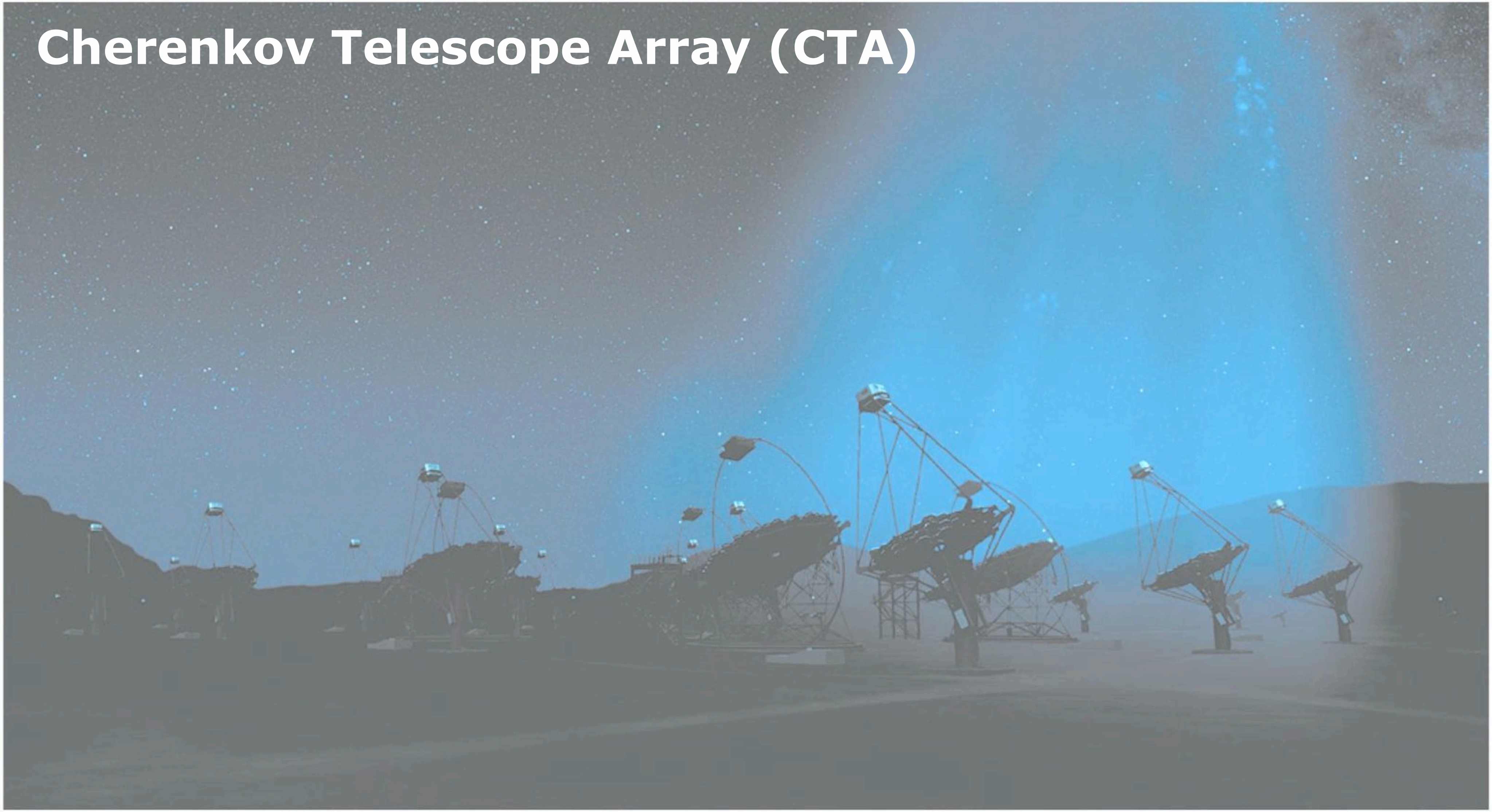
Cherenkov Telescope Array (CTA)



Jürgen Knödlseder

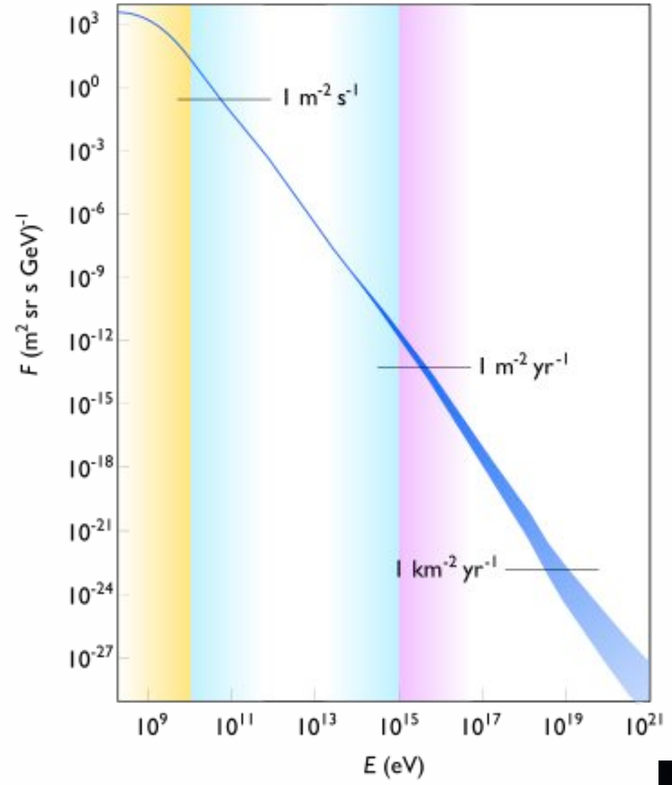
Chair of the CTA Consortium Board

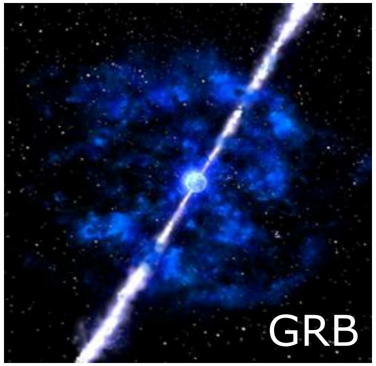
On Behalf of the CTA Consortium

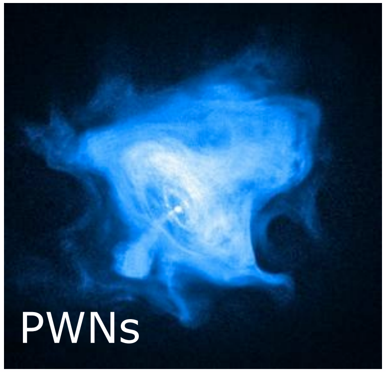
Vulcano 2014

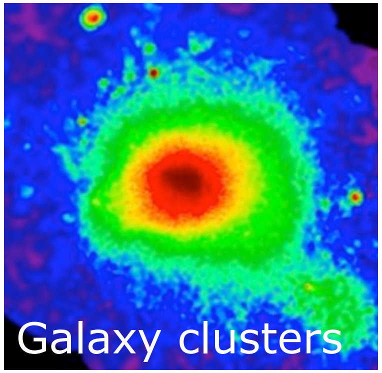
A World of Particle Accelerators

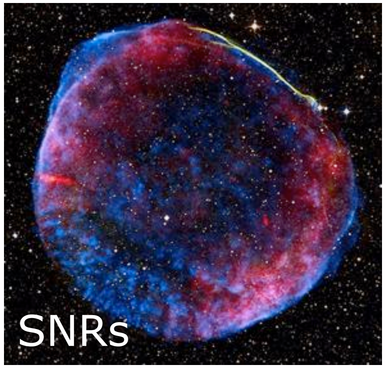
Recent gamma-ray observations (AGILE, Fermi, H.E.S.S., MAGIC, VERITAS, MILAGRO) have revealed that particle acceleration is a wide-spread phenomena in the Universe

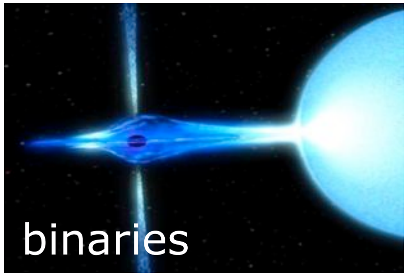




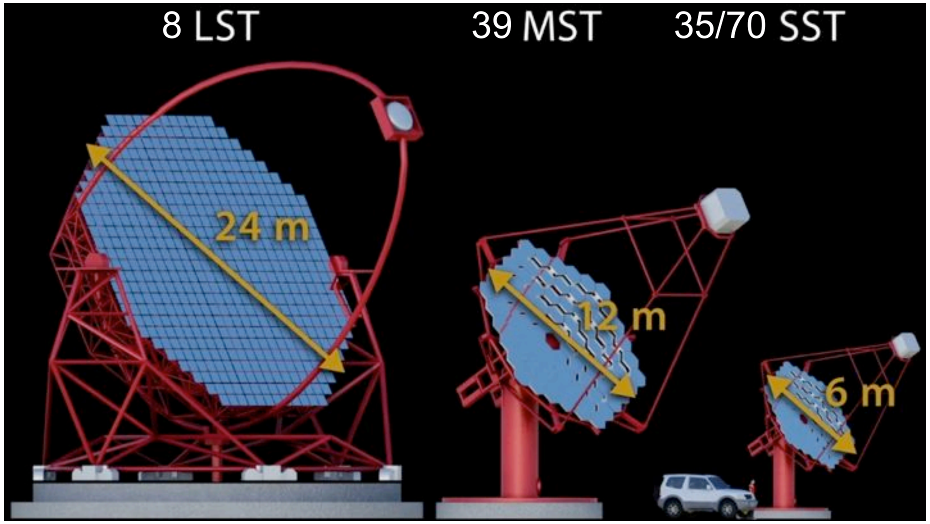






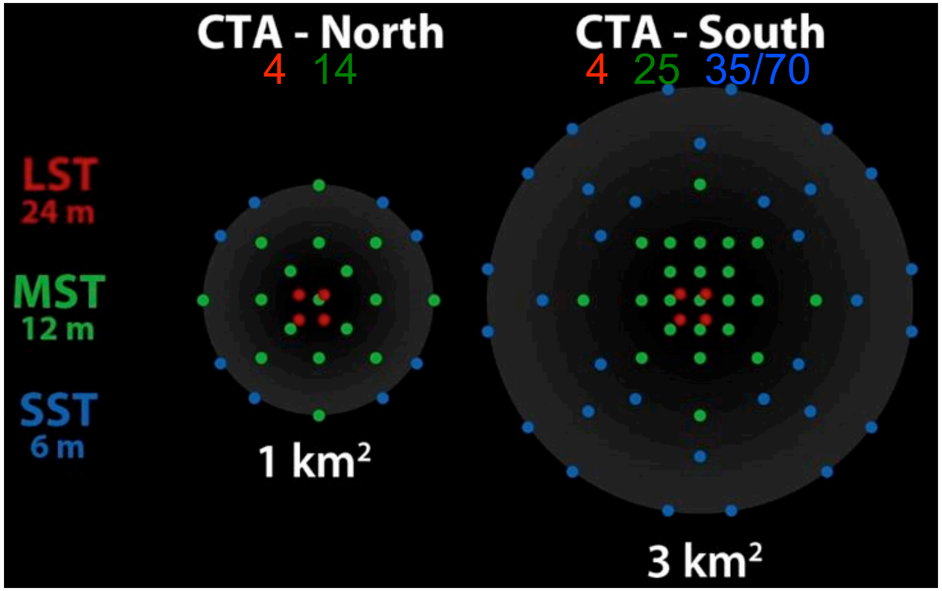


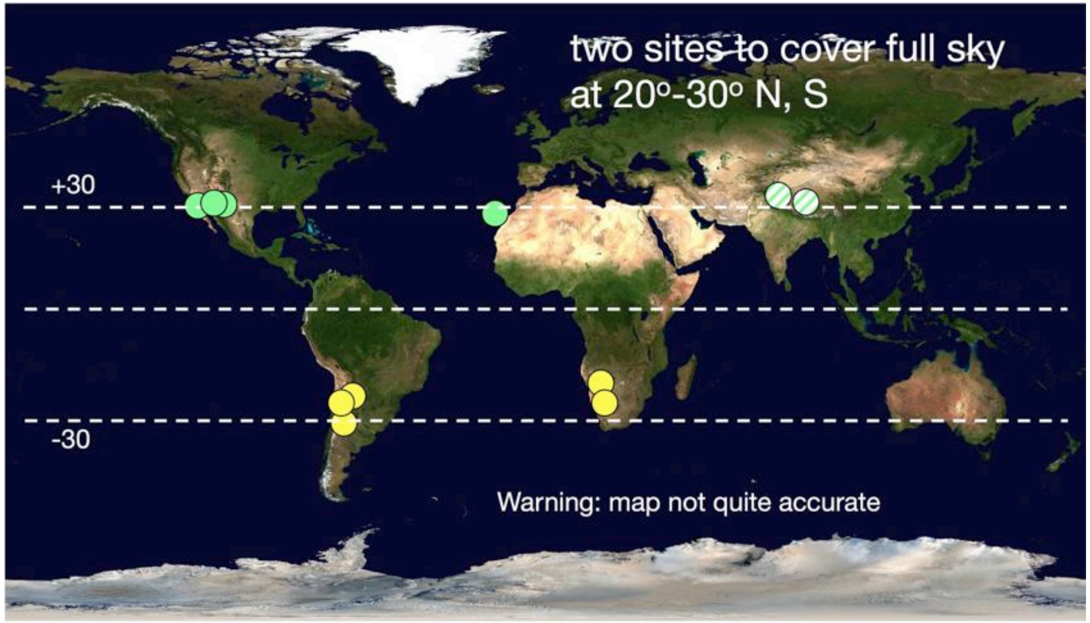
The CTA Observatory



Characteristics
3 telescope classes
2 sites (South and North)
About 100 telescopes

CTA versus existing telescopes
Tenfold enhanced sensitivity (mCrab @ 1 TeV)
Tenfold spectral coverage (30 GeV–100 TeV)
Fivefold improved angular resolution (2′ @ 1 TeV)

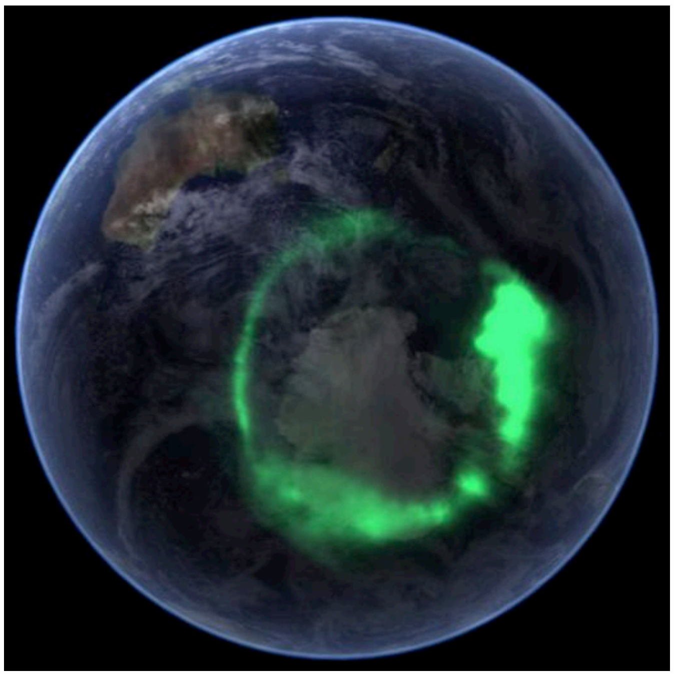




CTA Key Science

cosmic rays

Origin of cosmic rays
Acceleration physics
Impact on environment

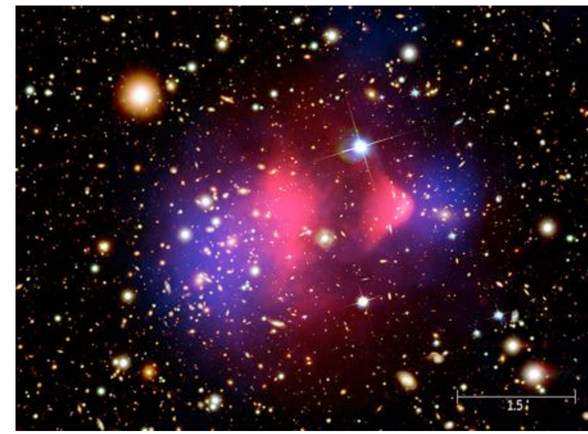


black holes

Role as particle accelerators
Acceleration physics
Probes of the Universe

dark matter

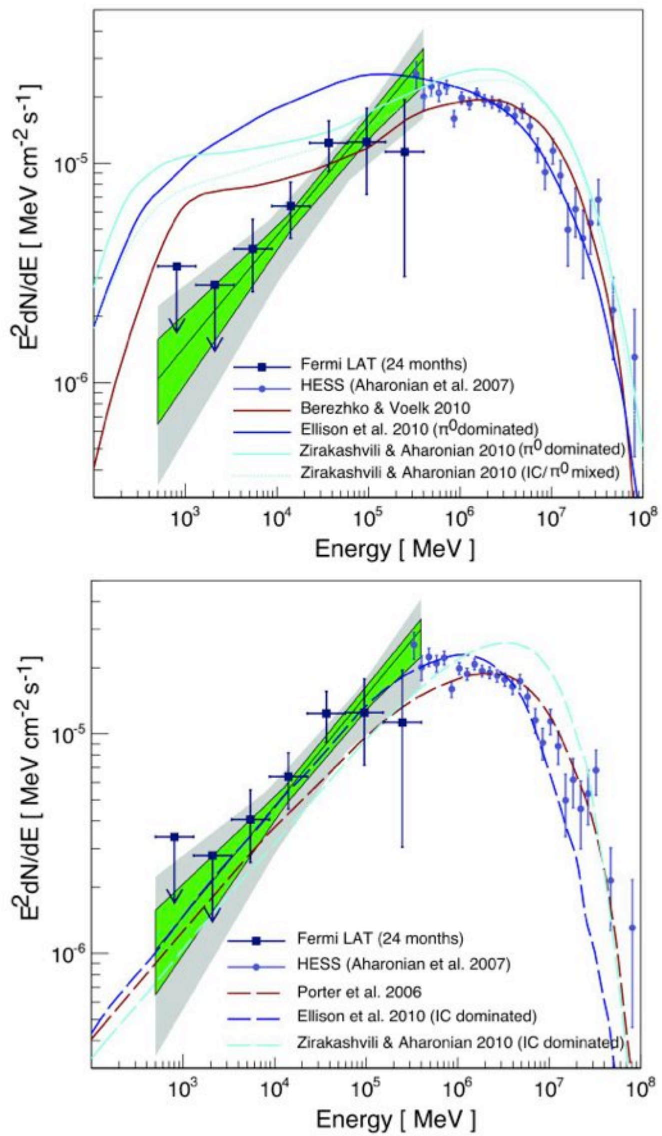
Nature of dark matter

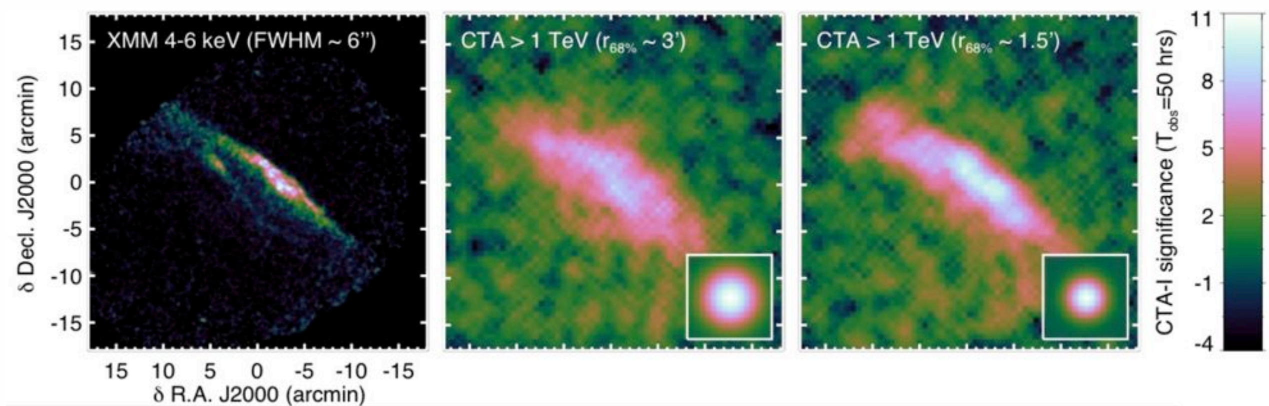


Galactic cosmic rays

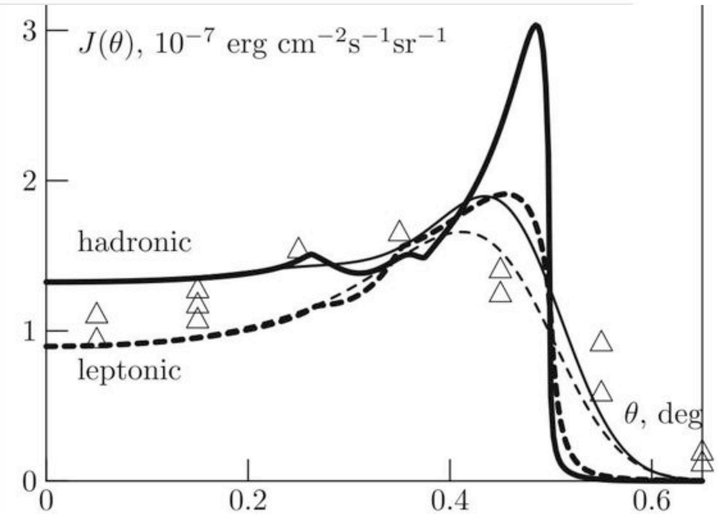
Unveiling the sources of Galactic Cosmic Rays

CTA will identify sources of Galactic Cosmic Rays by measuring the spectral and morphological signatures of hadronic particle acceleration





XMM & CTA simulation

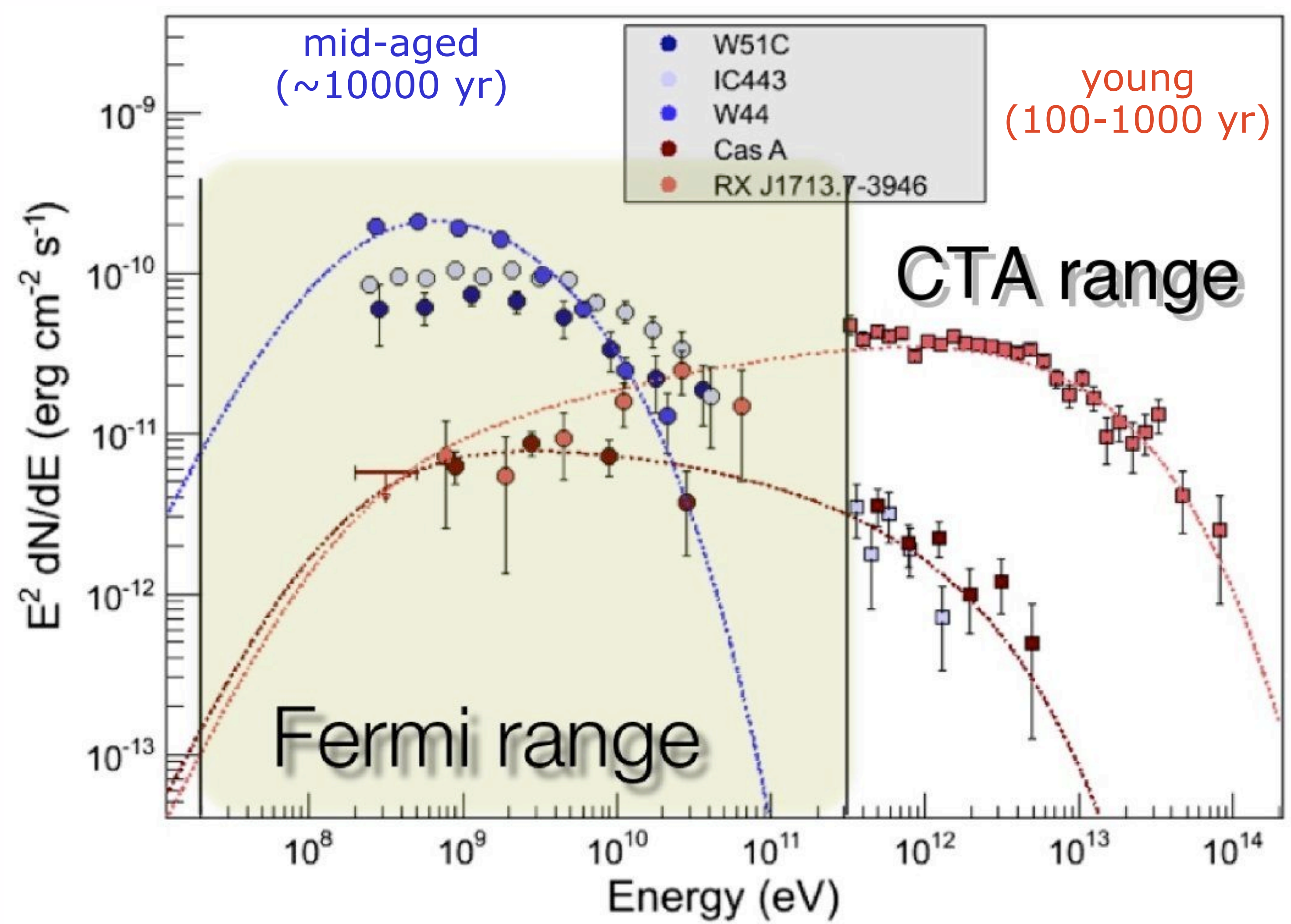


H.E.S.S. measurements
Aharonian (2013)

Fermi & H.E.S.S. measurements
Acero et al. (2011)

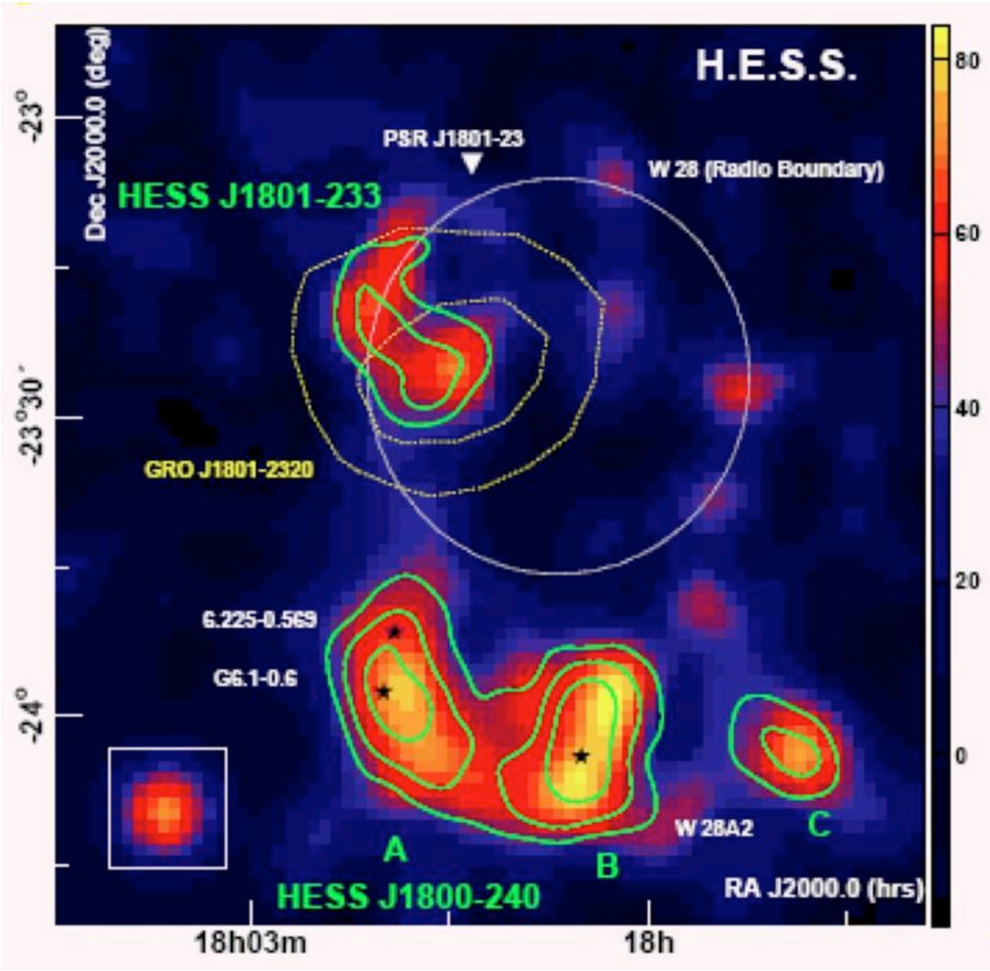
Understanding particle escape and the evolution of SNRs

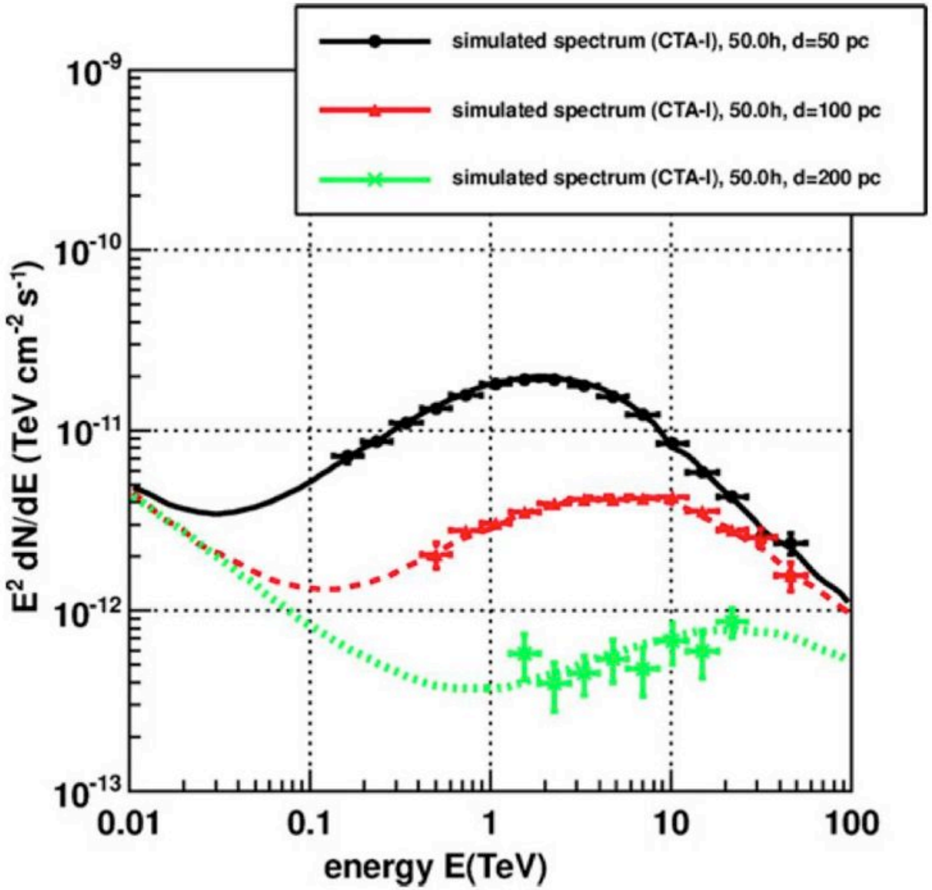
CTA will detect the entire population of TeV-emitting Galactic supernova remnants (about 80 objects). If the Galaxy hosts a proton PeVatron, CTA should see it!



Assessing the impact of cosmic rays on the Galactic environment

CTA will observe the leaking of cosmic rays from the sources into the interstellar environment, providing clues on cosmic-ray-propagation physics



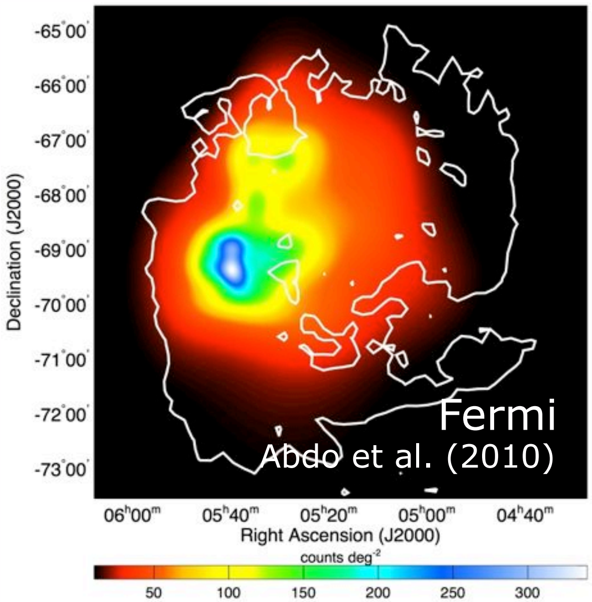


CTA simulation
Acero et al. (2013)

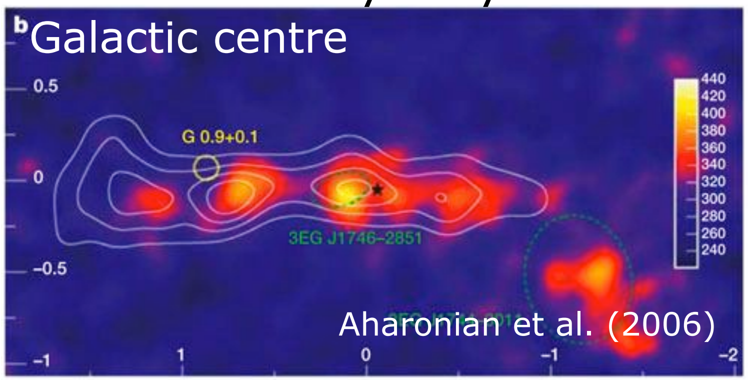
Understanding cosmic ray physics in diverse environments

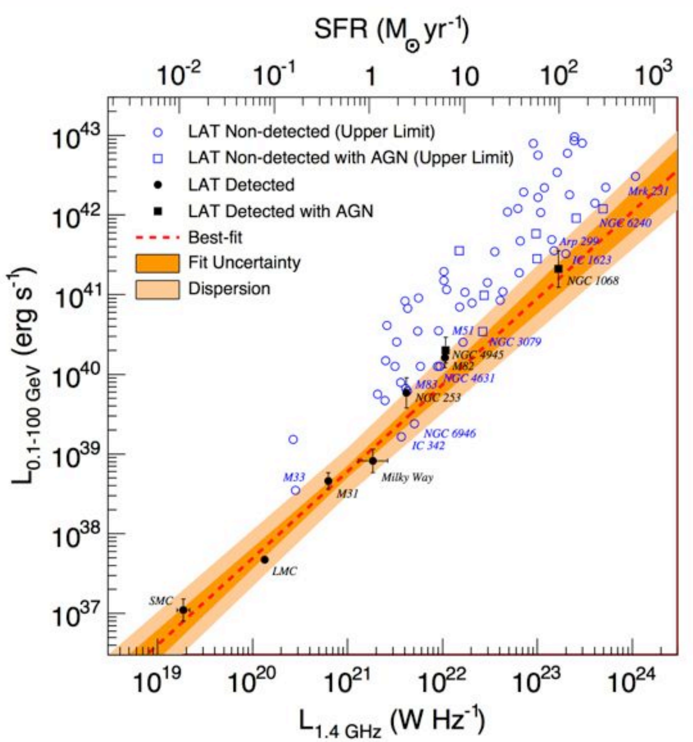
CTA will probe cosmic ray physics in a large variety of environments, covering dwarf galaxies, normal galaxies and starburst galaxies

LMC

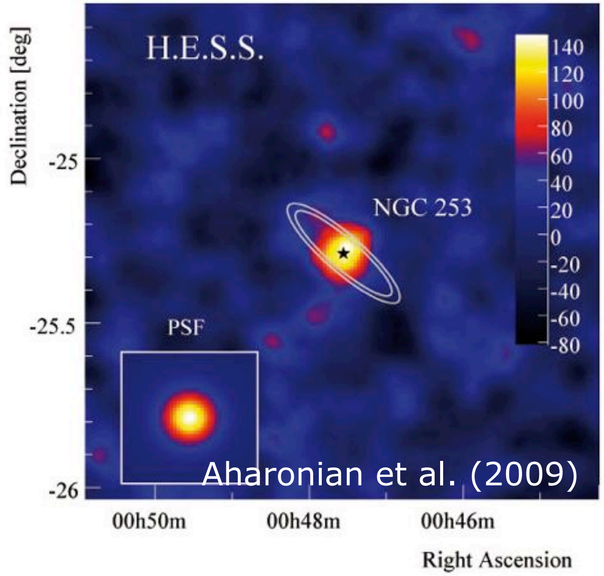


Milky Way





NGC 253

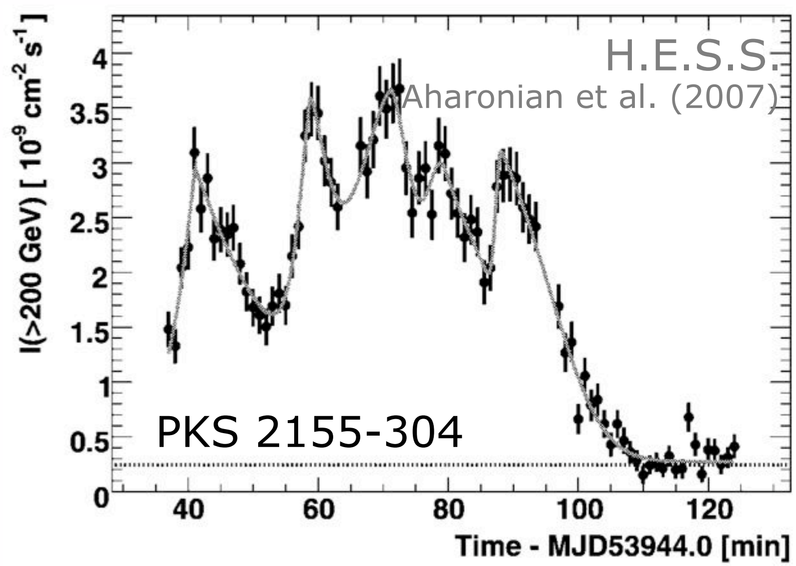


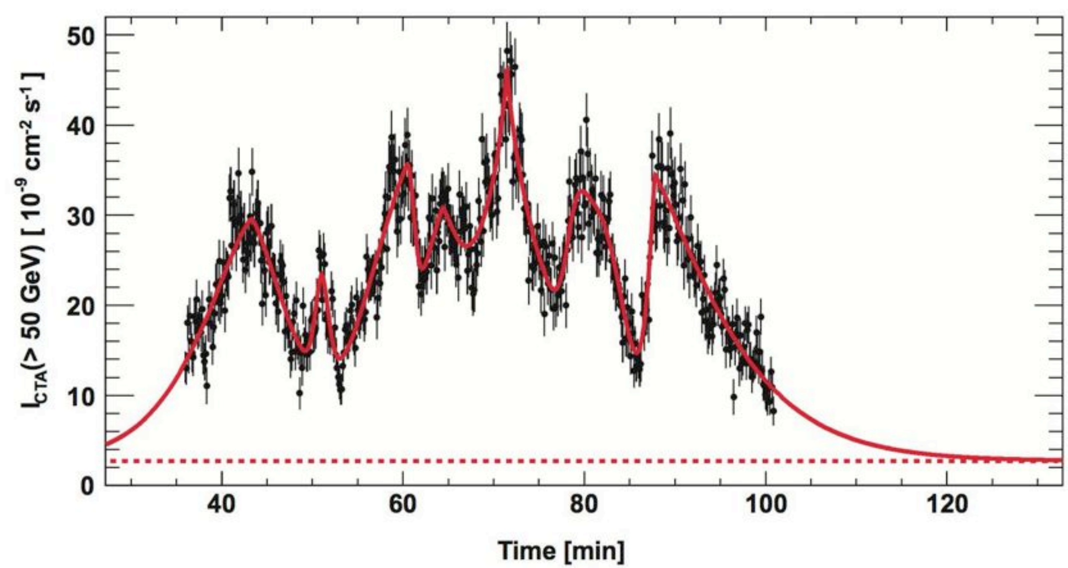
Abdo et al. (2012)

Black hole particle accelerators

Studying blazar variability at sub-minute scale

CTA will be able to measure variability time scales down to several seconds, corresponding to emission zone dimensions of 1 A.U. for plausible Doppler factors, probing blazar jet formation models



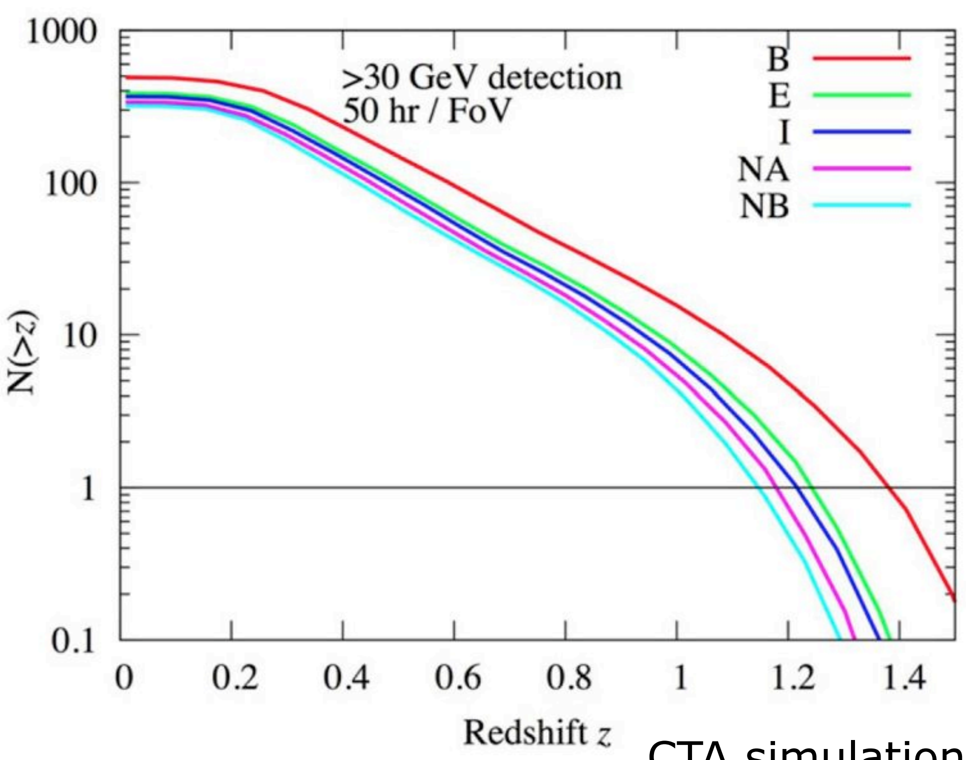


CTA simulation
Sol et al. (2013)

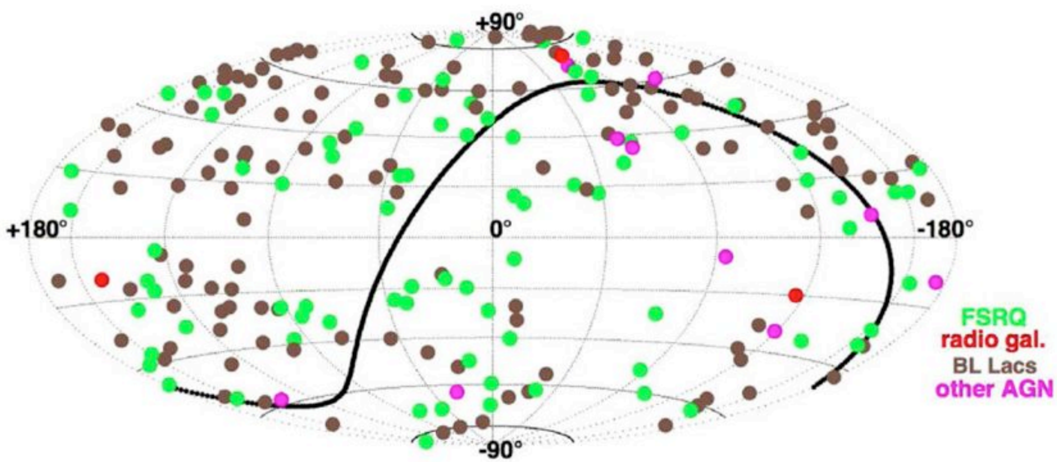
Black hole particle accelerators

Understanding the evolution of particle acceleration over cosmic times

CTA will provide a sample of several hundred blazars at different redshifts, revealing common patterns, allowing inference of the blazar TeV luminosity function, and assessing the evolution of particle acceleration over time



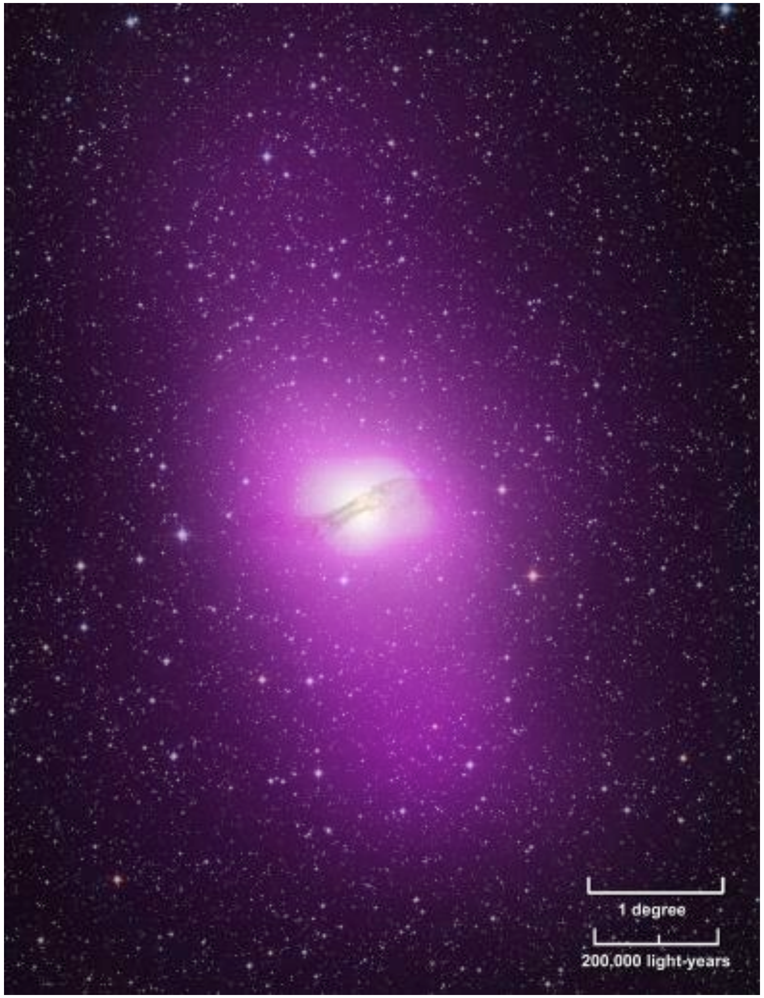
CTA simulation
Sol et al. (2013)



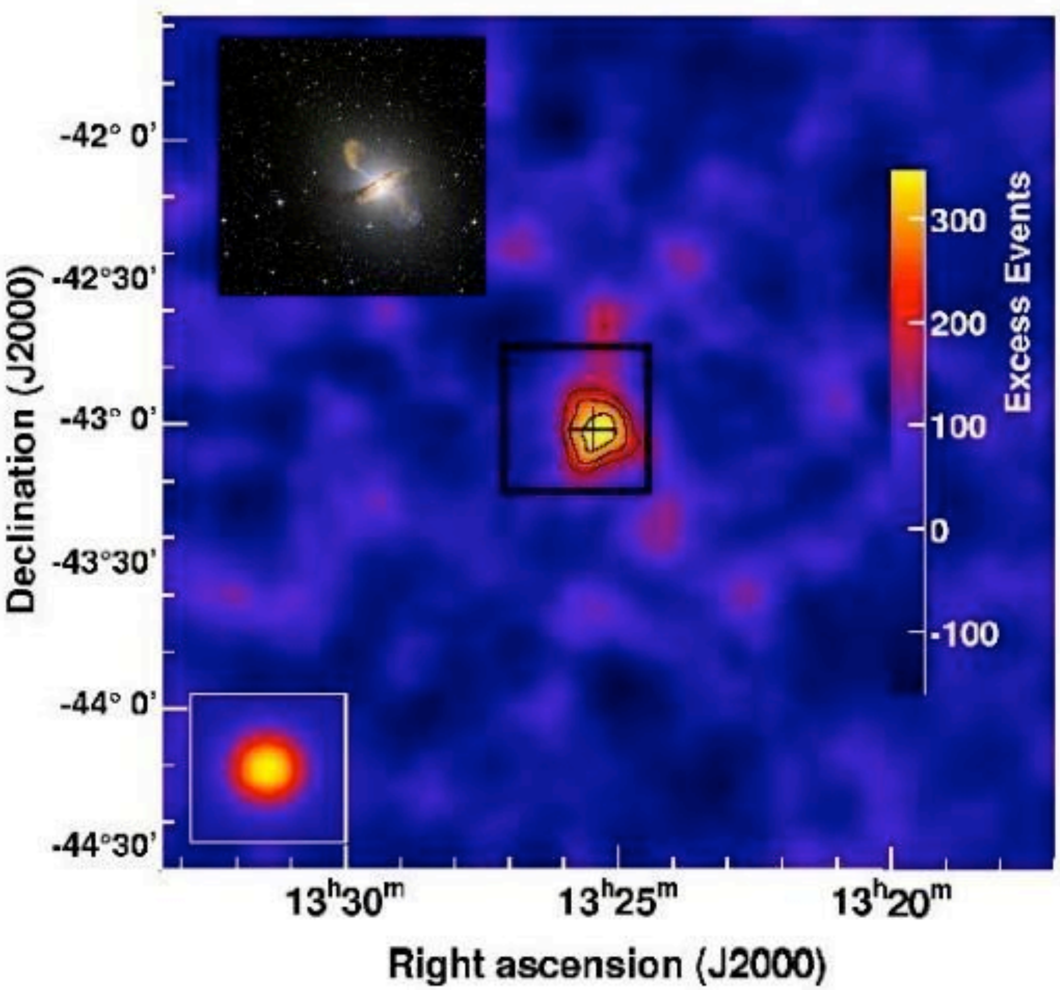
CTA simulation of 2FGL catalogue
Sol et al. (2013)

Studying the AGN diversity

CTA will probe particle acceleration in non-blazar AGN, providing an undiluted view on the jet. CTA has the capability to resolve the emission from radio galaxies.



Fermi
Abdo et al. (2010)

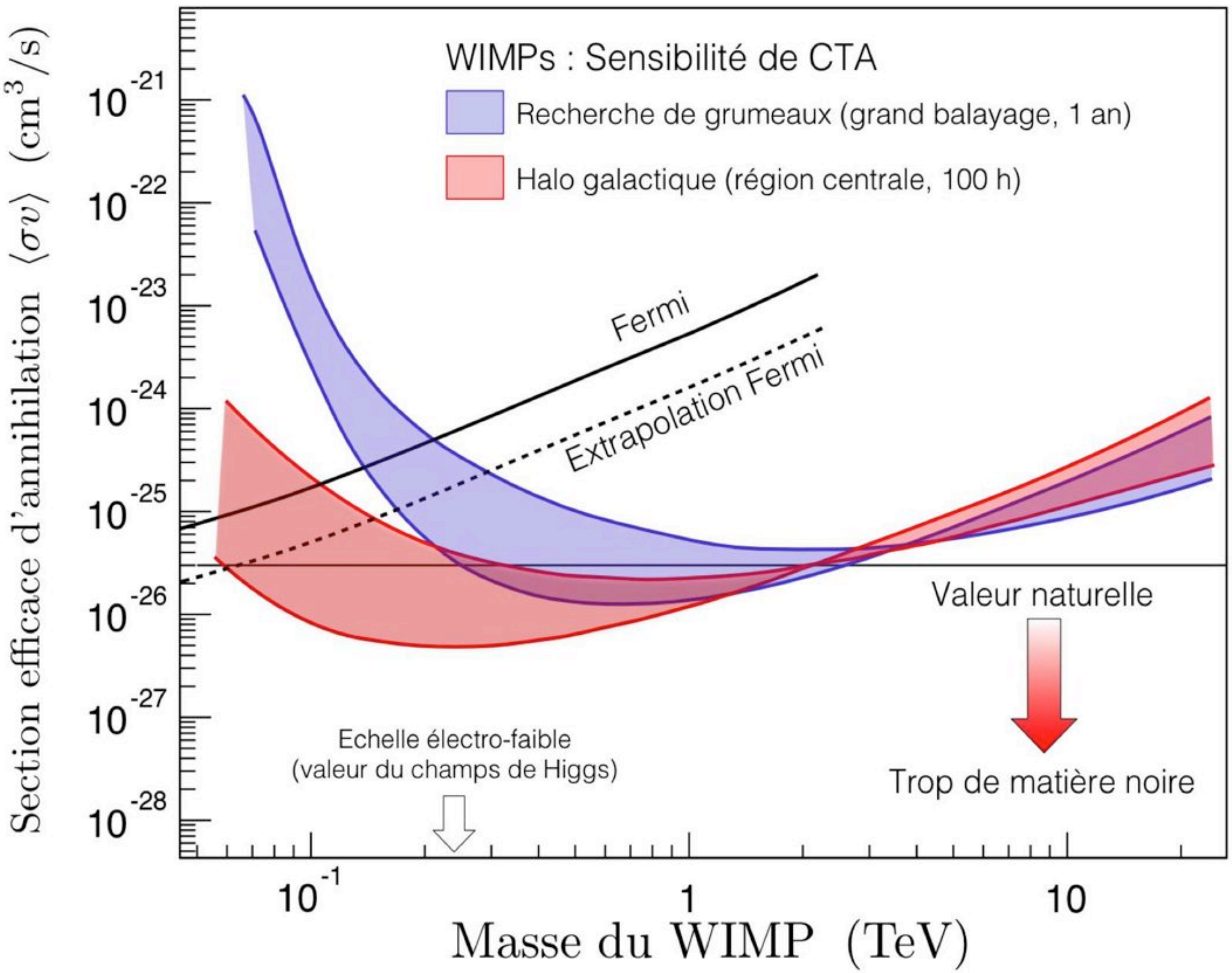


H.E.S.S.
Aharonian et al. (2009)

The quest for Dark Matter

Searching for WIMP Dark Matter

CTA has a unique discovery window for WIMP dark matter in the 300 GeV – 2 TeV energy domain, reaching the weak-scale cross sections inferred from the relic dark matter density

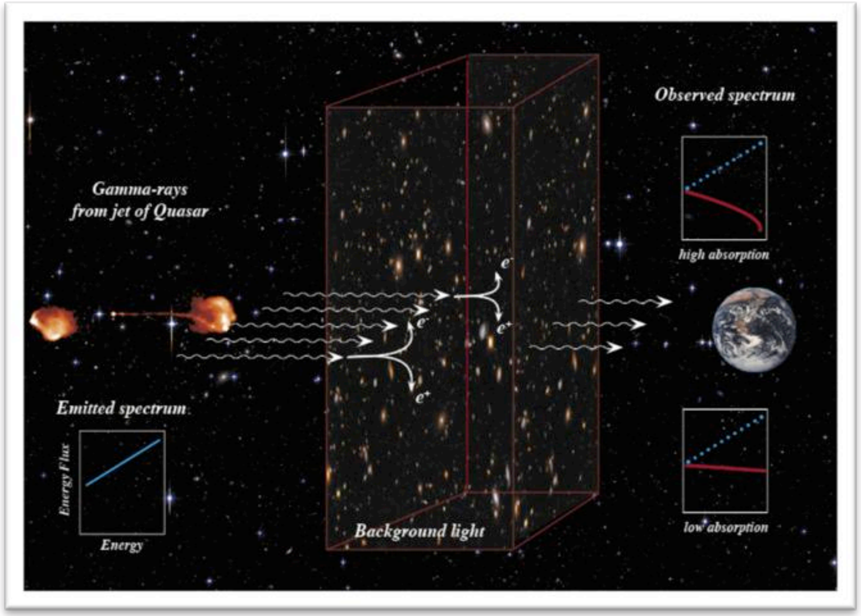


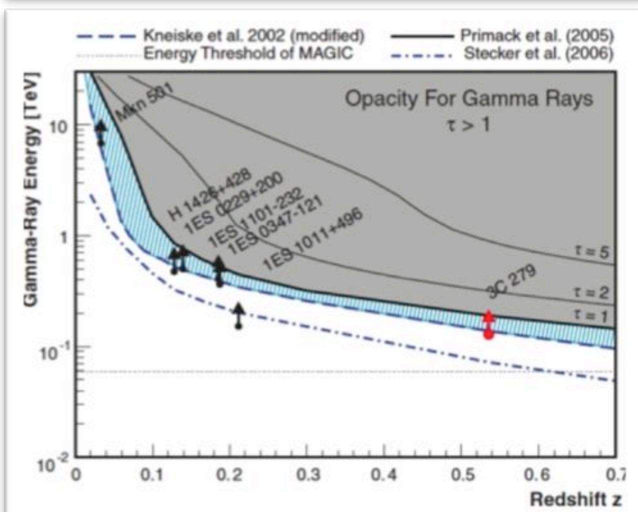
CTA simulations
Brun (priv. comm)

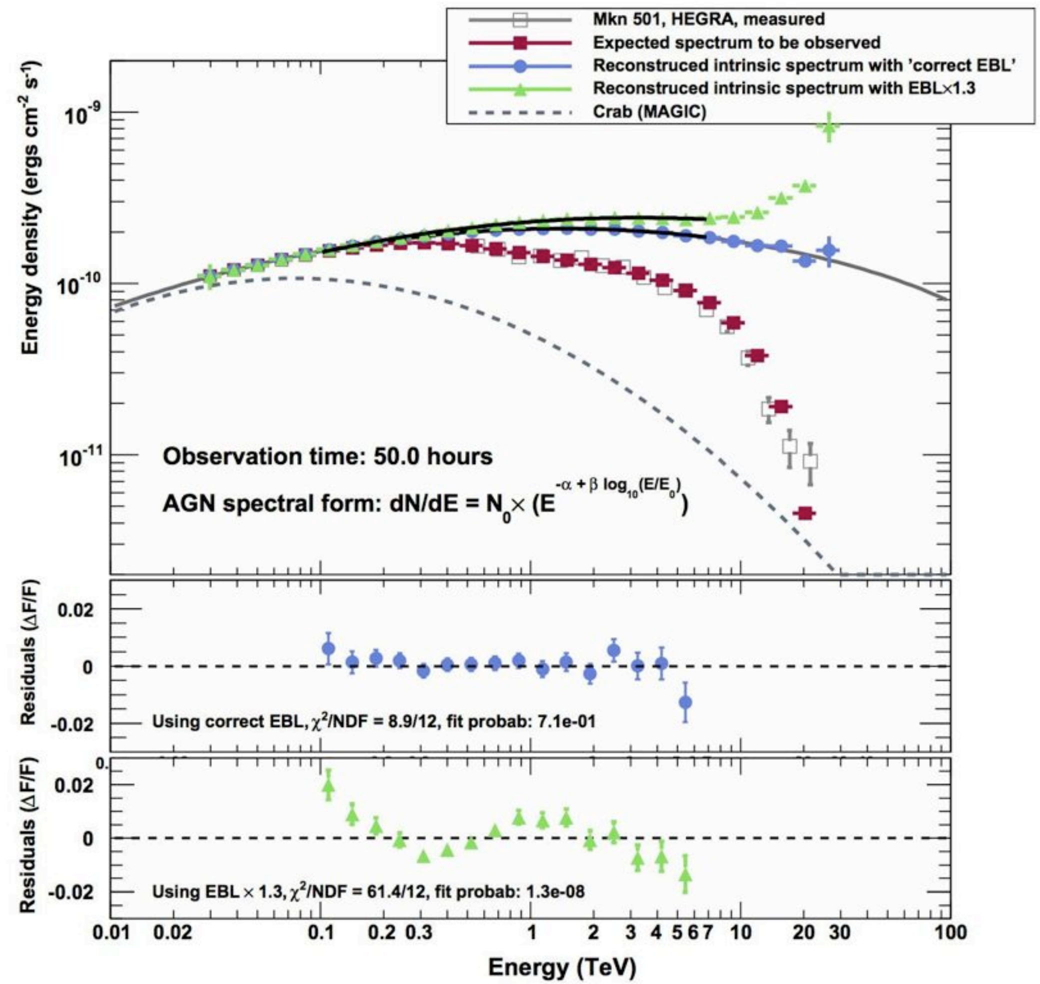
Gamma-Ray Sources as Probes

Probing the star-formation history of the Universe

CTA will measure the attenuation of gamma rays by pair production on infrared photons and thus determine the level of the extragalactic infrared background light (EBL)



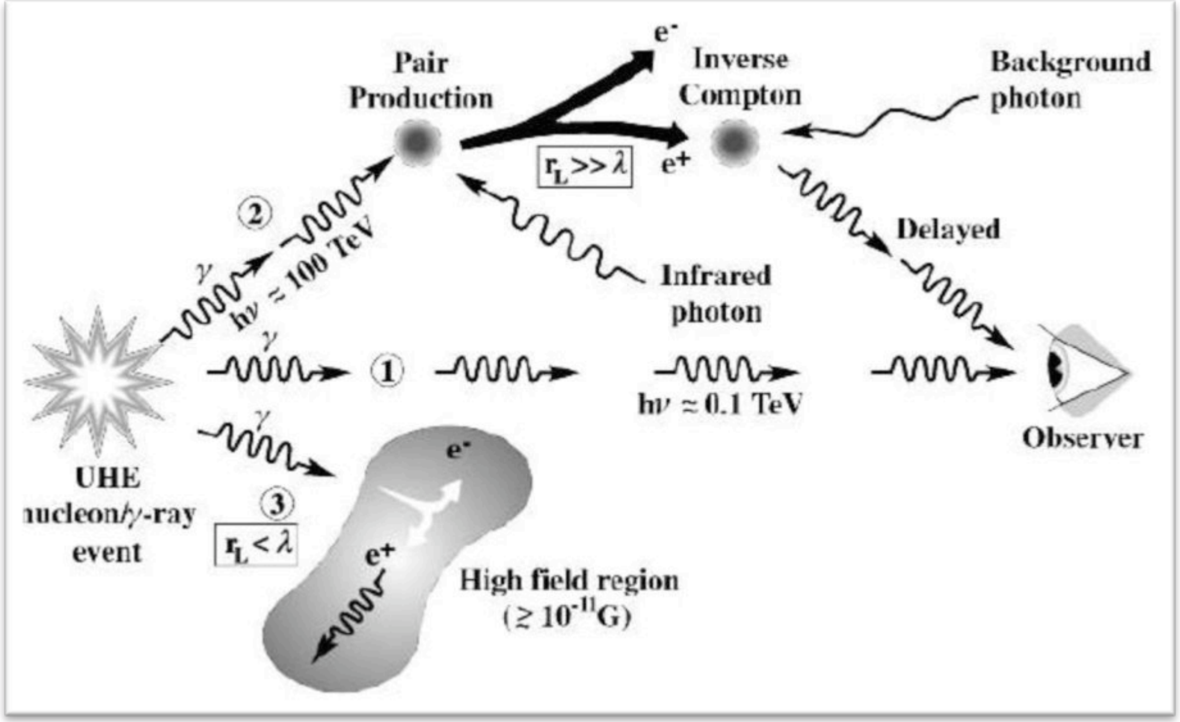


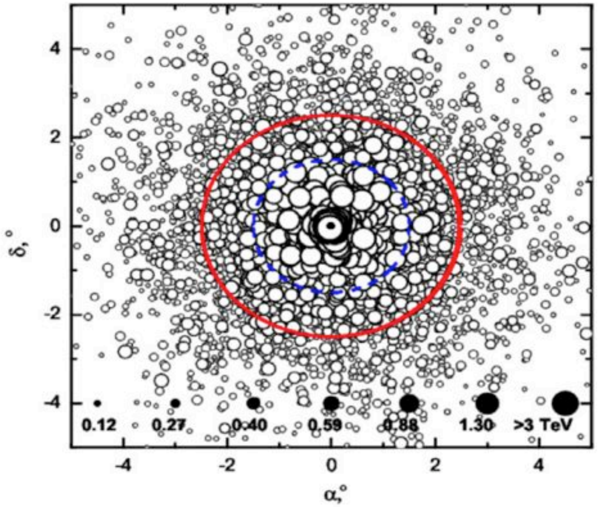


CTA simulation
Mazin et al. (2013)

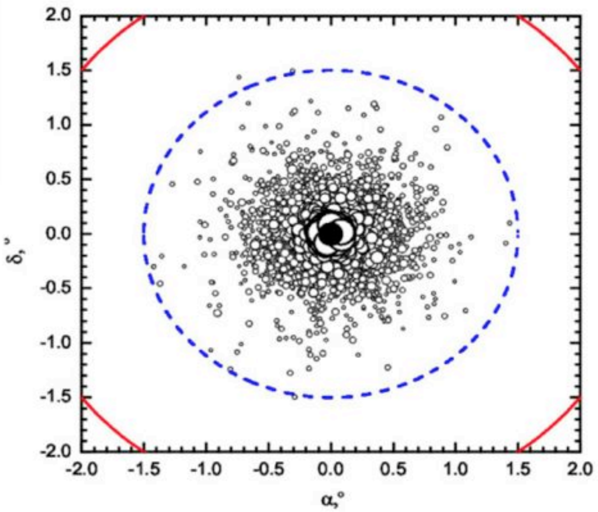
Probing the intergalactic magnetic field

CTA will search for pair halos (extension) or echos (time delays) of blazars to assess the strength of the intergalactic magnetic field





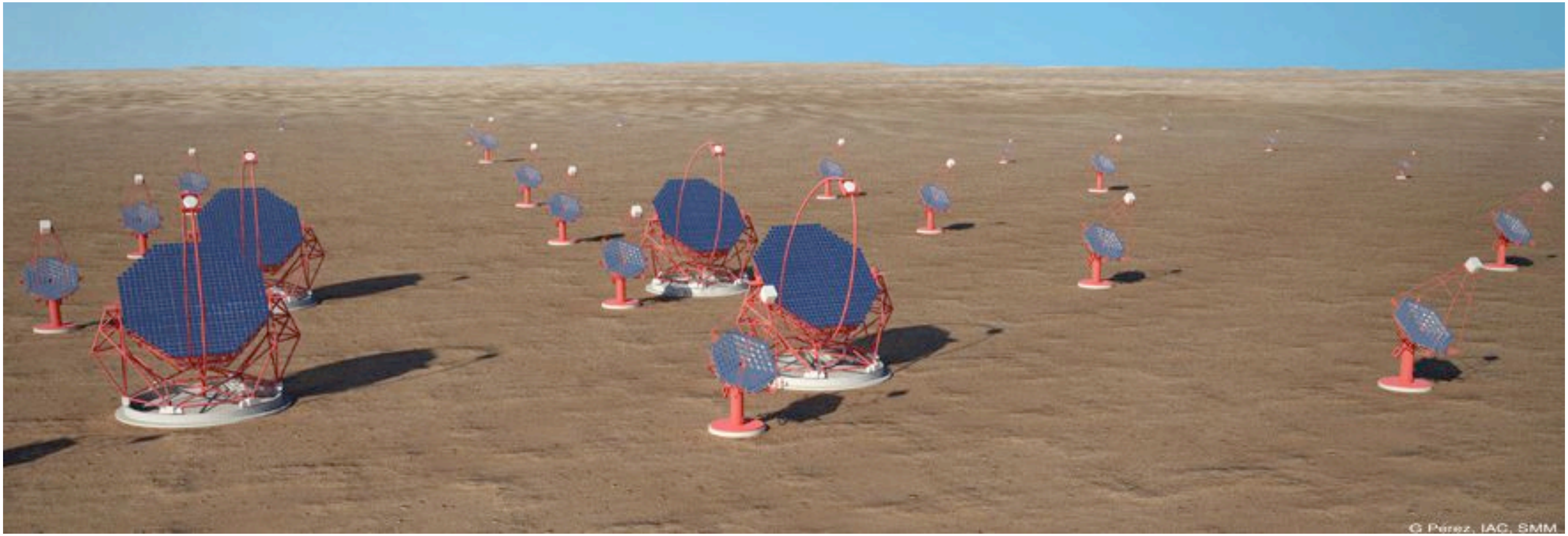
10^{-14} G



10^{-15} G

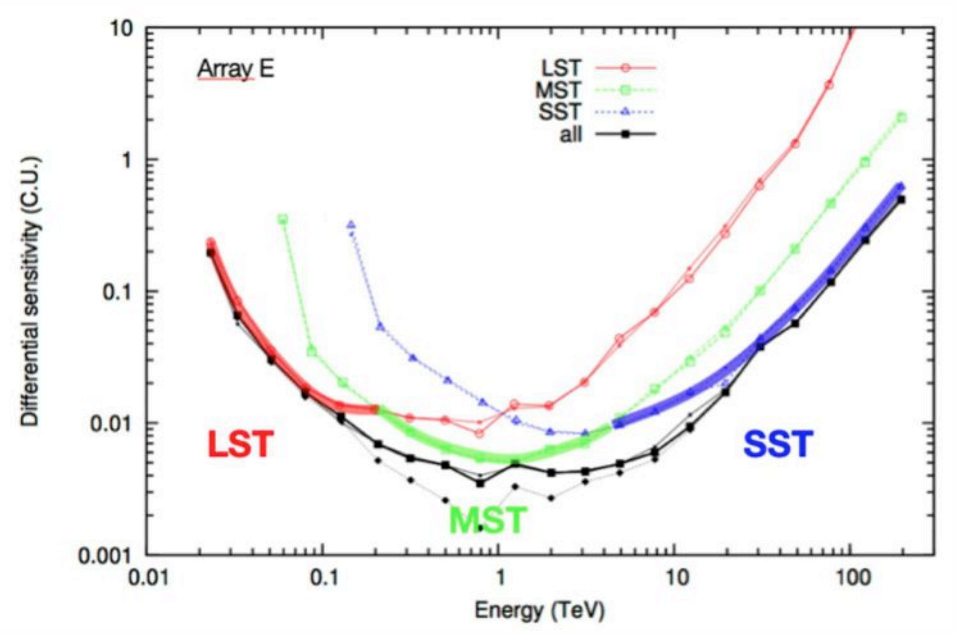
CTA simulation
Sol et al. (2013)

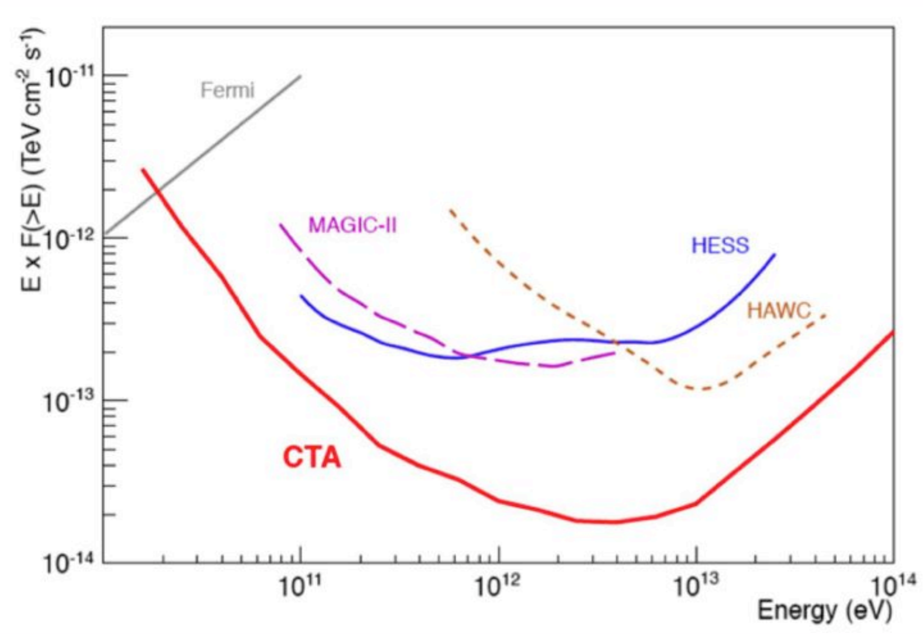
The CTA Observatory

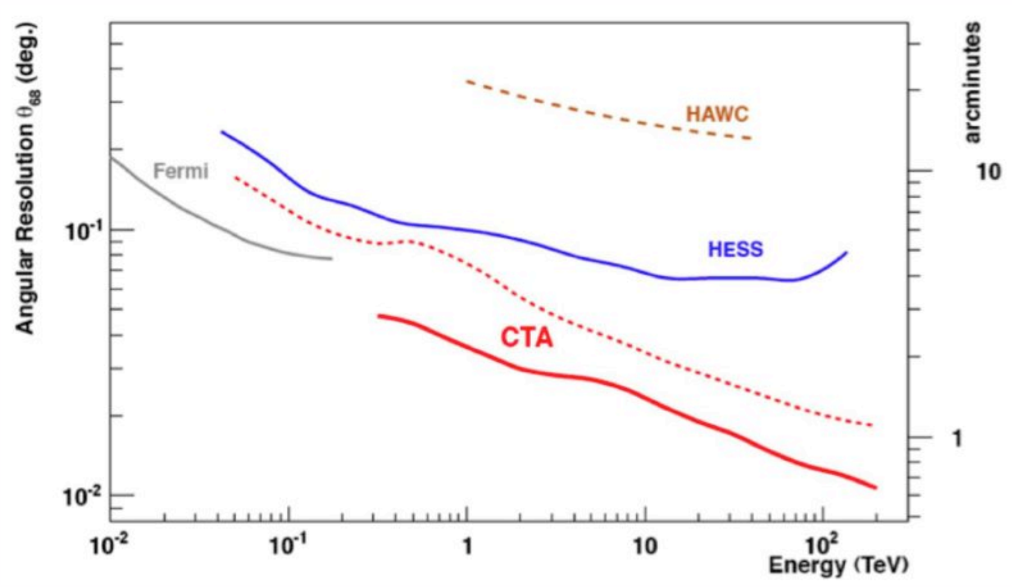


Take home facts

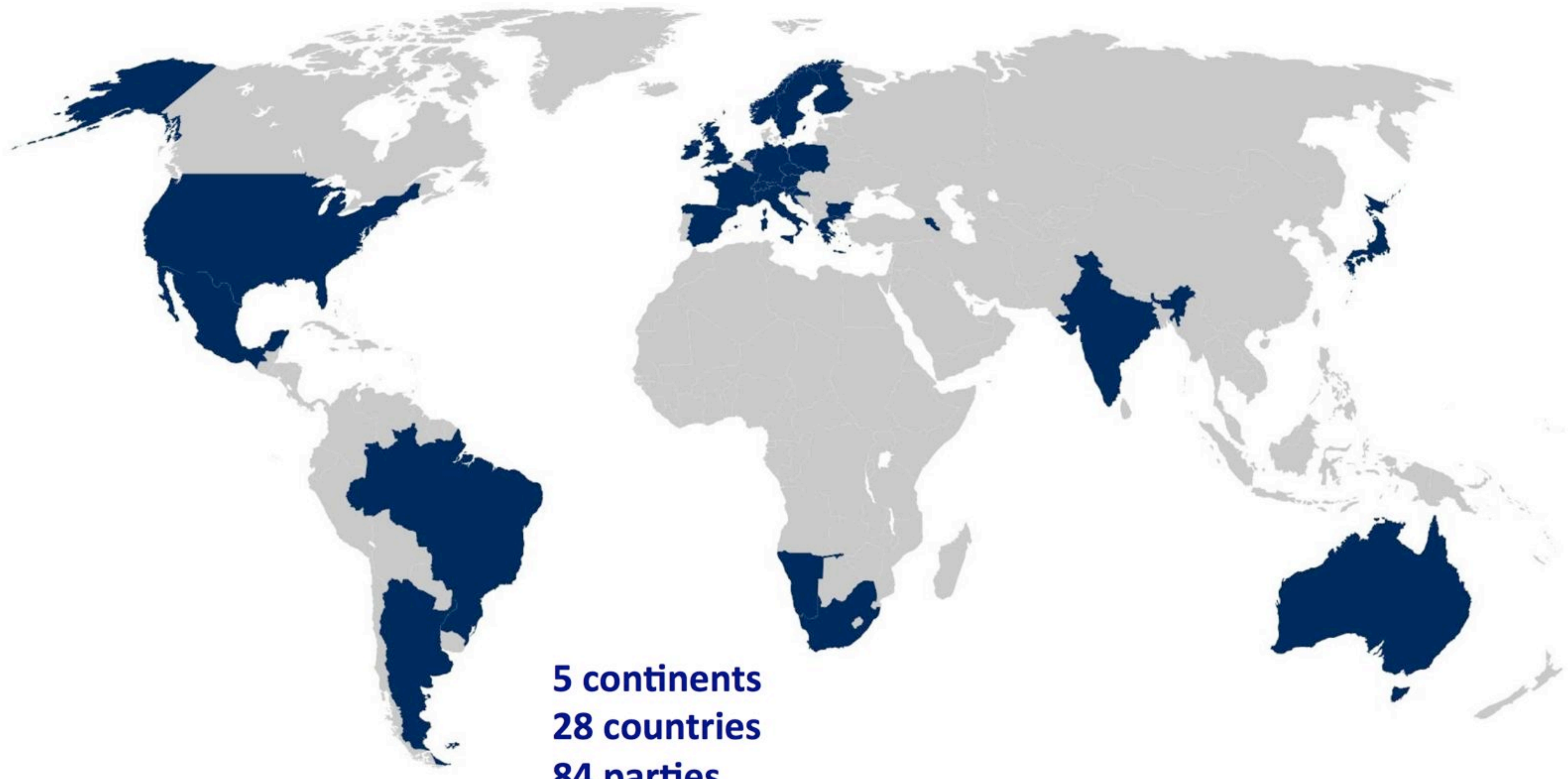
- About 100 Cherenkov telescope located in two sites (South, North)
- 3 size-classes of telescopes to cover a broad energy range (LST, MST, SST)
- Tenfold improvement in sensitivity and energy coverage w/r to existing telescopes
- Fivefold improvement in angular resolution w/r to existing telescopes
- An open observatory
- An international research infrastructure for the next decades


Array E
LST
MST
SST
all
Differential sensitivity (C.U.)
Energy (TeV)
LST
MST
SST
10
1
0.1
0.01
0.001
0.01
0.1
1
10
100


E x F(>E) (TeV cm^{-2} s^{-1})
Fermi
MAGIC-II
HESS
HAWC
CTA
10^{-11}
10^{-12}
10^{-13}
10^{-14}
10^{11}
10^{12}
10^{13}
10^{14}
Energy (eV)


Angular Resolution θ_{68} (deg.)
arcminutes
HAWC
Fermi
HESS
CTA
10^{-1}
10^{-2}
10
1
10^{-2}
10^{-1}
1
10
10^{2}
Energy (TeV)

A worldwide endeavour



5 continents
28 countries
84 parties
173 institutes
1178 members (378 FTE)

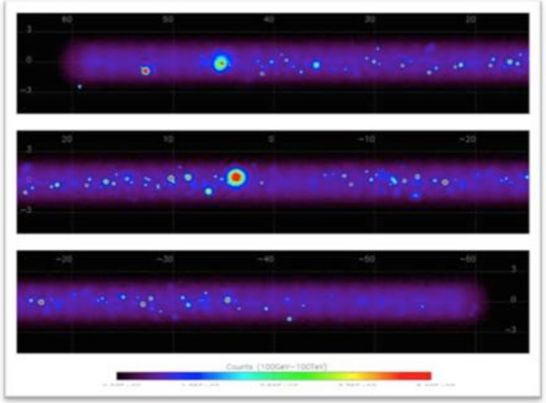
Some first CTA elements

MST prototype

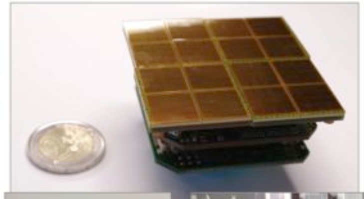
SST 1M prototype

Mirror panel field test

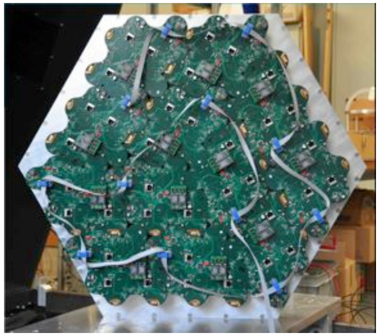
Simulation and analysis software

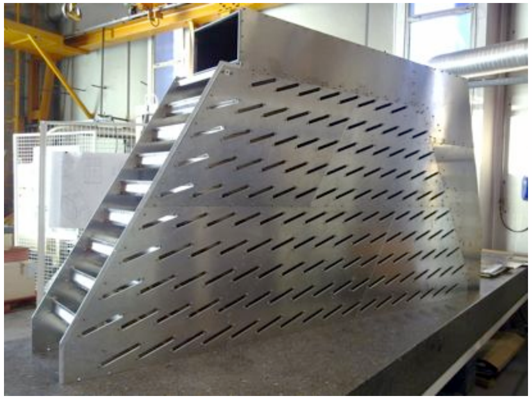


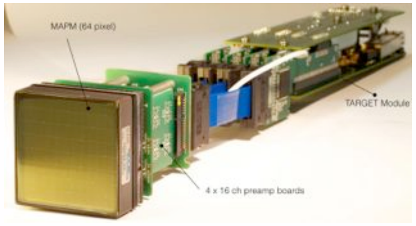
SST 2M prototype elements

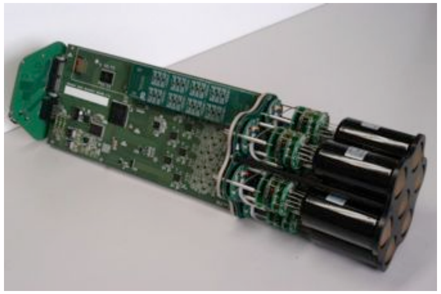


Camera elements









Roadmap

Juillet 2012: Signature of the Declaration of Intent

Feb. 2013: SPPRR

Nov. 2013: PDR

Avril 2014: Start of site negotiations

Q2 2014: Foundation of the CTAO GmbH

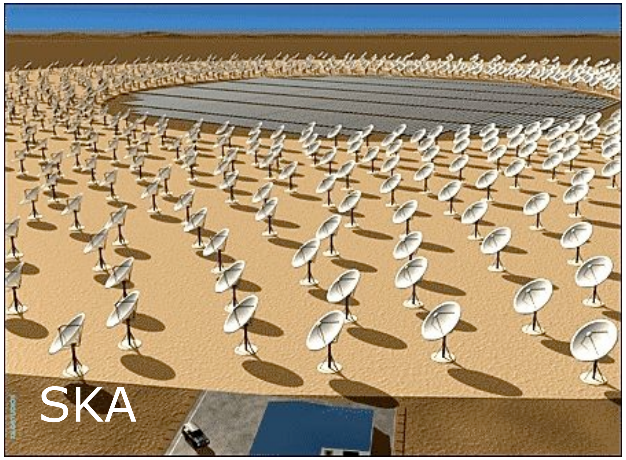
Q1 2015: CDR

2016: Construction start

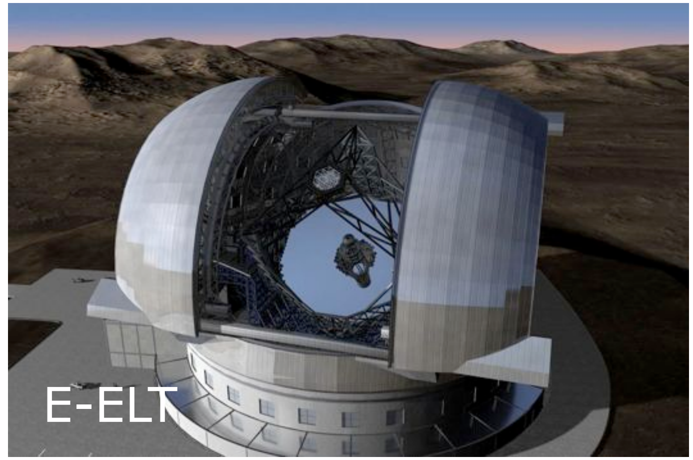
2020: CTA complete

CTA in context

Radio



Optical



X-rays

Gravitational waves

Gamma rays