

Euclid as a driver for a MegaCam survey of the northern sky

Elements of information for a Canada–France Imaging Survey

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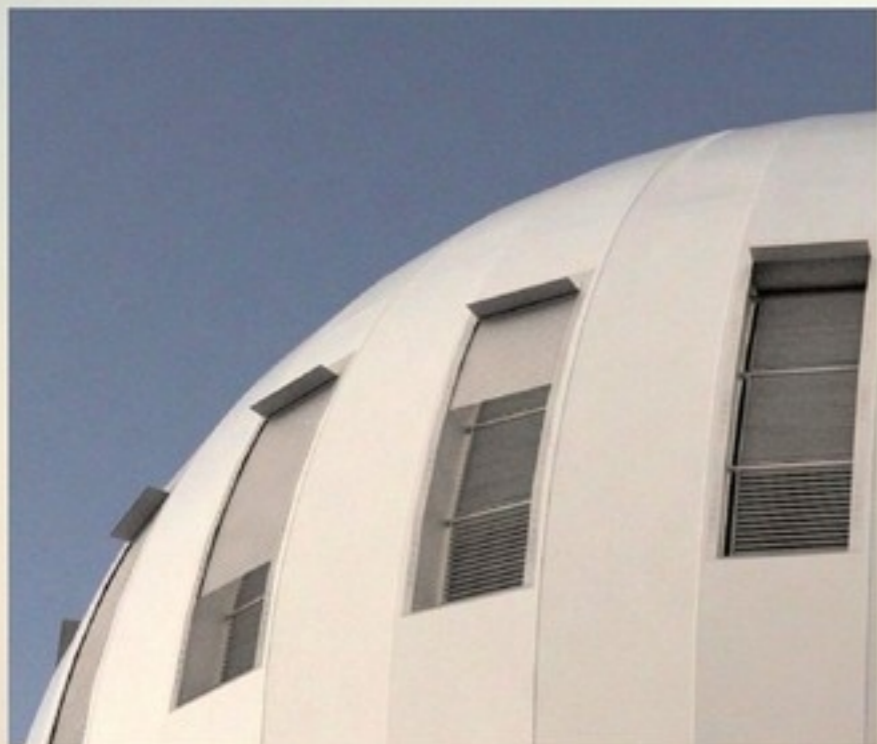


Journées Euclid–France 2014, Lyon, 4 & 5 décembre 2014

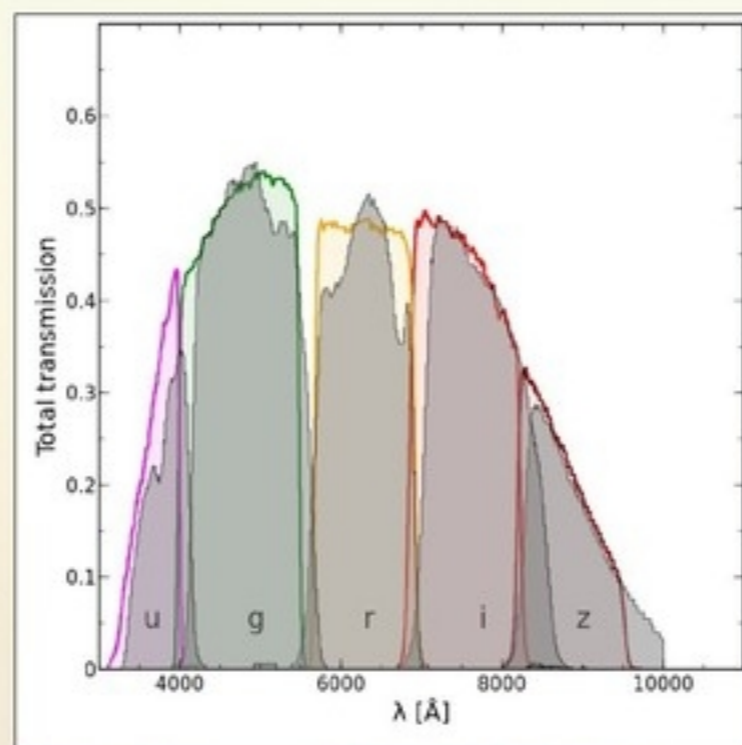


By 2015, we now know CFHT will be the best imager it has ever been

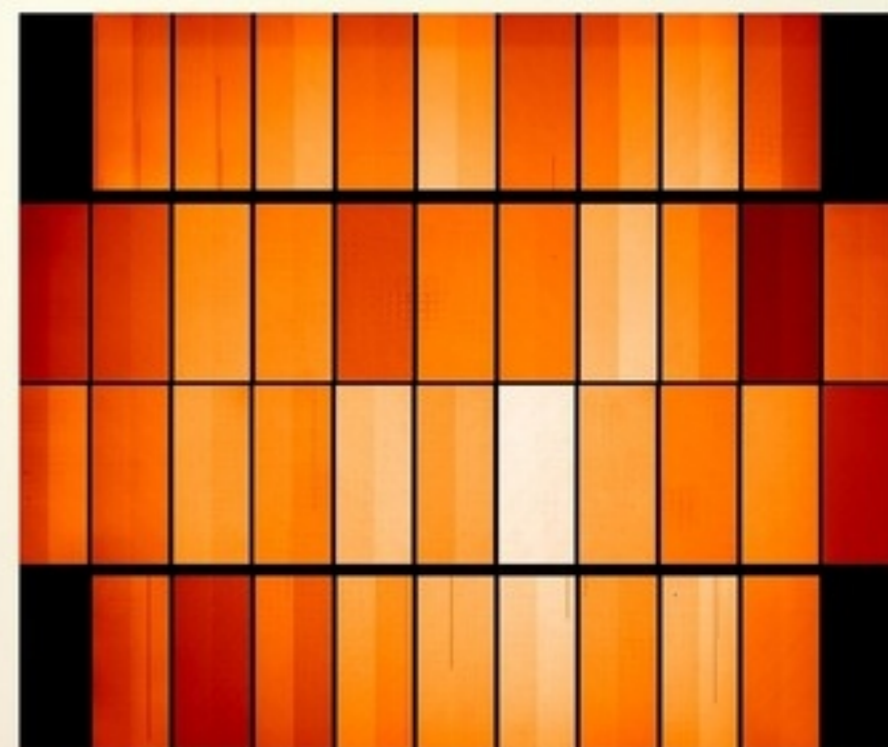
MegaCam and CFHT upgrades : all operational by 2015



Dome venting (since 02/2014)



New filters (02/2015)



40 CCDs + faster readout (2015)

Dome venting : active since Feb.2014, confirms prediction 0.1" gain (similar to Subaru)

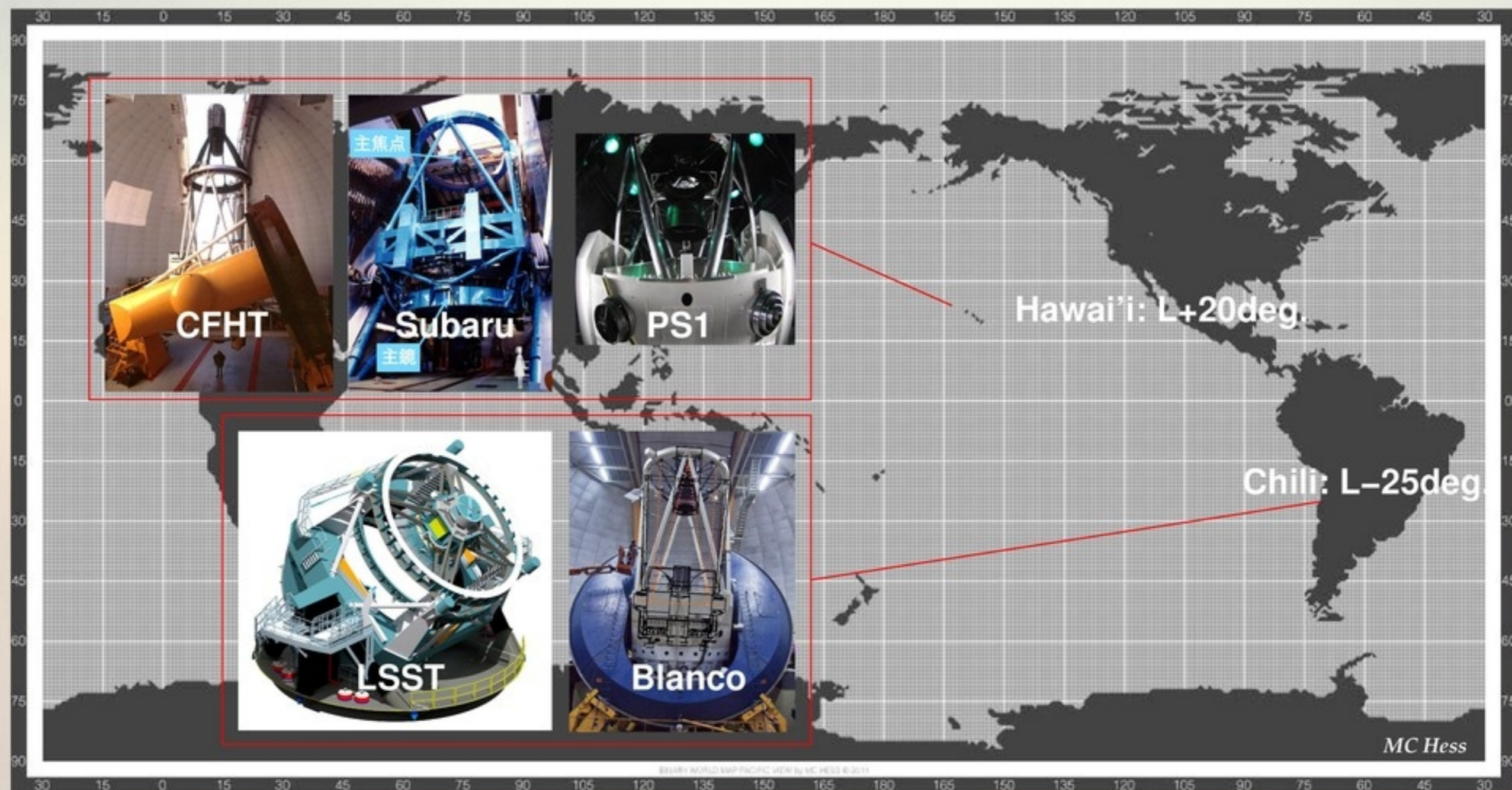
New filters : duplicate of DECam (DES) filters properties, all delivered in 2014

Readout of all original 40 CCDs (vs central 36) : +10% in survey mapping speed

Faster readout : goal of 30s vs current 50s of exposure to exposure overhead

To be added to the extensive expertise of the instrument (CFHTLS/NSLS/CFHTLenS/NGVS)

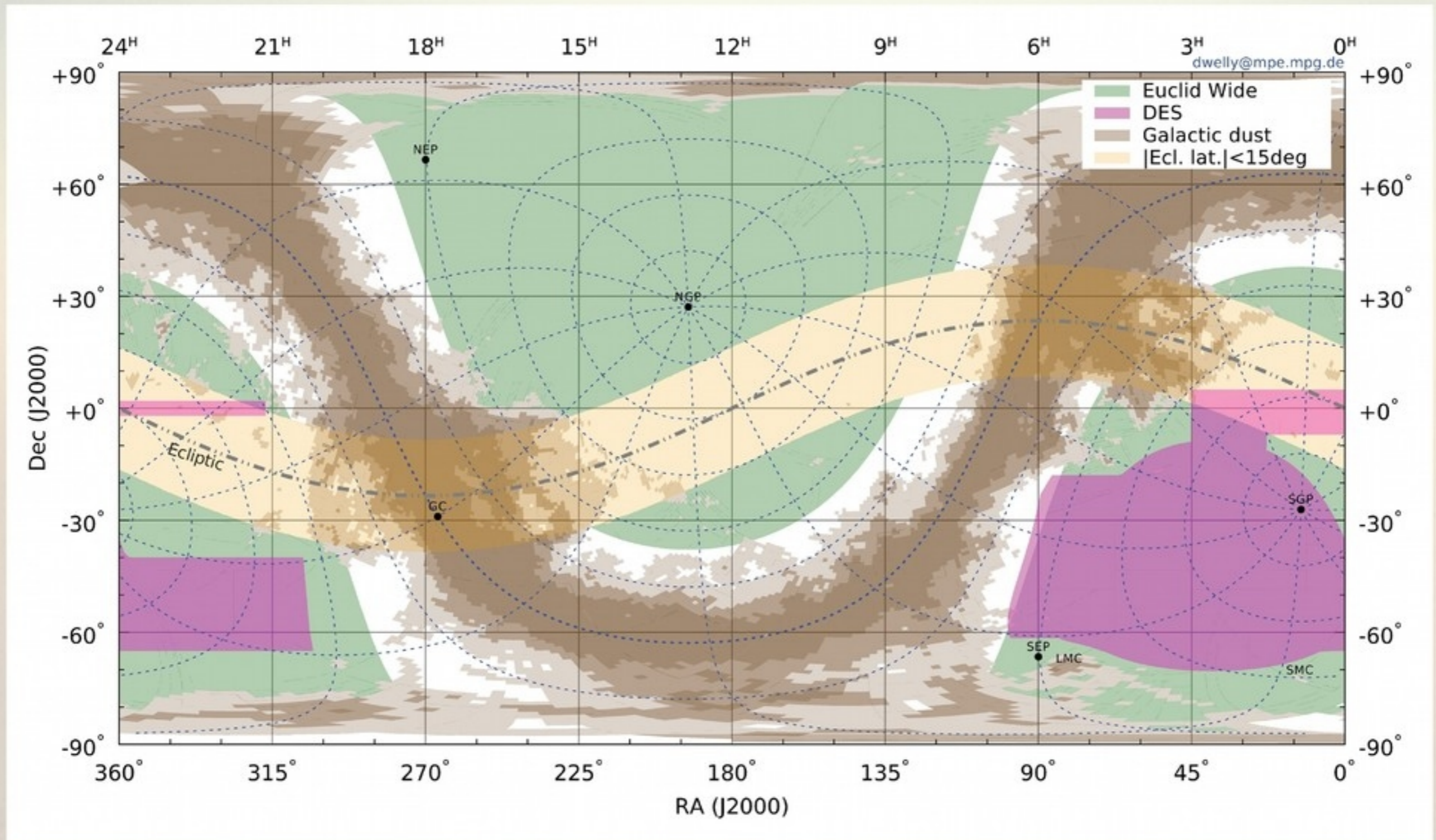
The "competition": present and upcoming WFIs that matter



Facility	Year	Aper.	FOV	IQ	CCD class	Type	Hemisphere
LSST	2022	6.6m	10 sq.deg.	0.8"	Deep depletion	Surveyor	South
Subaru	2014	8.2m	2 sq.deg.	0.6"	Fully depleted	Observatory	North
Blanco	2013	4.0m	3 sq.deg.	0.9"	Fully depleted	Observatory	South
CFHT	2003	3.6m	1 sq.deg.	0.6"	EPI	Observatory	North
PS1	2008	1.5m	7 sq.deg.	1.0"	Fully depleted	Surveyor	North

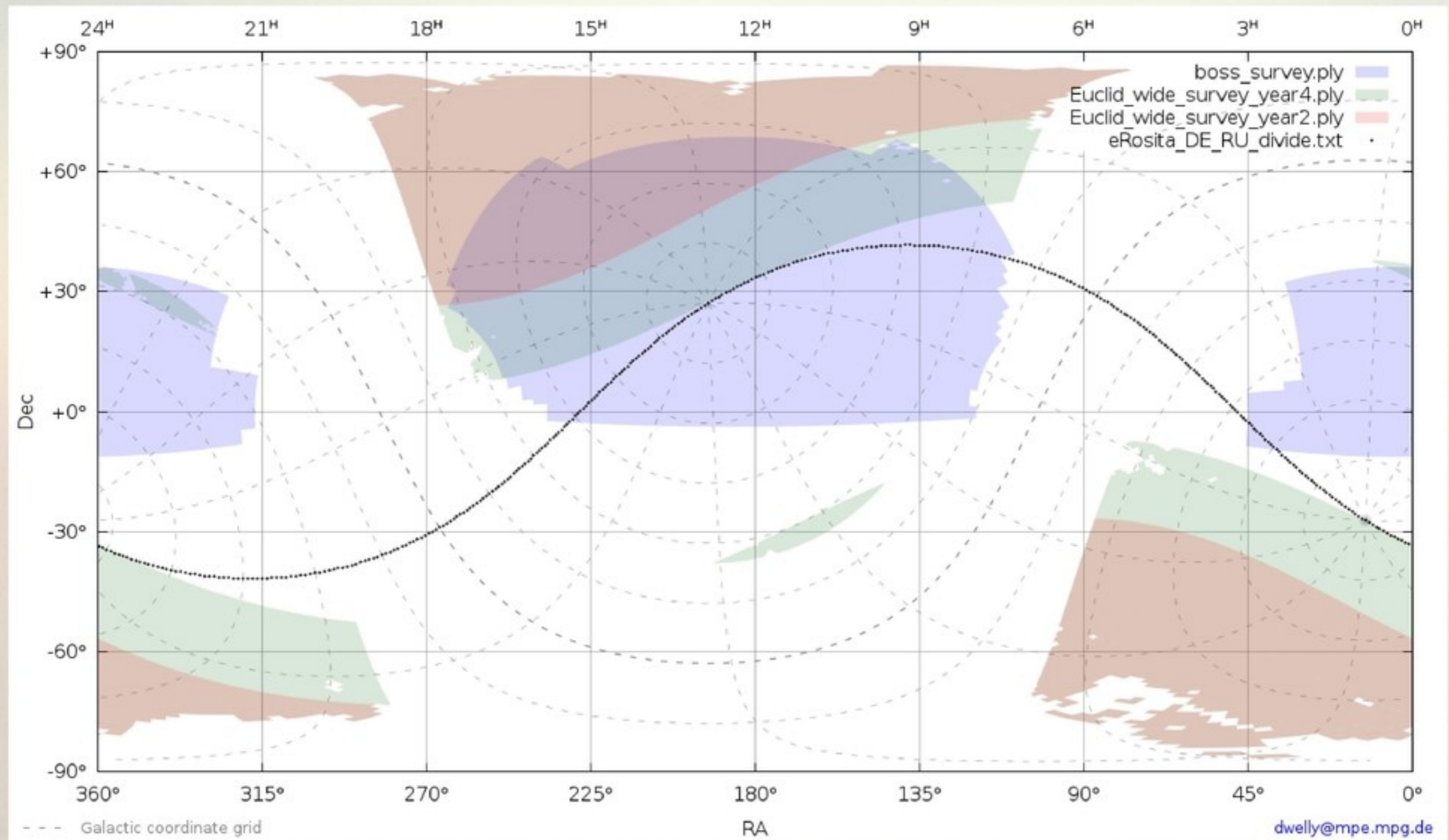
CFHT truly unique niche : combo{bluer bands, image quality, northern sky, large sky area}

A wide optical ground-based survey: Euclid "4th" instrument



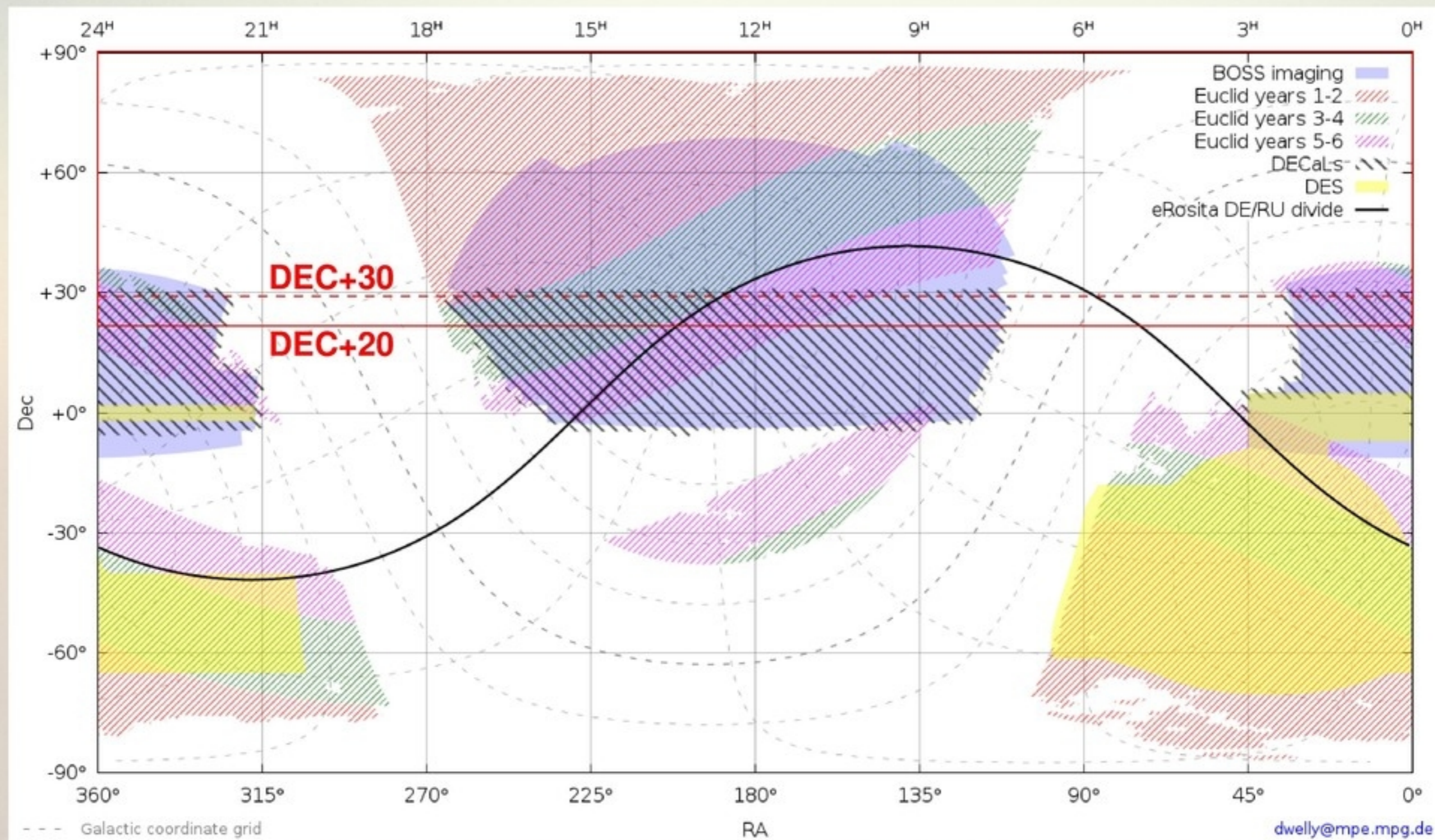
The Euclid survey covers ~15,000 square degrees, avoiding the galactic and ecliptic planes

Euclid requirement from L2: start from the ecliptic poles



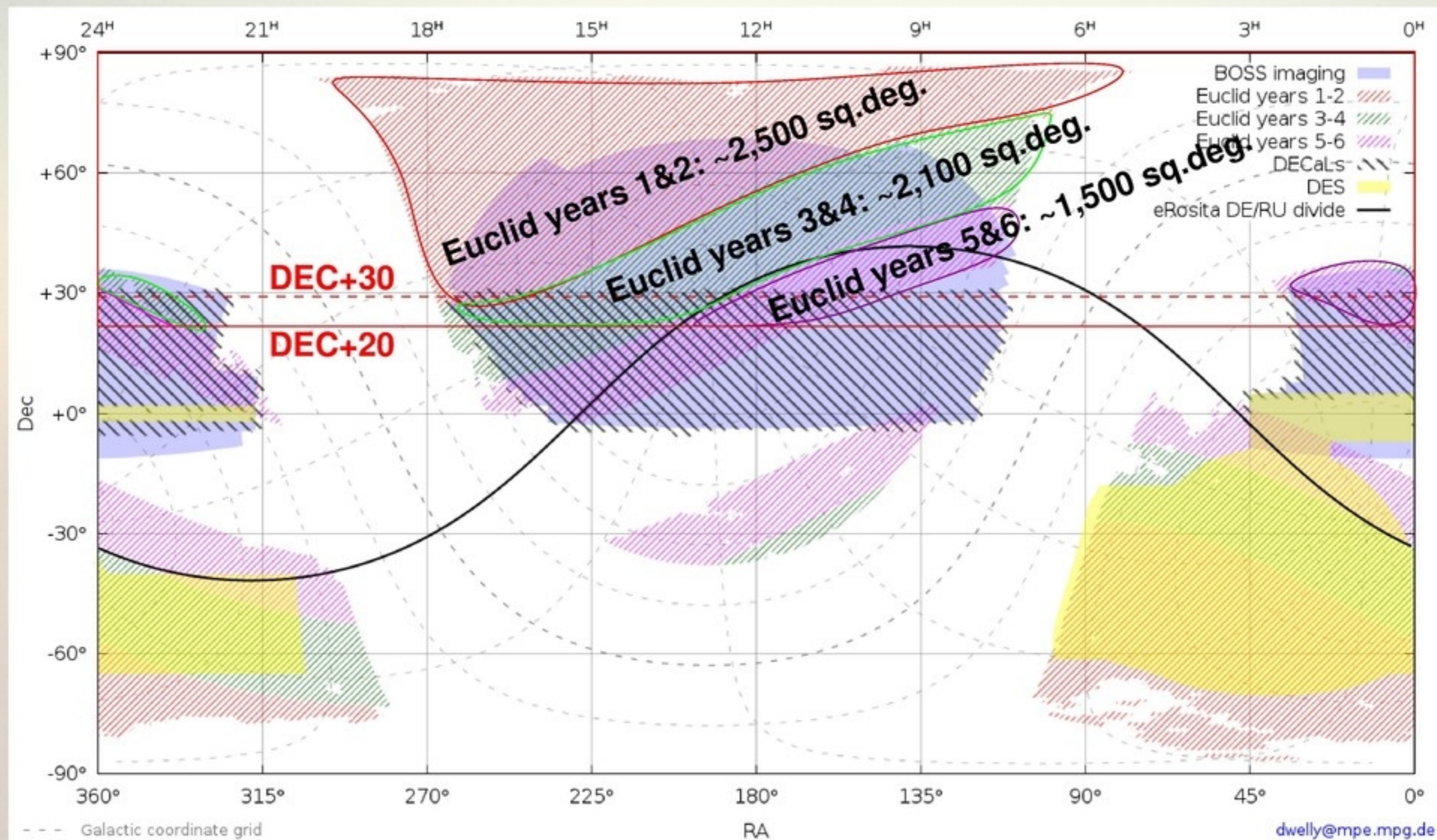
Every 2 years, for 6 years of mission, Euclid will cover 2,500 sq. deg. in each hemisphere

Euclid and CFHT: focus where LSST and/or DECam can't go



**Euclid needs: all Euclid survey area north of DEC+20 or DEC+30: resp. 6,100/4,800 sq.deg.
Top priority: get the first 2 years of Euclid north sky coverage at full depth = ~3,000 sq.deg.**

Euclid incremental northern sky coverage seen from CFHT



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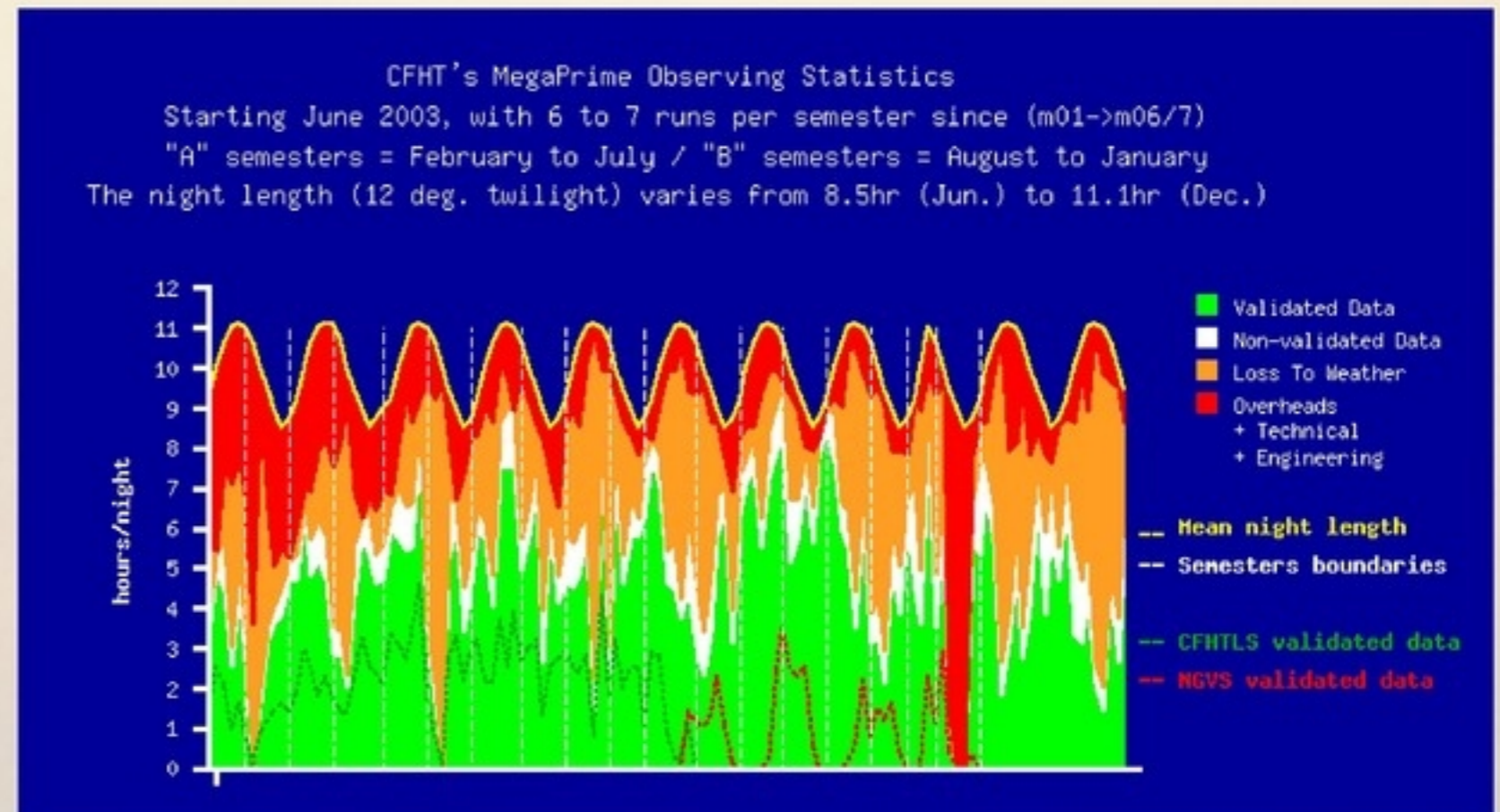
Euclid RA pressure and weather conditions on Mauna Kea

DEC	>0	>10	>20	>30
Total	7627	7092	6137	4828
RA				
00	234	234	220	93
01	135	135	135	88
02	18	18	18	15
03	0	0	0	0
04	0	0	0	0
05	1	1	1	1
06	18	18	18	18
07	239	239	239	239
08	371	371	371	371
09	419	419	419	415
10	483	483	483	424
11	564	564	550	422
12	650	650	551	415
13	750	703	558	423
14	834	704	560	424
15	835	705	560	424
16	787	695	560	424
17	545	545	515	417
18	160	160	160	160
19	7	7	7	7
20	0	0	0	0
21	112	23	0	0
22	268	221	88	4
23	187	187	114	35

A/B semester boundaries vs LST=RA at midnight
(maximal visibility throughout a night for the given RA)

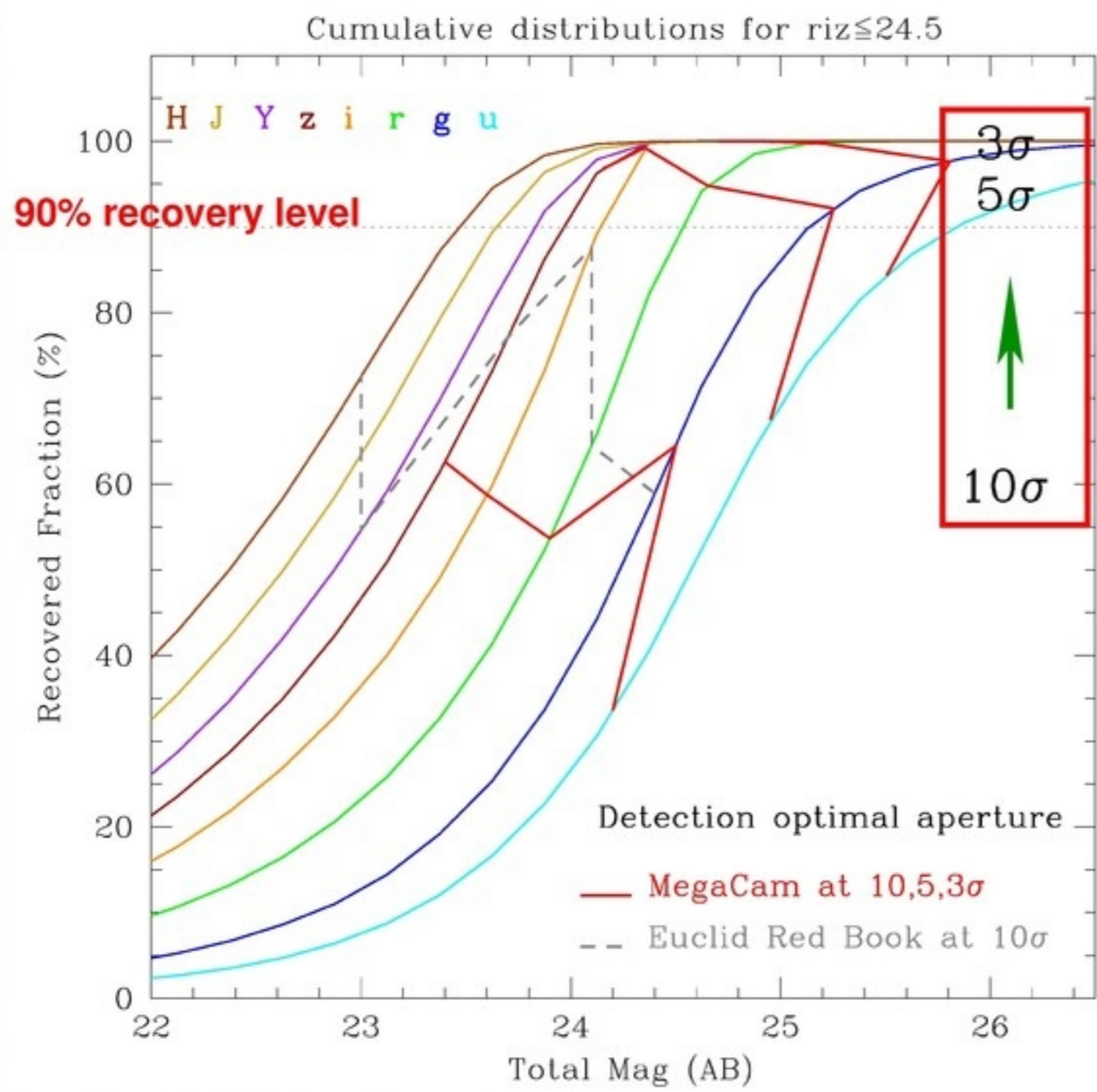
winter+spring: adopt current night efficiency of 5.5hr/night
and count on faster MegaCam + better observing efficiency

RA pressure vs DEC cut



2003-14 MegaCam observing statistics: avg. = 4.7 hr/night

Depths needed for Euclid: needs matching approach



The depths at 10-sigma, extended:

u = 24.2

g = 24.5

r = 23.9

i = 23.6

z = 23.4

Color optimized
photometric extraction

The depths at 5-sigma, point source:

u = 25.1

g = 25.4

r = 24.8

i = 24.5

z = 24.3

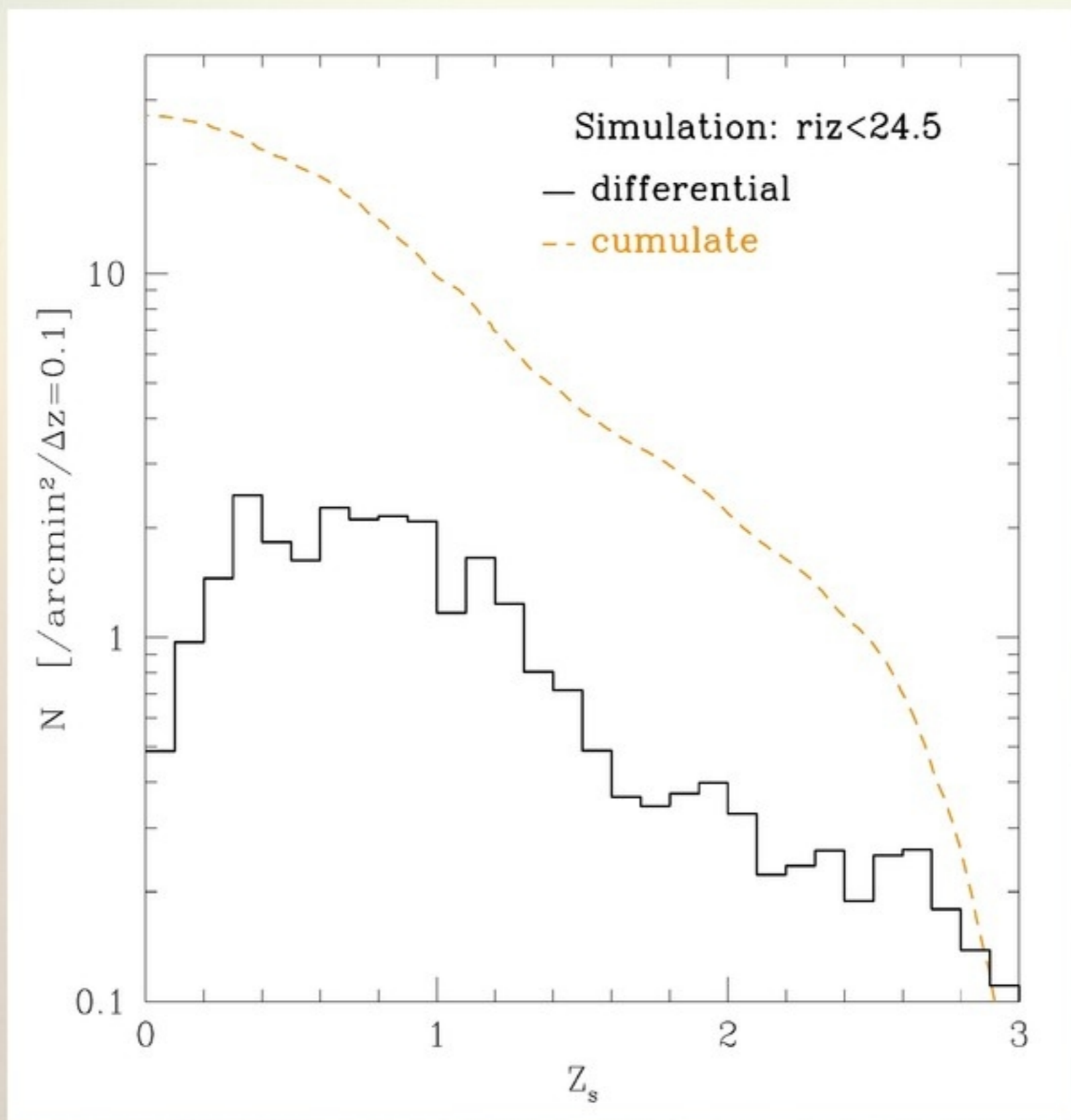
PSF fitting
photometric extraction

-1 mag. shallower vs CFHTLS-Wide

2+ mag. deeper vs PS1-3Pi / Sloan

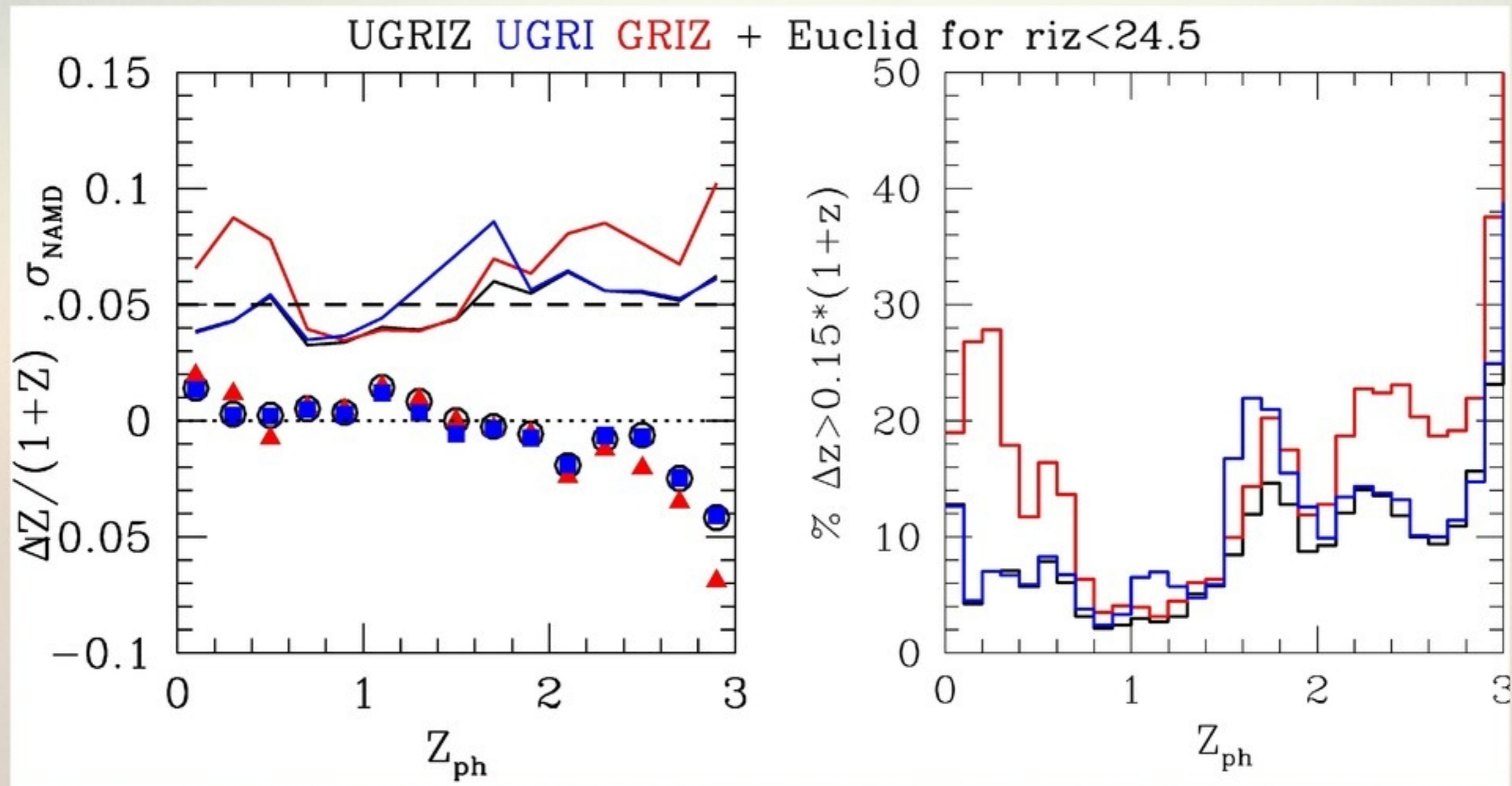
Depth based on 90% recovery at 6-sigma, extended (except for u-band, set for u-g=-0.3 mag)

Redshifts distribution in the COSMOS field for the Euclid galaxies

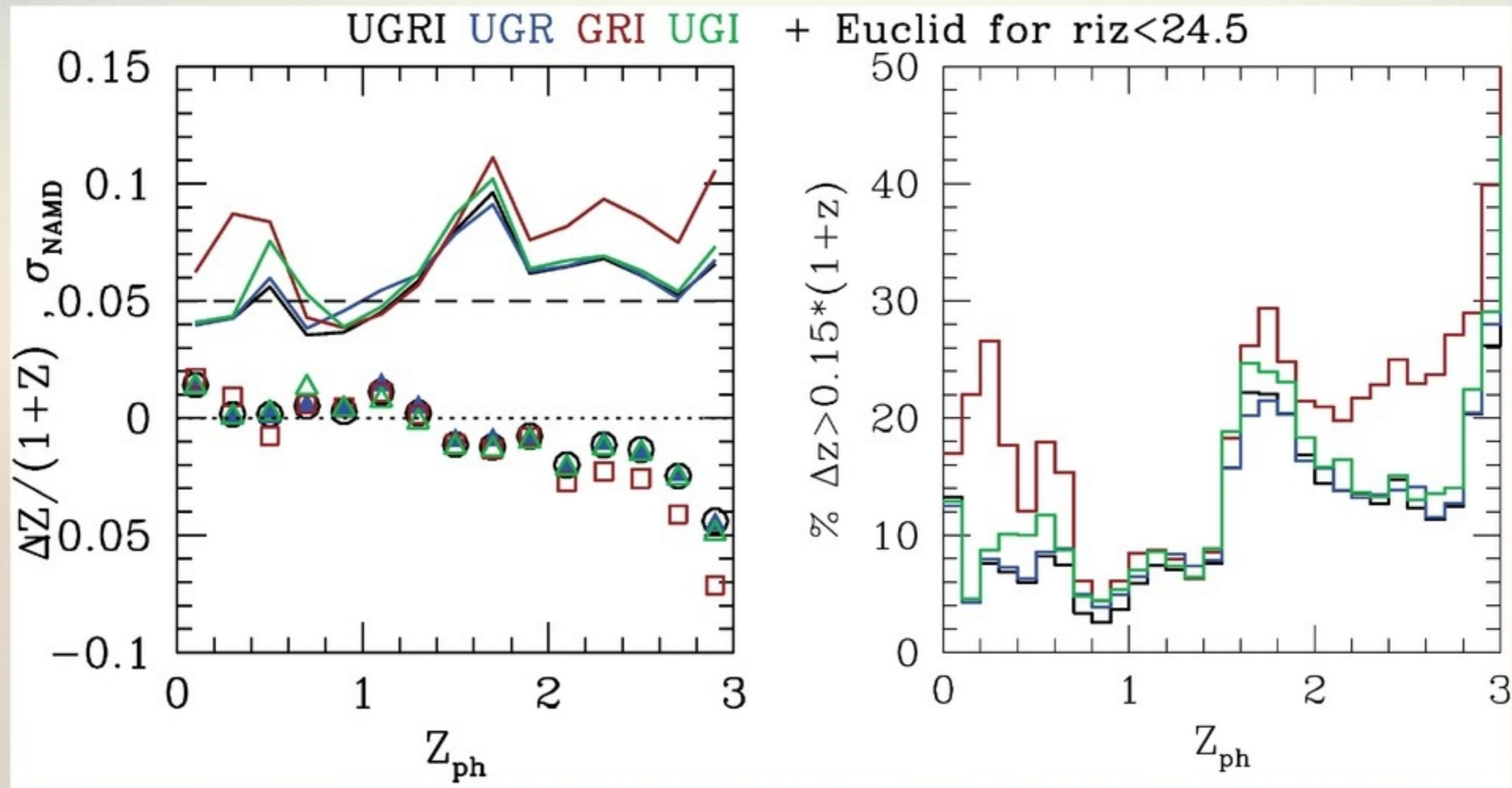


Redshift distribution for $\text{riz} < 24,5$

Photometric redshifts quality with different filters: 4 bands vs 5



Photometric redshifts quality with different filters: 3 bands vs 4



Deriving a time budget with MegaCam: optimal color extraction

Common parameters to the three cases:

- Dithering: 3 exposures per filter
- Euclid footprint DEC>+20 = 6,100 square degrees
- Grey time: 50% of g and 100% r-bands (resp. x2.0 x1.5 dark time integration)
- Average QSO validation time per night = current norm (5.5hr/night)
- Use modal IQ for planning: survey will use dynamic integration (SNR QSO)

MegaCam 2003–2014 = no elements of upgrade

MegaCam 40 CCDs = survey mapping boost (+10%) + faster readout (30s vs 50s)

MegaCam Full Opt. + exposure scaling with new filters (+5%) + dome venting (0.1")

	u	g	r	i	ugr	ugi	ugri
MegaCam 2003–2014	544	628	562	552			2286/889
MegaCam 40 CCDs	544	628	562	552	1734/561	1724/559	2286/741
MegaCam Full Opt.	438	527	456	460	1421/474	1425/475	1881/628

Center: time needed to reach the desired depth using an aperture optimized for color derivation

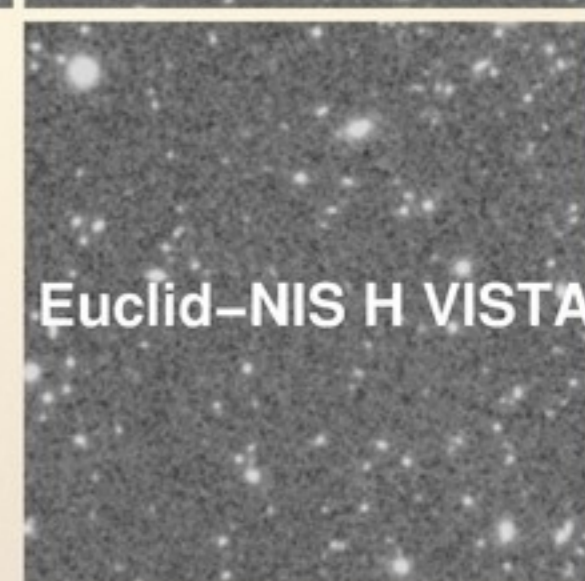
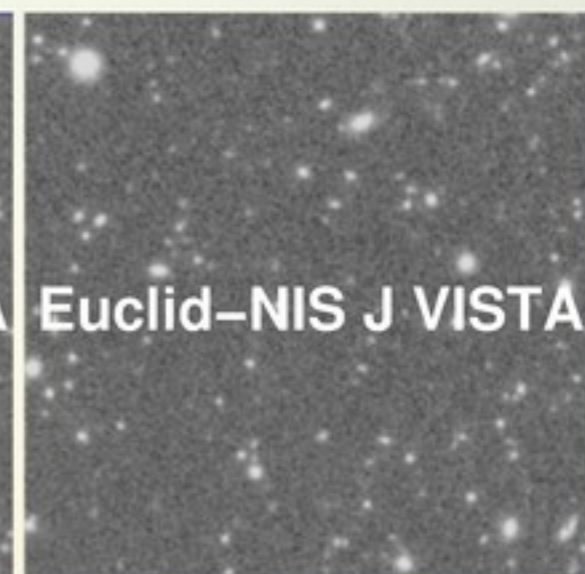
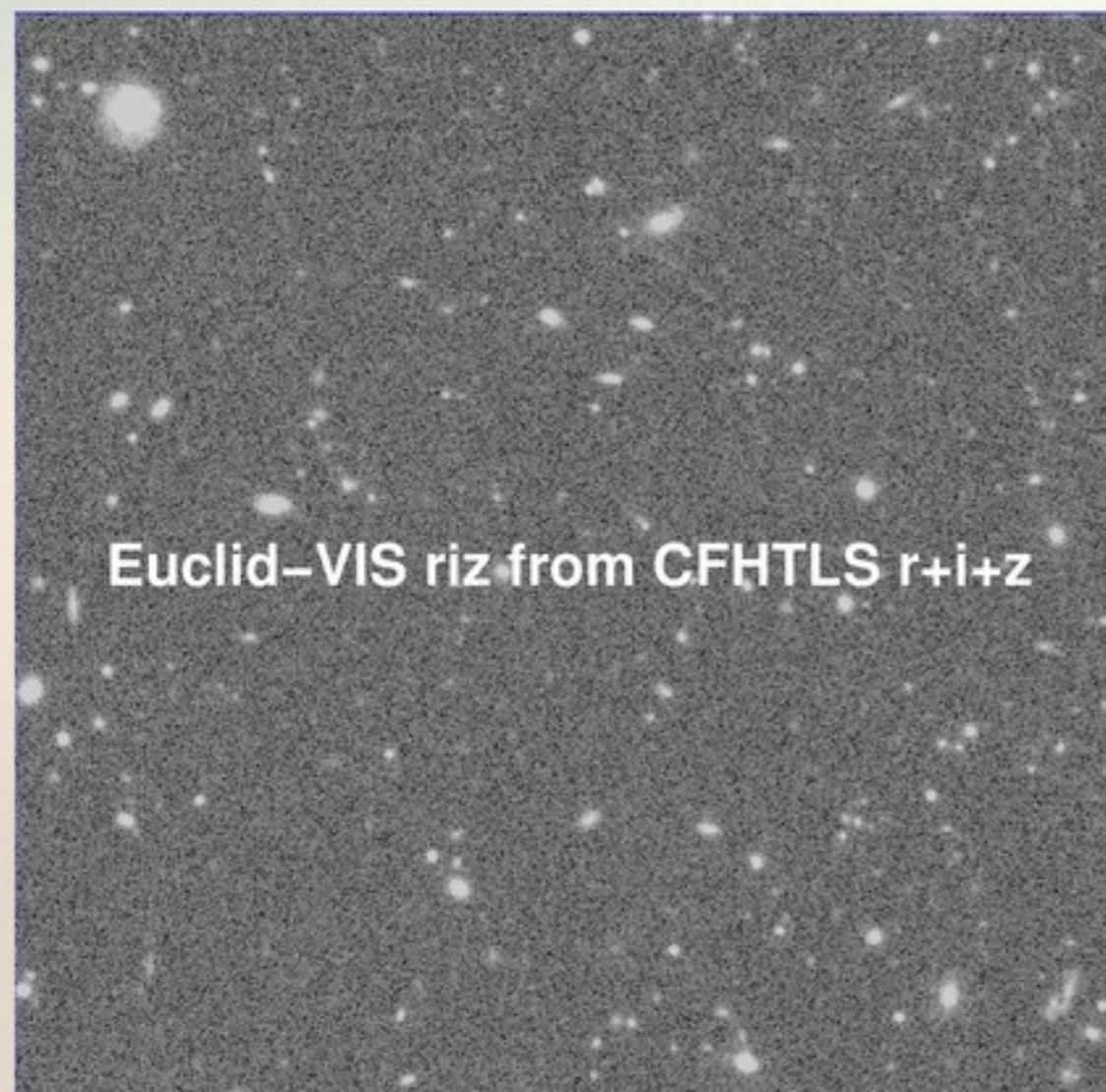
Right: total integration per filter set, and total number of nights* needed (pending sky controls)

* #nights (2nd and 3rd cases) = ((etimes+readouts)/3600) x (6100/1.1) / 5.5

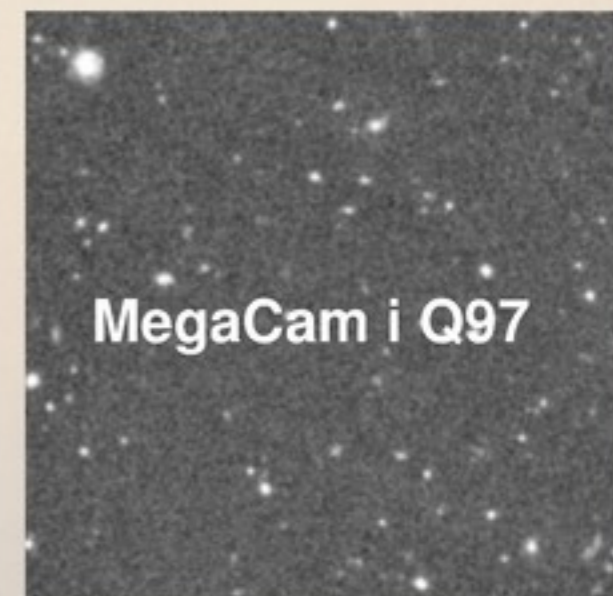
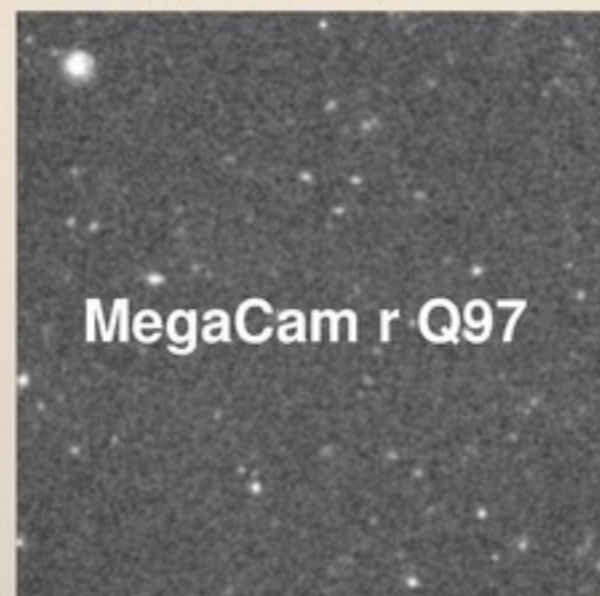
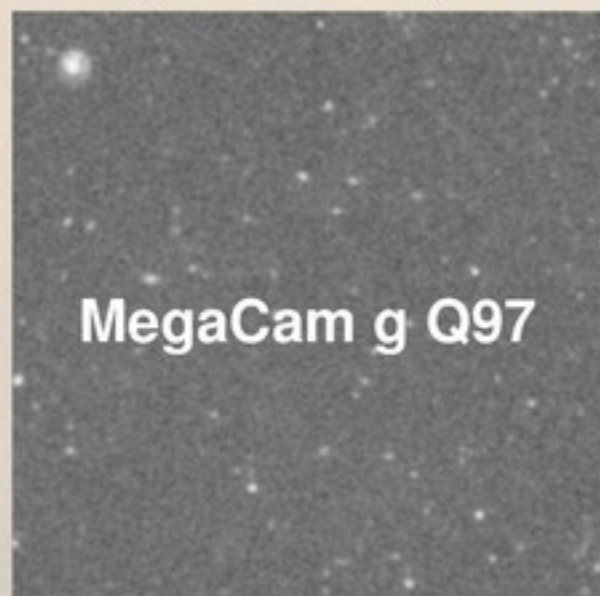
The upgraded MegaCam performance still need to be confirmed (starts fall 2014)

The various assumptions are tested now on a real data set (real pixels to photo-z)

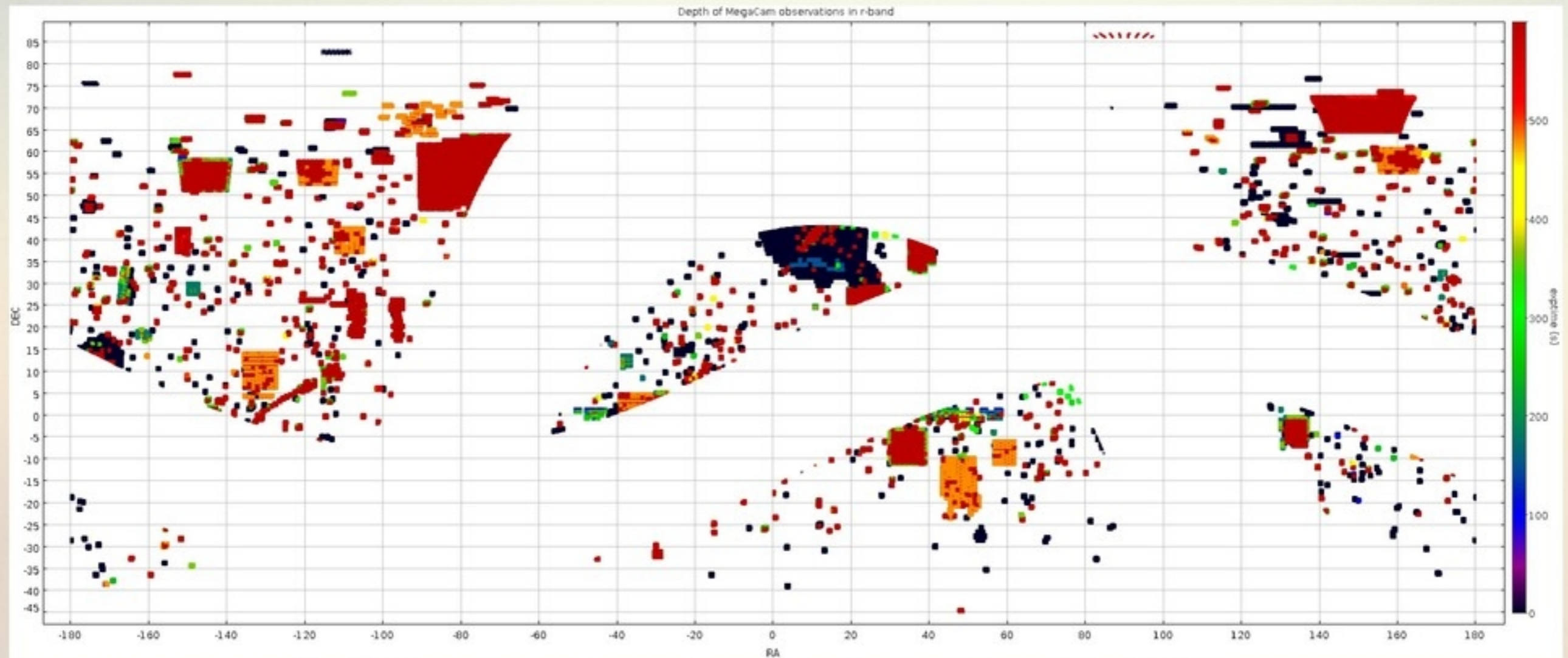
Control with a data set based on real data: the COSMOS field



2' wide stamp from the 1 deg. test set (~120 Euclid galaxies)



12 years of MegaCam archiving help reducing the time request



r-band archive vs Euclid footprint (color coding with depth, dark = other bands)

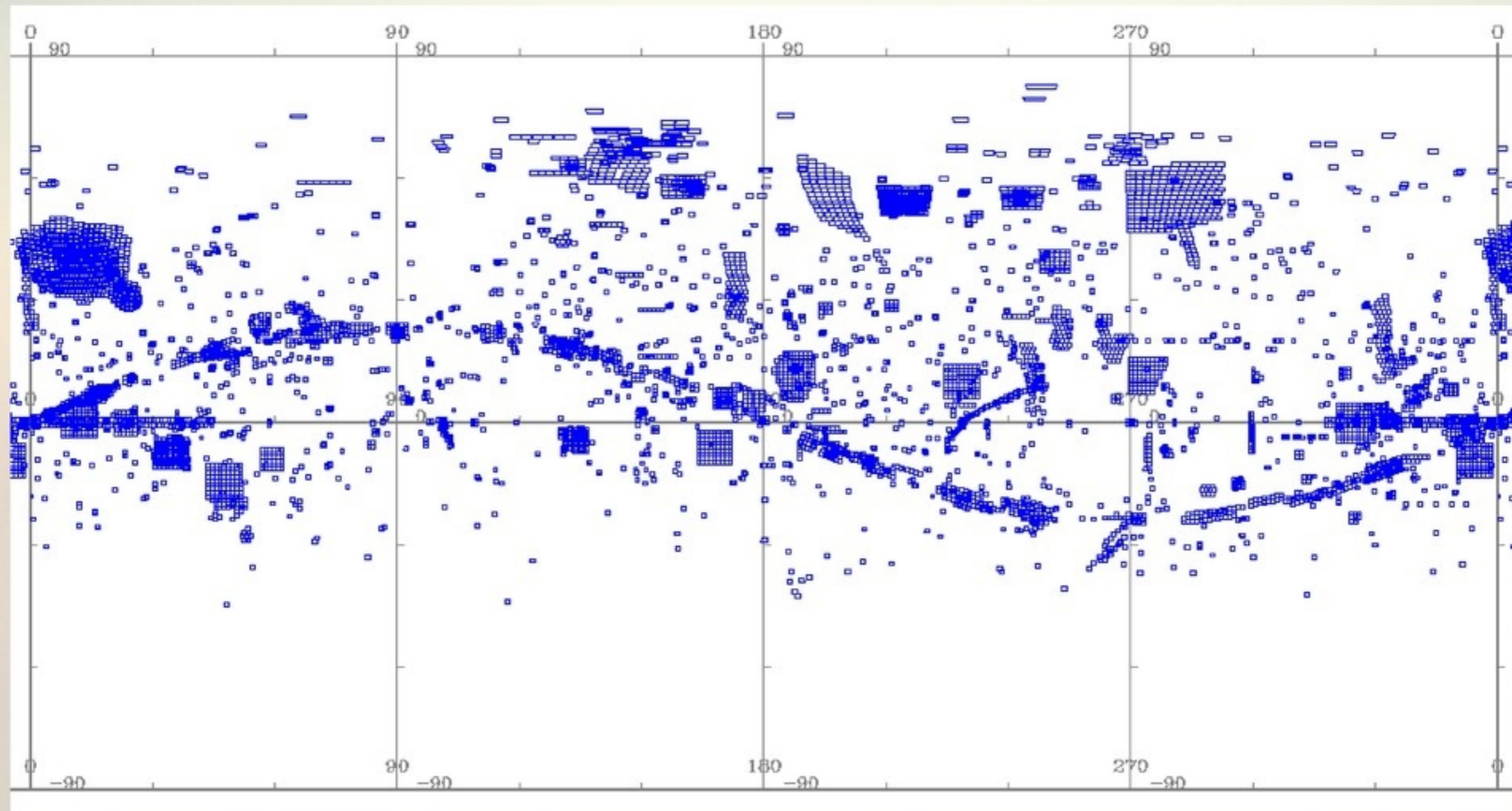
On average the archive covers 15% of the Euclid needs in ugri (6/16/21/14% resp.)

The archive will soon be fully reprocessed using the CFHTLS/SNLS recipes

The LUAU large program (350hr) will bring a useful fraction of u-band data

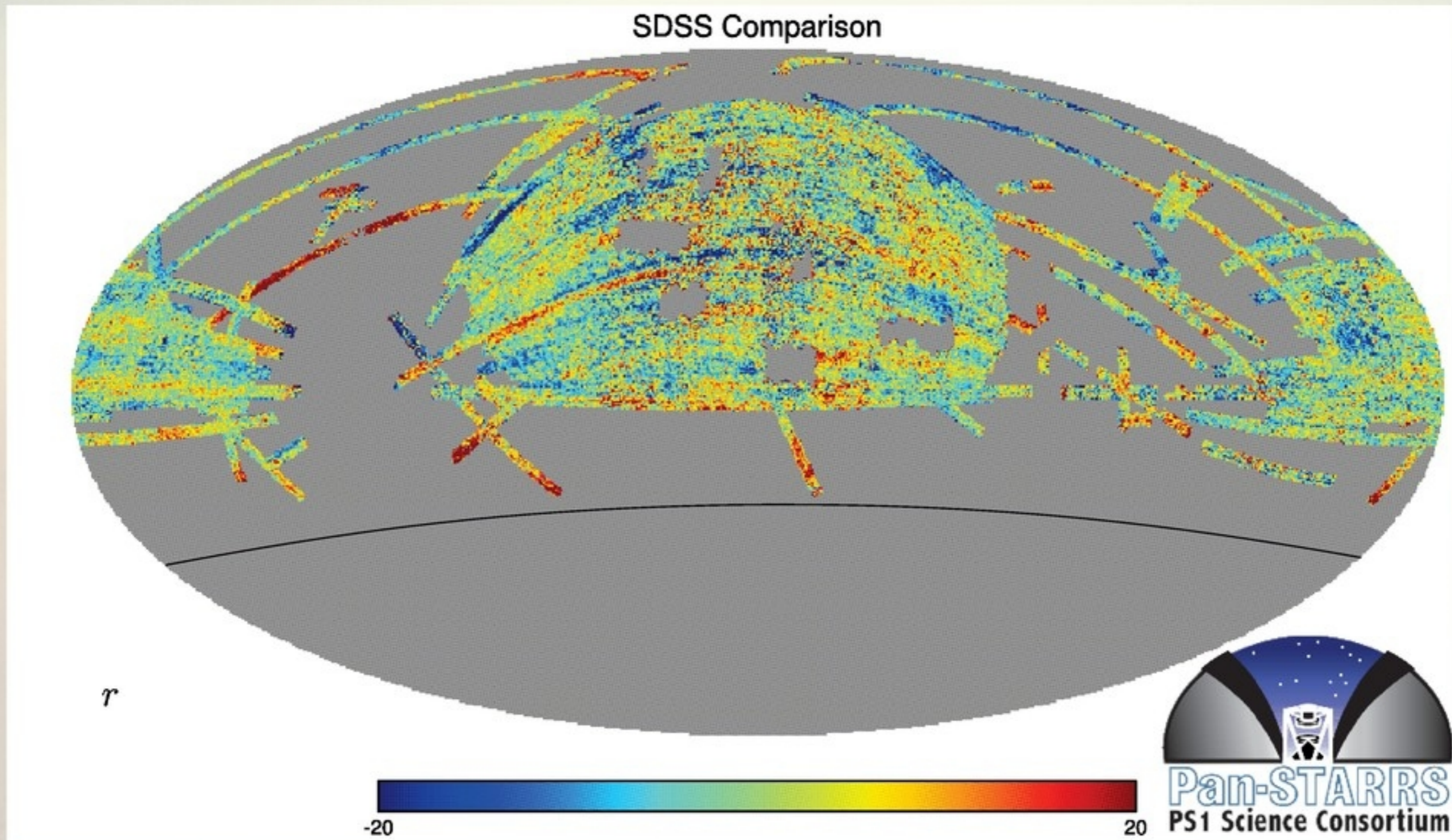
Pre-survey with the old filters could further patch the archive (vs full re-observing)

The NGVS : first in line with the CFHTLS for global reprocessing



MegaCam archive: ~8000 sq.deg., ~9000h, (2003–2012, plot from CADC/MegaPipe)

True absolute <1% photometric calibration: Pan-STARRS1 3Pi



3Pi survey (grizY, DEC +90 to -30) shows systematic SDSS structures (source E. Magnier)

France and the Euclid & DESI missions



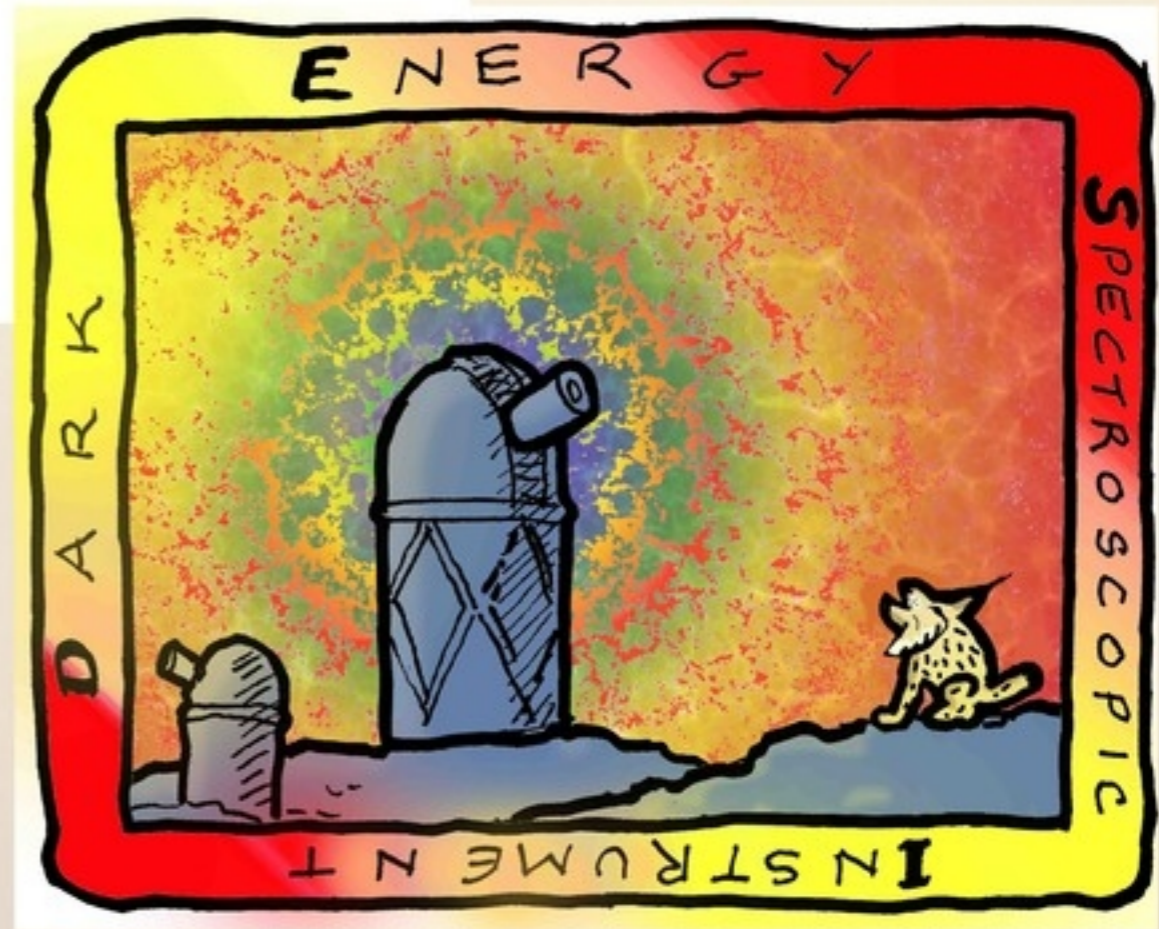
euclid

CNES/INSU/IN2P3: massive French undertaking
Launch: 2020

CFIS data would not flow to those collaborations

Euclid is interested in photometric redshifts

DESI is interested in target selection (color cuts)



CEA-SPP, LAM: tens of people
First light: 2019

Engaging the Canadian community



Wide-field astronomy meetings held in Waterloo, Toronto, Victoria, Vancouver (Oct. 2014)

Milestones for a Canada–France Imaging Survey (ex–NSLS)

May 2014: **CFHT SAC hinted a call for community surveys**

June 2014: **CFIS workshops in Paris (IAP coupled to SF2A, 2nd/3rd PM)**

Oct. 2014: **CFIS gets a top priority for implementation at the INSU prospective**

Oct. 2014: **CFIS Canada meetings (Waterloo, Toronto, Victoria, Vancouver)**

Nov. 2014: **CFHT SAC recommends a call for surveys?**

Dec. 2014: **CFHT board approves a call for community surveys or large programs**

Feb. 2015: **CFIS letter of intention to CFHT**

Sep. 2015: **Proposal submission to CFHT**

Dec. 2015: **Surveys selection (SPIRou/MegaCam/WIRCam/Espadons/Sitelle?)**

Feb. 2017: **Surveys start**



- **By 2015, we now know CFHT will be the best imager it has ever been**
- **MegaCam is unique in the world: u-band, image quality, northern sky**
- **CFHT competitive for very wide medium-deep surveys (vs HSC, PS1)**
- **A large survey is a scientific opportunity for the C-F community**
- **A Sloan type autonomous survey is in reach (regardless of Euclid)**
- **If we do not use the CFHT survey time, someone else will**