A Brief Introduction to EUCLID

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(and L. Paioro)

AstroSiesta 4 Novembre 2011

The Scientific Context

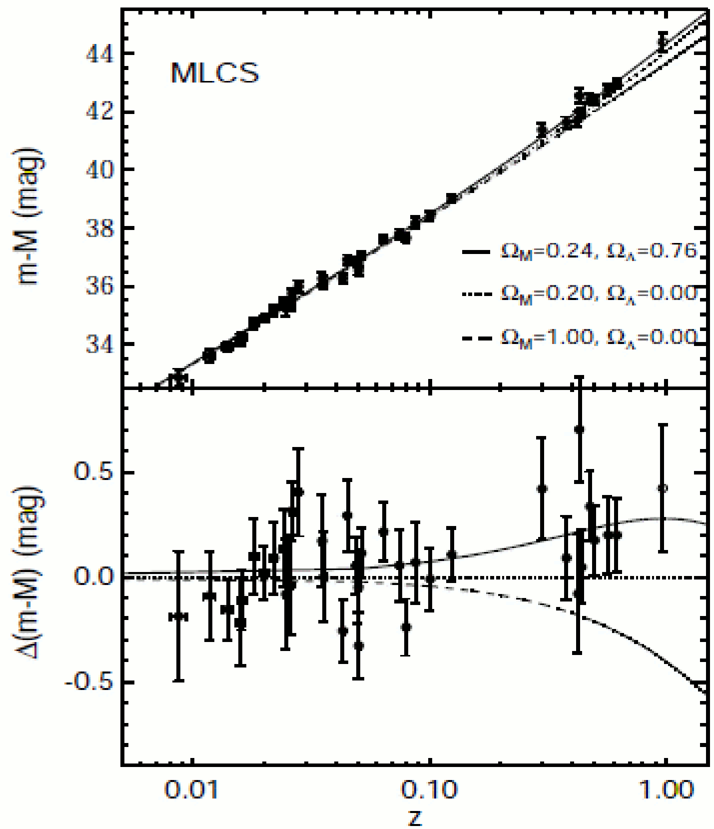

FIG. 4.—MLCS SNe Ia Hubble diagram. The upper panel shows the Hubble diagram for the low-redshift and high-redshift SNe Ia samples with distances measured from the MLCS method (Riess et al. 1995, 1996a; Appendix of this paper). Overplotted are three cosmologies: “low” and “high” Ω_M with $\Omega_\Lambda = 0$ and the best fit for a flat cosmology, $\Omega_M = 0.24$, $\Omega_\Lambda = 0.76$. The bottom panel shows the difference between data and models with $\Omega_M = 0.20$, $\Omega_\Lambda = 0$ [illegible] SN 1997ck [illegible] which lacks spectroscopic classification [illegible] color measurement. The average difference between the data and the $\Omega_M = 0.20$, $\Omega_\Lambda = 0$ prediction is 0.25 mag.

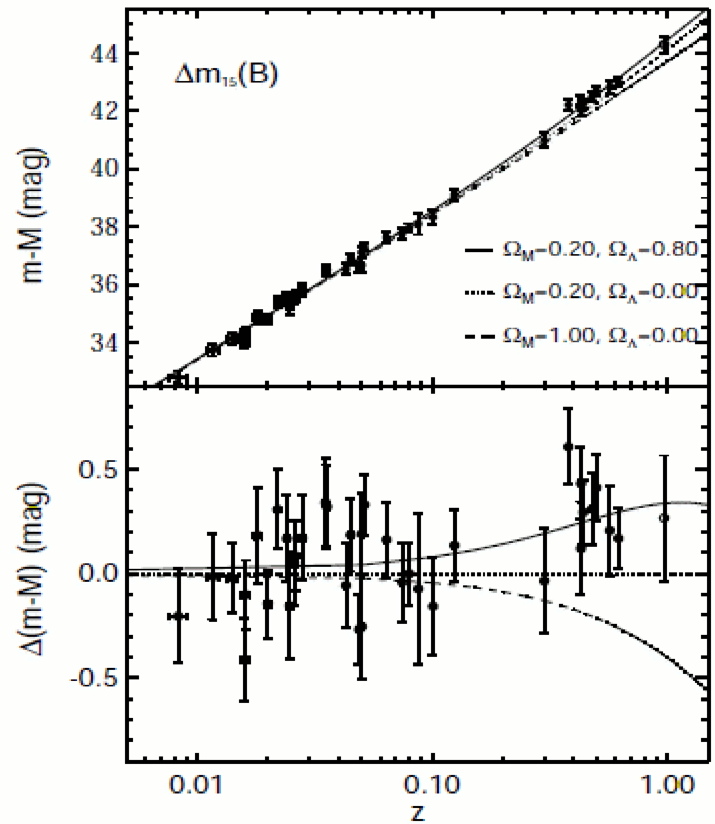

FIG. 5.—$\Delta m_{15}(B)$ SN Ia Hubble diagram. The upper panel shows the Hubble diagram for the low-redshift and high-redshift SNe Ia samples with distances measured from the template-fitting method parameterized by $\Delta m_{15}(B)$ (Hamuy et al. 1995, 1996d). Overplotted are three cosmologies: “low” and “high” Ω_M with $\Omega_\Lambda = 0$ and the best fit for a flat cosmology, $\Omega_M = 0.20$, $\Omega_\Lambda = 0.80$. The bottom panel shows the difference between data and models [illegible] SN 1997ck ($z = 0.97$) which lacks spectroscopic classification and a color measurement. The average difference between the data and the $\Omega_M = 0.20$, $\Omega_\Lambda = 0$ prediction is 0.28 mag.

2011 Nobel Prize for Physics !!!

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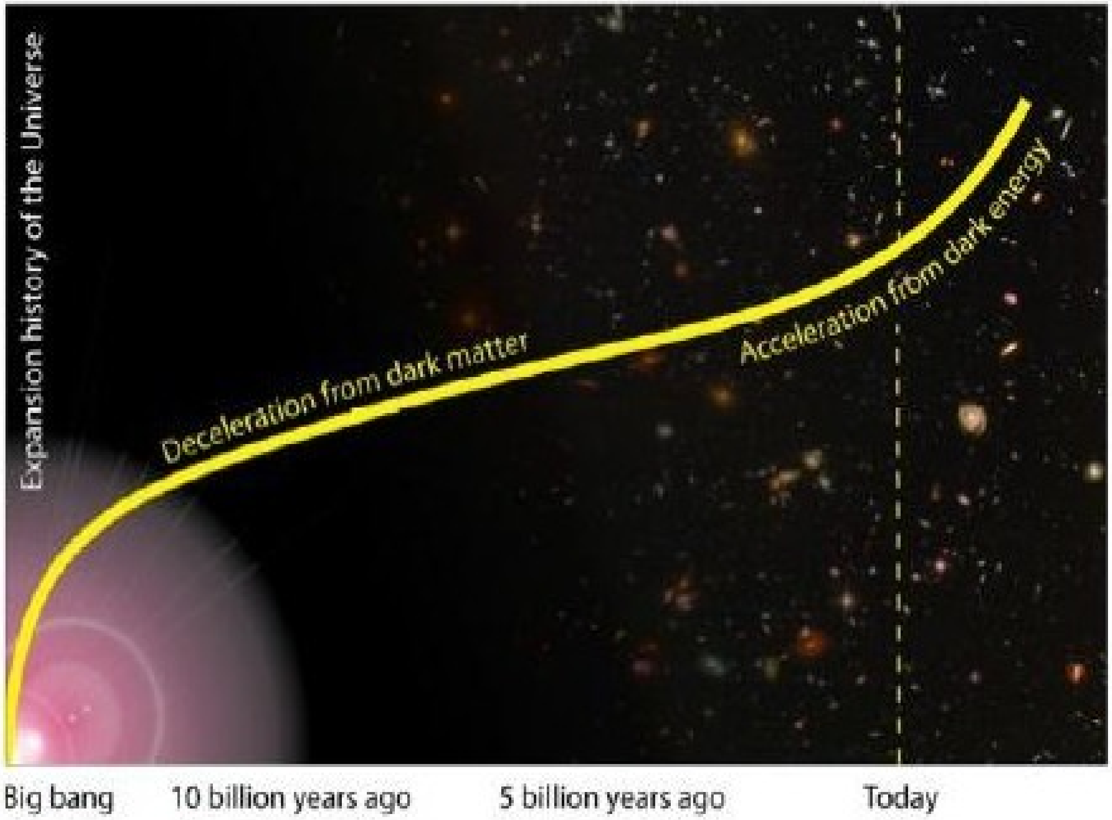
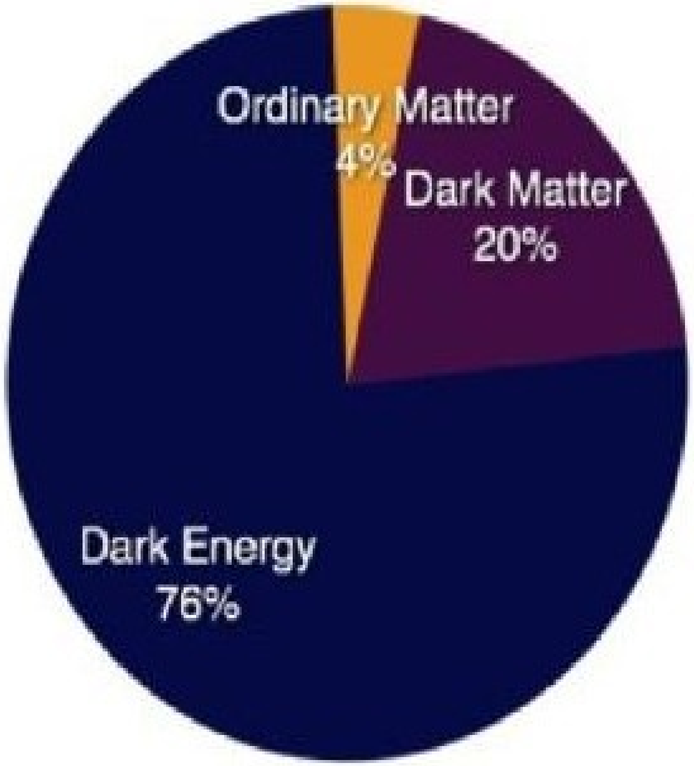
The Scientific Context

An accelerating Universe filled with Dark Energy
(and some Dark Matter too)





How to describe Dark Energy

$$R_{\mu\nu} - \frac{1}{2} R \, g_{\mu\nu} + \boxed{\Lambda \, g_{\mu\nu}} = \frac{8\pi G}{c^4} T_{\mu\nu}$$

General Relativity

$$p = \rho_m R T = \rho_m C^2$$

Perfect Gas: pressure and temperature

$$w = \frac{p}{\rho} = \frac{\rho_m C^2}{\rho_m c^2} = \frac{C^2}{c^2}$$

General Equation of State

Euclid Mission Summary

Main Scientific Objectives
Understand the nature of Dark Energy and Dark Matter by: • Reach a dark energy *FoM* > 400 using only weak lensing and galaxy clustering; this roughly corresponds to 1 sigma errors on w_p and w_a of 0.02 and 0.1, respectively. • Measure γ, the exponent of the growth factor, with a 1 sigma precision of < 0.02, sufficient to distinguish General Relativity and a wide range of modified-gravity theories • Test the Cold Dark Matter paradigm for hierarchical structure formation, and measure the sum of the neutrino masses with a 1 sigma precision better than 0.03eV. • Constrain n_s, the spectral index of primordial power spectrum, to percent accuracy when combined with Planck, and to probe inflation models by measuring the non-Gaussianity of initial conditions parameterised by f_{NL} to a 1 sigma precision of ~2.

SURVEYS		
	Area (deg2)	Description
Wide Survey	15,000 (required) 20,000 (goal)	Step and stare with 4 dither pointings per step.
Deep Survey	40	In at least 2 patches of > 10 deg^2 2 magnitudes deeper than wide survey

PAYLOAD					
Telescope	1.2 m Korsch, 3 mirror anastigmat, f=24.5 m				
Instrument	VIS	NISP			
Field-of-View	0.787×0.709 deg^2	0.763×0.722 deg^2			
Capability	Visual Imaging	NIR Imaging Photometry			NIR Spectroscopy
Wavelength range	550– 900 nm	Y (920-1146nm),	J (1146-1372 nm)	H (1372-2000nm)	1100-2000 nm
Sensitivity	24.5 mag 10σ extended source	24 mag 5σ point source	24 mag 5σ point source	24 mag 5σ point source	3 10^{-16} erg cm-2 s-1 3.5σ unresolved line flux
Detector Technology	36 arrays 4k×4k CCD	16 arrays 2k×2k NIR sensitive HgCdTe detectors			
Pixel Size Spectral resolution	0.1 arcsec	0.3 arcsec			0.3 arcsec R=250

SPACECRAFT	
Launcher	Soyuz ST-2.1 B from Kourou
Orbit	Large Sun-Earth Lagrange point 2 (SEL2), free insertion orbit
Pointing	25 mas relative pointing error over one dither duration 30 arcsec absolute pointing error
Observation mode	Step and stare, 4 dither frames per field, VIS and NISP common FoV = 0.54 deg^2
Lifetime	7 years
Operations	4 hours per day contact, more than one ground station to cope with seasonal visibility variations;
Communications	maximum science data rate of 850 Gbit/day downlink in K band (26GHz), steerable HGA

by f_{NL} to a 1 sigma precision of ~2.

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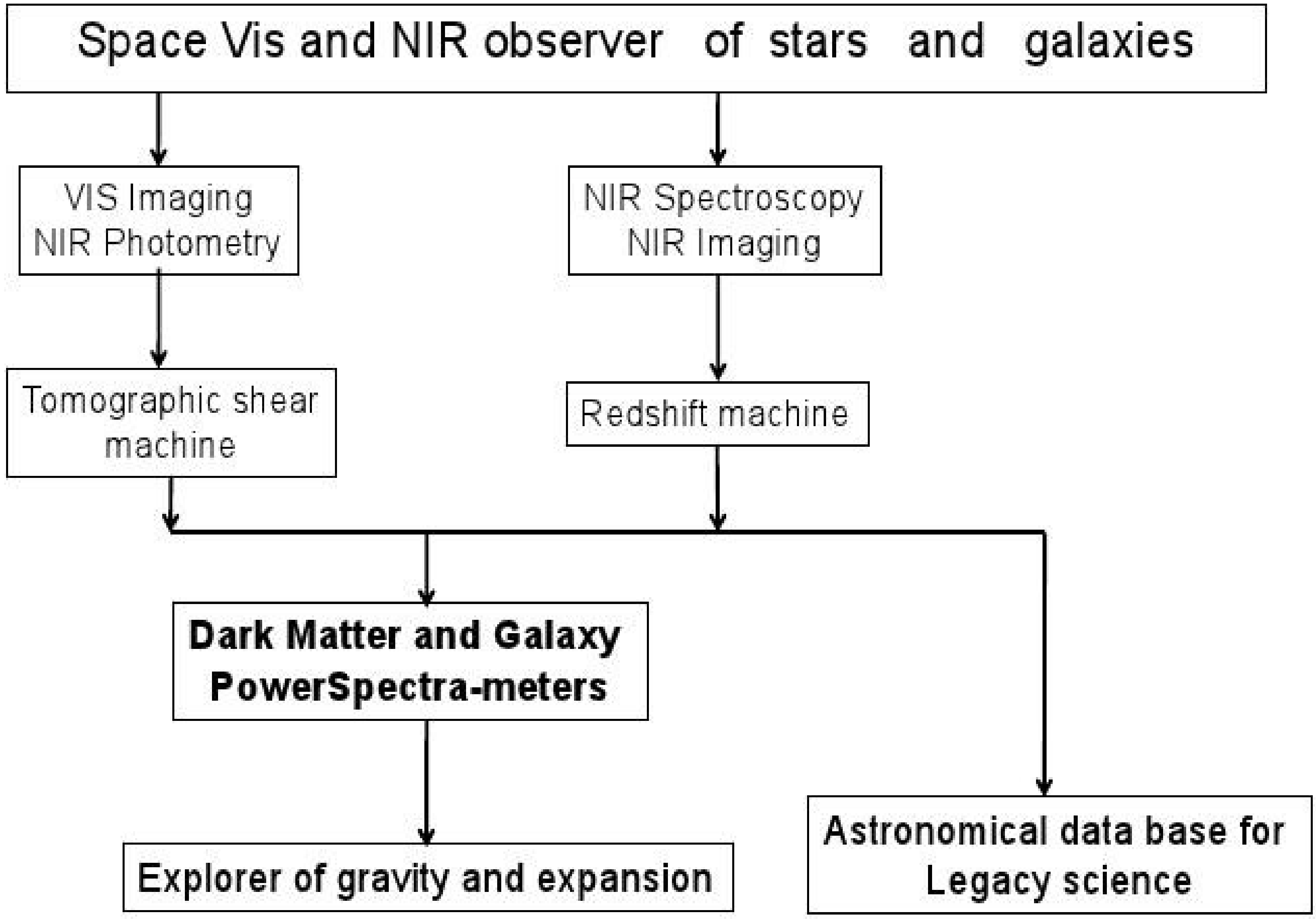
Budgets and Performance				
	Mass (kg)		*Nominal Power (W)*	
industry	TAS	Astrium	TAS	Astrium
Payload Module	897	696	410	496
Service Module	786	835	647	692
Propellant	148	232		
Adapter mass/ Harness and PDCU losses power	70	90	65	108
Total (including margin)	**2160**		**1368**	**1690**

The Euclid machine



VIS: Optical Imager

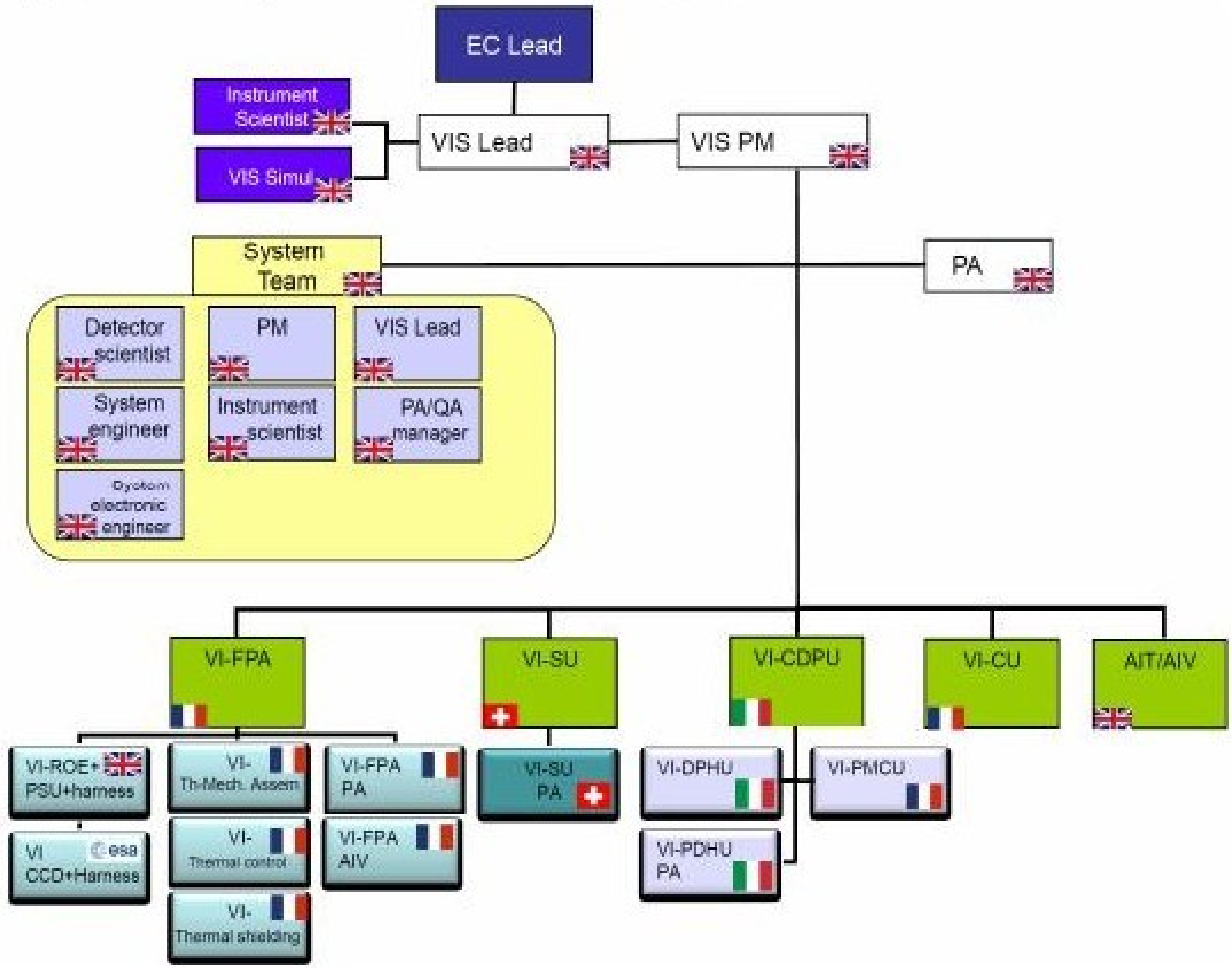
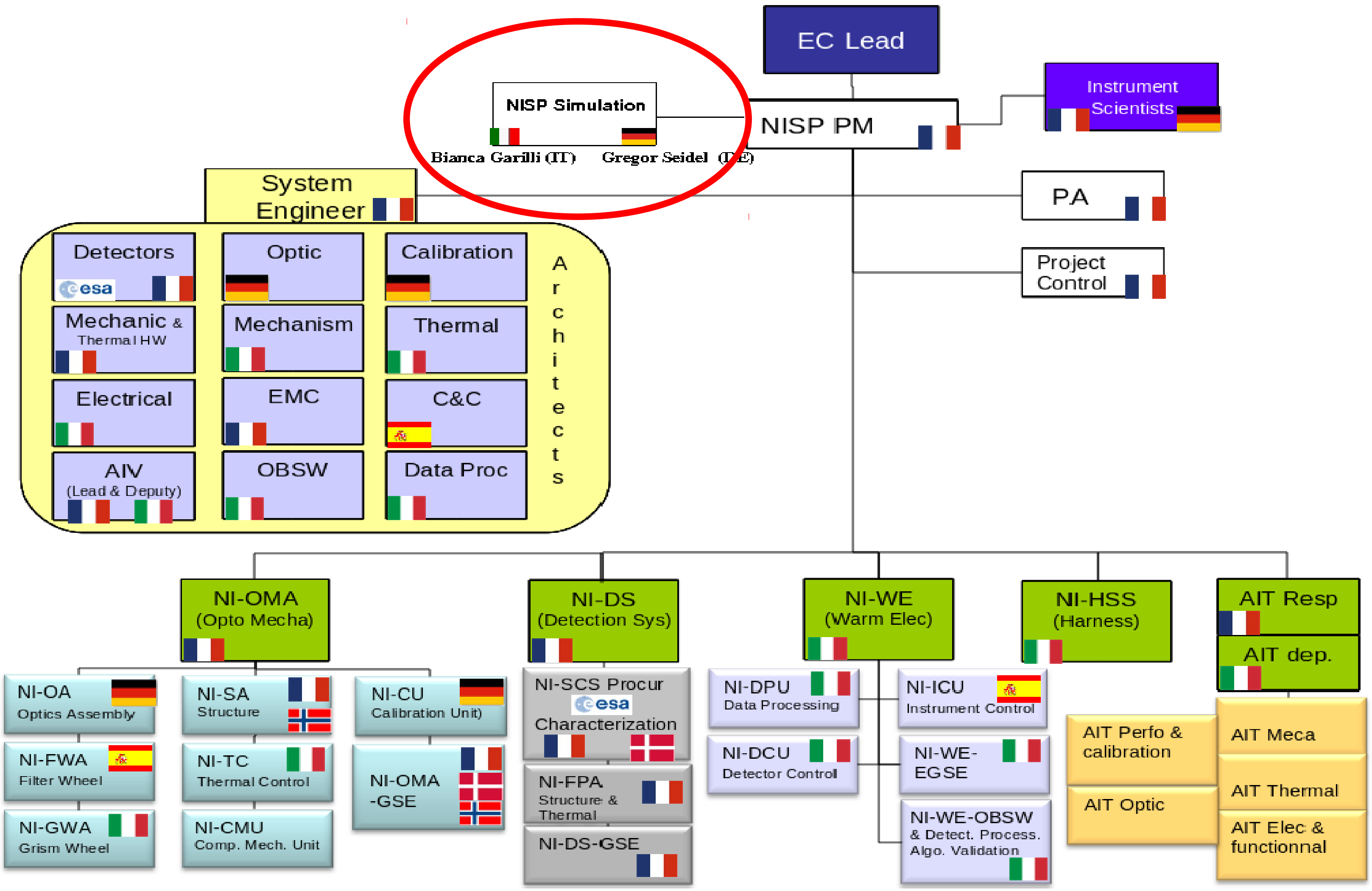


Figure 8.2a: The VIS management structure and WBS.

NISP: Near Infrared imager and spectrograph



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The Mission Ground Segment

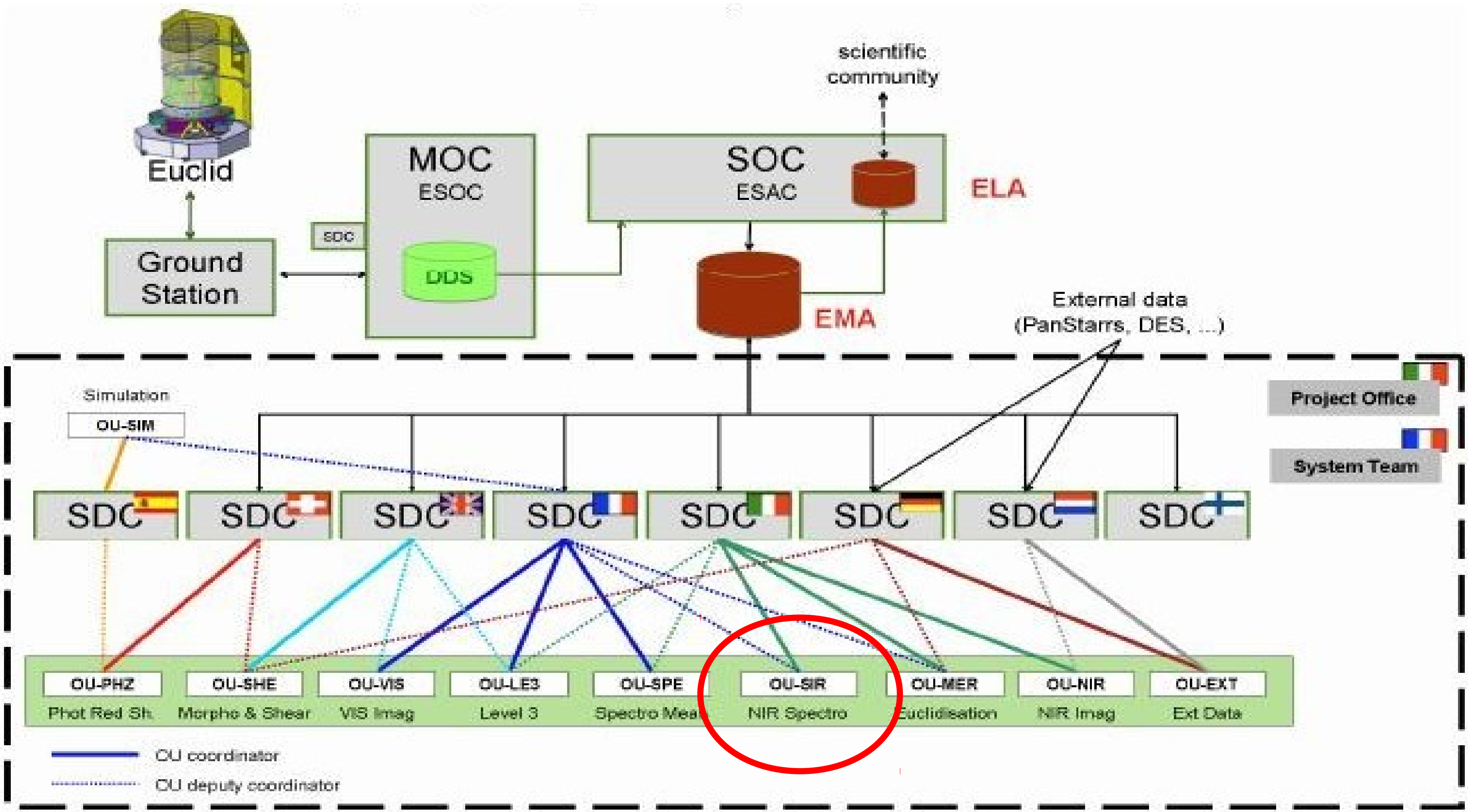
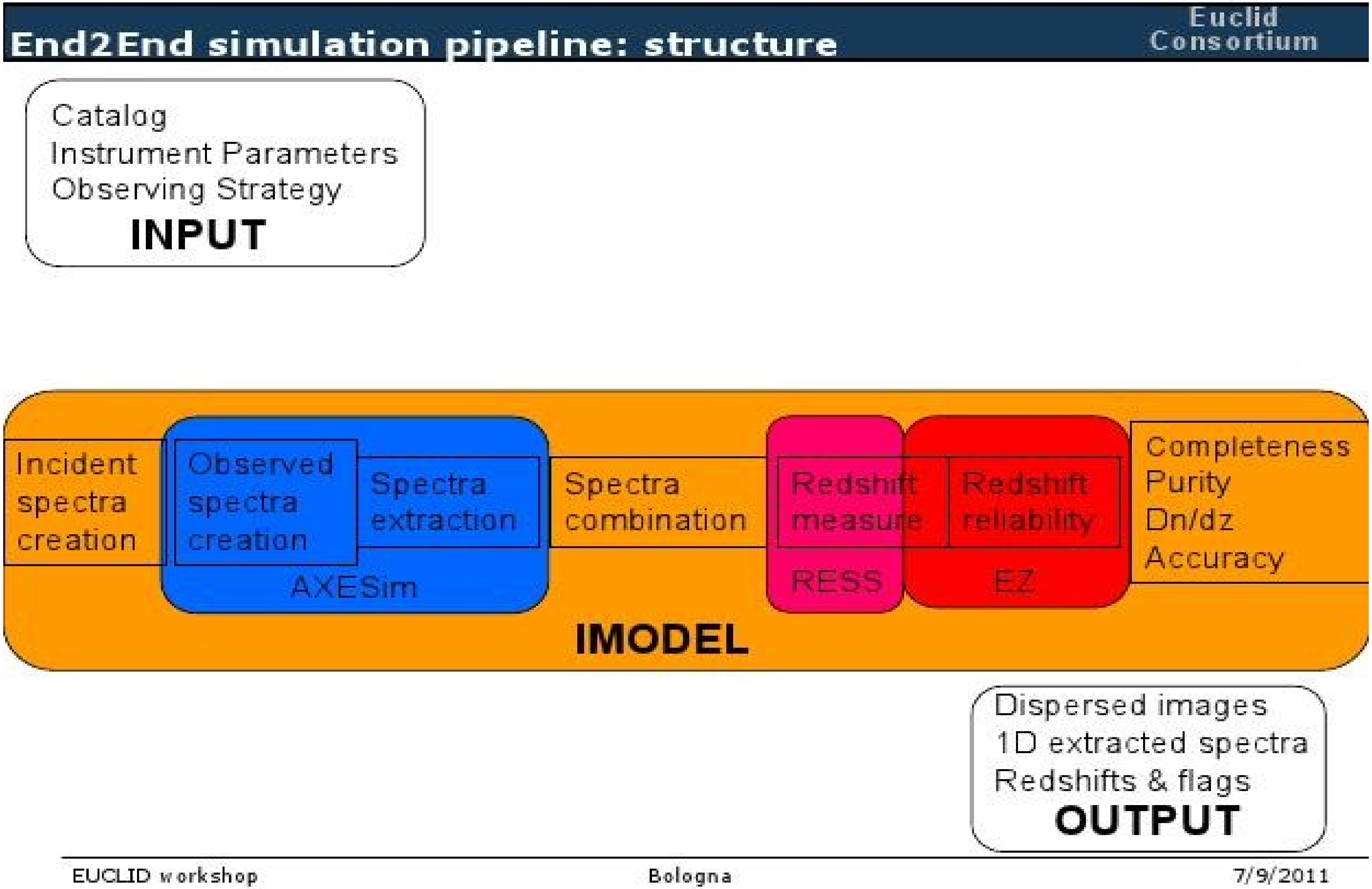


Figure 7.4: The overall set of tasks for the EMC SGS and the national data processing responsibilities

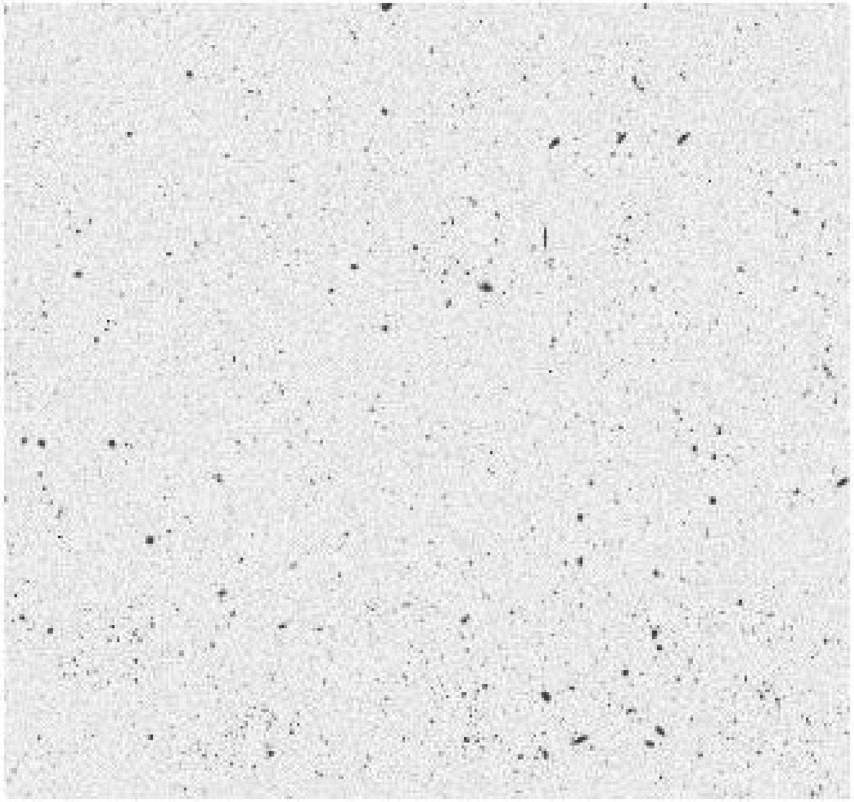
The Spectroscopic Simulations

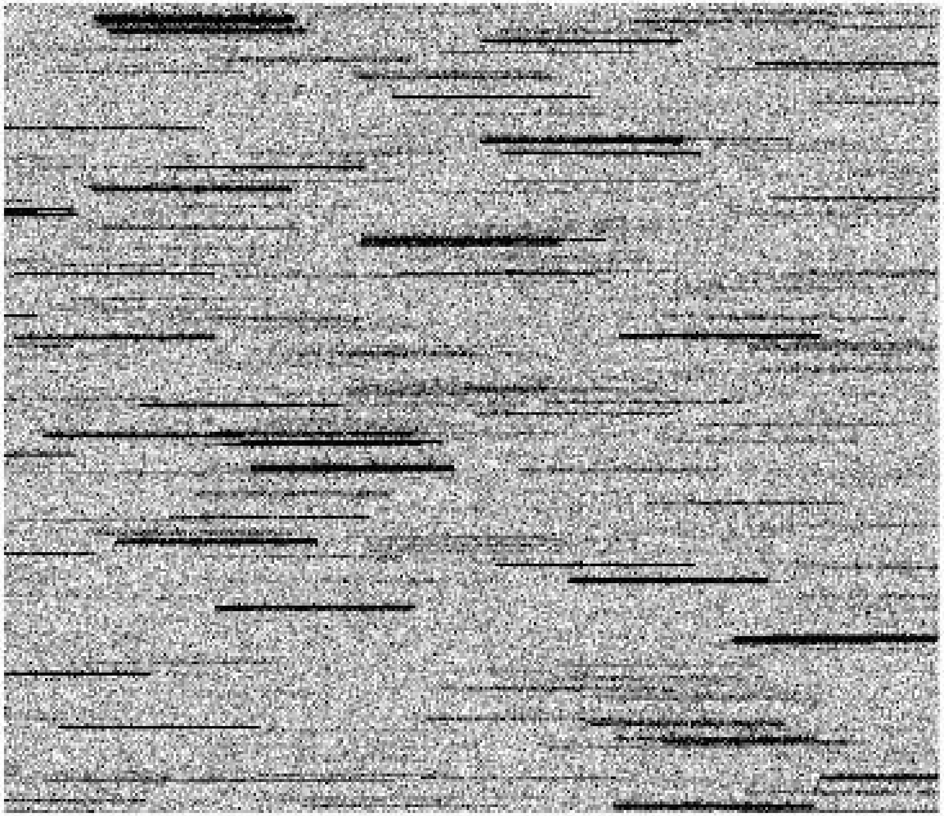


The Spectroscopic Simulations

Carried out by aXeSIM (M. Kümmel, J.R. Walsh, H. Kuntschner, 2010, http://axe.stsci.edu/axesim/)

- direct image
- dispersed image
- One simulation per dither per array





The Spectroscopic Simulations

Contamination

Euclid Consortium

- slitless spectroscopy is affected by the confusion arising from the superposition of spectra from adjacent objects

- Almost all spectra are affected by contamination
- Contamination is the main cause of redshift measurement failures.
- Reducing confusion produced by overlapping spectra is the first concern when devising observing strategy

Example of 2D dispersed image without any contamination reduction strategy, may 2009

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Conclusions

- Slitless spectra are not "so" nice
- A number of complication wrt slit/fiber spectroscopy
- Wide survey
  - 52 millions of galaxies over 15000 deg^2
  - redshift 0.7 to redshift 2.0
  - $\sigma_z < 0.001(1+z)$
- Deep survey
  - 40 deg^2
  - hundreds of galaxies at redshift z>7
  - tens of quasars at z>8,
  - and more……

Lot of science to be done!