Etat d'avancement de la mission Euclid

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www.euclid-ec.org

Euclid Level-0 Science Requirements

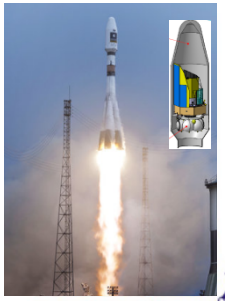
Sector	Euclid Targets
Dark Energy	• Measure the cosmic expansion history to better than 10% in redshift bins $0.7 < z < 2$. • Look for deviations from $w = -1$, indicating a dynamical dark energy. • Euclid *alone* to give $FoM_{DE} \geq 400$ (1-sigma errors on w_p, & w_a of 0.02 and 0.1 respectively)
Test Gravity	• Measure the growth index, γ, with a precision better than 0.02 • Measure the growth rate to better than 0.05 in redshift bins between $0.5 < z < 2$. • Separately constrain the two relativistic potentials Ψ, Φ. • Test the cosmological principle
Dark Matter	• Detect dark matter halos on a mass scale between 10^8 and $>10^{15}$ M_{Sun} • Measure the dark matter mass profiles on cluster and galactic scales • Measure the sum of neutrino masses, the number of neutrino species and the neutrino hierarchy with an accuracy of a few hundredths of an eV
Initial Conditions	• Measure the matter power spectrum on a large range of scales in order to extract values for the parameters σ_8 and n to a 1-sigma accuracy of 0.01. • For extended models, improve constraints on n and α wrt to Planck alone by a factor 2. • Measure a non-Gaussianity parameter f_{NL} for local-type models with an error less than +/-2.

- DE equation of state: $P/\rho = w$, and $w(a) = w_p + w_a(a_p - a)$
- Growth rate of structure formation: $f \sim \Omega^{\gamma}$;
- FoM=$1/(\Delta w_a \times \Delta w_p) > 400 \rightarrow$ ~1% precision on w's.

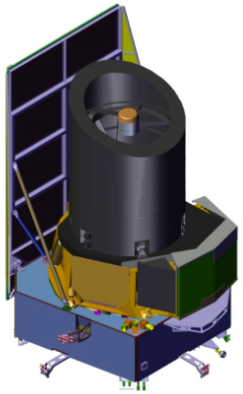
The ESA Euclid space mission: EC contributions

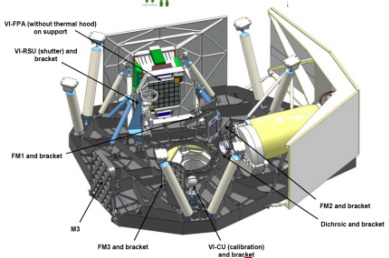
Soyuz@Kourou

2020



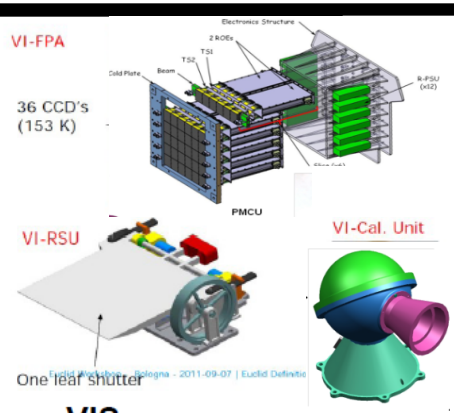
PLM+SVM: 2010-2020

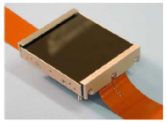




VIS imaging: 2010-2020

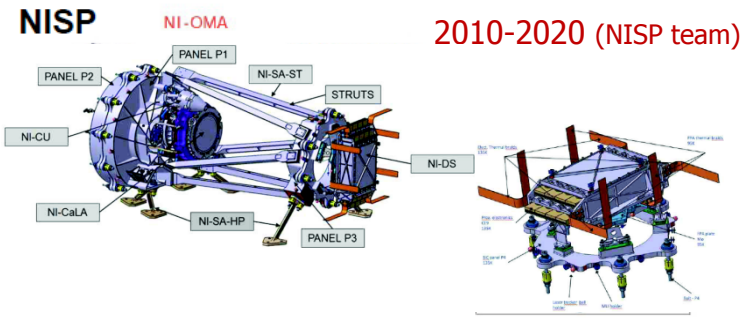
(VIS team)



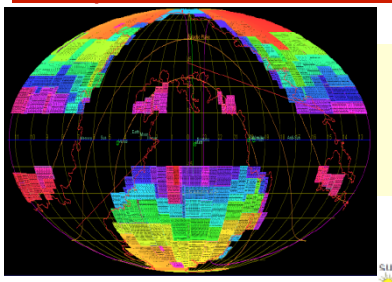


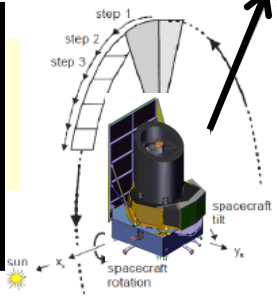
NIR spectro-imaging

2010-2020 (NISP team)



Surveys: 2010-2028 (Survey WG)





6 yrs - 15,000 deg^2

Commisionning – SV

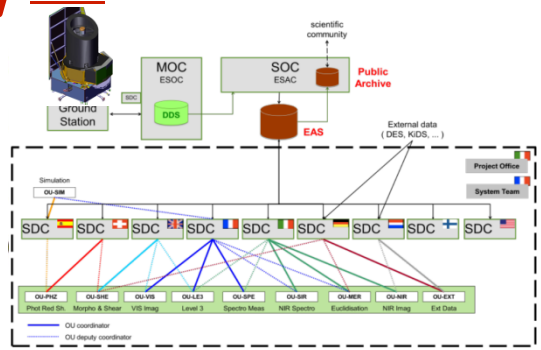
Euclid opération:

5.5 yrs:Euclid Wide+Deep

+: SNIa, mu-lens, MW?

Ground data

SGS: 2010-2028



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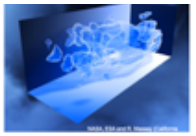
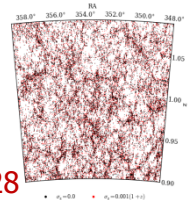
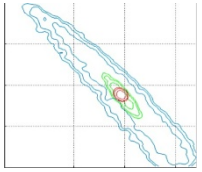


SWG:

2019-2028





Science analyses

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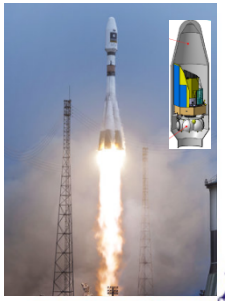

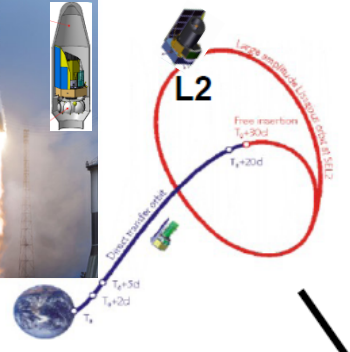

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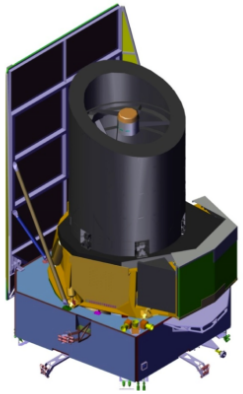

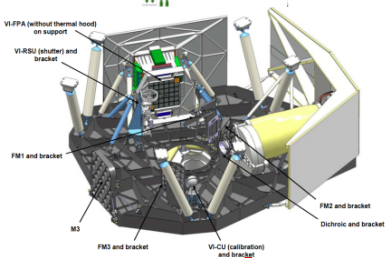

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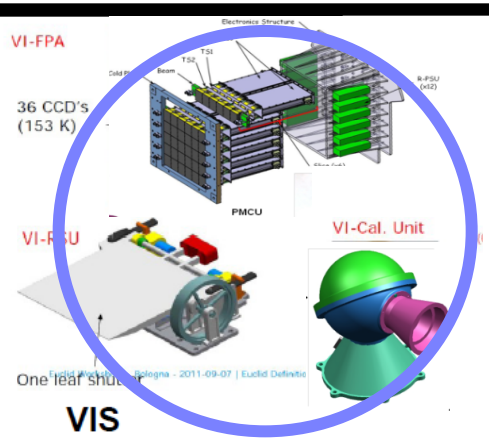

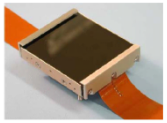

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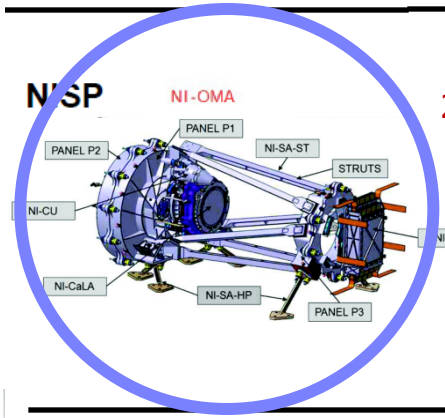

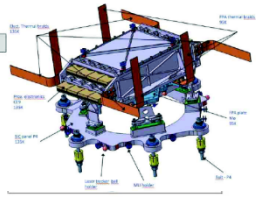

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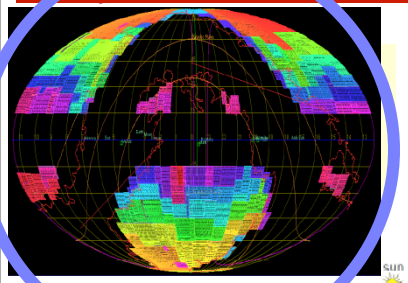

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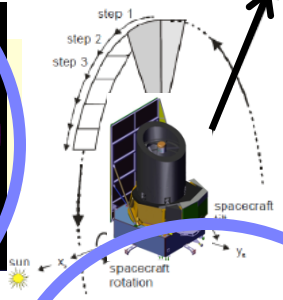

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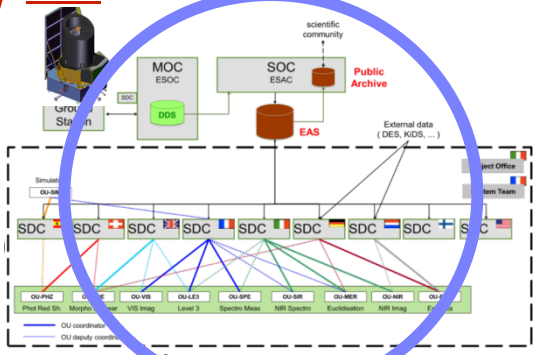

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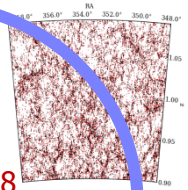
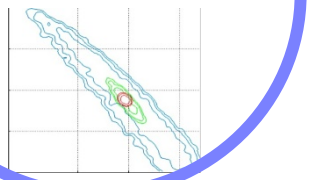
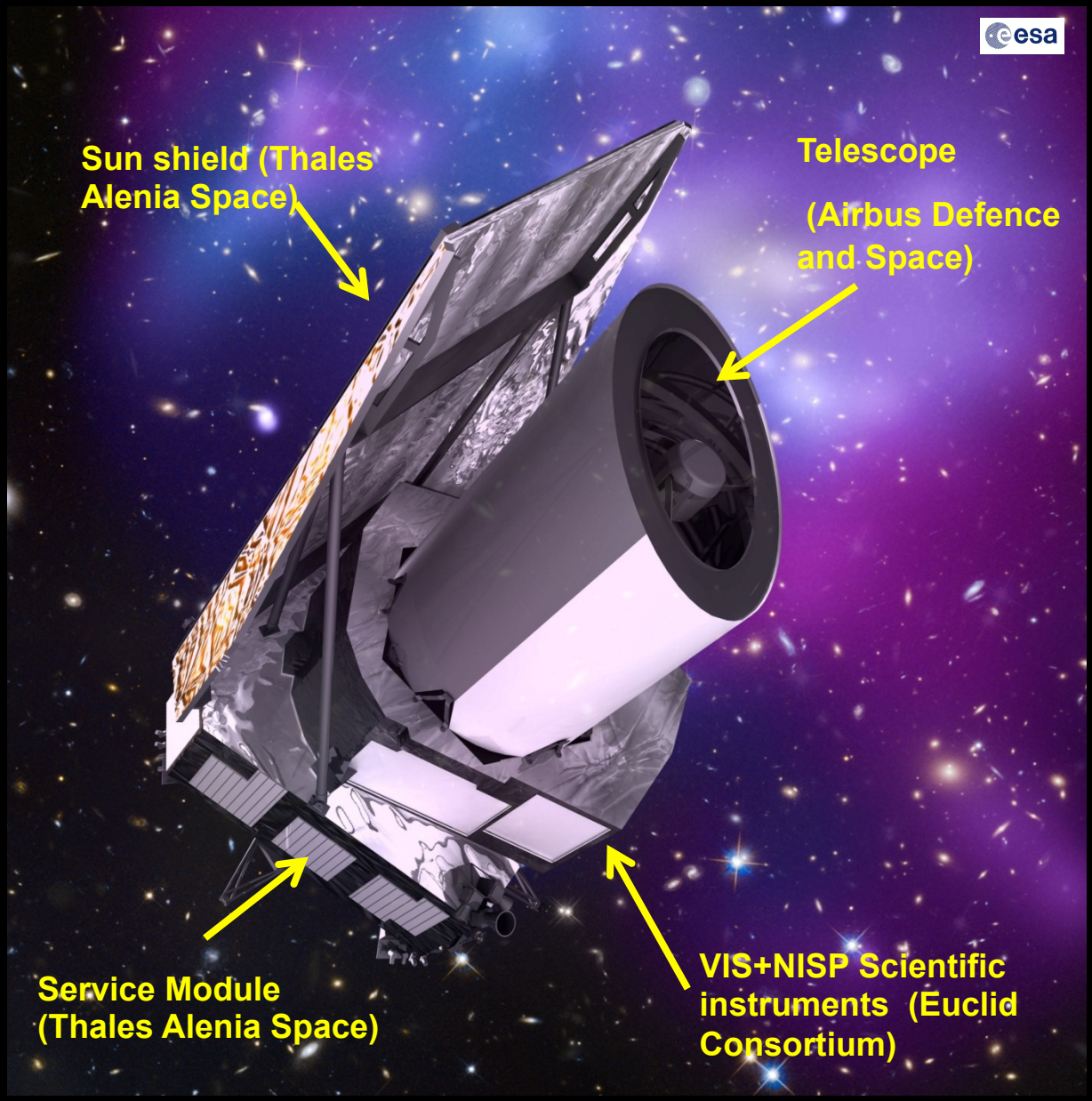




Science analyses

ESA Euclid mission

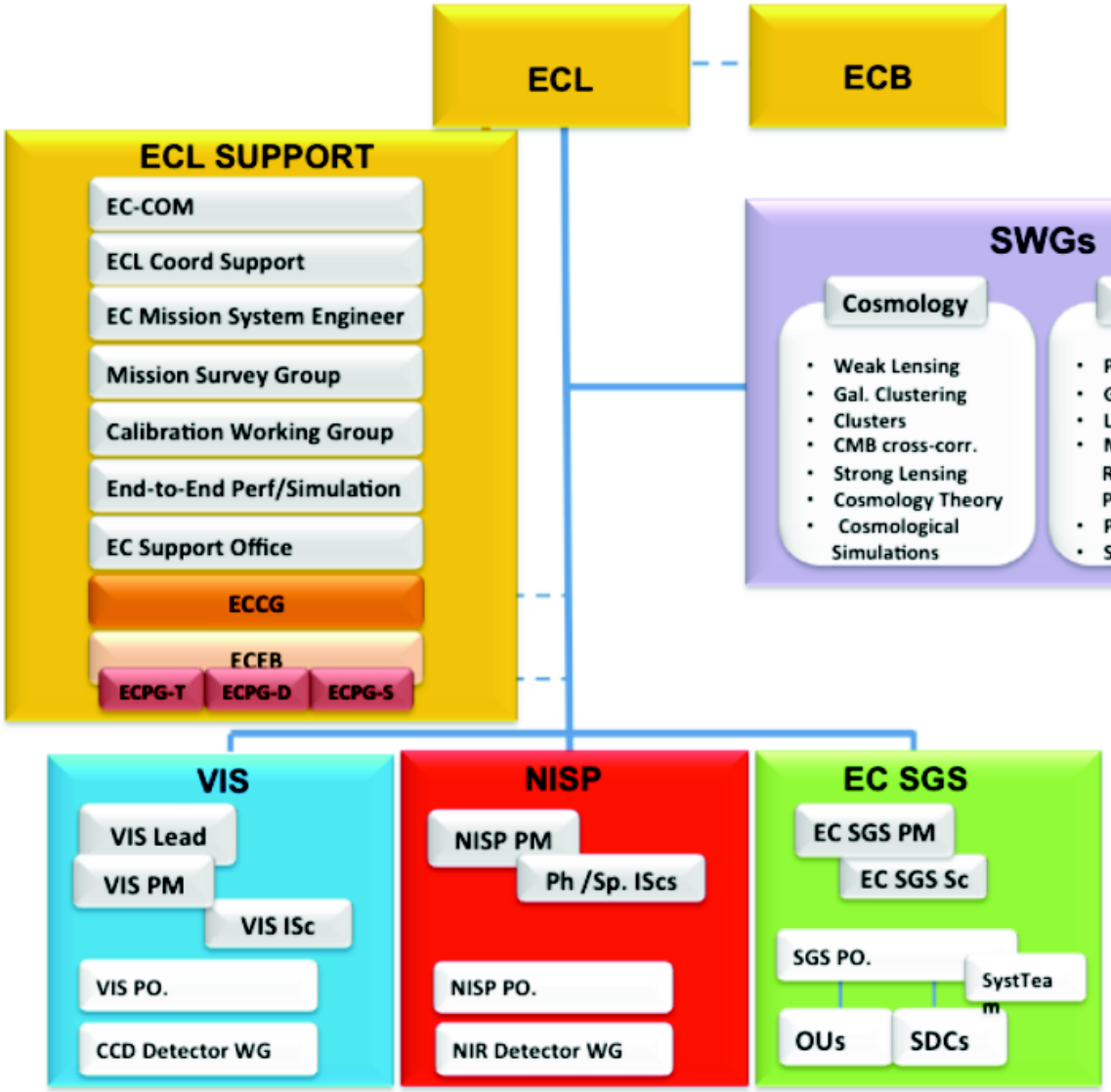
- - Total mass satellite :
- 2 200 kg
- - Dimensions:
- 4,5 m x 3 m
- - Launch: end 2020 by a Soyuz rocket from the Kourou space port
- - Euclid placed in L2
- - Survey: 6 years



Euclid Consortium organisation/leads

Update

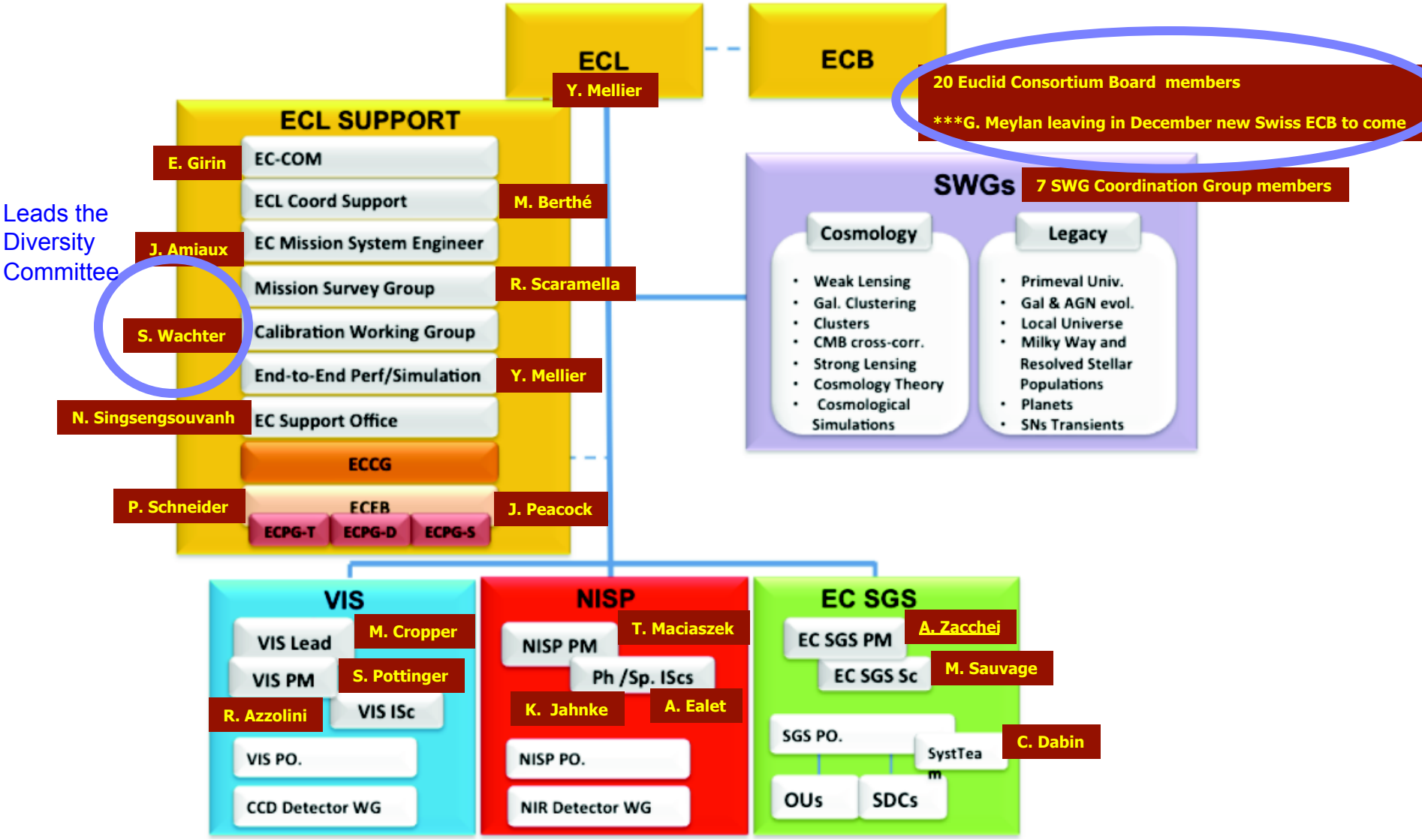
Euclid Consortium (Jan 2016 - update)



Euclid Consortium Jan 04 2015:

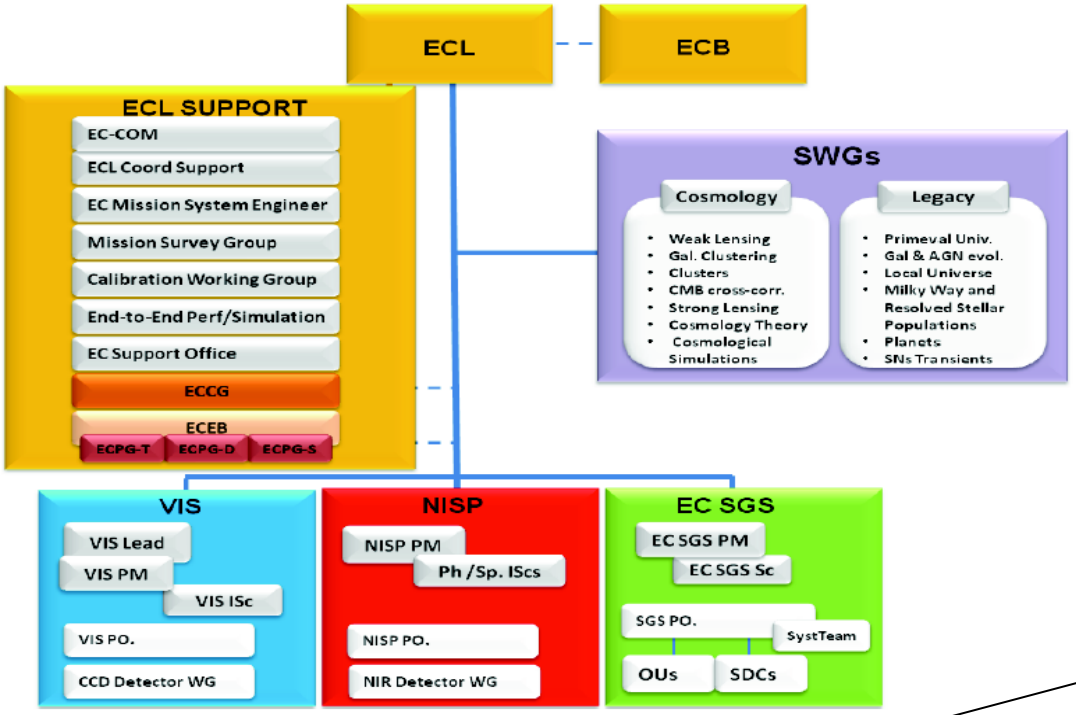
- 15 countries
- 125 labs
- 1274 Full members
- 329 FR Full member (26%)
- 62 Members at large
- 115 « Alumni »

Euclid Consortium (Jan 2016 - update)



EC Editorial Board and Publication Groups

(Jan 2016 - Reminder)



Euclid Consortium Editorial Board (ECEB)

Euclid Consortium Publication Group (ECPG)

ECPG-Science

L. Guzzo

J. Brinchmann

- NISP-P IS
- NISP-S IS
- EC SGS Scientist
- Mission Survey Scientist

ECPG-Technical

J.-G. Cuby

M. Cropper (T)

- VIS Lead
- VIS IS
- NISP-P IS
- NISP-S IS
- Mission Survey Scientist
- Euclid Mission System Engineer
- EC Chair Calib WG
- EC chairs NISP & VIS detector WGs

ECPG-DataRelease

M. Sauvvage

P. Fosalba

- NISP-P IS
- NISP-S IS
- EC SGS Scienctis
- Mission Survey Scientist

ECEB

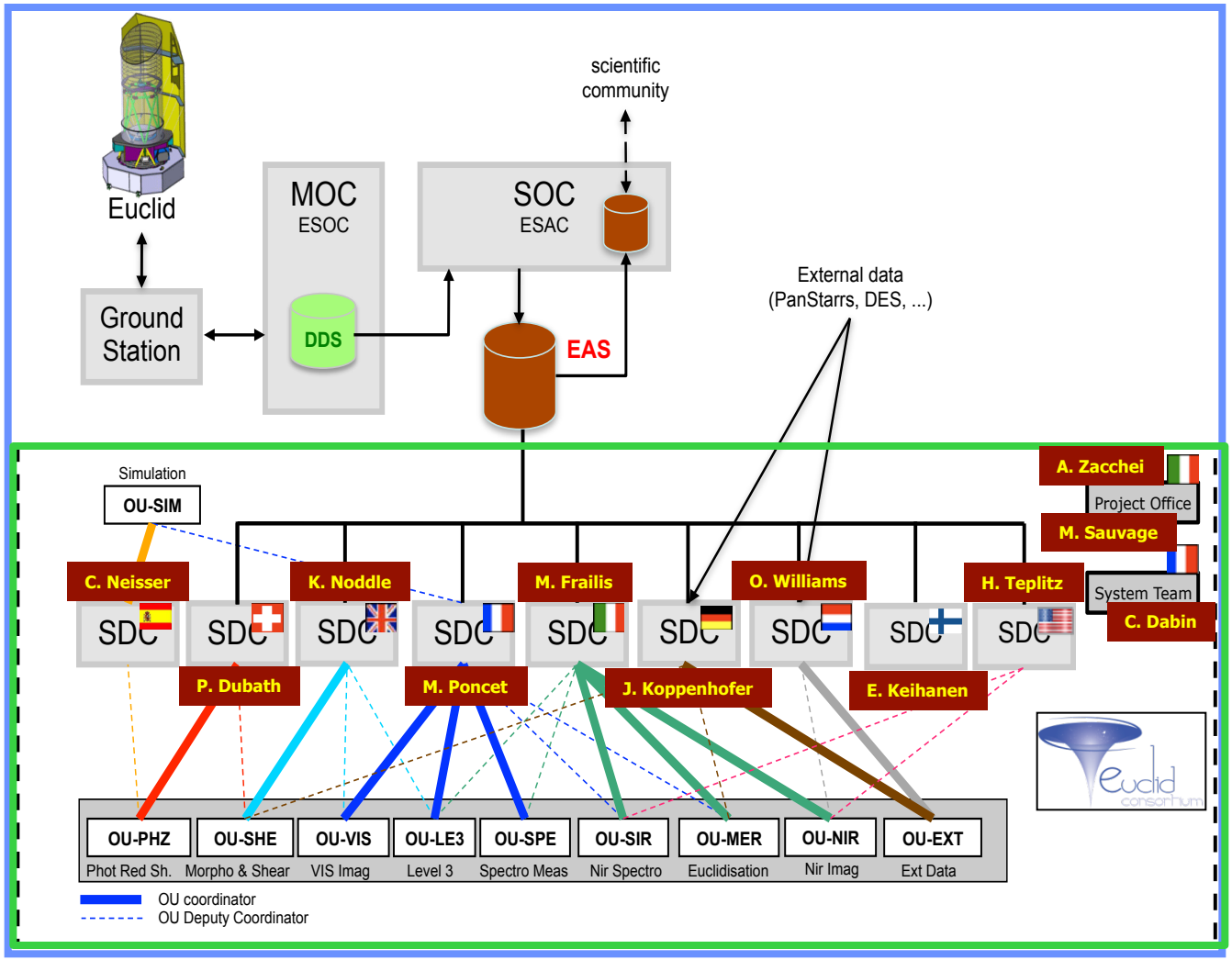
Bureau:

P. Schneider, J. Peacock

- ECEC Support team
- ECL
- EACSL
- 7 Science Coordinators
- EC EST Members
- 3 EC PMs
- VIS IS + NISP-P + NISP-S IS
- EC SGS Scientist
- Mission Survey Scientist
- EC COM Chair
- ESA Project Scientist (invited)

Ground Segment – SDC EC functions (Jan 2016 - reminder)

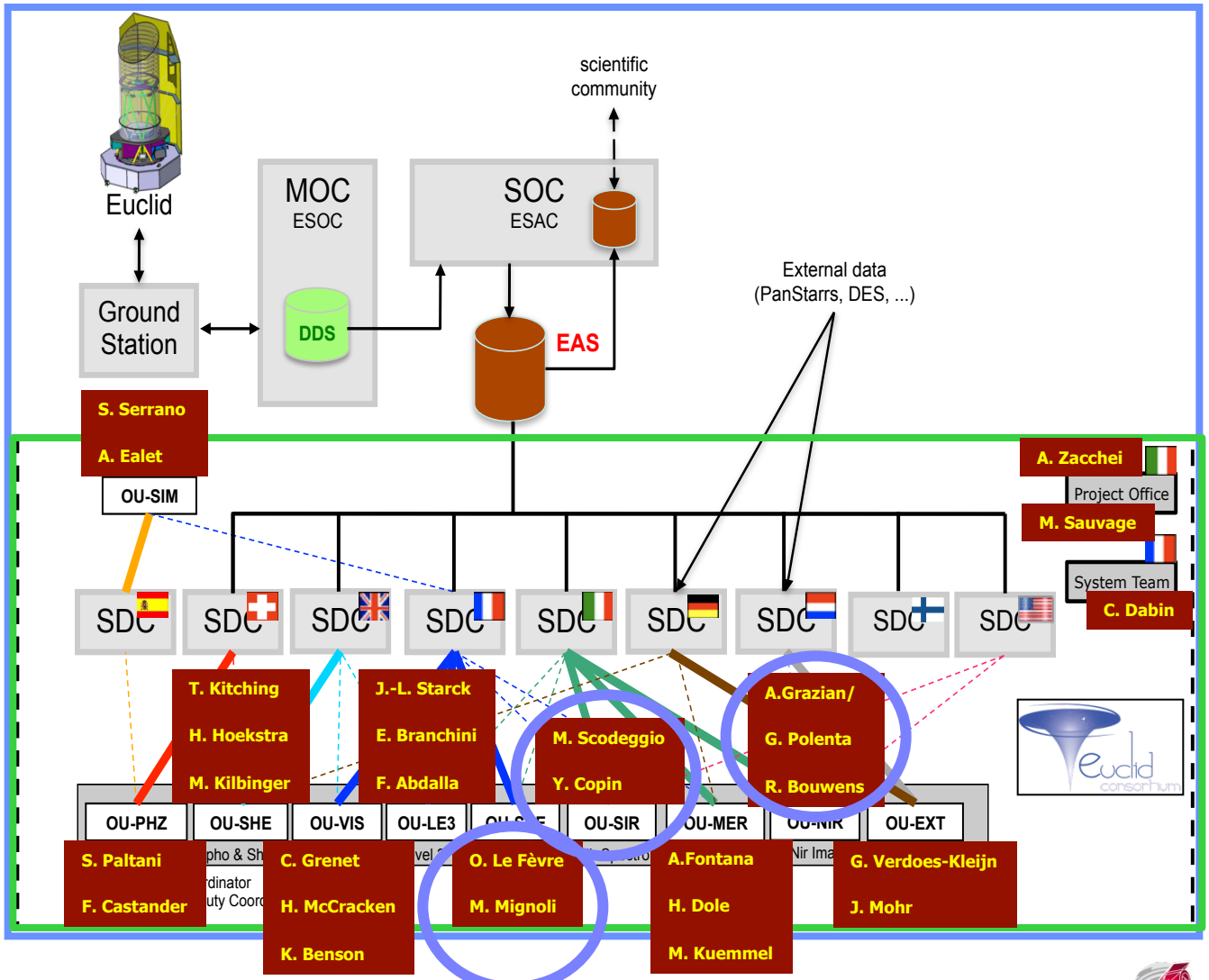
- **Relation with SWG**: expression of requirements by SWG & collaborative work on validation
- **Relation with instruments**: provide expertise for the first-rank OUs, place requirements on data processing related to instrument quality.
- **Relation with ECL support**: survey strategy impacts data processing, SGS supports the E2E activities.



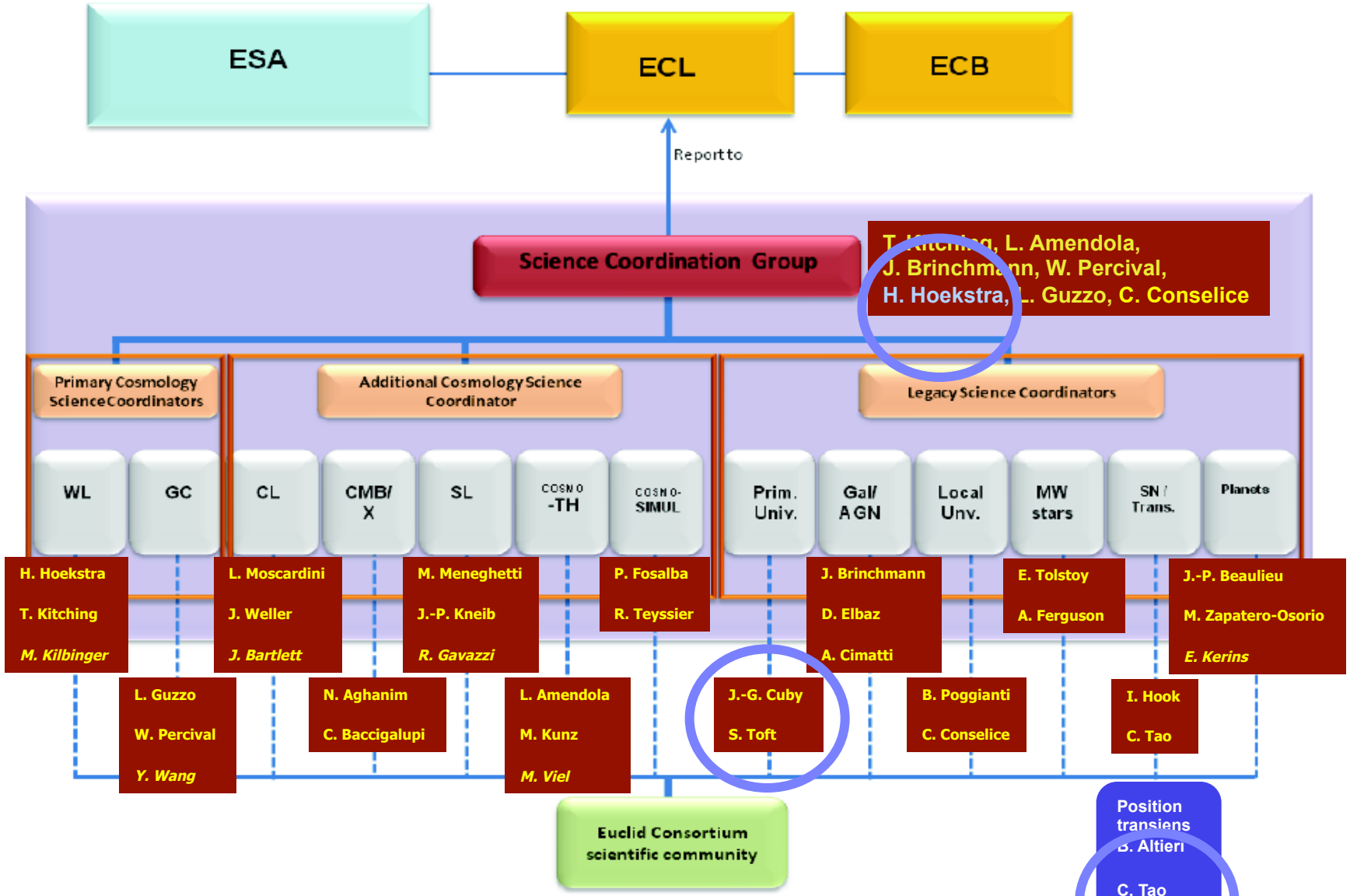
Ground Segment – OU EC functions (Jan 2016 - update)

EC-SGS functions

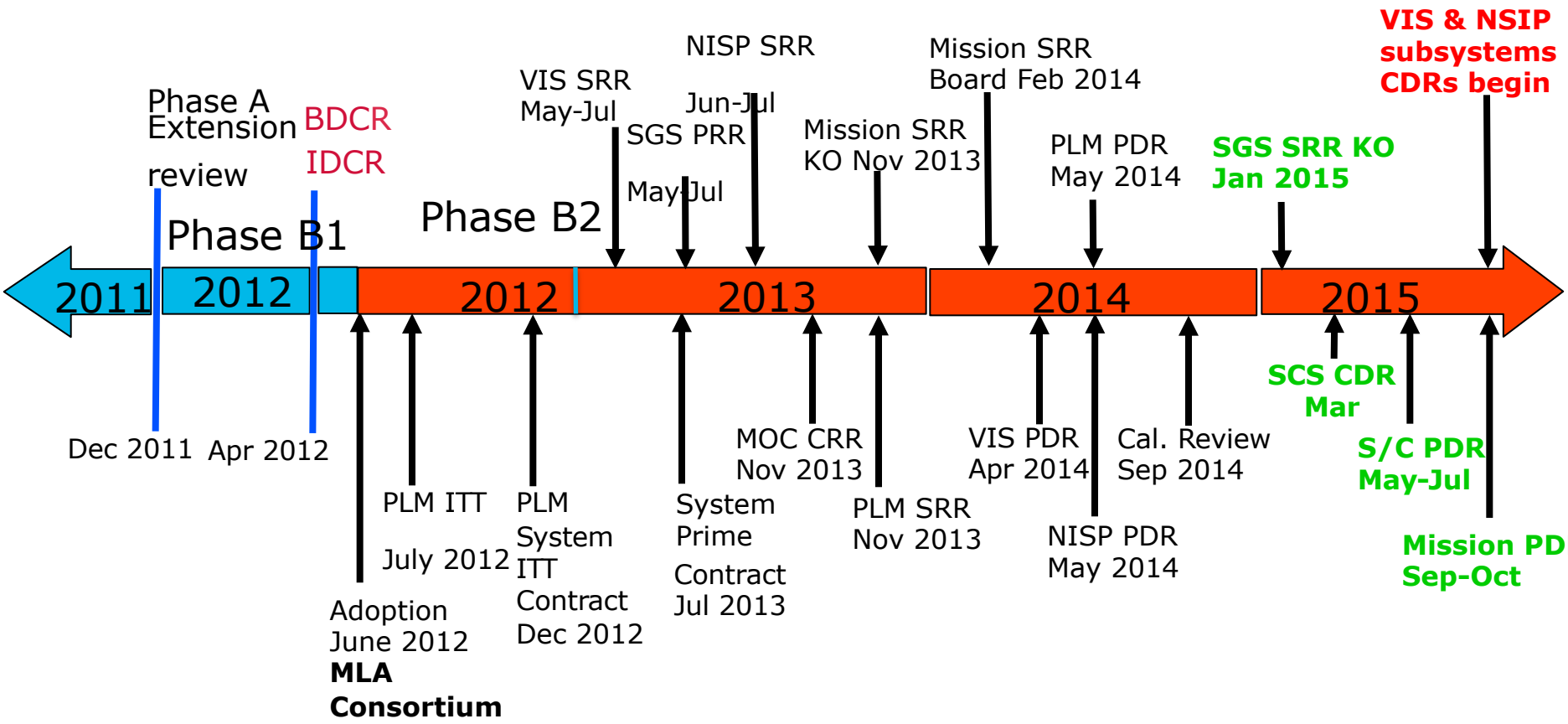
- **Instrument Operation Teams (IOTs)**: maintenance of the instruments, production of weekly instrument reports.
- **Science Data Centres (SDCs)**, host the IOTs and run Processing Functions (pipelines) produced by **Organisational Units (OUs)**;
- SDC's use Level 1 data from SOC and produce Level 2 and 3. Reprocess external data: Level E.



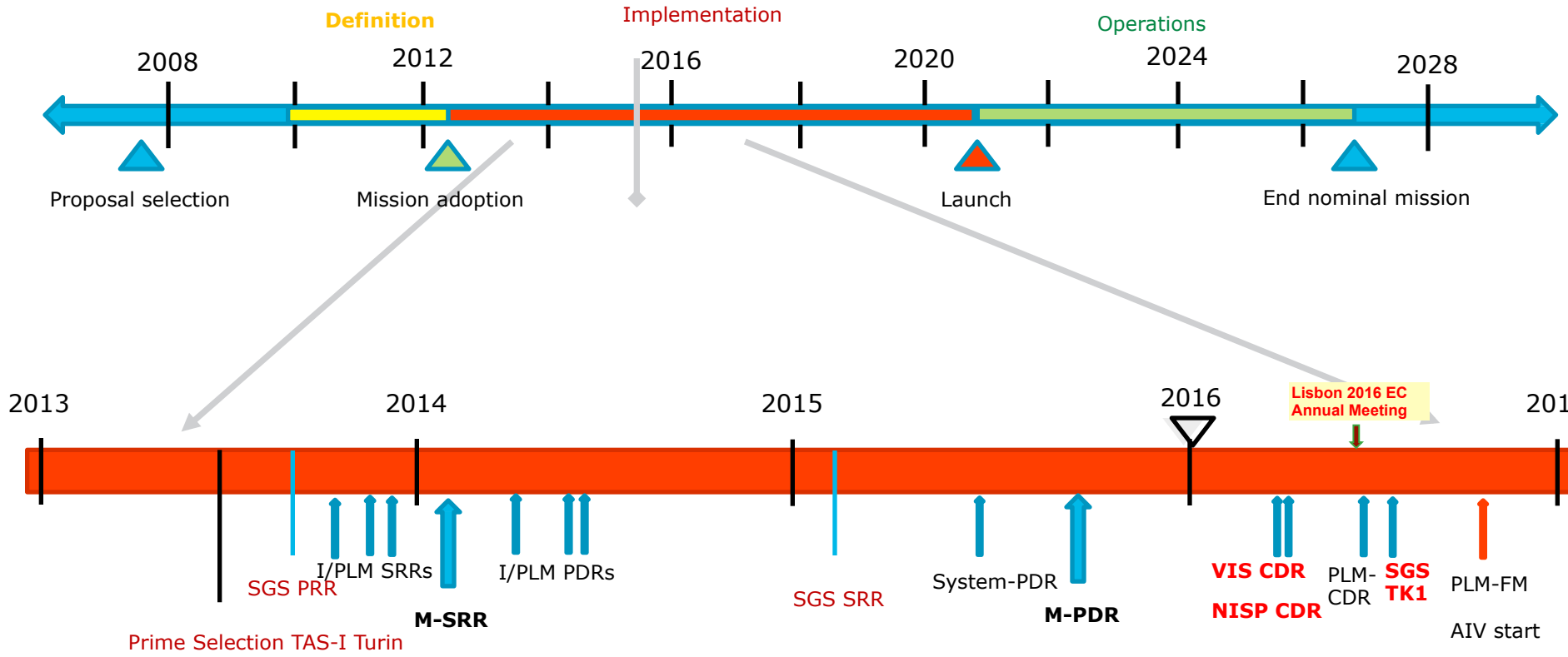
Science Working Groups (Jan 2016 - update)



Euclid planning history 2011 - 2015



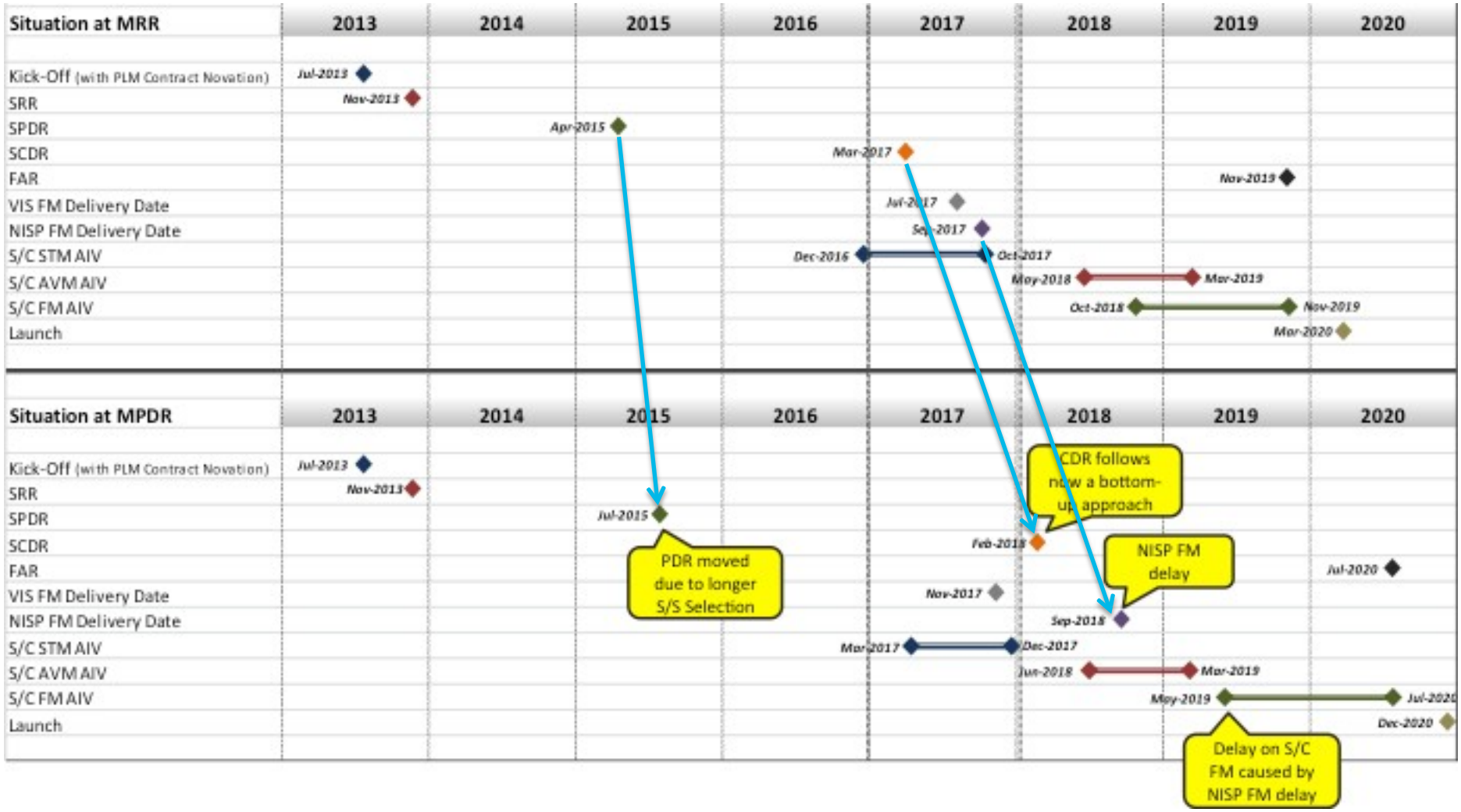
Overview mission timeline and … 2016



Major milestones passed since Lausanne:

- System PDR => project is in full C/D Phase
- Mission PDR, Board 20 October 2015
- VIS and NISP subsystem CDRs started

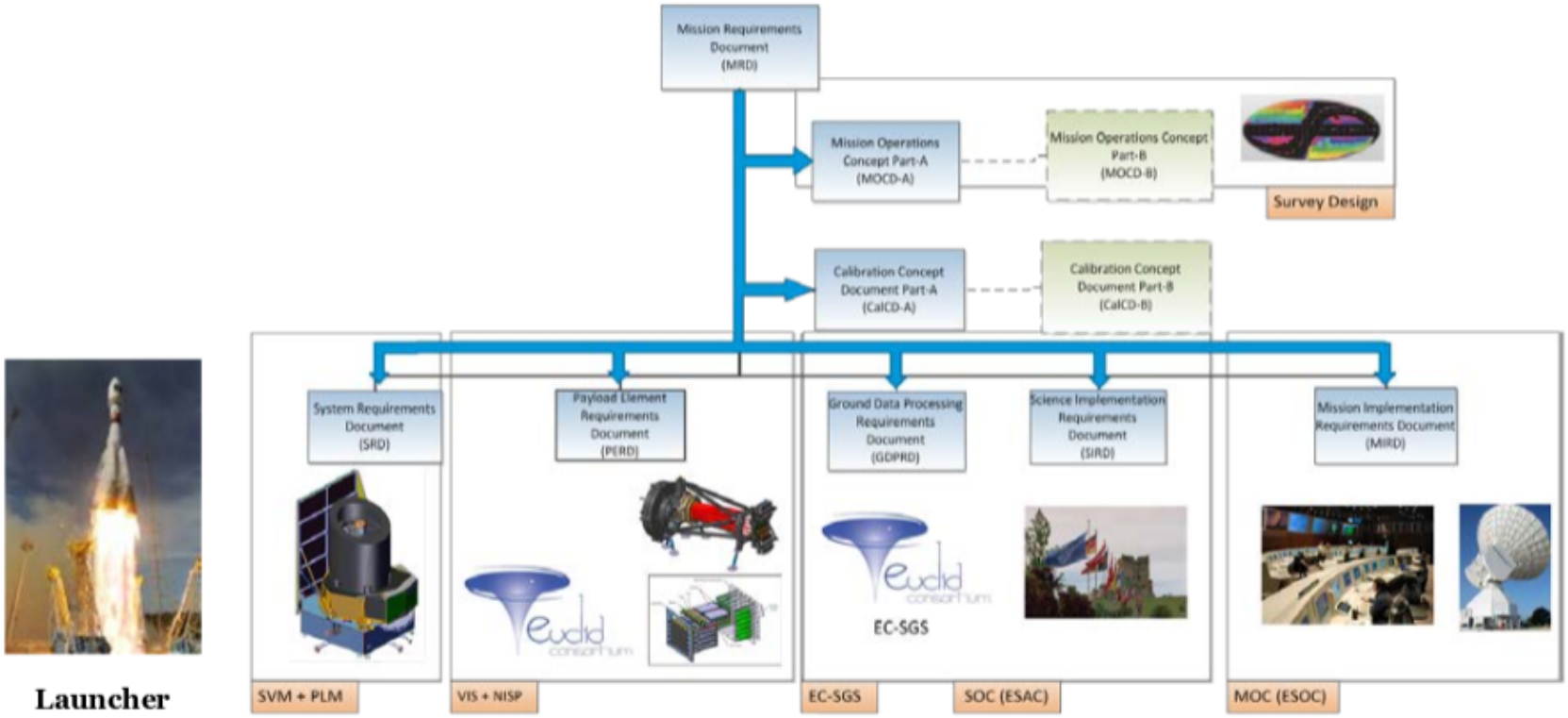
Launch delayed



Euclid – 2015
Engineering activities Progress (non VIS /NISP)

- **Prime – Service Module:**
  - Trade-off studies on the solar illumination during ascent and for ice-decontamination in orbit (Gaia lesson learnt);
  - Finalisation of the CMU implementation approach in AOCS (5th RW);
  - Support to EMI tests for CCD/FGS compatibility (good results);
  - Radiation analysis (proton fluence at CCD's, GRAS MC analysis, extra shielding likely needed to maintain a safety factor close to 2)
  - System PDR successfully completed (Board July '15)
- **Payload Module:**
  - Advance of the design of the SiC baseplate, MRR nearly completed;
  - NISP detailed interfaces, harness routing, VIS FPA/RSU accommodation;
  - Various advancement of the optical surfaces: envisaged chromatism in the dichroic much mitigated by latest layer design by OBJ (+ new machine);
  - Straylight mitigation (NDI definition, baffle optimisation, contamination control)
  - PDR's of various subsystems (Ext.Baffle, ACFlat, Collimator)

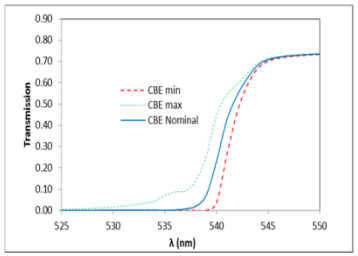
Euclid mission PDR objective

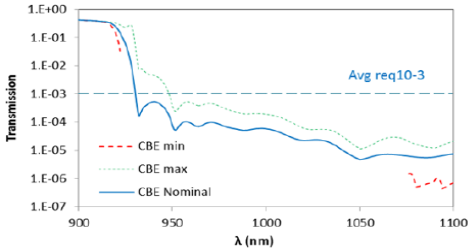


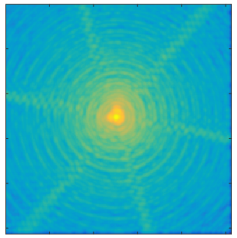
- To ensure the adequate progress of each element: spacecraft, instruments, ground segment (science and operations), launcher;
- To verify that the mission performances are compliant with the top level Mission Requirement Document (MRD)

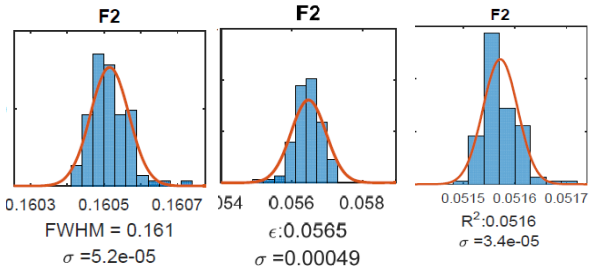
M-PDR: Successful

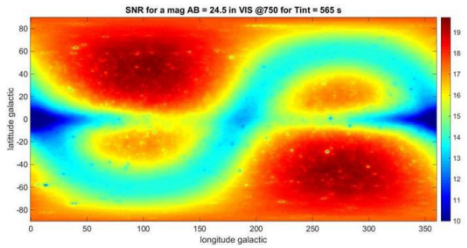
Technical Performance Measure		Requirement	CBE
Image Quality			
VIS Channel	FWHM (@ 800nm)	180 mas	163 mas
	ellipticity	15.0%	5.9%
	R2 (@ 800 nm)	0.0576	0.0530
	ellipticity stability σ(εi)	2.00E-04	2.00E-04
	R2 stability σ(R2)/<R2>	1.00E-03	1.00E-03
	Plate scale	0.10 "	0.10 "
	Out-of-band avg red side	1.00E-03	1.13E-05
	Out-of-band avg blue side	1.00E-03	2.12E-04
	Slope red side	35 nm	15 nm
	Slope blue side	25 nm	8 nm
NISP Channel	rEE50 (@1486nm)	400 mas	217 mas
	rEE80 (@1486nm)	700 mas	583 mas
	Plate scale	0.30 "	0.30 "
Sensitivity			
VIS SNR (for mAB = 24.5 sources)		10	17.1
NISP-S SNR (@ 1.6um for 2xe-16 erg cm-2 s-1 source)		3.5	4.87
NISP- P SNR (for mAB = 24 sources)	Y-band	5	5.78
	J-band	5	6.69
	H-band	5	5.35
NISP-S Performance			
Purity		80%	72%
Completeness		45%	0.52
Survey			
Wide Survey Coverage		15,000 deg2	15,000
[illegible]ngth [years]		5.5	5.4

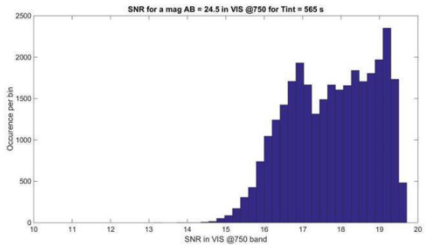












- **Performance at mission level in general in very good state.**
- Image quality of the system fully in line with needs.
- Ellipticity, R^2 stability and Non-convolutive errors performance dictated mainly by ground processing and will be evaluated at SGS DR
- *Purity* not compliant with current data processing methods but expected to be recovered.

Euclid Mission PDR: issues

- Launch Mass:
  - After application of maturity margins (~13%) and system margin (10%), we have a negative margin wrt the SRD requirement (2160 kg) of 17 kg with light adapter and 77 kg with a standard adapter;
  - There is however a considerable margin at launcher capability level (102 kg), which is however not officially committed by AE;
  - The NISP possible mass increase is also very critical, as the margin is very small (5%);
  - A NISP mass increase would possibly affect the PLM baseplate.
- Structural distortion (between SVM and PLM) affects in the system performance:
  - The analysis shows that the margin in I/F deformation is high;
  - Test should be performed to verify the analysis

Euclid Mission PDR: issues

- Water Outgassing and on-orbit decontamination mode:
  - The Gaia lesson learnt is implemented;
  - Cool-down strategy to be investigated to avoid contamination;
- Particular contamination affecting the Stray Light:
  - The performance analysis shows that the infield SL is not dominant;
  - Out-of-field SL shall be mitigated by proper cleanliness measures during the launcher/Euclid integration;
- Instrument status:
  - VIS e2e test to be performed at the right operational temperature;
  - Technology readines…
- SGS status:
  - The LE3 processing capability activities agreed were not completed and are still below the requirements;
  - Interface definition activities should be completed;

Euclid Mission PDR: issues

- "Purity" requirement cannot be achieved (72% vs. 80%):
  - Survey improvement;
  - Refinement of the simulation to calculate purity;
  - Possible challenge of the requirement? Affects SciRD;
- Zero point stability requirement (still a DCR):
  - Photometric calibration, difficult to achieve;
- Reference Survey has achieved its objectives;
- Dichroic verification to be performed at cold with mounts;
- Planning at mission level:
  - NISP development time, despite the large delay (up to 15 m) is still considered critical also compared to a typical instrument;
  - Optimisation of the AIT phase in order to remove other criticalities;

Main objectives for 2016

2016 priorities:

- Ground-based observations: top priority (J.-C. Cuillandre presentation)
- LSST MoA and INSU contribution
- E2E performance (J. Amiaux + A. Ealet presentations)
- Publications and contribution levels
- VIS CDR (M. Berthé presentation)
- NISP CDR (T. Maciaszek presentation)
- SWP WPs activities (O. Le Fèvre + SWG leads presentations)
- SGS KP1 (M. Sauvage)
- KOM CCIN2P3 (Q. Le Boulc'h & K. Ganga) + (C. Dabin & M. Poncet))
- Strategy for cosmological simulations and joint CG/WL simulations
- Lisbon 2016: May 30 (Garage Day) to June 4
- Euclid France summer school

Science Working Group
Work Packages

Science Working Group:

Defines

- Overal scope and responsibility of the SWGs
- How to achieve the Level 0 science objectives *beyond* the SGS processing
- Specifies the SWG management Work Packages
- Defines Inter-SWG TaskForces (IST) and their role
    - **Simulation Validation:** How to validate the comsological simulations (how can be objectively test we are are simulating the real universe)
    - **Probe Combination:** How to combine and make forecasts for the primary probes
    - **Cosmological Non-Linear Modeling:** How to create a model and simulations for non-linear modeling of the matter power spectrum

Euclid SWG Work Packages: WL (example)

WL	Shape measurement	Enabling	Kitching	UK MSS	Hoekstra	NL U.Leiden
WL	Photo-z	Enabling	Hildebrandt	DE AIFA	Abdalla	UK UCL
WL	Image Simulations	Enabling	Meneghetti	IT Bol.	Courbin	CH EPFL
WL	Lensing Estimator	Enabling	Kiessling	US JPL	Smith	US
WL	Likelihood	Interpretative	Kilbinger	FR CEA	Schneider	DE AIFA
WL	DP & Ins Validation	Enabling	Simon	DE AIFA	Kuijken	NL U. Leid
WL	Gal-Gal	Interpretative	Cacciato	NL U.Leiden		
WL	Magnification	Enabling	Heavens	UK IMP		
WL	PSF	Enabling	Miller	UK U.Oxford		
WL	IA	Enabling	Joachimi	DE AIFA		
WL	Mass mapping	Interpretative	Leonard	UK UCL	Julio	FR LAM
WL	Flexion	Interpretative	Bacon	UK U-Port		

SWG Work Packages Leads: statistics

UK : 30	UK-WL : 6	UK-GC : 1
IT : 28	IT-WL : 1	IT-GC : 4
FR : 17	FR-WL : 2	FR-GC : 1
DE : 15	DE-WL : 4	DE-GC : 3
US : 14	US-WL : 2	US-GC : 4
NL : 05	NL-WL : 3	NL-GC : 0
CH : 05	CH-WL : 1	CH-GC : 0
ES : 05	ES-WL : 0	ES-GC : 1
PT : 02	PT-WL : 0	PT-GC : 0
NO : 01	NO-WL : 0	NO-GC : 0
ESO: 01	ESO-WL: 0	ESO-GC: 0
AT : 00	AT-WL : 0	AT-GC : 0
BE : 00	BE-WL : 0	BE-GC : 0
DK : 00	DK-WL : 0	DK-GC : 0
FI : 00	FI-WL : 0	FI-GC : 0
[illegible]: 00	RO-WL : 0	RO-GC : 0

After inspection by ECB and presentation to / questions from ECB:

- Call for WPs and leads have been made by all SWG leads, but ECB received complains

→ ECB request : NEW call to be issued by the Science Coordination Group

- High contrast in responsivity between countries
- IST not assigned yet, still under discussion

SWG WPs: Science Coordination group proposal (1/3)

- We agree that there is currently an imbalance in terms of current WP leads given the expected country balances as circulated to us recently by the EC-lead.

- We feel that the ECB proposal that we hold a new open call for all WP-lead positions across all SWGs would be incredibly disruptive to the work being undertaken by Euclid and counter-productive in terms of morale and the work we need to do to prepare for Euclid.

- In addition, we consider it to be unnecessary as appointments are for 2 years, as described in the WP document, and so they will be gradually renewed anyway.

SWG WPs: Science Coordination group proposal (2/3)

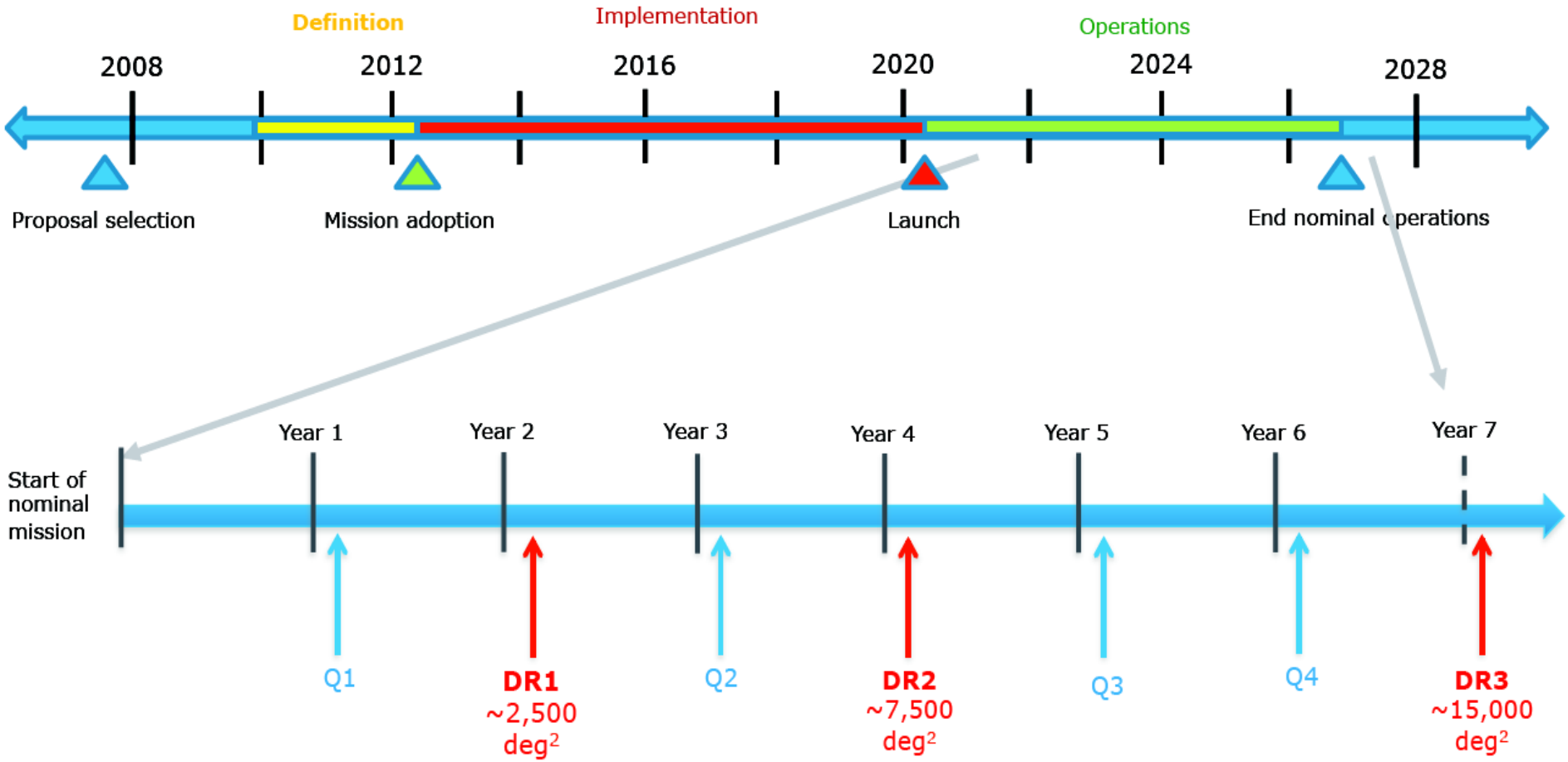
- We agree that we should make some changes in order to address the concerns, particularly with regard to how appointments are made. All SWGs will follow the same set of guidelines including an open-call for all positions.
- We propose that any WP-lead positions from now on will be hired through an open call. An email will be sent to the SWG email list to alert active scientists in relevant areas within Euclid, and to the ECB allowing the ECB members to push participants in their countries for these roles. This announcement will be made 3 weeks before the deadline for applications.
- Given the list of applicants, the leads of the relevant SWG leads will decide on their favoured candidate(s) based on them matching a balance of the following criteria. The relative importance of each will be determined by the SWG leads on a work-package by work-package basis:
    - Science, seniority / time available to dedicate to Euclid, geography, using tables of expected nationality splits provided by the ECB? gender balance , any other recommendations made by the Euclid Diversity Committee having a balance of groups with a solid background and those beginning to invest in an area.

SWG WPs: Science Coordination group proposal (3/3)

- Leads of all SWGs will send the list of applicants, their nationalities, application materials, and a short summary of the rationale for the proposed decision, and allowed a period of 2 weeks to look at the overall science and geographical balance. After this period, and the satisfactory conclusion of any discussion, the leads of the relevant SWG will let the new WP leads and the non-selected applicants know the outcome.
- This will be an ongoing and continual process. Every position will be re-advertised and have a new call at least within 2 years, as stated in the WP document. i.e. these appointments are for 2 years each. The same leads can be reappointed, but we propose that this is only after another open call. It may be that some leads ask to step-down or are asked to step-down if they are not fulfilling their obligations within this 2-year period. If so, we will have a new open call.
- In the short term, SWGs will identify a number of WPs for which new open calls should be made within the next 6 months, even if the current leads have been in post for less than 2 years. We will focus on SWGs where WP-leads were not previously chosen using an open call, and we will choose the advertised positions to address current geographical imbalances. We expect that roughly half of the WPs from some SWGs would be advertised. The others positions in these WPs will be reappointed with an open call within 2 years of prior appointment as discussed above.

Ground based observations photom+spectro + LSST

Data release



Imaging: Northern sky +30° for Euclid

- CFHT : CFIS (r+u)-bands: proposal in progress with Canada
- SUBARU HSC:
  - J.-C. Cuillandre and Y. Mellier at Subaru Users Meeting, Jan 19-21, in Japan + J. Rhodes
- JPAS soons also a good option… but when?:
  - H.-J. McCracken visited JPAS on week Dec 14-19 and discuss about informally Euclid-JPAS
  - J.-C. Cuillandre and O. Ilbert are discussing with JPAS
  - F. Castander, J.-C. Cuillandre and Y. Mellier to visit JPAS soon in 2016
- WHT ? : F. Castander/R. Rebolo ?
- PS1/2 interesting but expensive and too risky: K. Chambers and G. Hasinger have been informed that EC cannot contribute.

Spectroscopy: Keck proposals submitted for 2016-2017

- NASA Key Strategic Mission Support proposal (PI Stern, Science PI Masters) requested 5 nights/semester in 2016A - 2017B. 10 nights allocated, all DEIMOS, split evenly between 2016B and 2017B
- Caltech proposal (PI Cohen) requested 5 nights in 2016A, with plan to resubmit in future semesters. All time allocated: Dec 13 (DEIMOS), Feb 27-29 (2 DEIMOS, 1 MOSFIRE), Apr 12 (LRIS).
  - Cohen invited to join EC
  - TAC awarded us 4 nights and Caltech Optical Observatories Director awarded us another
  - Can be renewed each semester based on TAC
- Plan to request time in future semesters through UC system (PI Mobasher).]

Summary: 15 nights guaranteed, 15 more probable, 10-15 more possible

Spectroscopy: target selection

- Based on the Self-Organizing Map (SOM) presented in Masters, Capak, Stern et al. (2015): applied a well-developed machine-learning technique to optimally map out the multidimensional color-space where Euclid weak-lensing sample resides.
- ~50% of the cells in the SOM lack high-quality spectroscopic redshifts based on COSMOS + DEEP2 redshift surveys.
- Require ~5000 spectroscopic redshifts in Euclid calibration fields to provide at least one spectroscopic redshift for essentially the entire SOM (with small percentage of the most difficult cells dropped). Note: 'brute force' methods might require 20,000 -100,000 spectra
- Masters et al. (2015) describes how this could be done in a ~40 night Keck program (with suitable allowances for bad weather, repeated targets, etc…).

Spectroscopy: European proposal: ESO period 97A (Apr 2016 - Sep2016)

- Targetting ~2500 galaxies
  - FORS/blue: 500 galaxies; 20 hours
  - FORS/red: 1200 galaxies; 90 hours
  - KMOS/YJ: 300 galaxies; 35 hours
  - KMOS/H: 400 galaxies; 50 hours
- Fields:
  - SXDS, VVDS-Deep, ECDFS, COSMOS
  - Apr-Sep semesters (97-99): 64 hours
  - Oct-Mar semesters (98-100): 136 hours

Euclid-LSST LoA

- LoA significantly modified by DESC (?)
- Because « data sharing » is a DESC business, not a LSST one.
- New LoA is now more vague, different philosophy than the ECB had in mind
- DESC wants to share Euclid morphology of galaxies information, the gold mine of Euclid
- Overal ECB is negative

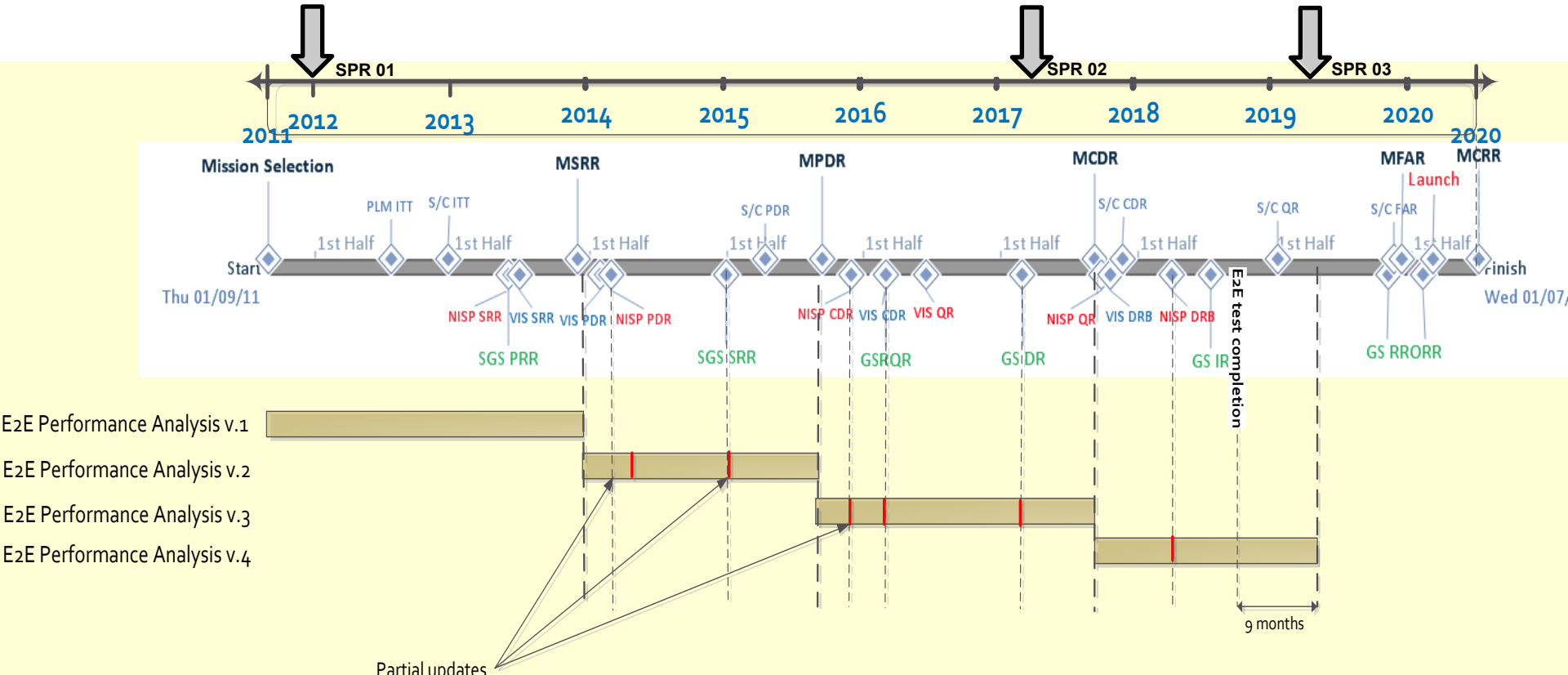
- Negotiations in progress with DESC, NASA and NSF. Complex and long.

Science Performance Verification Plan

Science Verification Plan

- **Cycle 01**: Science Performance Verification 01 (jan 2012)
- **Cycle 02**: Science Performance Verification 02 (June 2017)
- **Cycle 03**: Science Performance Verification 03 (April 2019)

(based on current scheduled but linked to external milestones)



SPR : Summary

- E2E for the M-PDR succesful (in particular spectro with a Tiger Team set)
- Move on next steps starting today with 2 major EC Mission Performance steps in 2017-2019
- All E2E building blocks show good progress. Meetings to coordinate, define tasks, interfaces. Internal schedule to be set in Dec.-Feb.:
    - Meeting with SWG-WL leads on Nov 4 in London
    - Meeting with SWG-GC leads on Jan 8 in Milan
    - Join SWG-WL/SWG-GC/SWG-CL meeting in Feb 2016
- Cosmo. sim. for OU-SIM with realistic universes could be an issue for the next steps (computing resources, manpower): roles and outputs from of OU-SIM to be clarified
- Parameter Data Base is a central point for all other blocks and a guarantee that all simulations used are based on the same references for cosmology, survey, telescope, instrument and SGS.
- Final FoM still to be done