CLAS-NOTE 96-003

Proposal for the E-T Coincidence Mapping Module

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March 14, 1996

1 Introduction

The focal plane of the Thomas Jefferson National Laboratory (previously known as CEBAF) photon tagger, located in Hall-B, is instrumented by two parallel planes of scintillators. These two planes have different functions, but their combined information is required for a 'tagged event' to be deemed as such. For more information on the tagger proper, please refer to [1].

The first plane is made up of 384 scintillators, called the E-counters. Their express purpose is to detect the location of the residual electron, and thereby determine the energy of the corresponding photon. These scintillators overlap each other by a third, effectively allowing for 767 channels in the tagged photon energy range.

The second plane is made up of wider scintillators, the T-counters, which are read at each ends by a pair of photomultiplier tubes. Their purpose is to minimize the time resolution of the event, so as to synchronize it correctly with the hadron detector.

For a tagged event to be considered acceptable, a coincidence between the E-plane and the appropriate counter along the T-plane must be established. While this can be performed easily by software, it has been deemed beneficial to perform this coincidence in hardware first. This would have for effect to greatly reduce the background, reduce the amount of useless data collected during the experiment, as well as reduce the overall dead-time. A specific module must then be built to perform the task of selecting only those events for which a coincidence between the E and the T-counters is meaningful.

We have studied a number of solutions, and we presently report only on the one retained. Its implementation is discussed within the framework of the hardware logic. We also discuss explicitly the mapping as well as the features provided by this module. Finally, we discuss the flexibility provided by allowing for the choice between two possible mappings; namely keeping only 52 T-counters as specified in the original design, or allowing for the 61 T-counters focal plane as required by some experiments.

2 System Requirements

We show on figure 1 [2], the original tagger cabling scheme as proposed by E. Smith.

Starting with the E-counter branch, the signals are patched through the ASU-ADML, where they are rerouted into a set of TDCs. Another set of outputs, using ECL levels, exist which combine the 384 original data lines, by groups of 8, into 48 data lines.

In the T-counter branch, the signals are patched into separate CFDs. The output from each CFD is then routed into the input of coincidence units, Phillips 754, allowing only left/right coincidences. It is important to realize that, as opposed to the E-branch, the signals in the T-branch are all NIM levels, carried through lemo cables. Prior to the coincidence units, there are, depending on the final geometry of the tagger plane, either 104 (2×52) or 122 (2×61) data lines corresponding to each photomultiplier of the T-counters.

As previously stated, we only discuss here the solution which was retained for the implementation of the E-T coincidence unit. This Unit should accept as its input the output from the ASU-ADMLs. In other words, the input of the E-T coincidence unit are the 48 signals from the E-counters.

The input signals are then rerouted, according to the appropriate map, into 52 (or 61) outputs corresponding to each T-counter channel. These output are then connected to the input of the Phillips 754 coincidence units. The requirement for a 'good tagged event' would then be the coincidence between three signals: left and right PM of the T-counter, and a signal from the appropriate output of the E-T coinc module.

Figure 2 displays the final, relevant part, of the tagger electronics. The configuration of the system is only shown up to the 3-fold coincidence unit. The times of transit through the various elements are shown in italics. The cumulative times of propagation from the original bremsstrahlung interaction are shown by the underlined quantities. The quantities in parentheses correct for the extra 10nsec difference between the E and the T signals as measured by H. Crannell [4]. Most transit times are quoted from [4], except for that through the E-T coinc unit itself, which is quoted from [5].

The strongest objection to this configuration lies in the difference in propagation time of the signals to the input of the coincidence. It takes around 183 nsec for the signals from the E-counters to reach it, as opposed to only around 160 nsec (at most) for the T-counter signals. This means that an extra delay of around 20 nsec would have to be applied to the T-counter data lines, possibly degrading the signals.

The strength of this solution, on the other hand, lies in its simplicity. The module itself is only a rerouter and performs no other active function such as verifying coincidences. It can easily be bypassed electronically or manually (i.e. be taken out), without having to rewire anything. Finally, selecting between the two possible mappings is significantly easier with this scheme than it was with any of the other schemes considered.

3 Physical Characteristics of the E-T Coincidence Module

- Input: 48 ECL signals from the ASU-ADML. These signals will be received by the concidence unit on three separate 34 pins (2x17) connectors.
- Output 1: 48 ECL signals fed into scalers. These signals will be transmitted from the concidence unit on three separate 34 pins (2x17) connectors.
- Output 2: 61 Lemo jacks, NIM levels, to 61 lemo cables. These signals are fed into the coincidence units corresponding to each of the T-counters. The signals from these output should be fairly long so as to insure that the timing of the final E-T coincidence is performed off the signals from the T-counters themselves, and not from the E-counters. Furthermore, the unit must be updating.
- One toggle switch to bypass the E-T coincidence module. This switch has for effect to drive all 52(61) NIM output to 'high'.
- One lemo input jack, NIM level, to perform the above operation remotely.

It has been suggested that this unit be packaged as a Fastbus module. The E-T coincidence module, due to the large number of input and output cables, is going to be rather large. It was also noticed that within the bays containing the tagger electronics, there is a FASTBUS crate which is under-utilized. Use of the empty slots within this crate would further allow us to power the module.

4 The Coincidence Maps

The correlations between E and T-counters have been determined using a Monte-Carlo calculation, written by D. Sober, for a primary electron energy of 900 MeV. This calculation includes multiple scattering effects as well the bremsstrahlung angular distribution. E-groups which contribute less than 0.1% of a T-counter rate have been omitted.

Figure 3 is a representation of the map used for operations with 52 T-counters, while figure 4 is that used with 61 T-counters. On the ordinate are the 48-ECL input lines from the E-counters, while on the abcissa are the NIM T-counters output. The black dots represent the physical connections. Thus, as an example, E-counter line 47 is physically connected to T-counters output data lines 56 though 59 in both schemes. Similarly, T-counter 58 is connected the E-counters input data lines 47 and 48.

While the original scheme provided for two distinct maps, one of us (DS) realized that by judicious labeling of the ouput data lines to the T-counters coincidences, and by modifying very slightly the 'acceptance band', one could get away with having only one map. This explains the presence of gaps within the acceptance band of figure 3.

Old numbering scheme	New numbering scheme	Comment
T1-T4	T1-T4	no numbering change
T5	T6	
T6	T8	Old T4-T10 replaced
T7	T10	by narrower
T8	T12	counters
T9	T14	
T10	T17	
T11-52	T20-61	Old numbering +9

Table 1: New numbering scheme for 52 T-counters operations.

Figure 5 shows the final map to be used in the E-T coincidence module. The open circles are suggested connections to conservatively insure coincidences between the two sets of counters.

5 Operation of the Module

Operation of the E-T coincidence module ought to be exceedingly simple. Three ribbon cables from the banks of ASU-ADMLs are plugged into the input of our module. The ECL outputs are sent to scalers in a similar fashion. It is felt strongly that separate monitoring of at least one branch of the final coincidence must be performed during data taking runs. This is done in addition to monitoring the scalers at the output of the Phillips 754 coincidence modules.

Finally, the NIM output cables are plugged into the above mentioned Phillips 754 coincidence modules. The numbering scheme, however, needs to be revised slightly in order to allow for the simple switching between 52 and 61 T-counters operation.

The suggested numbering to be used for 52 T-counters operation is listed in table 1. From this table, it is noted that the active output channels are T1-4, 6, 8, 10 , 12, 14, 17, and 20-61. The inactive channels are T5, 7, 9, 11, 13, 15, 16, 18, and 19. This numbering must be reflected in the numbering of the signals from the tagger detector plane itself.

Evidently, for 61 T-counters operation, the ouput of the E-T coincidence module is on a 1-to-1 basis with the T-counters.

It is also worth mentioning again that the NIM output pulses from the E-T coincidence unit must be sufficiently wide so as to insure, not only an overlap with the T-counters, but also that the timing is determined by the T-counters and not by the E-counters.

Finally, a simple toggle switch is provided to manually bypass the E-T coincidence unit. It is suggested that a feature be included within this module to perform this same operation remotely.The NIM input is designed for such a purpose. It is suggested that it acts as a dead-man switch effectively disabling the unit by driving all 61 NIM output to high when no signal is applied to it. When a 'high' signal is encountered, this feature is disabled and all 61 ouput are operational.

References

[1] H. Crannell, *CEBAF Tagger electronics, DRAFT 5*, (June 2, 1994).

[2] E. Smith, private communication.

[3] H. Crannell, private communication.

[4] S. Matthews, *Timing of the Tagger Master OR Signals - First Draft*, (Dec 19th, 1995).

[5] D. Ouimette, private communication.

Figure Caption

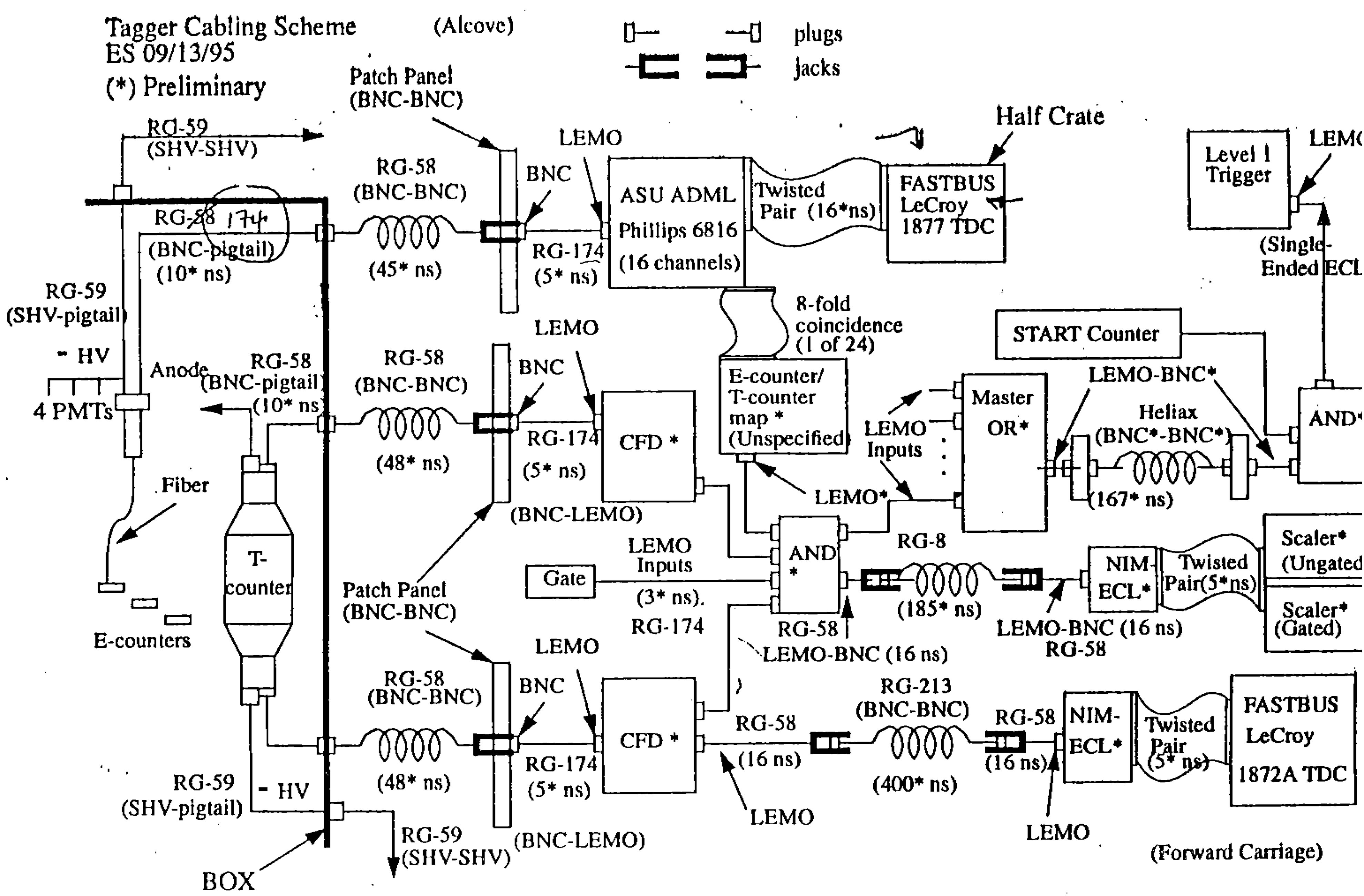
Fig 1 : The original Tagger cabling scheme proposed by E. Smith on sept 13th, 1995.

Fig 2 : Close-up of the tagger electronics, showing explicitly the location of the E-T coinc module. The underlined quantities are times measured from the time the interaction happened in the radiator. The quantities in italics represent the transit times of the signals through the various devices.

Fig 3 : Intermediate Mapping of the coincidence for 52 T-counters operation. The filled dots are physical connections.

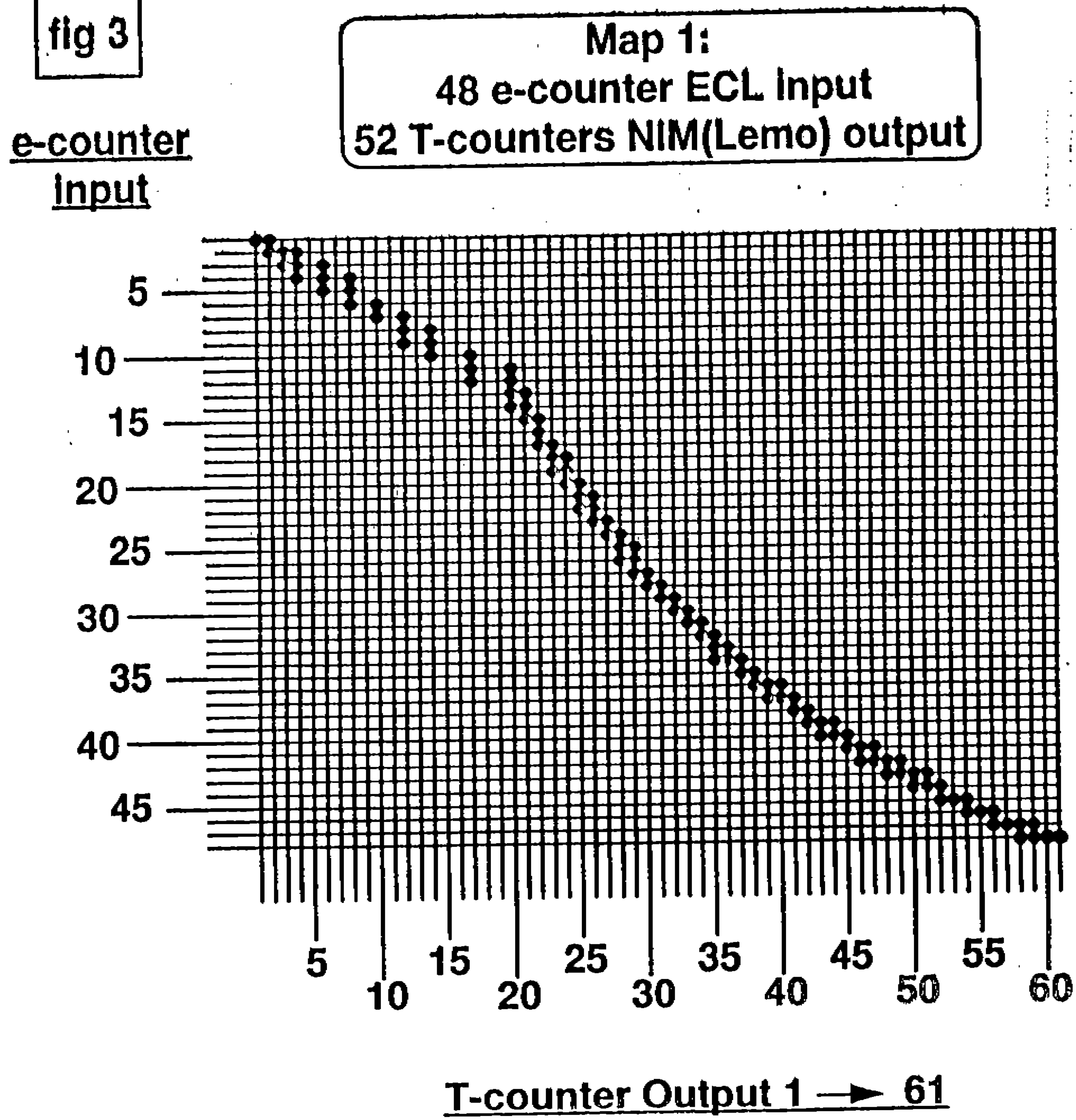
Fig 4 : Intermediate Mapping of the coincidence for 61 T-counters operation.

Fig 5 : Final Mapping of the E-T coincidence module. The open circles are suggested connections to conservatively insure a coincidence between the two detector planes.



Tagger Cabling Scheme
ES 09/13/95
(*) Preliminary
(Alcove)
plugs
jacks
Patch Panel
(BNC-BNC)
Half Crate
LEMO
RG-59
(SHV-SHV)
RG-58
(BNC-BNC)
BNC
ASU ADML
Phillips 6816
(16 channels)
Twisted
Pair (16*ns)
FASTBUS
LeCroy
1877 TDC
Level 1
Trigger
RG-58 174
(BNC-pigtail)
(10* ns)
(45* ns)
RG-174
(5* ns)
(Single-
Ended ECL
RG-59
(SHV-pigtail)
8-fold
coincidence
(1 of 24)
START Counter
- HV
4 PMTs
Anode
RG-58
(BNC-pigtail)
(10* ns)
(48* ns)
CFD *
E-counter/
T-counter
map *
(Unspecified)
LEMO
Inputs
Master
OR*
LEMO-BNC*
Heliax
(BNC*-BNC*)
(167* ns)
AND*
Fiber
T-
counter
LEMO*
(BNC-LEMO)
E-counters
Patch Panel
(BNC-BNC)
Gate
LEMO
Inputs
(3* ns).
RG-174
AND
*
RG-8
(185* ns)
NIM-
ECL*
Twisted
Pair(5*ns)
Scaler*
(Ungated
Scaler*
(Gated)
RG-58
LEMO-BNC (16 ns)
LEMO-BNC (16 ns)
RG-58
RG-213
(BNC-BNC)
RG-58
(16 ns)
(400* ns)
(16 ns)
Twisted
Pair
(5* ns)
FASTBUS
LeCroy
1872A TDC
RG-59
(SHV-pigtail)
- HV
RG-59
(SHV-SHV)
(BNC-LEMO)
BOX
(Forward Carriage)

fig 3


Map 1:
48 e-counter ECL input
52 T-counters NIM(Lemo) output
e-counter input
5
10
15
20
25
30
35
40
45
5
10
15
20
25
30
35
40
45
50
55
60
T-counter Output 1 → 61

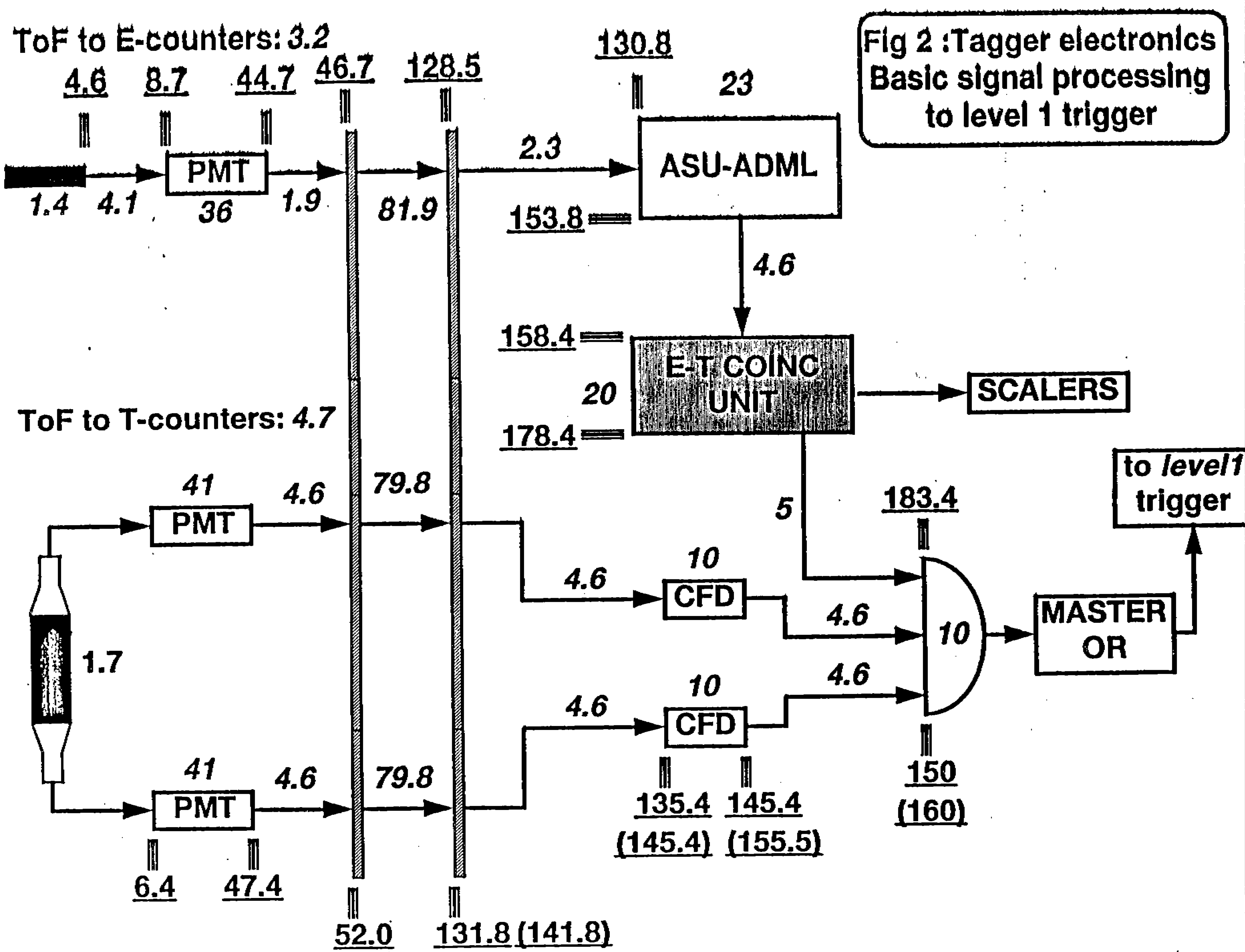
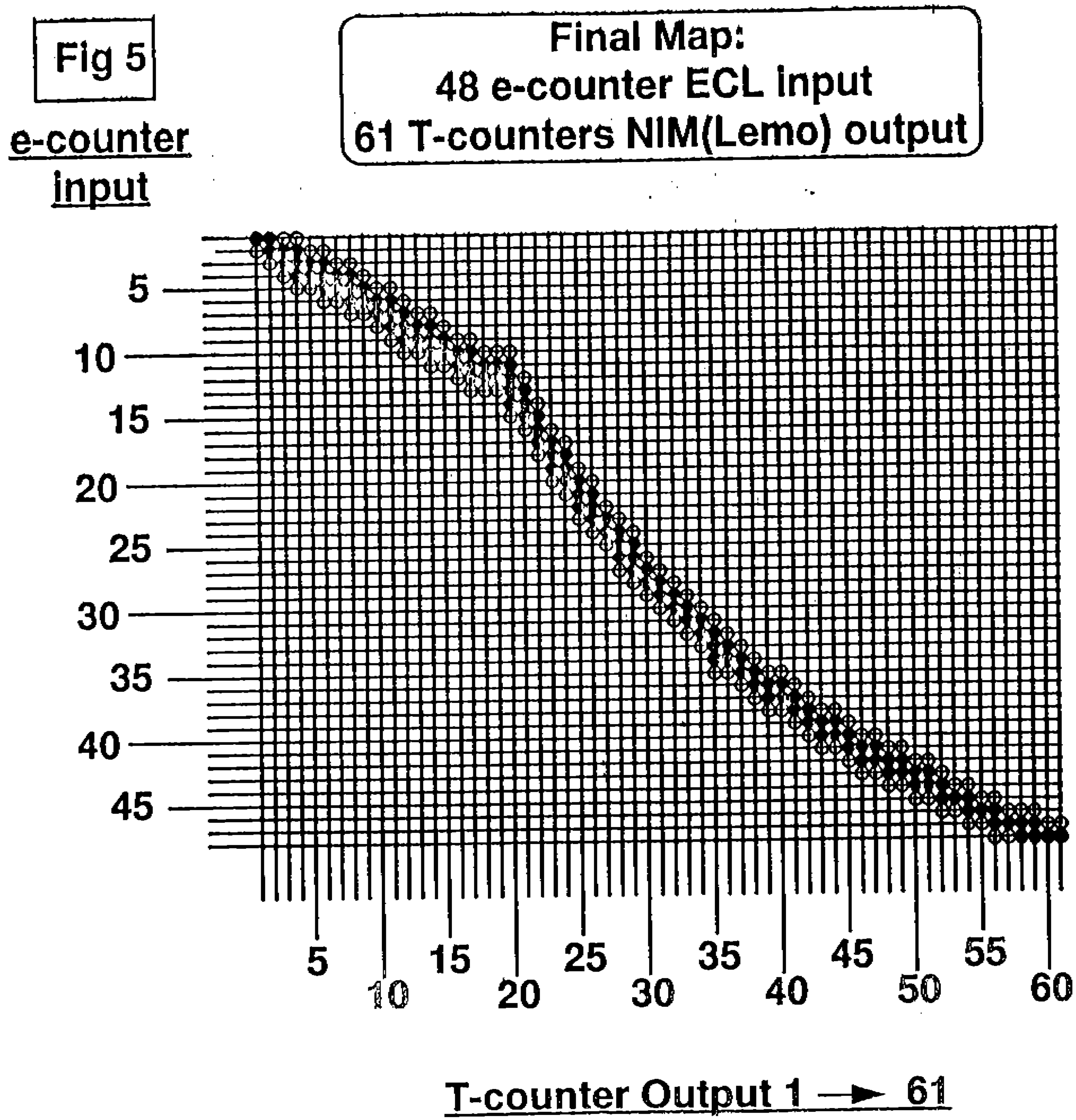


Fig 2 :Tagger electronics
Basic signal processing
to level 1 trigger

Fig 5



Final Map:
48 e-counter ECL input
61 T-counters NIM(Lemo) output
e-counter input
5
10
15
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45
5
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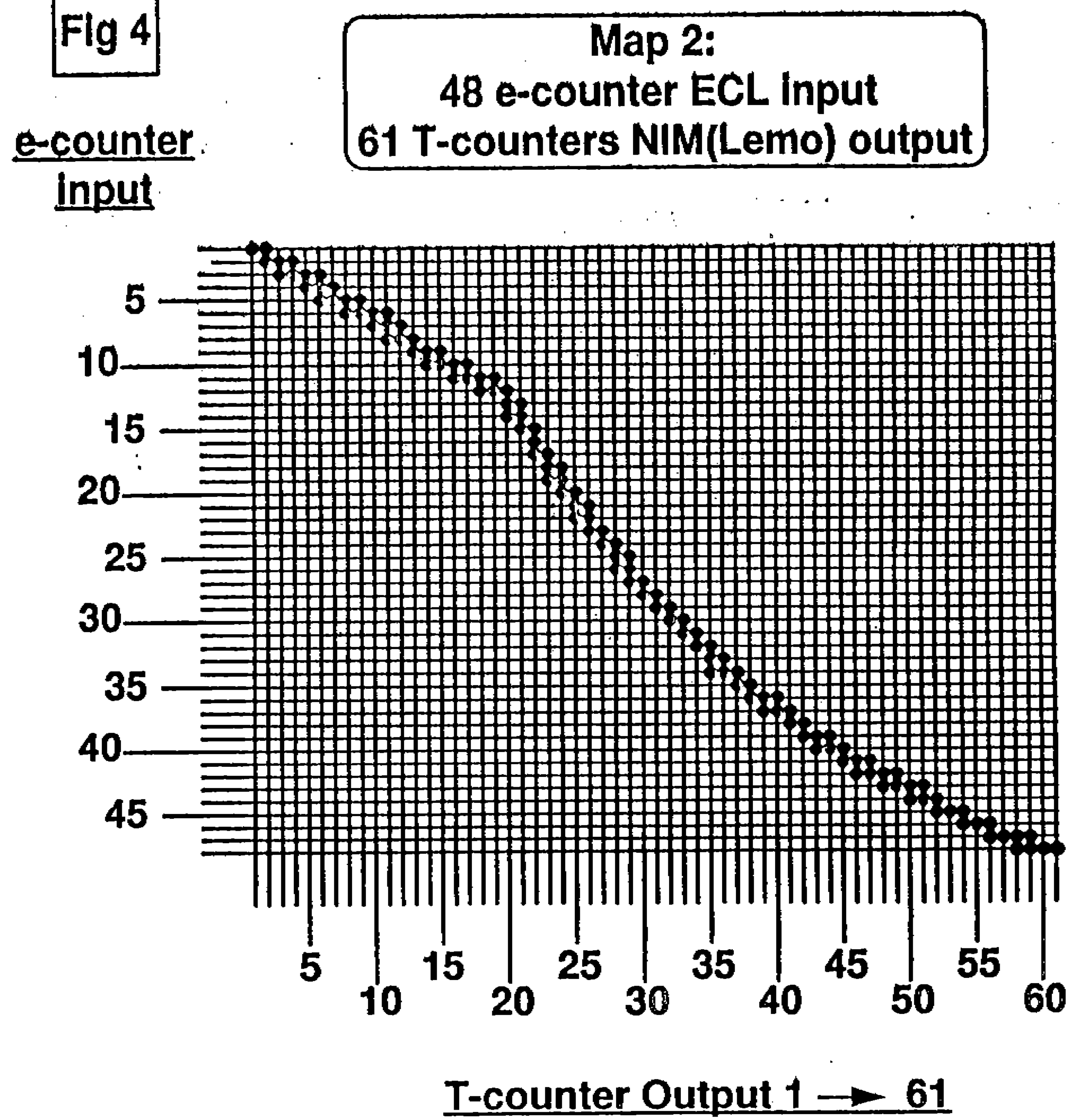
15
20
25
30
35
40
45
50
55
60
T-counter Output 1 → 61

Fig 4


Map 2:
48 e-counter ECL input
61 T-counters NIM(Lemo) output
e-counter input
5
10
15
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45
5
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15
20
25
30
35
40
45
50
55
60
T-counter Output 1 → 61