Nu mu CC cross-section measurement

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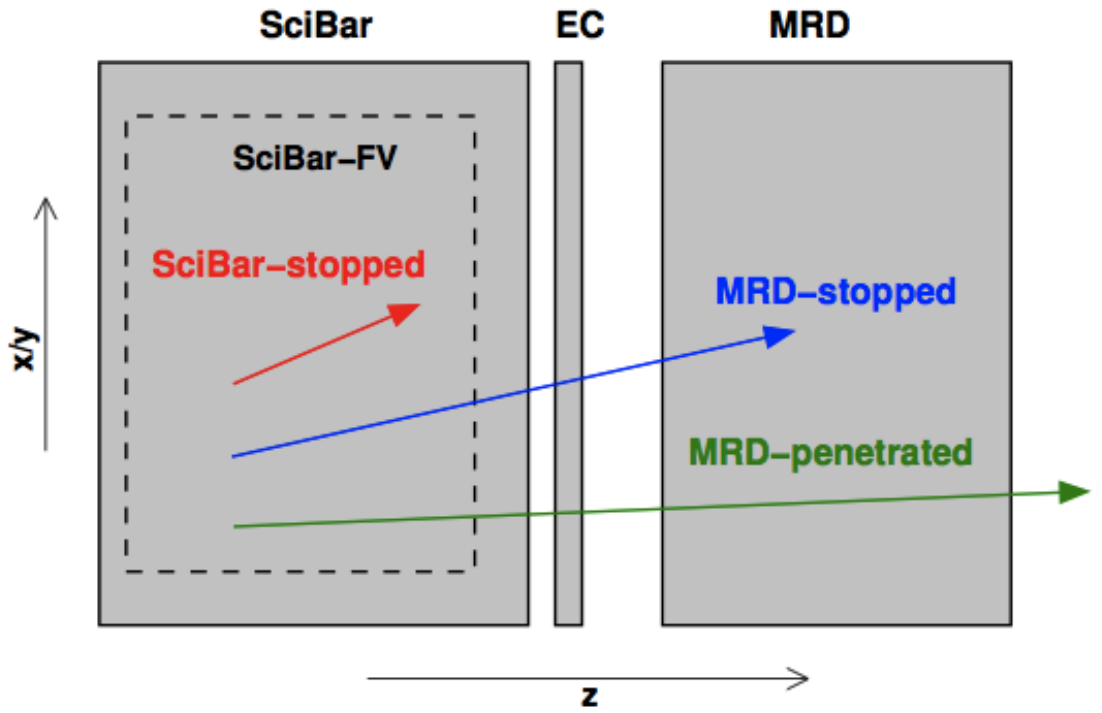
Introduction

- Summer project
  - Measure nu mu CC x-sec
    - Efficiency & Purity
    - Unfolding
  - NEUT & NUANCE independent
- MSc in Physics at Imperial College London
- Started June 2012
- Ends September 2012
- Start PhD at Liverpool University in October 2012.

Cuts



SciBar stopped: track upstream end within fiducial volume & track contained in SciBar.

MRD stopped: track upstream end within fiducial volume & track matched to MRD hit.

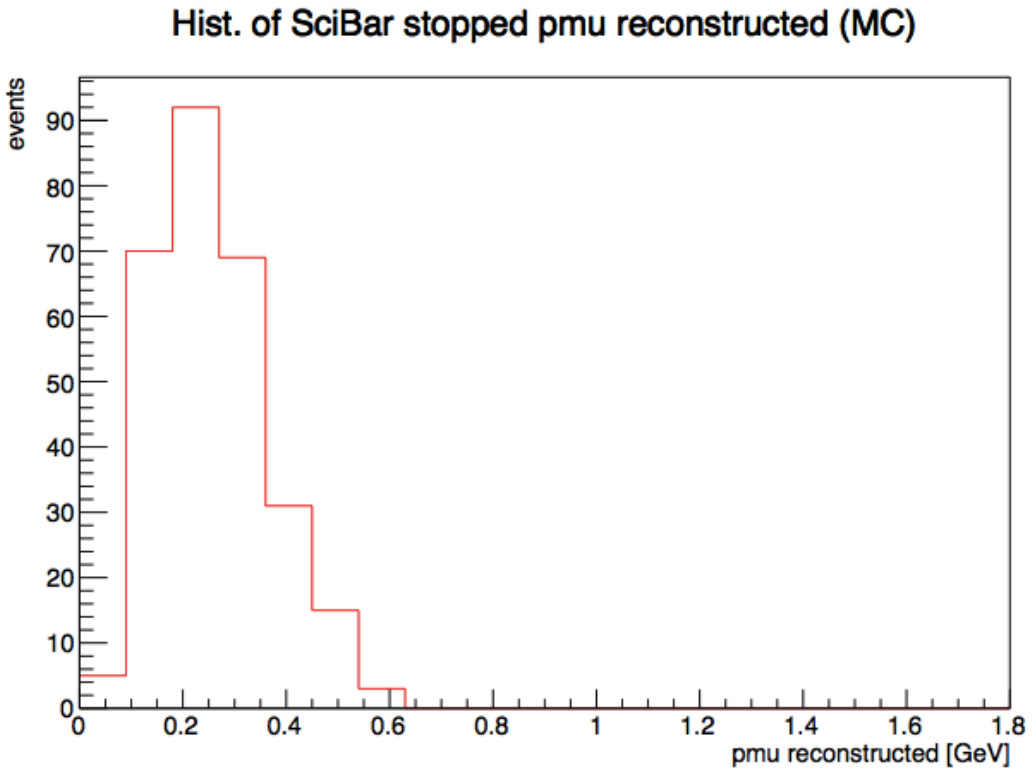
Fiducial volume: “|x|<130cm & |y|<130cm & 2.62cm<z<157.2cm”.

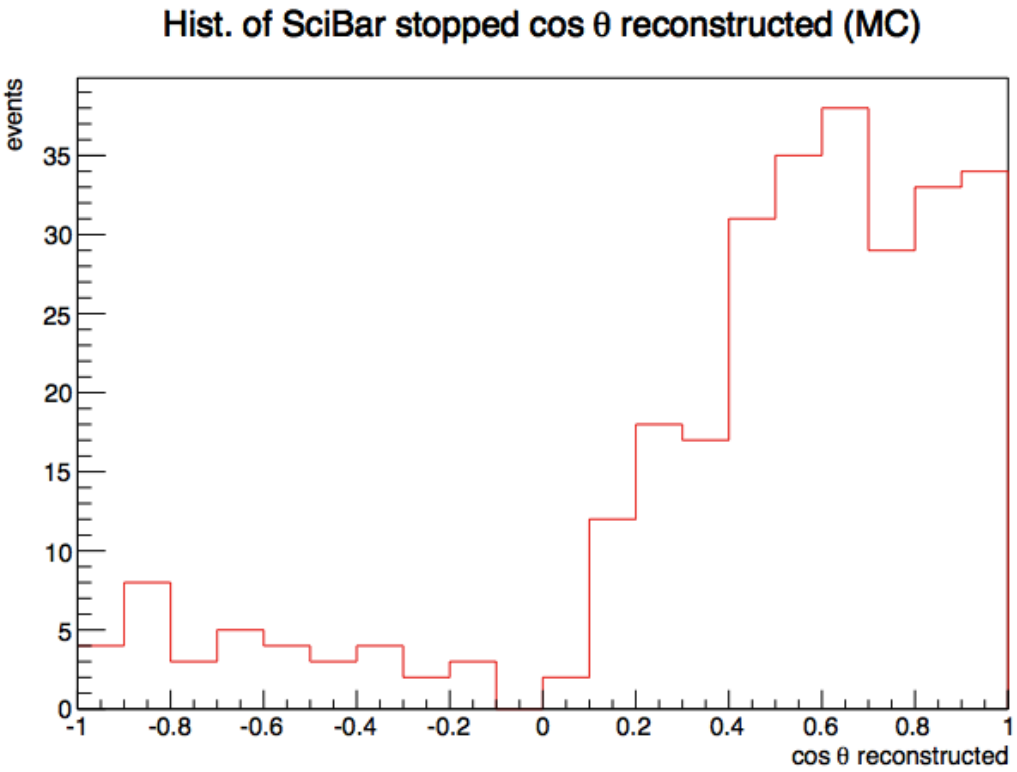
Not looking at MRD penetrated events because no pmu value.

Data

- Using processed root trees from Nakajima-san
- Using two Monte Carlo files, one treated as fake data.
- Two Monte Carlo files for blind analysis before applying method to real data.

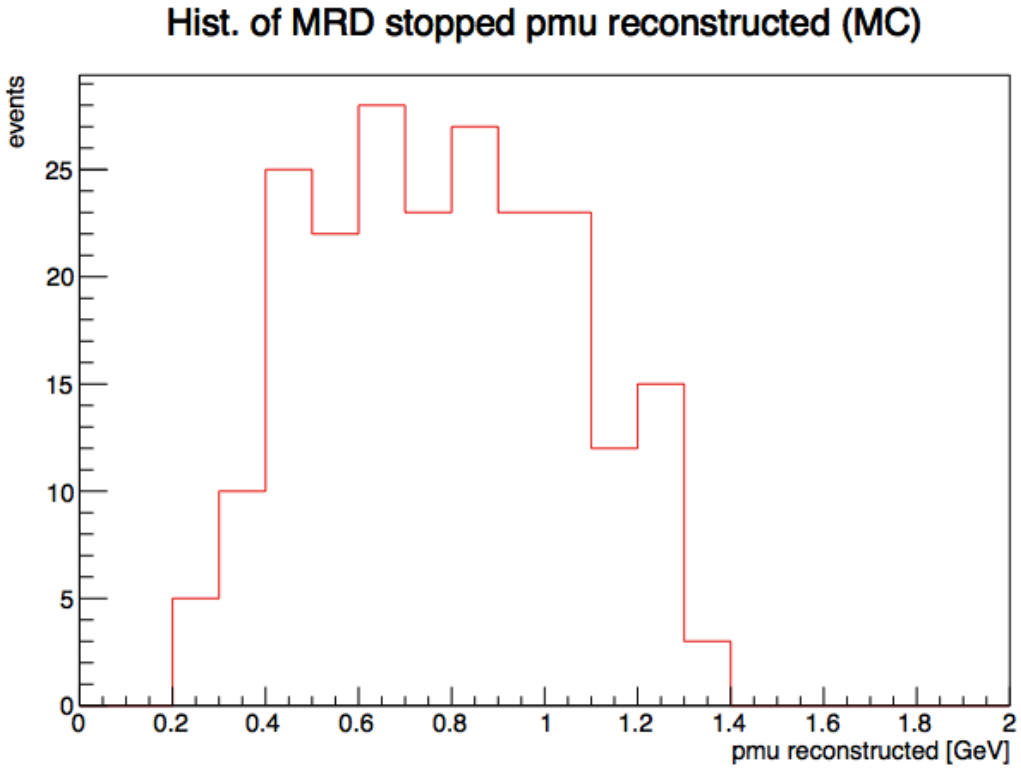
SciBar stopped events

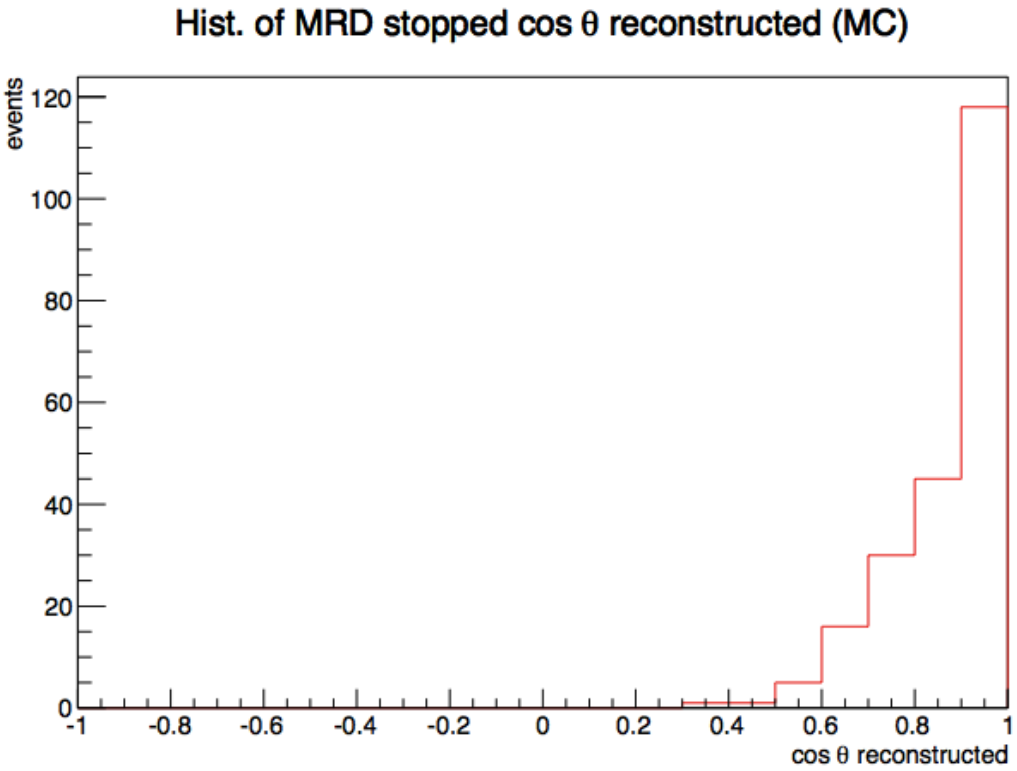




N^{MC}_{SB-TOT} = Number of SciBar stopped events in MC

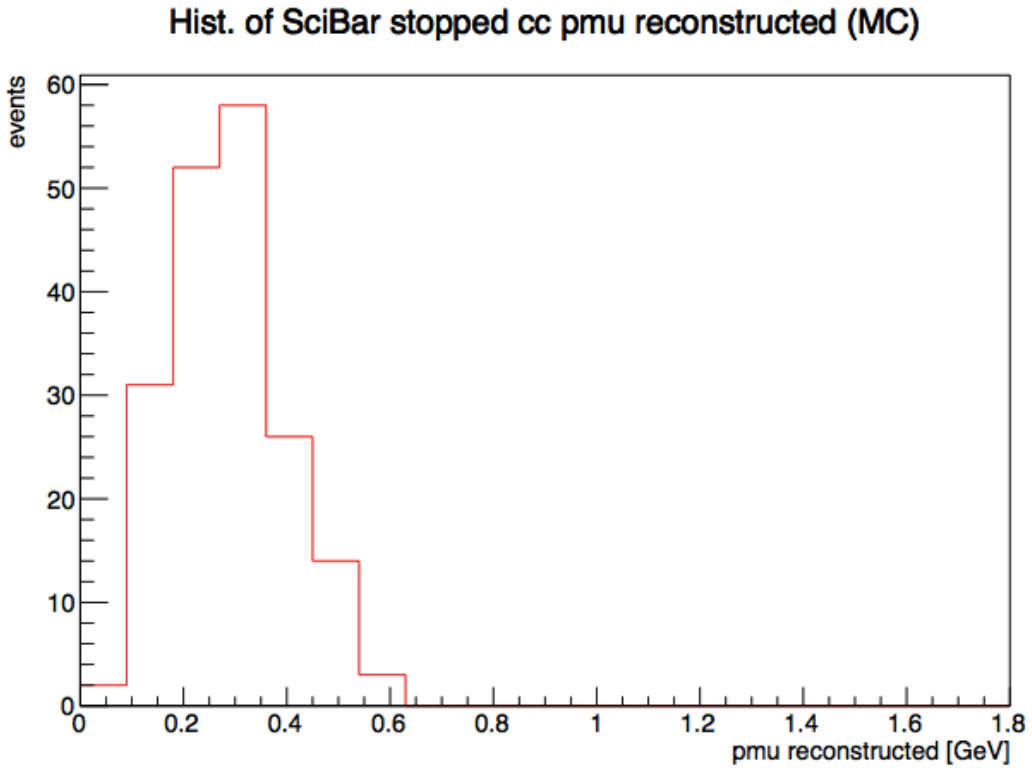
MRD stopped events

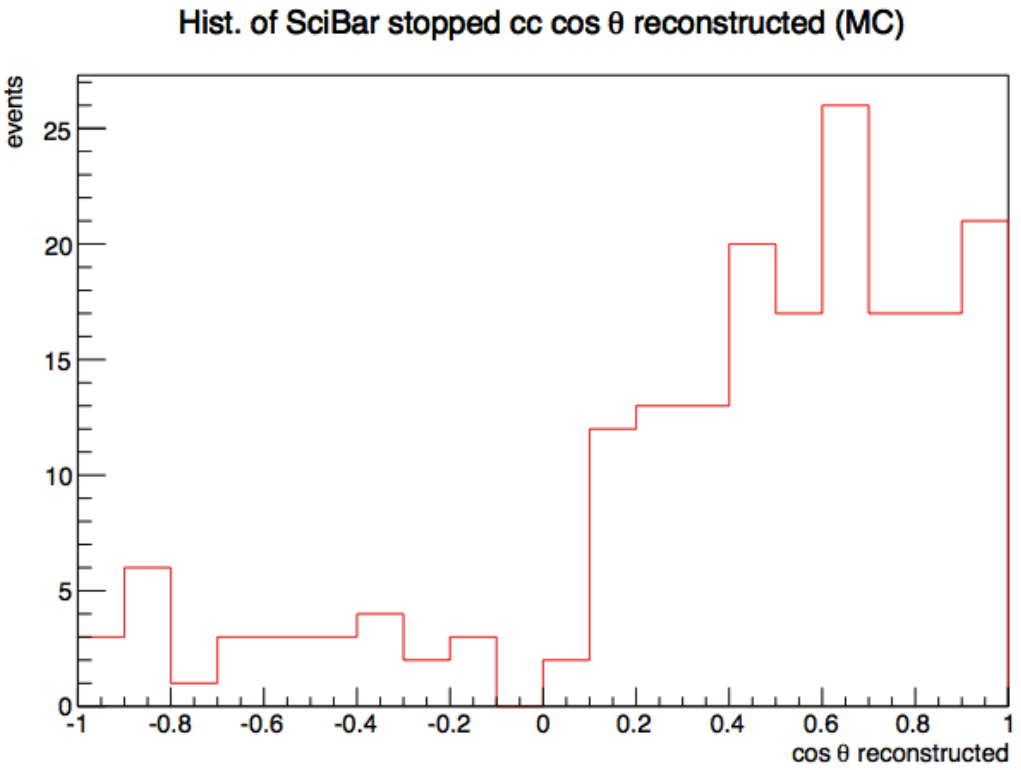




$N^{MC}_{MRD-TOT}$ = Number of MRD stopped events in MC

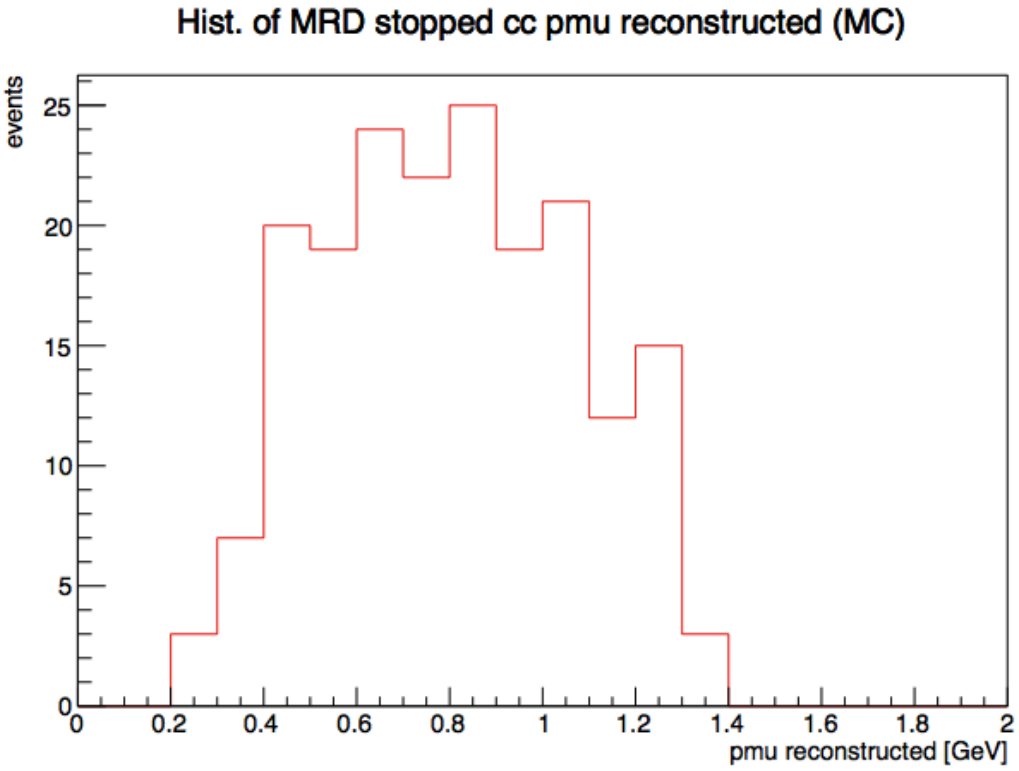
SciBar stopped CC events

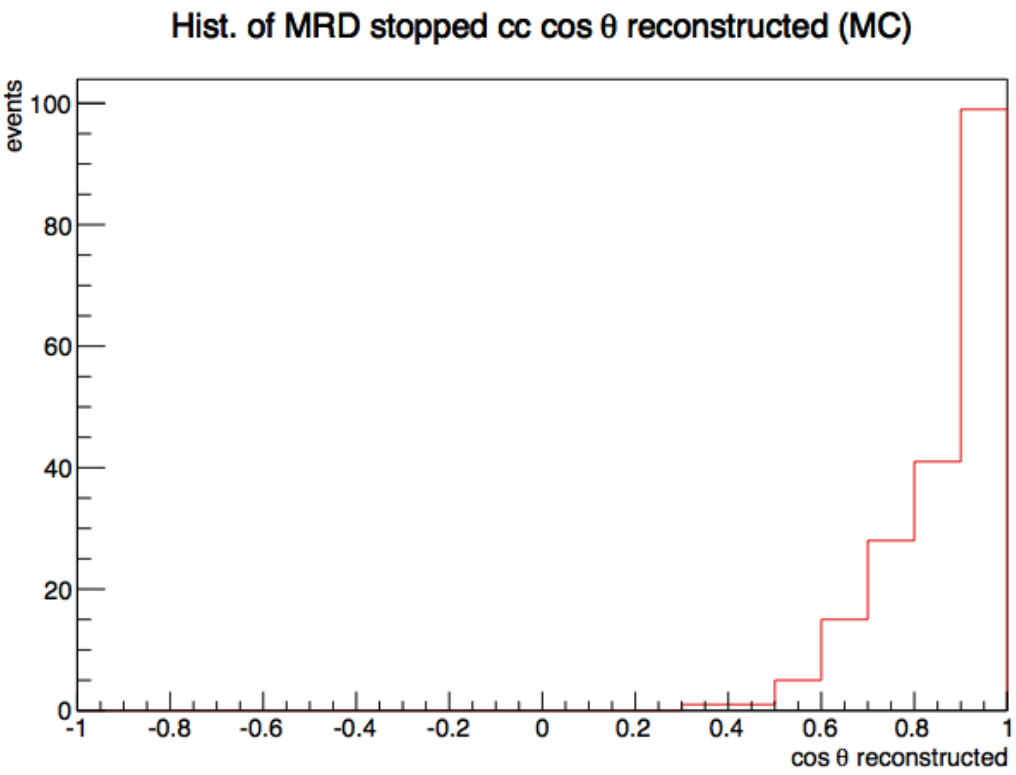




N^{MC}_{SB-CC} = Number of CC SciBar stopped events in MC

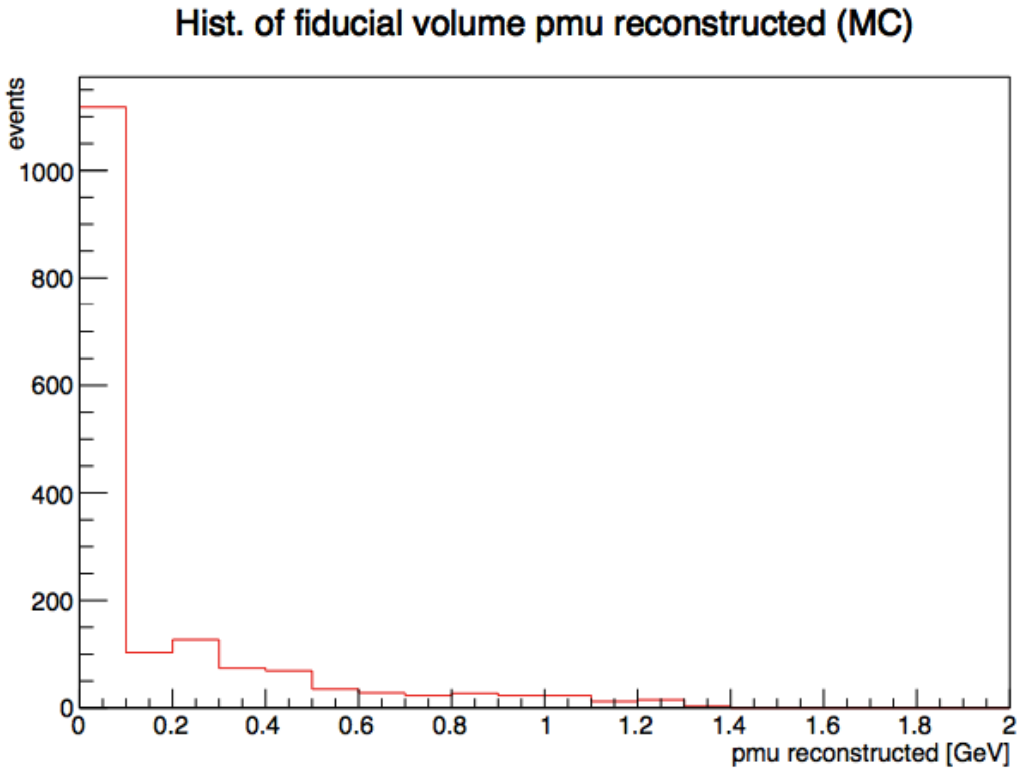
MRD stopped CC events

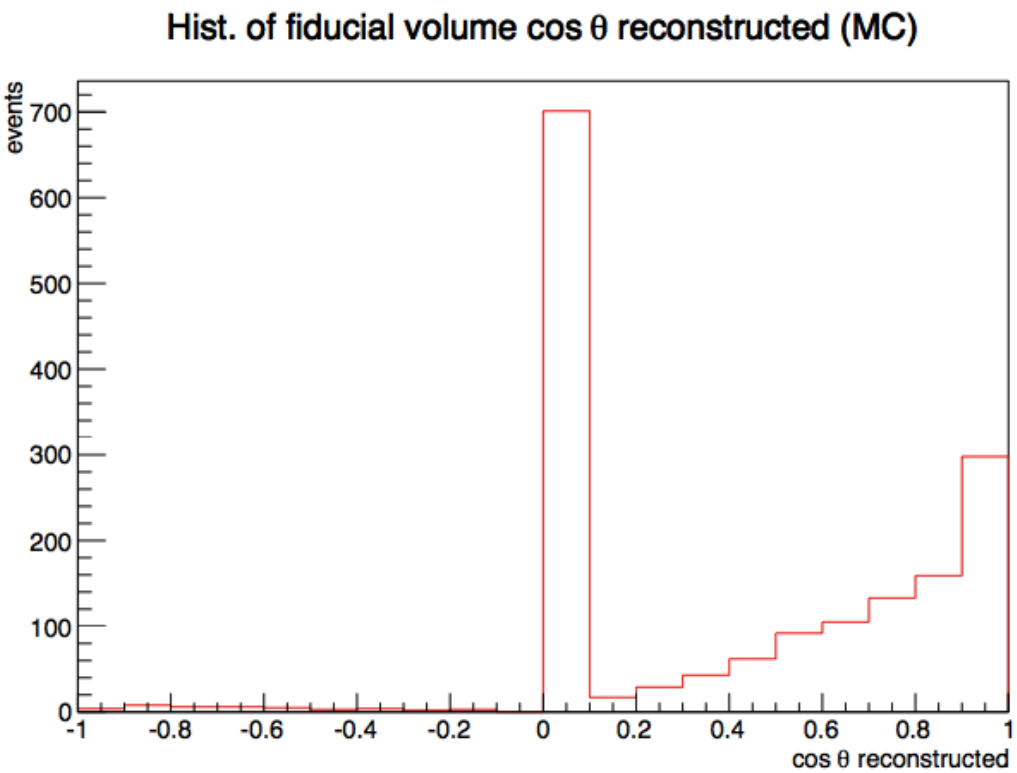




N^{MC}_{MRD-CC} = Number of CC MRD stopped events in MC

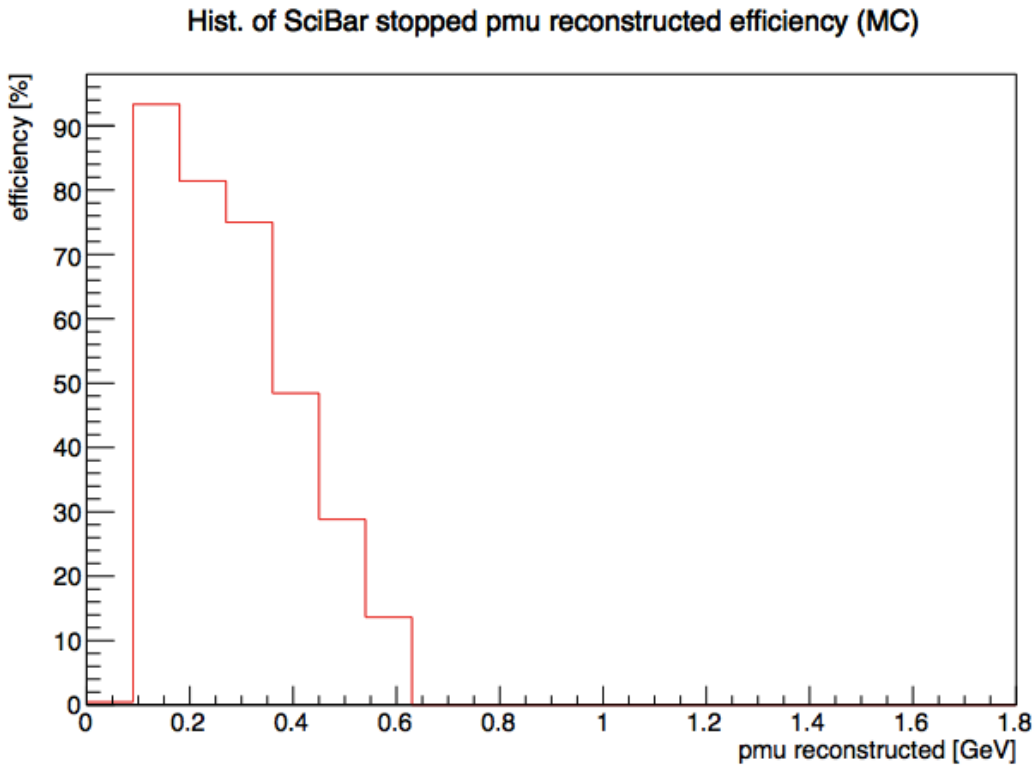
Fiducial volume interactions

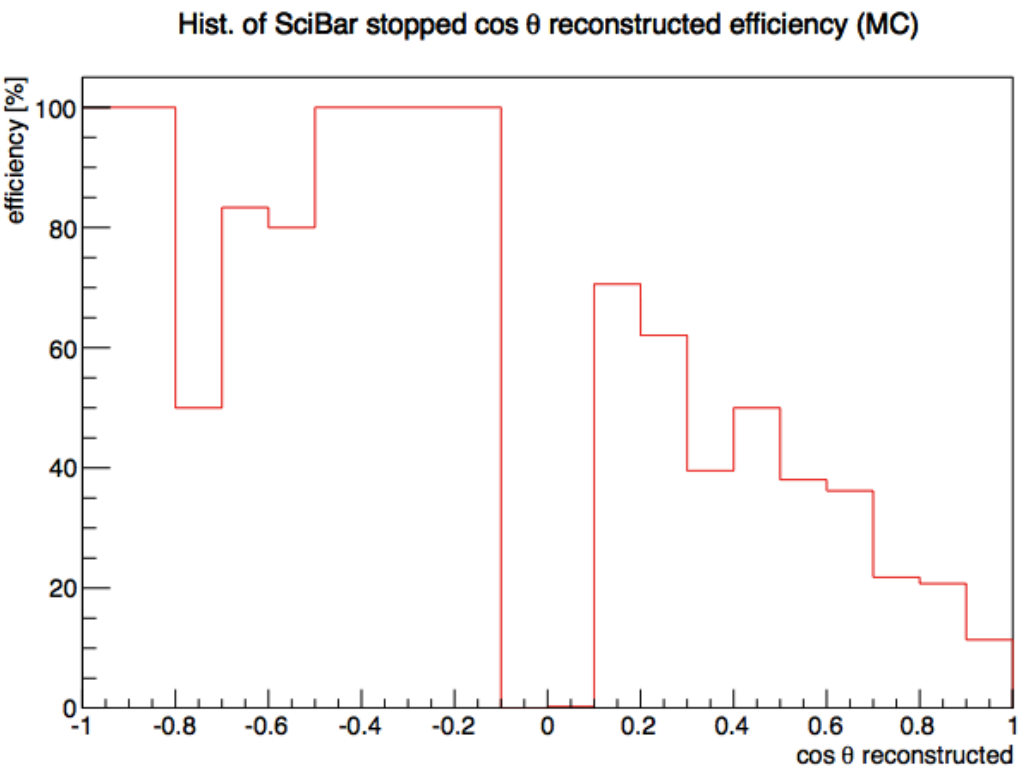




N^{MC}_{FV-TOT} = number of events for which true vertex occurs within fiducial volume for MC.

Efficiency plots



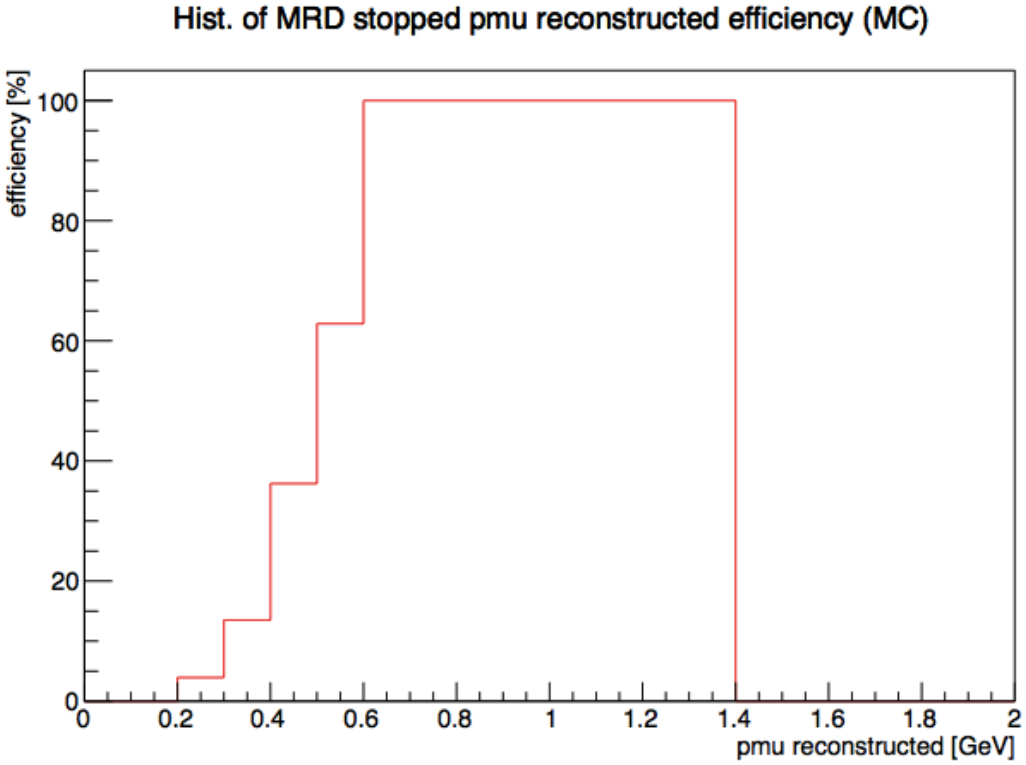


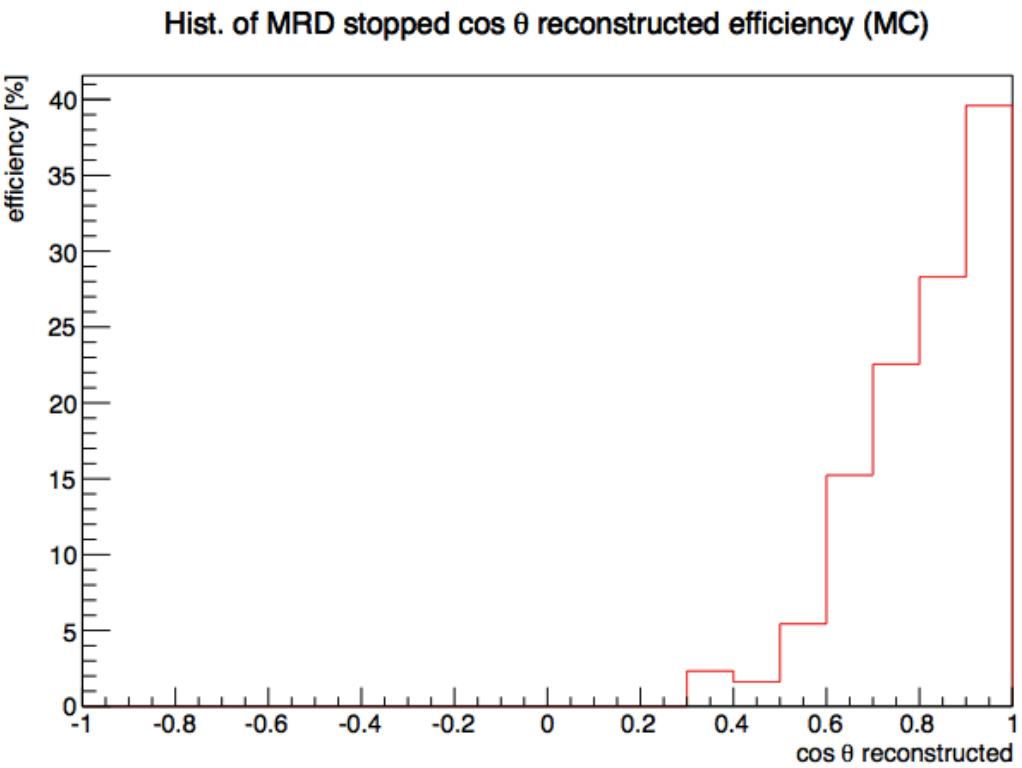
E_{SB} = efficiency for SB cuts in MC

N^{MC}_{SB-TOT} = number of events that pass SB cuts in MC

N^{MC}_{FV-TOT} = number of events for which true vertex occurs within fiducial volume.

$$E_{SB} = \frac{N^{MC}_{SB-TOT}}{N^{MC}_{FV-TOT}}$$





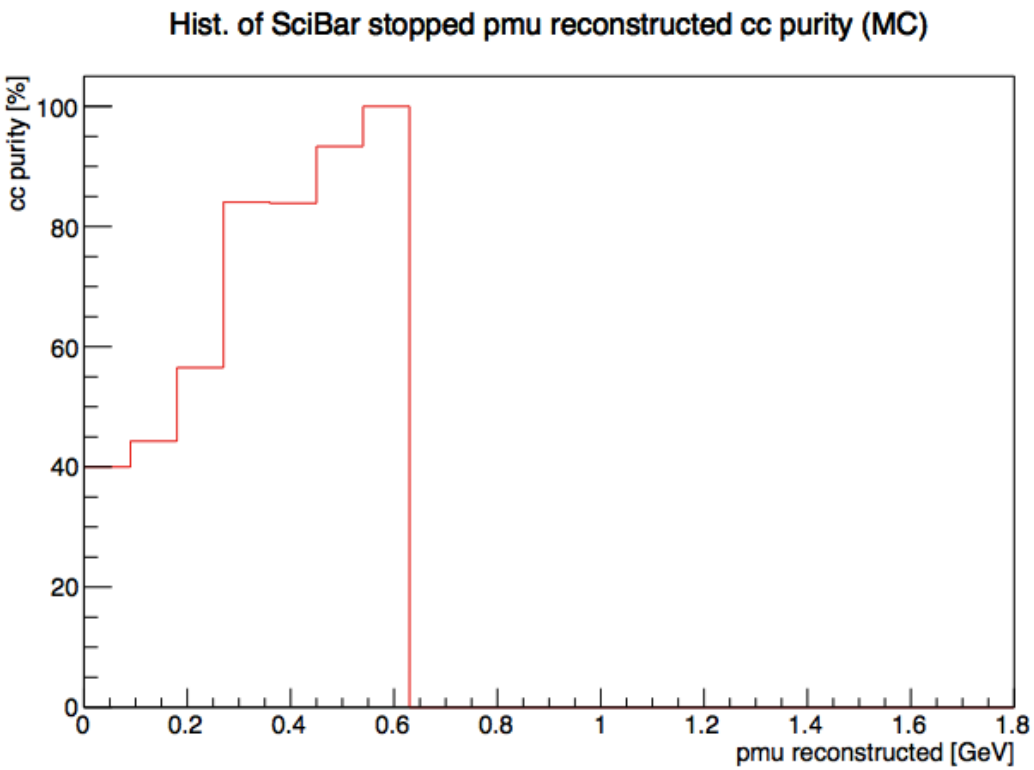
E_{MRD} = efficiency for MRD cuts in MC

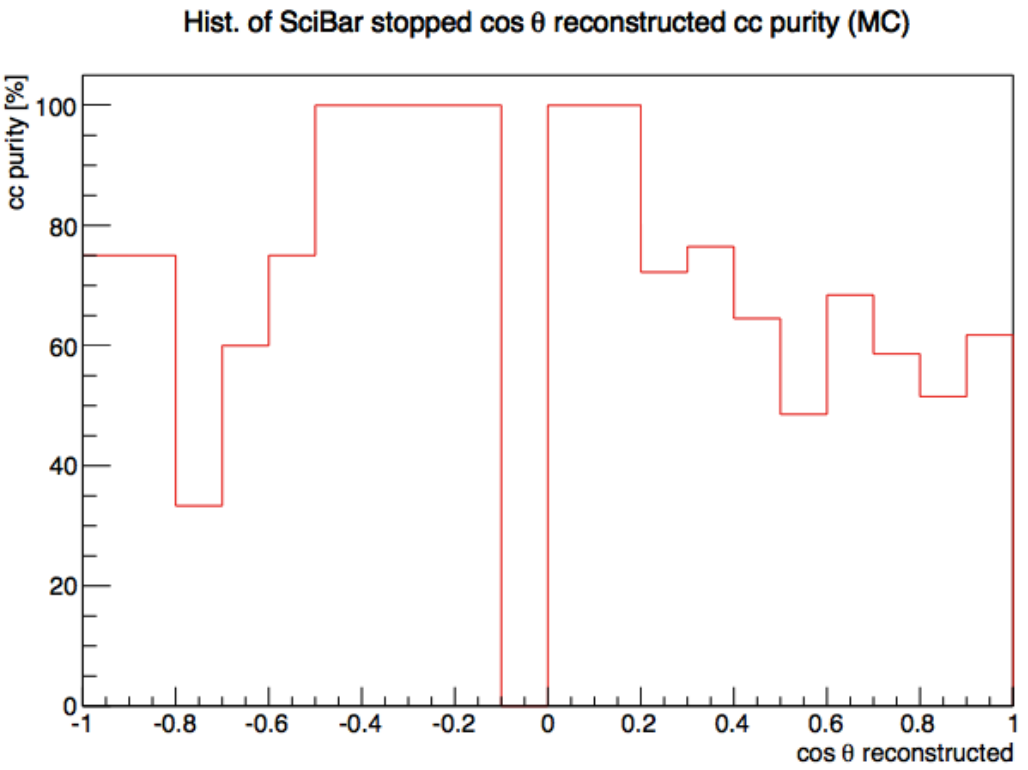
$N^{MC}_{MRD-TOT}$ = number of events that pass MRD cuts in MC

N^{MC}_{FV-TOT} = number of events for which true vertex occurs within fiducial volume.

$$E_{MRD} = \frac{N^{MC}_{MRD-TOT}}{N^{MC}_{FV-TOT}}$$

Purity plots



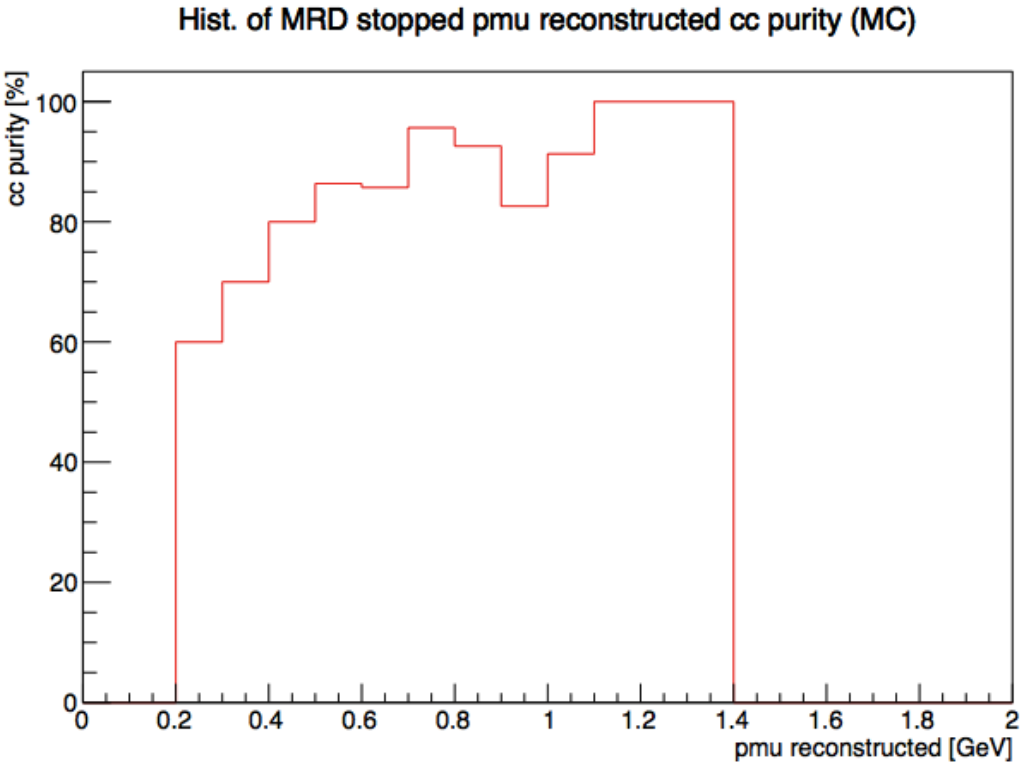


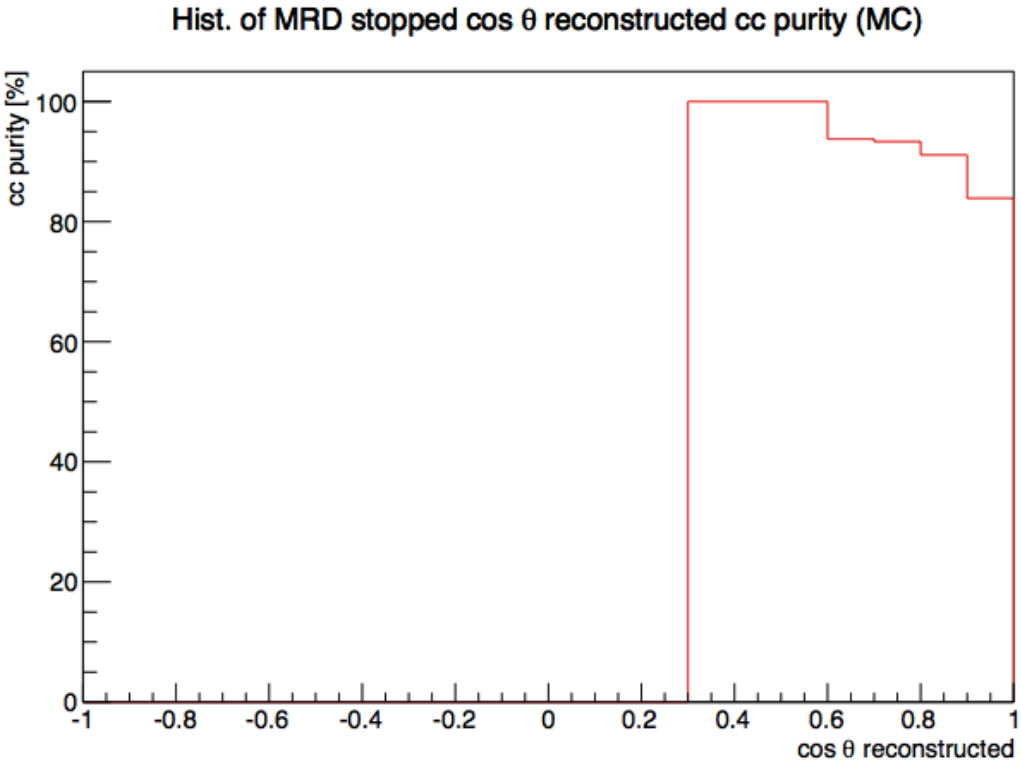
P_{SB-CC} = CC purity for SB cuts in MC

N^{MC}_{SB-CC} = number of true CC events that pass SB cuts in MC

N^{MC}_{SB-TOT} = number of events that pass SB cuts in MC

$$P_{SB-CC} = \frac{N^{MC}_{SB-CC}}{N^{MC}_{SB-TOT}}$$





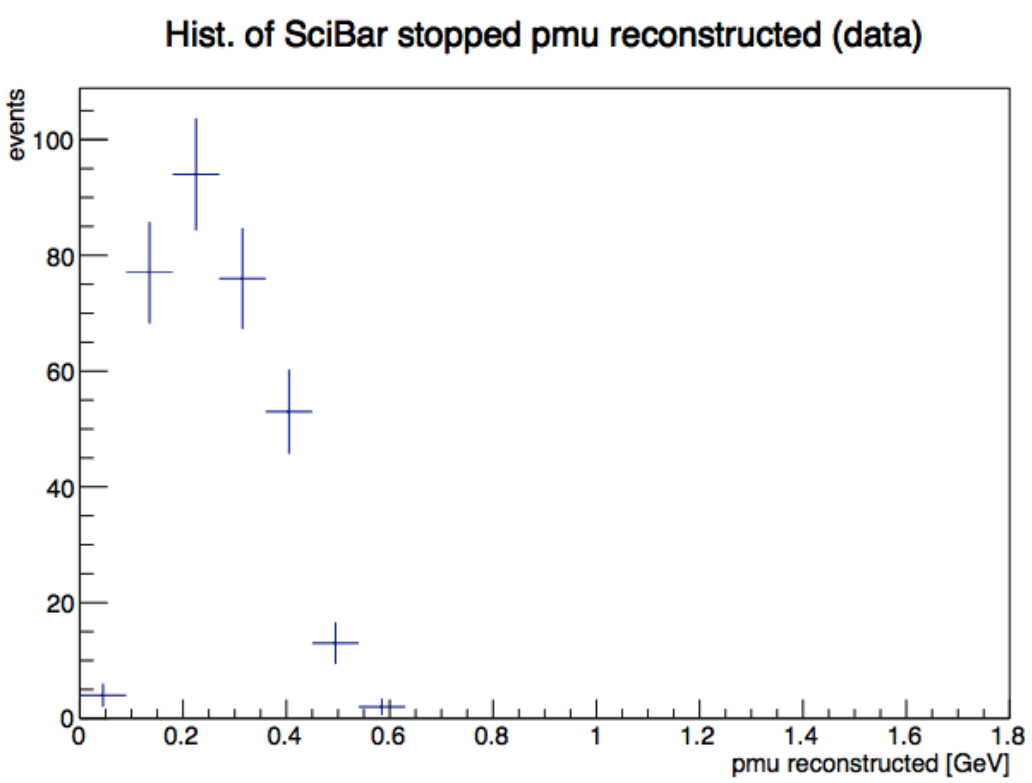
P_{MRD-CC} = CC purity for MRD cuts in MC

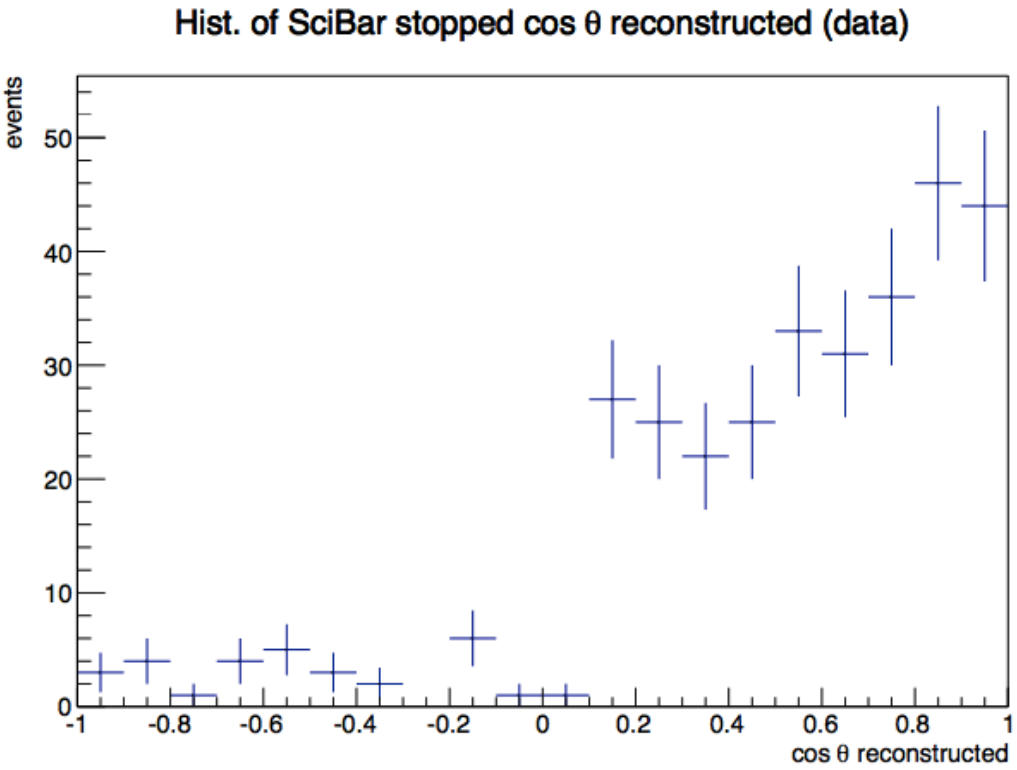
N^{MC}_{MRD-CC} = number of true CC events that pass MRD cuts in MC

$N^{MC}_{MRD-TOT}$ = number of events that pass MRD cuts in MC

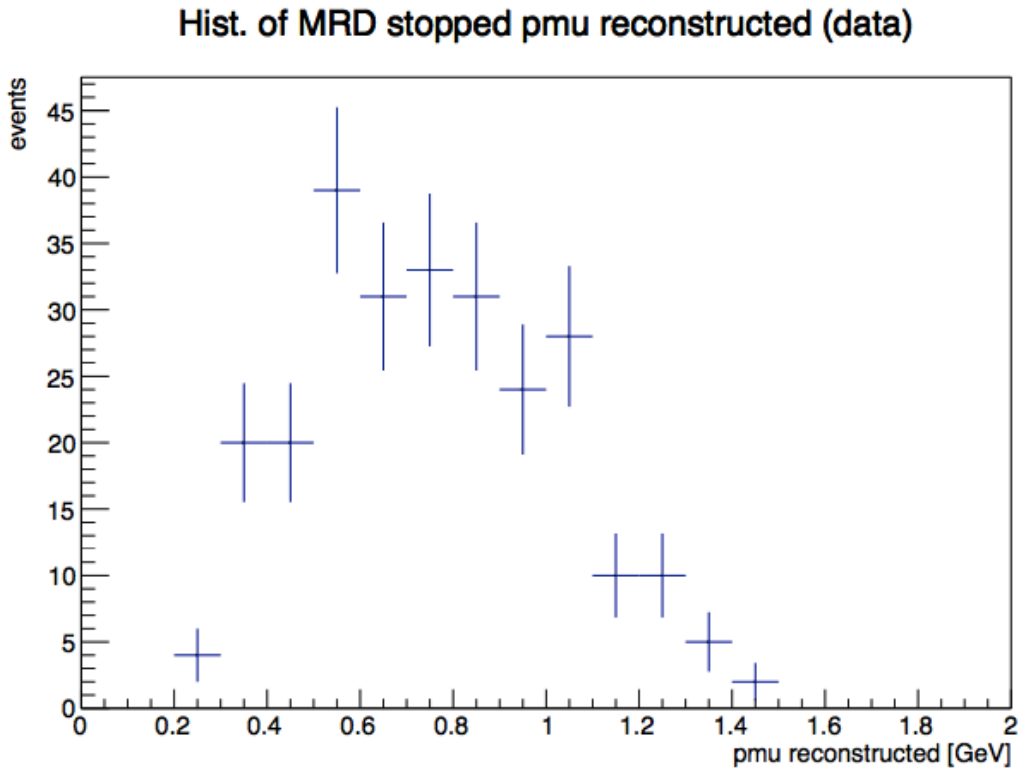
$$P_{MRD-CC} = \frac{N^{MC}_{MRD-CC}}{N^{MC}_{MRD-TOT}}$$

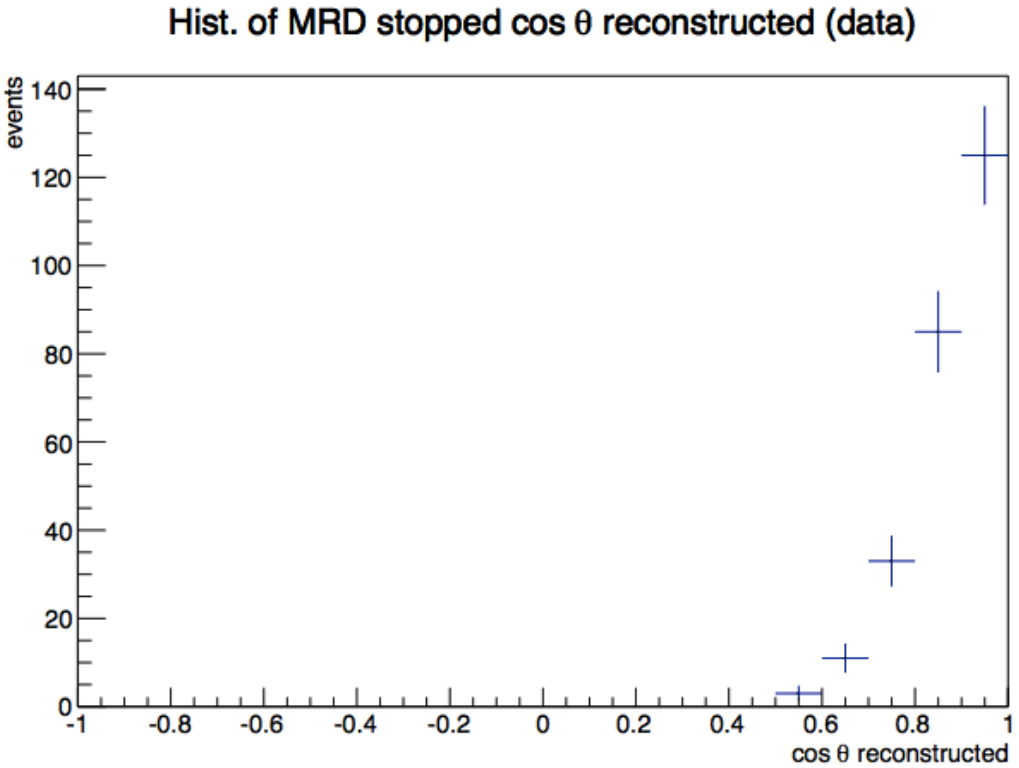
Data file events





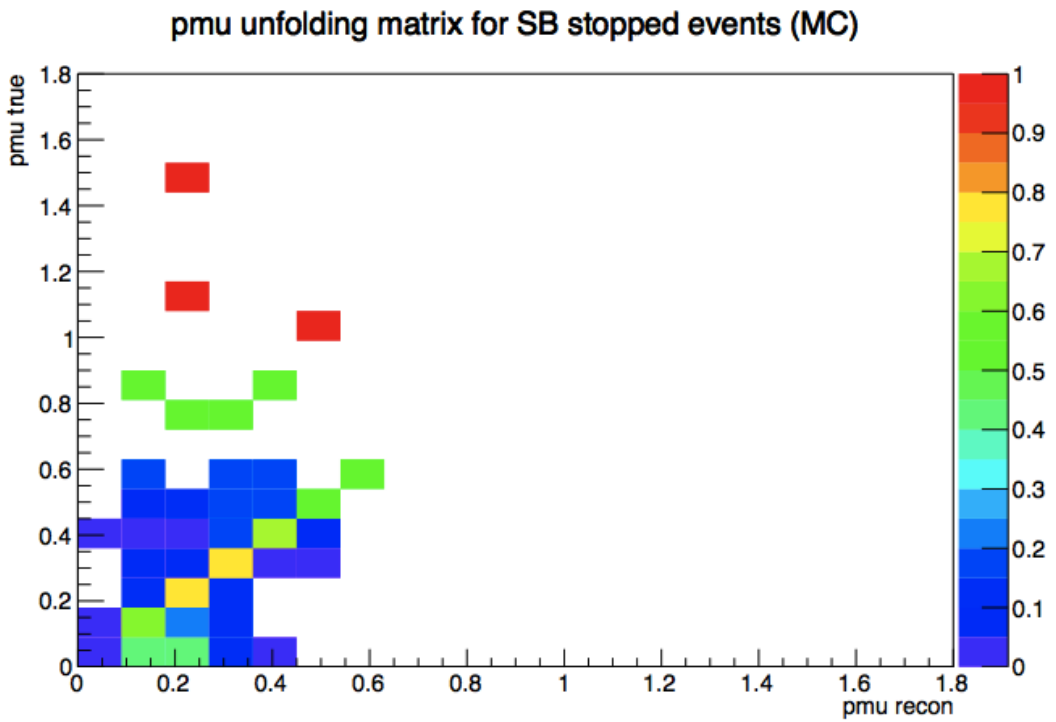
N_{SB-TOT}^{DATA} = number of events that pass SB cuts in data

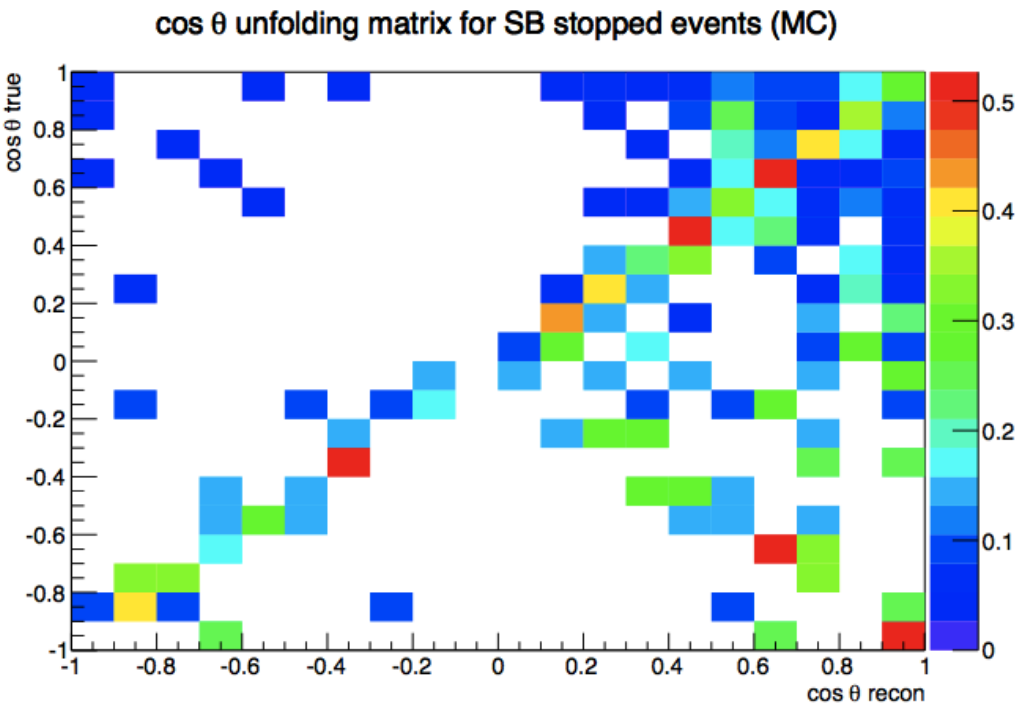




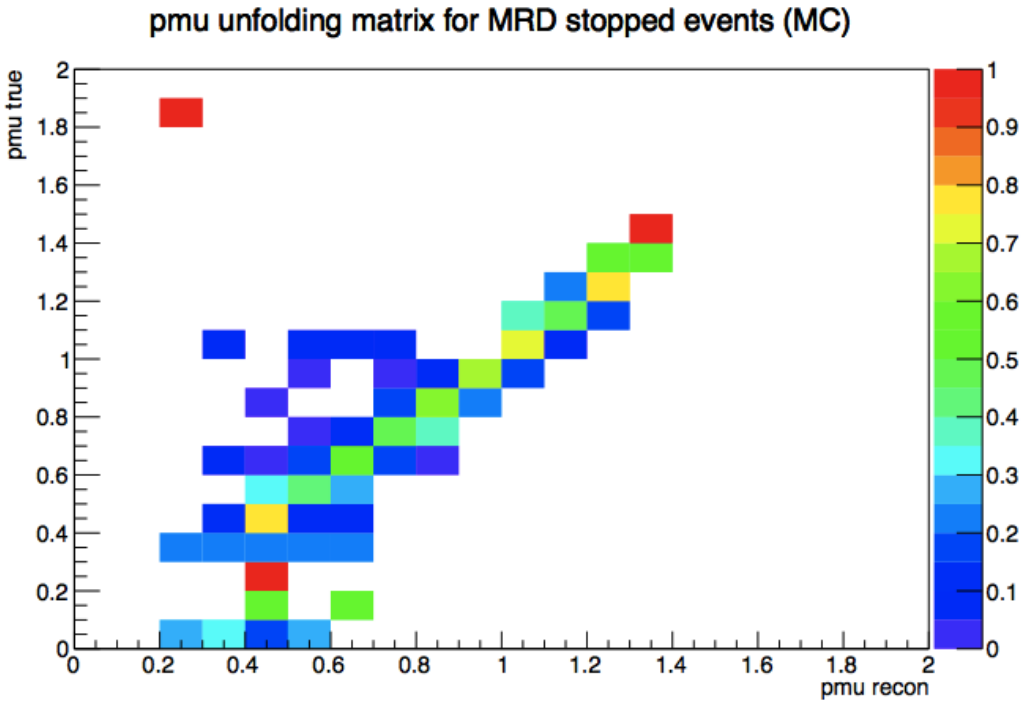
$N^{DATA}_{MRD-TOT}$ = number of events that pass MRD cuts in data

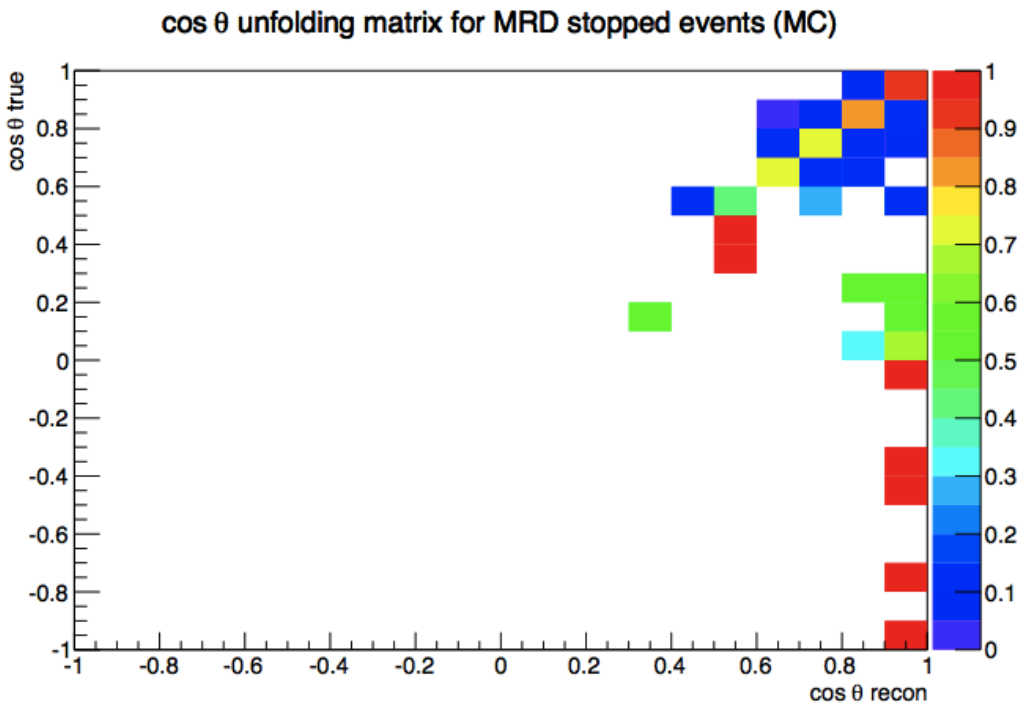
Unfolding matrices (MC)





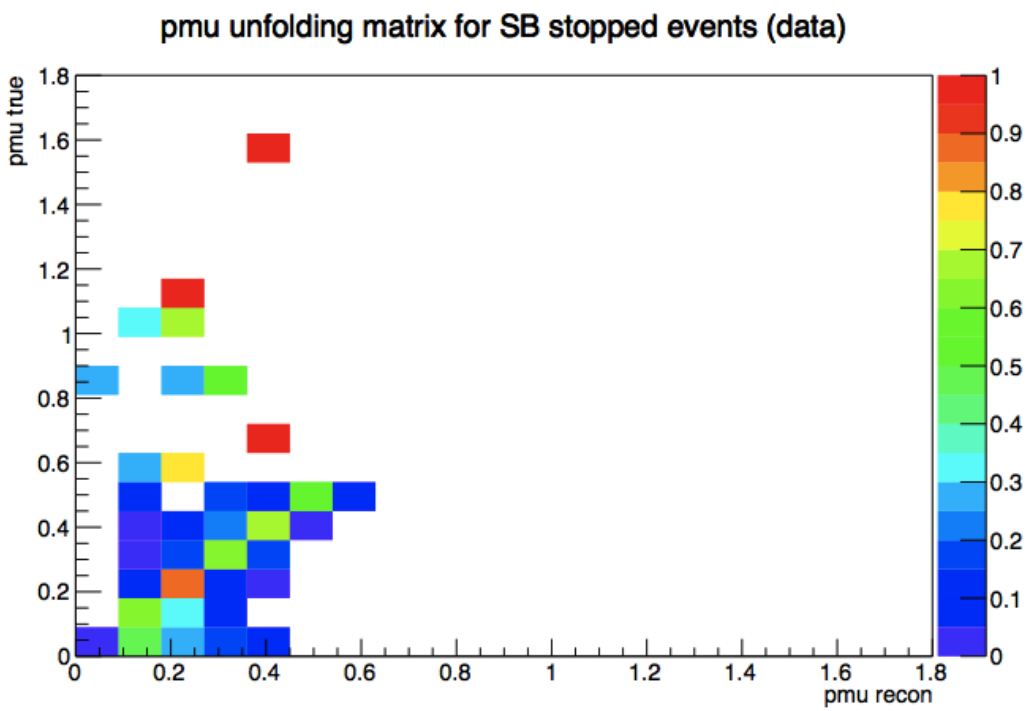
Unfolding(i,j) = P(true pmu in bin i | reconstructed pmu in bin j)

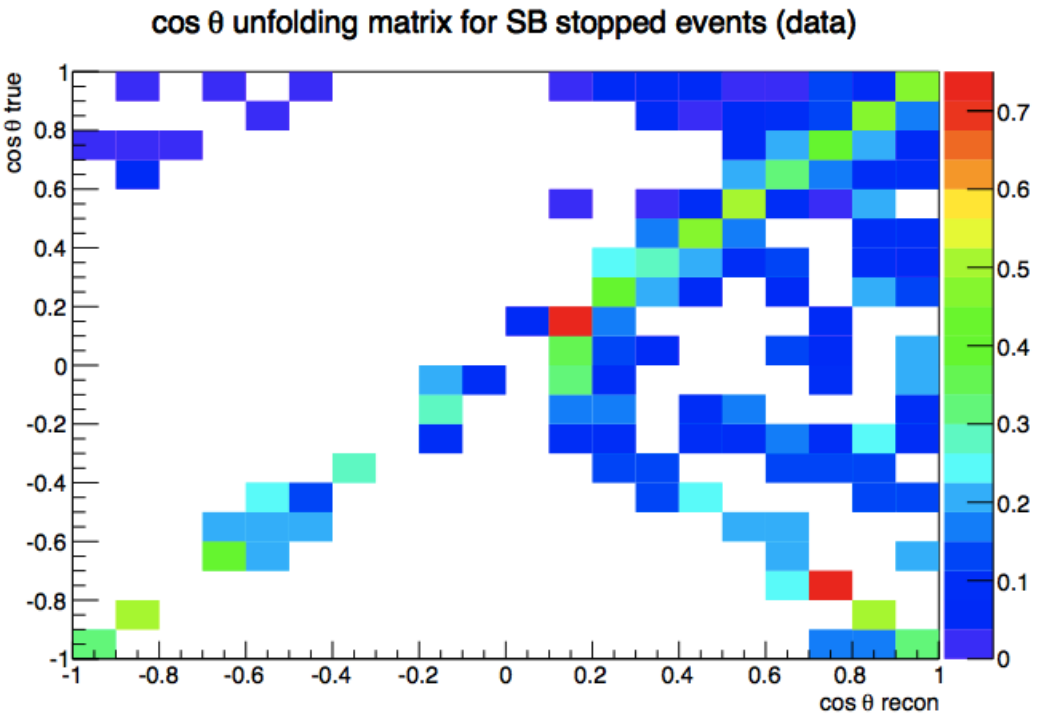




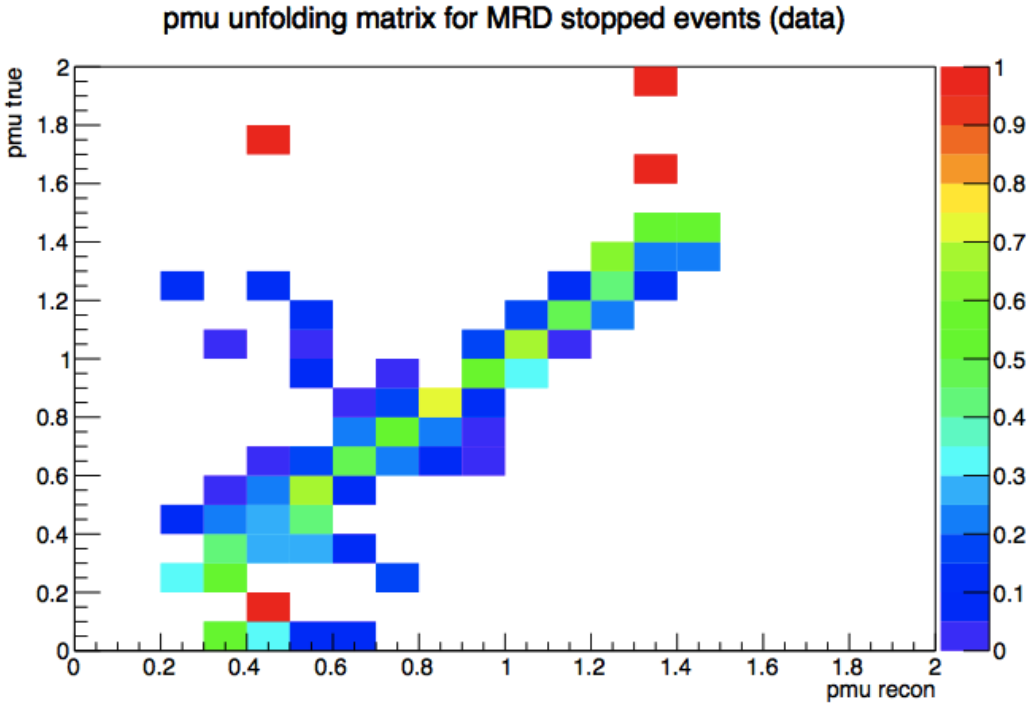
Unfolding(i,j) = P(true pmu in bin i | reconstructed pmu in bin j)

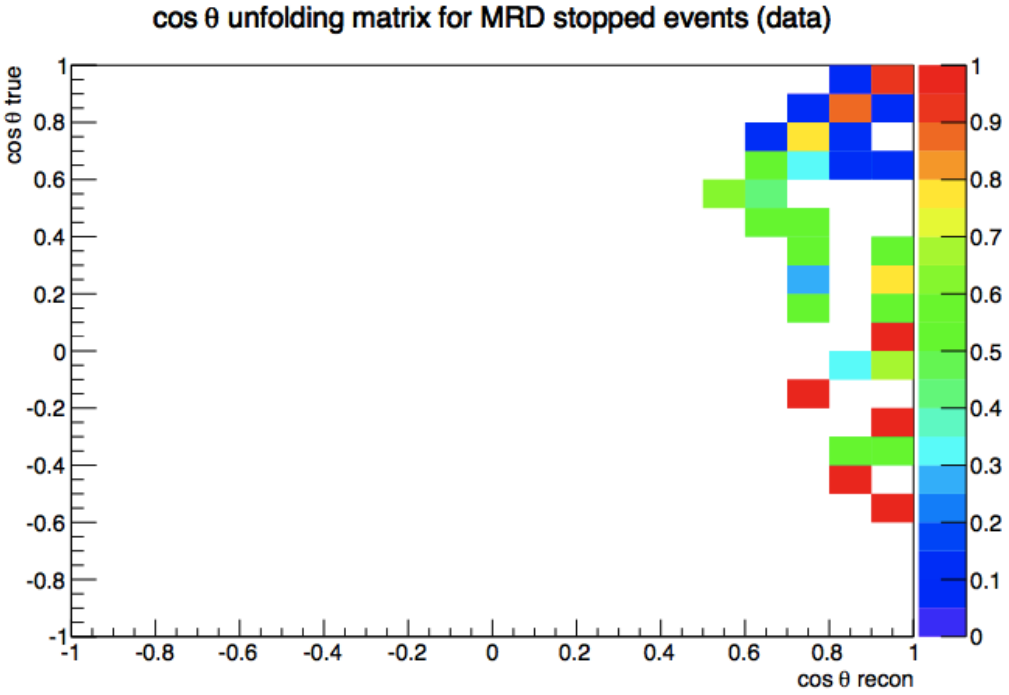
Unfolding matrices (data)





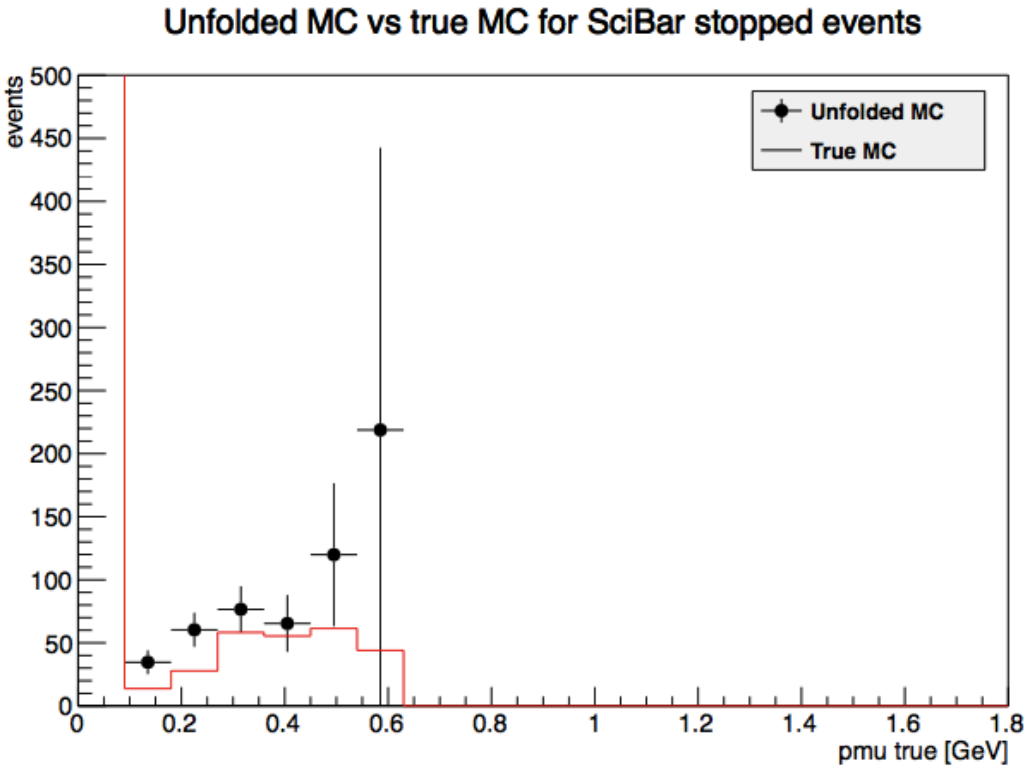
Unfolding(i,j) = P(true pmu in bin i | reconstructed pmu in bin j)

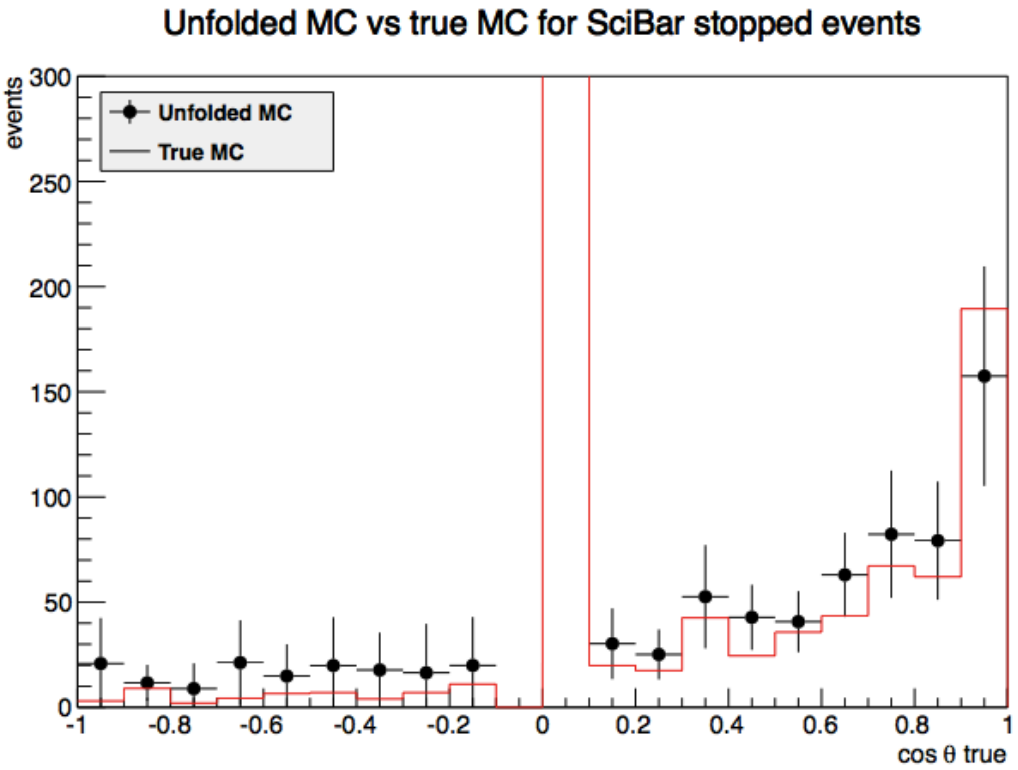




Unfolding(i,j) = P(true pmu in bin i | reconstructed pmu in bin j)

Corrected events: unfolded MC vs true MC

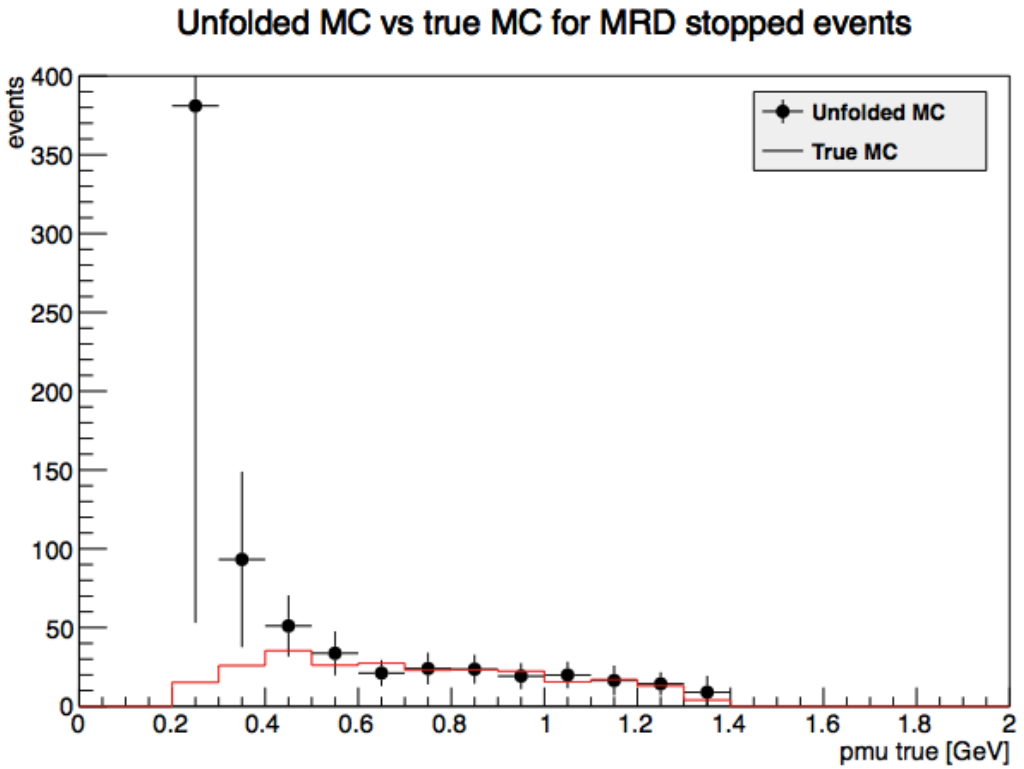


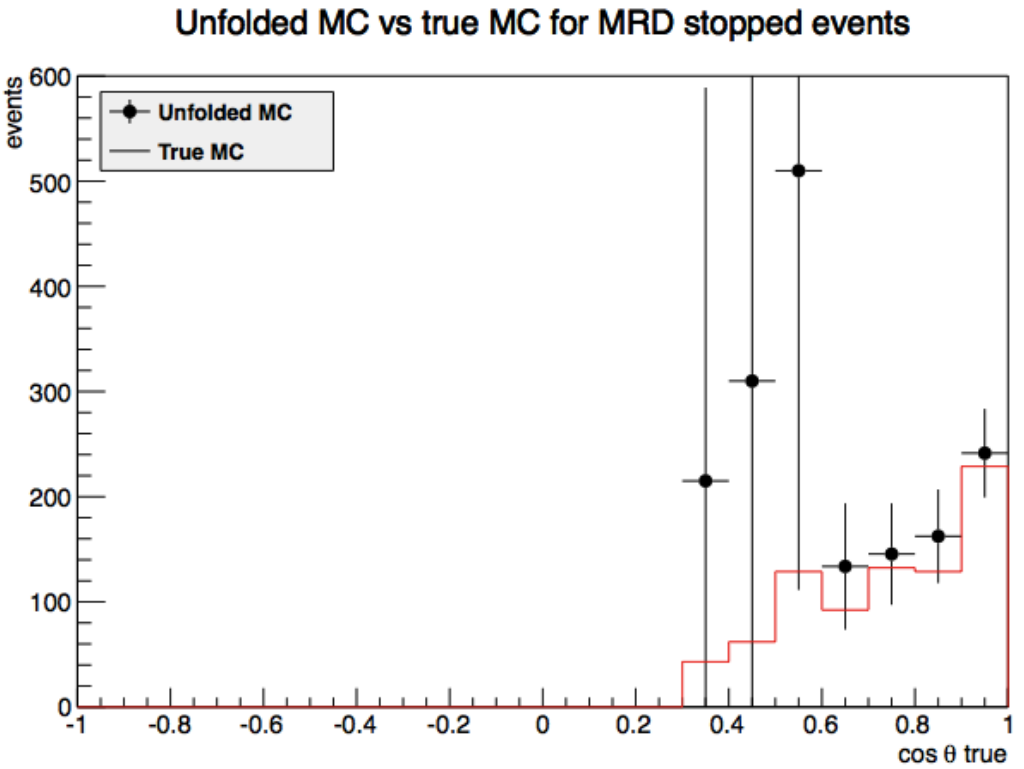


All SciBar-stopped events in the MC file, corrected for purity and efficiency calculated from MC events. Unfolded MC events are plotted vs true MC events.

$$N^{MC-UNF}_{SB-Corrected} = \frac{N^{MC-UNF}_{SB-TOT} \cdot P_{SB-CC}}{E_{SB}}$$

$$N^{MC-TRUE}_{SB-Corrected} = \frac{N^{MC-TRUE}_{SB-TOT} \cdot P_{SB-CC}}{E_{SB}}$$



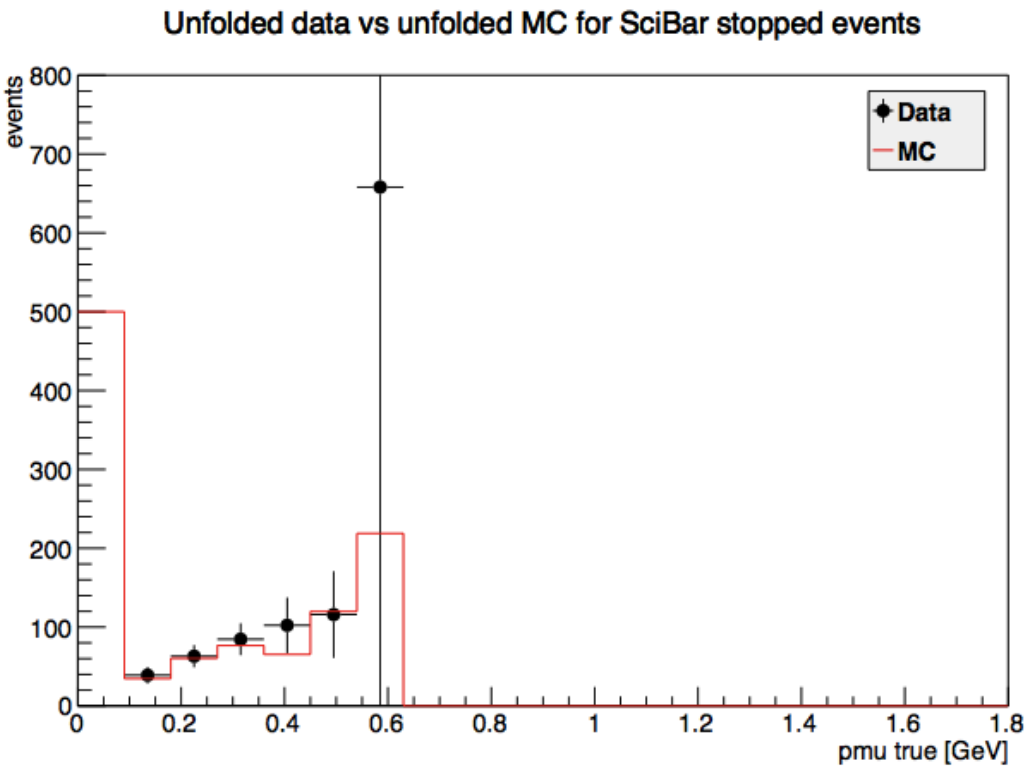


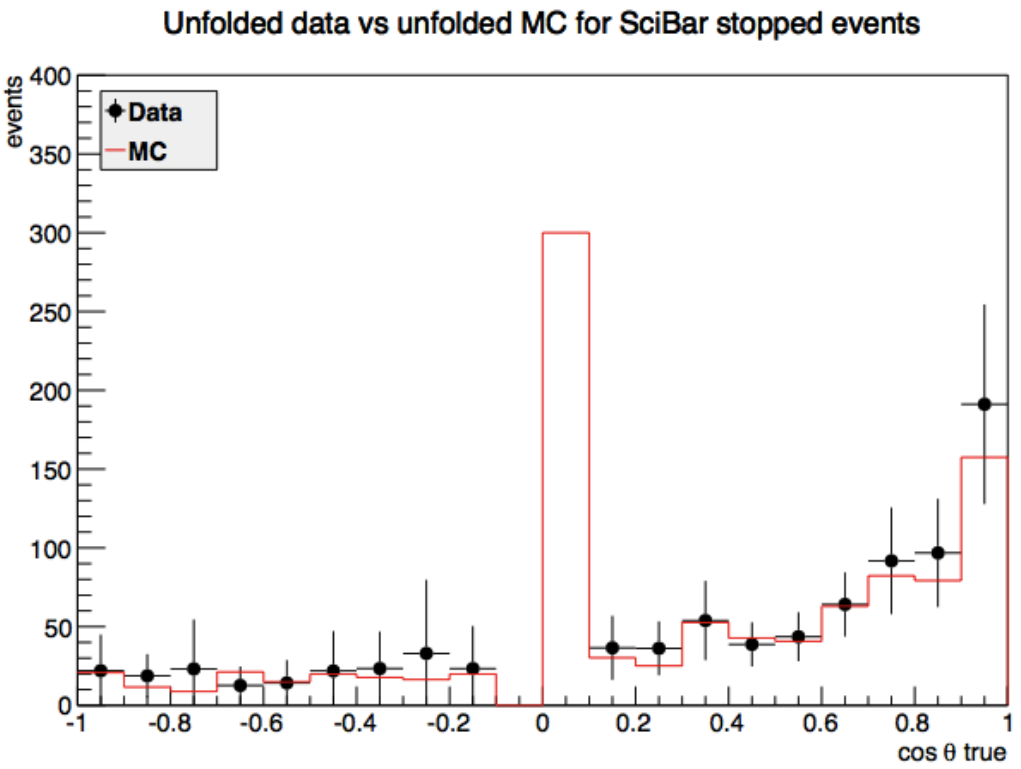
All MRD-stopped events in the MC file, corrected for purity and efficiency calculated from MC events. Unfolded MC events are plotted vs true MC events.

$$N^{DATA}_{MRD-Corrected} = \frac{N^{DATA-UNF}_{MRD-TOT} \cdot P_{MRD-CC}}{E_{MRD}}$$

$$N^{MC}_{MRD-Corrected} = \frac{N^{MC-TRUE}_{MRD-TOT} \cdot P_{MRD-CC}}{E_{MRD}}$$

Corrected events: unfolded data vs unfolded MC

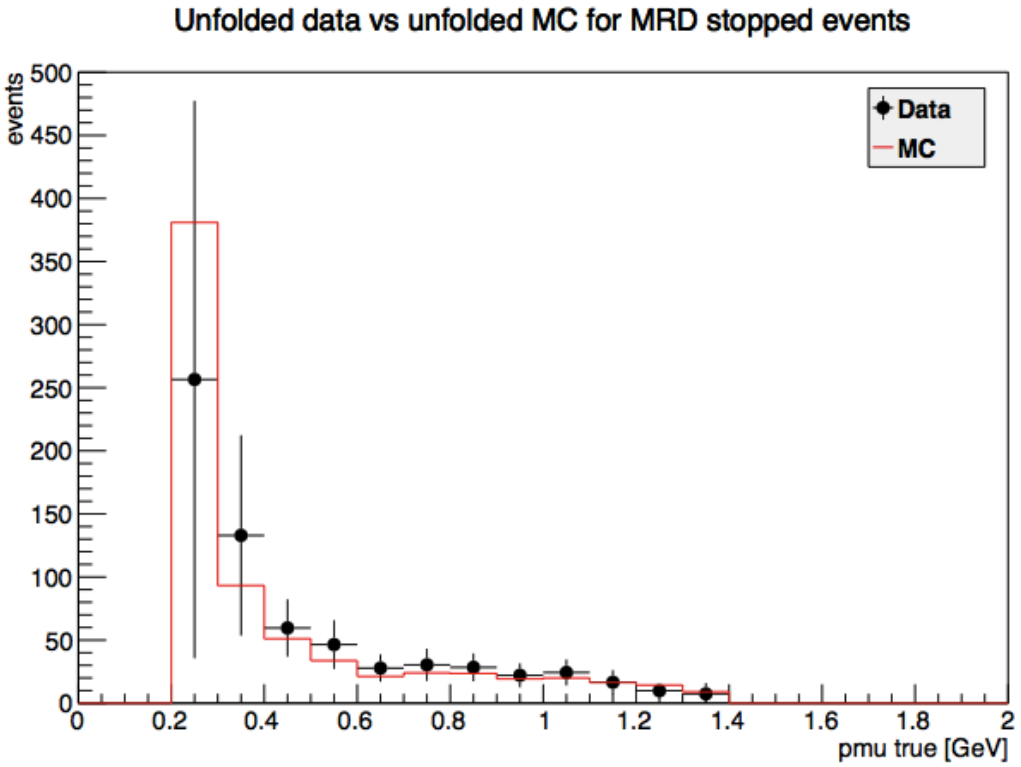


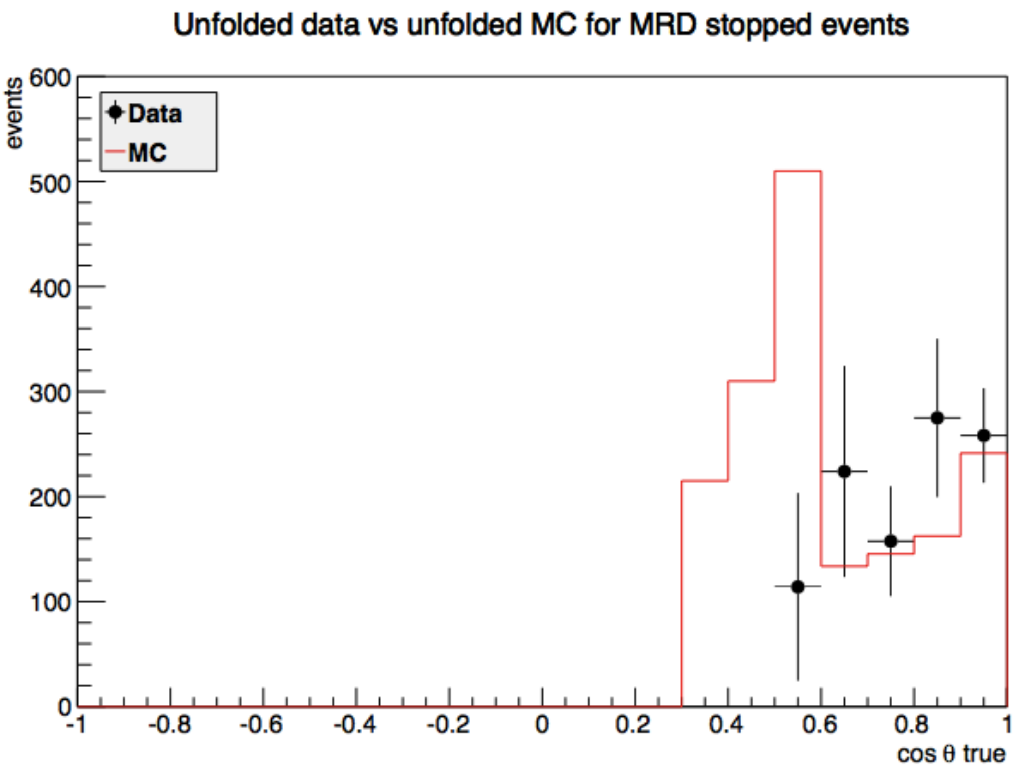


All SciBar-stopped events in the data and MC files, corrected for purity and efficiency calculated from MC events. Data and MC are unfolded.

$$N^{DATA}_{SB-Corrected} = \frac{N^{DATA-UNF}_{SB-TOT} \cdot P_{SB-CC}}{E_{SB}}$$

$$N^{MC}_{SB-Corrected} = \frac{N^{MC-UNF}_{SB-TOT} \cdot P_{SB-CC}}{E_{SB}}$$



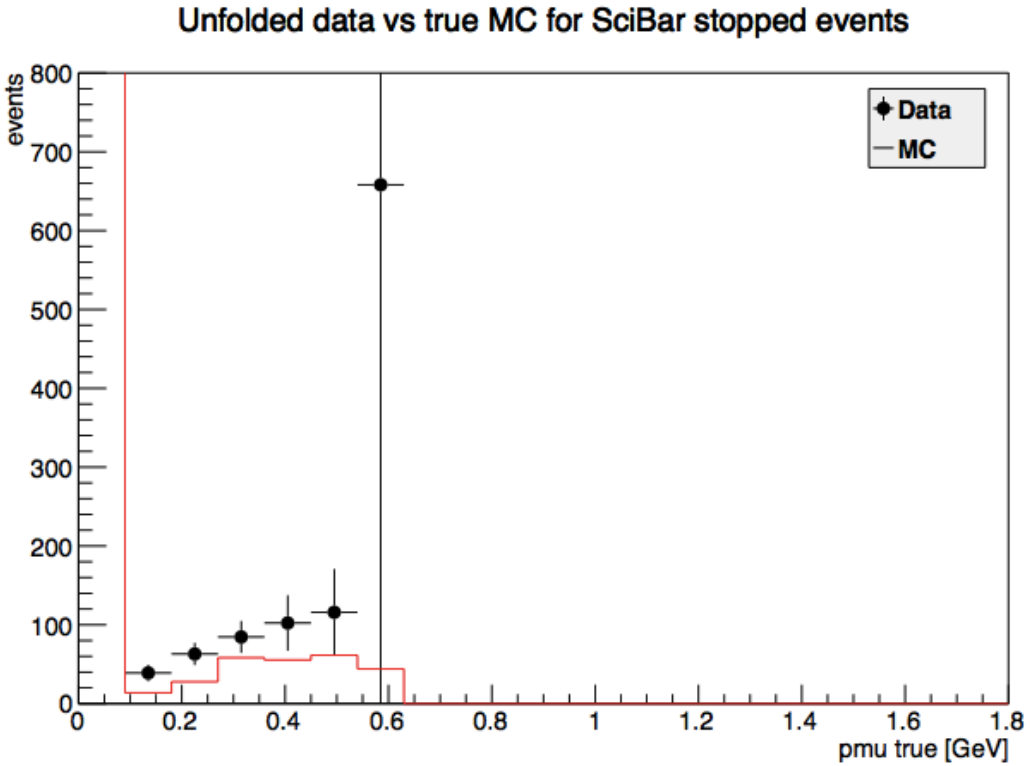


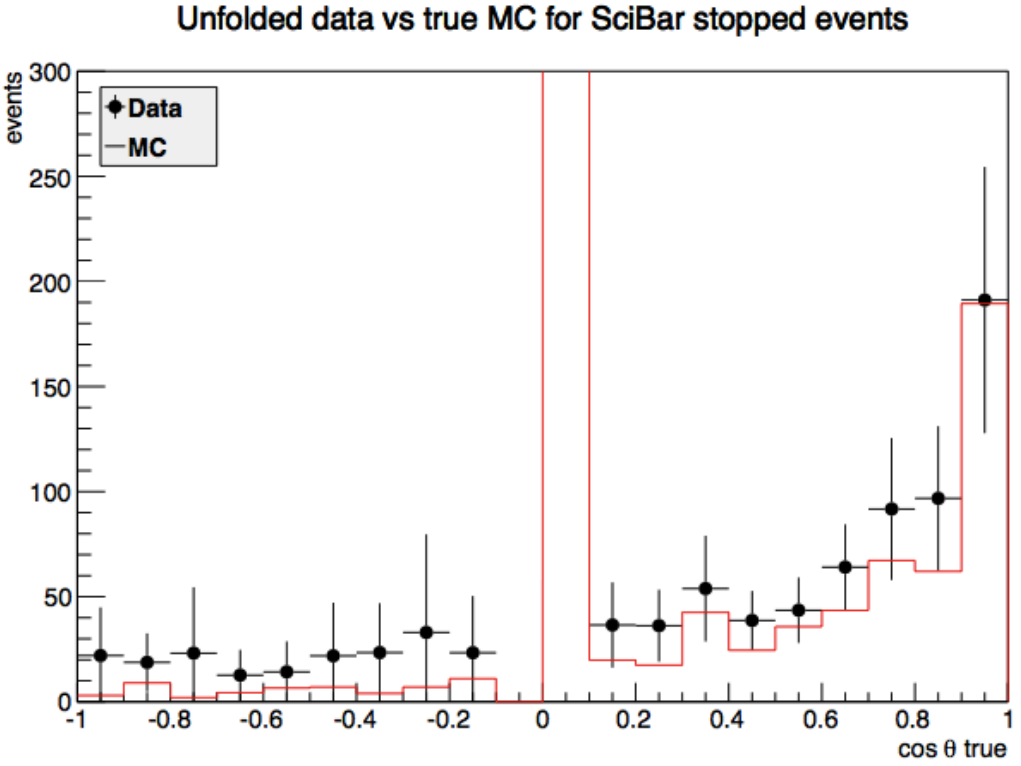
All MRD-stopped events in the data and MC files, corrected for purity and efficiency calculated from MC events. Data and MC are unfolded.

$$N^{DATA}_{MRD-Corrected} = \frac{N^{DATA-UNF}_{MRD-TOT} \cdot P_{MRD-CC}}{E_{MRD}}$$

$$N^{MC}_{MRD-Corrected} = \frac{N^{MC-UNF}_{MRD-TOT} \cdot P_{MRD-CC}}{E_{MRD}}$$

Corrected events: unfolded data vs true MC

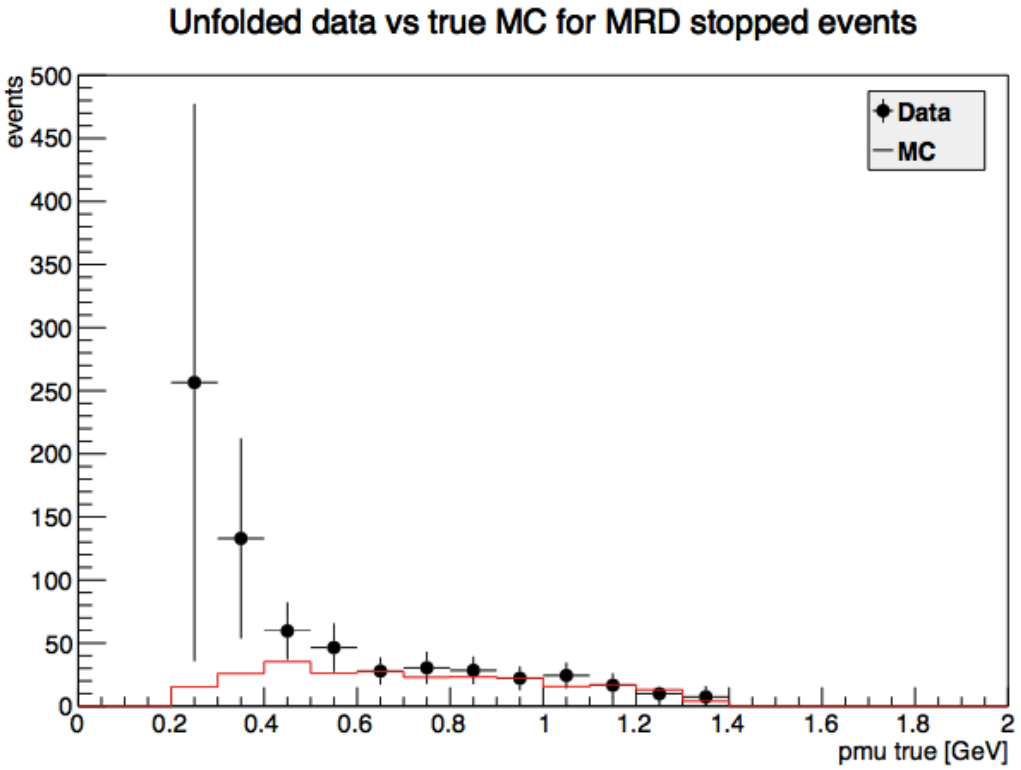


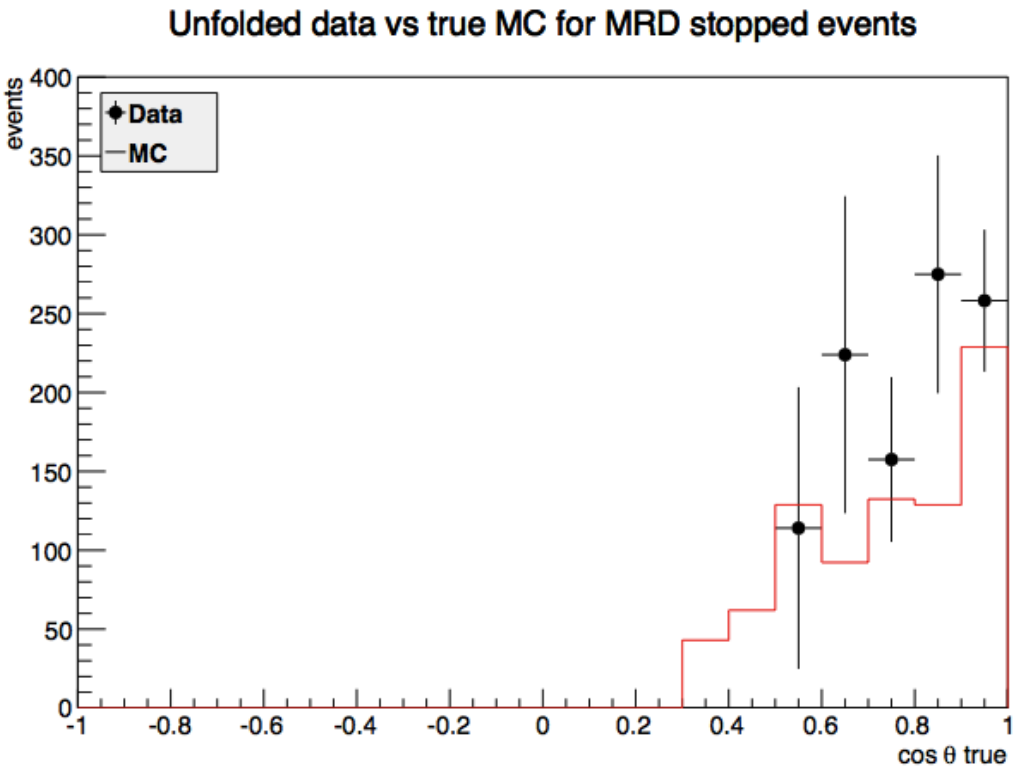


All SciBar-stopped events in the data and MC files, corrected for purity and efficiency calculated from MC events. Data is unfolded, MC uses true data.

$$N^{DATA}_{SB-Corrected} = \frac{N^{DATA-UNF}_{SB-TOT} \cdot P_{SB-CC}}{E_{SB}}$$

$$N^{MC}_{SB-Corrected} = \frac{N^{MC-TRUE}_{SB-TOT} \cdot P_{SB-CC}}{E_{SB}}$$





All MRD-stopped events in the data and MC files, corrected for purity and efficiency calculated from MC events. Data is unfolded, MC uses true.

$$N^{DATA}_{MRD-Corrected} = \frac{N^{DATA-UNF}_{MRD-TOT} \cdot P_{MRD-CC}}{E_{MRD}}$$

$$N^{MC}_{MRD-Corrected} = \frac{N^{MC-TRUE}_{MRD-TOT} \cdot P_{MRD-CC}}{E_{MRD}}$$

Future analysis

- Make sure method is correct.
  - Deal with errors properly.
- Weight adjusted
- Divide by flux to calculate cross section
- Apply method to real data