

3DST neutron study startup

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The analysis introduction

Goals of the analysis

- Start working on analysis for SAND for physics interests.
- Discriminating primary neutron from background (secondary neutron, gammas)
- Using these informations to improve the flux and neutrino energy measurements.

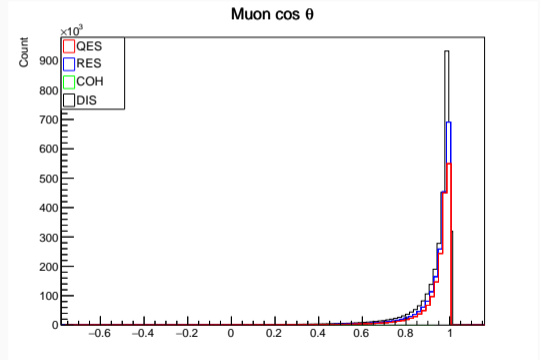
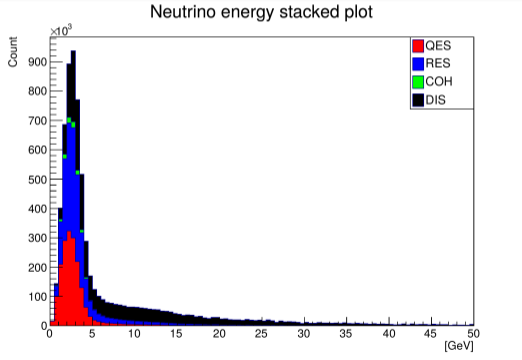
Data used

- Making use of Guang's simulations of 3DST interactions.
- Keeping only CC events for now.
- Only RHC for now.

Basic kinematics

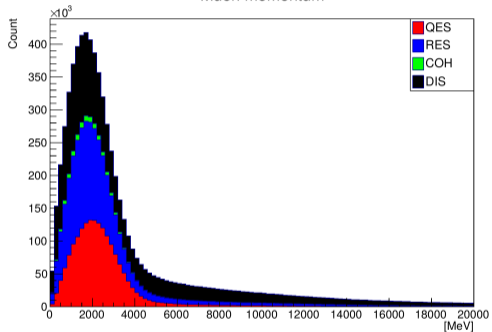
Kinematics

Convention : All the filled histograms are stacked histograms while the others are shape-comparison histograms

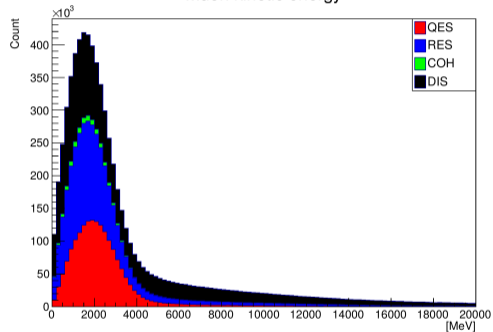


Kinematics

Muon momentum

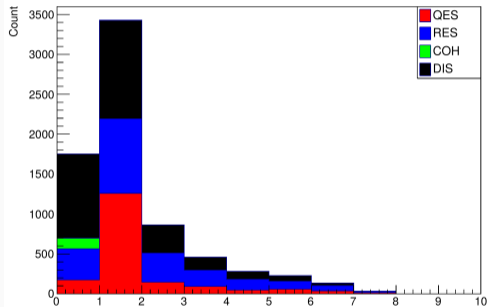


Muon kinetic energy

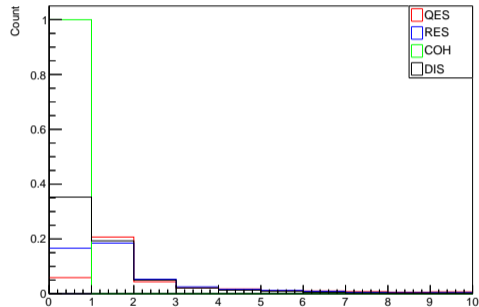


Kinematics

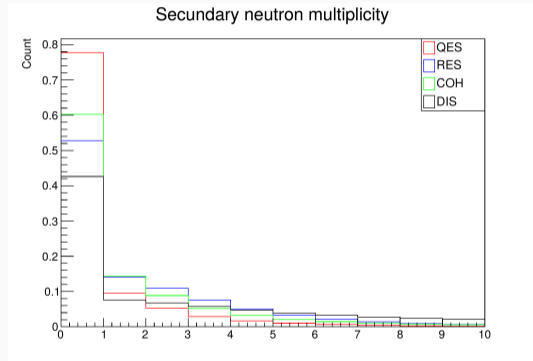
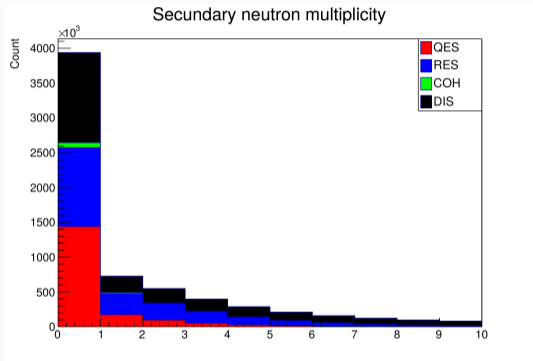
Primary neutron multiplicity



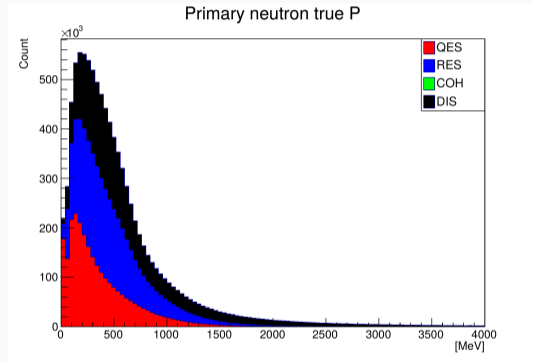
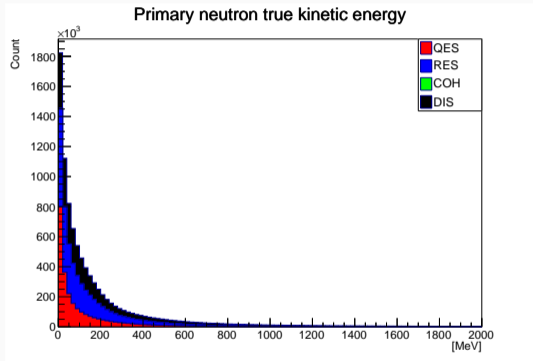
Primary neutron multiplicity



Kinematics

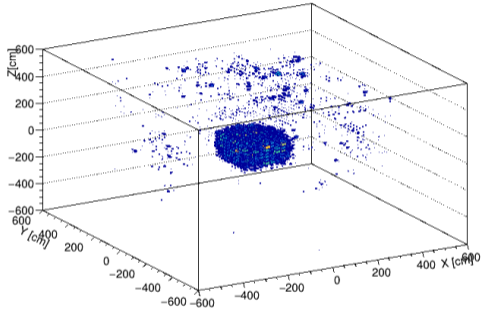


Kinematics

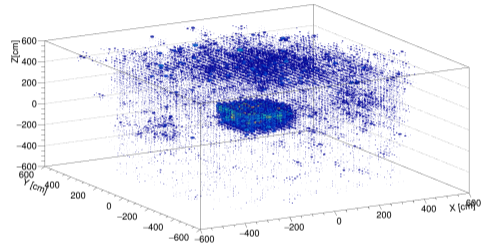


Kinematics

Energy deposited by primary neutrons



Energy deposited by secondary neutrons



Secondary neutrons are more likely to deposit energy outside of 3DST than primary neutrons.

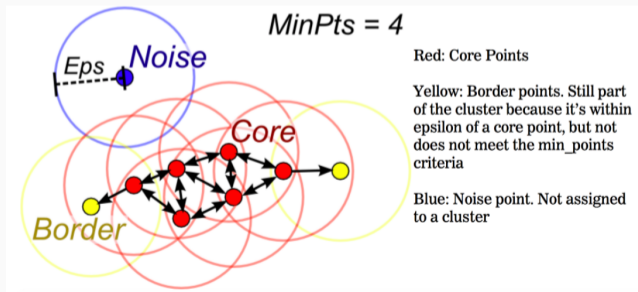
Clustering the hits

Clustering

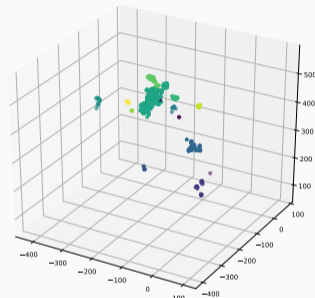
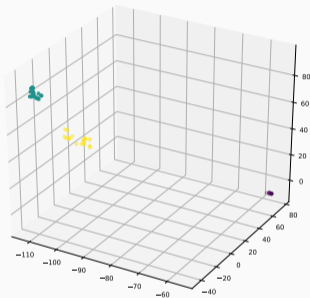
Necessity to cluster the hits together in order to detect particles and measure ToF and all other features.

Use of DBSCAN a density based clustering.

3D clustering on two parameters : a distance and a minimum of points to be found in that distance → defines a density.



Clustering examples



$$\epsilon = 30 \text{ cm and } \text{min_points} = 5$$

We are trying to define metrics in order to evaluate the clustering we make → suggestions are welcome.

Very preliminary results

Analysis procedure

Input used

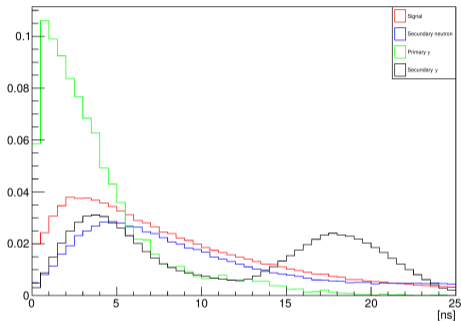
All the hits from neutrons and gammas are considered (even outside 3DST for now). Smearing applied on hits time but not on vertex time or position for now.

Procedure

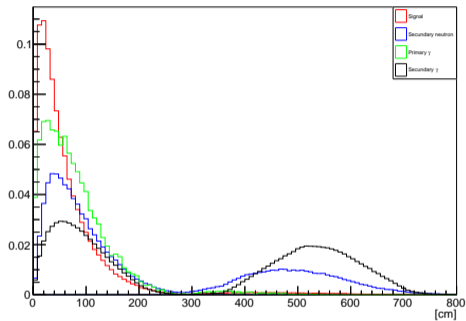
- We compute the clusters in order to define "detected" particles.
- For each cluster, the first hit is taken in order to compute the ToF, the distance from vertex and β .
- The number of cubes activated and the energy deposited in the cluster are also computed.

Results

Time of flight

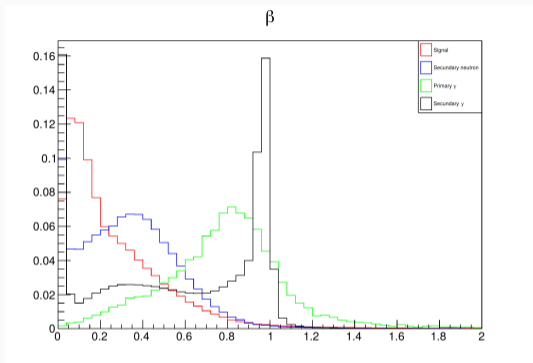


Distance to vertex



Double peak distribution because the hits outside 3DST are also included (probably ECAL).

Results



The distributions of the gammas are not as peaked as expected.

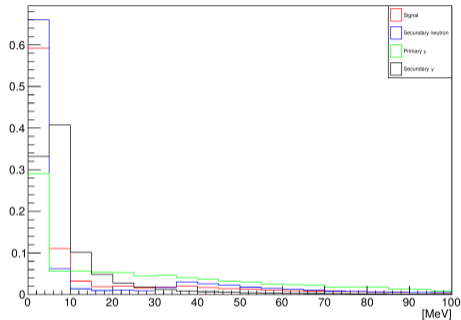
There is a large peak at 0 for secondary gammas to understand

We see some separations between neutrons and gammas for β as expected.

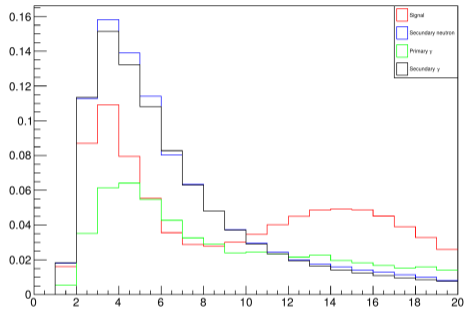
I will try to remove the hits outside 3DST to see if the results get different.

Results

Cluster energy



Number of activated cubes



Some kind of double distribution seems here to appear for the number of activated cubes for the neutron signal. We need to understand why.

Conclusion

- I am starting to look at the neutron analysis in 3DST in order to use these informations to improve the flux estimation and neutrino energy measurement.
- Some observations in the results I get show that some improvements have to be made in the processing of the data.

For example, the number of detected clusters doesn't seem to depend on the processus of the interaction.

