Capabilities of gamma ray telescope GAMMA-400 for lateral aperture

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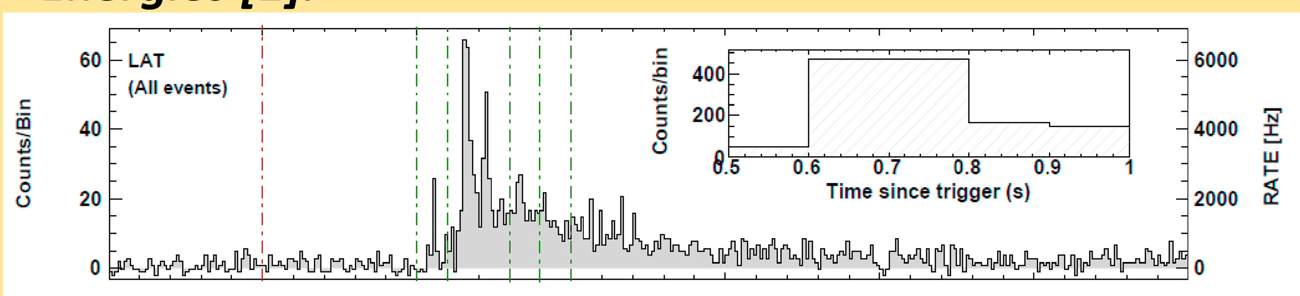
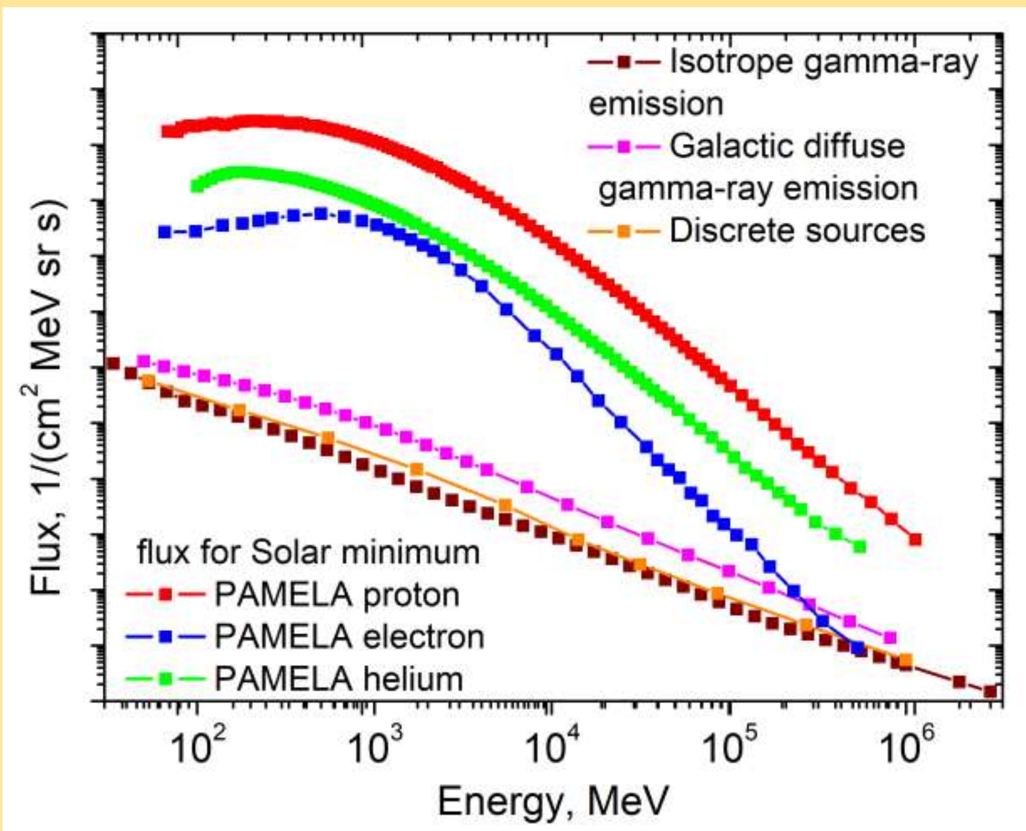
Introduction

Gamma-Ray Bursts (GRB) are the most mysterious events in the Space Physics. These short bursts of radiation originate from extremely energetic explosions at the edge of the Universe. Since the first GRB was observed by the Vela satellite, the thousand flashes were detected in various experiments. Since 2008 Fermi-LAT (Large Area Telescope) is successfully operating in space for more than ten years. Fermi-LAT detects the brightest, most energetic GRBs: ~10 per year with spectral range of 30 MeV - 300 GeV. The 4FGL catalog includes 5064 sources above 4σ significance, for which provide localization and were provided [1].

Count rate of Fermi-LAT telescope during GRB 090510 with an Hard Power-Law Component from 10 keV to GeV Energies [2].

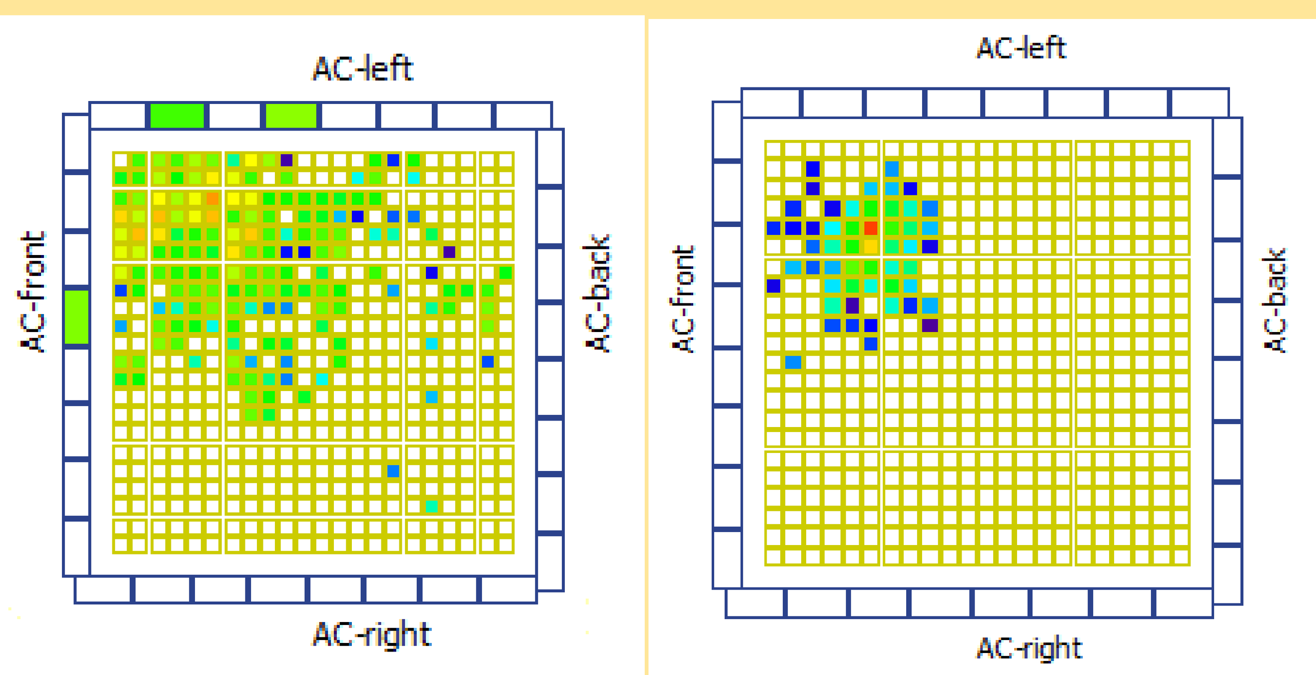


Energy spectra of simulated particles [4].



Examples of simulated events detected in calorimeter CC2 from lateral side of the instrument.

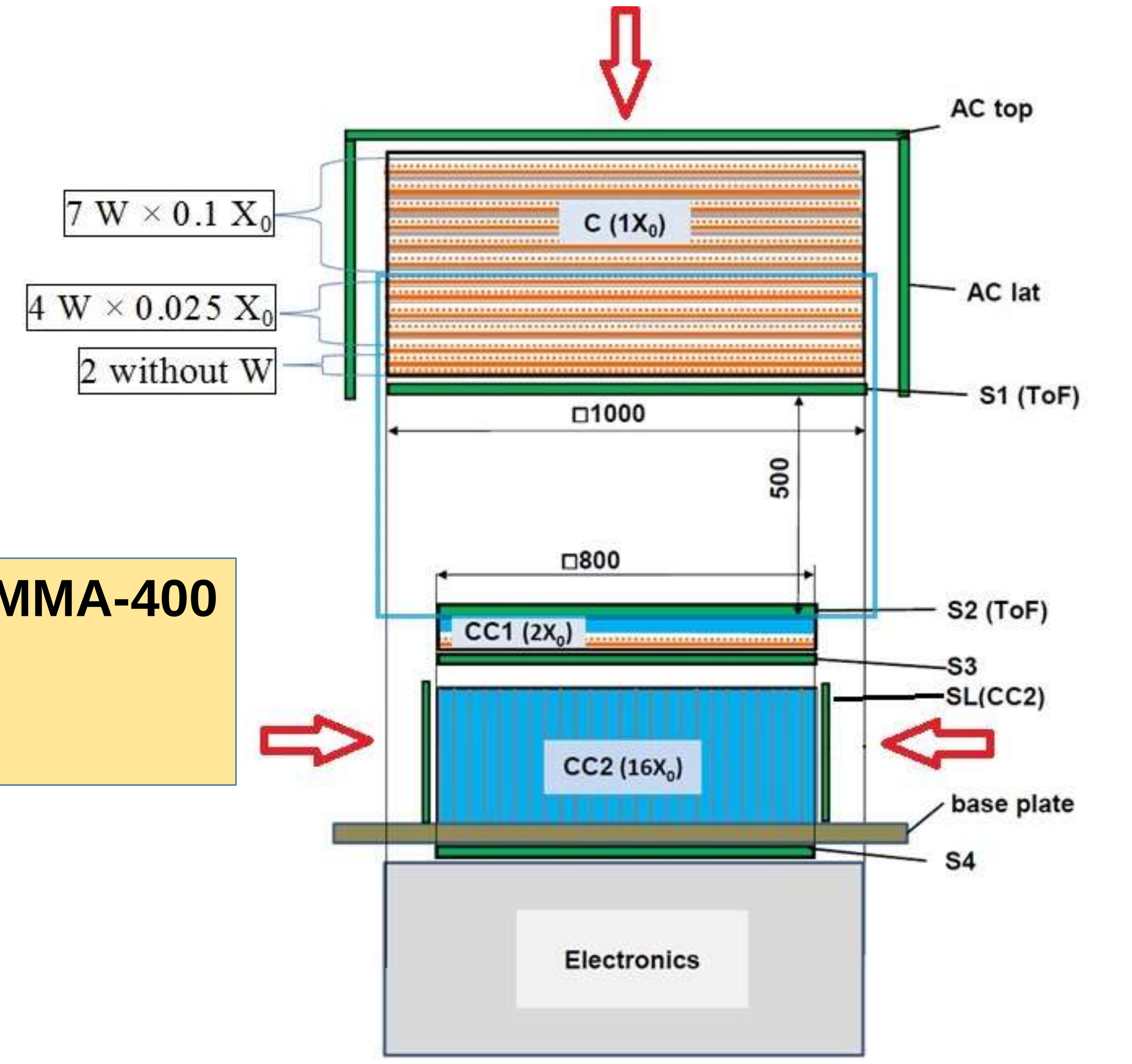
γ p



Main goals of the GAMMA-400 experiment:

1. To measure energy spectra of Galactic and extragalactic diffuse and isotropic gamma-ray emission, to search for features in gamma-ray energy spectra, to search for gamma-ray lines in the emission of discrete sources, in diffuse and isotropic gamma-ray emission when annihilating or decaying dark matter particles.
2. To detect fluxes of electrons + positrons with energy more than 1 GeV, to measure their energy spectra and to search for features, which can be connected with annihilating or decaying dark matter particles.
3. To search for new and study known Galactic and extragalactic discrete high-energy gamma-ray sources: supernova remnants, pulsars, accreting objects, microquasars, active galactic nuclei, blazars, quasars; measure their energy spectra and luminosity.
4. To identify discrete gamma-ray sources with known sources in other energy ranges including discrete sources discovered by ground-based gamma-ray facilities.
5. To monitor luminosity and energy spectrum of high-energy gamma-ray sources for studying the nature of their variability.
6. To search for and investigate high-energy gamma-ray bursts in the energy range 10 keV - 10 MeV and 100 MeV – 3000 GeV.
7. To measure fluxes of Galactic nuclei up to Fe.
8. To detect high-energy gamma rays and electrons + positrons fluxes from solar flares [3].

Scheme of GAMMA-400 and scheme of modelling



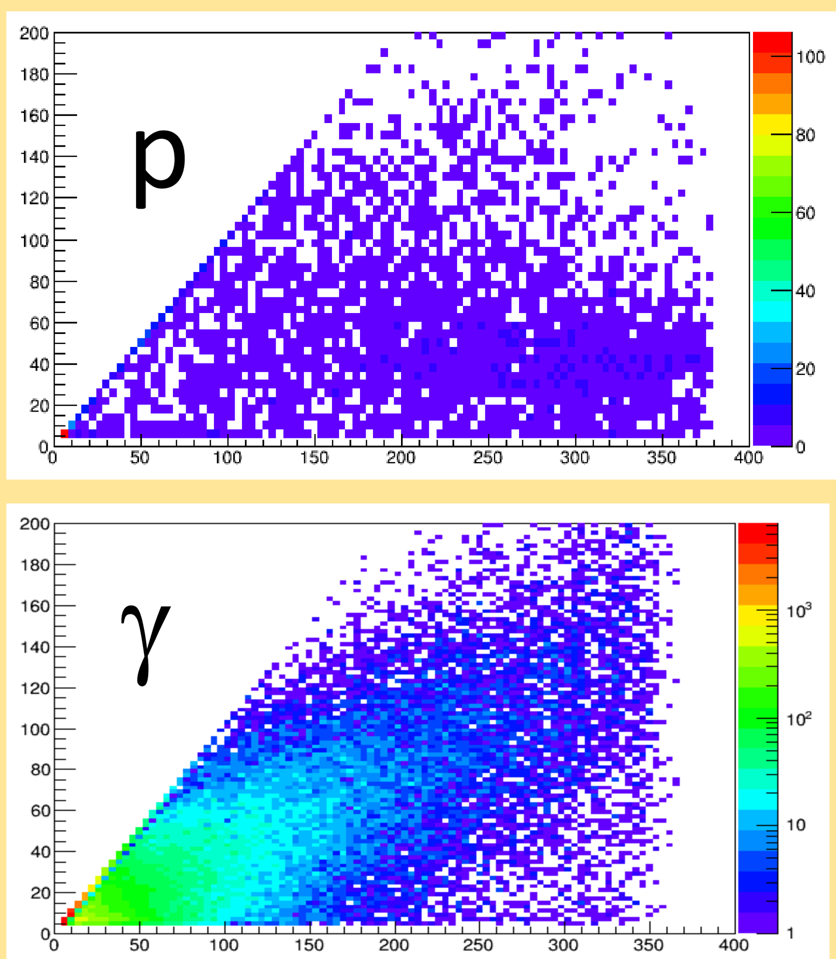
Main Trigger for lateral aperture

$$\overline{LD}\times\overline{S3}_{1m}\times\overline{S4}_{1m}\times CC2$$

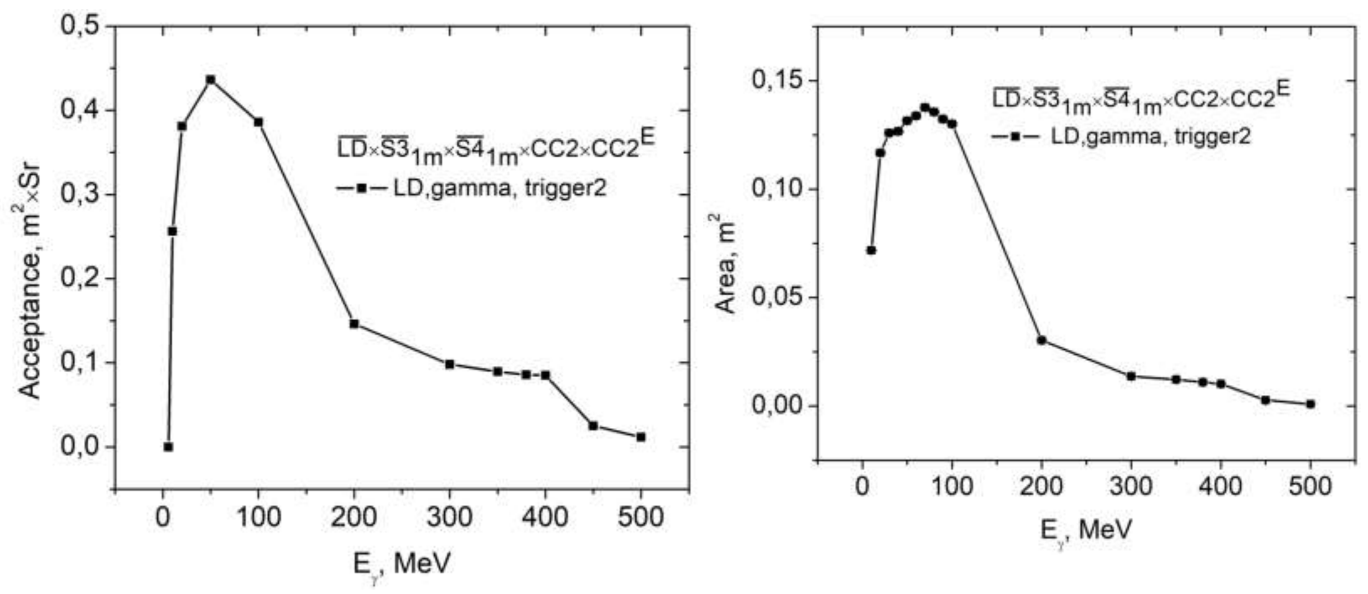
Additional Trigger for lateral aperture

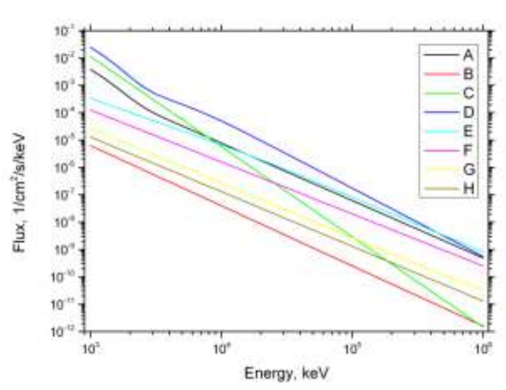
For selection of γ-quanta from charged particles background an additional criteria were applied based on differences in electromagnetic and hadronic cascades in calorimeter CC2.

Energy deposit in second row of CsI detectors as function of total energy deposit in whole calorimeter CC2.



Effective area and acceptance of gamma ray detection after applying of second level trigger based on off-line selection criteria





Models of energy distributions for GRB for different times . "A" corresponds to 30 sec. detection that was used in simulation in this work

Number of detected events for modelled GRB , diffuse gamma-ray flux, electrons , protons and nuclei.

Modelling	the main trigger, events (100%)	main & additional trigger, events (%)
gamma diffuse. (isotropic flow)	153	67 (44%)
protons (isotropic flow)	2016	171 (8.5%)
electrons (isotropic flow)	81	10 (12%)
helium (isotropic flow)	176	6 (3%)
gamma from the burst (flat stream A)	8317	2893 (30%)

Conclusion:

Lateral aperture of γ-telescope GAMMA-400 provides effective detection of GRB in energy range 20-200 MeV

References

1.Abdollahi, S. et al. [Fermi-LAT collaboration] The Astrophysical Journal Supplement Series, V. 247, 1, 33 (2020)
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3. A.M. Galper, N.P. Topchiev, and Yu.T. Yurkin. GAMMA-400 Project. Astronomy Reports, 2018, Vol. 62, No. 12, pp. 882–889
4. Cosmic ray Data Base https://tools.ssdc.asi.it/CosmicRays/