Synergies between high resolution radio observations and high energy emission in AGN

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on behalf of the CTA Consortium
and the Fermi-LAT collaboration

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Outline

- The Cherenkov Telescope Array
- Science with CTA
- Synergies between VLBI and high energy emission in AGN

Background

The gamma-ray sky provides a look into the most energetic and violent processes of the universe.

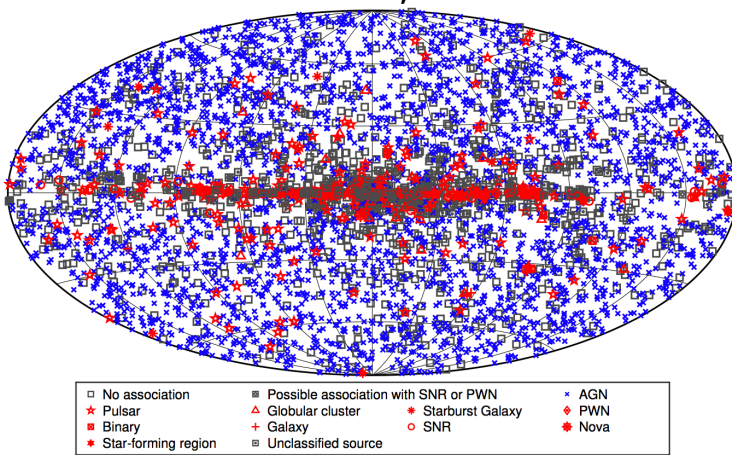
5065 sources are in the 4FGL (~25% unidentified at other wavelengths).

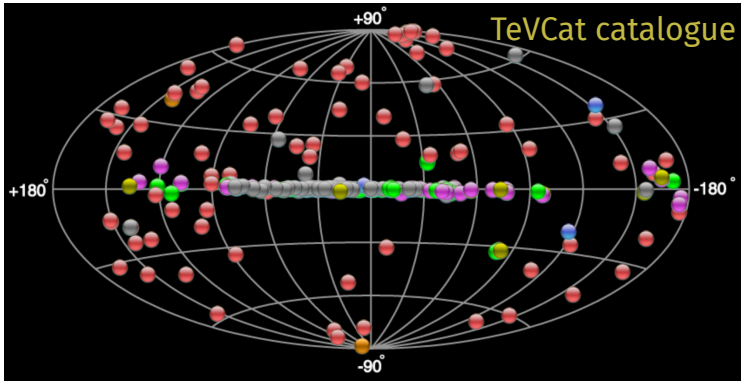
About 227 objects are in the TeVCat (~30% unidentified)

CTA will represent the next generation ground-based gamma-ray observatory and, in combination with multi wavelength and multi messenger studies, will address many of the open questions concerning non-thermal phenomena.

CTA will be the first **open, proposal-driven** ground-based gamma-ray observatory

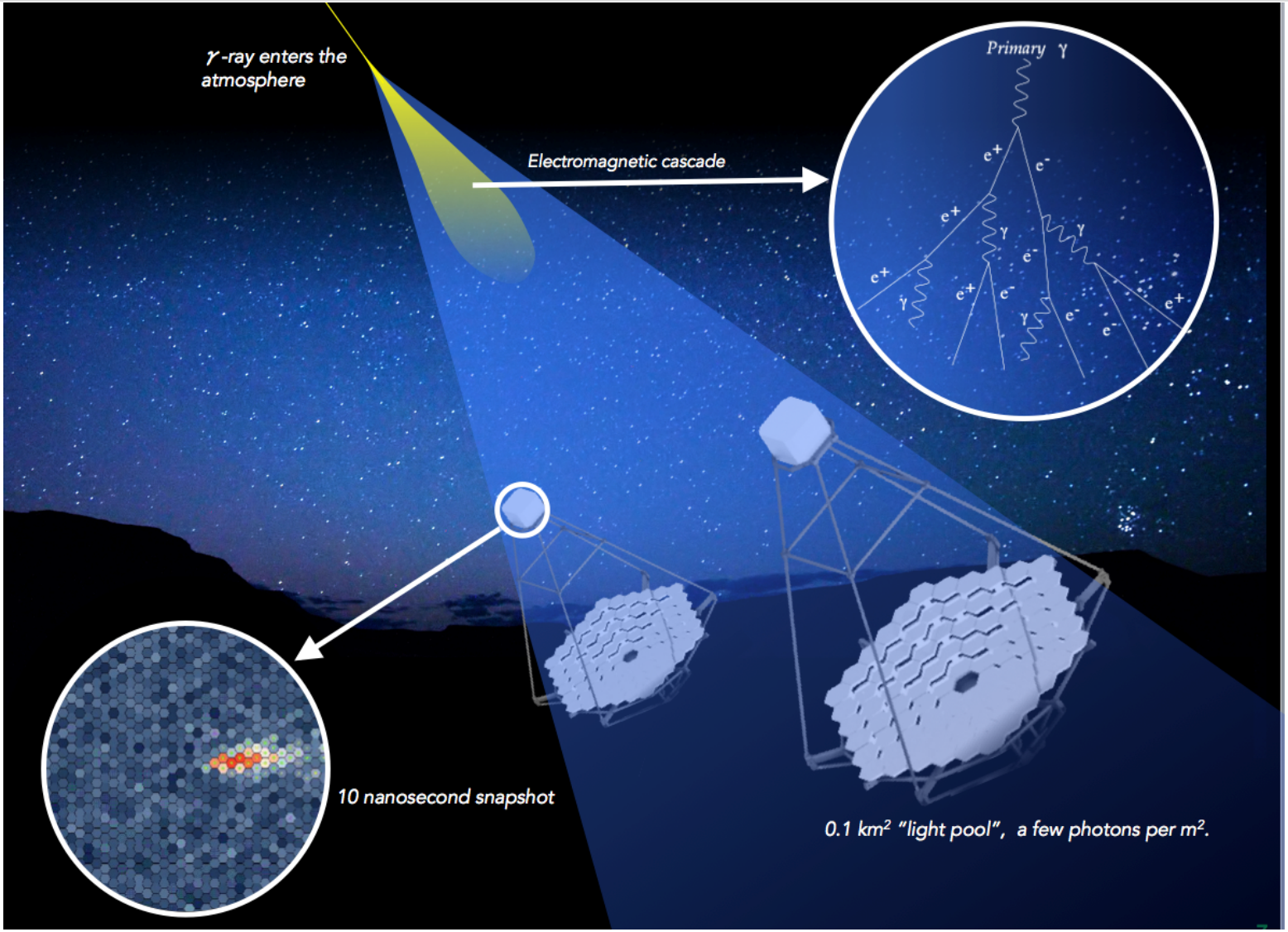
4FGL, Abdollahi+20





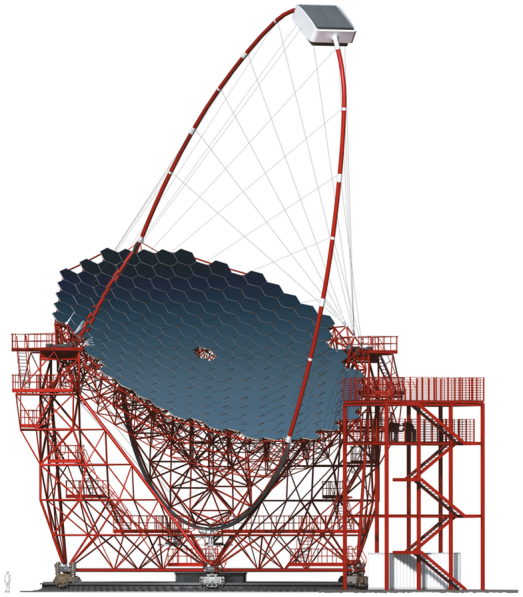
http://tevcat.uchicago.edu/

How CTA works



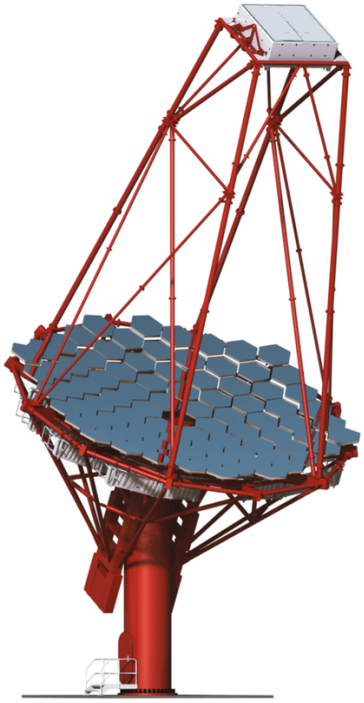
CTA Telescopes

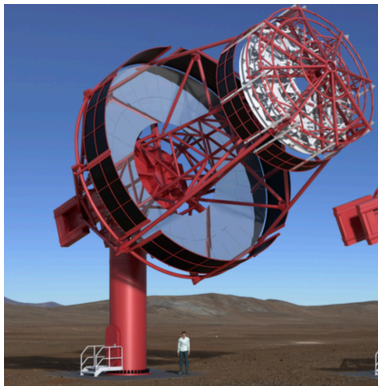
LST



E: 20 GeV - 150 GeV
D: 23.0m
FoV: 4.3 deg
Pointing: 30s

MST





E: 150 GeV - 5 TeV

D: 11.5m
FoV: ~7.5 deg
Pointing: 90s

D: 9.7m
FoV: ~7.6 deg
Pointing: 90s

SST

SST design will be based on ASTRI/CHEC one, accounting for all SST design experience

E: 5 TeV - 300 TeV
D: 4.3m
FoV: 10.5 deg
Pointing: 60s

CTA sites


Heidelberg
MPIK
Zeuthen
DESY
Spain
La Palma
CTA North
Bologna
INAF
northern hemisphere
southern hemisphere
CTA South
Chile
Paranal
La Palma Map: ©2015 Google, Inst. Geogr. Nacional
Paranal Map: ©2015 Google
Array Sites
CTAO Offices
Science Data Management Centre

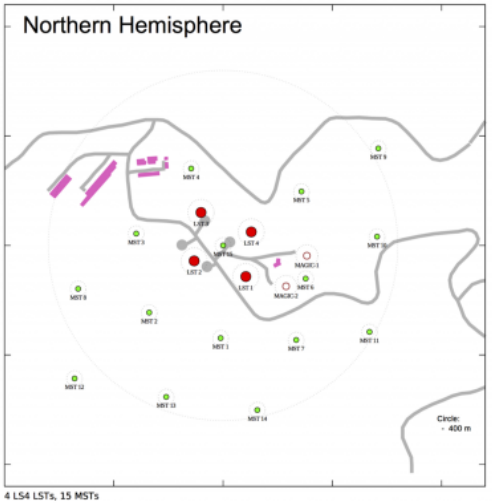
CTA North - La Palma

Credit: Gabriel Pérez Diaz, IAC, SMM

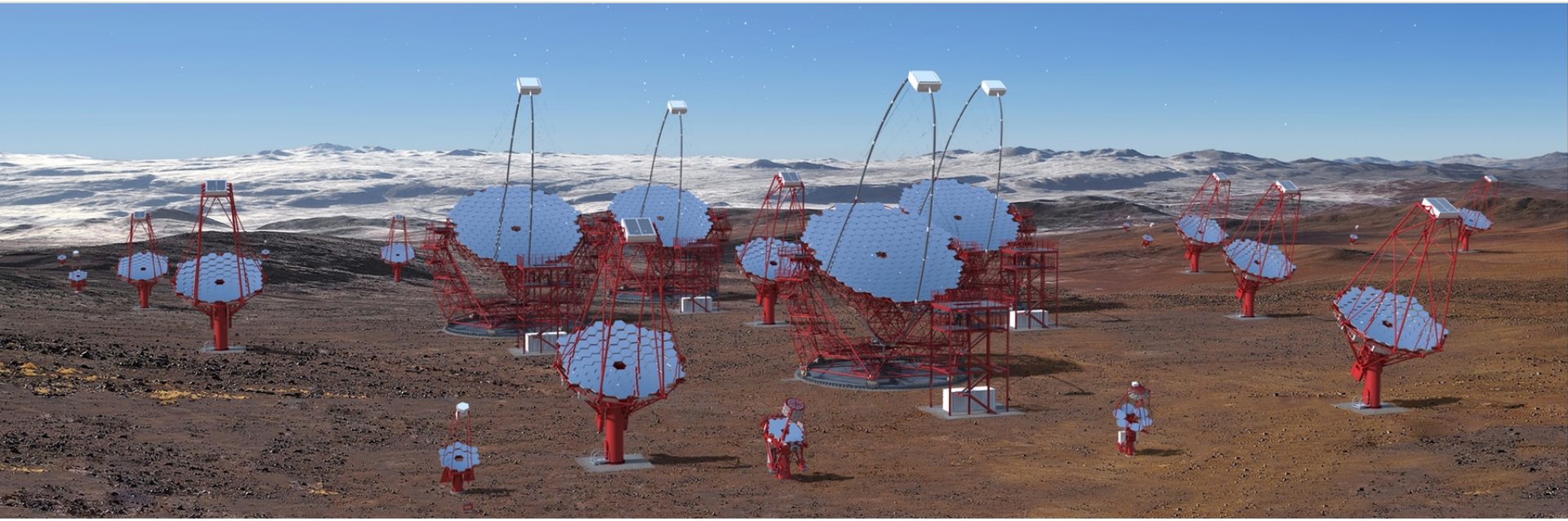
Energy range: 20 GeV - 20 TeV

4 LST; 15 MST spread over ~1 km^2

Galactic and Extragalactic science



CTA South - Chile

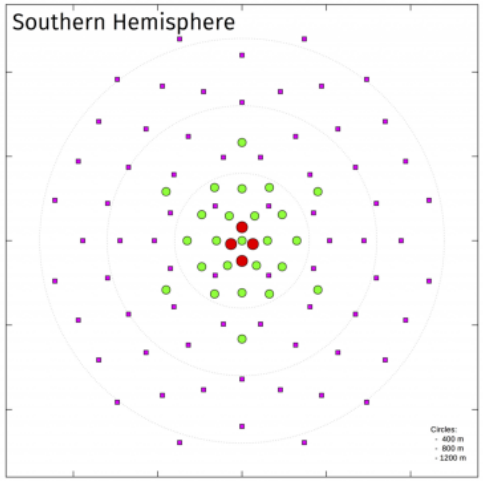


Credit: Gabriel Pérez Diaz, IAC, SMM

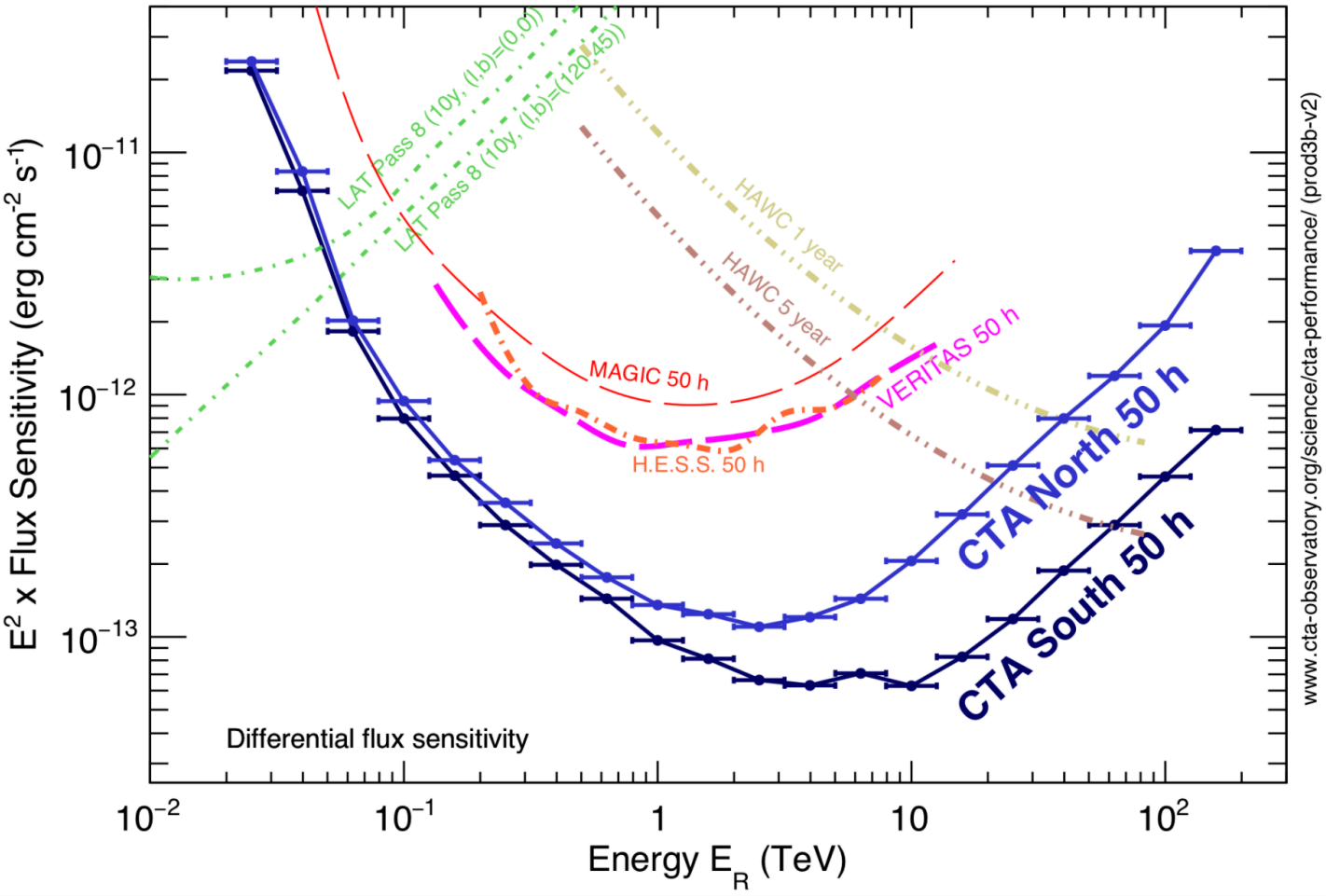
Energy range: 20 GeV - 300 TeV

4 LST; 25 MST; 70 SST spread over ~ 4 km^2

Galactic and Extragalactic science

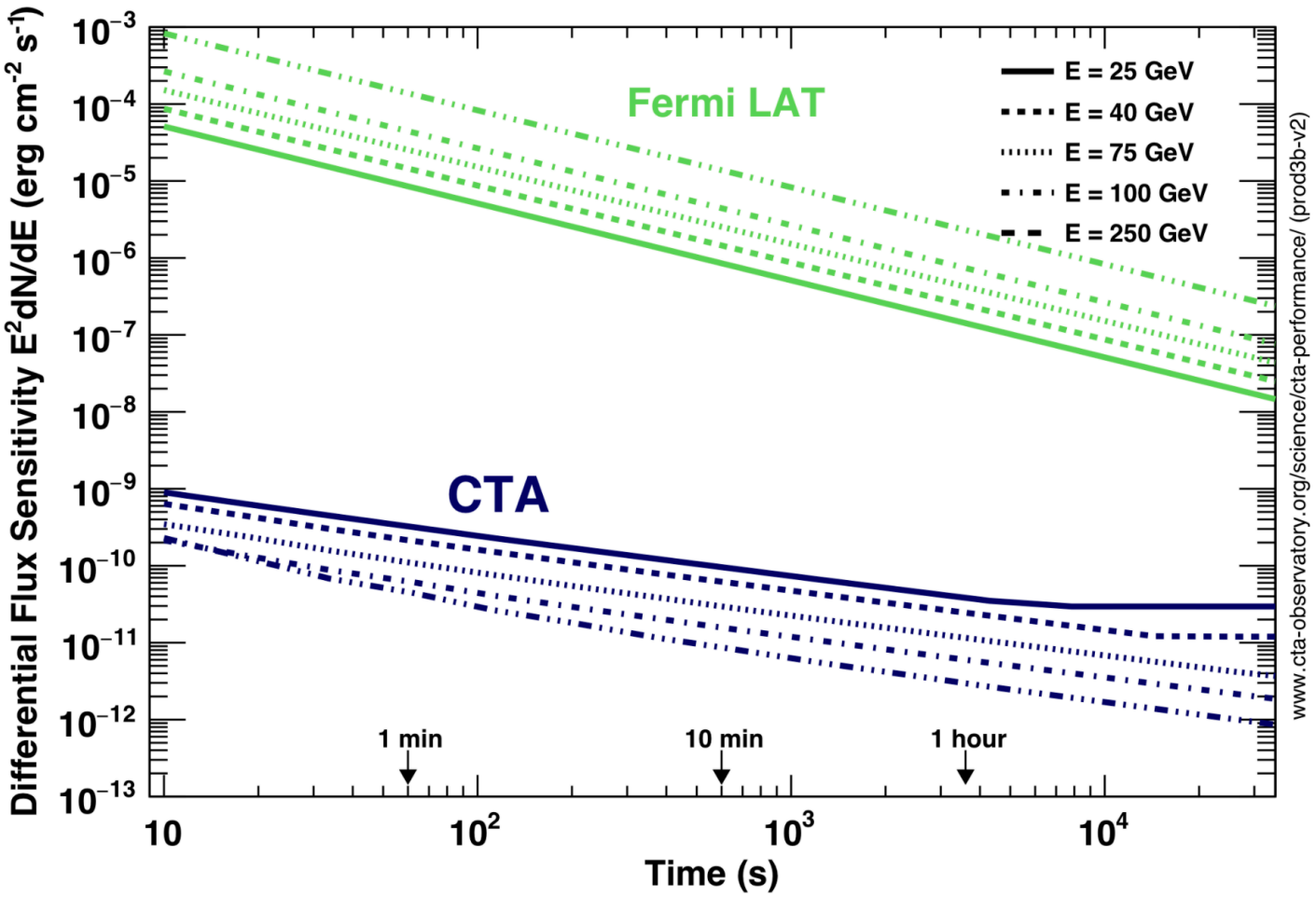


CTA Performance - Flux Sensitivity



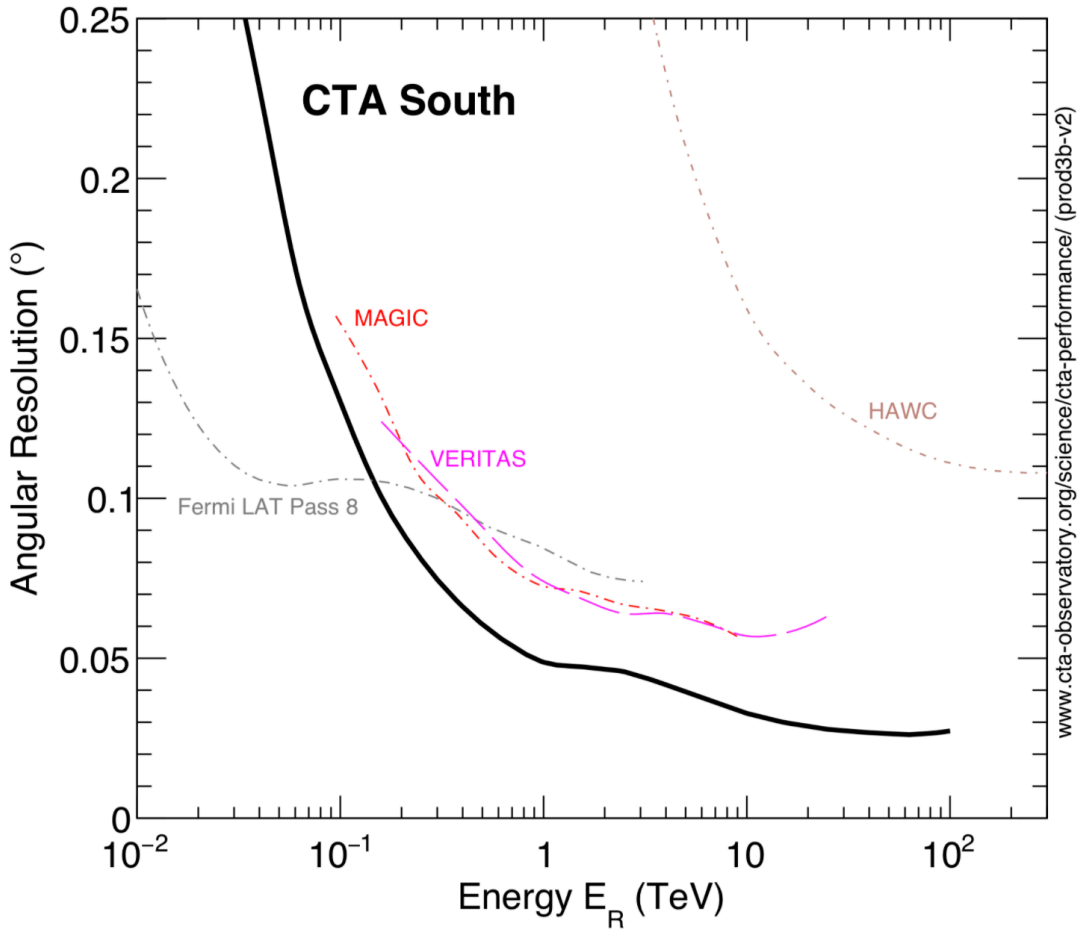
Significant sensitivity improvement and wider energy range

CTA Performance - Sensitivity vs Time



Huge sensitivity improvement for short timescale phenomena

CTA Performance - Angular resolution



Substantial angular resolution and field of view improvements

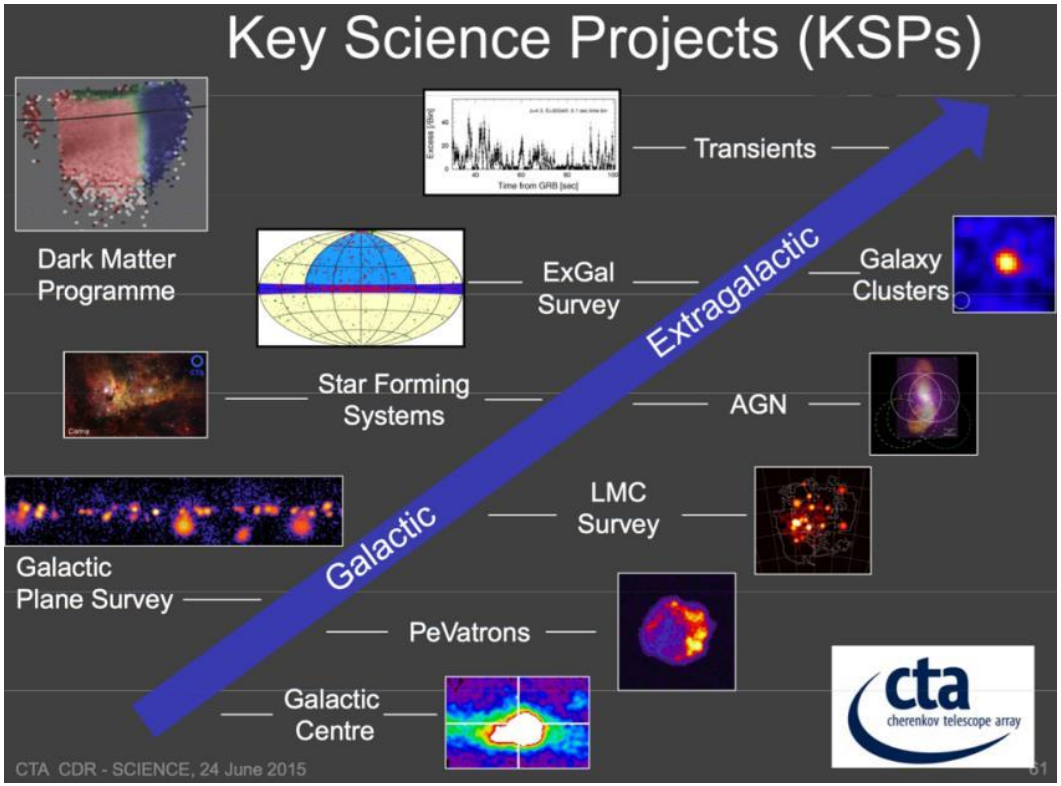
Science with CTA

arXiv:1709.07997v2

https://doi.org/10.1142/10986

Key Science Projects

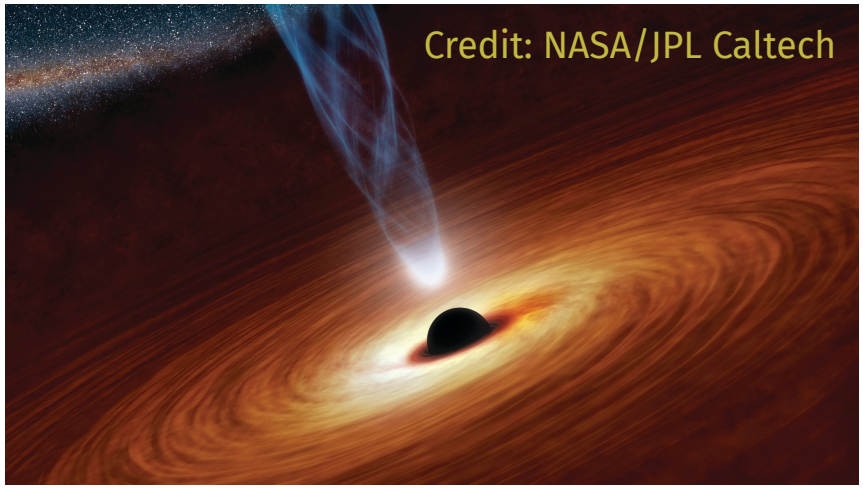
- Galactic centre
- Galactic Plane
- Large Magellanic Cloud
- Cosmic Ray PeVatrons
- Star forming systems
- Extragalactic Survey
- Galaxy clusters
- **Active Galactic Nuclei**
- Transient Phenomena
- Dark Matter programme



Active Galactic Nuclei

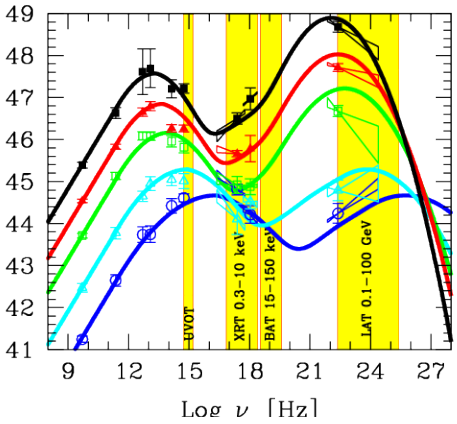
Radio-loud AGN represent a high fraction of gamma-ray emitting objects detected by Fermi-LAT and Cherenkov Telescopes.

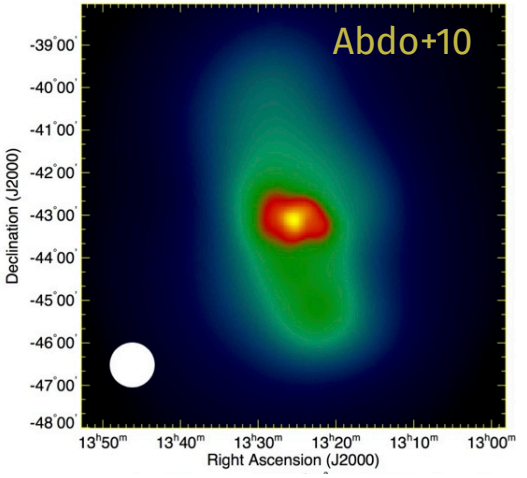
Their non-thermal emission is observed at all wavelengths and shows pronounced variability.



Open questions:

- Jet-disk coupling
- Gamma-ray emitting processes
- Gamma-ray emitting region
- Seed photon fields
- Extreme blazars





Active Galactic Nuclei

- **Long-term monitoring**

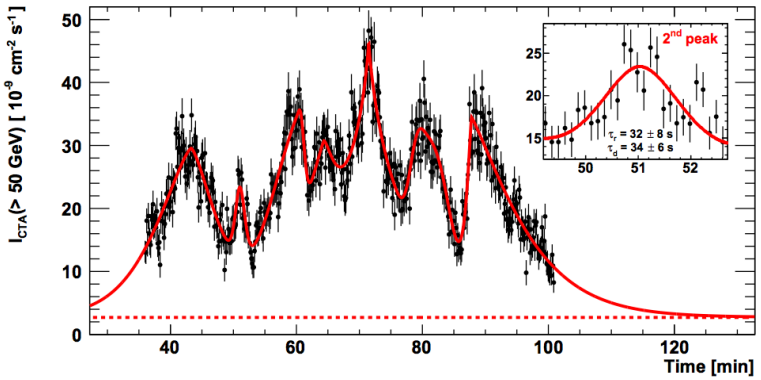
Long-term light curve and time-resolved spectra for ~15 sources representative of gamma-loud AGN population

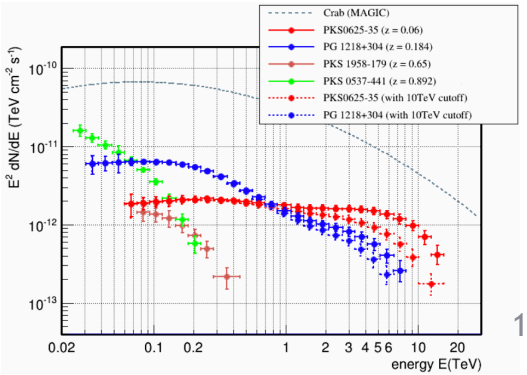
- **High-quality spectra**

High-quality spectra for ~40 sources with different redshift and AGN class and deep observations of Cen A and M87.

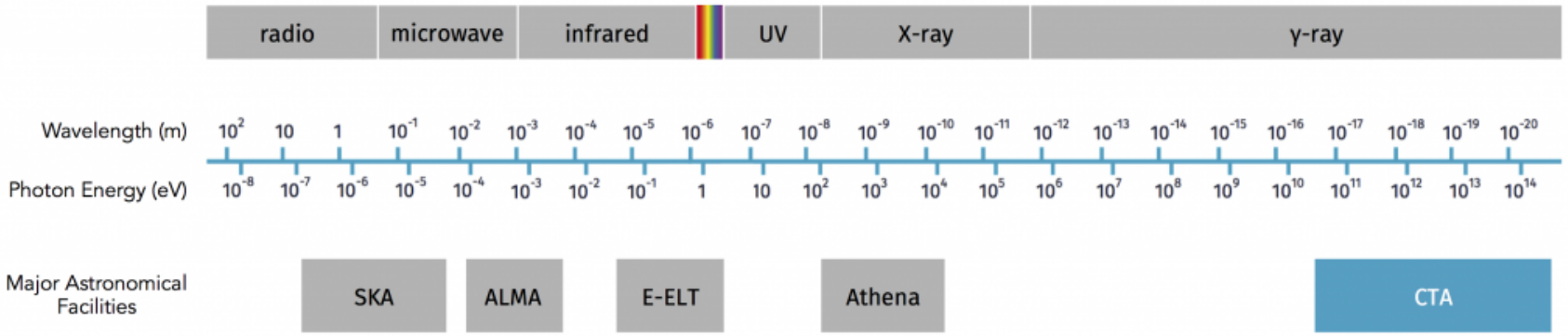
- **AGN flare programme**

Follow-up observations of AGN detected during a flare (external and self-triggered alerts) of a list of potential targets.





Synergies with VLBI

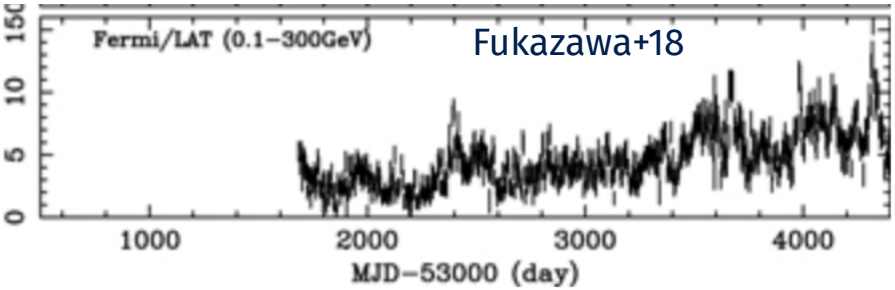


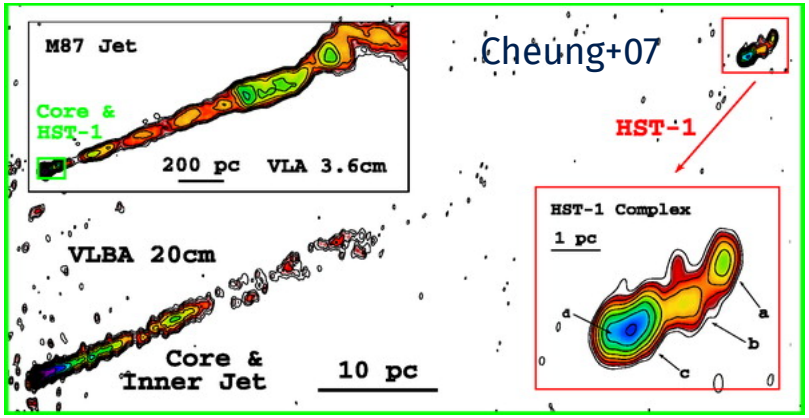
Two windows on the non-thermal universe

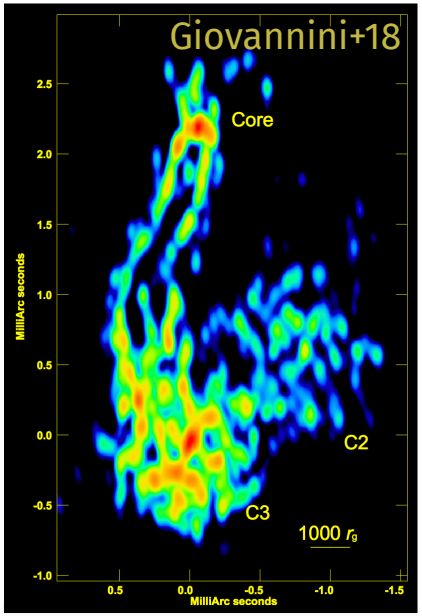
Radio VLBI: deep look into the innermost region of relativistic jet and radio outflows. Information on the magnetic field structure, shock propagation...

VHE observations: particle acceleration, seed photons for IC scattering, hadronic/leptonic processes, EBL, ...

Synergies with VLBI - AGN

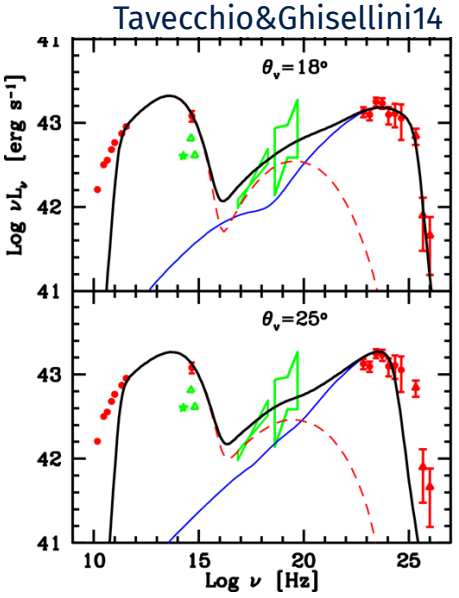






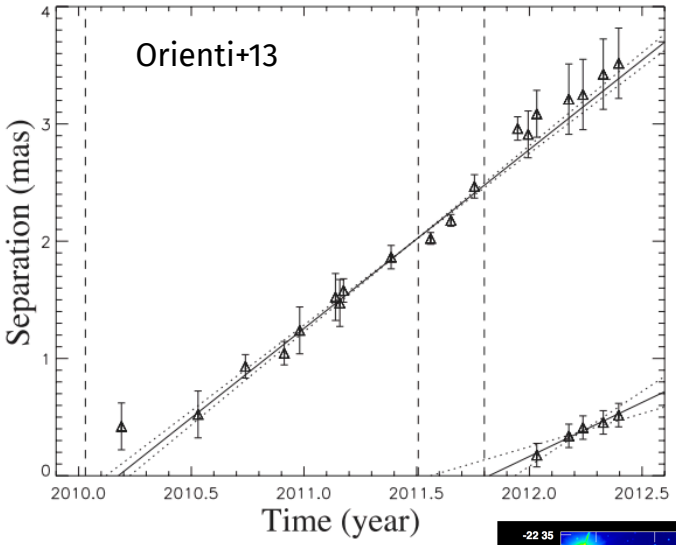
Long-term monitoring: Locating the high-energy emitting region in radio-loud AGN

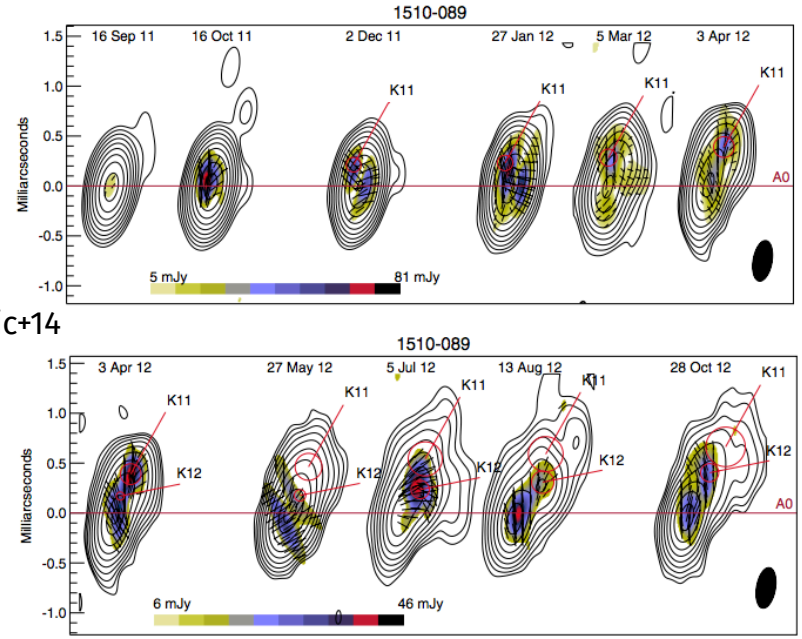
High-quality spectra: A deep look into the high-energy emitting processes



Synergies with VLBI - AGN

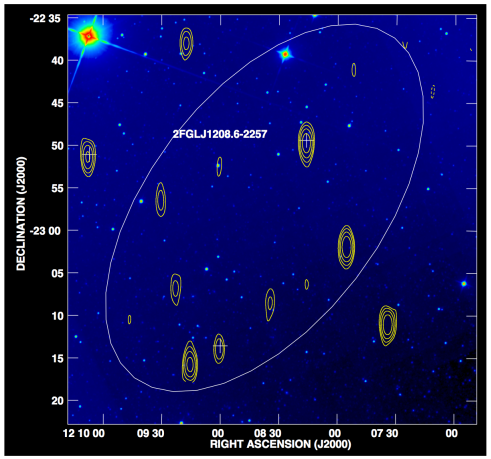
AGN flare programme: Gamma-ray flares and superluminal components

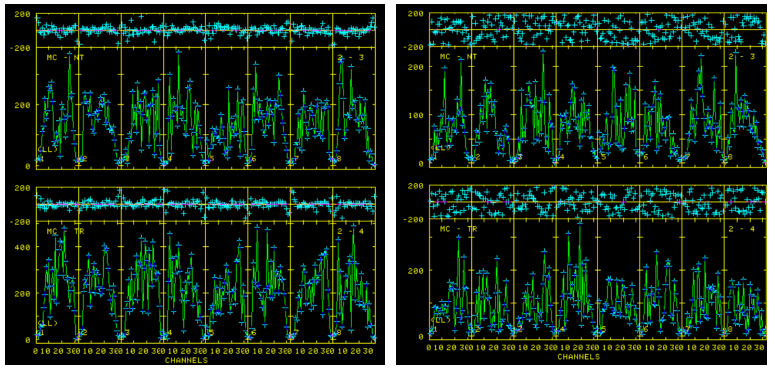




Aleksic+14

Unassociated sources: Association of gamma-ray counterparts

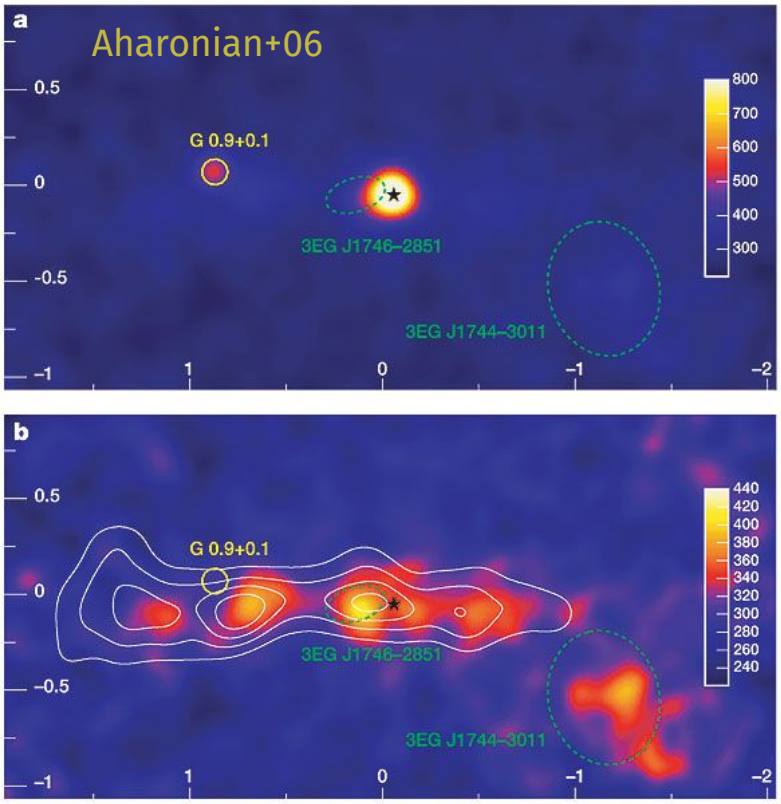


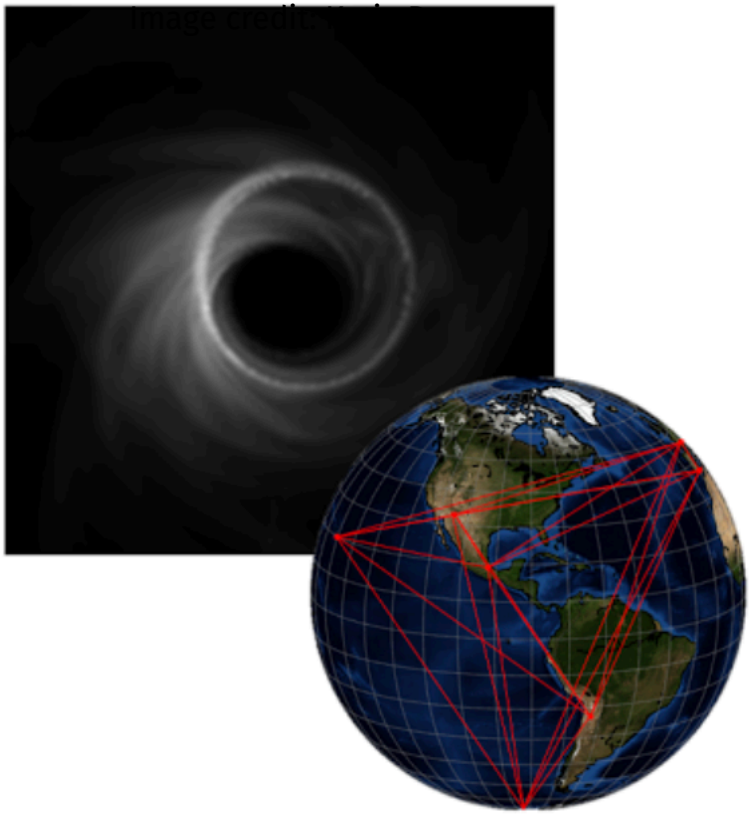


Credit: M. Giroletti

Synergies with VLBI - Galactic Centre

Complete em study of SgrA* by confirming its VHE emission





EHT: Imaging SMBH, accretion, jet formation and collimation

Summary

- CTA will be the ground-based gamma-ray observatory in the near future
- CTA will be open, proposal-driven observatory, but in the first years a large fraction of time will be devoted to KSP
- CTA has broad scientific potential: from particle acceleration to dark matter and is an explorer of the extreme universe
- CTA will have important synergies with many present and future MW and MM observatories. The combined strength among different facilities will be crucial for new discoveries.

- https://www.cta-observatory.org/
- https://www.cta-observatory.org/science/cta-performance/
- https://www.cta-observatory.org/project/technology/