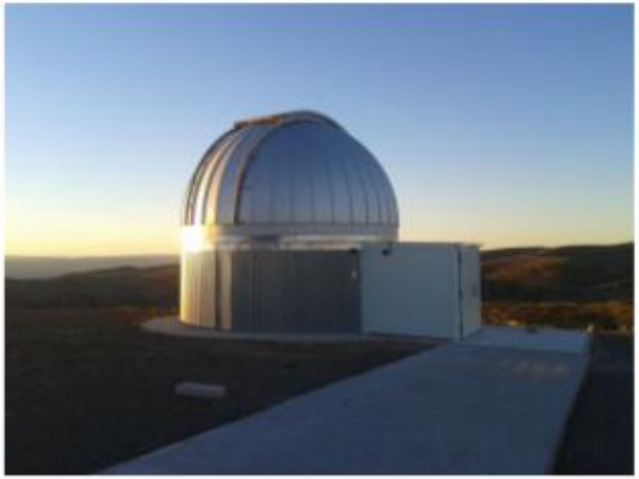
Javalambre
Physics of the Accelerating Universe
Astrophysical
Survey

Javalambre Physics of the Accelerating Universe Astrophysical Survey

J-PAS Overview

Keiichi Umetsu (ASIAA, Taiwan)



J-PAS Collaboration

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

Txitxo

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. 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[b], 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]

arXiv:1403.5237v1 [astro-ph.CO] 20 Mar 2014

J-PAS Collaboration

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. ... Ferreira[i], N. Chandrachani Devi[b], C.A.P. Ben... ngiovanni[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[b], 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]

Lensing WG formed in late 2013

J-PAS (2015-2020)

Abstract

The Javalambre-Physics of the Accelerated Universe Astrophysical Survey (J-PAS) is a narrow band, very wide field Cosmological Survey to be carried out from the Javalambre Observatory in Spain with a purpose-built, dedicated 2.5m telescope and a 4.7□° camera with 1.2Gpix. Starting in 2015, J-PAS will observe 8500□° of Northern Sky and measure $0.003(1+z)$ precision photometric redshifts for 9×10^7 LRG and ELG galaxies plus several million QSOs, about 50 times more than the largest current spectroscopic survey, sampling an effective volume of ~ 14 Gpc^3 up to $z = 1.3$. J-PAS will be the first radial BAO experiment to reach Stage IV.

J-PAS will also detect and measure the mass of 7×10^5 galaxy clusters and groups, setting constrains on Dark Energy which rival those obtained from BAO measurements. Thanks to the superb characteristics of the Javalambre site (seeing $\sim 0.7''$), J-PAS is expected to obtain a deep, sub-arcsec image of the northern sky, which combined with its unique photo-z precision will produce one of the most powerful cosmological lensing surveys before the arrival of Euclid. In addition, J-PAS unprecedented spectral time domain information will enable a self-contained SN survey that, without the need for external spectroscopic follow-up, will detect, classify and measure $\sigma_z \sim 0.5\%$ redshifts for ~ 4000 SNeIa and ~ 900 core-collapse SNe.

The key to the J-PAS potential is its innovative approach: the combination of 54 145Å filters, placed 100Å apart, and a multi-degree field of view (FOV) is a powerful "redshift machine", with the survey speed of a 4000 multiplexing low resolution spectrograph, but many times cheaper and much faster to build. Moreover, since the J-PAS camera is equivalent to a very large, 4.7□° "IFU", it will produce a time-resolved, 3D image of the Northern Sky with a very wide range of Astrophysical applications in Galaxy Evolution, the nearby Universe and the study of resolved stellar populations. J-PAS will have a lasting legacy value in many areas of Astrophysics, serving as a fundamental dataset for future Cosmological projects.

Keywords: Dark Energy, Cosmology, SNIa, Large Scale Structure, Baryonic Acoustic Oscillations, Lensing, Dark Matter, Galaxy Evolution, Stars, Solar System, Transients, Telescopes, Instrumentation, Photometric Redshifts

J-PAS = All Sky IFU

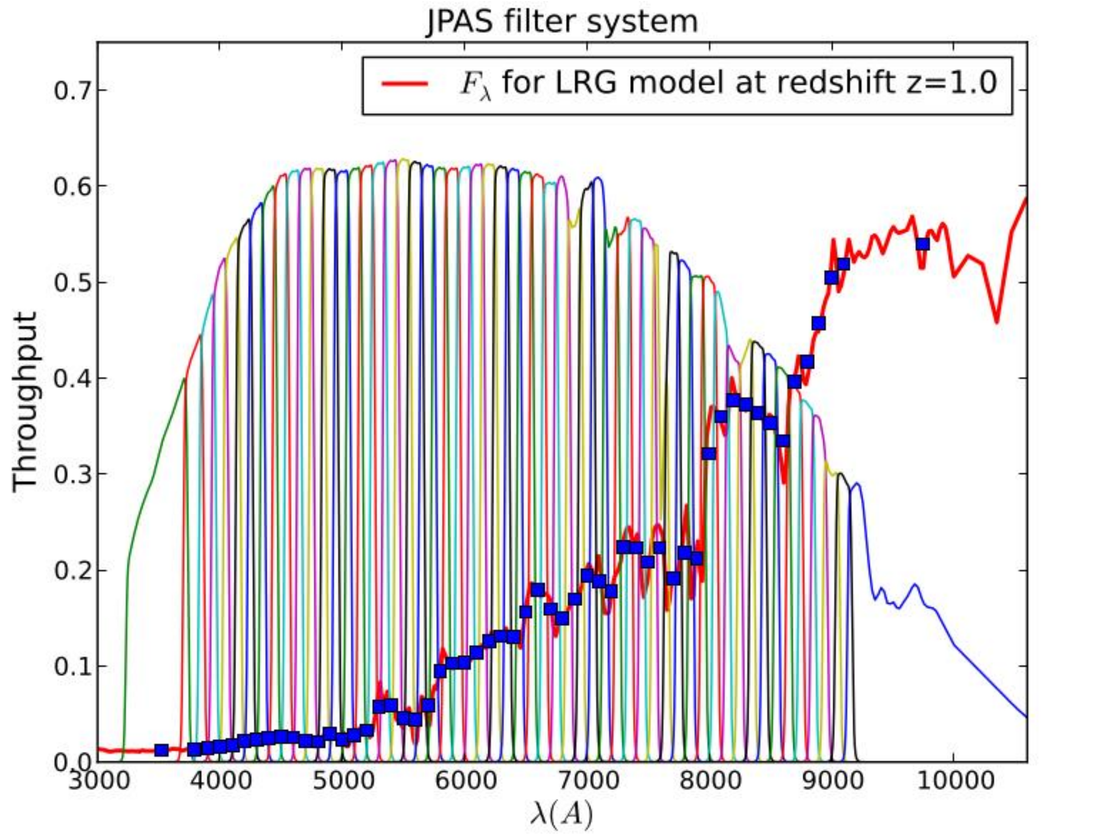
J-PAS: Spanish-Brazilian collaboration, ~120 scientists

First Stage-IV Dark Energy probes

- BAO (||, ⊥) + LSS (90M LRGs/ELGs w 0.3% z precision)
- SNIa (6,000 SNe, z<0.4)
- Cluster finding (0.7M halos w M>3e13Msun)
- Weak lensing shear and magnification (r=24ABmag, 5σ)

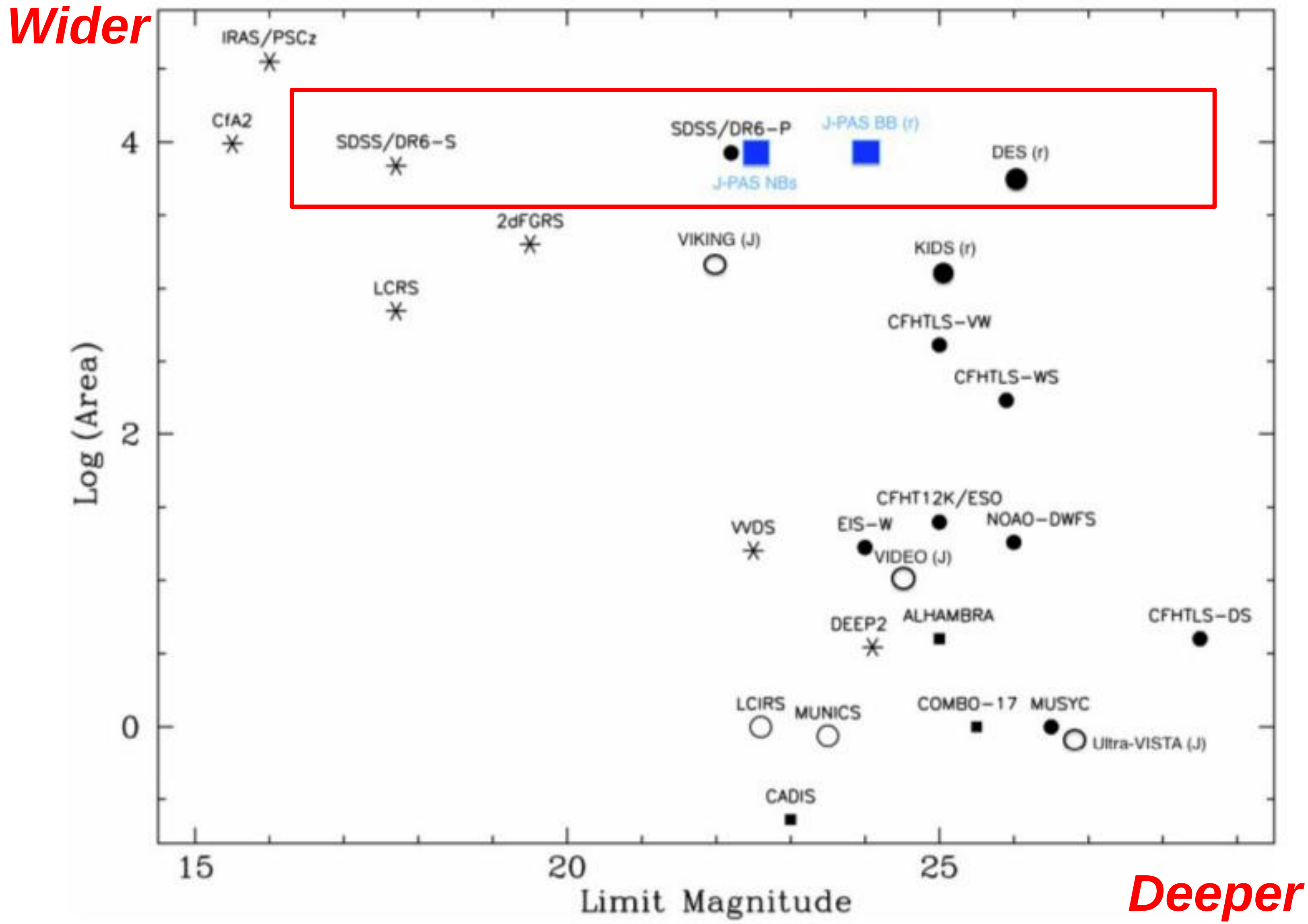
Unique data for Galaxy Evolution, Local Universe, TD Astronomy

- 300M (500M) galaxies w 1% (3%) z precision upto z~1.3
- Emission-line galaxies at 2<z<2.4 (LAEs)
- z~1 LAEs from J-PAS+GALEX
- Lyman break galaxies at 2<z<3
- 2M QSOs (~20K QSOs at 4<z<7)

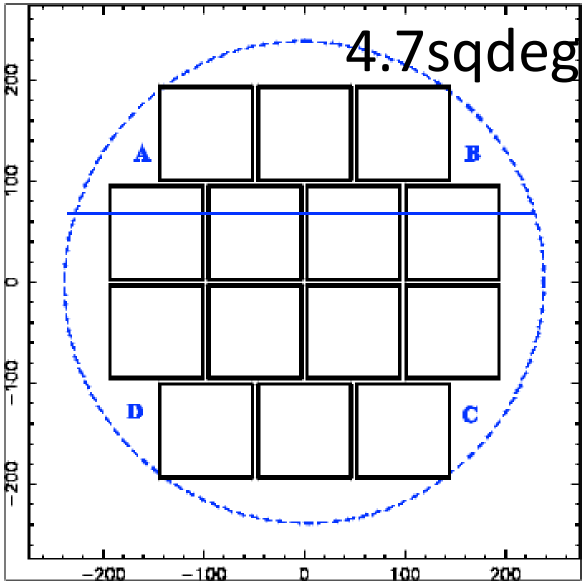


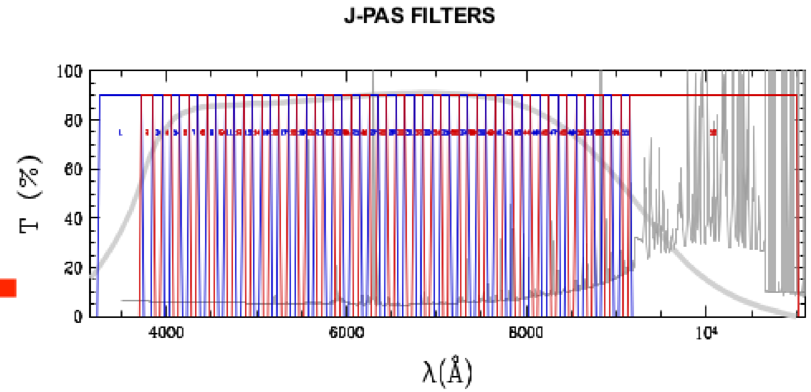
54 NB filters (15nm FWHM, 10nm spacing)
5 BB filters (ugr+360nm+950nm)
240-480s exposure
8500 sqdeg (fsky=0.2)

Survey Metric



Optimized Redshift-Survey Machine





The all 56 J-PAS filters can be **simultaneously** located at J-PCam.

J-PAS Strategy to driven by moon phase, seeing, weather conditions, etc.

~ 5000 multiplex spectrograph

But 10 times cheaper, 2 times faster to build

A few % of the cost of other Stage IV projects

~100M 0.3% redshifts

Figure 58: The OAJ main telescopes: JST/T250 at the integration

Site: Excellent Seeing

40d02’28.67” North, 01d00’59.10” West

OAJ: new facility in the Sierra de Javalambre (Teruel, Spain), 1957m altitude, ~53% totally-clear nights, very low artificial light contamination

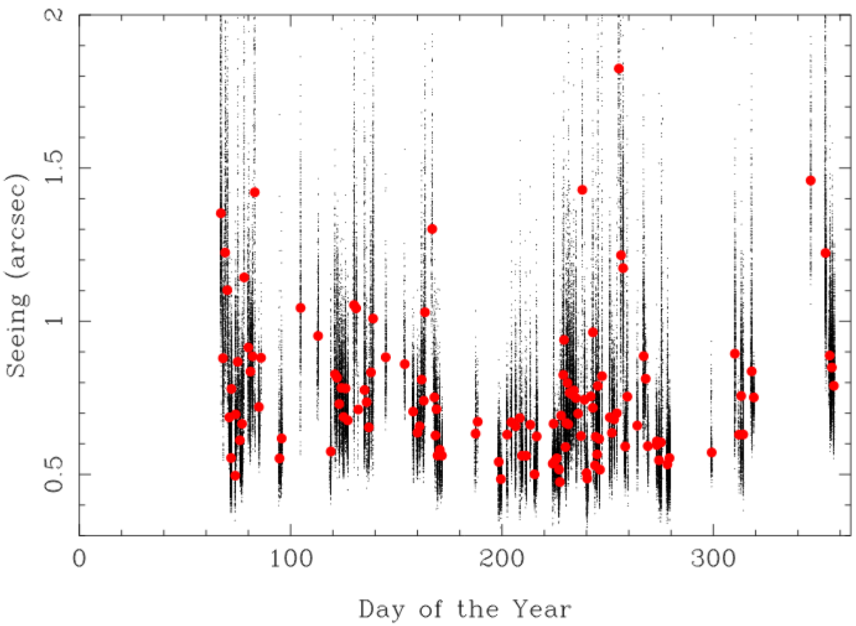
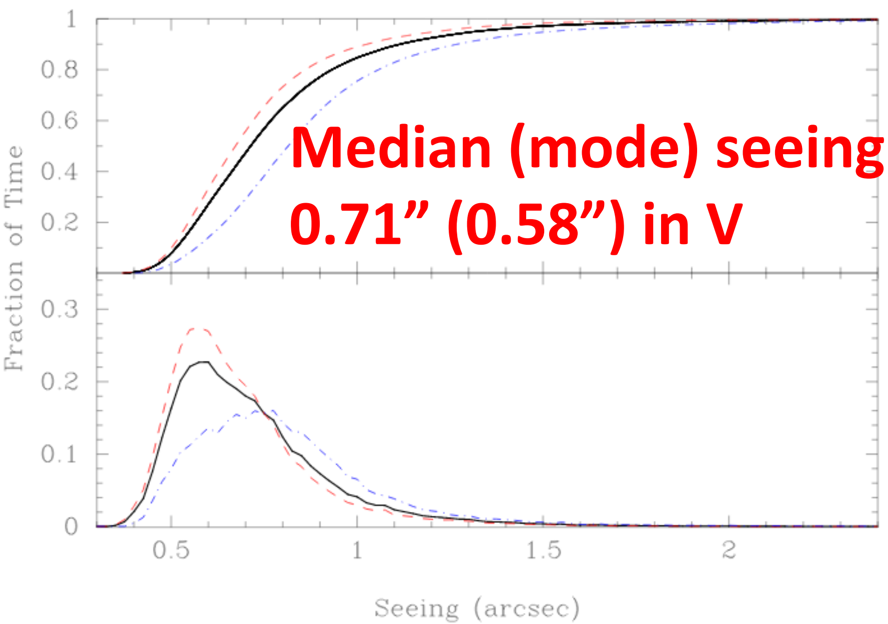
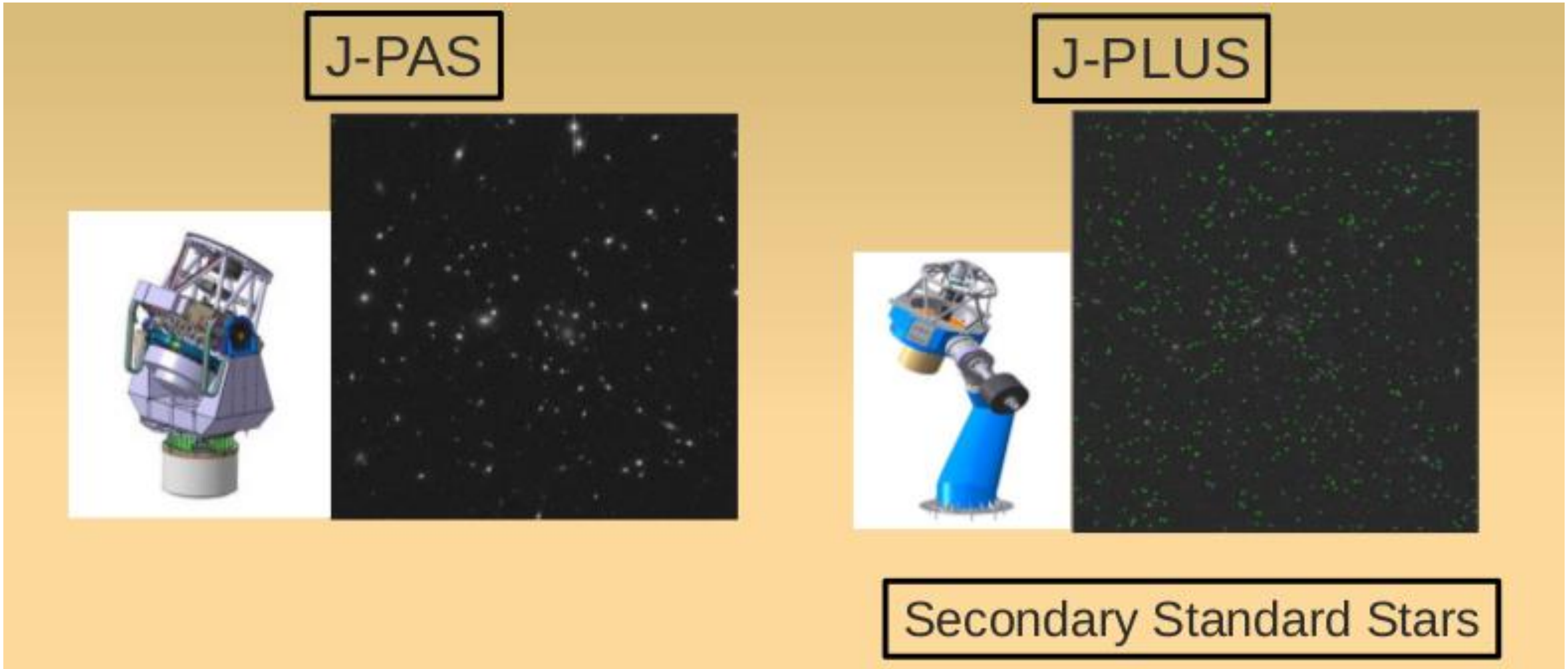


Fig. 2.— Distribution of the seeing collected for the 132 nights from March 2008 to September

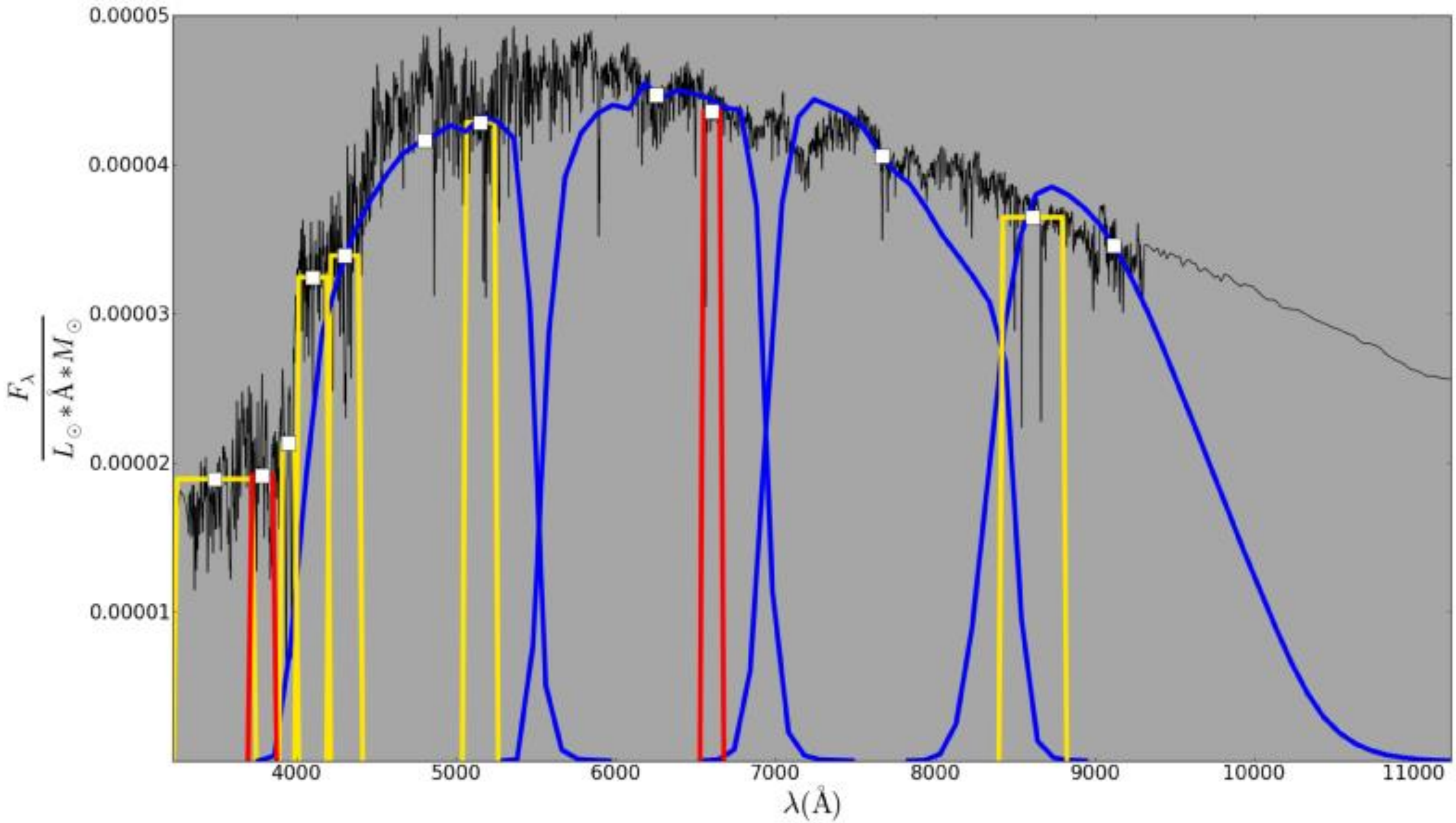


Moles+2010, PASP, 122, 363

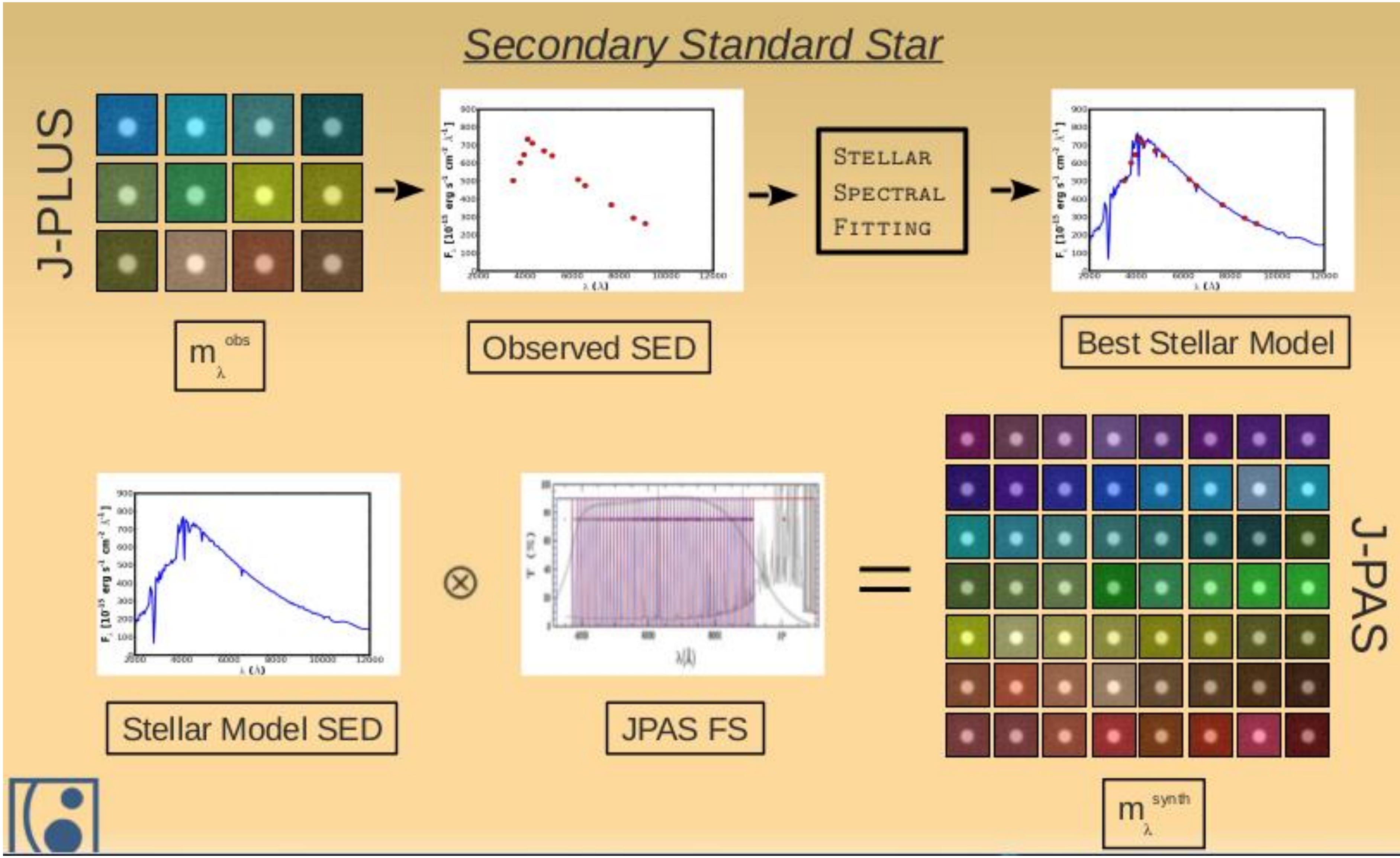
Photometric Calibration



- **J-PAS**
  - JPCam on JST/T250 (2.5m), F#3.5, 1.2Gpix @Cassegrain focus
- **J-PLUS**: auxiliary telescope w large FoV to identify and classify millions of (secondary standard) stars for J-PAS calibration
  - T80Cam on JAST/T80 (83cm), F#4.5


0.00005
0.00004
0.00003
0.00002
0.00001
$\frac{F_\lambda}{L_\odot * \AA * M_\odot}$
4000
5000
6000
7000
8000
9000
10000
11000
λ(Å)

Calibration Strategy



Central Wavelength shift across FoV

- J-PAS (4.7sqdeg) with a mosaic of 14 CCD units, each with 1 filter
- The maximum shift is 0.2% of CW.
- By combining an optimal dithering of 4 exposures, the net CW shift can be further reduced to well below 0.3% photoz requirement.
- J-PAS will keep track of the position of each object wrt the filter to reconstruct the effective transmission shape if necessary for some applications.

Synergy with Intensity Mapping (z=1-3)?

Lyman-α emitters (LAEs, 1216A Lyα)

- Massively-star-forming galaxies (z>0.8) as a tracer of CO?
- Ground-based LAE search only above z~1.6

J-PAS will detect bright LAEs at 2<z<5 (z~1 LAEs by J-PAS+Galex)

J-PAS filter system optimized for 2<z<2.4 LAE search

- J-PAS Survey: n = 7 +/- 2 LAEs/sqdeg (i < 23ABmag)
- J-PAS Deep Survey: n = 37 +/- 4 LAEs/sqdeg (i<24 ABmag)

with a rest-frame EW(Lyα) > 35A (filters@360, 379, 390, 400nm).

Additionally J-PAS will generate a large # of candidates for extremely-bright, compact Ly-a blobs (Lα=1e44-45erg/s, z~2-4).

TIMELINE

Q2 2014:

T250 delivery & on-site integration (Happening)

Q4 2014:

T250 Commissioning start

Q2 2015:

JPCAM delivery by E2V

Q3 2015:

JPAS-Pathfinder Survey, 0.35sq.deg camera

Q4 2015:

Main survey starts

Figure 52: The OAJ main telescopes: JST/T250 at the integration

BENITEZ ET AL 2014, arXiv:1403.5237

www.j-pas.org

Supplemental Slides

J-PAS: Limiting Magnitudes

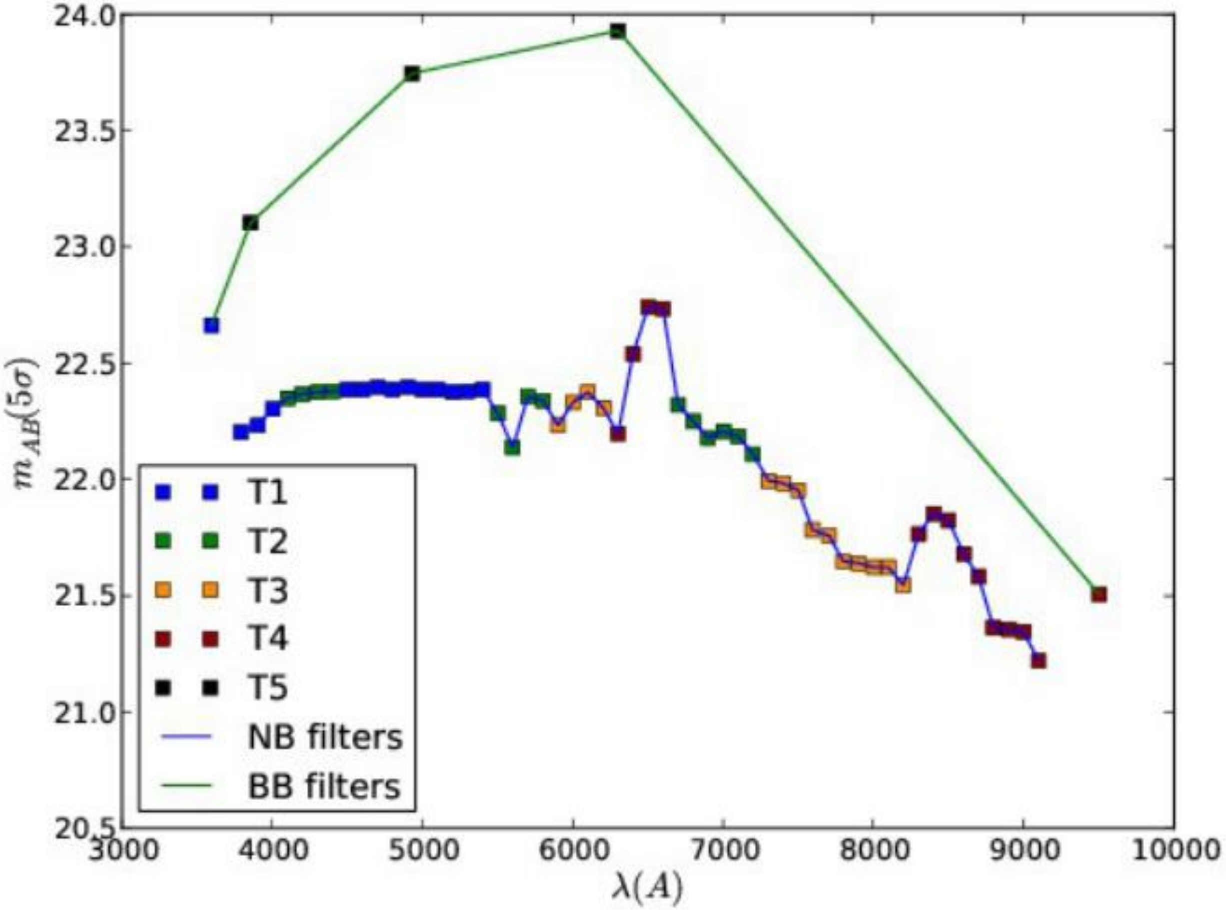


Figure 3: Limiting AB magnitudes (5σ, 3 arcsec aperture) for all the filters in the survey, color coded by their tray distribution

arXiv:1403.5237v1 [astro-ph.CO] 20 Mar 2014

JPCam Spec

FoV	$\oslash = 1.7^\circ$
EE50 EE80	$\oslash = 11\mu$m $\oslash = 22\mu$m
CCD format	Science (14X) $9.216k \times 9.232k$pix^2, 10μm/pix Guiding (4X) $1.024k \times 1.024k$ pix^2, 13μm (frame transfer) Wavefront sensing (8X) $2.048k \times 2.048k$pix^2, 15μm (frame transfer)
Pixel scale	$0.2267''$/pix
FoV coverage	$4.7\square^\circ$(fill factor 65%)
Read out time	$12s$
Read out noise	$4e^-$/pixel (goal)
Full well	$130ke^-$
CTE	0.99995
Dark current	$0.0006e^-$/pixel s^-1
Number of filters	70

Table 24: JPCam parameters

arXiv:1403.5237v1 [astro-ph.CO] 20 Mar 2014

J-PAS Intermediate/Broad-band Filters

Filter	λ_C	FWHM(Å)	$\mathbf{m}_{AB}^{5\sigma}(3''⌀)$	$\mathbf{m}_{AB}^{5\sigma}(/\Box'')$	$t_{exp}(s)$	Tray
J-PAS3518	3596	261	22.66	23.73	240	T1
u_{J-PAS}	3856	357	23.10	24.16	225	T5
g_{J-PAS}	4931	1441	23.75	24.81	225	T5
r_{J-PAS}	6301	1189	23.93	24.99	600	T5
J-PAS10069	9505	618	21.51	22.57	480	T4

Table 5: J-PAS Medium and Broad band observations. The central wavelengths λ_c and filter widths (FWHM) have been calculated taking into account the expected E2V CCD Quantum Efficiency and the Javalambre expected atmosphere at 1.2 airmasses. We also list the $5-\sigma$ detection magnitudes in a $3''$ diameter aperture and per $''^2$

arXiv:1403.5237v1 [astro-ph.CO] 20 Mar 2014

J-PAS: Telescope JST/T250

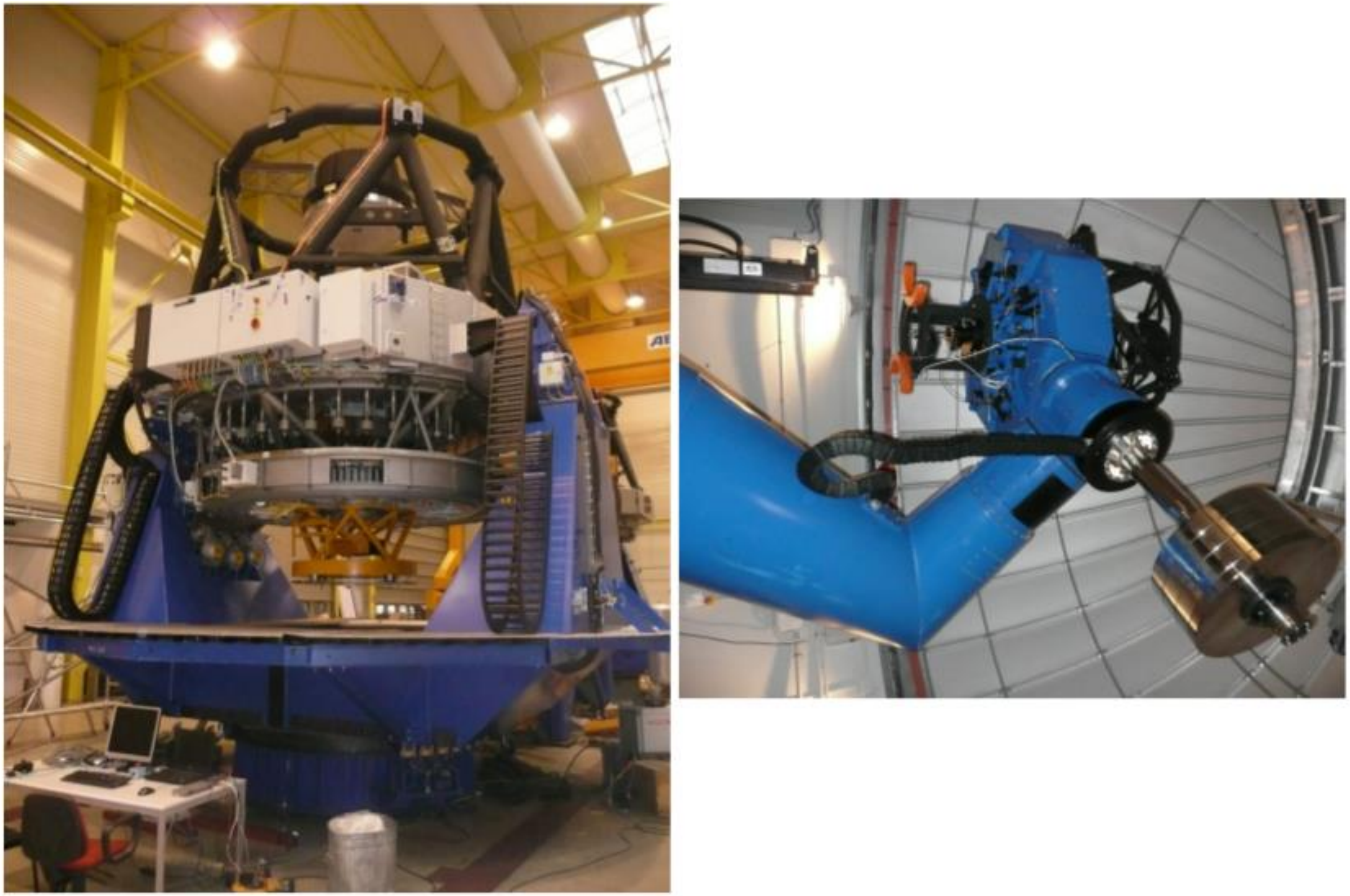


Figure 58: The OAJ main telescopes: JST/T250 at the integration hall in AMOS headquarters (left) and JAST/T80 at the OAJ (right).

J-PAS

FIRST STAGE IV experiment, starting around 2015

~ 100M galaxies with 0.3% photo-z > LSS

~ 300M galaxies with 1% photo-z > Cluster counting, 3D lensing tomography

~ 400-500M galaxies with 3% photo-z, Cosmic Shear

~ few M QSOs with 0.3% photo-z > Measure w all the way to z=3

~ 0.7 arcsec image of the Northern Sky

- Extremely mass sensitive optical cluster catalog
- Excellent characterization of low-z SN systematics
- 6000 SNIe survey, no spectroscopy required
- Pixel-by-pixel low-res spectrum of the whole northern sky up to m~23/arcsec^2

Unique, fundamental dataset for many Astrophysical areas

BENITEZ ET AL 2014, arXiv:1403.5237

www.j-pas.org