

Verifying DECcam Image Quality

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During Commissioning

- We verify that DECam works, as a system
- We complete the testing and verifying of the technical requirements
- We learn how to use the new “features”

Requirements I

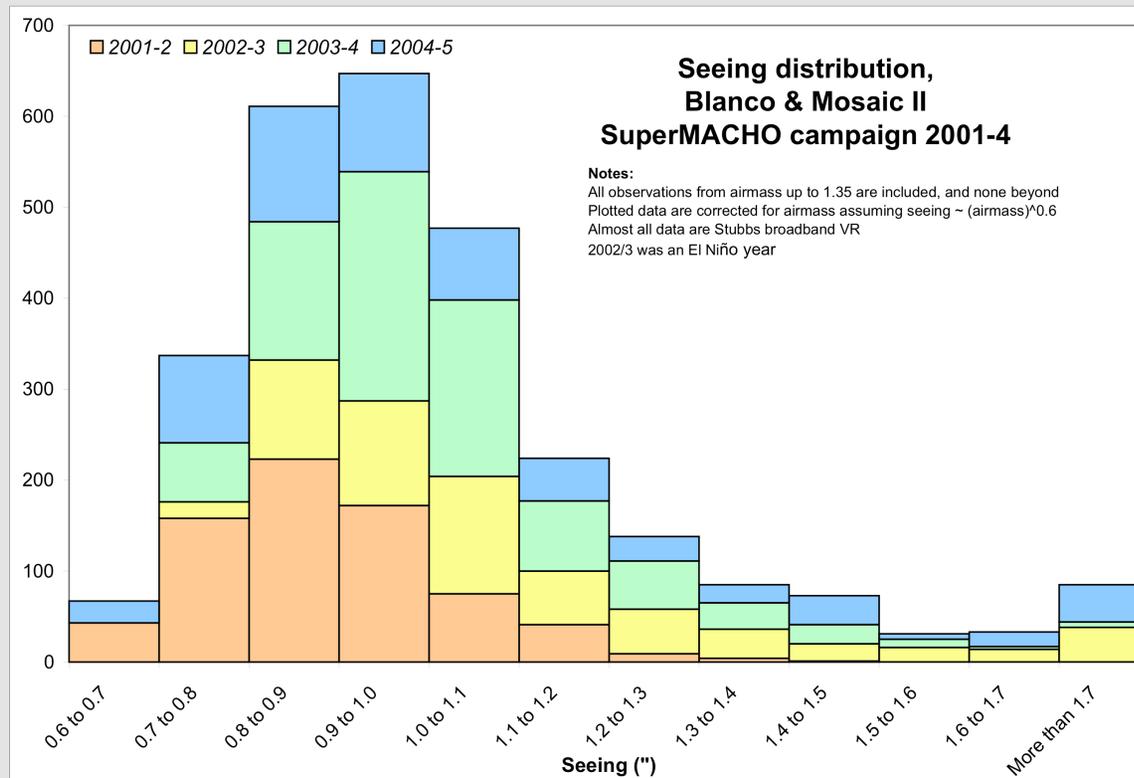
WE REQUIRE:

- **Image Quality** that meets the requirements specifications (see Darren's talk for the makeup of the basic image quality specification)
 - The Atmosphere
 - We need good seeing to test image quality during commissioning
 - Telescope Environment
 - Control of ambient during the daytime - we are improving this
 - Night time - dome ventilation, air sucker off primary – we are improving this too
 - Primary Mirror
 - Intrinsic Quality – this is excellent (80% encircled energy into 0.25 arcsec diameter)
 - Support System - now working optimally
 - Prime Focus
 - Alignment of primary to corrector – we can now control X-Y using the hexapods (100 μ)
 - Corrector
 - Intrinsic Quality – tests at SESO
 - Alignment between elements - assembly into barrel at UCL
 - Tilts & Spacings- ditto
 - Filters –
 - Tested at Asahi

Requirements II

- **Stability** of image quality with telescope orientation
 - Primary Mirror support system, baseline is a LUT as function of position
 - Control of collimation using a LUT that moves the hexapods
- **Stability** of image quality with time (seconds to weeks)
 - We need to keep the telescope focused ($<15\mu$)
 - And collimated ($< 100\mu$. 3 arcsec tilt = 145μ)
 - We can in principle tweak the primary mirror support LUT on a TBD time scale using donut analysis of images on the focus/alignment CCDs
 - Do we meet DES requirements by **ONLY** correcting for collimation, plus a sky-position LUT for the primary mirror supports?
 - Can the edge-of-field donut analysis provide the low-order Zernike's relevant for the whole field?
- **Stability** of telescope tracking and guiding. New TCS & encoders are near ready
 - <0.5 arcsec in 60s open-loop drift
 - <0.1 arcsec tracking jitter

The Baseline



What tools do we have?

- Hartmann Screen for prime focus
- Shack Hartmann tester to verify C1-C4 (partially)
- Focus/alignment CCDs, Donut analysis
- Basic image analysis tools for in-focus images
- More specialist tools used by the WL community (e.g. whisker analysis)

Tool use - Blanco Active Optics (aO)

- Blanco primary mirror support aO corrections
 - Nominal pressures (baseline)
 - Constant correction for each aberration term for all telescope positions (baseline), done with Hartmann test
 - Position-dependent corrections for each aberration term, done with Hartmann test
 - Global or position-dependent tweak with time, the result of strongly-averaged processed data from real-time WFS (Donut)
- Blanco coma corrections
 - Constant correction over the observing sky is the basic telescope alignment, from Hartmann test
 - Telescope position dependent correction (LUT) from Hartmann test
 - Position dependent coma tweak from Donut or BCams
- Future development is to define/test and rely on Donut or S-H based method to build the baseline and LUTs. This method could replace the Hartmann screen test eventually.

Technical requirements relating to Image Quality

Requirement	Description	Test	Where
TO.2	Delivered PSF < 0.55 arcsec	Images	CTIO
TO.4	Peak whisker amplitude < 0.045 arcsec per term	Analysis of images	CTIO/WL WG
TO.10	Focal plane p-p < 30 microns	CCD Lab	FNAL
TO.15-28	Filter specifications	S-H, others	Asahi
TD.10-11, TOM 1-3	Focal plane stability	CCD Lab, Simulator	FNAL
TD.13	CCD charge diffusion	CCD Lab	FNAL
TD.14-15	Detector Flatness	CCD Lab	FNAL
TGFA	Guiding	Test procedures & performance	CTIO
TGFA	Focus & Alignment	Test procedures & performance	CTIO

So what can go wrong with DECam Image Quality?

RISK AREA	RISK	COMMENT
Site conditions	Low	A five year El Niño is improbable!
Existing telescope, infrastructure	Low	Baseline is present operations
Cage, Imager mechanical stability	Low	Tested on simulator
Focal plane stability, CCD performance	Low	Tested in lab, and/or on simulator
Optical Corrector & filters	Moderate	Tested at SESO and UCL, but final performance verification only possible at the telescope
Alignment primary to focal plane	Moderate	We now have control here, but this is "new"
Observing software – focusing, guiding, donut, etc,	Moderate	Some PreCam tests will help, but for sure there will be bugs, and "inconvenience" -- solveable...

After Commissioning and into Operations...

- Closeout Review of Requirements
- Trending activities
 - Scientific
 - Engineering
- We expect to be tweaking the new knobs for a while!

The End
