Cherenkov Telescope Array

A global endeavor for astronomy and particle astrophysics with very high energy (VHE) gamma rays

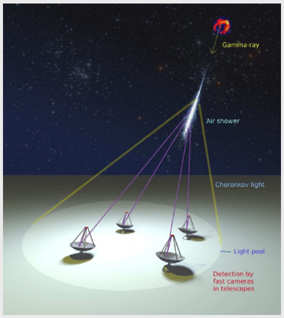
Astronomy and particle astrophysics with very high energy (VHE) gamma rays

The universe is a unique laboratory to study fundamental physical processes at extreme energies, well beyond any energy scale that can ever be reached with accelerators on Earth. Gamma-ray astronomy at Tera-electronvolt (TeV) energies uses this laboratory, to address issues such as

- Investigation of *the most energetic processes in the Universe*
- Understanding the *cosmic particle accelerators*
- Mapping the *energy density of cosmic rays* in the Galaxy
- Probing the *environment of black holes* and *neutron stars*
- *Cosmology* and the history of galaxy formation
- Probing the validity of *fundamental physics* laws at extreme energies
- What is the *origin of Dark Matter* ?

Detecting VHE gamma rays

When highly energetic cosmic particles hit the atmosphere, cascades of relativistic particles are generated. They emit faint flashes of Cherenkov light with nanosecond duration. Large telescopes focus the light onto fast photosenor arrays. Stereoscopic observation with several telescopes is the state of the art. They allow the determination of the properties of the primary particles with high accuracy. Gamma rays coming from sources can be identified and used to investigate the source properties.

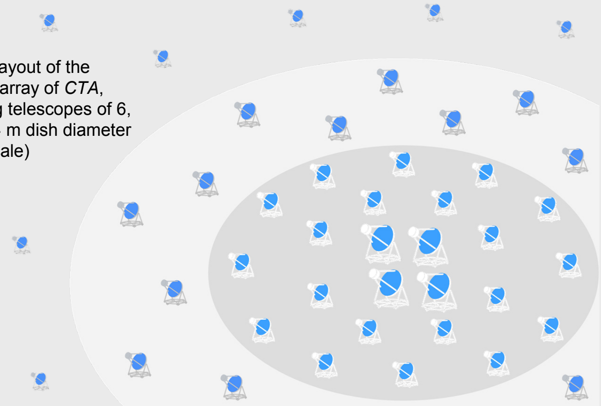


CTA : a quantum step for particle astrophysics

The great success of the current generation instruments (H.E.S.S., MAGIC, CANGAROO and VERITAS) has demonstrated the great potential of the young field of TeV gamma-ray astrophysics. In order to fully exploit this potential, the next generation instrument *CTA* aims for providing a significant improvement in all performance characteristics:

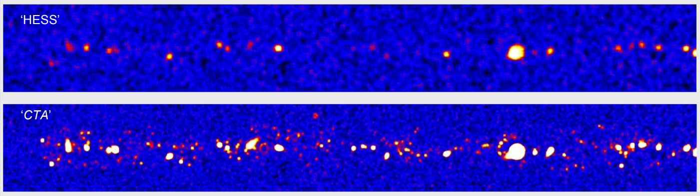
- Factor 10 higher sensitivity at TeV energies
- Energy range extending from some 10 GeV to some 100 TeV
- Improved angular resolution down to 1-2 arcmin
- Factor 5 - 10 higher detection rates
- Improved survey capability and full-sky coverage

In order to achieve the envisaged performance, about 50-100 telescopes of different sizes, distributed over an area of >1 km^2 will be needed. The array design has to be optimized for reliability and remote robotic operation.



Possible layout of the Southern array of *CTA*, combining telescopes of 6, 12 and 24 m dish diameter (not to scale)

The Galaxy viewed in gamma rays



CTA will have by far the best angular resolution of any type of gamma-ray instrument. It will therefore for the first time allow to resolve structures of Galactic emission regions on parsec scales and act like a “microscope” for cosmic accelerators. (Figures: sky-map of the inner part of a simulated Galactic plane as it would be visible with current instruments and with *CTA*). It is expected that *CTA* will discover more than 1000 TeV-gamma-ray sources - galactic and extra-galactic - a factor of >10 more than are detected with current instruments.

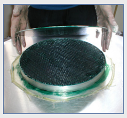
CTA as an observatory with full-sky coverage will have two sites, one in the Northern and one in the Southern hemisphere. They will be jointly constructed and operated by one international consortium and use the same technology.

CTA design: facing the challenges

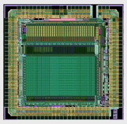
The development of cost effective, high performance components for the *CTA* telescope array is a major technological challenge. Examples are:

- Construction of 50 – 100 optical telescopes with dish sizes of ~6, ~12 and ~24 m for robotic operation with maximum reliability
- Production of ~ 70 m^2 photo sensitive area with nanosecond response
- Development of high speed cameras with >100 000 electronics channels to be operated in a rough environment
- Development of production techniques for 10 000 m^2 focusing mirrors
- Data handling of up to 50 GByte/sec

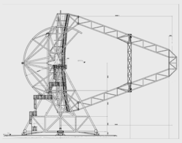
The *CTA* consortium currently meets these challenges in a *Design Study* that is jointly performed by all major European groups, together with Japanese and other international groups, and in cooperation with industry.



Development of new production techniques for mirrors

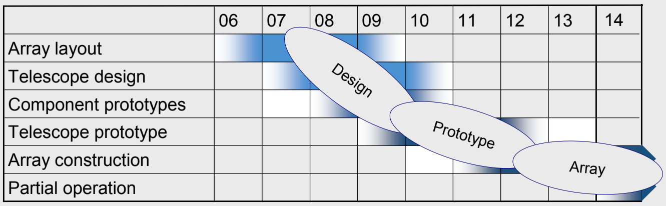


Development of micro-electronics and photon detectors



Design of telescope structures; concepts for safety and robotics

Tentative timeline towards the *CTA* observatory



CTA as a global endeavor

The *CTA observatory as world-class research infrastructure* will be open to the scientific community. The project directly involves more than 500 scientists from over 120 institutes worldwide. *CTA* is top ranked in the roadmaps of ASPERA and ASTRONET for future projects in particle astrophysics and astronomy. *CTA* is included in the 2008 update of the roadmap of the European Strategy Forum on Research Infrastructures (ESFRI).

aseps Asia Europe Physics Summit
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"Physics towards science innovations"

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www.cta-observatory.org