FLWO 1.5m telescope:ADC tests 2014-2016

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The ADC on the 1.5m corrects for atmospheric dispersion of spectra acquired with TRES and FAST. It eliminates the need to rotate to the parallactic angle to minimize dispersion.

Recently, we had reports that spectra of SN2016bkv showed a significant loss of counts at short wavelengths on 04/04.16, as shown in Fig. 1. Fig. 2 confirms a malfunction of the ADC that night, with spectra of Feige34. It began between about 04:49 and 09:10 UT, the interval that separates the white and red traces in Fig. 2. The ADC continued misbehaving through the end of the FAST run on 04/09/16, as shown by additional spectra (not shown) of the SN and of Feige34.

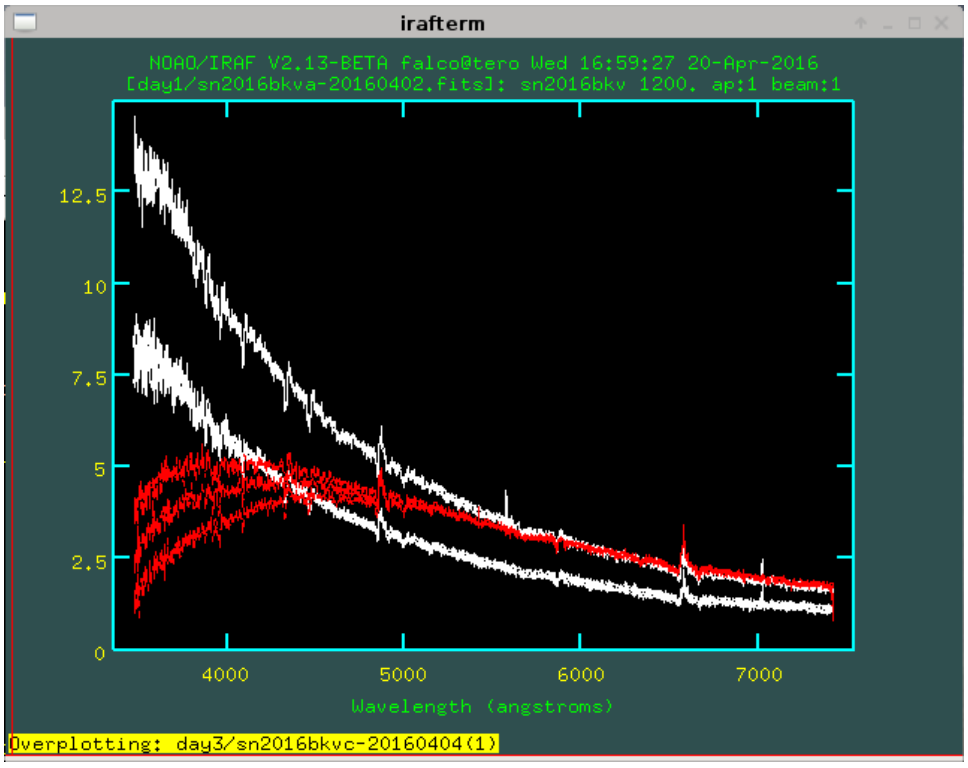

Fig. 1.— The white traces are spectra of SN2016bkv, taken on 04/02/16 (higher trace) and 04/03/16 (lower trace). The red traces are spectra taken on 04/04/16. The continua and the emission lines in the spectra from the 3 different nights are similar beyond about 4800Å, thus confirming that the slit was on the SN. However, there is a drastic drop in blue counts in the 04/04 spectra, as is typical for spectra suffering from an ADC malfunction.

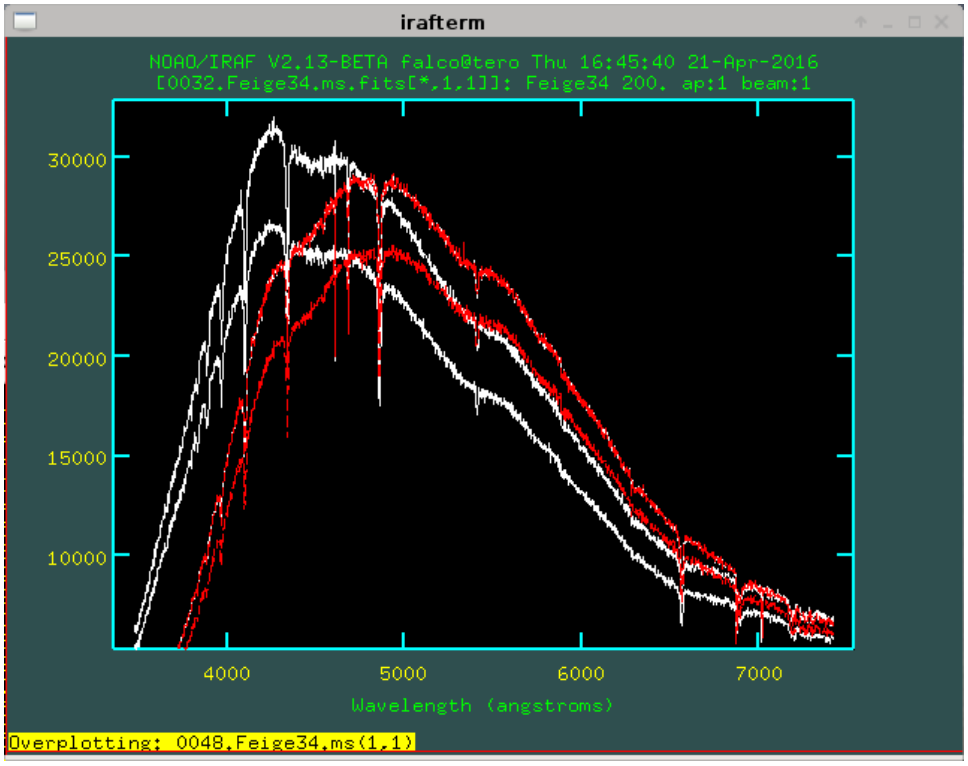

Fig. 2.— Spectra of Feige34, taken on 04/04/16. The white traces were taken 5 minutes apart and are normal. The red traces were also taken 5 minutes apart, 5 hours after the first two. They show depressed blue counts and no peak at 4250Å, confirming the ADC malfunction that affected the SN spectra that night. The absorption lines in the spectra remain visible at their normal wavelengths.

I searched for ADC malfunctions over the past three years that may have gone unnoticed. I made spot checks using FAST spectra of blue spectrophotometric standards Feige34, BD+332642 and G191B2B. I used mainly Feige34 spectra, supplemented with spectra of the other two standards in July-October when Feige34 was not observable. I inspected visually 184 spectra of these standards in the FAST archive for all FAST runs between 2013 and 2016. Table 1 lists the observations that showed ADC problems within that period. Easily identified telltale signs of a malfunction of the ADC are a drop in blue counts in all spectra, and the disappearance of a peak in the spectra of Feige34 at about 4250Å, as in Fig. 2.

I found 2 unexplained malfunctions:

- 2013: A single event on 01/14/13, shown in Fig. 3. It was not detected, and there were no log entries. Possible explanations are that the set screws that hold each gear to its shaft loosened, thus allowing the gears and the prisms to slip and not align properly, or that the ADC lost power for unknown reasons. The ADC was inspected, and the screws tightened as much as possible.

- 2016: A sequence of events starting 04/04/16, shown in Figs. 1 and 2. These were obviously detected, but we have no explanation. On 04/11/16, we removed the stovepipe and inspected the ADC. It clearly needed to be cleaned, so we did that. We exercised the two prisms several times from software, and found no problems. We went back and forth with the idea that the ADC may not have been mounted at the correct oreientation, but tests that night showed the orientation was correct to begin with. Since then, observations with TRES have shown the ADC is operating normally. We'll monitor it with FAST and spectra of blue standards.

I also found 2 malfunctions with known causes:

- 2013: Starting on 05/01/13, the ADC malfunctioned during several consecutive nights. We found the set screws had slipped again. Gabor replaced the ADC motors and shafts, which included pins in addition to set screws, to prevent slippage. It's very unlikely that there was any slippage after this date.

- 2015: Jonathan Irwin reported in the nightly log for 02/13/15: "ADC not making usual wheezing noises or lurches of the star image in focal plane after slew = not working?" On 02/14/15, Wayne found and fixed a problem with a wire to the ADC.

Plots

- **2013:**

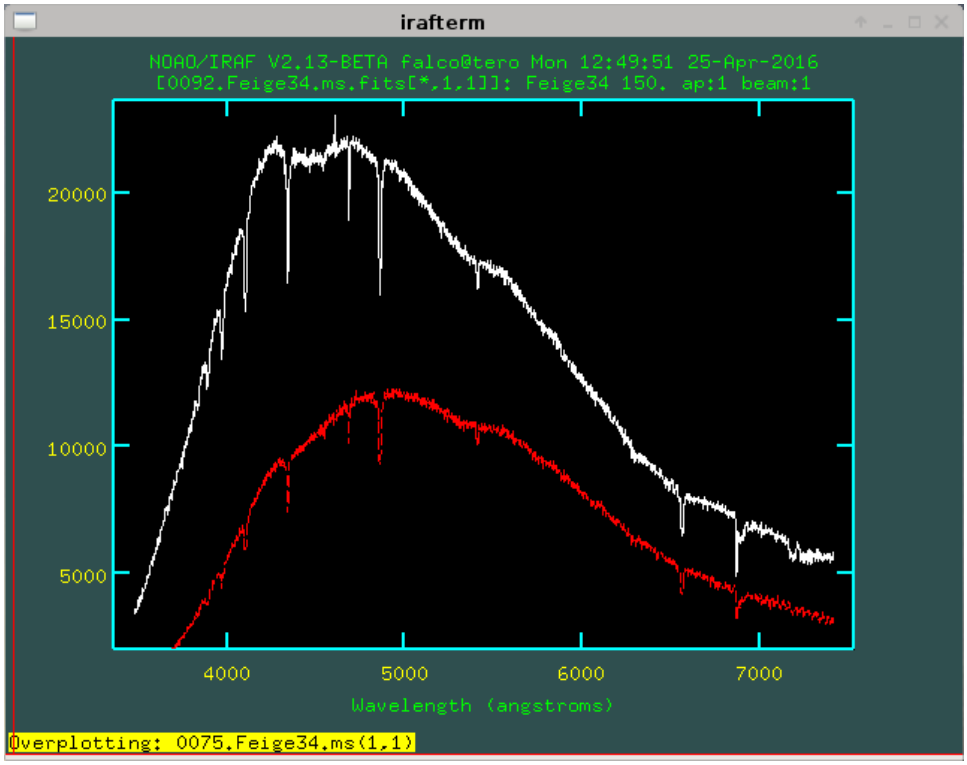

Fig. 3.— The white traces are normal spectra of Feige34, taken on 01/12/13 and 02/09/13. The red trace is a spectrum of Feige34 taken on 01/14/13, indicating a malfunction of the ADC.

- **2014:**

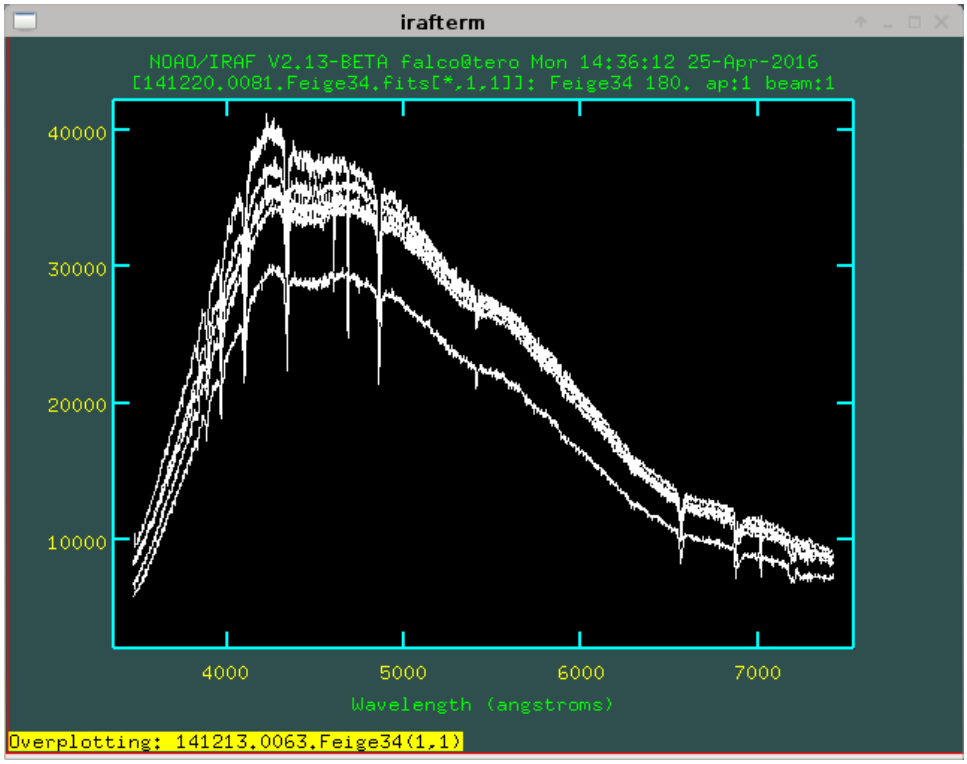

Fig. 4.— The ADC performed normally, all the traces showing a peak at about 4250Å. The counts vary by up to about 40%, due to clouds.

- **2015:**

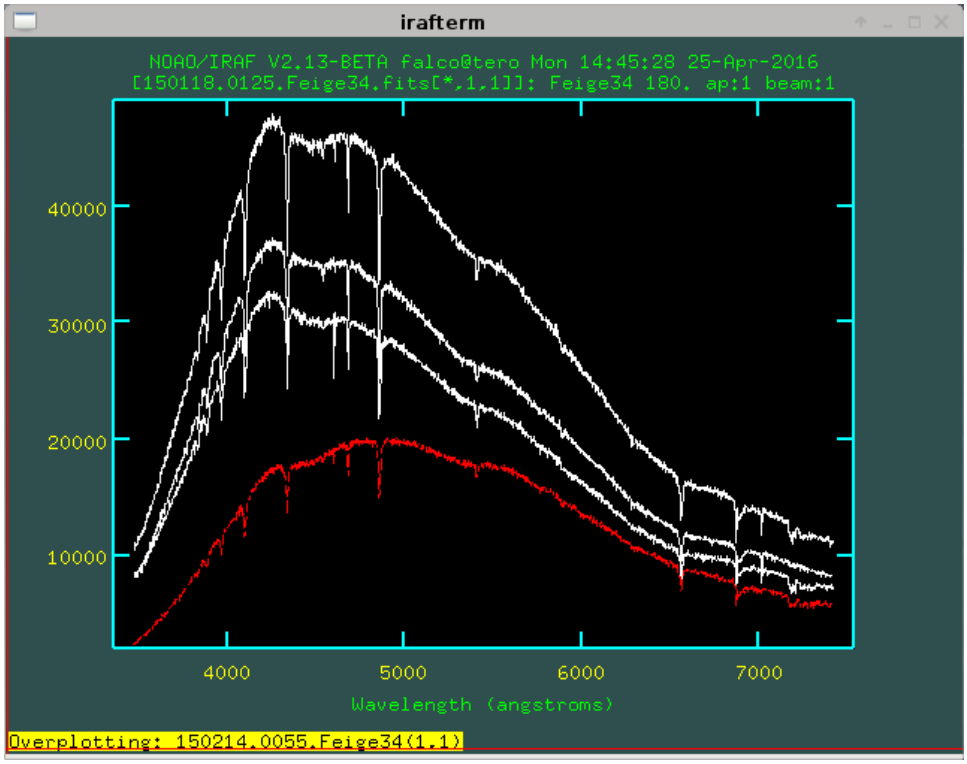

Fig. 5.— The counts vary by up to about 50%, again due to clouds. The red trace reveals a malfunction of the ADC, with a loss of both blue light and the peak at 4250Å. This malfunction had a clear explanation, see Table 1.

- **2016:**

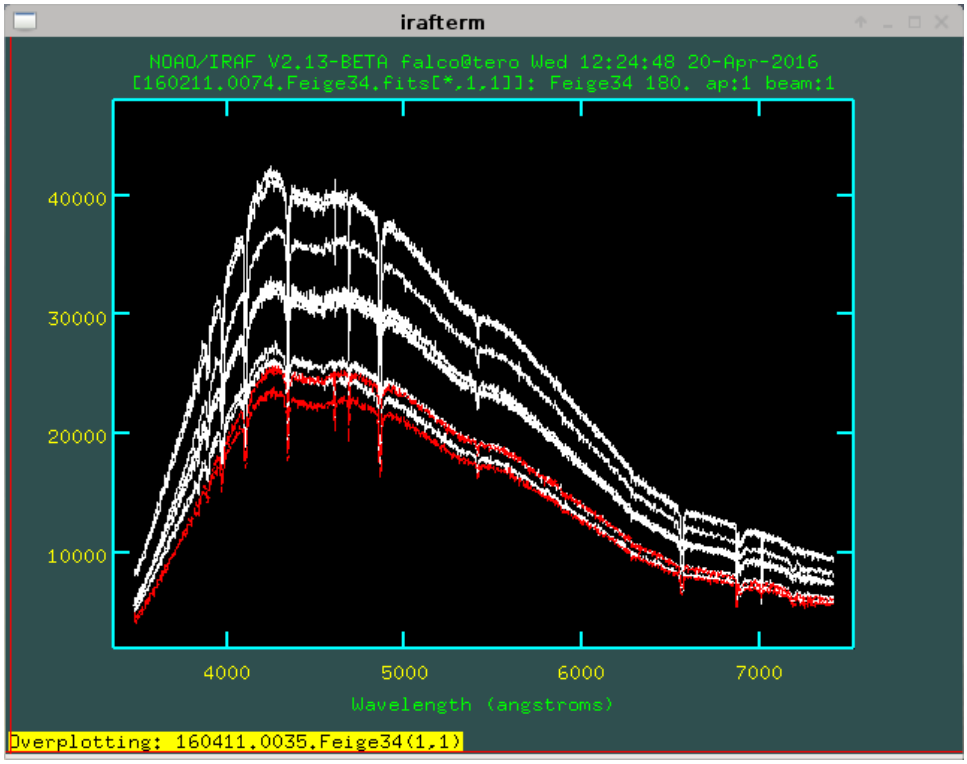

Fig. 6.— All the traces have a similar shape, with a peak at about 4250Å. The red traces are spectra from 04/11/16, when Perry tested the ADC. For the lower red trace, the ADC was off.

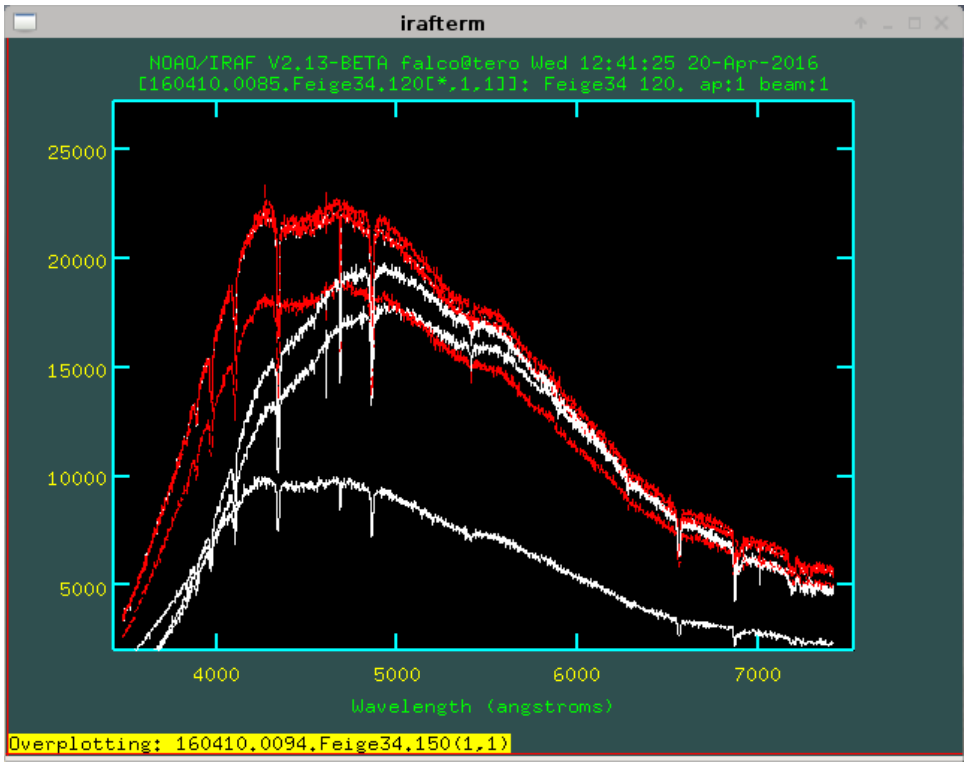

Fig. 7.— Mike Calkins obtained these spectra on 04/09/16. Clouds moved in and out during the night. The red traces are spectra taken with the ADC off, with the slit rotated to the parallactic angle. They all show the peak at 4250Å. The white traces are spectra taken with the ADC on. There was a clear loss of blue light, and the peak at 4250Å disappeared. The lowest trace is a 120s exposure, which looks attenuated but still shows a vestige of the 4250Å peak.

Table 1. Problem Spectra 2013-2016

FILE[a]	AIRMASS	Comments
2013.0114/0075.Feige34	1.21	MC, single malfunction
2013.0501/0062.Feige34	1.02	slipping set screws
2013.0503/0031.Feige34	1.02	slipping set screws
2013.0504/0033.Feige34	1.02	slipping set screws
2013.0506/0035.Feige34	1.03	slipping set screws
2013.0508/0062.Feige34	1.02	slipping set screws
2015.0214/0055.Feige34	1.05	Jonathan, cable problem
2016.0404/0047.Feige34	1.53	onset of malfunction
2016.0405/0039.Feige34	1.40	continuing malfunction
2016.0409/0090.Feige34	1.58	MC tests, with malfunction
2016.0409/0094.Feige34	1.70	MC tests, with malfunction
2016.0409/0096.Feige34	1.76	MC tests, with malfunction

[a]Files are labeled with the date of observation, CCD file number, and target name.

Conclusions

- A possible explanation for intermittent malfunctions is a loss of power to the ADC, resulting in homing it when power is restored, and not allowing it to rotate to the proper angle during observations. We cannot anticipate such events, but we will monitor all the electrical connections of the ADC.
- Slippage of the set screws is likely not to occur anymore.
- We will add new keywords to the headers of fits files, showing whether the ADC was on, and the position angles of the prisms. We will also add these to the TDC window on flwo60.
- We will monitor closely the spectra of all blue standards.