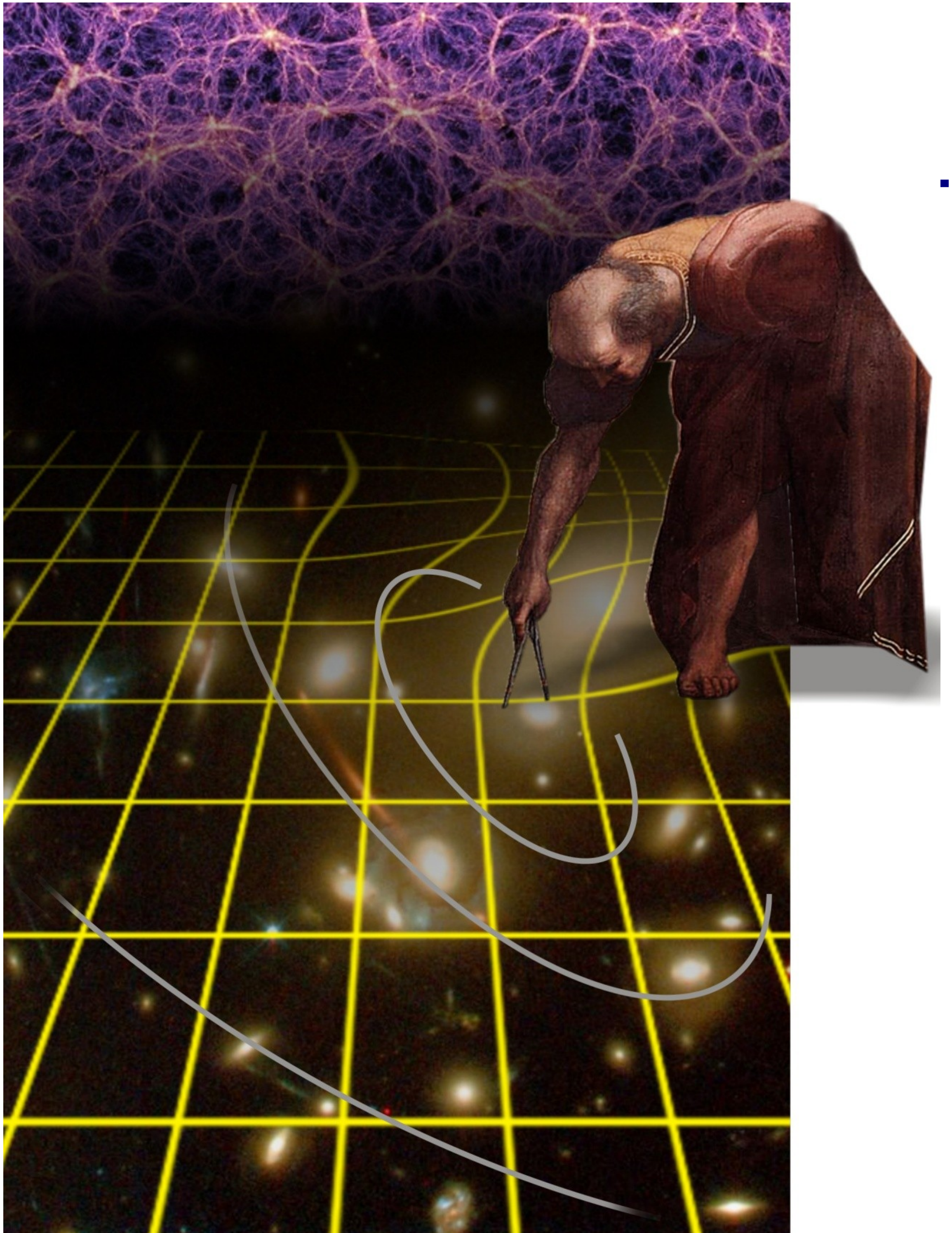
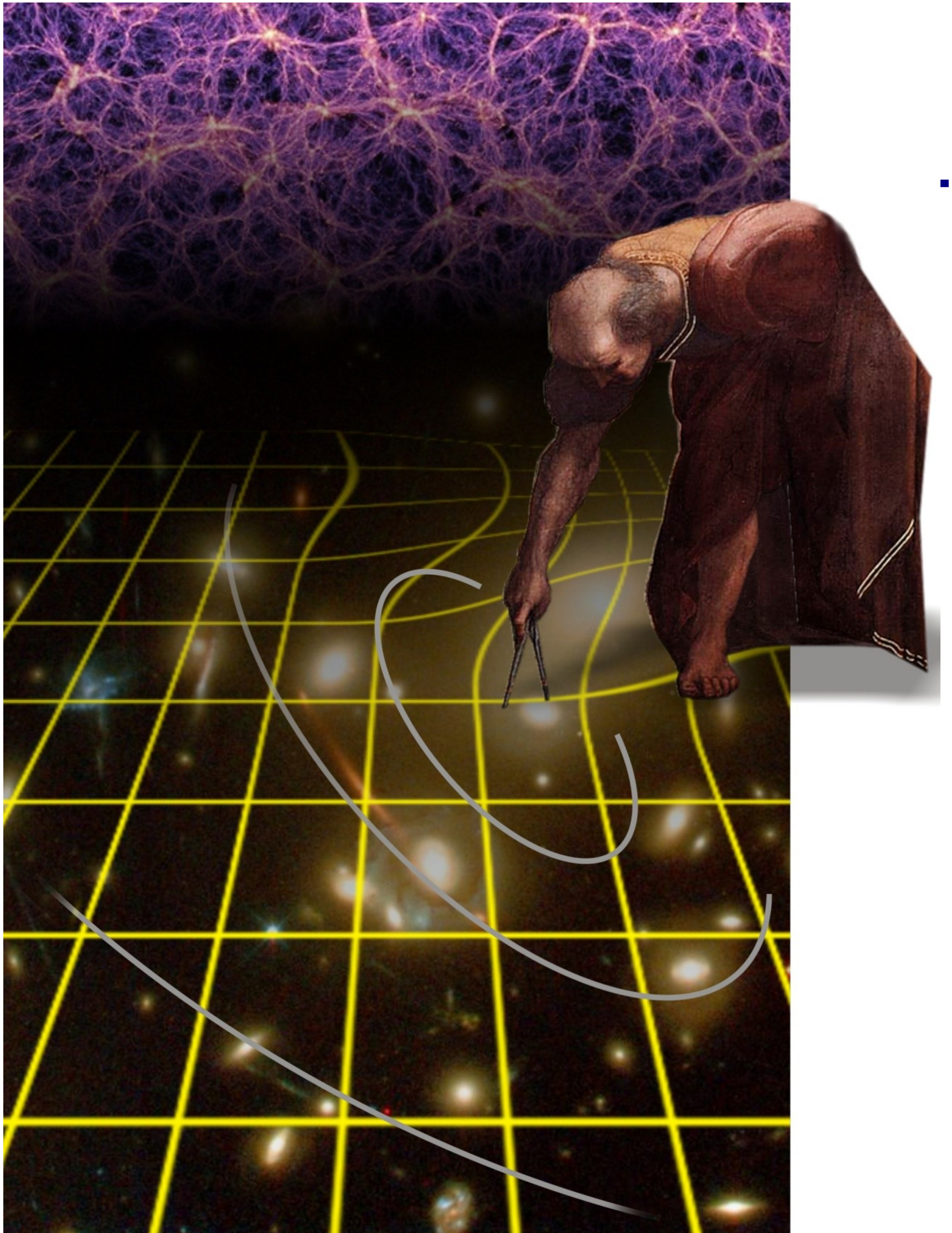


Euclid

Mapping the geometry of the dark Universe

Y. Mellier
on behalf of the Euclid Consortium

IAP, January 14, 2011



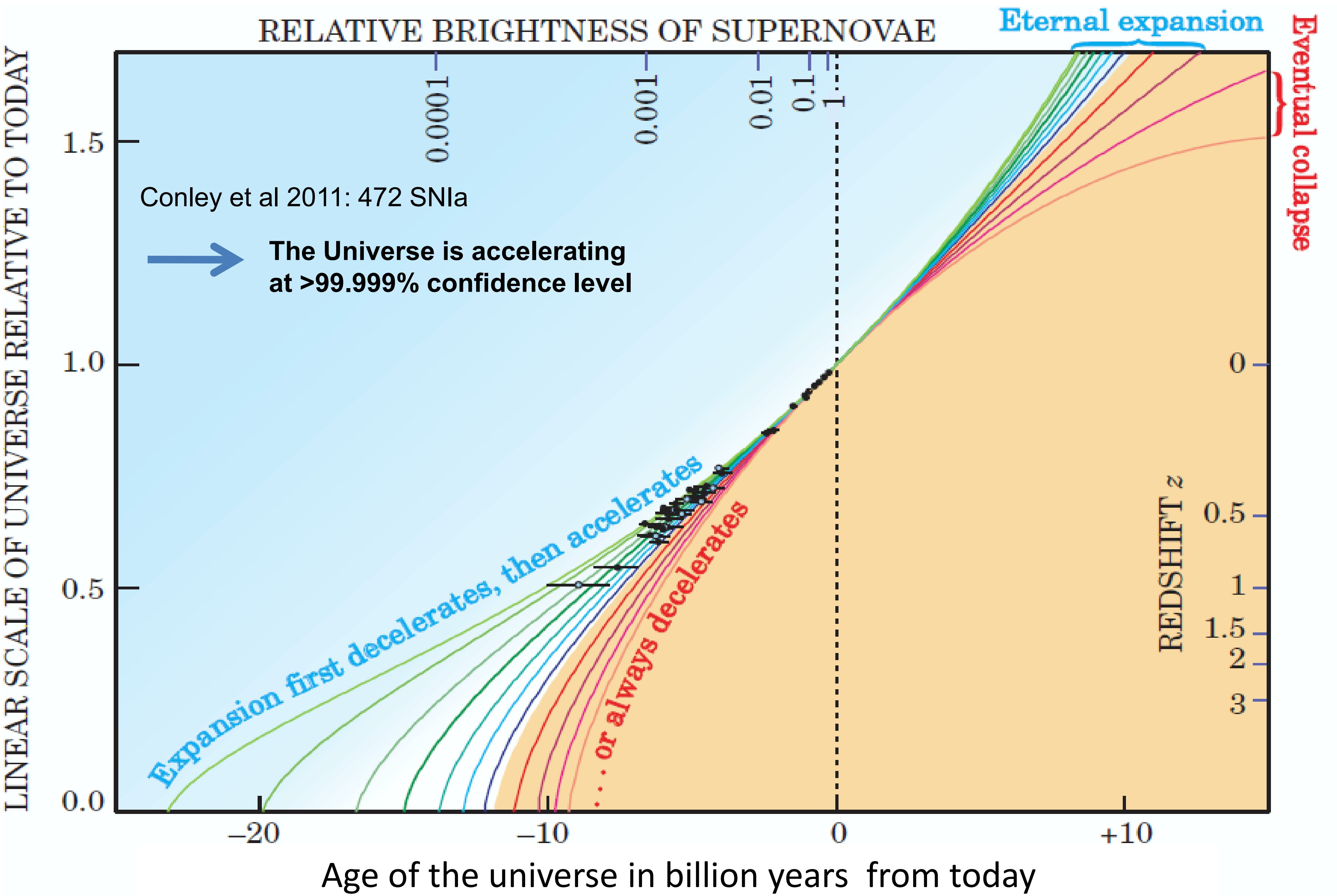
Euclid

- The quest for dark energy
- Euclid
- Euclid ground segment
- Conclusion

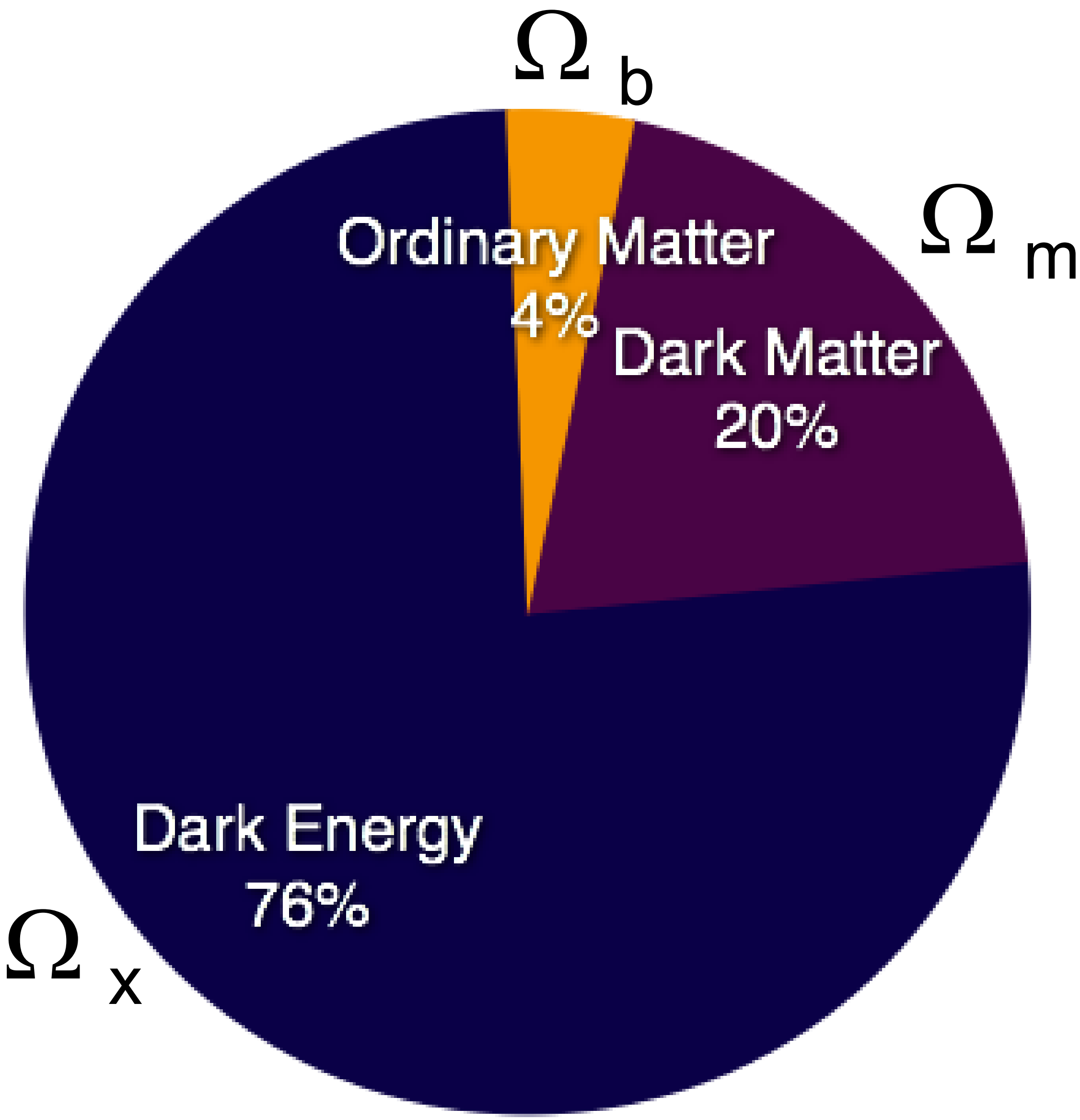
IAP, January 14, 2011

The quest for dark energy

The expansion of the Universe is accelerating



The content of the accelerating Universe is dominated by its dark components



The acceleration of the Universe is produced by a new component called « Dark Energy »

Origin of the observed acceleration of the Universe?

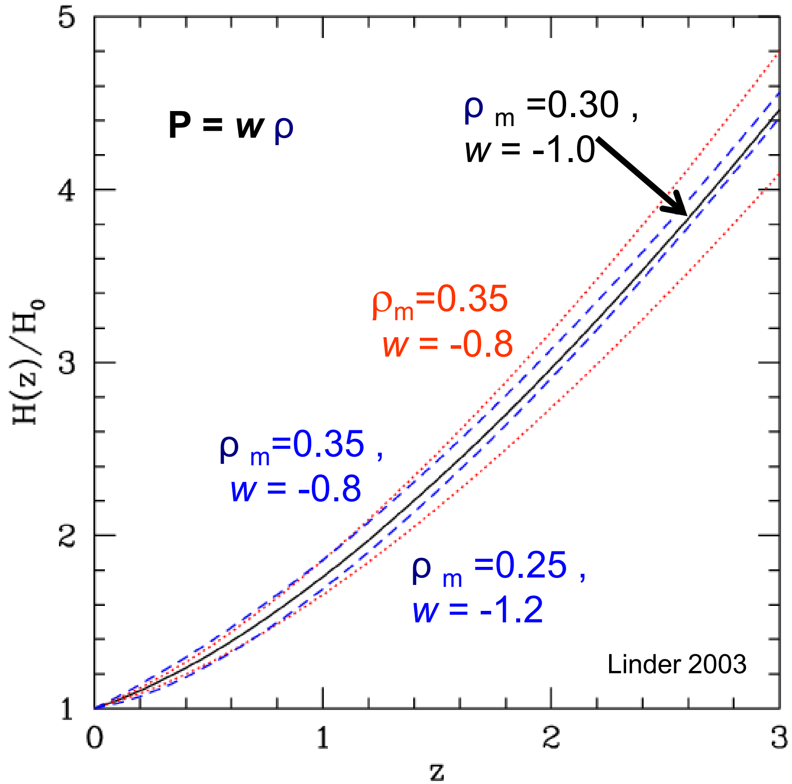
- Poses some of the most important and debated questions today in cosmology and fundamental physics

  - Three hypotheses:
    - A new component, dark energy, of unknown nature ?
    - A modification to gravity: Einstein's General Relativity needs to be revised on cosmological scales?
    - Some principles of standard FLRW cosmology (like the Cosmological Principle) need to be revised?

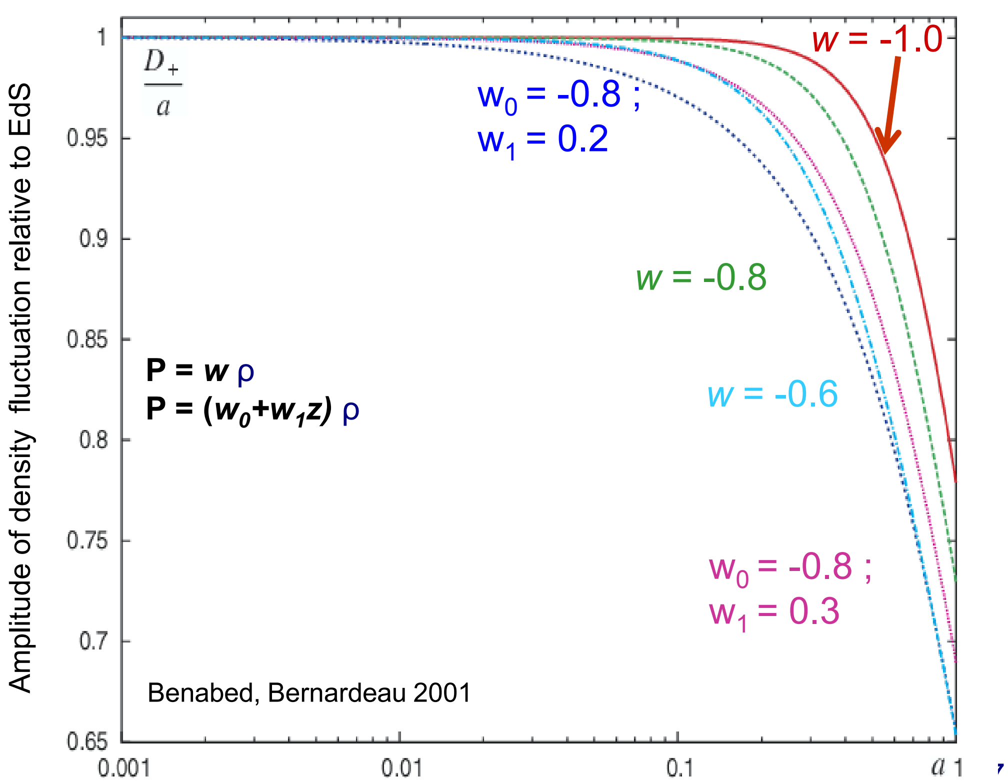
  - The answer:
    - Not known yet,
    - How can observations help to answer?

Effects of dark energy in the universe

- Modifications:
  - of the expansion rate $H(z)$
  - of the growth rate of structure $g(z)$
  - But very weak differences between popular models

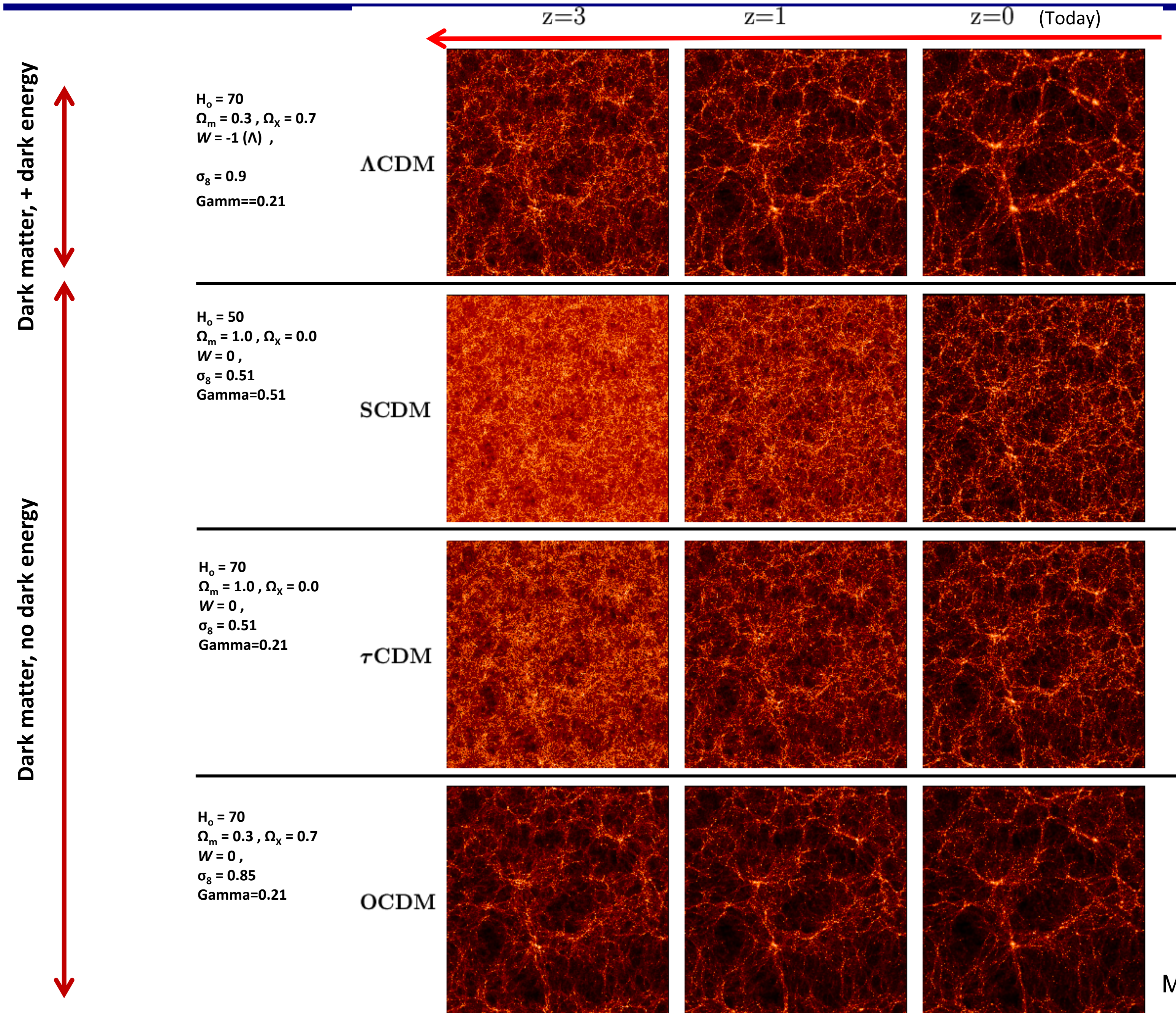


Expansion



Growth rate

Structure formation with/without dark energy



Differences can be detected by observing how dark matter clustering changes with time (redshift):

Tomography of dark matter clustering

Millenium simulations

Describing the properties of dark energy

- Description of the dark fluid: P = [w_0+$w_1(z)$] . ρ

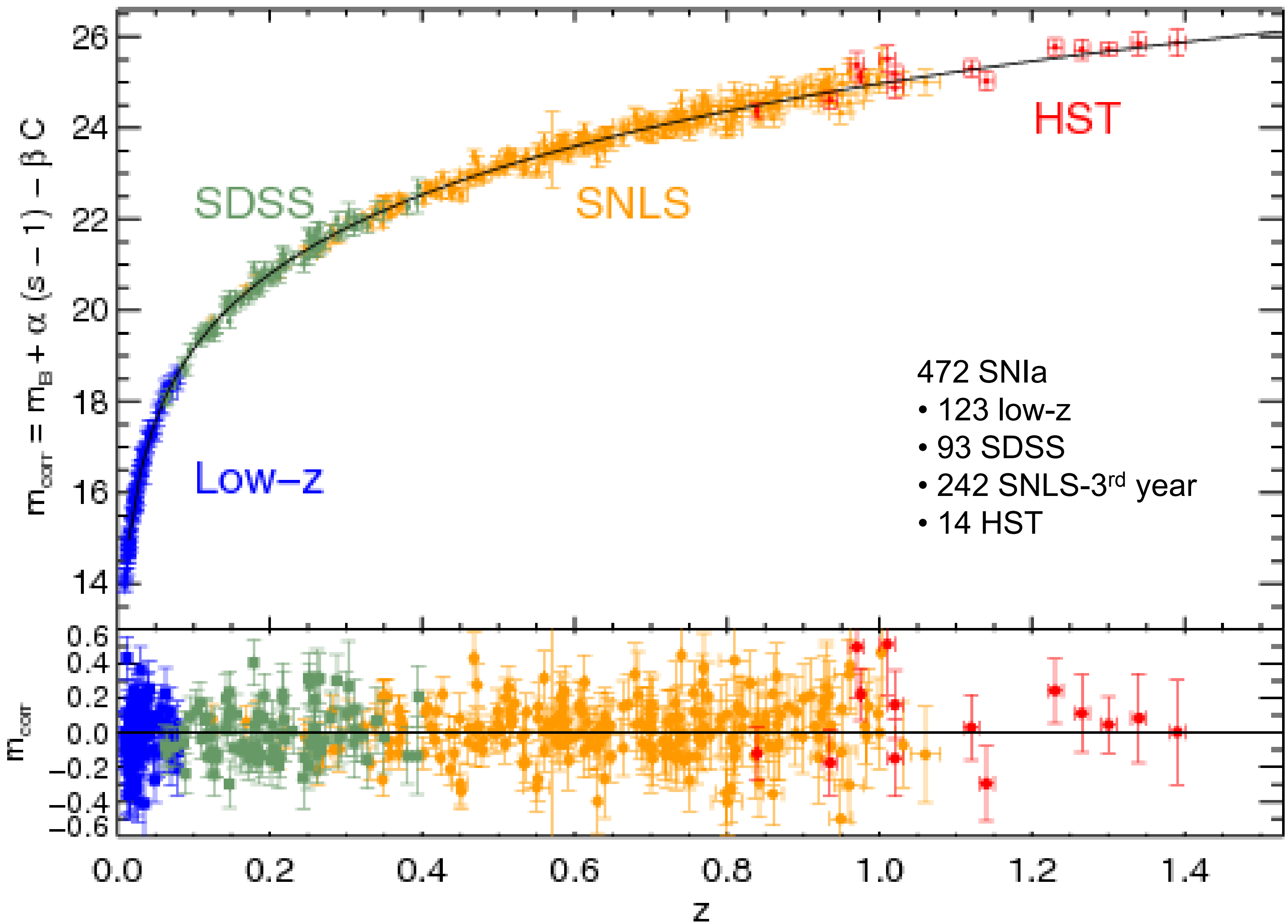
  $w(z)$ characterises effective properties of the dark fluid

- Shape and amplitude of $w(z)$: derived from observation of **cosmological probes** :
  - the expansion rate of the Universe $H(z)$
  - the growth rate of structure in the Univers $g(z)$
- Nature: by comparing probes to theoretical predictions
- Visibility:
  - Dark energy dominates at low-*z*. Focus on the low-z universe
  - The differences beween w(z)'s are tiny. Probing $w(z)$ is an observational challenge

Chosing the best cosmological probes of *w*(z) and dark energy

- « **Primary probes** »
  - Supernovae SNIa : Measure $D_L(z)$. *Well understood*, almost direct probe of expansion.
    Precision photometric calibration. Physics of SNIa explosion.

Hubble diagram SNIa



Conley et al 2011

Chosing the best cosmological probes of w(z) and dark energy

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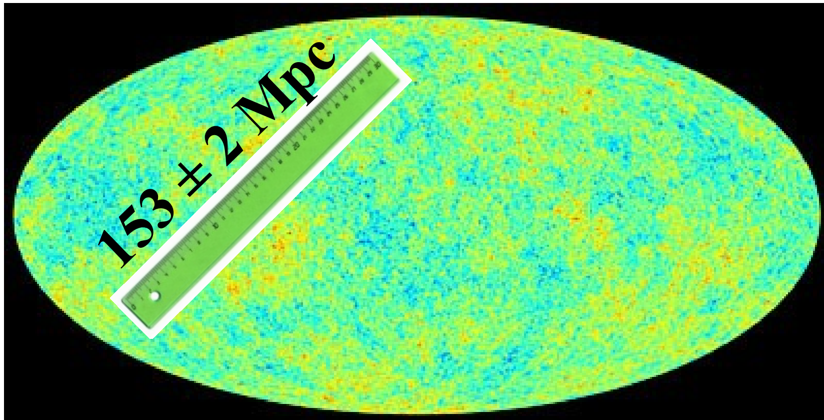
  - Baryon Acoustic Oscillations BAO: Measure $D_A(z)$ and $H(z)$. *Systematics not critical, technically easy* . Bias and non-linear physics of structure formation.

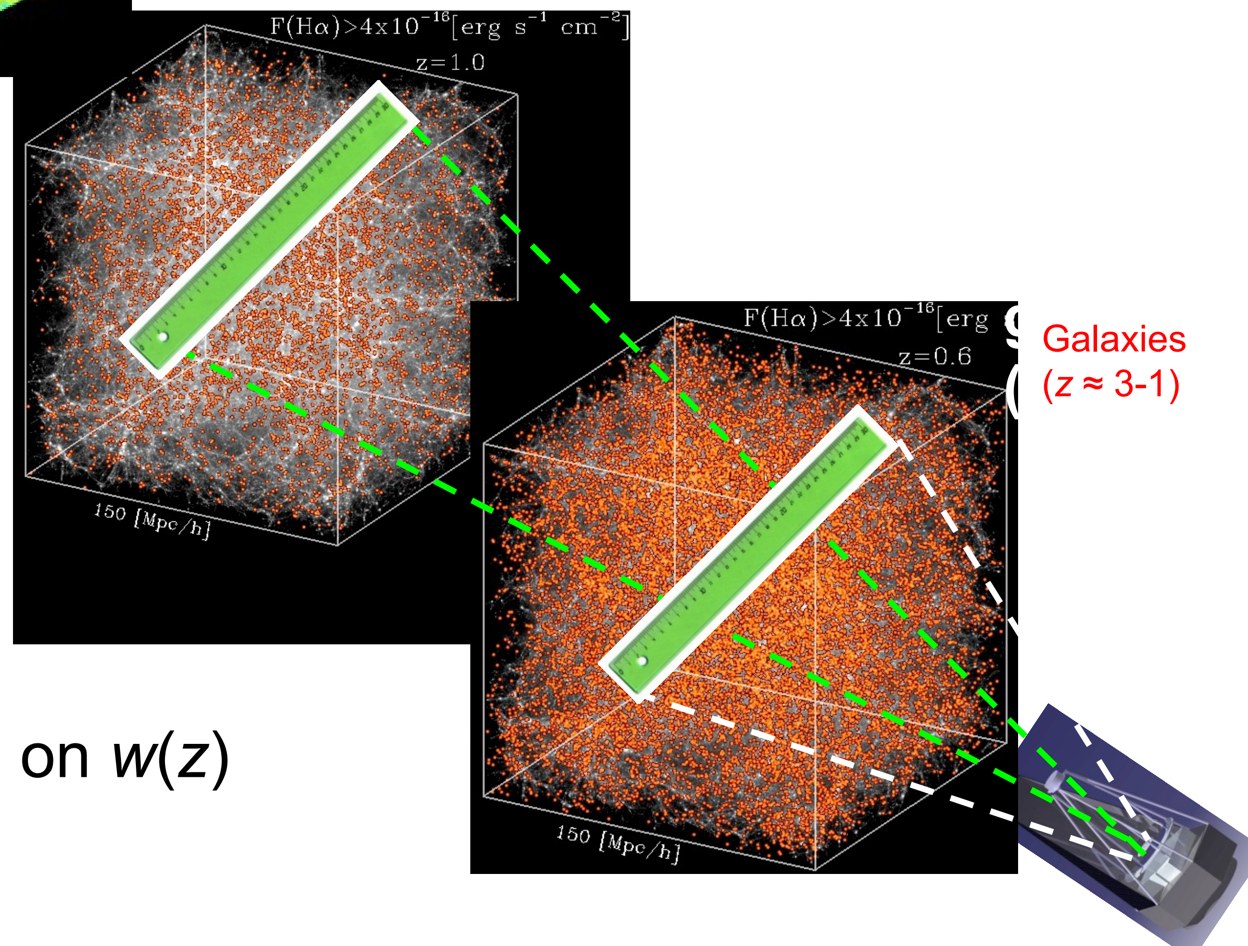
Baryon Acoustic Oscillations

Compare angular and radial sizes of accoustic pics at different redshift



CMB
(z≈1000)

Galaxies
(*z* ≈ 5-3)

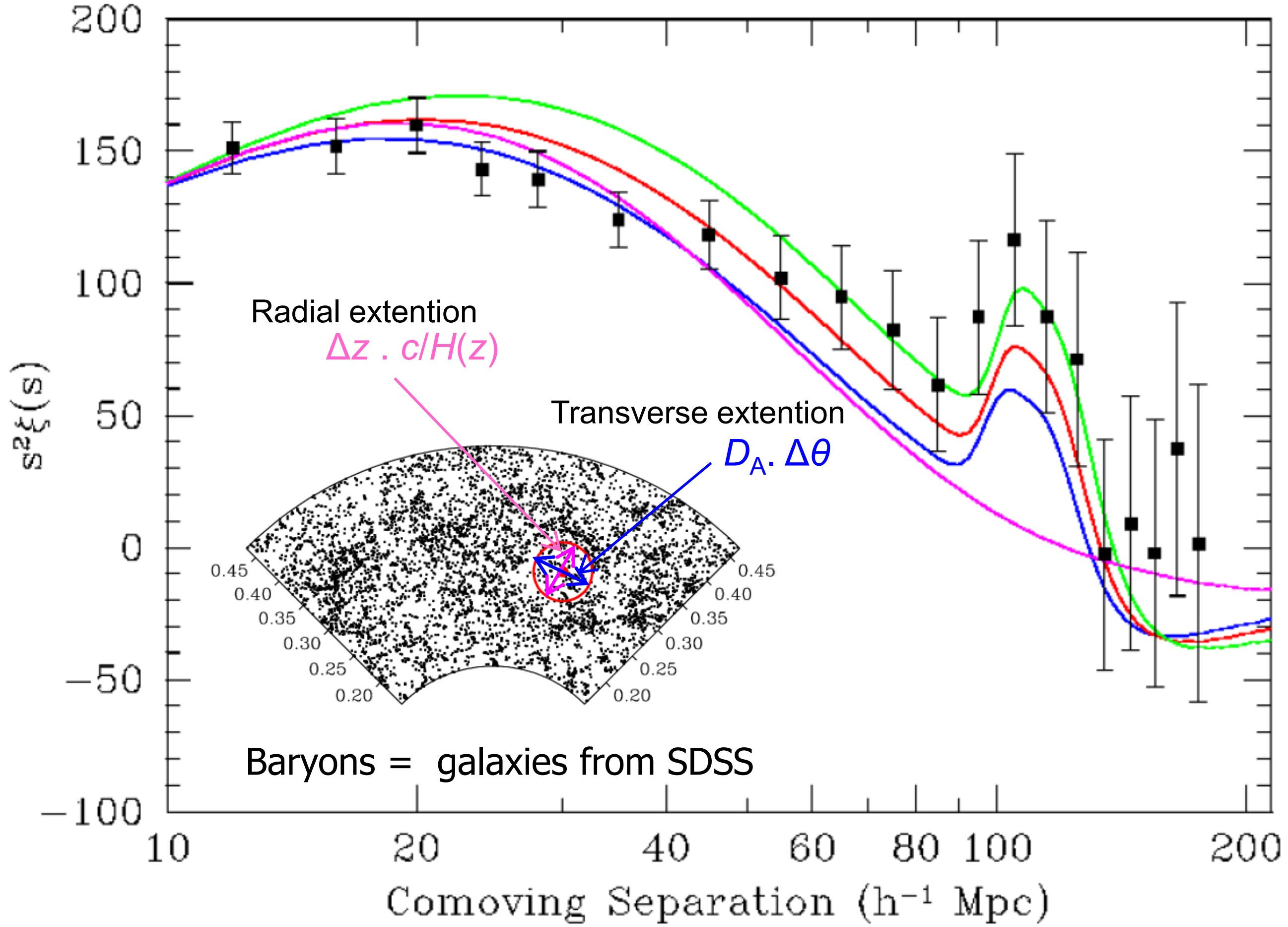


Galaxies
(*z* ≈ 3-1)

- $H(z)$ (radial)
- $D_A(z)$ (tangential)
- $H(z)$ and $D_A(z)$ depend on $w(z)$

Imprint of BAO in the galaxy power spectrum

Physical scale ~ 148 Mpc



Eisenstein et al 2005

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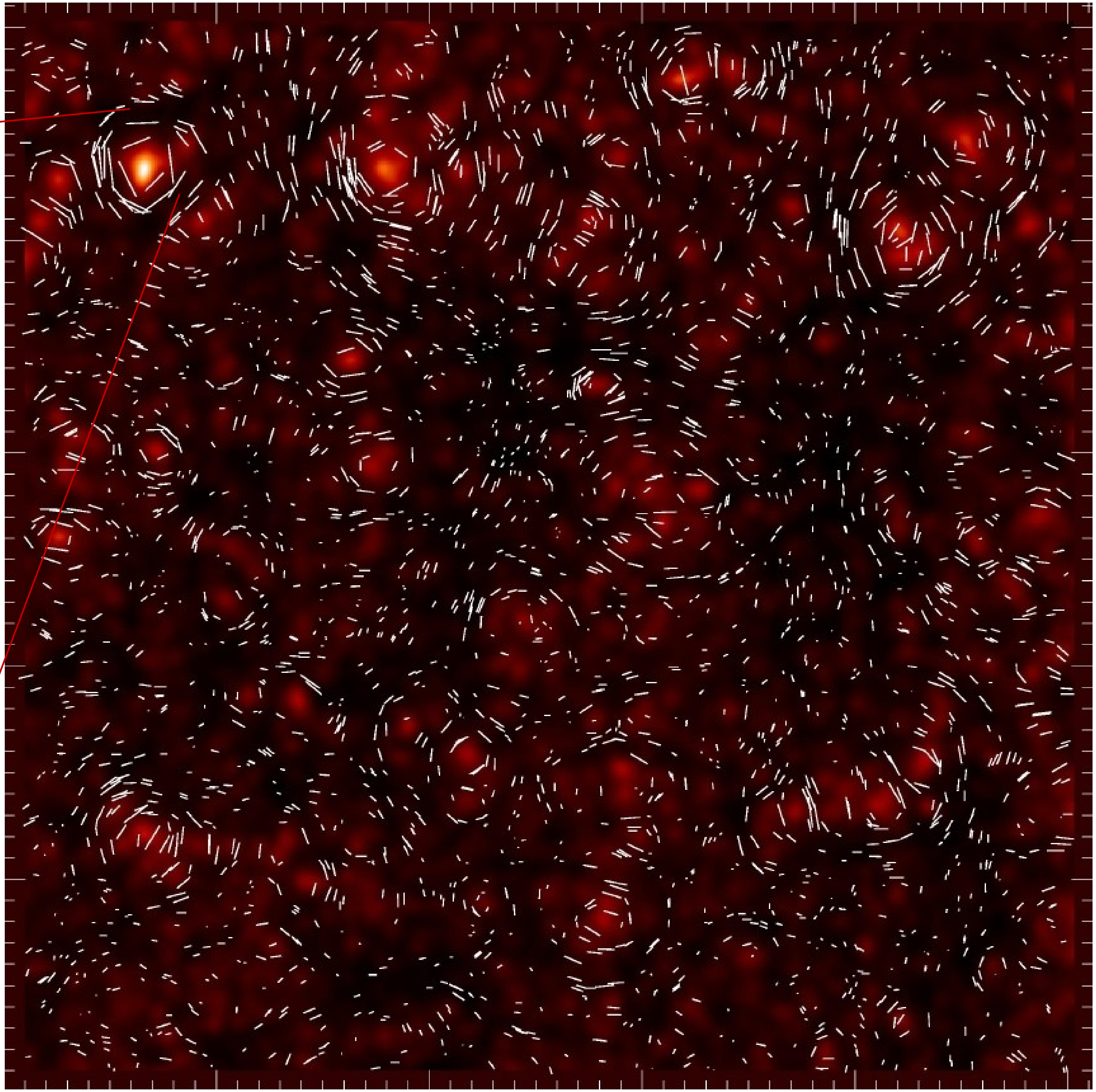
  - Baryon Acoustic Oscillations BAO: Measure $D_A(z)$ and $H(z)$.
    Systematics not critical, technically easy . Bias and non-linear physics of structure formation.

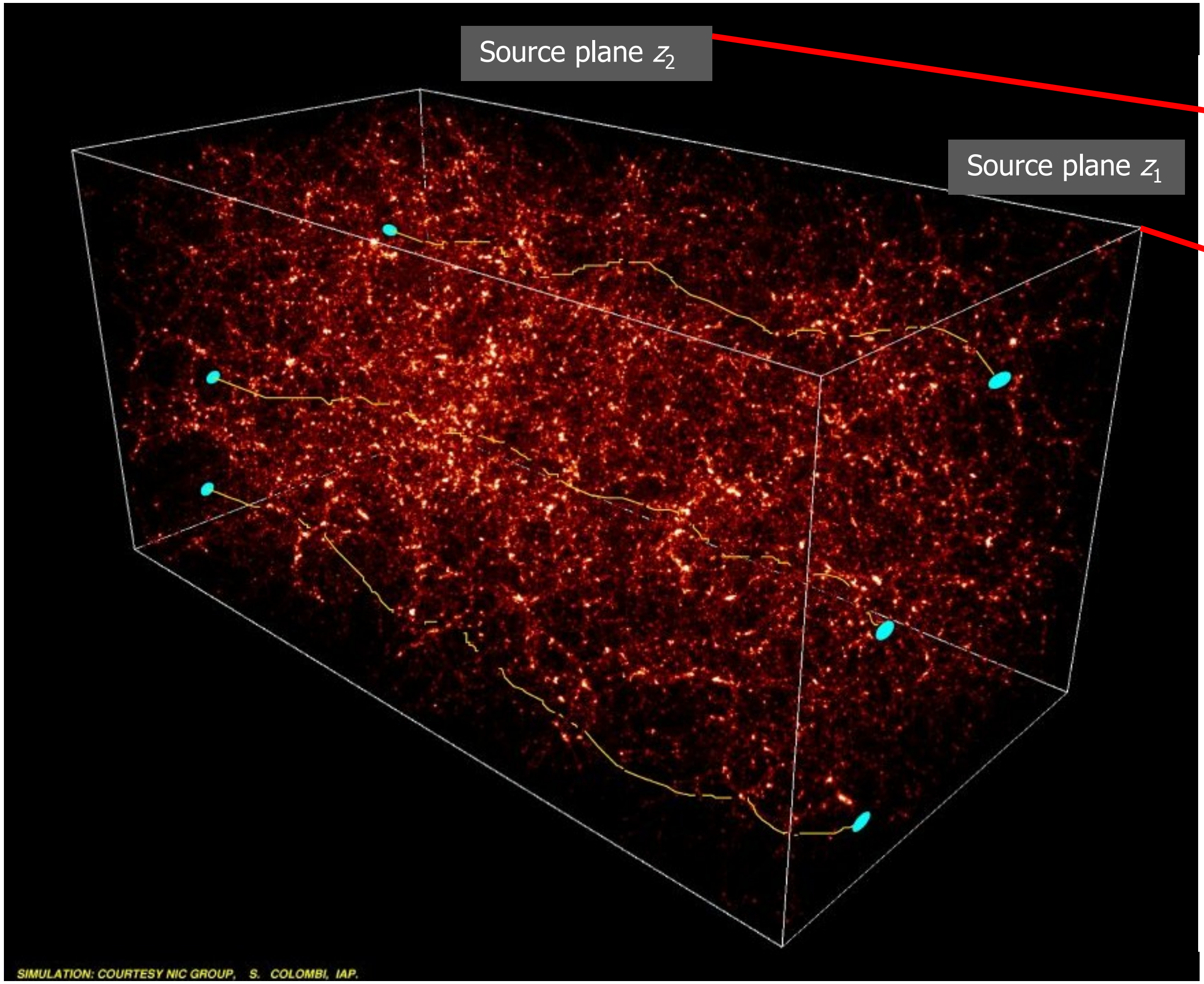
  - Weak lensing WL tomography: Measure $P(k,z)$ of dark matter and $g(z)$
    P*romising probe of the origin of dark energy.* Technically very hard. Morphometry and photometric redshifts of galaxies.

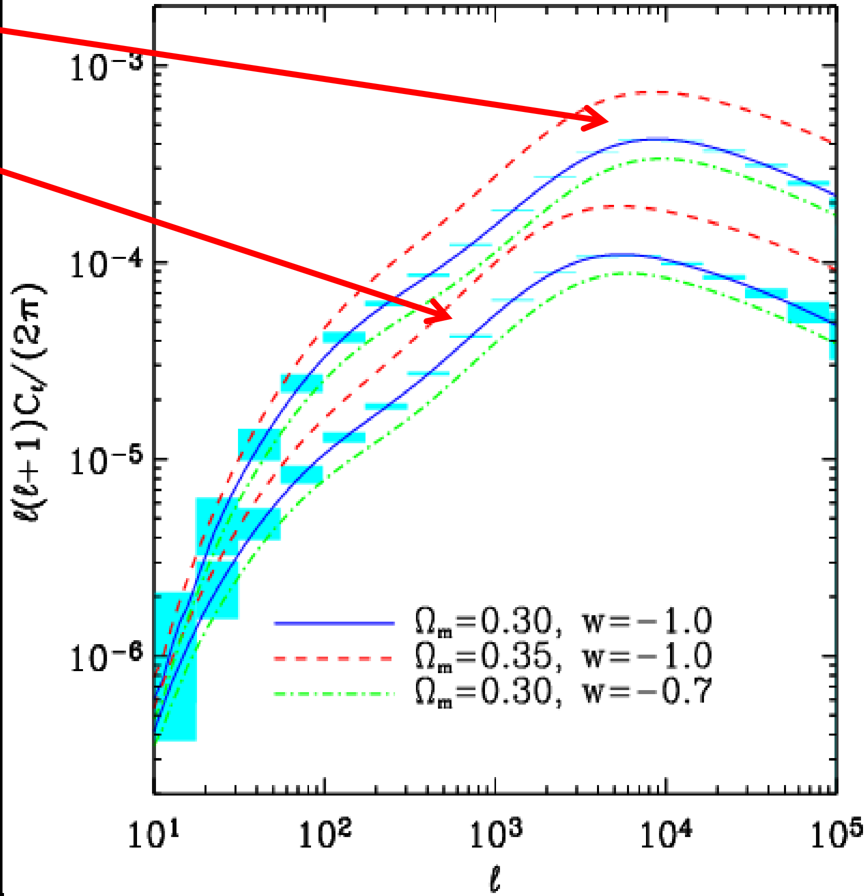
Weak lensing:
Gravitational distortion (shear)

Cosmological distortion field projected on the sky



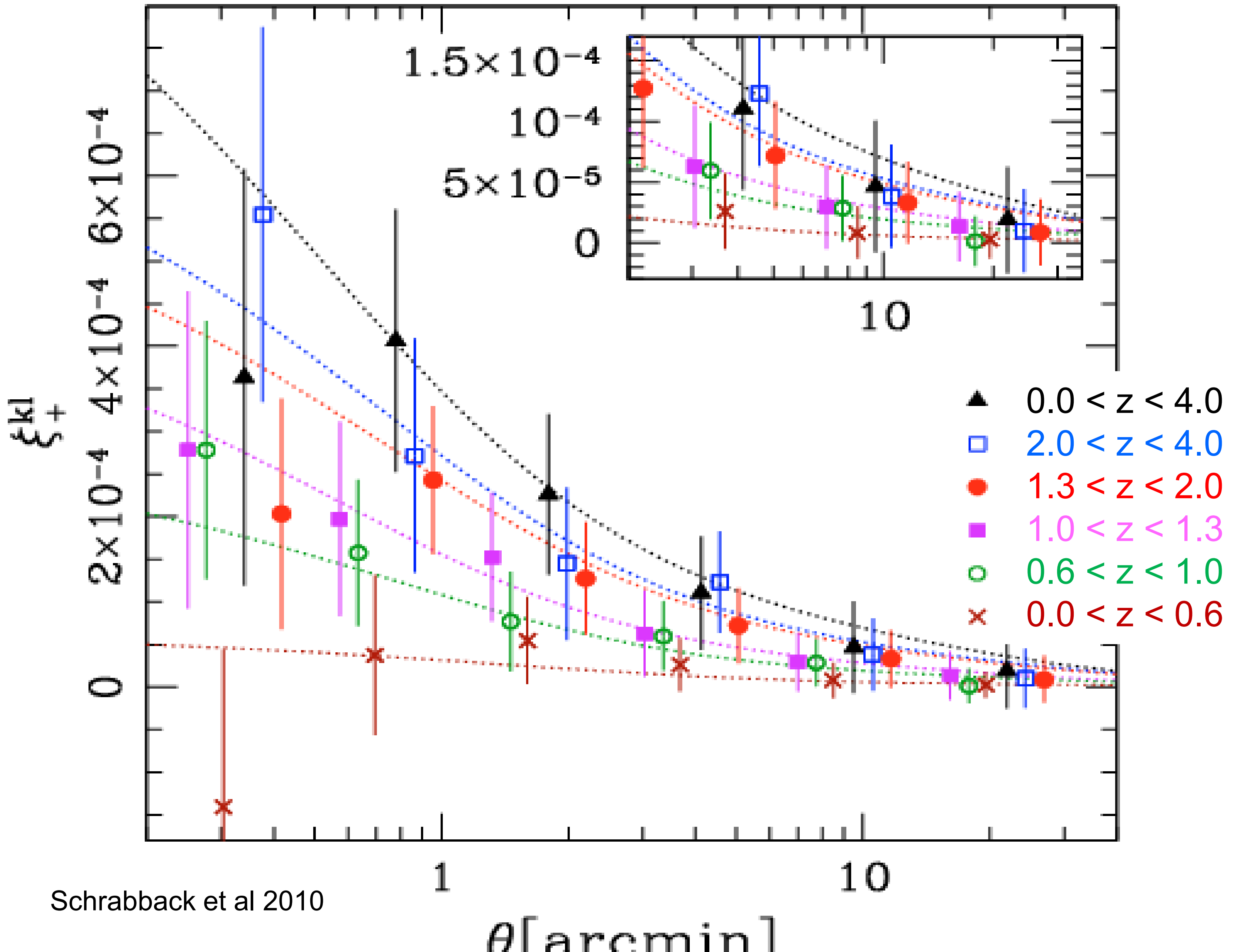
Cosmic shear tomography and $P(k,z,w)$





Colombi, Mellier 2001

Cosmic shear tomography is feasible : done in the COSMOS field with HST



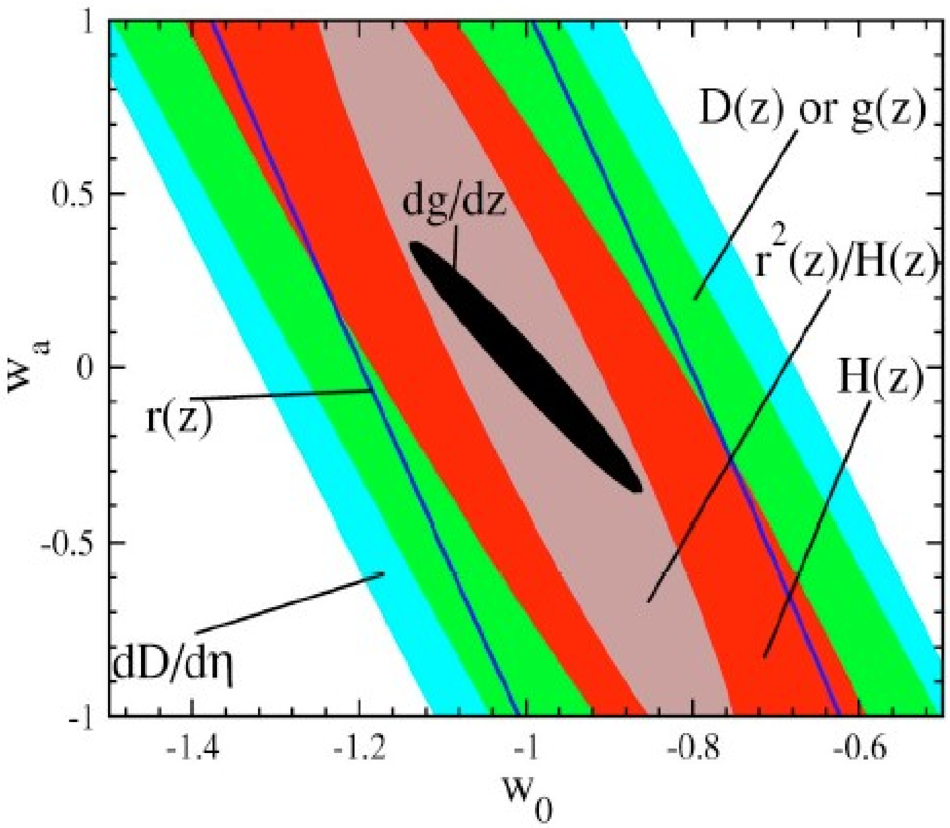
Schrabback et al 2010

Chosing the best cosmological probes of w(z) and dark energy

- « **Secondary probes** »

  - Galaxy clustering: the full power spectrum $P(k)$
    - Depends on the expansion history and the growth factor: amplitude and shape of $P_g(k) \rightarrow P_m(k)$
  - Redshift-space distortions:
    - Growth rate from the redshift distortions produced by peculiar motions.
  - Number density of clusters
    - Combines growth factor (from number of clusters) and expansion history (from volume evolution).
  - Integrated Sachs-Wolfe Effect :
    - Measures the expansion history and the growth

Finding the best probes of *w*(*z*)



Cooray, Huterer, Baumann 2004

- Sensitivity to dark energy:

$$w(z) = w_0 + w_a\, z/(1+z)$$

$r(z)$	=	comoving distance
$r(z)\ (1+z)$	=	luminosity distance
$r(z)/\ (1+z)$	=	angular distance
$r(z)^2\ H(z)$	=	comoving volume
$D(z)$; $g(z)$	=	growth and growth rate

➔ d*g*/d*z* is the best test

BUT: systematics…

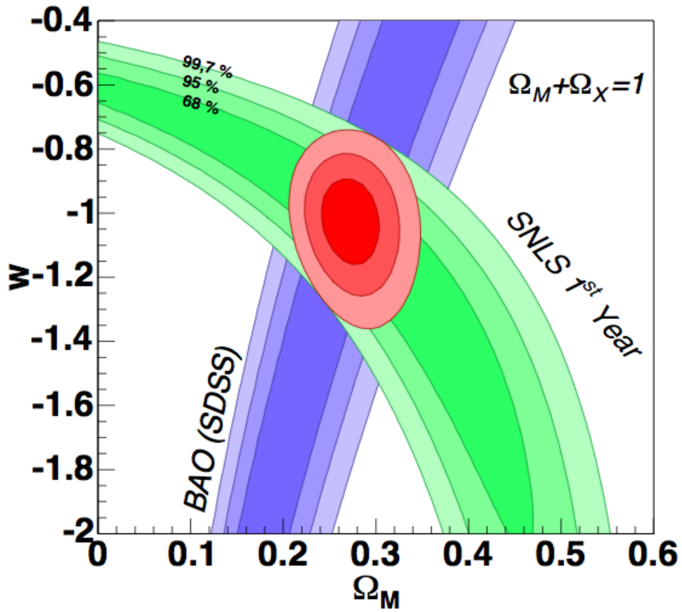
Current status of *w*(*z*) and dark energy with primary probes

Current : 10-20% error on constant *w*, assuming a flat universe

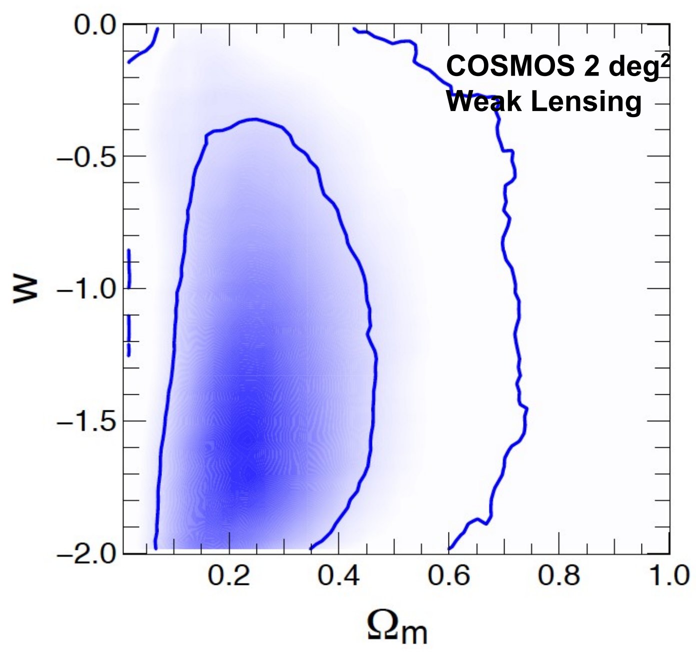
→ Eisenstein et al 2005 (SDSS-BAO)
→ Fu et al 2008 (CFHTLS-WL),
→ Dunkley et al 2009 (WMAP+BAO+SNIa)
→ Schrabback et al 2010 (COSMOS-WL tomography)

→ Conley et al 2011 (SNLS 3-yr only) : $w = -0.91^{+0.16}_{-0.20}\text{(stat)}\ ^{+0.07}_{-0.14}\text{(syst)}$

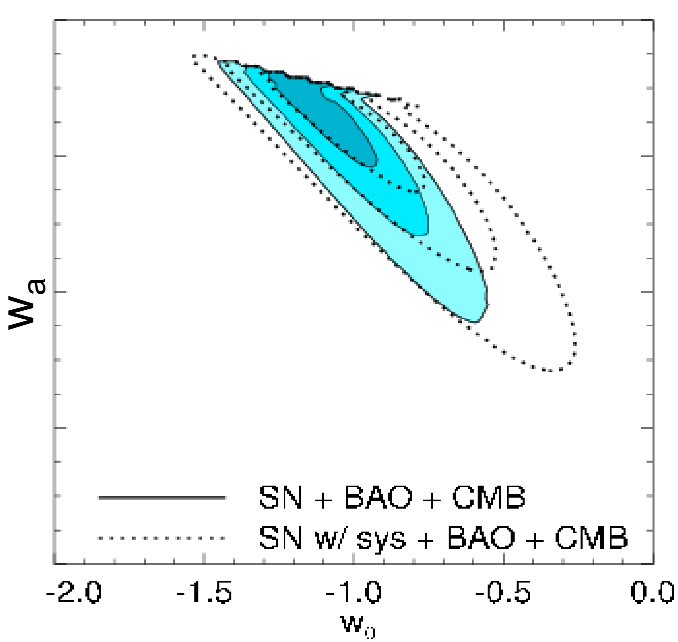
Astier et al. 2005, Conley et al 2011



Schrabback et al 2010



Dunkley et al 2009



Goals of the next decades

- Need to gain of factor of 10 on accuracy of $w(z)$
- None of the present-day probes outperforms the others. Need several different probes.
- All probes need spectrosopic and photometric redshifts in the range $0<z<3$-5 : near infrared data
- None of them can derive accurate information on dark energy without CMB data (Planck)
- Risks: select probes/surveys with high *legacy* value

Euclid

The Euclid mission

- High-precision survey space mission to map the geometry of the Dark Universe. Measure $w(z)$ with

  w_0 to 1%, and $w_a = dw/da$ to 10%
- Optimized for two complementary $H(z)+g(z)$ probes:
  - Weak Gravitational Lensing
  - Baryonic Acoustic Oscillations
  - +4 secondary probes for free: galaxy clustering, clusters, redshift space distortions, ISW
- Full extragalactic sky survey:
  - High precision visible Imaging
  - Near infrared photometry/imaging
  - Near Infrared Spectroscopy
- Legacy science for a wide range of areas in astronomy

Euclid: a combined BAO/WL mission

- Weak lensing will reconstruct, as function of redshift
  - the distribution of the dark matter and
  - the evolution of the growth rate of dark matter perturbations
- Baryon acoustic oscillations act as standard rods
  - determine $P(k)$ and
  - provide a measure of $H(z)$
  - also : map out the evolution of baryons of the Universe.
- WL+BAO: control of many systematic effects

- Both act as independent dark energy probes. If they differ, we learn about modifications to GR.

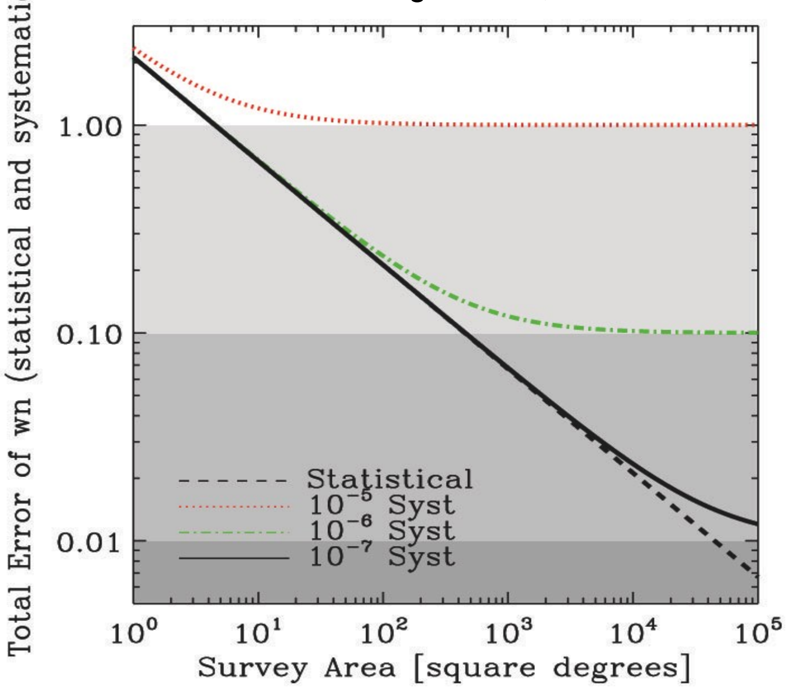
Requirements for Weak Lensing: shape measurements and photo-z

Statistics: optimal survey geometry: wide rather than deep for a fixed survey time, $\rightarrow$ need 20,000 deg^2 to reach ~1% precision on *w*

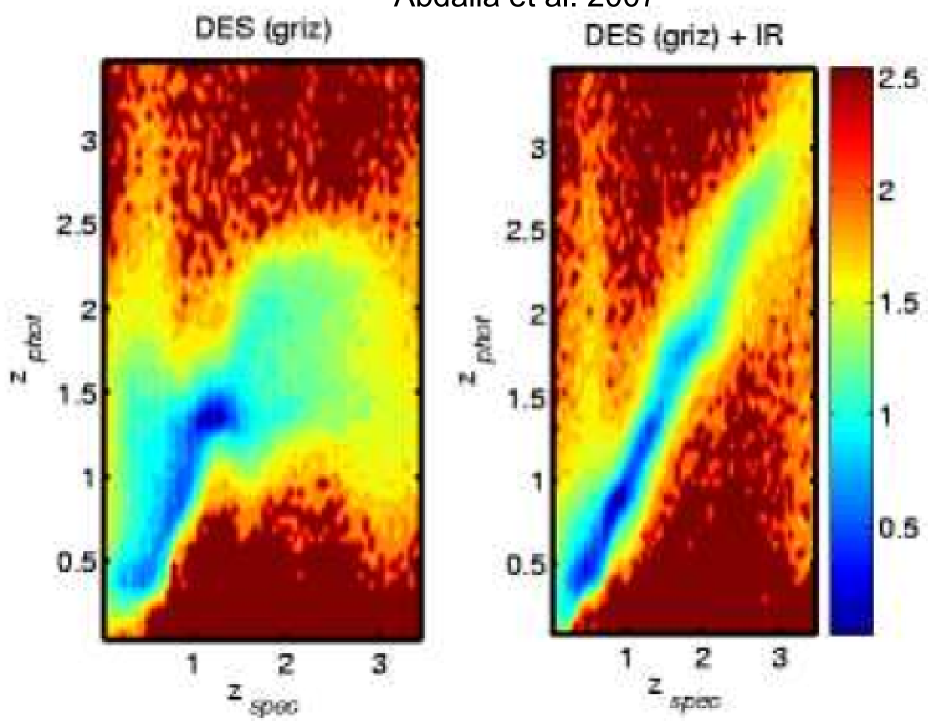
Redshift bins: good photo-z for redshift binning and intrinsic alignments $\rightarrow$ need deep NIR photometry + Visible photometry

Systematics: must gain 2 orders of magnitude in systematic residual variance $\rightarrow$ need about 50 bright stars to calibrate PSF

Amara & Refregier 2006,2007



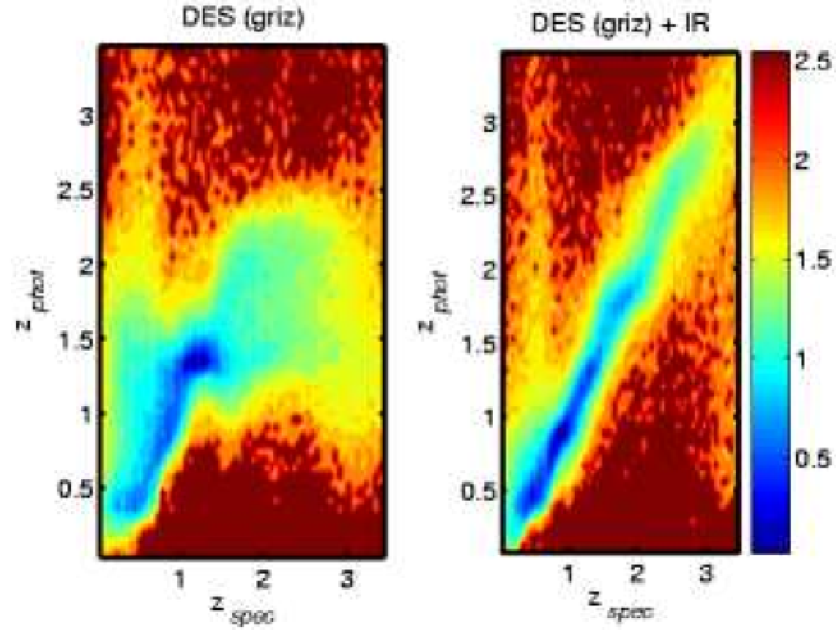
Abdalla et al. 2007



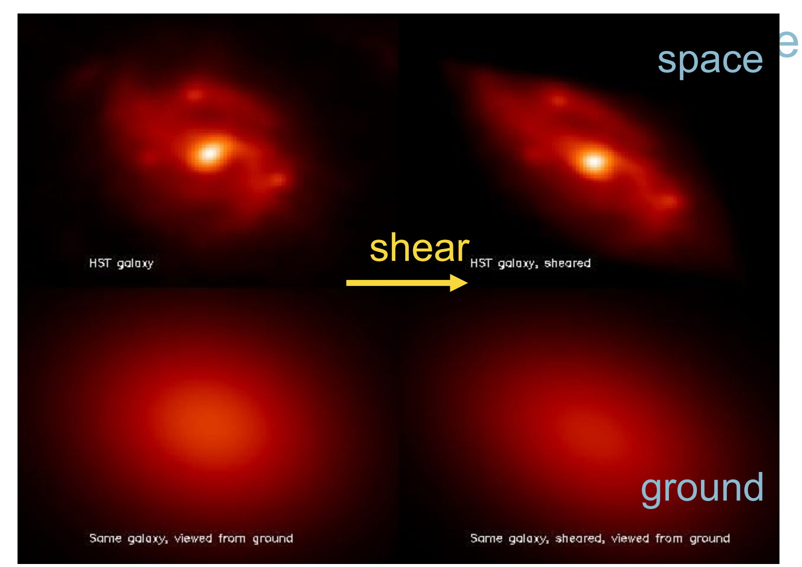
Why going to space?

- Need deep near infrared data over the whole extragalactic sky for :
    - NIR spectroscopy of faint sources in the visible *redshift desert* domain [1.2-2.5]
    - Need very accurate and unbiased photo-z sample for all sources used for WL: NIR photometry needed

Abdalla et al. 2007



- Image quality: excellent+stable PSF
- Very good sampling of small sources that dominate the faint/high-z galaxies at faint magnitude
- PSF and photometric stability and homogeneity over the whole sky



Euclid mission baseline

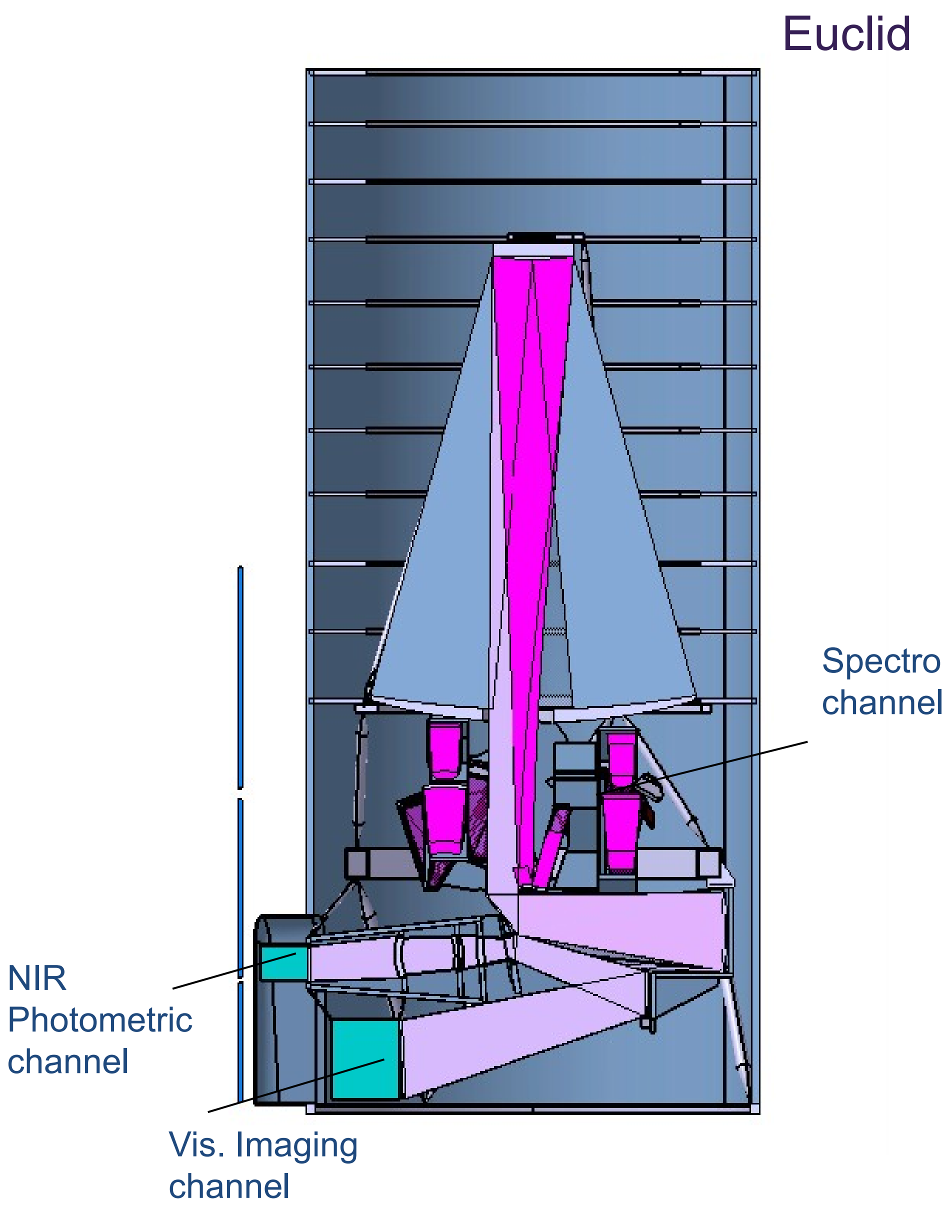
Mission elements:

- L2 Orbit
- 4-5 year mission
- Telescope: three mirror astigmat (TMA) with 1.2 m primary
- Instruments:

– Imaging instrument:

  - Visible imaging channel: 0.5 deg^2, 0.10'' pixels, 0.16'' PSF FWHM, broad band R+I+Z (0.55-0.92mu), CCD detectors, galaxy shapes
  - NIR photometry channel: 0.5 deg^2, 0.3'' pixels, 3 bands Y,J,H (1.0-1.7mu), HgCdTe detectors, photo-z's

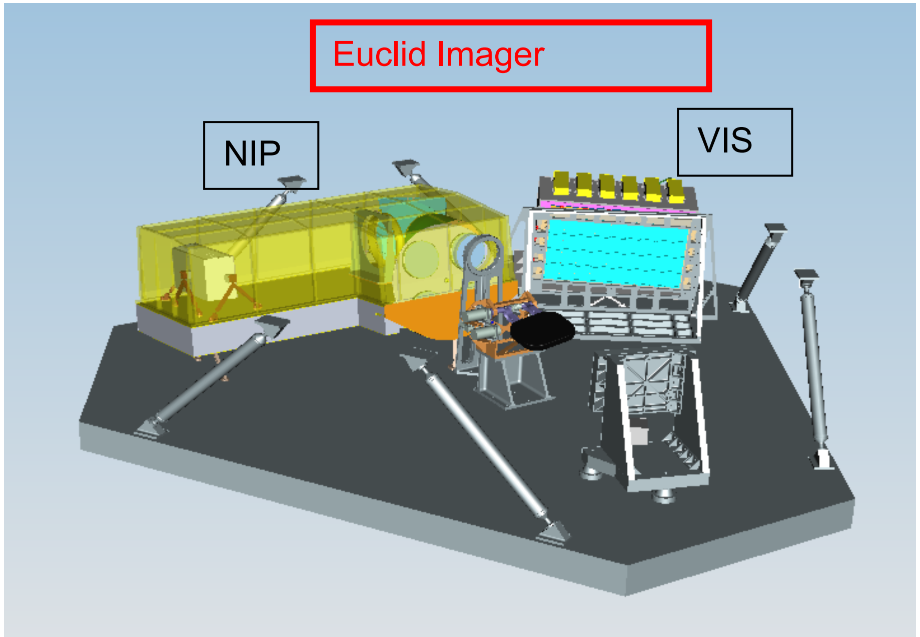
– NIR Spectroscopic channel: 0.5 deg^2, R=200-600, 0.9-1.7mu, slitless, redshifts



Euclid: imaging instrument

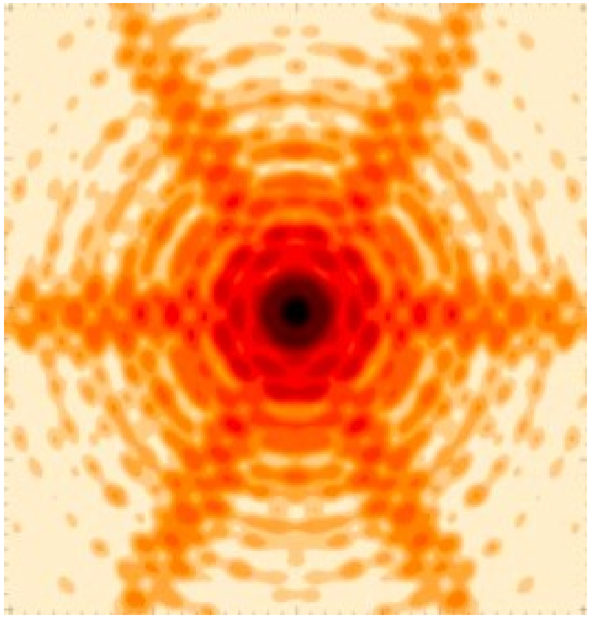
Imaging instrument:

- optimised for weak lensing
- Visible imaging channel: 0.5 deg^2, 0.10'' pixels, 0.16'' PSF FWHM, broad band R+I+Z (0.55-0.92mu), CCD detectors, galaxy shapes
- NIR photometry channel: 0.5 deg^2, 0.3'' pixels, 3 bands Y,J,H (1.0-2.0mu), HgCdTe detectors, photo-z's



Control of systematics:

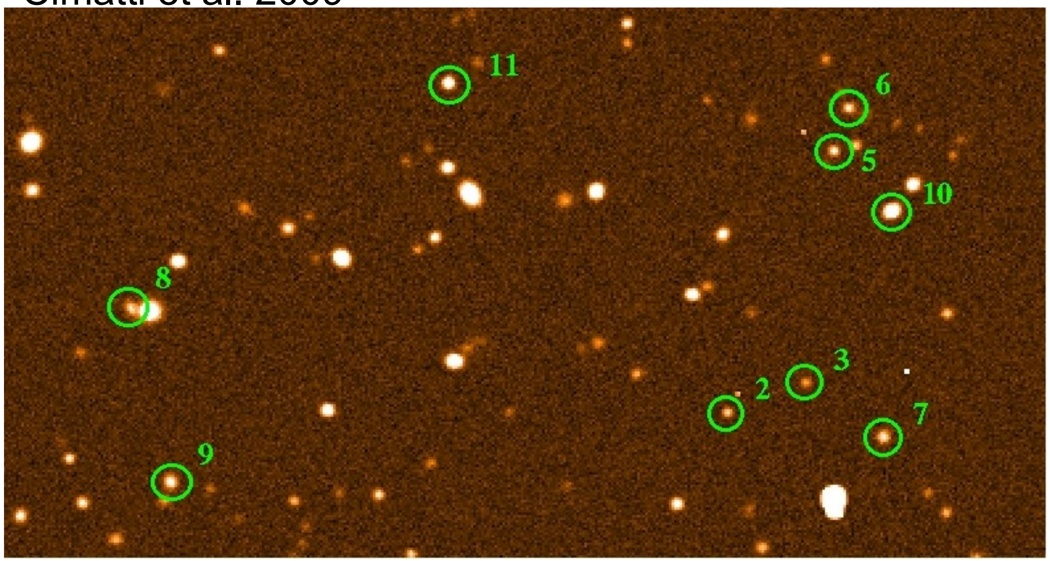
- Tight requirements
    - on PSF ellipticity and stability,
    - thermo-elastic distortions,
    - attitude control,
    - detector performance
- Instrument performance simulations
- Integrated data handling and calibration chain



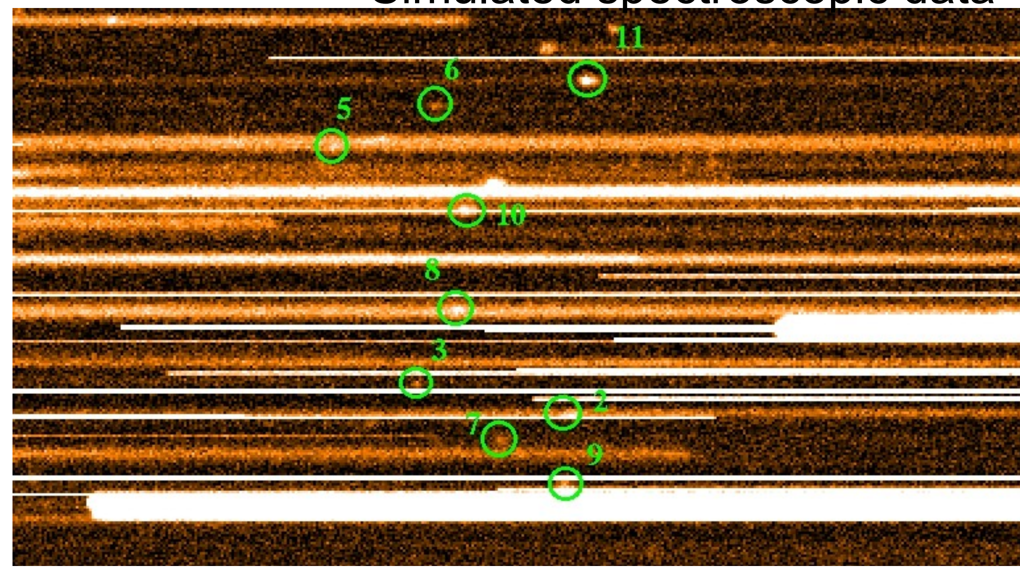
Euclid: redshifts with slitless spectroscopy
Primary targets : emission line galaxies

$\lambda/\Delta\lambda=500$ 1-2 μm FoV=0.5 deg^2

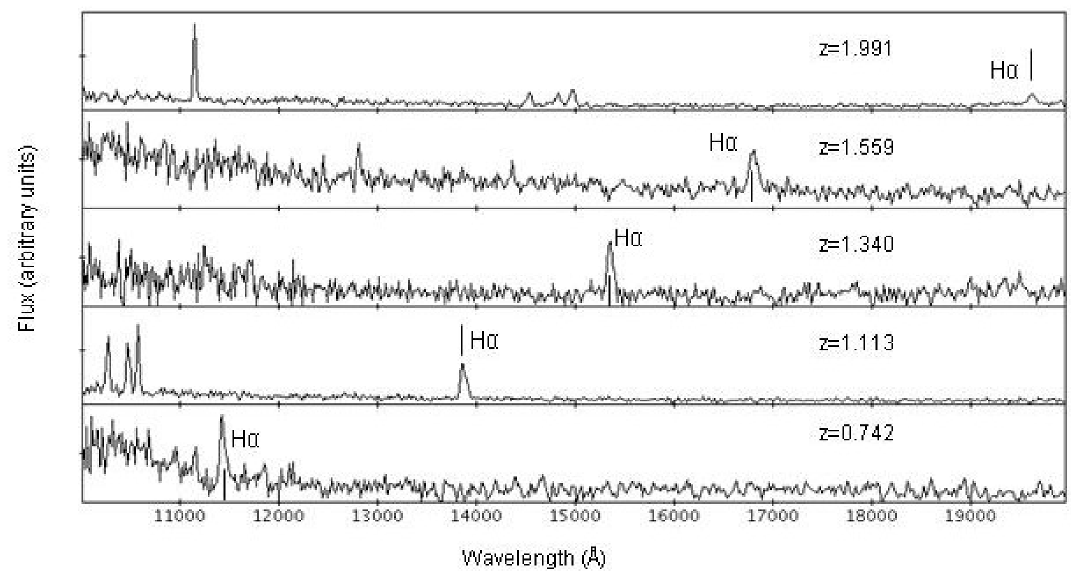
Cimatti et al. 2009



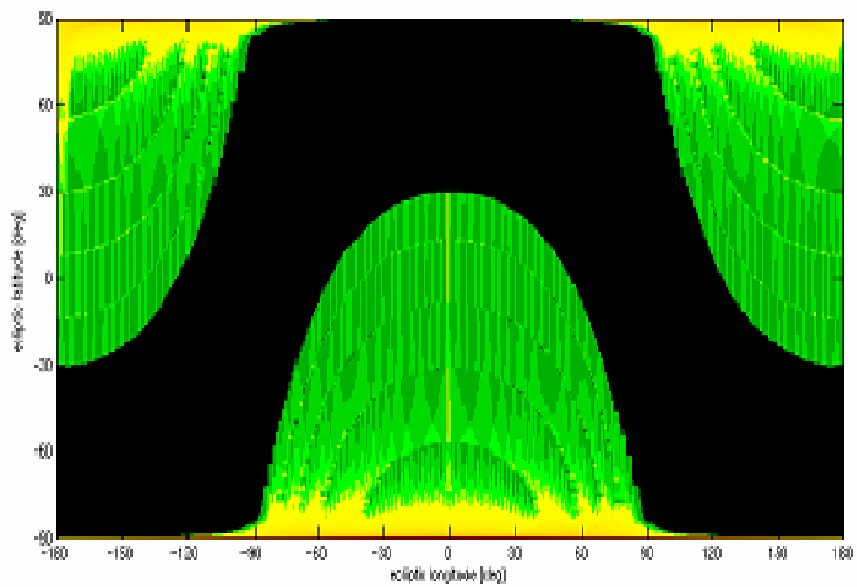
Simulated spectroscopic data

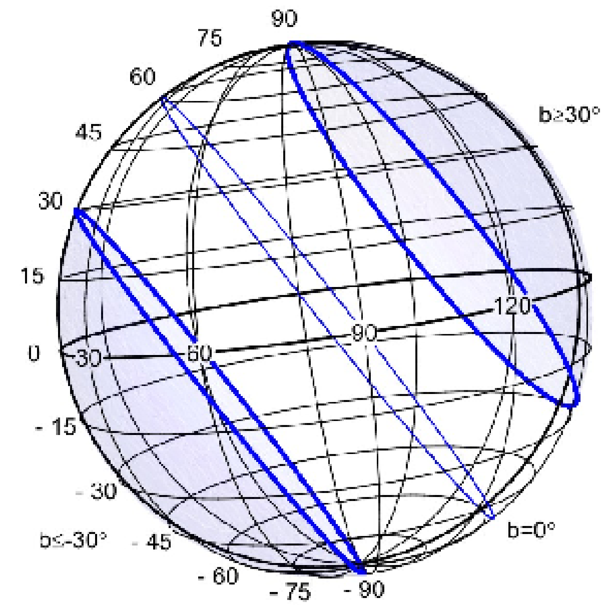


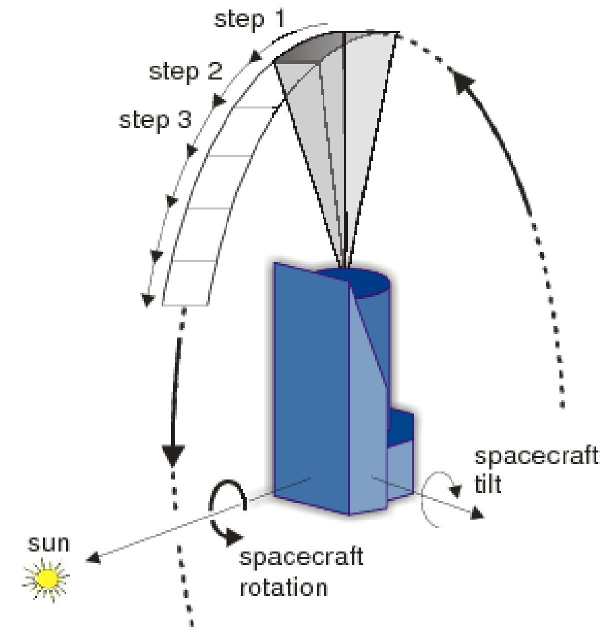
- Star-forming galaxies
- 0.5<z<2 (Hα)
- F_{line}> 4×10^{-16} erg/s/cm^2 (H<19.5)
- $\sigma_z \leq 0.001(1+z)$
- Redshift success rate ≥ 50%
- N(gal) ≈ 4 x 10^7
- Sky coverage = 20,000 deg^2
- Mission duration ≤ 5 years



Euclid mission baseline: surveys



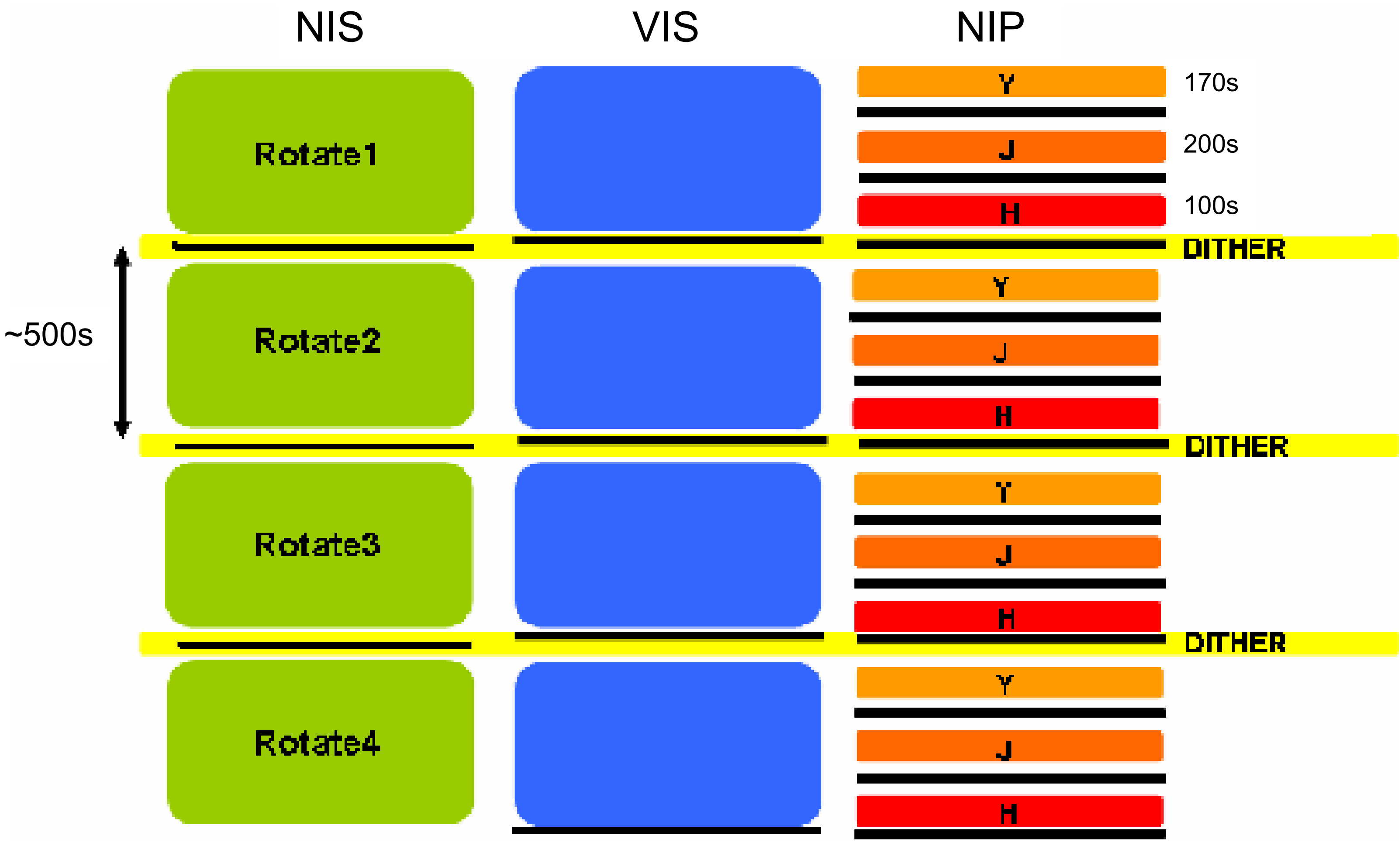




- Wide survey : 20000 deg^2 in patches of 100 deg^2
- Deep survey : 40 deg^2 in patches of 10deg^2

- Instantaneous field: 0.586 x 0.787 deg^2
- Each field observed in 4 dithers, with offsets of 115 arcsec and 60 arcsec in latitude and longitude respectively
- One strip scanned per day: 0.787 deg^2 in longitude x 21 deg^2 in latitude

Euclid mission baseline: observation sequence



Euclid mission baseline: surveys

Wide Survey: 20,000 deg^2: Extragalactic sky.

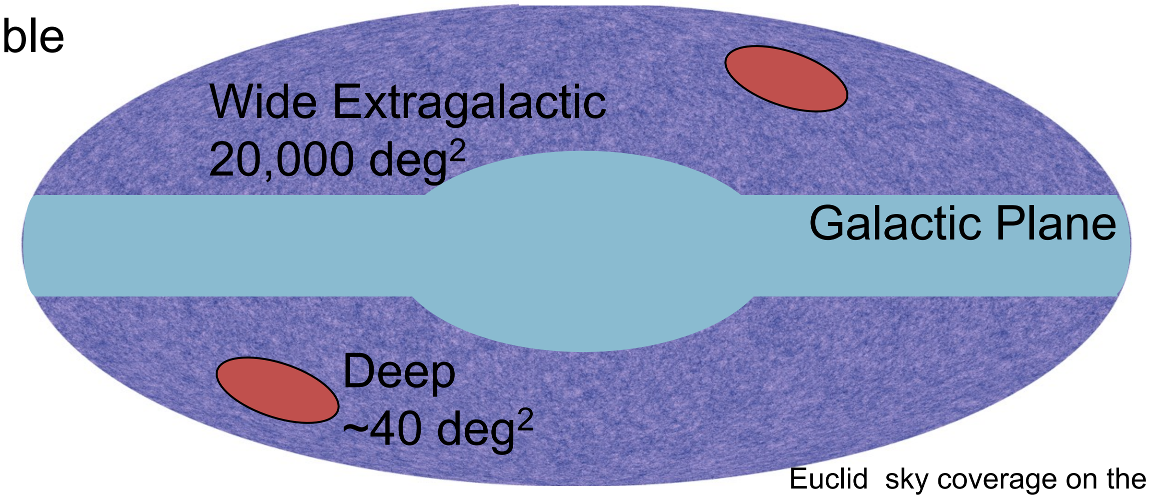
- Visible: Galaxy shape measurements for 2.10^9 galaxies to $RIZ_{AB} \leq 24.5$ (AB, 10σ) at 0.16" FWHM ➔ 30-40 resolved galaxies/amin^2, with a median redshift z~ 0.9
- NIR photometry: Y, J, $H \leq$ 24 (AB, 5σ PS) ➔ photo-z's errors of 0.03-0.05(1+z) with ground based complement (PanStarrs-2, DES. etc)
- Spectroscopy: redshifts for 70.10^6 galaxies with emission line fluxes >4.10^{-16} ergs/cm^2/s at 0<z<2 (slitless)

Deep Survey: 40 deg^2 deg^2 at ecliptic poles

- Monitoring of PSF drift (40 repeats at different orientations over life of mission)
- +2 magnitude in depth for both visible and NIR imaging data.

Possible additional Galactic surveys:

- Short exposure Galactic plane
- High cadence microlensing extra-solar planet surveys



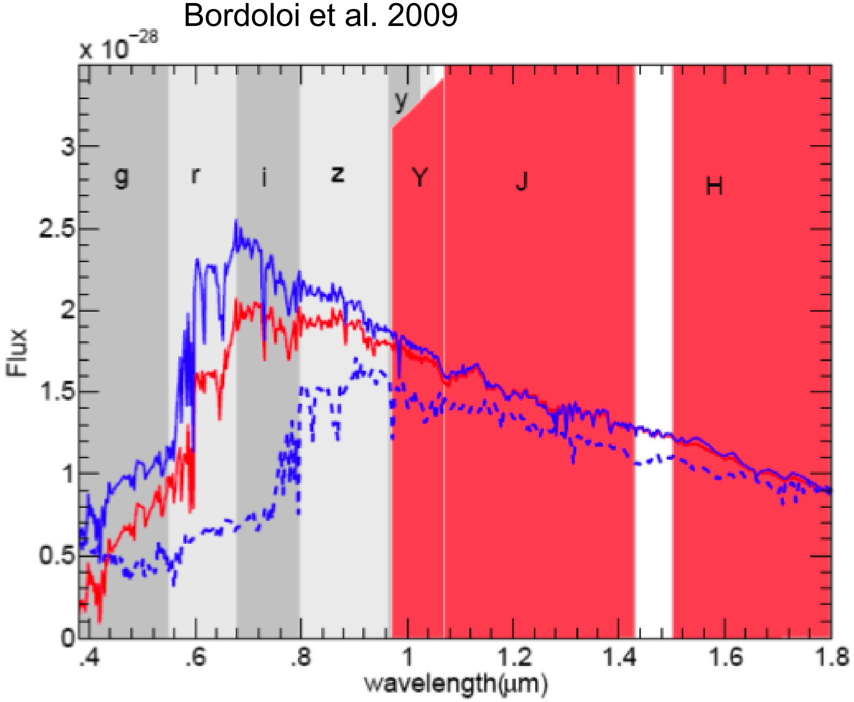
Euclid sky coverage on the Mare-Nostrum simulation Teyssier et al 2009

Ground-Space synergy and photometric redshifts

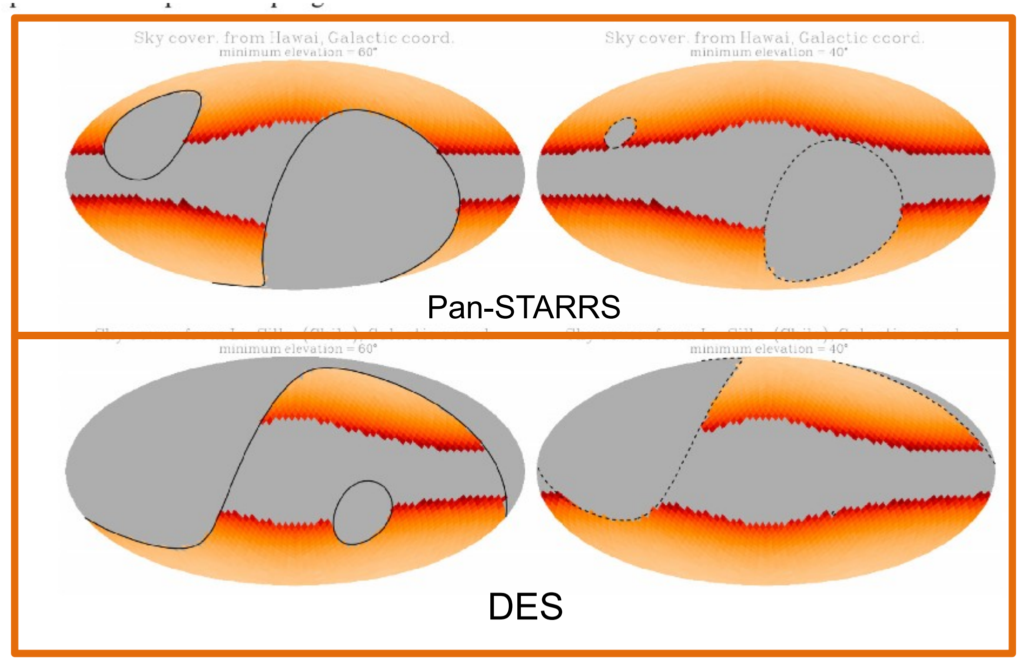
Photometric redshift precision : σ(z)/(1+z)=0.03(goal)-0.05(rq't):

- Combine Euclid visible/NIR photometry with visible photometry from the ground
- DES+Pan-STARRS2+LSST provide necessary depth and combined sky coverage for photo-z's → letters of support from DES and Pan-STARRS

Bordoloi et al. 2009

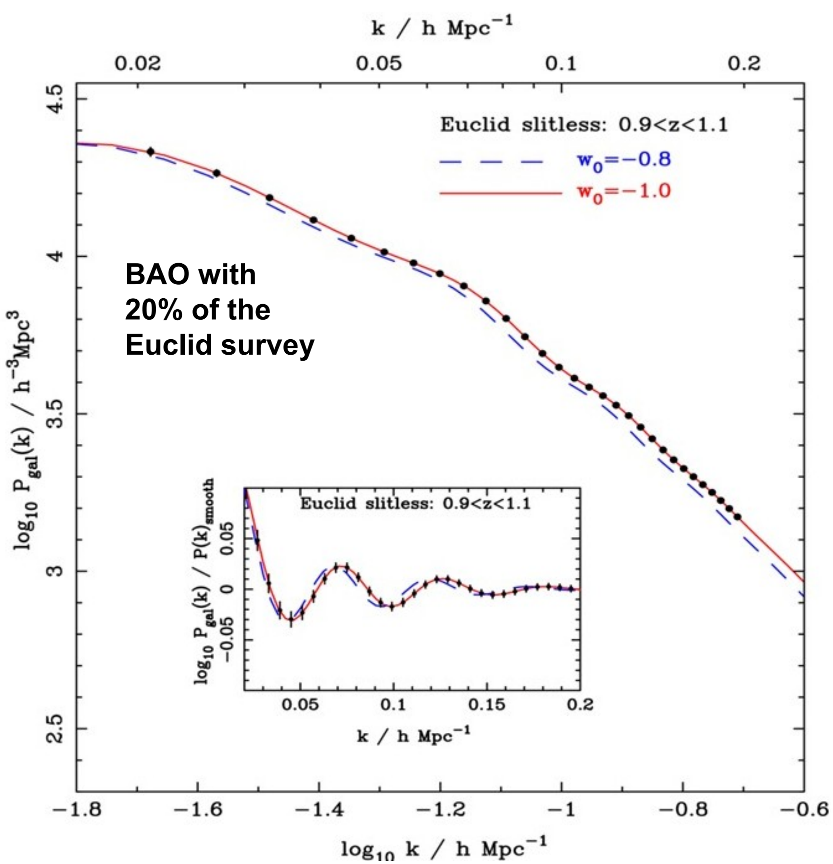


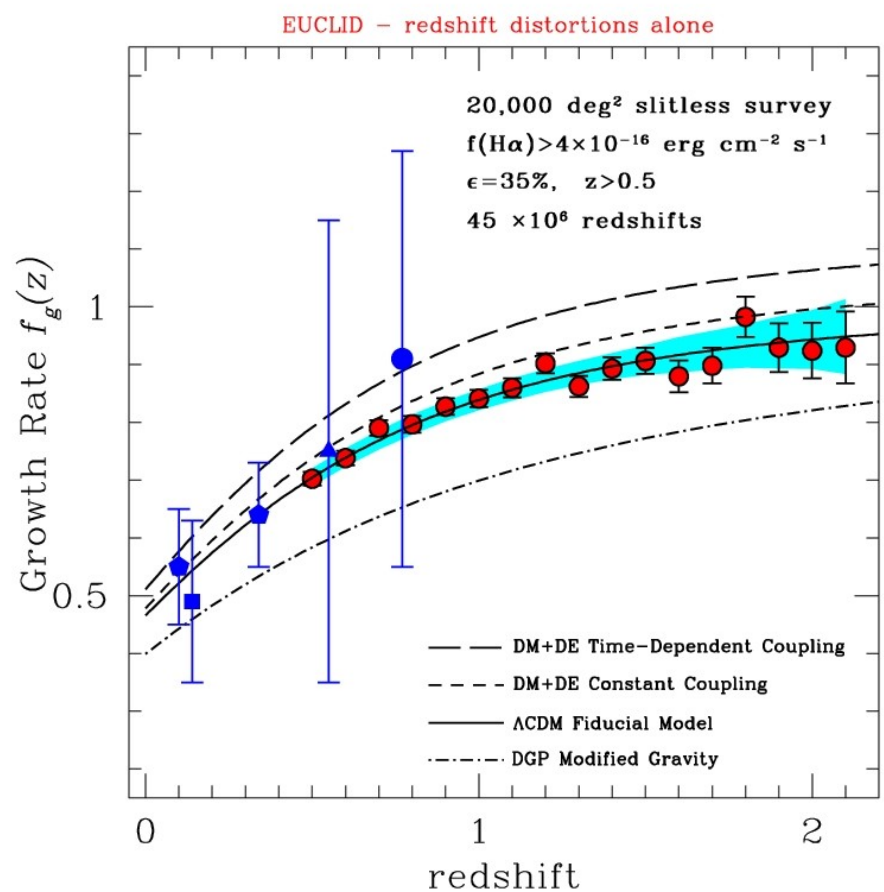
Paulin-Henriksson et al. 2009



Galaxy Clustering with Euclid: Expectations for BAO and redshift-distortion

- $V_{eff} \approx 19\ h^{-3}\ Gpc^3 \approx 75$x larger than SDSS
- Redshifts $0<z<2$
- $50\ 10^6$ redshifts: BAO, $P(k)$ and redshift space distortion





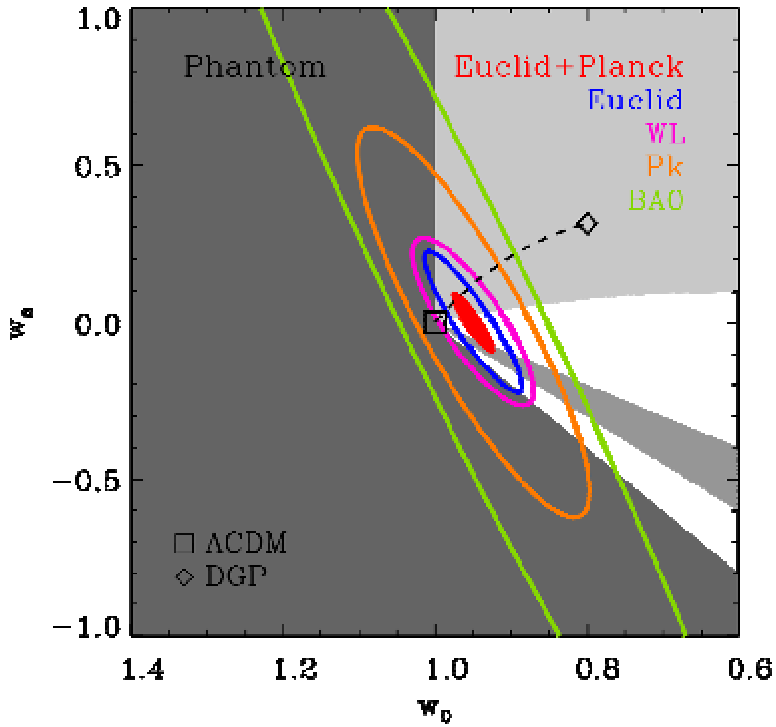
Cosmology with Euclid: expectation for dark energy

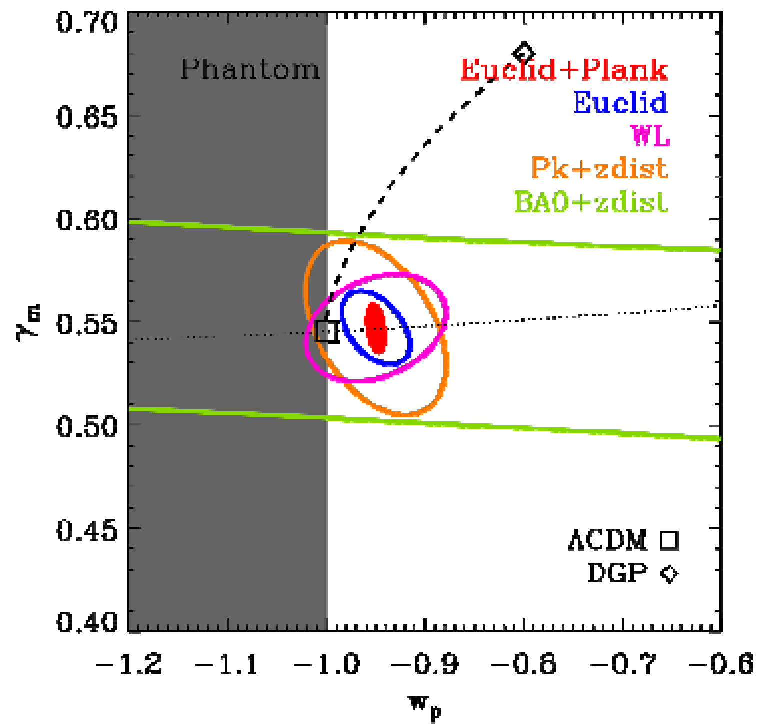
Dark Energy: w_p and w_a with an error of 2% and 13% respectively (no prior)

Dark Matter: test of CDM , precision of 0.04 eV on sum of neutrino masses (with Planck)

Initial Conditions: constrain shape of primordial power spectrum, primordial non-gaussianity

Gravity: test GR by reaching a precision of 2% on the growth exponent γ ($d\ln\delta_m/d\ln a \propto \Omega_m^{\gamma}$)



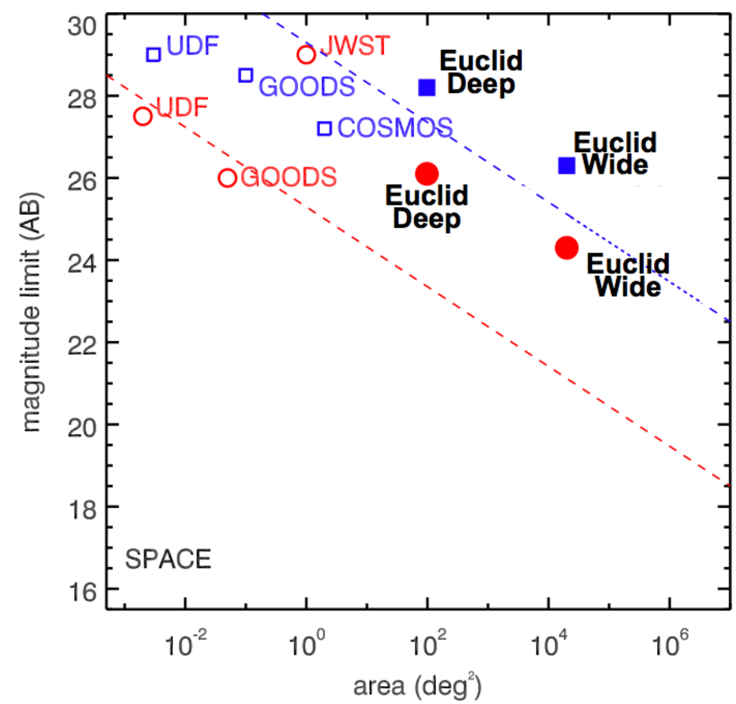


Cosmology with the current Euclid mission baseline

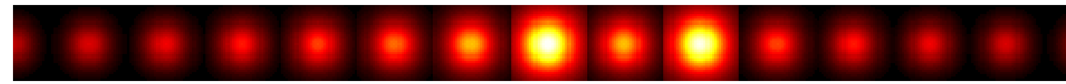
	Δw_p	ΔW_a	$\Delta\Omega_m$	$\Delta\Omega_\Lambda$	$\Delta\Omega_b$	$\Delta\sigma_8$	Δn_s	Δh	DE FoM
Current+WMAP	0.13	-	0.01	0.015	0.0015	0.026	0.013	0.013	~10
Planck	-	-	0.008	-	0.0007	0.05	0.005	0.007	-
Weak Lensing	0.03	0.17	0.006	0.04	0.012	0.013	0.02	0.1	180
Imaging Probes	0.018	0.15	0.004	0.02	0.007	0.009	0.014	0.07	400
Euclid	0.016	0.13	0.003	0.012	0.005	0.003	0.006	0.020	500
Euclid +Planck	0.01	0.066	0.0008	0.003	0.0004	0.0015	0.003	0.002	1500
Factor Gain	13	>15	13	5	4	17	4	7	150

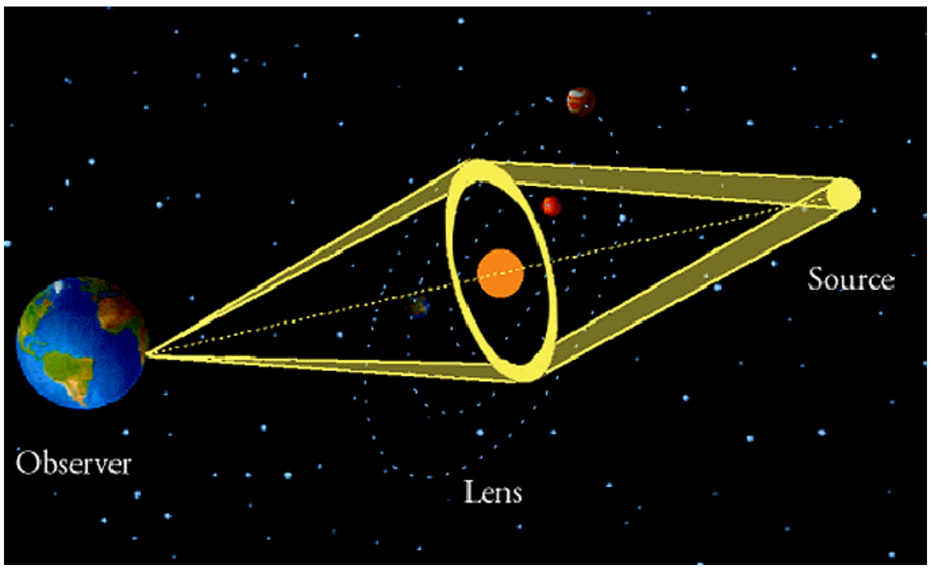
Euclid legacy science

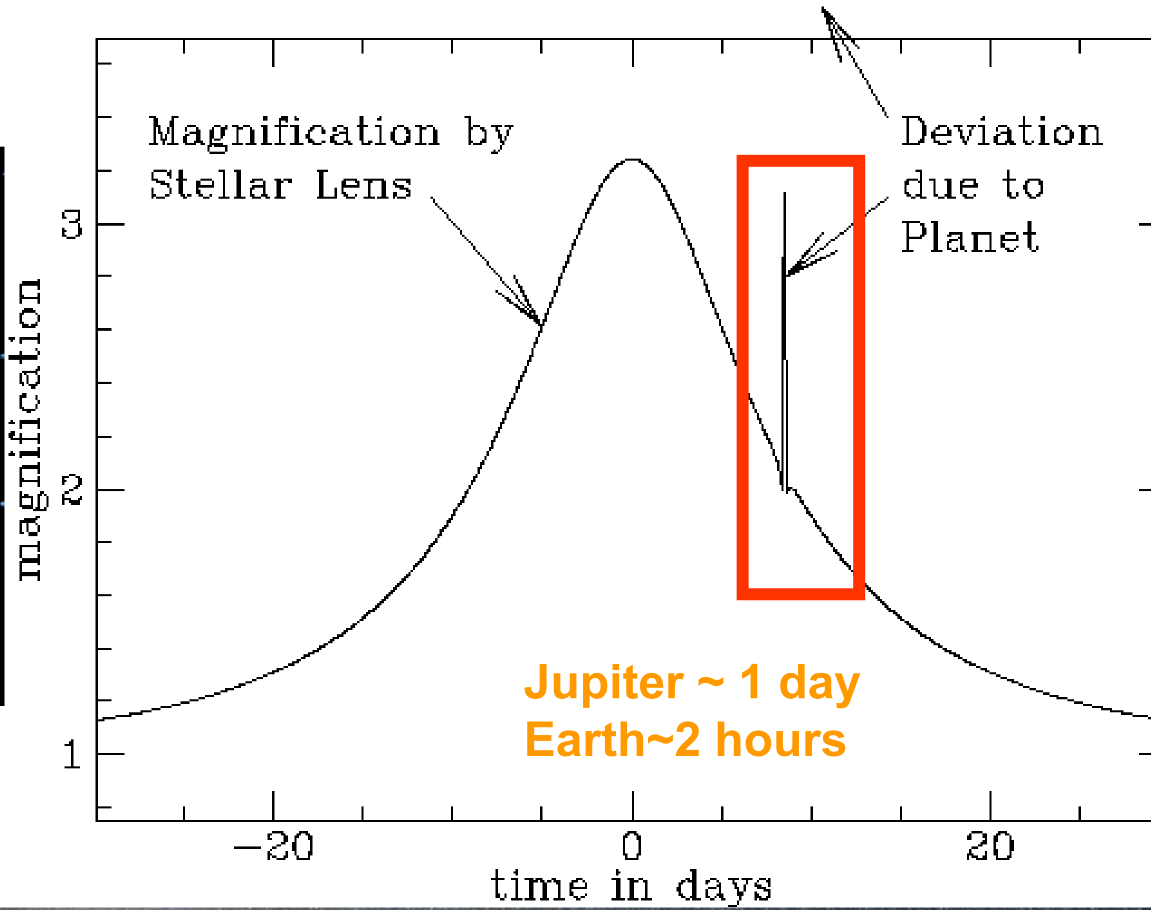
- Unique legacy survey: 2 billion galaxies imaged in optical/NIR to mag 24, 70 Million NIR galaxy spectra, full extragalactic sky coverage, Galactic sources
- Unique datase for astronomy: galaxy evolution, search for high-z objects, clusters, strong lensing, brown dwarfs, exo-planets, etc
- Synergies: JWST, Planck, Erosita, GAIA, DES, Pan-STARRS, LSST, etc
- All data publicly available through a legacy archive



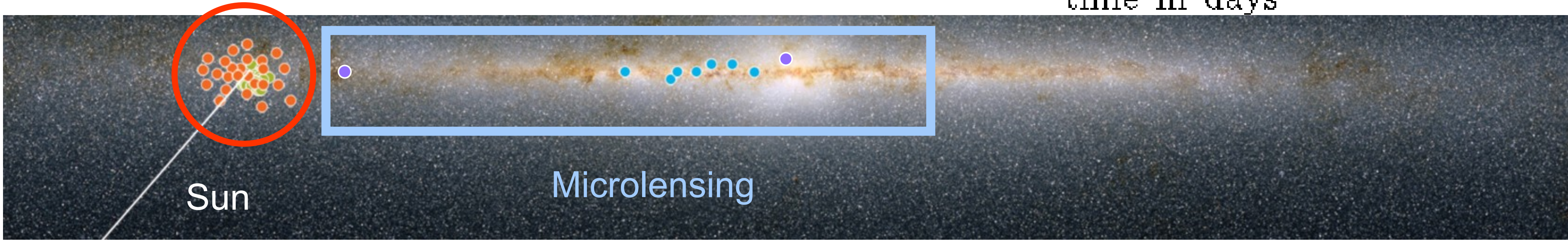
Euclid-microlensing and the detection of planets



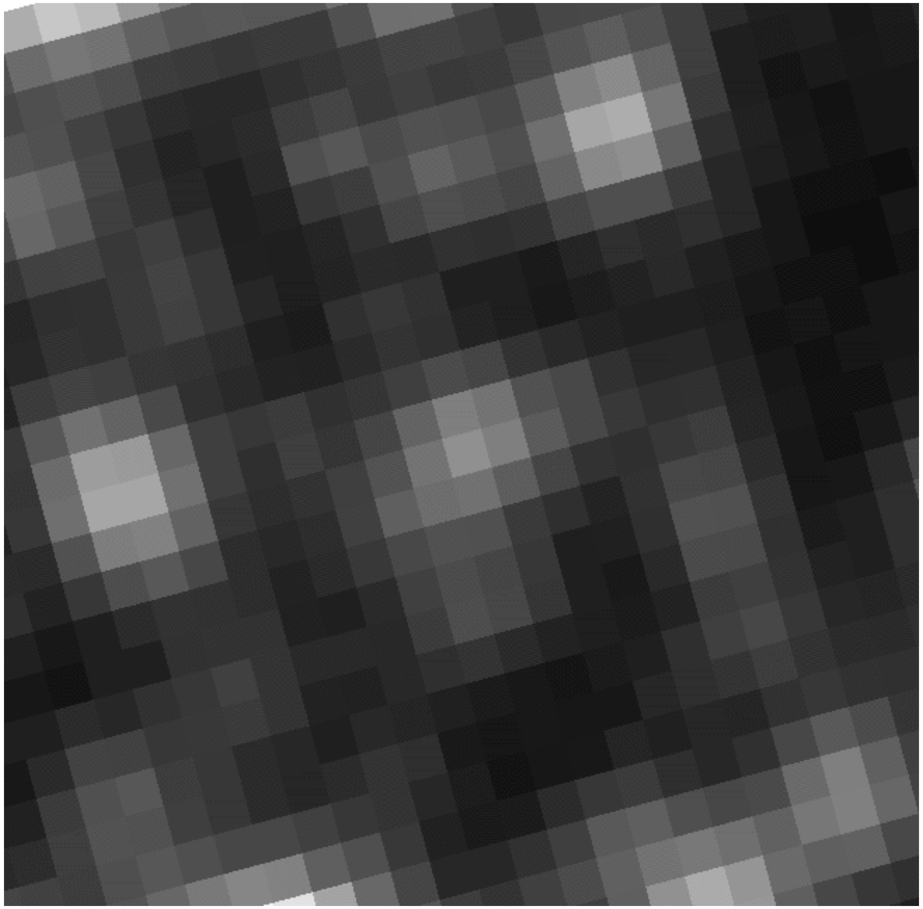


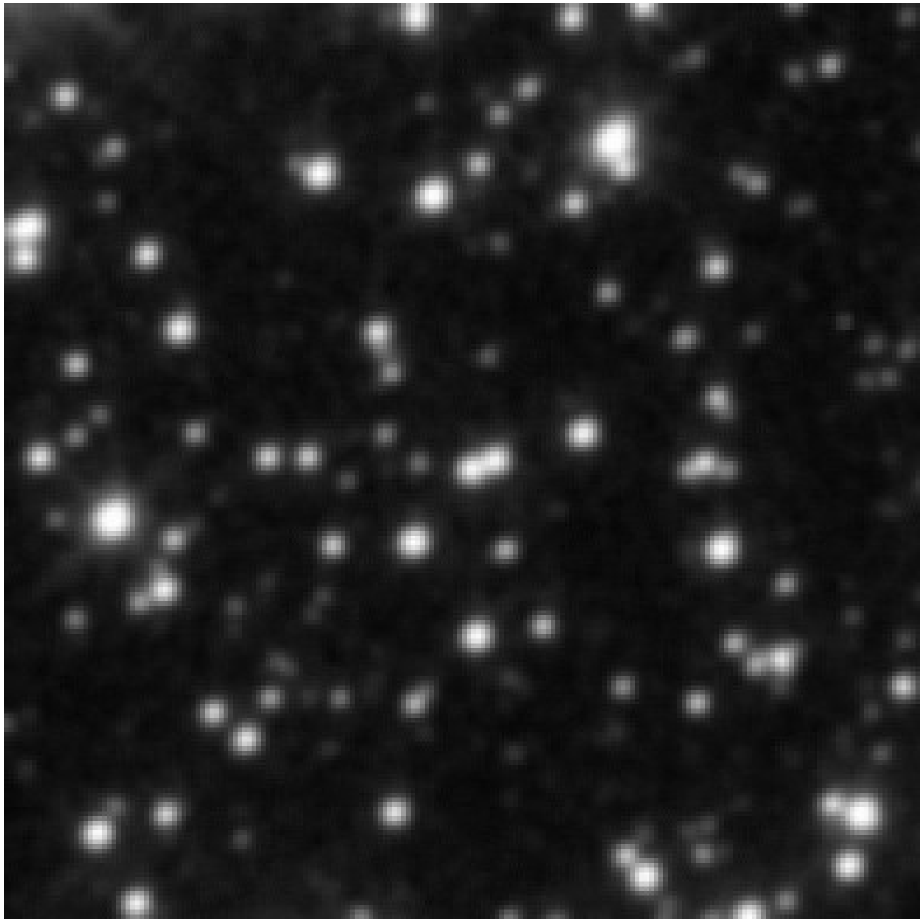


Radial velocities & transits



Ground-based confusion, space-based resolution

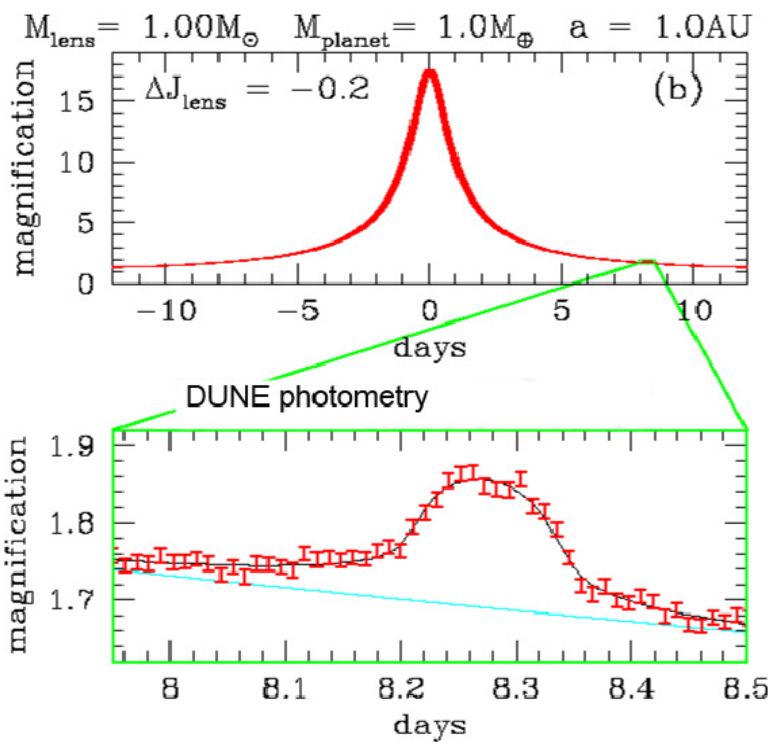


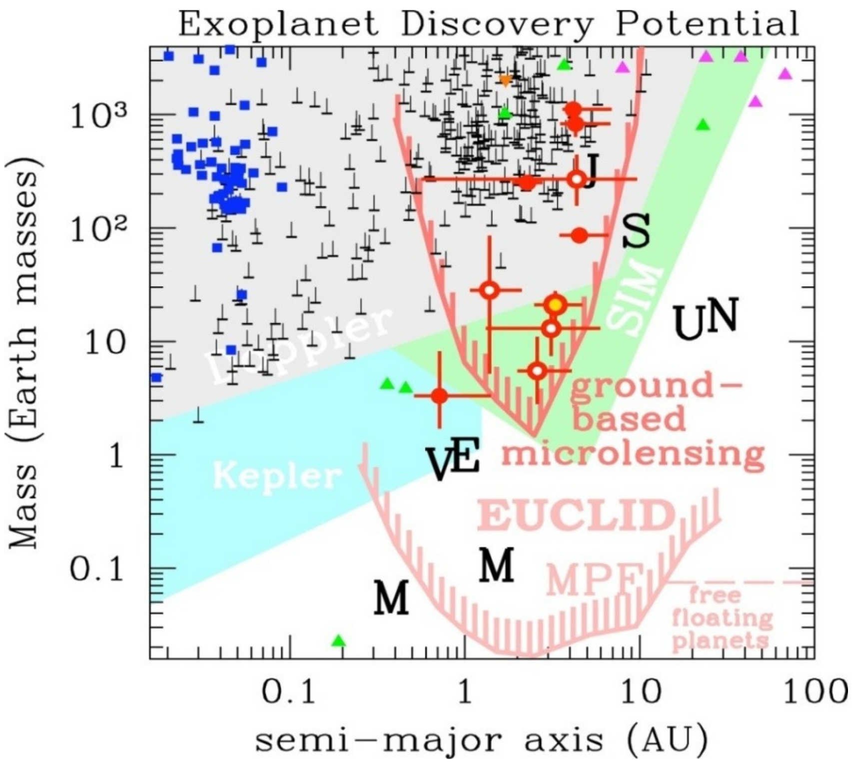


- Main Sequence stars are not resolved from the ground
- Systematic photometry errors for unresolved main sequence stars cannot be overcome with deeper exposures (i.e. a large ground-based telescope).
- High Resolution + large field

Euclid: microlensing additional science

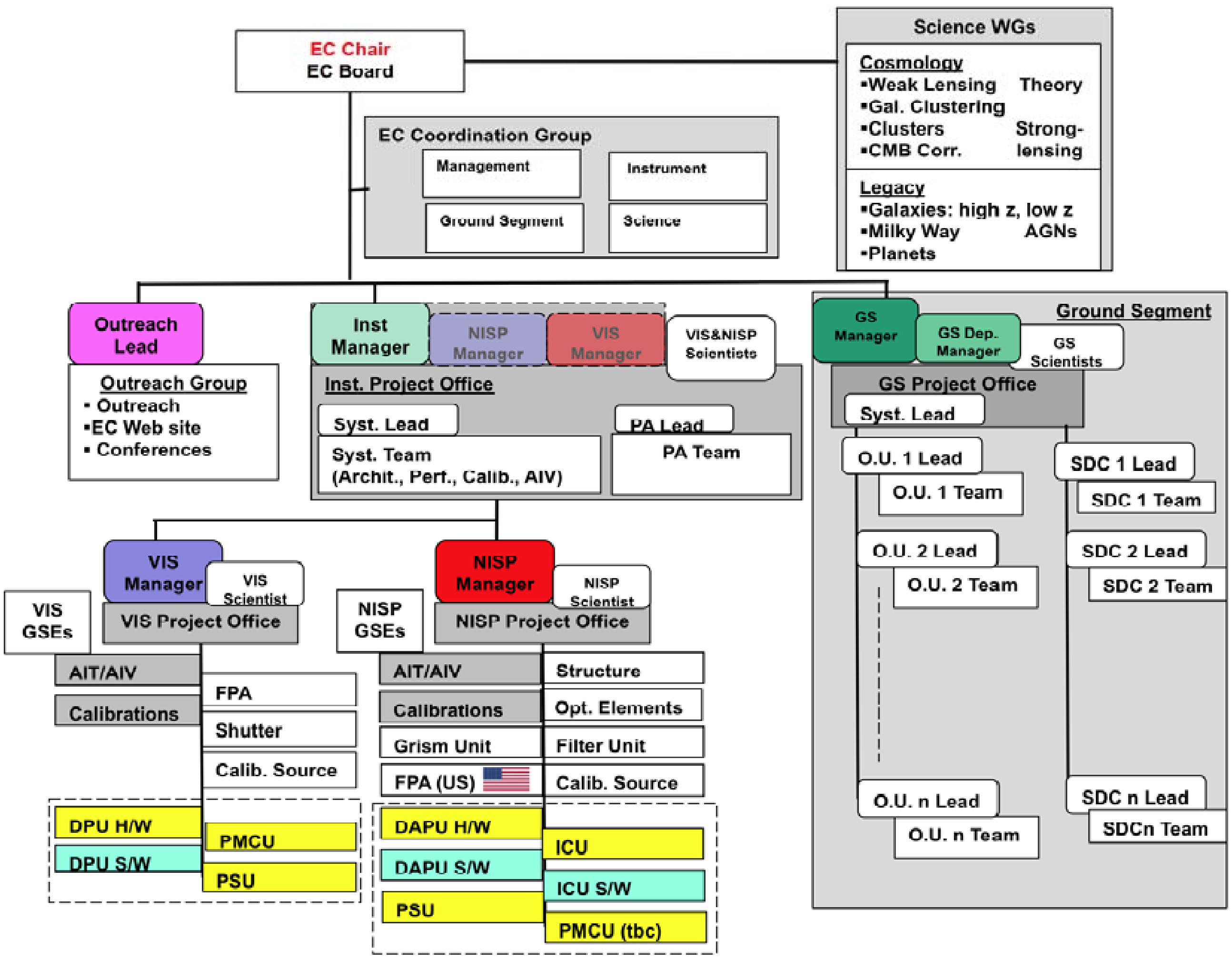
- Target field : 3 deg^2 centered at galactic coordinates (l = 1.125, b = - 1.75)
  - 3 months of observation ➔ down to Mars at snow line
  - + 9 months legacy prog ➔ habitable Earth?
- 540 sec exp. ➔ S/N ≈70 for mag 22 in visible, S/N≈90 for mag 21 in H.
- Perfect tool beyond Euclid: Euclid+WFIRST ➔ Sensitivity down to mass of Mars





Euclid Consortium : organisation

Euclid Consortium: 250 people, in 25 institutes, in 9 countries



Top level responsibilites:

- Euclid Consortium Lead
- Euclid Consortium Board
- Coordination group
- Science group
- Instrument Group: PMs, instrument scientists
- SGS group: PM, dPM/System lead, SGS scientist
- Communication group

Interactions:

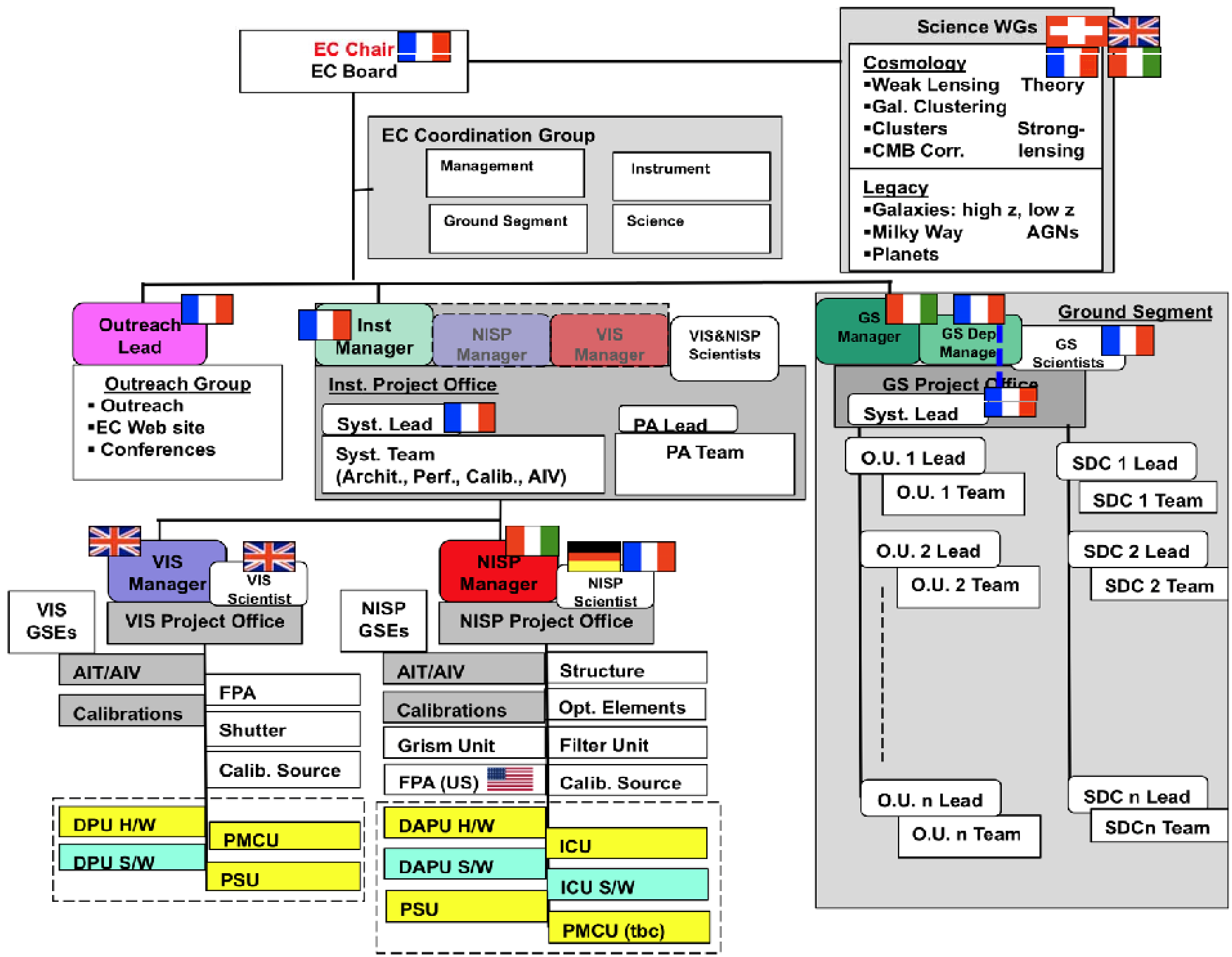
- Steering group
- ESA:
  - Euclid Science Team
  - Project Managers

Euclid Consortium : organisation

Euclid Consortium: 250 scientists & engineers, in 25 institutes,
In 10 countries: FR, IT, DE, UK, ES, NL, CH, NO, AT, US (+interest: PT,DK,FI,RO)

US :
contribution still debated

France:
- APC, CPPM, IAP, IAS, LAM +
- LATT, OCA
- CEA: IRFU/Sap, SPP , IPhT
- CNES



Euclid Consortium :
Board (ECB) and Coordination Group (ECG)

Responsibility		Country	Names	Note
ECL and France Rep		F	A. Refregier	
France Rep		F	O. Le Fèvre	
Italy Reps		I I	A. Cimatti R. Scaramella	
Germany Reps		G G	R. Bender H.W. Rix	
UK Reps		UK UK	M. Cropper R. Nichol	
Spain Reps		SP SP	F. Castander R. Rebolo Lopez	
Switz. Rep		CH	S. Lilly	
Netherland Rep		NL	H. Rottgering	
Norway Rep		NO	P. Lilje	
Austria Rep		AU	W. Zeilinger	
US Rep		US	J. Rhodes	

Responsibility		Country	Names	Note
ECB/EST Reps	ECB chair	F	A. Refregier	
	ECB/EST reps (2 TBC)			
Managers	Instrument manager	F	J.L. Augueres	
	VIS manager	UK	R. Cole	
	NISP manager	I	F. Valenziano	
	GS manager	I	F. Pasian	
System leads	Instrument sys lead	F	J. Amiaux	
	GS sys lead	F	T. Levoir	
Scientists	Cosmology coords	CH I UK	A. Amara G. Guzzo W. Percival	
	Legacy coords		TBD	Rotating
	GS scientist	F	Y. Mellier	●
	VIS scientist	UK	M. Cropper	Temporary
	NISP scientists	G F	R. Holmes A. Ealet	
Communication	Communication lead	F	A. Rassat	

● = IAP staff

Euclid Consortium : EST (EC members) and ESG (EC)

Responsibility		Country	Names	Note
EST EC Members	Survey scientist & ECL	F	A. Refregier	
	Legacy scientist	CH	S. Lilly	
	VIS EST scientist	UK	M. Cropper	
	NISP EST spec. scientist	I	A. Cimatti	
	GS scientist I	G	H.-W. Rix	
	GS scientist II	SP	F. Castander	

Coordinators		Country	Names	Note
Cosmology WGs coordinators	Cosmology Coords	CH, I, UK	A. Amara, L. Guzzo, W. Percival	
	Weak lensing	CH,UK F	A. Amara, S. Bridle Dpty: K.Benabed	
	Galaxy clustering	I,UK	L. Guzzo, W. Percival	
	Clusters	I,G F	Moscardini ,Weller, Dpty: TBD [F]	
	CMB x-correlations	F,I	N. Aghanim, C. Baccigalupi	
	Strong Lensing	I,F	M. Meneghetti, J.P. Kneib	
	Cosmo Theory	G,CH	L. Amendola, M. Kunz	
Legacy WGs coordinators	Legacy Coordinators	[rotating]	[rotating]	
	Primeval galaxies	CH,F	M. Carollo, Cuby	
	Galaxy/AGN evolution	NL,F,I	J. Brinchmann, D. Elbaz, G. Zamorani	
	Nearby Galaxies	I,UK	G. Gavazzi, M. Irwin	
	Milky Way	NL,UK	A. Helmi, S. Warren	
	Planets	F,SP	J.P. Beaulieu, M. Zapatero-Osorio	
	SNe & Transients	UK/I,F I	I. Hook, C.Tao Dpty: Manucci	
Cosmo. Simulation WG coordinators		SP,F/CH	P. Fosalba, R. Teyssier,	

Euclid Consortium : Project Office and instruments

Instrument Project Office:

Responsibility		Country	Name	Note
Project managers	Instrument Manager	F	J.-L. Augueres	
	VIS Manager	UK	R. Cole	
	NISP Manager	I	L. Valenziano	
System group	System lead	F	J. Amiaux	
	Optical architect	G	F. Grupp	
	Th-Mech architect	F	T. Tourette	
	Electrical architect	F	C. Cara	
	Software architect	I	A. Di Giorgio	
	CCD lead	UK	D. Walton	
	NISP FPA det. lead	I	F. Bartoletto	
	VIS system lead	UK	A. James	
	NISP system lead	I	F. Zerbi	
	VIS inst. scientist	UK	M. Cropper	Temporary
	NISP photo. Inst. scientist	G	R. Holmes	
	NISP spectro inst. scientist	F	A. Ealet	
	Calibration lead?			
PA/QA lead		F	J. Fontignie	

VIS instrument:

Responsibility		Country	Name	Note
VIS project office	Project manager	UK	R. Cole	
	Inst. scientist	UK	M. Cropper	Temporary
	System lead	UK	A. James	
	PA/QA manager	UK	A. Spencer	
VIS FPA	VIS FPA lead	F	J-L Augueres	
	Subsystem eng.	F	J. Amiaux	
	Th-Mech assembly	F	S. Cazaux	
	Thermal shielding	F	S. Cazaux	
	Thermal control	F	S. Cazaux	
	CCD+harness	UK	D. Walton	
	ROE+PSU+harness	UK	P. Guttridge	
Shutter		CH	A. Glauser	
Calibration Unit		F	F. Rouesnel	
VICDPU	VICDPU lead	I	A. Di Giorgio	
	PDHU	I	A. Di Giorgio	
	PMCU	F	C. Cara	
AIV/AIT		F	J. Amiaux	
GSE		F	F. Rouesnel	

NISP instrument:

Responsibility		Country	Name	Note
NISP project off.	Project manager	I	L. Valenziano	
	Inst. Scien. photo	G	R. Holmes	
	Inst. Scien. spectro	F	A. Ealet	
	System lead	I	F.M.. Zerbi	
	PA/QA manager	I	TBD	
NIOMA	NIOMA lead	F	E. Prieto	
	Optics	G	F. Grupp	
	FWA	SP	F. Madrid	(CH as backup)
	Design	SP	F.Madrid	
	Filters	G	R. Holmes	
	Mechanism	F	J. Amiaux	(SP interest)
	Struct. Manufact.	SP	F. Madrid	
	GWA	I	M. Riva	
	Design		M.Riva	
	Grisms	F	E. Prieto	TB discussed
	Mechanism	F	J. Amiaux	(SP interest)
	Struct. Manuf.	SP	F. Madrid	(SP interest)
	Calibration Unit	G	R. Holmes	NL as backup
	Th-Mech structure	F	L. Martin	I contribution
FPA	FPA lead	I	F. Bortoletto	
	[FPA]	[US]		[ESA procurement]
	FPA Design	I		G participation
	Detector characterisation	F	C. Cerna	G,I participation
Warm electronics	lead	I	L. Corcione	TBC
	NI-DPU	I	L. Corcione	
	NI-ICU	SP	R. Toledo	IT contribution (SW)
	NI-PSU	I	L. Corcione	
	NF-PSU	US		
AIV/AIT	Phase 1 opto-mech	F	E. Prieto	
	Phase 1 Detectors	US		
	Phase 1: WE+DS	I	M. Trifoglio	
	Phase 2 final	I	M. Trifoglio	
GSE		I,F,G,SP,NL		To be discussed

Euclid Consortium : Ground Segment

Responsibility		Country	Names	Note
GS Project Off.	GS manager	I	F. Pasian	
	GS deputy manager and system lead	F	T. Levoir	temporary
	GS scientist	F	Y. Mellier	
OUs	OU1 VIS imaging	coord: F dpty: UK	C.Grenet	
	OU2 NIR imaging	coord: I dpty: NL	A.Grazian	
	OU3 NIR spectro	coord:I dpty: F	B.Garilli	
	OU4 non-Euclid	coord: NL dpty: G	G.Verdoes-Kleijn	
	OU5 simulations	coord:SP dpty:F		
	OU6 merging	coord:I dpty: F	A.Fontana	
	OU7 spectra	coord:F dpty: I		
	OU9+10 level 3	coord: F dpty: I,UK	S. Borgani	
	OU11shear	coord: UK dpty: CH		
	OU12 photo-z	coord: CH dpty: SP		
SDCs	SDC UK manager	UK	K. Noddle	
	SDC CH manager	CH	S. Paltani	
	SDC I manager	I	A. Zacchei	
	SDC F manager	F		
	SDC NL manager	NL	O.R.Williams	
	SDC SP manager	SP	C. Neissner	
	SDC G	G	J. Koppenhöfer	
System Team	System Lead	F	T.Levoir	temporary
		F	J-M.Delouis	
		I	M.Frailis	
		N	S.V.H. Haugan	
		UK	R.Mann	
		UK	K.Noddle	
		F	M.Poncet	
		F	C.Surace	
		I	C.Vuerli	
		NL	O.R.Williams	
		I	A.Zacchei	

… IAP and Euclid

Country	Lab	Lab Position	Surname	First name	e-mail	Tel. Office	Group	S.Gr	Other
FR	IAP	SGS, OU-1 Manager	Grenet	Catherine	grenet@iap.fr	0144328023	GS	OU-1	SDC-FR
FR	IAP	Science	Charlot	Stéphane	charlot@iap.fr	0144328183	SG	SG-GAE	
FR	IAP	SGS, Science	McCracken	Henry	hjmcc@iap.fr	0144328182	GS	OU-1	GC,OU-6
FR	IAP	SGS Scientist , Science	Mellier	Yannick	mellier@iap.fr	0144328140	GS	OU-1	WL,OU-6,SDC-F
FR	IAP	SGS, System Task	Delouis	Jean-Marc	delouis@iap.fr	0144328163	GS	GSYS	SDC-FR
FR	IAP	SGS, SDC, Science	Hudelot	Patrick	hudelot@iap.fr	0144328021	GS	OU-1	SDC-FR,WL,OU-
FR	IAP	SGS, SDC	Magnard	Frederic	magnard@iap.fr	0144328096	GS	SDC-FR	OU-1,GSYS
FR	IAP	SGS, Science	Gavazzi	Raphael	gavazzi@iap.fr	0155328016	GS	OU-1	SG,WL,CLS
FR	IAP	Science	Prunet	Simon	prunet@iap.fr	0144328176	SG	WL	SIM,COS
FR	IAP	Science	Colombi	Stéphane	colombi@iap.fr	0144328120	SG	SIM	
FR	IAP	Science	de Lapparent	Valérie	lapparent@iap.fr	0144328137	SG	SG-GAE	
FR	IAP	SGS, Science	Bertin	Emmanuel	bertin@iap.fr	0144325151	GS	OU-1	SG-GAE,OU6
FR	IAP	SGS, System Task	Sybille	Techene	techene@iap.fr		GS	GSYS	
FR	IAP	SGS, System Task	Alexi	Quentin	quentin@iap.fr	0144328153	GS	GSYS	
FR	IAP	SGS, System Task	Philippe	Riant	riant@iap.fr	0144328124	GS	GSYS	
FR	IAP	SGS, System Task	Sylvain	Mottet	mottet@iap.fr	0144328180	GS	GSYS	
FR	IAP	Director IAP	Laurent	Vigroux	vigroux@iap.fr	0144328160			
FR	IAP	SGS	Monnerville	Mathias	monnerville@iap.fr	0144328092	GS	GSYS	SDC-FR
FR	IAP	SGS, Science	Mamon	Gary	gam@iap.fr	0144328115	GS	OU-1	CLS
FR	IAP	SWG Planets	Beaulieu	Jean-Philippe	beaulieu@iap.fr	0144328119	SG	PL	
FR	IAP	Science	Uzan	Jean-Philippe	uzan@iap.fr	0144328026	SG	COS	WL
FR	IAP	Science	Peirani	Sébastien	peirani@iap.fr	0144328134	SG	SIM	WL,SL
FR	IAP	SWG Weak lensing	Benabed	Karim	benabed@iap.fr	0144328045	SG	WL	COS

Euclid Consortium : non-ESA cost

Assumptions:

- Instrument: NISP FPA from international partner, VIS detectors paid for and procured by ESA
- SGS: all OUs under EC responsibility
- CaC costs not including science and operations

Preliminary Cost Estimation:

- Instrument: 120M€
- SGS: 100M€
- Total (no margins): 220M€
- Total with 20% margins: 264M€ (+ ~350 M€ ESA contribution to M mission)

Preliminary Distribution: FR: 80M€, IT: 60M€, DE: 50M€, UK: 35M€, ES: 20M€, CH: 10M€, NL: 6M€, NO: 3M€, AT: 3M€: Total: 267M€

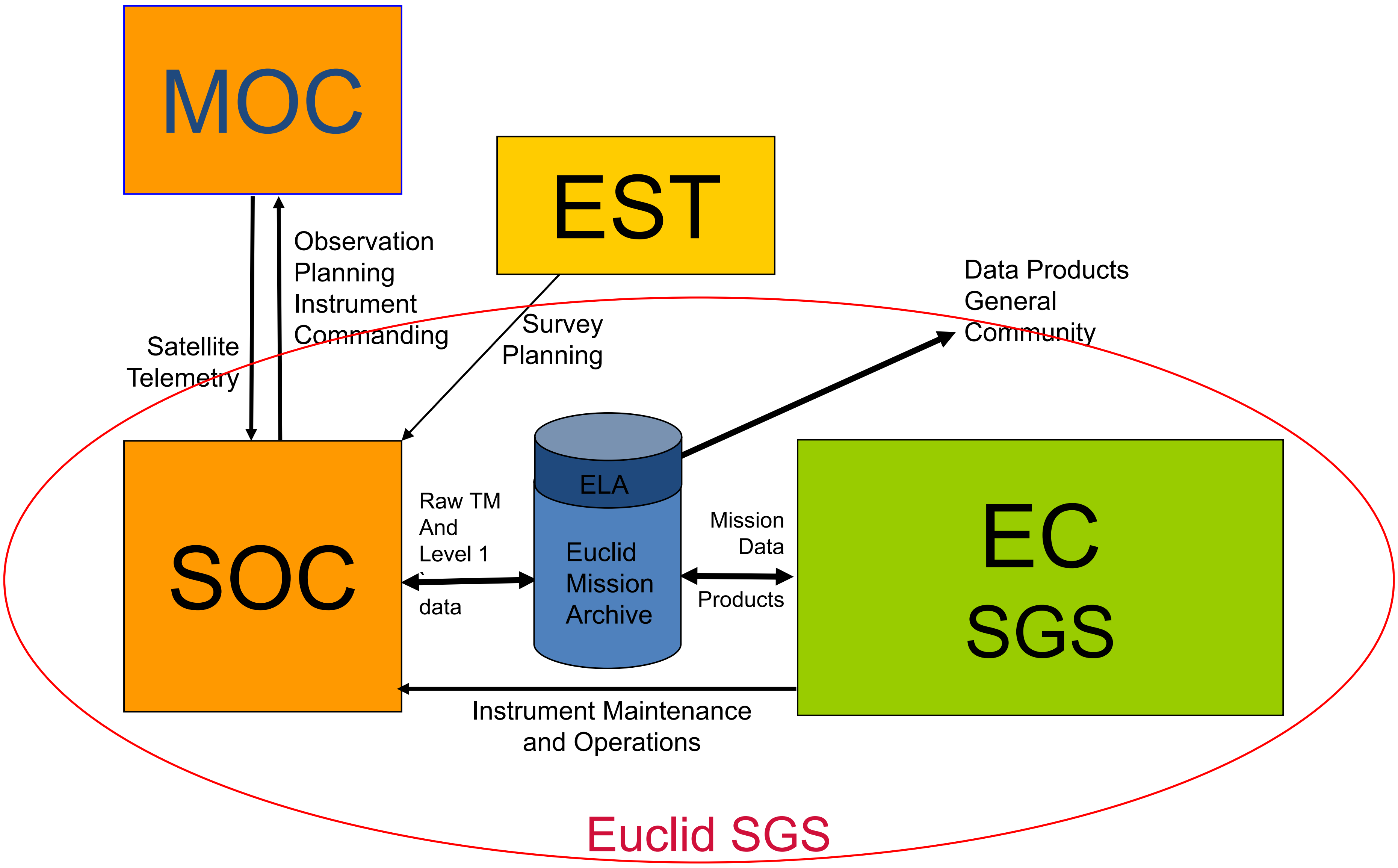
Note: Merging of NIP and NIS instruments has brought Euclid back into M-class mission margins

Project Status

- 2004: Dark Universe Mission proposed as a Theme to ESA's Cosmic Vision programme
- 2005: DUNE Phase 0 (pre-study) phase by CNES
- 2006: Recommendation of ESO/ESA Working Group on Fundamental Cosmology
- Oct 2007: DUNE and SPACE jointly selected for an ESA Assessment Phase
- May 2008: Validation of the merged concept *Euclid* by the ESA AWG
- Sept 2008: Recommendation from Astronet Infrastructure Roadmap report
- Sept 2008-Sept 2009: Assessment study phase (incl. IDECS attempt)
- 2010-2011: Definition phase
- March-May 2010: Baseline optimisation with EOAT (+US members, merging of NIP and NIS)
- April 2010: Formation of single Euclid Consortium
- July 2010: Definition phase ESA AO (due Oct 2010)
- October 2010: Definition phase NASA AO (TBC)
- February 2011: Formation of Euclid Science Team
- **June-Oct. 2011: M1/M2 Cosmic Vision Selection** (Solar Orbiter, PLATO, Euclid : 2 selected)
- 2012-2017: Implementation phase (if selected)
- 2017-2018: ESA launch of the Cosmic Vision M1/M2 missions

Euclid Ground Segment

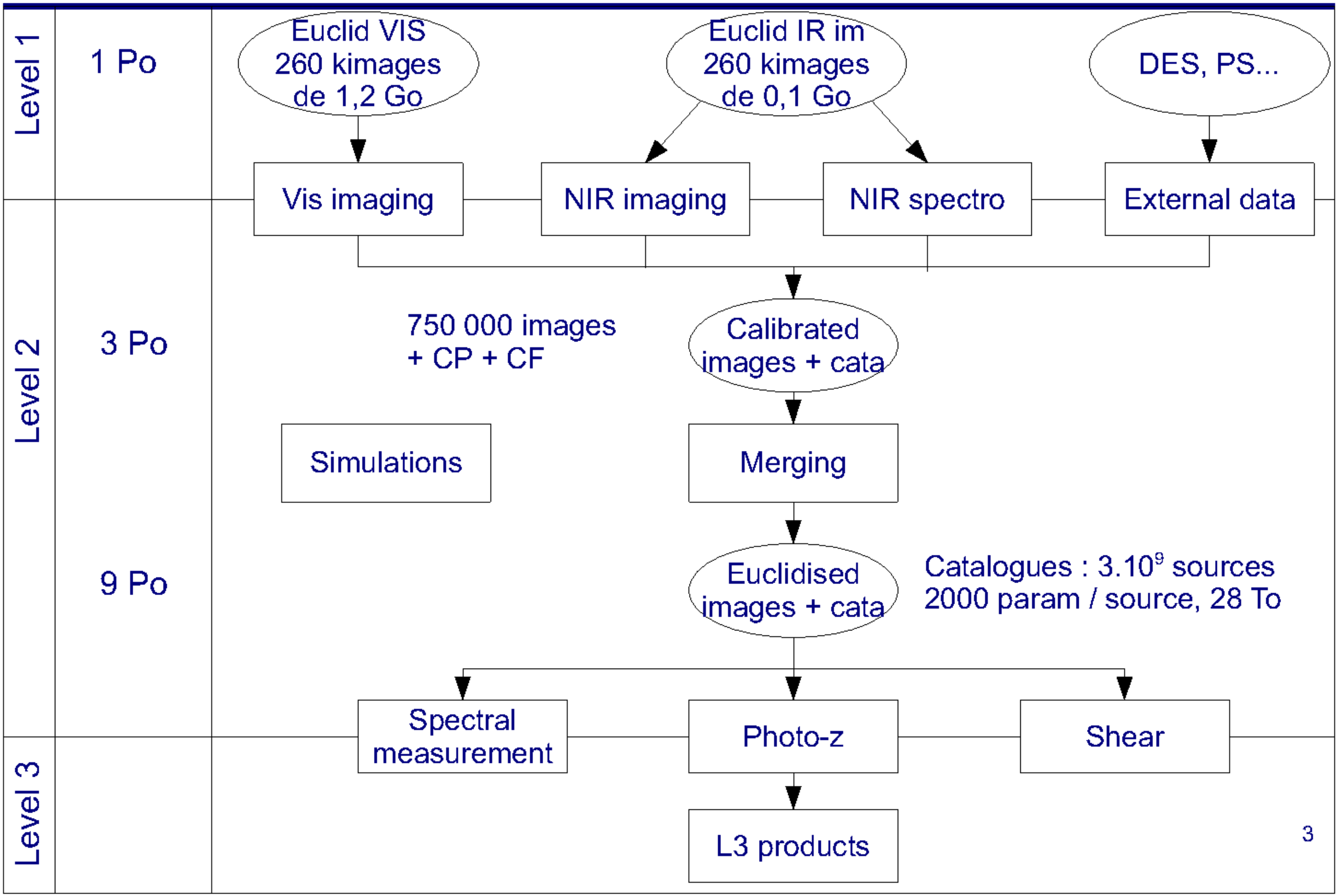
Euclid Ground Segment – organisation ESA



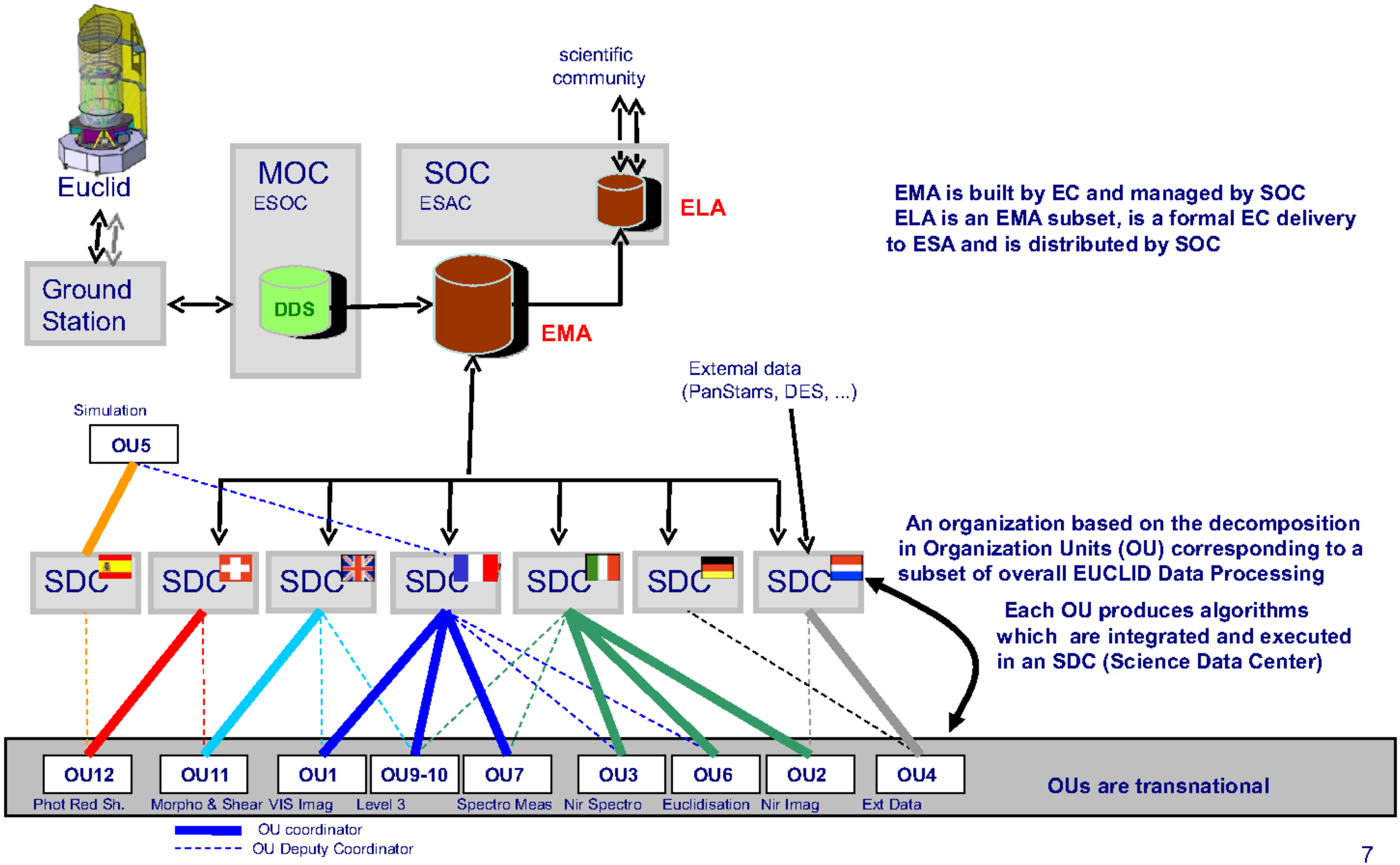
SGS : processing task organisation

OU-1	OU-VIS	Visible imaging
OU-2	OU-NIR	NIR imaging
OU-3	OU-SIR	NIR spectro
OU-4	OU-EXT	External data
OU-5	OU-SIM	Simulation
OU-6	OU-MER	Merging
OU-7	OU-SPE	Spectral measur.
OU-11	OU-SHE	Shear
OU-12	OU-PHZ	Photo-z
OU9+10	OU-LE3	Level3 products

Euclid : pipeline



Euclid : organisation of the ground segment: OUs and SDCs

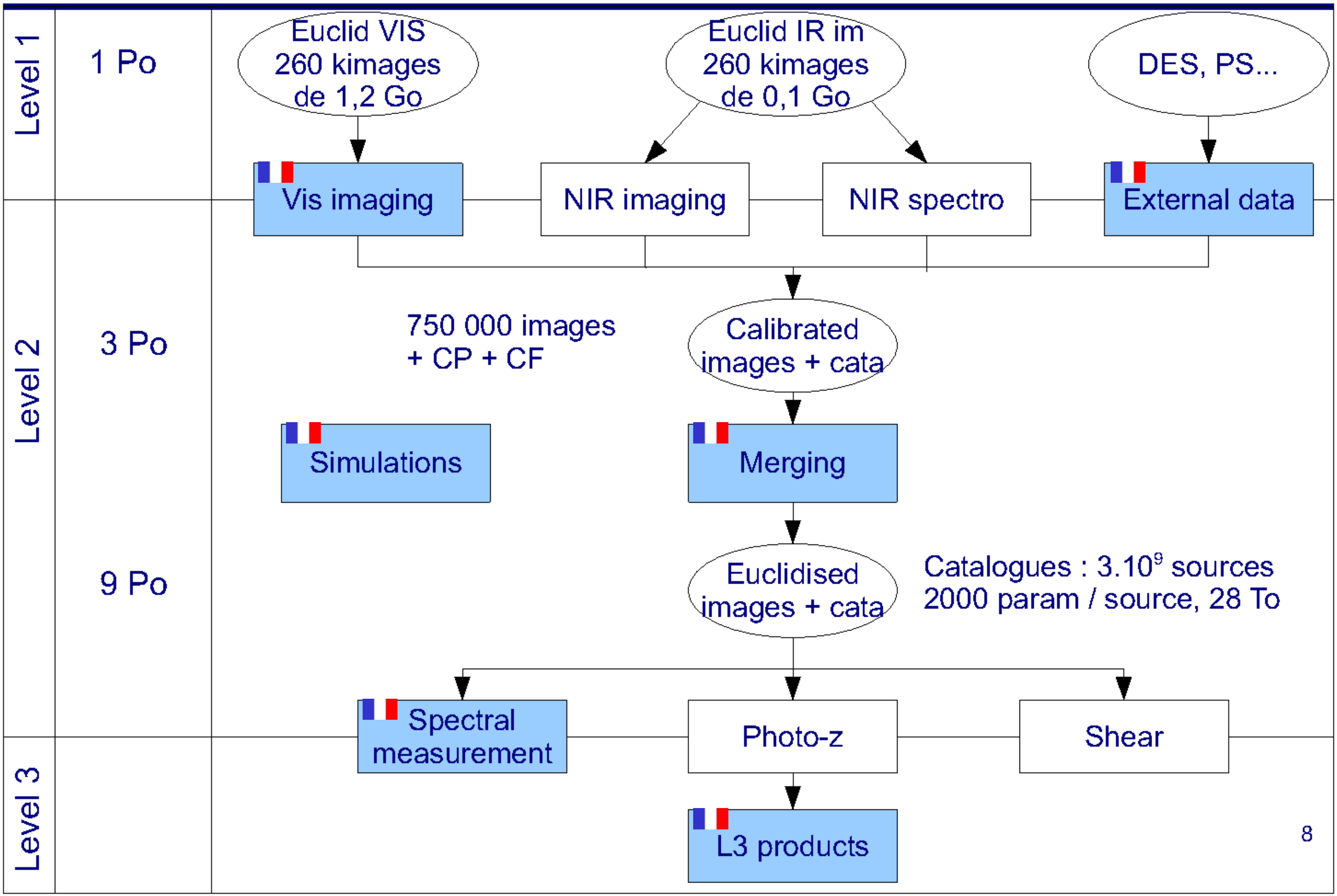


EMA is built by EC and managed by SOC
ELA is an EMA subset, is a formal EC delivery to ESA and is distributed by SOC

An organization based on the decomposition in Organization Units (OU) corresponding to a subset of overall EUCLID Data Processing

Each OU produces algorithms which are integrated and executed in an SDC (Science Data Center)

Euclid ground segment: French lead/co-lead



Conclusions

- Euclid is a high-precision wide-field survey mission to map the geometry of the Dark Universe
- Euclid concerns all sectors of the cosmological model: Dark Energy, Dark Matter, Initial Conditions, Gravity
- Euclid provides unique legacy science from its all sky legacy archive and additional surveys
- Complementary and analogous to CMB at matter-radiation transition epoch: Euclid will provide high-precision map of LSS at matter-DE transition epoch
- France strongly involved in Euclid , at all levels
- Still unclear : US contribution
- Final decision: ~ October 2011 - Launch 2018-2020

Euclid: 10 *galettes des rois* before launch…

Happy New Year and enjoy the galette!