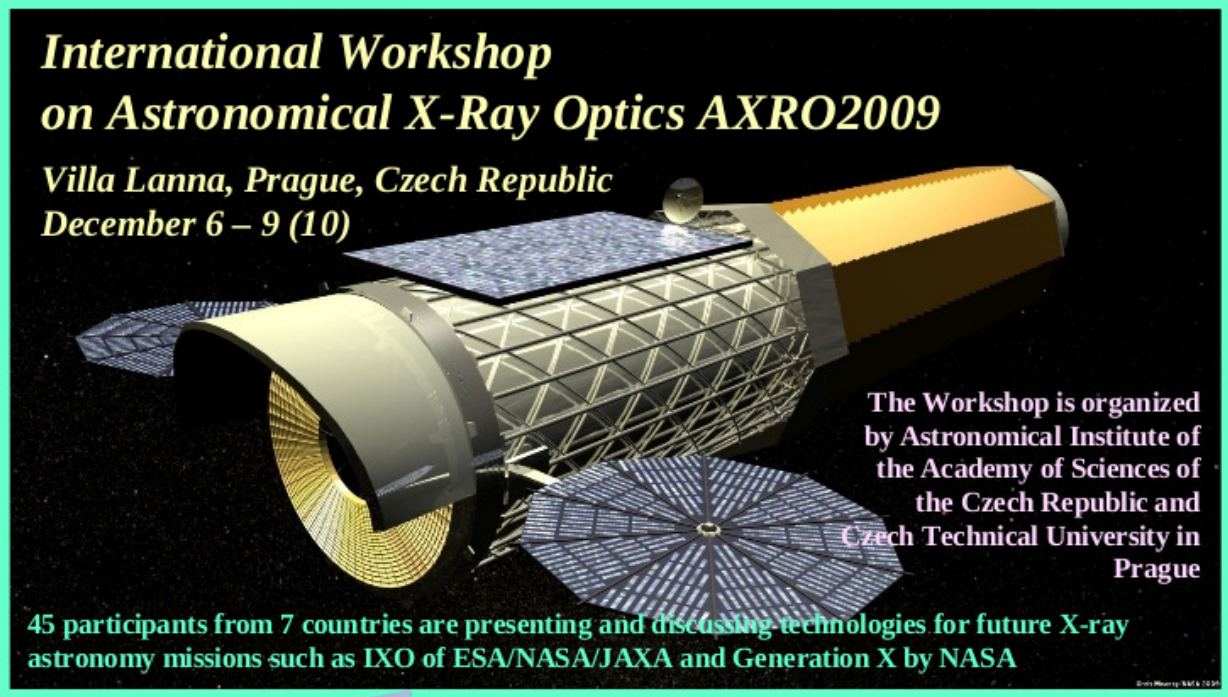
BOOK OF ABSTRACTS



Program:

December 6 – 9:
Workshop on astronomical X-ray optics

December 10:
IXO Telescope Working Group meeting
(only for IXO TWG members)

Program Committee:
Prof. Martin Elvis, Prof. Dick Willingale, Prof. Rob Petre, Prof. William Zhang (co-chair), Prof. Giovanni Pareschi, Prof. Webster Cash, Prof. Hideyo Kunieda, Prof. Steve O´Dell, Assoc.Prof. René Hudec (co-chair), Assoc. Prof. Ladislav Pina, Prof. Randall McEntaffer, Prof. John Nousek

Local Organising Committee:
Assoc. Prof. René Hudec (co-chair),
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Bc.Matúš Kocka
Mgr. Martin Blažek
Richard Marko

Contact:
http://axro.org, rene.hudec@gmail.com

X-ray telescope system onboard the Japanese X-ray Astronomy mission Astro-H

Author : Hisamitsu Awaki

Coauthors : Hideyo Kunieda (Nagoya Univ.), Y. Tawara (Nagoya Univ.), A. Furuzawa (Nagoya Univ.), H. Mori (Nagoya Univ.), T. Miyazawa (Nagoya Univ.), M. Ishida (ISAS/JAXA), Y. Maeda (ISAS/JAXA), K. Ogi (Ehime UNiv.), T. Kosaka (Osaka City Univ.), S. Yamauchi (Nara women's Univ.), R. Iizuka (Chuo Univ.), Y. Namba (Chubu Univ.), P.J. Serlemitsos (NASA/GSFC), Y.G. Soong (NASA/GSFC), T. Okajima (NASA/GSFC) and Astro-H team

Abstract : The new Japanese X-ray Astronomy satellite, Astro-H is an international X-ray mission which is currently planed for launch in fiscal 2013. One of the unique features of the mission is an imaging spectroscopy in a unprecedentedly wide energy region from 0.3 to 60 keV. The X-Ray Telescope (XRT) system covers the energy region by means of grazing incidence reflective optics. In the current baseline specification, the XRT system consists of two hard X-ray telescopes which cover 5 to 60 keV, and two soft X-ray telescopes which cover 0.3 to about 20 keV. Both of hard and soft X-ray mirrors employ tightly-nested, conically-approximated thin-foil Wolter-I optics. In this meeting, I will introduce the X-ray telescope system onboard Astro-H.

ESA concept of the IXO telescope

Author : Marcos Bavdaz

Coauthors : P. Gondoin, K. Wallace, T. Oosterbroek and E. Wille

Abstract : The International X-ray Observatory (IXO) is a candidate mission in the ESA Space Science Programme Cosmic Visions 1525. IXO is being studied as a joint mission with NASA and JAXA. The mission concept and x-ray telescope accommodation have both been studied in the ESA Concurrent Design Facility. Competitive industrial studies are now in place to study mission concepts. In parallel the required technologies are being developed, with the main emphasis being focused on Silicon Pore Optics (SPO). The paper will present a summary of the ESA system studies of IXO and provide an overview of the ESA led technology preparation activities.

Development of High Resolution X-ray Gratings

Author : Webster Cash

Abstract : We report on progress in the design, development, test and use of diffraction gratings for soft X-ray astronomy. Progress includes a) new designs that optimize performance and minimize resources b) advances in the engineering of grating modules c) new resolution testing in the laboratory and d) flight results from sounding rockets.

Suspension Mount and Alignment of IXO Mirror Segments

Author : Kai-Wing Chan

Coauthors : William Zhang, Lalit Jalota, Melinda Hong, James Mazzarella, Tyler Evans, Ryan McClelland and Lawrence Olsen

Abstract : A "suspension mounting" scheme is being developed for the IXO mirror segments at NASA/Goddard. The method, in which a mirror segment is first hung and temporary bonded onto a strongback, preserves the figure of the mirror segment with quantified forces and displacements. The mirror on its strongback can subsequently be aligned and transferred onto its mirror housing. Recent progress of this process and results of measurements will be presented.

Silicon Pore Optics for IXO

Author : Max Collon

Coauthors : Ramses Günther, Marcelo Ackermann, Rakesh Partapsing, Giuseppe Vacanti, Marco W. Beijersbergen, Marcos Bavdaz, Kotska Wallace, Mark Olde Riekerink, Peter Müller, Michael Krumrey and Michael Freyberg

Abstract : Silicon pore optics is a technology developed to enable future large area X-ray telescopes, such as the International Xray Observatory (IXO), a candidate mission in the ESA Space Science Programme 'Cosmic Visions 2015-2025'. IXO uses nested mirrors in Wolter-I configuration to focus grazing incidence X-ray photons on a detector plane. The IXO mirrors will have to meet stringent performance requirements including an effective area of ~ 3 m^2 at 1.25 keV and ~ 1 m^2 at 6 keV and angular resolution better than 5 arc seconds. To achieve the collecting area requires a total polished mirror surface area of ~ 1300 m^2 with a surface roughness better than 0.5 nm rms. By using commercial high-quality 12" silicon wafers which are diced, structured, wedged, coated, bent and stacked the stringent performance requirements of IXO can be attained without any costly polishing steps. Two of these stacks are then assembled into a co-aligned mirror module, which is a complete X-ray imaging system. Included in the mirror module are the isostatic mounting points, providing a reliable interface to the telescope. Hundreds of such mirror modules are finally integrated into petals, and mounted onto the spacecraft to form an X-ray optic of four meters in diameter. In this paper we will present the silicon pore optics assembly process and latest X-ray results. The required metrology is described in detail and experimental methods are shown, which allow to assess the quality of the mirror modules during production and to predict the performance when measured in X-ray facilities.

Recent development of light-weight & high-resolution X-ray optics in Japan

Author : Yuichiro Ezoe

Coauthors : Manabu Ishida, Kazuhisa Mitsuda, Noriko Y. Yamasaki, Takaya Ohashi, Makoto Mita, Ikuyuki Mitsuishi, Utako Takagi, Kensuke Ishizu, Teppei Moriyama, Kohei Morishita, Kazuo Nakajima, Shinya Fujihira, Yoshiaki Kanamori, Talor Boggs, Raul Riveros, Hitomi Yamaguchi, Fumiki Kato, Mitsuhiro Horade, Susumu Sugiyama, Takayuki Takano and Ryutaro Maeda

Abstract : We introduce our recent development of new light-weight and high resolution X-ray optics. We present new developments of different types of optics. One is ultra-light micro pore optics based on MEMS technologies aiming at 1 kg/m^2 and 15 arcsec. The other is high-resolution thermally slumped silicon optics aiming at 20 kg/m^2 and 5 arcsec resolution.

Back-Up Technologies for IXO

Author : Rene Hudec

Coauthors : V. Marsikova, M. Skulinova, L. Pina, M. Mika, J. Sik, M. Lorenc, A. Inneman and O. Gedeon

Abstract : Recent progress in advanced back-up technologies for IXO X-ray optics (with the emphasis of efforts of Czech consortium) will be presented and discussed. These technologies include improvements of Si wafer based X-ray optics and of glass thermal forming.

40 years of Astronomical X-Ray Optics in the Czech Republic

Author : Rene Hudec

Abstract : I will shortly introduce the past, recent and planned efforts in the field of astronomical X-ray optics in the Czech Republic. The development of our astronomical X-ray optics started in 1969 and first X-ray mirror was constructed in 1970 as a small aperture (50 mm) Wolter system for X-ray imaging of the Sun. Later 8 space experiments with Czech X-ray optics were flown in space. Recent efforts focus on very wide-field X-ray optics and on development of novel technologies for future X-ray telescopes.

X-ray Optics: Wolter versus KB

Author : Veronika Marsikova

Coauthors : Adolf Inneman, Jiri Marsik, Libor Sveda, Rene Hudec and Ladislav Pina

Abstract : We present recent development in Si/glass X-ray optics design and development in RITE/CTU Prague. We have compared gold coated KB system with focal lengths 20 and 40 meters with corresponding Wolter type system. Off axis imaging computer simulations and optimization of focal lengths of vertical mirrors independently on horizontal mirrors was performed. It shows that focal lengths have to be distinct, yet the difference is close to manufacturing limits. KB modules based on silicon and glass substrates are manufactured. Methodology of testing of long-focal optics is proposed and first tests using visible light are performed.

Design and Analysis of the IXO FMA

Author : Ryan McClelland

Coauthors : Timothy Carnahan and David Robinson

Abstract : The Flight Mirror Assembly (FMA) preliminary mechanical design for NASA's next major X-ray telescope mission, the International X-Ray Observatory (IXO), has been developed at NASA Goddard Space Flight Center (GSFC). The design addresses some unique engineering challenges presented by the unprecedented combination of high angular resolution and large effective area required to achieve the desired scientific objectives. To meet these requirements, the Wolter-I Soft X-Ray Telescope (SXT) optical design consists of about 14,000 0.4 mm thick glass mirror segments densely packed into a 3.4 m diameter FMA and supported with micron level accuracy and stability. Key engineering challenges addressed include ensuring positive stress margins for the glass segments with a high Factor of Safety, keeping the structure light enough to launch, providing a large effective area, and preventing unacceptable thermal distortion. Standard mechanical design techniques such as FEM modeling and optimization, integrated optomechanical analysis, and development testing were applied to this unique problem. The thin mirror segments are mounted into 60 intermediate wedge shaped structures called modules. Modules are kinematically mounted to the FMA primary structure which is optimized for minimum mass and obscuration of the clear aperture. The preliminary design demonstrates the feasibility of building and launching a large space-based SXT using slumped glass mirrors which meets the IXO effective area, mass, structural, and thermal requirements.

The Off-Plane X-ray Grating Spectrometer for IXO

Author : Randall McEntaffer

Abstract : -

Glass Composition Effect on Thermal Forming of Foils for X-ray Space Telescopes

Author : Martin Mika

Abstract : -

Glass – physical-chemical properties

Author : Martin Mika

Abstract : -

The Swift XRT performance

Author : John Nousek

Coauthors : David N. Burrows Alberto Moretti

Abstract : The Swift XRT is completing five years of successful operations. I review the Swift performance and our plans for the future.

Five Years of Swift Science: GRBs and More!

Author : John Nousek

Coauthors : Neil Gehrels

Abstract : The Swift Gamma-Ray Burst MIDEX Explorer has just passed the fifth anniversary of its launch. Conceived as a unique rapid response, multi-wavelength observatory for gamma-ray bursts (GRBs) and their afterglows, these same properties have made it an ideal platform for a wide variety of scientific applications, especially those involving response to transient events and monitoring of variable targets.

We review the GRB phenomenon and how Swift has improved our understanding, and survey the many other fields of astrophysics where Swift is playing a unique role.

SRG, astrophysical mission

Author : Mikhail Pavlinsky

Abstract : The Spectrum-RG (SRG) mission, to be launched in 2012, will conduct the first all-sky survey in the 0.5-11 keV band via two X-ray imaging telescope systems, eROSITA and ART-XC.

On going developments on monolithic X-ray optics at the Brera Astronomical Observatory: a status report

Author : Giovanni Pareschi

Coauthors : S. Basso, O. Citterio, M. Civitani, P. Conconi, V. Cotroneo, M. Ghigo, L. Proserpio and D. Spiga

Abstract : Grazing incidence mirrors based on monolithic pseudo-cylindrical configuration have been successfully utilized for past X-ray telescopes. The monolithic configuration, thanks to the cylindrical symmetry, improves the intrinsic stiffness of the mirrors and in general prevents from the aberrations caused by the deformations of the reflecting surface. Excellent angular resolution results (4-0.5 arcsec HEW), paying in terms of a modest throughput, were achieved by the Einstein, Rosat and Chandra optics, all based on relatively thick shells (ten millimiters or more) made in glass or glass-ceramic materials, precisely grinded and superpolished. Thin (1mm – 0.1mm) mirror shells produced via Ni elctroforming replication, used for SAX, XMM and Swift, are characterized by a less performing (but still very good) imaging capability (HEW 0 15 arcsec at 1 keV), with a large gain in terms of throughput. At the Brera Astronomical Observatory we are involved in a number of technological effort to improve the performances of monolithic mirror shell. In this paper we will report on these on-going activities and, in particular, we will discuss on recent results achieved on thin electroformed optics with multilayer reflecting coating for hard X-ray applications and on the direct figuring of thin glass or ceramic shells for obtaining high resolution and high throughput shells with polynomial profile for surveying purposes.

Adjustable Grazing Incidence Optics for X-ray Astronomy

Author : Paul Reid

Coauthors : William Davis (CfA), Brian Ramsey (NASA MSFC), Daniel Schwartz (CfA), Susan Trolier-McKinstry (PSU) and Rudeger Wilke (PSU)

Abstract : Two different types of adjustable grazing incidence optics are being developed at CfA; thin film piezo electric devices designed to achieve 1 to 0.1 arcsec imaging resolution of mirror segments, and radial electrostrictive devices for 3 - 5 arcsec imaging resolution of full shell electroformed metal optics. We describe the results of mirror modeling, piezo deposition experiments, and some early work on the measurement of adjuster influence functions.

Results using platinum as a release layer for IXO thermally formed glass optics

Author : Suzanne Romaine

Coauthors : R. Bruni, P. Gorenstein, S. Park and P. Reid

Abstract : Platinum and boron nitride are two of the materials being considered as release layers for thermally slumping glass substrates for IXO. SAO is investigating the use of platinum as a release layer for IXO glass substrates. Recent experimental results using dc magnetron sputtered platinum coatings will be presented.

Mirror fabrication via glass slumping techniques

Author : Anita Schael

Coauthors : Monika Vongehr

Abstract : -

Lessons from Chandra: Comparing the Wolter I and Wolter-Schwarzschild prescriptions to optimize sensitivity

Author : Dan Schwartz

Coauthors : R. J. Brissenden, M. Elvis, G. Fabbiano, T. Gaetz, D. Jerius, M. Juda, P. B. Reid, S. J. Wolk, S. L. O'Dell, W. W. Zhang and the Gen-X Team

Abstract : The ability to find faint objects in surveys depends on the telescope off-axis resolution, as well as its area and on-axis image quality. Chandra utilized a Wolter I prescription, on the rationale that the Wolter-Schwarzschild design was indistinguishable within the tolerances required for the 0.5 arcsec angular resolution of Chandra. We show that for a future mission such as Gen-X, with 0.1 arcsec resolution, that the Wolter-Schwarzschild design offers a distinct theoretical advantage in terms of numbers of resolution elements, lower background for point source detection, and therefore increased sensitivity to faint sources. This is important to detect the faintest possible sources serendipitously, as matched to the Gen-X objective of discovering the first Black Holes in the Universe.

Development of a critical-angle transmission grating spectrometer for the International X-Ray Observatory

Author : Mark Schattenburg

Coauthors : Ralf K. Heilmann, Minseung Ahn, Mark W. Bautz, John Davis, Dan Dewey, Rick Foster, David P. Huenemoerder, Herman L. Marshall, Pran Mukherjee, Norbert S. Schulz and Matthew Smith

Abstract : We present a high-resolution soft X-ray grating spectrometer concept for the International X-Ray Observatory (IXO) that meets or exceeds the minimum requirements for effective area ($>$ 1,000 cm^2 for E $<$ 1 keV) and spectral resolution (E/Delta E $>$ 3,000). At the heart of the spectrometer is an array of recently developed high-efficiency blazed transmission gratings, the so-called critical-angle transmission (CAT) gratings. They combine the advantages of traditional transmission gratings (very low mass, extremely relaxed alignment and flatness tolerances) with those of X-ray reflection gratings (high efficiency due to blazing in the direction of grazing-incidence reflection). Since our initial successful X-ray demonstrations of the CAT grating concept with large-period and lower aspect-ratio prototypes, we have now microfabricated 200 nm-period silicon CAT gratings comprised of grating bars with the required dimensions (6 micron tall, 40 nm wide, aspect ratio 150), optimized for the 0.3 to 1.0 keV energy band. Preliminary analysis of recent X-ray tests show blazing behavior up to 1.28 keV in accordance with predictions.

Shaping thin glass mirrors using air bearings

Author : Mark Schattenburg

Coauthors : Mireille K. Akilian, Ralf K. Heilmann and Abdul Husseini

Abstract : Thermal shaping of glass against precision mandrels is a promising technology for producing X-ray mirrors for future missions such as the International X-Ray Observatory (IXO). While a great deal of progress has recently been made to improve the accuracy of slumped glass mirrors, high-frequency ripples are still difficult to control, due primarily to problems with sticking and dust particles. In this talk we describe a new technology for shaping hot glass between pairs of precision porous ceramic air bearings which eliminates sticking and dust particle problems.

Application of layers with internal stress for silicon wafer shaping

Author : Jan Sik

Coauthors : Radomír Lenhard, David Lysáček, Michal Lorenc, Veronika Maršíková and René Hudec

Abstract : We review the impact of thin film stress on silicon wafer shaping. Layers with internal stress uniformly shape silicon wafer without deterioration of high quality of the polished front side. Stress in thin film is supposed to be constant regarding to the film thickness, which is valid for most of dielectric thin films used in microelectronics, except of poly silicon. Stress in poly silicon layer is reduced with film thickness due to atoms migration into low energy position. The circular wafer keeps the original axially symmetrical spherical shape after squaring and the solid area can be build from squared segments. Multilayer stack has been designed to decrease the radius of wafer curvature to R $\sim$ 2 m.

MEDIPIX/TIMEPIX Imaging Detectors on ESA Stratospheric Balloon Campaigns BEXUS

Author : Jaroslav Urbar

Coauthors : J. Scheirich and J. Jakubek

Abstract : Results of the first experiments using a MEDIPIX-type detectors for cosmic ray imaging in stratospheric environment are presented. The original detecting device was based on hybrid pixel detector of Medipix2-type developed at CERN with USB interface developed at Institute of Experimental and Applied Physics of Czech Technical University in Prague. The detector was used in its tracking mode allowing it to operate as an "active nuclear emulsion" as the first step to evaluate its feasibility to work as X-ray detector with focusing optics in space environment. Two flights (BEXUS-7 Oct08, BEXUS-8 Oct09) took about 4 hours each, with 2 hours at stable floating altitude of 26km. The flight opportunity was provided by Education dept. of European Space Agency (ESA) and Eurolaunch (Collaboration of SSC and DLR, German Space Agency). Whole concept served as original testbed for feasibility study of extended stratospheric flight exposures of Medipix detectors to near-space environment. Control hardware was custom designed, based on PC/104 platform. Extensive dataset of different types of cosmic ray particles image tracks were acquired in the stratospheric radiation environment, sorted and analyzed. Detector performance was evaluated for further design implications of advanced concept focusing on proposed configuration with Lobster-eye optics is discussed for X-ray imaging purposes. The original BEXUS-8 results to be presented during AXRO.

News from glass slumping project at MPE

Author : Monika Vongehr

Coauthors : Anita Schael and Peter Friedrich

Abstract : -

Active X-ray Optics

Author : Richard Willingale

Coauthors : Charlotte Feldman et al.

Abstract : Development of active X-ray optics by the Smart X-ray Optics consortium in the UK

Chinese X-ray astronomy program

Author : Chen Zhang

Abstract : -

Fabrication and Metrology of Mirror Segments for the IXO Mission

Author : William Zhang

Abstract : -

Faint objects on INTEGRAL/IBIS mosaics in 15-80 keV energy range

Author : Martin Blazek

Coauthors : Rene Hudec

Abstract : We discuss searches for positive detection of selected candidates (i.e. faint object, mostly intermediate polars and blazars) in INTEGRAL IBIS data. We discuss various approaches with emphasis on detection and confirmation of faint objects with low sigma.

Design Considerations of Polishing Lap for Computer-Controlled Cylindrical Polishing Process

Author : Gufran Sayeed Khan

Coauthors : Mikhail Gubarev, William Arnold and Brian Ramsey

Abstract : The future X-ray observatory missions, such as International X-ray Observatory (IXO), require grazing incidence replicated optics of extremely large collecting area (3 m^2) in combination with angular resolution of < 5 arcsec half-power diameter. The achievable resolution of a mirror shell depends ultimately on the quality of the cylindrical mandrels from which the mirror shells are being replicated. Mid-spatial-frequency axial figure error is a dominant contributor in the error budget of the mandrel. This paper presents our efforts to develop a deterministic cylindrical polishing process in order to keep the residual mid-spatial-frequency axial figure errors to a minimum. Simulation studies have been performed to optimize the operational parameters as well as the polishing lap configuration. By using the optimized operational parameters and lap configuration obtained from the simulation studies, a cylindrical mandrel has been polished on a newly developed computer-controlled cylindrical polishing machine. We report our first experimental results on this mandrel and discuss plans for further improvement in the polishing process.

A stainless-steel mandrel for slumping glass x-ray mirrors

Author : Stephen O'Dell

Coauthors : Mikhail V. Gubarev William D. Jones Thomas J. Kester Charles W. Griffith William W. Zhang Timo T. Saha Kai-Wing Chan

Abstract : We have fabricated a precision full-cylinder stainless-steel mandrel at Marshall Space Flight Center. The mandrel is figured for a 30-cm-diameter primary (paraboloid) mirror of an 840-cm focal-lengthWolter-1 telescope. We have developed this mandrel for experiments in slumping—thermal forming at about 600 °C—of glass mirror segments at Goddard Space Flight Center, in support of NASA's participation in the International X-ray Observatory (IXO). Precision turning of stainless-steel mandrels may offer a low-cost alternative to conventional figuring of fused-silica or other glassy forming mandrels. We report on the fabrication, metrology, and performance of this first mandrel; then we discuss plans and goals for stainless-steel mandrel technology.

Simulations of X-Ray Telescopes for eROSITA and IXO

Author : Christian Schmid

Coauthors : Michael Martin Jörn, Wilms Ingo Kreykenbohm, Martin Mühlegger, Nico Cappelluti, Hermann Brunner, Maria Fürmetz, Peter Predehl, Eckhard Kendziorra and Didier Barret

Abstract : We present a generic X-ray instrument simulation tool developed for studies of future X-ray missions. According to the concept of Monte Carlo simulations the software generates a sample of photons for different X-ray sources based either on several catalogs like the ROSAT all-sky survey or on images of light cones from cosmological hydrodynamical simulations. The imaging in a Wolter telescope and the detection process are modelled by means of standard calibration files like a point spread function and the detector response. The resulting event files have FITS format and can be analysed with standard tools. With this software we have done simulations of parts of the eROSITA all-sky survey for several fields of galaxy clusters, and we have studied the detector-specific pile-up behaviour for the High Time Resolution Spectrometer and the Wide Field Imager on the International X-ray Observatory.

Tests of Lobster Eye Optics for Possible Space Mission

Author : Vladimir Tichy

Coauthors : Marco Barbera, Alfonso Collura, Martin Hromčík, Rene Hudec, Adolf Inneman, Jiří Maršík, Veronika Maršíková, Ladislav Pína and Salvatore Varisco

Abstract : The Lobster eye design for a grazing incidence X-ray optics provides wide field of view of the order of many degrees, for this reason it can be a convenient approach for the construnction of space all-sky X-ray monitors. We present preliminary results of tests of prototype lobster eye X-ray optics in quasi parallel beam full imaging mode conducted using the 35 meters long X-ray beam-line of INAF-OAPA in Palermo (Italy). X-ray images at the focal plane have been taken with a MCP detector at several energy values from 0.3 keV to 8 keV. The gain, the field of view and the angular resolution have been measured and compared with simulations.

Oral Contributions

I. Session on Astrophysics with Astronomical X-ray Telescopes

II. Session on Astronomical X-Ray Optics

III. Session on IXO Telescope

Posters