



Institut
Physique de
l'Univers

Aix*Marseille Université

CLASS:

Cosmology with Large Scale Surveys



Cosmology Team /
Christian Marinoni

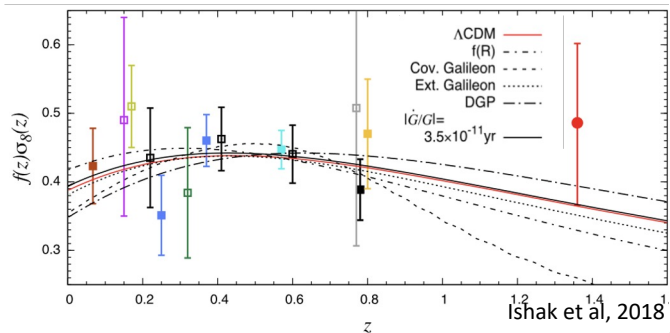


GECO Team /
Sylvain de la Torre



Renoir Team /
Dominique Fouchez

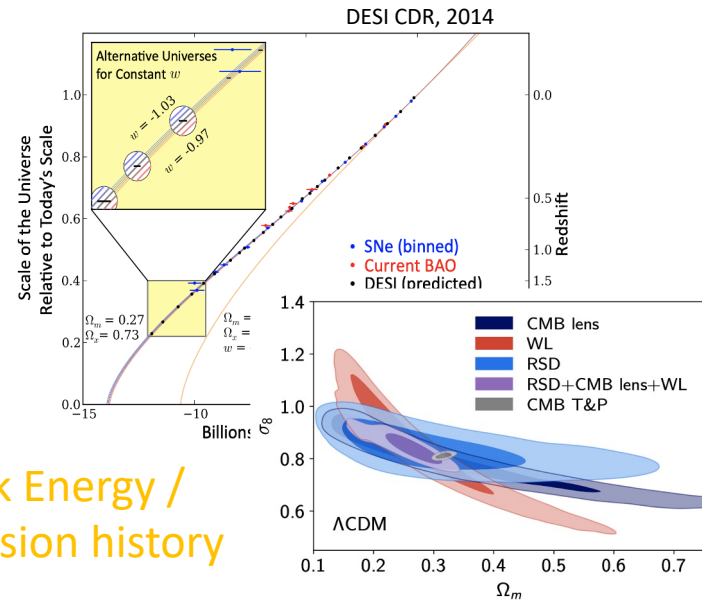
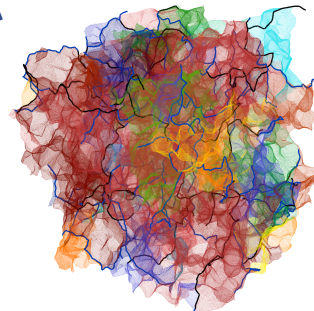
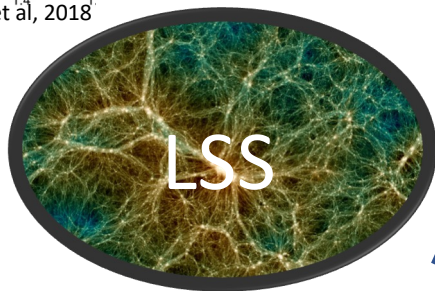
Context: cosmology & LSS



Growth of structure / gravity

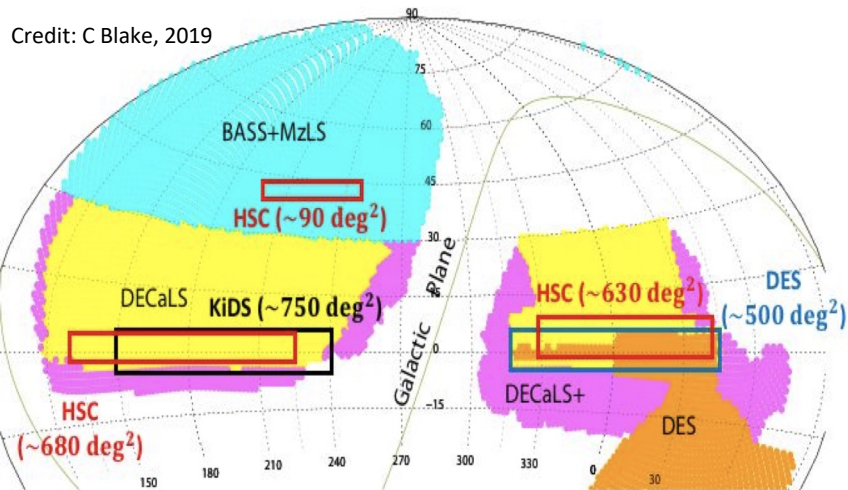
Dark Energy / expansion history

Assembly of cosmic web and first galaxies

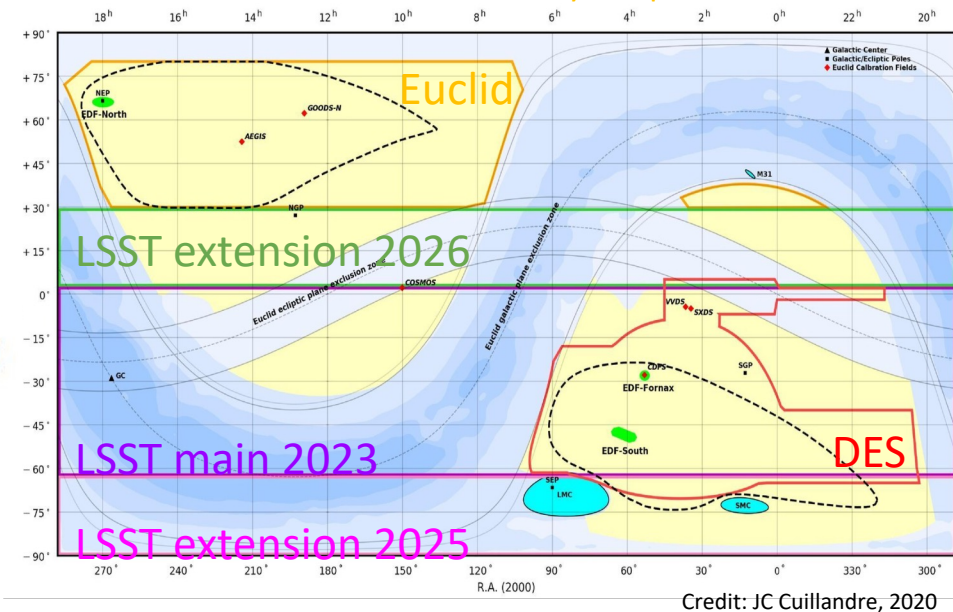


Context: large spectroscopic and photometric surveys

Spectroscopic survey footprint



Photometric survey footprint



- DESI 14,000 deg² based on BASS, MzLS, DECaLS, DES imaging
- PFS 1,400 deg² in the 3 HSC footprints
- WEAVE-QSO will observe 400,000 spectra in 6,000 deg² in the SDSS footprint
- GOYA survey will observe high-redshift galaxies behind galaxy clusters

- Euclid will observe 15,000 deg²
- LSST will observe 12,000 deg²

Large scale surveys roadmap

Surveys	Start [- End]	Surveys	Expected start
eBOSS	2015 - 2019	PFS	2024
GOYA/EMIR	2018 - 2023	LSST	2024
DESI	2020 - 2025		
HSC-CLAUDS	2016 - 2021		
WEAVE	2023 -		
Euclid	2023 -		

- **eBOSS:** Final cosmological papers published [eBOSS collaboration et al.](#), [Press Release](#) July 2020.
- **EMIR:** Technical issues. New detectors planned end of 2021. Survey starting 2022 (degraded mode) and ending in 2023.
- **DESI:** 47h SV observations in Dec 2021 (>50k redshifts). Lensing+clustering+void mock challenge.
- **HSC-CLAUDS:** Data acquired. Analysis on bright and faint galaxy evolution measurements up to $z = 3$.
- **WEAVE-QSO:** Science observations starting in 2022.
- **PFS:** Integration of 2nd & 3rd spectrographs at LAM. Science observations starting possibly in 2023.
- **Euclid:** NISP & VIS being integrated on spacecraft. Scientific preparatory work & papers on-going.
- **LSST:** 3200 megapixels camera took first image in Sept. 2020. Scientific preparatory work & papers on-going.

Project organisation

- Objectives: Understanding (1) cosmology (DE, gravity, expansion rate, geometry...) and (2) the build-up of the cosmic web and first galaxies with the large-scale structure
- Organisation
 - 3 labs involved: LAM, CPPM, CPT
 - 40 members in 2022
 - Duration: 2020-2024
 - Budget used in 2022: 9.8 k€
 - Wiki page: <https://projets.lam.fr/projects/class/wiki>
- CLASS meetings
 - Planning of a meeting for the 1st semester 2023
 - Recurrent sub-projects meetings between CPPM, LAM and CPT

Project human resources

New PhD:

- *Lucas Saunière* at CPPM, *Performance verification of the Euclid NISP instrument*
- *Simone Sartori* at CPPM, *Cross-correlation between cosmic voids and CMB*

New members:

- *Elena Sarpa*, postdoc at CPPM
- *Corentin Ravoux*, postdoc at CPPM

Departures:

- *Katarina Kraljic* (LAM),
- *Sylvain Gouyou Beauchamps* (CPPM)
- *Philippe Baratta* (CPPM)

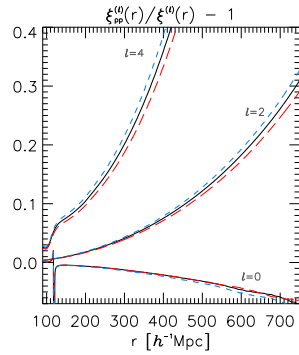
Project publications

List of publications in 2022:

A. Nicolis, **F. Piazza** and K. Zeghari. JCAP 10 (2022) 059
J. Bel, J. Larena, R. Maartens, C. Marinoni and L. Perenon, JCAP 09 (2022) 076
B. Kalbouneh, **C. Marinoni**, **J. Bel**, PhysRevD in press, arXiv:2210.11333
Harnois-Déraps J., **Martinet N.**, Reischke R. 2022, MNRAS, 509, 3868.
Hamaus N., **Aubert M.**, Pisani A., et al. 2022, A&A 658, A20
Contarini S., Verza G., Pisani A., Hamaus N., et al. A&A 2022 667 A162
Le Graët J., **Secroun A.**, Barbier R., **Gillard W.**, et al. SPIE 2022 12191 121911M
Aubert M., **Cousinou M.-C.**, **Escoffier S.**, **Hawken A. J.**, et al., MNRAS 2022 513 186
Bonici M., Carbone C., **Vielzeuf P.**, Paganin L., et al., arXiv 2022 arXiv:2206.14211
Lacasa F., **Aubert M.**, **Baratta P.**, Carron J., et al., arXiv 2022 arXiv:2209.14421
Gouyou Beauchamps S., Lacasa F., Tutusaus I., **Aubert M.**, et al., A&A 2022 659 A128
Baratta P., **Bel J.**, **Gouyou Beauchamps S.**, Carbone C., arXiv 2022 arXiv:2211.13590
Paviot, R., **de la Torre, S.**, de Mattia, A., et al., 2022, MNRAS, 512, 1341
Abareshi B., Aguilar J., et al., 2022 AJ 207
Lan T.-W., Tojeiro R. et al., 2022 arXiv arXiv:2208.08516
Breton M.-A., **de la Torre S.**, **Piat J.**, A&A 2022, 661A
Guinot A., ..., **Gavazzi R.** et al., A&A, vol. 666, 2022
Savary, E., ..., **Gavazzi R.** et al., A&A, vol. 666, 2022
Robison, B., ..., **Gavazzi R.** et al., arXiv:220909088R, 2022
Shuntov, M., ..., **Gavazzi R.** et al., A&A, vol. 664, 2022
Ayçoberry, E., ..., **Gavazzi R.** et al., arXiv:220406280A, 2022
Chan, J. H. H., ..., **Gavazzi R.** et al., A&A, vol. 659, 2022.
Bonnet G., **Nezri E.**, **Kraljic K.**, **Schimd C.**, 2022, MNRAS, 513
Kraljic K., Laigle C., Pichon C., ..., **Arnouts S.**, **Pieri M.** et al., 2022, MNRAS, 514
Kotecha S., Welker C., Zhou Z., ..., **Kraljic K.** et al., 2022, MNRAS, 512
Claeyssens et al. 2022, A&A, vol. 666, A78
Garzon, F., ..., **Pello R.** et al. 2022, A&A, vol. 667, A107
Sarpa, E., Longobardi, A., **Kraljic, K.**, et al., 2022, MNRAS, 516
Gkogkou, A., **Béthermin, M.**, Lagache, G., et al. 2022, arXiv:2212.02235

Theoretical developments on cosmological models

Cosmological models beyond homogeneity, isotropy, and flatness

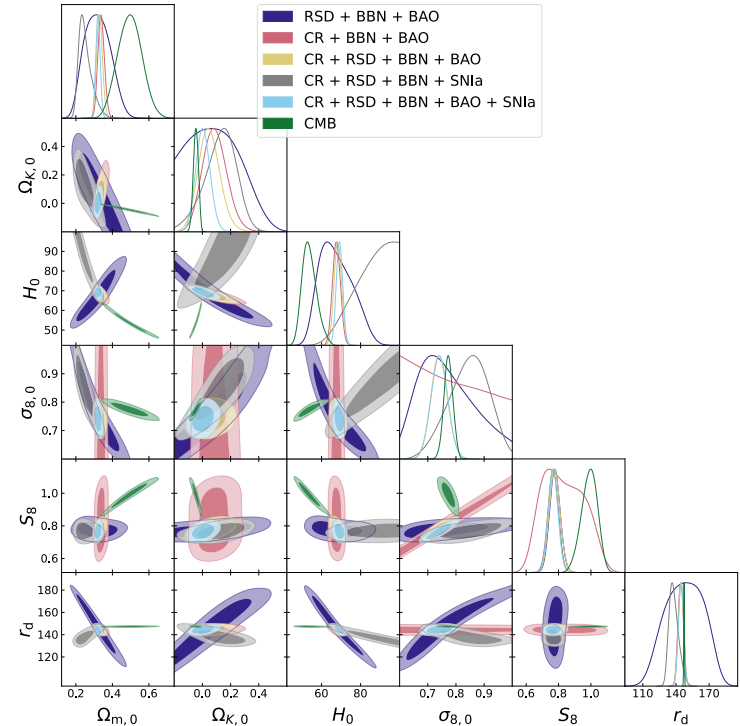


$$\eta_R(r) \equiv \frac{\xi_R^{(0)}(r)}{\sigma_R^2}$$

Clustering ratio

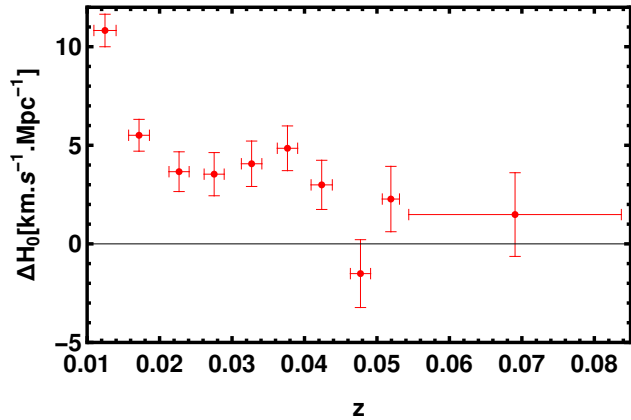
- Study of spatial curvature modelling in galaxy clustering and using the clustering ratio
- New CMB-independent constraints on curvature ($\Omega_{k,0} = 0.004 \pm 0.050$) from the clustering ratio

J. Bel, ... , C. Marinoni and L. Perenon 2022

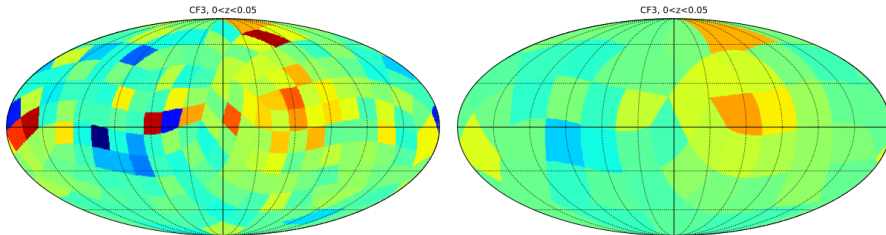


Theoretical developments on cosmological models

Cosmological models beyond homogeneity, isotropy, and flatness



- Study of the expansion rate fluctuation to characterize deviations from the linear relation between redshift and distance in the local Universe
- Useful to better understand H_0 tension with model where global uniformity is violated

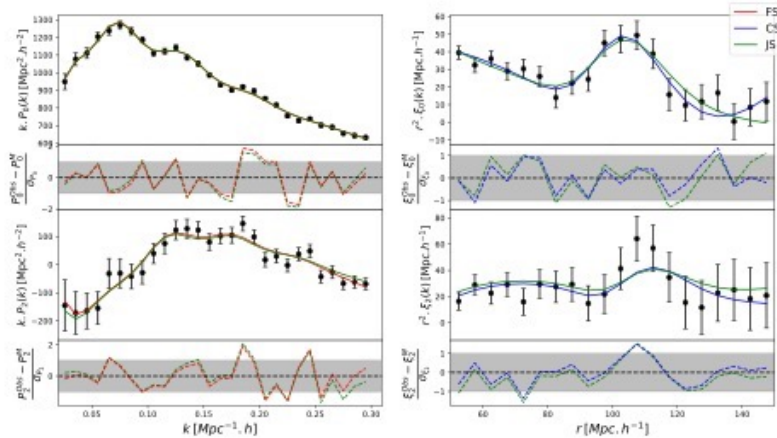


B. Kalbouneh, C. Marinoni, J. Bel 2022

Development of methods for analysing the LSS

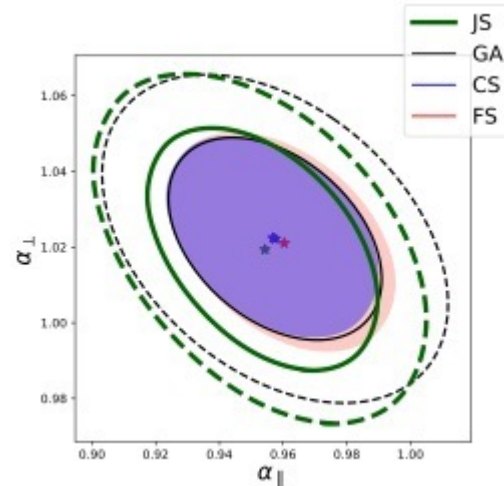
Baryon Acoustic Oscillations modelling

Joint space fits - CS, FS and JS analysis



Dummerchat & Bautista et al. 2022

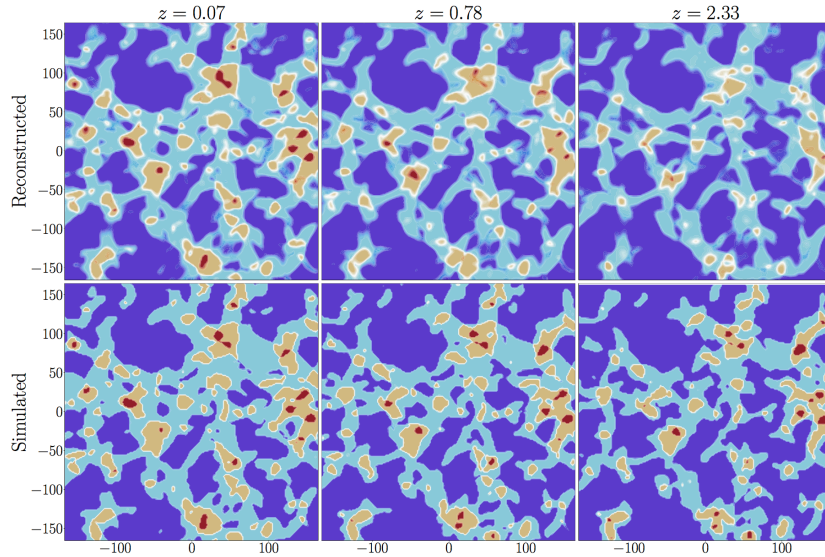
- Study joint analysis of BAO in configuration and Fourier spaces in eBOSS LRG
- Being extended to RSD
- Will be applied on first DESI data in 2023



Development of methods for analysing the LSS

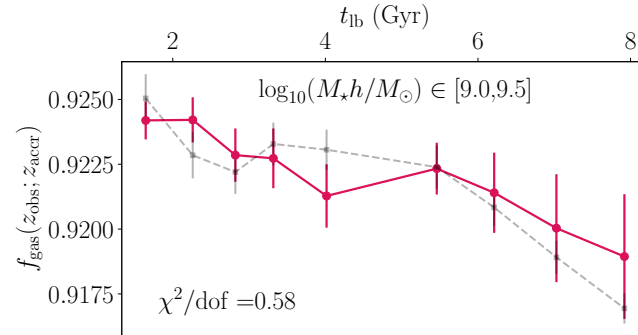
Cosmic web reconstruction

Reconstructed environments with eFAM



Sarpa et al 2022

- Use Fast Action Method to reconstruct past cosmic web and quantify the intergrated evolution of the large-scale environments (T-WEB, voids, filaments, nodes, walls)
- Very promising for application the real data from future redshift surveys



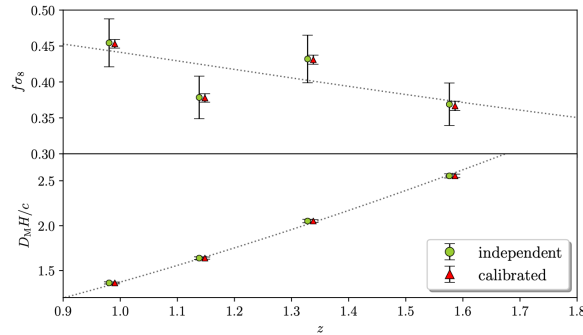
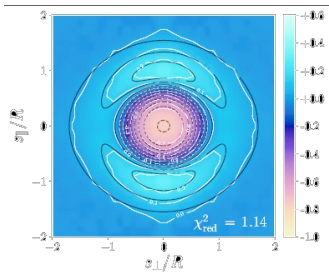
Evolution of the gas fraction in clusters as function of time of accretion

Cosmological constraints from the large-scale structure

Cosmic voids cosmology

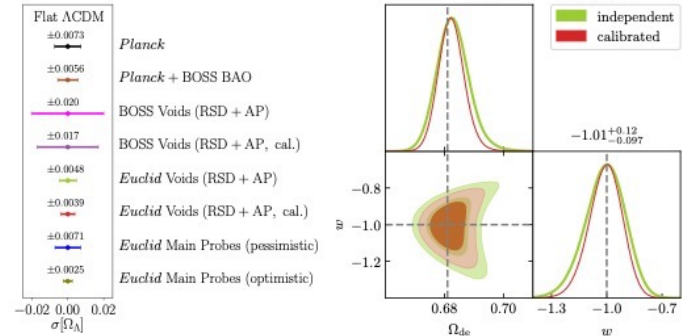
- Euclid forecast for different cosmological probes using voids
- New forecasts for combined AP and redshift-space distortions analysis of voids

Euclid forecasts RSD+AP



Bonici, Carbone, Vielzeuf et al 2022

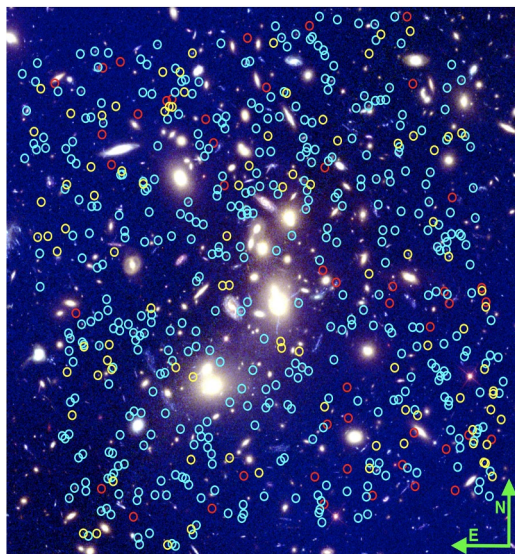
Euclid forecasts RSD+AP



Hamaus, Aubert et al. 2022

From first galaxies to late-time cosmic web

First structures and reionization



● LBG + LAE ● LBG only ● LAE only

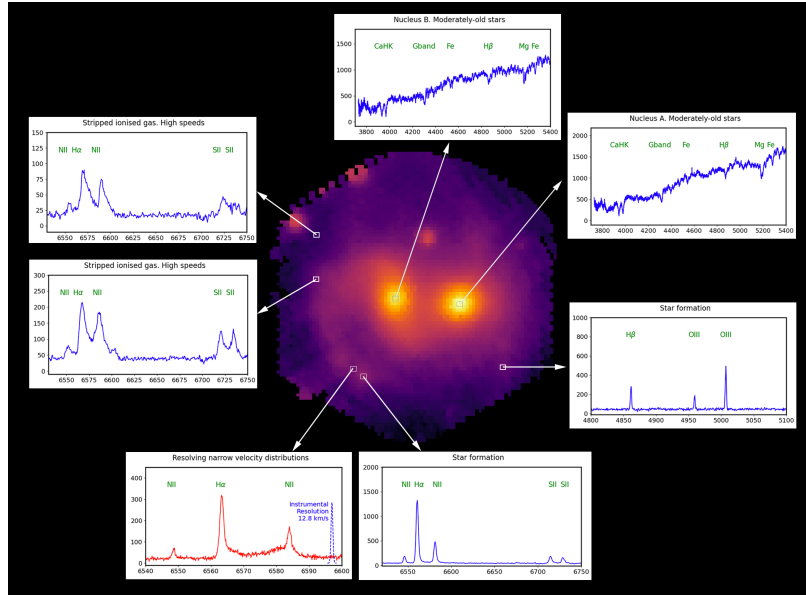
- Blind selection of Ly α Emitters (LAE) at $2.9 < z < 6.7$ with **MUSE/VLT** behind A2744 Complete census of Star Forming galaxies at the epoch of the reionization
- New developments initiated on estimating the total budget of ionizing sources at $3 < z < 7$ detected behind lensing clusters
- GOYA project (Galaxy Origins and Young Assembly) with EMIR: a multi-object NIR spectrograph mounted on the 10m telescope GTC (Canary Islands).
- GTO observations delayed, possibly starting in 2022

I. Goovearts, T. Thai, R. Pello

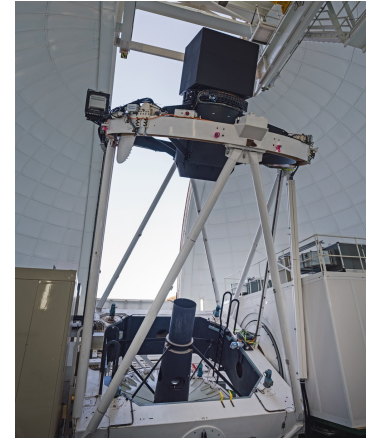
From first galaxies to late-time cosmic web

Cosmic web reconstruction and IGM tomography

- First light of WEAVE in december 2022



LIFU observations in the Stephan's Quintet



William Herschel Telescope

Pieri, Kraljic, Arnouts et al.

Summary

- Significant activity within in CLASS in 2022:
 - [Theoretical works](#) on non-homogenous universe models and curvature
 - [New methods](#) developed for survey analysis to account for systematic errors and new physical effects
- Prospects for 2023:
 - [DESI observations](#) have been observing for one year, first cosmological analyses expected for 2023 with early dataset
 - [Cosmic web](#) mapping has a growing impact on cosmological studies, new results expected with WEAVE in 2023, which will start scientific observations in 2023
 - [Euclid](#) should be launched in 2023, a lot of activity in the team for its preparation

