Investigating the Crosstalk Problem in the MSU Forward Array Telescope

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August 13, 1998

Abstract

Multifragmentation is a decay process wherein at least three fragments (of Z>3) is emitted by a single excited nucleus over a short time scale. It is a process which is distinctly different from fission or evaporation; theoretical calculations predict that it will provide new insight to the study of the liquid-gas phase transition in nuclear matter. The MSU Miniball/Miniwall Array is a detection device used to study multifragmentation. The forward array is the latest upgrade for this device that will provide better energy and position resolution and enable particle mass determination. The accuracy of the position and energy measurement as well as the accurate determination of counted particles is crucial to understanding multifragmentation; any crosstalk between different electronic channels will distort the data obtained from the experiment and

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render it useless. The topic of this paper is the investigation of the crosstalk problem that was observed in the CsI telescope set-up.

Crosstalk

A test run was performed with one telescope of the forward array. The goal of the test was to identify problems with the design of the telescope and its electronics. Perhaps the most significant problem observed was an electronic crosstalk between CsI detectors within the telescope.

The crosstalk observed in the test run was about 5% of the actual signal from the neighboring detector. On an actual experiment, this magnitude of crosstalk would significantly distort the interpretation of the experiment. For example, if we assume that a 100 MeV proton was detected in one detector, a 5% crosstalk in a neighboring detector might look like a 5 MeV ìvirtual protonî. We cannot ignore such (low energy) data points in a real experiment since it is highly probable that real lower energy protons will be produced in the reaction and because such crosstalking also distort the signal of a real particle that comes into the neighboring detector.

A bench top assembly that simulates the test runís crosstalk was used to investigate the problem.

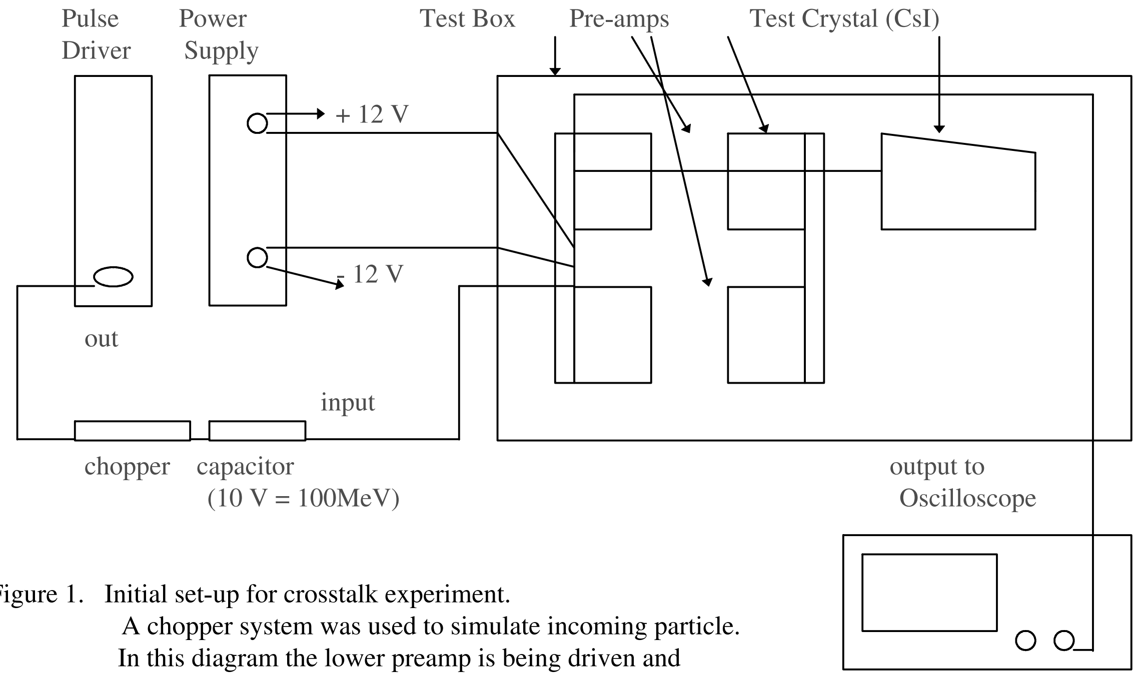

Figure 1. Initial set-up for crosstalk experiment.
A chopper system was used to simulate incoming particle.
In this diagram the lower preamp is being driven and
the upper preamp is being observed for crosstalk.

After a series of tests, the major modes for crosstalk were determined to be the following:

1. Electromagnetic radiation ñ The design of the telescope box only permits minimal spacing between preamplifiers. The spacing is restricted to the order of a few millimeters in order to accommodate the full forward array inside the miniball/miniwall configuration. This allowed one preamplifier to broadcast to the neighboring preamplifier by means of electromagnetic radiation. This broadcasting between two motherboards was minimized by

using a grounded copper shielding placed along the middle of the back plate.

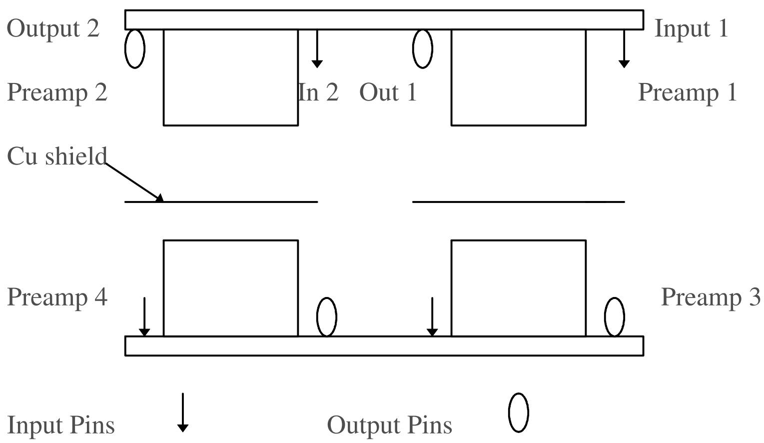

Figure 2. A diagram illustrating how the signal pins of CsI detector preamplifiers may broadcast onto nearby preamplifiers. (Not to scale).

The position and separation of the circuit elements on the motherboard were such that the elements that have considerable height (a few millimeters) from the motherboard effectively acted as little antennae that picked up electromagnetic radiation from the neighboring channel. These elements (bias resistor, input and output signal pins) were removed and replaced at the back of the motherboard.

Twisted pair cables were originally used to carry the detector output signal to the preamplifier input and to carry the preamplifier output to the outside world. This presented some pick-up problems because of poor shielding of the twisted pair cables and was manifested by the crosstalk being dependent on the orientation of the cables inside the box. These were changed to shielded coaxial cables, which were not as sensitive. The cables were also cut shorter to avoid excessive motion within the box.

2. Crosstalk due to Electronic Problems ñ A significantly large portion of the crosstalk between two preamplifiers on the same motherboard was eliminated by placing a 110 Ω resistor on the test input line connecting the two preamplifiers. This serves as a termination line where the signal from one preamplifier can go to instead of going into the other preamplifier.

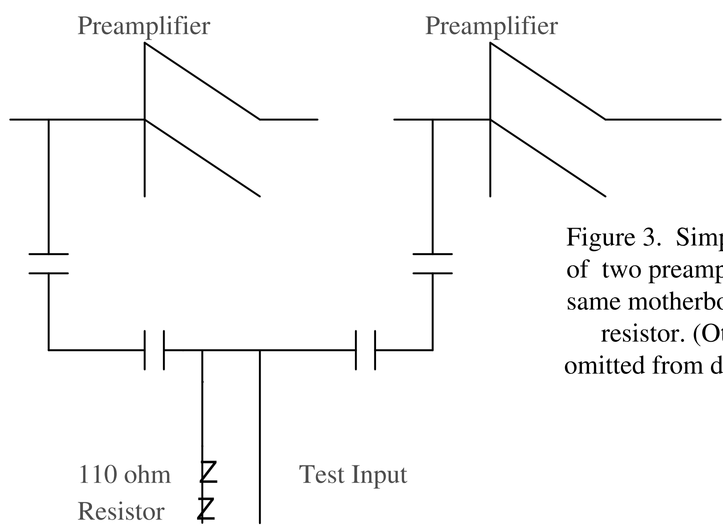

Figure 3. Simplified diagram of two preamplifiers on the same motherboard - with the resistor. (Other elements omitted from drawing)

A small part of the crosstalk that is propagated through the circuitry was eliminated by changing the test capacitor on the preamplifiers from 10 pF to 1 pF. This created an increased impedance on the preamplifiers and better isolated one preamplifier from the other one which it shares the same test input line on the common motherboard.

Result of Investigation

The crosstalk was reduced from 5% to 0.1%. The tests indicate that this is the lowest value that can be practically obtained through the methods that were described in this paper.

The final results are shown in the table. All of the telescopes are being modified according to the results of these tests.

Preamp 1	Driven 2 V	none	Crosstalk < 2mV	none
Preamp 2	Crosstalk 1.6 mV	Driven 2 V	none	none
Preamp 3	none	none	Driven 2 V	Crosstalk < 2mV
Preamp 4	none	Crosstalk 1.5 mV	none	Driven 2 V

Table 1. Relationships between preamplifiers that are driven are ones where crosstalk is observed. The proximity of the input and output pins and orientation of the signal wires determine the magnitude of the crosstalk. See fig.2 above.

Acknowledgements

Thanks to the following people for their guidance, patience, help and encouragement; and for the doors they have opened for me during my internship here at the NSCL:

Professors Bill Lynch and Betty Tsang, Wanpeng Tan, fellow REU intern Kevin ìScanî Chalut and the rest of the Miniball Group,

Professors Paul Parker, Scott Pratt and Mike Thoenessen, and the staff of the REU Program,

And the NSCL Staff.

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