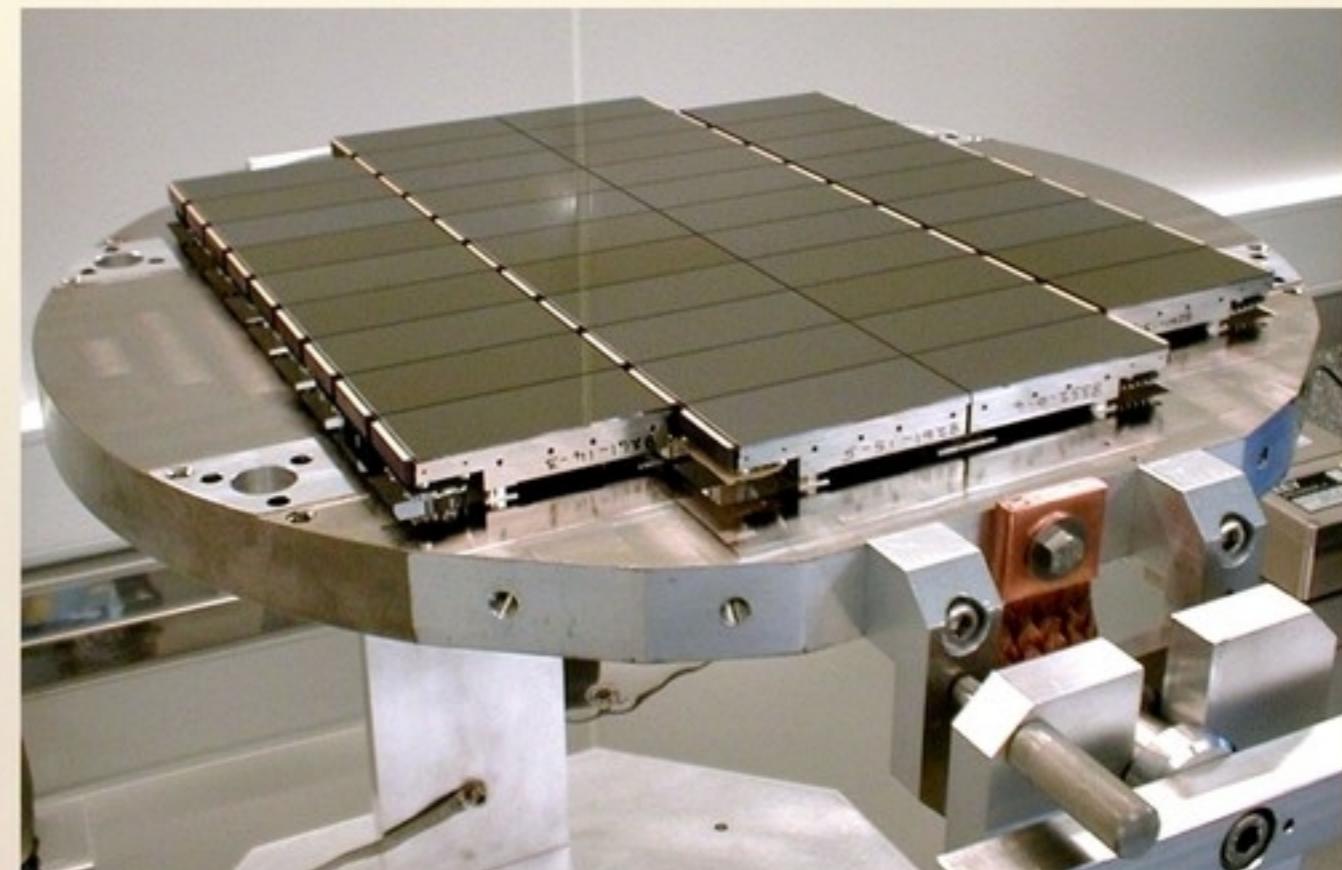


# The CFHT–MegaCam Northern Sky Legacy Survey (NSLS)

A proposal led by:

Jean–Charles Cuillandre (France)  
*CEA / Obs. de Paris*

Ray Carlberg (Canada)  
*University of Toronto*



MegaCam focal plane: first light 2003

# CFHT: a legacy 3.6m telescope still relevant after 34 years

... but for how long in its current PI driven regime?

Specializing on large surveys (500+ nights) appears to be a safe bet nowadays.



Mauna Kea (4,200m)

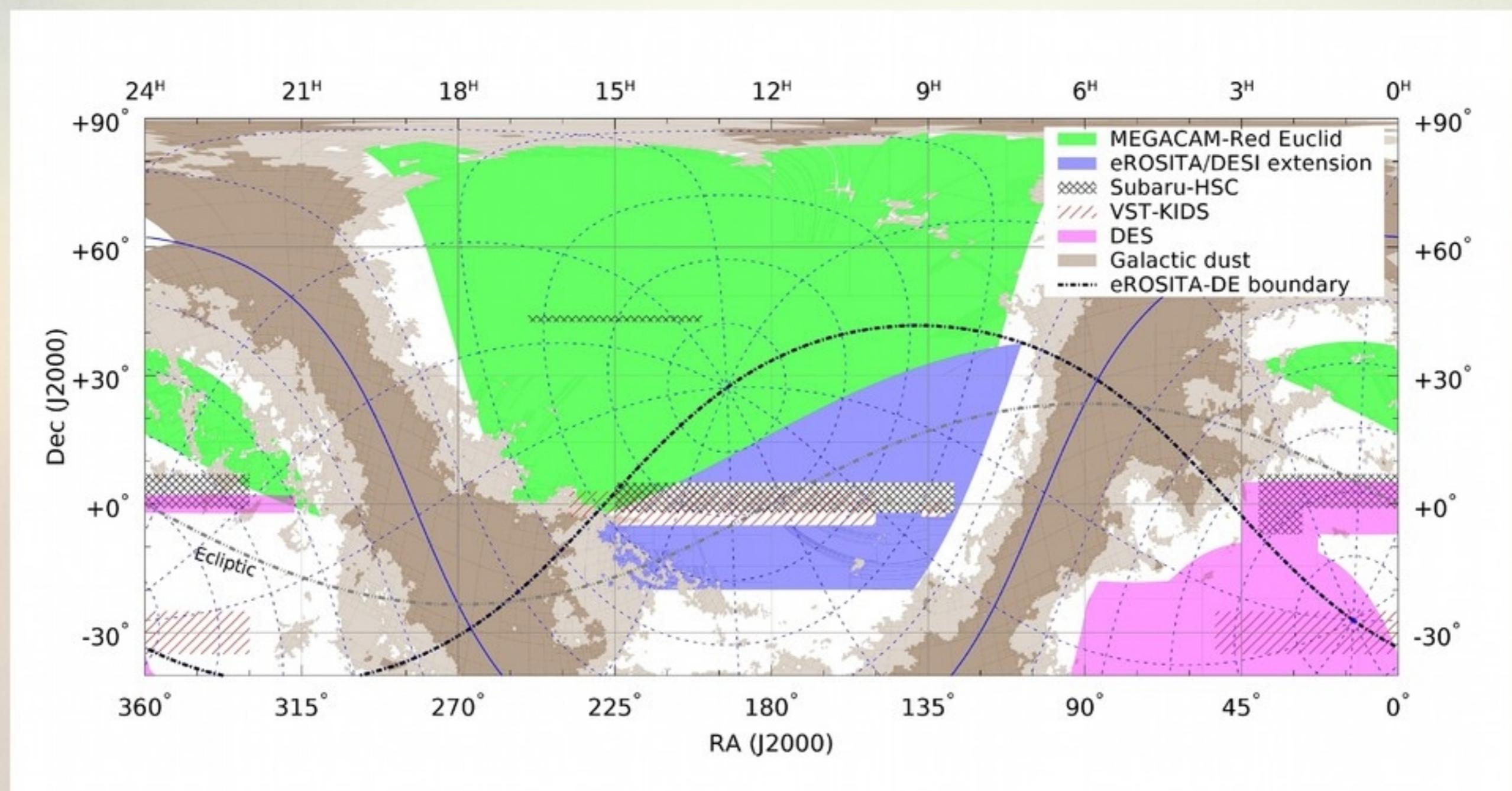


Equatorial mount with a prime focus cage



CFHT dome atop Mauna Kea (first light 1979)

# CFHT Northern Sky Legacy Survey: driven by DESI/Euclid



The sky visible from Hawaii

**CFHT NSLS (green): 7500 sq.deg. (4 bands), depth driven by Euclid**

**Other need: DESI/eROSITA (1/3 Euclid depth): 3000 sq.deg. (3 bands)**

# The headlines of the SNLS science

Construction d'échantillons photométriques panchromatiques de populations stellaires, de galaxies, d'AGNs et de QSOs couvrant l'ensemble du ciel extragalactique nord (hors plan galactique et évitant le plan de l'écliptique soit un total de 7500 degrés carrés en u, g, r, i). Les objectifs scientifiques sont encore en discussion ; parmi ceux-ci figurent:

- Étude des populations stellaires de la Galaxie
- Mesure de la fonction de corrélation des galaxies et de l'amplification cosmique des galaxies
- Analyse de la corrélation croisée des galaxies NSLS et SDSS redshift survey, puis DESI et Euclid redshift survey
- Données photométriques complémentaires pour GAIA
- Autres programmes en cours de définition pour la réponse à l'AO prévue pour 2015
- Etablir le catalogues de redshifts photométriques pour l'hémisphère nord de la mission spatiale Euclid à partir des données (u, g, r, i)CFHT+(VIS, Y, J, H)Euclid
- Construire l'échantillon de galaxies pour le relevé spectroscopique DESI à partir des données (u, g, r, i)CFHT+(z)BOK
- Préparation des catalogues pour les grands relevés spectroscopiques du Maunakea Spectroscopic Explorer (MSE, a.k.a. ngCFHT)

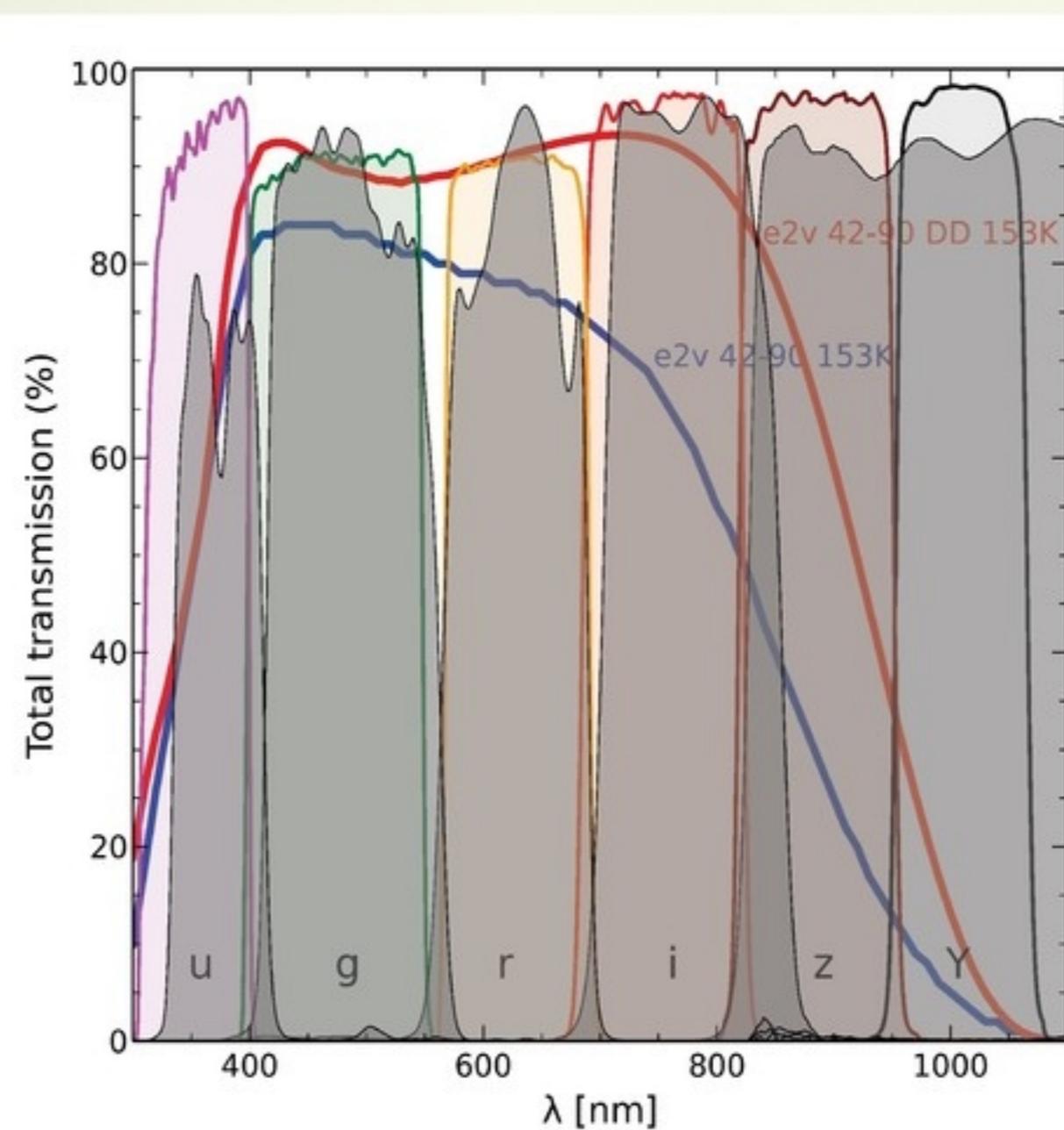
## Key advantages over the DES:

- u-band**
- image quality**

Laboratoire / organisation	Rôle	Co-proposant
CEA/Obs. de Paris	PI France	<i>J.-C. Cuillandre</i>
INSU/LAM	Photo-z	<i>S. Arnouts</i>
INSU/AIM	Galaxy evolution	<i>H. Aussel</i>
INSU/IAP	Software strategy	<i>E. Bertin</i>
CDS	VO	<i>F. Bonnarel</i>
INSU/IAP	Data production	<i>P. Hudelot</i>
Obs. de Strasbourg	Galactic archaeology	<i>R. Ibata</i>
CEA/SAp	Weak lensing	<i>M. Kilbinger</i>
INSU/LAM	Survey strategy	<i>O. Le Fèvre</i>
INSU/IAP/CEA-SAp	Co-I Euclid / DM-DE	<i>Y. Mellier</i>
CFHT	Survey monitoring	<i>S. Prunet</i>
IN2P3/LPNHE	Data calibration	<i>N. Regnault</i>
CEA/SAp	Data production	<i>M. Sauvage</i>
CEA/SPP	DESI / BAO	<i>C. Yèche</i>

French community co-Is (agencies: INSU/IN2P3/CEA)

# MegaCam upgrade (funded 2014): new filters, faster readout



Current MegaCam (blue) and RED (red)

No new CCDs e2v 42–90 deep depletion (not funded)

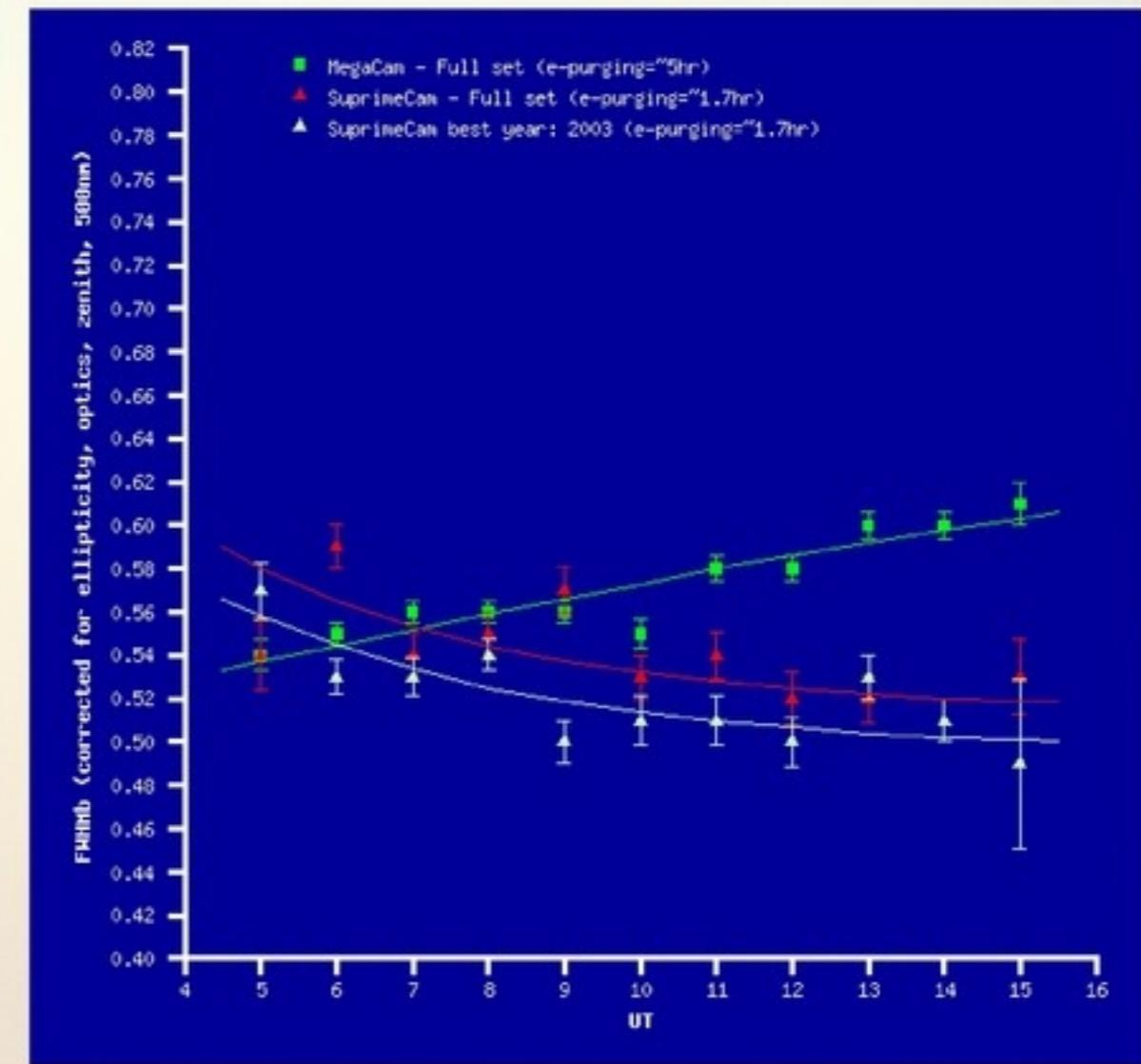
New filters: higher transmission, steeper, larger (expose MegaCam "ears")

Faster readout: goal is 30 seconds (down from 50 seconds)

# Dome venting: boosting the NSLS



Now operational (since Feb. 2014)



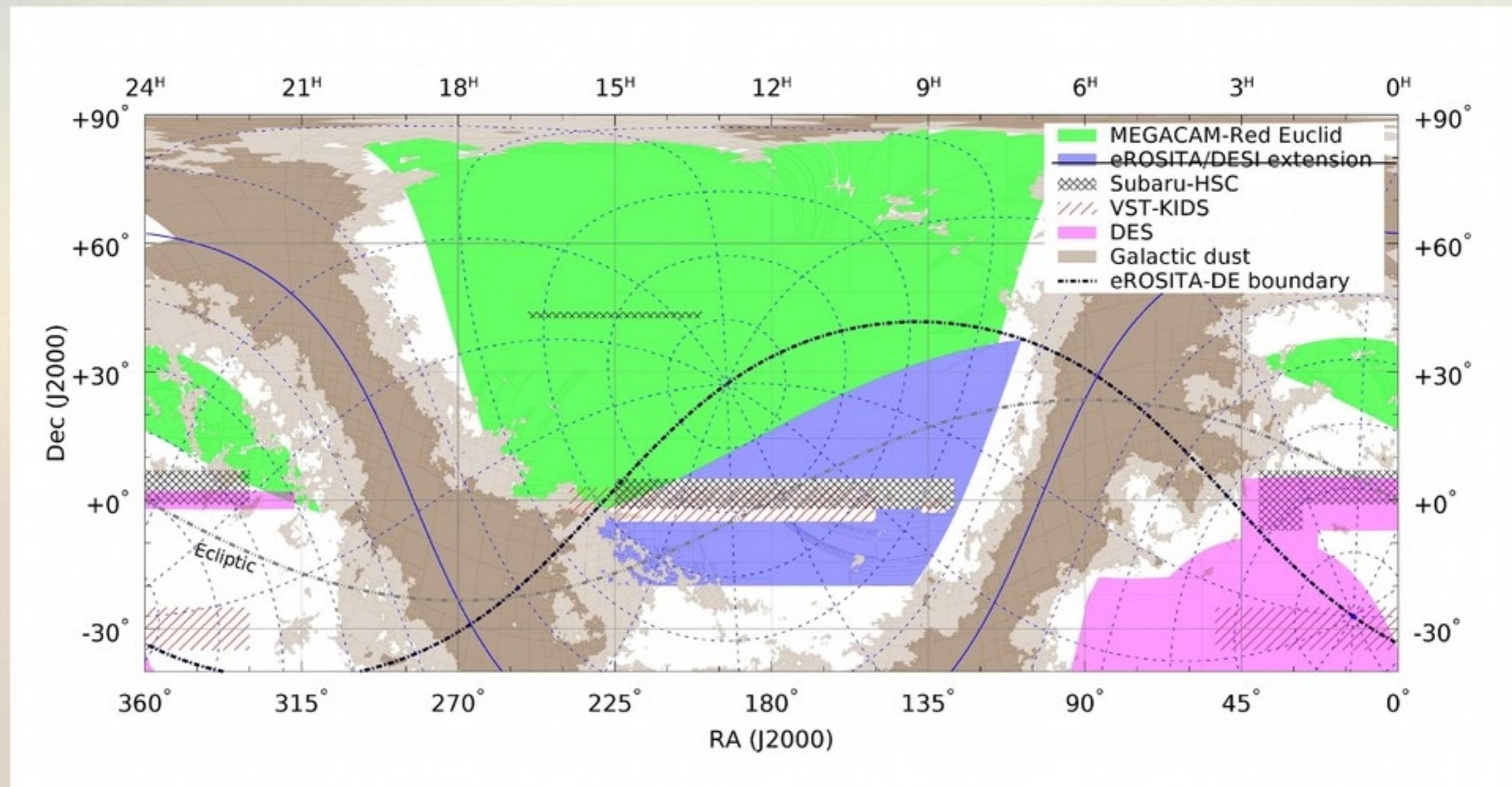
Matching Subaru's performance: 0.1" gain

Not just a gain in absolute: the IQ will get far more uniform throughout the night

CFHT could possibly reclaim its title of best in the class for image quality

Great potential for lensing with CFHT NSLS (0.6") versus DECam DES (1")

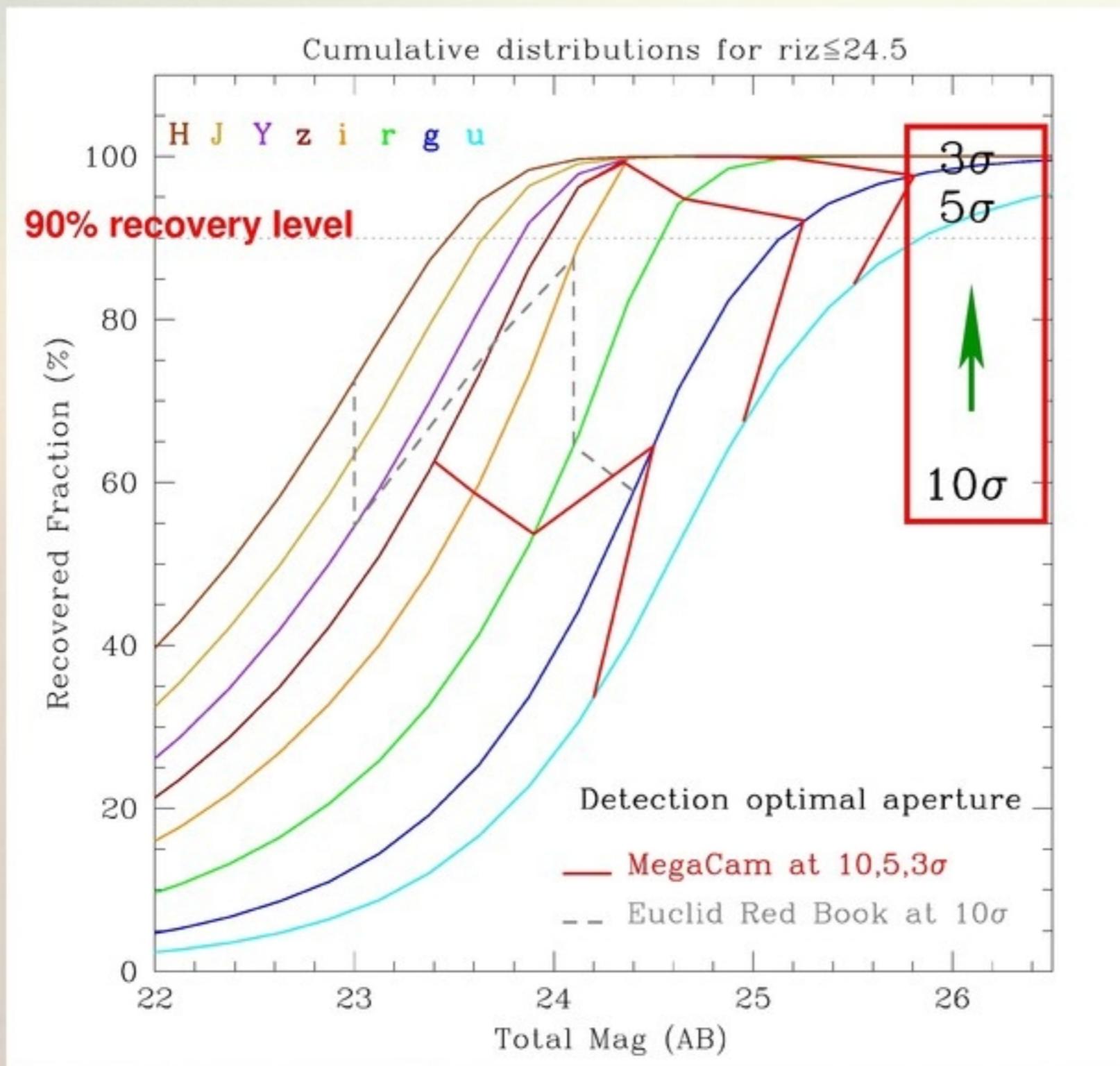
# NSLS: now focused on the Euclid footprint, also serves DESI



The sky visible from Hawaii

**CFHT NSLS (green): 7500 sq.deg. (4 bands), depth driven by Euclid**

# CFHT NSLS, a 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:

$u = 25.1$

$g = 25.4$

$r = 24.8$

$i = 24.5$

$z = 24.3$

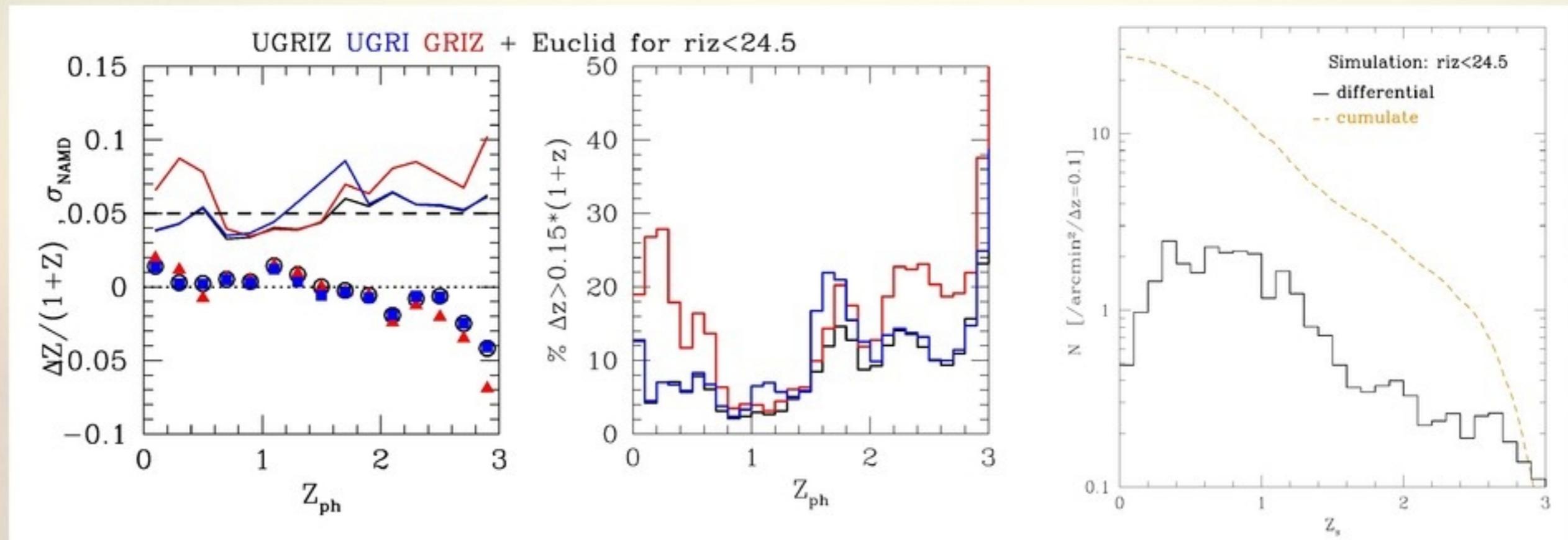
PSF fitting photometric extraction

~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)

# Photometric redshifts quality with different filter sets (S. Arnouts)



Left: photometric redshift accuracy as a function of redshift for MegaCam+Euclid

Center: the catastrophic fractions

Right: redshift distribution of the simulated sources with  $\text{riz} < 24.5$

# Deriving a time budget with MegaCam: optimal color extraction

Time scaling considering the gains with new filters, readout, and dome venting

Average time per night based on the 2003–2013 weather MegaCam statistics

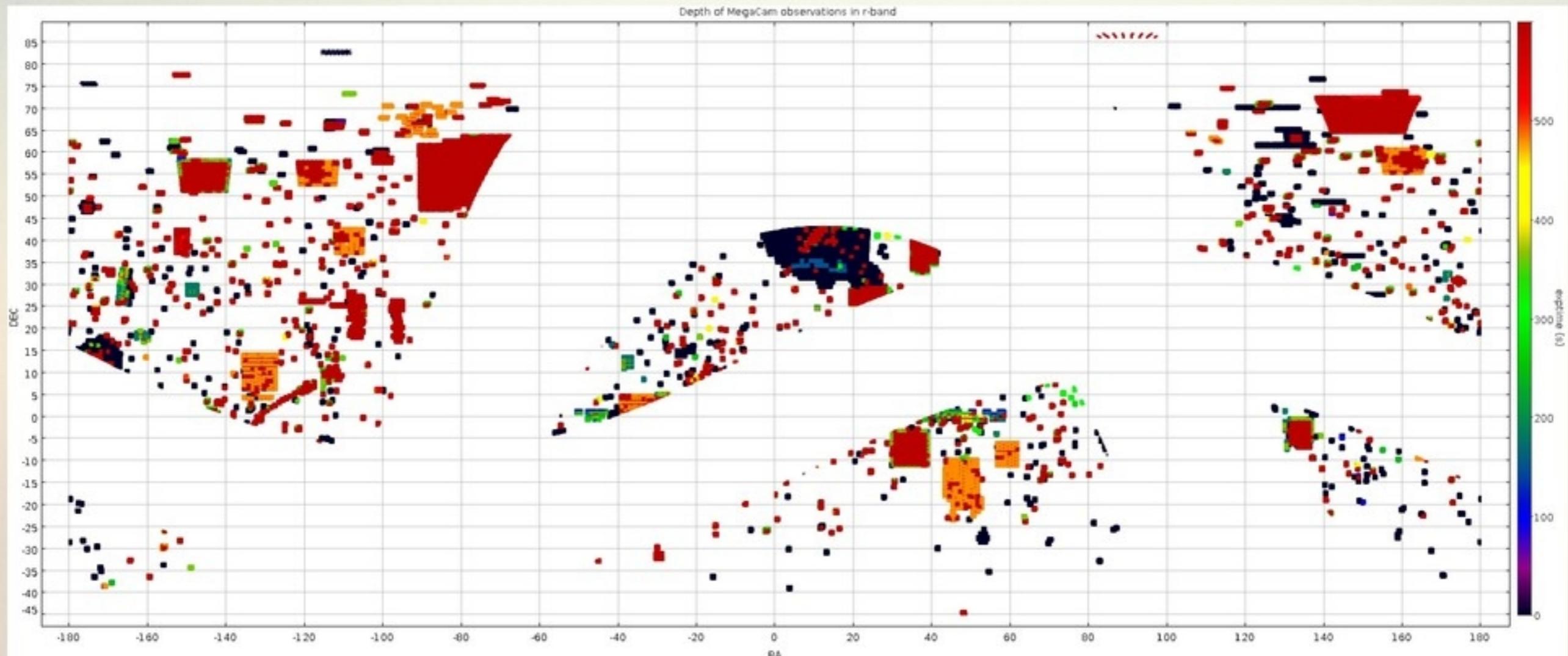
	u	g	r	i	z	ugri / Nights	griz / Nights
MegaCam-2003-13	544	419	375	552	2325	1890 / 787	3671 / 1410
MegaCam-Vented	461	367	320	484	2039	1632 / 697	3210 / 1249
MegaCam-SqFlts	380	349	315	456	2039	1500 / 651	3159 / 1231
MegaCam-RED	350	319	267	326	845	1262 / 567	1757 / 740

Time needed per filter to reach the desired depth using an aperture optimized for color derivation

A ugri survey is less expensive than a griz one even with new CCDs

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

# 12 years of MegaCam archiving helps reducing the time request



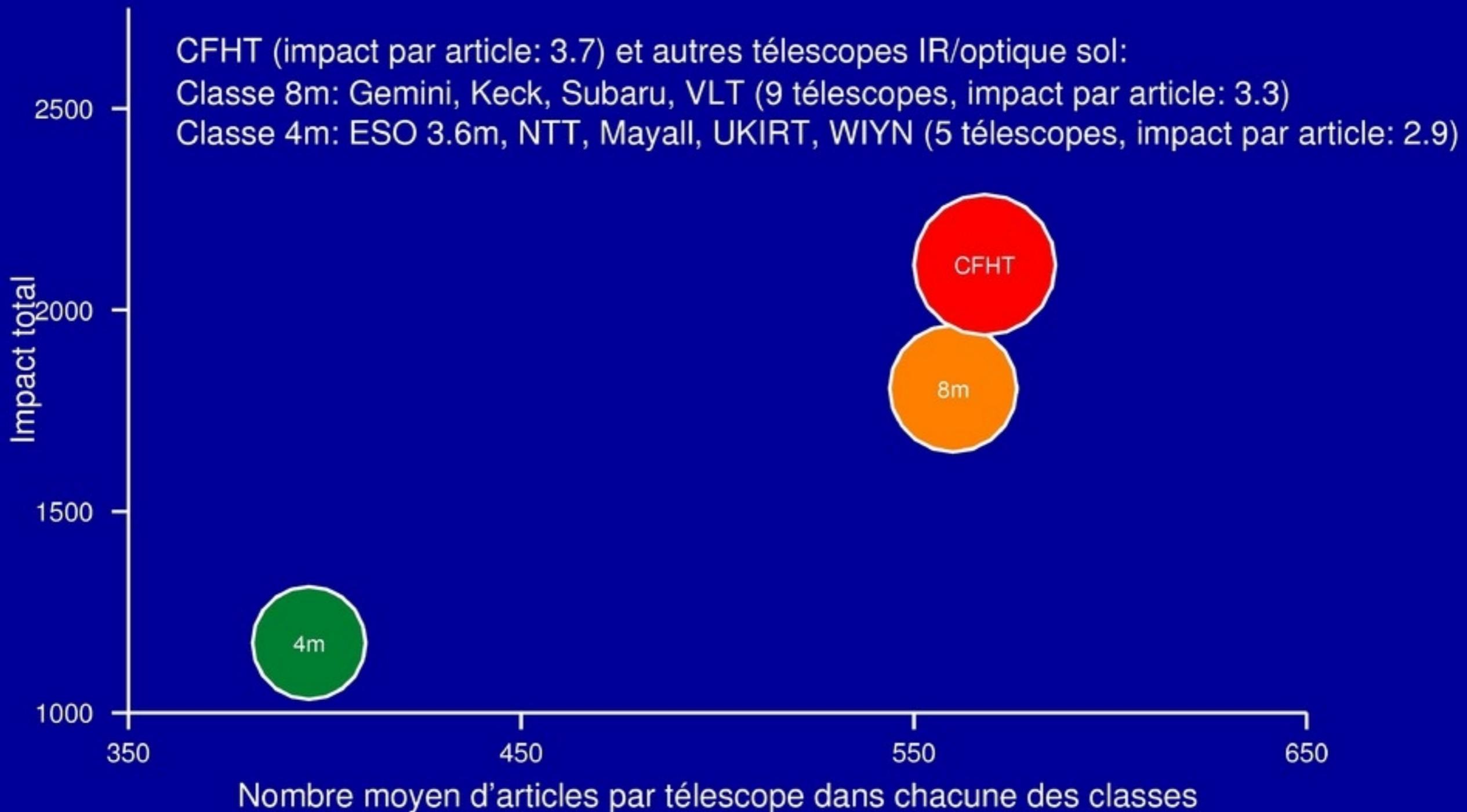
r-band archive vs Euclid footprint (color coding with depth) (P. Hudelot, Terapix)

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

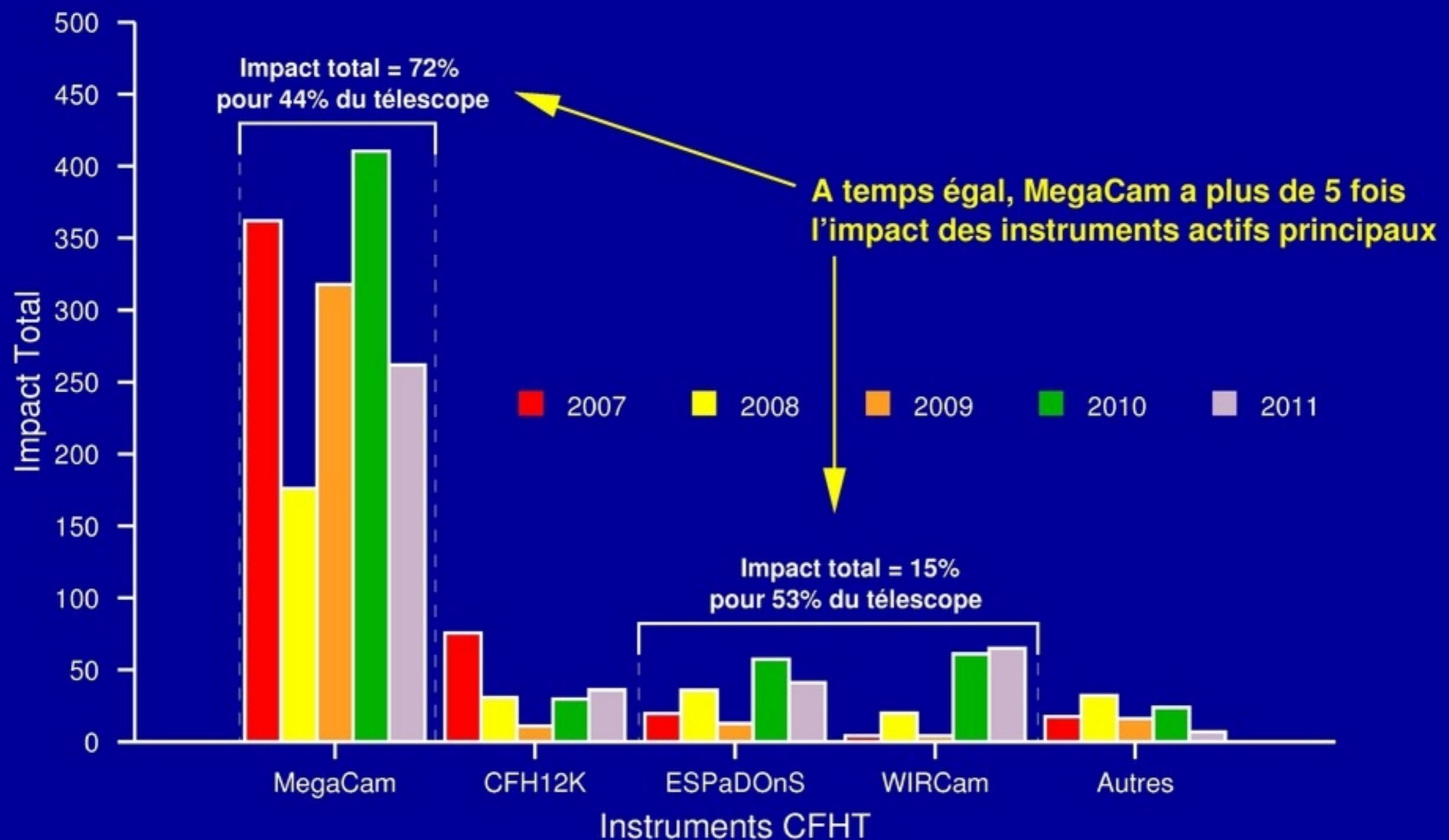
An Ibata/McConachie large program would bring a large fraction of u-band data

Impact bibliographique total 2007–2011 (5 années)  
Statistiques mises à jour en mars 2013 – Normalisation sur AJ



Source: D. Crabtree (HIA, NRC)

CFHT: impact bibliographique total  
Statistiques mises à jour en mars 2013 – Normalisation sur AJ



# Milestones for the CFHT NSLS

- May 2014: CFHT SAC recommends a call for community surveys?
  - June 2014: NSLS workshops in Paris (IAP coupled to SF2A, 2nd/3rd PM)
  - Dec. 2014: CFHT board approves a call for community surveys
  - Feb. 2015: NSLS letter of intention to CFHT (new name? SPIRou has SLS...)
  - Sep. 2015: Proposal submission to CFHT
  - Dec. 2015: Surveys selection (SPIRou/MegaCam/WIRCam/Espadons/Sitelle?)
  - Feb. 2017: Surveys start
- Wild card: CFHT absorbs UKIRT dedicated to SPIRou, CFHT focuses on MegaCam
- Short term:** build community support to create a survey producing science beyond the needs of large missions such as Euclid and DESI.