Design and tests of the hard X-ray polarimeter X-Calibur

M. Beilicke\textsuperscript{a}, M.G. Baring\textsuperscript{b}, S. Barthelmy\textsuperscript{c}, W.R. Binns\textsuperscript{a}, J. Buckley\textsuperscript{a}, R. Cowsik\textsuperscript{a}, P. Dowkontt\textsuperscript{a}, A. Garson\textsuperscript{a}, Q. Guo\textsuperscript{a}, Y. Haba\textsuperscript{d}, M.H. Israel\textsuperscript{a}, H. Kunieda\textsuperscript{d}, K. Lee\textsuperscript{a}, H. Matsumoto\textsuperscript{d}, T. Miyazawa\textsuperscript{d}, T. Okajima\textsuperscript{c}, J. Schnittman\textsuperscript{c}, K. Tamura\textsuperscript{d}, J. Tueller\textsuperscript{c}, and H. Krawczynski\textsuperscript{a}

\textsuperscript{a}Department of Physics and McDonnell Center for the Space Sciences, Washington University, St. Louis, MO, USA; \textsuperscript{b}Rice University, TX, USA; \textsuperscript{c}Goddard Space Flight Center, MD, USA; \textsuperscript{d}Nagoya University, Japan;

\textbf{ABSTRACT}

X-ray polarimetry promises to give qualitatively new information about high-energy astrophysical sources, such as binary black hole systems, micro-quasars, active galactic nuclei, and gamma-ray bursts. We designed, built and tested a hard X-ray polarimeter \textit{X-Calibur} to be used in the focal plane of the InFOCuS grazing incidence hard X-ray telescope. \textit{X-Calibur} combines a low-Z Compton scatterer with a CZT detector assembly to measure the polarization of 10 – 80 keV X-rays making use of the fact that polarized photons Compton scatter preferentially perpendicular to the electric field orientation. \textit{X-Calibur} achieves a high detection efficiency of order unity.

\textbf{Keywords:} X-rays, polarization, black hole, InFOCuS, X-Calibur