two layers of crossed strips and so it also gives sub-millimeter resolution in the Z direction). Figure 1 shows the R-φ pointing resolution and Fig. 2 shows the Z pointing resolution for the two configurations.
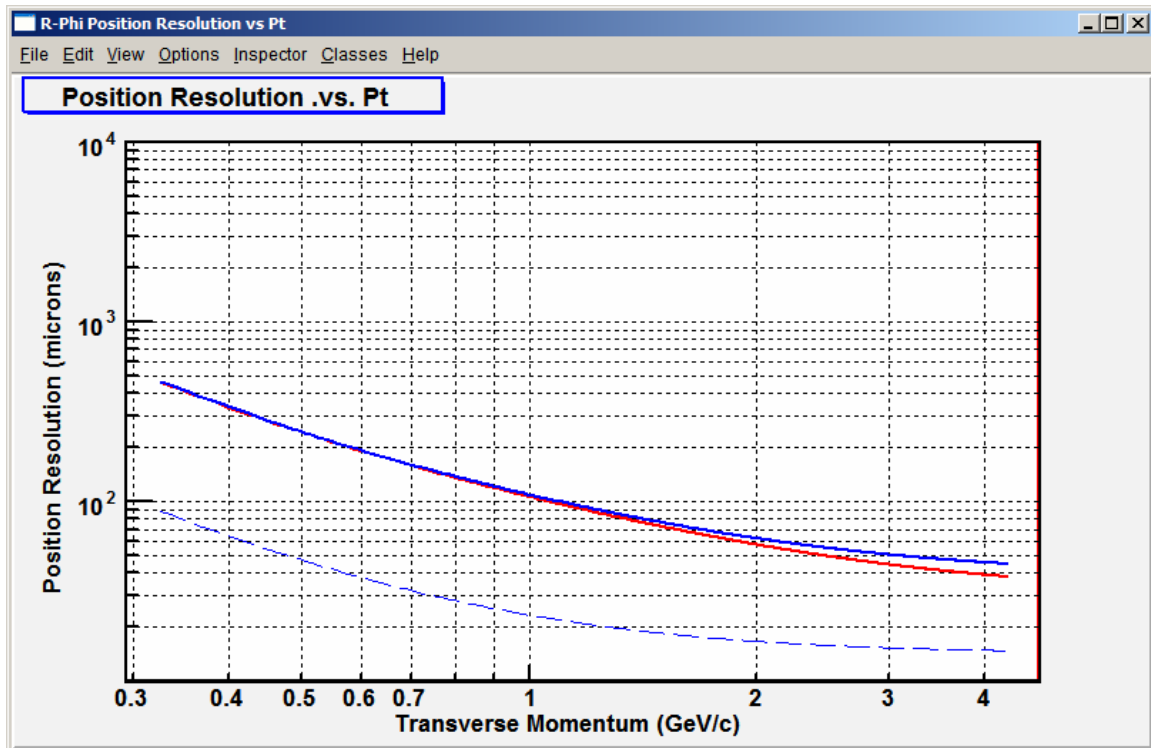

Figure One: R-φ pointing resolution for the SSD pointing at IST2 (Blue) compared to the pointing resolution of the IST2$^{\perp}$ at 23 cm pointing at IST2. The system is MCS limited so there is no gain in R-Phi resolution even though IST2$^{\perp}$ has narrower strips.
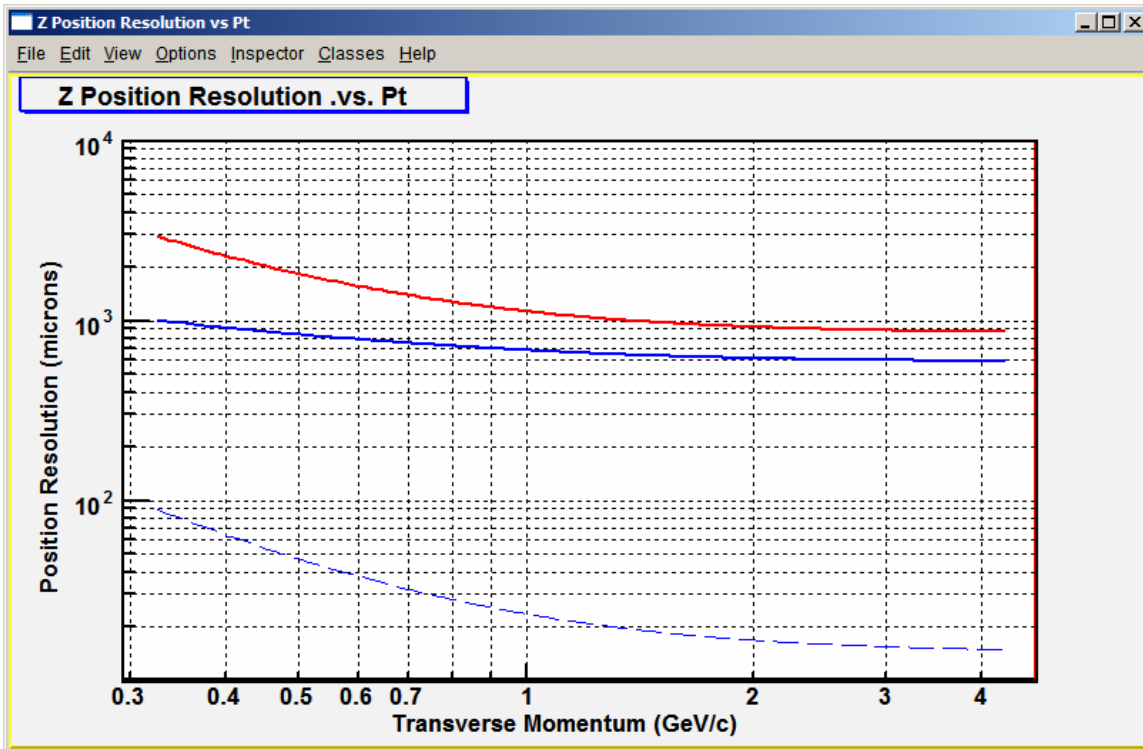
Figure Two: Z pointing resolution for the SSD pointing at IST2 (Blue) compared to the pointing resolution of the IST2$^{\perp}$ at 23 cm pointing at IST2. The Z resolution is worse for the IST2$^{\perp}$ at 23 cm configuration due to long length of the 4 cm strips.
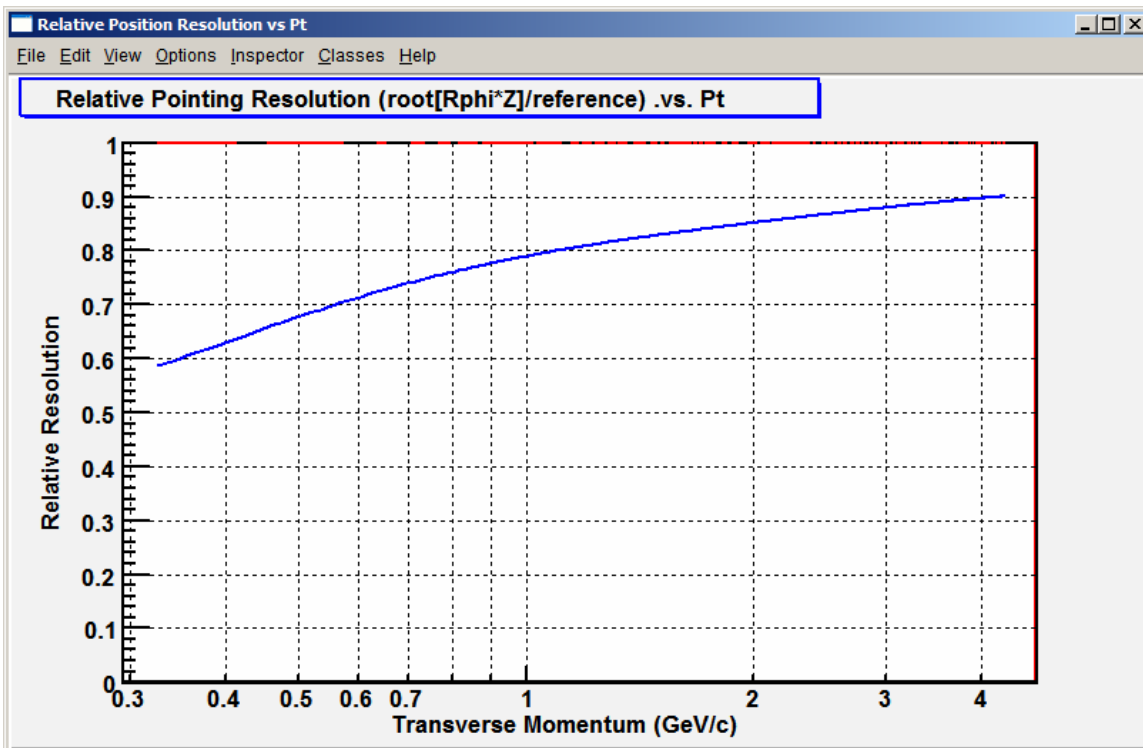

Figure Three: The ratio of the two configurations. The IST2$^{\perp}$ at 17 cm radius (with the SSD) configuration is better than the IST2$^{\perp}$ at 23 cm radius (without the SSD).

Figures 1, 2, and 3 show that the effective single track pointing resolution onto IST2 is about 25% better with the SSD. In terms of hit finding inefficiency … we have to square this number, and so the SSD configuration is better in the highest density events.

This is not the full story because we also have to consider the pointing resolution on IST1 when we change from configuration 1.) to 2.)   The pointing resolution onto IST1 is shown in the next set of plots. It is about 25% better with the SSD. So the conclusion will be the same. The SSD configuration is better for the highest density events.

Therefore, the configuration with the SSD is about 4x less inefficient than the configuration without the SSD. This statement applies to high multiplicity events and is not true for low multiplicity events. The SSD configuration is always better and the maximum gain in relative inefficiency is 4x.

There are many options with regard to the IST3 configuration. I have selected the cheapest configuration. If money were no object, then you could put IST strips plus IST pads at 23 cm radius and effectively get the same performance as the SSD. This would be very expensive due to the large radius.   Similarly, we could put the IST2$^{\perp}$ layer at a radius between 17 and 23 cm radius.   This would be a more efficient configuration but also modestly more expensive due to the larger radius and the additional engineering and mechanical structures required.
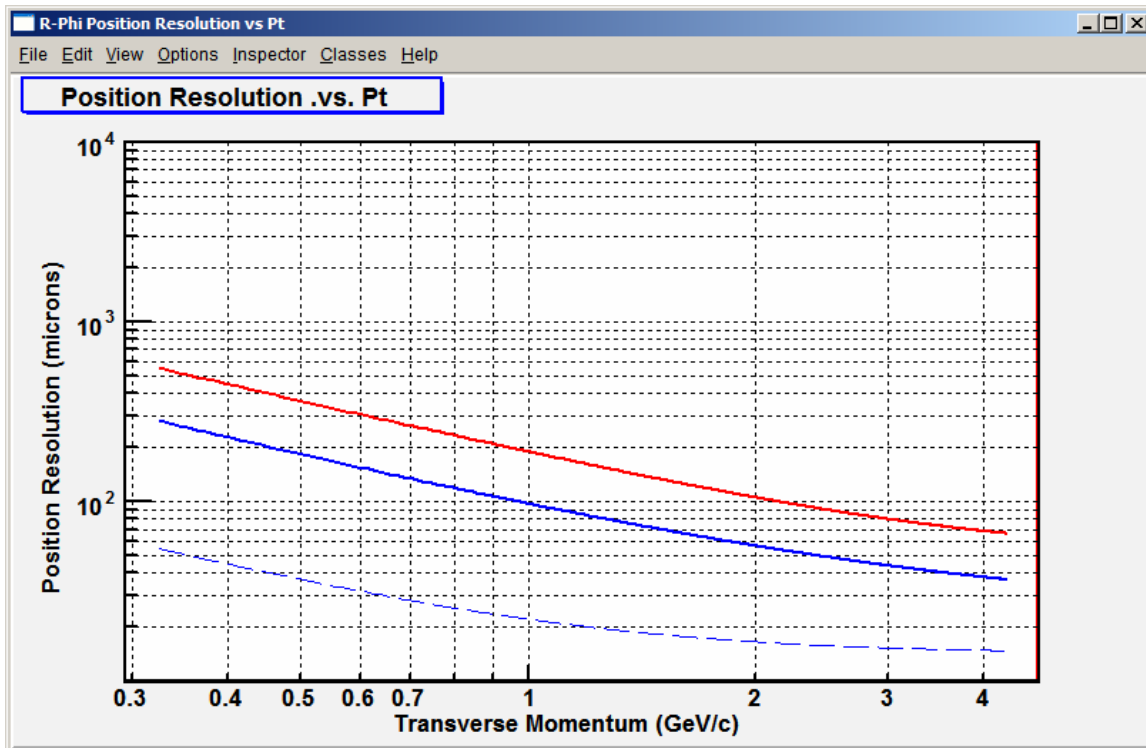

Figure 4: R-ϕ pointing resolution for the SSD+IST2+ IST2$^{\perp}$ pointing at IST1 (Blue) compared to the pointing resolution of the configuration with IST2$^{\perp}$ at 23 cm plus IST2 pointing at IST1.
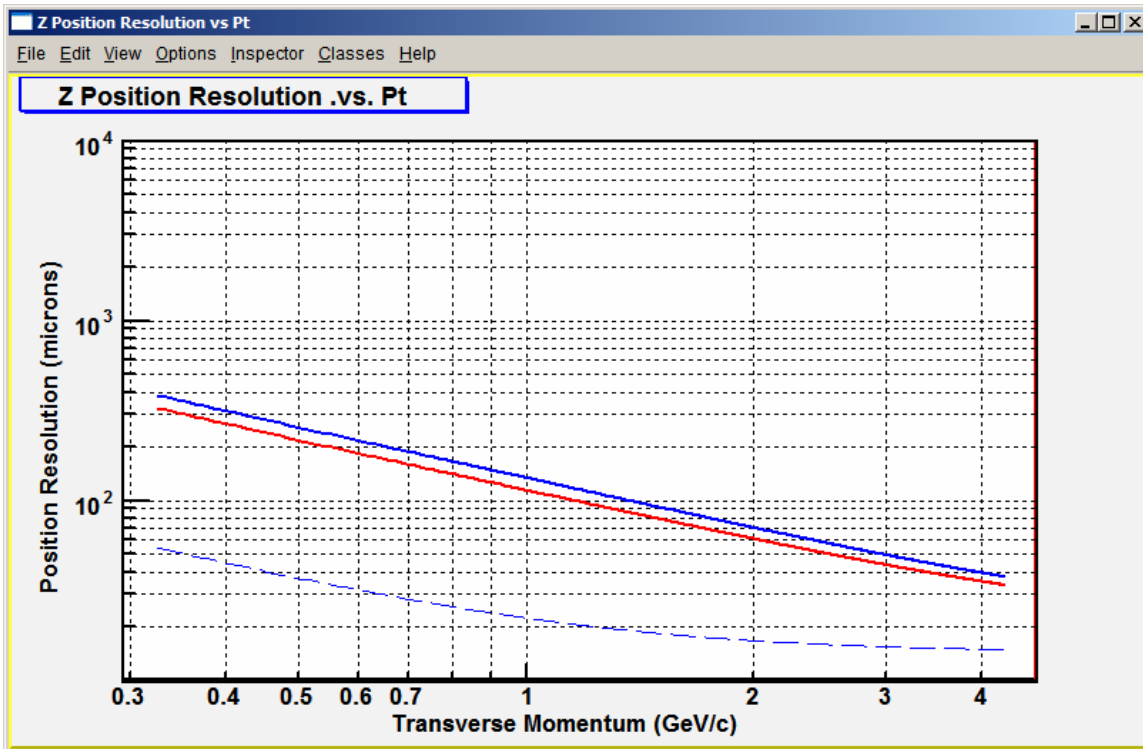
Figure 5: Z pointing resolution for the SSD+IST2+ IST2$^\perp$ pointing at IST1 (Blue) compared to the pointing resolution of the configuration with IST2$^\perp$ at 23 cm plus IST2 pointing at IST1.   With SSD is better.
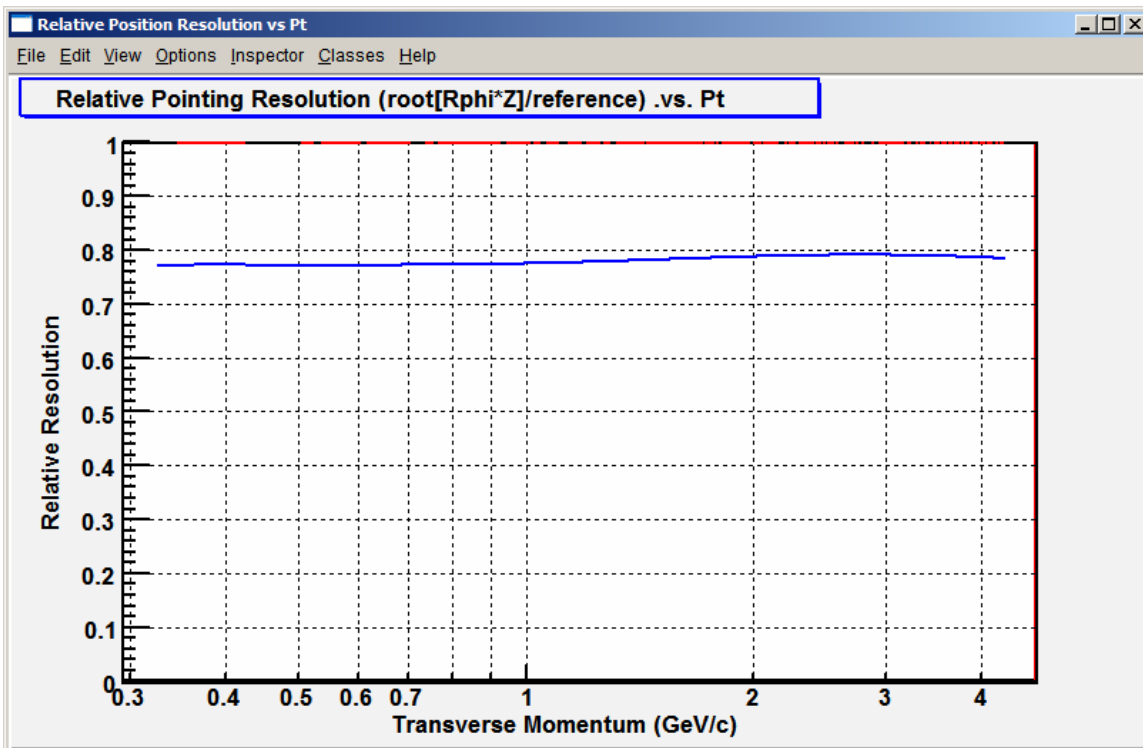

Figure 6: The ratio of the two configurations. The IST2$^\perp$ at 17 cm radius (with the SSD) configuration is better than the IST2$^\perp$ at 23 cm radius (without the SSD).