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DOCUMENT

ATHENA - Acronyms and Definitions

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1 APPLICABLE DOCUMENTS

[AD01] -

2 REFERENCE DOCUMENTS

[RD01] ATHENA – Coordinate System Document, ATHENA-ESA-ST-0001, Issue 1.0, 06/02/2015.

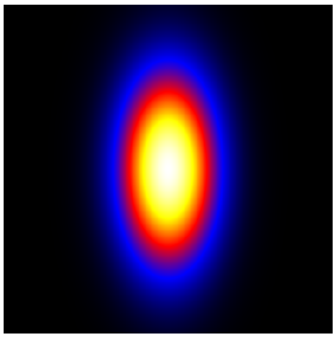
3 INTRODUCTION

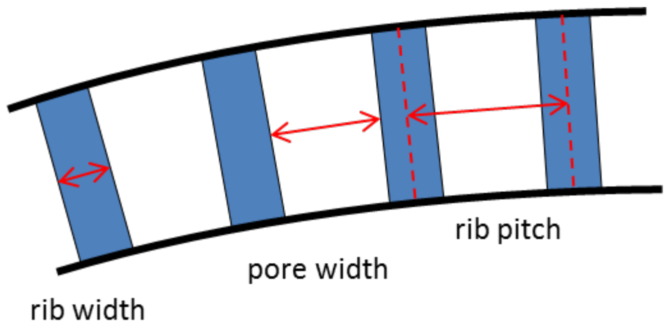
This document describes the acronyms and main definitions used in the ATHENA mission. This document ensures the consistency of terms through a common reference source for use at all levels of the project from SST, Payload Consortium, ESA through to industrial subcontractors.

4 DEFINITIONS

The following table shows a list of some concepts which are relevant to the ATHENA Mission.

Concept	Definition
Overall Effective Area	The Overall Effective Area is the Mirror Assembly Effective Area multiplied by the Quantum Efficiency (QE) of the instrument at the focal point, both of which are a function of energy. Instrument QE in this definition includes all relevant instrument effects, e.g. filter transmission and any other mechanisms contributing to loss of otherwise detectable photons.
Mirror Assembly Effective Area	The Mirror Assembly Effective Area is the open aperture area of the Mirror reduced by any photon losses caused by geometric shadowing and non-ideal reflectivity. Consequently, the Mirror Assembly Effective Area depends on Mirror geometric area, reflectivity (which is a strong function of energy), off-axis vignetting (also a function of energy as well as off-axis angle), and contamination (particular and molecular).
Relative Effective Area	Relative change in Overall or Mirror Effective Area between two given energies. Expressed in % of change over an energy range $[E1, E2]$: $Rel_{A_{eff}} = \frac{A_{eff}(E2) - A_{eff}(E1)}{A_{eff}(E1)}$.
On-optical axis Mirror Effective Area	Peak Effective Area of the Mirror Assembly.
Spectral (energy) resolution	FWHM (eV) of the distribution of measured detector energy response to monochromatic photon energies.
Mean spectral resolution	Average of the spectral resolution over all the pixels in the detector$\frac{\sum_1^n FWHM(i)}{n}$.
Energy resolution homogeneity	Two times the standard deviation (2σ) of the distribution of the spectral resolution over the active pixels in the detector.
Grasp	Overall Effective Area and solid angle averaged over a specified field of view. $Grasp = \int_0^{\propto} \int_0^{2\pi} A_{eff}(\propto, \theta) . \propto \partial\theta\partial \propto$. Where $\propto$ is radius of the FoV and θ is the azimuthal angle.
Half Energy Width (HEW)	HEW is defined as the angular diameter of a PSF containing 50% of the photons of a point source image. The HEW provides a measure of the angular resolution of the telescope. For misalignment and tolerance analyses during Phase A, a Gaussian PSF with a ratio of the σ's in the two orthogonal

	directions of a factor 2 is used to represent the PSF from a single MM. For the MM HEW specification of 4.3", this results in: Energy (keV) | σ_x | σ_y 6 | 1.24483" | 2.48966" 15 | TBD | TBD *Note: the long axis of the Gaussian is aligned with* $+Y_{MM\_PCS}$ *of the MM coordinate frame [RD01].*  Figure 1: Single MM 2D Gaussian PSF with σ-ratio of 2
Ideal focal plane instrument	The term 'ideal focal plane instrument' used in the formulation of the mission performance requirements indicates instruments with infinitely high spatial resolution, not further contributing to the degradation of the total observatory image quality (HEW). In addition an ideal instrument could be read-out (sampled) with infinitely high temporal resolution (sample rate).
Mirror Assembly Module (MAM)	The Mirror Assembly Module (MAM) consists of the Mirror Structure equipped with all the MMs, the thermal baffles and any required thermal control units, OBM, and Star Trackers.
Mirror Assembly	The Mirror Assembly consists of the Mirror Structure plus the Mirror Modules.
Mirror Module (MM)	The Mirror Module (MM) is a combination of mirror stacks corresponding to a Wolter I telescope design. The MM includes two brackets that connect the stacks and a mounting interface (three dowel pins) for integration into the Mirror Structure (previously indicated as 'petal'). A Mirror Module also includes (TBC) elements required for stray light rejection that are part of the mirror plates or connected to the brackets.
Mirror: Pore Width, Rib Pitch and Rib Width	Pore Width: Azimuthal distance between consecutive ribs in a mirror plate. Rib Pitch: Azimuthal distance between the centres of consecutive ribs in a mirror plate. Rib Width: Azimuthal width of a mirror rib. The following relationship holds:

	$$d_{rib\_pitch} = d_{pore\_width} + d_{rib\_thickness}$$ These distances are set when cutting the pores during the ribbing process. Increasing the Mirror rib spacing decreases off-axis vignetting and therefore increases the Effective Area. Note that these parameters may vary along a mirror plate, or between plates, in order to optimise the optical and mechanical properties of a Mirror Module.  Figure 2: rib width, pore width and rib pitch of a MM
Mirror Stack	The Mirror Stack is a stack of individual, silicon mirror plates assembled on a baseplate.
Mirror Structure	The Mirror Structure (MS, previously indicated as 'petal') is part of the MAM. The MS accommodates the Mirror Modules and supports them with the required alignment accuracy and stability.
Nodal point of the Mirror Assembly	The nodal point of the Mirror Assembly (MA) is a point with the property that rotations around it, to first order, lead to no image motion in the focal plane. The nodal point is located on the optical axis of the MA, on the spherical cap defined by the virtual intersection of primary (parabolic) and secondary (hyperbolic) mirrors. *Note: this coincides nominally with the origin of the MA_PCS reference frame, see [RD01].*
Off-axis Vignetting	Off-axis Vignetting is the effect that accounts for the fact that the optical performance of the Mirror deteriorates away from the optical axis. With increasing off-axis angle, less of the photons entering the telescope reach the focal plane, due to collimation by the pores and reduced reflectivity. In the case of ATHENA it is largely determined by the mirror rib spacing and the pore height.
GRB-ToO Reaction	The GRB-ToO reaction time is the duration starting from receipt

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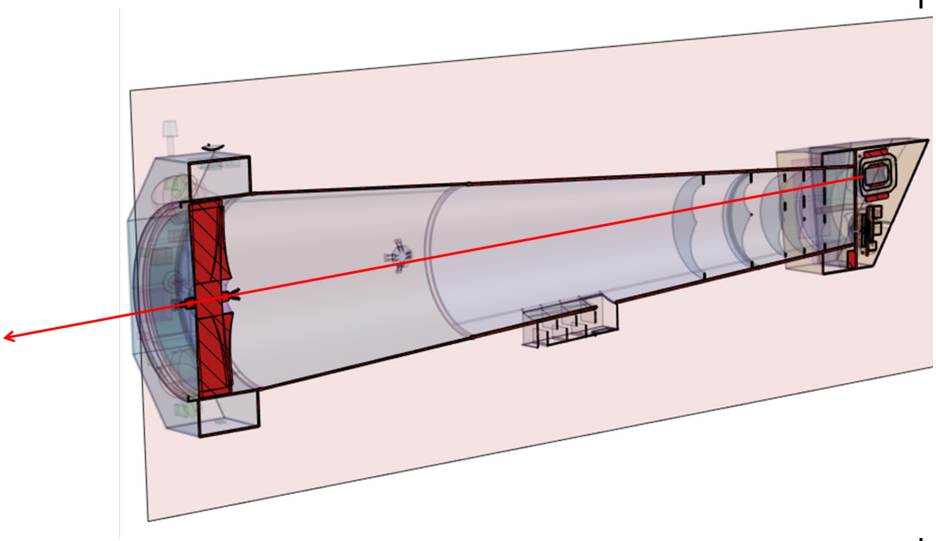
Time	of an un-validated ToO-alert by the SGS, until the subsequent commencement of TYPE_1 (Narrow-Field) observations of the ToO. (This definition is used for evaluating the ToO-response requirement, but does not preclude Wide-Field Observation of GRB-ToOs).
Telescope optical axis	The $+Z_{MA\_PCS}$ axis of the MA_PCS reference frame [RD01].
Telescope Line of Sight	The telescope Line of Sight (LoS) is defined by the vector (represented in inertial space, e.g. EME2000) connecting: [1] The nominated pixel of the detector on the Focal Plane Assembly (e.g. if the nominated pixel is the central X-IFU pixel, this point corresponds to the origin of the X-IFU_FPCS reference frame) [RD01]. [2] The nodal point of the Mirror Assembly Module (corresponding to the origin of the MA_PCS reference frame) [RD01].  Figure 3: X-IFU LoS definition
Type 1 Observations	Narrow field of view observations. Observations done with the X-IFU instrument detector at the focal point of the telescope.
Type 2 Observations	Wide field of view observations. Observations done with the WFI large array at the focal point of the telescope.
Type 3 Observations	Wide field of view observations. Observations done with the WFI fast-chip at the focal point of the telescope.
Field of Regard	The region of the sky where the Telescope LoS can be pointed to continuously for at least 100ks, allowing the nominal observing performance of the mission to be met. FoR is expressed as a percentage of the total sky, i.e.:

$$FoR = \frac{sr_{FoR}}{4\pi} \times 100$$

Because the FoR is typically constrained by the angular relationship with the Sun, the convention when discussing the FoR is as a deviation of the LoS from the yz-plane of the SCRACS reference frame [RD01], yz_{SCRACS}. When the LoS is parallel to yz_{SCRACS}, it is orthogonal to the Sun-line. The FoR is then expressed as a ± deviation from this position. In this case the above equation can be simply re-expressed as:

$$FoR = \frac{sin\alpha_1 + sin\alpha_2}{2} \times 100$$

Where α_1 and α_2 are the angular deviations of the LoS on either side from yz_{SCRSC}. e.g. the requirement of 50% of the sky is most effectively achieved by a symmetrical deviation of the LoS from the yz_{SCRACS} plane of ±30°, and will be written as 90°±30°. Note that the FoR is not necessarily symmetric (different values of α_1 and α_2).

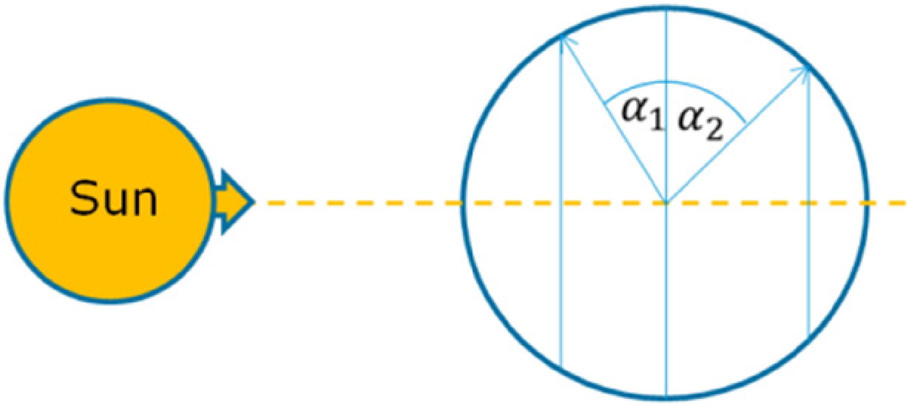


Figure 4: FoR definition

5 ACRONYMS

Acronym	Definition
ACS	Attitude Control System
ADC	Analogue to Digital Converter
ADPM	Antenna Deployment and Pointing Mechanism
ADR	Adiabatic Cooler
AFE	Analogue Front End
AFM	Atomic Force Microscope
AIT/V	Assembly, Integration and Test/Verification
AIV	Assembly, Integration and Verification
AKE	Absolute Knowledge Error
ALM	Additive Layer Manufacturing
AOCS	Attitude and Orbit Control System
APE	Absolute Performance Error
APM	Antenna Pointing Mechanism
ASH	Acquisition and Safe Hold Mode
ASIC	Application Specific Integrated Circuit
ASST	ATHENA Science Support Team
ATHENA	Advanced Telescope for High Energy Astrophysics
ATV	Automated Transfer Vehicle
AVM	Avionic Verification Model
BB	Bread Board
BCR	Battery charge regulator
BDR	Battery discharge regulator
BEE	Back End Electronics
BESSY	Berlin Electron Storage Ring Society for Synchrotron Radiation
BoL	Beginning of Life
CaC	Cost at Completion
CC	Cooling Chain
CCD	Charged Coupled Device
CCDS	Consultative Committee for Space Data Systems
CCSDS	The Consultative Committee for Space Data Systems
CDF	Concurrent Design Facility
CDF	Cumulative Distribution Function

CDMU	Command and Data Management Unit
CDMU	Central Data Management Unit
CER	Cost Estimating Relationship
CFDP	CCSDS File Delivery Protocol
CFE	Control Front End
CFEE	Cold Front End Electronics
CFI	Customer Furnished Item
CFRP	Carbon Fibre Reinforced Polymer
CMA	Cost Model Accuracy
CMG	Control Moment Gyro
CoG	Centre of Gravity
CoM	Centre of Mass
ConOps	Concept of Operations
CoP	Centre of Pressure
COTS	Commercial Off The Shelf
CReMA	Consolidated Report on Mission Analysis
CSS	Coarse Sun Sensor
CTE	Coefficient of Thermal Expansion
CV1525	Cosmic Vision Programme 2015 - 2025
DC	Direct Current
DCR	Digital Control Room
DDS	Data Dissemination System
DE	Detector Electronics
DE/EP	Digital Electronics/ Events Processing
DEPFET	Depleted P-channel Field Effect Transistor
DMM	Design Maturity Margin
DOA	Degree of Adequacy of the Cost model
DoF	Degree Of Freedom
DRE	Digital Readout Electronics
DSA	Deep Space Antenna
EBB	Elegant BreadBoard
EC	Economic Conditions
ECC	ESTRACK Control Centre
EIRP	Equivalent Isotropic Radiated Power
EMC	ElectroMagnetic Compatability

EoL	End of Life
EoP	Extended Operations Phase
EPC	Electrical Power Conditioner
EPDM	Ethylene propylene diene monomer
EPE	External Project Events
EPS	Electrical Power System
EQM	Engineering and Qualification Model
ERT	Earth Reception Time
ERT	Earth Reception Time
ESA	European Space Agency
ESOC	European Satellite Operations Centre
ESTEC	European Space Research and Technology Centre
ESTRACK	European Space TRACKing network
FDIR	Failure Detection Isolation and Recovery
FDM	Frequency Domain Multiplexing
FE	Finite Element
FEE	Front End Electronics
FEM	Finite Element Model
FFBD	Functional Flow Block Diagram
FFOS	Formation Flying Optical Sensor
FL	Focal Length
FM	Flight Model
FMS	Fixed Metering Structure
FOP	Flight Operations Plan
FOP-SW	Flight Operations Software
FoR	Field of Regard
FOS	Flight Operations Ground Segment
FoV	Field of View
FP	Focal Plane
FPA	Focal Plane Assembly
FPGA	Field Programmable Gate Array
FPM	Focal Plane Module
FPS	Fine Point Slew Mode
FRF	Frequency Response Function
G/S	Ground Station

GNC	Guidance, Navigations and Control
GPS	Global Positioning System
GRB	Gamma Ray Burst
GS	Ground Station
GS	Ground Station
GSE	Ground Support Equipment
GSP	General Studies Program
HDRM	Hold Down and Release Mechanism
HDRS	Hold Down and Release System
HEO	Highly Eccentric Orbit
HEO	Highly elliptical orbit
HEW	Half Energy Width
HGA	High Gain Antenna
HK	Housekeeping
HKTM	Housekeeping and Telemetry
HPO	High Performance Optics (outdated, shall not be used anymore)
ICE	Independent Cost Estimate
ICPU	Instrument Control and Power Unit
ICU	Instrument Control Unit
IFU	Integrated Field Unit
IO	Inputs and Outputs
IQM	Inherent Quality of the cost Model
IR	Infra Red
ISM	Instrument Switch Mechanism
Isp	Specific Impulse
IXO	International X-ray Observatory
JD	Julian Date
KPI	Key Performance Indicator
L/V	Launch Vehicle
L2	2^{nd} Lagrangian point (orbit)
L2	Libration Point 2 (on anti Sun side of Earth)
LED	Light Emmiting Diode
LEOP	Launch and early Orbiting Phase
LGA	Low Gain Antenna
LNA	Low Noise Amplifier

LoS	Line of Sight
LS	Launch Segment
LSRU	Low Shock Release Unit
LV	Launch Vehicle
LVA	Launch Vehicle Adapter
MA	Mirror Assembly
MAIVT	Manufacturing Assembly Integration and Testing
MAM	Mirror Assembly Module
MBD	Mission Budgets Document
MCS	Mission Control System
MDR	Mission Definition Review
MEMS	Micro Electrical Mechanical System
MGSE	Mechanical Ground Support Equipment
MIB	Minimum Impulse Bit
MIP	Moveable Instrument Platform
MIXS	Mercury Imaging XRay Spectrometer
MLI	Multi-Layer Insulation
MM	Mirror Module
MMA	Moveable Mirror Assembly
MMU	Mass Memory Unit
MO	(CCSDS) Mission Operations (Services)
MOC	Mission Operations Centre
MOI	Mission Operations Infrastructure
MOI	Moment Of Inertia
MOS	Metal Oxide Semiconductor
MOSFET	Metal Oxides Semiconductor Field Effect Transistor
MPE	Max Planck Institute for Extraterrestrial Physics
MPPT	Maximum Power Point Tracker
MRD	Mission Requirements Document
MS	Mirror Structure
NEA	Non Explosive Actuator
NOP	Nominal Operations Phase
OBC	On Board Computer
OBCP	On Board Control Procedures
OBDH	On Board Data Handling

OBF	Optical Blocking Filter
OBM	On Board Metrology
OBS	On Board Software
OBSM	On Board Software Maintenance
OBT	On Board Time
OCDT	Open Concurrent Design Tool
ODF	Observation Data File
OGB	Out Gassing Baffle
OGS	Operational Ground Segment
OSR	Optical Solar Reflector
PCDU	Power conditioning and distribution unit
PDCU	Power Distribution Control Unit
PDD	Payload Definition Document
PDE	Performance Drift Error
PDHU	Payload and Data Handling Unit
PDU	Power Distribution Unit
PEET	Pointing Error Engineering Tool
PEPS	Power system modelling tool developed by ESA TEC-EP
PF	Platform
PFM	Proto-Flight Model
PL	Payload
PLA	Payload Adaptor
PMD	Propellant Management Device
PMF	Probability Mass Function
PN	Pseudo Noise
POE	Project Owned Events
PRR	Preliminary Requirements Review
PSF	Point Spread Function
PSU	Power Supply Unit
PTB	Physikalisch-Technische Bundesanstalt
PUS	Packet Utilization Service
p-v	peak-to-valley
QE	Quantum Efficiency
QIV	Quality of the Input Values
QLA	Quick Look Analysis

QM	Qualification Model
RAMS	Reliability Availability Maintainability and Safety
RC	Resistor Capacitor
RCS	Reaction Control System
RF	Radio Frequency
RFDU	Radio Frequency Distribution Unit
RIU	Remote Instrument Unit
RMS	Root Mean Square
RPE	Relative Performance Error
RSS	Root Sum Squaring
RT	Room Temperature
RTU	Remote Instrument Unit
RW	Reaction Wheel
RXTE	Rossi X-ray Timing Explorer
SA	Solar Array
SADE	Solar array drive electronics
SADM	Solar array drive mechanism
SADS	Solar Array Deployment System
SC	SpaceCraft
SEL2	Sun-Earth Libration Point 2
SFT	System Functional Test
SGS	Science Ground Segment
SLI	Single Layer Insulation
SM	Structural Model
SMBH	Super Massive Black Hole
SoC	State of Charge
SPACON	SC Controller
SPF	Single Point Failure
SPO	Silicon Pore Optics
SPW	SpaceWire
SQUID	Semiconducting Quantum Interface Device
SRD	SC Requirements Document
SRR	Systems Requirements Review
SSCE	Sun-SC-Earth angle
SSDE	Sun Shield Drive Electronics

SSDM	Sun Shield Deployment Mechanism
SSM	Second Surface Mirror
STM	Structural Thermal Model
SVM	SerVice Module
SVT	System Validation Test
SW	Software
TAI	Time Atomic International
TC	Telecommand
TCM	Transfer Correction Manoeuvre
TCS	Thermal Control Subsystem
TDA	Technology Development Activity
TED	Thermo-Elastic Displacement
TES	Transition Edge Sensor
TM	Telemetry
ToO	Target of Opportunity
TRL	Technology Readiness Level
TRP	Technology Research Program
TT	Terrestrial Time
TT	Terrestrial Time
TT&C	Telemetry, Tracking & Command
TTV	Total Thickness Variation
TWG	Telescope Working Group
TWT	Traveling Wave Tube
TWTA	Travelling Wave Tube Amplifier
UTC	Universal Time Coordinated
UTC	Universal Time Coordinated
UV	Ultra Violet
WCPE	Worst Case Potential Effect
WFEE	Warm Front End Electronics
WFI	Wide Field Imager
XEUS	X-ray Evolving Universe Spectroscopy
X-IFU	X-Ray Integrated Field Unit
XMM	X-ray Multi Mirror Mission