100 MHz Cavity

We have measured a microbunch width of 242 ps for a 93 MHz cavity at 22 kV. Our simulation predicts a width of 217 ps for the same configuration. Since the 93 MHz cavity is very similar to the 100 MHz KOPIO cavity, the good agreement in microbunch widths gives us confidence that the 100 MHz cavity will be able to produce the required time structure.

However there is a factor of 2 discrepancy between the simulated and measured widths at 4.5 MHz that is not yet fully understood. The measured microbunch width of 1950 ps for 4.5 MHz at 270 kV can be compared with the simulated width of 930 ps.

We have simulated the behavior of the KOPIO configuration (25 MHz and 100 MHz both at 150 kV) and predict a width of 180 ps. The 25 MHz cavity alone would give a width of 238 ps according to our simulation.

We have confidence in the predictive power of the simulation for the two-cavity KOPIO configuration because the widths at 93 MHz agree at the 10% level. But our confidence in the predicted width for the 25 MHz cavity alone is not high enough to obviate the need for the 100 MHz cavity.

Microbunch width studies

We performed FastMC studies of the effect of increasing the microbunch width from the nominal value of 200 ps.

Conclusions drawn from figures on the next pages:

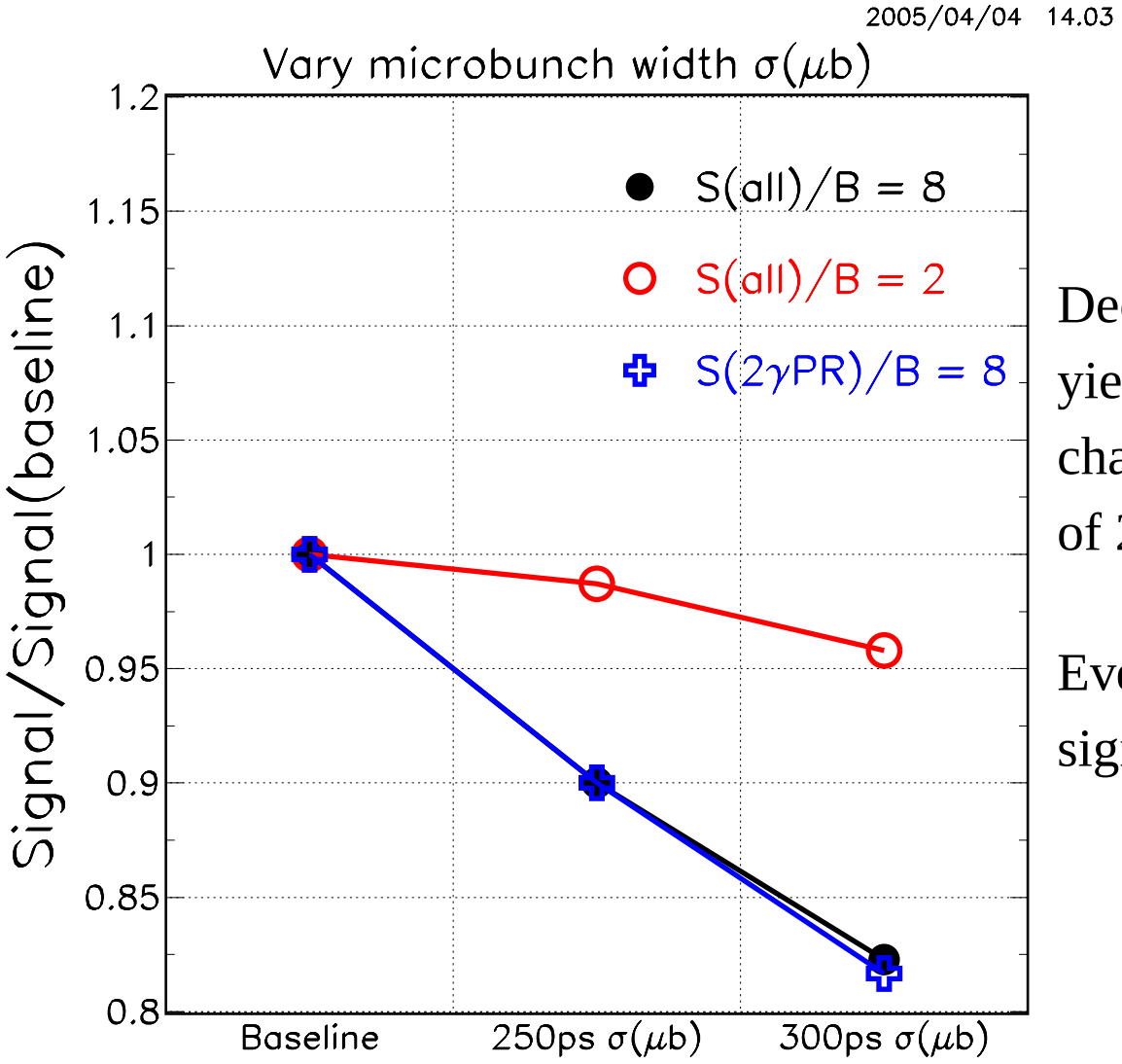
- Approximately 17% of the events at the highest signal-to-background are lost if the microbunch width is increased to 300 ps.
- We need an accurate measure of the microbunch width to achieve optimal sensitivity.

Events at the highest signal-to-background are essential in establishing the existence of the $\mathbf{K_L^0 \rightarrow \pi^0 \nu \bar{\nu}}$ decay.

Test beam measurements show we can accurately measure the microbunch width with a $\mathbf{90^\circ}$ monitor observing the neutral beam production target if it does not vary too quickly. The possible extent and timescales of the variation is not completely known.

In addition, as the microbunch width becomes large with respect to the intrinsic time resolution of the detector, the degree of precision that's needed to obtain the optimal sensitivity becomes greater.

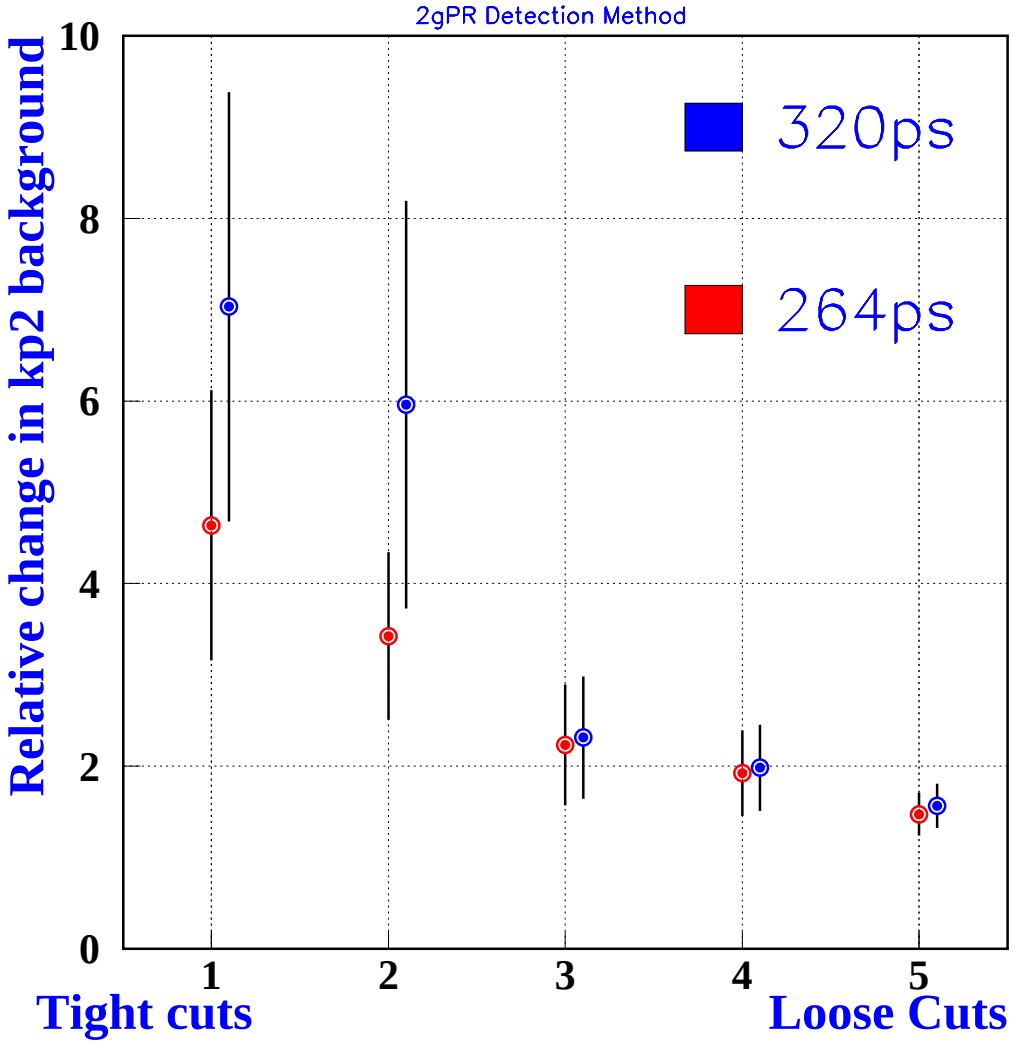
Microbunch width studies



Decrease in optimized signal yield as the microbunch width is changed from the baseline value of 200 ps to 250 ps and 300 ps.

Events with the highest signal-to-background are lost.

Microbunch width studies



Relative $K_L^0 \rightarrow \pi^0\pi^0$ background rate if kinematic cuts optimized for a microbunch width of 200 ps are applied to FastMC data with microbunch widths of 264 ps and 320 ps.

Optimal sensitivity requires an accurately measured, stable microbunch width.