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Subject: message on the components to our 100ps generic spec on the total  
timing resn

the 'pid'-resn is what counts, and it is  $dM$ , or  $d(M^2)$ ... the experimental resn on  $d(M^2)$  is trivially related to the experimental resn on  $dM$ , so for the following let me concentrate on  $dM$ .

here we point to figure 22 of the proposal.  $dM/M$  is expressed in terms of the resns on the three qtys that it depends on. the momentum resn  $dp$ , the path length resn,  $ds$ , and the timing resn,  $dt$ . the resn depends on the path length (which is  $\eta$  and  $Z_{vtx}$  dependent), but one sees from fig 22 that if one makes reasonable assumptions for  $dp$  and  $ds$  and also specifies that  $dt=100ps$ , then one gets  $2\text{-}\sigma$   $\pi:k:p$  pid to 1.6(2) gev in \*Momentum\* (not  $pt$ ), and  $\pi+k:p$  pid to 2.6(3.2) gev, for  $\eta$  near 0(1)...

one can twiddle a little what the assumptions are for  $dp$  and  $ds$ , which twiddles a little the momentum cutoffs, but overall those choices of  $dp$ ,  $ds$ , and  $dt$  result in momentum cutoffs close to what we expect and have measured in STAR in runs-2 through -5... so let's push on.

evaluating the individual terms in this equation (for some say intermediate values of  $s$  and  $p$ ) shows that the path length resn is an order of magnitude more important than the momentum resn, and the timing resn is another order of magnitude more important than the path length resn. hence, the timing resolution itself dominates our PID resolution.

so, what is the total timing resn benchmark of 100 ps made out of? let's say we specify the timing spec for Au+Au min-bias, which seems reasonable... w/ this spec on the collision system, we then say

$100ps > \sigma_{start} (+) \sigma_{stop}$ .

$\sigma_{stop}$  is easy.

$\sigma_{stop} = \sigma_{det} (+) \sigma_{daq} (+) \sigma_{corrections}$

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i.e. the pure stop resn is the quadrature sum of the intrinsic detector timing resn, and the digitization resn, and the resn from the fact that corrections are necessary, and these corrections are based on experimentally measured quantities that have their own measurement resn.... i.e. slewing uses ToT, the hit-position correction uses the tracking and tof geometry.

based on test beam experience, a reasonable number for  $\sigma_{\text{stop}}$  for us is 80 ps. i would break this up into its three components something like  $70 (+) 30 (+) 20 = 78\text{ps}$ .

on the start side, the kinematics are such that the more PMTs that fire in a given event, the better the start resolution will be. there is also the fact that in Au+Au at some high-enough beam energy, there are enough primary tracks matching to singly-struck tof cells that the start time can be inferred solely from the stop times.

but still we can say this much. there is a single detector resn for each upVPD PMT, that's somewhere near 80ps as well. one can reasonably break this 80ps into its experimental contributions (det, daq, and corrections) in exactly the same way as was done above for the stop side. the start detectors do indeed use the same digitization electronics as the stop side, and require a similar slewing correction based on ToT (but not a zhit correction). but still  $\sigma_0$  for a single start-side detector of 80ps =  $70 (+) 30 (+) 20\text{ps}$  is completely reasonable.

from  $\sigma_0$  one can get to  $\sigma_{\text{east}}$  and  $\sigma_{\text{west}}$  by dividing by the sqrt of the number of "promptly fired" pmts on each side. the start resn is then coming from these two total resns on each side.... so, for very peripheral auau and certainly for lighter systems, the start resn depends very much on exactly how many lit pmts one has to use on each side... the "averaging" effect we can exploit on the start-side, but not the stop-side, is quite powerful actually. (and its one of the motivations for the increased channel count of the upVPD)...

but ballpark, if someone demanded that i specify the two parts of the 'master' equation:  $100\text{ps} > \sigma_{\text{start}} (+) \sigma_{\text{stop}}$  i'd say  $\sigma_{\text{start}} \sim 80\text{ps}$  and  $\sigma_{\text{stop}} \sim 50\text{ps}$  makes  $\sim 95\text{ps}$ ...

we can/should discuss the details of the specific #s assumed above, but overall the above is a generally reasonable accounting of what contributes to our total resolution and our famous 100ps generic spec...

now, alice has a very similar breakdown of the components to the total resn spec in section 4.11 of their technical update... all the same terms can be identified, with one exception. the qty i call the daq resn above is further broken down in the alice document into two parts: the daq resn coming from the HPTDC and the

daq resn coming from the clock distribution.

as jo mentioned, we intend to perform the bench tests that would be needed to estimate the performance from our clock distribution and our HPTDC implementation separately, as alice does. we will distribute that result as soon as it is available...

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