KOSMOS System Design Note 1.04

Title: **Optimum Pixel Scale for Mayall**
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Introduction

This document discusses the optimum pixel scale, or range of pixel scales, for KOSMOS on the Mayall telescope. The discussion included only scientific considerations and neglects technical issues – for example, throughput or optical complexity.

OSMOS itself has a scale just under 0.3 arcsec, which makes sense from the MDM perspective, as OSMOS is the primary imager and spectrograph on that telescope.

Discussion

On the Mayall, however, the emphasis is very much on spectroscopy, and so there should be less concern about missing out on the very best seeing. Use of a wider slit doesn't really degrade resolution, in that we can specify dispersers that give the desired resolution when used with a 3-pixel or 4-pixel or N-pixel slit. But coverage in resolution elements is reduced if "N" is increased. That is, if N=2 you get pretty much the full octave of coverage you might hope for at R~2000 (assuming a 4k detector and assuming the camera is capable of feeding a 4k detector); at N=3 you don't get an octave at this resolution but you do get the wavelengths where the grating efficiency hasn't fallen off much, and N=4 you get less, and so on. Since much of the science done currently [see SDN 1.02] or described in the ReSTAR report [see SDN 1.03] is at resolutions around 2000, this suggests that a 3-pixel slit is acceptable (i.e., not much loss of effective spectral coverage).

For reference, the current median image quality on the Mayall (measured with Mosaic at prime focus) is ~0.9 arcsec in R near zenith, and 25% percentile image quality is <0.8 arcsec. Image quality degrades as one goes to shorter wavelengths or high zenith angles.

For programs where spectral line profiles are important, it is desirable to over-sample the spectral resolution somewhat - so N=3 may be preferable to N=2 as the default slit width.

This suggests that a scale of 0.3 arcsec/pixel is as small as we would want to get, and that larger values are likely better. (For reference, the number for the RC spectrograph is nearly 0.7 arcsec/pixel - but it has a very different camera/detector configuration.)

An interesting threshold value is ~0.36 arcsec/pixel, which is the point at which the 12 arcmin FOV only uses 2k pixels along the slit – this opens up more options for the detector source since once could then use a 2k x 4k array (we surely want to keep 4k pixels in the dispersion direction).

Sampling along the slit is important for people studying small, resolved objects, and for these programs one certainly wants to take advantage of better-than-average seeing, should it occur. Overly coarse pixels also limit the ability to use short slitlets in MOS mode, which can be a handicap in dense fields.

Obviously all this is subject to technical feasibility - if the camera can't fill the 4k detector in the dispersion direction there is no point in going to a larger pixel scale, and if the design loses throughput, becomes unbuildable or unaffordable, we've gone too far. For reference, 0.3 arcsec/pixel on the Mayall requires something like an f/3 camera, and 0.5 arcsec/pixel requires about f/1.8 .

Conclusions

- The specifications for KOSMOS should assume the default configuration is a 3-pixel slit matched to median image quality.
- The pixel scale should enable good use of ~25th percentile seeing along the slit (and possibly narrowing the slit).
- The ability to use a 2k x 4k detector is interesting but should not be the primary driver for pixel scale.

This suggests that a good target pixel scale is 0.36 arcsec/pixel. It may be worth examining a slightly coarser scale (0.40 arcsec/pixel?) as well. A finer scale should be adopted only if the optical design studies demonstrate problems at the target scale(s).

Note that the scales in this range offer the opportunity to bin in mediocre conditions (where a 4-pixel slit might be used) to reduce the effects of read noise.

Versions

Version	**Date**	**Changes**
1	October 2, 2009	First draft, with input from science team