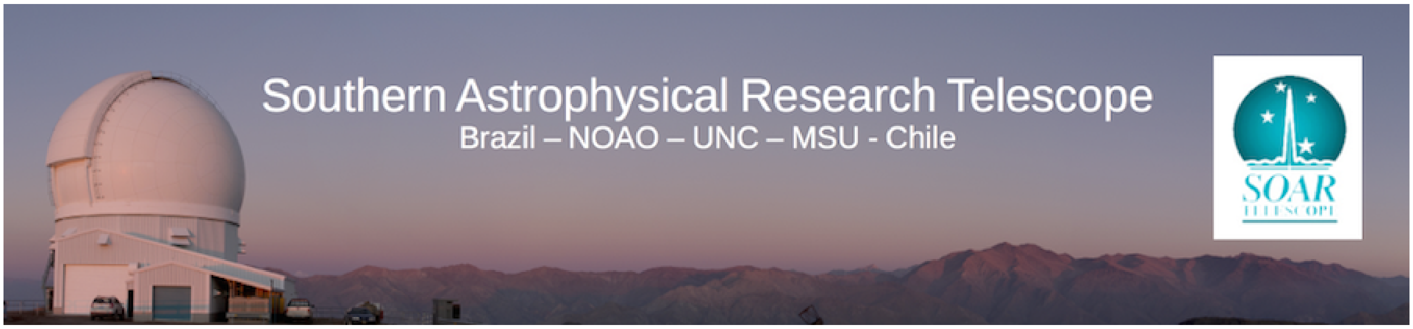


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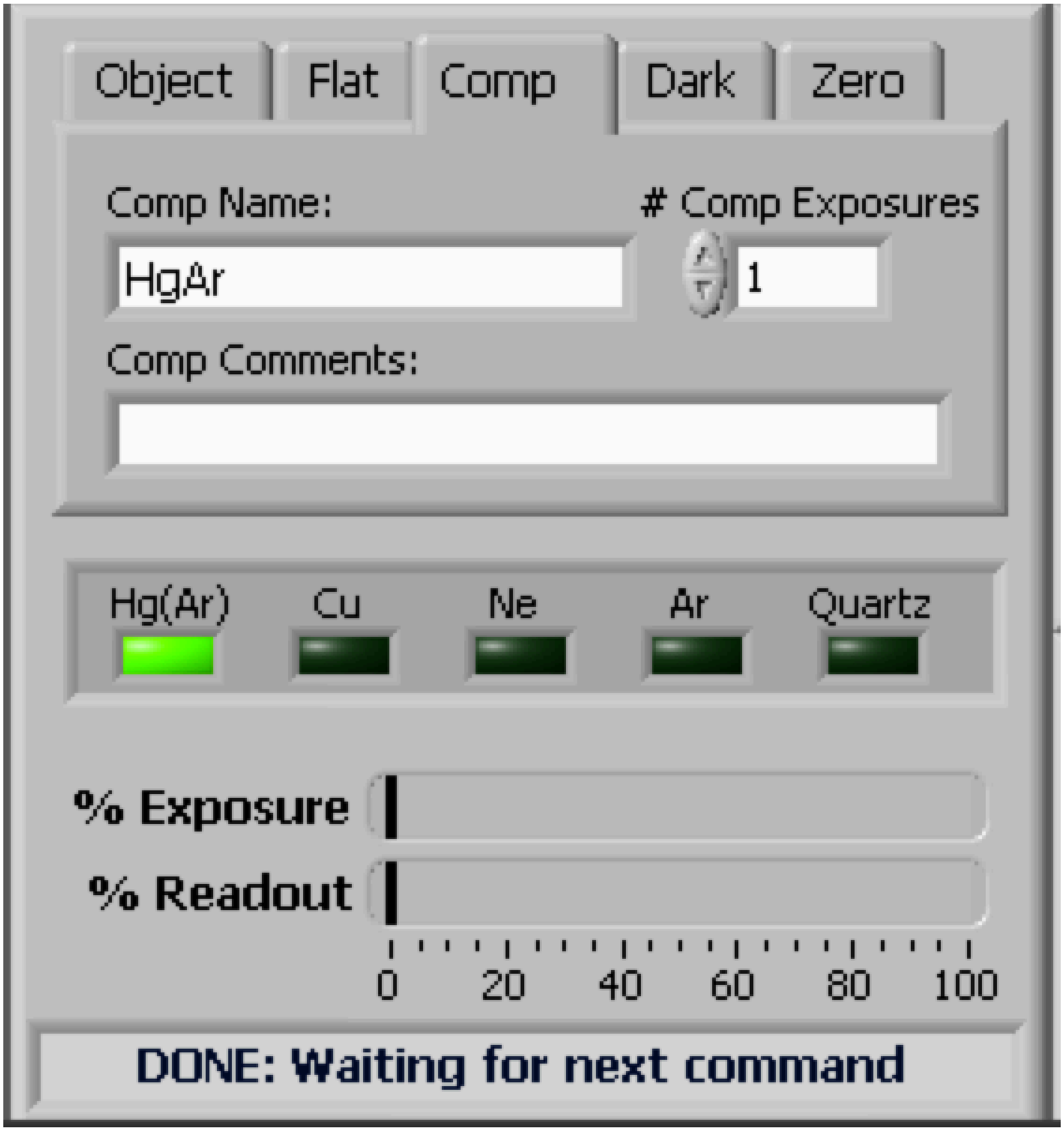
# Calibration Information

- **(NEW)** Goodman Spectrograph Reference Lamp Library [1]
- Goodman Spectrograph Comparison Lamp Spectra [2]
- Typical quartz and comparison lamp exposure times [3]
- Typical spectrograph focus values [4]
- Hamuy Spectrophotometric Standards [5]
- Radial Velocity Standards [6]

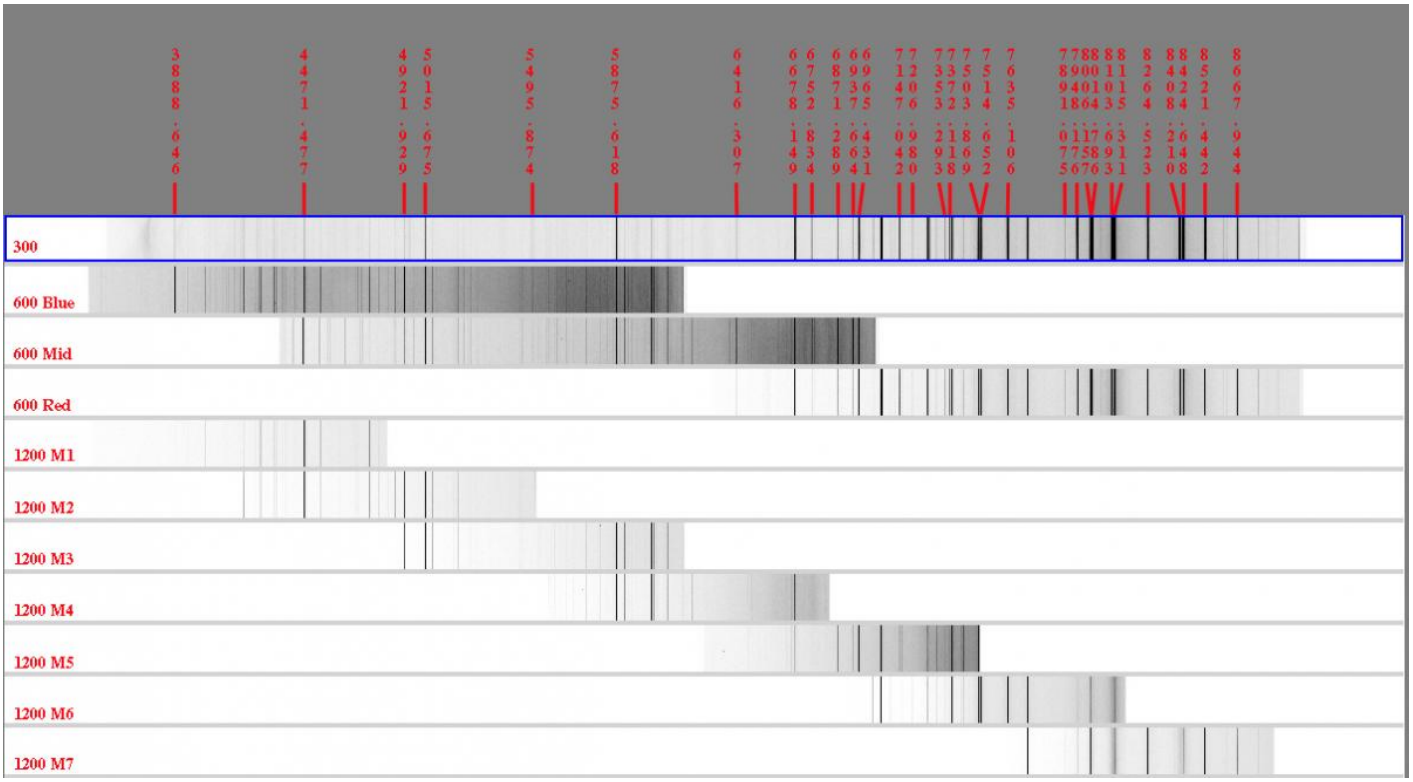
# Goodman Comparison Lamps (updated)

The SOAR Instrument Support Boxes (ISBs) contain facility calibration units containing both continuum sources for flat fielding and line sources for wavelength calibration.

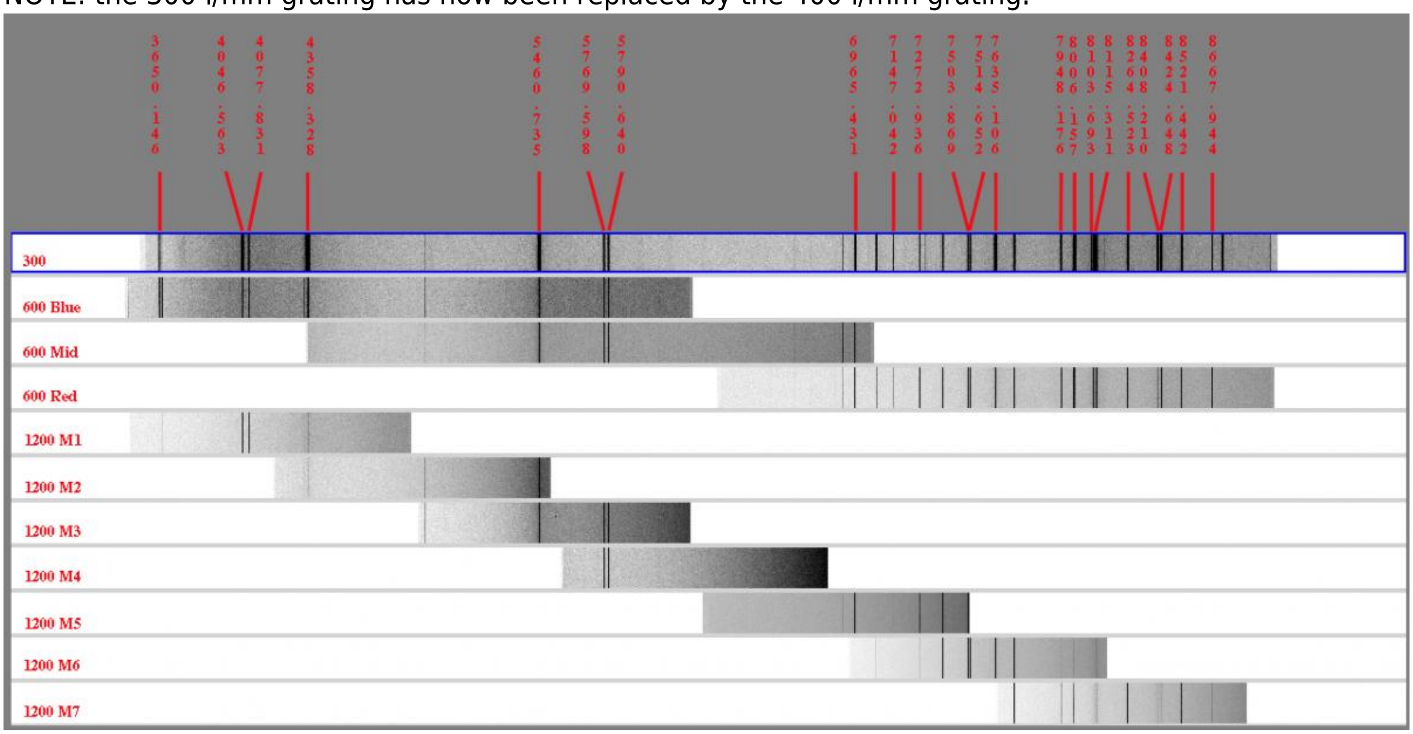



The wavelength calibration lamps normally used with the Goodman spectrograph are: HgAr, CuHeAr, Ne, and Ar.  An Fe lamp is also available.
The comparison lamps can be activated from the instrument GUI by you, or you can ask the Telescope Operator (TO) to do it for you from his technical GUI.
Note that you need to make a slow, substantial mouse click on the particular lamp in order for it to actually get the input and turn on or off (a quick click may make the green light go on or off but not turn on/off the lamp). If in doubt, check with the TO. The Fe lamp is not featured in the GUI and you need to ask the TO to rutn it ON/OFF for you. When obtaining comparison lamps, make sure you are in Spectroscopic Mode and that the TO has put the pickup mirror in.

In Figure 1 at below we show the **CuHeAr** arc lamp spectra for all of our pre-defined spectroscopic modes. NOTE: the 300 l/mm grating has now been replaced by the 400 l/mm grating.




In Figure 2 below we show the **HgAr** arc lamp spectra for all of our pre-defined spectroscopic modes. NOTE: the 300 l/mm grating has now been replaced by the 400 l/mm grating.




In the following table containing plots of the comparison lamps made with various gratings and setups. This library of comparison lamp spectra will be expanded and updated to make it include most, if not all of the setups available with the instrument.

| Grating | Setup | Lamp | Wavelength Coverage of the Plot |
|---|---|---|---|
| 400 | M1 | HgAr | 3000-7000 (Full range) [7] |
| 400 | M1 | HgAr | 3000-5000 (Zoom) [8] |
| 400 | M1 | HgAr | 5000-7000 (Zoom) [9] |
| 400 | M2 | HgAr | 5000-9000 (Full range) [10] |
| 400 | M2 | HgAr | 5000-9000 (Zoomed/split) [11] |
| 600 | UV,Blue,Mid,Red | HgAr | 3600-9000 (6 plots) [12] |
| 600 | UV,Blue,Mid | CuHeAr | 3600-6500 [13] |
| 930 | M1 | HgAr | 3000-4500 (Full range & zoom) [14] |
| 930 | M2 | HgAr | 3750-5500 (Full range & zoom) [15] |
| 930 | M3 | HgAr | 4750-6250 (Full range & zoom) [16] |
| 930 | M4 | HgAr | 5500-7200 (Full range & zoom) [17] |
| 930 | M5 | HgAr | 6400-8000 (Full range & zoom) [18] |
| 930 | M6 | HgAr | 7250-8750 (Full range & zoom) [19] |
| 930 | M2 | CuHeAr | 3750-5500 (Full range & zoom) [20] |
| 930 | M3 | CuHeAr | 4750-6250 (Full range & zoom) [21] |
| 930 | M4 | CuHeAr | 5500-7200 [22] |
| 930 | M5 | CuHeAr | 6400-8000 [23] |
| 930 | M6 | CuHeAr | 7250-8750 [24] |
| 1200 | M5 | HgArNe | 3600-8700 (7 plots) [25] |
| 1200 | M1,M2,M3,M4,M5,M6,M7 | CuHeAr | 3600-8700 (7 plots) [26] |
| 2100 | 650nm (Littrow) | Ne | 6150-6720 [27] |

**Useful links:**

The KPNO Spectral Atlas Central [28] is a useful resource for comparison lamp spectra

# Goodman Comps and Quartz Exposure Times


Typical Comparison Exposure Times:

| Grating | Mode | Slit | Lamp (%) / Exp (s) |
| --- | --- | --- | --- |
| 400 | M1 | | |
| 400 (+GG455) | M2 | | |
| 600 | UV | | |
| 600 | Blue | | |
| 600 (+GG-385) | Mid | | |
| 600 (+GG-495) | Red | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

# Goodman spectrograph typical focus values


See how to perform a spectroscopic focus measurement [29].

See how to perform an imaging focus measurement [30].

The folowing values are approximate and can change up to 500 units from run to run.
We recomend that you perform a focus sequence at the start of your run or even every afternoon.

## Red Camera spectroscopic focus values:

| Grating | Mode | Camera Temp (C) | Focus |
|---|---|---|---|
| 400 | M1 | 16 | -600 |
| 400 (+GG455) | M2 | 16 | -1200 |
| 600 | UV | 18 | -400 |
| 600 | Blue | 18 | -300 |
| 600 (+GG385) | Mid | 18 | -1100 |
| 600 (+GG495) | Red | 18 | -400 |
| 1200 | M2 | 17 | -700 |
| | | | |
| | | | |

## Blue Camera spectroscopic focus values:

| Grating | Mode | Camera Temp (C) | Focus |
|---|---|---|---|
| 400 | M1 | | |
| 400 (+GG455) | M2 | | |
| 600 | UV | 17 | 1650 |

| Grating | Mode | Camera Temp (C) | Focus |
|---|---|---|---|
| 600 | Blue | 17 | 1650 |
| 600 (+GG385) | Mid | 17 | 820 |
| 600 (+GG495) | Red | 17 | 1650 |
| | | | |
| | | | |
| | | | |

# Hamuy Spectrophotometric Standards

M. Hamuy led a group at CTIO to obtain observations of 10 secondary spectrophotometric standards from Taylor (1984) [31] and 19 tertiary spectrophotometric standards from Stone & Baldwin (1983) [32] and Stone (1977) [33]. These results were published in two papers:(1) Hamuy et al. (1992) [34] and (2) Hamuy et al. (1994) [35]. The former paper covers wavelengths from 3300Å to 7550Å and the latter paper covers wavelengths from 6000Å to 10500Å. The latter paper also combines both sets of observations and presents AB magnitudes for the 10 secondary standards at 16Å intervals from 3300Å to ~10400Å and for the 19 tertiary standards at 50Å intervals from 3300Å to ~10300Å. The AB magnitudes are converted to flux (erg $cm^{-2}$ $s^{-1}$Å$^{-1}$) using the formula:

AB Mag = -2.5 alog10(Fν) - 48.59 where Fν is in erg $cm^{-2}$ $s^{-1}$ $Hz^{-1}$.

| Secondary Spectrophotometric Standard Stars | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| HR# | Star | RA (J2000.0) | Dec (J2000.0) | MKType | (U-B) | (B-V) | V | $(V-R)_{KC}$ | $(V-I)_{KC}$ |
| 718 | $\xi^2$ Cet | 02:28:09.54 | +08:27:36.2 | B9 III | -0.107 | -0.056 | 4.279 | -0.023 | -0.063 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 1544 | $\pi^2$ Ori | 04:50:36.69 | +08:54:00.7 | A1 V | ... | 0.01 | 4.355 | 0.014 | 0.039 |
| 3454 | η Hya | 08:43:13.46 | +03:23:55.1 | B3 V | -0.743 | -0.200 | 4.295 | -0.083 | -0.200 |
| 4468 | θ Crt | 11:36:40.91 | -09:48:08.2 | B9.5 V | -0.18 | -0.07 | 4.700 | -0.023 | -0.063 |
| 4963 | θ Vir | 13:09:56.96 | -05:32:20.5 | A1 IV | -0.01 | -0.00 | 4.375 | 0.003 | 0.010 |
| 5501 | 108 Vir | 14:45:30.25 | +00:43:02.7 | B9.5 V | -0.080 | -0.023 | 5.681 | 0.004 | -0.026 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 7001 | α Lyr | 18:36:56.33 | +38:47:01.1 | A0 V | 0.00 | 0.00 | 0.03 | -0.037 | -0.045 |
| 7596 | 58 Aql | 19:54:44.80 | +00:16:24.6 | A0 II1 | -0.01 | 0.10 | 5.62 | ... | ... |
| 7950 | ε Aqr | 20:47:40.55 | -09:29:44.7 | A1 V | 0.029 | -0.001 | 3.778 | -0.005 | -0.010 |
| 8634 | ζ Peg | 22:41:27.64 | +10:49:53.2 | B8 V | -0.24 | -0.09 | 3.40 | -0.037 | -0.079 |
| 9087 | 29 Psc | 00:01:49.42 | -03:01:39.0 | B7 III-IV | -0.501 | -0.136 | 5.120 | -0.052 | -0.122 |

| Tertiary Spectrophotometric Standard Stars |
|---|

| Star | RA (J2000) | Dec (J2000) | Type | (U-B) | (B-V) | V | $(V-R)_{KC}$ | $(R-I)_{KC}$ | PM (RA) (" $yr^{-1}$) | PM (Dec) (" $yr^{-1}$) | Plots |
|---|---|---|---|---|---|---|---|---|---|---|---|
| [1]CD-34 241 | 00:41:46.9 | -33:39:09 | f | -0.065 | +0.478 | 11.229 | +0.295 | +0.289 | -0.45 | -0.25 | finder [36]/spectrum [37] |
| LTT 1020 | 01:54:49.7 | -27:28:29 | g | -0.186 | +0.557 | 11.522 | +0.361 | +0.364 | 0.33 | -0.21 | finder [38]/spectrum [39] |
| EG 21 | 03:10:30.4 | -68:36:05 | DA | -0.661 | +0.039 | 11.379 | -0.093 | -0.064 | 0.00 | -0.30 | finder [40]/spectrum [41] |
| LTT 1788 | 03:48:22.2 | -39:08:35 | f | -0.281 | +0.469 | 13.155 | +0.317 | +0.332 | 0.24 | -0.19 | finder [42]/spectrum [43] |
| LTT 2415 | 05:56:24.2 | -27:51:26 | ... | -0.215 | +0.400 | 12.214 | +0.267 | +0.293 | 0.30 | -0.18 | finder [44]/spectrum [45] |
| Hiltner 600 | 06:45:13.5 | +02:08:15 | B1 | -0.574 | +0.179 | 10.441 | +0.120 | +0.140 | ... | ... | finder [46]/spectrum [47] |
| LTT 3218 | 08:41:32.4 | -32:56:33 | DA | -0.574 | +0.220 | 11.858 | +0.096 | +0.111 | -1.10 | 1.34 | finder [48]/spectrum [49] |
| LTT 3864 | 10:32:13.8 | -35:37:42 | f | -0.167 | +0.495 | 12.171 | +0.323 | +0.329 | -0.34 | -0.01 | finder [50]/spectrum [51] |
| LTT 4364 | 11:45:42.9 | -64:50:29 | C2 | -0.664 | +0.162 | 11.504 | +0.173 | +0.127 | 6.19 | -0.33 | finder [52]/spectrum [53] |
| [2]Feige 56 | 12:06:47.3 | +11:40:13 | sdB8 | ... | -0.13 | 11.06 | ... | ... | -0.007 | -0.007 | finder [54]/spectrum [55] |
| LTT 4816 | 12:38:50.7 | -49:47:58 | DA | -0.656 | +0.166 | 13.794 | +0.013 | +0.027 | -0.86 | -0.13 | finder [56]/spectrum [57] |
| CD-32 9927 | 14:11:46.3 | -33:03:15 | A4 | ... | +0.349 | 10.444 | +0.324 | +0.014 | -0.004 | 0.007 | finder [58]/spectrum [59] |
| LTT 6248 | 15:38:59.8 | -28:35:34 | a | -0.197 | +0.491 | 11.797 | +0.319 | +0.345 | -0.25 | -0.18 | finder [60]/spectrum [61] |
| EG 274 | 16:23:33.7 | -39:13:48 | DA | -0.969 | -0.144 | 11.029 | -0.093 | -0.096 | 0.10 | -0.01 | finder [62]/spectrum [63] |
| LTT 7379 | 18:36:26.2 | -44:18:37 | G0 | -0.020 | +0.605 | 10.225 | +0.366 | +0.366 | -0.22 | -0.16 | finder [64]/spectrum [65] |
| LTT 7987 | 20:10:57.1 | -30:13:03 | DA | -0.670 | +0.046 | 12.230 | -0.062 | -0.078 | -0.43 | -0.24 | finder [66]/spectrum [67] |

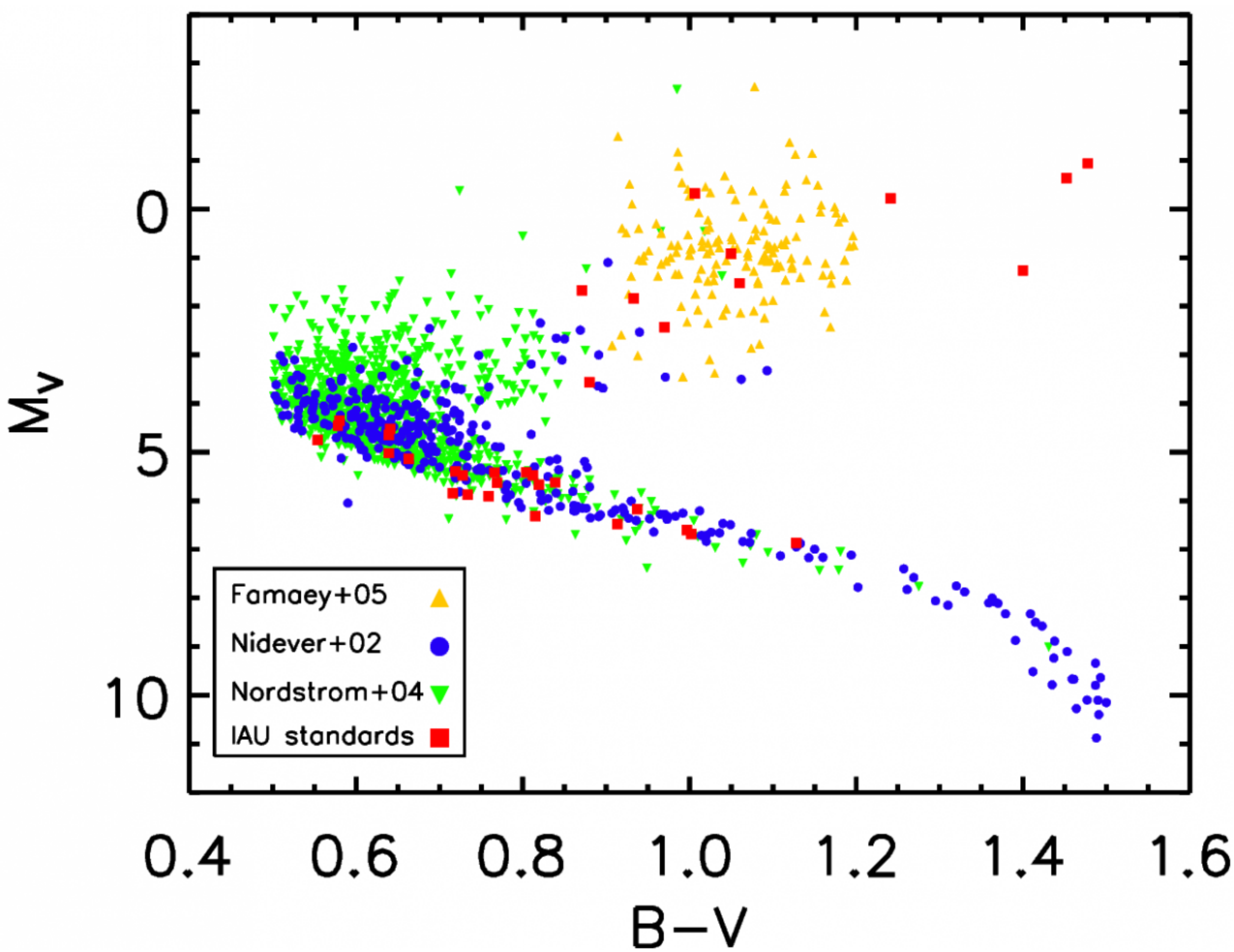
| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| LTT 9239 | 22:52:40.9 | -20:35:27 | f | -0.110 | +0.609 | 12.068 | +0.397 | +0.372 | 0.10 | -0.33 | finder [68]/spectrum [69] |
| Feige 110 | 23:19:58.3 | -05:09:56 | sdO8 | -1.09 | -0.05 | 11.50 | -0.47 | -0.175 | -0.011 | 0.0 | finder [70]/spectrum [71] |
| LTT 9491 | 23:19:35.2 | -17:05:28 | DC | -0.843 | +0.007 | 14.112 | +0.045 | +0.031 | 0.27 | 0.05 | finder [72]/spectrum [73] |
| Notes:<br>[1]CD-34 241 is mistakenly named LTT 377 in Stone and Baldwin (1983) and Hamuy et al. (1992 & 1994).<br>[2]The coordinates of Feige 56 are given incorrectly in Hamuy et al. (1992). | | | | | | | | | | | |

# Radial Velocity Standards

One of the latest and most complete lists of radial velocity standard stars is that by **Soubiran et al. 2013, A&A, 552A, 64** (**ADS link [74]**):

"The catalogue of radial velocity standard stars for Gaia. I. Pre-launch release."

This catalog contains 1420 stars with data over a baseline of over 6 yr,  with an overall stability of about 300 m/s




The data in their Table 4, can be accessed in the CDS service by click on **this link.** [75]

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**Source URL:** http://www.ctio.noao.edu/soar/content/calibration-information

**Links**
[1] https://goodman-lamps.readthedocs.io/en/latest/
[2] http://www.ctio.noao.edu/soar/content/goodman-comparison-lamps-updated
[3] http://www.ctio.noao.edu/soar/content/goodman-comps-and-quartz-exposure-times
[4] http://www.ctio.noao.edu/soar/content/goodman-spectrograph-typical-focus-values
[5] http://www.ctio.noao.edu/soar/content/hamuy-spectrophotometric-standards
[6] http://www.ctio.noao.edu/soar/content/radial-velocity-standards
[7] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/400m1_HgAr_3000-7000.pdf
[8] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/400m1_HgAr_3000-5000.pdf
[9] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/400m1_HgAr_5000-7000.pdf
[10] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/HgArNe_400M2_GG455_full.pdf
[11] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/HgArNe_400M2_GG455_split.pdf
[12] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/hgar_600.pdf
[13] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/CuHeAr_600_Blue_full.pdf
[14] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/HgAr_930m1.pdf
[15] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/HgAr_930m2.pdf
[16] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/HgAr_930m3.pdf

[17] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/HgAr_930m4.pdf
[18] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/HgAr_930m5.pdf
[19] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/HgAr_930m6.pdf
[20] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/CuHeAr_930m2.pdf
[21] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/CuHeAr_930m3.pdf
[22] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/CuHeAr_930m4.pdf
[23] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/CuHeAr_930m5.pdf
[24] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/CuHeAr_930m6.pdf
[25] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/HgArNe_1200M5_GG455_full.pdf
[26] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/cuhear_1200.pdf
[27] http://www.ctio.noao.edu/soar/sites/default/files/Instrument_Plots/GHTS_2100_650nm_Ne.2.pdf
[28] http://iraf.noao.edu/specatlas/
[29] http://www.ctio.noao.edu/soar/content/observing-goodman#S5c
[30] http://www.ctio.noao.edu/soar/content/imaging-focus
[31] http://adsabs.harvard.edu/abs/1984ApJS...54..259T
[32] http://adsabs.harvard.edu/abs/1983MNRAS.204..347S
[33] http://adsabs.harvard.edu/abs/1977ApJ...218..767S
[34] http://adsabs.harvard.edu/abs/1992PASP..104..533H
[35] http://adsabs.harvard.edu/abs/1994PASP..106..566H
[36] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/cd-34241_dss.pdf
[37] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/cd-34241_spec.pdf
[38] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt1020_dss.pdf
[39] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt1020_spec.pdf
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[52] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt4364_dss.pdf
[53] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt4364_spec.pdf
[54] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/feige56_dss.pdf
[55] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/feige56_spec.pdf
[56] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt4816_dss.pdf
[57] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt4816_spec.pdf
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[61] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt6248_spec.pdf
[62] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/eg274_dss.pdf
[63] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/eg274_spec.pdf
[64] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt7379_dss.pdf
[65] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt7379_spec.pdf
[66] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt7987_dss.pdf
[67] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt7987_spec.pdf
[68] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt9239_dss.pdf
[69] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt9239_spec.pdf
[70] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/feige110_dss.pdf
[71] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/feige110_spec.pdf

[72] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt9491_dss.pdf
[73] http://www.ctio.noao.edu/soar/sites/default/files/GOODMAN/Hamuy/ltt9491_spec.pdf
[74] https://ui.adsabs.harvard.edu/?#abs/2013A%26A...552A..64S
[75] http://vizier.u-strasbg.fr/viz-bin/VizieR-3?-source=J/A%2bA/552/A64/table4