LPSC cosmology prospective

"futur de la cosmo au labo et complémentarité entre expériences"

C. Combet, B.Comis, L. Derome, J.F. Macías-Pérez, D. Maurin, F. Mayet, F. Naraghi, L. Perotto, C. Renault, J-S. Ricol, D. Santos

Special thanks to R. Adam, J.F. Macías-Pérez, J-S Ricol and C. Vescovi for slide material

Outline

1. A (hopefully) pedagogical introduction

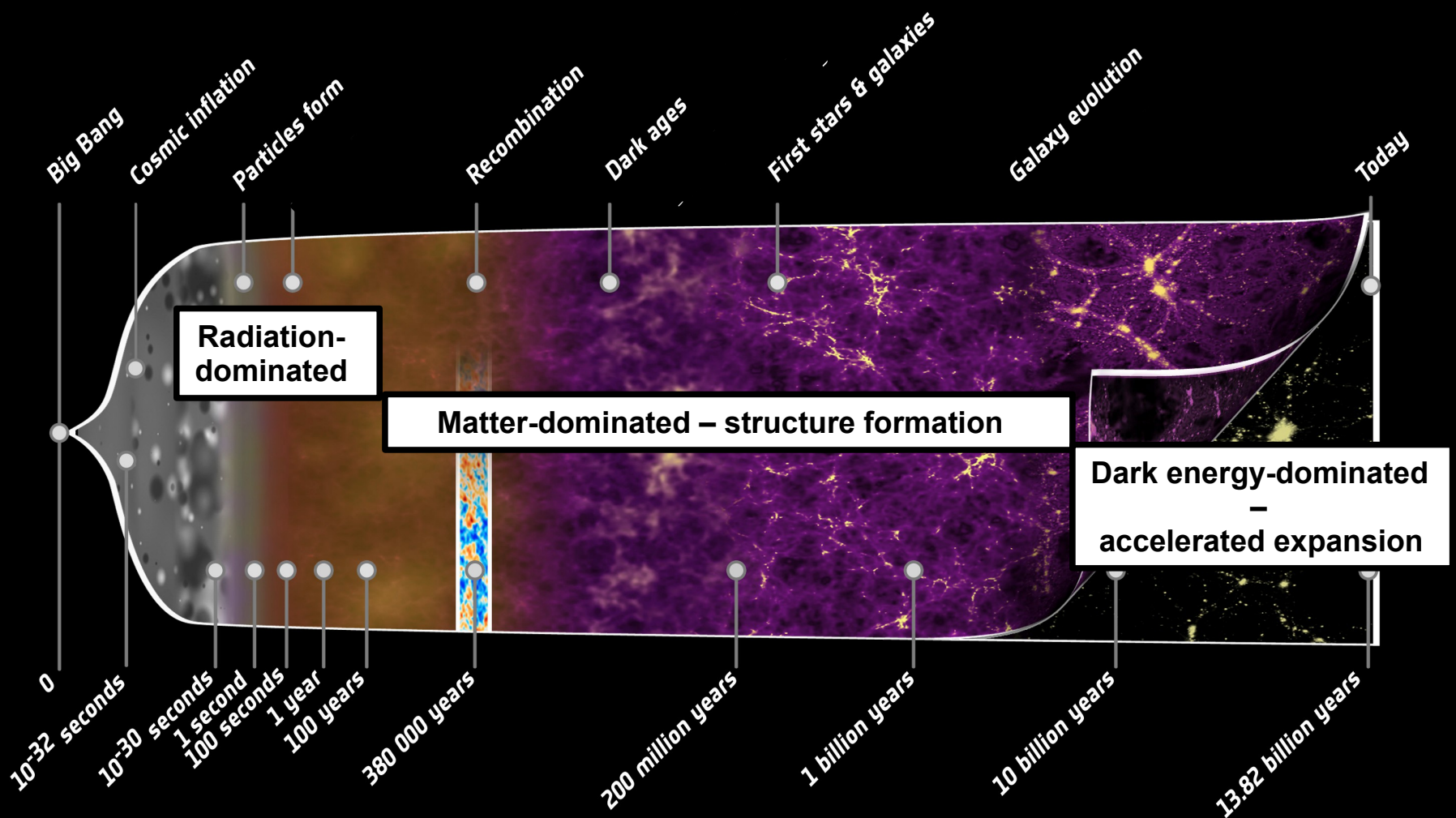
- observational cosmology, history of the universe and open questions
- the probes of observational cosmology
- what experiements for what probes in the next decade – world-wide

2. Cosmology at LPSC in the next few years

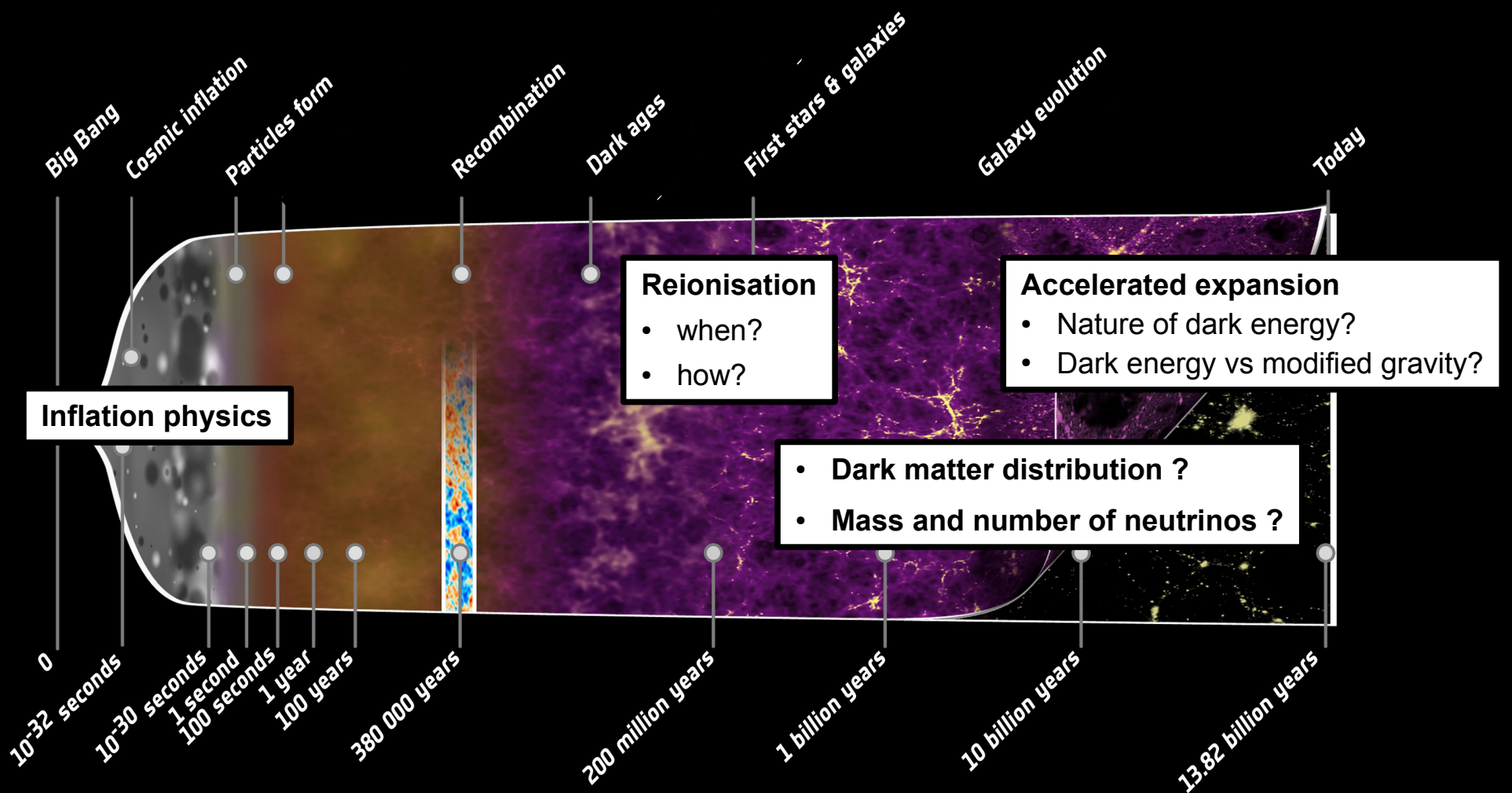
- **Planck/NIKA group → NIKA2/Euclid group**
  - CMB: instrumentation
  - Cluster cosmology: NIKA2 and Euclid

- **DARK=AMS/LSST group → LSST group**
  - LSST – overview
  - LSST @ LPSC: scientific objectives and development

History of the Universe



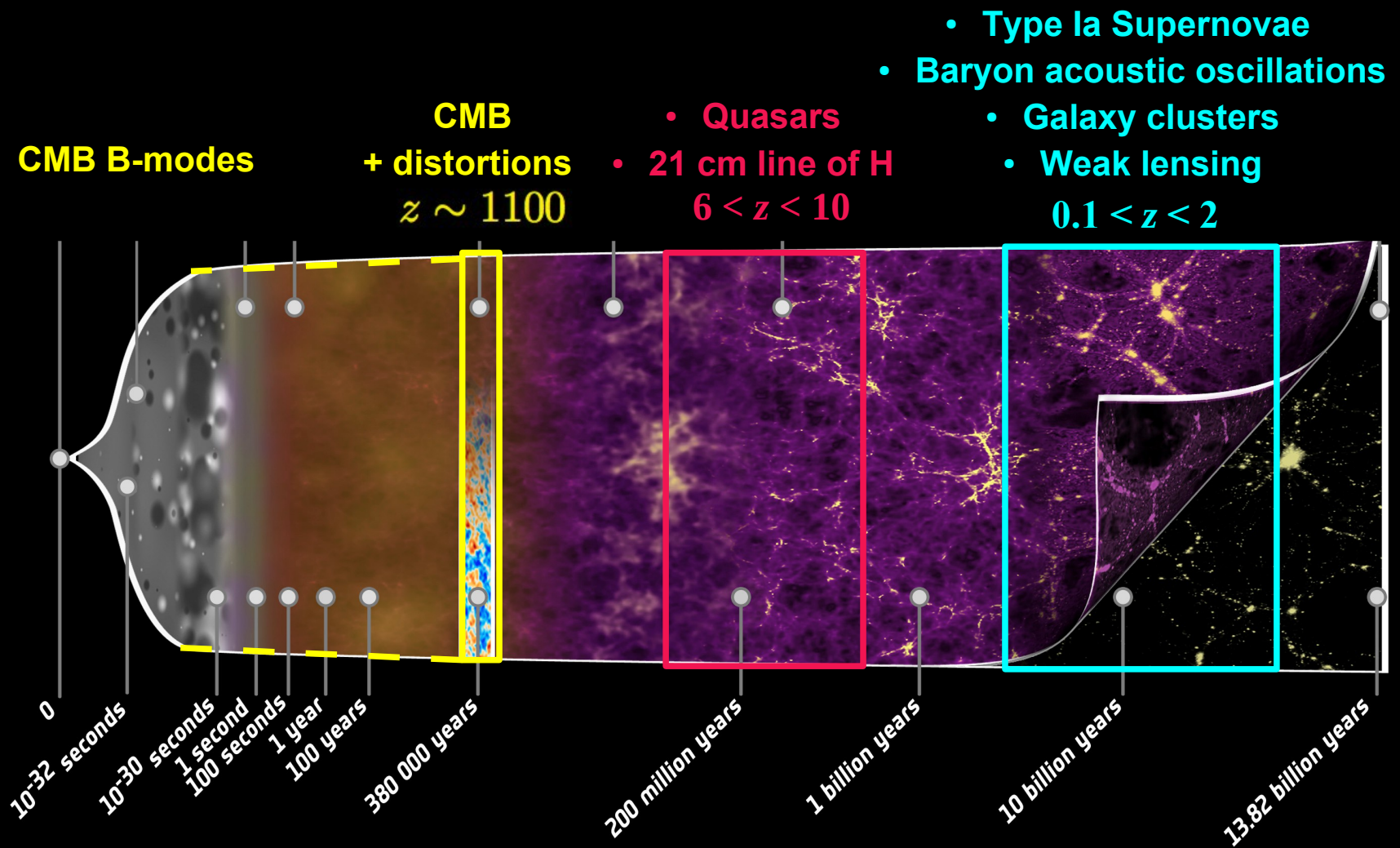
History of the Universe: open questions



History of the Universe: what probes?

Different observables probe different epochs

Flat universe, 69% dark energy, 26% dark matter, 5% baryons



Cosmological probes at $z < 1 – 2$

SNela (standard candles) – intrisinc luminosity known → compare to received flux and infer distance

BAO (standard ruler)

- favoured scale of galaxy pair separation defined by baryon acoustic oscillations in the primordial universe (same scale as CMB first peak)
- can constrain dark energy evolution if measured at different redshifts

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Galaxy cluster counts – # of clusters / redshift bin / mass bin

- dark matter distribution, structure growth, very sensitive to dark energy and neutrino masses
- requires robust cluster mass estimates:

  → X-ray, SZ (Planck, NIKA), lensing (Euclid, LSST)

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- requires exquisite imaging (Euclid, LSST)

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Measured as a function of redshift

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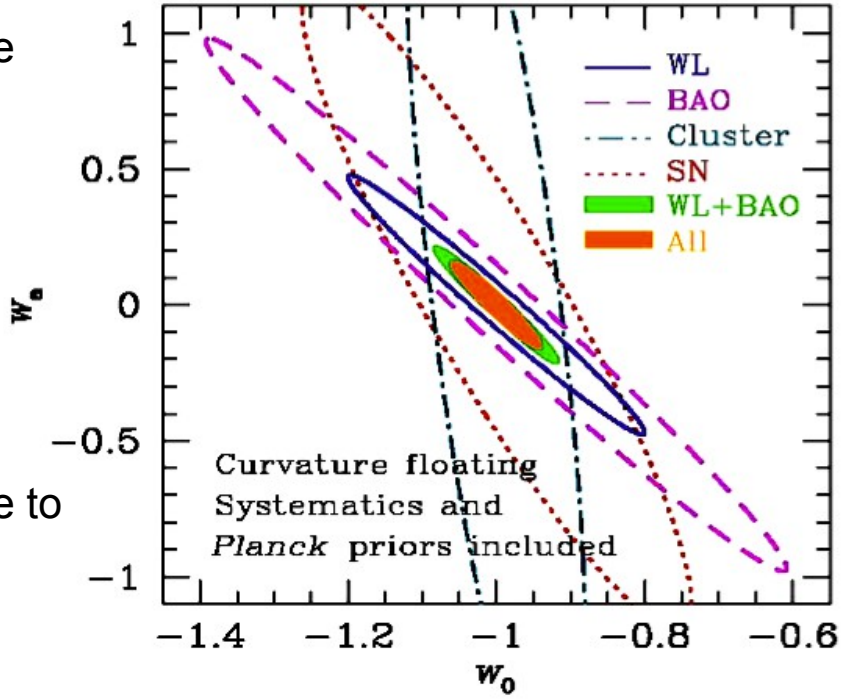
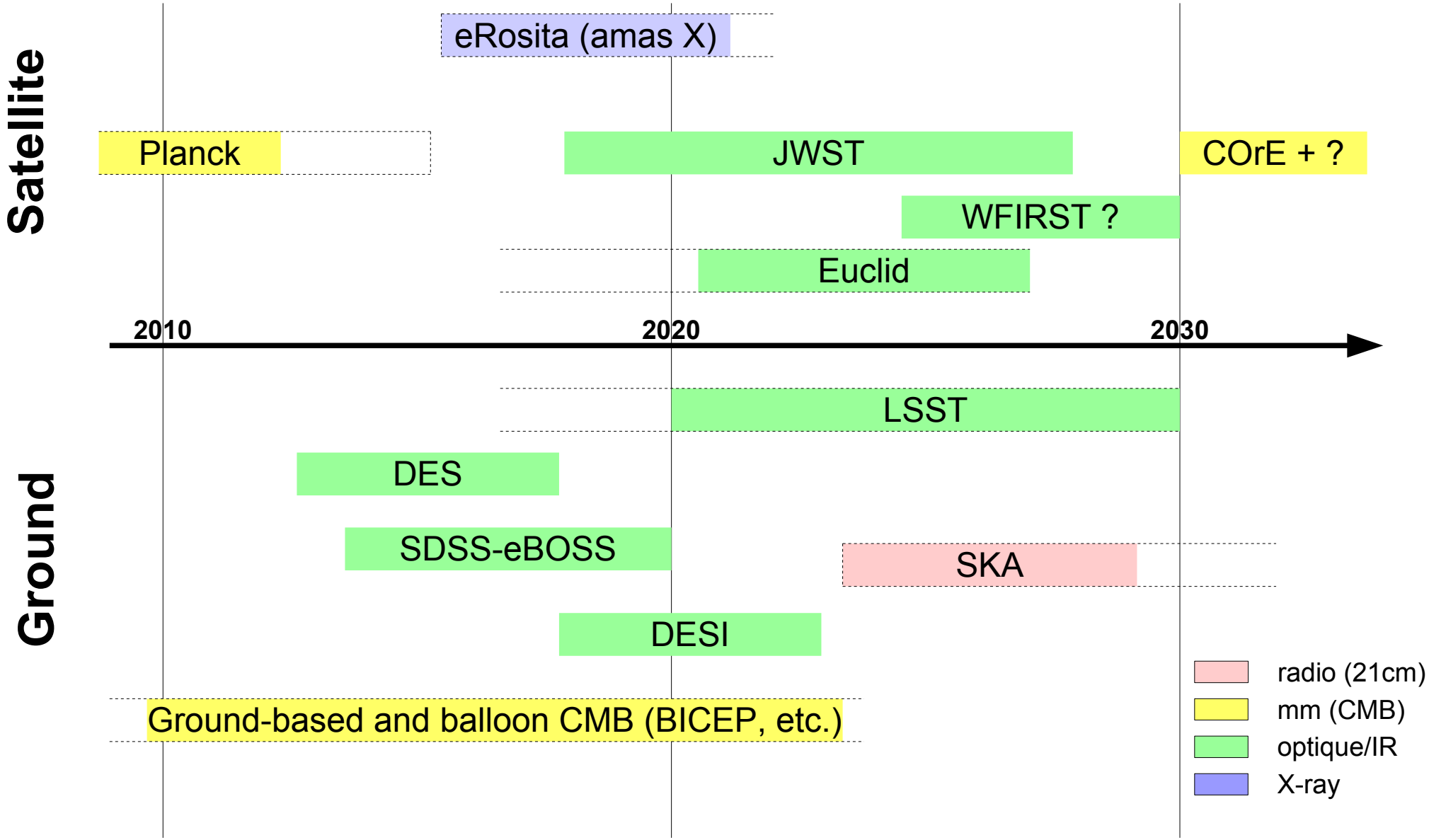


Observational cosmology: what projects ?

2010 – 2030



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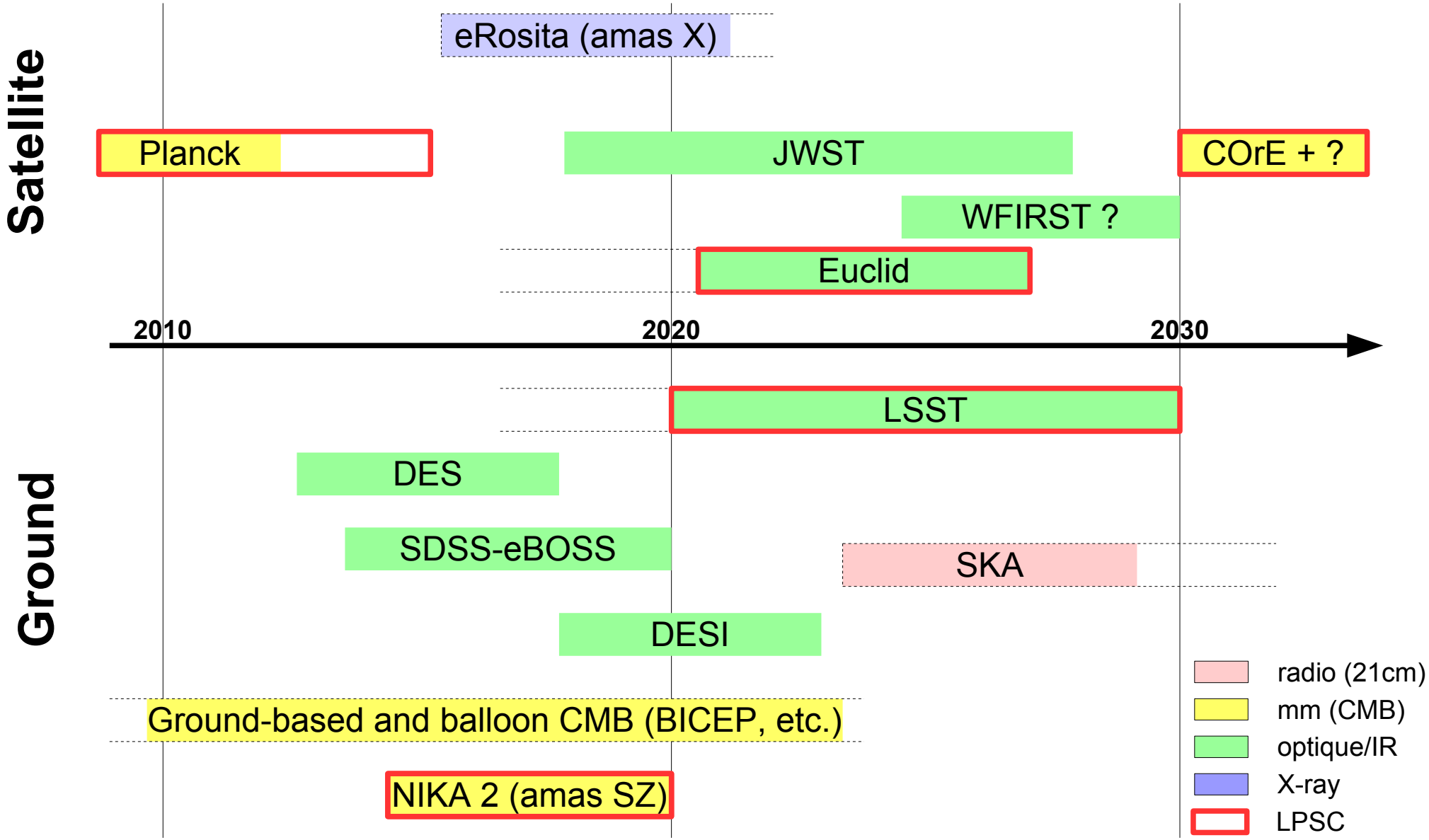

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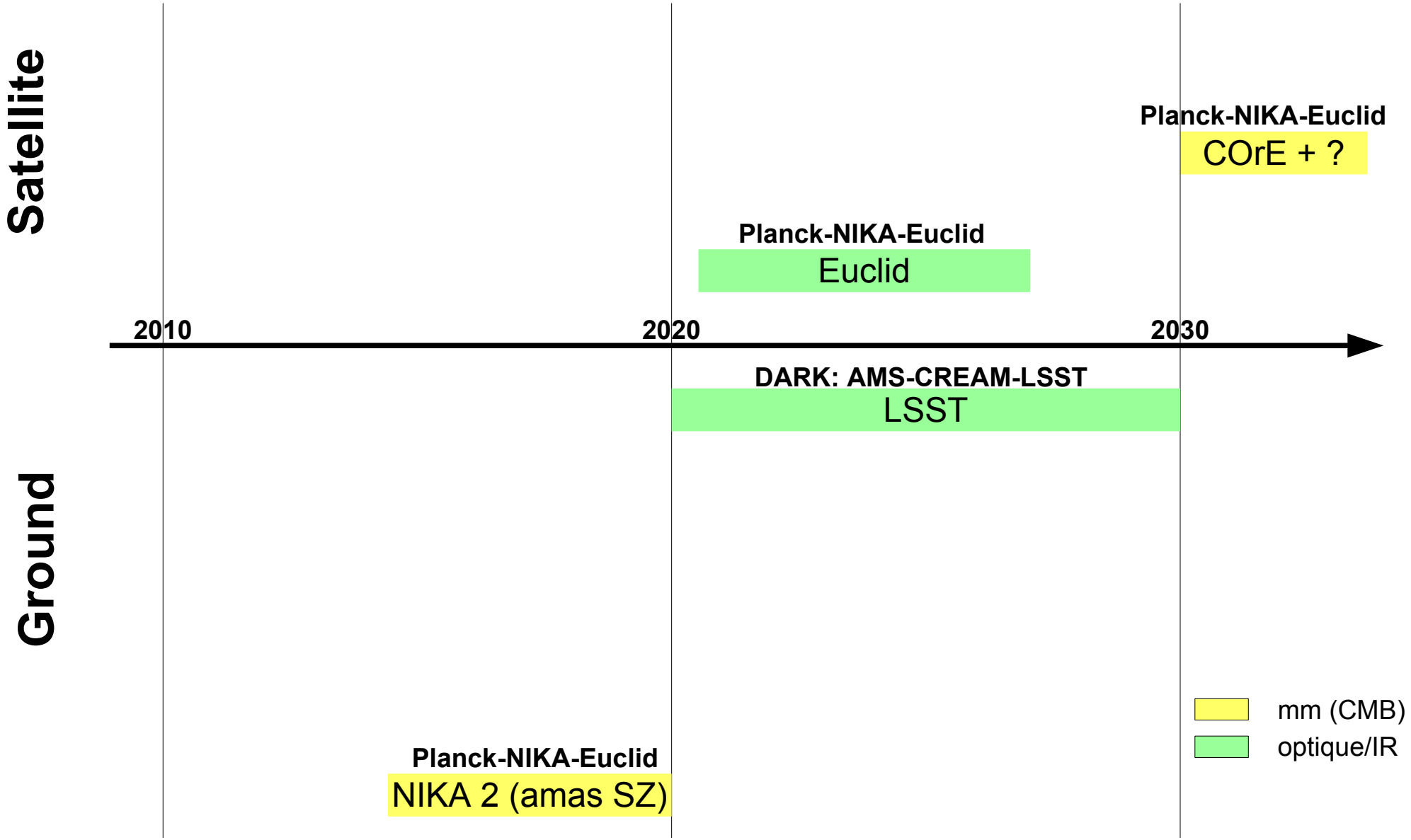

Observational cosmology at LPSC in the next few years

Developping detectors for CMB measurements

Planck – NIKA – Euclid

- **Improving CMB sensitivity measurements requires developping detector matrices (1000+ detectors)**

  - Bolometers, TES are the standard (expensive) technology

- **Kinetic Inductance Detectors (KIDs) are promising alternative:**

  - cheap and easy to make

  - naturally multiplexable → matrices with large number of pixels

NIKA 2 KIDs matrice

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- **Two main directions for the Planck-NIKA group:**

  1. Future CMB experiments for B-modes measurements in polarisation

  - SpaceKIDS project: develop KIDs for space, ongoing RT CNES funding, involvement of LPSC's technical services (electronics)
  - Possible involvment in balloon-borne experiment (Plan B)
  - Members of the COrE+ consortium (instrumentation + science)

  2. Millimetre spectroscopy to measure spectral distorsions of the CMB

  - Construction of ground-based pilot experiment to develop the technology

NIKA 2 and galaxy cluster cosmology

Planck – NIKA – Euclid

The NIKA2 instrument:

- 2 frequency channels, where SZ is maximal and null
- High sensitivity, resolution, large field of view thanks to 1000s KIDs
- Large contribution of all LPSC's technical services
- Installation at IRAM 30m telescope – end of September 2015


IRAM 30m telescope

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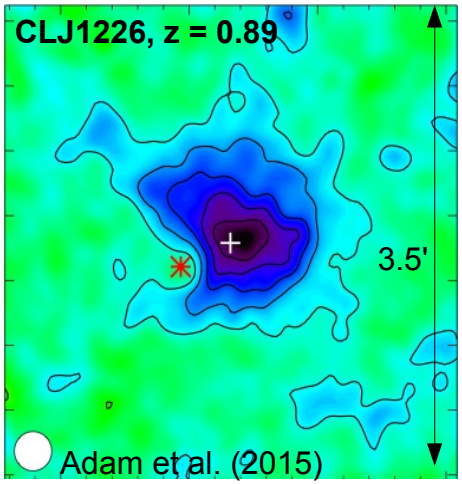
NIKA 2 science at LPSC – SZ large programme (2016 – 2021)

- 300 hours of guaranteed time over 4 years
- Observations to start mid-2016, after NIKA2 commissioning
- Scientific goals:

→ **Evolution of galaxy cluster physical properties at high redshift**

→ **Impact of cluster physics on cosmological studies** – robustify the relationship between cluster mass and SZ observable

→ **Production of a reference sample of galaxy clusters** – follow-up at other wavelengths

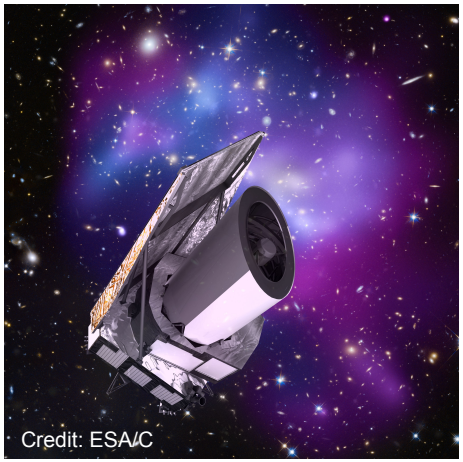


Euclid and galaxy clusters

Planck – NIKA – Euclid

The EUCLID mission

- satellite mission for cosmological survey at optical and infrared wavelengths (photometry and spectroscopy)
- 2021 launch + 6.5 years of data taking
- Primary science objectives: dark energy study, mainly with cosmic shear, BAO (and RSD)



Implications of the Planck/NIKA/Euclid group

- Instrumentation (using expertise developed for the Planck mission):

  → Impact of cosmic rays

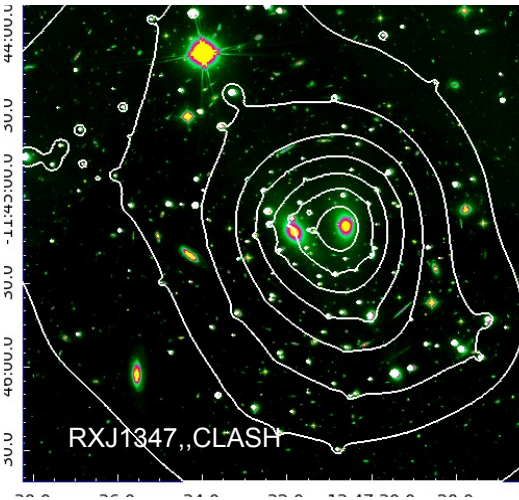
  → Near infrared spectrometer and photometer (NISP) characterisation

  → Raw data processing

- Scientific objectives:

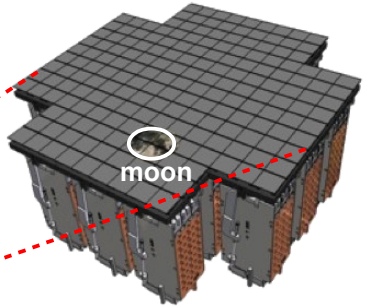
  → **Galaxy clusters studies**: cluster mass using lensing, cluster sample determination, morphology, radial mass distribution – complementarity with NIKA2

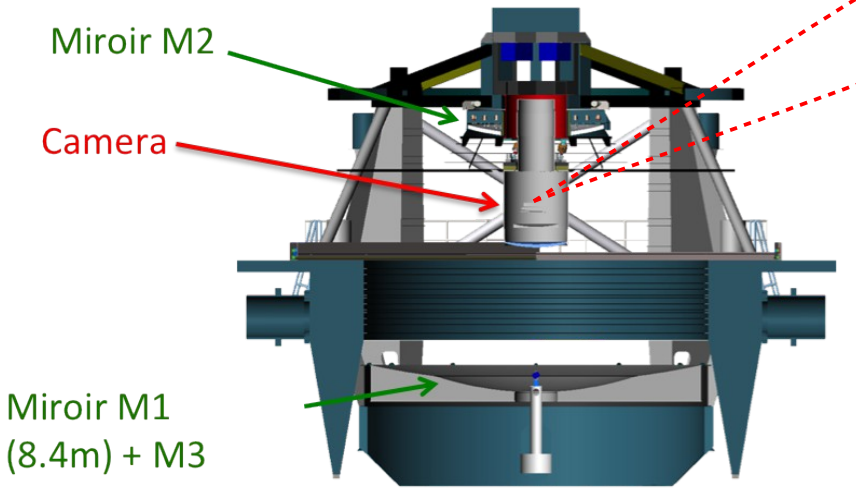
  → **Planck – Euclid joint cosmological analyses** (using knowledge of Planck data and analyses)



LSST overview

DARK - LSST





Structure de 300 tonnes

- Field of view = 9.3 deg^2
- 189 CCD → 3 x 10^9 pixels
- Readout → 2 seconds

→ Fullsky scan every 3-4 nights during 10 years (time-domain astrophysics)

Deep, **wide** and **fast**

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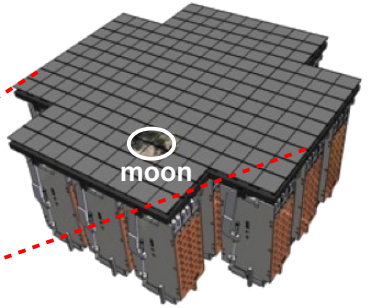

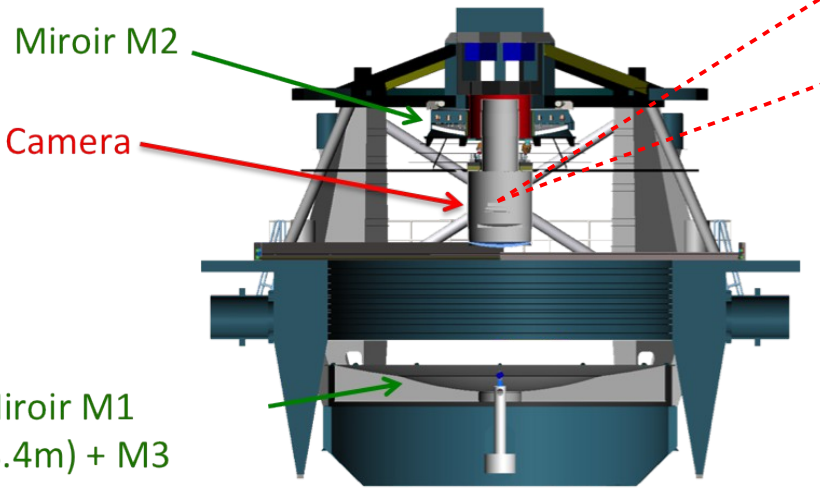

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- Solar system
- Optical transients
- Milky way mapping
- **Dark matter and dark energy – BAO, cosmic shear, cluster counts, SNela (from the same data)**

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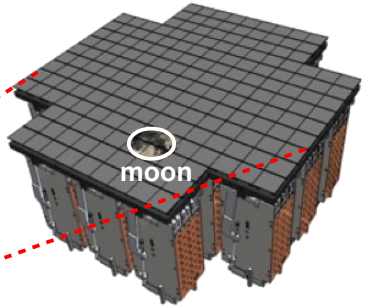

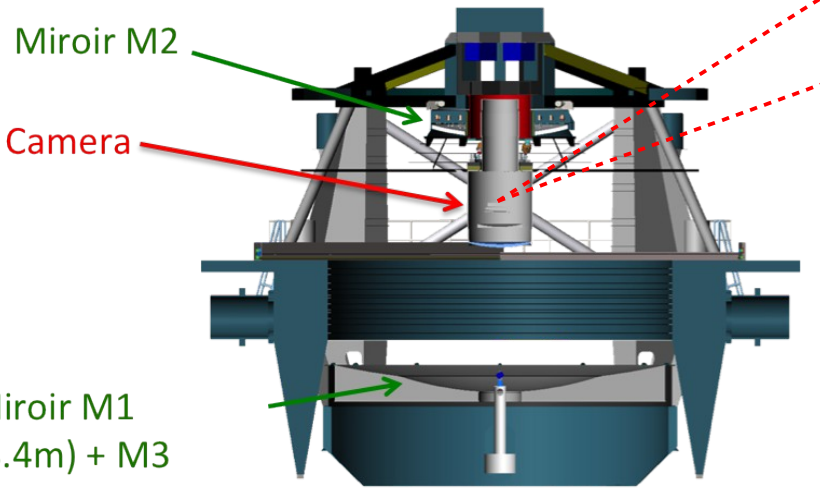

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need for accurate redshifts

LSST @ LPSC: scientific goals

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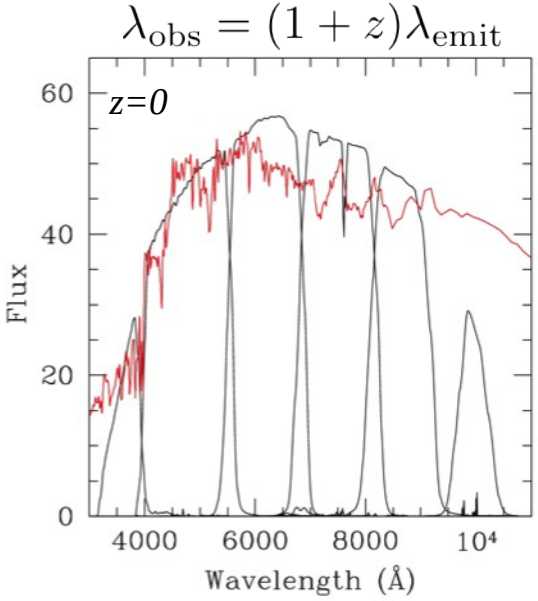

LSST = 6 band photometry (300 – 1100 nm)

Flux difference in the different bands → photometric redshift

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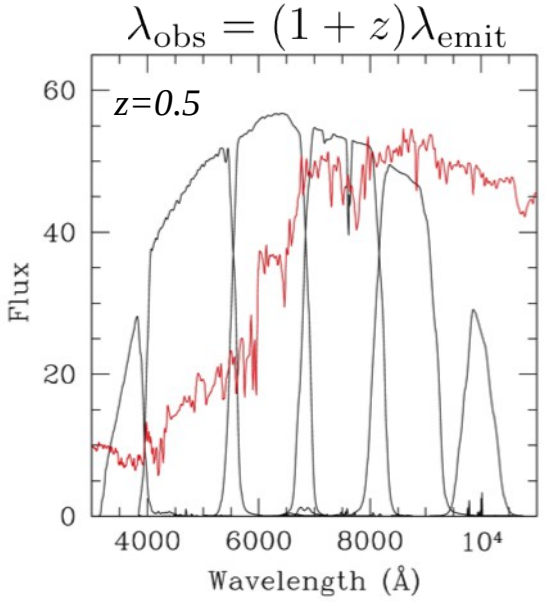

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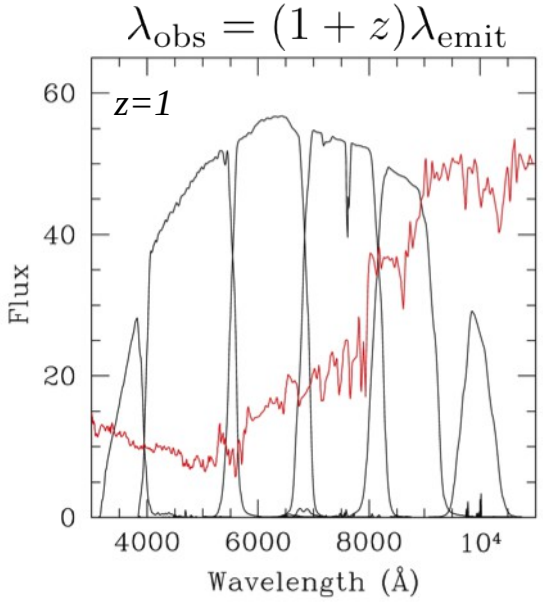

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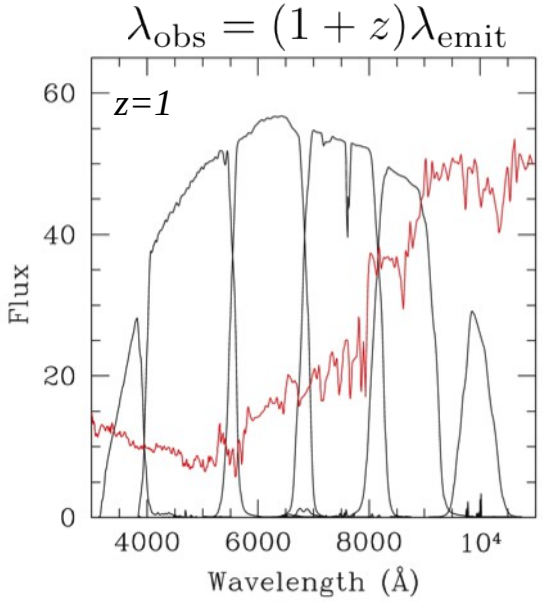


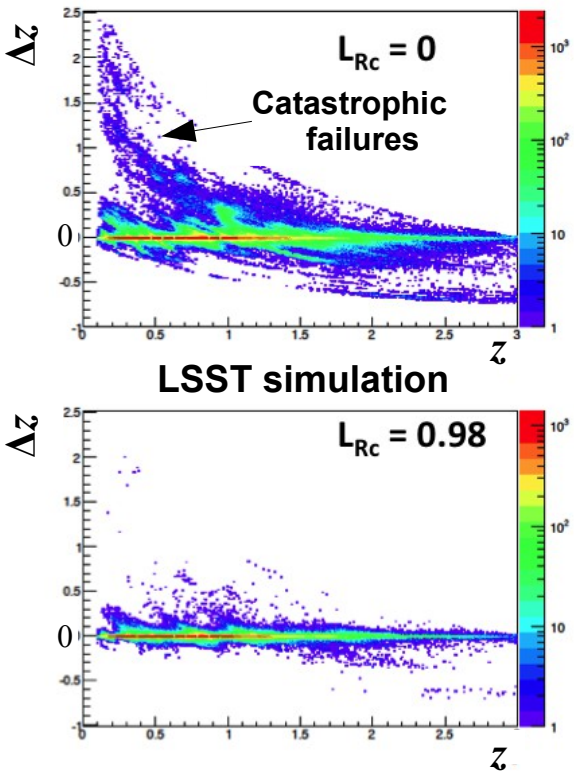
- **PZ code development + quality tool** (LR) for improved catastrophic failure rejection

  → group is important contributor to the DESC photo-z WG

  → main contributor to the French PZ group
- **Use PZ code for several analyses**

  → Impact of filter design on PZ reconstruction

  → SED libraries comparison, etc.



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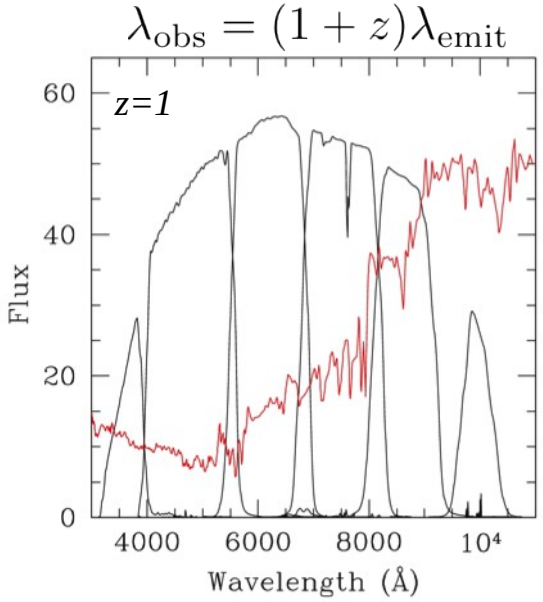

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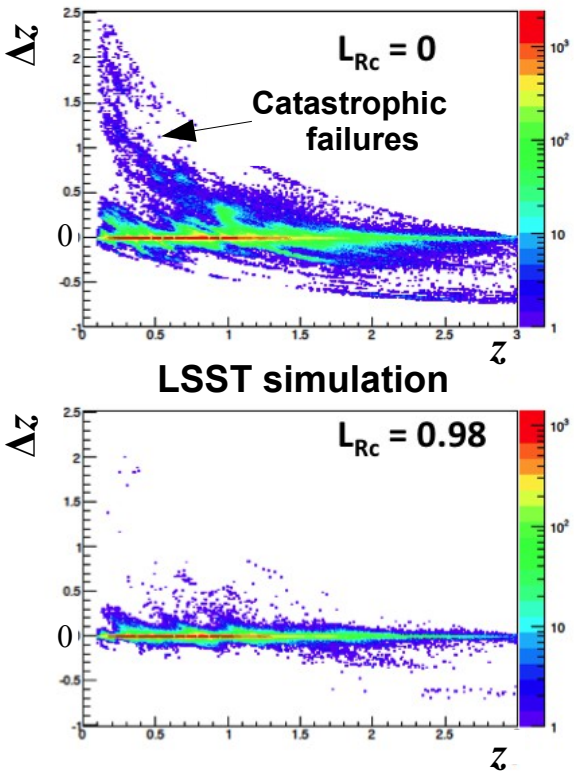
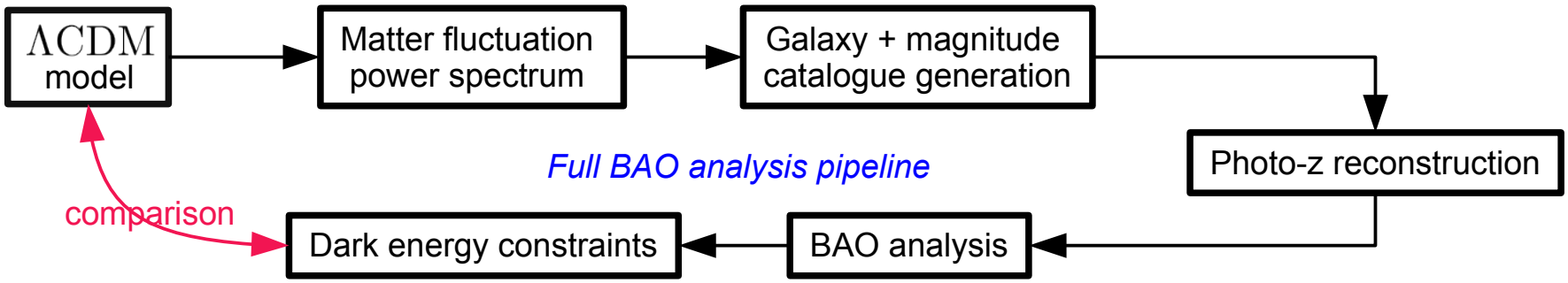


2. Impact of photo-z reconstruction on LSST's ability to constrain DE parameters with BAO



LSST @ LPSC: future developements

DARK - LSST

1. Scientific topics

- **Photo-z, BAO** (ongoing and to be pursued)
- **Weak lensing/Cosmic shear** (clear interest in the group, although no expertise yet): one of the main probe for LSST; so far little involvement at IN2P3 (mainly BAO and SN).

2. Computing

As of today, LPSC is the only IN2P3 LSST lab not involved at some level of the computing.

- Big data: data access, tool, softwares, etc.
- **Data challenge**: catalogue production using ancillary data (e.g. CFHTLS public data) and LSST software (calibration, zero level)

  → several interested LSST team members + possibly 1 computer science engineer

3. Instrumentation

- **CCOB** (camera calibration optical bench)
  → Delivery to SLAC in March 2016 (large beam) and October 2018 (thin beam)
- **Filter Loader**
  → Delivery in September 2017

Personnel

AMS/LSST → LSST : 6 permanent researchers before 2020

- 2015 : A. Barrau, J-S Ricol, C. Renault
- 2016: C. Combet
- 2018+: L. Derome, D. Maurin

Planck/NIKA → NIKA2/Euclid : 4 permanent researchers from 2016

- 2015 : J-F Macias-Perez, A. Catalano, C. Combet, F. Mayet, L. Perotto
- 2016 : C. Combet's departure → LSST
- Associate researchers: N. Ponthieu, X. Desert (IPAG), A. Morfandini (Neel)

Open Questions

Euclid/LSST synergy at LPSC

- Joint effort for cross-correlation with CMB?
- Clusters with LSST, to complement clusters with Euclid project of the NIKA/Euclid group?

Link with theoretical cosmology (A. Barrau)?

Comments, questions?

Go!