

The Technical Side Of Very Long (XMM-Newton) Projects

An XXL extragalactic survey:
prospects for the XMM next decade
Workshop, 14-16 April 2008, Paris

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XMM-Newton

Content

- **XMM-Newton and future extensions**
- **Technical Aspects**
 - Visibility
 - Question of PIERRE Marguerite
- **X-ray Universe 2008**

Content II

- **Question of PIERRE Marguerite**
 - (1) the mean background level as a function of observation position in the orbits
 - (3) the XMM current efficiency for our two current working hypotheses
 - a 20X10 deg² survey covered by 10 ks pointings
 - a 7x7 deg² survey covered by 40 ks pointings
 - (2) is it foreseen to improve the current performances?
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Newton

- **Is second cornerstone of ESA's horizon 2000 program**
- **ESA is in inter-governmental organization with the aim to ... promote the space technology..**
- **extensions of missions are not granted but must be "earned" in competition with other ESA missions**
- **Cornerstones for future XMM-Newton extensions:**
 1. Users/Community
 2. Oversubscription
 3. Number of Papers and citations
 4. Scientific Impact
 5. Public outreach

Users

Observatory type mission:

- Annual call for observing time proposals
- Peer review process (OTAC)
- Support for users: from definition of observation details, enhancement, scheduling/coordination, TOO request evaluation and TOO implementation ... help-desk, ...analysis...to ... (SAS) ... calibration ... archiving ... SAS workshops, documentation, conferences and public outreach

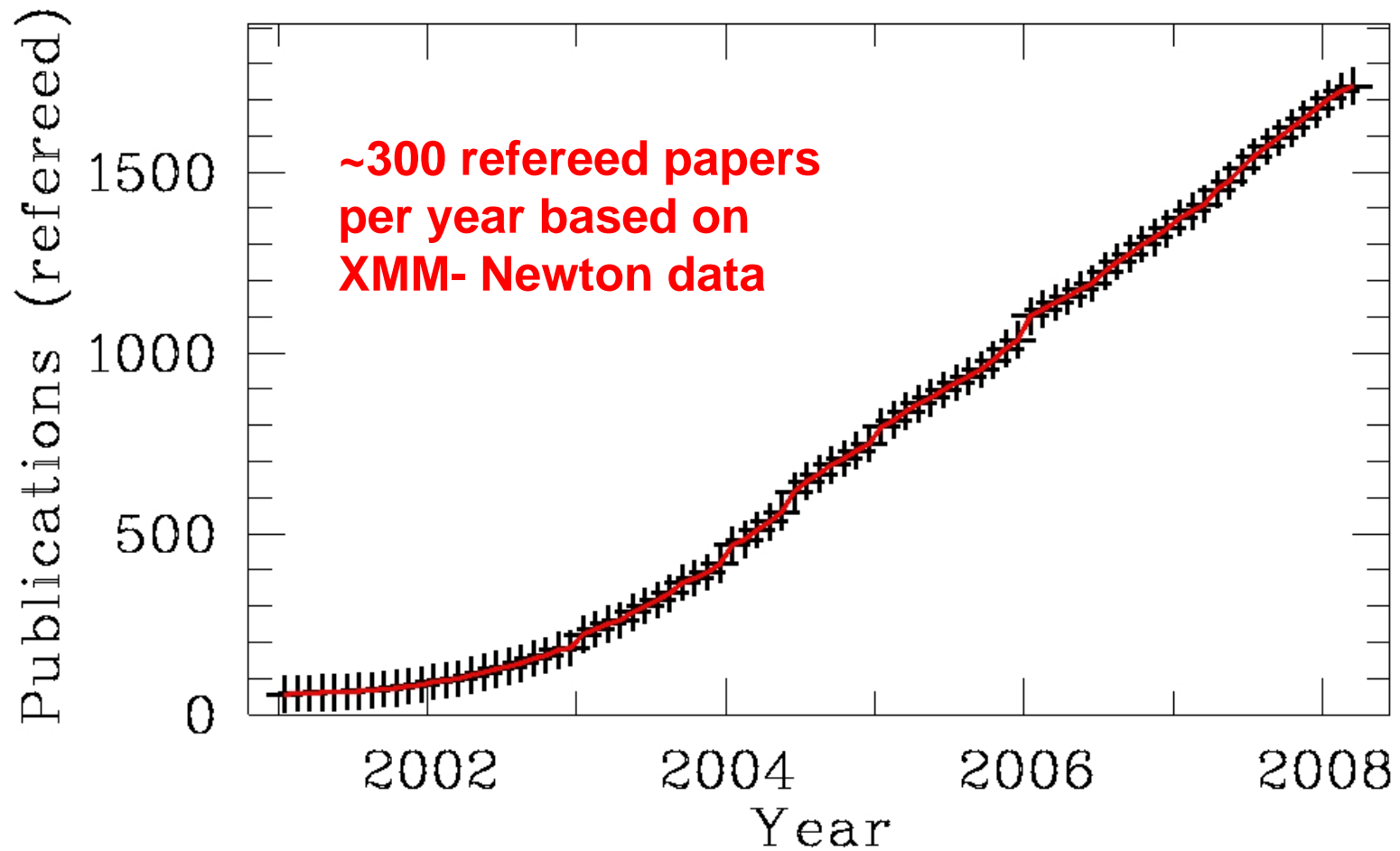
→ Users:

- **Large Community: 1500 - 2000 scientists**
 - All scientific topics are addressed
 - from comets and planets up to the most distant quasars
 - Most of the users are “external” to the XMM-Newton project, e.g. they do not belong to instrument institutes nor the Survey Science Center)
-

Requests and Users

- **Announcement of Opportunity: AO7**
 - 586 valid proposals were submitted
 - Oversubscription 7.8
 - 424 different principal investigators from 23 countries
 - 1560 individual scientists
 - 8 proposals joint XMM/Chandra
 - 11 proposals joint XMM/VLT
 - **Observing Time Allocation Committee: OTAC**
 - 13 panels
 - 66 scientists (rotation every 2 AOs)
 - **Archive: XSA**
 - 2200 external registered uses
 - 110 external users per month (typical value)
 - 2500 data sets (ODF and PPS) per month (typical value)
 - **Analysis Software: SAS:**
 - Version 7.1 (1st June 2006 – 13th July 2007)
 - 2075 downloads
 - ~1730 scientists have access to SAS 7.1 (not counting downloads with only one user)
-

Publications



Citations

Astron. Nachr. / AN 328, No. 9, 983–994 (2007) / DOI 10.1002/asna.200710826

Productivity and impact of astronomical facilities: A statistical study of publications and citations

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31.4 C/P

Key words publications, bibliography – telescopes

In calendar years 2001 and 2002, 20 journals of astronomy and astrophysics published 7768 papers that reported or analyzed observations at wavelengths from meter radio to ultrahigh energy gamma rays. In the three calendar years after publication, these papers were cited more than 97 000 times, according to the Science Citation Index/Web of Science data base (the most complete, we believe, available), for an average rate of 4.19 citations per paper per year. We slice these data up several ways, by subject matter, wavelength band, and the telescopes (etc.) used. Most of the results will not surprise: There are hot topics (cosmology, exoplanets) and not so hot topics (binary stars, planetary nebulae). Papers reporting space-

Scientific Highlights: Public Outreach I

03-Jan-2007:

Black hole found inside globular star cluster

Astronomers have found a black hole where few thought they could ever exist, inside a globular star cluster. The finding has broad implications for the dynamics of stars clusters and also for the existence of a still-speculative new class of black holes called 'intermediate-mass' black holes.

Read further details on the [ESA News Pages](#)

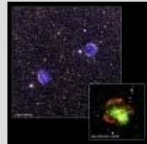


05-Jan-2007:

X-ray evidence supports possible new class of supernova

Evidence for a significant new class of supernova has been found with the European Space Agency's XMM-Newton and NASA's Chandra X-ray Observatory. These results strengthen the case for a population of stars that evolve rapidly and are destroyed by thermonuclear explosions.

Read further details on the [ESA News Pages](#)

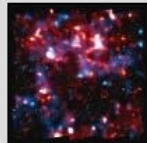


07-Jan-2007:

First 3D map of the Universe's dark matter scaffolding

An international team of scientists has assembled a three-dimensional map that offers a first look at the web-like large-scale distribution of dark matter in the Universe.

Read further details on the [ESA News Pages](#)



06-Feb-2007:

Universe contains more calcium than expected

The universe contains one and a half times more calcium than previously assumed. This conclusion has been drawn by astronomers using XMM-Newton observations.

Read further details on the [ESA News Pages](#)



16-Feb-2007:

First X-ray detection of a colliding-wind binary beyond the Milky Way

Imagine two stars with winds so powerful that they eject an Earth's worth of material roughly once every month and imagine those two winds colliding head-on. Astronomers have conclusively identified the X-rays from about two-dozen of these systems in our Milky Way, but they have never seen one outside our galaxy. Until now.

Read further details on the [ESA News Pages](#)



22-Feb-2007:

XMM-Newton reveals a magnetic surprise

XMM-Newton has revealed evidence for a magnetic field in space where astronomers never expected to find one. The magnetic field surrounds a young star called AB Aurigae and provides a possible solution to a twenty-year-old puzzle.

Read further details on the [ESA News Pages](#)

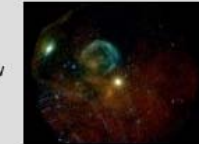


23-Feb-2007:

Anniversary view of nearest detected supernova

Twenty years after the first detection of SN 1987A, the nearest supernova ever detected so far, XMM-Newton provided a fresh-new view of this object. XMM-Newton confirms that the source keeps brightening.

Read further details on the [ESA News Pages](#)



09-Mar-2007:

XMM-Newton solves Decade Long Mystery

The brightest member of the so-called 'Magnificent Seven' has been found to pulsate with a period of seven seconds. This discovery casts some doubt on the recent interpretation that this object is a highly exotic celestial object known as a quark star.

Read further details on the [ESA News Pages](#)

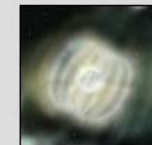


04-Apr-2007:

XMM-Newton catches Magnetar in Giant Hiccup

Astrophysicists have managed to catch a recently discovered magnetar in a sort of giant cosmic hiccup that still has them puzzled.

Read further details on the [ESA News Pages](#)



10-Apr-2007:

45-year old mystery spiral arms explained?

Astronomers may have cracked a 45-year old mystery surrounding two ghostly spiral arms in the galaxy M106 (NGC 4258).

Read further details on the [ESA News Pages](#)



Scientific Highlights: Public Outreach II

20-Apr-2007:

XMM-Newton pinpoints intergalactic polluters

Warm gas escaping from the clutches of enormous black holes could be the key to a form of intergalactic 'pollution' that made life possible, according to new results from XMM-Newton.

Read further details on the [ESA News Pages](#)

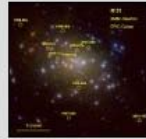


9-May-2007:

X-rays provide new way to investigate exploding stars

XMM-Newton has revealed a new class of exploding stars - where the X-ray emission 'lives fast and dies young'.

Read further details on the [ESA Space Science News Pages](#)



16-May-2007:

New technique for 'weighing' black holes

XMM-Newton has helped to find evidence for the existence of controversial Intermediate Mass Black Holes.

Read further details on the [ESA News Pages](#)



31-May-2007:

X-rays from gas streams around young stars revealed

XMM-Newton has surveyed nearly two hundred stars under formation to reveal, contrary to expectations, how streams of matter fall onto the young stars' magnetic atmospheres and radiate X-rays.

Read further details on the [ESA News Pages](#)



01-Jun-2007:

A&A XMM-Newton Special Feature

Astronomy & Astrophysics is publishing a special feature dedicated to the XMM-Newton extended survey of the Taurus molecular cloud. One of the main results is the identification of unusual physical processes not known before in forming stars. These unprecedented observations suggest that the gas streams falling down onto the forming star and the jets being ejected from it both play major roles in the production of X-rays.

Read further details on the [A&A Website](#)



18-Jul-2007:

The Biggest Collisions in the Universe

XMM-Newton catches a pair of galaxy clusters merging into a giant cluster, a discovery which adds to existing evidence that galaxy clusters can collide faster than previously thought.

Read further details on the [ESA News Pages](#)



27-Aug-2007:

XMM-Newton & Suzaku Pioneer Method for Probing Exotic Matter

Astronomers using XMM-Newton and Suzaku have seen Einstein's predicted distortion of space-time and pioneered a ground-breaking technique for determining the properties of neutron stars.

Read further details on the [ESA Space Science News Pages](#)

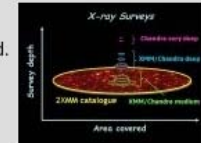


07-Sep-2007:

XMM-Newton releases the largest catalogue of X-ray sources

The largest catalogue of X-ray sources ever has now been released. The catalogue, '2XMM', has been compiled from observations carried out with ESA's XMM-Newton space observatory over six years of operation.

Further details on the [ESA Space Science News Pages](#)

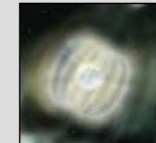


20-Sep-2007:

Explosion reveals tiny magnetic island

XMM-Newton has provided new insight into puzzling celestial objects known as magnetars. Astronomers have traced powerful explosions to a region just beneath a magnetars surface.

Further details on the [ESA Space Science News Pages](#)

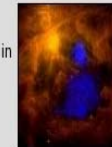


29-Nov-2007:

An X-ray Santa Claus in Orion

ESA's XMM-Newton X-ray observatory has discovered a huge cloud of high-temperature gas resting in a spectacular nearby star-forming region. An early christmas present for astronomers, the cloud suggests that hot gas from many star-forming regions leaks into the interstellar medium.

Further details on the [ESA Website](#)



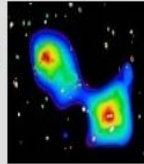
Scientific Highlights: Public Outreach III

14-Dec-2007:

XMM-Newton unveils Hidden Cosmic Giant

Astronomers working with XMM-Newton have discovered a new cluster of galaxies, hidden behind a previously identified cluster of galaxies. The recently exposed cosmic giant is apparently just as bright as the first group, but is six times further away.

Further details on the [ESA Space Science News Pages](#)

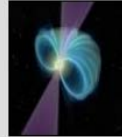


21-Dec-2007:

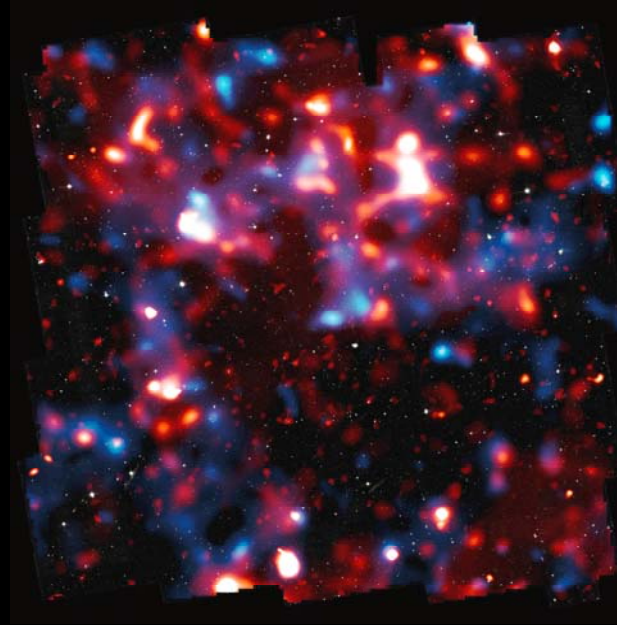
Pulsed heartbeat of a weird new type of star

XMM-Newton has detected periodic X-ray emission, or the pulsed heartbeat of a weird new type of star. Collecting the X-rays from the so-called rotating radio transient has confirmed the nature of the underlying celestial object and given astronomers a new insight into these exotic objects.

Further details on the [ESA Space Science News Pages](#)



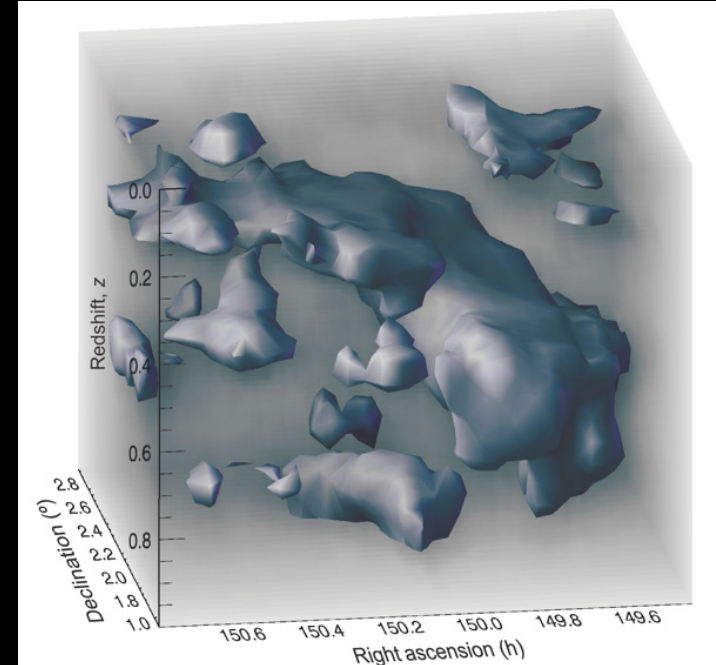
Dark Matter Maps reveal Cosmic Scaffolding



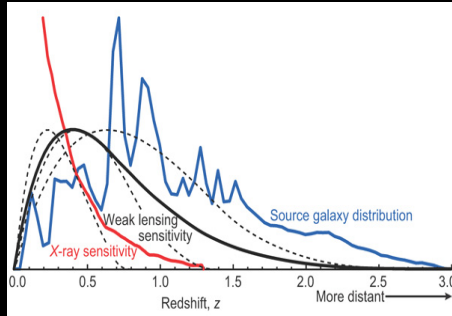
COSMOS Field:
1.637 degree²
1000 h (HST)
400 h (XMM)

Matter:
1/6 baryonic
(hot and cold)
5/6 dark

**Gravitational
lensing: total
amount of matter
(hot and cold)**



**R.
Massey
et al.,
2007,
Nature
445, 286**



**Optical & infrared:
cold baryonic
matter**
**XMM-Newton:
hot matter (red
in picture)**

→ Maps of the large-scale distribution of dark matter, resolved in both angle and depth.

→ Loose network of filaments, growing over time, which intersect in massive structures at the locations of clusters of galaxies

→ Consistent with predictions of gravitationally induced structure formation

First Black Hole in Globular Star Clusters

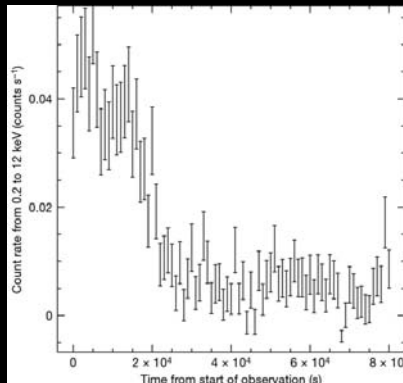
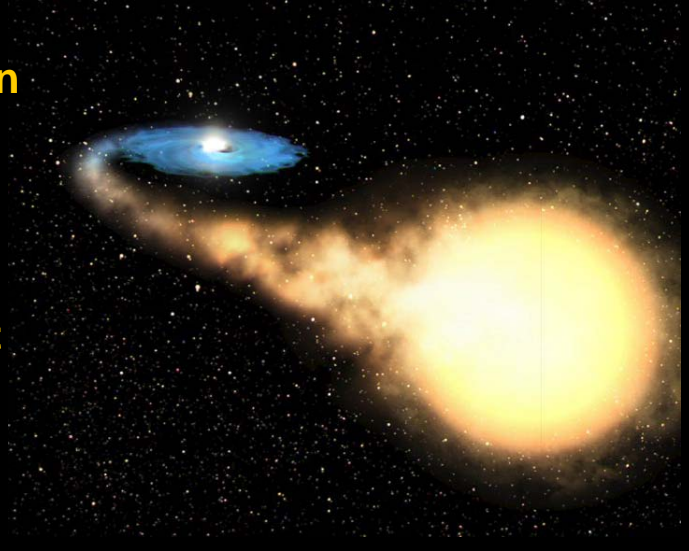


- GCs contain 10^3 - 10^6 old stars packed within tens of light years

- Formation of 10^3 solar mass BH ?

- Interaction will eject BHs ?

T.J. Maccarone et al.,
2007, Nature 445, 183



- X-ray source in GC associated with NGC 4472 (in the Virgo cluster)

- X-ray luminosity: 4×10^{39} erg s⁻¹

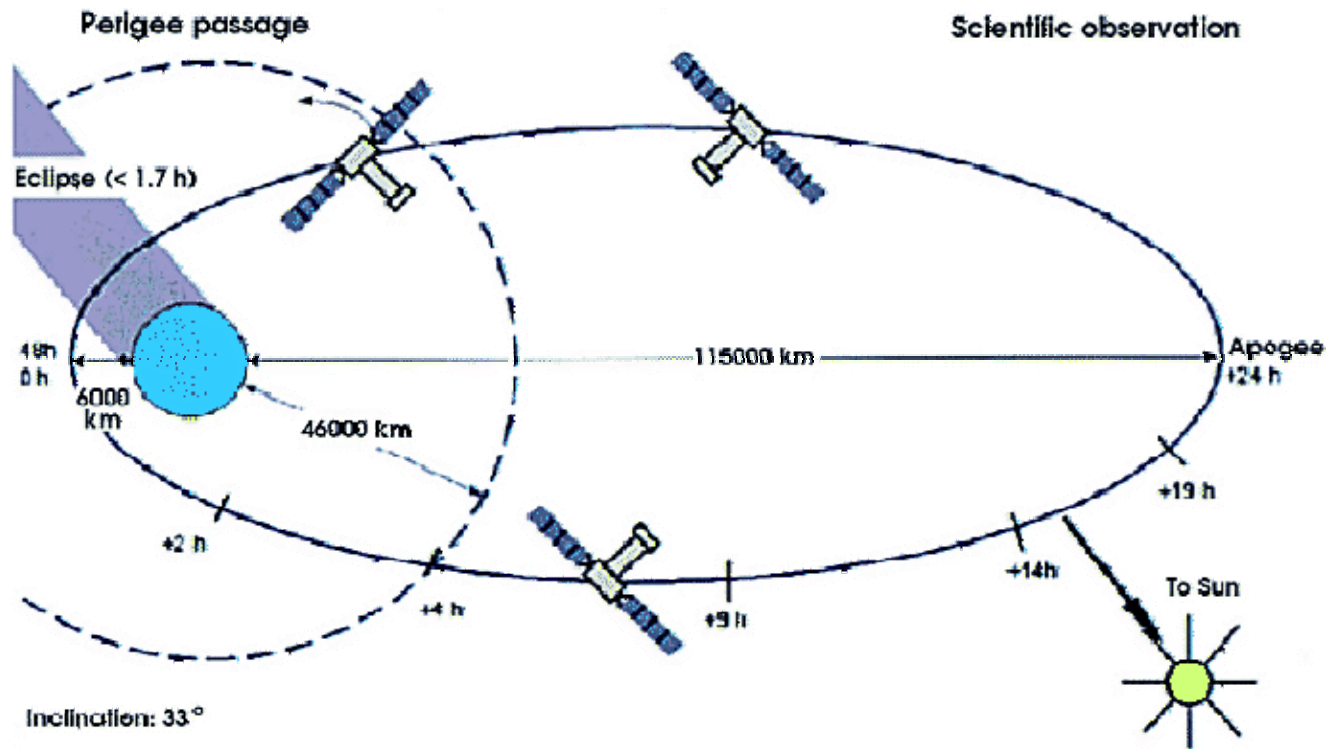
- Variability excludes composition by several objects

- Black hole (15-30 or 400 solar masses)

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Visibility I



XMM-Newton UHB

Visibility II

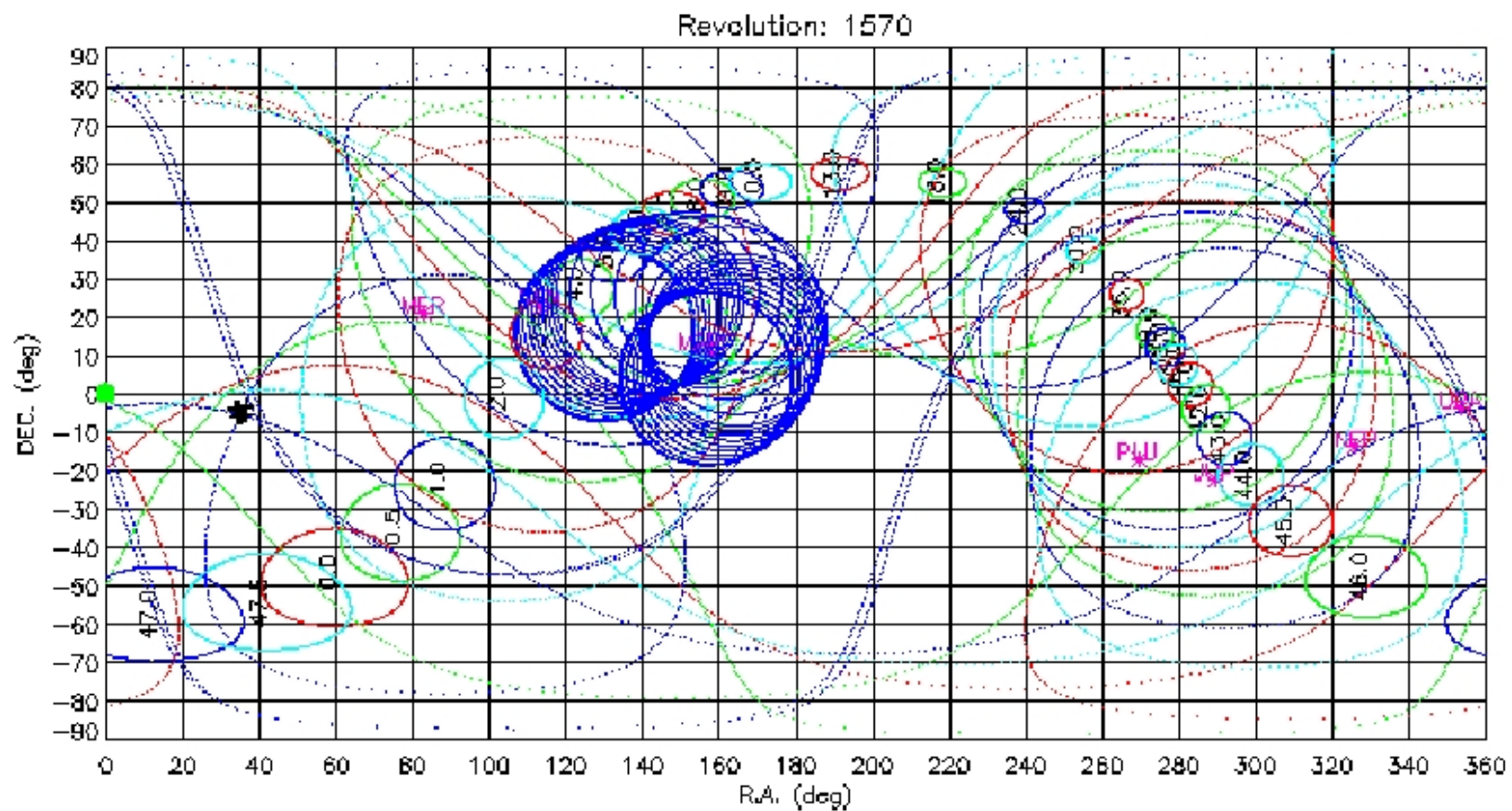
- **Celestial constraints**

- The visibility of sources in the sky depends on several constraints, including avoidance of solar system sources.

These are:

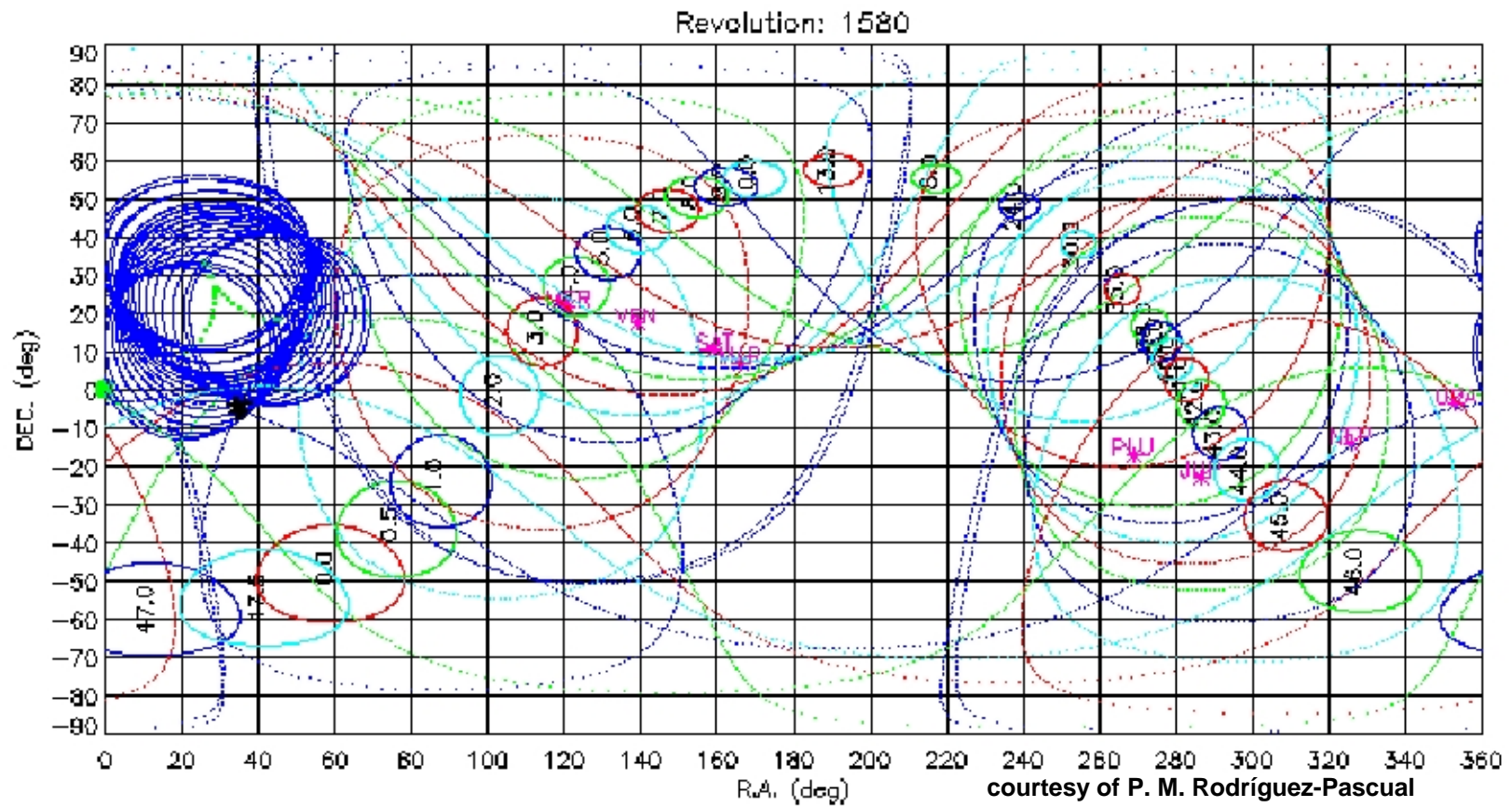
- **Earth limb avoidance** with a minimum avoidance angle: 42.5° .
 - **Solar avoidance** where a solar aspect angle within the range 70° - 110° must be maintained at all times.
 - **Lunar avoidance** with a nominal minimum avoidance angle: 22° . (Minimum avoidance angle during eclipses (a few weeks near equinoxes: 35°).

Sky I

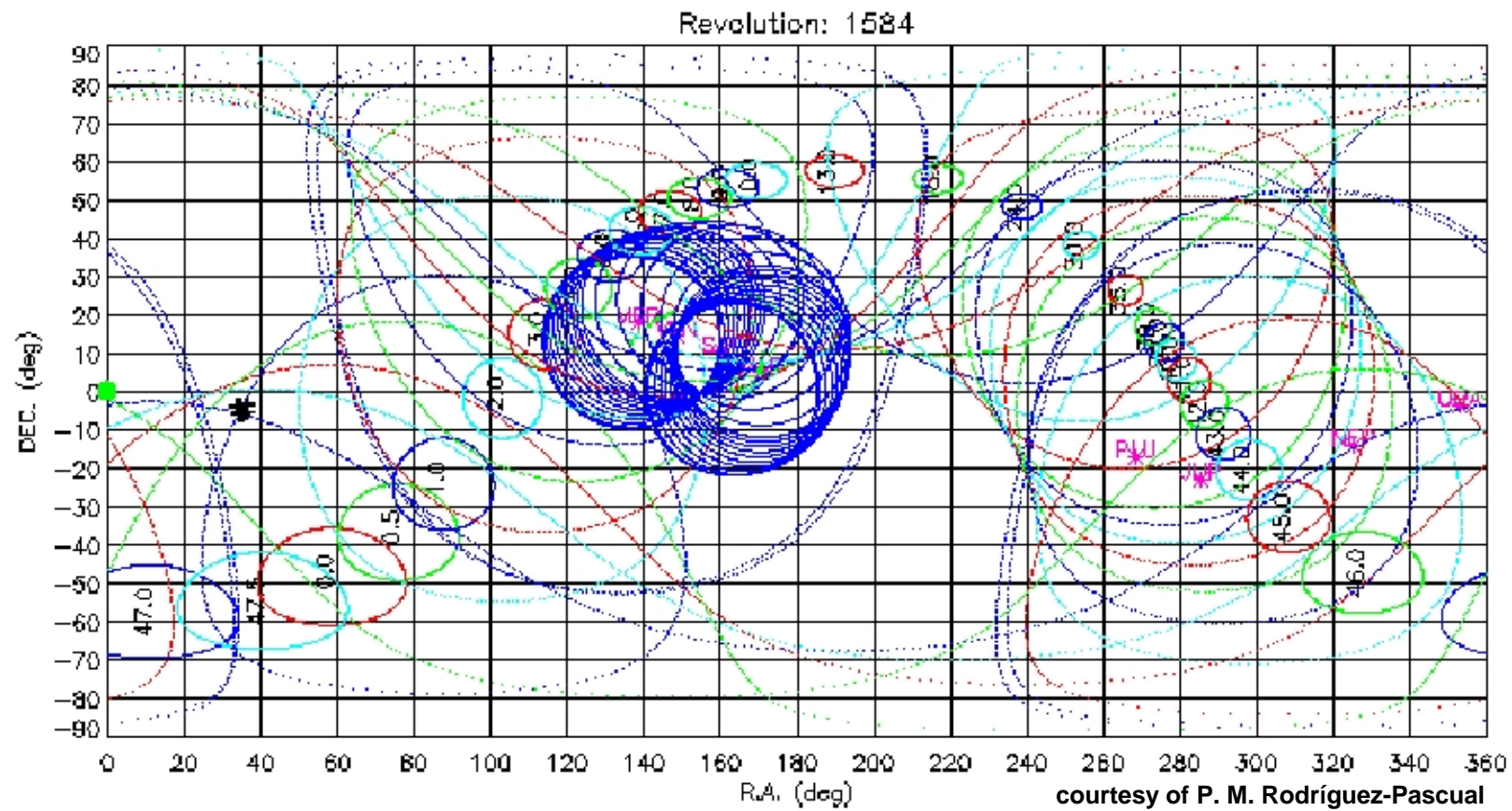


courtesy of P. M. Rodríguez-Pascual

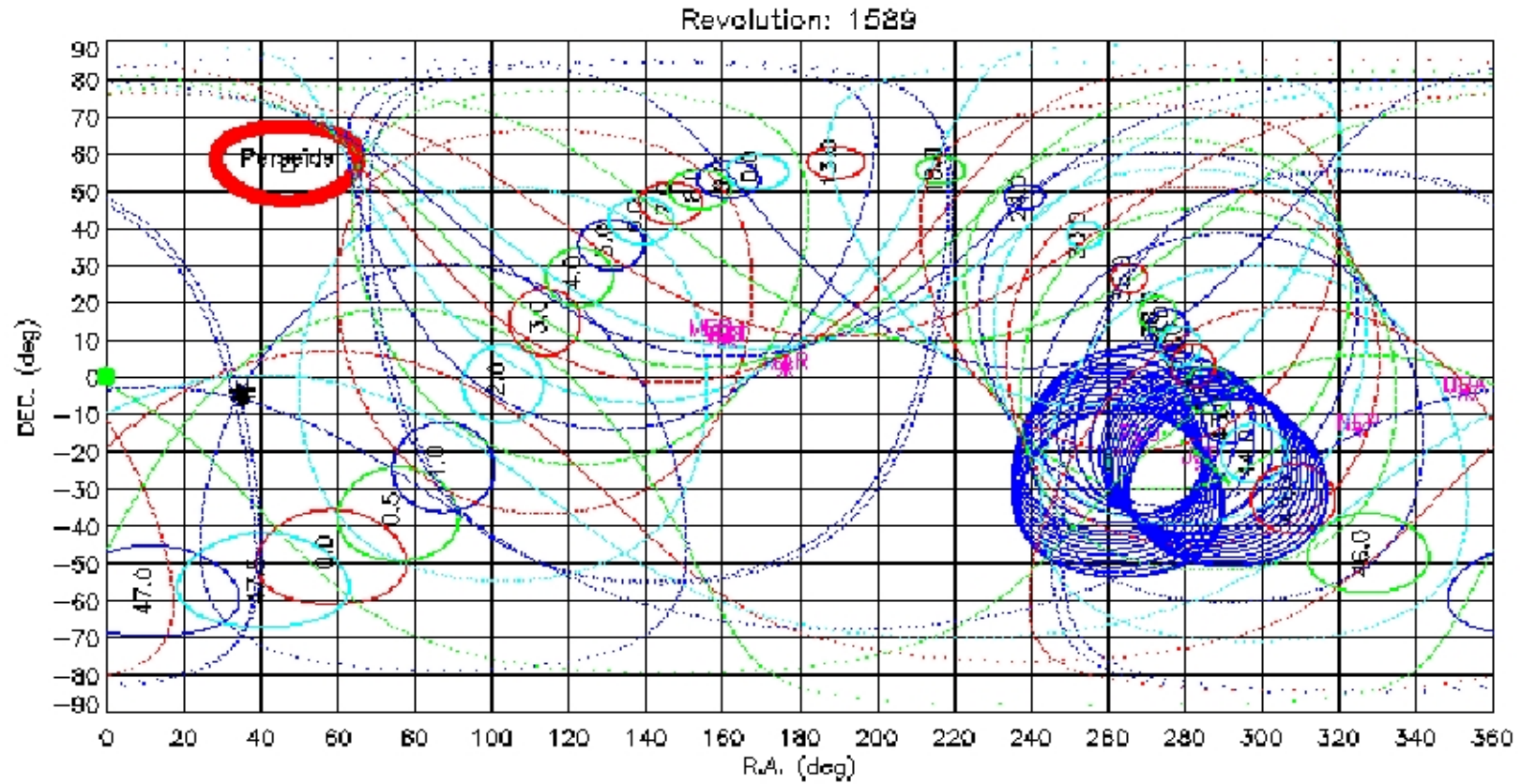
Sky II



Sky III

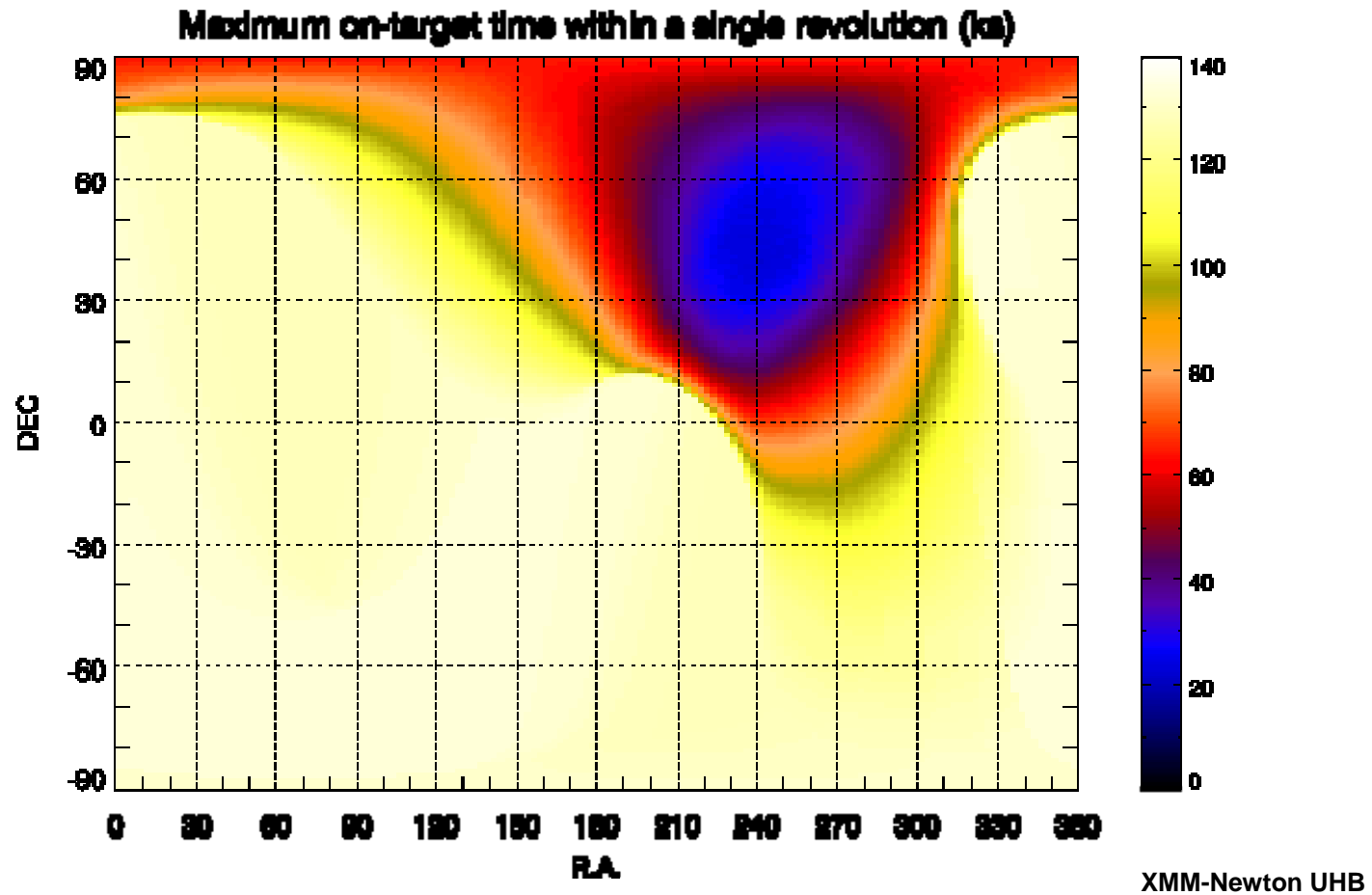


Sky IV

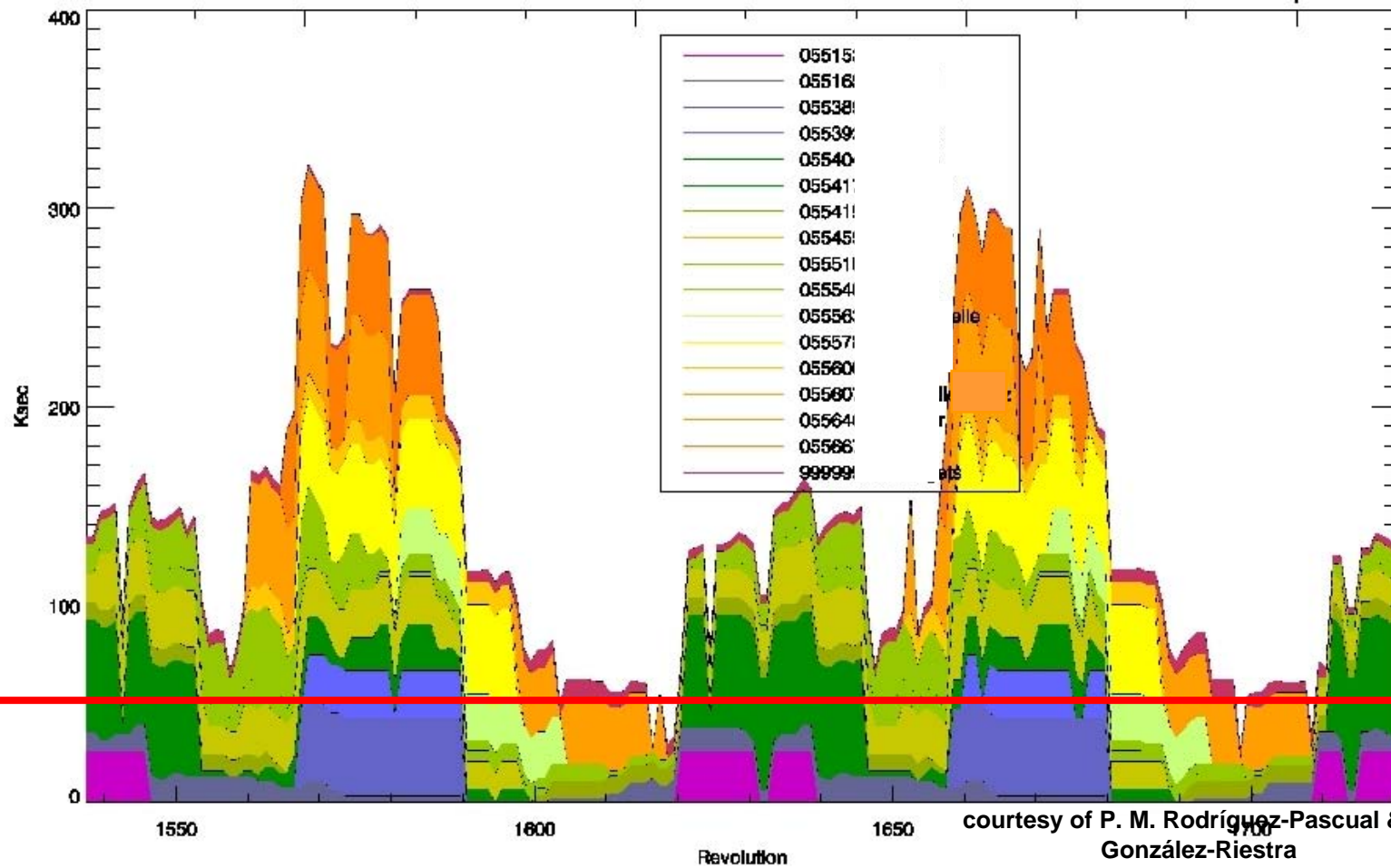


courtesy of P. M. Rodríguez-Pascual

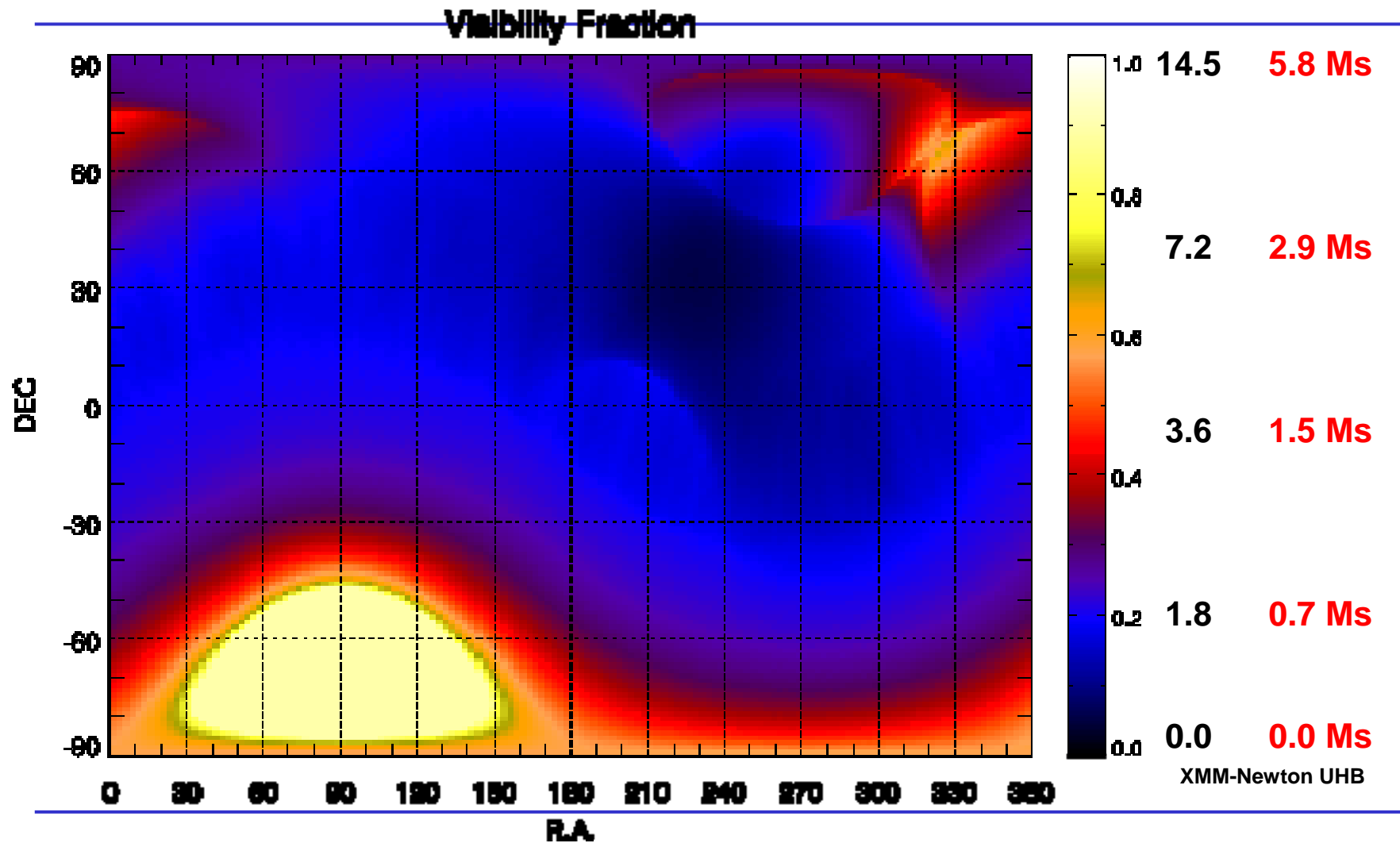
Visibility III



Visibility and Oversubscription



Visibility IV



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Background I

- http://xmm.esac.esa.int/external/xmm_sched/vischeck/AO7/Background_behaviour.pdf

The Behaviour of the XMM-Newton Background:
From the beginning of the mission until January 2008

XMM-SOC-USR-TN-0014
issue 2.0

P.M. Rodríguez-Pascual and R. González-Riestra

XMM-SOC User Support Group

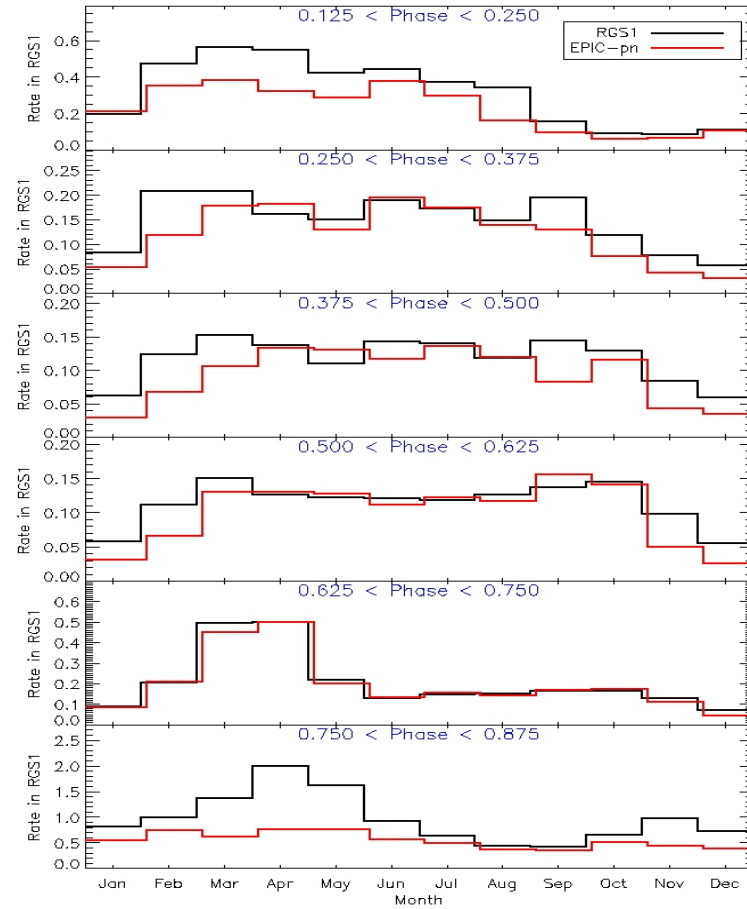
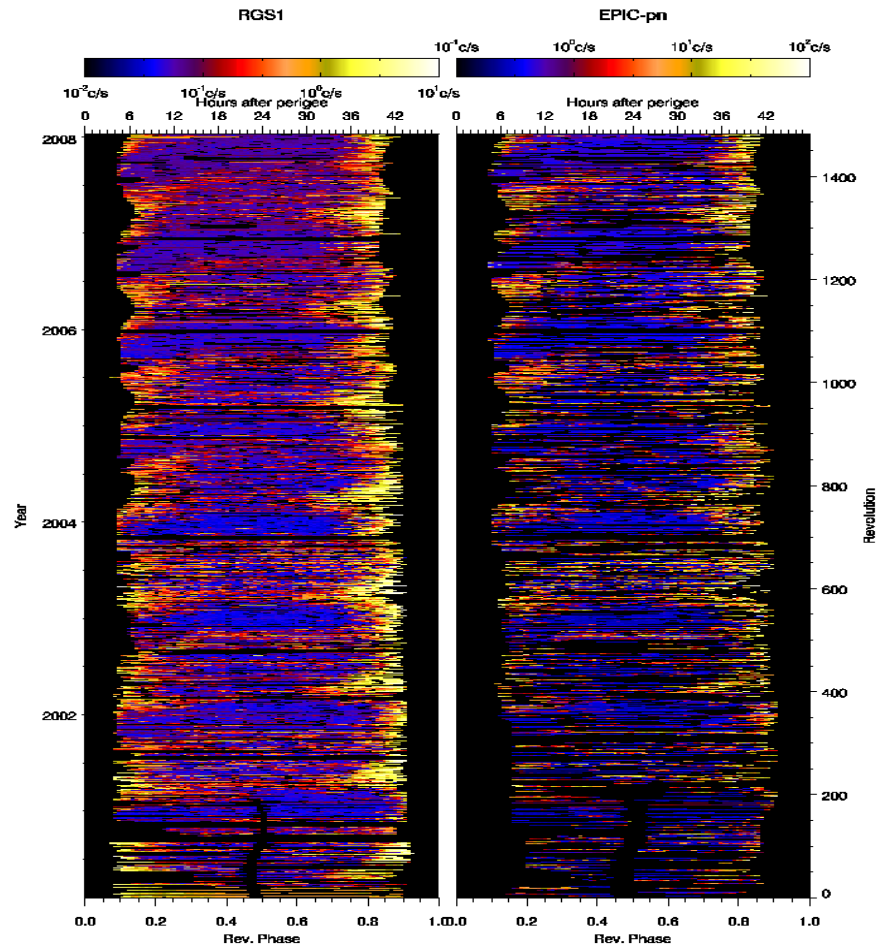
March 3, 2008

1 Introduction

This document supersedes XMM-SOC-USR-TN-0014, issue 1.0. It contains data from

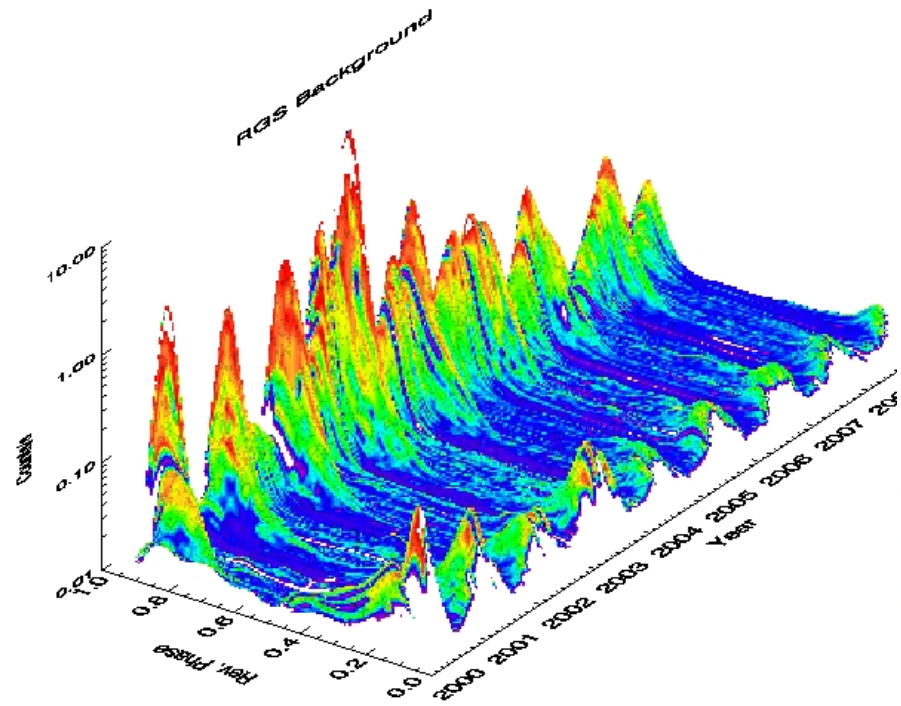
courtesy of P. M. Rodríguez-Pascual & R. González-Riestra

Background II

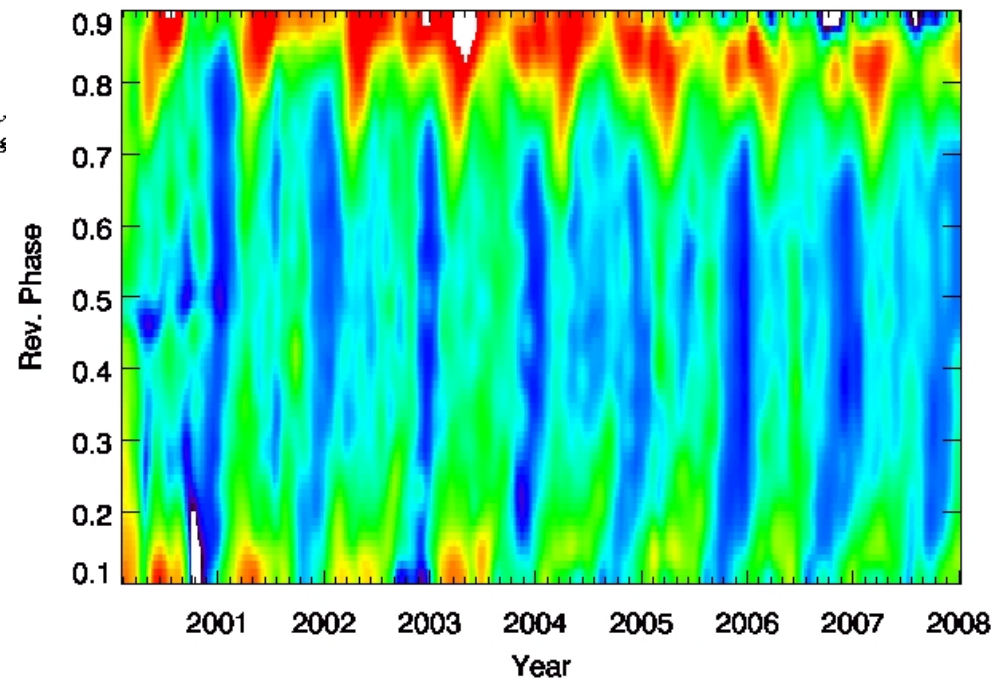


courtesy of P. M. Rodríguez-Pascual & R. González-Riestra

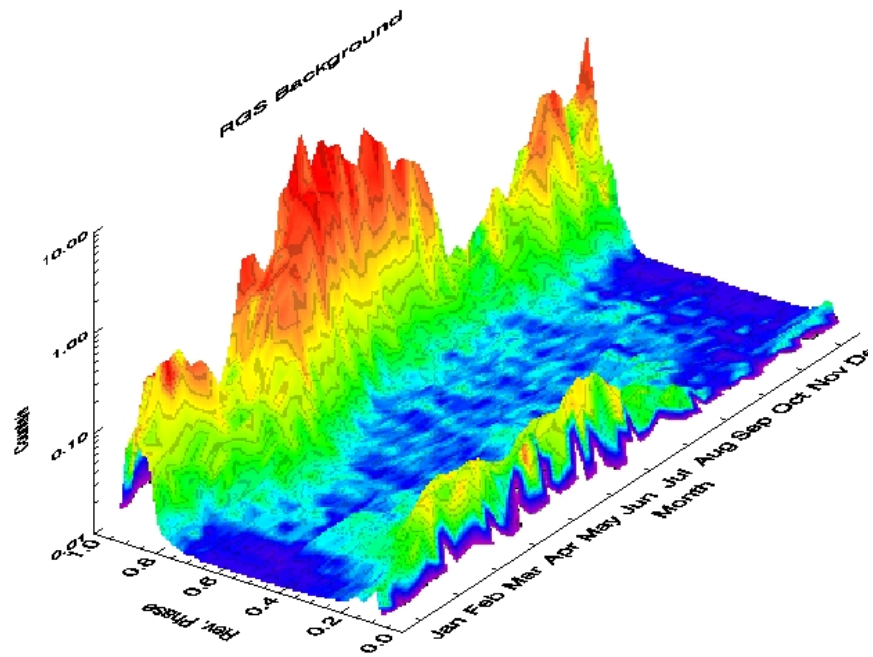
Background III / Years



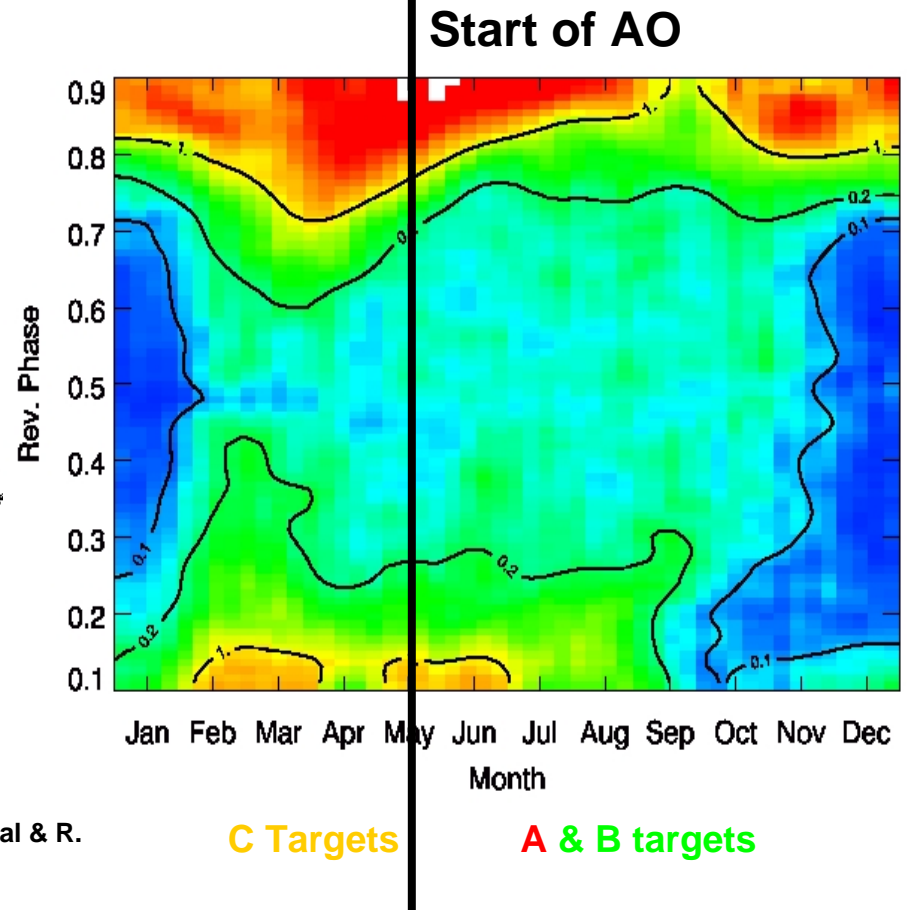
courtesy of P. M. Rodríguez-Pascual & R. González-Riestra



Background IV / Months



courtesy of P. M. Rodríguez-Pascual & R. González-Riestra



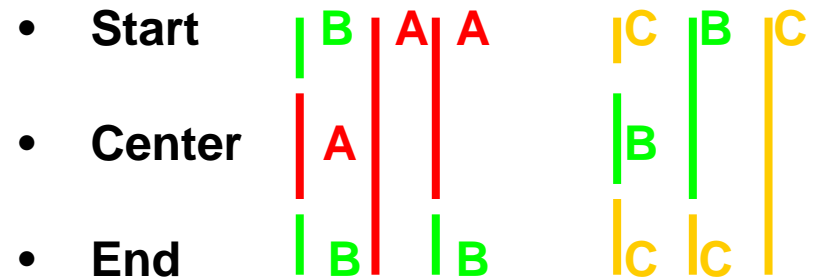
Background / Scheduling

- **Scheduling**

- Aim:
 - overall maximal efficiency is achieved
- Consider:
 - visibility
 - Time-critical observations: e.g. TOOs, triggered observations, eclipse, phase, coordinated with other instruments
 - Scientific merit
- About 30% of observations can be constraint in the schedule and require planning

- **Current Scheduling Schema**

- **In AO:** 1, 2,364, 365



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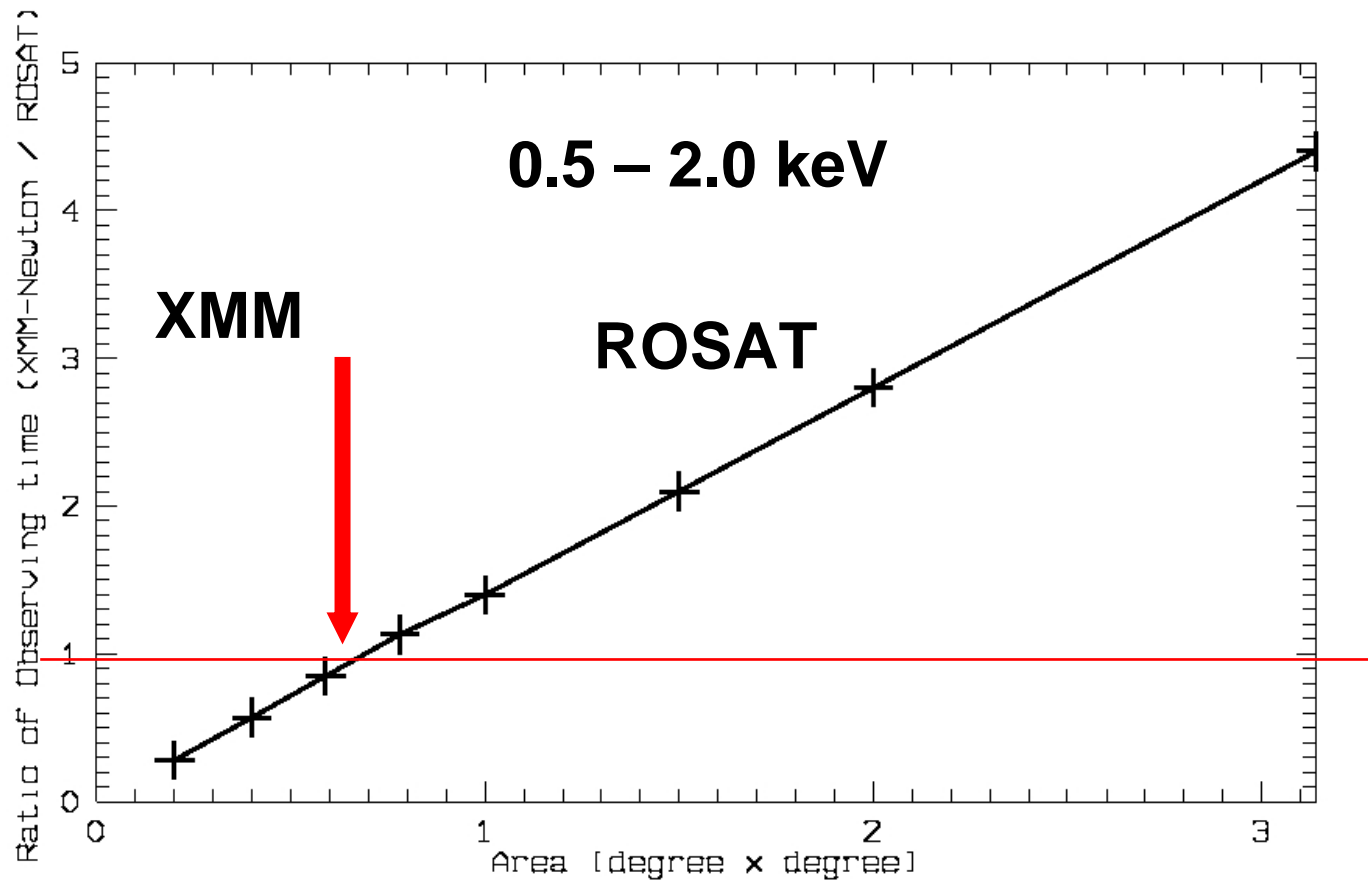
XMM-Newton I

- **Is it foreseen to improve the current performances?**
- **NO, this is not possible**
- **we allow to make very inefficient use of the capacities of XMM-Newton in order to allow scientific observations which are not possible with other satellites or which make even more inefficient used of other observatories**
- **EXAMPLE:**
 - Comparison of ROSAT All Sky Survey with an hypothetical XMM-Newton All Sky Survey
 - ROSAT All Sky Survey
 - 0.5-2 keV
 - assumption: mean exposure time: 400 s
 - effective area
 - field of view
 - background
 - total observing time

XMM-Newton II

- **Effective area:**
 - XMM/RASS = 1.5 (0.1-0.35 keV)
 - XMM/RASS = 7.2 (0.5-1.0 keV)
 - XMM/RASS = 7.1 (1.0-2.0keV)
 - **Field of View:**
 - XMM/ROSAT = 1/16
 - **High Background times:**
 - XMM (low) / XMM (total) = 0.7
 - **Science time per orbit**
 - XMM (science) / XMM (total) = 125 ks / 173 ks = 0.7
 - **ROSAT All Sky Survey needed 0.5 years. How long would it need to redo it with XMM-Newton?**
 - **0.5 year / 7.2 * 16 / 0.7 / 0.7 = 2.3 years**
 - **XMM-Newton is designed to perform long observations with the aim to obtain spectra**
 - **Scientific case**
-

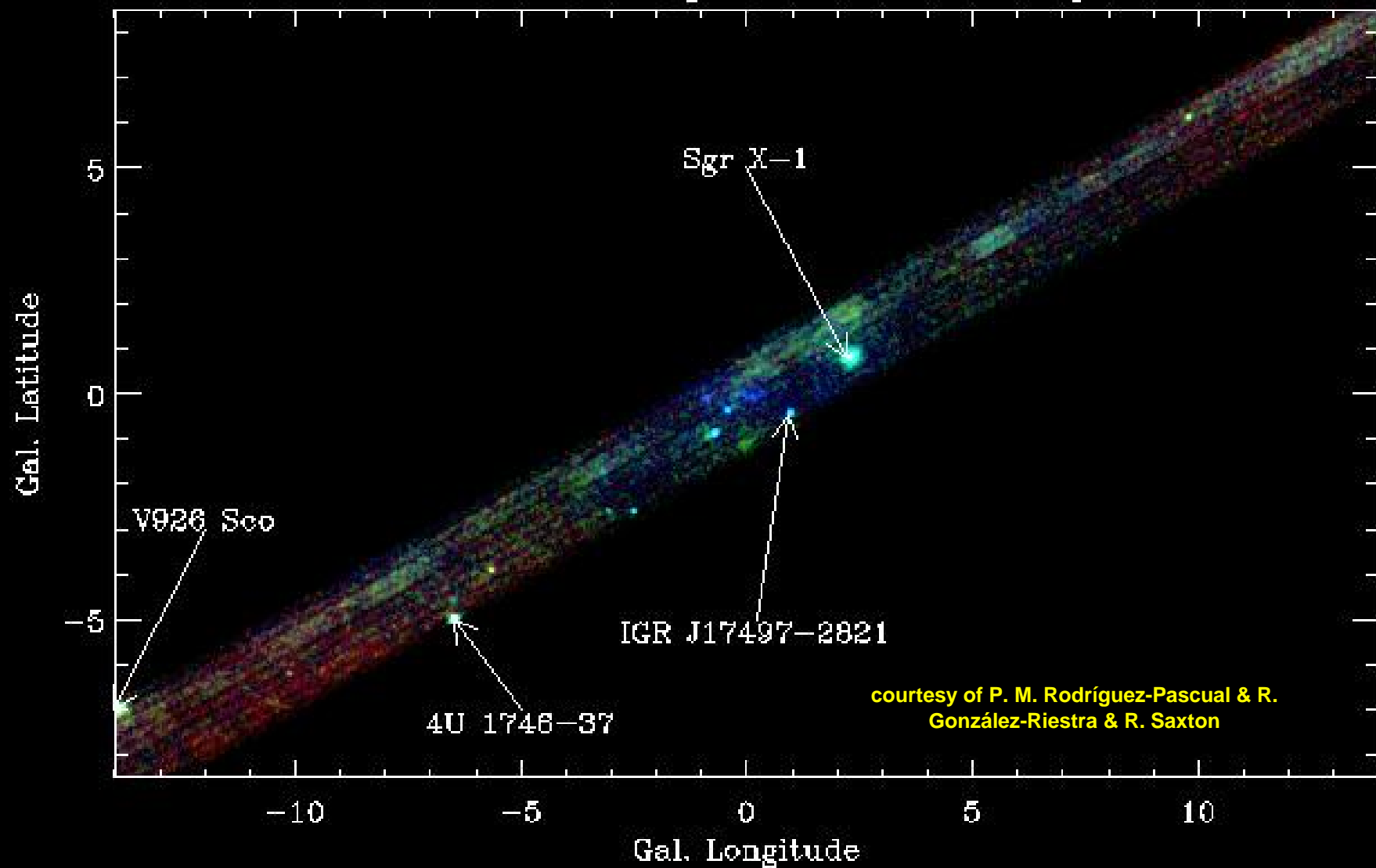
XMM-Newton III



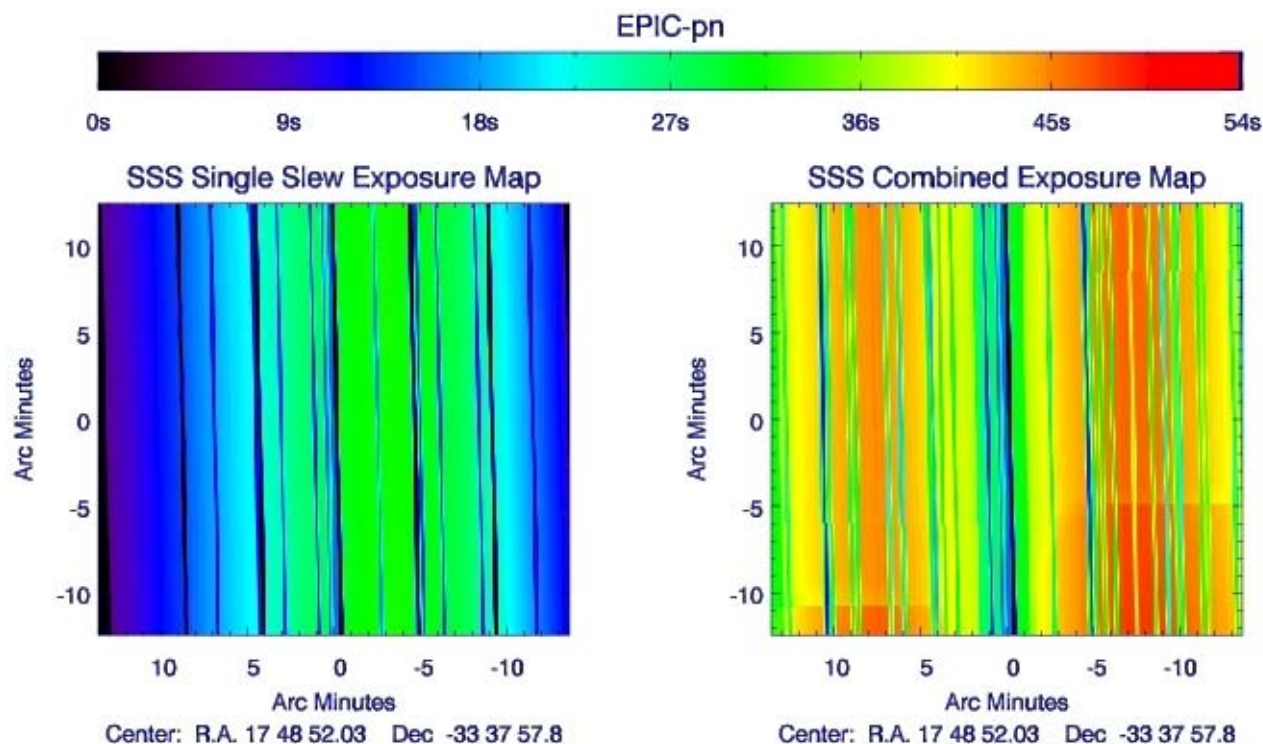
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XMM-Newton EPIC-pn Slow Slew Survey Test



Slow Slews?



XMM-Newton User Group Meeting: Action 2007-06-07/13: on the Users Group, the UG should provide the XMM-Newton SOC with two or three typical examples of slew surveys, with details about the needs on exposure time, sensitivity to be achieved, sky area to be covered and typical sky position. Deadline: end of June, 2007

Slew Slews II

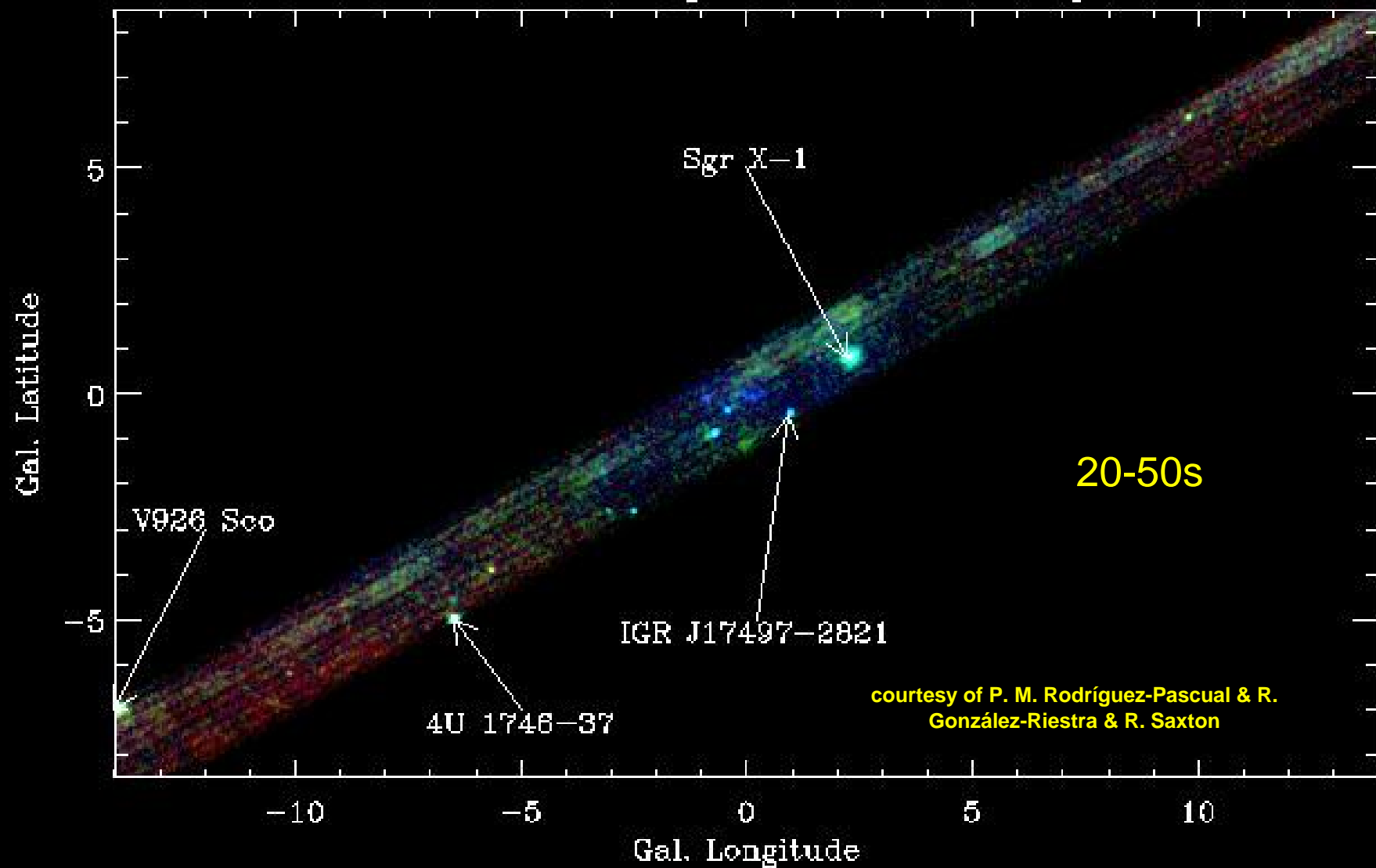
Workshop:

“XMM-Newton: The Next Decade”

- 4th - 6th June 2007
- all talks asked for a few ks exposure time in the minimum

- **Technical Constraints:**
- **Minimum slew speed: 5°/hour (test 30°/hour)**
- **Maximal Slew duration 1-1.5 hours**
- **Only one slew direction (orthogonal to direction towards sun)**
- **if longer slews or other direction then the slews error (especially the error orthogonal to the slew direction) becomes too large to align the slews**

XMM-Newton EPIC-pn Slow Slew Survey Test



Content II

- **Question of PIERRE Marguerite**
 - (1) the mean background level as a function of observation position in the orbits
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 - a 20X10 deg2 survey covered by 10 ks pointings
 - a 7x7 deg2 survey covered by 40 ks pointings
 - (2) **is it foreseen to improve the current performances?**
 - **In particular feedback on Action 2007-06-07/14 (pn overhead and modified mosaicing mode)** defined at the June 2007 Users Meeting would be very useful.- Maybe also, some information on the slew mode (Action2007-06-07/13 - min and max speed)
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Mosaic Mode I

1. no offset-map calculation for pn

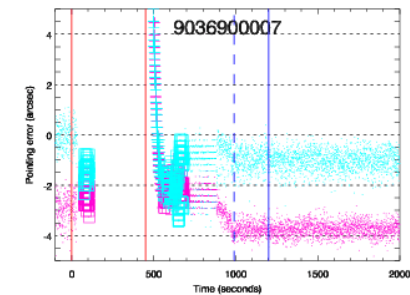
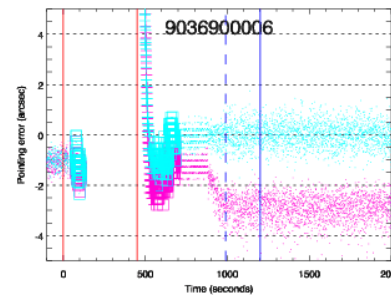
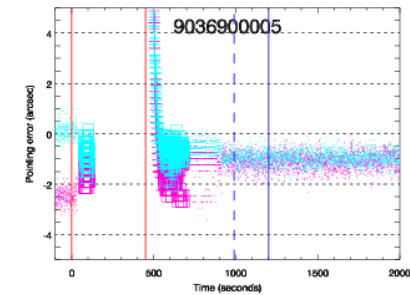
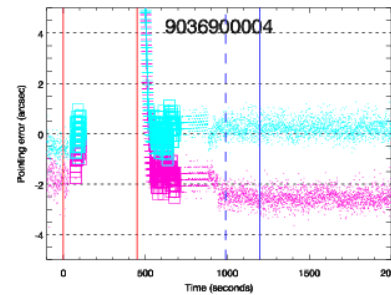
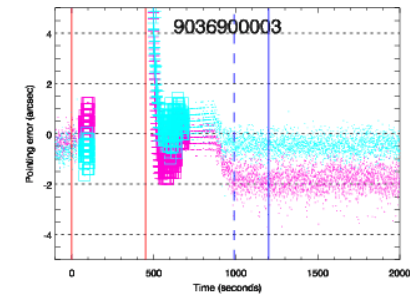
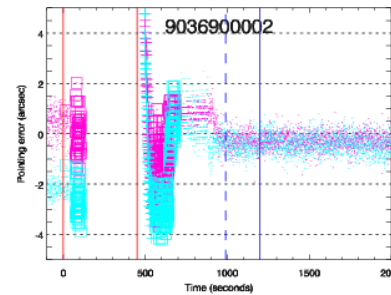
- reduced spectral resolution
- no (optical) bright stars
- no change of filter-wheel
- slews between pointings < 3 degrees

2. MOS and pn observe all the time (including during (close-loop slews))

- slews within 3 degrees

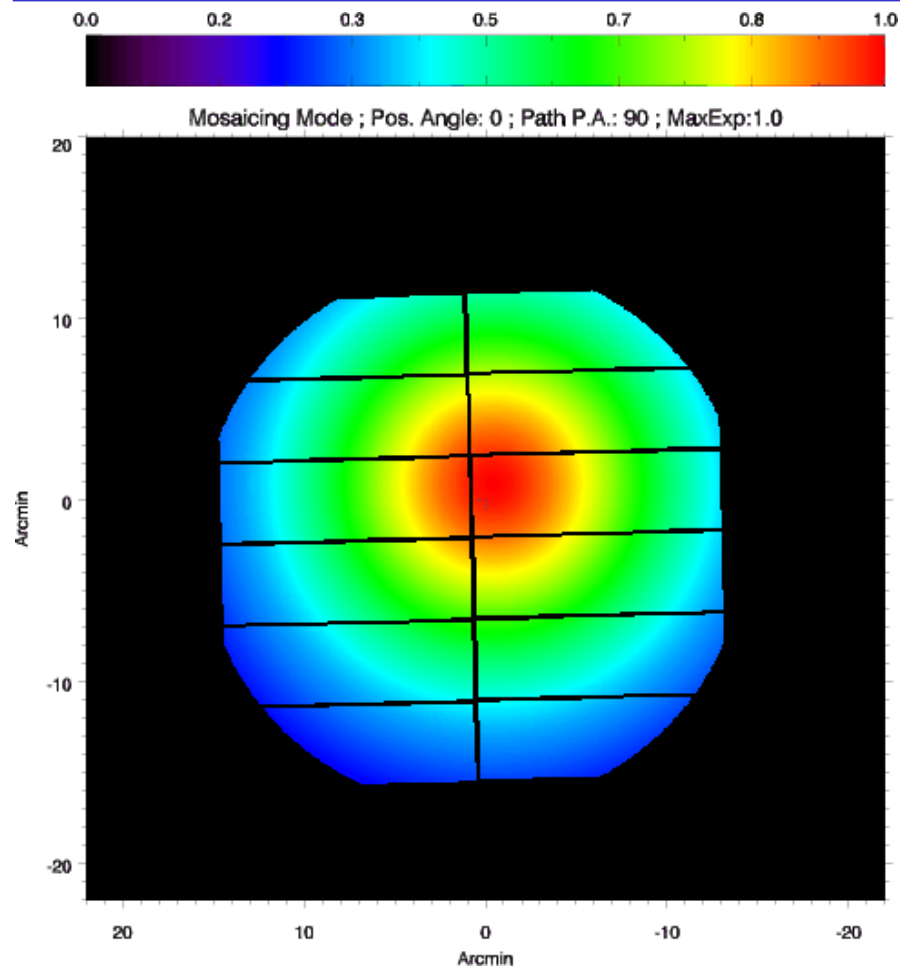
3. Overhead

- Is given by attitude
- ~1000 s per pointing

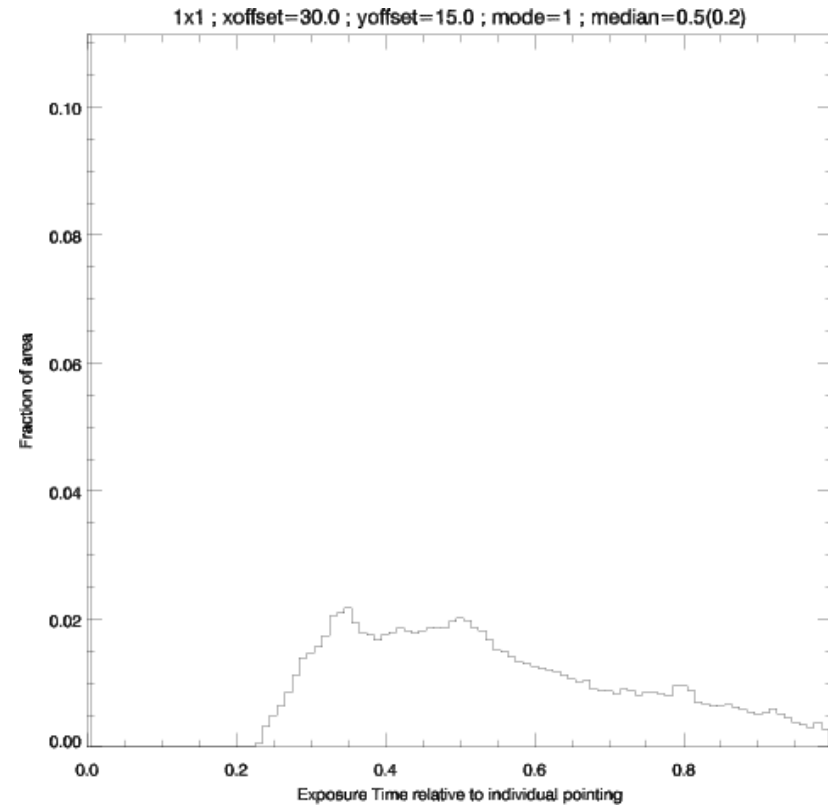


courtesy of P. M. Rodríguez-Pascual

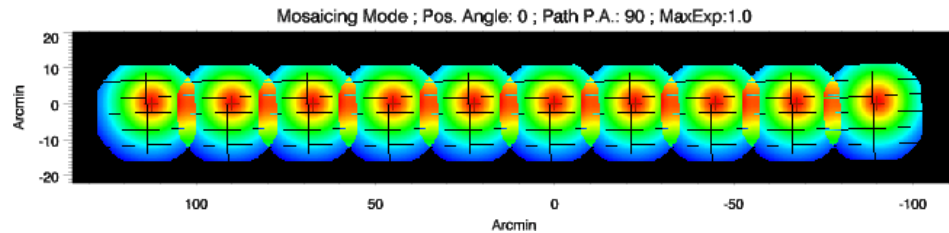
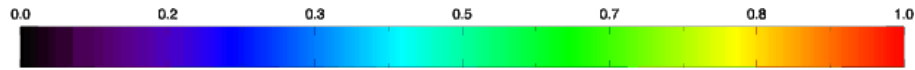
Mosaic Mode II



courtesy of P. M. Rodríguez-Pascual

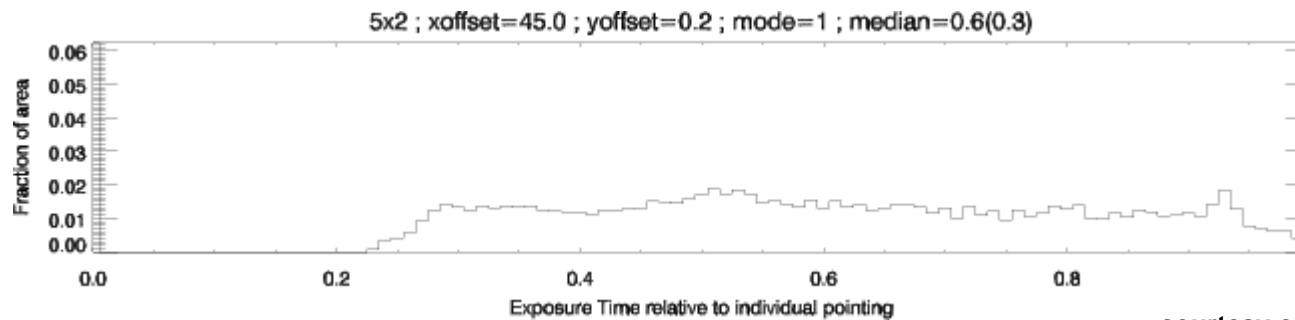


Mosaic Mode III



Time Calculation

- pn-offset-map 4 ks
 - close-loop slews 10 ks
 - exposure 2ks x 10 = 20 ks
 - -----
 - 34 ks
 - =====
- ➔ 10 ks / degree

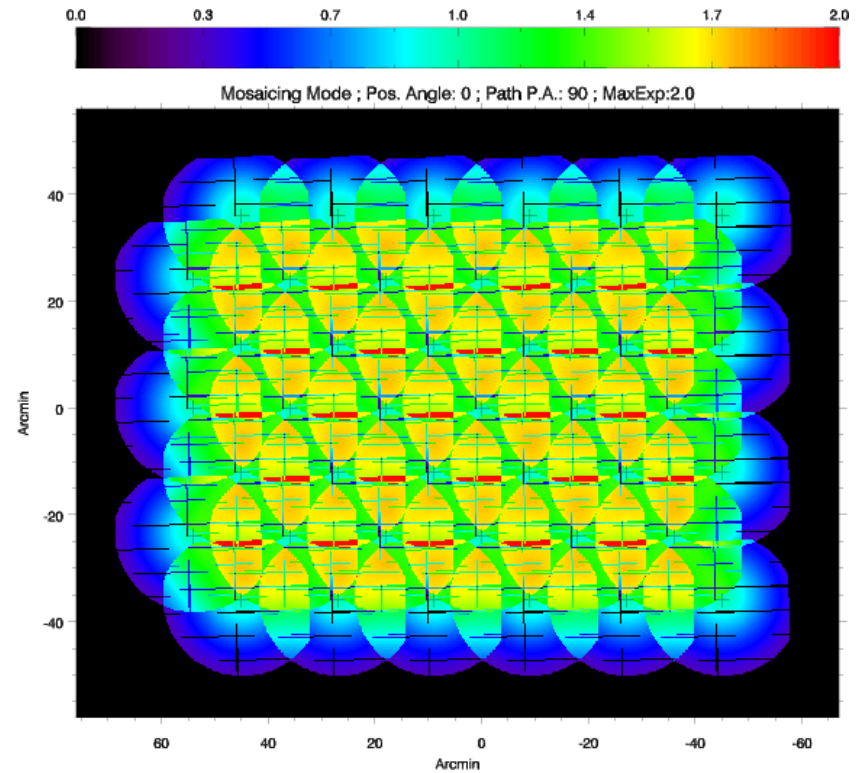
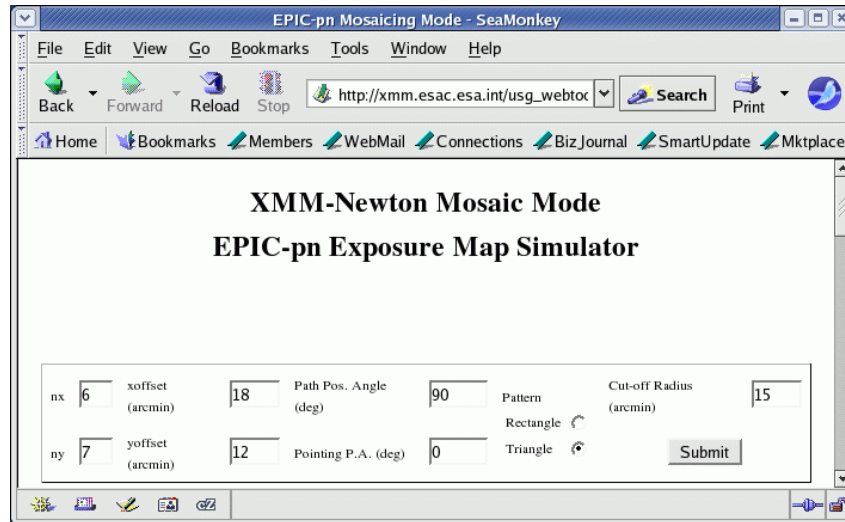


courtesy of P. M. Rodríguez-Pascual

Content II

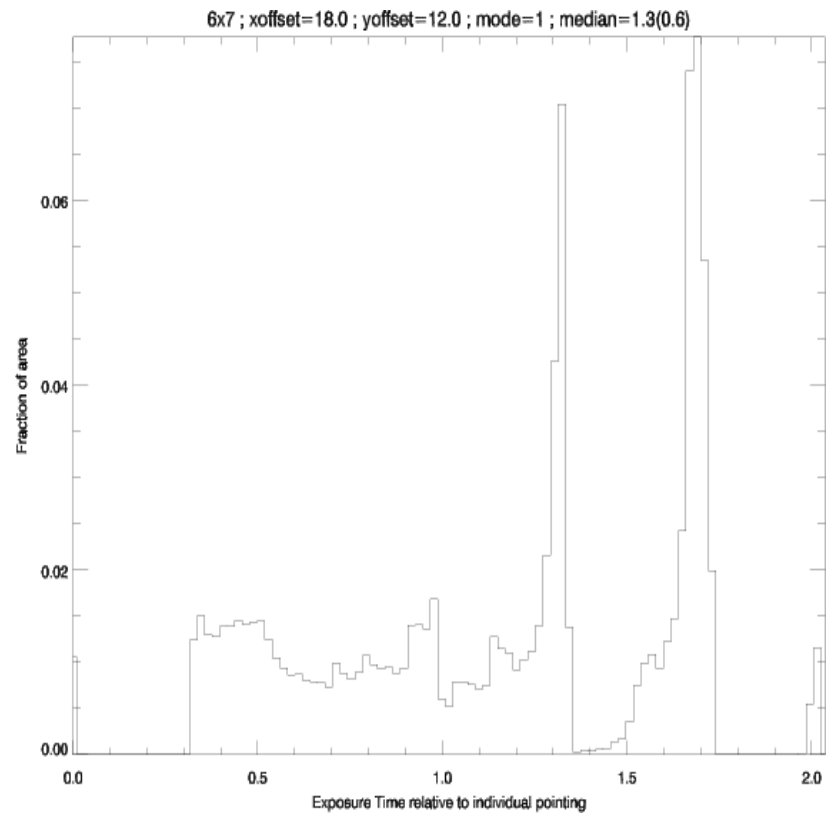
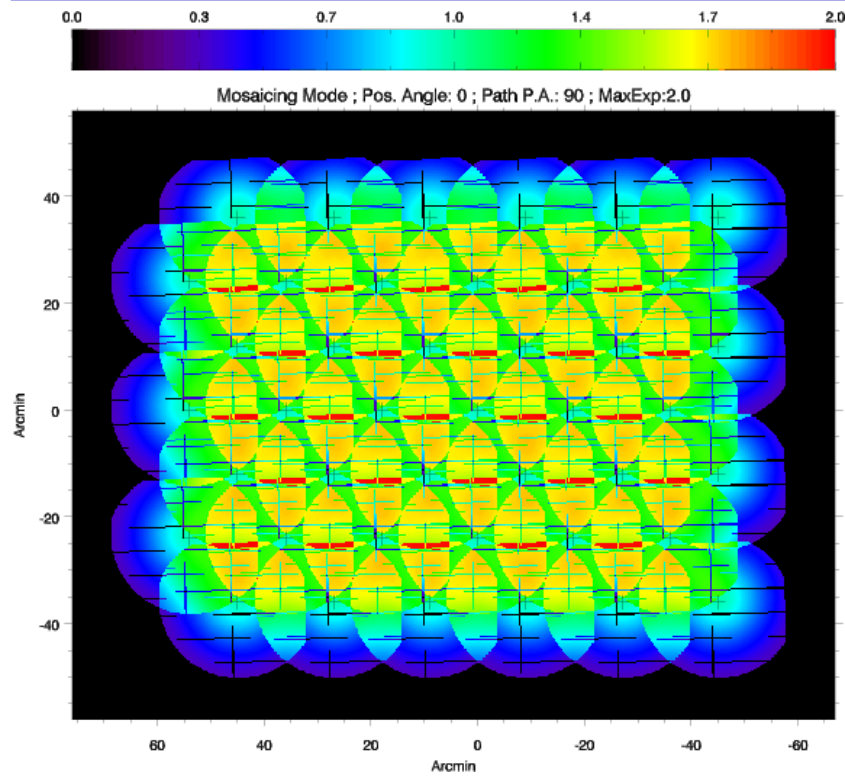
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Mosaic Mode IV



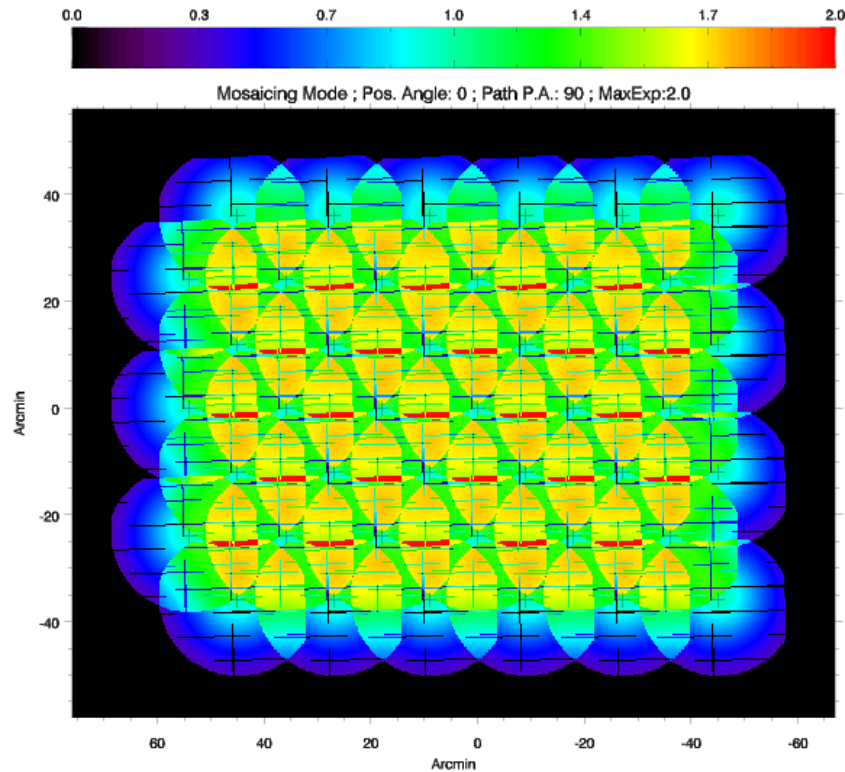
courtesy of P. M. Rodríguez-Pascual

Mosaic Mode V



courtesy of P. M. Rodríguez-Pascual

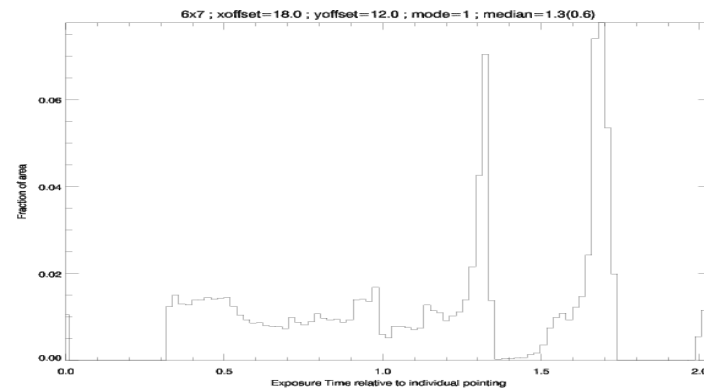
Mosaic Mode VI



courtesy of P. M. Rodríguez-Pascual

- **Time Calculation**

- revolution: 120 ks
- pn-offset-map 4 ks
- close-loop slews 35 ks
- -----
- 81 ks
- =====
- ➔ 2.3 ks exposure time

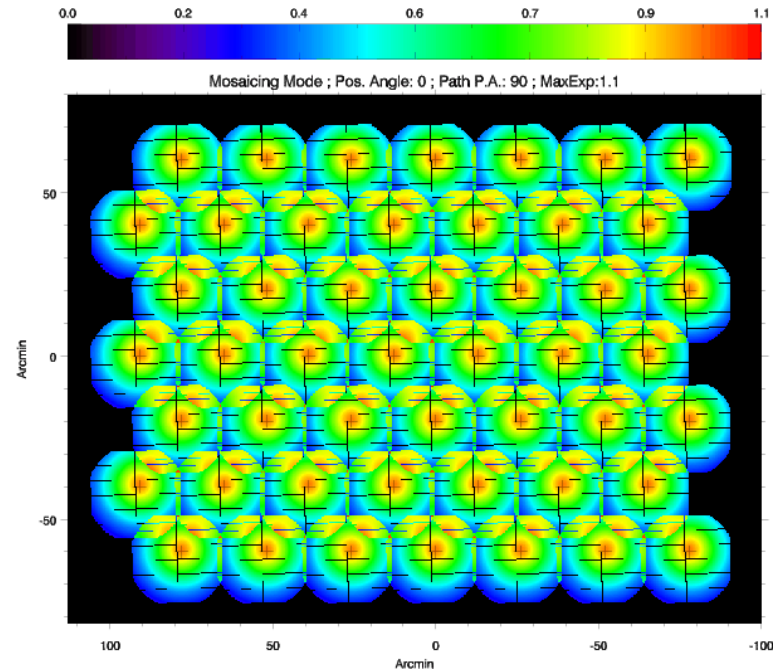
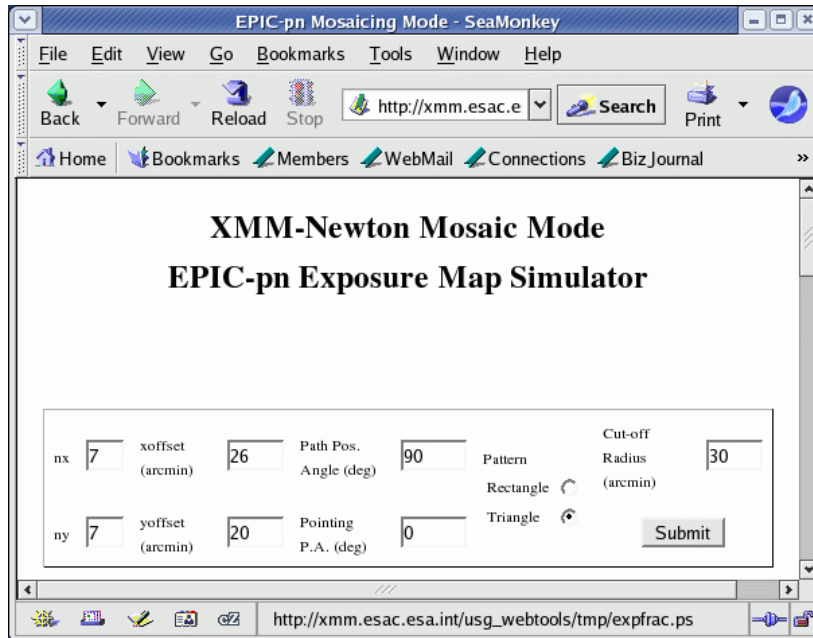


Working Hypothesis

- a 20X10 deg² survey covered by 10 ks pointings
 - 67 x 50 = 3350 pointings
 - 11 pointings per revolution
 - 304 revolutions
 - 1.66 years ~ 2 years
 - 600 refereed papers based on XMM-Newton data
- a 7x7 deg² survey covered by 40 ks pointings
 - 24 x 35 = 840 pointings
 - 2.5 pointings per revolution
 - 336 revolution
 - 1.84 years ~2.5 years
 - 750 refereed papers based on XMM-Newton data

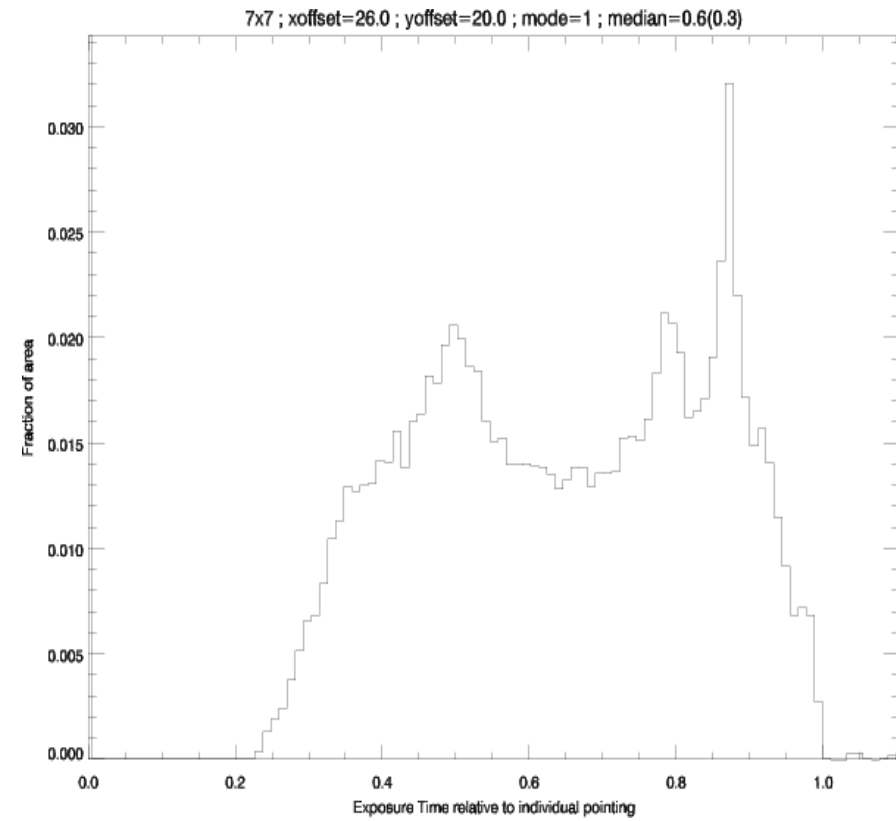
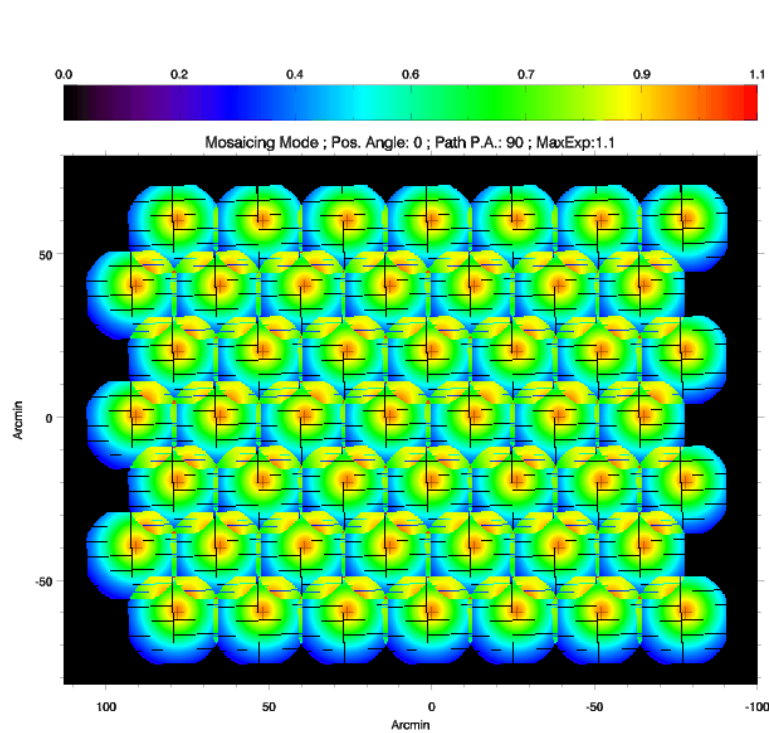
1 year = 182 revolutions = 14.5 Ms (normal efficiency) = 300 refereed papers

Mosaic Mode VI



courtesy of P. M. Rodríguez-Pascual

Mosaic Mode VII



courtesy of P. M. Rodríguez-Pascual

Working Hypothesis II

- a 20X10 deg² survey covered by 10 ks pointings
 - 47 x 31 = 1457 pointings
 - 11 pointings per revolution
 - 132 revolutions
 - 0.72 years ~ 1 years
 - 300 refereed papers based on XMM-Newton data
- a 7x7 deg² survey covered by 40 ks pointings
 - 17 x 22 = 374 pointings
 - 2.5 pointings per revolution
 - 150 revolution
 - 0.81 years ~1.1 years
 - 330 refereed papers based on XMM-Newton data

1 year = 182 revolutions = 14.5 Ms (normal efficiency) = 300 refereed papers

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Large and Very Large Programs

- History:
 - AO 0 (guaranteed program)
 - AO 1
 - AO 2
 - AO 3 **LP** > 300 ks
 - AO 4
 - AO 5
 - AO 6
 - AO 7 **VLP** 1 to 3 Ms
 - AO 8
- any change needs a brought acceptance in the community at large
- the first step for any changes in the overall concept of the mission is a recommendation of the XMM-Newton Users Group in coordination and agreement with the OTAC chairperson

Content

- **XMM-Newton and future extensions**
- **Technical Aspects**
 - Visibility
 - Question of PIERRE Marguerite
- **X-ray Universe 2008**

The X-ray Universe 2008

Granada, Spain, 27 - 30 May

Topics include:

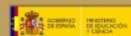
Stars, White Dwarfs & Solar System
WD & Neutron Star Binaries, CVs, ULXs & Black Holes
Supernovae, SNRs, Diffuse Emission & Isolated Neutron Stars
Galaxies & Galactic Surveys
AGN, Quasars & BL-Lac Objects
Groups of Galaxies, Clusters of Galaxies & Superclusters
Cosmology & Extragalactic Deep Fields
Future X-ray Missions

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