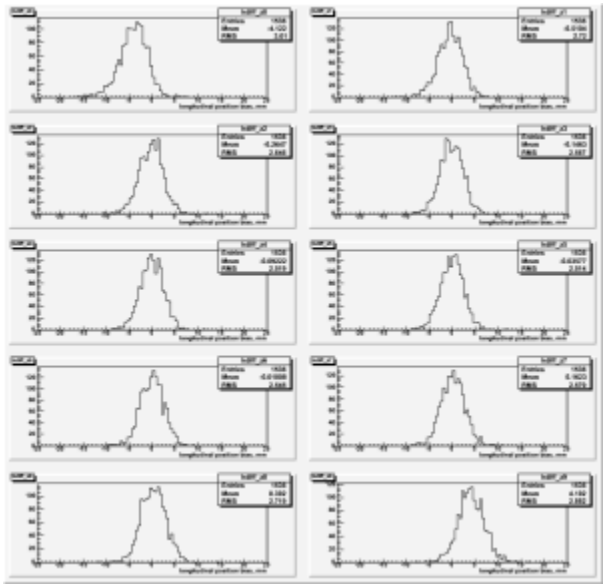
Time evolution of CAL asymmetry calibration

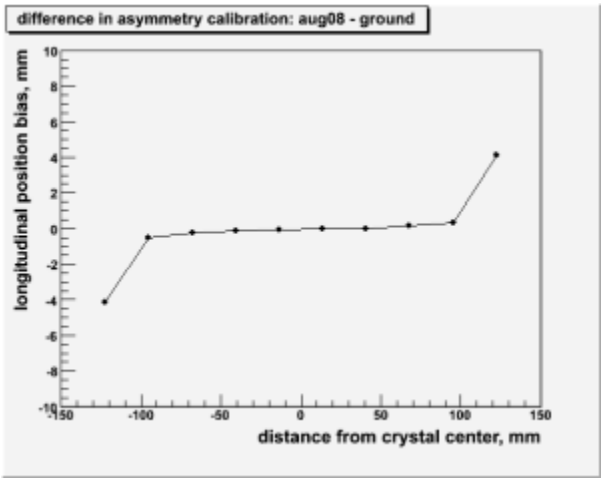
I've looked at the difference between CAL asymmetry calibration made on the ground with cosmic muons and on orbit with using CNO.

Difference between ground calibration and on-orbit calibration made in August 2008 is shown on the plot below separately for each of 10 segments along a crystal. Each histogram entry represents difference in asymmetry calibration constants for one crystal, converted to equivalent position bias in mm, using average asymmetry slope(0.0022 per mm).



(For C&A 21 June, look at the plot below first)

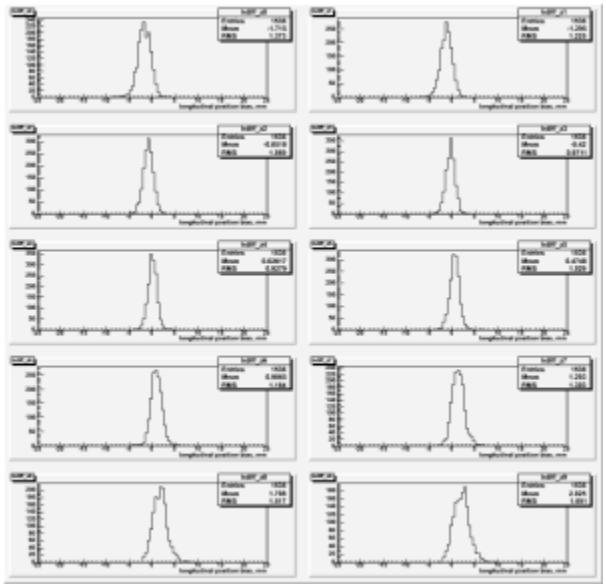
Each histogram shows gaussian spread with RMS ~2.5 mm, but the first and the last segment have also substantial systematic bias ~4 mm:

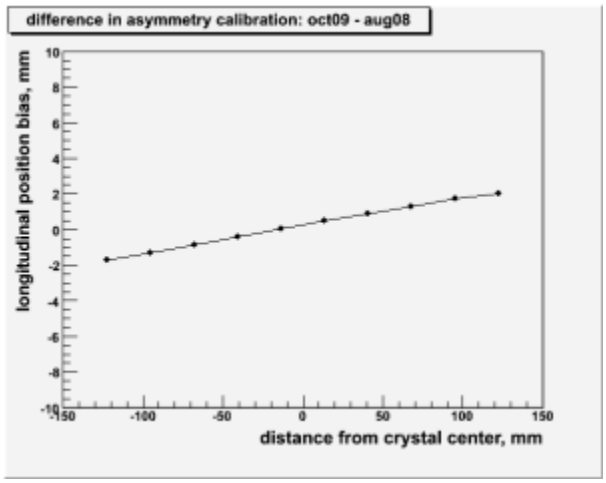


The reason for this bias was the error in ground asymmetry calibration procedure, which was later fixed in the on-orbit code: the 10-bin histogram of longitudinal position (each bin corresponds to a longitudinal segment) for each crystal was filled using asymmetry value for each event as a weight. The average value in each bin was used as a calibration constant, but it works properly only if events are uniformly distributed within a bin. This is not the case for the segments 1 and 10, because the event selection required that particle track crosses both top and bottom crystal surfaces at more then 30 mm from the crystal ends, while bin size is 27 mm. Together with angular distribution of the particle tracks this selection makes part of the segments 1 and 10 empty and thus introduces systematic bias in average coordinate of events in these segments. For on-orbit code this problem was fixed by histogramming only the difference between actual asymmetry value and average linear function with slope 0.0022 per mm - this way the systematic bias was decrease by factor of 10.

In reality the influence of this bias in ground calibration is even more significant, because for segments 0 and 11, which cannot be calibrated directly (because of spread caused by the effect of direct light) the calibration constant was linearly extrapolated from segments 1 and 10 and the bias of 4 mm become 8 mm in segments 0 and 11.

The error mentioned above was the biggest, but not the only source of systematic errors in asymmetry calibration. When I compared the calibrations based on data collected in August 2008 and in October 2009, the difference shows systematic behaviour with position along the crystal:

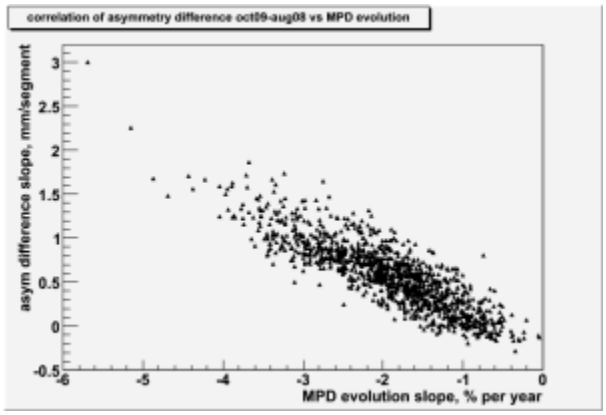




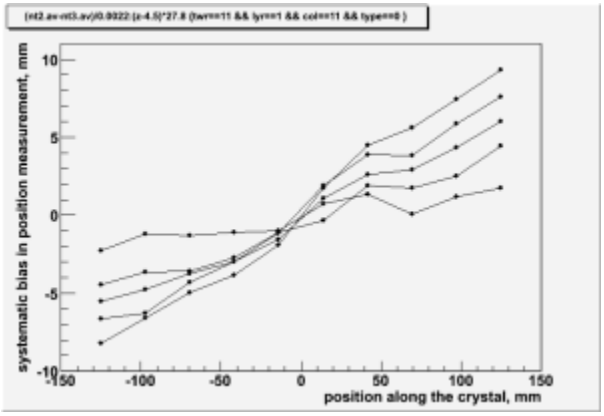
(C&A 21 June please look at the following section second)

This effect looks smaller than effect of the error in ground calibration procedure, but it affects all crystals. The change of asymmetry slope demonstrate substantial variations from crystal to crystal, but strongly correlated with the time drift of energy scale

for trhe same crystal, as shown on the following plot:



This correlation suggests that the drop of light yield is caused by increase of light absorption in the crystal due to radiation damage. In the crystal most sensitive to the radiation damage the systematic bias in longitudinal position is ~3 mm per segment.The evolution of asymmetry calibration in this crystal during first 1 year is shown on the following plot:



Each curve corresponds to period of 6 Ms (~2 month)

Conclusions

Conclusion is folowing:

- we can't use one calibration file for while 2 -year period, we have to update it every 2-3 month.
    - 6 files were generated for the period august 2008 - october 2009
- we really need to generate asymmetry calibration for the period starting from October 16 2009 (since this date GCR files become empty due to software bug)
- no problems for earth limb data reprocessing - we can use August 2008 calibration file.