

The Canada–France Imaging Survey or CFIS (*pronounced "Sea–Fizz"*)

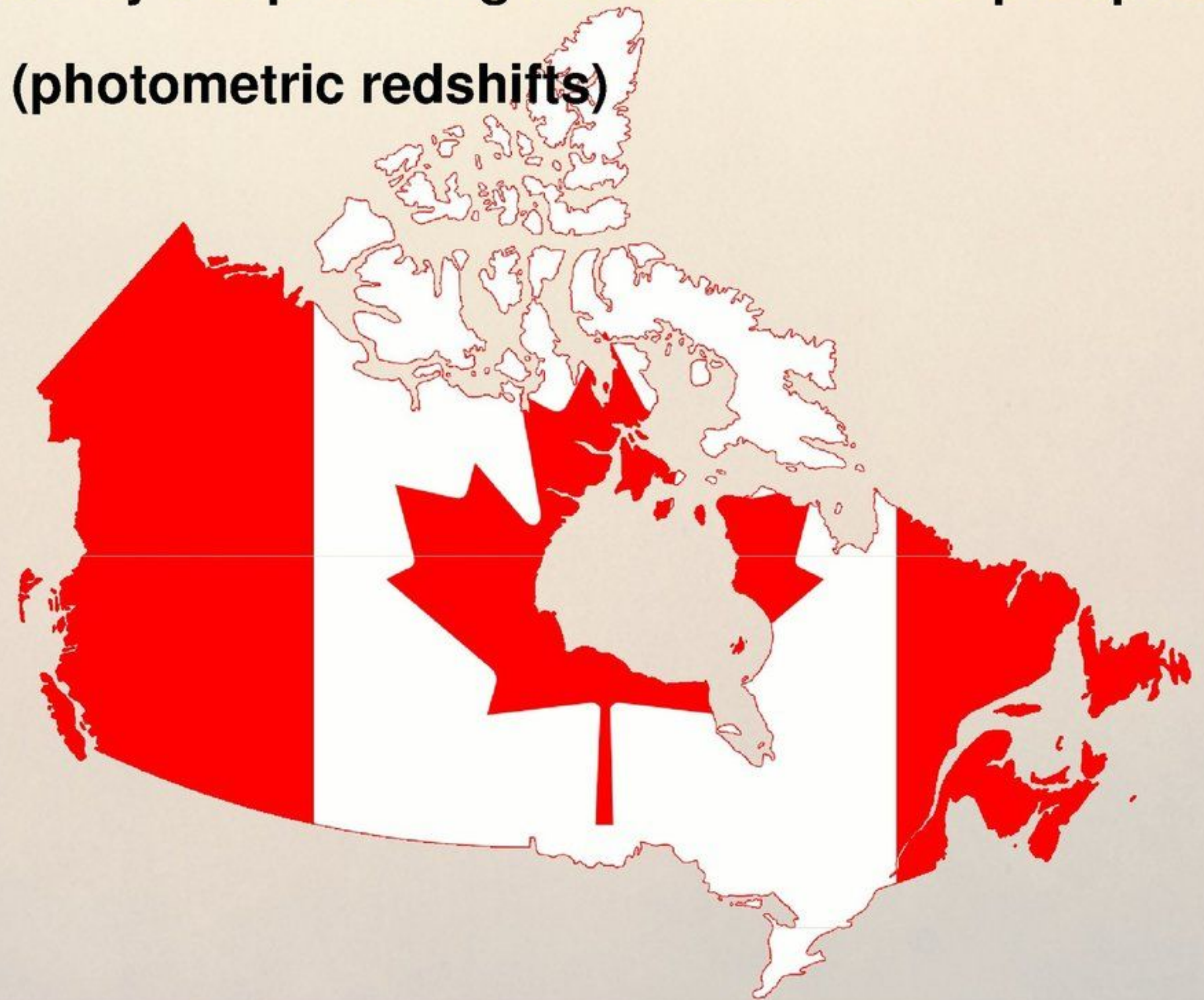
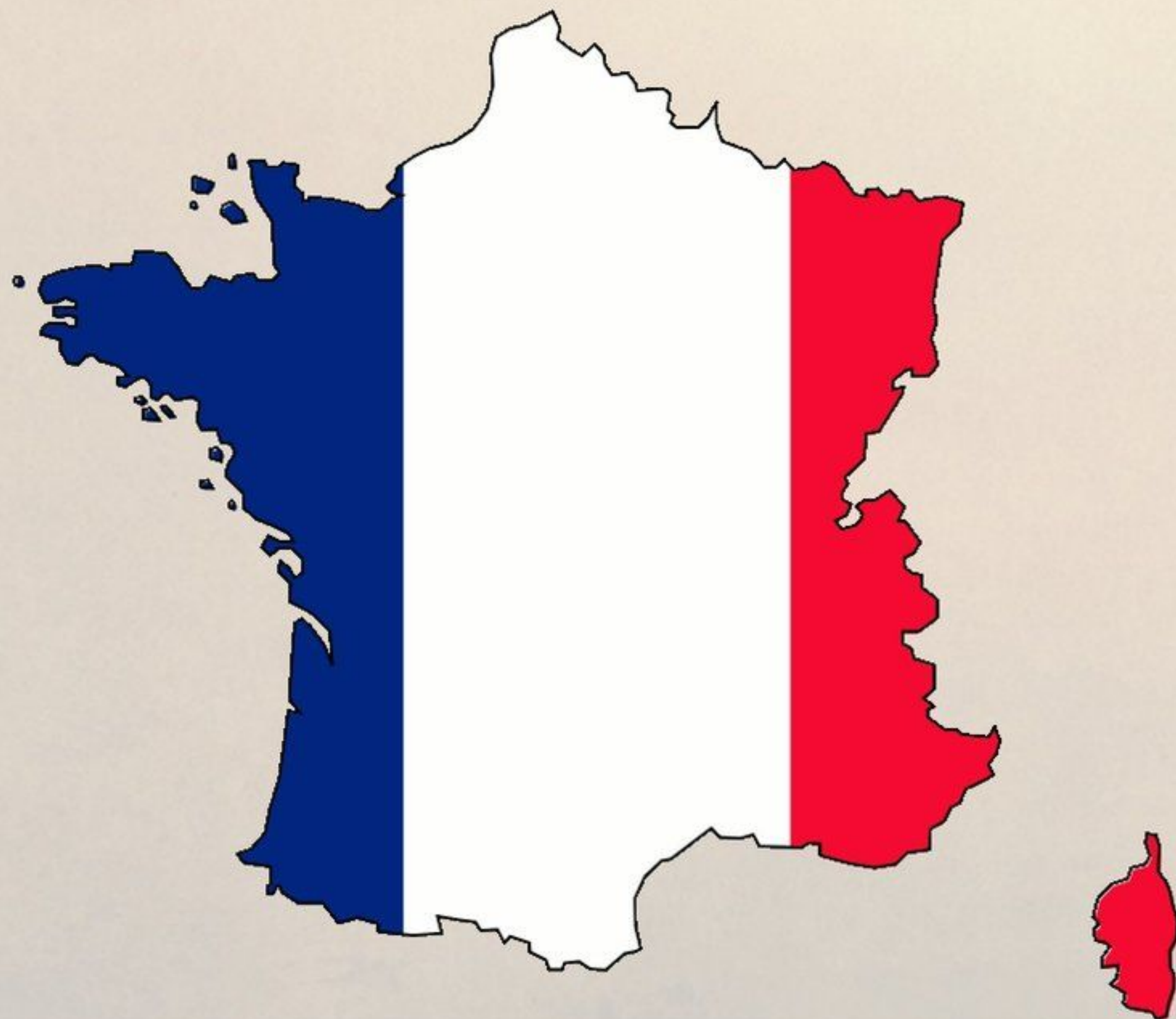


Jean–Charles Cuillandre on behalf of the CFIS Collaboration
CEA Saclay / Observatoire de Paris



The Canada–France Imaging Survey in a nutshell

- A collaboration of 121 scientists: 2/3 from France, 1/3 from Canada
- 271 CFHT–MegaCam nights allocated from Feb. 2017 to Jan. 2020, 25% of the whole telescope time
- A survey serving science from the solar system, the galaxy, nearby universe, and cosmology
- An "all–sky" type survey built on CFHT's greatest strengths (u–band, r–band image quality, FOV)
- A legacy dataset open to all interested scientists in Canada and France
- A collaboration welcoming all interested scientists in France and Canada (pending a few rules)
- A complete logistic support from CADC/CANFAR for data calibration, hosting, and distribution
- The result in France of a large consultation followed by a top ranking at the latest INSU prospective
- A critical component of the Euclid space mission (photometric redshifts)





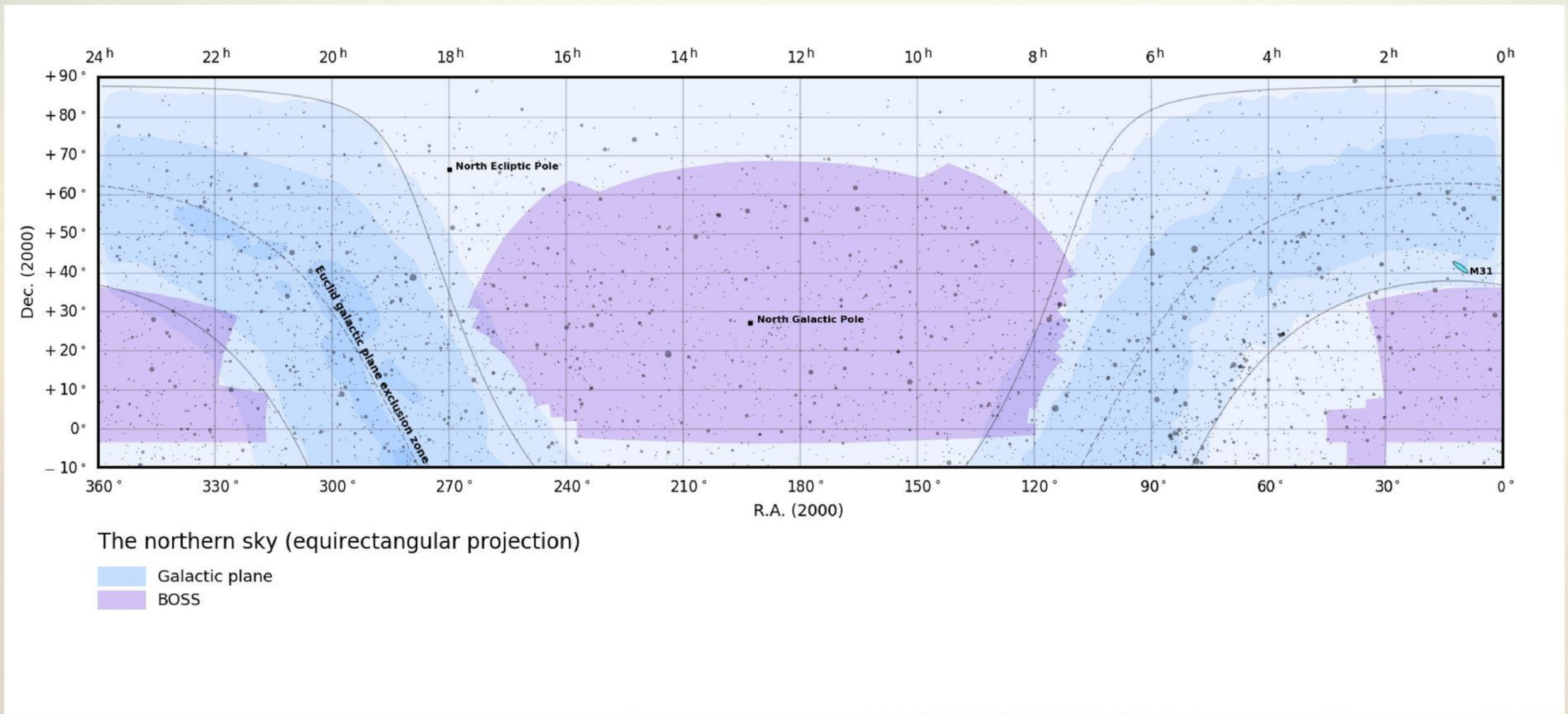
CFIS "all-sky" science

- Science drove a survey design building on CFHT's greatest strengths: u-band, image quality, FOV
- A broad range of themes that motivated the proposal are now pursued by the collaboration:

- Solar system
 - High-inclination TNOs
 - Large-pericenter TNOs
 - Active asteroids and comets
- Milky Way
 - White dwarf population studies
 - Distance-Metallicity-Kinematics decomposition of the Milky Way
 - Thick disc/halo shape and thick disc stellar formation history
 - Tidal stellar streams
 - Dynamical modelling of the Galactic halo
- Galaxies
 - Search for dwarf galaxies and Galactic Substructures
 - Demographics of star clusters in low-mass field galaxies
 - Identification of fine structures and debris around massive galaxies
 - Ultra-diffuse galaxies systematic search in the field
 - Diffuse light in clusters of galaxies
 - Cluster masses
- Weak lensing
 - Mass mapping comparison with other tracers of dark matter
 - Cosmological constraints from weak lensing convergence maps
 - Mass maps, shear maps and cross-correlations
 - Void weak lensing
 - Cross-correlation with SDSS and test of General Relativity
 - Cosmic shear
 - Cosmology with peaks
 - Filaments between LRGs
 - Tidal stripping from weak lensing measurements of satellite galaxies
 - Galaxy bias estimation
 - Galaxy-galaxy lensing: stellar to halo mass relation

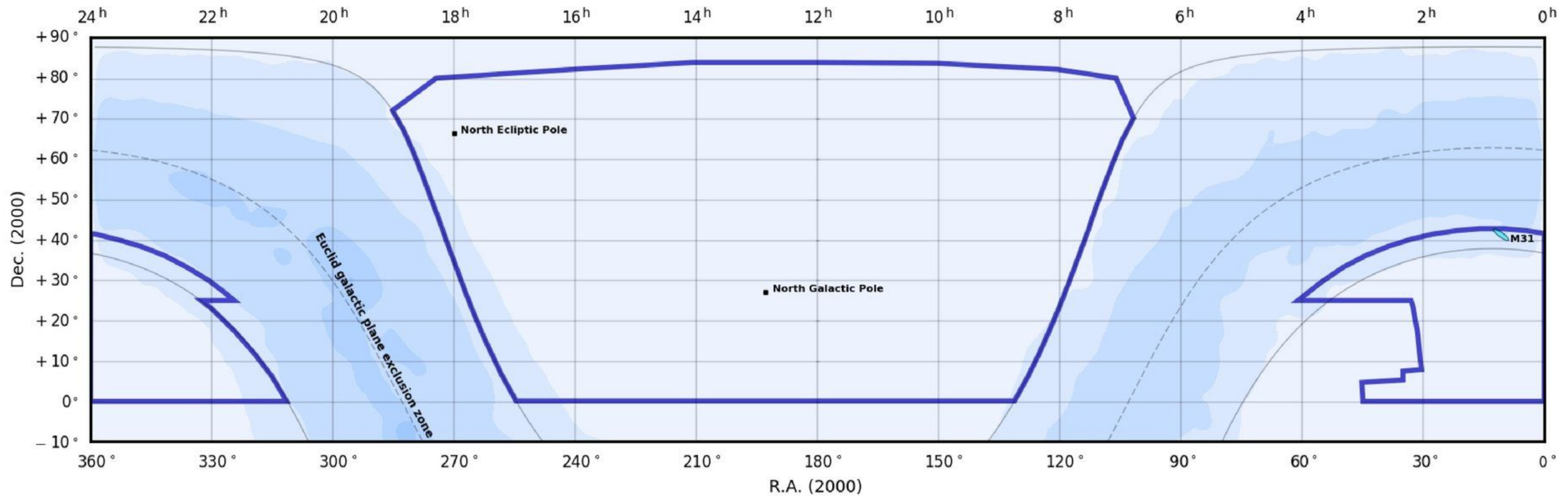
- Designed to serve many French and Canadian scientific communities (à la CFHTLS/NGVS)
- Naturally synergistic to many past/present/future all-sky surveys (Gaia, PS1, BOSS, DESI, etc.)
- Technically driven to provide critical data for the Euclid space mission photometric redshifts

CFIS zone: the "extragalactic" northern sky



- The Euclid space survey galactic plane exclusion zone is adopted (latitude clip at ± 25 deg.)
- The total BOSS area is 10,000 square degrees

CFIS-u footprint and depth

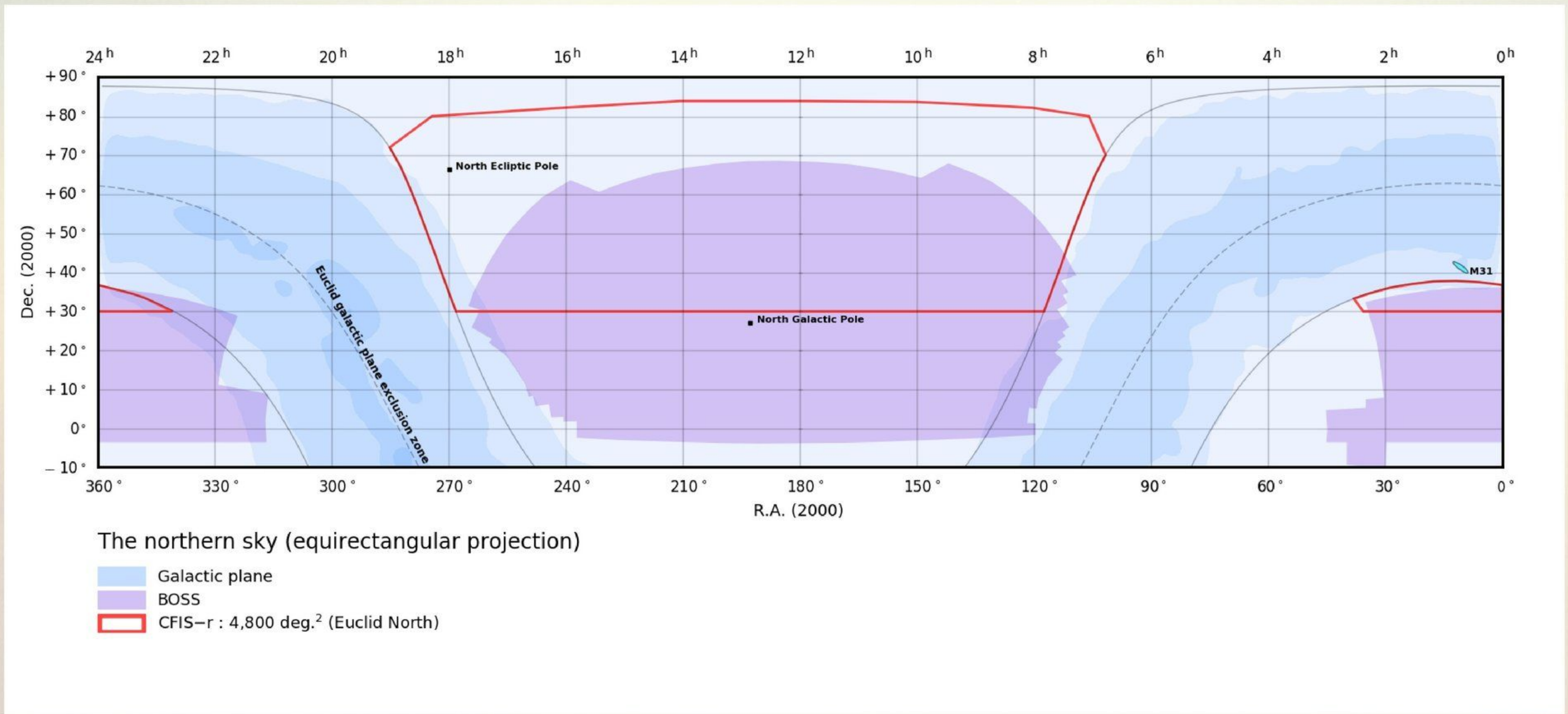


The northern sky (equirectangular projection)

- Galactic plane
- CFIS-u : 10,000 deg.² with priority to DEC>25 deg.

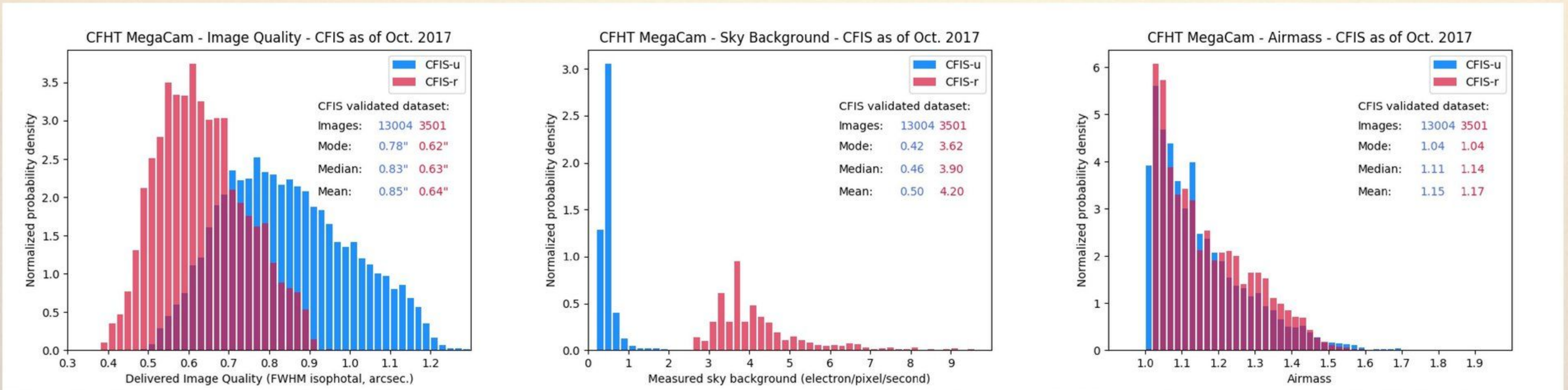
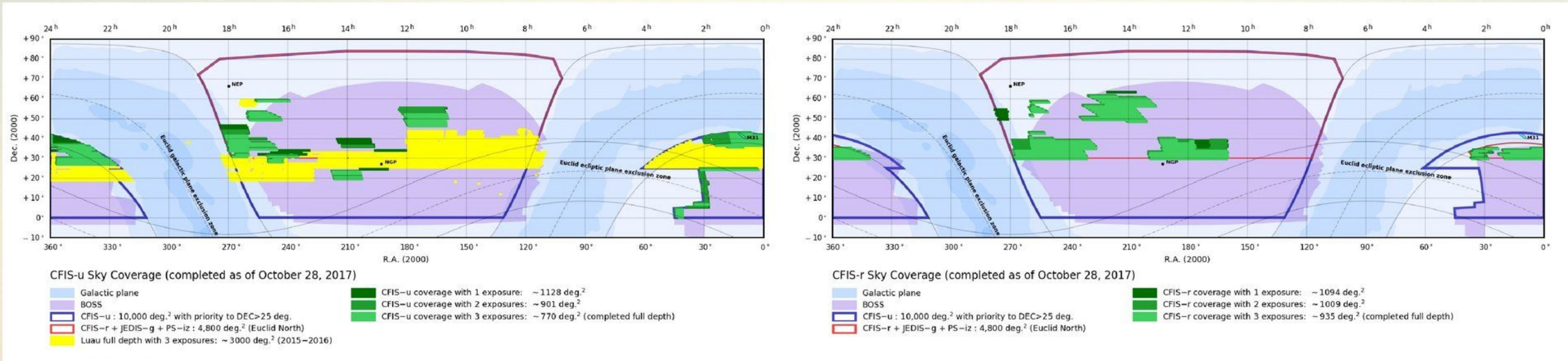
- The total CFIS planned area is 10,000 square degrees above a declination of +0 deg.
- The telescope hardware limits and galactic reddening limit the equatorial pole coverage (small)
- Depth: $u=24.4$, point source, 5-sigma, 2 arcseconds diameter aperture (SDSS-u + 3 mag. in 240s)
- LSST will cover the sky up to a declination of +2 deg. only: CFIS-u will remain unique
- The 2015-16 MegaCam Large Program Luau morphed into CFIS-u in 2017 (~3,000 square degrees)

CFIS-r footprint and depth



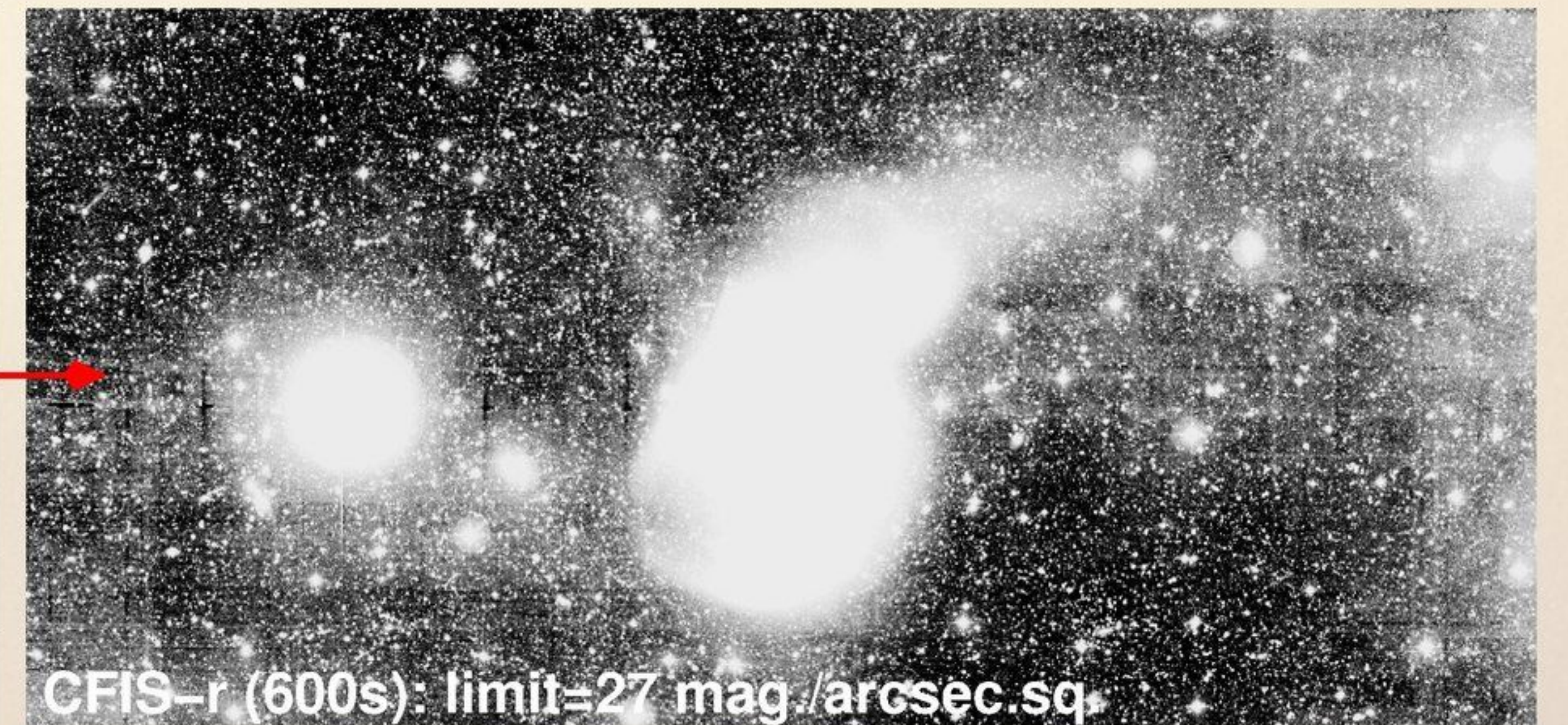
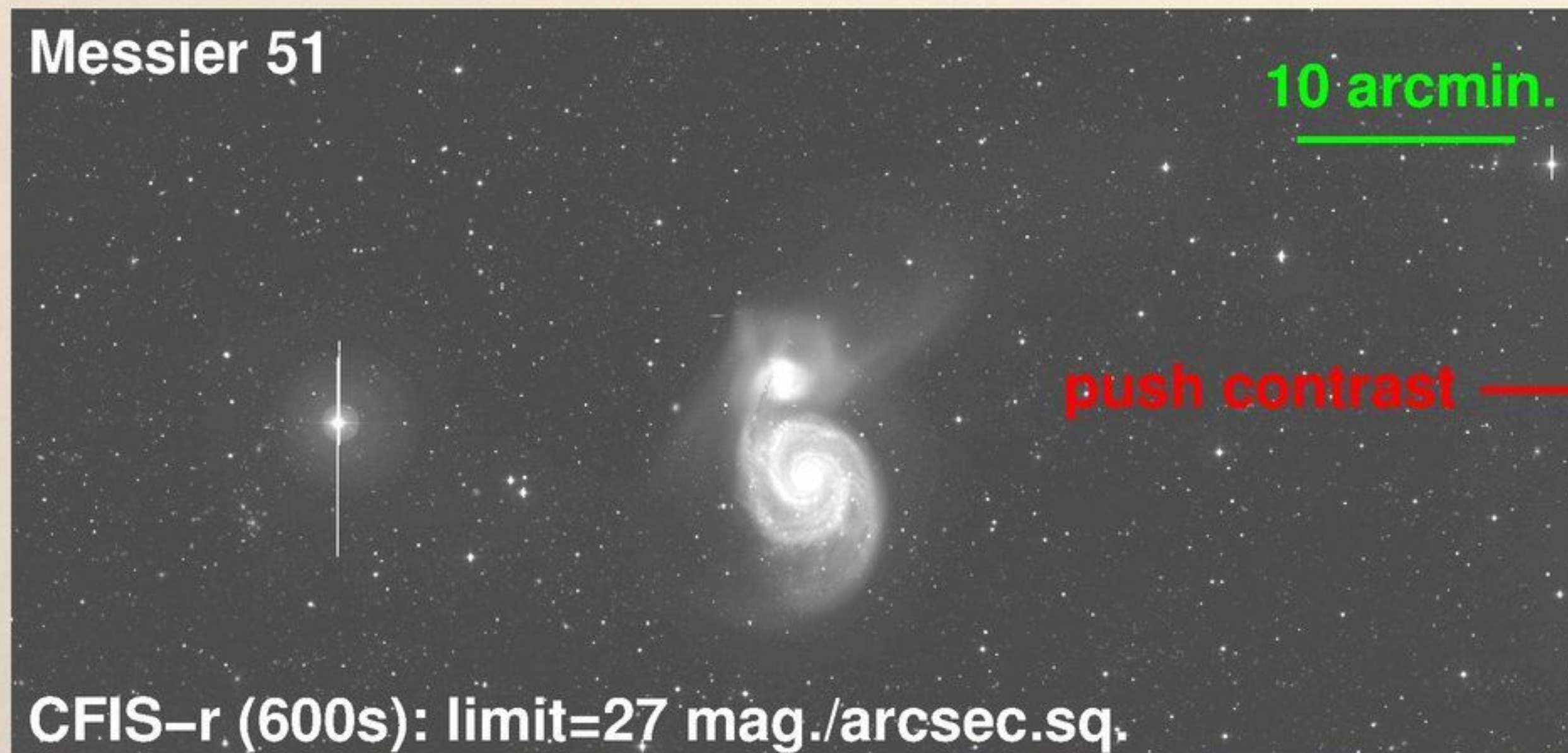
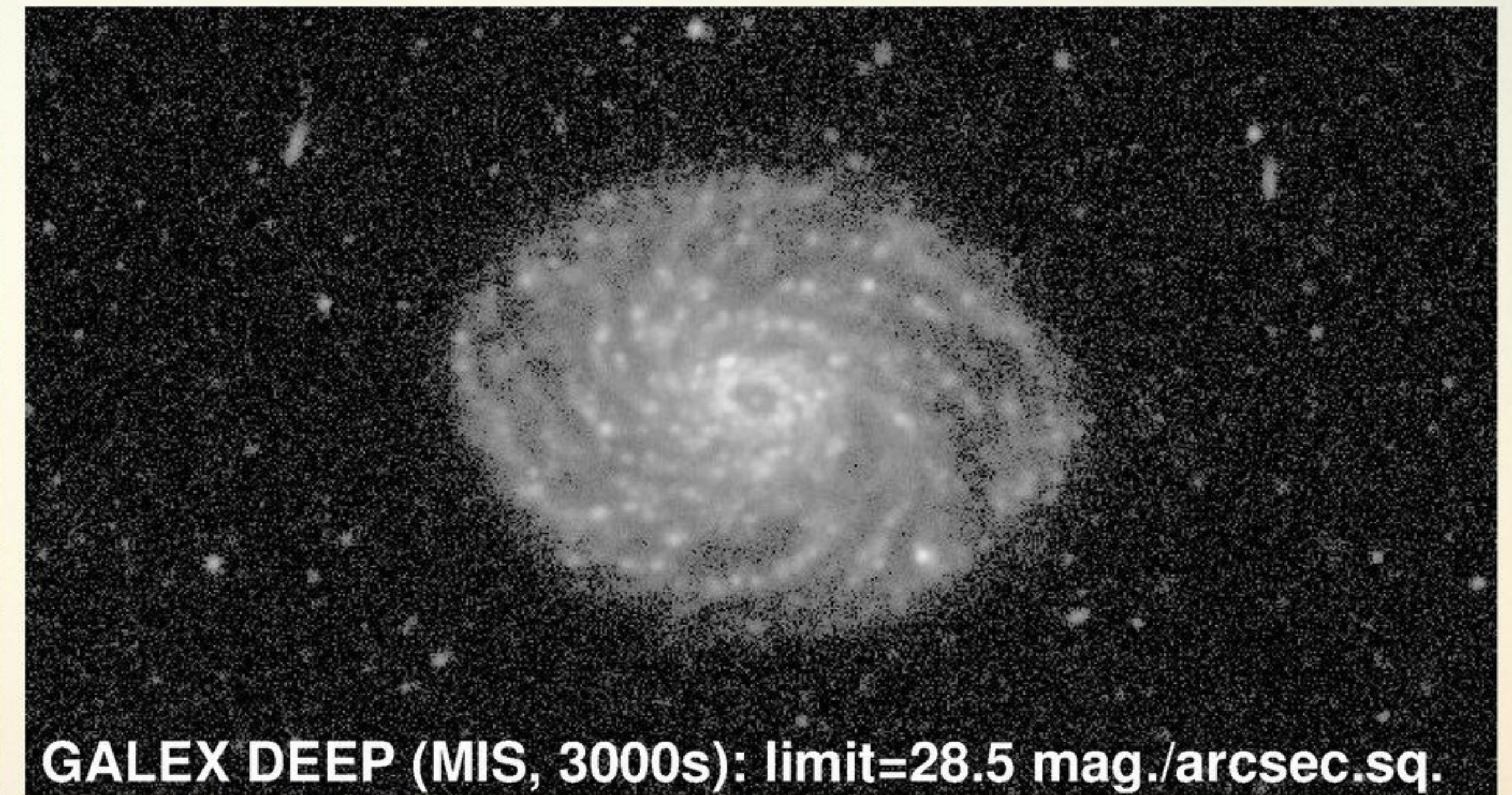
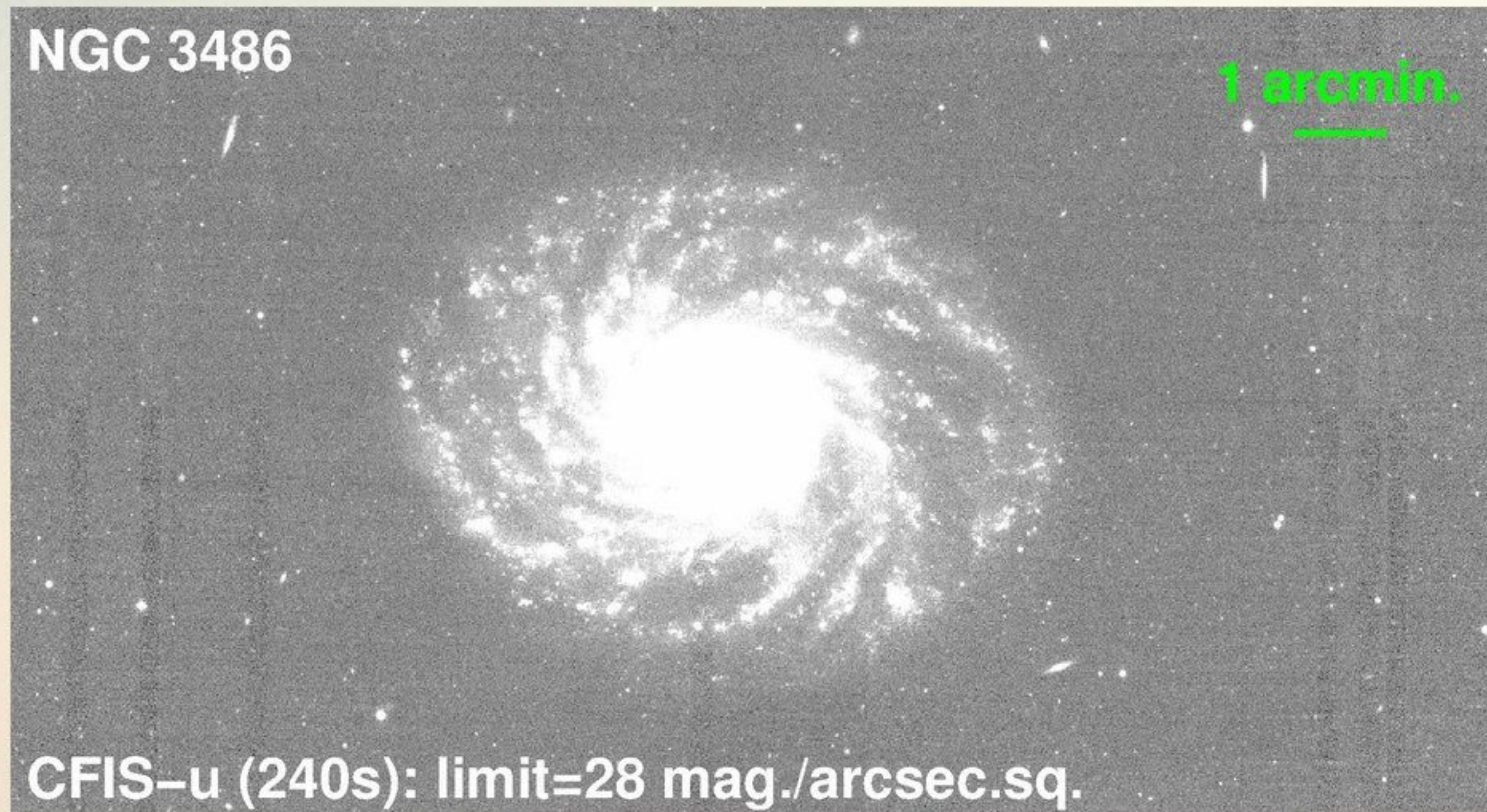
- The total CFIS planned area is 4,800 square degrees above a declination of +30 deg.
- The telescope hardware limits and galactic reddening limit the equatorial pole coverage (small)
- Depth: $r=24.8$, point source, 5-sigma, 2 arcseconds diameter aperture (~600 seconds integration)
- LSST can cover the sky up to a declination of +30 deg. in griz: CFIS-r charts the most northern sky
- CFIS-r science priority: lensing on the BOSS footprint (3,500 square degrees overlap)

CFIS observing status (10/2017)



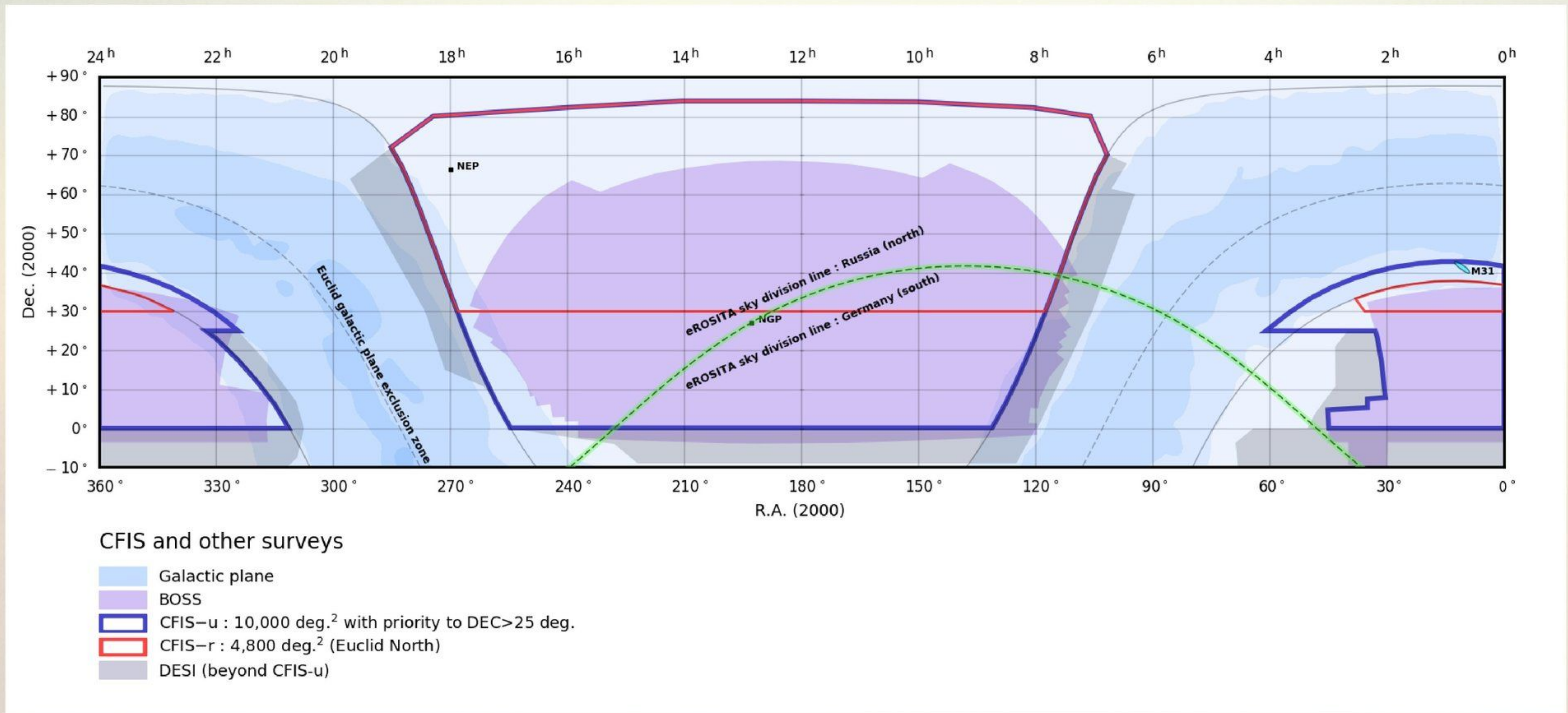
- The quality of the dataset is as expected and the proposal depths are reached
- There are now nearly 4,000 square degrees available in u–band, and 1,000 in r–band
- The CFIS is truly unique through its image quality (u=0.8", r=0.6") combo with depth and sky area
- When the QSO team schedules the CFIS, the observing efficiency is maximized (optimal)
- But after 8 months, a survey realization issue is surfacing: only 66% completion forecast by 2020

Not just a point source survey: LSB performance



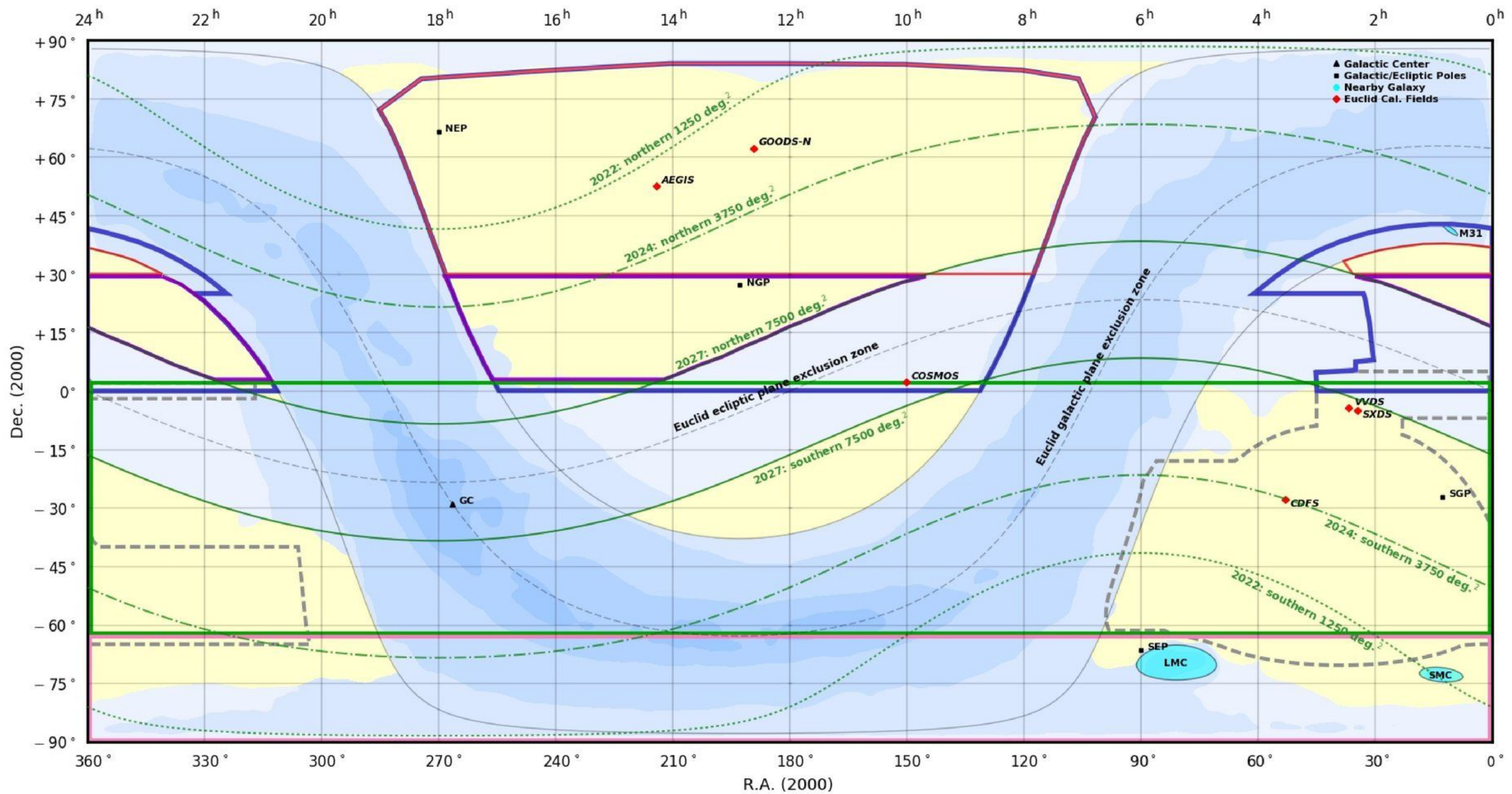
- The Low Surface Brightness plan was part of the CFIS proposal (NGVS legacy)
- The CFIS observing strategy (3 exposures dithered by 1/3 of the camera FOV) enables LSB
- The method reaches contrasts 5 to 6 magnitudes fainter than the sky background (u~28, r~27)
- The data are processed with the Elixir-LSB pipeline for the whole collaboration (default product)

CFIS synergy with other surveys (non Euclid related)



- The current CFIS scientific activities rely first and foremost on Gaia, SDSS, BOSS, and PS1 3pi
- CFIS would improve targetting for DESI (critical timing), path for legacy science collaboration?
- eROSITA has yet to launch and no real discussion has taken place for the northern sky synergy
- On-going eBOSS discussions for use in CFIS z-clustering calibration only
- Future investigations include WEAVE, MSE, ...
- All discussions conducted by the CFIS Steering Group for the benefit of the whole collaboration

The CFIS, a critical component of the Euclid mission

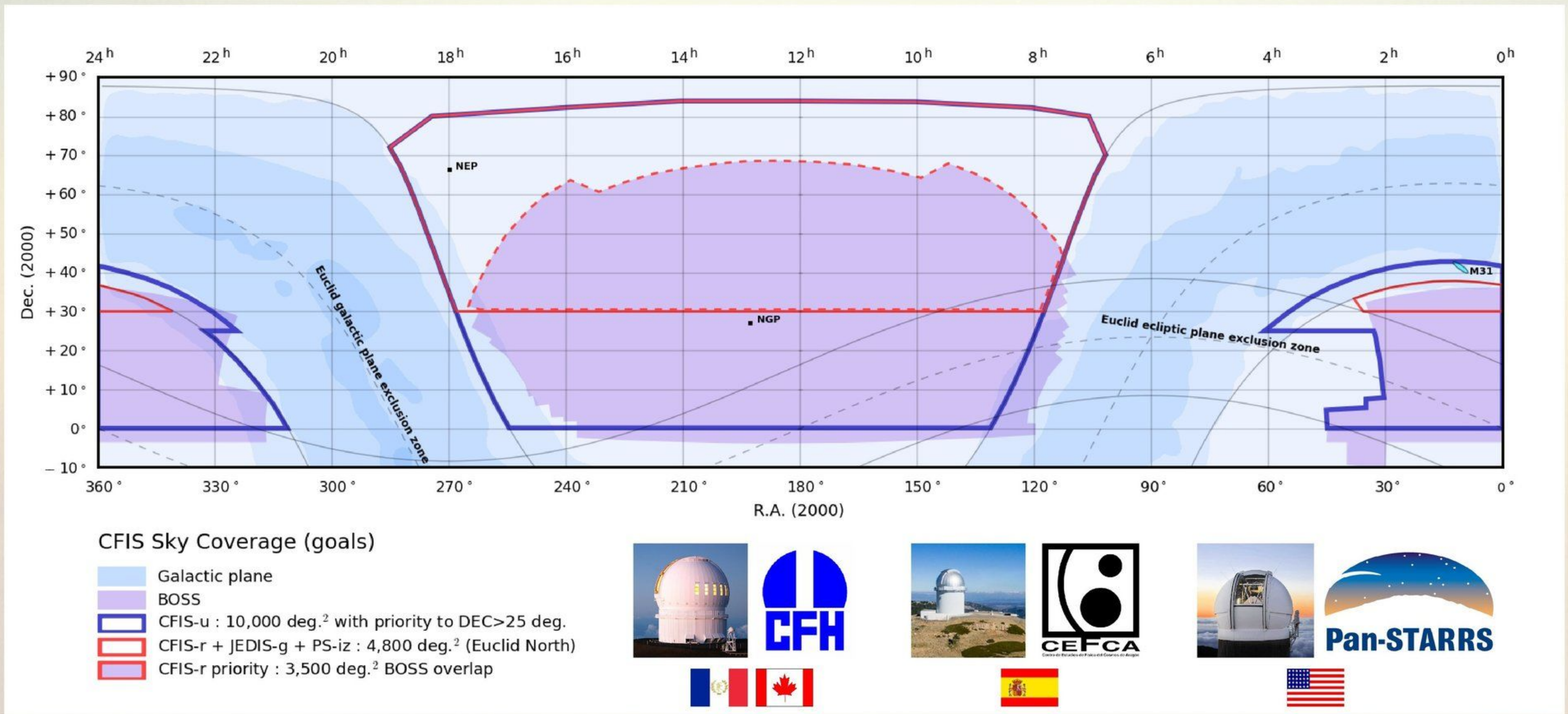


Expected ground-based coverage of the Euclid Wide Survey (origin/bands/overlap)

- | | | |
|---|---|---|
| Euclid exclusion zone : 26,000 deg. ² [galactic+ecliptic planes] | DES-griz : 4,500 deg. ² | LSST main survey, ugrizy : 7,000 deg. ² |
| Euclid Wide Survey : 15,000 deg. ² [with E(B-V)<0.08] | CFIS-u : 7,300 deg. ² | LSST south extension, ugrizy : 1,000 deg. ² |
| | CFIS-r + JEDIS-g + PS-iz : 4,800 deg. ² | LSST Euclid extension, griz : 3,000 deg. ² |

● CFHT leads a group of 5 world-class telescopes aimed at contributing to Euclid (LSST still TBD)

The Northern Sky Alliance: Euclid North in ugriz



- CEFCA's JST (2.5m) committed in 2016 to fully cover the 4,800 square degrees in g band
- IfA's Pan-STARRS (2x1.8m) committed in 2017 to fully cover the 4,800 square deg. in i&z bands
- Commitments to the Euclid Consortium are linked to the Euclid Data Releases (2023, 2025, 2027)
- The NSA will simply allow Euclid contributors to conduct science "today" outside of Euclid
- The NSA will be based on scientific collaborations rather than data exchange
- CFHT is leading the way (sky coverage) and could influence the other telescopes' plans



The CFIS science collaboration

Cuillandre Jean-Charles (co-PI)	CEA Saclay / Obs. de Paris	France	Elbaz David	CEA Saclay	France	Parker Laura	McMaster University	Canada
McConnachie Alan (co-PI)	NRC-Herzberg	Canada	Erben Thomas	AiFA UniversitÄt Bonn	Germany	Pettorino Valeria	CEA Saclay	France
Ibata Rodrigo (SG CFIS-u)	Obs. Astrom. de Strasbourg	France	Fabbro Sebastien	NRC-Herzberg	Canada	Pierre Marguerite	CEA Saclay	France
Hudson Michael (SG CFIS-r)	Univ. of Waterloo	Canada	Fahed Remi	APC	France	Pires Sandrine	CEA Saclay	France
Schade David (SG Data)	CADC	Canada	Famaey Benoit	Obs. Astrom. de Strasbourg	France	Pritchett Chris	Univ. of Victoria	Canada
Balogh Michael (SG C)	Univ. of Waterloo	Canada	Fantin Nicholas	Univ. of Victoria	Canada	Prunet Simon	CFHT	France
Carlberg Raymond (SG C)	Univ. of Toronto	Canada	Ferrarese Laura	NRC-Herzberg	Canada	Raichoor Anand	Obs. de Paris	France
Hill Vanessa (SG F)	Obs. de la Cote d'Azur	France	Flores Hector	Obs. de Paris	France	Recio-Blanco Alejandra	Obs. de la Cote d'Azur	France
Mellier Yannick (SG F)	IAP	France	Fouquet Sylvain	CAMK	Poland	Regnault Nicolas	LPNHE	France
Arnaud Monique	CEA Saclay	France	Ganga Ken	APC	France	Reyle Celine	Obs. de Besancon	France
Arnouts Stephane	LAM	France	Gangler Emmanuel	LPC	France	Richer Harvey	Univ. of British Columbia	Canada
Astier Pierre	LPNHE	France	Gavazzi Raphael	IAP	France	Rich James	CEA Saclay	France
Aubourg Eric	APC	France	Giraud-Heraud Yannick	APC	France	Robin Annie	Obs. de Besancon	France
Aussel Herve	AIM / CEA Saclay	France	Guy Julien	LPNHE	France	Rosset Cyril	APC	France
Babusiaux Carine	Obs. de Paris	France	Gwyn Stephen	CADC	Canada	Roucelle Cecile	LPNHE	France
Bannister Michele	Univ. of Victoria	Canada	Hall Pat	York University	Canada	Ruhlmann-Kleider Vanina	CEA Saclay	France
Bartlett James	APC	France	Hammer Francois	Obs. de Paris	France	Sanchez-Janssen Ruben	STFC	UK
Basa Stephane	LAM	France	Harris William	McMaster University	Canada	Sauvage Marc	CEA Saclay	France
Beckmann Volker	APC	France	Haywood Misha	Obs. de Paris	France	Sawicki Marc	Saint Mary's University	Canada
Benabed Karim	IAP	France	Heymans Catherine	IFA University of Edinburgh	UK	Schultheis Mathias	Obs. de la Cote d'Azur	France
Benoit-Levy Aurelien	IAP	France	Hildebrandt Hendrik	AiFA UniversitÄt Bonn	Germany	Scott Douglas	Univ. of British Columbia	Canada
Bergeron Pierre	Univ. of Montreal	Canada	Hlozek Renee	Dunlap Institute	Canada	Scottet Vivien	IAP	France
Bernard Edouard	Obs. de la Cote d'Azur	France	Holder Gil	McGill University	Canada	Siebert Arnaud	Obs. Astrom. de Strasbourg	France
Bertin Emmanuel	IAP	France	Hudelot Patrick	IAP	France	Smith Kendrick	Perimeter Institute	Canada
Betoule Marc	LPNHE	France	Huertas-Company Marc	Obs. de Paris	France	Spekkens Kristine	Royal Military College	Canada
Bonifacio Piercarlo	Obs. de Paris	France	Kavelaars JJ	NRC-Herzberg	Canada	Starck Jean-Luc	CEA Saclay	France
Bonnarel Francois	CDS	France	Kilbinger Martin	CEA Saclay	France	Starkenbug Else	Leibniz-Institut	Germany
Boulade Olivier	CEA Saclay	France	Lancon Ariane	Obs. Astrom. de Strasbourg	France	Taylor James	Univ. of Waterloo	Canada
Bovy Jo	Univ. of Toronto	Canada	Lang Dustin	Univ. of Toronto	Canada	Techene Sibylle	IAP	France
Burtin Etienne	CEA Saclay	France	Le Fevre Olivier	LAM	France	Thomas Guillaume	Obs. Astrom. de Strasbourg	France
Cabanac Remi	IRAP	France	Le Floch Emeric	CEA Saclay	France	Tresse Laurence	LAM	France
Caffau Elisabethette	Obs. de Paris	France	Lin Hsing Wen	NCU Institute for Astronomy	Taiwan	Van Waerbeke Ludovic	Univ. of British Columbia	Canada
Cavet Cecile	APC	France	Malhan Khyati	Obs. Astrom. de Strasbourg	France	Venn Kim	Univ. of Victoria	Canada
Chapman Scott	Dalhousie University	Canada	Martin Nicolas	Obs. Astrom. de Strasbourg	France	Vigroux Laurent	CEA Saclay	France
Chen Ying Tung	Academia Sinica	Taiwan	Maugordato Sophie	Obs. de la Cote d'Azur	France	Willis Jon	Univ. of Victoria	Canada
Chevalier Laurent	CEA Saclay	France	McCracken Henry	IAP	France	Willott Chris	NRC-Herzberg	Canada
Cote Patrick	NRC-Herzberg	Canada	Mei Simona	Obs. de Paris	France	Yeche Christophe	CEA Saclay	France
Cuby Jean-Gabriel	LAM	France	Miller Lance	University of Oxford	UK			
Di Matteo Paola	Obs. de Paris	France	Nasello Guillaume	Obs. de Strasbourg	France			
Duc Pierre-Alain	AIM / CEA Saclay	France	Navarro Julio	Univ. of Victoria	Canada			
Durret Florence	IAP	France	Palanque-Delabrouille Nathalie	CEA Saclay	France			

- Currently 2/3 French and 1/3 Canadians with a few key external collaborators (total 121 scientists)
- A group open to all scientists from Canada and France, pending a few rules
- No guarded science, but open communications are required
- All data products shared across the group (CADC/CANFAR repository)
- An international group short on funding...



CANADA-FRANCE IMAGING SURVEY