CTA: Camera calibration test-setup and plans

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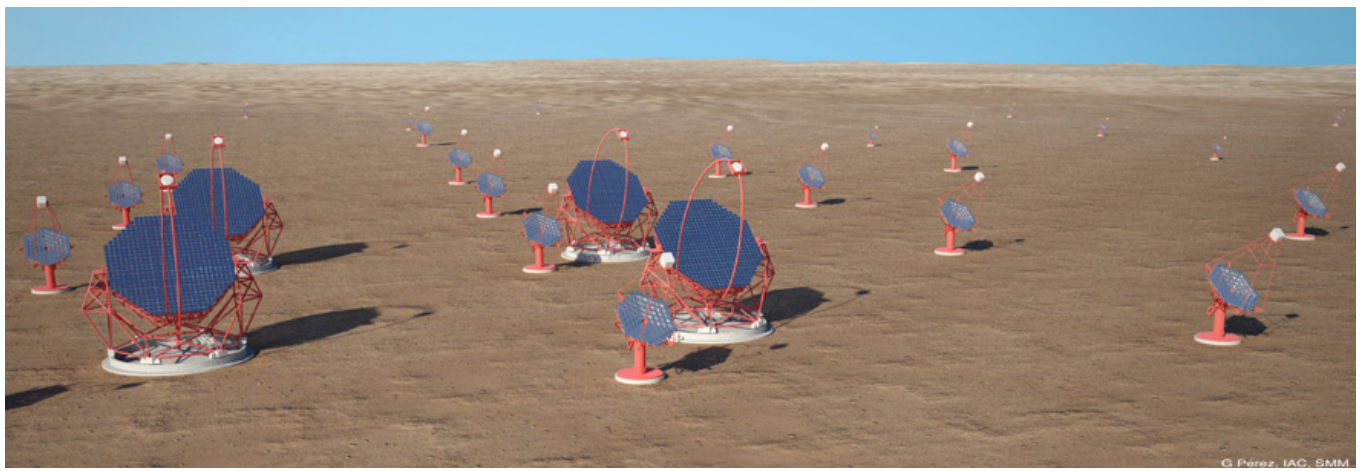
Outline

- CTA - the observatory
  - CTA overview
  - Detection principle
  - The telescopes
  - The cameras
- Calibration and camera testing
  - Our place in the collaboration
  - PMT testing
  - Setup for PMT test and calibration

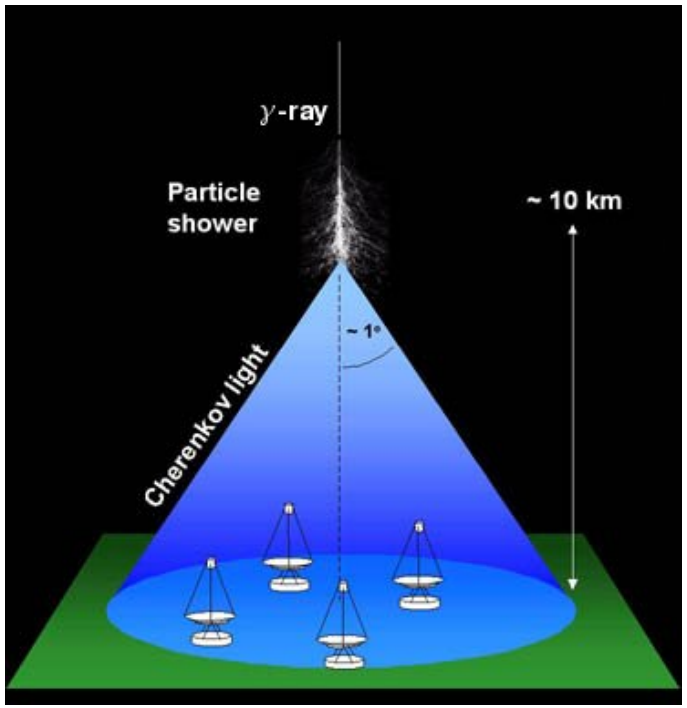
Cherenkov Telescope Array (CTA)

- The CTA project is an initiative to build the next generation ground-based very high energy gamma-ray instrument
- CTA will consist of two telescope arrays – one in each hemisphere
- The increased number of telescopes compared to present observatories will
  - increase number of detected gamma rays
  - improve angular resolution
  - improve cosmic ray background supression
- UiB is a part of the preparatory phase (ongoing)



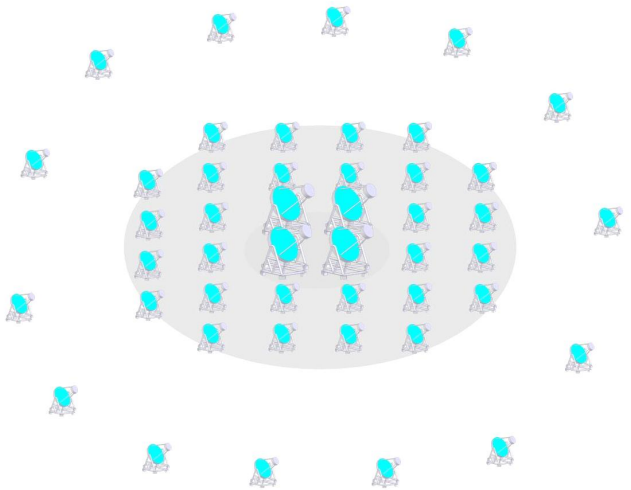
Detection principle

- Gamma rays (and cosmic rays) hitting the top of the atmosphere initiates a shower of both charged and neutral particles
- High energy charge particles may move faster through the atmosphere than the local speed of light
  - leads to emission of light in the optical wavelength range (Cherenkov radiation)
- Optical telescopes focuses light into a camera
- Shape of the emission used to distinguish gamma-initiated light from other sources



The telescopes

- The arrays will consist of three telescope sizes
  - 24 metre-class telescopes with $4^\circ - 5^\circ$ field of view (FOV) (low energy range)
  - 10-12 metre-class telescopes with $6^\circ - 8^\circ$ FOV (medium energy range)
  - 4-6 metre-class telescopes with around 10° FOV (high energy range, only southern array)
- Site selection is not finalised yet
  - still several sites being considered for both northern and southern array
  - decision expected by the end of 2013



The cameras

- Camera should satisfy:
  - high sensitivity around $\lambda = 350$ nm, preferably with sensitivty up to $\lambda = 600 - 650$ nm
  - non-uniformities no larger than $\sim 10\%$
  - dynamic range: 1-5000 photons
  - fast response (< 1 ns for large light pulses)
  - less than 1% cross talk
  - pixel size $\sim 50mm$
- Existing Cherenkov telescopes use PMTs
  - PMT is main option also for CTA
  - Silicon photomultipliers (SiPM) is also considered, but primarily as an option for a later upgrade

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    - SiPM is of interest to heavy ion group in Bergen

Our place in the collaboration

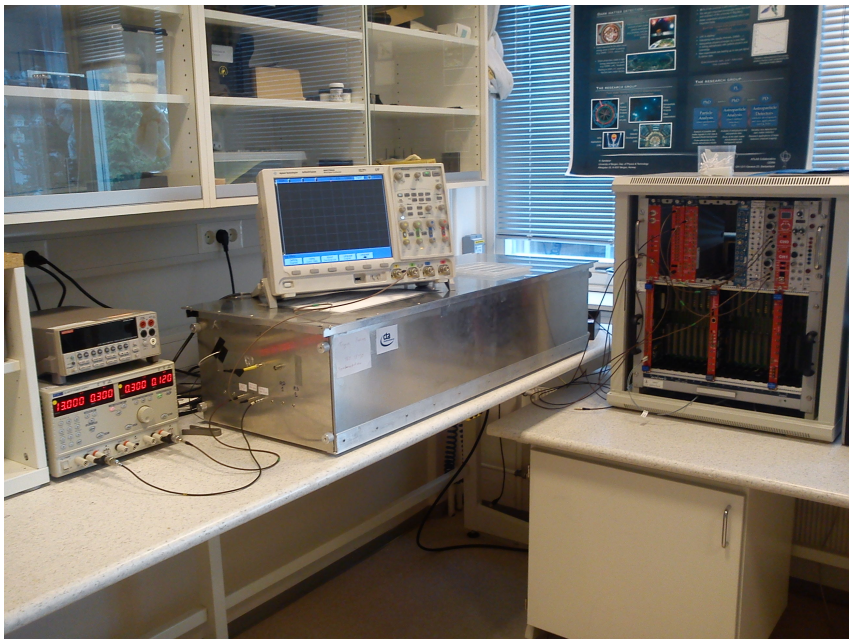
- Three different groups work on developing cameras
- The collaboration wants independent testing of camera (modules)
- We have started a collaboration with the Oscar Klein Centre in Stockholm who also has interest in PMT testing

PMT testing

- Goals
  - Measure PMT gain using single photon events
    - Tune light source intensity such that mean trigger probability is $< 1\%$
    - Identify pulse arrival time t_p and integrate waveform in range $t_p \pm 10$ns
  - Measure afterpulsing using fast pulsed light source
    - determination of photon arrival time critical for good spatial resolution
    - low energy threshold is necessary for high sensitivity
    - too high afterpulsing rate create spurious signals requiring energy thresold to be raised
  - Measure quantum efficiency (only Stockholm)

Setup for PMT test and calibration

- We are building a simple setup in our lab to gain experience and start testing PMTs
  - Fast pulsed light source ($\sim$ ns pulses, $\sim$ kHz-MHz repetition rate)
  - Almost monochromatic LED, peaked at 404 nm
  - Tunable light intensity
- We are supported by the measurement science group in Bergen, and the department's electronics engineers



Outlook

- This part of the project has just started
- Collaboration with Oscar Klein Centre has been initiated, but the real fruits of the collaboration comes later
- We will aim to have an appropriate level of overlap between the tests in Stockholm and Bergen to have necessary cross check without doing too much work twice
- Collaboration with groups making cameras is planned, but has not started yet