J-PAS

The Javalambre-Physics of the Accelerating Universe Astrophysical Survey

Renato Dupke
ON/UM

J-PAS Builder Institutions

CEFCA
Centro de Estudios de Física del Cosmos de Aragón

Observatório Nacional
Rio de Janeiro

IAG-USP

COLLABORATION BOARD:
Javier Cenarro (CEFCA)
Renato Dupke (ON)
José (Pepe) Vilchez (IAA)
Laerte Sodre (IAG-USP)

INSTITUTO de ASTROFISICA de ANDALUCIA
CSIC
I·A·A

Benitez et al. 2009 – Simulated with lower (by >10) resolution templates and 300A filters)

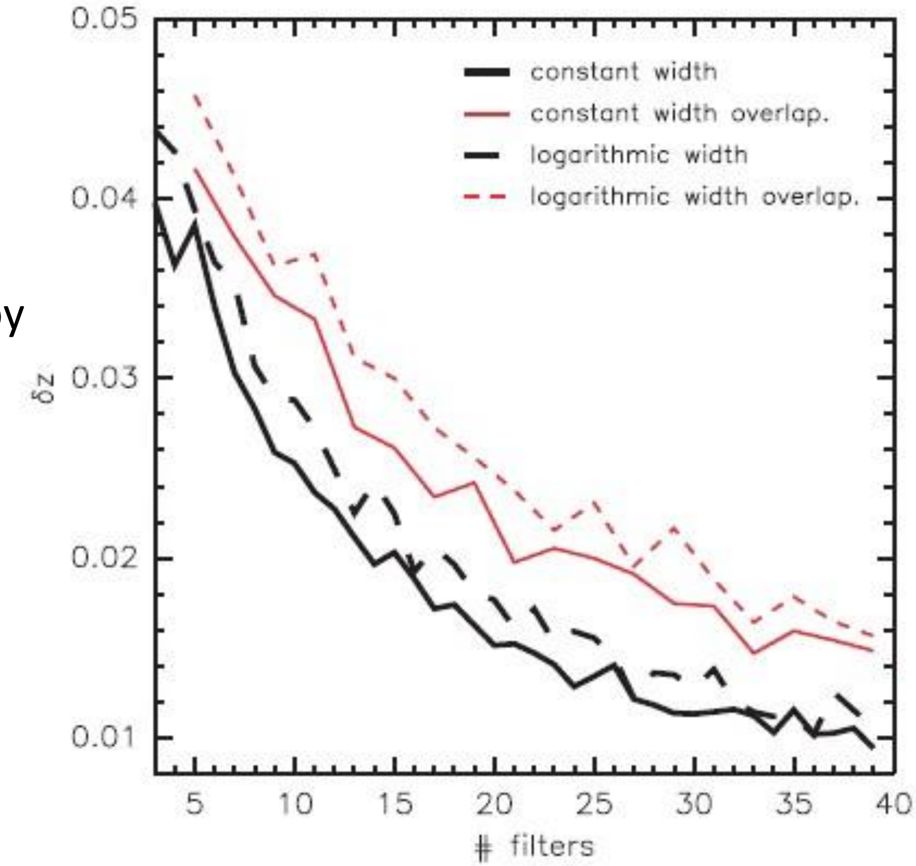
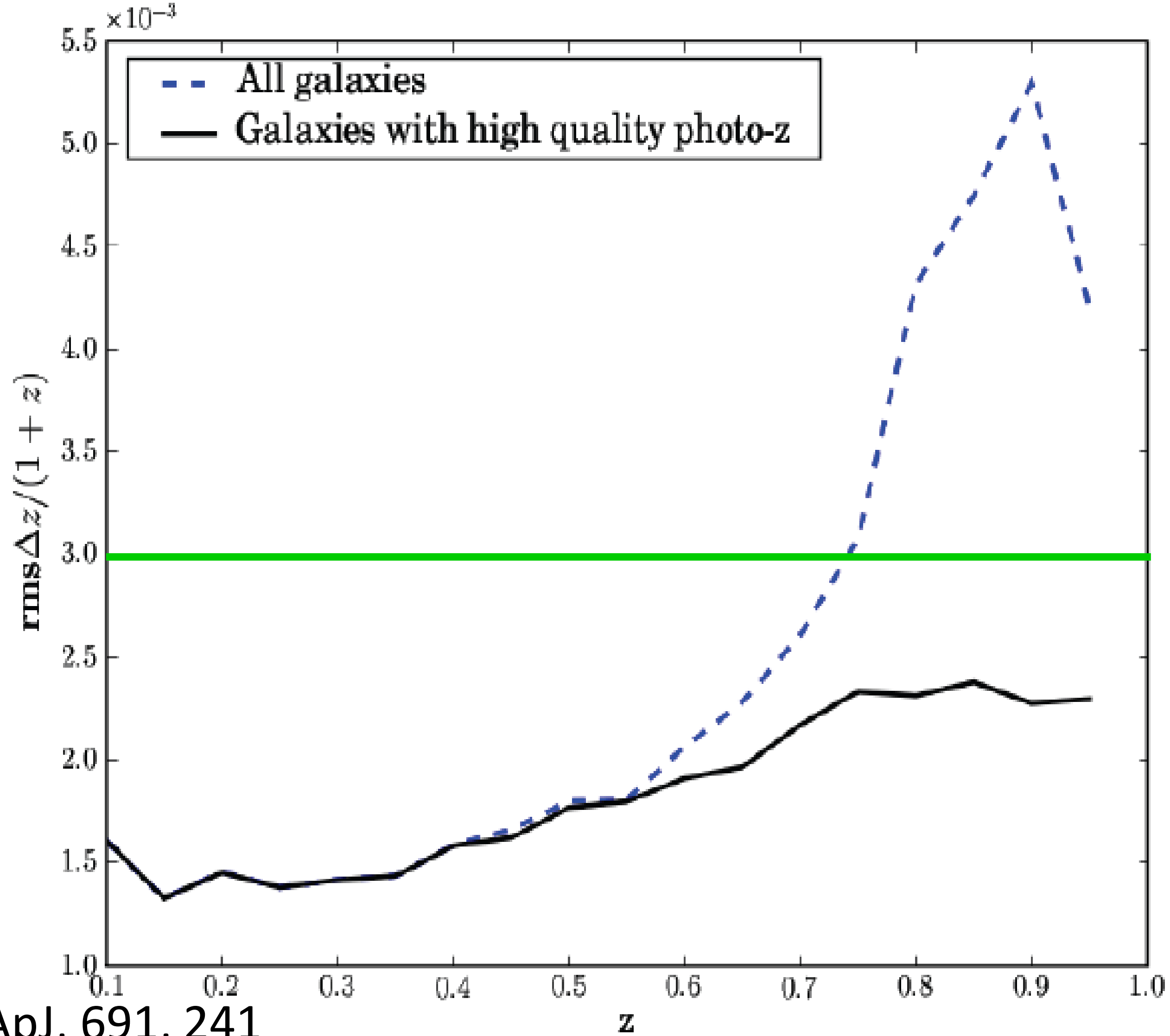


Figure 4. Dependence of the rms of quantity $(z - z_b)/(1 + z)$ for those galaxies with odds > 0.99 as a function of the number of filters for the four types of filter systems considered in the Letter and including near-IR observations (see

Δz r.m.s as a function of the true z

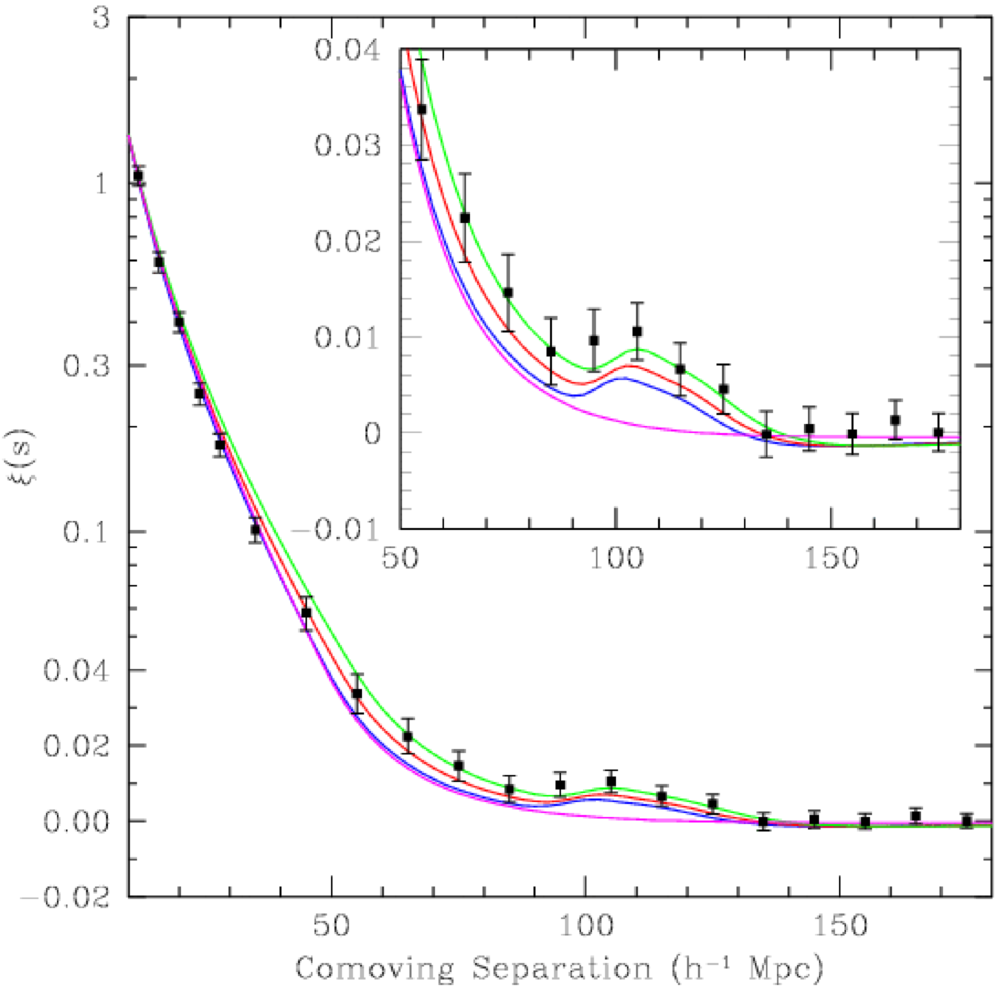
Bayesian photo-z quality indicator ("BPZ odds") can selects galaxies with high precision photo-z

Measuring the BAO radial scale requires quasi-spectroscopic precision: 0.003(1+z).



Benitez et al. 2009 ApJ, 691, 241

BAO measured in SDSS data (Eisenstein et al. 2005)



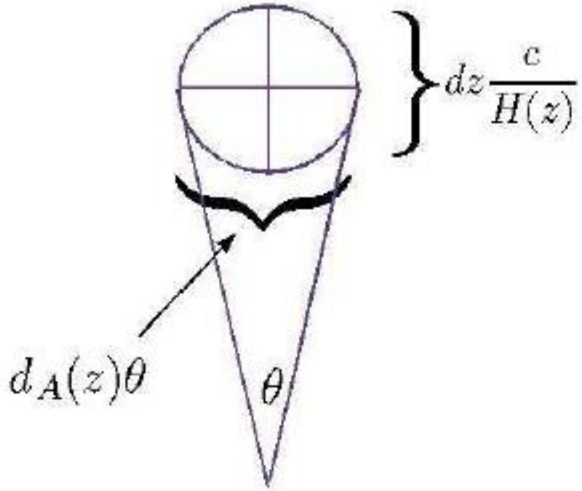
$$\xi(r) = \langle \delta(\vec{r}_1)\delta(\vec{r}_2) \rangle, \delta(\vec{r}) = \frac{\rho(\vec{r}) - \bar{\rho}}{\bar{\rho}}$$

3.5-σ detection of BAO

BUT even better to get radial!

For a flat universe

$$H(z) = h\sqrt{\Omega_m(1+z)^3 + \Omega_X \exp\left[3\int_0^z \frac{1+w(z)}{1+z}dz\right]}$$



- If we could measure H(z), we would get the dark energy density evolution
- However it is easy to measure **a** (redshift) but not **da/dt**
- We can indirectly measure H(z) through the measurement of distances:

$$D_A(z) = \frac{c}{1+z}\int_0^z \frac{dz}{H(z)}$$

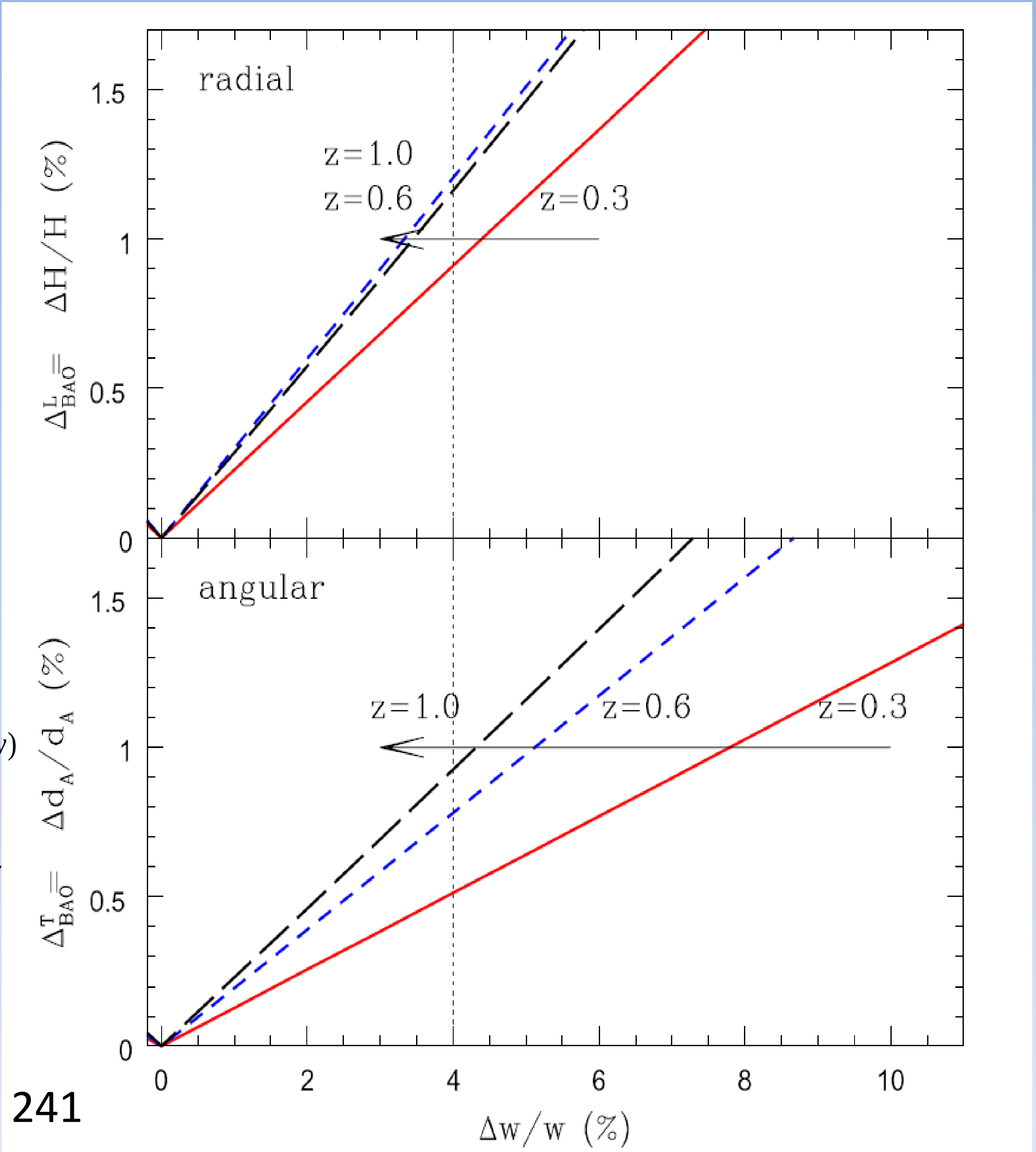
To measure dw/dz we need $d^2H(z)/dz^2$ or $d^3D_A(z)/dz^3$

Importance of measuring in the radial direction:

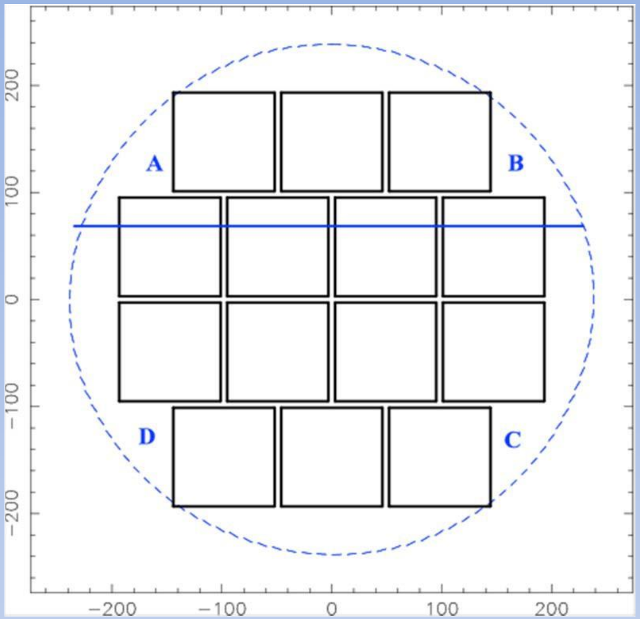
Assume flat universe, w=constant and Ω_m=.25

$$\frac{H^2(z)}{H_0^2} = \Omega_m(1+z)^3 + +(1-\Omega_m)(1+z)^{3(1+w)}$$

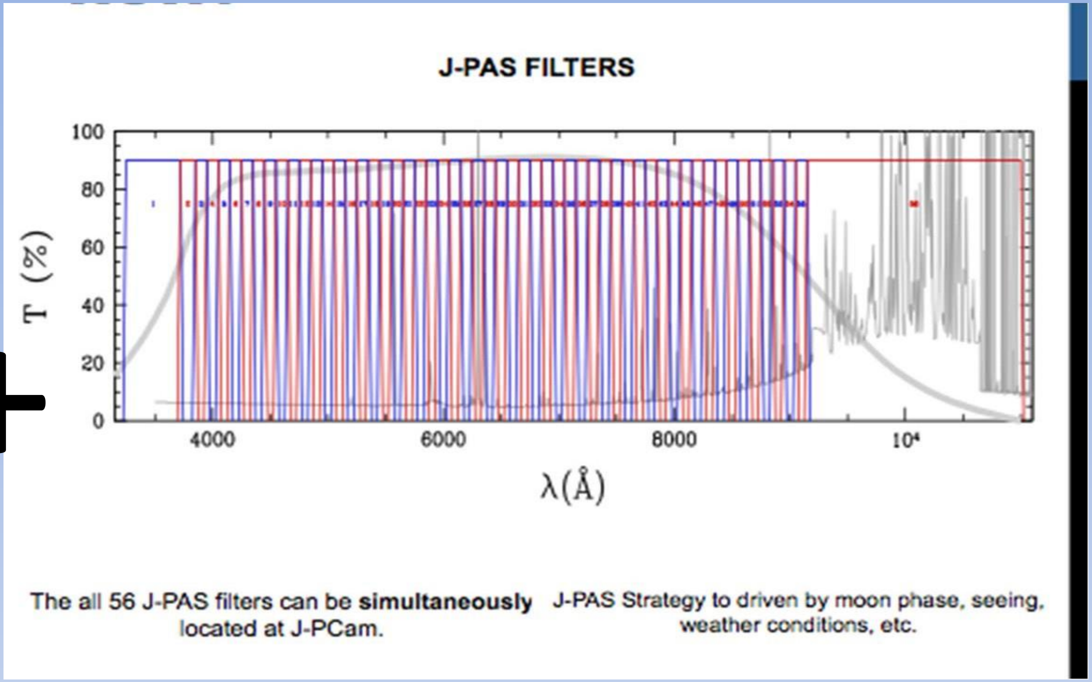
Error propagation:



Benitez et al. 2009 ApJ, 691, 241



+



Equivalent to a ~5000/ multiplex spectrograph

-A full system of NB filters has an effective throughput smaller than spectrographs but that is compensated by their stupendous multiplexing **IF** the FOV is large enough

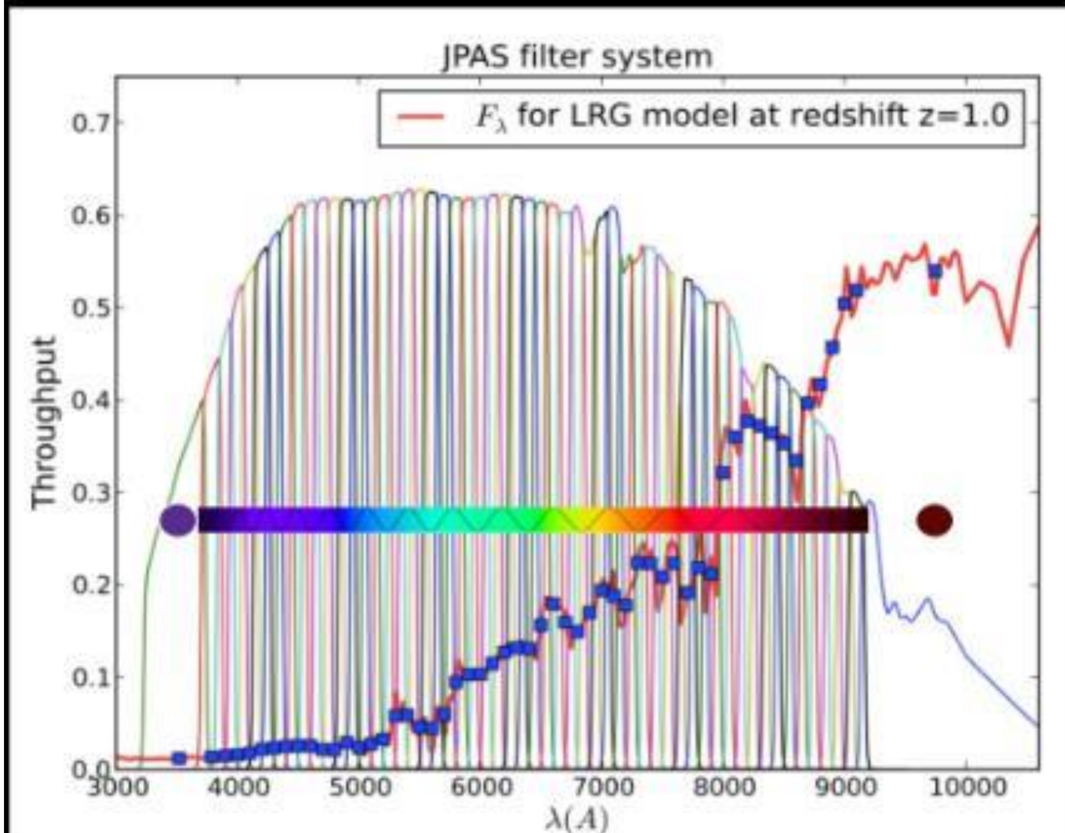
-To surpass the efficiency of state-of-the art spectrographs, the camera size must be very large, >4 sq.degs

- But still costs an order of magnitude less than comparable spectrograhs

J-PAS

JAVALAMBRE PHYSICS OF THE ACCELERATED UNIVERSE ASTROPHYSICAL SURVEY

DEFINITION & IMPLEMENTATION



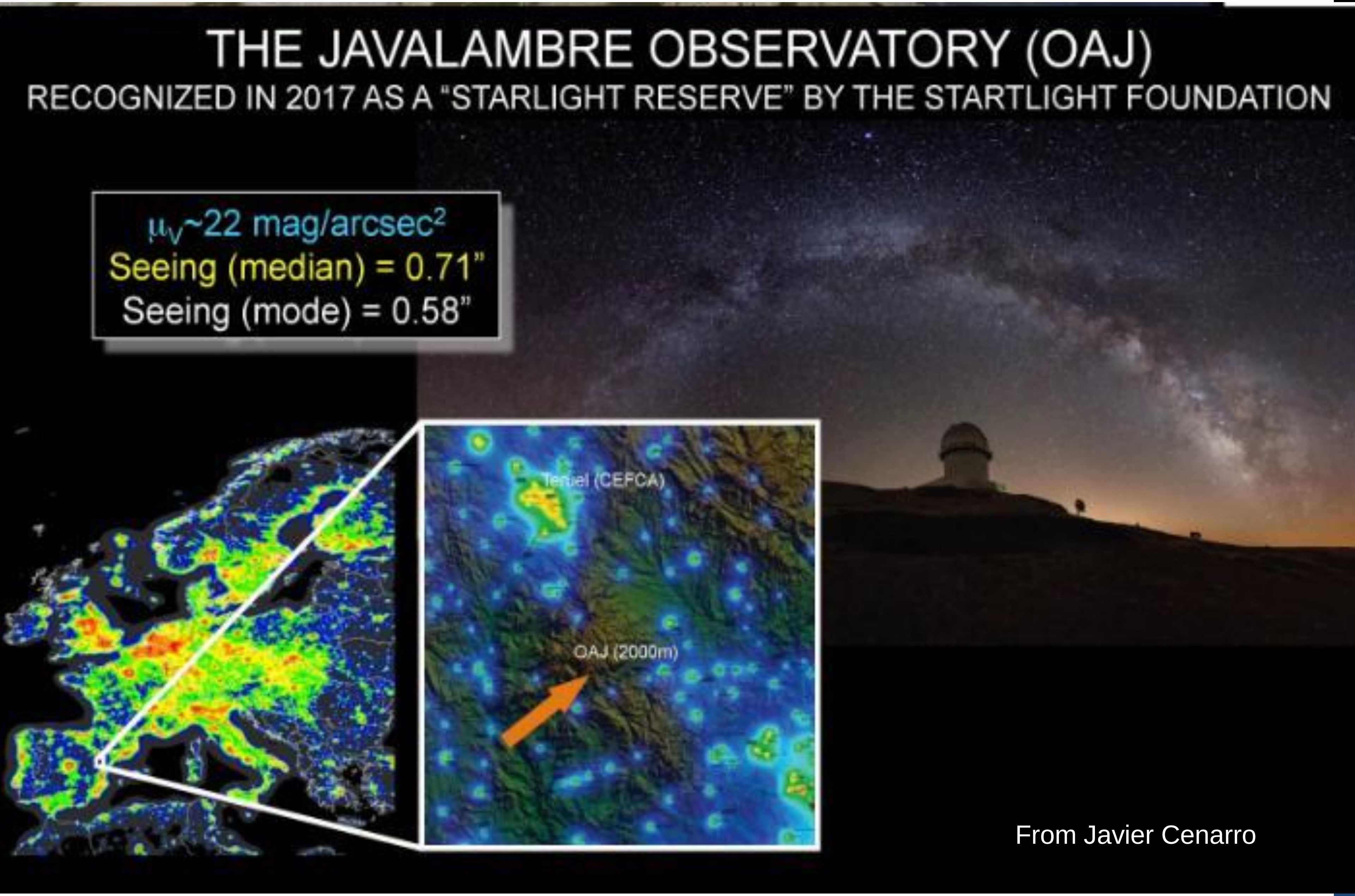
8500 deg^2 (14Gpc^3)

- 54 NB Filters (FWHM~14.5nm; $\Delta\lambda$~10nm)
- 1 Blue MB filter (FWHM~260Å; λ_c~3600Å)
- 1 Red BB filter (FWHM~620Å; λ_c~9500Å)
- Sloan u, g, r

In ~ 7 years

- BAOs: δz / (1+z) < 0.003
- Weak Lensing, Clusters, SNe

From Javier Cenarro



From Javier Cenarro

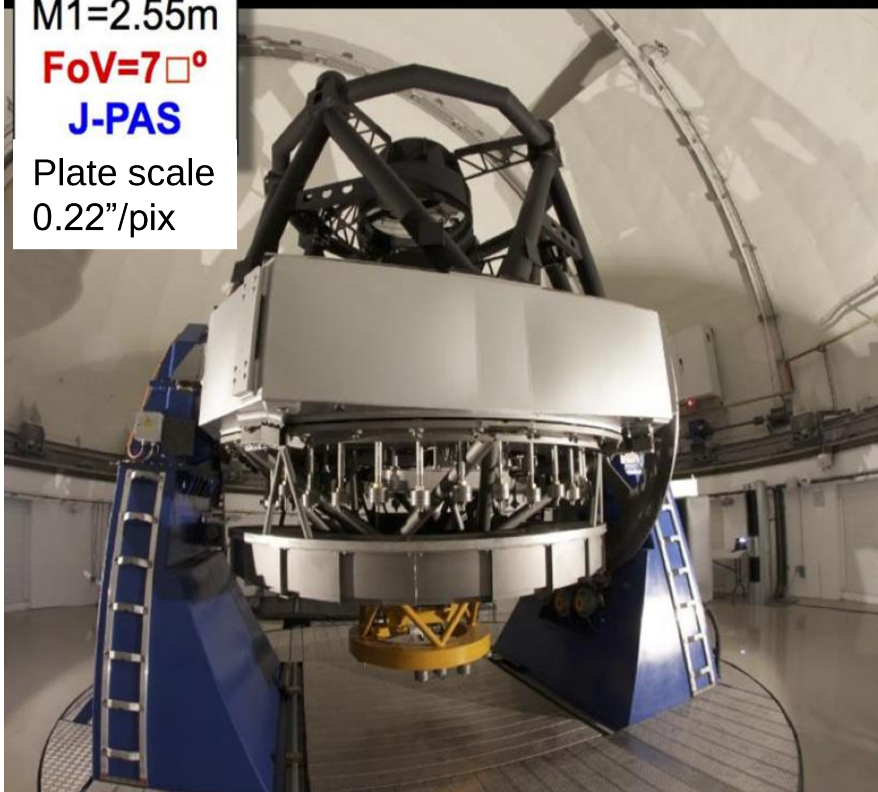
Observatorio astrofísico de Javalambre
GOBIERNO DE ARAGON
GOBIERNO DE ESPAÑA
MINISTERIO DE ECONOMIA Y COMPETITIVIDAD
UNIÓN EUROPEA
Fondo Europeo de Desarrollo Regional
Una manera de hacer Europa
OBSERVATORIO ASTROFÍSICO DE JAVALAMBRE
OAJ TELESCOPES
DIRECTOR
A. Javier Cenarro
CEFCA
OAJ Project Manager
CEFCA

CEFCA
Centro de Estudios de Física del Cosmos de Aragón

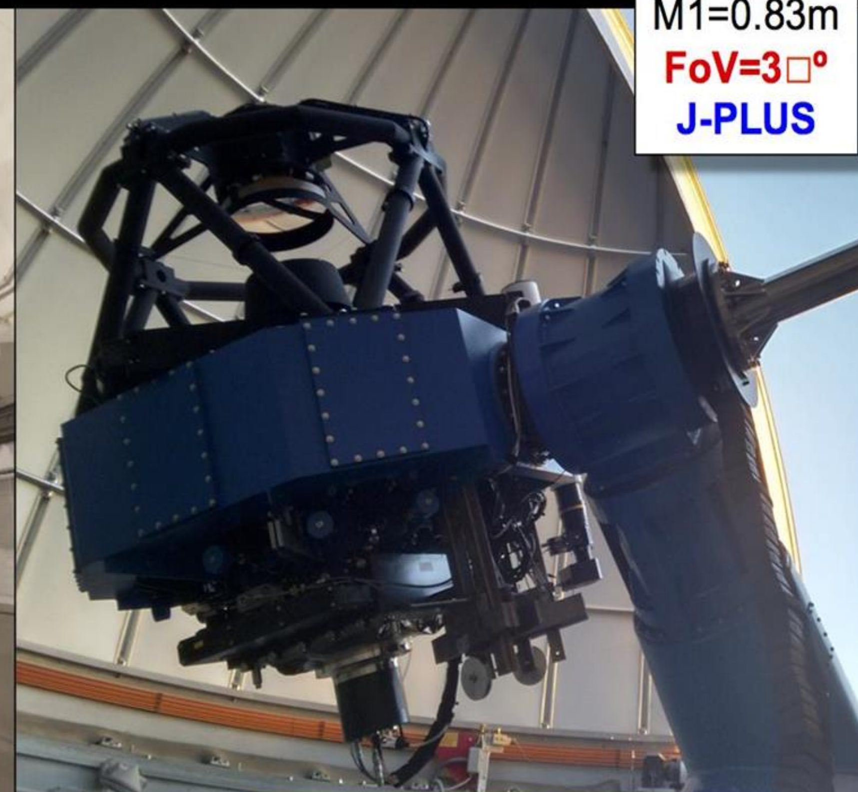
LARGE FOV TELESCOPES AT THE OAJ

FOR LARGE SKY SURVEYS

JST/T250
M1=2.55m
FoV=7□º
J-PAS
Plate scale
0.22”/pix



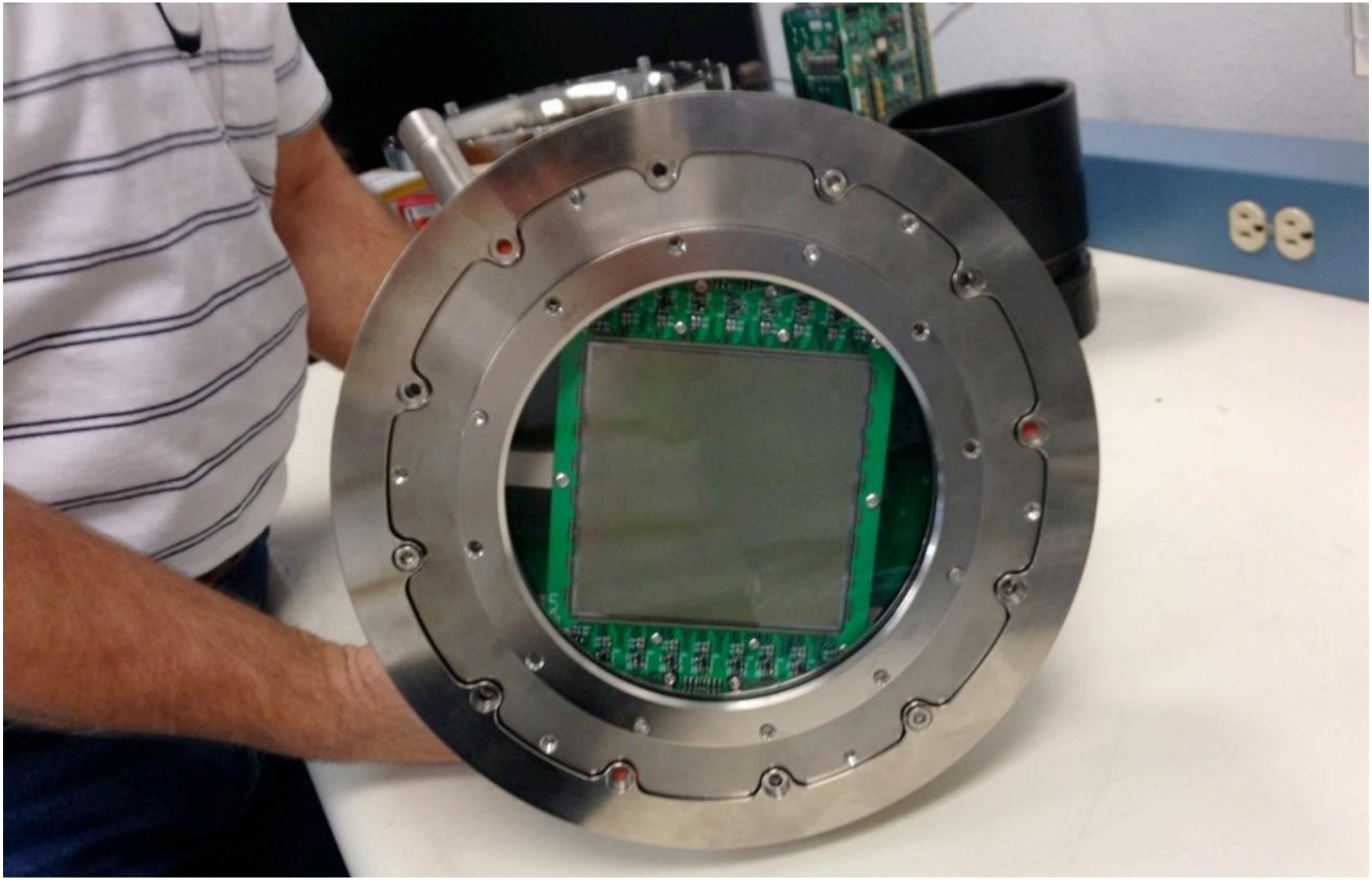
JAST/T80
M1=0.83m
FoV=3□º
J-PLUS



Already on site with PathFinder Commissioning & mini-jpas

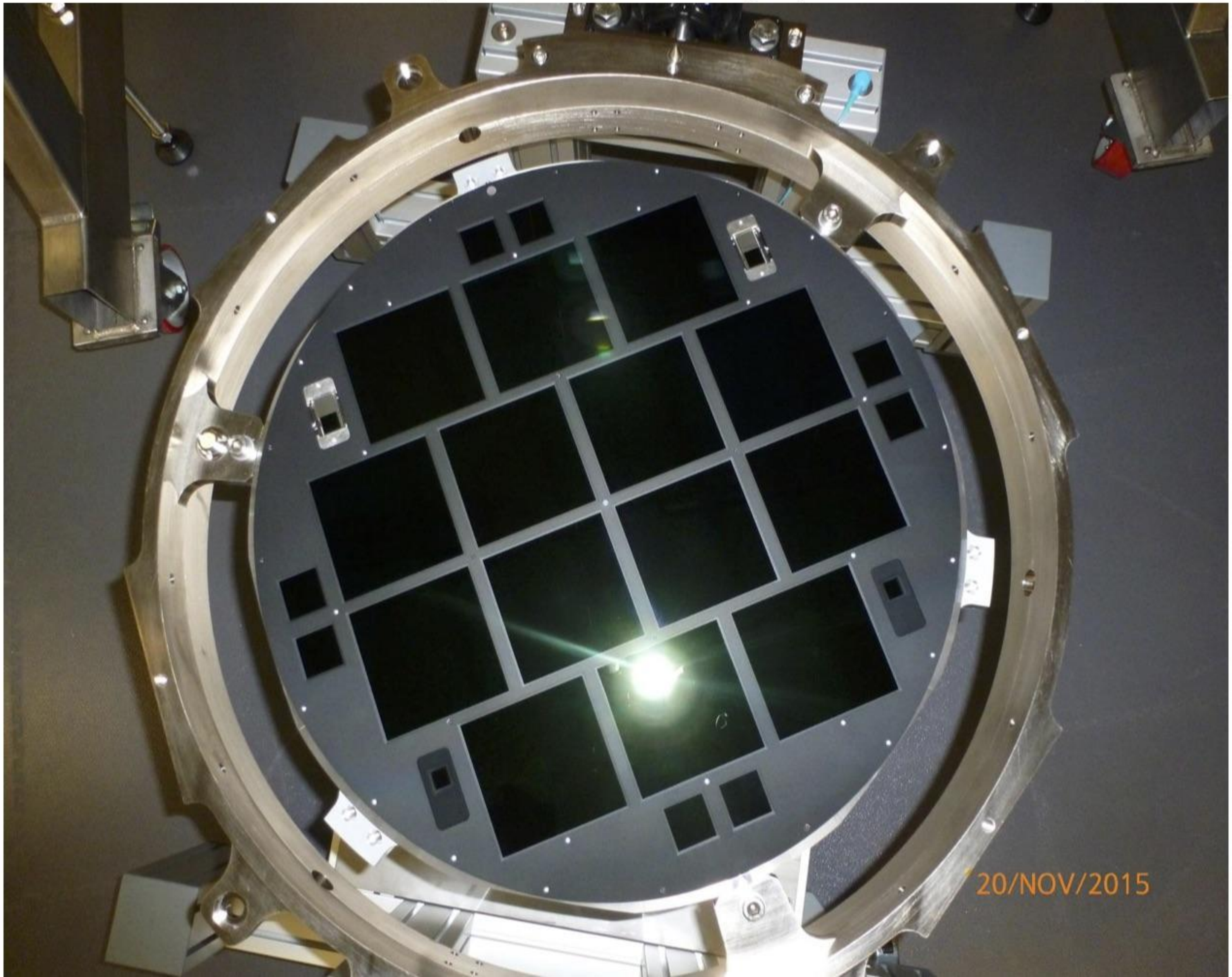
In science operations since Nov 2015

CCD installed in T80Cam – 5/2013
Taking data since 2015



JPCam CryoCam

Grade-5 focal plane assembly (ev2 – Nov'15)

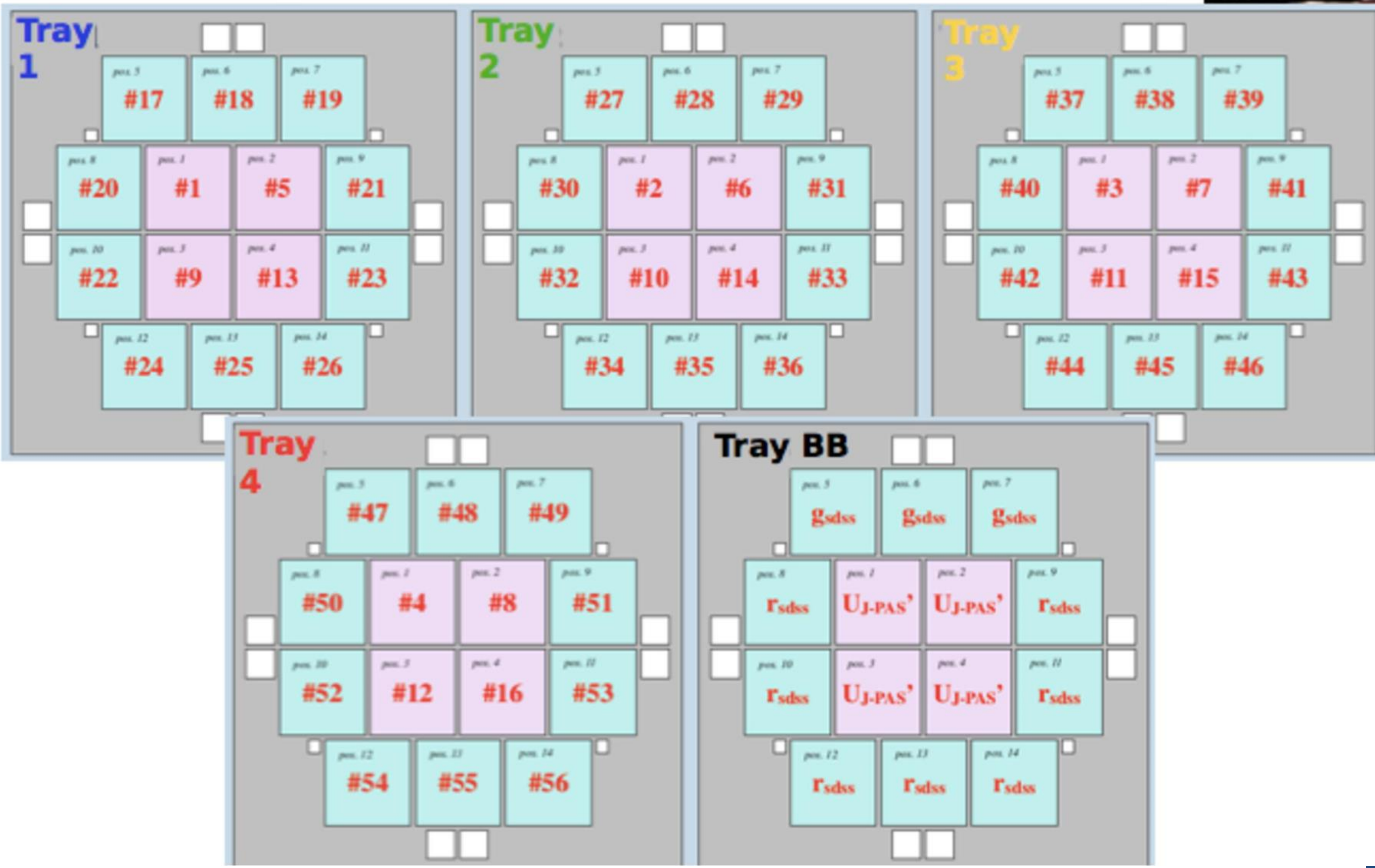


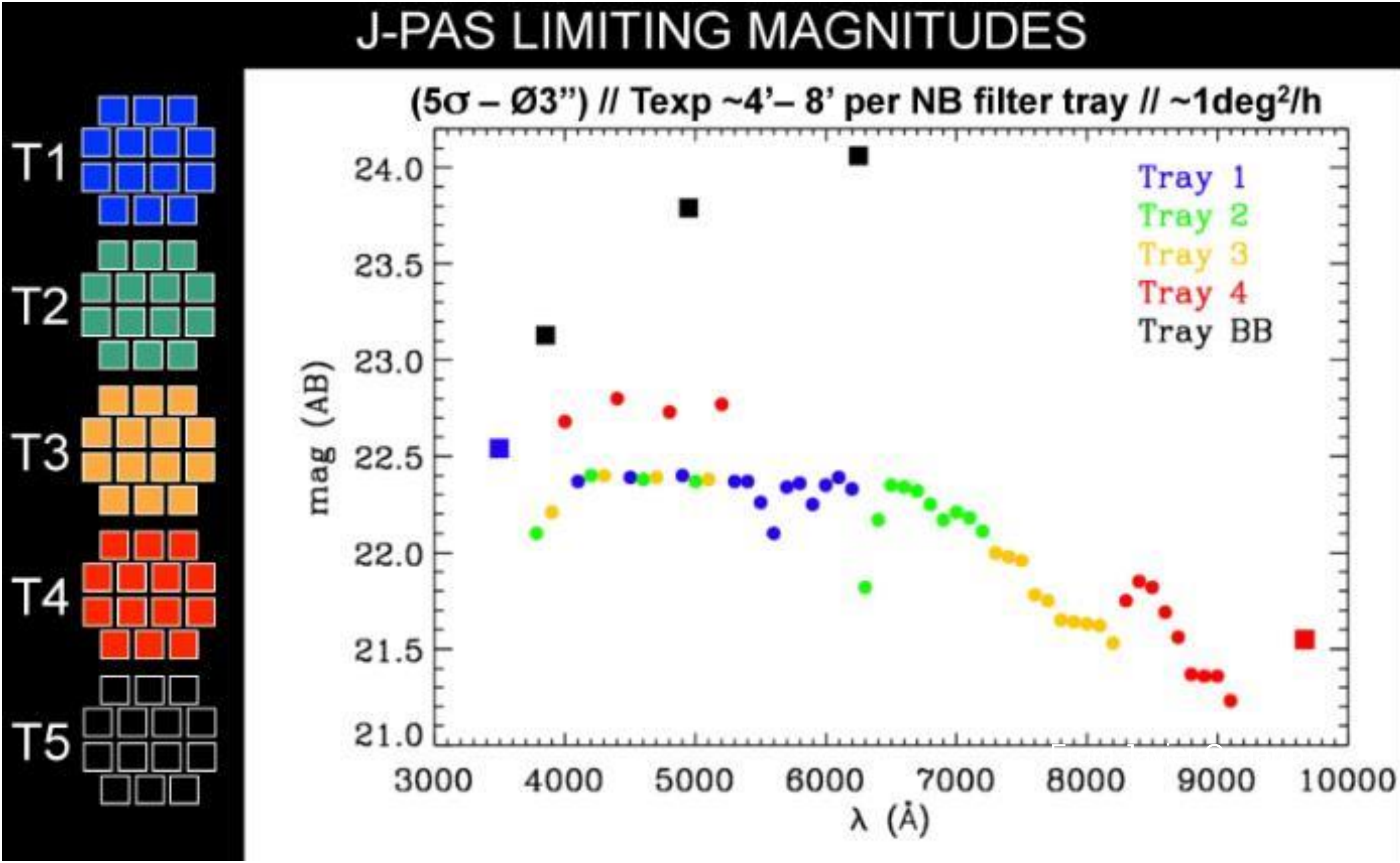
JPCam	
FoV	Ø=3.0º (full performance) Ø = 3.1º (reduced performance)
Ø EE50	0.23" / 10 μm / 1 pix
Ø EE80	0.45" / 20 μm / 2 pix
CCD format	(14 x) 9216 x 9232 pix 10 μm/pix **1.2 Gpixel camera**
Pixel scale	0.23"/pix
Full well	123ke$^-$
Read out time	13.5s
Read out noise	8 e$^-$/pixel (goal 4e-)
Dark current	0.001e$^-$/s/pix
FoV coverage	4.7□º (fill factor ~70%)
# filters	56 + BB (J-PAS filters)

At 5.6 e- now

The camera + filters

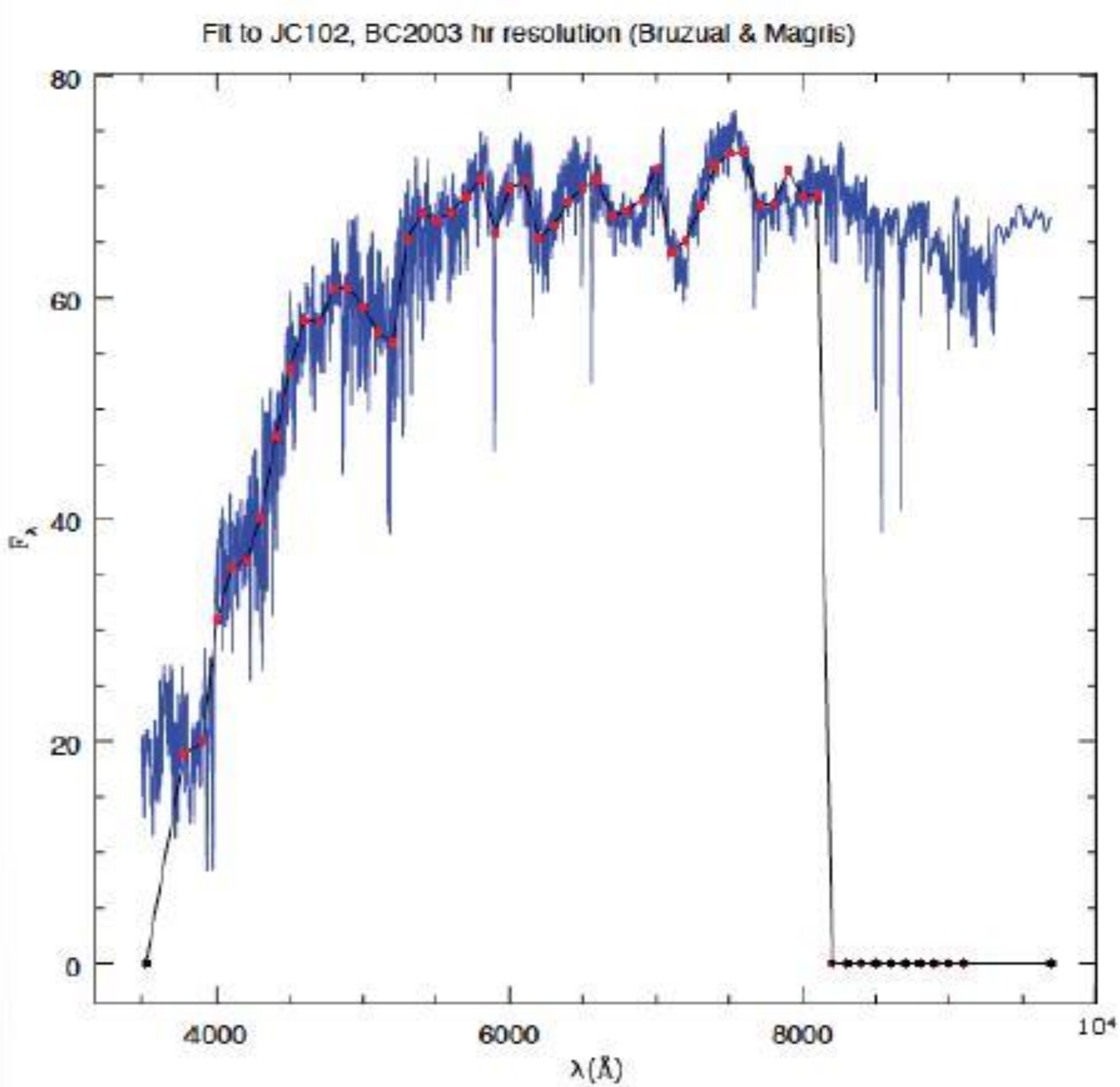
Every CCD "sees" a different filter in each tray x (4+1) trays



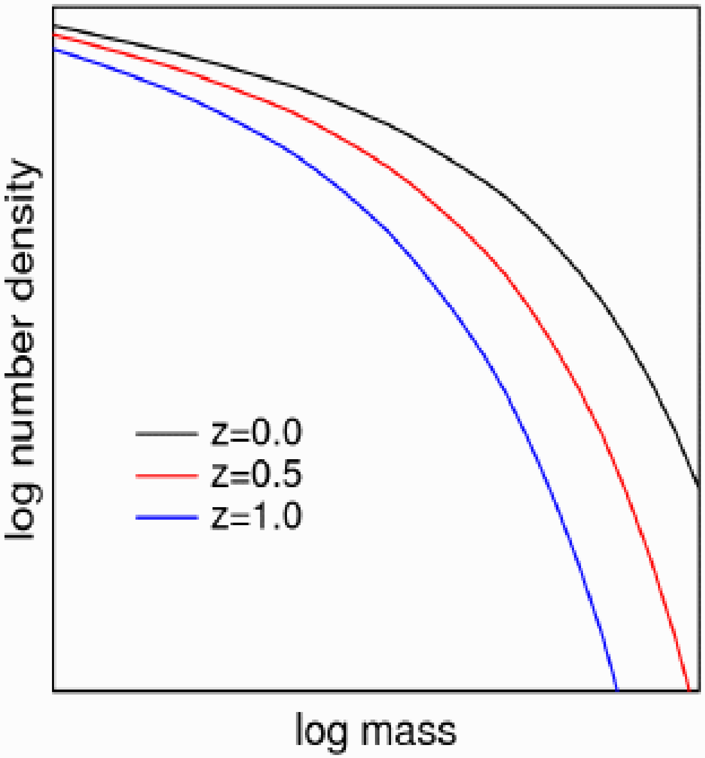


From Javier Cenarro

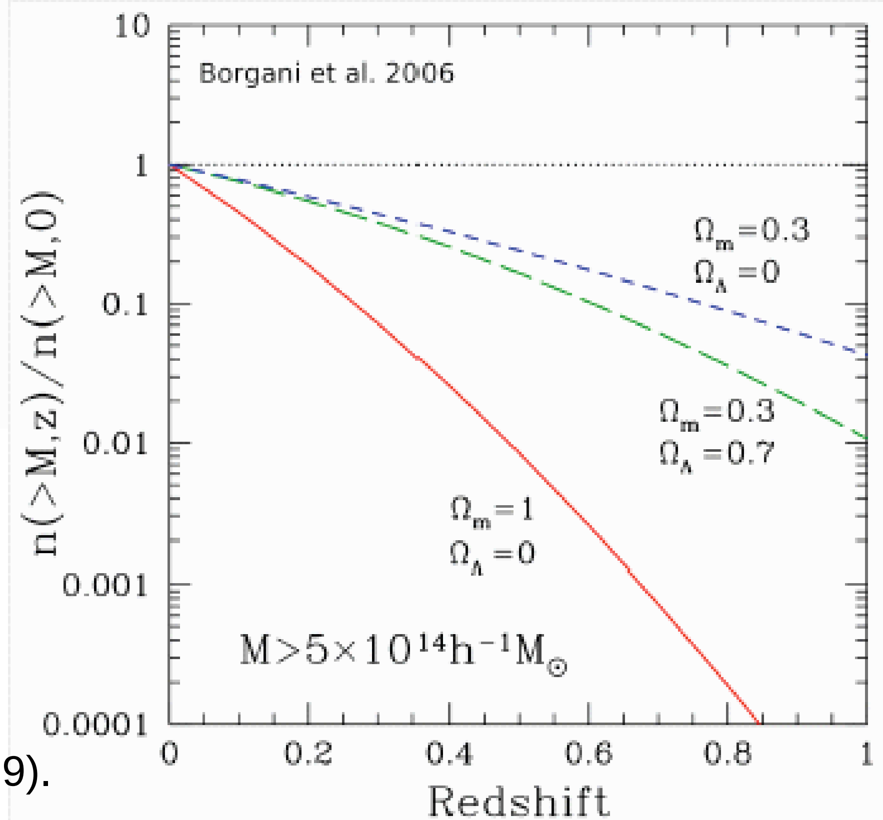
Not only cosmology: For high S/N objects, it is low resolution spectroscopy



Cluster abundance as a function of mass and redshift probes the mass function and expansion history.

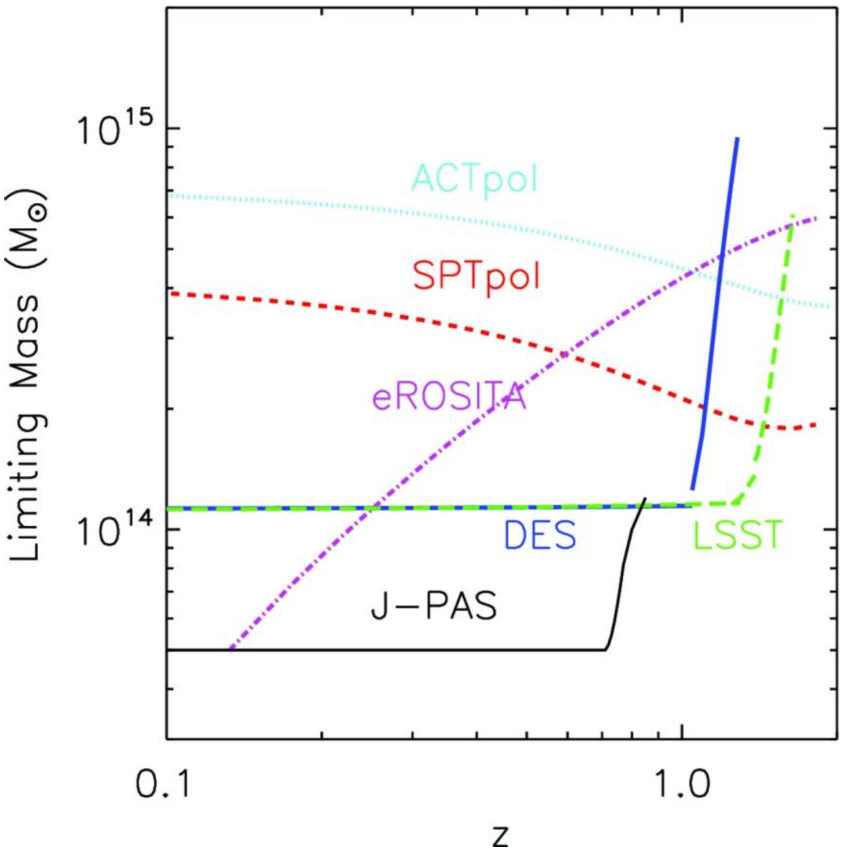


- Low redshift clusters → Ω_m, σ_8
- Evolution → dark energy



- Clusters are thought to be "fair samples".
- If so $f_b \sim \Omega_b/\Omega_m$ (White et al 1993).
- Ω_b comes from Big Bang nucleosynthesis (Schramm & Turner 1998)
- Strong constraints to Ω_m (e.g. Bahcall et al 1999).

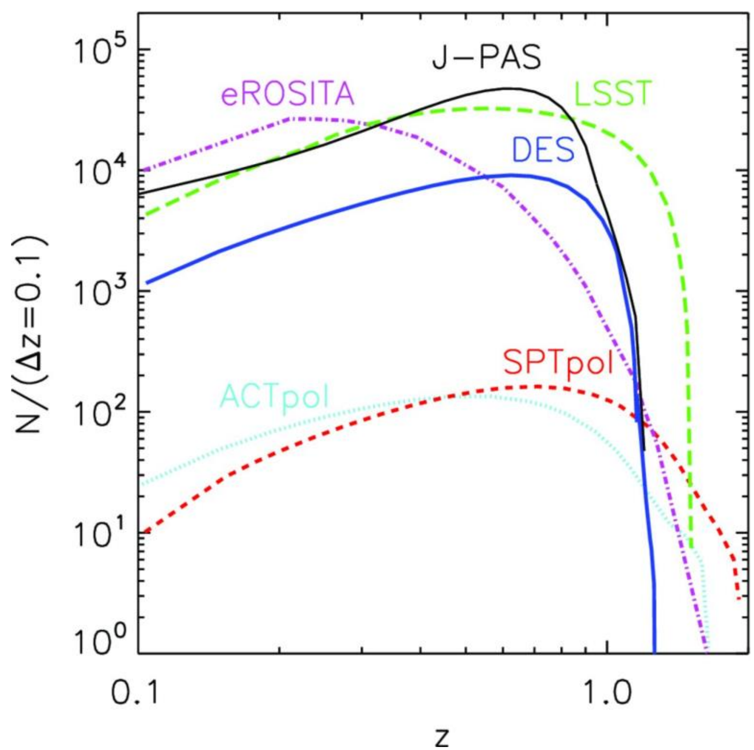
Selection function for different next-generation surveys: J-PAS (black solid line), DES (blue three dot–dashed line), LSST (green long dashed line), SPTpol (red short dashed line) and ACTpol (dotted cyan line).



Because of 100% completitude in redshifts and excellent redshift precision, low mass detection limits are extremely low
Note that we arbitrarily stop at $4x10^{13}$…

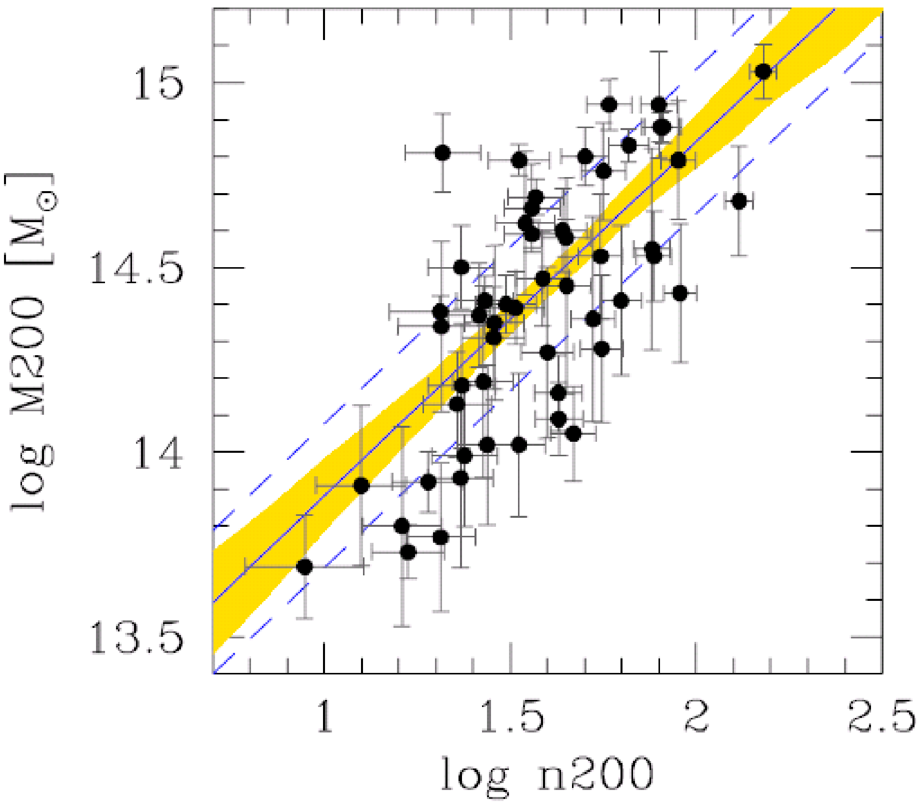
Ascaso, Benitez , Dupke & J-PAS col 2015

Total number of groups/clusters per redshift bin as a function of redshift for different next-generation surveys: J-PAS (black solid line), DES (blue three dot–dashed line), LSST (green long dashed line), SPTpol (red short dashed line) and ACTpol (dotted cyan line).

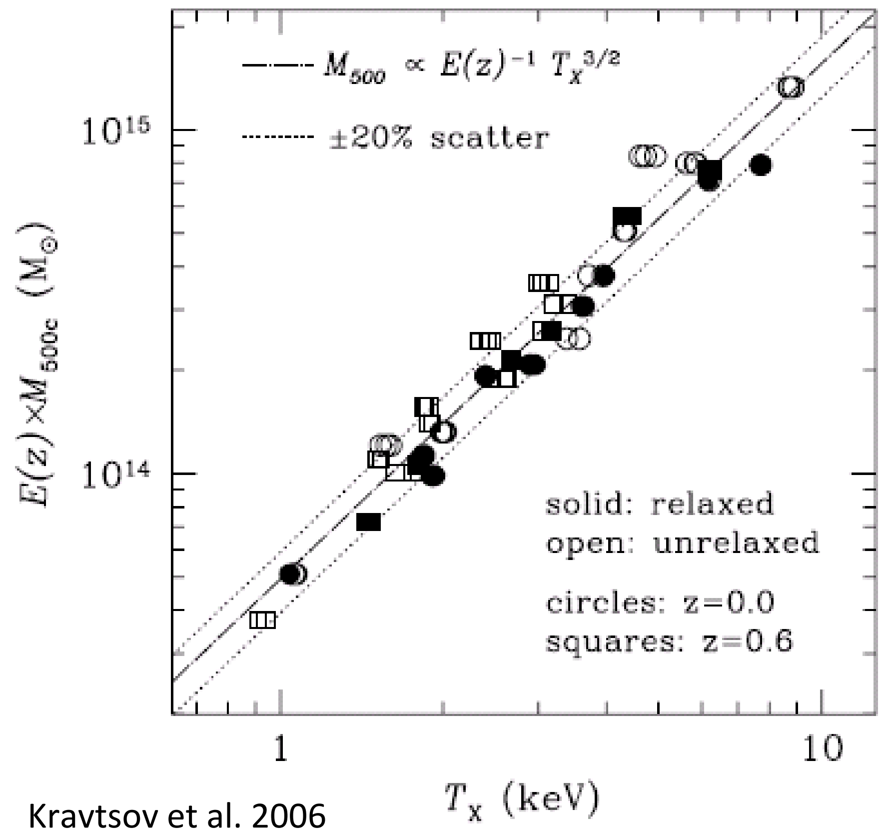


Clusters of Galaxies

- Mass Proxies -

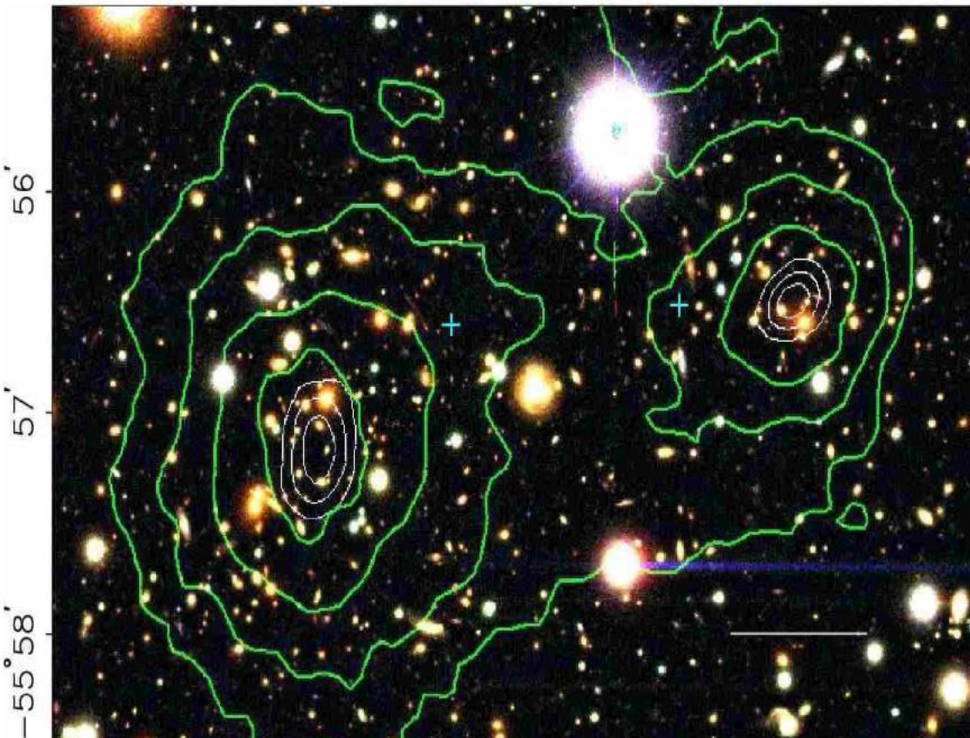


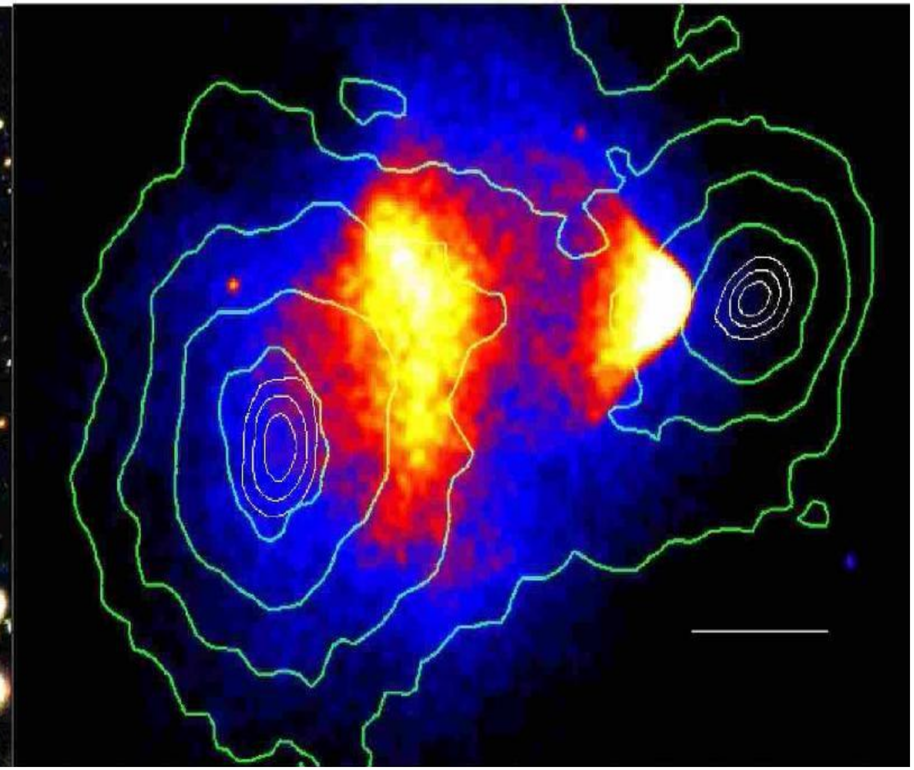
Andreon & Hurn 2010

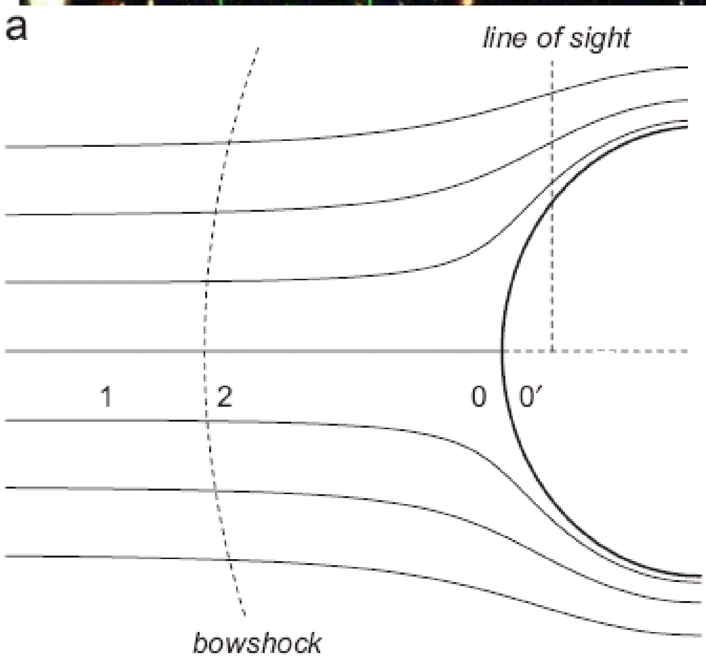


Kravtsov et al. 2006

FIG. 2.—Relation between the X-ray spectral temperature, T_X, and total mass, M_{500}. T_X is measured within the radial range $(0.15–1)\,r_{500}$. Separate symbols indicate relaxed and unrelaxed clusters, and also $z = 0$ and 0.6 samples. The dashed line shows the power-law relation with the self-similar slope fitted to the entire sample, and the dotted lines indicate 20% scatter. [*See the electronic edition of the*



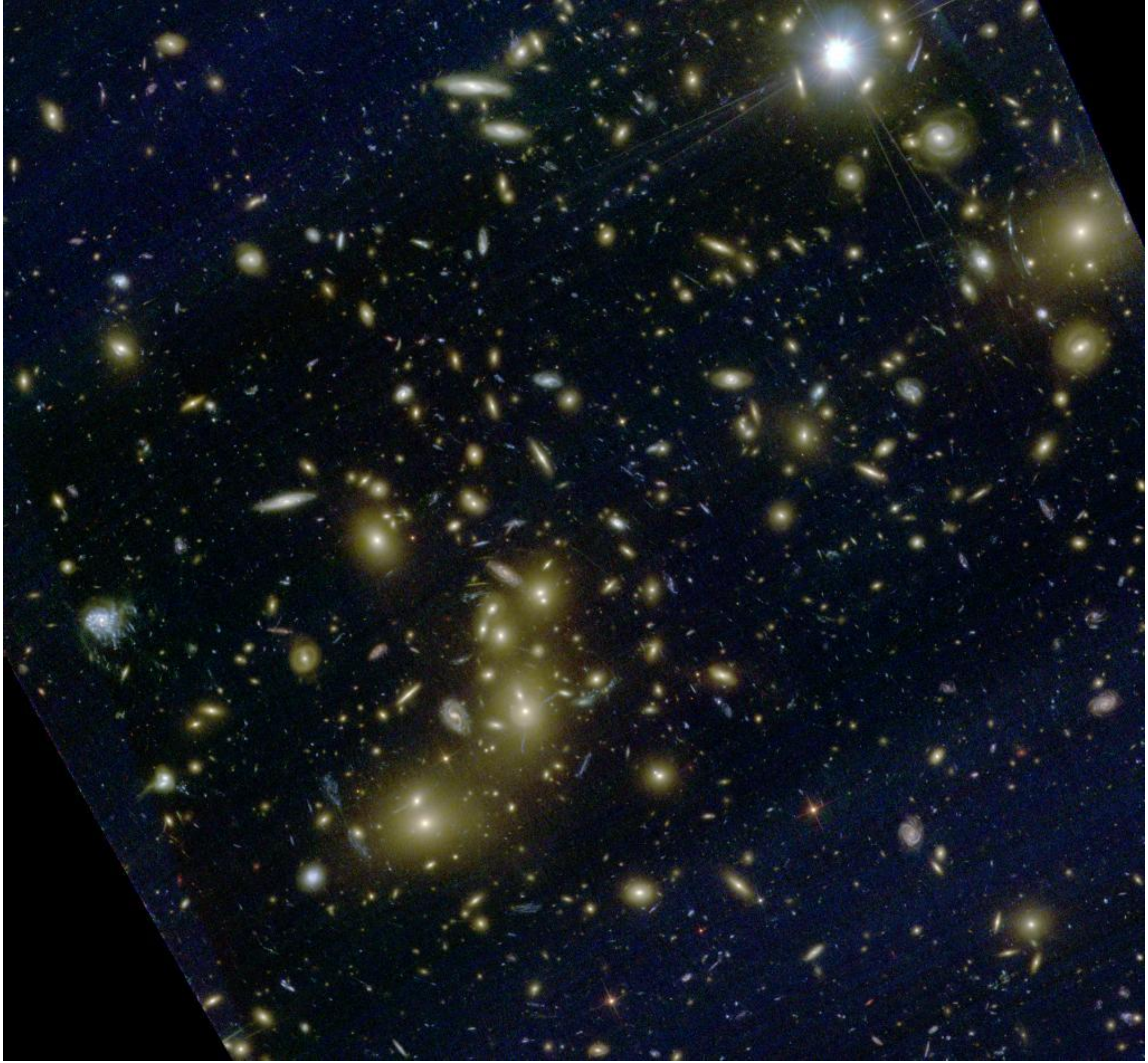


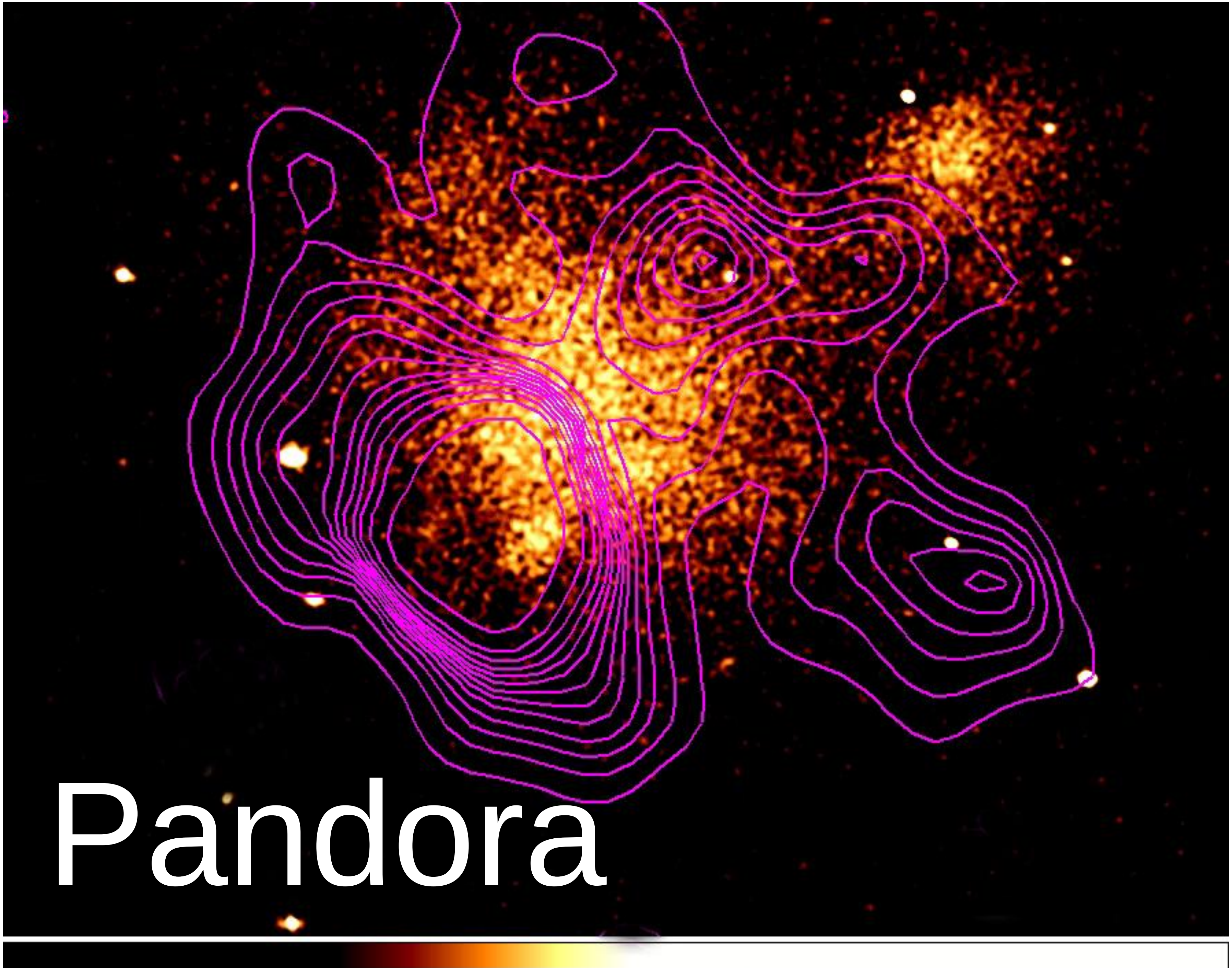


$$\frac{p_0}{p_1} = \left(1 + \frac{\gamma - 1}{2} M_1^2\right)^{\frac{\gamma}{\gamma-1}}, \quad M_1 \leq 1$$

$$\frac{p_0}{p_1} = \left(\frac{\gamma + 1}{2}\right)^{\frac{\gamma+1}{\gamma-1}} M_1^2 \left[\gamma - \frac{\gamma - 1}{2M_1^2}\right]^{-\frac{1}{\gamma-1}}, \quad M_1 > 1,$$

$\sigma/m < 4$, $M \sim 3 \pm 0.4$ (4700km s^{-1})





Pandora

Cluster masses

Euler's Equation

$$\underbrace{\frac{\partial \bar{V}}{\partial t} + (\bar{V}\nabla)\bar{V}}_{0?} = -\frac{\nabla P}{\rho} + \bar{g}$$

$$M(<r) = \frac{-kTr}{\mu m_p G}\left(\frac{d\ln T}{d\ln r} + \frac{d\ln\rho}{d\ln r}\right) - \frac{V_r^2 r}{G}\left[\frac{d\ln\rho}{d\ln r} + \frac{d\ln V_r^2}{d\ln r} + 2\left(1 - \frac{V_\tau^2}{V_r^2}\right)\right]$$

$$\varepsilon^{ff} = 1.4 \times 10^{-27} T^{1/2} n_e n_i Z^2 \text{ erg s}^{-1} \text{ cm}^{-3}$$

Usually some variant of King profile to fit the surface brightness

De-projection of lensing masses increases the scatter around the true masses by more than a factor of two due to cluster triaxiality. X-ray mass measurements have much smaller scatter (about a factor of two smaller than the lensing masses) but they are generally biased low by 5-20%. This bias is entirely ascribable to bulk motions in the gas of our simulated clusters. Meneghetti, Raisa et al. 2006, 2009 -estimates a 5-20% error in Mass from this. Nagai more recently 5-10%

Potential for Discriminating mergers with ICL

Jimenez-Teja & Dupke 2016,2017,2018

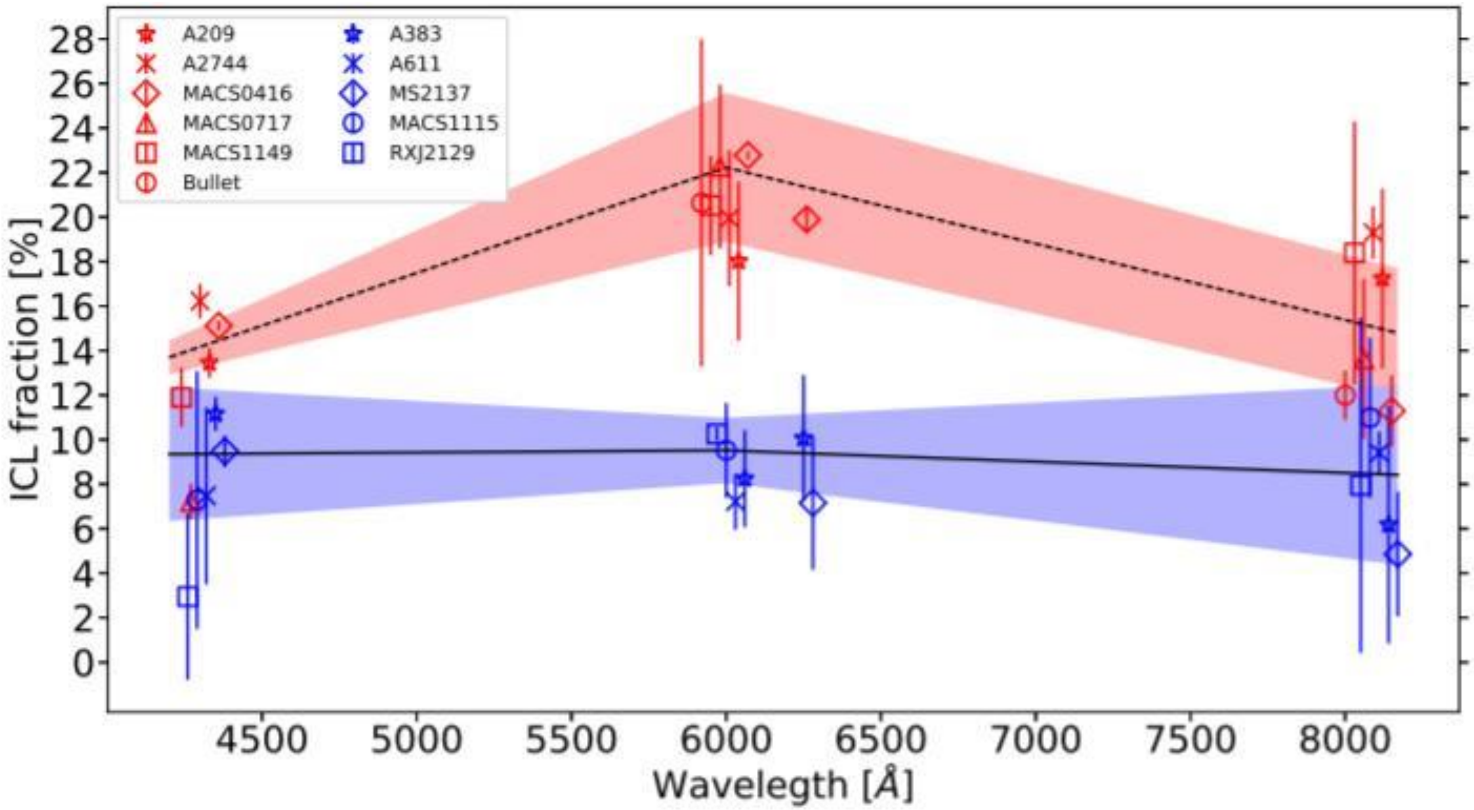


Figure 1. ICL fractions yielded by CICLE for our sample of eleven clusters. Red markers represent merging clusters while blue markers are associated to relaxed systems. The black lines indicates the error weighted mean for each subsample (solid for relaxed clusters and dashed for merging systems), and the shaded areas represent the mean of the errors. For clarity, we have offset horizontally the points by 30 Å gaps.

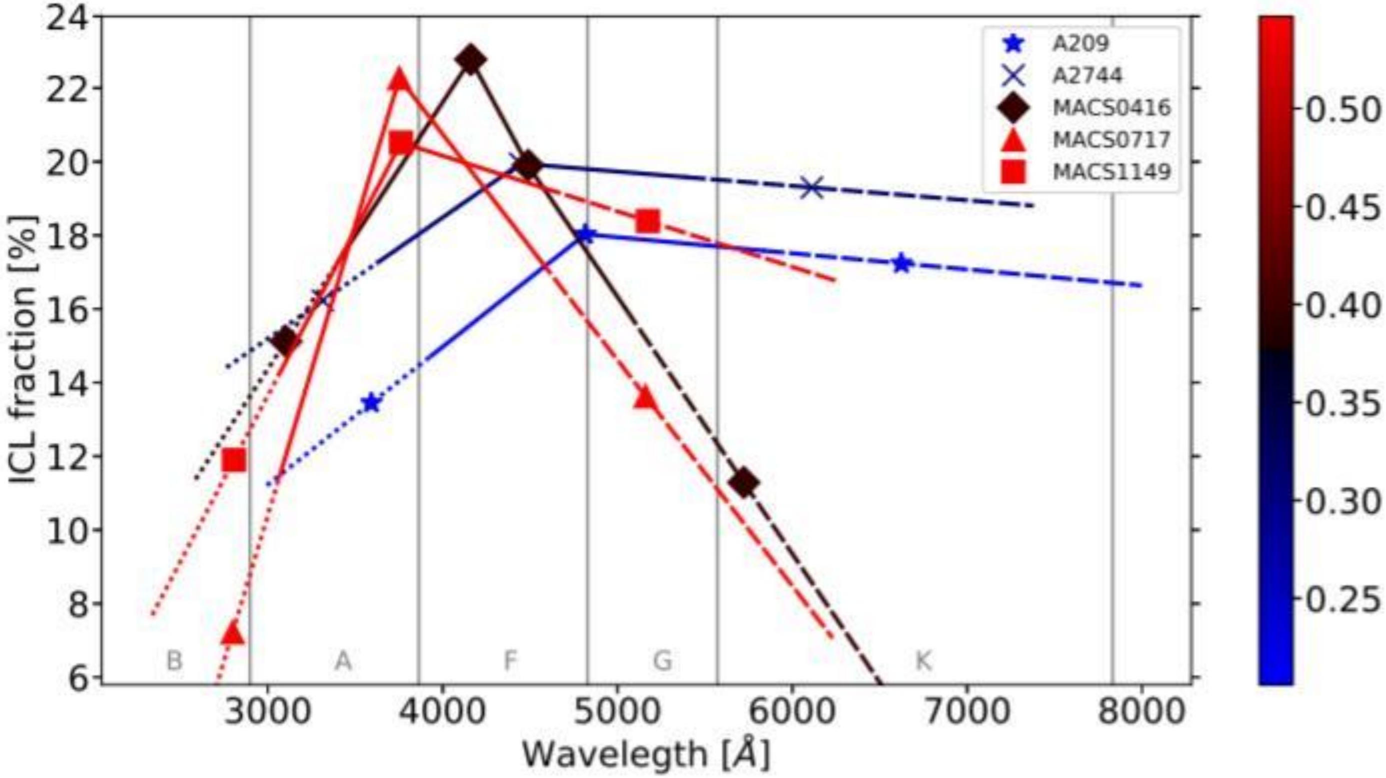


Figure 2. ICL fractions yielded by CICLE for our subsample of merging clusters at rest-frame wavelength. Lines are color coded by redshift and different styles are used to represent the wavelength range covered by each one of the three filters: dotted for the F435W filter, solid for the F606W filter, and dashed for the F814W filter. Vertical gray lines separate the wavelength intervals were the emission peaks of the different stellar spectral types are included, as indicated at the bottom of each region.

ALSO FOUND WITH **J-PLUS** – COMA - Jimenez-Teja, Dupke et al. 2018

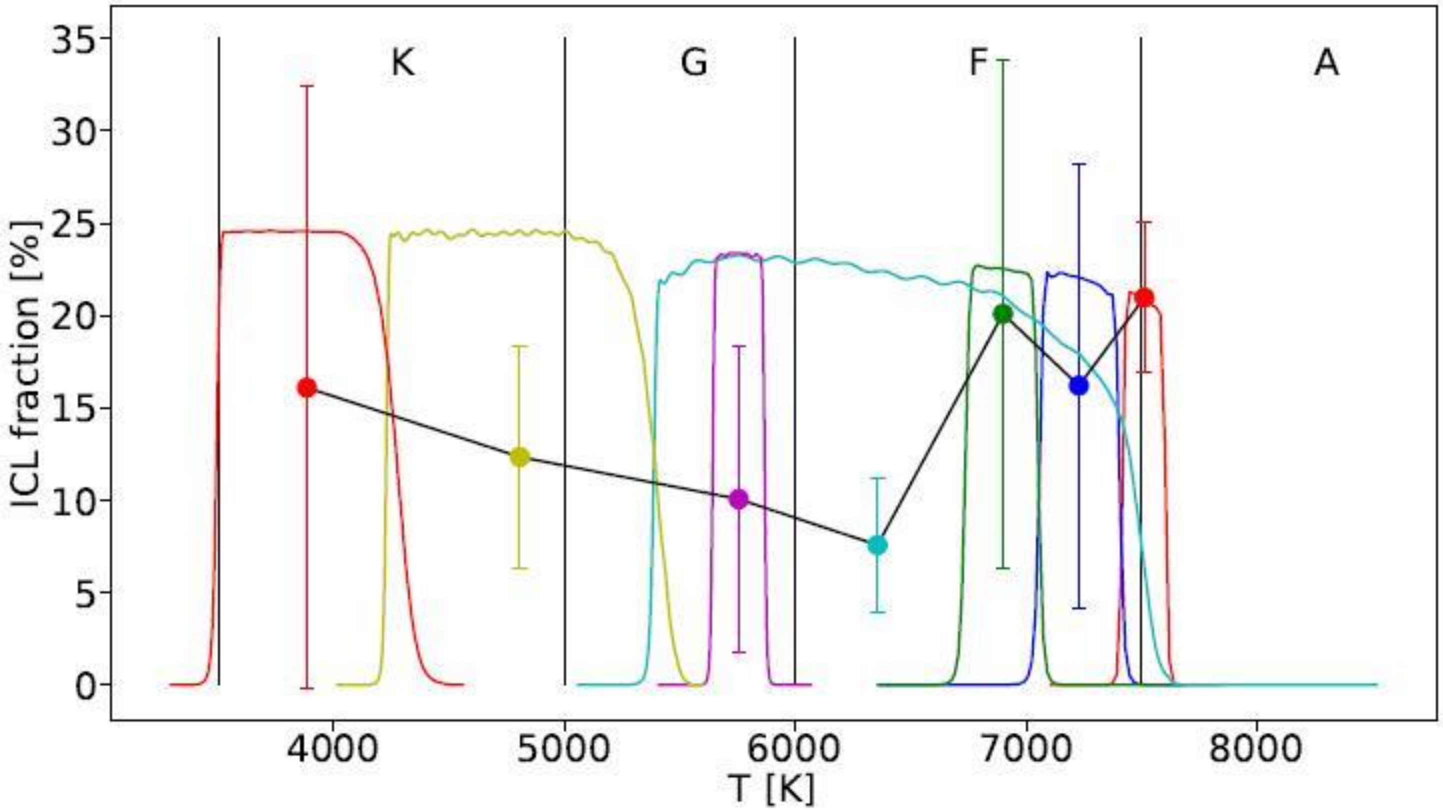
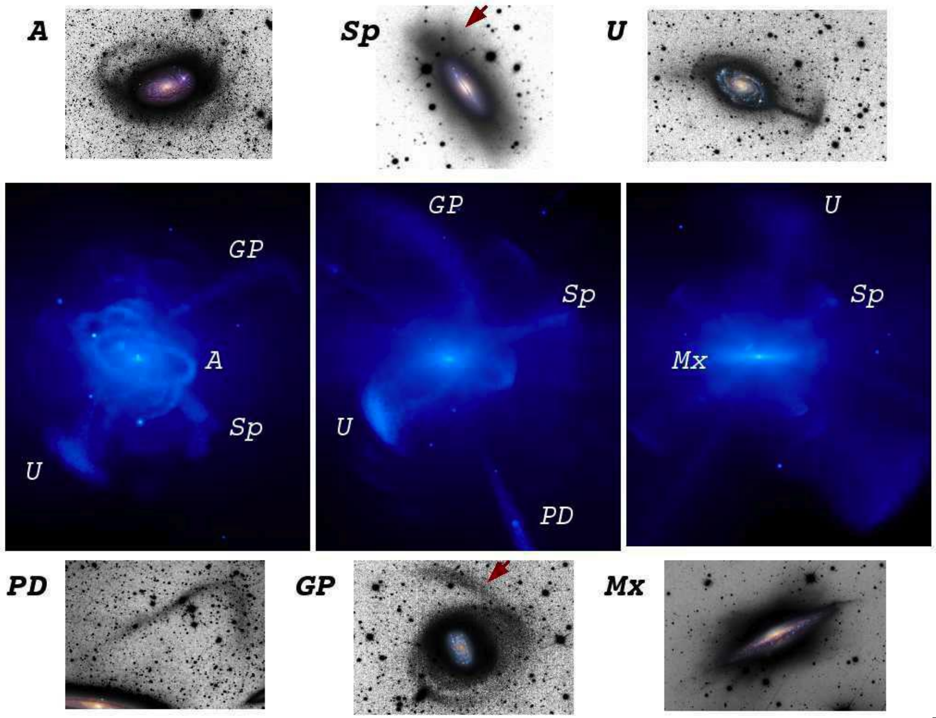


Fig. 1. ICL fractions for Coma as a function of the temperature range covered by each J-PLUS filter. Transmission curves of the seven J-PLUS filters analyzed are shown with lighter solid lines. Vertical black lines delimit the temperature intervals associated to each spectral type.

J-PAS stellar content

RR Lyrae, WD, CV → ~200 x 10^6
Old, low-mass stars of different nature
WDs, emission-line objects, Carbon stars, etc
Globular clusters
Streams
Halo itself



Galaxy Evolution

>10^8 gals will allow extensive studies of integrated stellar populations down to z ~>0.9 to study galaxy evolution.

Detailed studies of SFR, galaxy mergers and chemical evolution. Fine grain binning of galaxy types (morph, spectra, type, environment). Galaxy environment, absorption systems, etc

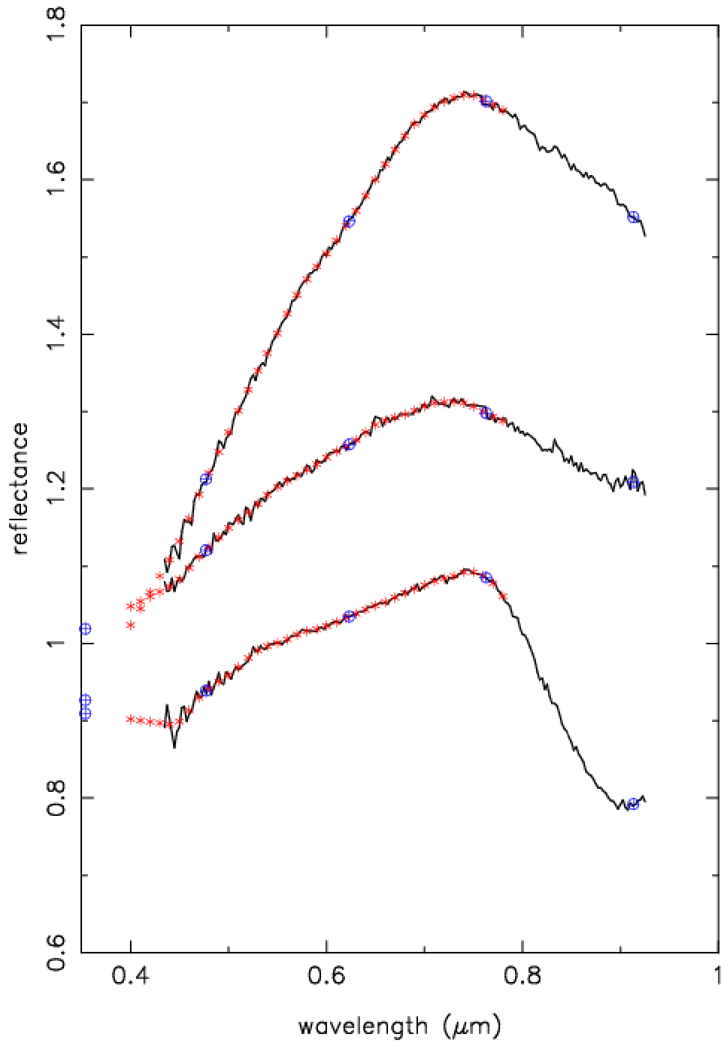
J-Steroids

Asteroid colors opened a window to study their family origin and the chemical distribution in the early solar system.

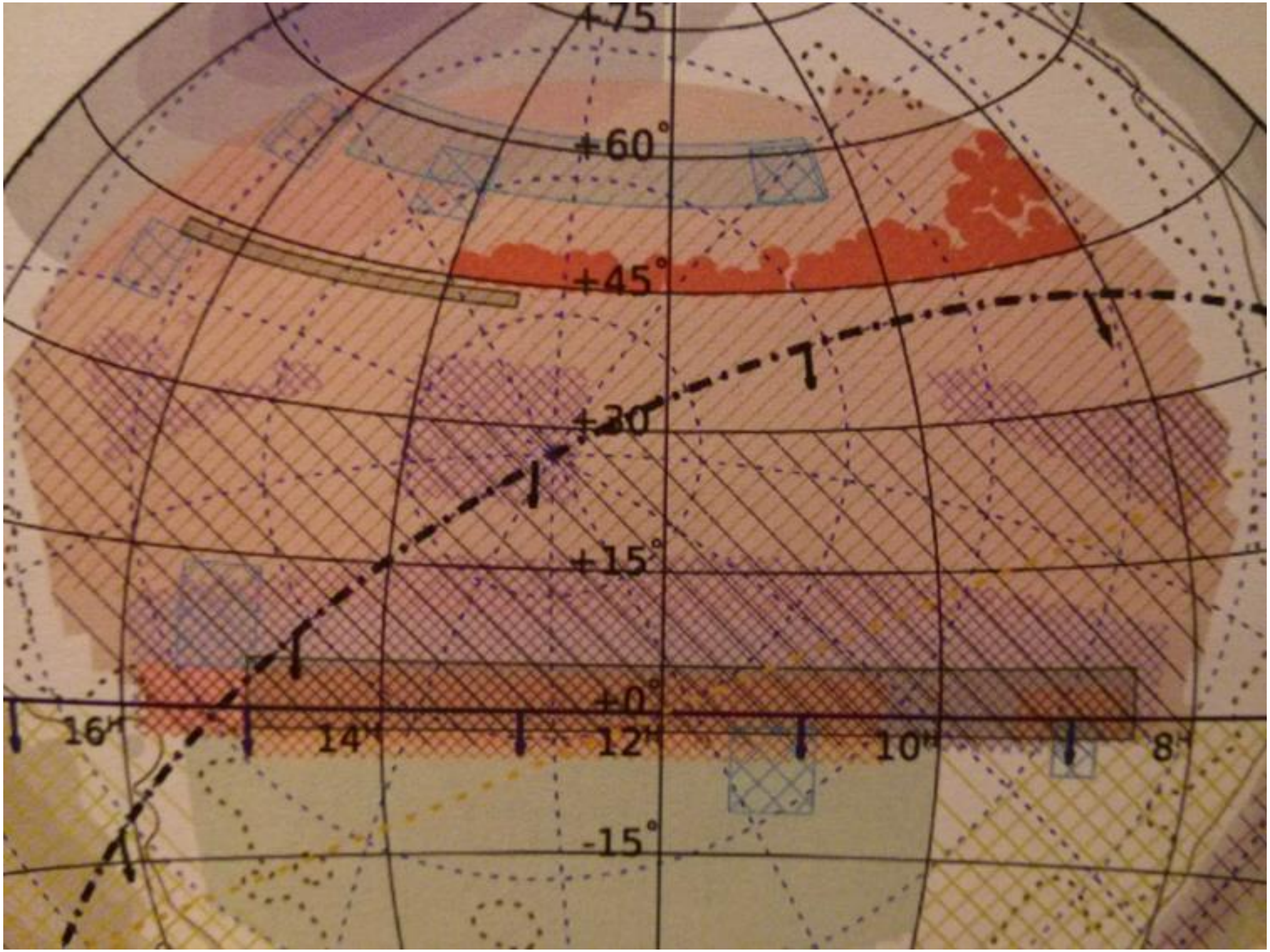
- *4th* release of the SDSS MOC (2008):
  220,000 observations of
  105,000 asteroids.

- SDSS has a wider spectral coverage
  - Better for Ol/Px bands

- J-PAS has a better spectral resolution
  - Ideal for aqueous alteration bands
  - Better for 0.5 μm Steins-like bands



Synergies with WEAVE, EUCLID & Overlap with eROSITA

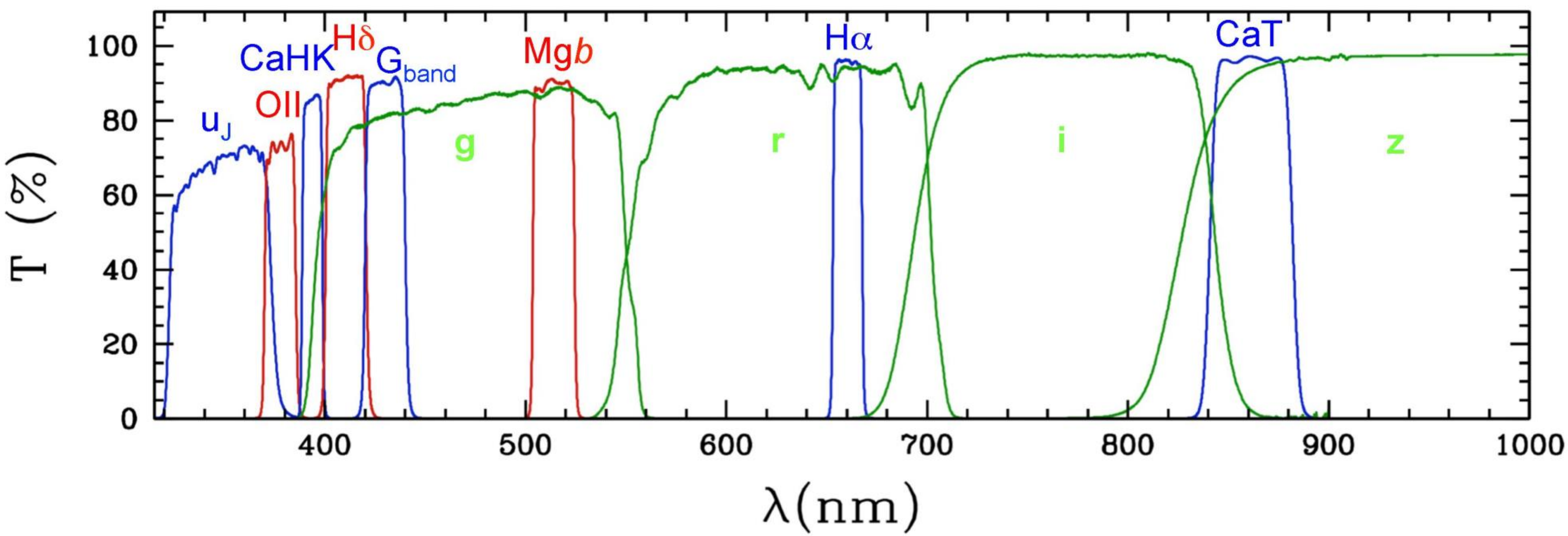


JPAS = ALL SKY IFU

- JPAS = Javalambre-*Physics of the Accelerated Universe* Astrophysical Survey, Spanish-Brazilian collaboration, PAU-BRASIL is the Brazilian conterpart
- 8500 sq.deg. survey with 54 contiguous filters, 100A apart 3700A< λ < 9200A + 5 broad(er) for lensing. Full coverage 3300A< λ < 10100A
- Dark site with 0.71 arcsec seeing: Javalambre in Teruel, Spain
- 2.5m tel. + 5 sq.deg. JPCam, 1.2Gpix/shot
- It will measure 0.3% photo-z for ~100M galaxies (Ellip z<1.05 and EmLine z<1.4)
- ~ 400-500 M galaxies with 3% photo-z,
- ~ few M QSOs with 0.3% photo-z > Measure w all the way to z=3
- ~ 0.8 arcsec image of the Northern Sky
- Extremely mass sensitive optical cluster catalog
- Excellent characterization of low-z SN systematics
- A few 1000 SNIe survey, no spectroscopy required
- Pixel-by-pixel low-res spectrum of the whole northern sky up to m~23/ arcsec^2
- It will measure radial BAOs up to z~1.4 → 14 $(Gpc/h)^3$
- Clusters (10^5), Weak lensing, SN(10^4), QSOs (10^6), Galaxy evolution (10^8), Stars (10^8), Asteroids, etc

WWW.J-PAS.ORG

OBSERVE THE J-PAS AREA WITH THE 12 J-PLUS FILTERS



"Stellar physical parameters can be recovered with a combination of 10-15 medium and broad band filters with S/Ns ~50"

Bailer-Jones (2000, 2004), Bessell (2005), Jordi et al. (2006)

SDSS (*g*, *r*, *i*, *z*) + u_J + J378_[OII] + J395_[H+K] + J410_[Hδ] + J430_[G-band] + J515_[Mgb-Fe] + J660_[Hα]+ J861_[CaT]

J-PLUS DR1

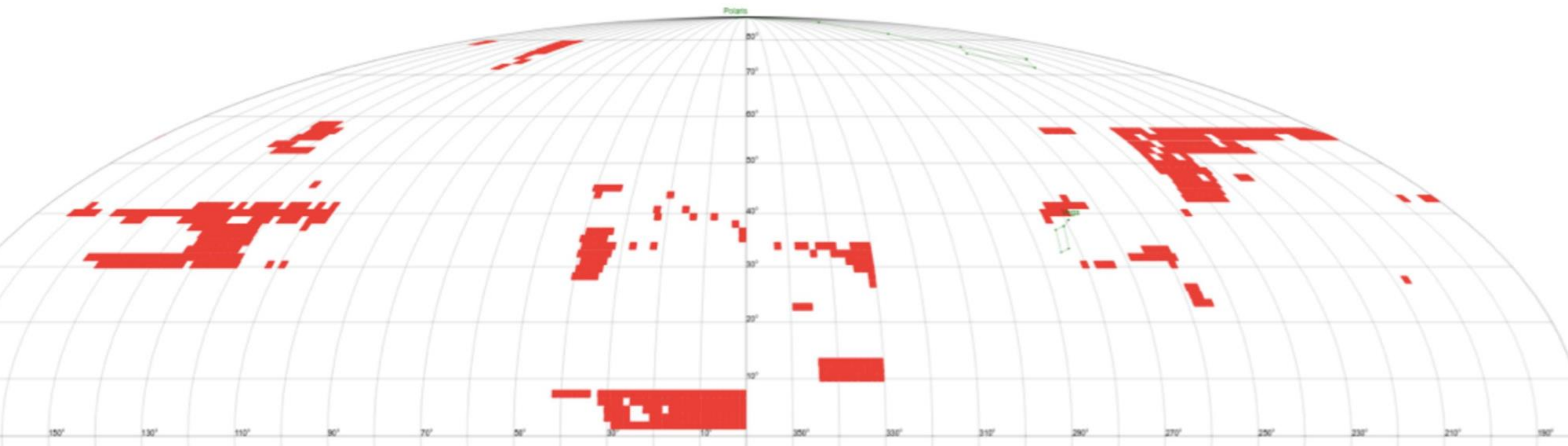


Figure 5: Footprint of the tiles included in J-PLUS Data Release 1.

Sky coverage = 1020 deg^2

4.5M stars + 3M galaxies with r<21

CURRENT STATUS

- J-PLUS has already >1000 sq deg observed – 36 sq deg public
- PathFinder is doing fine and it is expected that Science data started last week.
- JPCam on clean room at OAJ on tests and development of FSU integration – Final Installation after PF ends – 2nd semester 2018

PF potential fields

PATHFINDER SURVEY

Pathfinder camera: 1 single e2V CCD camera (9.2kx9.2k, 0.227 "/ pix), 0.30 sq.deg effective area

Pathfinder Survey: - mini-JPAS++

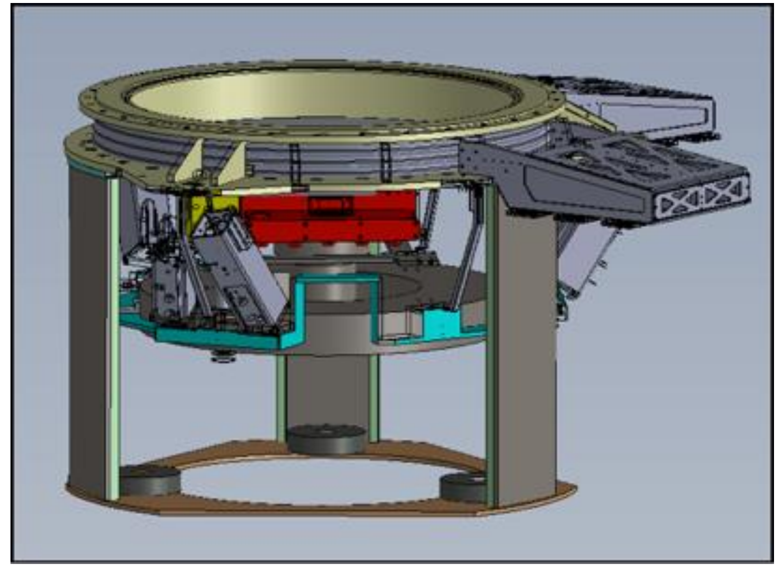
A few sq.deg. covered with 56+ filters to the same depth of the main survey

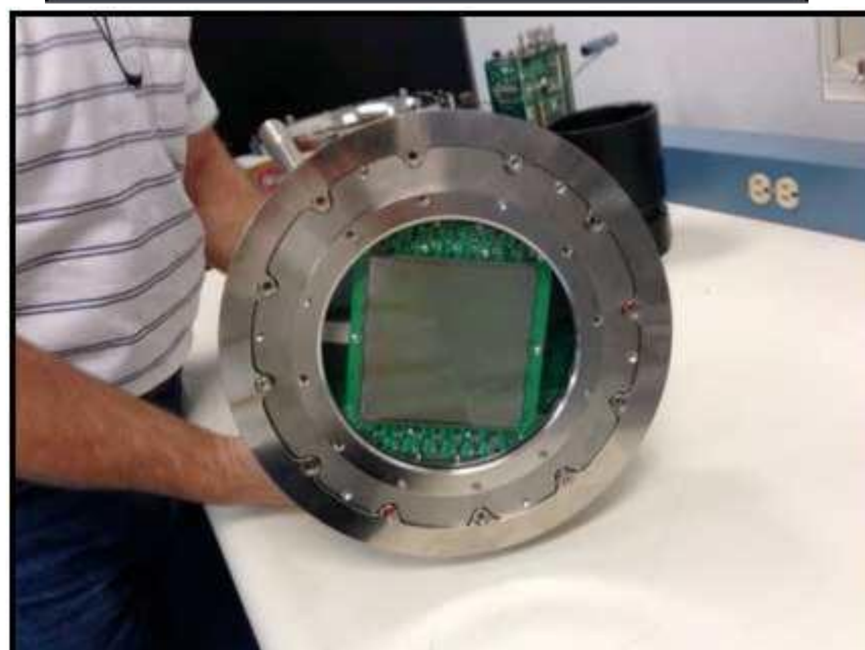
~10k redshifts with dz/(1+z)~0.003

~30k redshifts with dz/(1+z)=0.03

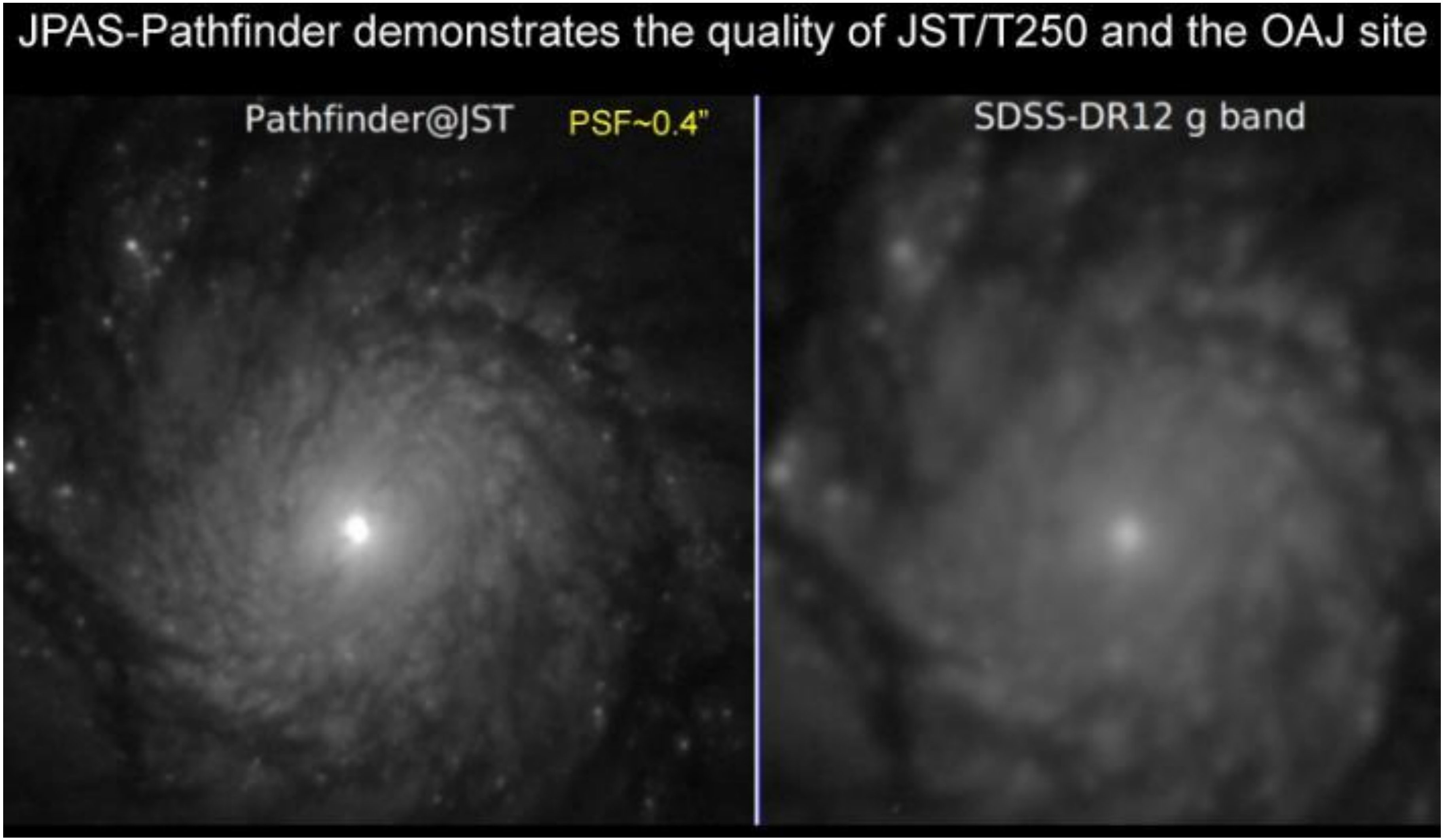
~1000 QSO redshifts

Originaly 2 fields, AEGIS and Hectomap, GAMA (with eROSITA)

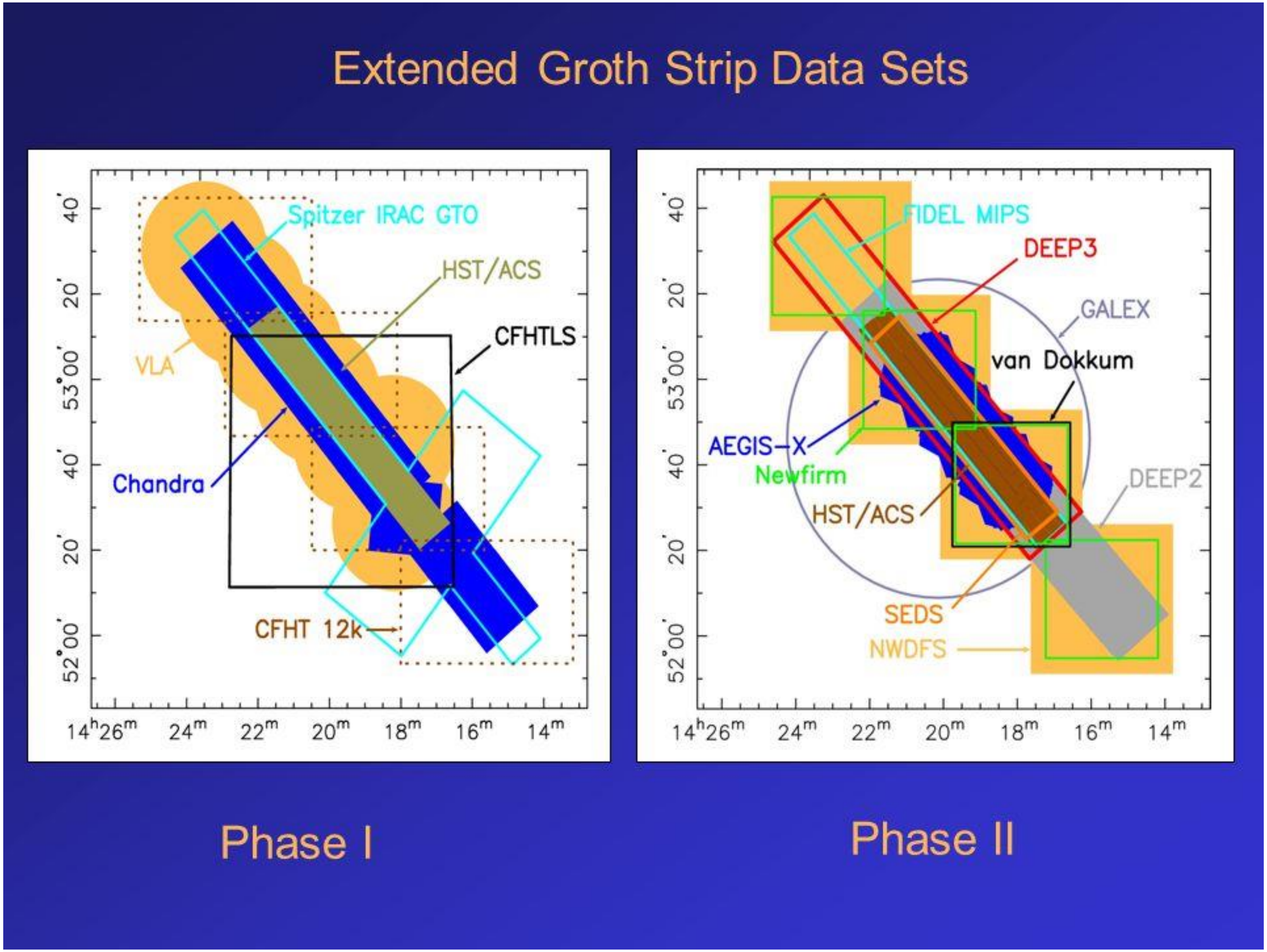




M51, resulting from the combination of 6x10s single exposures with no filter (left), and a g band image from SDSS (right).



BEST PRIMARY FIELD aka mini-JPAS field:
AEGIS
FIELD RA=216.6° Dec=+52.7° Size ~ 1 sq deg



WHO SCREWED UP THE WEATHER THIS YEAR ??

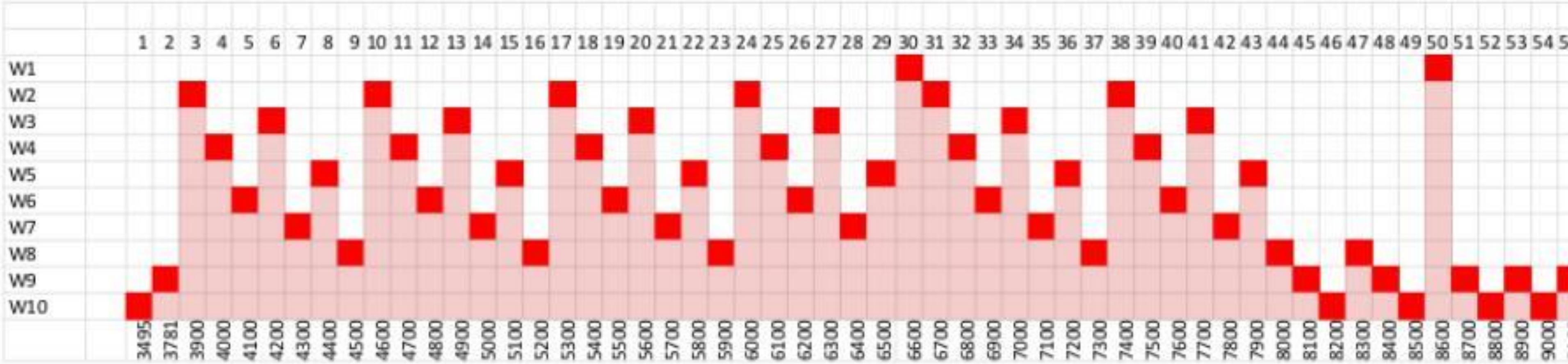
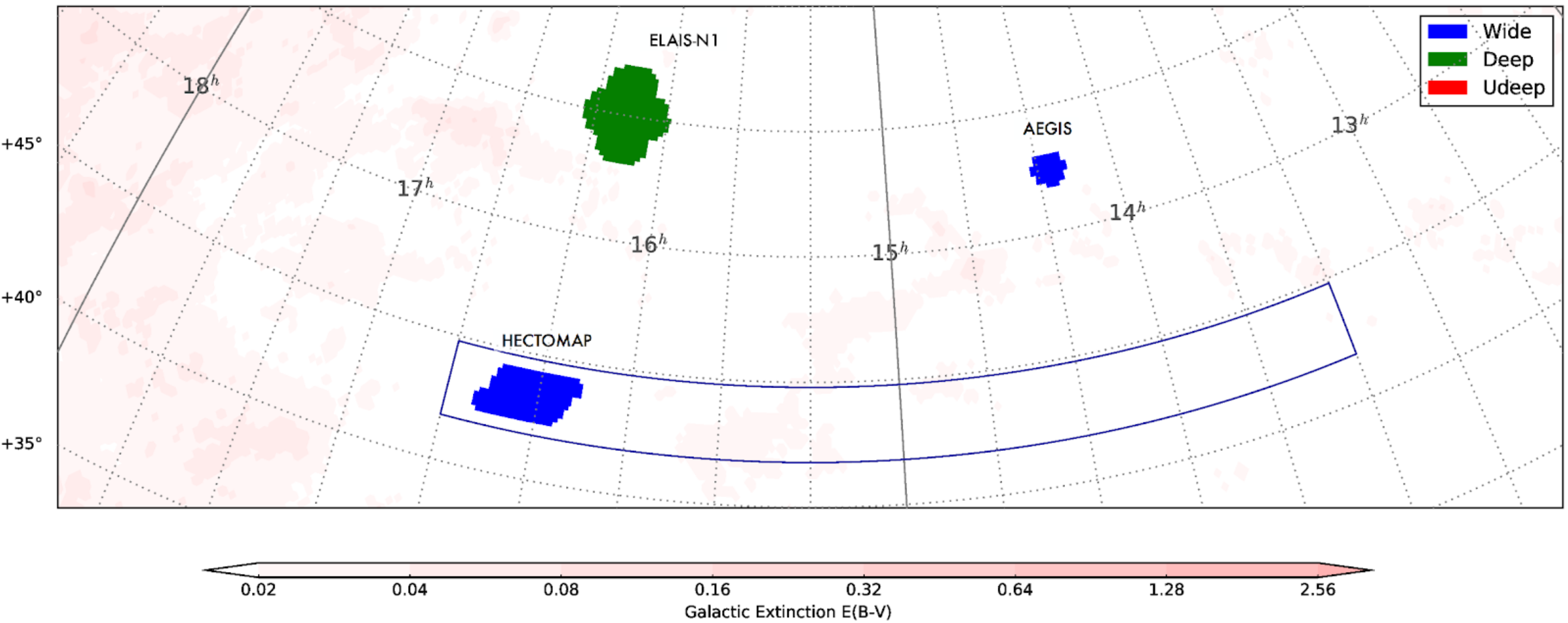
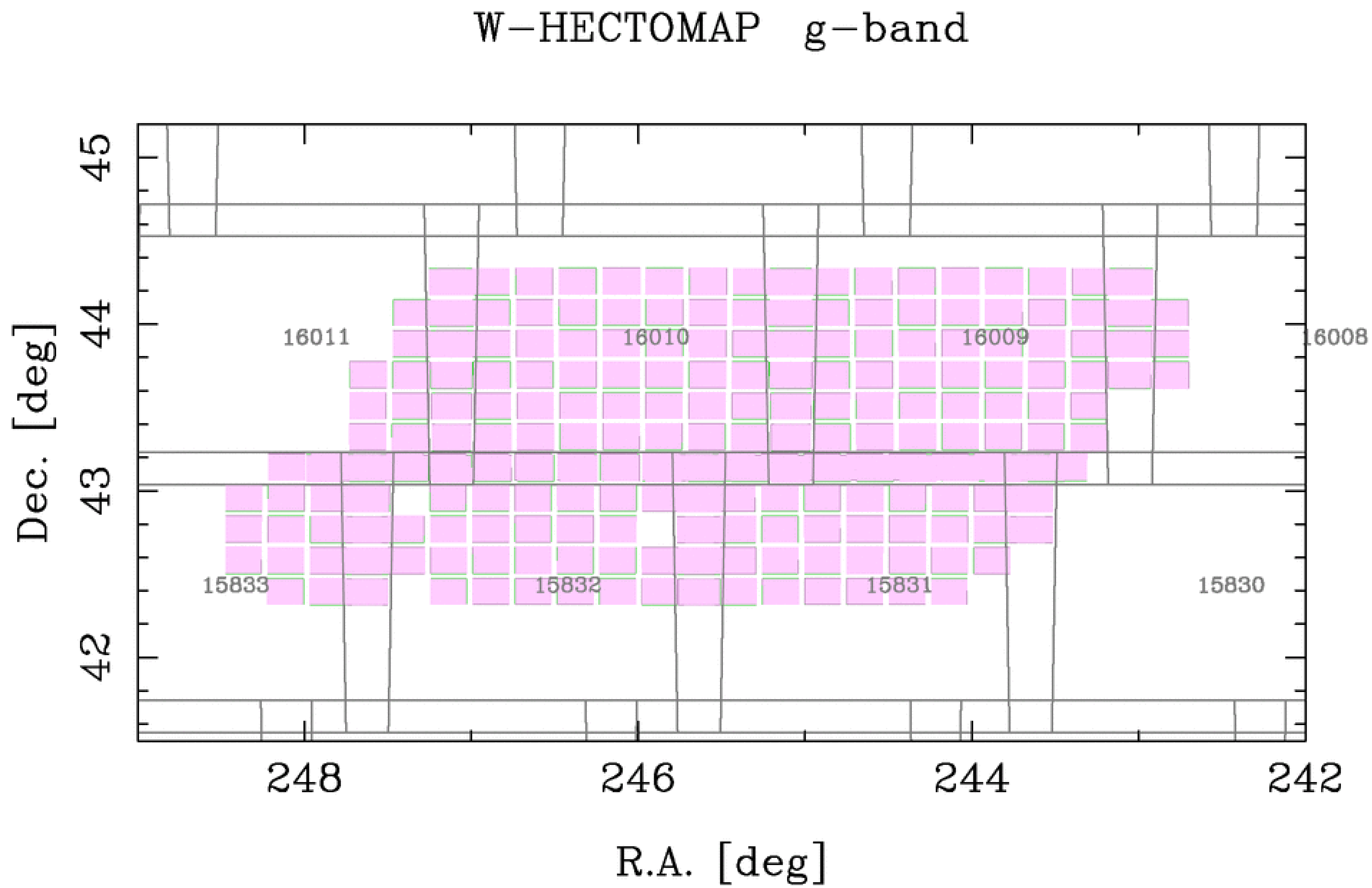


Figure 1: Filters belonging to each filter wheel.




W−HECTOMAP g−band
Dec. [deg]
R.A. [deg]
45
44
43
42
248
246
244
242
16011
16010
16009
16008
15833
15832
15831
15830

More details at (arXiv:1403.5237)

J-PAS: The Javalambre-Physics of the Accelerated Universe Astrophysical Survey

N. Benítez[a,b], R. Dupke[b,c,d], M. Moles[e,a], L. Sodré[f], A. J. Cenarro[e], A. Marín-Franch[e], K. Taylor[b], D. Cristóbal[e], A. Fernández-Soto[l], C. Mendes de Oliveira[f], J. Cepa-Nogué[h], L.R. Abramo[i], J.S. Alcaniz[b], R. Overzier[b], C. Hernández-Monteagudo[e], E. J. Alfaro[a], A. Kanaan[j], J. M. Carvano[b], R. R. R. Reis[k], E. Martínez González[l], B. Ascaso[a], F. Ballesteros[g], H. S. Xavier[i], J. Varela[e], A. Ederoclite[e], H. Vázquez Ramió[f], T. Broadhurst[n], E. Cypriano[f], R. Angulo[e], J. M. Diego[l], A. Zandivárez[o], E. Díaz[o], P. Melchior[p], K. Umetsu[q], P. F. Spinelli[r], A. Zitrin[s], D. Coe[an], G. Yepes[t], P. Vielva[l], V. Sahni[u], A. Marcos-Caballero[l], F. Shu Kitaura[v], A. L. Maroto[w], M. Masip[at], S. Tsujikawa[x], S. Carneiro[y], J. González Nuevo[l], G. C. Carvalho[b], M. J. Rebouças[av], J. C. Carvalho[b,z], E. Abdalla[i], A. Bernui[b], C. Pigozzo[y], E. G. M. Ferreira[i], N. Chandrachani Devi[b], C. A. P. Bengaly Jr.[b], M. Campista[b], A. Amorim[g], N. V. Asari[aa], A. Bongiovanni[h], S. Bonoli[e], G. Bruzual[ab], N. Cardiel[l], A. Cava[ac], R. Cid Fernandes[j], P. Coelho[ai], A. Cortesi[f], R. G. Delgado[a], L. Díaz Garcia[e], J. M. R. Espinosa[h], E. Galliano[b], J. I. González-Serrano[l], J. Falcón-Barroso[h], J. Fritz[ad], C. Fernandes[b], J. Gorgas[l], C. Hoyos[f], Y. Jiménez-Teja[a,b], J. A. López-Aguerri[h], C. López-San Juan[e], A. Mateus[j], A. Molino[a], P. Novais[f], A. O'Mill[f], I. Oteo[h], P.G. Pérez-González[l], B. Poggianti[af], R. Proctor[b], E. Ricciardelli[g], P. Sánchez-Blázquez[t], T. Storchi-Bergmann[ag], E. Telles[b], W. Schoennell[a], I. Trujillo[h], A. Vazdekis[h], K. Viironen[e], S. Daflon[b], T. Aparicio Villegas[b,a], D. Rocha[ah], T. Ribeiro[ai], M. Borges[b], S. L. Martins[ah], W. Marcolino[ah], D. Martínez-Delgado[i,aj], M.A. Pérez-Torres[f], B.B. Siffert[k], M.O. Calvão[k], M. Sako[m], R. Kessler[ak], A. Álvarez-Candal[b], M. De Prá[b], F. Roig[b], D. Lazzaro[b], J. Gorosábel[a], R. Lopes de Oliveira[al], G. B. Lima-Neto[f], J. Irwin[d], J. F. Liu[aj], E. Álvarez[t], I. Balmés[i], S. Chueca[e], M.V. Costa-Duarte[i], A. A. da Costa[i], M.L.L. Dantas[f], A. Y. Díaz[e], J. Fabregat[g], F. Ferrari[ao], B. Gavela[t], S. G. Gracia[f], N. Gruel[ae], J. L. L. Gutiérrez[f], R. Guzmán[ap], J. D. Hernández-Fernández[e], D. Herranz[h], L. Hurtado-Gil[q], F. Jablonsky[au], R. Laporte[au], L.L. Le Tiran[f], J Licandro[h], M. Lima[i], E. Martín[aq], V. Martínez[g], J. J. C. Montero[f], P. Penteado[f], C.B. Pereira[b], V. Peris[g], V. Quilis[g], M. Sánchez-Portal[ar], A. C. Soja[f], E. Solano[ao], J. Torra[as], L. Valdivielso[e]