

Image Quality: WL Requirements

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Requirement R-23

“We require that the multiplicative shear error, m , be smaller than $m < 0.004$ and that the additive residual shear, γ^{add} , be smaller than $\gamma^{\text{add}} < 4 \times 10^{-4}$.”

$$\gamma^{\text{meas}} = (1 + m)\gamma^{\text{true}} + \gamma^{\text{add}}$$

Requirement R-23

- This is the highest level weak lensing science requirement.
- Represents the **maximum tolerable biases** in the shear **after software correction**.
- Thus, not directly an image quality requirement, but motivates several of the other subsequent requirements.

Requirement R-24

“The **PSF FWHM** in each of the r , i , and z bands should, over all exposures and over the survey area, have a **median of less than 0.9**”. Moreover, for 95% of the survey area, there should be **at least one exposure** in each of these bands for which the **PSF FWHM is 0.9**” or smaller.”

Requirement R-24

- Motivated by our desired number density of sources usable for weak lensing.
- Galaxies are only usable if they are large enough relative to the PSF.
- Hard to estimate accurate shape if galaxy is smaller than the PSF (after deconvolution).
- Need to keep PSF FWHM $< 0.9''$.
- Sets total for the image quality budget.

Requirement R-25

“The mean **PSF whisker length** for stars per exposure must be **below 0.2**” in the *r*, *i*, and *z* bands for the wide-area survey.”

$$WL = \sqrt{(I_{xx} - I_{yy})(I_{xx} + I_{yy})}$$
$$e = \frac{I_{xx} - I_{yy}}{I_{xx} + I_{yy}} = \left(\frac{WL}{I_{xx} + I_{yy}} \right)^2$$

Requirement R-25

- This follows from R-23.
- We believe that we can correct for the shape of the PSF if the whiskers are smaller than 0.2” with biases below the required level.
- Constrains the design specs of the camera.
- Also **constrains the requirements on maintaining focus and alignment.**

Requirement R-26

“For the wide-area survey, the residual mean whisker length for stars on scales of 10 arcmin to 1 degree, after removal of a static component (i.e. the same for all exposures) and a bilinear fit in (x,y) per exposure, should be below 0.06” in r , i , and z bands.”

Requirement R-26

- This is basically constraining how variable the PSF anisotropy can be.
- A static pattern and a smooth component are both relatively easy to deal with in software.
- Much harder to correct a PSF pattern that changes quickly over the field of view.
- Constrains chip flatness, collinearity, etc.
- Also constrains camera design.

Requirement R-27

“For the wide-area survey, the **slope of r band PSF FWHM** (and ellipticity e) **vs $g-i$ color must be smaller than $0.0001''/\text{mag}$** ($0.0005/\text{mag}$) at zenith. For the i band, the slopes vs. $r-z$ color must be smaller than $0.001''/\text{mag}$ ($0.001/\text{mag}$). For the z band, the slopes vs. $i-z$ color must be smaller than $0.0006''/\text{mag}$ ($0.0006/\text{mag}$).”

Requirement R-27

- Basically says that the PSF can't be very color dependent.
- If the PSF varies a lot with wavelength, then PSF depends on the SED of the galaxy.
- Makes it very hard to know the right PSF to use for each galaxy.
- Constrains wavelength dependence in the design of the camera.

Goal G-3

“Systematic errors will not decrease the FoM for each dark energy probe by more than 20%.”

- Requirements based on 50% maximum decrease.
- This would cut down many of the previous numbers by about a factor of 5.

Goal G-5

“A goal is to achieve a median PSF in *riz* averaged over the wide-area survey of 0.8”.”

- Perhaps Darren will tell us whether this is a reasonable goal or a pipe dream.