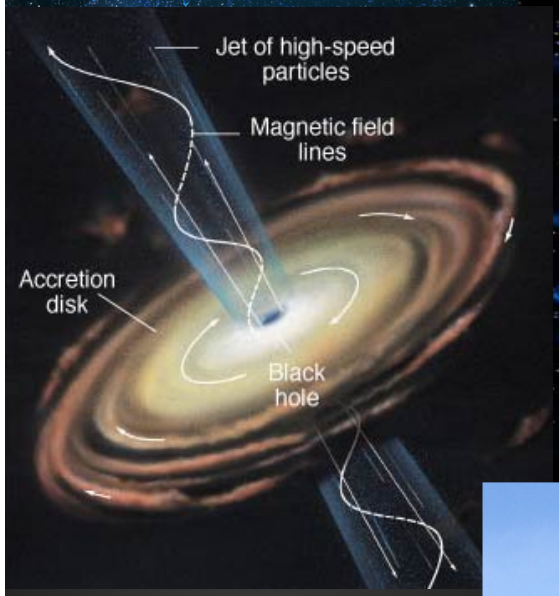
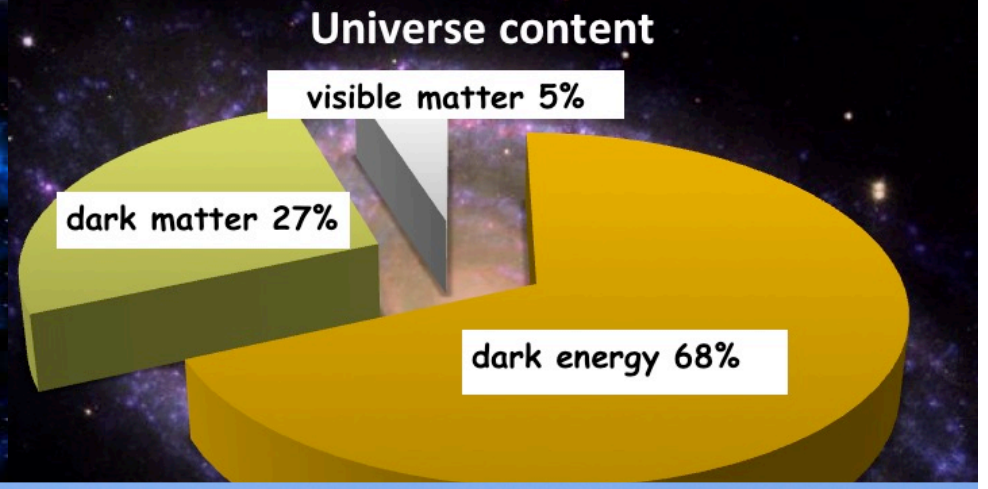
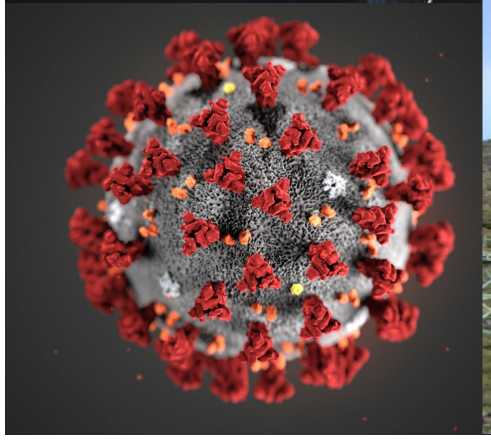
The MAGIC of very-high-energy gamma-ray astronomy

David Paneque
On behalf of the MPP gamma-ray group







MPP Project Review 2020

The MAGIC of very-high-energy gamma-ray astronomy

David Paneque

On behalf of the MPP gamma-ray group

MPP Project Review 2020

Outline

1 – The MAGIC telescopes

2 – The MAGIC MPP group (and overall contributions)

3 – Operation in Covid-19 times

4 – Technical activities in 2020

5 – Scientific results in 2020

6 – Conclusions

1 – The MAGIC telescopes (and collaboration)

The MAGIC Stereoscopic system

- **MAGIC: Two Imaging Atmospheric Cherenkov Telescopes (IACTs) of 17 meter diameter mirror dish to perform Very High Energy (VHE) gamma-ray astronomy**
  - **Operational energy range: from 50 (20) GeV to >100 TeV**
  - Sensitivity: 0.7% the Crab Nebula flux (above 220 GeV) after 50 hours observation
    - → About 5% of the Crab Nebula flux in 1 hour of observation
- **The strategy** : *operate until (at least) CTA is in scientific operation (**> 2024**)*
  - 2004 : Crab Nebula detected. Start scientific operation of MAGIC 1 (Single telescope)
  - 2006 : MAGIC upgraded with the MUX-DAQ system (More stable and better pulse-information)
  - 2009 : MAGIC upgraded with a second telescope (stereo observations)
  - 2012 : Large upgrade of the hardware system (*improved sensitivity and reliability*)

Observatorio Roque de los Muchachos (2200 meter a.s.l.)
La Palma, Canary islands (Spain)

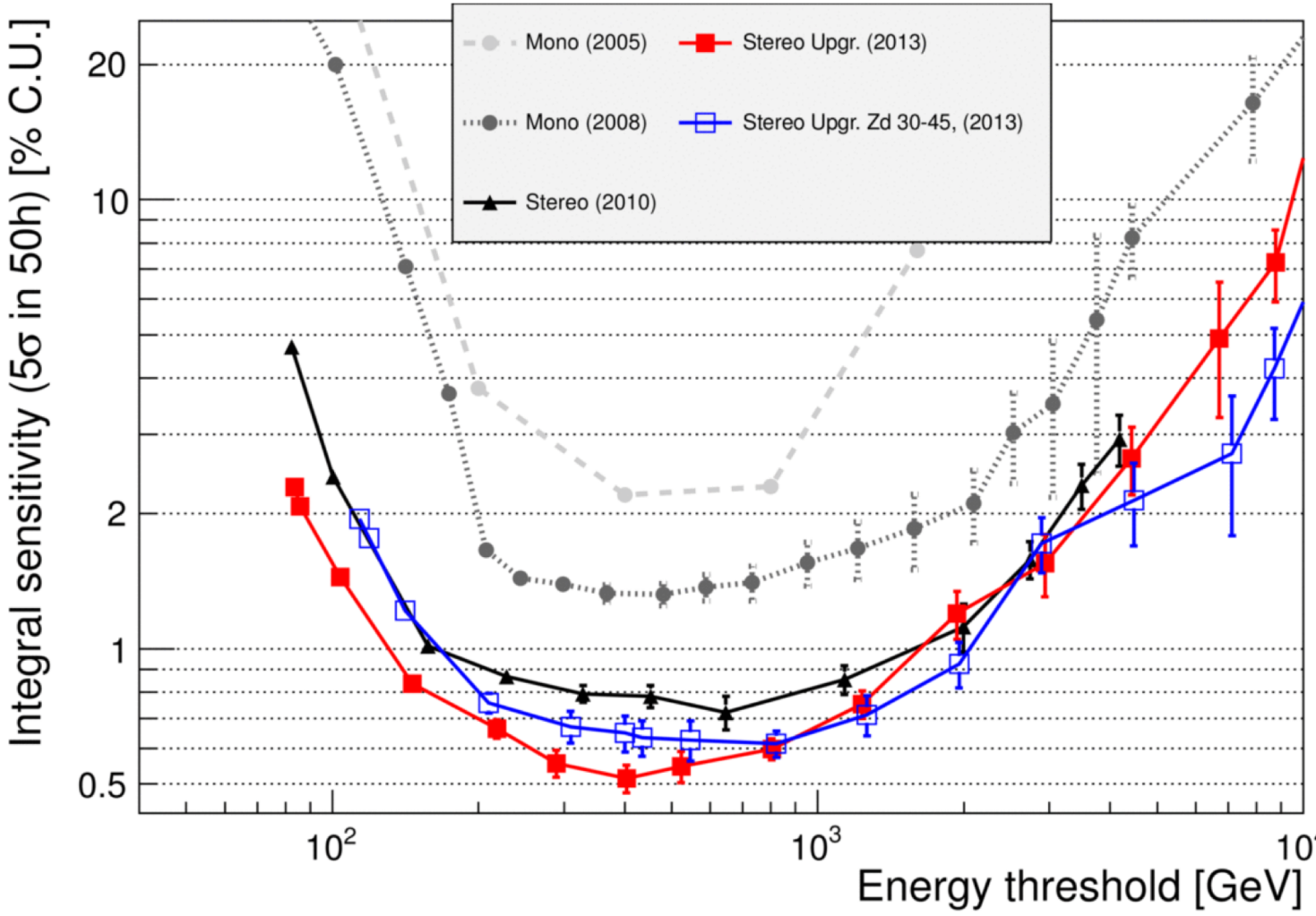
The MAGIC Collaboration

El Roque de los muchachos Observatory
(La Palma, Spain)

The **MAGIC Collaboration** is composed by ~150 physicists (230 members in total, including technical and administrative staff) from **12 countries**

Evolution of the MAGIC Performance

4-fold improvement in sensitivity over the last 17 years



Aleksic et al., (MAGIC collab.) Astroparticle Physics 72, 76-92, 2016

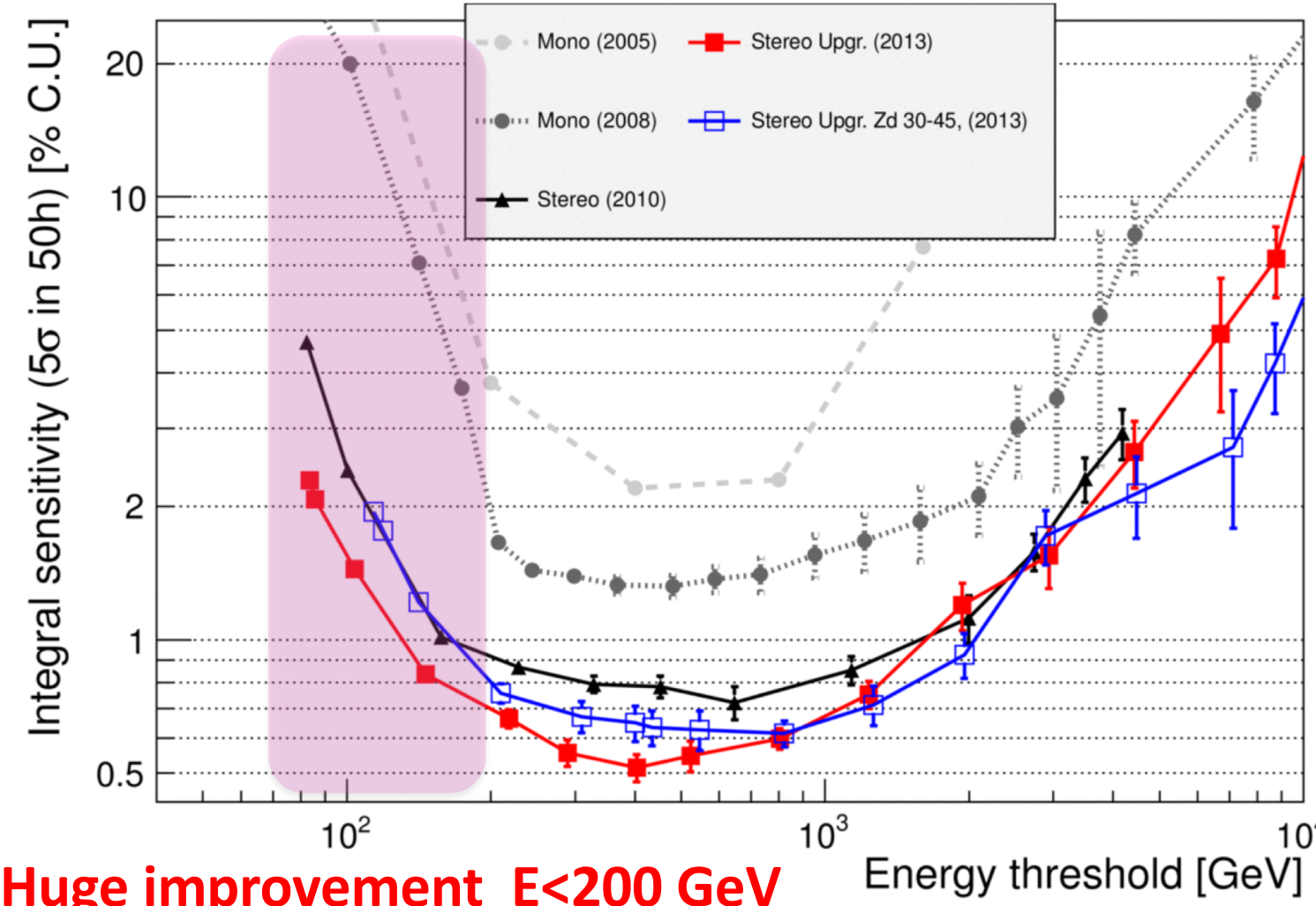
Better sensitivity + Lower energy threshold = More science !!

Evolution of the MAGIC Performance

4-fold improvement in sensitivity over the last 17 years

→ More than 10-fold improvement below 200 GeV

→ Obs. time for detection reduced 100 times below 200 GeV



Aleksic et al., (MAGIC collab.) Astroparticle Physics 72, 76-92, 2016

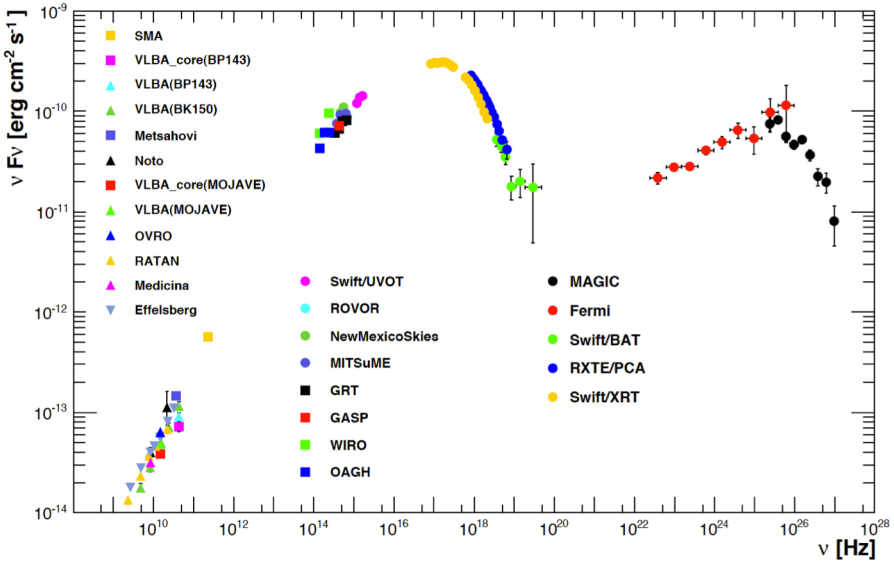
Huge improvement E<200 GeV

Better sensitivity + Lower energy threshold = More science !!

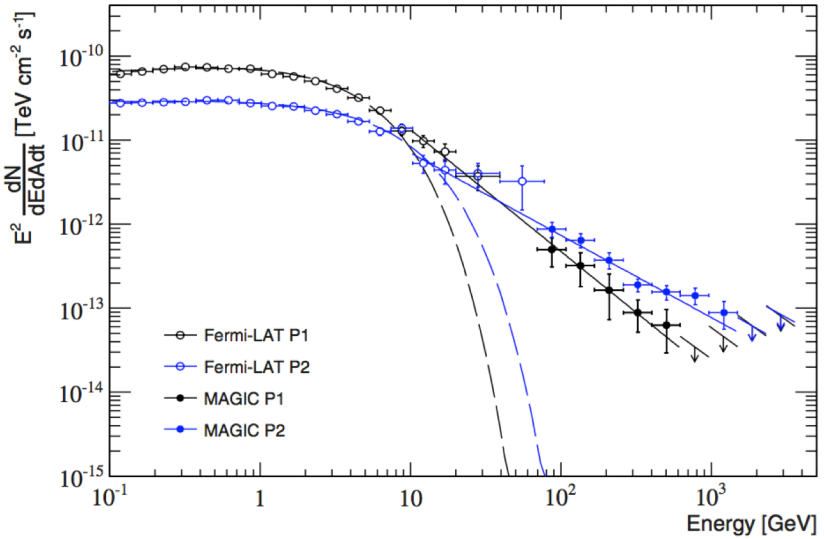
Synergy between *Fermi*-LAT and MAGIC

The GeV and TeV bands are complementary (wealth of behaviours)

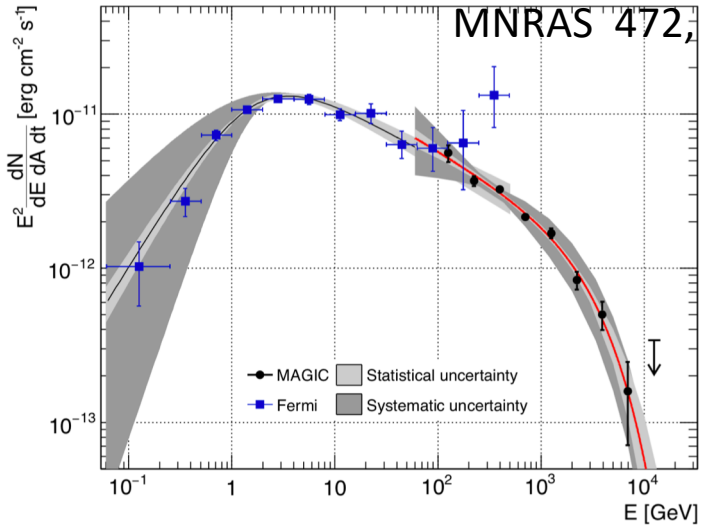
Mrk421 (blazar): Abdo et al 2011, ApJ 736, 131

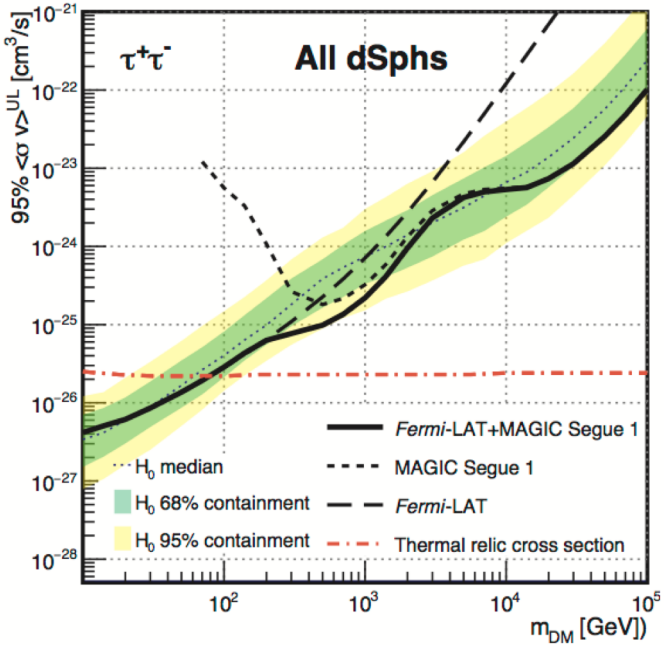


Crab pulsar: Ansoldi et al 2016, A&A 585, 133



Cassiopea A (SNR): Ahnen et al 2017, MNRAS 472, 2956



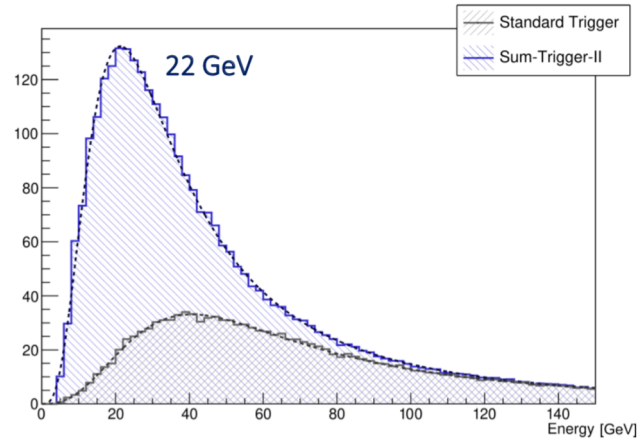


Dark Matter searches: Ahnen et al., 2016, JCAP 02, 039

Performance improvements in last years

Sum-Trigger-II

→ Decrease energy threshold (from ~40 GeV to ~20 GeV) and improve sensitivity below 100 GeV

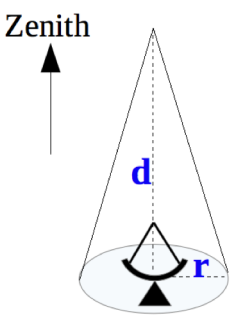


Very Large Zenith angle

→ Increase sensitivity for multi-TeV energies

Vertical observations

typical for IACTs

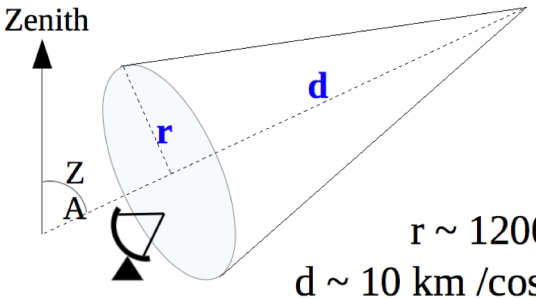


d ~ 10 km

r ~ 120 m

Large zenith angle observations

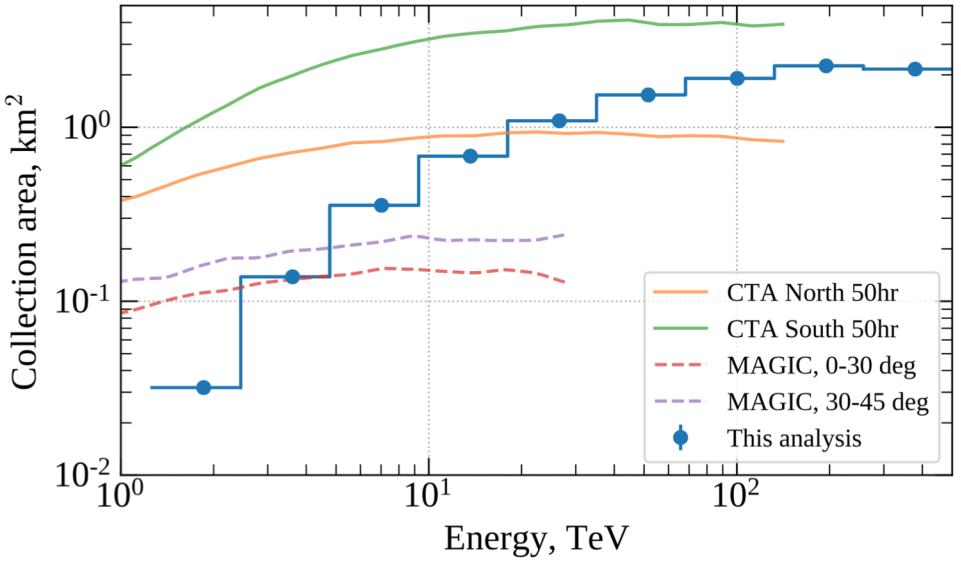
proposed



r ~ 1200 m

d ~ 10 km /cos(ZA) ~ 100 km

Need small pixels and good time information



Performance improvements in last years

Sum-Trigger-II

→ Decrease energy threshold (from ~40 GeV to ~20 GeV) and improve sensitivity below 100 GeV

Publication In preparation (→ 2021)

Very Large Zenith angle

→ Increase sensitivity for multi-TeV energies

Acciari et al 2020, A&A 635, A158

Developed strategies for Moon observations

→ Increase temporal coverage **Ahnen et al 2017, AP 94, 29**

→ Particularly relevant for short transients (e.g. fast AGN flares or GRBs), but also for long-term studies (binary systems or monitoring AGNs)

Usage of LIDAR to correct for non-optimal atmospheric conditions

→ Increase temporal coverage and quality of data **Fruck, C., & Gaug, M. 2015, EPJ Web Conf., 89, 02003**

→ MAGIC is the only IACT that is currently using LIDAR (will be used in CTA) **+ Pub. in preparation (→2021)**

Skyprism software package

→ Improve performance for extended sources **Vovk et al 2018, A&A 619, A7**

Energy reconstruction with Random Forest **Pub. In preparation (→2021)**

→ Improve resolution by factor 2 over a large range of phase space

2 – The MAGIC MPP group (and overall contributions)

The MPP experimental gamma-ray group

About 20 Scientists (2020)

Director: Masahiro Teshima

Senior (3): Razmik Mirzoyan, Thomas Schweizer, David Paneque

Postdoc (5-1+1): David Green, Moritz Huetten, Martin Will, Yusuke Suda, *Giacomo D'Amico,* ***Alessio Berti (next months)***

PhD Students (7-1-1): Lea Heckmann, Yating Chai, Alexander Hahn, Juliane van Schenperberg, Giovanni Ceribella, *Kazuma Ishio,* Marcel Strzys

Undergraduate (4-2): Felix Schmuckermaier, Marine Pihet, Stefan Keller, Daniel Hoff

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Undergraduate (4-2): Felix Schmuckermaier, Marine Pihet, Stefan Keller, Daniel Hoff

MAGIC (and CTA) gets a CRUCIAL support from the mechanical and electrical engineer departments from MPP

O. Reimann, T. Haubold, D. Fink, M. Fras, H. Wetteskind, S. Horn, S. Tran, J. Besenrieder, C. Jablonksi, R. Stadler, W. Haberer, S. Schmidl, T. Dettlaf…

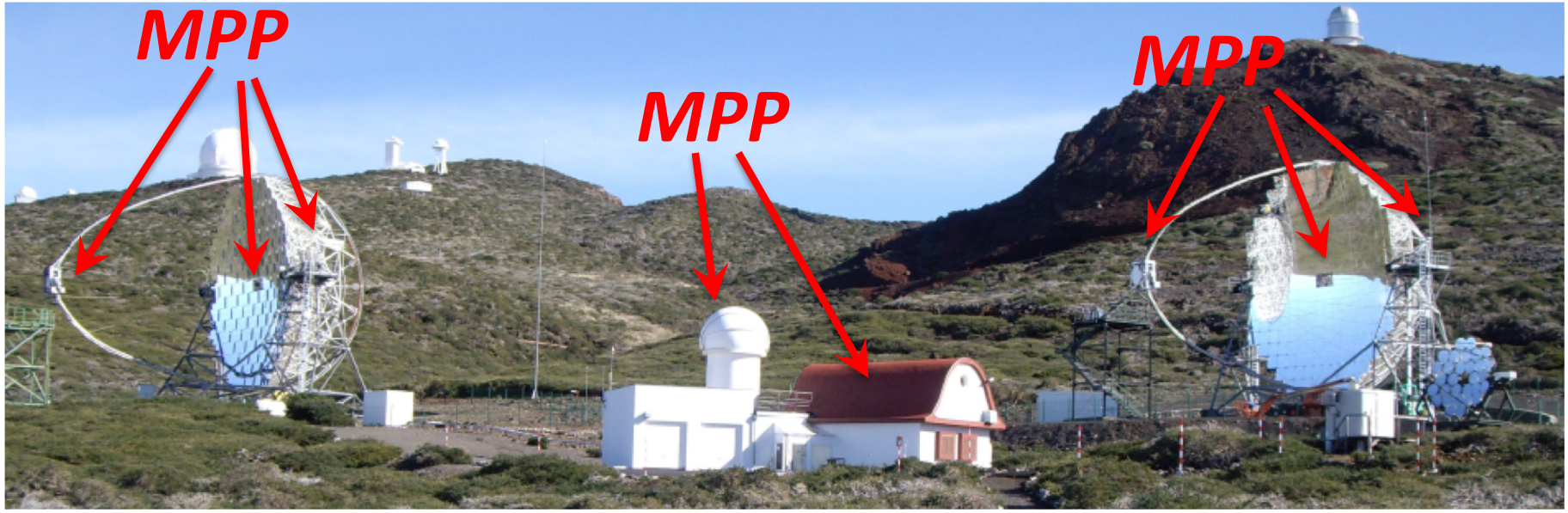
MPP activities with/within MAGIC

MPP is the group with most resources within the MAGIC collaboration

→ ***MAGIC was born at MPP (E. Lorenz & R. Mirzoyan in mid 90s)***

→ ***Most hardware was designed, built and now maintained by MPP***

2 Telescope structures (cooperation with company MERO)
2 Telescope cameras + 2 Calibration systems
LIDAR (for monitoring atmospheric conditions)
Sum-Trigger-II (for lowering energy threshold)
Support instrumentation for Very Large Zenith Angle observations
Mirror production with novel technology (for durability and easy clean)



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→ ***MAGIC was born at MPP (E. Lorenz & R. Mirzoyan in mid 90s)***

→ ***Most hardware was designed, built and now maintained by MPP***

Involvement at all levels: Organizational, hardware, software, science

Masahiro Teshima
MAGIC-LST contact and TAC chair

Razmik Mirzoyan
Spokesperson (until Feb2020),
now Deputy Chair of Collaboration Board

David Paneque
Physics coordinator (until Feb2020),
now Deputy Spokesperson

Martin Will
Technical coordinator until 2019, now Deputy Technical coordinator

MPP members are always playing key roles in the leadership of the MAGIC collaboration

Moritz Huetten Astroparticle and fundamental physics coordinator

David Green Galactic group coordinator

3 – MAGIC Operations in Covid-19 times:

Mission impossible ?

MAGIC operator trying to catch a plane to go to La Palma

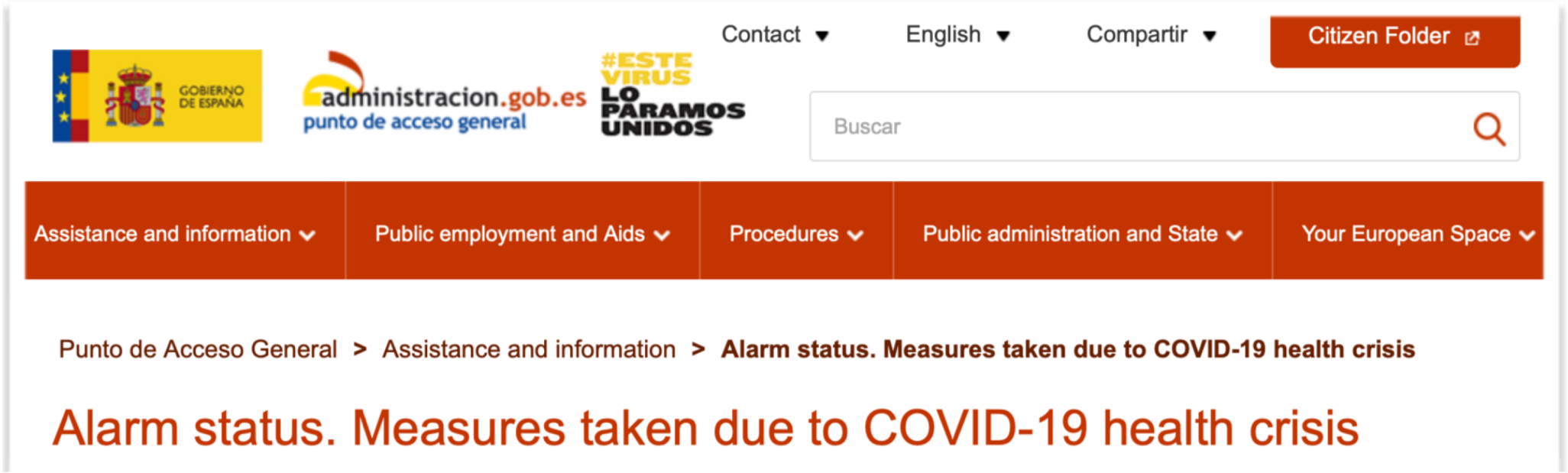
MAGIC operation while following the safety rules

3 – MAGIC Operations in Covid-19 times

In February it started to be a concern, but it was not until March when the pandemic escalated

MAGIC stopped operations on **March 13th,** all non-local operators sent back home

On March 14th, Spain declared state of emergency *(<200 deaths)*



MAGIC stopped observations, but activity in MAGIC collaboration did NOT stop

Keep Surveillance of the MAGIC telescopes

(La Palma Crew, TB)

MAGICians interconnected:

5-10 Meetings/week

Recovering the Telescopes:

Dust in the Mirrors, AMC, "Electronics PS"

(La Palma Crew,TB)

Preparing for re-starting the operation of the MAGIC telescopes

(TB, SoC, Safety Committee)

Data Analysis

Physics Interpretation

Publishing results

(Physics WG, SoBo, A&P, Outreach)

News at the Site — New Safety Rules

We had to revise the safety rules and adapt to the new covid-19 times

- http://www.magic.iac.es/site/safety/
- http://www.magic.iac.es/site/safety/general_safety_document.pdf

MAGIC
Major Atmospheric Gamma Imaging Cerenkov Telescope

Safety, Health and Behavior Rules at the MAGIC Site

Version 7.01
June 2, 2020

Operations and Safety Coordinator:
Ana Babic
comments to:
ana.babic@fer.hr

Abstract:
This document describes the safety and health procedures and the behaviour rules at the MAGIC telescopes site. You must read and understand it completely, receive a guided safety tour by the Support Astronomer or the La Palma Postdocs, sign a printed copy of the checklist found at the end of the document and give it to the Support Astronomer or the Postdocs at La Palma before you start any activity at the MAGIC site. Rules are written in bold and numbered. Failure to comply with them may result in a safety penalty.
If you find any omission, wrong or outdated information in this document, or you simply want to comment or make suggestions, please write to the Safety Committee.
If you are a visitor of the MAGIC site read the dedicated *Safety, Health and Behaviour Rules for Visitors at the MAGIC Site* document.

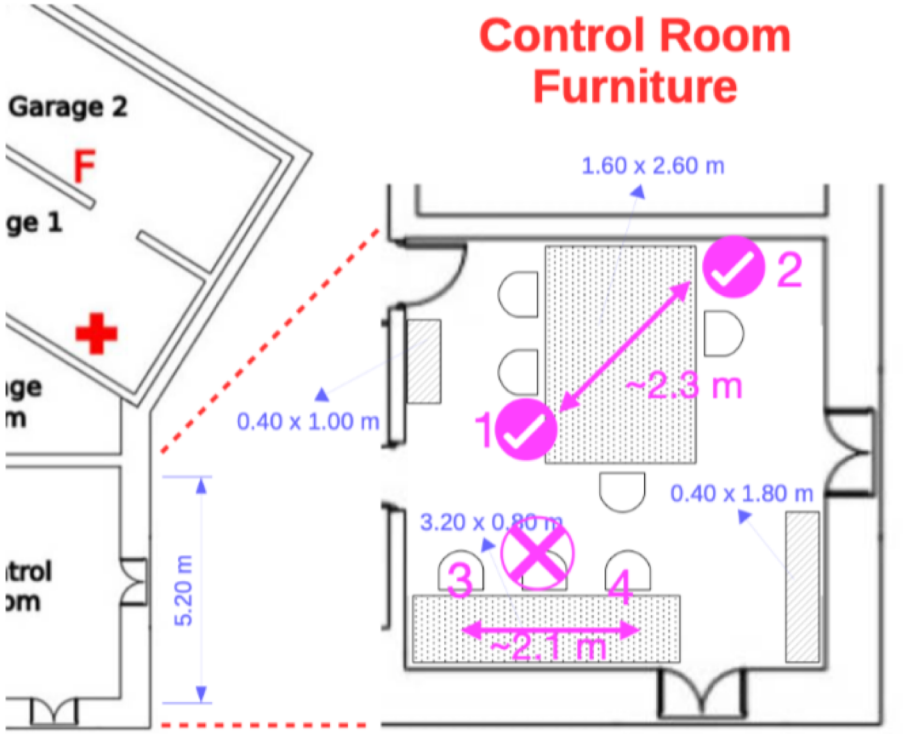
News at the Site — New Safety Rules

- A new Appendix — all new rules related to Covid-19
- Read the document before arriving

If signs of illness at MAGIC site:
Stop work, isolate, inform ORM and MAGIC

Contents

1. Introduction
1.1. Safety Status of Individuals
1.1.1. GLIMOS
1.1.2. Job profiles
...
...
4.3 Health Care at La Palma
5. Behavior in Common Areas
5.1. Behavior in the Counting House
5.2 Apartments and Residencia
Safety and Health Checklist
Appendix - Safety in time of Covid-19 epidemic



>1.5 meters, masks must be worn ….

No sharing of equipment, clean and sanitize before and after use …

Open windows, use air conditioning, discussions outside if possible …

Decided to resume observations through joint operations with CTA-LST (closest neighbour)

→ Reduction of number of people needed at the site

3 shifts (~ 3 months): June, July and August

Same crew of people operate both telescopes

→ take both safety tour‘s and adheres to each site‘s rules

Nice opportunity to get to work in both telescopes

MAGIC resumed observations on June 10th

(State of alarm in Spain ended on June 21st)

MAGIC coll. very thankful to the “Summer operators“

Alicia López-Oramas
Cosimo Nigro
Chaitanya Priyadarshi
Daniel Kerszberg (2 months)
Elia Do Souto Espiñeira
Edgar Molina
Daniel Morcuende
Jorge Otero-Santos

→ 4 groups in Spanish institutions

MPP group played a crucial role in re-starting the telescopes operation (MAGIC and LST)

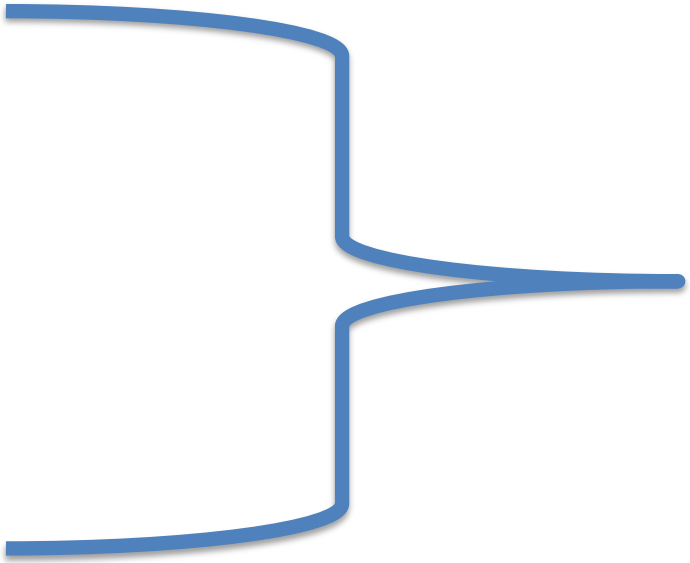
Martin Will (3 months)
Juliane van Scherpenberg (3 months)
Moritz Hütten (2 months)
Marine Pihet

→ **MPP**

Axel Arbet Engels → ETH (Zurich)

MAGIC coll. very thankful to the “Summer operators“

Toni Dettlaff
Christopher Jablonski
Holger Wetteskind
Stefan Horn
Jürgen Besenrieder
Felix Schmuckermaier



Additional MPP people going to MAGIC site for technical work (after August)

MPP group played a crucial role in re-starting the telescopes operation (MAGIC and LST)

Martin Will (3 months)
Juliane van Scherpenberg (3 months)
Moritz Hütten (2 months)
Marine Pihet

3 – MAGIC Operations in Covid-19 times

Canary islands are NOT a high-risk region according to RKI (7-day index below 50), and the **island of La Palma is a covid-19 almost-free region, with a 7-day index below 5.** *For reference, in Munich the 7-day index is above 200.*
We have operated the telescopes since June 2020 without any health incidence

But situation getting complicated all over Europe, and a few months ago we already expected that many groups may have difficulties sending people to La Palma. Because of that, we have hired 0.5+0.5+1 = 2 people **local at La Palma,** whose main activity is to help with the MAGIC operations.

We are also investing in updating software to partially operate telescopes remotely (*and hence decrease number of people present at MAGIC site*), but this may take a few months more…

We are determined to continue operations during Winter+Spring, always mantaining safety environment for everybody working at the MAGIC site.

4 – Technical activities in 2020

Remark:

Because of limited time for this talk, I will not report about the regular (yearly) activities related to the maintenance of the telescope structure, camera, calibration system, LIDAR …

(e.g. Felix Schmuckermaier solved problem with LIDAR in Nov/Dec)

All these activities are CRUCIAL for the standard operation of the MAGIC telescopes, and are done, mostly, by MPP mechanical&electronic engineers and technicians
(*H. Wetteskind, D. Fink, M. Fras, T. Dettlaf, J. Schlammer …)*

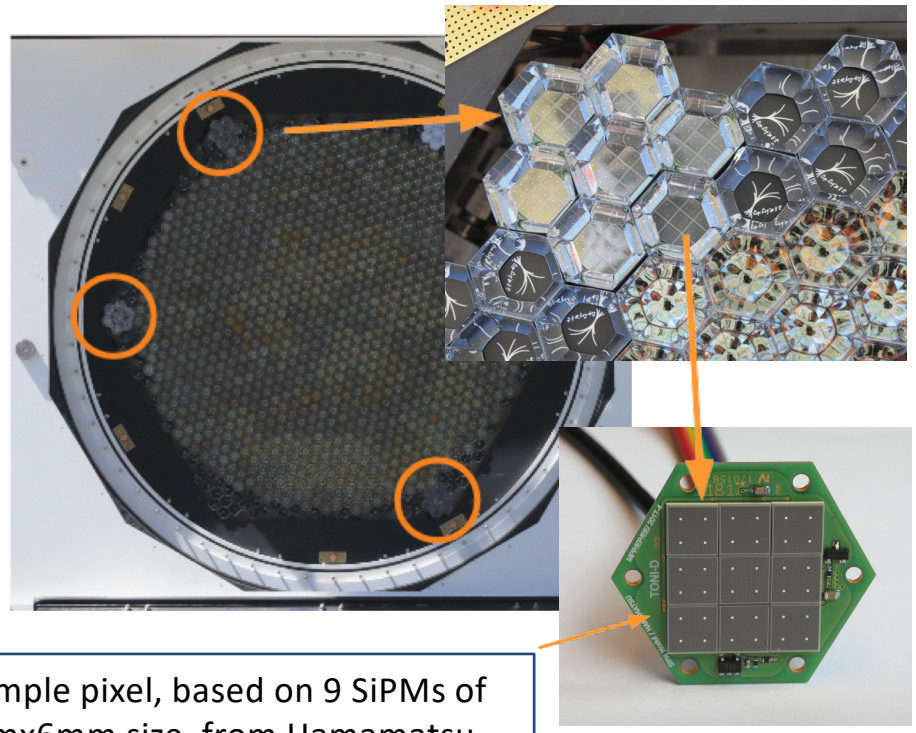
I will only (very briefly) report some activities that explore new ways of improving the current system, or aim to make path for new future systems

SiPM modules in the MAGIC Imaging Camera

(→ entered as "nasty question" in MPP quiz last week)

Alexander Hahn and Razmik Mirzoyan

- **Goal: Directly** compare performance of PMT and SiPM based detectors during real telescope operation
- Prototypes SiPM clusters from EXCELITAS, SensL & Hamamatsu installed in the MAGIC camera
- Operating every night, included in the standard data taking
- Calibration and initial performance studies completed
- On-going comparison of detection efficiencies and the signal to noise ratio. Study will finish in 2021



Example pixel, based on 9 SiPMs of 6mmx6mm size, from Hamamatsu

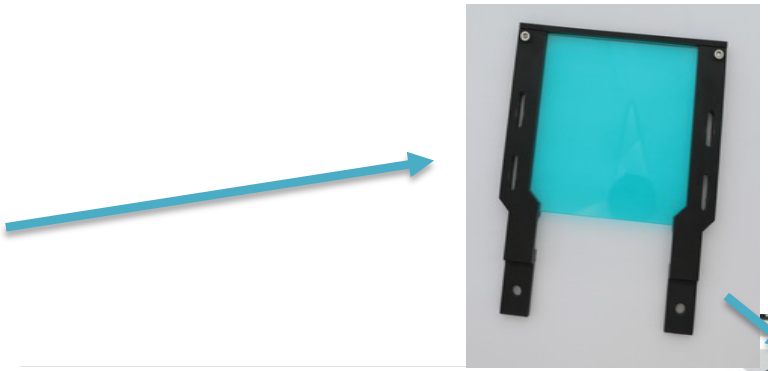
Drafting the publication summarizing the results, as well as finishing PhD thesis of Alex Hahn in 2021

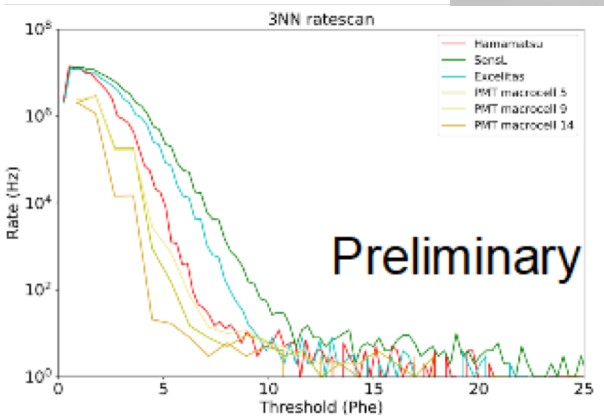
SiPM modules in the MAGIC Imaging Camera

(→ entered as "nasty question" in MPP quiz last week)

Alexander Hahn and Razmik Mirzoyan

- Performed L0 rate scans in the MAGIC camera ⇒ trying to assess the optimal threshold, similar as with PMTs,
- Rate scan with UV-pass filter in front
- Filter outside, on top of camera window
- Mounting mechanism produced in our workshop
- Run L1 ratescan (2NN, 3NN, 4NN, 5NN)
- Calibration of rate scans successful
- This data will be one of the main results of this project
- Evaluation ongoing





Drafting the publication summarizing the results, as well as finishing PhD thesis of Alex Hahn in 2021

Test of Mirror cleaning action with water

Juliane van Scherpenberg and Razmik Mirzoyan (with help from Marine Pihet)

Juliane and Marine at MAGIC site in Aug+Sep

- 9 mirrors tested before and after cleaning:
  3-Al, 5-glass, 1-back-coated ultra-thin glass

- At first sprayed with soapy water, then cleaned with pure water by using a pressurized sprayer

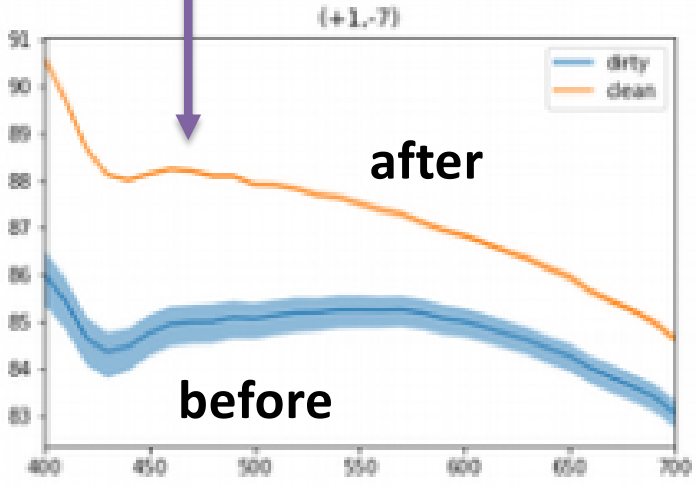
- Reflectivity spectrum (400nm-700nm) measured with Minolta reflectance measuring device before and after cleaning

Test of Mirror cleaning action with water

Juliane van Scherpenberg and Razmik Mirzoyan (with help from Marine Pihet)

- Inspection by eye:
  little effect after cleaning
- Back-coated, ultra thin glass protected mirror:
  Later on wiped off with paper towel

→ the cleaning effect is more visible



Plan to perform studies of dust adhesion on the mirror surface

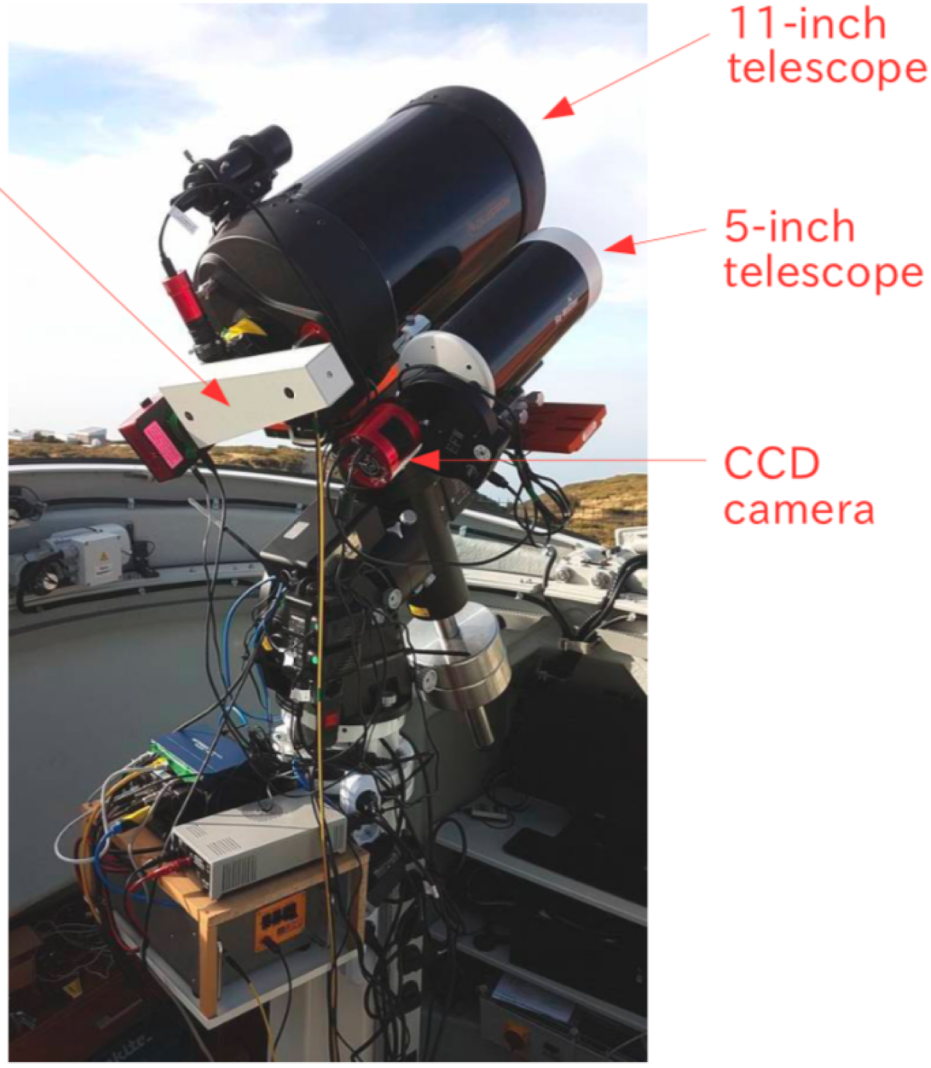
Commissioning of optical telescope for usage during very large zenith angle observations

M. Pihet
D. Hoff
J. Besenrieder
R. Mirzoyan

Marine and Jürgen were at MAGIC site in Aug+Sep

Master thesis of Marine Pihet

- Measure the atmosphere transmission, specially during VLZA observations, using spectroscopy and photometry
- Current work on photometric calibration and transmission measurements. Work on fully automatic operation mode is progressing.
- Difficulties automating the growth curve method. Due to the refraction effect at LZA, part of the spectrum is lost.
- Vibration of the mount and coupling of some mechanical components need to be improved. Directories of the main computer need to be reorganized.



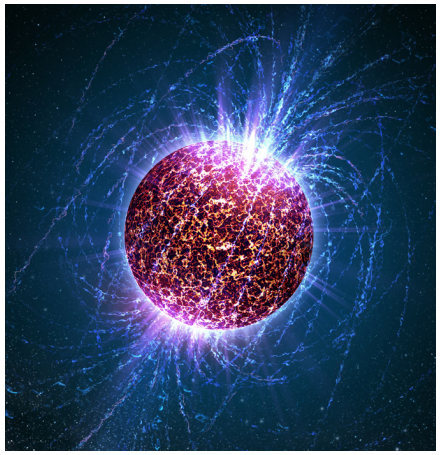
5 – Scientific results in 2020

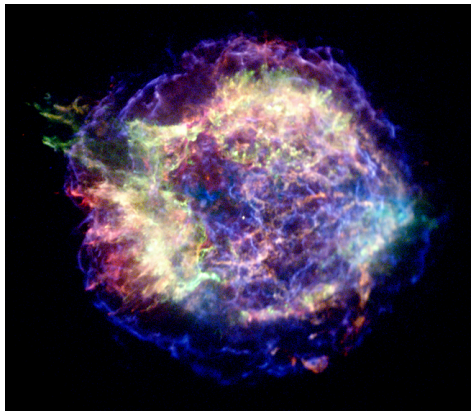
Science with the MAGIC telescopes

Find & characterize the extreme particle accelerators in the Universe

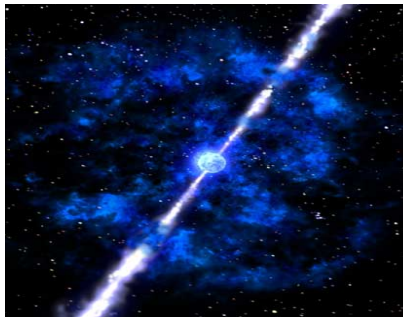
→ Gamma rays will be produced, and can be used to probe them

Pulsars



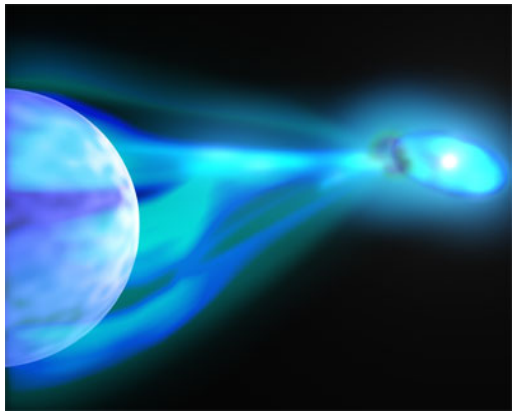


SNR+PWN

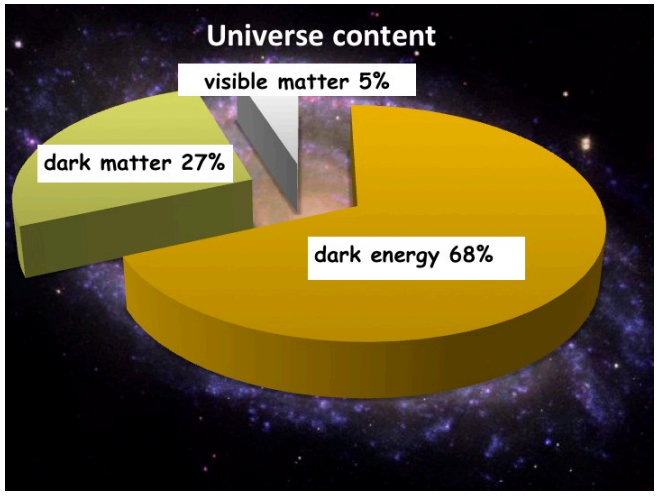


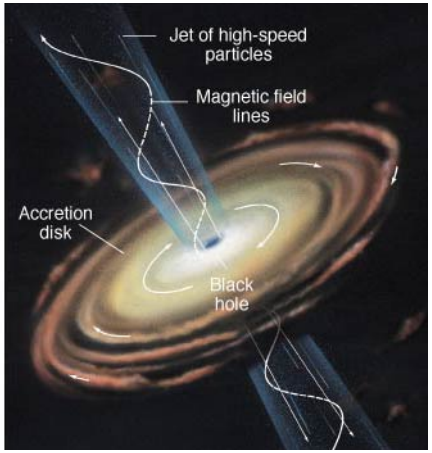
GRBs

Binary systems & Novae

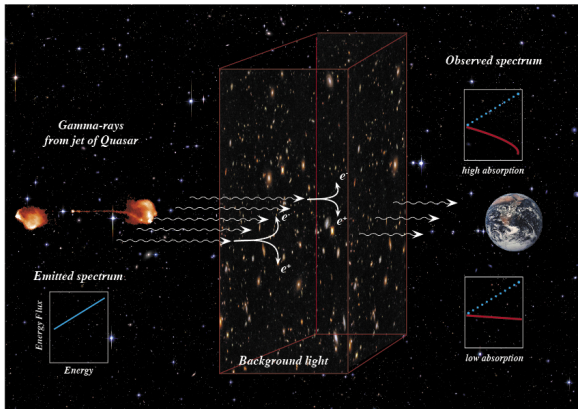


Dark Matter searches





AGNs



EBL
IGMF
ALPs
LIV

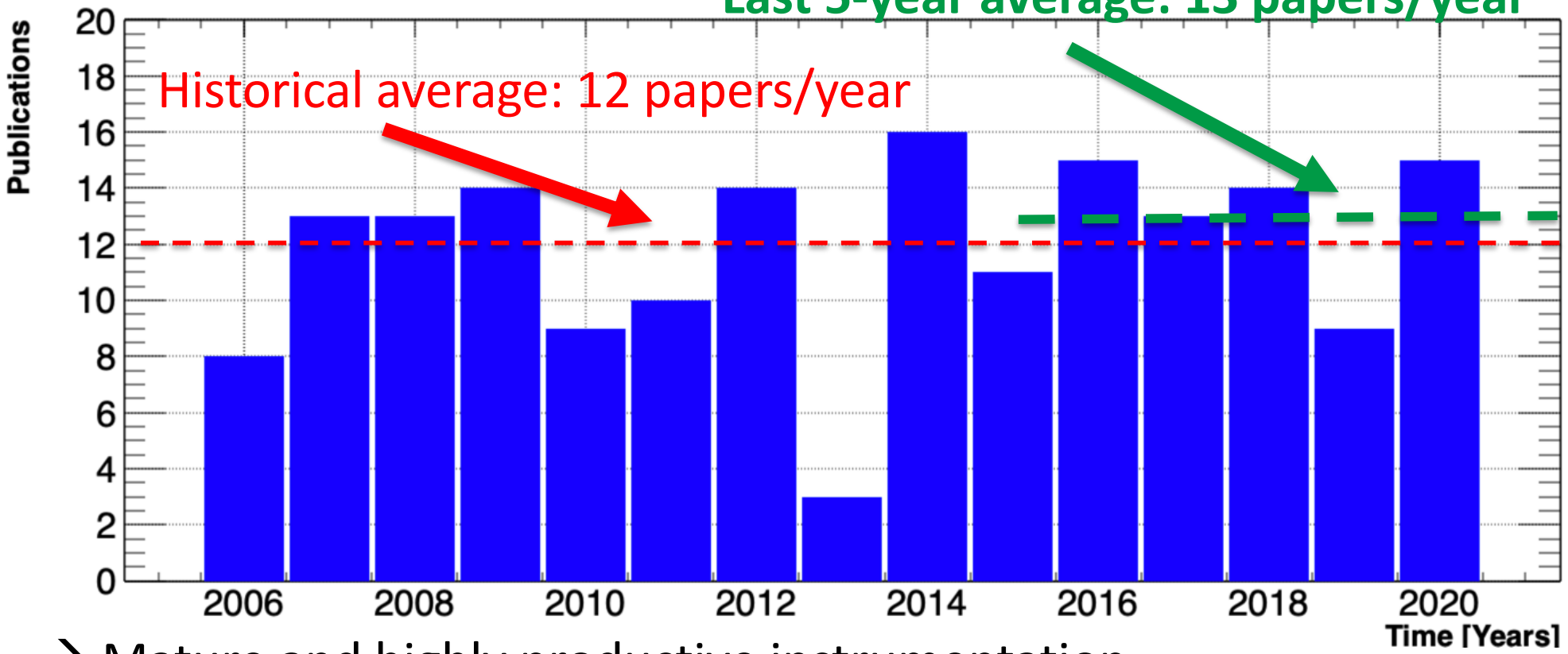
Science with the MAGIC telescopes

MAGIC refereed papers (published): 177

Broad range of topics: from conventional to exotic (astro)physics

https://magic.mpp.mpg.de/backend/publications/articles

Number of publications vs Year (*until 2020/12/13*)



→ Mature and highly productive instrumentation

→ **Many publications benefit from *Fermi*-MAGIC synergy**

→ Most scientifically productive IACT in last 5 years

MAGIC > List of publications » MAGIC Articles

Public FITS Database

SEARCH

GO OR AND

LIST OF RESULTS , ALL , 2020 , 2019 , 2018 , 2017 , 2016 , 2015 , 2014 , 2013 , 2012 , 2011 , 2010 , 2009 , 2008 , 2007 , 2006 , 2005 , 2004 , 2003 , 2002 , 2001 , 2000 , 1999 , 1998 , 1997

Multiwavelength variability and correlation studies of Mrk 421 during historically low X-ray and γ-ray activity in 2015-2016
MAGIC collaboration, Acciari *et al.*
Accepted for publication in Mon. Non. R. Astron. Soc. (2020)

Study of the GeV to TeV morphology of the γ-Cygni SNR (G78.2+2.1) with MAGIC and Fermi-LAT
MAGIC collaboration, Acciari *et al.*
Accepted for publication in Astron. Astrophys. (2020)

Testing two-component models on very-high-energy gamma-ray emitting BL Lac objects
MAGIC collaboration, Acciari *et al.*
Astron. Astrophys. **640** (2020) A132

A search for dark matter in Triangulum II with the MAGIC telescopes
MAGIC collaboration, Acciari *et al.*
Phys. Dark Universe **20** (2020) 100529

An intermittent extreme BL Lac: MWL study of 1ES 2344+514 in an enhanced state
MAGIC collaboration, Acciari *et al.*; FACT collaboration, : *et al.*
Mon. Non. R. Astron. Soc. **496** (2020) 3912-3928

Bounds on Lorentz invariance violation from MAGIC observation of GRB 190114C
MAGIC collaboration, Acciari *et al.*
Phys. Rev. Lett. **125** (2020) 021301

Broadband characterisation of the very intense TeV flares of the blazar 1ES 1959+650 in 2016
MAGIC collaboration, Acciari *et al.*; Fermi-LAT collaboration, Hayashida *et al.*
Astron. Astrophys. **638** (2020) A14

Detection of the Geminga pulsar with MAGIC hints at a power-law tail emission beyond 15 GeV
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Astrophys. J. Suppl. S. **247** (2020) 16

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MAGIC collaboration, Ahnen *et al.*
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Study of the variable broadband emission of Markarian 501 during the most extreme Swift X-ray activity
MAGIC collaboration, Acciari *et al.*; FACT collaboration, Arbet-Engels *et al.*
Astron. Astrophys. **637** (2020) 86

Studying the nature of the unidentified gamma-ray source HESS J1841-055 with the MAGIC telescopes
MAGIC collaboration, Acciari *et al.*
Mon. Non. R. Astron. Soc. **497** (2020) 3734–3745

The Great Markarian 421 Flare of 2010 February: Multiwavelength Variability and Correlation Studies
MAGIC collaboration, Abeysekara *et al.*
Astrophys. J. Suppl. S. **890** (2020) 97

Unravelling the complex behavior of Mrk 421 with simultaneous X-ray and VHE observations during an extreme flaring activity in April 2013
MAGIC collaboration, Acciari *et al.*
Astrophys. J. Suppl. S. **248** (2020) 29

5 – Scientific results in 2020

https://magic.mpp.mpg.de/backend/publications/articles/2020

15 papers published in the journals

+

2 papers accepted, and available in arXiv

+

1 paper accepted in ApJ in the last days, and not yet publicly available in arXiv

MAGIC observations of the nearby short gamma-ray burst GRB~160821B

15 papers published in the journals

Papers contain a large number of corresponding authors from MPP

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→ Giacomo D'Amico

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→ Giovanni Ceribella and Thomas Schweizer

MAGIC observations of the diffuse γ-ray emission in the vicinity of the Galactic Centre
MAGIC collaboration, Acciari *et al.*
Astron. Astrophys. **642** (2020) A190

→ Christian Fruck, Ievgen Vovk, Marcel Strzys
(work essentially done at MPP)

MAGIC very large zenith angle observations of the Crab Nebula up to 100 TeV
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Astron. Astrophys. **635** (2020) A158

→ R. Mirzoyan, Ievgen Vovk

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→ Priya Bangale
(work done during her PhD at MPP)

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Astrophys. J. Suppl. S. **248** (2020) 29

→ David Paneque

Several youtube live events to explain the results of some of our publications

(with key contributions from MPP members)

Acciari et al., 2020, *A&A 643, 14*

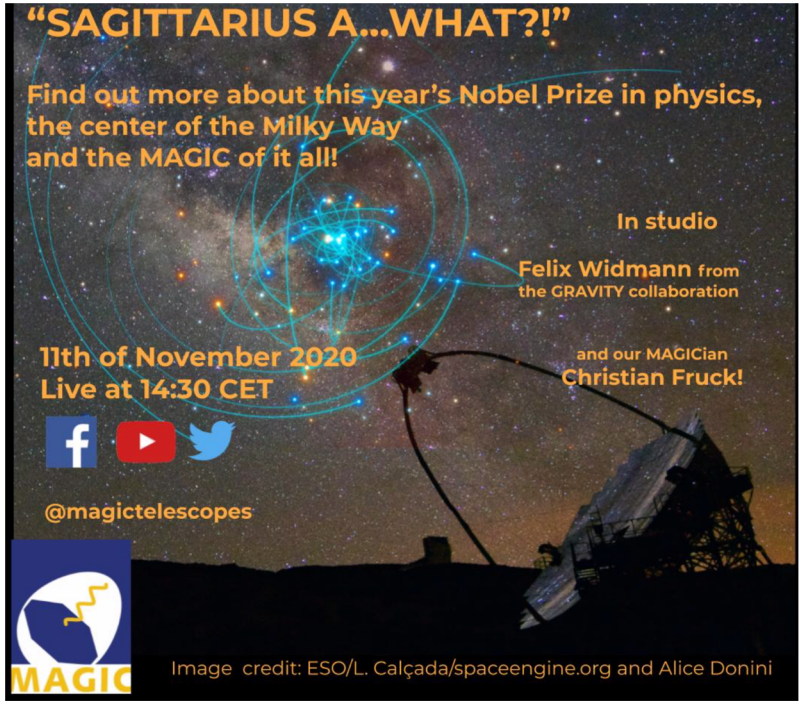
Giacomo D'Amico

Acciari et al., 2020, *A&A 643, 14*

G. Ceribella

Acciari et al., 2020, *A&A 642, 190*

Christian Fruck



Conclusions

MAGIC is 17 years old, but keeps operating wonderfully, under leadership of MPP at all levels (organization, science & technical)

- Factor of 4 improvement in sensitivity since beginning of science operation

  → *More than one order of magnitude better sensitivity below 200 GeV*

Many technological improvements, led by MPP group

- First Cherenkov Telescope that uses atmospheric corrections with LIDAR
- Sum-Trigger-II improving performance at energies below ~100 GeV
- Very Large Zenith Angle observations improving performance above ~10 TeV
- Skyprism sofware package improve performance for extended objects
- *Keep exploring new hardware possibilities (e.g. SiPMs & Mirrors)*

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The collaboration is big (~200 people) and diverse (12 countries), and keeps growing

→ Several groups from INFN officially joined in 2019,
and University Geneve in November 2020

Instrument+collaboration are matured and very productive, regularly publishing on a broad range of scientific topics

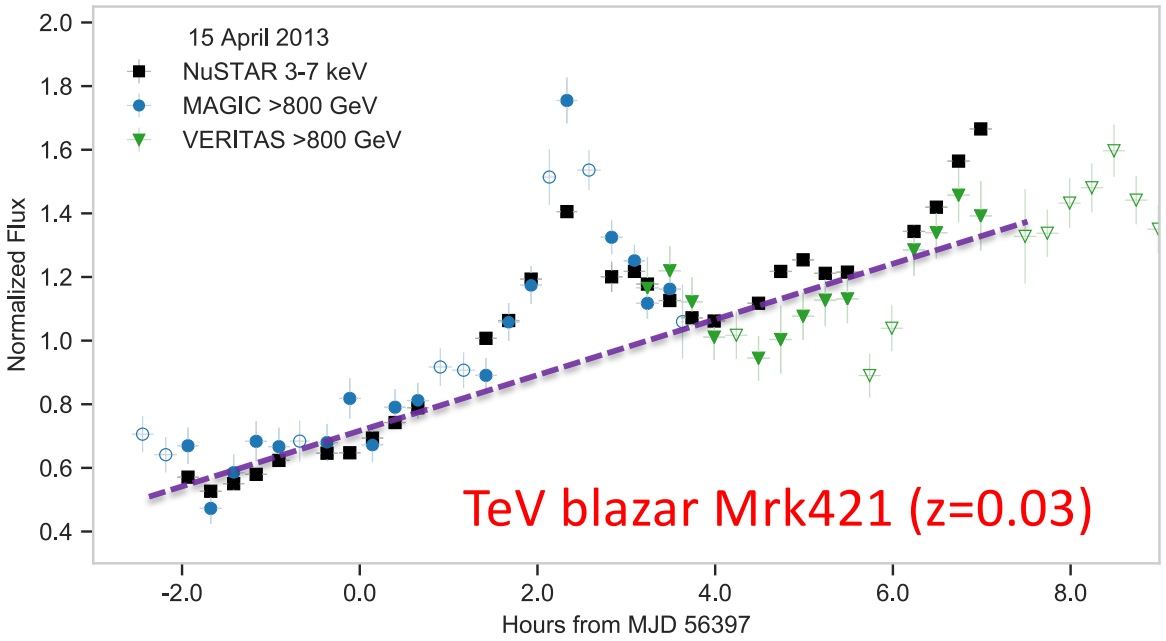
→ **15 publications in 2020, despite covid-19 (*same as HESS+VERITAS combined*)**

→ ***Most scientifically productive Cherenkov telescope in the last 5 years***

Backup slides

Precision Gamma-ray and X-ray light curves in Mrk421

Acciari et al., *ApJS 2020, 248 29A*



10 hours continuous observations with NuSTAR (X-rays) and MAGIC/VERITAS (VHE gamma rays)

→ General flux increase on multi-hours with a fast flare on sub-hours

Interpretation: X-ray/VHE activity is produced by plasmoids in a magnetic reconnection layer

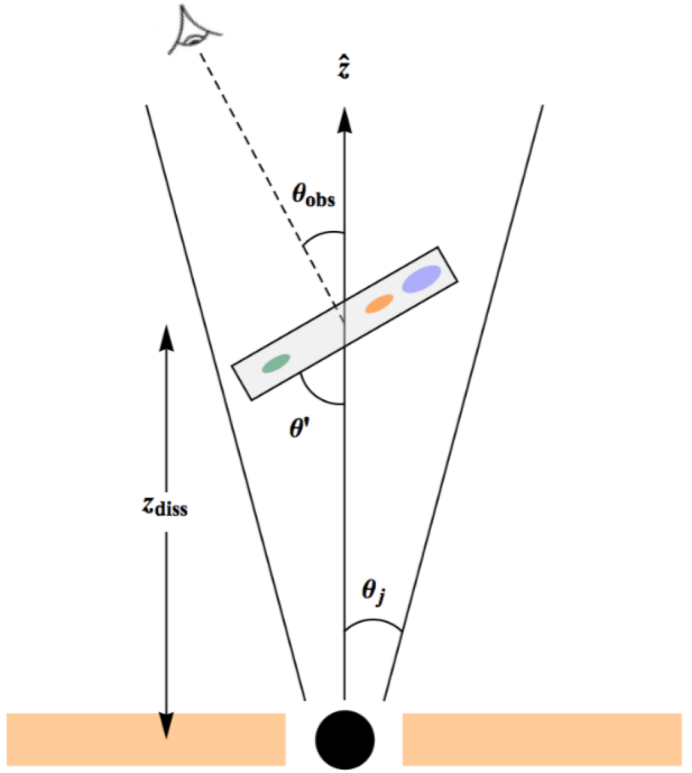


Figure 9. Sketch of a reconnection layer (of half-length L') forming in the jet at a distance z_{diss} (not in scale). The layer forms an angle θ' (as measured in the jet's rest frame) with respect to the jet axis. Plasmoids of different sizes and velocities move towards the sides of the layer while radiating. The jet has an opening angle θ_j and a bulk Lorentz factor Γ_j.

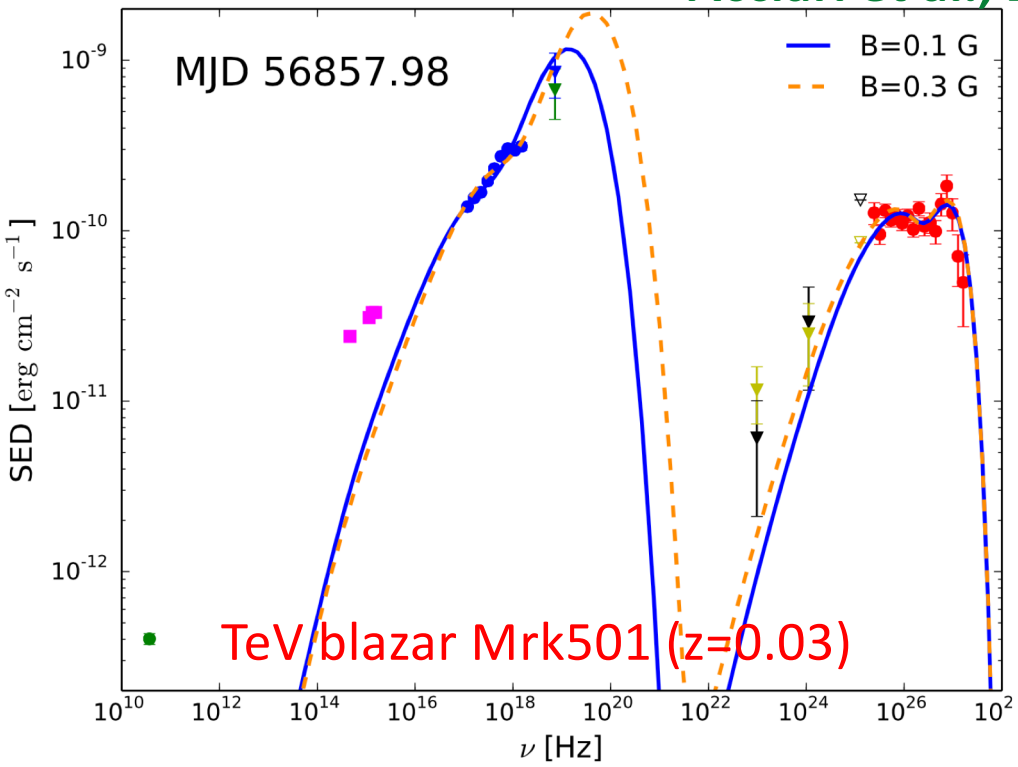
Fast (sub-hour) flares dominated by a single plasmoid (possibly small and highly relativistic), while *Slow* (multi-hour) and more luminous component, is dominated by superposition of emission from many plasmoids of different sizes and speeds

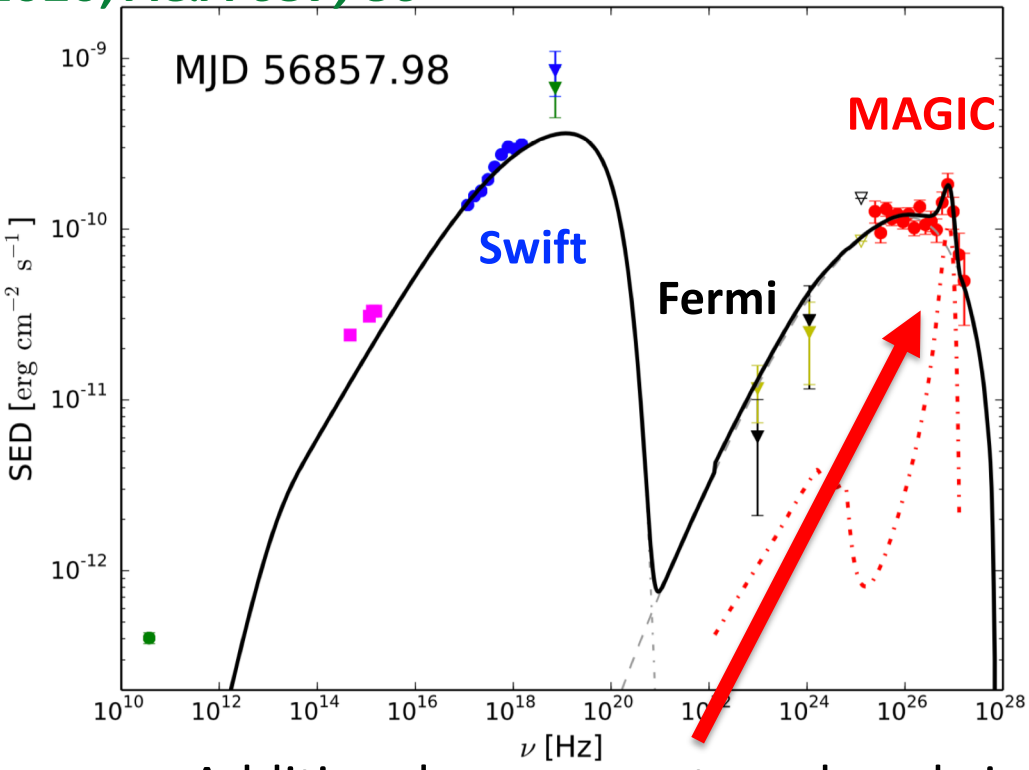
Narrow spectral features observed in Mrk501

Narrow feature at about 3 TeV found (>3σ) in the VHE gamma-ray spectrum of the TeV blazar Mrk501 on July 19th 2014, when X-ray flux was highest in last 15 years

→ *Same data allows for different theoretical interpretations leading to radically different conditions for particle acceleration at the source*

Acciari et al., 2020, *A&A 637, 86*





Pile-up in the electron energy distribution due to stochastic acceleration

$\text{Time}_{\text{Acceleration}}(\gamma_{eq}) \sim \text{Time}_{\text{Cooling}}(\gamma_{eq}) << \text{Time}_{\text{Escape}}$

Additional component produced via an Inverse Compton pair cascade induced by electrons accelerated in a magnetospheric vacuum gap close to the Black Hole

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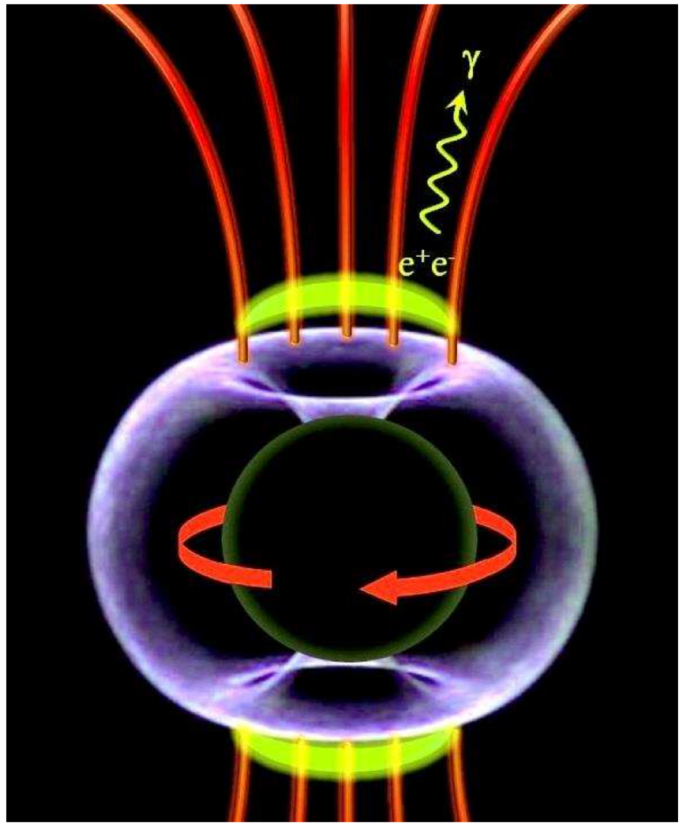
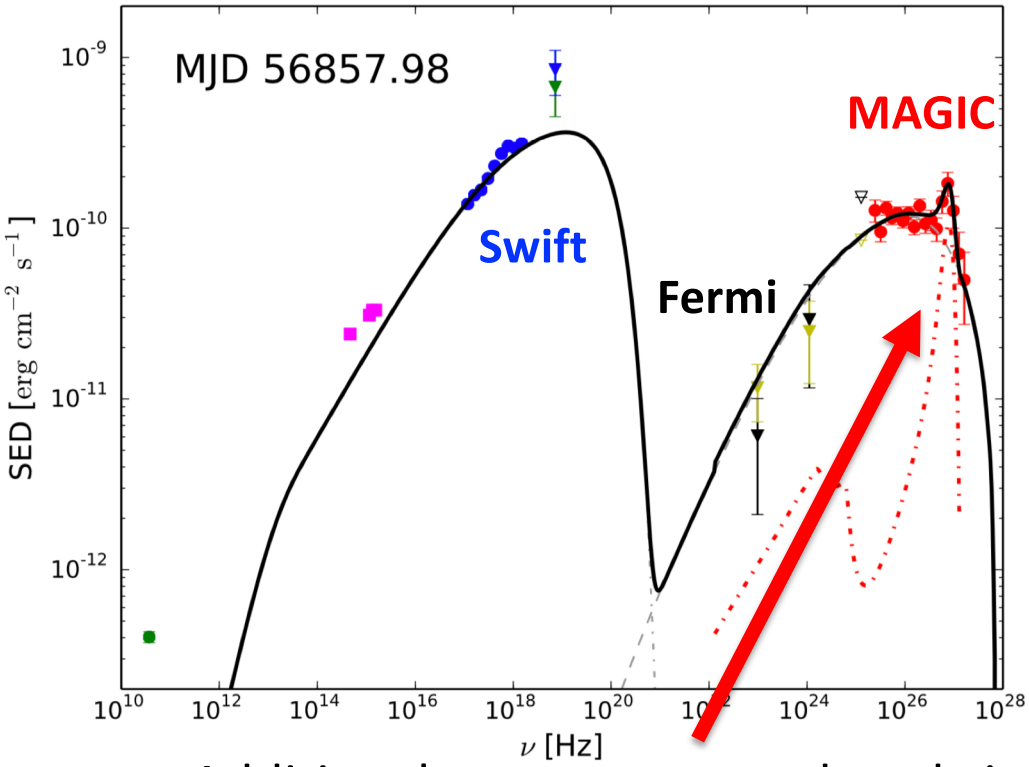


Acciari et al., 2020, *A&A 637, 86*



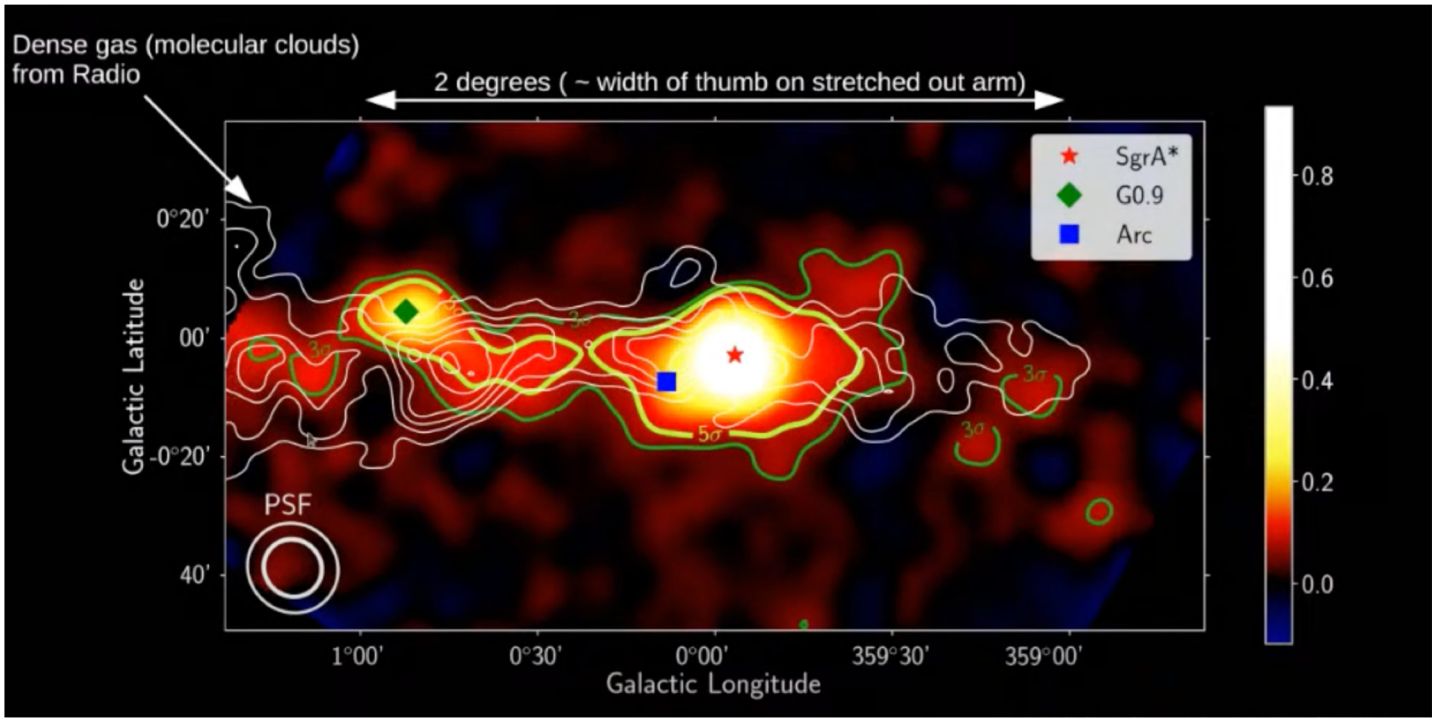
Similar theoretical model had to be used to explain the spectra and fast variability in MAGIC data from radio galaxies

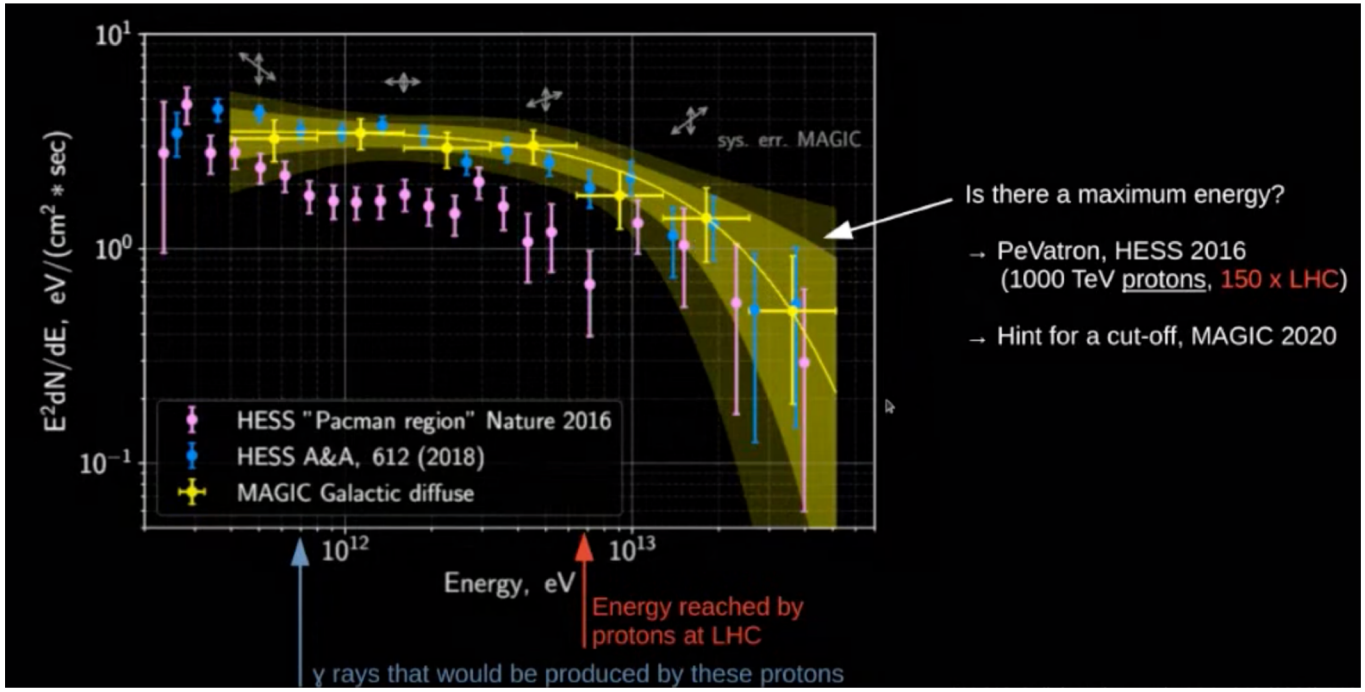
Aleksic et al. 2014, *Science*, 346, 1080

Ansoldi et al. 2018, A&A, 617, 91

Additional component produced via an Inverse Compton pair cascade induced by electrons accelerated in a magnetospheric vacuum gap close to the Black Hole

Acciari et al., 2020, *A&A 642, 190*



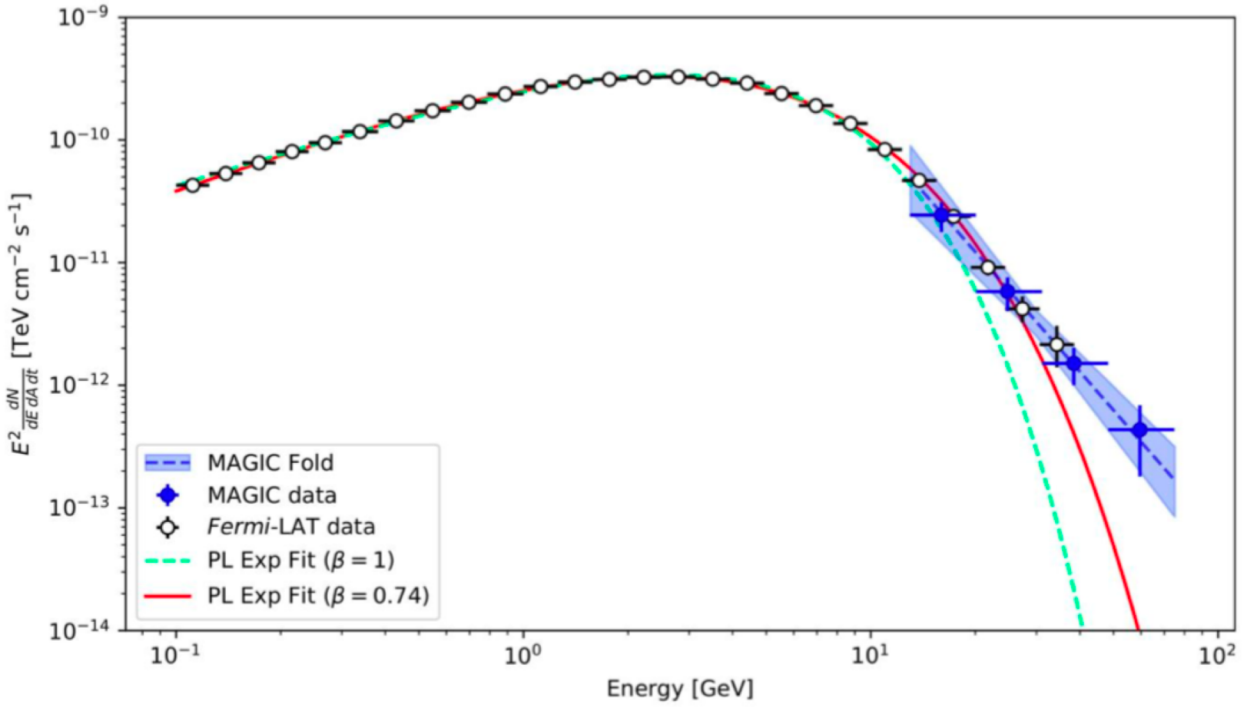


Acciari et al., 2020, *A&A 643, 14*

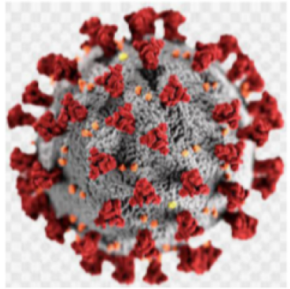
G. Ceribella

Modeling with the Outer Gap: Inverse Compton possible only with ingoing electrons (head-on collision) Dominant above 40 GeV
Fails to reproduce the overall shape: Contribution from heated polar cap?
→ Review of the model needed!

Alternative emission region: Equatorial Current Sheet (Brambilla G, et al. 2018)
How is it related to other pulsars?



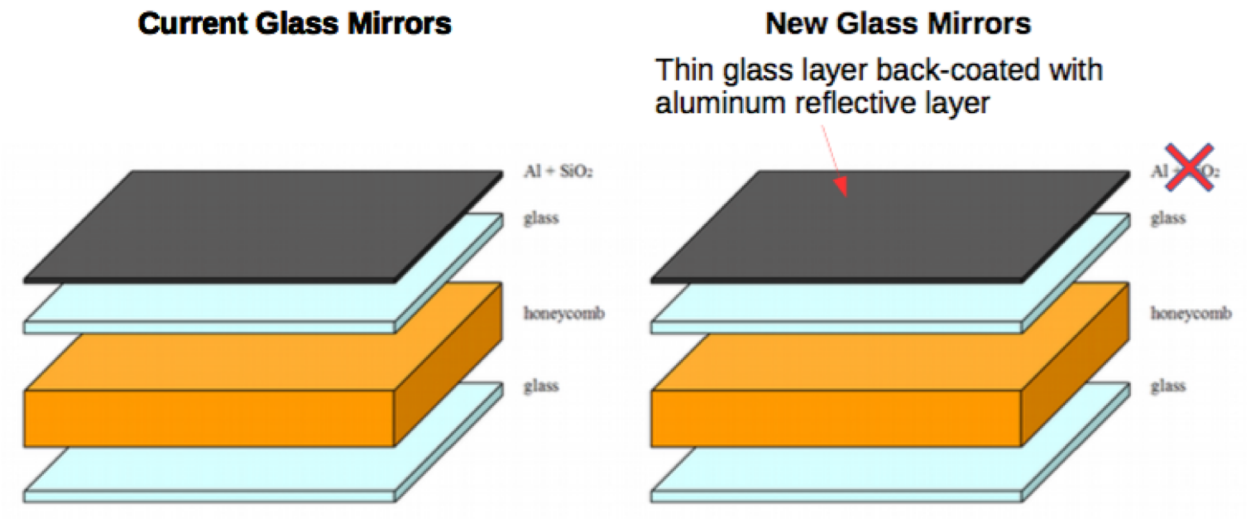
- New law of the local government in Canary Islands, with the aim of **increasing** toursim:
  - boc-a-2020-223-3996, Boletín Oficial de Canarias núm. 223, Sábado 31 de octubre de 2020, in effect from 16 Nov 2020
  - **All travellers arriving in Canary islands must have a test no older than 72 hours, ruling out current infection by SARS-cov-19.**
  - This was already done for all arriving in ORM, but now all accommodation in Canary islands will ask for this test.



  - **Radar Covid infection alert mobile application** must be downloaded and kept active during your stay on the islands and the 15 days immediately after return to your place of origin.

Hardware to improve the performance in long-round: development of novel back-coated ultra-thin glass mirrors

Coordinated by Razmik Mirzoyan ***(+Martin Will, J. van Scherpenberg …)***



In collaboration with
Media Lario Technologies

Their performance (reflectivity & PSF) is similar to that of the MAGIC mirrors

Advantages of back-coated glass mirrors:

Long lifetime: *Glass is robust against corrosion from dust and rain*
Stable performance over long time: *~ lifetime of a telescope*
Easy to clean from dust and dirt: *it does not get scratched*

Studies of dust adhesion on the mirror surface

Physical properties of dust attaching to surface material

- Shape and physical nature of dust particle plays important

– Mass (e.g. if surface is vibrating)

– Surface area (e.g. aerodynamic drag (wind))

- Roughness of surface material is relevant

(generally less contact, less adhesion on rougher surfaces)

→ Need knowledge about the composition of Sahara sand on Canary Islands

→ Roughness of mirrors relatively well known (but what happens after protective quartz coating?)

→ Effect on adhesion from deposits other than dust (from nearby passing cars, etc.)

Several back-coated mirrors available at MPP

- Plan to fix some mirrors to LST structure in MPP garden
- Test several different anti-dust recipes over winter months

2-examples of dust protecting chemicals