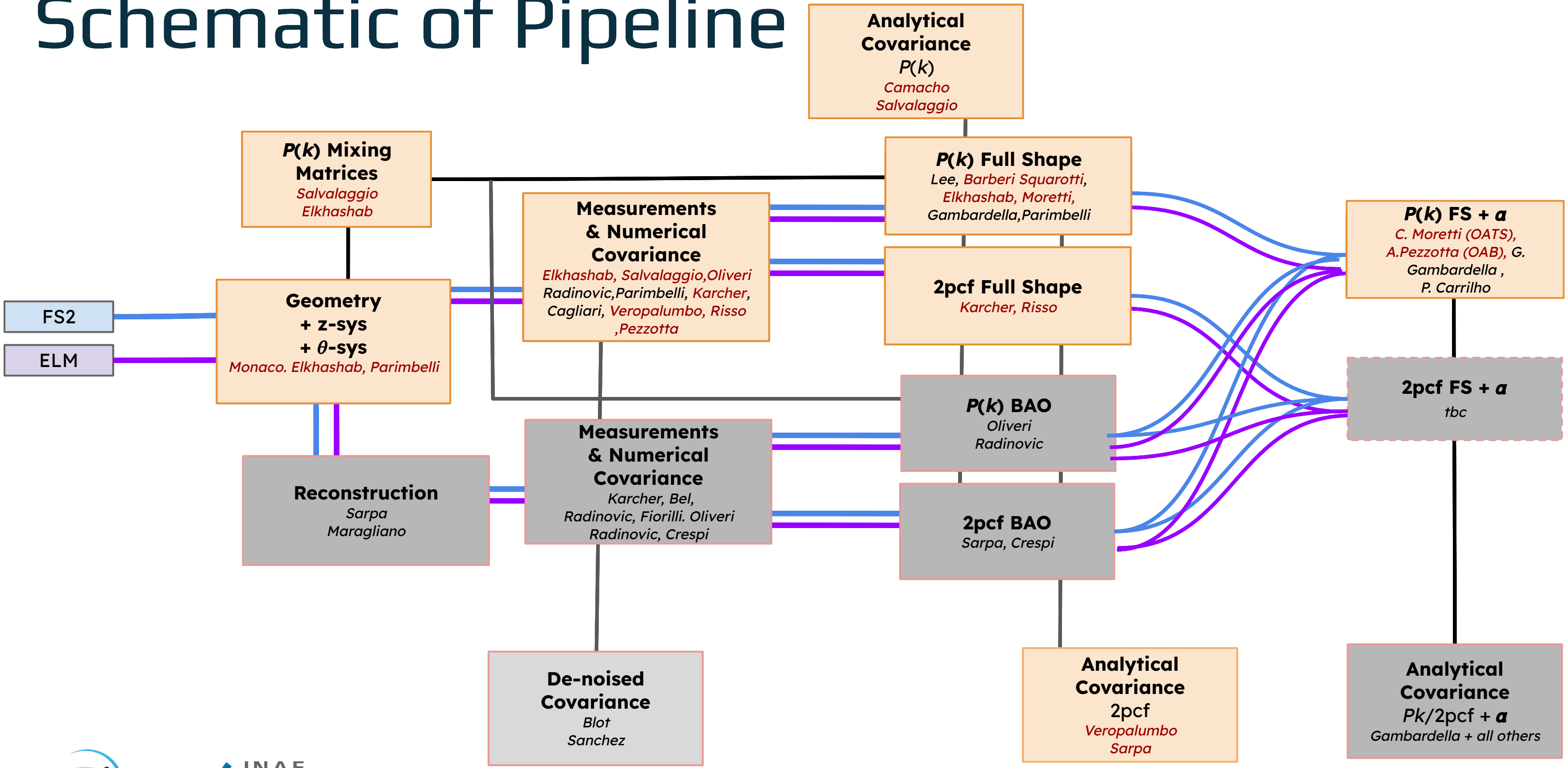
Full shape and joint analysis for GC

Mohamed Yousry Elkhashab

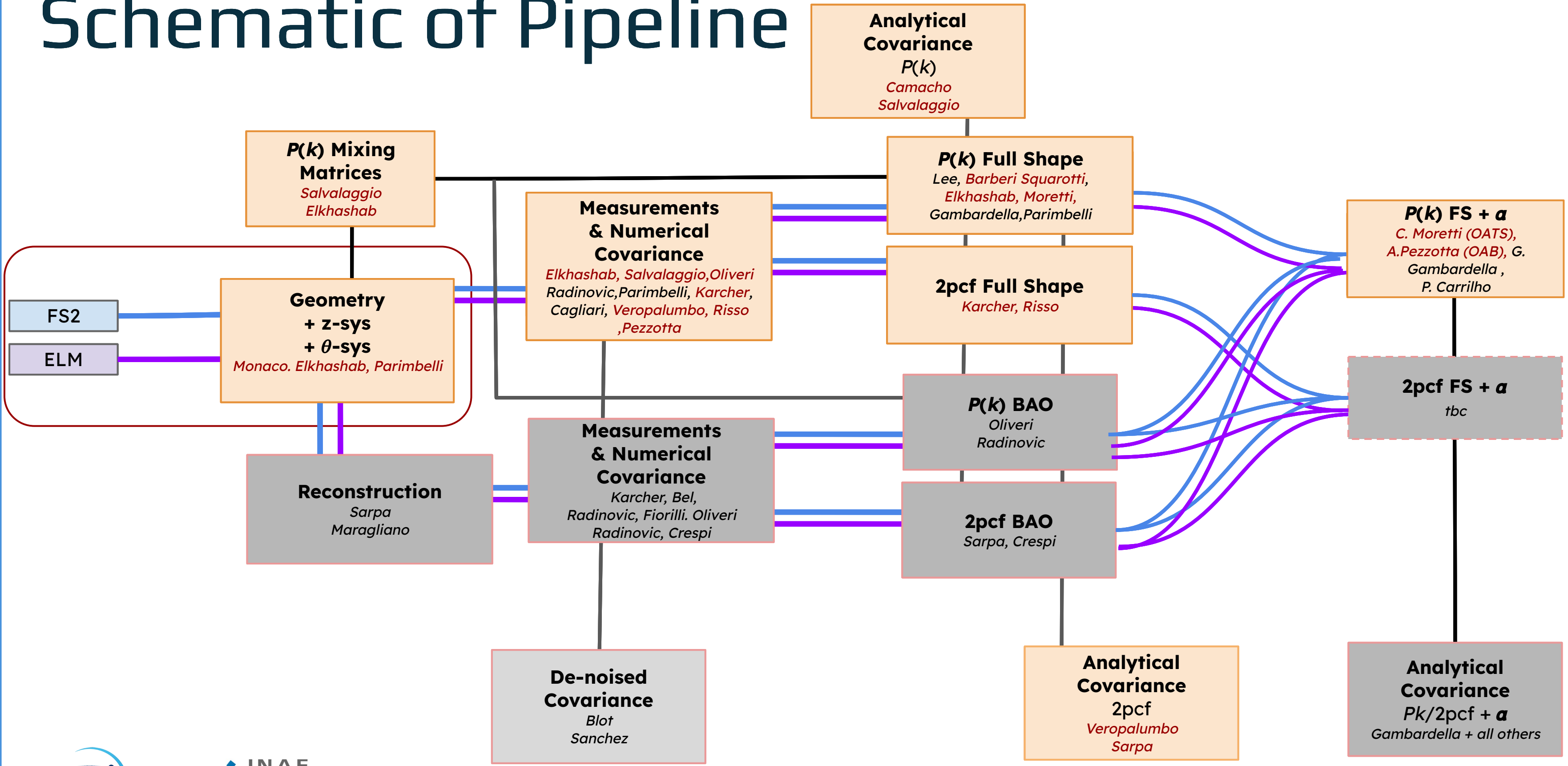
7° Meeting Nazionale Collaborazione Euclid Italia
Bologna, Tuesday July 1st, 2025

Schematic of Pipeline



2

Schematic of Pipeline



3

Mock Catalogs:
Simulations and Geometries

Euclid preparation

TBD. Simulating thousands of Euclid spectroscopic skies

Euclid Collaboration: P. Monaco[1,2,3,4*], G. Parimbelli, M. Y. Elkhashab, J. Salvalaggio, T. Castro, M.D. Lepinzan, E. Sarpa, E. Sefusatti, L. Stanco, L. Tornatore, G. Addison, S. Bruton, C. Carbone, F. Castander, J. Carrettero, S. de la Torre, P. Fosalba, G. Lavaux, S. Lee, K. Markovich, K. McCarthy, F. Passalacqua, W. Percival, I. Risso, C. Scarlata, P. Tallada-Crespí, Y. Wang, et al.

FS2

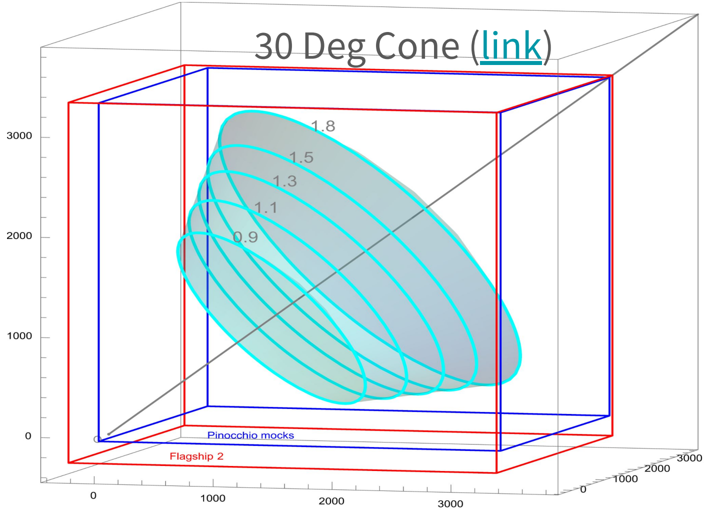
ELM

Geometry
+ z-sys
+ θ-sys
P. Monaco (UniTs)
M.Y. Elkhashab (UniTs)
G. Parimbelli

Available mocks (link)

- 1 Flagship 2 light cone
- 1000 Euclid Large Mocks (Pinocchio mocks)

30 Deg Cone (link)



Mock Catalogs:
Geometry

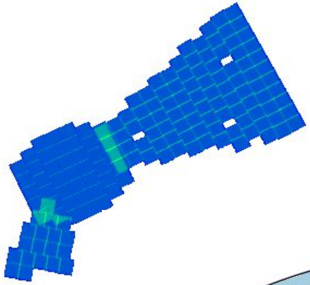
Planned Geometries

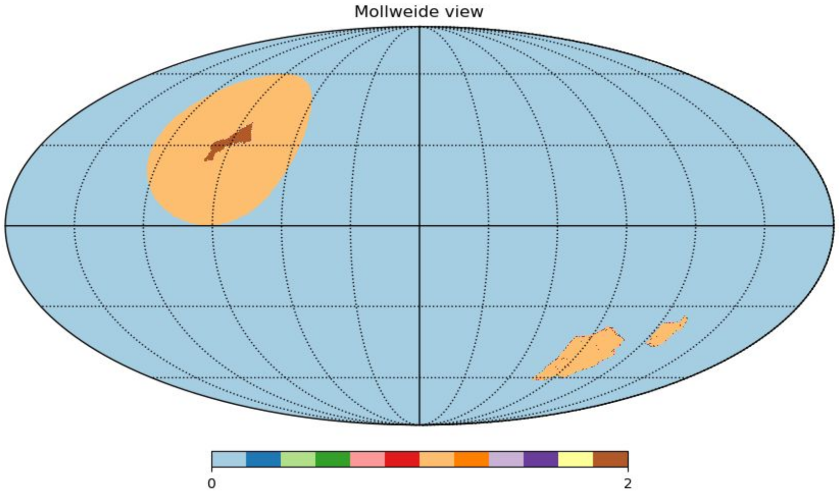
- 30 Deg Cone (link)
- RR2 (link)
- DR1 (TBD)

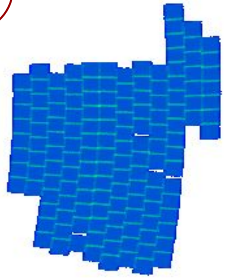
FS2

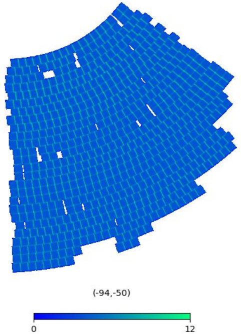
ELM

Geometry
+ z-sys
+ θ-sys
P. Monaco (UniTs)
M.Y. Elkhashab (UniTs)
G. Parimbelli





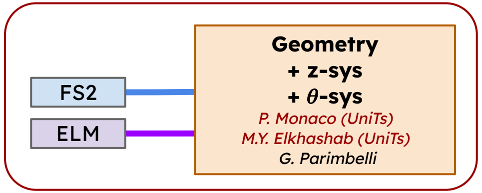




Agenzia Spaziale Italiana

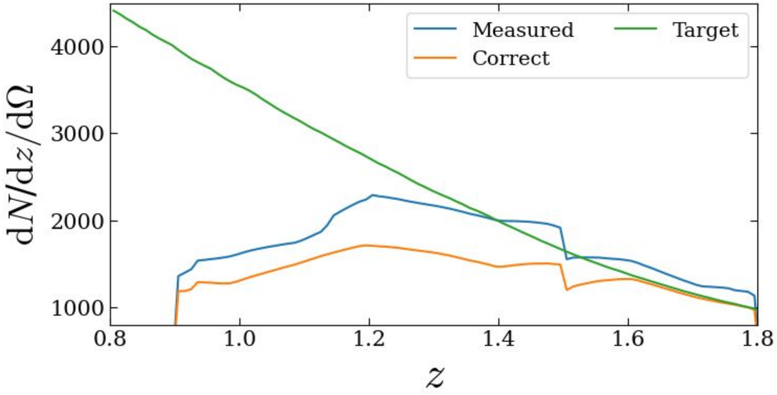
INAF
ISTITUTO NAZIONALE DI ASTROFISICA
NATIONAL INSTITUTE FOR ASTROPHYSICS

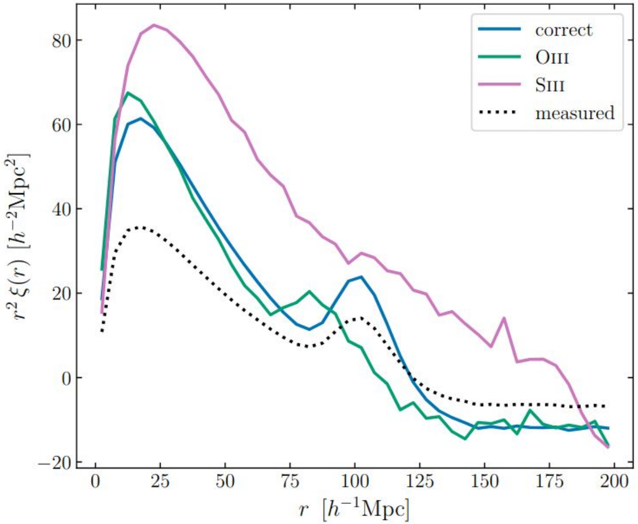
Mock Catalogs:
Radial systematics



Credit: Risso et al. 2025

Pre-launch





New Mocks

selection	density	purity	f_OIII	f_SIII	f_noise	PDFc	mean	sigma	gamma	trunc	PDFl	mean	sigma	footprint
pre-launch	1255	0.7999	0.0668	0.0497	0.0836	G	0	0.001		remove	G	0	0.001	30degCircle
high density 1	2000	0.6	0.05	0.05	0.3	V	0	0.0005	0.0004	remove	G	0	0.001	30degCircle
high density 2	2000	0.6	0.05	0.05	0.3	V	0	0.0006	0.001	noise	G	0	0.001	30degCircle
high purity	600	0.8	0.05	0.05	0.1	V	0	0.0005	0.0004	remove	G	0	0.001	4D-30degCircle
worst case	400	0.4	0.05	0.05	0.5	V	0	0.0006	0.001	noise	G	0	0.001	4D-30degCircle

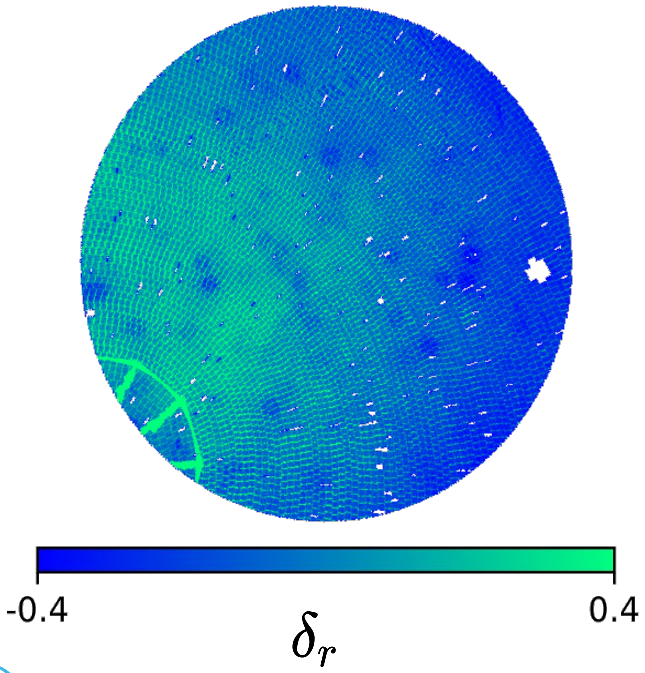
Mock Catalogs:
Angular systematics

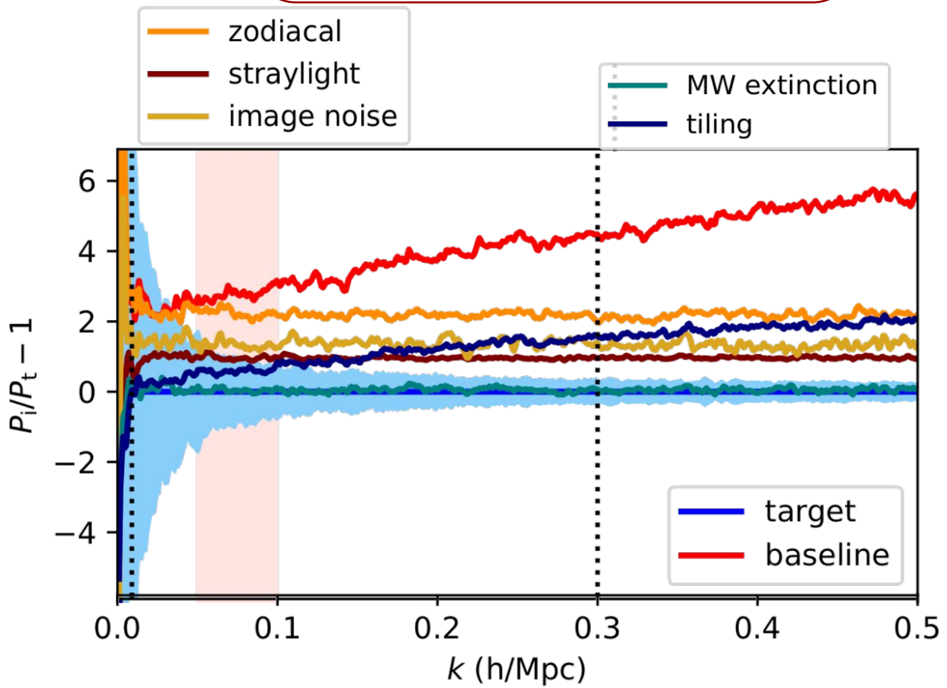
FS2

ELM

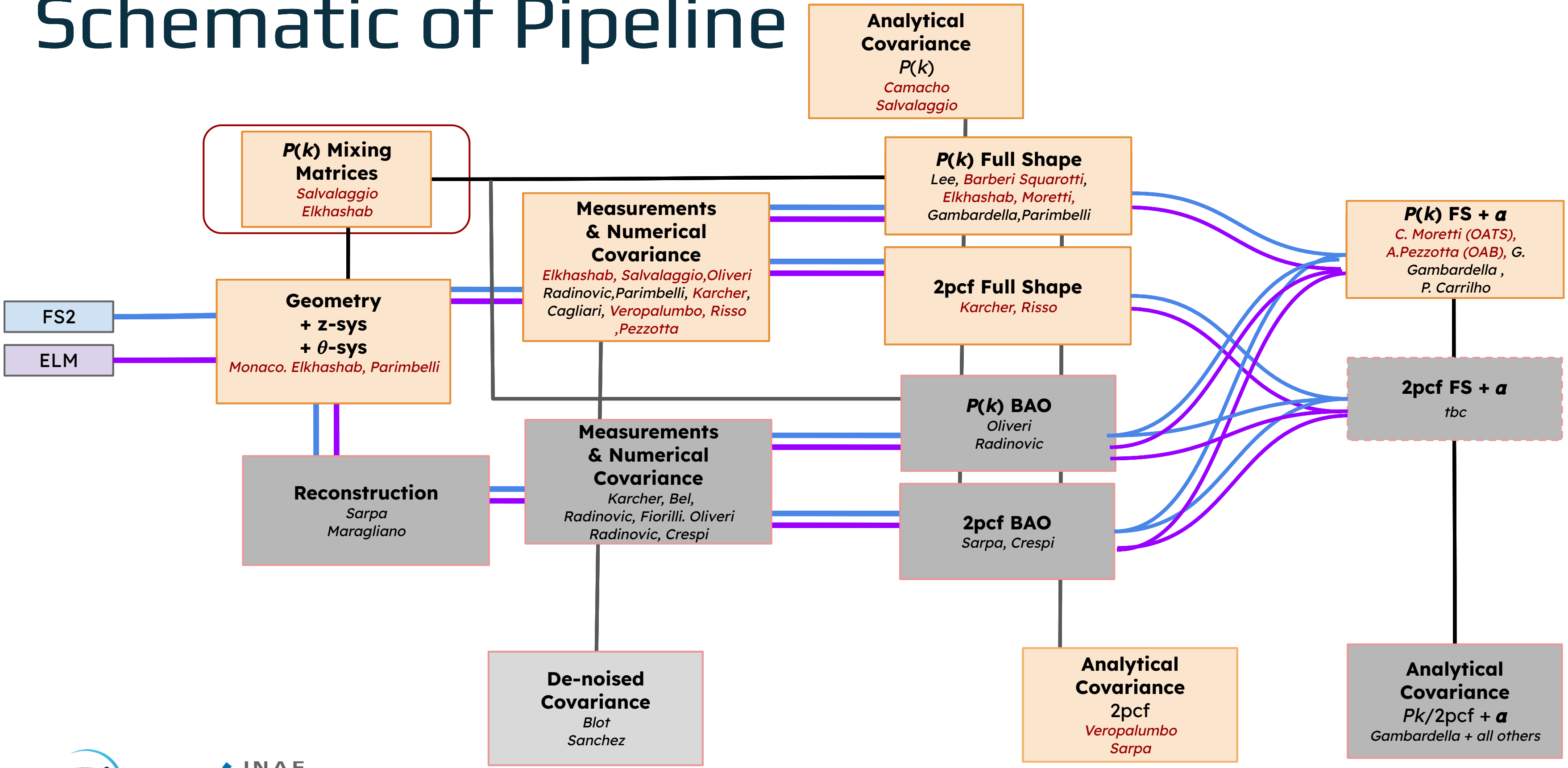
Geometry
+ z-sys
+ θ-sys

P. Monaco (UniTs)
M.Y. Elkhashab (UniTs)
G. Parimbelli





Schematic of Pipeline



8

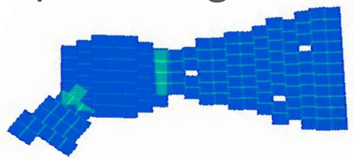
Mixing Matrices

$$P_\ell^{\rm obs}(k) \approx \sum_{\ell'} \int k'^2 \boxed{\mathcal{W}_{\ell\ell'}(k,k')} P_{\ell'}(k')\, \mathrm{d}k'$$

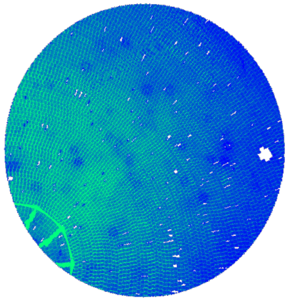
$P(k)$ Mixing Matrices
Salvalaggio (UniTs)
Elkhashab (UniTs)

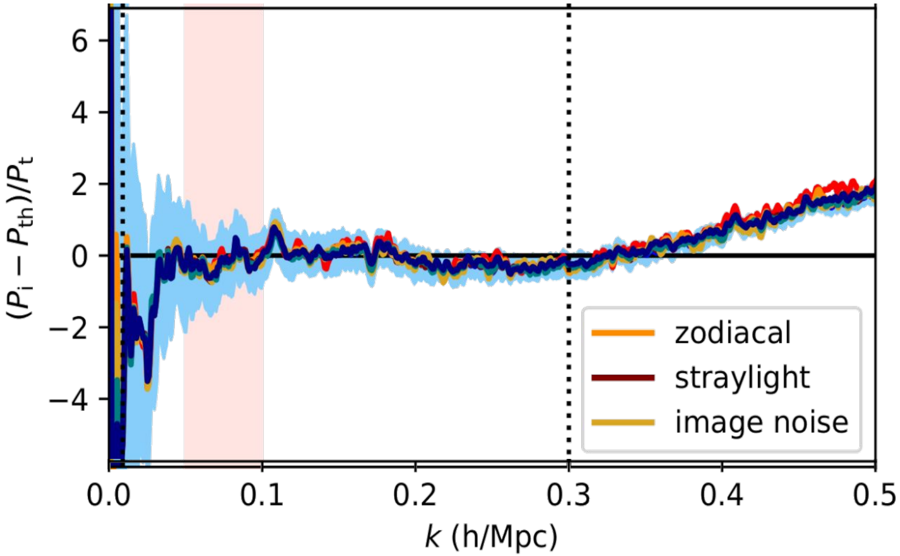
Using the package CONVO, We can handle

- complicated geometries

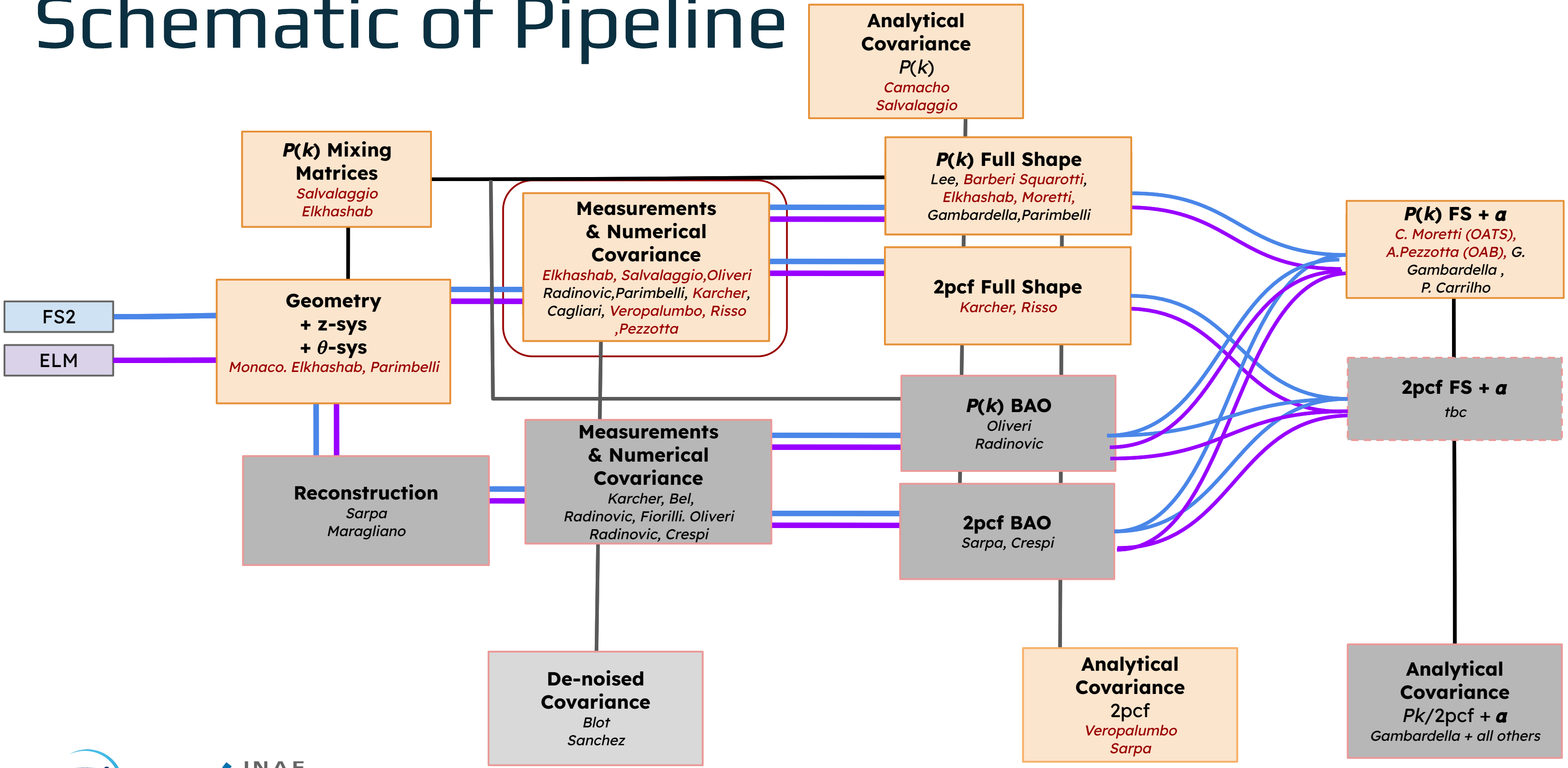


- Angular systematics



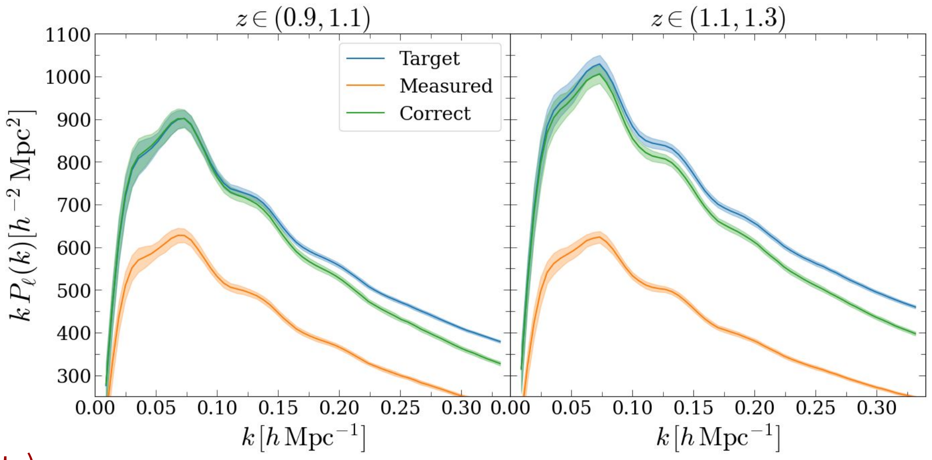


Schematic of Pipeline



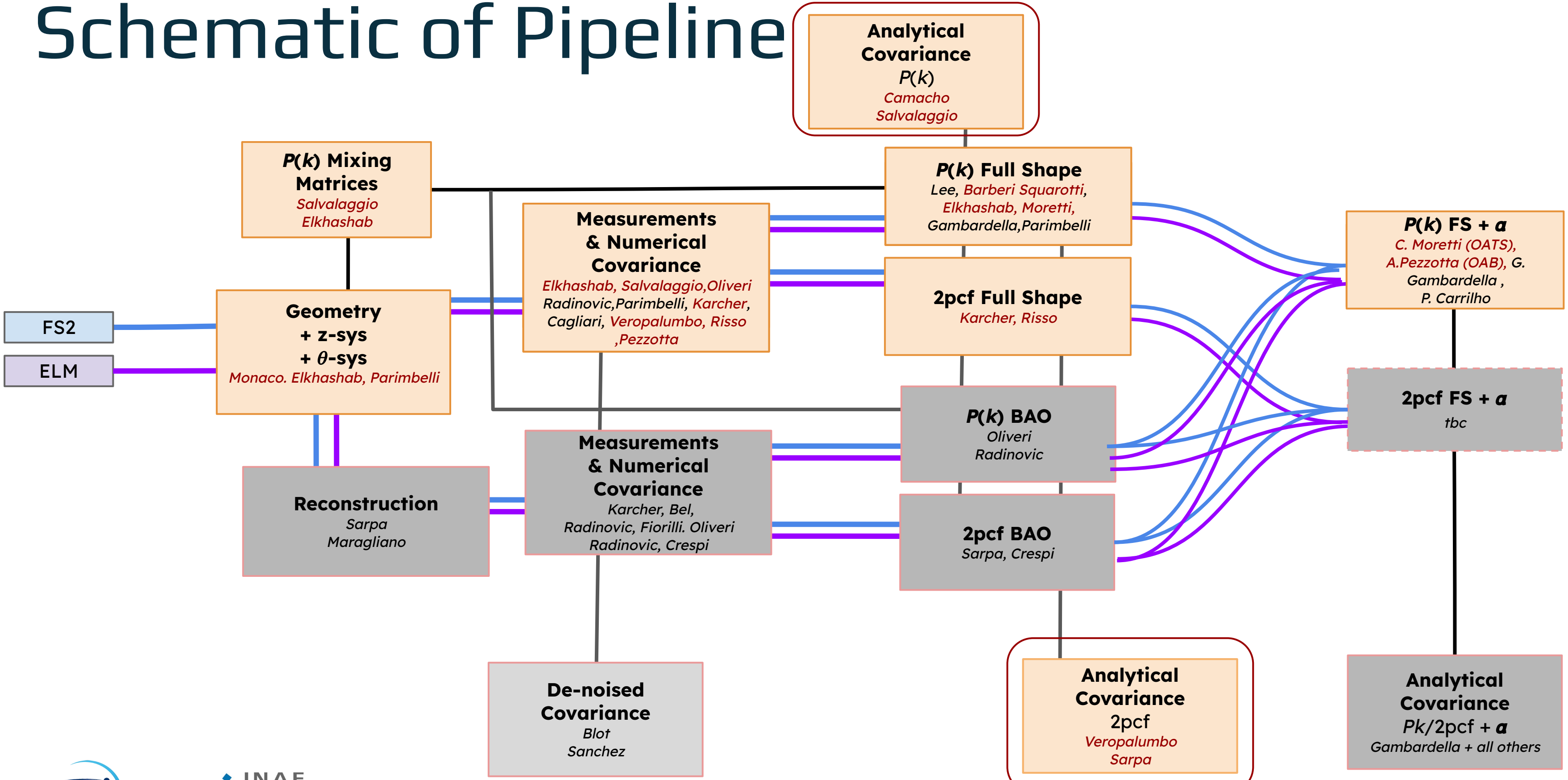
Measurements and Covariances

- Measurements for each type of :
  - Geometry (30DegCone, RR2, …)
  - Statistic (PK, 2PCF)
  - Catalog (Correct, Measured, Target, Angular Baseline)
- LE3 Codes:
  - PK: F. Rizzo (OATs)
  - 2PCF: S. de la Torre , F. Marulli (UniBo)
- Measurers:
  - PK: M.Y. Elkhashab (Units), J. Salvalaggio (Units), C.Oliveri (SISSA), S. Radinovic
  - 2PCF: A. Veropalumbo (UniGe), I. Risso (UniGe), A. Pezzotta (OAB), G.Parimbelli , M. Cagliari
- Measurements (**with Mixing matrices**) available at link
- Beginner Friendly Gitlab Repo: A. Veropalumbo (UniGe), I. Risso (UniGe), M. Y. Elkhashab (UniTs)



Measurements & Numerical Covariance

Schematic of Pipeline



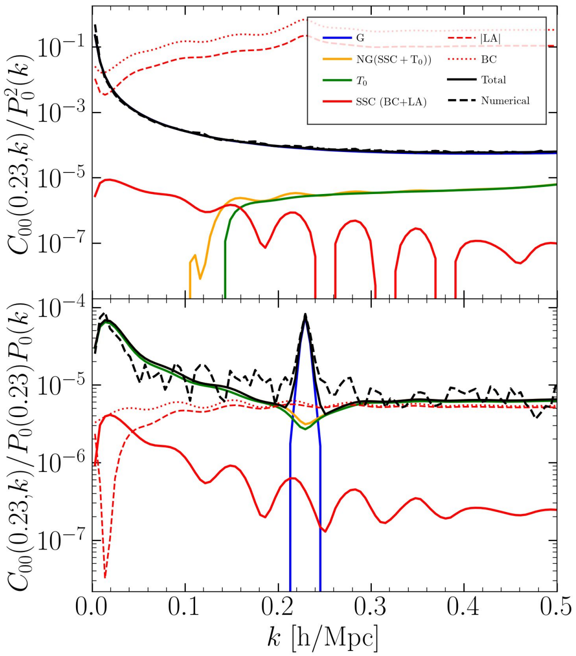
12

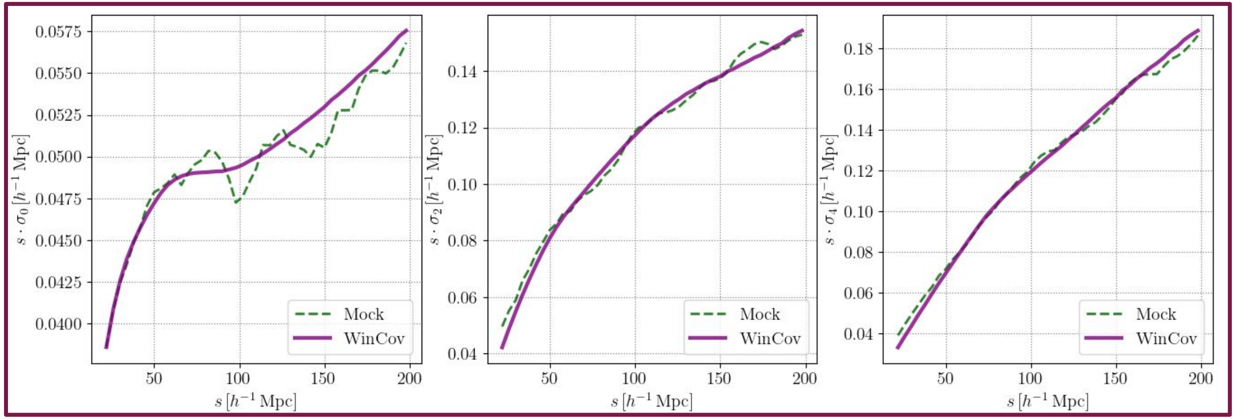
Analytical Covariances

P(k)
Camacho (UniTs)
Salvalaggio(UniTs)

- **Successful tests w.r.t. ELM Mocks**
- Ongoing: Including radial systematics

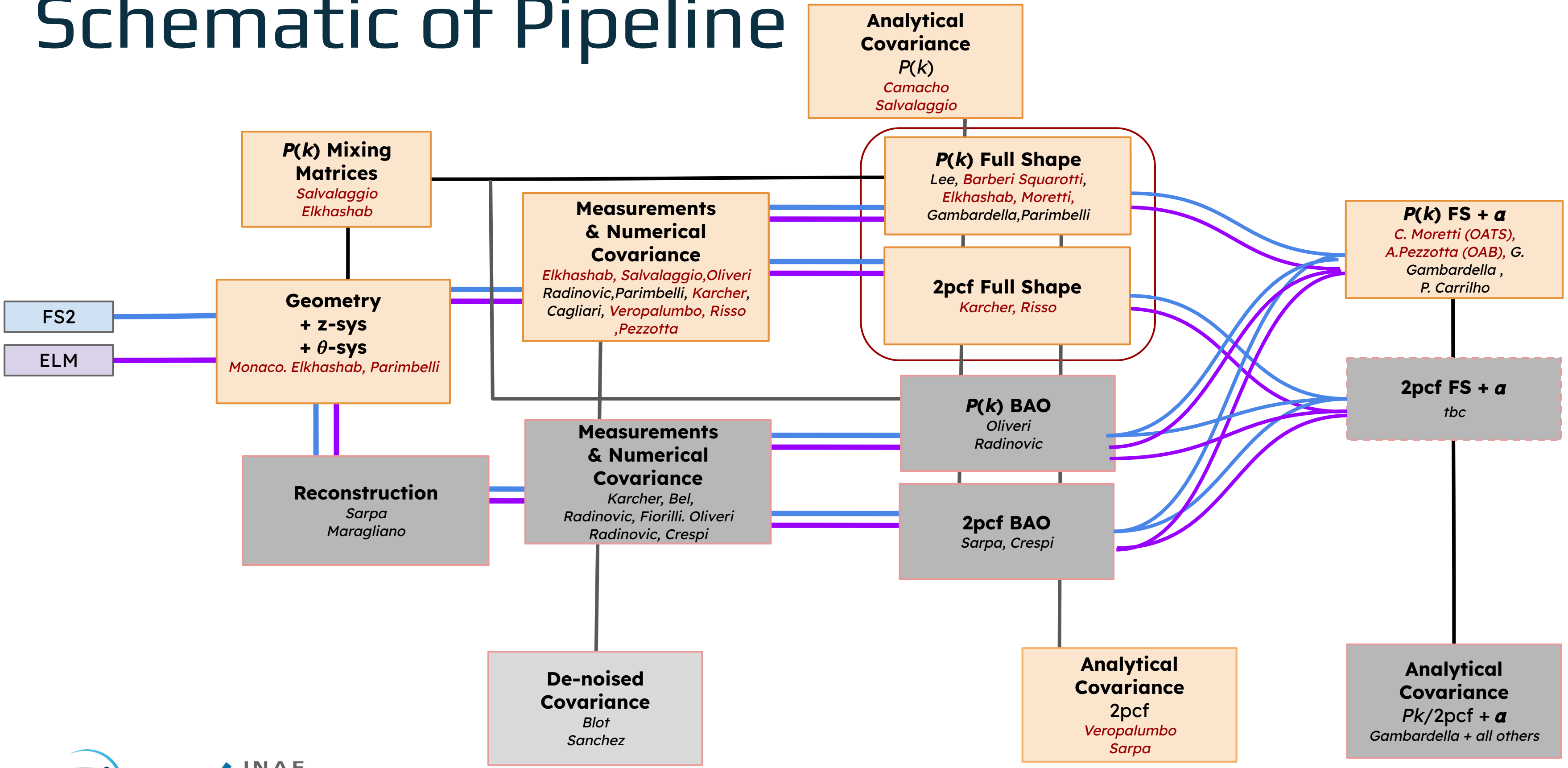
2PCF
Veropalumbo (UniGe)
Sarpa (UniTs)





Agenzia Spaziale Italiana
INAF
ISTITUTO NAZIONALE DI ASTROFISICA
NATIONAL INSTITUTE FOR ASTROPHYSICS

Schematic of Pipeline



14

ASI Agenzia Spaziale Italiana

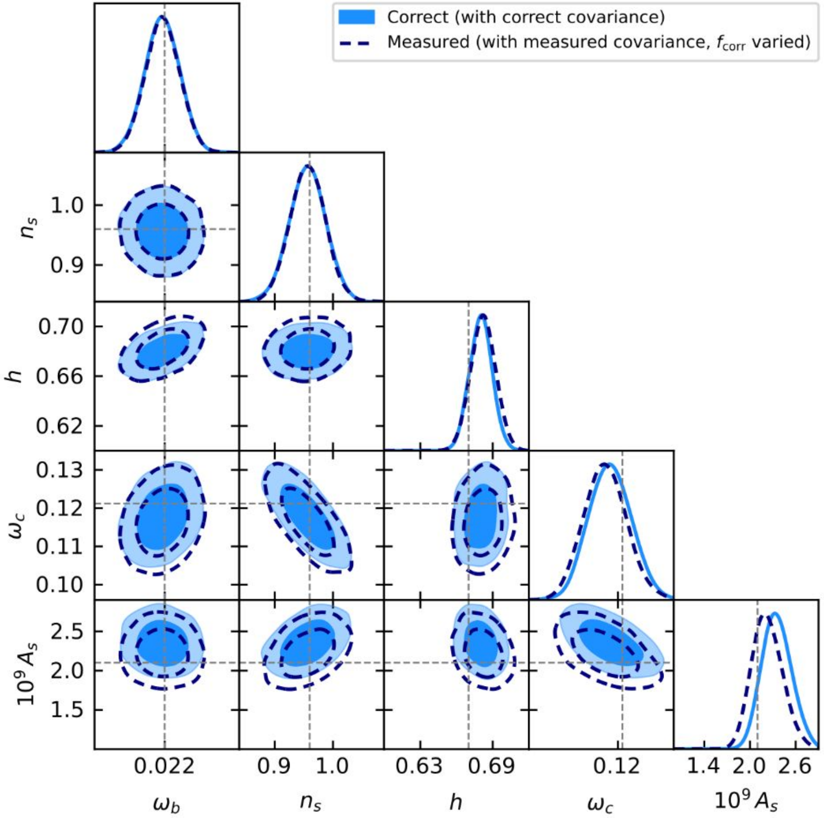
INAF ISTITUTO NAZIONALE DI ASTROFISICA NATIONAL INSTITUTE FOR ASTROPHYSICS

Impact of Radial systematics:
Interlopers

- Continuation of prelaunch projects lead by I. Risso (UniGe) for the 2PCF and S. Lee on the P(K)
- Tasks:
  - Simple rescaling by the fraction ✅
  - Model each interloper species
  - Testing on different versions of contaminated catalogues

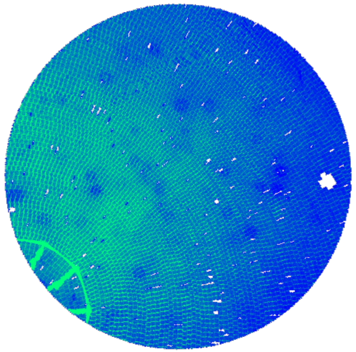
***P(k)* Full Shape**
Lee
M. Barberi
Squarotti (UniMi)
Elkhashab (UniTs)
C. Moretti (OATS)
Gambardella,Parimbelli

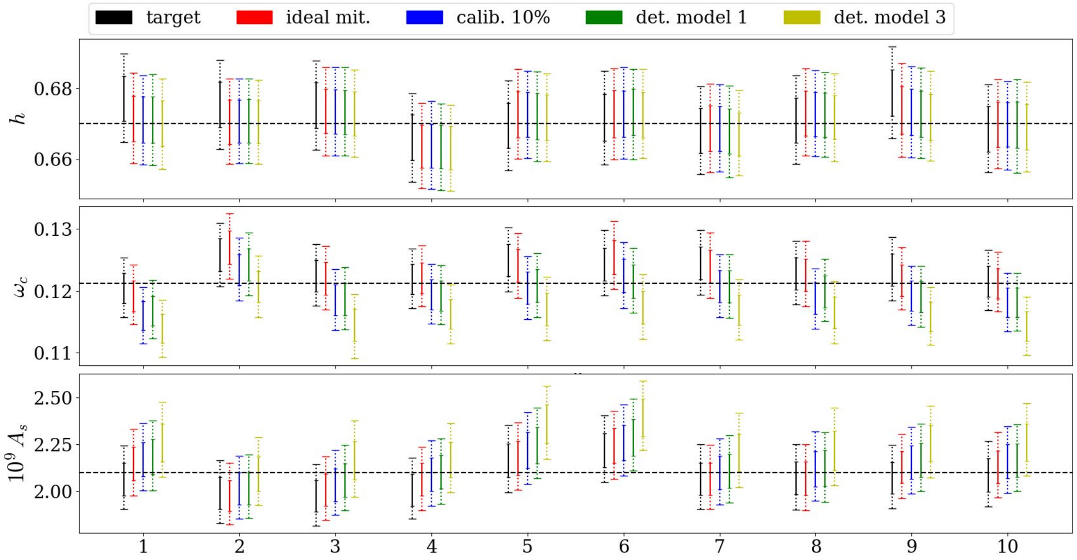
2pcf Full Shape
Karcher (UniMi)
Risso (UniGe)



Impact of Angular systematics:

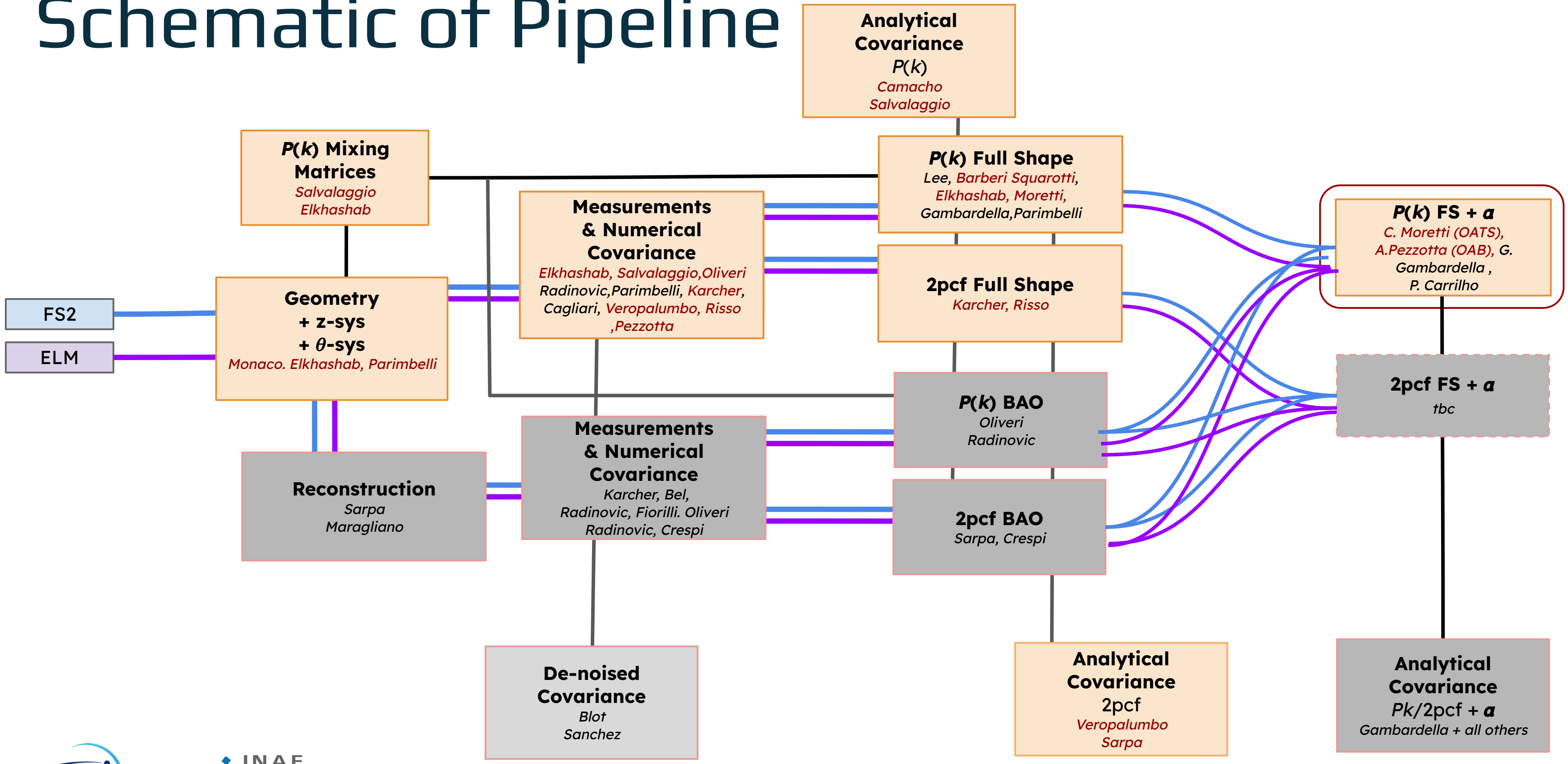
- Continuation of prelaunch project lead by P.Moncao (UniTs)
- Tasks:
  - Quantify Systematic errors for DR1 ✅
  - Include impact of angular systematics in the covariance





$P(k)$ Full Shape
Elkhashab (UniTs)
J. Salvalaggio(UniTs)

Schematic of Pipeline

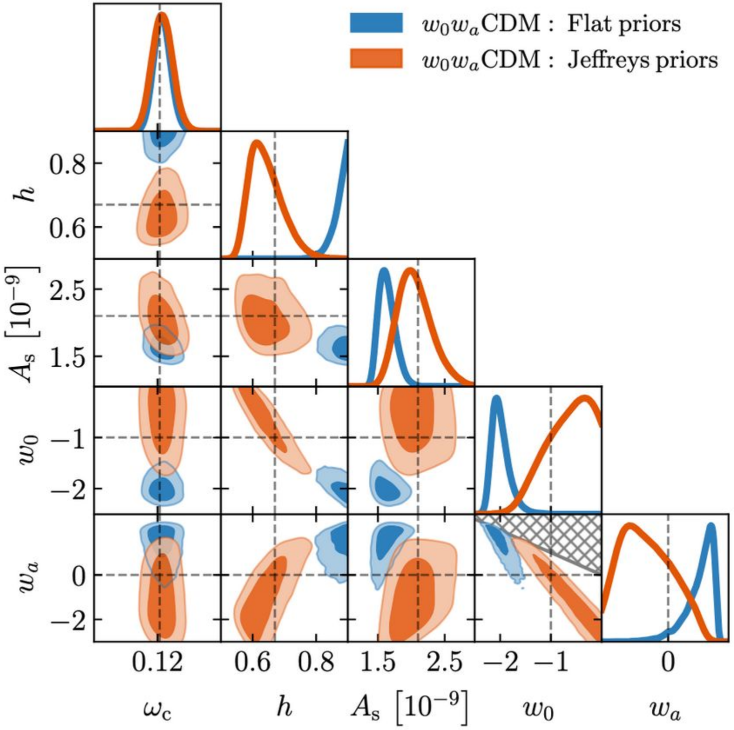


FS + α:
Priors & projection effects for FS

$P(k)$ FS + α
C. Moretti (OATS), A.Pezzotta (OAB), G. Gambardella , P. Carrilho

Identify mitigation strategies for projection effects

- Work started within IST:NL
- First exploration with synthetic data vectors, simple implementation of systematics
  - Combination with post-rec BAO
  - Re-parametrisation (similar to DESI)
  - Jeffreys priors / profiling of linear parameters
- Now investigating with mocks, more realistic systematics



BACK UP SLIDES

Redshift Errors

- Gambardella,Parimbelli