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Space Gamma-Ray Telescope GAMMA-400

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Abstract

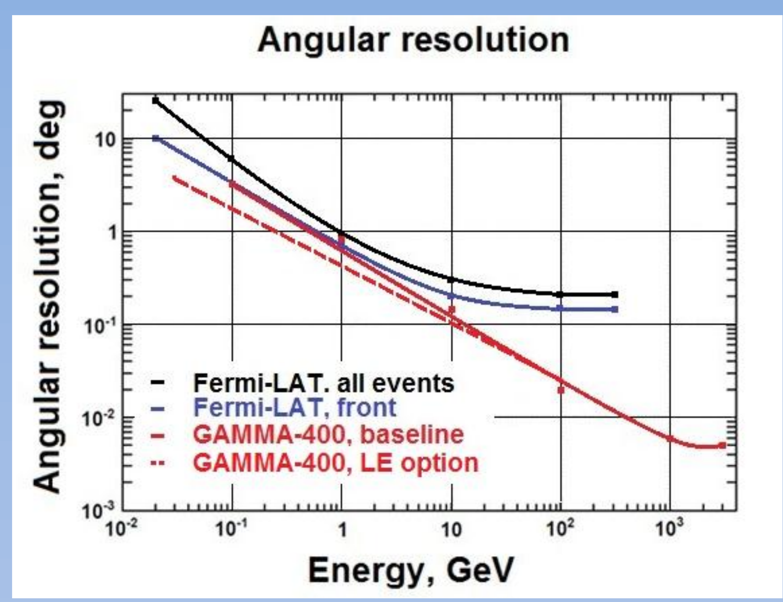
The preliminary design of the new space gamma-ray telescope GAMMA-400 for the energy range 100 MeV – 3 TeV is presented. GAMMA-400 will be installed on the Navigator space service platform. This mission is approved and funded by the Russian Federal Space Agency. The launch is planned for 2018. The mission (baseline concept) is optimized for the high-energy gamma-radiation above ~1 GeV with unprecedented angular resolution ~0.01° at E_γ > 100 GeV and energy resolution ~1% at E_γ > 100 GeV, with the proton rejection factor ~10^6. The observatory will also include the KONUS-FG gamma-ray burst monitor. The option of enhancing instrument performance at low energy below few GeV by placing more Si strip tracker planes without passive converter is currently under consideration in Italy and USA.

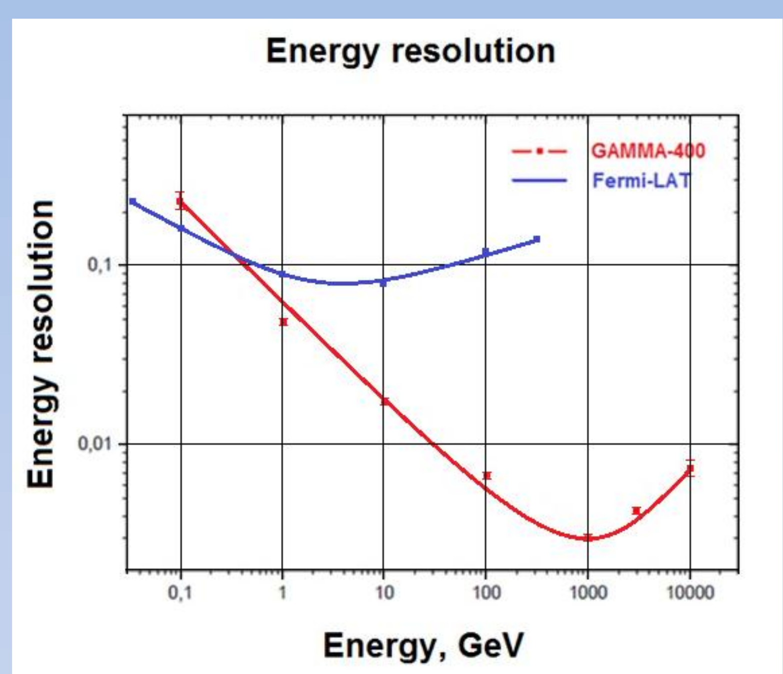
Main Scientific Objectives

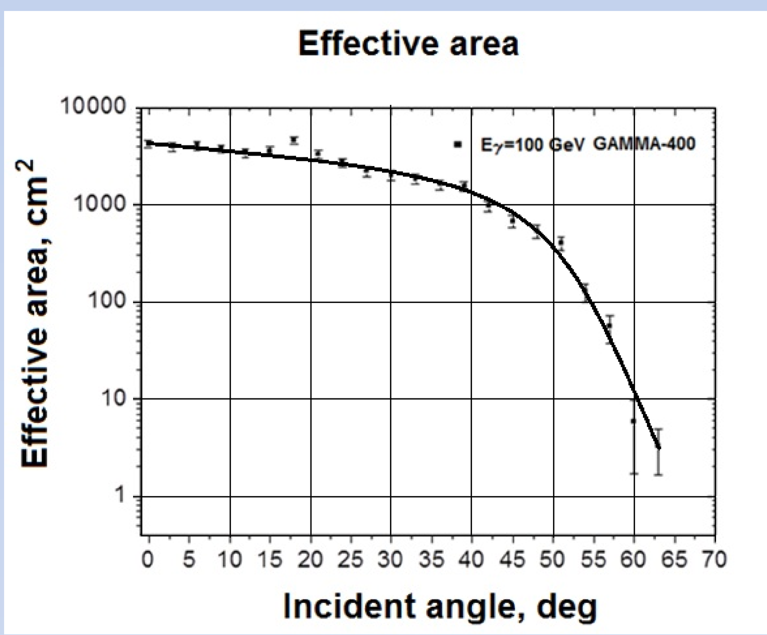
- search for dark matter particle annihilation and decay signatures;
- study of processes in active astrophysical objects both Galactic and extragalactic, namely, the Galactic center;
- study of origin and propagation of CR electron + positron and nuclear component of very high energy;
- study of gamma-ray bursts.

Main characteristics	
Gamma-ray energy range	0.1-3000 GeV
Multilayer converter-tracker	100 x 100 cm^2 ~$1X_o$
Calorimeter	80 x 80 cm^2 ~25 X_o
Angular resolution (E_γ > 100 GeV)	~ 0.01°
Energy resolution (E_γ > 100 GeV)	~ 1%
Proton rejection	~10^6
Effective area (E_γ > 100 GeV)	~4000 cm^2
Telemetry downlink	100 Gbyte/day
Power consumption	2000 W
Max. dimensions	2x2x3 m^3
Total mass	2600 kg

Gamma-400 performance: Monte-Carlo simulations

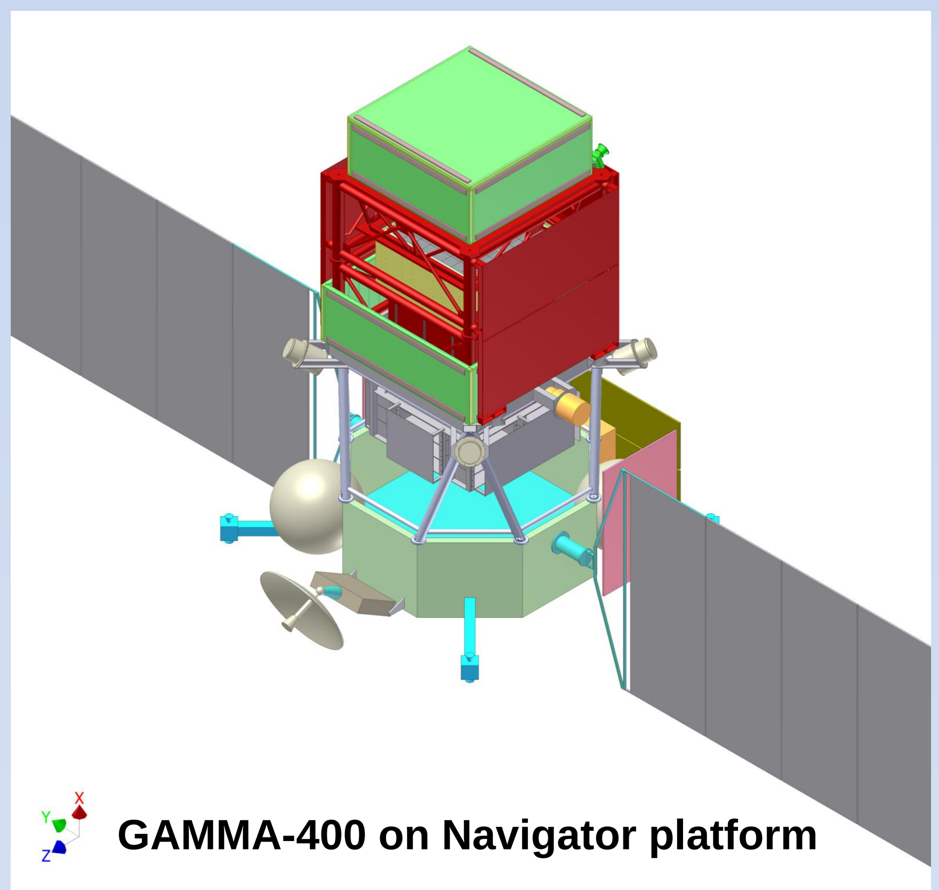




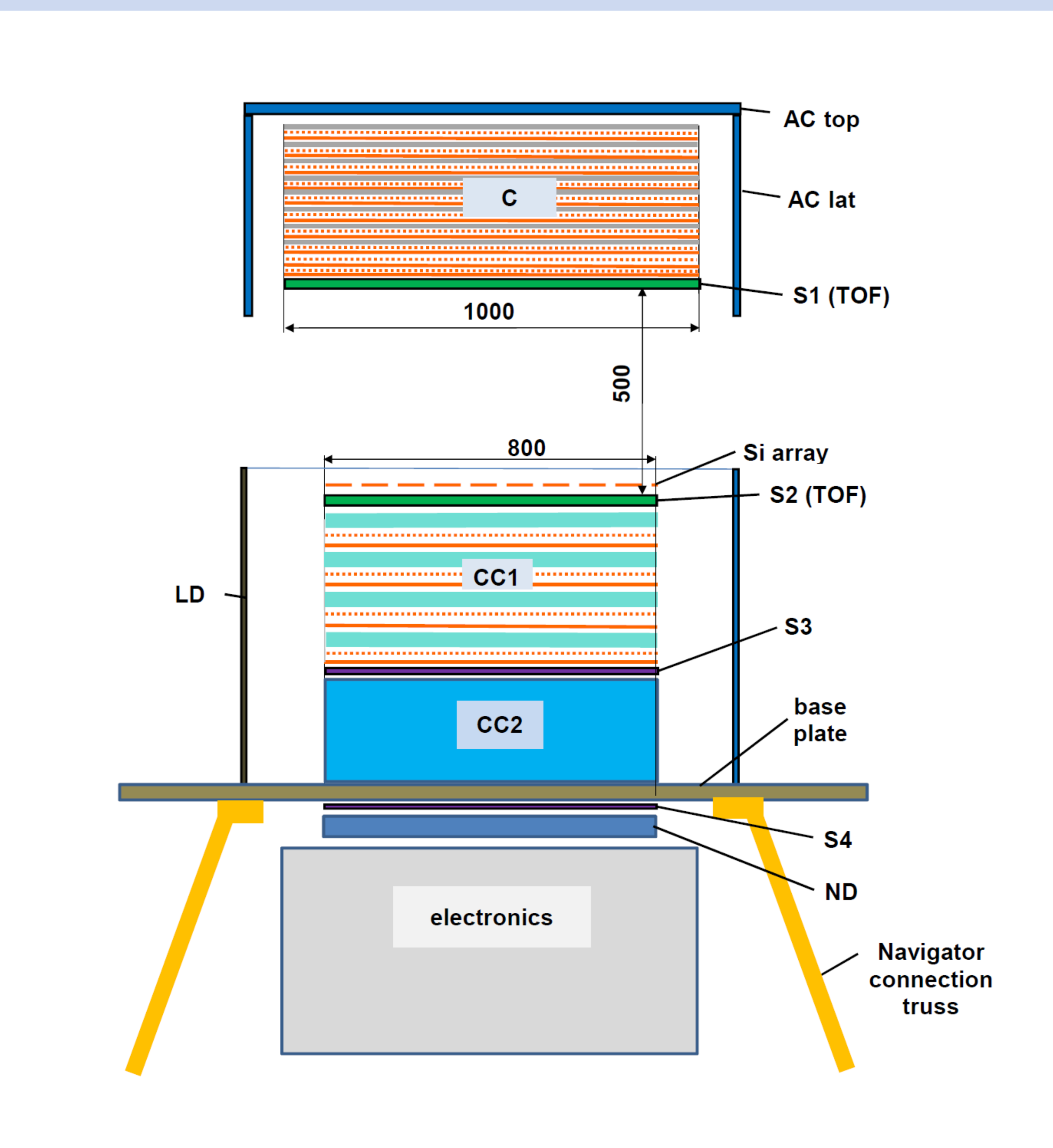


A comparison of main characteristics								
	Space-based gamma-ray telescopes					Ground-based gamma-ray telescopes		
	EGRET	AGILE	Fermi-LAT	CALET	GAMMA-400	H.E.S.S.	MAGIC	VERITAS
Energy range, GeV	0,03-30	0,03-50	0,02-300	10-10000	**0,1-3000**	>100	>50	>100
Angular resolution (E_γ > 100 GeV)	0,2° (E_γ~0,5 GeV)	0,1° (E_γ~1 GeV)	0,2°	0,1°	**~0,01°**	0,1°	0,1°	0,1°
Energy resolution (E_γ > 100 GeV)	15% (E_γ~0,5 GeV)	50% (E_γ~1 GeV)	10%	2%	**~1%**	15%	20%	15%

Some 100 GeV gamma-ray sources, which can be observed by GAMMA-400				
Name	Type	Expected flux I(>100 GeV),10^{-9} s^{-1} cm^{-2}	Expected number of quanta per 30 days N(>100 GeV)	Spectral index
Center Ridge	UKN	263 per sr	2740 per sr	2.29 ±0.07±0.02
3C 279	FSRQ	219	2270	4.11 ±0.68±0.2
PG 1553+113	HBL	204	2120	4.01 ±0.6±0.1
PKS 2155-304	HBL	69	716	3.53 ±0.05±0.1
1ES 1011+496	HBL	68	701	4 ±0.5±0.2
H 1426+428	HBL	26	248	3.55 ±0.46
Crab	PWN	12	121	2.48 ±0.03±0.2
Mkn 501	HBL	11	111	2.28 ±0.05
Mkn 421	HBL	6.1	63	3.2 ±0.2
1ES 1959+650	HBL	5.8	60	2.78 ±0.13
W Com	IBL	4.6	47	3.8 ±0.35±0.34
1ES 1218+304	HBL	4.1	42	3 ±0.4±0.7
Mkn 180	HBL	3.6	37	3.25 ±0.66±0.2
BL Lac	LBL	3.2	33	3.64 ±0.54±0.2
1ES 2344+514	HBL	1.7	17	3.3 ±0.7±0.7

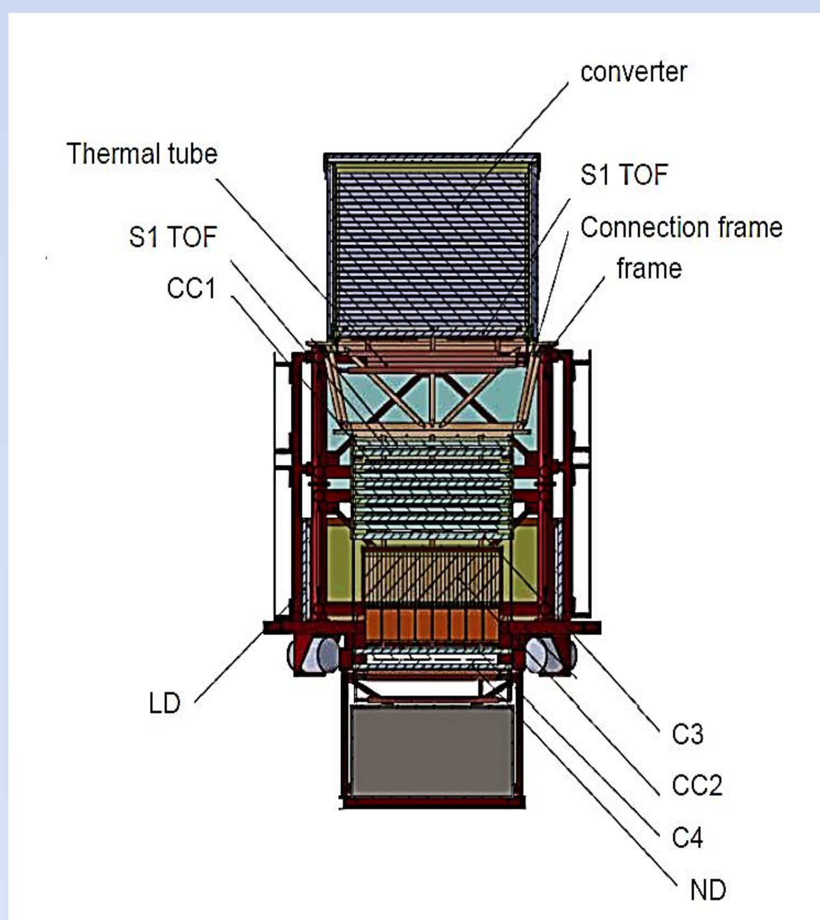


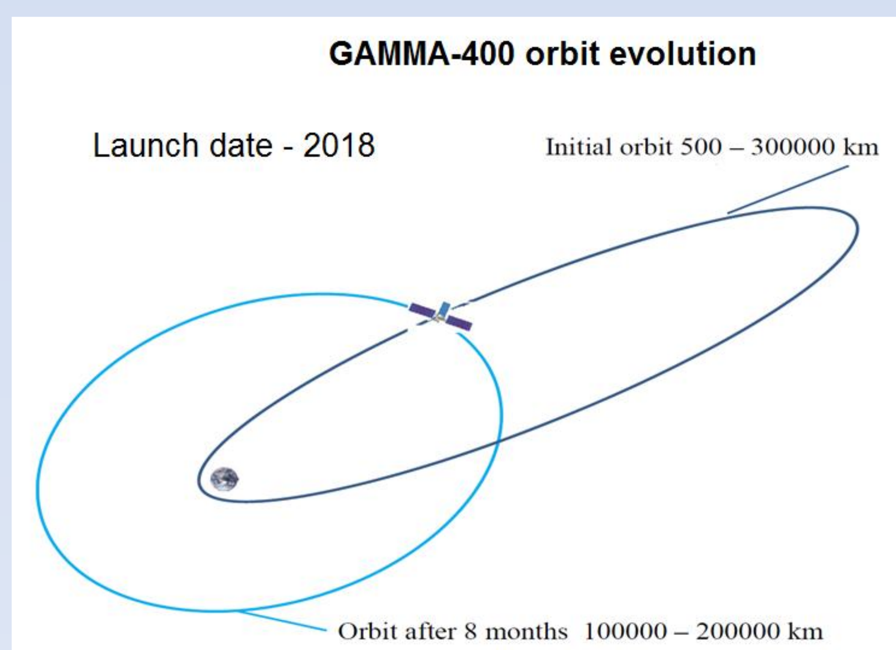
GAMMA-400 baseline concept



AC - anticoincidence detectors (AC_{top} + AC_{lat})
C - Converter-Tracker - 1 Xo
10 Si(x,y) (pitch 0.1 mm) + 8 W (0.1 Xo)*
S1, S2 - TOF detectors
Si array - Si pad (1x1 cm^2) detector
S3, S4 - calorimeter scintillator detectors
CC1 - imaging calorimeter 3Xo
4 layers: CsI 0.75 Xo + Si(x,y) (pitch 0.5 mm)
CC2 - electromagnetic calorimeter 22Xo
BGO (1024 crystals 2.5x2.5x25 cm^3)
LD - 4 lateral calorimeter detectors 50x120 cm^2
ND - neutron detector

*** To be changed to "25 Si(x,y) (pitch 0.1 mm) + 4 W (0.2 Xo)" for enhanced LE instrument option**





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