STUDY OF CC1Π+ IN CARBON (FGD1) WITH 4Π ACCEPTANCE

NEUTRINO HUNTERS: UNIGE-ETHZ-IFAE JOINT MEETING

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EXECUTIVE SUMMARY

Status

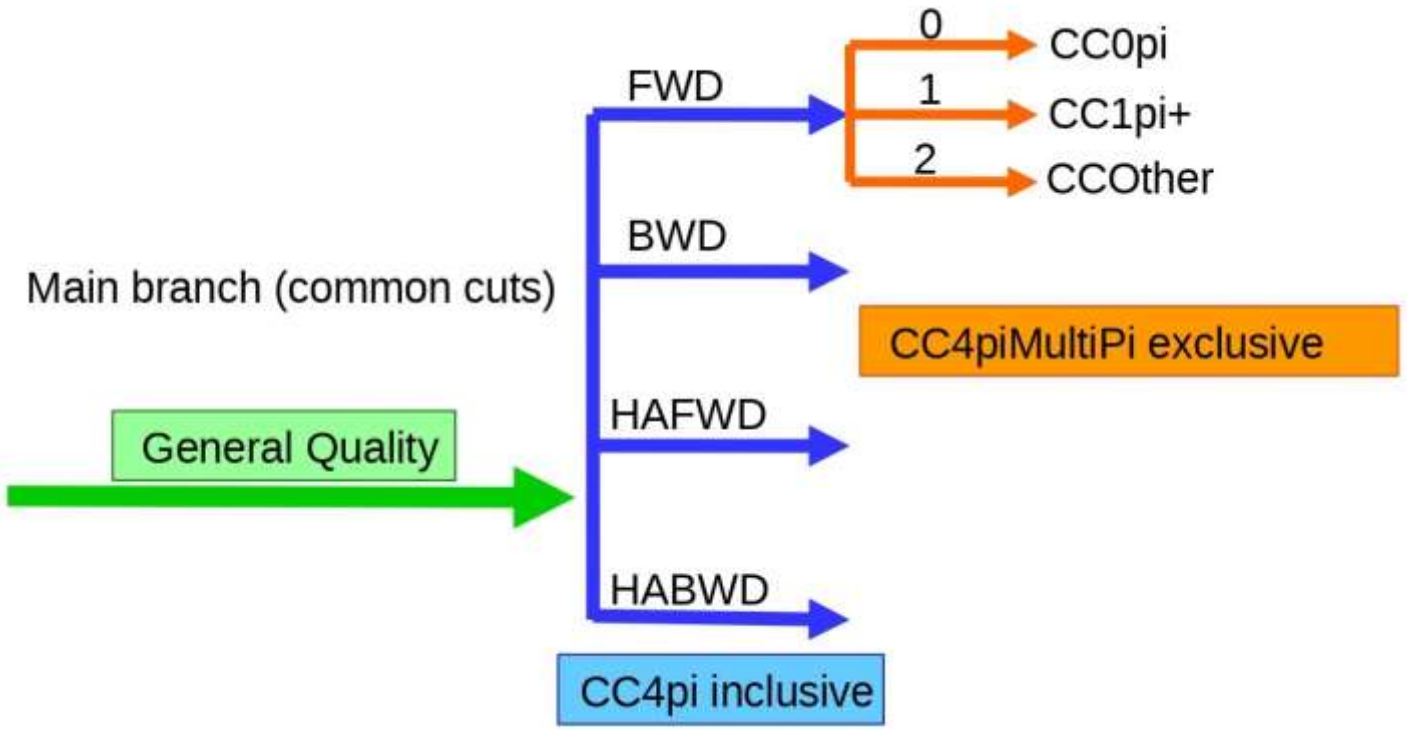
- Selection is being tested by Kevin, Stephanie and I.
- Implemented new selection steps (ToF inversion and correct track sense).
- Modified others (sort TPC tracks, quality+fiducial and common vertex).

Today

- Modified steps.
- CC1pi+ kinematic for 4π: Momentum and angular distribution.

NUMUCC4PIMULTIPI SELECTION BRANCHES

The selection is implemented following the scheme below, where FWD mean forward, BWD backward and HA high angle.



Branch Alias	Branch Name
0	"Fwd CC0pi"
1	"Fwd CC1pi"
2	"Fwd CCOther"
3	"Bwd CC0pi"
4	"Bwd CC1pi"
5	"Bwd CCOther"
6	"HAFwd CC0pi"
7	"HAFwd CC1pi"
8	"HAFwd CCOther"
9	"HABwd CC0pi"
10	"HABwd CC1pi"
11	"HABwd CCOther"

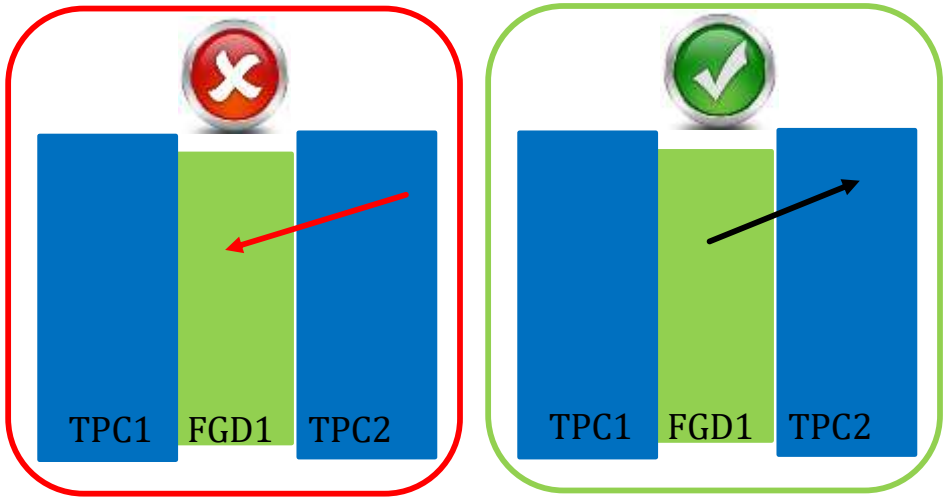
SORT TPC TRACKS ACTION

EventBoxTracker:

kTracksWithECal

start of the track
end of the track

kTracksWithGoodQualityTPCInFGD1FV → kTracksWithGoodQualityTPCWithStartOrEndInFGD1FV



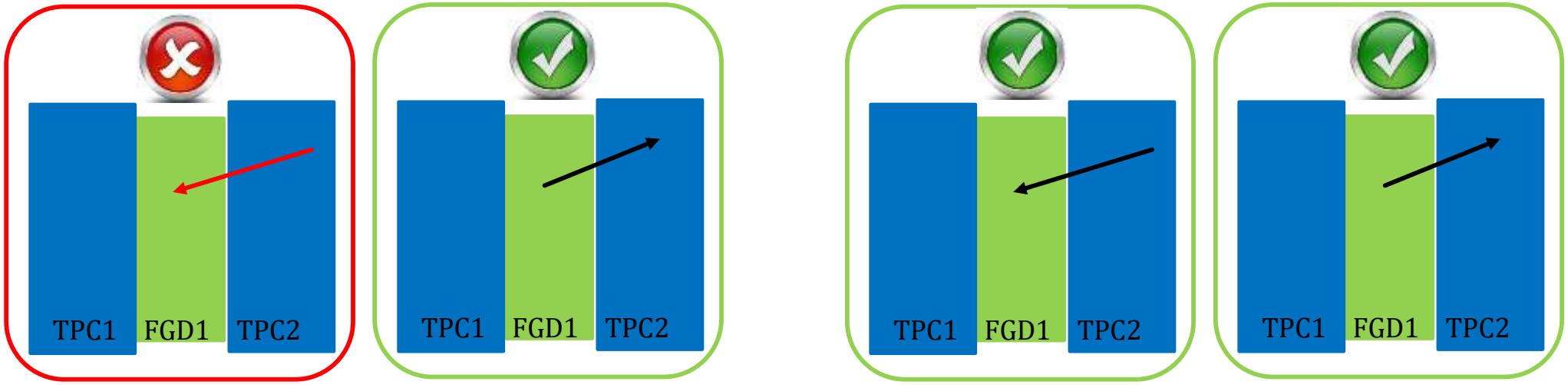
SORT TPC TRACKS ACTION

EventBoxTracker:

kTracksWithECal

start of the track
end of the track

kTracksWithGoodQualityTPCInFGD1FV → kTracksWithGoodQualityTPCWithStartOrEndInFGD1FV



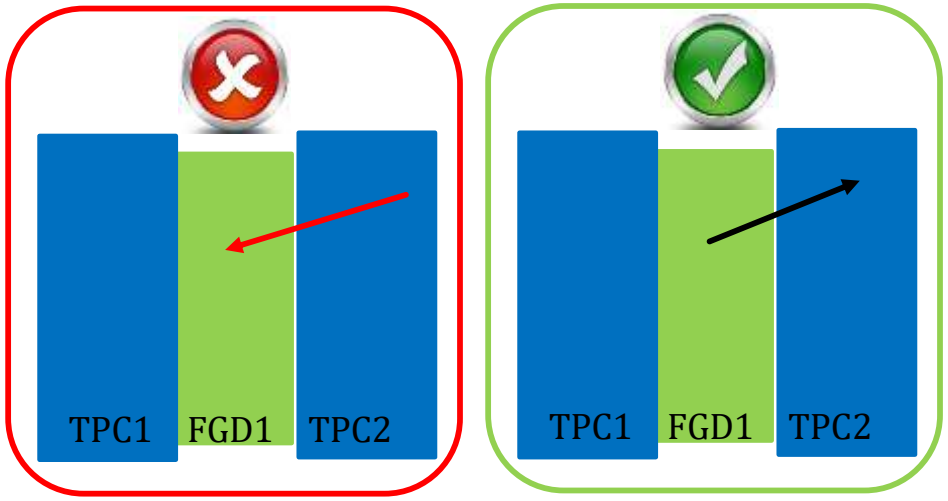
SORT TPC TRACKS ACTION

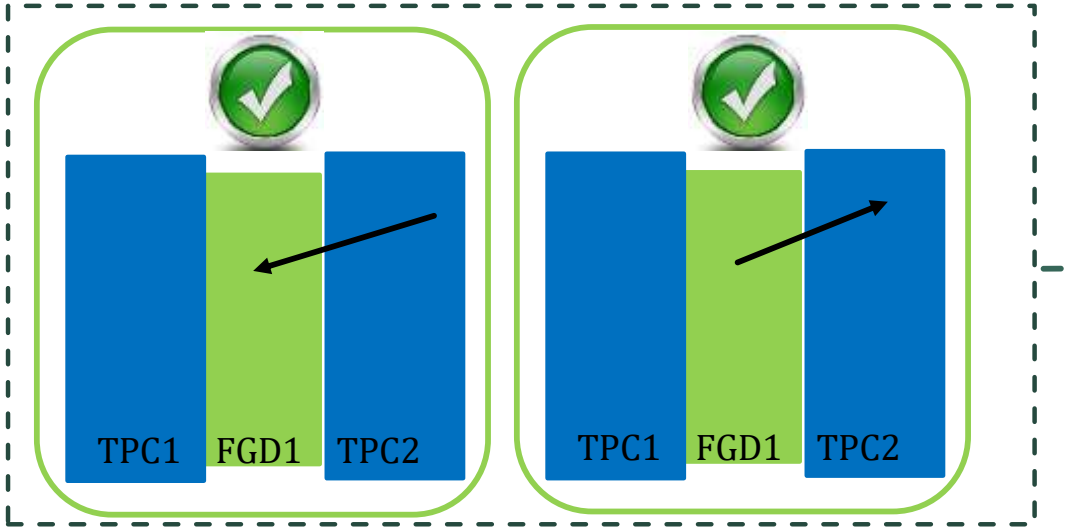
EventBoxTracker:

kTracksWithECal - - - → High Angle tracks

start of the track
end of the track

kTracksWithGoodQualityTPCInFGD1FV → kTracksWithGoodQualityTPCWithStartOrEndInFGD1FV





Low Angle tracks

QUALITY+FIDUCIAL CUT

Main change in this is:

- Before:
  - Tracks were sorted into FWD and BWD only checking that the start position of the tracks (for Low and High angle)
- Now:
  - Tracks are also sorted using the end position (if they weren't sorted already with the start position)

Note: All this assuming that the start or end of the track is in FGD1FV.

COMMON VERTEX CUT

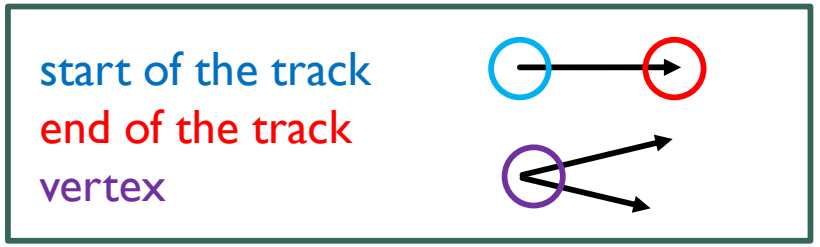
Old definition of Common Vertex:

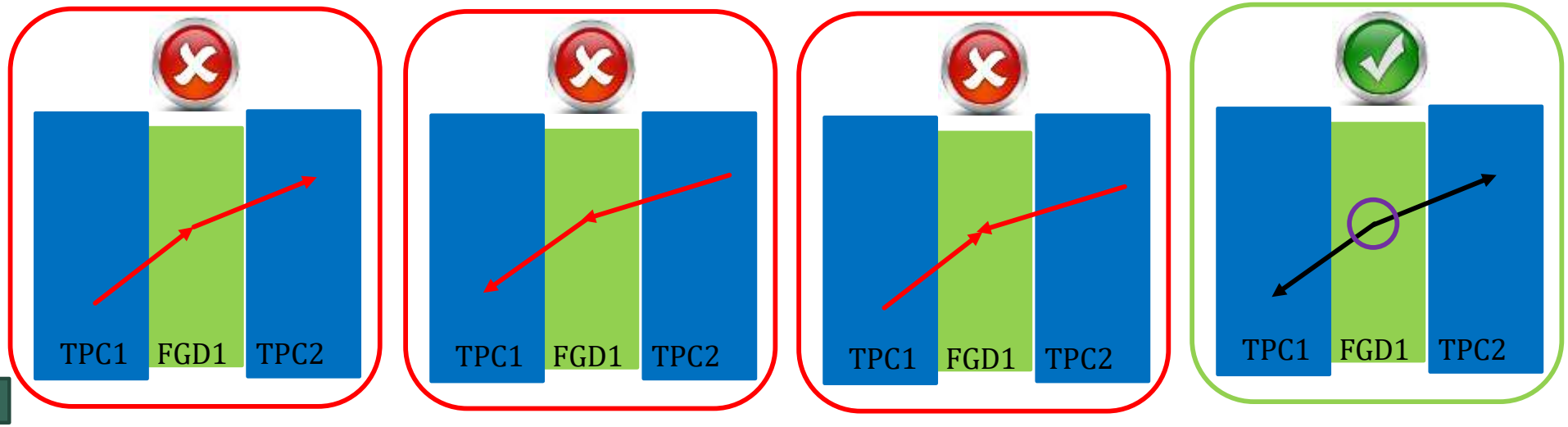
- All tracks going FWD,
- Compared only start positions of the tracks.

New definition of Common Vertex:

⑥ All tracks going FWD,

⑥ Compared start and end positions of the tracks.





COMMON VERTEX CUT

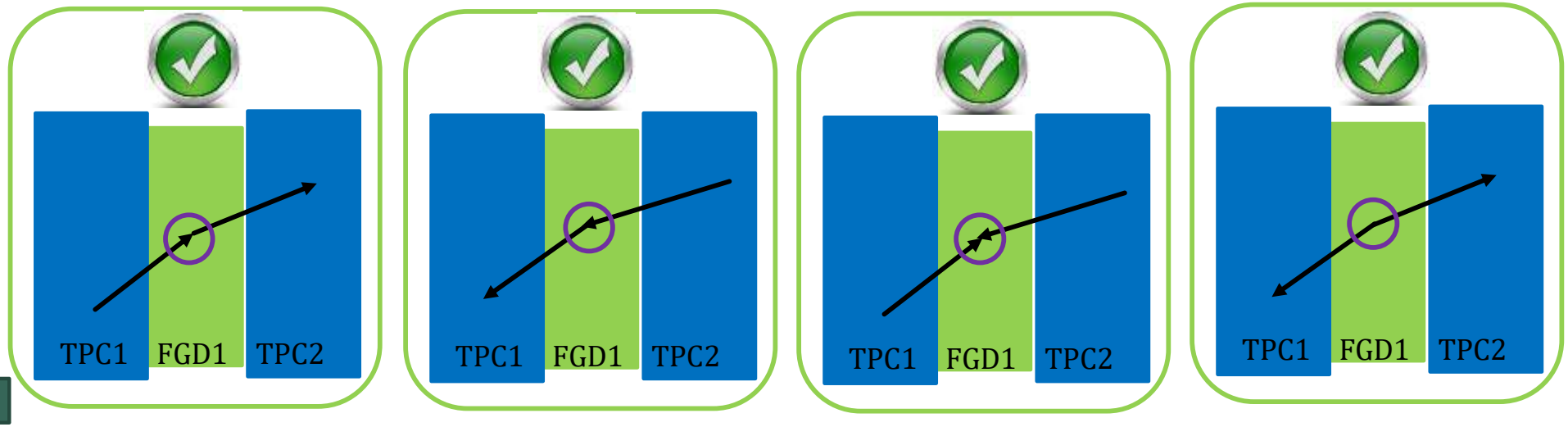
Old definition of Common Vertex:

- All tracks going FWD,
- Compared only start positions of the tracks.

New definition of Common Vertex:

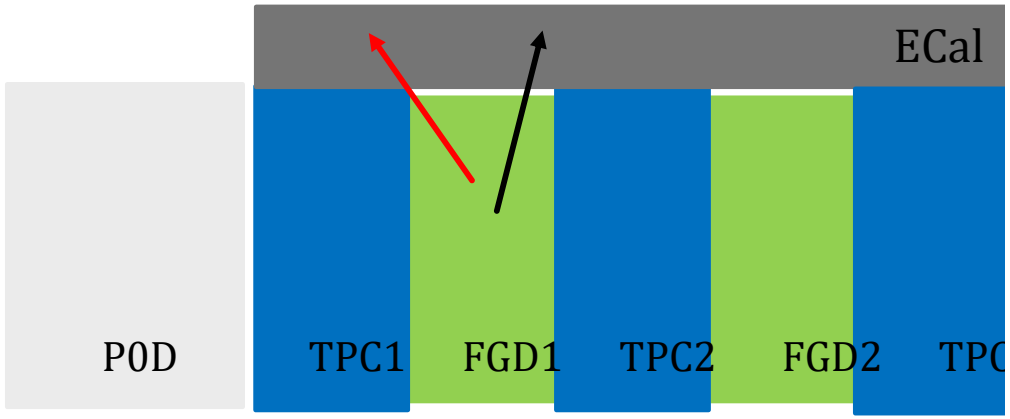
⑥ All tracks going FWD,
⑥ Compared start and end positions of the tracks.

start of the track
end of the track
vertex



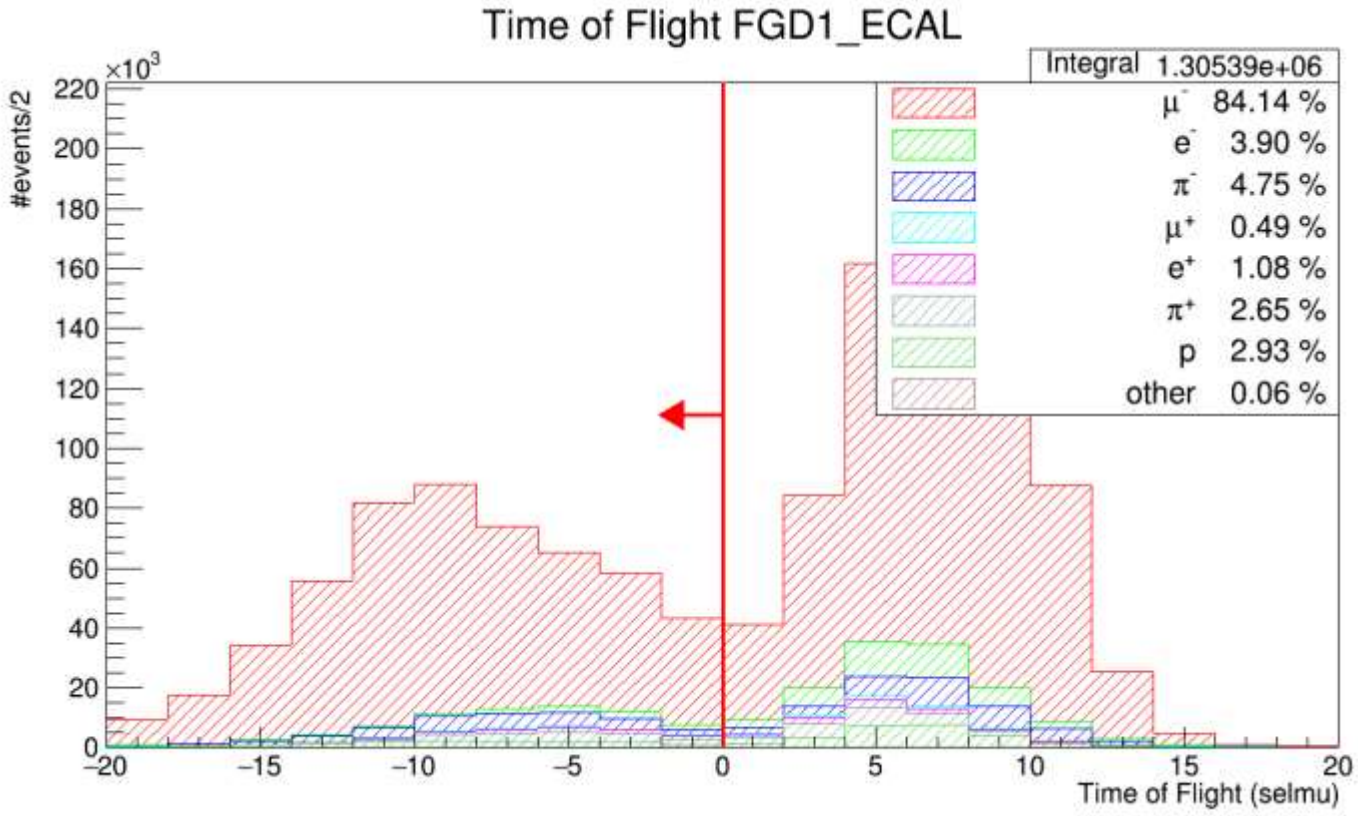
TRACKS TOF ACTION

$$ToF_{ECal} = t_{ECal} - t_{FGD1}$$

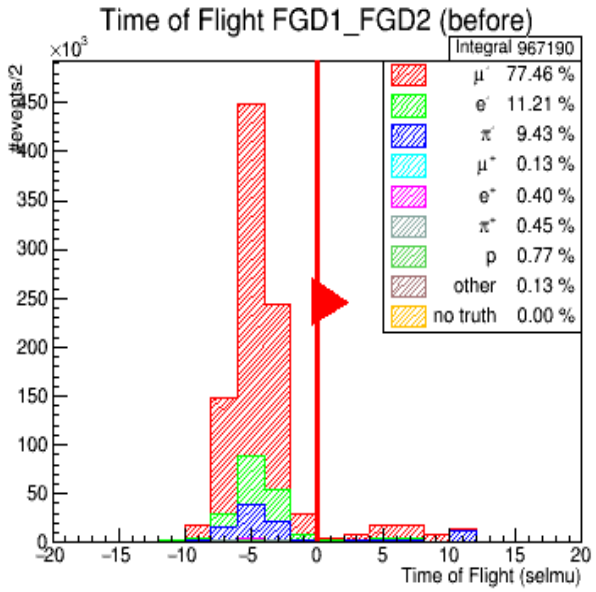


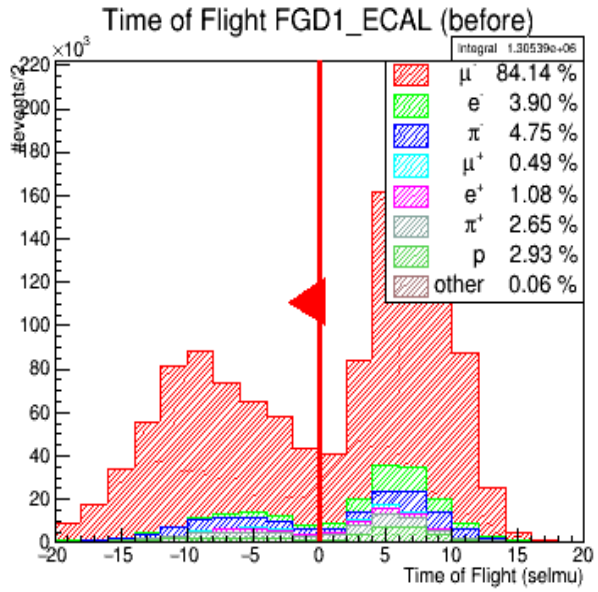
Highland2's 1st Law: All tracks are reconstructed as FWD.

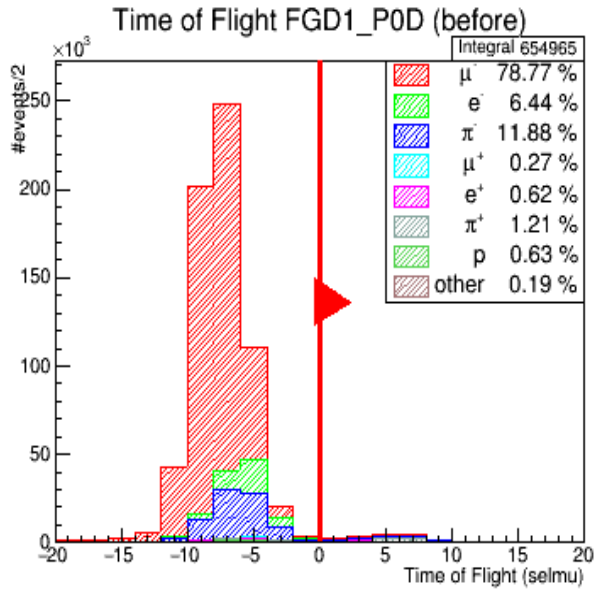
Highland2's father (Sasha): Tracks with segments in the ECal and FGDs are reconstructed in a way that the start position is always in the FGD.

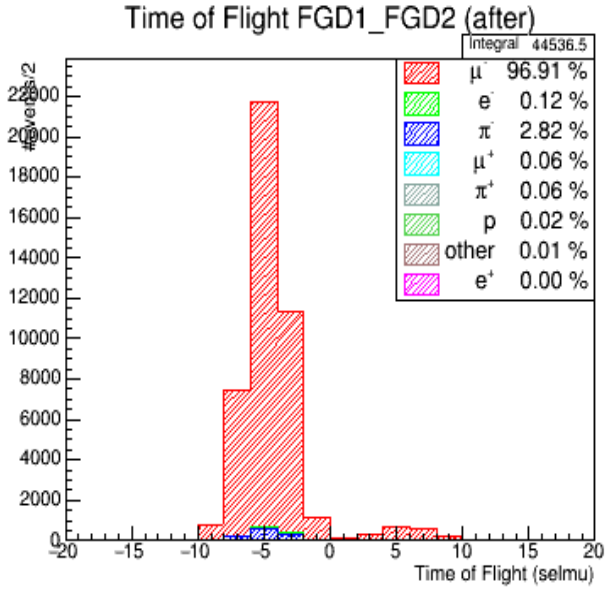


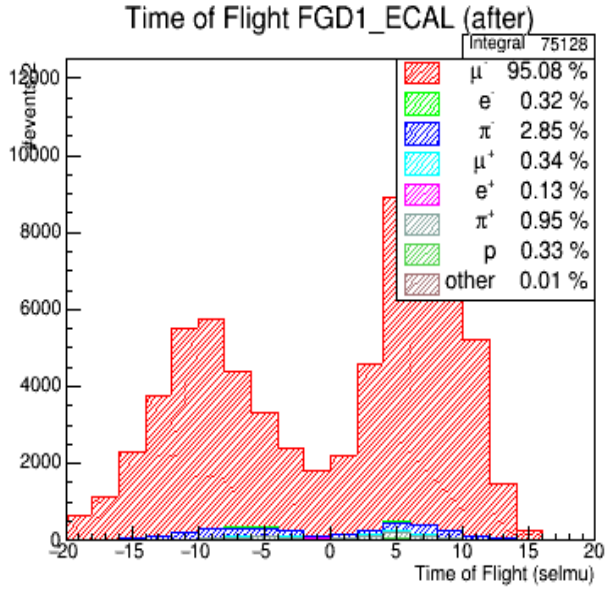
ToF ECal of muon candidate. If **Highland2's 1st Law** is true, should be some tracks with negative ToF.

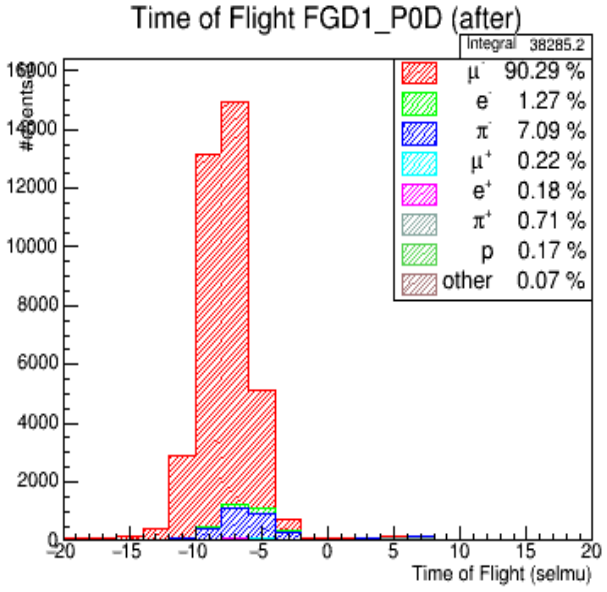








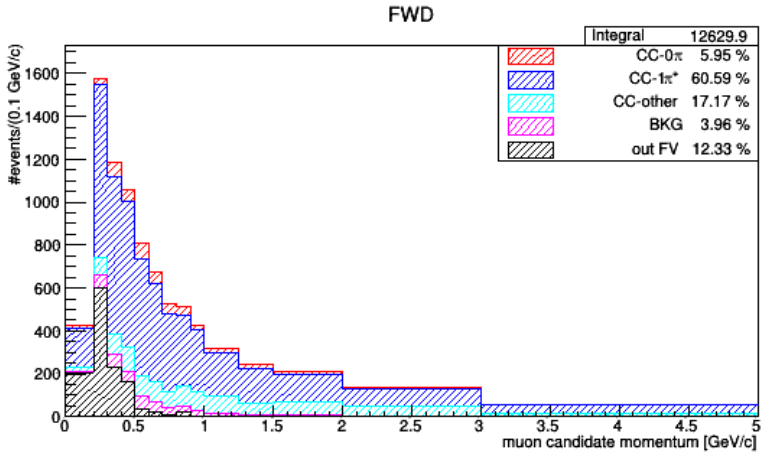


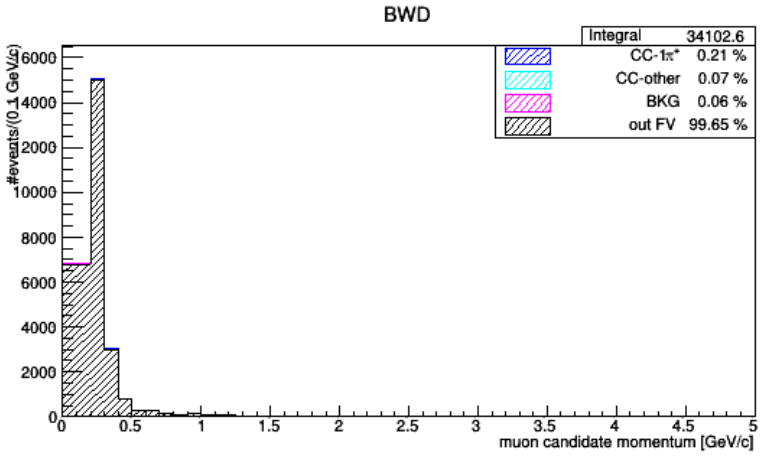


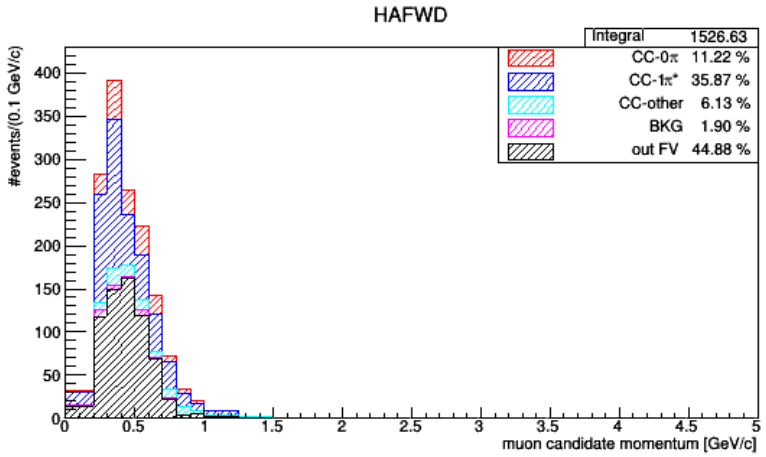
ToF of muon candidate for FWD, HA, and BWD directions.

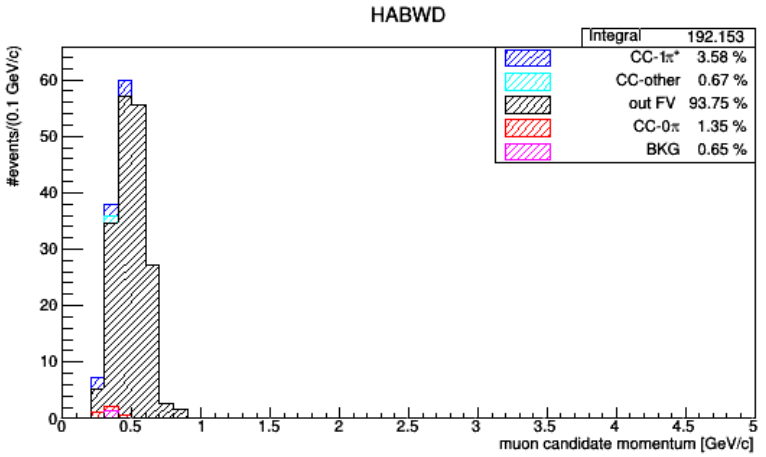
$$t_{(P0D)} - t_{(FGD1)}$$
$$t_{(FGD1)} - t_{(FGD2)}$$
$$t_{(ECal)} - t_{(FGD1)}$$

CC1PI+ KINEMATIC: MOMENTUM DISTRIBUTIONS









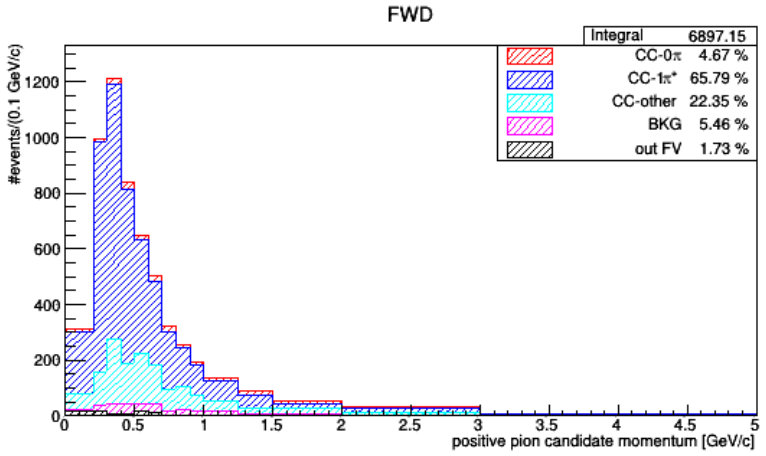
Momentum distributions for FWD, BWD, HAFWD and HABWD for:

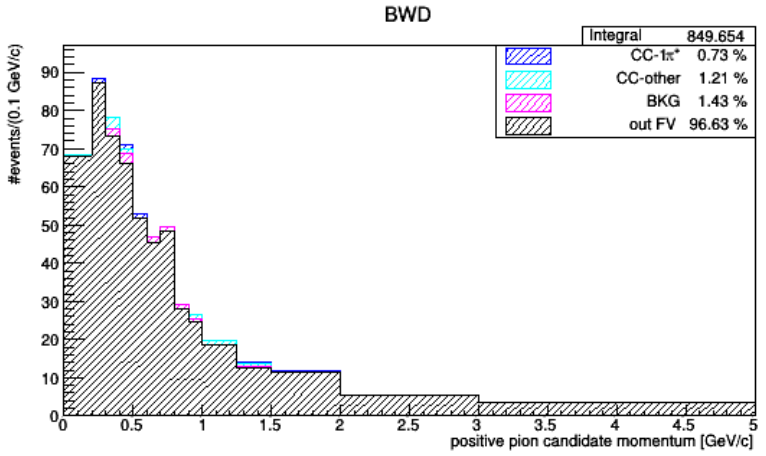
- **Muons**
- Positive pions

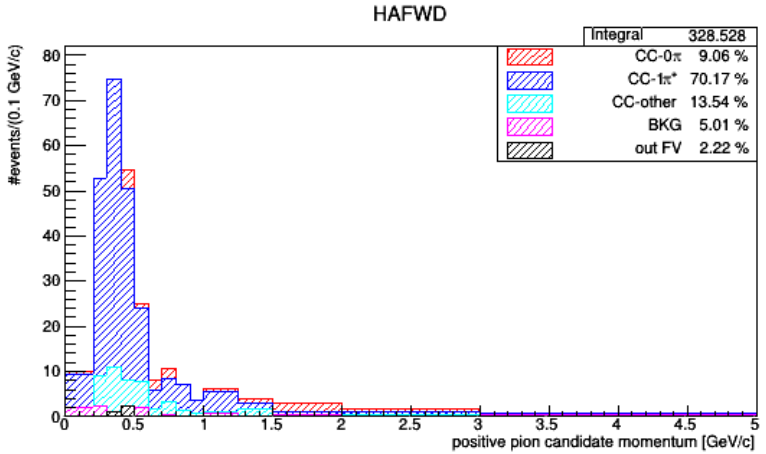
Note:

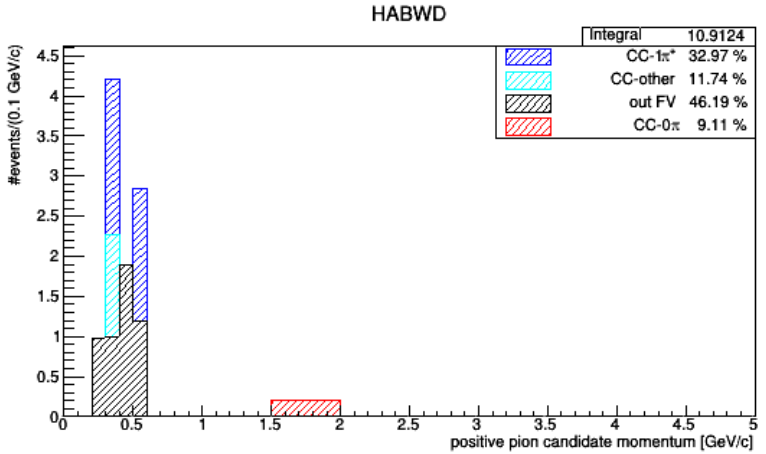
- Large contribution of OOFV events for muon variables (CC1π+).

CC1PI+ KINEMATIC: MOMENTUM DISTRIBUTIONS









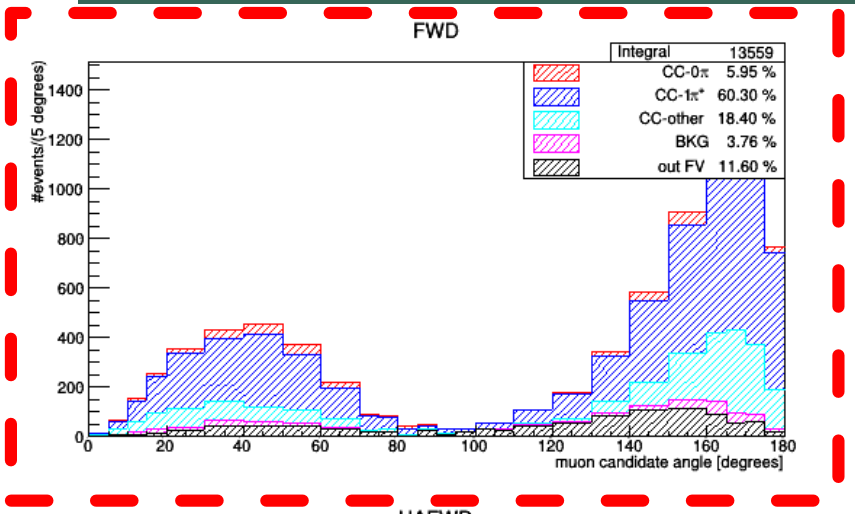
Momentum distributions for FWD, BWD, HAFWD and HABWD for:

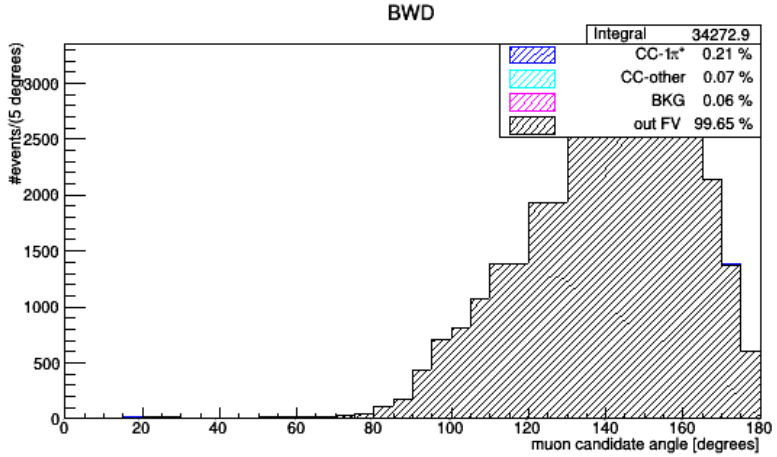
- Muons
- **Positive pions**

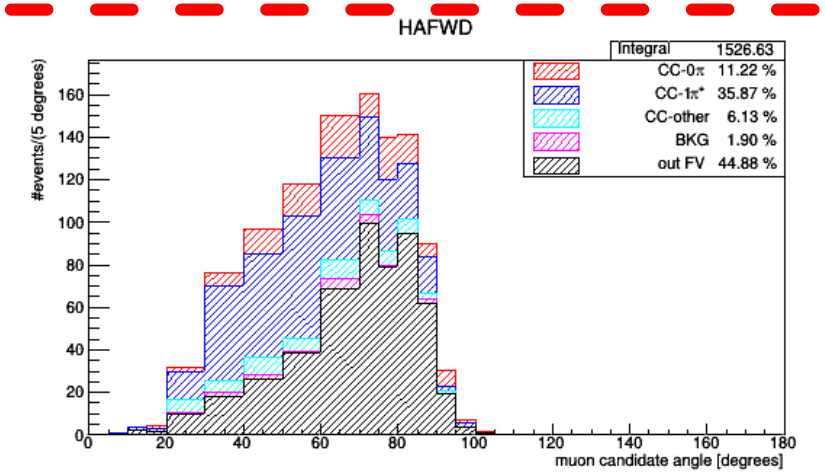
Note:

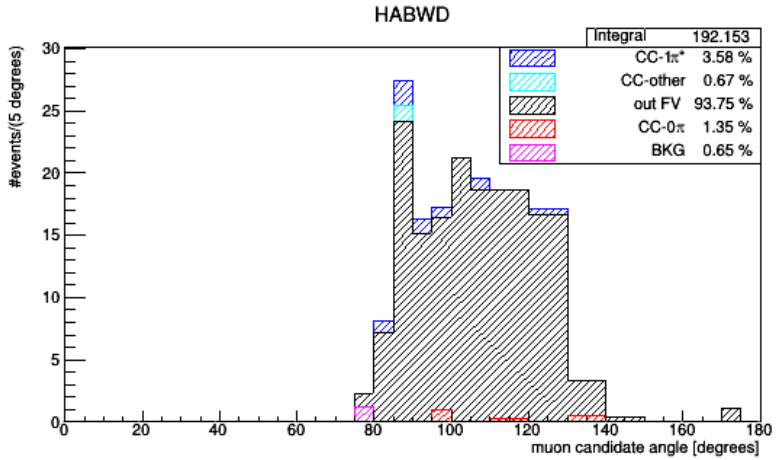
- Large contribution of OOFV events for positive pion variables (CC1π+) in the BWD.

CC1PI+ KINEMATIC: ANGULAR DISTRIBUTIONS









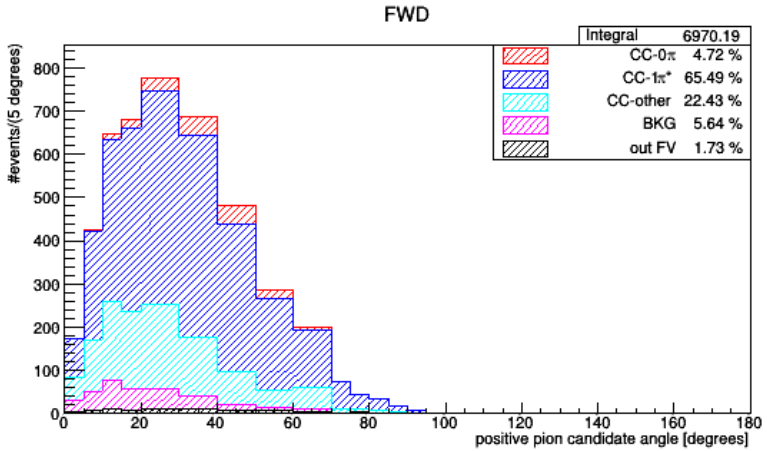
Angular distributions for FWD, BWD, HAFWD and HABWD for:

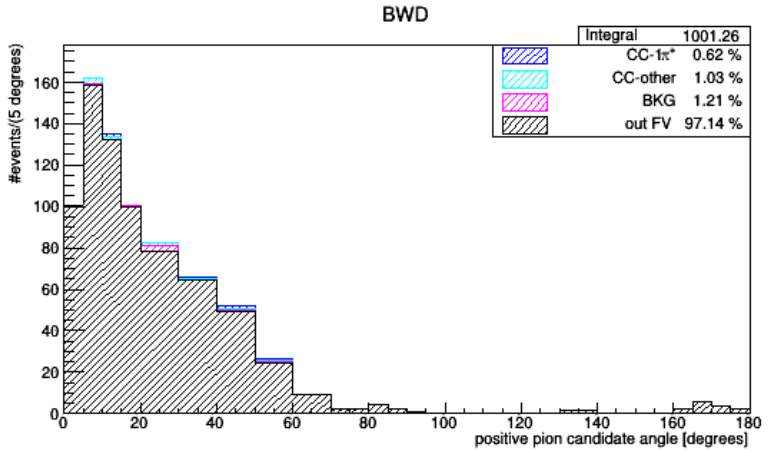
- ⑥ **Muons**
- ⑥ Positive pions

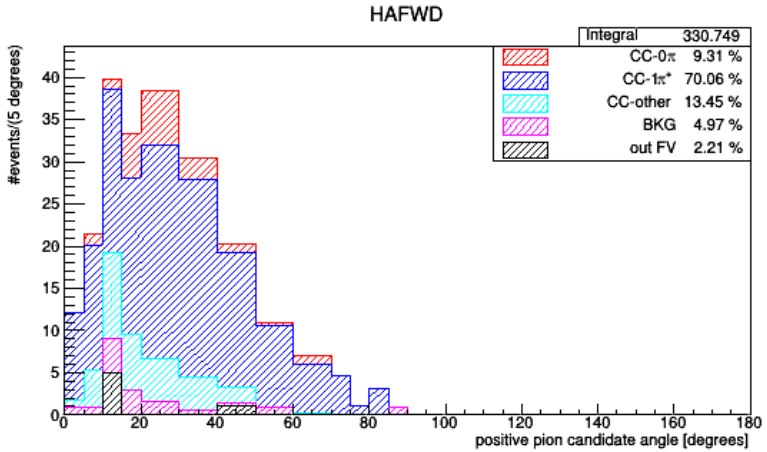
Note:

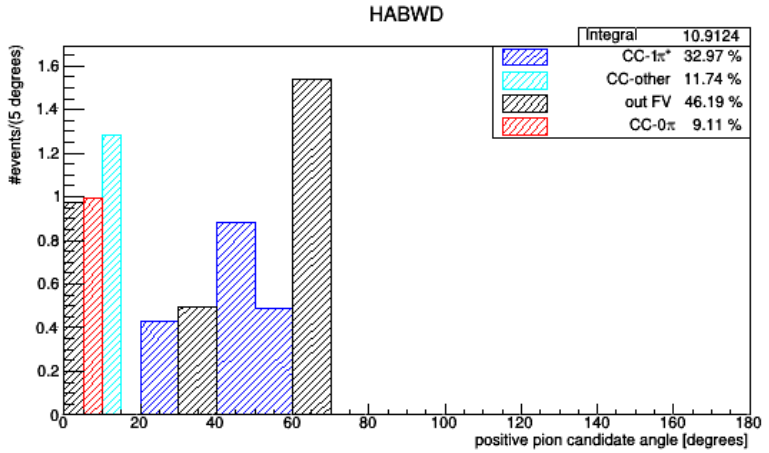
- ⑥ Large contribution of OOFV events for muon variables (CC1π+).
- ⑥ Checking the code!!

CC1PI+ KINEMATIC: ANGULAR DISTRIBUTIONS









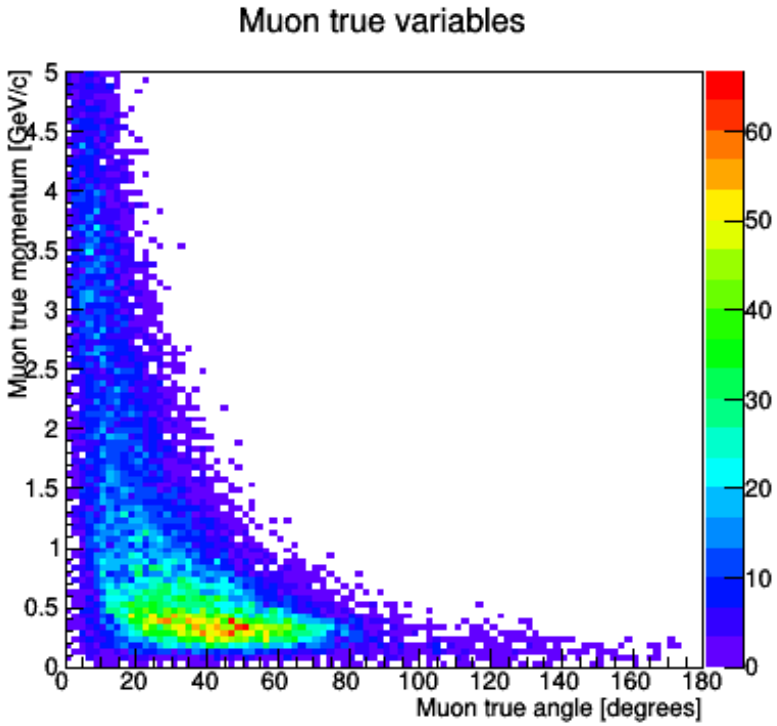
Angular distributions for FWD, BWD, HAFWD and HABWD for:

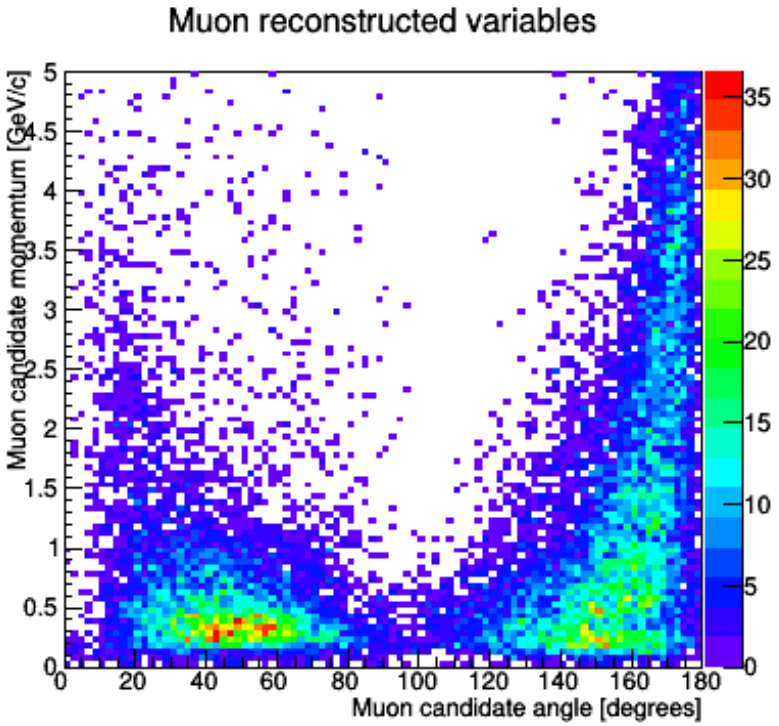
- Muons
- **Positive pions**

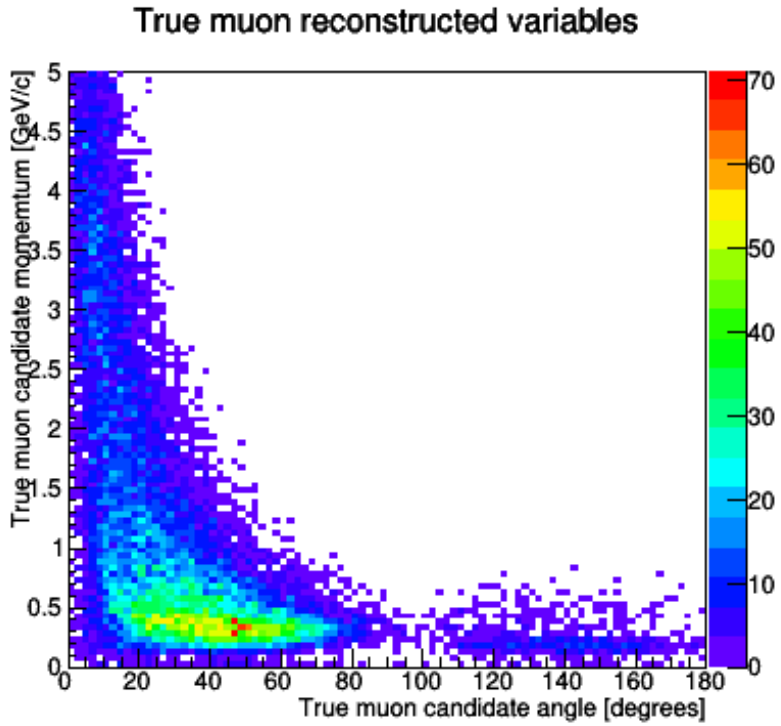
Note:

- Large contribution of OOFV events for positive pion variables (CC1π+) in the BWD direction.

CC1PI+ KINEMATIC: ANGULAR DISTRIBUTIONS



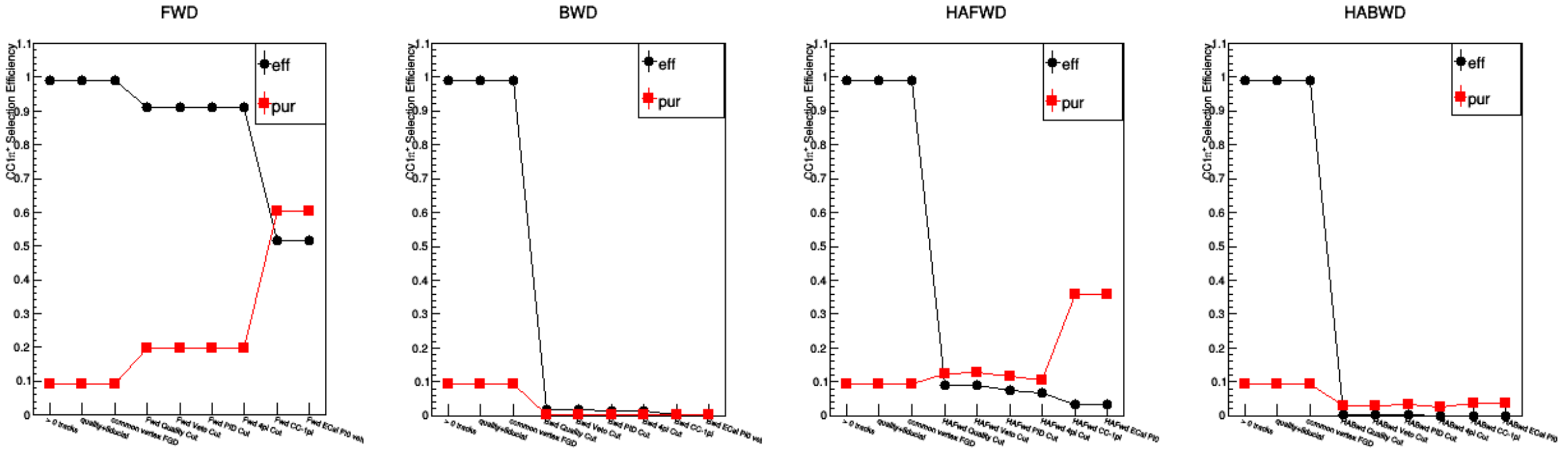




Relationship between muon momentum and muon angle, true variable (left), reconstructed (center) and true reconstructed (right),

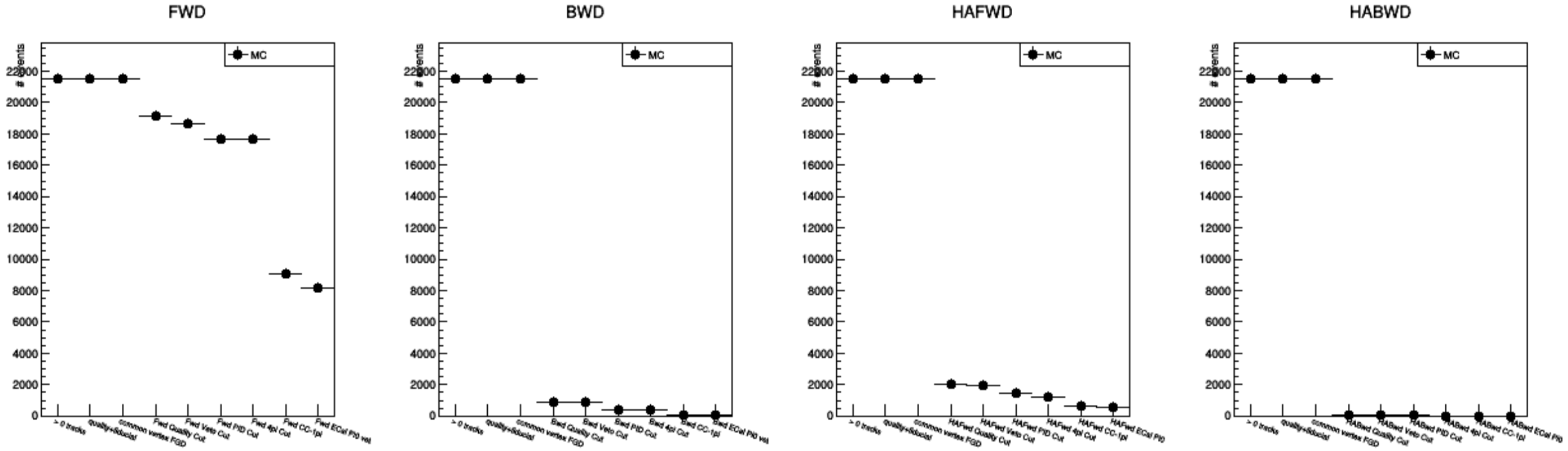
⑥ **Muons**

CC1PI+ EFFICIENCY AND PURITY



Efficiency and purity of the selection vs cuts (for FWD, BWD, HAFWD and HABWD): Poor efficiency for HAFWD because of the amount of events OOFV.

CC1PI+ EVENTS



Events of the selection vs cuts (for FWD, BWD, HAFWD and HABWD).

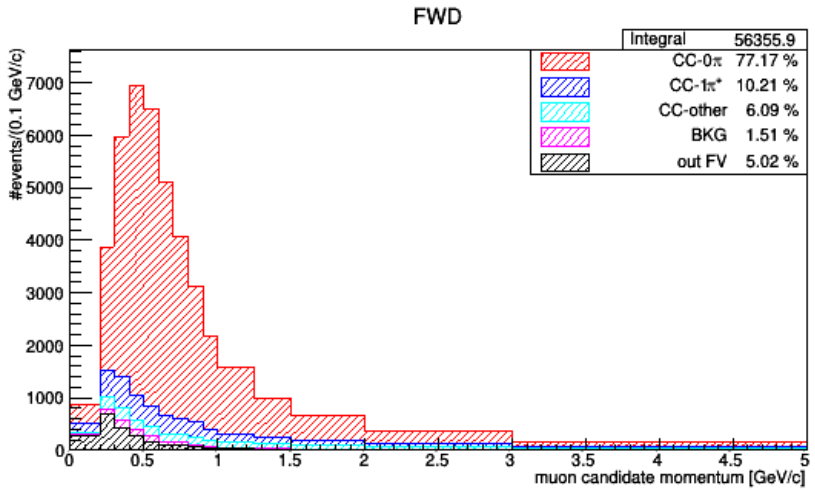
PROBLEMS UNTIL NOW

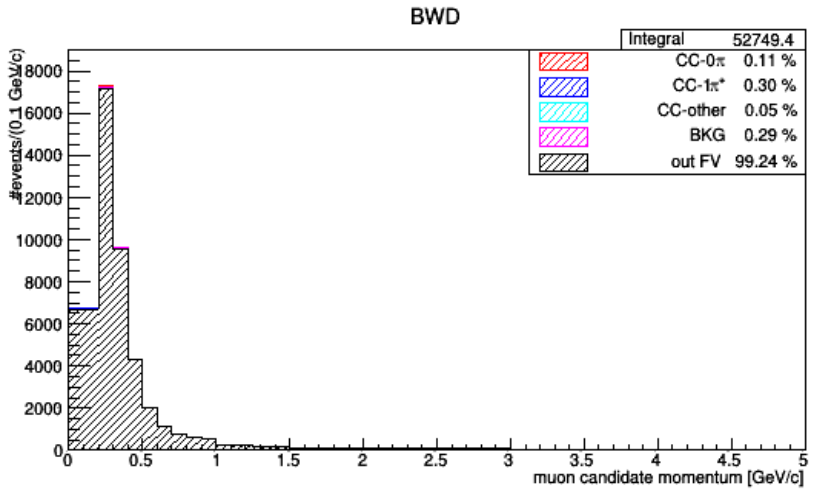
- **Large contribution of OOFV events for muon variables for CC1π+:**
  - Tracks coming from the ECal mostly.
    - **Solution:** Not using events selected by ME.
- **Large contribution of CCother events to CC1π+:**
  - A possible reduction of the pion contamination may be obtained with additional PID information from the ECal.
    - **Solution:** Using the ECal π0 veto step and run 7 and 8 for more statists.
- **Separation of the low angle tracks in FWD and BWD:**
  - Error in the code and flipping of the tracks (quality+fiducial step).
    - **Solution:** Checking the code.

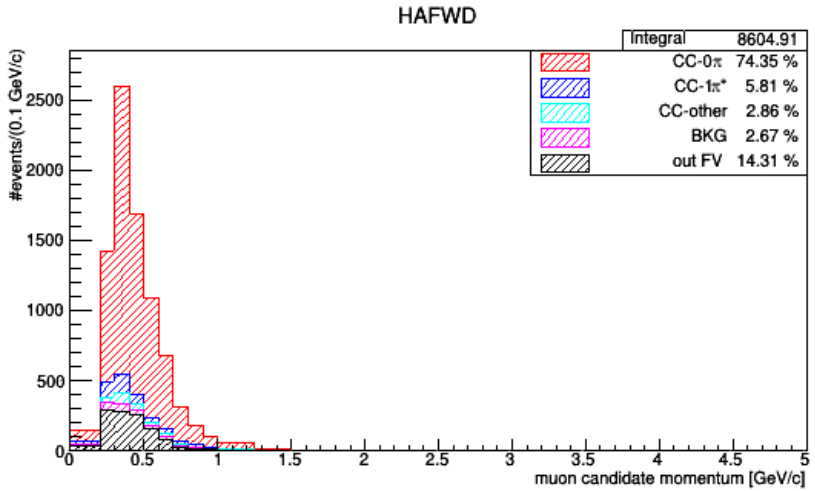
THANK YOU

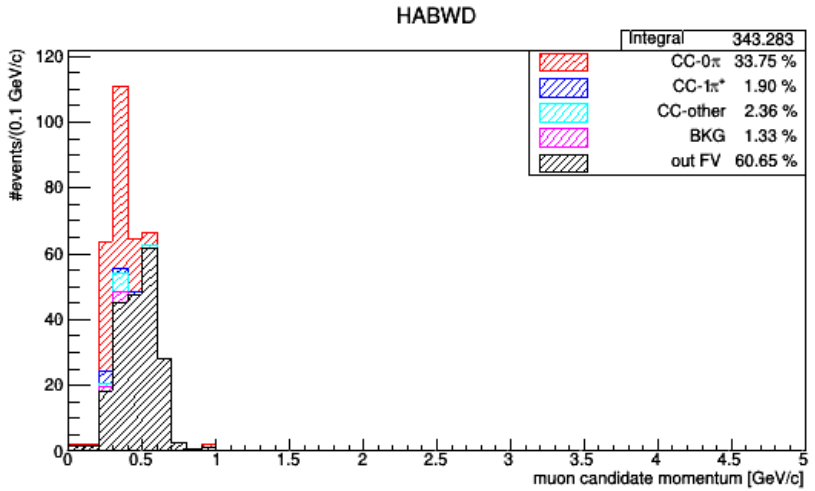
SUGGESTIONS?

CC0Π KINEMATIC: MOMENTUM DISTRIBUTIONS









Momentum distributions for FWD, BWD, HAFWD and HABWD for:

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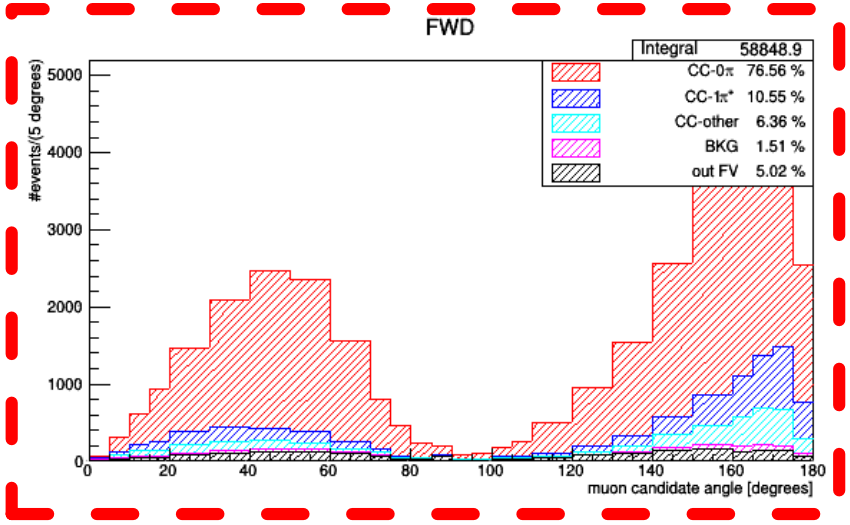
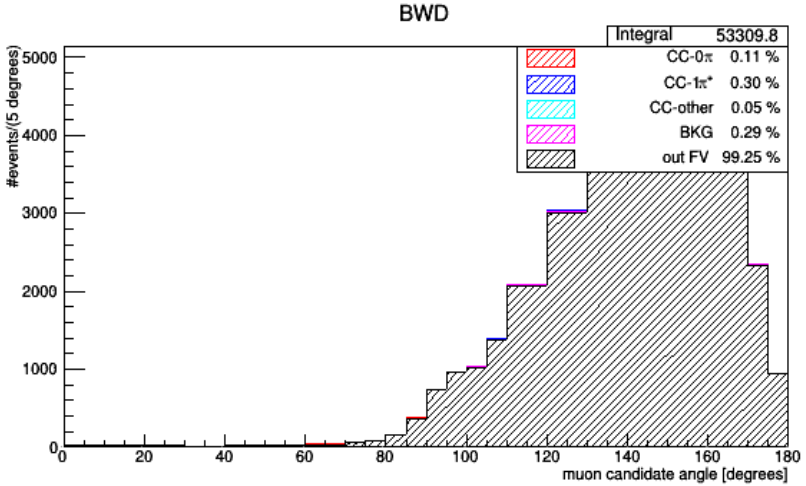
- Positive pions

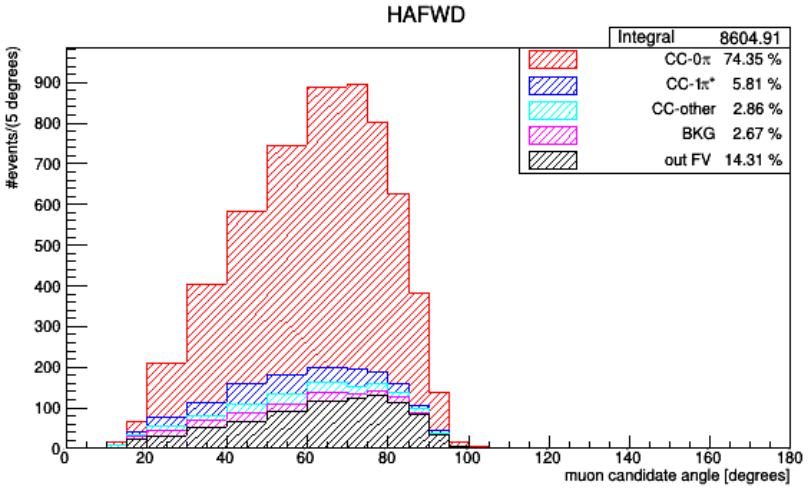
Note:

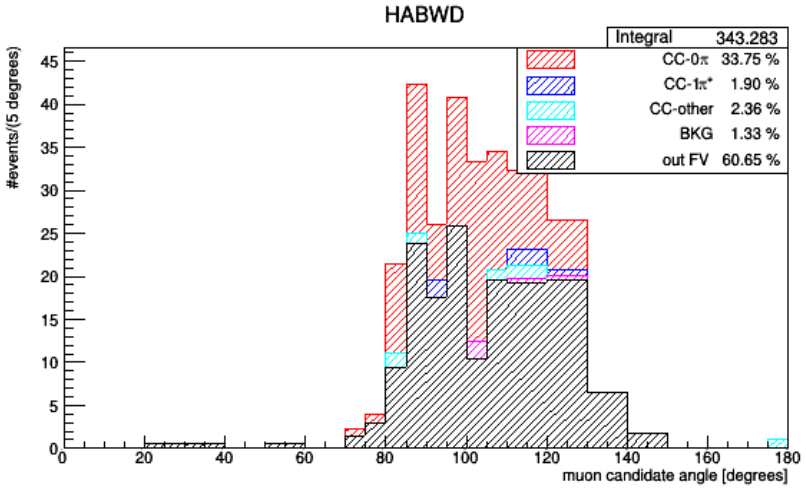
- Large contribution of OOFV events for muon variables (CC0π).

CC0Π KINEMATIC: MOMENTUM DISTRIBUTIONS









Angular distributions for FWD, BWD, HAFWD and HABWD for:

- **Muons**
- Positive pions

Note:

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- Checking the code!!