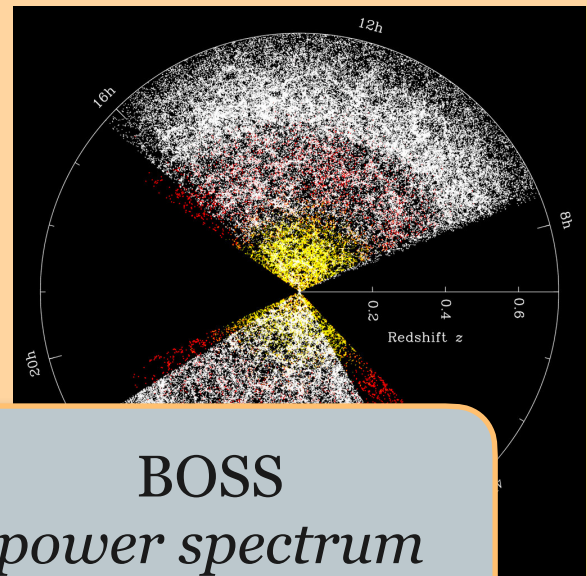# Modelling & Analysis of GalaxY Clustering Statistics: MAGYCS

Emiliano Sefusatti, Osservatorio Astronomico di Trieste
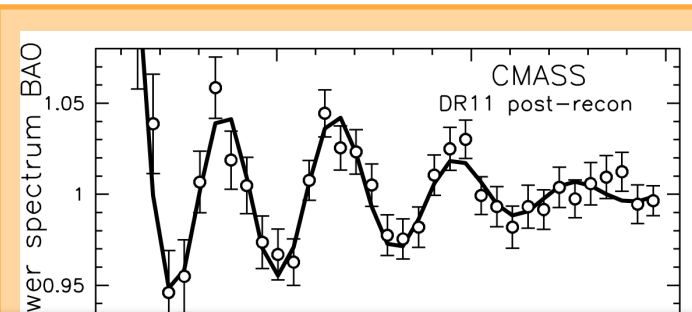
The Science: *State-of-the-Art*
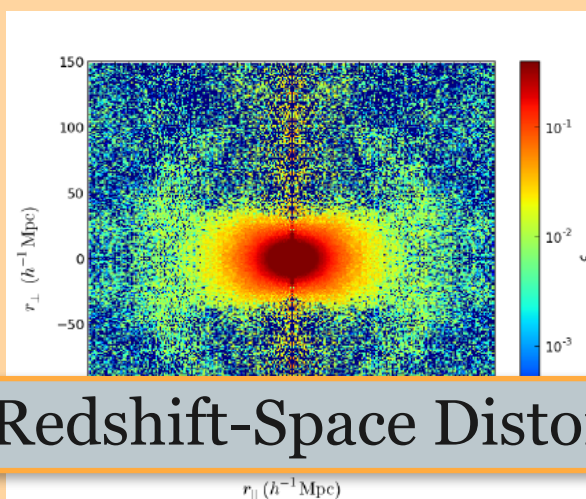
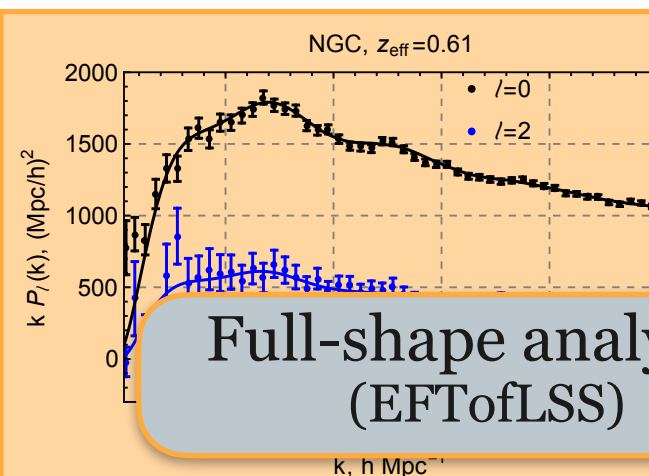Testing cosmological
models with the
Large-Scale Structure

Baryonic Acoustic Oscillations

Redshift-Space Distortions

Full-shape analysis
(EFTofLSS)

BOSS
*power spectrum
& 2-point function*

Dark Energy
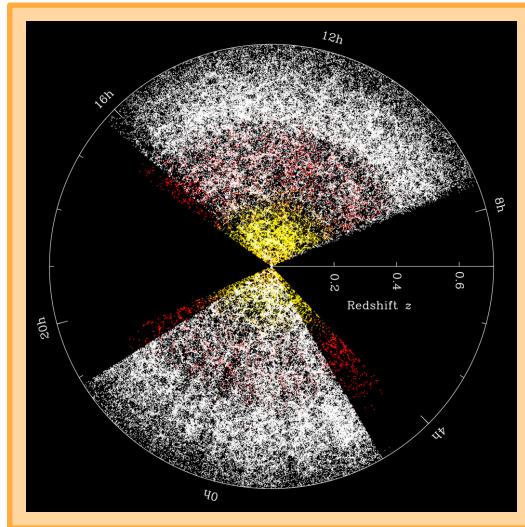
Gravity

Early Universe
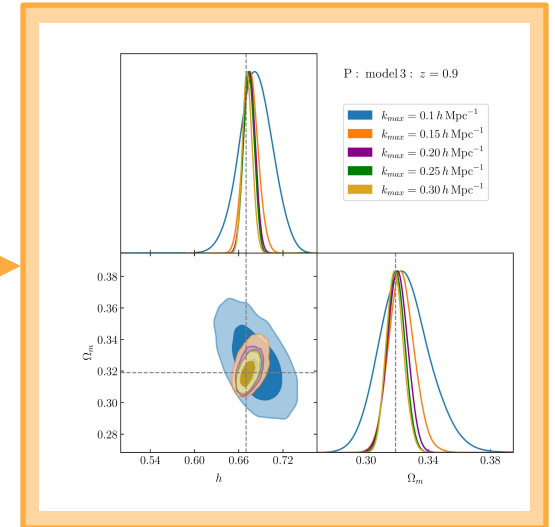
Neutrinos

Dark Matter

The Science of MAGYCS

Spectroscopic Galaxy Surveys

MAGYCS

Anything in-between spectroscopic galaxy catalogs and constraints on cosmological parameters

with a focus on Fourier-space higher-order statistics
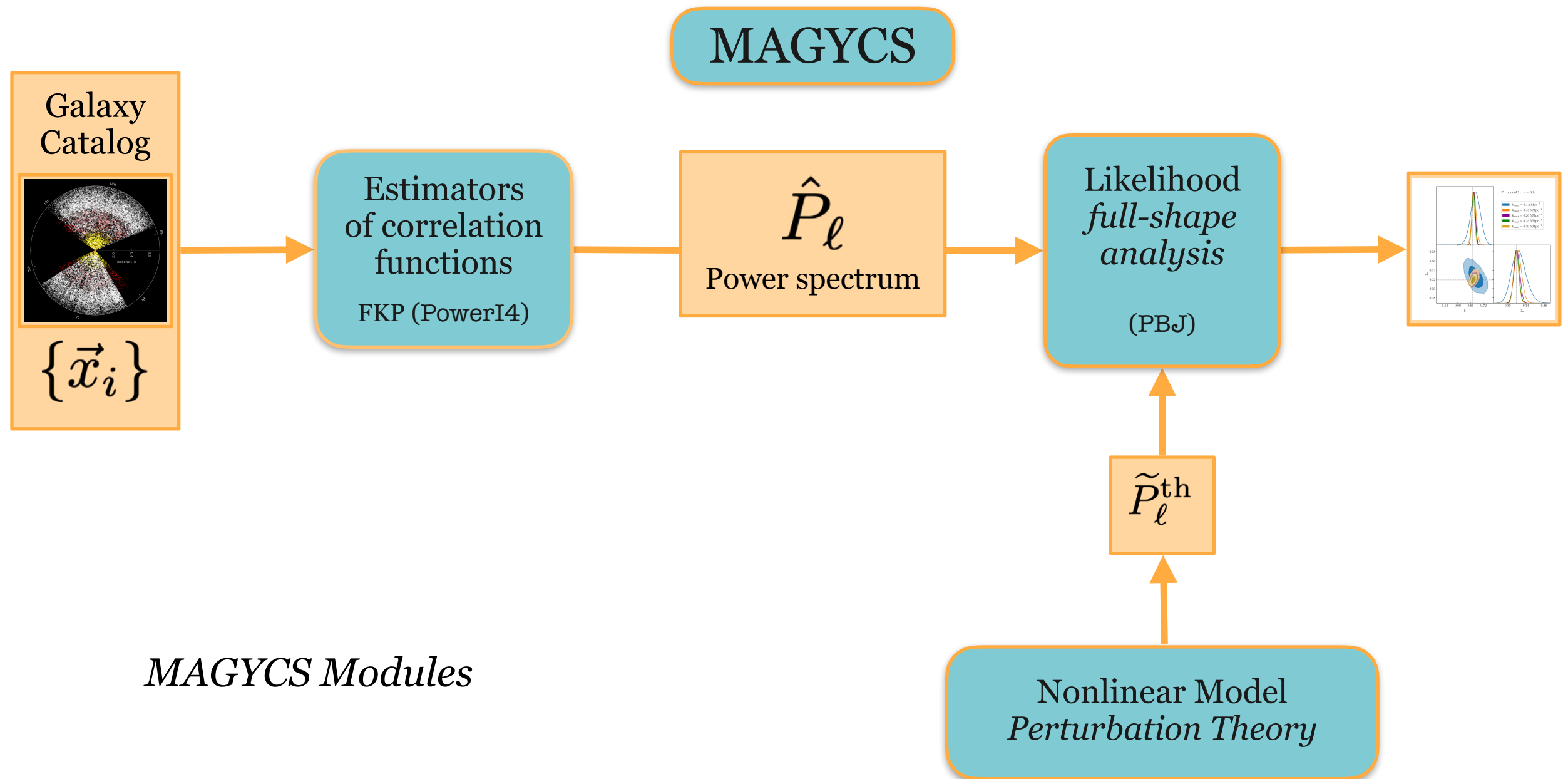
Early Universe, Inflation

Dark Matter

Neutrinos

Gravity

Dark Energy

The Science of MAGYCS

The Team

Staff

Emiliano **Sefusatti** (OATs, PI)
Pierluigi **Monaco** (Università di Trieste)
Emanuele **Castorina** (Università di Milano)

Postdocs

Matteo **Biagetti** (IFPU, Trieste)
Chiara **Moretti** (University of Edinburgh)

Students

Jacopo **Salvalaggio** (Università di Trieste)
Kevin **Pardede** (SISSA)
Federico **Rizzo** (Università di Trieste/OATs)
Alessandra **Fumagalli** (Università di Trieste)
Andrea **Oddo** (SISSA, *graduated 2021*)

Other, main collaborators (not affiliated to INAF)

Martin **Crocce** (Universidad Autonoma de Barcelona)
Guido **D'Amico** (University of Parma)
Vincent **Desjacques** (Technion, Haifa)
Cristiano **Porciani** (AIfA, Bonn University)
Roman **Scoccimarro** (New York University)

Results

First step: **PBJ code** for the Joint analysis of Power Spectrum and Bispectrum

Oddo *et al.* (2020)
Oddo *et al.* (2021)

Extension to **redshift-space**

Rizzo *et al.* (2022)
Moretti *et al.* (*in preparation*)

Public code for the analysis of simulations

Oddo *et al.* (*in preparation*)

Extension of PT predictions: **matter bispectrum at one-loop**

Alkhanishvili *et al.* (2021)

First step toward an **analytical covariance** for the bispectrum

Biagetti *et al.* (2021)

Survey geometry effects on the bispectrum

Pardede *et al.* (2022)

Primordial non-Gaussianity ($f_{\rm NL}$)

Moradinezhad *et al.* (2021)

Alternative estimator

Byun *et al.* (2021)

Goals

- Extended models:
  bispectrum at 1-loop, trispectrum

$\{\vec{x}_i\}$
Catalog

$\{\vec{x}_i^{ran}\}$
Random

Estimators
FKP (PowerI4)

$\hat{P}_\ell \ \hat{B}_\ell$
Power spectrum
Bispectrum

$\hat{T}_\ell$
Trispectrum

Likelihood code
(PBJ)

Cosmological parameters
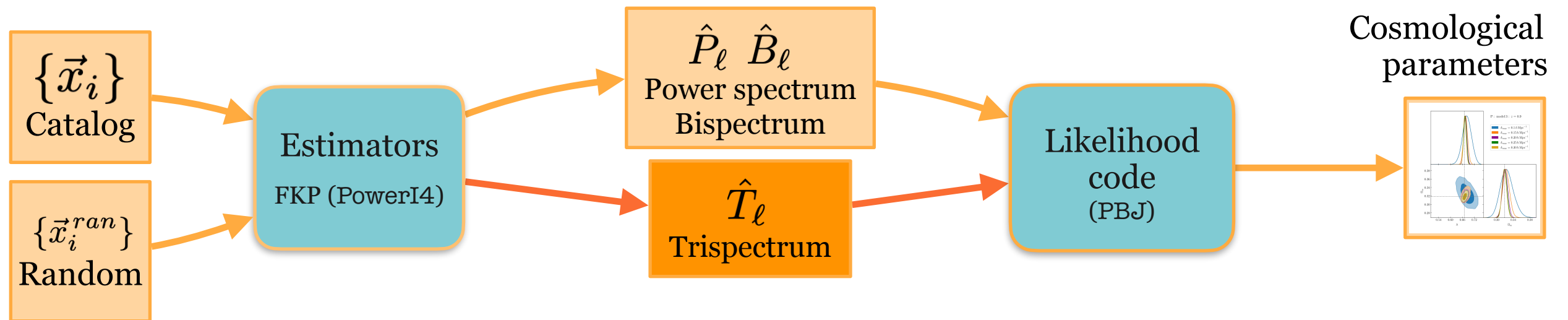
Goals

State-of-the-art

$P_{\text{th}}, B_{\text{th}}, T_{\text{th}}$

Nonlinear Model

Goals

- Extended models:
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- Full modelling of *survey geometry effects*

Goals

State-of-the-art

Goals

- Extended models:
  bispectrum at 1-loop, trispectrum
- Full modelling of *survey geometry effects*

- Full theoretical covariance

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$\widetilde{B}_\ell^{\text{th}}$ $\widetilde{T}_\ell^{\text{th}}$

C_{PBT}^{th}

Window Effects

Theory Covariance

$P_{\text{th}}, B_{\text{th}}, T_{\text{th}}$

Nonlinear Model

Goals

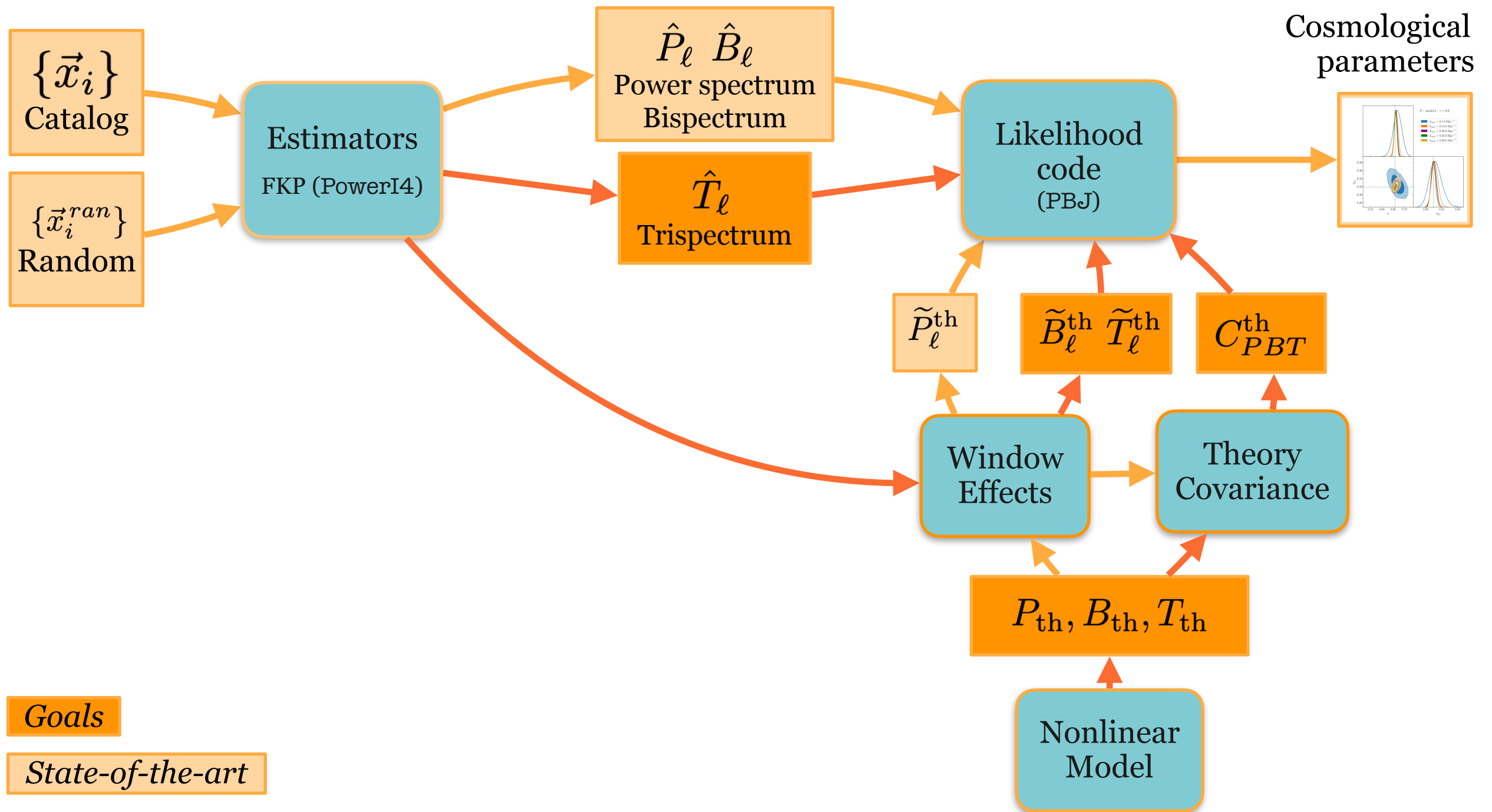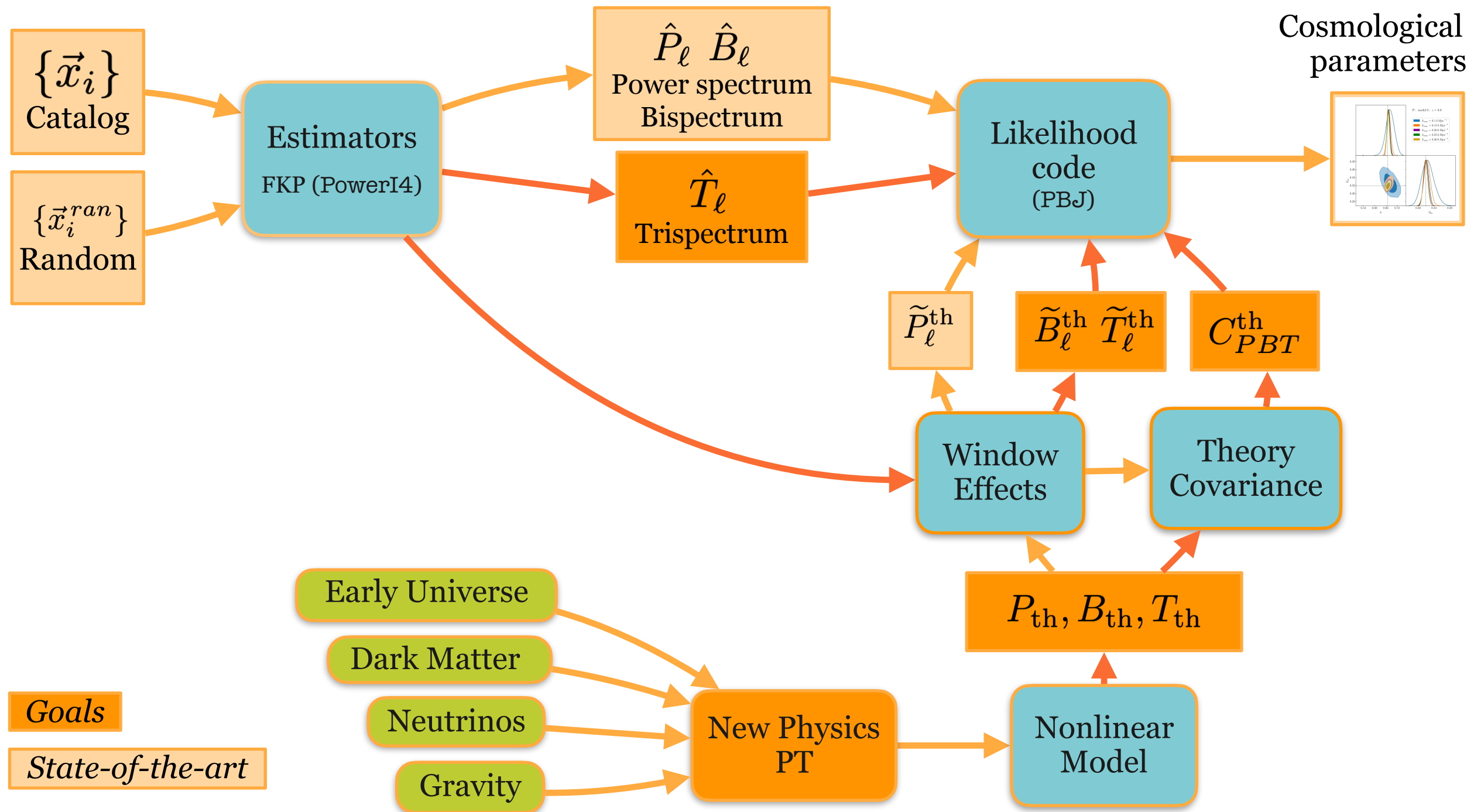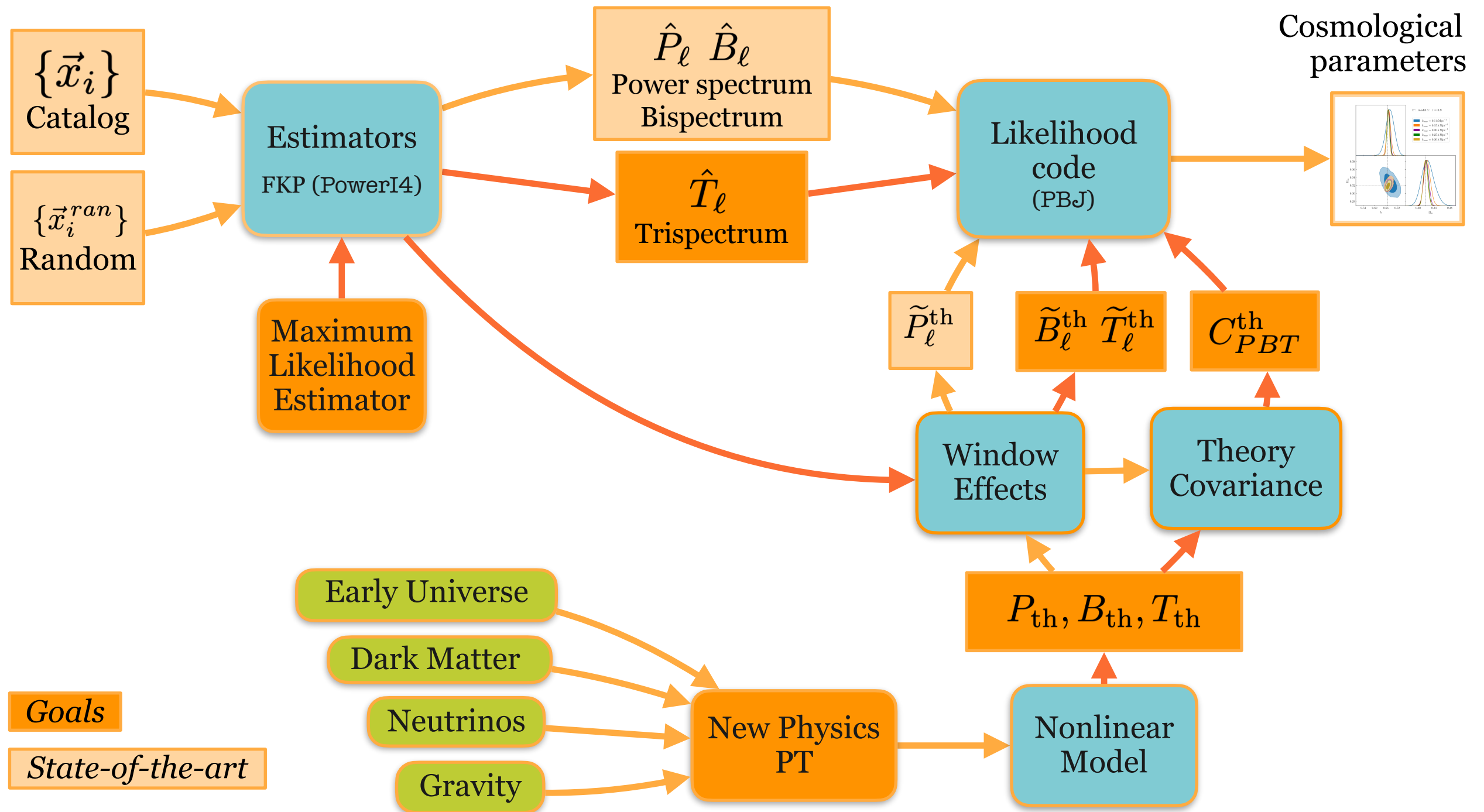*State-of-the-art*

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- Beyond Standard Model cosmologies

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Neutrinos

Gravity

New Physics PT

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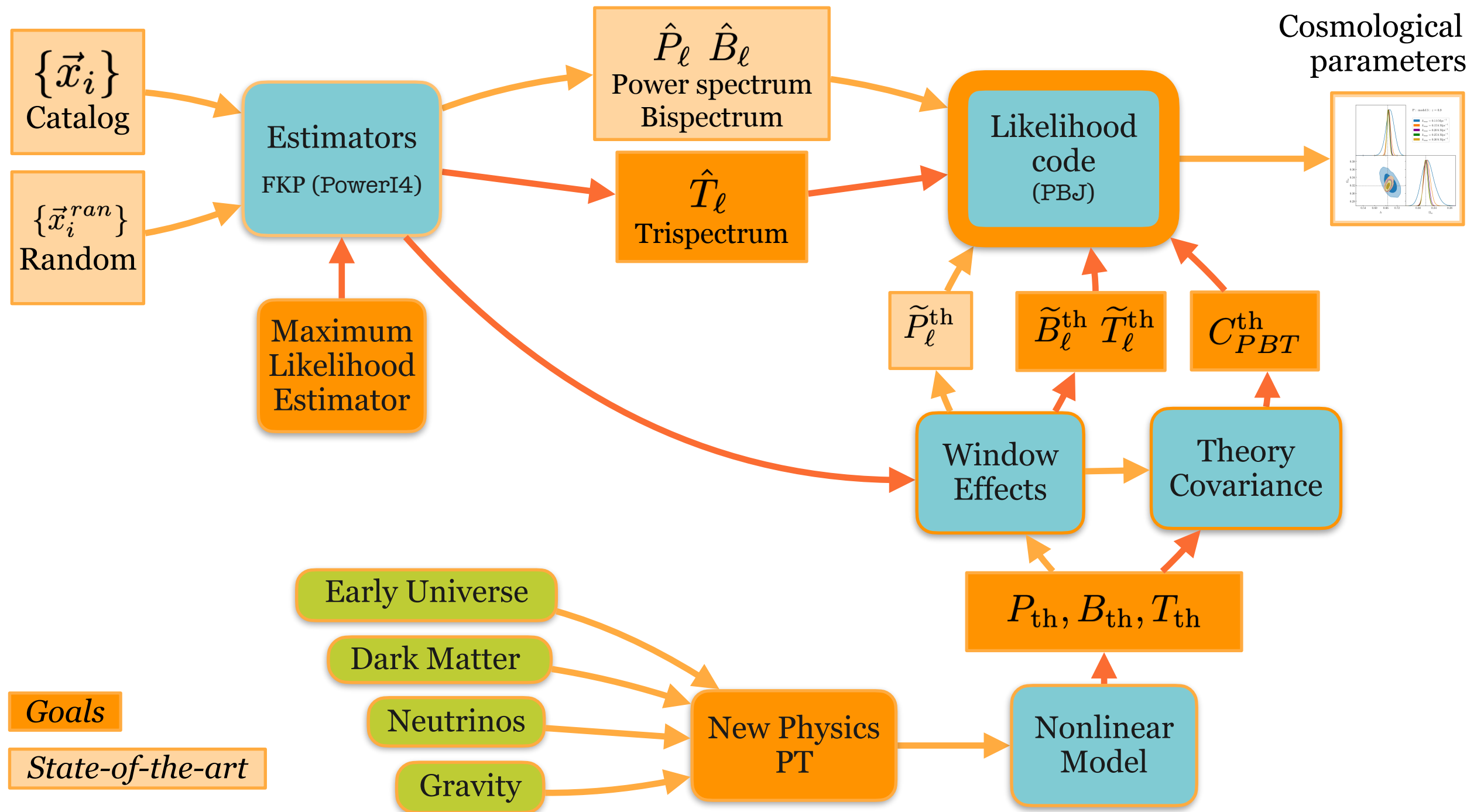- Beyond Standard Model cosmologies
- Alternative estimators

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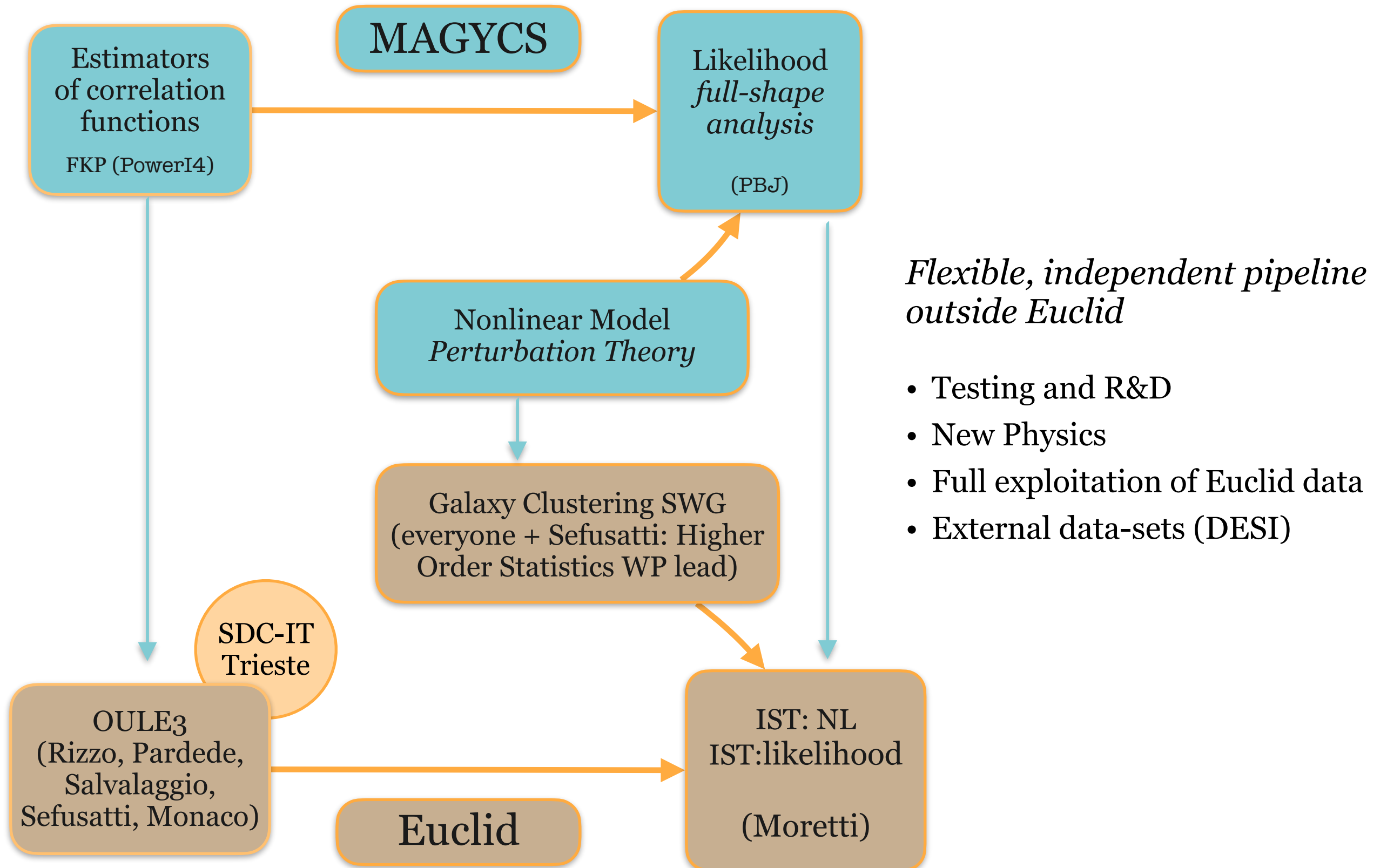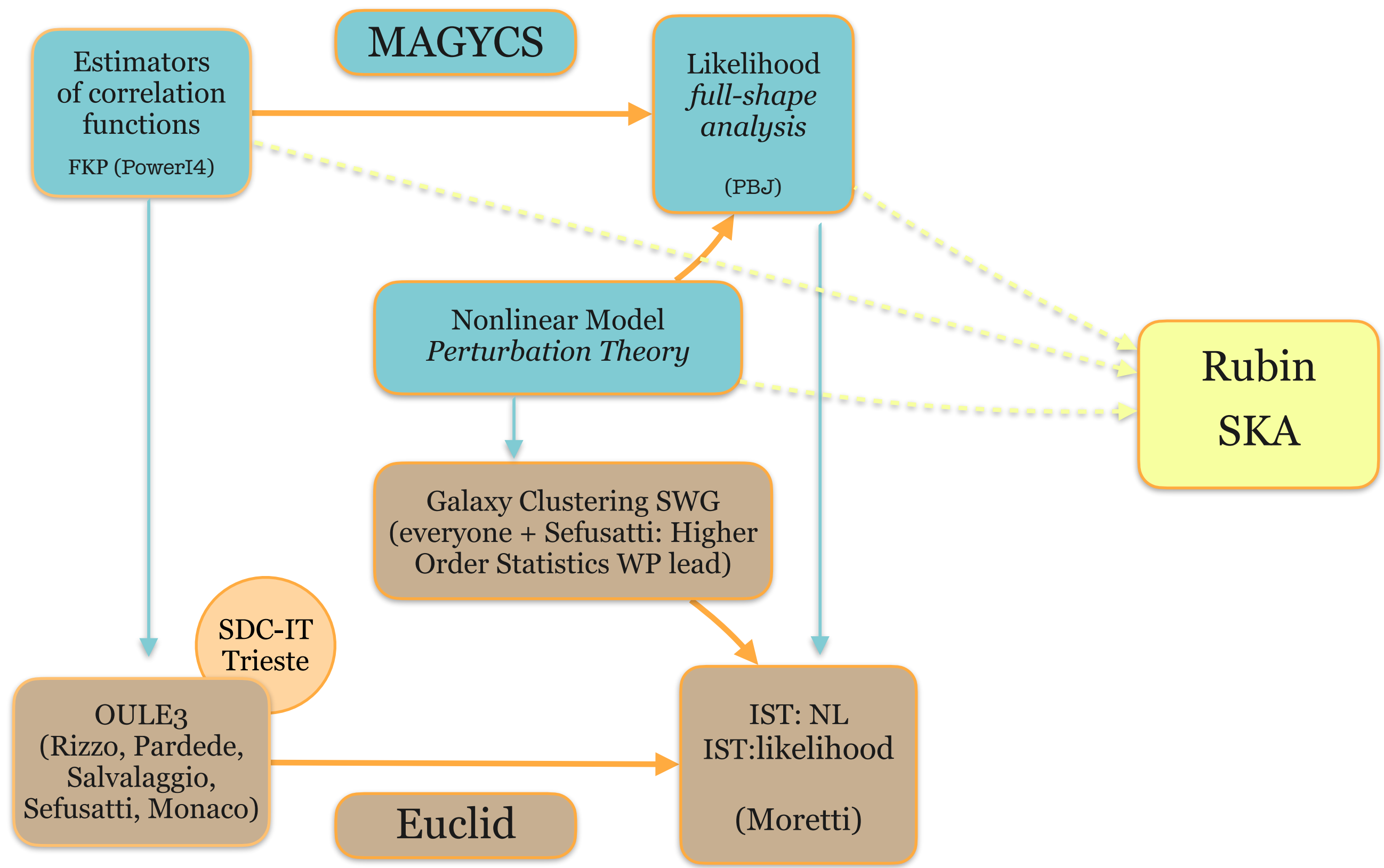- Alternative estimators
- Emulators from Machine Learning

MAGYCS, Euclid & beyond

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Funding & critical aspects

The project received so far **no dedicated funding**

- ~1,000 €/y from OATs funds ("ricerca libera")

- Students are on their on fellowships

- Postdocs work on a voluntary basis

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- At its core, the topic has a limited relation to observations …

- … and not much tradition in Italy

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The goal is developing the **fundamental infrastructure**, and related **technical expertise**, to analyse galaxy survey, crucial to:

- exploit future data-sets
- test novel, speculative cosmological models

Interactions