# Optimizing telescope time with ESPaDOnS

N. Manset, C. Moutou, L. Malo, G. Barrick, W. Mahoney, T. Vermeulen, J. Ward
CFHT

CFHT always strives to optimize and maximize the time spent on the sky so that users obtain as much data as possible. Limitations imposed by hardware, such as the time needed for telescope slews and dome rotation, can be managed by Queue Coordinators, who carefully plan sequences of observations to minimize those overheads. Another way to optimize the use of telescope time is to accumulate photons, not based on a pre-determined exposure time, but until the Principal Investigator's requested SNR is reached. When sky conditions are excellent, for example when the image quality gets as low as 0.4", the initial exposure time can be significantly reduced while still attaining the SNR needed for a scientific goal. Other hardware limitations, such as time spent reading out a detector, can be addressed with hardware and software upgrades. The Olapa 2amp project reduces the readout time by about half, by using both amplifiers on the e2v chip instead of just one.

## OPTIMIZING SKY TIME WITH CAREFUL NIGHT PLANS

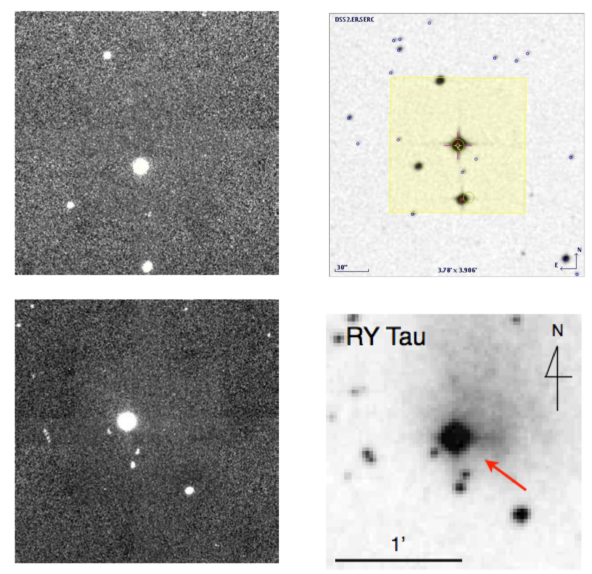
The Queue Coordinator has the responsibility of choosing appropriate targets that minimize telescope motion and dome rotation.

## OPTIMIZING SKY TIME BY HELPING THE OBSERVER QUICKLY ACQUIRE TARGETS

Due to a pointing accuracy of only about 30", the remote observer has to confirm targets by comparing the actual field of view with finding charts.

The acquisition was automated to save a little bit of time, by creating a mosaic.

The mosaic consists of a dither pattern of 5 images. Each individual image is 75" x 75". The resulting stitched image is 2' x 2'. The time to offset the telescope, take the individual images, and stitch them together is 25 seconds.




LEFT: mosaic of 5 images taken with the acquisition camera

RIGHT: Finding charts provided by the Principal Investigators

## OPTIMIZING SKY TIME BY REACHING A GOAL SNR INSTEAD OF A GOAL EXPOSURE TIME

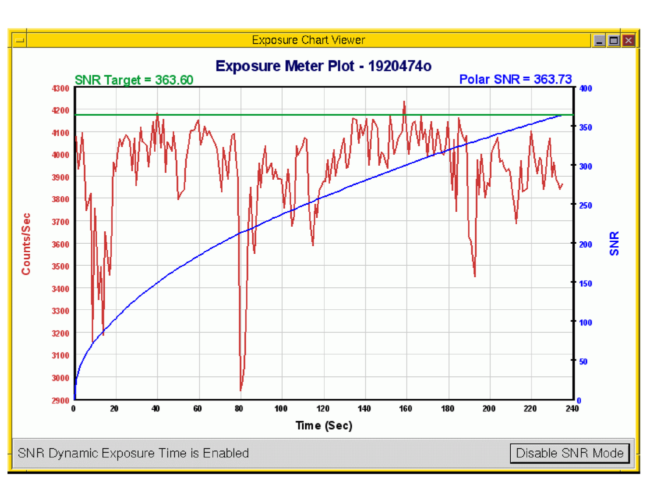
The QSO SNR mode stops exposures when the goal SNR has been reached.

Pros:

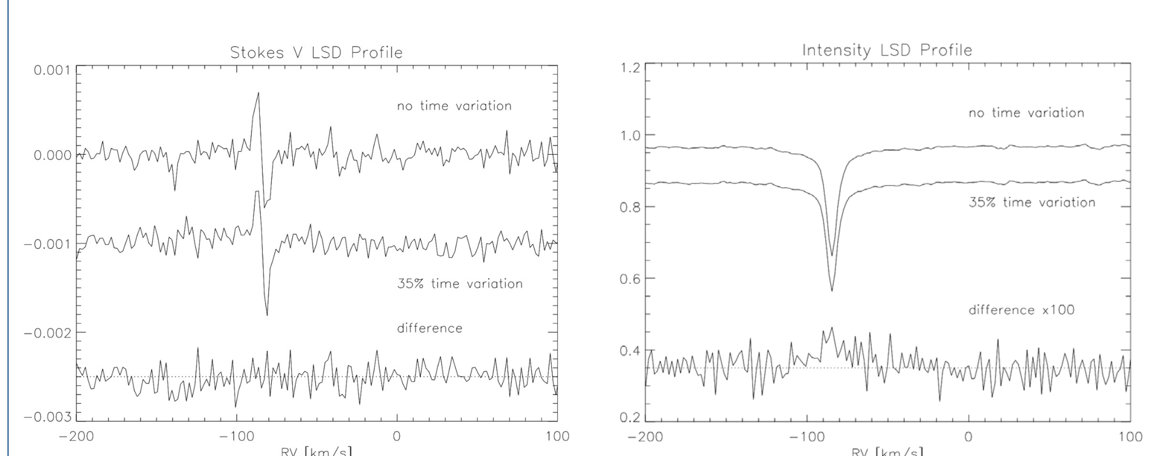
- Entirely optional
- PI can indicate the goal SNR at their favorite wavelength
- Flux and SNR are tracked in real time by using the Exposure Meter
- Exposure stops as soon as goal SNR is reached
- Can save a lot of time when sky conditions are excellent (up to 50%)
- Since Feb 2016, QSO-SNR has saved 4h out of 8h requested
- Works best for spectroscopy and non-variable targets

Cons:

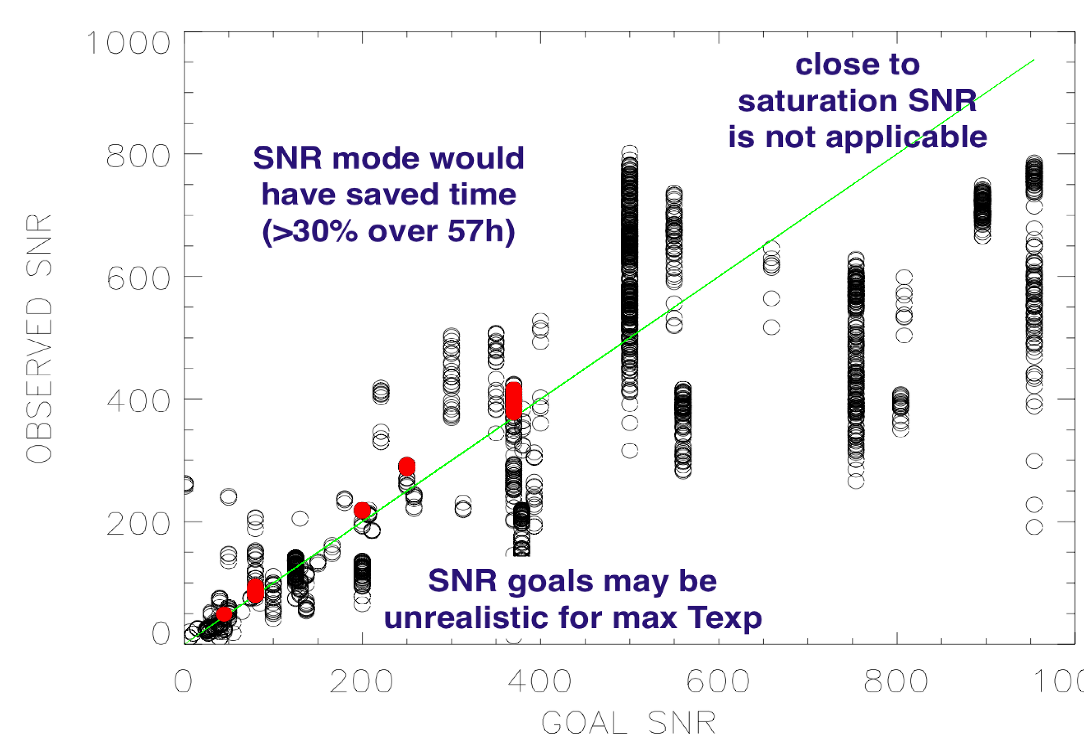
- PI has to use the ETC and provide a goal SNR
- Cannot be used under variable sky conditions in polarimetric mode without introducing spurious polarization signals
- Exposures cannot be lengthened
- Relies on a precise and accurate calibration of the Exposure Meter
- Requires more flexibility from the QSO team if the planned queue is shorter than expected



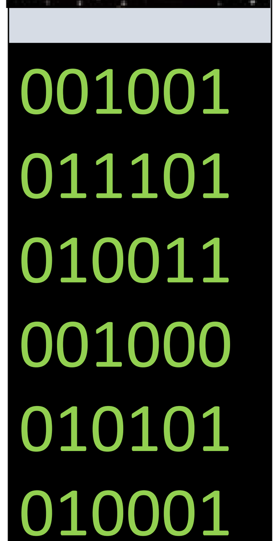

Observers can enable and disable the SNR mode (for programs that use the SNR mode). Using the Exposure Meter, they can follow at what rate the flux is coming (in red), see how stable the conditions are, and obtain a realtime measurement of the SNR (in blue).




Even with variations in flux of 35%, no spurious polarization signals are seen. Nonetheless, QSO SNR polarimetric observations are limited to stable sky conditions.




RED: 16A QSO-SNR observations showing that the goal SNR was reached.
Requested exposure times sometimes provide better SNR than needed; using QSO-SNR would optimize the use of sky time.
**The correct use of the Exposure Time Calculator is critical!**




## OPTIMIZING SKY TIME BY KEEPING THE DETECTOR READOUT TIME AS SHORT AS POSSIBLE

Potential estimated gains are on average 1h/day for calibrations and 0.5h/night on science exposures.

Current readout times for Olapa (1amp) vary between 32s (Fast) and 60s (Slow).
In 2016A (over 27 nights), on average, 1h/night was spent reading out science exposures, and 2h/day were spent reading calibrations.
The Olapa 2amp mode can decrease the readout time by a factor of almost 2.
The work is still ongoing.