MUEGAMMA PROTOTYPE TIMING COUNTER TESTS

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The aim of the **MuEGamma** experiment is to search for the lepton-flavour violating decay $\mu \to e\gamma$ to a sensitivity of $\sim 10^{-14}$, more than two orders of magnitude lower than the current search limit set by the MEGA-experiment at LAMPF [**?**]. In order to achieve this goal, a detector capable of handling the intense surface muon rate, produced by the πE5 beam at PSI, and able to resolve the positron and photon from the decay with the best possible momentum/energy-, positional- and timing-resolutions, is required.

The main detector components, are shown in Fig.**??**. Surface muons of 28 MeV/c enter the thin-coil, superconducting solenoid and are stopped in a small, thin target. The subsequent decay of the muon leads to a Michel positron, which exhibits a spiral path with increasing pitch, the bending radius of which depends entirely on its total momentum and is 'independent' of its emission angle. These novel features are achieved by the gradient field of the solenoid magnet, with a maximum field strength of 1.27 T at the centre of the detector and decreasing axially. The positron momentum and angle are determined by tracking the particle with a set of azimuthally spaced, staggered-cell drift chambers, while the energy, timing and angle of the photon are obtained from a liquid Xenon calorimeter, viewed from all sides by some 800 photomultiplier tubes. The timing of the positron and hence the trigger condition for coincident back-to-back decay products, is given by a set of fast, double-layered, orthogonally placed, scintillator timing-counter arrays, positioned at opposite ends of the detector.

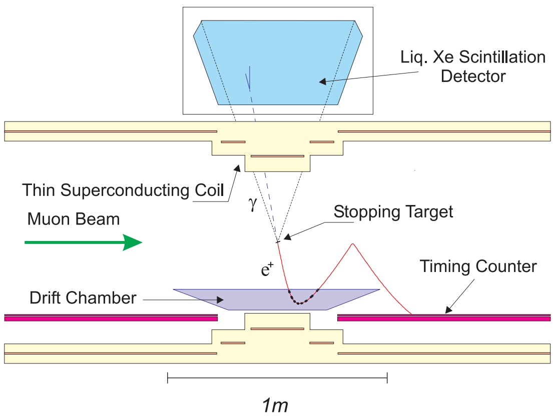

Figure 1: *Plan View of the MuEgamma Detector showing the main components, as well as an example of the decay trajectories of the positron and photon.*

Several timing-counter prototypes were built and tested at the cosmic ray test facility CORTES at INFN Pisa. The results reported below are for a (100 x 5 x 1) cm^3 Bicron 404 scintillator bar, wrapped with 50 μm of aluminized Mylar foil and coupled to Philips XP2020 UR photomultiplier tubes (PMTs) at either end. Tests were also done with Hamamatsu R5946 fine mesh tubes and variously shaped light guides.

The CORTES facility consists of a set of cosmic trigger counters, placed above and below the central tracking region, with two sets of four planes of Microstrip Gas Chambers (MSGCs) [**?**]. The dimensions of each chamber are 10 cm x 10 cm. Each set of the four planes of MSGCs provides two sets of orthogonal coordinates via two stereo planes inclined at 5.7°. Two additional fast timing counters, placed behind each other and just below the upper trigger counter give a good timing reference signal for the scintillator bar to be tested, which is placed between the two sets of MSGCs. The track impact point along the counter to be tested was reconstructed with a resolution better than 1 mm.

The cosmic muon timing, relative to the reference counters, is independently measured by each of the PMTs at either end of the counter, after corrections are made for "time-walk" effects. The resultant resolutions are shown in Fig.**??**. The weighted average of the two measurements is of the order of $\sim$ 60 ps, independent of the position along the counter. It was also checked that the timing resolution depends on

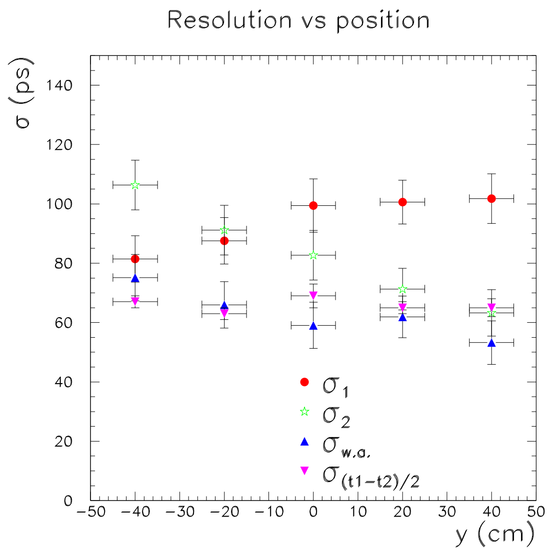

Figure 2: *Timing resolutions measured along the length of the counter.*

the square-root of the total number of photoelectrons. A full Monte Carlo simulation, taking into account the measured values, shows that the required 40 ps timing resolution stated in the proposal, will be obtained with a suitable counter geometry, the engineering studies of which are in progress.

REFERENCES

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