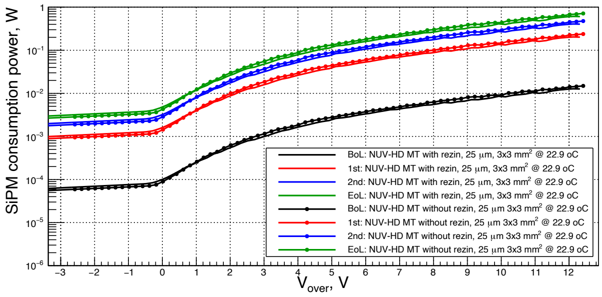

Figure 7: Power consumption by the SiPM camera.

This figure does not include the power consumption of the 10 ASICs, which are expected to consume 3.2 W reading out the 640 channels of the camera, and the trigger system for which the power consumption is estimated to be about 8 W.

Given all considerations and the fact that the NuV-HD-MT tests are not completed yet, our baseline solution is the NUV-HD-lowCT solution of FBK with 25 μm micro-cell size [7] and the optimal solution is NuV-HD-MT once validated with similar micro-cell size. If tuning of quenching resistor leads to a shorter slow component we can use 35 μm as well, ensuring larger PDE. Despite we are aware that the NuV-HD-MT can probably be run at higher over-voltage than what we assume in simulation, thanks to its low crosstalk, in Sec. 5.1 we used parameters at 6 V over-voltage of 50% PDE, DCR of 77 kHz/mm^2, CR+AP of about 1% + 6.6%, τ_s = 40 ns.

3 The Geant 4 simulation and the performance study

We have produced the preliminary simulation of Terzina based on Geant 4 [9, 10]. While the camera simulation resembles the system we are building, the optical system is preliminary. Recently, a final optimization was conducted in collaboration with a specialized company and this final configuration needs to be implemented in Geant 4 in the next future. Nonetheless, our results should not change substantially as the main optical parameters are similar between the two configurations.

The optical system of the two mirrors, currently implemented as spherical and not parabolic as they will be, is shown in Fig. 3 with the rectangular camera between mirrors and its parameters are provided in Table 1. The profile of the corrector lens is calculated to minimize the PSF for on-axis photons (see Fig. 8).

The optical system simulation takes into account the mirror and corrector lens reflectivity, transparency, the SiPM quantum efficiency and geometry of the photon sensitive camera. The resulting root mean square (RMS) of the light spot on the camera plane is shown in Fig. 9.

The FPA has been simulated using the geometrical shape of arrays and their appropriate fill factors in the micro-cells and in the arrays.

In the simulation we use the Photo-Detection Efficiency (PDE) of the FBK technology NUV-HD, optimized for the UV band shown in Fig. 10, at an over-voltage of V_{over} = 6 V [2]. Also the PDE of a NUV-HD bare sensors and of an RGB sensor (optimized for the optical-IR region) are shown.

To estimate the sensitivity and performance to the expected UHECR signal, a dedicated generator was interfaced to the Geant 4 simulation.

We use the Emission for Extensive Air Showers Cherenkov Simulation (EASCherSim) [11] as physics event generator. EASCherSim provides the average photon density, photon spectral composition (Fig. 11), the photon angle with respect to the shower axis and time (Fig. 12) of photons. We assume a uniform distribution of the azimuth angle with respect to the telescope axis and the absence of the correlation between photon angles, time and wavelength. For the moment it can only simulate proton interactions. The composition of UHECRs is mixed at 100 PeV (see e.g. [13]). Additionally Pierre Auger found out that it is dominated by light elements at 2000 PeV [12] and becomes heavier at higher energies. Hence, in the future we will investigate a mixed composition.

An example of the shower image on the camera plane is shown in Fig. 8 (middle panel) next to the simulated PSF for the same location on the camera plane (right panel).

As an example of results on the Terzina performance from the simulation, we also show the aperture of Terzina. The plot assumes the NGB and DCR of the first year of operation (see Fig. 13). A threshold of 7 p.e. per pixel, which suppresses the background, is assumed.

4 The environmental background of Terzina: the night glow.

The Night Glow Background (NGB) has been estimated in two different ways. Firstly, using the formula:

$$\text{Rate per pixel} = S \times d\Omega \times Flux \times Area \times PDE_{eff.} \quad (1)$$

where $Area$ = 0.1 m^2; PDE_{eff} = 0.1 is the total optical efficiency calculated from the convolution of the SiPM PDE and the NGB spectrum, as a function of wavelength times an average optical of the 2 mirrors; $\Delta\Omega$ is the pixel solid angle; $\text{Flux}[m^{-2}sr^{-1}ns^{-1}]\Big|_{\lambda=1000\ nm}^{\lambda=300\ nm} = 1.55\times10^4$; S = 6 is a conservative safety factor considering the possible largest variation of the glow, the rate per pixel is ~10 MHz [15].

Secondly, using the full simulation described in Sec. 3, we propagate photons assuming the NGB spectrum and a uniform angular distribution. Increasing the rate by a safety factor of 6 [6], which provide the typical variation with zenith angle of showers, we obtain a pixel background rate of ~5 MHz. Given the discrepancy between the two estimates, we decided to use the more conservative value of 10 MHz per pixel (see Fig. 14).

5 Event size and data throughput

The maximum daily data throughput for Terzina is 45 Gbit/day. Assuming that the data throughput will be

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[2] V_{over} = $V_{operation}$ (operational voltage) - V_{bd} (break down voltage)