THE THRIVING GAMMA-RAY ASTRONOMY WITH THE MAGIC TELESCOPES AND CTA PROSPECTS

ANTONIO STAMERRA *(INAF-OAR; and SSDC-ASI, SNS-PISA)*

Osservatorio Astronomico di Roma

SSDC Space Science Data Center

on behalf of
the MAGIC collaboration
and CTA consortium

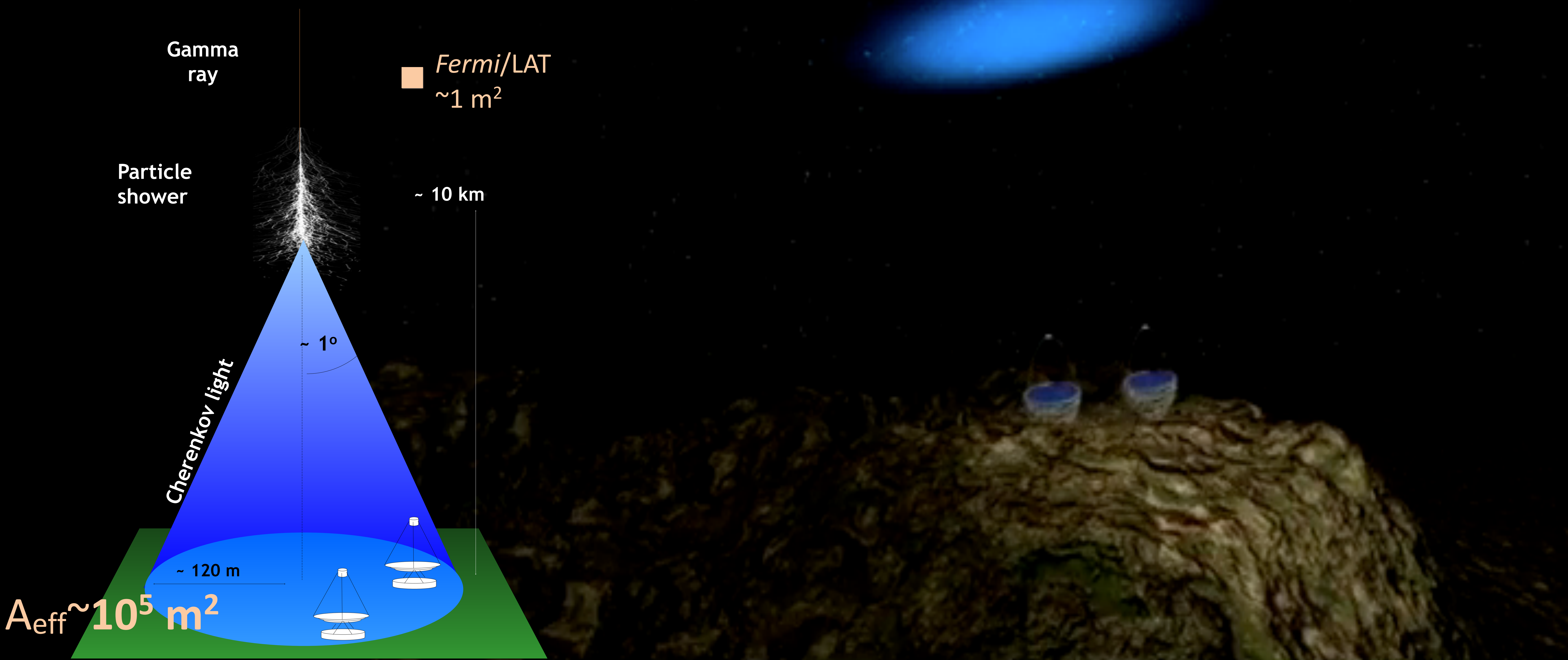
MAGIC Major Atmospheric Gamma Imaging Cerenkov Telescopes

cta cherenkov telescope array

Congresso SIF 2020 - 16 September 2020

TeV Astronomy with Cherenkov telescopes

- **Big effective area** ➠ photon statistics
- **Energy range** (~50 GeV up to >10 TeV)
- Angular resolution: 0.1 deg



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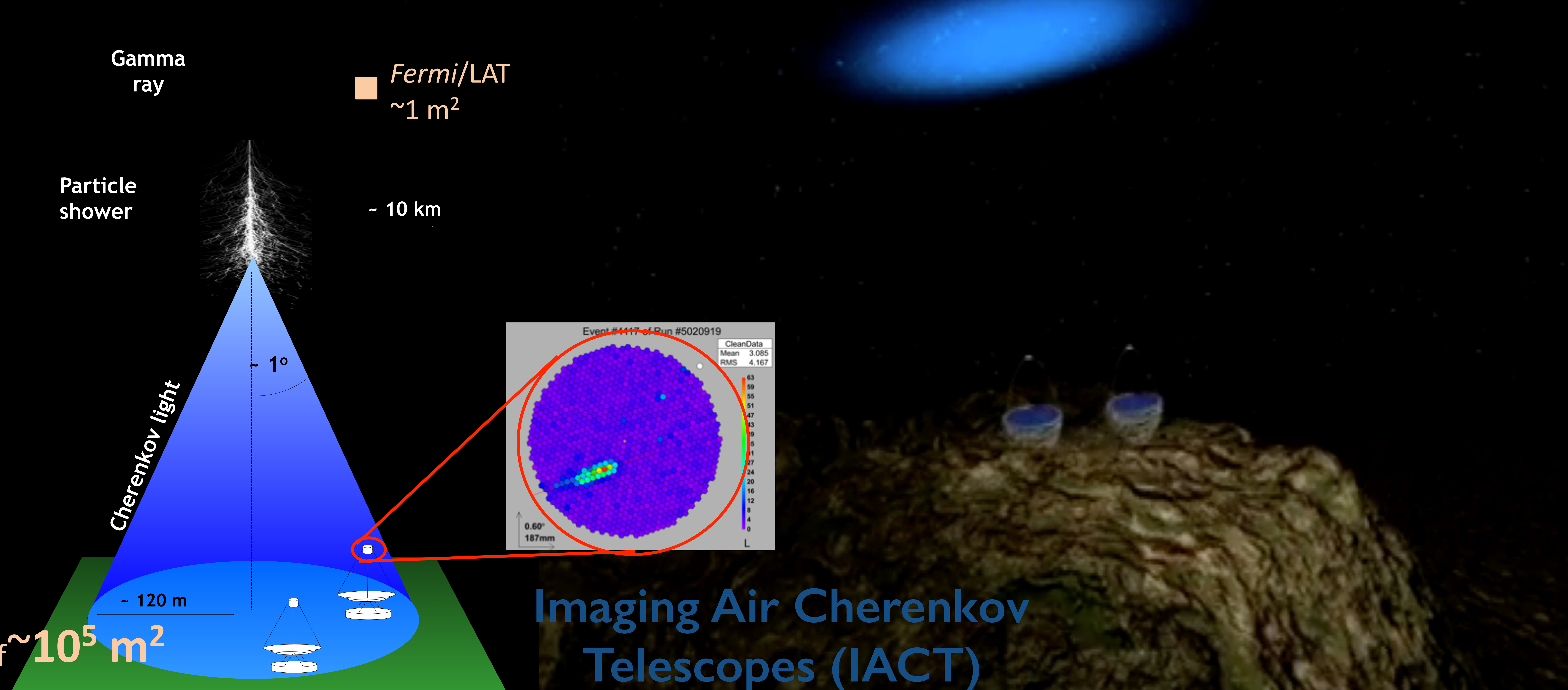

TeV Astronomy with Cherenkov telescopes: MAGIC

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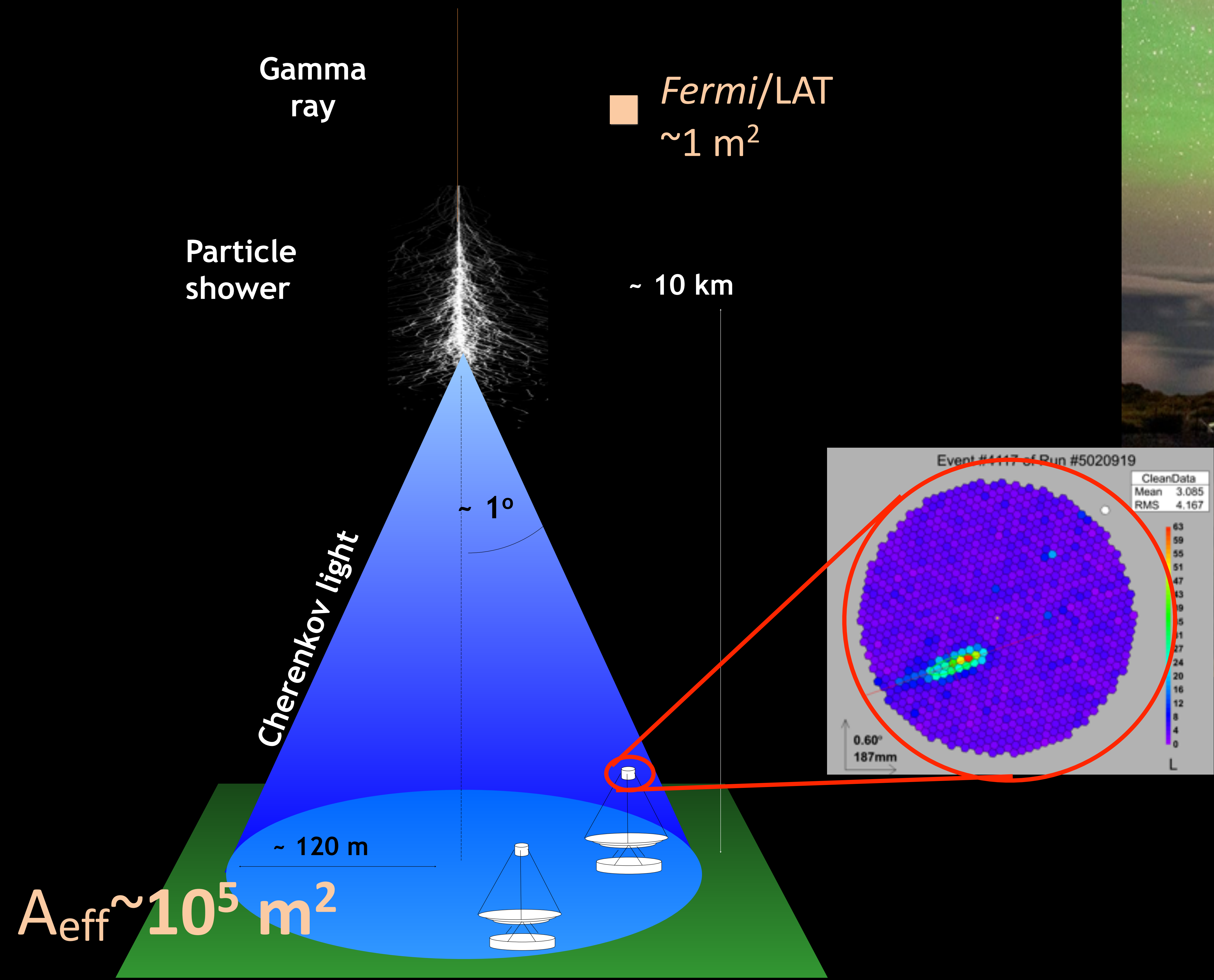
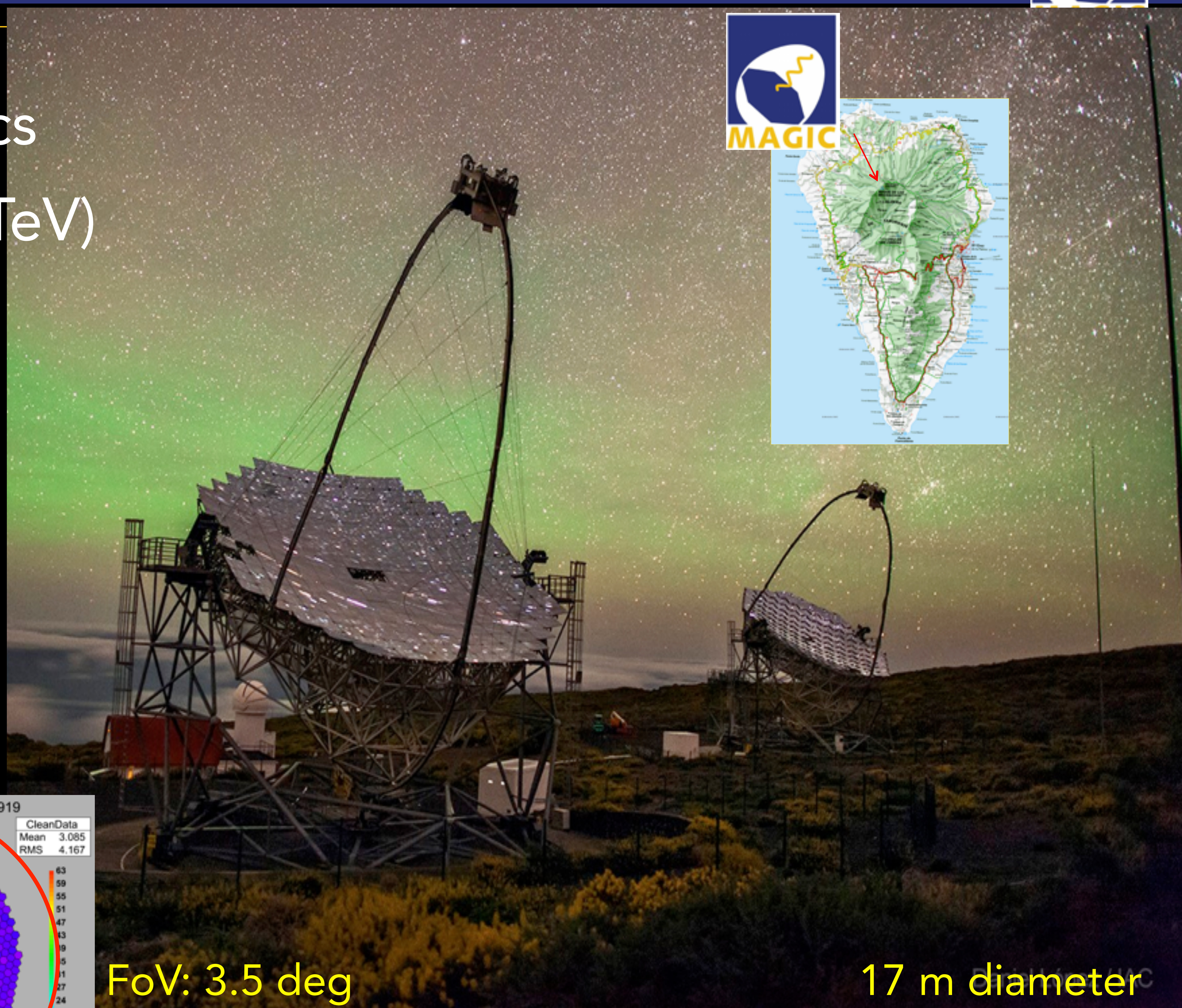
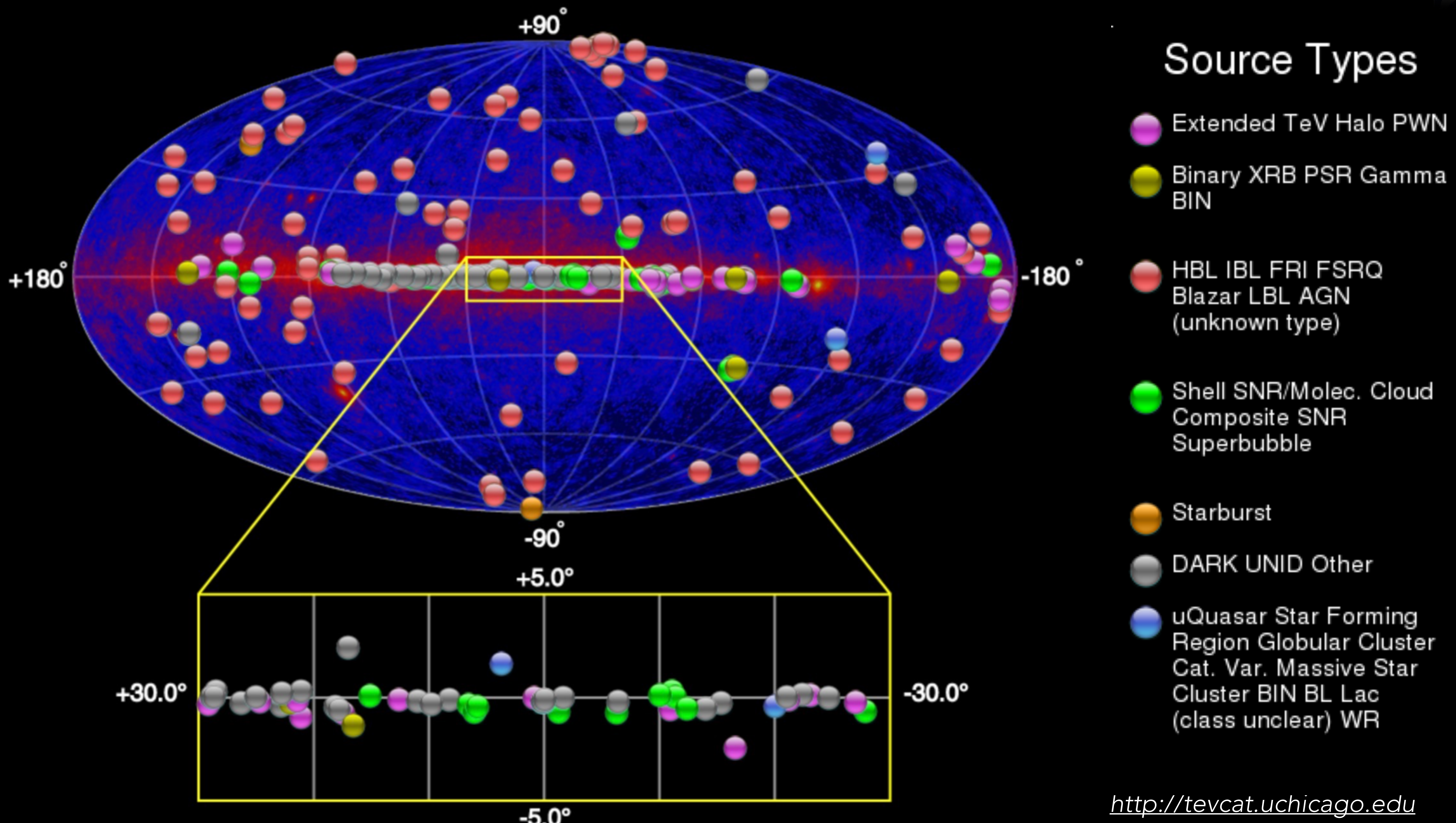




FoV: 3.5 deg	17 m diameter
Energy: 50 GeV - 10 TeV	carbon-fiber structure
Slewing: 7 deg/s	70 tons
Ang.res: <0.1°	2-4 GHz sampling
Sensitivity: ~0.8% Crab flux	in operation since 2003
in 50h (>220GeV)	stereo since 2009

The VHE (E>100 GeV) gamma-ray sky



http://tevcat.uchicago.edu

Blazar Flares and discoveries in 2019-20 by MAGIC

Detection of very-high-energy gamma-ray emission from B2 1420+32 with the MAGIC telescopes

ATel #13412; *Razmik Mirzoyan (Max-Planck-Institute for Physics, Munich), on behalf of the MAGIC collaboration*
on ***21 Jan 2020; 21:03 UT***
Distributed as an Instant Email Notice Transients
Credential Certification: Giacomo Bonnoli (giacomo.bonnoli@unisi.it)

Subjects: Gamma Ray, TeV, VHE, Blazar

Referred to by ATel #: 13417, 13421, 13428, 13479, 13582

Detection of sub-TeV gamma-ray emission from the flaring blazar TXS 1515-273 with the MAGIC telescopes

ATel #12538; *Razmik Mirzoyan (Max-Planck-Institute for Physics, Munich), on behalf of the MAGIC collaboration*
on ***28 Feb 2019; 22:14 UT***
Credential Certification: Razmik Mirzoyan (Razmik.Mirzoyan@mpp.mpg.de)

Subjects: Gamma Ray, >GeV, TeV, VHE, AGN, Blazar

Referred to by ATel #: 12565, 12575

MAGIC detection of very-high-energy gamma-ray flaring activity from BL Lacertae during the current historical optical and high-energy gamma-ray flare

ATel #13963; *Oscar Blanch (IFAE-BIST, Barcelona), on behalf of the MAGIC collaboration*
on ***22 Aug 2020; 13:11 UT***
Credential Certification: Oscar Blanch (blanch@ifae.es)

Subjects: Gamma Ray, TeV, VHE, Blazar

MAGIC detection of increased flux from 1ES 0647+250 at very-high-energy gamma rays

ATel #13331; *Razmik Mirzoyan (Max-Planck-Institute for Physics, Munich), on behalf of the MAGIC collaboration*
on ***5 Dec 2019; 15:05 UT***
Distributed as an Instant Email Notice Transients
Credential Certification: Daniela Dorner (dorner@astro.uni-wuerzburg.de)

Subjects: Gamma Ray, TeV, VHE, AGN, Blazar, Transient

MAGIC detection of an increased activity from BL Lacertae at very-high-energy gamma rays

ATel #12724; *Razmik Mirzoyan (Max-Planck-Institute for Physics, Munich), on behalf of the MAGIC collaboration*
on ***3 May 2019; 22:00 UT***
Credential Certification: Antonio Stamerra (antonio.stamerra@inaf.it)

Subjects: Gamma Ray, >GeV, TeV, VHE, Request for Observations, AGN, Blazar, Quasar

Referred to by ATel #: 13963

MAGIC detects an unprecedented activity from the blazar 1ES 1218+304 at very high energy gamma rays

ATel #12354; *Razmik Mirzoyan on behalf of the MAGIC Collaboration*
on ***3 Jan 2019; 22:11 UT***
Credential Certification: Razmik Mirzoyan (Razmik.Mirzoyan@mpp.mpg.de)

Subjects: Gamma Ray, >GeV, TeV, VHE, AGN, Blazar

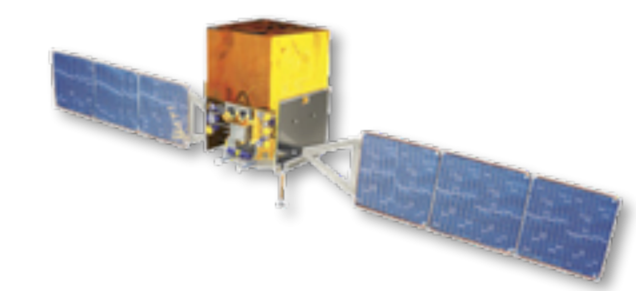
Referred to by ATel #: 12360, 12365, 13695

SED of a gamma-ray source: AGN/blazar

TeV emission dominated by the non-thermal continuum emission

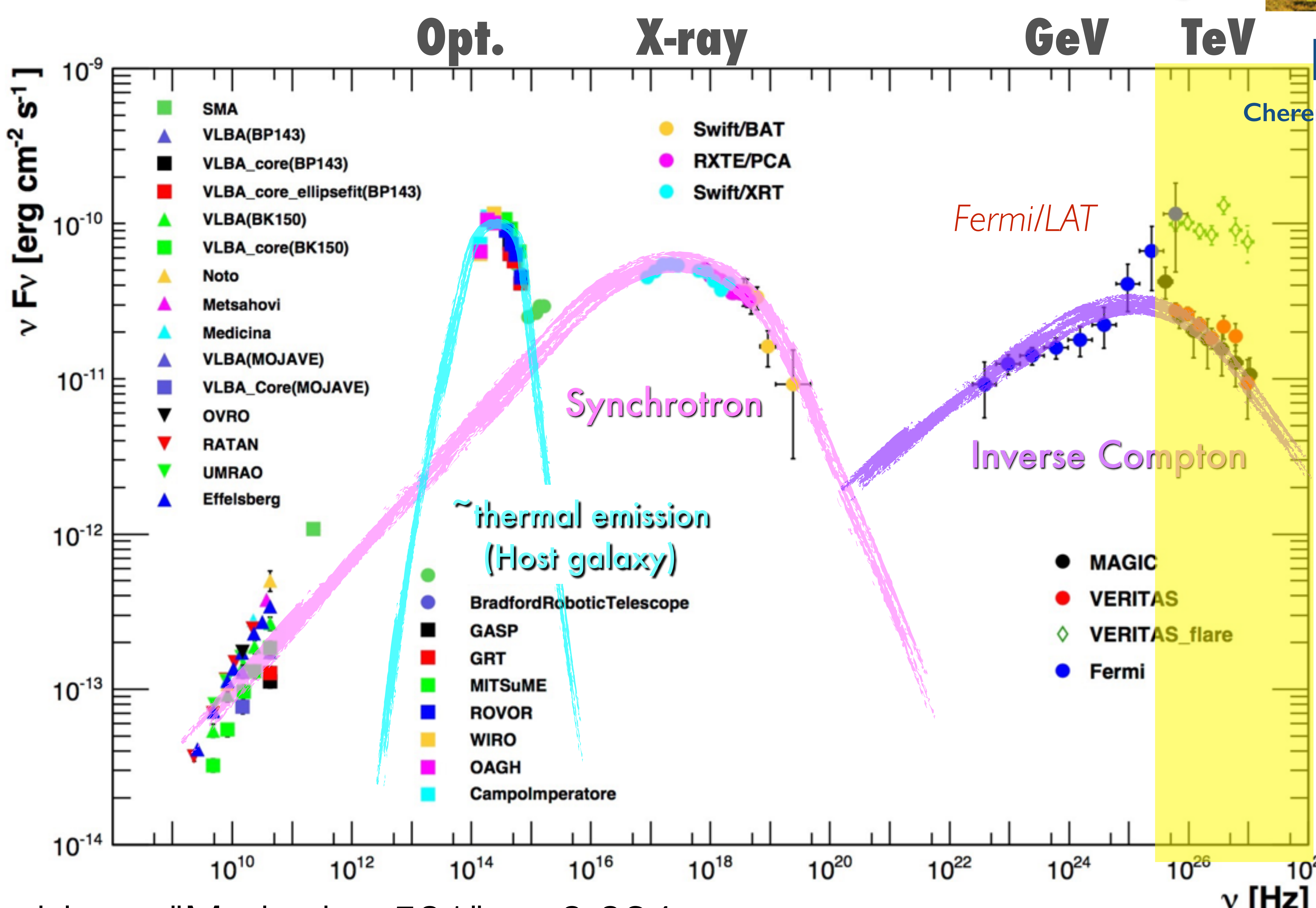
- Inverse Compton in leptonic models
- in blazars, jet emission is relativistically boosted

$$L_{\text{obs}} = L' \delta^4 \qquad \delta = \frac{1}{\Gamma(1-\beta\cos\theta_{\text{v}})}$$



IACT

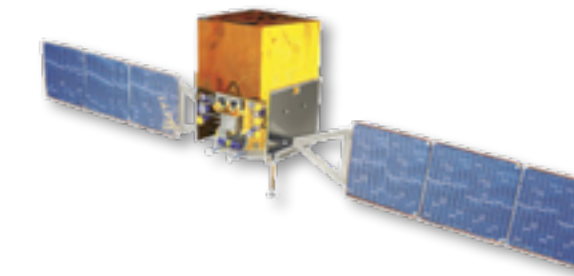
Cherenkov Telescopes



blazar "Markarian 501" z=0.034

Abdo+, 2011, ApJ, 727

SED of a gamma-ray source: AGN/blazar



IACT
Cherenkov Telescopes

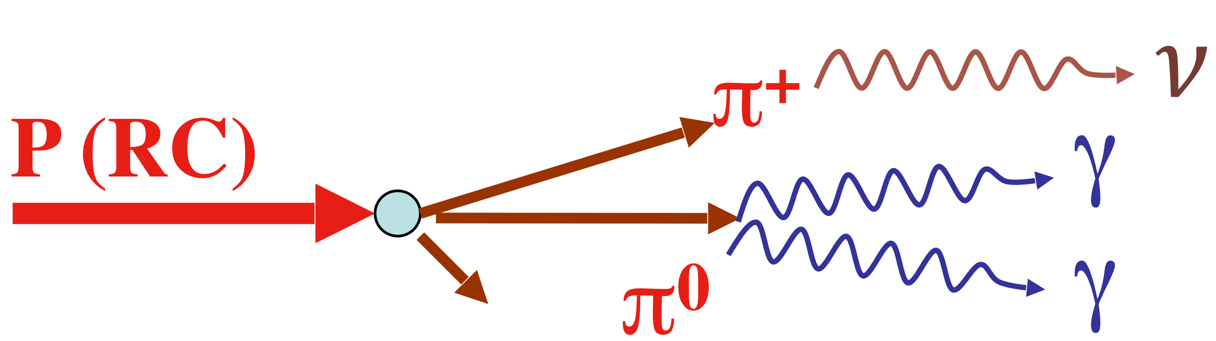
TeV emission dominated by the non-thermal continuum emission

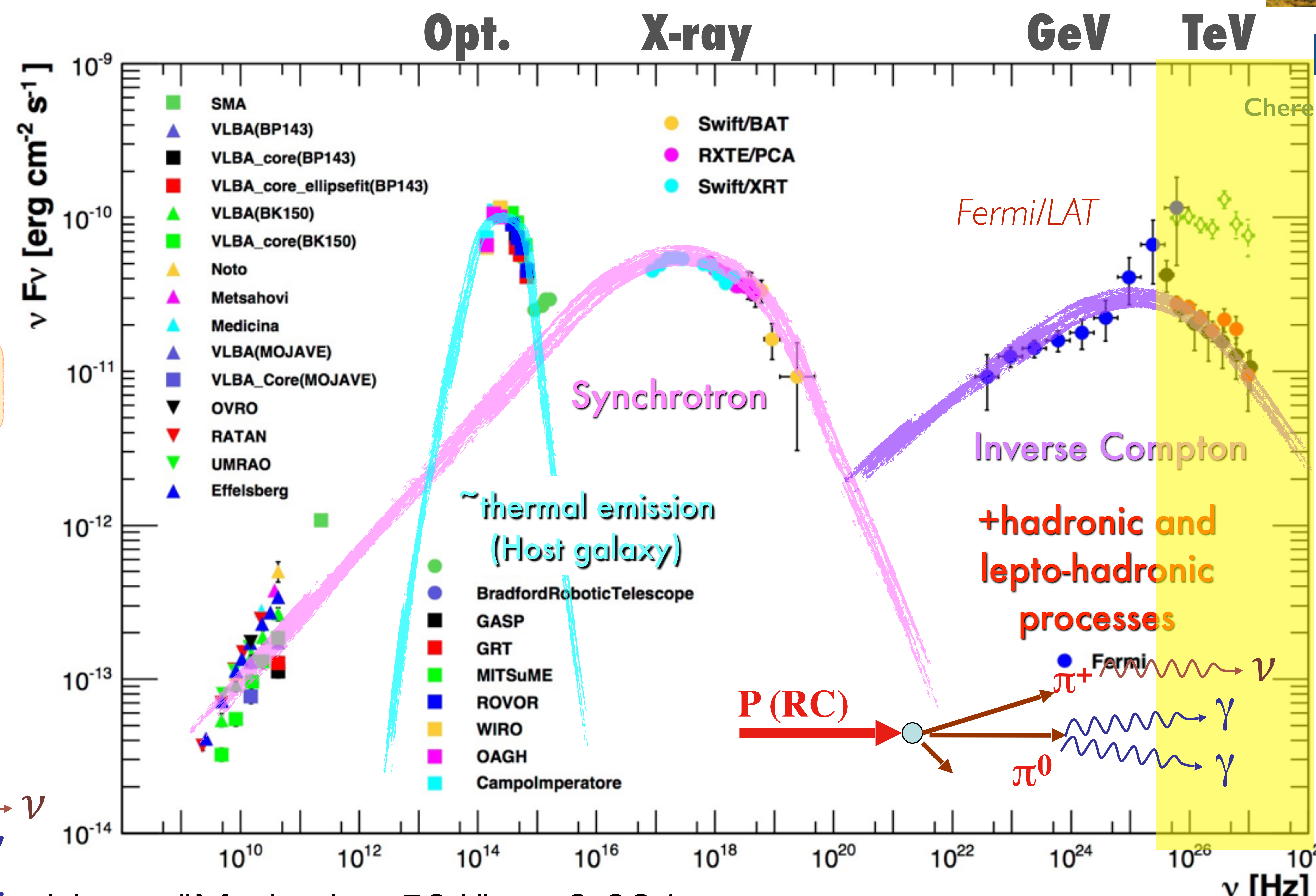
- Inverse Compton in leptonic models
- in blazars, jet emission is relativistically boosted

$$L_{\rm obs} = L'\delta^4 \qquad \delta = \frac{1}{\Gamma(1-\beta\cos\theta_{\rm v})}$$

- Hadronic models (photo-meson production, proton-synchrotron....)

  ➡ high-energy neutrinos



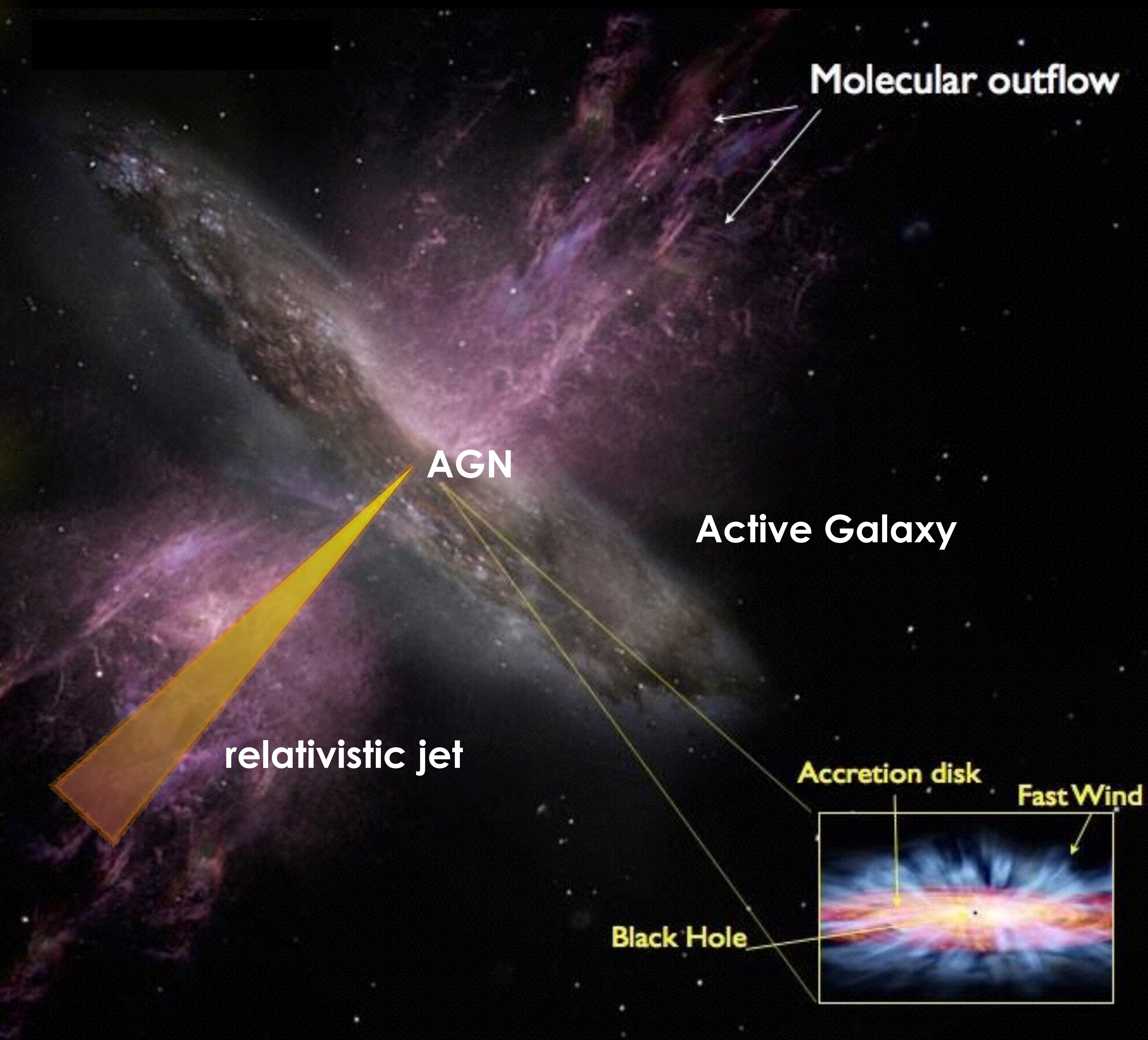


blazar "Markarian 501" z=0.034

Abdo+, 2011, ApJ, 727

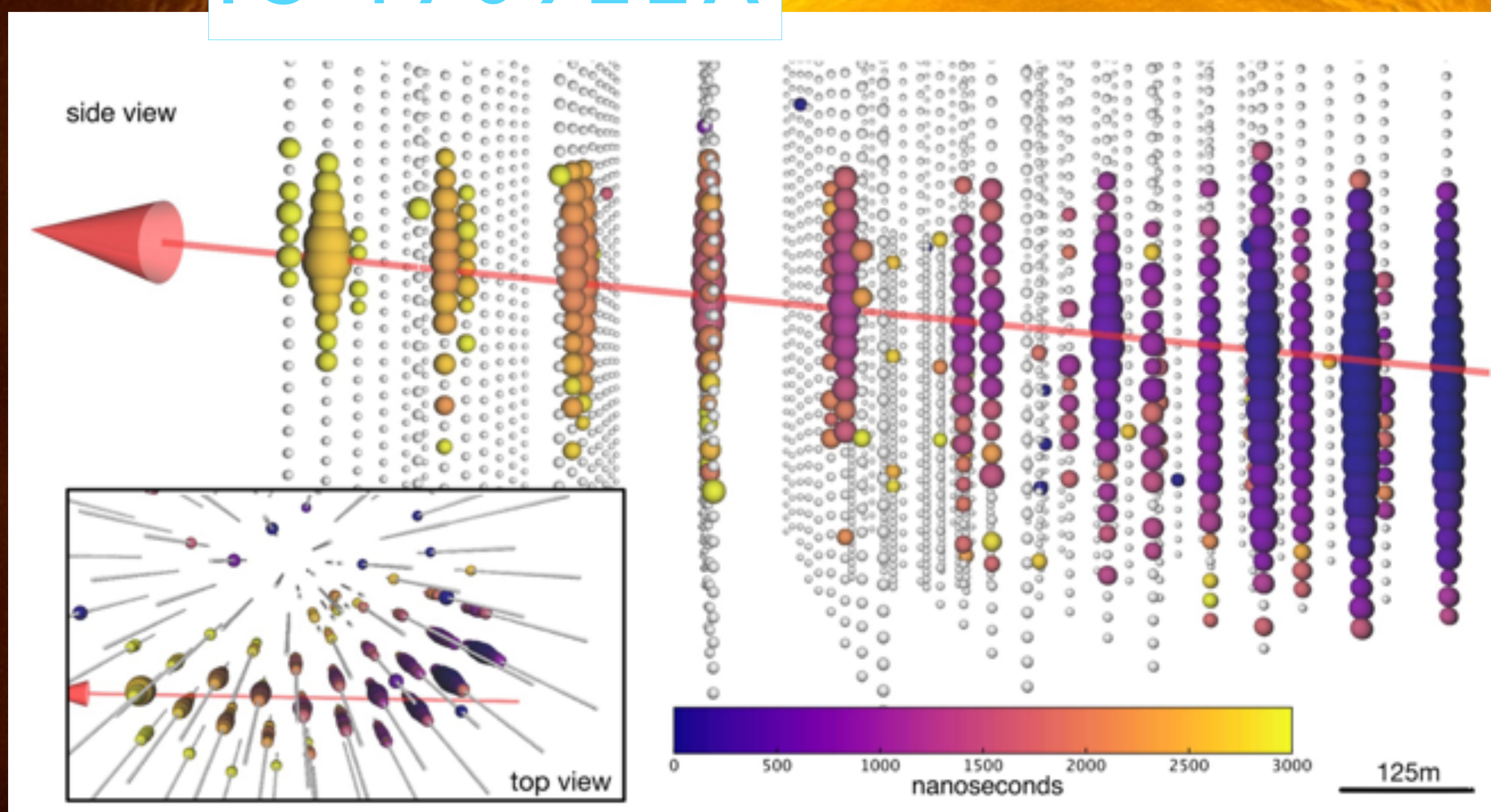
Candidates astrophysical sources

- **Jets in blazars**
  - hadronic acceleration in shocks
- Starburst galaxies
  - CR formation from SN explosions and interaction with ISM
- Galactic Winds
  - mildy relativistic
  - molecular outflow
  - CR interactions and cascades



VHE ASTRONOMY IN THE MULTI-MESSENGER DOMAIN: THE BLAZAR-NEUTRINO CONNECTION

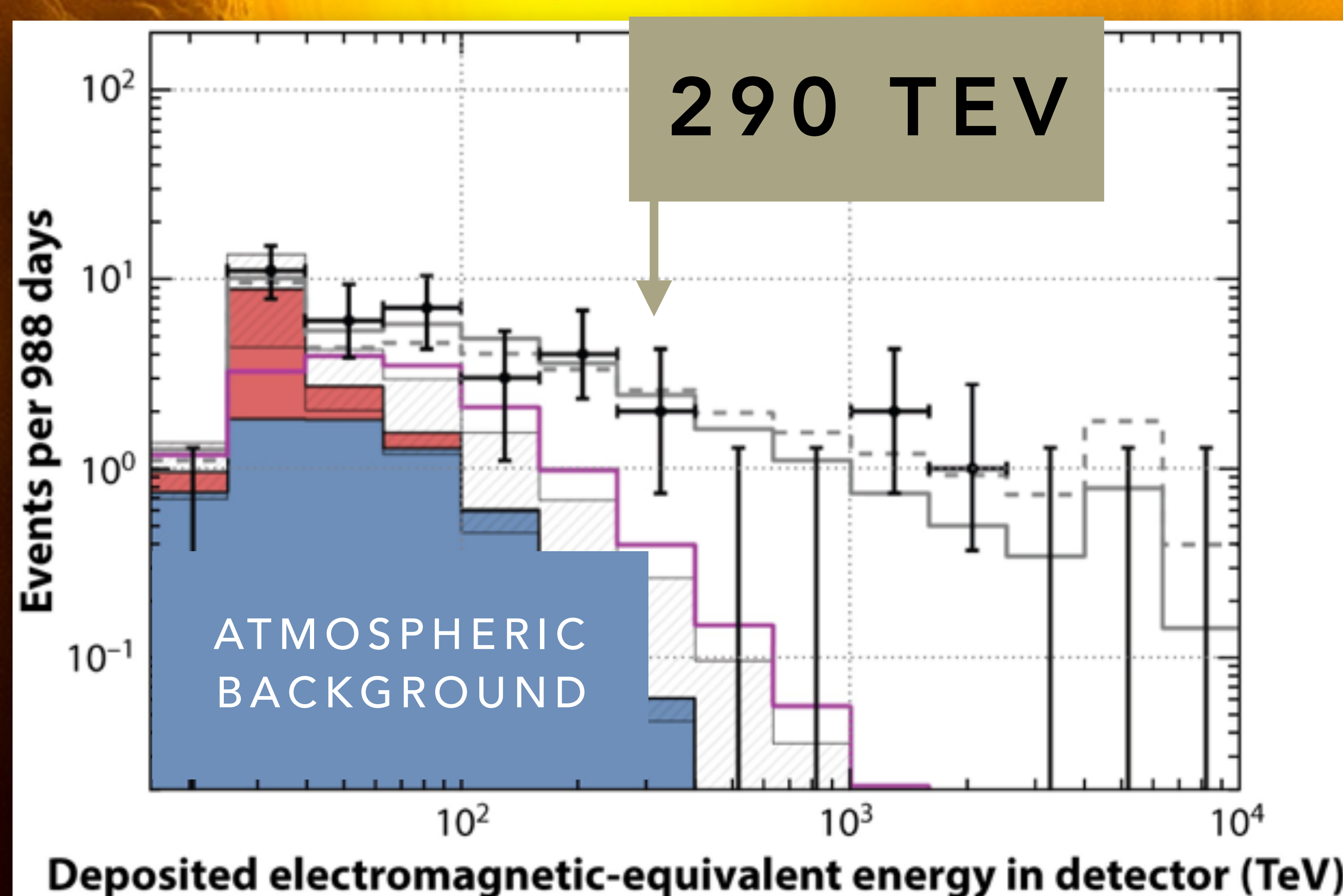
IC-170922A



22 September 2017

High energy neutrino event

Uncertainties on direction < 1 deg



First-time detection of VHE gamma rays by MAGIC from a direction consistent with the recent EHE neutrino event IceCube-170922A

ATel #10817; ***Razmik Mirzoyan for the MAGIC Collaboration***
on 4 Oct 2017; 17:17 UT
Credential Certification: Razmik Mirzoyan (Razmik.Mirzoyan@mpp.mpg.de)

Subjects: Optical, Gamma Ray, >GeV, TeV, VHE, UHE, Neutrinos, AGN, Blazar

Referred to by ATel #: 10830, 10833, 10838, 10840, 10844, 10845, 10942, 12260

Tweet

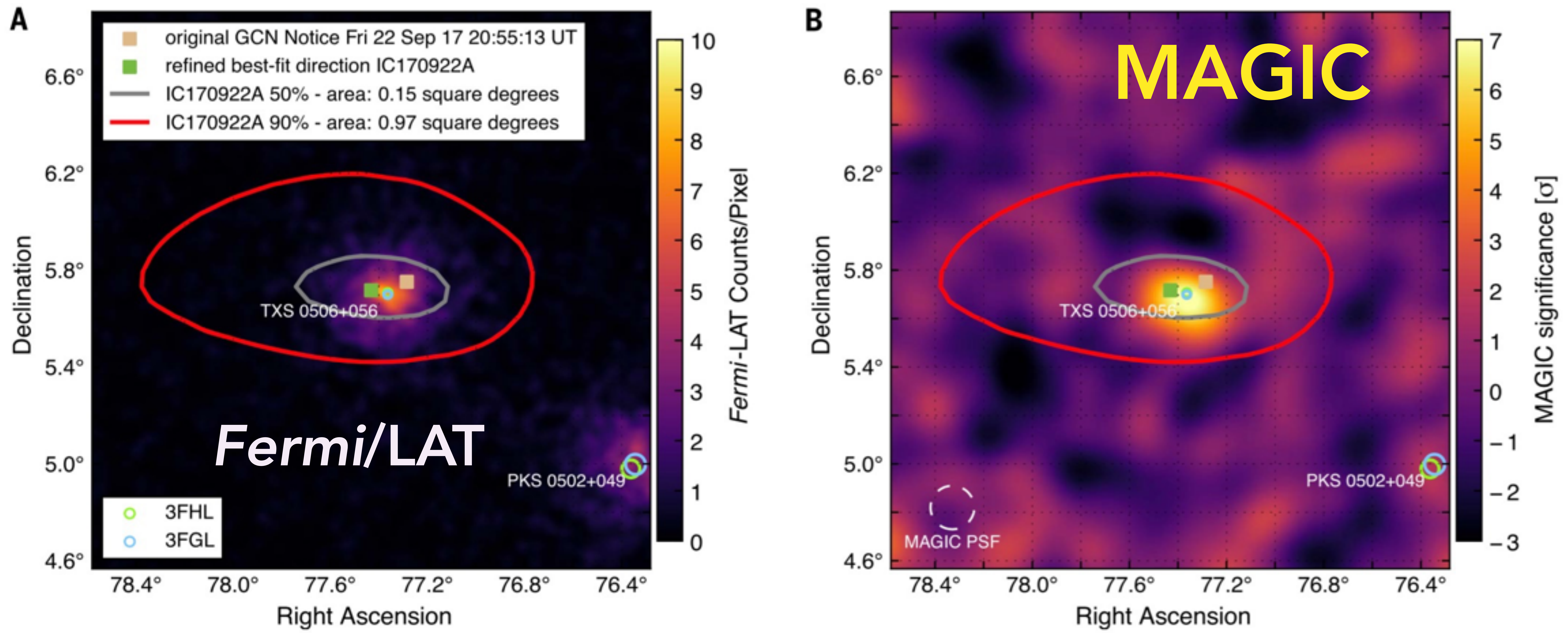
After the IceCube neutrino event EHE 170922A detected on 22/09/2017 (GCN circular #21916), Fermi-LAT measured enhanced gamma-ray emission from the blazar TXS 0506+056 (05 09 25.96370, +05 41 35.3279 (J2000), [Lani et al., Astron. J., 139, 1695-1712 (2010)]), located 6 arcmin from the EHE 170922A estimated direction (ATel #10791). MAGIC observed this source under good weather conditions and a 5 sigma detection above 100 GeV was achieved after 12 h of observations from September 28th till October 3rd. This is the first time that VHE gamma rays are measured from a direction consistent with a detected neutrino event. Several follow up observations from other observatories have been reported in ATels: #10773, #10787, #10791, #10792, #10794, #10799, #10801, GCN: #21941, #21930, #21924, #21923, #21917, #21916. The MAGIC contact persons for these observations are R. Mirzoyan (Razmik.Mirzoyan@mpp.mpg.de) E. Bernardini (elisa.bernardini@desy.de), K.Satalecka (konstancja.satalecka@desy.de). MAGIC is a system of two 17m-diameter Imaging Atmospheric Cherenkov Telescopes located at the Observatory Roque de los Muchachos on the Canary island La Palma, Spain, and designed to perform gamma-ray astronomy in the energy range from 50 GeV to greater than 50 TeV.

The γ-ν connection in TXS 0506+056

- Relatively small angular uncertainty of the HESE ν event
- The blazar TXS 0506+056 only plausible candidate
- Time correlation: TXS 0506+065 in γ high-state

MAGIC follow-up program on neutrino alerts

Science 361, eaat1378 (2018)



CHANCE COINCIDENCE FOR THE ASSOCIATION REJECTED AT 3σ LEVEL

Extreme blazars: hadronic accelerators?

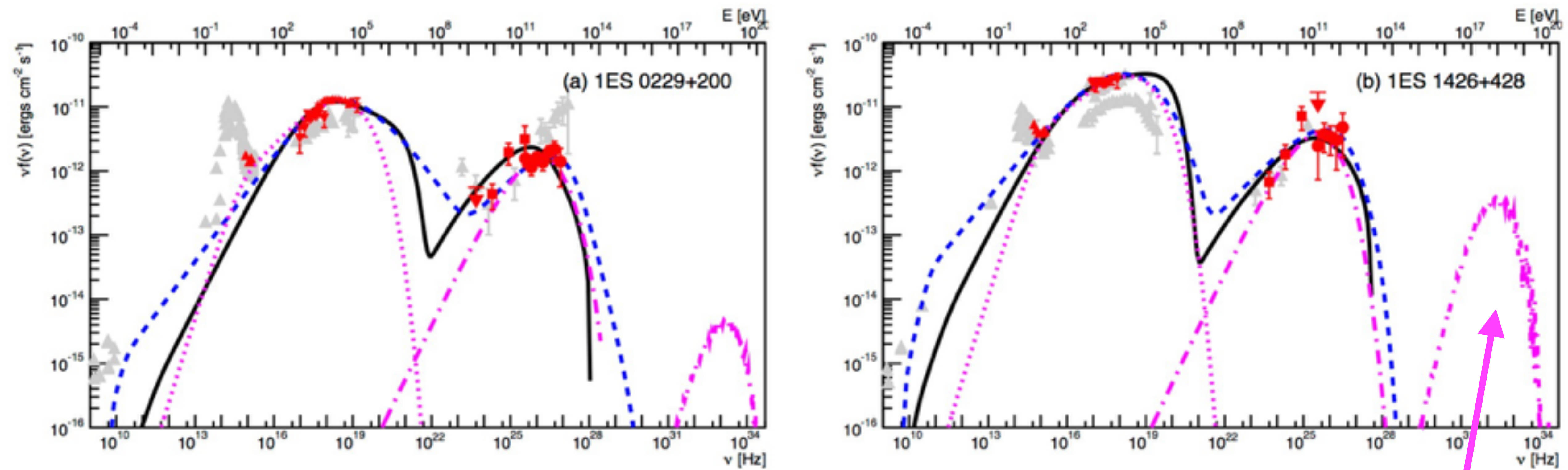
- Standard blazar models constrain the high-energy SED **peak below 1 TeV**

- Extreme TeV-blazars, with peak energy > 1TeV are **ideal targets** for **IACTs**

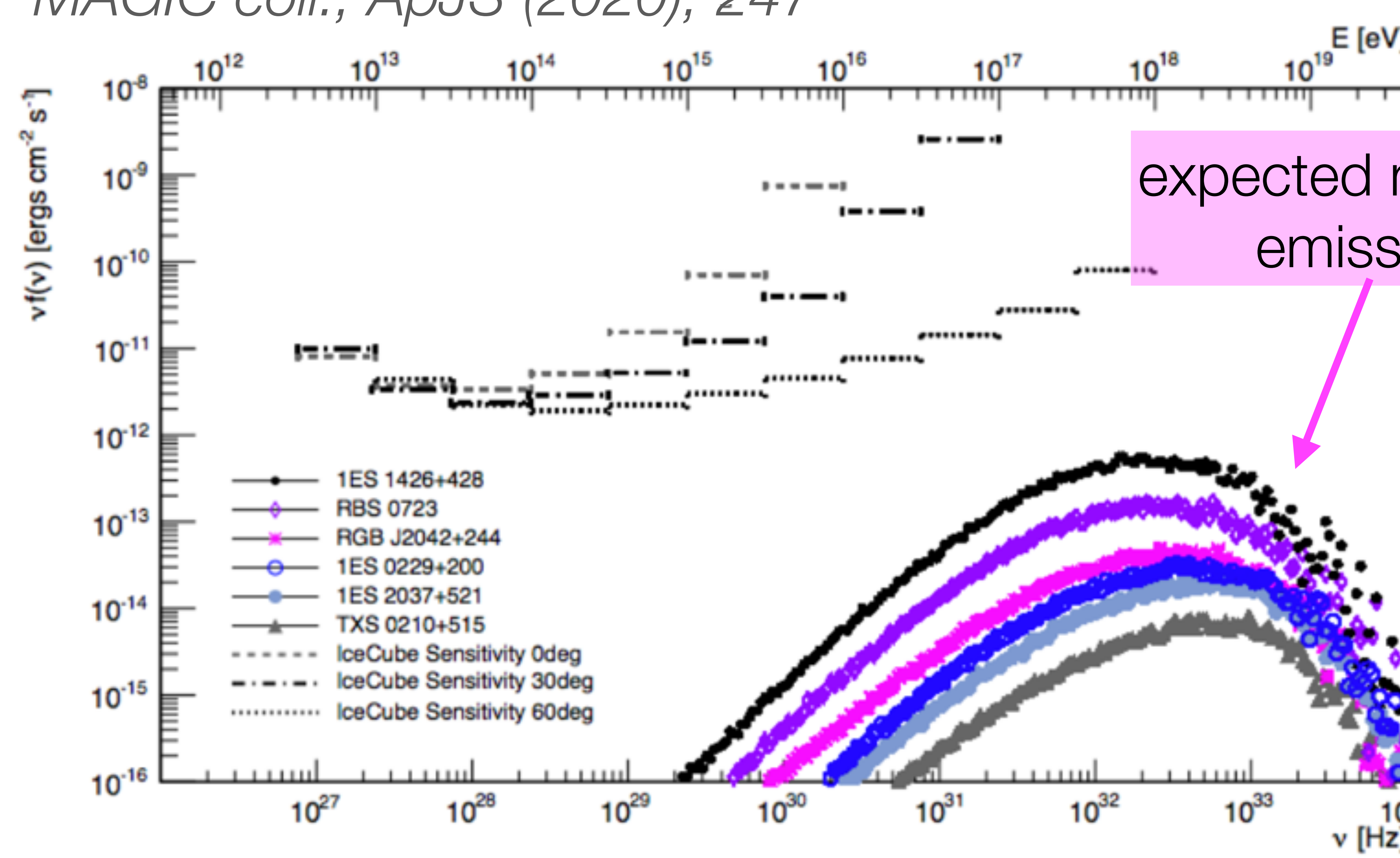
- Possible interpretation with hadronic models: **limits on neutrino emission**

  ✦ MAGIC coll., ApJS (2020), 247 *New hard-TeV extreme blazars detected with the MAGIC telescopes*

  ✦ MAGIC coll, (2019) MNRAS, 490 *Testing emission models on the extreme blazar 2WHSP J073326.7+515354 detected at VHE with MAGIC*



✦ *MAGIC coll., ApJS (2020), 247*



expected neutrino emission

Candidates astrophysical sources

- **Jets in blazars**
  - hadronic acceleration in shocks
- Starburst galaxies
  - CR formation from SN explosions and interaction with ISM
- **Galactic Winds**
  - mildy relativistic
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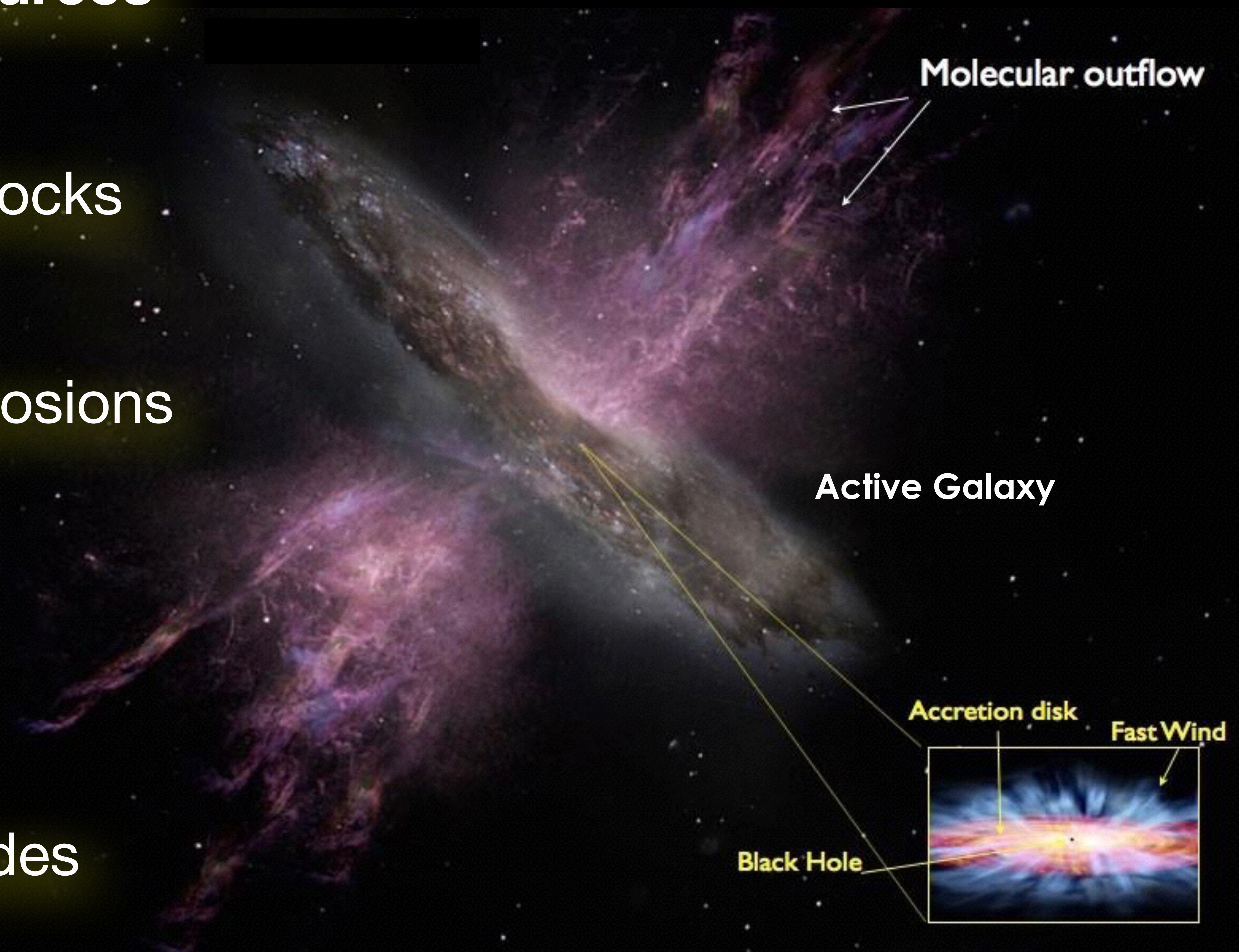


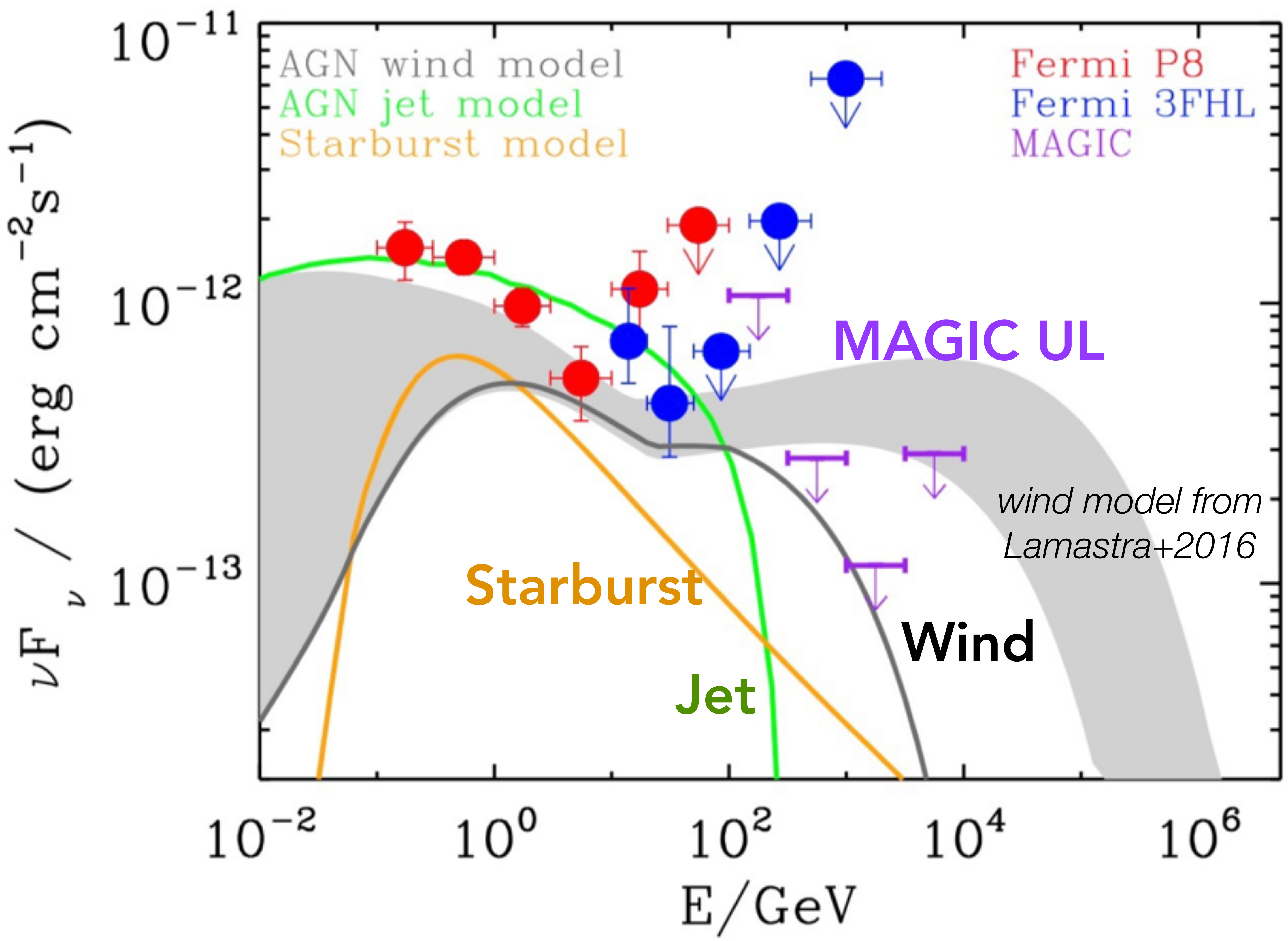
NGC 1068 as neutrino emitter?

- prototypical Seyfert-II galaxy (D=14.4 Mpc)
- composite starburst/AGN galaxy ($M_{BH}\approx10^7 M_{sun}$)
- Luminous infrared galaxy $L_{IR}=2.8\times10^{11} L_{sun}$
- High luminosity ($L_{AGN}=10^{44}$-10^{45} erg/s) high obscured ($N_H>10^{24}$ cm^{-2}) AGN

- 125 hours of observations with MAGIC from January 2016 to January 2019 based on proposal and models in Lamastra+2016, 2019
- MAGIC upper limits constrain the wind models parameters and the corresponding neutrino emission.

MAGIC coll., (2019) ApJ, 883

Constraints on Gamma-Ray and Neutrino Emission from NGC 1068 with the MAGIC Telescopes



IceCube coll., 2019, Phys.Rev.Lett., 124

NGC 1068 as neutrino emitter?

- **IceCube** all sky search for E > ~ TeV neutrino excess in 10 years of data
- **NGC 1068 as most significant candidate**
- To match the estimated neutrino flux and the MAGIC UL, gamma internal absorption is needed (e.g. *Y. Inoue+, 2020, ApJL, 891*)

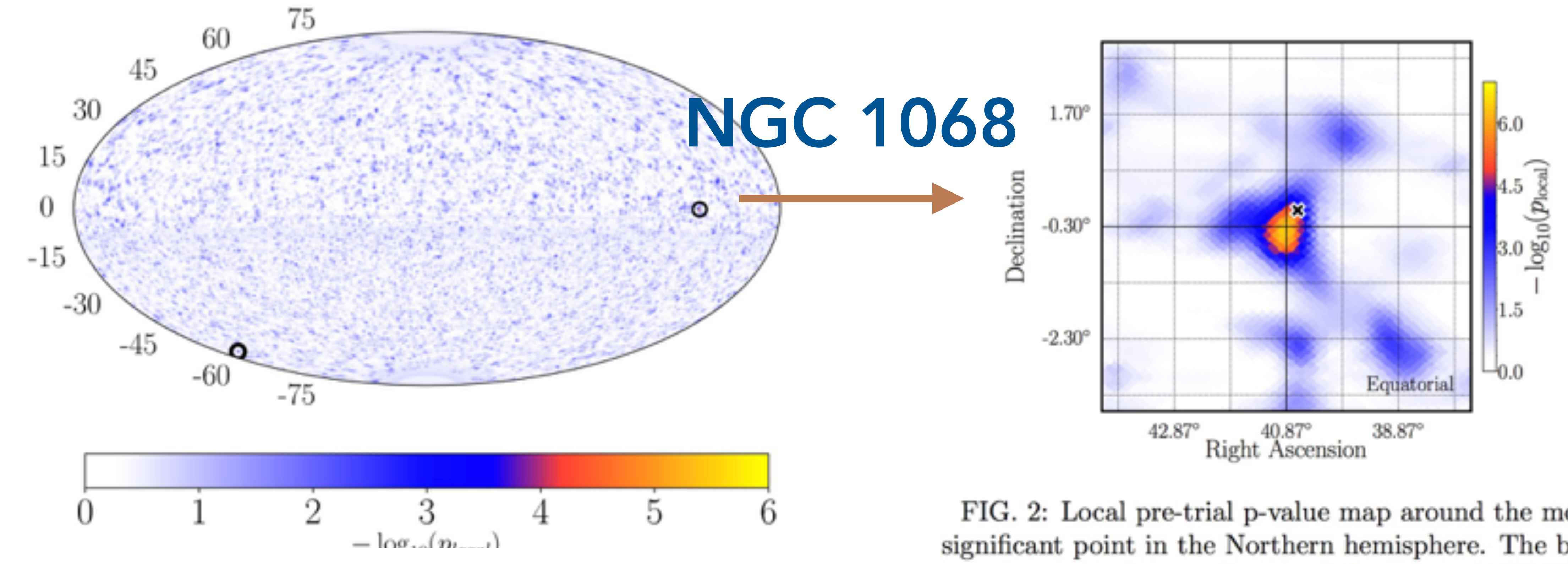
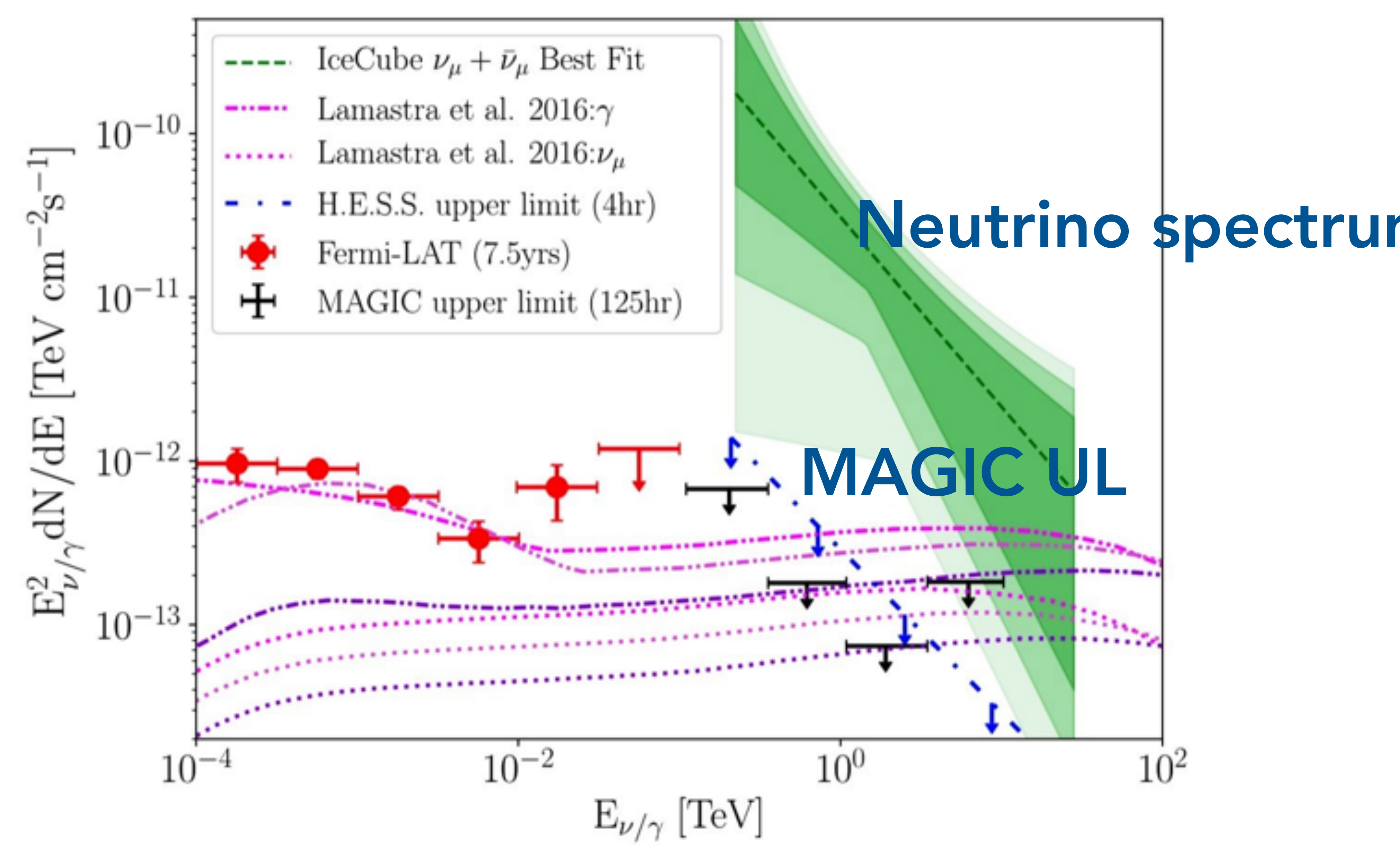


FIG. 2: Local pre-trial p-value map around the most significant point in the Northern hemisphere. The black cross marks the coordinates of the galaxy NGC 1068 taken from *Fermi*-4FGL.

- 125 hours of observations with MAGIC from January 2016 to January 2019 based on proposal and models in Lamastra+2016, 2019
- MAGIC upper limits constrain the wind models parameters and the corresponding neutrino emission.

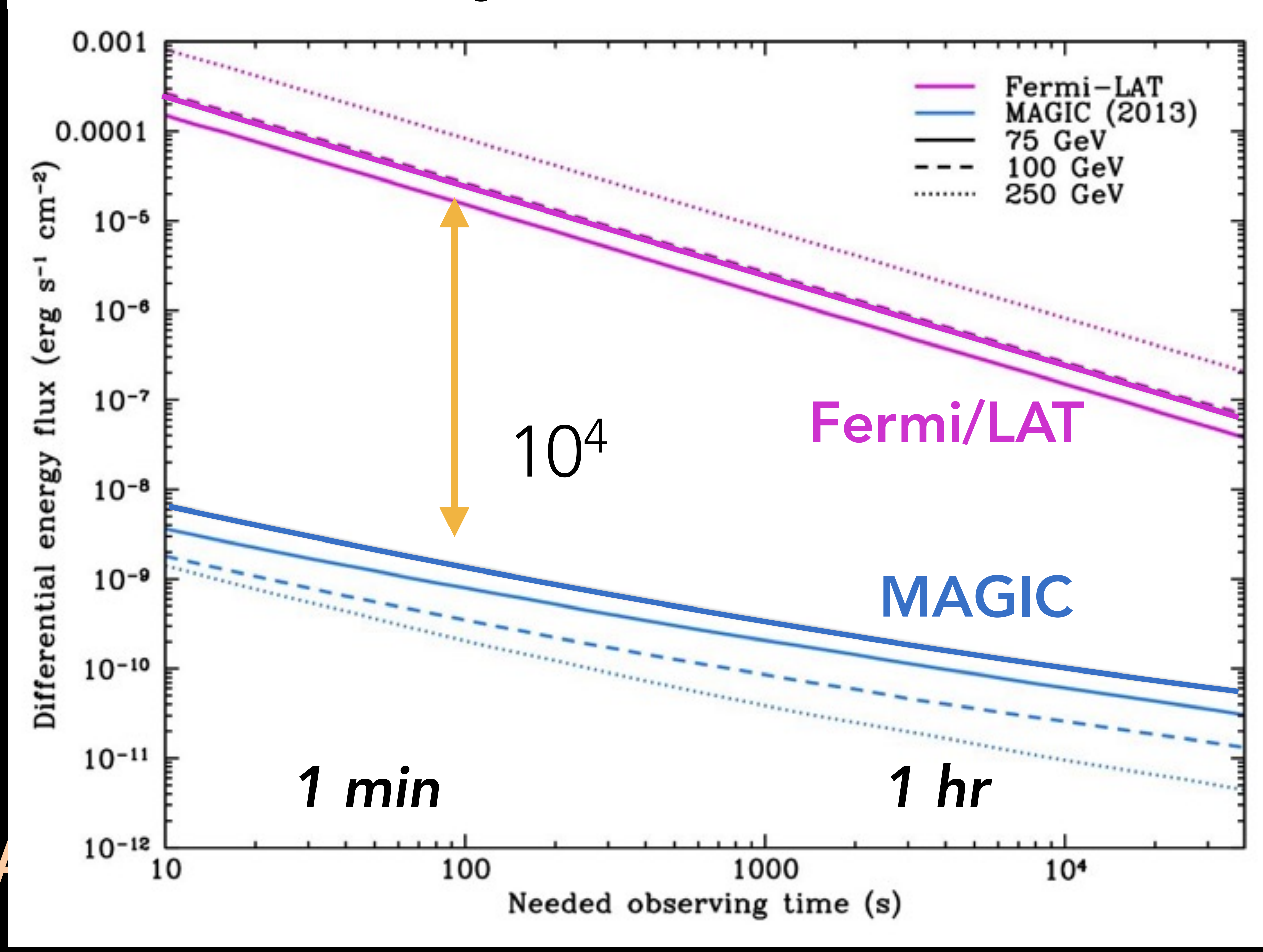


MAGIC as a transient facility

- **Big effective area** ➟ photon statistics
- **Low energy** threshold (~50 GeV)
- Angular resolution: 0.1 deg

duty cycle ~100% *Fermi*/LAT A_{eff}~1 m²

Sensitivity for GeV-TeV bursts

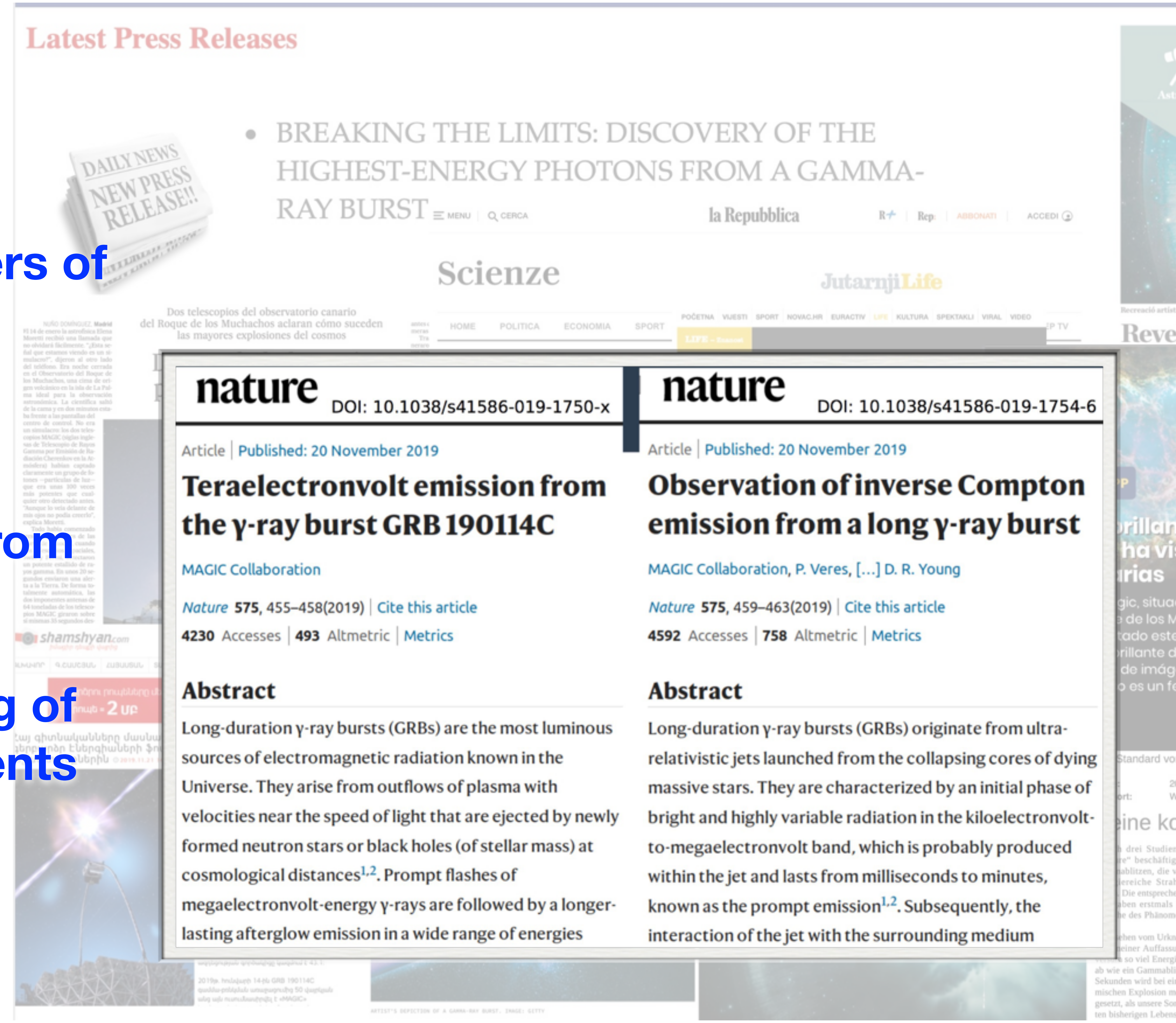


Energy: 50 GeV - 10 TeV
Slewing: 7 deg/s
Ang.res: <0.1°
Sensitivity: ~0.8% Crab flux in 50h (>220GeV)

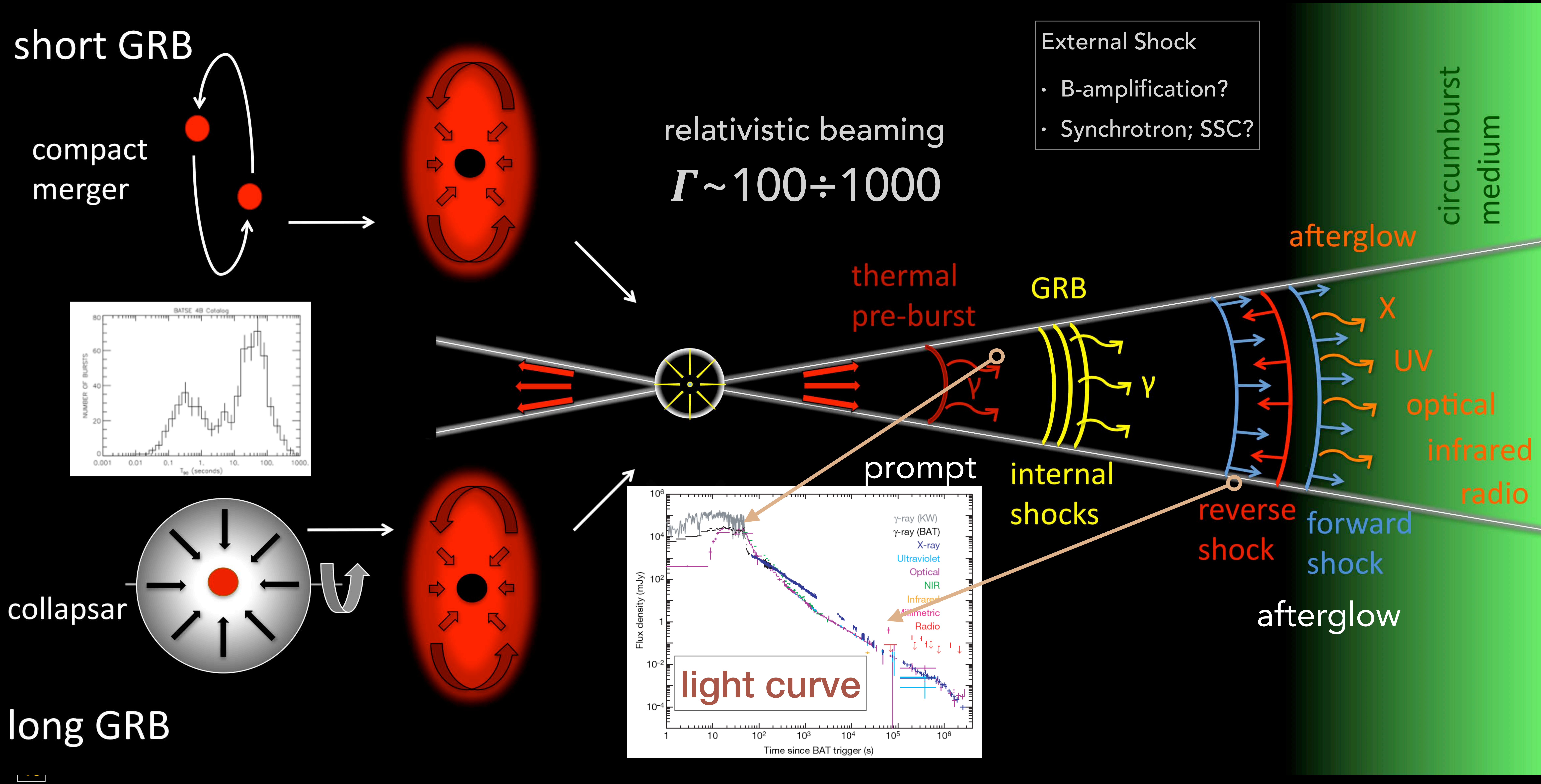
carbon-fiber structure
70 tons
2-4 GHz sampling
in operation since 2003
stereo since 2009

GRB190114C: a brief story of firsts

- **1st GRB detected at the teraelectronvolt (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 in the sky ever detected**



Fireball model of GRBs



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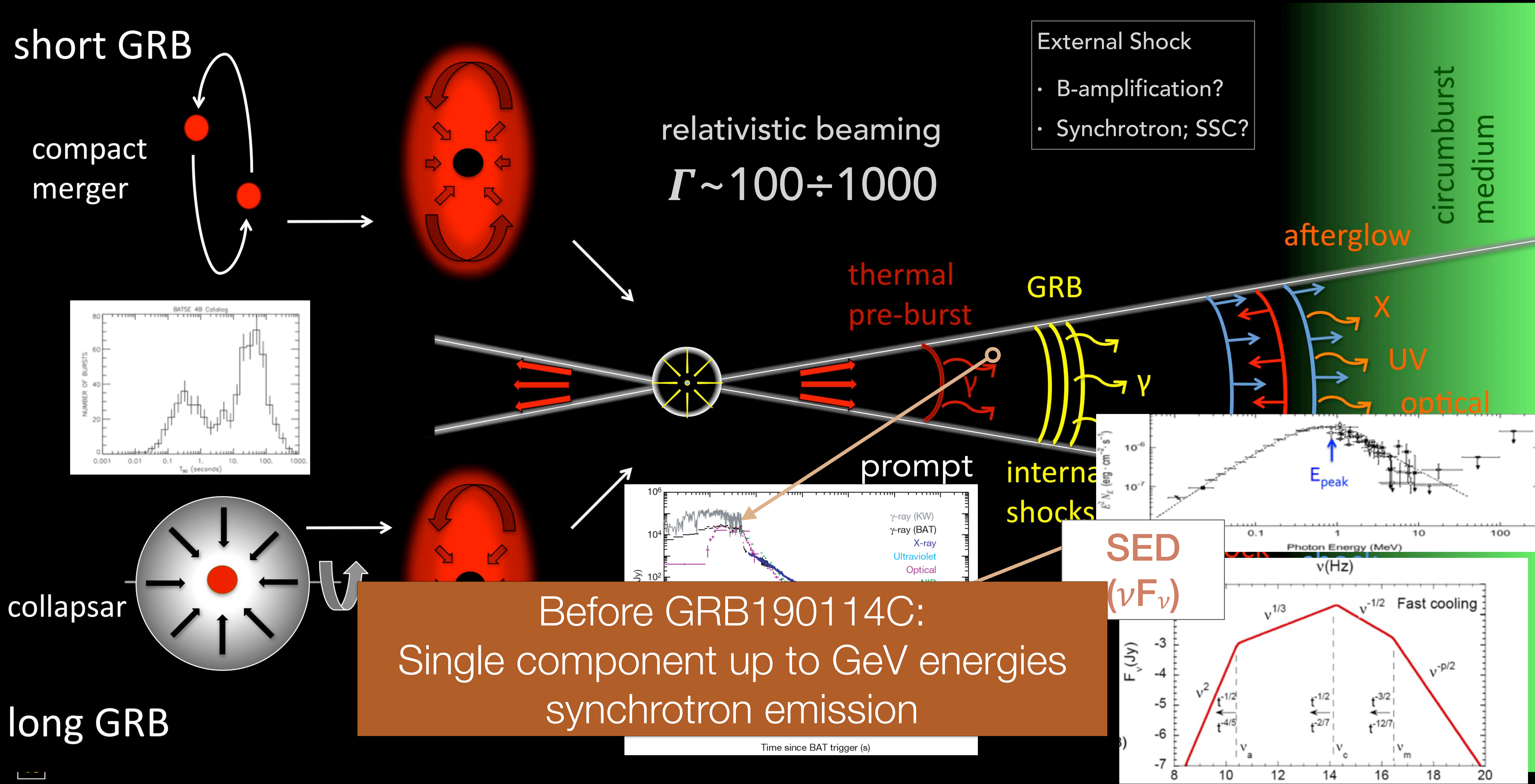
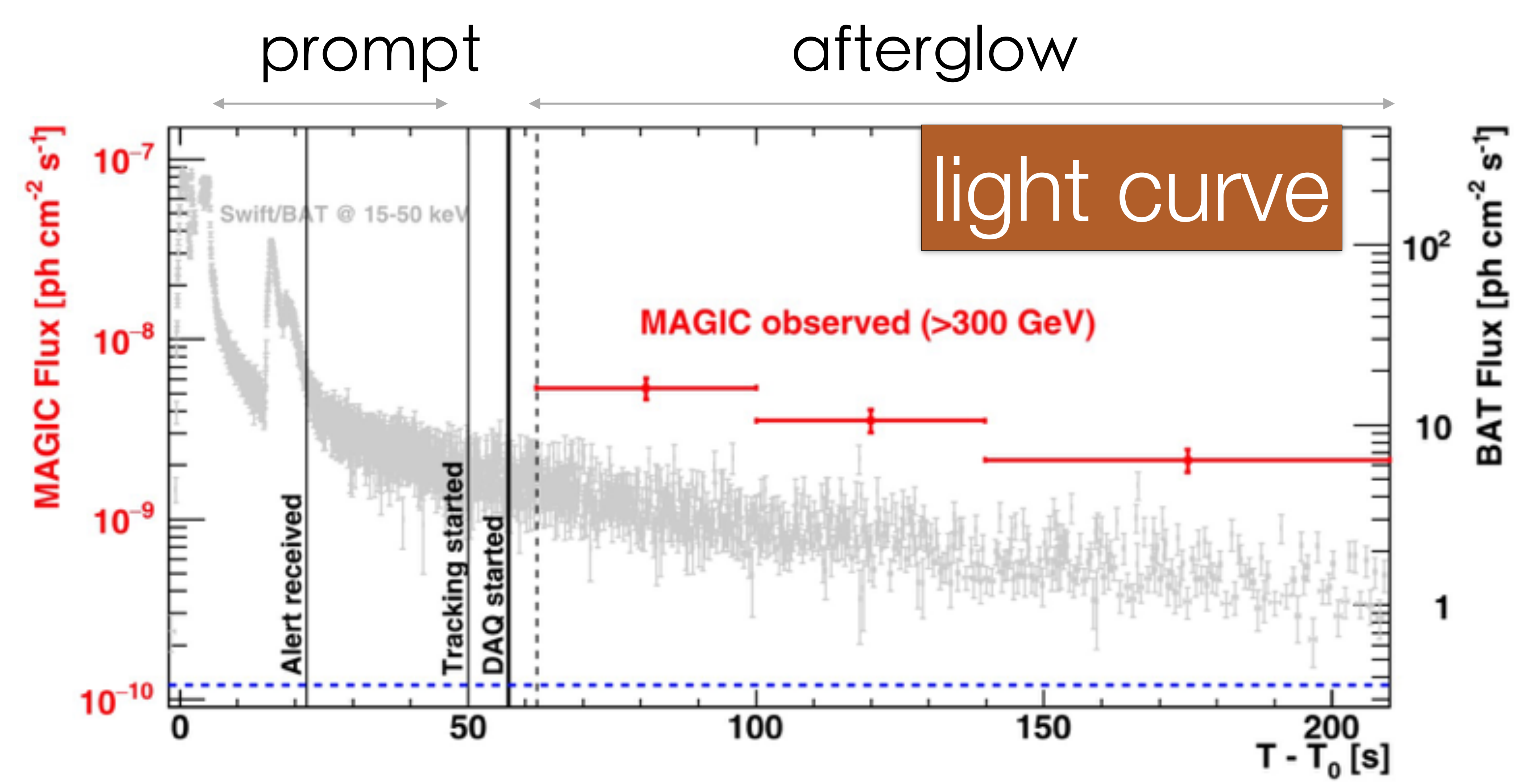


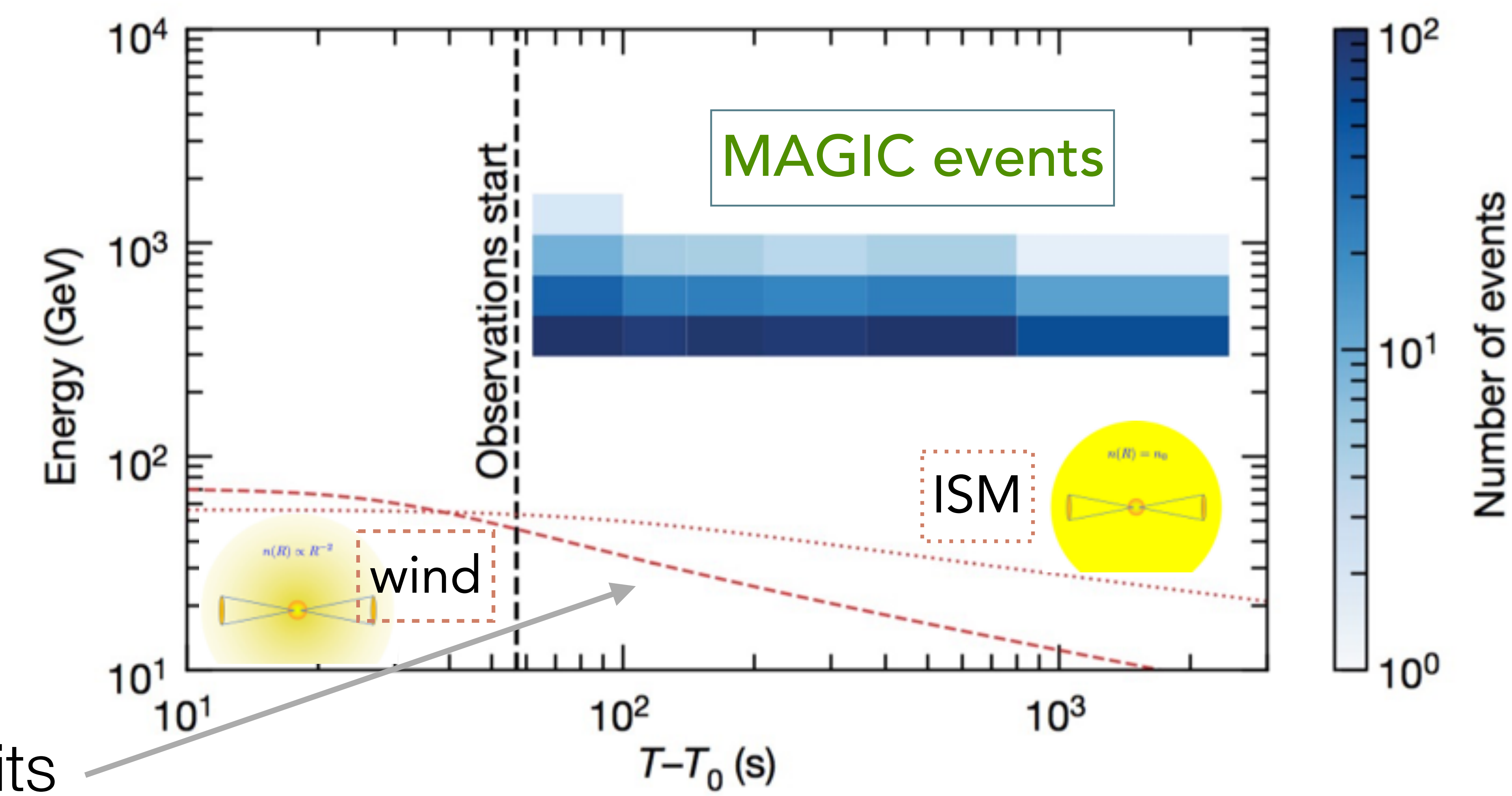
Before GRB190114C:
Single component up to GeV energies
synchrotron emission

GRB 190114C: the detection of TeV emission

MAGIC coll., Nature,575,455-458(2019)
https://www.nature.com/articles/s41586-019-1750-x

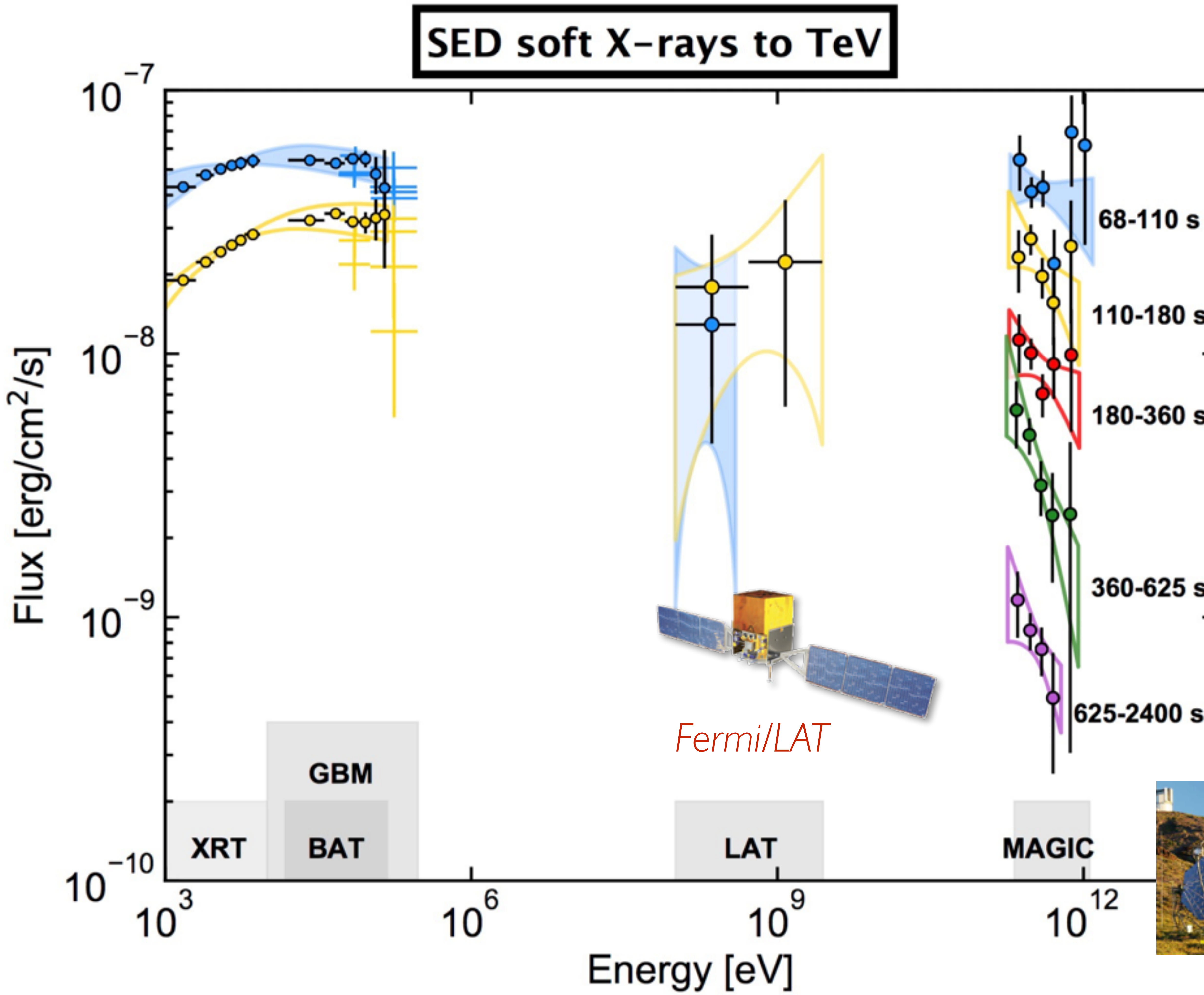
- Long GRB at z=0.425 (GCN #**23695 #23708**)
- E_{iso} = 3x10^{53} erg; **bright GRB, but not exceptional**
- MAGIC telescopes on target at T_0+50s
  - observations in the **afterglow phase**
  - Total observing time 4.25 hrs
- Brightest TeV source ever!
- VHE photons detected by MAGIC, at >100 GeV up to ~1TeV are **well beyond the burnoff limits**





"burnoff" limits

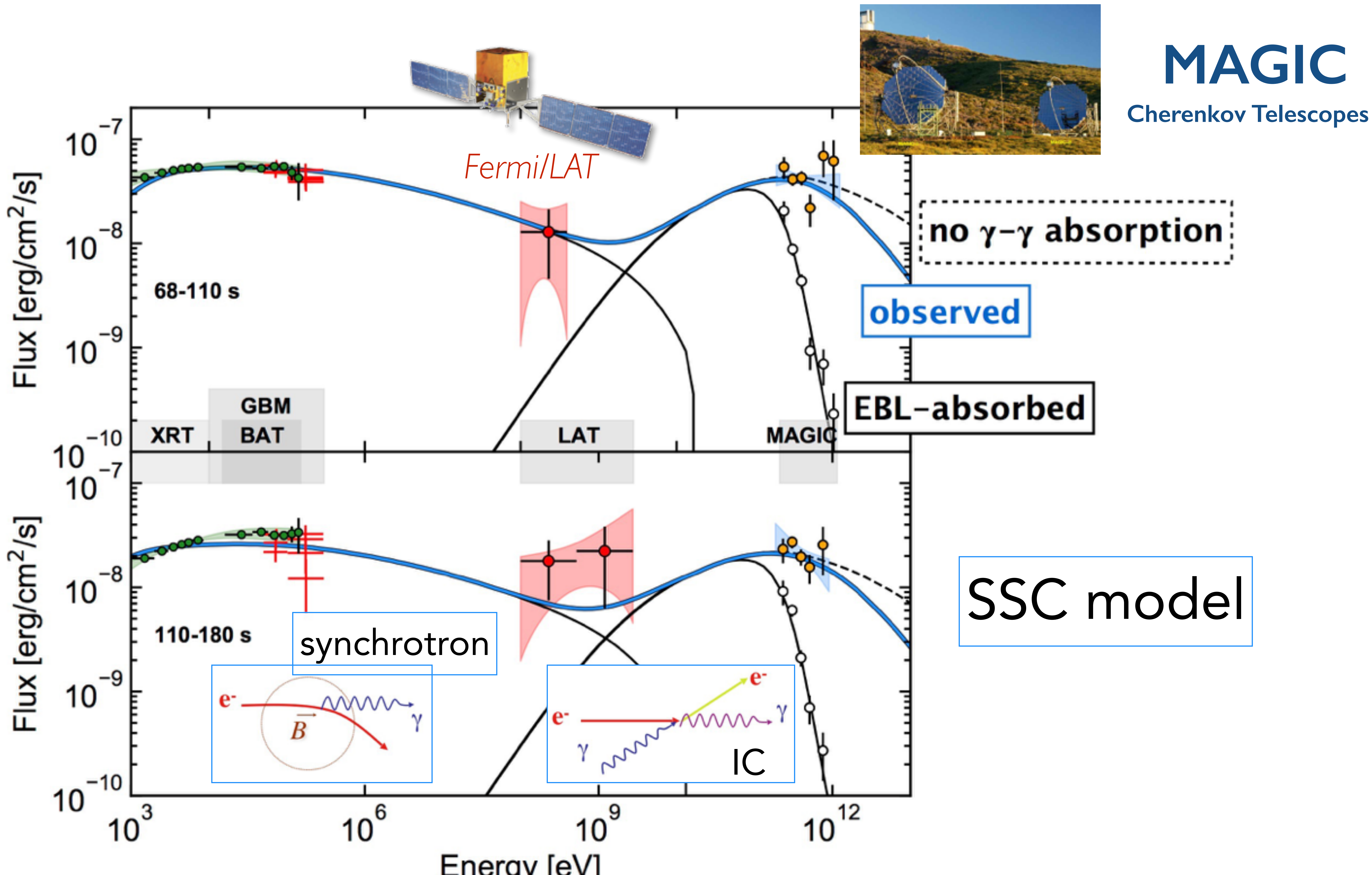
GRB190114C: the high energy SEDs



MAGIC Coll. et al., Nature,575,459-463(2019)
https://www.nature.com/articles/s41586-019-1754-6

GRB190114C: modeling with SSC afterglow radiation

- First modelling of broad-band and TeV emission from a GRB!



MAGIC Coll. et al., Nature,575,459-463(2019)
https://www.nature.com/articles/s41586-019-1754-6

GRB 190114C: LIV studies

MAGIC Coll., 2020, Phys. Rev. Lett., 125

- Delay Δt between photons with different energy ΔE

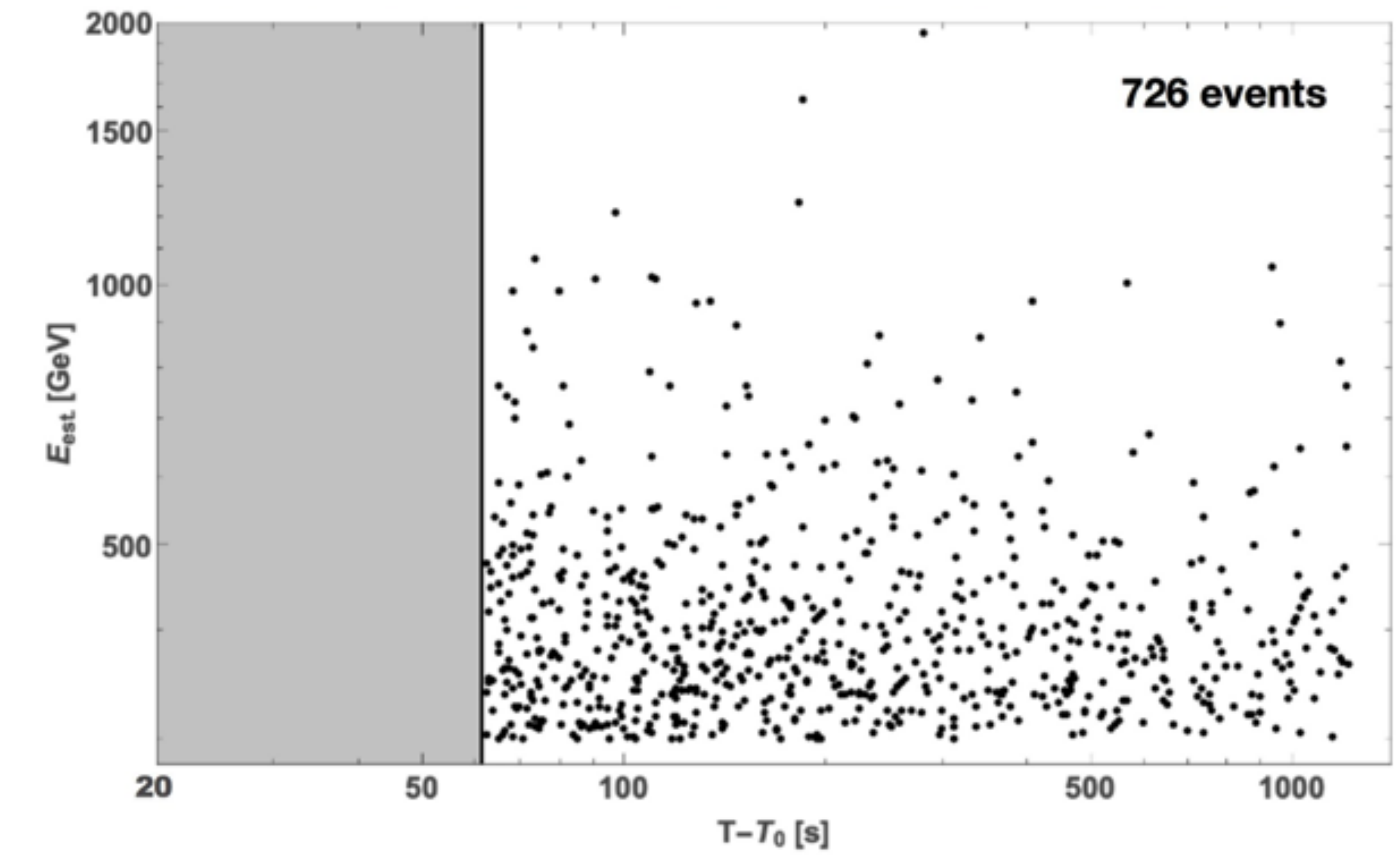
$$\Delta t = s\frac{n+1}{2}D_n(z)\left(\frac{\Delta E}{E_{\mathrm{QG,n}}}\right)^n$$

s=+1,-1 super-, sub-luminal

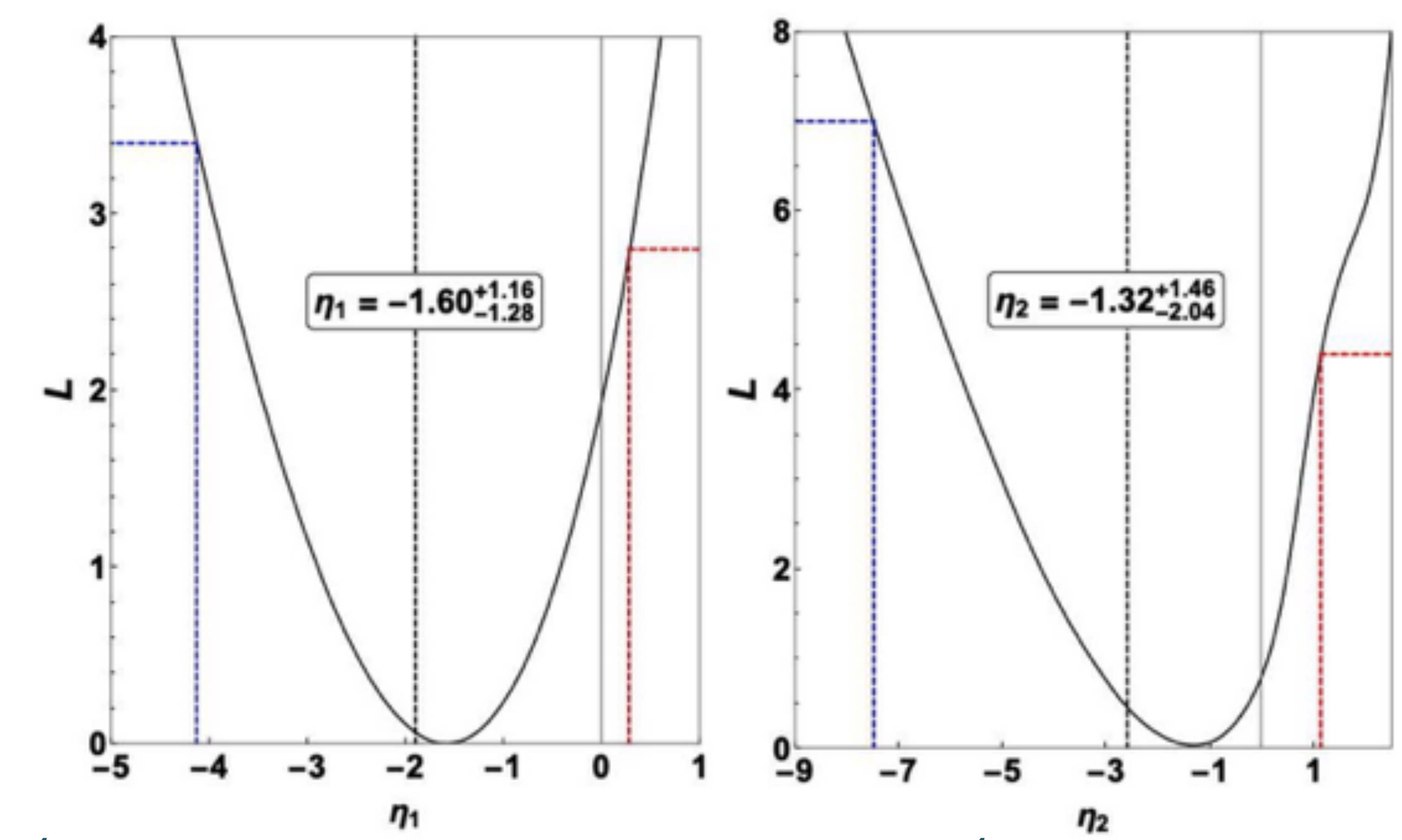
comoving distance

correction order

> Planck energy by a factor η



- Two assumptions on the shape of the temporal distribution of TeV photons (step function and observed light curve)
- Likelihood analysis to constrain η and thus the limits on the quantum energy



- Limits second order: ~ Mrk501 (larger energies > TeV);
- first order: less constraining than limits from GRB090510 (larger distance)

	s=-1 superluminal case	s=+1 subluminal case
n=1	$E_{QG,1} > 0.5 \cdot E_{Pl}$	$E_{QG,1} > 0.6 \cdot E_{Pl}$
n=2	$E_{QG,2} > 8.4 \cdot 10^{10}$ GeV	$E_{QG,2} > 7.9 \cdot 10^{10}$ GeV

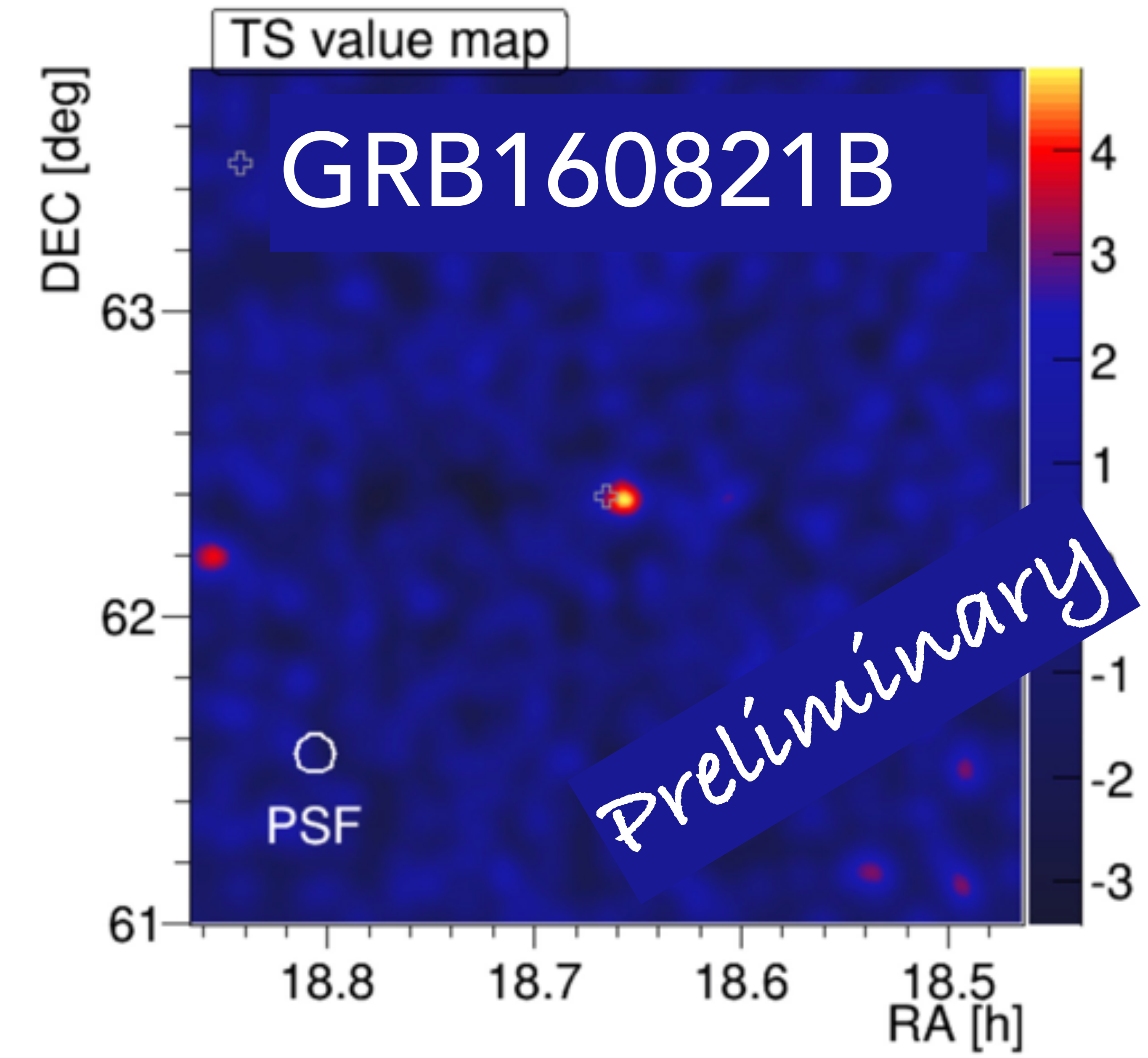
GRB190114C: the era of GRB in the TeV domain

- First clear and strong detection of a GRB in the TeV with high photon statistics

paper in preparation

K. Noda, Texas Symposium 2017

- **Hint of detection on the short GRB160821B by MAGIC (S. Inoue, ICRC 2017; K. Noda, Texas Symposium 2017; Berti et al., 2019, Proc. MG15)**
    - z=0.16; recently associated to a kilonova
      Lamb et al. 2019 arXiV:1905.02159, Troja et al. arXiV:1905.01290

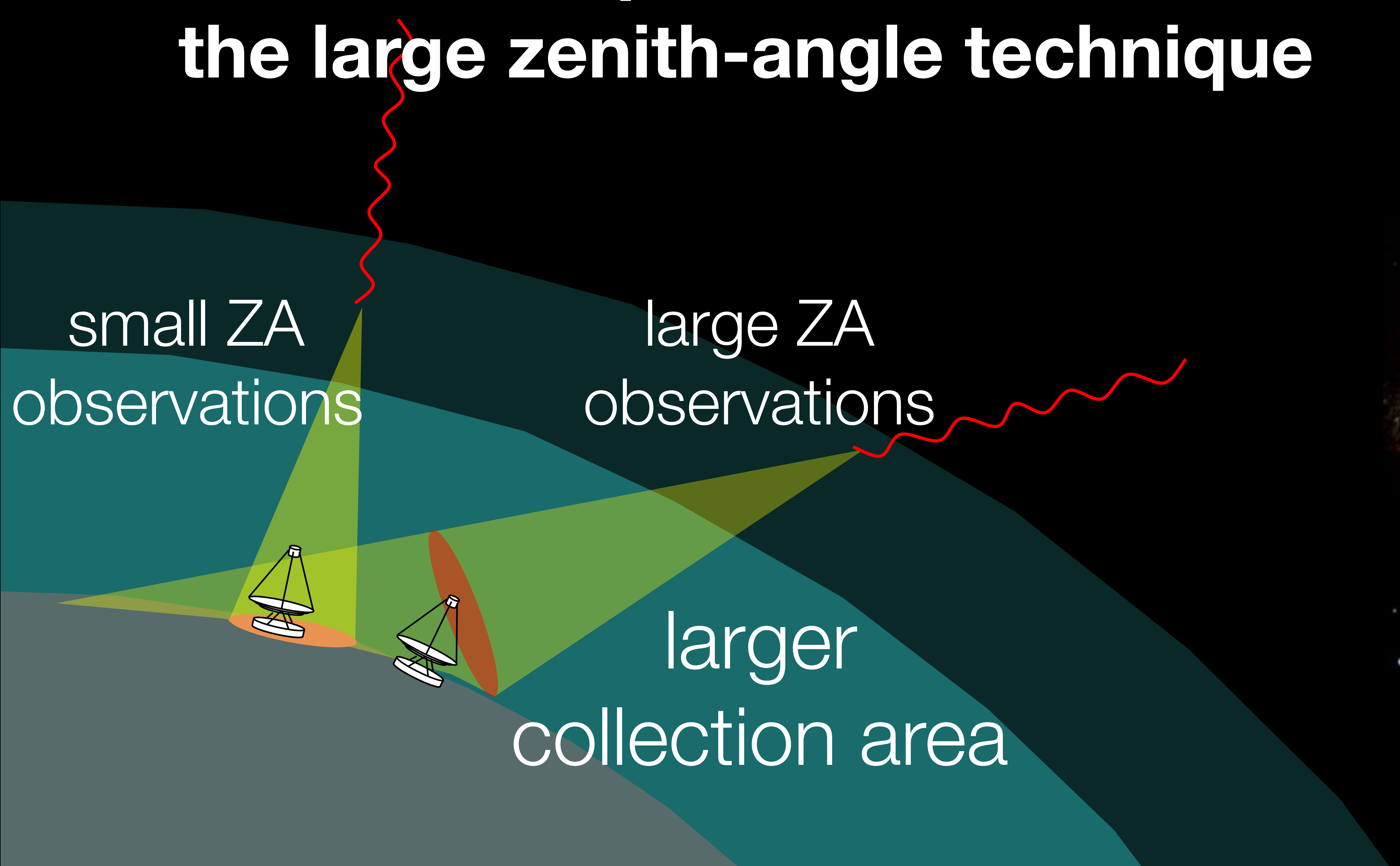


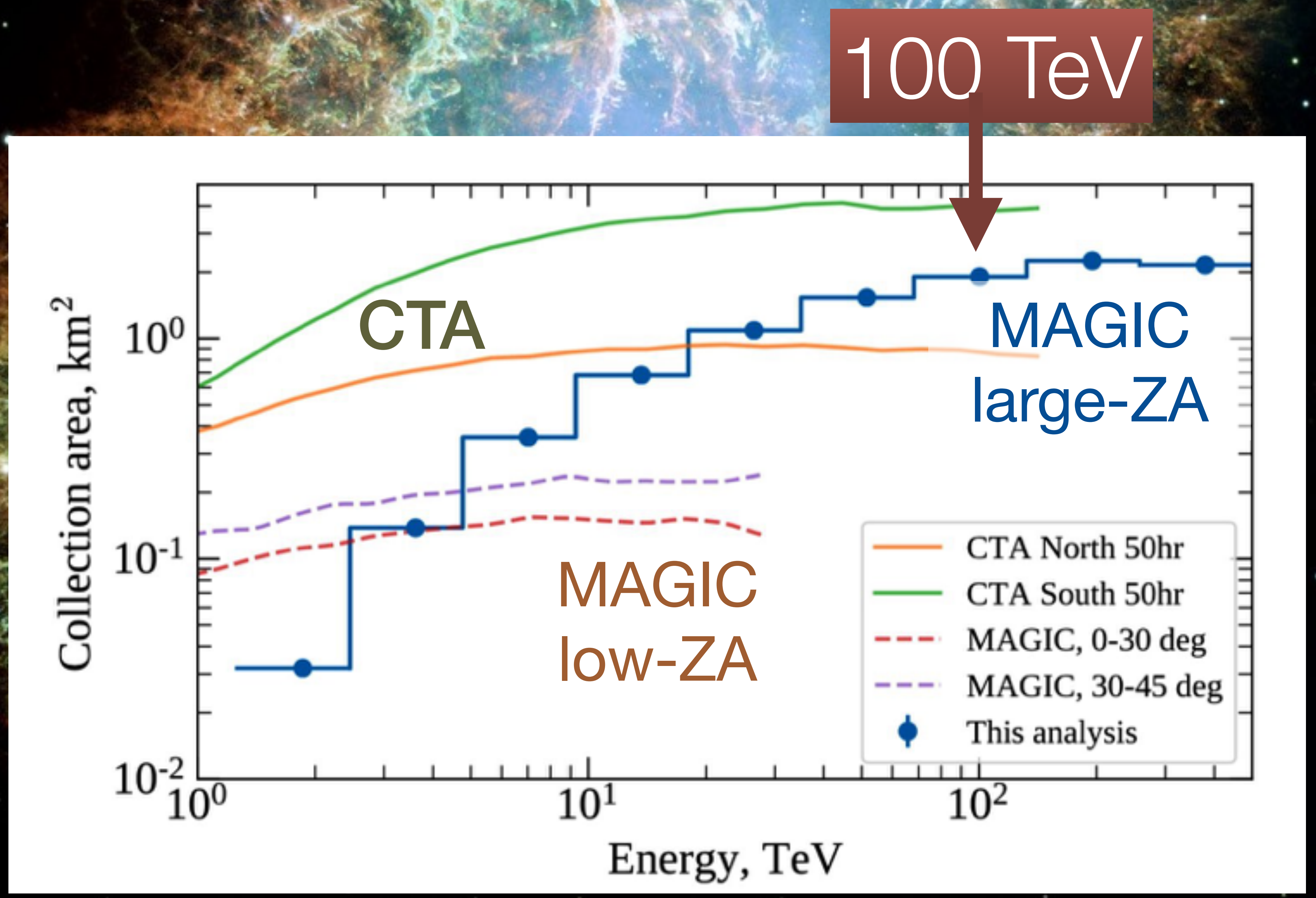
4 h data, $> 4\sigma$ pre-trial, 3.1σ post-trial above 600-800 GeV: **detection hint** (3 independent analyzers)

COMPELLING FOR FUTURE TEV-DETECTION OF GW COUNTERPARTS!

EXTREME ENERGIES: THE QUEST FOR PEVATRONS

- **MAGIC observes the Crab Nebula in the 100 TeV domain**
  - *MAGIC coll., A&A 635, A158 (2020)*
- **Extend the spectrum > 100 TeV with the large zenith-angle technique**





MAGIC coll., A&A 635, A158 (2020)

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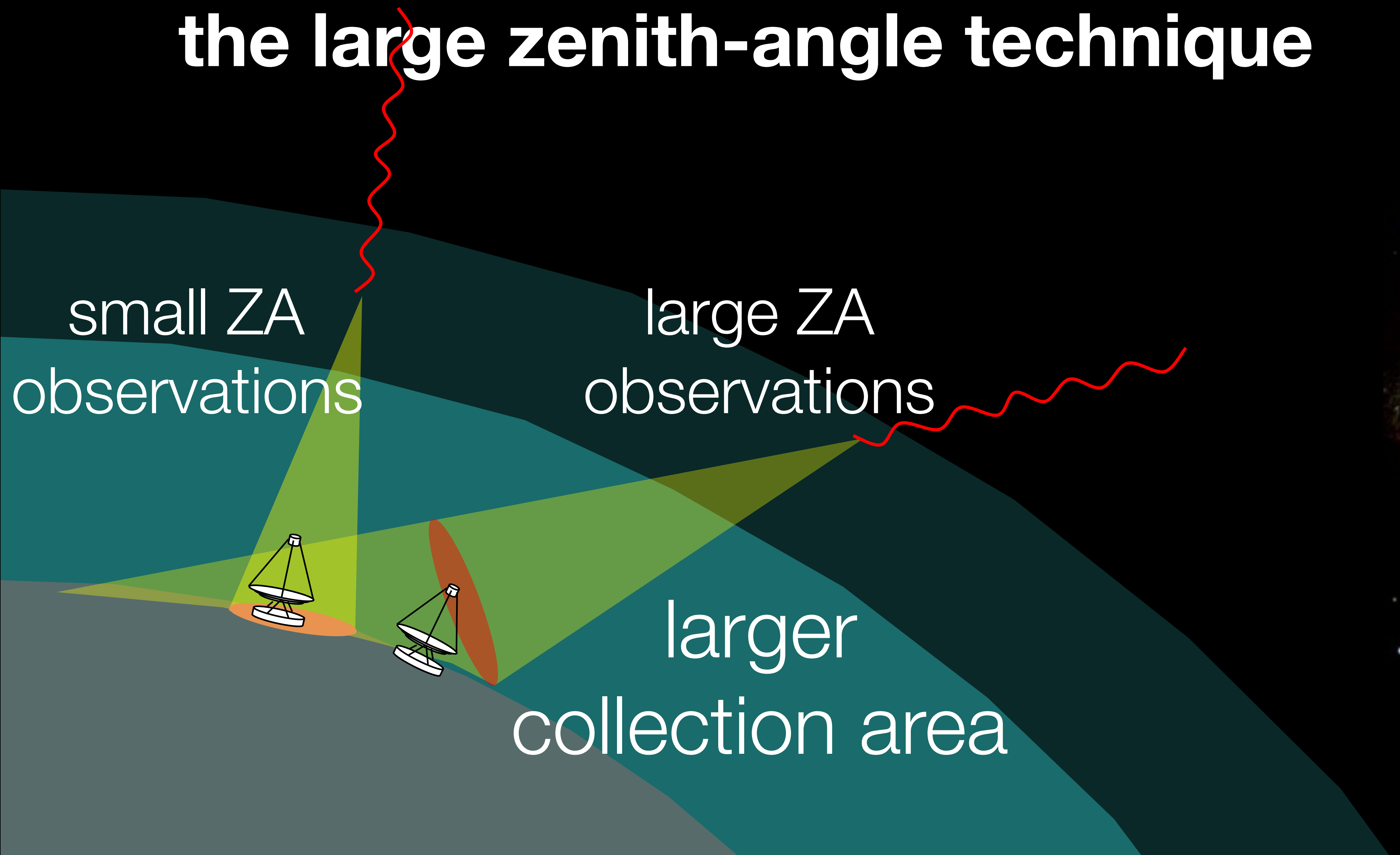
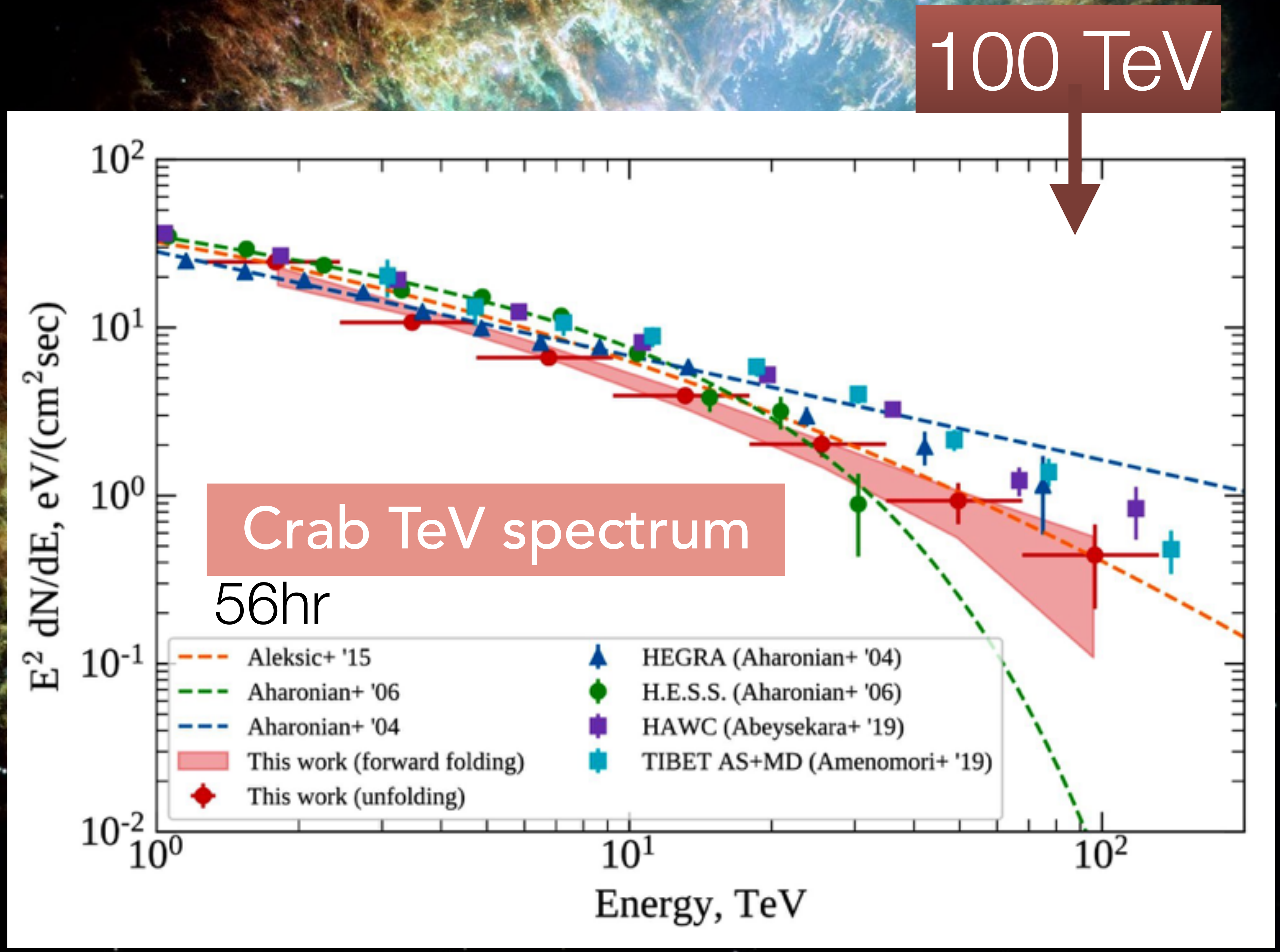
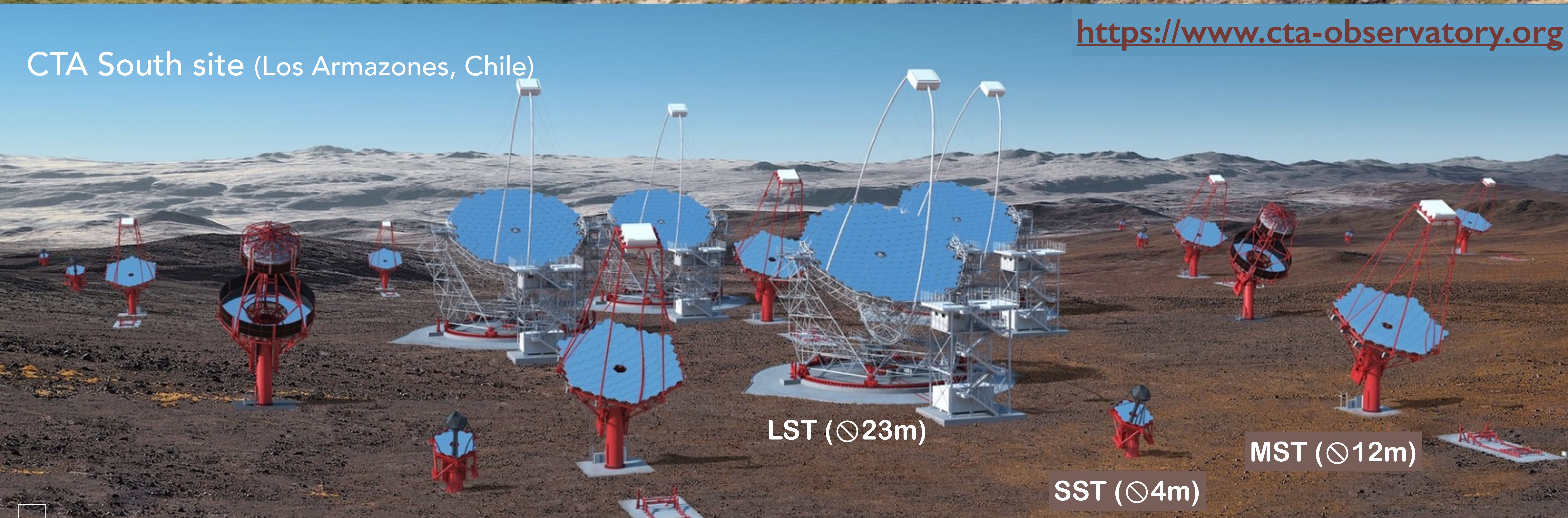


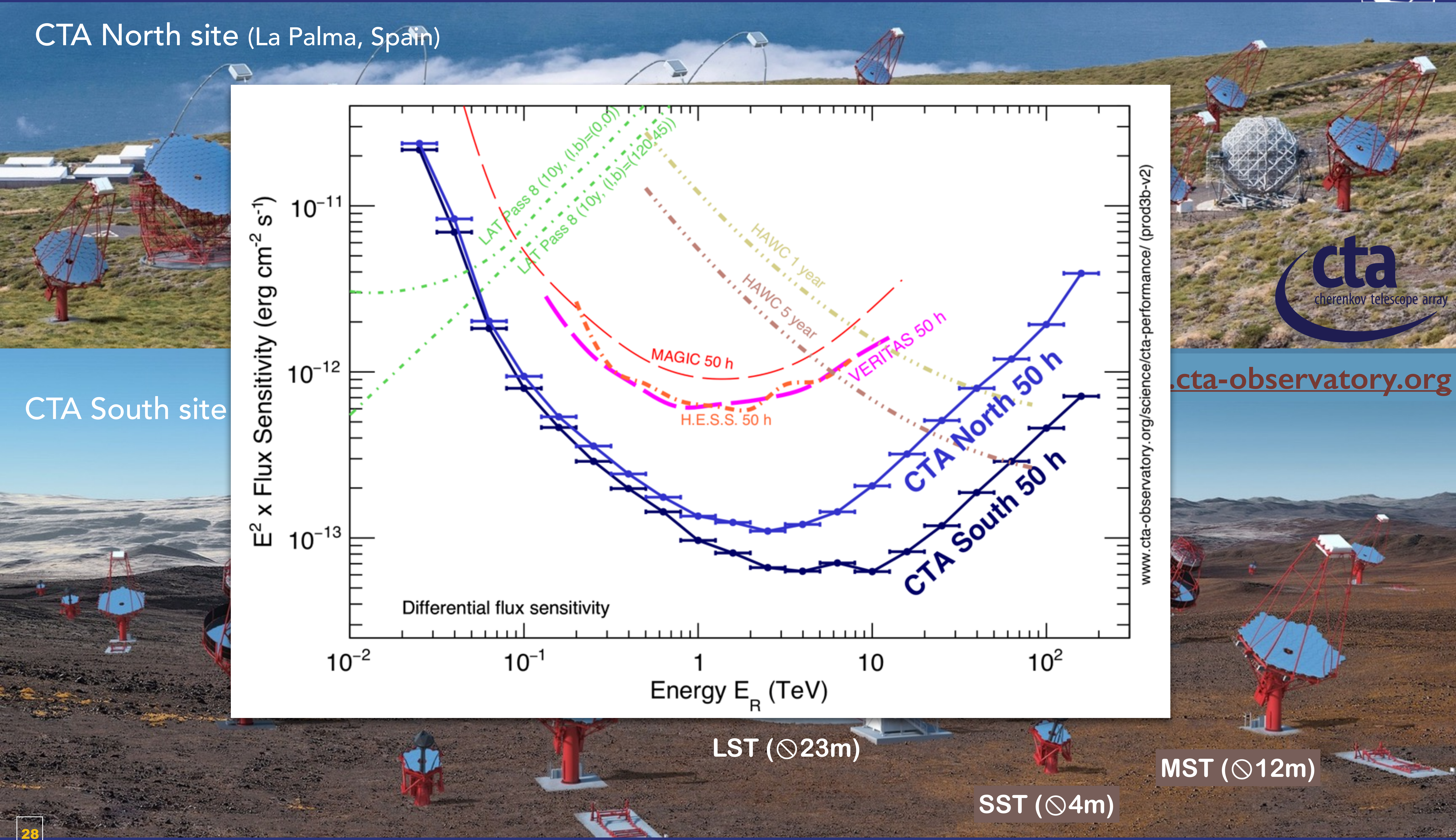


MAGIC coll., A&A 635, A158 (2020)

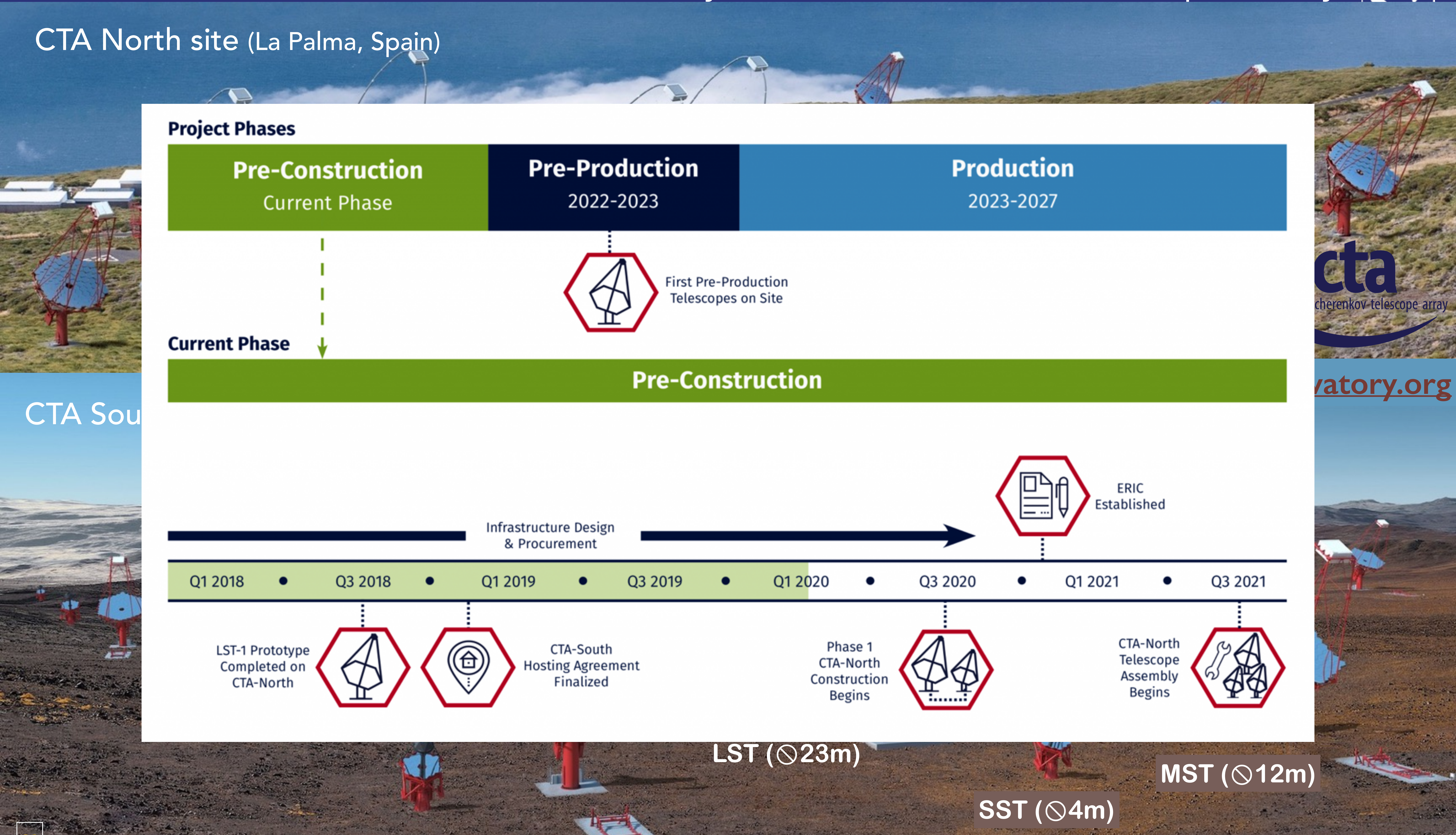
The future of the TeV astronomy: The Cherenkov Telescope Array



The future of the TeV astronomy: The Cherenkov Telescope Array



The future of the TeV astronomy: The Cherenkov Telescope Array



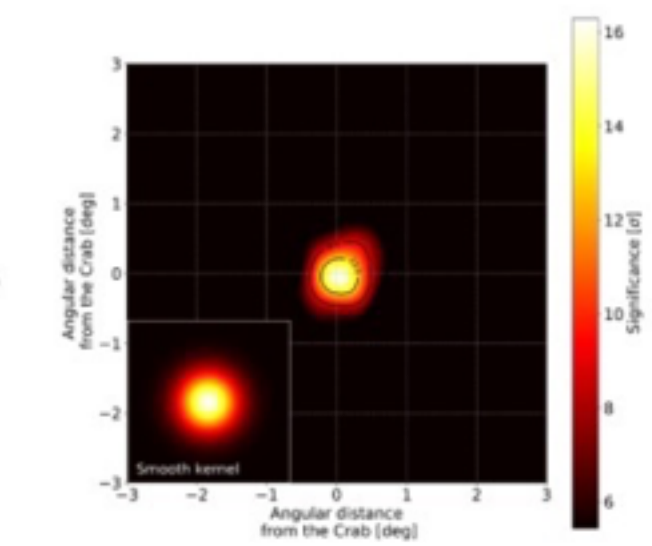

cta
cherenkov telescope array
LST
prototype
MAGIC-2
MAGIC-1
Live webcam
http://www.lst1.iac.es/webcams.html

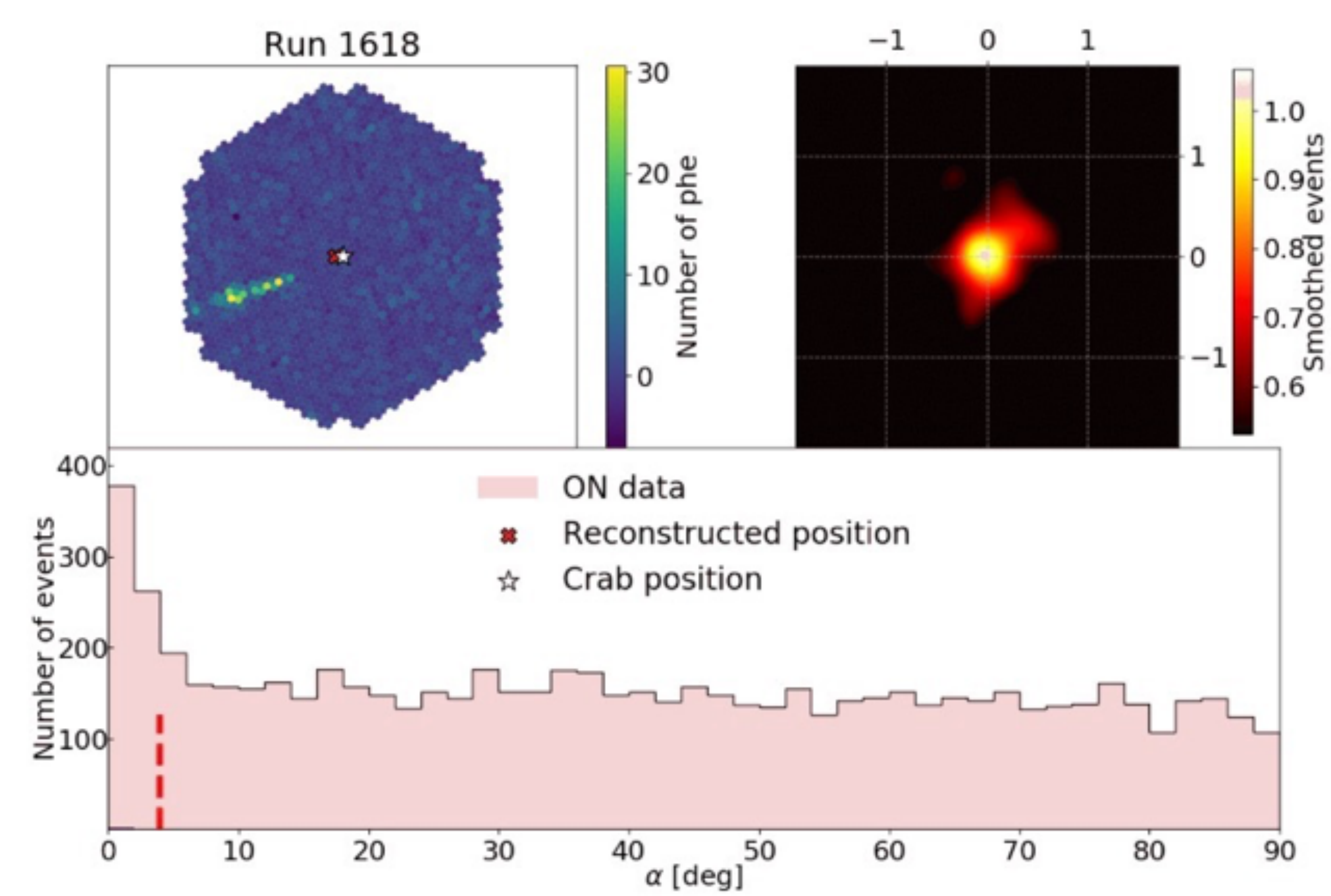
https://www.cta-observatory.org/lst1-detects-first-gamma-ray-signal/

5 December 2019

The LST-1 Detects its First Gamma-Ray Signal

In its first attempt to detect a gamma-ray source, the Large-Sized Telescope prototype (LST-1) successfully detected its first gamma-ray signal on 23 November 2019 when it pointed to the Crab Nebula, which is considered the standard candle in very high-energy astronomy. Preliminary analyses show a very clear detection of a gamma-ray signal coming from the source, reassuring the team's expectations that the telescope is performing as designed. These results are being discussed at the LST General Meeting that is taking place this week in Marseille, France. Right: the two-dimensional excess map of the gamma-ray excess from the direction of the Crab Nebula at an exposure of 269 min. (Credit: Rubén López-Coto, LST Collaboration)





Above: The time development of the gamma-ray signal in one run (30-min exposure) on the Crab Nebula on 23 November 2019. (Credit: Rubén López-Coto, LST Collaboration)

https://www.cta-observatory.org/lst1-detects-vhe-emission-from-crab-pulsar/

22 June 2020

roject News Outreach &

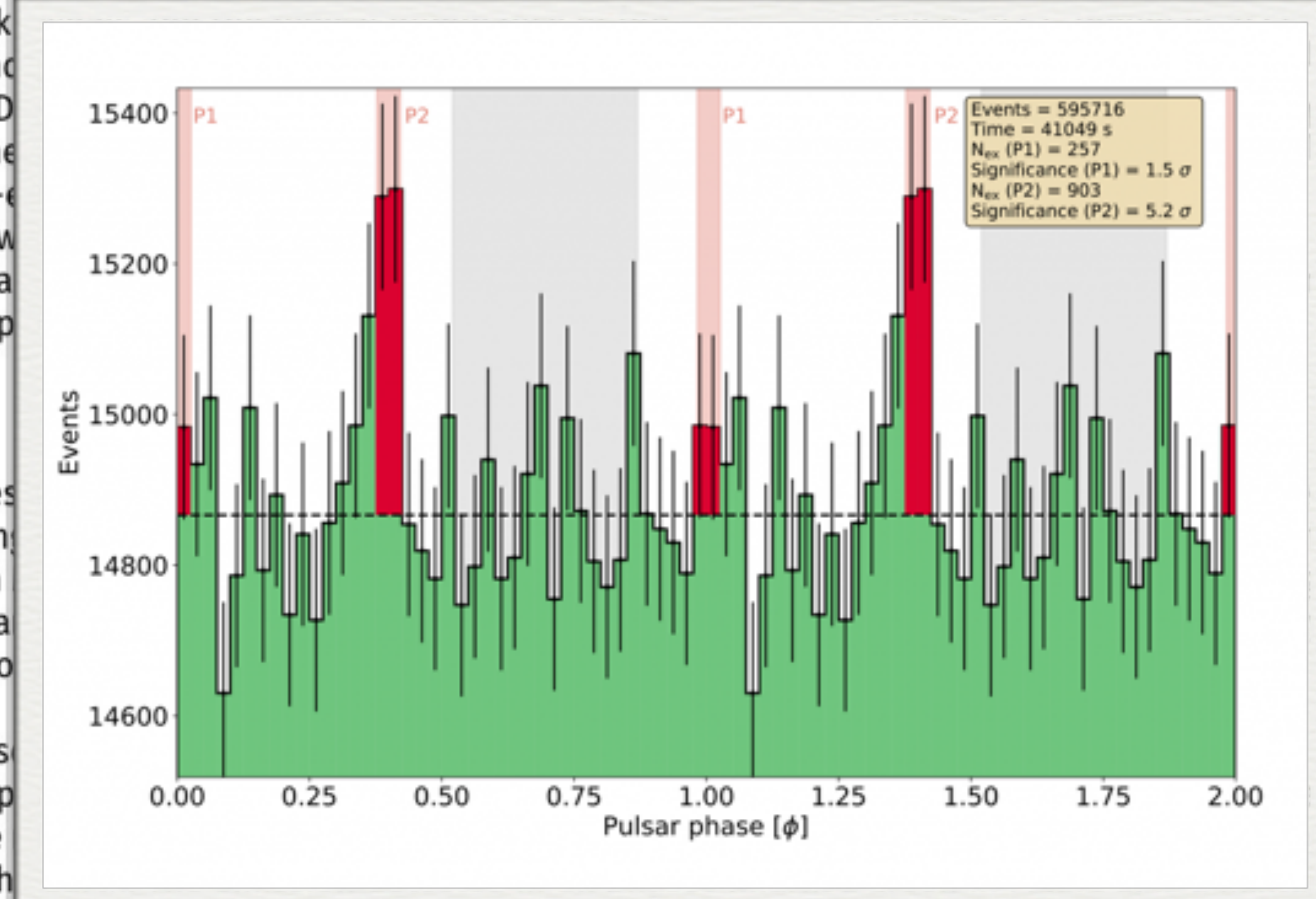
CTA Prototype LST-1 Detects Very High-Energy Emission from the Crab Pulsar

22 June 2020

Between January and February 2020, the prototype Large-Sized Telescope (LST), the LST-1, observed the Crab Pulsar, the neutron star at the centre of the Crab Nebula. The telescope, which is being commissioned on the CTA-North site on the island of La Palma in the Canary Islands, was conducting engineering runs to verify the telescope performance and adjust operating parameters.

Figure 1. Multiwavelength view of the Crab Nebula and the Crab pulsar – the bright spot at the centre of the image. Credit: NASA, ESA, G. Dubner (IAFE, CONICET-University of Buenos Aires) et al.; A. ...eward ...F; ...- ...cl

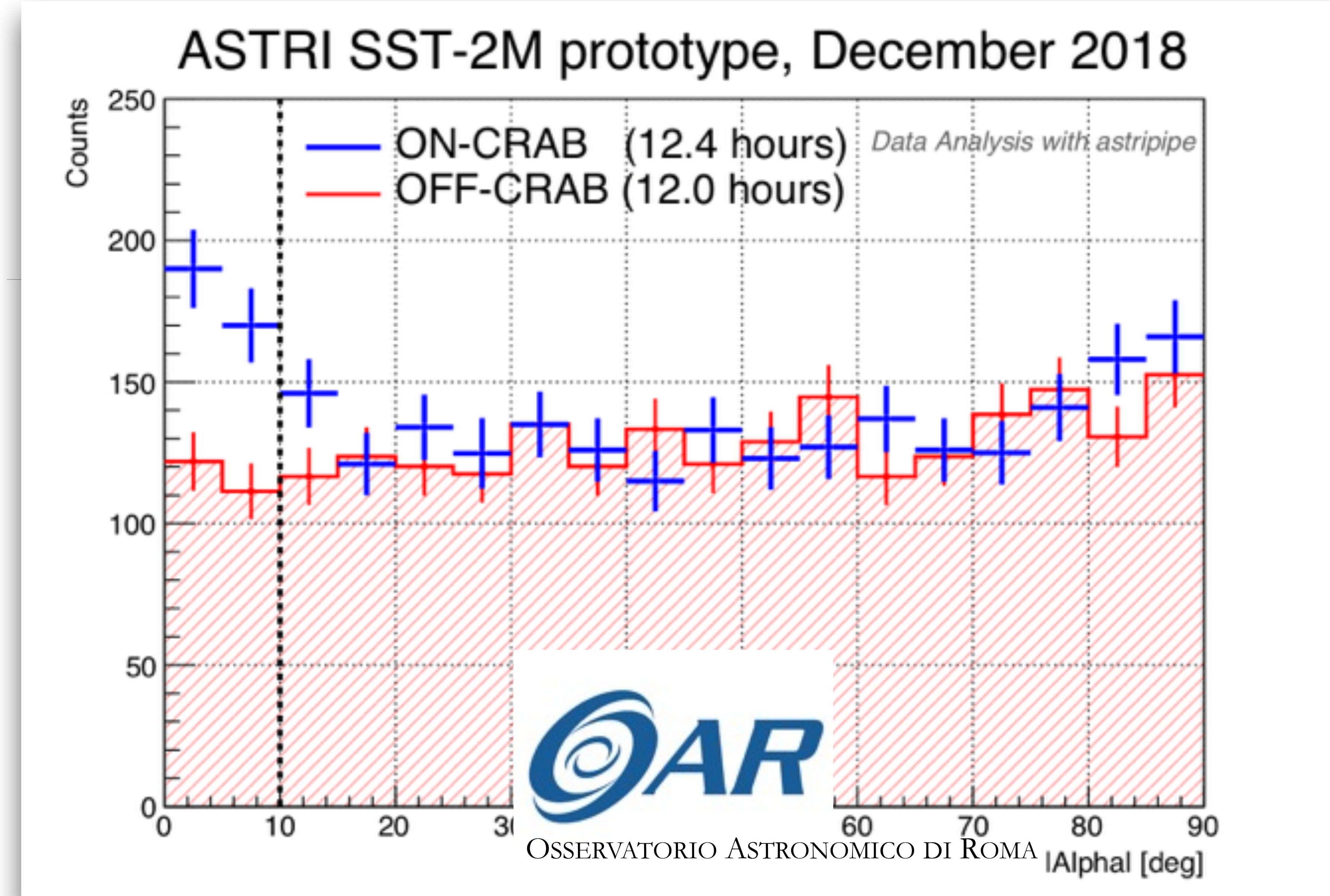
Pulsars are very rapidly rotating and strongly magnetized neutron stars that emit light in the form of two beams, which can be observed from Earth only when passing our line of sight. While detecting the strong and steady emission or outbursts of gamma-ray sources with Imaging Atmospheric Cherenkov Telescopes (IACTs) has become routine, pulsars are much more challenging to detect due to their weak ... foreground ... nebulae. D... around the ... very high-... so far. Now ... Crab pulsa... timestamp ... the

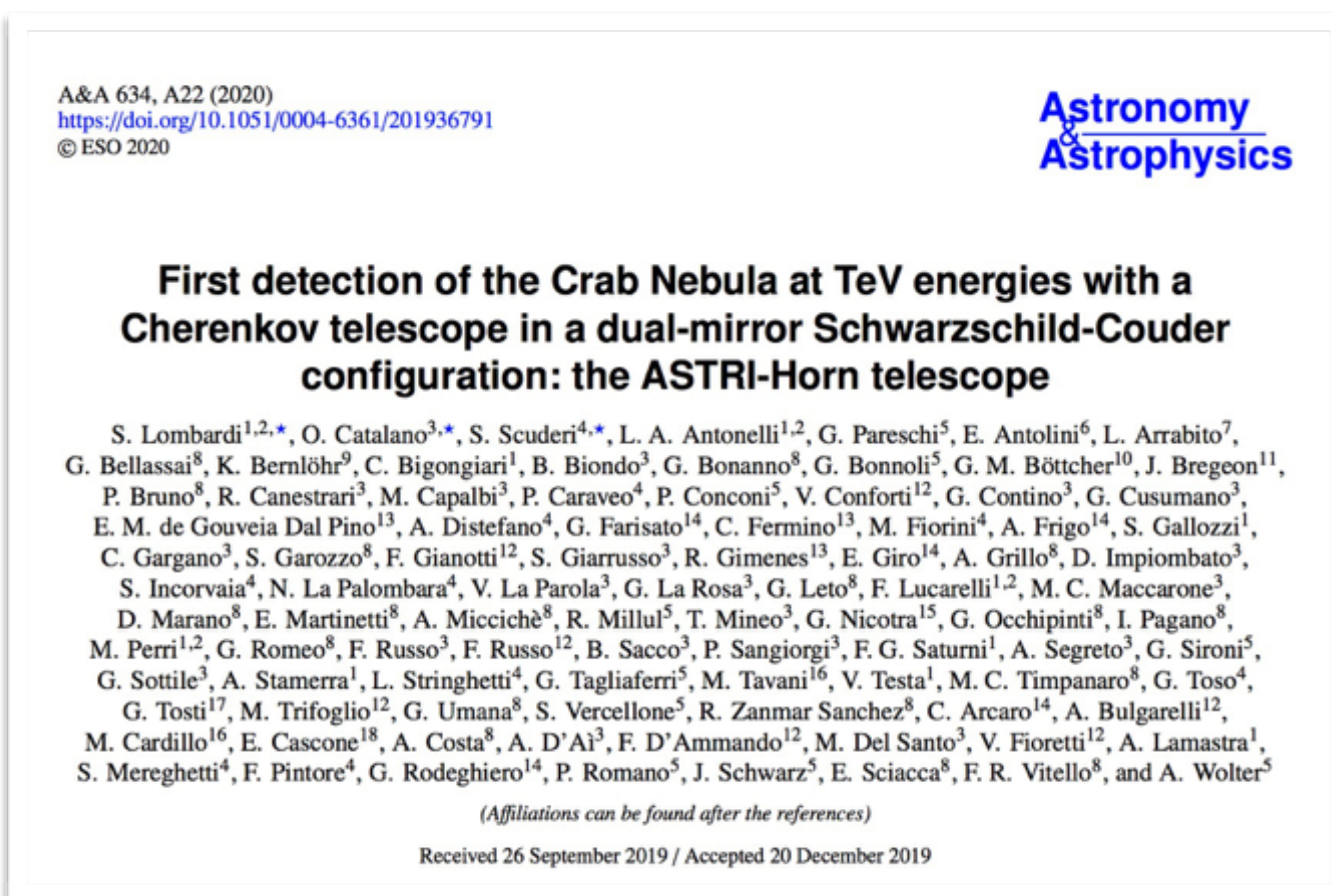


"This miles... ...ting a challengin... ...r physics in ... ...ts of the LSTs, a... commissio...

The data s... resulting p... ...e. In the phase ... ...its towards th... ...of different background contributions, including the irreducible steady emission from the Crab Nebula.

The very first source detection made by CTA!





A&A 634, A22 (2020)
https://doi.org/10.1051/0004-6361/201936791

Astronomy & Astrophysics

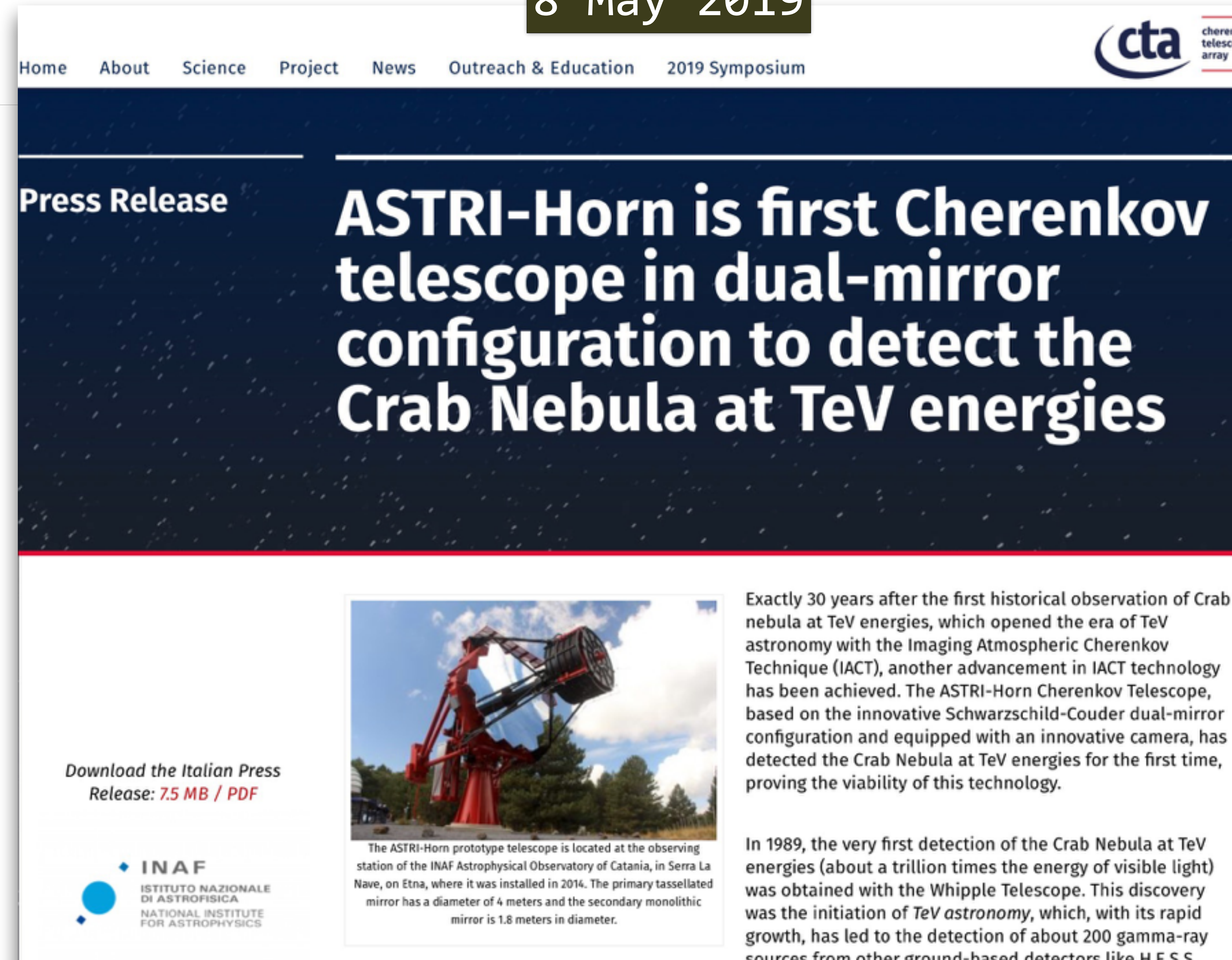
First detection of the Crab Nebula at TeV energies with a Cherenkov telescope in a dual-mirror Schwarzschild-Couder configuration: the ASTRI-Horn telescope

S. Lombardi[1,2,⋆], O. Catalano[3,⋆], S. Scuderi[4,⋆], L. A. Antonelli[1,2], G. Pareschi[5], E. Antolini[6], L. Arrabito[7], G. Bellassai[8], K. Bernlöhr[9], C. Bigongiari[1], B. Biondo[3], G. Bonanno[8], G. Bonnoli[5], G. M. Böttcher[10], J. Bregeon[11], P. Bruno[8], R. Canestrari[3], M. Capalbi[3], P. Caraveo[4], P. Conconi[5], V. Conforti[12], G. Contino[3], G. Cusumano[3], E. M. de Gouveia Dal Pino[13], A. Distefano[4], G. Farisato[14], C. Fermino[13], M. Fiorini[4], A. Frigo[14], S. Gallozzi[1], C. Gargano[3], S. Garozzo[8], F. Gianotti[12], S. Giarrusso[3], R. Gimenes[13], E. Giro[14], A. Grillo[8], D. Impiombato[3], S. Incorvaia[4], N. La Palombara[4], V. La Parola[3], G. La Rosa[3], G. Leto[8], F. Lucarelli[1,2], M. C. Maccarone[3], D. Marano[8], E. Martinetti[8], A. Micciché[8], R. Millul[5], T. Mineo[3], G. Nicotra[15], G. Occhipinti[8], I. Pagano[8], M. Perri[1,2], G. Romeo[8], F. Russo[3], F. Russo[12], B. Sacco[3], P. Sangiorgi[3], F. G. Saturni[1], A. Segreto[3], G. Sironi[5], G. Sottile[3], A. Stamerra[1], L. Stringhetti[4], G. Tagliaferri[5], M. Tavani[16], V. Testa[1], M. C. Timpanaro[8], G. Toso[4], G. Tosti[17], M. Trifoglio[12], G. Umana[8], S. Vercellone[5], R. Zanmar Sanchez[8], C. Arcaro[14], A. Bulgarelli[12], M. Cardillo[16], E. Cascone[18], A. Costa[8], A. D'Aì[3], F. D'Ammando[12], M. Del Santo[3], V. Fioretti[12], A. Lamastra[1], S. Mereghetti[4], F. Pintore[4], G. Rodeghiero[14], P. Romano[5], J. Schwarz[5], E. Sciacca[8], F. R. Vitello[8], and A. Wolter[5]

(Affiliations can be found after the references)

Received 26 September 2019 / Accepted 20 December 2019

8 May 2019



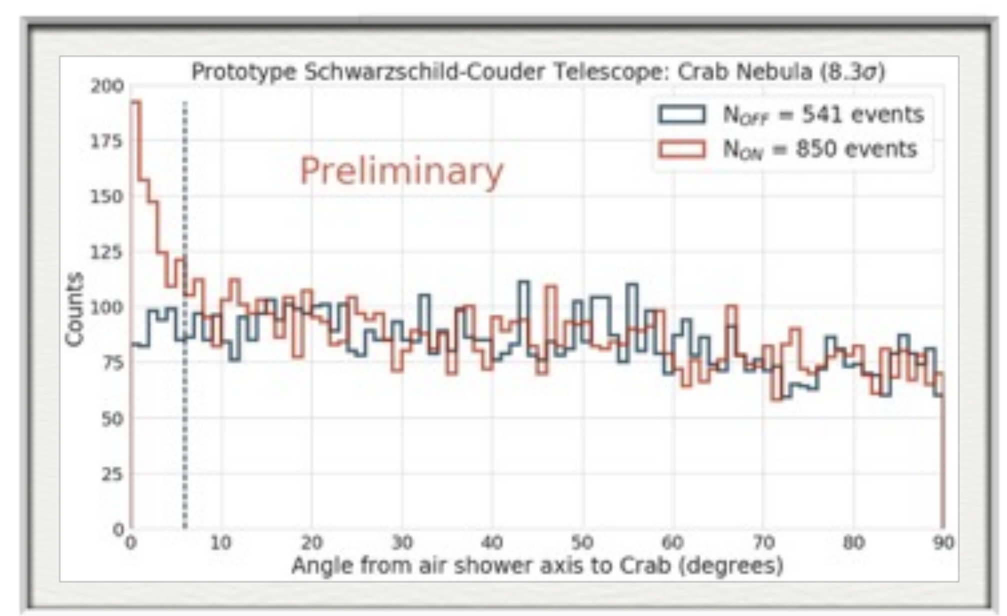
https://www.cta-observatory.org/astri-detects-crab-at-tev-energies/

The medium size Schwarzschild-Couder telescope, detects Crab Nebula

1 June 2020

t News Outreach & Education

CTA Prototype Telescope, the Schwarzschild-Couder Telescope, Detects Crab Nebula



Armado, AZ — On 1 June 2020, scientists from the Cherenkov Telescope Array (CTA) Consortium announced at the 236th meeting of the American Astronomical Society (AAS) that they have detected gamma rays from the Crab Nebula using a prototype telescope proposed for CTA, the prototype Schwarzschild-Couder Telescope (pSCT), proving the viability of the novel telescope design for use in gamma-ray astrophysics.

"The Crab Nebula is the brightest steady source of TeV, or very-high-energy, gamma rays in the sky, so detecting it is an excellent way of proving the pSCT technology," said Justin Vandenbroucke, Associate Professor, University of Wisconsin. "Very-high-energy gamma rays are the highest energy photons in the universe and can unveil the physics of extreme objects including black holes and possibly dark matter."

Detecting the Crab Nebula with the pSCT is more than just proof-positive for the telescope itself. It lays the groundwork for the future of gamma-ray astrophysics. "We've established this new technology, which will measure gamma rays with extraordinary precision, enabling future discoveries," said Vandenbroucke. "Gamma-ray astronomy is already at the heart of the new multi-messenger astrophysics, and the SCT technology will make it an even more important player."

https://www.cta-observatory.org/sct-detects-crab-nebula/

Science prospects with CTA

- Science cases are described in the book "Science with the Cherenkov Telescope Array", 2019, CTA consortium, World Scientific Publishing Co. Pte. Ltd., . ISBN #9789813270091 arxiv:1709.07997

- **Consortium papers:** specific cases are reviewed within the consortium, according to new observational and theoretical insight and with the brand-new simulations.

  - "*Pre-construction estimates of the Cherenkov Telescope Array sensitivity to a dark matter signal from the Galactic centre*" arXiv:2007.16129

  - "*Monte Carlo studies for the optimisation of the Cherenkov Telescope Array layout*" AstroP.Phys, 2019, 111;

  - "*The gravitational wave follow-up program of the Cherenkov Telescope Array*" arXiv:1908.08393 (proceed.)

  - More to come!

Call for proposals with MAGIC open to external scientists

MAGIC Cycle 16 call for proposals

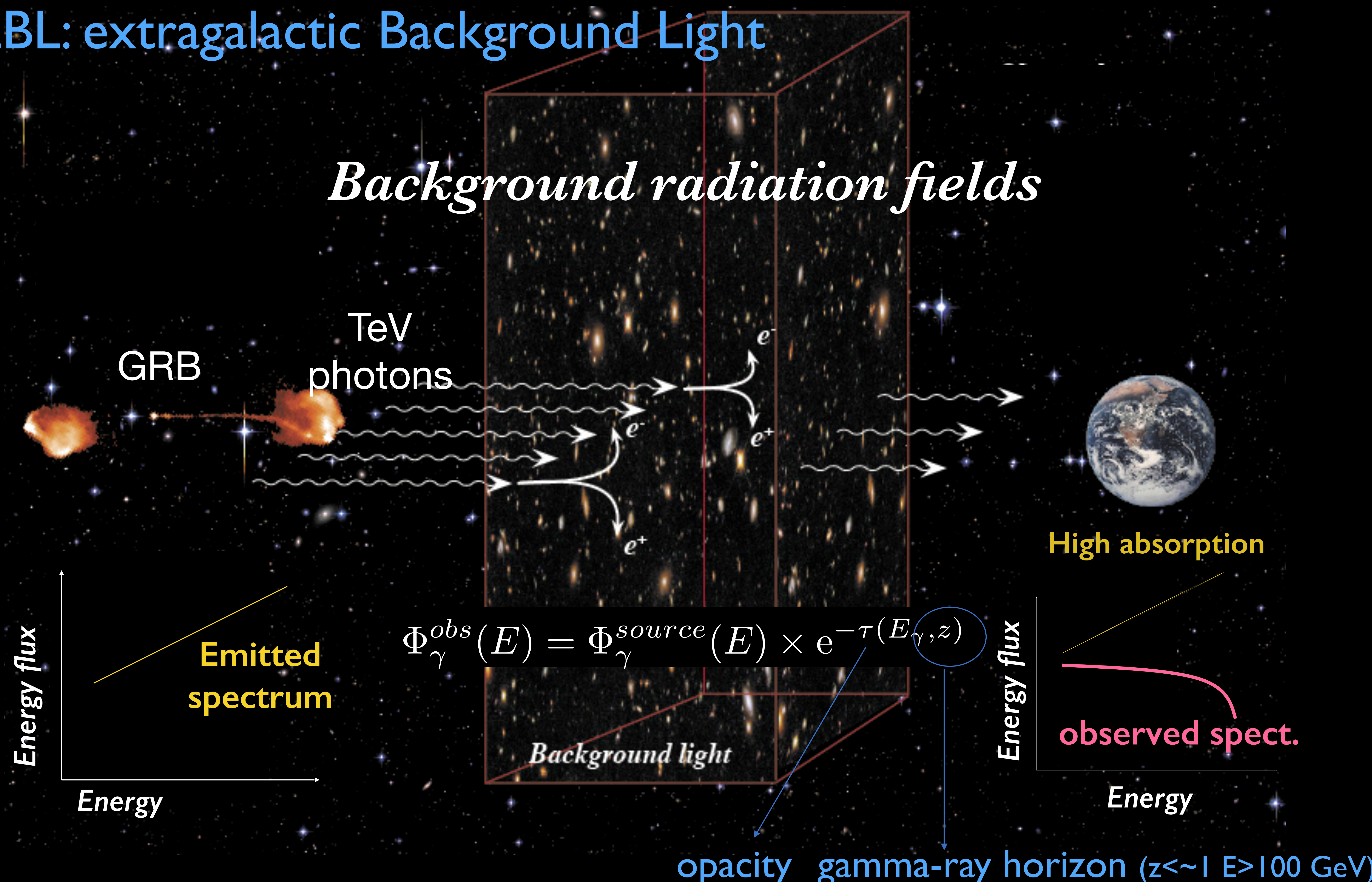
- ★ Observations: from 2021 January 25th to 2022 January 23rd
- ★ Deadline for submission: **23rd October 2020**
- ➡ Contact the Physics coordinator before **2nd October**
- ★ Guide for proposal preparation and submission: *https://magic.mpp.mpg.de/outsiders/magicop/*

MAGIC
Major Atmospheric
Gamma Imaging
Cerenkov Telescopes

END

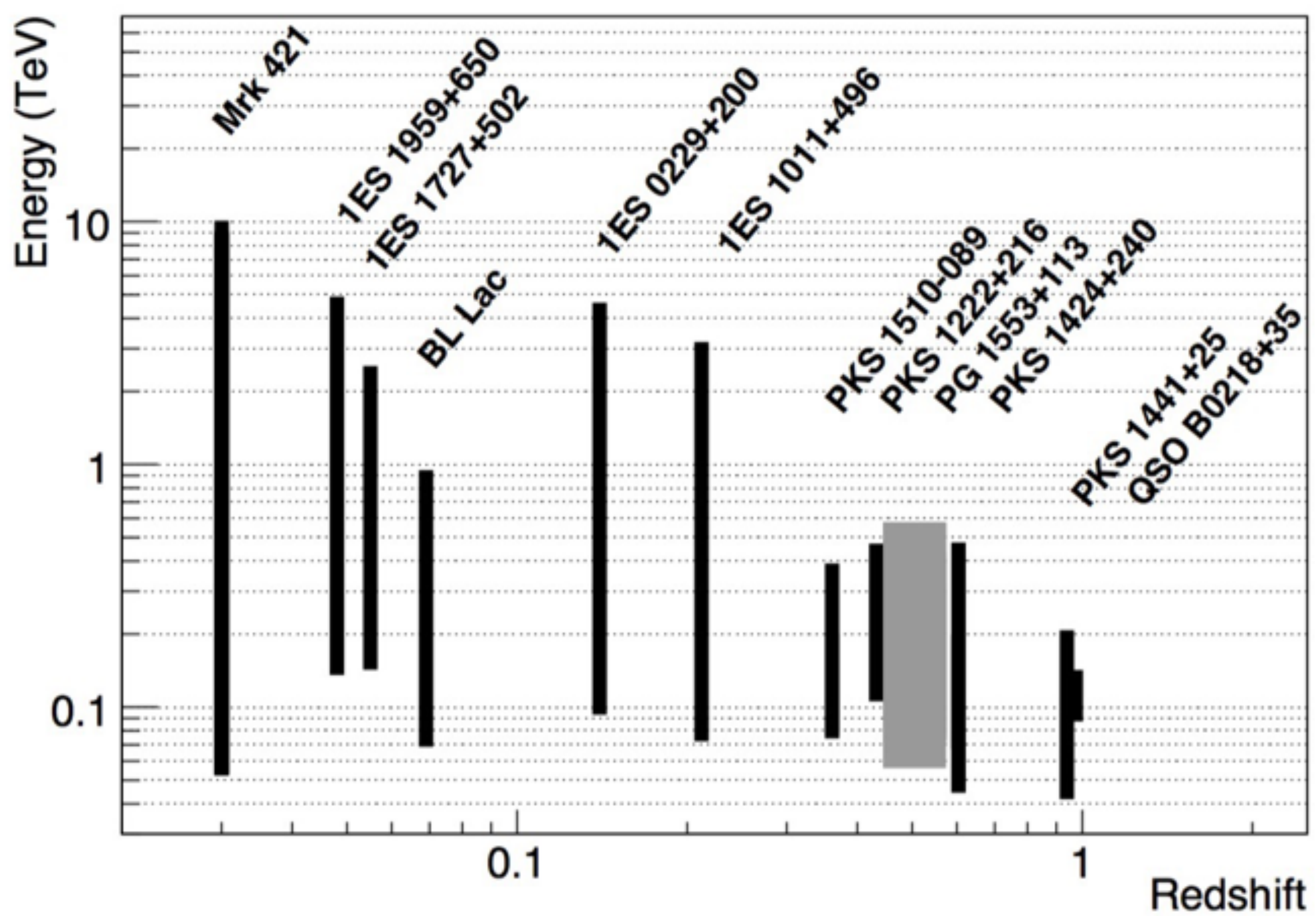
EBL absorption of TeV photons

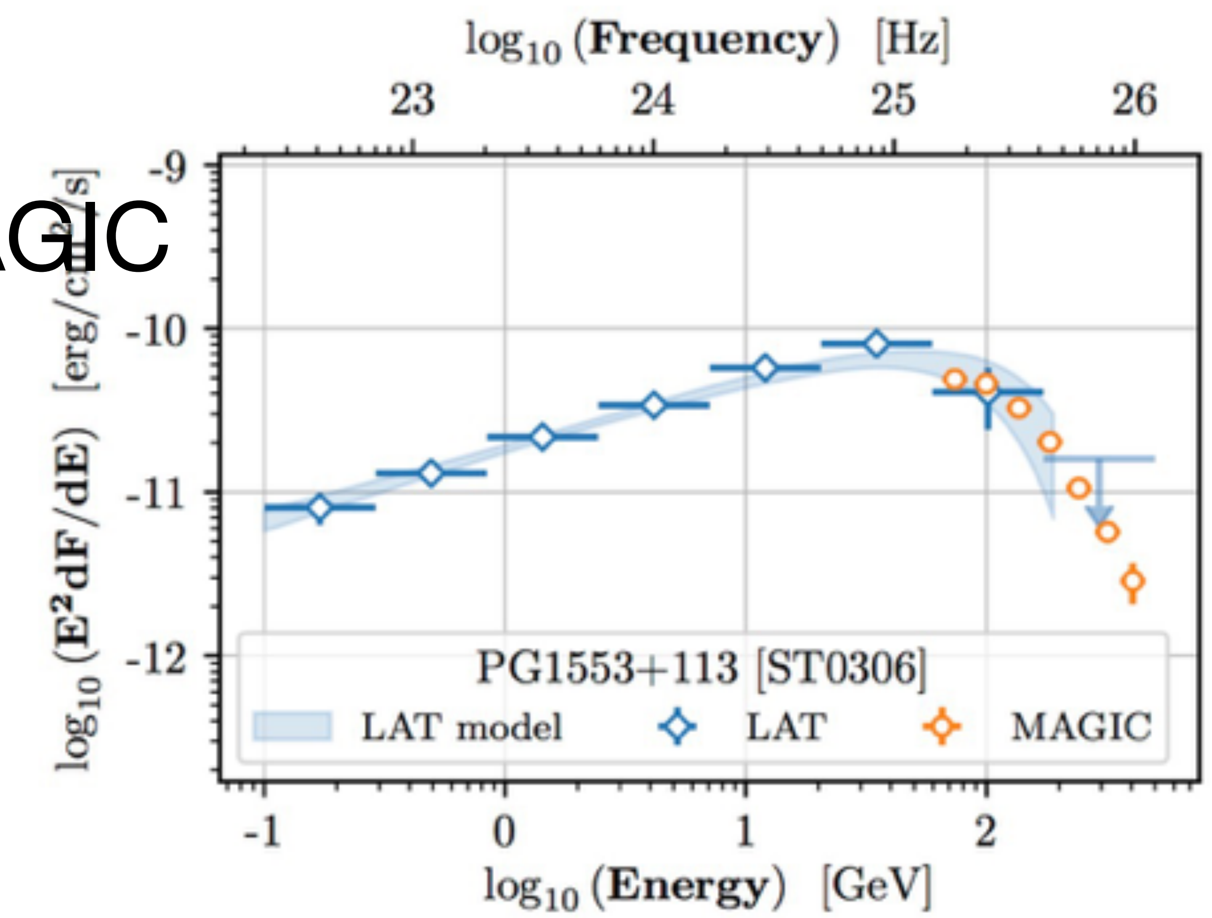
EBL: extragalactic Background Light

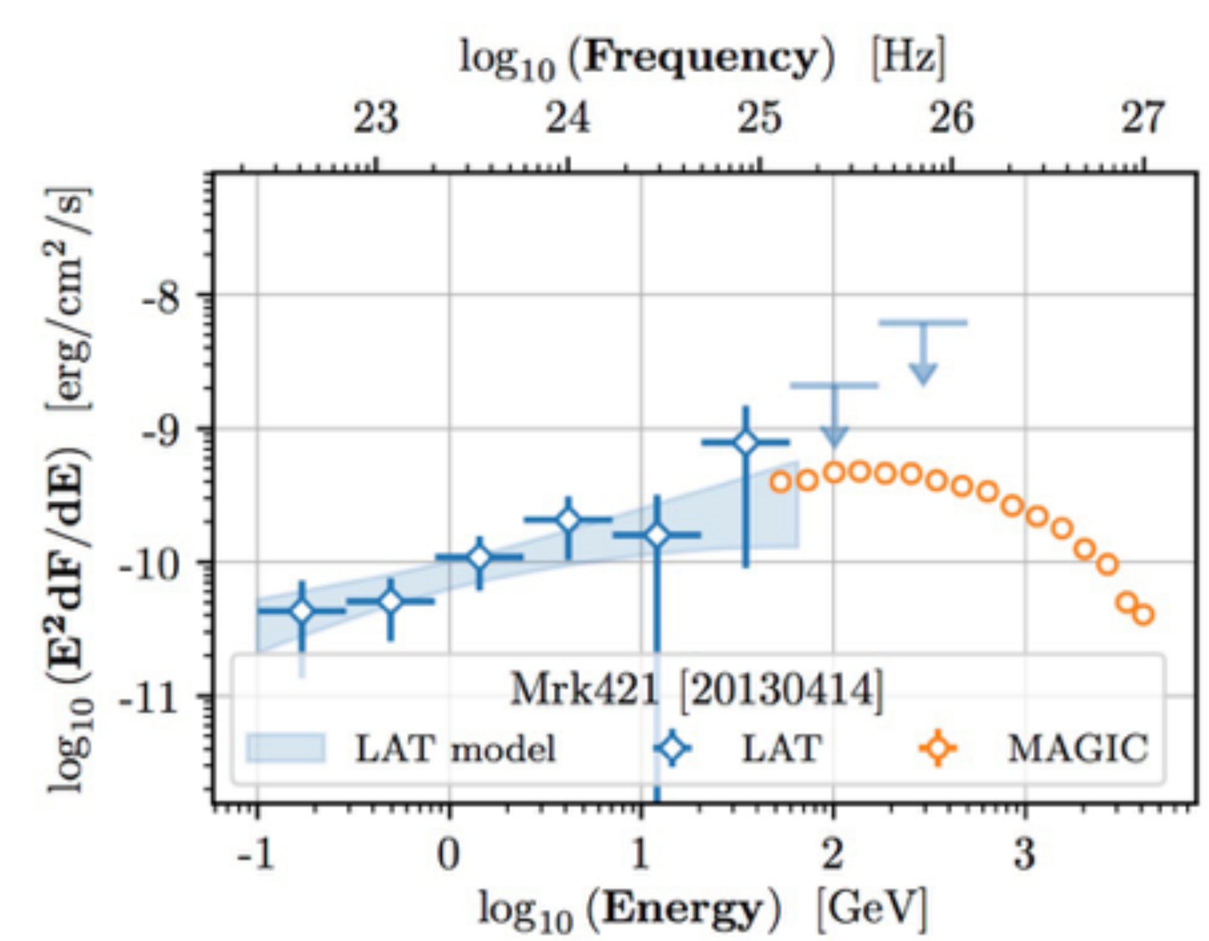


Precision and statistics: EBL measurement

- Sum contribution of 32 spectra of blazars
- Combined spectrum of Fermi/LAT and MAGIC





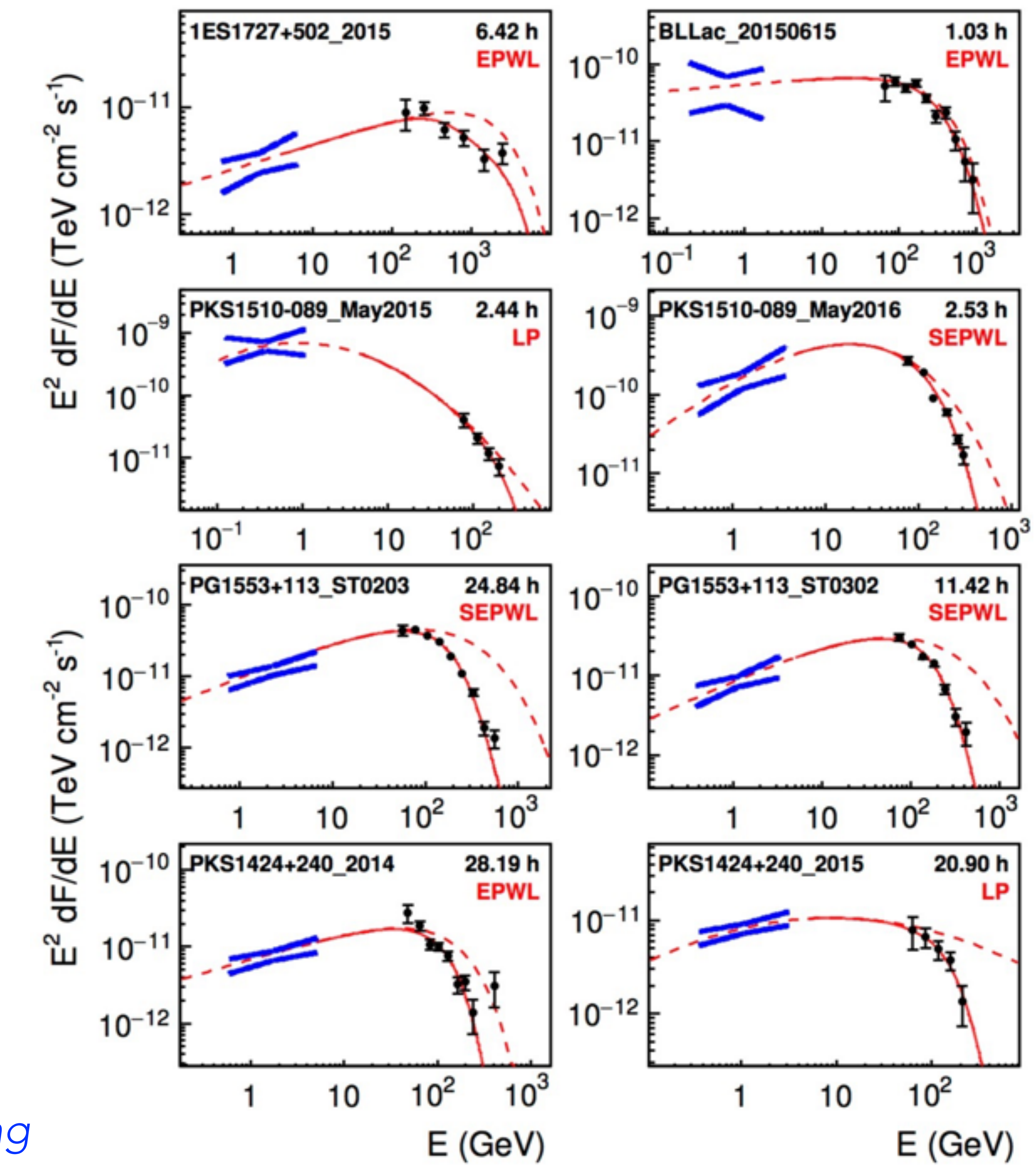


MAGIC coll., MNRAS acc., Measurement of the Extragalactic Background Light using MAGIC and Fermi-LAT gamma-ray observations of blazars up to z = 1 https://arxiv.org/abs/1904.00134

PRECISION AND STATISTICS: EBL MEASUREMENT

- Sum contribution of 32 spectra of blazars
- Combined spectrum of Fermi/LAT and MAGIC
- Different intrinsic spectral models

PWL:	$F_0\,(E/E_0)^{-\Gamma}$	EPWL: $F_0\,(E/E_0)^{-\Gamma}\,e^{-E/E_c}$
LP:	$F_0\,(E/E_0)^{-\Gamma-b\log(E/E_0)}$	
ELP:	$F_0\,(E/E_0)^{-\Gamma-b\log(E/E_0)}\,e^{-E/E_c}$	
SEPWL:	$F_0\,(E/E_0)^{-\Gamma}\,e^{-(E/E_c)^d}$	



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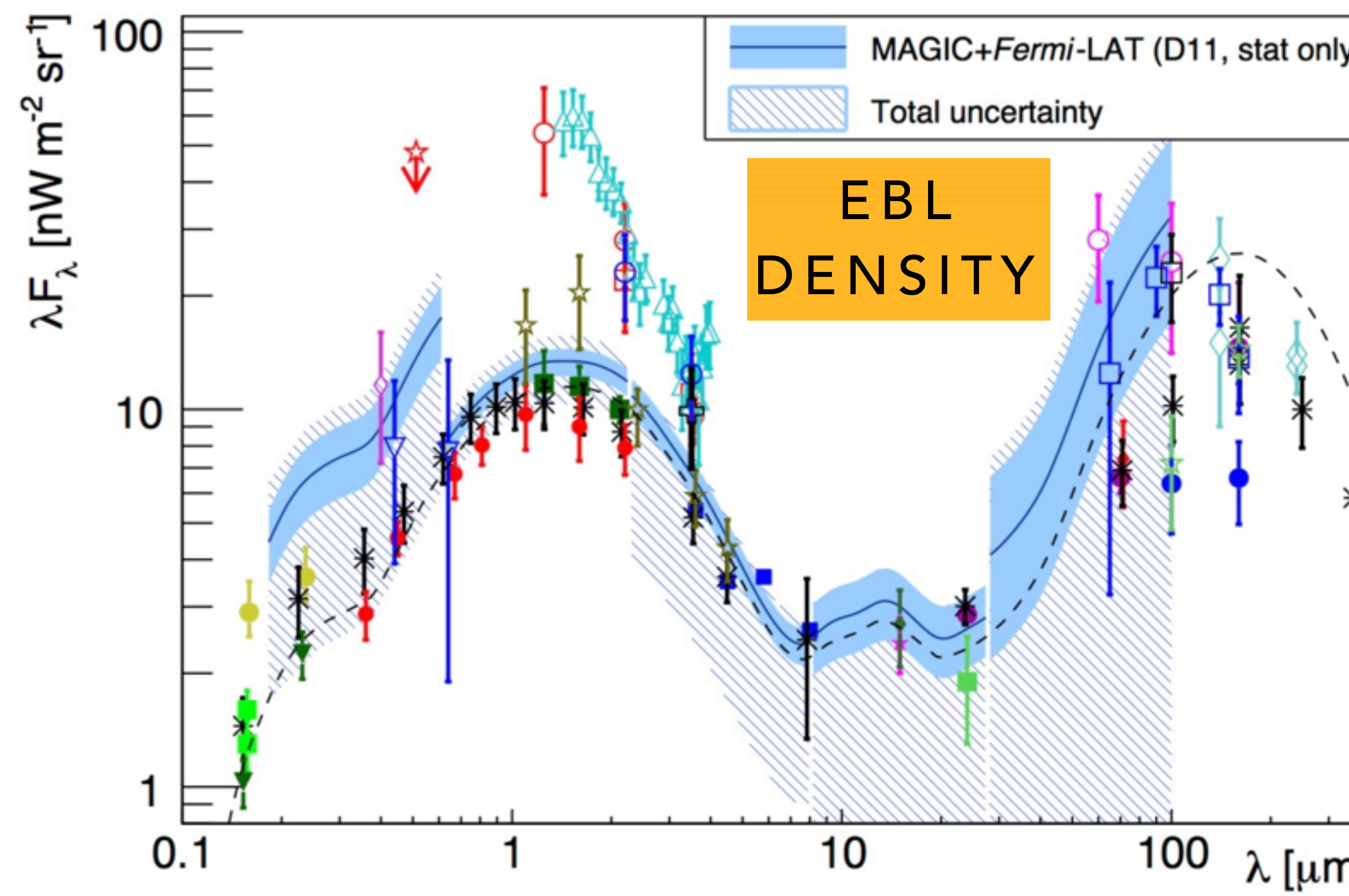
PRECISION AND STATISTICS: EBL MEASUREMENT

- Sum contribution of 32 spectra of blazars
- Combined spectrum of Fermi/LAT and MAGIC
- Different intrinsic spectral models
- **Studies on systematics**
  - intrinsic models
  - instrument response



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