KOSMOS System Design Note 1.01

Title: **KOSMOS – Science Requirements Issues**
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Introduction

This document is intended to outline the general principles guiding the definition of the science requirements for the KPNO OSMOS copy. This note describes our thinking as we start the project. It will not be updated to reflect the outcome of design studies, which will instead be described in subsequent notes.

The intent of the joint project is to build a copy of OSMOS adapted for use on the Mayall telescope. Use on the 2.1-m telescope is not precluded but should not drive design modifications in any significant fashion. It is understood that some modifications to the design as built for the MDM telescope will be made, but that the scope of the re-design is limited. Four guidelines should be considered to apply:

1 – Although KOSMOS is intended to replace the RC Spectrograph (RCSp) for many science programs, as well as enabling "new" science, Buell Jannuzi has indicated that (at least under current budget projections) he can continue to support RCSp. Thus it is not a requirement that KOSMOS provide *all* capabilities provided by RCSp.

2 – The overall performance of OSMOS as currently designed should not be compromised by any re-design for KOSMOS. That is, it is better for KOSMOS to do some things extremely well than to do more things less well. It would be acceptable to emphasize certain capabilities of OSMOS over others (see next point).

3 – Although OSMOS is expected to see substantial use for imaging programs, this is not the case for KOSMOS, where Mosaic (upgraded) will be available. Hence an improved imaging capability for KOSMOS should not drive design changes. A basic imaging capability should be retained.

4 – Potential design changes will be judged in terms of improved capabilities and in terms of impact on cost and schedule. Wholesale re-design will not take place.

Specific Issues:

While there are design changes driven primarily by engineering considerations (for example, different mechanical interface to the telescope, different CCD controller, etc.) the science team should be looking at changes driven primarily by scientific considerations. The following appear to be the main issues:

Pixel scale. OSMOS moved to the 4-m would have a relatively fine pixel scale – roughly 0.16 arcsec/pixel. If this pixel scale were retained, a 1 arcsec slit would use about 6 pixels and there would be fewer than 700 spectral resolution elements across the 4k detector. Thus any resolution >1000 or so would not provide complete wavelength coverage. A desire for a coarser pixel scale would lead to faster camera optics. The initial design study would examine the trades in field, throughput, and image quality vs. pixel scale, but scientific guidance on the pixel scale requirements and goals is needed. For reference, on MDM the OSMOS scale is 0.273 arcsec/pixel; it is probably feasible to provide a similar scale on the 4-m.

Maximum spectral resolution. OSMOS at MDM has a maximum spectral resolution of ~6000 or somewhat higher for plausible VPH grisms and a 1 arcsec slit. On the Mayall, a 1 arcsec slit is physically larger, resulting in a maximum resolution ~4000 for the same grisms. A narrower slit would provide higher spectral resolution (assuming 2-pixel sampling or better) but light losses would be significant. Resolution can be improved with a longer focal length collimator (implying a larger beam size). Examination of the instrument parameters suggests that it may be possible to get past R~5000 without wholesale modification of the instrument; higher resolution than that implies larger mechanisms and optics and a physically much larger and heavier instrument. It will be important to understand whether there are scientifically "critical" resolutions that should be achieved.

Wavelength coverage. OSMOS has good efficiency from 400-1000 nm. Performance above 1000 nm is affected primarily by the CCD, but below 400 nm the optics are important as well. Better UV performance is problematic in a refractive design without recourse to exotic materials (note that the likely push to a faster camera will not help). UV spectroscopy should probably be done elsewhere (RCSp or Goodman on SOAR). But this assertion should be reviewed.

Field of View. The OSMOS imaging field of view would be about 12 arcmin diameter on the Mayall. A larger FOV implies both larger collimator optics and a larger slit mechanism (for larger slit masks). Some of the other desired properties (coarser pixels, higher spectral resolution) are probably more feasible if the FOV is not enlarged (or not enlarged significantly).

Other issues. Are there other parameters that require scientific input? The baseline CCD and controller are a 4k x 4k E2V (15 μm pixels) and Torrent controller.

Target Questions:

We should be looking at how to answer these, not necessarily provide the answers right away!

- Required pixel scale; goal for pixel scale
- Required maximum spectral resolution (1 arcsec slit); goal; maximum spectral resolution for 2-pixel slit

- Is current wavelength coverage acceptable?
- Is default field of view acceptable?
- Other options – cross-dispersion, ability to change dispersers at the telescope – are these important? Are they easy to implement?

Links

Overview of OSMOS characteristics:
http://www.astronomy.ohio-state.edu/~martini/osmos/characteristics.html

Talks on instrument, some views of optics and layout:
http://www.astronomy.ohio-state.edu/~martini/osmos/OSMOS_MDM2009b.pdf
http://www.astronomy.ohio-state.edu/~martini/osmos/OSMOS_NOAO2009.pdf

Information on dispersers:
http://www.astronomy.ohio-state.edu/~stoll/OSMOS/Dispersers/grisms.htm

Versions

Version	**Date**	**Changes**
1	August 25, 2009	First draft
2	September 23, 2009	Updated presentation links; updated discussion of maximum resolution