Why so many telescopes?

- Light pool radius: $R \approx 100-150$ m
- ≈ typical telescope spacing

Sweet spot for best triggering and reconstruction: most showers miss it!

- Large detection area
- More images per shower
- Lower trigger threshold
Why are we planning an array of telescopes of different sizes?
Possible CTA sensitivity

An advanced facility for ground-based high-energy gamma ray astronomy

Possible CTA sensitivity

AGN and pulsar physics

Exploring the cutoff regime in Galactic sources

A deep look at the TeV sky

E \cdot F(>E) [TeV/cm²s]

E [GeV]

10^{-14} 10^{-13} 10^{-12} 10^{-11}
Possible CTA sensitivity

An advanced facility for ground-based high-energy gamma ray astronomy

CTA

E⋅F(>E) [TeV/cm² s]

GLAST

MAGIC

H.E.S.S.

Crab

1% Crab

10% Crab

~3000 m² mirror area

~5000 m² mirror area

~4000 m² mirror area

few 10⁴ m² with dense coverage (5-10%)

few 10⁵ m² with medium coverage (1-2%)

O(10⁷ m²) with low coverage (0.03-0.05%)
Sensitivity (in units of Crab flux) for detection in each 0.2-decade energy band

Array I 50 hours 5 sigma
LST MST SST all
background and systematic limited
rate (=area) limited

Differential sensitivity (C.U.)

Energy (TeV)

LST MST SST
LARGE 23 M TELESCOPE
OPTIMIZED FOR THE RANGE BELOW 200 GEV

400 m² dish area
27.8 m focal length
1.5 m mirror facets

4.5° field of view
0.1° pixels
Camera Ø over 2 m

Carbon-fibre structure

Active damping
of oscillations,
active mirror control

4 LSTs on each site

→ Masahiro Teshima
MEDIUM-SIZED 12 M TELESCOPE
OPTIMIZED FOR THE 100 GEV TO ~10 TEV RANGE

100 m² dish area
16 m focal length
1.2 m mirror facets

7-8° field of view
~2000 x 0.18° pixels

25 MSTs on South site
15 MSTs on North site
SMALL TELESCOPE
OPTIMIZED FOR THE RANGE ABOVE 10 TEV

ASTRI Design
4.3 m mirror
9.6° foV
0.25° pixels

Multiple options under study:
Conventional single mirror, PMT camera
Single mirror, silicon sensor camera
Dual mirror optics, silicon & MAPMT camera

70 SSTs on Southern site
The future in very high energy gamma ray astronomy

- An Observatory open to the community
- Safe extrapolation of proven technologies, well-predictable performance
- Supported by a large and diverse community
- Highly ranked by major science roadmaps
- Currently in FP7-supported Preparatory Phase
- Aim for deployment over 5 years – 2014-2018
RECOMMENDED BY NATIONAL AND INTERNATIONAL ROADMAPS ...
KEY SCIENCE ISSUES

- Where and how are particles accelerated in our Galaxy and beyond?
- What makes black holes of all sizes such efficient particle accelerators?
- What do high-energy gamma-rays tell us about the star formation history of the Universe or the fundamental laws of physics?
- What is the nature of dark matter?
- The flaring sky: short-timescale phenomena at very high energies?
Example: Galactic Plane Survey

H.E.S.S.

CTA, for same exposure

expect ~1000 detected sources
CTA as ultimate survey machine

Current Galactic VHE sources (with distance estimates)

CTA as ultimate flare machine

at 25 GeV, for flares 100000 times more sensitive than Fermi

Coherent full-sky coverage from two sites
The deepest surveys of the skies at the highest energies

The high energy variability at the shortest time scales

ctascherenkov telescope array
SITE CANDIDATES

Working towards quantifying site-dependent differences in performance and cost

two sites to cover full sky at 20°-30° N, S

Warning: map not quite accurate

Where?
COMMUNITY
CURRENTLY ENGAGED IN CTA
(subset of future user community)

Members (27 countries)
interested to join
Canada, Australia, Israel

CTA Consortium members
27 countries   + 1 in last year
171 institutions  + 19 in last year
1058 persons    + 198 in last year

by whom?
<table>
<thead>
<tr>
<th></th>
<th>SST</th>
<th>MST</th>
<th>LST</th>
<th>SCT</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&quot;small&quot;</td>
<td>&quot;medium&quot;</td>
<td>&quot;large&quot;</td>
<td>&quot;medium 2-M&quot;</td>
</tr>
<tr>
<td><strong>Number</strong></td>
<td>70 (S)</td>
<td>25 (S) 15 (N)</td>
<td>4 (S) 4 (N)</td>
<td>36 (S)</td>
</tr>
<tr>
<td><strong>Spec’d range</strong></td>
<td>&gt; few TeV</td>
<td>200 GeV to 10 TeV</td>
<td>20 GeV to 1 TeV</td>
<td>200 GeV to 10 TeV</td>
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<tr>
<td><strong>Eff. mirror area</strong></td>
<td>&gt; 5 m²</td>
<td>&gt; 88 m²</td>
<td>&gt; 330 m²</td>
<td>&gt; 40 m²</td>
</tr>
<tr>
<td><strong>Field of view</strong></td>
<td>&gt; 8°</td>
<td>&gt; 7°</td>
<td>&gt; 4.4°</td>
<td>&gt; 7°</td>
</tr>
<tr>
<td><strong>Pixel size ~PSF θ₈₀</strong></td>
<td>&lt; 0.25°</td>
<td>&lt; 0.18°</td>
<td>&lt; 0.11°</td>
<td>&lt; 0.075°</td>
</tr>
<tr>
<td><strong>Positioning time</strong></td>
<td>90 s, 60 s goal</td>
<td>90 s, 60 s goal</td>
<td>50 s, 20 s goal</td>
<td>90 s, 60 s goal</td>
</tr>
<tr>
<td><strong>Availability</strong></td>
<td>&gt; 97% @ 3 h/week</td>
<td>&gt;97% @ 6 h/week</td>
<td>&gt;95% @ 9 h/week</td>
<td>&gt;97% @ 6 h/week</td>
</tr>
<tr>
<td><strong>Target capital cost</strong></td>
<td>420 k€</td>
<td>1.6 M€</td>
<td>7.4 M€</td>
<td>2.0 M€</td>
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</table>
“By signing this Declaration of Intent, the signatories – Ministries and Funding Agencies – wish to express their common interest in participating in the construction and operation of CTA.”

- **Design Phase** up to 2010
- **Preparatory / Pre-construction Phase** 2011-2014
- **Construction Phase** late 2014-2019
- **Operation Phase** (up to 30 years) Early science starting 2016/17

So far signed by:
- Japan
- Namibia
- Poland
- South Africa
- Spain
- Switzerland
- UK
- Argentina
- Austria
- Brazil
- France
- Germany
- Italy
SCIENCE DEFINITION

Seeing the High-Energy Universe with the Cherenkov Telescope Array - The Science Explored with the CTA

Special issue of “Astroparticle Physics” in press

Overview articles & case studies

350+ pages