1 History

Version	Date	Author(s)	Change description
1.0	August 25, 2011	C. Jean, P. Royer, B. Vandenbussche	First issue

2 Introduction

In the framework of the PACS spectrometer flux calibration, I present the method used to derive a new set of calibration tables and the new version of the task pipeline *specDiffCs* which uses them. Then, I describe the results from the comparison between observations of astronomical standards and their corresponding theoretical models. I calibrated spectra on one hand with the nominal response, with the calibration block using the new version of *specDiffCs* and finally with the normalization method and, on the other hand, by considering the central spaxel only, the 3×3 central spaxels or the whole field of 5×5 spaxels.

When I considered the central spaxel, I applied the version 2 of the point source correction whereas I applied the version 1 of the 3×3 spaxels correction to convert the measured integrated flux to the total flux.

The Obsids 1342204342, 1342204343, 1342204344, 1342204351 and 1342204352 were excluded because they are affected by a DecMec anomaly.

Contents

3 Methodology

3.1 Observations

The lists of observations considered here are presented in the appendix (see A and B, respectively pages 18 and 27).

The first one is the list of the astronomical calibrators observations which were used to determine a mean response at every key wavelength. These astronomical calibrators consist of planets (Uranus, Neptune), astroids (Ceres, Pallas, etc.) and stars (αTau, αBoo, etc.)

The second list contains the observations of the star HD161796 which are used to check the reproducibility of the observations over time.

The wavelength ranges which were considered in the processing are described in Tab. 1. These ranges were used both for the computation of the responses and for the construction of the flatfield frames from the telescope background.

Identification	Band	Key wavelength (μm)	Range width (μm)
B3A_60	B3A	60.0	0.5
B2A_60	B2A	60.0	0.75
B2B_75	B2B	75.0	0.75
R1_120	R1	120.0	1.5
R1_150	R1	150.0	1.5
R1_180	R1	180.0	1.5

Table 1: Definition of the wavelength ranges considered in the processing

3.2 Responses of the spectral pixels of the central module

All the astronomical standards observations (see Appendix A) were reduced the same way with the standard reduction pipeline up to the Relative Spectral Response Function (RSRF) correction, both in the blue and the red channels. As these pipelines steps are common to all observations, the reduced frames were saved in FITS format in order to avoid to run again all the pipeline processing.

For each observation, we determine a spectrum (in V/s) of the observed source for each nod, for every pixel of the central module and in every wavelength range (see Tab. 1) whenever it is possible. As we only consider the central spaxel, we apply the point source correction to the spectrum in order to get the signal we would have by integrating over all the spaxels.

Then, for every spectral pixel, we rebin the spectrum of each nod in a grid defined by the wavelength range and by the spectral resolution in the band with an oversampling value of 2 and an upsampling value of 1. The rebinned spectra of the two nods are then averaged together. We also rebin in the same grid the reference spectrum, *i.e.* the model.

The observed spectrum (in V/s) is then divided by the reference spectrum (in Jy) and we get a direct response in V/s/Jy for each spectral pixel of the central module.

3.3 Flatfield

To make a flatfield image from the telescope background, we read the frames before the *specDiffChop* step, we only select the OFF position frames from the science part of the data and we apply the RSRF correction. We then select the frames for which the wavelengths fit inside the range defined in Tab. 1 for a given band. For each nod, after setting to NaN the masked signal values, we compute a median image (16 × 25 pixels) of the frames. We then average these two median images and we normalize the result by the mean value of the central module.

3.4 Mean response and mean flatfield

For each key wavelength and for each spectral pixel of the central module, we average the individual responses computed before (see Sec.3.2) after a 3 sigma-clipping to exclude the obvious outliers. We also average the individual normalized flatfield images (see Sec. 3.3). We then get a mean observed response for each spectral pixel of the central module and a mean flatfield image normalized to the central module.

We then scale the mean flatfield with the mean observed response of the central module in order to get a response image at a given key wavelength. However, for the central module, the response values remain the average responses of each individual spectral pixel.

These response images are then stored in the new calibration product *ObservedResponse*.

3.5 Absolute fluxes of the calibration sources

The calibration blocks provide us with data only at the following "band – key wavelength" combinations: B3A_60, B2B_75, R1_150 and R1_180. For each of these key wavelengths, we compute a mean image (16 × 25 pixels) of the signal of the calibration sources CS1 and CS2 by averaging the individual images determined from the calibration block of each observation.

By dividing these mean signal images by the corresponding mean response (computed in Sec. 3.4), we get an image of the absolute flux value of the calibration sources.

These new flux values of the calibration sources are stored in the *calsourceflux_v2* dataset of the *CalSourceFlux* product.

3.6 New version of *specDiffCs*

We have modified the task *specDiffCs* by two aspects:

1. it skips the first 30 seconds of the calibration block in order to avoid transient effects in the signal;
2. it uses the mean observed response determined from the astronomical standards observations to flux calibrate observations. The response computed from the calibration block is still used to scale the mean observed response.

Depending on the band of the calibration block, *specDiffCs* will compute responses in different ways. There are two different configurations: either a calibration block in band B3A at a key wavelength of 60 μm for the blue channel and the corresponding one for the red channel at 180 μm in band R1, or a calibration block in band B2B at 75 μm and another one in band R1 at 150 μm.

After several tests, it turns out that the best results, *i.e.* with the smallest dispersion (see the scatter plots in section 4.2), are obtained by considering each module independently and by scaling the mean observed response by the average, over the 16 spectral pixels of the module, of the ratio between the "instantaneous" calibration block response and the mean observed response[1]. The calibration block response is equal to the signal difference between the two calibration sources divided by the corresponding absolute fluxes difference.

This new version of *specDiffCs* together with the new calibration product *ObservedResponse* and the updated version of the *CalSourceFlux* product are available in Hipe as of build 8.0-1864.

[1] I have not tested yet all the different possibilities which might change the results: replacing the mean by the median, introducing a sigma-clipping, etc.

3.6.1 Calibration blocks in bands B3A_60 and R1_180

With a calibration block in band B3A, *specDiffCs* returns two responses: one in band B3A and another one in band B2A because observations in band B2A also have a calibration block in band B3A.

The response in band B3A is, for every module m:

$$R_m(\mathsf{B3A\_60}) = R_m^{\mathsf{obs}}(\mathsf{B3A\_60}) \times \left\langle \frac{R_{i,m}^{\mathsf{cal.block}}(\mathsf{B3A\_60})}{R_{i,m}^{\mathsf{obs}}(\mathsf{B3A\_60})} \right\rangle_{i=1\dots16}$$

Similarly, the response in band B2A is, for every module m:

$$R_m(\mathsf{B2A\_60}) = R_m^{\mathsf{obs}}(\mathsf{B2A\_60}) \times \left\langle \frac{R_{i,m}^{\mathsf{cal.block}}(\mathsf{B3A\_60})}{R_{i,m}^{\mathsf{obs}}(\mathsf{B3A\_60})} \right\rangle_{i=1\dots16}$$

In the red channel, the corresponding calibration block is at 180 μm but *specDiffCs* must return a response at the primary key wavelength 150 μm as it is expected by the calibration task in the pipeline, *specRespCal*. Therefore, the response in band R1 is, for every module m:

$$R_m(\mathsf{R1\_150}) = R_m^{\mathsf{obs}}(\mathsf{R1\_150}) \times \left\langle \frac{R_{i,m}^{\mathsf{cal.block}}(\mathsf{R1\_180})}{R_{i,m}^{\mathsf{obs}}(\mathsf{R1\_180})} \right\rangle_{i=1\dots16}$$

3.6.2 Calibration blocks in bands B2B_75 and R1_150

With calibration blocks in bands B2B (75 μm) and R1 (150 μm) for the blue and the red channels respectively, *specDiffCs* returns the following responses, for every module m:

$$R_m(\mathsf{B2B\_75}) = R_m^{\mathsf{obs}}(\mathsf{B2B\_75}) \times \left\langle \frac{R_{i,m}^{\mathsf{cal.block}}(\mathsf{B2B\_75})}{R_{i,m}^{\mathsf{obs}}(\mathsf{B2B\_75})} \right\rangle_{i=1\dots16}$$

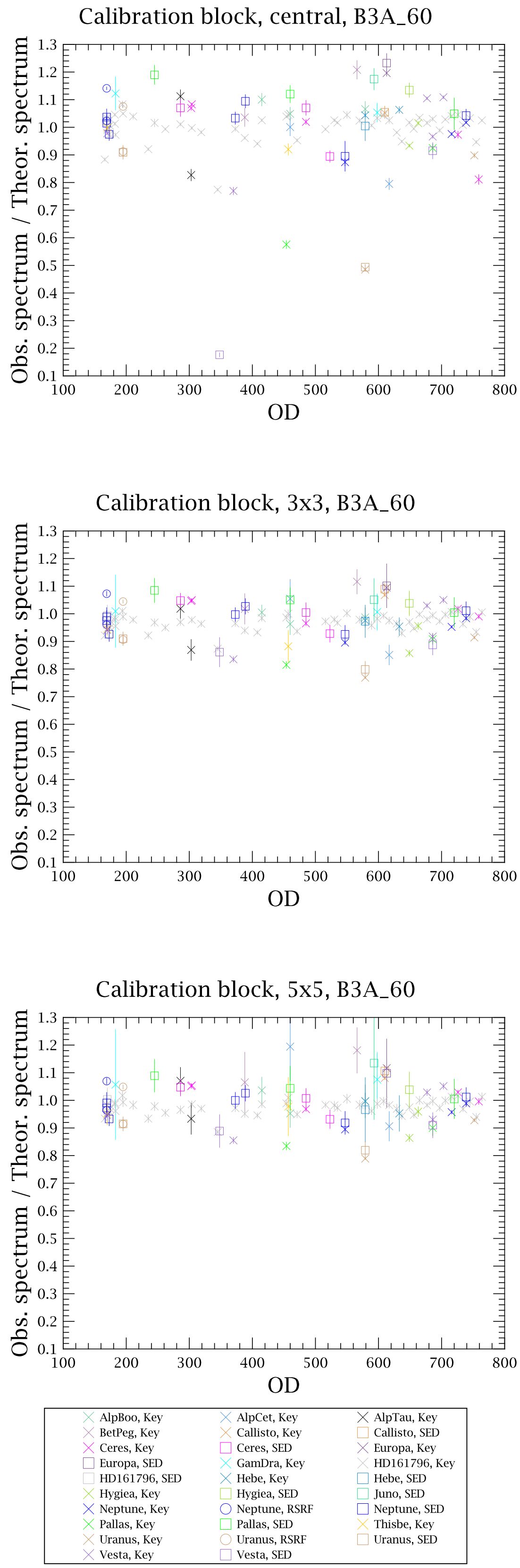
$$R_m(\mathsf{R1\_150}) = R_m^{\mathsf{obs}}(\mathsf{R1\_150}) \times \left\langle \frac{R_{i,m}^{\mathsf{cal.block}}(\mathsf{R1\_150})}{R_{i,m}^{\mathsf{obs}}(\mathsf{R1\_150})} \right\rangle_{i=1\dots16}$$

4 Results

4.1 Pointing problems and improvement with 3×3 spaxels

In this section, I show how integrating the flux in the central 3×3 or 5×5 spaxels reduces the dispersion of the ratios between the observed flux and the theoretical one. It is especially obvious for some outliers due to pointing problems such as Vesta observations on OD 348.

In order to better visualize the improvement, the following figures for one case (B3A_60 and calibration blocks used) have the same Y-axis range, which is large enough to include all the points.


Calibration block, central, B3A_60
Calibration block, 3x3, B3A_60
Calibration block, 5x5, B3A_60
Obs. spectrum / Theor. spectrum
OD
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
HD161796, Key
HD161796, SED
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, SED
Neptune, Key
Neptune, RSRF
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, RSRF
Uranus, SED
Vesta, Key
Vesta, SED

4.2 Scatter plots

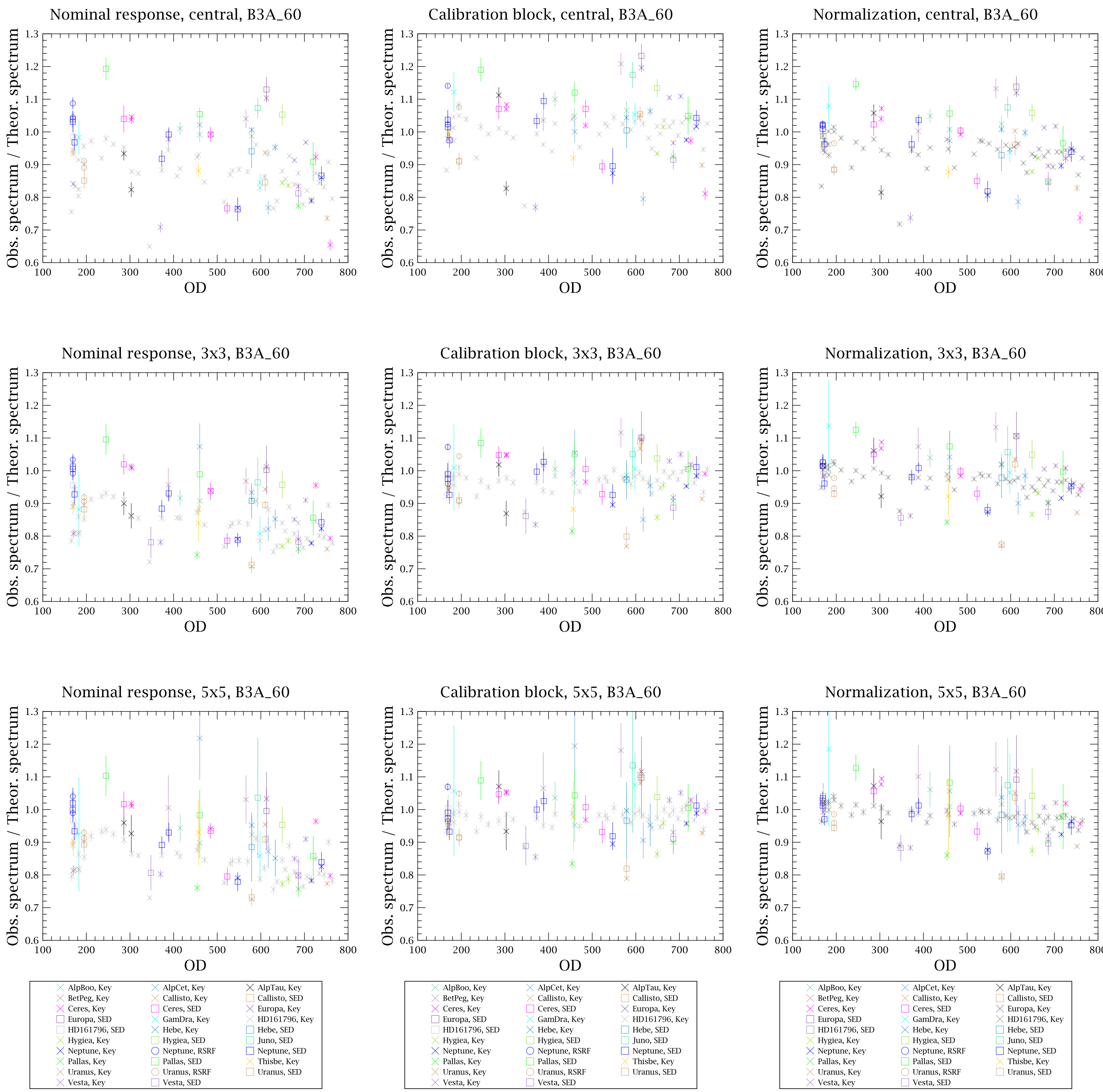
I present now the scatter plots for each configuration. For each of the six key wavelengths, there are nine plots: three for the nominal response (left column), three for the calibration block based flux calibration (middle column) and three for the normalization method. For each type of flux calibration, the top plot presents the ratios obtained when taking into account the central spaxel only, the middle plot the ratios obained from the 3×3 spaxels and the bottom plot from the 5×5 spaxels.

For a given key wavelength, all plots have the same Y-axis range which was reduced with respect to the previous section in order to exclude the obvious outliers due to pointing problems.

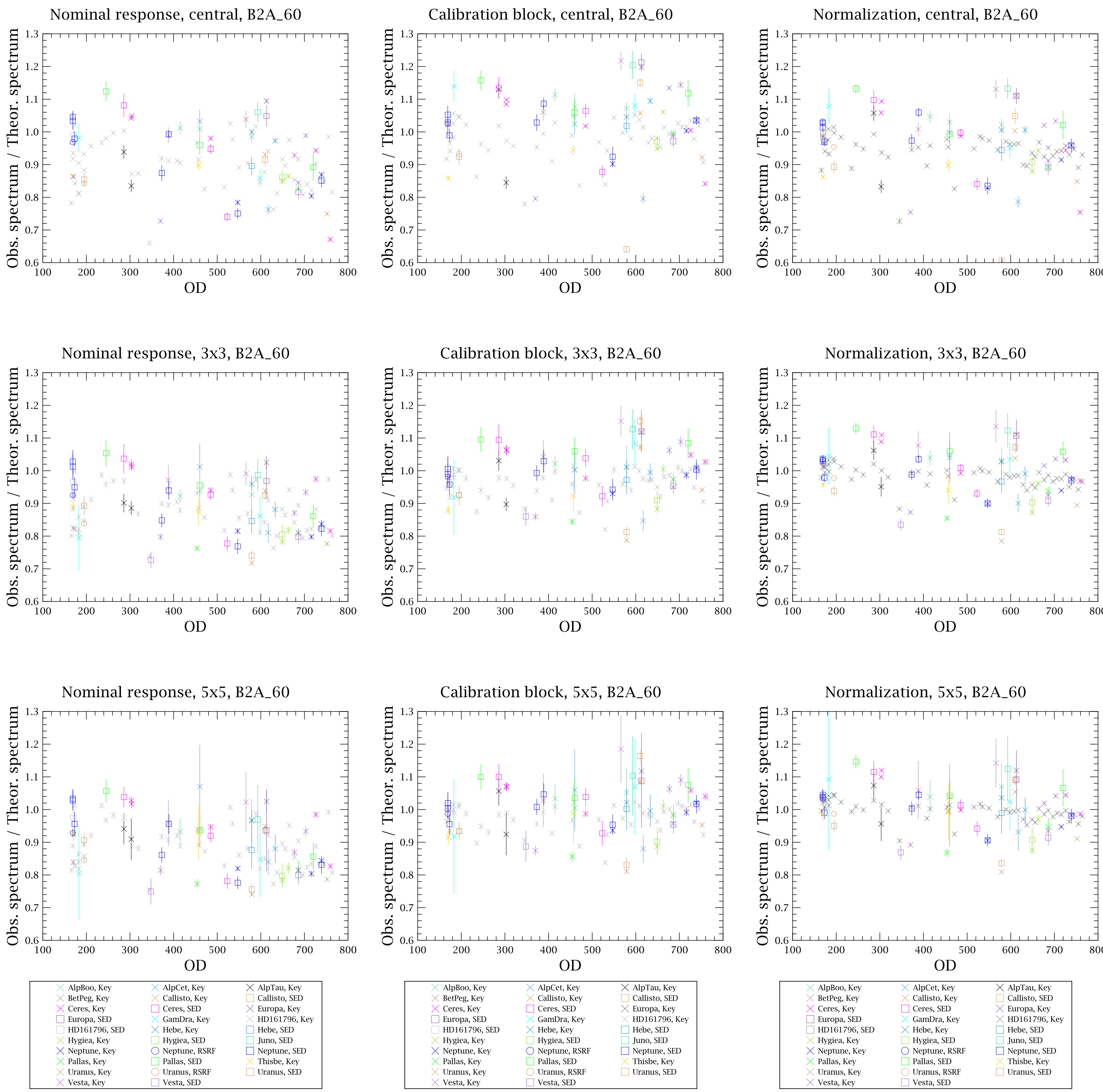
Visually, we can see that the best results are obtained with the central 3×3 spaxels.

When we look at the reproducibility source HD161796 on the plots with the nominal response, we can indeed see that the detectors response seems to slightly decrease with time since OD 200 as shown by Helmut Feuchtgruber during the 38$^{\text{th}}$ ICC Meeting.

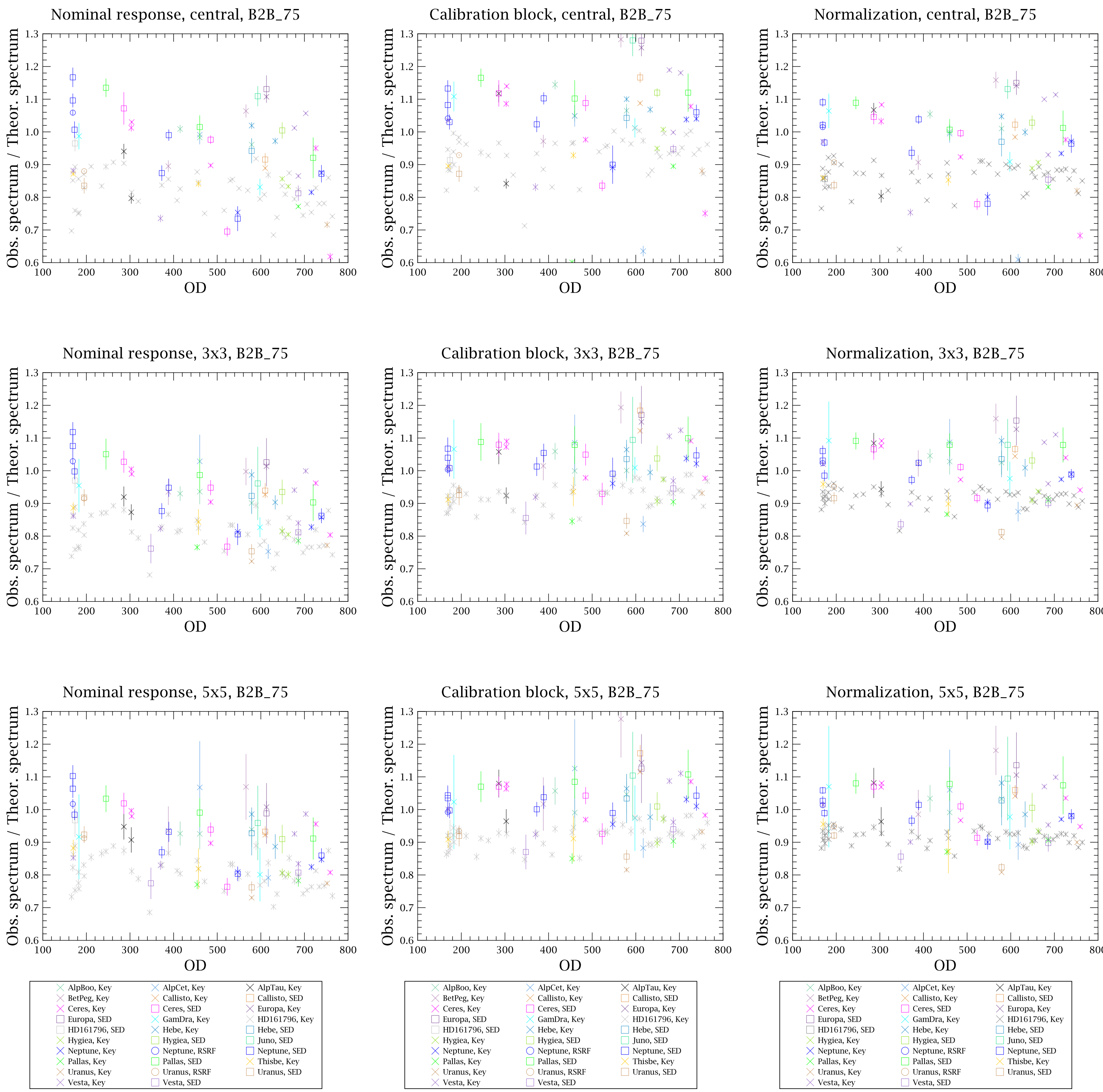
4.2.1 B3A_60


Nominal response, central, B3A_60
Calibration block, central, B3A_60
Normalization, central, B3A_60
Nominal response, 3x3, B3A_60
Calibration block, 3x3, B3A_60
Normalization, 3x3, B3A_60
Nominal response, 5x5, B3A_60
Calibration block, 5x5, B3A_60
Normalization, 5x5, B3A_60
Obs. spectrum / Theor. spectrum
OD
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
HD161796, Key
HD161796, SED
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, SED
Neptune, Key
Neptune, RSRF
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, RSRF
Uranus, SED
Vesta, Key
Vesta, SED

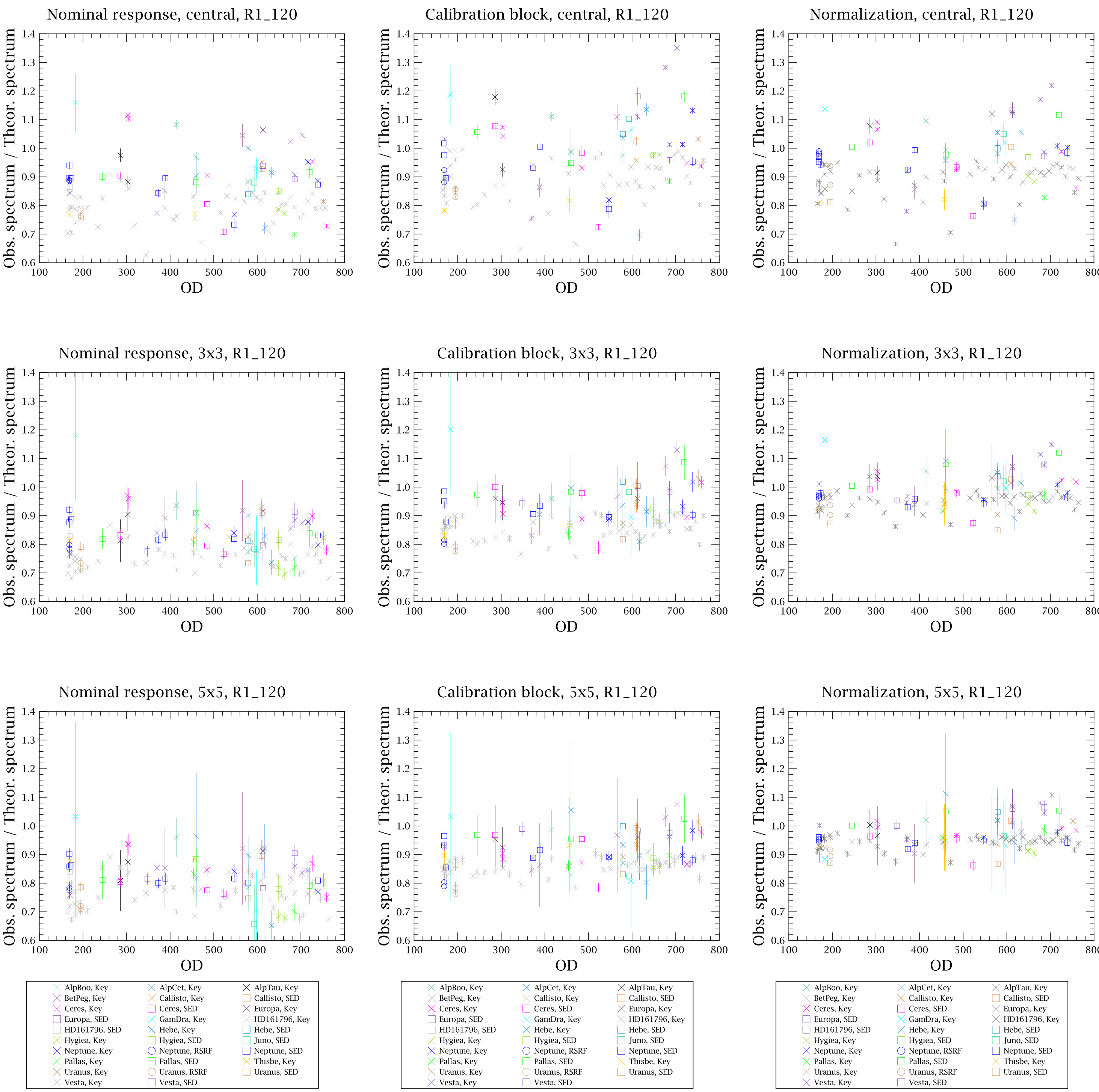
4.2.2 B2A_60


Nominal response, central, B2A_60
Calibration block, central, B2A_60
Normalization, central, B2A_60
Nominal response, 3x3, B2A_60
Calibration block, 3x3, B2A_60
Normalization, 3x3, B2A_60
Nominal response, 5x5, B2A_60
Calibration block, 5x5, B2A_60
Normalization, 5x5, B2A_60
Obs. spectrum / Theor. spectrum
OD
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
HD161796, Key
HD161796, SED
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, SED
Neptune, Key
Neptune, RSRF
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, RSRF
Uranus, SED
Vesta, Key
Vesta, SED

4.2.3 B2B_75

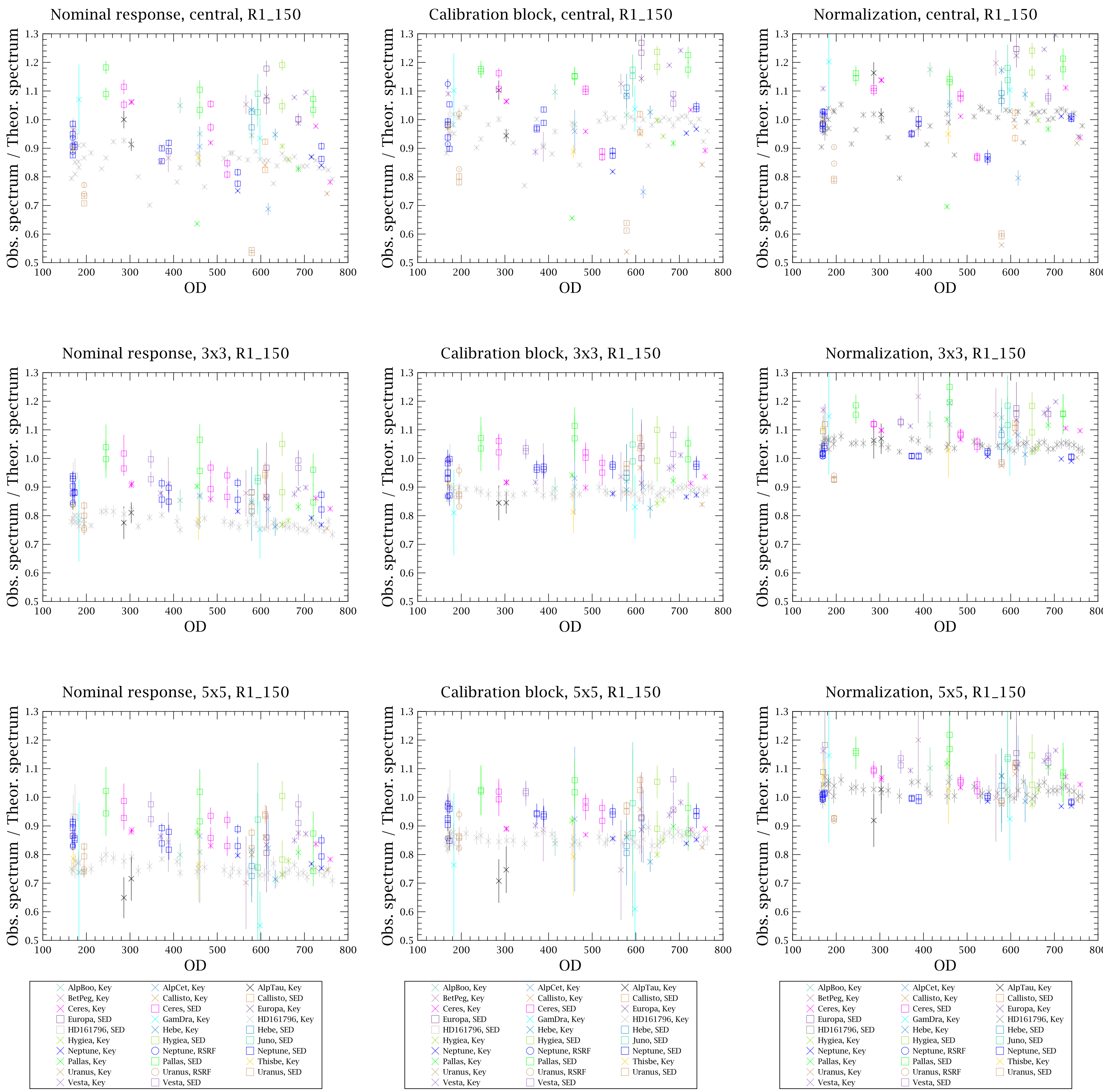

Nominal response, central, B2B_75
Calibration block, central, B2B_75
Normalization, central, B2B_75
Nominal response, 3x3, B2B_75
Calibration block, 3x3, B2B_75
Normalization, 3x3, B2B_75
Nominal response, 5x5, B2B_75
Calibration block, 5x5, B2B_75
Normalization, 5x5, B2B_75
Obs. spectrum / Theor. spectrum
OD
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
HD161796, Key
HD161796, SED
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, SED
Neptune, Key
Neptune, RSRF
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, RSRF
Uranus, SED
Vesta, Key
Vesta, SED

4.2.4 R1_120

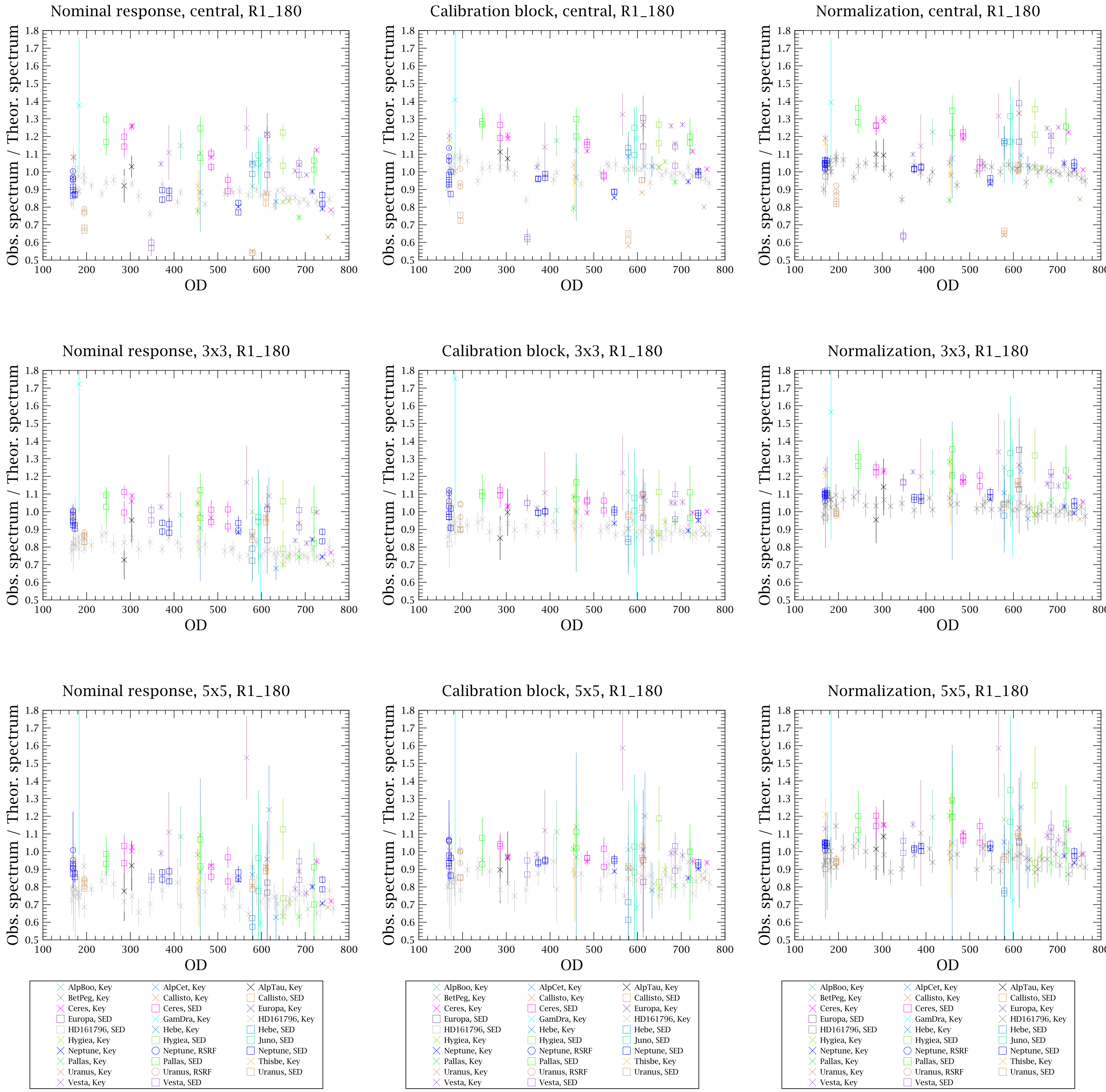


Nominal response, central, R1_120
Calibration block, central, R1_120
Normalization, central, R1_120
Nominal response, 3x3, R1_120
Calibration block, 3x3, R1_120
Normalization, 3x3, R1_120
Nominal response, 5x5, R1_120
Calibration block, 5x5, R1_120
Normalization, 5x5, R1_120
Obs. spectrum / Theor. spectrum
OD
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
HD161796, Key
HD161796, SED
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, SED
Neptune, Key
Neptune, RSRF
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, RSRF
Uranus, SED
Vesta, Key
Vesta, SED

4.2.5 R1_150


Nominal response, central, R1_150
Calibration block, central, R1_150
Normalization, central, R1_150
Nominal response, 3x3, R1_150
Calibration block, 3x3, R1_150
Normalization, 3x3, R1_150
Nominal response, 5x5, R1_150
Calibration block, 5x5, R1_150
Normalization, 5x5, R1_150
Obs. spectrum / Theor. spectrum
OD
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
HD161796, Key
HD161796, SED
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, SED
Neptune, Key
Neptune, RSRF
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, RSRF
Uranus, SED
Vesta, Key
Vesta, SED

4.2.6 R1_180



Nominal response, central, R1_180
Calibration block, central, R1_180
Normalization, central, R1_180
Nominal response, 3x3, R1_180
Calibration block, 3x3, R1_180
Normalization, 3x3, R1_180
Nominal response, 5x5, R1_180
Calibration block, 5x5, R1_180
Normalization, 5x5, R1_180
Obs. spectrum / Theor. spectrum
OD
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
HD161796, Key
HD161796, SED
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, SED
Neptune, Key
Neptune, RSRF
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, RSRF
Uranus, SED
Vesta, Key
Vesta, SED

4.3 Statistics

Finally, here are some statistics about the computed ratios, first after excluding the HD161796 observations and then with only the HD161796 reproducibility observations.

The mean ratio in the case of the flux calibration with the calibration block and with the central spaxel only is not perfectly equal to one when the key wavelength of the calibration block is equal to the key wavelength of the observation (B3A_60, B2B_75 and R1_150), because, when I computed the mean response of the 16 spectral pixels of the central module from the astronomical standards observations, I introduced a sigma-clipping which excluded some outliers and these outliers were included back when I processed again the observations with the new calibration method (new calibration files, new version of *specDiffCs*).

4.3.1 Without the reproducibility observations

B3A_60 (62 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.895	0.177	0.163	1.193	1.030
Calibration block	central	0.983	0.181	0.176	1.232	1.056
Normalization	central	0.928	0.171	0.166	1.146	0.980
Nominal response	3×3	0.888	0.094	0.707	1.095	0.388
Calibration block	3×3	0.974	0.080	0.769	1.116	0.347
Normalization	3×3	0.980	0.083	0.772	1.137	0.365
Nominal response	5×5	0.904	0.100	0.726	1.218	0.492
Calibration block	5×5	0.991	0.084	0.789	1.194	0.405
Normalization	5×5	0.992	0.081	0.795	1.185	0.390

B2A_60 (60 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.888	0.161	0.199	1.123	0.924
Calibration block	central	0.995	0.172	0.232	1.218	0.986
Normalization	central	0.939	0.161	0.217	1.132	0.915
Nominal response	3×3	0.886	0.088	0.718	1.054	0.336
Calibration block	3×3	0.991	0.084	0.787	1.151	0.364
Normalization	3×3	0.992	0.082	0.785	1.135	0.350
Nominal response	5×5	0.895	0.088	0.740	1.070	0.330
Calibration block	5×5	1.001	0.080	0.811	1.185	0.374
Normalization	5×5	1.002	0.079	0.809	1.147	0.337

B2B_75 (60 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.889	0.182	0.223	1.167	0.944
Calibration block	central	0.998	0.194	0.247	1.283	1.036
Normalization	central	0.926	0.178	0.227	1.159	0.931
Nominal response	3×3	0.904	0.092	0.723	1.118	0.395
Calibration block	3×3	1.012	0.088	0.808	1.193	0.385
Normalization	3×3	0.997	0.085	0.797	1.159	0.362
Nominal response	5×5	0.902	0.091	0.731	1.102	0.372
Calibration block	5×5	1.010	0.088	0.816	1.277	0.461
Normalization	5×5	0.993	0.081	0.808	1.181	0.373

R1_120 (62 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.862	0.149	0.288	1.159	0.871
Calibration block	central	0.957	0.176	0.348	1.351	1.003
Normalization	central	0.939	0.158	0.333	1.219	0.887
Nominal response	3×3	0.839	0.078	0.695	1.179	0.483
Calibration block	3×3	0.930	0.083	0.777	1.202	0.425
Normalization	3×3	0.995	0.067	0.849	1.164	0.316
Nominal response	5×5	0.824	0.079	0.652	1.033	0.381
Calibration block	5×5	0.913	0.073	0.761	1.075	0.314
Normalization	5×5	0.975	0.057	0.862	1.112	0.251

R1_150 (84 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.913	0.159	0.436	1.191	0.755
Calibration block	central	0.993	0.167	0.460	1.268	0.808
Normalization	central	1.013	0.171	0.450	1.296	0.846
Nominal response	3×3	0.877	0.072	0.750	1.065	0.315
Calibration block	3×3	0.951	0.072	0.811	1.114	0.303
Normalization	3×3	1.081	0.074	0.924	1.250	0.326
Nominal response	5×5	0.839	0.083	0.552	1.022	0.470
Calibration block	5×5	0.909	0.084	0.609	1.063	0.454
Normalization	5×5	1.056	0.079	0.918	1.344	0.425

R1_180 (86 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.951	0.183	0.540	1.376	0.836
Calibration block	central	1.043	0.175	0.580	1.408	0.828
Normalization	central	1.085	0.175	0.633	1.393	0.760
Nominal response	3×3	0.934	0.137	0.679	1.723	1.044
Calibration block	3×3	1.018	0.113	0.827	1.754	0.926
Normalization	3×3	1.139	0.111	0.954	1.563	0.609
Nominal response	5×5	0.889	0.182	0.574	1.940	1.366
Calibration block	5×5	0.968	0.162	0.614	1.967	1.353
Normalization	5×5	1.075	0.158	0.725	1.931	1.206

4.3.2 Only the reproducibility observations

B3A_60 (50 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.875	0.070	0.649	0.986	0.336
Calibration block	central	1.002	0.050	0.774	1.083	0.309
Normalization	central	0.938	0.048	0.718	1.014	0.296
Nominal response	3×3	0.846	0.055	0.721	0.955	0.234
Calibration block	3×3	0.970	0.027	0.874	1.010	0.137
Normalization	3×3	0.974	0.029	0.876	1.028	0.151
Nominal response	5×5	0.851	0.055	0.730	0.967	0.237
Calibration block	5×5	0.976	0.025	0.885	1.018	0.132
Normalization	5×5	0.984	0.029	0.891	1.042	0.151

B2A_60 (50 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.896	0.076	0.660	1.026	0.366
Calibration block	central	0.982	0.060	0.780	1.056	0.277
Normalization	central	0.944	0.047	0.727	1.014	0.287
Nominal response	3×3	0.878	0.063	0.738	0.998	0.260
Calibration block	3×3	0.963	0.043	0.820	1.027	0.207
Normalization	3×3	0.985	0.030	0.883	1.037	0.153
Nominal response	5×5	0.888	0.065	0.755	1.012	0.258
Calibration block	5×5	0.976	0.041	0.838	1.035	0.198
Normalization	5×5	0.997	0.028	0.904	1.045	0.141

B2B_75 (50 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.817	0.068	0.584	0.965	0.380
Calibration block	central	0.930	0.058	0.713	1.011	0.298
Normalization	central	0.861	0.050	0.641	0.927	0.286
Nominal response	3×3	0.812	0.055	0.681	0.970	0.289
Calibration block	3×3	0.924	0.036	0.842	0.989	0.146
Normalization	3×3	0.918	0.026	0.817	0.961	0.144
Nominal response	5×5	0.808	0.054	0.685	0.967	0.282
Calibration block	5×5	0.919	0.034	0.847	0.982	0.135
Normalization	5×5	0.915	0.025	0.818	0.955	0.137

R1_120 (50 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.792	0.056	0.627	0.909	0.281
Calibration block	central	0.890	0.076	0.646	0.994	0.348
Normalization	central	0.887	0.059	0.666	0.954	0.289
Nominal response	3×3	0.759	0.043	0.681	0.867	0.185
Calibration block	3×3	0.853	0.039	0.757	0.920	0.163
Normalization	3×3	0.947	0.028	0.862	0.987	0.125
Nominal response	5×5	0.764	0.053	0.672	0.892	0.220
Calibration block	5×5	0.859	0.027	0.785	0.910	0.125
Normalization	5×5	0.939	0.023	0.873	0.974	0.101

R1_150 (51 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.857	0.048	0.701	0.969	0.268
Calibration block	central	0.968	0.051	0.770	1.042	0.272
Normalization	central	0.992	0.050	0.796	1.053	0.257
Nominal response	3×3	0.785	0.040	0.734	0.940	0.206
Calibration block	3×3	0.886	0.021	0.856	0.986	0.130
Normalization	3×3	1.050	0.018	1.024	1.119	0.096
Nominal response	5×5	0.761	0.045	0.709	0.933	0.224
Calibration block	5×5	0.860	0.028	0.820	0.976	0.156
Normalization	5×5	1.030	0.031	0.984	1.183	0.199

R1_180 (51 observations)						
Mode	Modules	Mean	Standard deviation	Minimum	Maximum	Peak-to-peak amplitude
Nominal response	central	0.881	0.053	0.761	1.014	0.253
Calibration block	central	1.002	0.048	0.842	1.088	0.246
Normalization	central	1.007	0.044	0.843	1.084	0.241
Nominal response	3×3	0.797	0.043	0.720	0.940	0.219
Calibration block	3×3	0.905	0.032	0.817	0.988	0.171
Normalization	3×3	1.034	0.037	0.967	1.123	0.156
Nominal response	5×5	0.749	0.058	0.646	0.918	0.272
Calibration block	5×5	0.852	0.059	0.748	1.007	0.259
Normalization	5×5	0.966	0.056	0.871	1.145	0.274

4.3.3 Comparison with Helmut Feuchtgruber's results on HD161796

To compare with the results that Helmut Feuchtgruber presented during the 38th ICC meeting, I normalized the flux ratios (Observed / Theoretical) by their mean and then computed the standard deviations of the normalized values.

	3×3 with calibration block		5×5 with calibration block	
Band	Present results	Helmut's results	Present results	Helmut's results
B3A_60	0.028	0.029	0.026	0.029
B2A_60	0.045	0.047	0.042	0.045
B2B_75	0.039	0.040	0.037	0.039
R1_120	0.045	0.050	0.031	0.041
R1_150	0.024	0.024	0.032	0.041
R1_180	0.035	0.059	0.069	0.109

We obtain very similar standard deviations and the results presented are often slighlty better, possibly because a flatfield is included in the new calibration tables.

A List of astronomical calibrators observations

Tables 2 to 7 present the lists of observations that were used to compute the observed responses at every key wavelength.

There are three different observations types:

Key These are key wavelengths observations, *i.e.* short observations over a small wavelength range around a key wavelength;

RSRF These are large wavelength range observations with a high spectral resolution;

SED These are large wavelength range observations over a full band (in the blue).

A.1 B3A_60

Table 2: List of the calibration observations used for the computation of the response in band B3A at 60 μm.

Obsid	OD	Target	Observation type
1342186537	169	Neptune	RSRF
1342186538	169	Neptune	RSRF
1342186543	169	Neptune	SED
1342186544	169	Neptune	SED
1342186553	170	Vesta	Key
1342186565	170	Thisbe	Key
1342186648	173	Neptune	SED
1342186983	183	GamDra	Key
1342187215	195	Uranus	RSRF
1342187216	195	Uranus	RSRF
1342187220	195	Uranus	SED
1342189273	245	Pallas	SED
1342191140	286	Ceres	SED
1342191150	286	AlpTau	Key
1342192113	303	Ceres	Key
1342192118	303	AlpTau	Key
1342192158	304	Ceres	Key
1342195634	348	Vesta	SED
1342196699	370	Vesta	Key
1342196877	373	Neptune	SED
1342197831	388	BetPeg	Key
1342197895	389	Neptune	SED
1342199737	415	AlpBoo	Key
1342202586	454	Pallas	Key
1342203048	457	Thisbe	Key
1342203131	460	AlpCet	Key
1342203133	460	AlpBoo	Key
1342203137	460	Pallas	SED
1342204334	485	Ceres	SED
1342204335	485	Ceres	Key
1342204351	485	AlpTau	Key
1342206872	523	Ceres	SED
1342208869	547	Neptune	SED
1342208870	547	Neptune	Key
1342210653	566	BetPeg	Key

Table 2: (continued)

Obsid	OD	Target	Observation type
1342211163	579	Hebe	SED
1342211164	579	Hebe	Key
1342211168	579	Uranus	SED
1342211169	579	Uranus	Key
1342211177	579	AlpBoo	Key
1342211822	593	Juno	SED
1342212265	598	GamDra	Key
1342212605	610	Callisto	Key
1342212609	610	Callisto	SED
1342212785	613	Europa	SED
1342212786	613	Europa	Key
1342213144	617	AlpCet	Key
1342213748	633	Hebe	Key
1342214620	649	Hygiea	Key
1342214624	649	Hygiea	SED
1342215635	663	Hygiea	Key
1342216617	677	Vesta	Key
1342217789	686	Pallas	Key
1342217791	686	Vesta	Key
1342217795	686	Vesta	SED
1342218752	703	Vesta	Key
1342220320	726	Ceres	Key
1342220597	720	Pallas	SED
1342220926	716	Neptune	Key
1342221611	739	Neptune	Key
1342221621	739	Neptune	SED
1342222185	752	Uranus	Key
1342222574	759	Ceres	Key

A.2 B2A_60

Table 3: List of the calibration observations used for the computation of the response in band B2A at 60 μm.

Obsid	OD	Target	Observation type
1342186536	169	Neptune	RSRF
1342186543	169	Neptune	SED
1342186544	169	Neptune	SED
1342186551	170	Vesta	Key
1342186563	170	Thisbe	Key
1342186648	173	Neptune	SED
1342186983	183	GamDra	Key
1342187214	195	Uranus	RSRF
1342187220	195	Uranus	SED
1342189271	245	Pallas	SED
1342191138	286	Ceres	SED
1342191150	286	AlpTau	Key
1342192113	303	Ceres	Key
1342192118	303	AlpTau	Key
1342192158	304	Ceres	Key
1342195632	348	Vesta	SED

Table 3: (continued)

Obsid	OD	Target	Observation type
1342196699	370	Vesta	Key
1342196875	373	Neptune	SED
1342197831	388	BetPeg	Key
1342197893	389	Neptune	SED
1342199737	415	AlpBoo	Key
1342202586	454	Pallas	Key
1342203048	457	Thisbe	Key
1342203131	460	AlpCet	Key
1342203133	460	AlpBoo	Key
1342203135	460	Pallas	SED
1342204332	485	Ceres	SED
1342204335	485	Ceres	Key
1342204351	485	AlpTau	Key
1342206870	523	Ceres	SED
1342208867	547	Neptune	SED
1342208870	547	Neptune	Key
1342210653	566	BetPeg	Key
1342211161	579	Hebe	SED
1342211164	579	Hebe	Key
1342211166	579	Uranus	SED
1342211169	579	Uranus	Key
1342211177	579	AlpBoo	Key
1342211820	593	Juno	SED
1342212265	598	GamDra	Key
1342212605	610	Callisto	Key
1342212607	610	Callisto	SED
1342212783	613	Europa	SED
1342212786	613	Europa	Key
1342213144	617	AlpCet	Key
1342213748	633	Hebe	Key
1342214620	649	Hygiea	Key
1342214622	649	Hygiea	SED
1342215635	663	Hygiea	Key
1342216617	677	Vesta	Key
1342217789	686	Pallas	Key
1342217791	686	Vesta	Key
1342217793	686	Vesta	SED
1342218752	703	Vesta	Key
1342220320	726	Ceres	Key
1342220595	720	Pallas	SED
1342220926	716	Neptune	Key
1342221611	739	Neptune	Key
1342221619	739	Neptune	SED
1342222185	752	Uranus	Key
1342222574	759	Ceres	Key

A.3 B2B_75

Table 4: List of the calibration observations used for the computation of the response in band B2B at 75 μm.

Obsid	OD	Target	Observation type
1342186539	169	Neptune	RSRF
1342186541	169	Neptune	SED
1342186542	169	Neptune	SED
1342186552	170	Vesta	Key
1342186564	170	Thisbe	Key
1342186649	173	Neptune	SED
1342186984	183	GamDra	Key
1342187217	195	Uranus	RSRF
1342187219	195	Uranus	SED
1342189272	245	Pallas	SED
1342191139	286	Ceres	SED
1342191151	286	AlpTau	Key
1342192114	303	Ceres	Key
1342192119	303	AlpTau	Key
1342192159	304	Ceres	Key
1342195633	348	Vesta	SED
1342196700	370	Vesta	Key
1342196876	373	Neptune	SED
1342197832	388	BetPeg	Key
1342197894	389	Neptune	SED
1342199738	415	AlpBoo	Key
1342202587	454	Pallas	Key
1342203049	457	Thisbe	Key
1342203132	460	AlpCet	Key
1342203134	460	AlpBoo	Key
1342203136	460	Pallas	SED
1342204333	485	Ceres	SED
1342204336	485	Ceres	Key
1342204352	485	AlpTau	Key
1342206871	523	Ceres	SED
1342208868	547	Neptune	SED
1342208871	547	Neptune	Key
1342210654	566	BetPeg	Key
1342211162	579	Hebe	SED
1342211165	579	Hebe	Key
1342211167	579	Uranus	SED
1342211170	579	Uranus	Key
1342211178	579	AlpBoo	Key
1342211821	593	Juno	SED
1342212266	598	GamDra	Key
1342212606	610	Callisto	Key
1342212608	610	Callisto	SED
1342212784	613	Europa	SED
1342212787	613	Europa	Key
1342213145	617	AlpCet	Key
1342213749	633	Hebe	Key
1342214621	649	Hygiea	Key
1342214623	649	Hygiea	SED
1342215636	663	Hygiea	Key

Table 4: (continued)

Obsid	OD	Target	Observation type
1342216618	677	Vesta	Key
1342217790	686	Pallas	Key
1342217792	686	Vesta	Key
1342217794	686	Vesta	SED
1342218753	703	Vesta	Key
1342220321	726	Ceres	Key
1342220596	720	Pallas	SED
1342220927	716	Neptune	Key
1342221612	739	Neptune	Key
1342221620	739	Neptune	SED
1342222186	752	Uranus	Key
1342222575	759	Ceres	Key

A.4 R1_120

Table 5: List of the calibration observations used for the computation of the response in band R1 at 120 μm.

Obsid	OD	Target	Observation type
1342186536	169	Neptune	RSRF
1342186539	169	Neptune	RSRF
1342186543	169	Neptune	SED
1342186544	169	Neptune	SED
1342186551	170	Vesta	Key
1342186563	170	Thisbe	Key
1342186648	173	Neptune	SED
1342186983	183	GamDra	Key
1342187214	195	Uranus	RSRF
1342187217	195	Uranus	RSRF
1342187220	195	Uranus	SED
1342189271	245	Pallas	SED
1342191138	286	Ceres	SED
1342191150	286	AlpTau	Key
1342192113	303	Ceres	Key
1342192118	303	AlpTau	Key
1342192158	304	Ceres	Key
1342195632	348	Vesta	SED
1342196699	370	Vesta	Key
1342196875	373	Neptune	SED
1342197831	388	BetPeg	Key
1342197893	389	Neptune	SED
1342199737	415	AlpBoo	Key
1342202586	454	Pallas	Key
1342203048	457	Thisbe	Key
1342203131	460	AlpCet	Key
1342203133	460	AlpBoo	Key
1342203135	460	Pallas	SED
1342204332	485	Ceres	SED
1342204335	485	Ceres	Key
1342204351	485	AlpTau	Key
1342206870	523	Ceres	SED

Table 5: (continued)

Obsid	OD	Target	Observation type
1342208867	547	Neptune	SED
1342208870	547	Neptune	Key
1342210653	566	BetPeg	Key
1342211161	579	Hebe	SED
1342211164	579	Hebe	Key
1342211166	579	Uranus	SED
1342211169	579	Uranus	Key
1342211177	579	AlpBoo	Key
1342211820	593	Juno	SED
1342212265	598	GamDra	Key
1342212605	610	Callisto	Key
1342212607	610	Callisto	SED
1342212783	613	Europa	SED
1342212786	613	Europa	Key
1342213144	617	AlpCet	Key
1342213748	633	Hebe	Key
1342214620	649	Hygiea	Key
1342214622	649	Hygiea	SED
1342215635	663	Hygiea	Key
1342216617	677	Vesta	Key
1342217789	686	Pallas	Key
1342217791	686	Vesta	Key
1342217793	686	Vesta	SED
1342218752	703	Vesta	Key
1342220320	726	Ceres	Key
1342220595	720	Pallas	SED
1342220926	716	Neptune	Key
1342221611	739	Neptune	Key
1342221619	739	Neptune	SED
1342222185	752	Uranus	Key
1342222574	759	Ceres	Key

A.5 R1_150

Table 6: List of the calibration observations used for the computation of the response in band R1 at 150 μm.

Obsid	OD	Target	Observation type
1342186537	169	Neptune	RSRF
1342186539	169	Neptune	RSRF
1342186541	169	Neptune	SED
1342186542	169	Neptune	SED
1342186543	169	Neptune	SED
1342186544	169	Neptune	SED
1342186552	170	Vesta	Key
1342186564	170	Thisbe	Key
1342186648	173	Neptune	SED
1342186649	173	Neptune	SED
1342186984	183	GamDra	Key
1342187215	195	Uranus	RSRF
1342187217	195	Uranus	RSRF

Table 6: (continued)

Obsid	OD	Target	Observation type
1342187219	195	Uranus	SED
1342187220	195	Uranus	SED
1342189272	245	Pallas	SED
1342189273	245	Pallas	SED
1342191139	286	Ceres	SED
1342191140	286	Ceres	SED
1342191151	286	AlpTau	Key
1342192114	303	Ceres	Key
1342192119	303	AlpTau	Key
1342192159	304	Ceres	Key
1342195633	348	Vesta	SED
1342195634	348	Vesta	SED
1342196700	370	Vesta	Key
1342196876	373	Neptune	SED
1342196877	373	Neptune	SED
1342197832	388	BetPeg	Key
1342197894	389	Neptune	SED
1342197895	389	Neptune	SED
1342199738	415	AlpBoo	Key
1342202587	454	Pallas	Key
1342203049	457	Thisbe	Key
1342203132	460	AlpCet	Key
1342203134	460	AlpBoo	Key
1342203136	460	Pallas	SED
1342203137	460	Pallas	SED
1342204333	485	Ceres	SED
1342204334	485	Ceres	SED
1342204336	485	Ceres	Key
1342204352	485	AlpTau	Key
1342206871	523	Ceres	SED
1342206872	523	Ceres	SED
1342208868	547	Neptune	SED
1342208869	547	Neptune	SED
1342208871	547	Neptune	Key
1342210654	566	BetPeg	Key
1342211162	579	Hebe	SED
1342211163	579	Hebe	SED
1342211165	579	Hebe	Key
1342211167	579	Uranus	SED
1342211168	579	Uranus	SED
1342211170	579	Uranus	Key
1342211178	579	AlpBoo	Key
1342211821	593	Juno	SED
1342211822	593	Juno	SED
1342212266	598	GamDra	Key
1342212606	610	Callisto	Key
1342212608	610	Callisto	SED
1342212609	610	Callisto	SED
1342212784	613	Europa	SED
1342212785	613	Europa	SED
1342212787	613	Europa	Key

Table 6: (continued)

Obsid	OD	Target	Observation type
1342213145	617	AlpCet	Key
1342213749	633	Hebe	Key
1342214621	649	Hygiea	Key
1342214623	649	Hygiea	SED
1342214624	649	Hygiea	SED
1342215636	663	Hygiea	Key
1342216618	677	Vesta	Key
1342217790	686	Pallas	Key
1342217792	686	Vesta	Key
1342217794	686	Vesta	SED
1342217795	686	Vesta	SED
1342218753	703	Vesta	Key
1342220321	726	Ceres	Key
1342220596	720	Pallas	SED
1342220597	720	Pallas	SED
1342220927	716	Neptune	Key
1342221612	739	Neptune	Key
1342221620	739	Neptune	SED
1342221621	739	Neptune	SED
1342222186	752	Uranus	Key
1342222575	759	Ceres	Key

A.6 R1_180

Table 7: List of the calibration observations used for the computation of the response in band R1 at 180 μm.

Obsid	OD	Target	Observation type
1342186537	169	Neptune	RSRF
1342186538	169	Neptune	RSRF
1342186540	169	Neptune	RSRF
1342186541	169	Neptune	SED
1342186542	169	Neptune	SED
1342186543	169	Neptune	SED
1342186544	169	Neptune	SED
1342186553	170	Vesta	Key
1342186565	170	Thisbe	Key
1342186648	173	Neptune	SED
1342186649	173	Neptune	SED
1342186983	183	GamDra	Key
1342187215	195	Uranus	RSRF
1342187216	195	Uranus	RSRF
1342187218	195	Uranus	RSRF
1342187219	195	Uranus	SED
1342187220	195	Uranus	SED
1342189272	245	Pallas	SED
1342189273	245	Pallas	SED
1342191139	286	Ceres	SED
1342191140	286	Ceres	SED
1342191150	286	AlpTau	Key
1342192113	303	Ceres	Key

Table 7: (continued)

Obsid	OD	Target	Observation type
1342192118	303	AlpTau	Key
1342192158	304	Ceres	Key
1342195633	348	Vesta	SED
1342195634	348	Vesta	SED
1342196699	370	Vesta	Key
1342196876	373	Neptune	SED
1342196877	373	Neptune	SED
1342197831	388	BetPeg	Key
1342197894	389	Neptune	SED
1342197895	389	Neptune	SED
1342199737	415	AlpBoo	Key
1342202586	454	Pallas	Key
1342203048	457	Thisbe	Key
1342203131	460	AlpCet	Key
1342203133	460	AlpBoo	Key
1342203136	460	Pallas	SED
1342203137	460	Pallas	SED
1342204333	485	Ceres	SED
1342204334	485	Ceres	SED
1342204335	485	Ceres	Key
1342204351	485	AlpTau	Key
1342206871	523	Ceres	SED
1342206872	523	Ceres	SED
1342208868	547	Neptune	SED
1342208869	547	Neptune	SED
1342208870	547	Neptune	Key
1342210653	566	BetPeg	Key
1342211162	579	Hebe	SED
1342211163	579	Hebe	SED
1342211164	579	Hebe	Key
1342211167	579	Uranus	SED
1342211168	579	Uranus	SED
1342211169	579	Uranus	Key
1342211177	579	AlpBoo	Key
1342211821	593	Juno	SED
1342211822	593	Juno	SED
1342212265	598	GamDra	Key
1342212605	610	Callisto	Key
1342212608	610	Callisto	SED
1342212609	610	Callisto	SED
1342212784	613	Europa	SED
1342212785	613	Europa	SED
1342212786	613	Europa	Key
1342213144	617	AlpCet	Key
1342213748	633	Hebe	Key
1342214620	649	Hygiea	Key
1342214623	649	Hygiea	SED
1342214624	649	Hygiea	SED
1342215635	663	Hygiea	Key
1342216617	677	Vesta	Key
1342217789	686	Pallas	Key

Table 7: (continued)

Obsid	OD	Target	Observation type
1342217791	686	Vesta	Key
1342217794	686	Vesta	SED
1342217795	686	Vesta	SED
1342218752	703	Vesta	Key
1342220320	726	Ceres	Key
1342220596	720	Pallas	SED
1342220597	720	Pallas	SED
1342220926	716	Neptune	Key
1342221611	739	Neptune	Key
1342221620	739	Neptune	SED
1342221621	739	Neptune	SED
1342222185	752	Uranus	Key
1342222574	759	Ceres	Key

B List of the reproducibility observations

The star HD161796 is regularly observed all along the mission to check the reproducibility of the observations. Tables 8-13 present the lists of those observations for each key wavelength.

B.1 B3A_60

Table 8: List of the reproducibility observations in band B3A at 60 μm.

Obsid	OD	Observation type
1342186328	166	Key
1342186535	169	Key
1342186561	170	Key
1342186562	170	SED
1342186663	174	Key
1342186682	174	Key
1342186963	182	Key
1342186976	182	Key
1342186982	183	Key
1342187196	194	Key
1342187213	195	Key
1342188032	211	Key
1342188947	235	Key
1342189276	245	Key
1342189955	262	Key
1342191143	286	Key
1342192152	304	Key
1342192978	319	Key
1342195500	345	Key
1342196868	373	Key
1342197822	388	Key
1342199301	408	Key
1342199724	415	Key

Table 8: (continued)

Obsid	OD	Observation type
1342202585	454	Key
1342203045	457	Key
1342203689	471	Key
1342204344	485	Key
1342206345	516	Key
1342207191	530	Key
1342207772	535	Key
1342208930	550	Key
1342210819	570	Key
1342211543	589	Key
1342212269	598	Key
1342212546	608	Key
1342213141	617	Key
1342213680	629	Key
1342214025	637	Key
1342214627	649	Key
1342214886	656	Key
1342215708	665	Key
1342216621	677	Key
1342217810	686	Key
1342218566	697	Key
1342219432	706	Key
1342220324	726	Key
1342220925	716	Key
1342221361	734	Key
1342221886	745	Key
1342222244	755	Key
1342222763	764	Key

B.2 B2A_60

Table 9: List of the reproducibility observations in band B2A at 60 μm.

Obsid	OD	Observation type
1342186326	166	Key
1342186533	169	Key
1342186560	170	Key
1342186562	170	SED
1342186661	174	Key
1342186680	174	Key
1342186961	182	Key
1342186974	182	Key
1342186980	183	Key
1342187194	194	Key
1342187211	195	Key
1342188030	211	Key
1342188945	235	Key
1342189274	245	Key
1342189953	262	Key
1342191141	286	Key

Table 9: (continued)

Obsid	OD	Observation type
1342192150	304	Key
1342192976	319	Key
1342195498	345	Key
1342196866	373	Key
1342197824	388	Key
1342199299	408	Key
1342199722	415	Key
1342202583	454	Key
1342203043	457	Key
1342203687	471	Key
1342204342	485	Key
1342206343	516	Key
1342207189	530	Key
1342207770	535	Key
1342208928	550	Key
1342210817	570	Key
1342211541	589	Key
1342212267	598	Key
1342212544	608	Key
1342213139	617	Key
1342213678	629	Key
1342214023	637	Key
1342214625	649	Key
1342214884	656	Key
1342215706	665	Key
1342216619	677	Key
1342217808	686	Key
1342218564	697	Key
1342219430	706	Key
1342220322	726	Key
1342220923	716	Key
1342221359	734	Key
1342221884	745	Key
1342222242	755	Key
1342222761	764	Key

B.3 B2B_75

Table 10: List of the reproducibility observations in band B2B at 75 μm.

Obsid	OD	Observation type
1342186327	166	Key
1342186534	169	Key
1342186559	170	Key
1342186662	174	Key
1342186679	174	SED
1342186681	174	Key
1342186962	182	Key
1342186975	182	Key
1342186981	183	Key

Table 10: (continued)

Obsid	OD	Observation type
1342187195	194	Key
1342187212	195	Key
1342188031	211	Key
1342188946	235	Key
1342189275	245	Key
1342189954	262	Key
1342191142	286	Key
1342192151	304	Key
1342192977	319	Key
1342195499	345	Key
1342196867	373	Key
1342197823	388	Key
1342199300	408	Key
1342199723	415	Key
1342202584	454	Key
1342203044	457	Key
1342203688	471	Key
1342204343	485	Key
1342206344	516	Key
1342207190	530	Key
1342207771	535	Key
1342208929	550	Key
1342210818	570	Key
1342211542	589	Key
1342212268	598	Key
1342212545	608	Key
1342213140	617	Key
1342213679	629	Key
1342214024	637	Key
1342214626	649	Key
1342214885	656	Key
1342215707	665	Key
1342216620	677	Key
1342217809	686	Key
1342218565	697	Key
1342219431	706	Key
1342220323	726	Key
1342220924	716	Key
1342221360	734	Key
1342221885	745	Key
1342222243	755	Key
1342222762	764	Key

B.4 R1_120

Table 11: List of the reproducibility observations in band R1 at 120 μm.

Obsid	OD	Observation type
1342186326	166	Key
1342186533	169	Key

Table 11: (continued)

Obsid	OD	Observation type
1342186560	170	Key
1342186562	170	SED
1342186661	174	Key
1342186680	174	Key
1342186961	182	Key
1342186974	182	Key
1342186980	183	Key
1342187194	194	Key
1342187211	195	Key
1342188030	211	Key
1342188945	235	Key
1342189274	245	Key
1342189953	262	Key
1342191141	286	Key
1342192150	304	Key
1342192976	319	Key
1342195498	345	Key
1342196866	373	Key
1342197824	388	Key
1342199299	408	Key
1342199722	415	Key
1342202583	454	Key
1342203043	457	Key
1342203687	471	Key
1342204342	485	Key
1342206343	516	Key
1342207189	530	Key
1342207770	535	Key
1342208928	550	Key
1342210817	570	Key
1342211541	589	Key
1342212267	598	Key
1342212544	608	Key
1342213139	617	Key
1342213678	629	Key
1342214023	637	Key
1342214625	649	Key
1342214884	656	Key
1342215706	665	Key
1342216619	677	Key
1342217808	686	Key
1342218564	697	Key
1342219430	706	Key
1342220322	726	Key
1342220923	716	Key
1342221359	734	Key
1342221884	745	Key
1342222242	755	Key
1342222761	764	Key

B.5 R1_150

Table 12: List of the reproducibility observations in band R1 at 150 μm.

Obsid	OD	Observation type
1342186327	166	Key
1342186534	169	Key
1342186559	170	Key
1342186562	170	SED
1342186662	174	Key
1342186679	174	SED
1342186681	174	Key
1342186962	182	Key
1342186975	182	Key
1342186981	183	Key
1342187195	194	Key
1342187212	195	Key
1342188031	211	Key
1342188946	235	Key
1342189275	245	Key
1342189954	262	Key
1342191142	286	Key
1342192151	304	Key
1342192977	319	Key
1342195499	345	Key
1342196867	373	Key
1342197823	388	Key
1342199300	408	Key
1342199723	415	Key
1342202584	454	Key
1342203044	457	Key
1342203688	471	Key
1342204343	485	Key
1342206344	516	Key
1342207190	530	Key
1342207771	535	Key
1342208929	550	Key
1342210818	570	Key
1342211542	589	Key
1342212268	598	Key
1342212545	608	Key
1342213140	617	Key
1342213679	629	Key
1342214024	637	Key
1342214626	649	Key
1342214885	656	Key
1342215707	665	Key
1342216620	677	Key
1342217809	686	Key
1342218565	697	Key
1342219431	706	Key
1342220323	726	Key
1342220924	716	Key
1342221360	734	Key

Table 12: (continued)

Obsid	OD	Observation type
1342221885	745	Key
1342222243	755	Key
1342222762	764	Key

B.6 R1_180

Table 13: List of the reproducibility observations in band R1 at 180 μm.

Obsid	OD	Observation type
1342186328	166	Key
1342186535	169	Key
1342186561	170	Key
1342186562	170	SED
1342186663	174	Key
1342186679	174	SED
1342186682	174	Key
1342186963	182	Key
1342186976	182	Key
1342186982	183	Key
1342187196	194	Key
1342187213	195	Key
1342188032	211	Key
1342188947	235	Key
1342189276	245	Key
1342189955	262	Key
1342191143	286	Key
1342192152	304	Key
1342192978	319	Key
1342195500	345	Key
1342196868	373	Key
1342197822	388	Key
1342199301	408	Key
1342199724	415	Key
1342202585	454	Key
1342203045	457	Key
1342203689	471	Key
1342204344	485	Key
1342206345	516	Key
1342207191	530	Key
1342207772	535	Key
1342208930	550	Key
1342210819	570	Key
1342211543	589	Key
1342212269	598	Key
1342212546	608	Key
1342213141	617	Key
1342213680	629	Key
1342214025	637	Key
1342214627	649	Key
1342214886	656	Key

Table 13: (continued)

Obsid	OD	Observation type
1342215708	665	Key
1342216621	677	Key
1342217810	686	Key
1342218566	697	Key
1342219432	706	Key
1342220324	726	Key
1342220925	716	Key
1342221361	734	Key
1342221886	745	Key
1342222244	755	Key
1342222763	764	Key

In this addendum to the report PICC-KL-TN-047, statistics of the flux calibration of the astronomical calibrators from Dec 2013 are presented.

The same data have been flux calibrated:

- with the `Telescope normalisation' method with symmetric chopping and
  - the then current telescope model (calTree v 60)
  - the new telescope model then being tested (which went into calTree v 61)
- with the `Calibration block' method

For the statistics with the normalisation method and the new telescope model, a table without Neptune and Uranus observations is provided, as it was considered that these sources may fall in a non-linear regime.

Calibration blocks

Absolute calibrators observations						
Band	N	Mean	Std dev.	Min	Max	Peak-to-peak
B3A_60	143	1.0000	0.0733	0.7560	1.2155	0.4595
B2A_60	143	1.0081	0.0748	0.7651	1.1546	0.3896
B2B_75	143	1.0000	0.0805	0.7673	1.1792	0.4119
R1_120	143	0.9896	0.0755	0.8128	1.2673	0.4544
R1_150	143	1.0000	0.0664	0.7926	1.1856	0.3930
R1_180	143	1.0372	0.1393	0.1520	1.6629	1.5110

Reproducibility source observations						
Band	N	Mean	Std dev.	Min	Max	Peak-to-peak
B3A_60	120	0.9663	0.0256	0.8690	1.0230	0.1540
B2A_60	120	0.9520	0.0395	0.7988	1.0387	0.2399
B2B_75	120	0.8932	0.0337	0.7843	0.9562	0.1719
R1_120	120	0.9172	0.0419	0.8007	1.0093	0.2087
R1_150	120	0.9980	0.0154	0.9631	1.0485	0.0855
R1_180	120	0.9835	0.0389	0.9029	1.1418	0.2388

Normalization

Absolute calibrators observations						
Band	N	Mean	Std dev.	Min	Max	Peak-to-peak
B3A_60	143	1.0352	0.0844	0.7780	1.3086	0.5306
B2A_60	143	1.0470	0.0823	0.7916	1.2028	0.4112
B2B_75	143	1.0444	0.0819	0.8069	1.2130	0.4060
R1_120	143	1.0374	0.0606	0.8802	1.2200	0.3399
R1_150	143	1.1216	0.0725	0.9665	1.4426	0.4761
R1_180	143	1.1372	0.1467	0.1748	1.6961	1.5213

Reproducibility source observations						
Band	N	Mean	Std dev.	Min	Max	Peak-to-peak
B3A_60	120	0.9925	0.0347	0.8553	1.0544	0.1990
B2A_60	120	1.0072	0.0372	0.8629	1.0742	0.2113
B2B_75	120	0.9315	0.0285	0.8196	0.9754	0.1558
R1_120	120	0.9823	0.0294	0.8968	1.0322	0.1353
R1_150	120	1.0937	0.0185	1.0451	1.1454	0.1004
R1_180	120	1.0489	0.0474	0.9512	1.2072	0.2560

Normalization (new telescope model)

Absolute calibrators observations						
Band	N	Mean	Std dev.	Min	Max	Peak-to-peak
B3A_60	143	1.0123	0.0735	0.7740	1.2427	0.4687
B2A_60	143	1.0238	0.0705	0.7875	1.1623	0.3747
B2B_75	143	1.0255	0.0793	0.7922	1.1884	0.3961
R1_120	143	1.0009	0.0594	0.8425	1.1742	0.3316
R1_150	143	0.9637	0.0625	0.8258	1.2580	0.4321
R1_180	143	0.9153	0.1114	0.1460	1.2901	1.1440

Reproducibility source observations						
Band	N	Mean	Std dev.	Min	Max	Peak-to-peak
B3A_60	120	0.9739	0.0264	0.8758	1.0304	0.1546
B2A_60	120	0.9883	0.0263	0.8857	1.0406	0.1549
B2B_75	120	0.9157	0.0277	0.8136	0.9552	0.1416
R1_120	120	0.9479	0.0283	0.8615	0.9995	0.1381
R1_150	120	0.9390	0.0124	0.9080	0.9760	0.0681
R1_180	120	0.8428	0.0270	0.7901	0.9851	0.1950

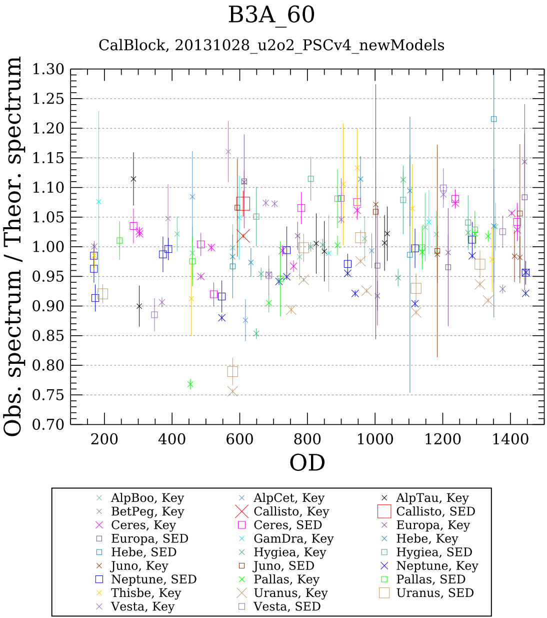
Normalization (new telescope model)

Absolute calibrators without Neptune and Uranus						
Band	N	Mean	Std dev.	Min	Max	Peak-to-peak
B3A_60	109	1.0317	0.0668	0.7809	1.2427	0.4618
B2A_60	109	1.0412	0.0655	0.7920	1.1623	0.3703
B2B_75	109	1.0436	0.0758	0.8060	1.1884	0.3824
R1_120	109	1.0089	0.0610	0.8621	1.1742	0.3121
R1_150	109	0.9827	0.0590	0.8387	1.2580	0.4193
R1_180	109	0.9319	0.1219	0.1460	1.2901	1.1440

Reproducibility source observations						
Band	N	Mean	Std dev.	Min	Max	Peak-to-peak
B3A_60	120	0.9739	0.0264	0.8758	1.0304	0.1546
B2A_60	120	0.9883	0.0263	0.8857	1.0406	0.1549
B2B_75	120	0.9157	0.0277	0.8136	0.9552	0.1416
R1_120	120	0.9479	0.0283	0.8615	0.9995	0.1381
R1_150	120	0.9390	0.0124	0.9080	0.9760	0.0681
R1_180	120	0.8428	0.0270	0.7901	0.9851	0.1950

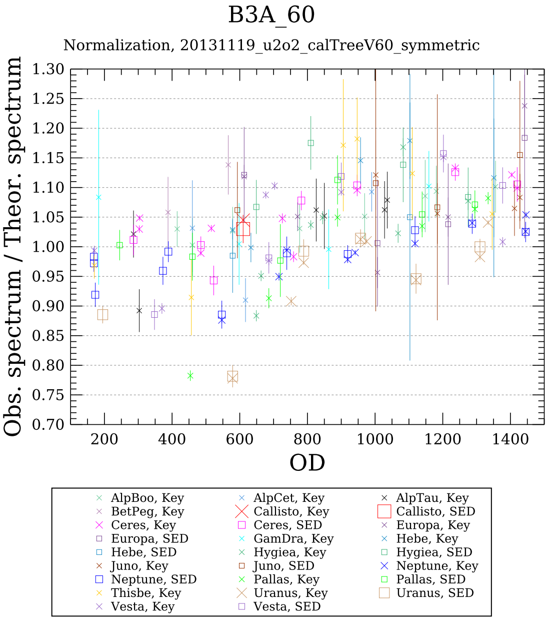
Scatter plots: absolute calibrators

B3A_60



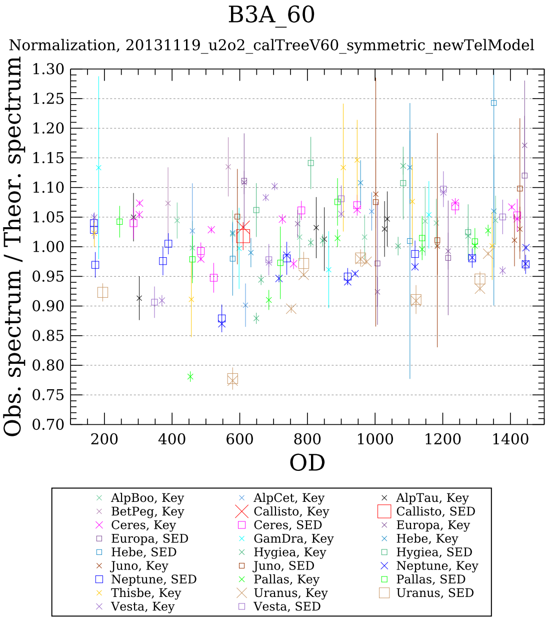
B3A_60
CalBlock, 20131028_u2o2_PSCv4_newModels
Obs. spectrum / Theor. spectrum
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
200
400
600
800
1000
1200
1400
OD
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, Key
Juno, SED
Neptune, Key
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, SED
Vesta, Key
Vesta, SED

B3A_60



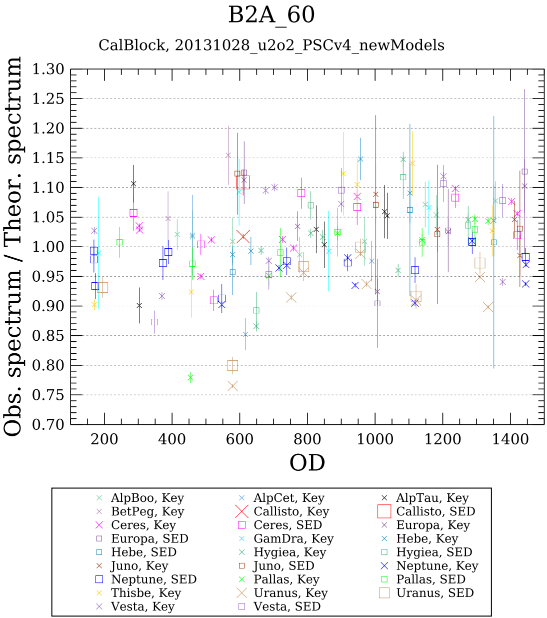
B3A_60
Normalization, 20131119_u2o2_calTreeV60_symmetric
Obs. spectrum / Theor. spectrum
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
200
400
600
800
1000
1200
1400
OD
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, Key
Juno, SED
Neptune, Key
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, SED
Vesta, Key
Vesta, SED

B3A_60



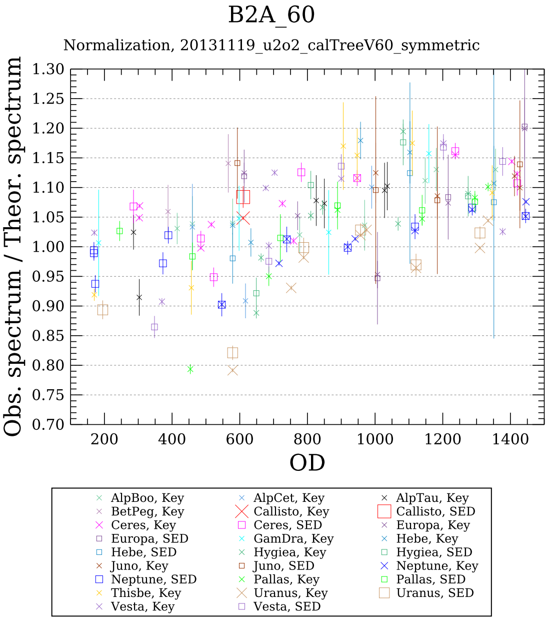
B3A_60
Normalization, 20131119_u2o2_calTreeV60_symmetric_newTelModel
Obs. spectrum / Theor. spectrum
OD
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
200
400
600
800
1000
1200
1400
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, Key
Juno, SED
Neptune, Key
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, SED
Vesta, Key
Vesta, SED

B2A_60

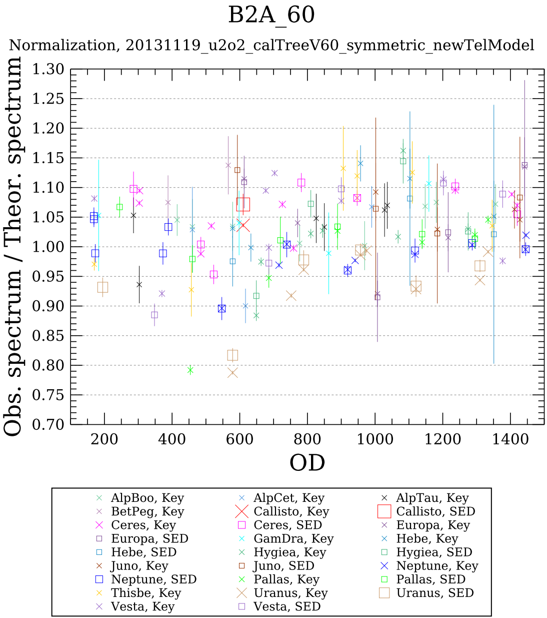


B2A_60
CalBlock, 20131028_u2o2_PSCv4_newModels
Obs. spectrum / Theor. spectrum
OD
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
200
400
600
800
1000
1200
1400
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, Key
Juno, SED
Neptune, Key
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, SED
Vesta, Key
Vesta, SED

B2A_60


B2A_60
Normalization, 20131119_u2o2_calTreeV60_symmetric
Obs. spectrum / Theor. spectrum
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
200
400
600
800
1000
1200
1400
OD
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
GamDra, Key
Hebe, Key
Hebe, SED
Hygiea, Key
Hygiea, SED
Juno, Key
Juno, SED
Neptune, Key
Neptune, SED
Pallas, Key
Pallas, SED
Thisbe, Key
Uranus, Key
Uranus, SED
Vesta, Key
Vesta, SED

B2A_60



B2A_60
Normalization, 20131119_u2o2_calTreeV60_symmetric_newTelModel
Obs. spectrum / Theor. spectrum
1.30
1.25
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
0.75
0.70
200
400
600
800
1000
1200
1400
OD
AlpBoo, Key
AlpCet, Key
AlpTau, Key
BetPeg, Key
Callisto, Key
Callisto, SED
Ceres, Key
Ceres, SED
Europa, Key
Europa, SED
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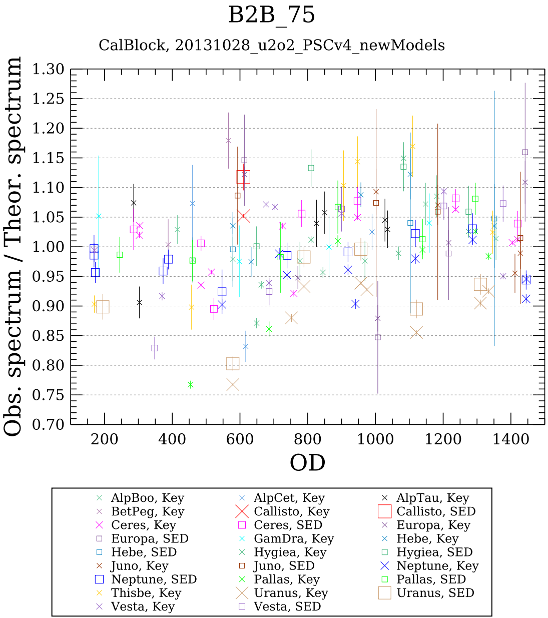
B2B_75



B2B_75
CalBlock, 20131028_u2o2_PSCv4_newModels
Obs. spectrum / Theor. spectrum
OD
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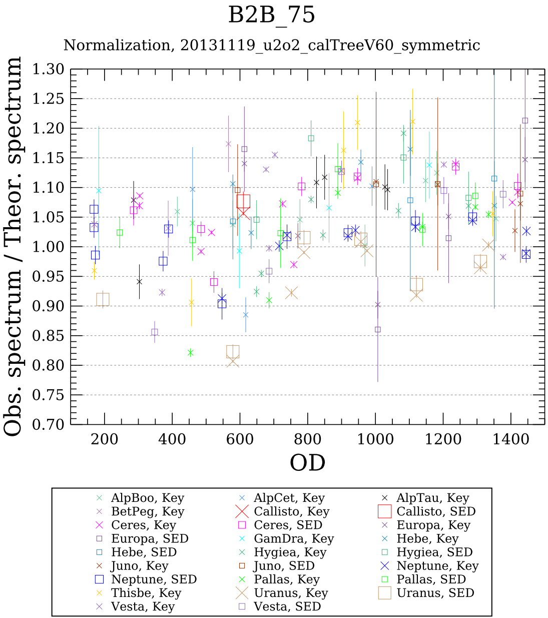
B2B_75



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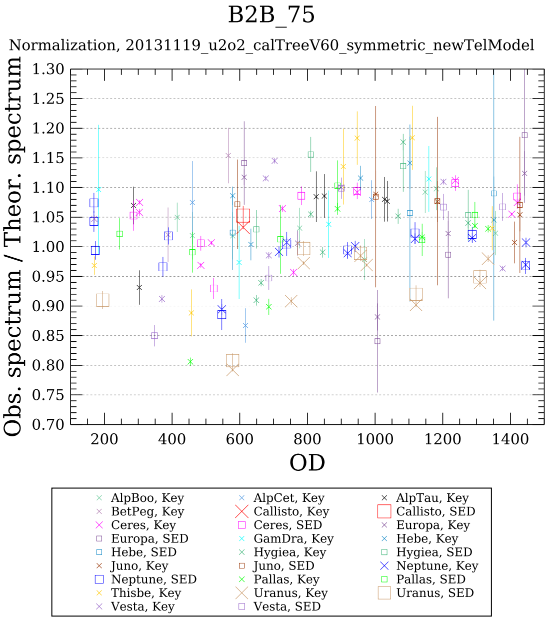
B2B_75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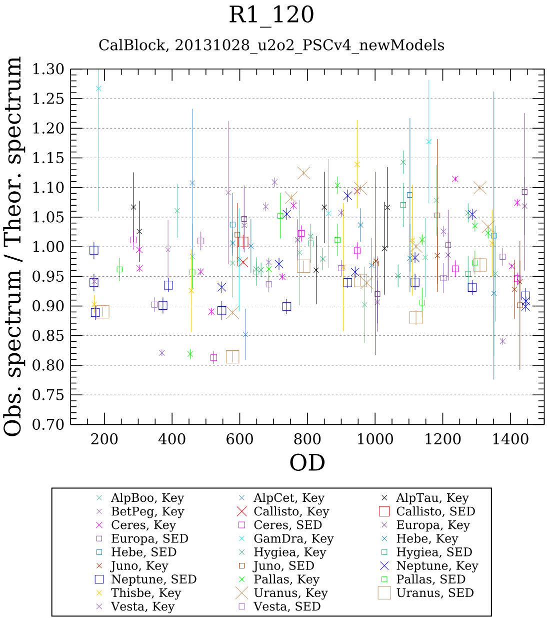
R1_120



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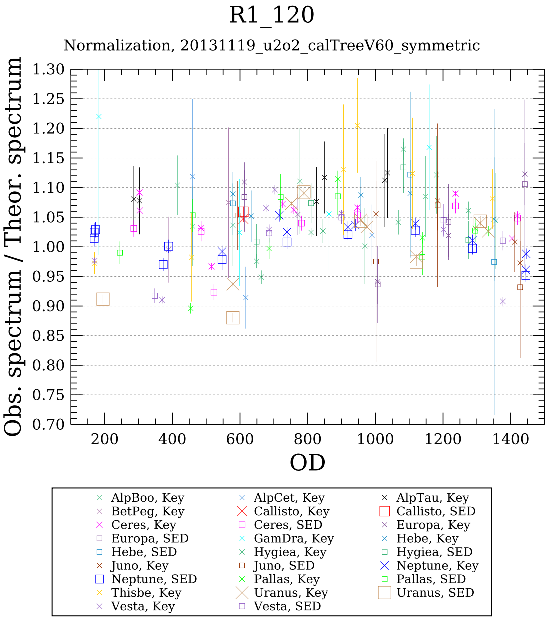
R1_120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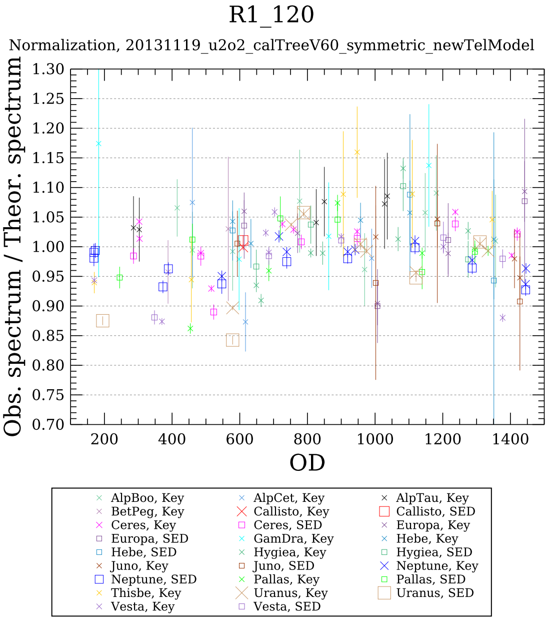
R1_120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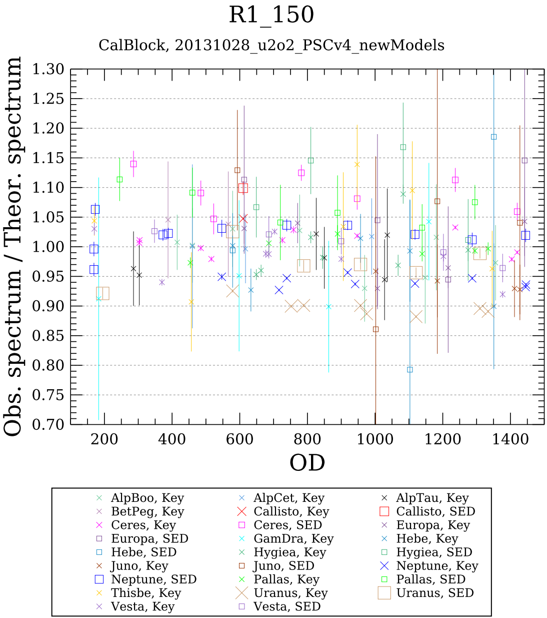
R1_150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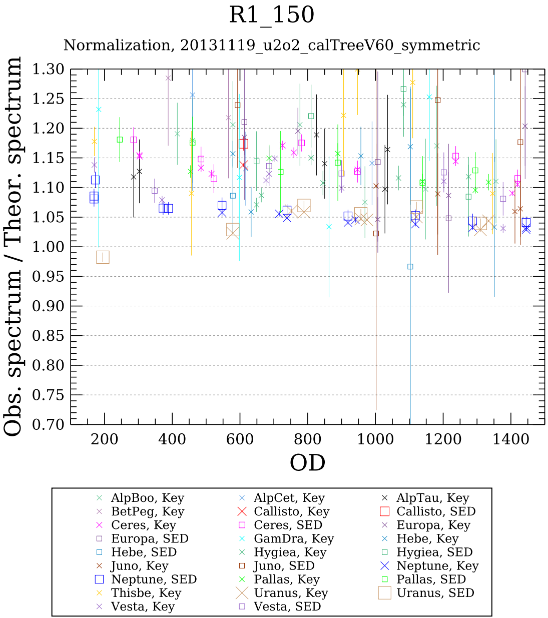
R1_150



R1_150
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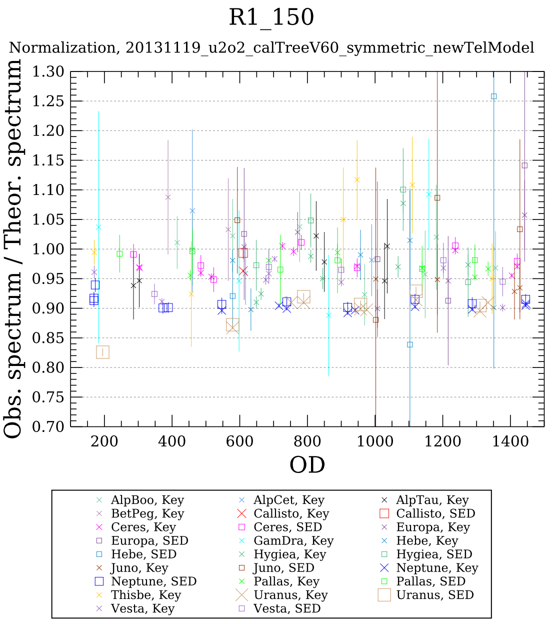
R1_150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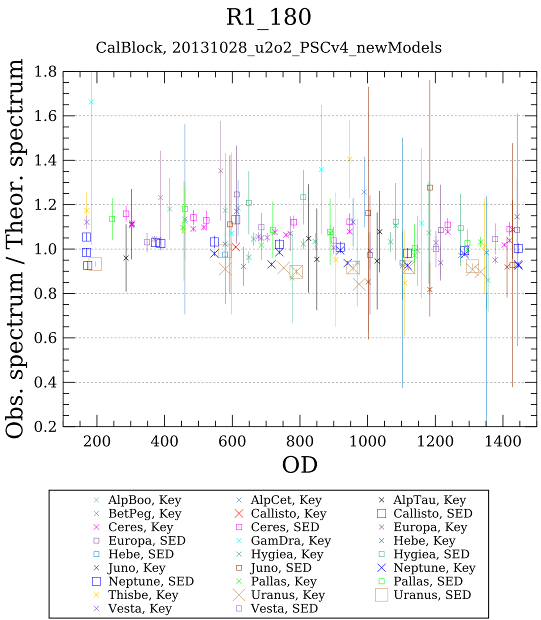
R1_180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0.4
0.2
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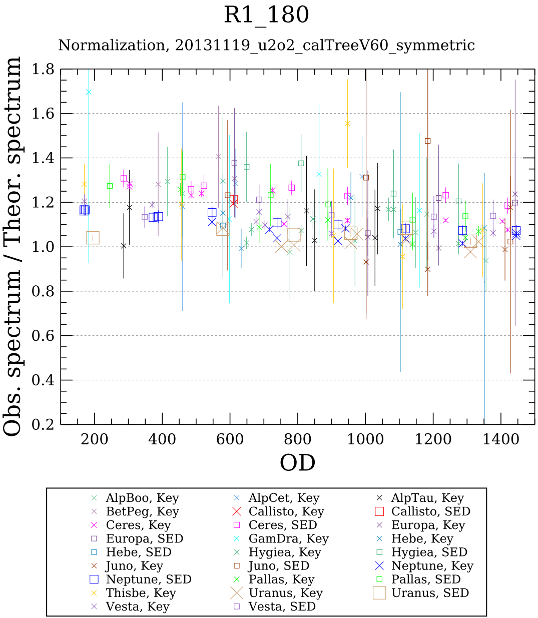
R1_180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Obs. spectrum / Theor. spectrum
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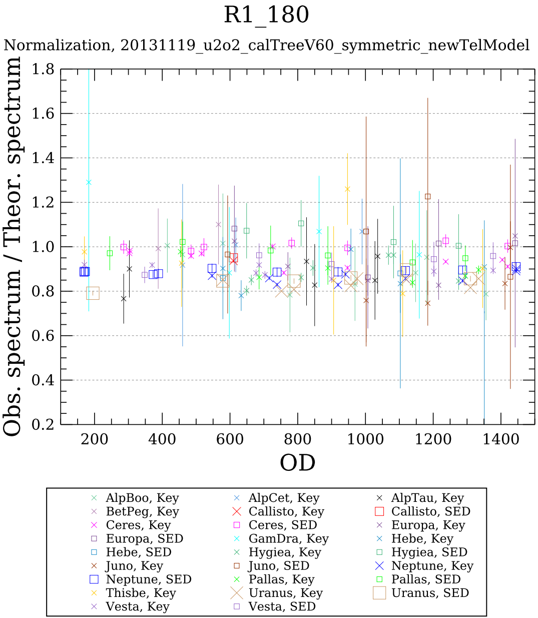
R1_180



R1_180
Normalization, 20131119_u2o2_calTreeV60_symmetric_newTelModel
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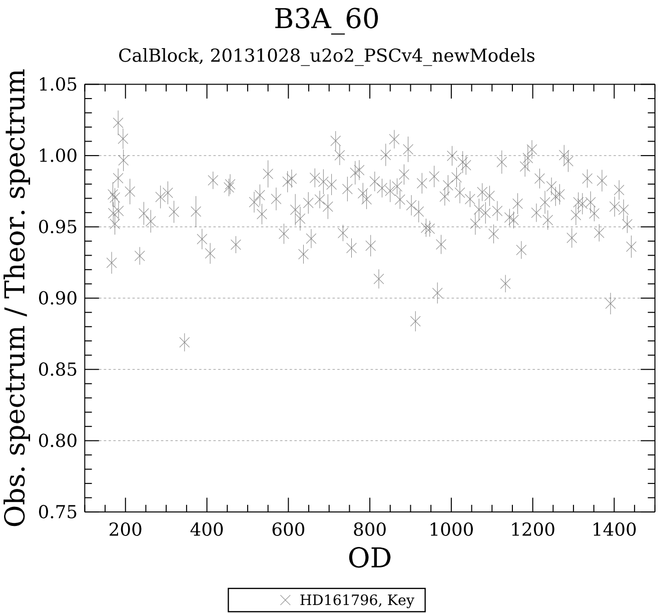
Scatter plots: reproducibility source HD161796

B3A_60


B3A_60
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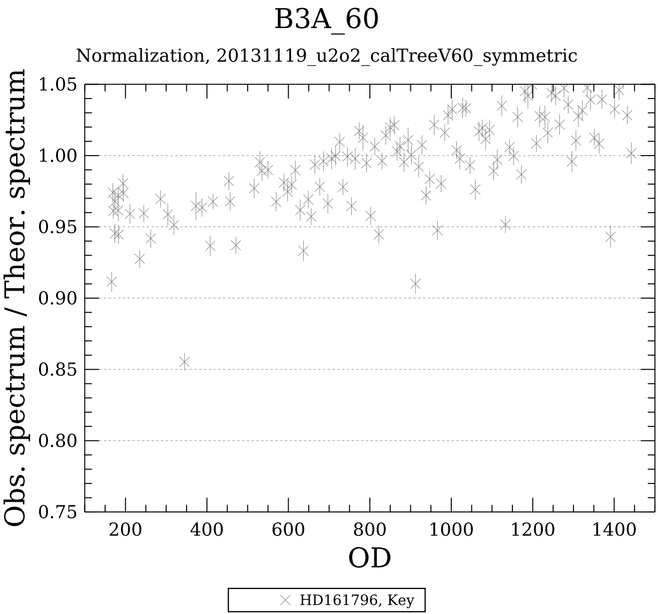
B3A_60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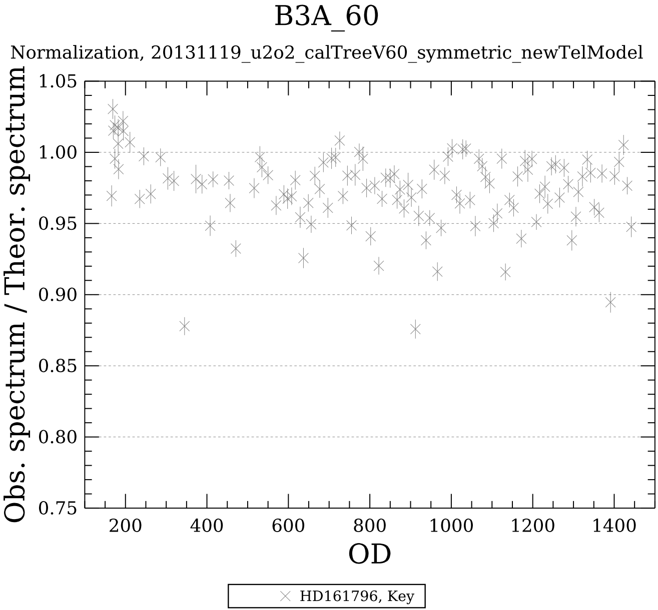
B3A_60



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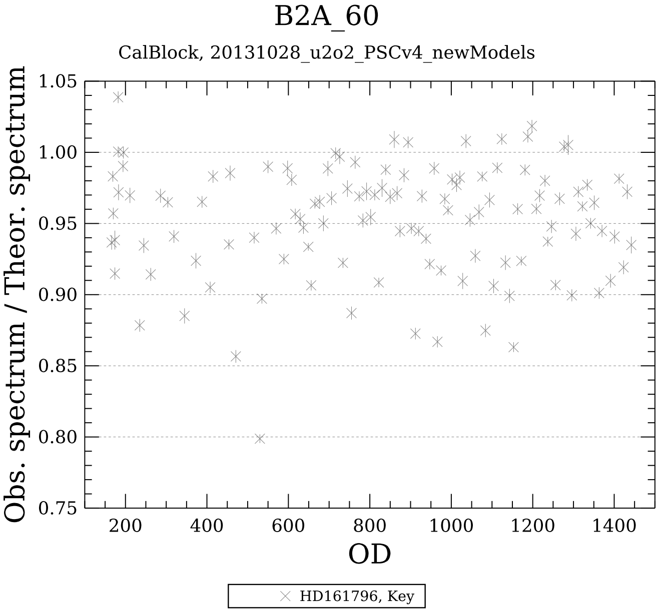
B2A_60



B2A_60
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Obs. spectrum / Theor. spectrum
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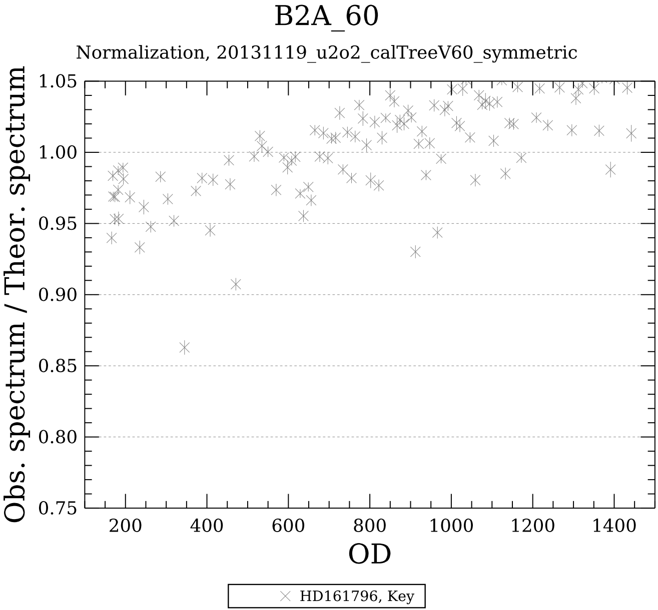
B2A_60



B2A_60
Normalization, 20131119_u2o2_calTreeV60_symmetric
Obs. spectrum / Theor. spectrum
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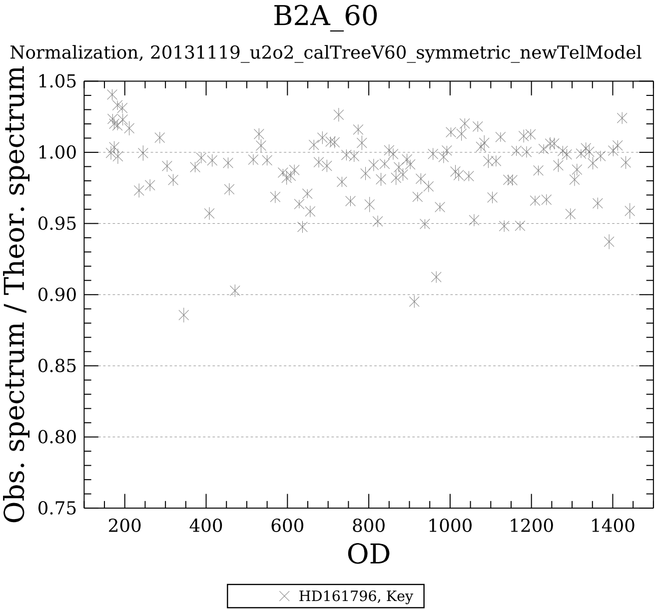
B2A_60



B2A_60
Normalization, 20131119_u2o2_calTreeV60_symmetric_newTelModel
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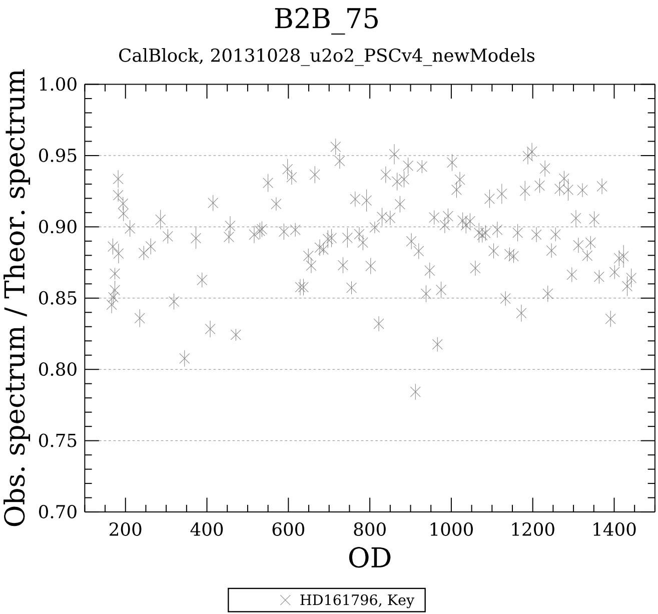
HD161796, Key

B2B_75


B2B_75
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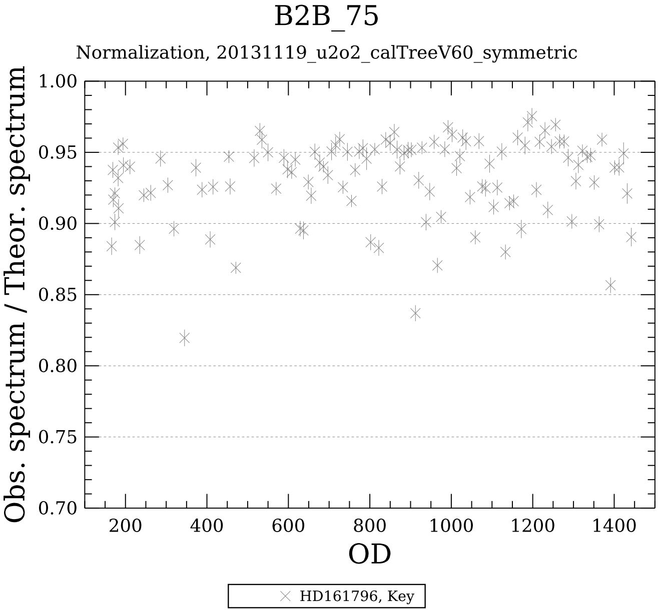
B2B_75



B2B_75
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Obs. spectrum / Theor. spectrum
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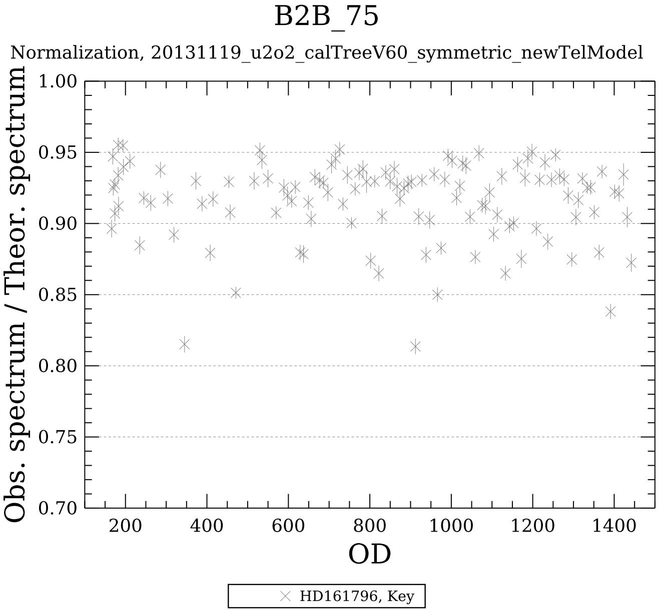
B2B_75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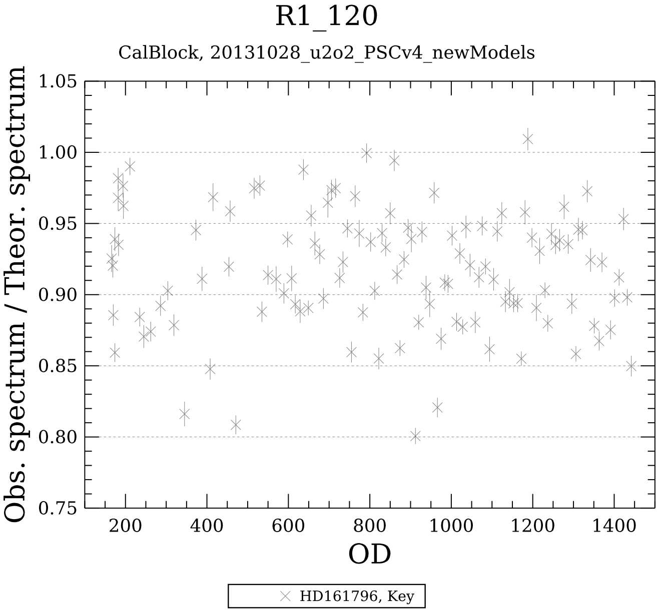
R1_120


R1_120
CalBlock, 20131028_u2o2_PSCv4_newModels
Obs. spectrum / Theor. spectrum
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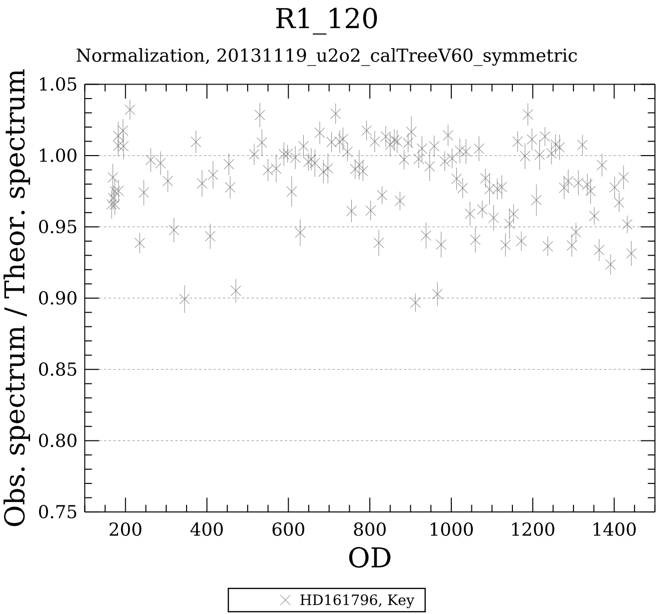
R1_120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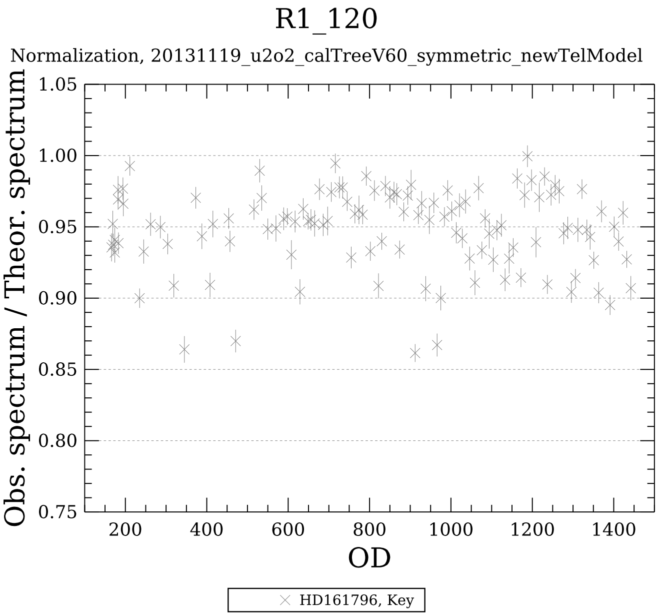
R1_120



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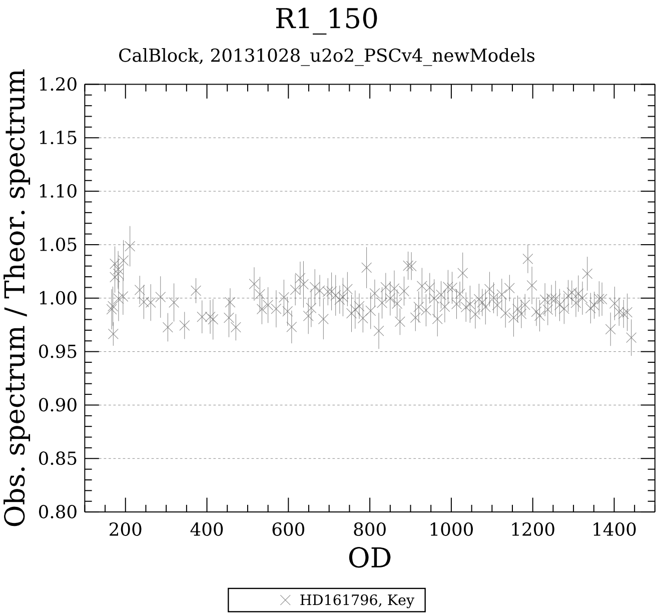
R1_150



R1_150
CalBlock, 20131028_u2o2_PSCv4_newModels
Obs. spectrum / Theor. spectrum
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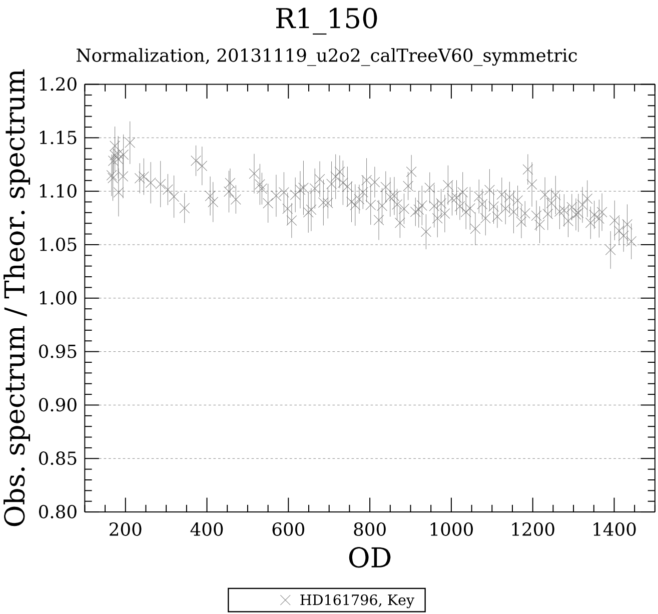
R1_150



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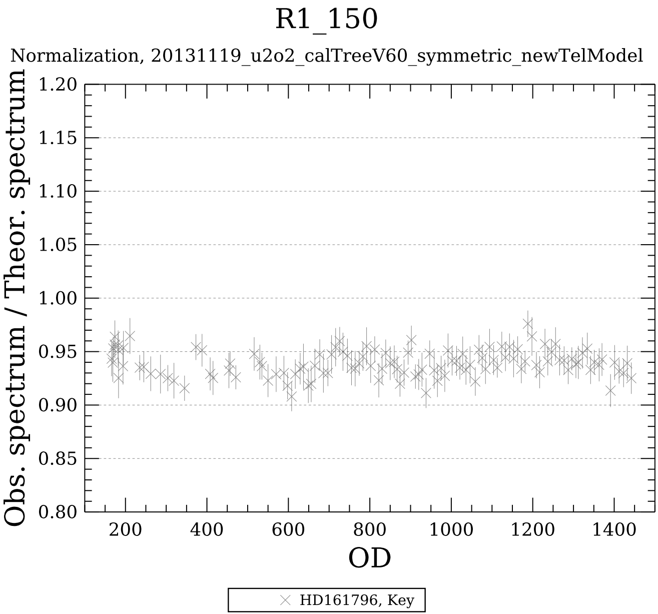
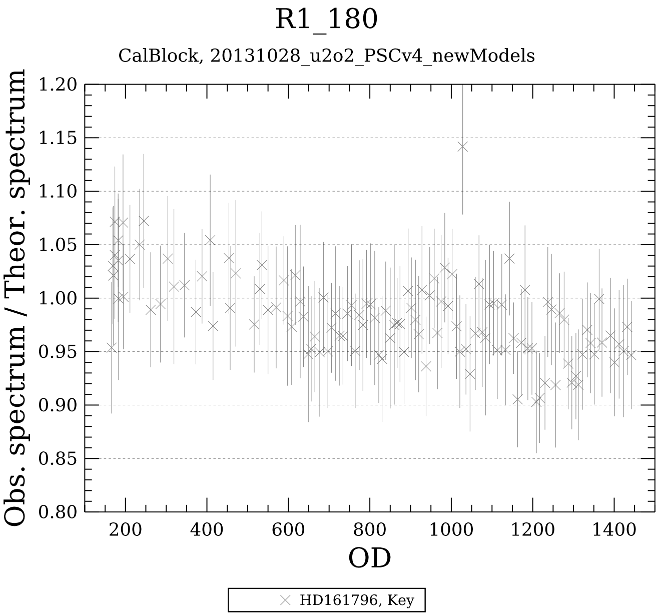
HD161796, Key

R1_150

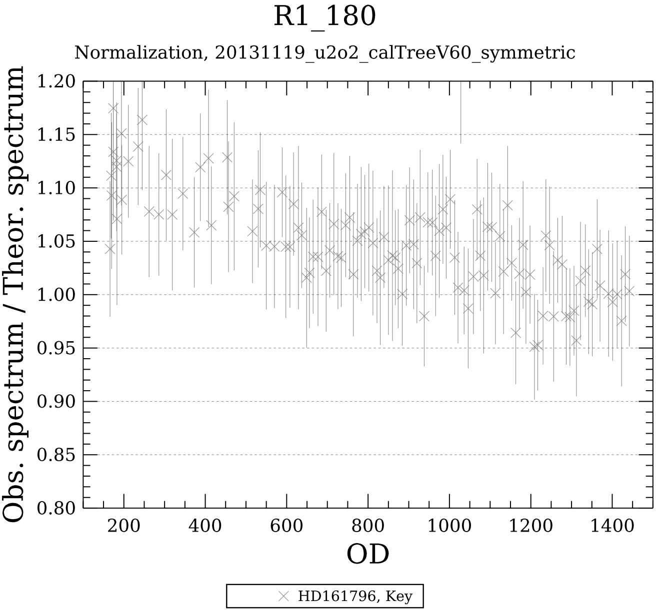


R1_150
Normalization, 20131119_u2o2_calTreeV60_symmetric_newTelModel
Obs. spectrum / Theor. spectrum
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
200
400
600
800
1000
1200
1400
OD
HD161796, Key

R1_180

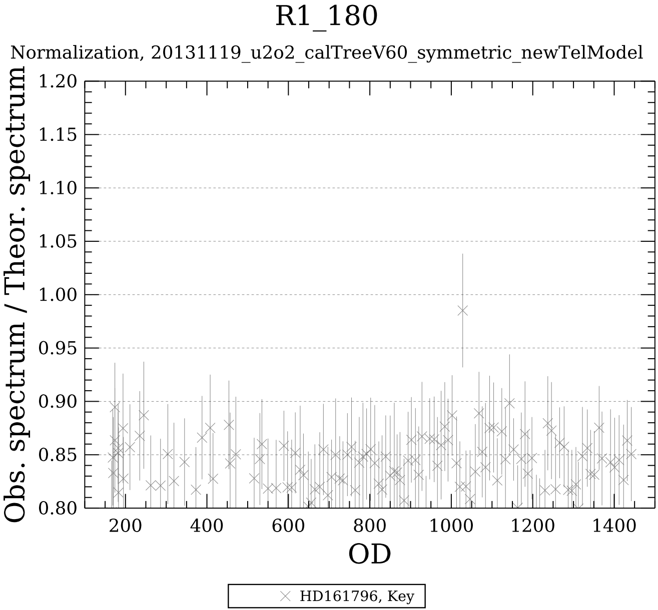

R1_180
CalBlock, 20131028_u2o2_PSCv4_newModels
Obs. spectrum / Theor. spectrum
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
200
400
600
800
1000
1200
1400
OD
HD161796, Key

R1_180



R1_180
Normalization, 20131119_u2o2_calTreeV60_symmetric
Obs. spectrum / Theor. spectrum
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
200
400
600
800
1000
1200
1400
OD
HD161796, Key

R1_180



R1_180
Normalization, 20131119_u2o2_calTreeV60_symmetric_newTelModel
Obs. spectrum / Theor. spectrum
1.20
1.15
1.10
1.05
1.00
0.95
0.90
0.85
0.80
200
400
600
800
1000
1200
1400
OD
HD161796, Key