Ancestor List with Fluka

NuMI-X Meeting

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Fermilab

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Introduction

The idea is to keep a record of all the neutrino history, i.e. we want to store the neutrino parent, grandparent and so on, until the initial proton on target.

- The strategy is to record particles every time there is an **interaction**;
- Then, starting from the final neutrino, latch all the particles till the POT that generated all the neutrino history;
- Each interaction is a **step** in the neutrino history;
- Two or more steps could refer to the same particle, for ex. if it underwent an elastic interaction.

Software framework:

Fluka version	11.2c.0
Flugg version	2009_3

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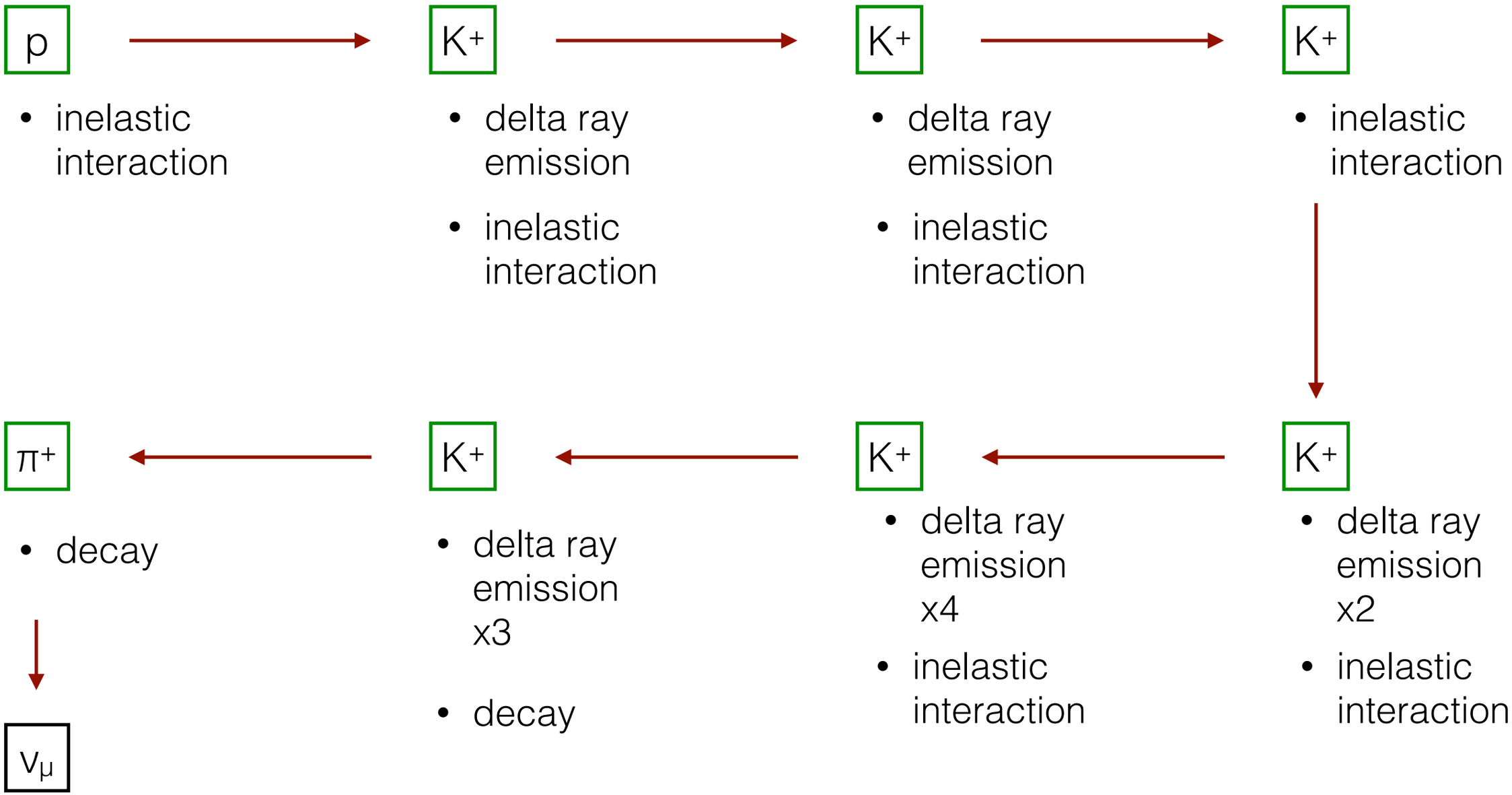
A neutrino history example



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How to do it

- Use user routines mgdraw.f and stuprf.f to access all the informations about the particles being transported by Fluka.
- The user has 11 double and 11 int variables to use as he likes.
- These variables are used to connect informations between parent and daughter particles in run time.
- In this way, every time there is an interaction, we can access informations about:
  A. the particle that underwent the interaction (Fluka allows to do that by default);
  B. the parent of that particle (thanks to the user variables).
- So every time an interaction occurs, informations A. and B. are recorded in arrays for future analysis.
- These arrays will contain all necessary informations about the particles simulated by Fluka. For each particle they will contain an unique ID of the current particle and of the parent particle.
- Using the unique ID, every time there is a neutrino, the arrays are analyzed in order to latch all the particles till the POT that generated such neutrino.
- The information about the latched particles are stored in an ancestor.dat and then to the .root file that constitute the output of the simulation.
- Finally, the .root file is converted to dk2nu format.

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How big the files are:

File	Size per POT	Size per 500k POT
ancestors.dat	15kB	7.5GB
.root Flugg	342B	171MB
.root Flugg latched	1.6kB	800 MB
.dk2nu.root	1.8kB	900 MB

A technical note about all my work will be available soon.

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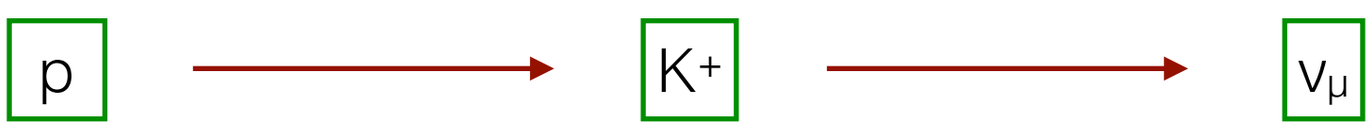
Ancestor List example

```
root [1] dk2nuTree->Scan(“ancestor.pdg:ancestor.startz:ancestor.startpz”, “",
"colsize=16")
*****************************************************************************
*    Row   * Instance *     ancestor.pdg *  ancestor.startz * ancestor.startpz *
*****************************************************************************
[...]
*        2 *        0 *               14 * 821.762718999999 *       1.00635102 *
*        2 *        1 *              321 *      329.565367 *       3.37901836 *
*        2 *        2 *              321 * -9.3178274499999 *       3.38971406 *
*        2 *        3 *              321 *     -112.197906 *       3.39572853 *
*        2 *        4 *              321 *     -114.688117 *       4.22898029 *
*        2 *        5 *              321 *     -116.943597 *        4.2366518 *
*        2 *        6 *              321 *     -124.442878 *       4.25746782 *
*        2 *        7 *             2212 *     -124.706205 *       119.930887 *
*        2 *        8 *             2212 *     -137.872651 *       119.985382 *
*        2 *        9 *             2212 *     -140.755019 *       119.993872 *
*        2 *       10 *             2212 *            -600 *              120 *
[...]
```



- delta ray x3
- inelastic interaction

- delta ray x5
- decay

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Ancestor List at work

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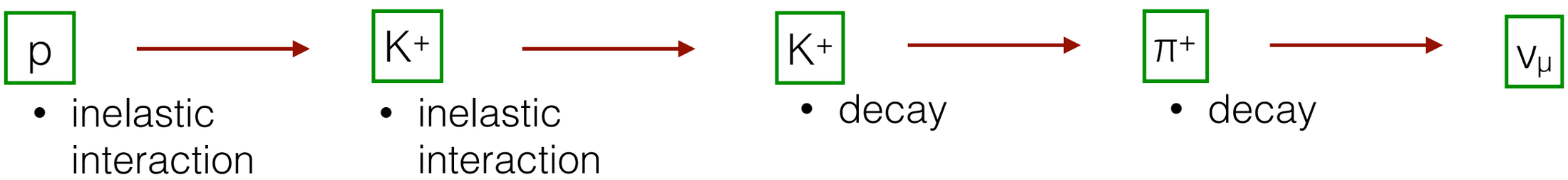
Number of interactions

Given a neutrino directed toward the ND, here is a table of the number of interactions its ancestors had.
For example:

count as 1 interaction, since there is only a proton that interact with the material, while the others are just decays.
And:



count as 2 interactions, since there are the proton and the kaon that interact with the material.

Delta ray and elastic do not count as interaction.

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Number of interactions

What follows is the number of neutrinos directed toward the center of the ND, every 6 x 10^{20} POT, per cm^2.

Interactions	ν_μ / 6e20 POT / cm^2	ratio
1	4.28E+12	59.4%
2	2.06E+12	28.6%
3	4.70E+11	6.5%
more than 3	1.47E+11	2.0%
total	7.22E+12	

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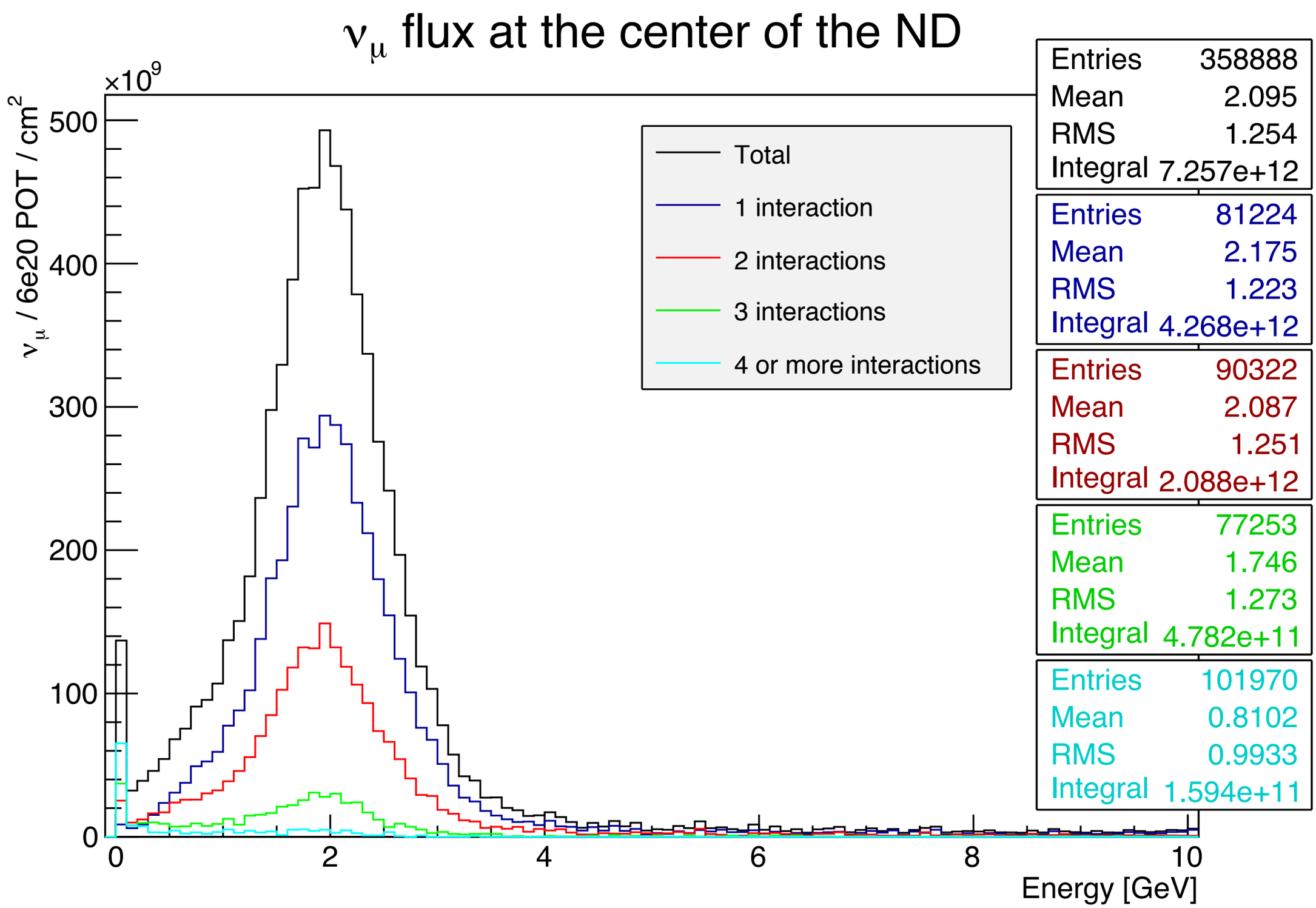
ν_μ Flux at the center of the ND / 6e20 POT



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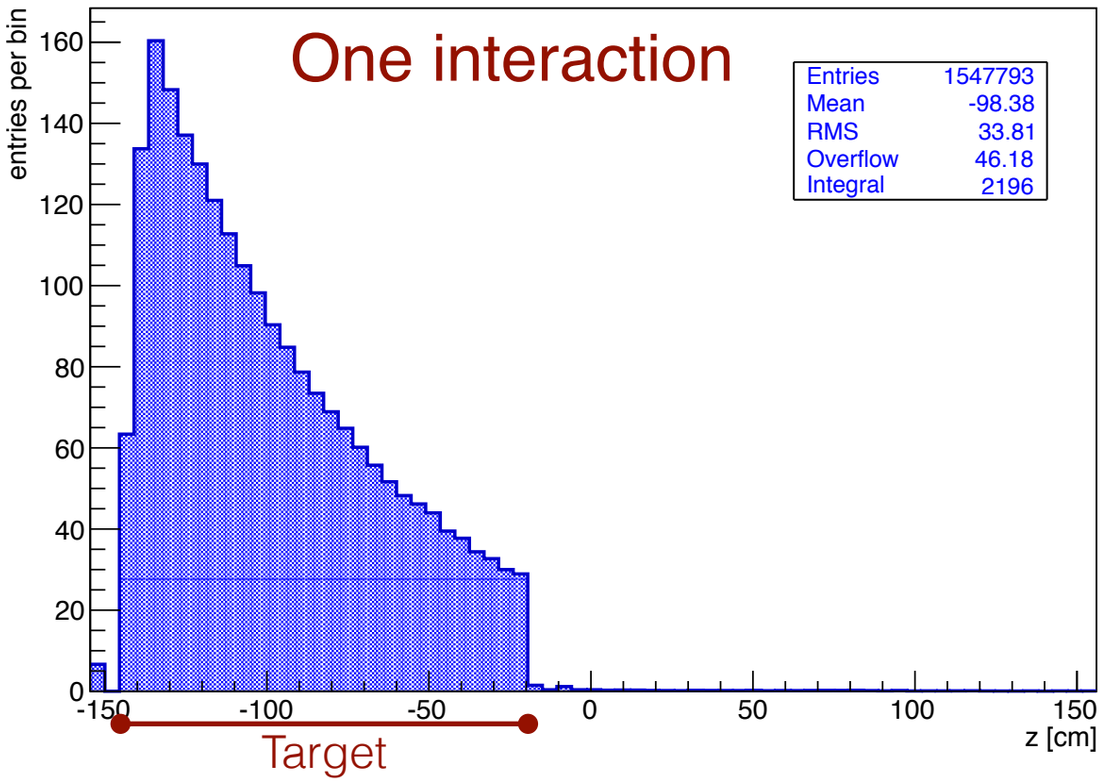
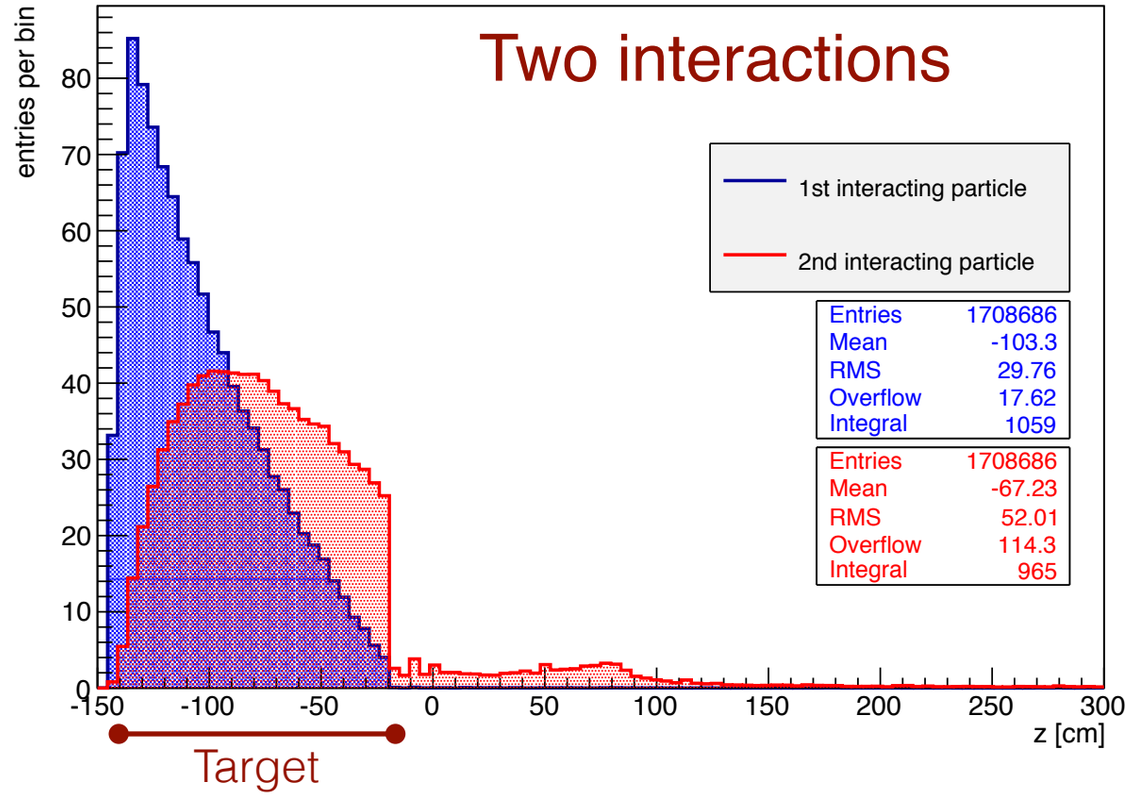
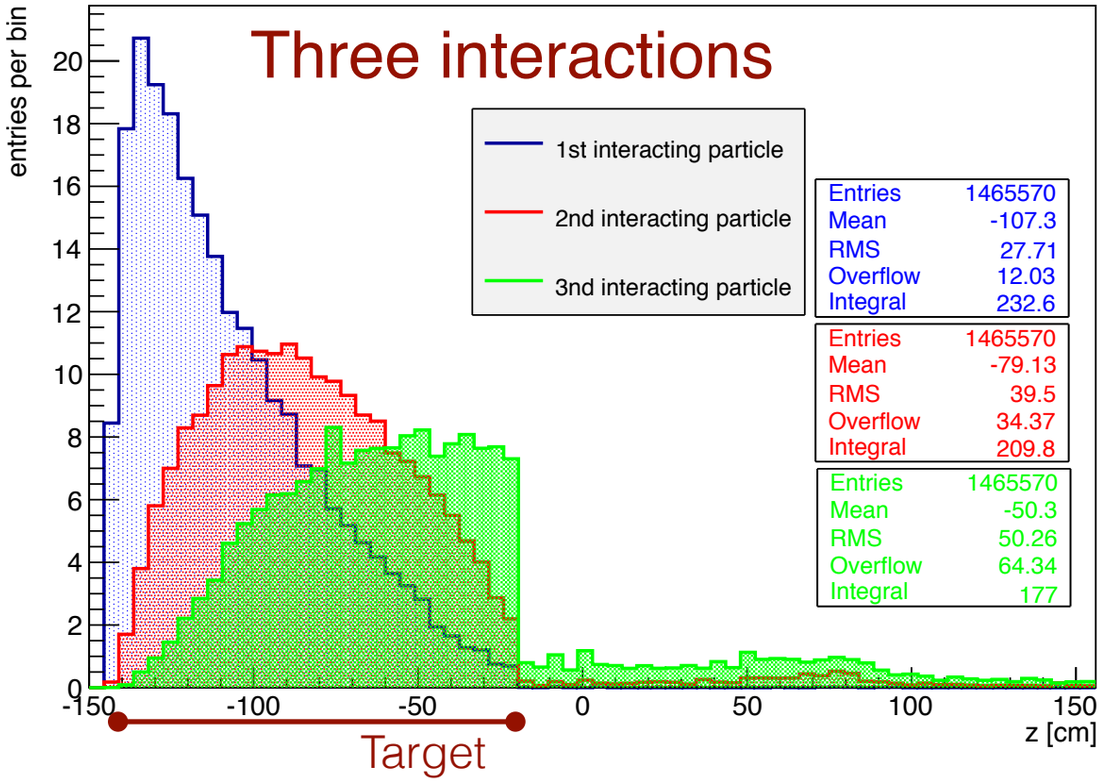
End point of ancestors that interacted with the material







ν_μ / 6e20 POT:

int.		in Target	out Target	% out
1	first	1.37E+17	4.18E+15	2.9%
2	first	6.68E+16	1.43E+15	2.0%
2	second	5.60E+16	1.22E+16	20.3%
3	first	1.47E+16	8.60E+14	4.6%
3	second	1.28E+16	2.75E+15	16.2%
3	third	9.64E+15	5.89E+15	42.7%

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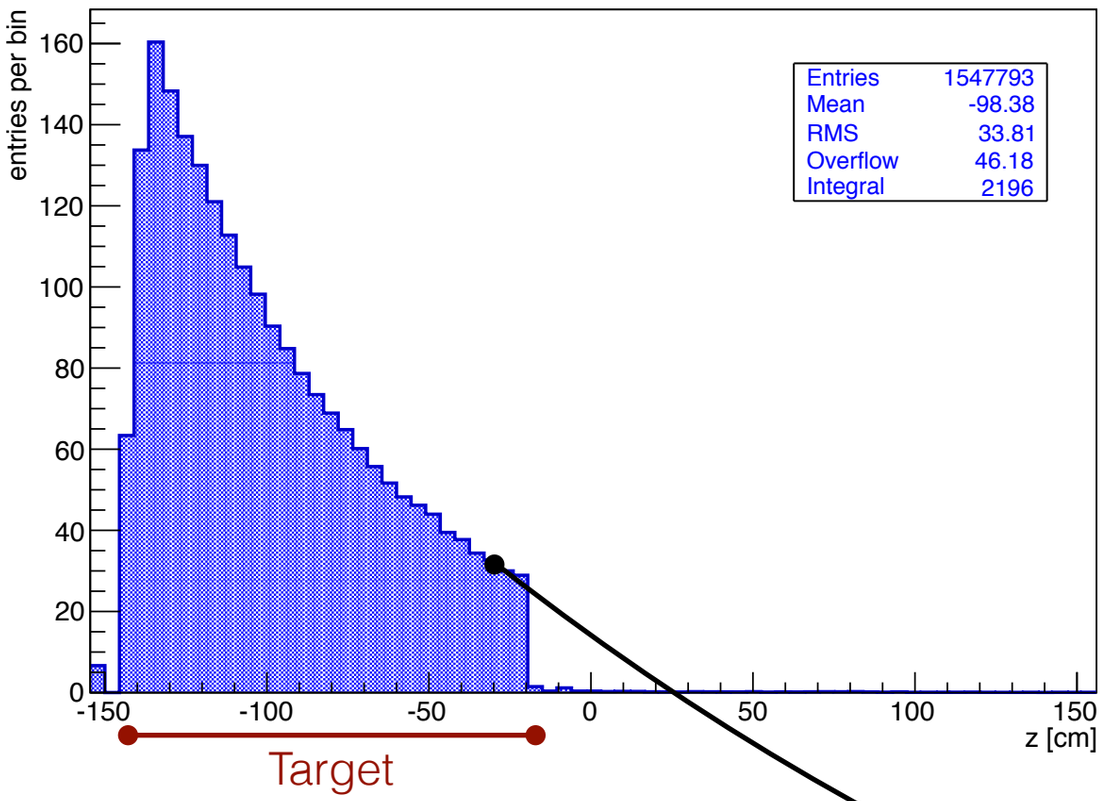
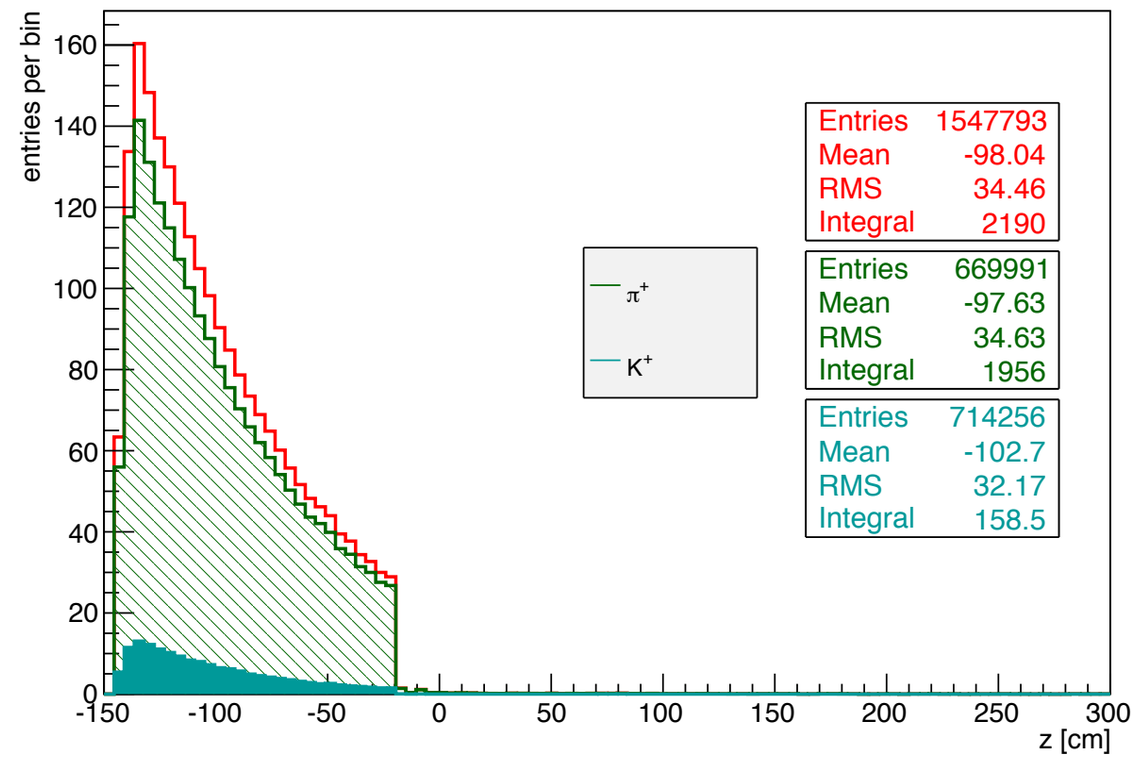
End point of ancestors that interacted with the material

One interaction





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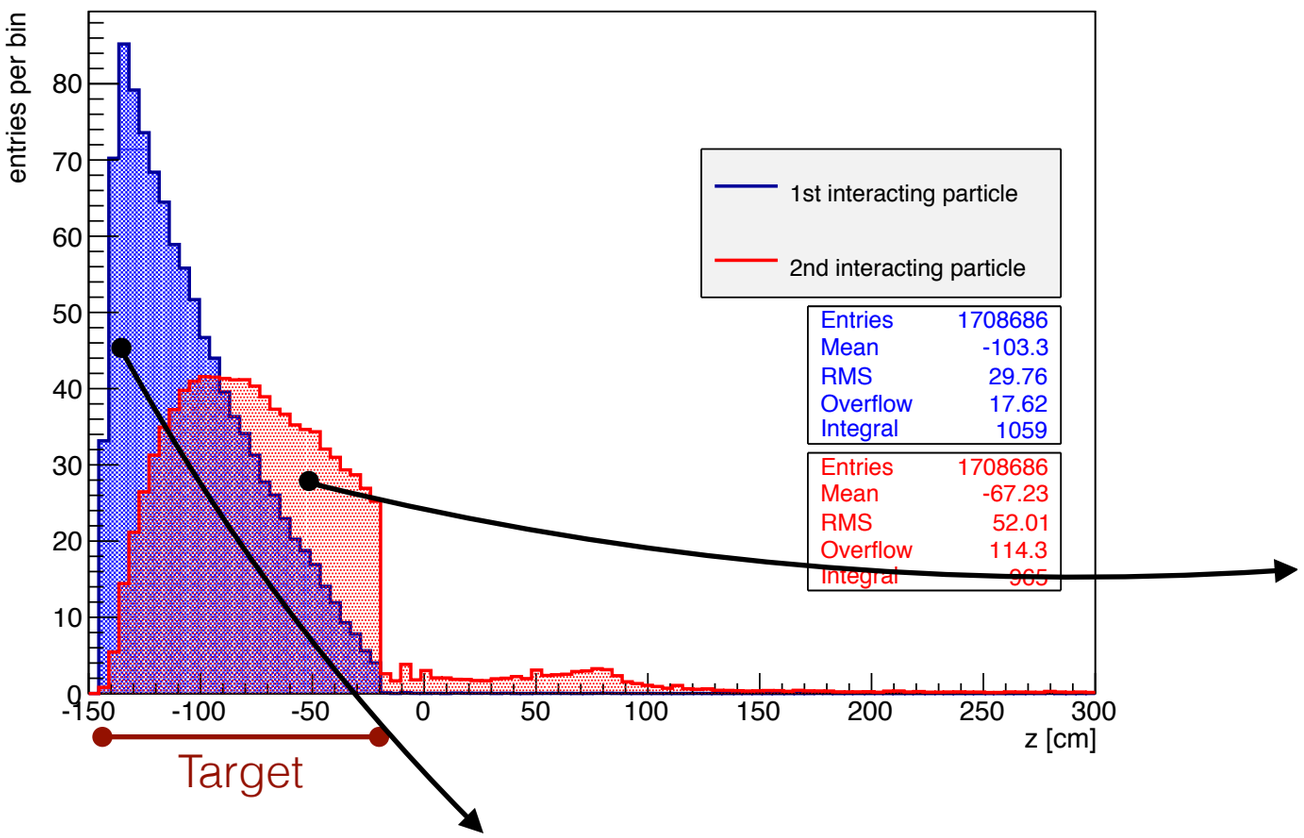
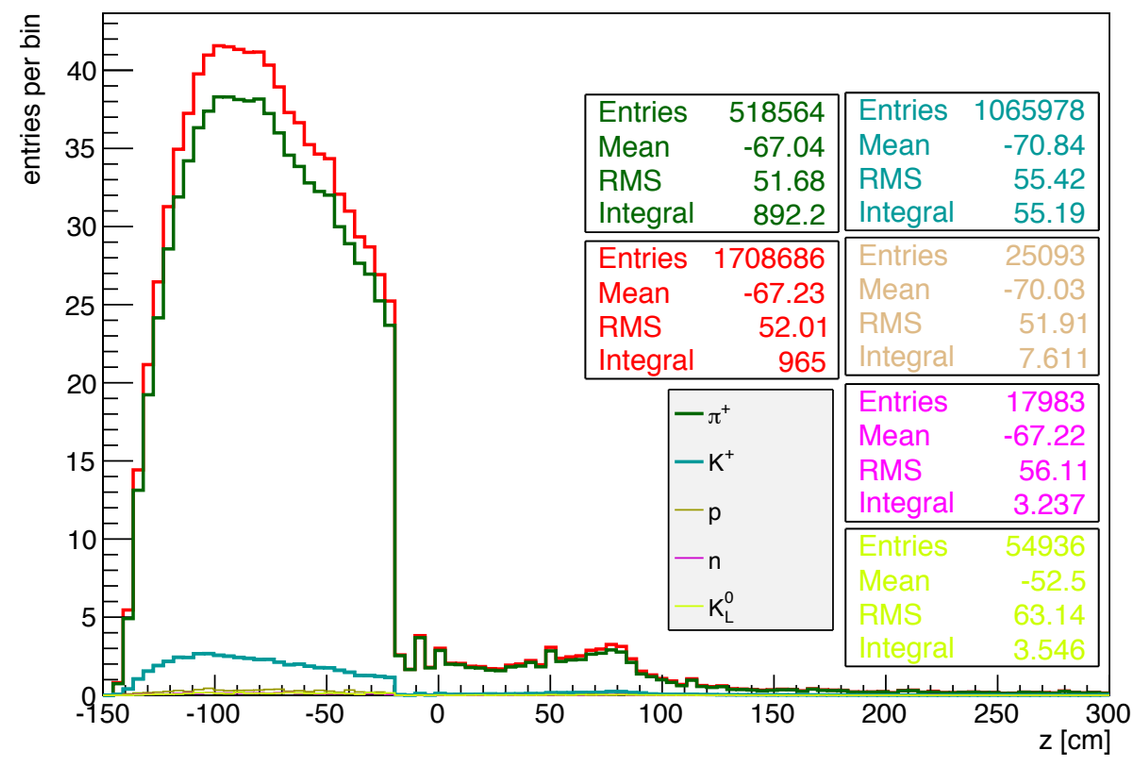
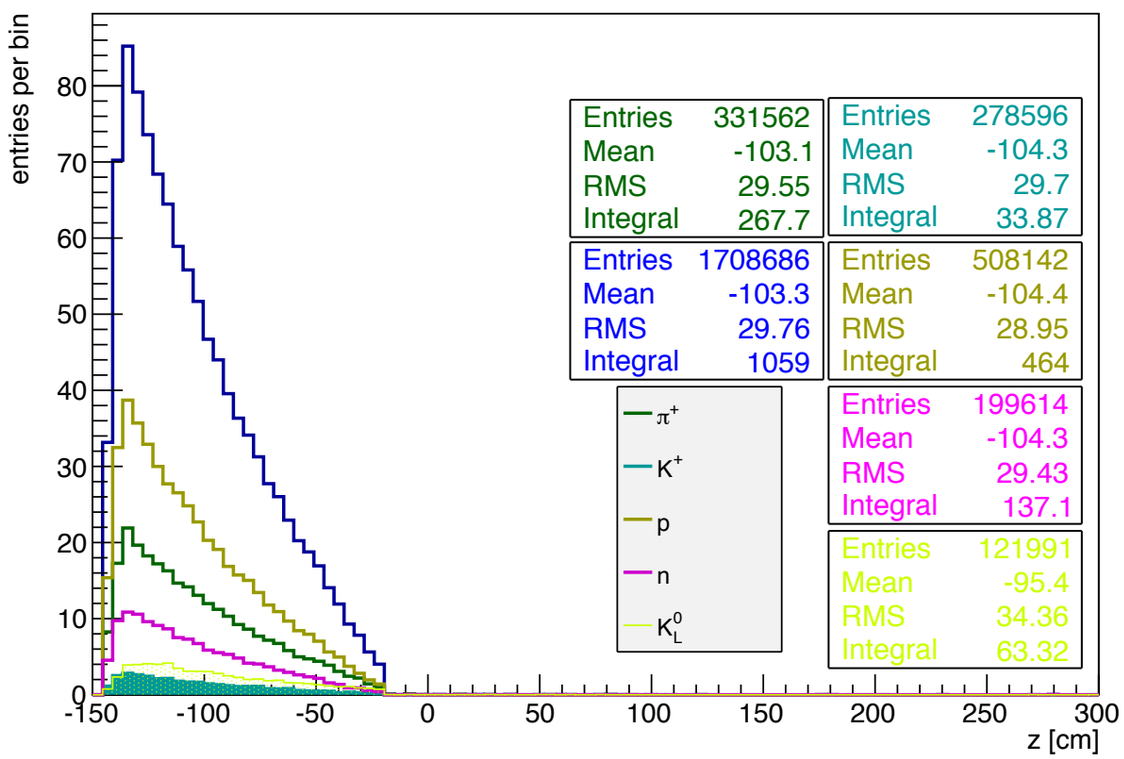


Two interactions





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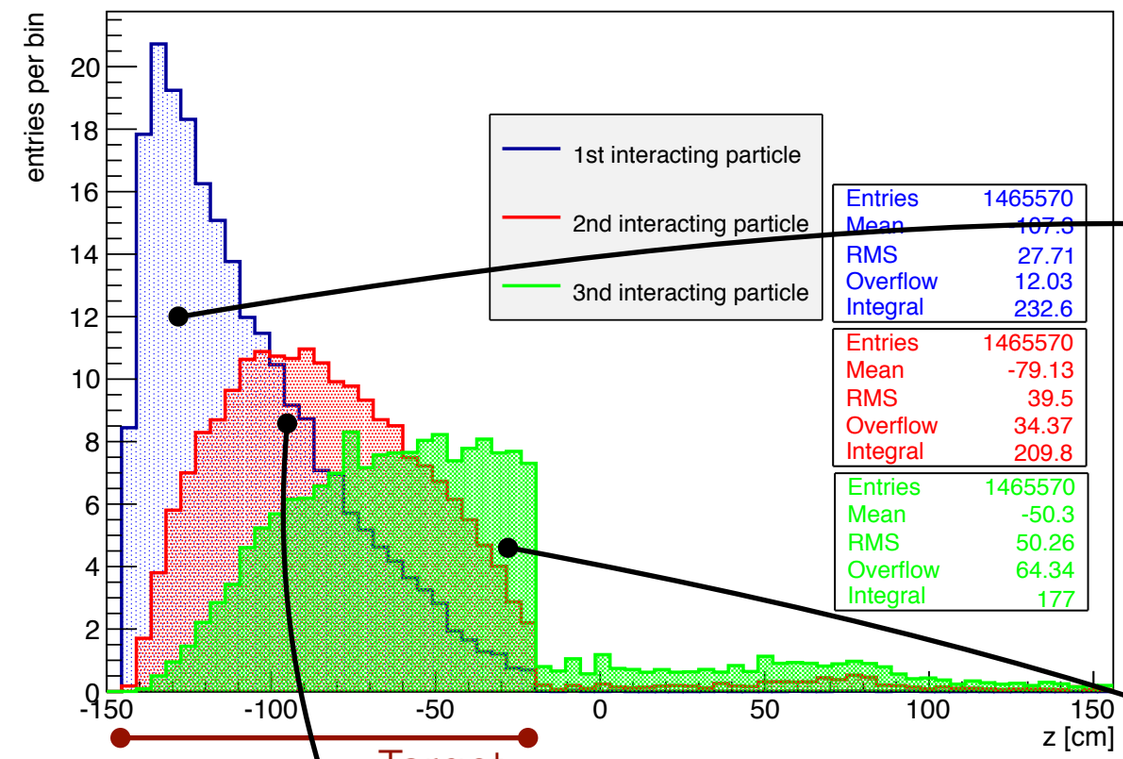
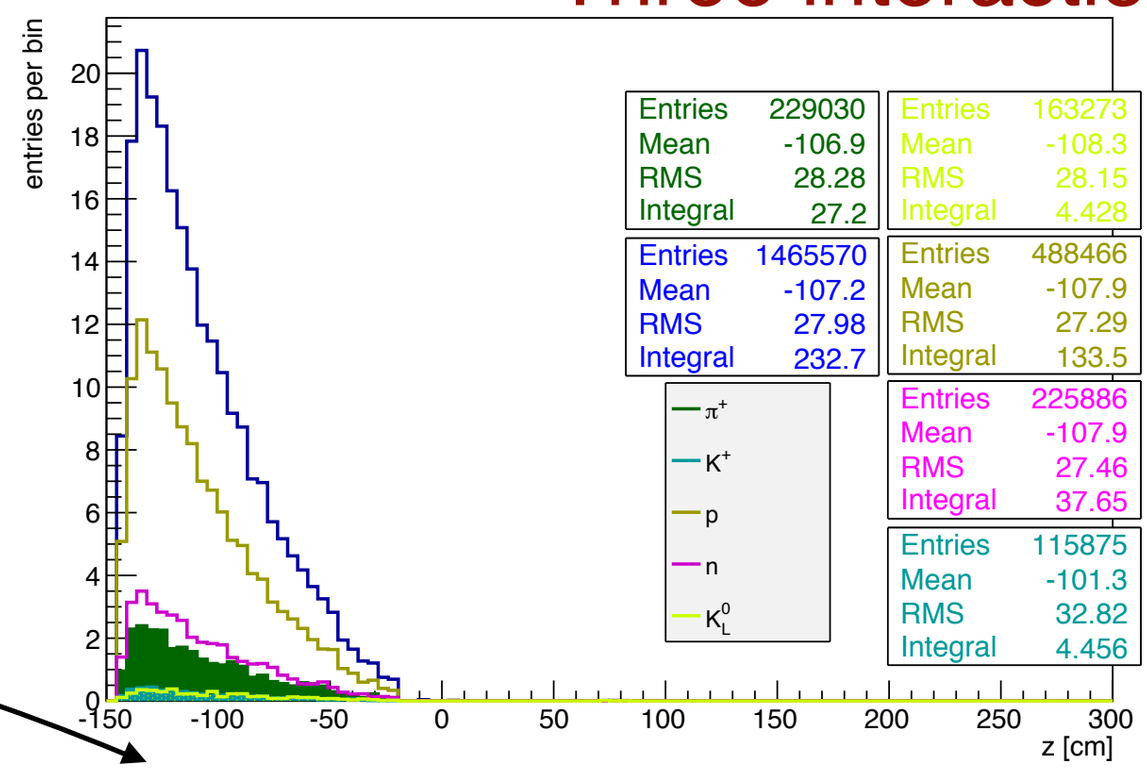
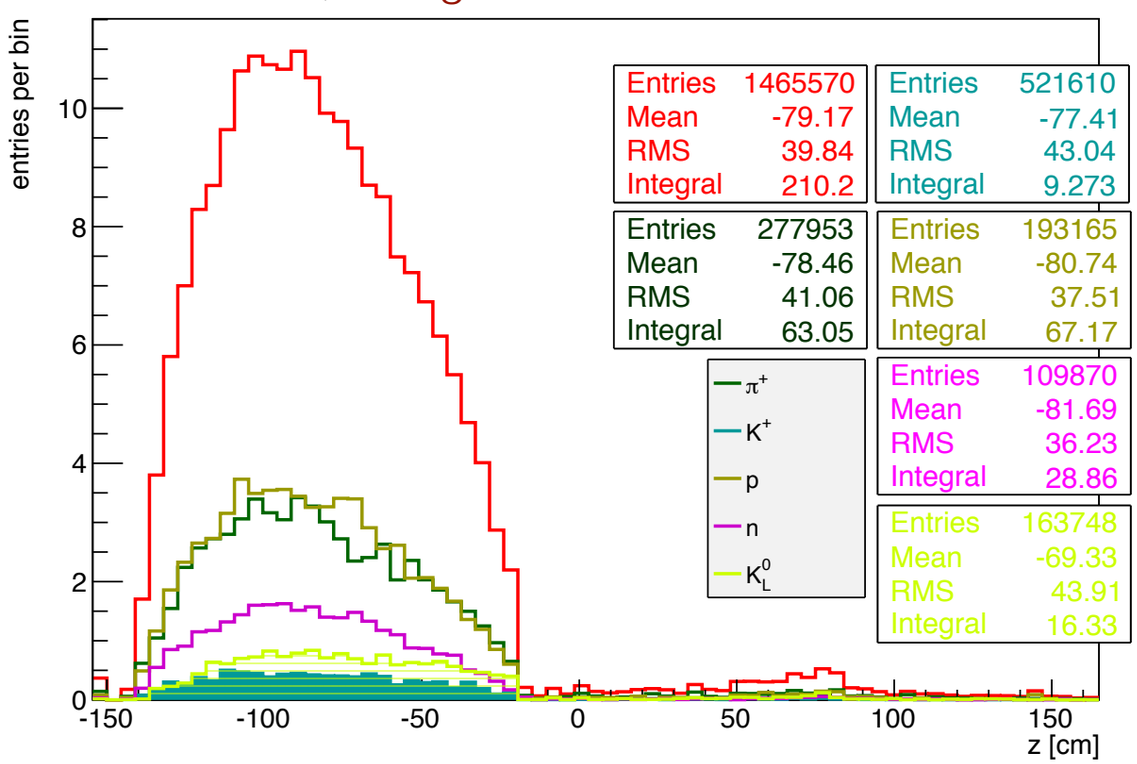
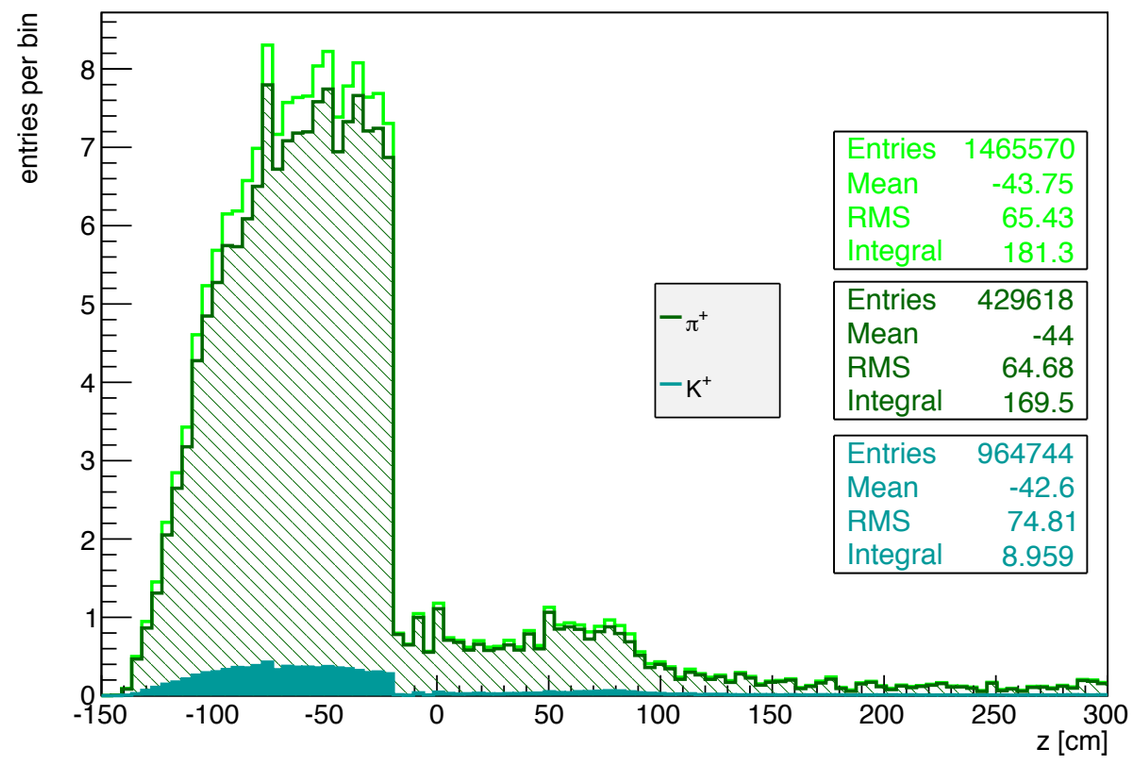


Three interactions







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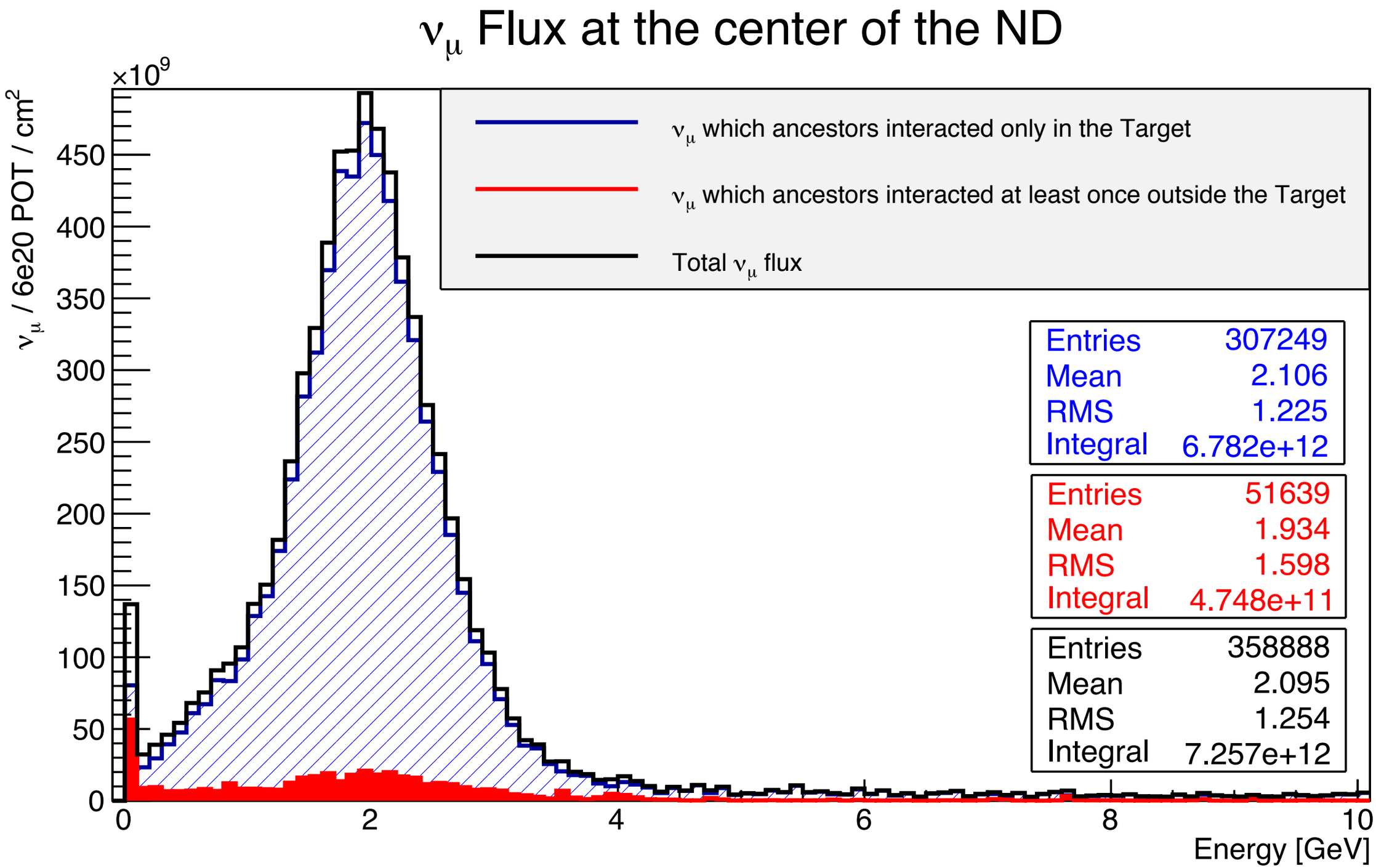
ν_μ Flux at the center of the ND / 6e20 POT



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