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## Improved PMTs for the Cherenkov Telescope Array

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The Cherenkov Telescope Array (CTA) is planned as a next generation ground-based large instrument for astrophysics by means of very high energy  $\gamma$ -rays. The CTA core is based on the MAGIC, the H.E.S.S. and the VERITAS collaborations. Also, a large number of astrophysicists from European institutions, large teams from Japan and USA have joined the CTA. The aim of CTA is to build an array of  $\sim 100$  imaging telescopes of three sizes (small:  $\sim (4-6)$ m, middle:  $\sim 12$ m and large:  $\sim (17-23)$ m class). These shall provide  $\sim 10$  times higher sensitivity compared to the current generation of telescopes. The telescopes will use imaging cameras consisting of  $\sim 1500-3000$  PMT channels. We have set up a PMT development program with Hamamatsu (Japan) and Electron Tube Enterprises (England) aiming to produce  $1.5''$  PMTs of optimised parameters for the CTA project.

Very encouraging improved parameters have been obtained from manufacturers in a time scale of 1-2 years but, for example, the level of after-pulsing still needs to be reduced. For the CTA cameras we need PMTs with an afterpulsing level of 0.02 % for the threshold of  $\geq 4$  ph.e.. The newest PMTs show an after-pulsing level that is rather close to the requirements of CTA. Together with it they show an average peak QE of  $\sim 34$  %. The Monte Carlo simulations performed by Hamamatsu show a ph.e. collection efficiency of  $\geq 95$  % for wavelengths in the red part of the spectrum. For shorter wavelengths the collection efficiency is somewhat degrading, this is still under study. The Electron Tubes (ET) Enterprises have chosen their  $1.5''$  hemi-spherical PMT ET 9117B as the starting point for parameter improvements. While most parameters of this PMT could satisfy the needs of CTA they still have to improve the QE of these tubes. We expect that after this also ET Enterprises can produce good PMTs for the CTA project. We want to report about the above development work.

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