ProtoDUNE-SP DD Generator Test: Analysis and Simulation

Pulsed Neutron Source WGM
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Motivation For DDG Analysis

- Understanding the neutron spread in ProtoDUNE-SP
- Remove cosmic events from the DDG run
- 3d space point reconstruction to test the neutron transport model
- Fit the data using the MC simulations

Pulsed Neutron Source

- Deuterium-Deuterium (DD) neutron generator produces 2.5 MeV neutrons; adjustable pulse width/rate

$$^{2}H + ^{2}H \rightarrow ^{3}H + n + Q(2.5\ MeV)$$

- No Moderator was used in the first test

Spacepoint Clustering Using DBScan 3D

Run Number: 11711 – Pulsed Trigger Run (E = 350 V/cm Field)

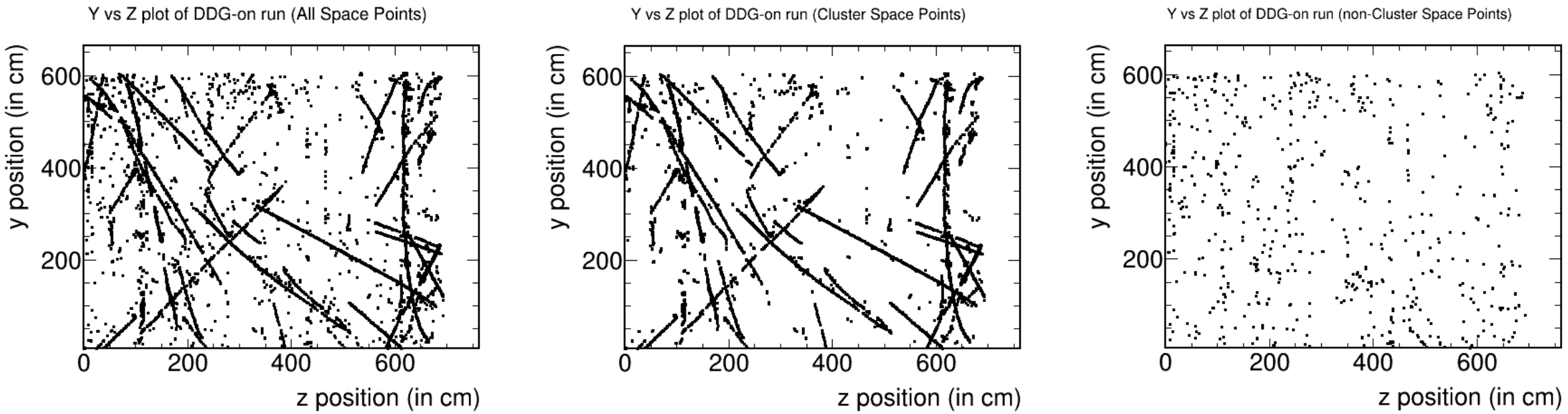


Fig. Y vs Z plot of spacepoints for one event. Clustering is performed on the reconstructed 3D spacepoints.

- Minimum points per slice is set to 3
- Epsilon (neighborhood radius) is set to 2cm
- Cosmic rays partially removed by a cut on slice size

Determining the Slice Size Cutoff

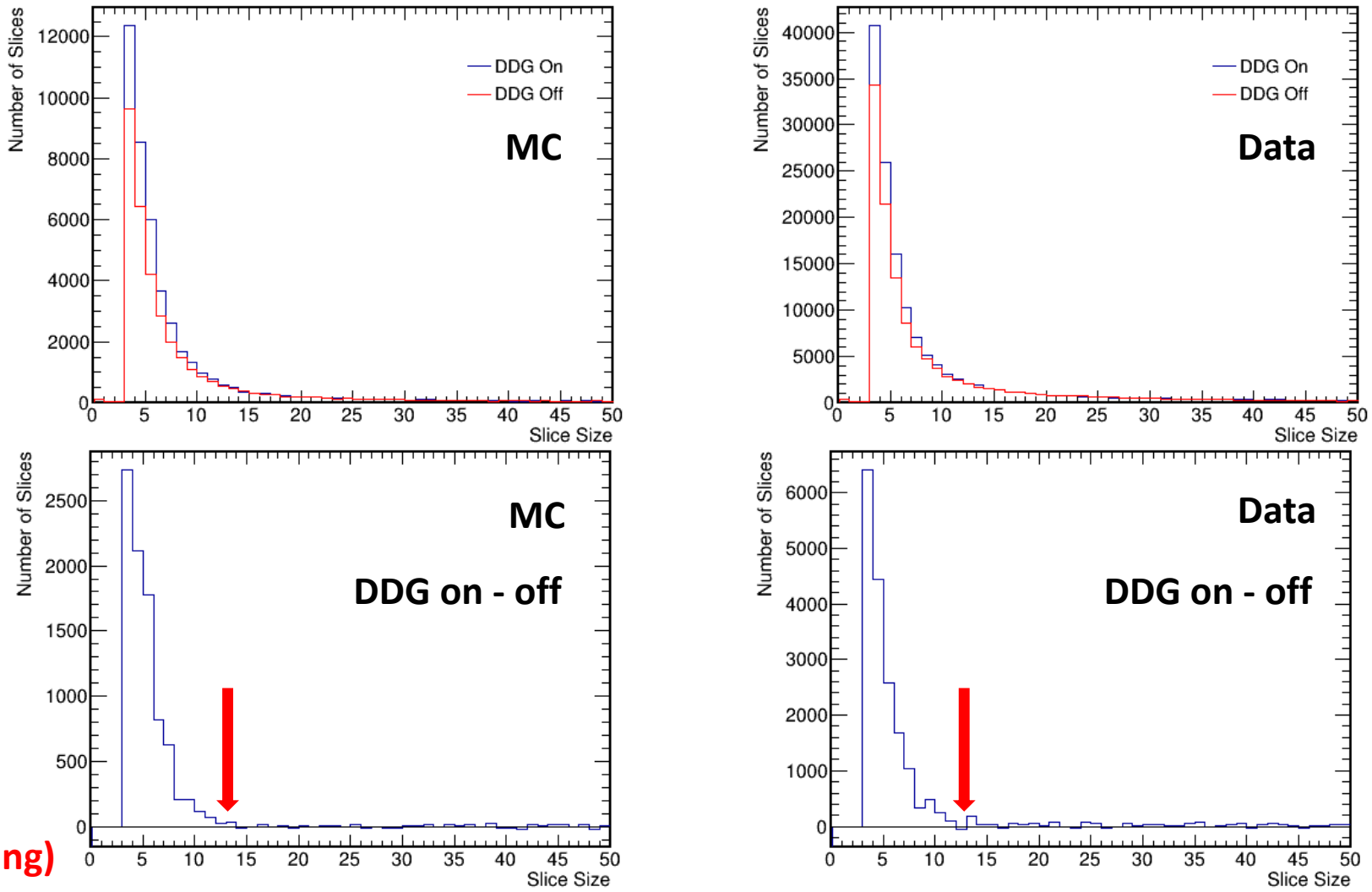
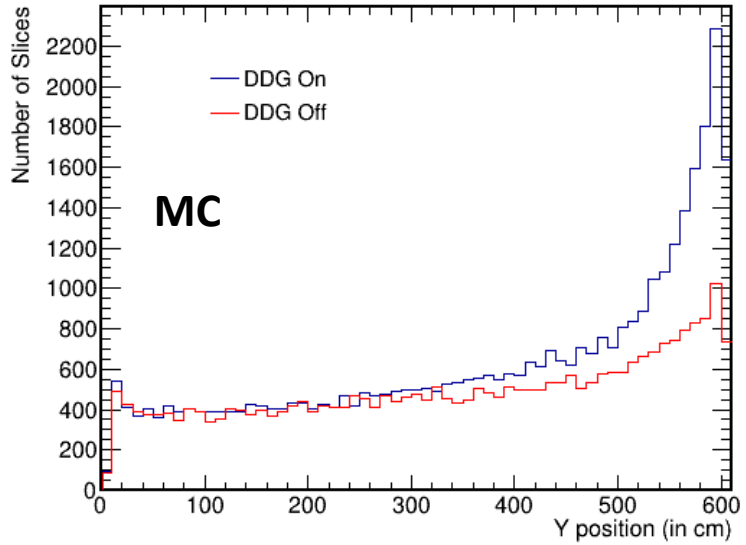


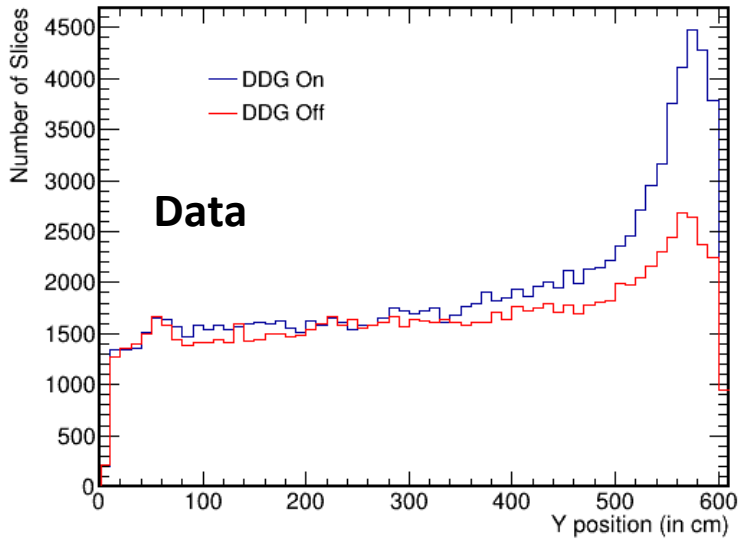
Fig. Slice Size vs Number of Slices Plots

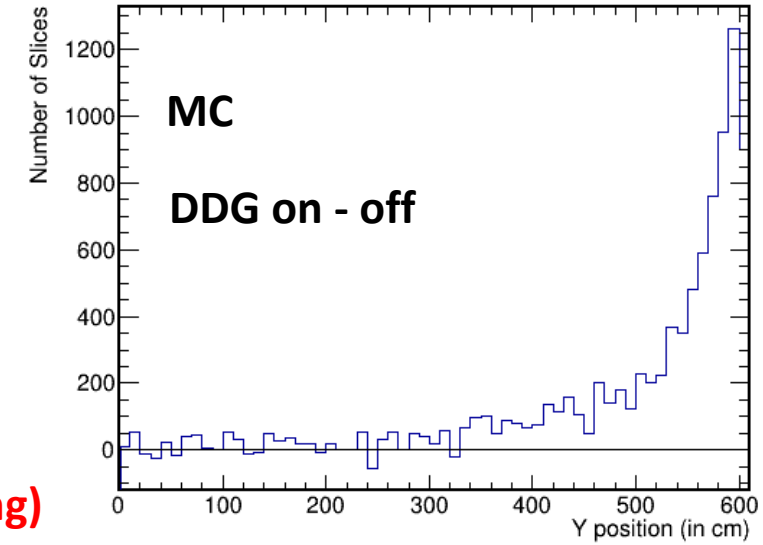
- We use a slice size cutoff of <=13 to remove some cosmics.
- 5000 events included.

(Junying)

Y-Position of Slices







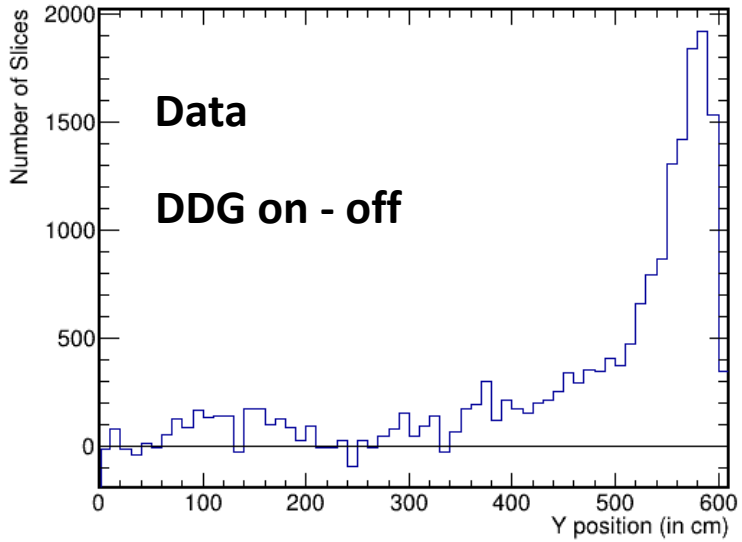


Fig. Y Position vs Number of Slices Plots (after the cut on slice size)

- 5000 events included.
- Apparent Inefficiency near top of detector?

(Junying)

Fitting the DDG on using MC

- We are using a chi square fit

$$\chi^2 = \sum_{bins} \frac{(D_i - \alpha F_i - \beta M_i)^2}{D_i}$$

- Here:
  - D = Data DDG On
  - F = Data DDG Off
  - M = MC (On – Off)
- We are minimizing chi square for the parameters α and β
- Minimizing done using Minuit

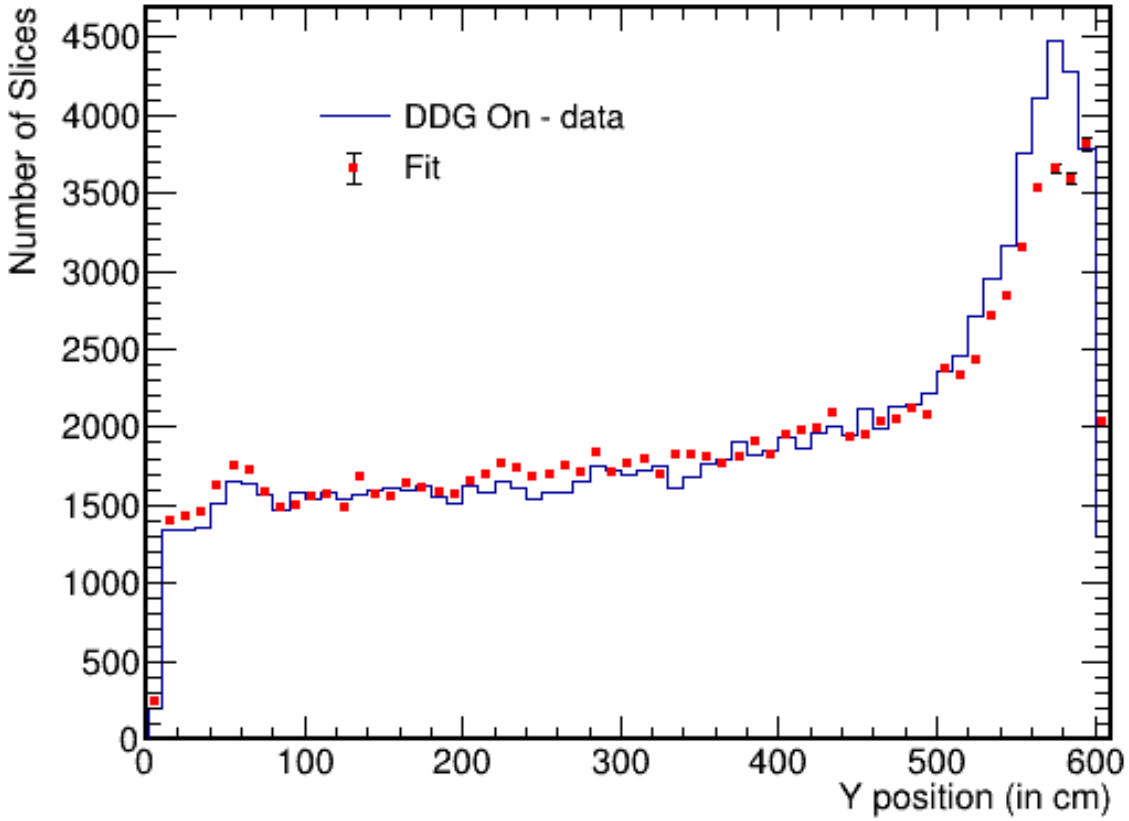


Fig. Y Position vs Number of Slices Plot

NO.	NAME	VALUE	ERROR
1	Alpha	1.06312e+00	3.86307e-03
2	Beta	1.12857e+00	2.70458e-02

Conclusions

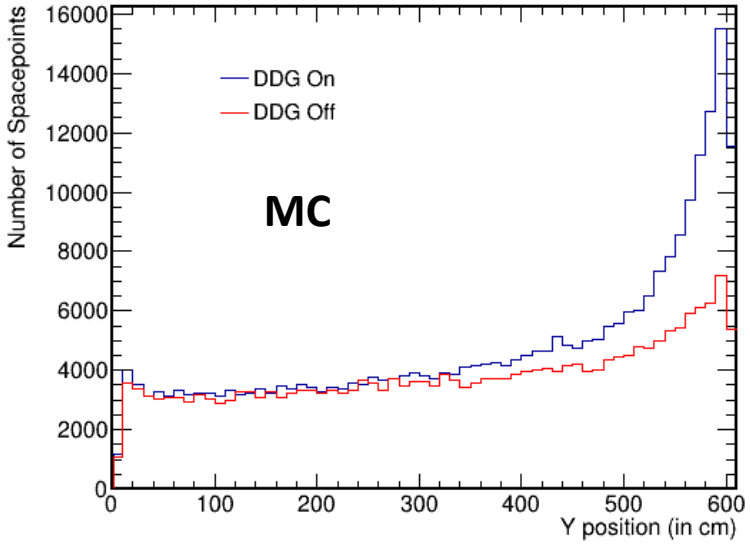
- Key features in Data are also seen in Monte Carlo simulations
- Need to know why there is an inefficiency at the top of the detector
- Increased the statistics to 5000 events
- Did a Fit for DDG On (data) using DDG Off (data) and MC

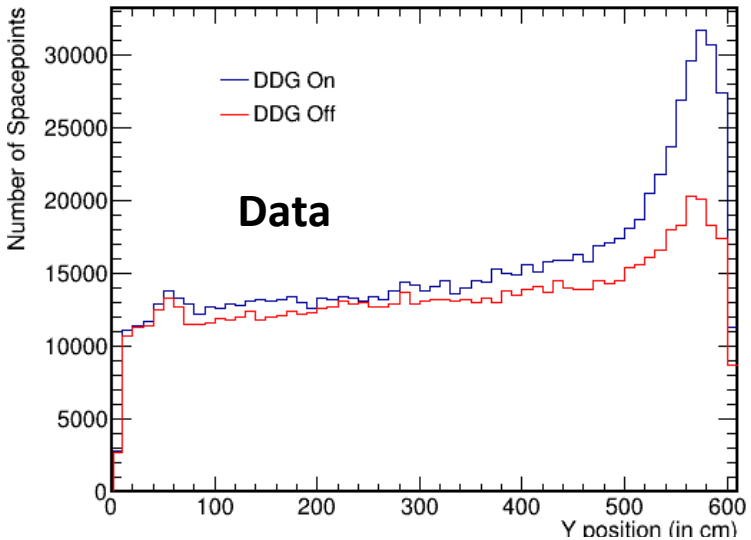
To Do List:

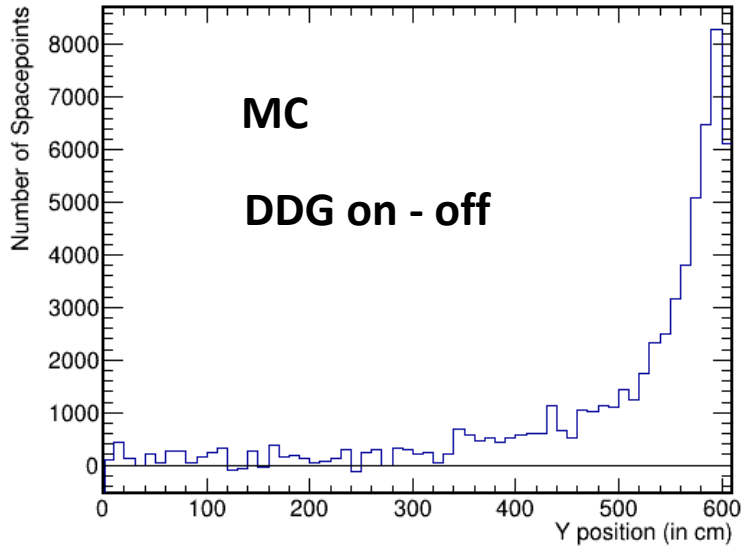
- Second Clustering with a larger epsilon to associate gammas to neutrons
- Comparing DB Scan results to Pandora
- Write an analysis report

Backup Slides

Y-Position of Spacepoints







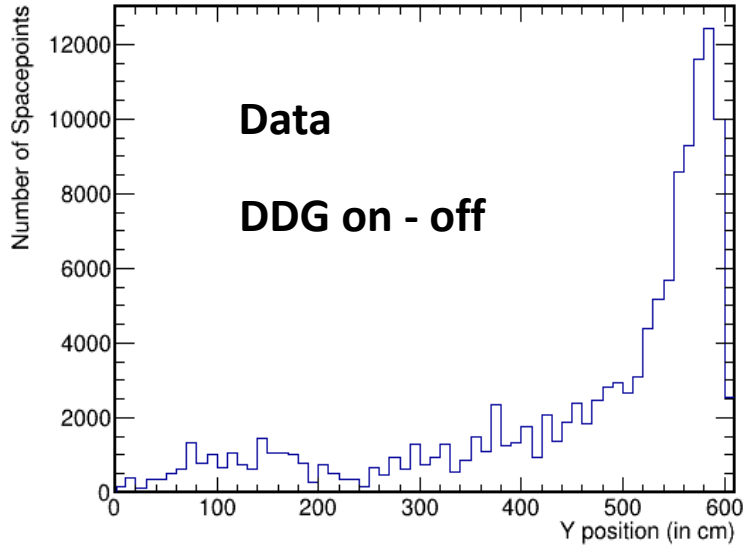


Fig. Y Position vs Number of Spacepoints Plots (after the cut on slice size)

- 5000 events included.
- Apparent Inefficiency near top of detector?