ESO's optical multi object spectrographs

IOT Overview Talk

The 2007 ESO Instrument Calibration Workshop
Garching, January 23-26, 2007

L. Schmidtobreick

Thank you!!!

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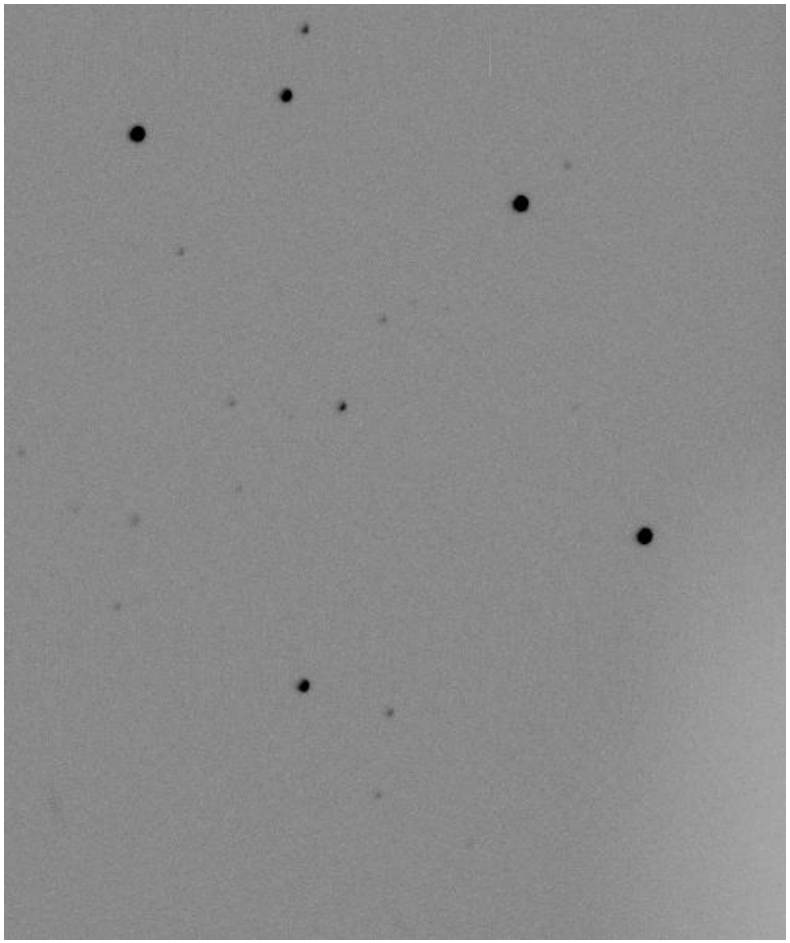
Kieran O'Brien
Emanuela Pompei
Ivo Saviane

What is Multi Object Spectroscopy (MOS)?



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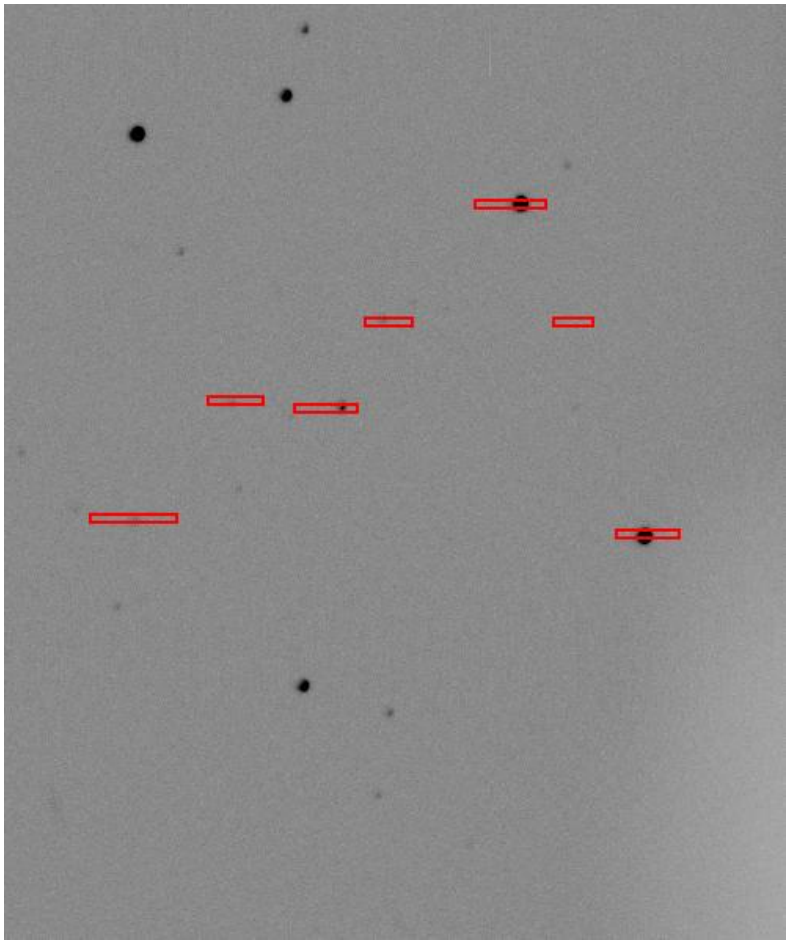

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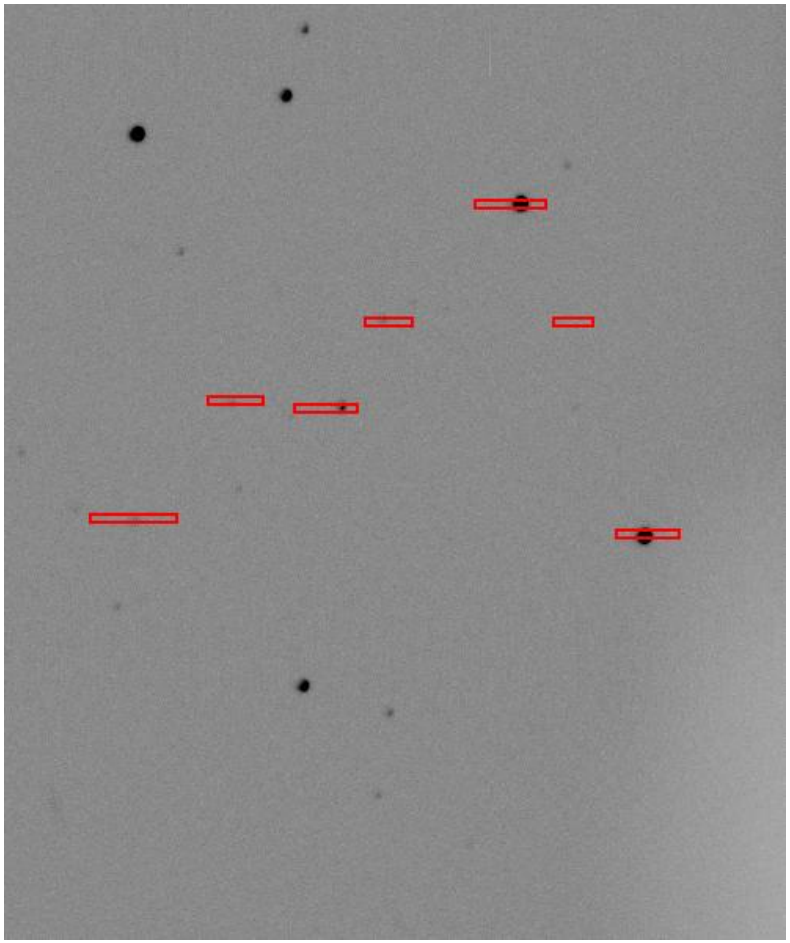
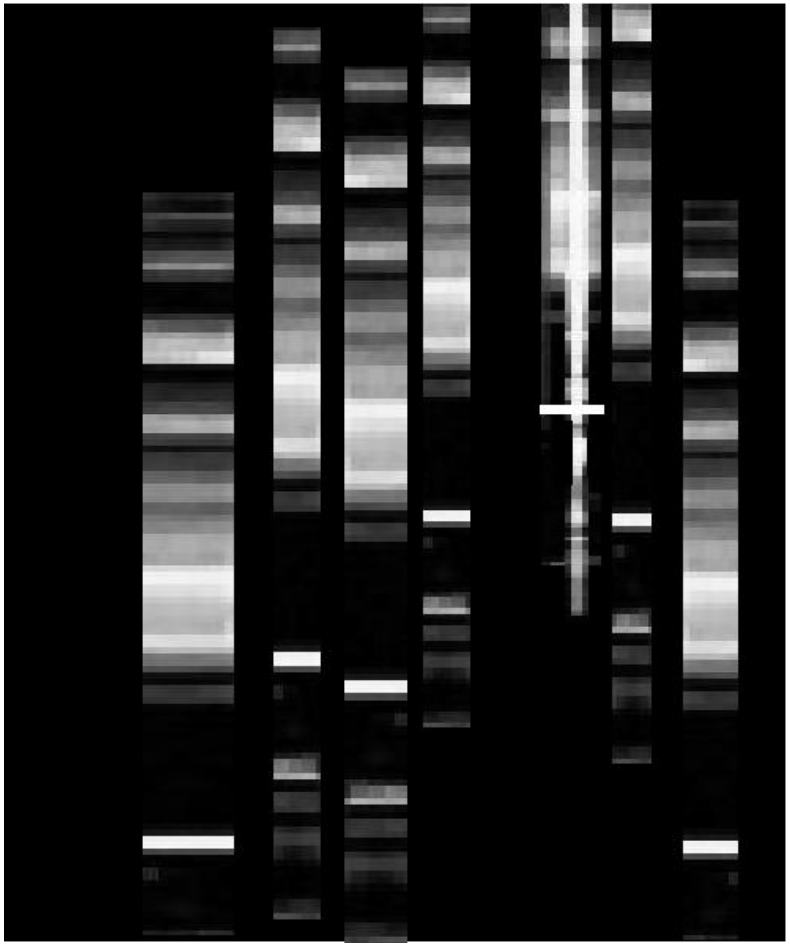




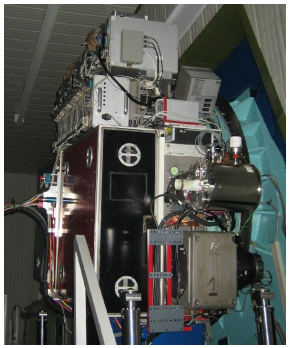
Optical MOS Instruments

La Silla

Paranal

EFOSC

EMMI

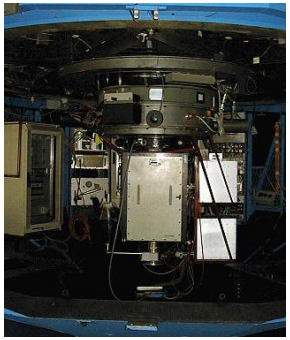


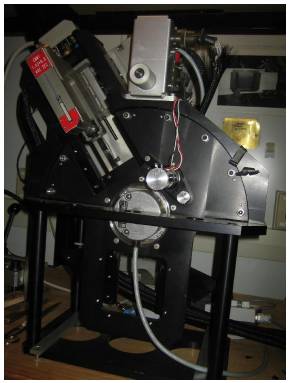
FORSes

VIMOS

FLAMES

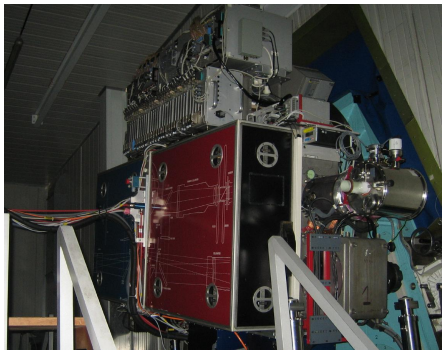
EFOSC @ 3.6m, La Silla

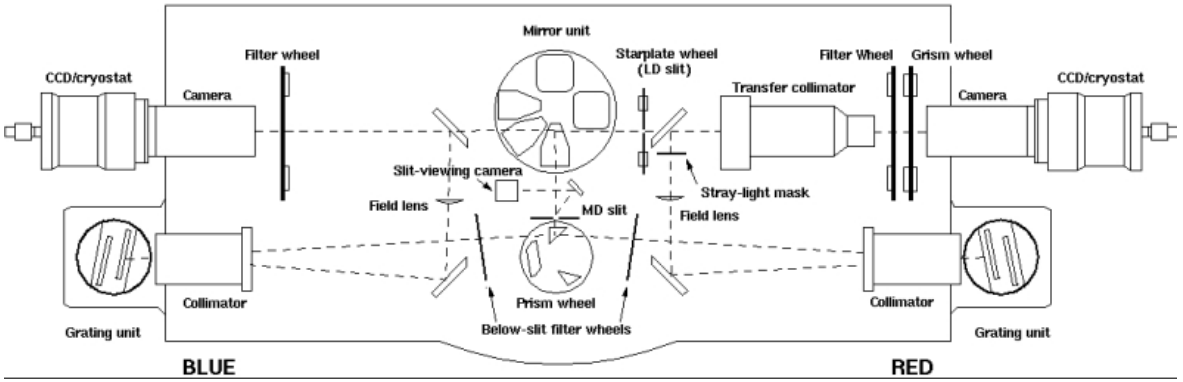




- mounted in Cassegrain of the 3.6m telescope
- MOS usually executed in visitor mode
- MOS plates are punched (1.15”, 1.35”, 1.75”)
- up to 5 masks can be loaded at the same time
- exchange during night possible
- grisms cover range 3200 – 11000Å
- fwhm resolution between 6Å and 60Å

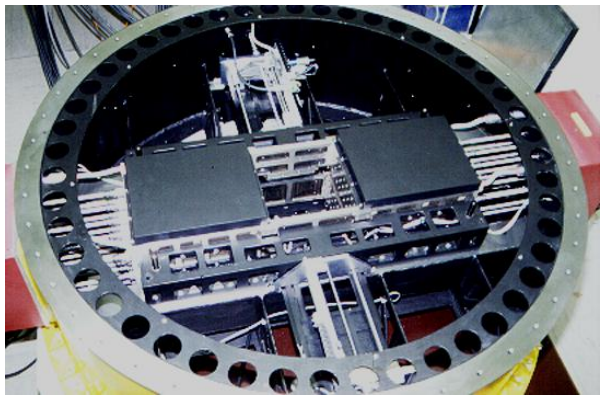
EMMI @ NTT, La Silla

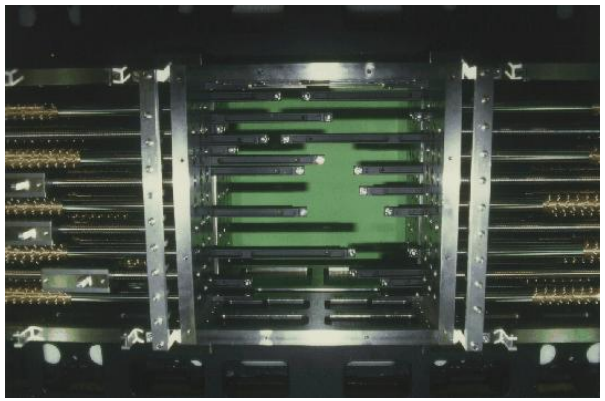




- mounted in Nasmyth focus of NTT
- MOS usually executed in visitor mode
- plates are punched (0.8”, 1.02”, 1.34”, 1.87”)
- up to 6 masks can be loaded at the same time, no exchange during night
- MOS supported in RILD mode: range 4000 – 10000Å, fwhm resolution 4Å – 45Å

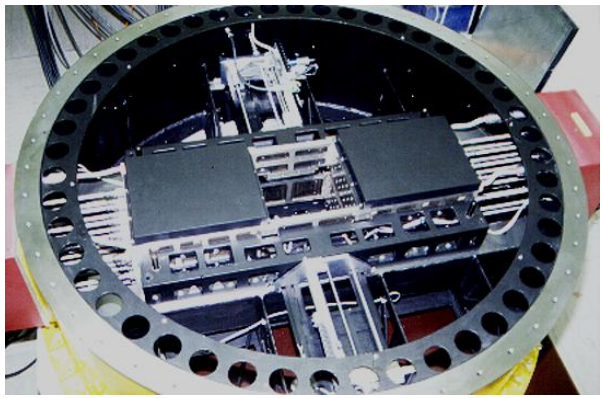
FORS1 @ UT2, Paranal

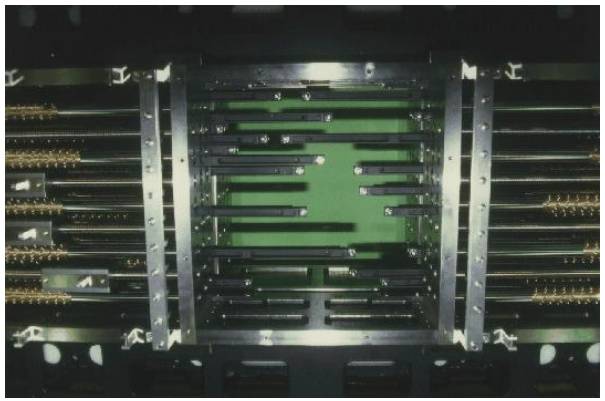




- mounted in Cassegrain of Kueyen (UT 2)
- slits are built by pairs of slitlets which are continuously mounted and are individually driven
- maximum of 19 slits can be built
- MOS executed in visitor or service mode, ToO possible
- possible range: 3300 –11000Å, fwhm resolution 1Å– 60Å

FORS1 @ UT2, Paranal: PMOS

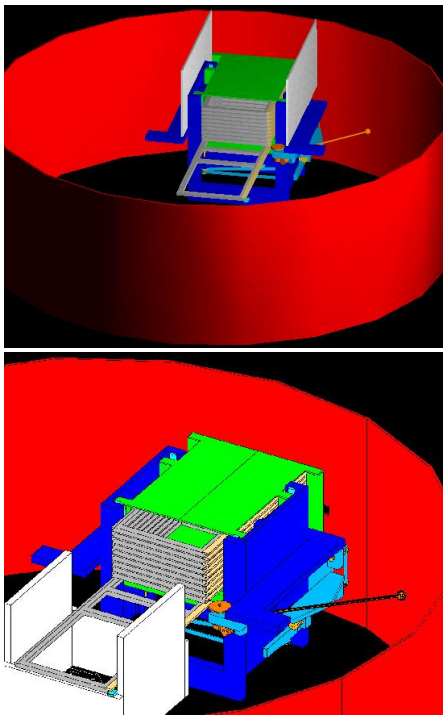




- linear polarisation ($\lambda/2$ plate and a Wollaston prism)
- circular polarization ($\lambda/4$ plate and a Wollaston prism)
- slitlets on up to 9 targets (half of the available slitlets, since two are used per target for the separation of the two polarisation beams.

FORS2 @ UT1, Paranal

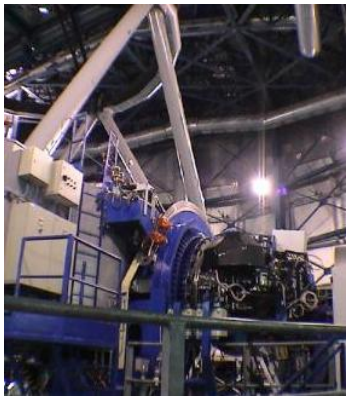
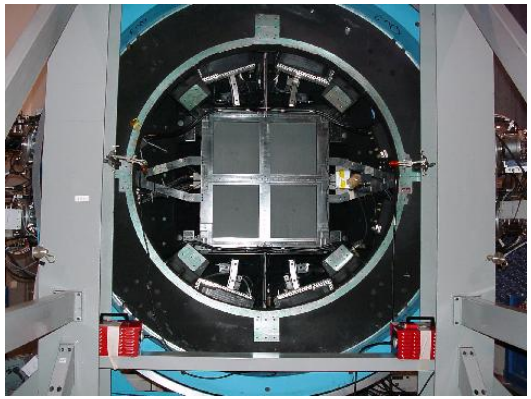
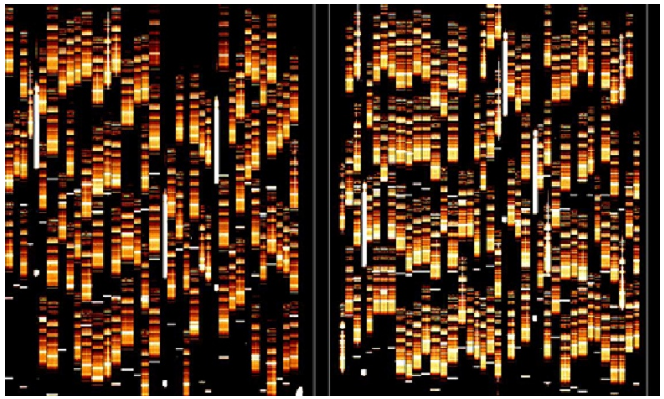
MOS available as for FORS1 - but without polarimetry



additional MXU mode:

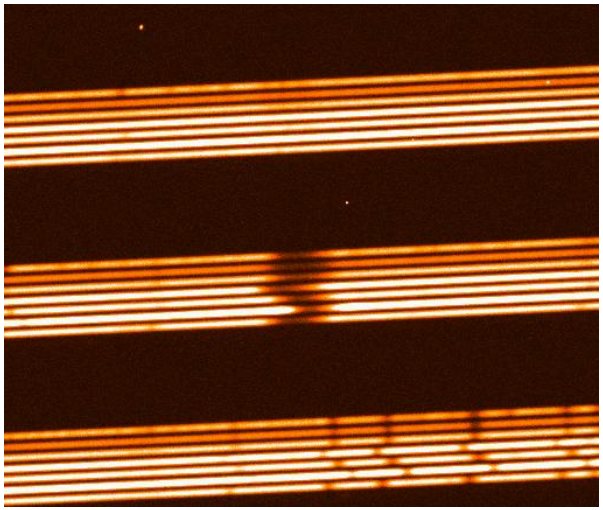
- to observe more objects in one go
- masks are pre-cut and up to 10 are installed in the instrument
- service or visitor mode possible - but no ToO

VIMOS @ UT3, Paranal

- largest imaging field at the VLT with $\approx 15'' \times 15''$
- $\approx$ 800 slits can be observed simultaneously
- low resolution (640 pix), medium resolution (2000 pix), high resolution (4096 pix)
- possible range: 3700 – 10000Å, fwhm resolution 1Å– 60Å.
- visitor and service mode offered

FLAMES @ UT2, Paranal

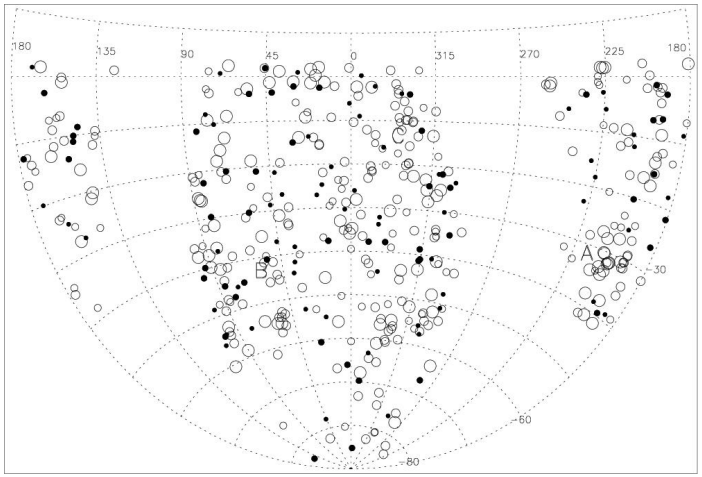


- GIRAFFE: fiber–fed spectrograph of medium resolution
- 130 spectra with resolving power 12000 - 24000
- UVES: fiber-fed spectrograph of high resolution
- 8 spectra with resolving power 47000
- both instruments are offered in service or visitor mode

Some scientific highlights:

Charting the Giants: The REFLEX survey

(X-ray flux-limited sample of 447 galaxy clusters – more than 90% statistically complete)

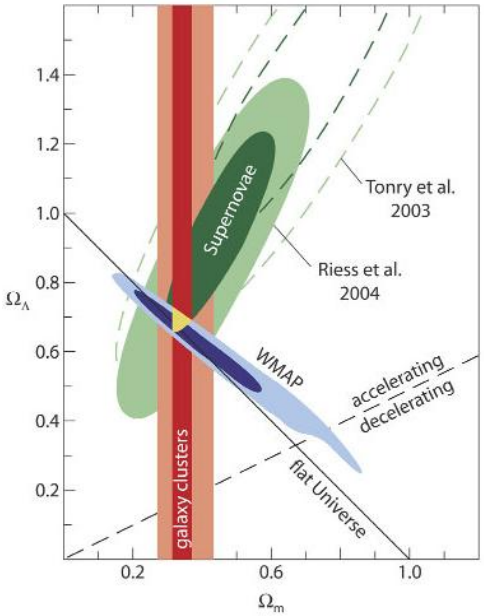


Sky distribution in α and δ of the galaxy clusters in the REFLEX sample. The symbols indicate the cluster distance. Superstructures can be recognised.

Böhringer et al. 2004, A&A 425, 367

Some scientific highlights:

Charting the Giants: The REFLEX survey



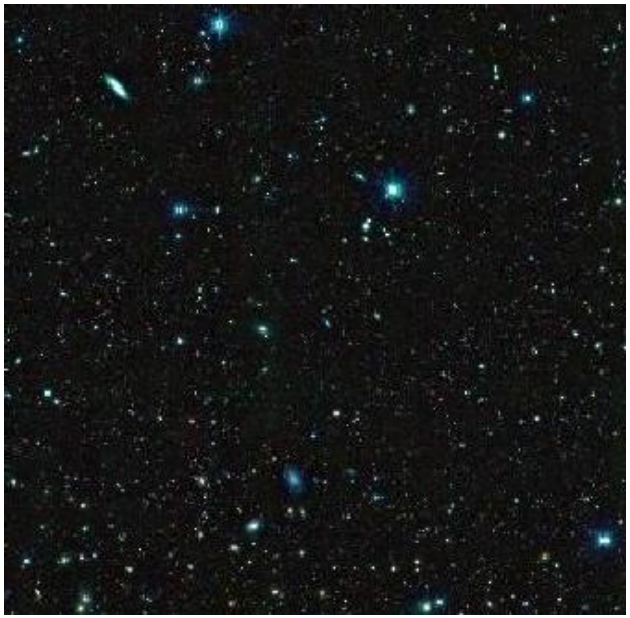
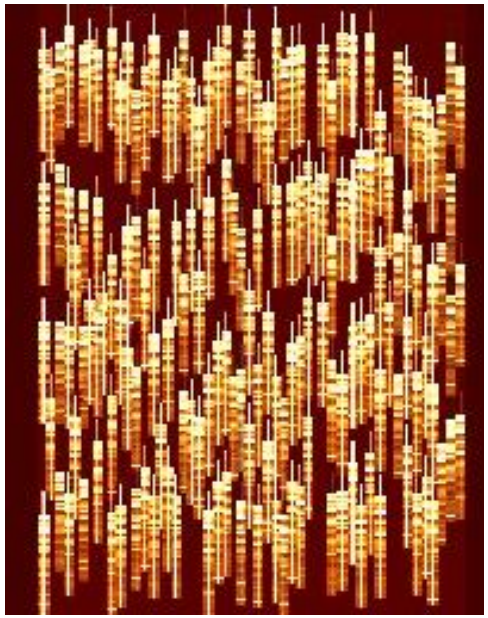
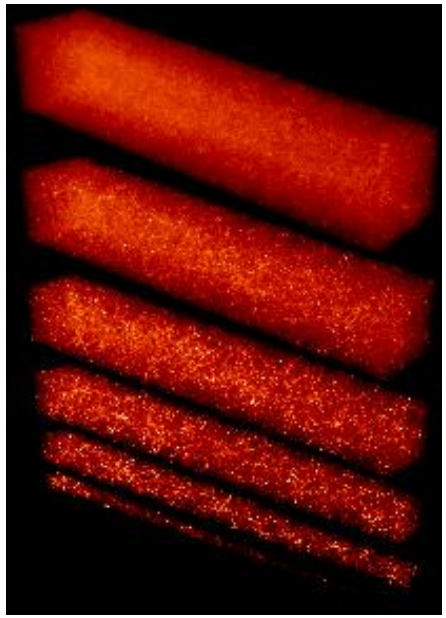
The current observational constraints on the cosmic density of all matter including dark matter (Ω_m) and dark energy (Ω_Λ). All three observational tests by means of supernovae (green), the cosmic microwave background (blue) and galaxy clusters converge at a Universe around $\Omega_m \approx 0.3$ and $\Omega_\Lambda \approx 0.7$.

ESO PR Photo 18d/04 (3 June 2004)

Science done with MOS

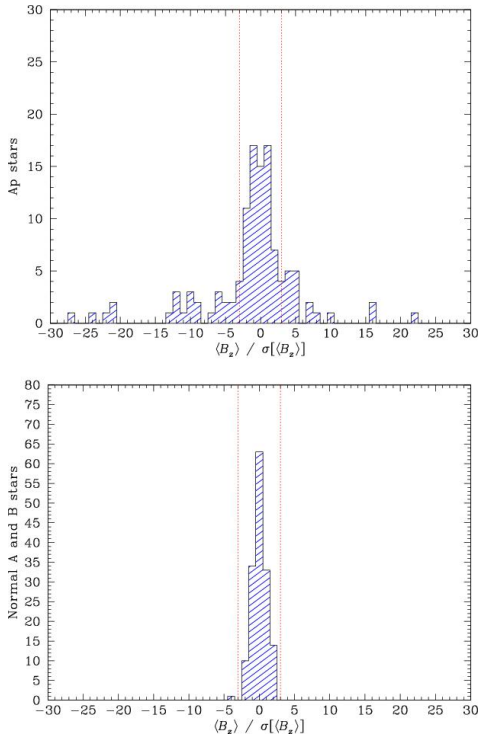
Some scientific highlights:

The VIMOS VLT Deep Survey (VVDS)

- A sample of 100,000 redshifts for objects up to AB = 22.5
- A sample of 50,000 redshifts for objects up to AB = 24
- A sample of 1,000 redshifts for objects up to AB = 26

Searching for links between magnetic fields and stellar evolution: I. A survey of magnetic fields in open cluster A- and B-type stars



- mass, age, metallicity through cluster membership
- magnetic field of 235 early-type stars measured from circular polarisation in several lines
- analysis of relations between evolution and magnetic field will follow in Paper II

Bagnulo et al. 2006, A&A 450, 777

Calibration

in general, calibration similar to long–slit:

- bias and overscan
- flatfield with the mask
- wavelength calibration: arc lamps with mask
- spectrophotometric calibration: standard star with longslit

but, there are some caveats:

- MOS slitlets are not necessarily aligned along the central column $\longrightarrow$ different slitlets cover different spectral ranges
- spectrophotometry difficult, as slit loss not known $\longrightarrow$ relative photometry (correction for instrument function)
- calibration must be taken before masks are moved

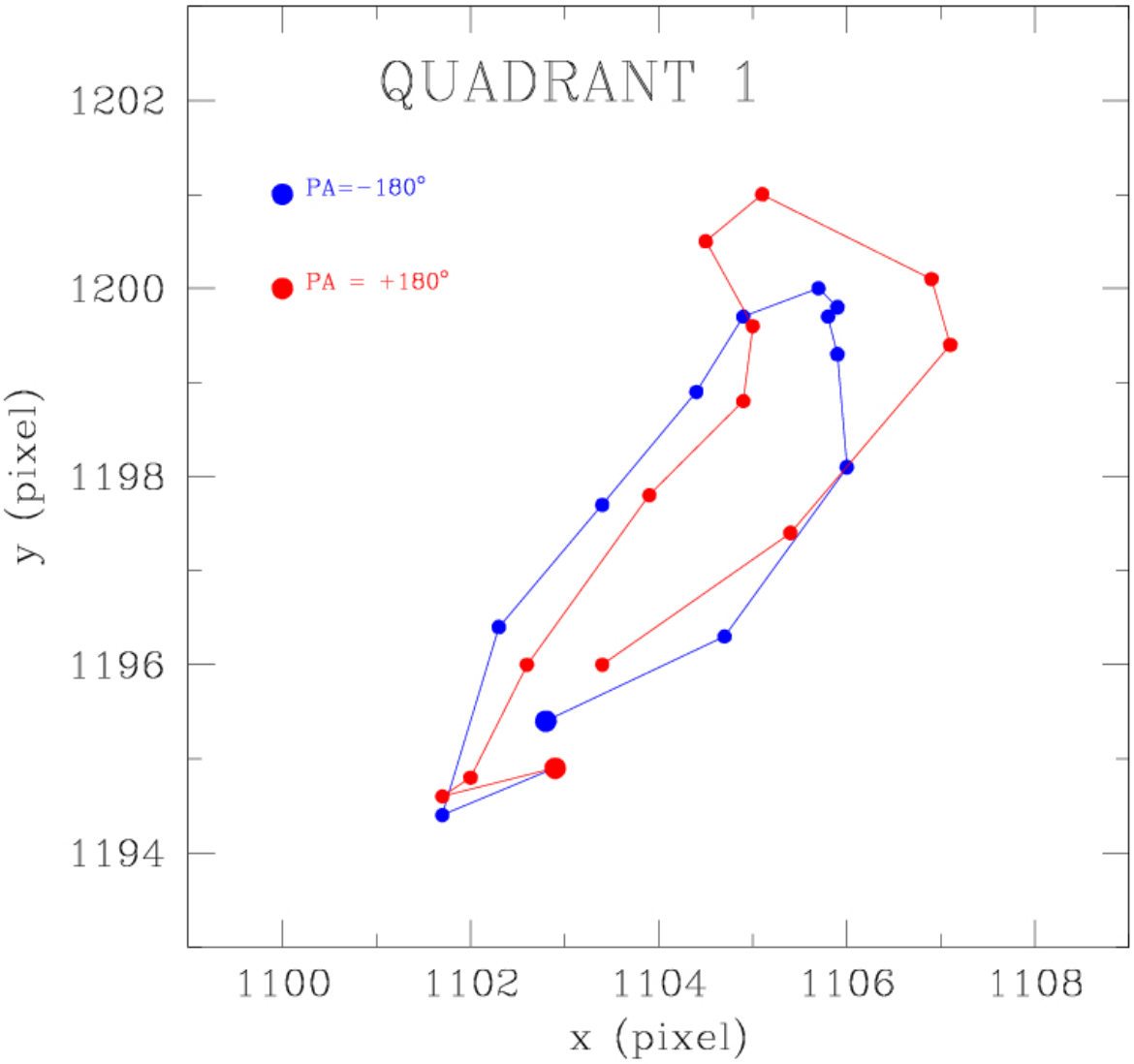
Special Calibration Issues: VIMOS

Instrument flexure:

- flexing of the whole instrument depends on position angle
- ”folding-mirrors” may to some extent compensate for such flexures, but still problems
- measuring the image position of a pinhole mask at various instrument position angles

Special Calibration Issues: VIMOS

Instrument flexure:



Special Calibration Issues: VIMOS

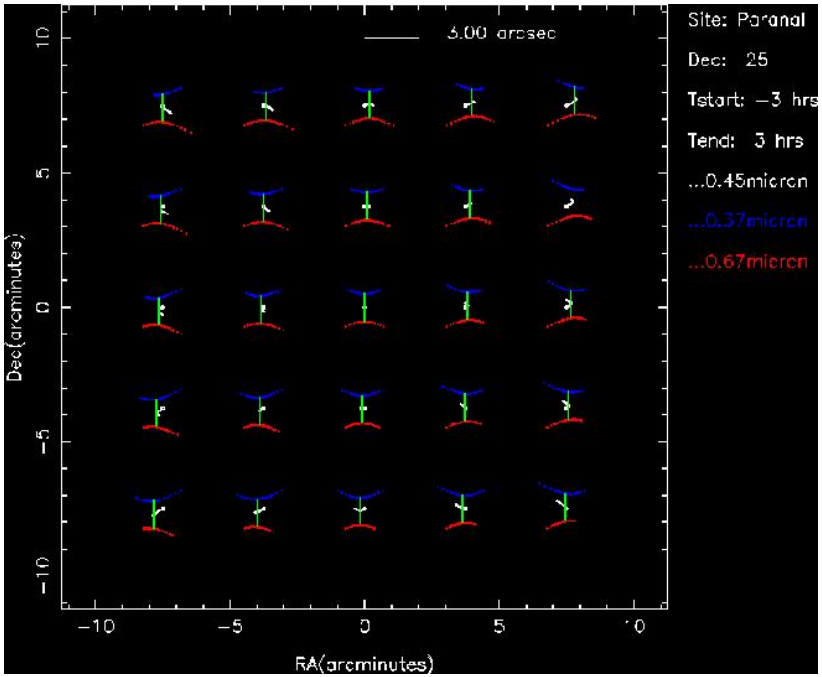
Instrument flexure:

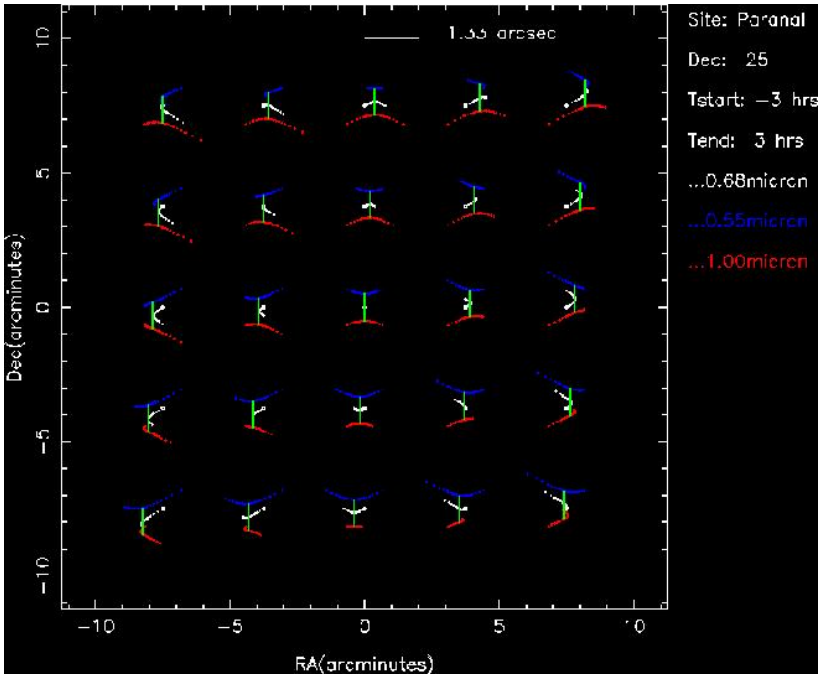
- effects the fit of mask to CCD
  - uncertainty in slitloss
  - in severe cases, the objects do not fall on the slit anymore
- effects wavelength calibration
  - calibrations taken at day-time at a fixed position angle do not necessarily represent the actual situation during the science observations
  - night-time calibration needed for all grisms which have not sufficient sky lines for calibration $\rightarrow$ blue modes

Atmospheric dispersion:

- no Atmospheric Dispersion Corrector (size issue)
- field differential refraction
- chromatic dispersion

Atmospheric dispersion:





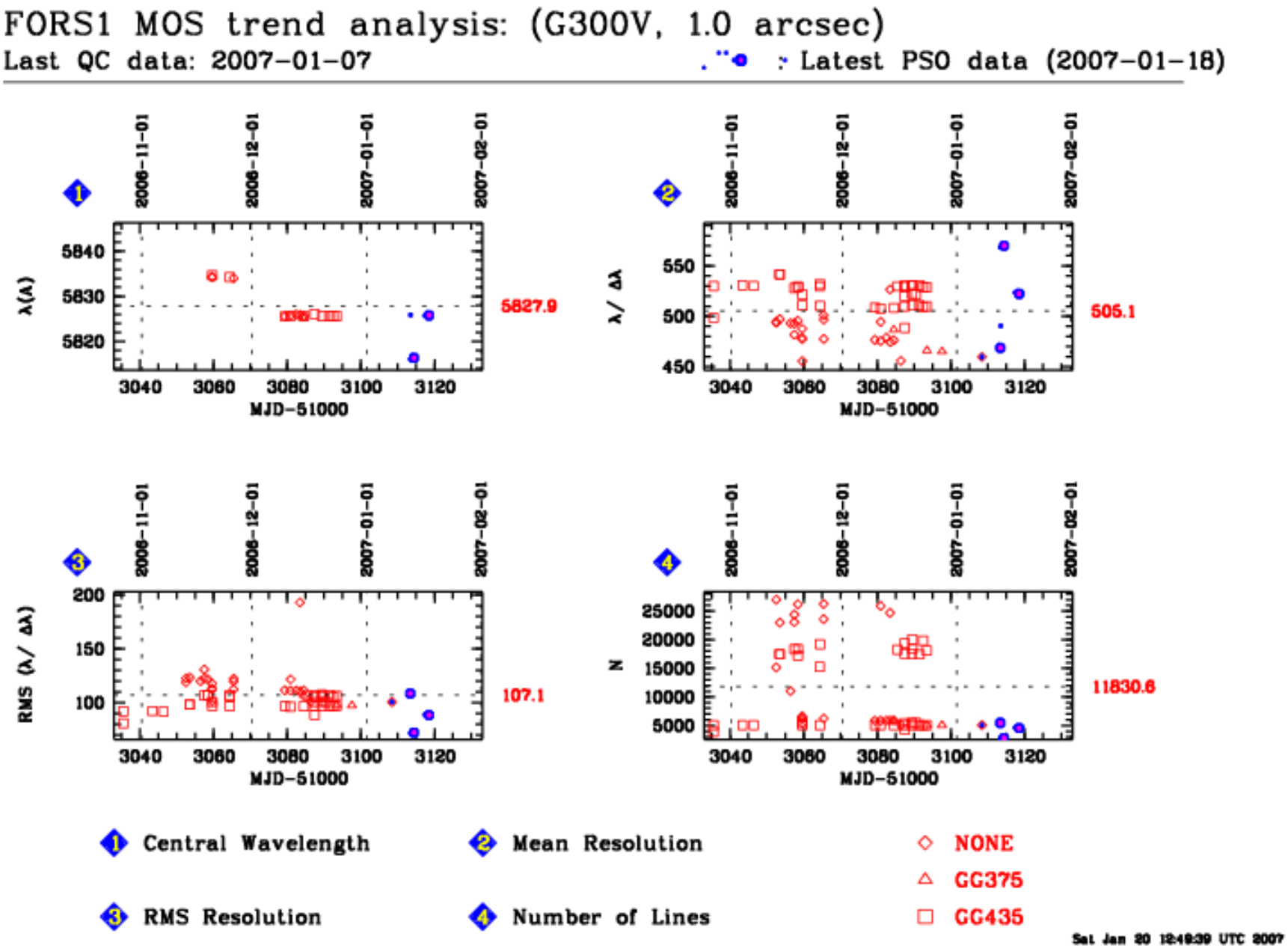
Atmospheric dispersion:

- MOS observations as well as pre-imaging are taken at a field orientation of 90 degrees with slits oriented N-S.
- MOS observations as well as pre-imaging are taken only within 2 h of the meridian.
- Motivated exceptions can be requested by the users through a waiver.

Monitoring the Instrument Performance

again similar to longslit spectroscopy,
but some examples for MOS:

Monitoring the Instrument Performance



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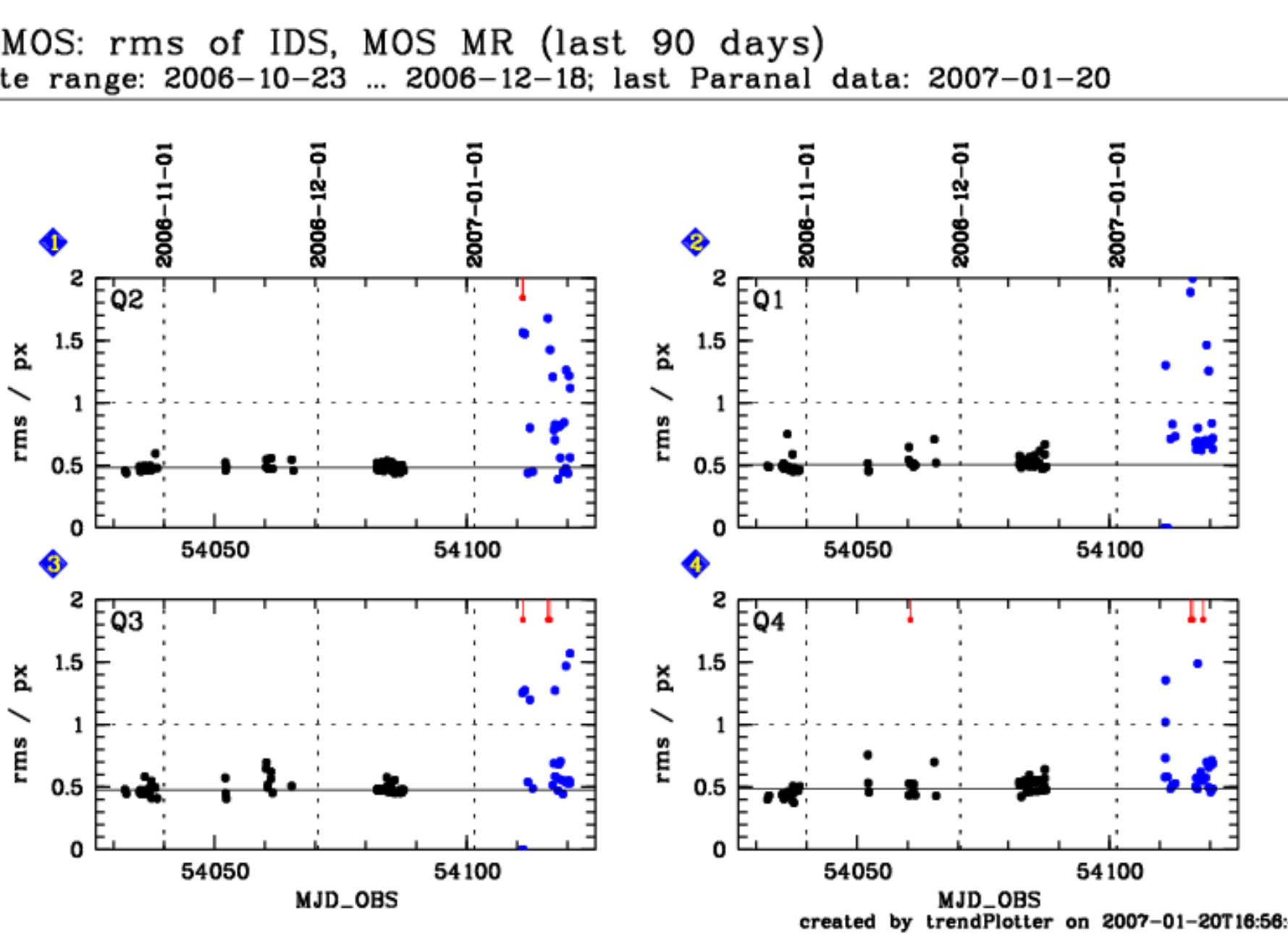

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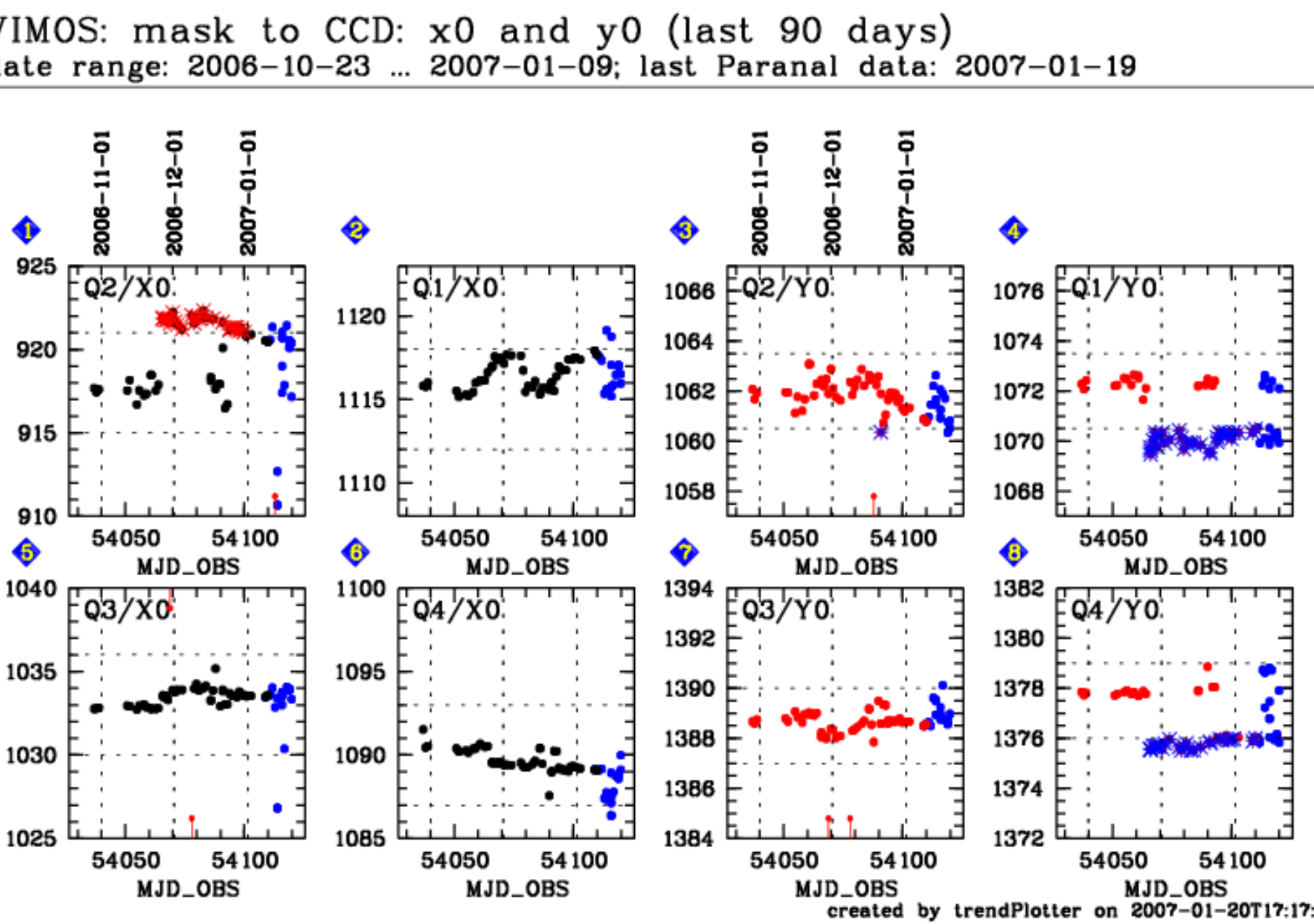

What to improve?

What to improve?

it’s up to you...