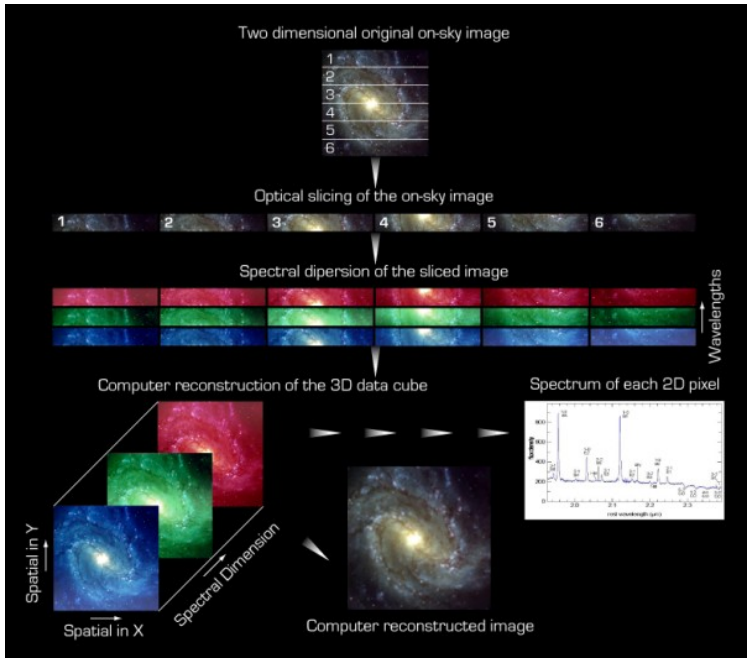
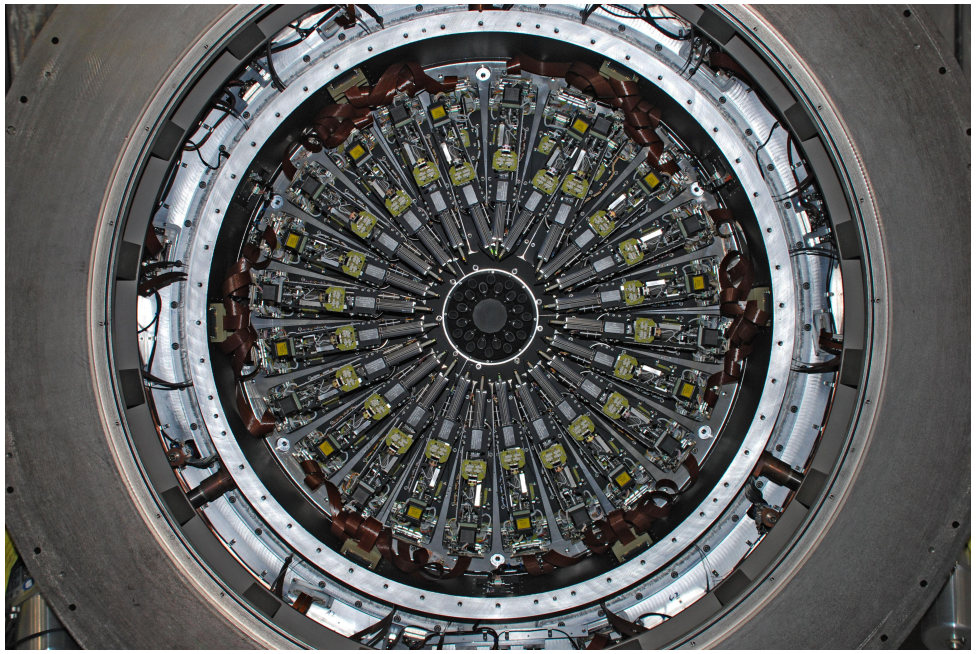
KMOS: K-band Multi-Object Spectrograph



+ Statistic ➔

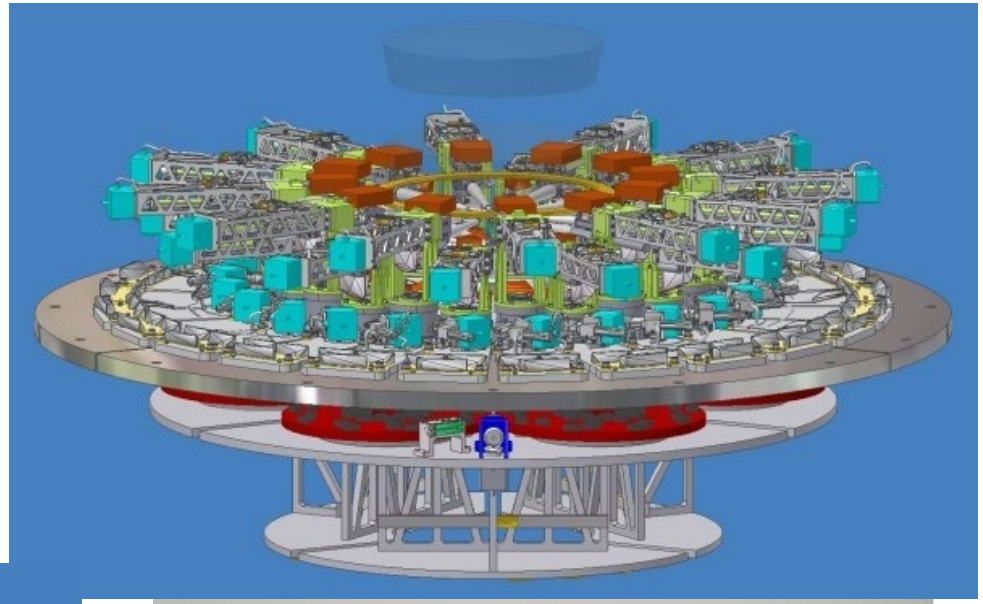


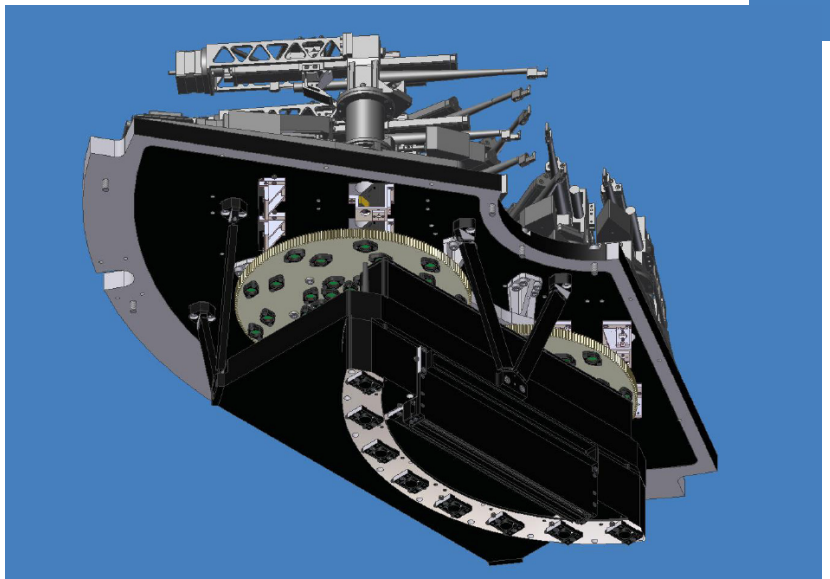
K-band Multi Object Spectrograph (KMOS)

- Second generation instrument designed for operations at VLT
- Performs Integral Field Spectroscopy in the near-infrared bands for 24 targets simultaneously.
- 24 configurable arms that position pickoff mirrors at user-specified locations, each producing a 14x14 spaxel spectra over a FoV of 2.8x2.8 arcsec^2
- Pickoff patrol field diameter 7.2 arcmin
- Light from the IFUs is then dispersed by three cryogenic grating spectrometers (IZ, YJ, H, HK, K_s)

KMOS: pick-off arm subsystem

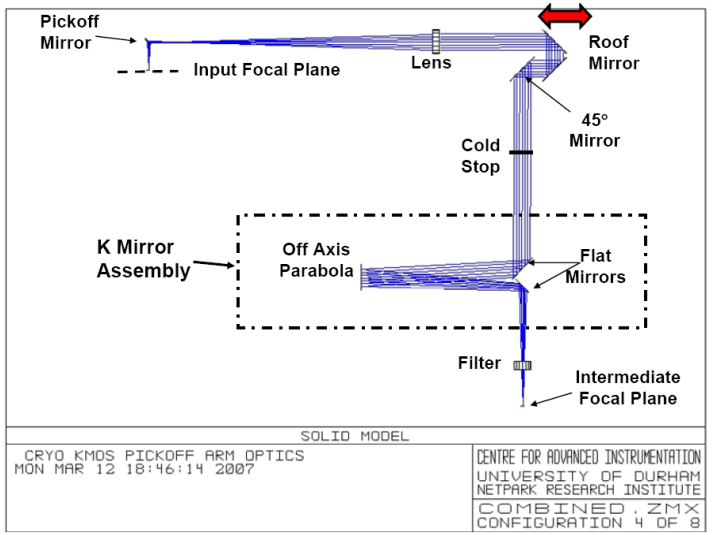
- Pick-off fields selected by means of 24 rotating telescopic arms. Arms arranged in two (intra-, extra-focal) layers, each one covering the entire patrol fields
- Angular and linear motions driven by stepping motors adapted to work at cryogenic temperatures.
- Security checks to prevent arm collisions: KARMA takes care about possible collisions; linear variable differential transforming (LVDT) encoder; hardware collision-detection system

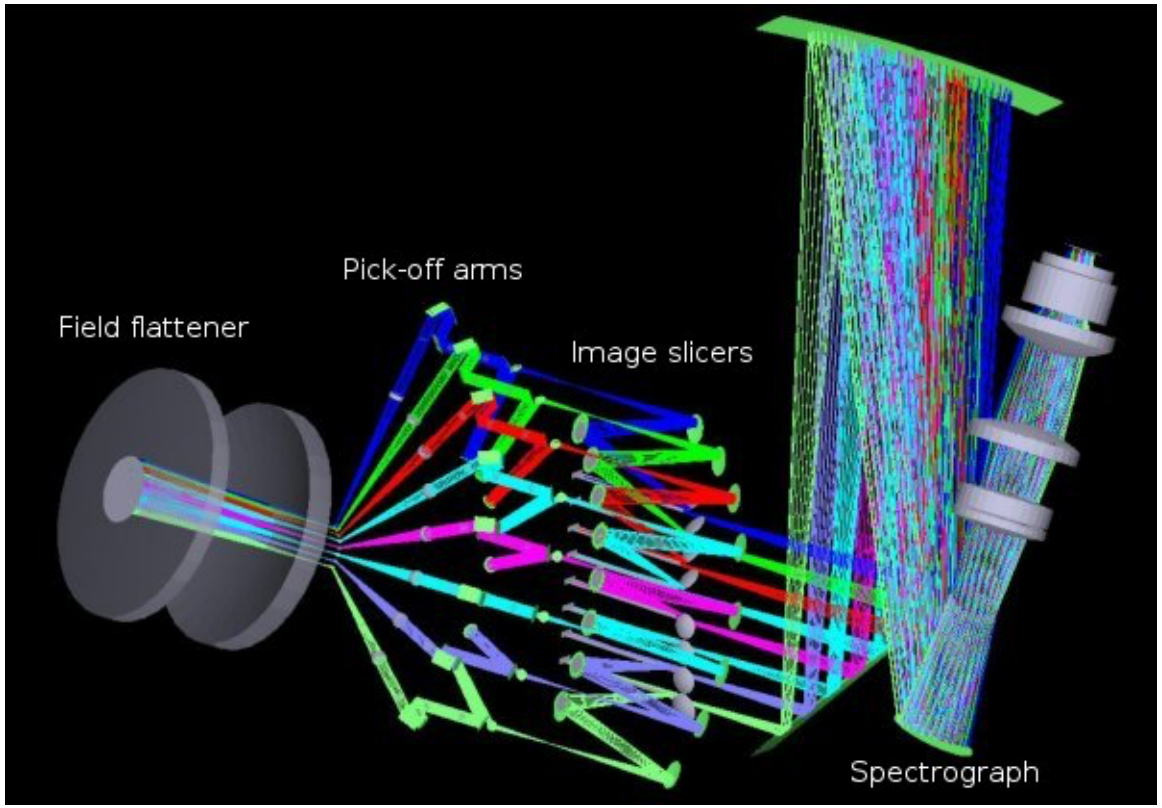




KMOS: IFU + filter subsystem

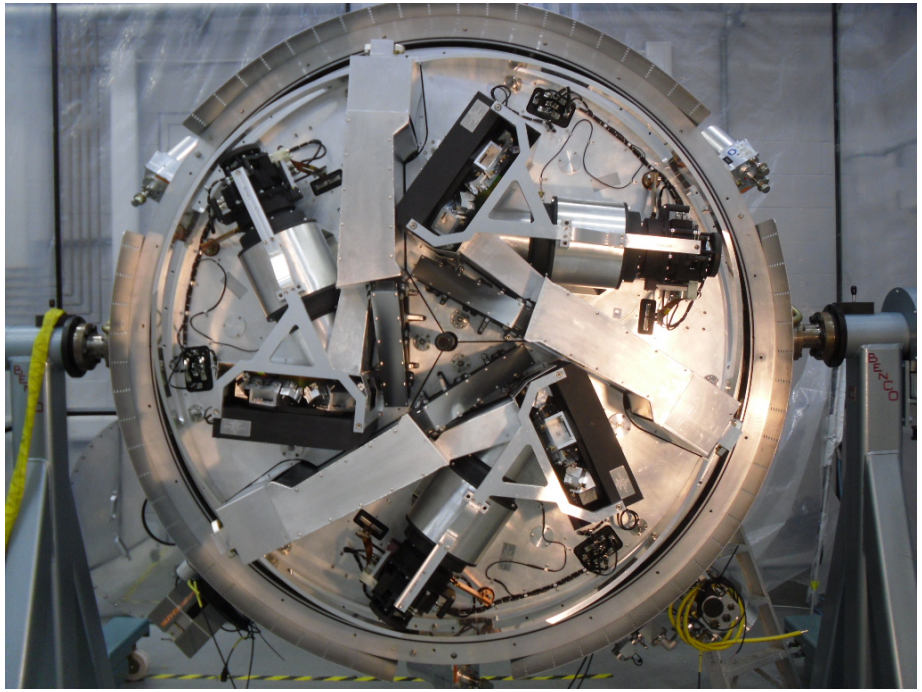
- IFUs contain the optics to collect the output beam from pick-offs and reimage it on the image slicers
- Band pass filters used to: select the desired wavelength and correct for chromatic aberrations
- All the slices from a group of 8 sub-fields are aligned and reformatted on a single detector for each of the 3 spectrographs

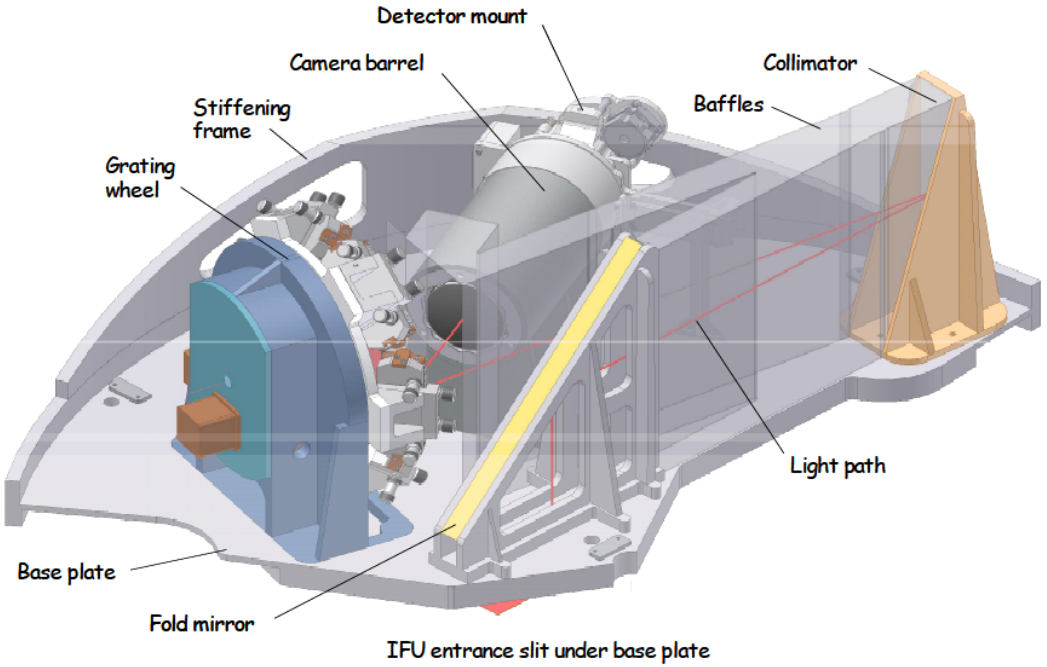




KMOS: Spectrograph module

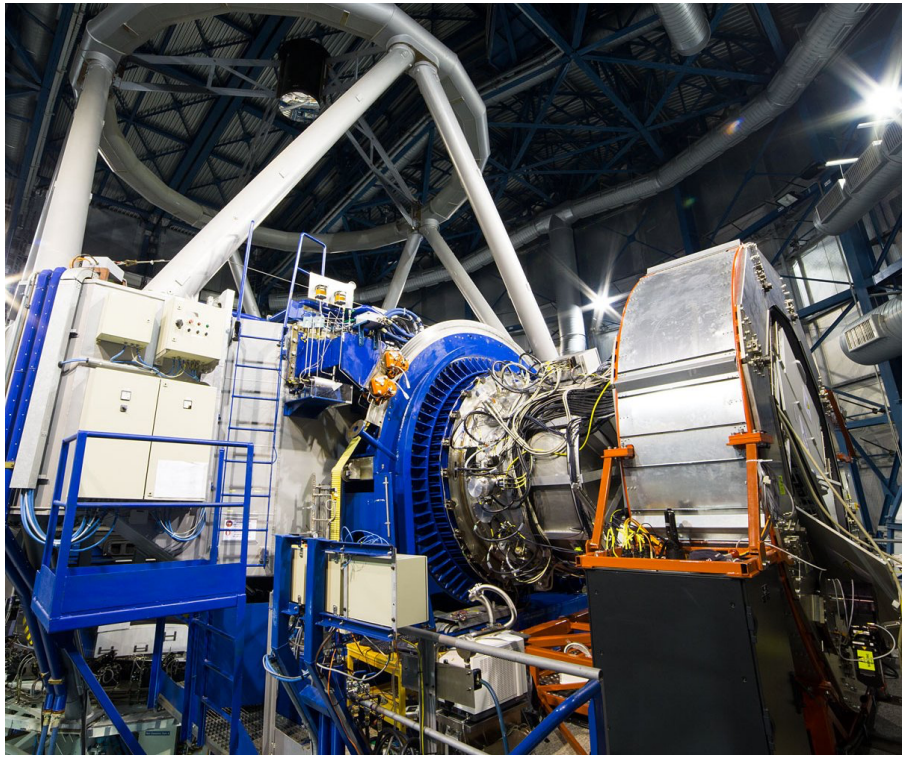
- Light from IFUs is dispersed by 3 identical spectrograp
- Flat fold mirror, toroidal collimating mirror, grating wh
- Camera with 2048x2048 Hawaii-2RG HgCdTe detector

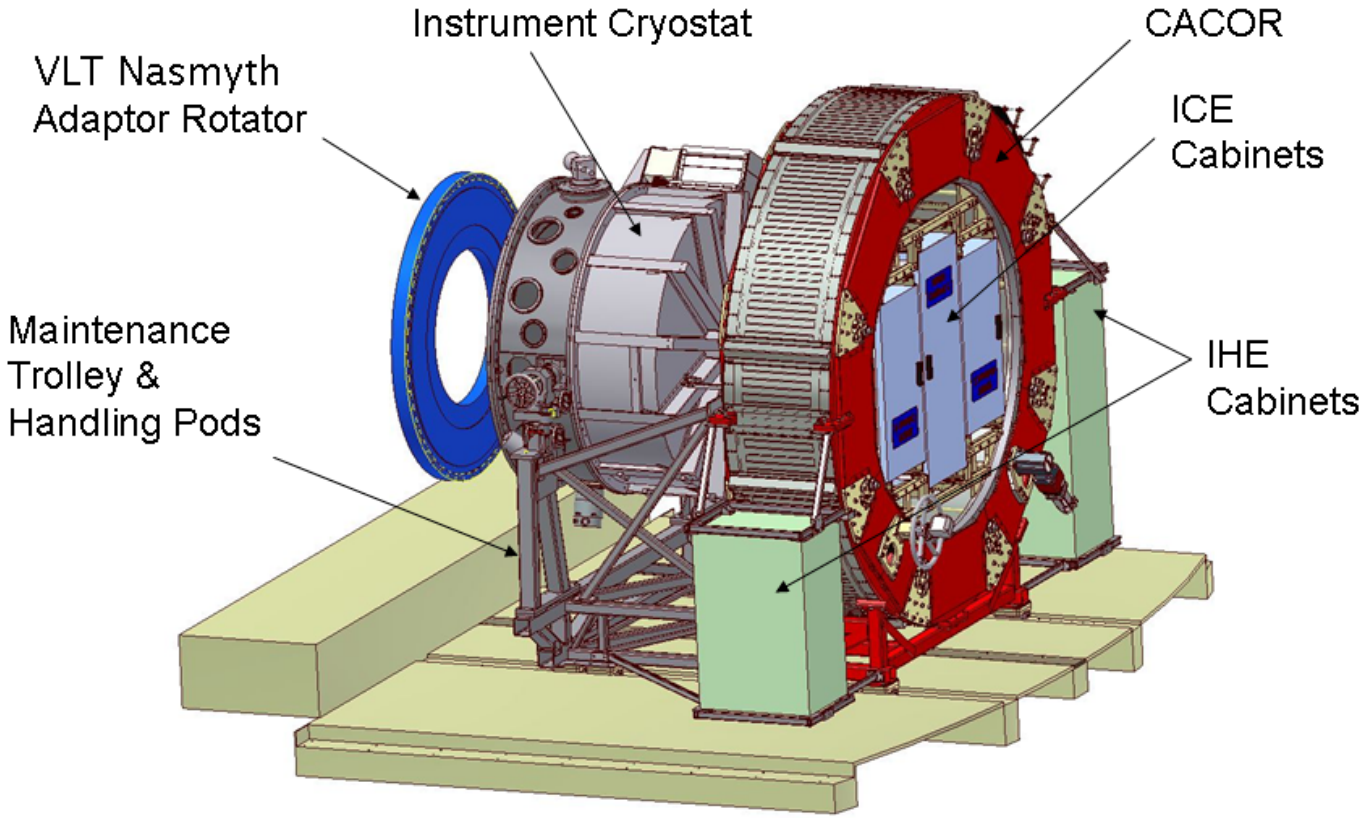




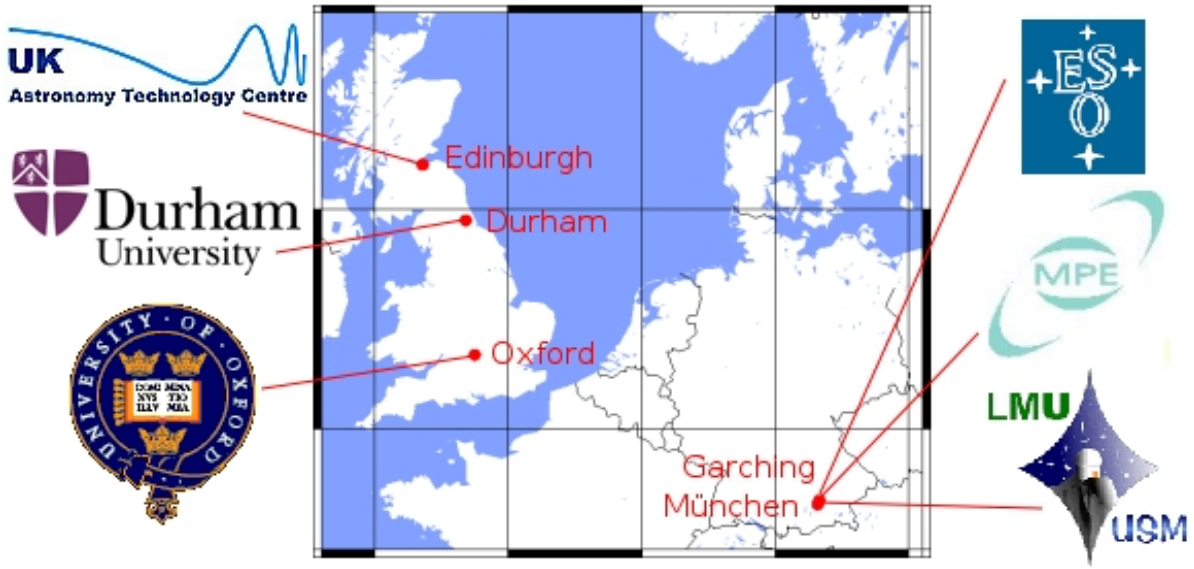
KMOS: Infrastructure and electronics

- All opt-mechanical part contained in a cryostat at ~125 K (detectors at ~40 K)
- 3 independent Local Control Units (LCUs)
- Electronics and cables on Nasmyth B platform inside CACOR





KMOS Team



Instrument Operation Team

IOT members

Paranal		
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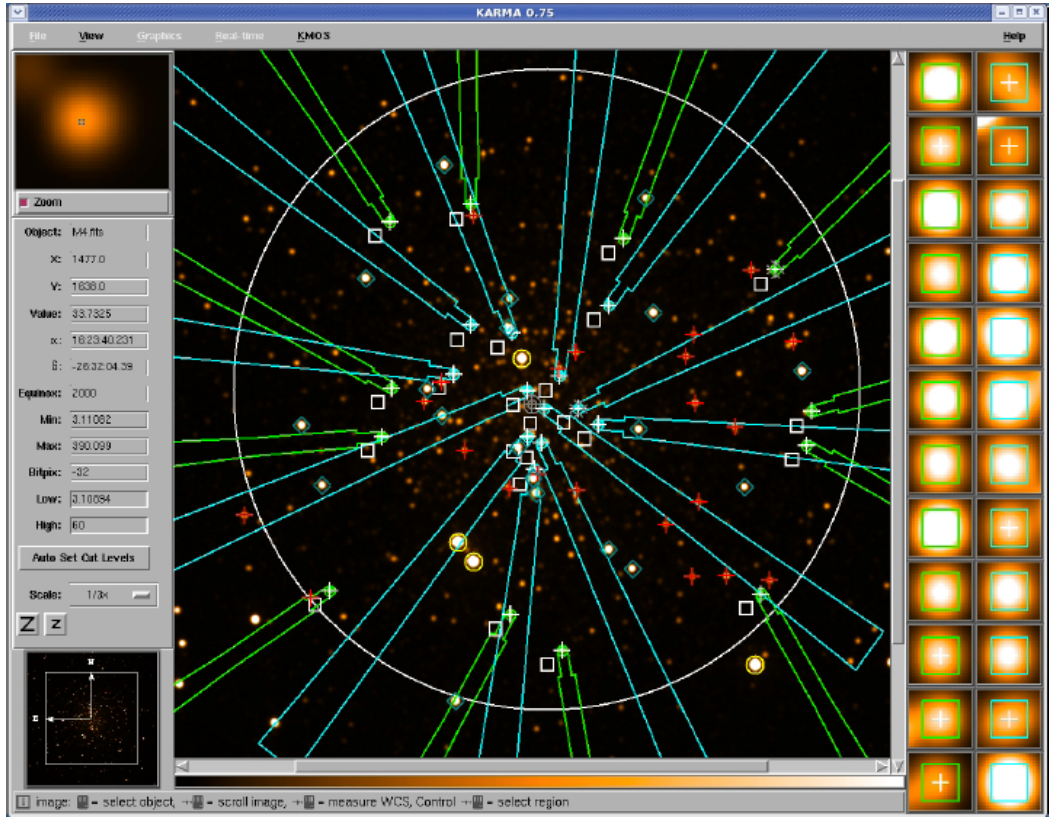
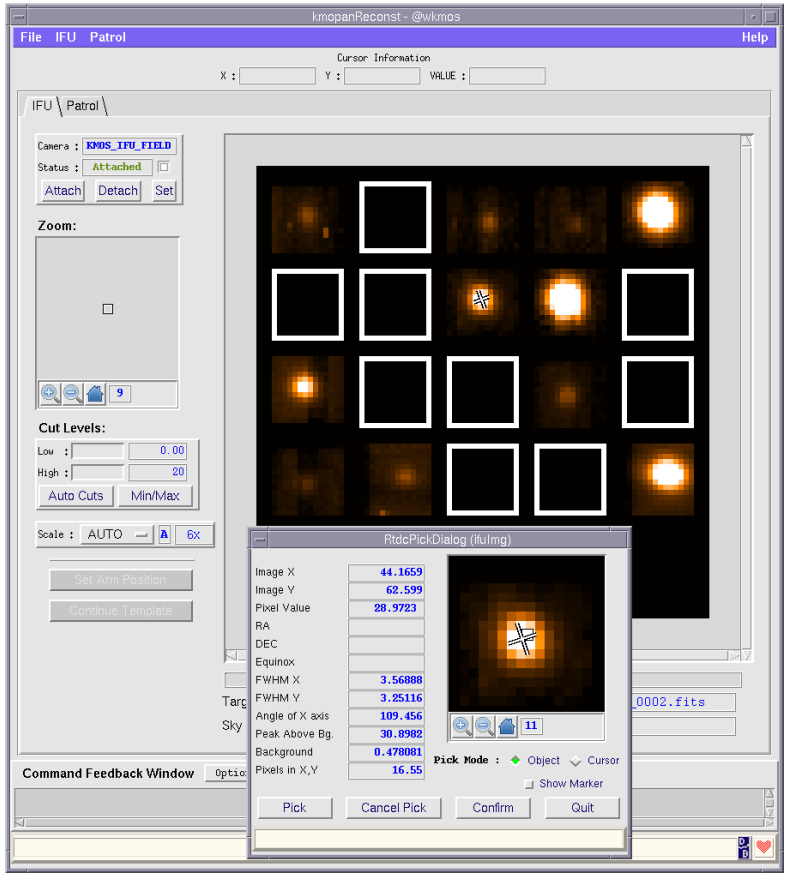
KMOS observing modes

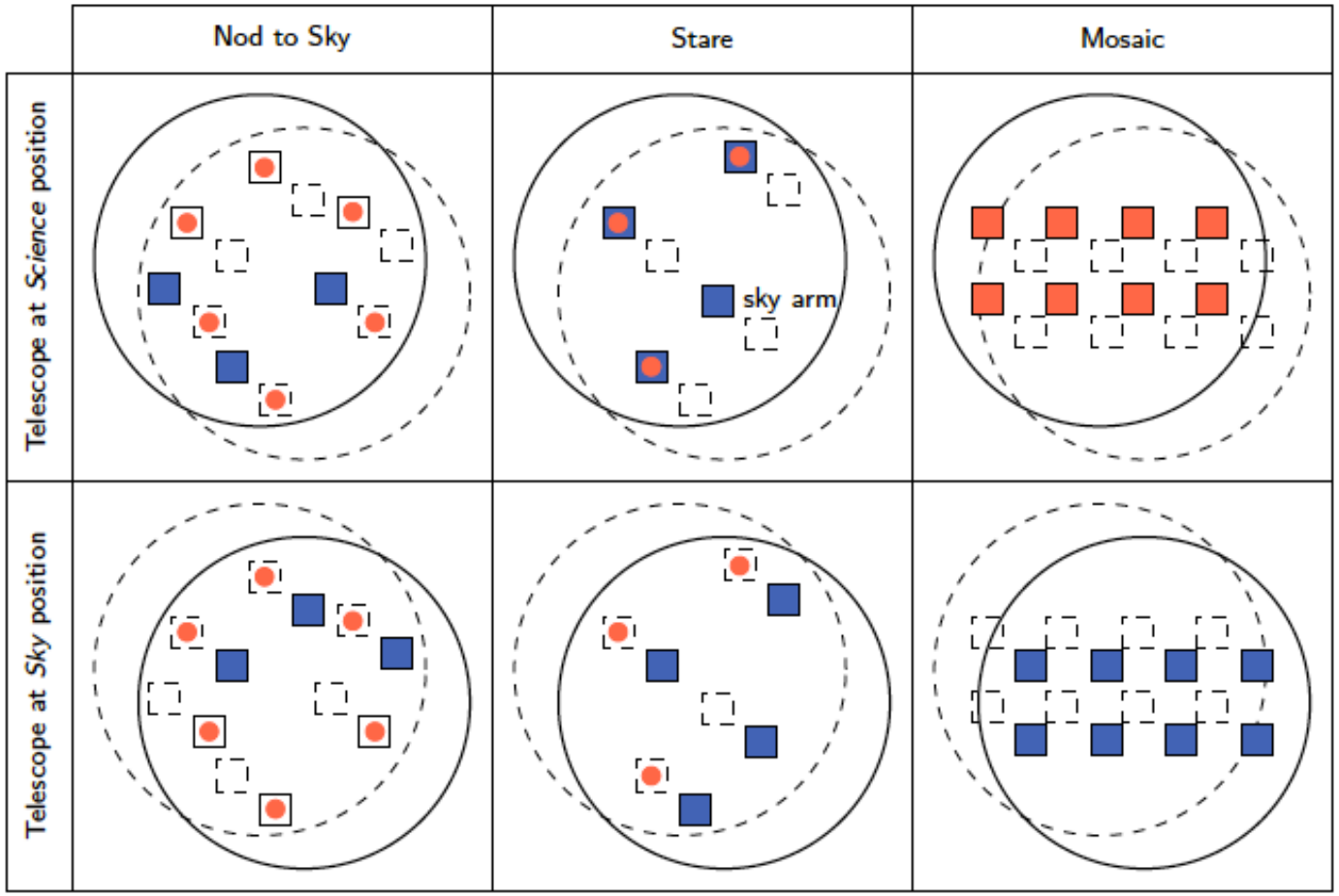


KARMA: KMOS ARM Allocation



Acquisition: reconstructed 3D cube

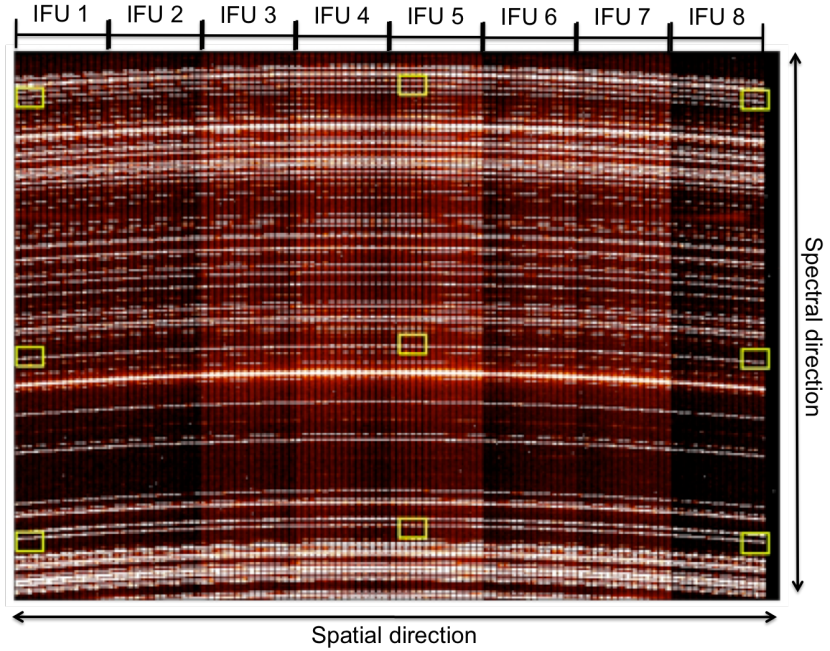
KMOS observing modes

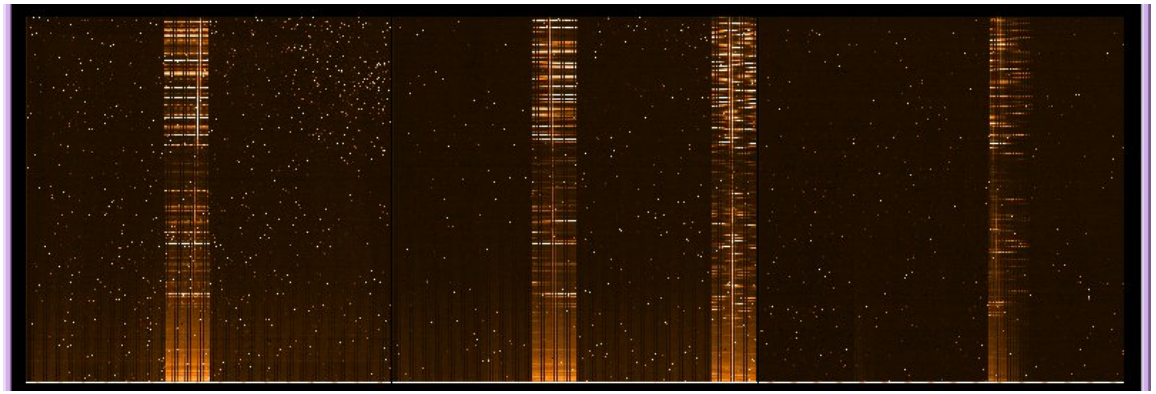


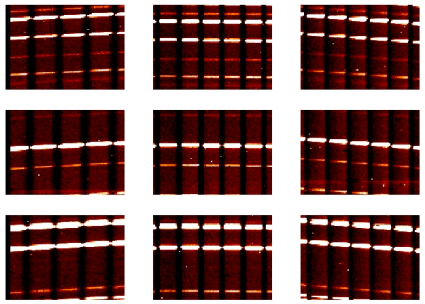
- Pick-off arm configuration is fixed
- Only the telescope/rotator change position

- Nod to sky: each IFU has an associated sky observations
- Stare: dedicated sky arms
- Mosaic: with 24 arms (~0.8 sqared arcmin) or 8 arms (~0.15 sqared arcmin). Nod on sky

KMOS: from raw to science







Band	Wavelength Coverage (μm)
IZ	0.779 - 1.079
YJ	1.025 - 1.344
H	1.456 - 1.846
K	1.934 - 2.460
HK	1.484 - 2.442

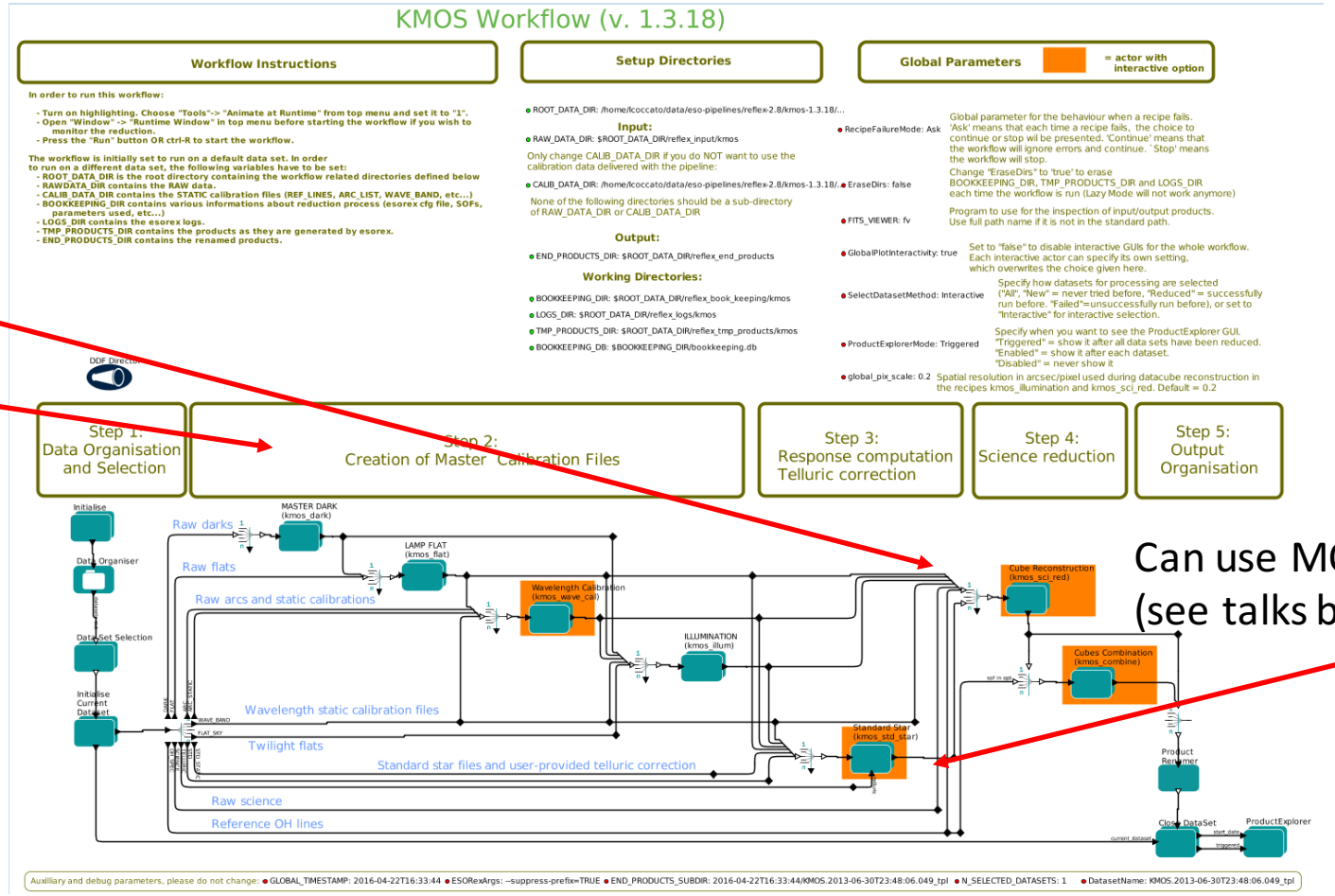
Band	Pixel scale [nm/pixel]	Resolving power		
		Short wavelength	Band centre	Long wavelength
IZ	0.143	2795	3406	3773
YJ	0.165	3089	3582	4088
H	0.203	3570	4045	4555
K	0.266	3809	4227	4883
HK	0.489	1514	1985	2538

KMOS: from raw to science

KMOS reflex workflow based on SPARK (Davies +13, A&A 558, 56)

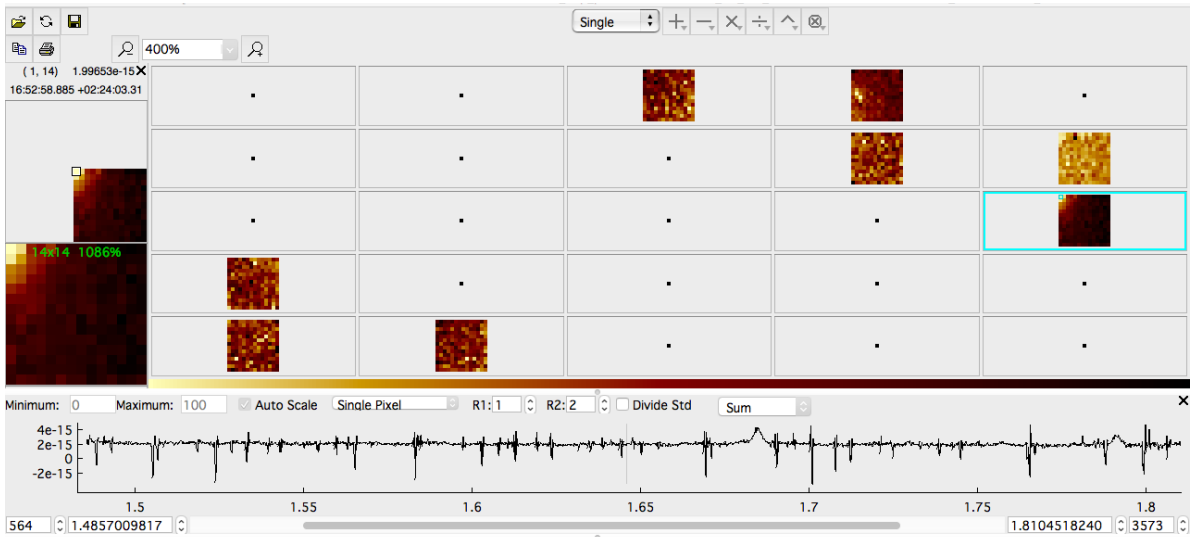
Lamp FLATs, ARCs for

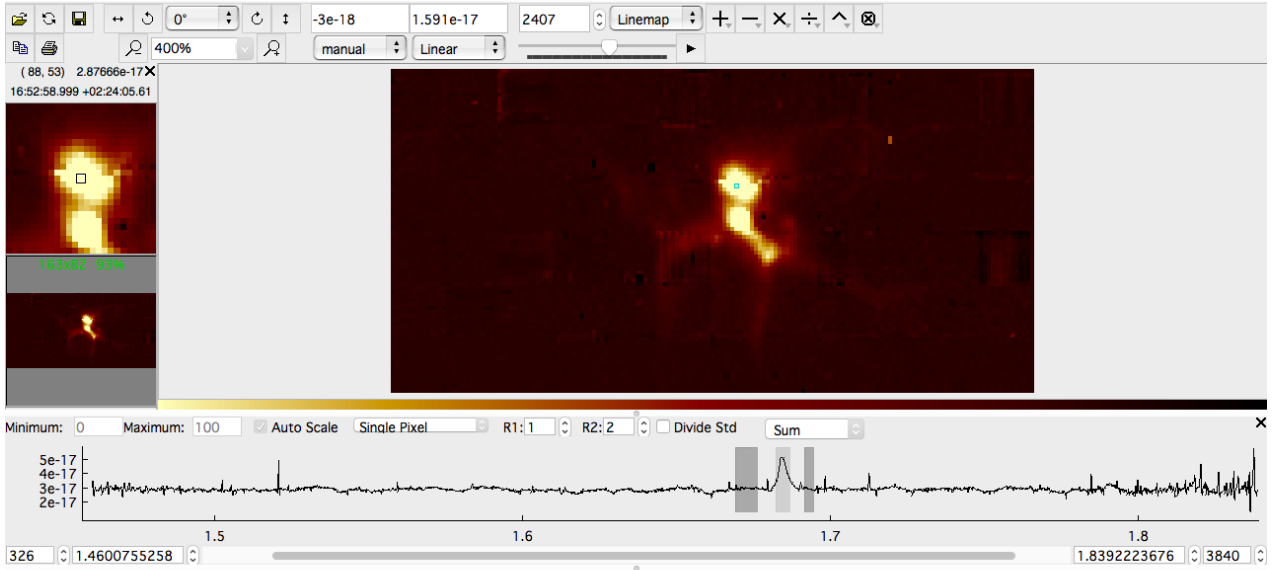
- LUTs and image reconstructions
- Wavelength solution



Can use MOLECFIT (see talks by A. Smette, T. Mendel)

KMOS: from raw to science





Features (wiggles, cross-talk, persistency, astrometric positioning, sky subtraction…)

see talk by T. Mendel, poster by S. Ramsay

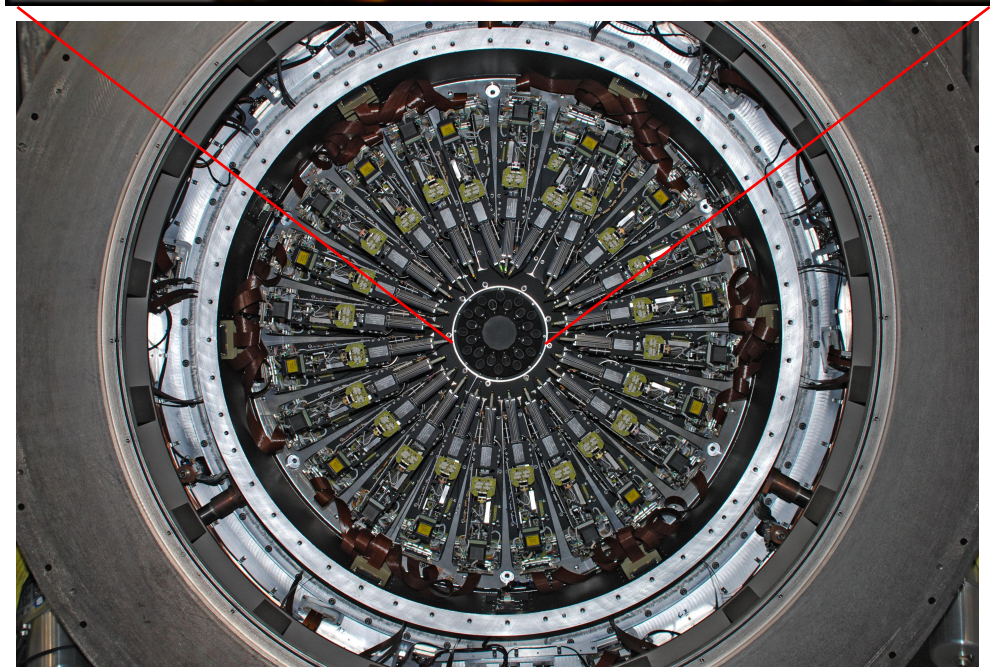
KMOS: calibration plan

Day calibrations

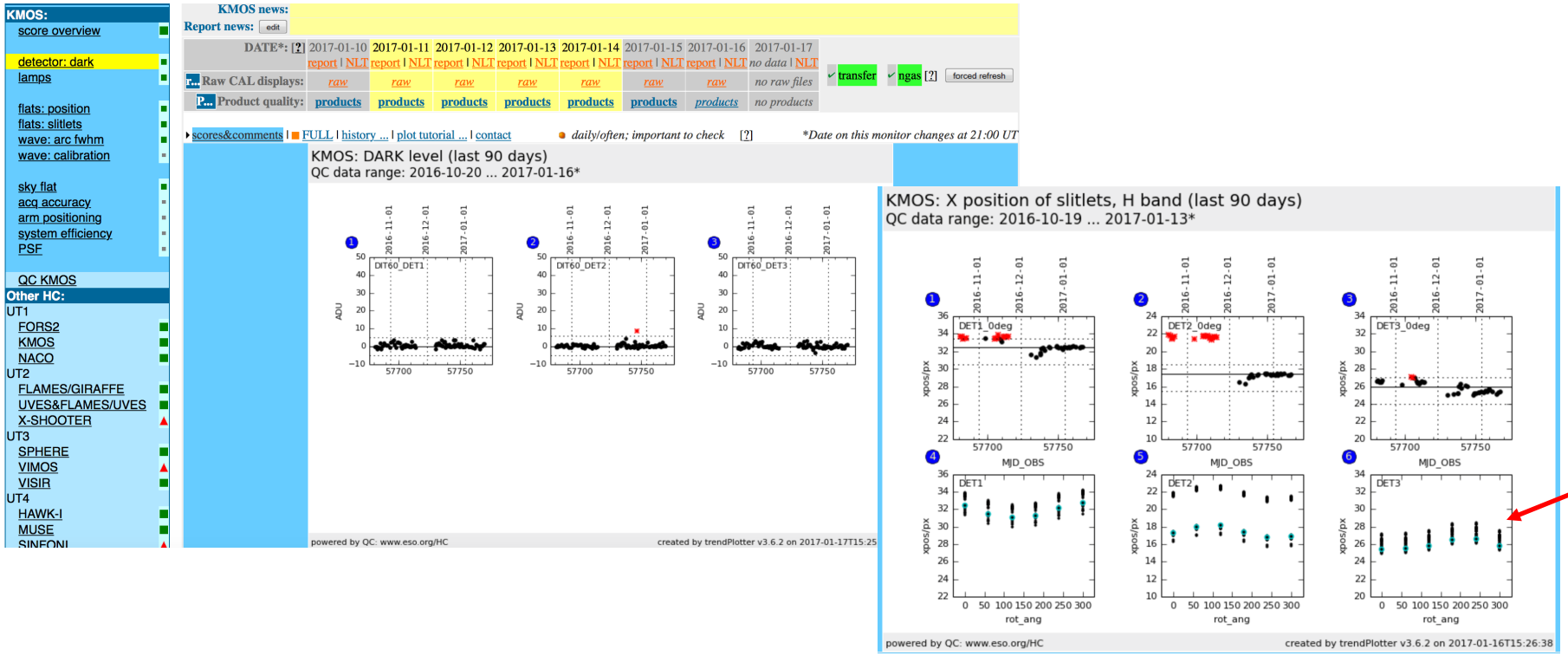
- Darks (used only for detectors monitoring) → daily
- Lamp Arcs and Flats (Th FF; Ar+Ne ARC used for wavelength calibration, image reconstruction) → daily

Night calibrations

- Sky flats (quantum efficiency) → monthly
- Standard Star (telluric removal, flux calibration)--> for each OB
  - within 2.0 hrs,
  - within $\Delta airmass < 0.2$,
  - preferably within the same region of the sky
- Relative astrometry --> be-weekly



KMOS: calibration plan



Because of flexures, depends on rotator position

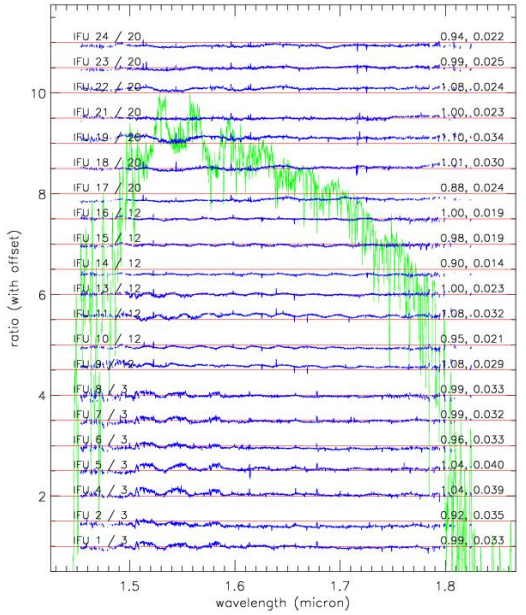
Day calibrations

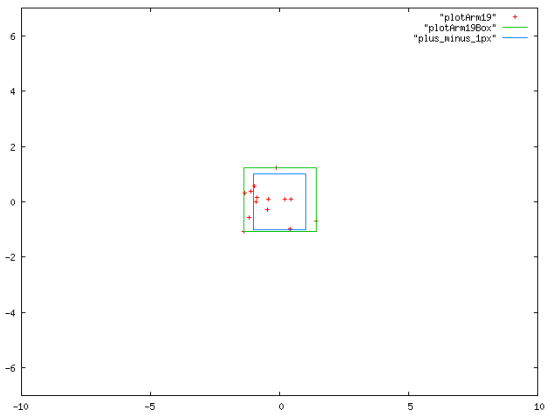
- Darks (used only for detectors monitoring) → daily
- Lamp Arcs and Flats (used for wavelength calibration, cube reconstruction) → daily, taken at 0 60 120 180 240 300 deg

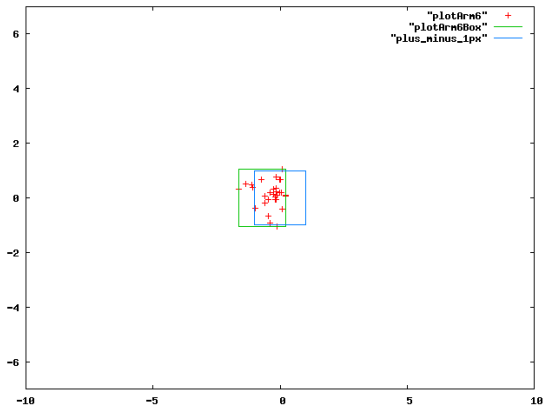
KMOS: calibration plan

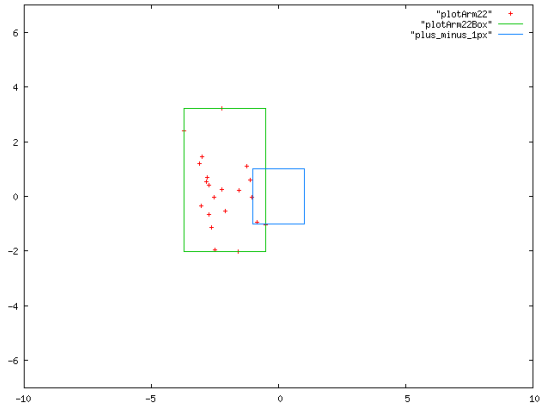
Night calibrations

- Sky flats (illumination correction) → monthly
- Standard Star (telluric removal, flux calibration)--> nightly, for each OB
  - within 2.0 hrs,
  - within $\Delta airmass < 0.2$,
  - preferably within the same region of the sky
  - Observed with 1 arm/spectrograph
- Relative astrometry --> be-weekly (check in 45 min, ATC update takes 0.5 nights)









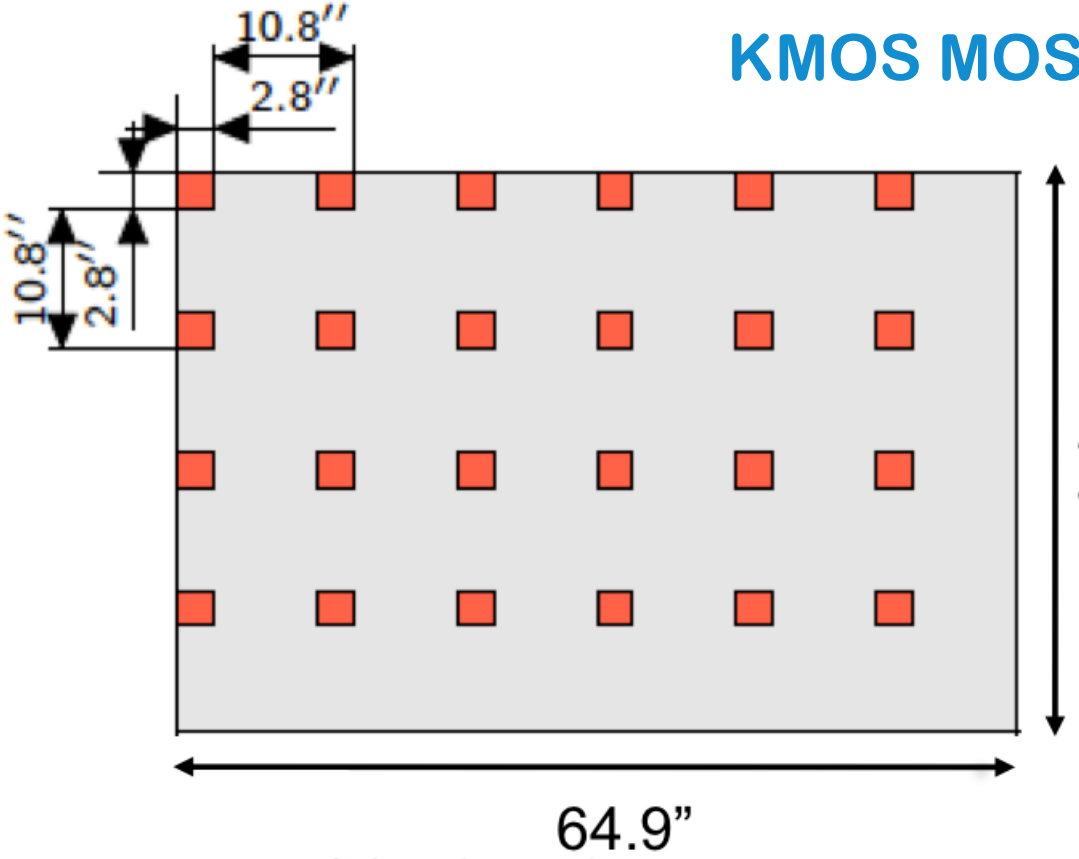
KMOS: summary

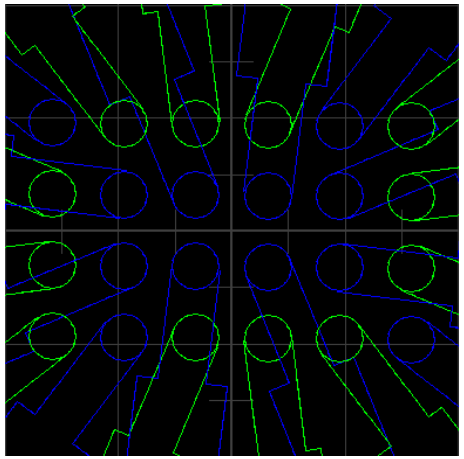
- Galaxy evolution as main scientific driver → Extremely versatile (stellar clusters, planetary transits, stellar BH, extended sources…)
- Simple observing modes
- Complicated opto-mechanics in a cryogenic environment → challenging monitoring and maintenance
- STD observations and Astrometric calibrations can be time consuming

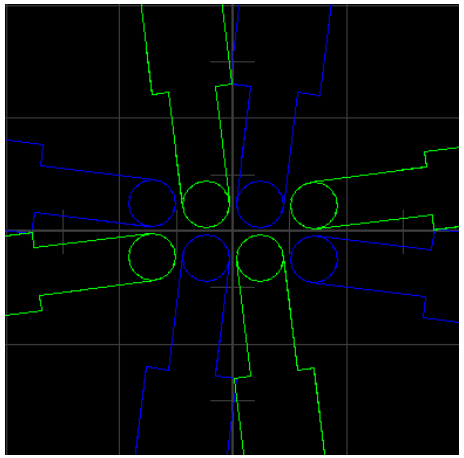
- Ongoing projects:
  - Grating wheel fallback init,
  - use/implement Molecfit,
  - characterize LSF,
  - pipeline and workflow updates

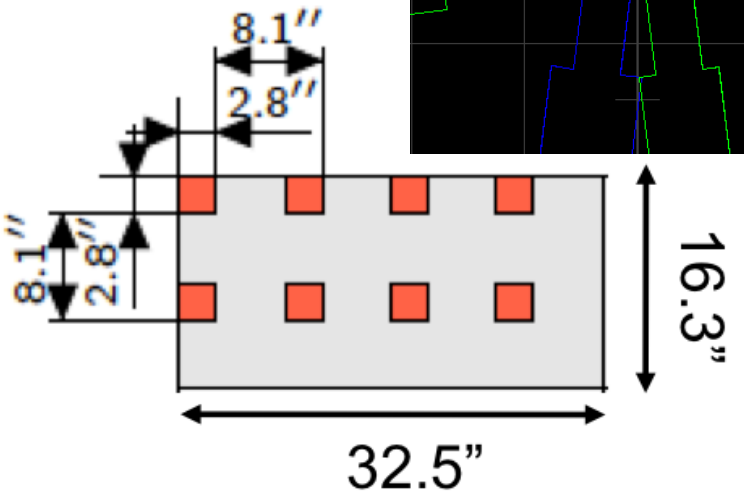
KMOS observing modes

KMOS MOSAIC mode: some details









Large MOSAIC configuration with all **24 arms**

~0.8 sqared arcmin

16 telescope pointings are required

Small MOSAIC configuration with **8 arms**

~0.15 sqared arcmin

9 telescope pointings are required