The *MAGIC* Telescope Project: Phase II

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Where are we now ?

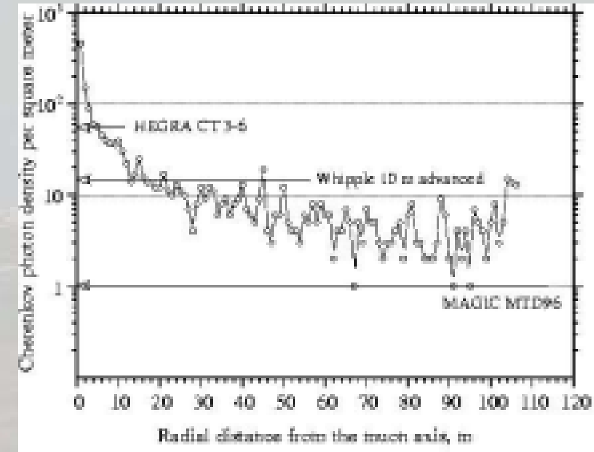
After 7 years of work:

- Soon the 1st tests in an unknown terrain
- Several „new“ & strong (for us) backgrounds: e, µ

To which extent can the expected performance be achieved ?

How to further suppress the unwanted backgrounds, to lower more the threshold and to improve the sensitivity ?

The μ problem



Lateral distribution of Cherenkov light from a 20 GeV vertical μ injected into US standard atmosphere at 15 km height

Phase II of the project: further increase of the sensitivity

- What are the options ?
- In spring 2002 a dedicated meeting of the collaboartion has discussed the following options:

a) To build a new camera based on very high QE light sensors (like in the original proposal)

b) To build 2 more clones of MAGIC

c) To build a new ~30m diameter telescope

In the next I`ll discuss the above 3 options.

High QE light sensor camera

- The best candidate are HPDs with negative affinity GaAsP or InGaP photocathodes.
- *Hamamatsu & Intevac* are providing commercial HPDs with GaAsP window (40-45 % max. QE)
- We have an R&D agreement with Hamamatsu for an HPD with the following parameters:

a) large, 18mm diameter photocathode
b) much faster *avalanche diode* as anode
c) better focusing, less afterpulsing
d) higher QE, longer life-time

High QE light sensors

- Step by step we are obtaining from *Hamamatsu* HPDs with better and improved parameters for tests. In about 1,5 years form now we hope to obtain few tubes of the final design and pre-specified performance.
- Drawback: these HPDs are still by about a factor 4-5 more expensive than the classical PMTs.
- *ITT* from USA is developing another type of high QE hybrid tube (*ReFerence* tube) and wants to become a supplier for our field

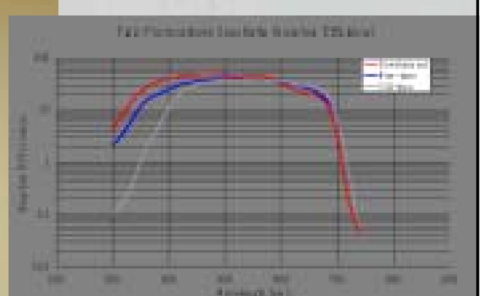
High QE light sensors

- <u>The main expected parameters:</u>

a) QE (see the curve) in (extended) max. ~45%
b) Rise time 1 ns and fall time 3-4 ns
c) Life time longer than 10000 hours
d) 18 mm photocathode, 30mm tube diameter
e) Prototype tube has confirmed a) and b)

- Estimate: a MAGIC camera (more precise its central high resolution part of 2.2° diameter) of 400 high QE HPD pixels may cost ~ 1M€.

High QE light sensors



High QE light sensors

- The effective increase in QE (folded with Cherenkov spectrum) is ~ x 2. This improvement is equivalent to a reflector with 1.4 times larger size (17*m* x 1.4 = 24*m*).

(according ESO cost of an optical telescope scales as *d^2.6*, i.e. a 24*m* telescope is 2.4 times more expensive than MAGIC. 1,5M€ (MAGIC mount + mirrors) x 2.4 = 3.6M€. Such option is by 1,1M€ more expensive.)

In addition, high QE HPDs will allow one to avoid *dept-of-field* type aberrations because of large *D*.

MAGIC + ~30 m diameter telescope ?

- Attractive because of possible lower threshold (down to 10 GeV with classical PMTs). Poor energy and angular resolutions but still interesting because of high sensitivity (compared to satellite detectors). Variability and pulsar studies,...
- Will have large *depth-of-field* type aberration which will limit the measured dynamic range in energy, probably only sub-100 GeV showers can be measured.
- Although we have already started a feasibility study one definitely needs some years for R&D

NOW

SOON IN FUTURE

Innovations for the next MAGIC telescope

- Lighter frame & bogeys
- No stretching of analog signals for FADCs
- Multiplexed 2 GHz FADCs for the DAQ
- Light guides made of 98% reflectivity material
- 1*m* size all Al mirrors
- Permanent active mirror control by using infrared lasers and an infrared CCD
- Digital pattern recognition coincidence trigger between MAGIC1 & MAGIC2 for γ selection

Conclusions

- The MAGIC collaboration is going to start the construction of the 2nd telescope, essentially an improved version of the 1st one and in its close vicinity, in one year from now.
- Completion of the 2nd telescope in 2-3 years from now.
- Situation with funding optimistic