

# EXTraS

Exploring the X-ray Transient and variable Sky

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# EXtraS in short

A project funded by EU-FP7.

EXTraS aims at fully exploring the serendipitous content of the EPIC database in the time domain and to make it available and easy to use to the whole community.

# Rationale

## Variability

### **Variability pervades the cosmos.**

Almost all source classes detected by high energy telescopes display peculiar variability in flux and/or spectral shape at different time scales, which yields crucial clues on the emission physics.

## Serendipity

In the soft X-ray energy range (0.1-12 keV), narrow-field, focusing telescopes have a much larger sensitivity than wide-field monitors and are better suited to spot and study variable phenomena in dim sources.

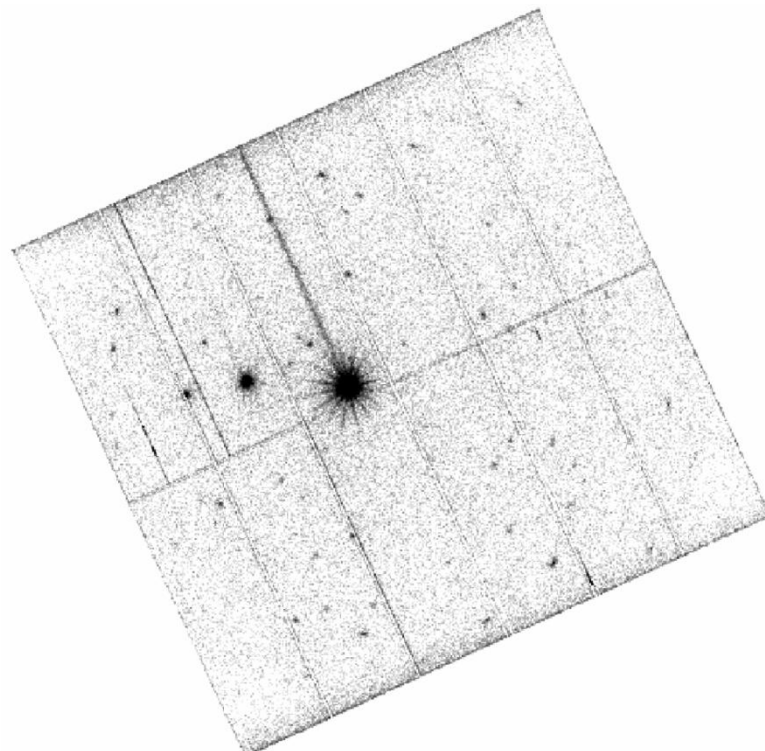
**A huge amount of time domain information is stored – and mostly unexploited – in data archives.**

# Why XMM-Newton EPIC

The powerful tool to study faint sources in the soft X-ray energy range (0.2-10 keV) due to its unprecedented combination of high sensitivity, large field of view, and good temporal and spectral resolution



	pn	MOS
E range	0.1-12 keV	0.2-12 keV
FOV	R=15'	R=15'
A <sub>eff</sub> @ 1 keV	1500 cm <sup>2</sup>	550 cm <sup>2</sup> (x2)
$\Delta\theta$ (FWHM)	5"	5"
Time res	73 ms	2.6 s
$\Delta E$ @ 1keV	85 eV	70 eV



# The EPIC database (13+ yr)

- Pointed observations

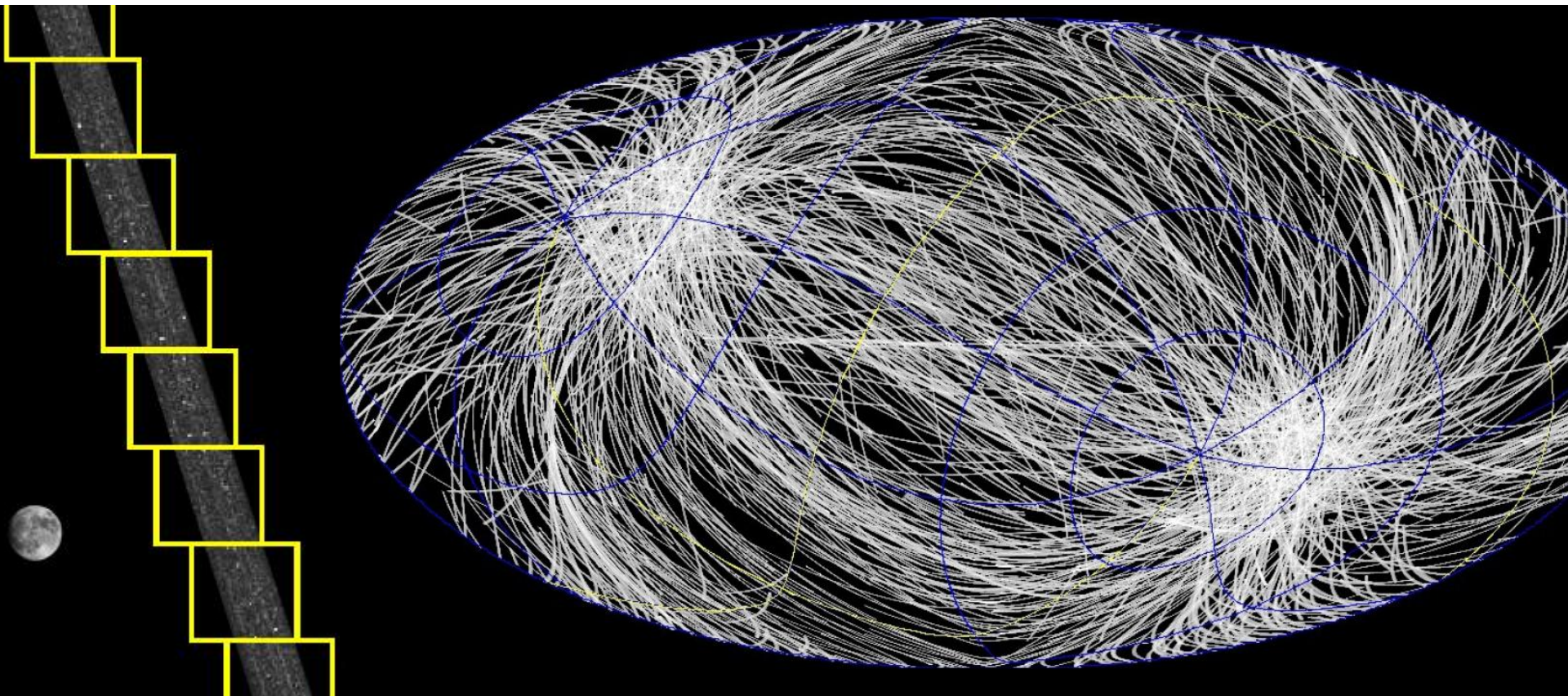
instrument	# obs	Total time	$\Omega_{\text{tot}}$
Pn	>9400	225 Ms	>800 sqdeg
MOS	>9400	232 Ms	>800 sqdeg

- Slew data

  - >65% of the sky, growing

  - >20% of the sky with at least 2 scans

# Slew data



Credit: A.Read

EPIC/pn Slew data

Slew speed: 90 degrees / hour  
Exposure time on a source: ~10 s (max),  
7 s (average)

# EPIC serendipitous science - 1

<b>The 3XMM catalogue.</b>	
# of EPIC observations	7427
Time range of observations	03-Feb-00 -- 08-Dec-12
Sky area (excluding overlaps)	794 sq deg
# of clean detections	432,231
# of unique sources	372,728
0.5-2 keV typical (deepest) sensitivity limit	$\sim 3(1) \cdot 10^{-15} \text{ erg cm}^{-2} \text{ s}^{-1}$
2-10 keV typical (deepest) sensitivity limit	$\sim 1.5(0.8) \cdot 10^{-14} \text{ erg cm}^{-2} \text{ s}^{-1}$
# of sources with spectra and light curves	$\sim 123,900$

Time domain:

- light curves (20 cts/bin, 10s min bin),
- basic variability test,
- FFT on binned light curve

# EPIC serendipitous science - 2

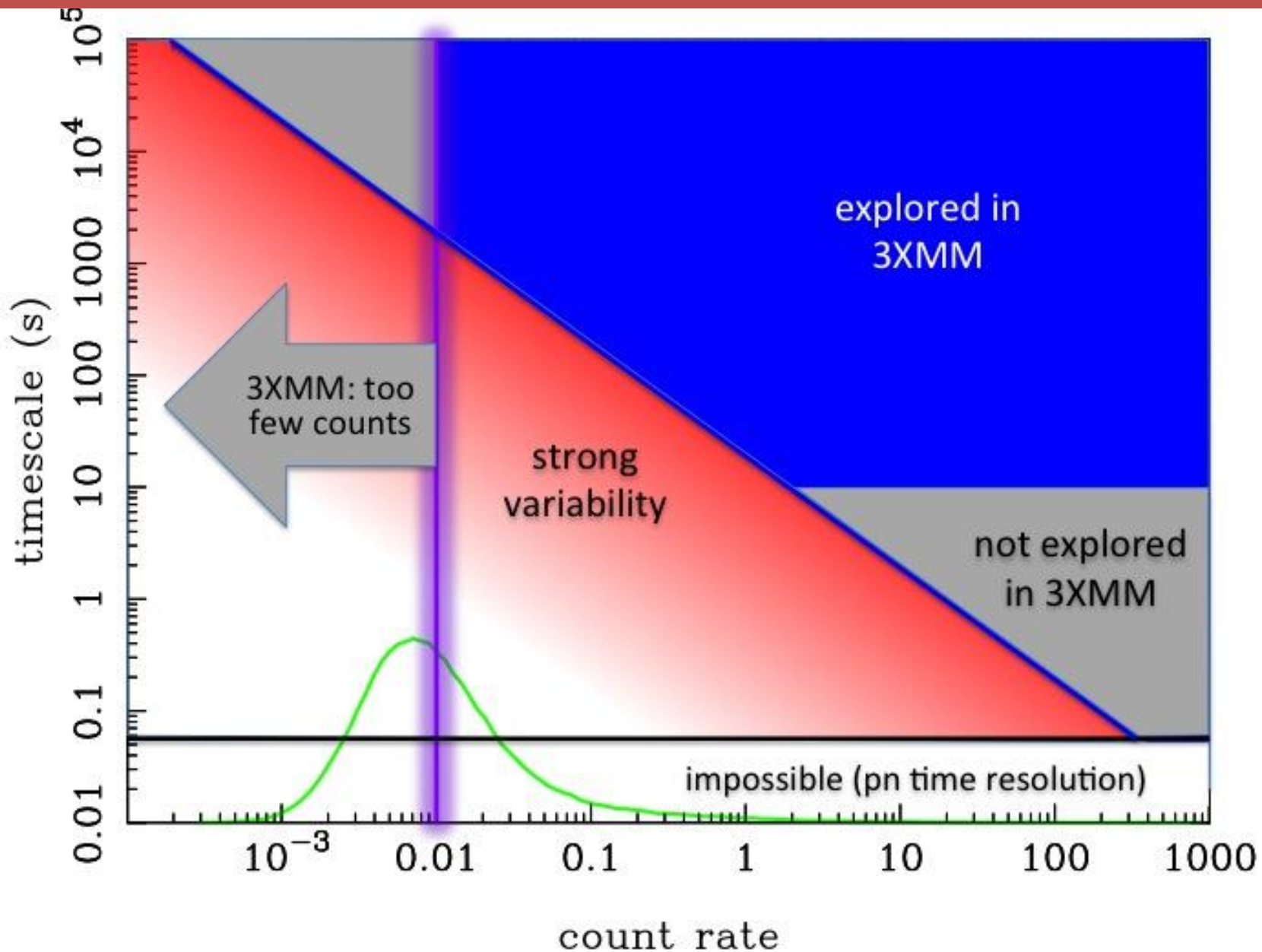
Time range of observations	August 2001 – August 2012
Exposure time (single scan)	7 -- 10 s
Sky area	61.8% of the sky
Sky area (multiple scans)	> 20% of the sky
# of clean detections	18,250
0.5-2 keV sensitivity limit	$\sim 6 \cdot 10^{-13}$ erg cm <sup>-2</sup> s <sup>-1</sup>
2-10 keV sensitivity limit	$\sim 2 \cdot 10^{-12}$ erg cm <sup>-2</sup> s <sup>-1</sup>

Time domain:

No systematic characterization/cataloguing of variability



# Discovery space of EXTraS



# The EXTraS project

1. blind search for transient sources

3. Systematic search for periodicity

2. Systematic search for aperiodic variability

4. Systematic search for long-term variability

5. Phenomenological classification of all detected variable sources

# The EXTraS project

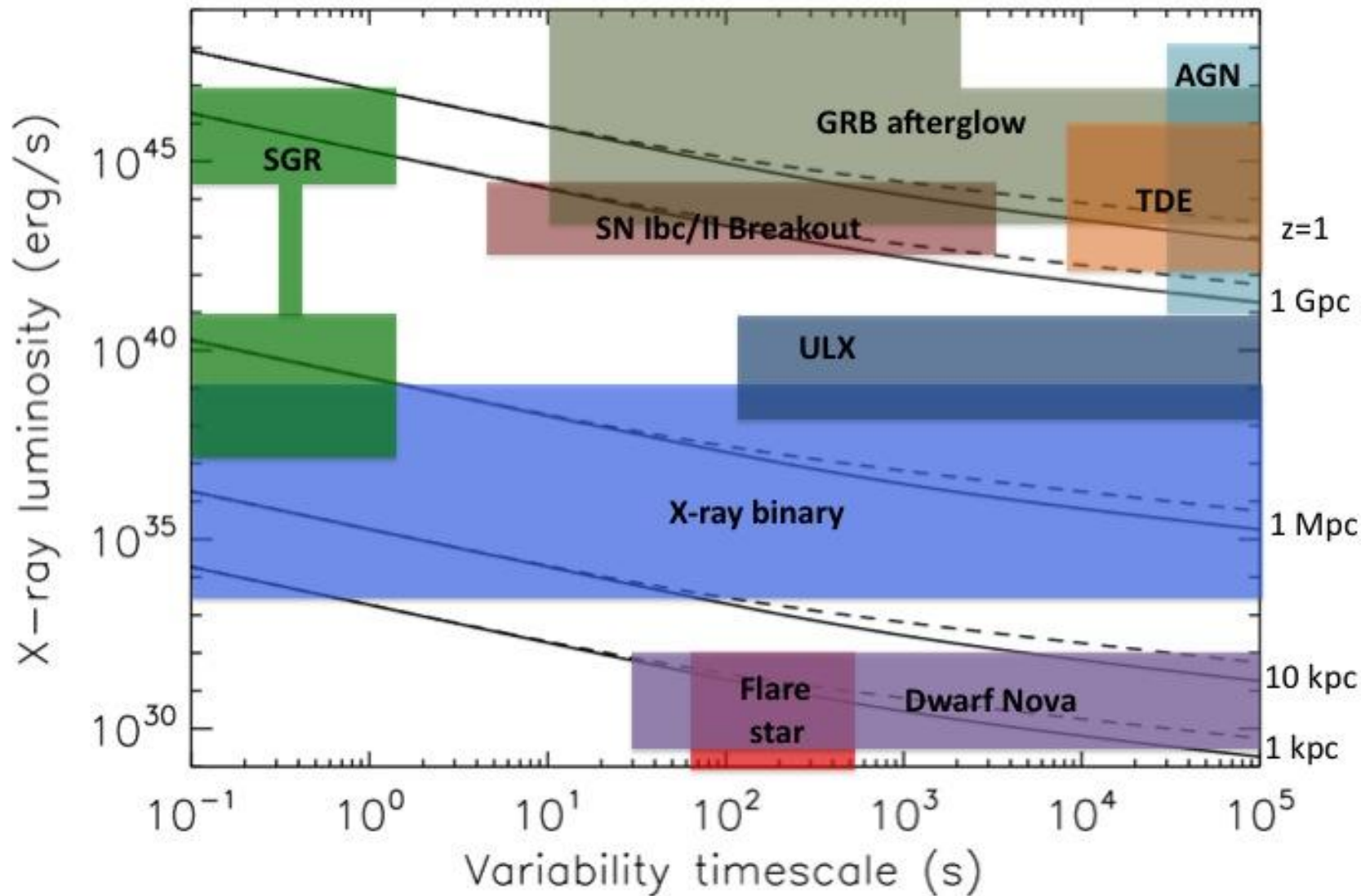
## The output

- A variable source catalogue, including all detected variable sources and spanning more than 8 orders of magnitude in variability time scale and 6 orders of magnitude in flux.
- Time series, spectra as well as characterization and classification results will be released in the catalogue using VO-compliant data models and software.
- New software tools will also be made available to the community.

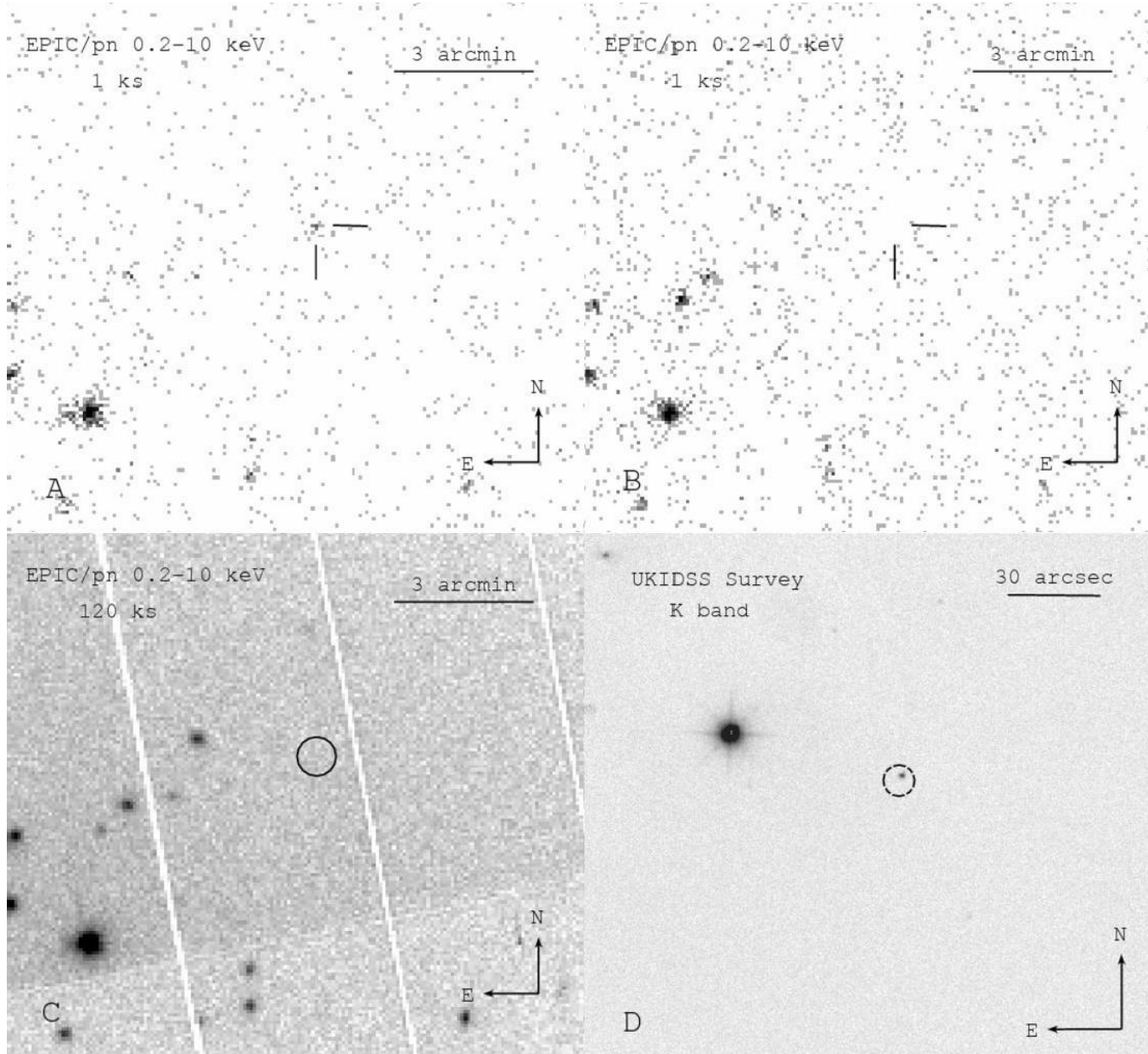
## Dissemination

- Advertizing!
- Experimental didactic program for high schools

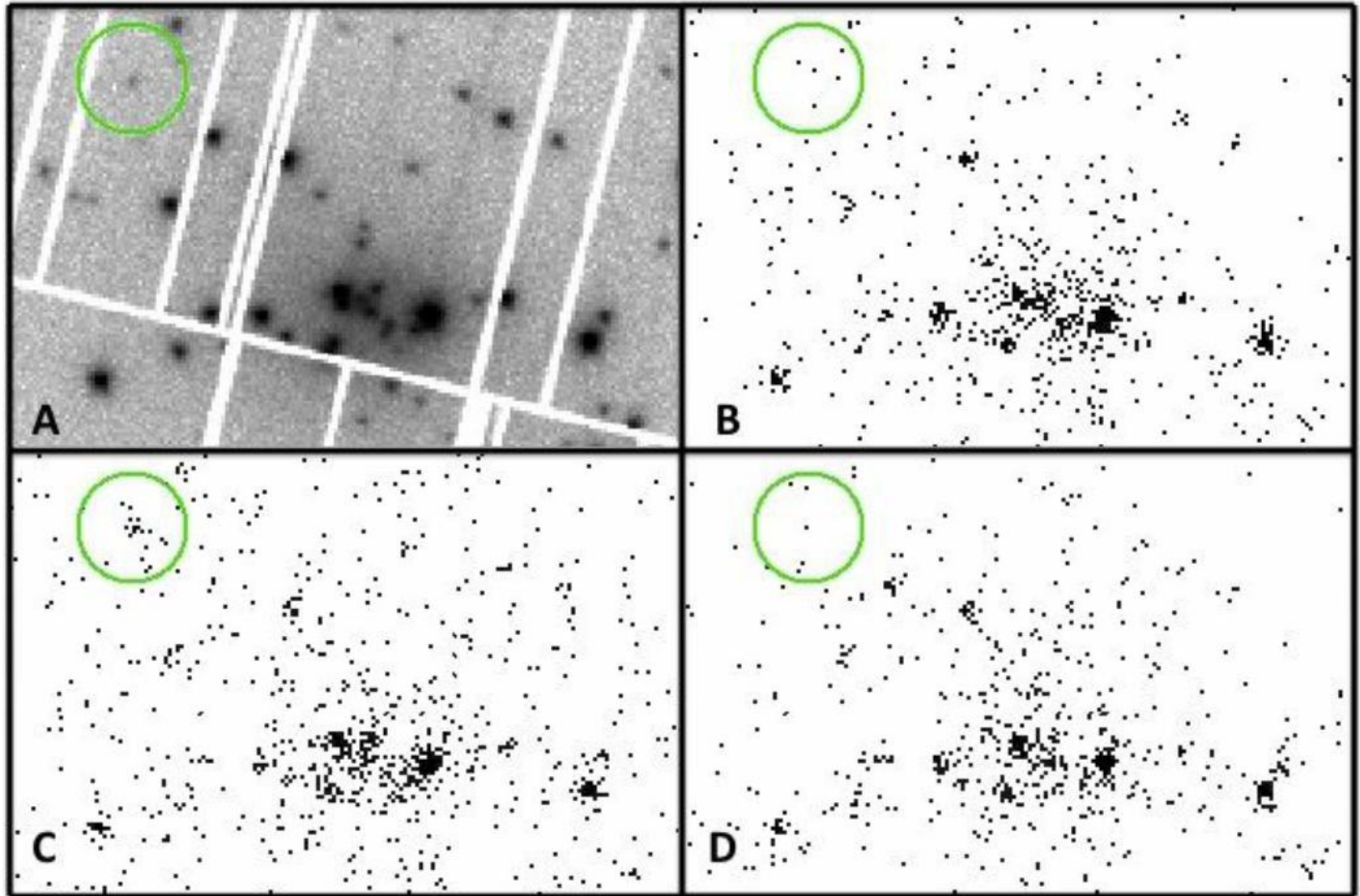
# Sensitivity



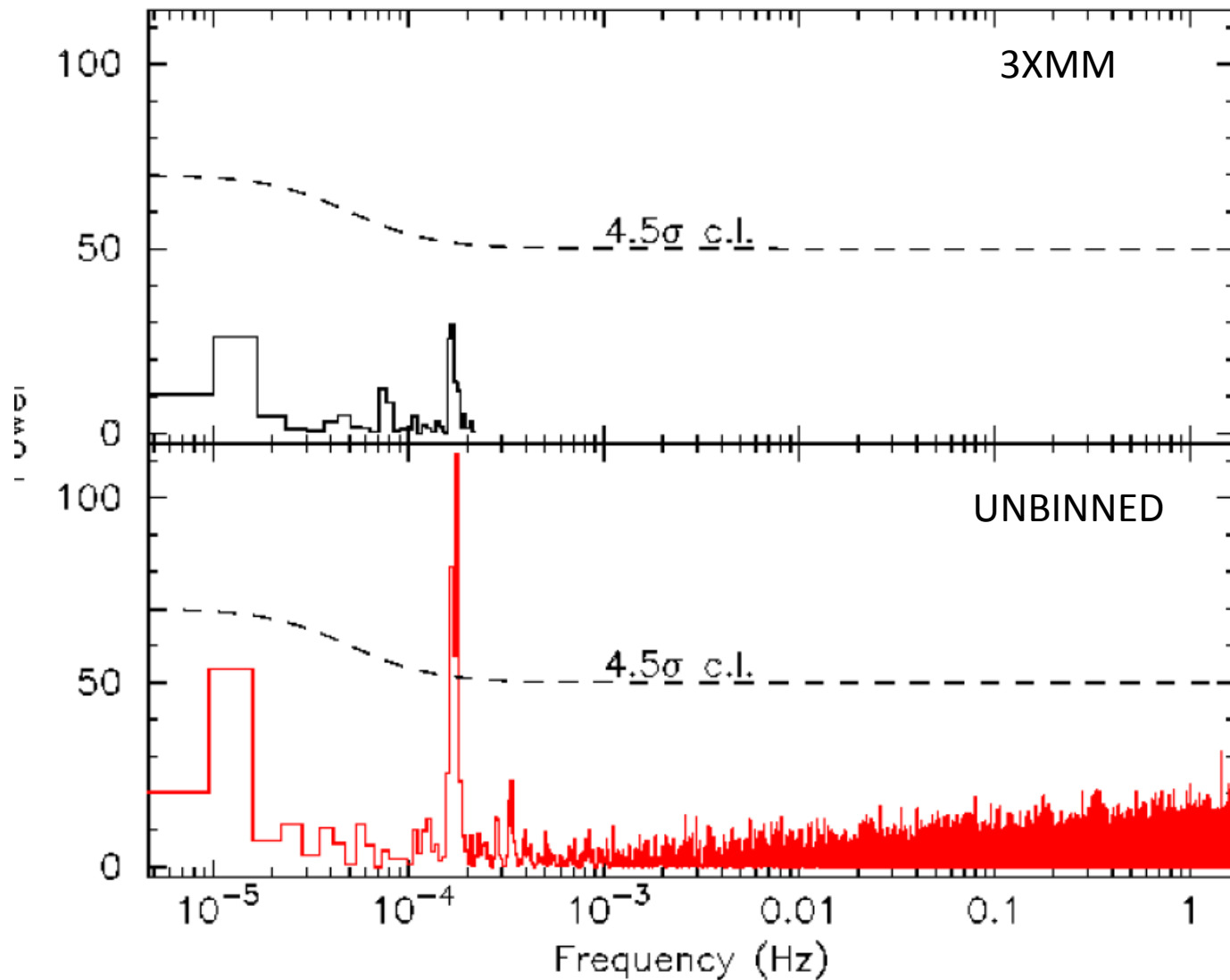
# Faint flares from a young stellar object



# Blind detection of type-I bursts from M31

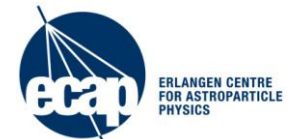


# A 95-min pulsator not apparent in 3XMM



# EXTraS

- **2012, November:** submitted in response to FP7-Space call for proposal, area SPA.2013.2.1-01 - Exploitation of science and exploration data
- **2013, March:** EXTraS enters negotiation phase
- **2013, September:** Grant Agreement signed
  
- Start of the project: 2014, January 1
- Duration: 36 months
- Primary Coordinator: A. De Luca
- Consortium:
  - INAF (coordinator)
  - IUSS Pavia
  - CNR-IMATI Genova
  - University of Leicester (UK)
  - MPE Garching (Ge)
  - Erlangen Center for Astrophysics (Ge)





# EXTraS

INAF (coordinator)

IASF-Mi – OAB – OATs – IASF-Bo – OARm – OACt – OAPa

- Project management
- Search for aperiodical variability
- Search for periodicity
- Dissemination