PHOTOMETRIC ERROR FOR W MONTECARLO SIMULATIONS

This document summarize the test I have performed in order to quantify the uncertainties in the:
a) absolute zero points calibration
b) field to field relative calibration.
We will use the value of these errors as a input for montecarlo simulations meant to estimate the impact of the (a) and (b) uncertainties on the error associate with *w*.

a) To define the precision of our absolute calibration we need to compare it with that we can obtain using other catalogs. With the current data we can perform this comparison in two way:

1. For the fields (waa, wbb and wdd) on which our catalogs overlap with SDSS, we can directly compare the magnitude of the common stars. Fig. 1 shows the differences 2006_new_cat-SDSS (left side plot) and 2006_new_cat-SDSS_new (right side plot). Where 2006_new_cat are the catalogs we use to compute the ZPs for each ESSENCE field/amplifier image. Both SDSS and 2006_new_cat magnitude are in the MOSAIC natural system. SDSS_new are catalogs I have generated using new (more precise) SDSS photometry that cover the wbb fields and the new transformation form the Sloan to the Johnson photometric systems that Gajus have derived. As you can see from the plots the scatter in 2006_new_cat-SDSS_new is clearly smaller (r.m.s$_R$=0.021 and r.m.s$_I$=0.026) than in 2006_new_cat-SDSS (r.m.s$_R$=0.042 and r.m.s$_I$=0.058), but in the I band 2006_new_cat-SDSS_new show a bigger color term and zero point difference than 2006_new_cat-SDSS. Gajus is still working in the new reformations and when I will be at CTIO I will generate new 4m catalogs using 0.9m photometry calibrated using the two different color terms, one for blue stars and other for red stars, found by Kevin.

   Since the new transformations from SDSS to Johnson need still to be verified, for the comparisons below I have used the catalogs generated using the old SDSS photometry with the old transformations from SDSS to Johnson.

   Fig. 2 shows the distribution of the differences m(2006_new_cat)-m(SDSS) for stars with $R - I < 0.8$. . Both SDSS and 2006_new_cat magnitude are in the MOSAIC natural system. The histograms show a departure from a gaussian distribution mainly due to a color trend in the m(2006_new_cat)-m(SDSS) differences (see this document for detail about it *http://ctiokw.ctio.noao.edu:8080/Plone/essence/teamonly/calibration/2006_new_cat.ps.gz*).
   The gaussian central value and σ are -0.012 and 0.035 for the R band and -0.014 and 0.043 for the I band.

   Fig. 2 right plot shows the distribution of the color differences $R - I$(2006_new_cat)-$R - I$(SDSS) for stars with $R - I < 0.8$. The gaussian central value and σ are -0.003 and 0.040 respectively.

2. We can compare the zero points (ZPs) we obtain with the observation of the ESSENCE field with those we compute observing standard fields.

   The ZPs obtained as difference between the Dophot PSF instrumental magnitudes and the catalogs magnitudes were aperture and airmass corrected. The differences between the ESSENCE and the Stetson ZPs are reported in Fig. 3. For the R band the distribution is well fitted by a gaussian, while in the case of the I band the data are too few and sparse to draw any conclusion.

Assuming that the (1) and (2) methods are independent, I would take the combination of the two gaussians σ as an estimation of the absolute calibration error $\sigma^2_{abs} = \frac{1}{(1/\sigma^2_{SDSS}+1/\sigma^2_{Stetson})}$. For the R

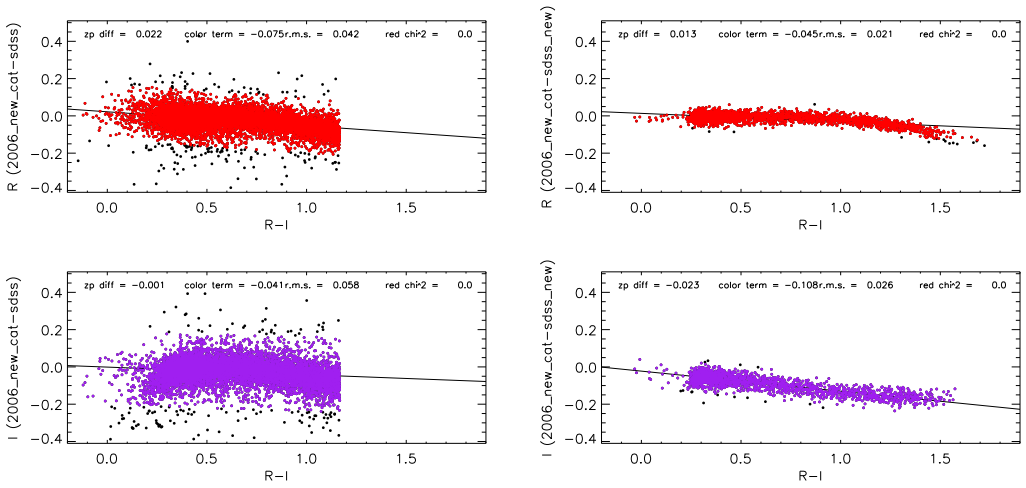

Figure 1: differences between 2006_new_cat-SDSS plotted in function of the $R-I$ color (left panel). Differences between 2006_new_cat-SDSS_new plotted in function of the $R-I$ color (right panel).

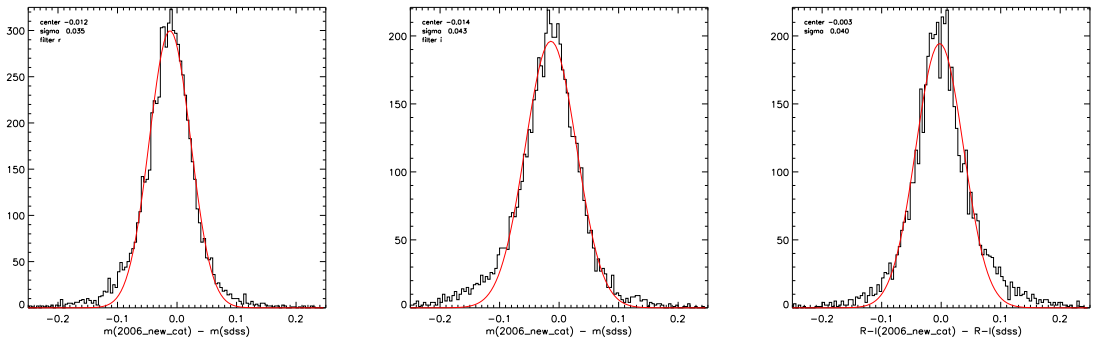

Figure 2: Distribution of the differences 2006_new_cut-SDSS for stars with $R-I<0.8$ for the R band (left plot), I band (middle plot) and $R-I$ color (right plot) . Both SDSS and 2006_new_cut magnitude are in the MOSAIC natural system

band considering σ_{SDSS}= 0.035 and $\sigma_{Stetson}$ = 0.014 we get σ_{abs} =0.013. For the I band considering σ_{SDSS} = 0.043.and $\sigma_{Stetson}$ = 0.027 we get σ_{abs} =0.023. Finally, for the $R-I$ color we have $\sigma_{abs}=0.040$.

b) To figure out how well the catalogs relative to different field are tied to the same zero point, I have considered all the ESSENCE images acquired under photometric conditions. For a given photometric night I have computed the difference between the airmass corrected ZPs relative to a given filedamplifier image and an average zero point $\overline{ZP}$. In Fig. 4 are reported those differences for all the photometric nights in the R band (left plot and I band (right plot). I have fitted the distributions with a gaussian and I have obtain σ=0.014 and σ=0.022 for the R and I bands respectively

Summarizing the magic numbers we have to montecarlo are the following:

a) Absolute zero point calibration $=>$ R = 0.013, I = 0.023 and $R-I$ = 0.040
b) Field to field relative calibration $=>$ R = 0.014 and I = 0.022

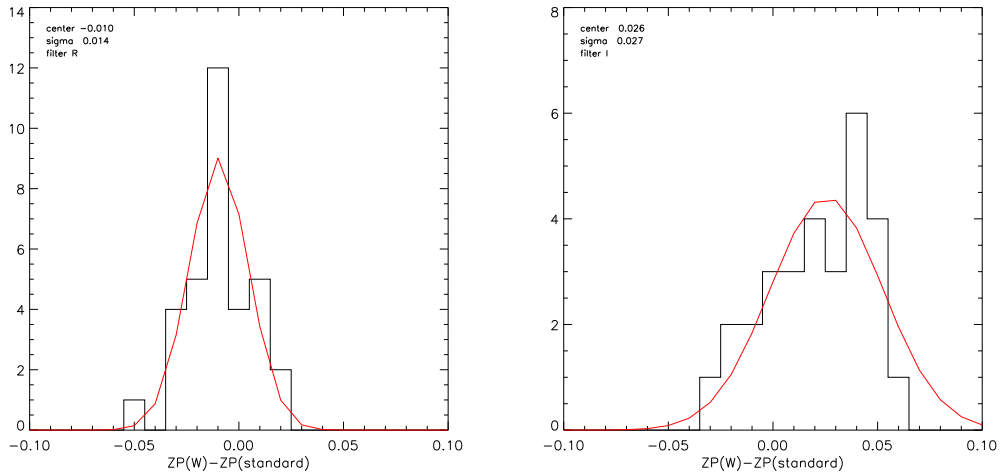

Figure 3: Differences between the ESSENCE and the Stetson ZPs fro the R band (left plot) and I band (right plot)

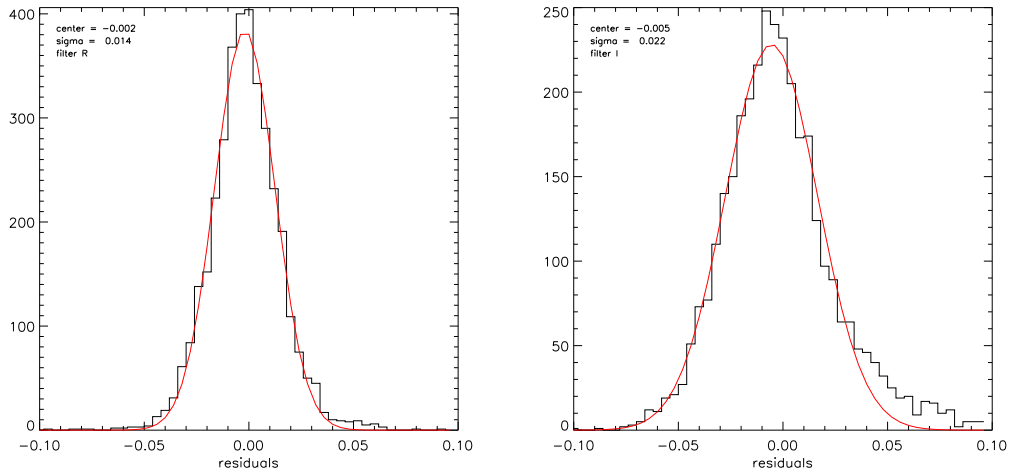

Figure 4:

I would like to stress the fact that with better SDSS photometry (see Fig. 1(right plot) the scatter is significantly lower than with SDSS DR3. Therefore, a large part of the scatter we see in the 2006_new_cut-SDSS is due to SDSS. This means that the errors in the absolute zero point calibration are overestimated.