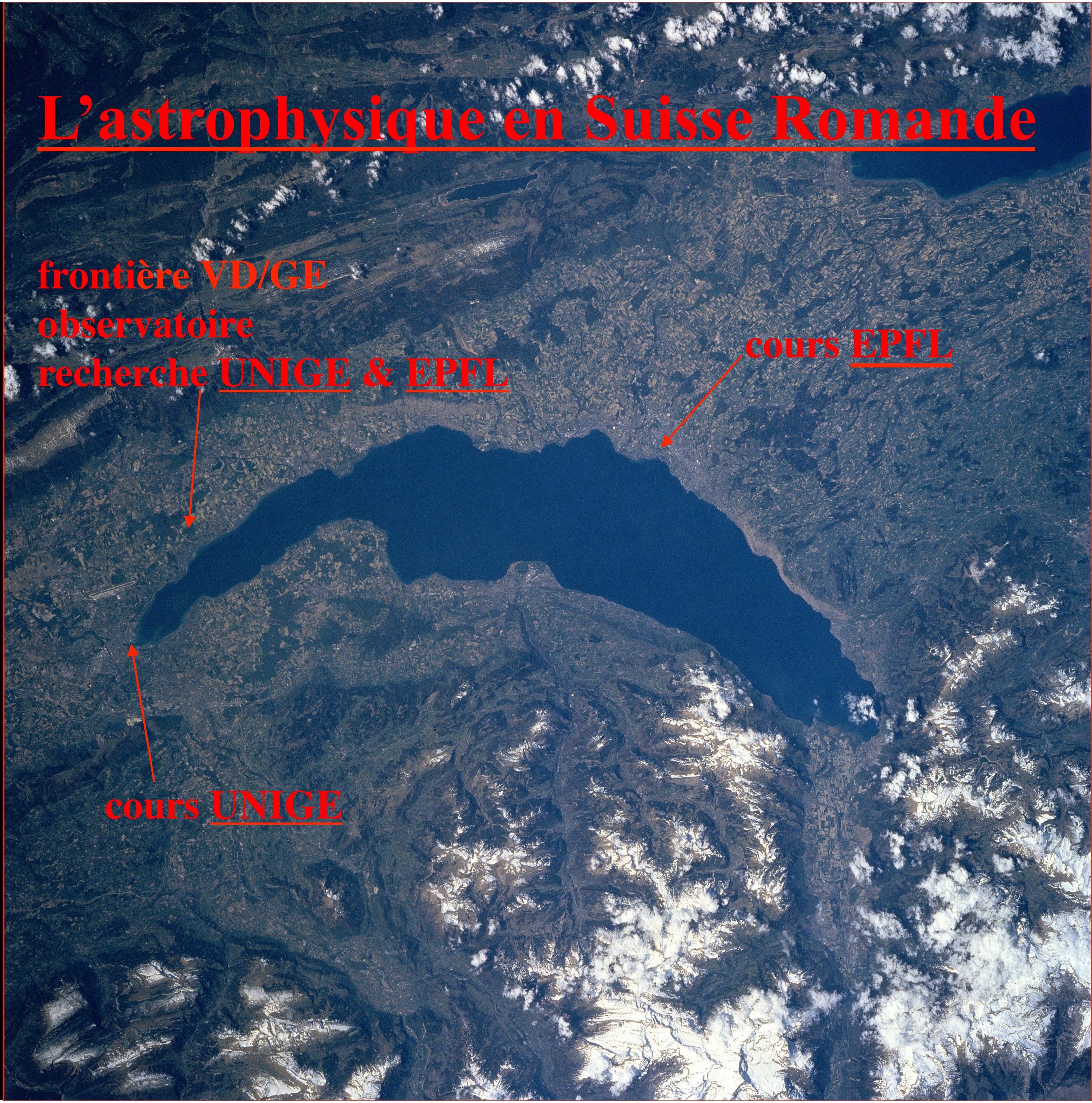
Laboratoire d'astrophysique

Ecole Polytechnique Fédérale de Lausanne

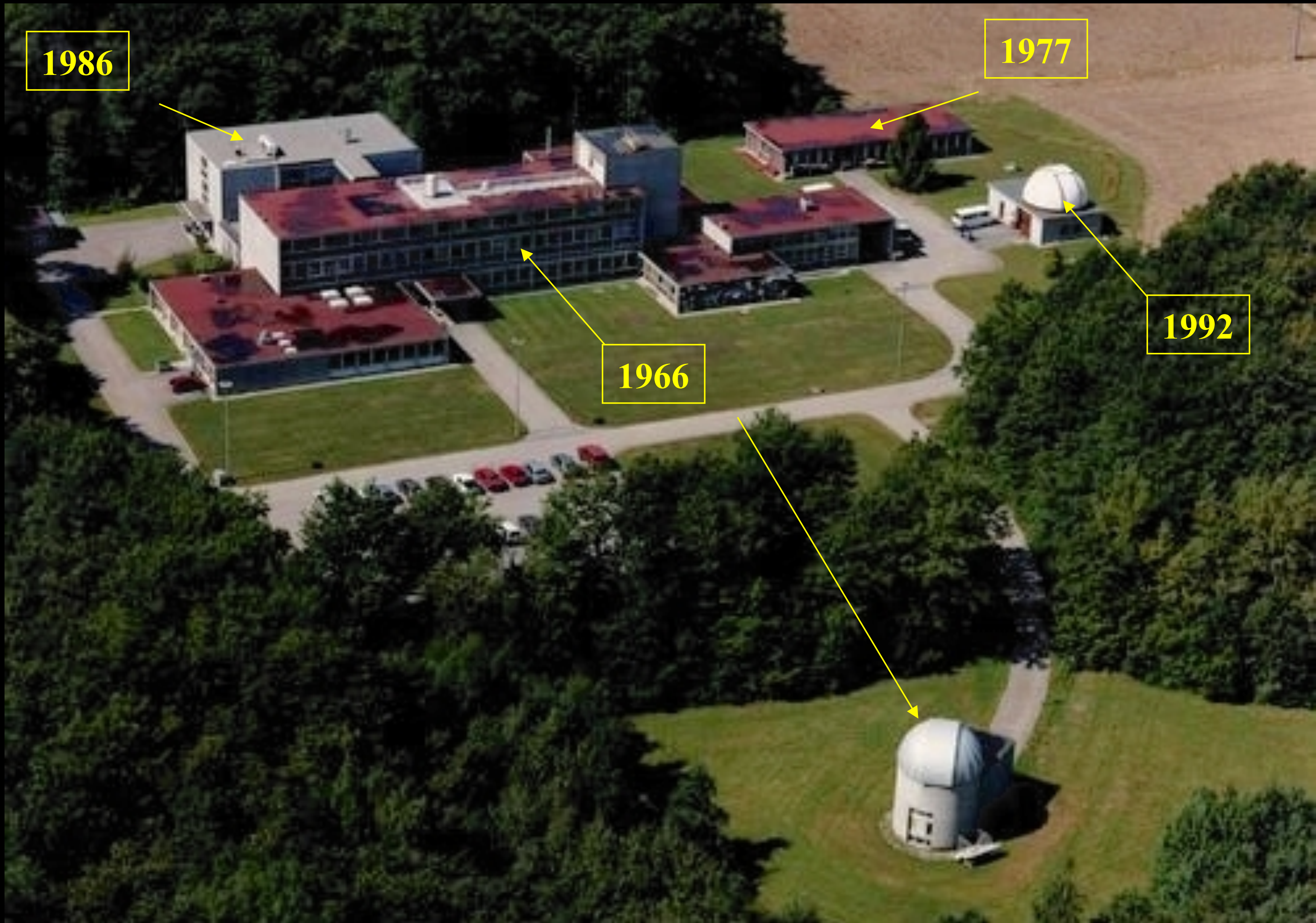
Rolex Learning Center de l'EPFL

L’astrophysique en Suisse Romande



Lake Geneva as seen from the Space Shuttle

L’Observatoire de Sauverny : UniGE and EPFL



Extragalactic Astrophysics
Observational Cosmology

Laboratoire d'astrophysique
Ecole Polytechnique Fédérale de Lausanne

Extragalactic Astrophysics Observational Cosmology

EPFL - LABORATOIRE D'ASTROPHYSIQUE

There is a total of 35 people working in the Lastro - EPFL

Laboratoire d'astrophysique
Ecole Polytechnique Fédérale de Lausanne

Formation - Evolution of Galaxies

Numerical Simulations
dark matter + stars + gas
including chemical evolution

Observations 1rst generations of stars
in the Universe and
Environmental effects : filaments

[redacted]

Study of the Dark Sector

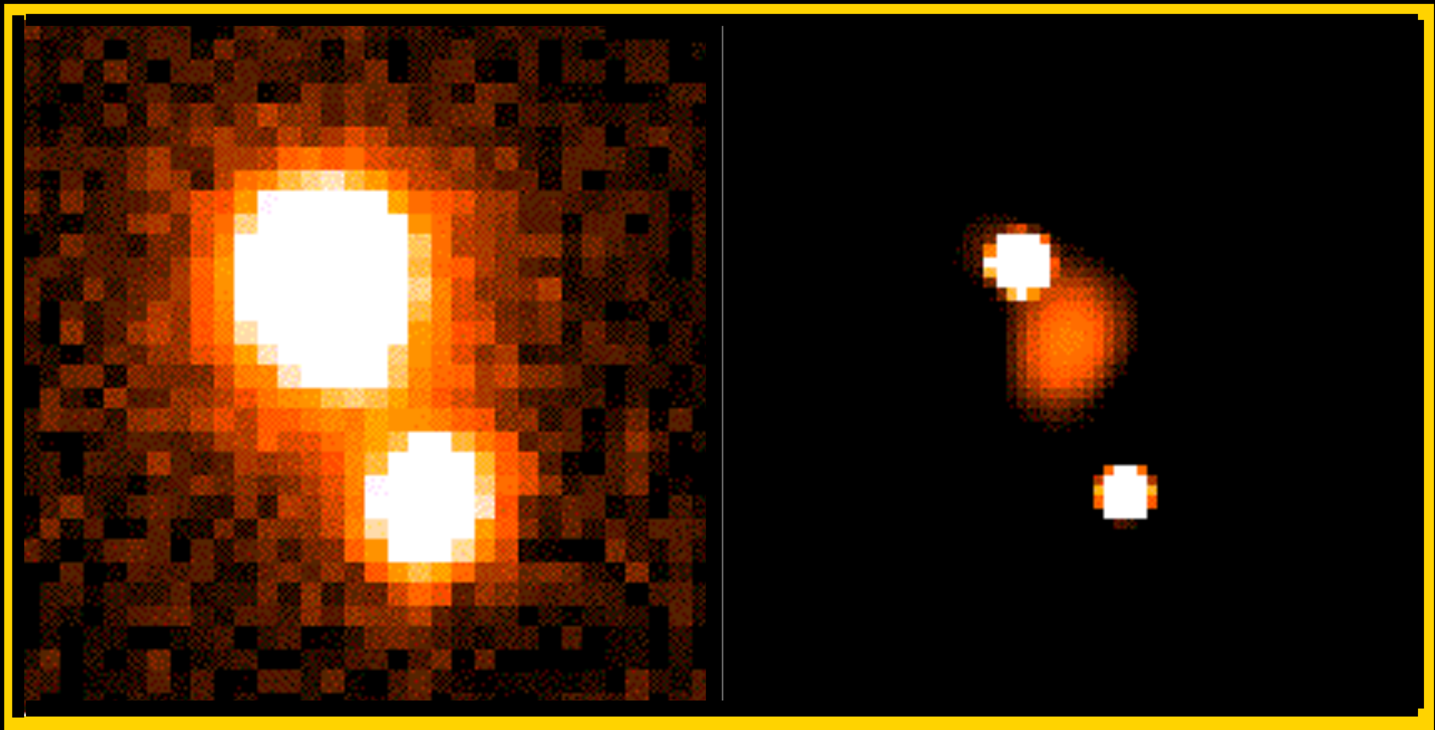
Galaxy Surveys from the Ground

Numerical Data Processing

Deconvolution, Denoising,
Pattern Recognition

QSO HE 1104-1805 ESO-MPI 2.2-m IRAC J

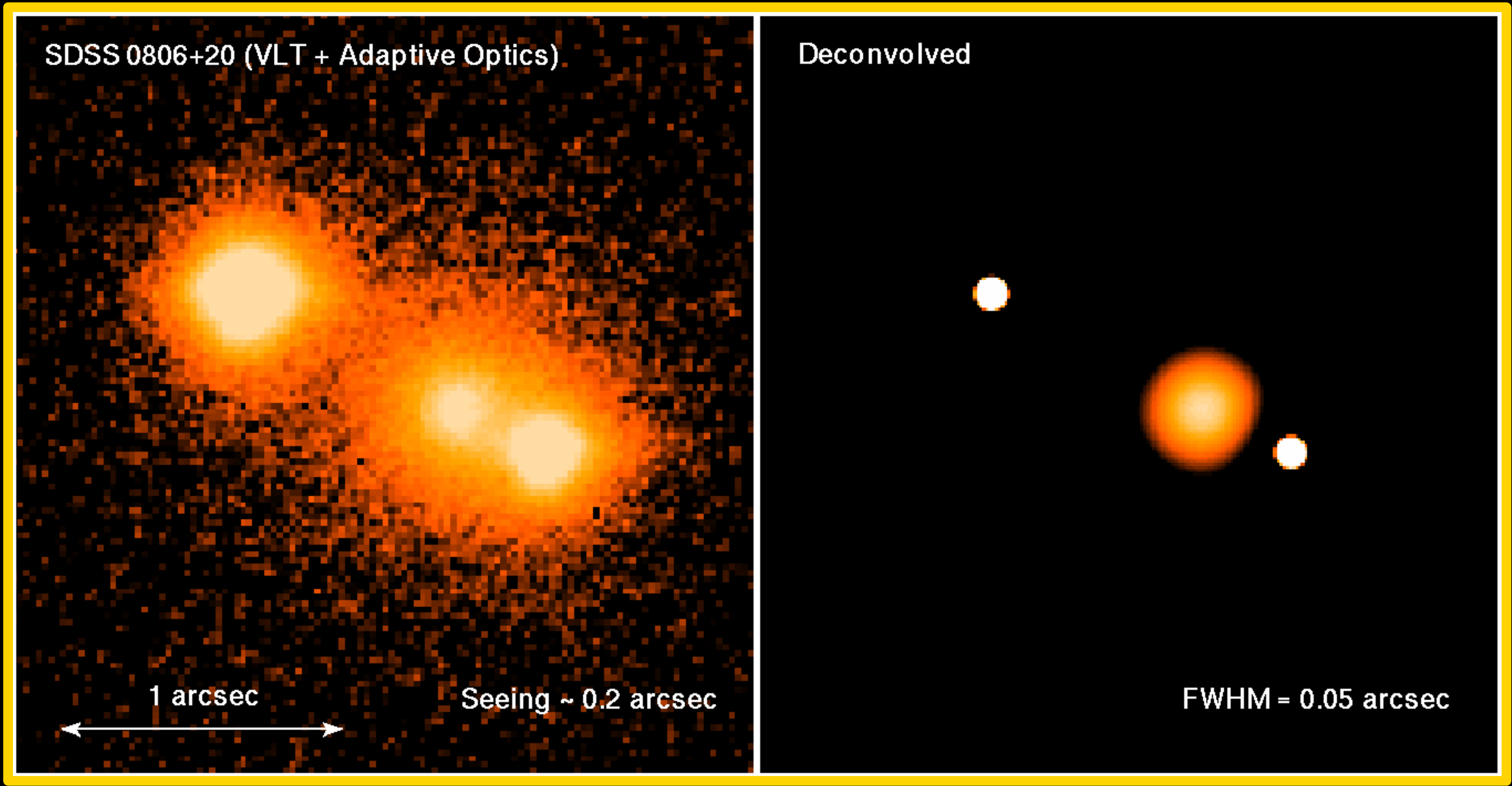
Courbin et al., 1998, ApJ, 330, 57 Δ(A,B) = 3.19" z_{source} = 2.32 z_{lens} = 0.73



Observations 0.7" After deconvolution 0.3"

The deconvolution provides an essential step

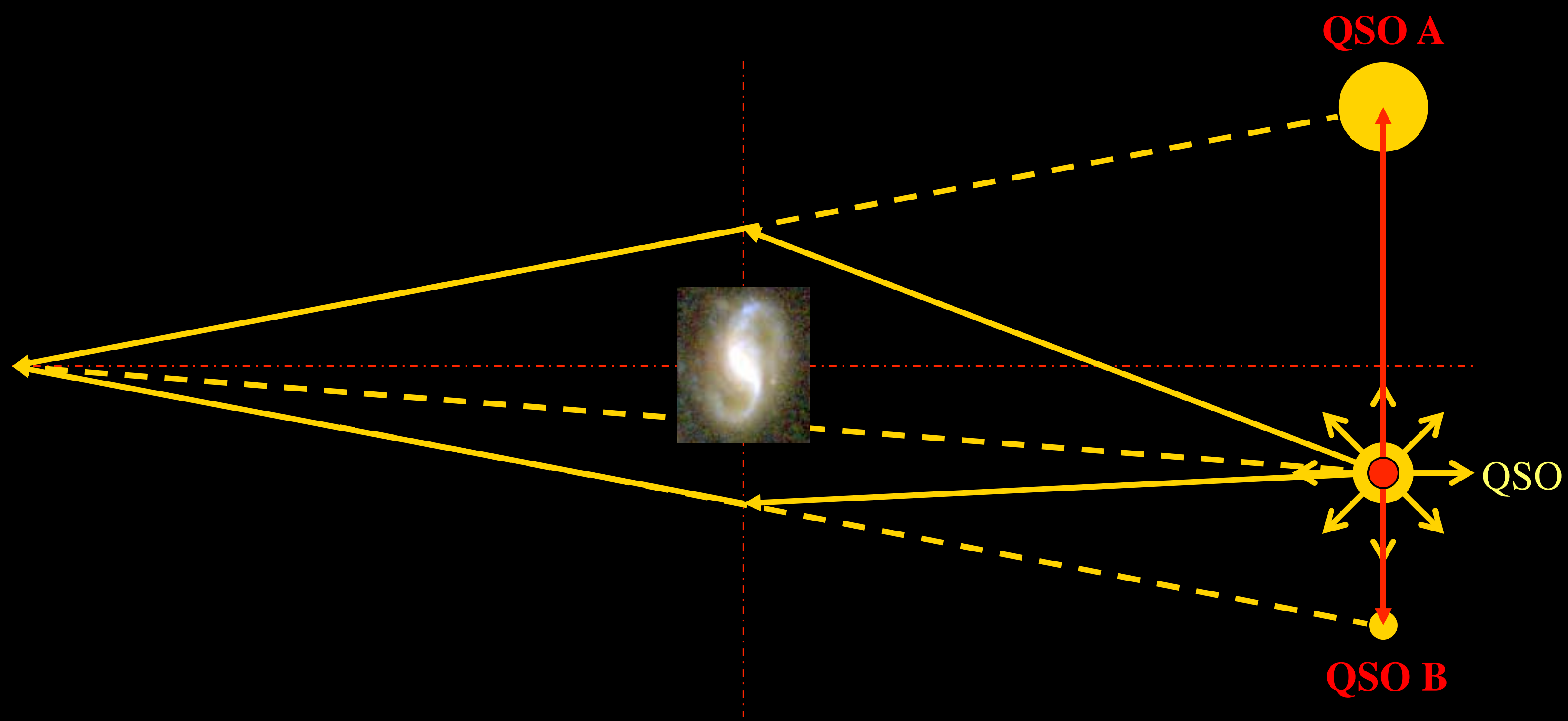
Deconvolution



Cosmological Parameters

Hubble Constant
Age of the Universe
from the Cosmograil Survey

The perturbing action of the lensing galaxy demultiplies the single image of the quasar



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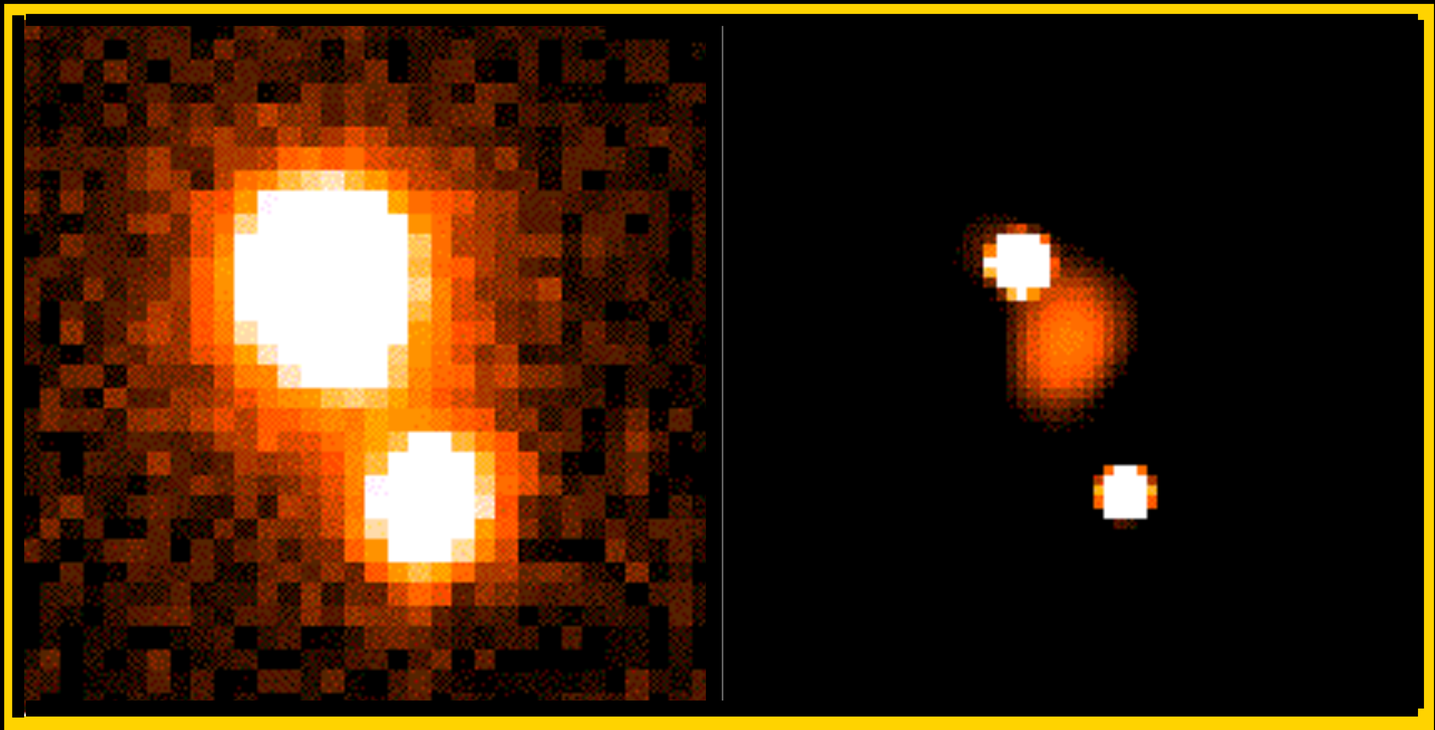

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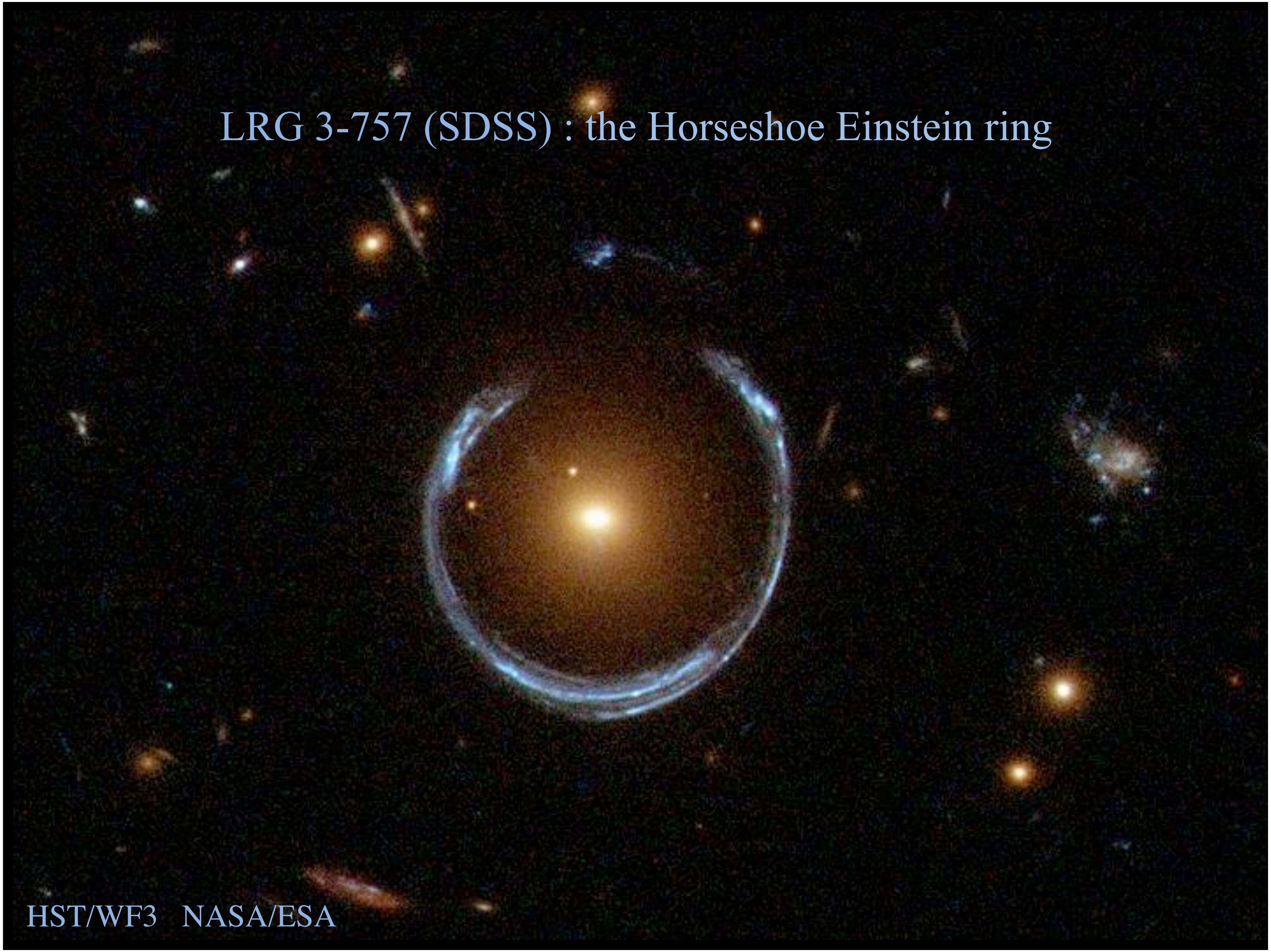
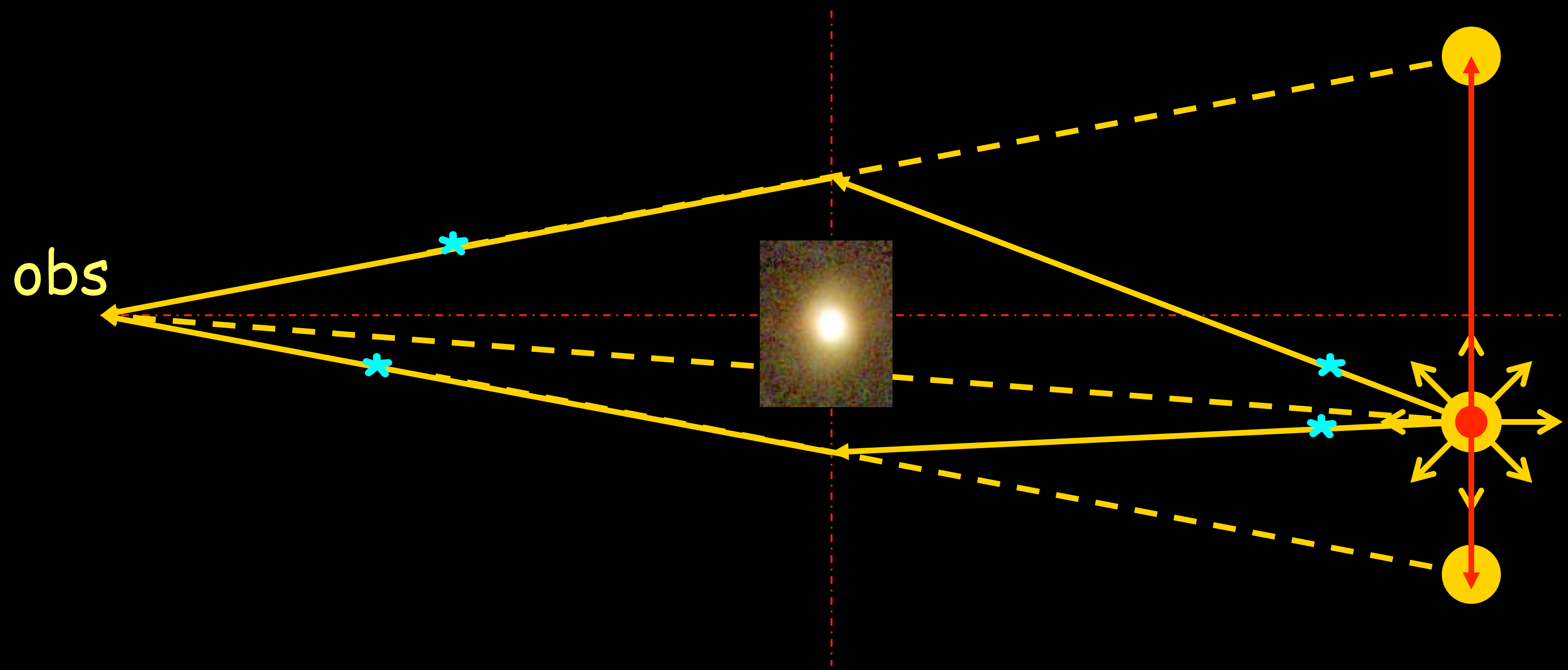

LRG 3-757 (SDSS) : the Horseshoe Einstein ring
HST/WF3 NASA/ESA

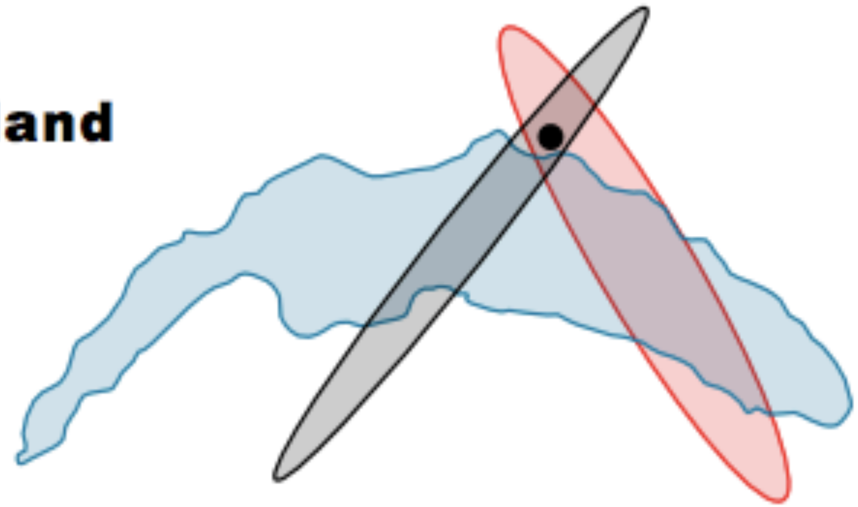
Time delay between two different light paths with different lengths



Intrinsic QSO light variations ⇒ time delay **Δτ**

MORE THAN THE SUM OF ALL PARTS:
COMPLEMENTARITY OF COSMOLOGICAL PROBES

Lausanne, Switzerland
24 – 26 June 2013



ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

WELCOME

EPFL - LABORATOIRE
D'ASTROPHYSIQUE

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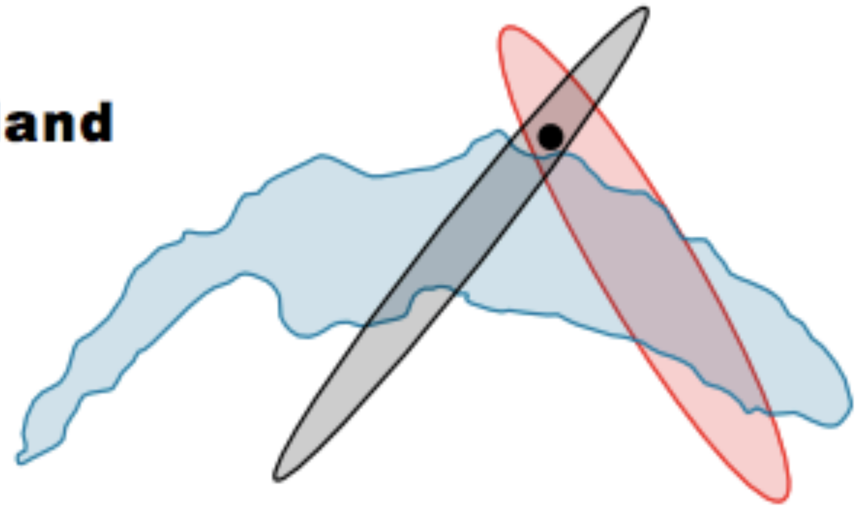
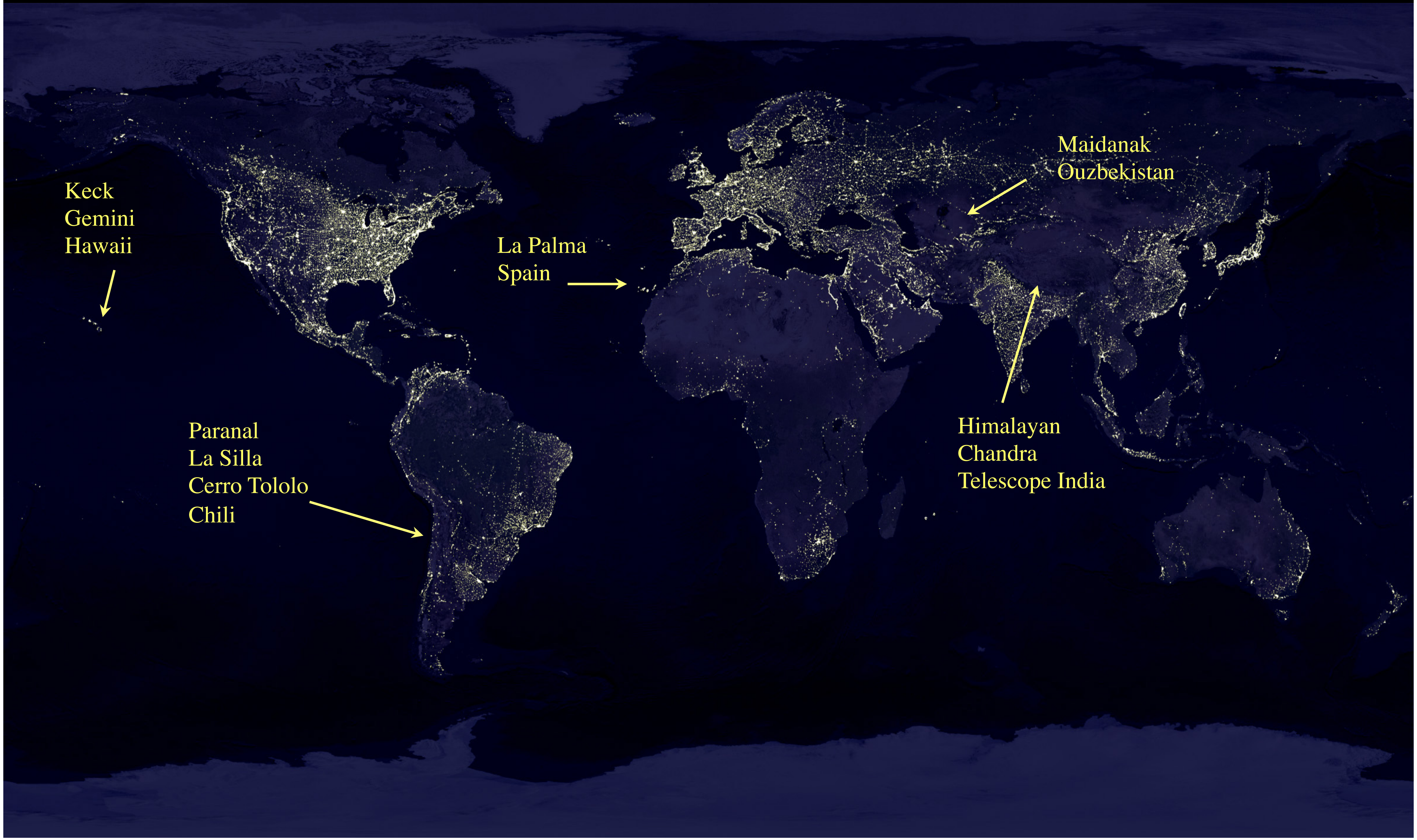


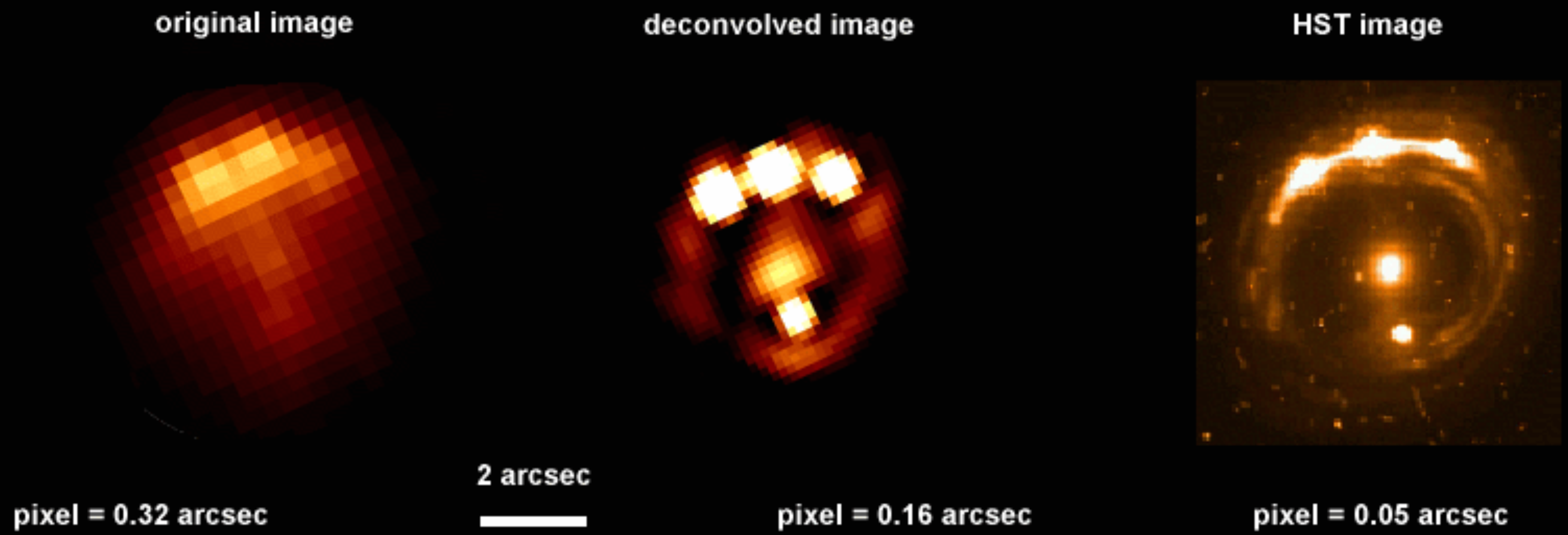
Invited Speakers

In alphabetical order: **Nabila Aghanim** (CNRS, F), **Steve Allen** (Stanford, USA), **Luca Amendola** (Uni Heidelberg, D), **Matthias Bartelmann** (Uni Heidelberg, D), **Roger Blandford** (Stanford, USA), **Jim Braatz** (NRAO, USA), **Tamara Davis** (Queensland, AU), **Joanna Dunkley** (Oxford, UK), **Wendy Freedman** (Carnegie, USA), **Steven Gratton** (Cambridge, UK), **Shirley Ho** (Carnegie Mellon, USA), **Robert Kirshner** (Harvard, USA), **Marek Kowalski** (Bonn, D), **Ofer Lahav** (UCL, UK), **Bruno Leibundgut** (ESO, D), **Yannick Mellier** (IAP, F), **Alexandre Refregier** (ETHZ, CH), **Thomas Reiprich** (AIfA Bonn, D), **Adam Riess** (Johns Hopkins/STScI, USA), **Anže Slosar** (DOE BNL, USA), **Sherry Suyu** (ASIAA, TW).

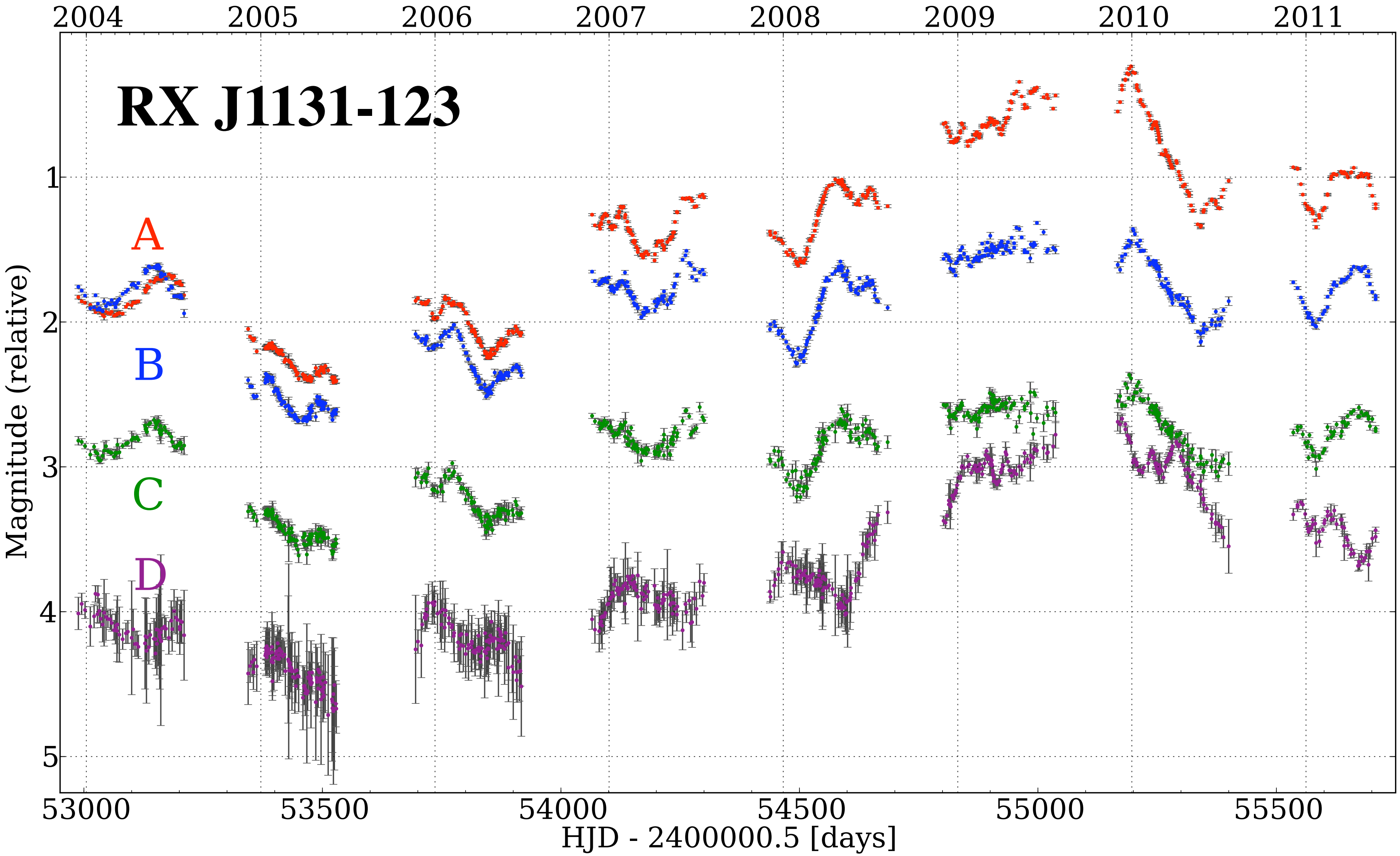
Lieux des observations de Cosmograil



QSO RXJ 1131-123

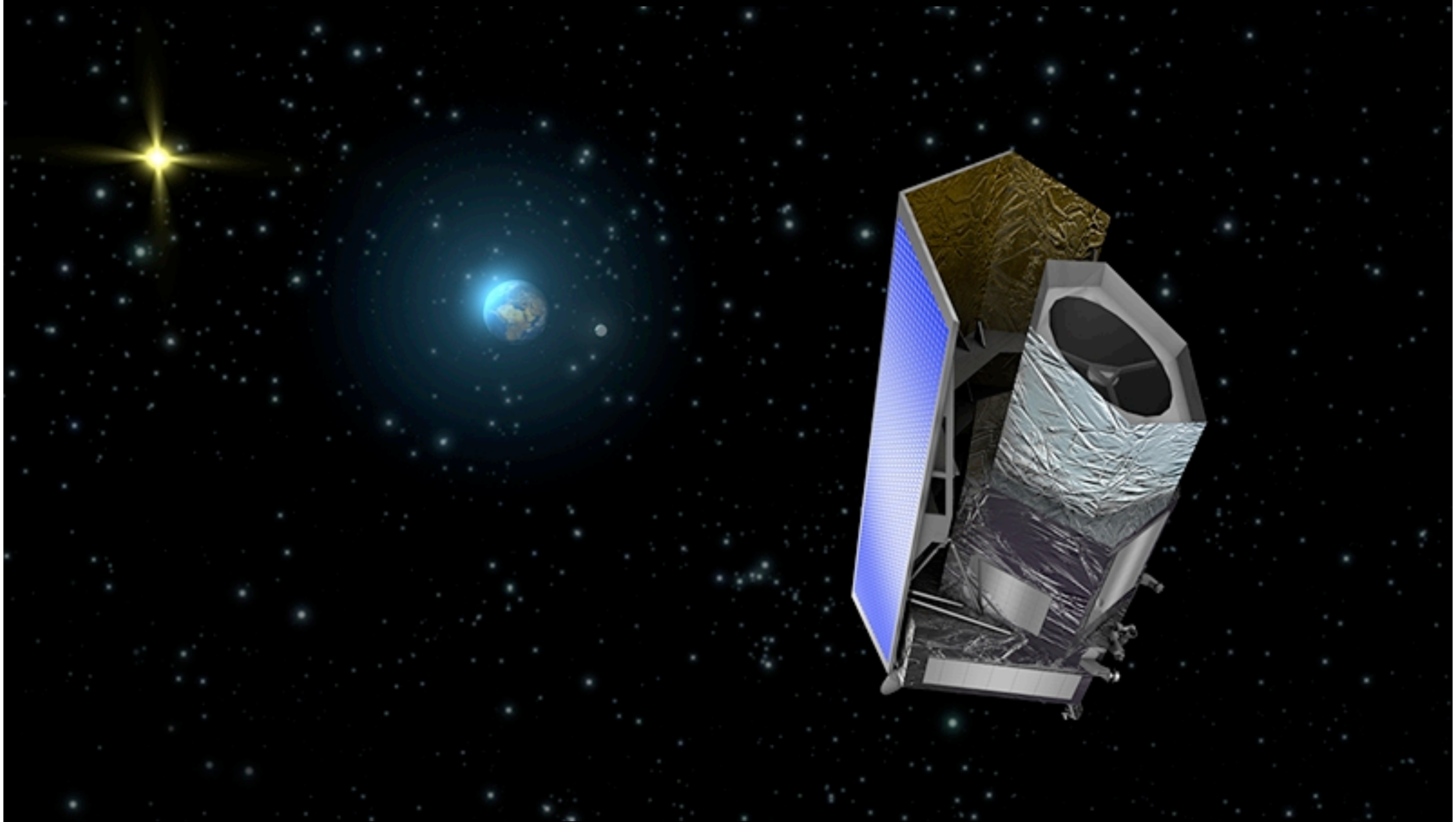


La mesure du retard temporel fournit une estimation de l'âge de l'Univers



Study of the Dark Sector

Galaxy Surveys from Space



Euclid Esa - Nasa

ESA – NASA Satellite

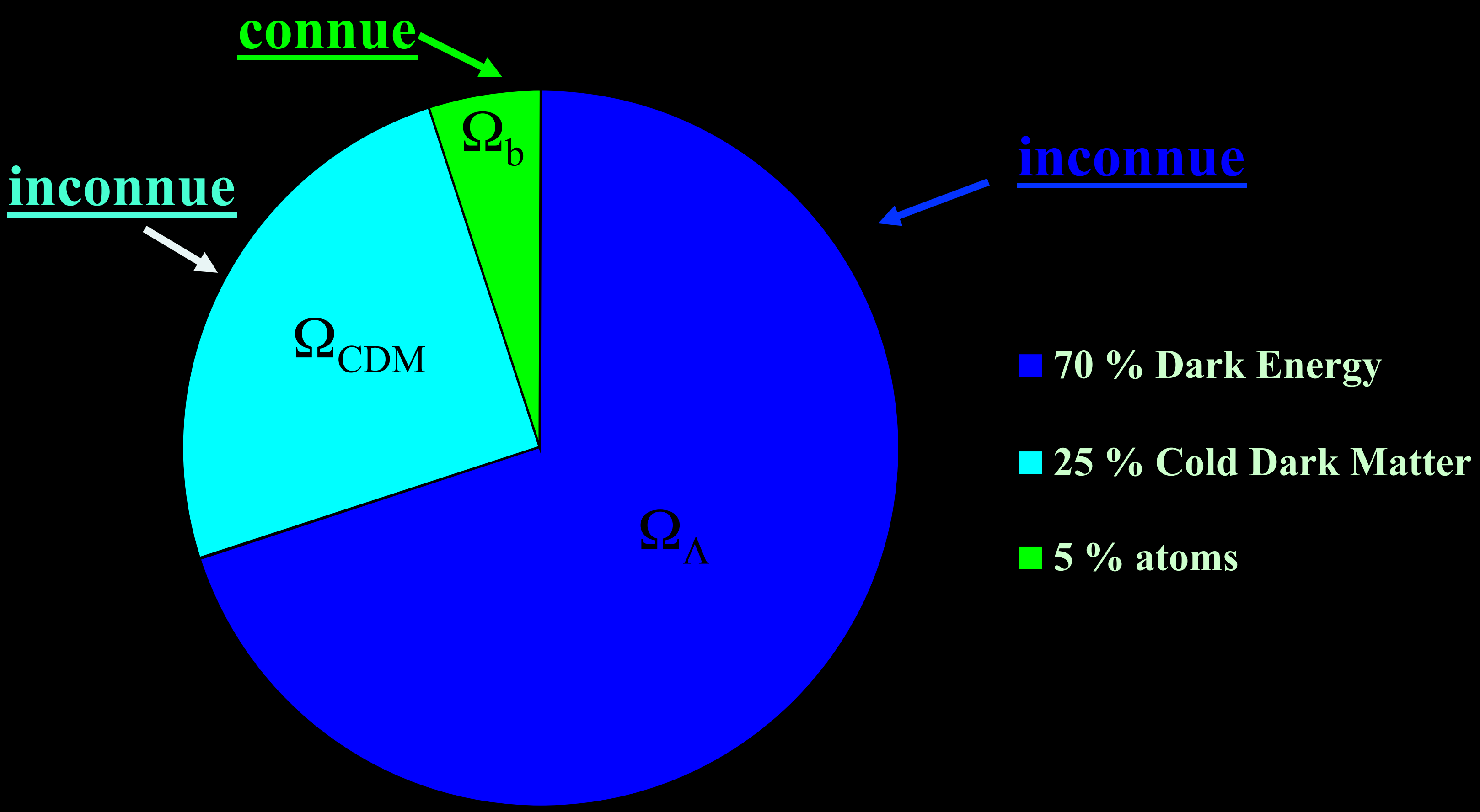
EUCLID

selected on 4 October 2011
confirmed on 19 June 2012
launch in early 2020

1) Ω_b matière baryonique (attractive)

2) Ω_{CDM} matière sombre (attractive)

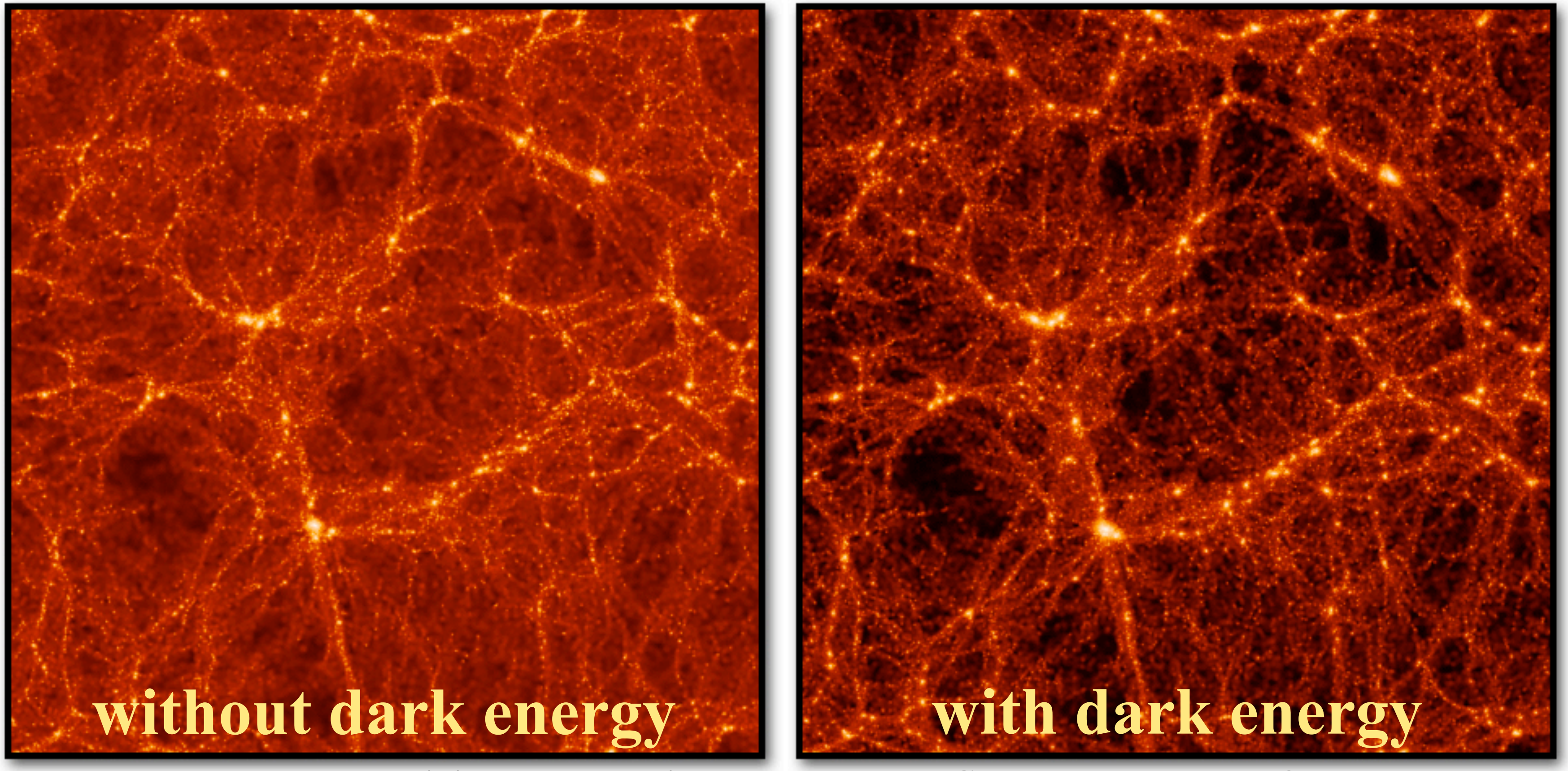
3) Ω_Λ énergie sombre (répulsive)



Le modèle cosmologique actuel repose sur des bases observationnelles très solides, mais comporte deux composantes inconnues dont la nature devrait révolutionner la physique fondamentale et notre compréhension de l'Univers

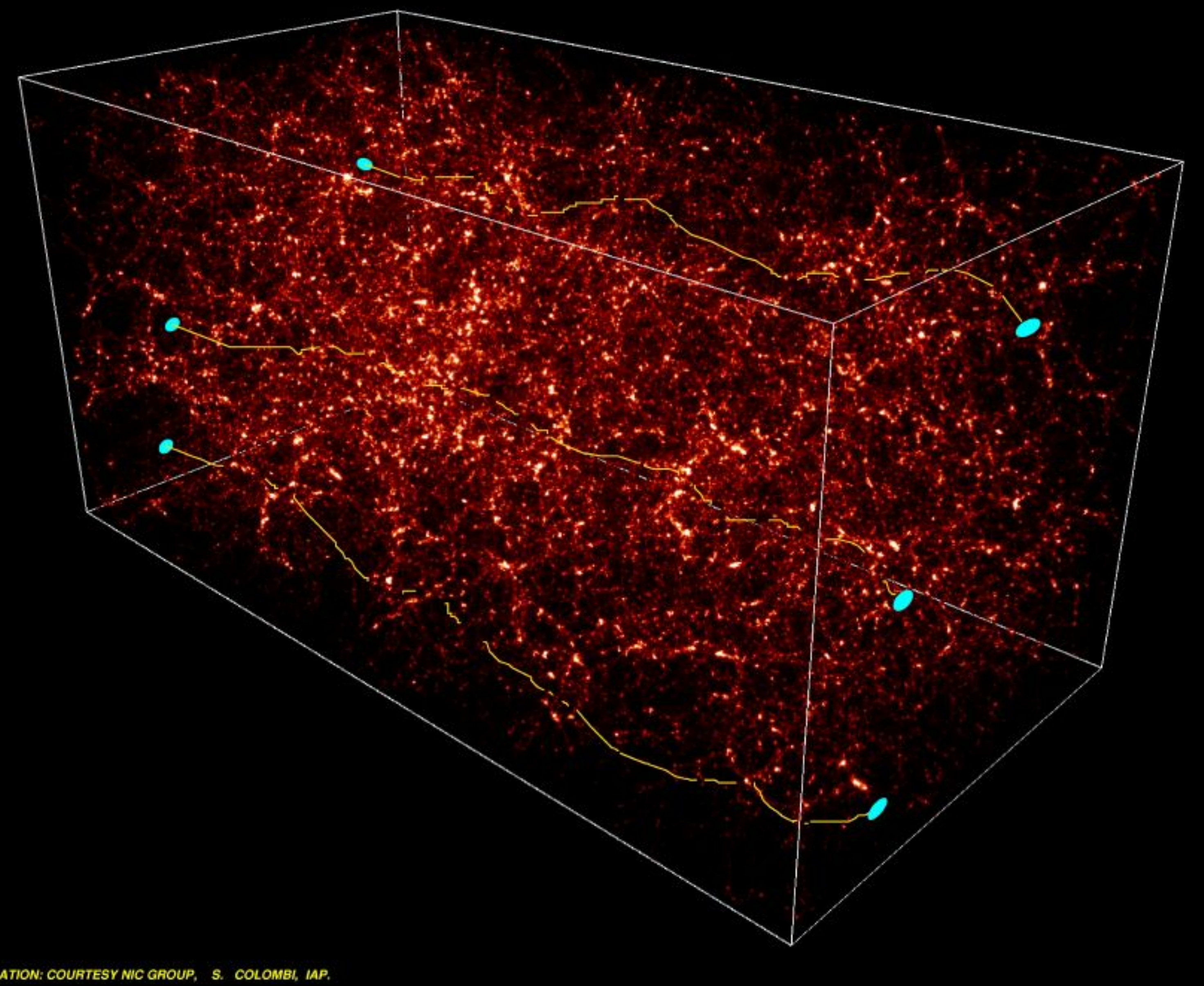
dark matter and dark energy

Cosmic structure grew from gravitational instability of tiny pertubations that reached macroscopic scales during an early inflation period

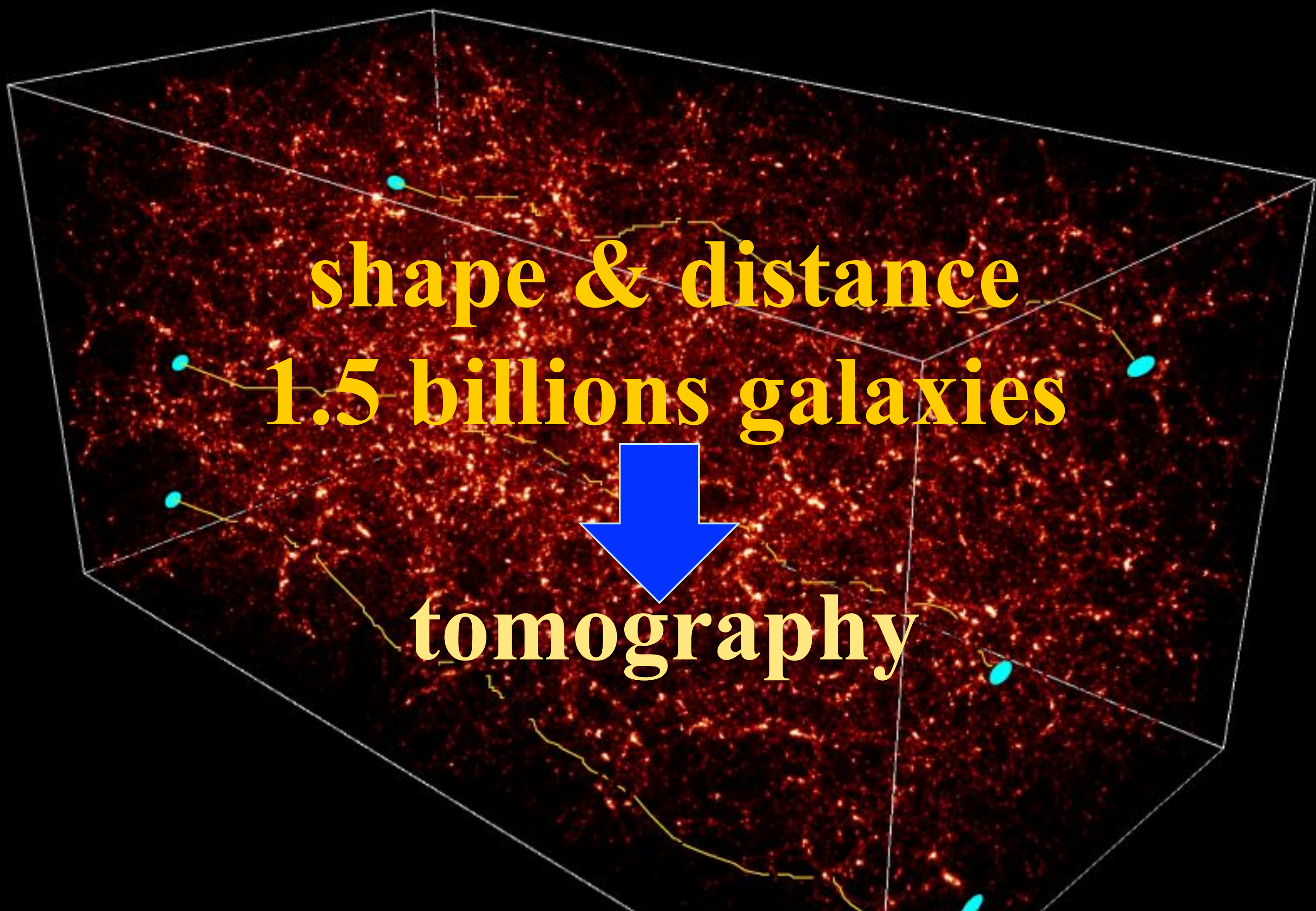


Dark matter shapes visible matter in a way that reflects the nature of dark energy. How galaxies are distributed in a Universe with no dark energy (left) would differ measurably from one in which dark energy is significant (right).

Deflection of light rays, emitted by distant galaxies, while crossing the Universe induces of phenomenon called weak gravitational lensing

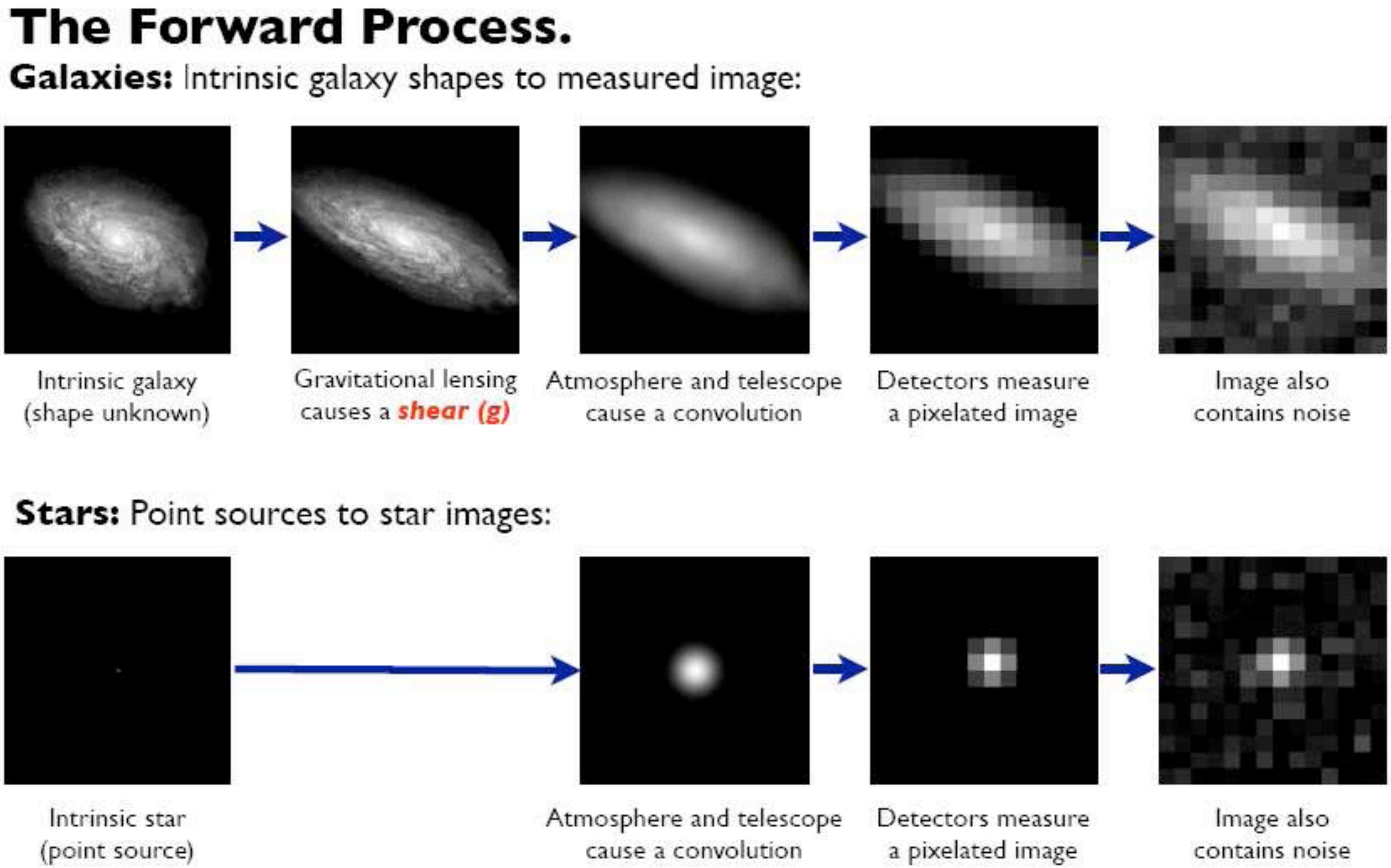


Euclid : optical/near-infrared survey covering 15,000 deg^2 + two 20 deg^2 deep fields
optimized for two independent primary cosmological probes
Weak Gravitational Lensing (WL) and Baryonic Acoustic Oscillations (BAOs)



The 2 instruments VIS (R+I+Z) + NISP (Y, J, H) will provide shape & distance for about 1.5 billion galaxies
WL : small systematic alignments in the random orientations of galaxies as a function of their distances
BAO : “wiggle” patterns in the clustering of galaxies : a standard ruler to assess the evolution of the Universe

The shape of a galaxy at ~ 1% accuracy



Sarah Bridle Great08

EUCLID data reduction

GREAT10

GRavitational lEnsing Accuracy Testing

A challenge to design and test weak lensing algorithms for whole-sky surveys

The goal is to address two fundamental issues in weak lensing tomography, using realistic simulated data (Kitching et al. 2010, arXiv:1009.0779)

Challenge 1 : to measure the shape of 52 millions of galaxies

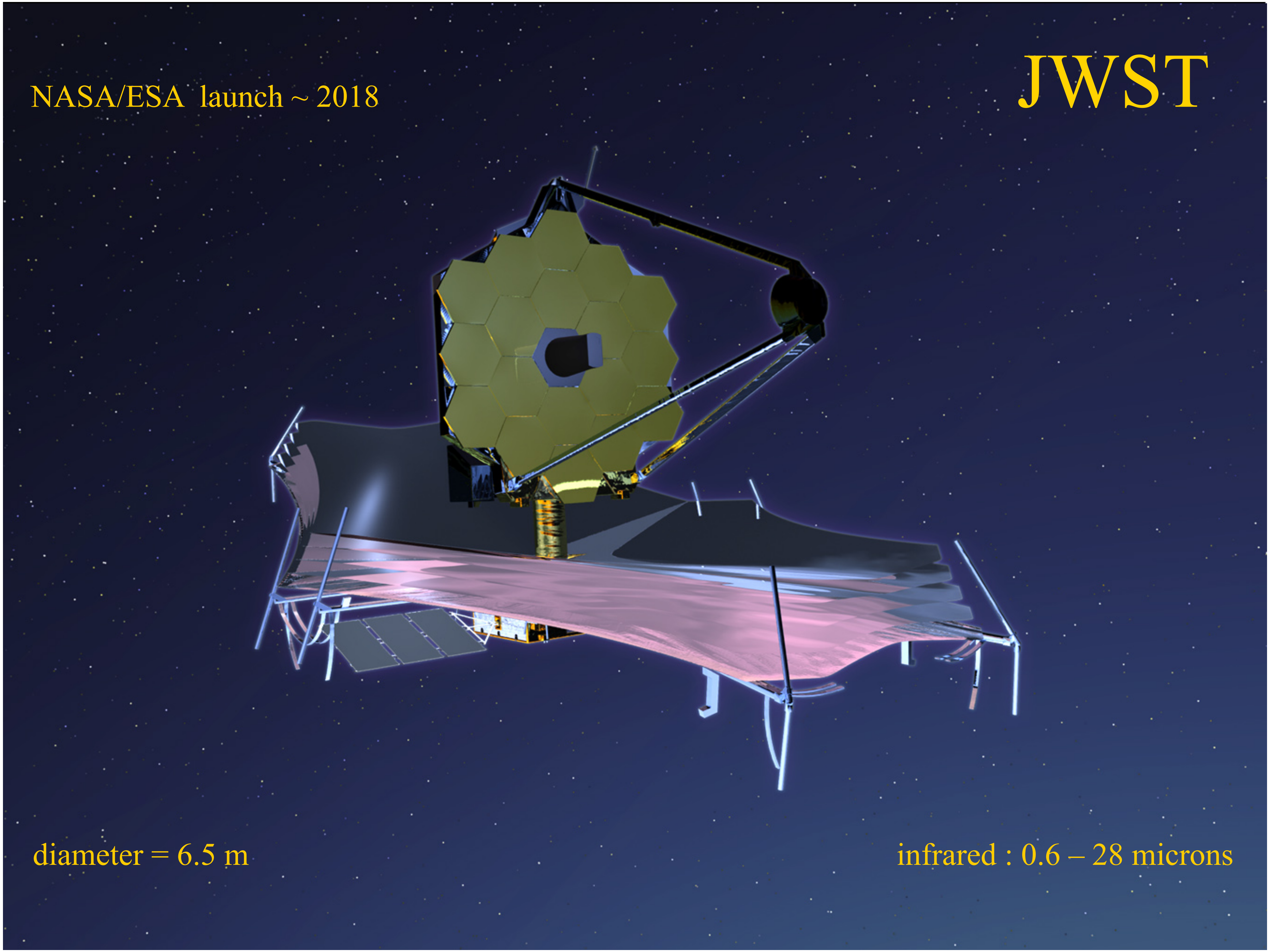
Challenge 2 : to characterize and interpolate the instrumental response or PSF (Point Spread Function) with exquisite accuracy

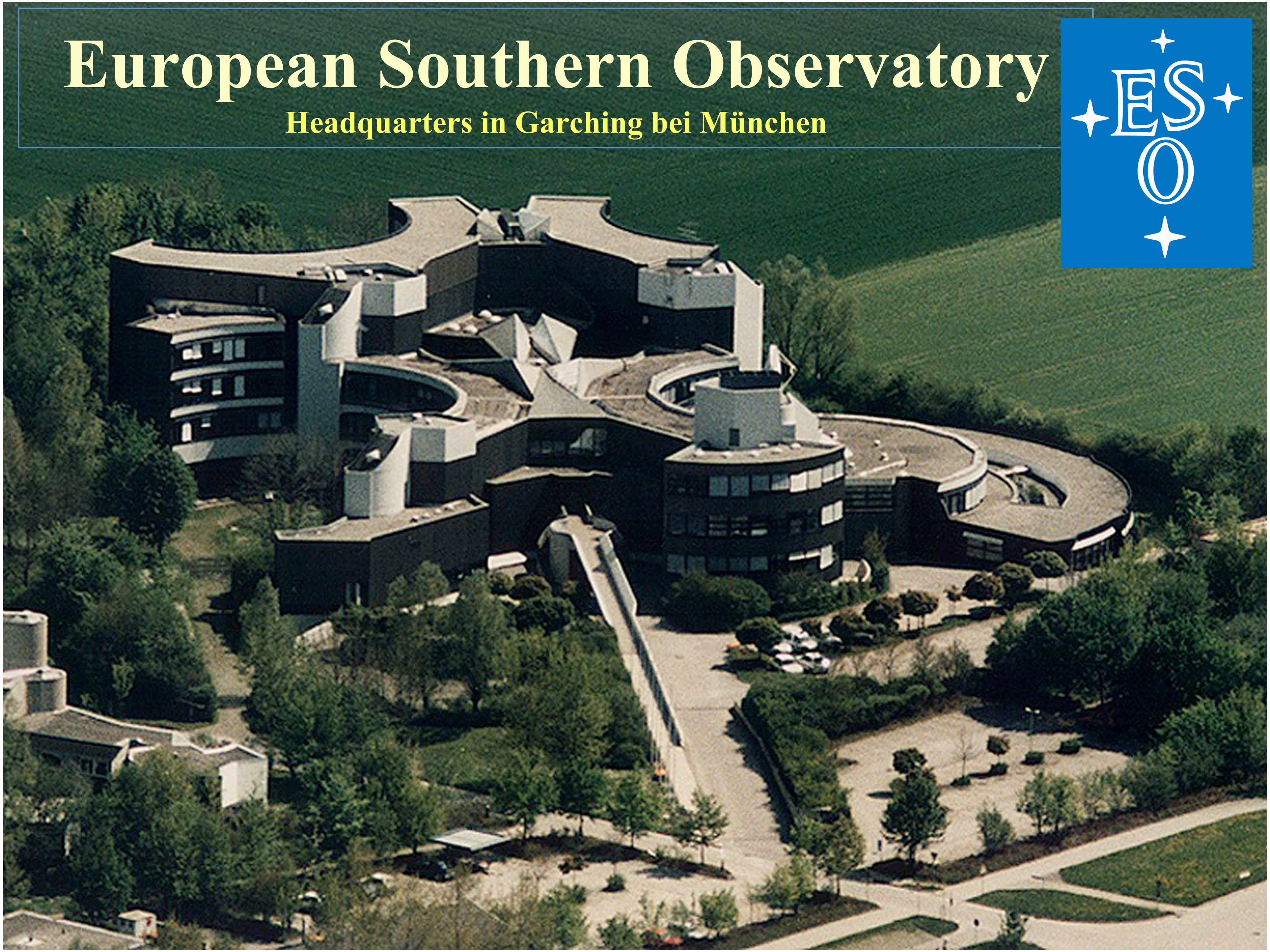
The series of « GREAT » challenges is a blind test-bench for EUCLID and for ongoing and future ground-based and space surveys. The challenge is progressively made more and more complex and realistic to allow robust lensing measurement methods to be developed.

EPFL/LASTRO is ranked 1rst on Challenge 2 and is ranked 4th (out of 82) on Challenge 1, beating most popular algorithms.

All data analysis methods will be used for all data coming from ground-based and space-born facilities

JWST
NASA - ESA


NASA/ESA launch ~ 2018
JWST
diameter = 6.5 m
infrared : 0.6 – 28 microns


European Southern Observatory
Headquarters in Garching bei München
ESO

Richards Deep
-8,065 m
(-26,460 ft)
Antofagasta
Río Loa
Desert
Salta
Nevado Ojos
del Salado
6,893 m
(22,615 ft)
Andes
Gra
San Miguel
de Tucumán
Río Copiapó
Río Salado
Río Dulce
Salinas
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Chiquita
Córdoba
Cerro
Aconcagua
6,962 m
(22,841 ft)
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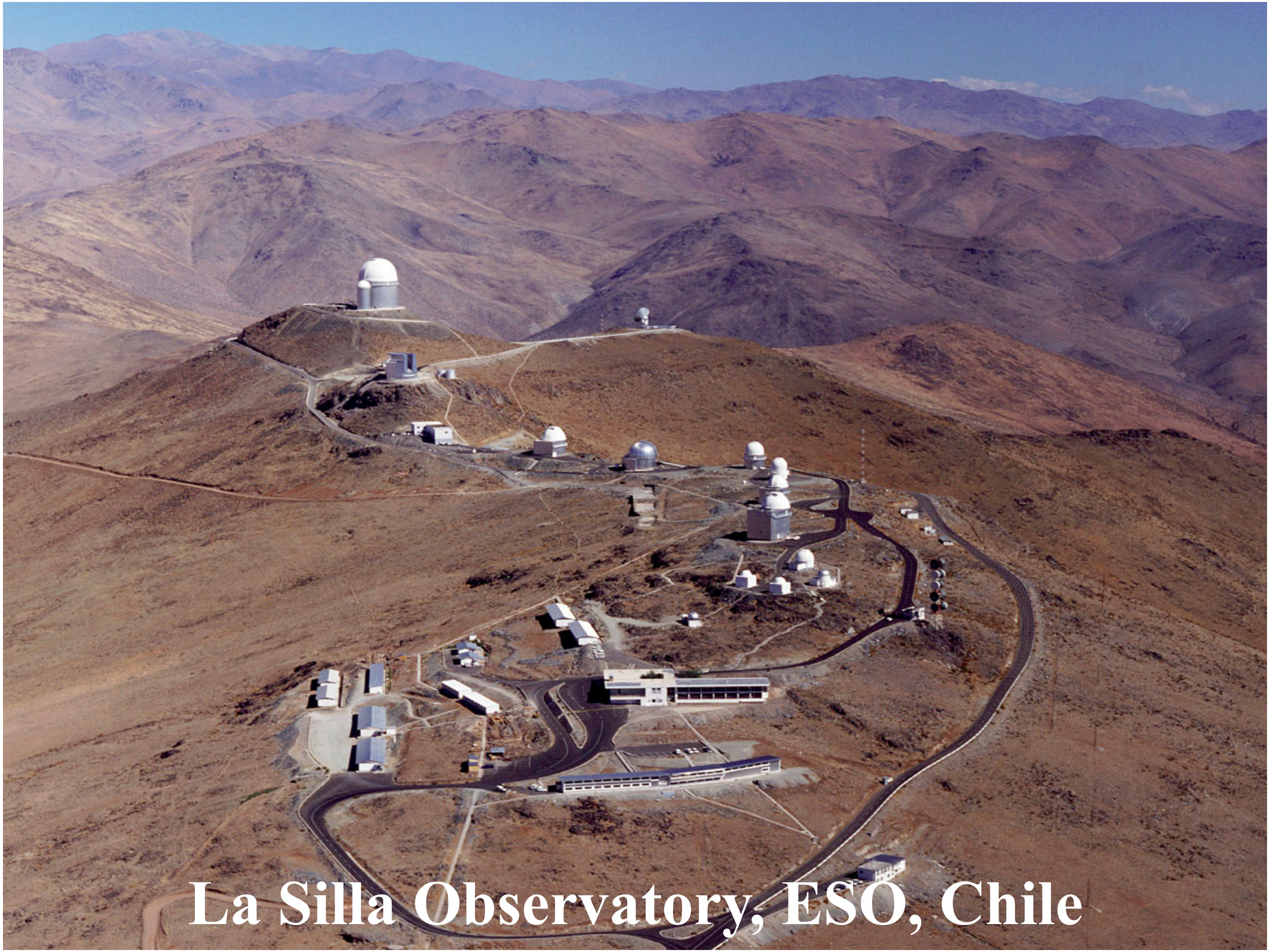
La Silla


La Silla Observatory, ESO, Chile

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Paranal Observatory, ESO, Chile
VLT - VLTI - VST - VISTA

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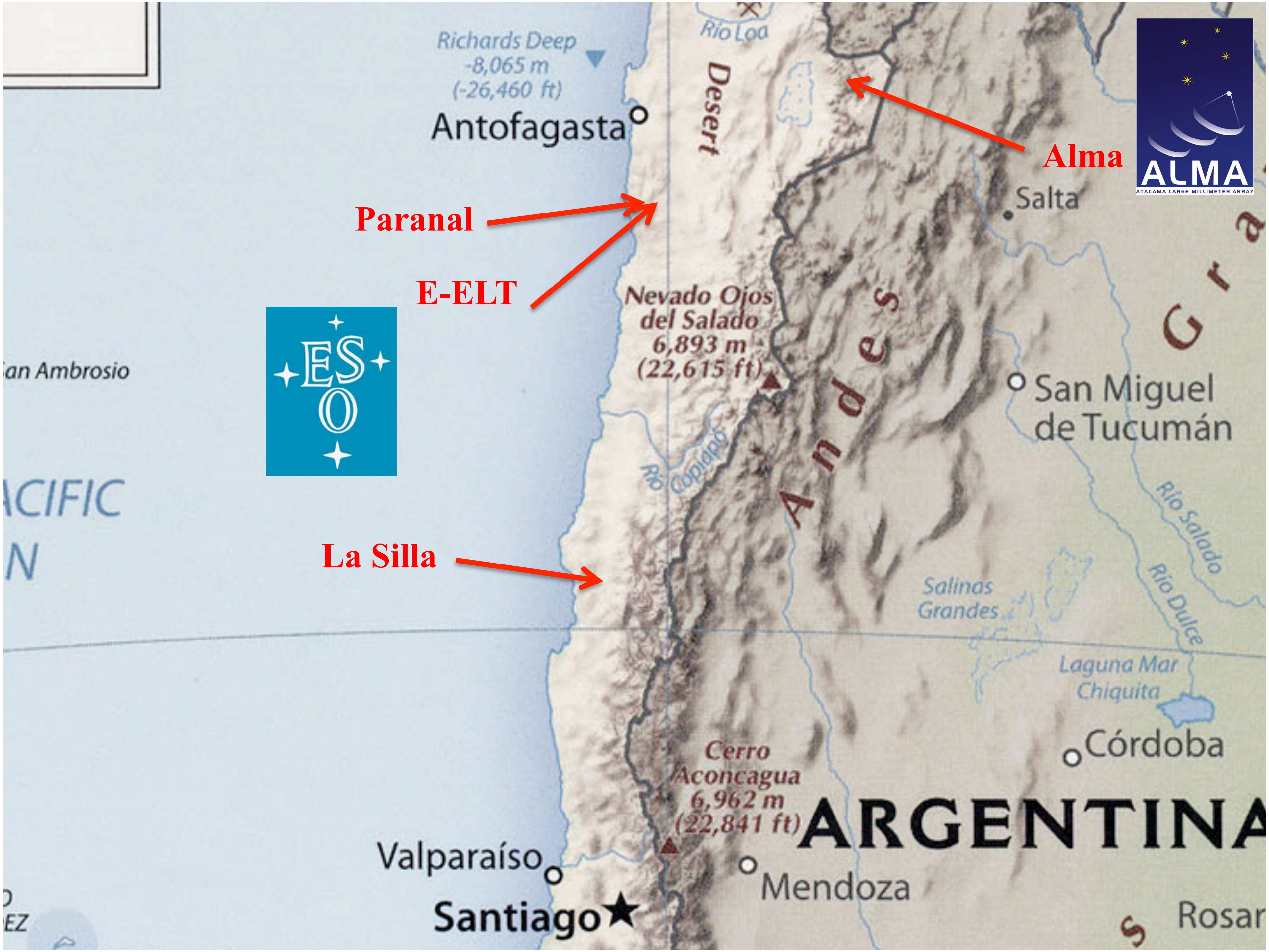
ALMA Atacama Large Millimeter Array   ESO - USA - Japan   Inauguration March 14, 2013

E-ELT

European Extremely Large Telescope



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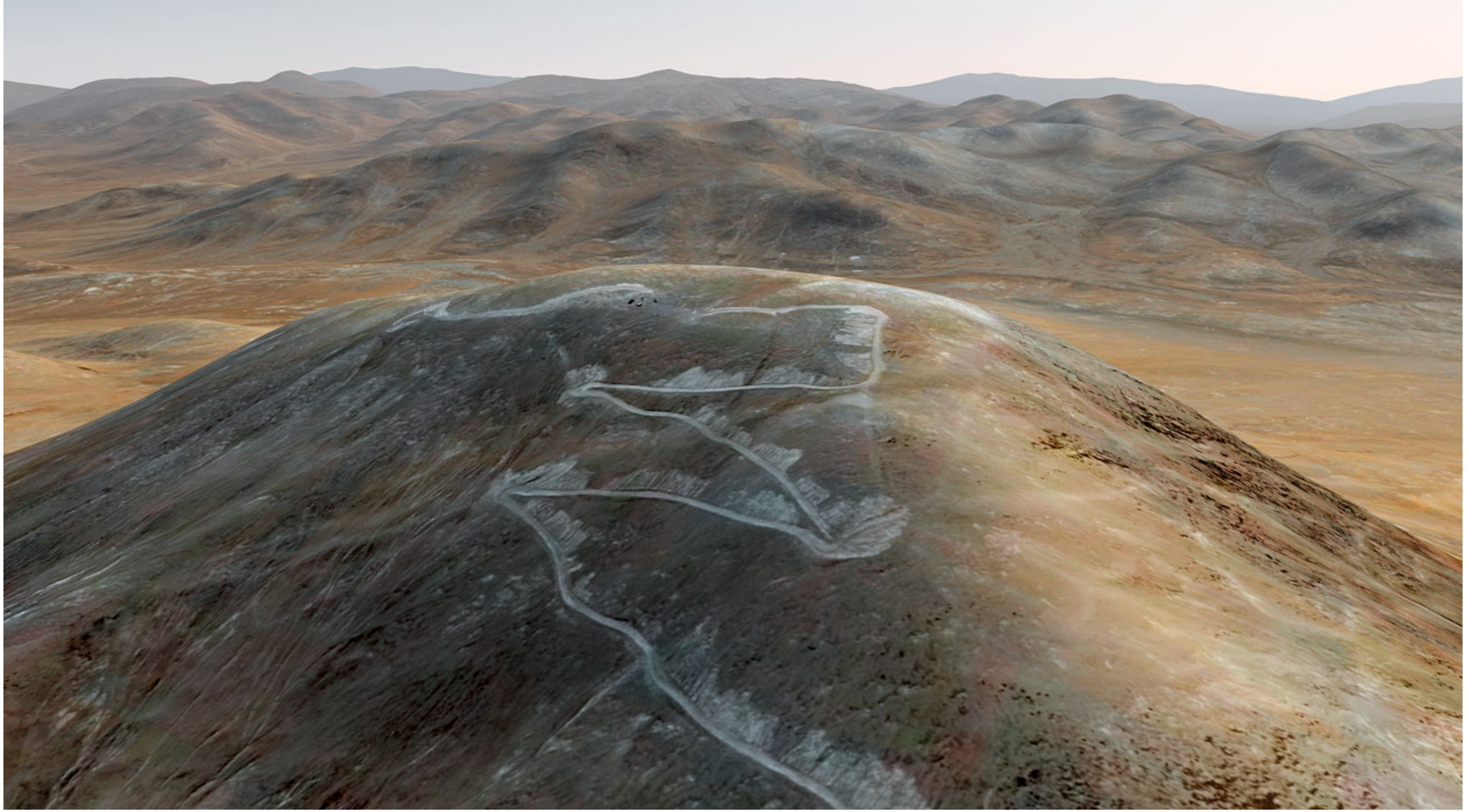
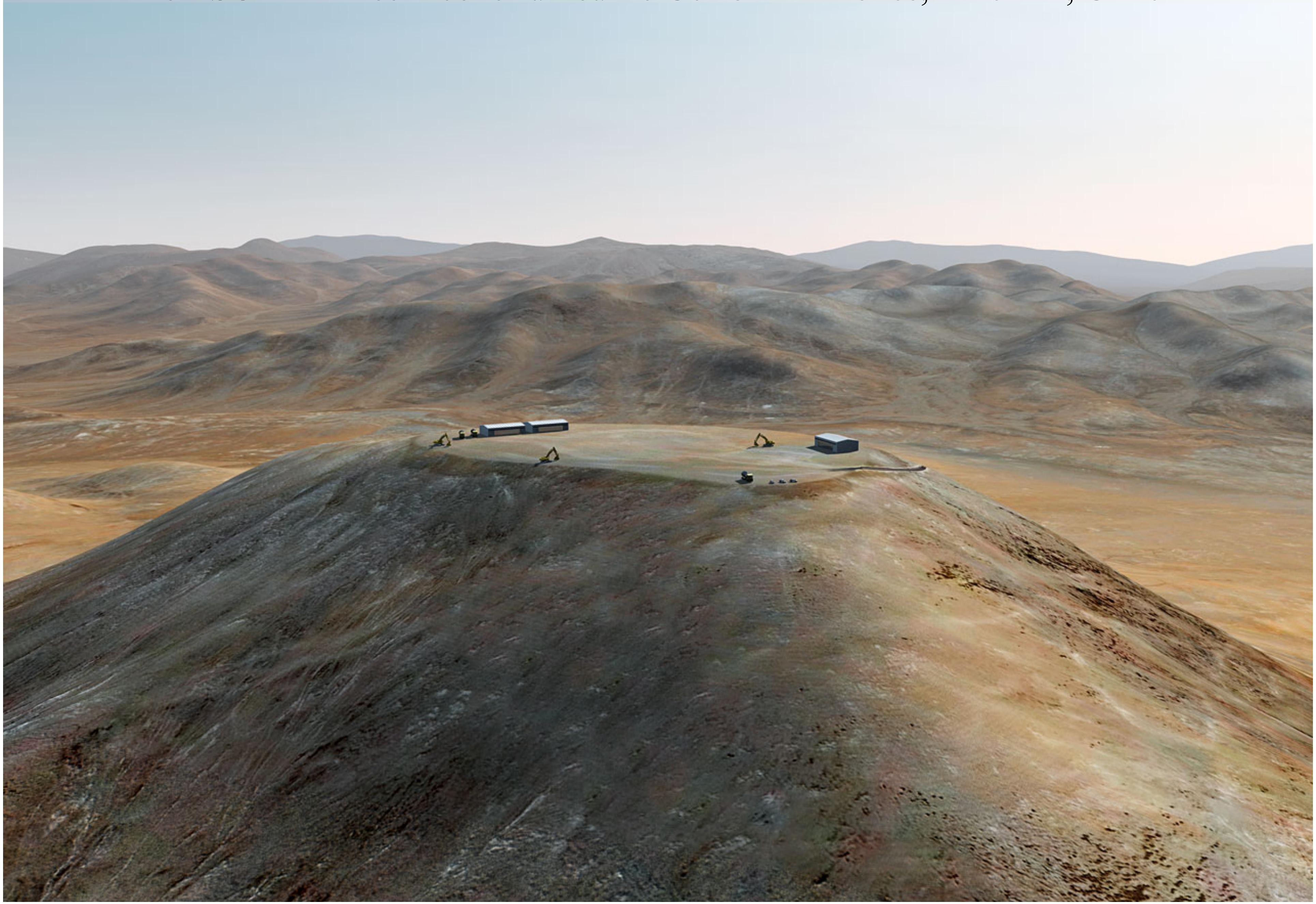
le ESO E-ELT sera construit sur le Cerro Armazones, Atacama, Chile (vu depuis Paranal)

le ESO E-ELT sera construit sur le Cerro Armazones, Atacama, Chile

septembre 2013 :
appel d’offres pour la route



le ESO E-ELT sera construit sur le Cerro Armazones, Atacama, Chile



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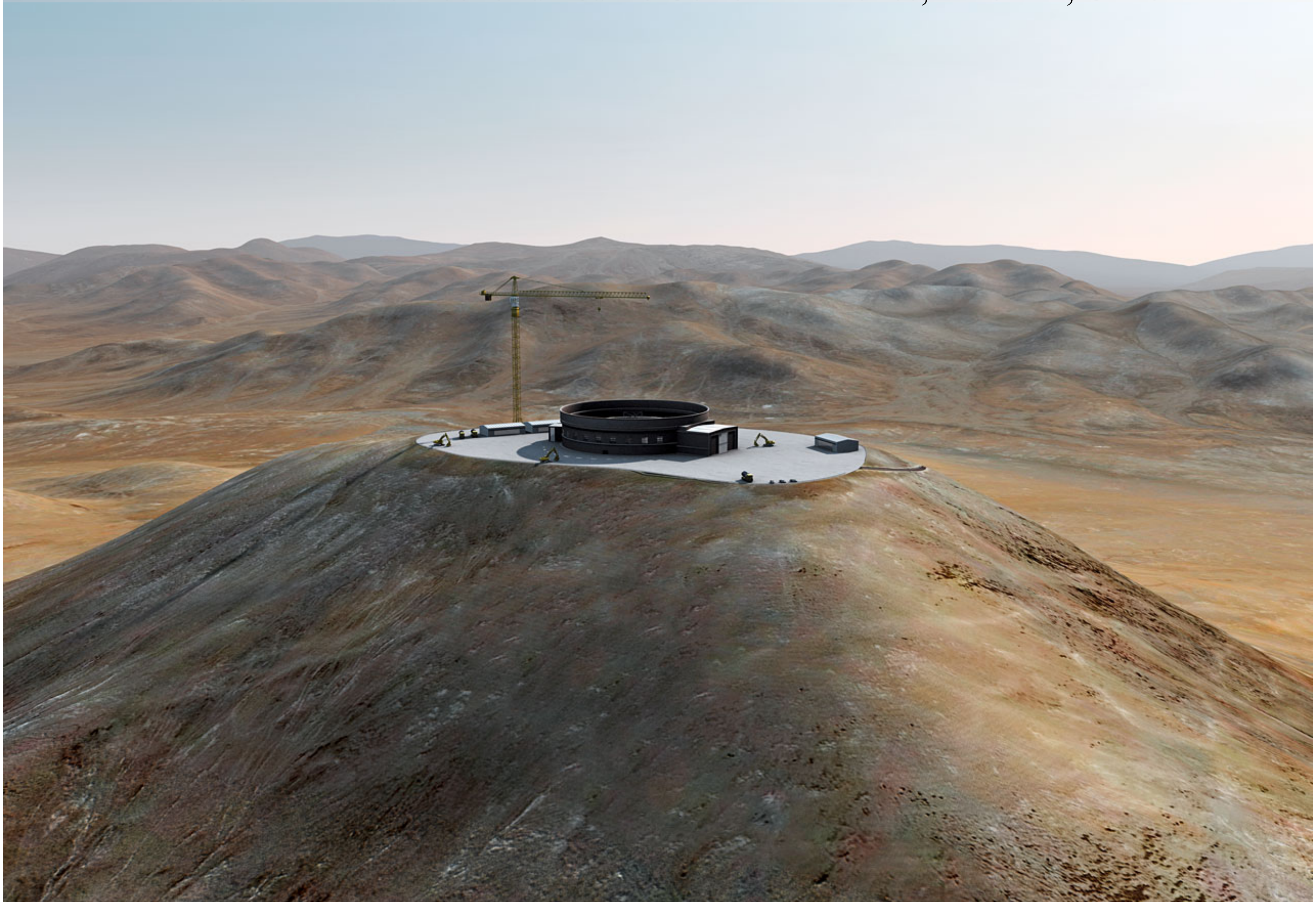

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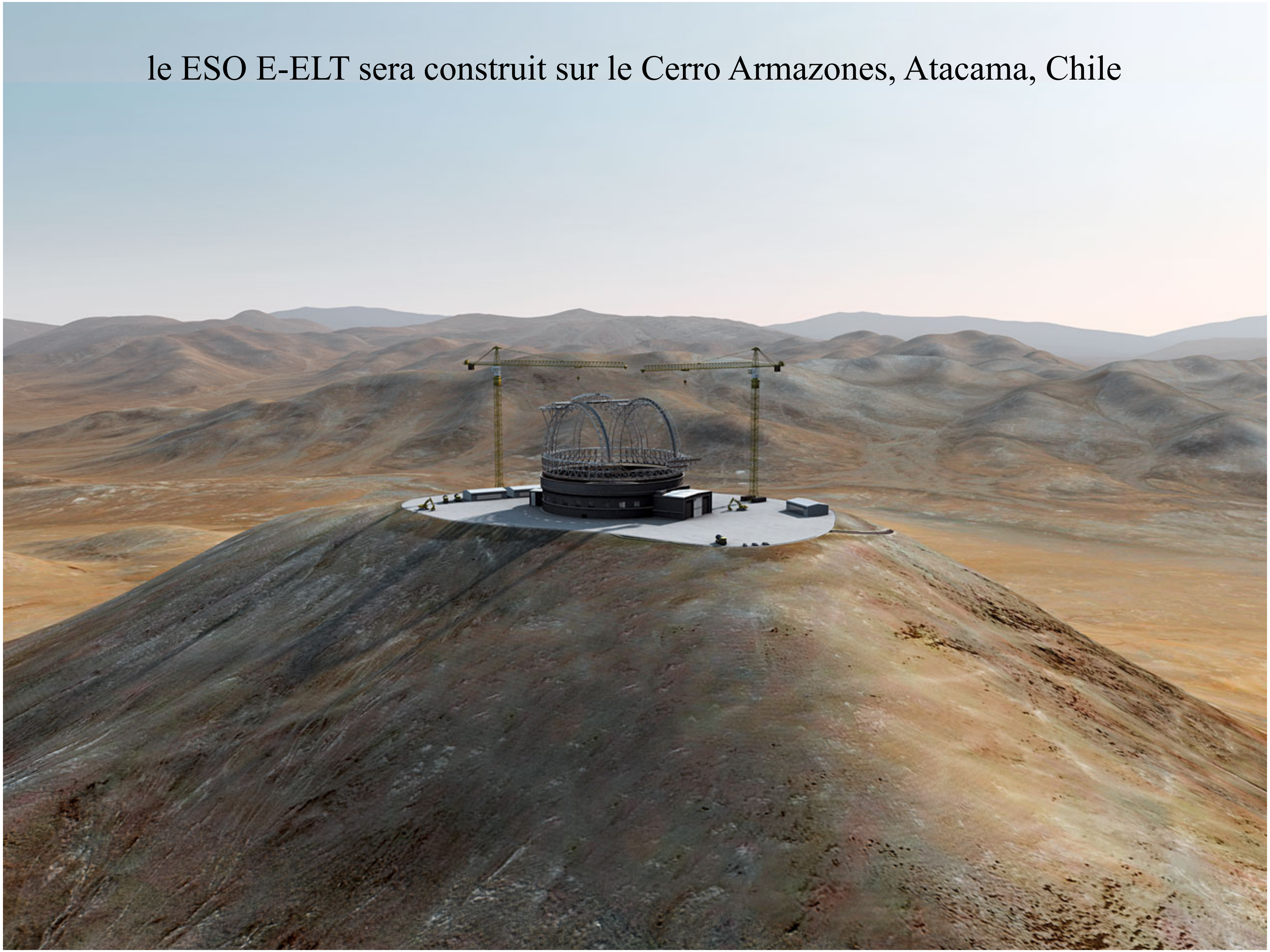

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