The Disappearance of the Primary Blazar Zone in PKS 1510-089

Markus Böttcher, Joleen Barnard, Hester Schutte, and Michael Zacharias, on behalf of the H.E.S.S. Collaboration

NORTH-WEST UNIVERSITY
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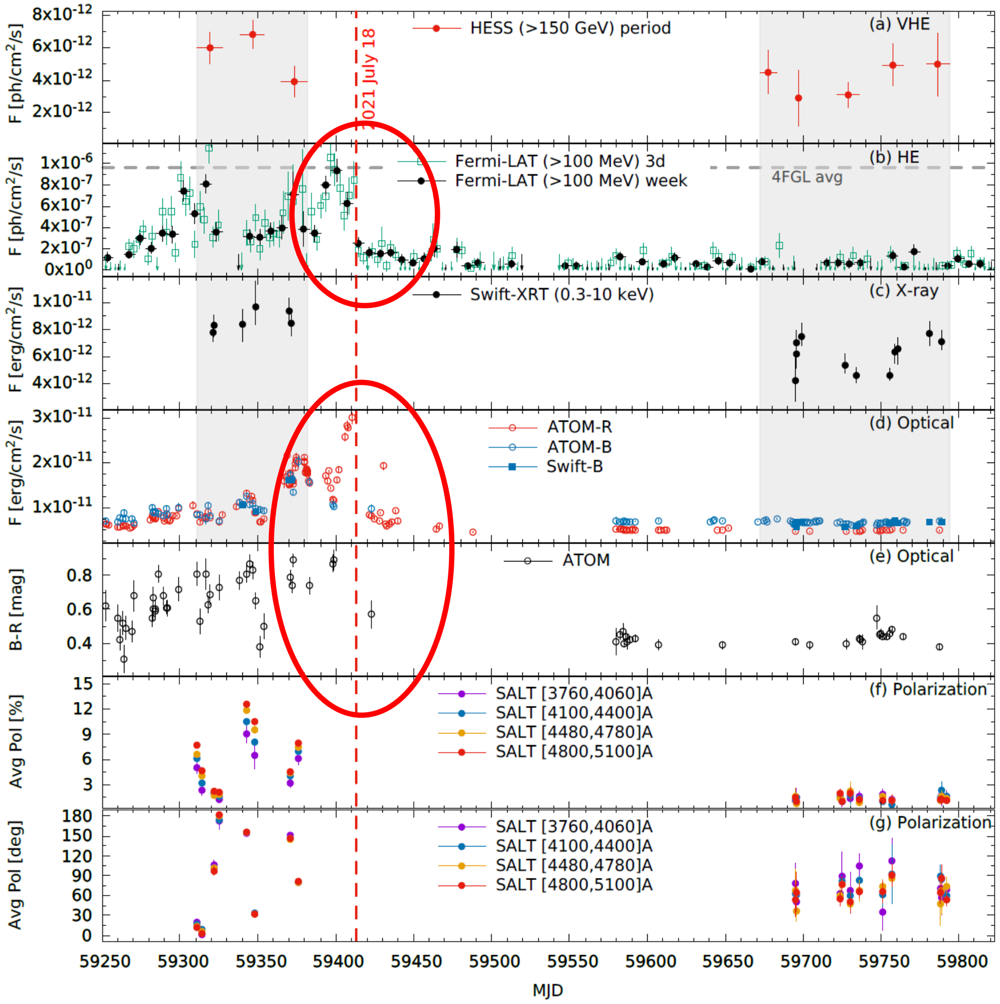
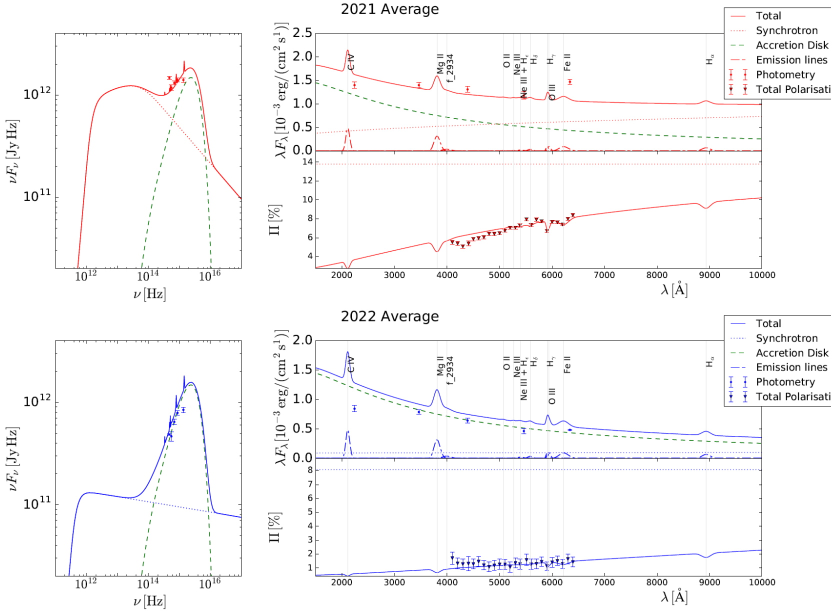
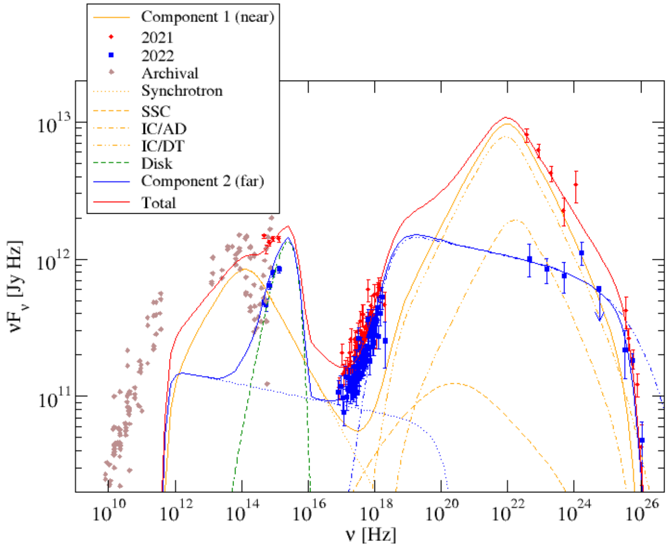
YUNIBESITI YA BOKONE-BOPHIRIMA

H.E.S.S.







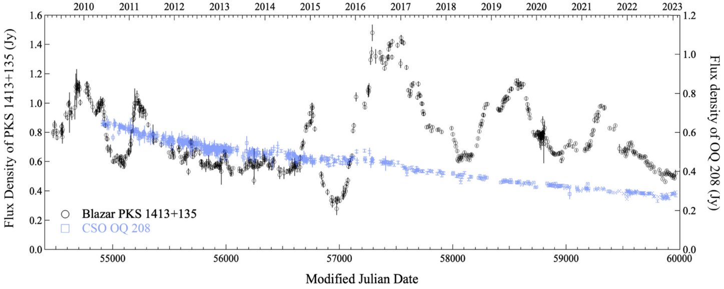
- Unusual variability pattern in PKS 1510-089 in 2021-22: sudden drop of HE γ-rays and optical (flux and polarization), while X-rays and VHE remain high.
- Coordinated MWL + SALT spectropolarimetry observations
- Combined SED + Spectropol modeling constrains accretion-disk spectrum.
- SED modelling strongly favours (at least) 2 emission zones.

A new method for the characterization of variability and its application to the radio light curves of the OVRO blazars

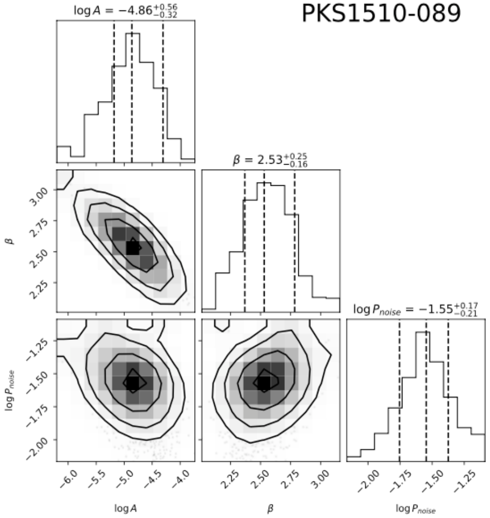
Universidad de Chile

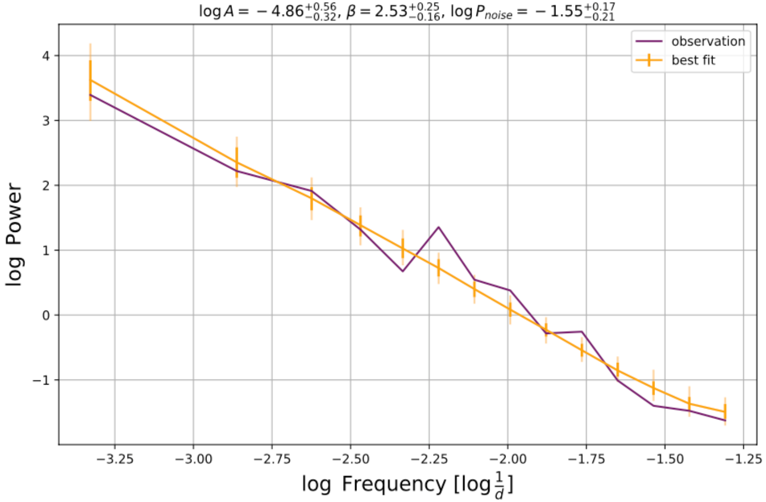
W. Max-Moerbeck, V. Navarro-Aranguiz et al

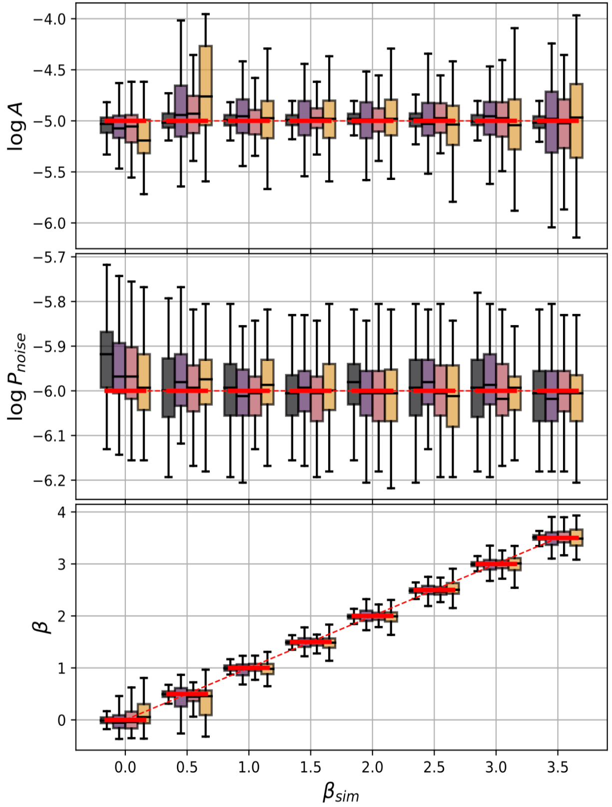
PKS 1413+135 and OQ208 from Kiehlmann et al. 2024



PSD fit of unevenly sampled light curves







INVESTIGATING THE TEV SKY THROUGH RADIO GALAXIES

A Time Dependent SED Modeling of 3C 264

Ettore Bronzini[1,2]

on behalf of the MAGIC collaboration

[1]*Department of Physics and Astronomy, University of Bologna*
[2]*INAF, Astrophysics and Space Science Observatory Bologna*

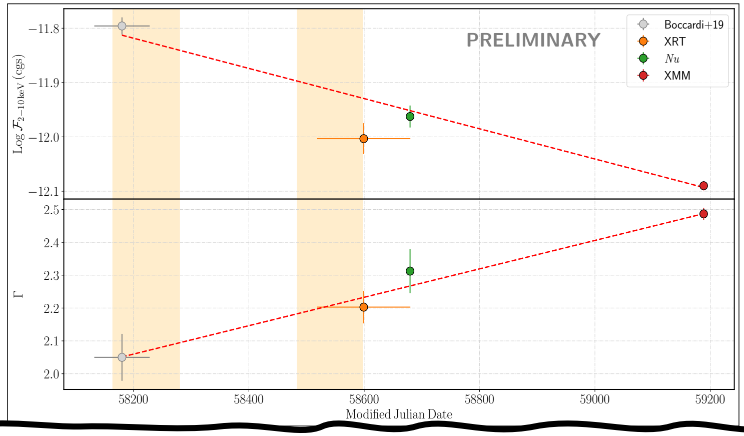
38

3C 264

- FRI/LERG radio galaxy (z=0.0216)
- Head-tail kpc structure with extended radio, optical, X-ray jet
- Detected (7.8σ) for the first time by VERITAS during a “flaring” state in 2018
  - ➢ 3C 264 is **the second most distant TeV-emitting radio galaxy**
- Multiwavelength study by Boccardi+19:
  - unprecedented **VLBI study of the jet components**
  - **X-ray high state contemporary to TeV** enhanced activity
  - multi-zone leptonic model to explain the observed SED in the high-state

High and quiescent states

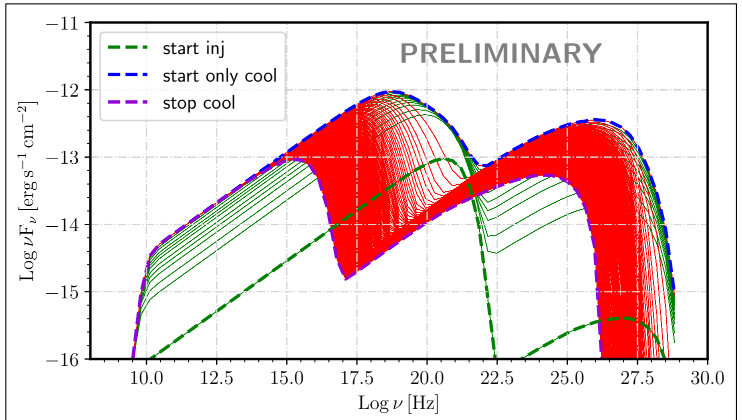
- MAGIC observed (4.4σ) 3C 264 during the flare (2018) and followed it up during its quiescent period (2019). Fainting behaviour after 2018 also observed by VERITAS
- No statistically significant variability in GeV band by *Fermi*-LAT
- **Softening when fading trend in X-ray after 2018**



SED modeling

New model: **self-consistent time-dependent modeling of the source from the high to the low state**

- **Pre-flare**: steady emission from the core
- **Flare**: injection of new energetic particles in the ejection flow
- **Post-flare**: radiative cooling of injected electrons



EBL insights from current and upcoming γ-ray observatories

CTAO Science Symposium
15-18 April 2024 **Bologna, Italy**

Lucas Gréaux*, J. Biteau

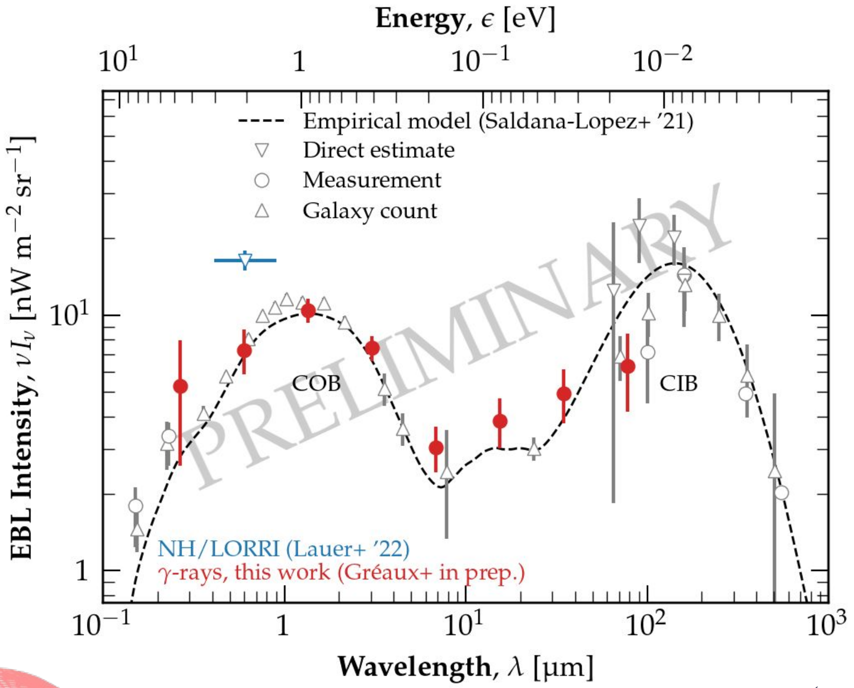
Extragalactic Background Light, EBL: sum of all the **thermal light** in the Universe

- Resolved galaxies (**IGL**)
- (diffuse sources)
- (sources of reionization)

Optical controversy

- **5σ tension** at 600nm **IGL** vs **Direct meas.**

➢ **New γ-ray cosmology** analysis (archival data)



Expectations for CTAO with new γ-ray cosmo. analysis?

Possible science cases

➢ EBL contribution from **reionization sources**

➢ New measurement of **Hubble constant**

➢ Constraints on emissions from **exotic processes**

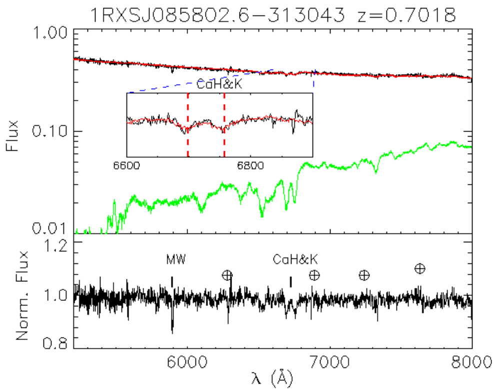
cta cherenkov telescope array cnrs université PARIS-SACLAY

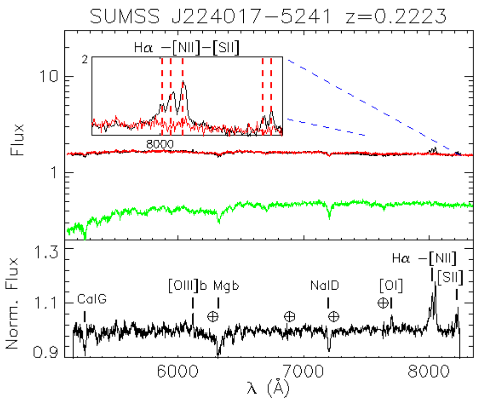
Redshift Measurement of Gamma-ray Blazars for the Cherenkov Telescope Array

cherenkov telescope array

Summary of our Spectroscopic Observing Campaigns

Paper (1)	Number of targets (2)	Redshifts (z) (3)	Redshift lower limits (4)	S/N ≥ 100 sources (z) (5)	S/N < 100 (z) (6)	z_{med} (7)	Efficiency (8)
I	19/19	11 (+1)^C	2(+1)^C	9 (8)	10 (3+1)	0.21	11/19 | 58%
II	25/33	14 (+1)	2	7 (1)	26 (13+1)	0.37	14/25 (33) | 56%
III	24/41	12 (+1)	2	15 (6)	26 (6+1)	0.39	12/24 (41) | 54%
Combined	63/83	37(+2)	6	31(15)	62(22+2)	0.30	37/63 | 59%





- Deep spectroscopic observations with Keck II, Lick, SALT, GTC, NTT and VLT of a sample of BL Lacs without redshift detectable with CTAO in obs of 30 h or less
- In the first two campaigns we determined 25 spectroscopic redshifts with values between 0.0838 and 0.8125, 2 tentative redshifts and 5 upper limits [Paper I and II]
- In the third campaign 12 spectroscopic redshift (values between 0.2223 and 0.7018) and 1 tentative redshift (0.6622) have been determined, together with 2 lower limits ($z > 0.6145$ and $z > 0.6347$) [Paper III]
- 15/24 spectra had S/N > 100, but only for 6 of them a redshift measurement has been obtained. We found a high level in the redshift detection in case of a low- or intermediate-activity state of the AGN [Paper III]

Paper I: Goldoni et al. 2021, A&A, 650, A106
Paper II: Kasai et al. 2023, MNRAS, 515, 2675
Paper III: D'Ammando et al. 2024, A&A, 683, A222

F. D'Ammando (INAF-IRA Bologna), P. Goldoni, S. Pita, D. A. Williams, E. Kasai, J. Becerra-Gonzalez, C. Boisson, G. Cotter, E. Lindfors, W. Max-Moerbeck, N. Alvarez-Crespo, M. Backes, U. Barres de Almeida, V. Fallah-Ramazani, O. Hervet, S. Lambert, D. Mukhi-Nilo, B. Rajput, S. Potter, M. Splettstoesser, B. van Soelen, F. Taris for the CTA Consortium

Active Galactic Nuclei population studies with the Cherenkov Telescope Array Observatory

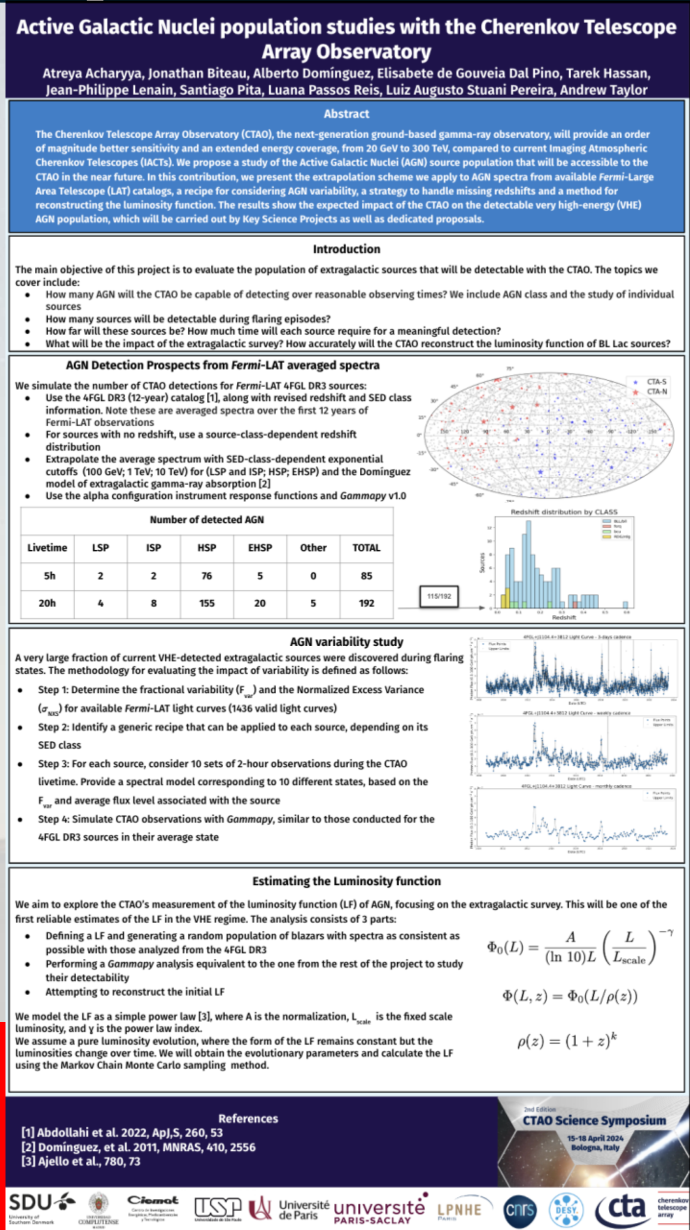
The main objective of this project is to evaluate the population of extragalactic sources that will be detectable with the CTAO. The topics we cover include:

- How many AGN will the CTAO be capable of detecting over reasonable observing times? We include AGN class and the study of individual sources
- How many sources will be detectable during flaring episodes?
- How far will these sources be? How much time will each source require for a meaningful detection?
- What will be the impact of the extragalactic survey? How accurately will the CTAO reconstruct the luminosity function of BL Lac sources?

Image Credit: G. Perez, IAC

2nd Edition
CTAO Science Symposium
15-18 April 2024
Bologna, Italy

For more information, please check out our poster ID-068, as well as talk at CTAO/CTAC Science Meeting Extragalactic Session on Friday



Active Galactic Nuclei population studies with the Cherenkov Telescope Array Observatory

Atreya Acharyya, Jonathan Biteau, Alberto Domínguez, Elisabete de Gouveia Dal Pino, Tarek Hassan, Jean-Philippe Lenain, Santiago Pita, Luana Passos Reis, Luiz Augusto Stuani Pereira, Andrew Taylor

Abstract

The Cherenkov Telescope Array Observatory (CTAO), the next-generation ground-based gamma-ray observatory, will provide an order of magnitude better sensitivity and an extended energy coverage, from 20 GeV to 300 TeV, compared to current Imaging Atmospheric Cherenkov Telescopes (IACTs). We propose a study of the Active Galactic Nuclei (AGN) source population that will be accessible to the CTAO in the near future. In this contribution, we present the extrapolation scheme we apply to AGN spectra from available *Fermi*-Large Area Telescope (LAT) catalogs, a recipe for considering AGN variability, a strategy to handle missing redshifts and a method for reconstructing the luminosity function. The results show the expected impact of the CTAO on the detectable very high-energy (VHE) AGN population, which will be carried out by Key Science Projects as well as dedicated proposals.

Introduction

The main objective of this project is to evaluate the population of extragalactic sources that will be detectable with the CTAO. The topics we cover include:

- How many AGN will the CTAO be capable of detecting over reasonable observing times? We include AGN class and the study of individual sources
- How many sources will be detectable during flaring episodes?
- How far will these sources be? How much time will each source require for a meaningful detection?
- What will be the impact of the extragalactic survey? How accurately will the CTAO reconstruct the luminosity function of BL Lac sources?

AGN Detection Prospects from *Fermi*-LAT averaged spectra

We simulate the number of CTAO detections for *Fermi*-LAT 4FGL DR3 sources:

- Use the 4FGL DR3 (12-year) catalog [1], along with revised redshift and SED class information. Note these are averaged spectra over the first 12 years of Fermi-LAT observations
- For sources with no redshift, use a source-class-dependent redshift distribution
- Extrapolate the average spectrum with SED-class-dependent exponential cutoffs (100 GeV; 1 TeV; 10 TeV) for (LSP and ISP; HSP; EHSP) and the Domínguez model of extragalactic gamma-ray absorption [2]
- Use the alpha configuration instrument response functions and *Gammapy* v1.0

Number of detected AGN

Livetime	LSP	ISP	HSP	EHSP	Other	TOTAL
5h	2	2	76	5	0	85
20h	4	8	155	20	5	192

AGN variability study

A very large fraction of current VHE-detected extragalactic sources were discovered during flaring states. The methodology for evaluating the impact of variability is defined as follows:

- Step 1: Determine the fractional variability (F_{var}) and the Normalized Excess Variance (σ_{NXS}) for available *Fermi*-LAT light curves (1436 valid light curves)
- Step 2: Identify a generic recipe that can be applied to each source, depending on its SED class
- Step 3: For each source, consider 10 sets of 2-hour observations during the CTAO livetime. Provide a spectral model corresponding to 10 different states, based on the F_{var} and average flux level associated with the source
- Step 4: Simulate CTAO observations with *Gammapy*, similar to those conducted for the 4FGL DR3 sources in their average state

Estimating the Luminosity function

We aim to explore the CTAO's measurement of the luminosity function (LF) of AGN, focusing on the extragalactic survey. This will be one of the first reliable estimates of the LF in the VHE regime. The analysis consists of 3 parts:

- Defining a LF and generating a random population of blazars with spectra as consistent as possible with those analyzed from the 4FGL DR3
- Performing a *Gammapy* analysis equivalent to the one from the rest of the project to study their detectability
- Attempting to reconstruct the initial LF

$$\Phi_0(L) = \frac{A}{(\ln 10)L}\left(\frac{L}{L_{\rm scale}}\right)^{-\gamma}$$

$$\Phi(L,z) = \Phi_0(L/\rho(z))$$

$$\rho(z) = (1+z)^k$$

We model the LF as a simple power law [3], where A is the normalization, L_{scale} is the fixed scale luminosity, and γ is the power law index.
We assume a pure luminosity evolution, where the form of the LF remains constant but the luminosities change over time. We will obtain the evolutionary parameters and calculate the LF using the Markov Chain Monte Carlo sampling method.

References
[1] Abdollahi et al. 2022, ApJ,S, 260, 53
[2] Domínguez, et al. 2011, MNRAS, 410, 2556
[3] Ajello et al., 780, 73

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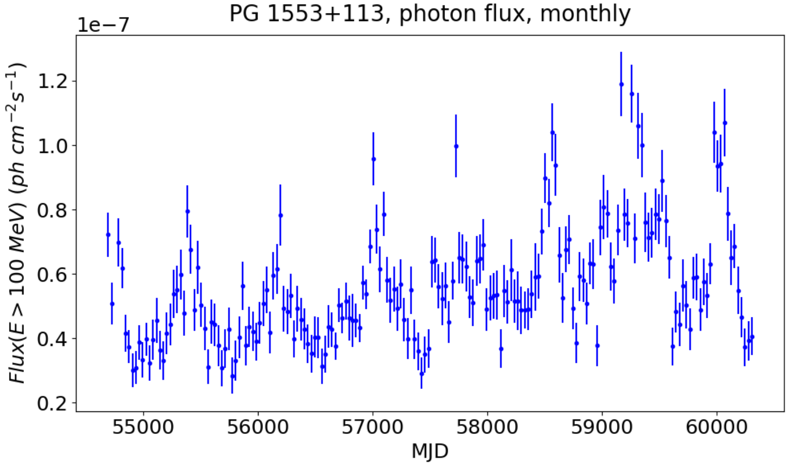
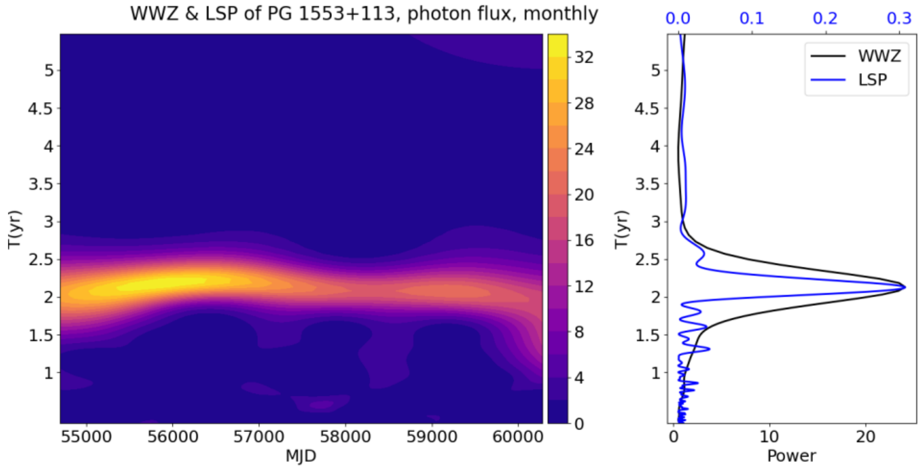
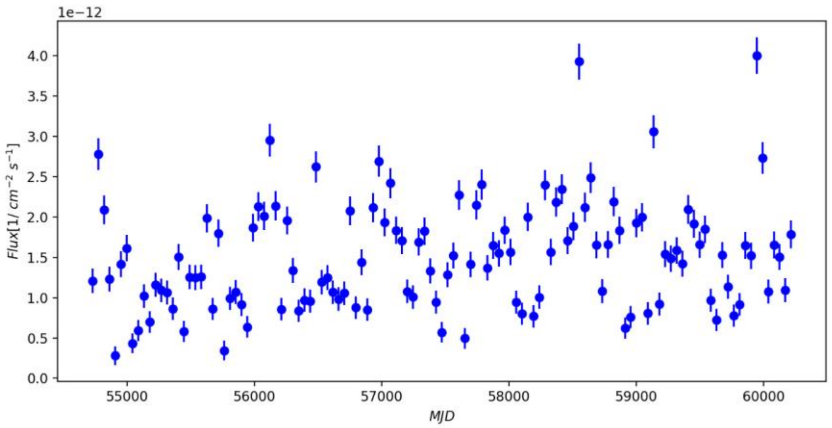
Studi of periodicity of Blazar light curves observed by Fermi-LAT and previsions for CTA Observatory

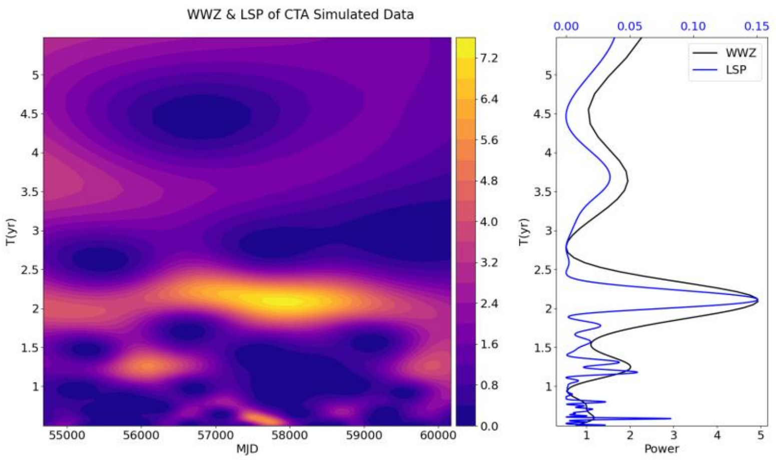
Anaysis of Fermi-LAT blazar light curves periodicity results in 6 blazar with periodicity significance greater than 4 sigmas.

One of the sources resulting in higher significance is PG 1553+113









Using Fermi-LAT light curves and the spectral index measured by MAGIC to simulate CTAO-North observations of 10h every 45 days we obtain hints of periodicity detection.

Effects of non-continuous Compton cooling in blazars

NWU®
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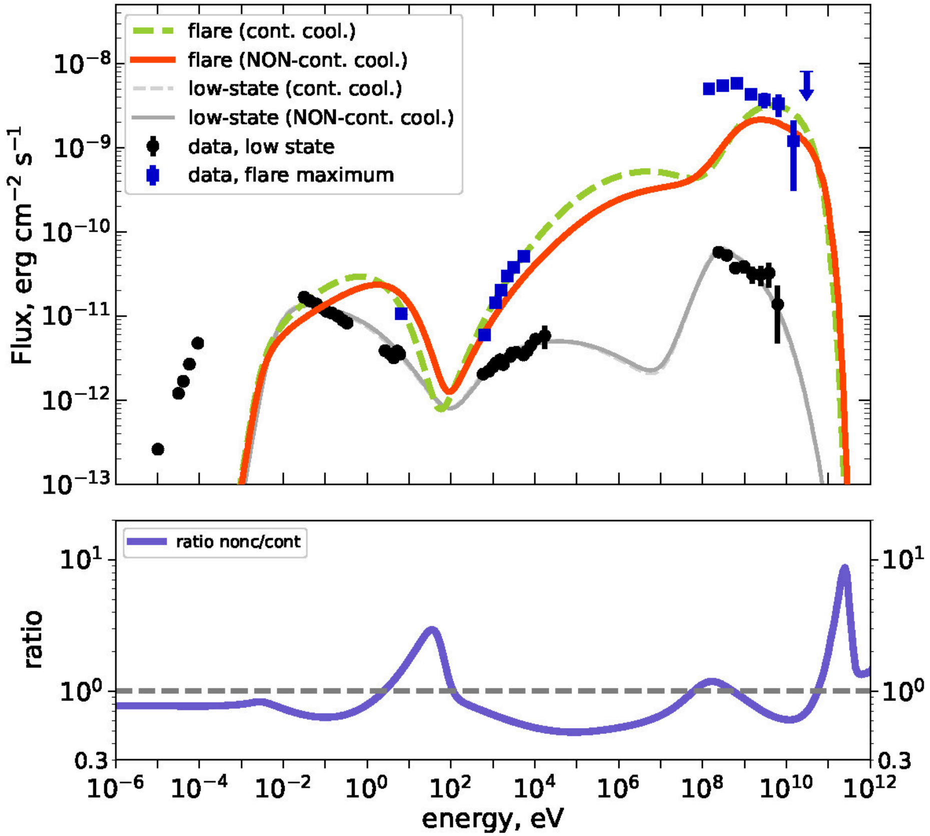
Markus Böttcher & Anton Dmytriiev

North-West University, Potchefstroom, South Africa

$$\frac{\partial N_e(\gamma,t)}{\partial t} = \frac{\partial}{\partial \gamma}\left[-\dot{\gamma}_{\rm cool} N_e(\gamma,t)\right] - \frac{N_e(\gamma,t)}{t_{\rm esc}} + Q_{\rm inj}(\gamma,t),$$

$$\frac{\partial N_e(\gamma,t)}{\partial t} = -N_e(\gamma,t)\int_1^{\gamma} C(\gamma,\gamma')d\gamma' + \int_{\gamma}^{\infty} N(\gamma',t)C(\gamma',\gamma)d\gamma' + \frac{\partial}{\partial \gamma}\left[-\dot{\gamma}_{\rm cool,syn} N_e(\gamma,t)\right] - \frac{N_e(\gamma,t)}{t_{\rm esc}} + Q_{\rm inj}(\gamma,t)$$



- The usual way of simulating time-dependent blazar emission treats all cooling processes as continuous (i.e., $\Delta\gamma << \gamma$ for Compton scattering)
- In blazars with high Compton dominance (FSRQs), External Compton at the highest energies is in Klein-Nishina regime => Large energy jumps!
- Developed code to compare continuous vs. non-continuous cooling implementations.
- Application to 3C279: During flares with high Compton dominance: Deviations up to ~ 50 % in the γ-ray spectrum!
- Even more important for predictions for future CTA observations!

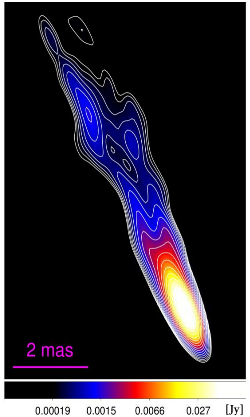
Studies of Cosmic Ray Acceleration in Relativistic Jets

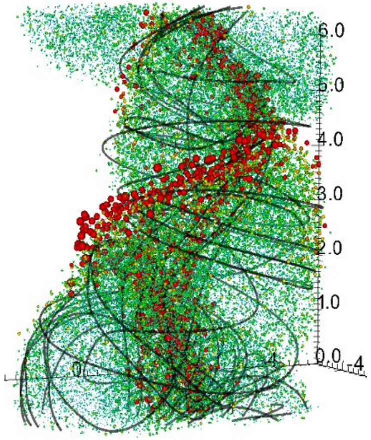
Tania E. Medina-Torrejón[1], Vitor de Souza[1], Rita C. Anjos[2], Luiz A. Stuani P.[3]

[1]Instituto de Física de São Carlos, Universidade de São Paulo, [2]Universidade Federal do Paraná, Palotina, [3]Universidade Federal de Campina Grande, Paraiba

temt@usp.br

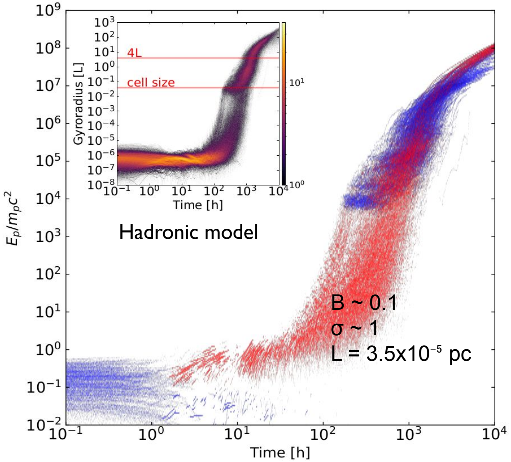
MHD Jet simulation





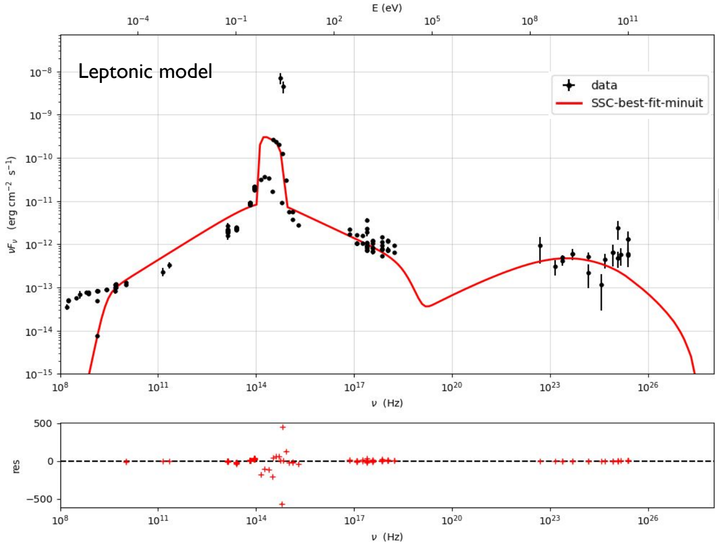
Smith et al. 2000
Boccardi et al. 2019
Archer et al. 2020

Particle acceleration by magnetic reconnection in Relativistic relativistic jets



Gaccel code (Kowal, de Gouveia Dal Pino, Lazarian, PRL 2012)
Kadowaki, de Gouveia Dal Pino, Medina-Torrejón et al. APJ (2021)
Medina-Torrejón, de Gouveia Dal Pino, Kadowaki, et al. ApJ 2021
Medina-Torrejón, de Gouveia Dal Pino, Kowal, ApJ 2023

Spectral Energy Distribution (SED) of AGN sources



Are blazars neutrino-emitting sources? A VLBI investigation
ID-102

Cristina Nanci (University of Bologna and INAF - Institute of Radioastronomy),
and M. Giroletti, M. Orienti, G. Migliori, J. Moldón, S. Garrappa, M. Kadler, E. Ros, S. Buson, T. An, M. A. Pérez-Torres, F. D'Ammando, P. Mohan, I. Agudo, B. W. Sohn, A.J. Castro-Tirado, Y. Zhang

Aim:

Study candidate neutrino emitting blazars through VLBI (parsec scale) follow-ups

Method:

- characterization of the co-spatial radio sources
- neutrino emission correspond to enhanced radio activity?
- are there recurring radio properties linked to neutrino production?

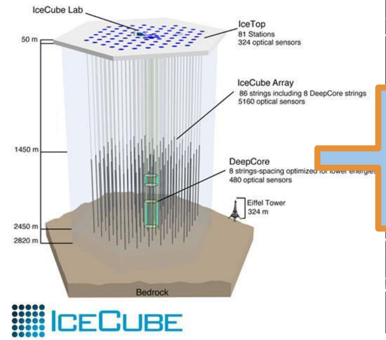
Result:

Between 2019-2020:
+ **4 VLBI follow ups** of IceCube events (Nanci et al 2022)
→ **10 radio sources** candidate counterparts → **5 "best" candidates** (blazar-like + γ-ray associated)
→ 2 of them in **enhanced state at VLBI scales** at the neutrino arrival

Ongoing Result & CTAO contribution:

Between 2021 and 2024 **+7 new VLBI follow ups** of IceCube events (to be published)
CTAO will enhance our understanding of TeV-blazars promising neutrino-emitters

Sensitivity of the Cherenkov Telescope Array Observatory to the gamma-ray emission from neutrino sources detected by IceCube



CTA will:

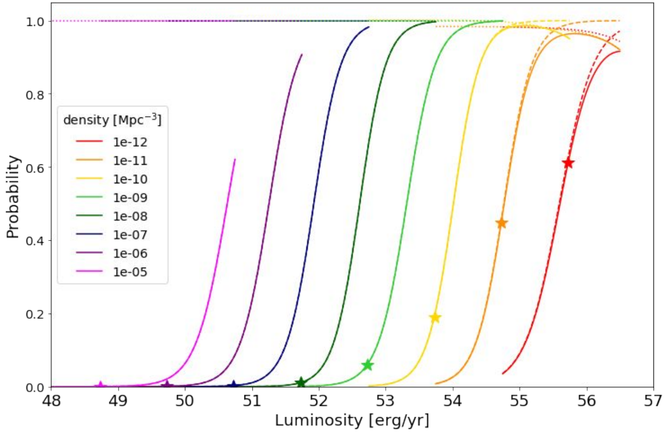
- monitor the hot-spots exceeding the IceCube sensitivity
- look for the gamma-ray counterpart to a neutrino source alert

SIMULATIONS:

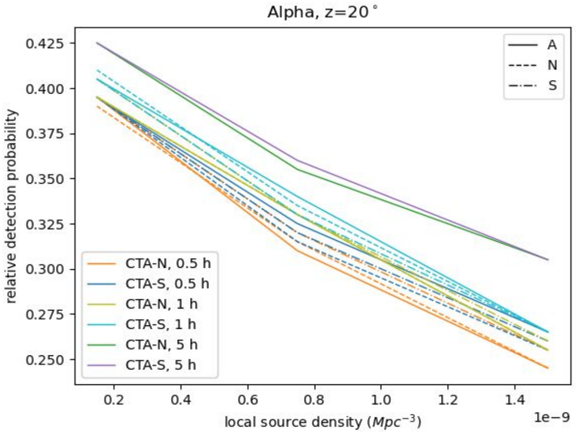
Hadronic contribution: pγ process

FIRESONG+ctools

Steady sources



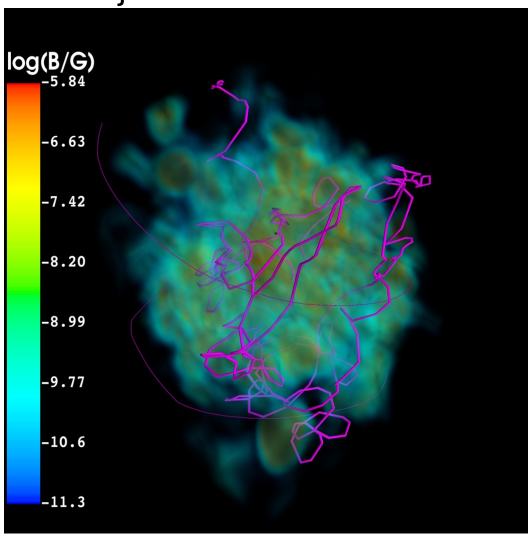
Transient sources



Neutrinos and Gamma Rays from Galaxy Clusters Constrained by the Upper Limits of IceCube

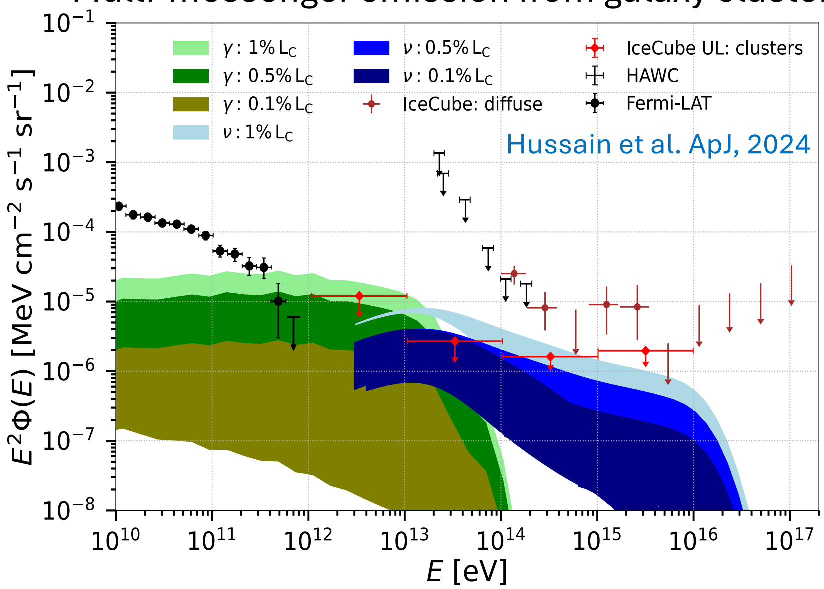
Saqib Hussain (*saqib.hussain@gssi.it*)

CRs trajectories inside a cluster

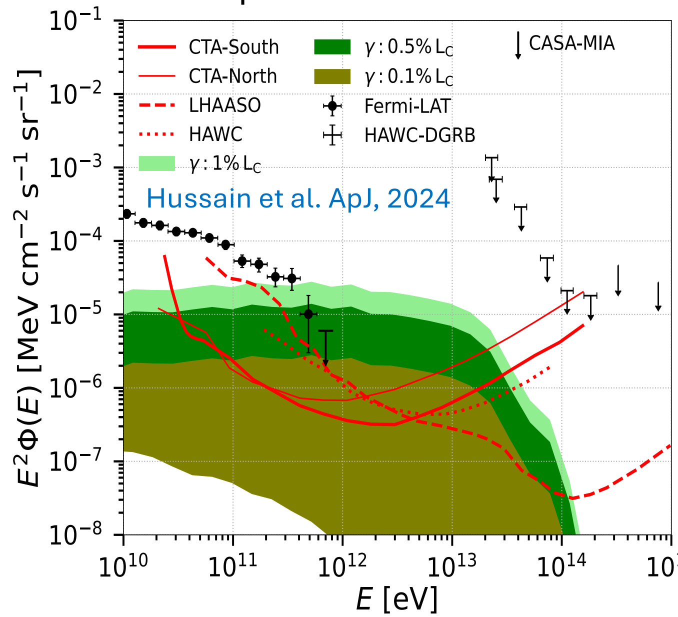


Hussain et al. 2023 Nat. Commun.

Multi-messenger emission from galaxy clusters



Comparison with sensitives

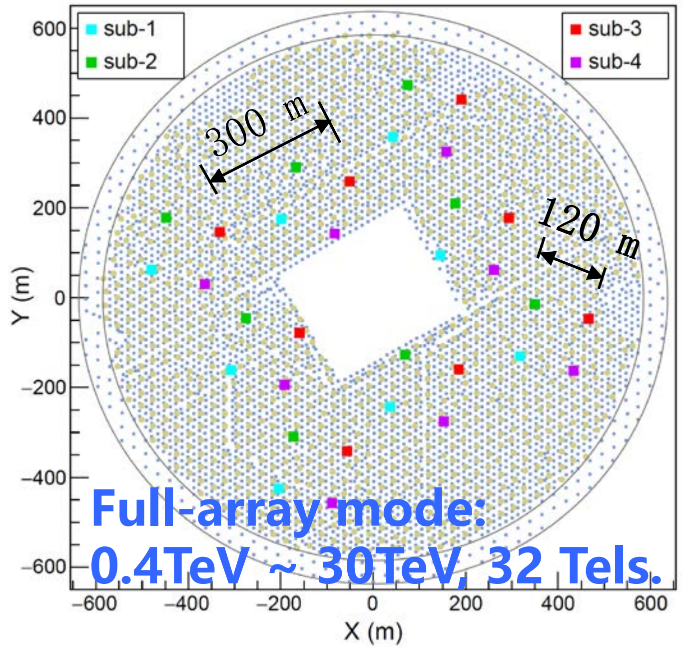


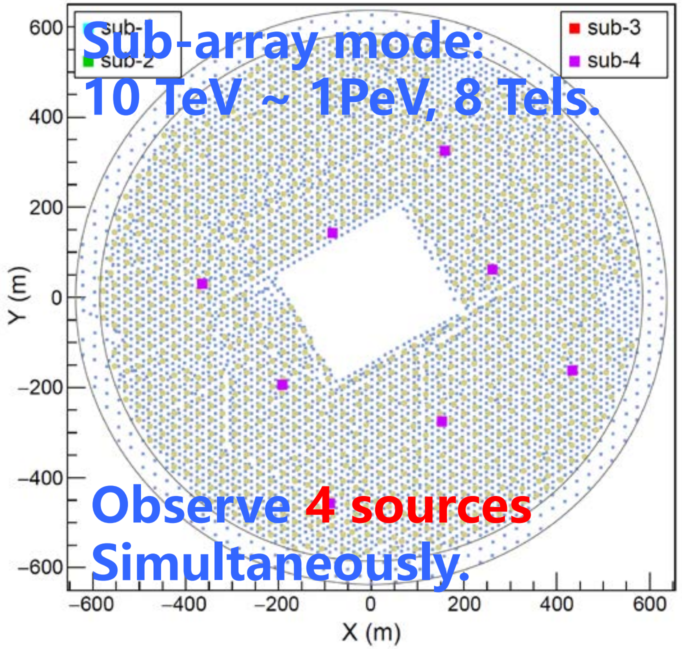
- Neutrino flux from clusters is comparable with existing upper-limits of the IceCube for clusters, between energies 100 TeV and 10 PeV.
- Gamma-ray flux from clusters can contribute to a fairly large fraction to the diffuse background above 100 GeV observed by the Fermi-LAT.

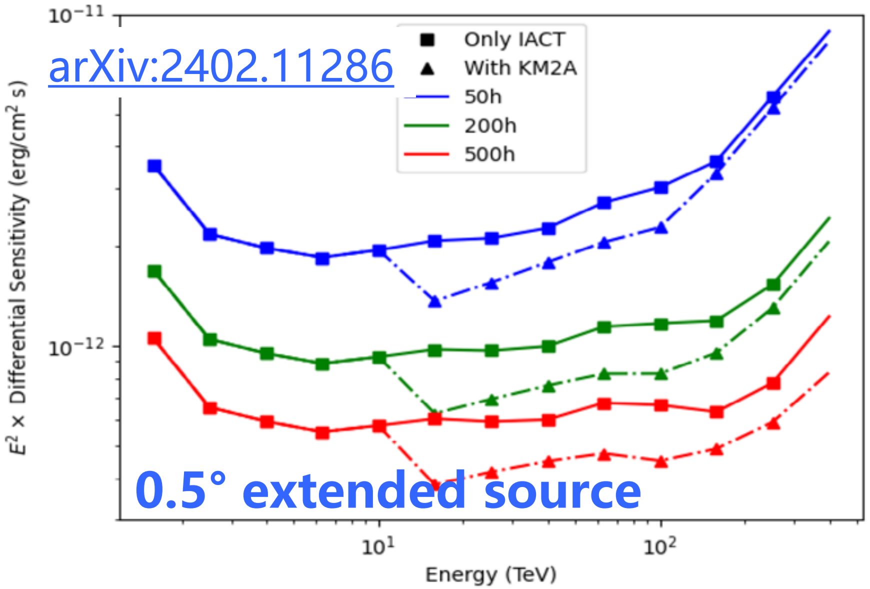
These results might be confirmed by LHAASO, upcoming CTA and IceCube-Gen2, GRAND…

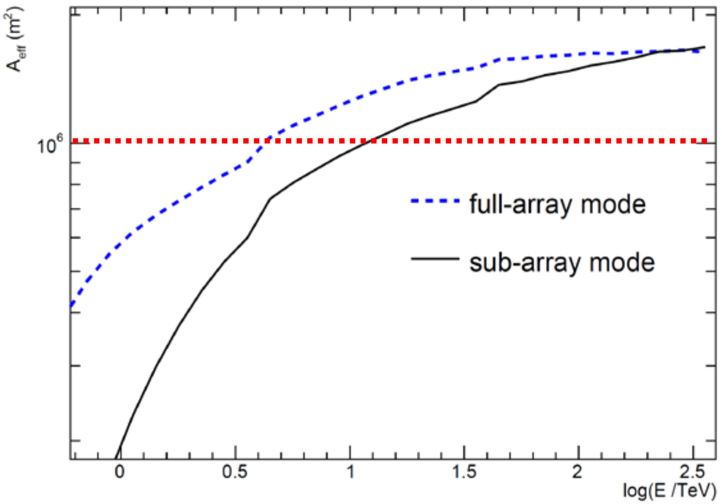
R&D of Large Array of imaging atmospheric Cherenkov Telescopes （LACT)

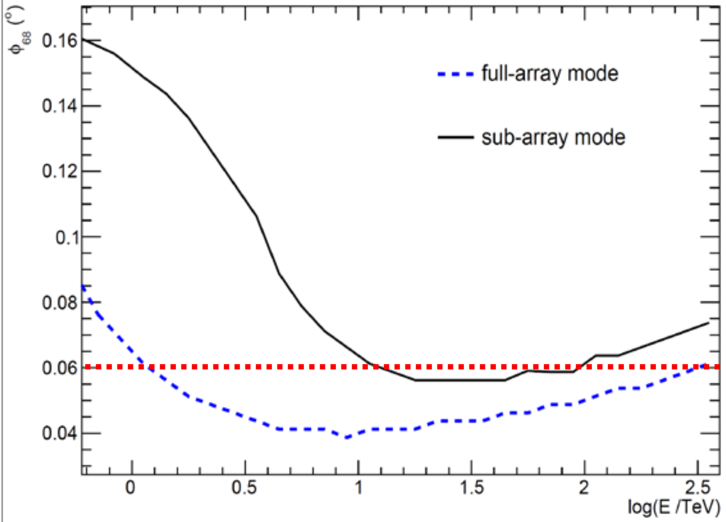
Jiali Liu for the LACT group (jlliu@ihep.ac.cn) , IHEP, CAS, Beijing, China.











- **Performance**
  - --Angular resolution: ~ 0.06°
  - --Effective area: ~ 1.5 km²
- **Project status and schedule**
  - -- It was funded.
  - -- 2024.12: a prototype
  - -- 2026.12: 8 telescopes
  - -- 2028.12: 32 telescopes

SST-1M

SST-1M

Commissioning and Preliminary Observation Results

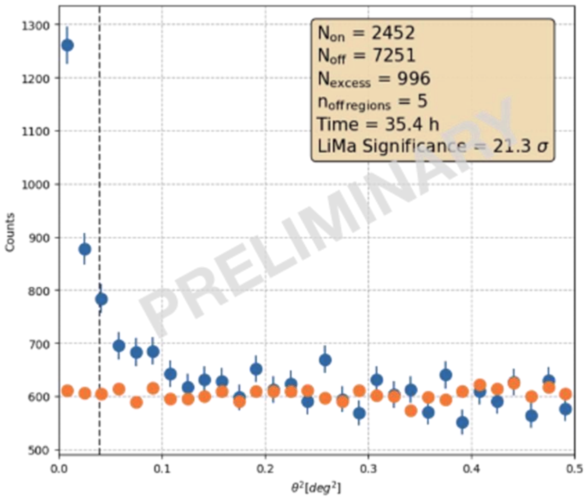
Bastien Lacave, SST-1M Collaboration

Two Davies-Cotton telescopes working in stereo in Ondřejov, Czech Republic. Observations are conducted entirely remotely.

Successful detections of the **Crab Nebula**, **Markarian 421** and **1ES 1959+650**.

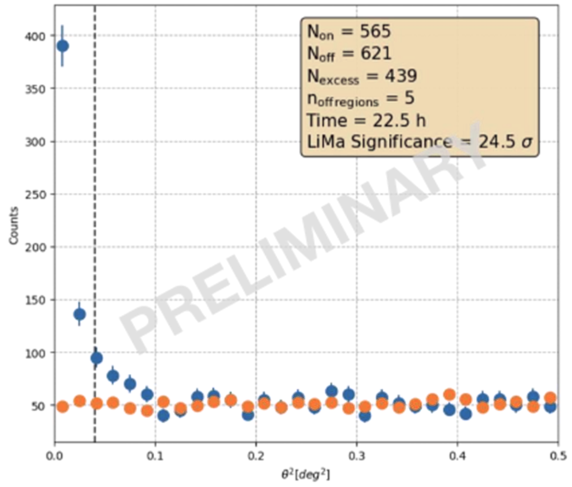
MONO

5σ in 3h



STEREO

5σ in 2h



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THE HENRYK NIEWODNICZAŃSKI INSTITUTE OF NUCLEAR PHYSICS POLISH ACADEMY OF SCIENCES
UNIWERSYTET WARSZAWSKI
Astronomický ústav AV ČR
AGH
Palacký University Olomouc

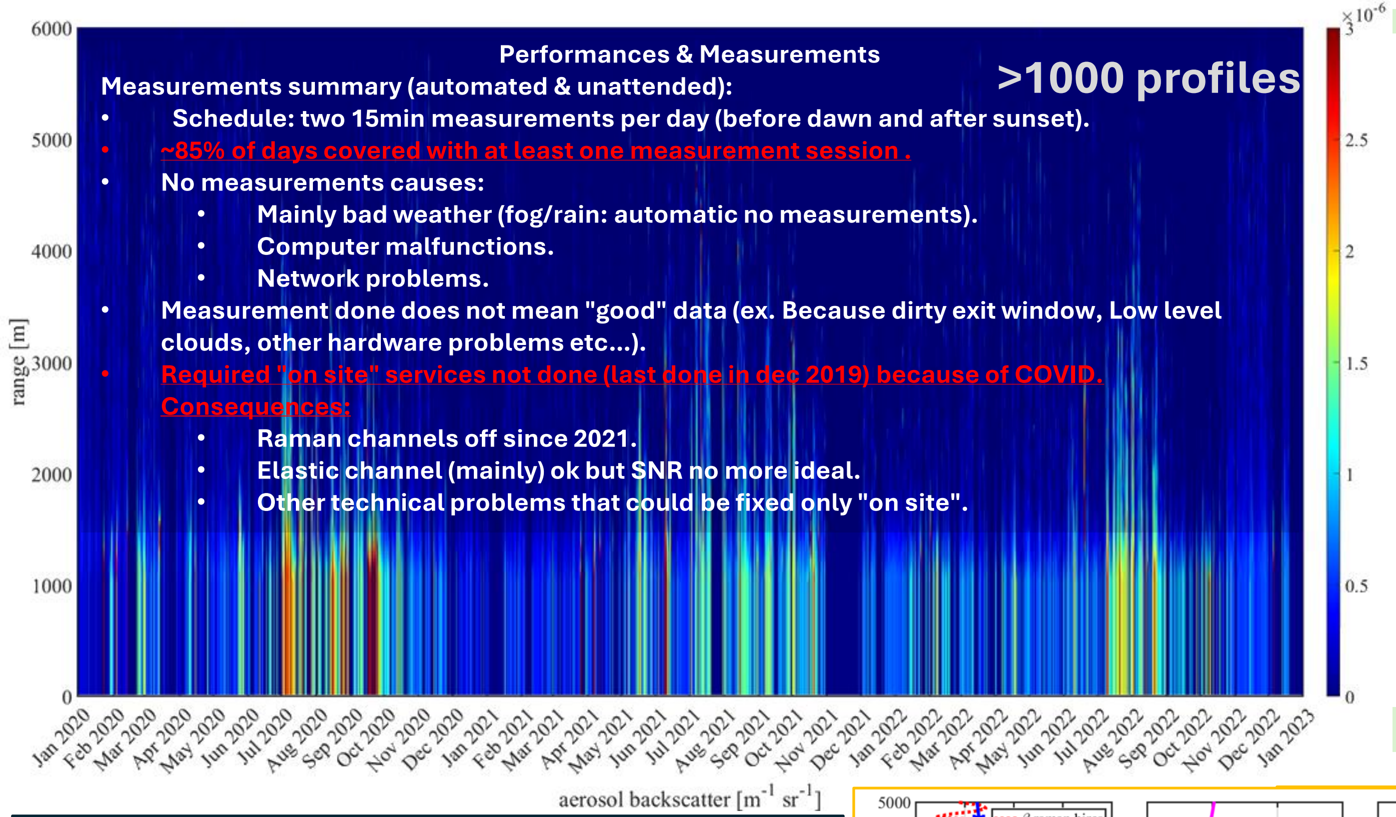
INFN Raman LIDAR measurements at CTA North - M. Iarlori et al. – CTAO, Bologna (Italy) – 15-18 April 2024

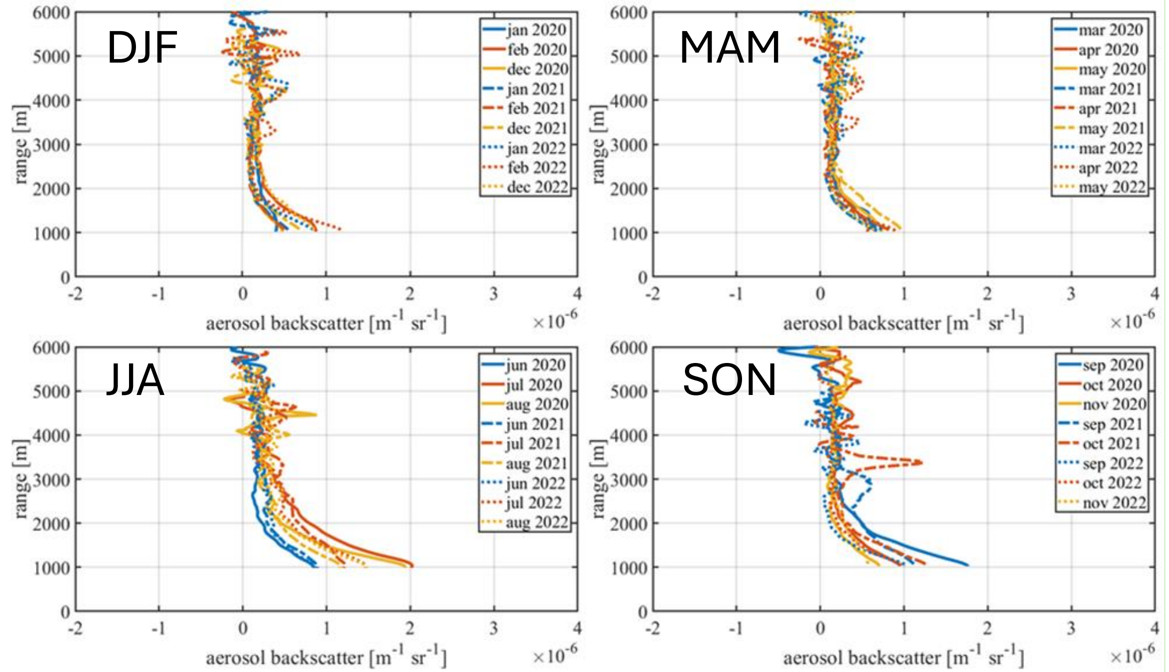
Performances & Measurements

>1000 profiles

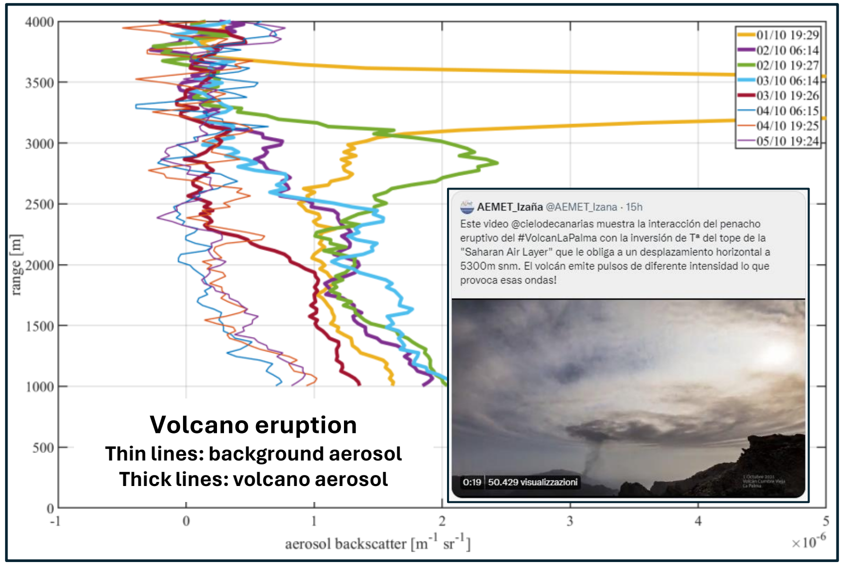
Measurements summary (automated & unattended):

- Schedule: two 15min measurements per day (before dawn and after sunset).
- ~85% of days covered with at least one measurement session .
- No measurements causes:
  - Mainly bad weather (fog/rain: automatic no measurements).
  - Computer malfunctions.
  - Network problems.
- Measurement done does not mean "good" data (ex. Because dirty exit window, Low level clouds, other hardware problems etc...).
- Required "on site" services not done (last done in dec 2019) because of COVID.
  Consequences:
  - Raman channels off since 2021.
  - Elastic channel (mainly) ok but SNR no more ideal.
  - Other technical problems that could be fixed only "on site".

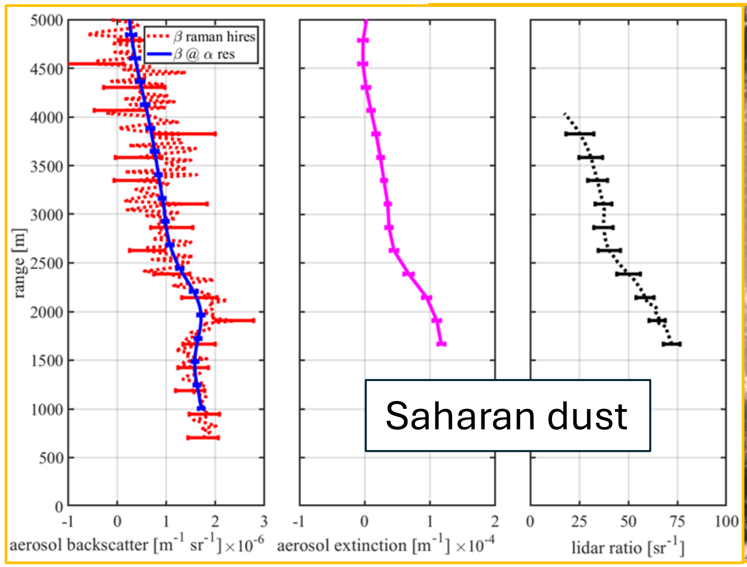




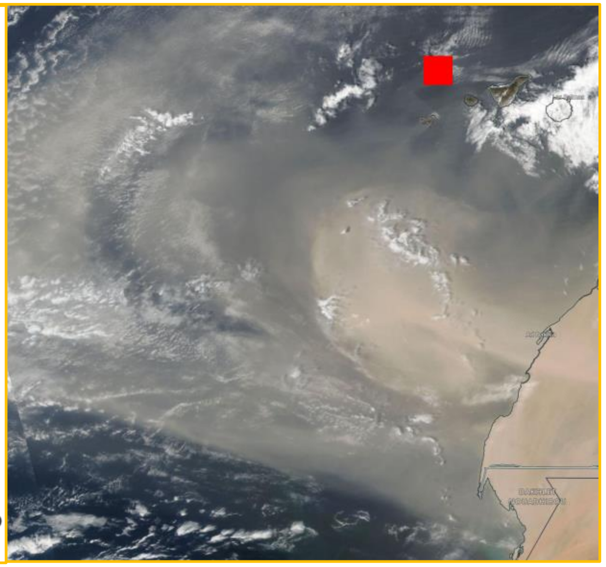
Monthly averages

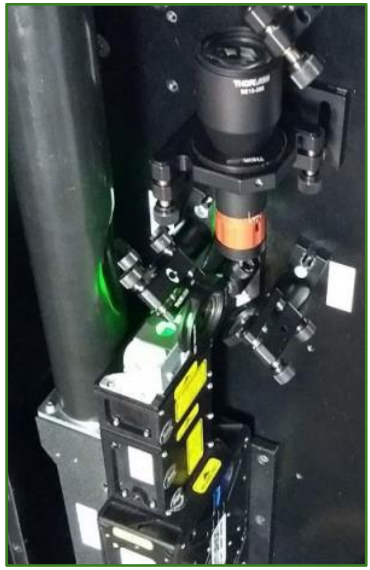


Volcano eruption
Thin lines: background aerosol
Thick lines: volcano aerosol



Saharan dust





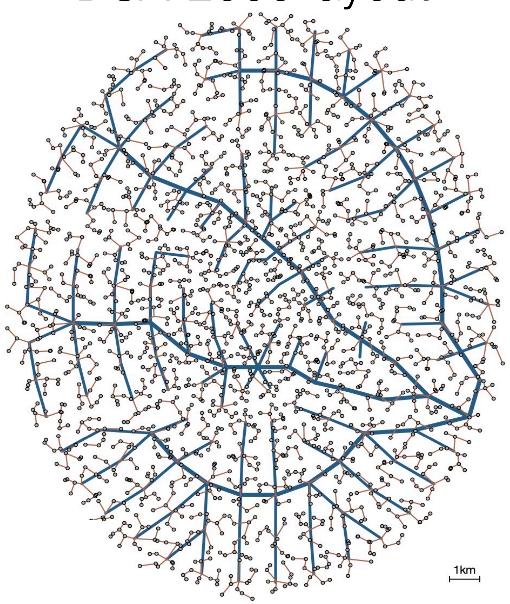
The Future of Intensity Interferometry beyond CTA*

A purpose-built Observatory for SII

SIITAR

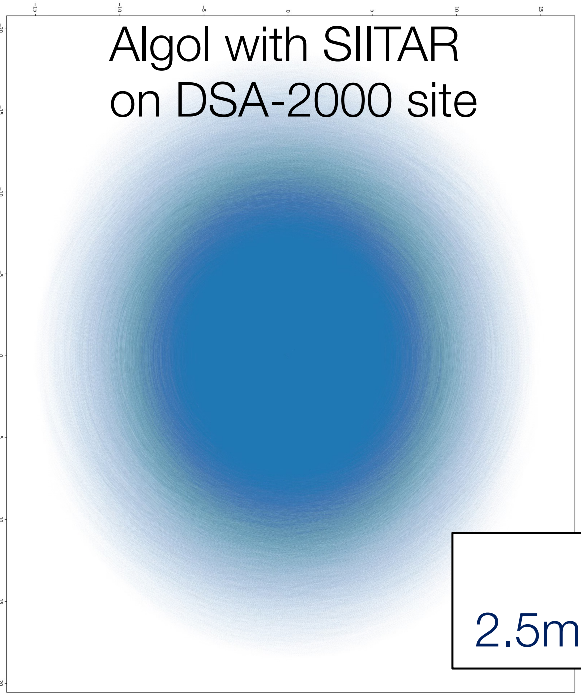
Let's think BIG – inspired by DSA-2000** with its 2048 radiotelescopes – Let's have 2048 OPTICAL telescopes

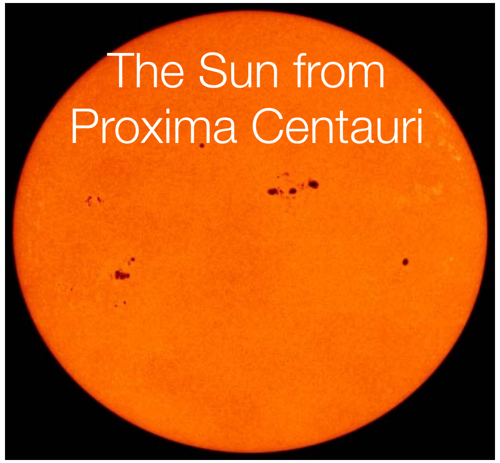
DSA-2000 layout



▲ **THE PLAN** This map shows the DSA-2000's configuration — a vast oval spanning 19 by 15 kilometers, with each dot representing a 5-meter dish. A network of fiber-optic cables (red and blue lines) will link the telescopes together into an array.

Algol with SIITAR on DSA-2000 site





40 million pixels
2.5mas angular resolution!

* Carlile, Dravins & Thorsbro ** Hallinan et al.

The Future of Meetings in the Particle Astrophysics Community

L. Tibaldo, E. Prandini, J. Biteau, D. Horan, G. W. Kluge & A. Nelles

PERCEPTION OF THE NUMBER OF CONFERENCES