KMOS

An multi-object integral field spectrograph for the ESO VLT

KMOS is a multi-object near-infrared integral field spectrograph being constructed by a consortium of UK and German institutes as one of the 2nd generation instruments for the ESO VLT at Paranal Observatory in Chile. KMOS uses a set of cryogenic pickoff arms to obtain spatially resolved spectra for up to 24 objects distributed over a field of 7.2 arcmin diameter. Each object is sampled with an image slicing integral field unit (IFU) which covers a field of 2".8x2".8 with 196 spatial samples (sampling element of 0".2x 0".2) . The IFU outputs are fed into one of 3 identical spectrometers which cover the range 0.8-2.5 microns in one of 5 spectral bands (IZ,YJ,H,K,HK) at a spectral resolution sufficient to work in the low background regime between the strongest OH night sky lines. In addition to distributed targets, the KMOS arms can also be positioned in a close packed configuration which can be used to map a contiguous region of ~1 sq. arcmin in a mosaic of 16 pointings. KMOS is currently nearing the end of its integration & test phase, and should begin commissioning on the VLT in Spring 2011. One of the main scientific drivers for KMOS is the ability to make large spectroscopic surveys of z>1 galaxies to address key questions about the formation mechanisms, metal enrichment history and mass assembly of galaxies. Deep surveys to study the resolved properties of large samples of field and cluster galaxies are now being planned for the GTO programme of 250 nights.

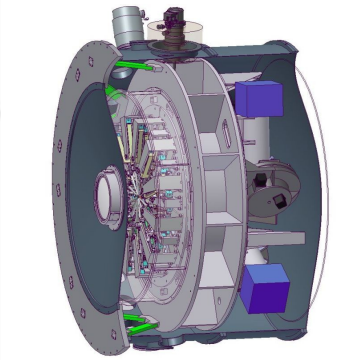

Fig. 1: Cutaway view of the main KMOS cryostat showing the entrance window and the pickoff arm module at the front, and the spectrograph module at the rear. The cryostat is an aluminium/stainless steel hybrid to reduce weight. Not shown here are the electronic racks which are mounted on a corotating frame behind the cryostat.

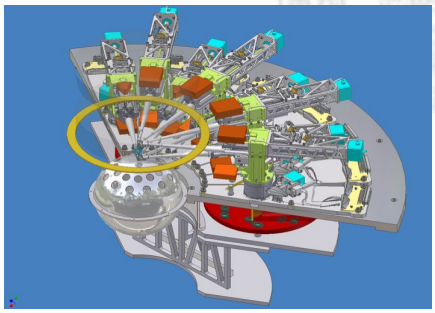

Fig. 2: One of the three integrated pickoff and IFU sub-modules showing the tiered mounting plates for the pickoff arms, the filter wheels and the IFU optics. Each sub-module is attached to the main cryogenic optical bench within the cryostat. At the centre of the unit is shown the integrating sphere of the calibration unit and the ring mirror which reflects light from the calibration sources into the pickoff arms.

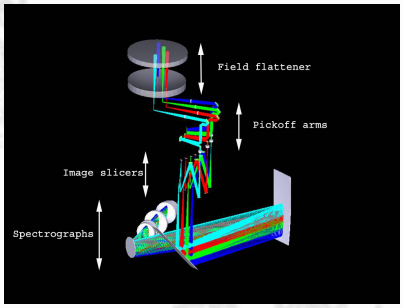

Fig. 3: Optical raytrace through four pickoff arms, their associated IFUs and one of the spectrometers. Light exiting the pickoff arms is brought to an intermediate focus using a 3-element K-mirror, which aligns the edges of all 24 IFU fields on the sky so that they can be put into a compact sparse array configuration for blind surveys of contiguous areas on the sky.

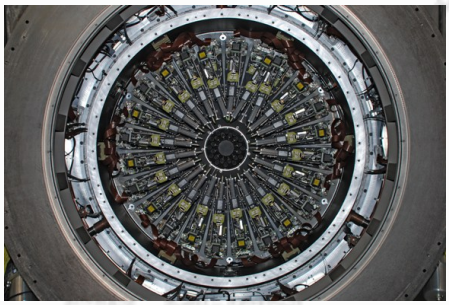

Fig. 4: Front view of the KMOS cryostat showing the 24 robotic pickoff arms surrounding the patrol field. The cryostat diameter is approximately 2 metres. The arms patrol in one of two different planes to reduce interference.

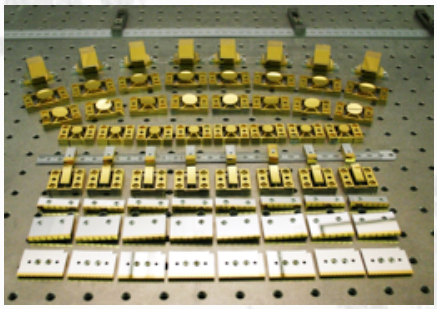

Fig. 6: Gold-coated diamond machined optics for one of the three 8-IFU modules in KMOS. The total image slicer system for all 24 channels contains 1152 optical surfaces with form erros in the range 10-15nm and surface roughness <10nm.

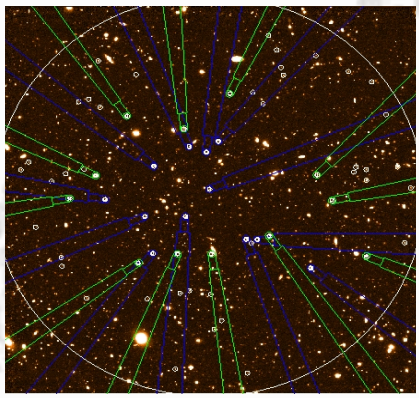

Fig. 7: I-band image of the FORS Deep Field with KMOS pickoff arms assigned to 24 Extremely Red Objects. The blue arms belong to the lower plane (and can therefore be vignetted by arms in the upper plane) whilst the green arms patrol the upper plane. The positioning efficiency of the arms has been checked against a number of important science cases which demonstrate a high multiplexing factor on interesting targets.

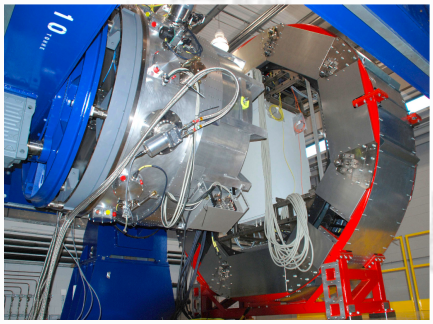

Fig. 5: Completed KMOS cryostat under test on the flexure rig at the ATC in Edinburgh. The red structure behind the cryostat is the CACOR unit which corotates with the spectrograph and contains all the control and housekeeping electronics.

KMOS Baseline Specifications

Requirement	Baseline Design
Instrument Throughput	IZ=30%, YJ=35%, H=40%, K=30%
Point Source Sensitivity (5σ, 8hrs)	IZ=21.0, YJ=21.2, H=21.0, K=19.2
Wavelength coverage	0.8 to 2.5 μm
Spectral Resolution	R=3300,3200,3900,3700,2100 (IZ,YJ,H,K,HK)
Number of IFUs	24
Extent of each IFU	2.8 x 2.8 arcseconds
Spatial Sampling	0.2 x 0.2 arcseconds
Patrol field	7.2 arcmin diameter circle
Close packing of IFUs	>3 within 1 sq. arcmin
Closest approach of IFUs	edge-to-edge separation of 6 arcsec

KMOS Timeline

Milestone	Date
Preliminary Design Review (PDR)	May 2006
Final Design Review (FDR)	Sep 2007
Preliminary Acceptance Europe (PAE)	Dec 2011
Preliminary Acceptance Chile (PAC)	Jun 2012

Ray Sharples, University of Durham r.m.sharples@durham.ac.uk