Galaxy Clusters in the CFHTLS

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CFHTLS Cluster Collaboration

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Outline

- Science goals
- Cluster samples: CFHTLS in context

    cluster surveys

    detection methods
- First samples extracted from the CFHTLS
- Issues
- Summary

Science goals

- **Cosmology :**

  - Abundance and cluster mass function

  > N(z,m) <

- **Physics of galaxy clusters : from z = 0 to 1**

  at z ~ 1 cluster sample of 300-400 clusters

  - Fraction of merging clusters
  - Large scale environment
  - Luminosity function
  - Mass – observable relation
  - SFR (B.O., Red sequence, …)

Some numbers for current cluster surveys

Low-z	Mid-z	High-z	« Desert »	Lyman-break proto clusters
z < 0.5	0.5 < z < 0.8	0.8 < z < 1.5	1.5 < z < 2.2	2.2 < z
1000’s	100’s	10’s	1’s	10’s

Blind detection of galaxy clusters

Origin	Mean	Redshift	Pro's	Con's
gas	X		Limited projection effects	time consuming contamination
gas	SZ	any	Limited projection effects	resolution
DM	lensing	not high	access to mass	projections
galaxies	Opt	z < 1.4	area	projection effects
	+NIR	z < 1.6		
	+IR	z < 2.2		

Detecting clusters from optical data

- **Filtering methods**

  improve the detection of galaxy overdensities by making some assumptions: morphology, radial profile, galaxy populations,..

  derived product :   built in redshift / richness

  - *Matched Filter*
  - *Filtering in colour space:*
    - => Red-sequence (2 bands)
    - => Photometric redshifts (5 bands)

- **Weak lensing**   [Gavazzi & Soucail 2006, see G. Soucail's talk]

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Essential to drive these various approaches in parallel in order to understand possible biases generated by the various assumptions for detection and characterisation.

Some optical surveys of clusters

Survey	Filters	meth.	Surface (deg²)	#Patch	z
NSOCS	DPOSS	AK-V	2700	4	<0.5
SDSS	UGRIz	MF-RS	8000		<0.3
Postman	I	MF	16	1	0.-1.2
EIS	B-V-I	MF	15	4	0.-1.2
RCS	r-z	RS	90	22	0.5-1.4
RCS2	g-r-z	RS	~800		0.5-1.4

Galaxy clusters & CFHTLS

- 170 deg² spread in 4 patches

  5 bands, contiguity & depth !

  In the optical domain: without any competitor for high redshift clusters statistical studies.

  RCS2 – (grz) shallower => target most massive clusters

  => Dark Energy Survey / LSST

- Surveys at other wavelengths

  (XMM-LSS - Galex – Ukids-Wircam - Swire - VLA)

  10 deg2 in W1

Extracting cluster samples from the CFHTLS-Deep

- Setting the parameters of the various detection algorithms for the Wide fields
- Availability of well controled photometric redshifts
- D1: presence of the XMM-LSS survey

Matched Filter

- Needs only a one pass-band galaxy catalogue
- Filtering assuming for the clusters : a profile [Hubble] and a LF

$$\begin{aligned} D(r,m) &= \mathrm{background} + \mathrm{cluster} \\ &= b(m) + \Lambda_{cl} P(r/r_c)\phi(m-m^*) \end{aligned}$$

- Maximum Likelihood maps at each redshift
- Noise filtering
- Catalogue including redshift and richness

-Applied to the i band (Olsen, Benoist, Cappi et al. 2006)
-Applied to r & z bands (Olsen et al. in preparation)

MF : threshold choice

Real data

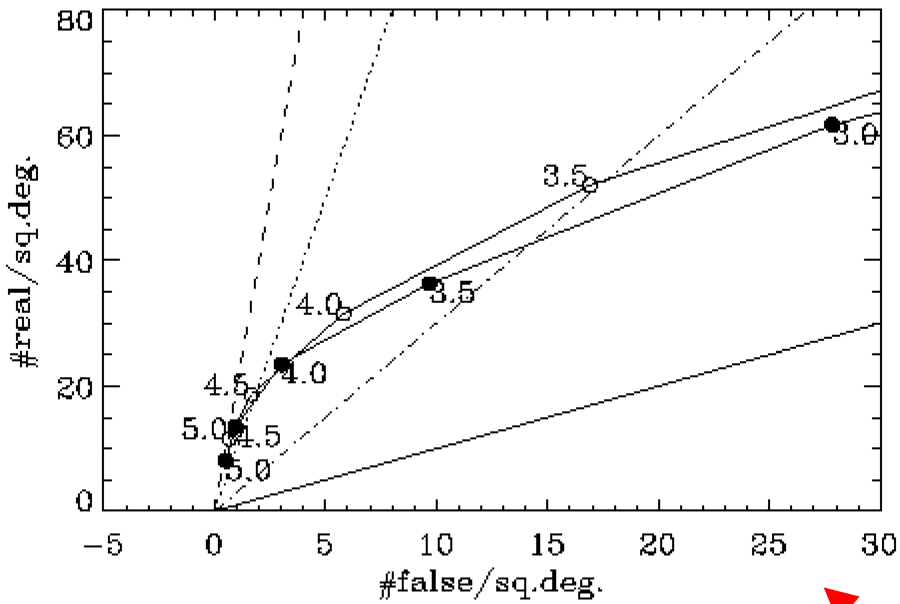


Fig. 3. The number of real and false detections per square degree for different detection thresholds and minimum area. The number of false

Mock correlated backgrounds

Choice : 3.5σ => 30% de false detections

MF : i-band results

⇒Total density = 52 /deg2

⇒Visual inspection of all systems

- -grade A : spatial and colour concentration ~20 / deg^2
- -grade B : colour part relaxed ~15 / deg^2
- -grade C : doubtful
- -grade D : remaining masking issues

⇒Validation by photometric redshifts

⇒Consistent with 30% false detections

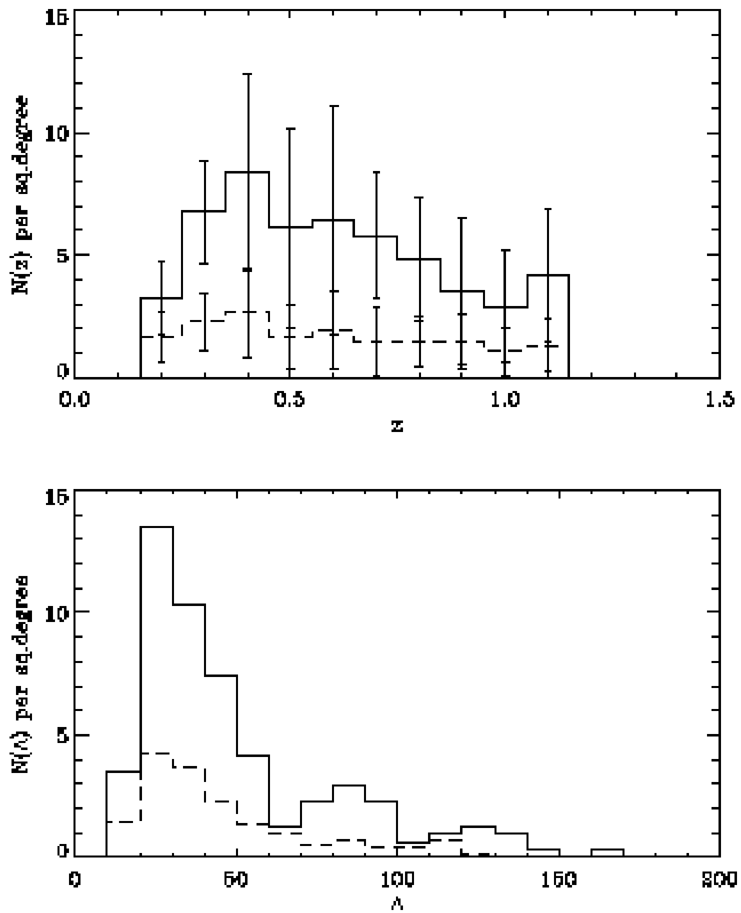


Fig. 11. Redshift (top) and richness (lower) distributions (solid lines) for all the candidate clusters. The distributions of false detections (dashed lines) are estimated using the correlated backgrounds. For the redshift distribution the error bars denote the scatter between the fields.

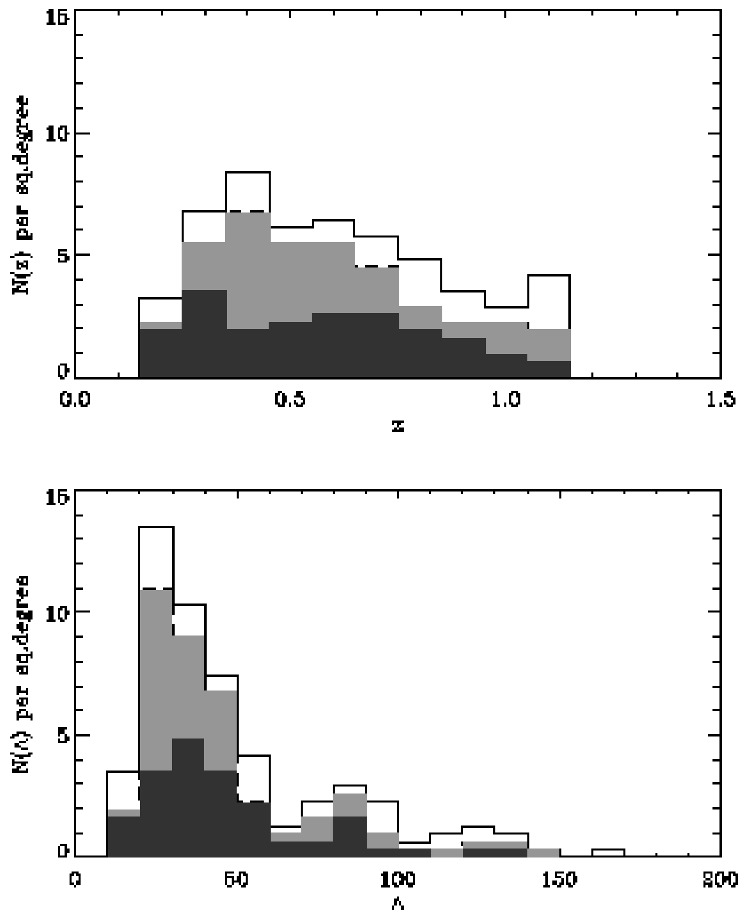


Fig. 12. Redshift (top) and richness (lower) distributions for all the candidate clusters (solid lines) and marking the grade A (dark grey) and B (light grey) systems.

[Olsen, Benoist, Cappi et al. 2006]

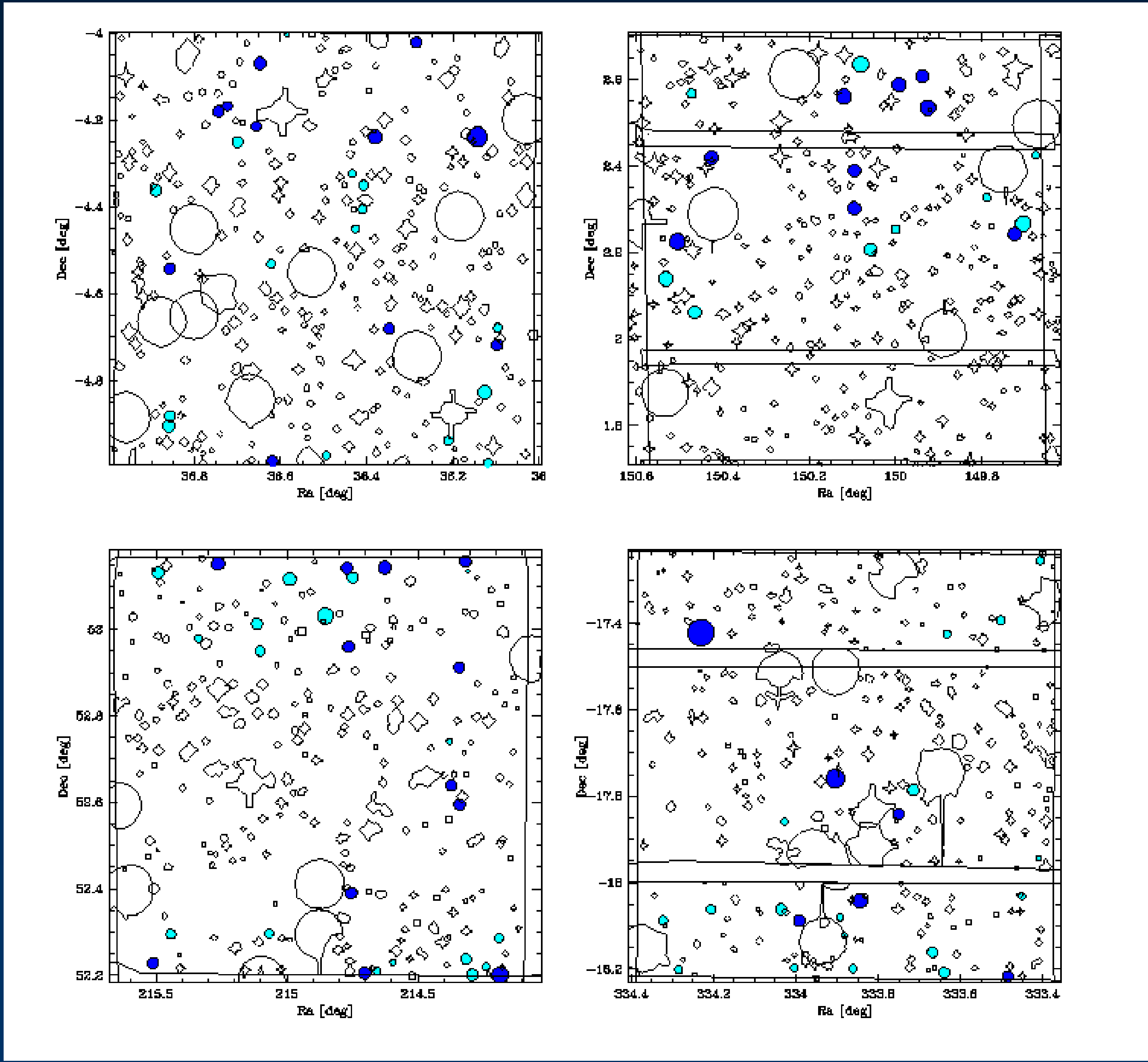
Z < 0.6

D1

D2

D3

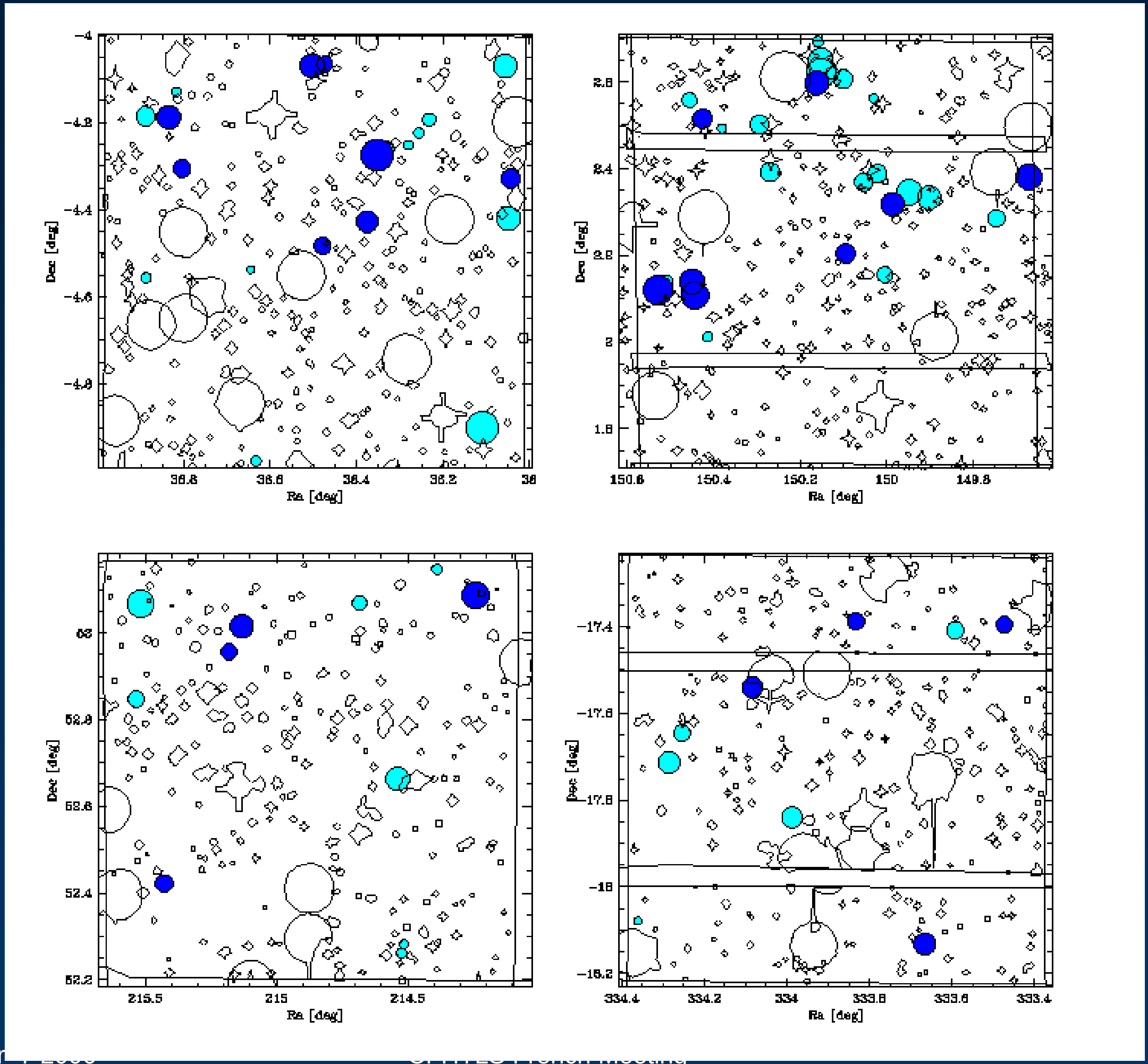
D4



z > 0.6

D1

D2



D3

D4

Z = 0.7

5’

Z = 0.9

5’

Comparison to other optical catalogues

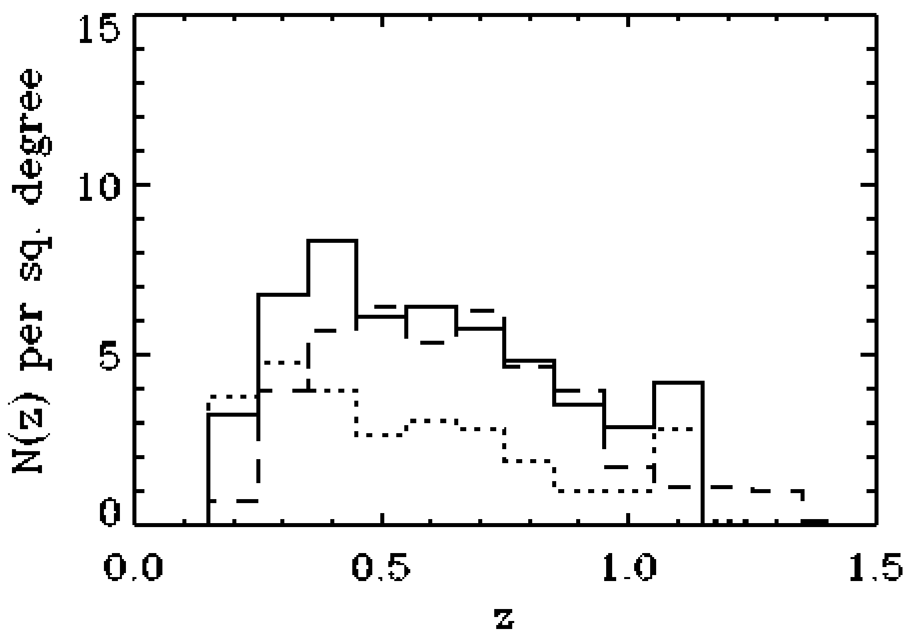


Fig. 15. Comparison of redshift distributions for the CFHTLS (solid line), KPNO/Deeprange (dotted line, Postman et al. 2002) and RCS (dashed line, Gladders & Yee 2005) cluster catalogues.

MF : r- & z-band results

- r-band does not bring much
- z-band appears essential at z>0.8

[several additional grade A systems / deg^2]

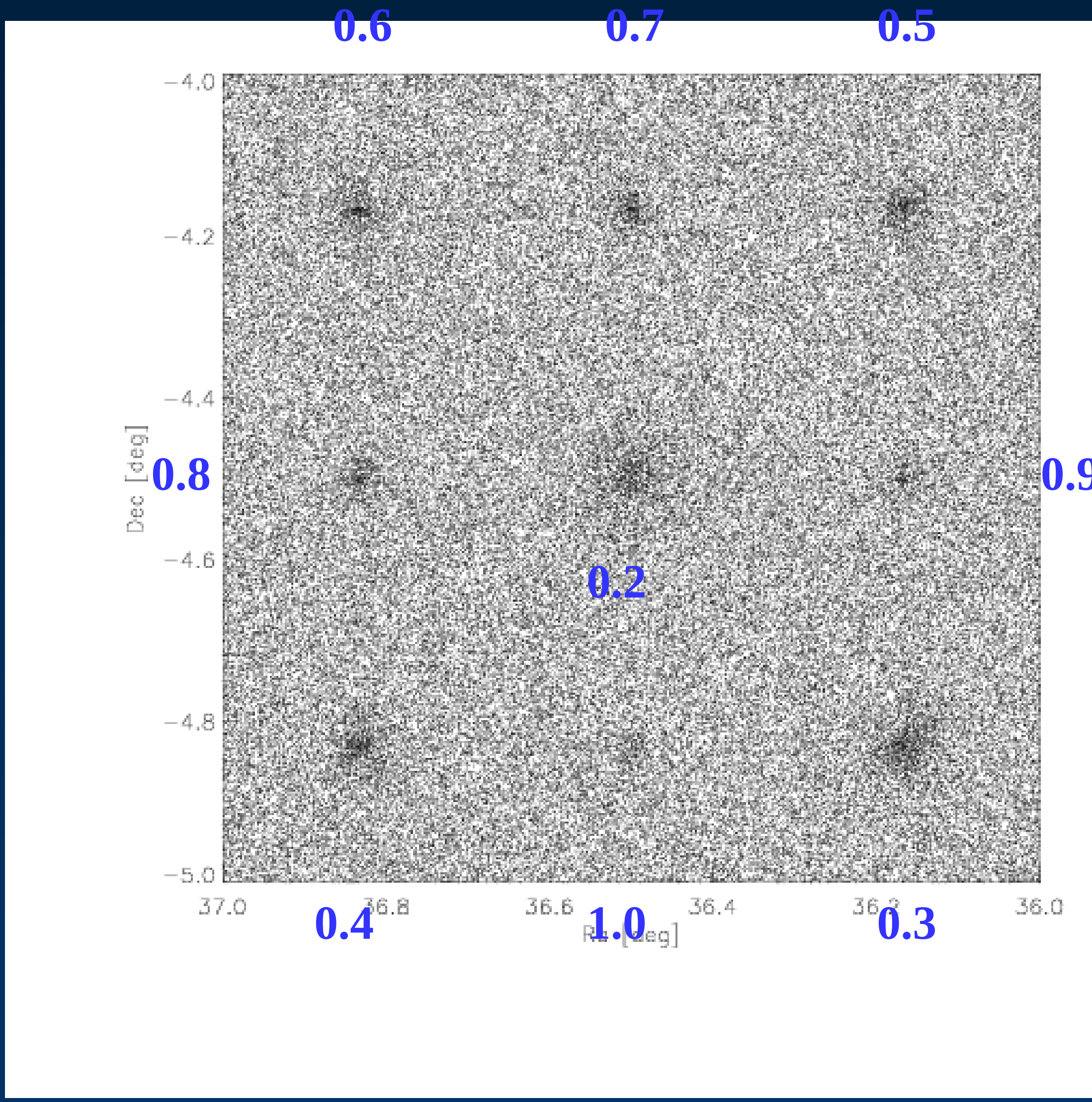
Only in z-band

z = 1.0

5’

Selection function – first steps

- Clusters resembling the model of the filter
- Richnesses R ~0 – ~4, 9 steps
- 20 clusters of each combination in z and R
- Correlated background simulations



Selection function : first estimate

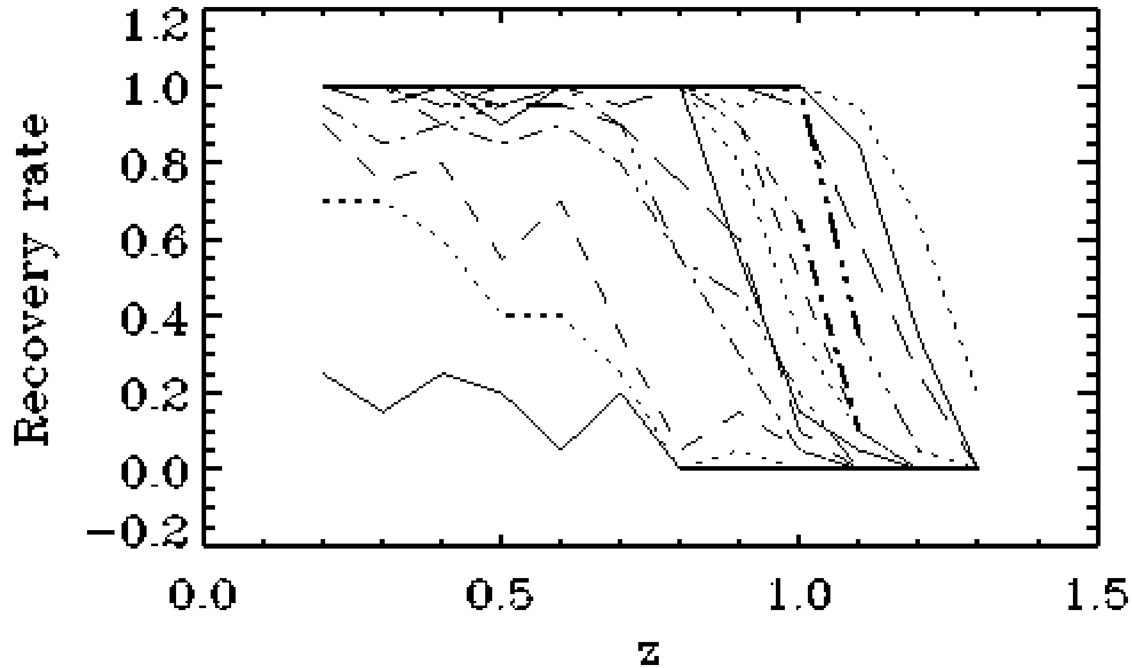


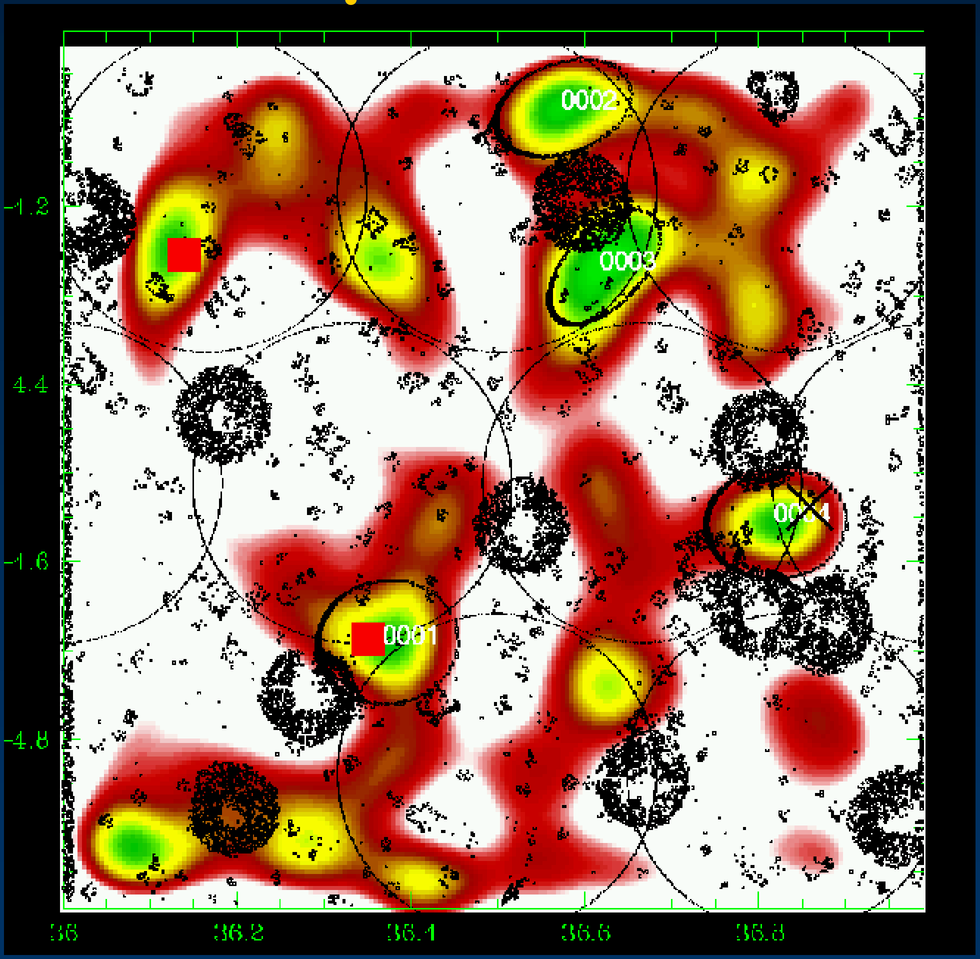
Fig. 5. The detection efficiency for the correlated background $\sigma_{det} = 3.5\sigma$, area$\sim \pi(0.5r_c)^2$. The lines correspond to $\Lambda_{cl} = 10 - 300$ from left to right.

Photometric redshift filtering

- Galaxies selected in photometric redshift slices of width 0.1 between z=0 and z=1.5
- Adaptive kernel
- Pics extraction – S/N by bootstrap
- Association of the slices

(Mazure, Adami et al. 2006, submitted)

Photometric redshift filtering
example of a slice



(Mazure, Adami et al. 2006)

Photometric redshift filtering: results

- Applied to D1
- Results: density ~ 50 /deg^2 with $z = 0 – 1.5$

Comparison MF / Zphot / XMM

MF grade A systems

- XMM / Zphot
- Zphot

MF:<Δz> = -0.02

scatter = 0.12

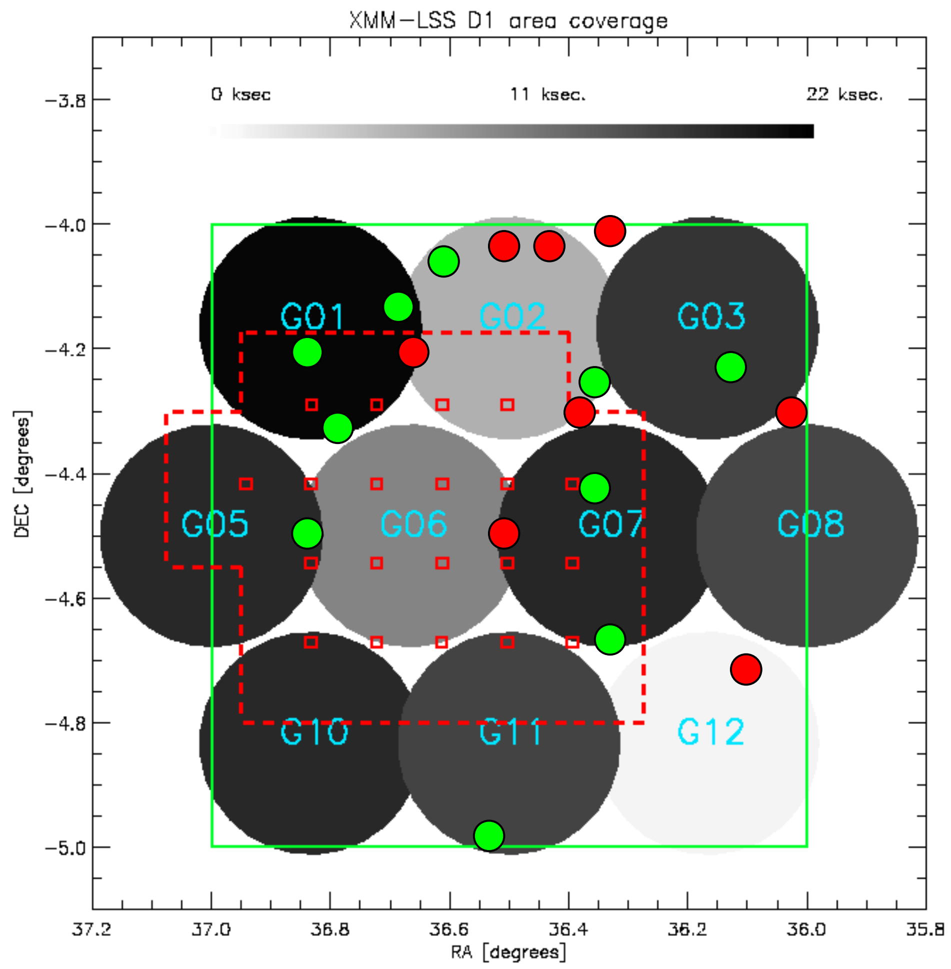
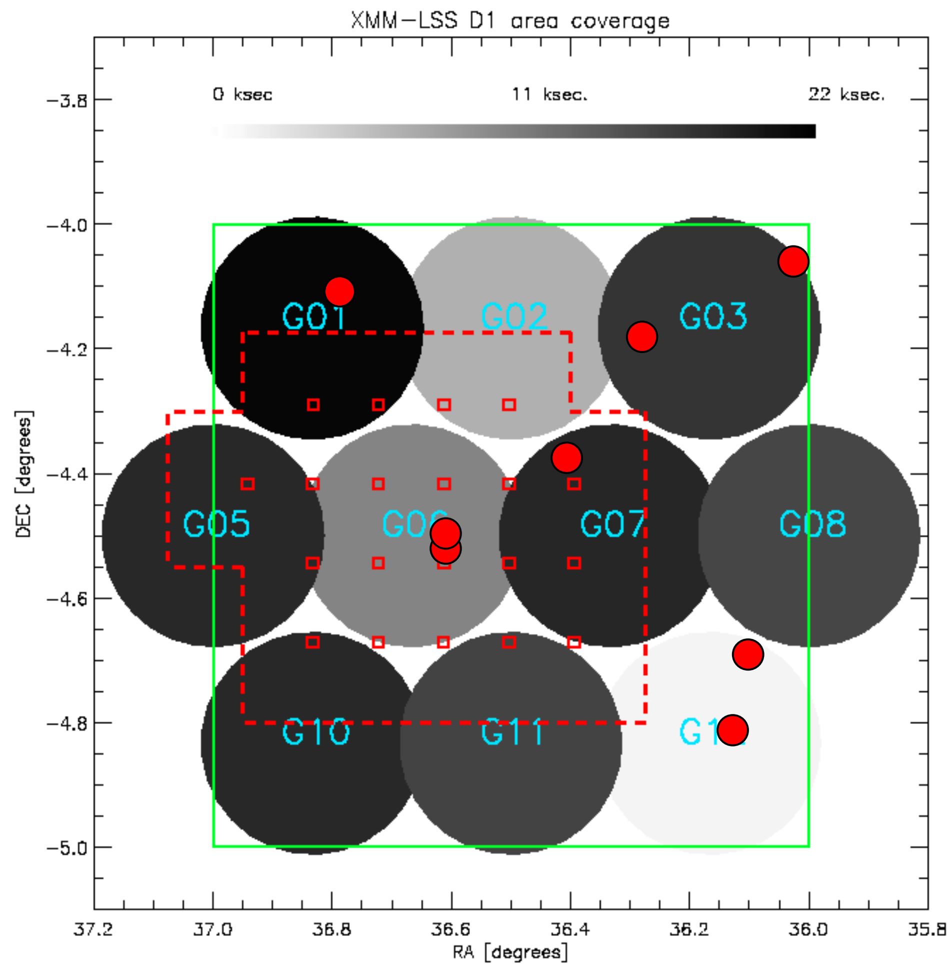


Figure 1. The XMM pointing mosaic over the D1 area (green square). The radius of the displayed pointings is 11 arcminutes. The grey-scale indicates effective mean exposure time per detector, after removal of high background periods. The red squares show the centres of the VVDS pointings (Ilbert et al. 2005) and the red dotted line indicates the total area covered covered by the VVDS. The VLA-VIRMOS Deep Field encompasses exactly the D1 region

Comparison MF / Zphot / XMM

MF grade B systems

MF / Zphot



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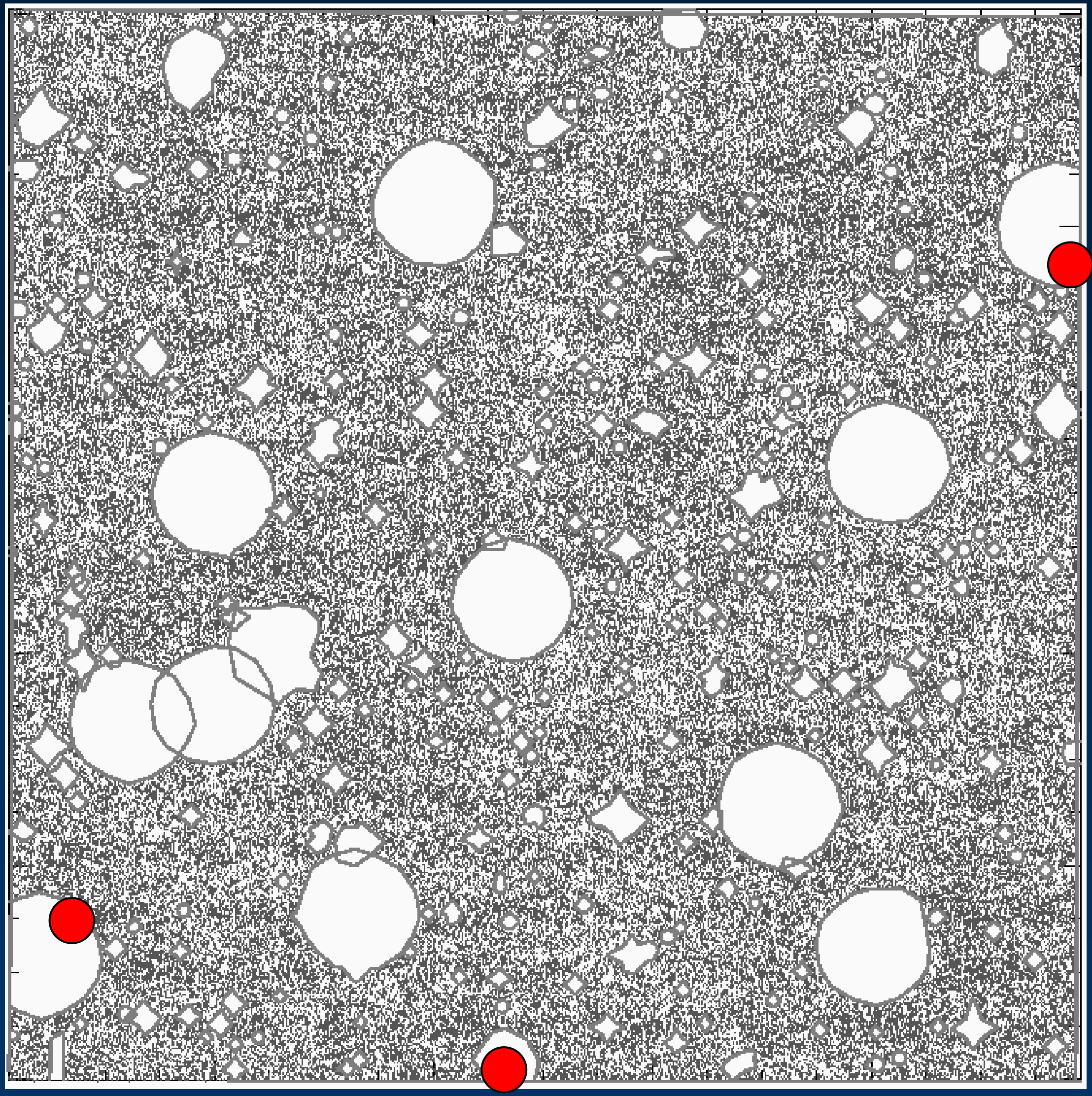
D1 : some XMM-LSS lost in the optical catalogues



Several issues

- Controle biases & systematics
- Build up a realistic selection function
- Tests within various cosmologies
- Mass – observable relation

⇒ Realistic galaxy mock catalogues and associated clusters

⇒ Multi-λ / spectroscopy for calibration purposes

Several recent studies show that an optical richness could be used as a mass tracer within a large survey strategy (Popesso et al. 2005; Hicks et al. 2006; Biviano et al. 2006; etc.)

Simulations

Construction of galaxy Mock catalogues (CFHTLS – Wide & Deep) & associated cluster catalogues.

=> Th. Sousbie – J. Devriendt – H. Courtois (CRAL)

Method :

Large DM simulations
(1000 h^{-1}Mpc, 512^3 part.)

+

Smaller DM simulations
(100 h^{-1}Mpc, 256^3 part.)
+
GalICS

↓

Large scale distributions and characteristics of galaxies

CFHTLS - Wide Perspective

Selection Function

Detection

Realistic Mocks

N(z,m)

MF

RS

Photo-z

Spectro

Mass - Observable

Optical luminosity

WL

X

[*substructures*]

Dedicated Database at OCA

Administrate:

- the progress of the survey
  - Geometry of the Wide
  - Available bands and depth at a given time
  - Various versions of galaxy catalogues (masks...)
- cluster detection
  - Unsupervised detection
  - Several detection methods & configurations
- the analysis of clusters or cluster catalogues
  - analysis toolbox
  - Creation of an “id card” for each cluster
  - Include multi-λ / spectroscopic information

Applications Raccourcis Système ven 13 oct, 11:09

Clusters database - Firefox

File Edit View Go Bookmarks Tools Help

http://athena/cluster/search2.html Go plusieurs versions

Getting Started Latest BBC Headlines

DATABASE QUERY

CATALOGUE CONSTRAINTS:

Field:

Deep Survey	Wide Survey
☐ D1	☐ W1
☐ D2	☐ W2
☐ D3	☐ W3
☐ D4	☐ W3

Detection method:

- ☐ Matched_Filter-i band
- ☐ Matched_Filter-z band
- ☐ Red_Sequence
- ☐ Photometric_Redshift

Catalog version:

- ○ all versions
- ◉ last version

CONSTRAINTS ON CLUSTER PROPERTIES:

Done

Applications Raccourcis Système lun 16 oct, 17:09

41 clusters found - Firefox

File Edit View Go Bookmarks Tools Help

http://athena/cgi-bin/cluster/list.py Go

Getting Started Latest BBC Headlines

Search result: 41 clusters found

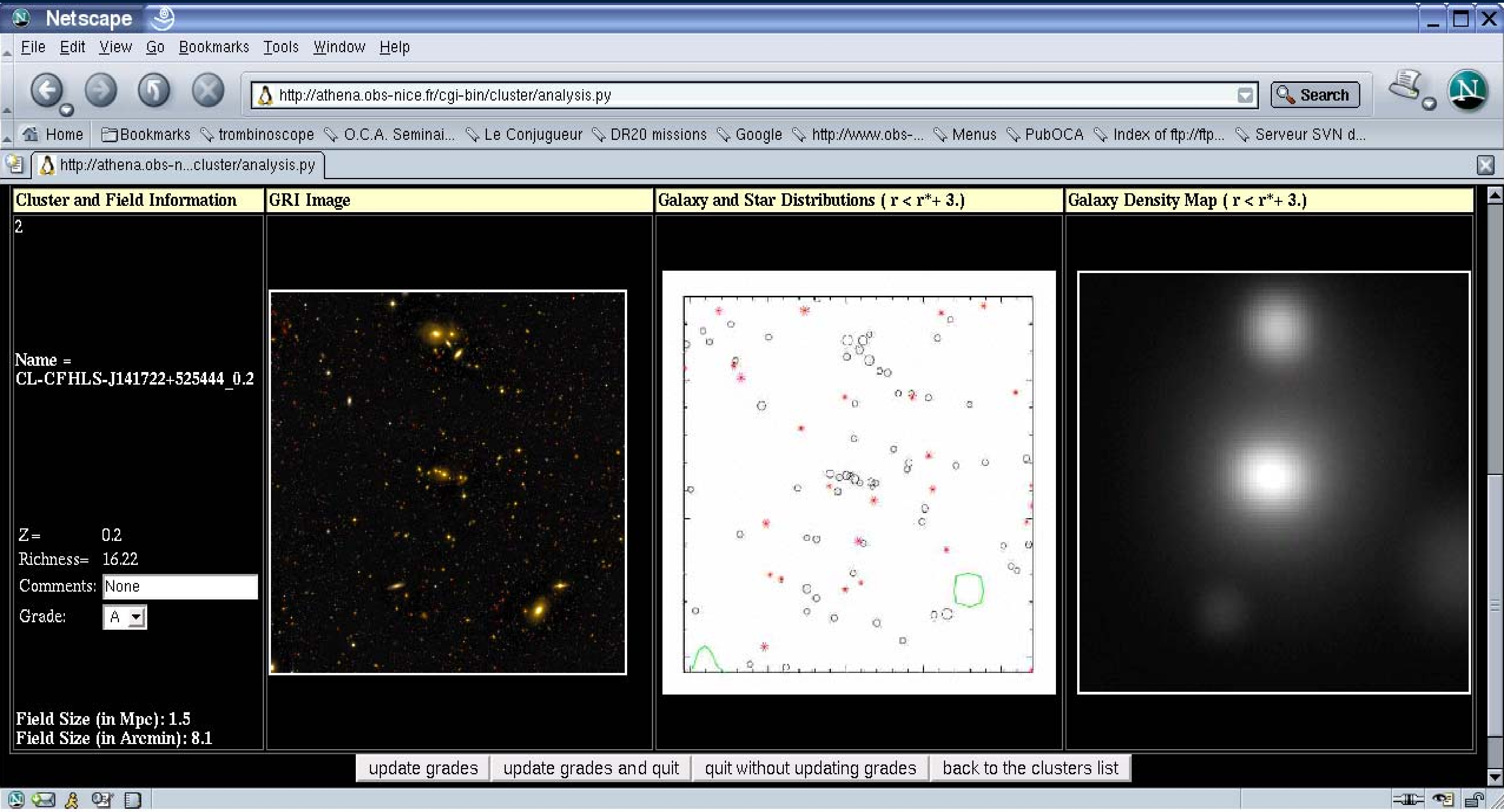
Select clusters in the table below and save to a file with the "save" button

Select clusters in the table below and perform their analysis with the "analysis" button

select all Clear Save Analysis

	field	detection	name	ra	dec	z	Richness	grade	Date	Version
☐	D2	Matched_Filter-i_band	CL-CFHLS-J095945+023627_0.3	149.9380	2.608	0.3	25.70	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J095854+021433_0.4	149.7260	2.242	0.4	23.92	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100043+014552_0.5	150.1820	1.764	0.5	28.44	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100035+020345_0.7	150.1470	2.063	0.7	43.81	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J095957+023512_0.5	149.9900	2.587	0.5	26.93	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100028+023339_0.5	150.1170	2.561	0.5	28.32	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J095942+023205_0.5	149.9250	2.535	0.5	41.40	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100022+021215_0.7	150.0940	2.204	0.7	44.22	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J095956+021905_0.7	149.9860	2.318	0.7	46.26	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100038+023552_0.8	150.1620	2.598	0.8	57.87	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100007+022107_0.8	150.0300	2.352	0.8	56.53	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100142+022510_0.2	150.4260	2.419	0.2	34.74	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100022+022322_0.2	150.0950	2.389	0.2	15.88	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100201+021331_0.6	150.5050	2.225	0.6	45.99	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100142+020351_0.3	150.4280	2.064	0.3	29.35	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100206+020714_1.0	150.5270	2.121	1.0	112.37	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100022+021801_0.3	150.0940	2.300	0.3	20.57	A	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J095947+022044_1.1	149.9480	2.346	1.1	130.50	B	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100202+020816_0.8	150.5110	2.138	0.8	76.27	B	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100024+023628_1.1	150.1010	2.608	1.1	133.98	B	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100131+022934_0.7	150.3810	2.493	0.7	45.42	B	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100139+020052_0.6	150.4130	2.014	0.6	32.36	B	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100036+023712_1.1	150.1520	2.620	1.1	148.96	B	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J095848+021600_0.6	149.7030	2.267	0.6	47.06	B	2006-05-15	1
☐	D2	Matched_Filter-i_band	CL-CFHLS-J100153+023403_0.3	150.4730	2.567	0.3	28.50	B	2006-05-15	1

Done


Netscape
File Edit View Go Bookmarks Tools Window Help
http://athena.obs-nice.fr/cgi-bin/cluster/analysis.py
Search
Home
Bookmarks
trombinoscope
O.C.A. Seminai...
Le Conjugueur
DR20 missions
Google
http://www.obs-...
Menus
PubOCA
Index of ftp://ftp...
Serveur SVN d...
http://athena.obs-n...cluster/analysis.py
Cluster and Field Information
GRI Image
Galaxy and Star Distributions (r < r*+ 3.)
Galaxy Density Map (r < r*+ 3.)
2
Name =
CL-CFHLS-J141722+525444_0.2
Z= 0.2
Richness= 16.22
Comments: None
Grade: A
Field Size (in Mpc): 1.5
Field Size (in Arcmin): 8.1
update grades
update grades and quit
quit without updating grades
back to the clusters list

Summary

⇒ We have demonstrated the possibility of detecting galaxy clusters up to $z > 1$ with several algorithms.

⇒ In D1 good consistency between X-ray and optical detections +additional systems from optical data

⇒ Preliminary selection function for MF

⇒ Extraction from the wide is on-going.

⇒Realistic mock catalogues for

- Systematics & selection function for all algorithms through realistic mock catalogues
- Testing Optical richnesses / mass scaling relations