The μ^- Misidentification Background

Richard Imlay

Louisiana State University

November, 2000

- **THE MUON MISIDENTIFICATION BACKGROUND**

$$\nu_\mu +^{12} C \rightarrow \mu^- + X$$

- μ^- misidentified as electron if both
  * Muon satisfies electron PID criteria and
  * No decay electron is observed within $\sim 12\mu s$ (0.3%)
- 92.2% of μ^- decay to Michel electrons
  * 0.1% of Michel electrons are below 4 MeV
  * 0.7% of Michel electrons are below 8 MeV
- $7.8 \pm 0.2\%$ of μ^- are captured.
- Conclusion:
  * Almost all ($\sim 99\%$) μ^- which decay are identified as muons
  * Background arises mostly from μ^- which are captured.

- μ^- CAPTURE ON ^{12}C
  - Capture occurs typically $2\mu s$ after primary μ^- event
  - $\sim$ 18% capture to $^{12}B_{gs}$ or other bound states

$$\mu^- +^{12} C \rightarrow \nu_\mu + {}^{12}B_{gs}$$

followed by β-decay

$$^{12}B_{gs} \rightarrow^{12} C_{gs} + e^- + \bar{\nu}_e$$

(13.4MeV endpoint, 30ms lifetime)

  - 82% go to excited states $\sim$ 25MeV
    * Giant dipole and spin dipole resonances
    * Almost all events have one neutron

$$\mu^- +^{12} C \rightarrow \nu_\mu +^{12} B^* \rightarrow \nu_\mu + n +^{11} B$$

- TIMING OF ACTIVITY IN MINI-BOONE

Stopping μ^- at $t = 0$ See μ^-, (n, p, γ)

μ^- Capture at $t \approx 2\mu s$ See (n, p, γ)

Neutron Capture at $t \approx 200\mu s$ See 2.2 MeV γ

${}^{12}B_{gs}$ decay (18%) at $t \approx 30ms$ See $\sim$ 8 MeV β

- Will detect a few μ^- captures along with Michel electrons (probably small effect)
- Will see 2.2 MeV γ from both
  - μ^- capture - 82% have an associated neutron
  - neutrino interaction - A μ^- event with the same visible energy as an electron event will, on average, come from a 200MeV higher energy neutrino and will therefore more likely have an associated neutron.
- Might be able to detect some β's (18% of events)

- **Neutrons and Oscillation Sample**
  - ν_e (from μ decay, K decay, oscillation) events have fewest associated neutrons.
  - π^0 misidentificationevents have ~ 0.5 additional neutrons per event compared to ν_e events.
  - μ^- misidentification events (with μ^- capture) have ~ 1 additional neutron per event compared to ν_e events.