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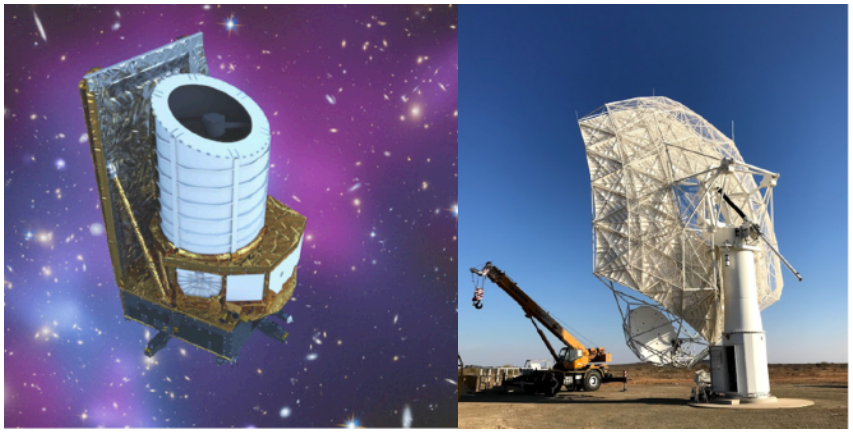
AU SERVICE DE LA SCIENCE

TOSCA – New weak Lensing statistics: optimizing the synergy between *Euclid* and *SKA*

http://tosca.cosmostat.org/

Comité « Physique subatomique et astrophysique »

TOSCA



Start: 01/04/2023 End: 30th Sept 2027

- Duration : 54 months
- 4 Partners

CEA Paris-Saclay: J.L. Starck, M. Kilbinger, *S. Farrens*, ***C. Mc Lean Dalay***, V. TS

Univ. de La Côte d'Azur: A.Ferrari, S. Prunet, C. Richard, M. Spinelli, **P. Tripathi**, S. Wang

ENSI Caen: J.Fadili, **H. Leterme** **Univ. Genève**: M. Kunz **ESA:** *V. Pettorino*

Having data from different surveys is an opportunity and a challenge:

- opportunity to c**ross-validate systematics** and **better constrain** cosmological parameters
- **different wavelengths require different method**s. Space surveys like Euclid will observe images in real space and in the visible frequency range; observations from SKA provide measures in Fourier space, implying different technical challenges to reconstruct radio images in real, pixel space.

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PROJECT WORK PACKAGES

Here is the break out of the analysis, and partners involved

WP1

Image Map Reconstruction from large surveys such as Euclid/SKA

NICE
(A.FERRARI)

1 PhD x 3 years in Nice

WP2

Machine Learning for Convergence Map Reconstruction

ENSI CAEN
(J.FADILI)
+
CEA
(J.-L. STARCK)

1 postdoc x 2 years in CAEN

WP3

Theoretical predictions for Weak Lensing observables in Euclid / SKA

M. Kilbinger

CEA
(V.PETTORINO)
+
UNIV. GENEVA
(M.KUNZ)

1 postdoc x 3 years at CEA

Includes experts in: SKAO radio image reconstruction (OCA), mathematical imaging (ENSICAEN), theory (Geneva) and Euclid key members in weak lensing and cosmology (CEA).

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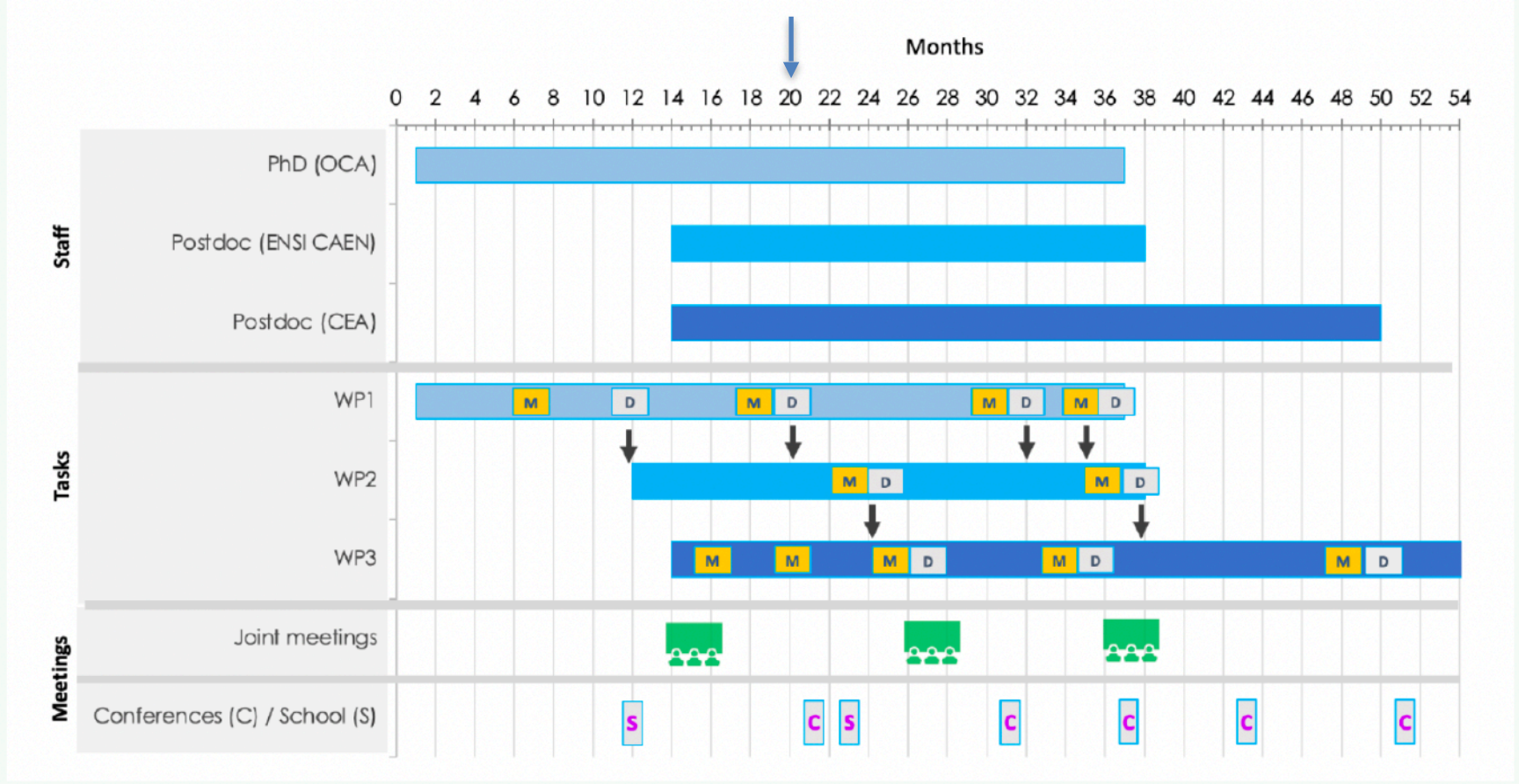
Timeline

We are here



Milestones:

M-m6: bibliography and implementation of SuperCAL in RASCIL

M-m18: development and implementation of DSCR1

M-m30: development and implementation of DSCR2

M-m36: evaluation of proposed algorithm performances for shear measurement with WP2

Deliverables:

D-m6: Fully functional implementation of SuperCAL in RASCIL.

D-m20: Submission of the first publication on Deep Shape Constraint Reconstruction.

D-m32: Submission of the second publication on Deep Shape Constraint Reconstruction.

D-m34 Integrate in RASCIL a state-of-the-art reconstruction algorithm optimised for the shear measurement.

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DSCR1 = Deep Shape Constraint Reconstruction

WP2 - from shapes to convergence maps

Lead: this WP will be shared by CEA (Jean-Luc Starck) and ENSICaen (Jalal Fadili) with contribution by Sam Farrens and Joana Frontera-Pons (CEA). A postdoc will be involved in this WP on the following tasks, will be hosted at ENSICaen and will be co-supervised by Jalal Fadili and Jean-Luc Starck.

Milestones:

M-m24: A new mass mapping software package that generalises well and quantifies uncertainties.

M-m38: A new mass mapping software package that is an extension of the previous one on the sphere.

Deliverables:

D-m24: Submission of a first publication describing the developed algorithm relative to M-m24.

D-m38: Submission of a second publication describing the developed algorithm relative to M-m38.

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Milestones:

(M-m12) Learn to use CLOE and cobaya codes and reproduce benchmark plots provided by Euclid pipeline

(M-m16) Implementation of the binned parameterisation in the background expansion and on perturbations, based on CosmicFish code developed in CosmoStat by former postdoc S. Casas

(M-m21) Forecasts for *Euclid* / *SKA*

(M-m30) Tests of the new tomographic estimator for the gravitational lensing potential

(M-m44) Cross-correlations in the photometric probes and between Intensity Mapping (IM) in SKA and Euclid power spectrum

Deliverables:

(D-m22) Submission of the first publication on a tomographic analysis of dark energy background and perturbations, using simulated data.

(D-m32) Submission of the second publication on impact of different statistics and a new tomographic estimator for the gravitational lensing potential; application to mass maps delivered by WP2.

(D-m46) Submission of the third publication on final results, integrated with the updated pipeline from WP2, and Modified Boltzmann code, publicly available, and suitable to be interfaced with CLOE.

WP3 - synergy and cosmological parameters

M-m16 Learn CLOE, cobaya, reproduce Euclid benchmark plots: DONE:

- Lisa Goh has become expert in CLOE; she is using CLOE interfaced with cobaya and CosmoSIS; running MCMCs for Euclid overview paper (Mellier et al. 2024), and CLOE pre-launch papers in prep.

M-m20 Background expansion and perturbations. MODIFIED:

- Work done on tomographic coupled dark energy.
- Published in Goh, Gomez-Valent, Pettorino & Kilbinger (2023); code implemented and published

M-m25 Constraints for Euclid

- Have to wait for Euclid DR1 (or later) data

Other work in progress

- Constraints on dark energy and modified gravity from UNIONS-3500 (Goh/CosmoStat people et al. in prep., w/Isaac Tutusaus). Plans to use Weyl tensor, as another estimator of LSS within modified gravity.
- SBI model for UNIONS and Euclid weak lensing, allowing to derived constraints from field-level and higher-order statistics. Can include small-scale physics via baryonification, forward-modelling systematics (Guerrini, MK et al. in prep.)
- Emulator for l_1 norm and other HOS (Vilasini in prep.);
- Synergies between optical and radio; kinematic lensing using shapes and spectroscopy and/or polarization; ALMA? (Daley)

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