The Euclid Consortium Newsletter - Winter 2017

News from the Bridge

The very succesful NISP instrument Critical Design Review (CDR) last November opened a series of important reviews that will last over 2017 and probably part of 2018: the VIS instrument CDR, the Payload Module (PLM) CDR, the Science

Performance Verification review SPV02, the SGS Design Review and the spacecraft CDR. At the same time several complementary observation programs will start at the Canada France Hawaii Telescope (CFHT), the Javalambre Survey Telescope (JST), the Keck telescope, the ESO VLT telescope and with the Spitzer satellite. In order to organise and coordinate all these activities the Euclid Consortium made some changes in its organisation: Canada is now a full EC partner, with Prof Ray Carlberg (University of Toronto) as ECB Canadian representative, the Spanish Centro de Estudios de Física del Cosmos de Aragón (CEFCA in Teruel) will lead the JST observations, Herve Aussel (CNRS and CEA/IRFU in Saclay) is now leading the SPV group and Prof Konrad Kuijken (Leiden Observatory) is leading the new EC Complementary and Ancillary Observations Group.

Let me welcome and thank them and their teams and wish them all a succesfull year. I would like to take this opportunity to also welcome Prof Sven De Rijcke from Ghent University, who will replace Prof Andre Fuzfa (Namur University) as ECB Belgian representative, and warmly thank Andre for its remarkable work over the past years in order to set up the Belgian team and organise its entry into the Euclid Consortium.

We still have four important years to come prior to launch Euclid and start getting the scientific fruits of our hard work. This is not that far and I feel more and more excited as days pass by, imagining all of us analysing Euclid data, digging imprints of dark energy or modified gravity in them and get the first feel on the source of the accelerating expansion of the Universe. The excellent progresses made in 2016 on all fronts of the mission should keep us most optimistic and strenghten our will and passion to make Euclid an outstanding mission.

Let me close by wishing you all a very happy and succesful Euclid year and look forward to seeing you at the Euclid Consortium Annual Meeting in London next June.

Yannick Mellier

From the editors

Welcome to the first newsletter of 2017. The frequency and content of newsletters has not quite matched the hectic activity within the Euclid Consortium - particularly on the side of the ground segment. To bring you details on what is going in in the ground segment, we will from now on also have updates from the Organisational Units and in the future also from other ground segment units. This newsletter contains updates from OU-SIM and OU-VIS that show simulated images close to what we will receive from the satellite - exciting, and sobering, to see!

Let me also point you to the update by the cosmological simulations science working group - they have been busy with creating a massive reference simulation for Euclid and some details of this major undertaking is given in their update below.

I hope the newsletter gives you a taste of the great activity in the EC and that 2017 will be a good year for us all!

As always, contributions both of writing and for helping with the newsletter are very welcome, please contact me!

Jarle Brinchmann (jarle@strw.leidenuniv.nl)

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Update from the Euclid Project Scientist

In May 2008, the Concept Advisory Team (CAT), chaired by prof. Malcolm Longair, presented to ESA's Astronomy Working Group the most acceptable concept for a dark energy mission. The CAT agreed to name the mission "Euclid", either as an acronym for "European Cosmic aLl sky Investigator of the Dark universe", or as a name for "a Space mission to investigate the geometry of the dark Universe". The start of the implementation phase was assumed in 2012 with launch in 2017. Between the presentation by Malcolm Longair and today, early 2017, a lot has happened. The mission has triggered efforts much larger than the CAT could have guessed. Euclid has become a household name among scientists and it established one single active scientific consortium, which is the largest in astronomy. The mission design has come to maturity and meets the original concept with only few, but important, compromises. In hindsight, with all the excellent work achieved so far, and the necessary work still to be done before launch, it is hard to imagine that we could have considered a 2017 launch. Euclid's closest competitor back in 2008, Solar Orbiter was regarded as a more mature mission than Euclid. Solar Orbiter was selected for the 2017 M1 slot, but at present it is clear that it will not be launched before the end of 2018. It would be a great achievement if Euclid can meet a launch by the end of 2020, in line with our current planning.

Before the CAT agreed on the mission concept, it had intense discussions on the feasibility of the proposed probes, Weak Lensing and Baryon Acoustic Oscillations. Redshift space distortions as a probe was considered, but its observational proof of concept came only later that year. Studies by the dark energy task force and the ESO/ESA study by John Peacock and Peter Schneider (who were members of the CAT), as well as the technical and programmatic envelope provided by ESA, were used in detail to arrive at an agreed concept. At the scale of Euclid there was no proof that the concept would work, and the CAT had to rely on calculations based on early simulations. This uneasiness was largely removed at the Phase-A Extension Review which was passed in January 2012. One important review objective was to verify the end-to-end performance of the Euclid mission, based on the requirements baseline, spacecraft and instrument design, and the key instrument specifications. That review is now called "SPV1". In this context the second Science Performance Verification – SPV2 – kicked-off in January 2017, is an extremely important exercise. It will give us our position with respect of the original concept with today's best knowledge of both cosmology and Euclid.

Where do we stand in 2017? We are in the process of finalising the critical design reviews (CDRs) of the subsystems, in particular the telescope and instruments, meaning that we will be ready to manufacture the flight hardware for delivery. In less than two years from now, the instruments will be delivered. The ground segment is taking shape, in November 2017 we will have to pass the (S)GS Design Review, a major milestone. Even though the Euclid concept concerns cosmology, the presentation by Malcolm Longair already mentioned Euclid's potential of enabling an unprecedented amount of legacy science. In 2016 the Euclid Deep Fields have been defined and there is a readiness by other facilities to start observing these areas. I would like to mention our recent workshops addressing Solar System Objects and the possible science with the NISP Blue Grism. The success of these topics with Euclid depends on the efforts by the Euclid community, willing to make the required preparations in order to be ready when the observational data become available. Coordination and intense collaboration are necessary, but in view of the interest and professional enthusiasm in the working groups, there is no doubt that Euclid's legacy science has a great promise.

René Laureijs

The Euclid Solar System Objects Science Working Group

Although the Euclid survey will avoid ecliptic latitudes below 15 degrees, the imaging sequence, in repeated sequences of four broad-band filters is rather well adapted to the detection of Solar System objects (SSOs) and their characterisation and has a great potential for Solar System research with its spectral coverage (0.5 to 1.8 µm) - for details see Carry (2017).

Several 10^5 SSOs should be observed by Euclid. These objects will all have high inclination, which contrasts with many SSO surveys focusing on the ecliptic plane. There is therefore a clear margin for discovery by Euclid until the Large Synoptic Survey Telescope (LSST) becomes operational.

The hour long sequence of observation (see top figure on right) will allow us to determine preliminary orbits, and follow-up of some specific targets can be envisioned. These observations, consisting in a suite of four sequences of four measurements, can be used to determine the SSO rotation period, spin orientation, and 3-D shape model, once combined with sparse photometry such as measured by Gaia and LSST.

The prospect for spectral characterisation seems the most promising: by extending the spectral coverage provided by Gaia and LSST, Euclid will refine the spectral classification of SSOs and break degeneracies in classification (see lower figure on right).

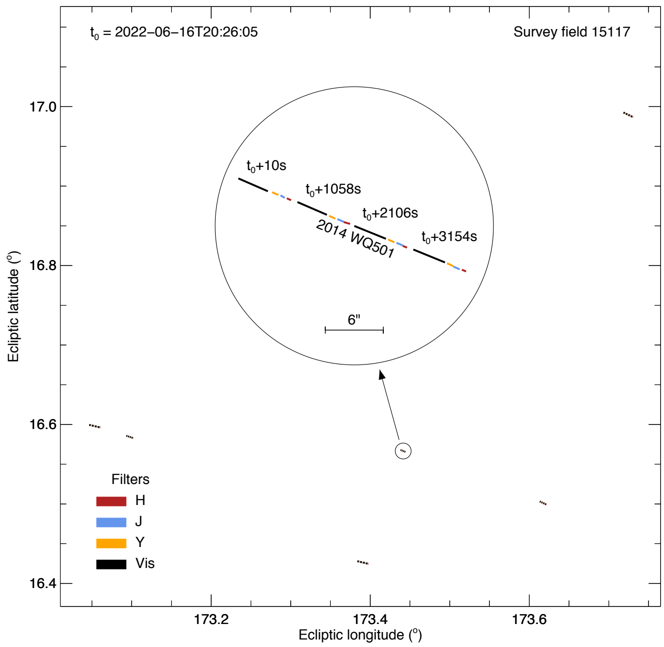
For this purpose the SSO Science Working Group (SWG) was set-up in 2016 to coordinate efforts building up on the experience of Gaia in this field. A dedicated processing for the detection of SSOs, catalogs of SSOs astrometry, photometry, spectroscopy, and spectral classification, could be delivered as Legacy Science.

A kick-off meeting was held at the Nice observatory on the 24th of November 2016 to discuss and define Work Packages with scientists and experts in the field interested to join the SSO SWG within the Euclid Consortium.

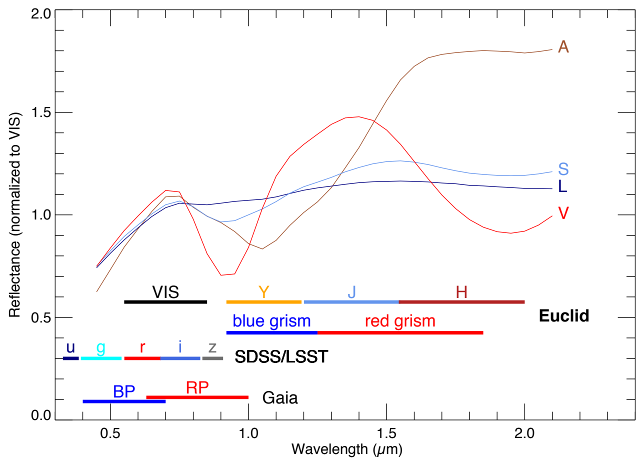
One of the first tasks is to provide the detection envelop of Euclid, for both VIS and NISP: ie. the fraction of SSO recovered as function of apparent speed, orientation, apparent magnitude, as well as astrometric and photometric accuracy.

The Science Operations Centre at ESAC is expected take an important role by implementing and running a short-term pipeline for fast detections of SSOs allowing ground-based follow-up or dissemination of alerts .

Bruno Altieri



Trails shown by known SSOs in one Euclid hour-long sequence of VIS-NSIP imaging. The inset shows a magnified view of one main-belt asteroid, 2014 WQ501. For further details see Carry (2017) which the figure is taken from.



Examples of asteroids classes (A, L, S, and V) which are degenerated over visible wavelength range. The large wavelength coverage ofEuclid will allow to easily disentangle such degeneracy (from Carry 2017).

For further information on the SSO SWG:

SWG Wiki: https://wiki.cosmos.esa.int/euclid/index.php/EC_SWG_PT

Reference: “Solar System Science with ESA Euclid”, B. Carry, A&A, in prep.

Structural-Thermal-Optical Performance analysis of the Euclid telescope

Low distortion of the telescope under thermal loads transmitted from its environment is the key to the optical performance of the Euclid mission. Structural-Thermal-Optical Performance (STOP) analysis is employed at different levels to verify compliance with the tight distortion budgets of the instruments.

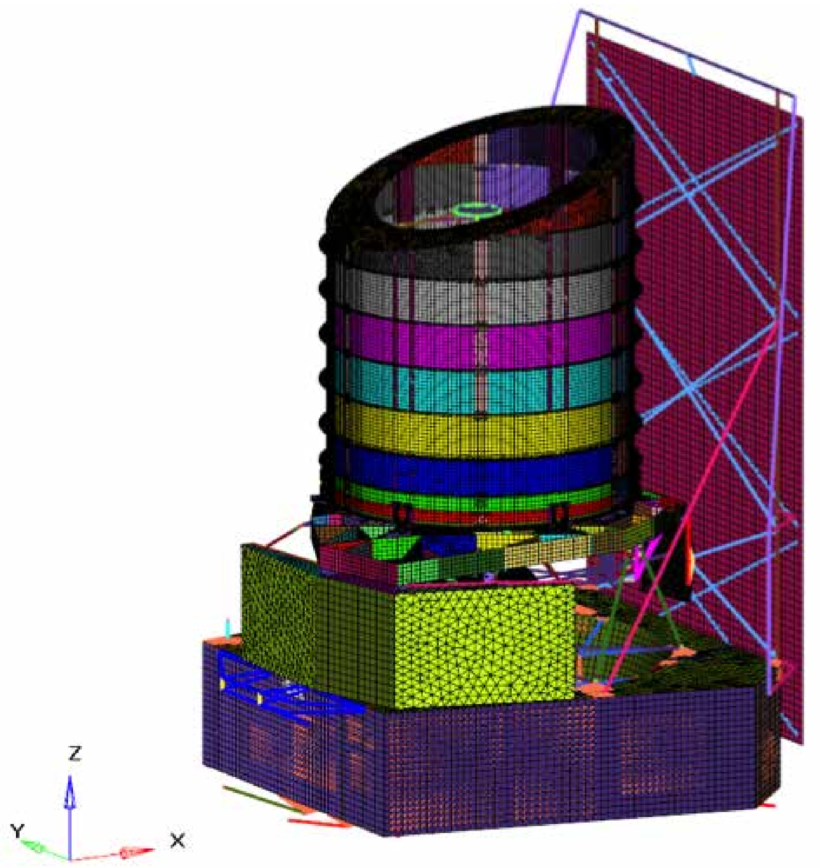
The VIS instrument drives the image quality (IQ) performance of the telescope. The VIS IQ is defined in terms of metrics, notably the PSF (Point Spread Function) FWHM (Full Width at Half Maximum), ellipticity ε, and squared radius R^2 (defined as the sum of the xx and yy quadrupole moments). These parameters describe the size and shape of the PSF in the telescope x-y focal plane. Each of these metrics must comply with *static* and *dynamic* requirements. The *static* requirements must be met by any exposure taken during the mission. By *dynamic* requirements it is intended the spatio-temporal variations of the PSF during a window of 11,000 seconds encompassing two consecutive fields, each with four dithered exposures and across the entire focal plane. The static requirements take contributions from tolerances in the integration and manufacturing, ground-to-space temperature drop, zero-g relaxation etc., which will not change after the initial telescope set-up and calibration, as well as effects like thermoelastic distortion and line-of-sight jitter (due to the attitude control system), which may vary from exposure to exposure. The dynamic requirements are affected, in practice, only by thermoelastic effects. The requirements applied to the spacecraft are summarized in the following table[1]:

Static Requirements		Dynamic Requirements	
FWHM	< 155 mas	--	--
Ellipticity (ε)	< 0.14	$\delta\varepsilon$	$< 2\cdot10^{-3}$
R^2	< 0.055 as^2	$\delta R^2/R^2$	$< 2\cdot10^{-3}$

The task of ensuring compliance with the low distortion requirements begins with the spacecraft and mission design. Major provisions include structural and thermal decoupling of the Payload Module (PLM) hosting the telescope and instruments from the Service Module (SVM), including the sunshield, which makes up the main part of the PLM environment; the same, highly stable ceramic material, Silicon Carbide, used throughout the PLM (baseplate, telescope truss structures and mirrors); and operational limits to the allowed excursion of the sun in the satellite reference frame.

Verification of the image quality requirements under thermo-structural distortion is achieved in a series of concatenated runs of highly detailed thermal, mechanical and optical mathematical models. In a first step, the initial conditions of a large number of test cases are defined to capture the range of variation of the parameters representing the external environment (e.g., sun irradiance, azimuth and elevation of the sun in the satellite frame) and the satellite's internal state (e.g., system and payload operating modes). Such static environment cases are processed in the thermal model to derive thermal maps. The thermal maps are then processed in the structural finite-element model to derive mechanical displacements. Finally, the resulting telescope deformations are applied to the optical model and provide PSFs in selected points over the field of view, from which IQ metrics are derived. Given the size of the models (several thousand nodes per module and model), for an efficient execution it is essential that the process be automated, which requires careful preparation and extensive prior verification of model interfaces (correspondence of thermal and structural nodes and of structural nodes and optical elements, interpolation, data transfer, etc.).

1 One should carefully consider these values. While they do apply directly to the spacecraft performance, they are not the overall IQ obtained at mission level. These static requirements at mission level are slightly less demanding ($\varepsilon \le 0.15$, FWHM≤180mas, $R^2 \le 0.057$ as^2), while the stability at mission level is one order of magnitude more demanding, as the temporal stability of the telescope can be improved by aggregating the stars from more than one field in post-processing.



Structural Finite Element Model of the Euclid spacecraft

For practical reasons, the process is performed separately for the SVM (by TAS) and the PLM (by ADS). The environmental conditions are applied to the SVM thermal and mechanical models, in sequence, to derive interface thermal loads (conductive and radiative) and displacements at the base of the three bipods connecting the SVM to the PLM baseplate. The resulting temperatures and displacements are applied as external loads to the appropriate PLM models (together with the internal loads, most notably the payload's thermal power dissipation). Then, the PLM proceeds with its own thermal-structural-optical analysis.

The same approach is used for verification of the dynamic requirements, with, in place of different static environmental cases, a time sequence of snapshots of the satellite captured during the evolution of a transient such as those occurring after the satellite has been commanded to point at a different area of the sky.

The fully-fledged STOP process is being applied for the first time as part of the mission's Critical Design Review (CDR) cycle. It will be repeated, with models of ever increasing detail and fidelity, at every major system review (qualification, PLM delivery, flight acceptance). In time, it will take inputs from lower level models, test results and model correlations. Eventually, the consolidated telescope performance will be used to validate the reference survey strategy and help plan the survey execution.

Alberto Anselmi (Thales Alenia Space Italia – Torino)

Giuseppe Racca (ESA/ESTEC – Noordwijk (NL))

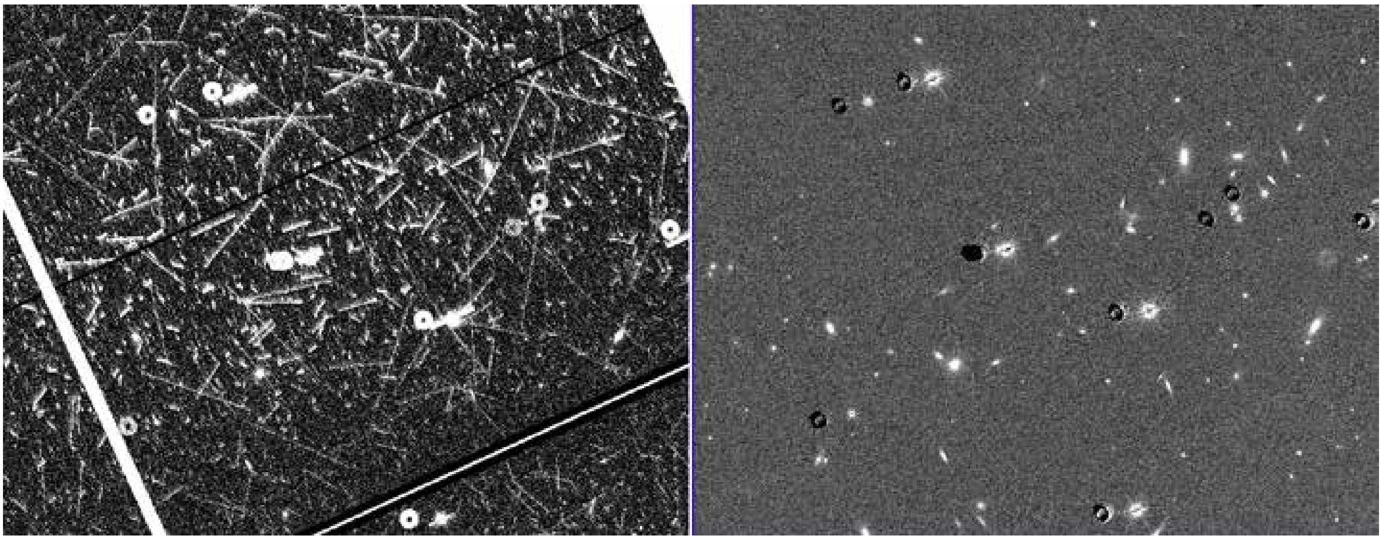
Updates from the Organisational Units

OU-VIS

VIS data processing activities in 2016

In 2016 several major milestones were achieved by the OU-VIS and SDC-FR teams. In the framework of the Scientific Challenge 2, the existing VIS PF prototype pipeline was successfully migrated to the Euclid ground segment architecture. This pipeline has been now been executed on both the SDC-FR infrastructure and (independently) at SDC-IT. In preparation for Scientific Challenge 3, many bugs identified in the previous version of the pipeline have been corrected and several new processing elements have been added. In December 2016, for the first time, this new pipeline processed SIM images containing both galaxies and stars. Although the input SIM images do not yet contain objects to the depth that Euclid will provide, the VIS pipeline output provides an exciting glimpse of the new Universe that Euclid will open to us (see figure below)..

The VIS data processing team (OU-VIS and SDC-FR)



The left panel shows a section of one CCD of a 565s VIS exposure. Cosmic rays, charge transfer inefficiency, ghosts, background, flat-field and bias effects have been applied to the simulated images of stars and galaxies. The right panel shows the combination of four such images after they have been processed by the VIS pipeline. This image covers only a tiny fraction of the 0.6 square degrees of the VIS focal plane.

OU SIR

Activities are busily progressing along many different directions for OU-SIR, as we prepare to enter into year 2017. Software development for the main spectroscopic data reduction pipeline is moving forward pretty much as scheduled, with the main pipeline components already in-place, and able to withstand their functionality challenge as part of the Ground Segment Scientific Challenge nr. 2, that took place in the spring months of 2016.

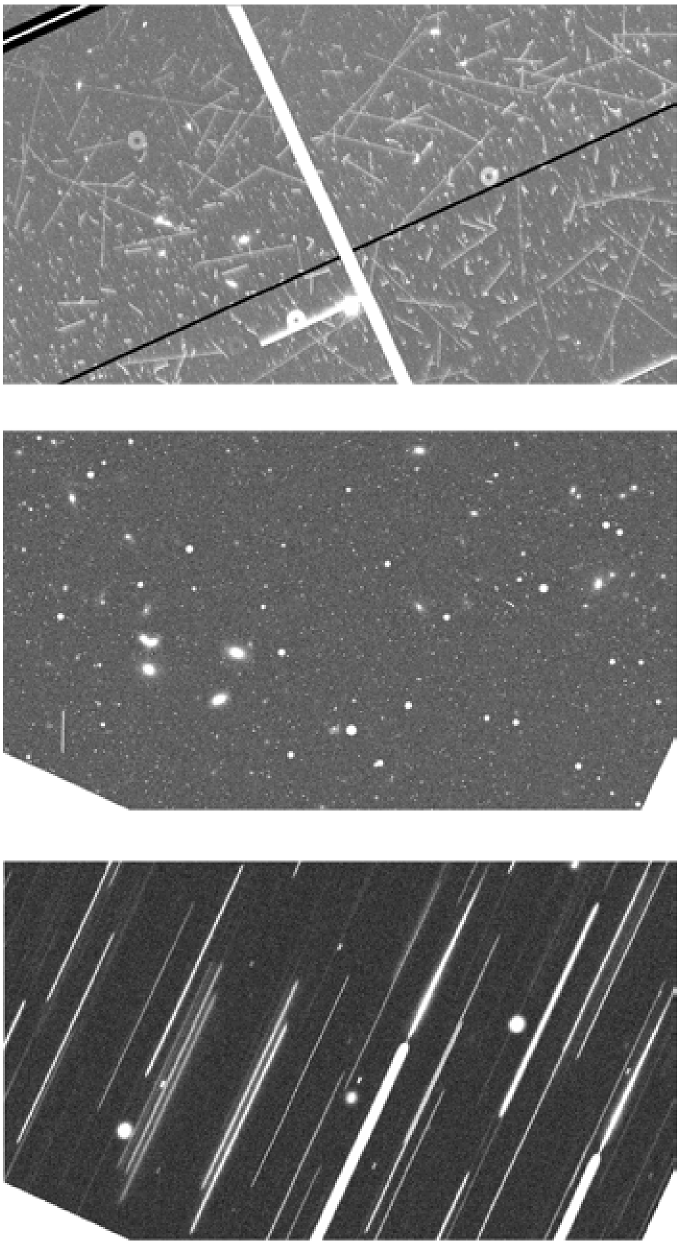
For 2017 we will be facing two new important challenges, the Ground Segment Scientific Challenge nr. 3 (SC3), and the Euclid Consortium second Science Performance Verification (SPV2). As part of SC3 we will be able to test for the very first time a realistic flow of operations among the different Euclid pipelines. Most important for us will be the fact that the spectroscopic pipeline will be running its tasks starting from a real photometric catalog, created by the OU-MER pipeline on the basis of simulated VIS and NISP imaging data (reduced by the OU-VIS and OU-NIR pipelines, respectively), instead of relying on the perfect catalog used by OU-SIM to create the simulated data as it was done so far. As part of SPV2 we will have, for the first time, the real spectroscopic pipeline to be integrated in the end-to-end simulations designed to test the overall Euclid mission capability of reaching the scientific goals it was designed to achieve.

Software development for the calibration pipeline is instead lagging a bit behind, with respect to the main data reduction pipeline, in part by design, and in part because some of the calibration requirements are still being refined and consolidated. This situation is also partly to blame for the delay in defining all details about the validation procedures for the OU-SIR pipeline. In fact the validation part of the pipeline development will be the major focus of our activities for the next six months, because it will have to be completed by the summer of 2017, to meet the third important challenge we will be facing next year: the Ground Segment Design Review, one of the official ESA reviews, designed to monitor the development of all Ground Segment activities.

Marco Scodeggio

OU-SIM

During the last semester of 2016, OU-SIM has concentrated all efforts in the development and production of the simulation images required for the Scientific Challenge 3 (SC3). With respect to the previous challenge, this simulation will include new features and models for the VIS and NISP instruments, such as new Point Spread Functions in all channels, detector nonlinearities and a realistic dark and flat maps as measured in the laboratory amongst other. In addition to the Euclid instrument simulators, SC3 will also contain simulated images from two external ground-based surveys: the Dark Energy Survey (DES) and the Kilo-Degree Survey (KiDS). All Euclid and External simulations must have a consistent and homogeneous parameter and input set. The stellar input will come from the same Besançon model, as it was for the Scientific Challenge 2 (SC2). The cosmological input will be renewed and the brand new Euclid Flagship simulation will be fed to all SC3 simulations. A first set of images have already been produced in November to test the Science Ground Segment pipeline (see figure in the right column). In order to deliver a minimum of 3x3 Euclid field area (~6 sq. deg.) agreed for this Challenge, OU-SIM is making both pipeline and data model homogeneous and standard to the common Euclid Ground Segment system. A validated simulation set for SC3 will be delivered by the end of February 2017.



Simulated Level 1 images for the same field of view, only a small region of the FoV is shown. From the top down is VIS, NISP and the slitless NIR spectrum shown (note that no cosmic rays are included in the latter).

The data produced will also serve for the Science Performance Verification Cycle 02 (SPV-02), a key process for the verification of the mission. The SPV simulation set will be delivered after the SC3 and its size and depth will depend on the final code performance and will be stablished with the SPV group in January 2017.

Santiago Serrano & Anne Ealet

OU-MER

MER is the Organizational Unit responsible of a crucial part of the Euclid Ground Segment - namely the preparation of the photometric catalog including all VIS, NIR and EXT data.

MER has reached two important milestones in these months. First, a complete version of the whole MER Processing Function has been completed. MER has implemented a pipeline that performs all the steps required for the processing of the Euclid data: - i.e. computation of final image mosaics, background subtraction, detection (over a combination of VIS+NIR images), deblending (using high resolution VIS images), optimal photometry of VIS, NIR and EXT images, star-galaxy separation, final assembly of the multiwavelength catalogue.

The second milestone is the integration of this pipeline into the Euclid processing system, that has been done in tight collaboration with the relevant SDCs (IT, DE and FR). These activities have been performed in the framework of the Scientific Challenge 3 (SC3), for which MER has the scientific responsibility. Two important milestones are foreseen for the next months. The first is the evaluation of the scientific performances of the whole pipeline and the comparison with the mission requirements. To accomplish this goal MER will analyze a proper set of simulated images eventually delivered by OU-SIM. The second milestone is the adoption of an improved technique for object deblending, that is particularly challenging due to combination of high spatial resolution and large dynamic range of the Euclid images. Several competing algorithm are being evaluated and a final selection will be performed using simulated and emulated data.

Adriano Fontana

OU-PHZ

The OU-PHZ activities over the last year have been marked by three significant advances: the second PHZ Data Challenge (DC2), the color-space calibration of photometric redshifts and the development of the first building blocks of the Euclid PHZ pipeline.

The second PHZ Data Challenge combined COSMOS data from the Dark Energy Survey Science Verification, HST ACS data and Ultra-Vista near-infrared data, with some 20'000 reliable spectroscopic redshifts from COSMOS/CANDELS. OU-EXT and OU-MER have been involved in the data processing in order to provide us with Euclid-like photometric data. In addition to allowing us to evaluate the performance of our algorithms, DC2 has been very interesting to test our interfaces with OU-EXT and OU-MER. Six algorithms have been officially submitted to DC2, including machine-learning algorithms, template-fitting algorithms and a hybrid algorithm. DC2 has also served as a testbed for a number of other algorithms.

The calibration of the photometric redshifts is one of the biggest challenges to achieve the scientific goals of weak-lensing tomography. We achieved a breakthrough by exploring the color-space distribution of galaxies, which allowed us to considerably reduce the number of spectroscopic redshifts needed for the calibration. Dedicated observations have already started on Keck, GTC, and possibly soon on VLT. More than 2000 spectra have already been obtained out of the estimated 5000 that are needed.

In parallel to the algorithm exploration by OU-PHZ, Euclid-compliant tools dedicated to photometric-redshift computations are developed by the Swiss SDC. Phosphoros is a C++ code written from scratch with the support of OU-PHZ to compute photometric redshifts and physical parameters using the template-fitting algorithm. It also implements advanced effects, like in particular the full treatment of Galactic extinction. Phosphoros 0.6 has been released, and will be made available next year to all Euclid members, when sufficient scientific validation will have been made. A Euclid-compliant framework to implement any kind of machine-learning algorithm, called PRIMAL, has been also developed. PRIMAL will allow us to rapidly implement, test and optimize the numerous machine-learning algorithms that can be used to compute photometric redshifts.

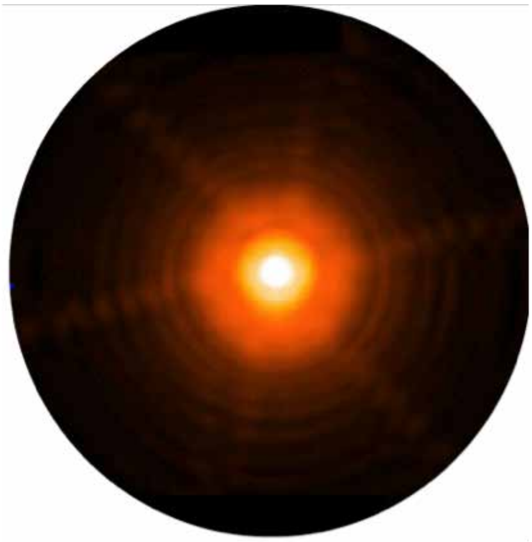
Stephane Paltani & Francisco Castander

OU-SHE

Measuring Cosmic Shear with Euclid

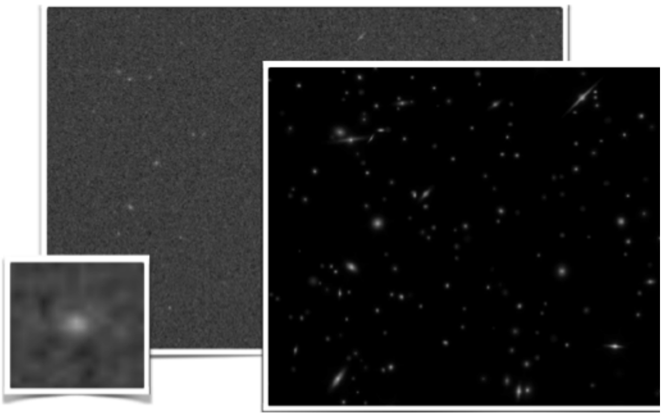
OU-SHE has one of the most technically challenging tasks within Euclid, ensuring that the measurement of the Cosmic Shear signal from the tiny distortions of over 1.5 billion galaxy images across the sky is unbiased to one-part in a thousand, per galaxy, for Dark Energy Science. Given the angular size of the galaxies is about the size of a one Euro coin held up about ten kilometres away and only covers a few pixels, while the distortion of the coin is only a few hairs breadth in size, this is no mean feat.

To do this, OU-SHE has to correct the galaxy images for distortions introduced by the telescope optics and detector effects which would otherwise dominate the signal by many orders of magnitude. It can do this by using stellar images, which are not lensed, but whose light travels the same path through Euclid. To make this correction OU-SHE has developed an accurate Point Source Function (PSF) model of the VIS-channel, which will account for image distortions introduced by the telescope optics and its modes of deformation (see figure below). This will be calibrated to a ground-model before launch and then tuned to fit stellar images in flight. This PSF model will be used throughout the Euclid pipeline, and will be available to Euclid Consortium members.



Euclid broadband VIS PSF Model based on a physical model of the telescope structure and optics.

The heart of the Euclid Cosmic Shear measurement is the shear estimation, based on measuring the shapes of galaxies. Here we have developed both galaxy model-fitting and moment-measuring approaches, which can be used for Frequentist or Bayesian shear estimation. These multiple methods allow for internal cross-checking of results, and are optimised for unbiased estimation of the shear field. To develop and test these methods we have developed realistic Euclid image simulations which mimic the real Universe and Euclid distortions. To ensure the image simulations look as real as possible, we are "Euclidizing" Hubble Space Telescope (HST) images of galaxies (see figure below), correcting for HST image distortion before adding Euclid's, to emulate the Universe Euclid will see as closely as possible. Our methods will have to deal with blended images, the colour-dependent differences in stellar and galaxy distortions, residual trailing from the correction of Charge Transfer Inefficiency in the VIS CCDs, and many other real-world effects. In addition, with the Weak Lensing Science Working Group, we have developed a suit of Validation tests and sanity checks which will be implemented in OU-SHE.



OU-SHE simulations of galaxy images, based on realistic galaxy properties (foreground right), with Euclid detector noise (background), and a typical low-signal-to-noise galaxy used to measure cosmic shear (foreground left).

All of the prototype code OU-SHE will need has been developed over the last three years, and is now coming together in a single pipeline in the SDC. Over the next year, we plan to fully integrate with OU-VIS, OU-MER, OU-PHZ and OU-LE3, in anticipation of Science Challenge 4 in early 2018, by which time all our code will be in a mature state and we hope to run simulations through the main Weak Lensing pipeline. Many challenges still await OU-SHE, in particular object selection which will introduce shear biases. But development is on track and holding steady. If you are interested in joining in with the OU-SHE work, please drop us an email.

Andy Taylor, Tim Schrabback & Frederic Courbin, on behalf of the OU-SHE Team.

Updates from the Science Working Groups

Cosmological Simulations SWG

The primary task of the Cosmological Simulations SWG (CSWG) is to validate the tools used to generate mock galaxy catalogues with the level of quality expected from the Euclid Science Requirements Document. For example, these catalogues must reproduce the main Euclid observables with a predefined target accuracy. The CSWG is also providing to the Euclid collaboration, on a best-effort basis, simulated galaxy catalogues. These synthetic catalogues will be used by the various science SWGs to prepare the mission, and by the Science Ground Segment (SGS) to test the various data processing pipelines.

Simulations from the CSWG are also a key ingredient in the ongoing Science Performance Verification (SPV) exercise, which will review the entire Euclid SGS performance with respect to the so-called Level 0 requirements. The second cycle of the SPV will run throughout 2017 using the first official Euclid mock galaxy catalogue based on a recent state-of-the-art cosmological simulation and called the Euclid Flagship Simulation.

This N body simulation was run on the Swiss supercomputer Piz Daint using 4000 Graphical Processing Units (GPU) running in parallel. This unprecedented effort featured 2 trillion ($2x10^{12}$) dark-matter particles, whose dynamical evolution was computed by the Fast Multipole Tree code PKDGRAV3 (https://bitbucket.org/dpotter/pkdgrav3), developed at the University of Zurich. A gigantic light-cone containing the simulation data between redshift 0 and redshift 2.3 was generated and stored to disk, providing a halo catalogue that will allow to model billions of galaxies with masses as small as one tenth of the Milky Way mass. More details on the simulation and other benchmarks can be found in the paper submitted to the arXiv, https://arxiv.org/abs/1609.08621.

The Flagship Simulation dark matter outputs and halo catalogues are being ingested in the Spanish Data Center at Port d'Informacio Cientifica (PIC) in Barcelona. These outputs are then processed by a complex scientific pipeline developed by the scientists at the Institut de Ciencies de l'Espai (ICE, www.ice.csic.es) and PIC (www.pic.es) to produce a massive synthetic galaxy catalogue. This catalogue, based on the Halo Occupation Distribution (HOD) algorithm, contains a complete set of galaxy properties, including those relevant for galaxy clustering and weak lensing, the main science probes of Euclid. Besides, it shall include key systematics, such as intrinsic galaxy alignments, that closely match those of the observational data. Ultimately, the Flagship Galaxy Catalogue is expected to cover 14'000 square degrees in the sky, including about 2 billion galaxies down to the magnitude limit expected for the wide survey. The first data release of the Flagship Mock Catalogue to the Euclid Collaboration is expected by end of February 2017, and will cover about 5000 sq.deg. (one octant of the entire sky).

In the annual CSWG meeting, held in the Institut de Ciencies de L'Espai on November 10-11, about 40 simulation experts within the Euclid collaboration gathered to discuss critical aspects of the working group roadmap. In particular, they focused on the construction and validation of the Flagship Galaxy Mock Catalogue, improved physical modeling aspects that are relevant to achieve the accuracy promised by the Euclid mission, such as gas physics, the impact of massive neutrinos, or the ability to model non-standard gravity models. Another major topic was the design of optimal strategies for the computation of massive covariance matrices needed for cosmological parameter inference, or for the development of emulators that accurately reproduce observables within a wide parameter space. Development of these roadmap aspects will require large access to HPC resources before and after the launch of the Euclid satellite. Synergies and complementary efforts between European and US funding resources were explored as a way to address this major bottleneck.

In summary, these are exciting times for the cosmological simulations working group, with major challenges ahead that require the coordinated work of many experts within the science collaboration. The upcoming release of massive synthetic galaxy catalogs with unprecedented accuracy, for the science working groups and the ground segment, will be a major milestone in the scientific preparation of the Euclid mission.

Pablo Fosalba & Romain Teyssier

CMB Cross-correlation SWG

Closing the loop on Simulations

Over the past year, the Cosmic Microwave Background Cross-correlation Science Working Group (CMBXC) met two times, in a dedicate meeting in Orsay, as well as in a splinter meeting at the Consortium. There, the structure of the Work Packages (WP) was updated, and estimators of the relevant observables for Euclid surveyed. In the fall, the CMBXC WP coordinators joined simulation meetings in Munich and Barcelona presenting ray tracing infrastructure, completed over the last year, and plans for dedicated simulations. The CMBXC is organizing a dedicated meeting in February 2017, dedicated to the latter.

Good news! The italian ministry for University and Research approved the first national proposal dedicated to Euclid, supporting explicitely science activities with PostDoc, calls expected to open soon in 2017. One of the positions will be at SISSA, dedicated to CMBXC work.

Carlo Baccigalupi & Nabila Aghanim

PUSWG

Over the past year the Primeval Universe WG has provided input to the discussions on the selection of the Euclid Deep Fields and on the blue grism science case.

For the Deep Field selection we have provided rankings of potential fields for criteria such as zodiacal light, extinction and access from ground-based facilities for follow-up and preparatory observations. We made in particular the case for the choice of 10 sq. degrees in the CDFS. A large programme with Spitzer was proposed by P. Capak on the CDFS and NEP fields. More than 5,000 hrs of observations have been subsequently allocated. Observations are now progressing at full pace and the first epoch is completed.

As for the blue grism discussion, a strong science case is emerging for the detection and evolution of Ly-alpha emitters at the end of reionization. Recent results indicate that there are more bright Ly-alpha emitters than had been anticipated a few years ago. With the blue grism, the direct detection in spectroscopy of thousands of objects will enable studying the evolution and clustering of Ly-alpha emission as a function of redshift, thereby providing signatures of re-ionization.

On other fronts, theoretical work is progressing for estimating the feasibility of detecting very high-redshift popIII SNe and how tomographic measurements of the sky background with the NISP filters will enable isolating and constraining the Cosmic Infrared Background at redshifts $10<z<16$.

Jean-Gabriel Cuby & Sune Toft

Euclid dates in 2017 (unless otherwise stated)

- *November 2016* - First SC3 simulation set from OU-SIM
- *January 11-13* - EcSGS PA (Product Assurance) Workshop, Paris IAP
- *January 12* - VIS Instrument CDR Kick off meeting at ESTEC
- *January 25* - Science Performance Verification SPV02 Kick off meeting at IAP
- *February 01-02* - Euclid Consortium Board F2F meeting in Heidelberg
- *February 20-21* - Calibration meeting at University College London (UCL)
- *February 22* - SWG-OU Garage days at UCL
- *February 23-24* - OU-LE3 meeting RAS
- *February* - Final SC3 simulation set from OU-SIM
- *March 1-2* - WL Validation & Verification meeting, also UCL
- *March 1* - Start of Infrastructure Challenge 7
- *March 15* - Start of Scientific Challenge 3
- *March 23-24* - Euclid Science Team meeting in Heidelberg
- *April* - Extended SPV simulation set with the new Flagship cosmological simulation from OU-SIM
- *June 5-8* - Euclid consortium annual meeting in London.
- *June 12-14* - CFIS meeting at IAP
- *July 06-07* - Euclid Science Team meeting at ESTEC

Social media presence

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Instagram: euclidconsortium. Send images to consortiumeuclid@gmail.com, along with any needed credit, your name and supporting short text.

Contact list

Euclid Consortium Lead	Yannick Mellier	mellier@iap.fr
ESA Project Scientist	René Laureijs	rlaureij@rssd.esa.int
ESA Project Manager	Giuseppe Racca	Giuseppe.Racca@esa.int
ECL Advisory and Coordination Support Lead	Michel Berthe	michel.berthe@cea.fr
Mission Survey Scientist	Roberto Scaramella	kosmobob@oa-roma.inaf.it
Mission System Engineer	Jerome Amiaux	jerome.amiaux@cea.fr
Calibration WG Lead	Stefanie Wachter	wachter@mpia.de
EC SGS Project Manager	Andrea Zacchei	zacchei@oats.inaf.it
EC SGS Deputy Project Manager	Christophe Dabin	Christophe.Dabin@cnes.fr
EC SGS Scientist	Marc Sauvage	marc.sauvage@cea.fr
VIS Project Manager	Sabrina Pottinger	sjp@mssl.ucl.ac.uk
VIS Instrument Lead	Mark Cropper	msc@mssl.ucl.ac.uk
VIS Instrument Scientist	Ruymán Azzolini	r.azzollini@mssl.ucl.ac.uk
NISP Project Manager	Thierry Maciaszek	thierry.maciaszek@lam.fr
NISP-P Instrument Scientist	Knud Jahnke	jahnke@mpia.de
NISP-S Instrument Scientist	Anne Ealet	ealet@cppm.in2p3.fr
COMS Responsible	Eugenie Girin	girin@iap.fr
EC Editorial Board Chair	Peter Schneider	peter@astro.uni-bonn.de
EC Editorial Board co-Chair	John Peacock	jap@roe.ac.uk
Science Coordinators	Henk Hoekstra	hoekstra@strw.leidenuniv.nl
	Tom Kitching	t.kitching@ucl.ac.uk
	Luigi Guzzo	luigi.guzzo@brera.inaf.it
	Will Percival	will.percival@port.ac.uk
SWG Legacy Coordinators	Chris Conselice	christopher.conselice@nottingham.ac.uk
	Jarle Brinchmann	jarle@strw.leidenuniv.nl
	Jochen Weller	jochen.weller@usm.uni-muenchen.de
EC Complementary and Ancillary Observations Lead	Konrad Kuijken	kuijken@strw.leidenuniv.nl
Science Performance Verification Lead	Hervé Aussel	herve.aussel@cea.fr

EC Board Members

Werner Zeilinger	werner.zeilinger@univie.ac.at	Sven De Rijcke	sven.derijcke@UGent.be
Hannu Kurki-Suonio	hannu.kurki-suonio@helsinki.fi	Kristian Pedersen	kp@dark-cosmology.dk
Yannick Mellier	mellier@iap.fr	Olivier Le Fèvre	Olivier.LeFevre@lam.fr
Ralf Bender	bender@usm.lmu.de	Hans-Walter Rix	rix@mpia.de
Andrea Cimatti	a.cimatti@unibo.it	Roberto Scaramella	kosmobob@oa-roma.inaf.it
Huub Röttgering	rottgering@strw.leidenuniv.nl	Per Lilje	per.lilje@astro.uio.no
António da Silva	asilva@astro.up.pt	Lucia Popa	lpopa@spacescience.ro
Francisco Castander	fjc@ieec.uab.es	Rafael Rebolo Lopez	rrl@iac.es
Romain Teyssier	romain.teyssier@uzh.ch	Jason Rhodes	jason.d.rhodes@jpl.nasa.gov
Mark Cropper	msc@mssl.ucl.ac.uk	Bob Nichol	bob.nichol@port.ac.uk
Ray Carlberg	raymond.carlberg@utoronto.ca		

The Organisational Units

OU-VIS - Visual imaging	
Henry McCracken	hjmcc@iap.fr
Catherine Grenet	grenet@iap.fr
Kevin Benson	kmb@mssl.ucl.ac.uk
OU-NIR - Near-IR imaging	
Gianluca Polenta	gianluca.polenta@@asdc.asi.it
Rychard Bouwens	bouwens@strw.leidenuniv.nl
OU-SIR - Near-IR spectroscopy	
Marco Scodeggio	marcos@lambrate.inaf.it
Yannick Copin	y.copin@ipnl.in2p3.fr
OU-SPE - Spectroscopic measurements	
Olivier Le Fèvre	Olivier.LeFevre@lam.fr
Christian Surace	christian.surace@lam.fr
OU-EXT - Data external to Euclid	
Gijs Verdoes-Kleijn	verdoes@astro.rug.nl
Joe Mohr	jmohr@usm.lmu.de

OU-SIM - Simulations of Euclid data	
Santiago Serrano	serrano@ieec.uab.es
Anne Ealet	ealet@cppm.in2p3.fr
OU-MER - Merging of external and Euclid data	
Adriano Fontana	adriano.fontana@oa-roma.inaf.it
Hervé Dole	Herve.Dole@ias.u-psud.fr
Martin Kuemmel	mkuemmel@usm.lmu.de
OU-LE3 - Level 3 data	
Jean-Luc Starck	jstarck@cea.fr
Enzo Branchini	branchini@fis.uniroma3.it
Filipe Abdalla	fba@star.ucl.ac.uk
OU-SHE - Shear measurements	
Andy Taylor	ant@roe.ac.uk
Frédéric Courbin	frederic.courbin@epfl.ch
Tim Schrabback	schrabba@astro.uni-bonn.de
OU-PHZ - Photometric redshifts	
Stephane Paltani	stephane.paltani@unige.ch
Francesco Castander	fjc@ieec.uab.es

The Science Working Groups

Weak lensing SWG	
Henk Hoekstra	hoekstra@strw.leidenuniv.nl
Tom Kitching	t.kitching@ucl.ac.uk
Martin Kilbinger (dpty)	martin.kilbinger@cea.fr
Galaxy clustering SWG	
Luigi Guzzo	luigi.guzzo@brera.inaf.it
Will Percival	will.percival@port.ac.uk
Yun Wang	wang@ipac.caltech.edu
Galaxy & AGN evolution SWG	
Andrea Cimatti	a.cimatti@unibo.it
David Elbaz	delbaz@cea.fr
Jarle Brinchmann	jarle@strw.leidenuniv.nl
Milky Way and Resolved Stellar Populations SWG	
Eline Tolstoy	etolstoy@astro.rug.nl
Annette Ferguson	ferguson@roe.ac.uk
Local Universe SWG	
Bianca Poggianti	bianca.poggianti@oapd.inaf.it

Chris Conselice	christopher.conselice@nottingham.ac.uk
Clusters of galaxies SWG	
Jochen Weller	jochen.weller@usm.uni-muenchen.de
Lauro Moscardini	lauro.moscardini@unibo.it
Jim Bartlett (dpty)	bartlett@apc.univ-paris7.fr
CMB Cross-correlations SWG	
Carlo Baccigalupi	bacci@sissa.it
Nabila Aghanim	nabila.aghanim@ias.u-psud.fr
Extrasolar planets SWG	
Jean-Philippe Beaulieu	beaulieu@iap.fr
Maria Zapatero-Osorio	mosorio@iac.es
Eamonn Kerins (dpty)	eamonn.kerins@manchester.ac.uk
SNe and Transients SWG	
Charling Tao	tao@cppm.in2p3.fr
Isobel Hook	i.hook@lancaster.ac.uk
Enrico Cappellaro (dpty)	enrico.cappellaro@oapd.inaf.it

Cosmological Simulations SWG	
Pablo Fosalba	fosalba@ieec.uab.es
Romain Teyssier	romain.teyssier@gmail.com
Primeval Universe SWG	
Jean-Gabriel Cuby	jean-gabriel.cuby@lam.fr
Sune Toft	sune@dark-cosmology.dk
Strong lensing SWG	
Jean-Paul Kneib	jean-paul.kneib@epfl.ch
Massimo Meneghetti	massimo.meneghetti@oabo.inaf.it

Raphael Gavazzi (dpty)	gavazzi@iap.fr
Cosmological Theory SWG	
Luca Amendola	l.amendola@thphys.uni-heidelberg.de
Martin Kunz	Martin.Kunz@unige.ch
Matteo Viel (dpty)	viel@oats.inaf.it
Solar System Object SWG	
Bruno Altieri	bruno.altieri @ sciops.esa.int

The Science Data Centres

SDC Switzerland	
Pierre Dubath	Pierre.Dubath@unige.ch
SDC United Kingdom	
Keith Noddle	keith@keithnoddle.com
SDC Italy	
Marco Frailis	frailis@oats.inaf.it
SDC France	
Maurice Poncet	Maurice.Poncet@cnes.fr
SDC Netherlands	
Rees Williams	o.r.williams@rug.nl

SDC Spain	
Christian Neissner	neissner@pic.es
SDC Germany	
Maximilian Fabricius	mxhf@mpe.mpg.de
SDC Finland	
Hannu Kurki-Suonio	hannu.kurki-suonio@helsinki.fi
SDC US	
Harry Teplitz	hit@ipac.caltech.edu