StarDICE PoC paper preparation

StarDICE collaboration
LSST Calibration workshop @ LPNHE

Reminder : Experiment

Goal : Flux calibration of the survey - potential alternative to WD. (SRM PC6)

Hamamatsu S2281

Detector

Source

NIST calibrated photodiode

convenient and stable light source

DICE: 24 LEDs from near UV to near IR

Telescope (small aperture) + camera

Astronomical standards

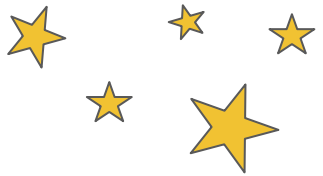
Hayes experiment (setup 10x more stable and smaller distance)

Site: OHP (atmospheric data available, simple logistics)

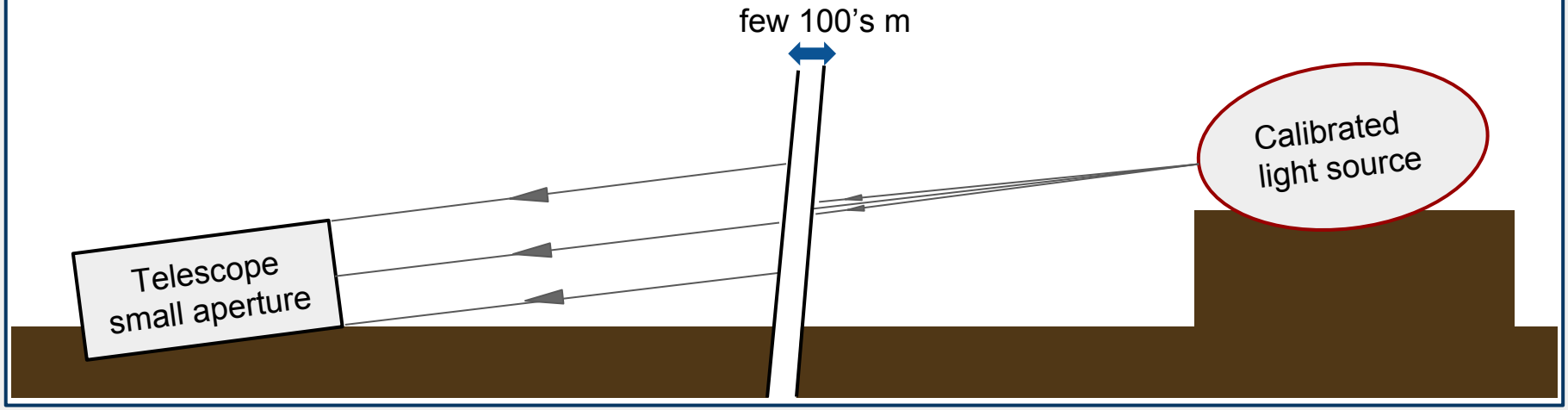
Specificity: Science and calibration beams very similar

Reminder : Experiment

Goal: broadband flux calibration transfert at **0.1%**

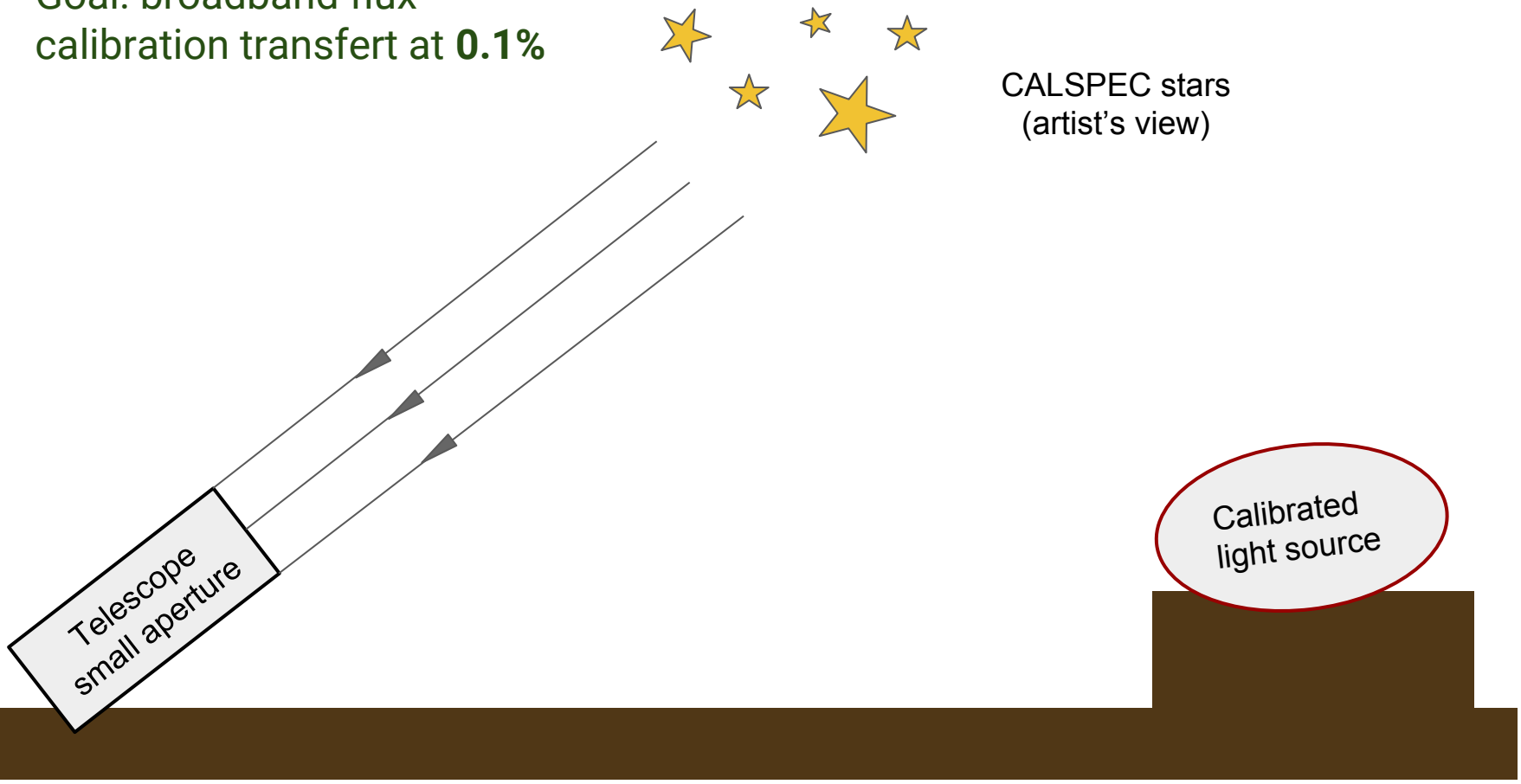


CALSPEC stars
(artist's view)



Reminder : Experiment

Goal: broadband flux calibration transfert at **0.1%**



Setup @ OHP

Data taken over six months @ OHP

- **Goal** : reach the %
- CALSPEC :
  - 2260 astrometry confirmed CALSPECs
- LEDs :
  - 1320 exposures over 12 nights with Filter (+ LEDOFF exposures)
  - 59 exposures without Filter (open transmission)
  - 15 exposures with GRISM
  - 16 stable LEDs (< 1%), 4 noisy (including 3 very faint)
- Dark exposures : 383
- Twilight : 851

Problems in July

During the May-June break of observations : fall of the protection cover of the LED head.

Contamination of the LED head by hornets nests:

- 4 channels obstructed
- Temperature monitoring lost

Observation week completed and calibration source brought back to the bench at LPNHE for cleaning, examination and calibration

First draft of analysis on LEDs

- Bias and dark subtracted from raw images.
- Flat-fielding applied.
- LED-OFF images subtracted.
- Aperture photometry in radii between 2 and 24 pixels.
- 4 Noisy channels excluded.
- July images excluded (no temperature).
- We compute the instrumental magnitude : $m = -2.5\log(\Phi_{14})$, with Φ_{14} the flux integrated in a 14 pixels aperture.

Those magnitudes modeled as follows:

$$\mathbf{m = zp}(\text{night}) \mathbf{+ m_0}(\text{led}) \mathbf{+ k}(\text{led}) \mathbf{*} (\mathbf{T - T_{mean}})$$

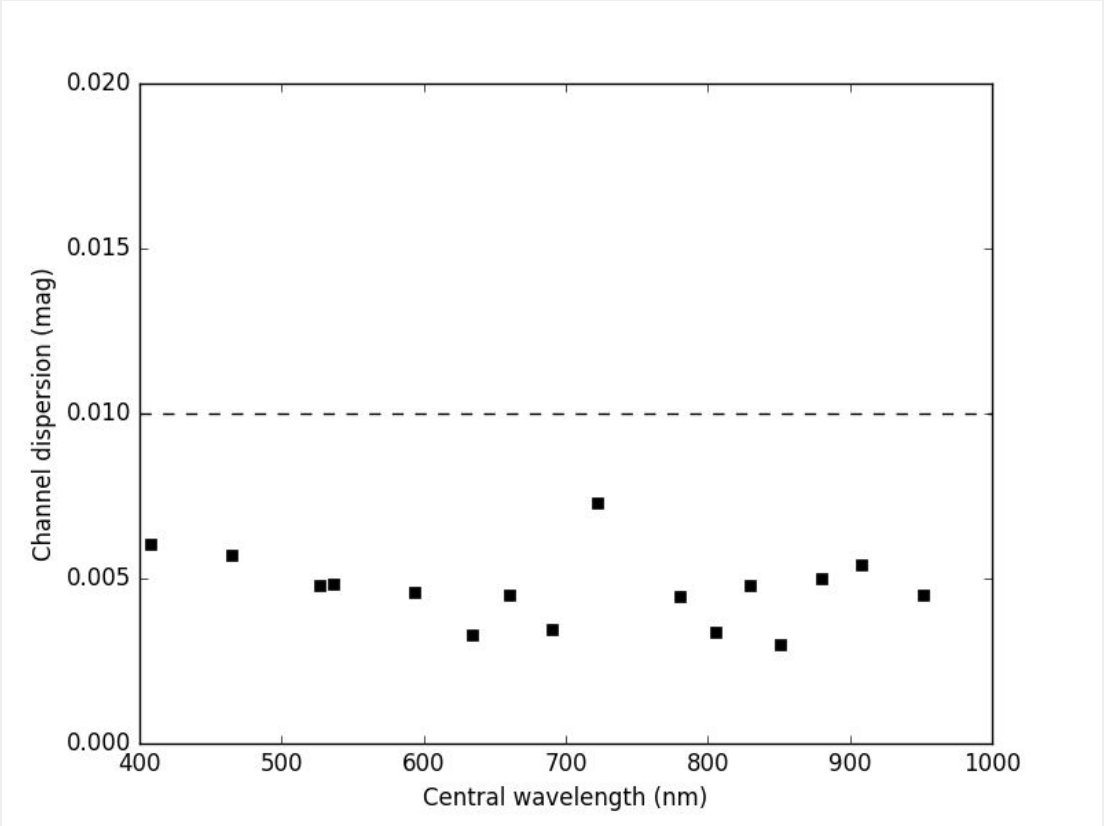
Results

Dispersion of the residuals of the fit in each channel in 3 months.

All channels below the % level.

Errors includes:

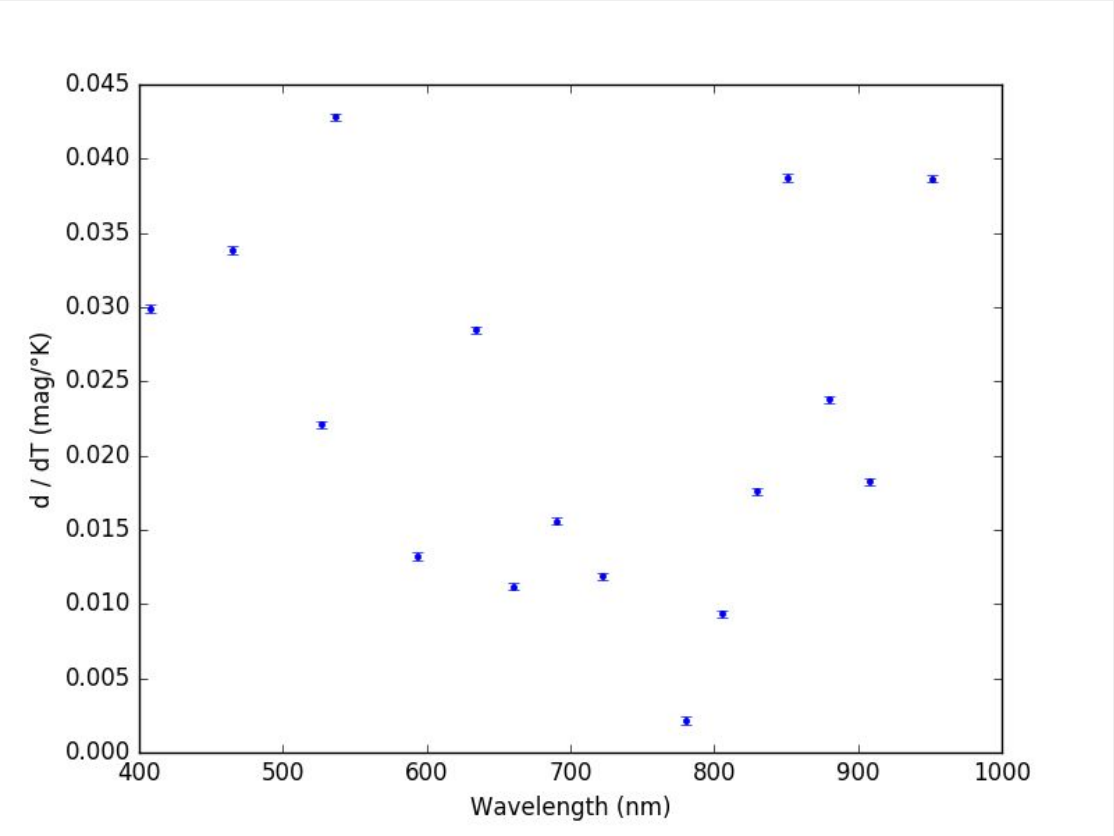
- LEDs variability
- Setup variability in a night



LEDs flux evolution vs T

Fitted **k** terms for all LEDs

- Error bars ~ 0.3 mmag/K
- →3mmag at ΔT = 10K
- LEDs Magnitude linear with T?



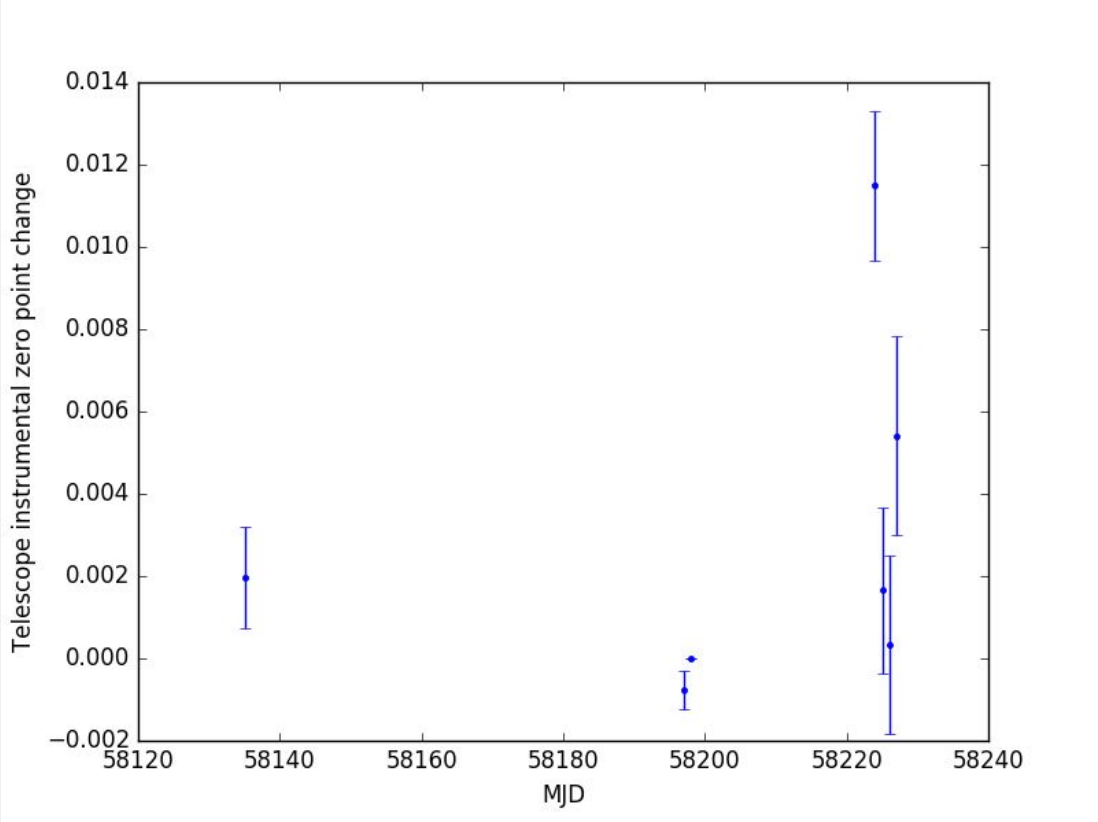
Evolution of ZP / night

Zeropoint relative to one reference night.

Not all the nights are “photometric” along the line of sight.

High variability between nights of a same run, probably due to:

- Telescope vibrations due to wind
- Absorption of the atmosphere along the LoS



LEDs back on Spectrophotometric Bench

LED head dismounted : hornets hatched during the process

Flux measurements on bench

Flux of each LED measured at temperatures between 8°C and 30°C

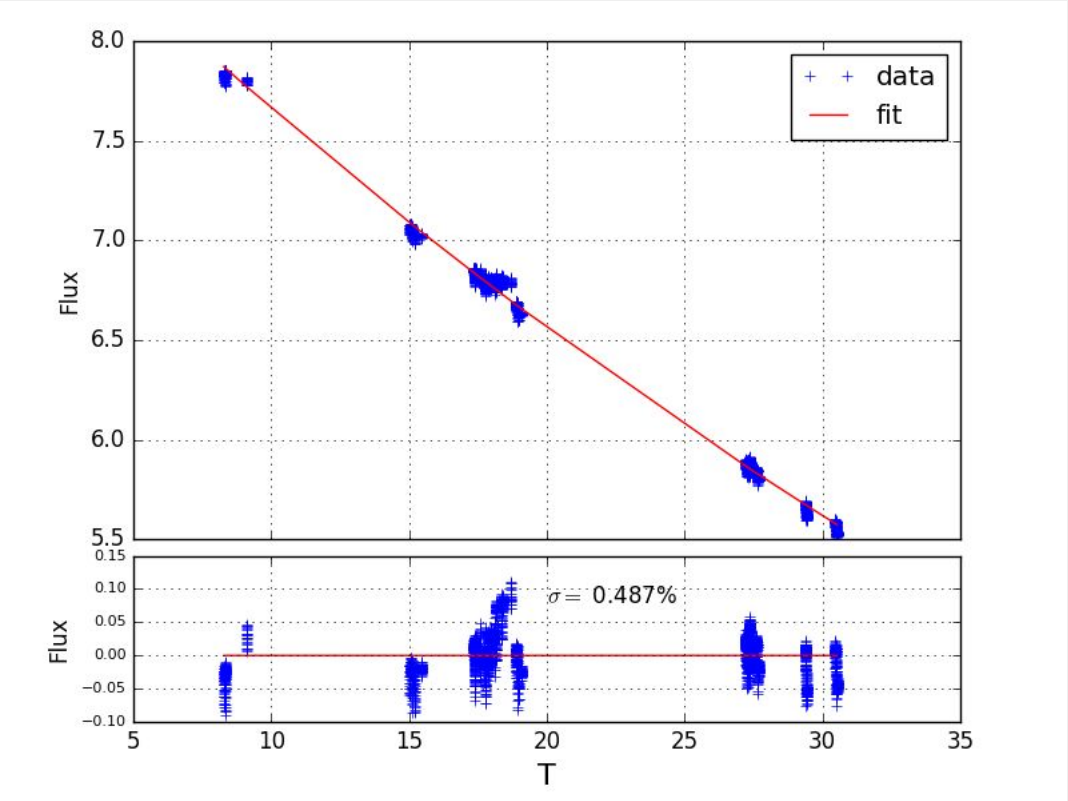
Linear evolution of LED magnitudes seems to be a good proxy.

Measurements dispersion oddly high

---> More temperature monitoring

Need:

- Better T sampling
- T < 8°C measurements



What's left to do for the LEDs?

- Spectra
  - Very low flux → can not use the NIST photodiode.
  - Trying to build a setup to measure flux with a CMOS calibrated by the photodiode.
- ---> **Spectrophotometric model** to get true telescope zeropoint for each filter + telescope open transmission (tension between mirror reflectivity measurements).

- Investigating ways to save the July data (without junction T measurement).
  - Modelization using mount temperatures has been found not precise enough (~3% uncertainty on flux due to LEDs temperature evolution)
- Investigate LEDs aperture corrections.

Concerning the stars

Analysis at its beginning:

- Quick study fitting one mag by star and one airmass term by night and by filter
  - Magnitude at 1.3% for each CALSPEC
- Need to understand the telescope open transmission using LEDs data
- Build an atmospheric model using:
  - A FGCM-like parametrization.
  - Ancillary data available from OHP.

Ongoing effort

- Preparing the Proof of Concept paper, with a complete calibration transfert at the % level, release estimated by 2018's end including:
  - Bench characterization of the instrument transmission (Camera QE + Filters + Gain)
  - Description of the raw data reduction
  - Details of the analysis
- R&D on the new low flux source being build at CPPM
  - That will be put on top of a mast at OHP
  - Simpler electronics, to go below 0.1% in stability
- Refurbishing of the old telescope mount + buying a new tube