

X-ray and γ -ray Polarimetry Satellite PolariS

PolariS Working Group

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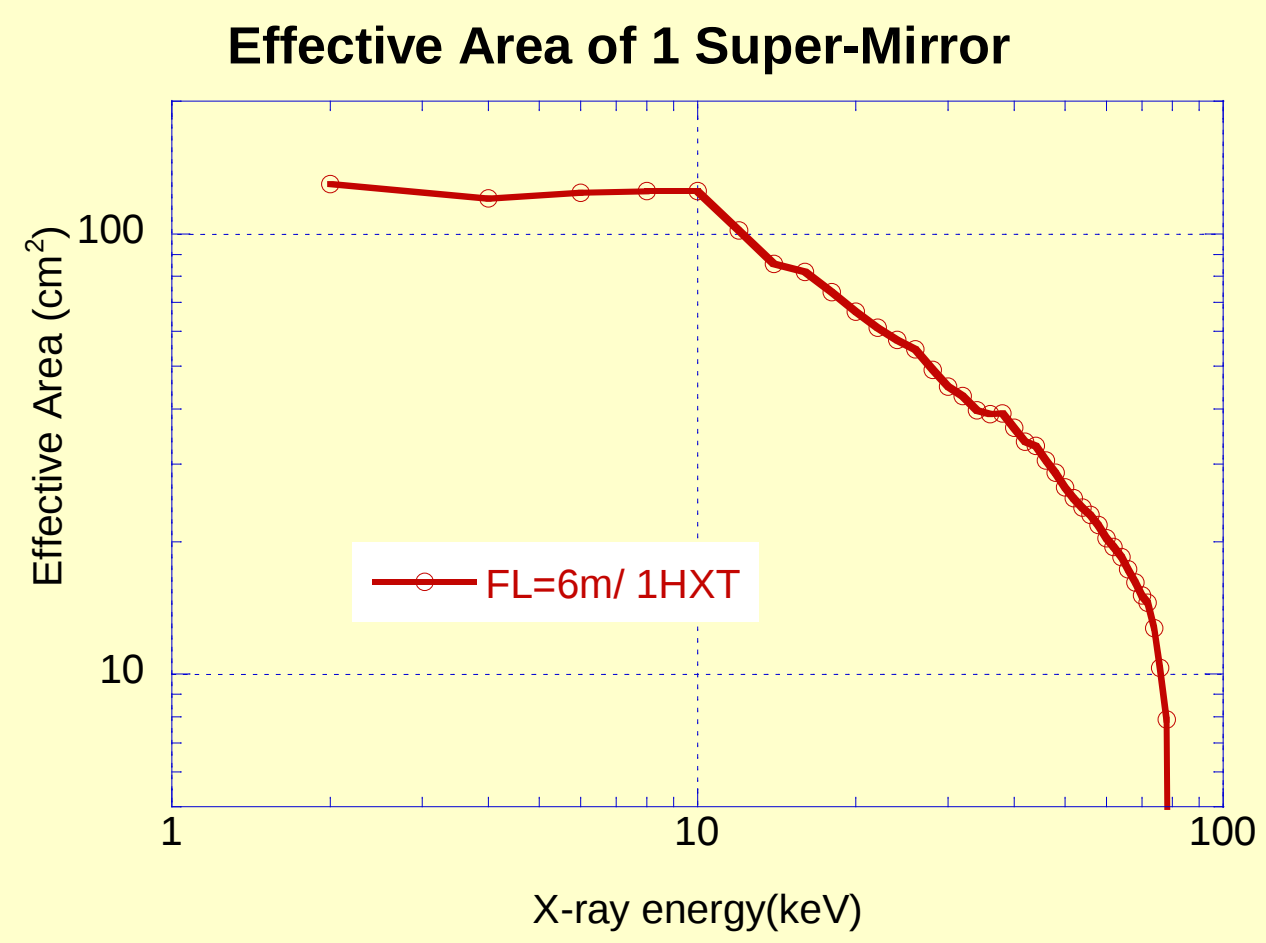
PolariS (Polarimetry Satellite) is a Japanese small satellite mission dedicated to the polarimetry of X-ray and γ -ray sources. The aim of the mission is to perform hard X-ray (10-80 keV) polarimetry of sources brighter than 10mCrab, employing three X-ray super mirrors and imaging polarimeters. The X-ray polarimetry enables us to measure unresolved structure of the universe, for example, magnetic field in the super nova remnants, geometry of accretion disks around a black hole. Energy dependence of the polarization degree and direction is essential to interpret the such unresolved structures. The second purpose of the mission is to measure GRB polarization with wide field instruments, as was done with IKAROS/GAP. PolariS GRB polarimeters aim to detect 10GRBs/yr. The satellite design follows the guideline of the JAXA small satellite series, for which common bus system will be employed. Target launch date is in the latter half of 2010's.

Energy Dependence of the Polarization is the key.
Hard X-ray band, where Non-Thermal Emission is dominant is important.

Hard X-ray Telescope x 3

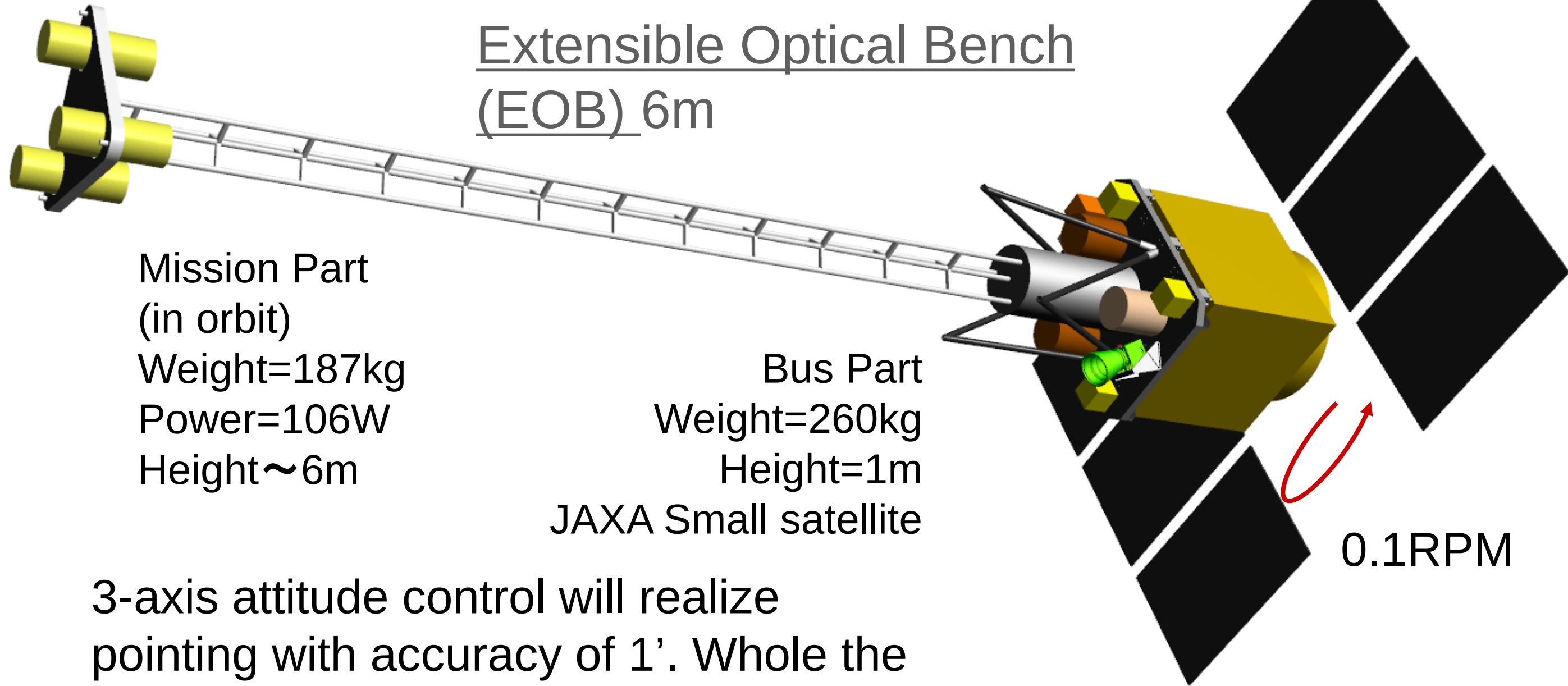


Half size (in diameter) of the ASTRO-H Hard X-ray Telescope(HXT; left panel). Focal Length will be 6m, 1/2 of the ASTRO-H.



Aim of PolariS[8]

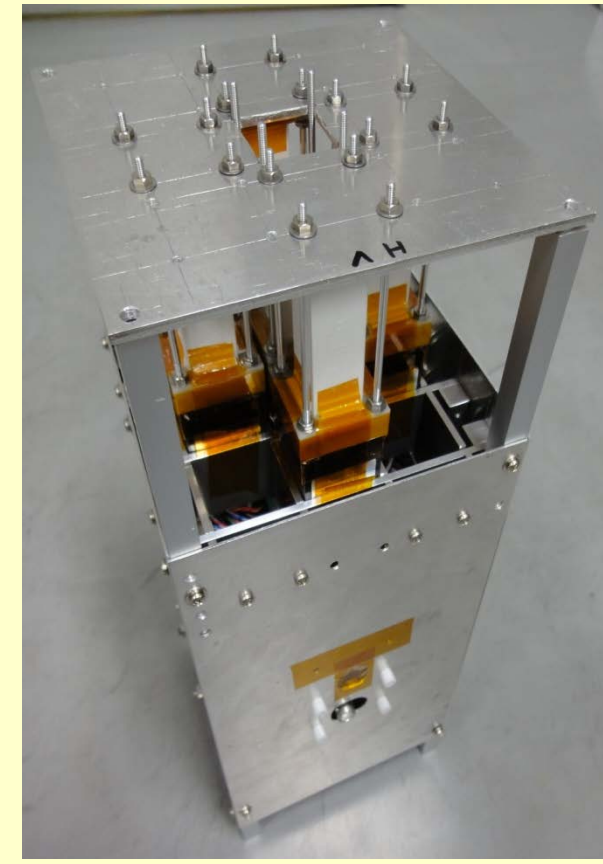
1. Hard X-ray (10-80keV) Polarimetry of Sources Brighter than 10mCrab
2. Polarimetry of GRBs 10bursts/year



3-axis attitude control will realize pointing with accuracy of $1'$. Whole the satellite is rotated at 0.1RPM around the axis of the line of sight to minimize the systematic error in polarimetry.

*) Solar Paddle Direction will be 90degree different from this figure.

Scattering Imaging Polarimeter x 3



Two kinds (plastic, GSO) of segmented scintillator blocks and position sensitive photo-multiplier (MAPMT) will be assembled, and installed on the focal plane of the telescopes. Position resolution is 2.3mm, corresponding to 1.3'

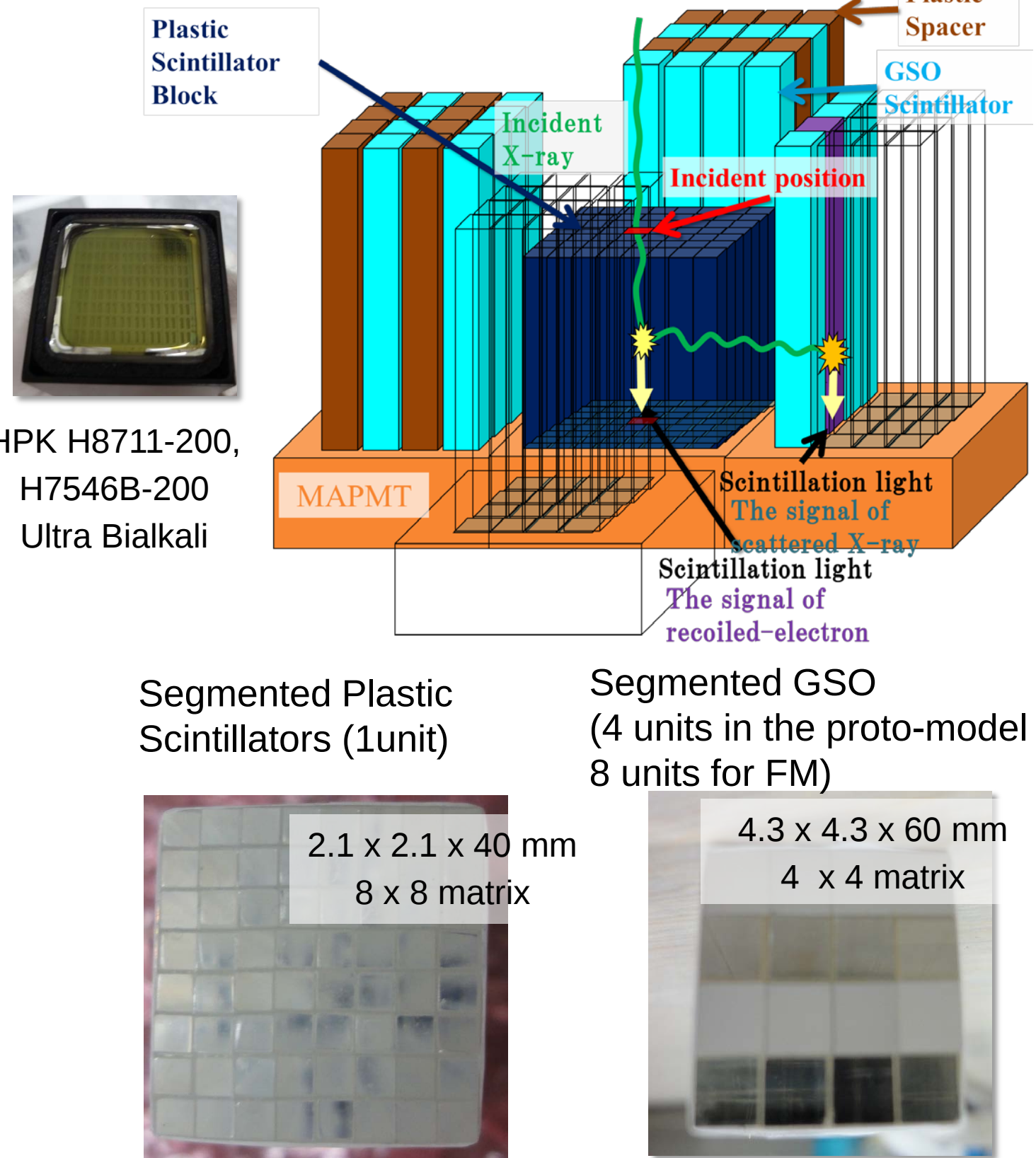
Wide Field GRB Polarimeter x 4



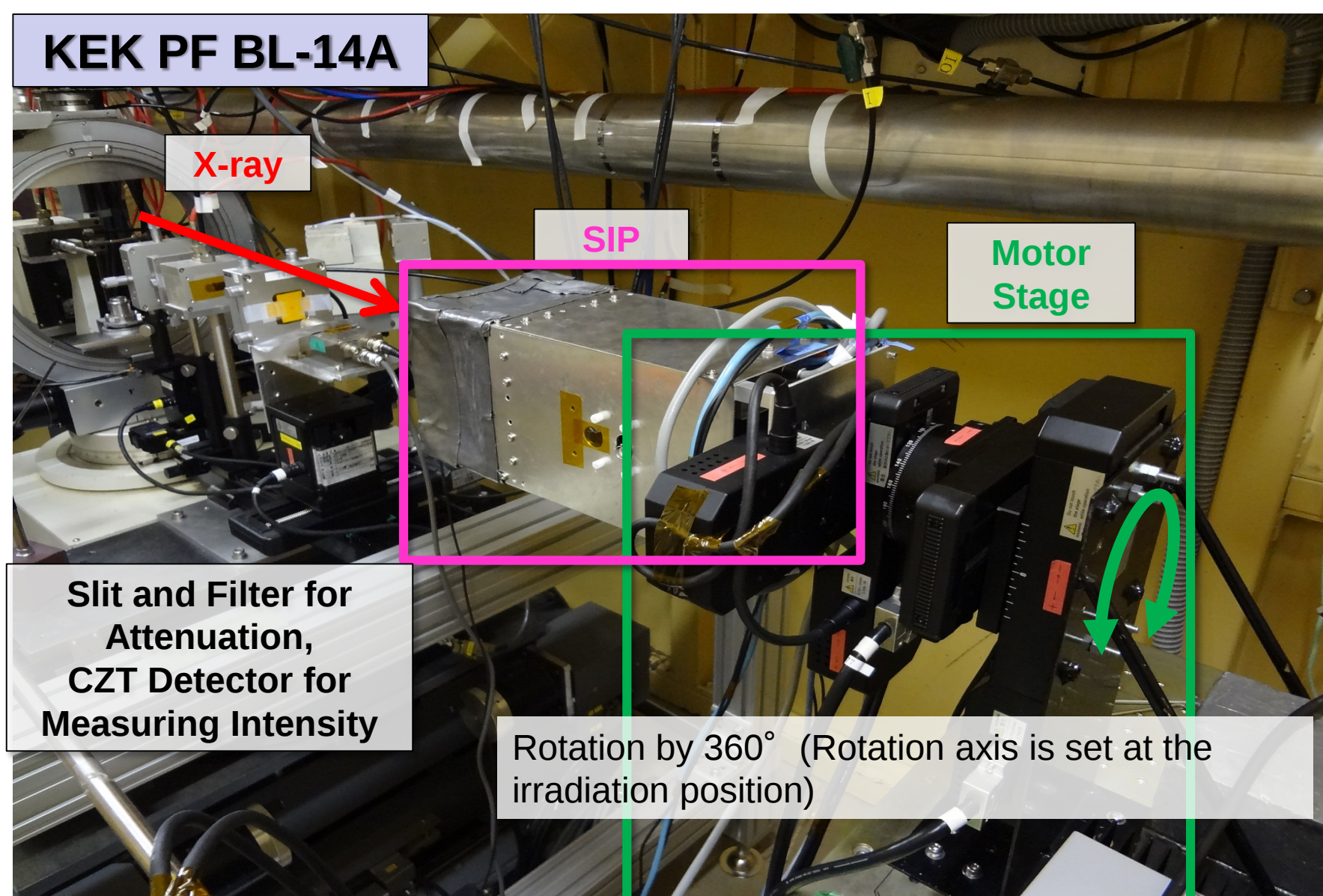
Wide field scattering polarimeters will be employed to measure polarization of GRBs. Design is in progress based on IKAROS/GAP(left panel), TSUBAME, PHENEX polarimeters

Scattering Imaging Polarimeter (SIP) Proto-model

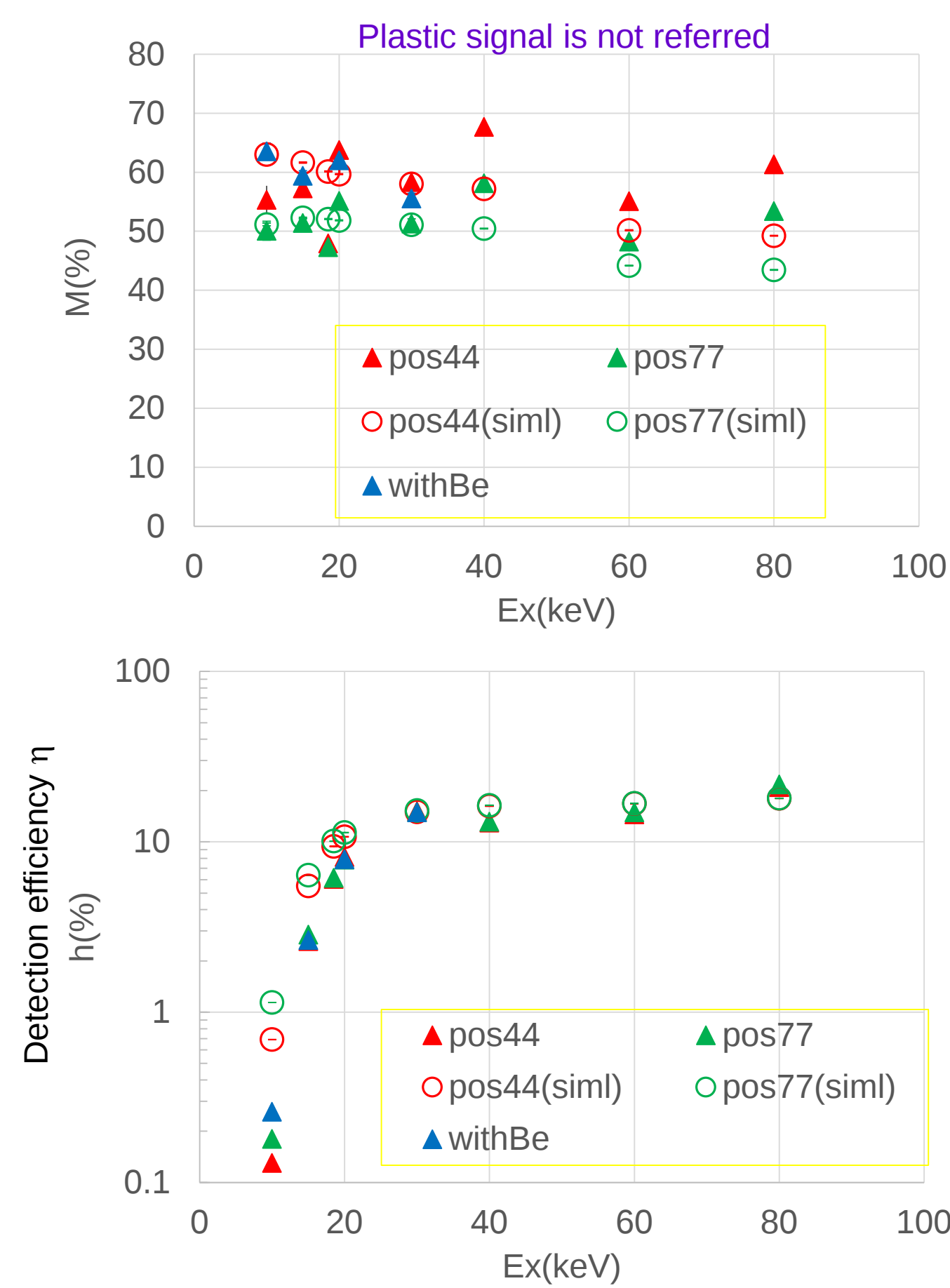
Proto-model



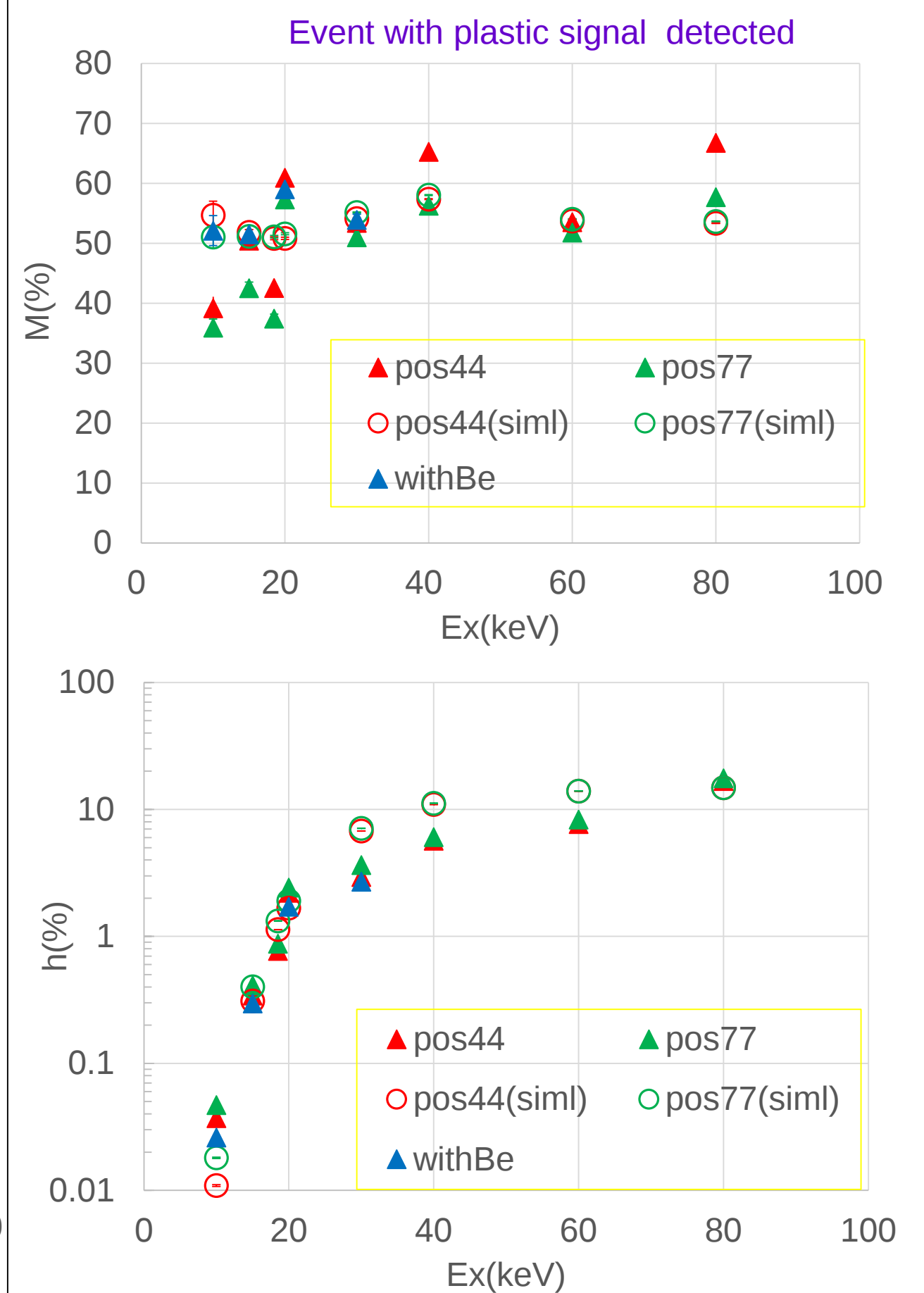
We measured the X-ray polarimetry performance (modulation factor, M , and detection efficiency, η) of the SIP proto-model on 20, 30, 40, 60 keV (Dec. 2012), 10, 15, 18.5, 40, 80 keV (Jun. 2013). X-ray beam was irradiated at 4 different positions in the segmented plastic scintillators.



Single&Double Hit



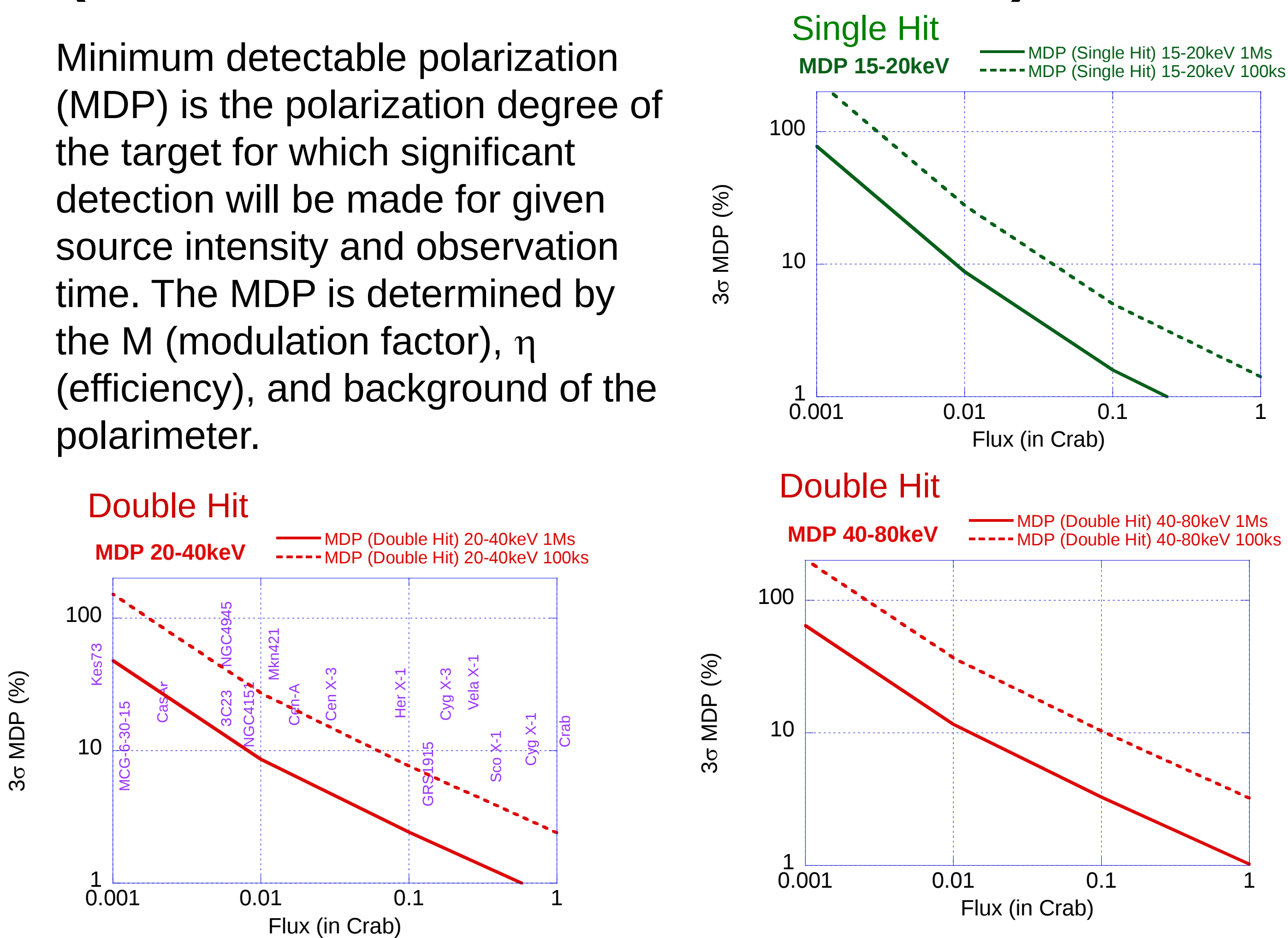
Double Hit



Pos44: center pixel Pos77: off-center pixel withBe: Be target added

Expected Sensitivity
(Minimum Detectable Polarization)

Minimum detectable polarization (MDP) is the polarization degree of the target for which significant detection will be made for given source intensity and observation time. The MDP is determined by the M (modulation factor), η (efficiency), and background of the polarimeter.



Double Hit in SIP can enable detection of the incident position and scattering direction simultaneously. Polarimetry of diffuse sources is possible and background is reduced in this mode. On the other hand, in the **Single Hit Mode**, only polarimetry of point sources is possible.

Observation Plan

Very preliminary version of observations plan of the targets is as follows. 34 objects are listed, and we expect positive detection of the hard X-ray polarization for the first time in most of the sources.

Source	Polaris(s)	F20-40keV (mCrab)	Type	Source	Polaris(s)	F20-40keV (mCrab)	Type
Crab	300	1000.0	PWN,PSR	Mrk 421	500	25.6	AGN,BL Lac
Cyg X-1	300	747.2	HMXB,BH,M	X Per	500	24.9	HMXB,XP,Be
Sco X-1	100	589.1	LMXB,Z,M	4U 1630-47	500	23.8	LMXB,BHC,D,T
GRS 1915+105	300	284.4	LMXB,BH,T,M	4U 0115+634	500	17.9	HMXB,XP,T
Vela X-1	100	216.9	HMXB,XP	NGC 4151	500	15.6	AGN,Sy1.5
4U 1700-377	100	201.2	HMXB,Sg	Circinus Galaxy	500	13.1	AGN,Sy2
EXO 0331+530	100	190.8	HMXB,XP,Be,T	NGC 4945	500	11.9	AGN,Sy2
Cyg X-3	100	171.0	HMXB,M	IC 4329A	500	11.8	AGN,Sy1.2
GX 301-2	100	155.1	HMXB,XP,T	3C 273	500	10.4	AGN,QSO
Her X-1	100	96.0	LMXB,XP	Vela Pulsar	500	6.8	PWN,PSR
GS 1826-24	100	82.6	LMXB,B	Oph Cluster	500	4.9	Cluster
OAO 1657-415	100	70.9	HMXB,XP	Cas A	500	4.0	SNR
EXO 2030+375	100	69.0	HMXB,XP,Be,T	MCG-06-30-015	1000	3.1	AGN,Sy1.2
GRS 1758-258	300	56.3	LMXB,BHC,M	Kes 73	1000	2.2	SNR,AXP
Cen X-3	300	54.6	HMXB,XP				
SWIFT J1753.5-0127	300	51.6	LMXB,BHC,T				In addition, Transient like SGR, and flares of blazars, AXP 4U0142, SN1006 may be candidates.
GX 5-1	300	49.7	LMXB,Z	Sum	12200		
GX 339-4	300	41.9	LMXB,BH,T,M	No.of Target	34		
SMC X-1	300	36.3	HMXB,XP				
Cen A	500	32.2	AGN,Sy2				

References

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