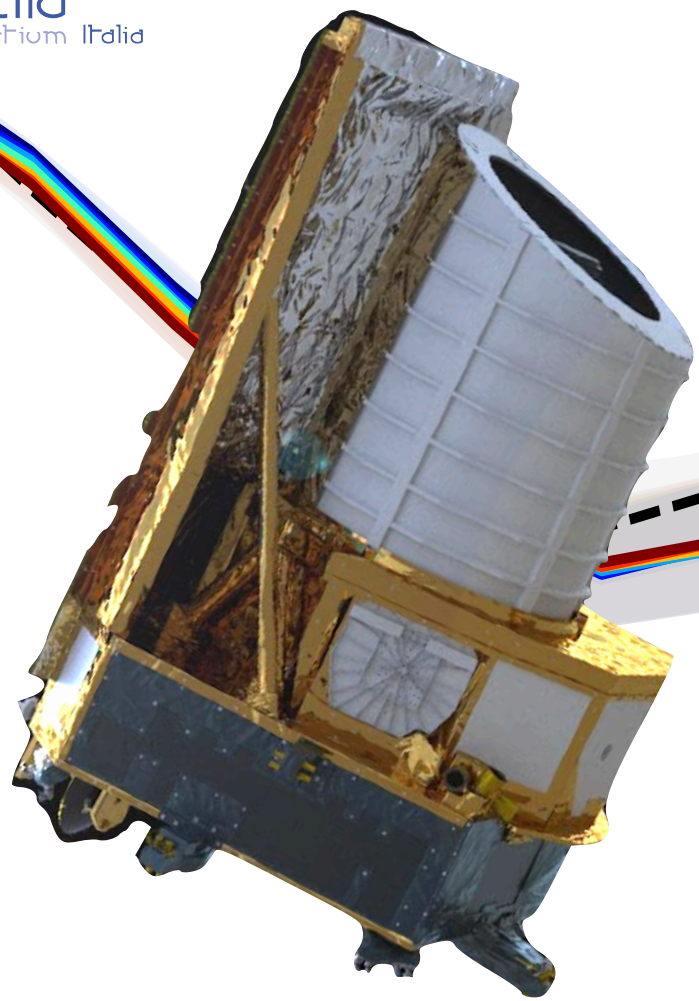


# GC4: Cosmology from BAO in 2-point Galaxy Clustering in DR1 Data


## Elena Sarpa (SISSA) - GC4 Co-Lead

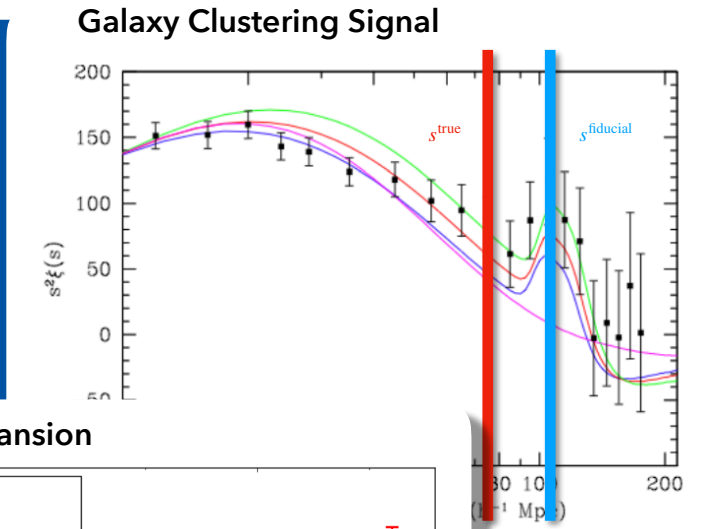
On behalf of: C. Oliveri, S. Radinovic, A. Crespi, J. Bel, A. Pezzotta, M. Karcher, E. Maragliano, A. Veropalumbo, M. Bonici, C. Moretti, E. Sefusatti, S. Nadathur, A. Fiorilli

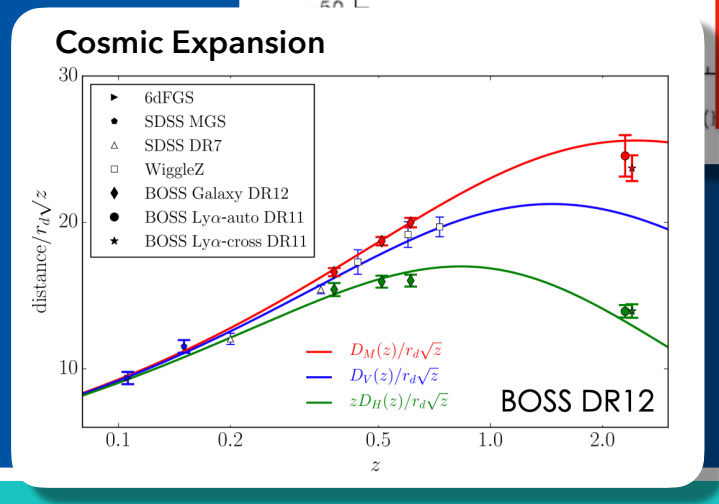
With the invaluable support of J. Salvalaggio, Y. Elkhashab, and G. Gambardella, F. Rizzo

# Baryon Acoustic Oscillations

**Standard Ruler**
From BAO to Dark Energy

- Primordial sound perturbations of **known size**
- Observed size set by **Universe expansion at observed redshift**
- **Constrain DE** by tracing the Universe evolution




**Simple, Robust, Precise**

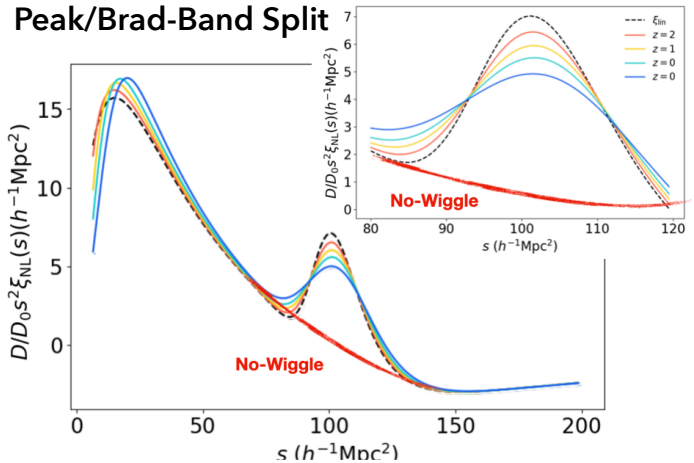
# Baryon Acoustic Oscillations

## Standard Ruler
From BAO to Dark Energy

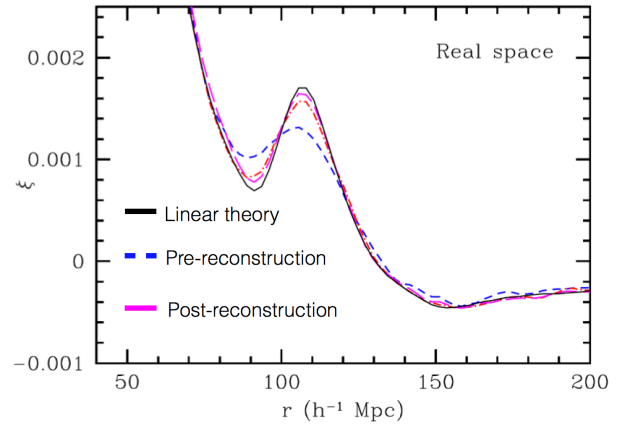
**Simple, Robust, Precise**

- BAO modelling:
  **Fitting a Gaussian Peak**
- BAO **S/N can be improved** w/ respect to observations via numerical techniques:
  **BAO Reconstruction**

Peak/Brad-Band Split




BAO Reconstruction



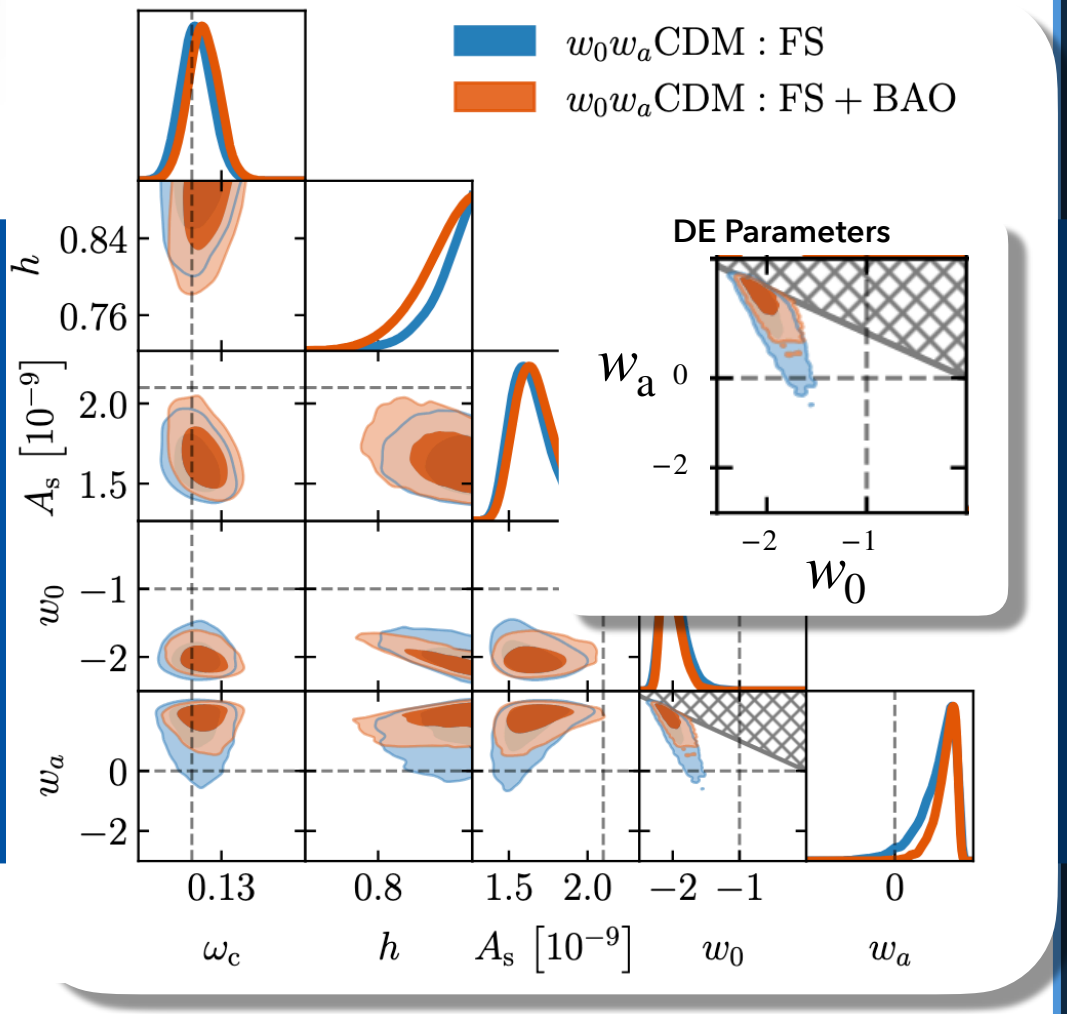
# BAO in Euclid

## 1 Anchoring Cosmological Parameters

Analysis & Plots: **A. Pezzotta (OAB)**, **C. Moretti (OATS)**
Covariance: G. Gambardella (ICE-CSIC), **E. Sarpa (SISSA)**

- Robust Estimates of Cosmological Expansion
- Guide Full-Shape Fit
- Improving **Constraints on DE Equation of State** Parameters: $w_0$ , $w_a$

Credits: A. Pezzotta



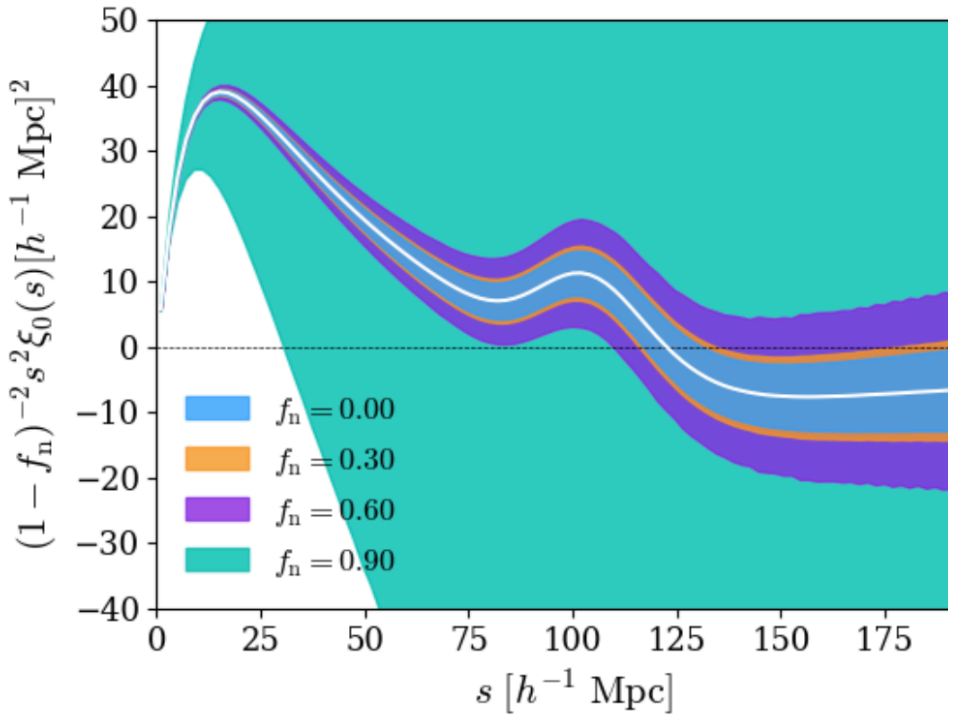
# BAO in Euclid

## 2 Feasibility Test

Synergy Between: GC2 (Sys: **P. Monaco, UniTS; I. Risso, UniGe; Y. Elkhashab, OATS; B. Camacho, SISSA**); GC3 (Catalogue: **A. Farina, UniGe**); GC4 (BAO: **E. Sarpa, SISSA**)

- **Resilient to Observational Systematics**
- **Peak-Detection**: Fast and Simple
- **Forward Modeling**: BAO response to Obs-Sys, "easy" to predict, can be used to **Guide Sample Selection**

BAO Signal To Noise Ratio

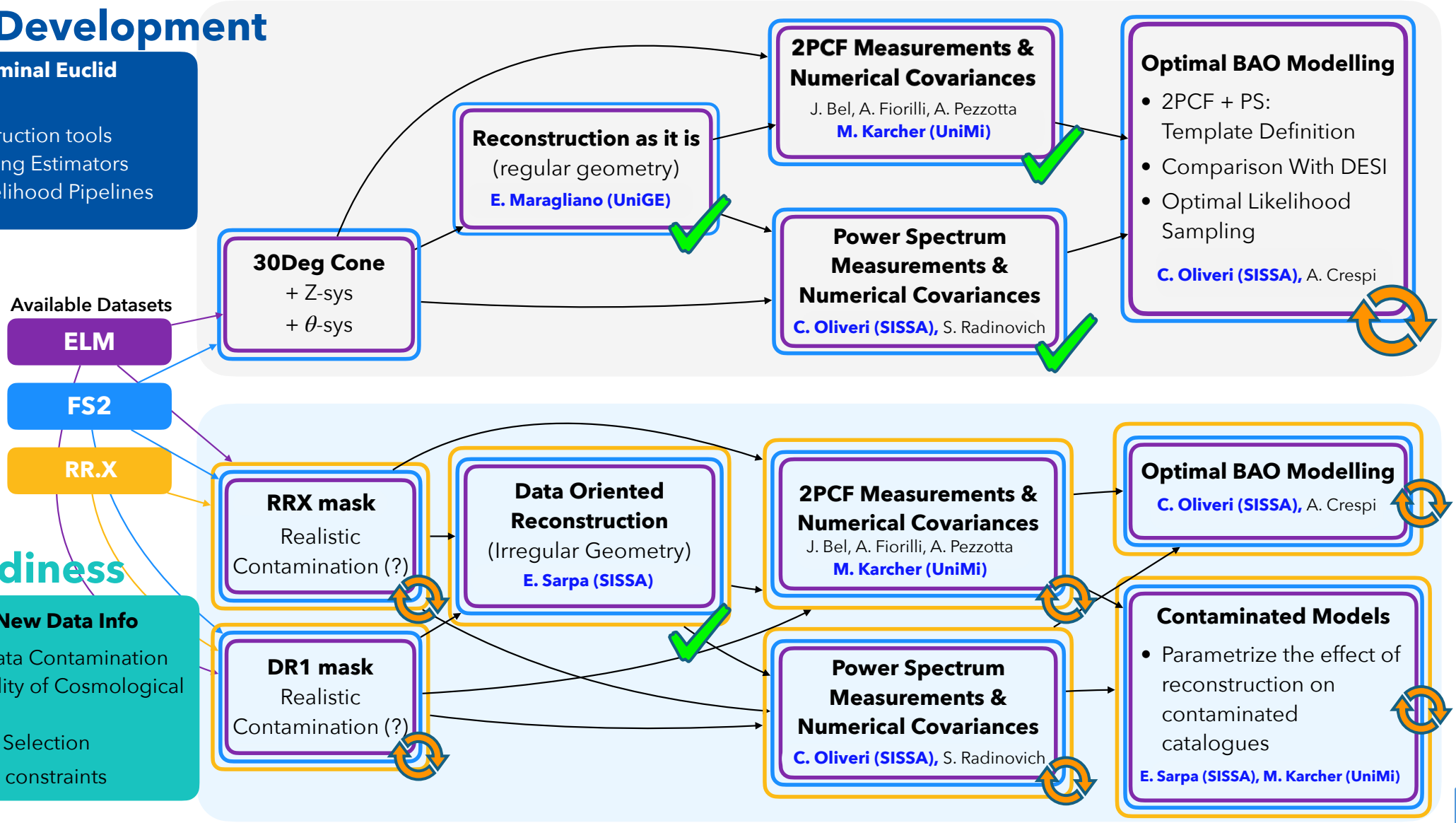


# Radmap To DR1

## Pipeline Development

**Calibrated on Nominal Euclid Characteristics**

- Set up reconstruction tools
- Galaxy Clustering Estimators
- Optimized Likelihood Pipelines




## Data Readiness

**Adapted Live on New Data Info**

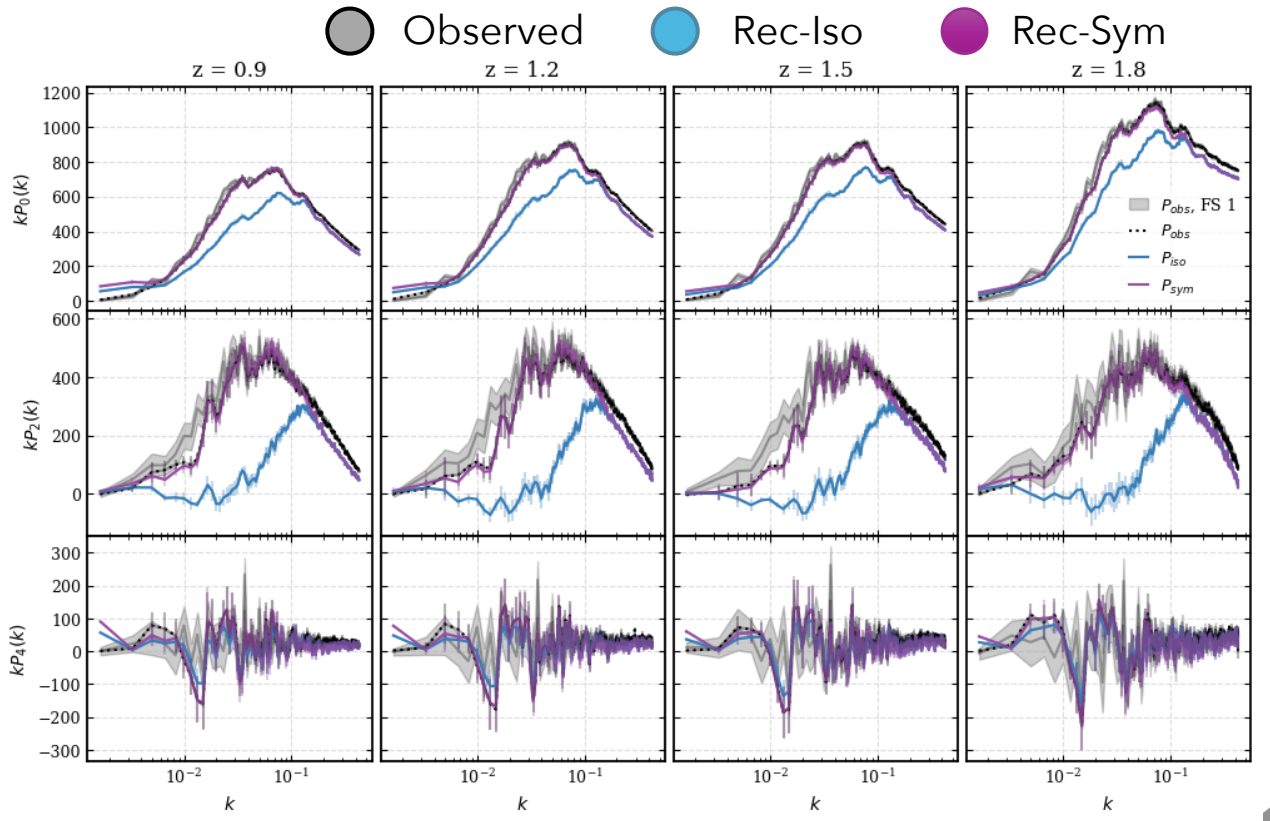
- Understand Data Contamination
- Assess Feasibility of Cosmological Analysis
- Guide Sample Selection
- Optimize BAO constraints

# Completed Work

## 1 Post-reconstruction Power Spectrum Estimator

Design, Development, Testing: **F. Rizzo (OATS, LE3)**, **J. Salvalaggio (OATS)**, **Y. Elkhashab (OATS)**, **C. Oliveri (SISSA)**, S. Radinovic, **E. Sarpa (SISSA)**, **E. Sefusatti (OATS)**

- **Accounts for 2 Randoms**: window sampling + shifted random (clustering information)
- **Validated** against FS1 results
- Successfully Applied to **FS and ELM**



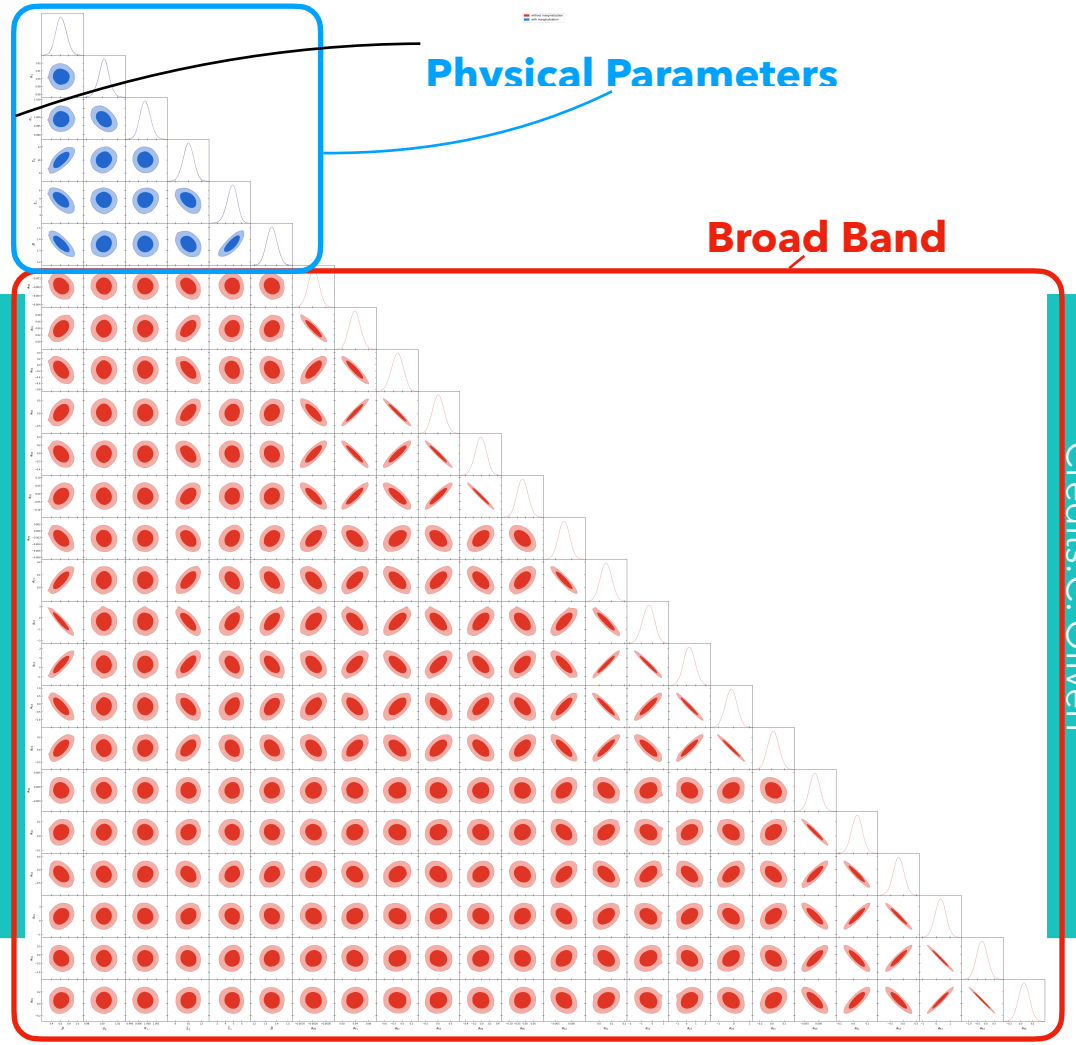

Credits: S. Radinovic

# Completed Work

## 2 Power Spectrum Likelihood Analysis

Design, Development, Testing: **C. Oliveri (SISSA), C. Moretti (OATS), E. Sarpa (SISSA), J. Salvalaggio (OATS), Y. Elkhashab (OATS), E. Sefusatti (OATS)**

- Template: **Power Spectrum Multipoles Window Convolution**
- Analytical Marginalization
  **Speed up:** 100 →3 CPUh
- **Nautilus Sampler**
- **Numerical & Analytical Covariance**
- **Enables Mock Analysis** (Applied to ELM)



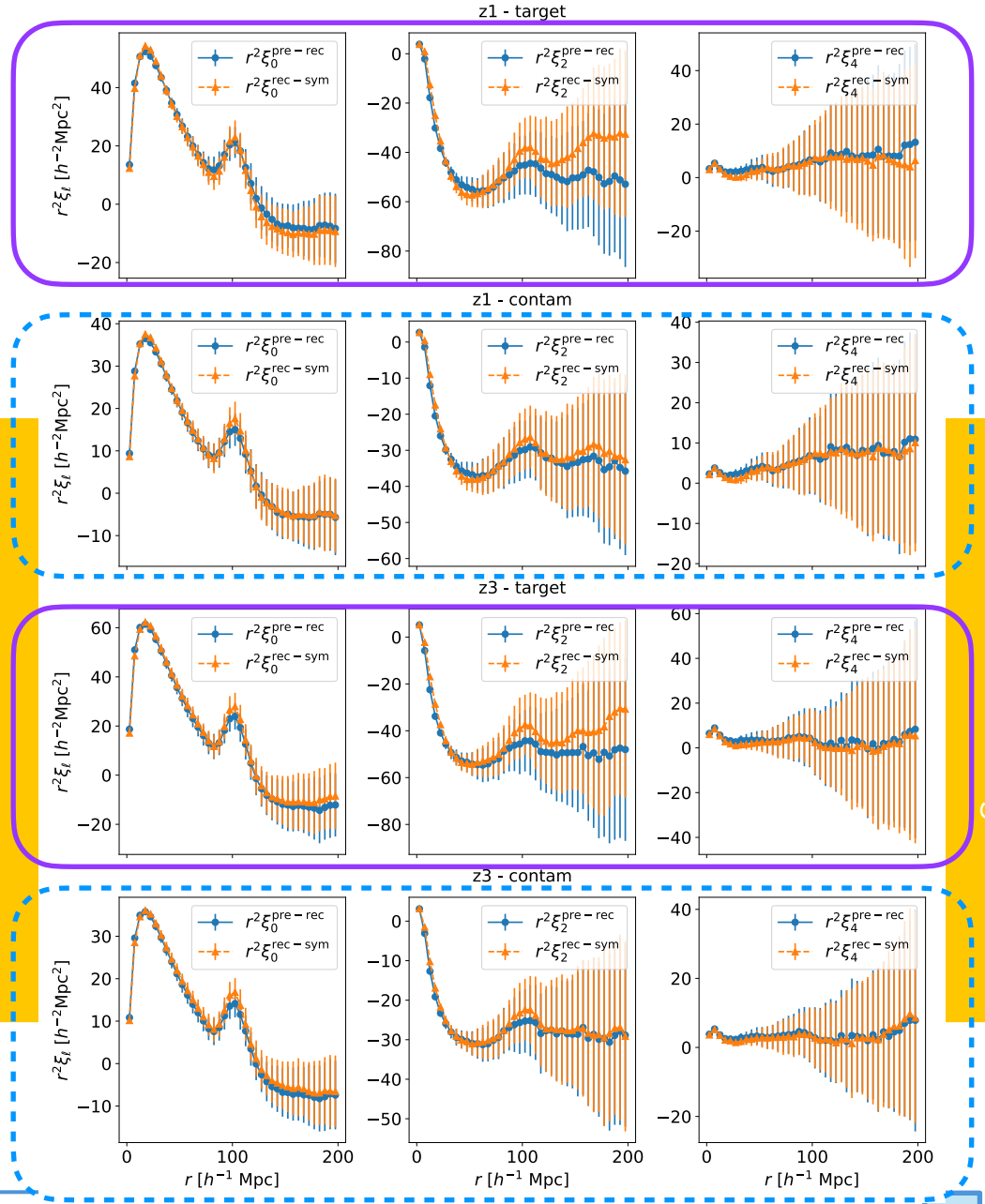

Credits: C. Oliveri

# Completed Work

## 3 2PCF Analysis on ELM

Reconstruction: **E. Maragliano (UniGE),** Measurements: **M. Karcher (UniMi), A. Pezzotta (UniMi),** J. Bel, A. Fiorilli. Modelling: A. Crispi, **M. Bonici (ex IASF)**

- **Group Growth:**
  Jan 2025, **2** Active members → Jun 2025, **16** Active members
- **8000** Measured post-red **2PCF**:
  Correct & Measured Galaxies to **Study interlopers**
- 2PCF Modeling with ML Emulators:
  **100 CPU/h -> 3 CPU/min**
- Emcee, Nautilus, NUTS samplers
- **Enables Mock Analysis** (Applied to ELM)




Credits: E. Maragliano

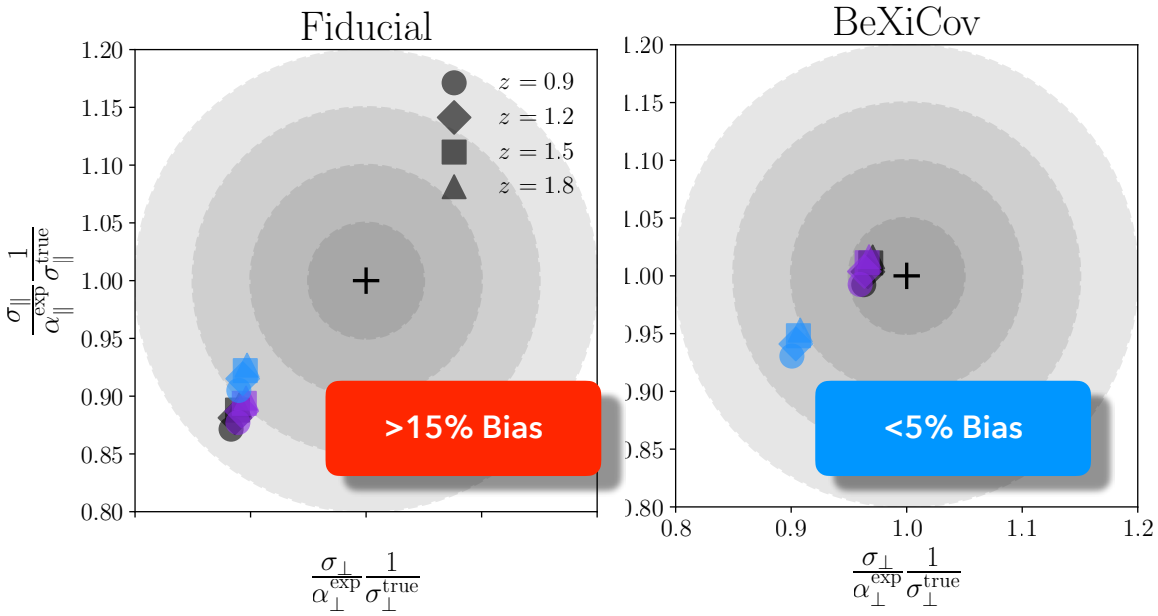
# Completed Work

## 4 Semi Analytical Covariances

Design, Development, Testing: **A. Veropalumbo (UniGe), E. Sarpa (SISSA)**

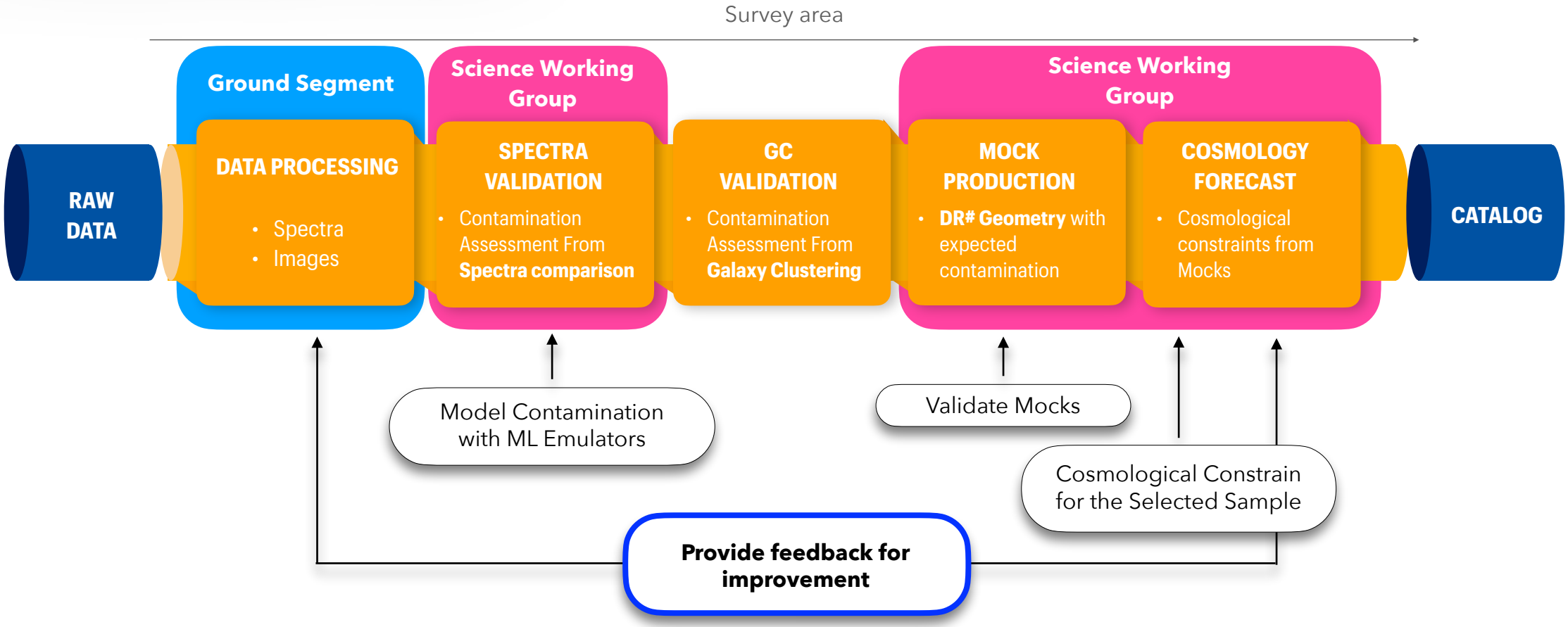
- **Observed Clustering Signal As input**
- **Weak Cosmology Dependence**
- **Robust against Unknown Obs. Systematics**

**Modeled Vs True Error, Cosmology Dependence**



# What's Next

## Joining Forces For DR1 LE3, Spectroscopic Pipeline, Observational Systematics, Catalogues, GC4

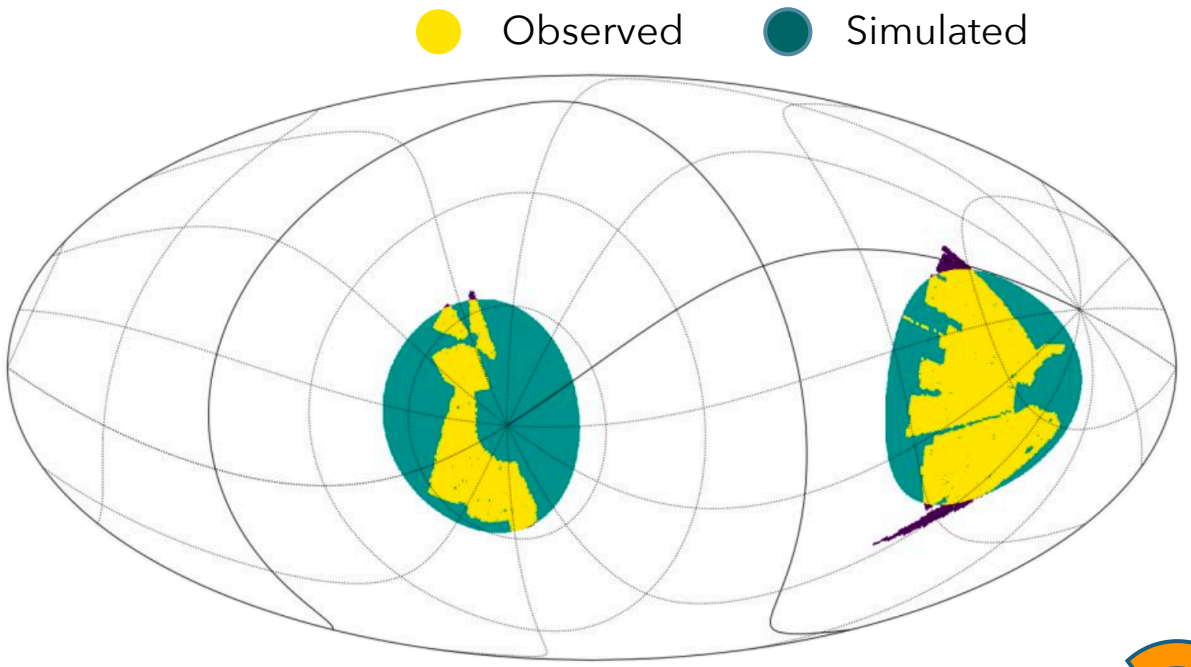


# First Steps

## 1 Reconstruction with Complex Geometry (see RR2)

Design, Development, Testing, Running: **E. Sarpa (SISSA)**

- **Advanced Reconstruction Algorithm:**
  Disconnected Patches, Masks, Angular Systematics
- **Strategy:** Combine Observed and Simulated Data
- Goal: Mitigate Biases & spurious effects




Credits: P. Monaco

Under Validation

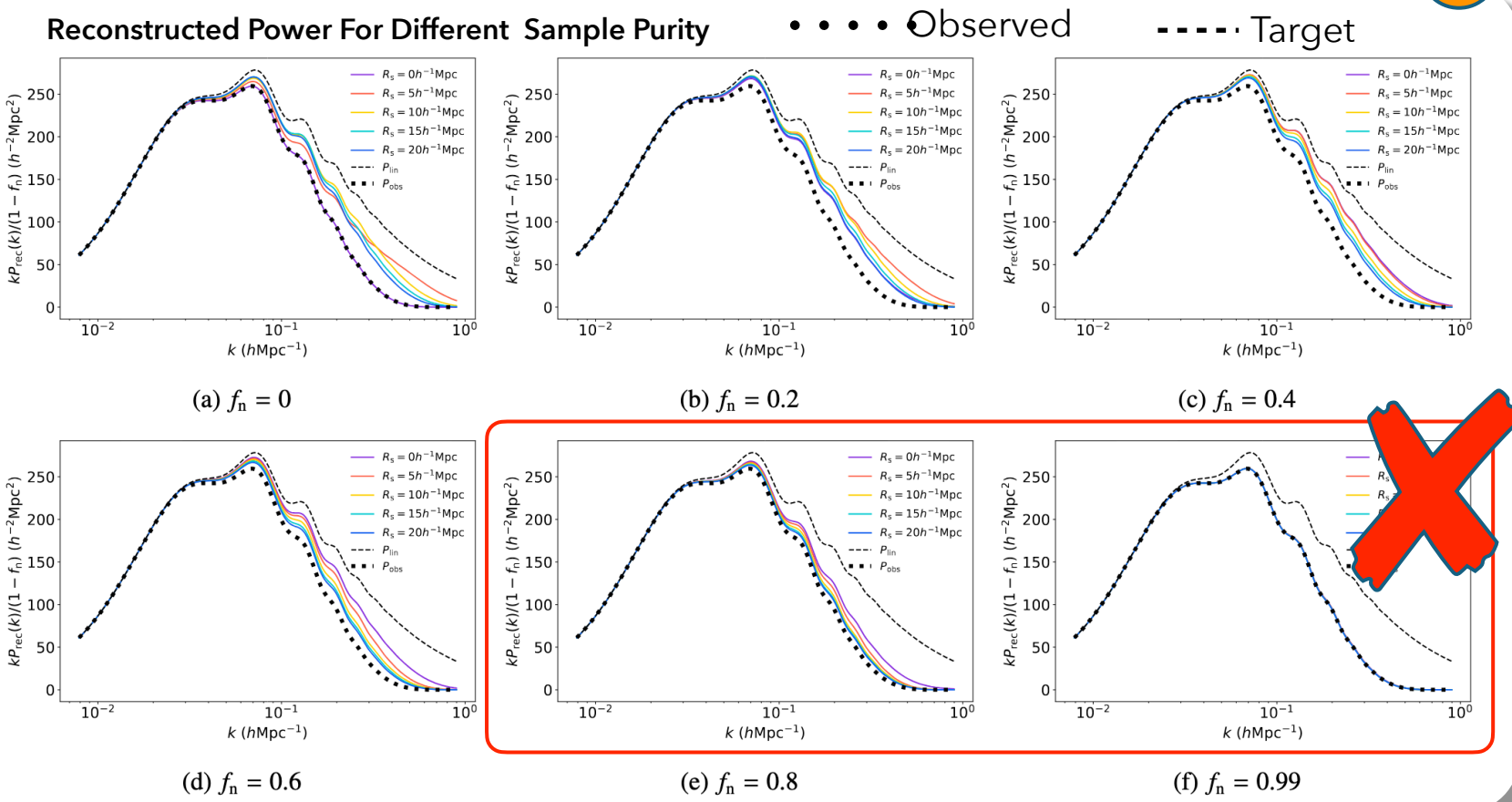
# First Steps

## 2 Modeling the Effect of interlopers

Design, Development, Testing: **E. Sarpa (SISSA), M. Karcher (UniMi)**

Under Development

- **Construct Post-recon BAO templates w/ interlopers**
- **Maximize Accuracy and Precision of BAO** measurements w/ contamination
- **Assess Feasibility** of a given selection
- **Guide Sample Selection**: Identify ranges of contaminations values for a meaningful cosmological analysis



# Target Analysis

Multi Scale BAO Analysis: RR#, RR# Mocks & DR1 Mocks

**What can we achieve with DR1?**

Coming Soon … Before October