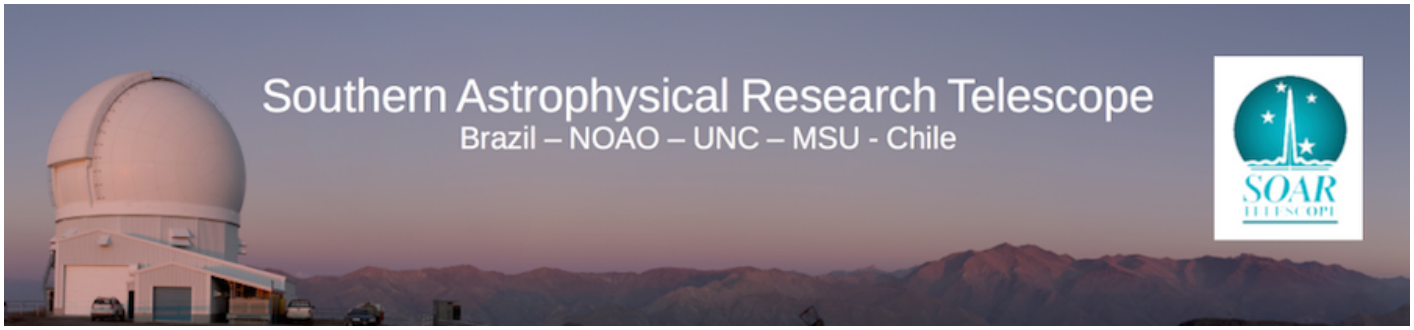

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Optimizing the Goodman CCD read out

It is tempting to assume that the best way to read out the Goodman detectors is with maximum sampling and minimum read noise – but this is not the case. Reading out in this mode takes a long time; for a typical program you could spend half an hour every night reading out the CCD, which could be better used observing an additional target.
The recommendations below are just that – advice in optimizing your program. There may be cases where different choices are warranted, but you should work out the implications first.

Binning

In general, you should bin to the required resolution:

- Binning in the spatial direction should normally be 2x (0.3 arcsec per binned pixel)
- Binning in the spectral direction should normally be 2x for slit widths of 0.9 arcsec or wider (6 pixels or more); 1x for 0.6 or 0.45 arcsec slits (4 or 3 pixels).

Because binning reduces the number of individual reads to get the image, you gain almost linearly with the binning factors. Also, because there are fewer reads per spectral element (orPSF for imaging mode), the read noise contribution is reduced.
The menu of read out modes does not include 2x1 binning, but you can set that up with the custom read out mode – don't be afraid to use it (but do make sure you always use the same settings). Note that the spatial and spectral axes are switched between the red and blue cameras!

Region of Interest

Apart from the binning, for spectroscopic mode you may not need the full region in the default spectroscopic modes – if you are doing single objects you can shrink the dimension along the slit from nearly 5 arcminutes to 2 arcminutes or less. You need to use the custom read out mode for this, and remember to change both the length of the readout and the origin of the readout.

Read Rate

Slower read rates produce lower read noise, but since most observations are photon-noise-limited, the gains are modest with the slowest read rate. Remember that read noise adds in quadrature to photon noise, not linearly. Recommendations:

- Blue Camera – Use the 200 kHz rate, ATTN = 0. For spectroscopy, 100 kHz, ATTN = 3 may not add much read time if you bin and shorten the slit.
- Red Camera – Use the 344 kHz rate, ATTN = 3. For broad-band imaging, 750 kHz, ATTN = 2 can be more efficient.

Note that once you get the read time under 10 seconds (consult the tables), the read time is dominated by overheads. Also, saving a couple of seconds per image has less impact than saving a minute.
