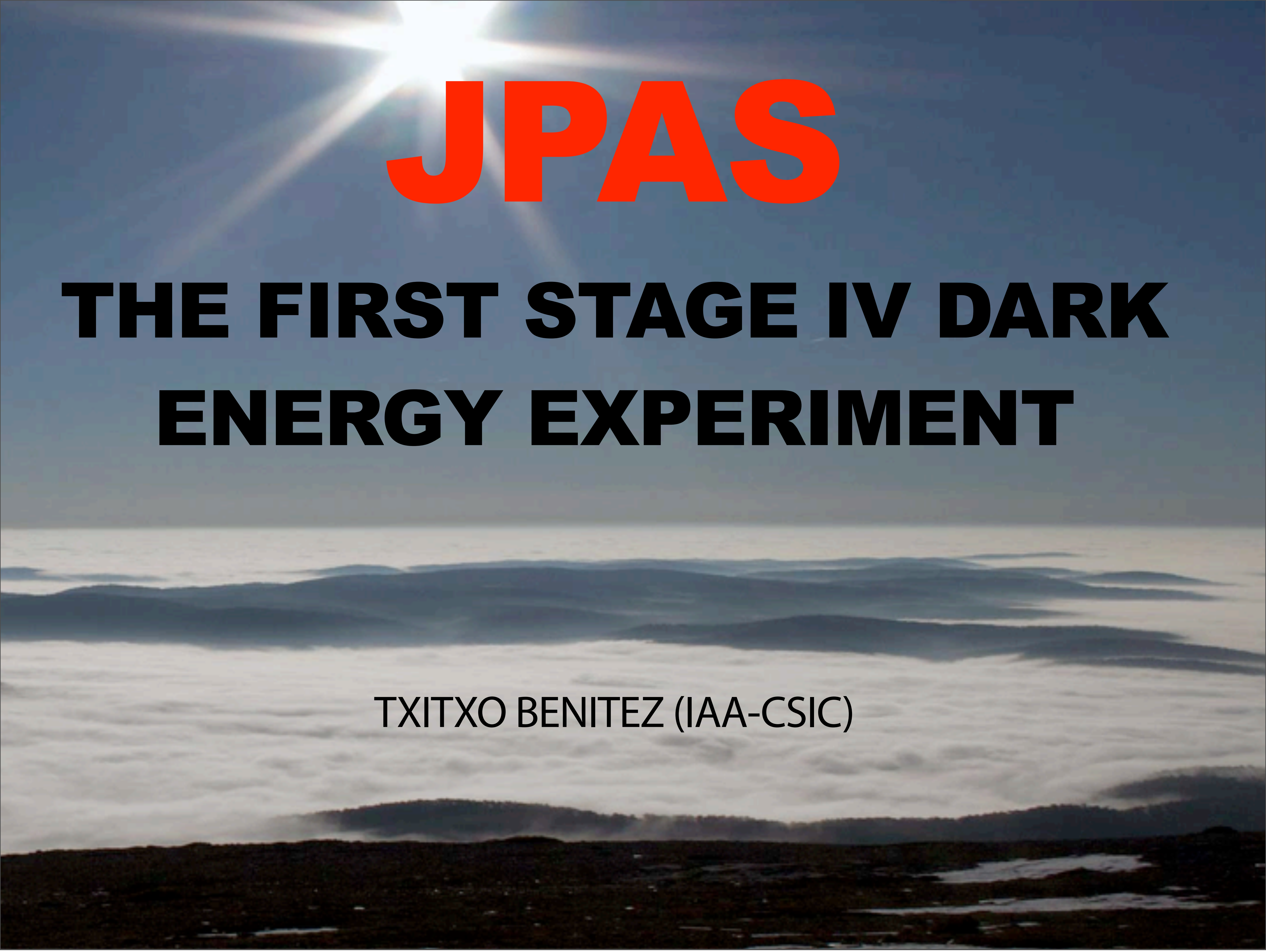


JPAS

THE FIRST STAGE IV DARK ENERGY EXPERIMENT

TXITXO BENITEZ (IAA-CSIC)

JPAS = ALL SKY IFU

Original motivation: you don't need spectroscopic redshift precision to measure the BAO scale; 0.003(1+z) photo-z are enough (Benitez et al 2009, PAU Consolider)

Javalambre-PAU Astrophysical Survey:

***Competitive in all "canonical" Dark Energy probes**

- BAOs+LSS

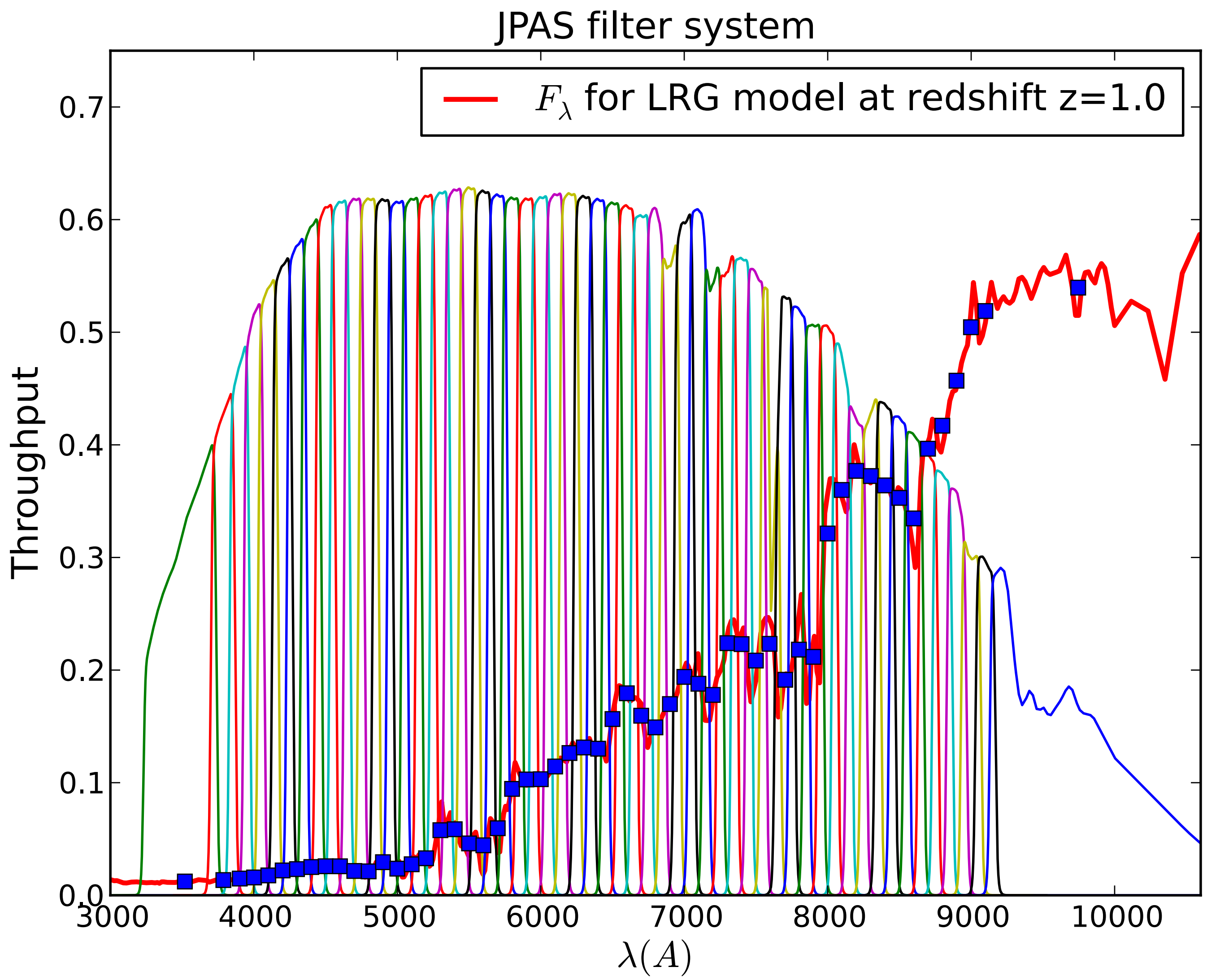
- SNIe

- Cluster Counting

- Weak lensing

***Almost every other major area in Astrophysics, AGN, Galaxy Evolution, the Galaxy, Solar System**

see Benitez et al. 2013



54 NB filters, 5 BB filters
240-480s exposure
8500 sq.deg.

Benitez et al. 2009

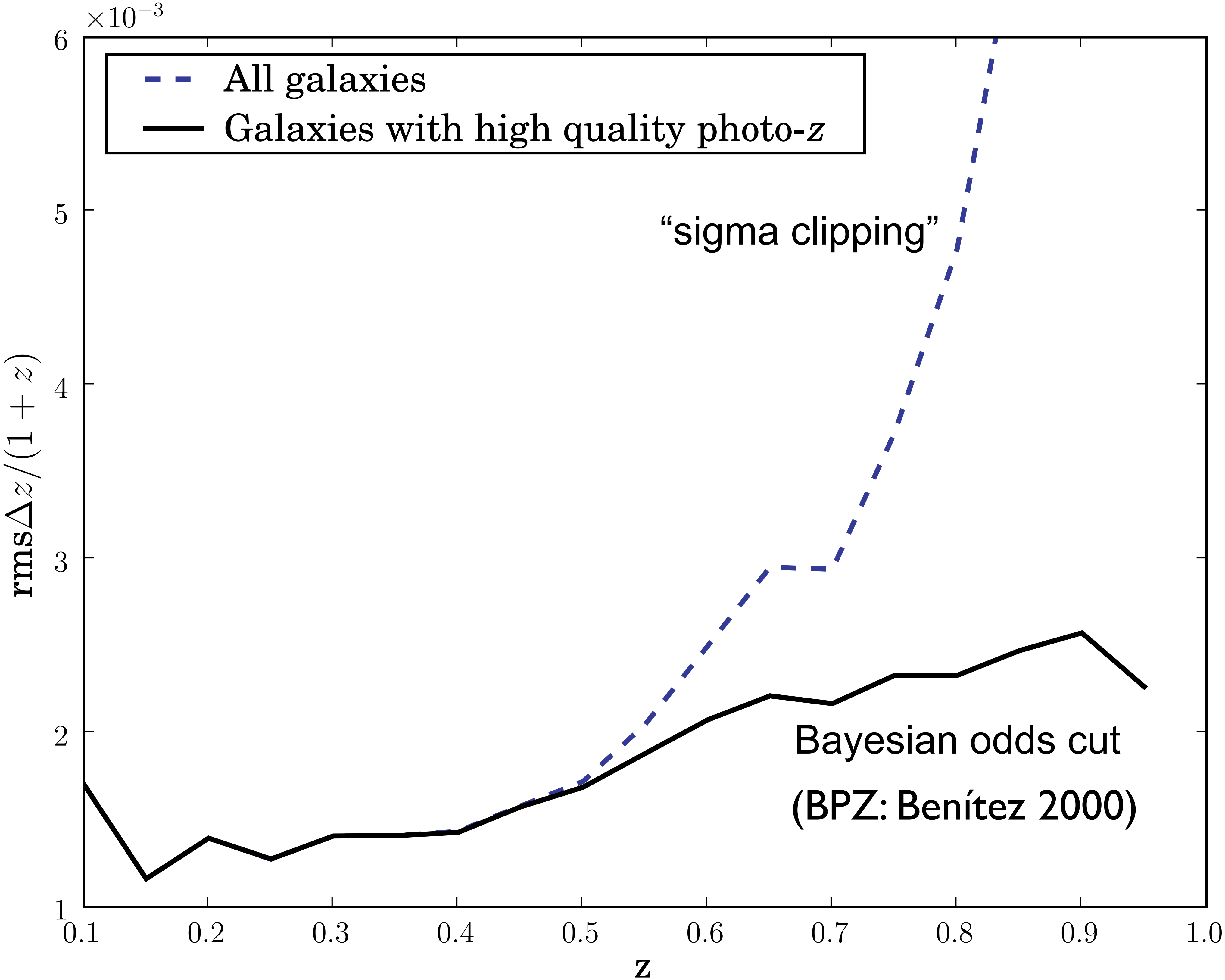
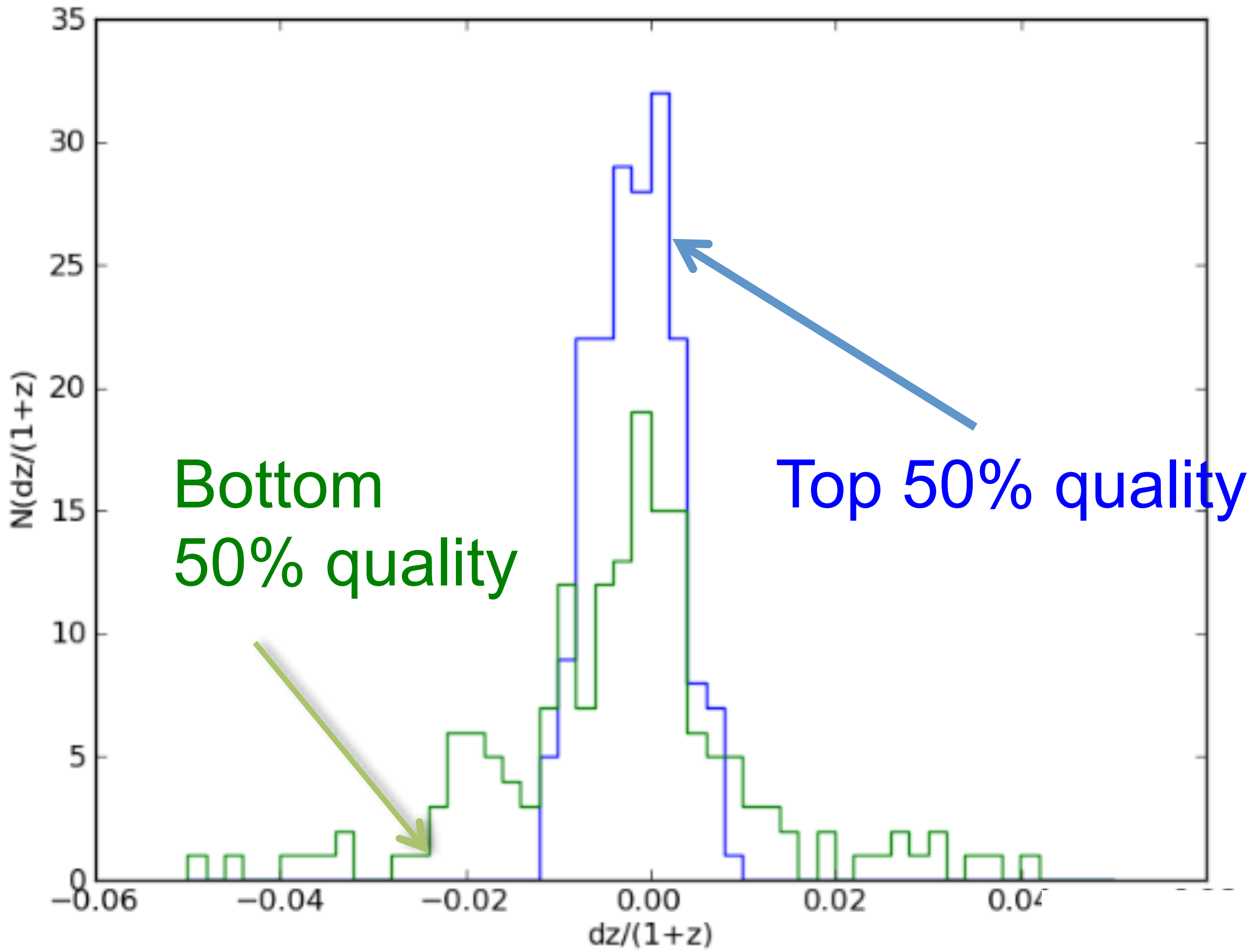


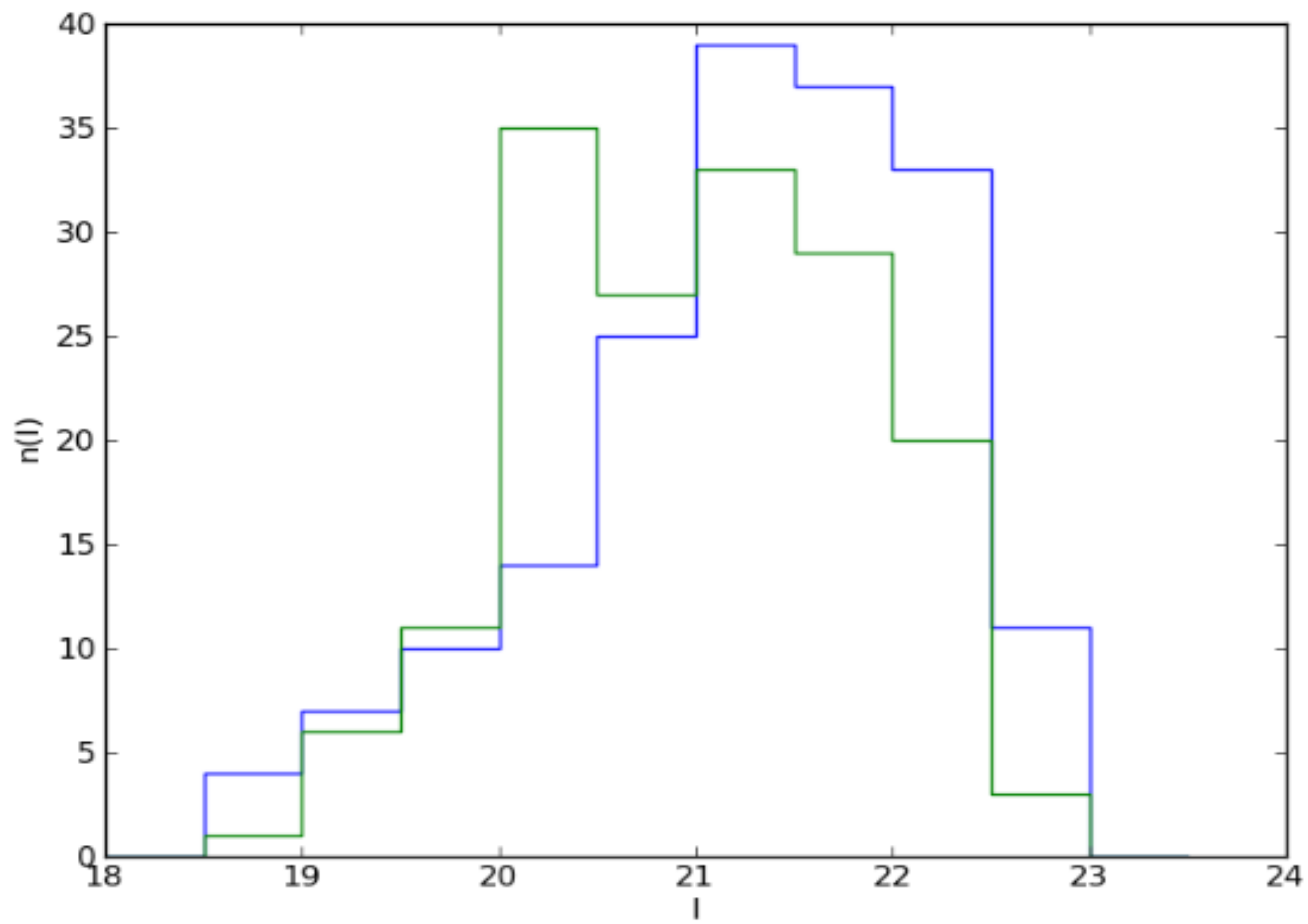
Figure 13. Photometric redshift error as a function of redshift, for all $L > L_\star$, $I < 23$ red galaxies, and for the subset with high-quality photo-z.



-COSMOS (Ilbert et al. 2009) catalog
~300A filters
-Photo-z with high odds 0.0045(1+z)

Bayesian Odds provide a reliable precision predictor!

- Magnitude or S/N cuts are not Efficient
- Need to use Bayesian approach with a quality indicator
- “Battle tested”



SPECTROSCOPY VS NB IMAGING

SPECTROSCOPY VS NB IMAGING

Compare imaging with N_F filters to a spectrograph

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v_S for spectroscopy: $N_{max} \times \eta$

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Spectropic efficiency $\eta \sim 0.25$ imaging efficiency $\eta_I / N_F \sim 0.024$

SPECTROSCOPY VS NB IMAGING

Compare imaging with N_F filters to a spectrograph

v_S for spectroscopy: N_{max} x η

v_S for imaging: n_g x A x η_i / N_F = $(n_g A) x (\eta_I / N_F)$ = N_{max} x η

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Spectroscopy (BOSS): $N_{max}=1000$ $v_S \sim 250$

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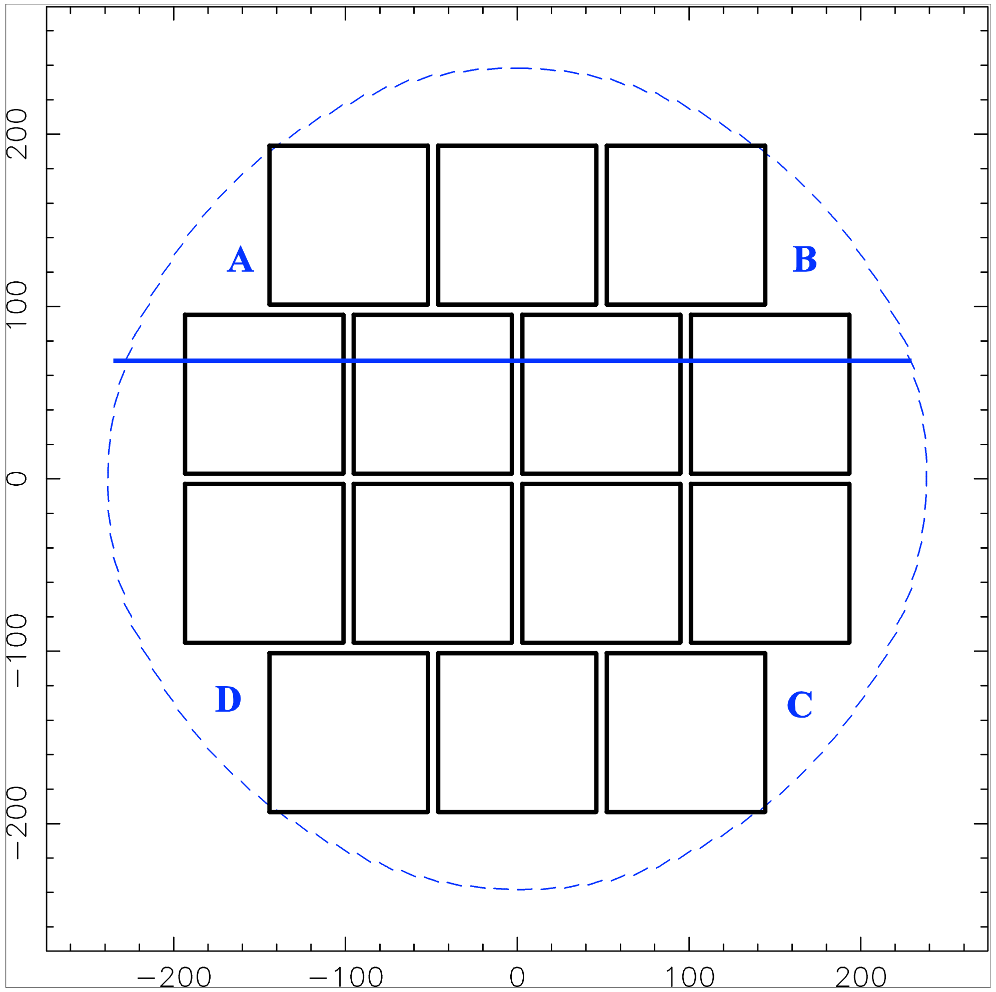

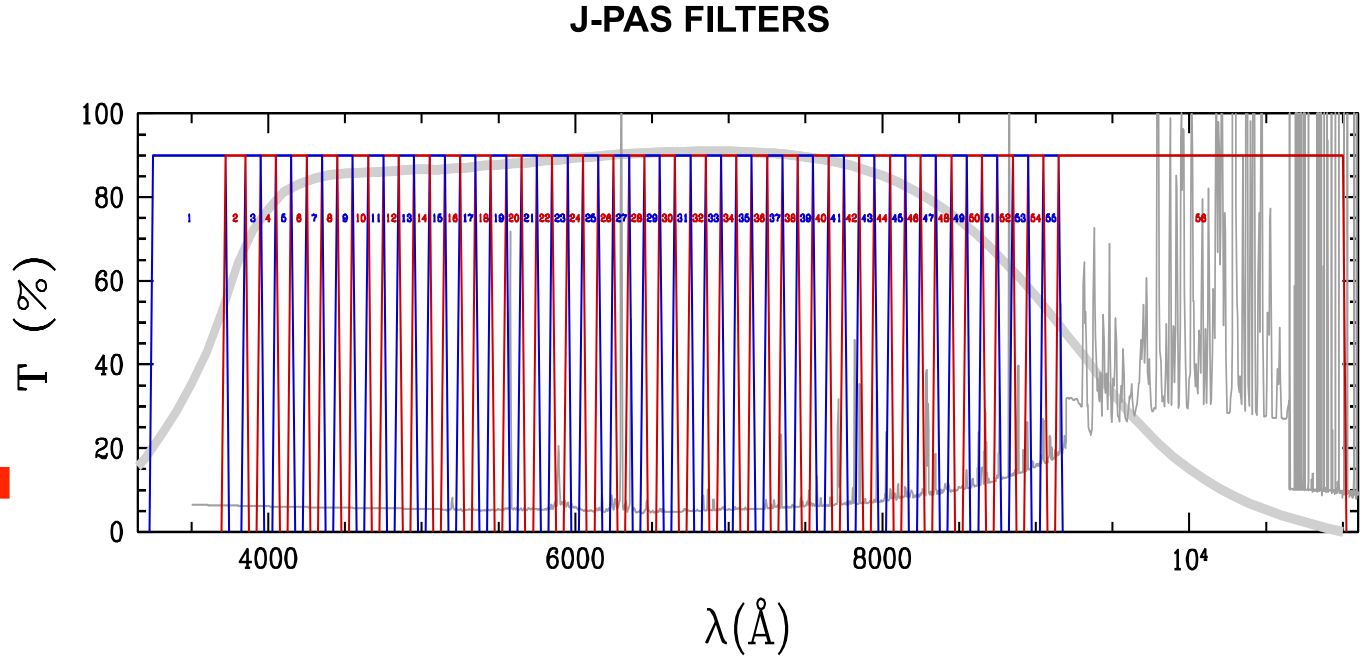

The all 56 J-PAS filters can be **simultaneously** located at J-PCam.

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

≈ 5000 multiplex spectrograph

But 10 times cheaper, 2 times faster to build

Stage IV experiment starting in 2015

A few % of the cost of other Stage IV projects

THE ALHAMBRA SURVEY: RESULTS AND LESSONS

ALHAMBRA Survey (Moles et al. 2008, Benitez et al. 2009)

- Define optimal filter set to reach photometric redshift depth.

- Observations carried out from Calar Alto using LAICA,OMEGA2000

- Plagued by LAICA technical problems, bad weather

- Lacking essential data after 8 years of observation:

*** Deep, homogeneous high-quality broad band detection images**

*** Lack of auxiliary spectroscopy for calibration**

- Problems solved:

*** New method to generate photometrically calibrated combined images, using galaxy colors**

*** New method to calibrate the photometry using the photo-z themselves.**

The ALHAMBRA Survey: Bayesian Photometric Redshifts with 23 bands for 3 squared degrees.

A. Molino[1], N. Benítez[1], M. Moles[2], A. Fernández-Soto[3], D. Cristóbal-Hornillos[2], B. Ascaso[1], Y. Jiménez-Teja[1], W. Schoenell[1], P. Arnalte-Mur[4], M. Pović[1], D. Coe[5], C. López-Sanjuan[2], Díaz-García L. A.[2], I. Matute[1], J. Masegosa[1], I. Márquez[1], J. Perea[1], A. Del Olmo[1], C. Husillos[1], E. Alfaro[1], T. Aparicio Villegas[9], M. Cerviño[1], V. J. Martínez[3], J. Cabrera-Caño[6], R. M. González Delgado[1], J. A. L. Aguerri[7], J. Cepa[7,8], T. Broadhurst[10], F. Prada[1], L. Infante[11], J. M. Quintana[1]

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[6] *Departamento de Fí sica Atómica, Molecular y Nuclear, Facultad de Fí sica, Universidad de Sevilla, Spain*
[7] *Instituto de Astrofísica de Canarias, Vía Láctea s/n, La Laguna, Tenerife 38200, Spain*
[8] *Departamento de Astrofísica, Facultad de Física, Universidad de la Laguna, Spain*
[9] *Observatrio Nacional-MCT, Rua Jos Cristino, 77. CEP 20921-400, Rio de Janeiro-RJ, Brazil*
[1] *0 Department of Theoretical Physics, University of the Basque Country UPV/EHU, Bilbao, Spain*
[11] *Departamento de Astronomía, Pontificia Universidad Católica. Santiago, Chile*

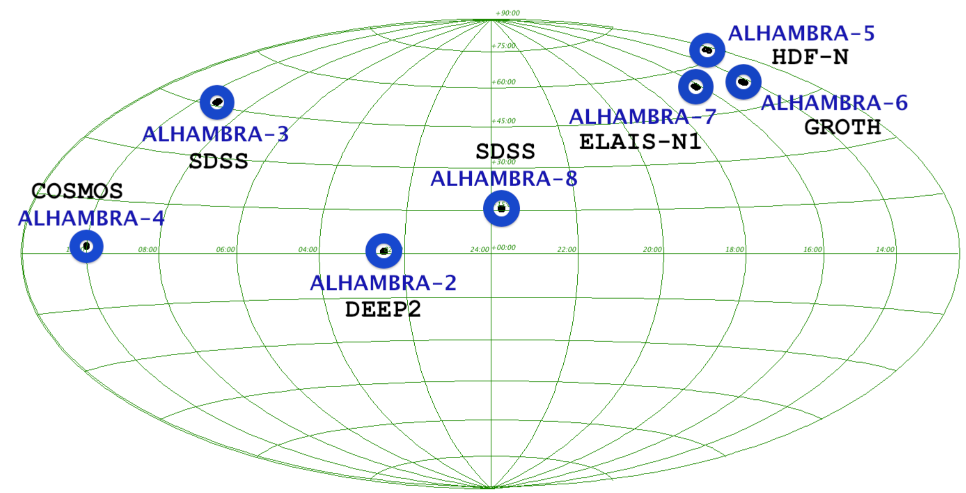


Figure 1. The figure shows the different fields observed by the ALHAMBRA survey along with their correspondence with other existing surveys. The mean galactic coordinates are specified in Table 1.

SEE POSTER BY ALBERTO MOLINO

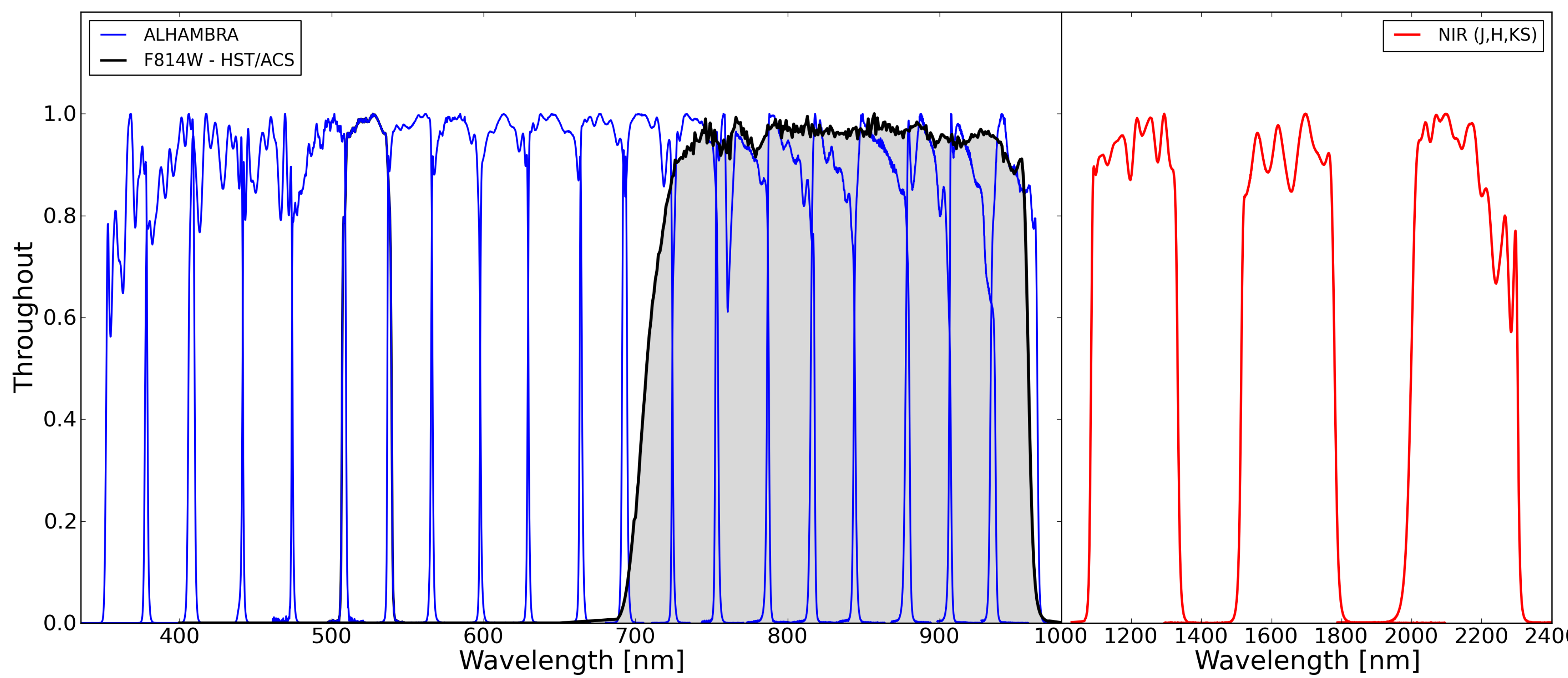
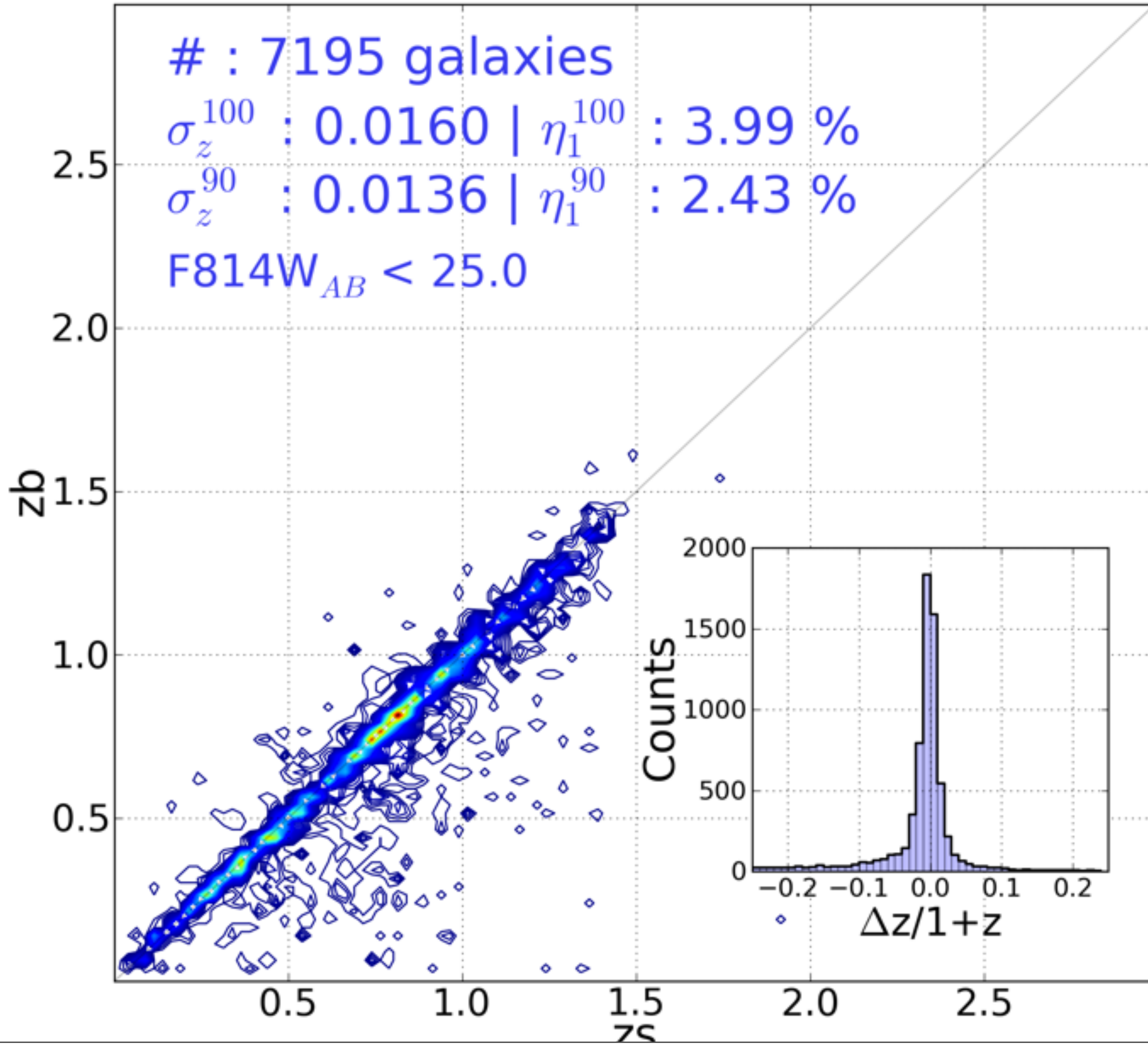


Figure 2. The ALHAMBRA survey filter set. On the left-hand side, solid blue lines represent the Optical filter system composed by 20 contiguous, equal-width, non overlapping, medium-band ($\sim 300 \AA$) filters. The solid black line corresponds to the synthetic F814W filter used to define a constant observational window across fields. On the right-hand side, solid red lines represent the standard JHKs near-infrared broad bands.



: 7195 galaxies
σ_z^{100} : 0.0160 | η_1^{100} : 3.99 %
σ_z^{90} : 0.0136 | η_1^{90} : 2.43 %
$F814W_{AB} < 25.0$
zb
zs
Counts
$\Delta z/1+z$

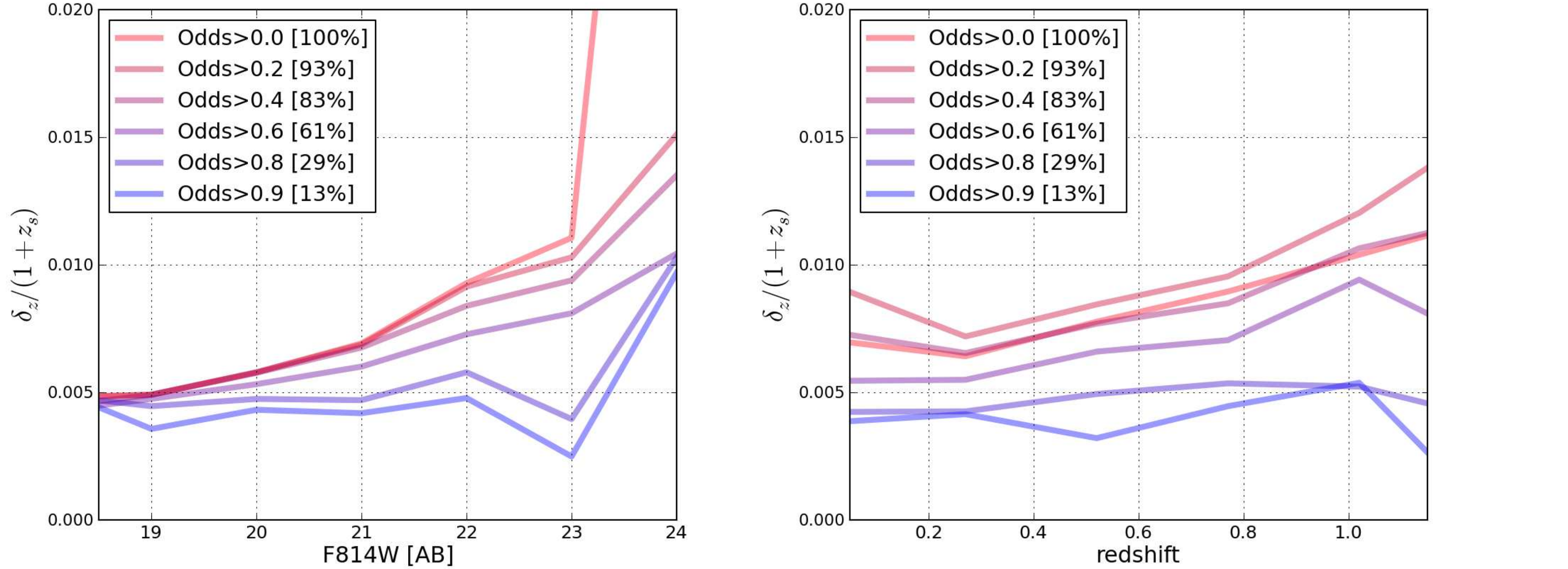
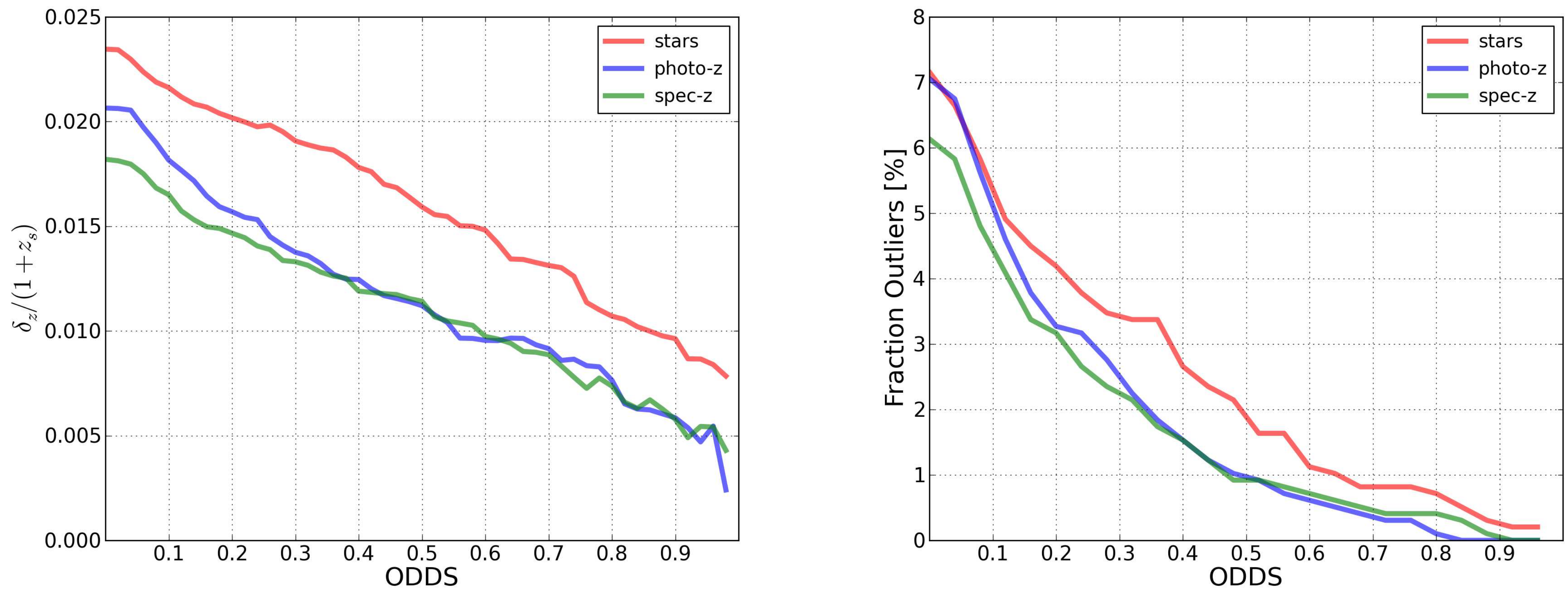


Figure 25. Photometric redshift accuracy as a function of apparent magnitude F814W (left panel) and spectroscopic redshift (right panel). We explored the expected accuracy for our photometric redshifts in terms of a specific magnitude range and redshift range applying different $Odds$ intervals.



ALHAMBRA LESSONS

1. In Spain, most members of the Survey are not hired to work on it; it is essential to offer specific scientific rewards for technical work (pipelines, etc.). Try to design incentives well.

2. Predictions of expected photometric performance/observing time need to be carefully calibrated with real observatory data.

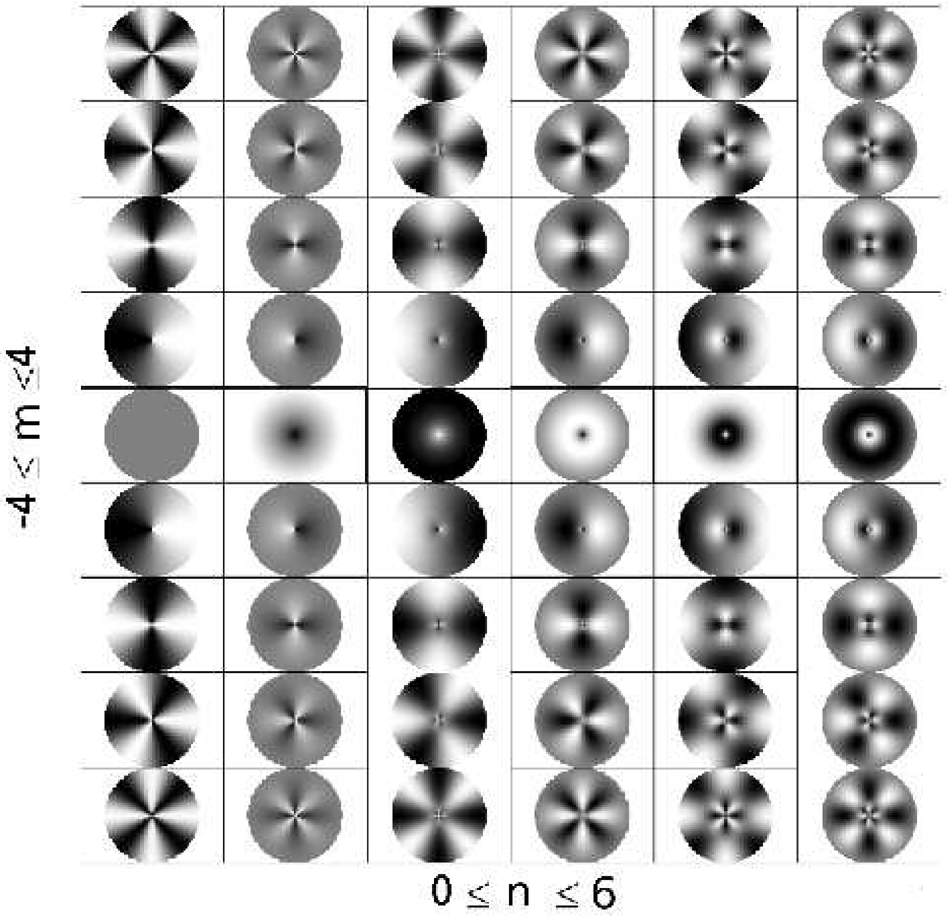
3. Photo-z mocks can be very accurate; ALHAMBRA in fact has performed better than expected (1.5% precision predicted vs. 1% measured).

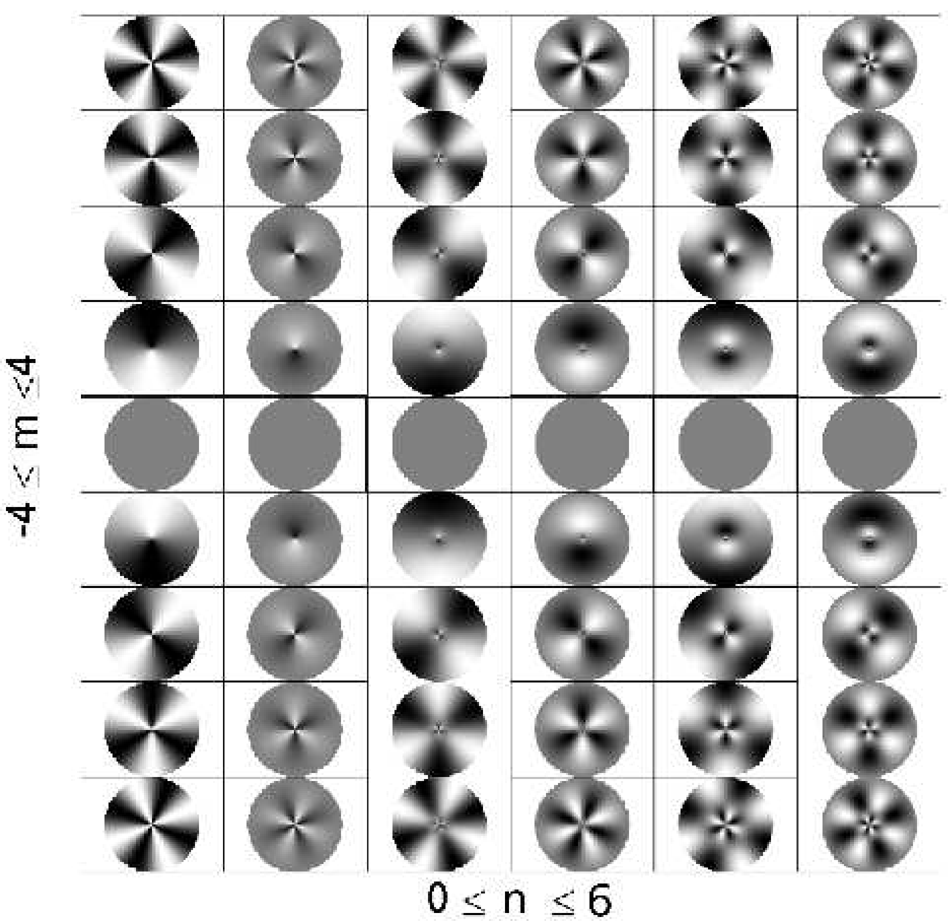
4. NB photo-z are much more robust regarding calibration errors than BB photo-z; “relative” ZP calibration can be done robustly, the colors of galaxies are the same everywhere.

5. Absolute ZP calibration, specially on very large scales, is still an issue.

6. It is essential to have a full complete dataset as early as possible in the beginning of the Survey.

7. Main bottleneck: quality, PSF-corrected photometry dominates error budget (see CHEFs poster by Yolanda Jiménez-Teja);





.ESSONS

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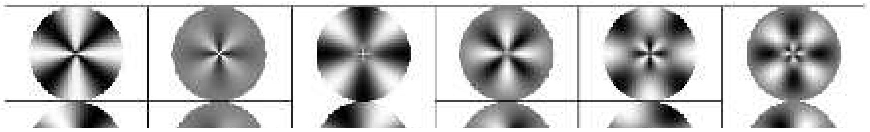
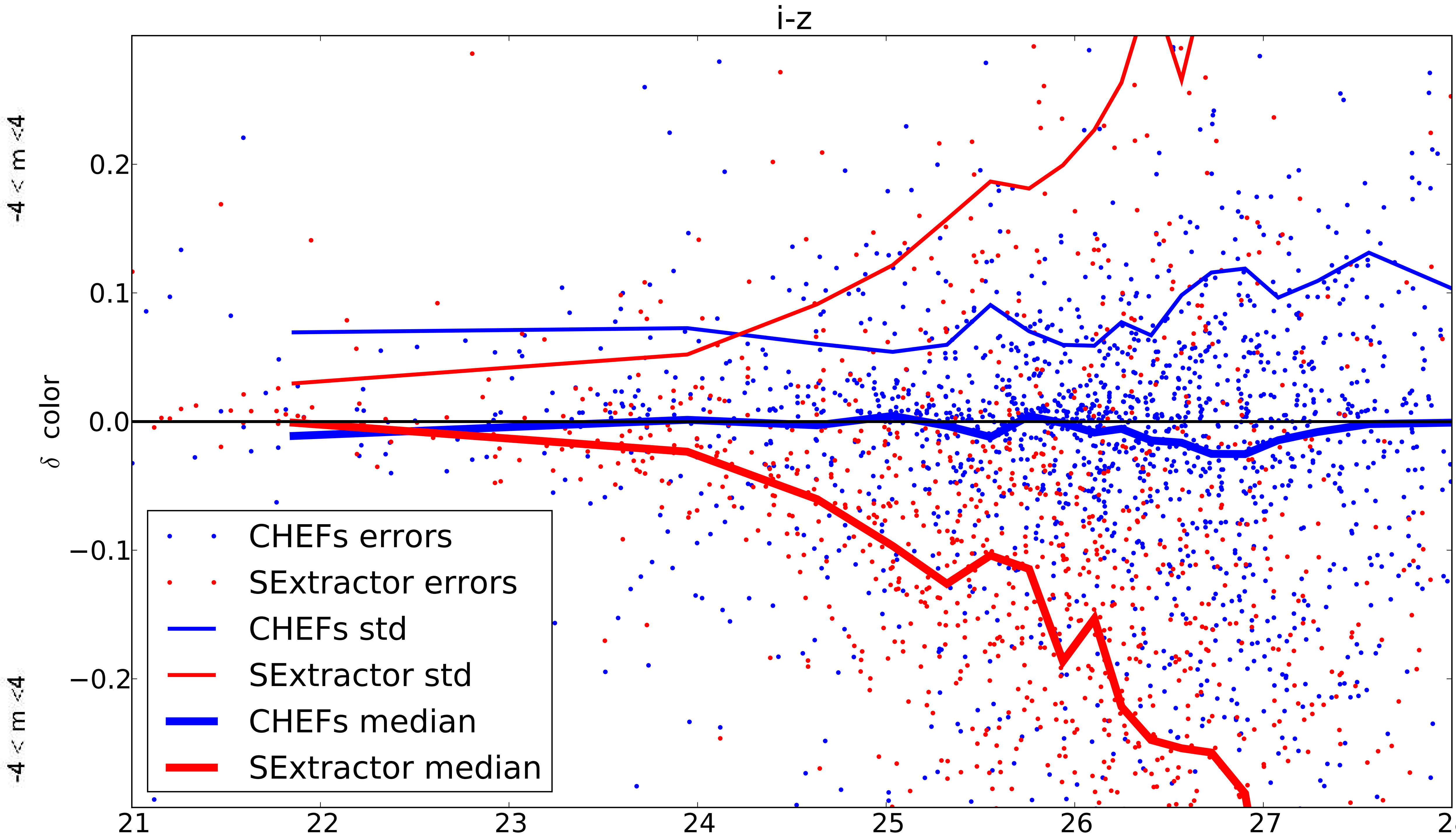


.ESSONS



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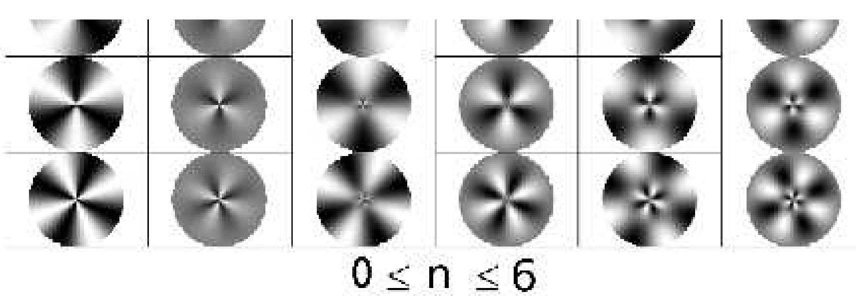

ALHAMBRA: DATA RELEASES

ALHAMBRA "Gold": June 21st, 2013 (solstice)

- Photo-z catalog with 100k galaxies with high quality photo-z
- Images

Full ALHAMBRA dataset November 15th, 2013

- ALHAMBRA open workshop (November 13-15th, Granada)
- 440k galaxies with full probability distributions p(z,T)

JPAS-SPAIN

CEFCA: **Mariano Moles**, **Javier Cenarro**, **David Cristóbal**, **Antonio Marín-Franch**, **Carlos Hernández-Monteagudo**, Alessandro Ederoclite, Jesús Varela López, José Luis Lamadrid, Kerttu Vironen, Luis Alberto Díaz, Luisa Valdivieso, Natalio Maicas, Sergio Chueca, Susana Gracia, Axel Yanes Díaz, Carlos López-Sanjuan, Nicolás Gruel

IAA: **Txitxo Benítez**, **Emilio Alfaro**, Begoña Ascaso,Carlos Barceló, Rosa González, **Javier Gorosabel**, Matilde Fernández, Yolanda Jiménez-Teja, Alberto Molino, William Schoenell, Miguel A. Pérez Torres

Universitat de Valencia: Vicent Martínez, Pablo Arnalte, Juan Fabregat, Lorena Seoane, **Alberto Fernández-Soto**, Vicent Peris, Vicent Quilis, Fernando Ballesteros, Elena Ricciardelli,

IAC: **Jordi Cepa**, José Miguel Rodríguez-Espinosa, Angel Bongiovanni, José Alfonso López-Aguerri, Elena Ricci, Ignacio Trujillo, Alexandre Vazdekis

IFCA: Enrique Martínez-González, **José María Diego**, **Ignacio González- Serrano**, Patricio Vielva, Airam Marcos Caballero

Universidad Complutense de Madrid: Javier Gorgas, Nicolás Cardiel, Patricia Sánchez-Blázquez, Jesús Gallego, Pablo Pérez-González

Universidad Autónoma de Madrid: Gustavo Yepes, Belén Gavela, Enrique Alvárez, Patricia Sánchez-Blázquez

Universidad del País Vasco-EHU: Tom Broadhurst

CAB: Álvaro Giménez, **Eduardo Martín**

Universidad de Zaragoza: Antonio Elipe

Universidad de Barcelona: Jordi Torra

ESAC: Enrique Solano, Miguel Sánchez-Portal

PAU-BRASIL

IAG/USP **Raúl Abramo**, Eduardo Cypriano, Eugenia Díaz, **Claudia Mendes de Oliveira**, Paulo Penteado, Robert Proctor, **Laerte Sodré**, Patricia Spinelli , Ariel Zandivárez, Henrique Xavier
Observatorio Nacional **Jailson Alcaniz**, Teresa Aparicio, **Jorge Carvano**, Simone Daflon, **Renato Dupke**, Daniela Lazzaro, **Keith Taylor**, Edu Telles
UFSC Abilio Mateus, André Luiz de Amorim, **Roberto Cid Fernández,** Antonio Kanaan
UFRJ **Mauricio Calvão**, Ribamar Reis,Beatriz Siffert, Ioav Waga,
INPE Fernando Jablonski
CBPF/TEO Marcelo Rebouças
NAT Paula Coelho

CIDA Gustavo Bruzual

Universidad de Florida: Rafael Guzmán
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UPenn Masao Sako, Henrique Xavier
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- IAA-CSIC (MICINN)
- CEFCA
- Observatorio Nacional, Río de Janeiro
- Departamento de Astronomia, Universidade de São Paulo
- Centro Brasileiro de Pesquisas Físicas

Centro de Estudios de Física del Cosmos de Aragón

- IAA-CSIC (MICINN)
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- Observatorio Nacional, Río de Janeiro
- Departamento de Astronomia, Universidade de São Paulo
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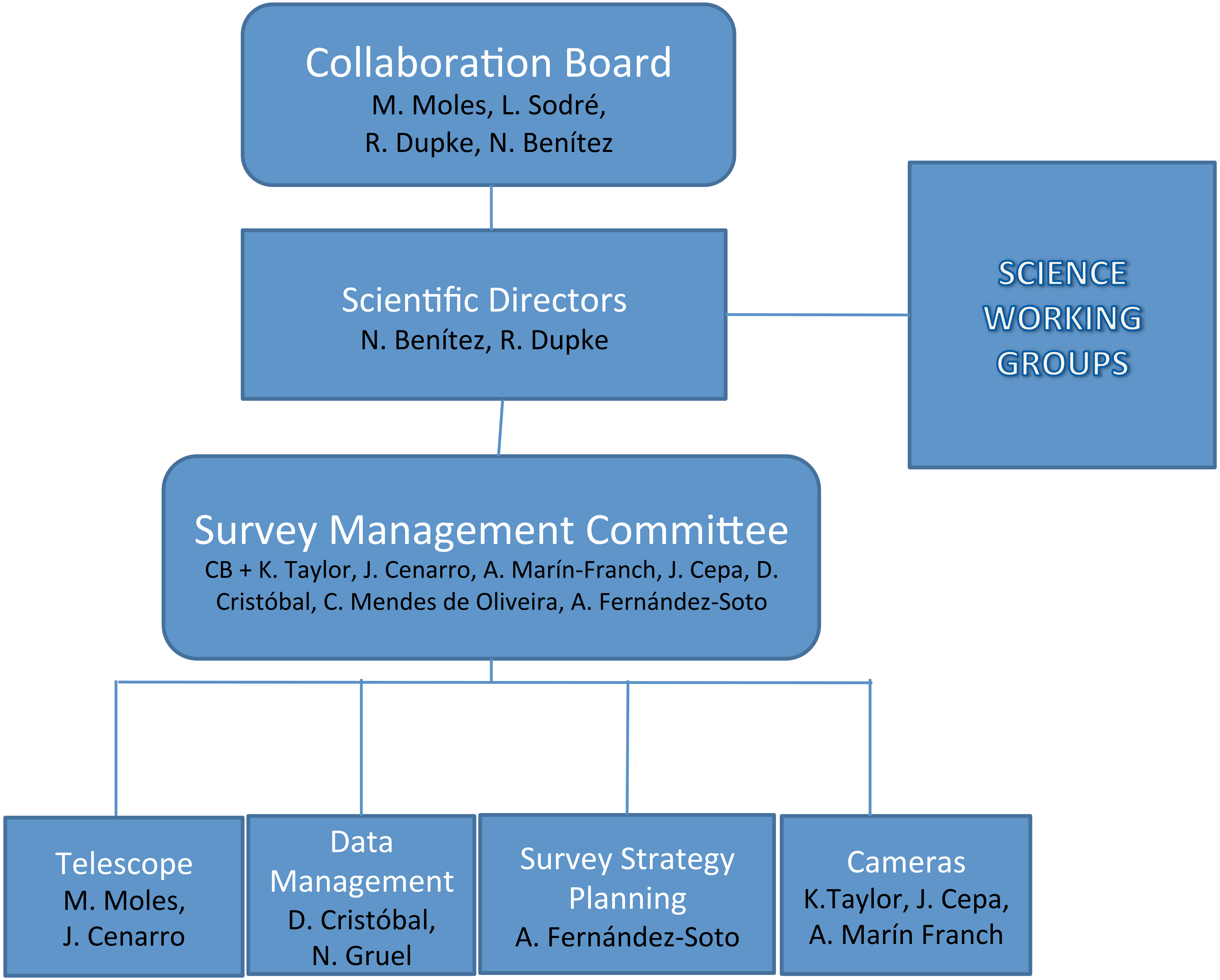

Collaboration Board
M. Moles, L. Sodré,
R. Dupke, N. Benítez
Scientific Directors
N. Benítez, R. Dupke
SCIENCE
WORKING
GROUPS
Survey Management Committee
CB + K. Taylor, J. Cenarro, A. Marín-Franch, J. Cepa, D.
Cristóbal, C. Mendes de Oliveira, A. Fernández-Soto
Telescope
M. Moles,
J. Cenarro
Data
Management
D. Cristóbal,
N. Gruel
Survey Strategy
Planning
A. Fernández-Soto
Cameras
K.Taylor, J. Cepa,
A. Marín Franch

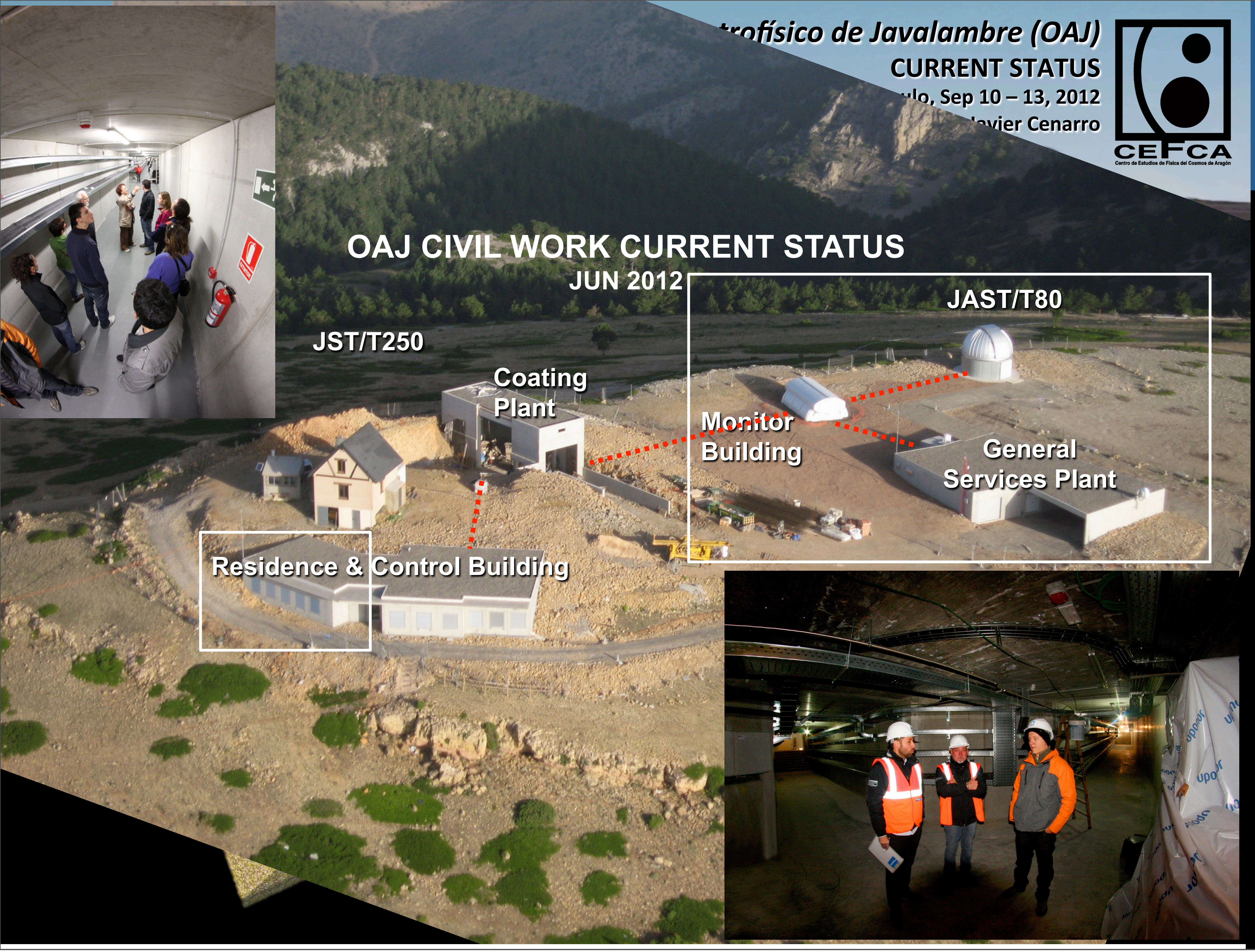
PUBLICATIONS OF THE ASTRONOMICAL SOCIETY OF THE PACIFIC, **122**:363–372, 2010 March

Site Testing of the Sierra de Javalambre: First Results

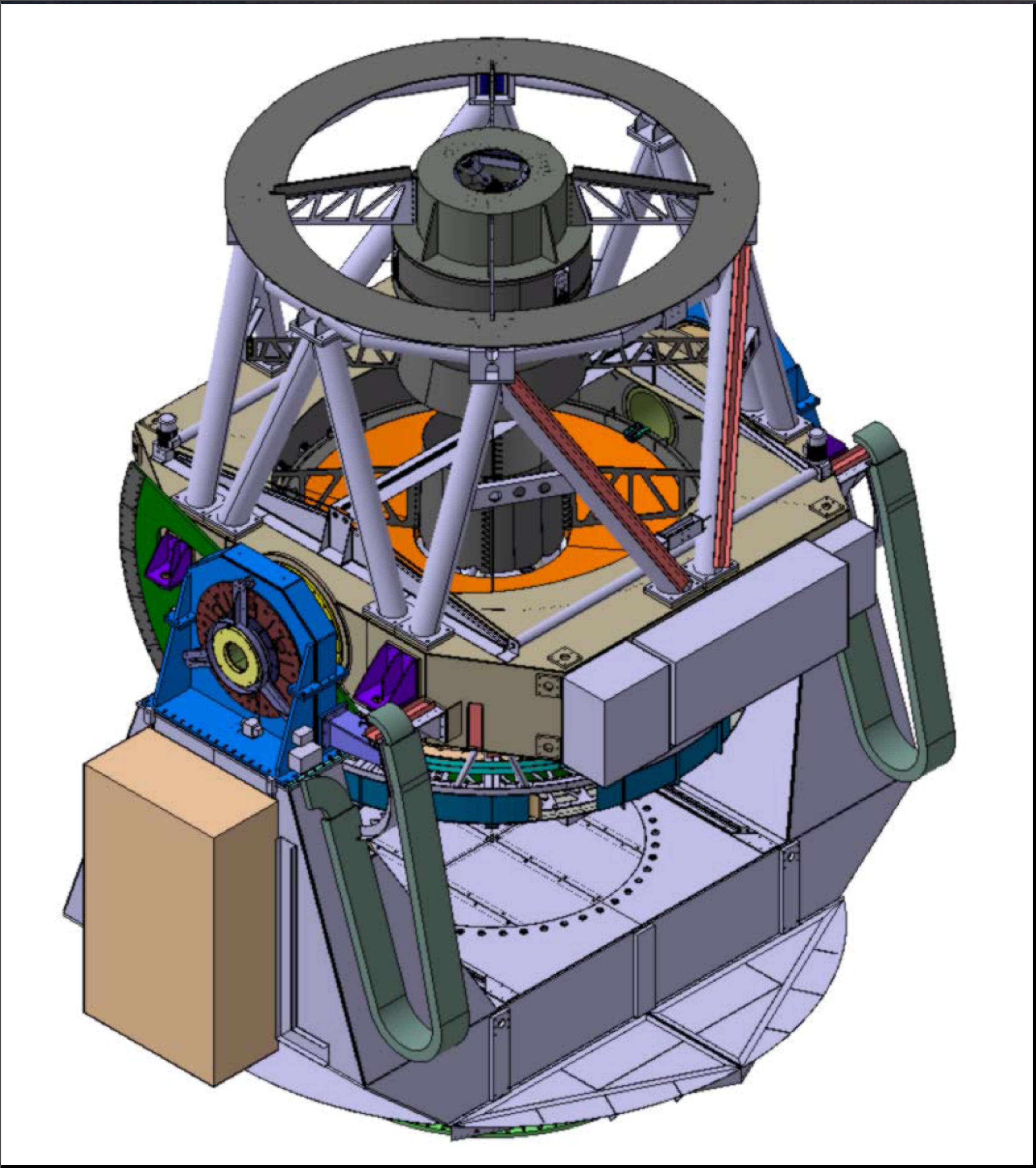
M. MOLES,[1,2] S. F SÁNCHEZ,[1,3,4] J. L. LAMADRID,[1] A. J. CENARRO,[1]
D. CRISTÓBAL-HORNILLOS,[1,2] N. MAICAS,[1] AND J. ACEITUNO[4]

Received 2009 November 30; accepted 2009 December 30; published 2010 February 16

-- Dark Site - ~ no pollution
-- SB(sk): B= 22.8,V= 22.1, R = 21.5,I = 20.4
-- k_V = 0.22 (0.18) - Summer (few values)
-- Seeing: Med = 0.71”, Mode = 0.58”, for 5h when < 0.8”
-- Clear Nights: 53% / 62% / 74%


trofísico de Javalambre (OAJ)
CURRENT STATUS
ulo, Sep 10 – 13, 2012
avier Cenarro
CEFCA
Centro de Estudios de Física del Cosmos de Aragón
OAJ CIVIL WORK CURRENT STATUS
JUN 2012
JST/T250
Coating Plant
JAST/T80
Monitor Building
General Services Plant
Residence & Control Building

JST/T250 BUILDING

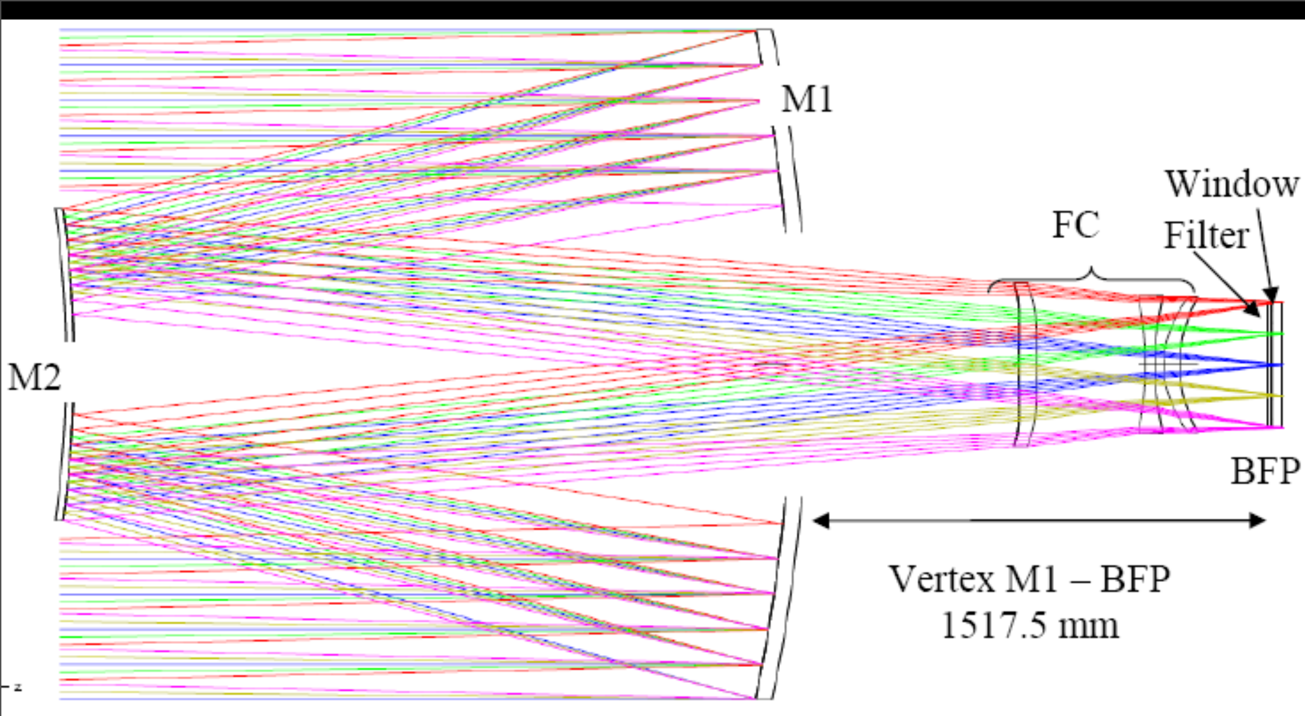


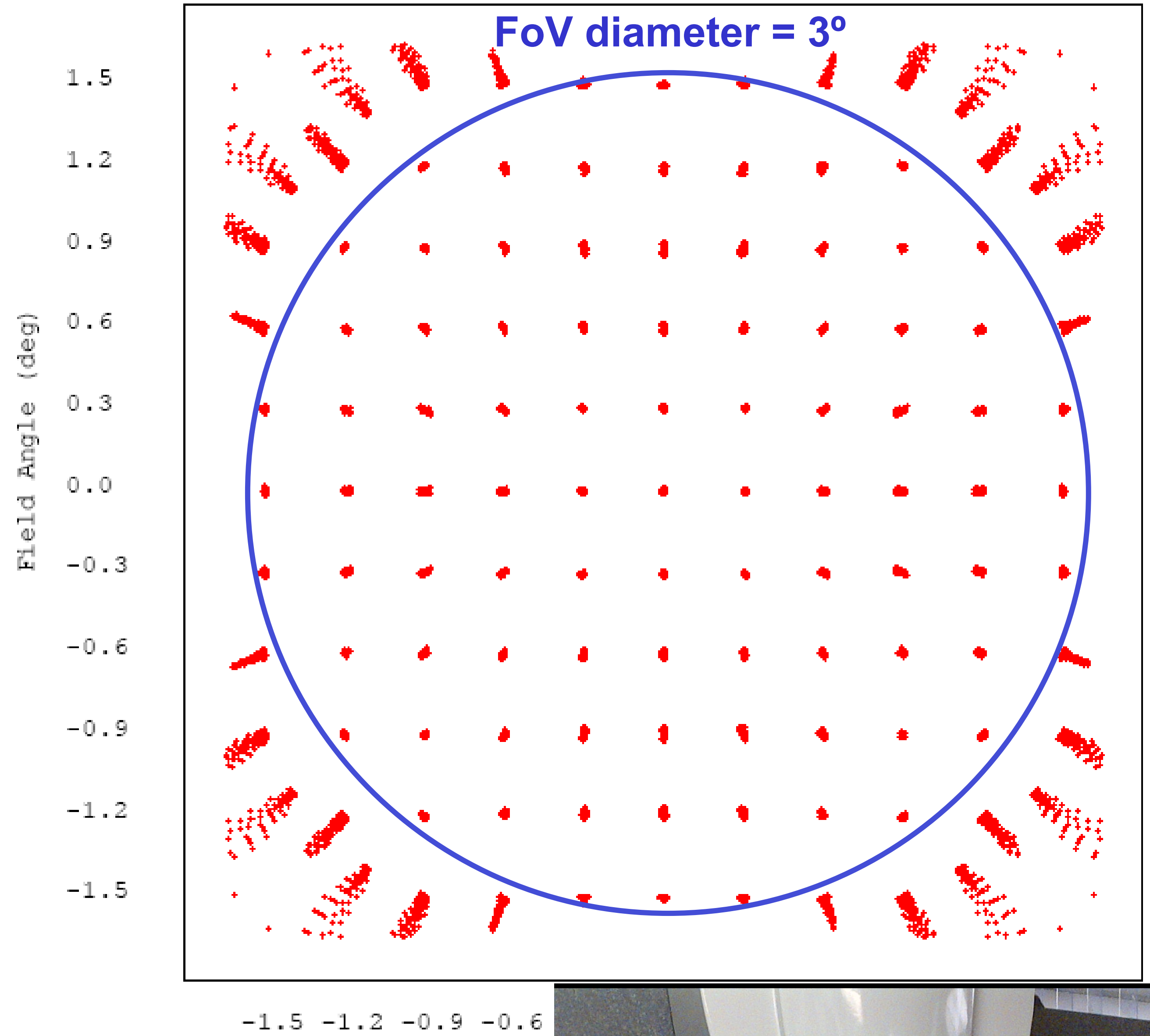
JST/T250

- M1 (∅) = 2.55 m
- FoV (∅) = 3 deg = 476 mm at FP
- Effective collecting area = 3.89 m^2
- Etendue = 27.5 m^2deg^2
- Plate scale = 22.67 arcsec/mm
  = 0.22 arcsec/pix
- Focal length = 9098mm → F#3.5
- IQ EE50 (∅) < 12μm = 0.27 arcsec
- IQ EE80 (∅) < 20μm = 0.45 arcsec

- Mount = Alt-azimuthal
- Config. = Ritchey Chrétien-like
- Focus = Cassegrain
- Field corrector of 3 lenses
- Mass ~45.000 kg
- 1st Eigenfrequencies > 10 Hz

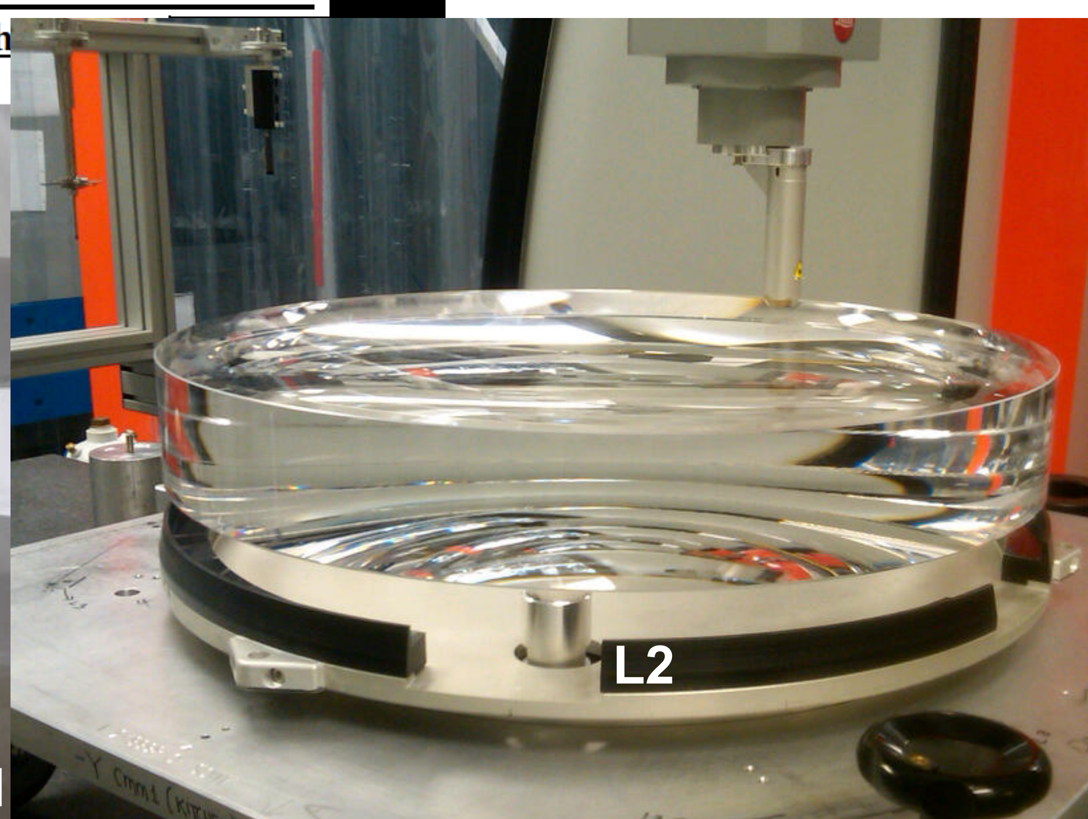
- Manufacturer: AMOS (Belgium)
- Current Status: AIV – Integration
- On site: when dome & building finished

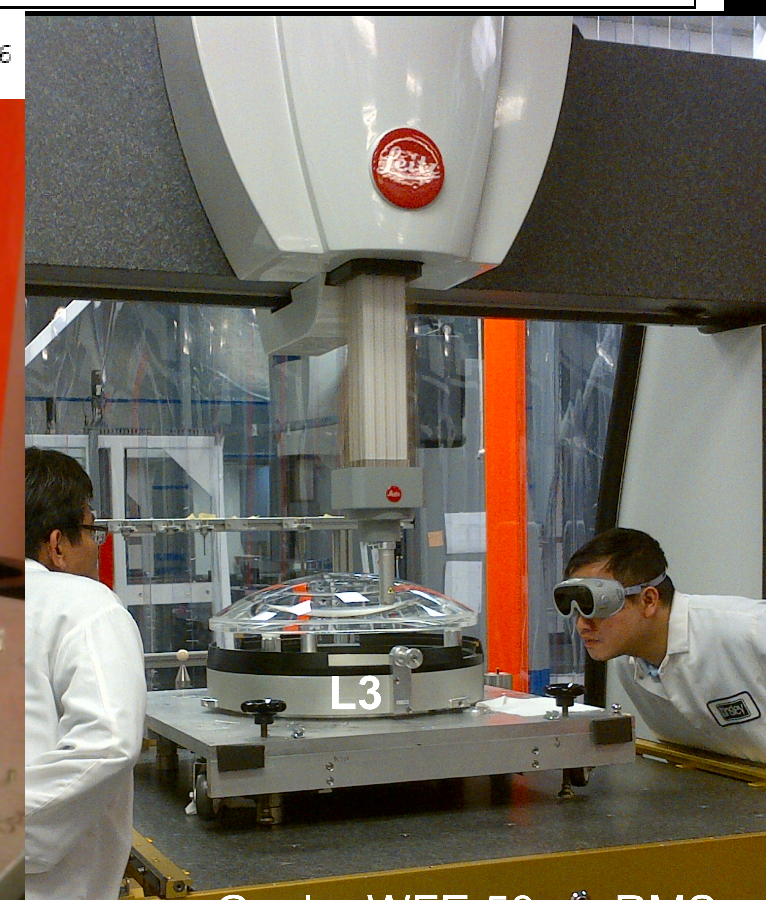




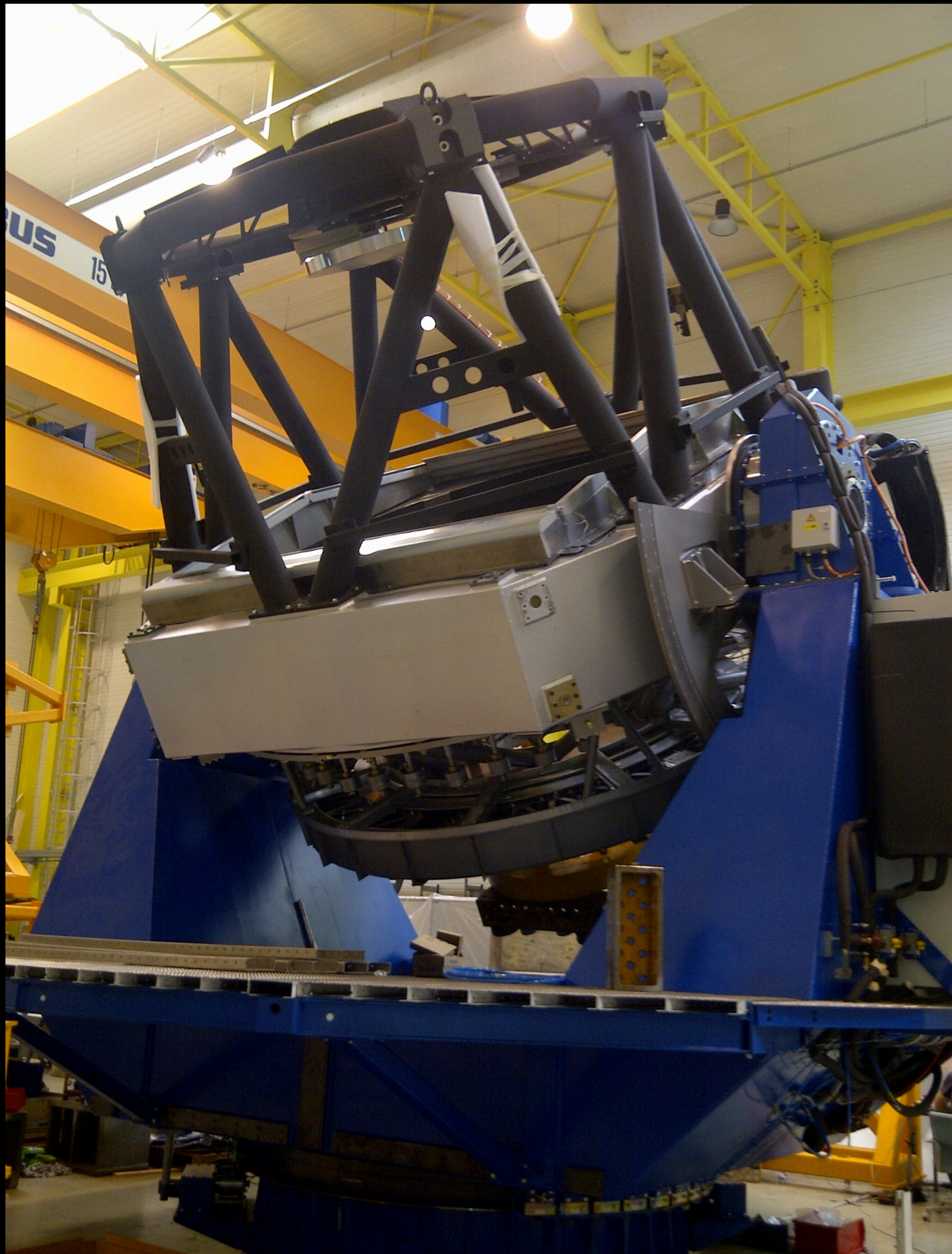
	Distance (mm)
M1 – M2	2207.7
M2 – L1	2909.654
L1 – L2	335.0225
L2 – L3	27.35545
L3 – Filter	273.2982
Filter – Dewar window	4
Dewar Window – CCD plane	8

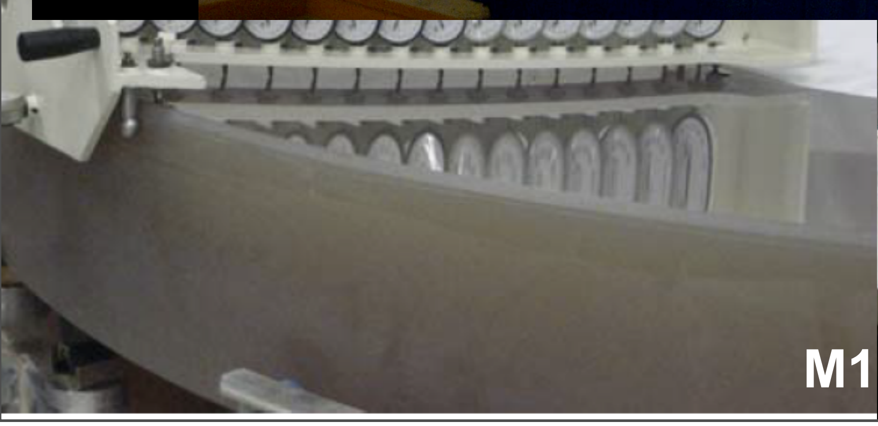
ed profilometer designed for T250 M1 OAJ set on th

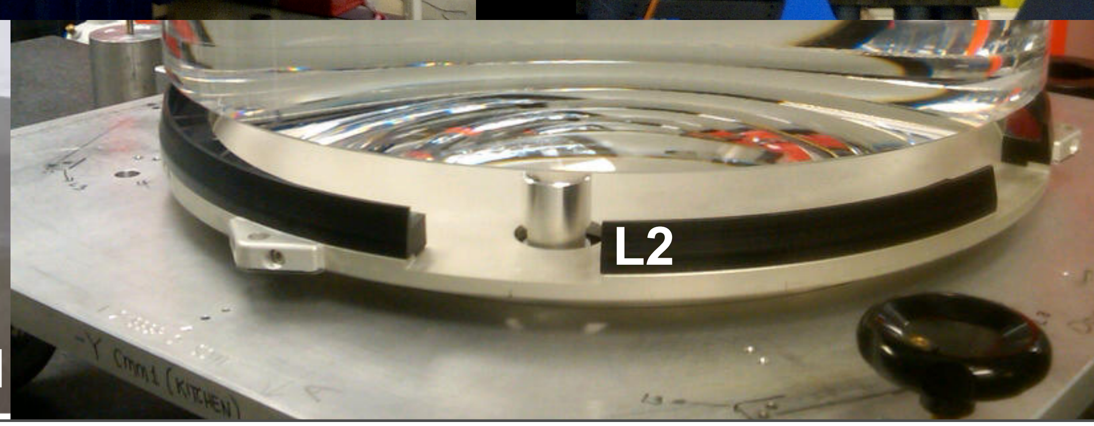


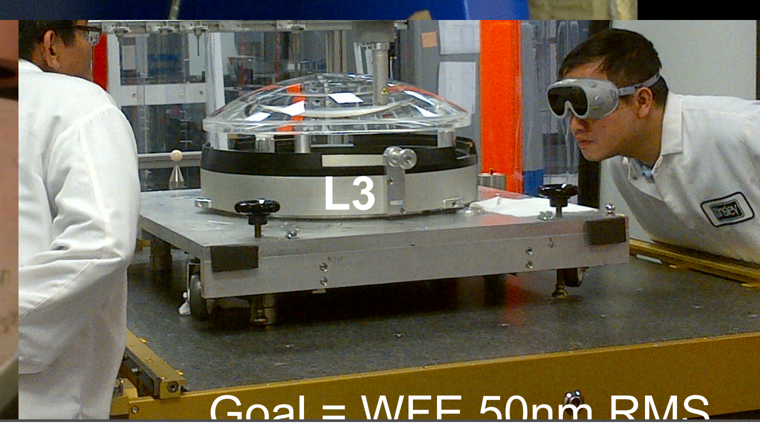


JST/T250



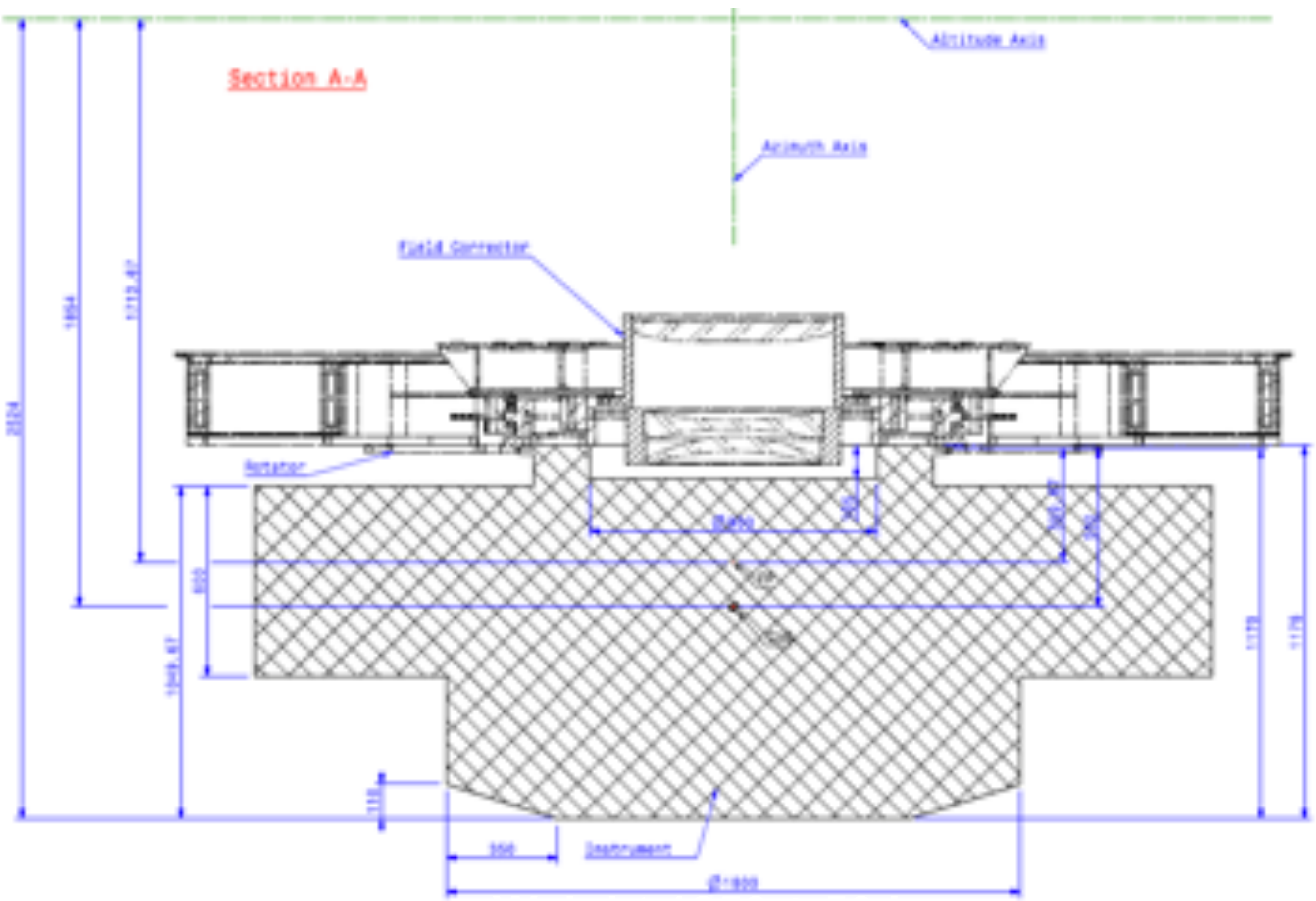


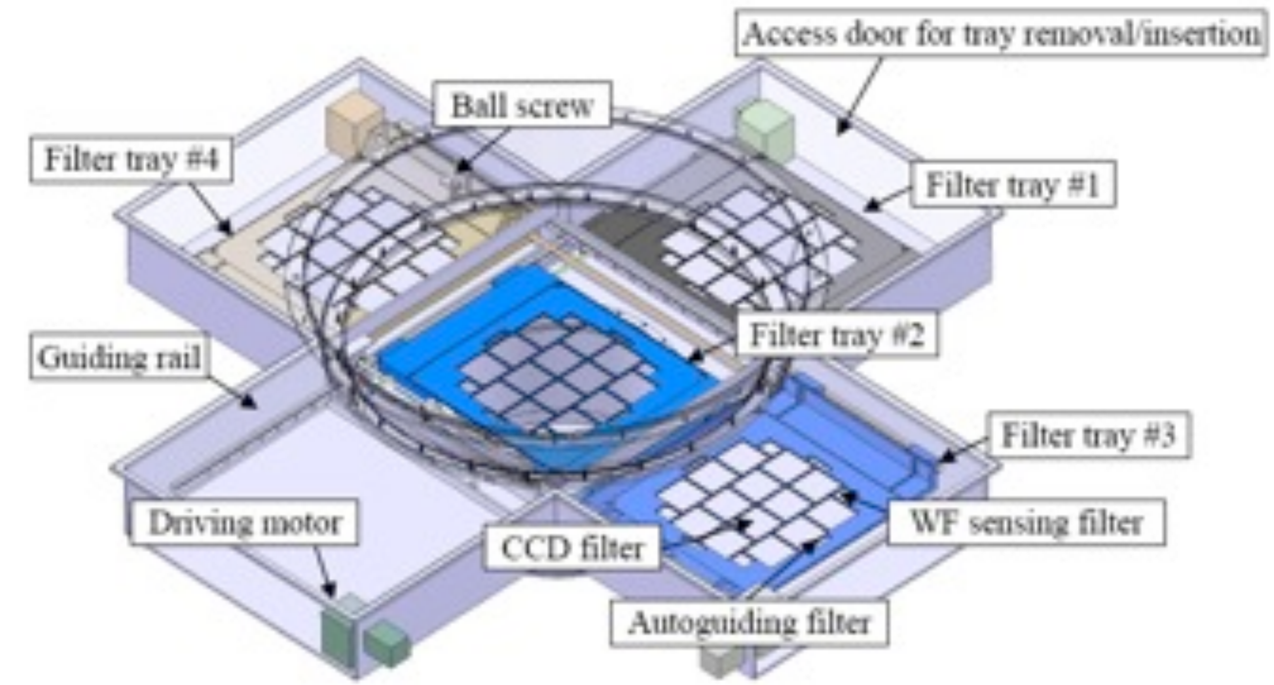


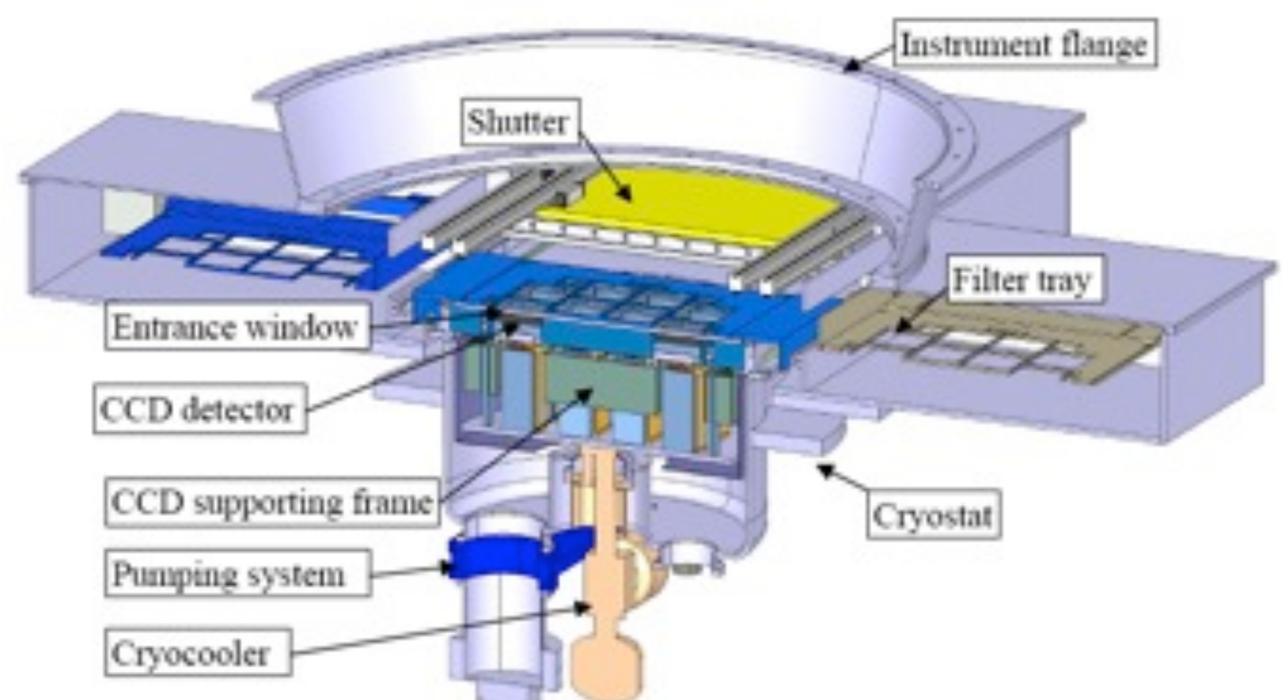


http://arxiv.org/abs/1301.4175   Taylor et al. 2013

J-PCAM: A PANORAMIC CAMERA @ T250 FOR J-PAS







The the 56 J-PAS filters can be **simultaneously** located at J-Pcam.

Conceptual Design by AMOS

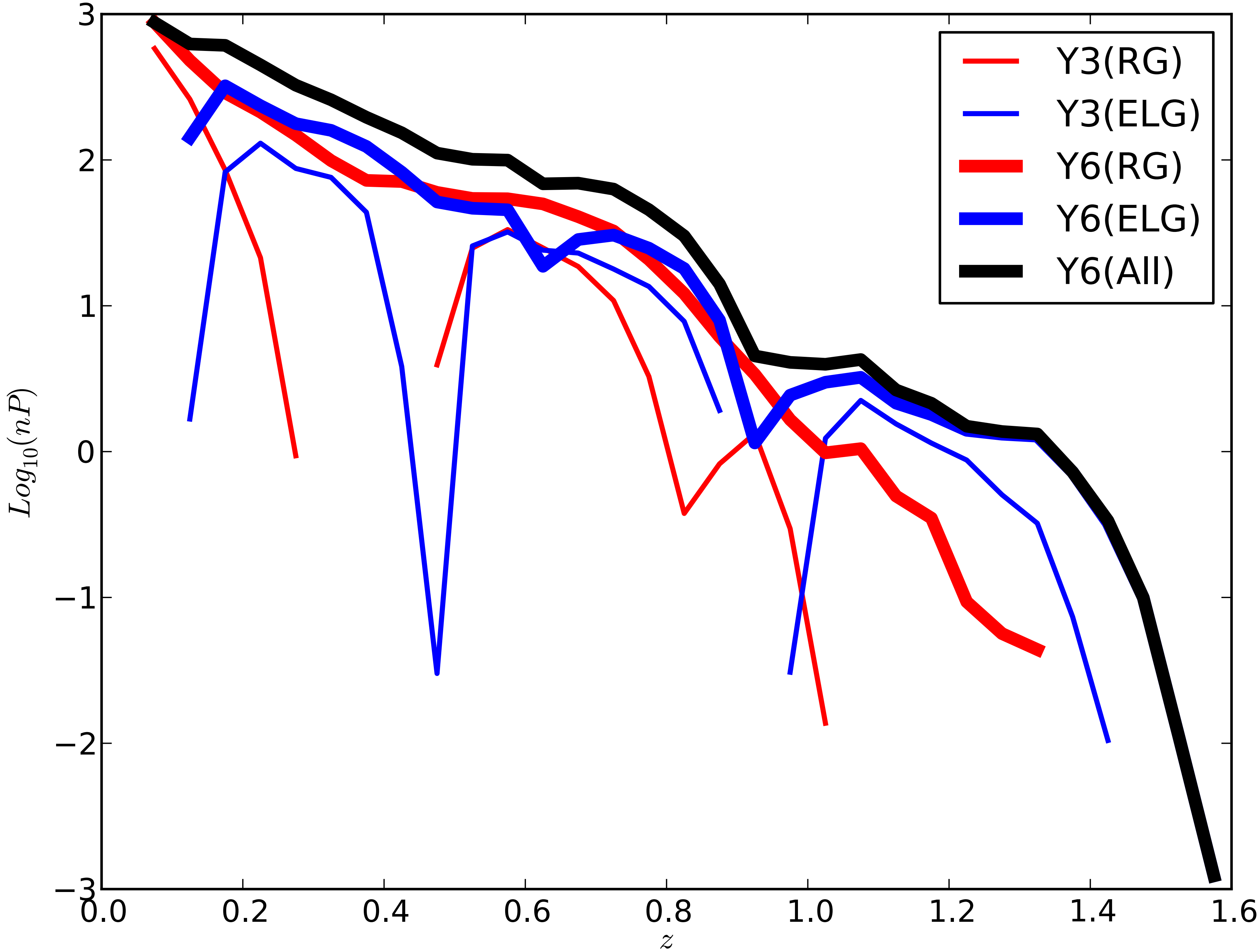
DATA MANAGEMENT

UPAD: Teruel Data Center, 2.5PB, 300 cores

- JPAS raw data ~1PB of data
- Real storage needs ~2PB
- Pipelines: scaled ALHAMBRA pipelines +SWARP

Gradually increasing data flow, time to fine tune: JPLUS(2013), JPAS-Pathfinder (2014), JPAS(2015)

"J-PAS data management pipeline and archiving", Cristóbal Hornillos et al. 2012, SPIE 8451



'ig. 7.— Product of the galaxy density for Red Galaxies (RG) and Emission Line galaxies (ELG) by he power spectrum (taking into account the corresponding bias) for different stages of completion f J-PAS

SN-all types

- Automatic census of ***all*** SN types in regions of the survey with appropriate cadence
- Multiband observations provide automatic classification by type
- ~6000 SNIe survey (PI: Masao Sako)

Weak lensing

- Javalambre has excellent seeing conditions (median ~0.7 arcsec)
- Good seeing is quite stable in time
- Broad band “detection image” with r~25 : unique resource for lensing

Cluster counting

- Automatic census of most $L>L^*$ galaxies for $z<1$
- High photo-z resolution: lower mass detection threshold
- Best optical cluster catalog available for $z<1$
- SED information available: use stellar mass as calibrator for total mass

Galaxy Evolution

- Low-res spectroscopy of everything up to $I<22.5$
- Filter set carefully designed to detect emission lines in the local universe
- Redshifts for every $L>L^*$ for $z<1$
- High quality broadband imaging: morphological classification, mergers

More Science

- QSOs: Unique survey, few M QSOs with 0.2-0.3% photo-z to $1<z<3$
- Stars: halo + area in the galaxy
- Asteroids: rotation spectrum
- GRBs
- Low-res spectroscopy of transients!
- Serendipitous discoveries, low frequency objects, etc.

TIMELINE

Summer 2013:

T250 delivery & on-site integration/JPLUS Survey(T80)

Fall 2013:

T250 commissioning starts

Early 2014:

JPAS-Pathfinder Survey, 0.35sq.deg camera

200 sq.deg by year end, verify all pipelines, algorithms

Fall 2014:

JPCAM delivery by E2V

Early 2015: Full JPAS survey starts

~2018: FoM~300 threshold reached

End 2021: Full survey finished

JPAS

FIRST STAGE IV experiment, starting in 2015

Conservative FoM ~ 300 by ~2018, FoM~500 by 2021

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

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

~ 400M 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 data for many Astrophysical areas

Done in Spain, 85% funded from Spain (but only 1-2% from regular science funds!)

COMING SOON!