The XMM Large Scale Structure Survey:

Scientific motivations and first results

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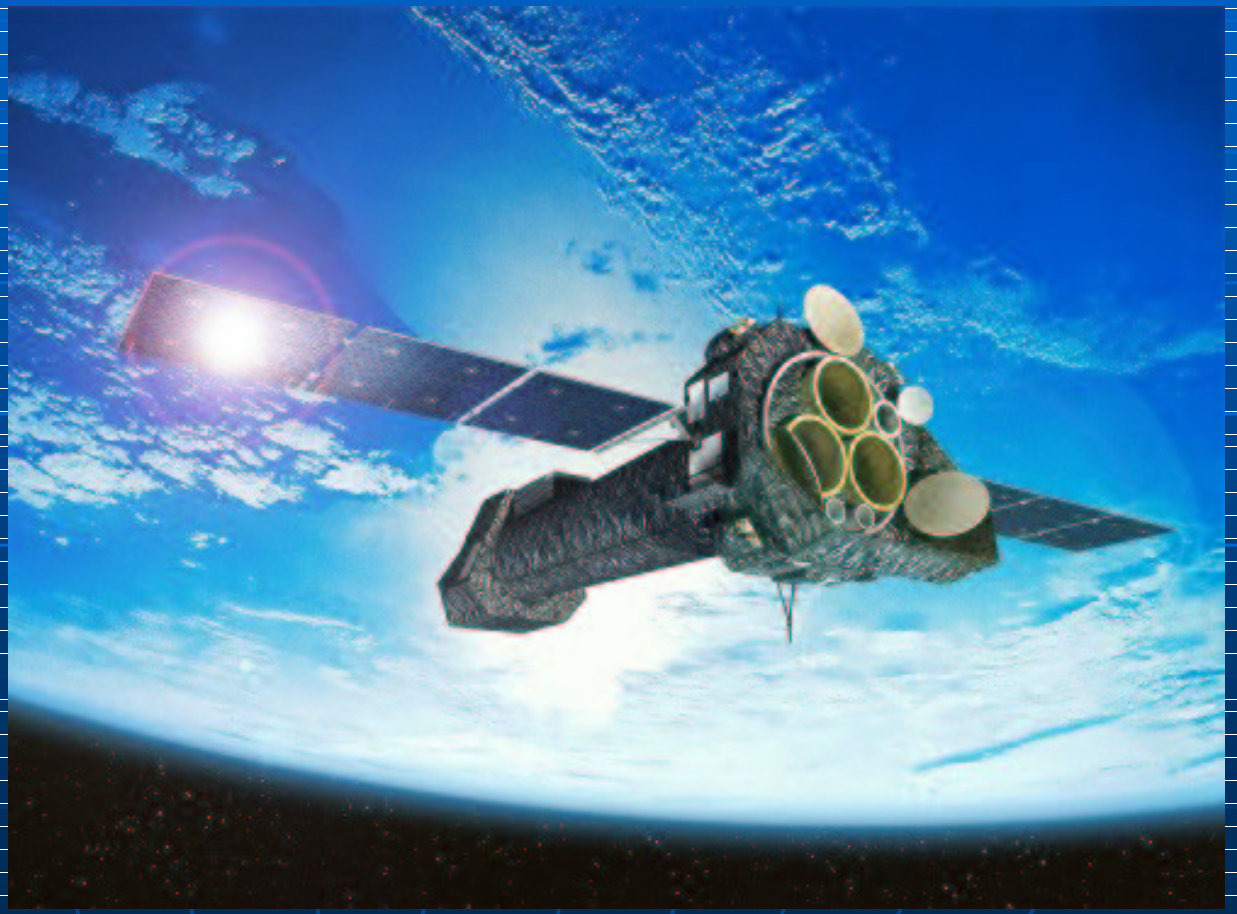
CEA Saclay

ESO/Santiago Oct. 2002

Plan of the talk

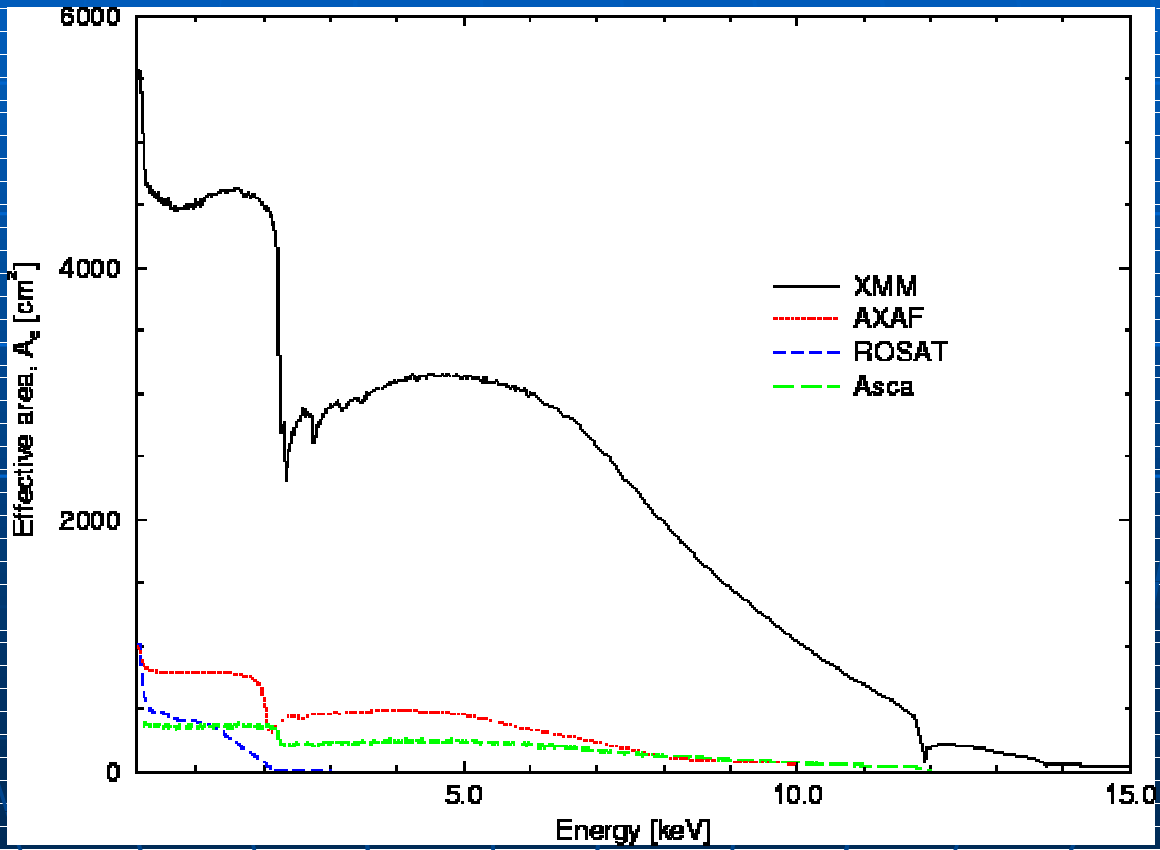
- Short overview of XMM
- The XMM-LSS survey - **main goal**
- The XMM-LSS survey - **further science**
- First results
- Demo : XMM-LSS cluster database

1. XMM



Launched: Dec 1999

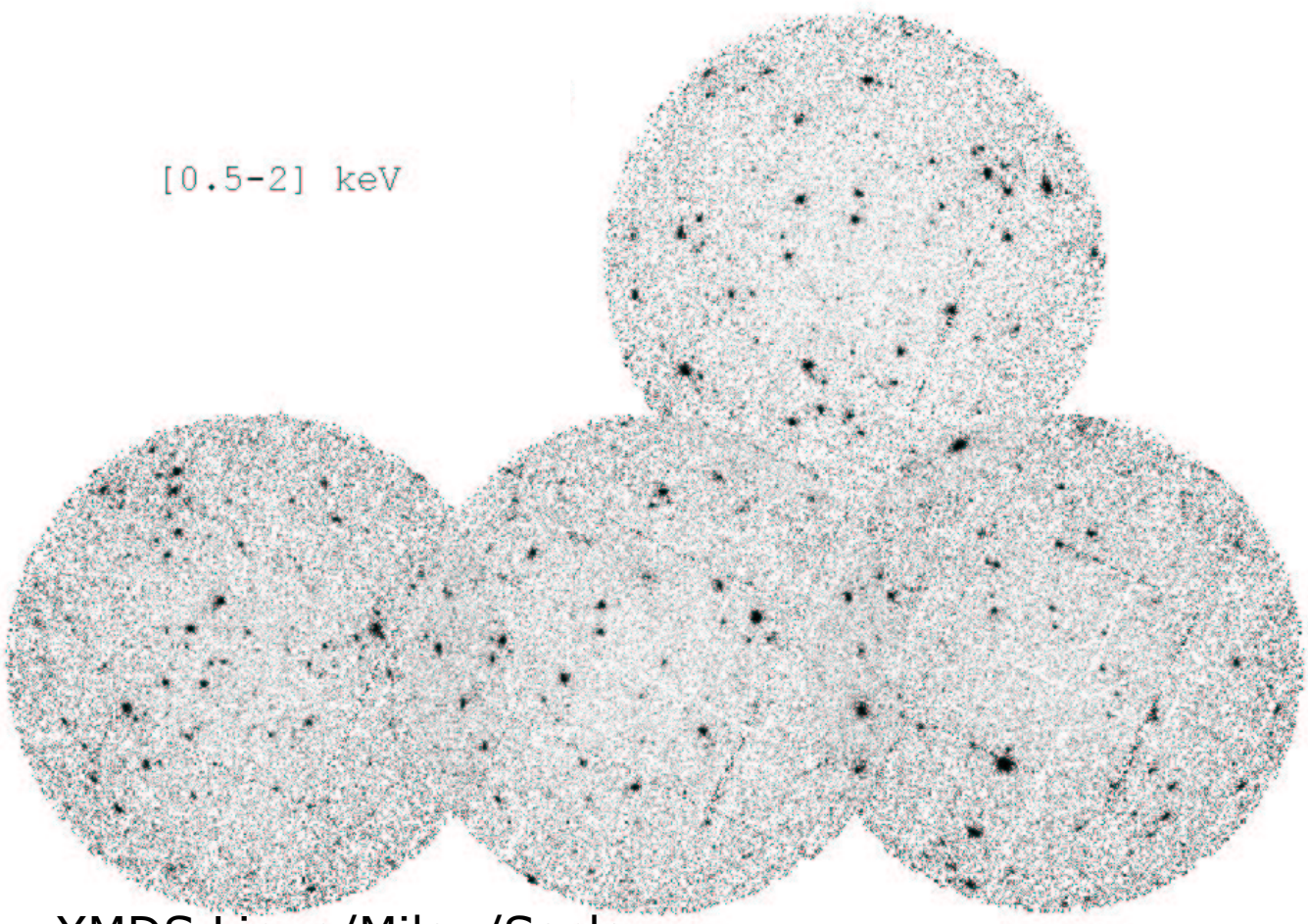
XMM sensitivity



125 A

1.25A

XMM field of view = 30 arcmin



XMDS Liege/Milan/Saclay

The XMM eye

FoV = 30 arcmin **on-axis PSF ~ 6" FWHM**

=> Clusters detected as extended sources out to z ~ 1-2

=> A high galactic latitude field observed by XMM is clean

Only two types of objects:

- QSOs: pointlike
- Clusters: extended

Thanks to its

- unrivalled sensitivity
- large field of view
- good PSF

XMM opens a new area for cluster LSS

X-ray cluster LSS Surveys

- So far : the REFLEX sample from the ROSAT All Sky Survey . $S = 3\ 10^{-12}$ erg/s/cm^2 *(Böhringer et al)*

  $z < 0.2$

  => the cluster correlation function with ~ 450 clusters

- Our goal : determine the cluster correlation function :

  in two redshift bins $0 < z < 0.5$ $0.5 < z < 1$

  each bin containing 450 clusters.

The XMM-LSS Survey

This has fixed the XMM-LSS survey characteristics:

a 8x8 deg2 area covered by 10 ks XMM pointings.

$\Rightarrow$ sensitivity 5 10^{-15} erg/s/cm^2 in the [0.5-2] keV band

A European/Chilean Consortium

PI : Saclay, France

- Birmingham
- Bristol
- Copenhagen
- Dublin
- ESO/ Santiago
- Leiden
- Liège
- Marseille (LAM)
- Milano (AOB)
- Milano (IFCTR)
- Munich (MPA)
- Munich (MPE)
- Paris (IAP)
- Santiago (Uni. Cato.)

2. The XMM-LSS survey

Primary science goals

GOAL

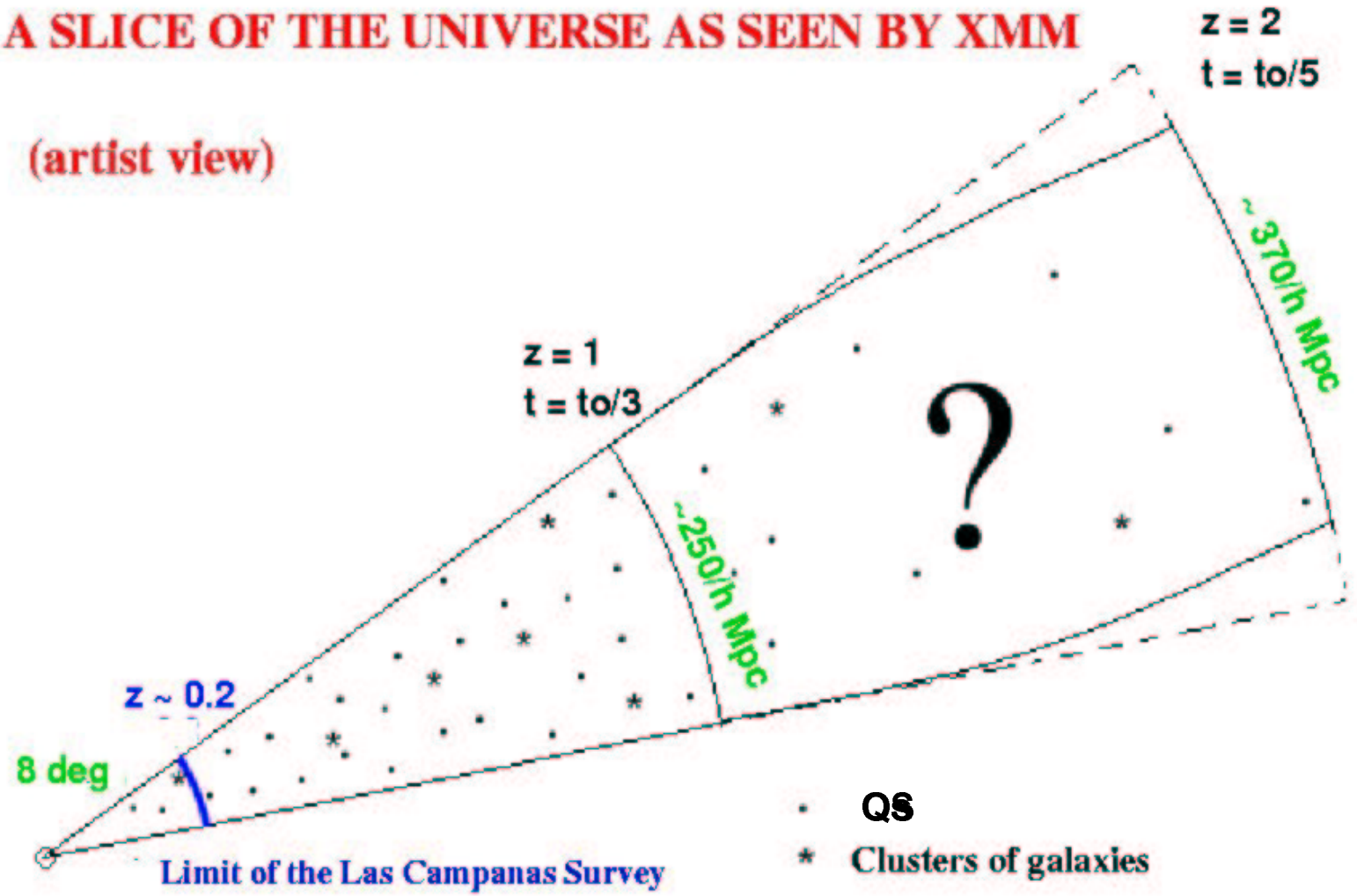
Map the evolution of LSS of the universe out to $z = 1$

with the galaxy cluster and QSO populations

For the first time !

A SLICE OF THE UNIVERSE AS SEEN BY XMM

(artist view)



Concept

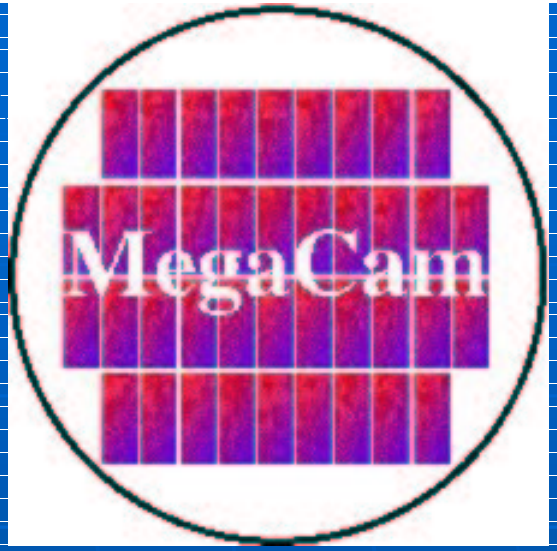
XMM observations

Optical imaging with the **CFHT Legacy Survey**

- Optical ID
- Spectroscopic survey with **FORS, VIMOS…**
- **Cluster and QSO** ξ
- **Weak lensing mass determination**

COSMOLOGY

The CFHT-LS



1deg FOV Camera for CFHT

Several patches at various depths.

The one centered on XMM-LSS will cover 10 x 10 deg^2 in :

u* = 25.5 g' = 26.5 r'=25.7 i' = 25.5 z'=24.0

At a rate of 15 deg^2/yr from mid-2003

Data reduction by

Terapix at IAP/Paris

Expected numbers of objects

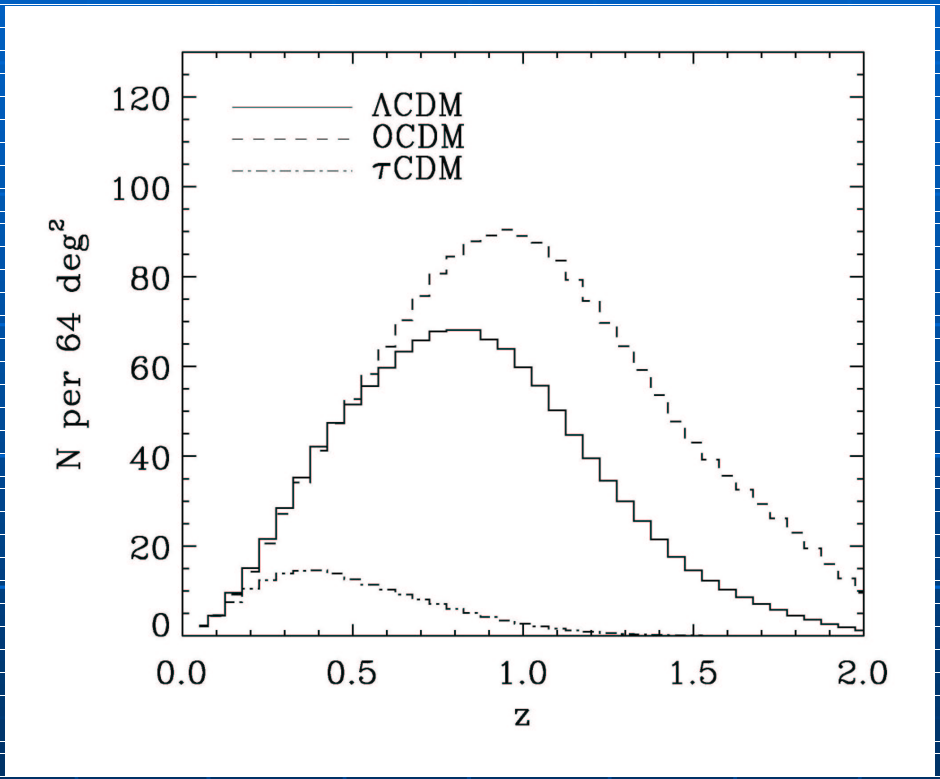
At the survey sensitivity: ~ 3E-15 erg/s/cm2 in [0.5-2] keV

~ 300 X-ray sources per square degree:

- 200 QSO/AGN (40% z < 1)
- 15 clusters z<1
- 5 clusters 1< z <2 ?
- Galaxies + stars

Expected number of clusters

over a 8x8 sq.deg area



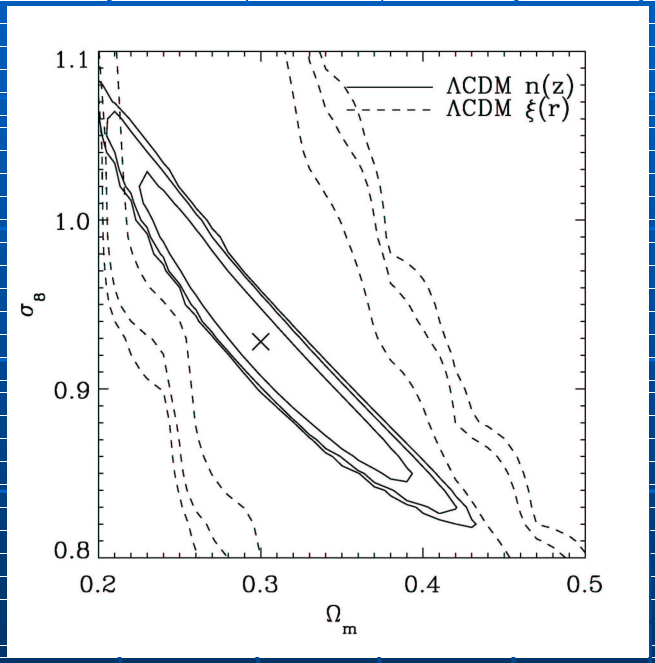
~ 900 clusters 0 < z < 1 for ΛCDM

~ 300 clusters z > 1

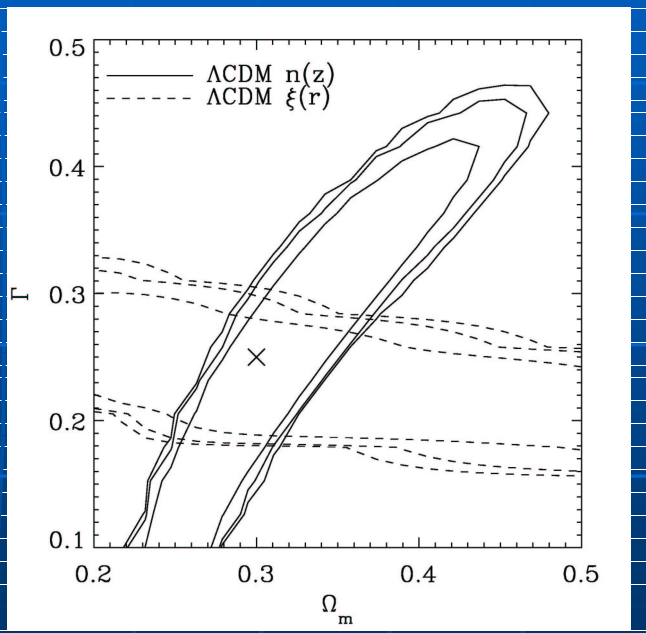
Refregier, Valtchanov & Pierre 2001

Cosmology with clusters
0<z<1

σ_8 / Ω_m



Γ / Ω_m

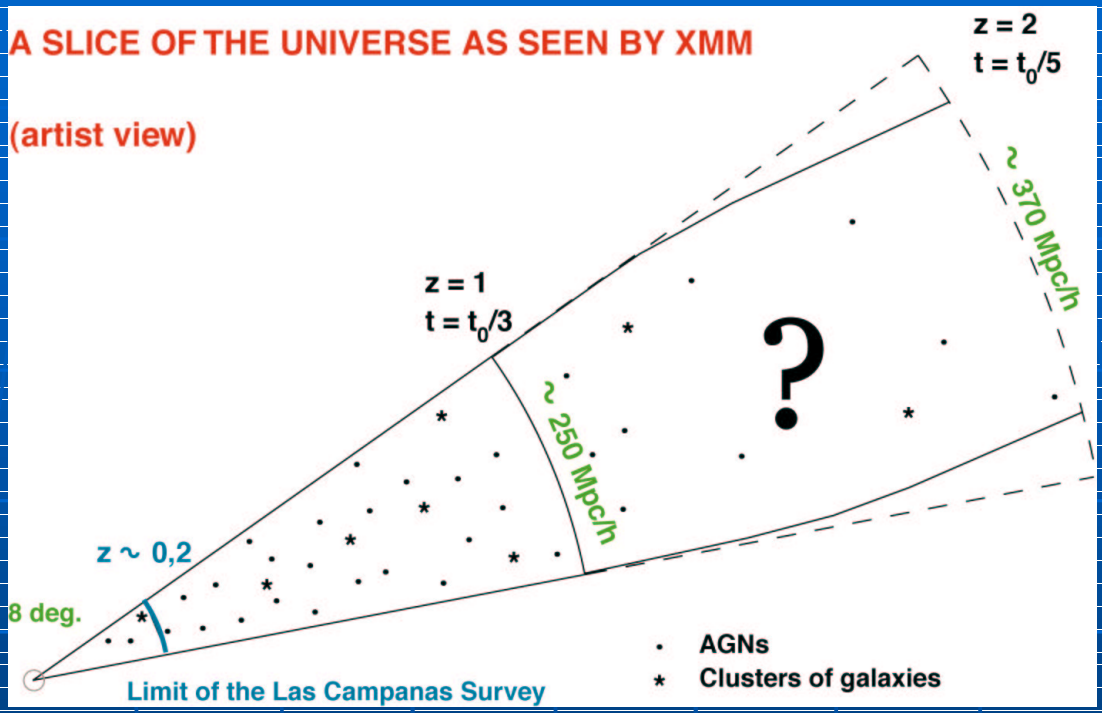


Confidence levels: 68%, 90%, 95%

clutser number density

cluster-cluster correlation fct.

Refregier, Valtchanov & Pierre 2001



Will provide cosmological constraints independent from CMB and SN

Cosmology with clusters
1<z<2

Probability to find a Coma-type cluster in the XMM-LSS (64 sq.deg.)

within 1.5<z<2 : 6.5×10^{-7}

(ΛCDM universe)

3. The XMM-LSS survey

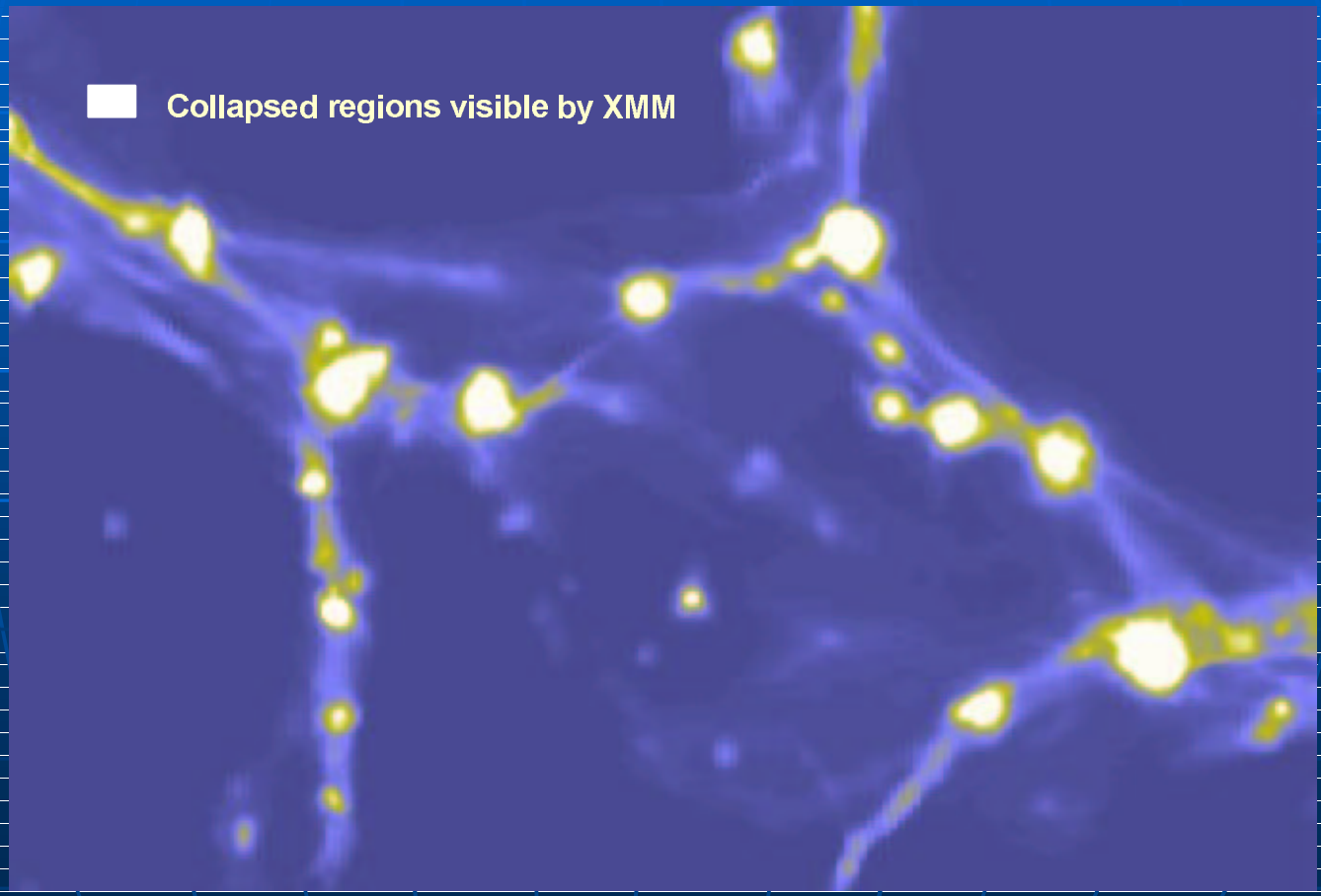
"secondary" science goals

From the multi-λ follow-up

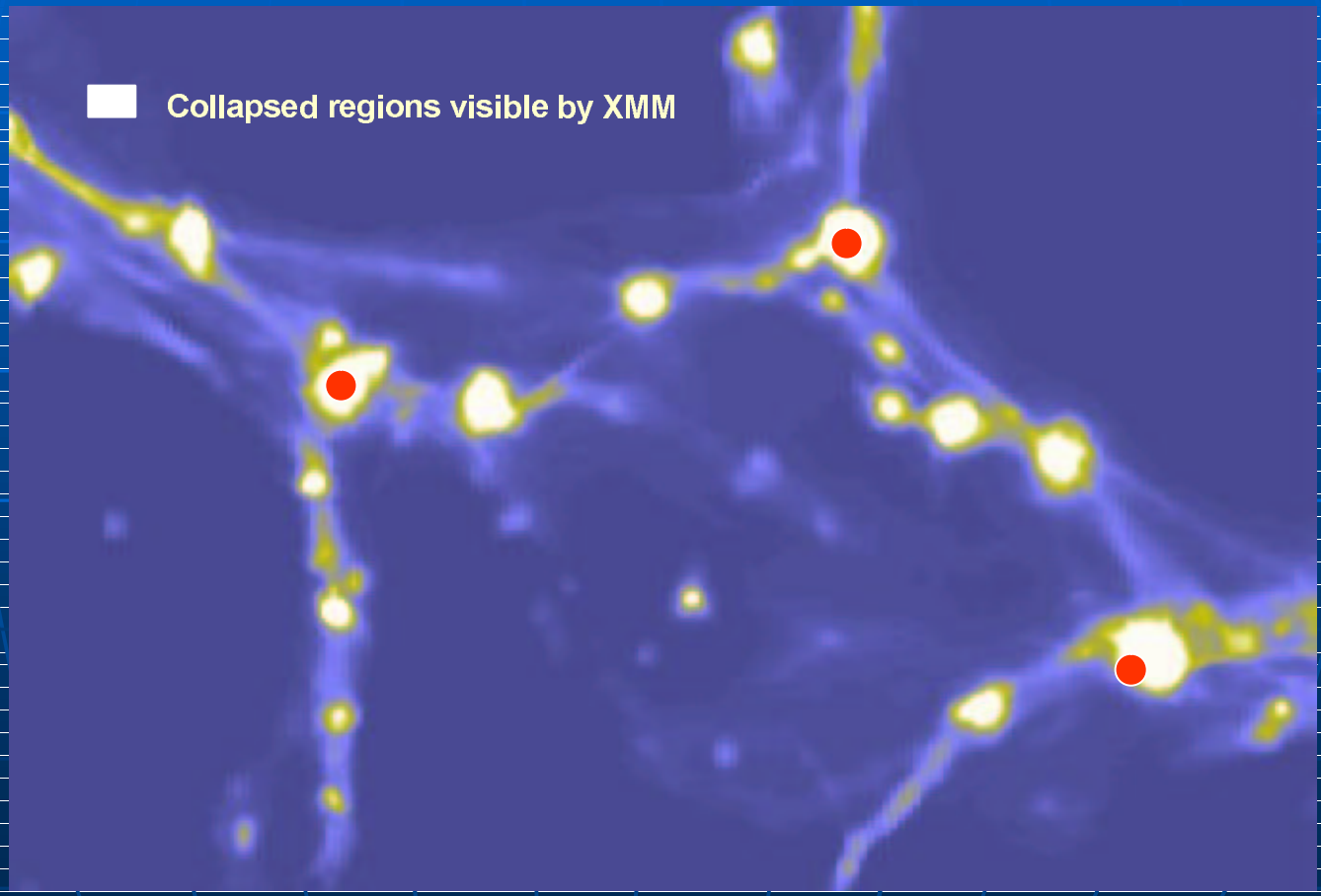
“Secondary” science goals:

- Study the combined x-ray/optical evolution of clusters and ANGs
- Compute the AGN/QSO correlation function with a high degree of accuracy out to z ~ 4 (density = 6x 2dF)
- Map the space distribution of the AGNs within the cosmic web outlined by the cluster/group population

Where are the AGNs located ?

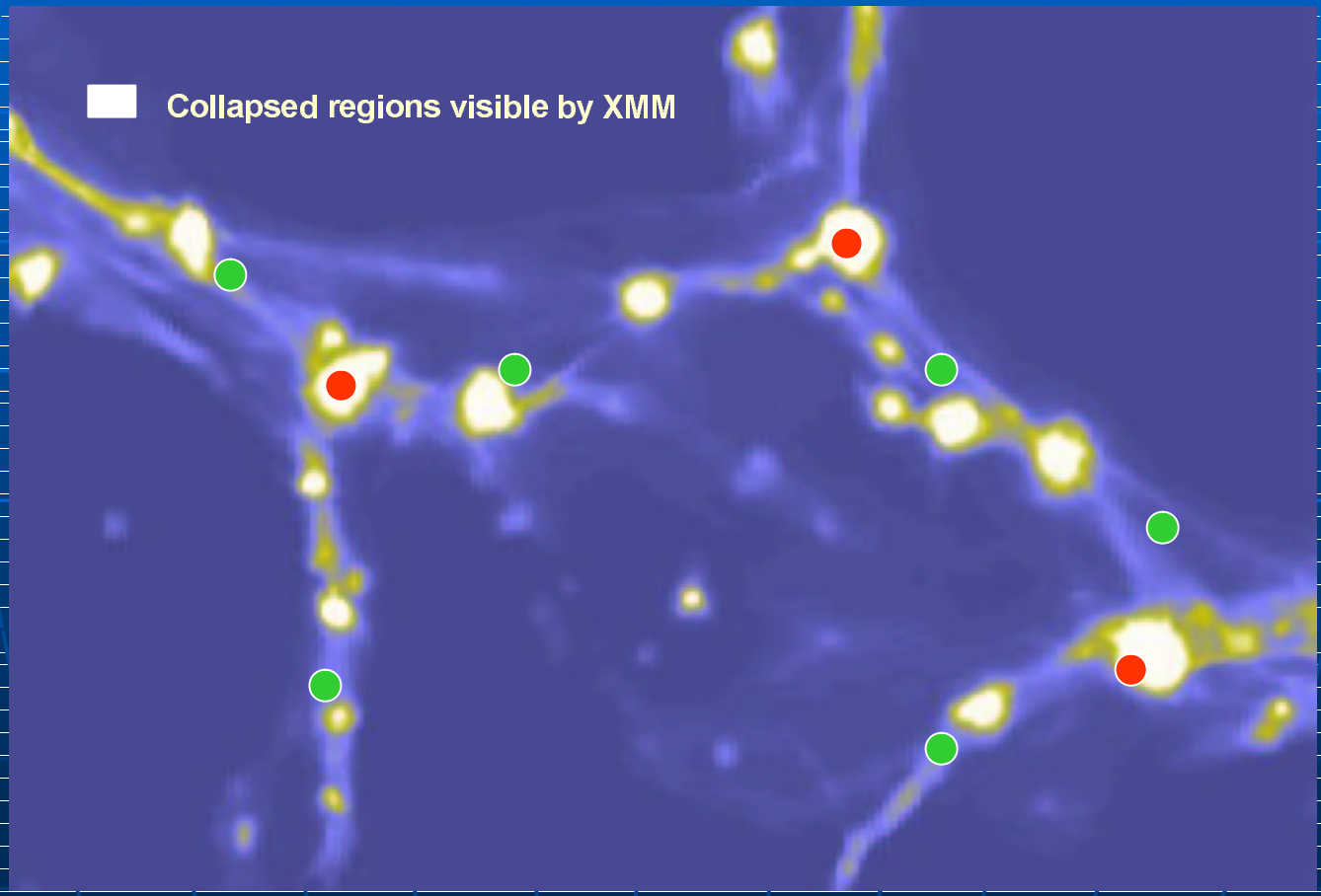


Where are the AGNs located ?



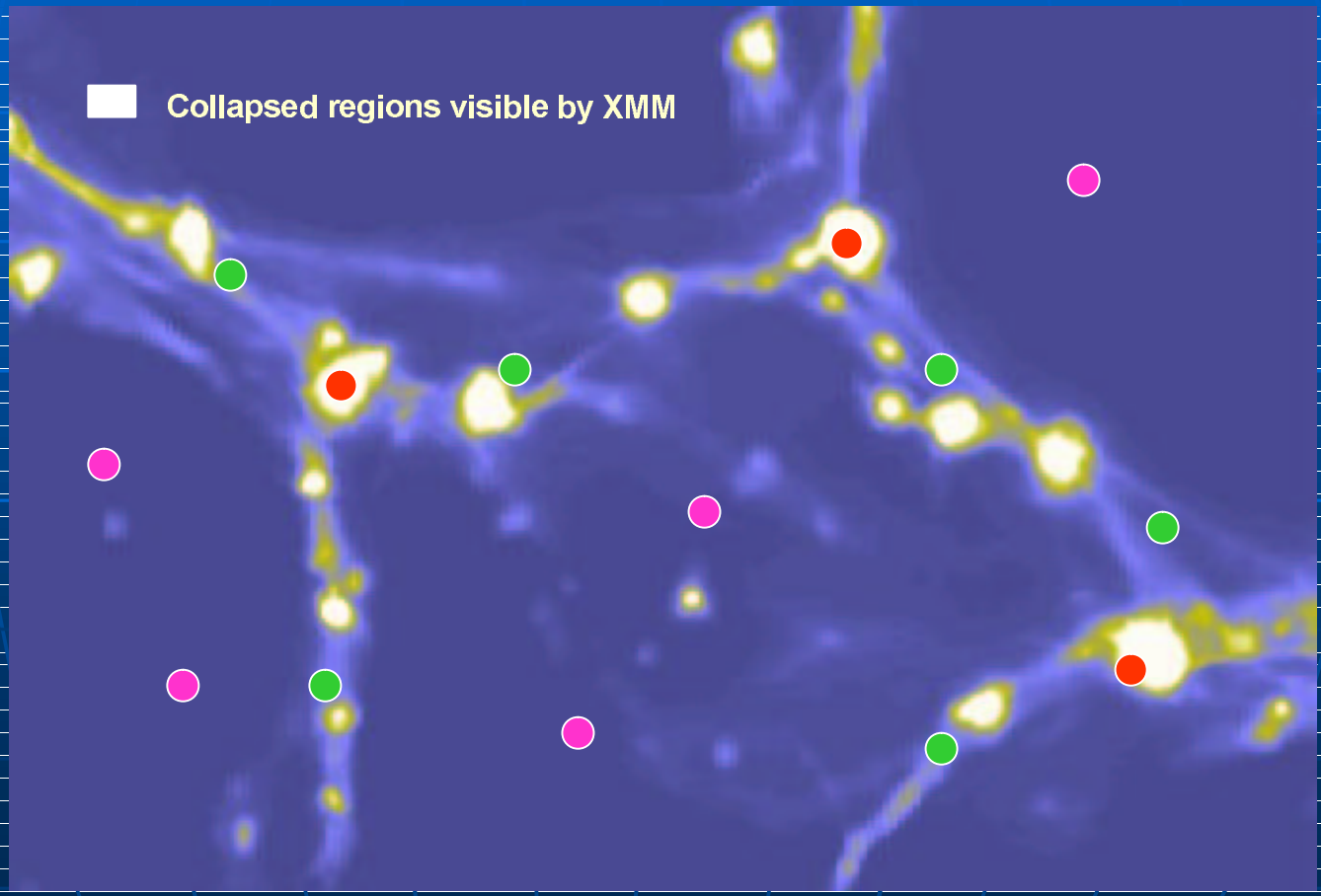
In the clusters ?

Where are the AGNs located ?



In the filaments ?

Where are the AGNs located ?



In the voids ?

Advanced follow-up

- Radio VLA survey *cluster environment - mergers*
- S-Z observations (OCRA (2003) AMiBA (2005))
  low density structures
- SIRTF Legacy associated survey in the MIR-FIR

Associated SWIRE SIRTF Legacy Programme

Will cover 10 sq.deg of the XMM-LSS

at 3.6, 4.5, 5.6, 8, 24, 70, 160 μm

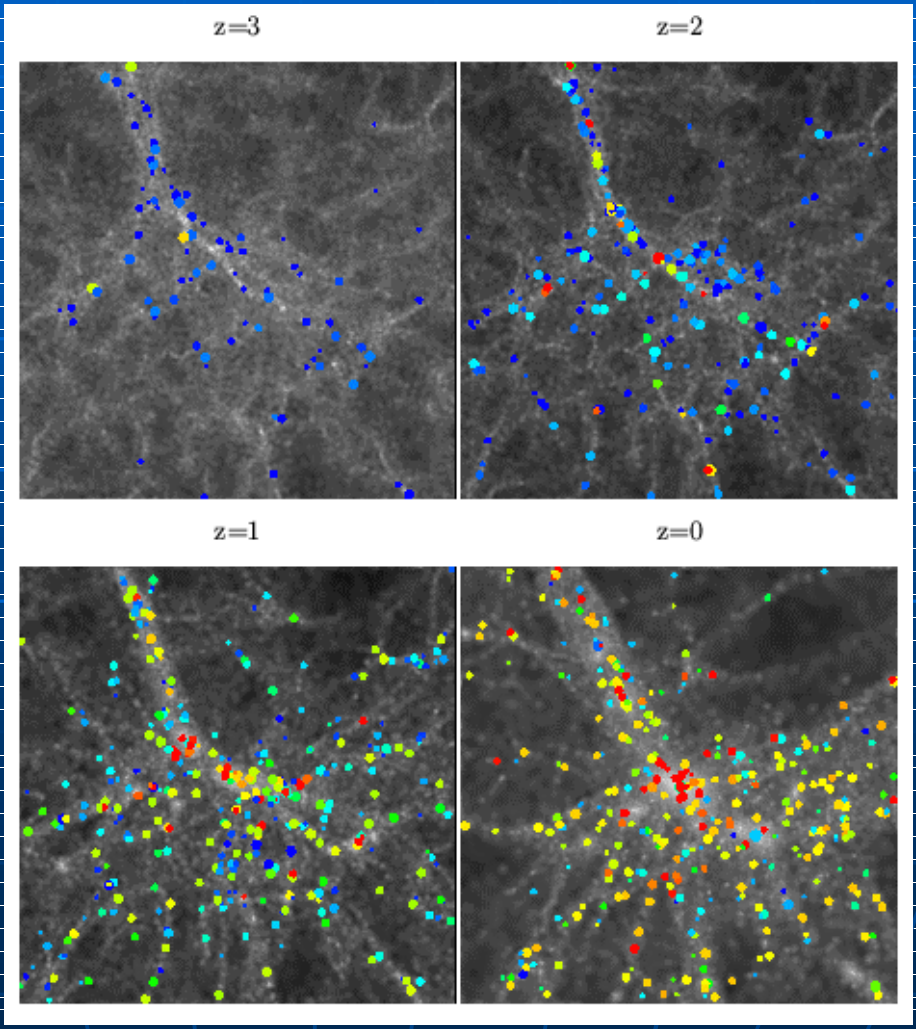
- MIR : emission from
  stars and hot dust (AGN)
- FIR : emission from
  'cold' dust (star forming regions)

XMM + SIRTF
+ MegaCam + FORS/VIMOS + VLA

- Evolution of star forming galaxies and AGNs as a function of environment $(0 < z < 2.5)$:
  - ICM and potential strength (X-ray)
  - galaxy density and velocities
  - dark matter distribution
  - radio activity
- Clustering properties of starburst galaxies, AGNs. Location within the LSS. Evolution.
- Detection and properties of 'obscured' AGNs

XMM + SIRTF
+ MegaCam + VIRMOS + VLA

Box size:
42 Mpc



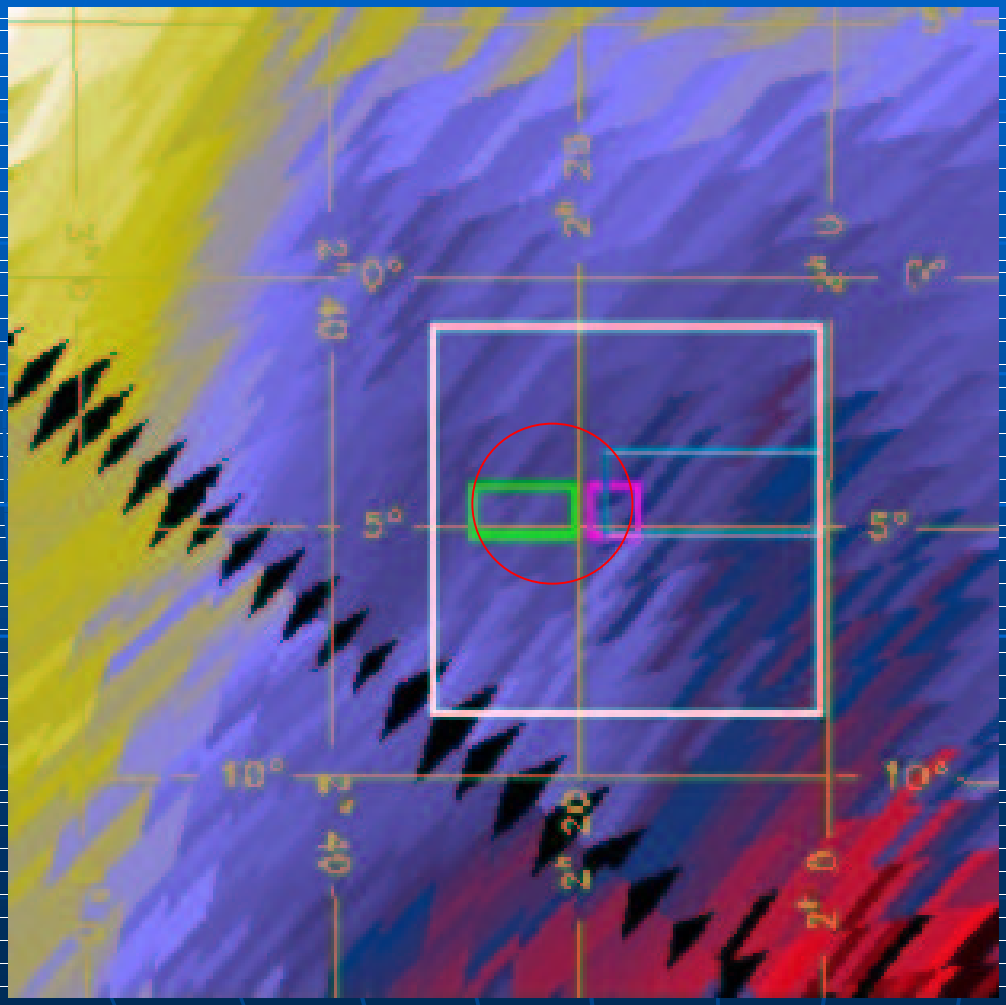
Kaufmann, J.M. Colberg, A. Diaferio, S.D.M. White, 1999

4. First results

X-ray processing and overlays : Ivan Valtchanov

Optical processing : Terapix Team

Survey location



XMM-LSS

XMDS

VIRMOS Deep Survey

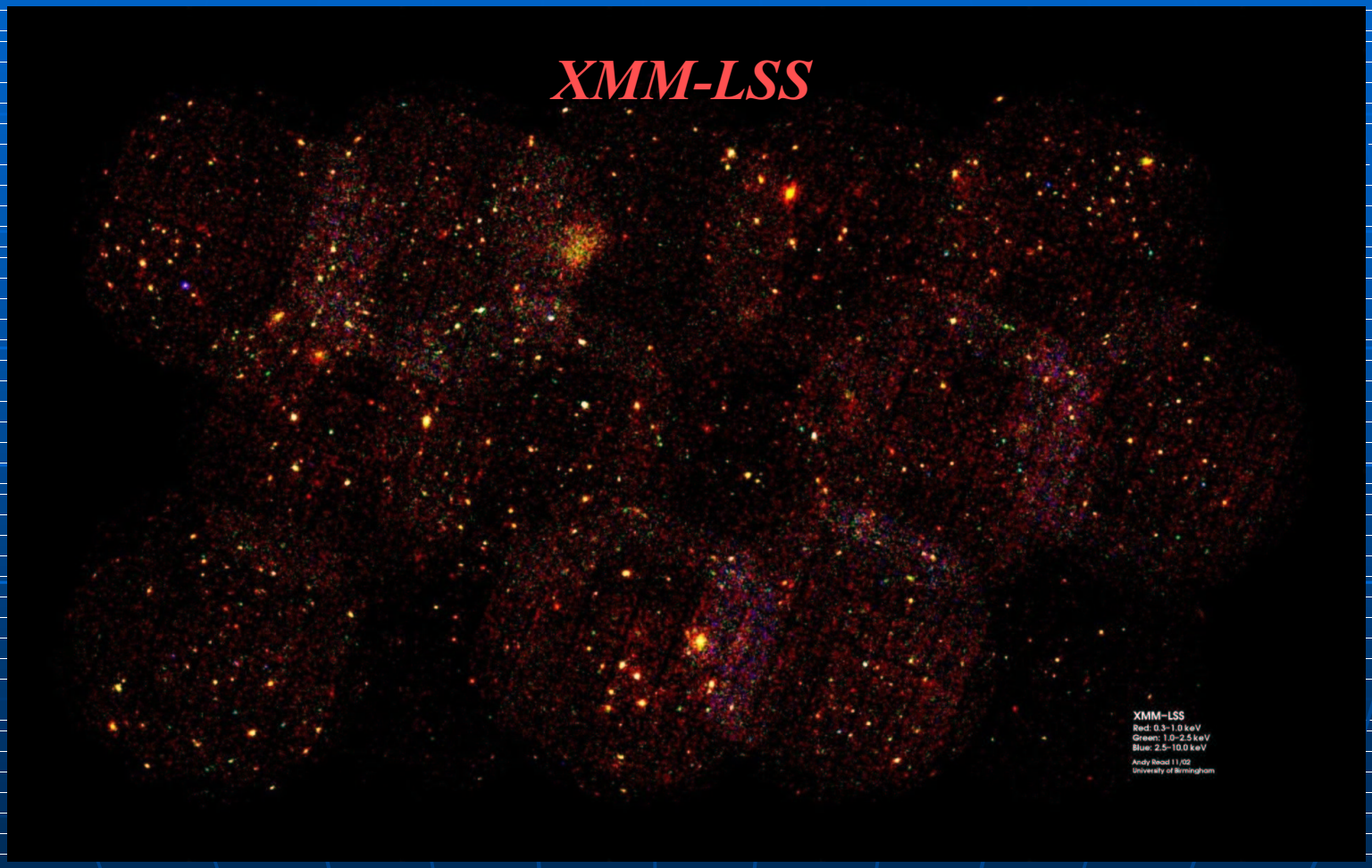
XMM/Subaru

Deep Survey

NOAO DS

SIRTF Legacy

First Mosaic



10 ks exp., 2 deg2 red < 2 keV blue > 2 keV

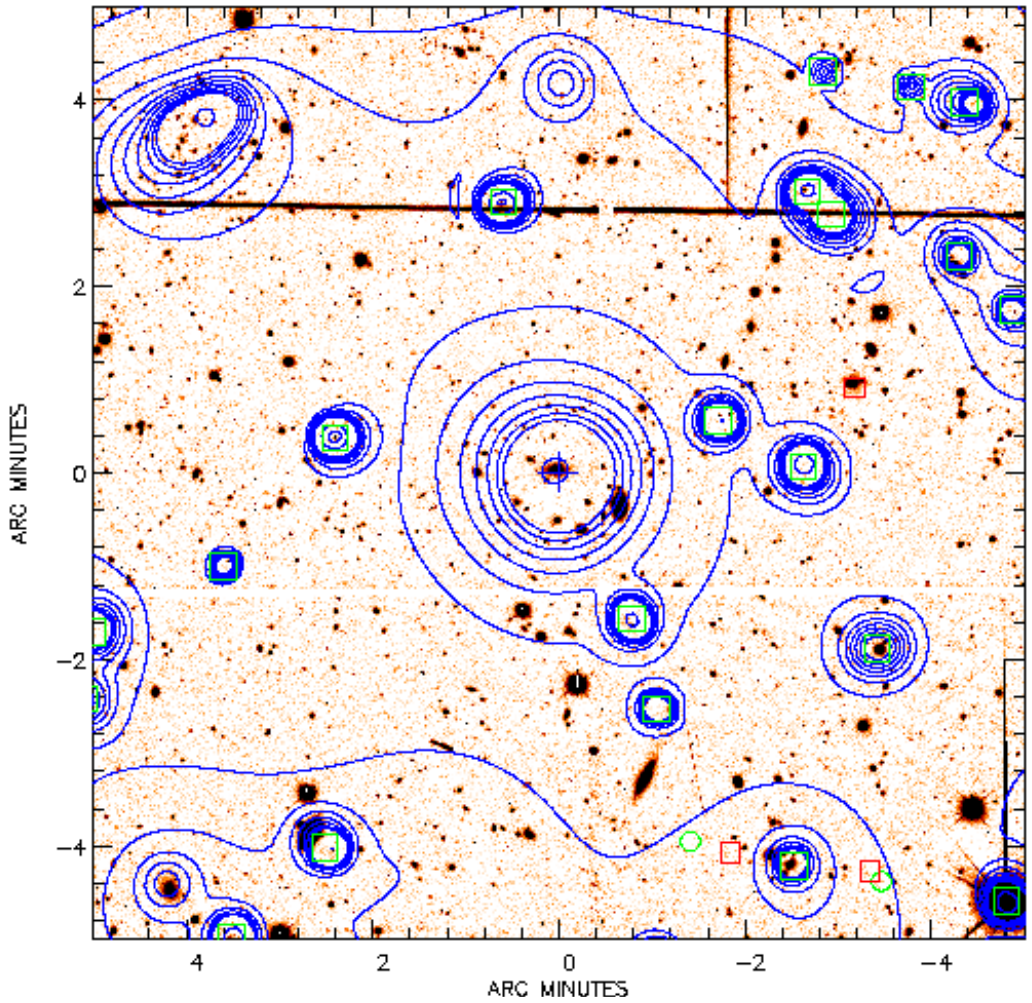
Current identification procedure

- **XMM obs Jan/july**
- pre-processing
- Co-add 2MOS+PN
- Images in 8 bands
- Source lists
- Select extended src
  = clusters
- Overlays
- Eye inspection
- Final list of candidates

- **CFH12K obs (B)VRI**
  => MegaCam
- RGB images
- Photo-z

Cluster image (1)

XMM-LSS



CFH12k I-band/
Terapix

field size: 10'x10'

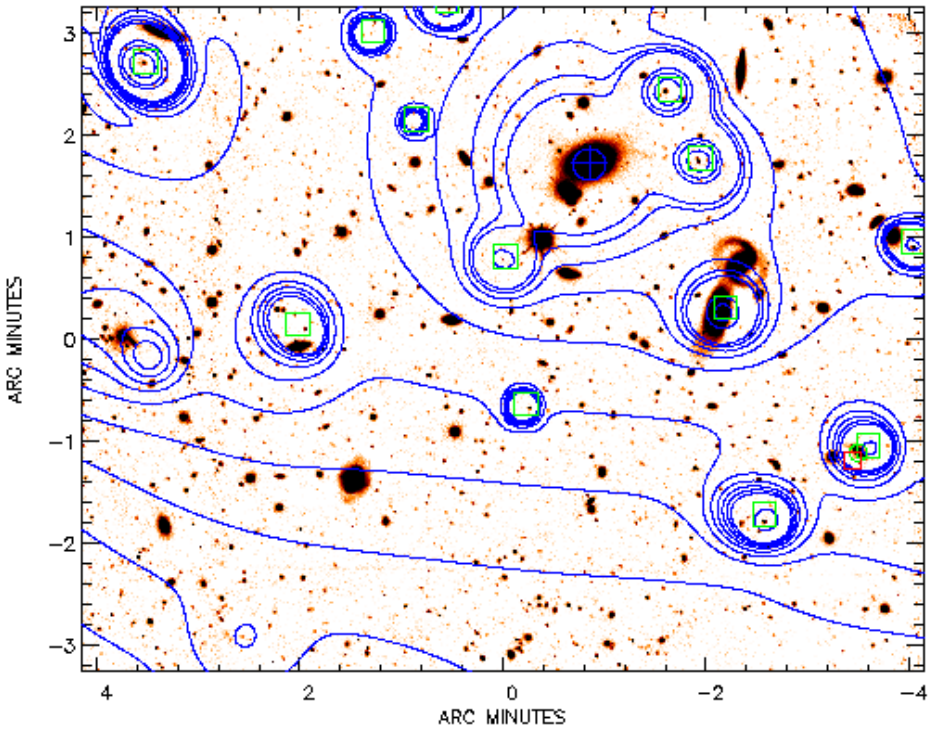
Centre:
a nearby candidate
~ 600 cts [0.5-5] keV

Upper left:
a distant candidate

Blue contours : XMM
Wavelet filter
Green squares : pointlike sources

Cluster image (2)

XMM-LSS

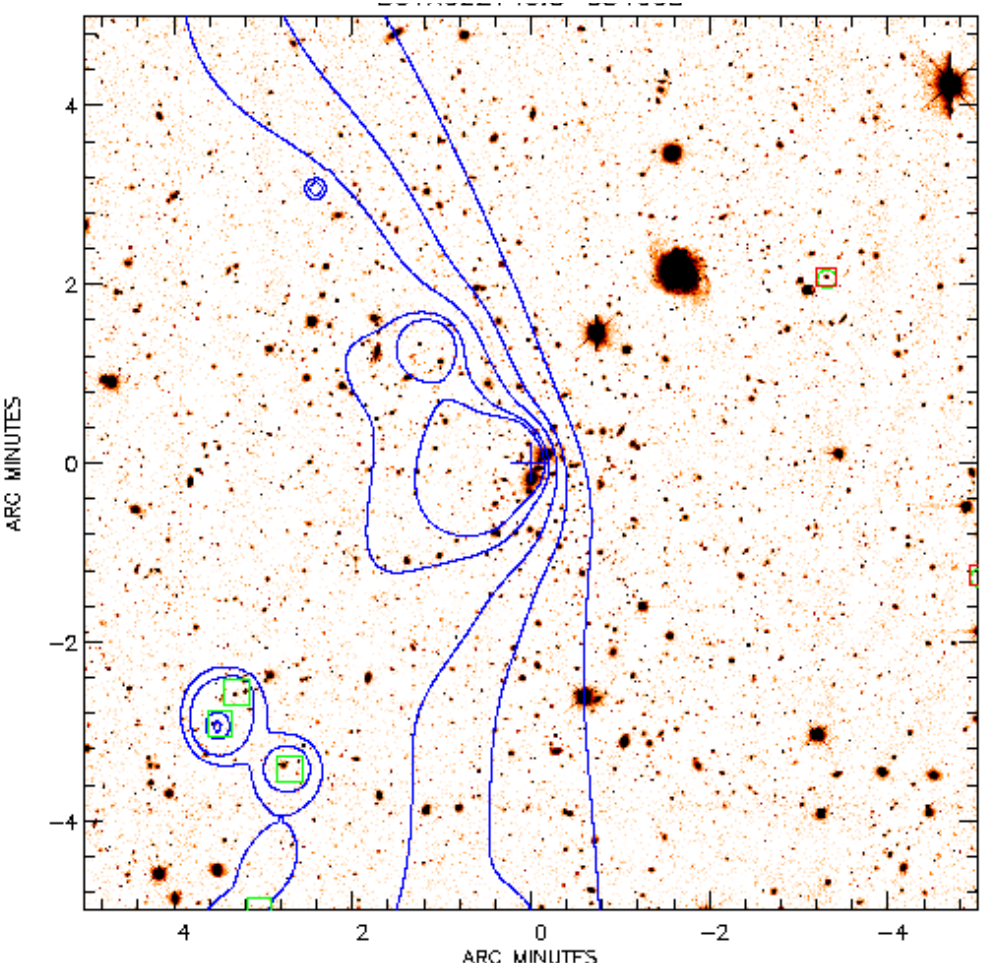


CFH12k I-band/ Terapix

Nearby group

Cluster image (3)

XMM-LSS

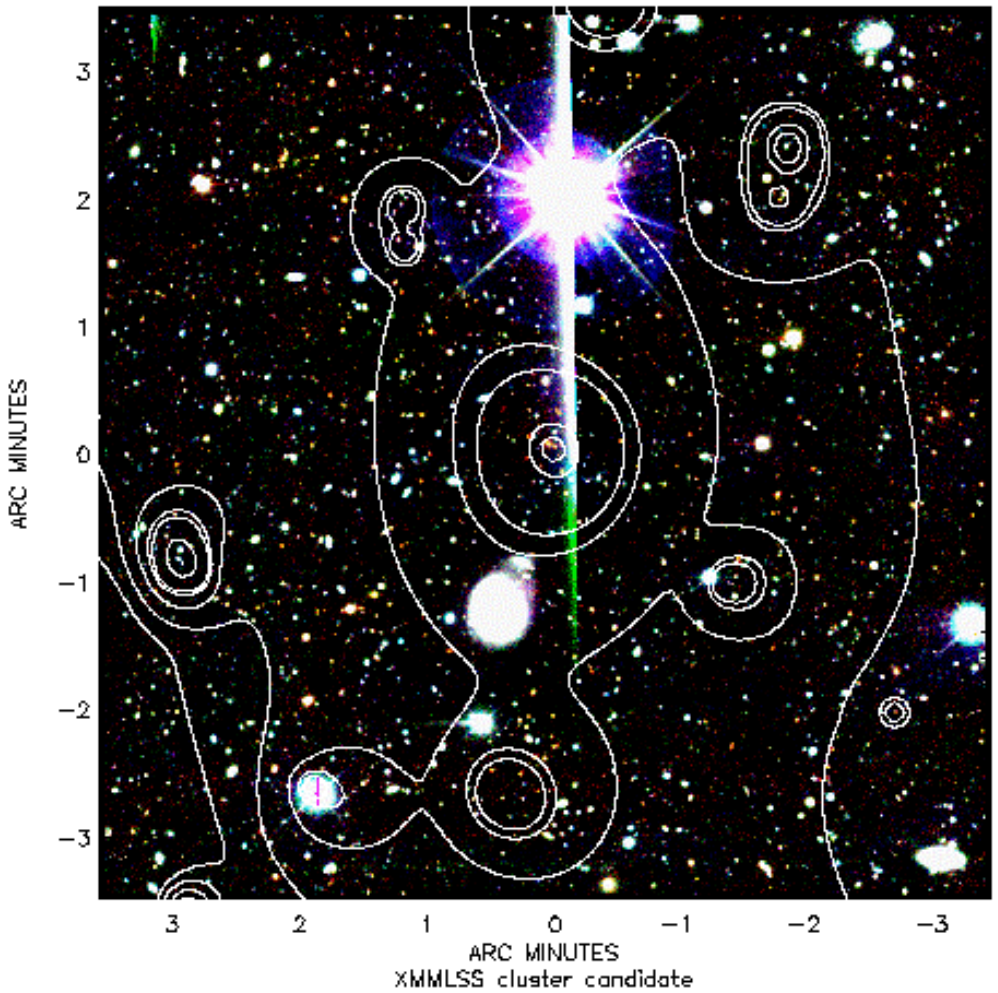


CFH12k I-band/ Terapix

Double cD cluster at the edge of X obs.

Cluster image (4)

XMM-LSS



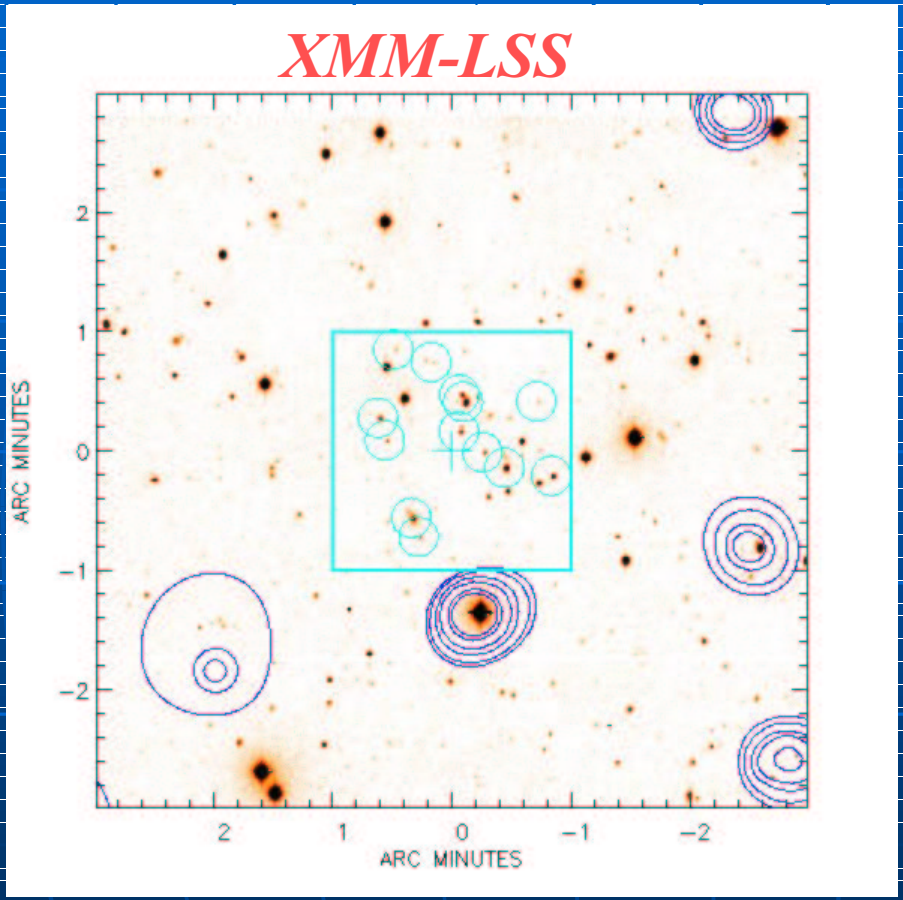
CFH12k VRI imagesVIRMOS DS /Terapix

field size: 7'x7'

a z > 1 candidate

~ 560 cts [0.5-5] keV

Cluster image (5)



Images: z'CTIO

X-ray contours

Cluster without X-ray counterpart

('red sequence' detection, z~0.3-0.4)

XMM-LSS

Preliminary results

Some 20 reduced pointings so far (Sept. 02):

As expected we find
~1.5 cluster/group per pointing

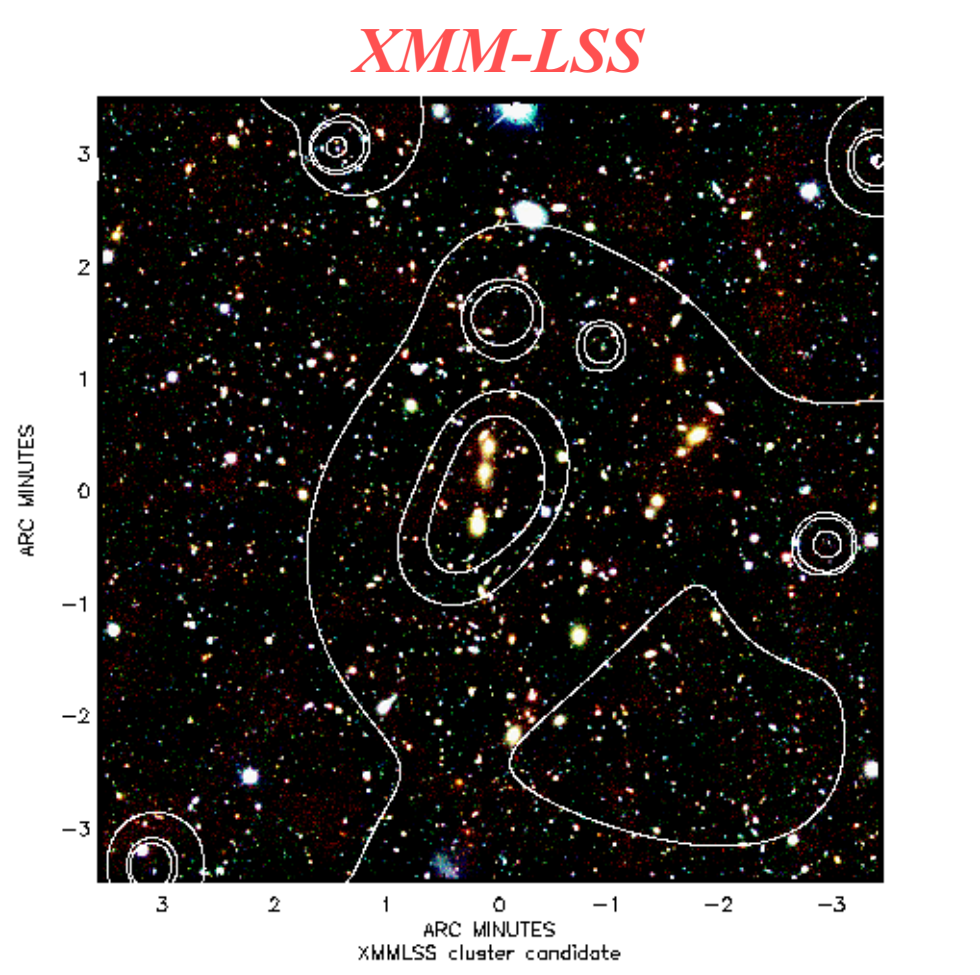
i.e. ~15 clusters per sq. deg

FIRST spectroscopic follow-up:

Magellan (Willis, Altieri) **& VLT** (Pierre, Valtchanov)
October 2002

A glimpse at the spectroscopic results:

Magellan run



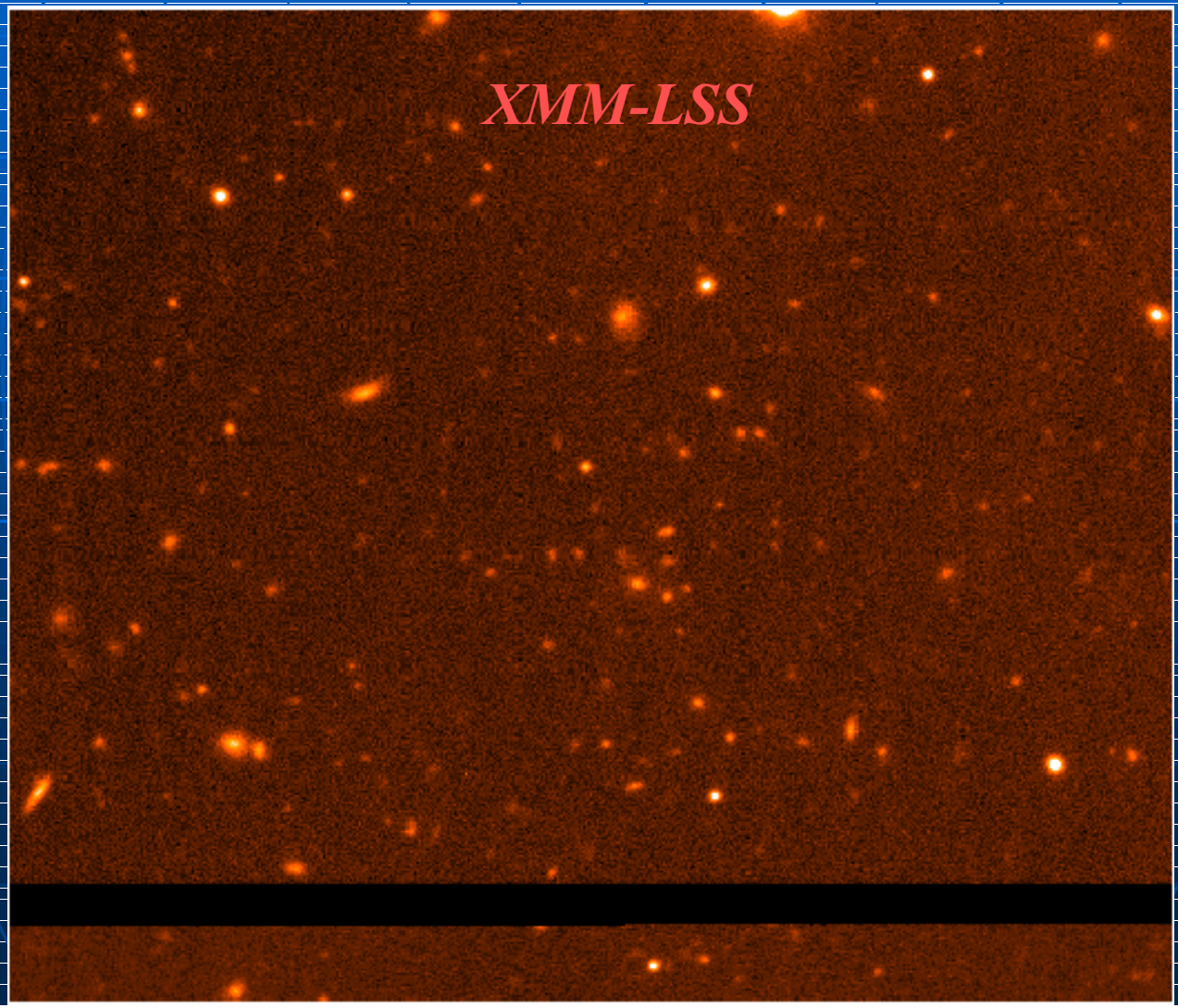
<= this one :

z = 0.43

with 13 galaxies

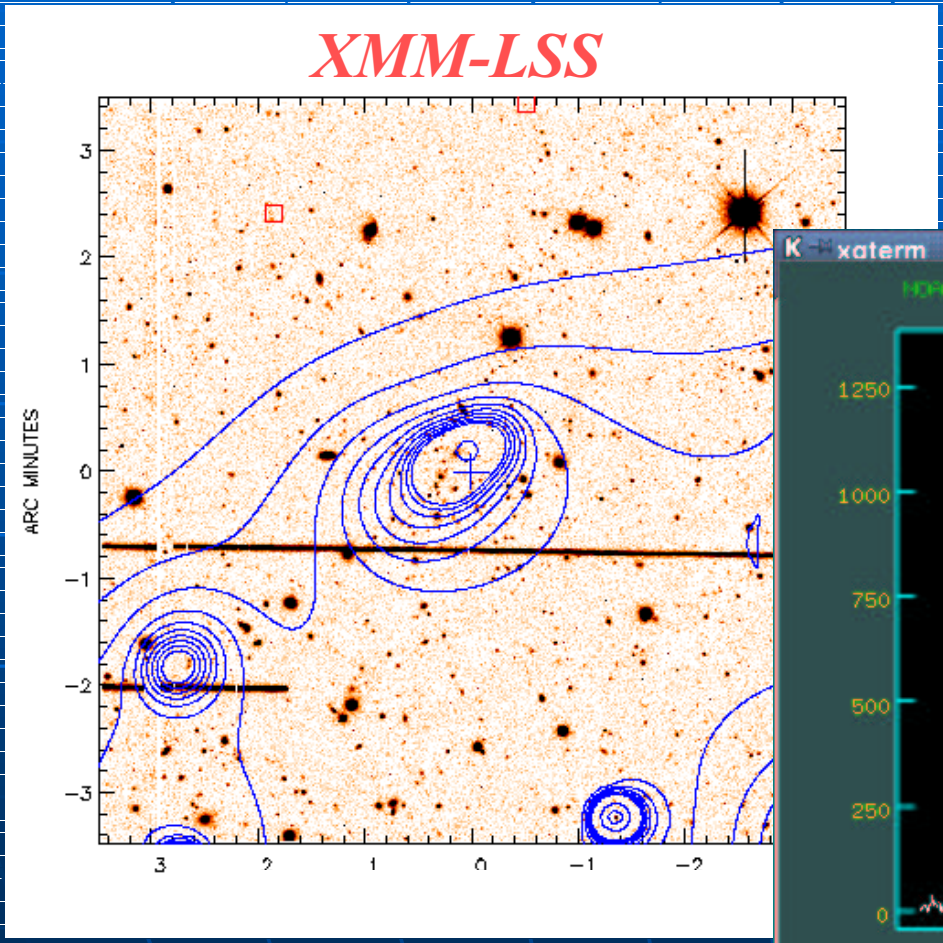
VLT/FORS2 pre-images

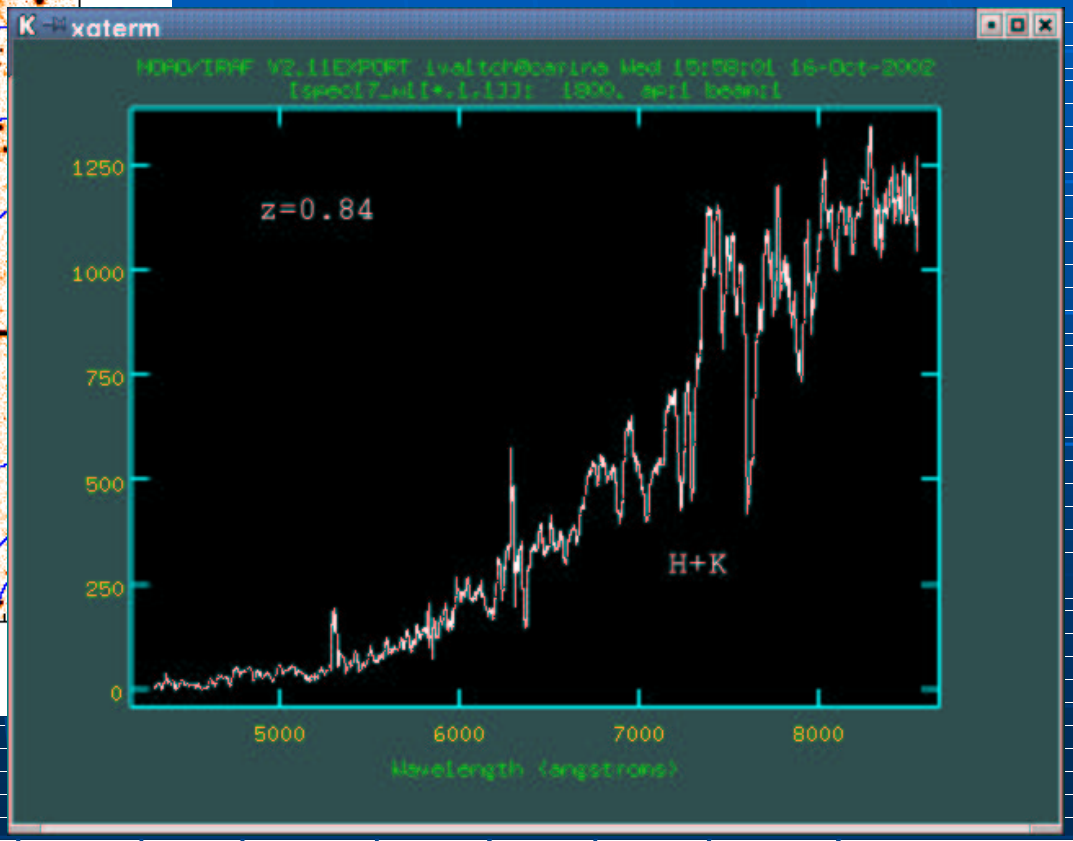
seeing = 0.4” !



A cluster at z = 0.84

VLT/FORS2



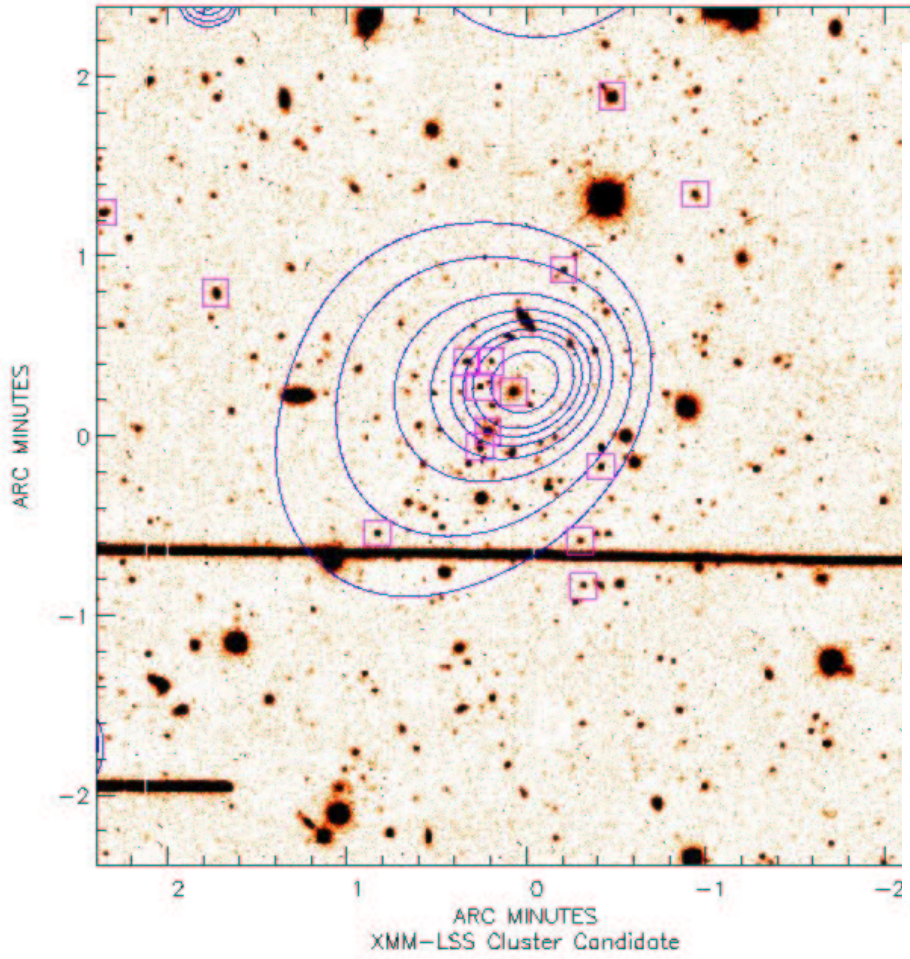


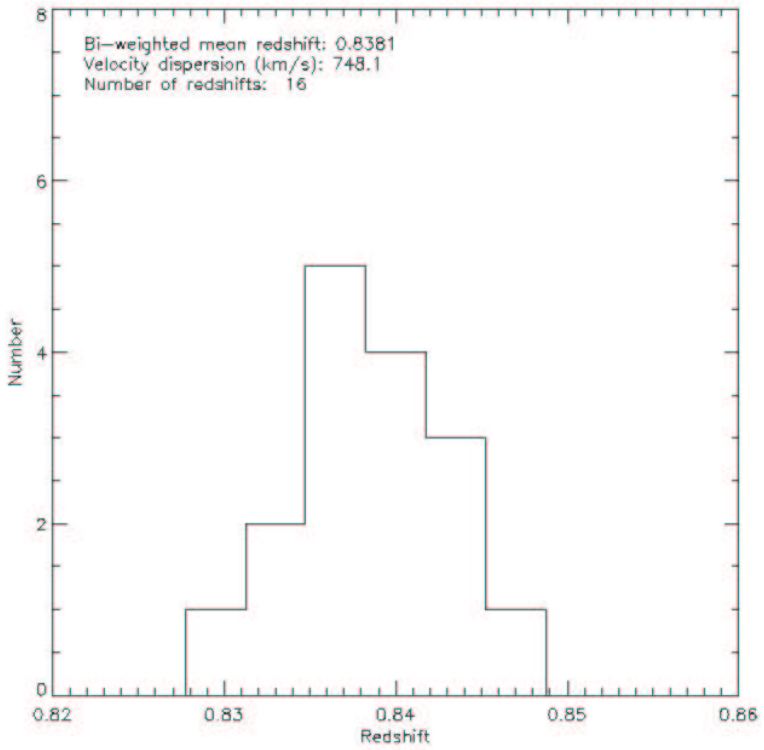
The CD galaxy : 1h VLT/FORS2

A relaxed cluster at z ~0.84

VLT/FORS2

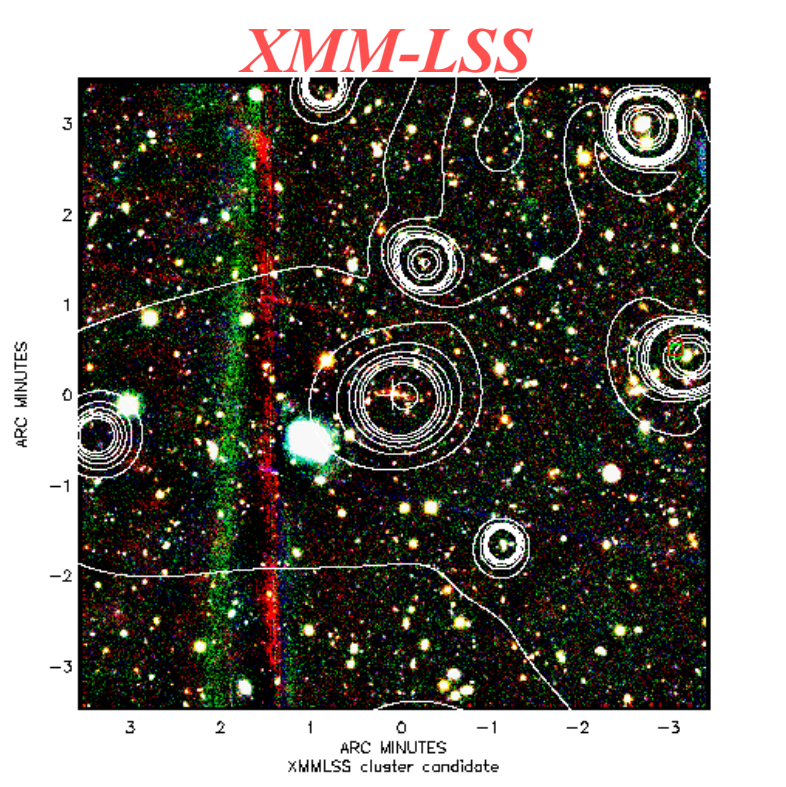
XMM-LSS

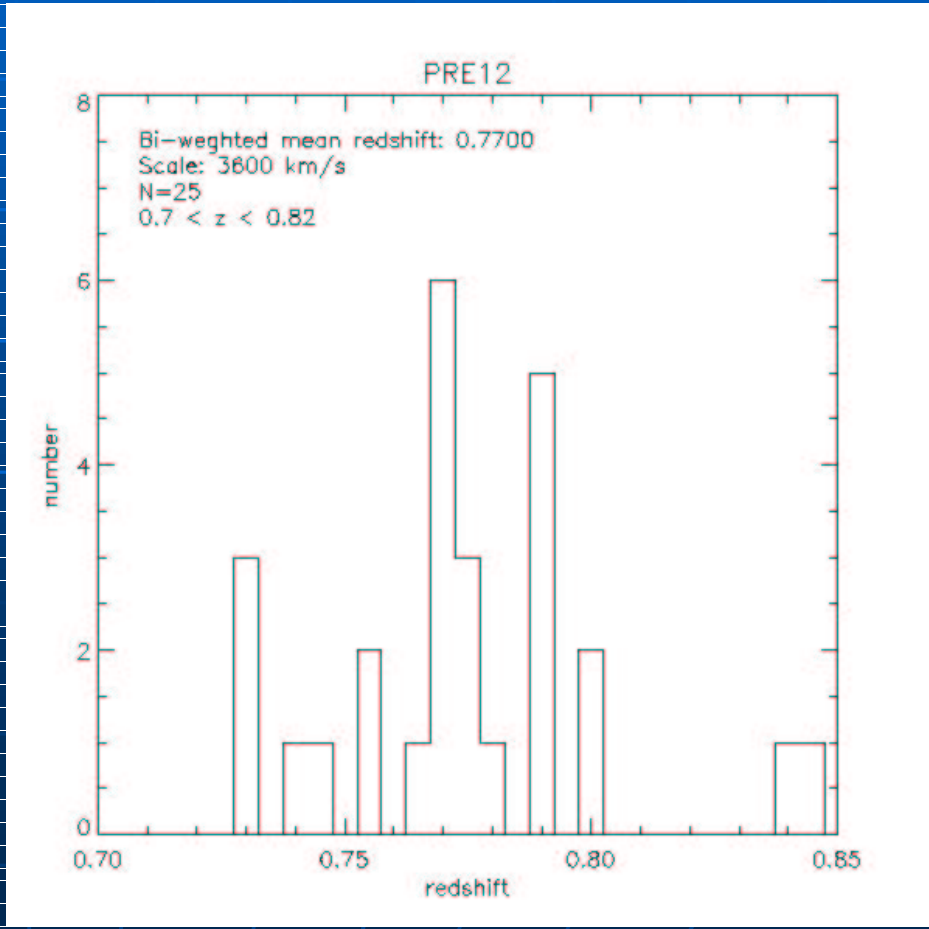




A collapsinpg cluster at z ~ 0.77

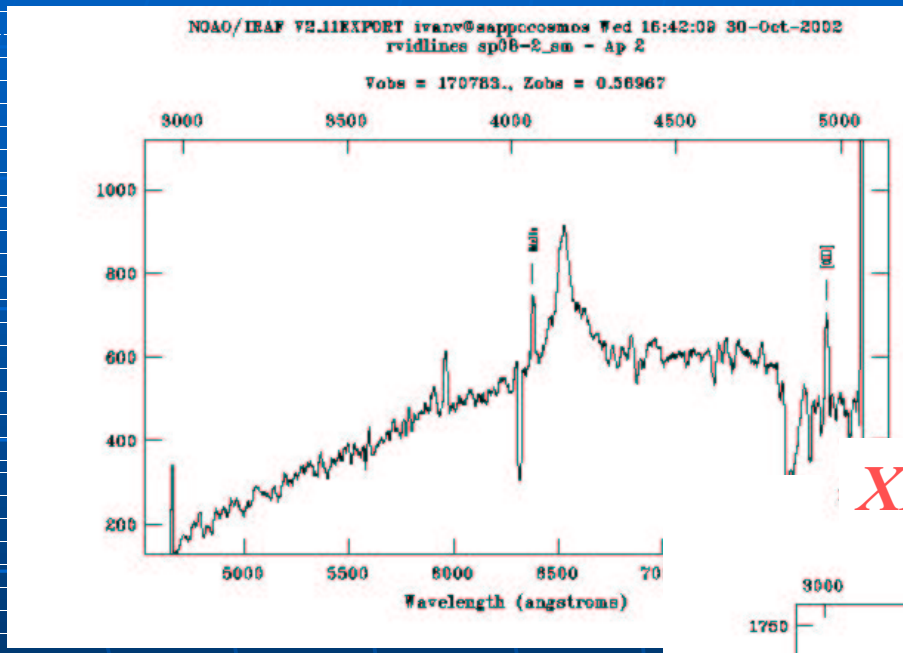
VLT/FORS2

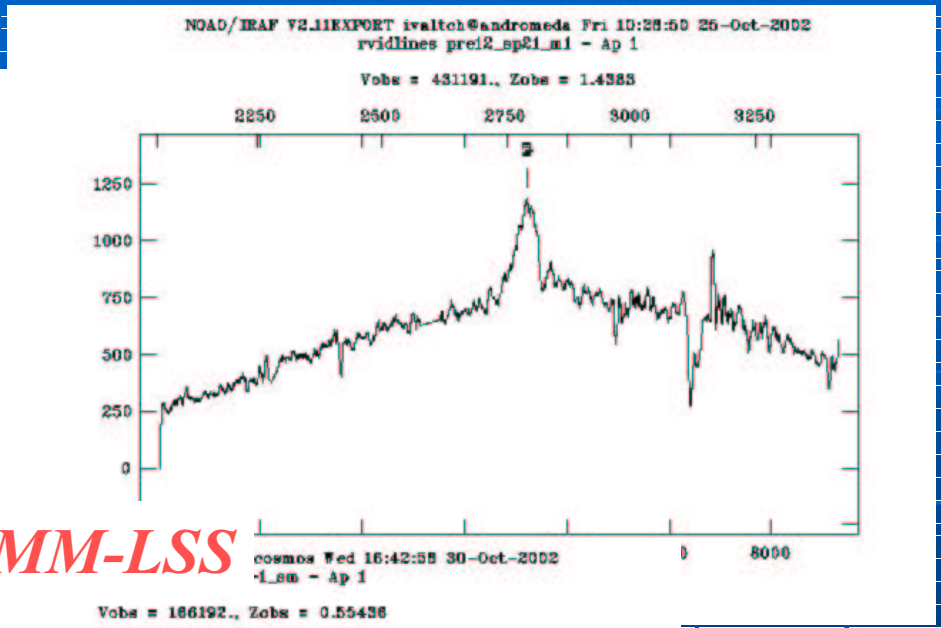




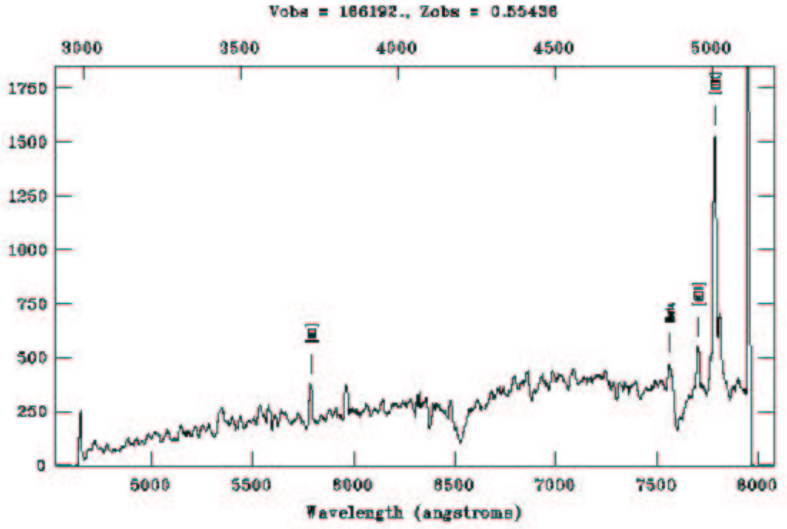
XMM AGNs in the same field

VLT/FORS2





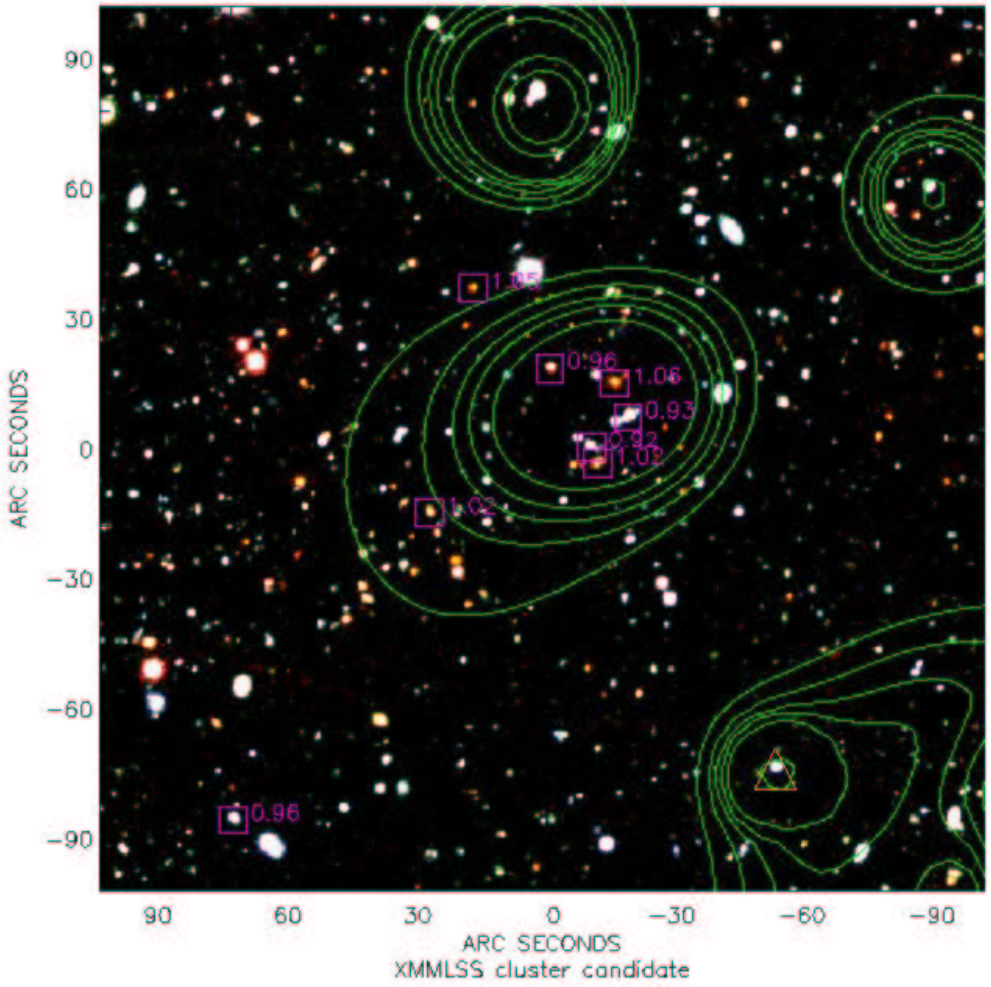
XMM-LSS

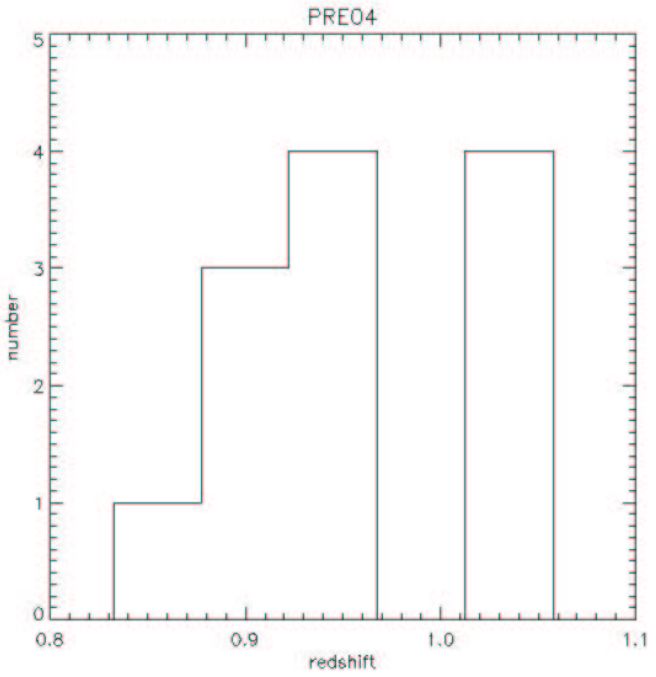


A structure at z ~ 1

VLT/FORS2

XMM-LSS



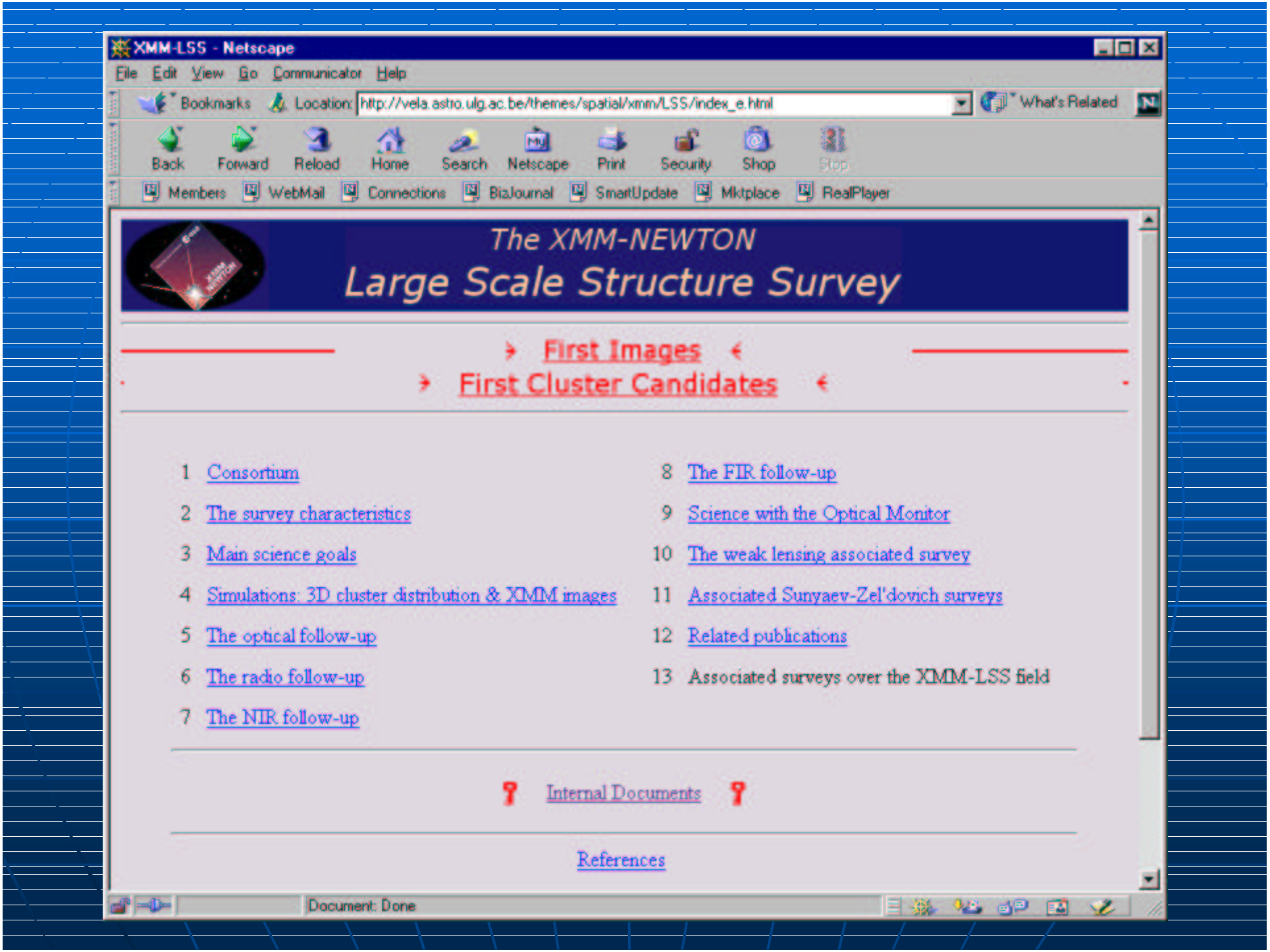


preliminary results from the VLT run

- 5 clusters $0.6 < z < 1.1$
- 7 clusters $0.3 < z < 0.5$
- 2 local compact groups

- 1 bad X-ray cluster candidate (or a z~1 cluster) ?

A few more details :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Back Forward Reload Home Search Netscape Print Security Shop Stop
Members WebMail Connections BizJournal SmartUpdate Mktplace RealPlayer
The XMM-NEWTON
Large Scale Structure Survey
First Images
First Cluster Candidates
1 Consortium
2 The survey characteristics
3 Main science goals
4 Simulations: 3D cluster distribution & XMM images
5 The optical follow-up
6 The radio follow-up
7 The NIR follow-up
8 The FIR follow-up
9 Science with the Optical Monitor
10 The weak lensing associated survey
11 Associated Sunyaev-Zel'dovich surveys
12 Related publications
13 Associated surveys over the XMM-LSS field
Internal Documents
References
Document: Done

Release of the data

- First release expected by end-2003
  => catalogue at CDS
- Increased/Updated annually

  X-ray, optical, VLA then SIRTF
- Join the VO efforts

Ultimate GOAL

Map the mass distribution within

8x8 sq.deg. & $0 < z < 1\text{-}2$

by 4 methods :

X-ray clusters **weak lensing**

S-Z **O/IR/X galaxies and AGNs**