PMTrack Performance Study

Avik Ghosh
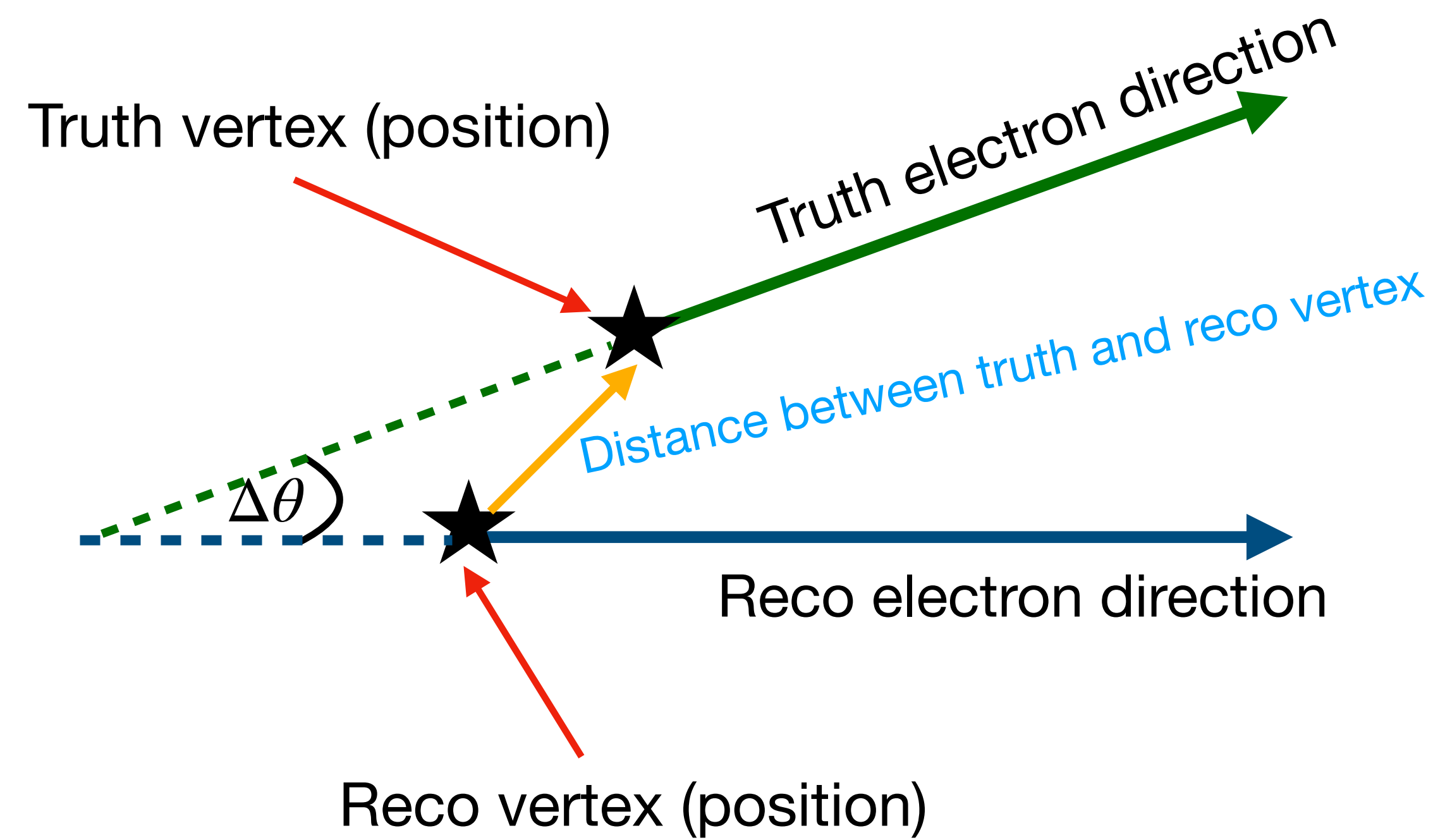
Introduction

- CC and ES interactions were simulated using SN GVKM input neutrino spectrum.

- To extract the pointing information the interaction vertex and particle tracks need to be reconstructed.

- The reconstruction utilizes PMTrack algorithm to do so.

- We have electron truth and reconstructed information (direction, vertex position and energy).

Obtained simulation files from Janina

Goal

- Analyze and compare the truth and reco information to study resolution for electron energy, direction and interaction vertex position.

- Study how inefficient PMTrack is? i.e How often it fails to reconstruct tracks?

- To understand how PMTrack's performance depends on Energy.

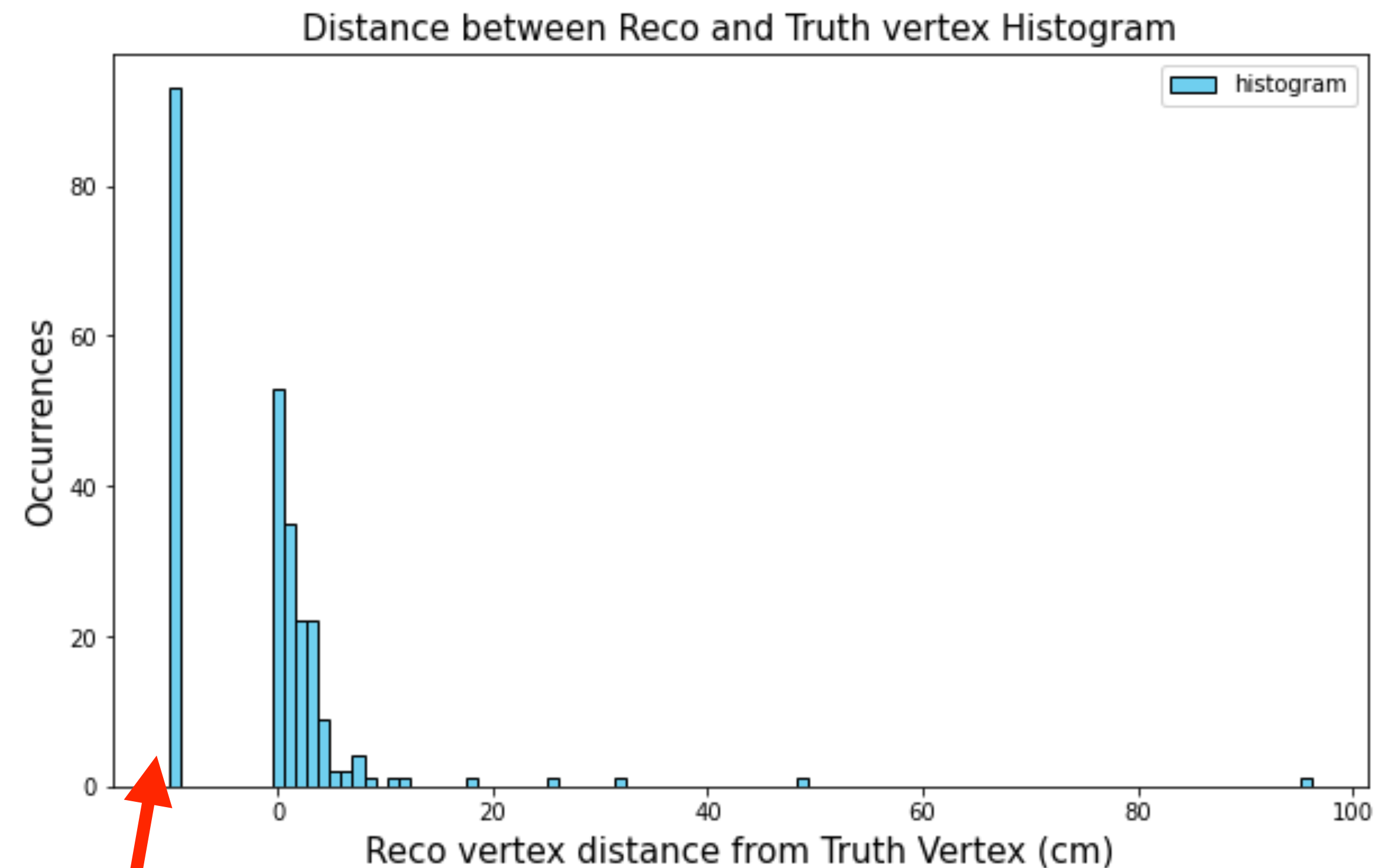# Understanding Truth and Reco direction and Position

Truth vertex (position)

Truth electron direction

Distance between truth and reco vertex

$\Delta\theta$

Reco electron direction

Reco vertex (position)

Distance between truth vertex and reco vertex
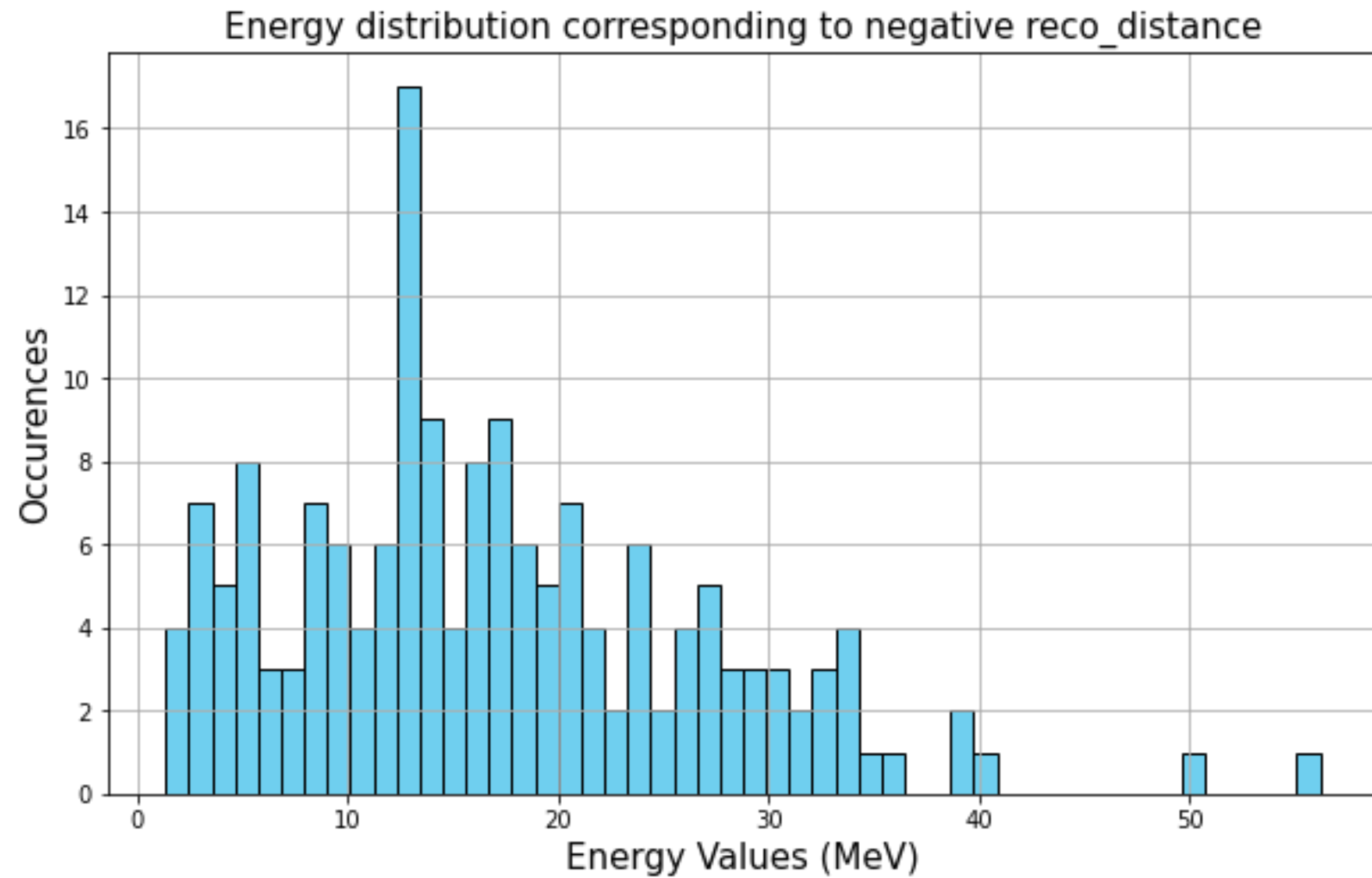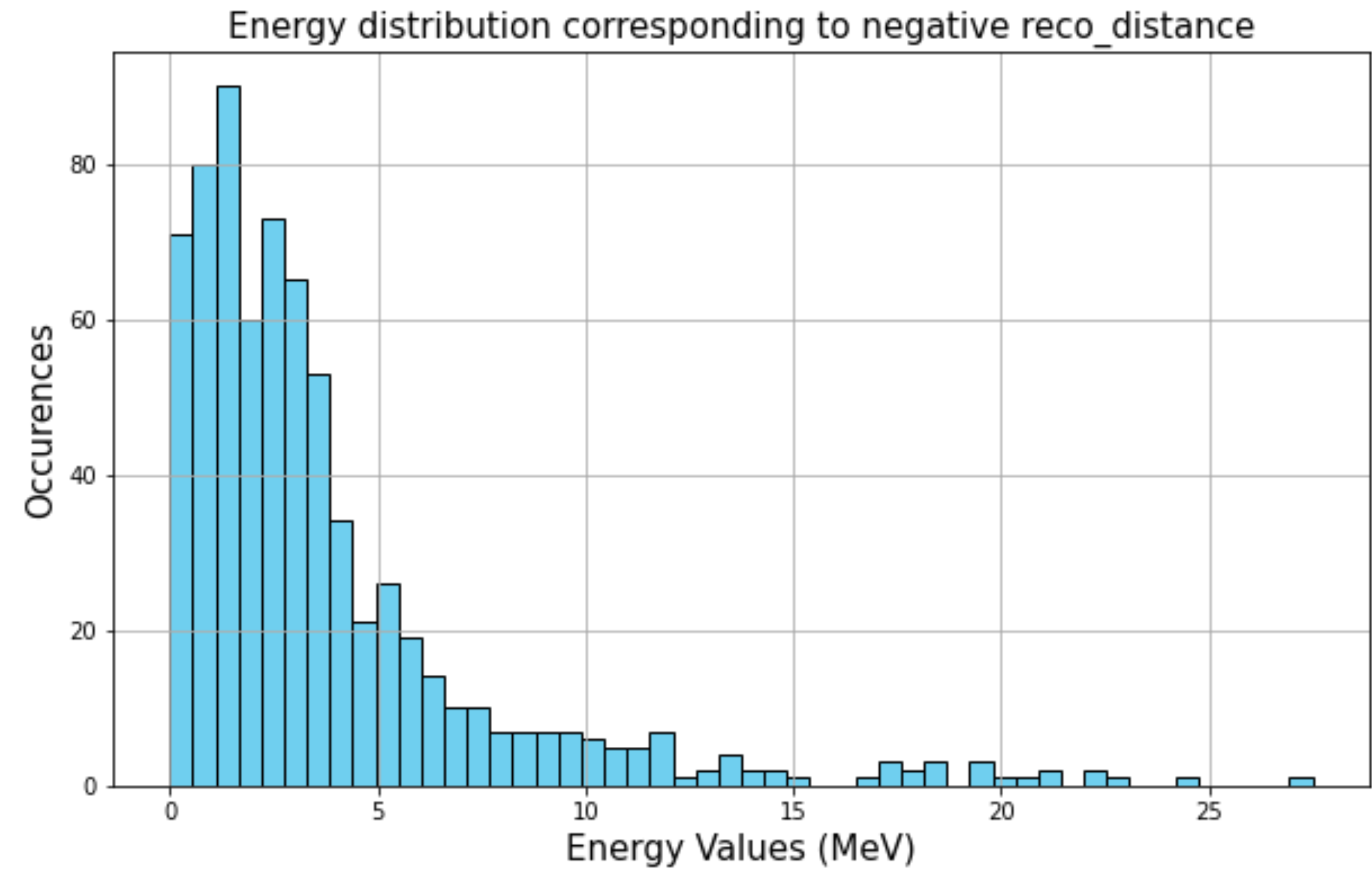
Distribution
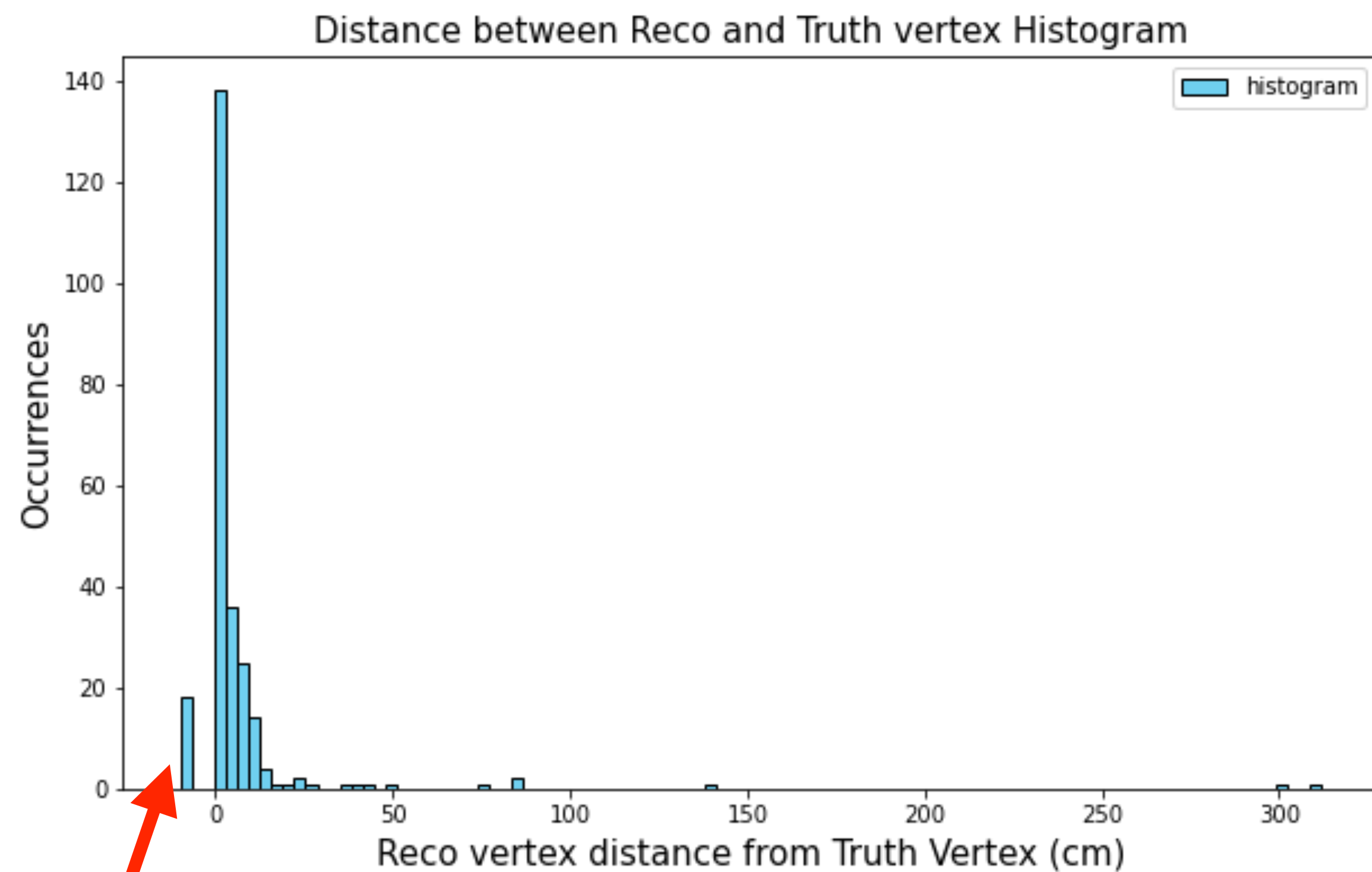
CC Interaction

ES Interaction

Negative value (-10)
Assigned for distance b/w truth and reco vertex

Negative Values for the distance between truth and reco vertex = Failed reconstructions

CC Interaction

ES Interaction
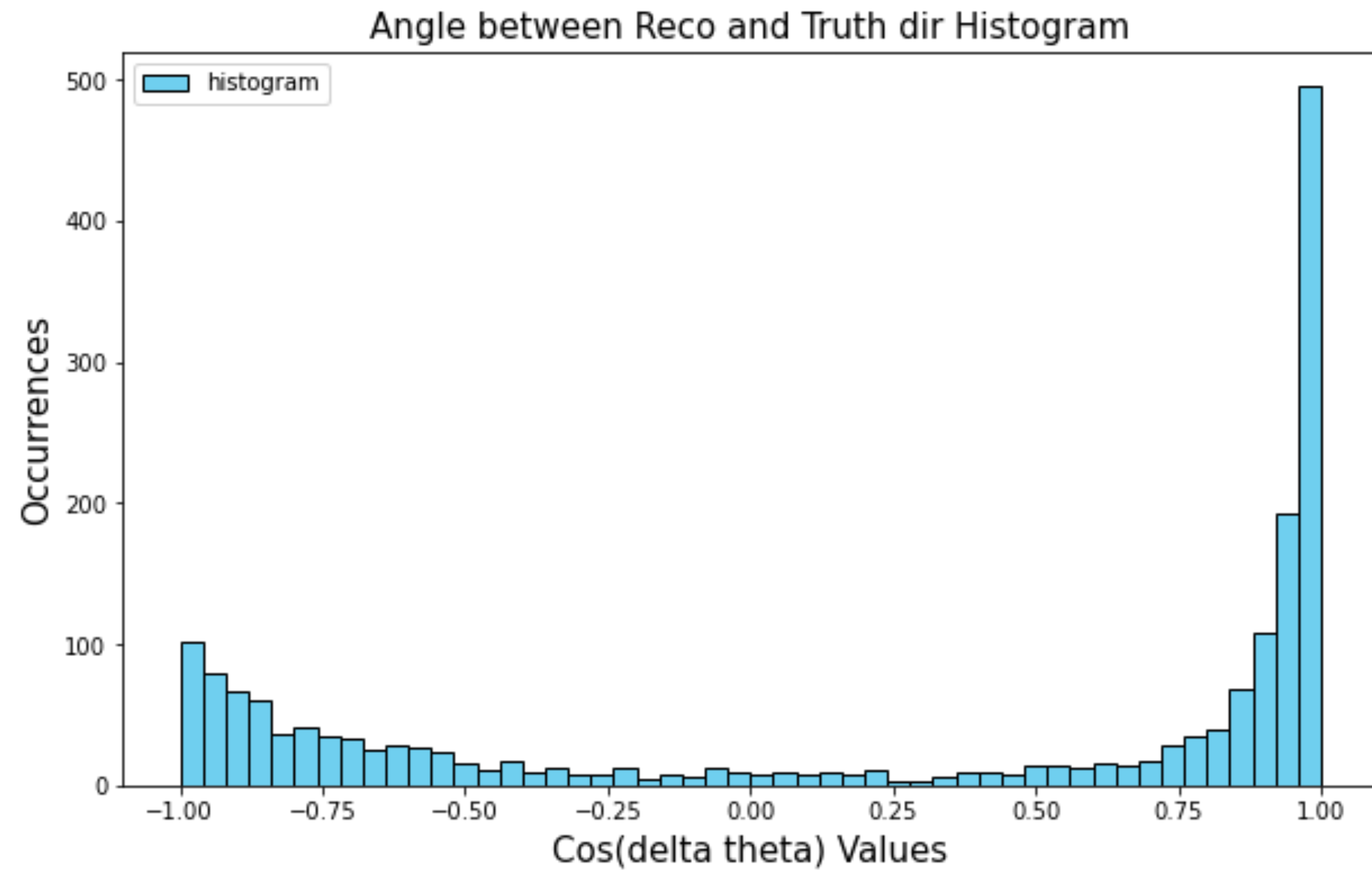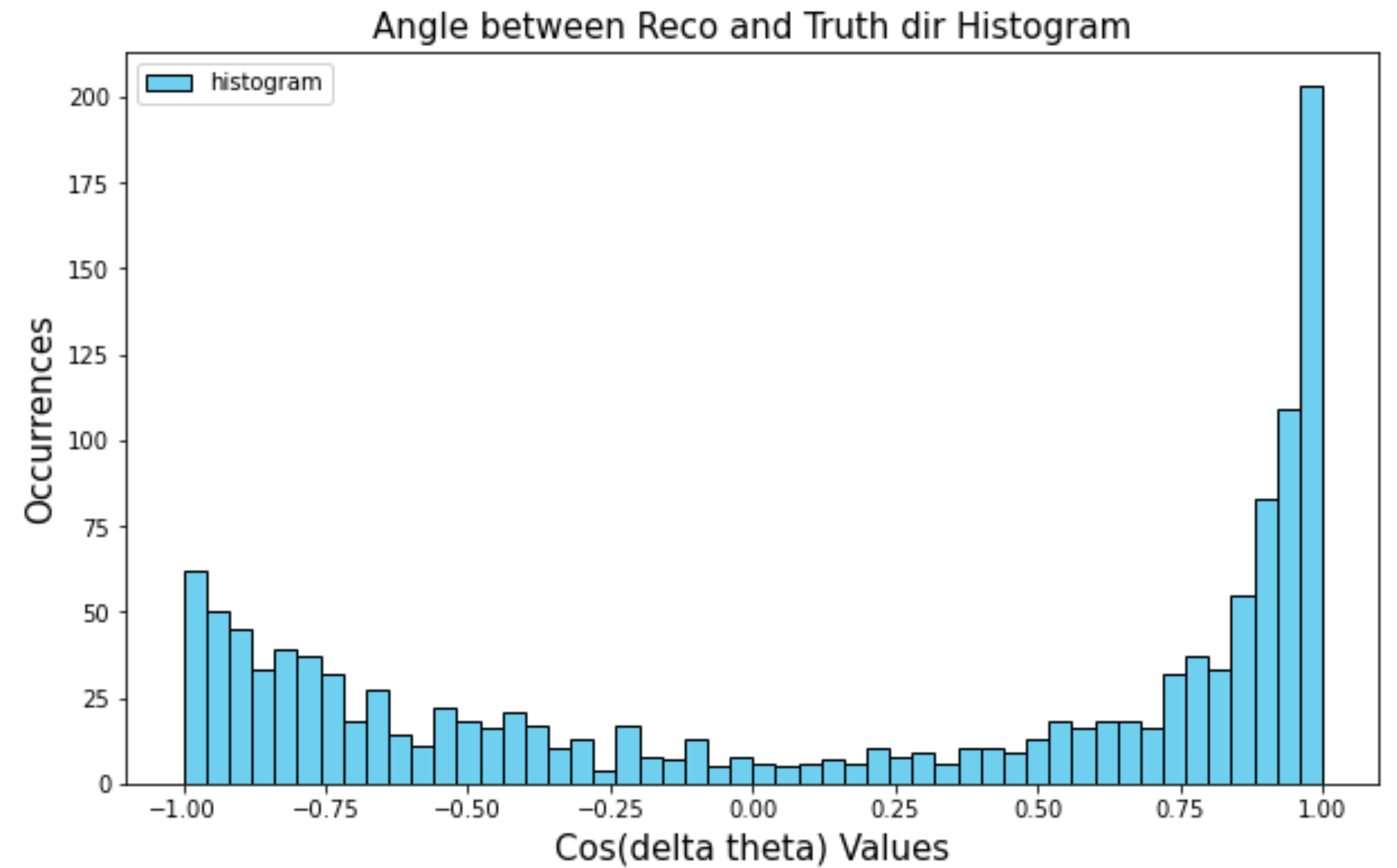
Reconstruction Failure percentage: 8.3

Reconstruction Failure percentage: 35.5

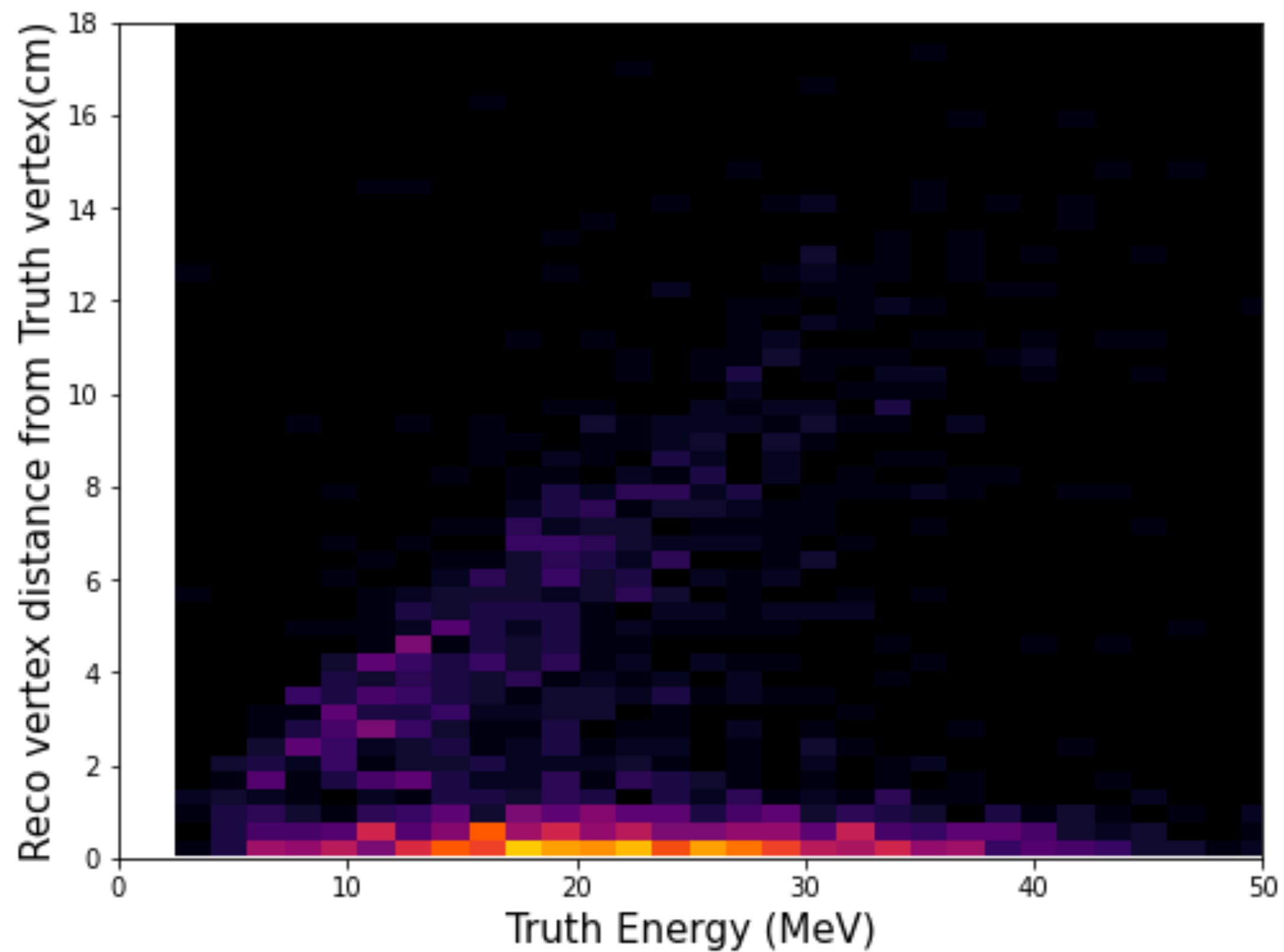# Cosine of the Angle between truth dir vector and reco dir vector
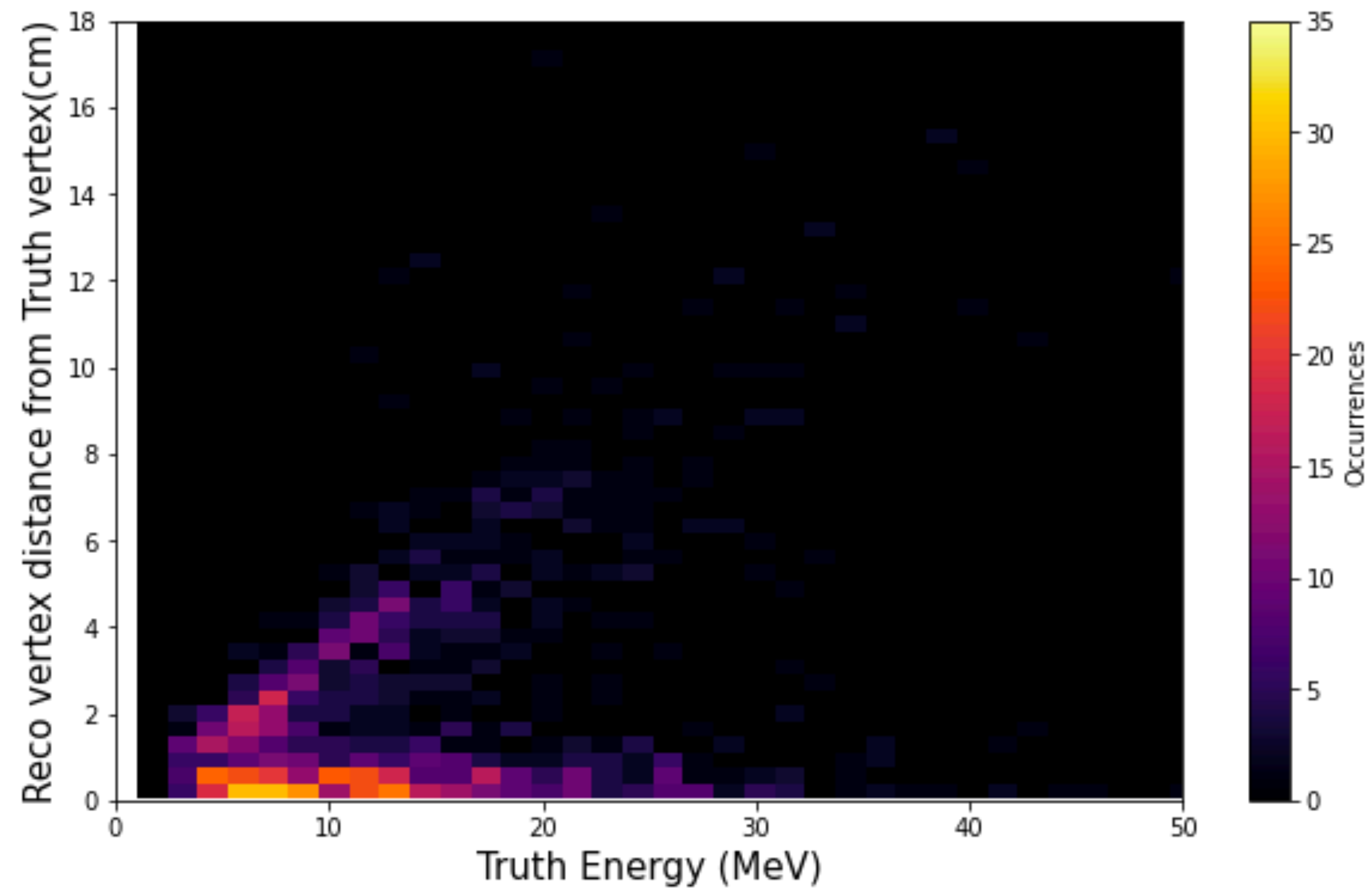
Distribution

CC Interaction

ES Interaction

Distance between truth vertex and reco vertex

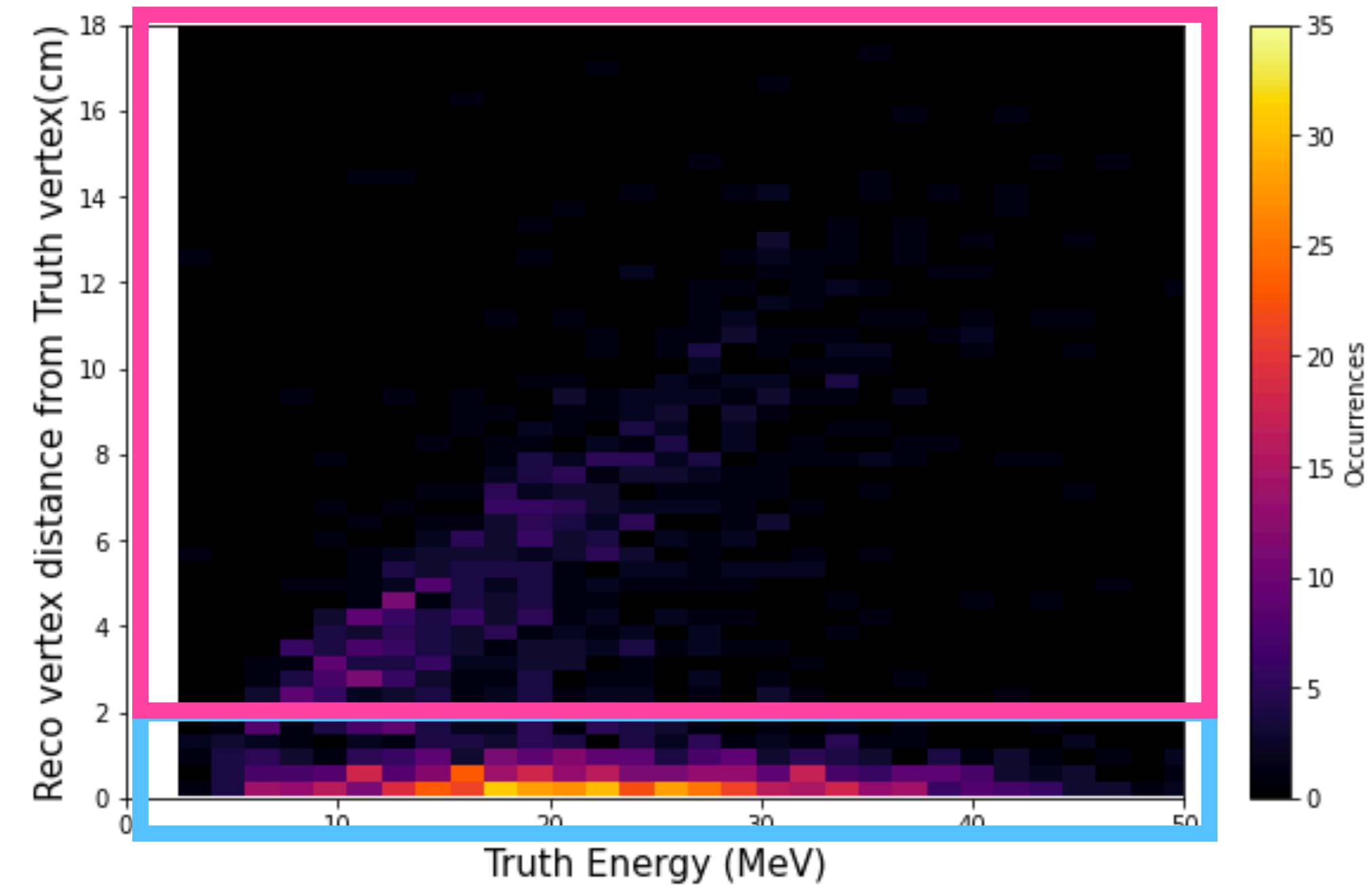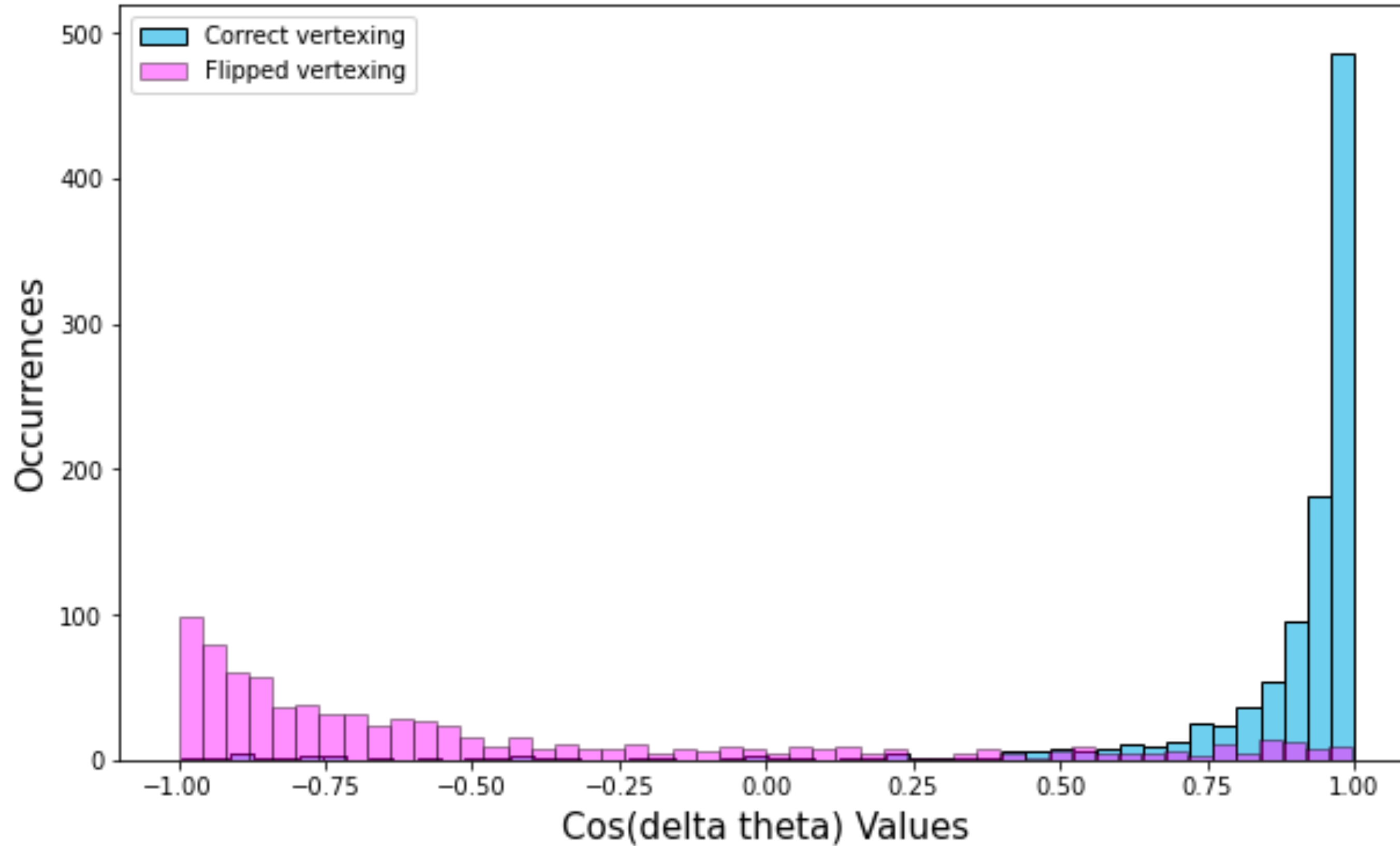## Distribution with Energy dependence (Zoomed in)

All Events

CC Interaction

ES Interaction

Cos (delta theta) distribution for correct vertexing and flipped vertexing

CC Interaction

Primary and Secondary tracks

For a total of 2000 events

Fraction of tracks / Interaction	Primary	Secondary 1st	Secondary 2nd	Secondary 3rd	Total tracks
CC	63.75	27.56	7.23	1.46	2877
ES	81.54	15.93	2.34	0.19	1582

No tracks for events where reconstruction failed

Reconstructed Track length (All tracks)
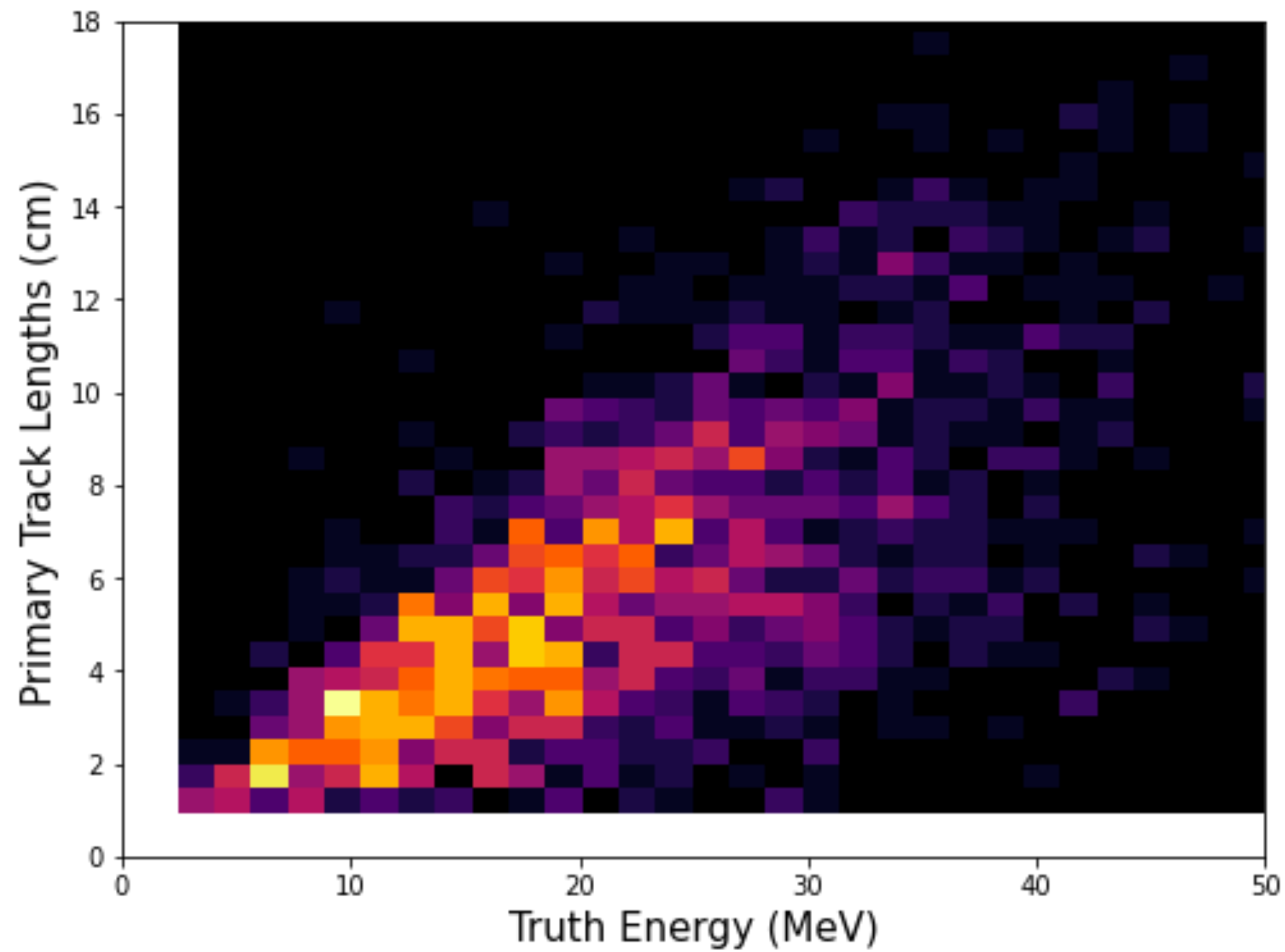
Distribution with Energy dependence (Zoomed In)
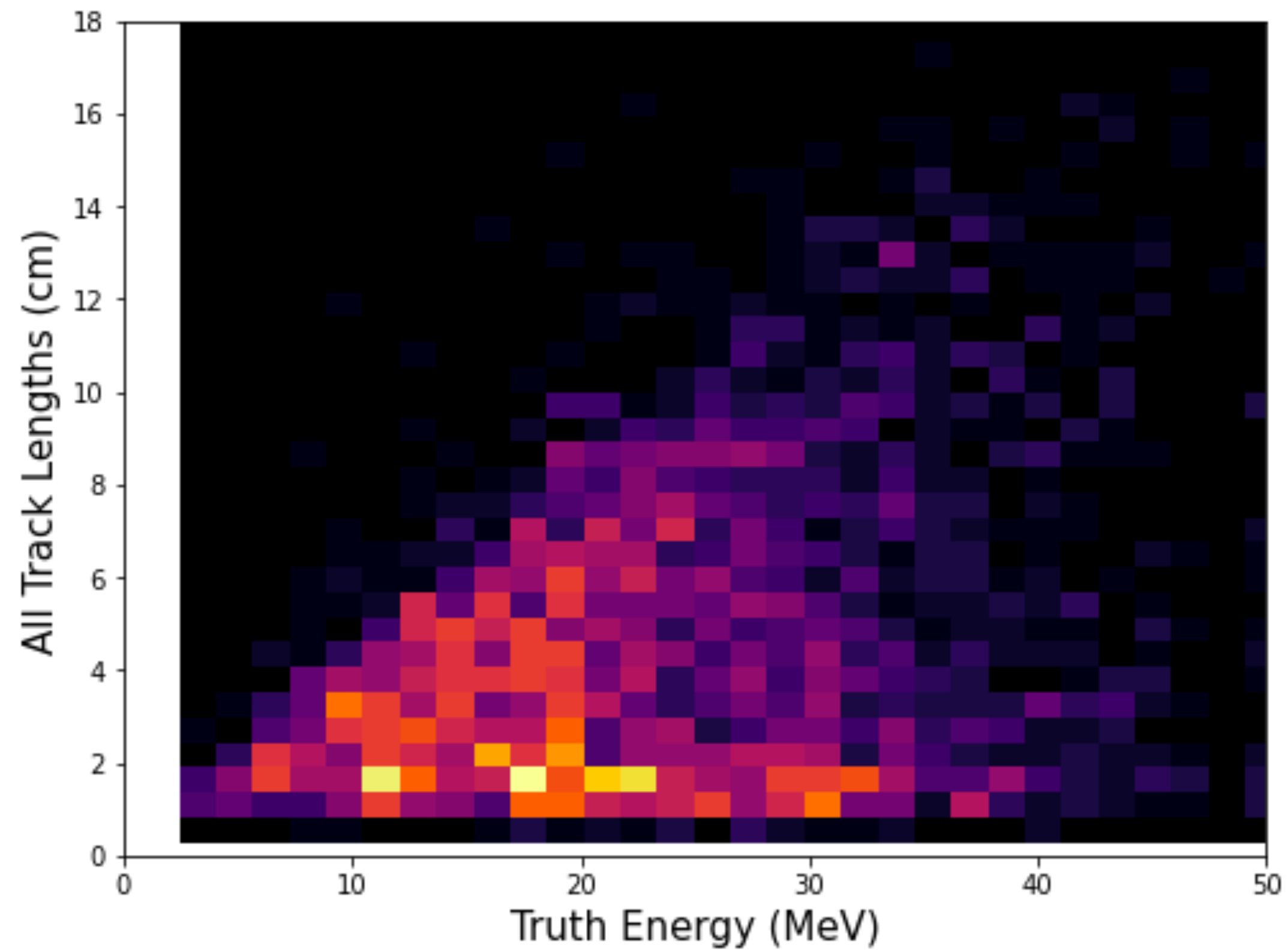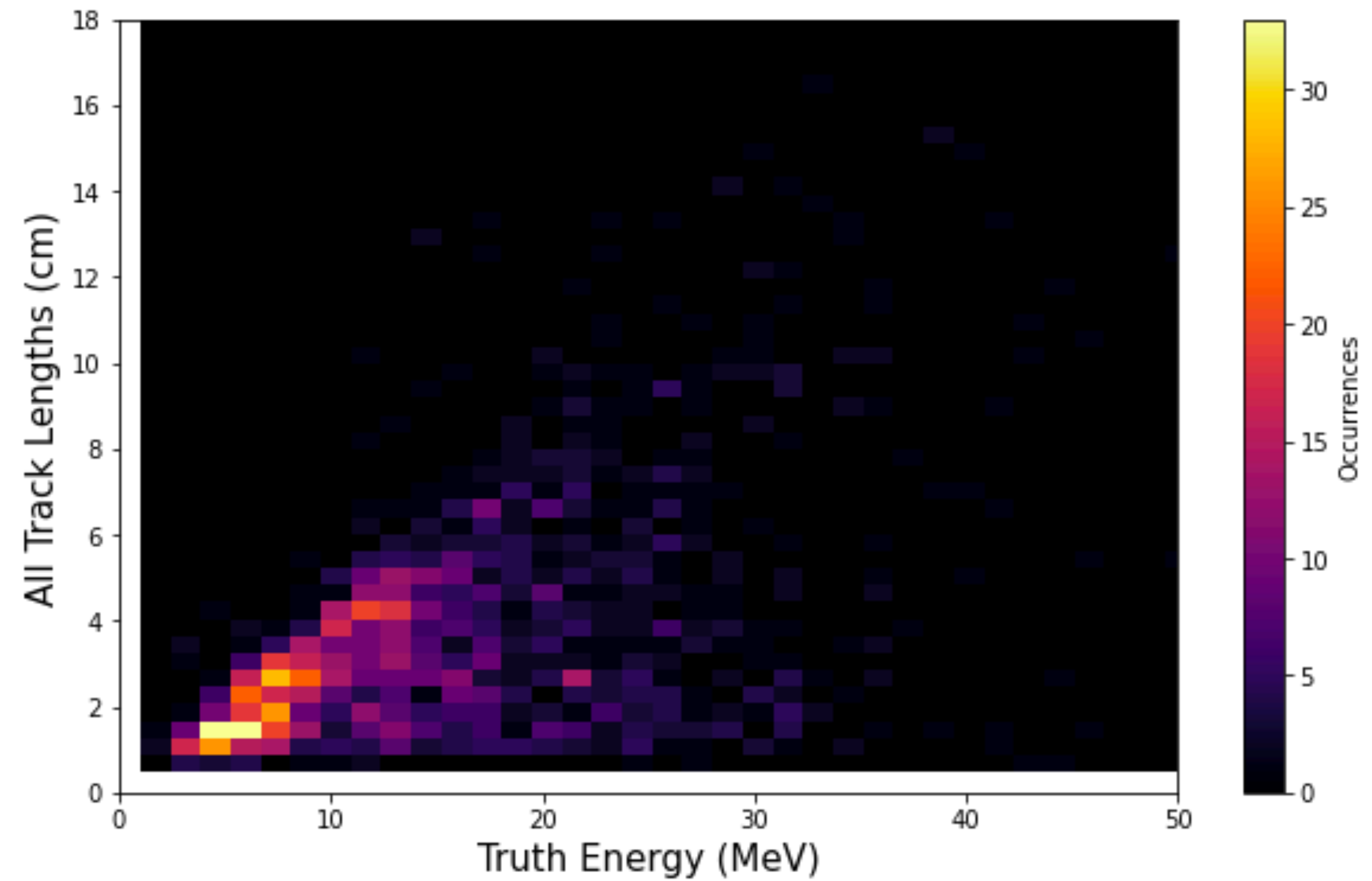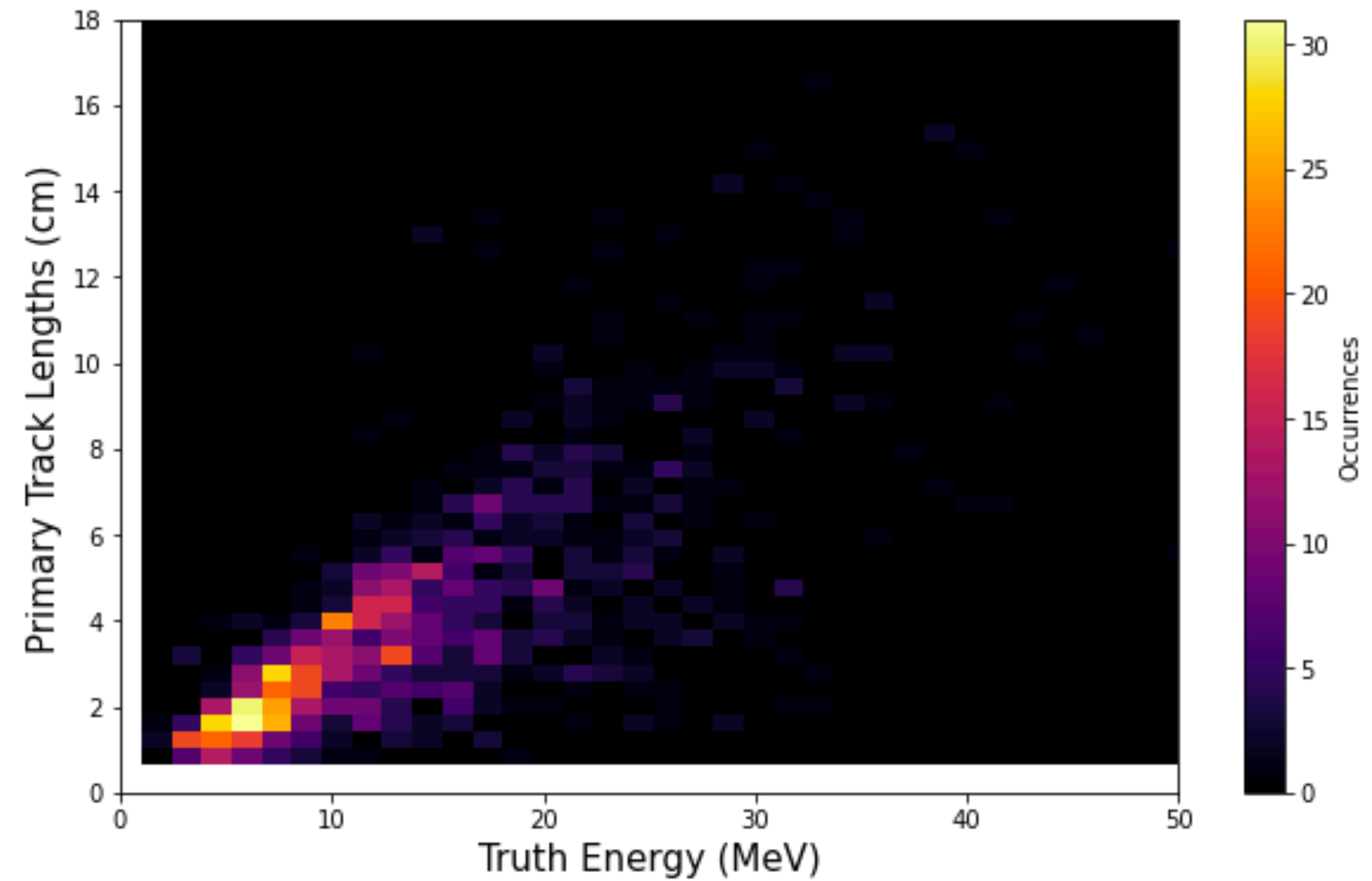

CC Interaction

ES Interaction

Reconstructed Track length (Primary tracks only)

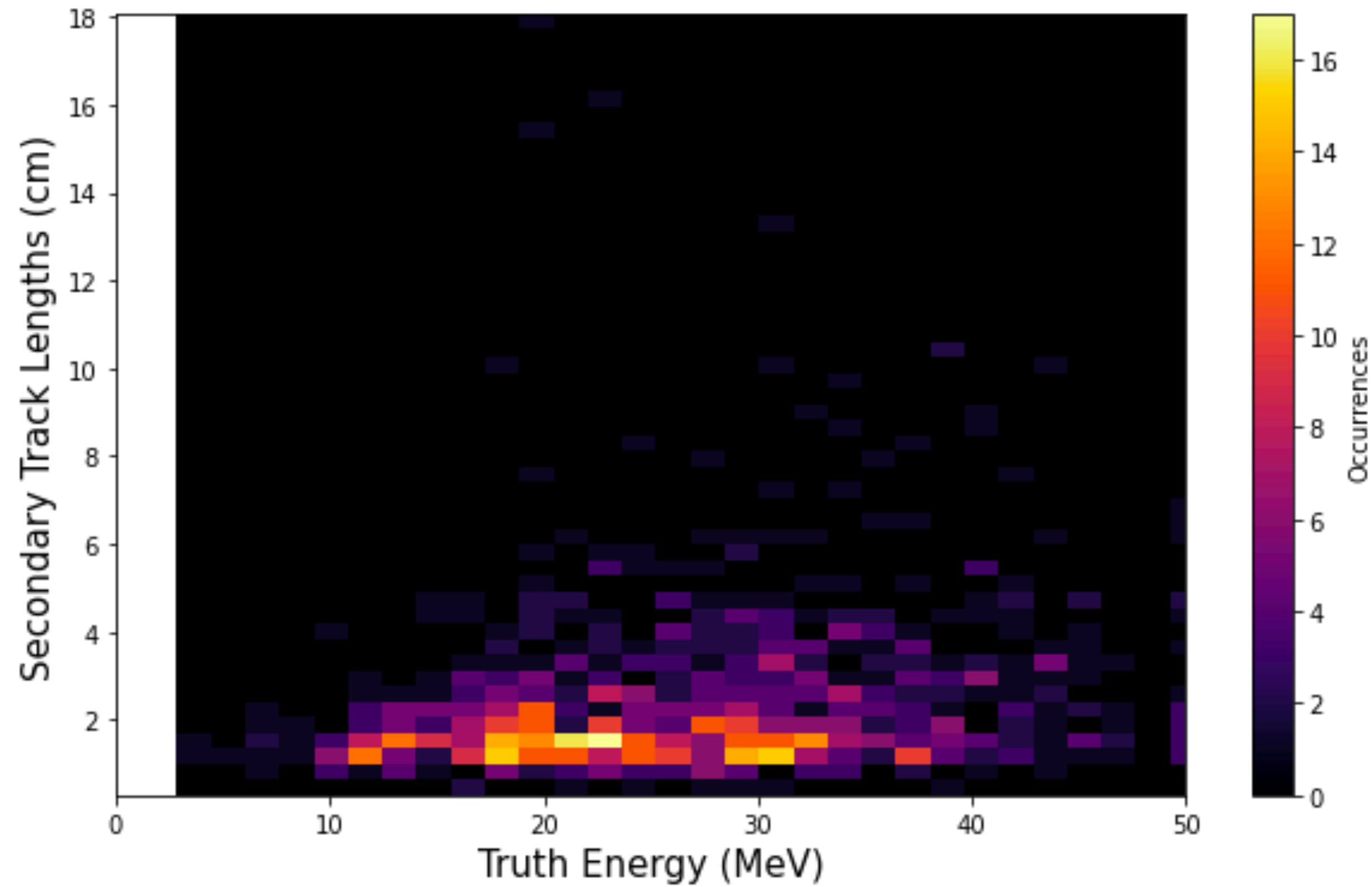## Distribution with Energy dependence (Zoomed In)
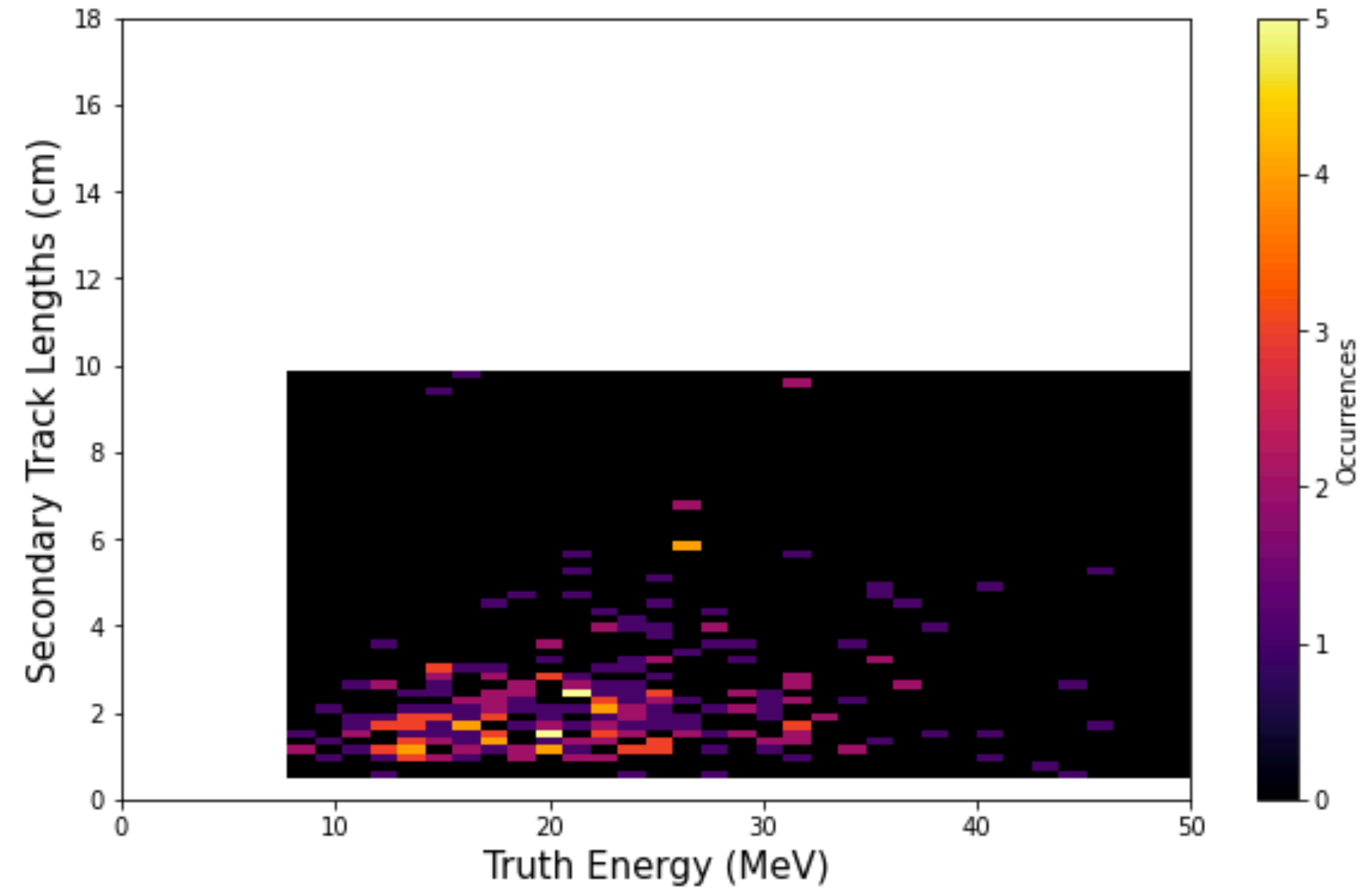

CC Interaction

ES Interaction

Reconstructed Track length (Secondary tracks only)

Distribution with Energy dependence (Zoomed In)

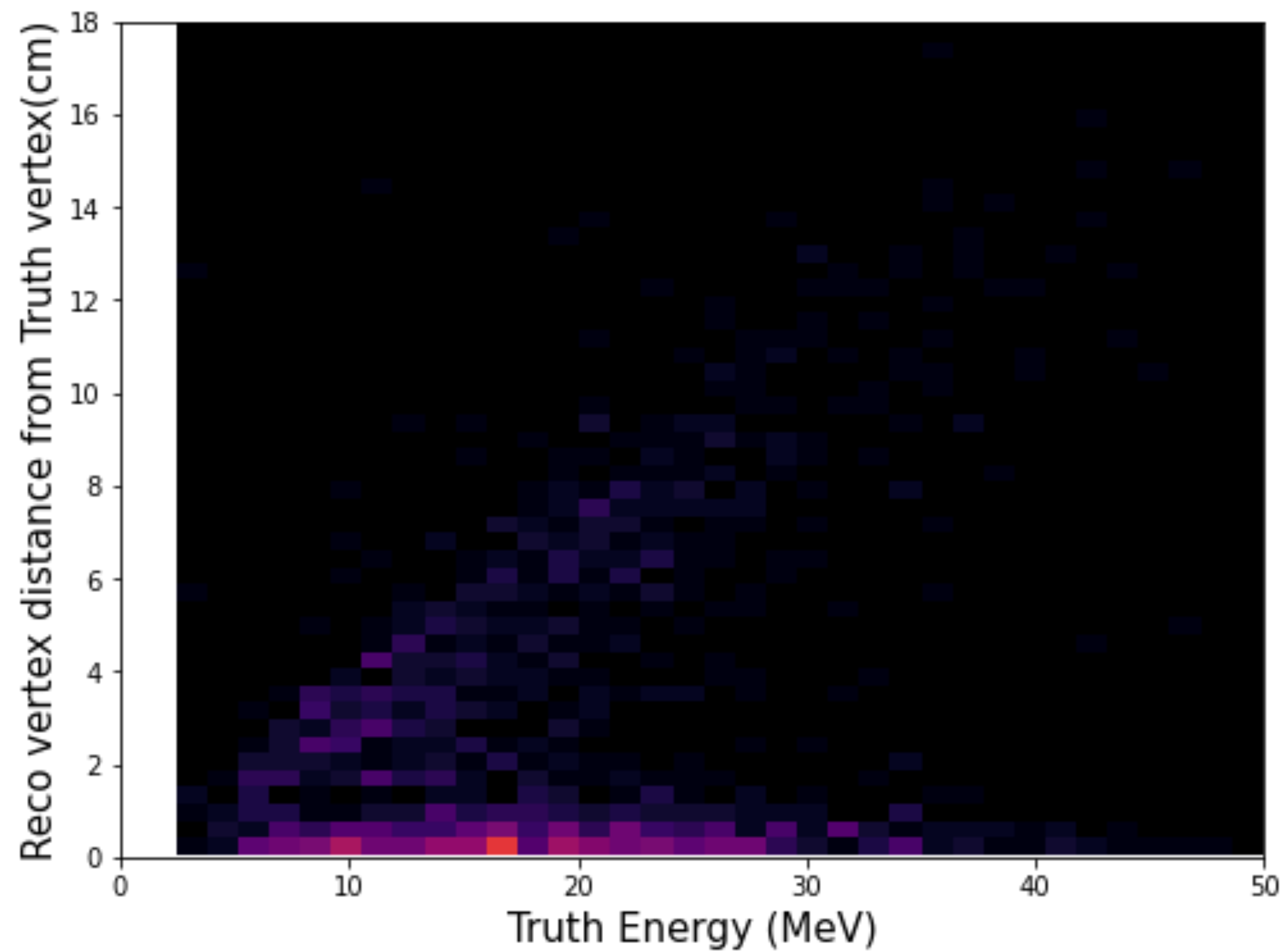CC Interaction

ES Interaction

To do

- Include Energy resolution study

- Study low energy events separately to identify if there is any energy dependence present

- Investigate the reason behind reconstruction failures in more detail

- Include relation between the electron direction and neutrino direction truth info and look at the energy dependence
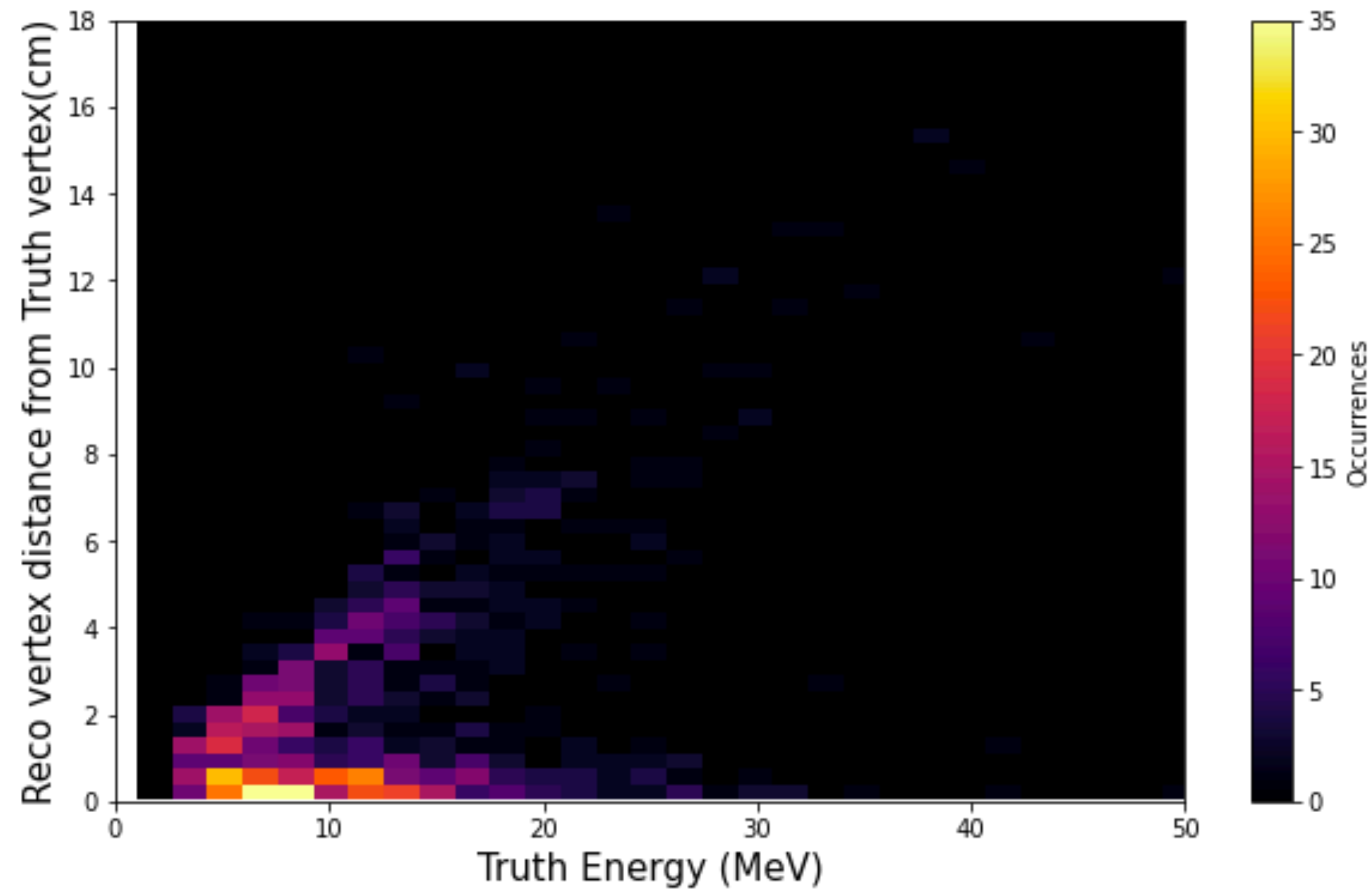
Backups

Distance between truth vertex and reco vertex

Distribution with Energy dependence (Zoomed in)
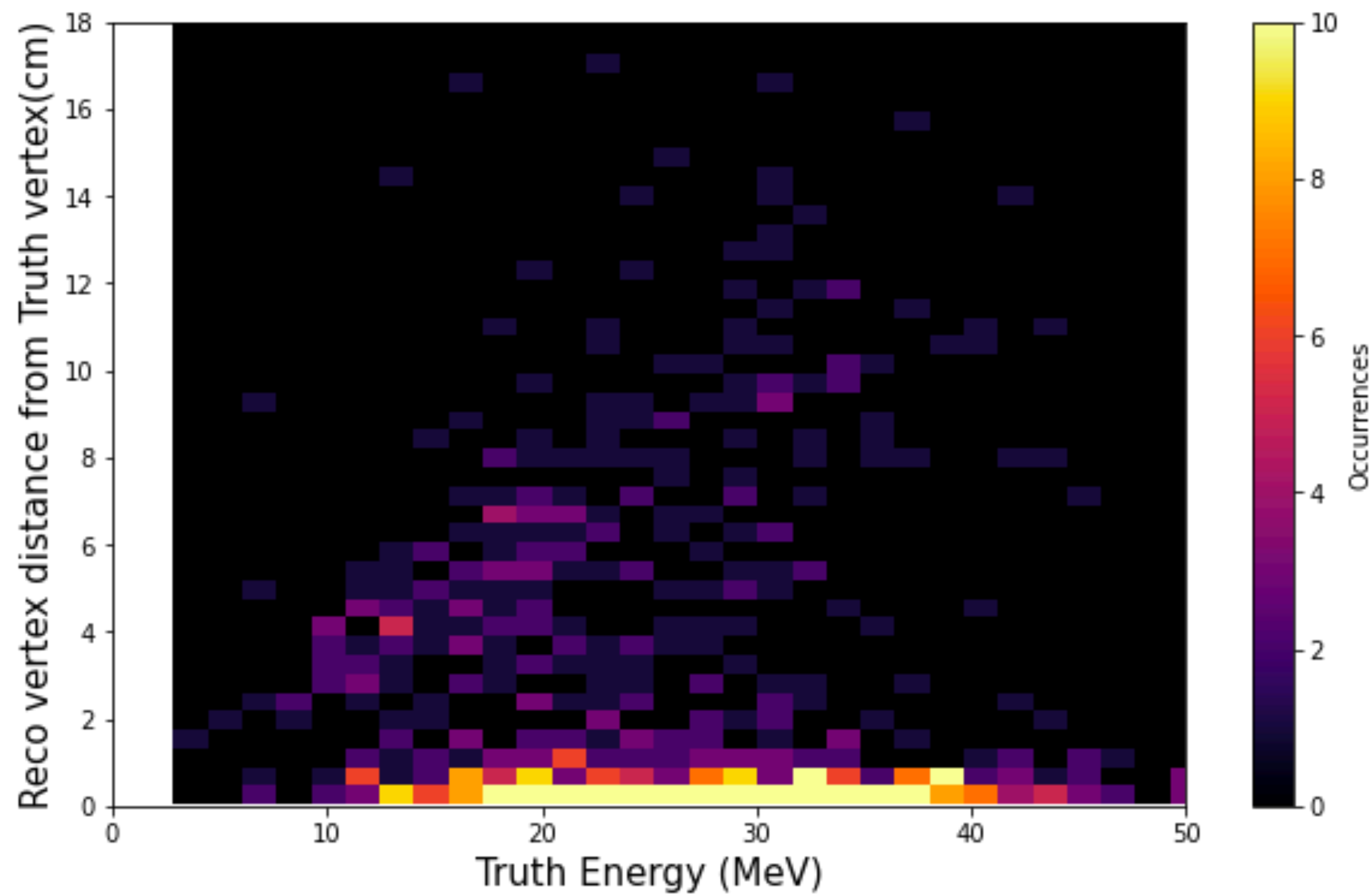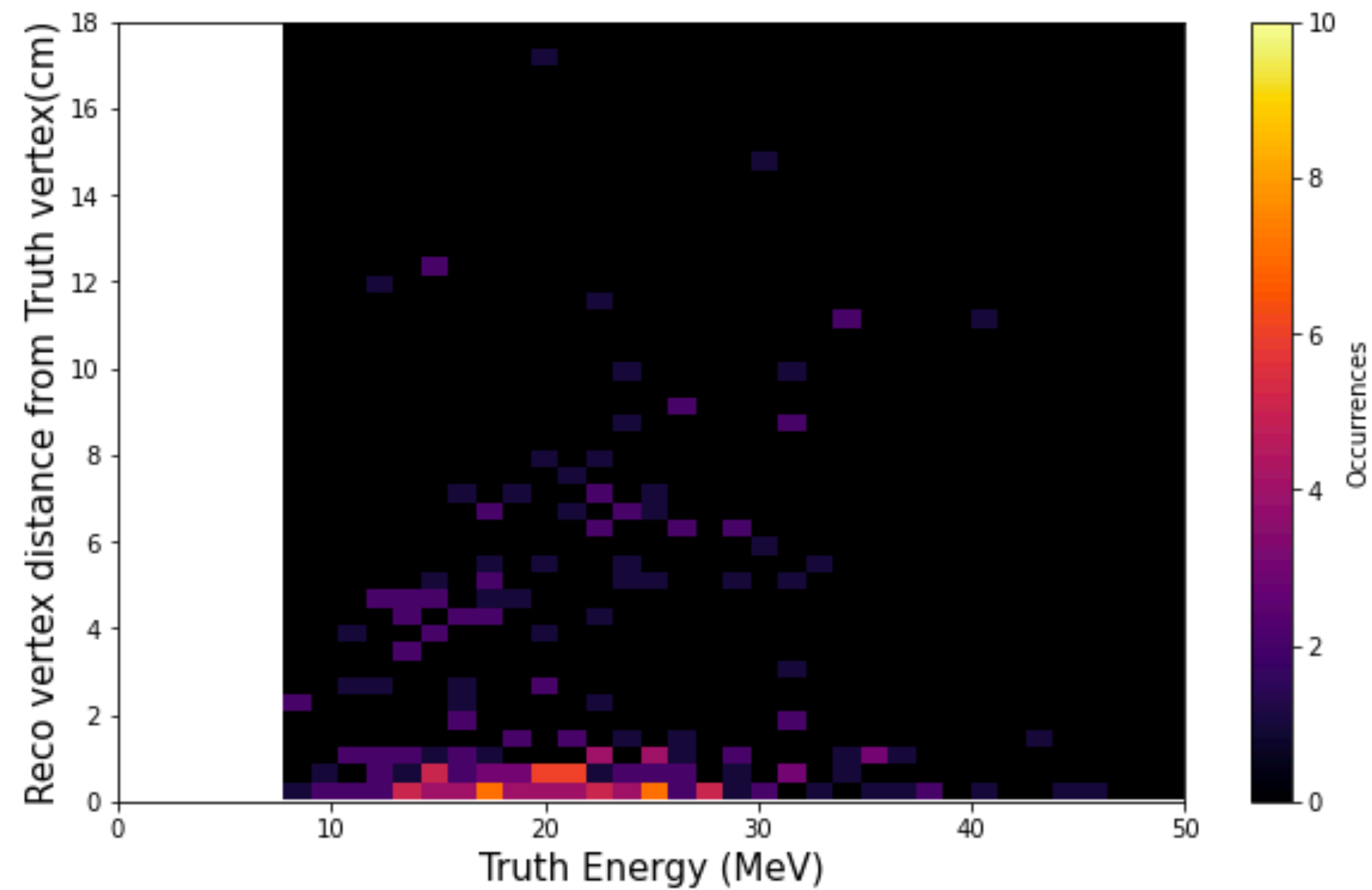
Events with Primary tracks only

CC Interaction

ES Interaction

Distance between truth vertex and reco vertex

Distribution with Energy dependence (Zoomed in)
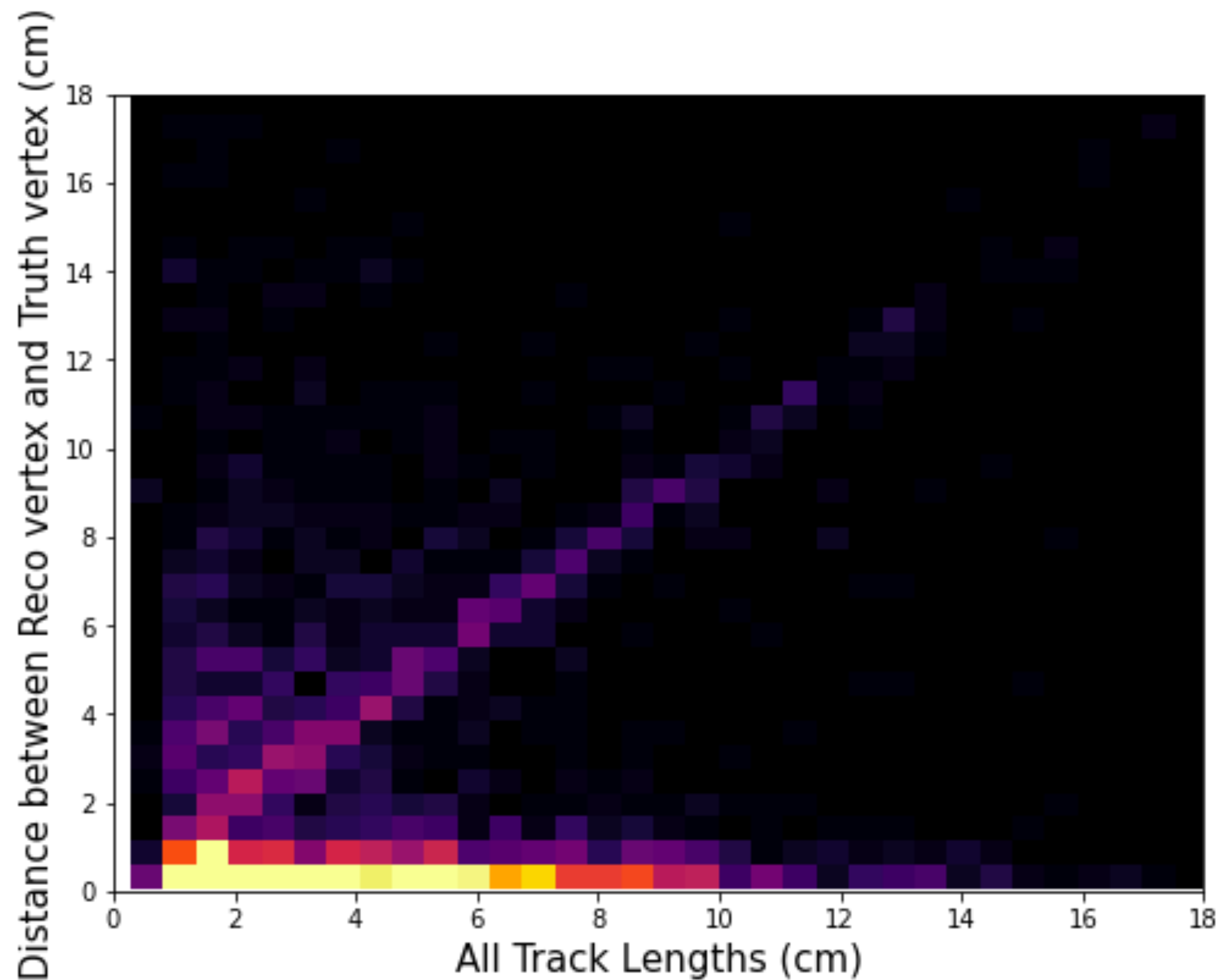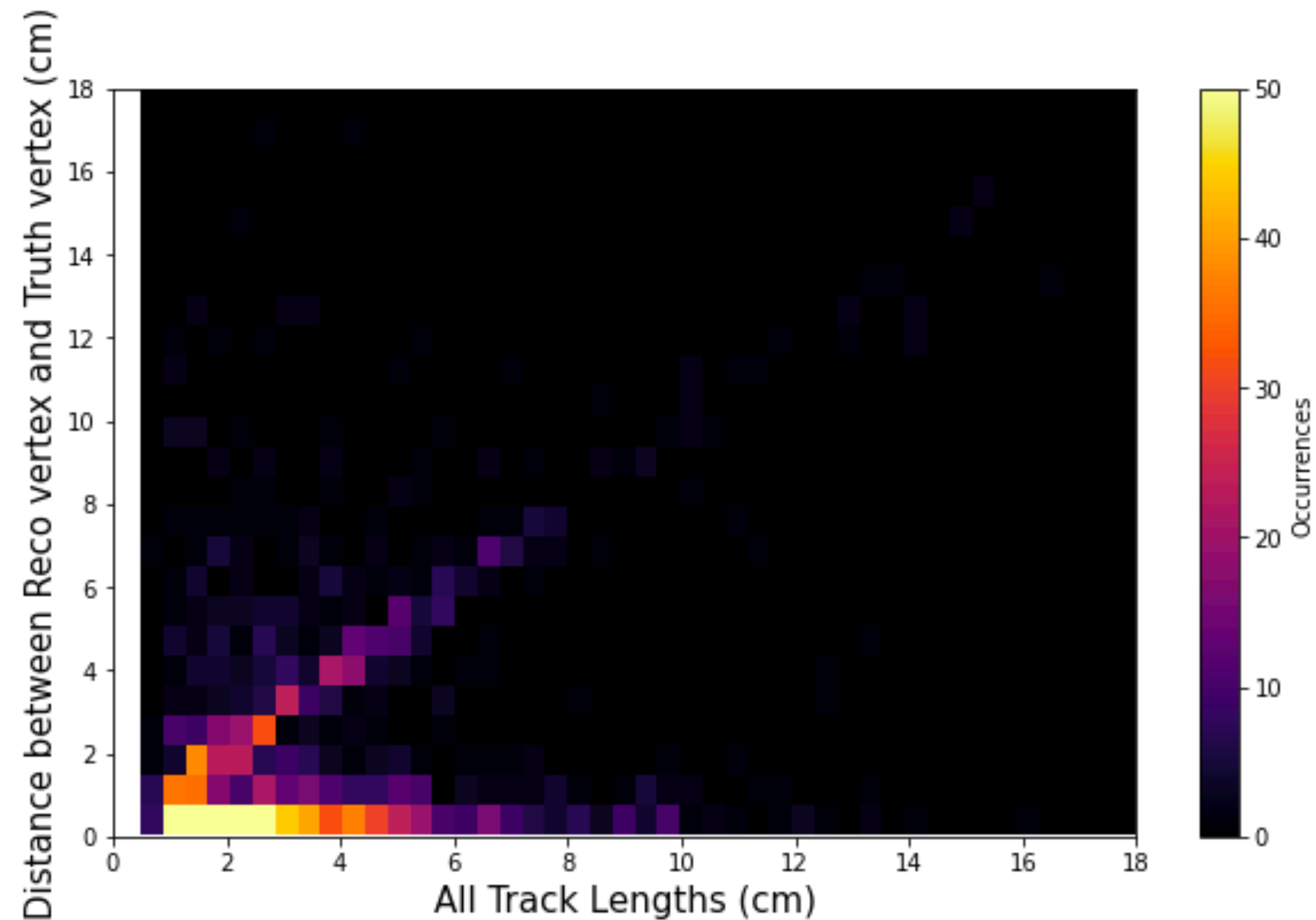
Events with Multiple tracks only

CC Interaction

ES Interaction

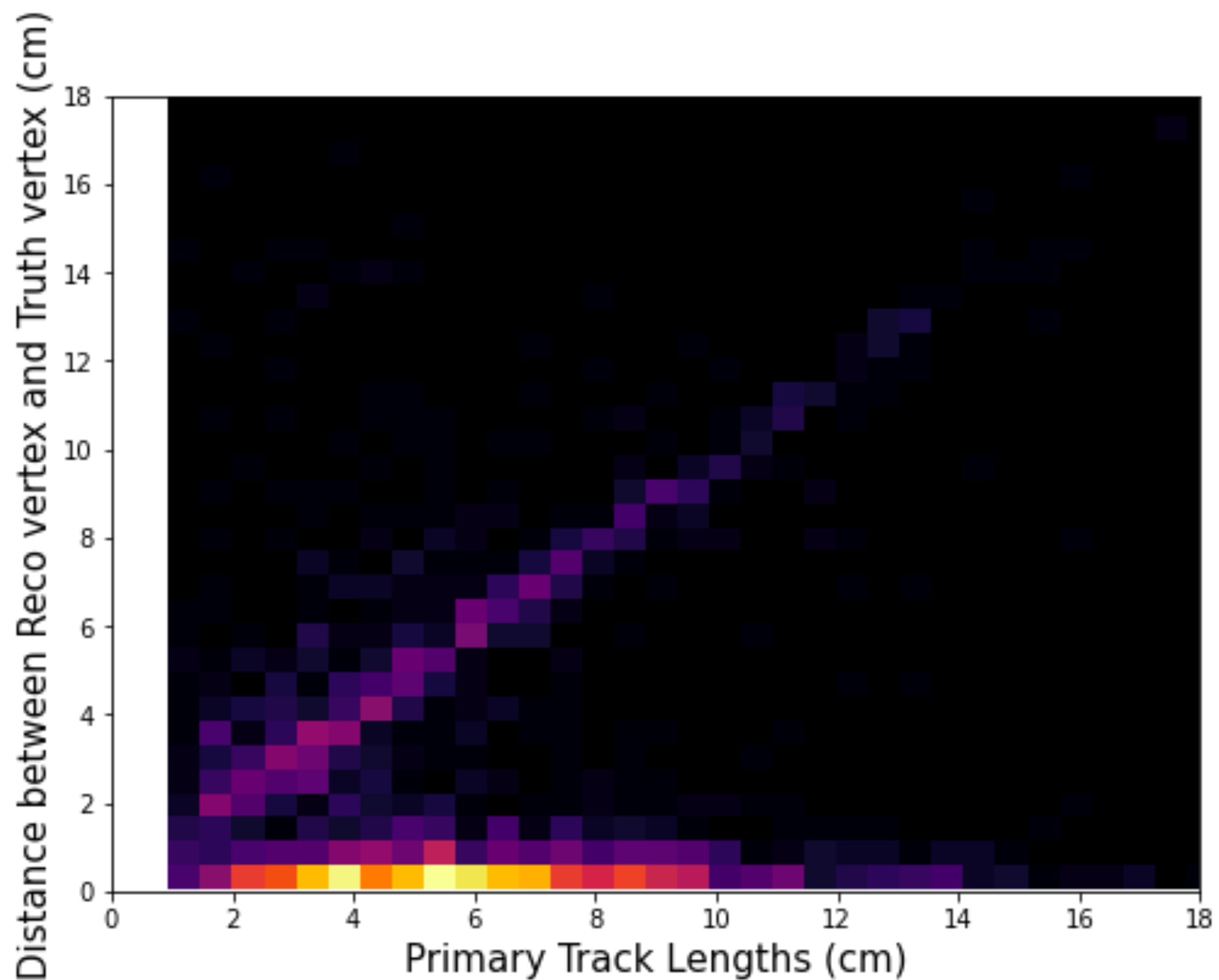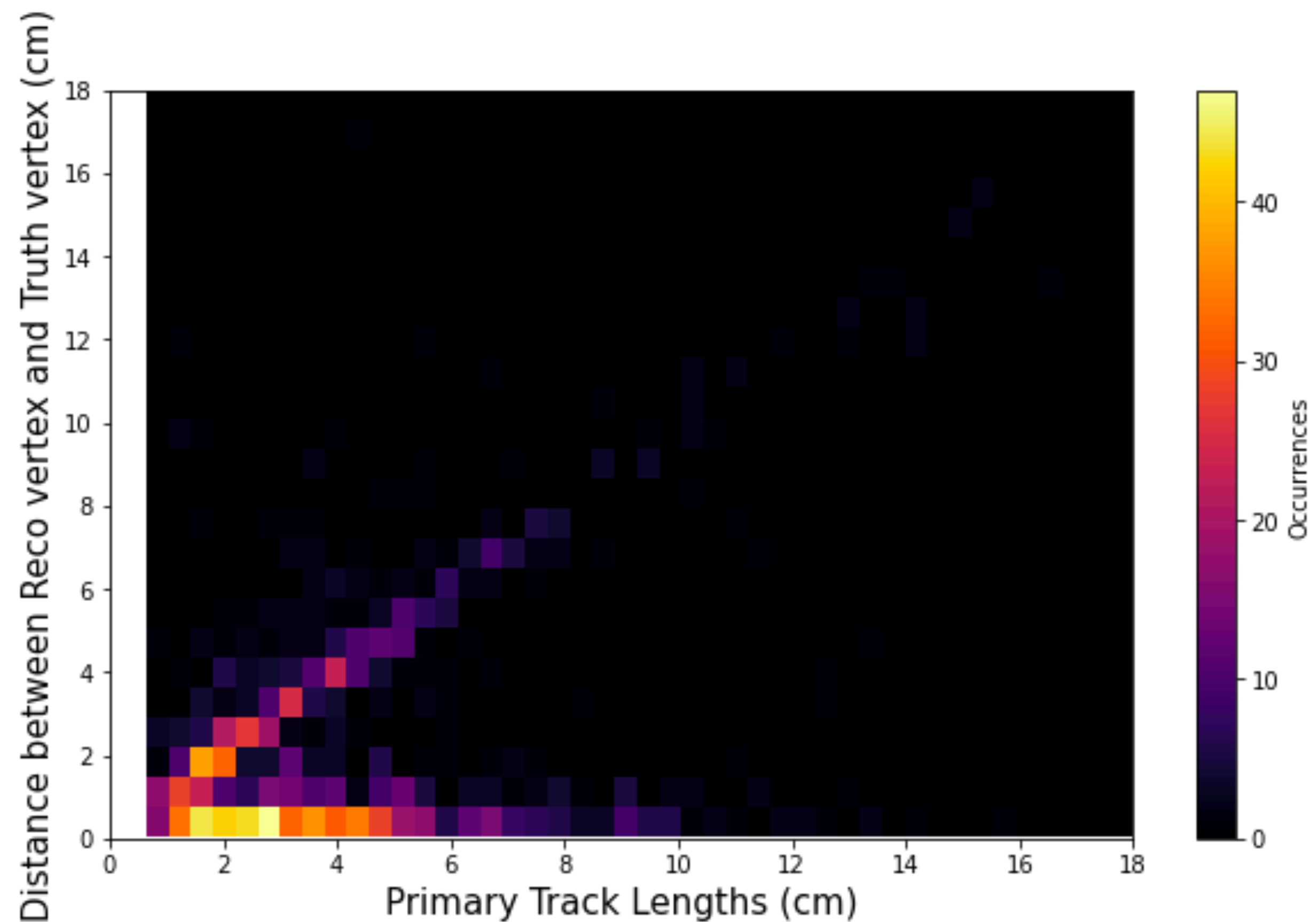# Distance between Truth and Reco vertex Vs Reconstructed Track length (All Tracks)

CC Interaction

ES Interaction

Distance between Truth and Reco vertex Vs
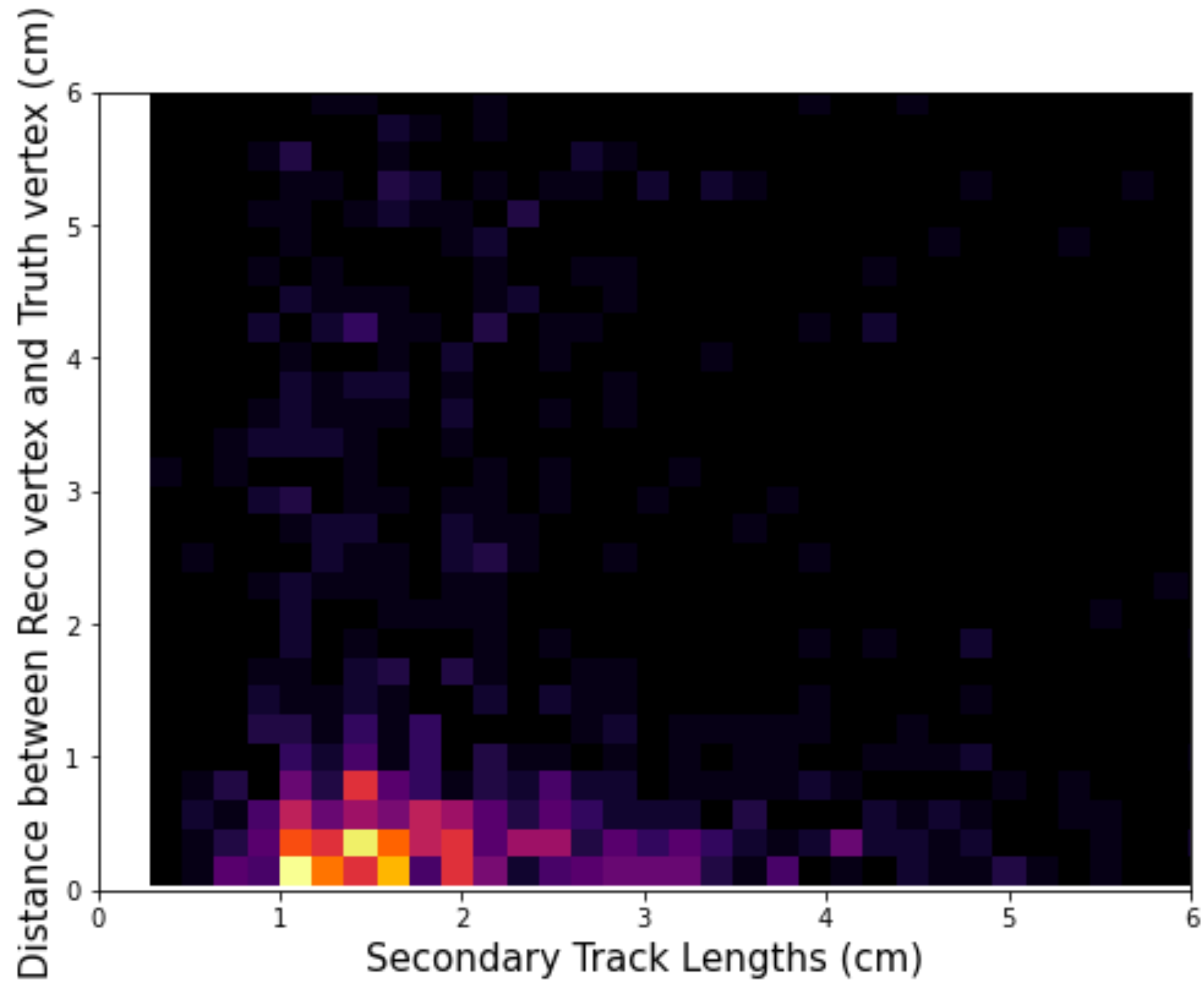
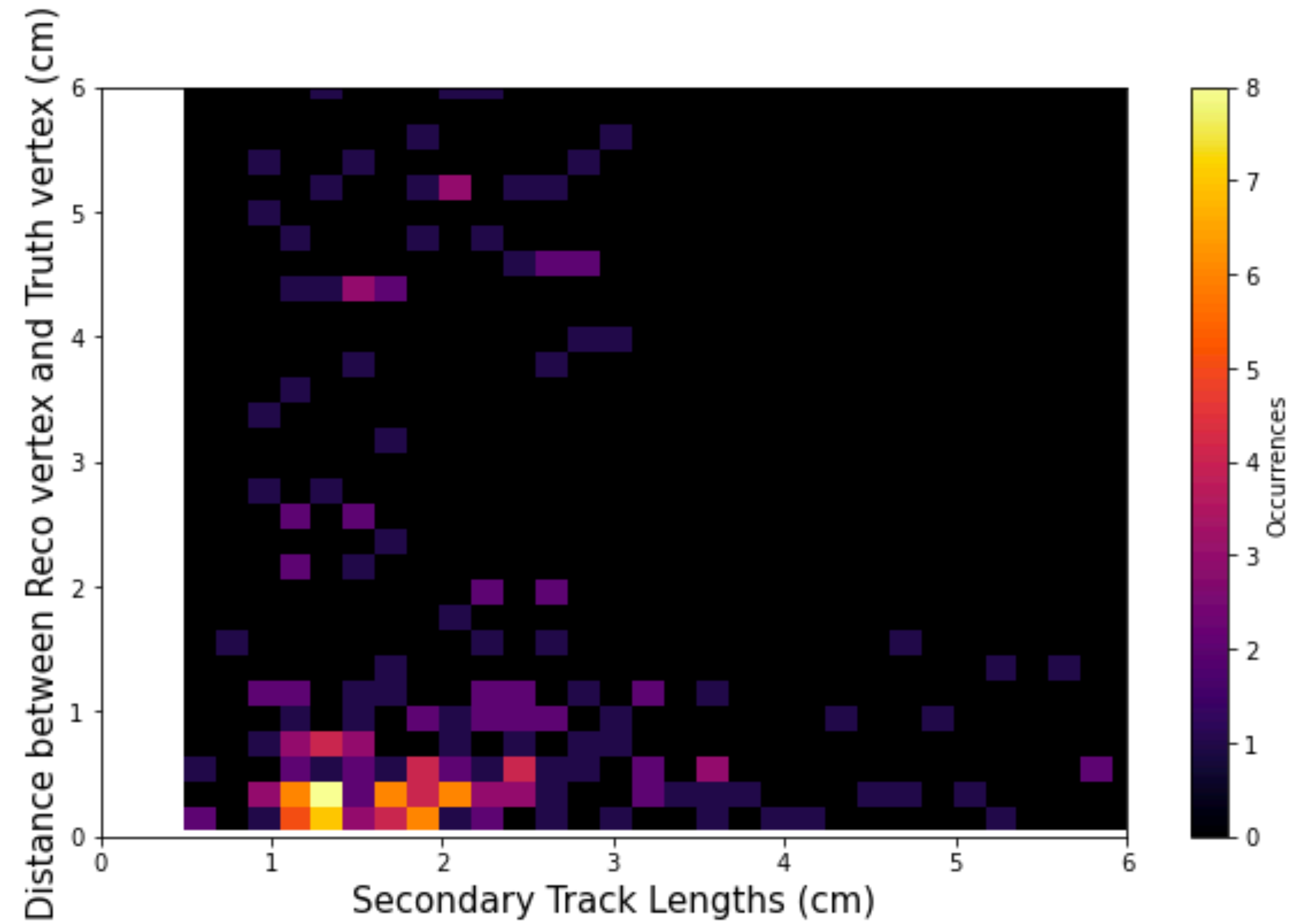# Reconstructed Track length (Primary Tracks)

CC Interaction

ES Interaction

Distance between Truth and Reco vertex Vs Reconstructed Track length (Secondary Tracks)
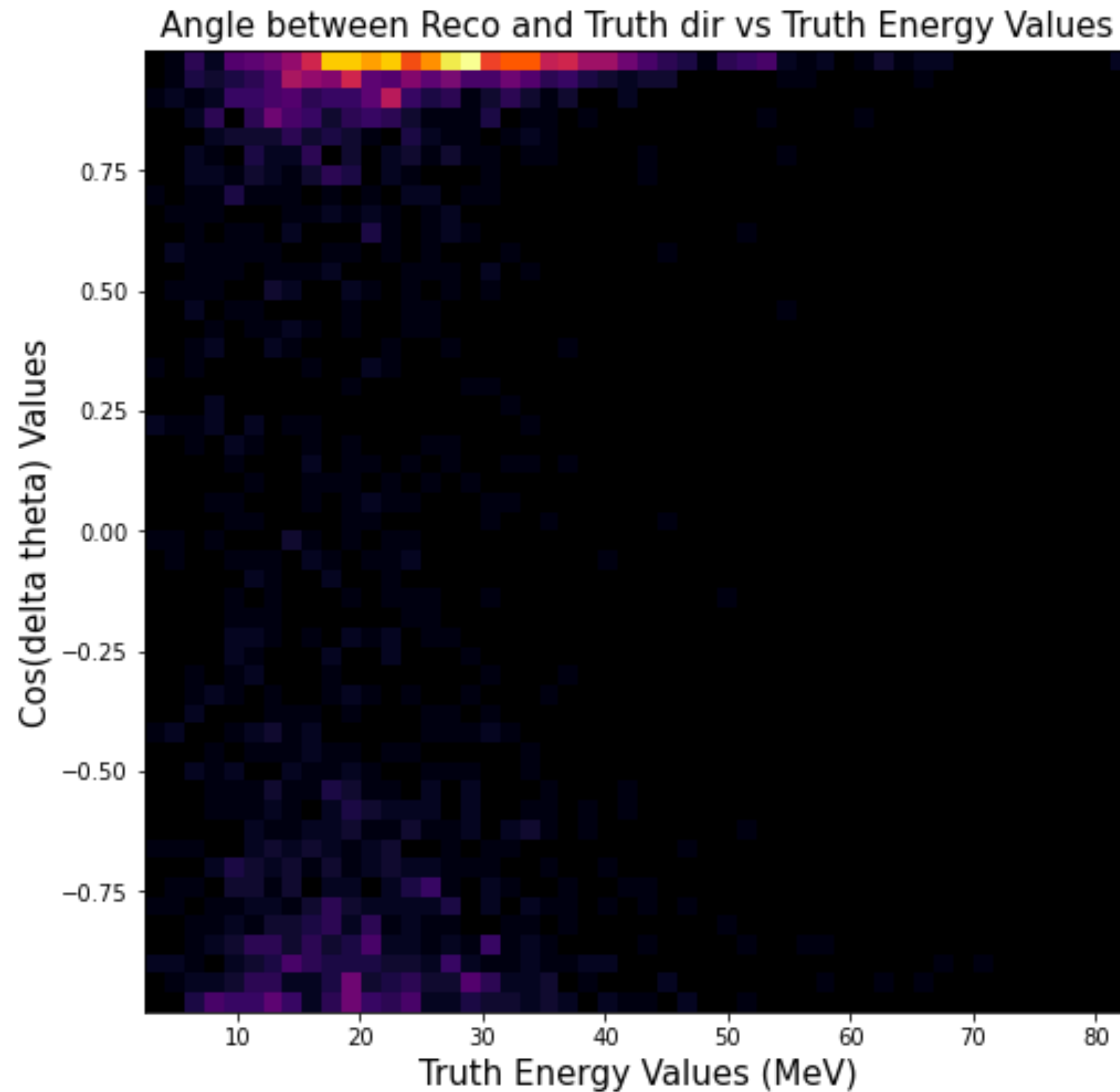
CC Interaction

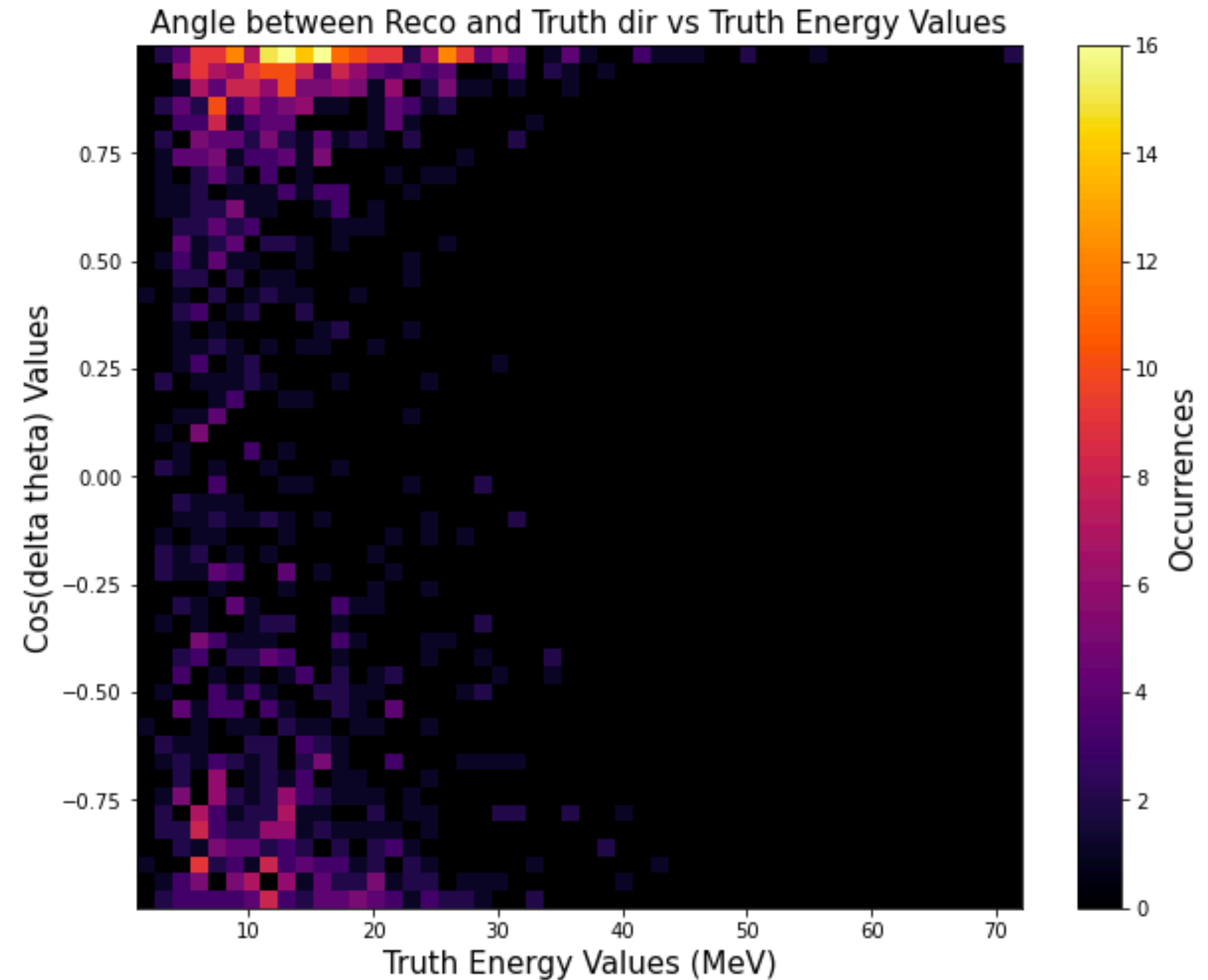ES Interaction

Cosine of the Angle between truth dir vector and reco dir vector

Distribution with Energy dependence

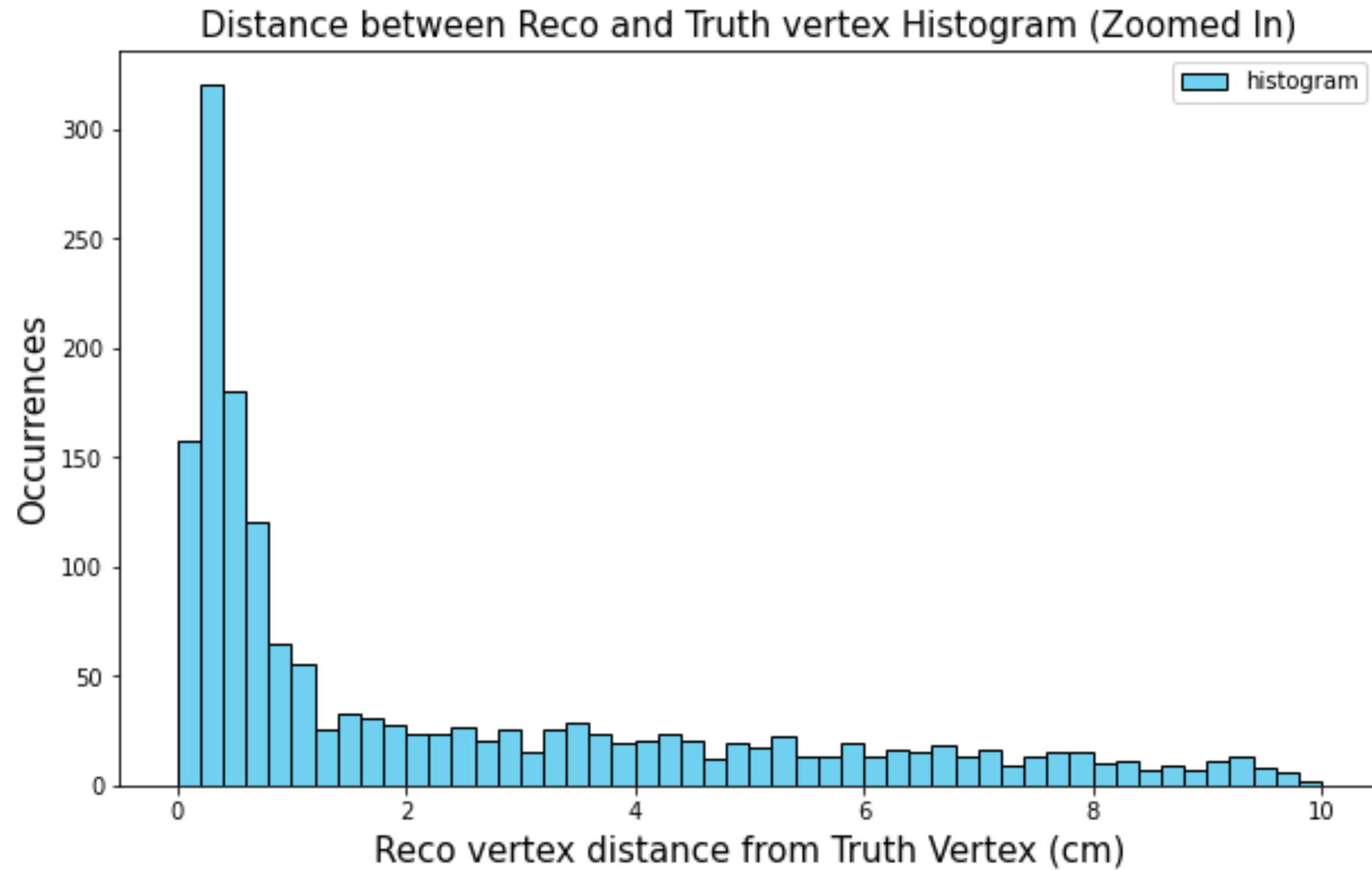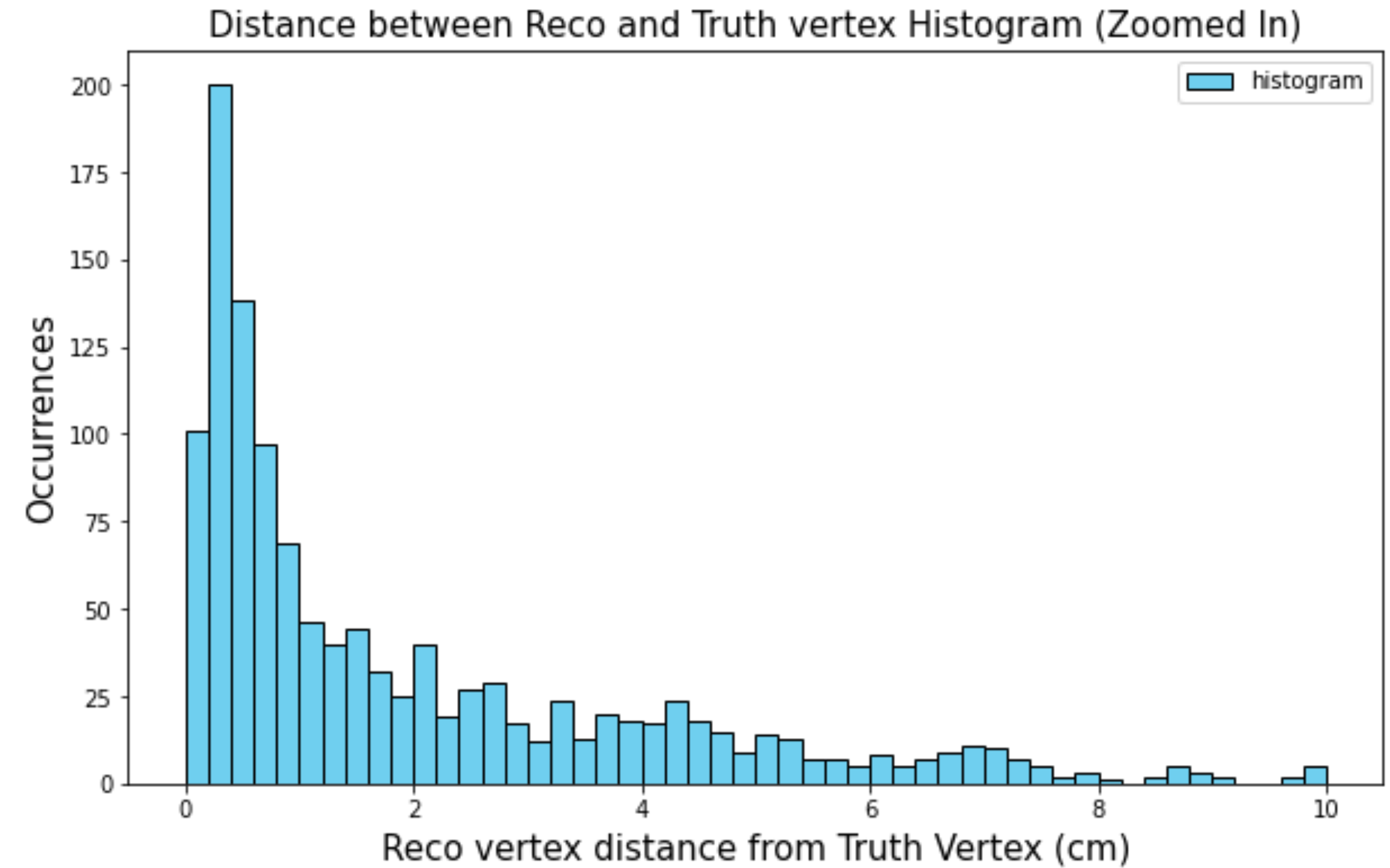CC Interaction   ES Interaction

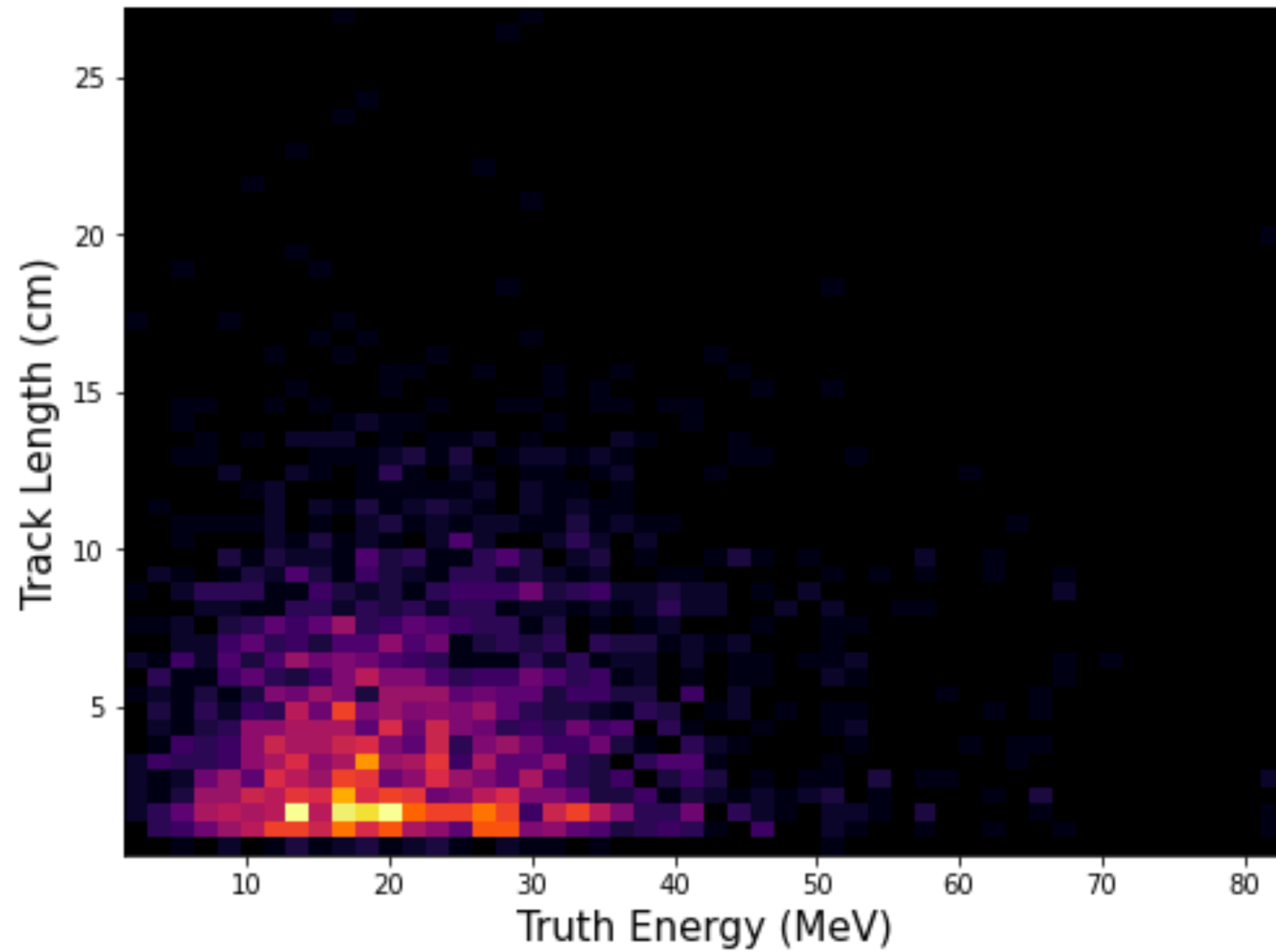# Distance between truth vertex and reco vertex

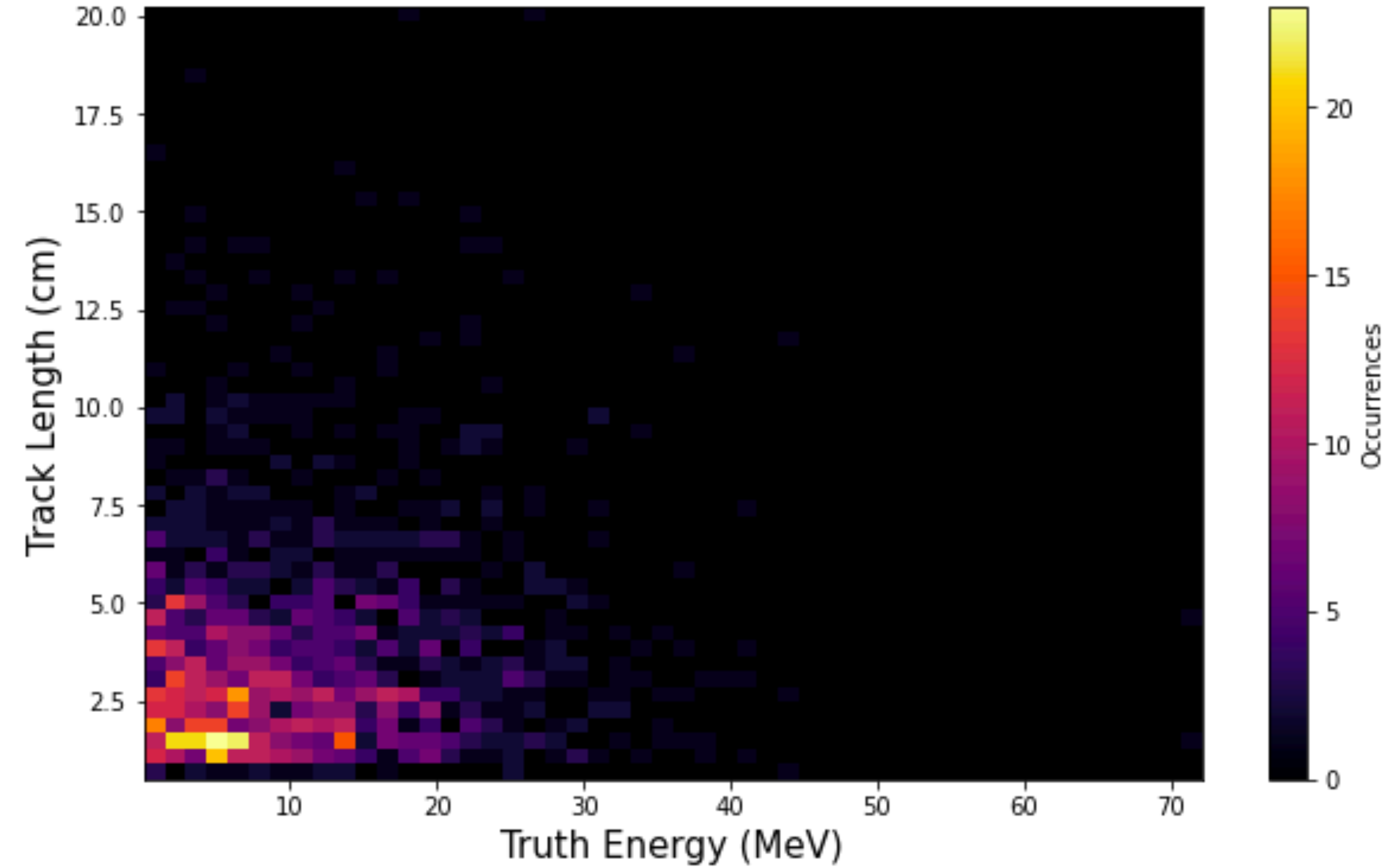## Distribution (Zoomed in)

CC Interaction

ES Interaction

Reconstructed Track length (All tracks)

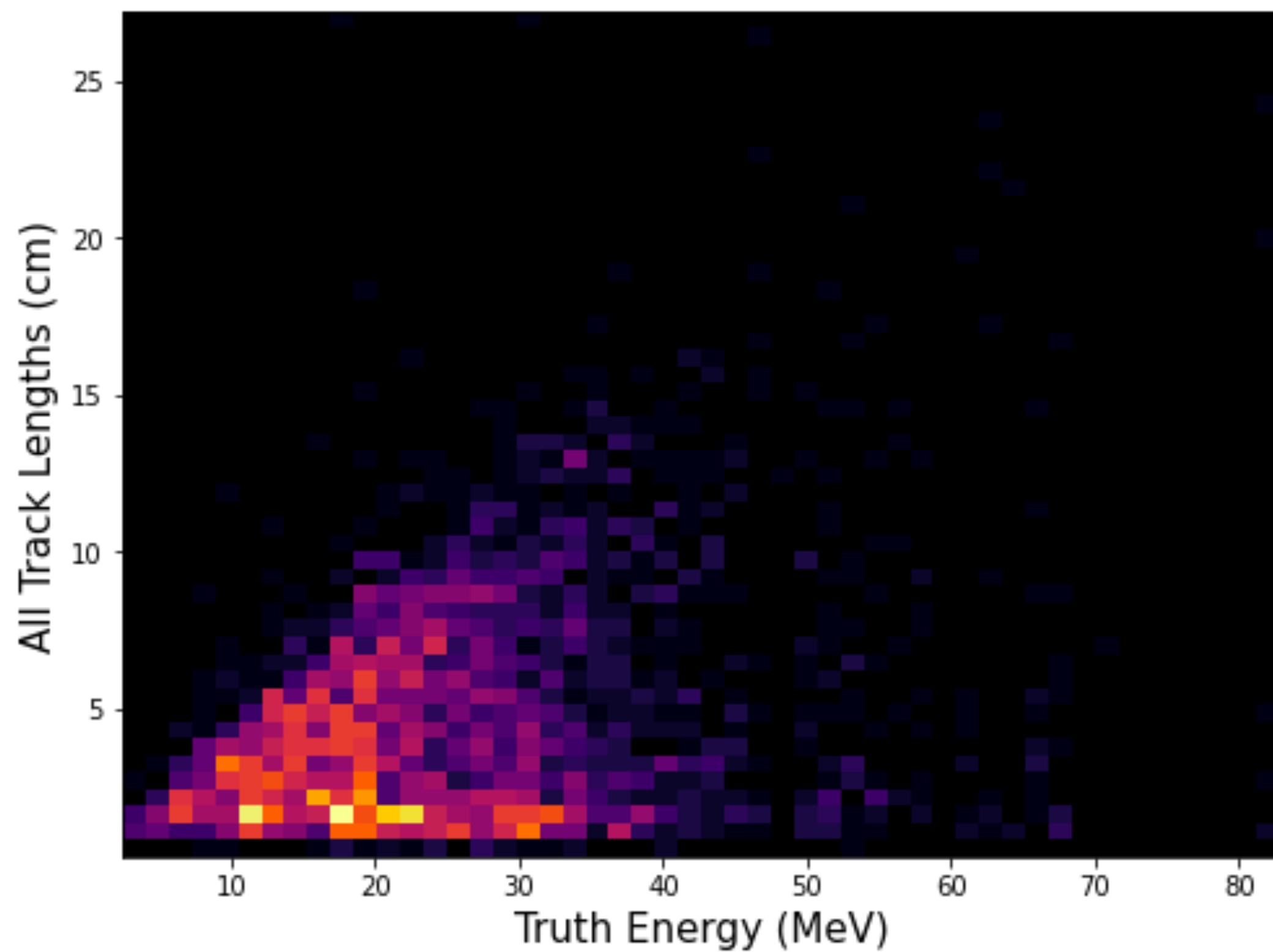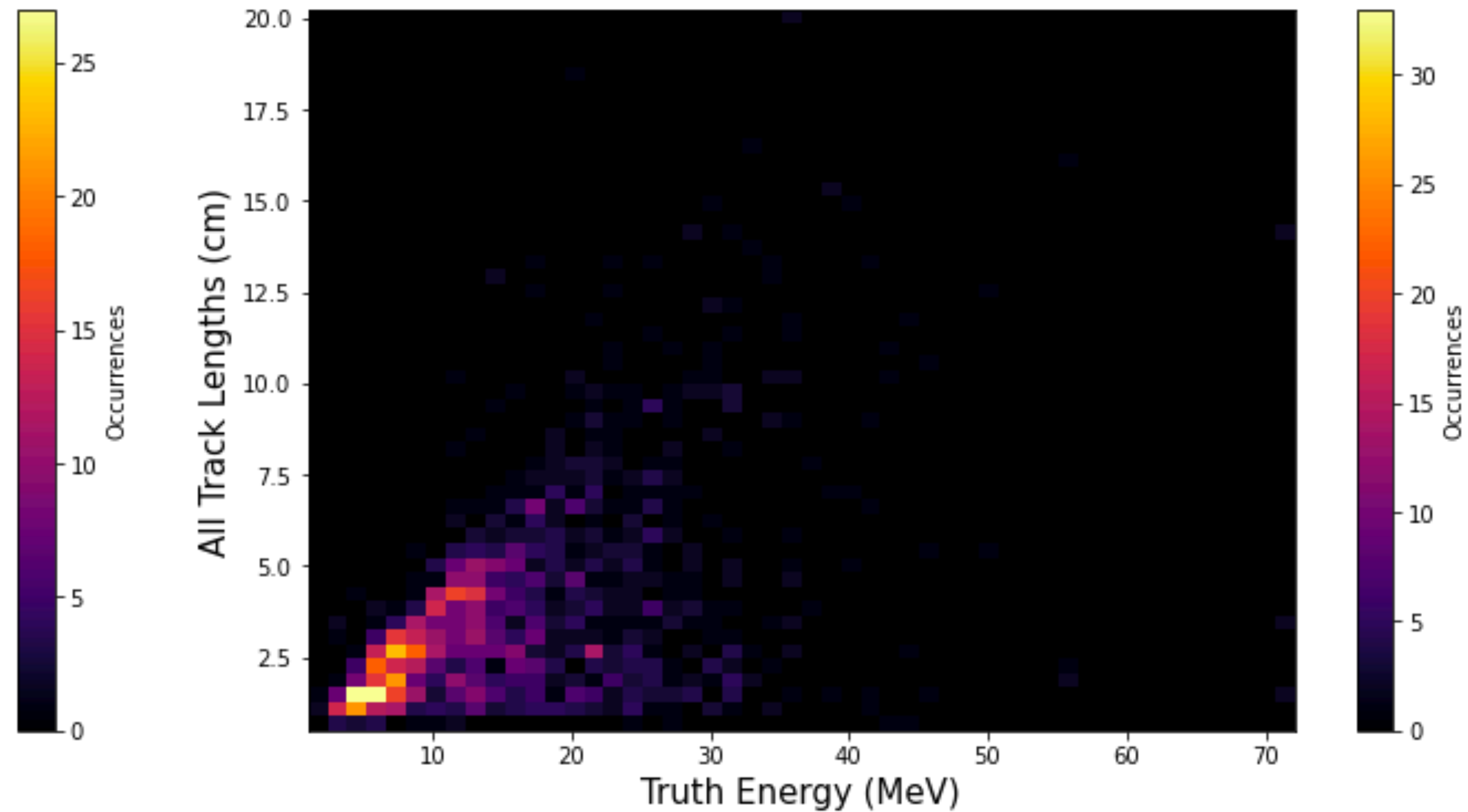## Distribution with Energy dependence

CC Interaction

ES Interaction

Wrong

(what I showed earlier)

Reconstructed Track length (All tracks)

Distribution with Energy dependence
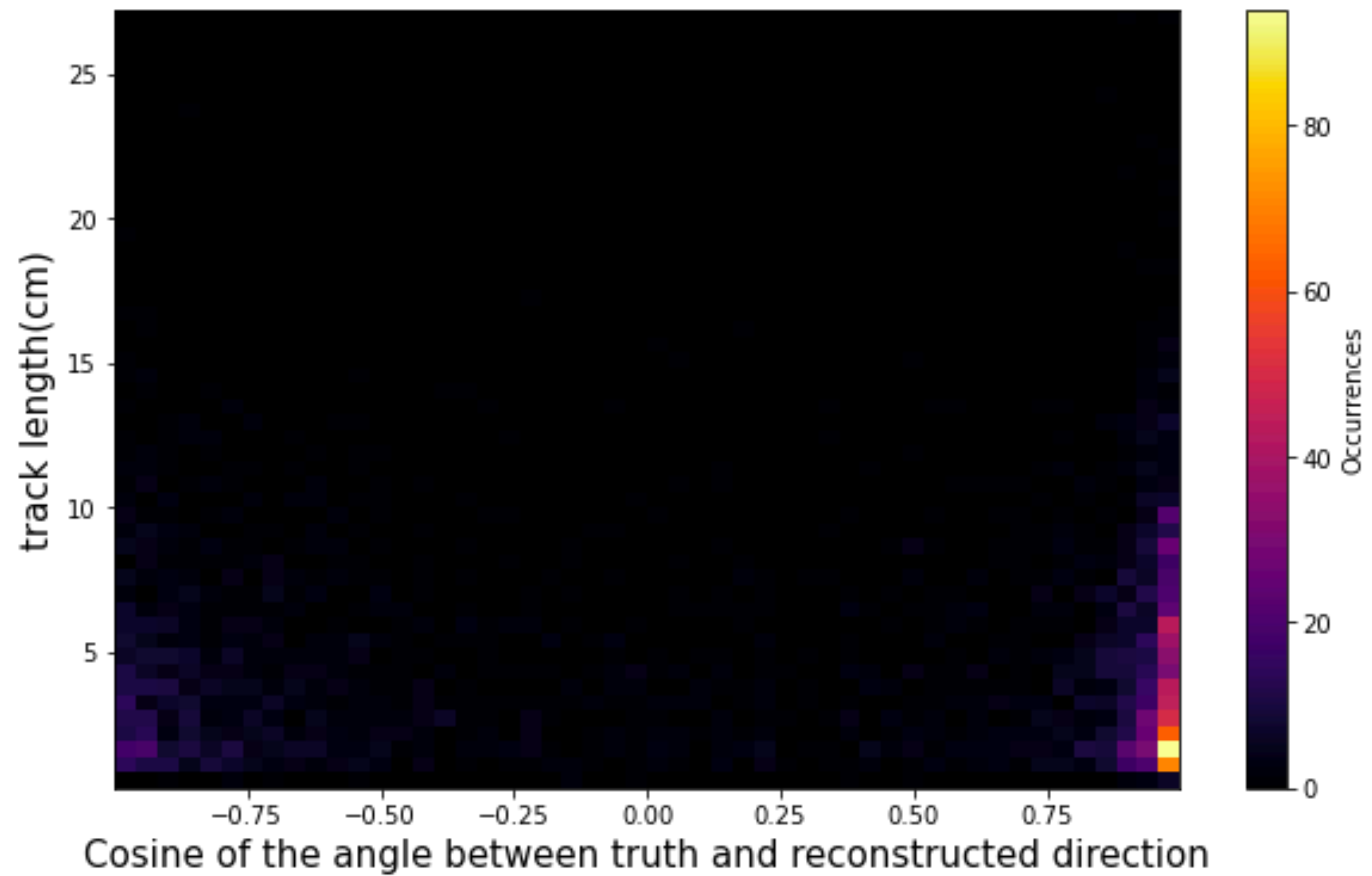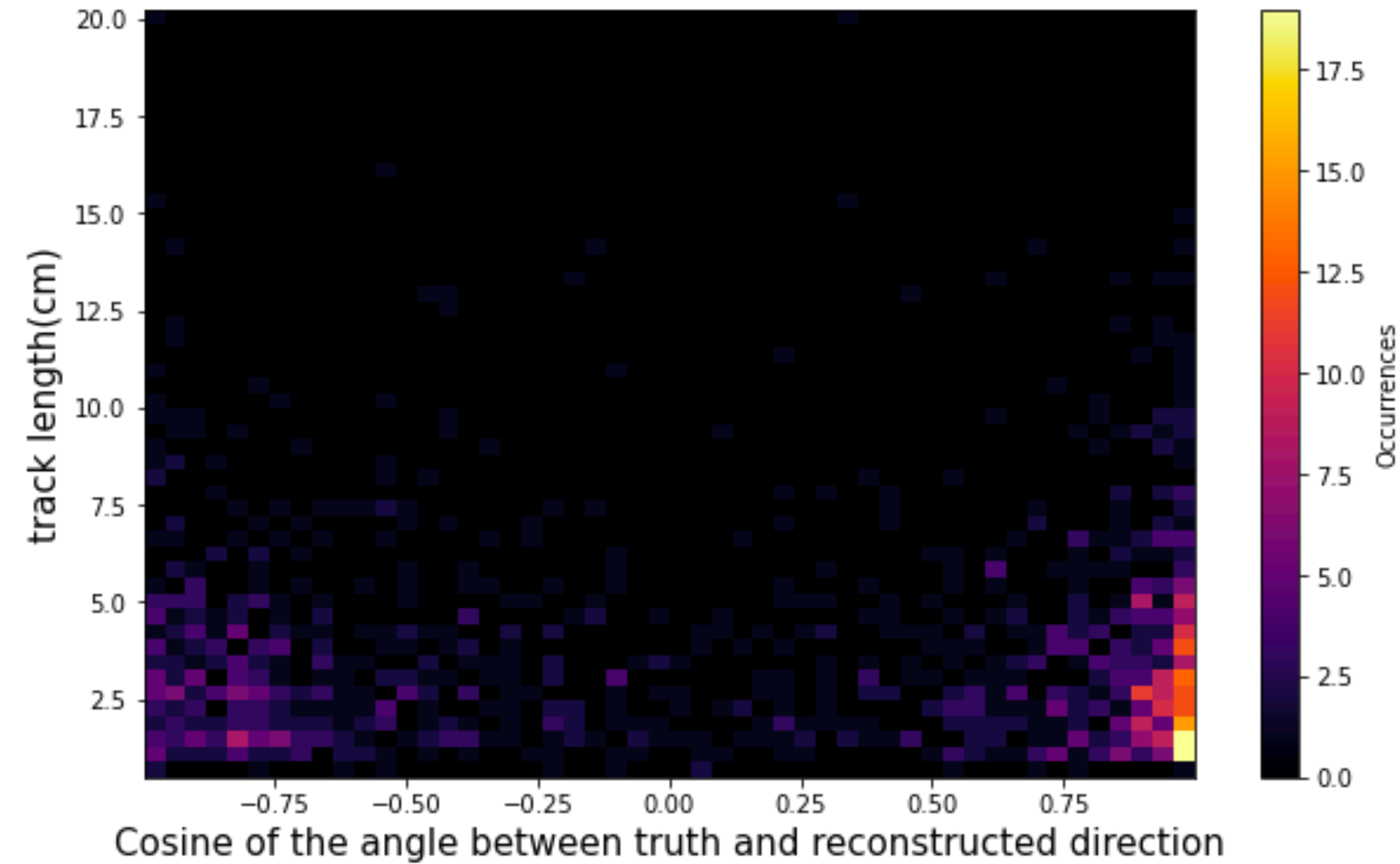

CC Interaction   Correct   ES Interaction

Reconstructed Track length

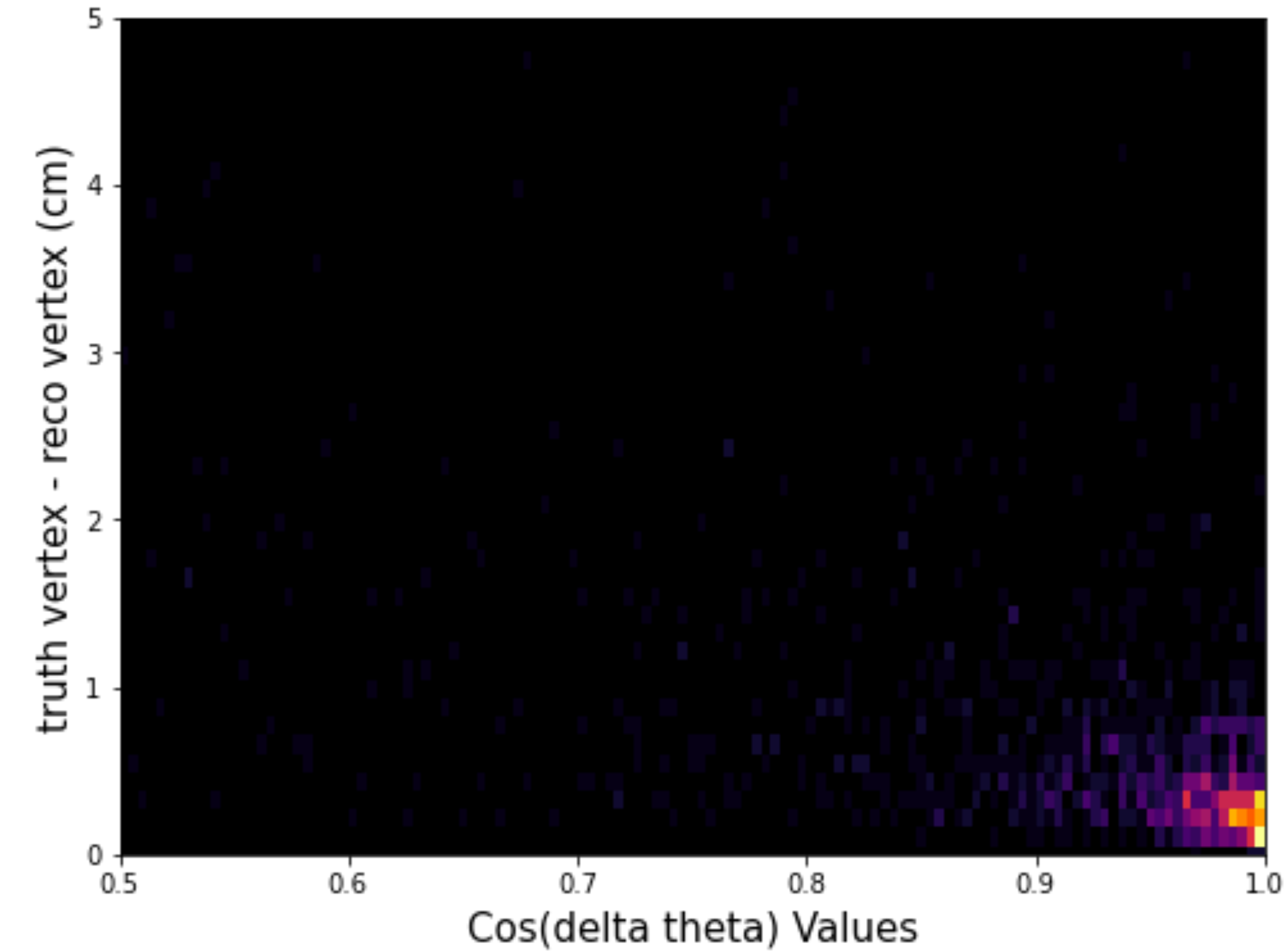## Distribution with difference between truth and reconstructed direction
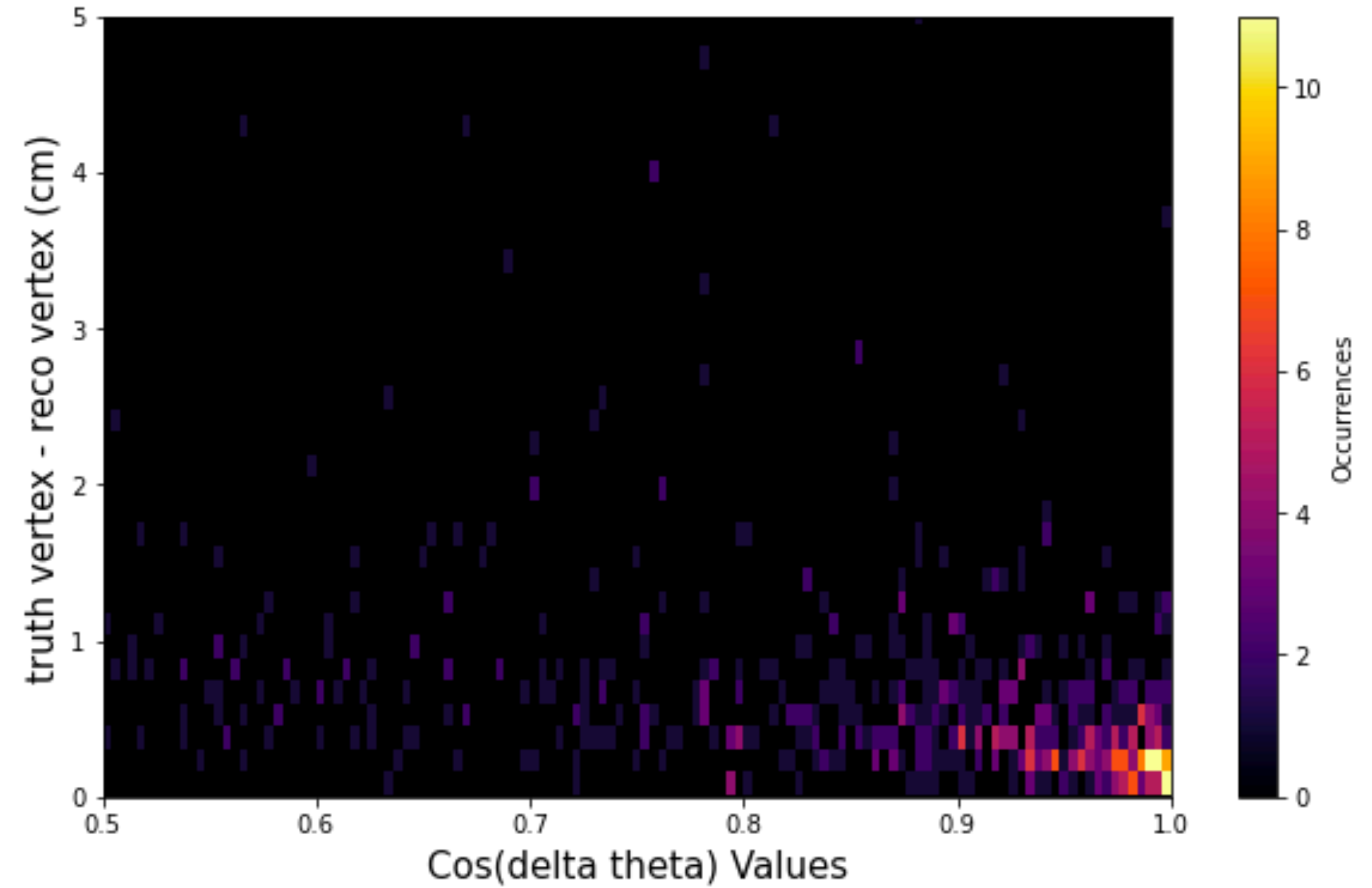

CC Interaction

ES Interaction

Distance between truth and reco vertex vs cosine of the angle between truth and reco direction
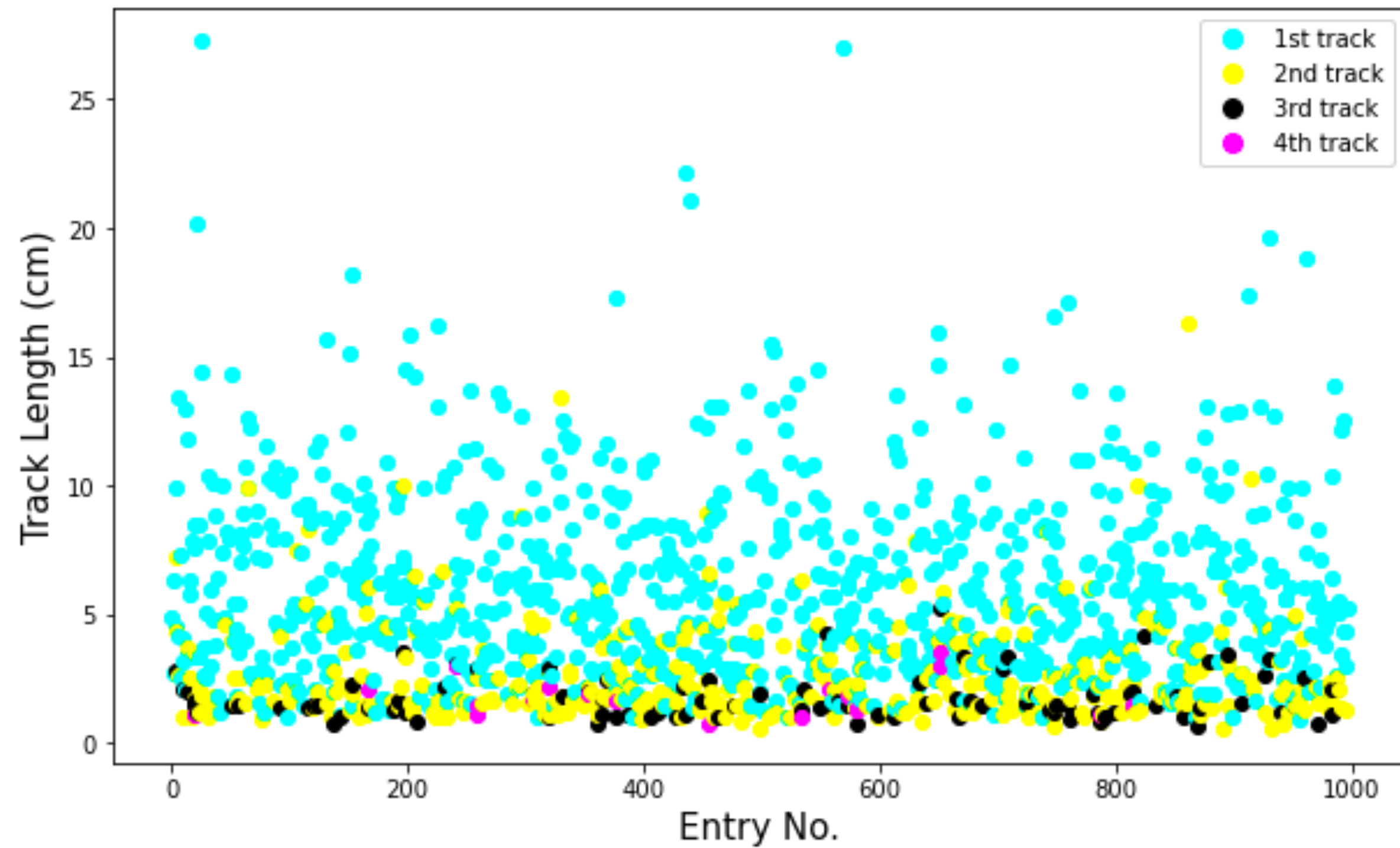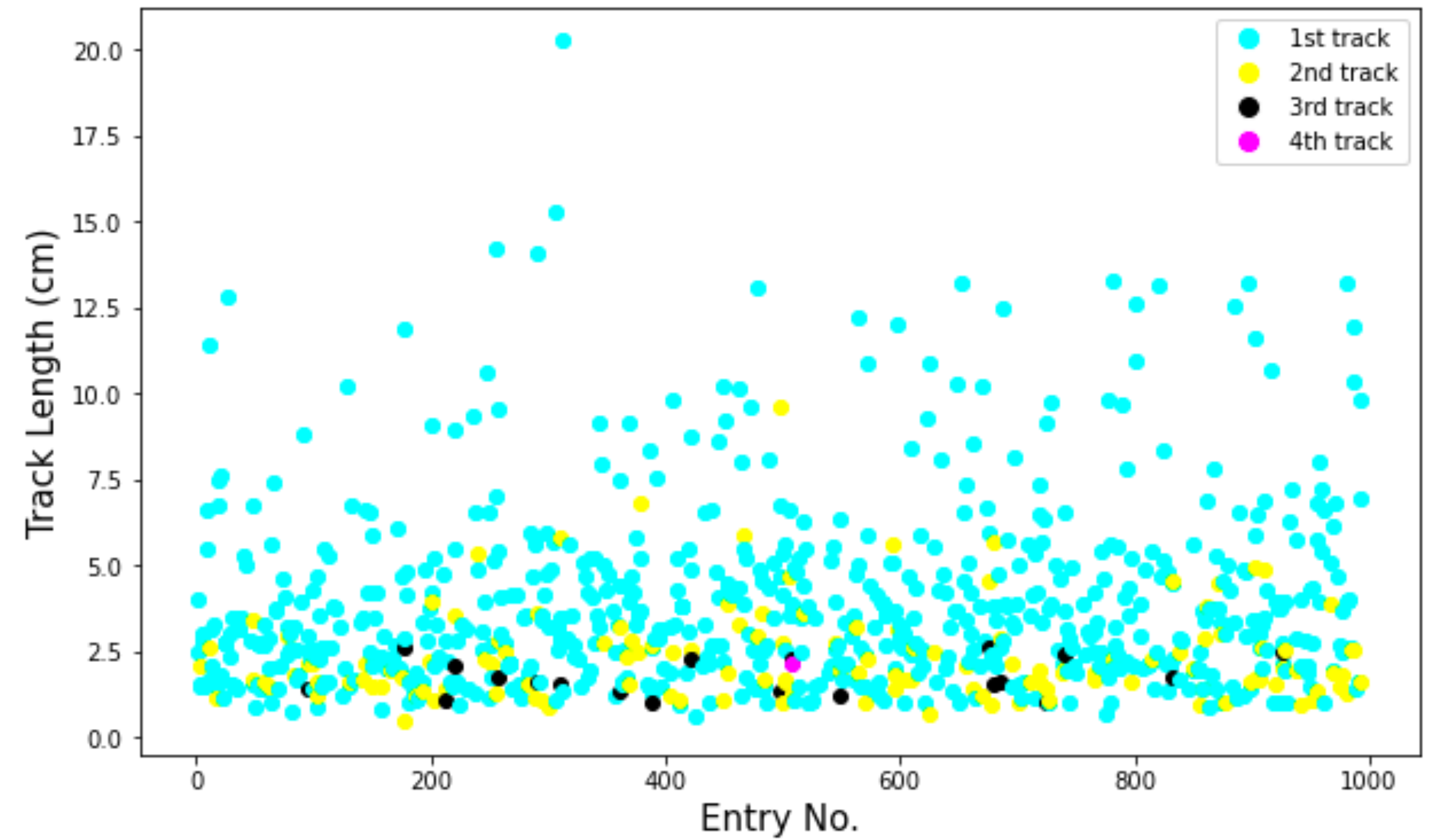
Distribution (Zoomed in)

CC Interaction

ES Interaction

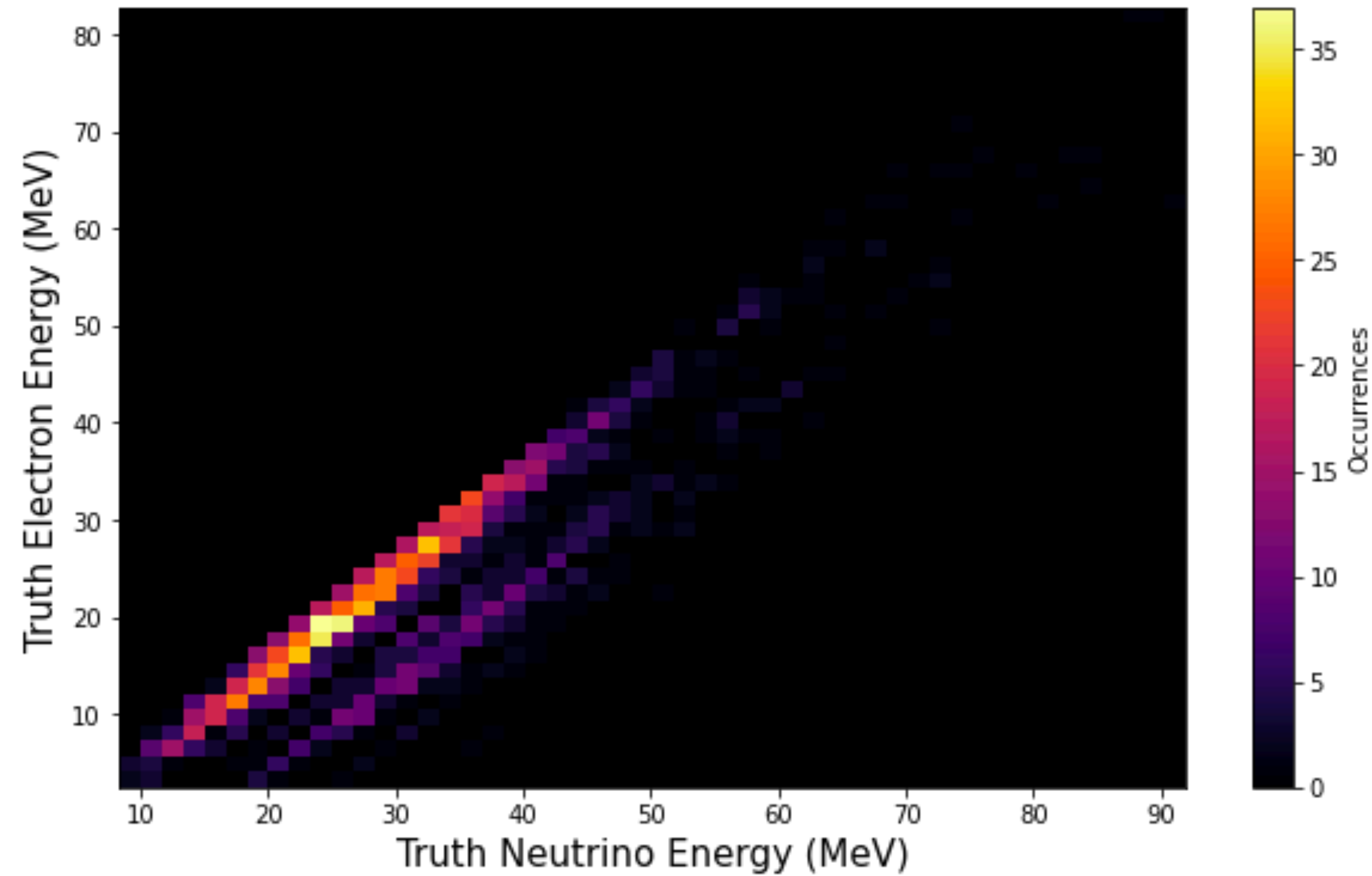# Reconstructed Track length
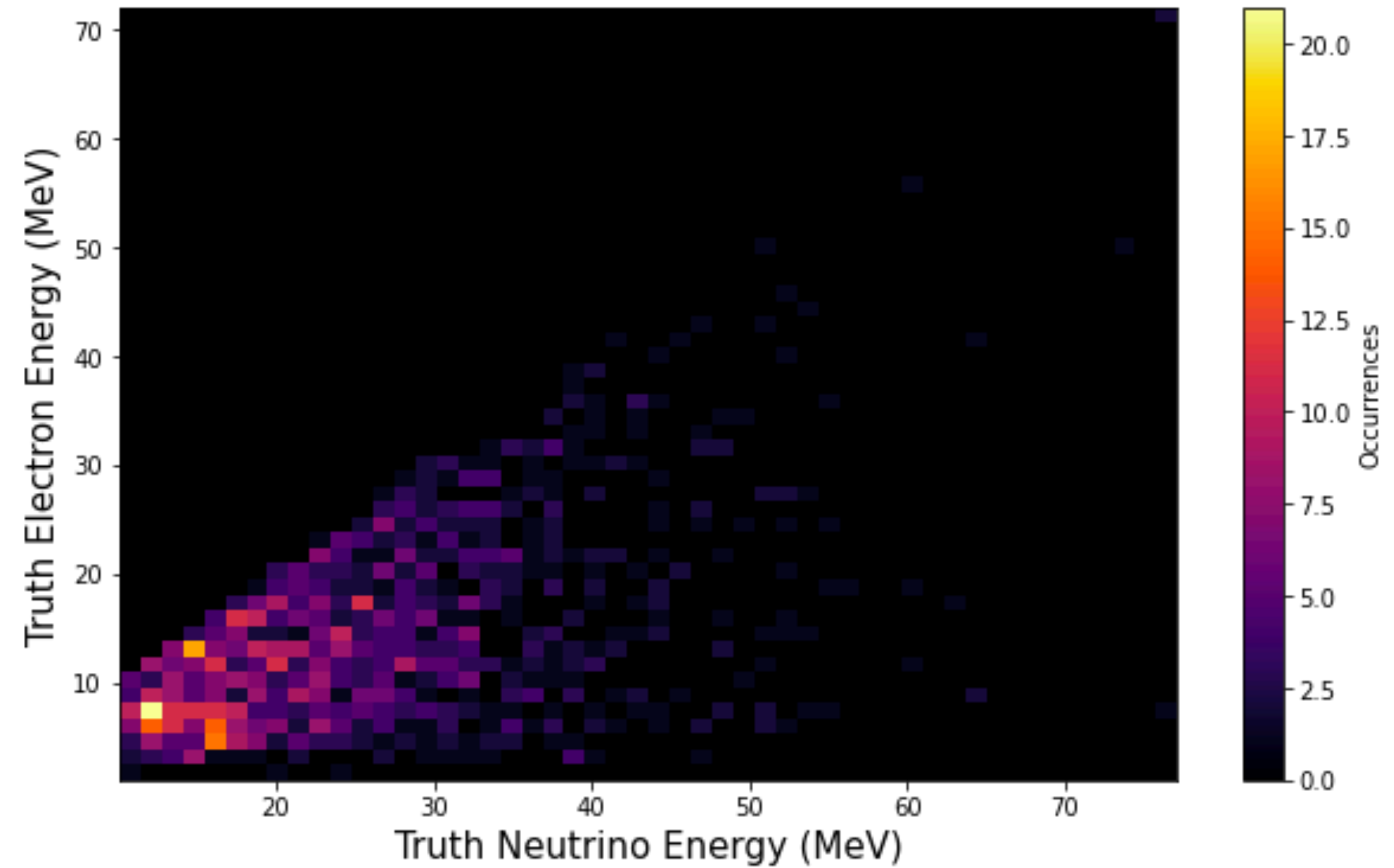
Distribution

CC Interaction

ES Interaction

Truth Neutrino Energy Vs Truth Electron Energy

CC Interaction

ES Interaction