Estimators of the ISW-galaxy cross-correlation: status and prospects

D. Molinari

also on behalf of

A. Gruppuso, M. Lattanzi, M. Migliaccio, P. Natoli, G. Polenta

Euclid CMBX meeting, Orsay, 22/03/2019

Brief summary

A brief summary on the activities we are working on:

1) Zero-th order simulations
   - Generated maps with correlated CMB T and Galaxy counts at several resolutions.
   - Fully extended for tomographic and multi-survey analyses.
   - Theoretical predictions are compliant with IST-forecast recipe

2) Realistic masks
   - Focus on the production of realistic masks.

3) Pseudo-Cl estimator
   - Validated on zero-th order simulations and also on realistic (but outdated) masks.
   - Tested also for tomographic analyses.

4) QML estimator
   - Developed a full QML code to extract the spectra from CMB T and two Galaxy counts surveys
   - Validated some tricks (binning, block diagonal covariances) to speed up the code and quantified their impact on the APS extracted.
   - Exploring further improvements of the code.

Masks

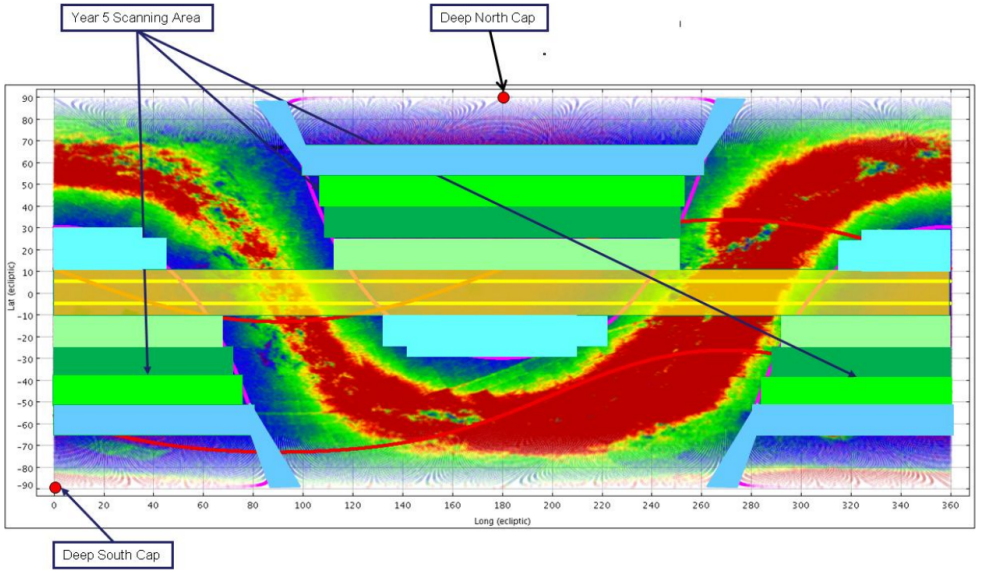


Figure 5.5: Targeted area for year 5.

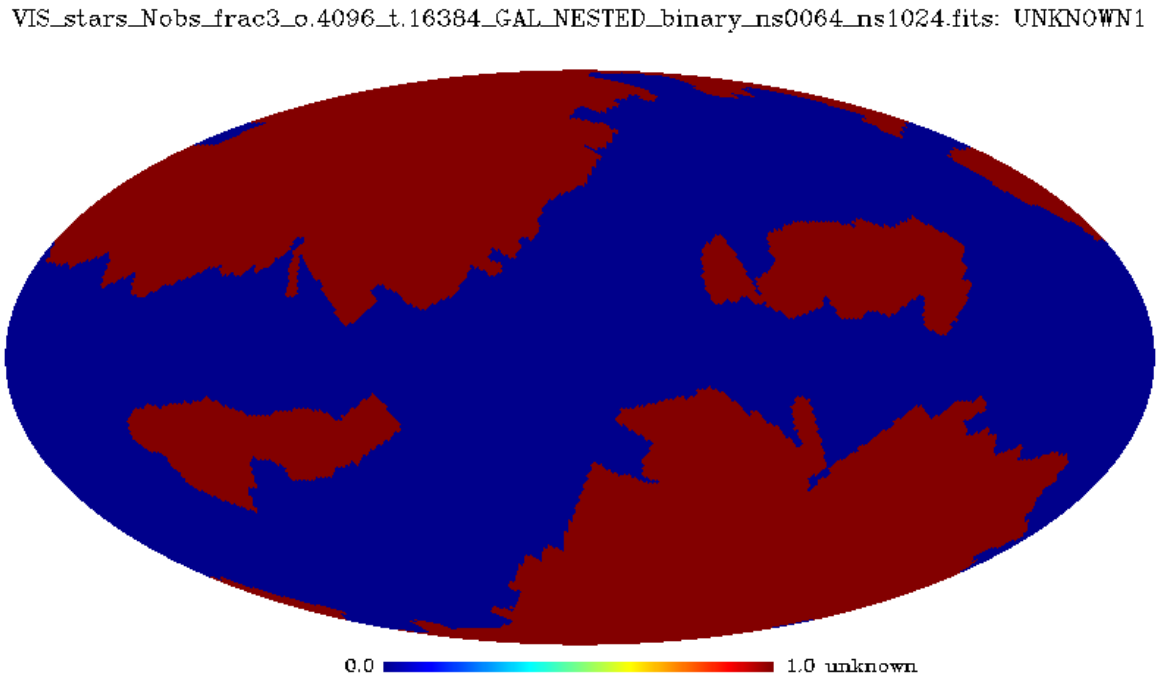
We started from the Red Book expectations. We used it to generate very simple masks as starting point.

Benoit-Levy and Burigana produced more realistic masks.

But these are quite obsolete today (generated in 2016-2017)

Scanning strategy has changed in the last year. Need to update the masks.

Also would be important to have additional masks:
- mask per year
- visibility mask (for tomography)



survey for CDR

A “capless” wide (temporary)

In order to fulfil the limits on slews at large ecliptic latitudes we are currently developing a second, new code to deal with larger overlaps required by the limits on eigenrotation angles at high ecliptic latitude. So we applied the working code on regions up to lecliptic l lat l < 75 degrees (actually this can be extended up to 80 degrees). We define this as the “capless” survey. Not much area is left to cover in the caps (~900 sq degs) because of the presence of galaxy plane and LMC in the South and of the EDF-N at NEP. Not a real problem.

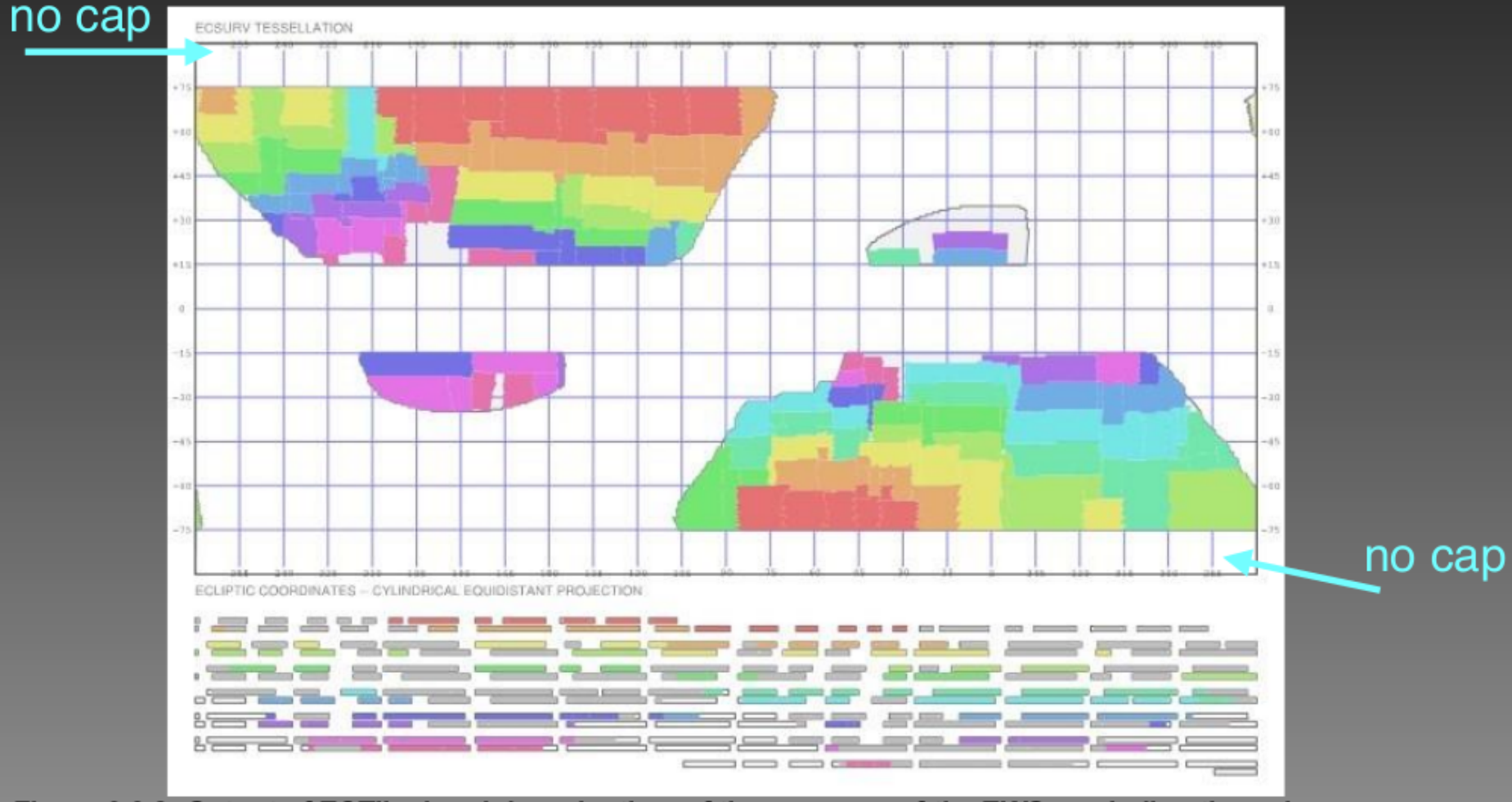
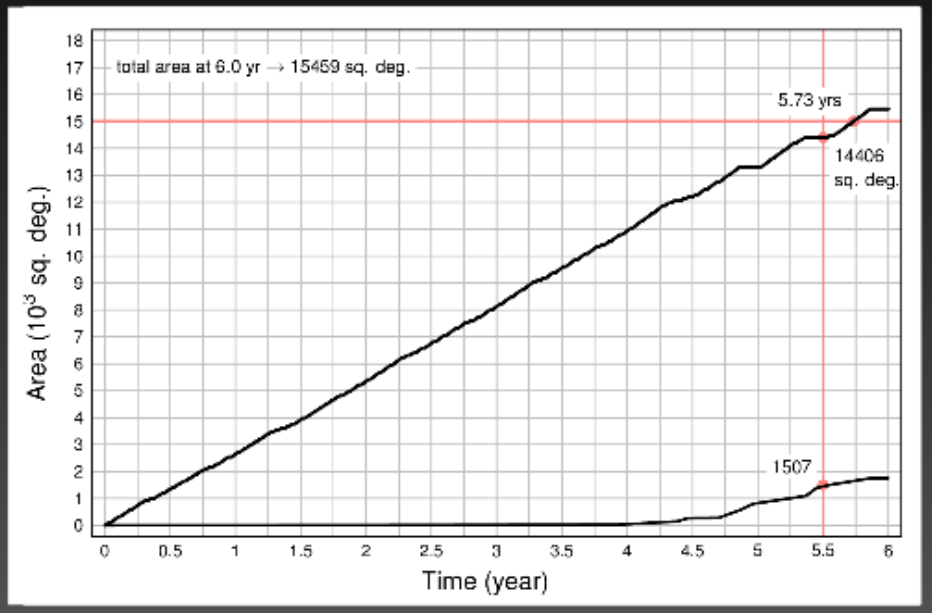


Figure 6.3.2: Output of ECTile: breakdown by time of the coverage of the EWS, excluding the polar caps

From Scaramella’s talk at Italian Euclid Consortium, 13/02/2019

survey for SPV2



Growth of area coverage for the wide survey
At the final stages in some epochs there is no longer a new sky region available. This is shown by the bottom line (in equivalent area); ~< 2000 sq deg ~ 6 months

capless

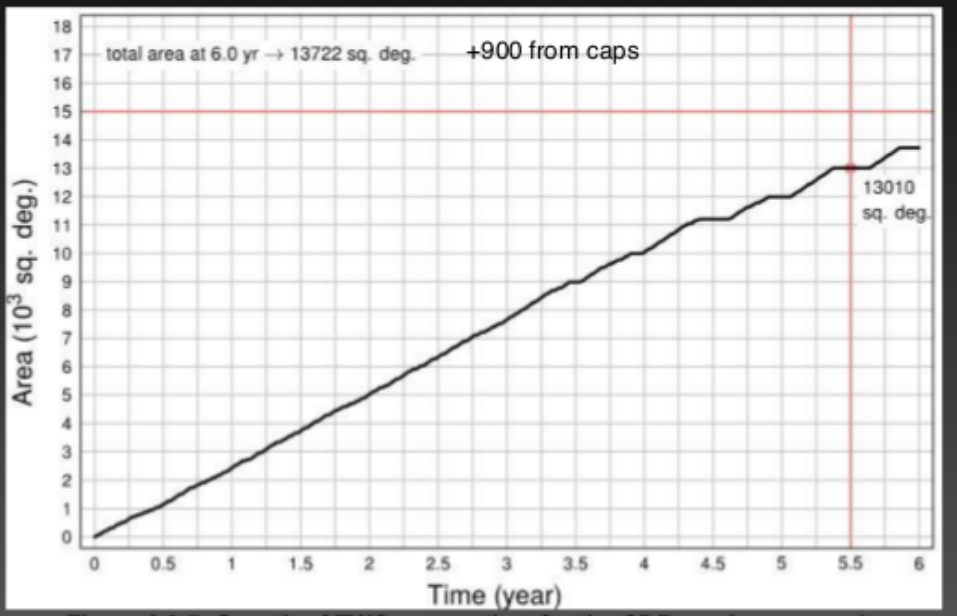
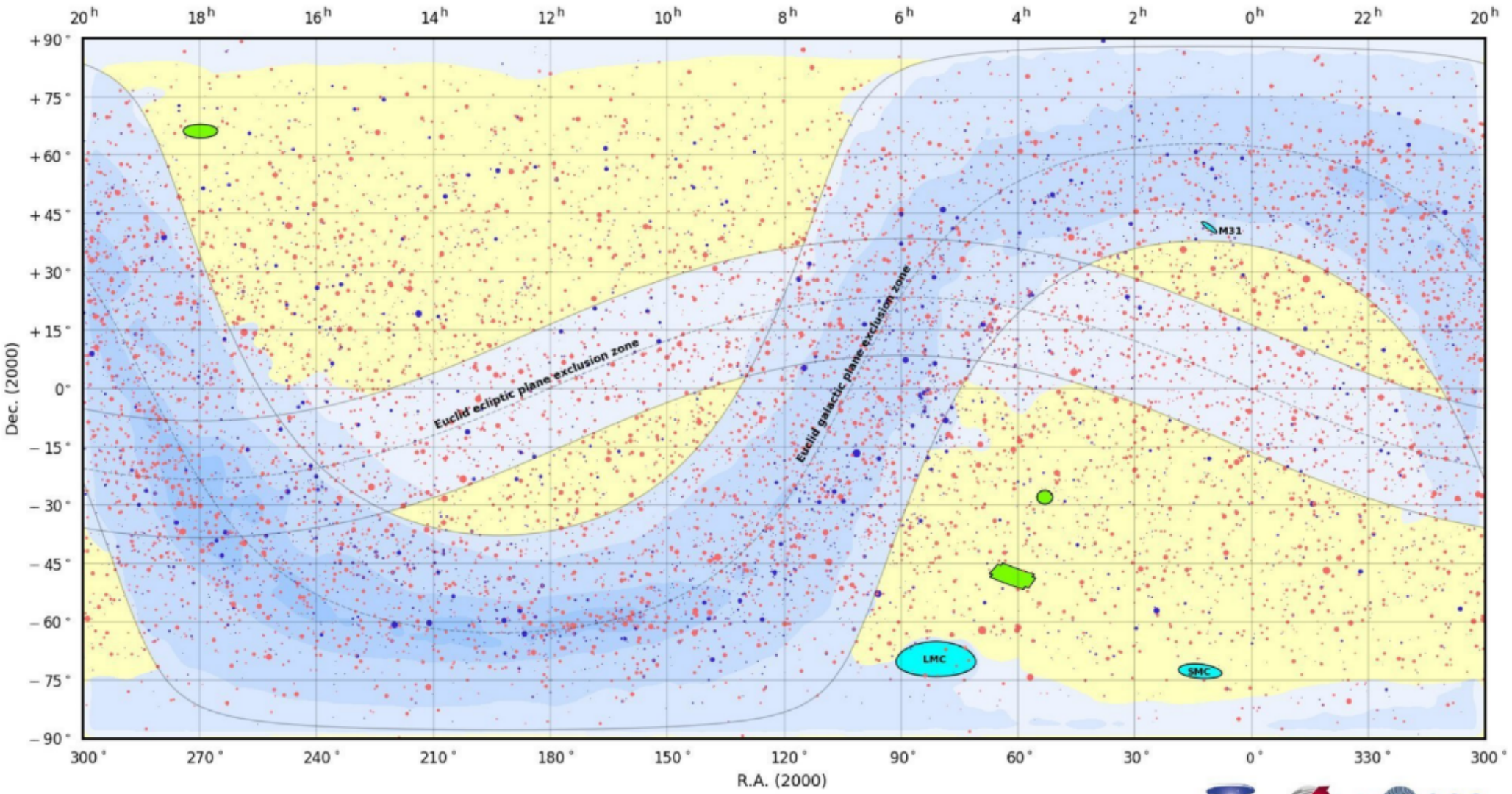


Figure 6.3.7: Growth of EWS area vs time for the CDR_capless scenario

Adding ~900 sq degs gives 14600, i.e. -2.6% from the 15000, one month of observations, use new weights and slightly less stringent limits on hard boundaries. Not a huge problem. ~3–4 months unallocated

From Scaramella's talk at Italian Euclid Consortium, 13/02/2019

Also Galactic stars are an important issue for the mask
We would like to avoid so many holes. Can be done also at high resolution?



Euclid Foregrounds (4/8): bright stars from the visible to the near-infrared

Euclid Wide Survey : 15,000 deg.^{2} [with E(B−V)<0.08, up to 0.15 to avoid holes&islands]

Euclid exclusion zone : 26,000 deg.^{2} [galactic+ecliptic planes + reddening]

Euclid Deep Fields : North=10 deg.^{2}, Fornax=10 deg.^{2}, South=20 deg.^{2}

g or H magnitude (AB): -2 0 2 4 6

All 8000 brightest stars in the sky up to g-band = 6.5

All 8000 brightest stars in the sky up to H-band = 6.8

g-band: Yale Bright Star Catalog (Hoffleit & Warren 1991)
H-band: The Two Micron All Sky Survey (2MASS, Skrutskie et al. 2006)

From Scaramella's talk at Italian Euclid Consortium, 13/02/2019

Masks

It is important to have realistic masks:

- make some tests on them (i.e. how to degrade at lower resolution)

- the real/final performances and comparison among the estimators should be done considering realistic masks (irregular borders, holes, etc.)

- improve and more detailed forecasts considering masks per year and visibility masks for tomography

I tried to resurrect the discussion with people previously involved.

Hope to discuss with Carlo Burigana soon on this topic.

Roberto Scaramella suggested to consider the masks of the SPV02.

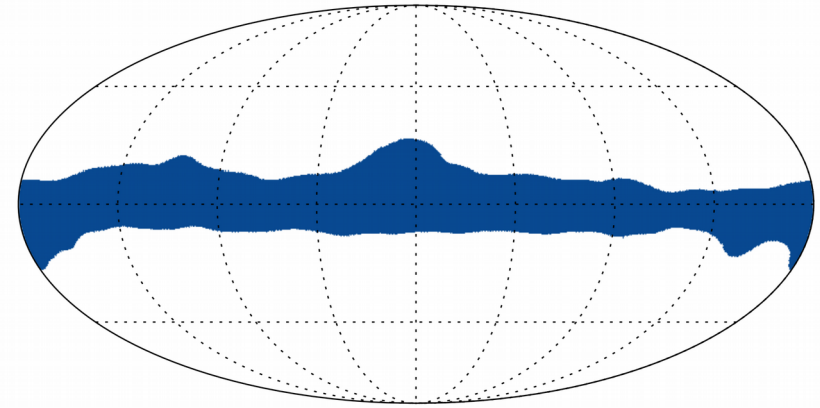
Need access to Euclid Mission Database.
Euclid Redmine credentials are not correct.

Trying to get in contact with Pedro Gomez and Hervé Aussel, suggested contact point for useful data in the Euclid Database.

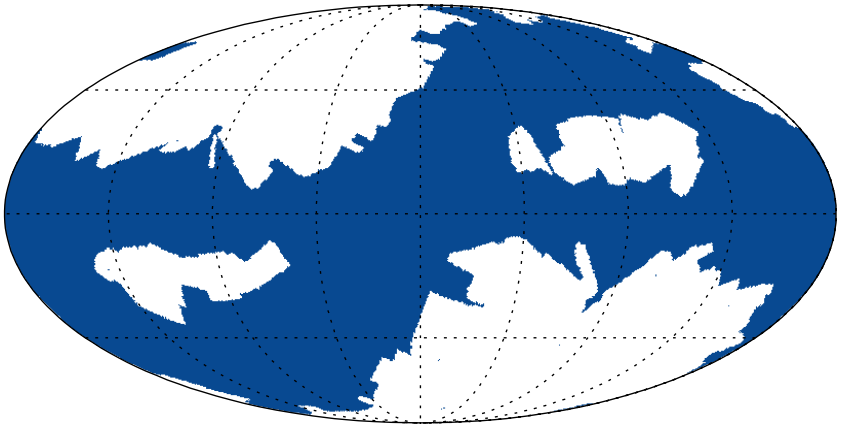
By DM and M. Migliaccio

Pseudo-Cl estimator
Tested on realistic preliminary masks

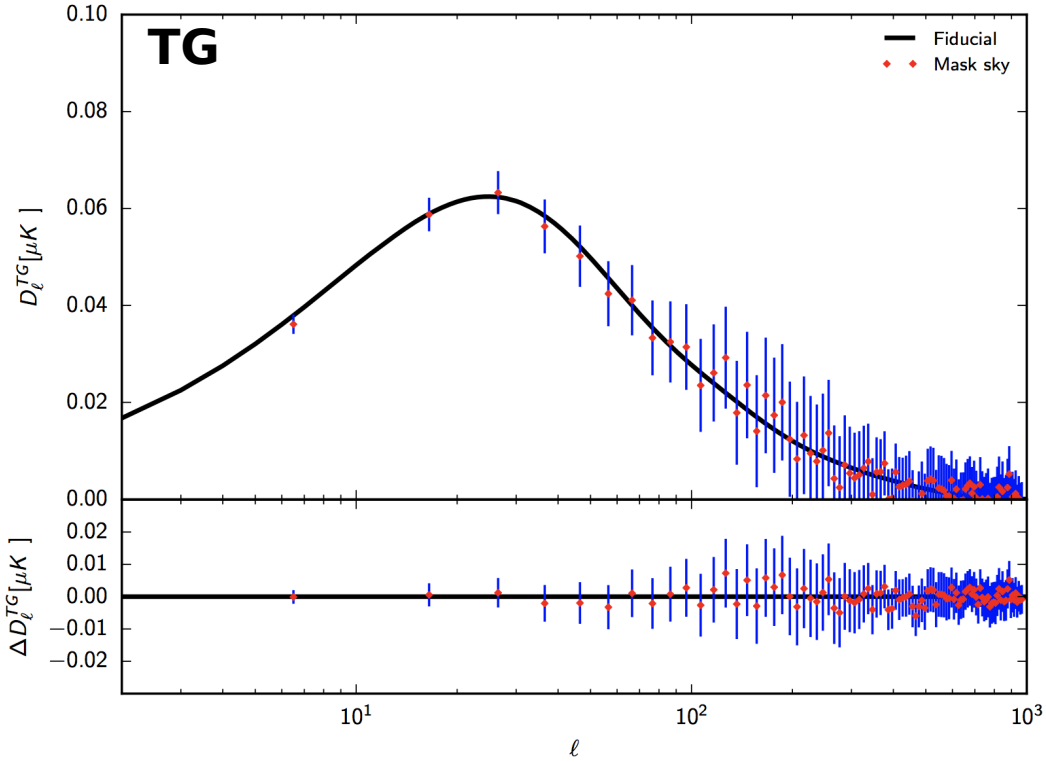
CMB (F_{SKY} = 80%)



EUCLID (F_{SKY} ~ 40%)



Photometric Survey



$3\sigma/\sqrt{N_{sim}}$

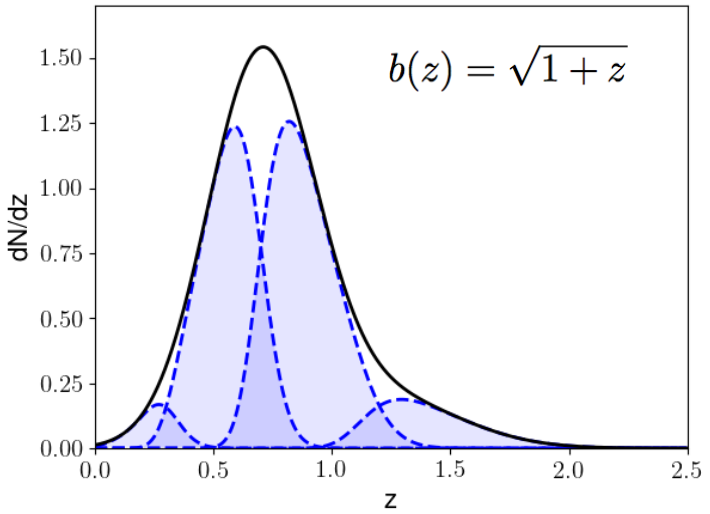
error bars

By M. Migliaccio

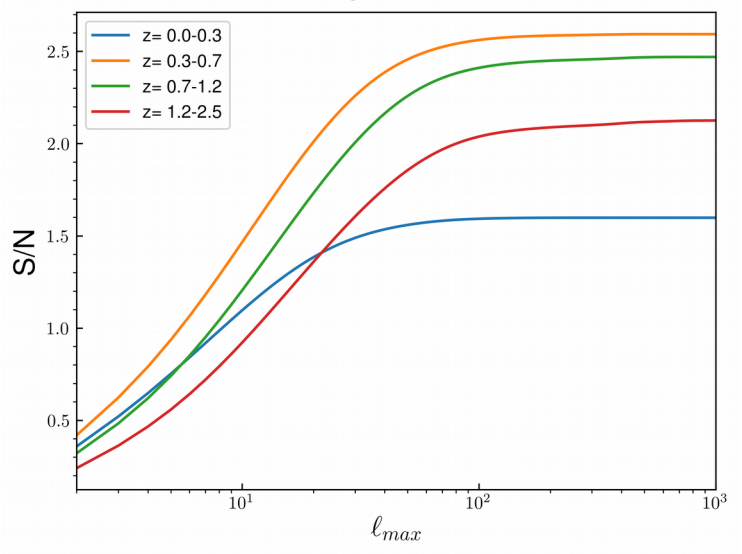
Pseudo-Cl estimators: Validated on tomographic simulations

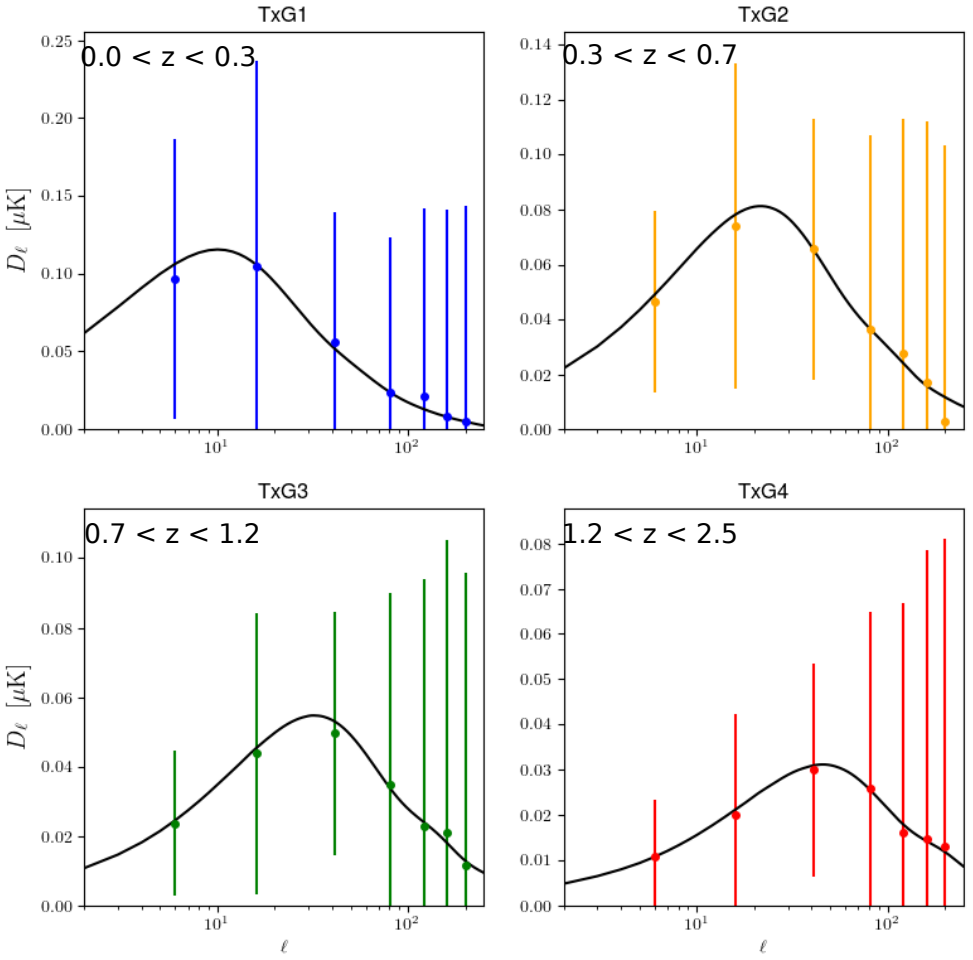
Photometric Survey Tomography

CFHTLens normalized number counts



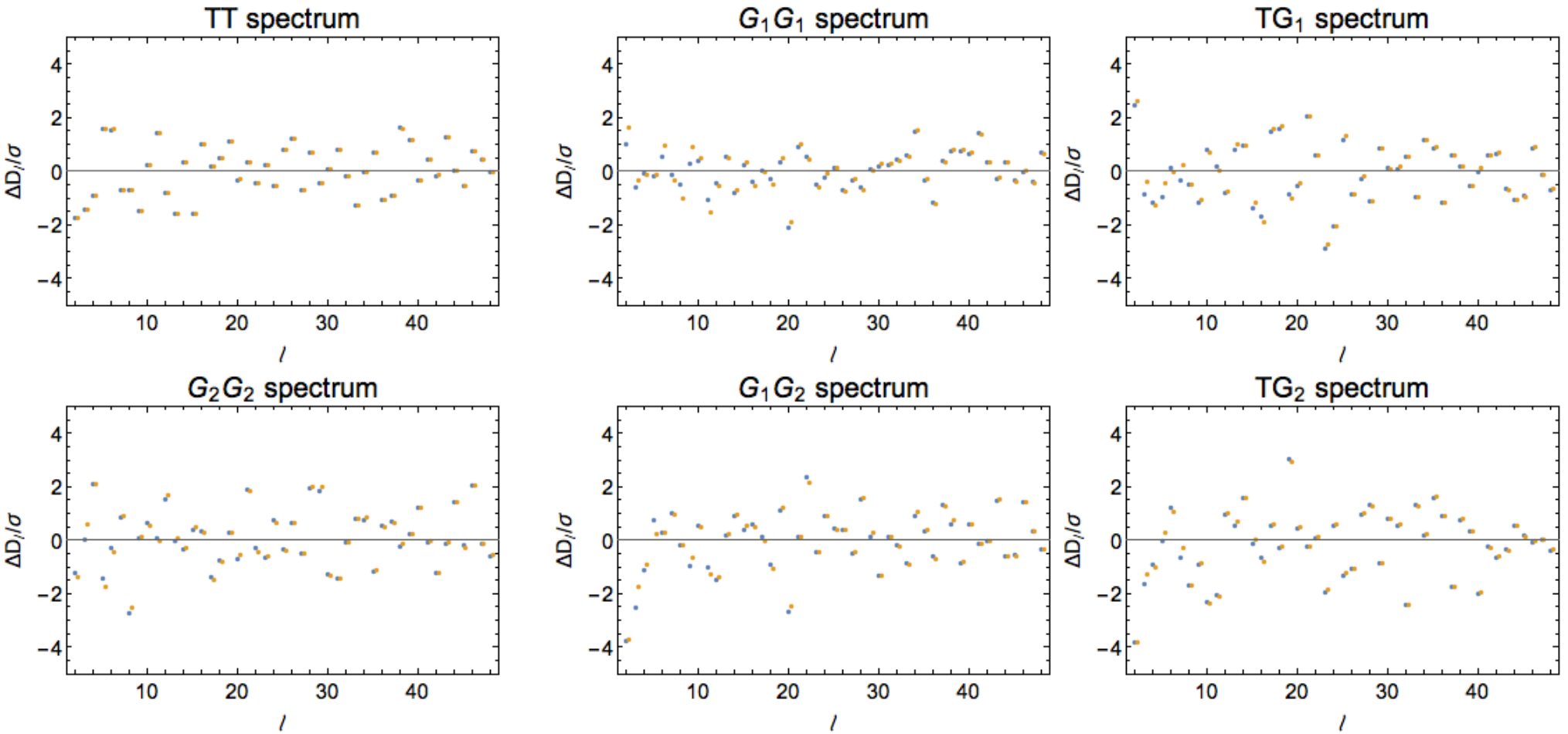
Combined analysis S/N ~ 4





QML: Validation (nside=16)

By A. Gruppuso



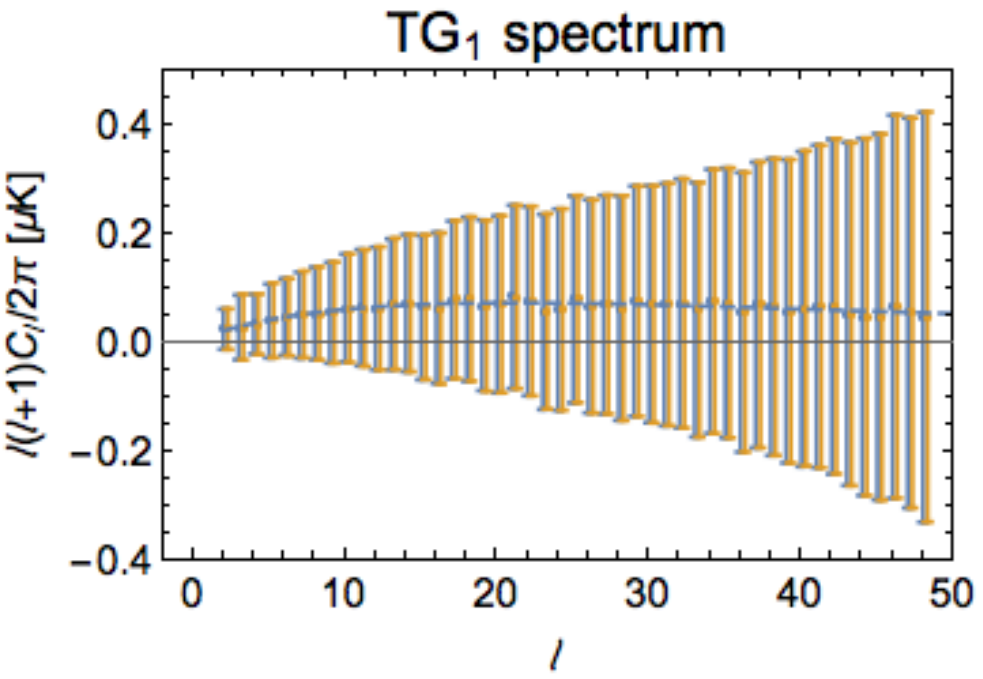
Distance of MC average (1000 sims) from the fiducial spectra in units of standard deviation of the mean

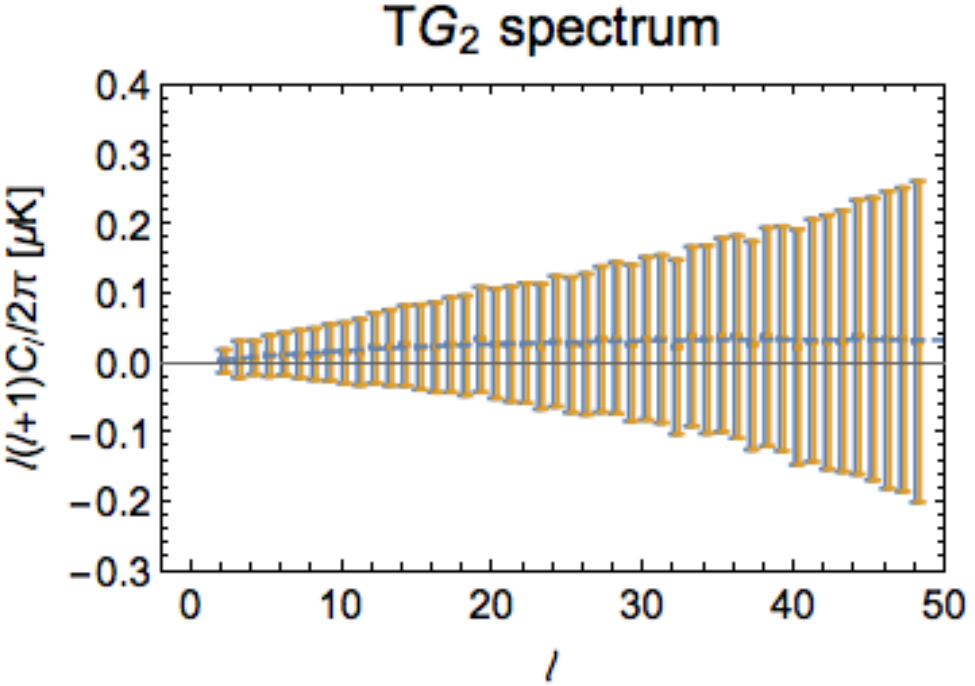
Blue estimates = estimator built with the same fiducial used for the MC

Orange estimates = estimator built with only block diagonal covariances (i.e. cross fiducial spectra set to zero)

By A. Gruppuso

Spectra (nside=16) no binning





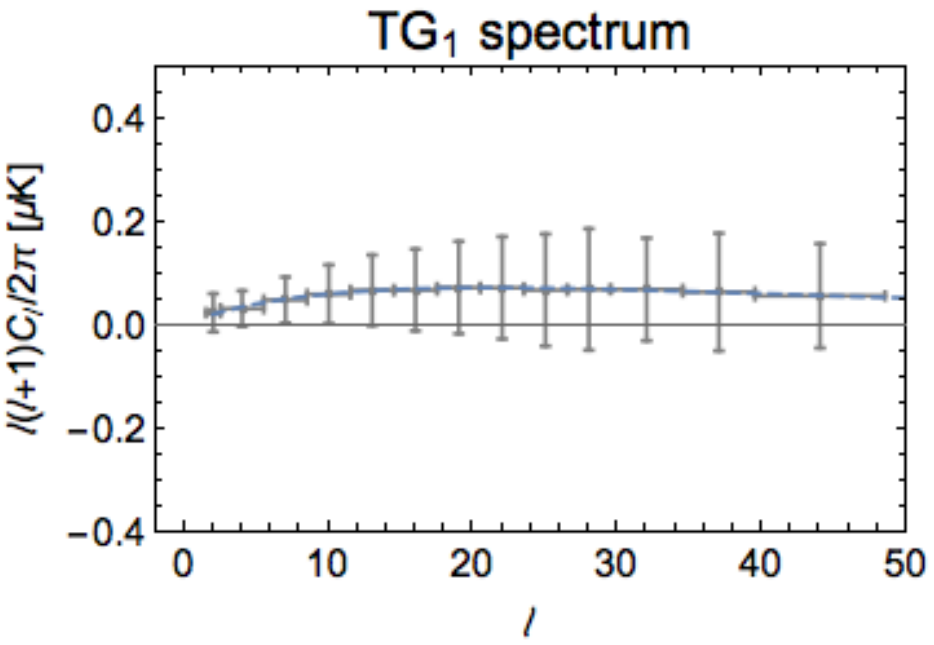
Blue estimates = estimator built with the same fiducial used for the MC

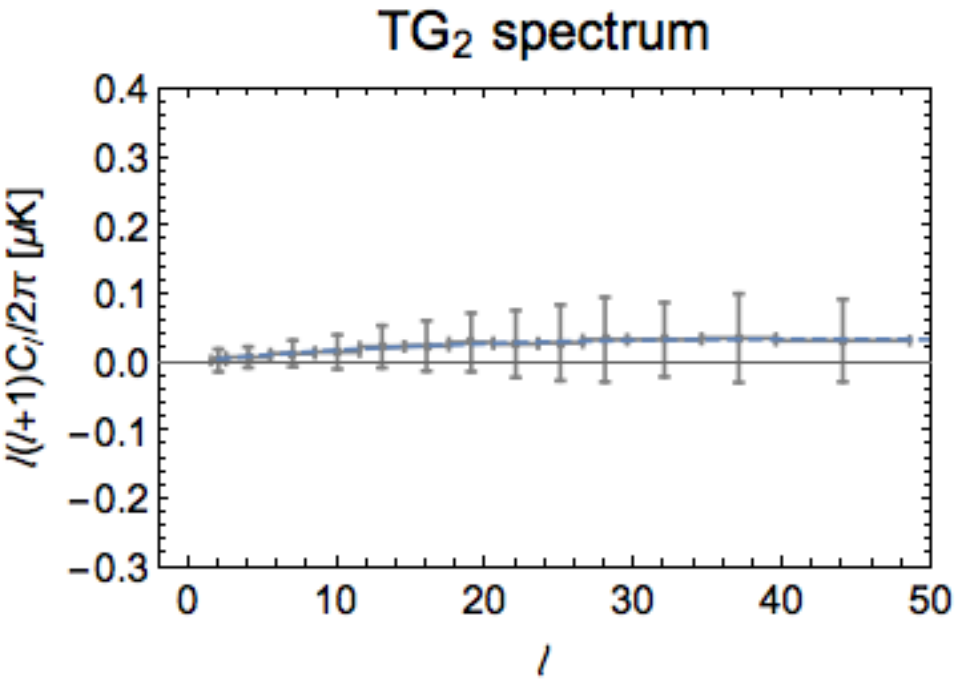
Error = Fisher matrix (single realisation)

Orange estimates = estimator built with only block diagonal covariances (i.e. cross fiducial spectra set to zero)

By A. Gruppuso

Spectra (nside=16) binning





Blue estimates = estimator built with the same fiducial used for the MC

Error = Fisher matrix (single realisation)

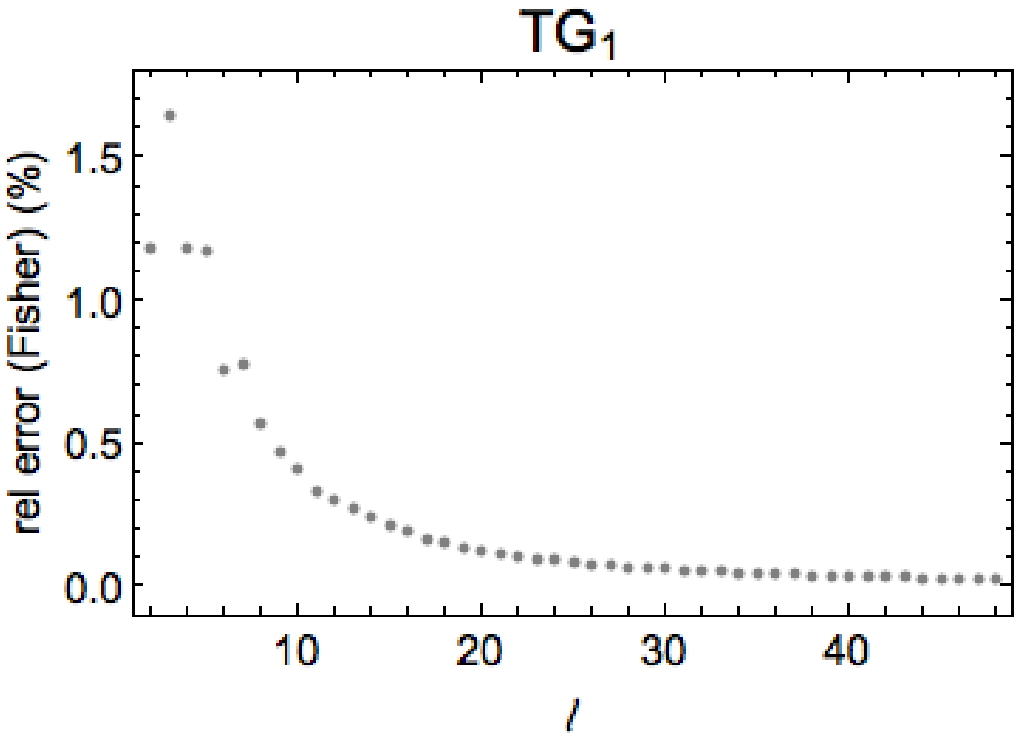
Orange estimates = estimator built with only block diagonal covariances

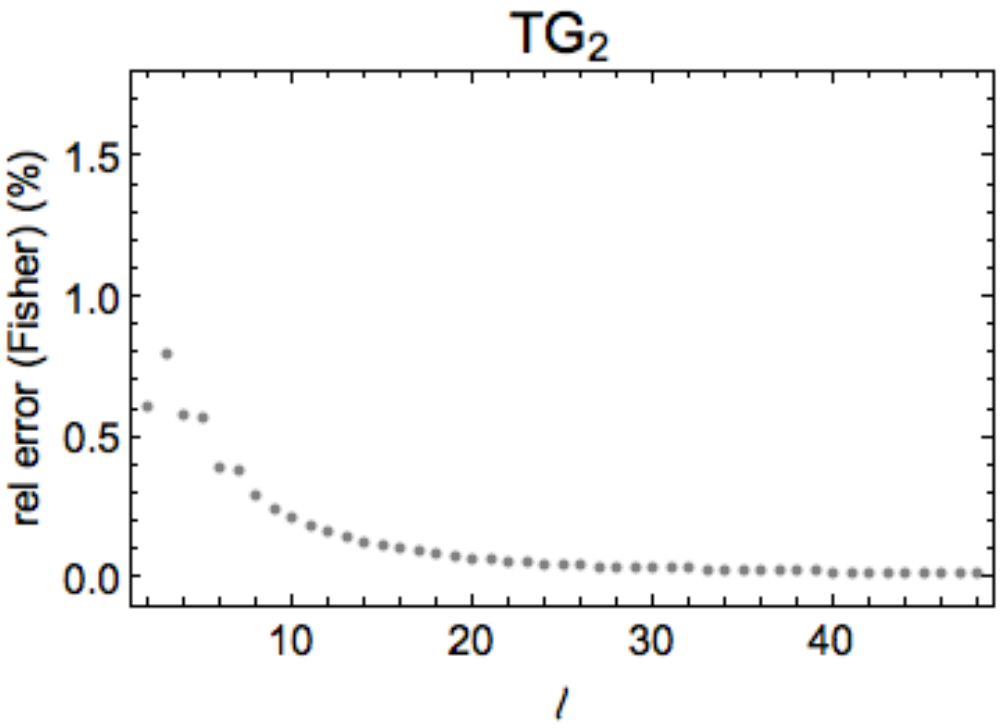
(i.e. cross fiducial spectra set to zero)

Impact on Fisher uncertainties

By A. Gruppuso

"(Orange - Blue)/Blue "



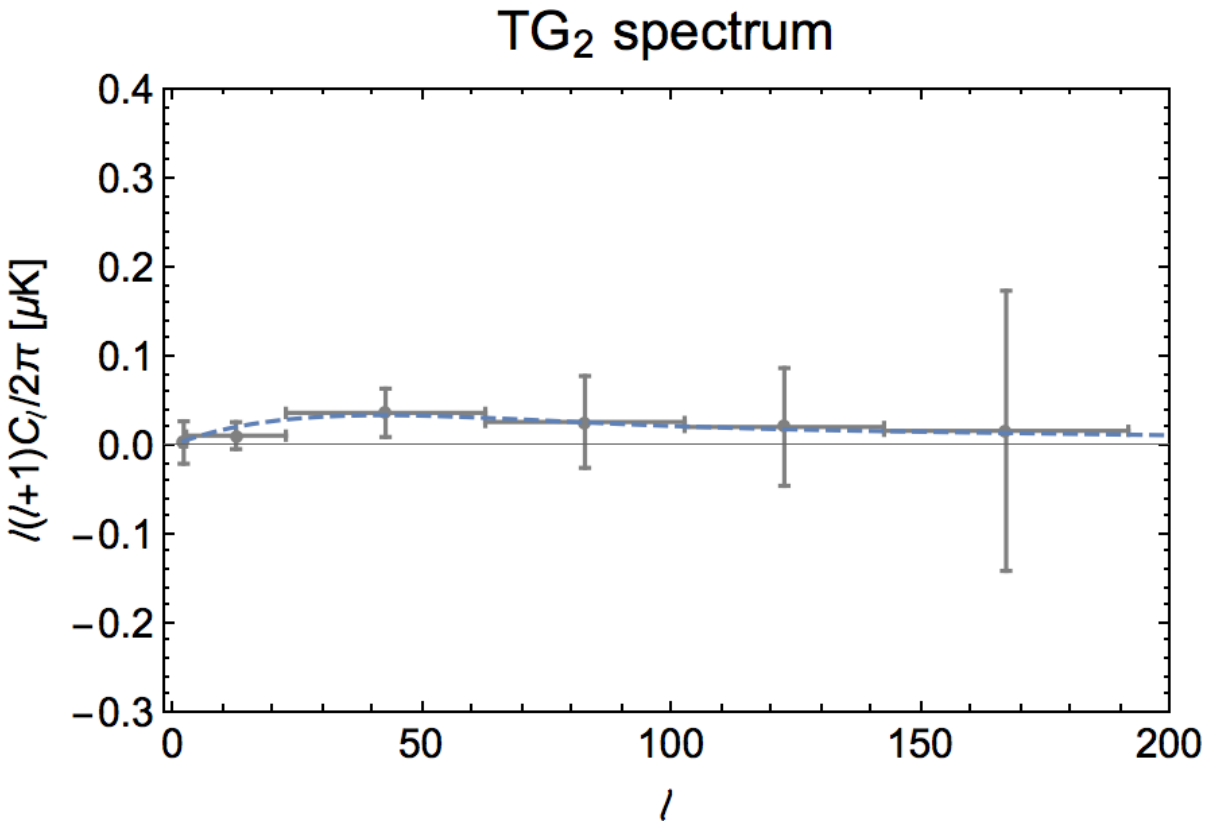


When the fiducial is not exactly the one used to generate the MC, the QML is not exactly optimal anymore. This quantifies the increase of the error in percentage for each multipole when we use this simplification. Note that if the peak of the cross correlation is not below ell~10 the impact might be mild. However this has to be quantified at the level of cosmological parameters.

By A. Gruppuso

Expanding to high resolution

Preliminary results at Nside 64



MC average of 100 sims at nside 64.
About 1h running time with 900 processors

Next steps

Masks

- We will continue to look for realistic masks because are fundamental for the Euclid Project on the estimators.

Pseudo-Cl

- Testing increasingly realistic and updated setups and survey specs, e.g Sky Mask (mask per survey, visibility mask), dN/dz, Optimizing tomography, …
- Interface to N-body sims and mock catalogues from the EC and SWG
- Adding CMB polarization information
- Including CMB lensing as LSS tracer
- Developing and validating a likelihood pipeline for cosmological model testing and nuisance/systematic parameters marginalization

QML

- Optimize the code at higher resolution (Nside 64). Quite computationally demanding. Needs binning but not too much to avoid loosing information.
- To be faster we are working on a new implementation of the QML estimator which is aimed at only-TG. (equivalent to setting cross-fiducial to zero and selecting the spectrum of interest)