FLOYDS wavelength calibration plan

Summary: We should use the HgAr lamp for night time wavelength calibration. However, there are only four lines in second order with this lamp. We should also use the Zinc-Ar lamp, which adds three extra lines from 460-500 nm, for 'day-time' wavelength calibration. Note that it is impractical to use zinc during the night due to its long warm-up time. The 'best' wavelength solution from the HgAr+Zinc day-time calibrations can be applied to night time HgAr observations, with a shift to match the four blue Hg lines, if necessary, to account for any flexure. Even simpler would be to offset the day time wavelength solution so that the bright 557.7 nm sky line is appropriately place.

Note added on June 27, 2011. Some spectra of the HgAr lamp were taken in second order while preparing the flat field calibration plan document. The four blue mercury lines were prominent after only a 5 second exposure, and were better balanced than is apparent in Figure 2. The flux in these lines is dominated by the grating transmission function in Figure 2. Overall, lamp spectra can be taken in less than 10 seconds given the setup described in this document.

Introduction: The goal of this document is to briefly present a wavelength calibration plan for FLOYDS, following some lab tests with the 'mock' FLOYDS setup and Dubberley's gizmo for getting light from the lamps to the slit.

The basic problem is easy to define, and is illustrated in Figure 1. FLOYDS will be working in first and second order with first order running from 520-900+nm and second order from 350-570 nm. We would like to utilize the minimum number of arc lamps in order to cover our entire wavelength range, and we must be able to calibrate each order independently. We are not against the idea of using extra lamps during 'day time' calibrations to get an excellent wavelength solution, which can then be applied to a simpler set of lamps during the night (plus, presumably a zero point offset due to flexure). Similarly, the 557.7 nm oxygen sky line can be used to tweak a day time wavelength solution.

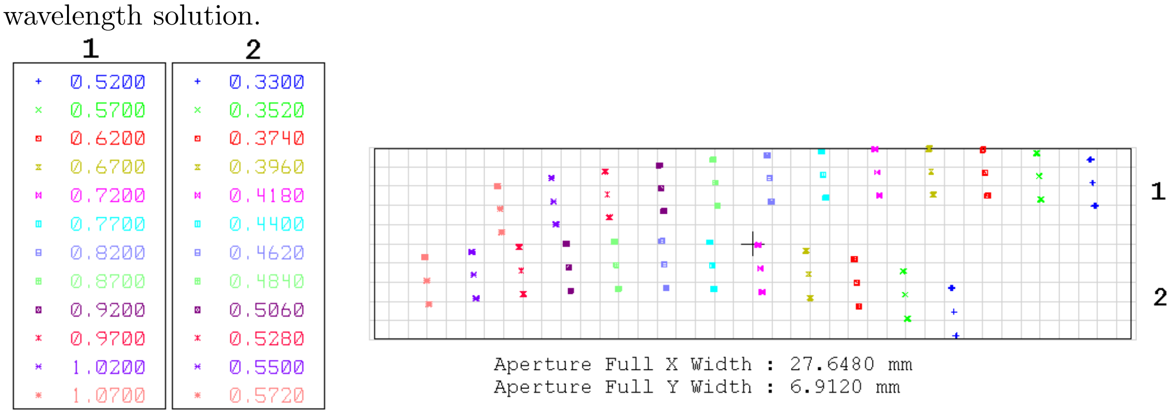

Figure 1: A schematic showing the geometry of first and second order on the FLOYDS CCD. First order goes from roughly 520-900+ nm, and second order from 330-570 nm.

The Lamps:

HgAr: As can be seen from Figure 2, the HgAr lamp is excellent, and provides a series of lines from 360 nm to 900+ nm. The relative fluxes of the Hg and Ar lines are similar, not requiring separate exposure times for red and blue wavelengths.

The one deficiency of the HgAr lamp is that there are only four available lines in second order, and this is not enough for an adequate wavelength solution.

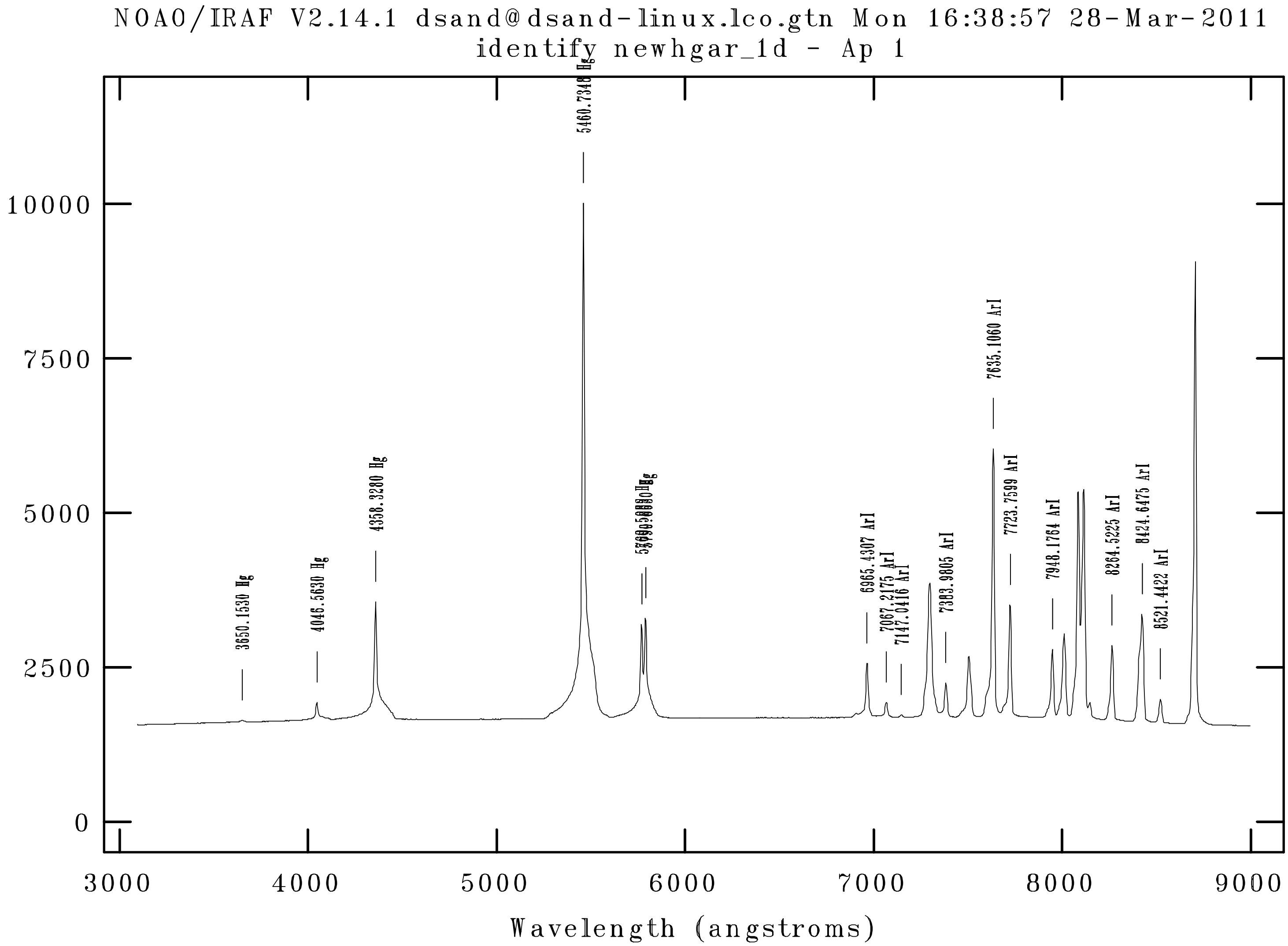

Figure 2: HgAr lamp as tested in the lab. HgAr provides many lines across the wavelength coverage of FLOYDS, but only four that would appear in second order on the chip.

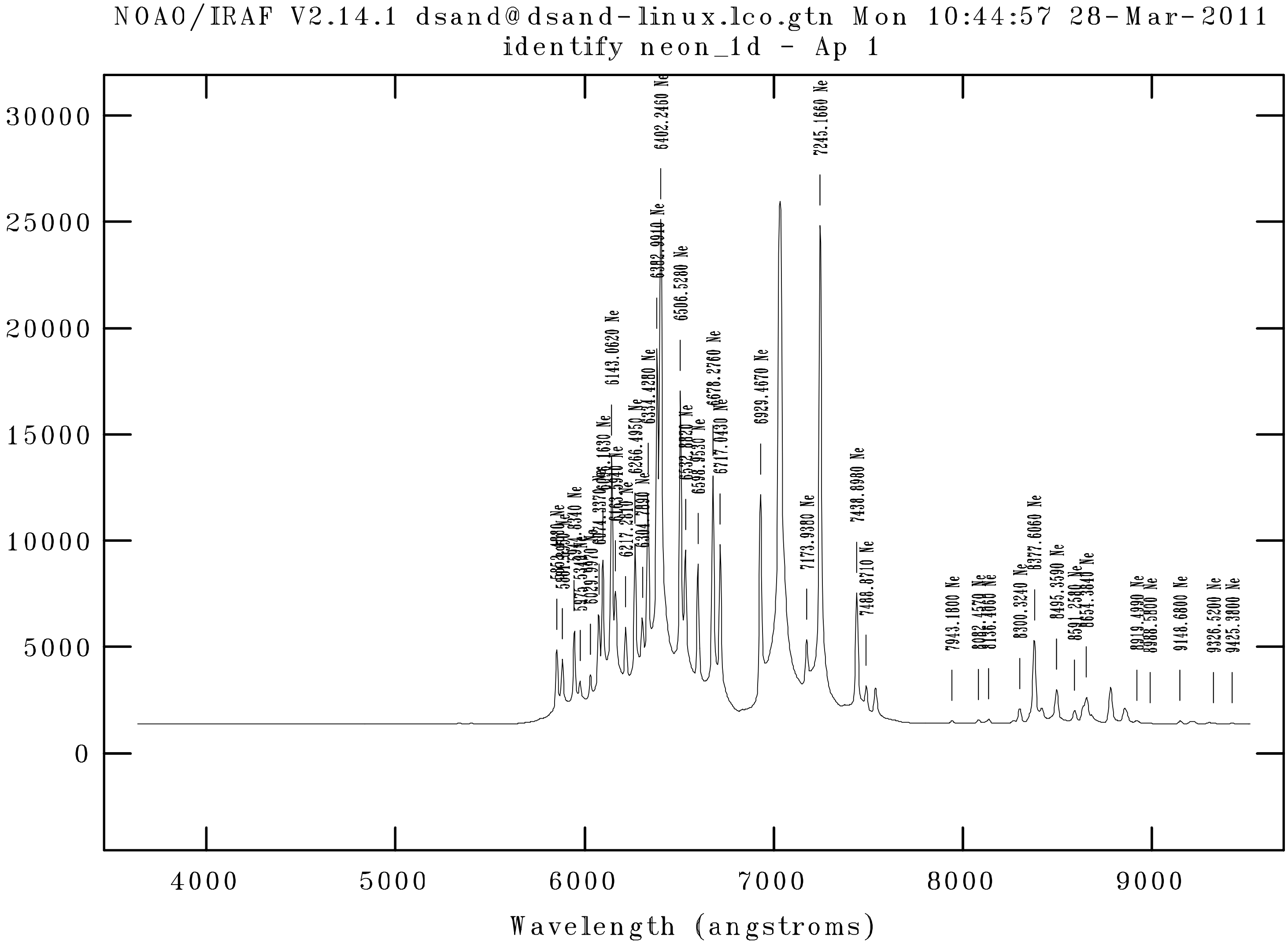

Figure 3: Neon arc lamp as test in the lab. While Neon provides many lines from 600 to 700 nm it is still unnecessary to include this additional lamp into the FLOYDS calibration unit.

Neon: As can be seen from Figure 3, the Neon lamp has a dozen-plus lines between 6000-7000 Å, providing an abundance of lines in the region where the HgAr lamp is light. However, there are enough first-order lines to the blue (from Hg) and red (Argon) of this gap in the HgAr lamp that neon seems unnecessary. The Neon lamp is not useful for second-order calibrations.

Zinc: We ordered a Cadmium lamp, but it turned out to be Zinc+Argon. This is fine, because they have similar features of interest – a triplet of lines from 450-500 nm. These three lines can be seen in Figure 4, which is a combination of the Zinc and Hg lamp.

The zinc lamp has a long warm-up time of around 5 minutes (note that Cadmium also has a long warm up time – still trying to quantify that with Spectral Products, our lamp source), making it impractical for night time operations. Also, the Ar lines on the red end saturate for the exposure times necessary to get sufficient zinc line flux.

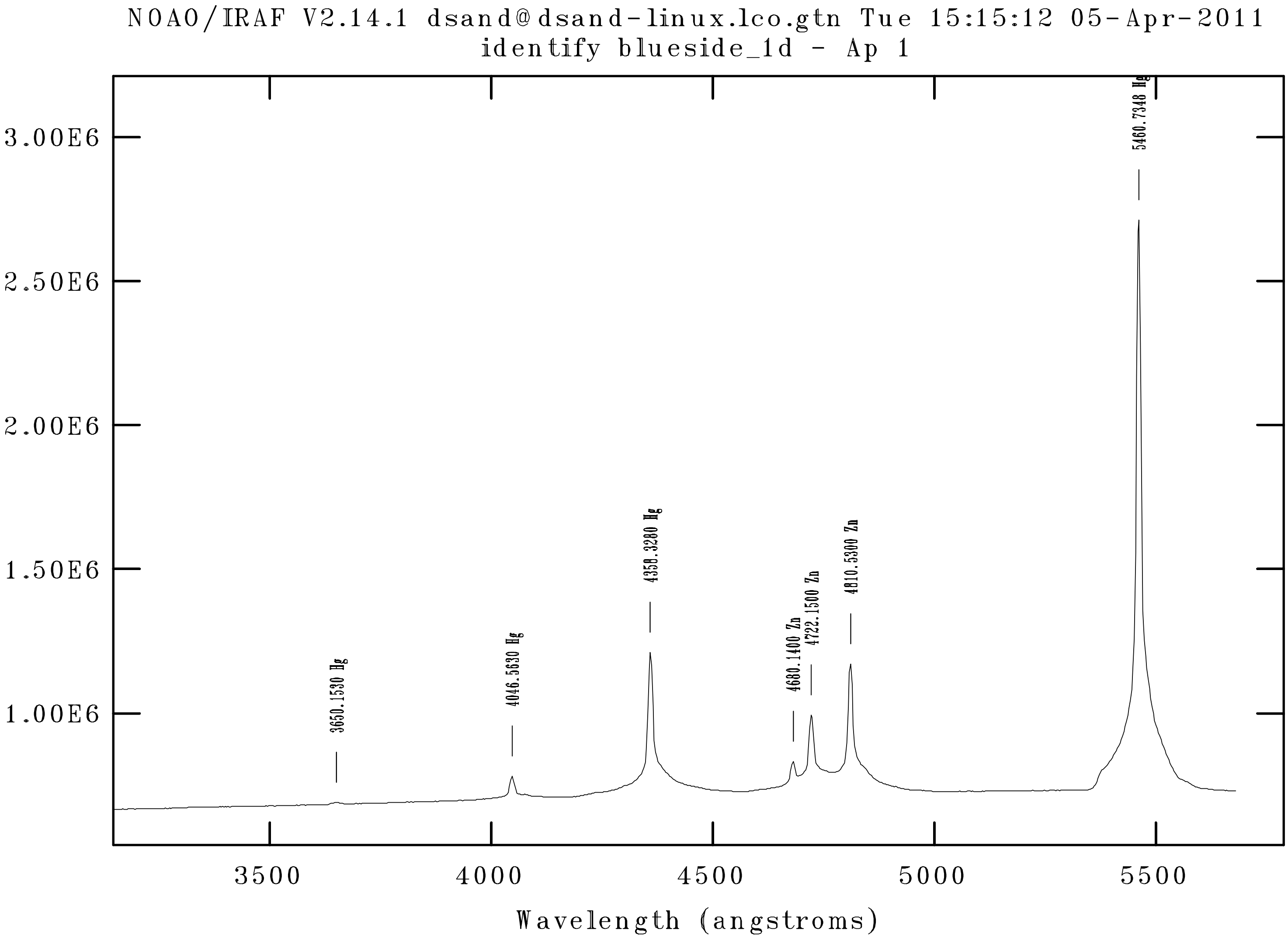

Figure 4: A combination of the Mercury and Zinc lamps, covering only the wavelength range in second-order FLOYDS. There are a total of 7 lines, and a 4th-order polynomial fit leads to a ∼0.2 Årms in the wavelength solution.

A Plan

I imagine a two-pronged solution to getting wavelength calibration for science exposures.

First, we should employ both the HgAr and Zinc lamps for day time calibrations, and from it we should derive our 'master' wavelength calibration solution on a regular basis. There are plentiful lines in first order with HgAr alone, and with Hg+Zinc, there will be seven lines in second order (see Figure 4). This was enough to fit a 4-th order polynomial to the second order data, and to achieve ∼0.2 Å rms residuals in the wavelength solution.

Note that this will require a red wavelengths blocking filter to be associated with the zinc+Ar lamp, in order to avoid saturation of the chip in first order (and bleeding into second order).

We should also perform 'night time' wavelength calibrations as well, at least as we break in FLOYDS. This will involve only taking HgAr exposures at roughly the same time as the science observations. The HgAr lamp is great due to the broad wavelength coverage and the relative fluxes of the lines. Then, we can apply the 'master' wavelength solution, along with a zeropoint shift (made to match the HgAr lines taken at the science field), to account for any shifting due to flexure.

If things are extremely stable, we might even consider cutting out these night-time wavelength calibrations, and instead use the 557.7 nm sky line as the final wavelength solution offset. Lets not worry about this option for now.