Prospective
dark energy and inflation

Science Drivers

To consolidate our knowledge of fundamental physics from cosmological observations, the main science drivers for the cosmological physics community are:

- Explore cosmic inflation
- Understand the global expansion
- Probe gravitational models (at cosmological scales)
- Understand the fundamental constituents of the Universe (through cosmology)
- Test the robustness of the concordance model

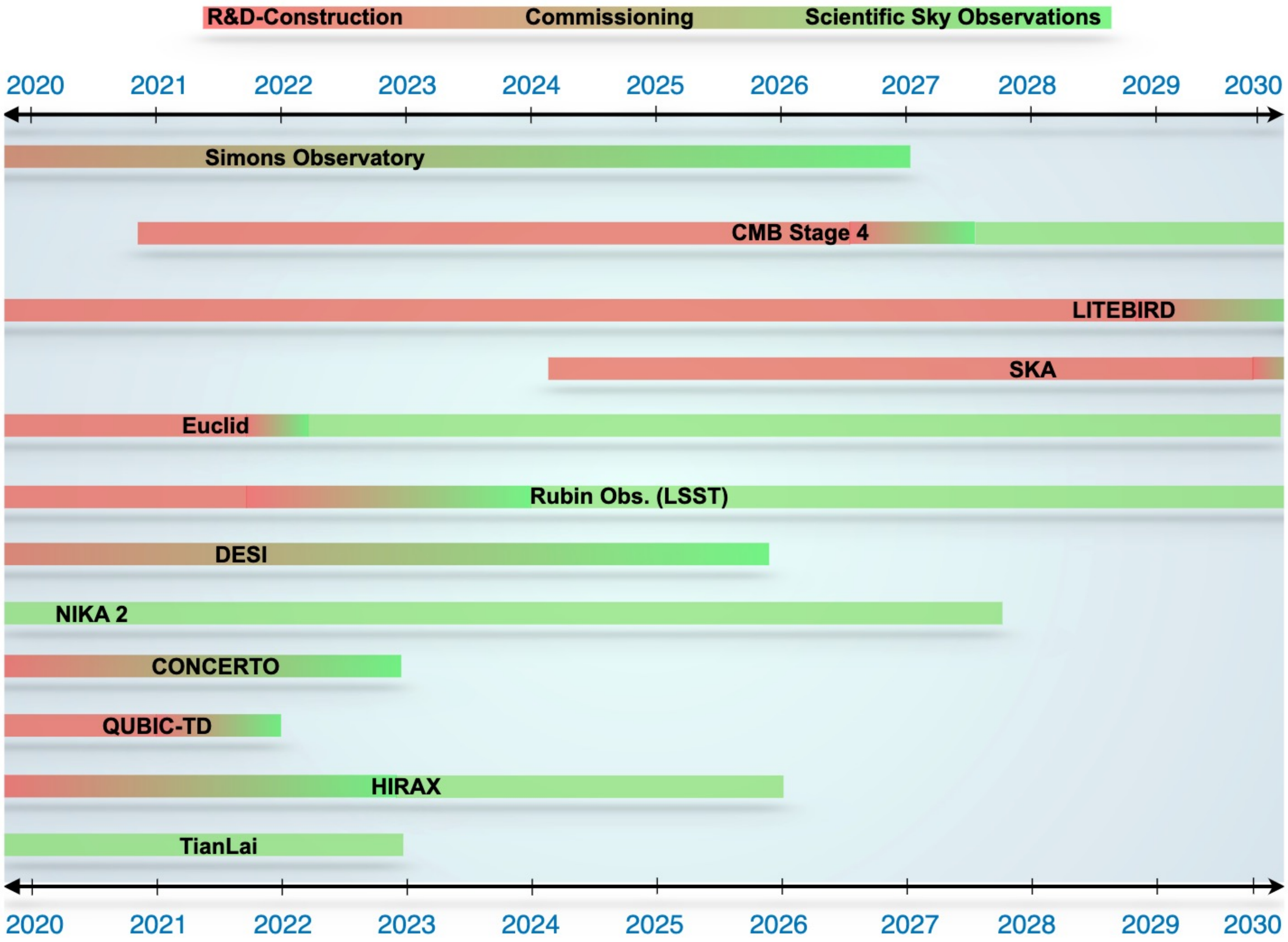

Figure 1: Timeline for projects listed in Table 1, divided into construction, commissioning and observations.

Program-wide recommendations

Recommendation 1: Pursue a program to address the five science Drivers. France should support and develop theoretical and experimental research programs adressing the five science drivers in the coming decade. Since the drivers are intertwined they are not prioritized.

Recommendation 2: improve cosmological physics exchanges Cosmological physics draws upon the fields of particle and astroparticle physics, astrophysics and cosmology. It transcends scientifically and technologically the GTs of these national 2020 perspectives, as well as the institutional organization of CNRS and CEA, such that theoretical and experimental exchanges in France can be improved through e.g. well organized recurrent meetings. These would allow to develop the full potential of the synergies, which were particularly apparent during the seminal discussions, as well as provide a scientific watch on upcoming opportunities and future projects in the coming decade (see, e.g., (19)) for an example of concept preparing well beyond 2030).

⇒ Lien transverse?

⇒ Participation niveau national ?

Recommendation 3: Develop a scientific program enabled by cross-correlation of probes. There are specific physical signals accessible only by combination of data from different projects and wavelengths. A typical example is the cross-correlation of the CMB lensing data with large-scale structure tracers (e.g., galaxies, quasars), which allows to reconstruct the three-dimensional matter field, and measure the growth of structure with redshift. Such studies, whichtranscend the experimental projects and research operator perimeters, would benefit from a project organization.

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Recommendation 4: Maintain a program of projects of all scales, from the largest international projects to mid-and small-scale projects. Most of the science drivers are primarily addressed by large and mid-scale experiments. It is however possible that small-scale projects can also address questions related to the drivers - and sometimes complement large projects. This includes additional observational projects needed for the scientific analysis of the main programs.Opportunities are likely to arise in the coming decade which can provide leadership roles for scientists and allow for partnerships among laboratories.
⇒ ZTF etc..

5: Support computing development for upcoming, data-intensive experiments Computing in-frastructure and algorithm development in an astrophysical context, for example in the Rubin Observatory LSST, Euclid and LiteBIRD, is different in some ways from the usual high energy physics computing use cases. As the cosmological physics computing needs evolve, so should its computing resources (see, e.g., (3) for examples of where computing may be a determining factor).

Recommendation 6: Develop and maintain R&D programs Advances in experimental cosmological physics which address the science drivers come also from R&D for detectors and experimental techniques. Development of synergies between different institutions to rise the technology readiness for ground and space environment and for different observational approaches (imager, spectrometer, etc...) should be encouraged.

Project-specific recommendations

The ordering of the project-specific recommendations reflects the project's relevance on the science drivers, its timeliness,its feasibility, the existing commitments, and the size of the French collective of scientists involved.

Recommendation 7: Complete LSST and EUCLID as planned and ensure the scientific return These large projects represent a major French investment, and will drive the scientific achievements of the next decade. The scientific return should be kept at the height of the investments made.

Recommendation 8: Consolidate the French contributions to LiteBIRD. The LiteBIRD project is in a phase A. If further selected, it will drive the science on cosmic inflation for the next decades. French participation to both hardware and science responsibilities should be supported during this phase, and beyond if the mission is approved.

Recommendation 9: Define a ground-based CMB path forward A strategy for a French participation in a third generation ground-based CMB project should be developed, to define the objectives and the necessary actions.

Lien à la theorie et aux observables

- La mesure de la constante de Hubble à haute précision peut permettre de tester des modèles d'énergie noire susceptibles de modifier la loi de Hubble et d'être responsable des mesures differentes de la constante de Hubble.
$\Rightarrow$ SNIa + CMB

- La répartition des galaxies agit aussi comme un traceur de la matière noire (considérée macroscopiquement) .
$\Rightarrow$ Grandes structures

Au sein du groupe Théorie, il y a un intérêt pour les modèles à champs scalaires, aussi bien pour l'énergie noire que pour la matière noire, ainsi que pour les interactions entre matière noire et énergie noire.

- Il serait possible d'utiliser ces observations pour contraindre les modèles du type quintessence/fuzzy dark matter/dark fluid.

-Tester la gravité ? Lien a des modèles de gravité modifiée via par exemple Th. Buchert (ENS/CRAL)