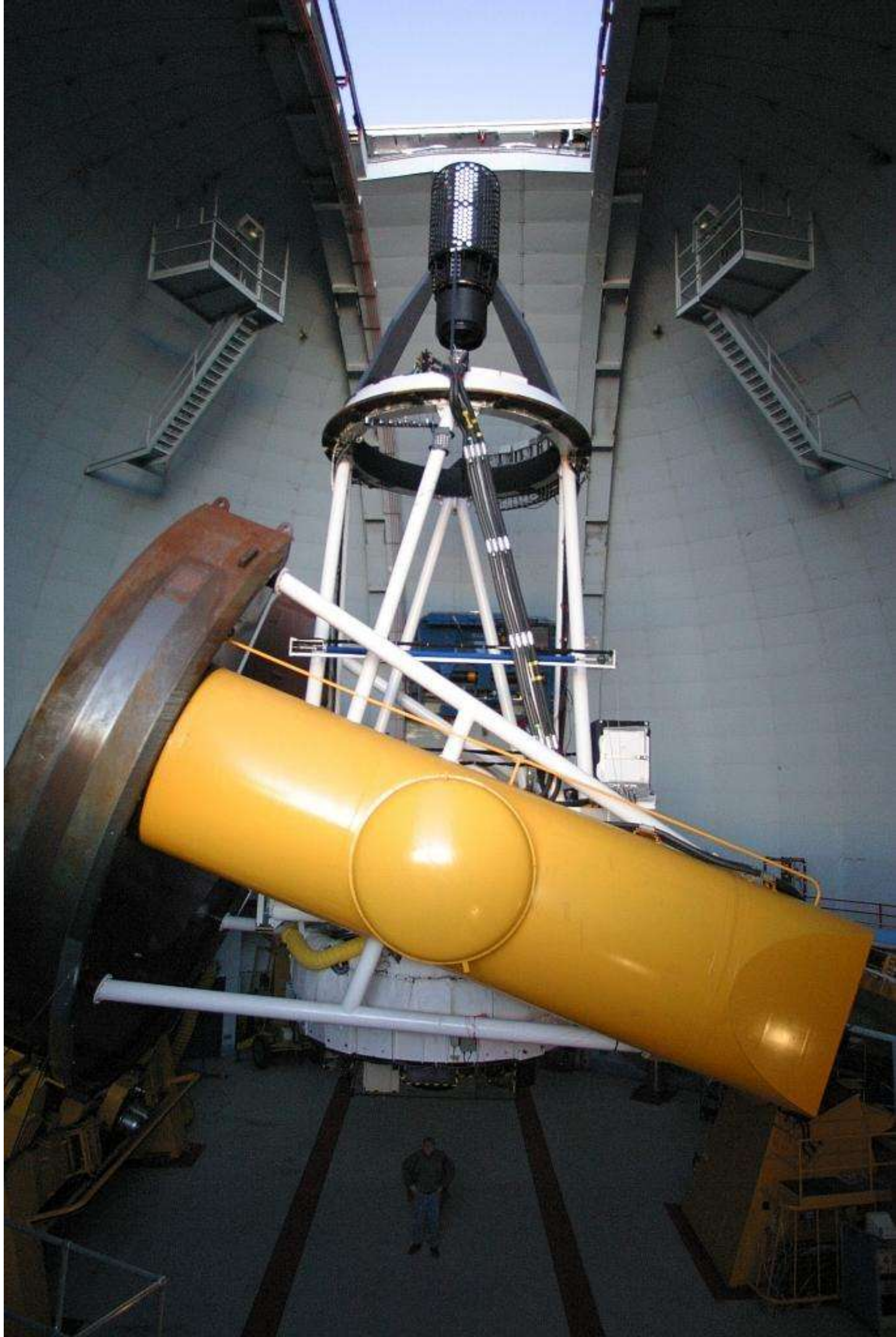
SNDICE

SuperNova

Direct Illumination

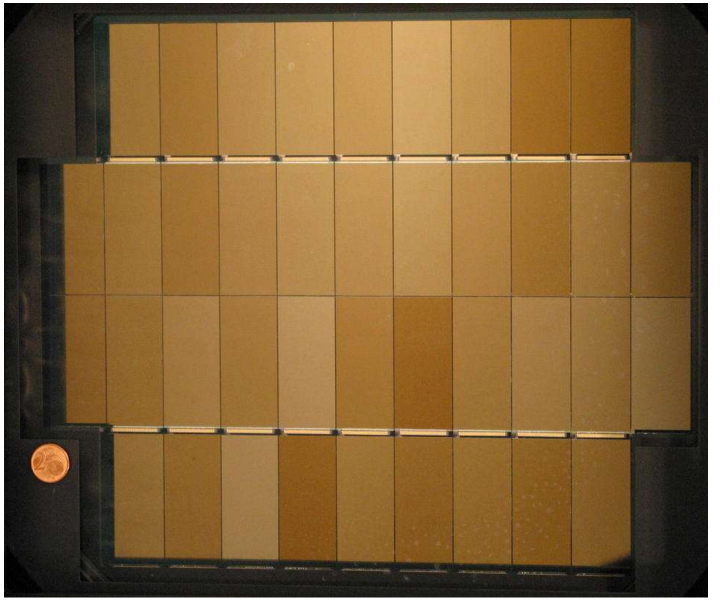
Calibration

Experiment



SNDICE

Megacam Instrumental Calibration



- On CFHT end of 2007 (duration > 1 y.)
- People involved :
  - E. Barrelet, C. Juramy ($\rightarrow$2006), K. Schahmaneche
  - SNLS Paris

    (P. Antilogus,P. Astier, J. Guy, D. Hardin, R. Pain, N. Regnault)
  - Engineering staff meca + elec

    (D. Vincent, W. Bertoli, C. Evrard, H. Lebolo, R. Sefri,

    A. Vallereau, P. Bailly, J-F Huppert)
- Total cost $\approx$ 125 k€

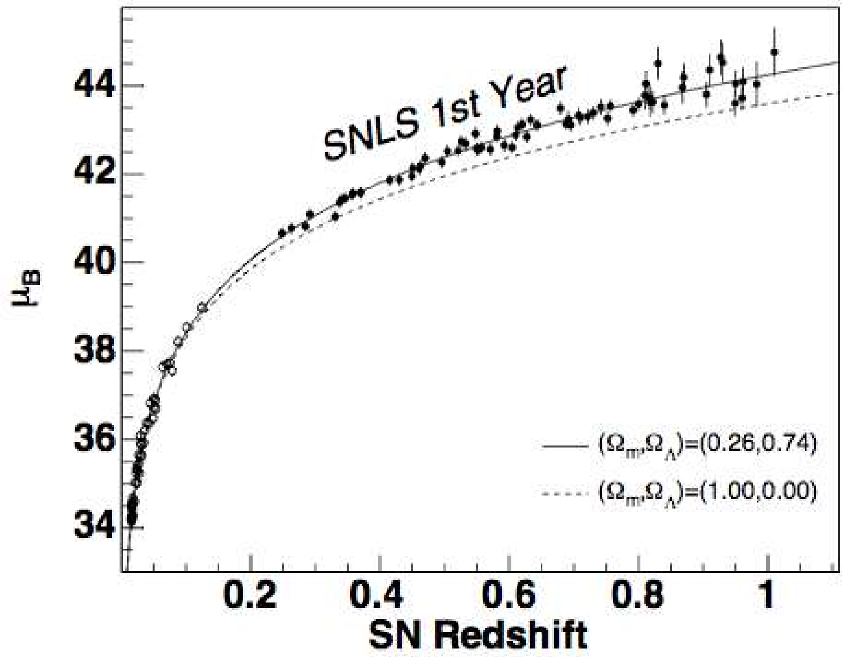
Luminosity Distances

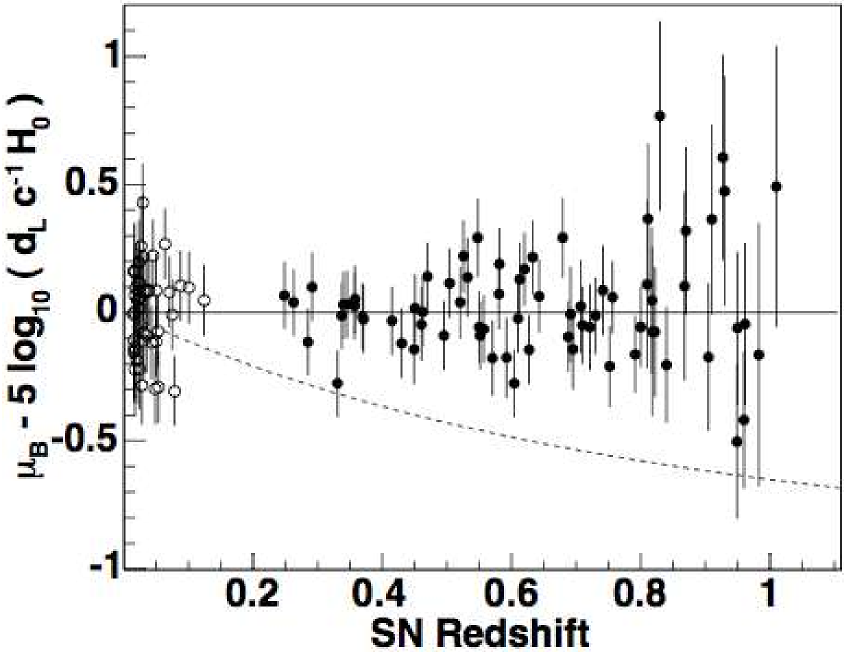
- High precision photometry
- Calibration between filters

Calibration

🡇

Uncertainties





OUTLINE

$$N^{ADU}_{x,y}(X,t,\Delta t) = \int \Phi(t,\lambda).T_{atm}(Z,t,\lambda).A.T_{opt}(t,\lambda).T_{filt\,X}(t,\lambda).QE(t,\lambda,x,y).G.\,\Delta t.d\lambda$$

- Scientific justification
  - Current calibration :
    $T_{atm}(Z,t,\lambda).A.T_{opt}(t,\lambda).T_{filt\,X}(t,\lambda).QE(t,\lambda,x,y).G$
  - Instrumental calibration :
    $T_{opt}(t,\lambda).T_{filt\,X}(t,\lambda).QE(t,\lambda,x,y).G$
- Project principles
  (LPNHE 2006-02) ➔ CFHT

Current Astronomical Calibration

$$T_{atm}(Z,t,\lambda).A.T_{opt}(t,\lambda).T_{filt\ x}(t,\lambda).QE(t,\lambda,x,y).G$$

Flatfielding

&

Non uniformities corrections

$$N^{ADU}_{x,y}(X,t,\Delta t) = \int \Phi(t,\lambda).T_{atm}(Z,t,\lambda).A.T_{opt}(t,\lambda,x,y).T_{filt\ X}(t,\lambda).QE(t,\lambda,x,y).G.\ \Delta t.d\lambda$$

$$\Downarrow$$

$N^{ADU}_{x,y}(X,t) / N^{ADU}_{x',y'}(X,t)$ ➔ QE(x,y) + "plate scale" variations

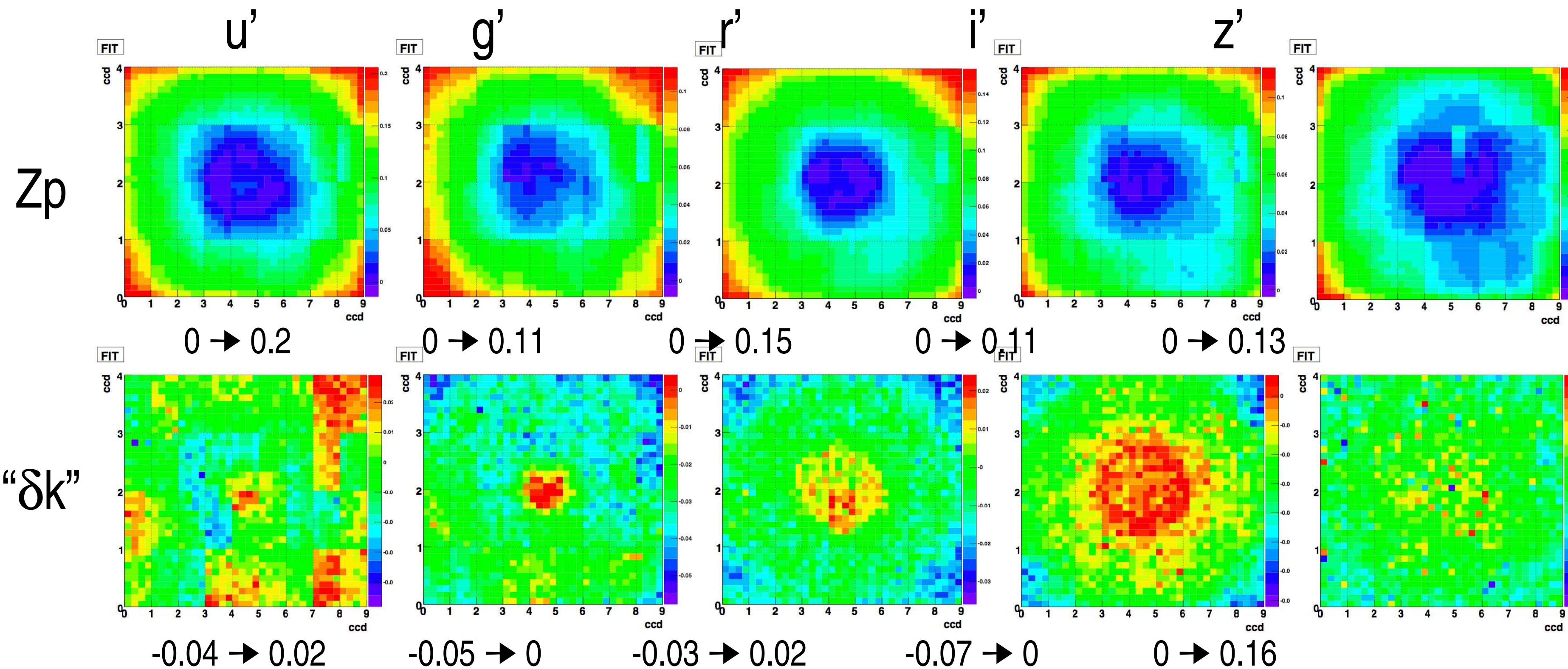
Twillight spectrum/science images spectrum ➔ $\Phi(t,\lambda)$

Scattered light ➔ beam geometry of $\Phi(t,\lambda)$

DENSE STARS FIELDS OBS.

➡ each of the 36 CCD divided in 4x9 cells

➡ non-uniformity of the camera : “zp” & “color term”



Reference spectrum

$$N^{ADU}_{x,y}(X,t,\Delta t) = \int \Phi_{Veg}(\lambda).T_{atm}(Z,t,\lambda).A.T_{opt}(t,\lambda).T_{filt\,X}(t,\lambda).QE(t,\lambda).G.\Delta t.d\lambda$$

1) Vega too bright

2) Spectrum uncertainties

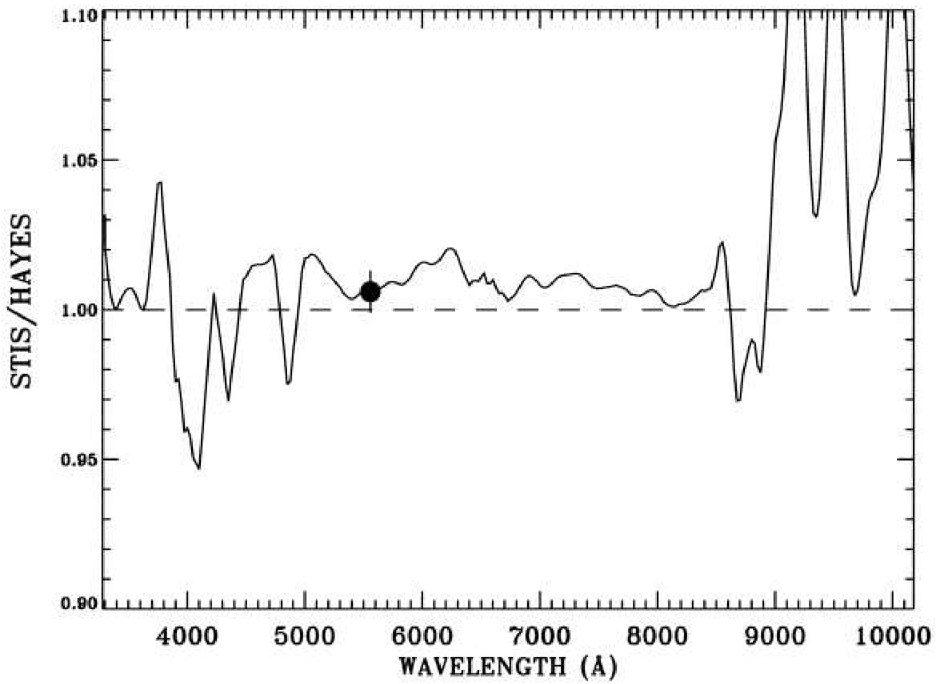
Bohlin

(HST + White Dwarfs ref)

vs

Hayes

(Ground based + Black body)

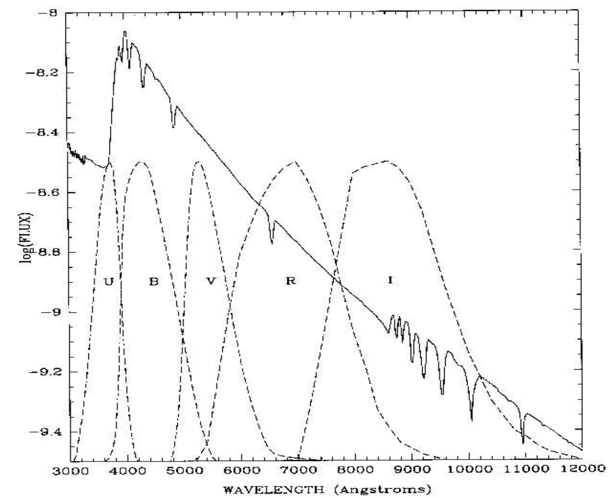


Standard stars catalogs

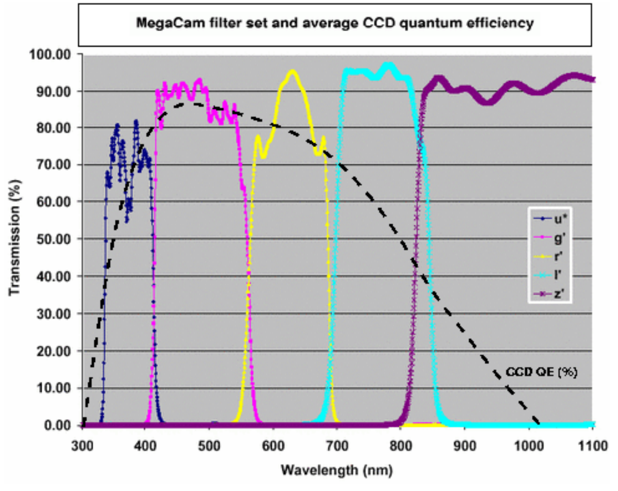
$$N^{ADU}_{x,y}\,(X,t,\Delta t) = \int \Phi(t,\lambda).T_{atm}(Z,t,\lambda).A.T_{opt}(t,\lambda).T_{filt\,X}\,(t,\lambda).QE\,(t,\lambda).G.\,\Delta t.d\lambda$$

X → X'

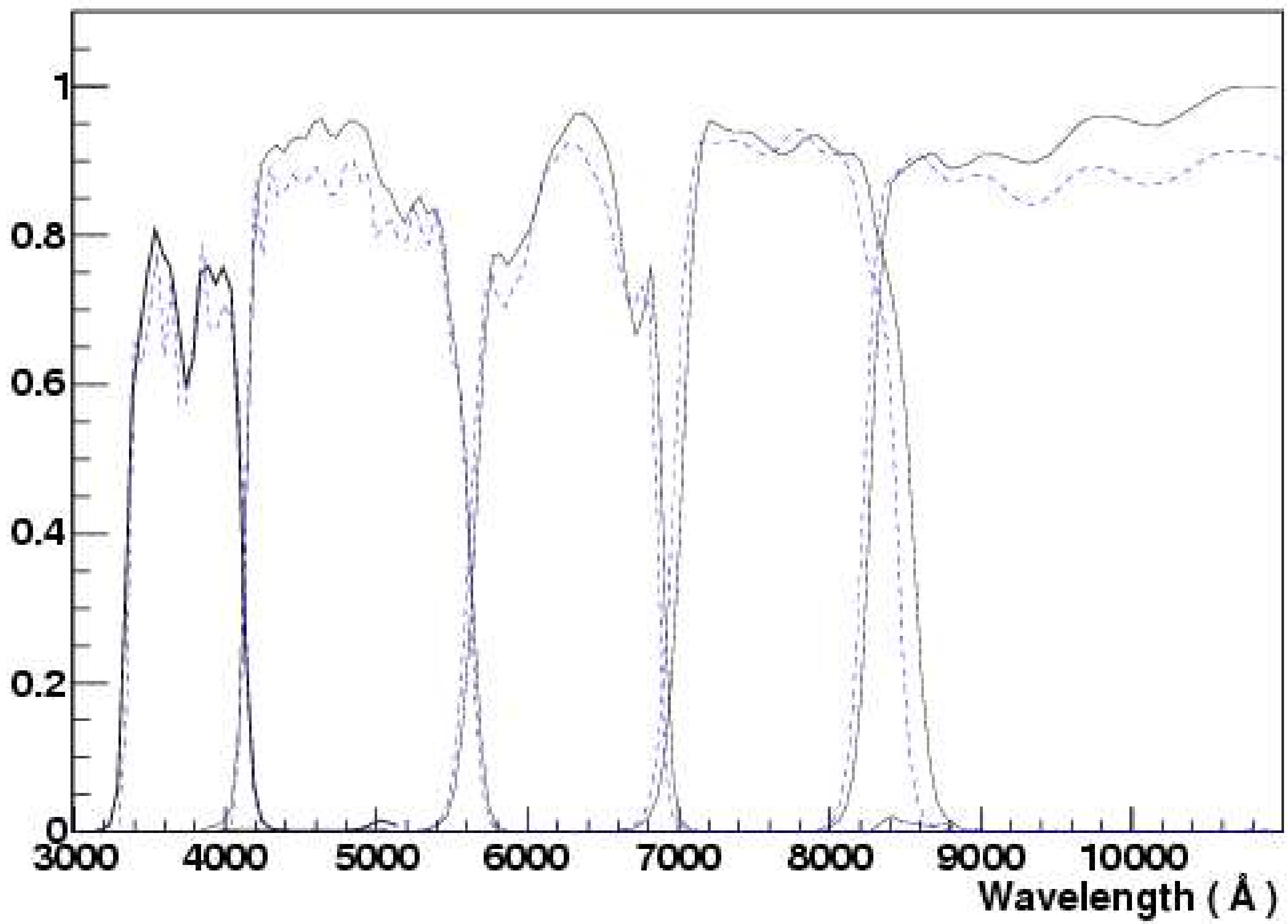
- Landolt system (X'=UBVRI)



- Megacam natural system (X=u*g'r'i'z')



CFHT Filters



Expected improvements

Bohlin spectrophotometric standards (HST)

$$N^{ADU}_{x,y}(X,t,\Delta t) = \int \Phi_{Ref}(t,\lambda).T_{atm}(Z,t,\lambda).A.T_{opt}(t,\lambda).T_{filt\,X}(t,\lambda).QE(t,\lambda).G.\,\Delta t.d\lambda$$

SDSS fields ➔ x,y dependancies

(CFHT system ≈ SDSS system)

Instrumental Calibration

$T_{opt}(t,\lambda).T_{filt\ x}\ (t,\lambda).QE\ (t,\lambda,x,y).G$

Instrumental calibration

- Stable, multi-λ, *calibrated* source

➜ $R(\lambda)$ of the instrument

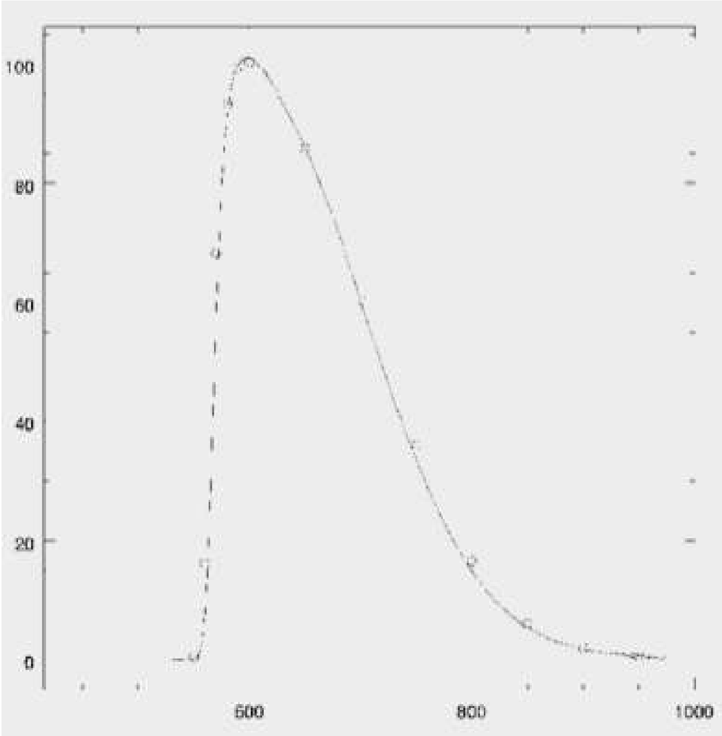
$$R(t,\lambda,x,y) = T_{opt}(t,\lambda,x,y).T_{filt\ X}\ (t,\lambda,x,y).QE\ (t,\lambda,x,y).G$$

- Limit : modeling the atmosphere

$$T_{atm}(Z,t,\lambda)$$

Tunable Laser (C. Stubbs)

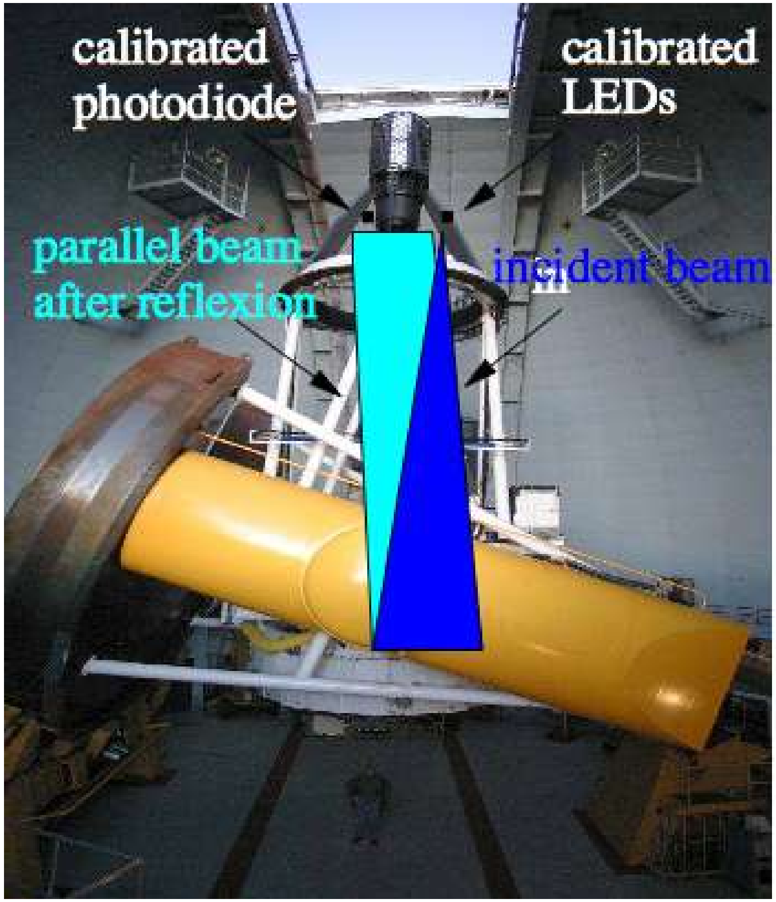
- Principle :
  - Tunable laser illuminating flat screen
  - NIST calibrated photodiode
- Benefits :
  - fine measurement of R(λ)
- Complementary R&D
  - Monitoring → R(λ,t)
  - Uniformity of the beam → R(λ,x,y)
  - Remove scattered light → Beam geometry



Direct Illumination using <u>Calibrated</u> LEDs

(LPNHE2006-02)

- Stable & <u>calibrated</u> source
  → Permanent monitoring
- Sampling of R(λ)
- Uniform beam
- No stray light
- *Simple design*



LEDs Light Stability

- Central wavelength

  (≈ 0.05 nm/K constr. data)

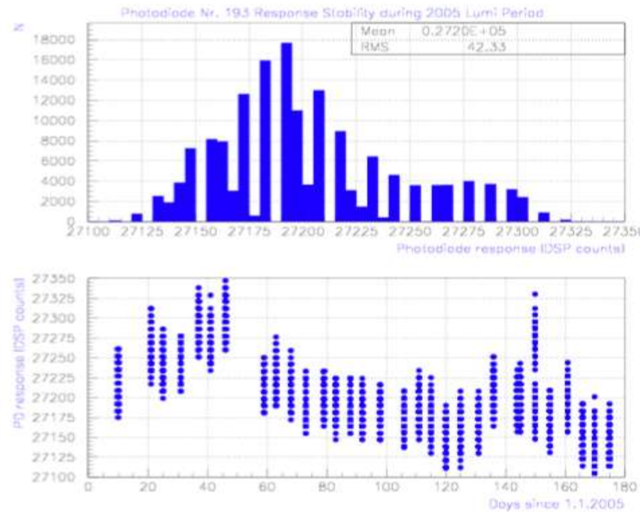
  & Luminosity

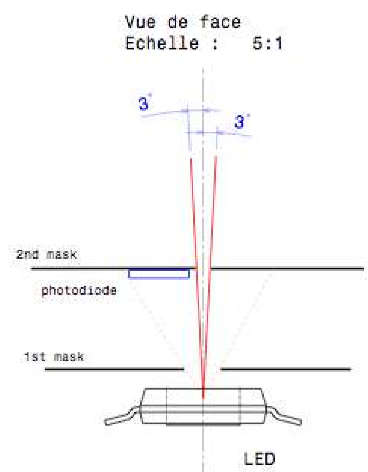
  (≈ 0.5 % /K constr. data)

  Temp. Dependance

- HEP (H1) : 0.2 % rms

- Punctual source





Beam geometry

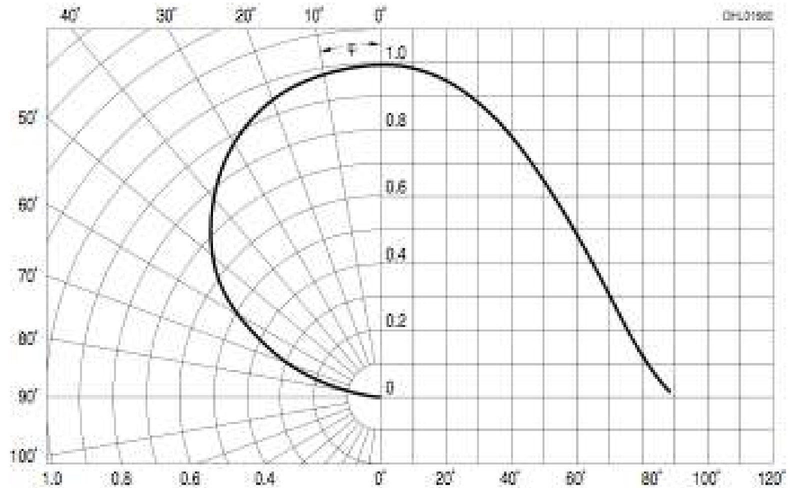
- Isotropic emission

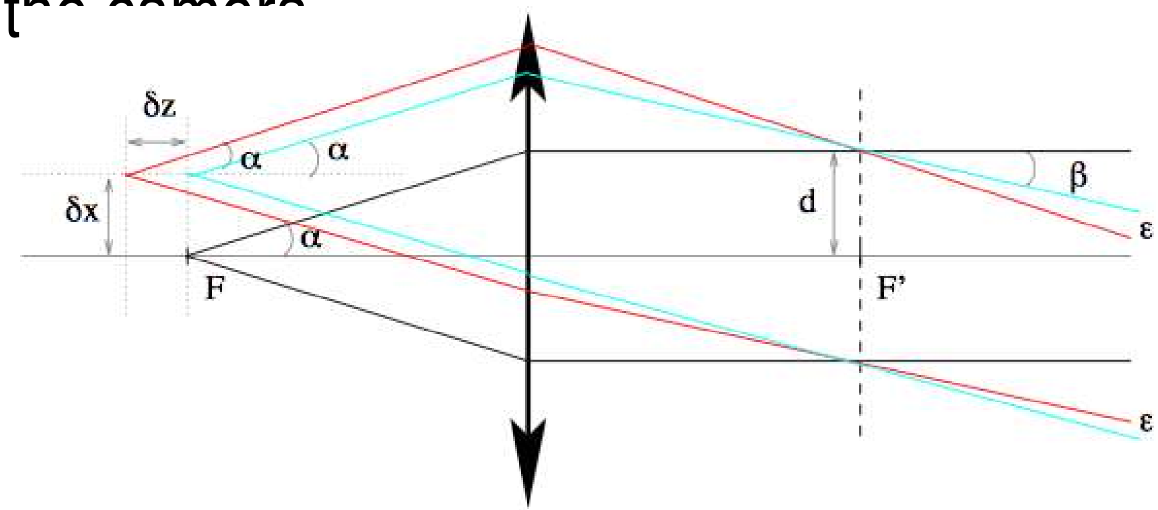
  (constr. data)

  + delimited beam

  ⇒ Uniform beam

  on the camera

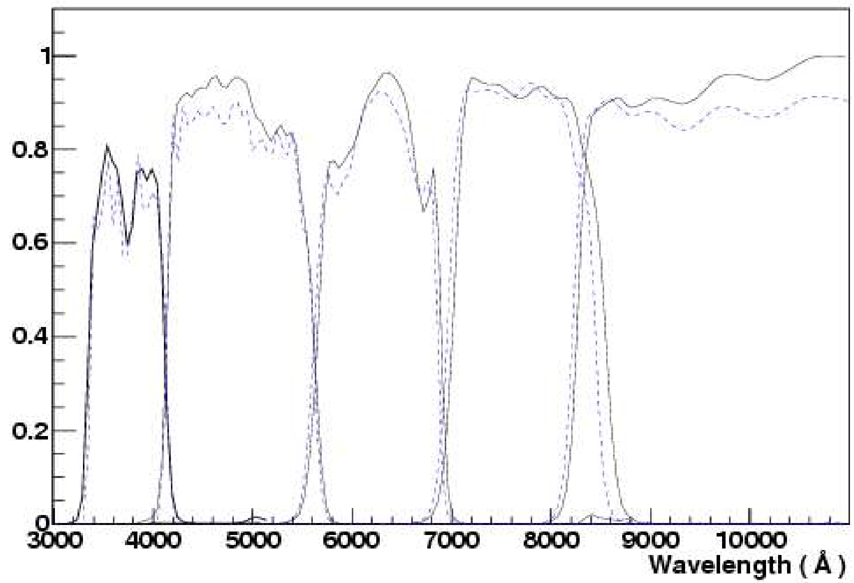


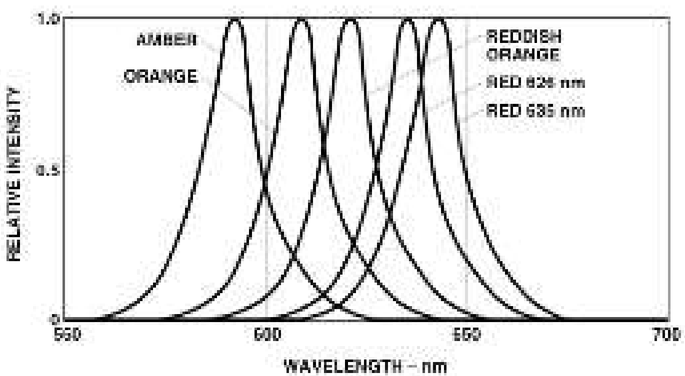


- Sharply delimited beam ⇒ No stray light (?)

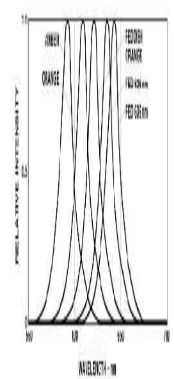
Sampling MegaCam bandwidth

- LEDs spectra
  - No fringes
    $\Delta\lambda/\lambda \approx 7\%$
  - $\approx$ 20 LEDs





$\Rightarrow$

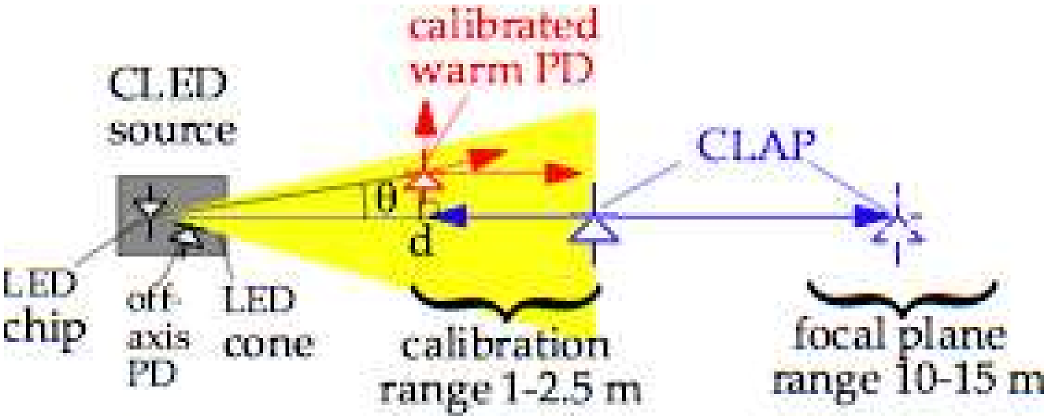


Calibration Bench

- Calibration transfer :

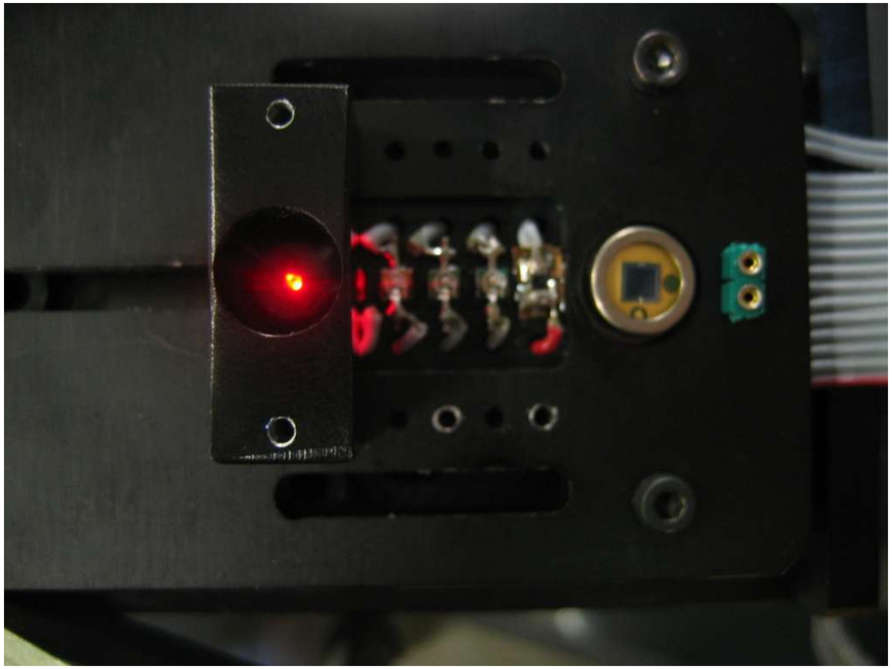
  NIST ➔ LEDs ➔ Cooled Photodiode

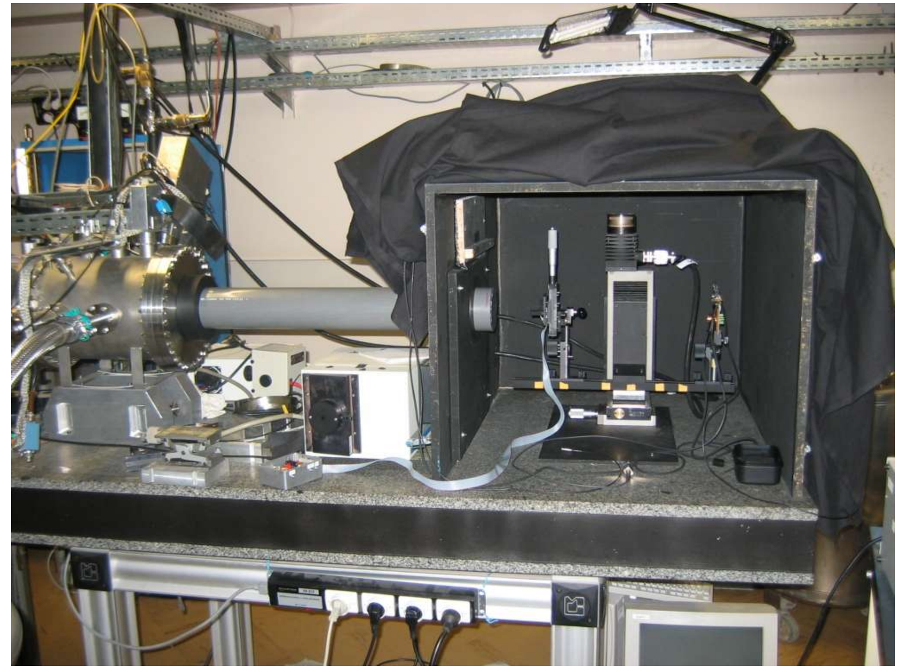
- Check of the isotropy



Distance/luminosity relation !

PROTOTYPE





- LEDs stability (λ,t,Temp)
- Beam uniformity
- Very low photocurrent measurement

Project description

- Electronics (control, acquisition)
- LEDs head project/Calibration bench
- Schedule & Manpower
- Data Analysis