Science and Background Issues of Detector Design

(From Steve Ritz' Memo)

1.1.1. Background rejection and pattern recognition

As the pitch is increased, the background rejection and pattern recognition capabilities of the TKR are reduced. In particular, the two-track resolution is compromised. Since, in a pair-conversion telescope, the fundamental difference between signal and background events at low and middle-range energies (where the background rejection is most difficult) is the presence of a track pair, this issue requires some attention. There is not, at present, any evidence that a shift from 200 microns to 235 microns would be catastrophic, but further study is warranted.

1.1.2. Science issues: Pitch

In addition to background rejection, effects of increased strip pitch on science include:

1. Worse PSF, particularly at high energy. The UCSC note indicates a 12% (5%) worsening of the PSF at 10 GeV for 282 (235) micron pitch relative to the baseline. The change in diffuse background events entering an error circle on the sky around a point source scales approximately as 2x the change in PSF.
2. Forget polarization. Earlier studies by seemed to indicate that 200 micron pitch with thin radiator could be marginally adequate for polarization measurements. Since no one has yet demonstrated any real capability for our instrument in this area, it is difficult to justify this as a driver; nevertheless, it is important to list science we may be giving up with any decision.

1.1.3. Science issues: Footprint

The effective area is obviously reduced by 2x the reduction in linear dimension of the footprint. In addition, the fractional active area of the instrument is reduced (gaps between detectors are fixed, but the active area of the detectors is reduced). The power savings only scales linearly with the dimension reduction, which is ~2%. Note that the fractional active area of the instrument is not compromised by pitch increases alone. Thus, per Watt, the impact on science may be greater from footprint decreases than from pitch increases.

1.1.4. Science issues: Recommendations

1. Check science impact of degraded PSF at high energy. A few key performance parameters (e.g., high latitude point source sensitivity, source localization vs source intensity) should be chosen.
2. Check impact on background rejection. In particular, check the shift in the surplus_hit_ratio distribution for gammas and background events for the wider pitch. Also examine the impact on the parameters we use to measure the track quality.