The MIPP Trigger Document

0.1 Introduction

This document describes the MIPP trigger design. It is primarily intended to serve as a planning document for discussion and implementation of the trigger. Sec. 0.2 covers the basic physics goals of the experiment. Sec. **??** describes the characteristics of the MIPP beamline. Sec. **??** reviews the tools available for forming the trigger, including detectors and specialized trigger modules. The intended trigger layout in logic and timing is described in Sec. **??**. The final section (or more appropriately appendix) is reserved for the inevitable modifications that will occur in the design as we attempt to implement it.

0.2 The MIPP Experiment - Physics Goals

MIPP is a survey experiment, collecting data on hadron-nucleus interations over a wide range of projectile species, π, K, p of both signs, a wide range of energies and target masses. The data have a wide range of applications, from calibrating particle production from the NUMI target to measuring particle production backrounds for proton radiographs. Thus the requirements of the trigger are simple:

- Select beam particles with high probability for interaction and detction in the experiment
- Tag Particle identity
- Select nuclear interactions

The latter two requirements set the primary constraints for the definition of a good beam particle. Accurate particle identification with the Beam Cerenkov Counters a beam spot size of less than 1 cm and a dispersion of better then 0.5 mrad. The T00 and T01 counters will be used to to provide beam definition. A good beam focus is also needed to form a bullseye trigger that can detect the absence of an uninteracted beam particle.

The interaction trigger should be as general as is feasible, with the goal of including a significant fraction of the elastic cross-section, with an emphasis on including diffractive production. To achieve, we will try to combine a bulleye trigger with multiplicity threshold on one or more detectors.

0.3 Beamline Characteristics

0.3.1 The Fermilab Accelerator Complex

All beams at Fermilab start out in the Linac. The Linac injects into the Booster that accelerates protons to 8 GeV/c. The Booster feeds protons to the Main-Injector (MI) and to the MiniBoone experiment. The Main Injector accelerates the protons to 120 GeV/c and feeds the Tevatron (with most of the protons going to pbar production), the fixed target area experiments (Mtest and MIPP), and in the future will provide beam for Minos. Beam gets to the fixed target area throug the Switchyard 120, where beam is split to the different fixed target areas.

From the Main Injector beam can be extracted in different modes, fast spill or slow spill. The pbar production and Minos need fast spill, meaning that the entire beam in the MI is extracted in one turn. MIPP needs slow extracted beam because the experiment wants only one beam particle per event, with one event following the next as fast as the MIPP detectors and the accelerator allow (to minimize running time).

0.3.2 Beam Time Structure

Spill

Sub-spill

0.3.3 Beam Composition

In the primary MIPP target 120 GeV/c Main Injector protons are converted into the six secondary beam species. The beam momentum on the secondary target is selected in the MIPP secondary beam line. The ratio of particle species depends on the selected secondary momentum and charge of the secondary beam. The primary intensity is set to optimize the yield of useful secondary interactions.

0.4 Hardware

0.4.1 Detectors

Each MIPP detector (TPC, BeamCkov, DCs, MWPCs, RICH, TOF, EMCAL, HCAL, ...) is listed below with the signals it can possibly provide to form a trigger (Multiplicity from TOF, etc.) and with the signals needed from the trigger electronics, including timing (adc gates, tdc common stops, etc.).

0.4.2 Beam Cerenkov Counters

The beam Cerenkov counters are intended to provide mass identification of the incident particles, except at the lowest momenta. There are two counters each with two photomultiplier tubes: one tube denoted as "inner" and the other as "outer", according to the Cerenkov angular range covered. Coincidence relations may vary depending on momentum and polarity.

Additional input signals needed are a coincidence between T00 and T01 to establish the geometry (diameter) of the beam, and a beam gate would be desirable.

Output signals will tag the two minority particles, and these in anticoincidence with the T0 coincidence, for example, would identify the majority particle. All four, including T0, would be scaled. Amplified outputs from the four phototubes would be provided for ADCs. If the signals from the Cerenkov tubes, rather than the T0 signal, are the latest to arrive at the electronics rack, the outer tube of the upstream counter, BCKV1, would be the last. It would arrive 100ns after the particle traversed the primary mirror of BCKV1, or 60ns after traversing the primary mirror of BCKV2, i.e.T01. Processing time for the NIM circuitry will be approximately 70ns. All outputs should be scaled, event gated and beam gated.

1.TOF T0/T01 2.Veto, Mult, and Bullseye 4.TOF 5.DC4

0.4.3 Modules

This section describes some of the specialized modules used in the MIPP trigger.

1.CES8210

2.PD-22 4 Channel Prescaler

3.TPC Clock

0.5 Trigger Design

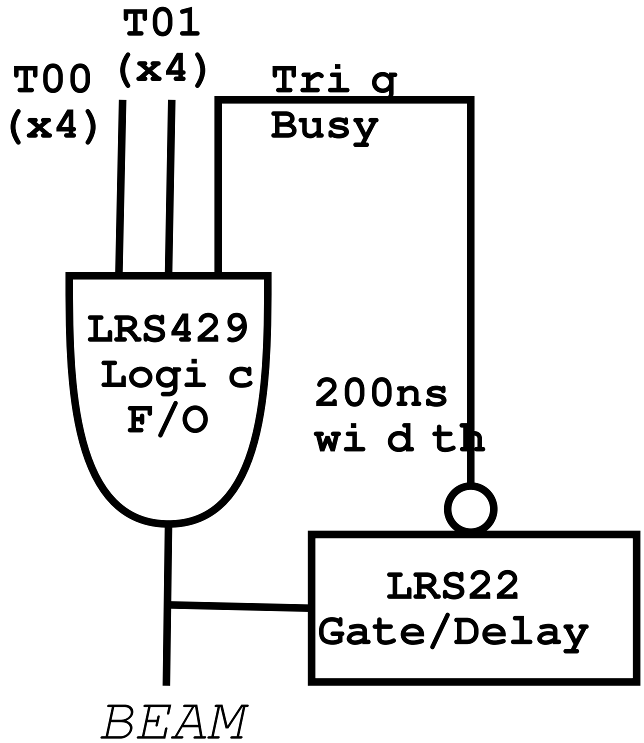

Figure 1: Beam Trigger Logic

0.5.1 Logic

Beam

Beam Cerenkov Tagging

Interaction

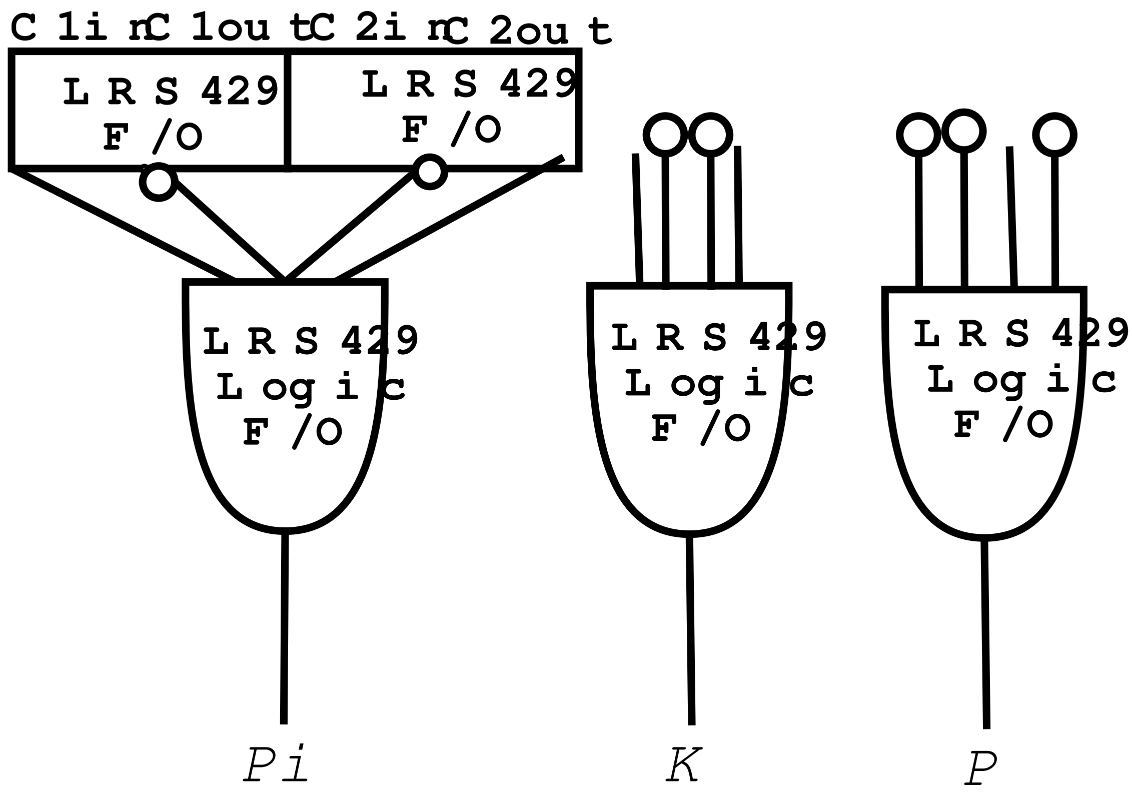

Figure 2: Particle ID logic

0.5.2 Trigger Timing

Formation Time

Detector Gate Times

0.6 Setup Notes

This section is reserved for modifications to the initial design made during actual setup of the MIPP trigger.

Chapter 1

Initial Setup

A.Trigger Commissioning

B.Run-time adjustments