

# Introduction for BigBite trigger logic for SBS form factors experiments

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## 1 Short introduction on BigBite spectrometer in Super BigBite form factors experiments

The BigBite spectrometer will play a central role in the SBS form factors experiments. It will fill different purposes:

- measure the vertex of the elastic  $e - N$  interaction;
- measure the elastic electron momentum;
- provide a precise time reference for the elastic electron;
- reject pions;
- provide the main trigger for the reaction;

To accomplish these missions, the BigBite spectrometer is equipped with a detector package (see Fig. 1) composed of the following detectors:

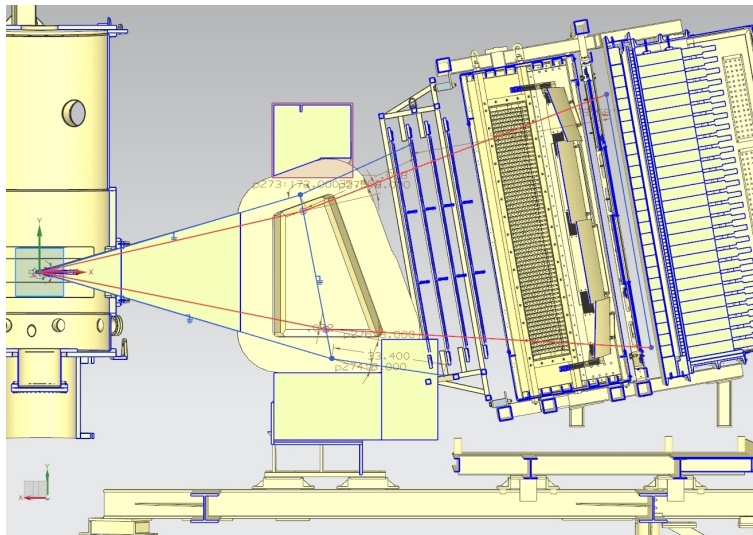


Figure 1: The BigBite spectrometer with the upgraded detector stack.

- GEM trackers (to measure the vertex of the elastic  $e - N$  interaction and the elastic electron momentum);

- the GRINCH cherenkov counter (to reject pions);
- the timing hodoscope (to provide a precise time reference for the elastic electron);
- The calorimeter (to measure the electron energy, provide some level of pion rejection, and provide the elastic electron trigger);

In the rest of this document, we will focus on the description of the elastic electron trigger logic for the SBS form factors experiments.

## 2 BigBite trigger for SBS form factors experiments

### 2.1 Trigger logic

For the SBS form factors experiments, the trigger logic relies only on the BigBite preshower and shower. The shower is composed of 189  $8.5 \times 8.5 \text{ cm}^2$  section ( $\times 37 \text{ cm}$  length) lead glass modules, laid out in an array of 27 rows and 7 columns. The preshower is composed of 52  $9 \times 9 \text{ cm}^2$  section ( $\times 37 \text{ cm}$  length) lead glass modules, laid out in an array of 26 rows and 2 columns (the modules being laid out transversely with respect to the spectrometer central ray).

The lead glass modules section is over 3 times the Moliere radius of the material, which means that the electromagnetic shower is completely contained in a 2x2 module sum in the shower and in a 2 row sum of the preshower. Hence, the shower of a quasi-elastic electron should be entirely contained into the sum of two rows of modules from the BigBite preshower plus the sum of two rows of modules from the BigBite shower. Since the geometry of the preshower and shower blocks is not exactly the same, there is not a one-to-one correspondence between the sum of two rows from the preshower and the sum of two rows from the shower that must be associated. Fig. 2 shows these correspondences, and we can deduce from that which sum of two rows from the shower have to be associated with each of the two rows from the preshower.

### 2.2 Trigger implementation

To implement such a trigger, we use NIM electronics modules to treat the signals from the BigBite preshower and shower modules. This signal first needs to be amplified. For the shower, this is done with a 7-sum/amplifier custom modules (#1 in Table 1) which take as input the signals from 7 modules (1 row) from the shower. A copy of the individual shower modules signals is sent to the BigBite weldment through 500ns delay cables to be recorded by FADCs. For the preshower, the signal is amplified with PS 776 16 channels amplifiers (#2 in Table 1). One copy of the of the amplified preshower modules signal is sent to the BigBite weldment through 500ns delay cables to be recorded by FADCs. The other copy is splitted by a passive splitter (#3 in Table 1). The splitted preshower signals are then summed in 4x(4-in/4-out) fan-in/fan-out modules (Lecroy 428F or PS 740, #4 in Table 1). Each “submodule” of the fan-in/fan-out for the preshower summing receives the signal from (for sums of row “n” and “n+1”: the signal from preshower row “n” left and right; and the signal from preshower row “n+1” left and right. Each of the sums of two rows from the preshower is then summed with the sums of their corresponding showers rows as defined in Fig. 2. This summing is also made with 4x(4-in/4-out) fan-in/fan-out modules (#4 in Table 1). The total sums of the signals from the preshower and shower are run through PS 706 16 channels discriminators; each discriminator channel will output a gate signal if the amplitude of the sum it receives as an input is above the threshold set for the discriminator.

The discriminator signals are then run through a “or” logic (implemented using PS 754 Quad logic units 4x(4-in/4-out)) such that if at least one discriminator outputs a gate signal, a trigger will be issued.

The final layout is shown of Fig. 3.

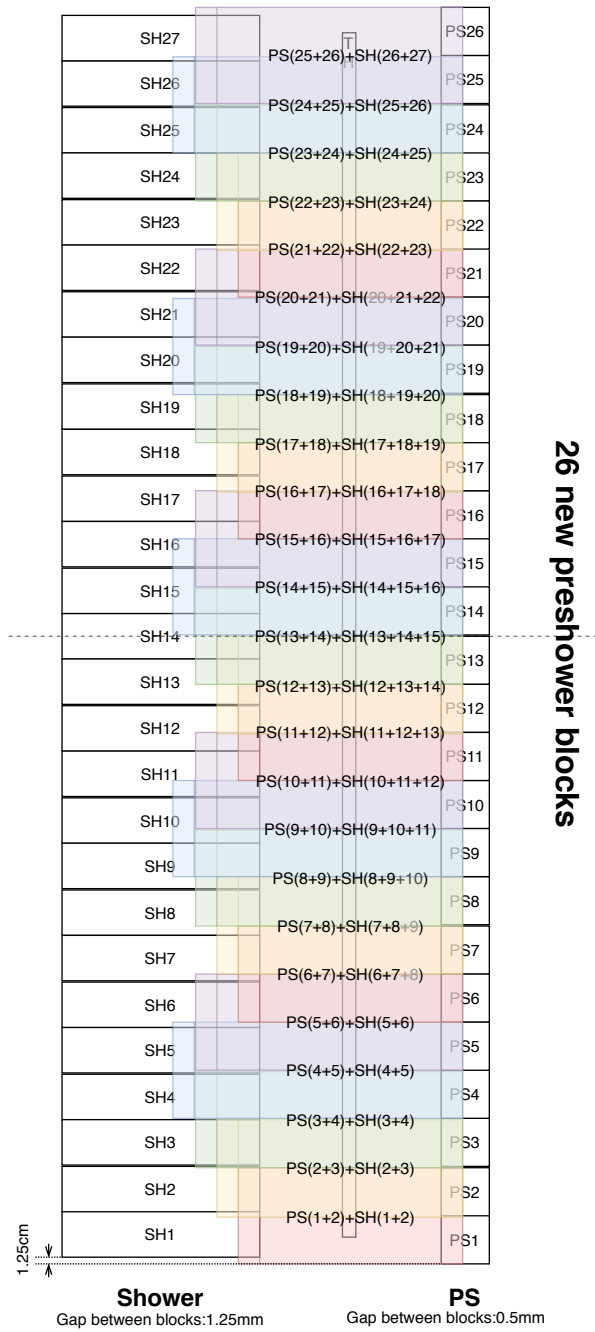
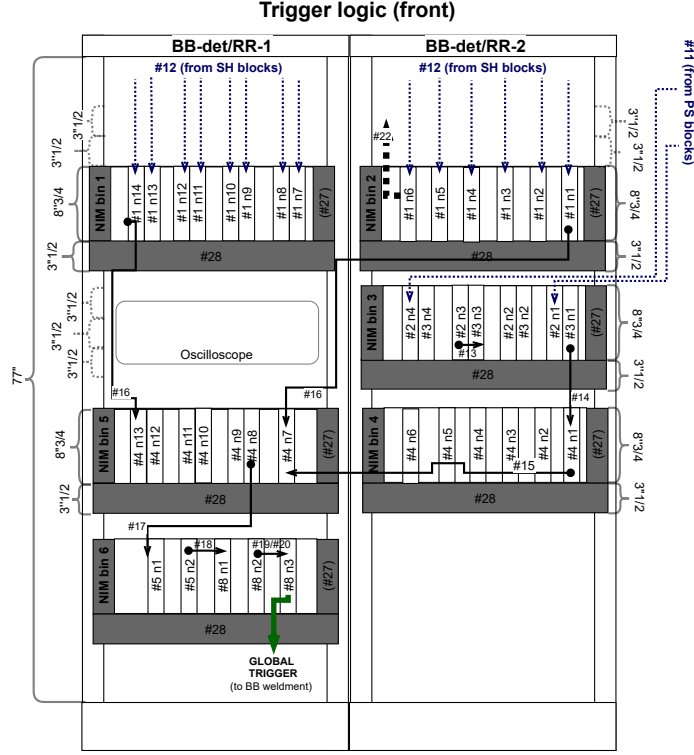


Figure 2: The BigBite preshower/shower trigger groups. In each of the colored boxes is indicated which rows from the shower has to be associated with each two-row groups from the preshower.



For back patch panels, check back scheme

Figure 3: The BigBite trigger logic layout. The reference for the electronic NIM modules are available in Table 1. (Note: “PS” stands for preshower, “SH” stands for Shower)

Table 1: Reference for electronic NIM modules in Fig. 3. (Note: “PS” stands for preshower, “SH” stands for Shower)

ID (#)	module	function
#1	7-sum/amplifier custom modules	Sum and amplify the signals from a row of the SH
#2	PS 776 16 ch amplifier	Amplify the signals from the PS
#3	Custom passive splitter	split the amplified signal from the PS
#4	Fan-in/Fan-out 4x(4-in/4-out) (Lecroy 428F and PS 740)	sum the splitted signals from the PS (n1-n7) sum the PS sums and the SH sums (n7-n14)
#5	PS 706 16 ch discriminators	apply a threshold on the PS+SH amplitude sums
#6	PS 754 Quad logic units 4x(4-in/4-out)	“Or” together the signals from the discriminators