Hi Jim,

In preparation for the IST-fest this week I wanted to gather the state of the art LBL hand calculations for various IST configurations so that we can benchmark the MC results Willie/Andrew are producing against something semi-analytic. I think that we don't yet fully know how to define efficiency and purity in the tracker (at the track/hit level), but the pointing resolution is fairly robust, so I would propose that as our key metric. Of course full D0 simulation is the best, but that's too intensive to do in 3+ configurations on this time scale. What Willie has done is code up a quick digitization simulator that takes into account the various strip/pad configurations. MC Hits are binned into the strips and pads, and then we make reco hits out of strips/pads and send them on to the tracker. The various configurations are as follows (all have IST2 perp. IST1):

0) Baseline configuration for past review (strips+pads on each layer) without any digitization simulation, just gaussian smearing

1) Baseline configuration (4cm x 60 um strips, with the pads) on both IST1 and IST2 including digitization

2) Long strips on both IST1 and IST2 (4cm x 60 um) but no pads on either layer + digitization

3) Strip-lets on both IST1 and IST2, but no pads (640 x 2 strips/ wafer, each 2cm x 60 um)

Would it be possible for you to collect the expected pointing resolution (at outer HFT) in those various configurations from your various calculations? That way we have something to really discuss.

Thanks, Mike

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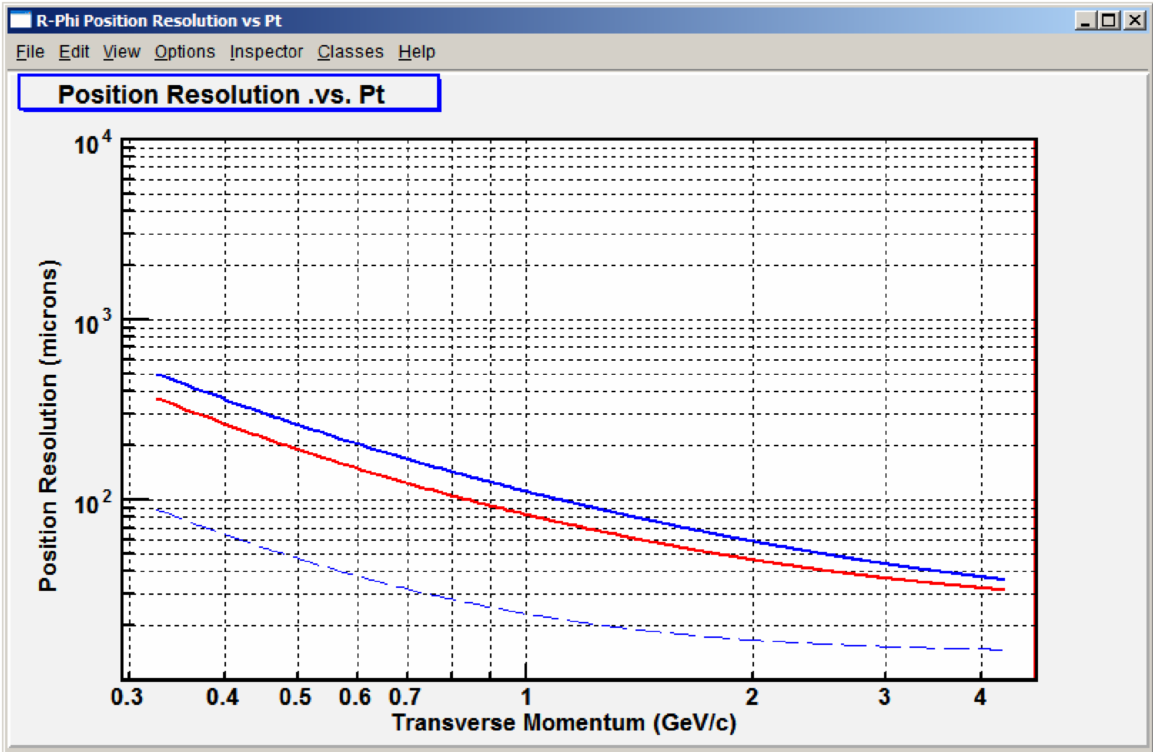

Figure 1: Question 0 and 2) Baseline configuration with and without pads. Note improvement in pointing resolution on HFT2 when the pad layer is removed. This is caused by MCS. For example, R-Phi resolution drops from 152 to 112 microns @ 750.

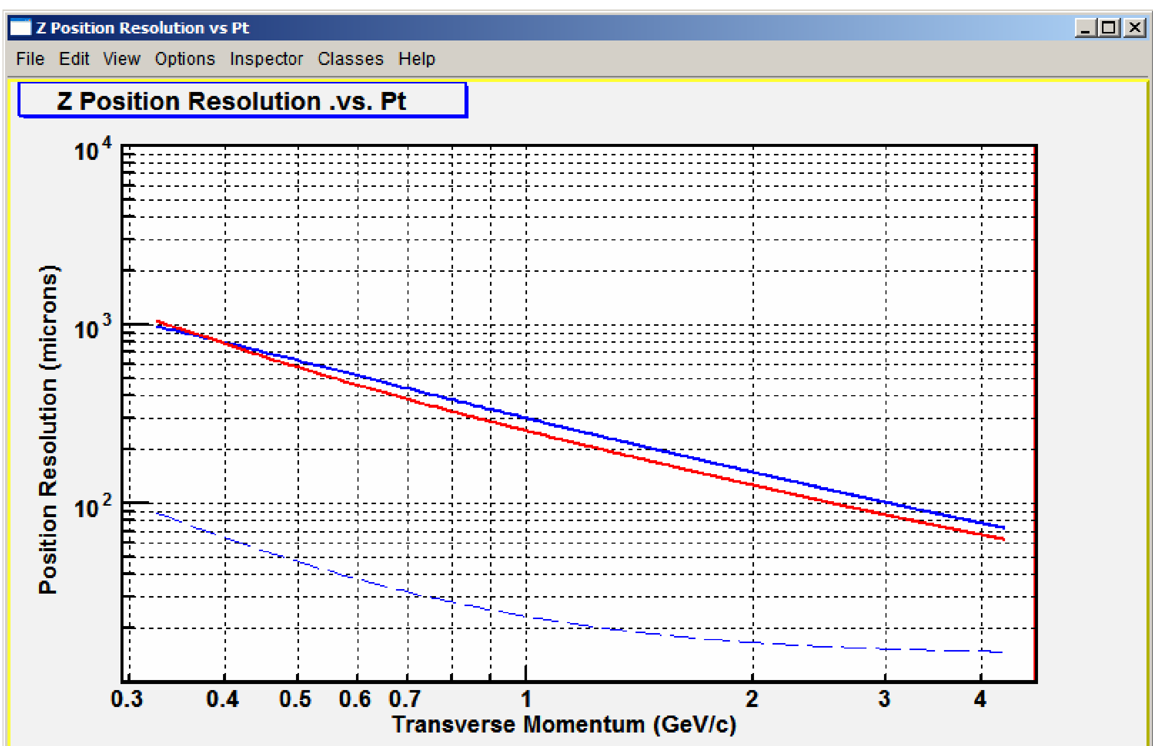

Figure 2: Same conditions as Fig 1 but showing the pointing resolution in the Z direction. Note that we do not have symmetric resolution in R-Phi and Z.

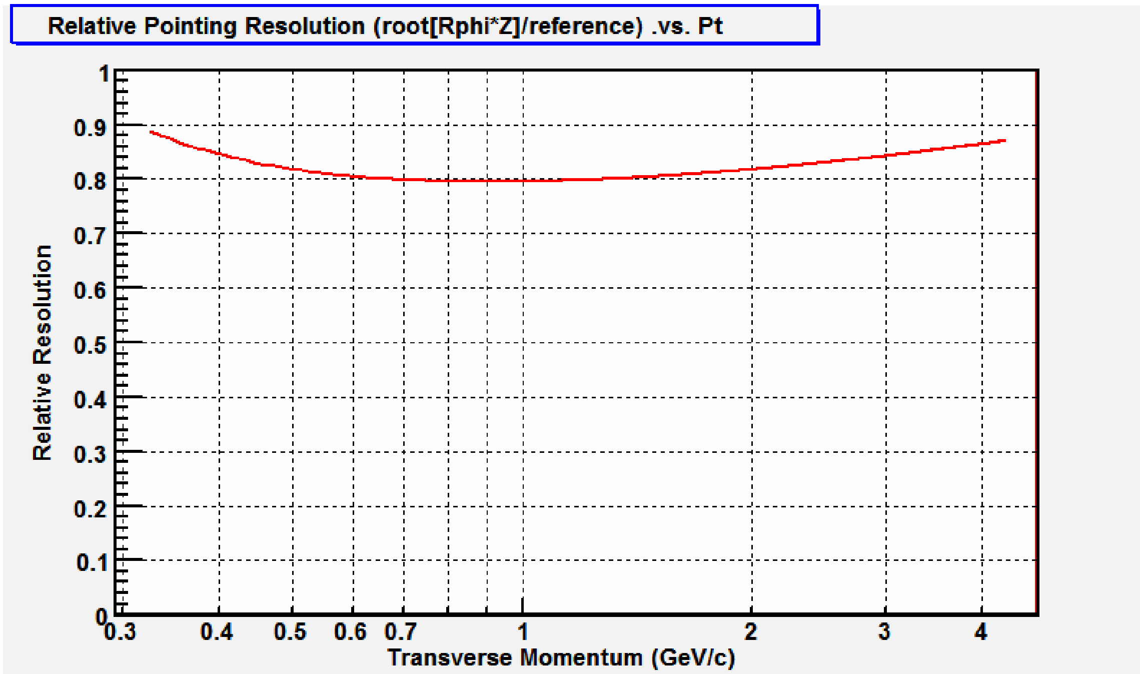

Figure 3: A relative comparison of the pointing resolution of the system. The figure of merit is the Sqrt(R-Phi Resolution * Z Resolution) because the inefficiency depends on the product of these two resolutions (i.e. $2\pi \, \sigma_x \, \sigma_y \, \rho$). Overall, the average pointing resolution onto HFT2 decreases by 20% when the pad layers are installed.

Note that the pointing resolution onto HFT2 is dominated by the MCS in IST1 and the pointing resolution of the system immediately before the HFT. The same thing happens when you ask about the pointing resolution onto IST1 … the performance is limited by the next previous layer (aka IST2). See the next page. IST2 pointing at IST1 is important, too, because the pointing resolution onto each layer contributes to the overall (in)efficiency of the system (it’s the product of the efficiency of each the layers).

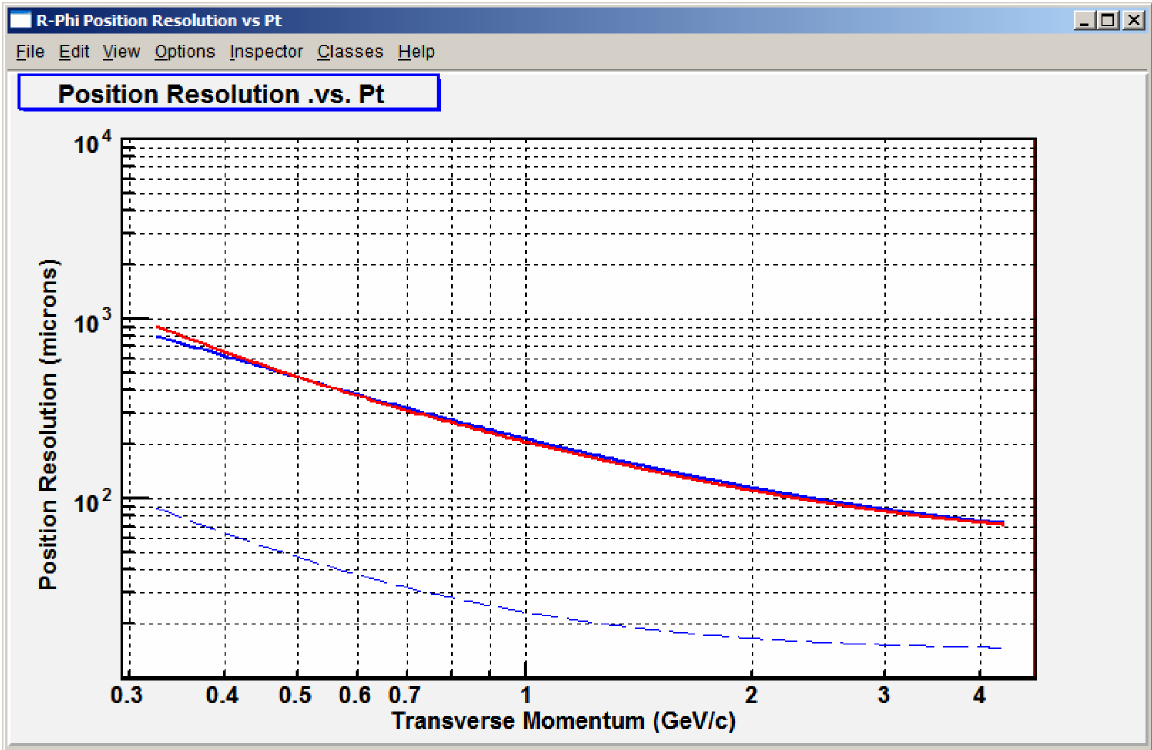

Figure 4: Baseline configuration with and without pads pointing at IST1. Note that the R-Phi resolution onto IST1 does not change very much because it is already large.

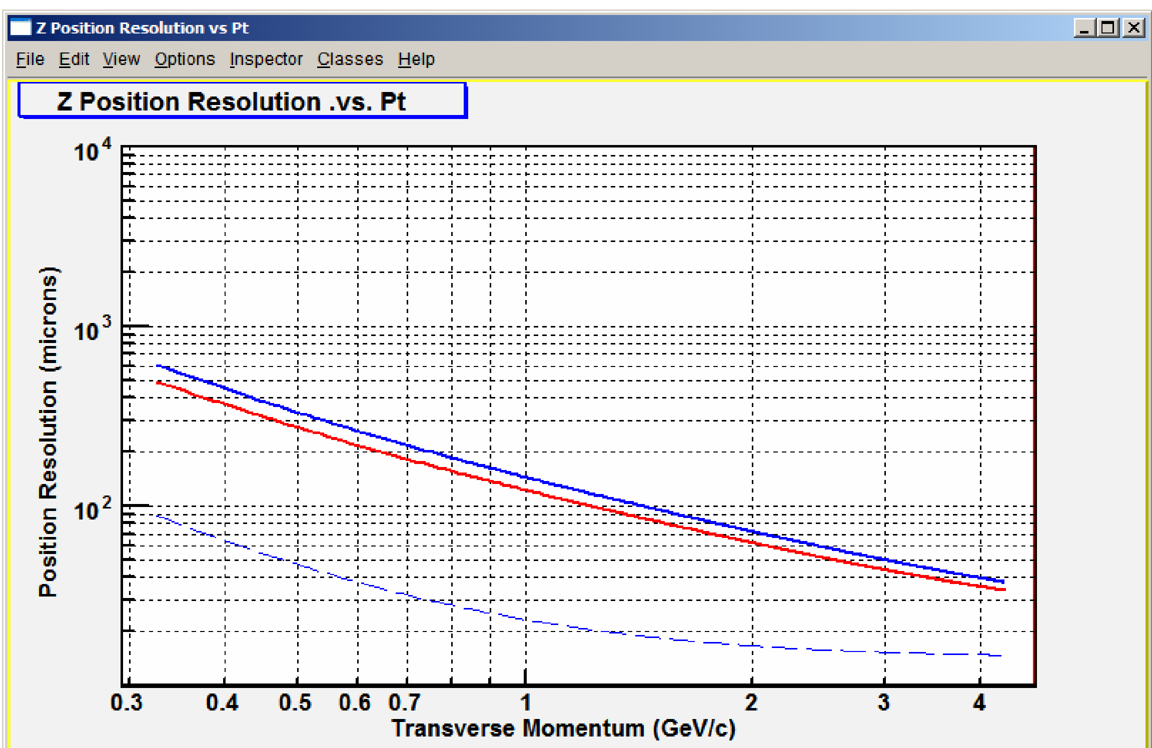

Figure 5: Same conditions as Fig 4 but showing the pointing resolution in the Z direction. Note that that HFT2 provides better Z resolution onto IST1 and goes into the MCS limited regime. Thus, removing the pads improves the pointing onto IST1.

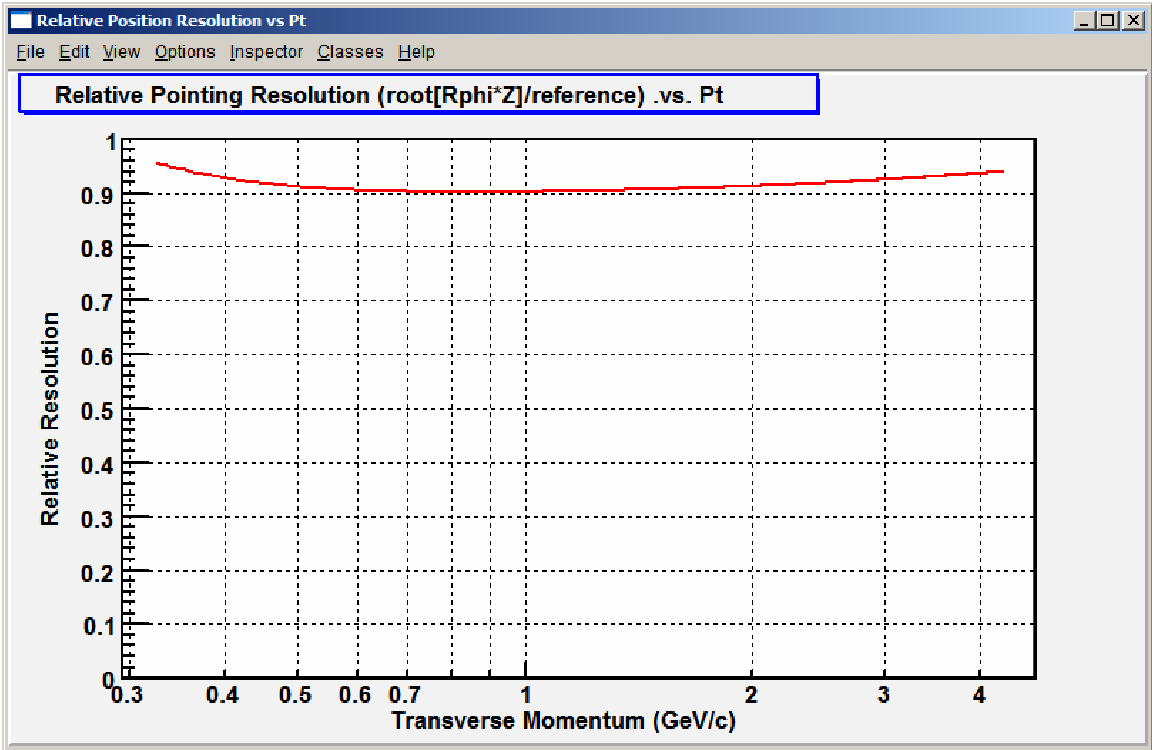

Figure 6: A relative comparison of the pointing resolution of the system. The figure of merit is the Sqrt(R-Phi Resolution * Z Resolution) because the inefficiency depends on the product of these two resolutions (i.e. $2\pi \sigma_x \sigma_y \rho$). Overall, the average pointing resolution onto IST1 decreases by 10% when the pad layers are installed.

Questions 1 and 3 cannot be addressed by a pointing resolution calculation. The formation of a space point from a pad plus strip layer does not improve the pointing resolution of the system because the previous layers in the system already provide better pointing resolution than the gain achieved by 'shortening' the strips by adding pads. In other words, changing the strip length from 4.0 cm to 2.0 cm does not improve the pointing resolution because the 4 cm strip length was not the limiting factor in determining the resolution of the system at this point.

However, the length of the strips does affect the inefficiency due to ghosting and ambiguities. If you try to form a space point out of a pad plus strip layer, then your ambiguities cause the effective hit density to go up geometrically.

Gene VanBuren and Howard Wieman have done the best ghosting and ambiguity calculations. Their results show that the half length strips are the most efficient system we can easily build. To be specific, Gene's figure shows the probability for correctly associating a hit with a track as a function of hit density. Lets assume that the hit density on IST1 is 1 particle per cm**2 and its 0.5 particles per cm**2 on IST2. Then you find the following improvements by adding pads or half length strips.

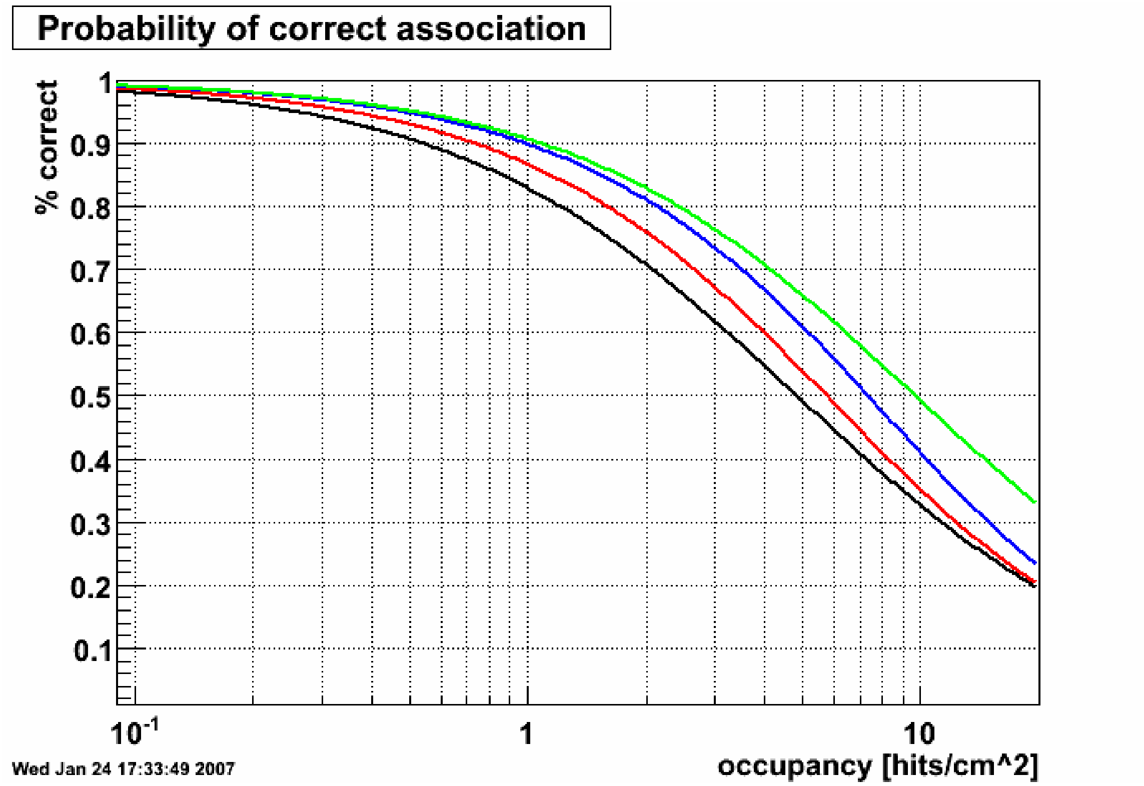

Figure 7: Figure from the work of Gene VanBuren and Howard Wieman.

See: http://www.star.bnl.gov/~genevb/IST_Study/ and http://rnc.lbl.gov/~wieman/HitFindingStrip2DMC2Gory.htm

Layer Efficiency	Long strips & no pads	Long strips & baseline pads	Kotov Skinny Pads	Half Length strips & nopads
IST2 (0.5 per cm**2)	91%	94%	96%	96%
IST1 (1 per cm**2)	83%	86%	91%	92%

Therefore, Gene's calculation suggests that the pad layer at IST2 increases the probability of a correct hit association by 3% relative to a system without pads. Half length strips increase the probability of a correct hit association by 5%.

The improvement on IST1 is better due to the higher hit density. Pads improve the hit association probability by 3%. Half length strips improve the hit association probability by 9% .

Overall, the half length strip looks very attractive on IST1 because the probability of a correct hit association is up and the MCS is down. By dropping one layer of Si we can improve the average pointing resolution of this layer onto HFT2 by 20%. And, of course, improved pointing resolution on HFT2 will increase the yield of D^0s.