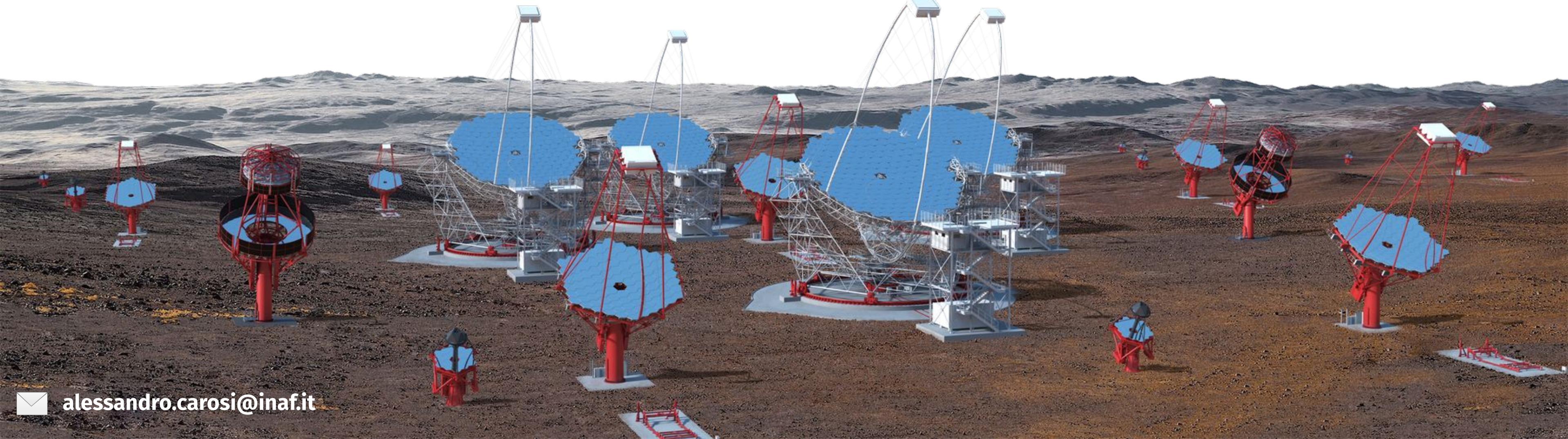
AVENGe
Advances in Very-High Energy Astrophysics with Next-Generation Cherenkov Telescopes

The CTA "*Extragalactic Transients*" Key Science Project

Alessandro Carosi
INAF - Osservatorio Astronomico di Roma

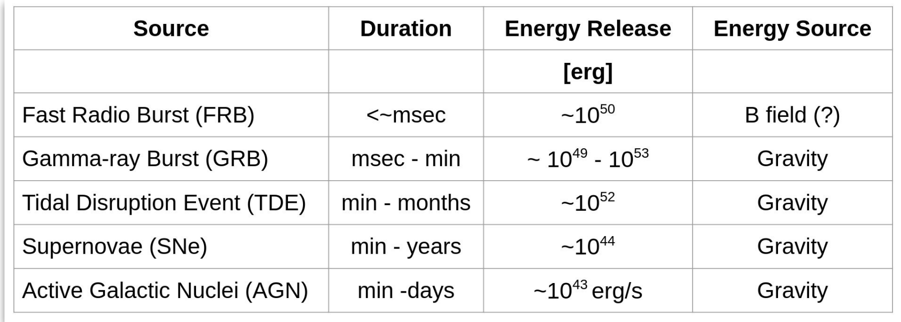


alessandro.carosi@inaf.it

Very High Energy Transients

Short time-scale transients represent a very “wide” science case although they are key science targets for both current IACT collaborations and for CTA. Short time-scale follow-ups often differ from normal observations:

- interruption of nominal operations, fast repointing, special setup, custom data analysis
- They cover all areas of the experiment: instrument, analysis & physics



Source	Duration	Energy Release [erg]	Energy Source
Fast Radio Burst (FRB)	<~msec	$\sim 10^{50}$	B field (?)
Gamma-ray Burst (GRB)	msec - min	$\sim 10^{49} - 10^{53}$	Gravity
Tidal Disruption Event (TDE)	min - months	$\sim 10^{52}$	Gravity
Supernovae (SNe)	min - years	$\sim 10^{44}$	Gravity
Active Galactic Nuclei (AGN)	min -days	$\sim 10^{43}$ erg/s	Gravity

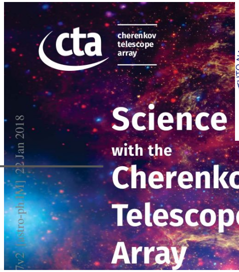
+ Multi-messenger: GW, Nu….

Hot topics at the frontiers of VHE and multi-messenger astrophysics

Requirements:

- low energy threshold
- fast repointing
- synergies with other facilities

Very High Energy Transients



A) **Gamma-ray bursts** (GRBs), based on external alerts from monitoring facilities. Thought to be triggered by special types of stellar collapse and merger events involving NSs and/or BHs, these highly luminous and distant explosions in the universe are also one of its most mysterious phenomena, with many basic aspects still poorly understood [254, 14, 255]. In addition to addressing k
the physics of GRBs, CTA will use GRBs as probes of cosmic-ray physics, observati
fundamental physics [14, 31, 256].

B) **Galactic transients**, based on external alerts from monitoring facilities. A wide range of compact objects in our Galaxy exhibit different types of jets and winds that accelerate high-energy particles in sporadic outbursts, whose production mechanisms can be greatly clarified through CTA observations [257, 15, 20]. These include flares from pulsar wind nebulae (PWNe; relativistic outflows driven by rotating NSs) [15, 258], flares from magnetars (NSs with anomalously high magnetic fields), jet ejection
nicroquasars and other X-ray binaries (NSs or BHs accreting matter from a stellar compan-
, novae (explosions on the surfaces of white dwarfs) [259], etc.

C) **X-ray, optical and radio transients**, based on alerts from "transient factory" facilities. Large numbers of X-ray, optical and radio transient phenomena will be newly identified by current and upcoming transient factories capable of regularly monitoring large areas of the sky in these wavebands [260], including tidal disruption events (TDEs) [261], supernova shock breakout (SSB) events [262] and fast radio bursts (FRBs) [263]. Observing a selected sample of such alerts with CTA offers new strategies for elucidating various known types of transients, as well as the potential for discovering completely new source classes.

D) **High-energy neutrino transients**, based on alerts from neutrino observatories. Cosmic high-energy neutrinos are clear indicators of hadronic cosmic-ray production [264] and have begun to be detected by current facilities [45], although their origin is yet unclear [265]. CTA follow-up of appropriately selected alerts can determine their origin [266, 267] and can possibly give insight on extragalactic and/or Galactic cosmic rays as well.

E) **GW transients**, based on alerts from GW observatories. GWs are mos
cosmic transients and were directly detected for the first time from binary BH merger events [7, 29]
without any clear evidence of associated electromagnetic signals [268] (see however [269]). More GW detections are expected in the coming years, including those of NS mergers accompanied by electro-

F) **Serendipitous VHE transients**, identified via the CTA real-time analysis (RTA) during scheduled CTA observations. The RTA can recognize new transients or flaring states of known sources at very high energies anywhere in the FoV and automatically issue alerts within 30 sec [272, 273]. As with transient factory events, follow-up of a selected sample will greatly advance studies of known and unknown transients.

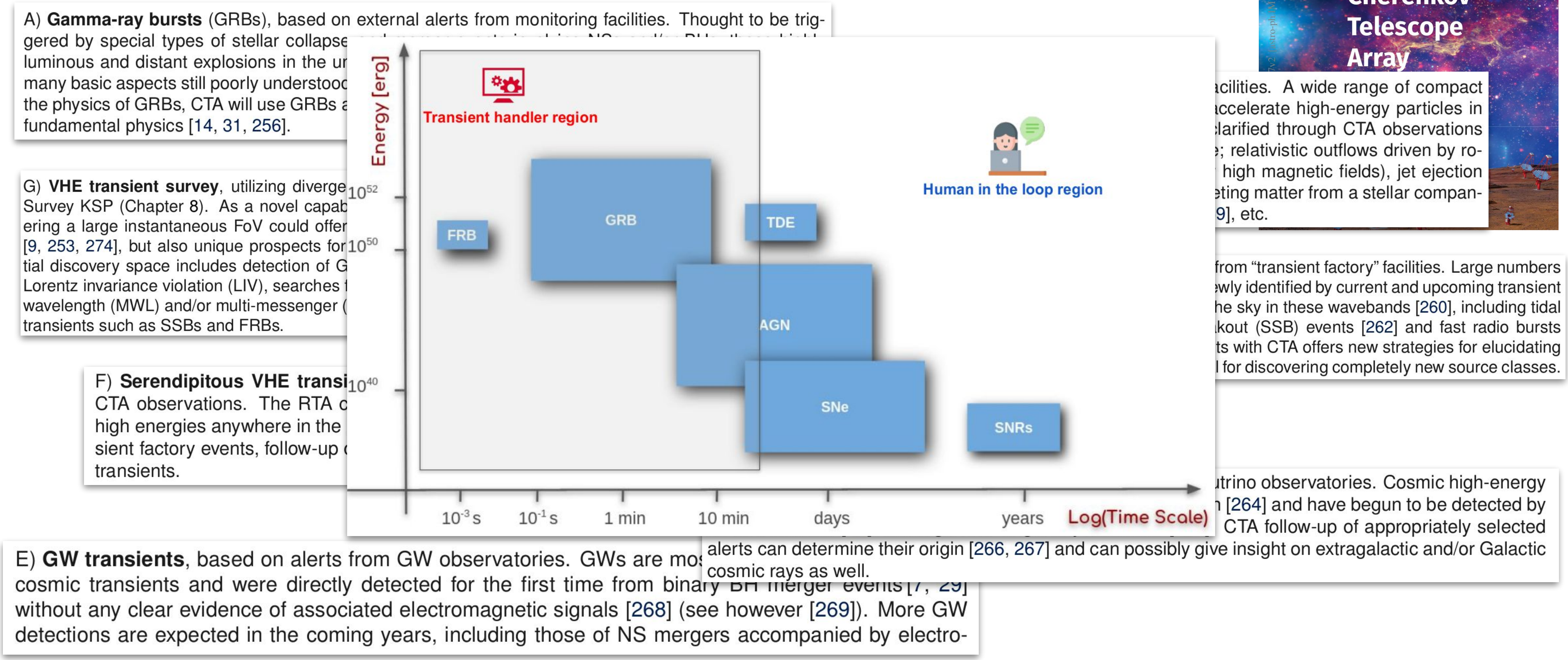
G) **VHE transient survey**, utilizing divergent pointing and in conjunction with the CTA Extragalactic Survey KSP (Chapter 8). As a novel capability of CTA, observations in divergent pointing mode covering a large instantaneous FoV could offer not only more efficient surveying of the extragalactic sky [9, 253, 274], but also unique prospects for a VHE transient survey not biased by alerts. The potential discovery space includes detection of GRBs from their onset and consequently improved tests of Lorentz invariance violation (LIV), searches for new classes of VHE transients, and simultaneous multi-wavelength (MWL) and/or multi-messenger (MM) studies with other wide FoV facilities of short-duration transients such as SSBs and FRBs.

Very High Energy Transients

cta cherenkov telescope array

Science with the Cherenkov Telescope Array

7v2 [astro-ph.IM] 22 Jan 2018



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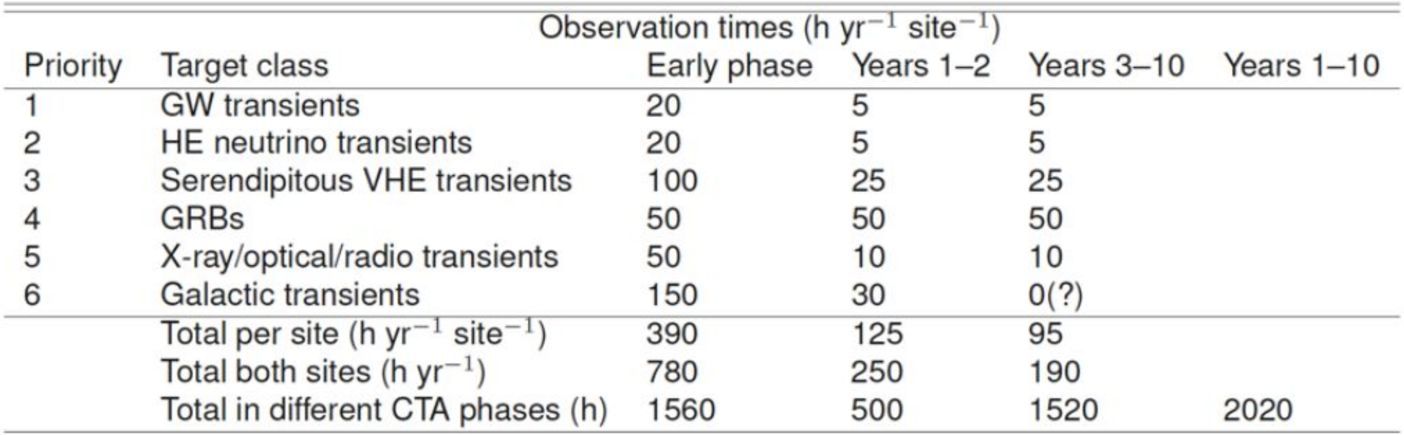
Very High Energy Transients

Transient KSP

- ❏ Initially written in 2014 → published in 2017 in the core science paper
- ❏ Requirements based on our knowledge of transients in early “20tenth”

arXiv:1709.07997



		Observation times ($h\ yr^{-1}\ site^{-1}$)			
Priority	Target class	Early phase	Years 1–2	Years 3–10	Years 1–10
1	GW transients	20	5	5	
2	HE neutrino transients	20	5	5	
3	Serendipitous VHE transients	100	25	25	
4	GRBs	50	50	50	
5	X-ray/optical/radio transients	50	10	10	
6	Galactic transients	150	30	0(?)	
	Total per site ($h\ yr^{-1}\ site^{-1}$)	390	125	95	
	Total both sites ($h\ yr^{-1}$)	780	250	190	
	Total in different CTA phases (h)	1560	500	1520	2020

cta cherenkov telescope array

Science with the Cherenkov Telescope Array

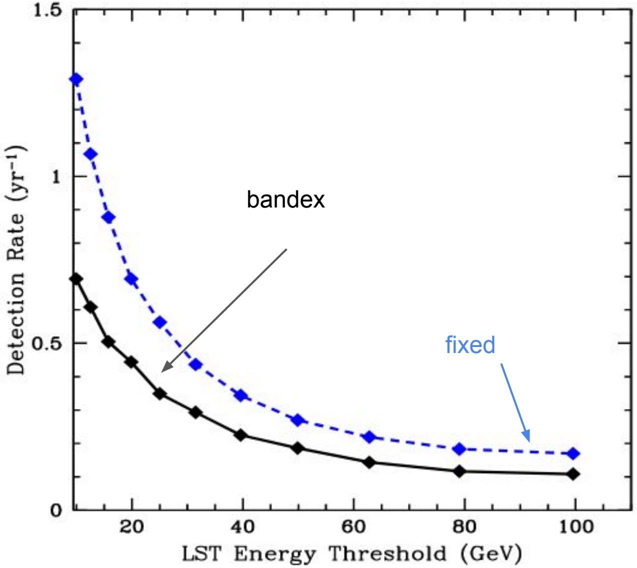
arXiv:1709.07997v2 [astro-ph.IM] 22 Jan 2018

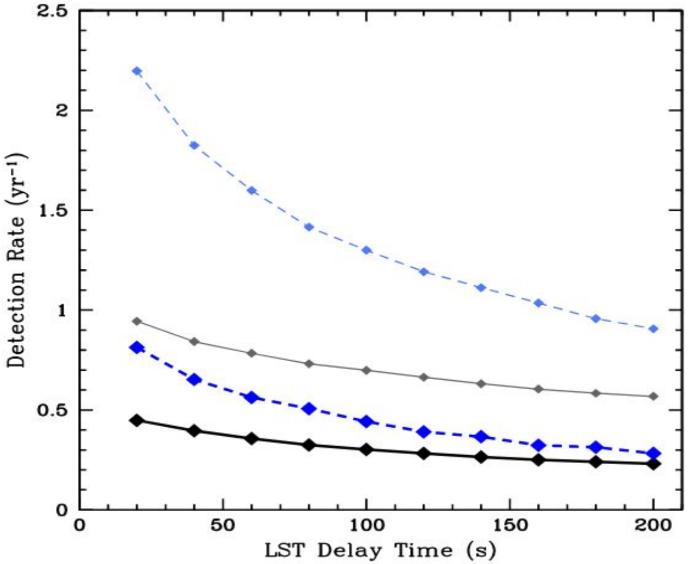
From where these numbers con

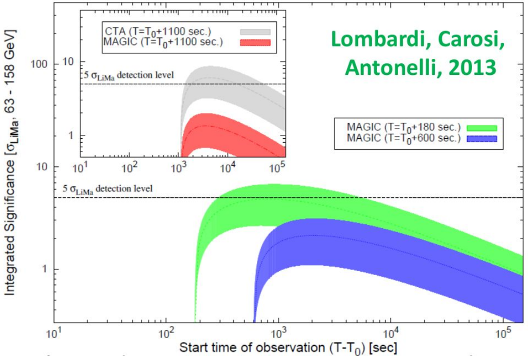
“old” approach: extrapolation of observed X-ray and gamma-ray emission toward the VHE band using GRB 090902B and GRB 080916C as template for spectra and light curves reconstruction

+

Phenomenological model for detection rate: “bandex” & “fixed” approach







Lombardi, Carosi, Antonelli, 2013

Expected detection rate:

< ~ 1 GRB yr $^{-1}$

(depending on the assumed GRB model and array layout and performance)

Limiting factors:

- Duty cycle
- Energy threshold
- Repointing time

From where these numbers con

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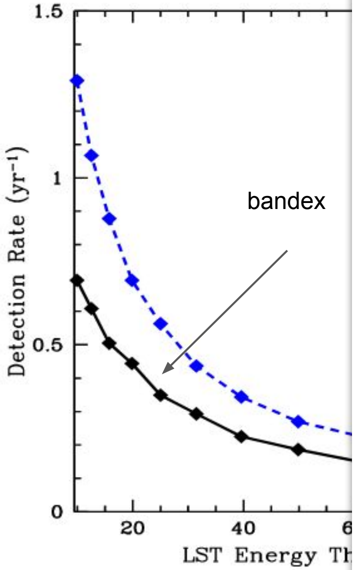


Gamma-Ray Burst Science in the Era of the Cherenkov Telescope Array

Susumu Inoue[a,b,1], Jonathan Granot[c], Paul T. O’Brien[d], Katsuaki Asano[e], Aurelien Bouvier[f], Alessandro Carosi[g], Valerie Connaughton[h], Markus Garczarczyk[i], Rudy Gilmore[f,j], Jim Hinton[d], Yoshiyuki Inoue[k,l], Kunihito Ioka[m], Jun Kakuwa[n], Sera Markoff[o], Kohta Murase[b,p], Julian P. Osborne[d], A. Nepomuk Otte[q], Rhaana Starling[d], Hiroyasu Tajima[r], Masahiro Teshima[b,s], Kenji Toma[t], Stefan Wagner[u], Ralph A. M. J. Wijers[o], David A. Williams[f], Tokonatsu Yamamoto[v], Ryo Yamazaki[w], for the CTA Consortium

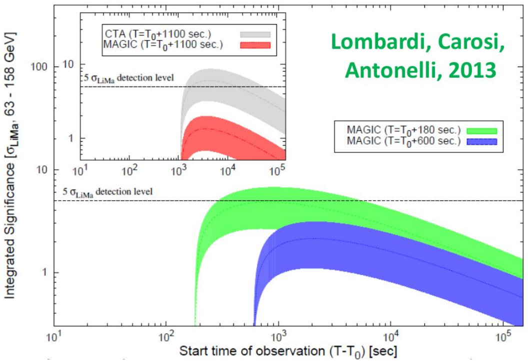
[a] *Max-Planck-Institut für Kernphysik, Saupfercheckweg 1, 69117 Heidelberg, Germany*
[b] *Institute for Cosmic Ray Research, University of Tokyo, Kashiwanoha 5-1-5, Kashiwa 277-8582, Chiba, Japan*
[c] *Department of Natural Sciences, The Open University of Israel, 1 University Road, POB 808, Raanana 43537, Israel*
[d] *Department of Physics and Astronomy, University of Leicester, University Road, Leicester LE1 7RH, UK*
[e] *Interactive Research Center of Science, Tokyo Institute for Technology, 2-12-1 Ookayama, Meguro-ku, Tokyo 152-8550, Japan*
[f] *Santa Cruz Institute for Particle Physics, University of California, Santa Cruz, CA 95064, USA*
[g] *Istituto Nazionale di Astrofisica, 00136 Roma, Italy*
[h] *Department of Physics, University of Alabama in Huntsville, Huntsville, AL 35805, USA*
[i] *Instituto de Astrofísica de Canarias, 38200 La Laguna, Tenerife, Spain*
[j] *Scuola Internazionale Superiore di Studi Avanzati (SISSA), via Bonomea 265, 34136 Trieste, Italy*
[k] *Department of Astronomy, Kyoto University, Oiwake-cho, Kitashirakawa, Sakyo-ku, Kyoto 606-8502, Japan*
[l] *SLAC National Accelerator Laboratory, Stanford University, Stanford, CA, USA*
[m] *Theory Center, Institute of Particle and Nuclear Studies, KEK, 1-1 Oho, Tsukuba 305-0801, Japan*
[n] *Department of Physical Science, Hiroshima University, Higashi-hiroshima 739-8526, Japan*
[o] *Astronomical Institute gAnton Pannekoekh, University of Amsterdam, Postbus 94249, 1090 GE Amsterdam, The Netherlands*
[p] *Center for Cosmology and AstroParticle Physics, Ohio State University, 191 West Woodruff Avenue, Columbus, OH 43210, USA*
[q] *School of Physics & Center for Relativistic Astrophysics, Georgia Institute of Technology, 837 State Street NW, Atlanta, GA 30332-0430, USA*
[r] *Solar-Terrestrial Environment Laboratory, Nagoya University, Nagoya 464-8601, Japan*
[s] *Max-Planck-Institut für Physik, Föhringer Ring 6, 80805 München, Germany*
[t] *Department of Earth and Space Science, Osaka University, Toyonaka 560-0043, Osaka, Japan*
[u] *Landessternwarte, Universität Heidelberg, Königstuhl, 69117 Heidelberg, Germany*
[v] *Department of Physics, Konan University, 8-9-1 Okamoto, Higashinada-ku, Kobe, Hyogo 658-8501, Japan*
[w] *Department of Physics and Mathematics, Aoyama Gakuin University, Sagamihara 252-5258, Japan*

Abstract

We outline the science prospects for gamma-ray bursts (GRBs) with the Cherenkov Telescope Array (CTA), the next-generation ground-based gamma-ray observatory operating at energies above few tens of GeV. With its low energy threshold, large effective area and rapid slewing capabilities, CTA will be able to measure the spectra and variability of GRBs at multi-GeV energies with unprecedented photon statistics, and thereby break new ground in elucidating the physics of GRBs, which is still poorly understood. Such measurements will also provide crucial diagnostics of ultra-high-energy cosmic ray and neutrino production in GRBs,
advance observationa … actic magnetic fields, and
contribute to fundame … quantify these goals, we
present some simulat … etection rates with CTA.
Although the expecte … gy photons per burst may
be attainable once the … ellites and other facilities
with CTA, as well as … serving GRBs from their
onset including short GRBs during a wide-field survey mode is also briefly discussed.

Keywords: gamma-ray bursts, high-energy gamma rays, Cherenkov telescopes, cosmic rays, cosmology, special relativity

Gamma-ray burst science in the era of the Cherenkov Telescope Array, S. Inoue et al., 2013, Astroparticle Physics, 43, 252



Lombardi, Carosi, Antonelli, 2013

Expected detection rate:

< ~ 1 GRB yr $^{-1}$

(depending on the assumed GRB model and array layout and performance)

Limiting factors:

- Duty cycle
- Energy threshold
- Repointing time

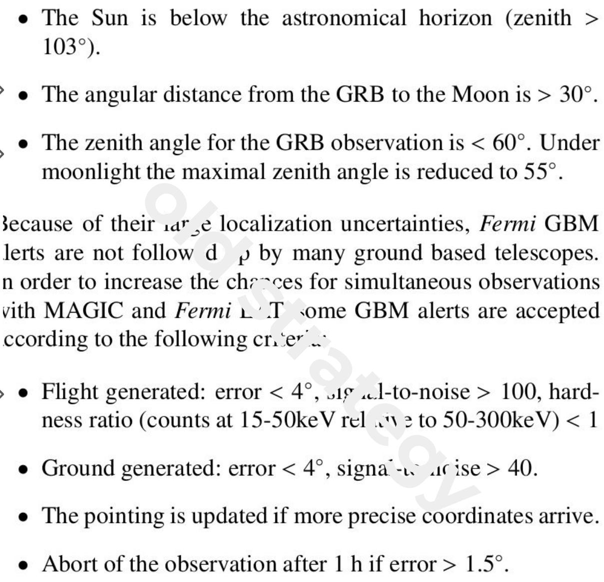
From where these numbers come from

Need to re-evaluate these numbers basing on new instruments characteristics and "new" VHE landscape

SiPM (??)

For CTA: 70deg

For CTA: tiling



- The Sun is below the astronomical horizon (zenith > 103°).
- The angular distance from the GRB to the Moon is > 30°.
- The zenith angle for the GRB observation is < 60°. Under moonlight the maximal zenith angle is reduced to 55°.

ecause of their large localization uncertainties, *Fermi* GBM lerts are not followed up by many ground based telescopes. n order to increase the chances for simultaneous observations vith MAGIC and *Fermi* LAT some GBM alerts are accepted ccording to the following criteria:

- Flight generated: error < 4°, signal-to-noise > 100, hardness ratio (counts at 15-50keV relative to 50-300keV) < 1
- Ground generated: error < 4°, signal-to-noise > 40.
- The pointing is updated if more precise coordinates arrive.
- Abort of the observation after 1 h if error > 1.5°.

old strategy

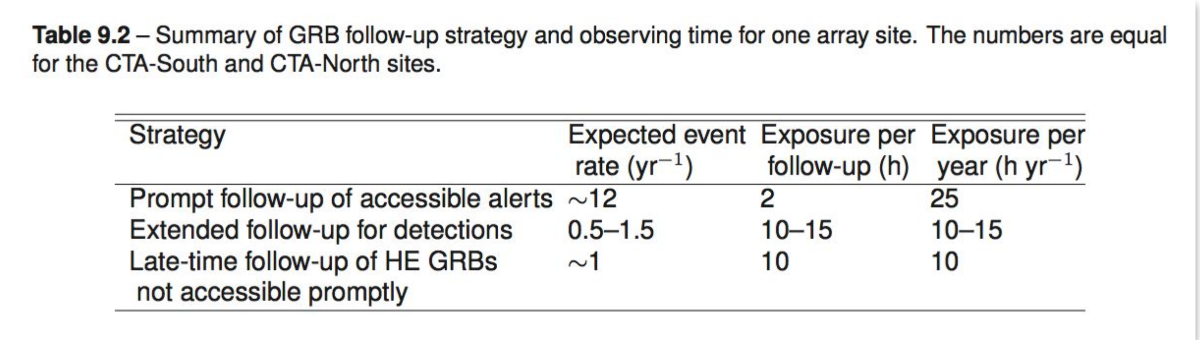


Table 9.2 – Summary of GRB follow-up strategy and observing time for one array site. The numbers are equal for the CTA-South and CTA-North sites.

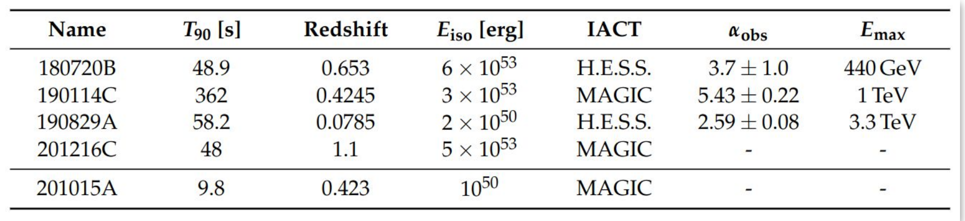
Strategy	Expected event rate (yr^{-1})	Exposure per follow-up (h)	Exposure per year ($h\ yr^{-1}$)
Prompt follow-up of accessible alerts	~12	2	25
Extended follow-up for detections	0.5–1.5	10–15	10–15
Late-time follow-up of HE GRBs not accessible promptly	~1	10	10

Very High Energy Transients

VHE Transient Astrophysics is “warming up” in the last years:

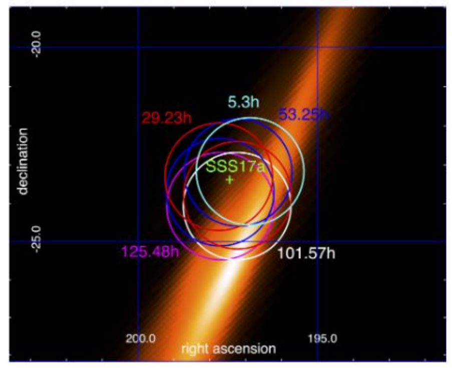
GRB detection at VHE: a long-awaited result!

MAGIC GRB 190114C... (2019, Nature, 575, 455/459)
H.E.S.S. GRB 190829A... (2021, Science , 372, 6546)



Name	T_{90} [s]	Redshift	E_{iso} [erg]	IACT	α_{obs}	$E_{\max}$
180720B	48.9	0.653	6×10^{53}	H.E.S.S.	3.7 ± 1.0	440 GeV
190114C	362	0.4245	3×10^{53}	MAGIC	5.43 ± 0.22	1 TeV
190829A	58.2	0.0785	2×10^{50}	H.E.S.S.	2.59 ± 0.08	3.3 TeV
201216C	48	1.1	5×10^{53}	MAGIC	-	-
201015A	9.8	0.423	10^{50}	MAGIC	-	-

+ GRB 221009A LHAASO >10 TeV (?)



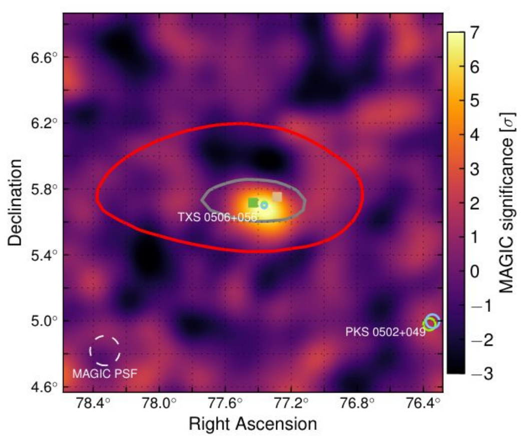
GWs astrophysics (now in O4)

- GW 170817: sGRB are mergers
- H.E.S.S. GW 170817 (2017, ApJL, 850, L22)
- many more alerts expected in O4

Neutrino/VHE connections for TXS 0506+056

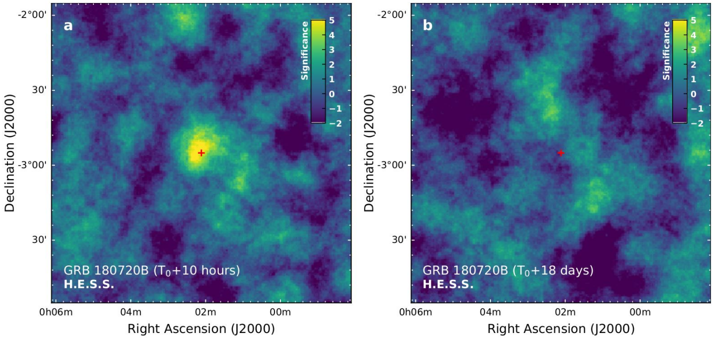
- Blazar Found in flaring state by Integral, Fermi/GBM, MAGIC, ...
- Then neutrinos founds by IceCube...

(2018, Science, 361, 6398)



+ steady nu source (NGC 1068)

Gamma ray Burst



GBM trigger at 14:21:39 UTC **GRB 180720B**

- ☐ $z = 0.653$ (VLT/X-shooter)
- ☐ LAT: detected up to $T_0 + 700$ s
- ☐ Emax = 5 GeV, $T_0 + 142$ s
- ☐ $T_{90} = 48.9 \pm 0.4$ s
- ☐ $E_{iso} \sim 6 \times 10^{53}$ erg (50-300 keV)

(6th brighter GBM event)
(2nd highest 11 hr flux in XRT)

H.E.S.S. follow up:

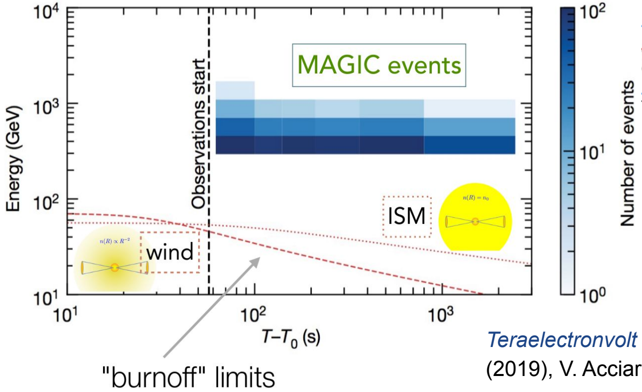
- ☐ start at T_0+10 hr
- ☐ Total exposure: 2 hr

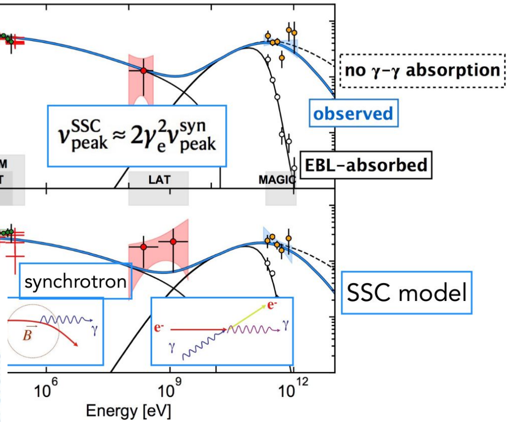
H.E.S.S.

A very high energy component deepin the Gamma-Ray Burst afterglow, H. Abdalla et al. (H.E.S.S. Coll.), Nature, 575, 464

GRB 190114C

MAGIC
Major Atmospheric
Gamma Imaging
Cerenkov Telescopes



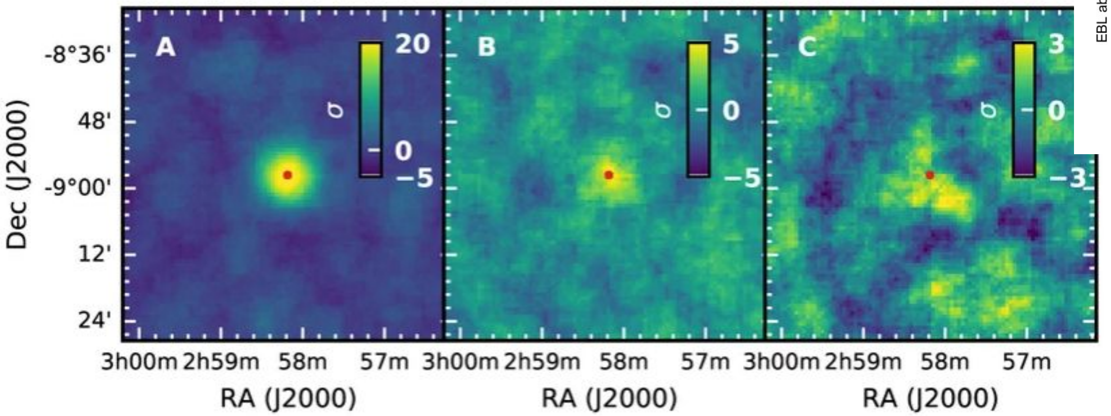


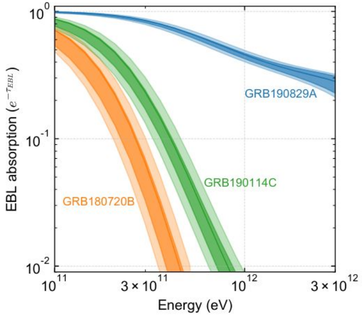
- ☐ Synchrotron burnoff limit largely exceeded
- ☐ First clear evidence of a second emission component (SSC - blazar-like)

Teraelectronvolt emission from the gamma-ray burst GRB 190114C (2019), V. Acciari et al. (MAGIC Collaboration) Nature, 575, 45

- 1st GRB unambiguous detection at TeV energies
- 1st GRB observed over 20 orders of magnitude in energy
- 1st GRB with unambiguous detection of a new energetic emission component distinct from synchrotron
- 1st single broad-band modeling of a GRB including both components
- Brightest TeV source ever detected (>~ 100 crab)

Gamma ray Burst

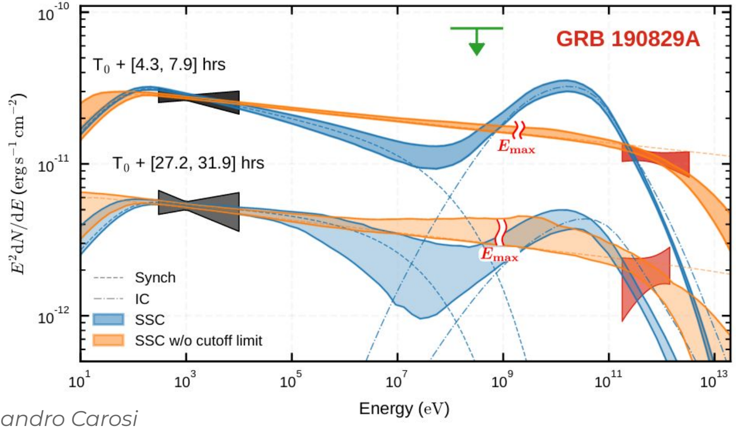




- ❑ SSC model unlikely
- ❑ challenging the the synchrotron burnoff limit → acceleration mechanisms?

H.E.S.S.

Revealing X-ray and gamma ray temporal and spectral similarities in the GRB 190829A afterglow, H. Abdalla et al. (H.E.S.S. Coll.), Science, 372, 6546



Detected by Swift and Fermi-GBM on 2019/08/29 at 19:56:44 UTC (swift T_0)

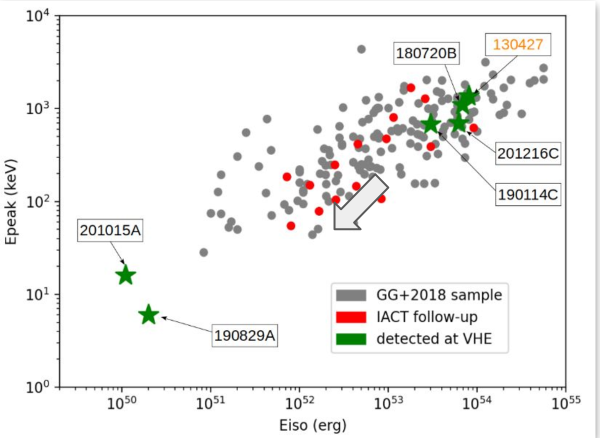
- very low-luminosity (E_{iso}~ 2 x 10^{50} erg) & nearby (z~0.08) event
- Not detected by Fermi-LAT (~ 100 MeV - 100 GeV)
- Prompt emission (T_{90}) <~ 1 min;
- low value of E_{peak} ~ 11 keV but harder precursor
- Beside a large flare at T=T_0+103 s, quite normal X-ray afterglow behaviour

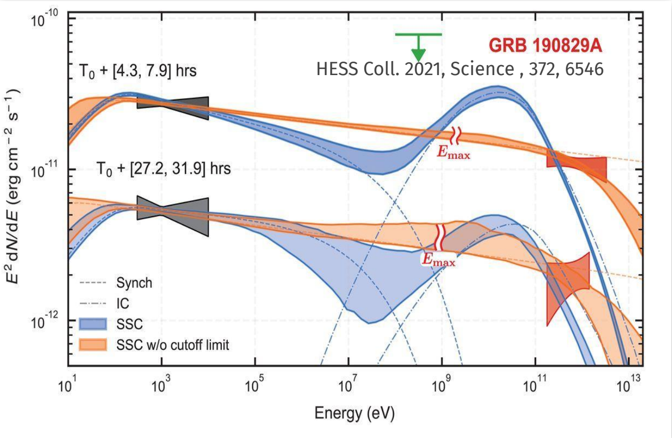
GRB: what have we learned

❑ (see Lara's talk)

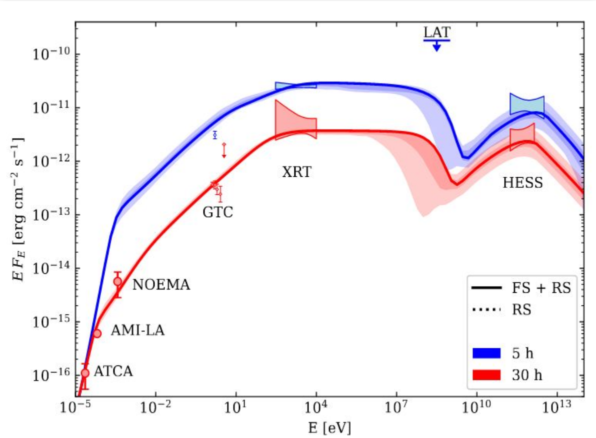
Although the quest for the first detection is over, we are now moving to the phase of physics interpretation and, possibly, populations studies

- ❑ Which are the emission mechanisms? VHE during afterglow and/or prompt? ***Do all GRB have a VHE component?*** Why haven't we detected GRB before ?
- ❑ We now had few detections (like GRB 180720B and GRB 190114C) that were somehow 'expected' (bright, powerful etc). However, we also have something that is (apparently) different. Are we observing the first (or one of the first) event of a new GRB population? Or do we just have to think that the parameters space of the possible VHE-emitter GRB is much larger than we thought in the past?





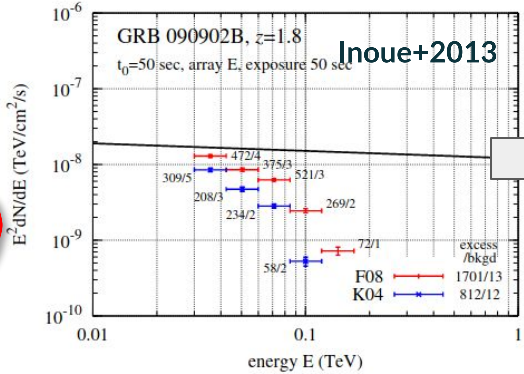
HESS Coll. 2021, Science , 372, 6546



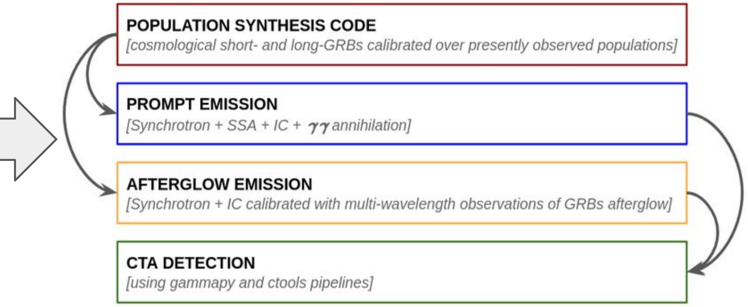
GRB: where we are heading in CTA

From "empirical" to
"theoretical" approach

Expected numbers:
still ~ **few/years** considering both array



Inoue+2013



POPULATION SYNTHESIS CODE
[cosmological short- and long-GRBs calibrated over presently observed populations]

PROMPT EMISSION
[Synchrotron + SSA + IC + $\gamma\gamma$ annihilation]

AFTERGLOW EMISSION
[Synchrotron + IC calibrated with multi-wavelength observations of GRBs afterglow]

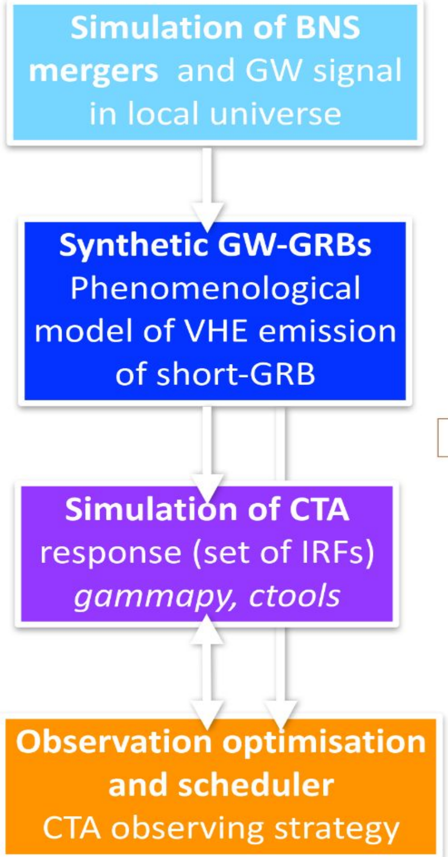
CTA DETECTION
[using gammapy and ctools pipelines]

- Simulation of a GRB population by assuming a few intrinsic properties (E_{peak} & z distribution + E_{peak}-E_{iso} correlation)
- Bulk Lorentz factor distribution obtained by measured time of afterglow onset → Bulk Lorentz factor of the coasting phase
- Assumed spectrum allow to compute the flux and fluence in the energy bands corresponding to the instruments used to calibrate the sample

➢ GRB detection rate and parameter space study
➢ Spectra & Light curves
➢ Assess the effect on different array conf.

Bernardini+2019, POSyTIVE - a GRB population study for the Cherenkov Telescope Array, ICRC 2019, id. 1177

GW: where we are heading in CTA

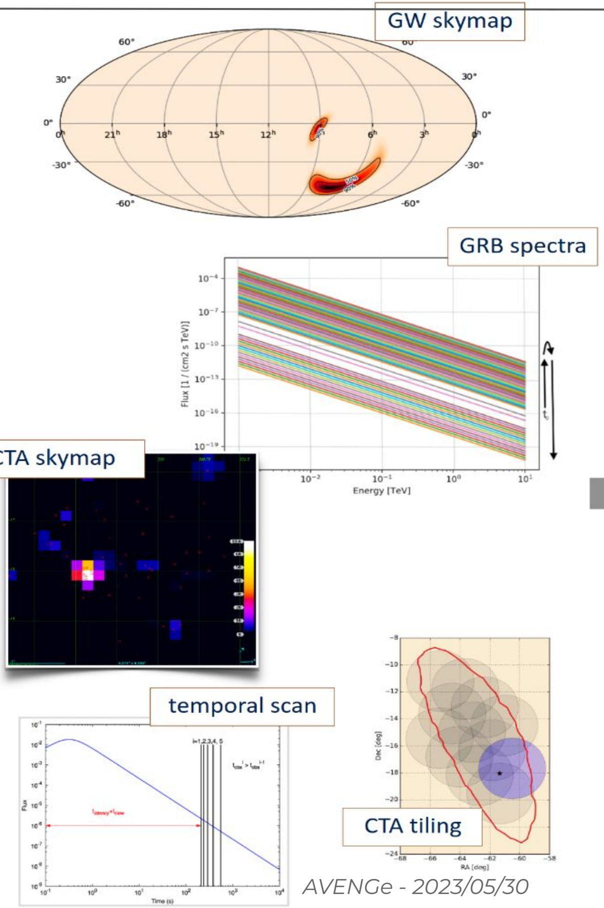


Simulation of BNS mergers and GW signal in local universe

Synthetic GW-GRBs
Phenomenological model of VHE emission of short-GRB

Simulation of CTA response (set of IRFs)
gammapy, ctools

Observation optimisation and scheduler
CTA observing strategy

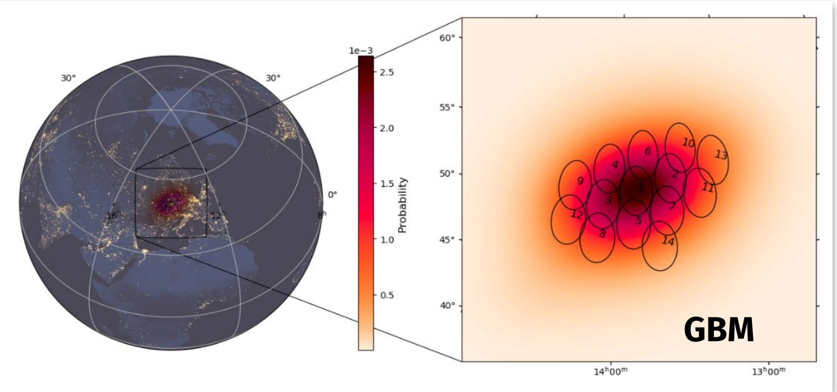


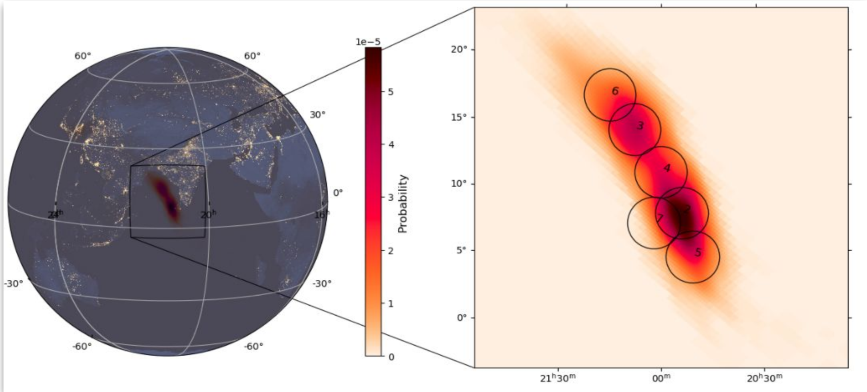
from A. Stamerra@Granada CTA meeting

Content of the GW-CTA paper

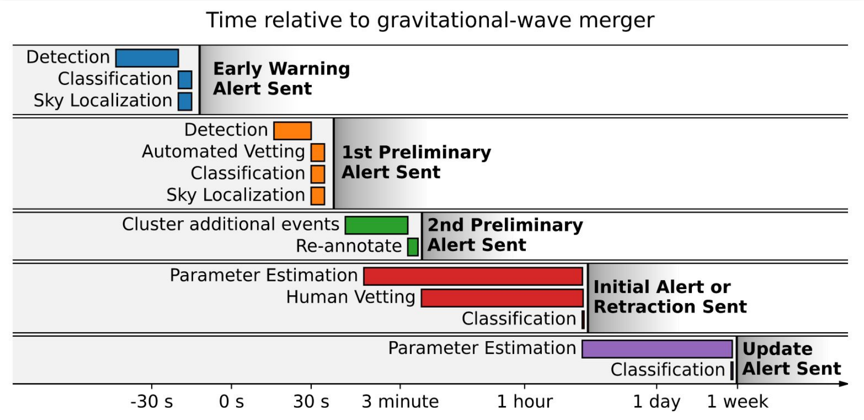
- Joint GW-CTA rates
- Optimization of observing strategy
- Optimal parameter space of GW-GRB
  - physical (luminosity, spectral shapes...)
  - observational (time delays, integration times)

GRB/GW: few considerations

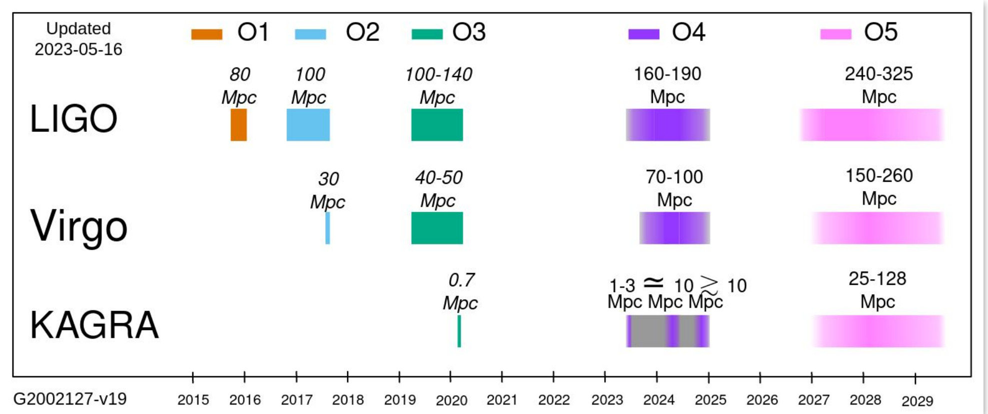


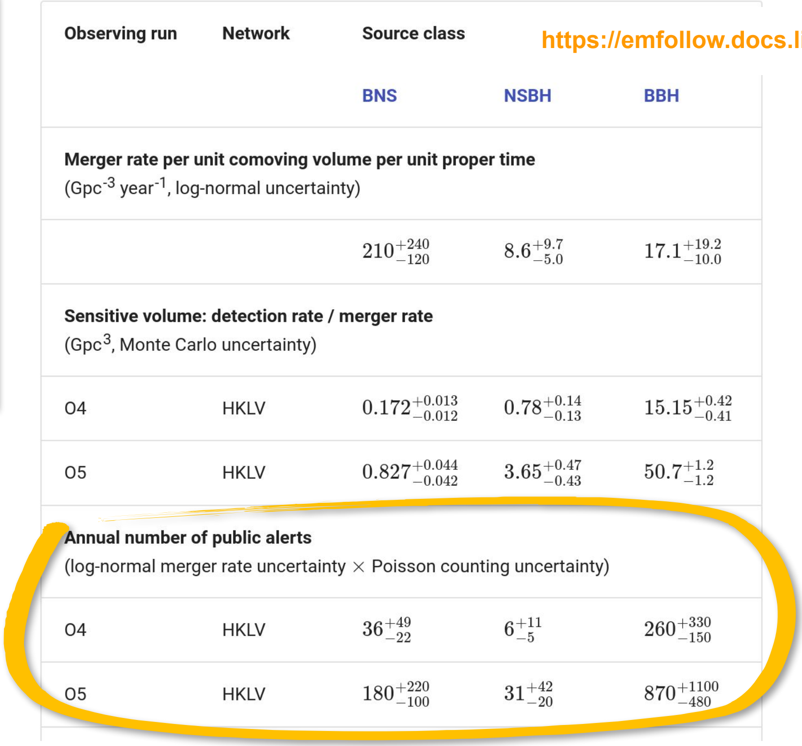


- **Major challenge: poor localization→GBM-like GRBs & GW**
  - localization uncertainty ranging from 10-1000 deg^2
  - optimizing pointing strategy for tiling observations



GRB/GW: few considerations



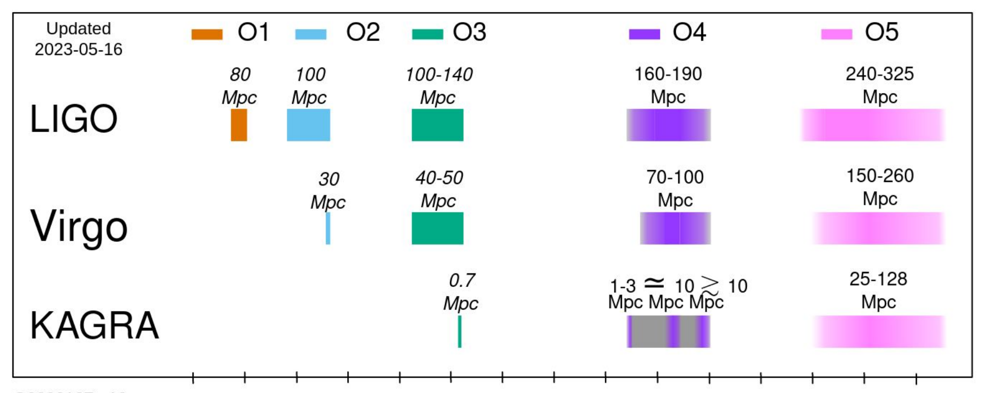


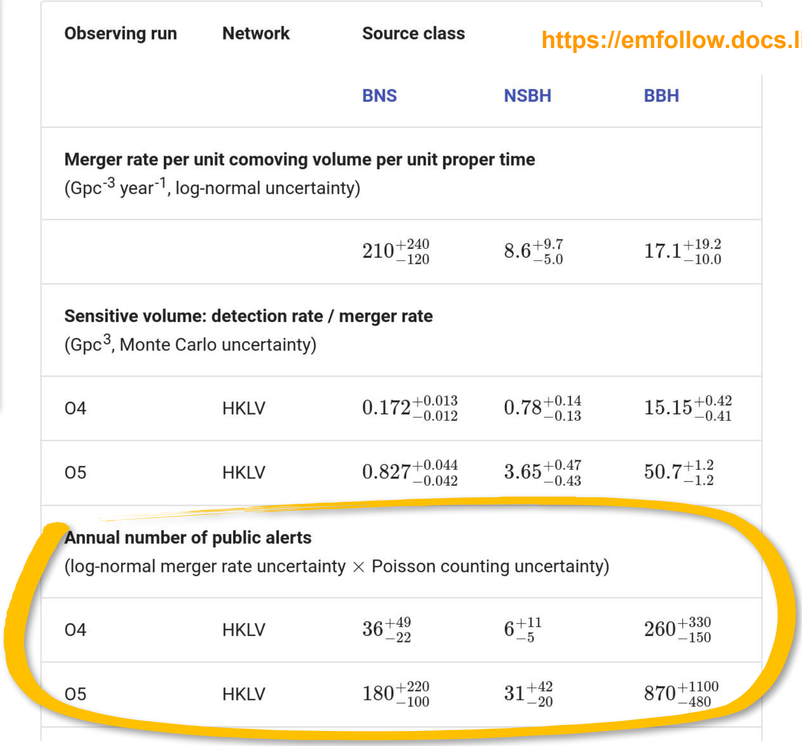
https://emfollow.docs.ligo.org

Observing run	Network	Source class BNS	 NSBH	 BBH
Merger rate per unit comoving volume per unit proper time (Gpc^{-3} year^{-1}, log-normal uncertainty)				
		210^{+240}_{-120}	$8.6^{+9.7}_{-5.0}$	$17.1^{+19.2}_{-10.0}$
Sensitive volume: detection rate / merger rate (Gpc^{3}, Monte Carlo uncertainty)				
O4	HKLV	$0.172^{+0.013}_{-0.012}$	$0.78^{+0.14}_{-0.13}$	$15.15^{+0.42}_{-0.41}$
O5	HKLV	$0.827^{+0.044}_{-0.042}$	$3.65^{+0.47}_{-0.43}$	$50.7^{+1.2}_{-1.2}$
Annual number of public alerts (log-normal merger rate uncertainty × Poisson counting uncertainty)				
O4	HKLV	36^{+49}_{-22}	6^{+11}_{-5}	260^{+330}_{-150}
O5	HKLV	180^{+220}_{-100}	31^{+42}_{-20}	870^{+1100}_{-480}

These numbers won't fit easily with the numbers of hours reported in the original KSP that, in this regard, didn't report enough details

GRB/GW: few considerations





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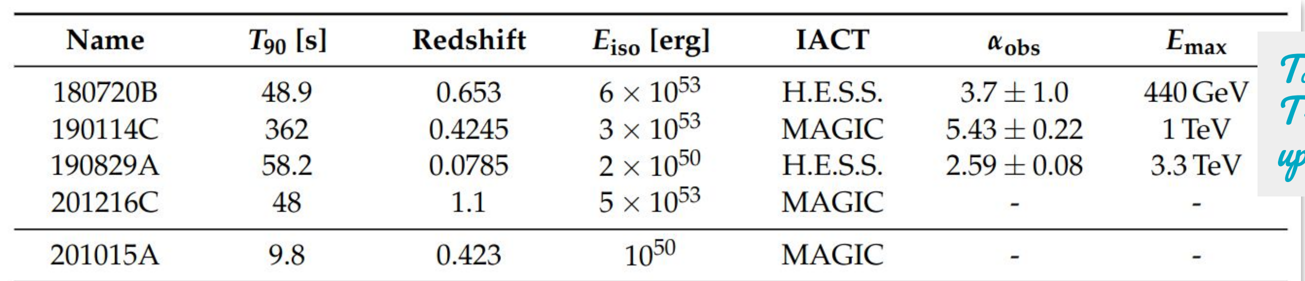
Optimization of these type of observations must be done now.

- ❑ scheduling/divergent pointing (see Irene’s talk)
- ❑ test-bench for ET (see Biswajit’s talk)

GRB/GW: few considerations



Name	T_{90} [s]	Redshift	E_{iso} [erg]	IACT	α_{obs}	E_{max}
180720B	48.9	0.653	6×10^{53}	H.E.S.S.	3.7 ± 1.0	440 GeV
190114C	362	0.4245	3×10^{53}	MAGIC	5.43 ± 0.22	1 TeV
190829A	58.2	0.0785	2×10^{50}	H.E.S.S.	2.59 ± 0.08	3.3 TeV
201216C	48	1.1	5×10^{53}	MAGIC	-	-
201015A	9.8	0.423	10^{50}	MAGIC	-	-

T_0+10h
T<~15 min
up to T_0+3days

+ GRB 221009A LHAASO >10 TeV (?)

GRB/GW: few considerations

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T_0+10h
T<~15 min
up to T_0+3days

+ GRB 221009A LHAASO >10 TeV (?)

fast reaction & low threshold are important but not as important as we thought ***for pure detection rate***

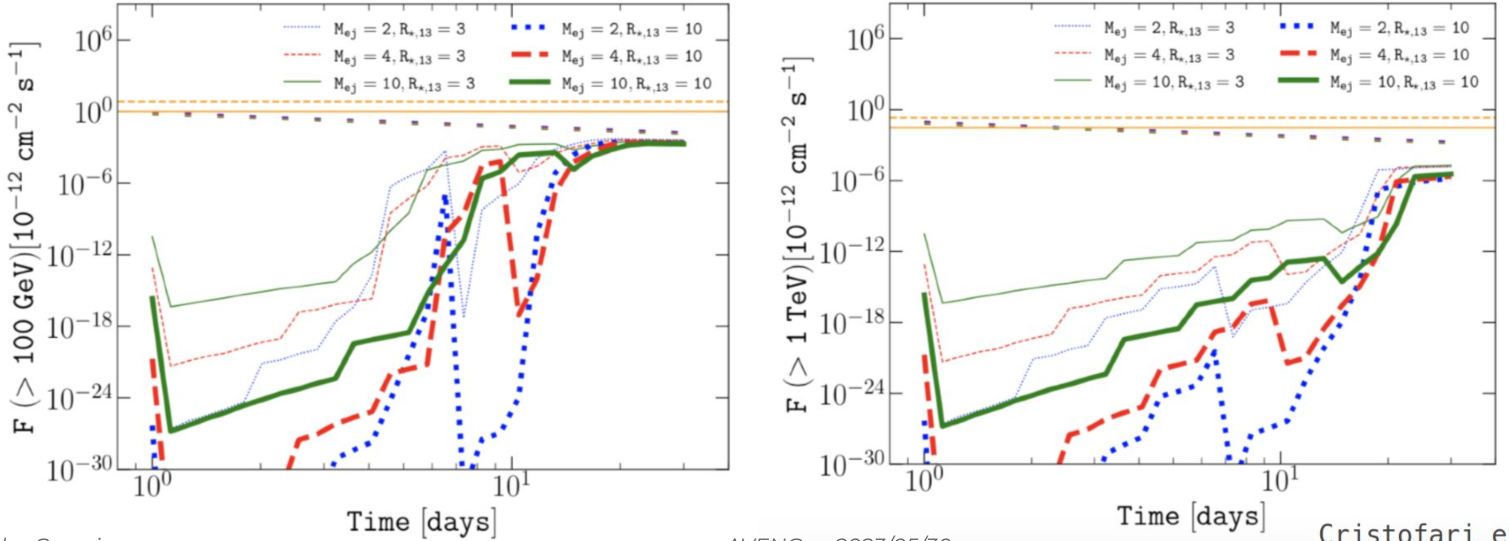
However, the physics they give access to is dramatically different
(prompt-to-early-afterglow phase, time resolved spectra, high redshift…)

Requirements:

- low energy threshold
- fast repointing
- synergies with other facilities

Core Collapse Sn

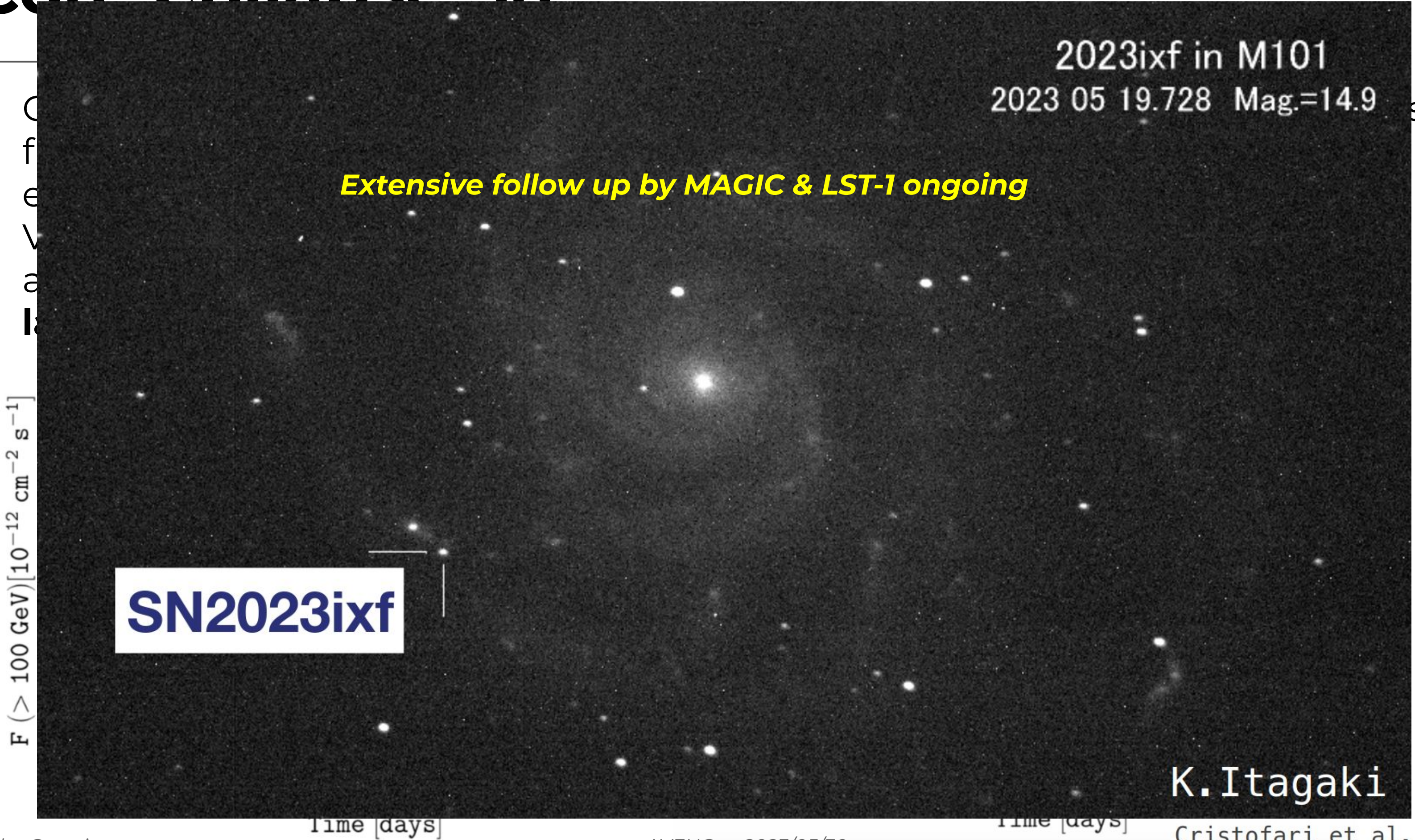
- CCSNe (type II) originating from (massive) stellar progenitors with dense winds can fulfil the right conditions for CR acceleration (Katz et al. 2011; Murase et al. 2011; Bell et al. 2013, Cristofari et al. 2022)
- VHE emission is expected in Type II CC-SNe but the gamma-ray signal can be attenuated in the first days (Cristofari et al. 2022) and can rise again about **5-10 days later.**



Cristofari et al. 2022

Core Collapse Sn

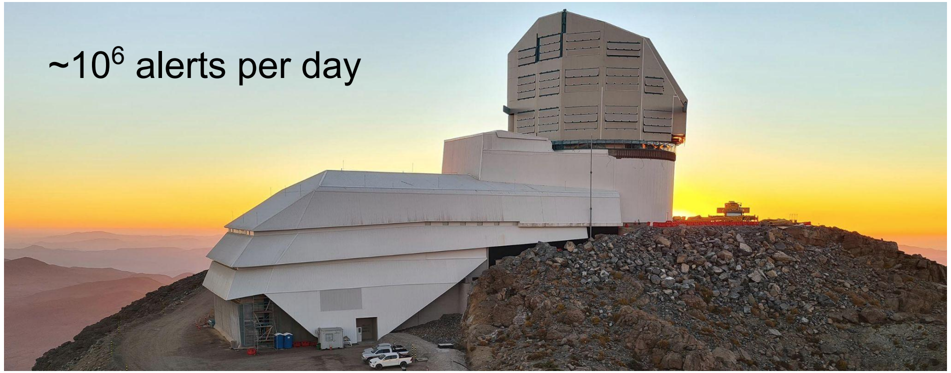
- C s can f Bell e
- V a **days l**



Extensive follow up by MAGIC & LST-1 ongoing

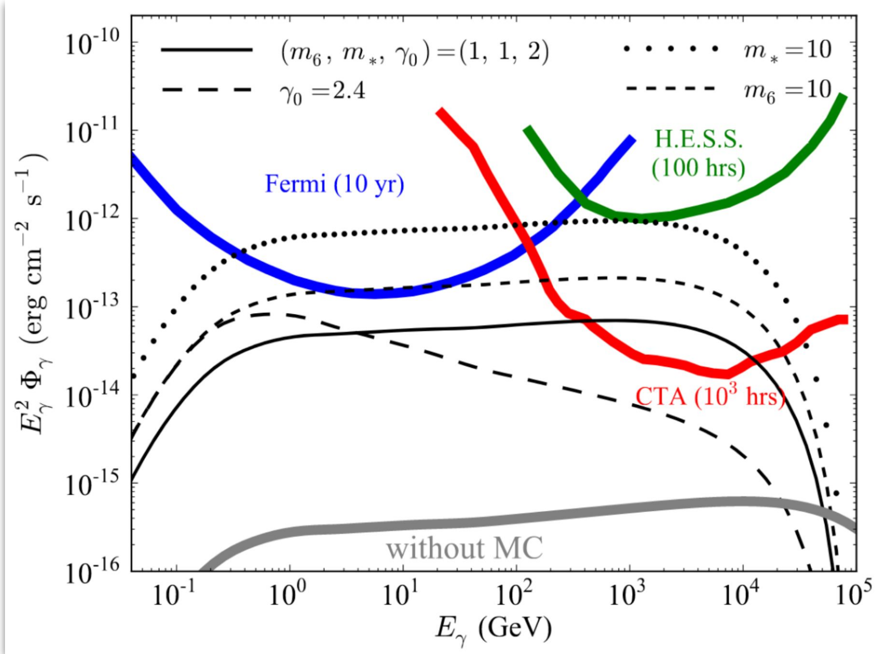
Cristofari et al. 2022

New Generation Transient Factories



~10^6 alerts per day

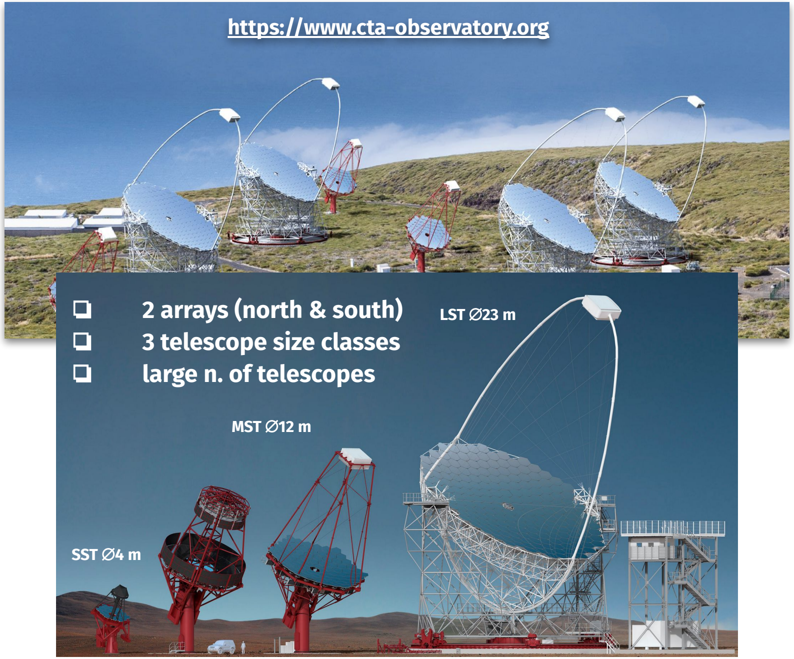
- **Supernovae:** LSST will observe ~10 million supernovae in 10 years (~1 million per year)
- **Active Galactic Nuclei:** LSST is predicted to observe millions of AGN. If 10% show any variability at any given time, then the estimate is that ~0.1 million alerts over 15.000 deg 2 would generate ~7 alerts deg 2
- **TDE, GRB, Galactic Transients....**



To be set up: alert chain & FILTERS!

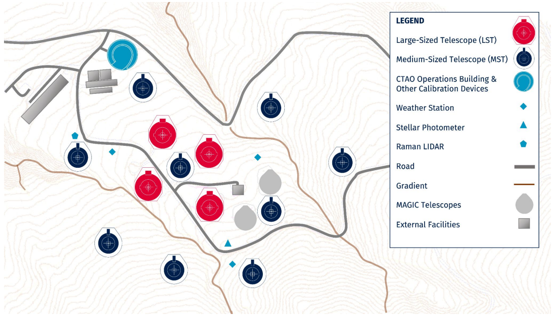
The Cherenkov Telescope Array

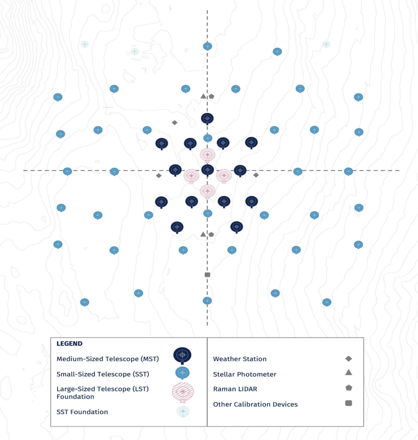
Cherenkov Telescope Array (CTA): a facility **(observatory)** for Very High Energy gamma-ray astrophysics in the next decades



https://www.cta-observatory.org

- ☐ 2 arrays (north & south)
- ☐ 3 telescope size classes
- ☐ large n. of telescopes





alpha configuration (first phase):

North: 4 LST + 9 MST
South: 14 MST + 37 SST

omega configuration (ultimate goal):

North: 4 LST + 15 MST
South: 4 LST + 25 MST + 70 SST

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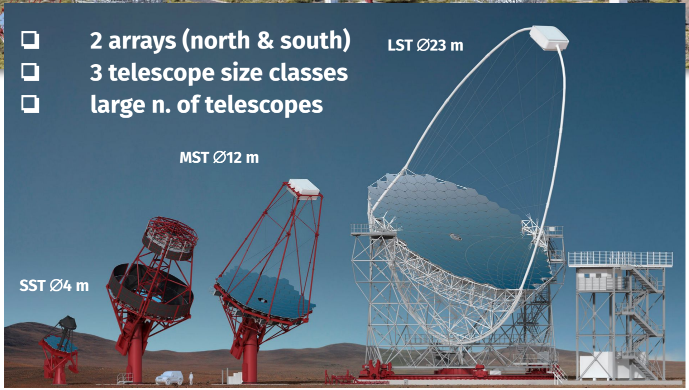
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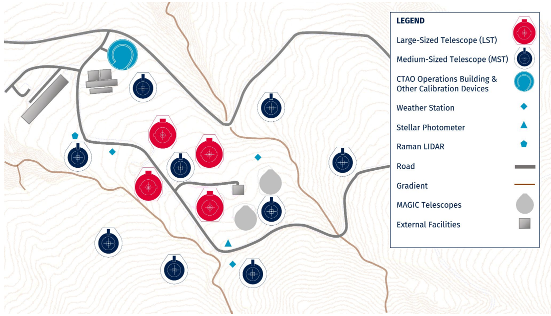

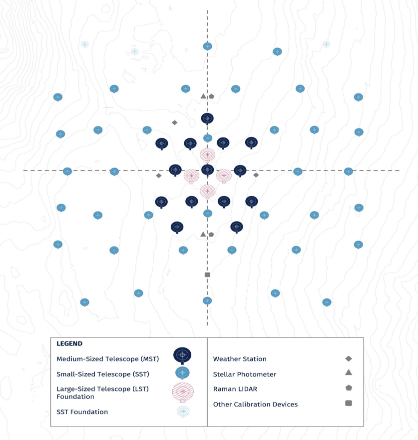

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LST 1–4 & MST 1 ongoing

The Cherenkov Telescope Array

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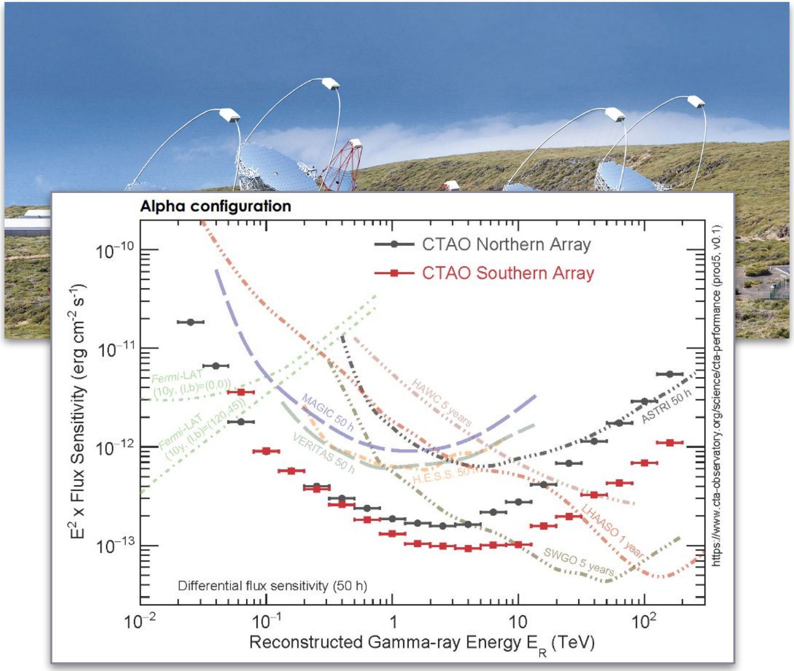
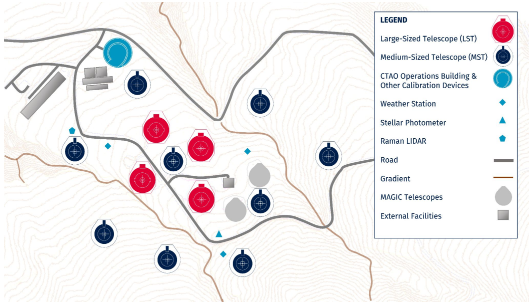
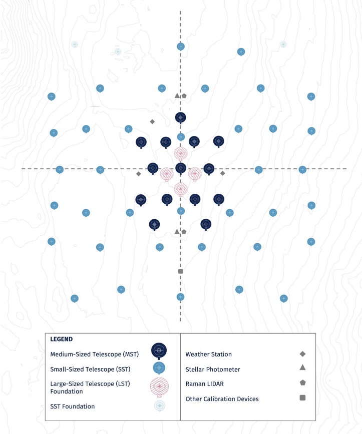






- near full sky coverage
- wider energy range (~20 GeV - 300 TeV)
- higher sensitivity: ~5-10x current IACT
- better angular resolution: ~5x current IACT
- larger FoV: 2.5x current IACT

The Cherenkov Telescope Array

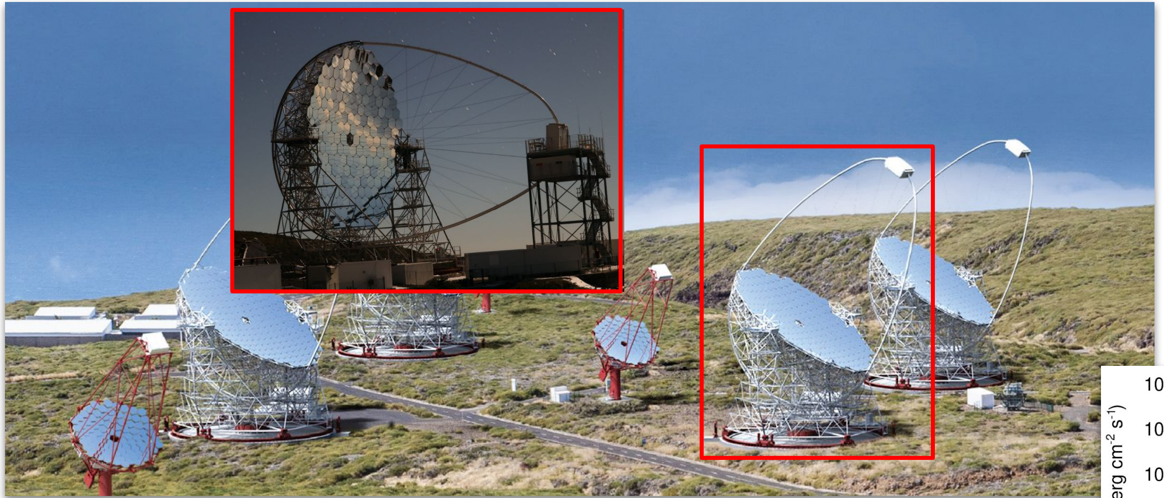
🟥 **LST Collaboration**
Brazil
Bulgaria
Croatia
Czech Rep.
France
Germany
Italy
Japan
Poland
Spain
Switzerland

- 11 Countries
- > 40 Institutions
- ~ 350 members (scientists, engineers, technicians, …)

LST-1 inaugurated in 2018

The LST-1 prototype, the first 23-m class telescope for the CTA, is already performing regular observations on a wide range of astrophysical sources

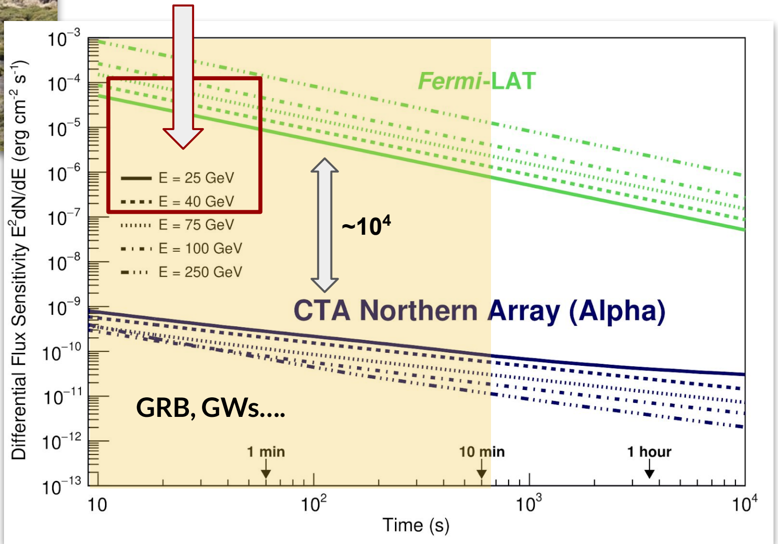
The Cherenkov Telescope Array



- Camera: 1855 PMTs, FoV ~ 4.3°
- Parabolic mirror: 23 m, 400 m²
- Focal length: 28 m
- Moving weight: ~100 tons

❑ Low energy threshold (down to ~20 GeV)
❑ Large effective area at multi-GeV range (~ 10^4 x Fermi-LAT @ ~ some mins. timescale)
❑ Fast slewing capabilities (~20 s/180^0 in azimuth)

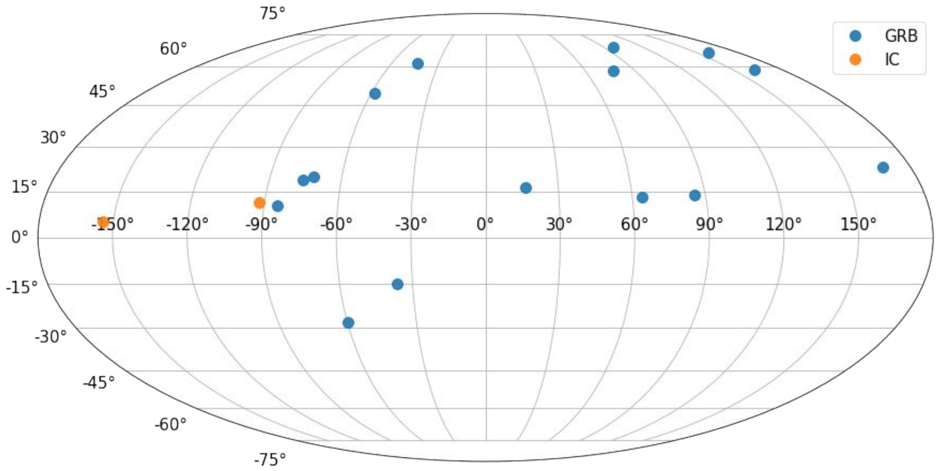
LST “sweet range”
(CTA sensitivity dominated by LSTs)

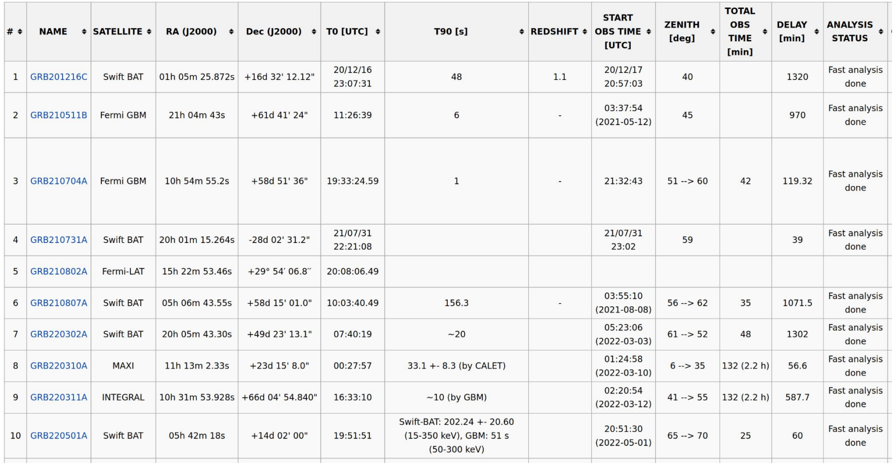


The Cherenkov Telescope Array

❑ **First regular follow-up started at the end 2020/beginning of 2021 :**

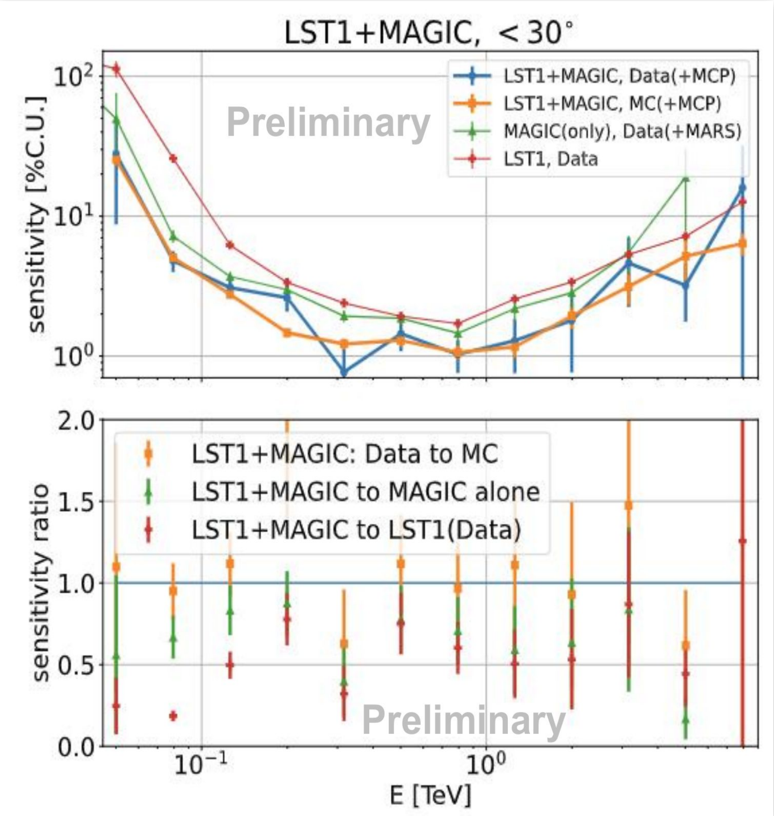
- Quite some events observed so far
- Still human-in-the-loop follow-up but implementation of dedicated automatic procedure is ongoing
- Tuning of observations/alerts chain/BA/analysis
- Initial science already possible (still but hopefully not for long, with ULs…)





#	NAME	SATELLITE	RA (J2000)	Dec (J2000)	T0 [UTC]	T90 [s]	REDSHIFT	START OBS TIME [UTC]	ZENITH [deg]	TOTAL OBS TIME [min]	DELAY [min]	ANALYSIS STATUS
1	GRB201216C	Swift BAT	01h 05m 25.872s	+16d 32' 12.12"	20/12/16 23:07:31	48	1.1	20/12/17 20:57:03	40		1320	Fast analysis done
2	GRB210511B	Fermi GBM	21h 04m 43s	+61d 41' 24"	11:26:39	6	-	03:37:54 (2021-05-12)	45		970	Fast analysis done
3	GRB210704A	Fermi GBM	10h 54m 55.2s	+58d 51' 36"	19:33:24.59	1	-	21:32:43	51 --> 60	42	119.32	Fast analysis done
4	GRB210731A	Swift BAT	20h 01m 15.264s	-28d 02' 31.2"	21/07/31 22:21:08			21/07/31 23:02	59		39	Fast analysis done
5	GRB210802A	Fermi-LAT	15h 22m 53.46s	+29° 54′ 06.8″	20:08:06.49							
6	GRB210807A	Swift BAT	05h 06m 43.55s	+58d 15' 01.0"	10:03:40.49	156.3	-	03:55:10 (2021-08-08)	56 --> 62	35	1071.5	Fast analysis done
7	GRB220302A	Swift BAT	20h 05m 43.30s	+49d 23' 13.1"	07:40:19	~20		05:23:06 (2022-03-03)	61 --> 52	48	1302	Fast analysis done
8	GRB220310A	MAXI	11h 13m 2.33s	+23d 15' 8.0"	00:27:57	33.1 +- 8.3 (by CALET)		01:24:58 (2022-03-10)	6 --> 35	132 (2.2 h)	56.6	Fast analysis done
9	GRB220311A	INTEGRAL	10h 31m 53.928s	+66d 04' 54.840"	16:33:10	~10 (by GBM)		02:20:54 (2022-03-12)	41 --> 55	132 (2.2 h)	587.7	Fast analysis done
10	GRB220501A	Swift BAT	05h 42m 18s	+14d 02' 00"	19:51:51	Swift-BAT: 202.24 +- 20.60 (15-350 keV), GBM: 51 s (50-300 keV)		20:51:30 (2022-05-01)	65 --> 70	25	60	Fast analysis done

LST-1 & MAGIC

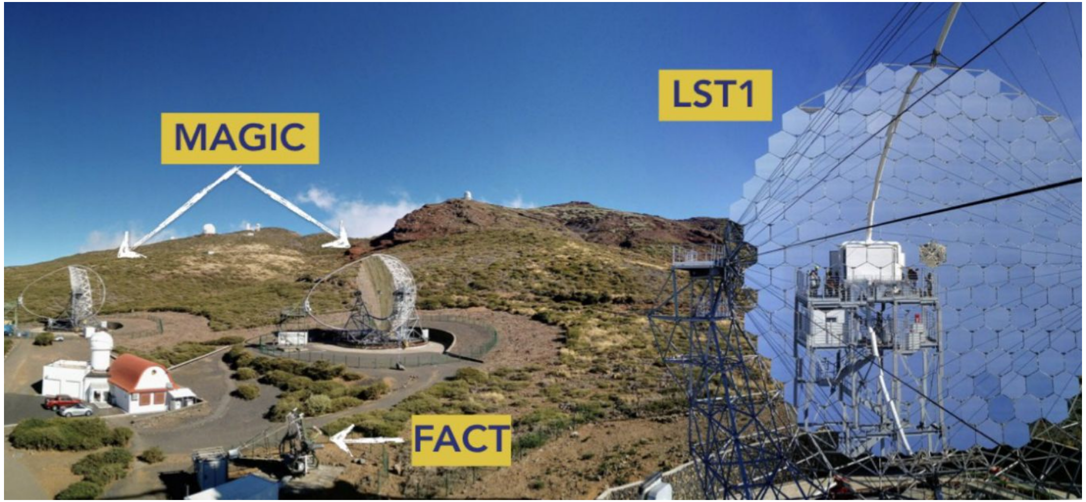


Separation between MAGICs and LST-1 is ~100m

- The same events can trigger ***all*** telescopes

~40% improvement in sensitivity for MAGIC+LST-1 analysis wrt MAGIC-only (better bkg suppression)

(My biased) conclusions



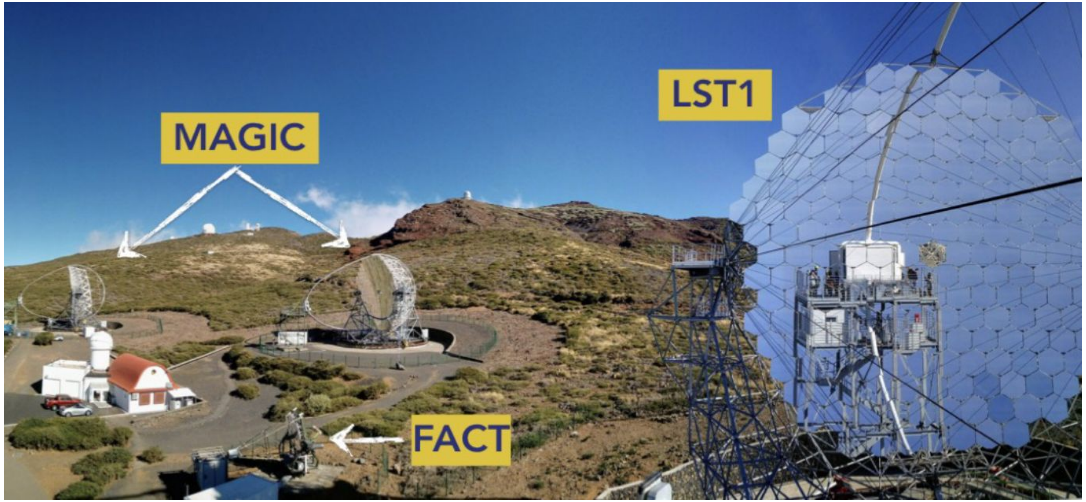
KSP on transients need to be re-formulated:

- Too wide, very heterogeneous needs in terms of technical, analysis and science requirements
- GRB (GW): the quest is over-> to abandon the “detection rate” approach and focus on the physics (GRB/GW CPs are on this line)
- Time request re-evaluation

In the north, science phase is not “formally” started….but it will soon to come (2025?).
We (as INAF & INFN) are at forefront with MAGIC, LST-1 and (why not?) ASTRI. We will be the first one in setting up the machinery for follow up of alerts triggered by new-generation transient facilities (Vera Rubin): italian groups very active since years (Franz, Antonio and many many other collaborators)

- **it’s not guarantee that transients will be a KSP (and which transient?)**
- Synergies are crucial both for triggering and characterization: spectral and variability studies (INAF experience in this regard is simply huge!) + long experience in follow-up

(My biased) conclusions



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- Synergies are crucial both for triggering and characterization: spectral and variability studies (INAF experience in this regard is simply huge!) + long experience in follow-up programs: **how to translate this in our “rewards”?**
- Difficult to disentangle technical part from science in the early phase: transient handler (the core for these observations, is in other’s hands)