Revision 1538, 19.8 KB checked in by jhartman, 6 years ago (diff)
fu-howto.wiki: minor changes
Property **svn:mime-type** set to *text/x-trac-wiki*

(Follow-up) Photometry HOWTO

Download and and prepare data

To download from the CfA:

```
flwo_kepcam_rsync_realtime.sh 2009.0205 cfa
```

Or from FLWO direct:

```
flwo_kepcam_rsync_realtime.sh 2009.0205 flwo
```

gets data

Here 2009.0205 is the directory name.

Clean stale files such as object images to other projects (e.g. the service observations) and flats using notused filters:

```
fu_clean.sh raw/2009.0205 > raw/2009.0205/clean.log
```

Calibrate data

TBD: clean sh

This is a dependency of the photometry. Briefly:

```
nohup time kepcam_ficalib.sh \
--raw /H/FU/FLWO/data/raw/2009.0205 \
--red /H/FU/FLWO/data/red/2009.0205 \
--master /H/FU/FLWO/data/red/2009.0205 > /H/FU/FLWO/data/red/2009.0205/red.log
```

Automated Photometry

Use the fu-auto.sh script to automate the reduction of the follow-up images.

- Create the standard location for analysis, link to the red directory:

/home/jid/

```
cfhat10$ mkdir -p /H/FU/FLWO/anl/yyyy.mmdd/$OBJECT/PHOT_$USERINITIALS
cfhat10$ cd /H/FU/FLWO/anl/yyyy.mmdd
cfhat10$ ln -s ../../data/red/yyyy.mmdd RED
e.g.
cfhat10$ mkdir -p /H/FU/FLWO/anl/2010.0316/HTR136-001/PHOT_JH
cfhat10$ cd /H/FU/FLWO/anl/2010.0316/
cfhat10$ ln -s ../../data/red/2010.0316 RED
```

- Run the script

```
cfhat10$ cd /H/FU/FLWO/anl/2010.0316/HTR136-001/PHOT_JH
cfhat10$ mkdir scripts
cfhat10$ mkdir LOGS
cfhat10$ cp $(which fu-auto.sh) ./scripts/
cfhat10$ cp $(which fiastrom.sh) ./scripts/
cfhat10$ ./scripts/fu-auto.sh -h HTR136-001 -i kepcam \
         --setup --mkastromcat | tee LOGS/fu-auto.log
cfhat10$ ./scripts/fu-auto.sh -h HTR136-001 -i kepcam --ootepd \
         --astrom --apselect --phot --refselect --singlemagfit \
         --masterphotref --mastermagfit --mergeaps --dumplcs \
         --badframes --epd --plotlc --plotneighbors | \
         tee -a LOGS/fu-auto.log
```

- If necessary (e.g. astrometry fails on > 10% of images), use the --astrom_thresh, --astrom_order, --astrom_shrink --phot_aps --phot_lowmag or --epdbits options to improve the photometry.

- Check the $OBJECT_yyyy.mmdd_AP?.eps files that are created in the present directory and the files for neighbors created in the NEIGHBORPLOTS dir. If needed, redo epd using ootepd, use the -T $jdstart $jdstop option if the transit is obvious, or don't specify if it isn't.

Skip

```
cfhat10$ ./scripts/fu-auto.sh -h HTR136-001 -i kepcam \
         --force epd,plotlc,plotneighbors --ootepd \
         --epd --plotlc --plotneighbors -T $jd1 $jd2
or
cfhat10$ ./scripts/fu-auto.sh -h HTR136-001 -i kepcam \
         --force epd,plotlc,plotneighbors --ootepd \
         --epd --plotlc --plotneighbors
```

- If you would like to make changes to the plot (adjust yrange for example), copy fullplot.gp to the scripts/ directory and change that local version.

Below is an obsolete description of the reduction pipeline

Create basic directory structure

Suggested structure is the following:

- Standard location for analysis is (called $ANL)

```
cfhat10:/H/FU/FLWO/anl/yyyy.mmdd/$OBJECT/$USER
```

- Relink image dir under analysis:

```
ln -s /H/FU/data/red/yyyy.mmdd /H/FU/FLWO/anl/yyyy.mmdd/RED
```

- One may create directory for the (mini) project related to an object, especially if spanning multiple nights. This will be the $PROJ main project directory. Example:

```
mkdir /H/PROJ/hatuser/200809_HTR213-002/phot_gb
```

- Under $ANL, create subdirectories for various products: mkdir $PROJ/LC $PROJ/BASE $PROJ/LOGS

Run list generator

For example, create list for STID 102 = Piszkes Schmidt for a specific target that has coordinates given on the cmdline (important for calculating HJD, BJD). Save list to BASE/fp.lis.

```
        fiastrom.sh -i 102 --hatra 297.709244 --hatdec 48.080791 \
        --sfpin BASE/fp.lis ./RED/obj_*.fits
```

Here hatra and hatdec are the RA and DEC of the target to be followed up. For FU data (or, wherever hatra and hatdec are defined), the Z, HA, HJD, BJD, X output will be for the object itself. Otherwise it is for the field center as defined in the image header.

To run the list generator on a general set of wide-field HATNet frames, there is no need to specify the hatra and hatdec, as it should be the field center. Caveat: if the hatnet field is off-coordinates, for some reason, and the FITS frame center RA and DEC are also off, then this will modify the HJD/BJD calculation. **TODO**: clean up this loose end.

It may happen that there is not object name in the header, e.g. Konkoly Schmidt is notorius for poor header setup. Then one can define the HAT object on the cmdline. This is then inserted in the FITS headers. Note: this needs rw access to the FITS frames.

```
        fiastrom.sh -i 102 --hatra 297.709244 --hatdec 48.080791 \
        --hatobj HTR155-001 --sfpin BASE/fp.lis ./RED/obj_*.fits
```

TODO: Current BASE/fp.lis contains a full absolute pathname to the FITS files. Ie.. it resolves the symlinks. This can be harmful, as symlinks are maintained in the long term, but absolute locations not. E.g. /H/FU will contain the follow-up in the long term, but may point to another partition if we need to swap data.

Also generate keylist. For FLWO this is:

```
        gawk '{printf "%s-%s %5s %15s %3s %10s %10s %10s %10s %10s %10s %10s\n",\
        $1,$3,$4,$7,$5,$8,$9,$10,$11,$12,$13,$15}' fp.lis > keylist.txt
```

Astrometry

The default astometry order may be already defined in the fiastrom.sh script. To override, use the astrom_order flag.

We need a reference catalogue. This is typically 2MASS. Our astrophotometry scripts retrieve the 2MASS file into a proxy automatically. If there is need for taking into account proper motions, then there are two options.

- Create a new catalogue based on the fistar files. This option is also useful when the instrument yields better astrometry in general than the original 2MASS 1.3m telescope at FLWO. Then try to cross-match this new catalogue with the 2MASS to have the IDs of the stars correct.
- Apply proper motion to the 2MASS catalogue using known ppm data from e.g. UCAC2, and copy the new 2MASS catalogue to a new place. Here is an example:

```
        2mass_htr155001_ppm.sh BASE/2MASS_297.70_48.08_16.0_1.0_I.txt 2008-06-03
```

In any case, a high proper motion target can distort astrometry, and also will be measured at the wrong position with fixed centroid aperture photometry.

The example below also retrieves the 2MASS file into a proxy, IF it does not exist. Check the output *.trans file headers for the name of the 2MASS file.

Make sure that at the end the 2MASS file that was used is copied to BASE/. Also make sure that no multiple 2MASS files were used for the same object, i.e. the script does not select different proxies. By supplying --hatra and --hatdec on the cmdline this is ensured (**TODO:** check script for this statement). Optimally one selects a 2MASS catalogue in advance, copies it in the BASE/ directory, and uses the --astrom_cat cmdline argument.

Astrometry:

```
        fiastrom.sh -i 102 --astrom_order 2 --ab ANL --pb ANL --astrom \
        --fpin BASE/fp.lis >& fiastrom_astromphot.log &
OR
        fiastrom.sh -i 102 --hatra 297.709244 --hatdec 48.080791 \
        --hatobj HTR155-001 \
```

```
        --fpin BASE/fp.lis \
        --astrom --astrom_order 2 --ab ANL --astrom_cat BASE/2MASS.txt \
        >& LOGS/fiastrom_astrom.log &
OR
        fiastrom.sh -i 101 --ab ANL --pb ANL --astrom --astrom_order 1 \
        --hatra 209.389489 --hatdec 43.493534 --hatobj HTR145-002 \
        --astrom_shrink 2 --astrom_thresh 3000 --astrom_cat BASE/2MASS.txt \
        --fpin BASE/fp.lis  >& fiastrom_astrom.log &
```

Check astrometry success rate. If the success rate is low, then finetuning is needed. Possibilities:

- Display FITS frame, overlay the stars found by fistar.

```
        ~/s/HATpipe/scripts/genutils_scr/fitsview.sh fits/R0603.HTR213-002.fits
        ~/s/HATpipe/scripts/genutils_scr/tvmark.sh <something>.fistar -x 2,3
```

- Count the number of stars in the catalogue (2MASS file) and the fistar files.

If there are too many or too few stars in fistar, or some are bogus, then tune the threshold and fits shrink factor:

```
        fiastrom.sh -i 101 --hatra 47.368964 --hatdec 30.673594 \
        --hatobj HTR213-002 \
        --fpin BASE/fp.lis \
        --astrom --astrom_order 2 --astrom_shrink 2 --ab ANL --astrom_thresh 6000 \
        > LOGS/fiastrom_astrom.log &
```

TODO: Separate 2MASS file is needed for various steps. For astrometry we need only the kosher stars (AAA). We may want to avoid high ppm stars. We may not want to go very deep. For photometry we would like to measure the flux of all sources on the frame, including those that are AAC, or UAC, etc. We may need deeper limiting magnitude.

TODO: Diagnostics at the end of the run on the success rate.

Initial characterization of frames

For the choice of apertures, it is important to know the typical S,(D,K) values. On way is to do astrometry with saving the match-files, and then grepping for specific targets, then plotting the time evolution of SDK. In this case the photometry needs to be done at a later stage.

For example, a rough way to check SDK:

```
        for i in ANL/*/*fistar; do
                echo -n $i "";
                gstater -c 6 -i $i -d --terse;
        done | \
        sed -e 's|101-R| |g' -e 's|\.fistar| |g' -e 's|\.HTR| |g' | \
        gawk '{print $0, 2.35*1/sqrt($5)}' > sdk.txt
        gnuplot> plot "sdk.txt" u 2:6 w lp
        # Final apertures:
        #
        gstater -i sdk.txt -c 5 -d --terse | \
        gawk '{medf=int($2 * 10)/10;
                # Typical usage
                ap1 = 1.2 * medf;
                ap2 = 1.6 * medf;
                ap3 = 2.0 * medf;
                # High background, faint star:
                #ap1 = 0.5 * medf;
                #ap2 = 0.75 * medf;
                #ap3 = 1.25 * medf;
                an  = 3 * medf;
                dan = 2 * medf;
                printf "%.1f:%d:%d,%.1f:%d:%d,%.1f:%d:%d\n",
```

```
            ap1, an, dan, ap2, an, dan, ap3, an, dan;
    }'
```

TODO: We need a script for initial characterization. Results must be merged with fp.lis, or kept in a separate file, with file-names, JDs and other unique identifiers matched. Keep in mind that at the end we would like to plot not only the light curve, but also the variation of S, D, K as a function of JD.

TODO:: If the target name is not HTR, but e.g. WASP-12, then the above simple SDK script does not work.

Photometry

At this stage one can check the median FWHM on the frames, or the history of the FWHM during the night. Based on that, we can select aperture series, such as 1x, 1.5x and 2x FWHM, or other values based on other considerations.
TODO: Need little script for this, or function within fiastrom.sh

Run photometry:

```
    fiastrom.sh -i 102 --hatra 297.709244 --hatdec 48.080791 \
    --hatobj HTR155-001 \
    --fpin BASE/fp.lis \
    --astrom --astrom_order 2 --ab ANL --astrom_cat BASE/2MASS.txt \
    --phot --pb ANL --sdkfit >& LOGS/fiastrom_astrom.log &
    fiastrom.sh -i 101 --hatra 47.368964 --hatdec 30.673594 \
    --hatobj HTR213-002 --fpin BASE/fp.lis \
    --astrom_order 2 --astrom_shrink 2 --ab ANL --astrom_thresh 6000 \
    --phot --pb ANL --phot_aps 3.5:21:14,5.3:21:14,8.9:21:14 \
    --sdkfit >& LOGS/fiastrom_phot.log.2 &
```

Further characterization of the frames

For selecting ideal photometry reference we could characterize:

- Image background mean
- Image background standard deviation
- Image background large scale variation
- Extinction (based on photometry in large aperture of few selected stars)
- SDK params
- Tracking errors

TODO: We may need a script for this finer characterization. We need to generate a master file with all these data as a function of unique frame identifier and/or JD, so later on these quantities can be plotted.

Here is a real temporary way of checking the instrumental lc of a selected star:

```
    zcat ANL/HTR213-002/*phot.gz | grep HAT-213-0001977 | \
    sed -e 's|101-R|101 R|g' > foo
    grmatch -r BASE/fp.lis -i foo --match-id --col-ref-id 3 --col-inp-id 3 \
            -o foo2
    gnuplot> plot "foo2" u ($7 - 2454000):29
```

Select single photref

Select in some way the single photref. E.g. check BASE/fp.lis for the smallest zenith distance, or bring in other considerations.

- Copy the selected phot file to BASE/
- Uncompress

- Symlink, zero version
- Truncate

```
        cp ANL/HTR155-001/102-obj_268.phot.gz BASE/
        gunzip 102-obj_268.phot.gz
        ln -s 102-obj_268.phot sphref0.phot
        sreftruncate.sh sphref0.phot > sphref.phot
```

After this, if we do photometry follow-up mode, then exclude any star that is within a critical radius, as compared to the target. Also exclude the target in photometry follow-up mode.

TODO: We need better tools for this selection. For HATNet, the selection was based e.g. on MySQL tables, and was very fast.

Single magnitude transformation

```
        mfit_grcol_v7S.sh HTR155-001 2 1 > LOGS/mfit_grcol_v7S.log 2>&1 &
```

Output: BASE/sgrcolstat.AP?.txt

TODO: What to do when we have multiple nights on the same object. Is can be advantageous to use the same sphref.phot for all nights. On the other hand, there are situations when per night magnitude master files are more of an advantage.

A solution is to modify mfit_grcol_v7S.sh and change the save_phot_output flag to 1. Then do a grand grcollect on all photS files.

```
    grcollect - -V --stat count,median,mediandev,medianmeddev --col-base 1 \
        --col-stat 16 --max-memory 2g --tmpdir $TMP \
        --output ${STATFILE}
```

TODO: The magnitudes for individual apertures can be fitted simultaneously with the magfit.sh utility (bash shell function by apal@).

Create master photref

```
        mphref_create.sh BASE BASE/2MASS.txt
```

In case you would like to use the same stars as comparison for all three apertures, then:

```
        gawk '{print $1}' BASE/sgrcolstatsel.AP*.txt | sort | uniq -c | \
                gawk '$1 == 3 {print $2}' > BASE/refstar_all.txt
        # Possible manual edit to exclude or add stars.
        for AP in 1 2 3; do
                idmatch -f BASE/sgrcolstatsel.AP${AP}.txt BASE/refstar_all.txt | \
                        gawk '{print $1,$2,$3,$4,$5}' > foo
                mv foo BASE/sgrcolstatsel.AP${AP}.txt
        done
```

- Possibly add stars by hand to the selected list by hand.
- Possibly delete some by hand, e.g. those having suspiciously low rms, or are outliers for some other reason.

Master photref transformation

```
        mfit_grcol_v6M.sh HTR155-001 2 1 4G >&LOGS/mfit_grcol_v6M.log
```

Here the arguments are "OBJECT", "XY order", "Color order" and maximal memory to use.

Merge photometry files

```
photapsmerge.sh ANL/HTR155-001 > LOGS/photapsmerge.log 2>&1
```

TODO: This step must be obsoleted. We can now fit all three apertures simultaneously. No need for

---

Dump raw light curves

Note: you need keylist.txt for this step! **TODO**: This step and dependency must be eliminated.

```
fiastrom.sh -i 102 --fpin BASE/fp.lis --ab ANL --pb ANL \
--sdktrans >& LOGS/fiastrom_sdktrans.log &
```

Create bad-frame list

```
IMG-5-XFRAMES.sh > IMG-5-XFRAMES.log 2>&1
# Count the number of kosher lcs, e.g. this is 53730
minnum=$(gstater -c 2 -i BASE/mgrcolstat.AP1.txt -d --terse | \
    gawk '{print $2/2}')
koshernum=$(gawk -v minnum=$minnum '$2 > minnum {print}' \
    BASE/mgrcolstat.AP1.txt | wc -l)
gawk -v koshernum=$koshernum '
    $2 > koshernum/2.0 {print $1}' fscount.dat > BASE/outlier.txt
```

Note that BASE/outlier.txt MUST exist. Otherwise the next steps will fail. It can be an empty file.

Run EPD

This is the **first iteration** that runs on the entire lc:

```
fiastrom.sh --massfile BASE/2MASS.txt --pr BASE --epd LC --ncpus 1 \
        --fpin BASE/fp.lis >& LOGS/fiastrom_epd.log
```

At the **second iteration**, we need to know the transit start and end. This may be obvious from the lc. But if not, then the ephemeris has to be used for estimating it. Here is an example:

```
E = 2454346.83718
P = 4.88778574
zeta = 22.78
p = 0.0854
b2 = 0.707
dur = 2/zeta * sqrt( ((1+p)^2 - b2) / (1-b2) )
start = E - dur/2 + 73 * P
end = E + dur/2 + 73 * P
fiastrom.sh --massfile BASE/2MASS.txt --pr BASE --epd LC --ncpus 4 \
        --fpin BASE/fp.lis --epd_dumpmode full \
        --jd_epd1 $(gawk '{print $1}' BASE/tredge.txt) \
        --jd_epd2 $(gawk '{print $2}' BASE/tredge.txt) \
        --epdbits 111110010 > LOGS/fiastrom_epd.log
```

Using existing BLS parameters this is much simpler. Example: **TODO**.

EPD BITS are: X Y S D K HA Z BG BGDEV

If the lc has no enough points outside of transit, then the number of EPD parameters need to be decreased, e.g. HA and ZD is left in, everything else not fitted for.

The EPD parameters need to be checked. Their domain for the outside transit points must be larger than that for the intransit points.

Reconstructive EPD

This means fitting a function to the transit, and using all the residuals for EPD. Scripts for this: **TODO**.

Alternative: leave the lc as-is. During the transit modeling, not only fit for the transit parameters, but also introduce some trend parameters, e.g. HA, ZD, etc. and perform simultaneous fitting.

In any case, we need to retain the EPD parameters for the new lcs, i.e perform a **full epd**:

```
fiastrom.sh --massfile BASE/2MASS.txt --pr BASE --epd LC --ncpus 8 \
        --fpin BASE/fp.lis --epd_dumpmode full >& \
        LOGS/fiastrom_epd.log.3 &
```

Output (this part not broken to 80char on purpose!):

```
# NAME               BJD - 2400000 MAG1      MERR1   S1 MAG2      MERR2   S2 M
# 1                  2             3         4       5  6         7        8 9
#
101-R0196.HTR145-002 54216.6701800 11.37678  0.00165  G 11.29792  0.00165  G 1
```

Desired output

Upper panel: plot of BJD (lower X axis) and frame number (upper X axis) vs. magnitude (Y axis). We need errorbars on the magnitude (formal errors). HTR target name clearly in the header.

Lower panels:

- Instrumental raw magnitude of target as function of time (t)
- Target background and its standard deviation (as error-bars) as function of time.
- FWHM (t)
- D, K (t)
- X position of target (t)
- Y position (t)

Repeat the same plot for:

- 3 similar brightness stars in the field that were used as comparison
- Any nearby star (within 5 x FWHM)

Edig, and then use fullplot.gp to plot the output and the above diagnostics.