



## ATHENA - WFI

Title **PREPARATION OF BACKGROUND FILES**

Subtitle

No. WFI-MPE-ANA-Background\_20180705

Issue 6D3

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CHANGE RECORD

ISSUE	DATE	SECTION/PARAGRAPH AFFECTED	REASON/INITIATION DOCUMENTS/REMARKS
1D0	05.04.2013	All	First Release
2D0	09.04.2013	4,6,7	simulations redone with new WFI responses; fraction of 80% of resolved sources assumed for extra-galactic background emission; removed specification of background units in section 3.2; corrected erroneous units in Tab. 1
3D0	27.08.2013	6,7,8	Changed CXB photon model from Lumb to McCammon et al. 2002; specified integration area
3D1	13.01.2014	1	Changed document name following document identification rules described in WFI-MPE-TNO-0010-0d1-Configuration-and-Document-Management
4D0	07.02.2014	7,8,9	Added separate background files for extended sources ( $a_{min}^2$ ) and point sources (5" radius aperture). Included reference to description for different extraction areas, response matrices, focal length by adopting text from X-IFU document IAPS-XIFU-TN-2013-002.
4D1	13.02.2014	8,9,deliverables	Changed ATOMDB version from 1.3.1 to 2.0.2, which has an impact on the low energy (0.1-0.3keV) diffuse background component. Removed unused parameter (const=0.2) from Table 1.
5D1	27.03.2015	All	Updated to new detector geometry. New responses for mirror model trade-off study exercise.
6D1	03.04.2018	7,8,9	New responses for 15 and 19 row mirror models.
6D2	20.06.2018	7	Update version number of deliveries to 20180620
6D3	05.07.2018	7	Bug-fix to 5" normalized background files. Update of version number of deliveries to 20180705



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DOCUMENT DISTRIBUTION

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## **1 Scope**

This document summarises the preparation of the photonic and particle background files for ATHENA/WFI.



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## 2 Introduction

### 2.1 Detector Layout

Fig 2-1 shows the WFI design assumed for the background calculations – a focal plane position for wide field applications formed by four quadratic large DEPFETs and a second position for with a single DEPFET optimized for high count rate applications.

Both DEPFETs will use  $130 \times 130 \mu\text{m}^2$  pixels with a thickness of  $450 \mu\text{m}$ . The four large DEPFETs are  $512 \times 512$  pixels each with an insensitive gap within between. The high-count rate DEPFET has a size of  $64 \times 64$  pixels.

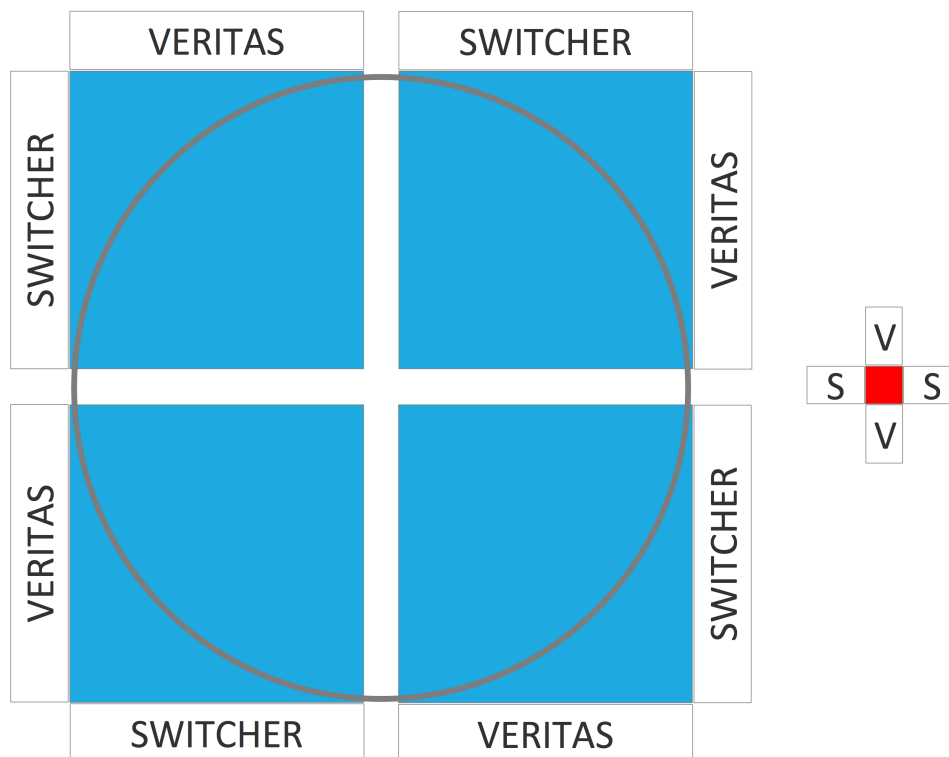


Figure 2-1: Schematic WFI layout.

## 3 Background Files

### 3.1 Response Matrices



The response matrices used here are described in [RD1]. Following the naming convention of  
athena\_wfi\_<N>row\_20171019\_<F>\_filter\_<AREA>.rsp

these are:

Item	Values
<N> = number of mirror rows	15 19
<F> = with or without external light blocking filter	w wo
<AREA> = area over which the response is averaged	OnAxis FovAvg 5aminAvg

athena\_wfi\_baseline.rmf [RD1] was used for the particle background calculation.

## 3.2 Deliveries

The provided background files follow the naming convention of:

athena\_wfi\_<N>row\_20180705\_bkgd\_sum\_<P/E>\_<F>\_filter\_<AREA>.pha

Item	Values
<N> = number of mirror rows	15 19
<P/F> = point source (normalized to a 5" radius extraction region) or extended (normalized to 1 arcmin <sup>2</sup> )	extended psf
<F> = with or without external light blocking filter	w wo
<AREA> = area over which the response is averaged	OnAxis FovAvg 5aminAvg

## 3.3 Cosmic X-ray Background and Galactic Foreground

The cosmic photon background consists of the integrated emission from unresolved extragalactic point sources and the diffuse Galactic foreground. The calculations have been performed using the following model:

model apec+wabs(apec+powerlaw)

The parameter values are given in Table 1. The fraction of resolved sources was assumed to be 80%



Table 1: XSPEC model parameters for the photon background. Normalizations refer to 1 amin<sup>2</sup>.

Model	Parameter	Value	Unit
apec	kT	9.9E-2	keV
apec	abundance	1	
apec	redshift	0	
apec	norm	1.7E-6	$(10^{-14}/(4\pi(D_A(1+z))^2)) \int n_e n_H dV$ <sup>1)</sup>
wabs	N <sub>H</sub>	0.018	10 <sup>22</sup> cm <sup>-2</sup>
apec	kT	0.225	keV
apec	abundance	1	
apec	redshift	0	
apec	norm	7.3E-7	
powerlaw	photon index	1.45	
powerlaw	norm	2.0E-7	pho/keV/cm <sup>2</sup> /s @ 1 keV

<sup>1)</sup>: where D<sub>A</sub> is the angular size distance to the source (cm), and n<sub>e</sub> and n<sub>H</sub> are the electron and H densities (cm<sup>-3</sup>)

### 3.4 Particle Background

A flat particle background of 5x10<sup>-3</sup> cnt/keV/s/cm<sup>2</sup> (i.e, 6x10<sup>-4</sup> cnt/keV/s/amin<sup>2</sup>) was used. This corresponds to the Athena science requirement for WFI LDA observations over the energy band from 2 to 7 keV.



### 3.5 Total Background

The individual background components as well as the sum are shown in Fig.3-1.

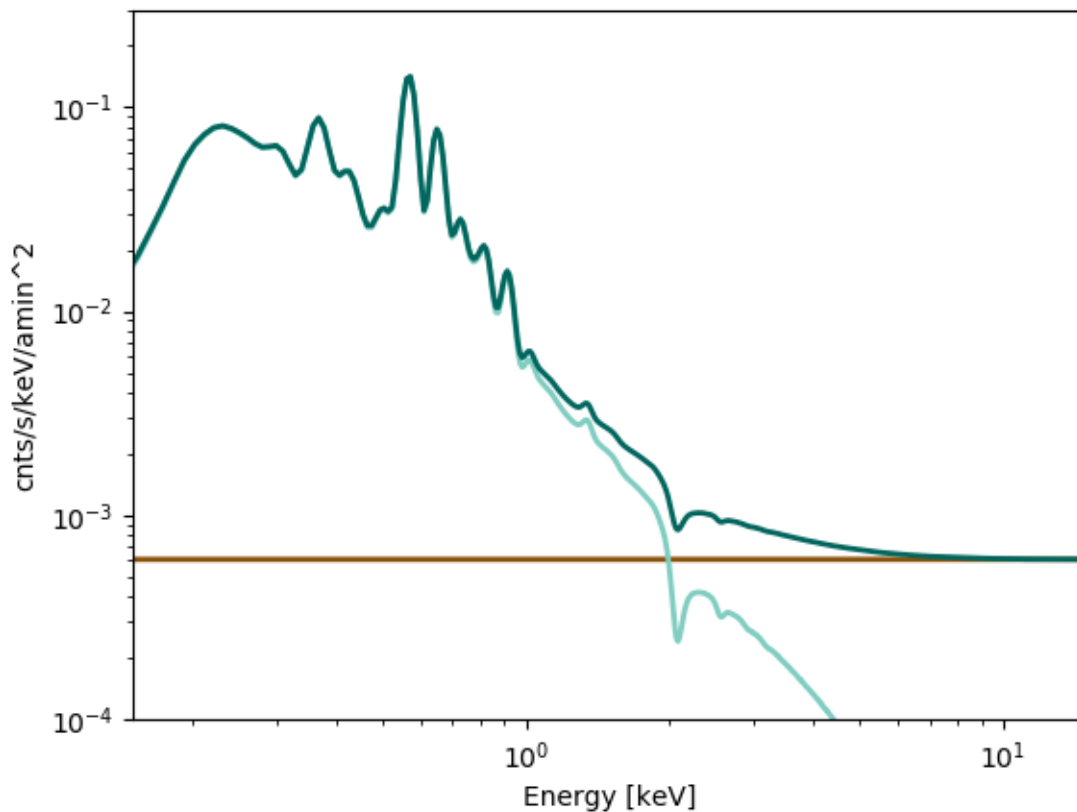


Figure 3-1: WFI background models for extended sources in units of  $\text{cnt s}^{-1} \text{keV}^{-1} \text{amin}^{-2}$ . The photon background (light green), the particle background (brown), and the sum of both (dark green) are shown.



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## 4 Applicable and Reference Documents

### 4.1 Applicable Documents

AD Doc.-No and Title	Issue	Date
[AD1]		
[AD2]		
[AD3]		

### 4.2 Reference Documents

RD Doc.-No. and Title	Issue	Date
[RD1] <a href="#">ECAP-ATHENA-WFI-RSP_20171019.pdf</a>	4	2017-10-19



## APPENDIX 1: Abbreviations and Acronyms

This document employs several abbreviations and acronyms to refer concisely to an item, after it has been introduced. The following list is aimed to help the reader in recalling the extended meaning of each short expression:

ATHENA	Advanced Telescope for High ENergy Astrophysics
DEPFET	Depleted P-channel Field-Effect Transistor
WFI	Wide Field Imager
X-IFU	X-ray Integral Field Unit