

Decay Search Study with MC events : I

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OUTLINE

- **Goals**
- **Method**
- **Status**
- **Changes**
- **Results**
- **Ongoing work**

GOALS

- The goals are to :
 - **Test and improve (if possible)** the performance of **Decay Search code** on **MC events** (decay m-files with no “irrelevant tracks” but just the interactions tracks).
 - **Test and improve (if possible)** the performance of **Decay Search code** on **Hybrid MC** events (MC decay m-files merged with true decay m-files).
 - **Use** the resulting **Decay Search Code** (after **tuning” and improvements**) on **neutrino events**.

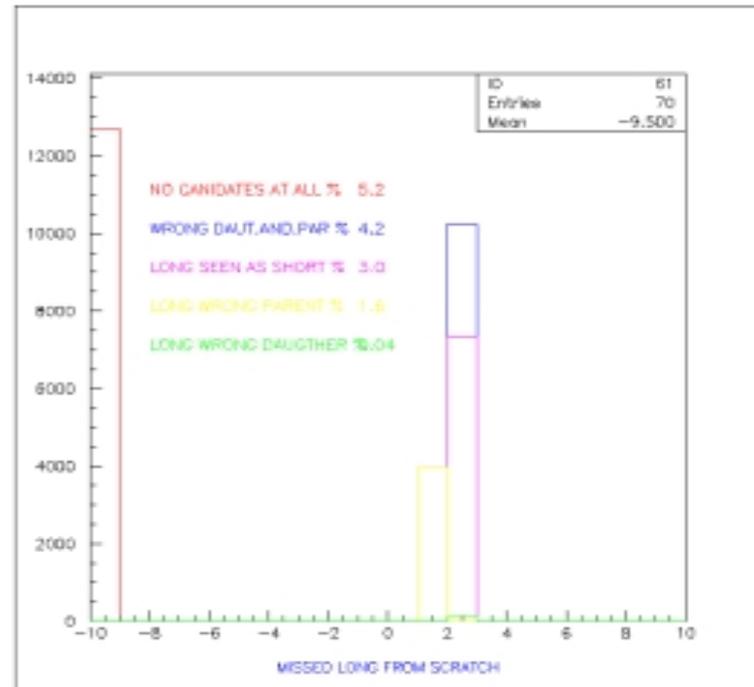
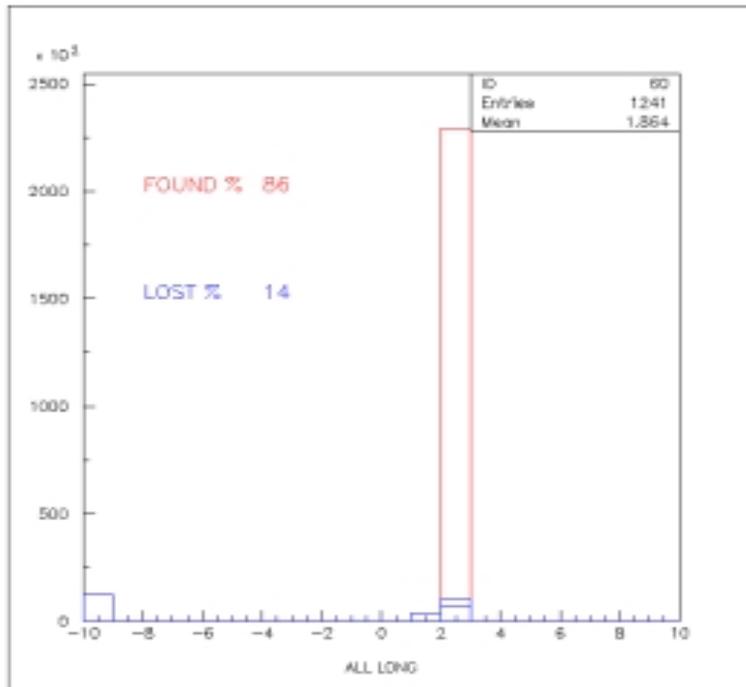
METHOD

- **A) Generate MC ν_τ CC interactions and :**
 - Process them with the existing (Bruce's) decay search code and study mainly **success and failure percentages (and reasons of failure)** on **Long-Large** and **Short** tau decays.
 - Introduce additional cuts in an effort to **improve** the **Short** tau decay **finding efficiency**.
- **B) Generate a sufficient number of Hybrid MC ν_τ CC interactions and study (as above) the tau decay finding efficiency.**

STATUS

- We have **completed part (A)** :
 - Generated 5000 ν_τ CC interactions
 - Processed with the Decay search code
 - Studied initial tau decay finding efficiencies for Large Long and Short tau decays
 - Introduced cuts in order to improve the Short decays finding efficiency.
- We have **completed** and **tested** all the “**initial**” steps that are necessary in order to be able to **generate and process Hybrid MC decay m-files** that are needed for part (B)

Initial Results: LL



- IP cut = 5 microns and Opening angle cut = 250 mrad . (Primary IP cut = 10 μ)

FOUND = 86% LOST = 14%

- LOST (NO CANDIDATES AT ALL) = 5.20 %
- LOST (WRONG DAUGHTER AND PARENT) = 4.20 %
- LOST (SEEN AS SHORT) = 3.00 %
- LOST (WRONG PARENT) = 1.60 %
- LOST (WRONG DAUGHTER) = 0.04 %

Changes (Modifications & Cuts)

- Change #1 : IP cut for selecting primary tracks 5μ
- Change #2 : Logic for examining one of the 'primary' tracks as S daughter candidate.
- Change #3 : Set A of cuts on IP , Opening angle and flight in order to eliminate S decays 'seen' as LL.
- Change #4 : Set B of cuts on IP, Opening angle and flight in order to eliminate S decays with wrong daughter.

Change #1

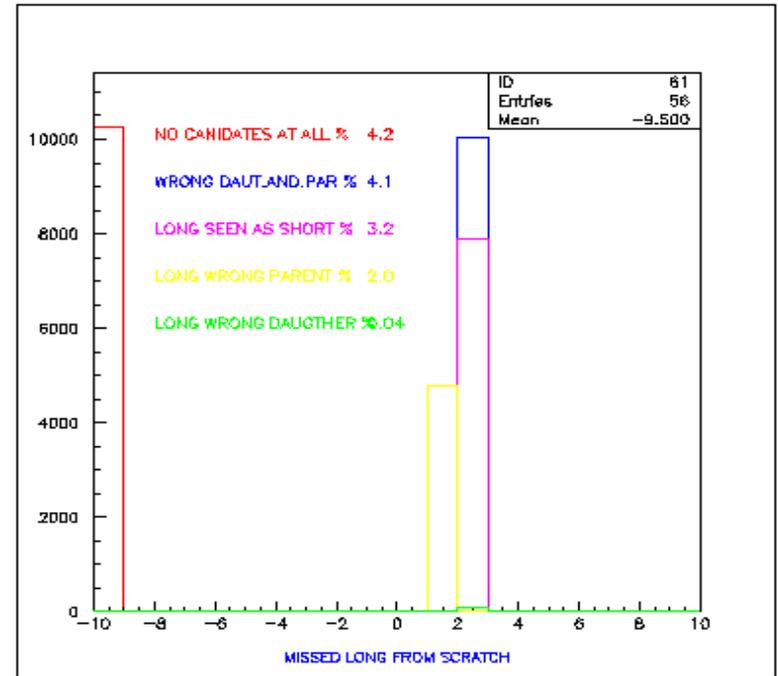
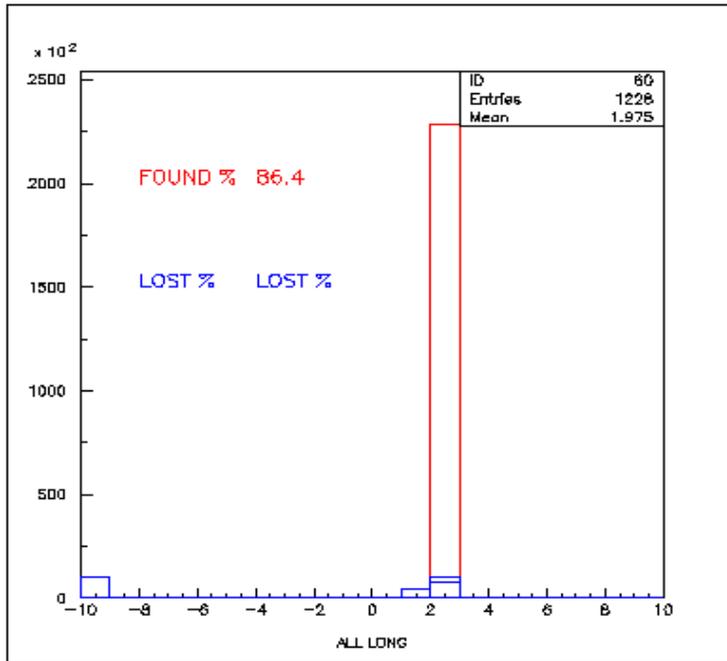
- **Initial results**

- The **LL finding efficiency** is **(86%)**
- The **S finding efficiency** is low **(45.7 %)**
- **93 %** of **missed S** are due to the fact that the **daughter** is **“seen”** as one of the **primary tracks** so:

- **Change #1**

- We reduced the **10 μ** cut for **selecting primary** tracks to **5 μ** which is also the cut used by the Event - Location code.

Results after change #1: LL

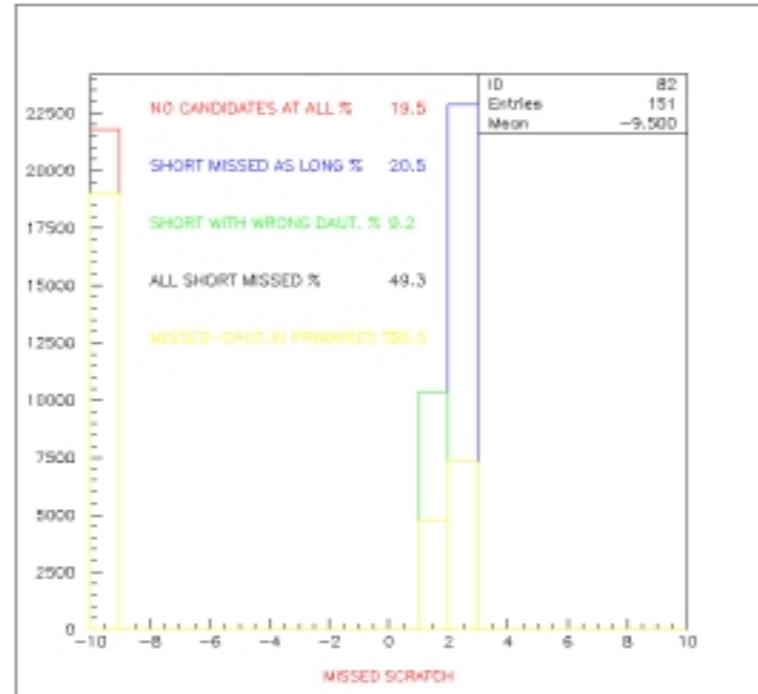
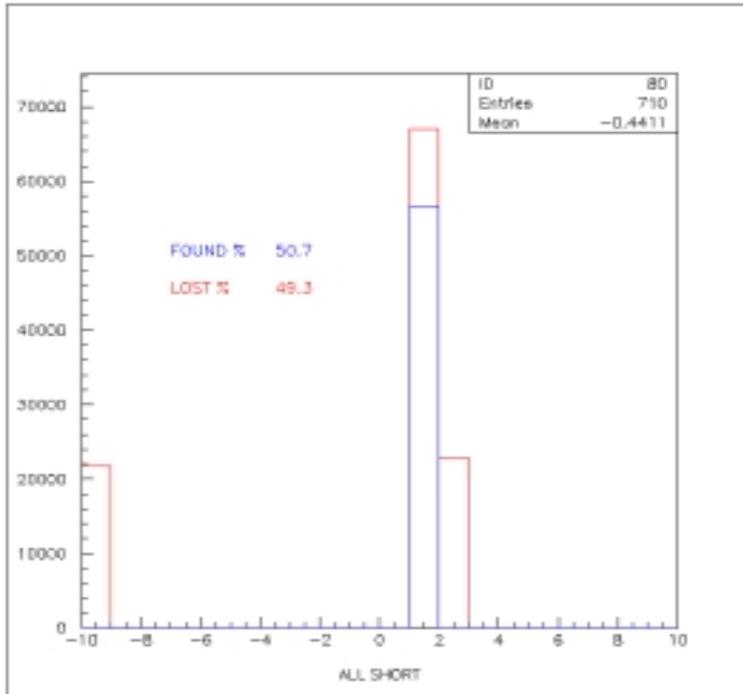


- IP cut = 5 microns and Opening angle cut = 250 mrad . (Primary IP cut = 5 μ)

FOUND = 86.4% LOST = 13.7%

- LOST (NO CANDIDATES AT ALL) = 4.20 %
- LOST (WRONG DAUGHTER AND PARENT) = 4.30 %
- LOST (SEEN AS SHORT) = 3.20 %
- LOST (WRONG PARENT) = 2.00 %
- LOST (WRONG DAUGHTER) = 0.04 %

Results after change #1: S



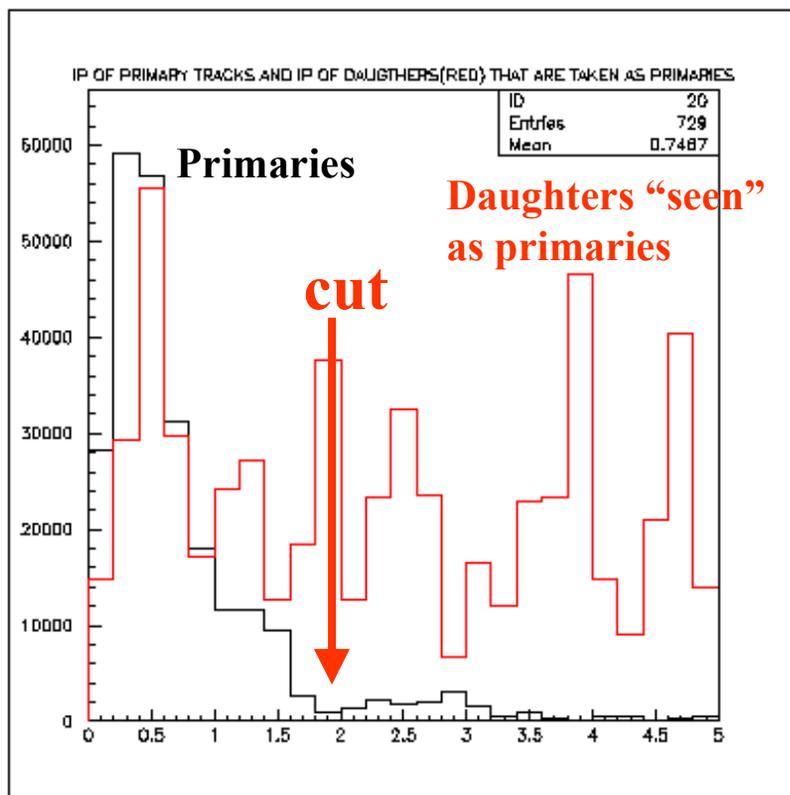
- IP cut = 200 microns and Opening angle cut = 200 mrad . (Primary IP cut = 5 μ)

FOUND = 50.7% LOST = 49.3%

- LOST (NO CANDIDATES AT ALL) = 19.50 %
- LOST (SEEN AS LONG) = 20.50 %
- LOST (WRONG DAUGHTER) = 9.20 %
- Percentage of the above LOST = 38.30 %
due to DAUGHTER SEEN AS PRIMARY

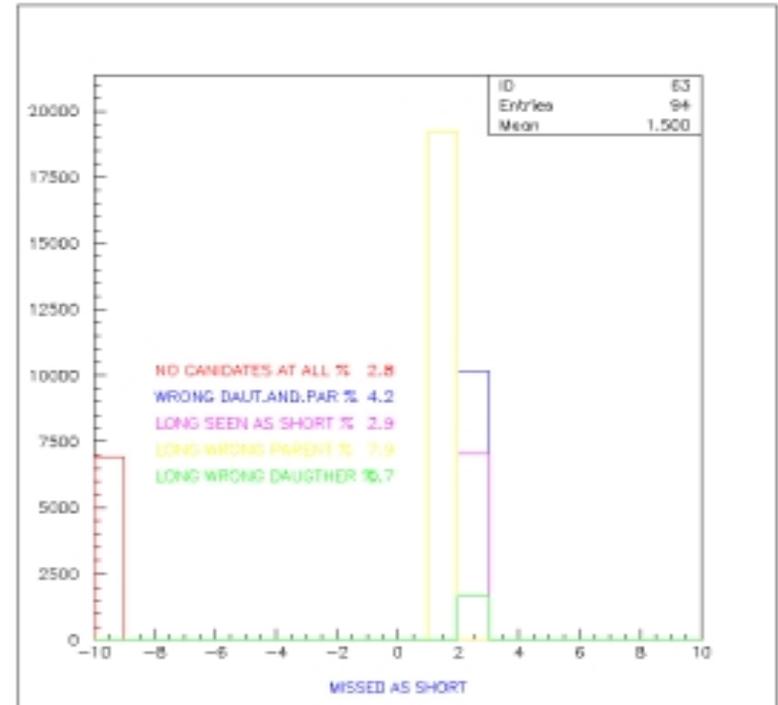
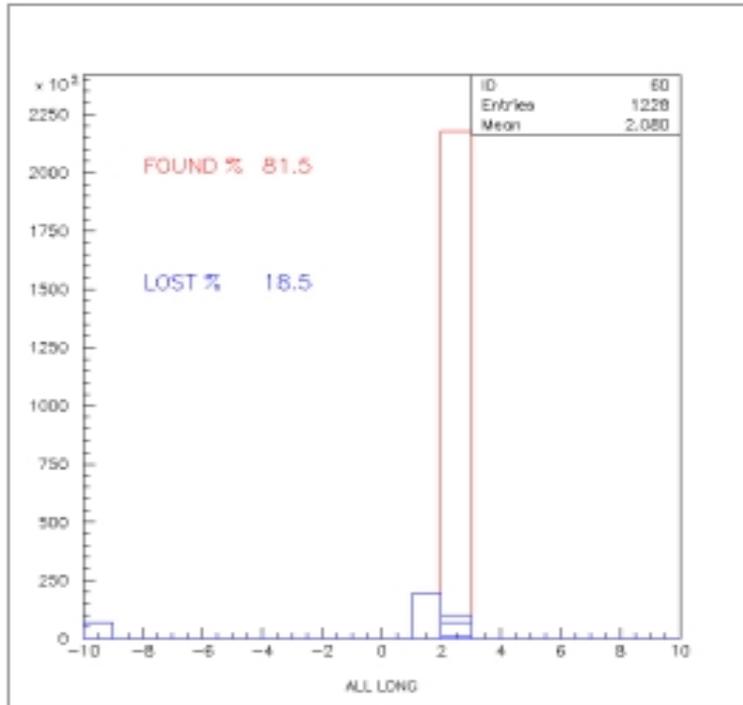
Change #2

IP distributions of “primary” Tracks



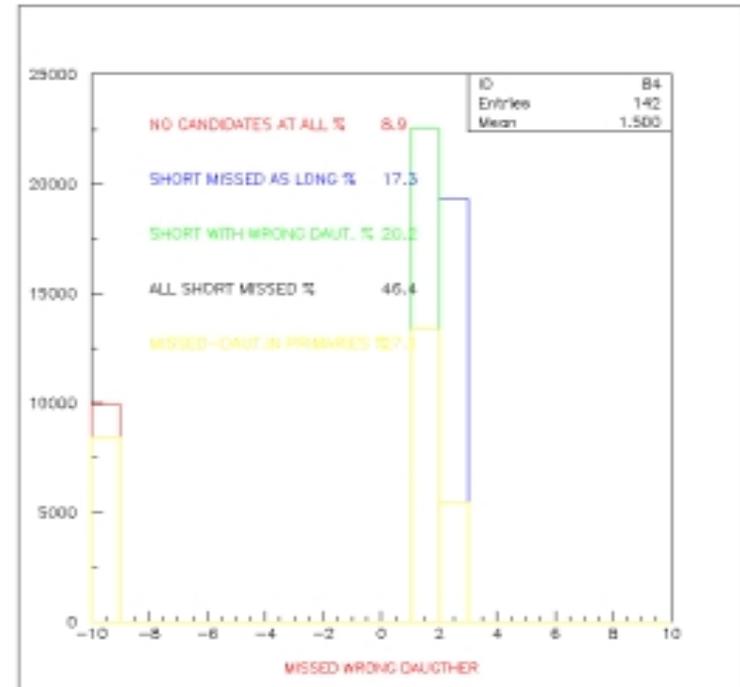
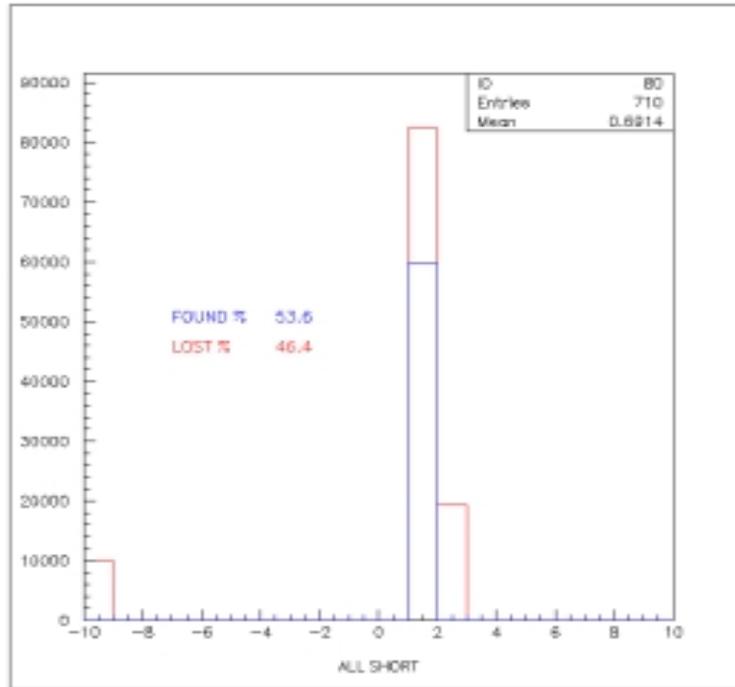
- **Results of change #1**
 - The **LL finding efficiency** is retained (**86.4%**)
 - The **S finding efficiency** increased to (**50.7 %**)
 - Still **78 %** of **missed S** are due to the fact that the **daughter** is “**seen**” as one of the **primary tracks** so:
- **Change #2**
 - We form the vertex throwing every time one of the primary tracks out and then consider the one with the largest IP from the vertex that exceeds a 2μ cut as a potential decay candidate that has to be examined.

Results after change #2: LL



- IP cut = 5 microns and Opening angle cut = 250 mrad . (Primary IP cut = 5 μ)
FOUND = 81.5% **LOST = 18.5%**
- LOST (NO CANDIDATES AT ALL) = 2.80 %
- LOST (WRONG DAUGHTER AND PARENT) = 4.20 %
- LOST (SEEN AS SHORT) = 2.90 %
- LOST (WRONG PARENT) = 7.90 %
- LOST (WRONG DAUGHTER) = 0.70 %

Results after change #2 :S



- IP cut = 200 microns and Opening angle cut = 200 mrad . (Primary IP cut = 5 μ)
 - **FOUND = 53.6%** **LOST = 46.4%**
 - **LOST (NO CANDIDATES AT ALL) = 8.90 %**
 - **LOST (SEEN AS LONG) = 17.30 %**
 - **LOST (WRONG DAUGHTER) = 20.20 %**
 - **Percentage of the above LOST = 27.10 %**
due to DAUGHTER SEEN AS PRIMARY

Change #3

- **Results of change #2**

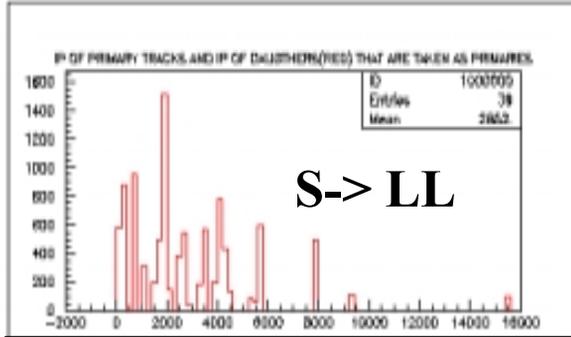
- The **LL finding efficiency** was slightly decreased (**81.5%**)
- The **S finding efficiency** was increased (**53.6 %**)
- The main reasons for **missing S** decays are now S decays **seen as LL (17.3%)** and S decays with the **wrong daughter (20.2 %)**.

- **Change #3**

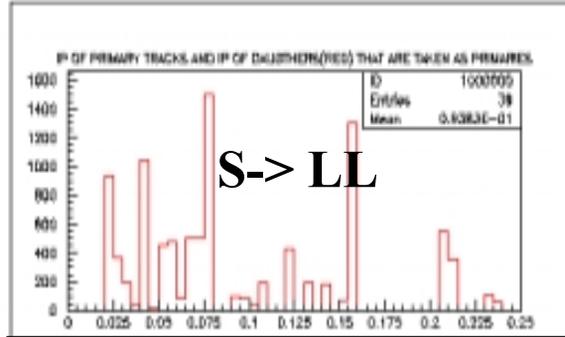
- Is based on a combination of cuts in **IP , opening angle and tau flight** in order to **eliminate S seen as LL**. This cut is applied only when LL and S candidates exist in the list.

Change #3 cont.

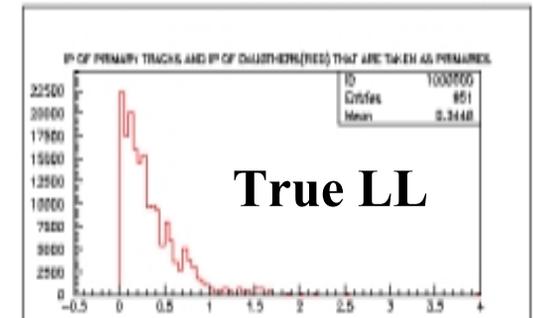
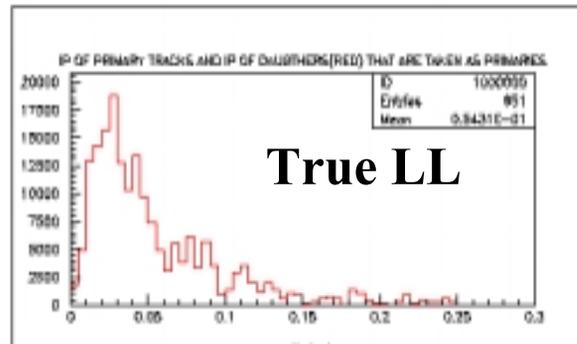
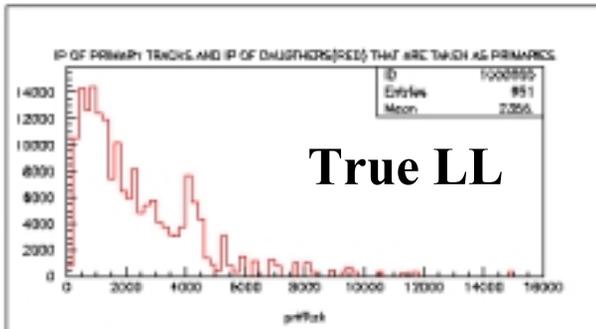
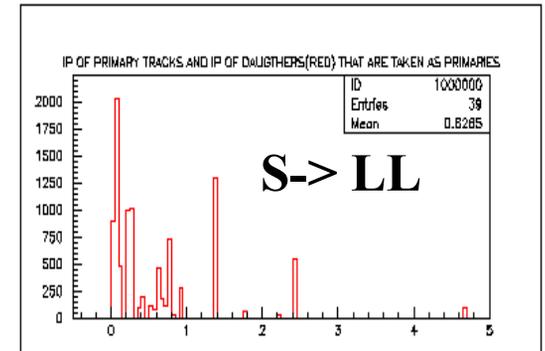
Flight



Angle



IP



CUTS: 6000 μ

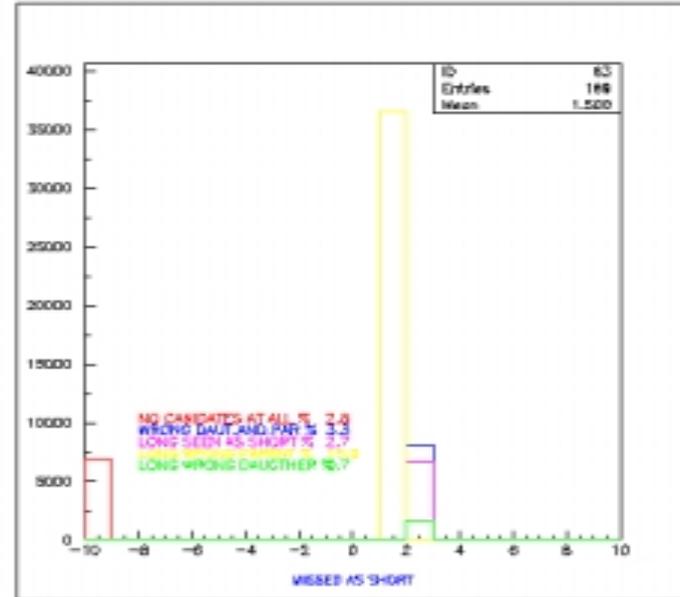
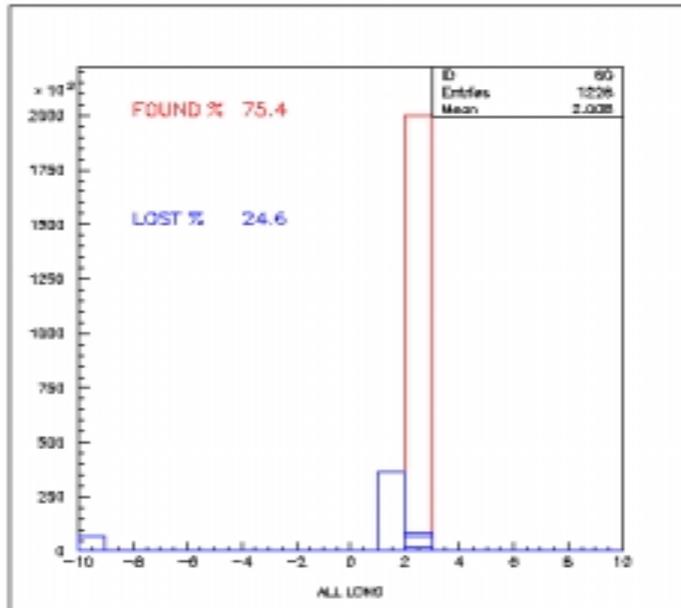
150 mrad

1 μ

Short “seen” as LL (upper)

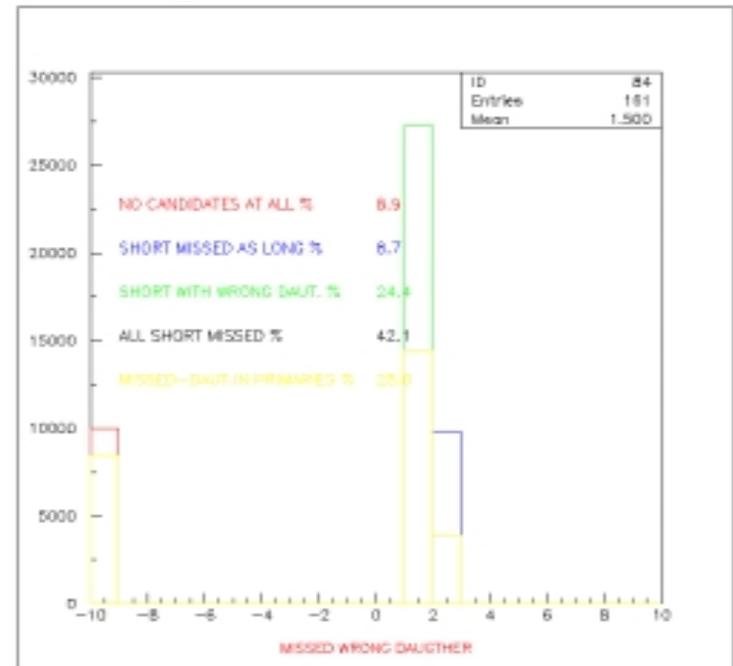
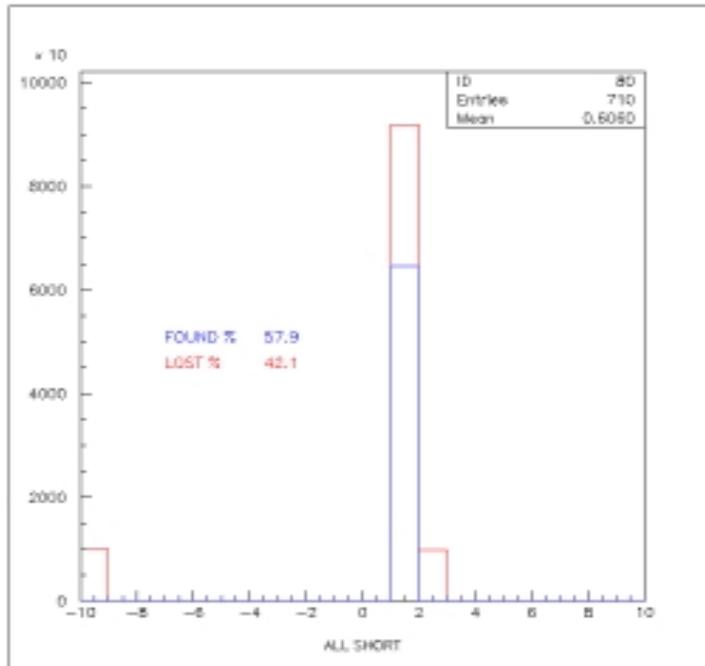
True LL (lower)

Results after change #3: LL



- IP cut = 5 microns and Opening angle cut = 250 mrad . (Primary IP cut = 5 μ)
FOUND = 75.4% LOST = 24.6%
- LOST (NO CANDIDATES AT ALL) = 2.80 %
- LOST (WRONG DAUGHTER AND PARENT) = 3.30 %
- LOST (SEEN AS SHORT) = 2.70 %
- LOST (WRONG PARENT) = 15.00 %
- LOST (WRONG DAUGHTER) = 0.70 %

Results after change #3 : S



- IP cut = 200 microns and Opening angle cut = 200 mrad . (Primary IP cut = 5 μ)
 - **FOUND = 57.9%** **LOST = 42.1%**
 - LOST (NO CANDIDATES AT ALL) = 8.90 %
 - LOST (SEEN AS LONG) = 8.70 %
 - LOST (WRONG DAUGHTER) = 24.40 %
 - Percentage of the above LOST = 28.00 %
due to DAUGHTER SEEN AS PRIMARY

Change #4

- **Results of change #3**

- The **LL finding efficiency** was decreased (**75.4%**)
- The **S finding efficiency** was increased (**58 %**)
- The percentage of S decays **seen as LL** was decreased to **8.7%** but the one of S decays with the **wrong daughter** is still high (**24.4 %**).

- **Change #4**

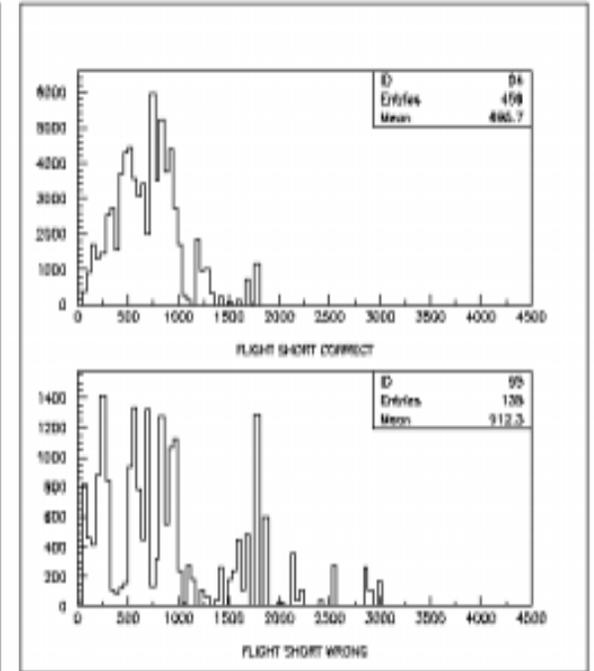
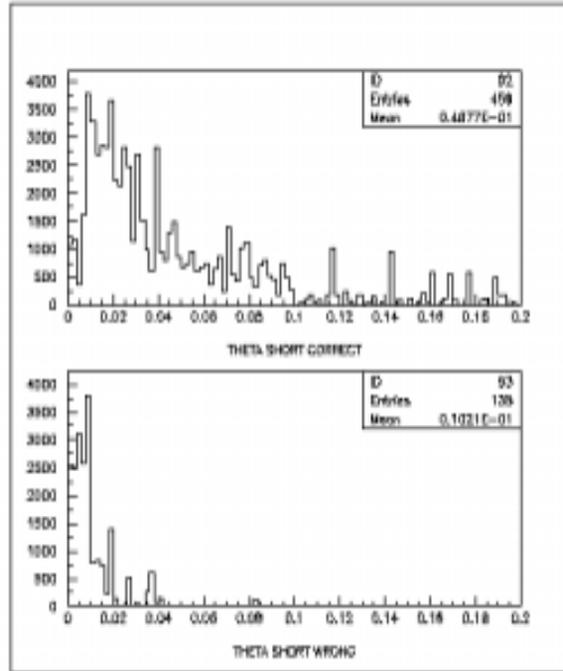
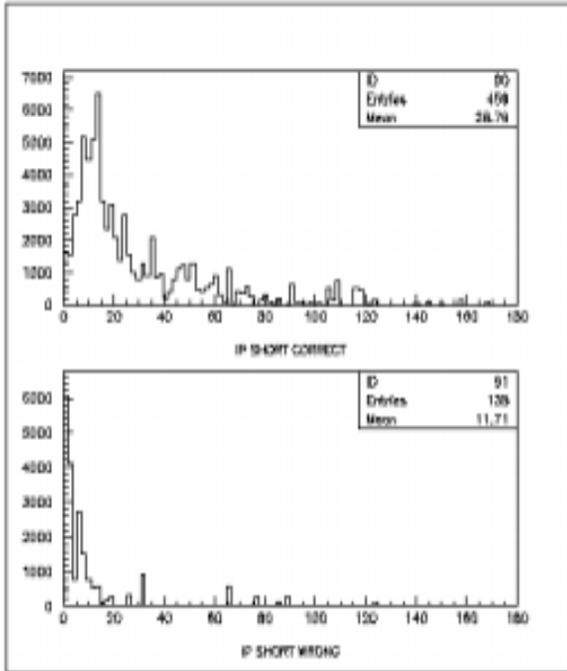
- Is based on a combination of cuts in **IP , opening angle and tau flight** in order to **eliminate S with wrong daughter**.

Change #4 cont.

IP

Opening Angle

Flight



CUTS: 4 μ

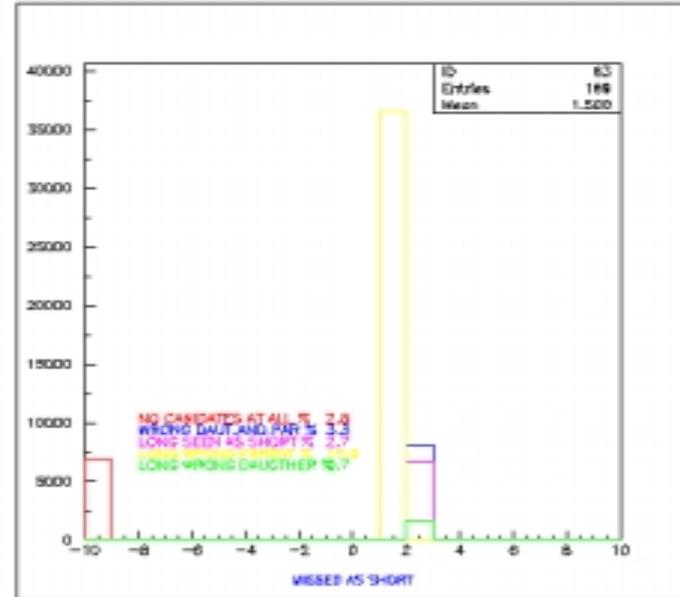
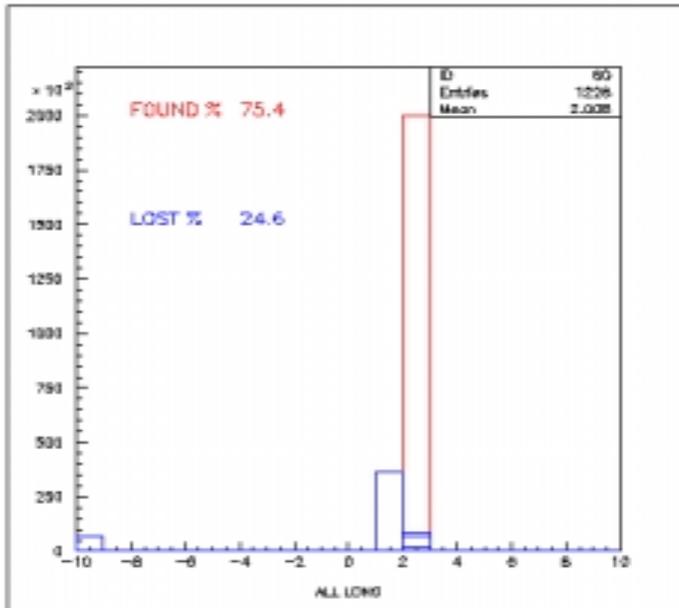
0.006 mrad

2000 μ

SHORT CORRECT DAUGHTER (TOP)

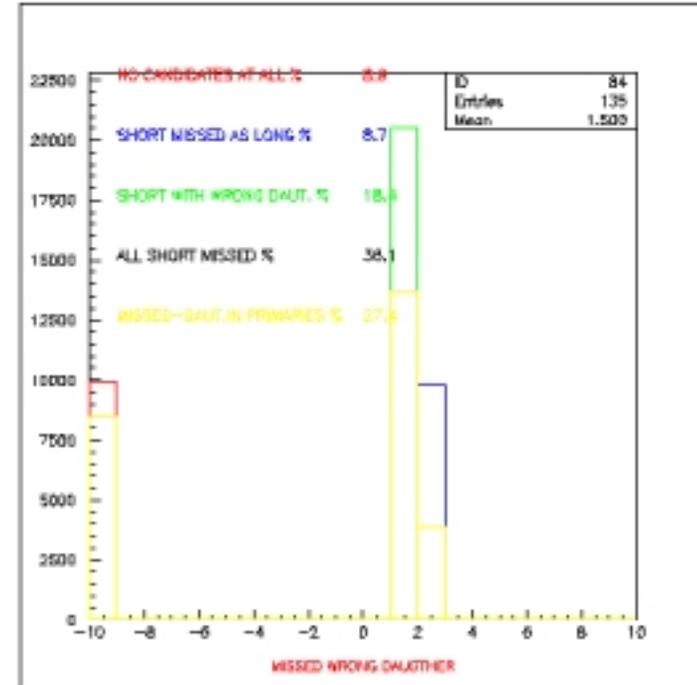
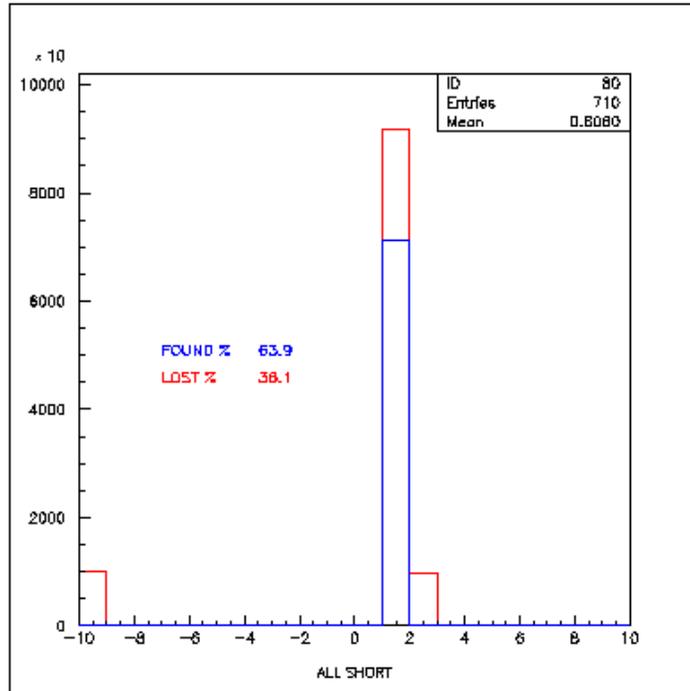
SHORT WRONG DAUGHTER (BOTTOM)

Results after change #4 : LL(same)



- IP cut = 5 microns and Opening angle cut = 250 mrad . (Primary IP cut = 5 μ)
FOUND = 75.4% LOST = 24.6%
- LOST (NO CANDIDATES AT ALL) = 2.80 %
- LOST (WRONG DAUGHTER AND PARENT) = 3.30 %
- LOST (SEEN AS SHORT) = 2.70 %
- LOST (WRONG PARENT) =15.00 %
- LOST (WRONG DAUGHTER) = 0.70 %

Results after change #4: S



- IP cut = 200 microns and Opening angle cut = 200 mrad . (Primary IP cut = 5 μ)

FOUND = 63.9%	LOST = 36.1%
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- LOST (NO CANDIDATES AT ALL) = 8.90 %
- LOST (SEEN AS LONG) = 8.70 %
- LOST (WRONG DAUGHTER) = 18.40 %
- Percentage of the above LOST due to DAUGHTER SEEN AS PRIMARY = 27.10 %

Conclusions

- The **LL** finding **efficiency decreased** from **86.4 %** to **75.4 %**, mainly due to the third set of cuts trying to eliminate S seen as LL decays.
- The **S** finding **efficiency increased** from **45.7%** to **63.9 %**. The increase was about $\sim 5\%$ for every new set of cuts.
- **Without** applying the **change #3** the **LL** efficiency is $\sim 82\%$ and the **S** finding efficiency $\sim 59 \%$.

On going work

- We have to finalize our cuts in order to determine the upper limit of the LL and S code finding efficiency from the MC events.
- Use that set of cuts to examine the algorithm's efficiency on Hybrid MC events that describe the real neutrino events in a more better way.