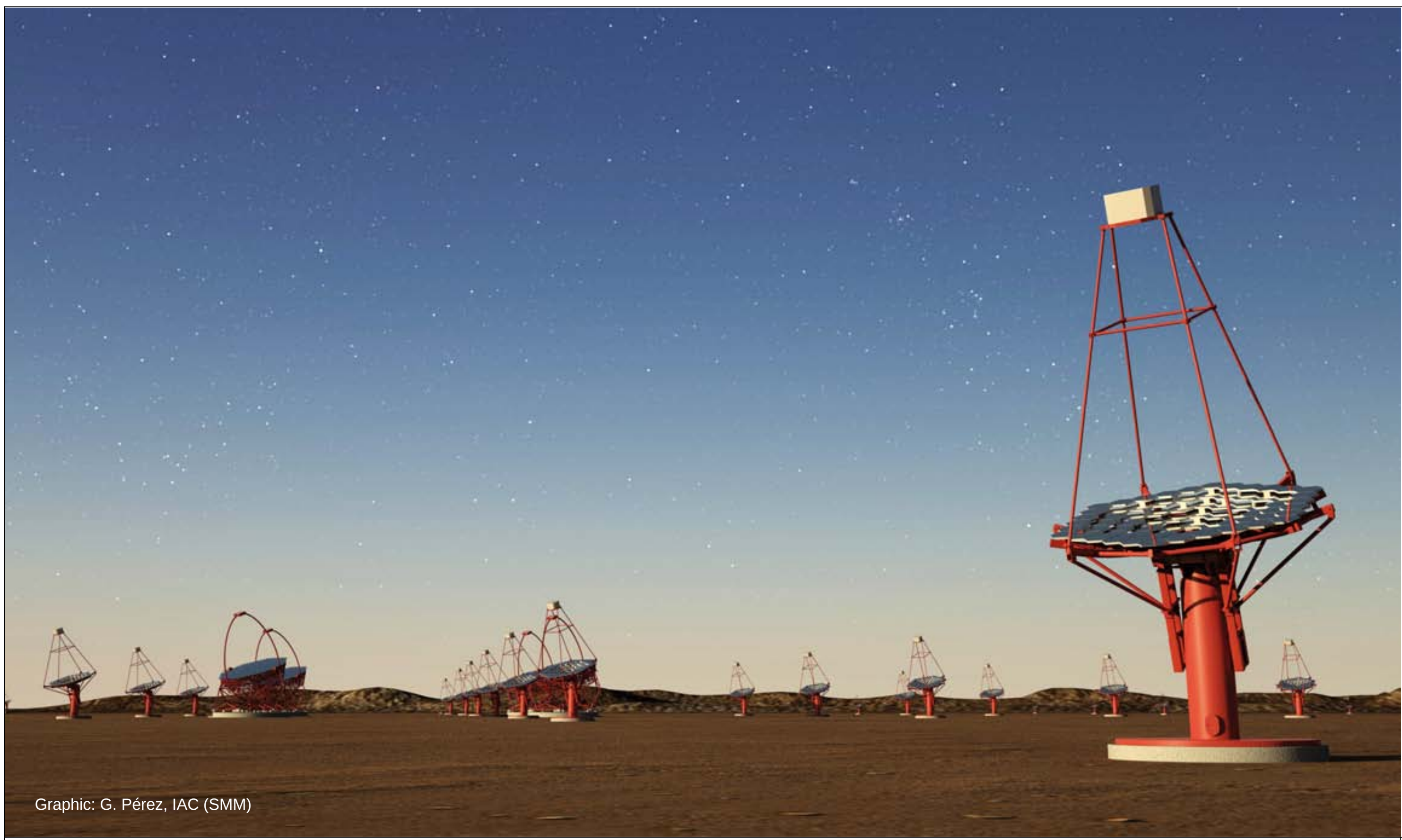
CTA – Research and Development at DESY.

A unique observatory for high-energy astrophysics


Graphic: G. Pérez, IAC (SMM)

The Cherenkov Telescope Array CTA

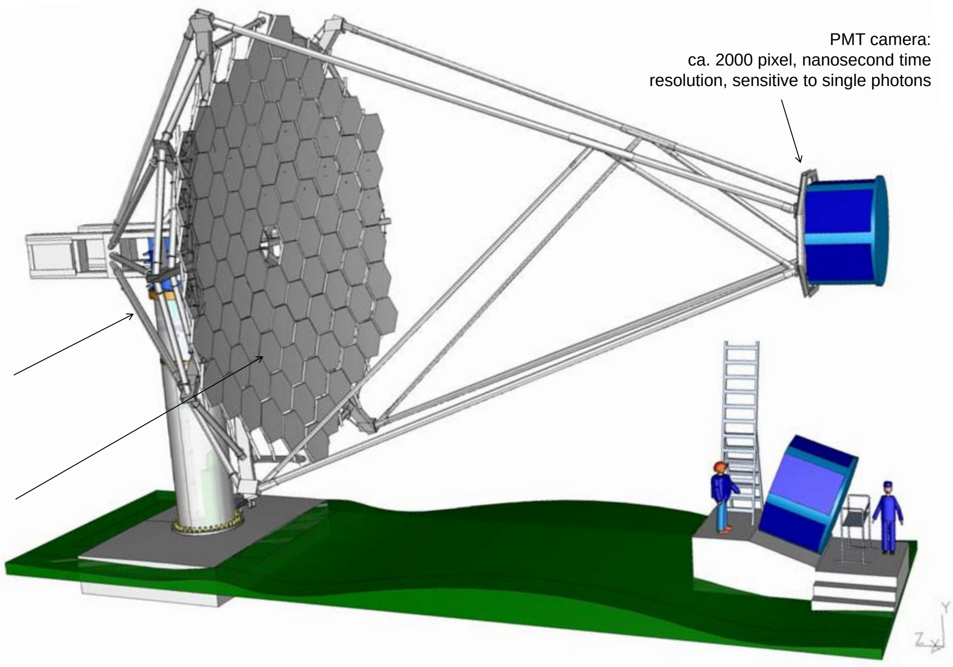
CTA is a next-generation gamma-ray observatory. It will be a unique tool to study the Universe at high energies. Gamma rays are light particles, about thousand millions more energetic than visible light. They are produced in the most violent environments in the Universe. High-energy gamma rays induce particle showers in the atmosphere. Several CTA telescopes measure simultaneously the weak and extremely short flash of light from these particle showers and allow to reconstruct energy and direction of the original light particle.

CTA will gain a factor of ten in sensitivity compared to current instruments. This will allow exciting new insights into astrophysics, cosmology and fundamental physics. CTA will consist for complete sky coverage of two arrays: a southern array consisting of about 60 telescopes and a northern array with 40 telescopes.

CTA is build by an international collaboration with institutes from Europe, North and South America, Asia and Africa.

The 12-metre telescope

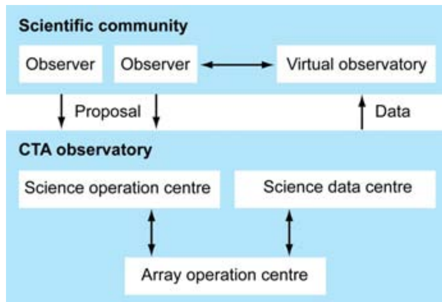
DESY is leading the construction of the mid-size telescopes. A prototype is set up in Berlin in collaboration with partners in Saclay and Argonne.



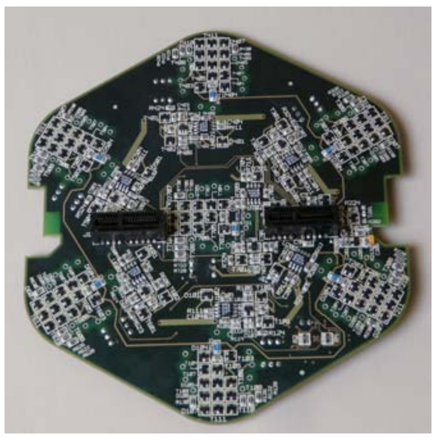
Array control and organization centre

Steering, control and monitoring of the CTA telescopes requires a complex, fail safe and distributed software solution.

A software package of ESO, developed for the ALMA array, is currently adapted for CTA.

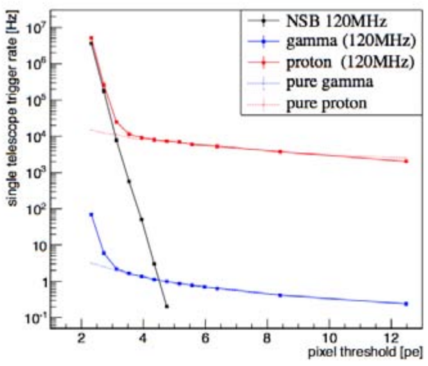


High-voltage system



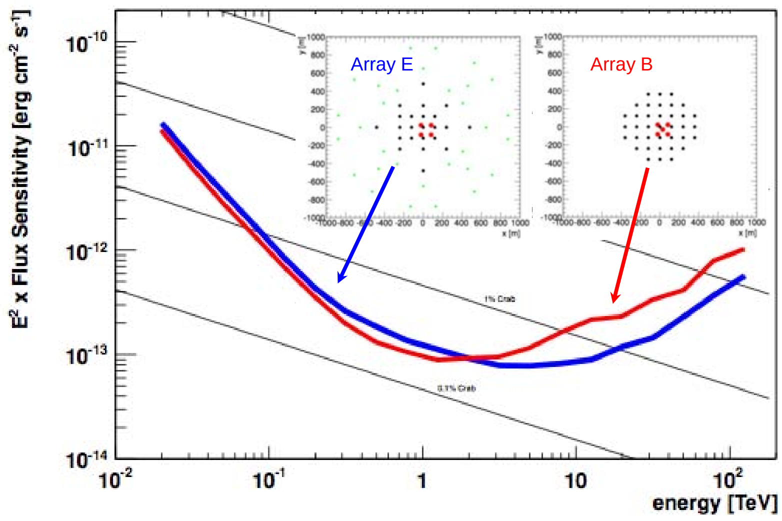
Several thousand Photomultipliers (PMT) need to be supplied with stable and adjustable high voltage.
The safety of the sensitive photo-detectors must be guaranteed at all time. DESY develops a complete high-voltage system for CTA.

Telescope trigger



A sophisticated trigger system is needed to suppress the large number of random triggers from night-sky background and cosmic-ray events. The performance of the trigger electronics is crucial to achieve an energy threshold of about 10 GeV.
DESY develops a FPGA based trigger and a detailed simulation chain to compare different trigger algorithms.

Simulations and analysis



The Monte Carlo technique is applied to find the telescope parameters (mirror area, field of view, pixel size) and array configuration for best performance. New analysis techniques are developed in order to achieve the desired sensitivity.
DESY is one of the centres in CTA for MC production and analysis.

HELMHOLTZ ASSOCIATION

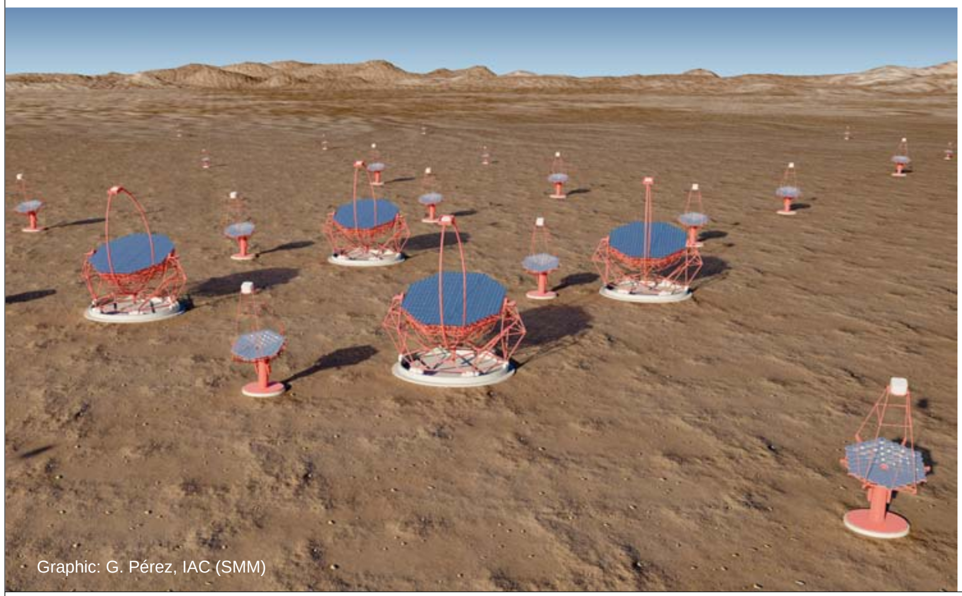
cta cherenkov telescope array

www.desy.de/CTA
www.cta-observatory.org

Physics with the Next Generation Gamma-ray Observatory CTA.

A unique instrument for high-energy astrophysics

The Cherenkov Telescope Array – a tenfold increase in sensitivity


Graphic: G. Pérez, IAC (SMM)

The Cherenkov Telescope Array is a next-generation gamma-ray observatory. It will dwarf its predecessors, H.E.S.S., MAGIC and VERITAS in nearly all aspects :

> gain of factor of ten in sensitivity compared to current instruments
> very large spectral coverage (20 GeV to >100 TeV)
> significantly improved angular resolution
> temporal resolution down to sub-minute time scale
> nearly full sky coverage with observatories in both hemispheres

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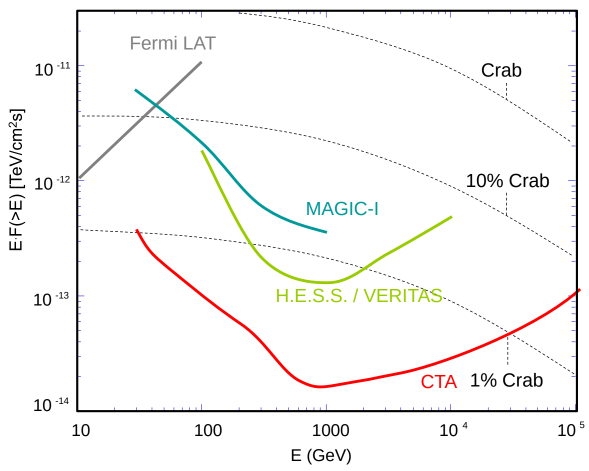
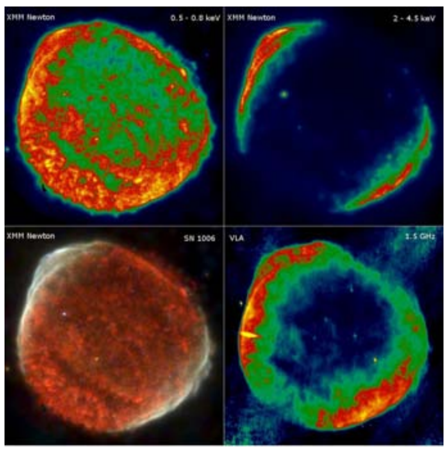
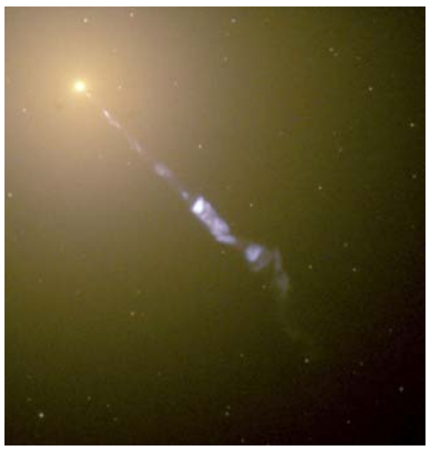
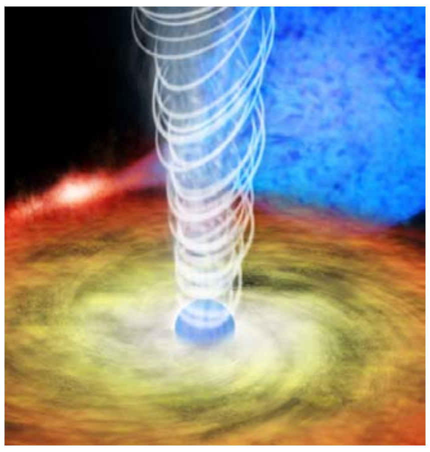


Cosmic ray accelerators


Particle accelerator in the supernova remnant SN 1006 (Image: CEA/DSM/DAPNIA/SAp and ESA)


Active galactic nuclei


Microquasar

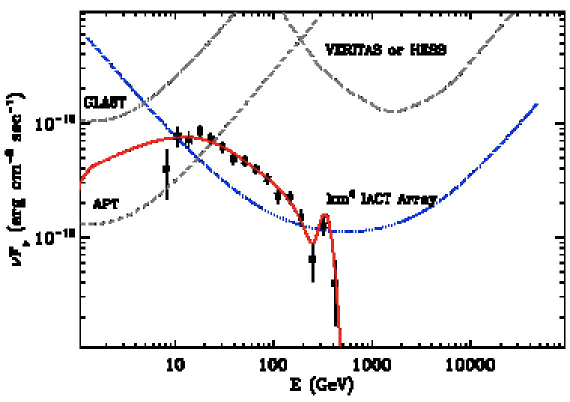

Star formation

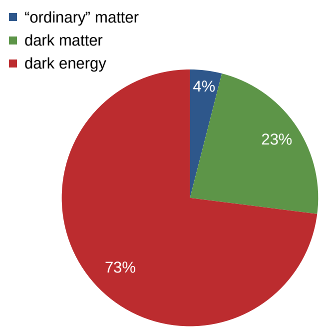
The Milky Way is filled with a gas of high-energy particles. Known for about a 100 years, the sources of these cosmic rays are still not un-ambiguously identified. High-resolution imaging of TeV emission and precision measurements of the spectral energy distribution is required to disentangle the emission from electronic versus hadronic cosmic rays.

Jets are powerful outflows of matter and energy produced close to black holes. Charged particles are accelerated to extremely high energies in their vicinity. What is happening in astrophysical jets to produce high-energy radiation with energies far beyond what is possible with Earth-based accelerators? CTA's sensitivity, enlarged spectral coverage and temporal resolution are likely the key to understanding the physics of jets.

The nature of dark matter

Dark matter accounts for ~23 % of the mass-energy density of the universe. Its nature is unknown. CTA will be a unique tool to detect or constrain the nature of dark-matter particles and to measure the dark-matter distribution in the universe.

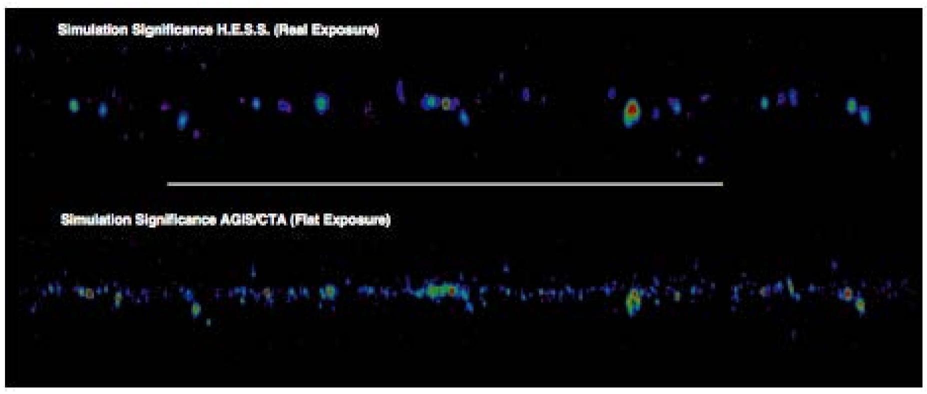




Predicted gamma-ray signal from the dwarf spherodial galaxy Ursa Minor

The unknown

CTA will detect a large amount of new sources, new source categories, and probably many unexpected features of our high-energy universe.



Maps in very-high energy gamma rays of the inner galaxy for a current generation observatory (top) and CTA (bottom). The increase in sensitivity and the improved angular resolution will allow to resolve precisely the extended emission regions of Galactic gamma-ray sources and to pin down the acceleration sites of cosmic rays.

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