StarDICE proof of concept
Summary and perspectives

Marc Betoule (LPNHE)
LSST/DESC calibration workshop,
Paris 2018

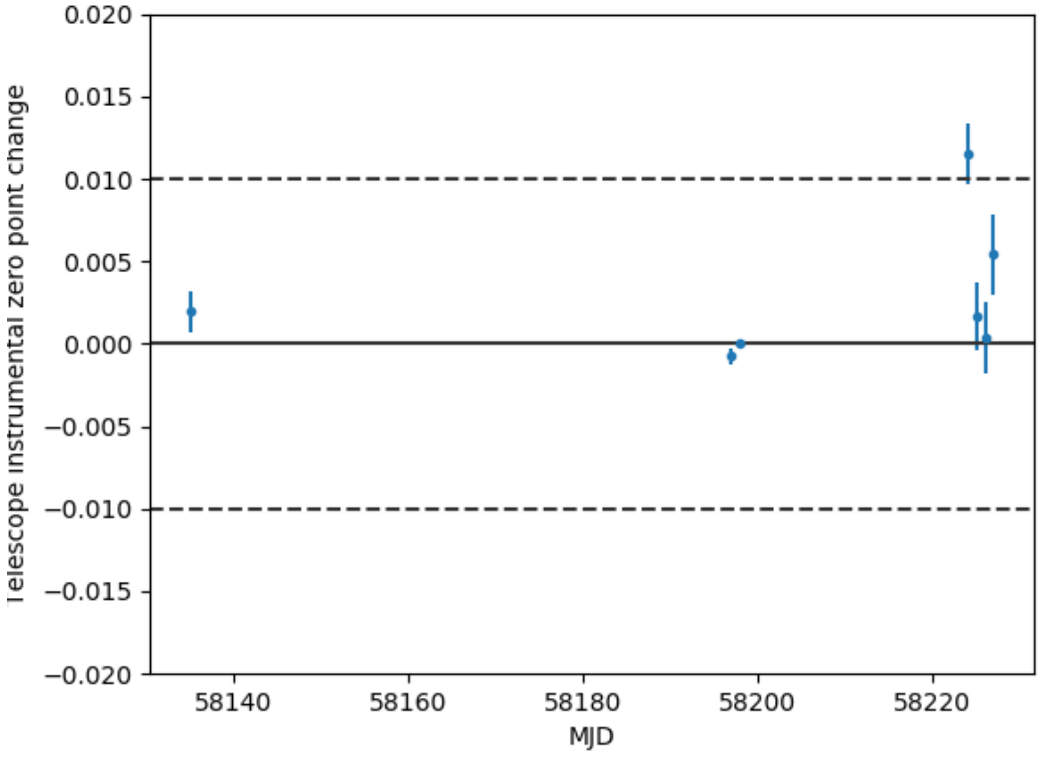
CPPM : O. Angelini, S. Beurthey, S. Deguero, F. Feinstein
LPNHE : P. Antilogus, P. Astier, Ph. Bailly, E. Barrelet, M. Betoule, S. Bongard, J. Coridian, A. Guyonnet, F. Hazenberg, C. Juramy, H. Lebbolo, L. Le Guillou, N. Regnault, Ph. Repain, K. Schahmaneche, E. Sepulveda
LUPM : J. Cohen-Tanugi, Eric Nuss, B. Plez
LAL : S. Dagoret-Campagne, M. Moniez
OHP : Pierre-Eric Blanc, Auguste Le Van Suu

Outline

- What we already learned from this test run
- What we can expect from the data we took
- Next step planning

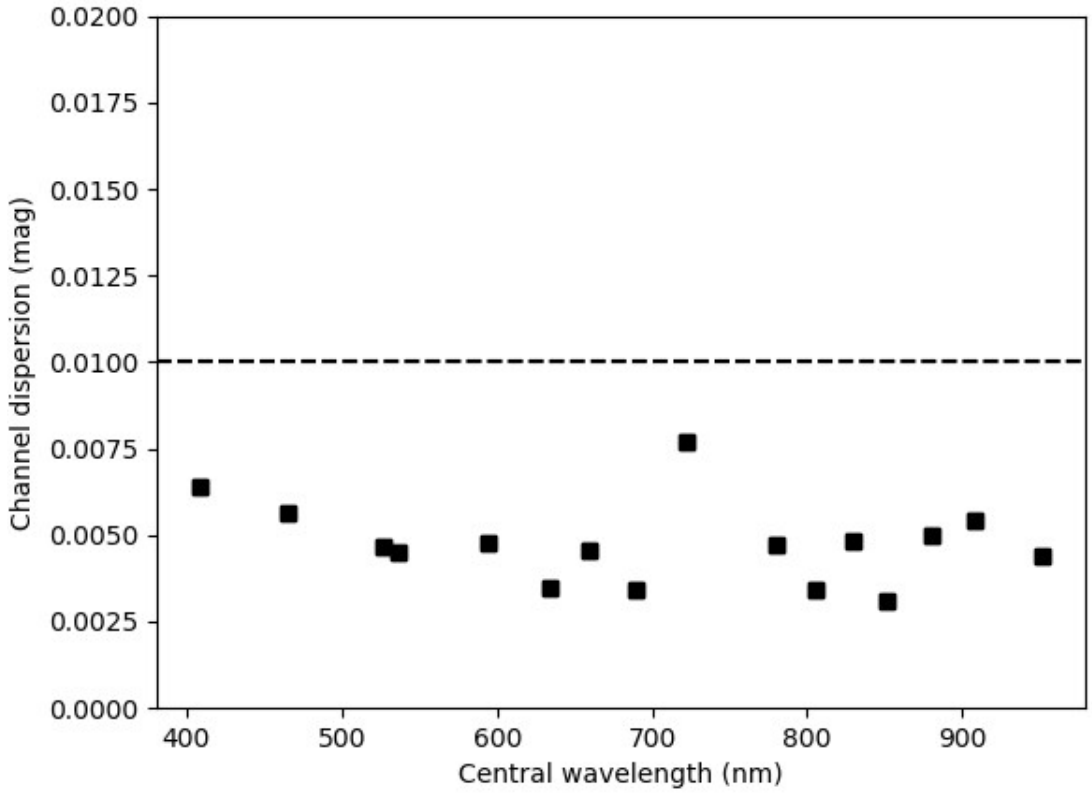
The concept works

- Observations of the artificial star delivers precise instrumental zero points
- And the zero point is very stable
  - Here over a three months period
  - All contrib. Included (aperture correction and temperature standardization errors)



Repeatability of led measurements is between 3 and 7 mmag

- 20 channels observed in 76s open shutter
- In principle we could reach the mmag level by accumulating 25 exp. in all channels in ~30min each night.
- Say 1 hour with realistic camera readout overheads
- Currently real time dominated by overheads in the LED head (20min for 76s open shutter)

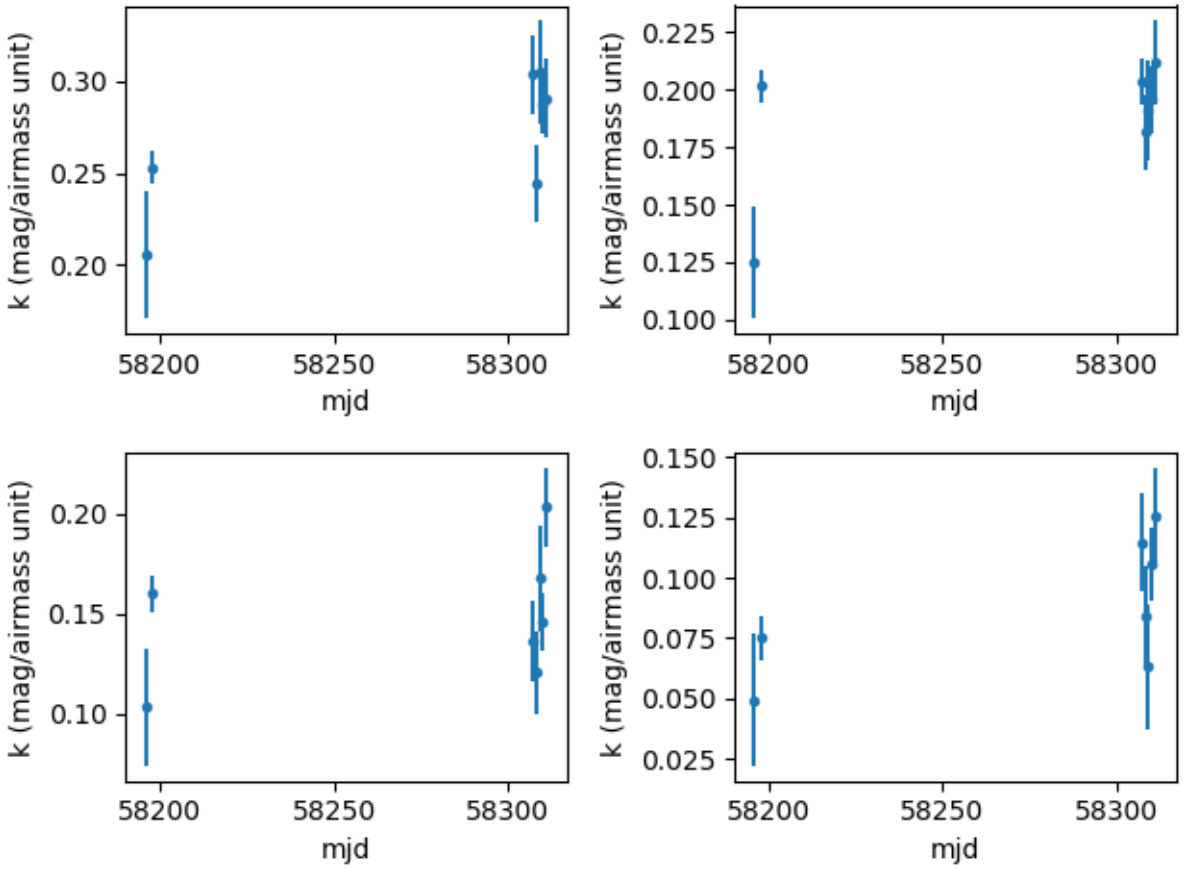


The final implementation requires an upgrade of the led head

- Better enclosure
- Better temperature monitoring
- Faster sampling

Our average determination of the nightly airmass term is at 2 %

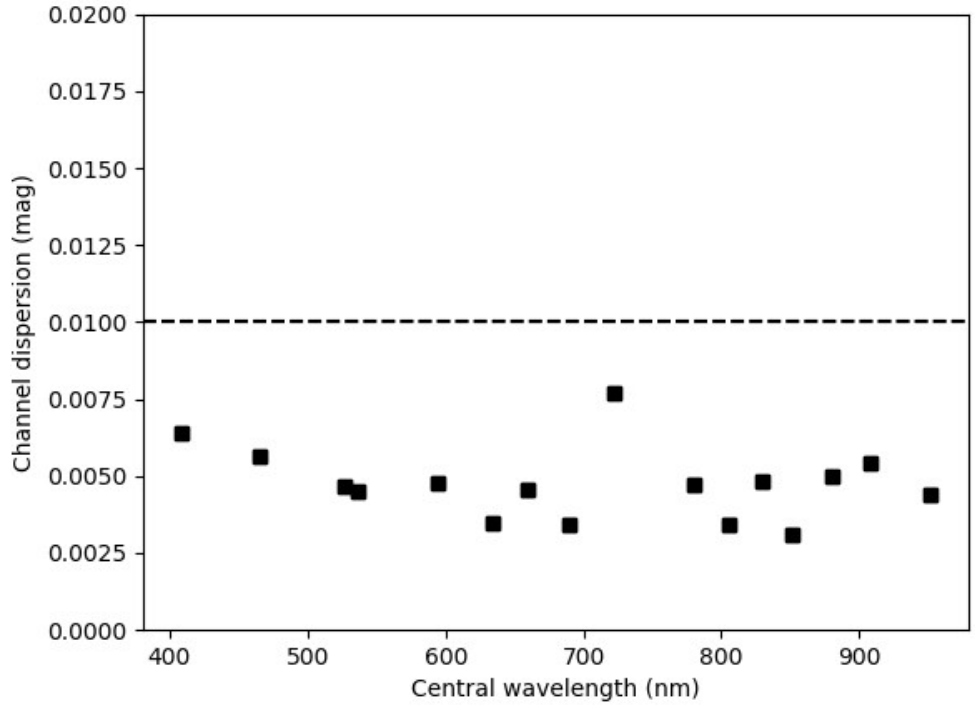
- We observed all spectroscopic nights (7/11)
- Best night determination is precise at 1 %
- But average is 2 %
- Beating such a noise would require ~400 (spectroscopic) nights
- Again large overheads (open shutter time on stars between 67 and 176 mins per night)



What is yet to be learn from those data ?

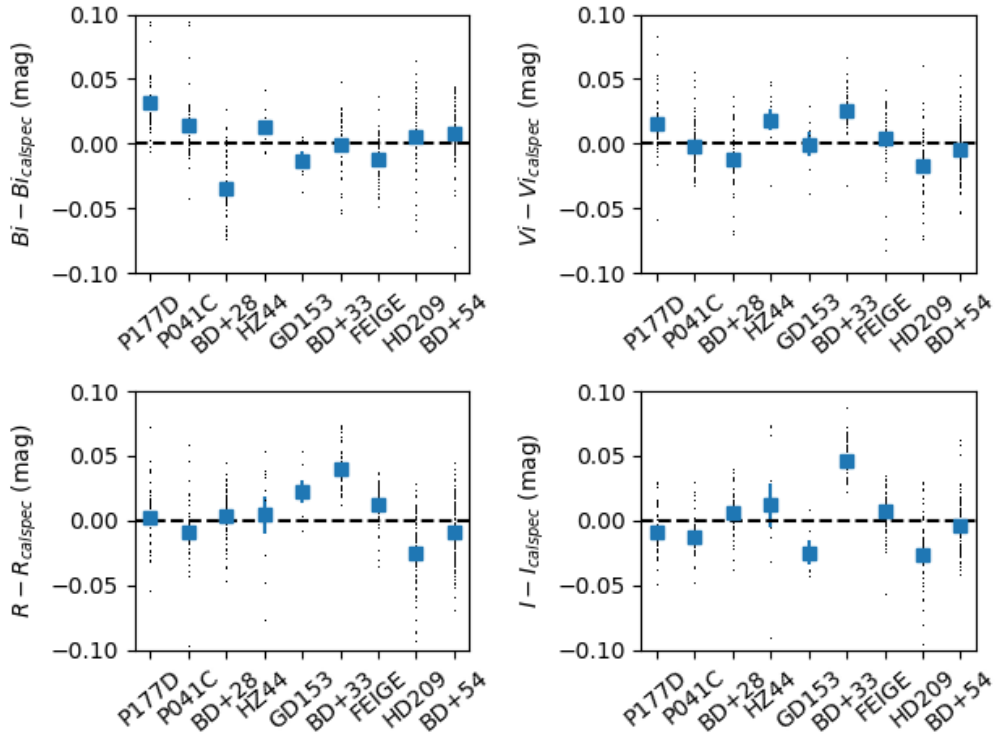
Disantangle the various contribution to the dispersion

- Photon noise is around 3 mmag
  - Background paid twice with this observation scheme
  - Yet we don’t want overbright LEDs to avoid other contributions (shutter noise and linearity in particular)
- Line of sight fluctuations ?
  - Interestingly the noisiest is on top of 0_2
- Variations of aperture corrections ?
  - Definitely yes but how much ?
- Spatial variations of the photometric response ?
  - Currently master flats from twilight
- LED noise ? Measured on bench



Toward a first CALSPEC/NIST comparison

- 9 CALSPECS/7 nights
- Dispersion of individual measurements ~3 %
- Dispersion of stars < 2 % in all channels
- Should be able to go below 1 % averaging all data
- Detailed analysis ongoing



This is in wait for bench calibration

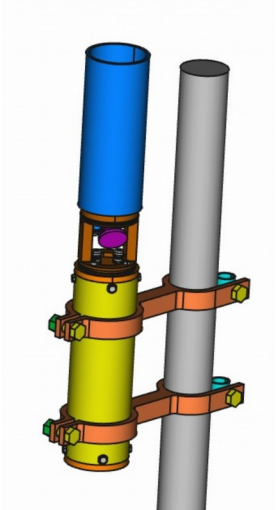
- We reached 0.01 % repeatability on the spectrophotometric test bench at the flux level we are considering here
- The bench has been upgraded and our first measurements are closer to 0.5 %
- Some time may be required to return to optimal operations
- Say 6 months to get a complete analysis of those data

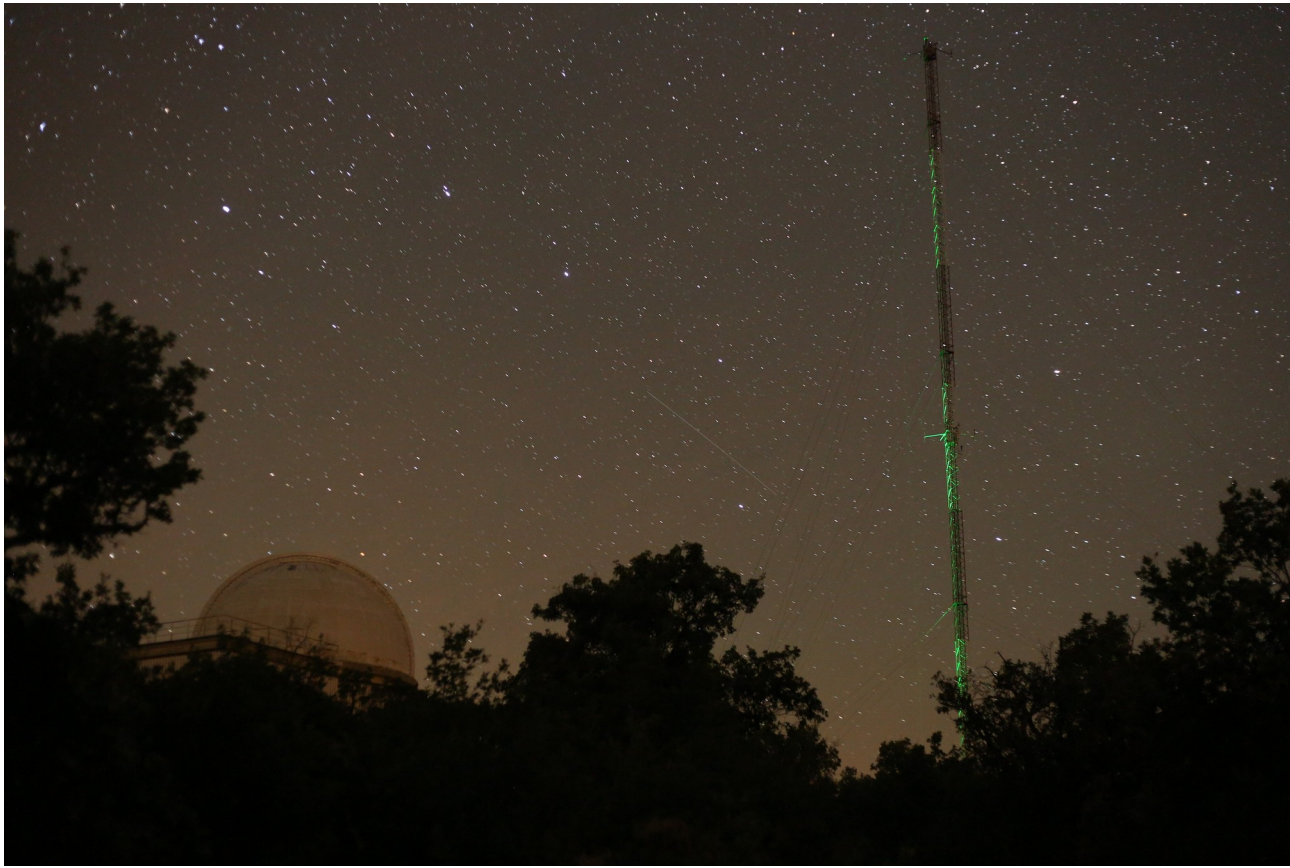
Main topic to be developped is the atmospheric transmission model

- Photometric constraints alone are a little bit weak
  - The 2 % number is conservative (even for the data presented not all stars in our fields)
  - Yet, not as many stars as in DES for exemple
  - Fully photometric nights are rare (10%)
- Ancillary monitoring to be developped
  - Starting with what is already available on site

Planned upgrade

- Better enclosure
- Second line of sight
- Ready to be tested (this winter)



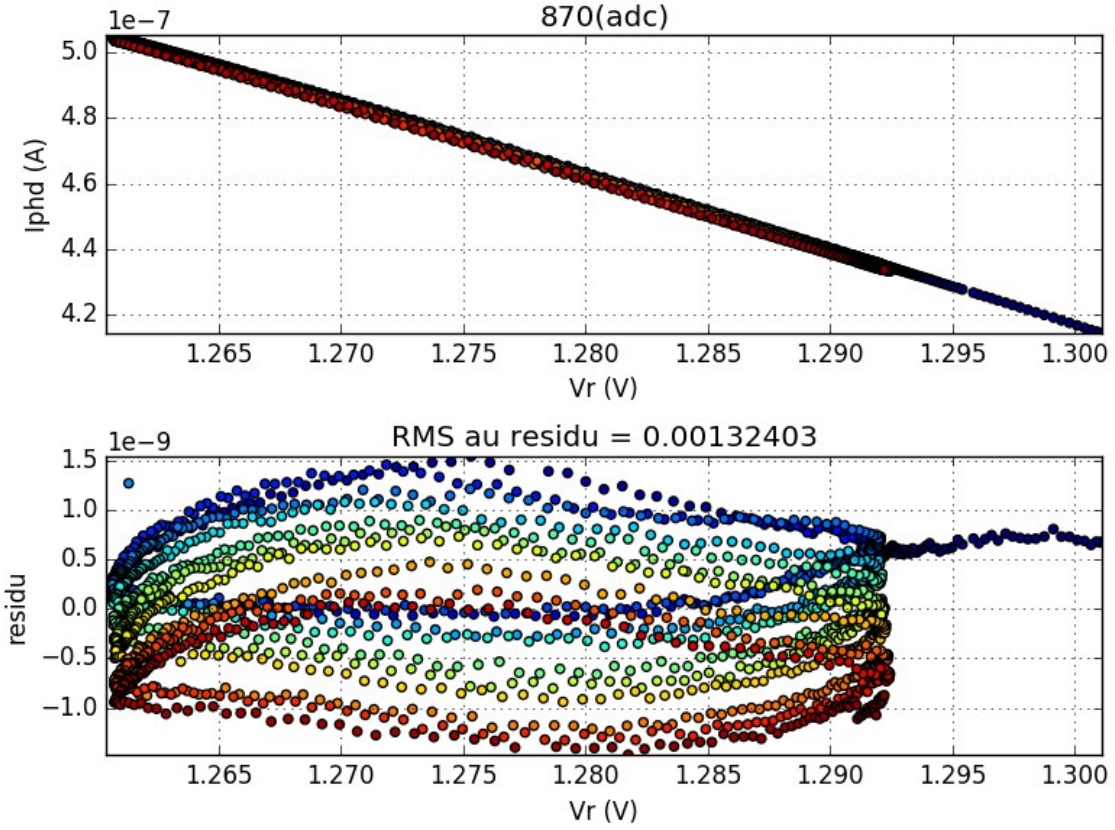


Planned upgrade

- Better (faster) mount (begining of next year)
- Better detector (Already available but caracterisation required, 6 months)
- Larger telescope (begining of next year)

Planned upgrade

- R&D for better LEDs Drive electronics
  - Very simple and inexpensive
  - The difficulty is the metrology
  - A six months development



Unplanned upgrades (how to go faster)

- Atmospheric transmission monitoring
  - Various ideas to detect a priori photometric sequences
  - Polaris monitoring
  - Line of sight sky temperature monitoring in the infrared
  - Spectro on second auxilliary telescope
- Add a monochromatic light source for detailed transmission study ?
- Repeat the measurement from a better site