Electronics for the BigBite Auxiliary Plane

G.Ron, E. Piasetzky, M. Zilka

1 Introduction

The BigBite detector will be installed in JLAB Hall A, during July-Sept 2002, for parasitic runs. We also plan to check it with cosmic rays perior to the installation in the Hall (June-July 2002).
In order for the installation to proceed on schedule electronics for the auxiliary plane need to be finalized now. Electronics for the $E/\Delta E$ planes will be implemented according to a design by Glasgow university [1].
The Auxiliary plane consists of 56 scintillator detectors, each connected to a single PMT. For a total of 112 channels, 56 for the TDC, and 56 for the ADC.

Two options were proposed for the electronics:

- A. Front End electronics to be placed next to the detector and a long ($\sim 500ns$) delay cable for each channel (for coincidence with HRS detectors) to be laid for each of the channels, eventually reaching a rear end electronics area (see Figure 1).
- B. A $\sim 15m$ cable to be laid for each PMT (not per channel) to the electronics area, delay, amplification and discrimination to be performed within the electronics area (see Figure 2).

Obviously, a more cost effective solution would be to select option B, cutting down on cabling, connector, and electronics cost. However, in option B no processing is performed on the signals from the PMT prior to being transferred to the electronics area via the coax cable, thus, signal degradation, particularly with respect to time resolution, will occur.

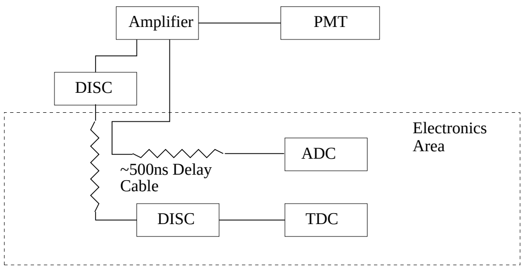

Figure 1: Option A - Front End Electronics

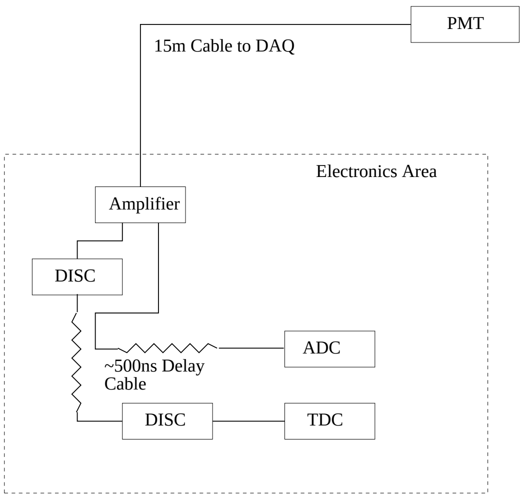

Figure 2: Option B - No Front End Electronics

2 Testing

In order to select between the two proposed electronics schemes, the effect of a 15m cable on time resolution was tested. A comparative test was performed on the auxiliary plane configurations by using two detectors placed one atop the other, simulating the auxiliary and $E/\Delta E$ plane detectors. The signals from both detectors were input to constant fraction discriminators, the resulting logic pulses were used to start and stop a LeCroy 3100 QVT set a t-mode (the upper and lower detectors, triggering the start and stop, respectively) (see Figure 3). Thus using this configuration, the time resolution for the base configuration (short cables) was measured.
After measuring the time resolution for the base configuration, 20m cables were added between the PMT outputs and the CFD inputs (simulating option B) (see Figure 4), again the pulses were used to start and stop the QVT, giving us an estimate of the degradation is time resolution due to adding a 20m coax cable to each PM. In both tests an ^{90}Sr source was used to trigger the detectors.

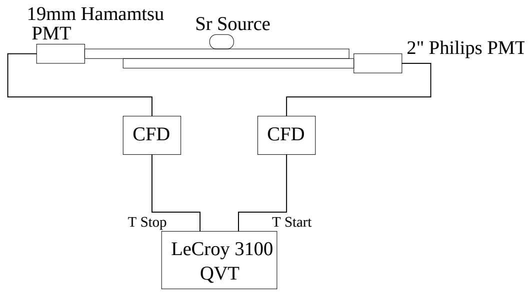

Figure 3: Test Configuration - Base

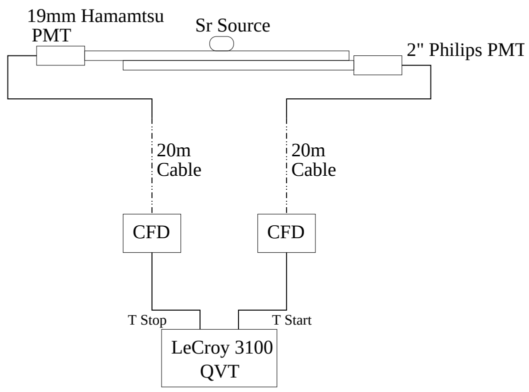

Figure 4: Test Configuration - With Delay Cables

3 Results

In the tests performed the following results were measured:

- For the base configuration (Figure 3), a time resolution of ~ 1 channel ($\sim 100ps$) FWHM, was measured, it is noted that since the resolution of the QVT is 100ps per channel, the resolution may have been superior but unmeasurable.

- Using the 20m coax cable increased the FWHM of the output to $\sim 2-3$ channels ($\sim 200-300ps$). Thus, the estimated degradation in time resolution (σ) is in the order of 100ps.

4 Momentum determination

Since the time of flight measurements between the auxiliary and $E/\Delta E$ planes will be used to determine particle momentum, a simple calculation is in order.
The distance between the two planes is 1m. The expected momentum for the highest energy detected protons is $500MeV/c$, giving a value of $\beta \sim 0.47$. Thus the time of flight for the particle will be $TOF \sim 7.1ns$. Assuming a combined degradation in time resolution from both planes to be in the order

of $\sqrt{2} \cdot 100ps = 140ps$, the degradation in momentum resolution will be in the order of

$$\sigma = \frac{0.14}{7.1} 500 \sim 10 MeV/c \left(\frac{\Delta P}{P} = 0.02 \right)$$

The same calculation for a 300MeV/c particle yields a degradation of $\sigma \sim 4MeV/c (\Delta P/P = 0.015)$.
To set the scale we can compare the results to the contribution to the momentum uncertainty due to the fact that we do not know the exact location of the hit along the Auxiliary detector. If we assume $\sigma \sim 5cm$, the resulting uncertainty in time of flight (for a 500 MeV/c particle) is $5cm \cdot 5ns/m = 250ps$

5 Recommendation

In view of the results for the tests performed, which are well within accepted values for the triple coincidence experiment, and the large saving in costs and installation, it is our recommendation to select and proceed with option B for the trigger electronics (i.e. no front end electronics, all signal processing and delay to be performed near the electronic area) (See Figure 5).

6 Shopping list for cable and electronics

Cables:

Type	Connector 1	Connector 2	Comments	Quantity
RG58	BNC	BNC	Det. to elc. area	$64 \times 20m$ (incl. spares)
HV	HV	HV	Det. to elc. area	$64 \times 30m$ (incl. spares)
LEMO				$224 \times 16ns$

Patch Panels:

Number	Connectors	Comments	Number of Connectors
A	BNC to LEMO		64 (incl. spares)
B	BNC to LEMO		4 X 64

Electronics:

- $4\times$Philips 776 ($10\times$ Amplifier, 16 channels).

- 4×LeCroy 3412 (16 channel CAMAC discriminator).
- 2×CAEN VME 792 (32 ch. QDC).
- 2×CAEN VNE 775 (32 ch. TDC).

Crates/Bins:

- 1 NIM Bin.
- 1 CAMAC Crate.

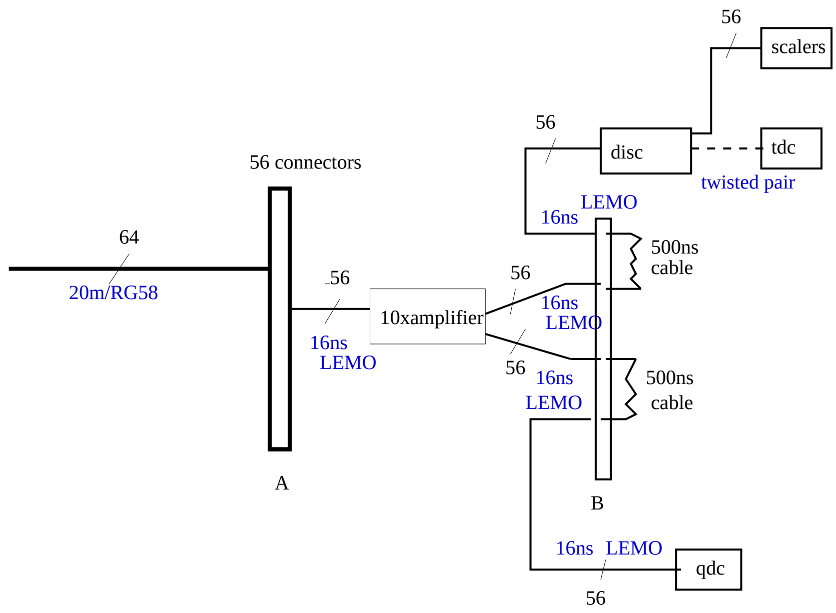

Figure 5: Detailed Configuration

References

[1] "Big Bite Trigger Specifications and Consting", J.R.M Annand