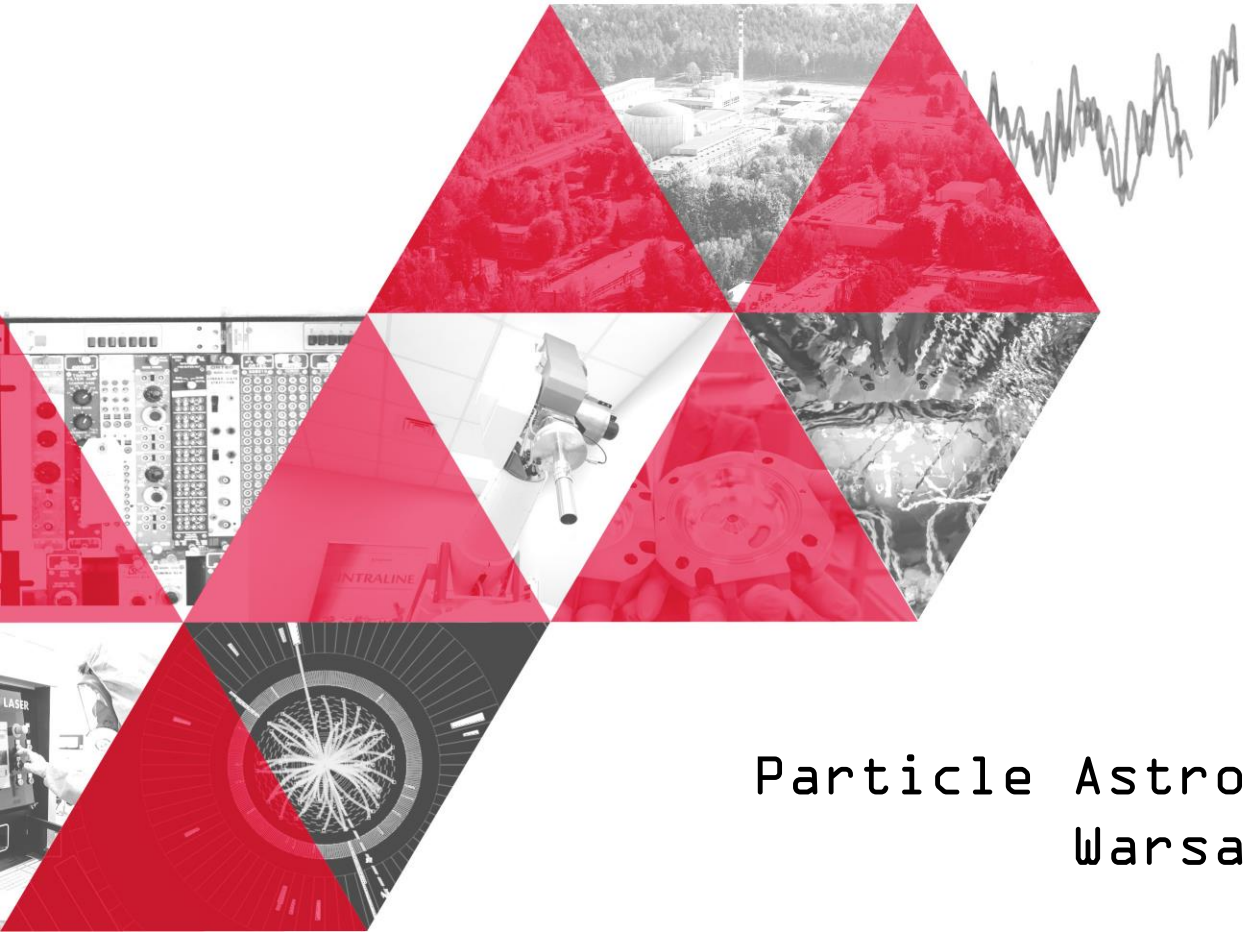
POLAR and POLAR-2 Instruments

Dominik Rybka
on behalf of the POLAR Collaboration



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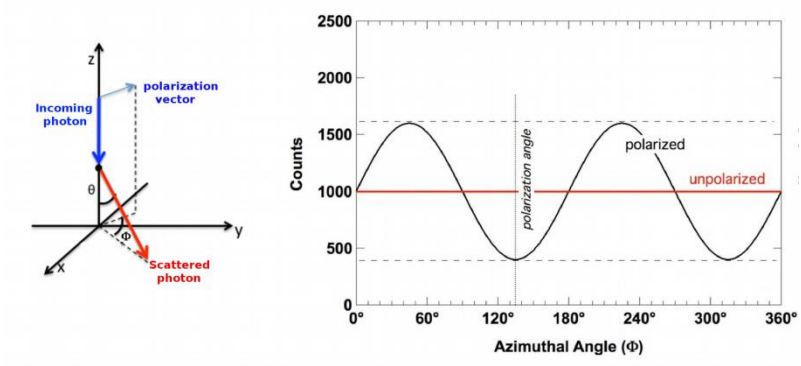
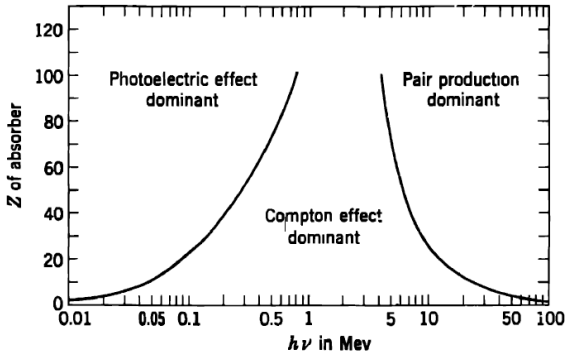
Particle Astrophysics in Poland
Warsaw, 20-21 May 2019

Gamma-Ray Burst Polarimetry

- Most energetic events in the universe since the big bang
- Timing, Direction and Energy spectrum measured in great detail
- Two parameters remain: polarisation degree and polarisation angle
- Polarisation holds information on emission process, e.g. synchrotron emission or photospheric emission, also on emission region.



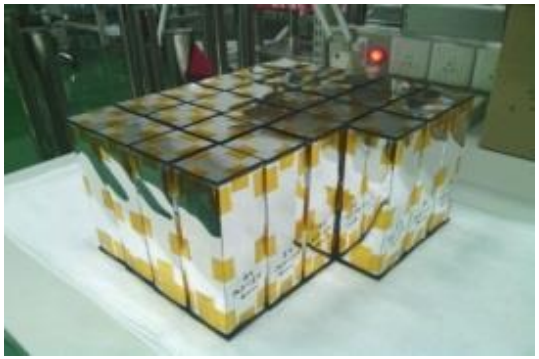
Azimuthal scattering angle dependence on polarisation

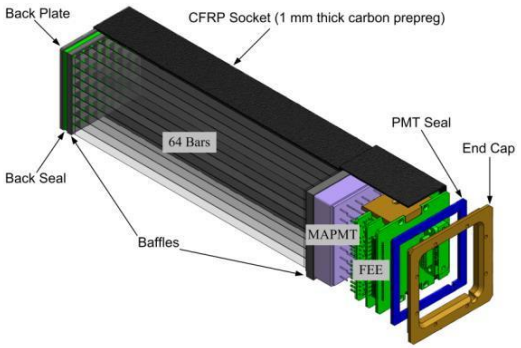


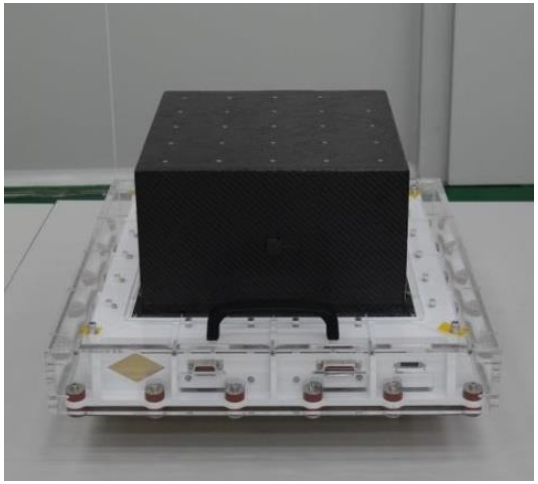
Three major types of photon interaction depending on the energy of the incoming photon and on the atromic number of the absorber

POLAR design

- segmented scintillator array to measure the Compton scattering angle
- in total 1600 plastic scintillators, 6x6x176 mm^3, EJ-248M, optimised for the cross section for Compton scattering in the 50-500 keV energy range
- plastic scintillators allow for a relatively large eective area, with low mass of 30kg
- each group of 64 scintillators is read-out using a single MAPMT H8500 from Hamamatsu
- relatively large effective area (30x30 cm)
- small pixels allows for high precision scattering angle measurements
- uniform effective area gives us a large Field of View (1/3rd of the sky)







POLAR Polish tasks

- Back End electronics design
- VHDL Programming of FEE and BEE
- High Voltage Power Supply design

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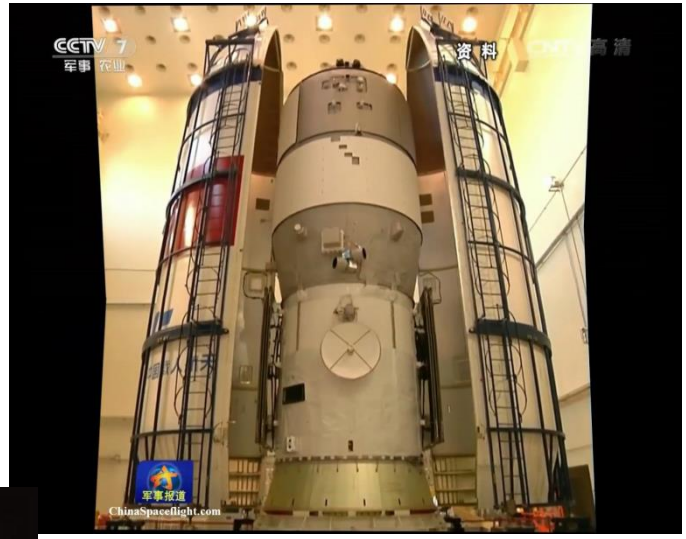
POLAR launch



Jiuquan Satellite Launch Centre
15 September 2016

POLAR results

LETTERS
https://doi.org/10.1038/s41550-018-0664-0

nature astronomy

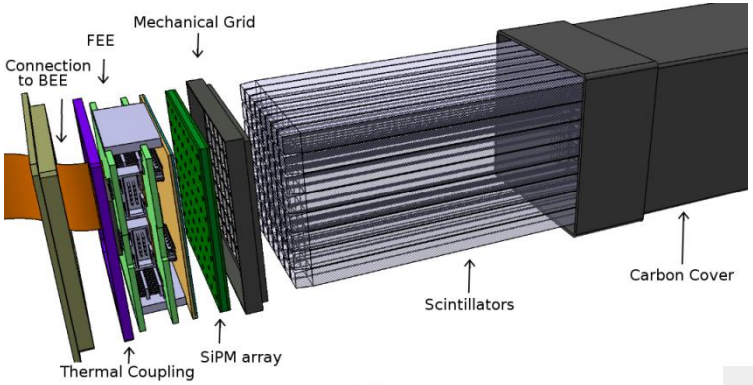
Detailed polarization measurements of the prompt emission of five gamma-ray bursts

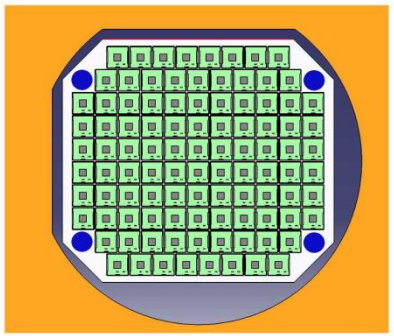
Shuang-Nan Zhang[1,2,10*], Merlin Kole[3,10*], Tian-Wei Bao[1], Tadeusz Batsch[4], Tancredi Bernasconi[5], Franck Cadoux[3], Jun-Ying Chai[1,2], Zi-Gao Dai[6,7], Yong-Wei Dong[1], Neal Gauvin[5], Wojtek Hajdas[8], Mi-Xiang Lan[6,9], Han-Cheng Li[1,2], Lu Li[1], Zheng-Heng Li[1,2], Jiang-Tao Liu[1], Xin Liu[1,2], Radoslaw Marcinkowski[8], Nicolas Produit[5], Silvio Orsi[3], Martin Pohl[3], Dominik Rybka[4], Hao-Li Shi[1], Li-Ming Song[1,2], Jian-Chao Sun[1], Jacek Szabelski[4], Teresa Tymieniecka[4], Rui-Jie Wang[1], Yuan-Hao Wang[1,2], Xing Wen[1,2], Bo-Bing Wu[1], Xin Wu[3], Xue-Feng Wu[9], Hua-Lin Xiao[1,8], Shao-Lin Xiong[1], Lai-Yu Zhang[1], Li Zhang[1], Xiao-Feng Zhang[1], Yong-Jie Zhang[1] and Anna Zwolinska[4]

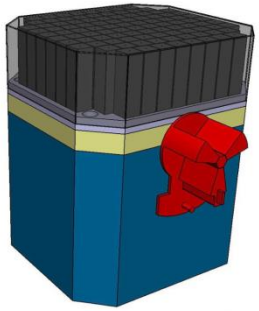
Nature Astronomy Vol. 3 No 1 (2019)

POLAR-2 design

- launch in 2014, on-board of Chinese Space Station
- 4 times bigger:100 modules with 64 plastic scintillator bars of 6x6x176mm^3
- SiPM arrays instead of MAPMT
- 4 additional spectrometers based on the GECAM detectors
- Field of View: half of the sky
- 580x650x770m^3,160kg, 300W
- gain in sensitivity of a factor 9 (bigger instrument, new detectors)







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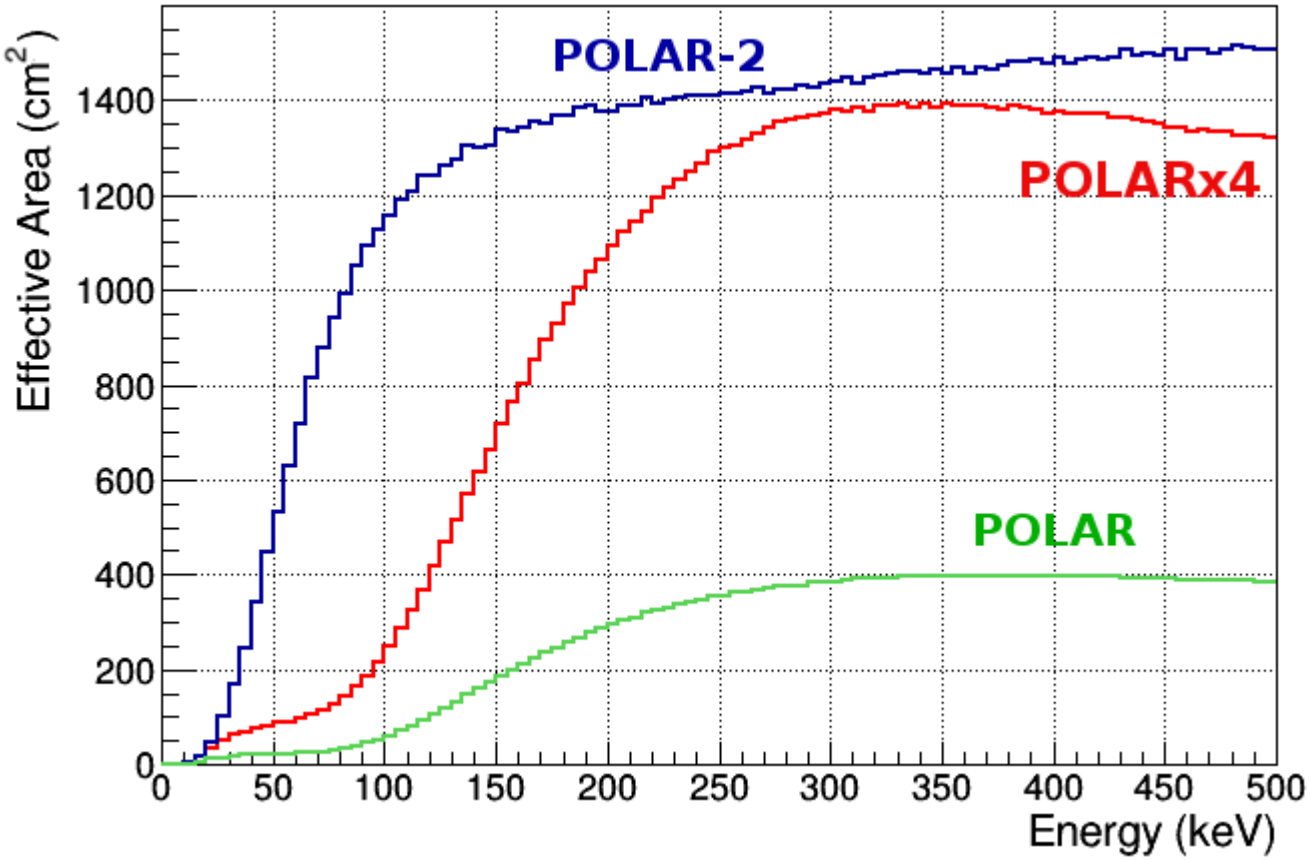
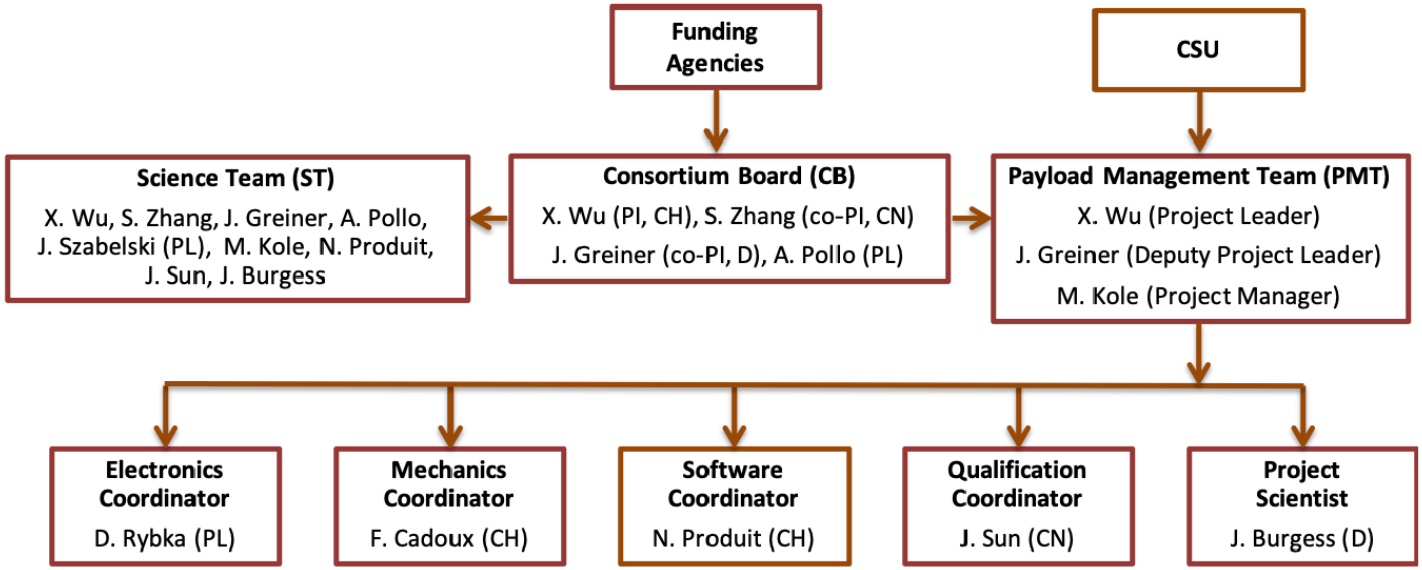
POLAR-2 gains at lower energies



Monte Carlo simulation of effective area of POLAR-2

POLAR-2 Polish tasks

- Front End electronics design and production
- Back End electronics design and production
- VHDL Programming of FEE and BEE
- Low Voltage Power Supply



Thank You

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