1. Project's name and descriptive title
CTA: An advanced facility for ground-based high-energy gamma ray astronomy
2. Short description of project and main characteristics
Imaging atmospheric Cherenkov telescopes have proven an extremely successful approach to gamma ray astronomy in the energy range above a few tens of GeV. The proposed facility will consist of arrays of telescopes, aiming to (a) increase sensitivity by another order of magnitude for deep observations, (b) boost significantly the detection area and hence the detection rates, particularly important for transient phenomena and at the highest energies, (c) increase the angular resolution and hence the ability to resolve the morphology of extended sources, (d) provide wide and uniform energy coverage from some 10 GeV to beyond 100 TeV, and (e) enhance the all sky survey and monitoring capability. These features will allow the exploration of non-thermal processes in the Universe, in close cooperation with and complementing observatories in other wavelength ranges of electromagnetic radiation, and for other messenger types. Given the wealth of sources in the central region of our Galaxy and the richness of their morphological features, a site in the southern hemisphere is attractive. On the other hand, a complementary northern site has to be considered for the study of AGNs and the cosmological evolution of galaxies and star formation. The ensemble would provide full sky coverage and wider energy range coverage as demonstrated by H.E.S.S. - MAGIC large/small zenith angle simultaneous observations.
3. Science case (scientific justification, including new areas to be opened)
Data from Cherenkov telescopes of the latest generation have revealed a sky rich in features at TeV energies; in the last years, the number of sources has quadrupled. First sky maps show the band of the Milky Way lined with cosmic accelerators, with complex and resolved morphology. Their energy spectra extend beyond 10s of TeV; some of the objects emit most of their energy in the TeV range. Extragalactic sources at unprecedented distances of up to three billion light years have been detected; the shape of their gamma ray spectra relates to the density of radiation in the space between galaxies, and thus to the hotly debated history of cosmological structure formation. Gamma rays from distant galaxies probe effects of quantum gravity. A vivid interplay between high-energy instruments and other domains of astronomy from radio to X-rays has developed, with common observation campaigns and exchange of data. While the results achieved with current instruments are already very impressive, the detailed understanding of processes in cosmic particle accelerators as well as their use for cosmological applications requires wider energy coverage, improved resolution, and higher detection rates. The performance in this domain can be improved dramatically by a much larger deployment based on now well-established techniques and observation strategies. The opportunity for discoveries and growth similar to the one experienced in high energy gamma ray astronomy from satellites is now clearly perceived in the adjacent domain of very high energy astronomy. The proposed facility should result in breakthroughs in several fields of modern astronomy such as the origin of cosmic rays, the environment of compact objects, the physics of pulsars and black holes, and possibly the long-standing question of the nature of dark matter.
4. Impact to society and to new technologies for industry
Astronomers increasingly work across wave bands, and the new instrument will provide a wealth of information at highest energies of the electromagnetic spectrum, with data made available both to the science community and to interested amateurs via the Virtual Observatory. The high-quality images of the sky in this new domain will continue to attract and interest the public in this scientific endeavour. Development of novel photon detectors and their large-scale production in the context of this project is expected to have significant impact on industry, for example in medical applications. Operation of the instrument requires precise understanding of atmospheric characteristics, fostering cooperation with environmental science. Given the large amounts of data generated by the instrument (and by simulations of its characteristics), close cooperation with efforts in e-science and grid computing is envisaged. Finally, the facility will enable education and training in many fields of science, fundamental and applied.

5. Strategic importance to ERA
Currently, European efforts in ground-based high-energy gamma-ray astronomy are split among three partly competing projects, MAGIC and VERITAS in the northern hemisphere and H.E.S.S. in the southern hemisphere. The project will combine these existing efforts to construct a next-generation world-leading state-of-the art facility, and will capitalize on the expertise and diverse instrumental developments. Resolution of the governance, legal and funding aspects of such a project will provide significant input to future European-scale research infrastructure projects, and national and EU research agencies. In particular concerning the southern site, exchange of knowledge and expertise with pan-European countries will be an important element.
6. Maturity of proposal (including possible timetable)
The performance and scientific potential of arrays of Cherenkov telescopes has been studied in significant detail; what remains to be decided is the exact layout of the telescope array. Ample experience exists in constructing and operating telescopes of the 10-12 m class (H.E.S.S., VERITAS). Telescopes of the 17 m class and 28 m class are operating (MAGIC) or under construction (H.E.S.S. II) and will serve as prototypes. Photon detectors with improved quantum efficiency are under advanced development and testing and will be available when the array is constructed. After a phase of detailed design (2006-2008), implementation could start in 2009/10, with full operation in 2012, allowing significant overlap with the GLAST satellite instrument to be launched in 2007, which covers the energy range below some 10 GeV and which serves as an all-sky monitor, triggering pointed observations at higher energies.
7. Budgetary information (preparation, construction and operation costs)
Depending on the exact number and size of the telescopes to be deployed, about 100 M€ are required for a southern site which will cover a wide energy range from some 10 GeV to 100 TeV for observations of our Galaxy at high resolution. A complementary site in the northern hemisphere would focus on extragalactic and cosmological objects, with instrumentation optimized for low energies (10 GeV-1 TeV), at a cost of about 50 M€. The stations would be constructed and operated by a single consortium. Total operating and maintenance costs are currently estimated to 3 to 5 M€ per year, including local staff. Up to 10 M€ are needed for site exploration, detailed design and industrial prototypes.
8. Comments on possible partnerships (optional)
As indicated under 5, all research groups working in this field in Europe are expected to join under this project, with participants from the Czech Republic, Germany, France, Italy, Ireland, the UK, Poland, Spain, Switzerland and non-European partners, as well as industrial partners, already significantly involved in the design and construction of the current generation of telescopes.