XXL

or

The Dark Energy, now

The X-ray universe, Berlin,
June 28, 2011

M. Pierre

XXL

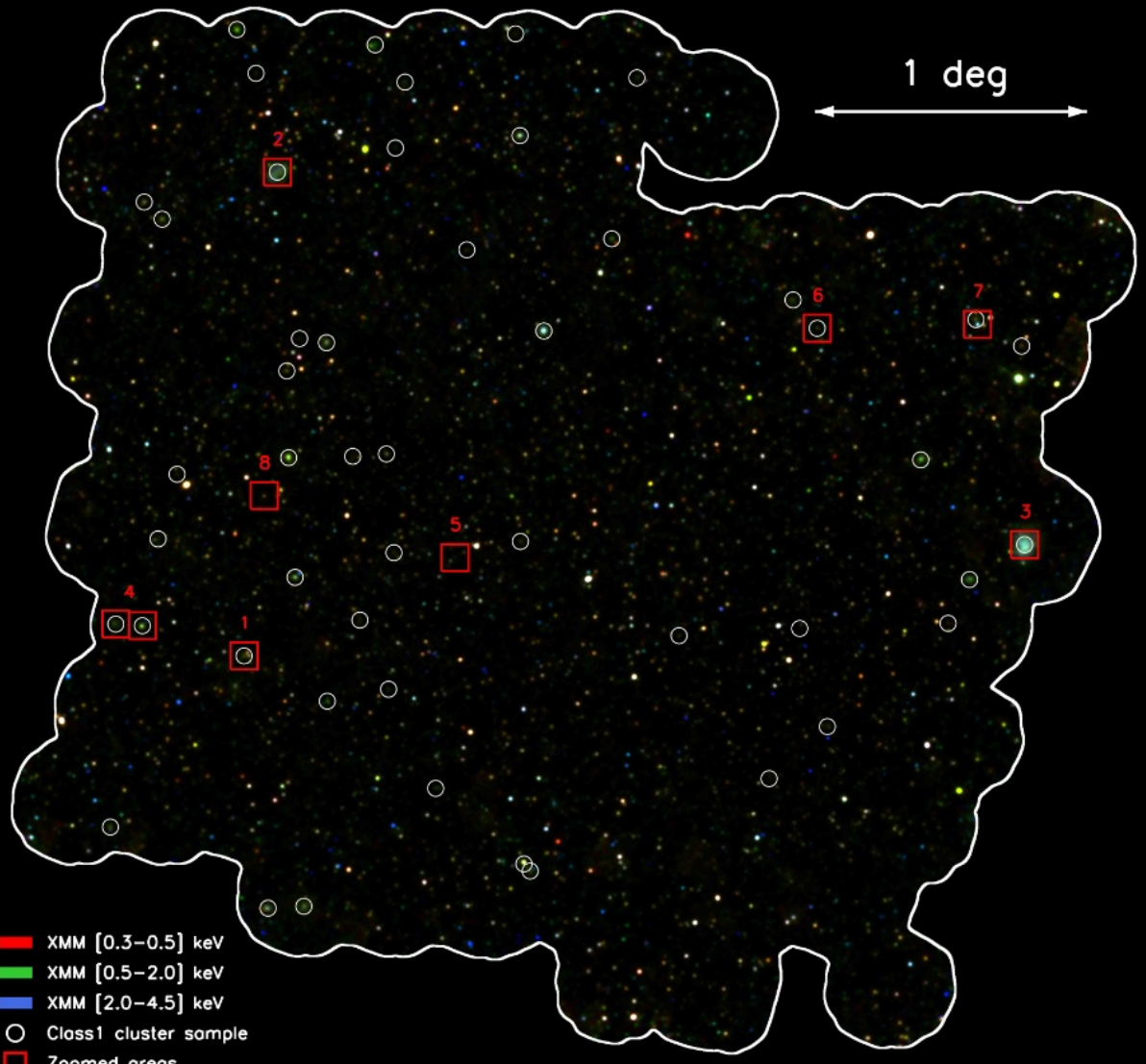
The ultimate XMM extragalactic survey

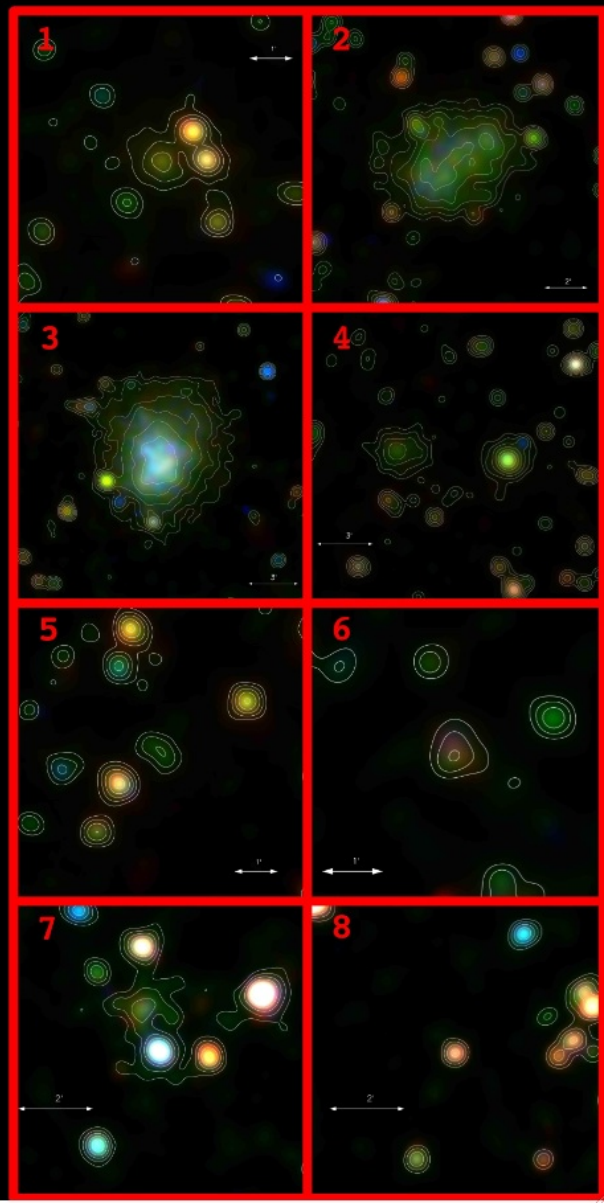
die Kunst über in der Wissenschaft

- History
- **Dark energy and clusters of galaxies**
- XXL : The largest XMM programme
- Main science goals
- **The associated surveys and the legacy aspect**
- How to contribute ?

BRIEF HISTORY

The XMM-LSS survey



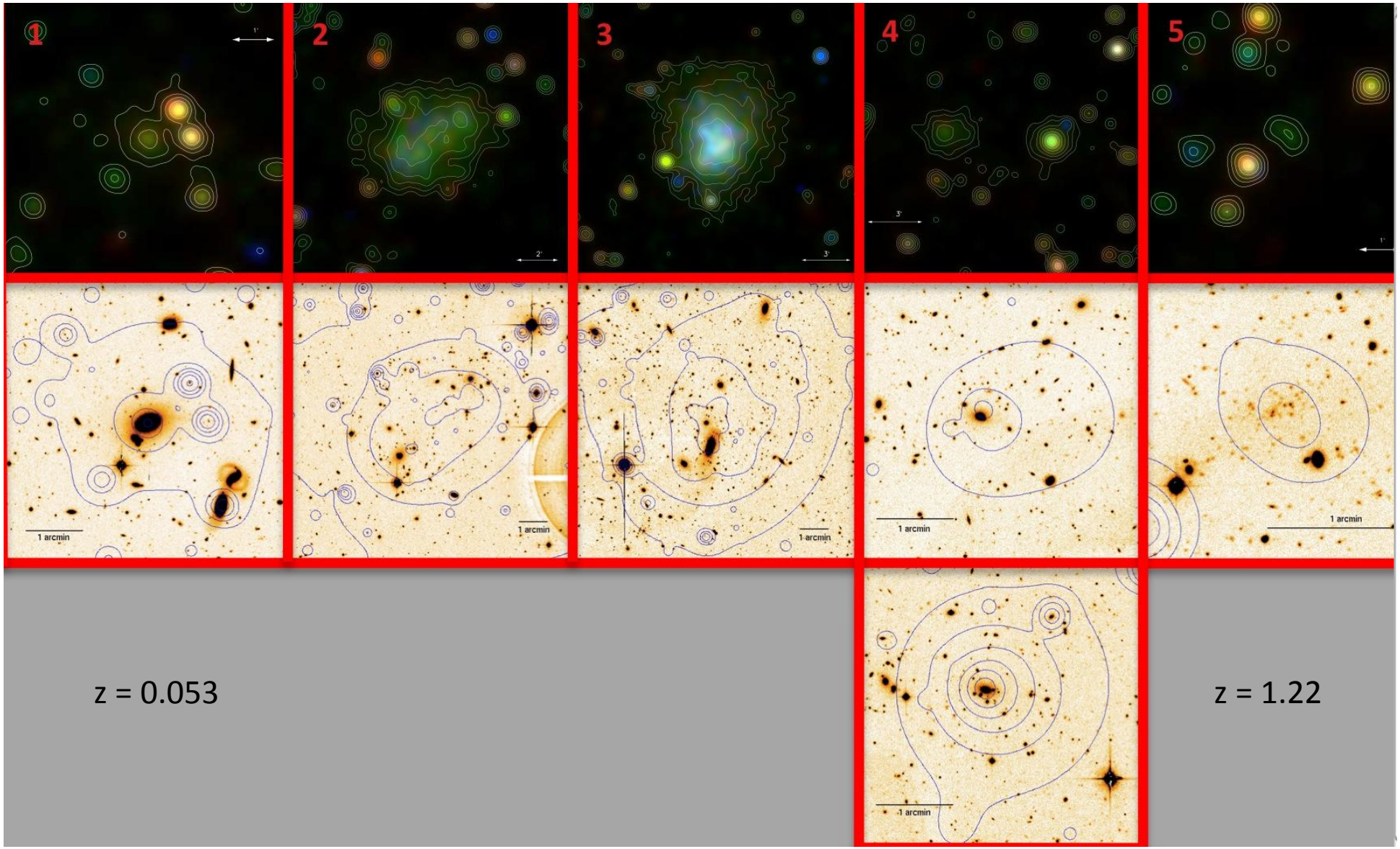


XMM-LSS 2000-2010

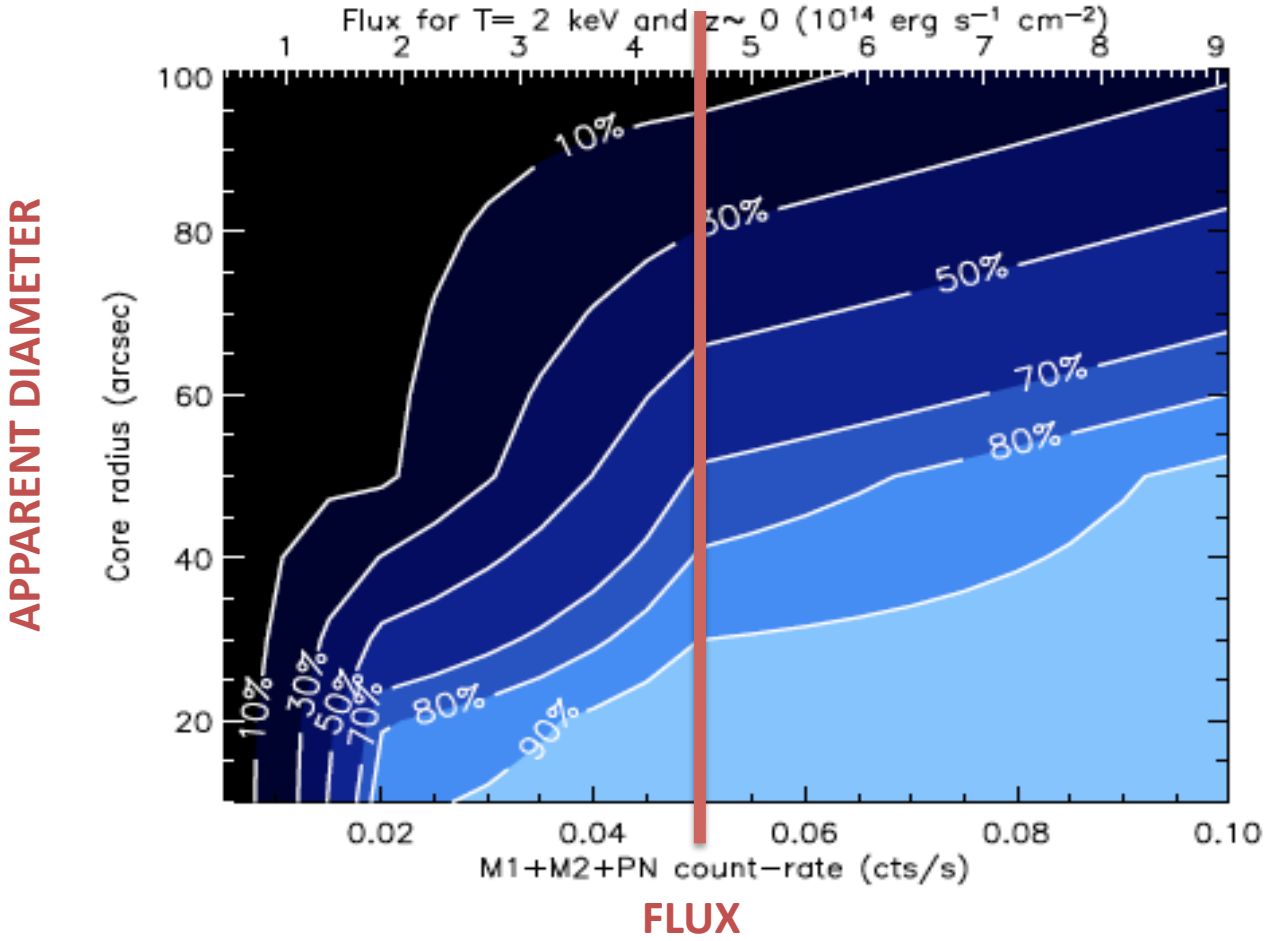
- Started on the guaranteed time of Liège, Milan & Saclay
- Several time allocations, including a LP in 2005
- 11 deg^2 at 10-40 ks , on the CFHTLS-W1

- Development of a sophisticated X-ray pipeline *(Pacaud et al, 2006)*
- Cluster data-base (X-ray, multi-λ, follow-up management)
- Tens of VLT hours for the cluster spectroscopic follow-up

XMM-LSS clusters
and their optical counterpart in the CFHTLS



The cluster selection funtcion



Pacaud et al 2007

Important results from XMM-LSS

- For the first time, a very well determined cluster selection function (≠ flux limit)
- The determination of the cluster scaling laws

  flux, R, z => M

  observables => theory => cosmological models

  strongly depens on the survey selection effects

➔ **Critical for cosmology**

- More than 30 refereed publications and 7 theses

DARK ERNERGY with CLUSTERS

Pierre, Pacaud, Juin, Melin, Valageas, Clerc, Corasaniti, MNRAS 2011, in press

The effect of DE on clusters

- Geometrical effect

  Volume, D_L

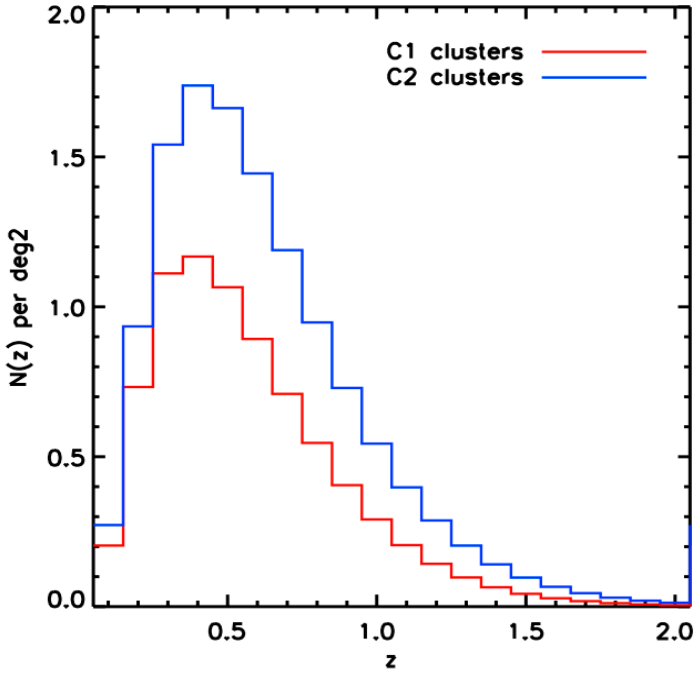
- Gravitational effect

  Growth of the density perturbations

The cosmological quantities

- dn/dz

  for a given selection function



C1: 6 clusters /deg^2 ~ 1/deg^2 à z>1
C2: 12 clusters /deg^2

- ξ : 3D correlation function

➔ **ξ increases the constraints by a factor of ~ 2**

Predictions for XXL
= 50 deg^2

Table 7. Cosmological constraints. Survey configuration A2 - 50 deg^2 1/4 depth (10 ks XMM exposures) 1-σ errors on w_0 / w_a

XXL

Selection	Redshift range	dn/dz + Planck	dn/dz + ξ + Planck
C1 (pessimistic)	$0 < z < 1$	2.77 / 5.98	**0.97 / 3.08**
C2 (optimistic)	$0 < z < 2$	1.14 / 2.44	**0.55 / 1.70**

Table 8. Cosmological constraints from clusters following the DETF survey designs 1-σ errors on w_0 / w_a

Ref.
Dark Energy Task Force
clusters

Stage	Pessimistic	Optimistic
III	0.70 / 2.11	0.26 / 0.77
IV	0.73 / 2.18	0.24 / 0.73

The DE equation of state from clusters

- Most realistic DE predictions with clusters to date:
  - well validated selection function
  - realistic errors on the mass (≈ nb(photons))

- We can probably get even better constraints:

- Forthcoming paper on *dn/dM/dz* *(Pacaud et al in prep.)*

THE XXL SURVEY

XXL: Overview

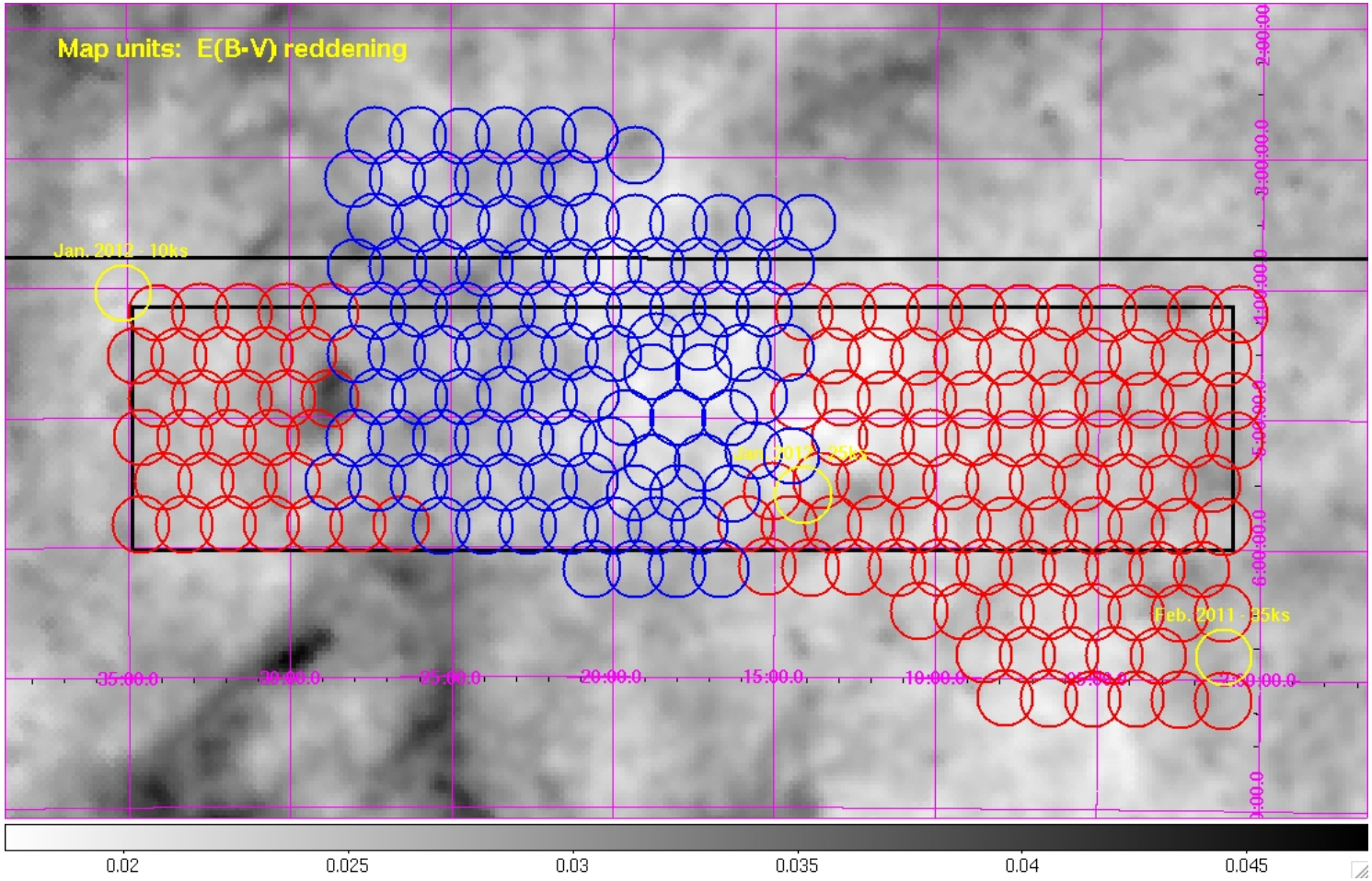
- 2 areas of 25 deg^2 each, paved with 10 ks XMM observations – Mosaic mode
  - 3Ms allocated in December 2010 (May 2011 – April 2013)
  - Some 3Ms of already existing data

- Main science goal: the equation of state of the dark energy from clusters of galaxies

- Hot topics for AGNs and clusters and XRB

25 deg^2 in CFHTLS-W1 2h23 -5d00

(extension of the XMM-LSS field)

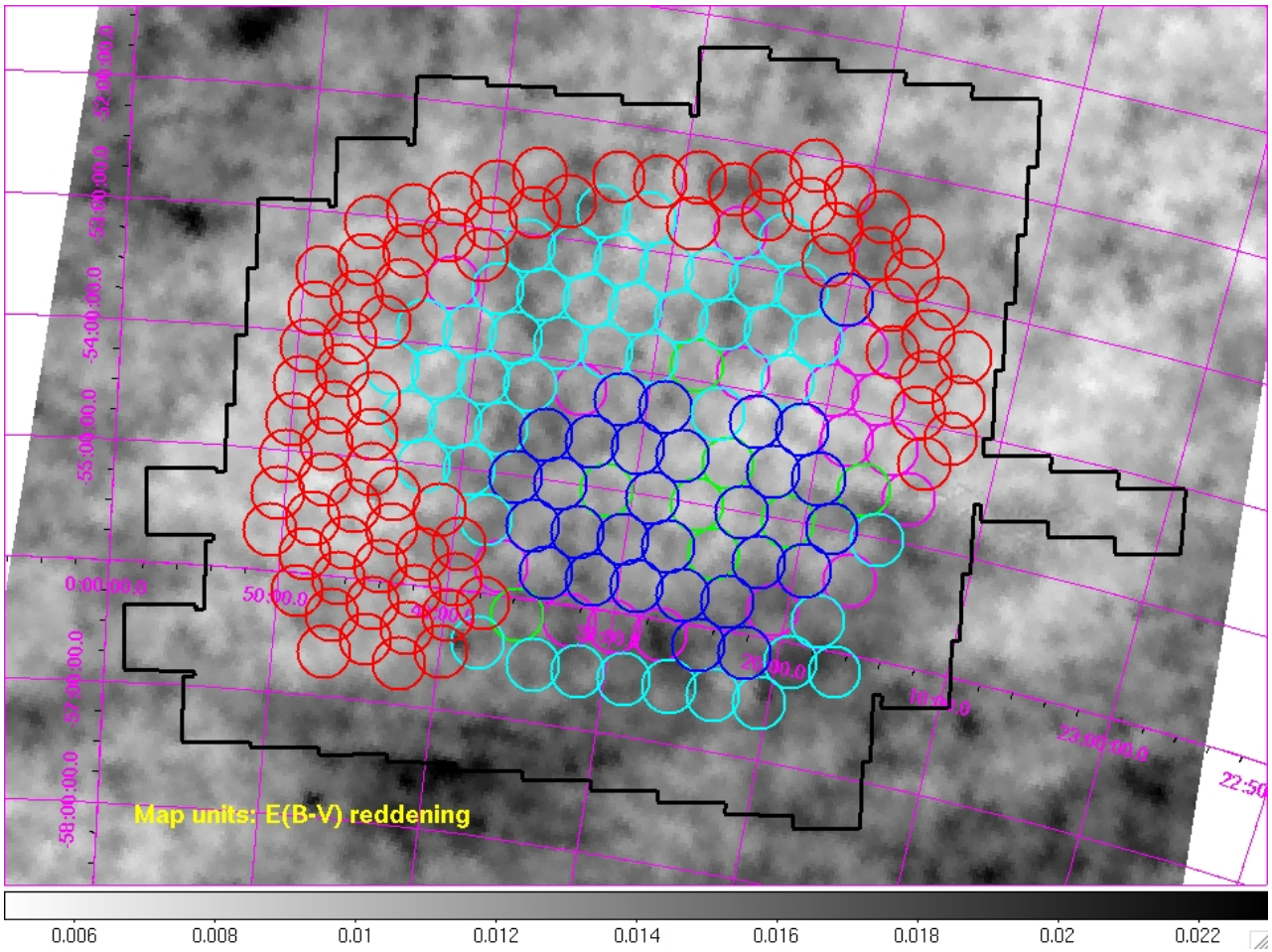


In red: the new observations (126)

$\Delta\alpha = \Delta\delta = 20'$ everywhere

25 deg^2 in BCS 23h30 -55d00

(extension of the XMM-BCS field)



In red: the new observations (80)

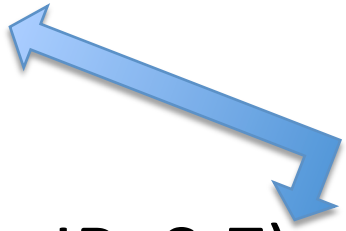
$\Delta\alpha = \Delta\delta = 20'$ ($\Delta\alpha = \Delta\delta = 23'$ in the initial central survey)

MAIN SCIENCE GOALS

Cluster ‘hot topics’

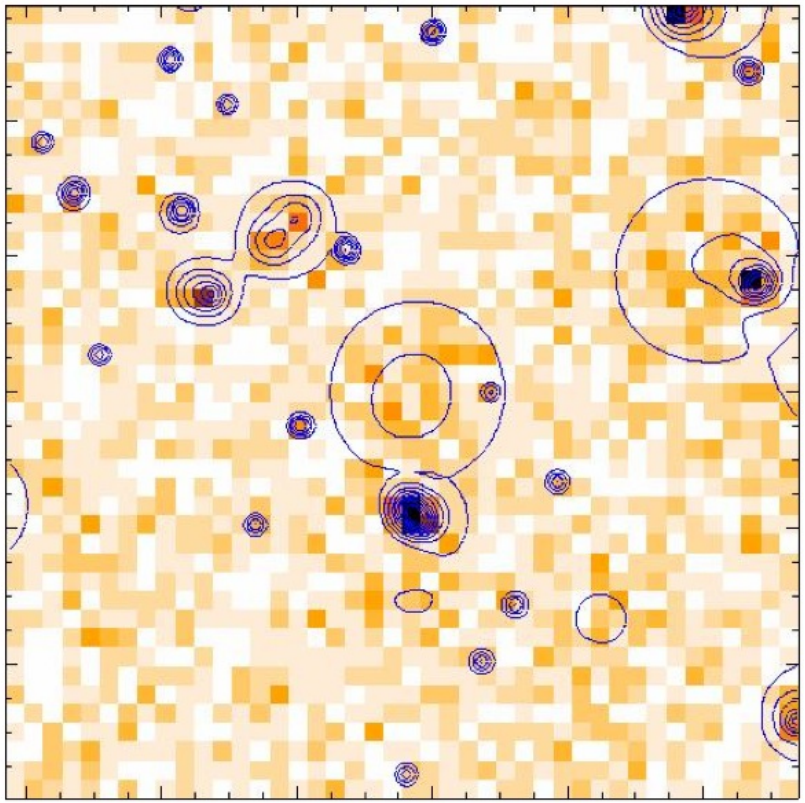
Specific to XXL

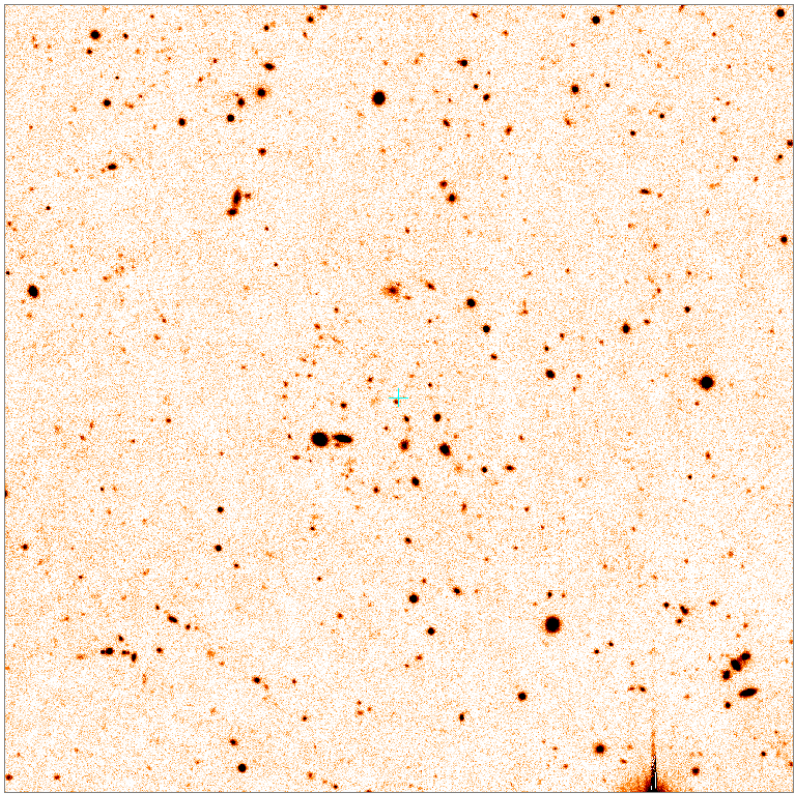
- The DE equation of state
- The group population at z~0.5
- Mass measurements (X,optical, lensing, IR, S-Z)
- Census of the 1<z<2 clusters
  - volume : 0.6 Gpc^3
  - compared to the SDSS within 0<z<0.3 : 1.4 Gpc^3



A candidate at z ~ 1.5

ID_1762





I 3.6 μm 4.5 μm

Cosmological modelling with XXL

Fit at the same time:

- The selection effects
- The cluster scaling laws
- The cosmology

➔ self-consistent analysis of the cluster data set

AGN ‘hot topics’

Specific to XXL

More than 200 X-ray AGNs/deg2

- Large Scale Structure
- Distant / Exotic AGNs
- The statistics of lensed QSOs

CATALOGUES

In the X-ray band:

450 XMM pointings
500 clusters
10 000 sources

Associated surveys

- Equatorial field (LSS)
  - CFHTLS, HSC — optical
  - ACT — SZ
  - UKIDSS — NIR 9 deg2
  - Spizter — MIR 9 deg2
  - Herschel — NIR 9 deg2
  - eRosita — X
  - GAMA — spectroscopy and multi-λ z<0.5
  - VIPERS — spectroscopy (VIMOS@VLT) 14 deg2
- Southern field (BCS)
  - DES — optical
  - Spitzer — MIR
  - ACT, SPT — SZ
  - VISTA — NIR
  - eRosita — X

… and many others in preparation (Chandra, EVLA, Herschel, ASKAP, LOFAR….)

… Euclid ?

Legacy:
The Utlimate XMM Extraglactic Survey

- X-ray source catalogues
  - Clusters — Saclay
  - Point sources — Milan
- Multi-λ catalogues — Milan
  - Photo-z
  - Special efforts on:
    - Requirements for band merging
    - Photometric uniformity
- Spectroscopy — Marseille

WORKING ORGANISATION

Project status

- Kick-off meeting 2-6 May 2011
  (45 participants, 60% not XMM-LSS)

- Work organisation
  - Steering Committee, MoU
  - Working Groups: observations et science

- ~70 people have registered to the collaboration to date

The Working Groups

- **X-ray processing**
- **Catalogues**
- **Photo-z**
- **Theory**
- **Simulations**
- **Clusters**
  - Cosmology
  - Mass measurements and scaling relations
  - Distant clusters
  - The group population at z~0.5
  - Baryon physics
  - Physics and properties of cluster galaxies
  - S-Z surveys
  - Spectroscopic follow-up
  - Core ID programme
    - z<1 clusters
    - z>1 clusters
- **Clusters (continued)**
  - Validation of the cluster redshifts for the catalogue
  - Further follow-up
    - Velocity dispersions
    - Galaxy properties
- **AGNs**
  - LSS with AGNs
  - Extreme AGNs
  - Lensed AGNs
  - AGN properties
    - SEDs
    - LF, counts and high-z population
    - Compton thick Agns
    - Star formation vs AGNs
  - Spectroscopic follow-up
- **Multi-wl follow-up**
  - Optical
  - Radio
  - NIR
  - MIR
  - FIR

Data access and catalogues

- The raw XMM data will be immediately public
- The XMM-LSS pipeline takes about 10 min per pointing
- The observations will be processed on a weekly basis

Data access and catalogues

- At the end of each visibility window
  - The general catalogue (X-ray sources +optical ID) will be available in the Milano DB
  - The cluster catalogue (C1+C2 clusters, X-ray + optical images) will be available in the Saclay-Lyon DB

- The catalogues will be released to the consortium after each visibility window
  - to do science
  - to check for any inconsistency, feature or bug in the catalogues
- **AIM:** public catalogue releases to take place one year after the internal consortium releases

Working environment

- The project is open to any interested scientist from the international community
- Activities are coordinated by dedicated data and science WGs
- Free access to all data sets for the consortium members
- Lists of science topics and provisional papers updated once a year

- Each individual has to sign the MoU
- The steering committee consists of one representative per country (Chair M.P.)

Join the XXL collaboration ?

- Read the MoU
- Propose a contribution
  - Data processing
  - Science
  - Multi-λ follow-up
  - Multi-λ catalogue
- Sign the MoU
  - Join the WGs
  - Access to the consortium wiki

Summary 1

- **XXL** is the largest XMM programme
- 10 years after the XMM launch, this is **the right time** to undertake such a survey:
  - excellent knowledge of the instrument
  - lots of experience with data processing and interpretation
  - lots of realistic and exciting science ideas!
- There is plenty of work for years… to make everybody more than happy! We are embarking on a 5-10 years project
- Favor post-docs to take on responsibility

Summary 2

- XXL will provide **competitive constraints on the DE very soon**

- Key contribution to **the XMM Legacy**

➔**Minimal investments** en proportion

Collaborators are welcome !

The END