Impact of LSST filters on photometric redshifts performances

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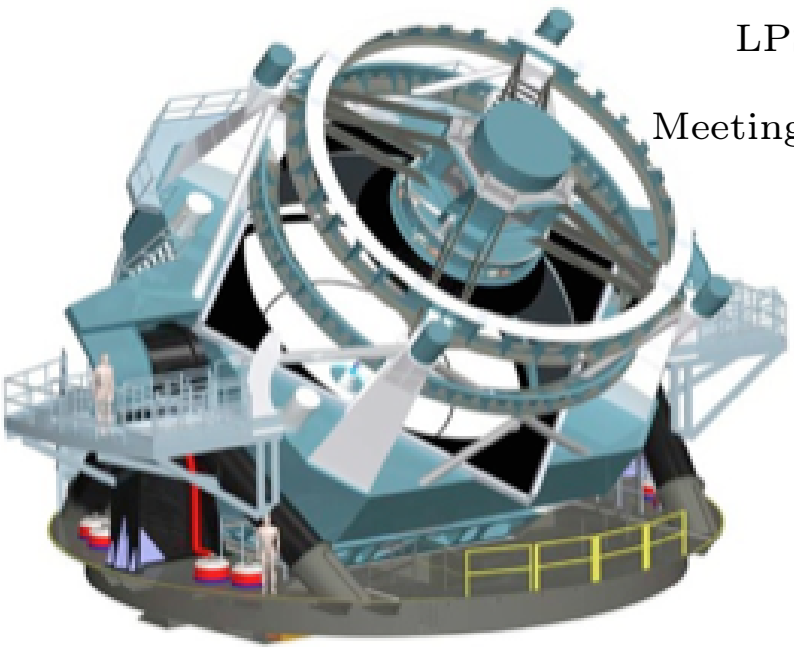
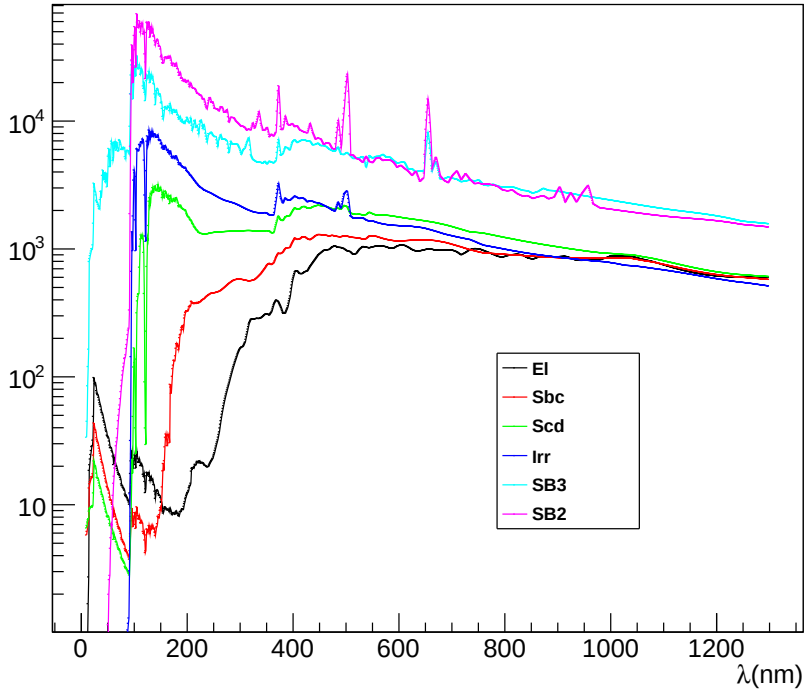


Photometric redshift reconstruction

1. Simulated catalog:
   - Absolute Magnitude, color excess E(B-V), z_{true},
   - 51 galaxies spectral types interpolated between 6 main SEDs: El, Sbc, Scd, Irr, SB3, SB2.



2. Photo-z reconstruction: template fitting method,
   - z_p reconstructed redshift,
   - z_s true redshift,
   - quality estimator:

$$\Delta z = \frac{z_p - z_s}{1 + z_s}$$

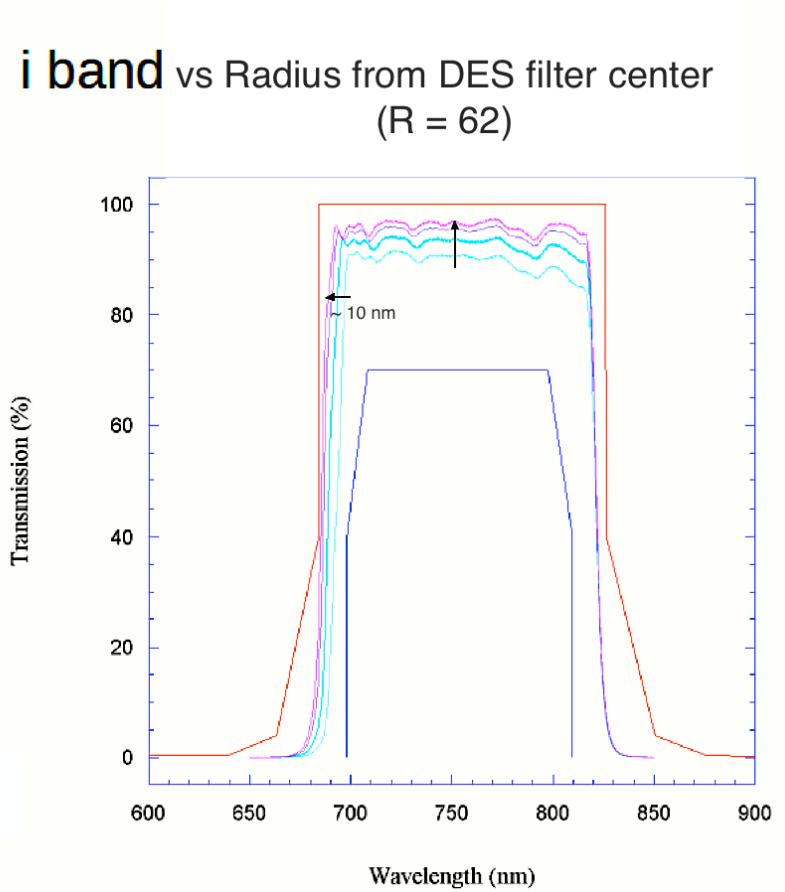
3. Quality cut.

Impact of filters transmission shape

- The photo-z reconstruction rely on flux measurement, which depends of filters.

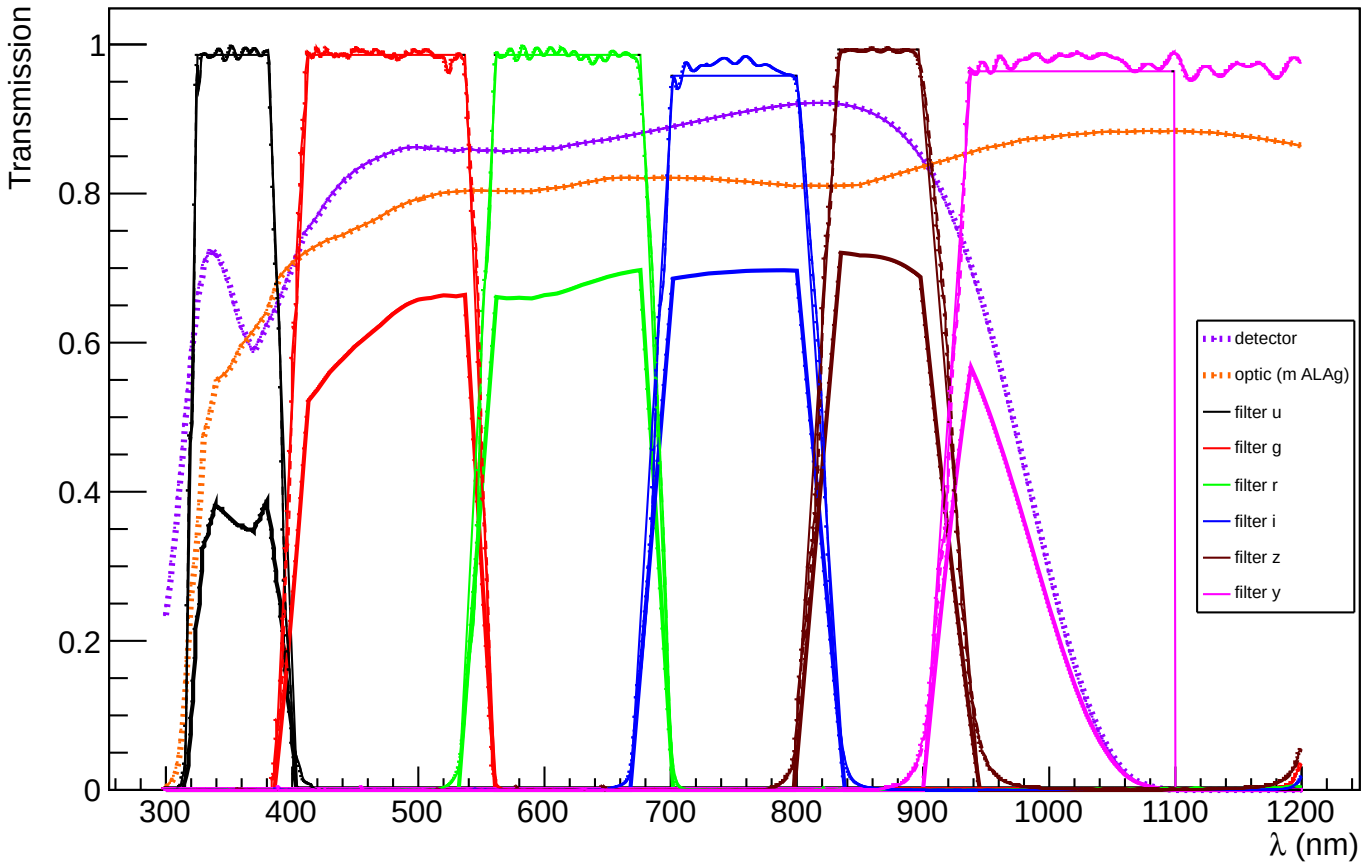
- Filters design is not fixed yet.
- LSST filters are quite big (78 cm diameter)
  $\Rightarrow$ spatial in-homogeneities (coating)

$\Rightarrow$ Impact of filters on photo-z quality ?
  - impact of slope design,
  - impact of filter band-pass callibration,
  - impact of spatial in-homogeneities.



Filter Modeling

- Filters are taken as trapezoidal functions,
- y filter = y4 (latest version),
- Atmosphere is not considered,
- Out of band transmission is neglected.



Filter studies done in the note

Filter taper:

Filter known shift:

Filters unknown shift

Impact of spatial in-homogeneities

Filters impact studies

Filter taper: $\delta_{slope} \in [-90\%; +300\%]$ (integral conserved)

- small impact on photo-z,
- steep shape (-90%) seems to be favored,
- good photometric quality if $\delta_{slope} < 100\%$.

Filter known shift:

Filters unknown shift

Impact of spatial in-homogeneities

Filters impact studies

Filter taper: $\delta_{slope} \in [-90\%; +300\%]$ (integral conserved)

- small impact on photo-z,
- steep shape (-90%) seems to be favored,
- good photometric quality if $\delta_{slope} < 100\%$.

Filter known shift: shift $= \pm 1\%; \pm 2.5\%$

- impact at particular redshift (SB3 galaxies) but globally faint,
- good photo-z quality if filter shift is $< 1\%$.

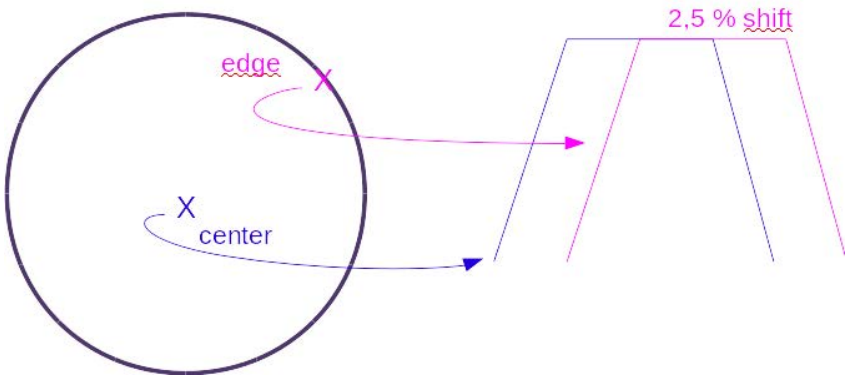
Filters unknown shift

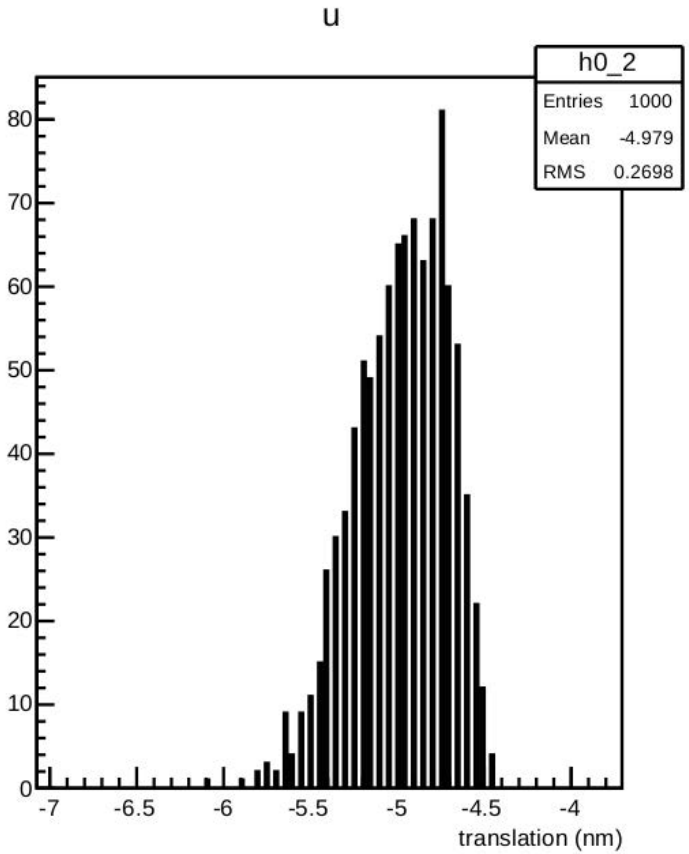
Impact of spatial in-homogeneities

- Filters could be shifted up to $\pm 2.5\%$ (*LSST spec.*)

Impact of spatial in-homogeneities (1)

- *LSST spec : ±2.5% shift*

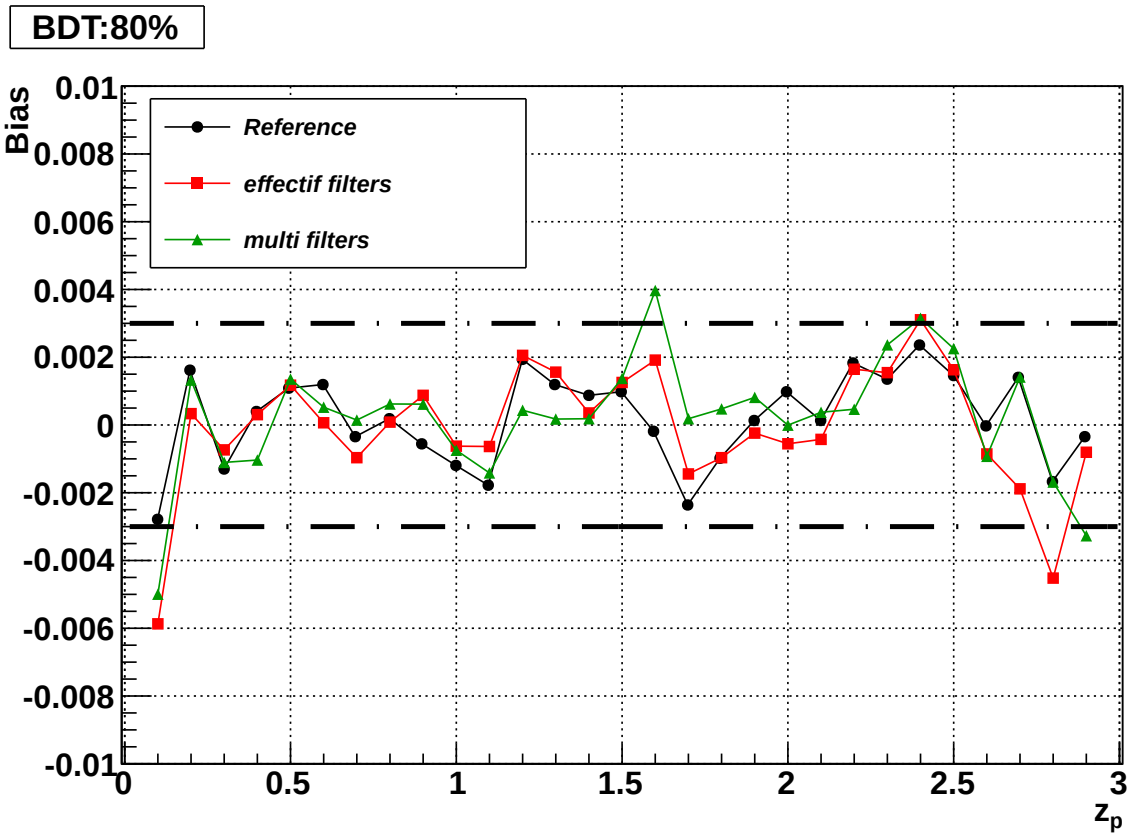




- simulation of **effective filters** (ten years of observation) for each galaxy,
  → apparent magnitude computation
- computation of **average** (effective) **filters**,
  → photo-z reconstruction

	u	g	r	i	z	y
average filter	-5.25 nm	7.2 nm	-8.1 nm	10.25 nm	-11.85 nm	13.7 nm
±2.5% filter	±9 nm	±12 nm	±16 nm	±19 nm	±22 nm	±25 nm

Impact of spatial in-homogeneities (2)



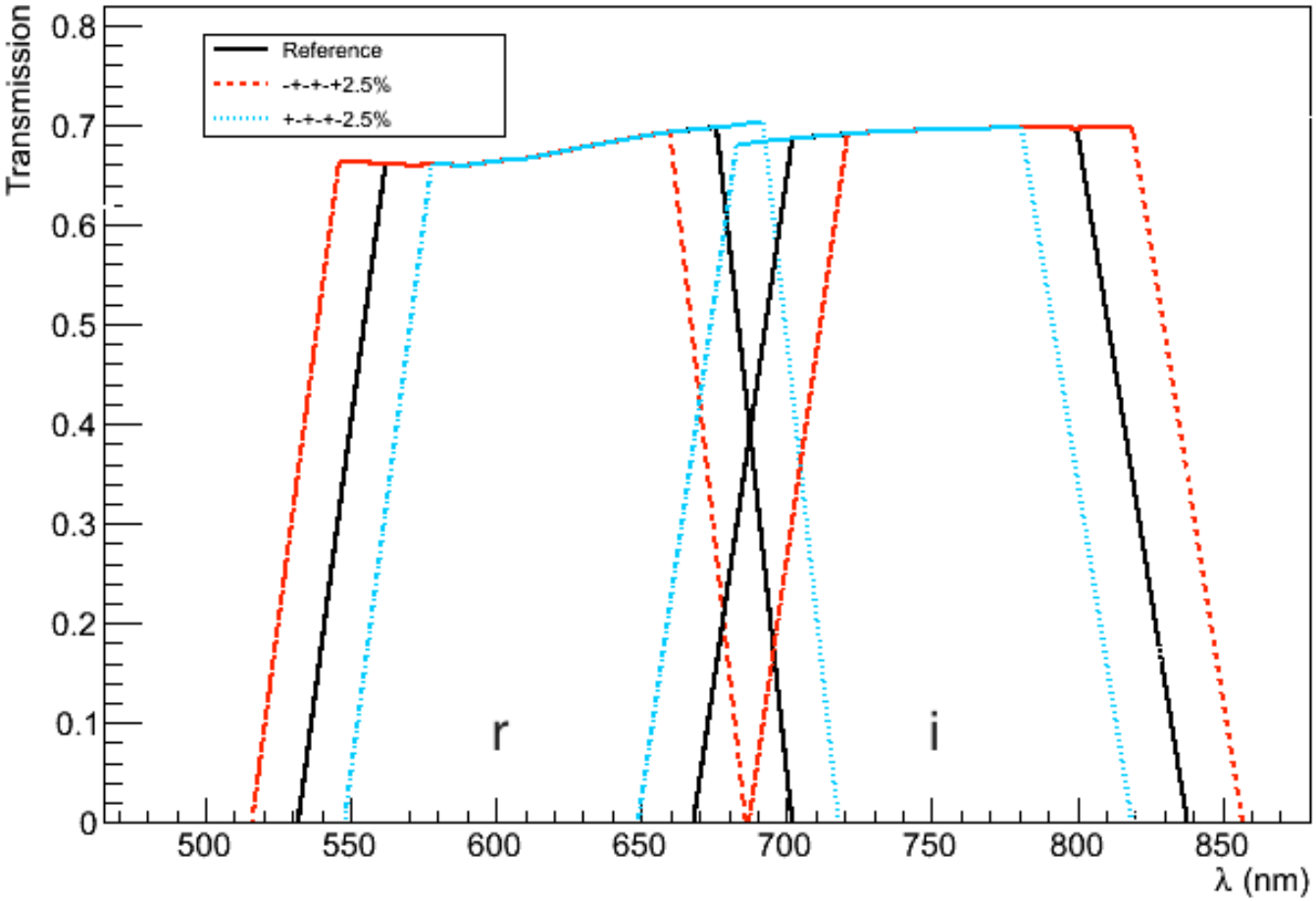
- slight impact on photo-z performances,
- except at $z \sim 1.2$ and $z \sim 1.6$ (Starburst galaxies).

$\Rightarrow$ Good quality of the photo-z reconstruction even if:

- positions on filters are not recorded,
- effective filter per galaxy not computed.

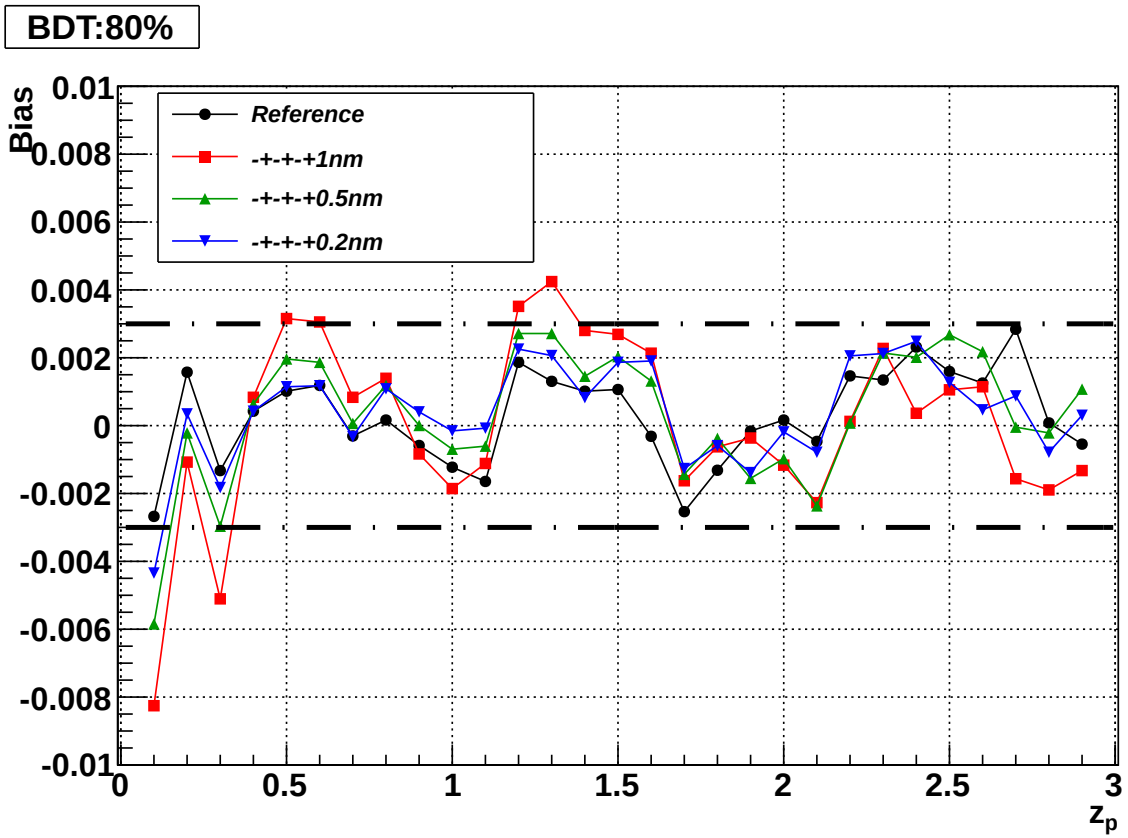
Filter shifts

- Two scenarii tested: filters are shifted in opposition
  - scenario 1: increase gap UG, RI, ZY.
  - scenario 2: increase gap GR, IZ.



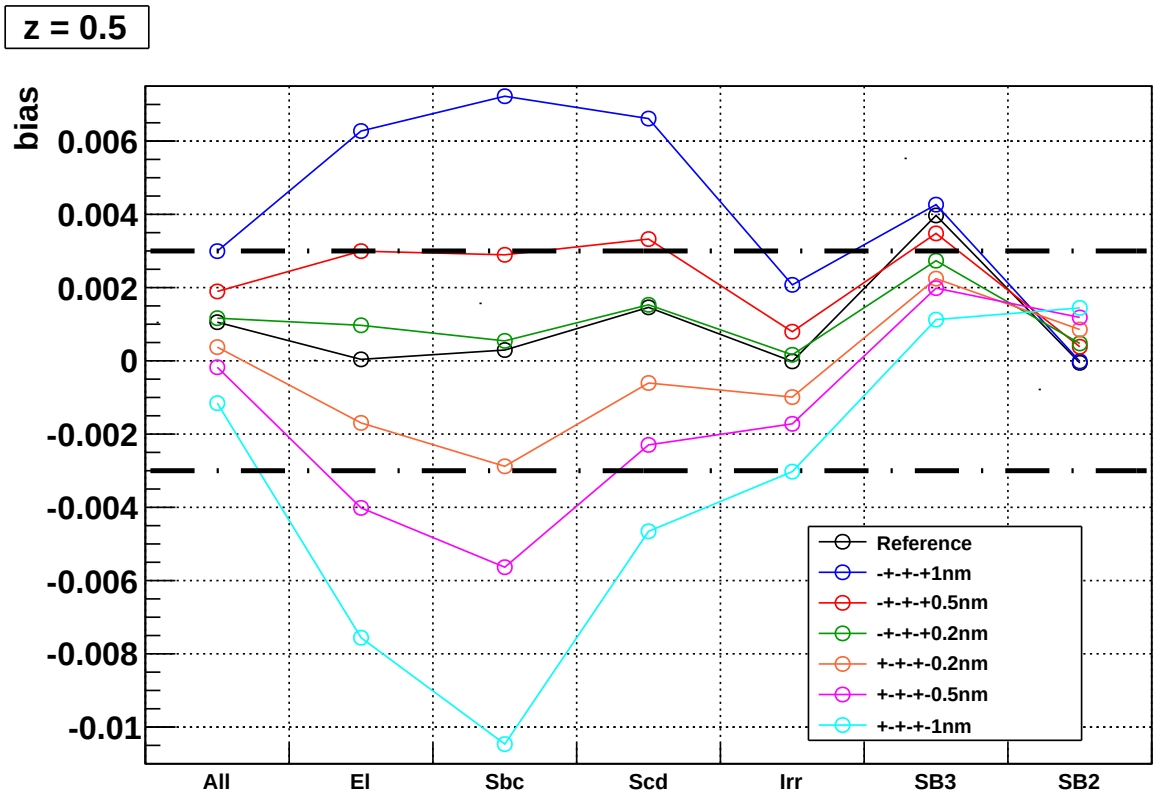
Impact of an error on the filter pass-band

- Apparent magnitudes: computed using shifted filters,
- Reconstructed redshift: from reference filters.



- 1 nm error dramatically damaged photo-z,
- 0.5 nm error: non negligible impact,
- 0.2 nm error: similar to reference results.

Dependence on the galaxy spectral types



- Spiral galaxies are the most affected by uncertainties,
- Starburst are slightly affected
  - more numerous in the catalog,
  - photo-z quality is driven by starburst galaxies.

$\Rightarrow$ Filters pass-band should be known with a precision better than 0.2 nm, **for studied scenarii**.

Summary and conclusions

Filters unknown shift:

- two *worse possible* scenarii have been studied,
- significant damages on photo-z quality from a few nanometers shift,
- overall: photo-z quality in agreement with LSST specifications if filters bandwidth is measured with an accuracy better than 0.5 nm,
- some particular galaxy types need the accuracy to be better than 0.2 nm.

$\Rightarrow$ the constraint on filters accuracy is **very strict** and **higher than LSST requirement** !

- because of incident angle dependence ($0.1°/Å$), measurement at 0.2 nm will be difficult, measurement at 0.5 nm should be OK, (see talk from Benoit Sassolas)
- a precise measurement is needed only on filter edge,
- we only test two scenarii $\rightarrow$ other test are needed (see J.S Ricol'stalk).

Effect of filter calibration error per band

Filters for observed flux simulation :
- LSST baseline
- bandwidth shifted by -1nm / +1nm
- transmission reduced by -1% (Tx0.99)

Filters for photo-z reconstruction :
- LSST baseline

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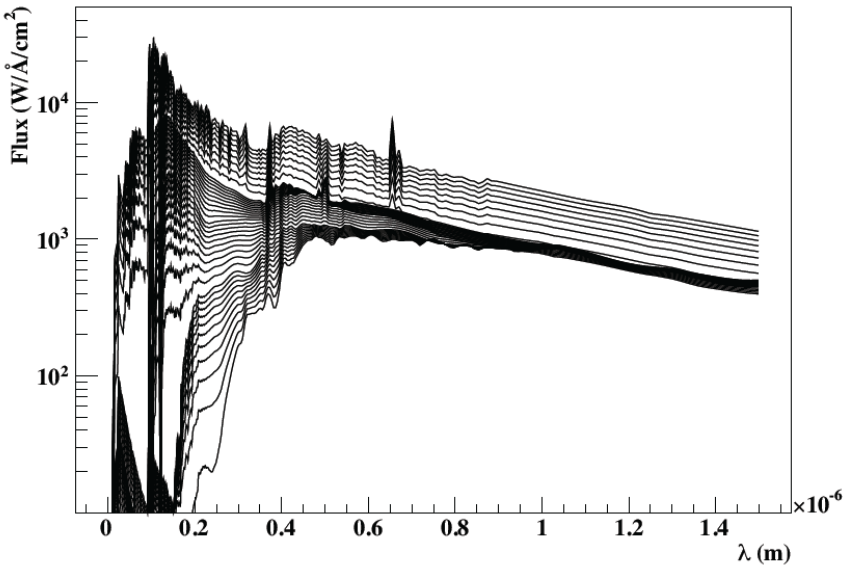

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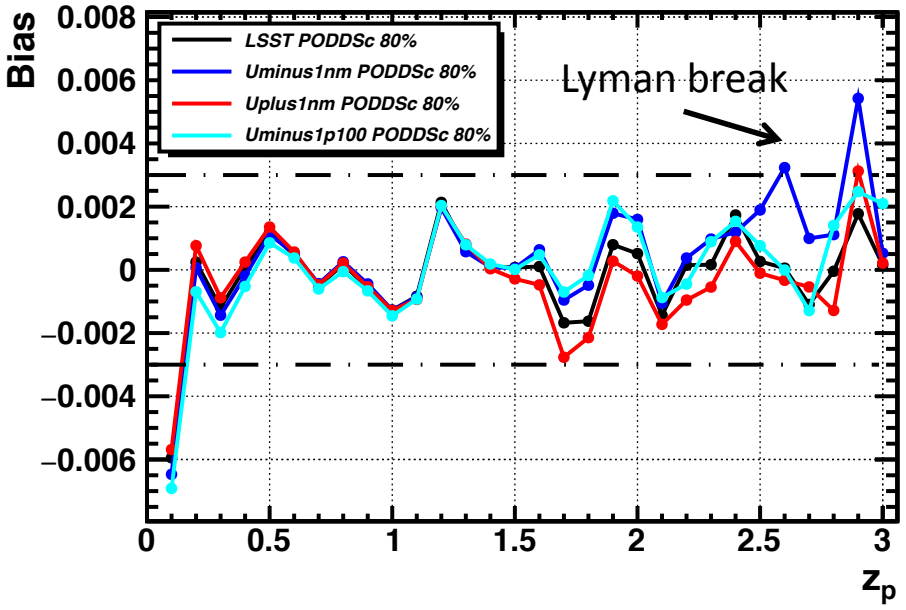

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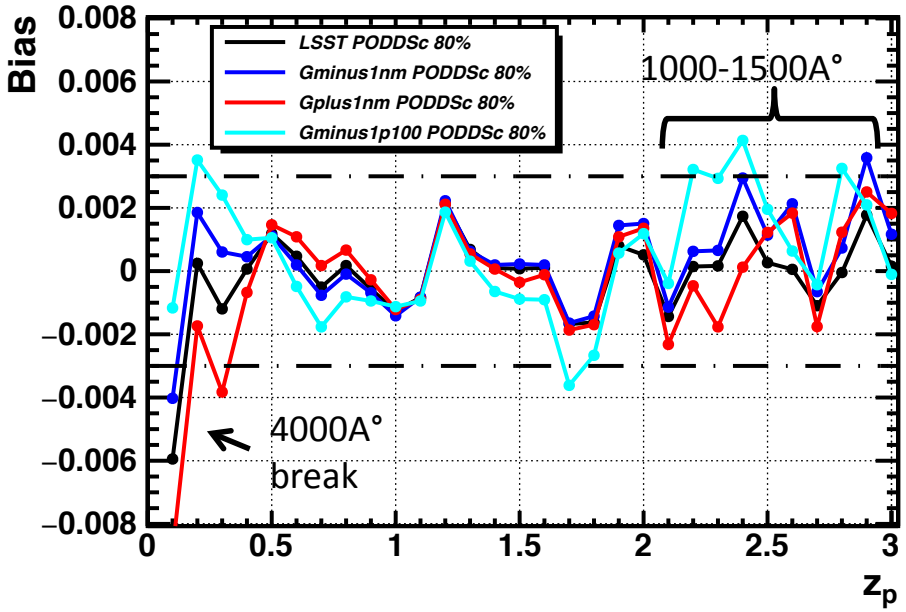

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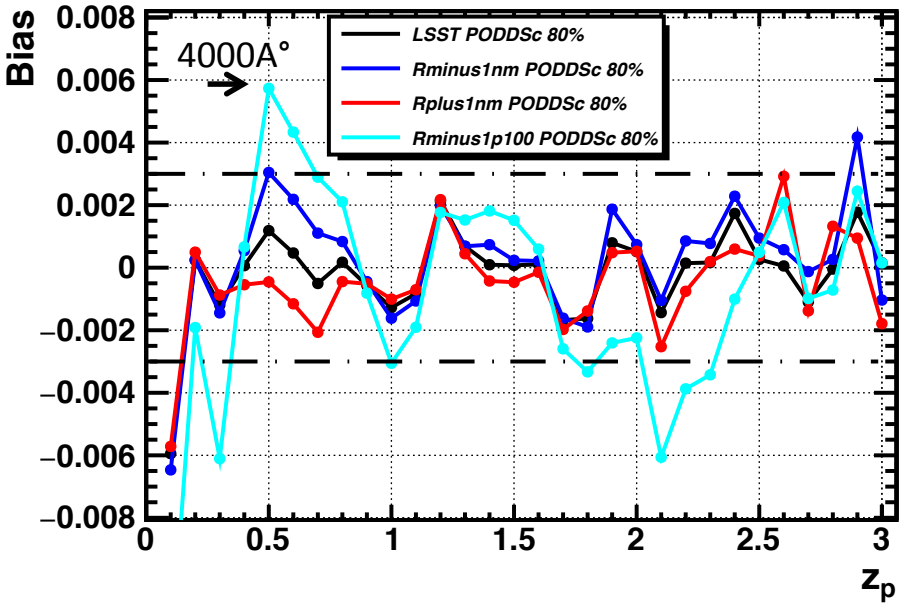
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−0.004
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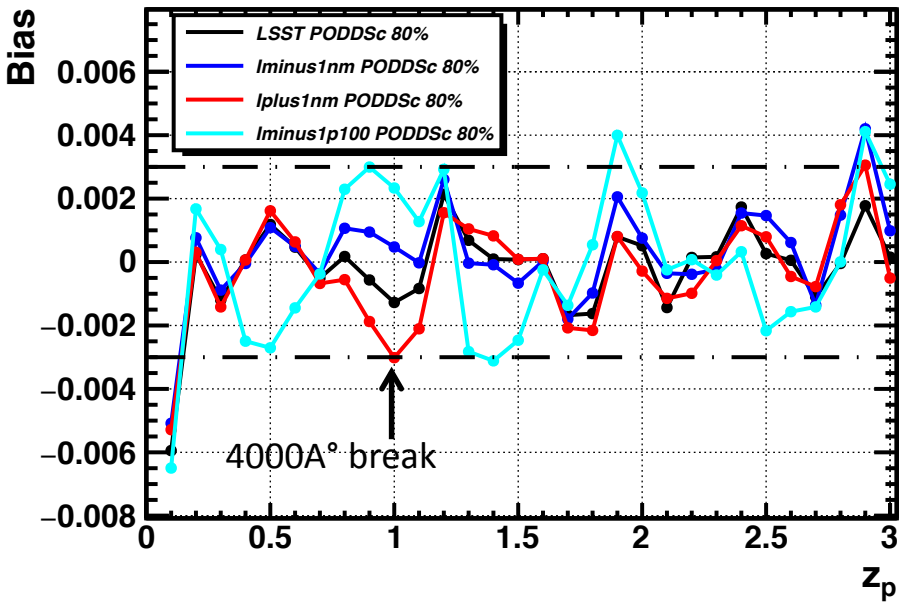
2
2.5
3
z_p
4000A°
LSST PODDSc 80%
Rminus1nm PODDSc 80%
Rplus1nm PODDSc 80%
Rminus1p100 PODDSc 80%

I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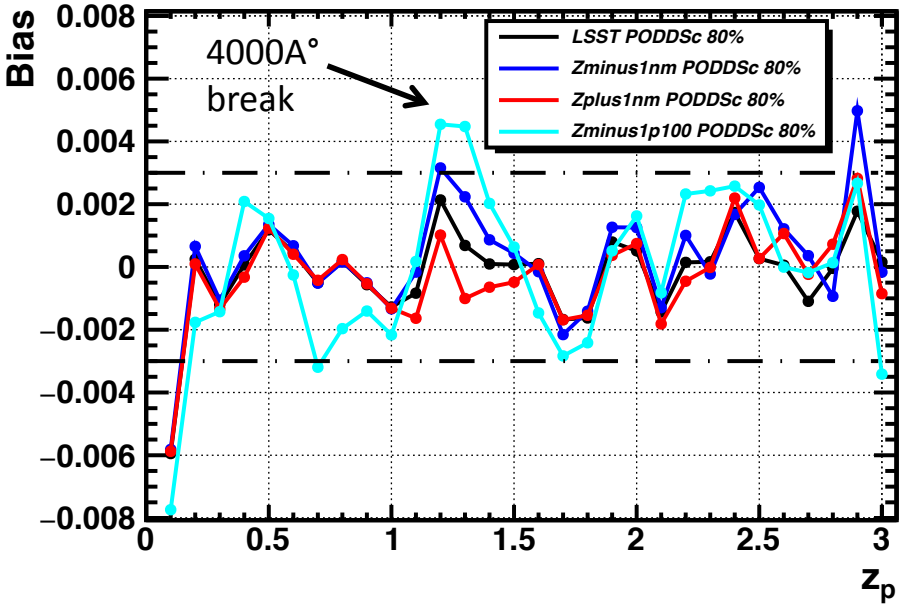
Iminus1p100 PODDSc 80%
4000A° break

Z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break
LSST PODDSc 80%
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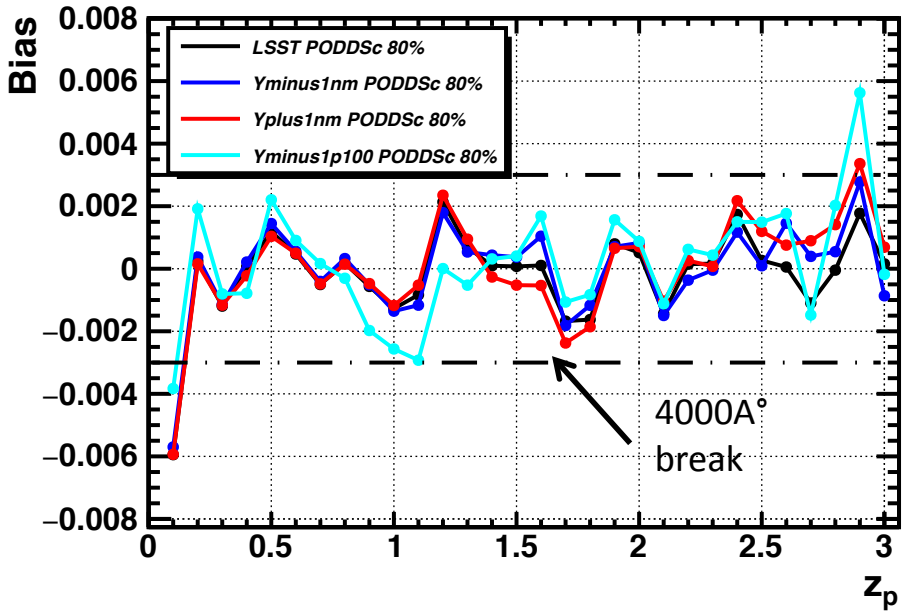
Y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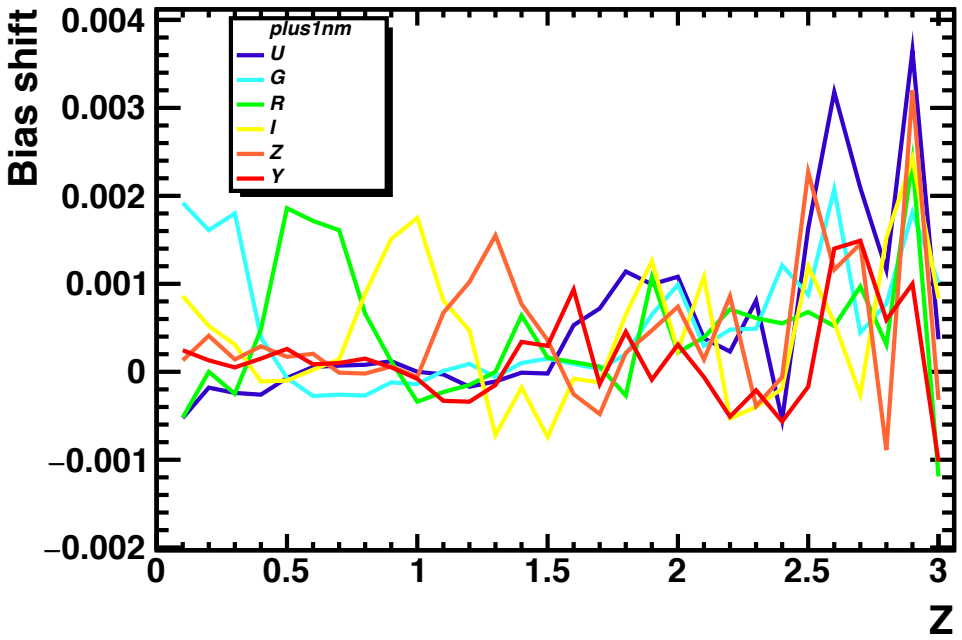
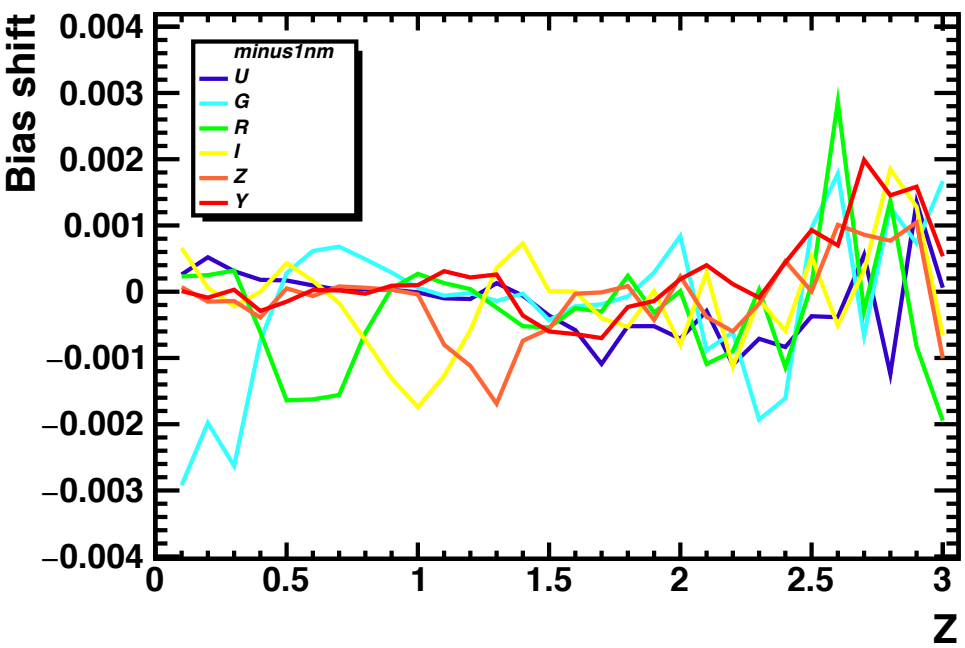
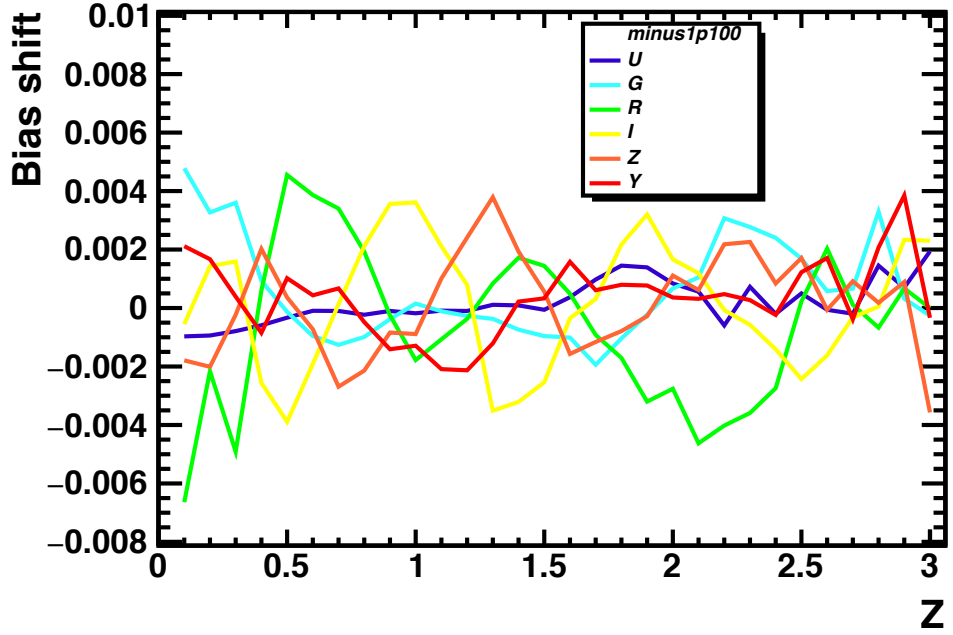
Effect of filter calibration error per band

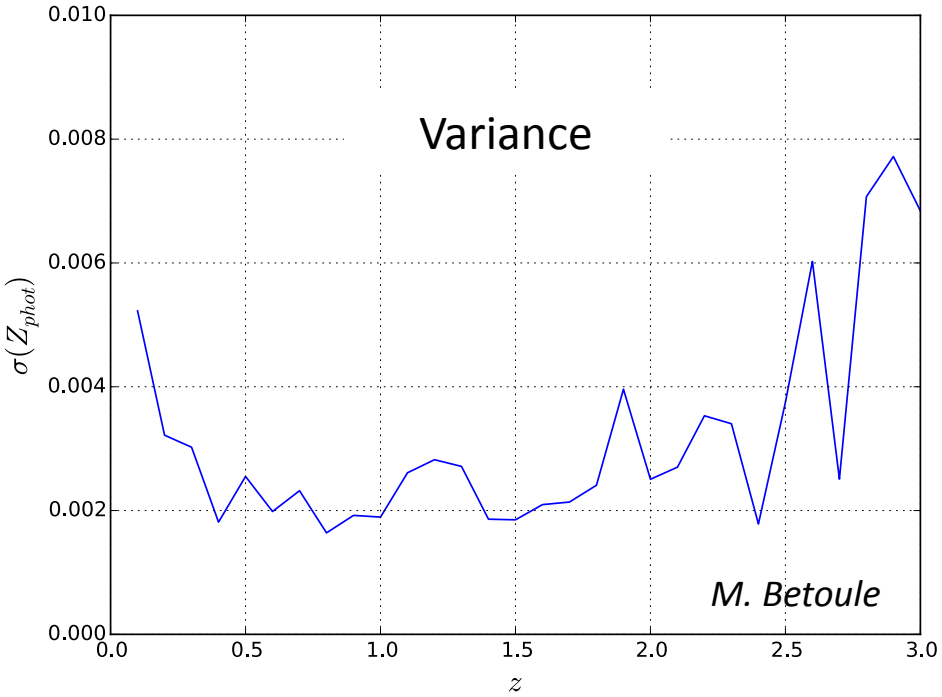




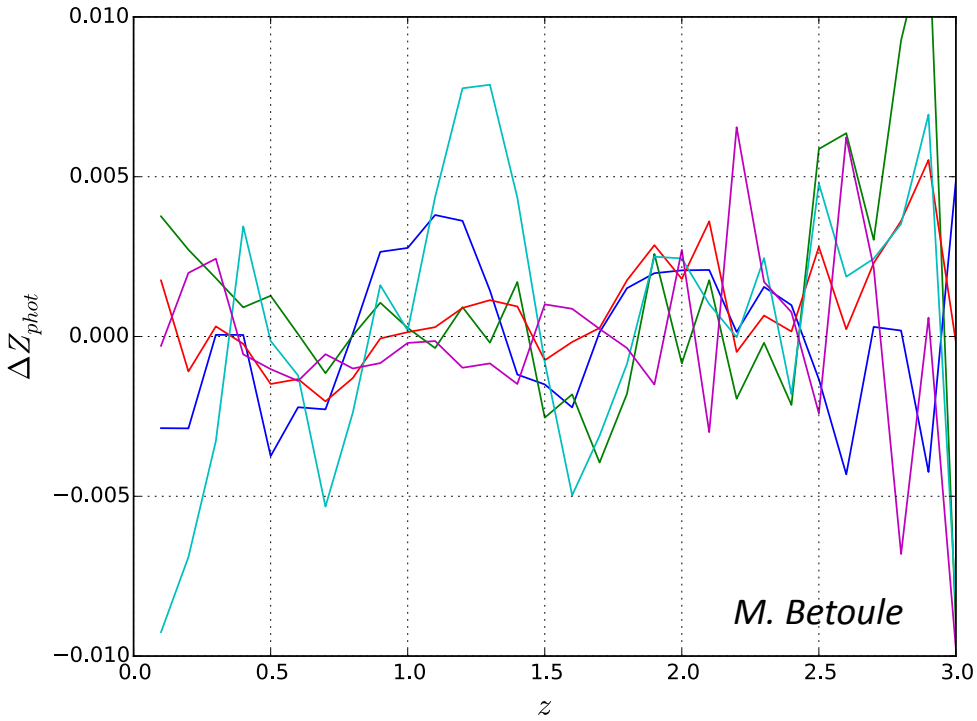


- Transmission accuracy is more critical than bandwidth accuracy
- U band does almost not impact the results
- All effects can co-add

Matrice des dérivés du biais par rapport aux 12 paramètres (shift_x, transmission_x)
Matrice de covariance des 12 paramètres de calibration MegaCam
Matrice de covariance des photo-z



5 tirages d'erreurs aléatoires



Specs LSST = 0.003