GRAN SASSO SCIENCE INSTITUTE
SCHOOL OF ADVANCED STUDIES
Scuola Universitaria Superiore

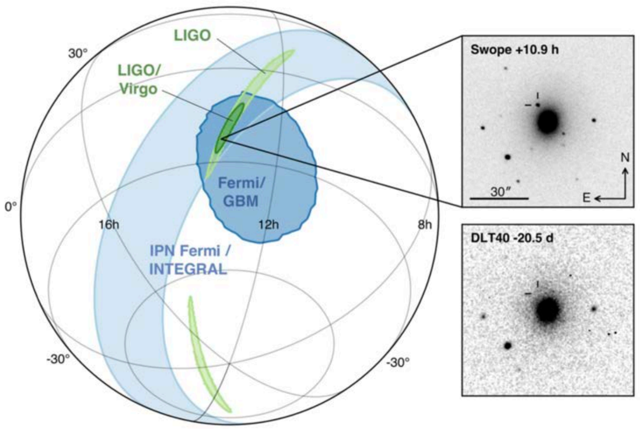
CRYSTAL EYE

WINK: the Crystal Eye X and γ ray all sky monitor

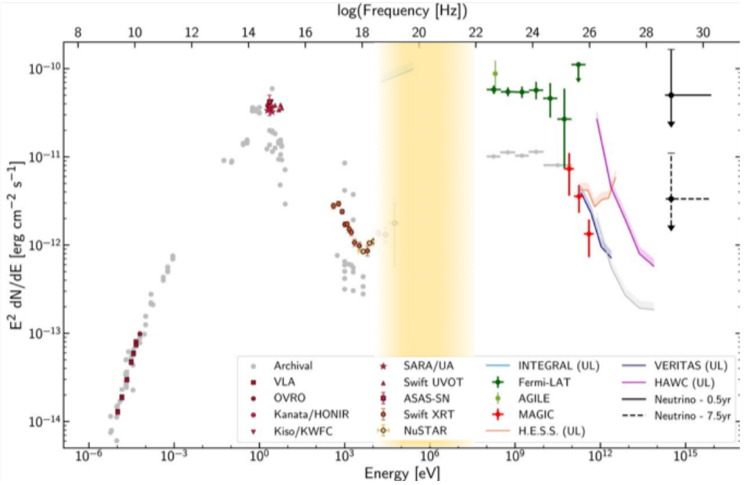
F. Barbato on behalf of Crystal Eye collaboration
Gran Sasso Science Institute & INFN-Laboratori Nazionali del Gran Sasso

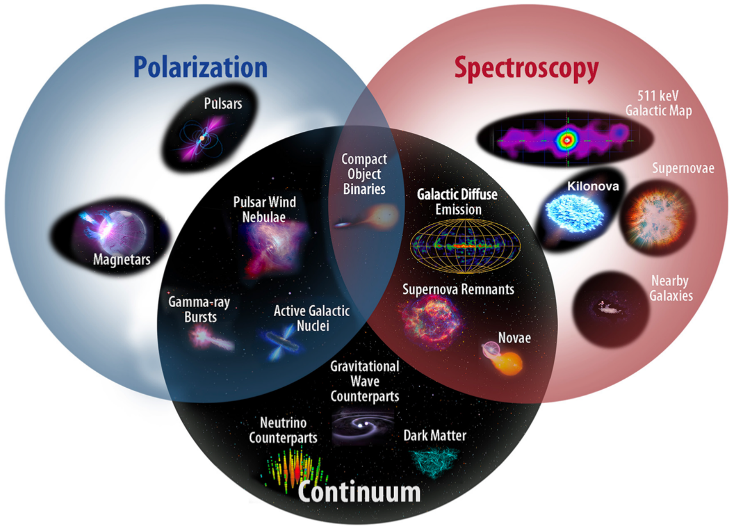
Powerful probes for the extreme Universe

GW170817



TXS 0506+056





arXiv:1907.07558v2 [astro-ph.IM] 25 Nov 2019

Medium energies still under-explored (E ~ MeV)

Primary Scientific Goal: Monitoring the electromagnetic counterpart of gravitational waves

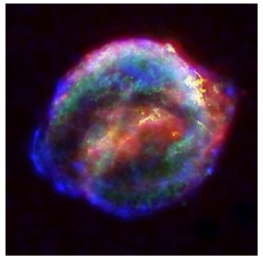
Primary scientific goals

1) Detect and localize -> Trigger multimessenger observations

The alert are transmitted in the GCN (General coordinate network)
Progress in understanding mechanism that power jets (like GRBs, AGNs)
Progress in understanding particle acceleration mechanism
Definition of GRB+afterglow models

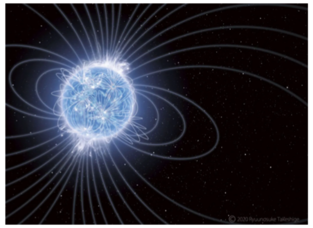
2) Observe the prompt emission

Origin of MeV gamma rays
Emission mechanism of MeV gamma rays
Heavy elements production



3) Soft Gamma ray Repeaters (SGR)

Information about magnetars
Understand the difference with GRBs
Define the best model about their origin



Secondary scientific goals

4) Long emitting sources with Earth occultation technique

XRB
Seyfert galaxies
AGN

5) Fast Radio Bursts

Study of the gamma ray counterpart

6) SuperGiant Fast X-ray transient

Detection of the outburst and study the tail of the spectrum

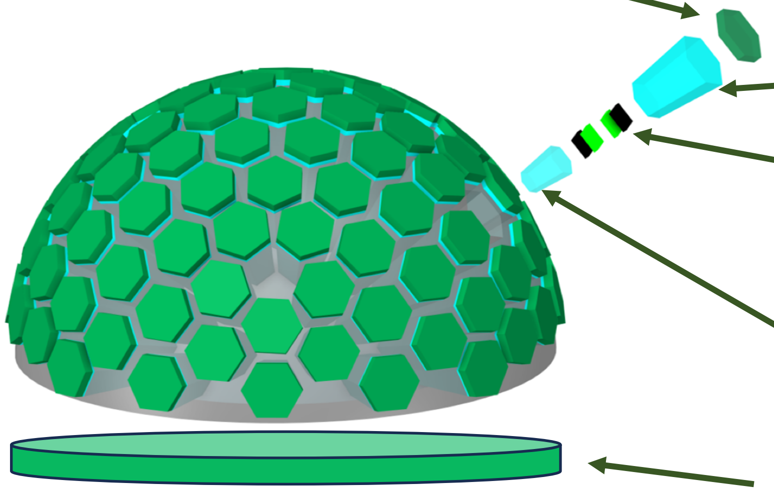
- These sources are mostly unexplored in the keV-MeV energy range.
- The correlation between the activity in this energy range and the others like radio, soft x-ray, etc. will enable better understanding of the physics going in these sources.
- Notification of the onset of outburst.

7) Space weather (dedicated runs)

TGF
Solar flares

HOW IT IS MADE?

BASELINE MODEL



Radius: ~15 cm
Mass: <50 kg
Energy range: 10keV - 30MeV
Material: LYSO/GAGG
Photodetectors: SiPM-array
FOV: 2π

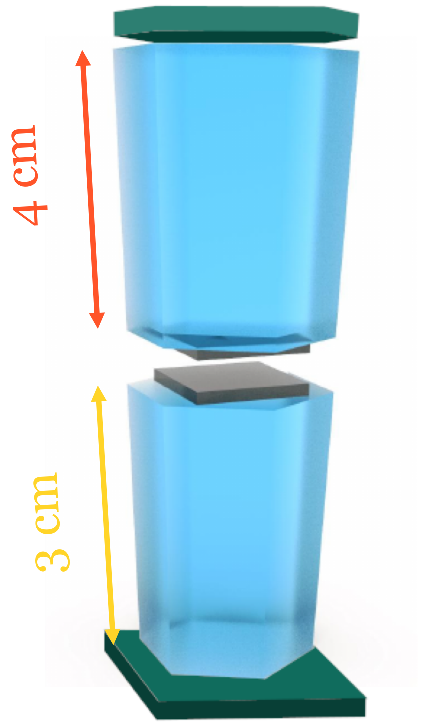
Born to be:

Free-flyer (@LEO altitude: ~550 km; ~equatorial).
Onboard space stations.
GBM module of larger satellite.

Key Features:

☆ Wide FOV: > 2π sr.
☆ Full sky coverage.
☆ Very large effective area: ~ 5xFermi-GBM @ 1 MeV.
☆ High localization capability: 1-2 degrees.
☆ Compactness, symmetry, thermal and radio-protection for the SiPMs.

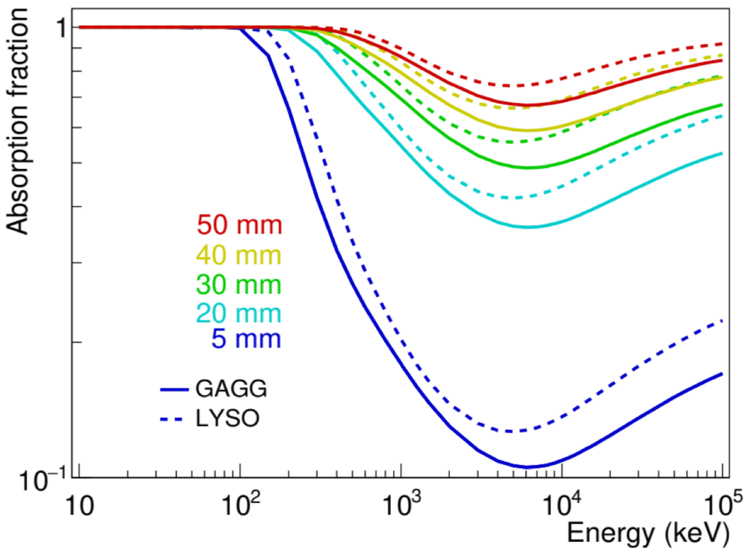
THE PIXEL



- **Pixel FOV:** 2.5° × 2.5°.
- **Scintillator crystals** (in cyan) read by Hamamatsu MPPC arrays (in gray).
- **Crystal material:** LYSO/GAGG
  - high photon absorption probability and light yield, fast time response, self radiation calibration (LYSO), low intrinsic noise rate (GAGG).
- **Photodetectors:** SiPM array (MPPC 3×3 mm² and 6x6mm², 50 µm pitch)
- **Anti-coincidence system (ACS):** BC408 plastic scintillator, for charged cosmic ray rejection.
  - Tiles on the top of the outer crystals.
  - two staggered sliced discs at the bottom of the whole dome.

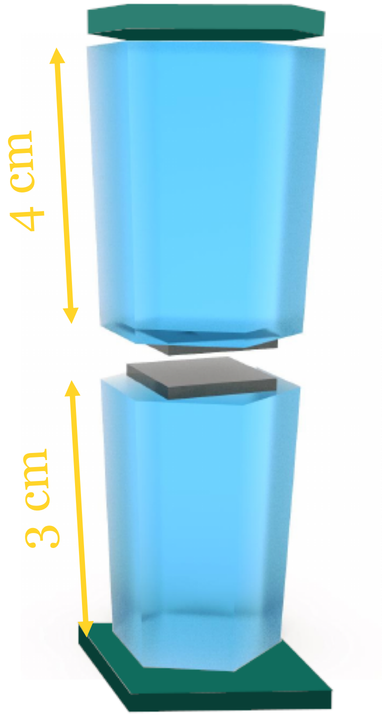
	LYSO	GAGG
Density (g cm^{-3})	7.25	6.6
Refractive index	1.82	1.91
Light output (ph/MeV)	30,000	30,000
Wavelength of emission peak (nm)	420	520
Decay constant (ns)	40	50
Energy resolution (% @662 keV)	10.9	7

Absorption fraction at different crystal thickness



3 possible combinations:

- GAGG + GAGG — Expensive
- GAGG + LYSO
- LYSO + LYSO — High intrinsic noise



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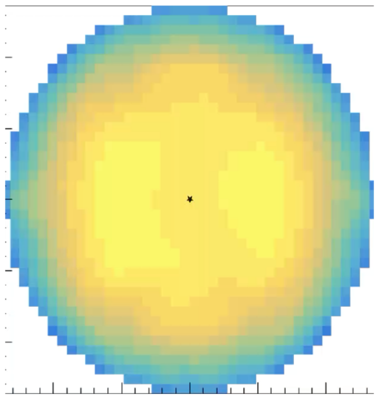
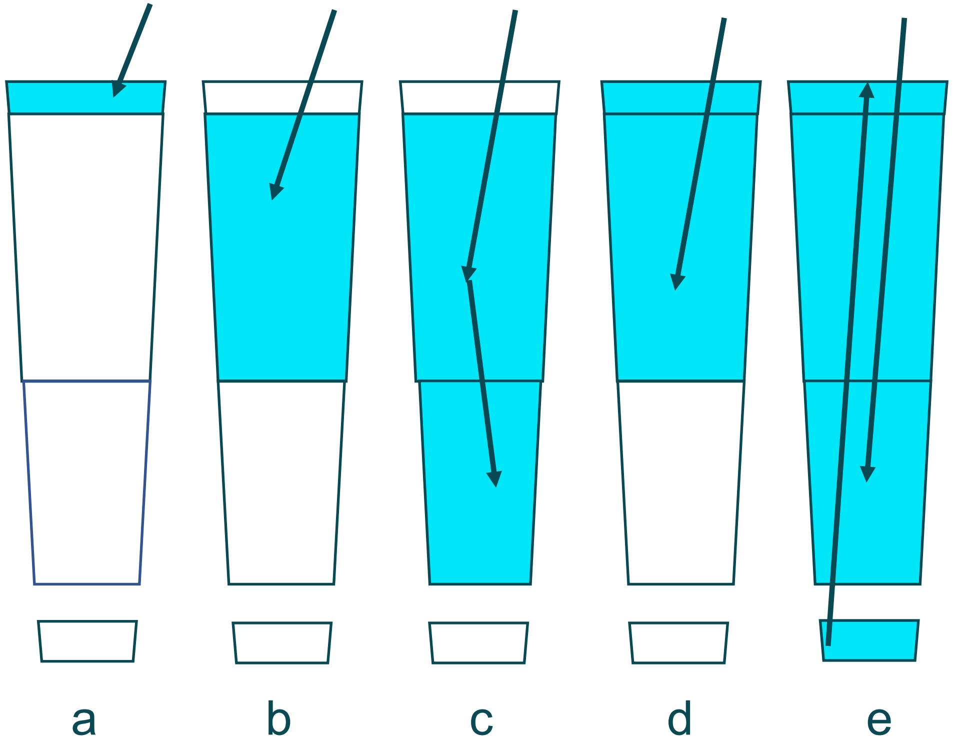
Light output (ph/MeV)	30,000	30,000
Wavelength of emission peak (nm)	420	520
Decay constant (ns)	40	50
Energy resolution (% @662 keV)	10.9	7

How the signal over the detector looks like



a – Down-going hard X-ray
b – Down-going LE γ-ray
c – Down-going ME γ-ray
d – Down-going LE charged particle
e – HE charged particle



3 possible combinations:

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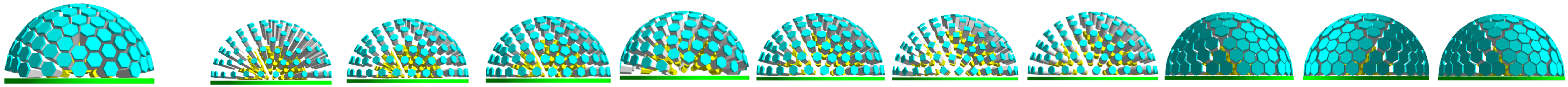
- LYSO + LYSO — High intrinsic noise

FROM THE CONCEPT TO THE ENGINEERING MODEL



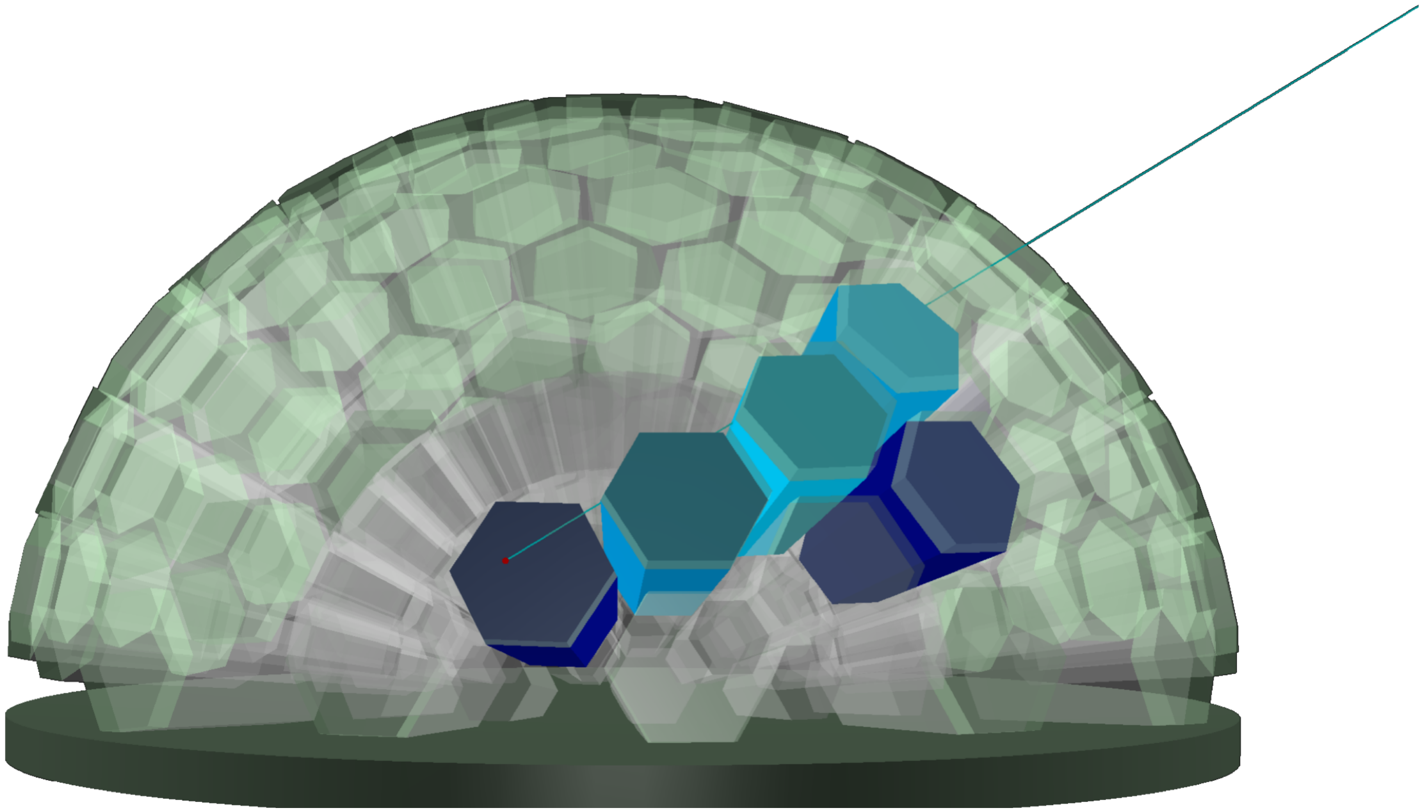
GLOBAL PARAMETERS										
Study name	Minimum_Volume	Study_1	Study_2	Study_3	Study_4	Study_5	Study_6	Study_7	Study_8	Study_9
Description	Dome with tapered prismatic crystals. Layout used during PDR. This configuration has been made in order to minimize both crystal volume and dome dimensions.	Dome with tapered prismatic crystals. Similar crystal volume to Minimum_Volume layout, the crystals are wider but shorter in height. External diameters is the same. The aim of this design is to test crystal width effectivness	Dome with tapered prismatic crystals. Same crystals as in Study_1, however external cristals are closer to the internal ones. The aim of this design is to test crystal positioning effectivness.	Dome with tapered prismatic crystals. Compared to previos studies, this design have larger crystals, and thus increased crystal volume. Has been made in order to make something similar to preliminary drafts.	Dome with tapered prismatic crystals. Similar volume to Study_3 domes, however the crystals are positioned according to previous studies disposition. This would be useful for using the already developed dome in PDR.	Dome with straight parallelepipedon crystals. This dome have a volume similar to Study_3. The aim of this design is to test the effectiveness of this geometry, wich could be more easy to manufacture.	Dome with cylindrical crystals. This dome have a volume similar to Study_3. The aim of this design is to test the effectivness of this geometry, wich could be more easy to manufacture.	Dome with tapered prismatic crystals. The crystals have been grouped, reducing the space between each dome. This will reduce the dome size. Also ACS Crystal are slightly larger than the crystal below.	Removed the geometric projection between bottom and top face of the external crystals. Top face are larger and cover the entire base of the ACS crystal.	Increased External Crystal Height
Total Crystal Volume [m^3]	1.012	1.030	1.043	2.092	2.126	2.096	1.985	2.438	3.495	4.326

INTERNAL DOME																		
Study name	Minimum_Volume		Study_1		Study_2		Study_3		Study_4		Study_5	Study_6	Study_7		Study_8		Study_9	
Prism Shape	HEXA.	PENT.	HEXA.	PENT.	HEXA.	PENT.	HEXA.	PENT.	HEXA.	PENT.	SQUARE	CIRCLE	HEXA.	PENT.	HEXA.	PENT.	HEXA.	PENT.
Side length of lower base / Diameter[mm]	6.35	8.355	9.94	12.52	9.94	12.52	7.25	9.12	7.97	10.5	16	16	18	16	18	16	18	16
Prism height [mm]	30		30		30		25		18		13.3	16.9	30		30		40	
Lower base distance from the center [mm]	62.9		62.9		62.9		91		112.7		143.7	119.1	130		130		120	
Icosahedron reference parameters	[5,0]		[5,0]		[5,0]		[4,1]		[5,0]		[5,0]	[5,0]	[5,0] CUSTOM		[5,0] CUSTOM		[5,0] CUSTOM	
External Diameter [mm]	185.8		185.8		185.8		232		261.4		314	272	320		320		320	
Crystal Dome Volume [mm^3]	282,608		282,608		282,608		427,13		438,934		429,005	428,141	2,056,199		3,113,165		3,944,468	
Unused Volume [%]	83.55%		83.55%		83.55%		84.64%		86.44%		90.66%	87.72%	69.92%		54.46%		49.55%	

EXTERNAL DOME																		
Study name	Minimum_Volume		Study_1		Study_2		Study_3		Study_4		Study_5	Study_6	Study_7		Study_8		Study_9	
Prism Shape	HEXA.	PENT.	HEXA.	PENT.	HEXA.	PENT.	HEXA.	PENT.	HEXA.	PENT.	SQUARE	CIRCLE	HEXA.	PENT.	HEXA.	PENT.	HEXA.	PENT.
Side length of lower base / Diameter[mm]	6.35	8.355	9.94	12.52	9.94	12.52	13.61	13.61	12	12	21	22.9	7.6	9.5	7.6	9.5	7.6	9.5
Prism height [mm]	40		20		20		30		30		30	30	30		30		30	
Lower base distance from the center [mm]	117.6		137.6		122.6		141		150.7		177	156	50		50		50	
Icosahedron reference parameters	[5,0]		[5,0]		[5,0]		[4,1]		[5,0]		[5,0]	[5,0]	[5,0] CUSTOM		[5,0] CUSTOM		[5,0] CUSTOM	
External Diameter [mm]	315.2		315.2		285.2		342		361.4		414	372	160		160		160	
Crystal Dome Volume [mm^3]	729,626		747,257		759,974		1,664,711		1,686,813		1,666,980	1,556,871	381,748		381,748		381,748	
Unused Volume [%]	90.30%		86.35%		82.07%		79.43%		81.88%		87.33%	84.46%	67.32%		67.32%		67.32%	

FROM THE CONCEPT TO EM: SIMULATIONS

Geometry design: CAD
Simulation: Geant4
Analysis: ROOT



Digitization:

- Edep in a single crystal > 30 keV
- Edep in a single ACS tile > 7 keV

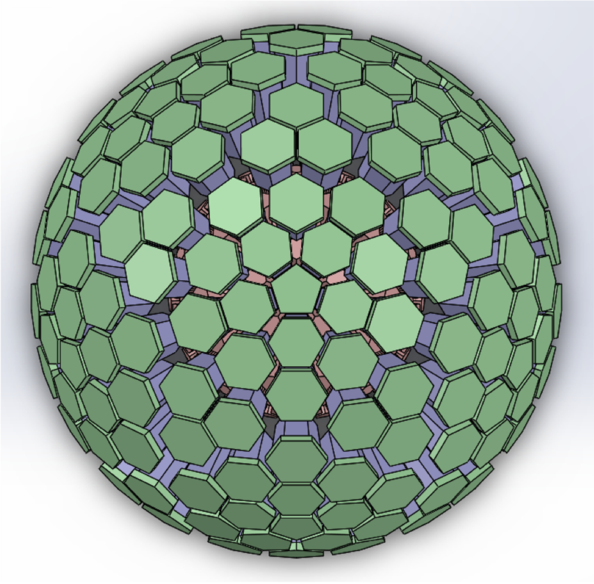
Event trigger selection conditions:

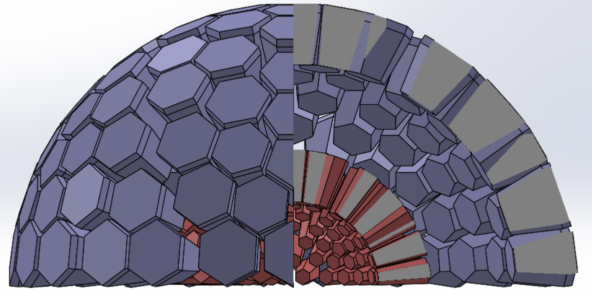
- Total top ACS energy deposition < 200 keV.
- No signal from bottom ACS.
- Deposited energy in outer crystals > inner crystals.
- Edep in at least one outer crystal and in the neighboring crystals (outer/inner)

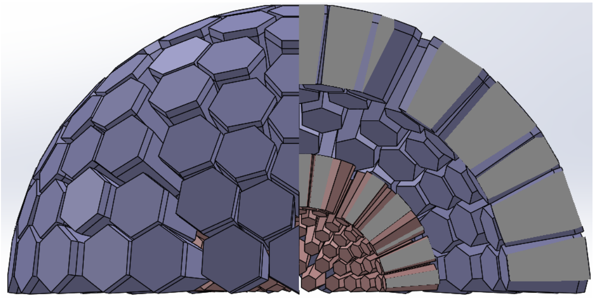
Basic trigger (first three conditions)

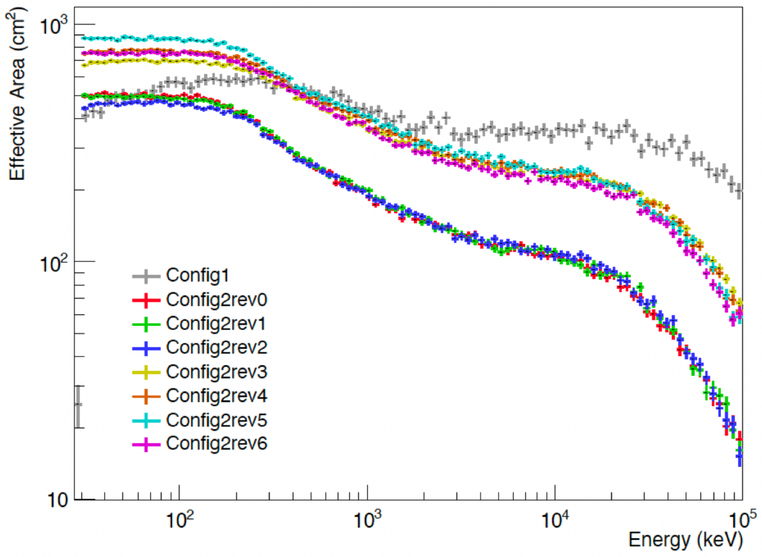
Topological trigger (all four conditions)

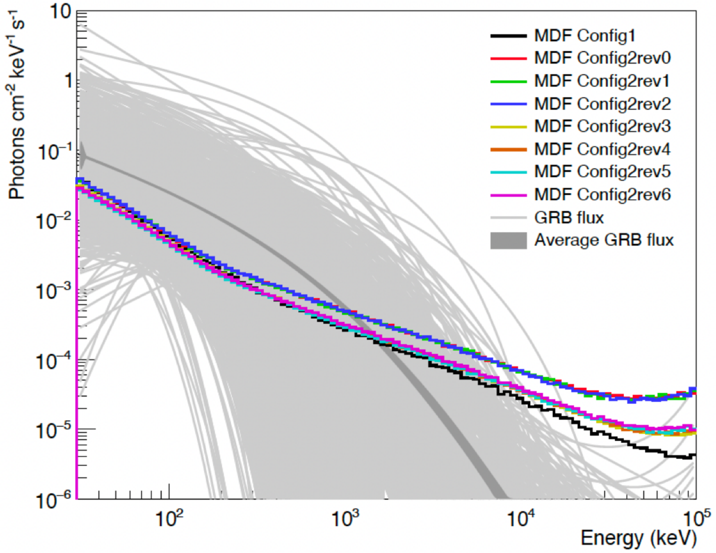
FROM THE CONCEPT TO EM: SIMULATIONS SUMMARY



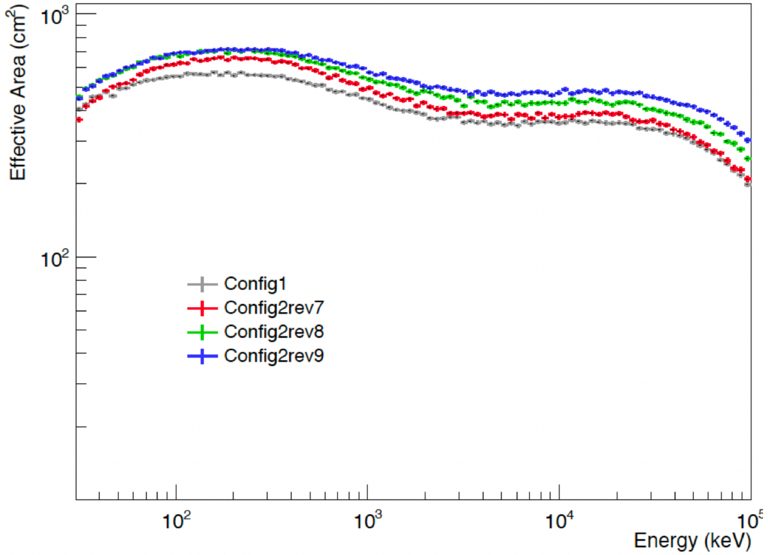


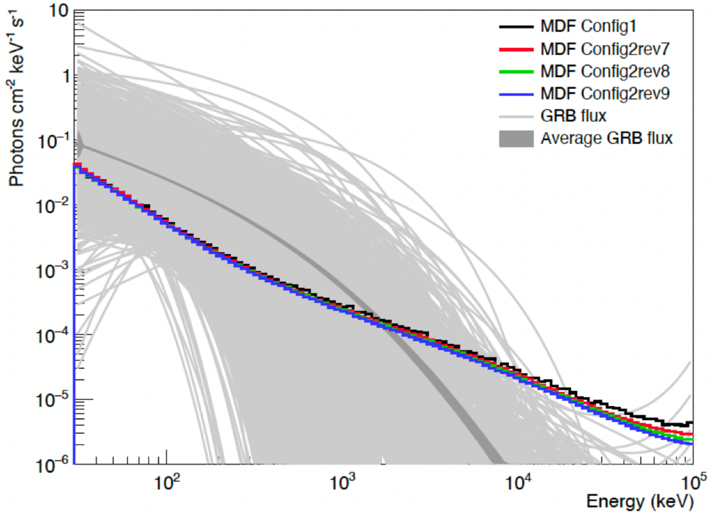




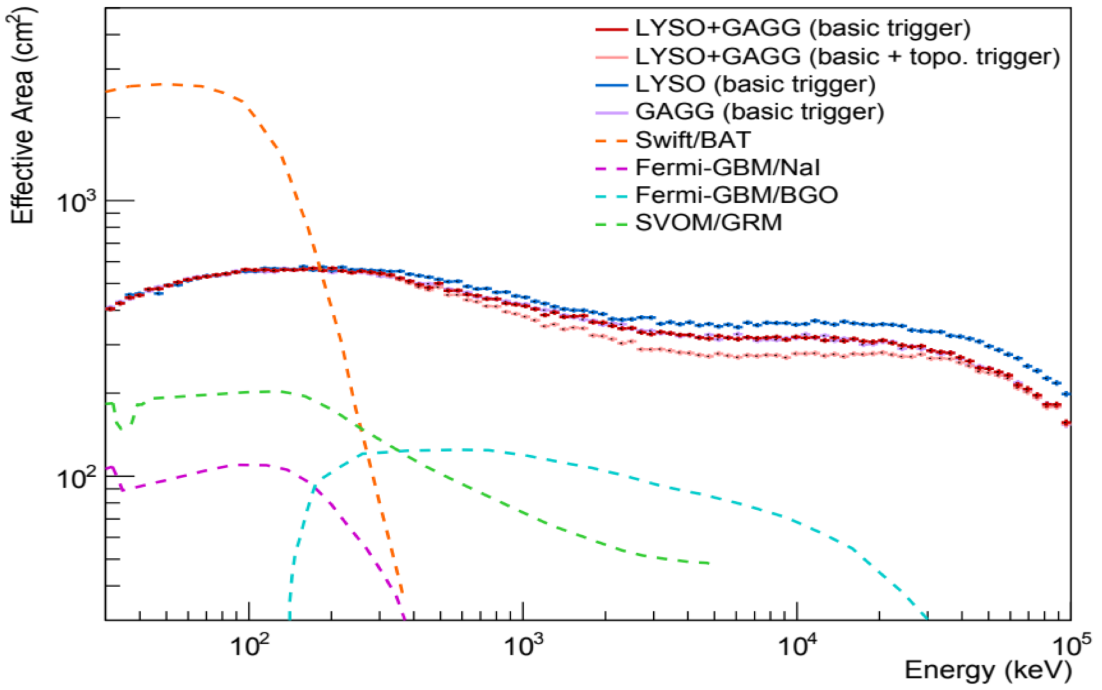


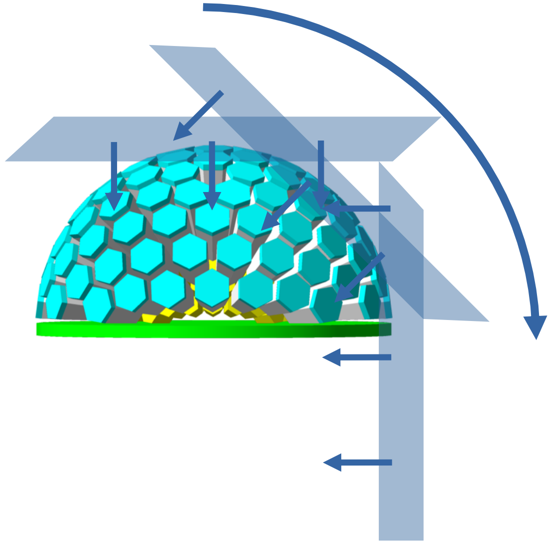
(a)

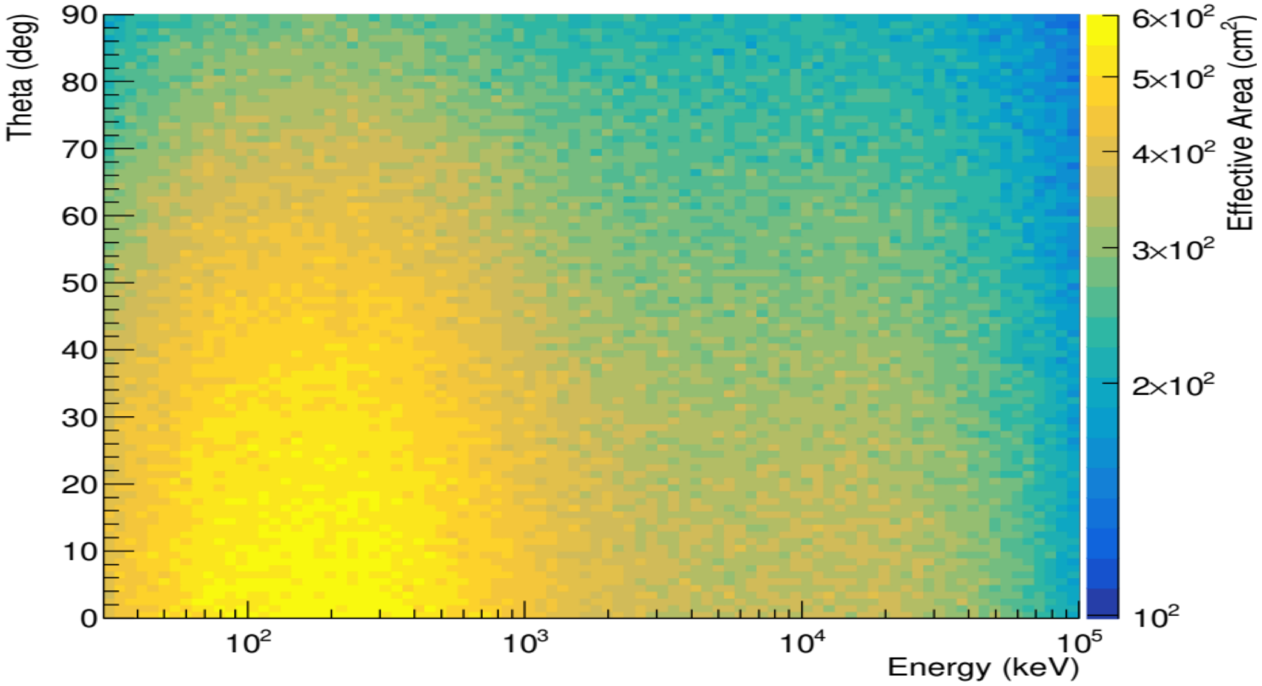




MODEL 8 PERFORMANCES: EFFECTIVE AREA







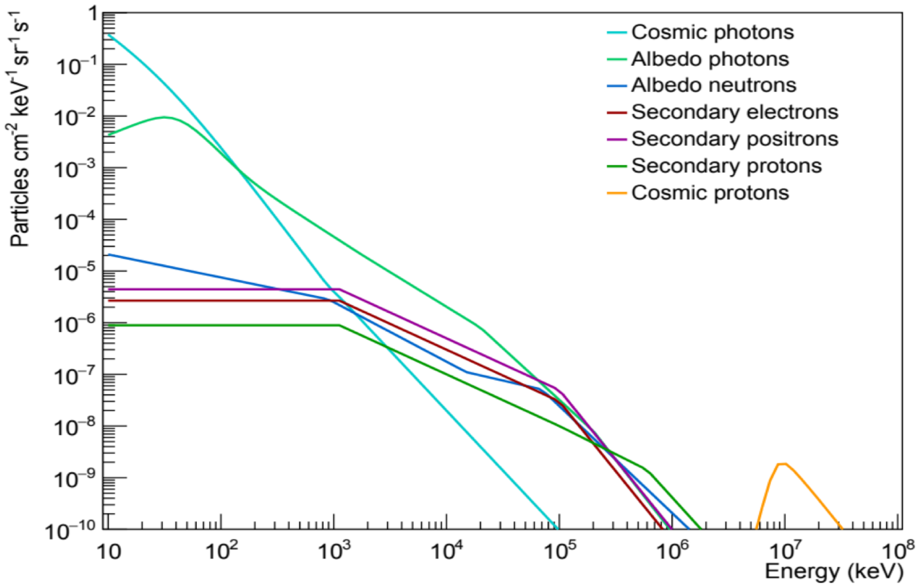
$$A_{\mathrm{eff}} = \frac{N_{\mathrm{sel}}}{N_{\mathrm{sim}}} \times A_{\mathrm{src}}$$

A_{src} – Source surface area;

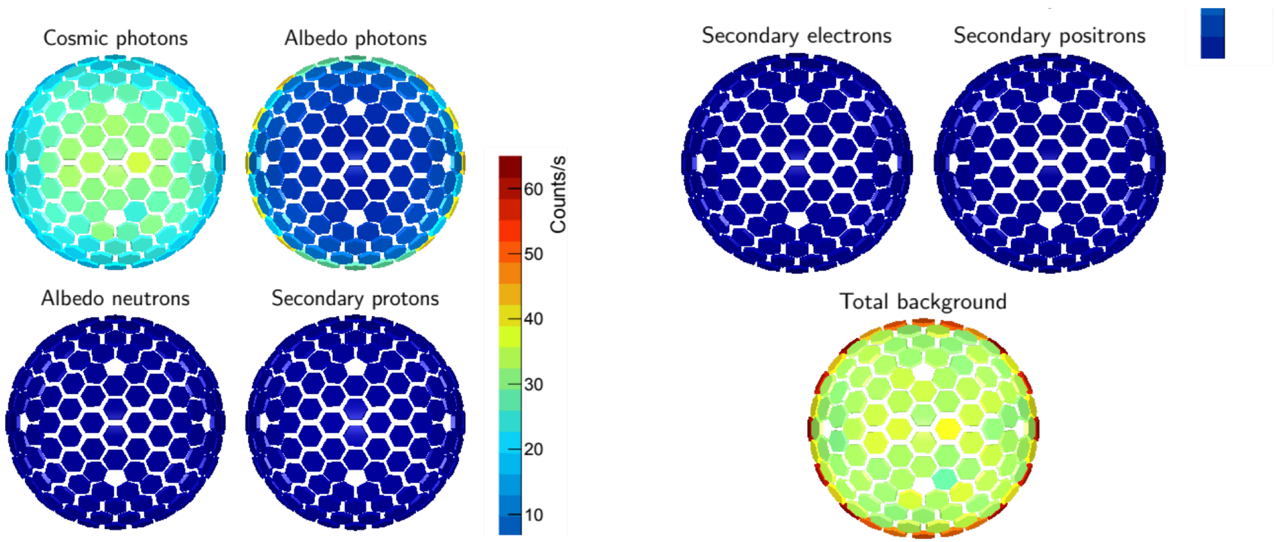
N_{sel} – Selected counts;

N_{sim} – Simulated particles.

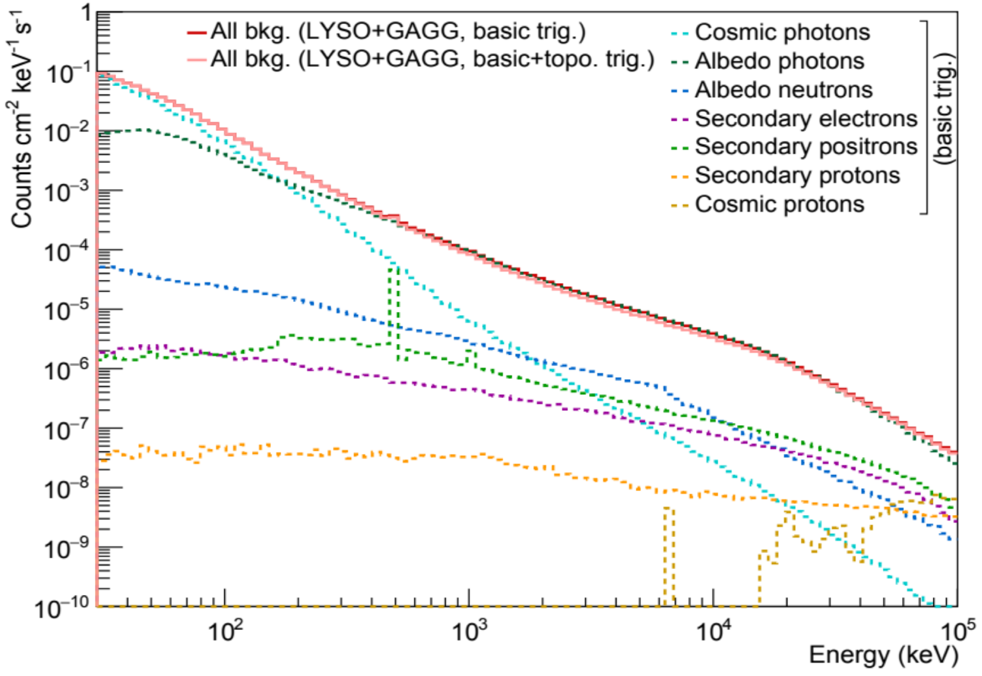
MODEL 8 PERFORMANCES: ORBITAL BACKGROUND



Major background fluxes at LEO orbit. (Cumani et al. 2019).



Differential background fluxes in the detector for orbital radiation environment

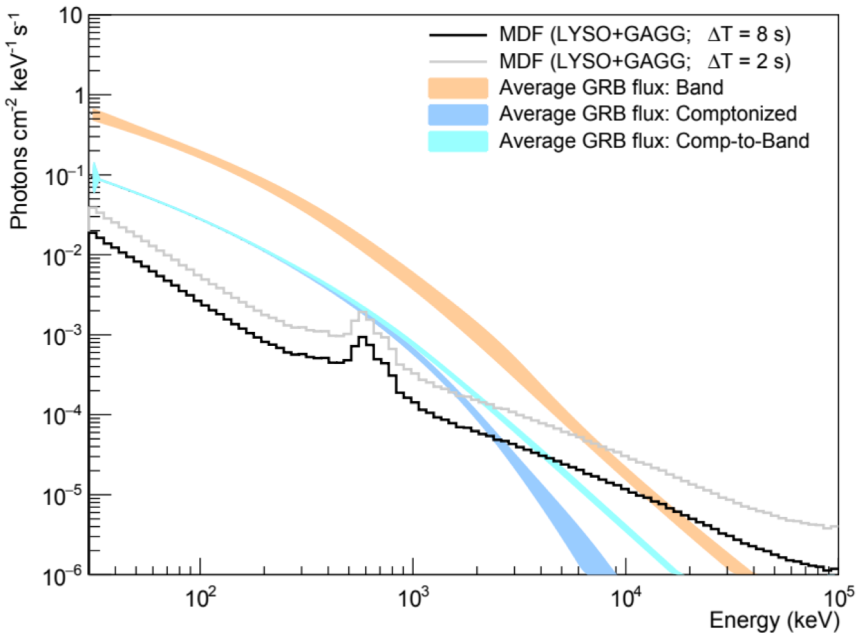


LEO Orbit

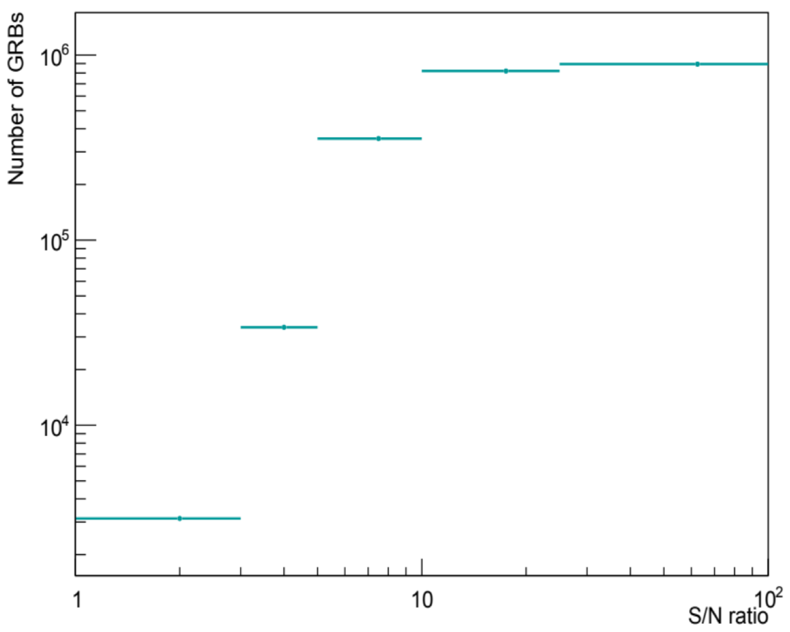
Altitude: 550 km

Inclination: 20°

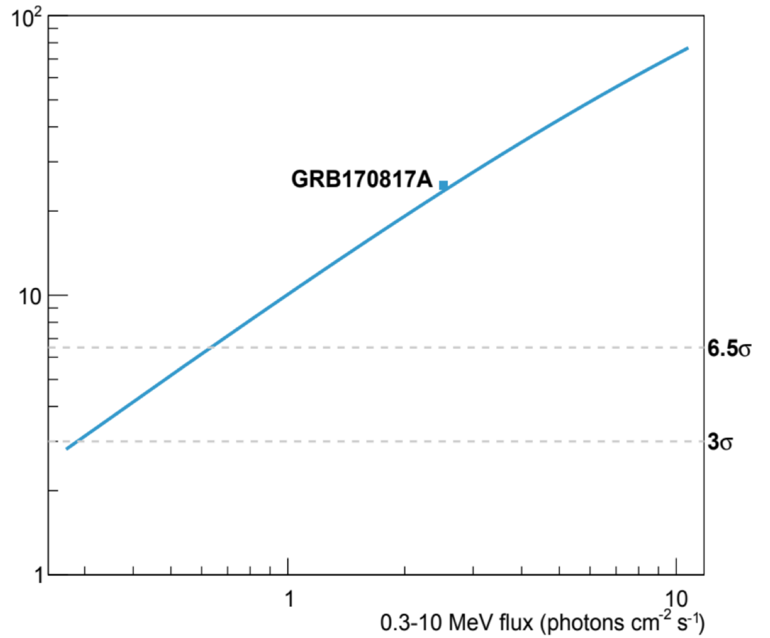
MODEL 8 PERFORMANCES: SENSITIVITY AND GRB DETECTION



CE minimum detectable flux (with $N_\sigma = 3$) and the GRB spectra from Fermi-GBM.

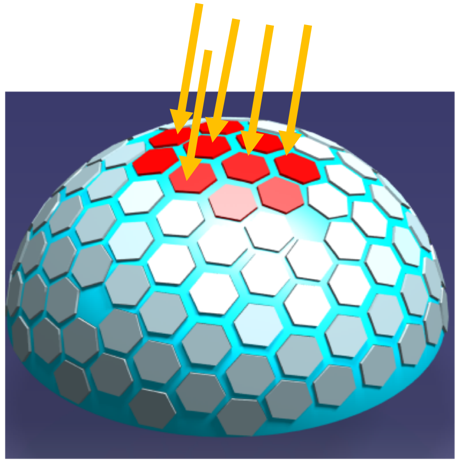


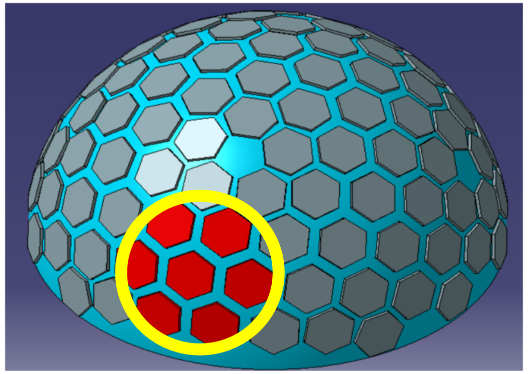
The signal-to-noise ratio (S/N) in CE for all the GRBs from the Fermi-GBM catalog.

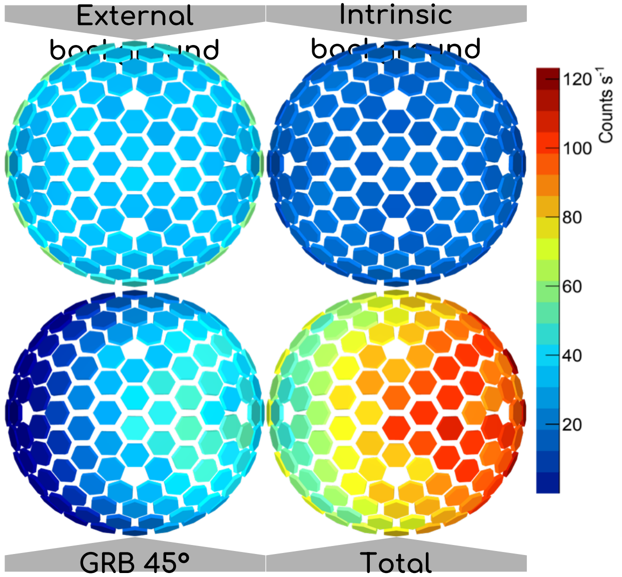


S/N as a function of the integrated GRB flux for a average Comptonized spectral model located at zenith. The S/N is also calculated for GRB170817A.

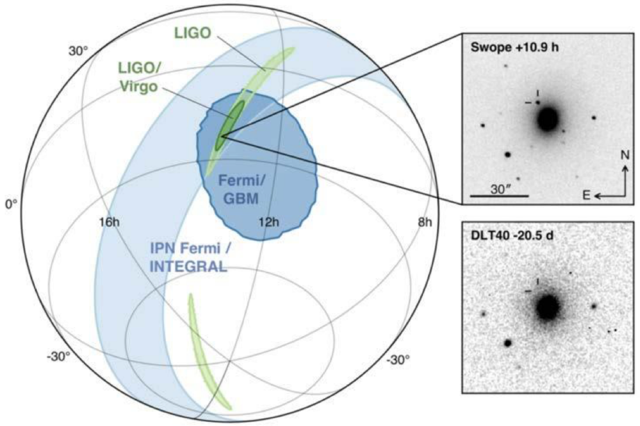
MODEL 8 PERFORMANCES: TRANSIENT LOCALIZATION



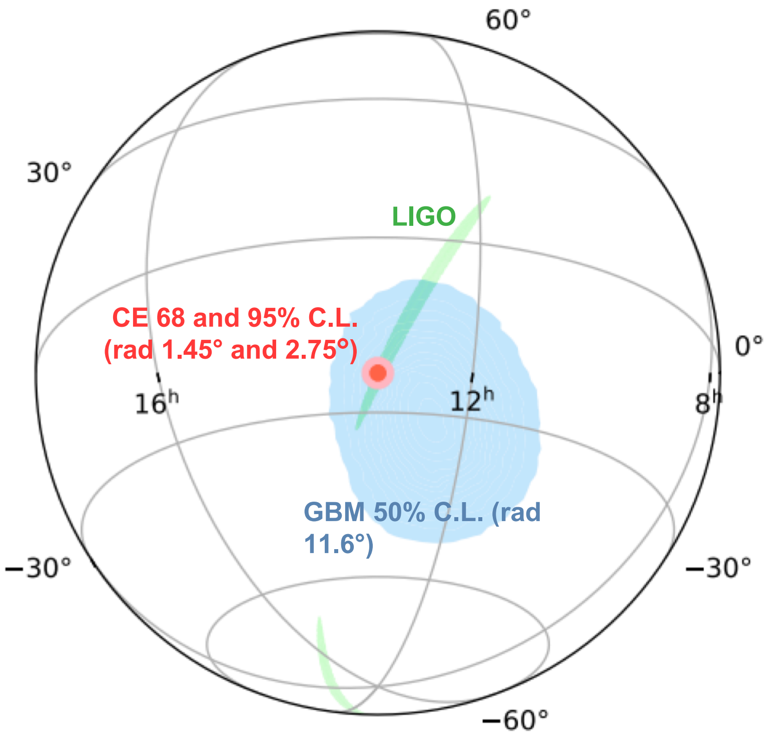




The localization is possible by following the charge distribution on the detector



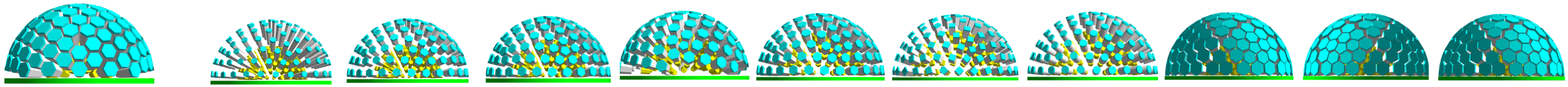
GRB170817A



	Fermi-GBM	Crystal Eye
High SNR Threshold (SNR>25)	4.0 ph/cm²/s	1.8 ph/cm²/s
"Golden Sample" (SNR>25) sGRBs/year	16.13	20.55
Bright sGRBs (SNR>60, High fluence) sGRBs/year	0.84	0.36
5s Trigger Threshold	0.8 ph/cm²/s	0.3 ph/cm²/s
Estimated Total Triggered sGRBs/year	30	60

GSSI

FROM THE CONCEPT TO THE ENGINEERING MODEL



	Minimum_Volume	Study_1	Study_2	Study_3	Study_4	Study_5	Study_6	Study_7	Study_8	Study_9
GLOBAL PARAMETERS										
Study name	Minimum_Volume	Study_1	Study_2	Study_3	Study_4	Study_5	Study_6	Study_7	Study_8	Study_9
Description	Dome with tapered prismatic crystals. Layout used during PDR. This configuration has been made in order to minimize both crystal volume and dome dimensions.	Dome with tapered prismatic crystals. Similar crystal volume to Minimum_Volume layout, the crystals are wider but shorter in height. External diameters is the same. The aim of this design is to test crystal width effectivness	Dome with tapered prismatic crystals. Same crystals as in Study_1, however external cristals are closer to the internal ones. The aim of this design is to test crystal positioning effectivness.	Dome with tapered prismatic crystals. Compared to previos studies, this design have larger crystals, and thus increased crystal volume. Has been made in order to make something similar to preliminary drafts.	Dome with tapered prismatic crystals. Similar volume to Study_3 domes, however the crystals are positioned according to previous studies disposition. This would be useful for using the already developed dome in PDR.	Dome with straight parallelepipedon crystals. This dome have a volume similar to Study_3. The aim of this design is to test the effectivness of this geometry, wich could be more easy to manufacture.	Dome with cylindrical crystals. This dome have a volume similar to Study_3. The aim of this design is to test the effectivness of this geometry, wich could be more easy to manufacture.	Dome with tapered prismatic crystals. The crystals have been grouped, reducing the space between each dome. This will reduce the dome size. Also ACS Crystal are slightly larger than the crystal below.	Removed the geometric projection between bottom and top face of the external crystals. Top face are larger and cover the entire base of the ACS crystal.	Increased External Crystal Height
Total Crystal Volume [m^3]	1.012	1.030	1.043	2.092	2.126	2.096	1.985	2.438	3.495	4.326
INTERNAL DOME										
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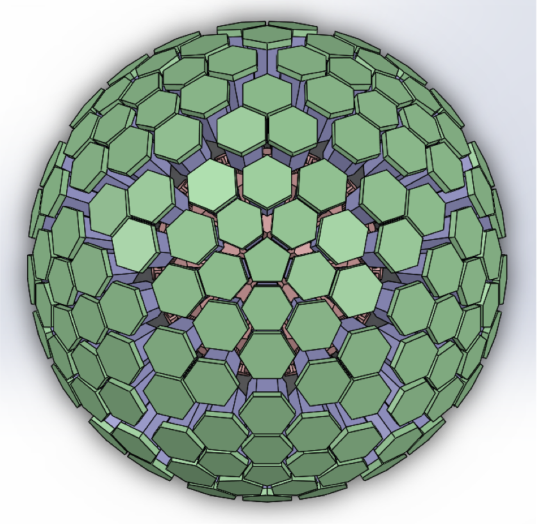
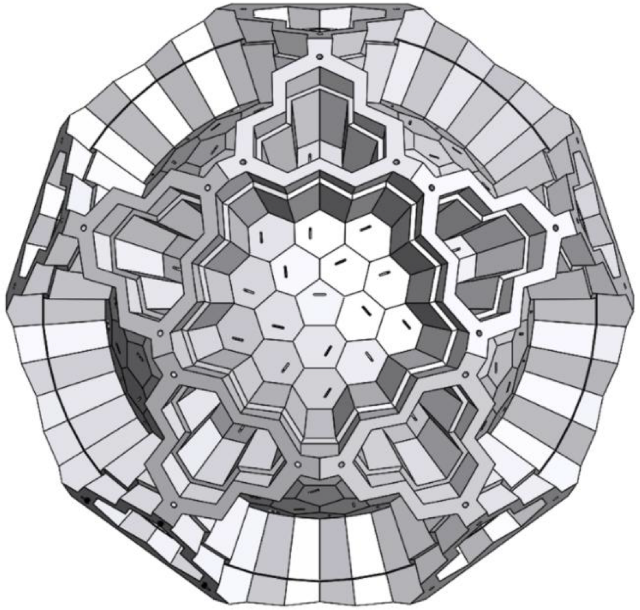
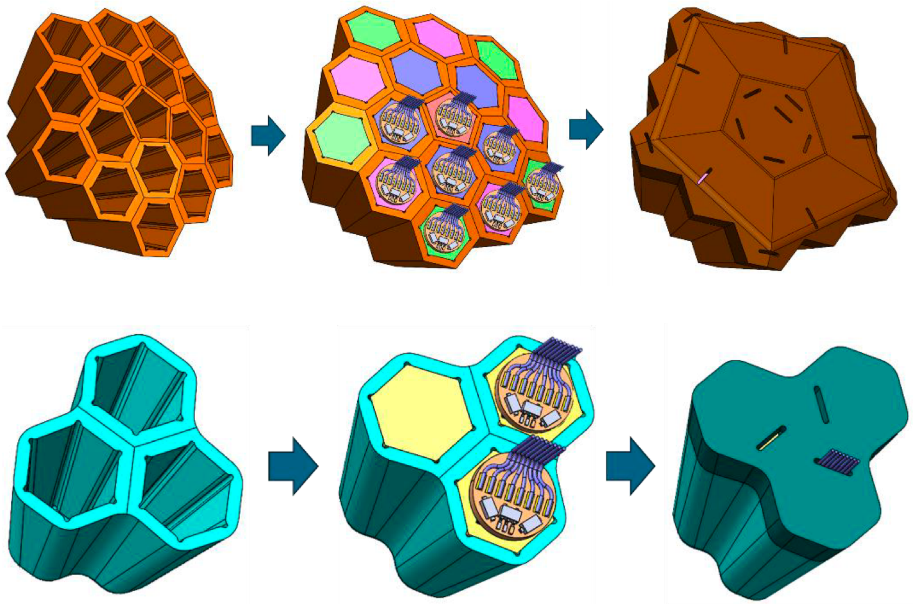
Prism Shape	HEXA. / PENT.	HEXA. / PENT.	HEXA. / PENT.	HEXA. / PENT.	HEXA. / PENT.	SQUARE	CIRCLE	HEXA. / PENT.	HEXA. / PENT.	HEXA. / PENT.
Side length of lower base / Diameter[mm]	6.35 / 8.355	9.94 / 12.52	9.94 / 12.52	7.25 / 9.12	7.97 / 10.5	16	16	18 / 16	18 / 16	18 / 16
Prism height [mm]	30	30	30	25	18	13.3	16.9	30	30	40
Lower base distance from the center [mm]	62.9	62.9	62.9	91	112.7	143.7	119.1	130	130	120
Icosahedron reference parameters	[5,0]	[5,0]	[5,0]	[4,1]	[5,0]	[5,0]	[5,0]	[5,0] CUSTOM	[5,0] CUSTOM	[5,0] CUSTOM
External Diameter [mm]	185.8	185.8	185.8	232	261.4	314	272	320	320	320
Crystal Dome Volume [mm^3]	282,608	282,608	282,608	427,13	438,934	429,005	428,141	2,056,199	3,113,165	3,944,468
Unused Volume [%]	83.55%	83.55%	83.55%	84.64%	86.44%	90.66%	87.72%	69.92%	54.46%	49.55%
EXTERNAL DOME										
Study name	Minimum_Volume	Study_1	Study_2	Study_3	Study_4	Study_5	Study_6	Study_7	Study_8	Study_9
Prism Shape	HEXA. / PENT.	HEXA. / PENT.	HEXA. / PENT.	HEXA. / PENT.	HEXA. / PENT.	SQUARE	CIRCLE	HEXA. / PENT.	HEXA. / PENT.	HEXA. / PENT.
Side length of lower base / Diameter[mm]	6.35 / 8.355	9.94 / 12.52	9.94 / 12.52	13.61 / 13.61	12 / 12	21	22.9	7.6 / 9.5	7.6 / 9.5	7.6 / 9.5
Prism height [mm]	40	20	20	30	30	30	30	30	30	30
Lower base distance from the center [mm]	117.6	137.6	122.6	141	150.7	177	156	50	50	50
Icosahedron reference parameters	[5,0]	[5,0]	[5,0]	[4,1]	[5,0]	[5,0]	[5,0]	[5,0] CUSTOM	[5,0] CUSTOM	[5,0] CUSTOM
External Diameter [mm]	315.2	315.2	285.2	342	361.4	414	372	160	160	160
Crystal Dome Volume [mm^3]	729,626	747,257	759,974	1,664,711	1,686,813	1,666,980	1,556,871	381,748	381,748	381,748
Unused Volume [%]	90.30%	86.35%	82.07%	79.43%	81.88%	87.33%	84.46%	67.32%	67.32%	67.32%

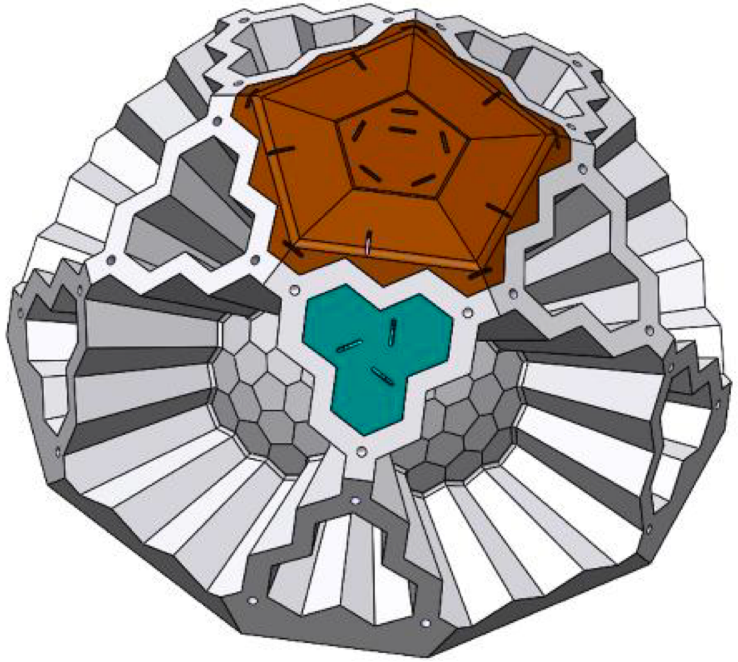
HOW TO BUILT IT: THE DETECTOR



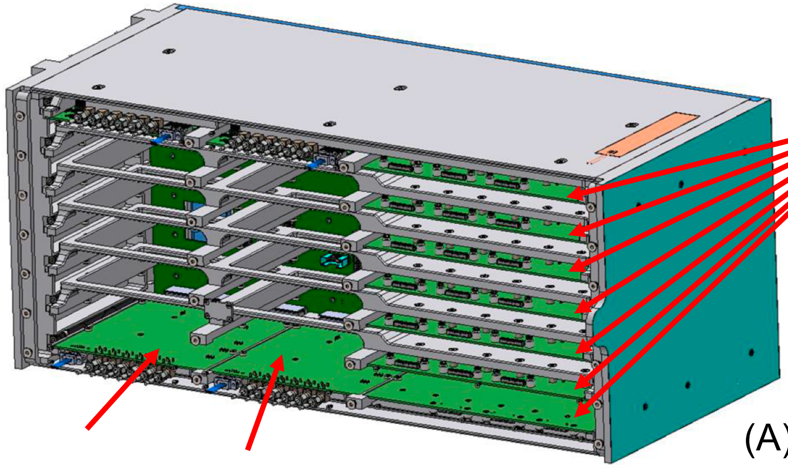
Exploiting symmetries to maximize the effective area and reduce the weight

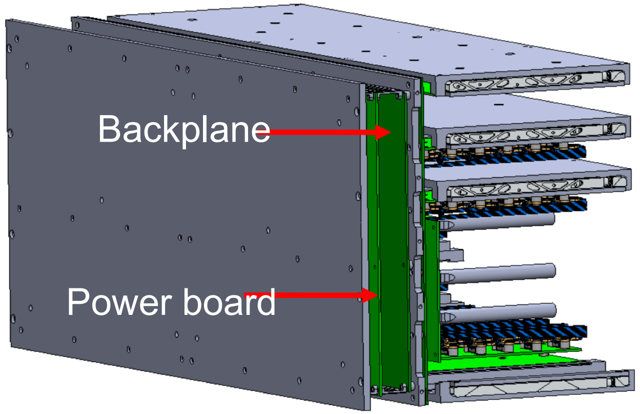


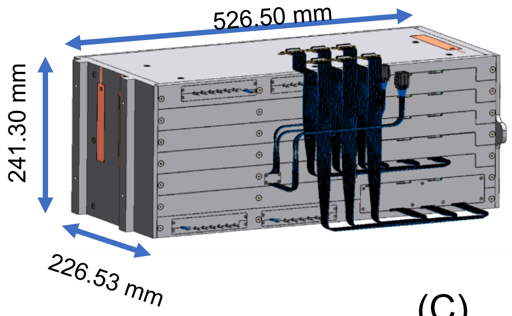


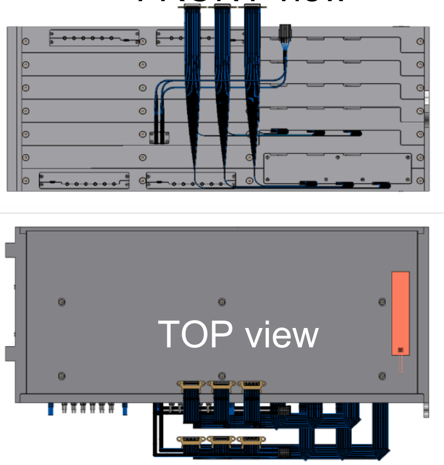


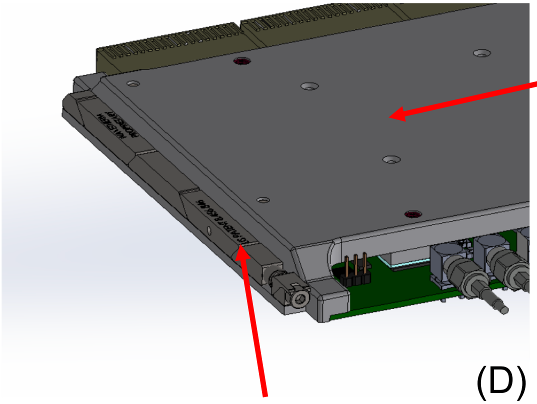
HOW TO BUILT IT: THE ELECTRONICS BOX



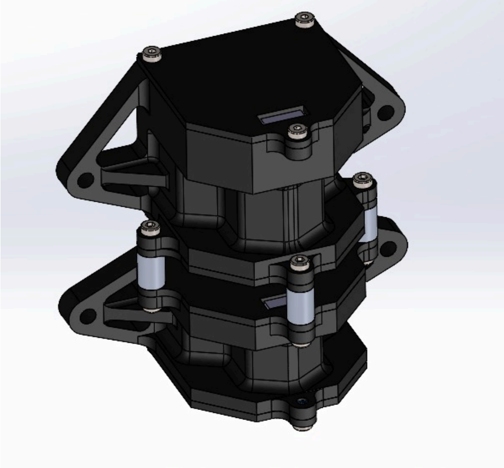


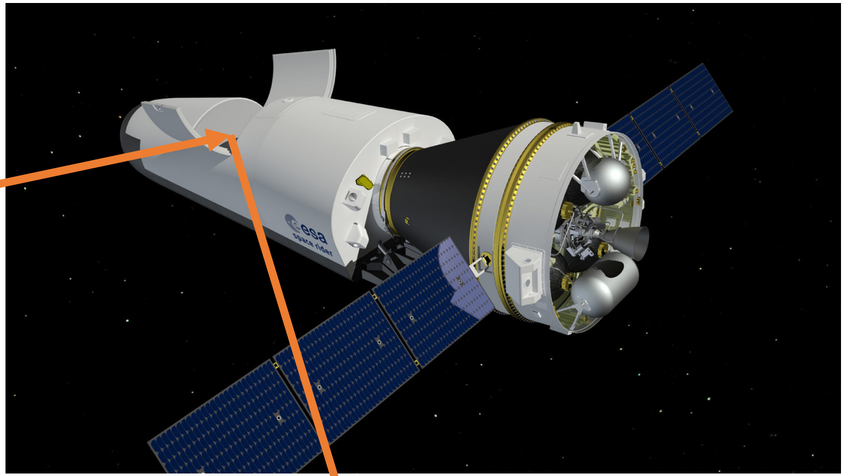




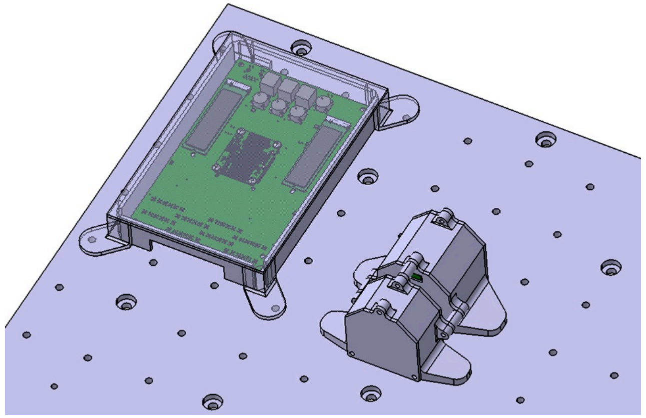


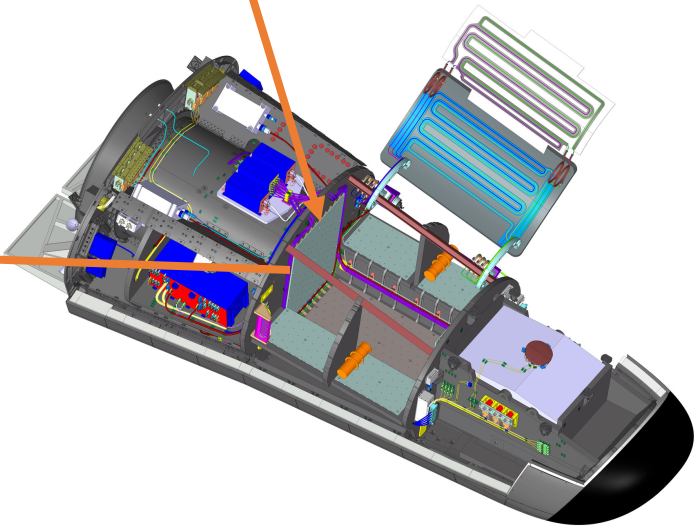
WINK FOR SPACE RIDER

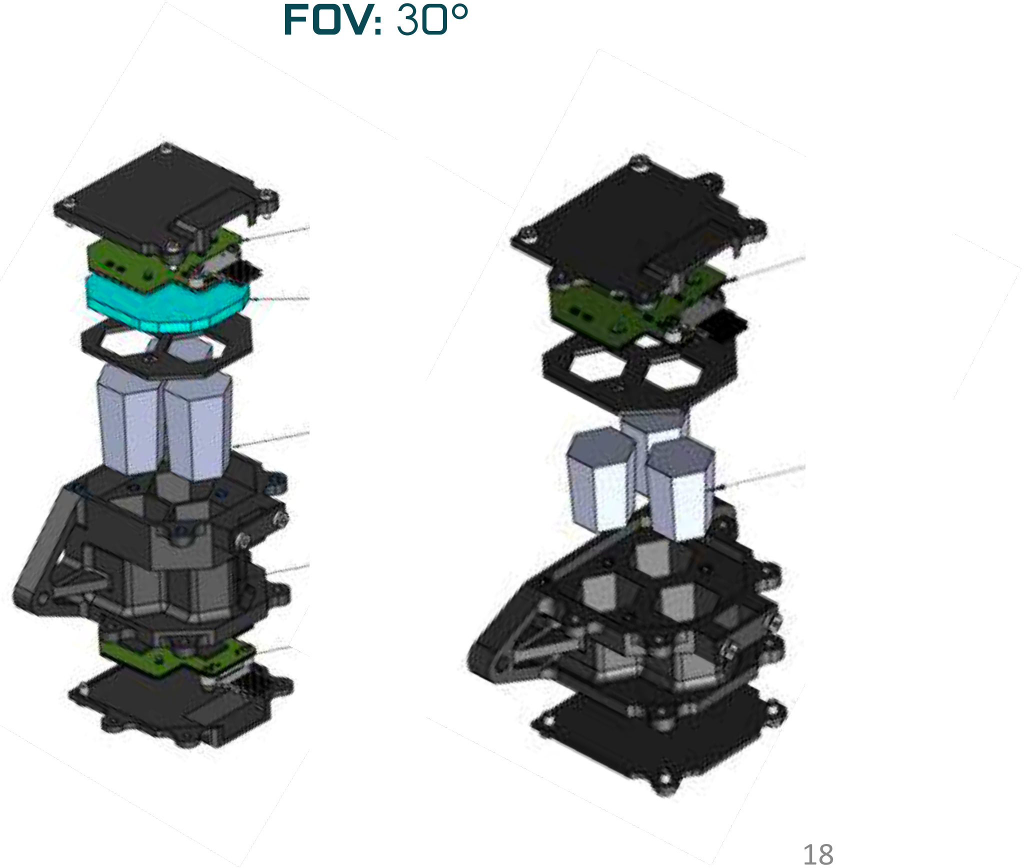




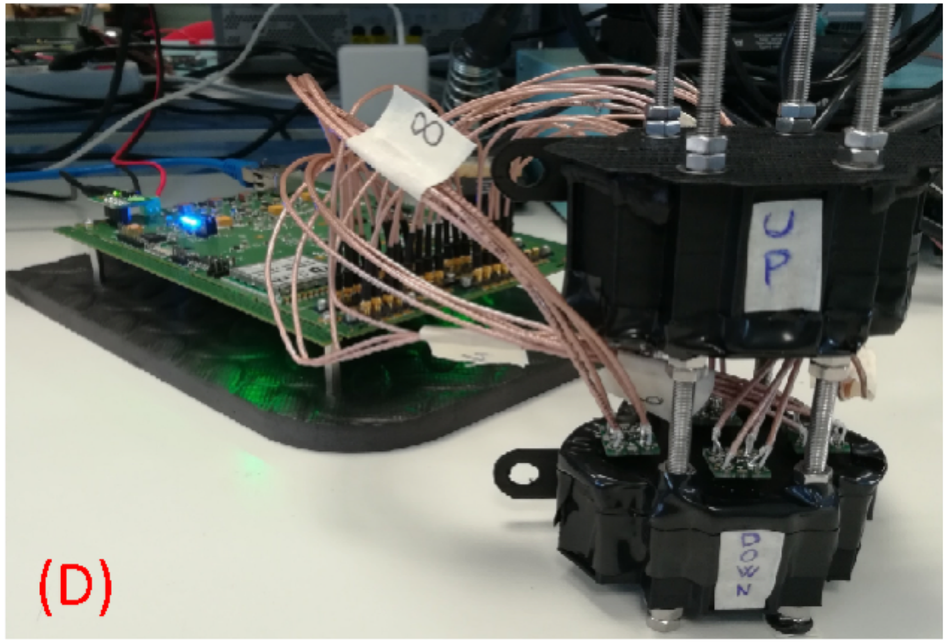
Number of pixels: 3
Material: LYSO
Photodetectors: SiPM-array
Weight: 2kg
Power consumption: <15 W
FOV: 30°



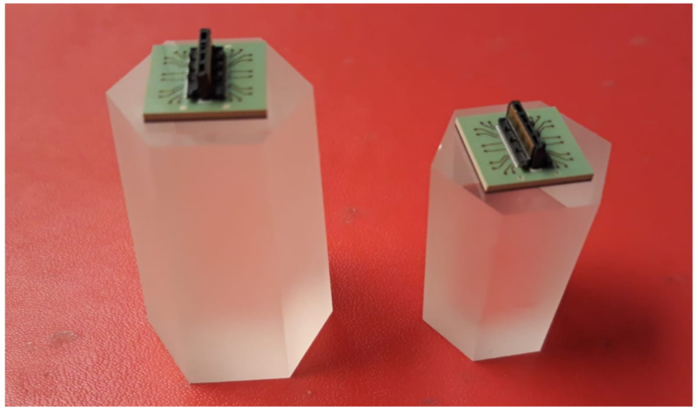


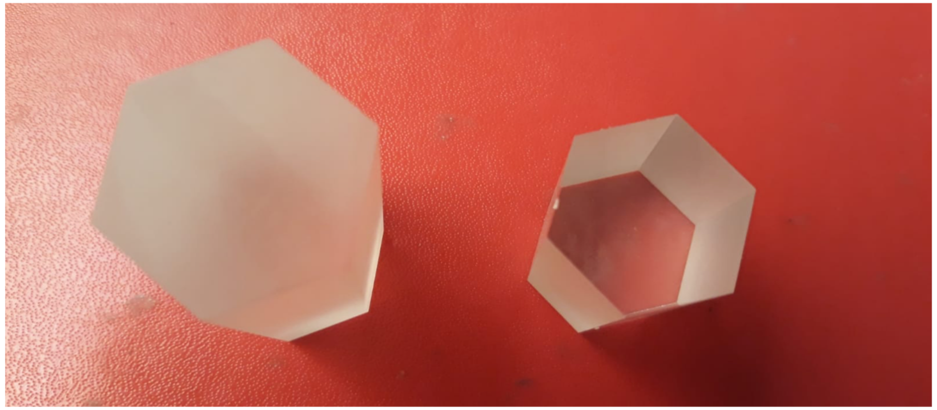


WINK FIRST PROTOTYPE



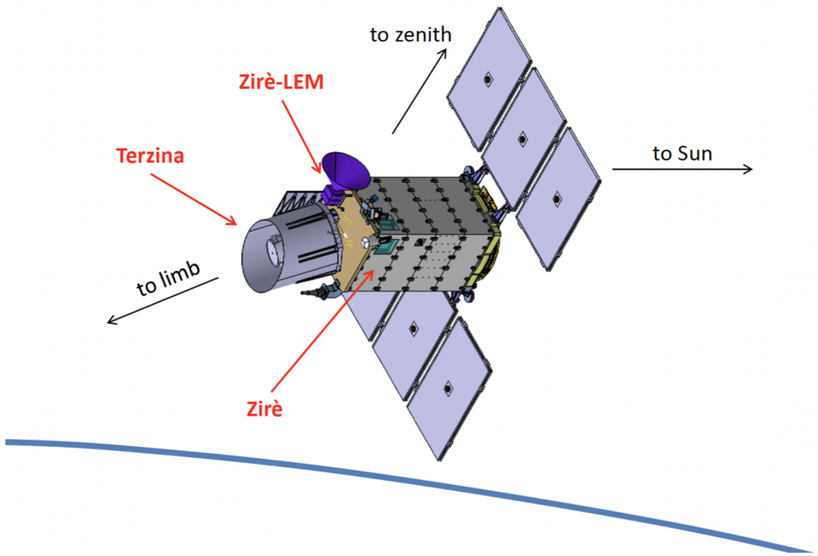
- BANDO STAR 2018
- PRIN 2022
- ASTRA-PNRR





see Ivan presentation

NUSES/Zirè

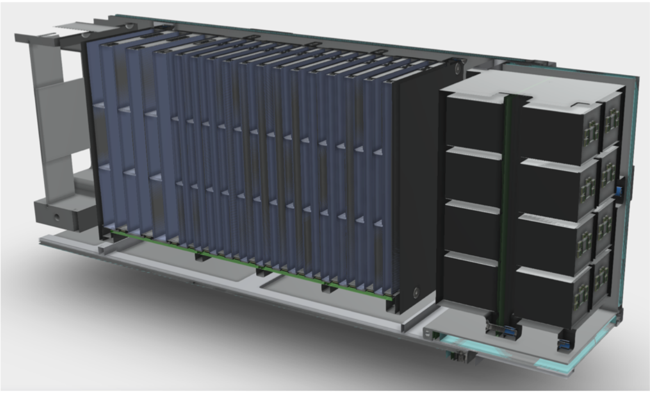


A joint Gran Sasso Science Institute -Thales Alenia Space Italy (TAS-I) **mission conceived as a pathfinder for new observation methods and technologies in the study of high and low energy radiations enabling new sensors, tools and detection techniques.**

>60 scientists from Italian Universities and INFN sites, international research and academic institutions and industrial partners.

Large expertise (and synergies) from space missions/R&D programs: AMS, DAMPE, ASTROGAM, FERMI, GAPS, HERD, LIMADOU, PAMELA, POEMMA, SPB2 , …

- To measure UHE cosmic rays and enable neutrino astronomy through **space-based atmospheric Cerenkov light detection**.
- To **monitor the fluxes of low energy (<250 MeV) e, p, CR** to study Van Allen belts, space weather and the magnetosphere-ionosphere-litosphere couplings (**MILC**) in case of seismic / volcanic activities.
- To detect 0.1-10 MeV photons for the study of **transient** (GRB, e-m follow up of GW events, SN emission lines,…)
- To develop new observational techniques, to test sensors (e.g. Silicon PhotoMultiplier, SiPM) and related electronics/DAQ for space missions.

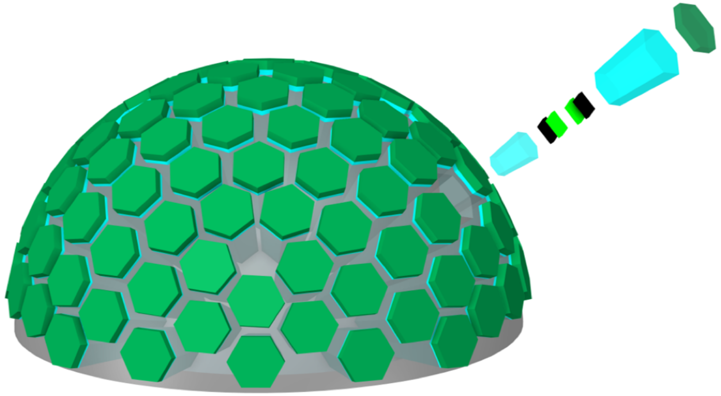


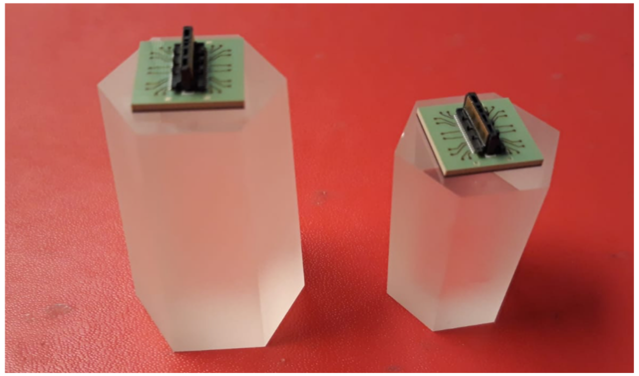
CALOg Crystal Eye-like

Synergy on the technological approach

CRYSTAL EYE HERITAGE

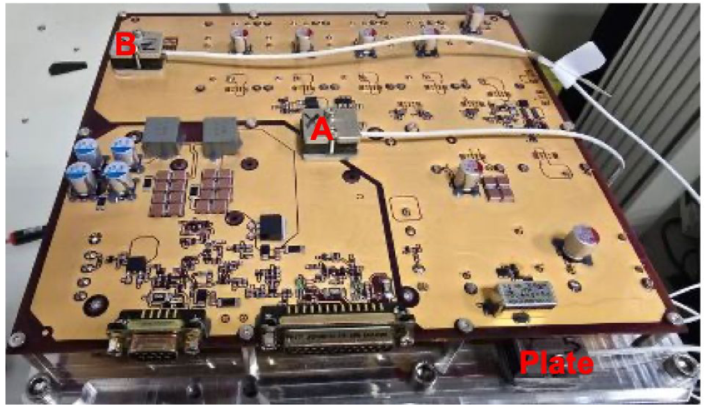
DAQ (large scale concept from WINK)
from NUSES mission

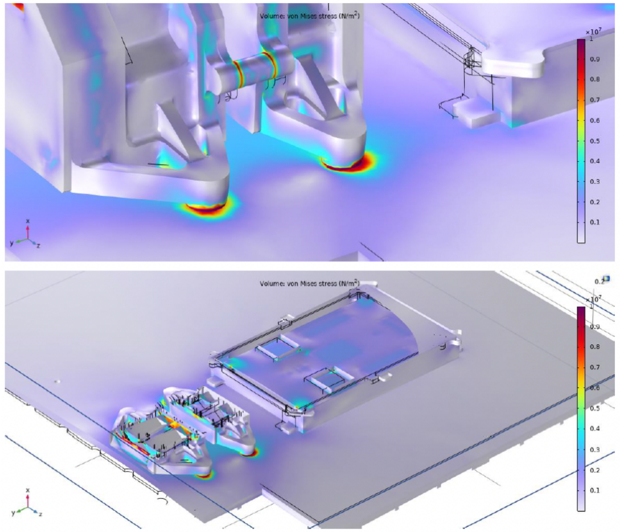




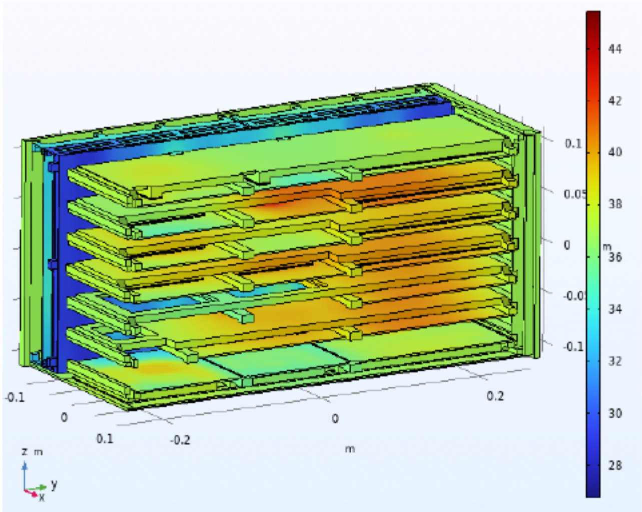
Crystals and SiPMs from WINK

POWER board from NUSES

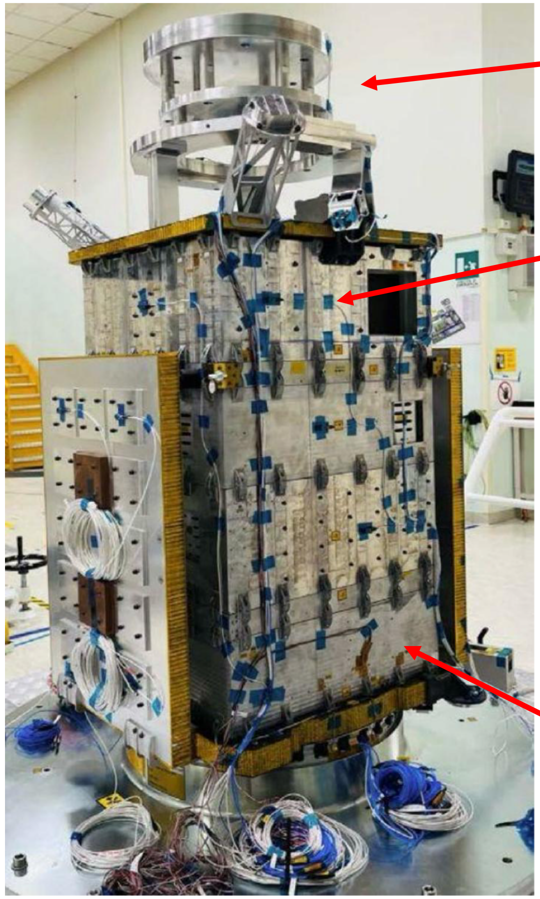




Thermal design method already assessed for WINK and NUSES-electronics box



Crystal Eye mission profile



Crystal Eye will take this place

Electronics box - tray

Structural model of NUSES mission, Crystal Eye want to exploit the same platform (NIMBUS)

Intersatellite link for fast alert

Orbit	550km, 5° (preferred), 0-20° (acceptable)	
Spacecraft	NIMBUS	
Payload mass	Detector	48kg
	Electronics box tray and harness	35 kg
Payload power	86W (including 25% inefficiency of the power boards)	
Data budget	Burst data	60Mb/burst event*
	Continuous monitoring data sampling	93Gb/dd
	Payload housekeeping data	16Gb/dd
Spacecraft wet mass	~320kg	
Communications	Intersatellite link (ISL) or L-band transponderto set fast alert	
	X-band for scientific data	
	S-band for housekeeping data, TM e TC	
Pointing accuracy	Crystal Eye needs to look at the zenith. It is an all sky monitor, not a pointing instrument. The raw data needs to be tagged with the spacecraft position to correctly localize the event.	
Propulsion system	Cold Gas Thrusters	
Lifetime	≥ 2 years	
Ground stations	Kourou (X and S-bands compatibility necessary)	
Thermal control	Passive expected, thermal interface for SiPM currently under definition	
AOCS requirements	3-axis knowledge <0.1° sufficient for localization. Control not mandatory but useful for power and thermal optimization	
Radiaton environment	LEO equatorial radiation-tolerant; no shielding required beyond standard	
Mission operations	Mission operated with regular TM/TC via S- and X-band, real-time alert delivery via ISL/EDRS; bulk science via scheduled X-band passes	
Launch compatibility	VEGA-C in PLAT1, PLAT2, FLEXI-3/$ and Vespa Extended	

Crystal Eye collaboration

Crystal Eye Mission Consortium					
	Institution	Experience	Team Member	Mail address	Role
GSSI	Gran Sasso Science Institute	Payload development: ZIRE, TERZINA, WINK, Light-1, PSD (HERD) Space experiments: Dampe, HERD, NUSES, Light-01, WINK GW experiments: Virgo, Einstein Telescope, GRAWITA-INAF, ENGRAVE X and gamma ray experiments: Einsein Probe, Swift, Fermi	Roberto Aloisio	roberto.aloisio@gssi.it	Payload development, Science Core Team, CNN development and localization algorithm
			Biswaijt Banerjee	biswajit.banerjee@gssi.it	
			Felicia Barbato (Lead Proposer)	felicia.barbato@gssi.it	
			Marica Branchesi	marica.branchesi@gssi.it	
			Ivan De Mitri	ivan.demitri@gssi.it	
			Adriano Di Giovanni	adriano.digiovanni@gssi.it	
			Dimitrios Kyratzis	dimitrios.kyratzis@gssi.it	
			Herman Lima	herman.lima@gssi.it	
			Gor Oganesyan	gor.oganesyan@gssi.it	
			Filippo Santoliquido	filippo.santoliquido@gssi.it	
			Ritabrata Sarkar	ritabrata.sarkar@gssi.it	
			Pierpaolo Savina (Data manager)	pierpaolo.savina@gssi.it	
GRAN SASSO TECH	Fondazione Gran Sasso Tech	NIMBUS intllectual property, Radiation hardness and Space qualification	Valerio Conicella	valerio.conicella@gransassotech.org	NIMBUS optimization for Crystal Eye mission and space qualification test
			Rita Di Iulio	rita.diiulio@gransassotech.org	
			Ulisse Di Marcantonio	ulisse.dimarcantonio@gransassotech.org	
			Giancarlo Tempesta	giancarlo.tempesta@gransassotech.org	
IFAE Institut de Física d'Altes Energies	IFAE Barcelona	Space experiments: HERD Gamma ray telescopes: MAGIC, CTA	Javier Rico	javier.rico.castro@cern.ch	Trigger and data analysis
INAF IAPS	INAF-IAPS	Space experiments: INTEGRAL, BeppoSAX, IXPE, Agile	Fiamma Capitanio	fiamma.capitanio@inaf.it	Ancillary science team
			Antonella Tarana	antonella.tarana@inaf.it	
	University of Geneva	Space experiments: AMS, DAMPE, NUSES, POLAR2 ,HERD	Teresa Montaruli	Teresa.Montaruli@unige.ch	CNN development and data analysis
			Andrii Tykhonov	Andrii.Tykhonov@cern.ch	
FEDERICO II	Università Degli Studi Di Napoli	Space experiments: Jem-Euso, SPB2, WINK, PAMELA GW experiments: Virgo	Roberta Colalillo	colalillo@na.infn.it	Data managment and data analysis
			Fabio Garufi (Technical Manager)	garufi@na.infn.it	
			Fausto Guarino	guarino@na.infn.it	
			Laura Valore	cvalore@na.infn.it	
	Università Di Trieste	Space experiments: Fermi, AGILE Gamma ray telescopes: MAGIC, CTA, ASTRI	Francesco Longo	Francesco.Longo@ts.infn.it	CNN development, localization algorithm and data analysis
			Martinelli Riccardo	RICCARDO.MARTINELLI@phd.units.it	
			Alessandro Armando Vigliano	Alessandro.Armando.Vigliano@ts.infn.it	

Engineering Team					
Company Name		Expertise	Key Persons	Mail address	Role
SOPHIA HIGH TECH	Sophia High Tech	Expert in design, development and manufacturing of mechanics assy for Space and propulsion application. Manufacturing capability according to ECSS reuirements in CNC and ALM field.	Domenico Borrelli (Project Manager)	domenico.borrelli@sophiahightech.com	Mechanical and thermal Engineering
			Antonio Caraviello (General Manager)	antonio.caraviello@sophiahightech.com	
NI Nuclear Instruments	Nuclear Instruments	Electronics for advanced detection systems for particle physics	Andrea Abba (Project Manager)	abba@nuclearinstruments.eu	Front end and data acquisition board, firmware, software and electronis I/F
			Luigi Ferrentino (Firmware Designer)	l.ferrentino@nuclearinstruments.eu	
			Edoardo Carlotti (Hardware designer)	e.carlotti@nuclearinstruments.eu	
			Alberto Cusimano (Hardware Designer)	cusimano@nuclearinstruments.eu	
			Gabriel Marelli (Quality and Testing)	g.marelli@nuclearinstruments.eu	
AGE SCIENTIFIC	Age Scientfic	Aerospace/Defense - Industrial - Particle Physics application	Lorenzo Perillo (Project manager)	lperillo@agescientific.com	SiPM and power board
			Giovanni Franchi	gfranchi@agescientific.com	
			Andrea Puccini	apuccini@agescientific.com	
			Giada Pieruccioni (Technical Support)	gpieruccioni@agescientific.com	

SUMMARY

- CE is an all-sky instrument capable of monitoring the hard X-ray/low γ-ray energy range can have a deep impact in multi-messenger astronomy in the near future.
- Duty-cycle and sky-coverage is optimized by proper choice of orbit (inclination ~ 20˚) and using two or three modules in suitable orbits.
- Enhanced sensitivity using latest detector materials and photon detection techniques.
- Works in the energy range crucial for the transients like GRBs.
- The design ensures symmetrical and quasi-uniform response efficiency over a wide field-of-view (>2π sr) of the sky.
- Better effective area, sensitivity and localization power than the existing experiments.
- Will gain from the technology innovation in WINK pathfinder and exploiting the heritage of the NUSES mission

Join our effort!

CRYSTAL EYE