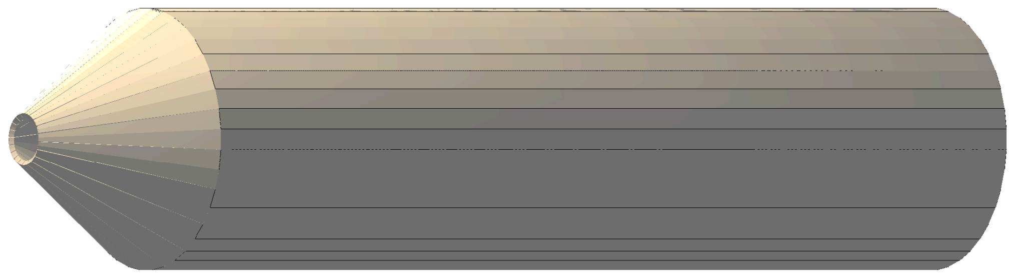

Figure 1: 3D impression of the start counter. The conical section represents the downstream end of the detector. The 'hole' diameter is 20 mm.

Start Counter Update

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1 General Description

The main purpose of the GlueX start counter (figure 1) will be, in coincidence with the tagger, to identify the electron beam bucket associated with the detected particles. It will be used mainly in the initial, low intensity phase of the experiment but is designed to operate at photon intensities of up to $10^8 \gamma/s$ as well.

The detector consists of an array of 40 scintillators with 'pointed' ends that bend towards the beam at the downstream end. The straight section is 500 mm long while the part bending towards the photon beam is about 100 mm long (figure 2). The minimum distance between the photon beam and each scintillator element is 10 mm. This arrangement makes is possible to trigger on charged particles at angles between 3.0° and 134° over the full length of the target. The segmentation has been chosen in order to have an electromagnetic rate per scintillator element of not more than 200 kHz for the high beam intensity.

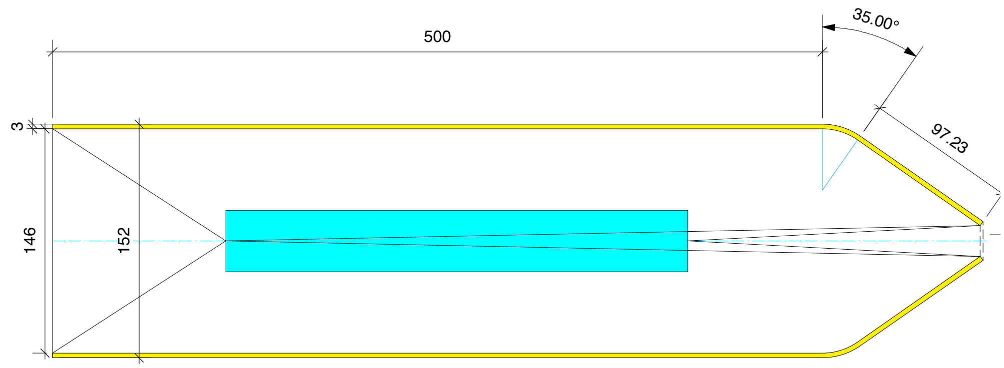

Figure 2: Cross section through the start counter along the beam line. Yellow: scintillator bars, turquoise target. Two particle tracks are indicated representing the smallest angles with respect to the beam that still hit the start counter

Figure 3: Front view of a single scintillator element.

The array has been designed in such a way that the individual bars will be glued together in order to form a rigid structure approximating a cylinder with a conical end. In this way the entire detector will be mostly self-supporting to minimize the amount of inactive material surrounding the target. Cross talk between the scintillator elements will be eliminated by inserting a thin layer of aluminized mylar between the glue joints. The asymmetric shape of the scintillator cross sections prevents the glue joints from pointing to the beam position(figures 3,4). This eliminates particles from 'slipping through the cracks' of the array without producing a signal. We are currently waiting to hear from the scintillator manufacturers on the possibilities and the costs of having these shapes produced. As scintillator materials we plan to use a

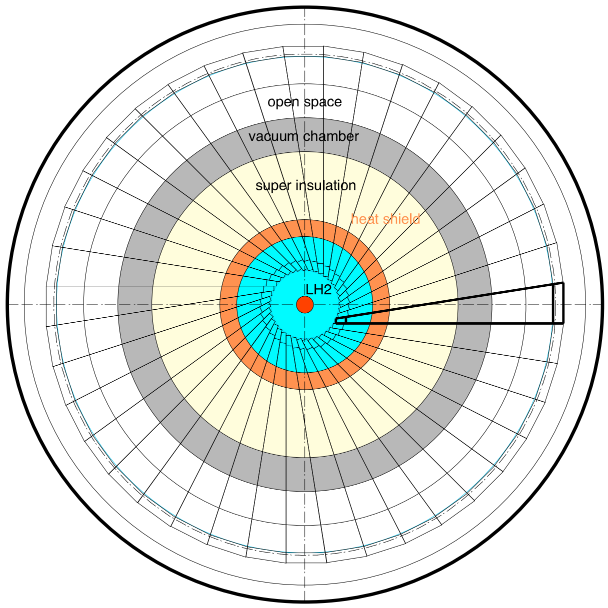

Figure 4: Front (upstream) view of the start counter including the various areas representing schematically the target, vacuum chamber and support structure as well as the inside of the CDC.

fast scintillator with a decay time of the order of 2 ns and a long attenuation length such as EJ-200. The emission spectrum of EJ-200 is well matched to bialkali photocathodes such as the one of the Hamamatsu PMT R5924-70.

2 PMT and Light Guide Based Readout

With a typical energy loss of 0.5 MeV (for minimum ionizing particles) in the scintillator, a scintillator light output of the order of 8000 photons/MeV, a light collection efficiency of 18%, a 2m rigid light guide and a quantum efficiency of about 20% we expect on the order of 62 photo electrons from the PMT photo cathode. Together with a transit time spread for the Hamamatsu R5924-70 of 0.44 ns we estimate a time resolution of $\sigma \approx 0.27$ ns corresponding to a FWHM ≈ 0.64 ns. These resolutions will certainly allow the identification of the beam buckets which are about 2 ns (or 6.4 sigmas) apart. The R5924-70 PMT is capable to operate in a magnetic field of 0.5T with a gain of $4.1{\cdot}10^6$ and at 1T with a gain of $2.5{\cdot}10^5$. The gain as a function of magnetic field is shown in figure 5 for two field directions, 0°(along the axis of the PMT) and

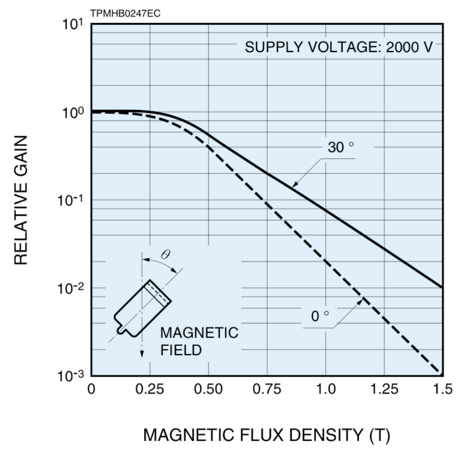

Figure 5: The gain of the Hamamatsu PMT R5924-70 as a function of the magnetic field (from the Hamamatsu catalog)

for 30°. We plan to place the PMT in an area where the magnetic field is of the order of 0.2T, which would result in a gain of $\approx 0.9{\cdot}10^7$. These estimates agree quite well with measured time resolutions wiht cosmic rays using a 5 mm scintillator bar and a R5924 high field PMT (see GlueX document 860-v1)

3 SiPM Based Readout

If suitable SiPM become available the readout system of the start counter can be considerably simplified. The SiPM would then be connected either directly to the scintillator bars or via a very short (a few centimeters) light guide. If these detectors are directly coupled to the scintillator bars the expected number of photo electrons would increase to about 176 and the corresponding time resolution would improve to $\sigma \approx 0.16$ ns or a FWHM of ≈ 0.37 ns. Including the short light guides the time resolution would be $\sigma \approx 0.22$ ns and the FWHM ≈ 0.51 ns.

4 Support Structure

The support structure will be kept at an absolute minimum in the active region of the detector and made of up to 0.8 cm Rohacell. Its details including the coupling of light guides to the scintillator bars and the exact routing of the light guides or the mounts of the SiPM still need to be designed.

Rohacell material parameters.

A	Z	Weight
1.008	1	11
12.01	6	8
14.008	7	1
16.0	8	2

General detector parameters	
Paddle length	500 mm
Paddle width	10 mm
Paddle (max) length after bend	97.23 mm
bend angle	35°
bend radius	40 mm
Distance from beam center to	
inner support structure	65.00 mm
Thickness of inner support	8.00 mm
Density of inner support	0.110 g/cm^2
Thickness of scintillator	3.0 mm
Location of the detector :	
target center – downstream end of start counter	340 mm

5 Simplified Description for Simulations

The start counter geometry for GEANT could also be described by an array of 40 elements. Each element consists of a tube segment, representing the straight part of the paddle, and 2 conical segments which represent the bent part. The light guides can also be represented by tube segments leading to the upstream end of the solenoid. The same also applies to the Rohacell support.