Charged Current Event Analysis

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Overview

- Reporting on analysis done by Tony Mann, Aaron McGowan and myself
- Overall goals are:
  - Goal 1: Check the incoming data and carry out a crude analysis to an approximate end result to make sure that nothing is horribly wrong
  - Goal 2:Test the possibility that manual scanning with aggressive scan rules can substantially increase the number of usable events
  - Goal 3: Test the feasibility of using rock vertex events to make an independent estimate of oscillation parameters

Process

- Initially we selected snarls from the "all" files by checking the time of each snarl against the SPILLTIMEND database
- More recently we have used the "blinded spill" (bntp) files, still checking the timing of each event
- Plan to go back to "all" files to check for missing snarls
- Wrote monthly "scan files" with a total (through Dec. 31) of 1,074 snarls in time with at least one track or one shower

Process

- Tony scanned with NueAna; Aaron and I scanned with MAD; discussed results and settled on a final data sample
- Used pulse heights in showers to search for evidence of a muon track
- Accepted events with vertex more than 10 cm from detector edge as “contained vertex”

Process

- Scanned ~900 snarls from “beet” Monte Carlo analyzed with R1_18
- Scanned ~1,300 snarls from “beet” Monte Carlo analyzed with R1_18_2
- Scanned ~3,800 events (5.82e20 pot) from “carrot” Monte Carlo analyzed with R1_18_2
- Scanned 1,074 data snarls (through 31 December 2005) analyzed with R1_18_2 (LE beam flux 1.08e20 pot)
- MC/data ratio is 5.39

Impressions from Scanning

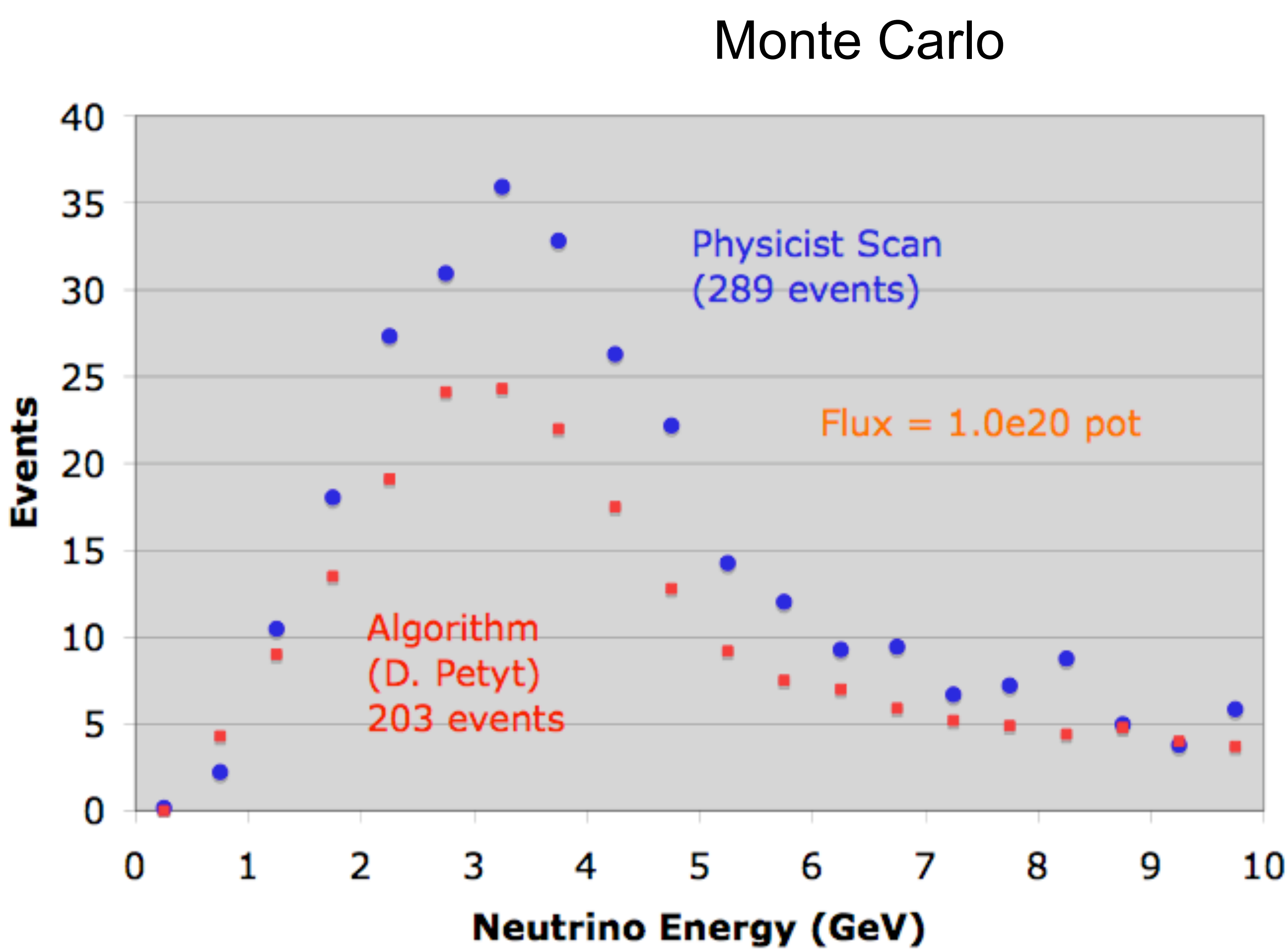
- There is nothing horribly wrong with reconstruction
- Scanning data and Monte Carlo “feel different”; scanning data is “easier”
  - Data include significant numbers of “rock muons” and “cosmic muons,” neither of which are included in MC. These events are easily identified.
  - Monte Carlo has much larger fraction of ambiguous, generally low-energy events.

Goal 1: Check incoming data

- We have found no substantial problems with the incoming data. We have observed between 1.5 and 2 easily identifiable contained-vertex, charged current events every day of beam since mid-summer.
- There is a second group of charged current events with a vertex outside the detector. The rate for these events is 1.0 to 1.5 events per day. A majority of these “rock” events enter the front of the detector (“rock front”). The remainder are “rock side.”
- Both data samples (contained vertex and non-contained vertex) are individually analyzable to an “end result,” that is, Δm^2 and $\sin^2 2\theta$

Goal 2: Test Manual Scanning

- Manual scanning appears to be a useful, complementary technique to algorithmic event classification
- The numbers of events (including Monte Carlo) are not too large
- Scanning is fast for most events; can do 4 or 5 snarls per minute with MAD
- Reconciliation of results among scanners is straightforward
- Able to recognize additional charged current events (~40% more), especially events near detector edge or events in which muon tracks and showers overlap

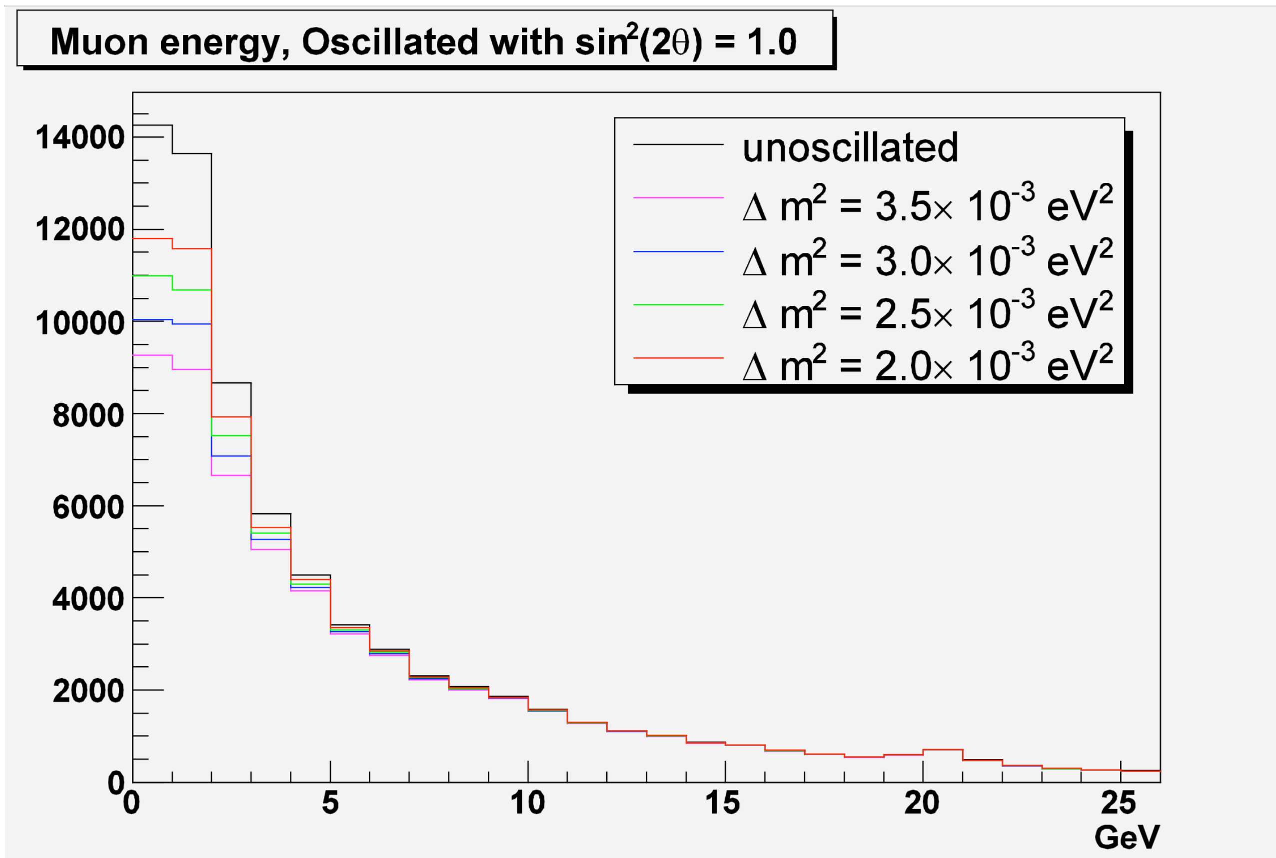


Monte Carlo
Physicist Scan
(289 events)
Flux = 1.0e20 pot
Algorithm
(D. Petyt)
203 events
Events
Neutrino Energy (GeV)
0
5
10
15
20
25
30
35
40
0
1
2
3
4
5
6
7
8
9
10

Goal 3: Test "Rock Event" Analysis

- "Rock events" are numerous (increase data sample by ~70%) and easily identified
- As an independent sample, "rock events" provide a check on systematics, for example, comparing "rock front" events with "rock side" events
- With current exposure, "rock muons" may already provide a ~3σ result for oscillation and an independent estimate of oscillation parameters

Rock Events



Muon energy, Oscillated with sin²(2θ) = 1.0
unoscillated
Δ m² = 3.5× 10⁻³ eV²
Δ m² = 3.0× 10⁻³ eV²
Δ m² = 2.5× 10⁻³ eV²
Δ m² = 2.0× 10⁻³ eV²
14000
12000
10000
8000
6000
4000
2000
0
0
5
10
15
20
25
GeV

Conclusions

- Will have more to say about both contained vertex analysis and rock event analysis if “box is opened”
- Need more people to work on both of these analyses to refine results and better understand uncertainties