Update on diffusion studies in ProtoDUNE-SP

ProtoDUNE DRA meeting

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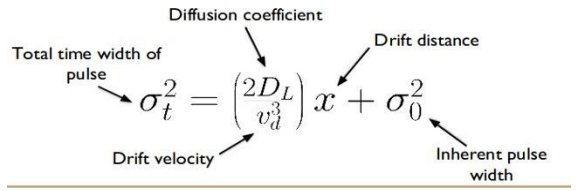
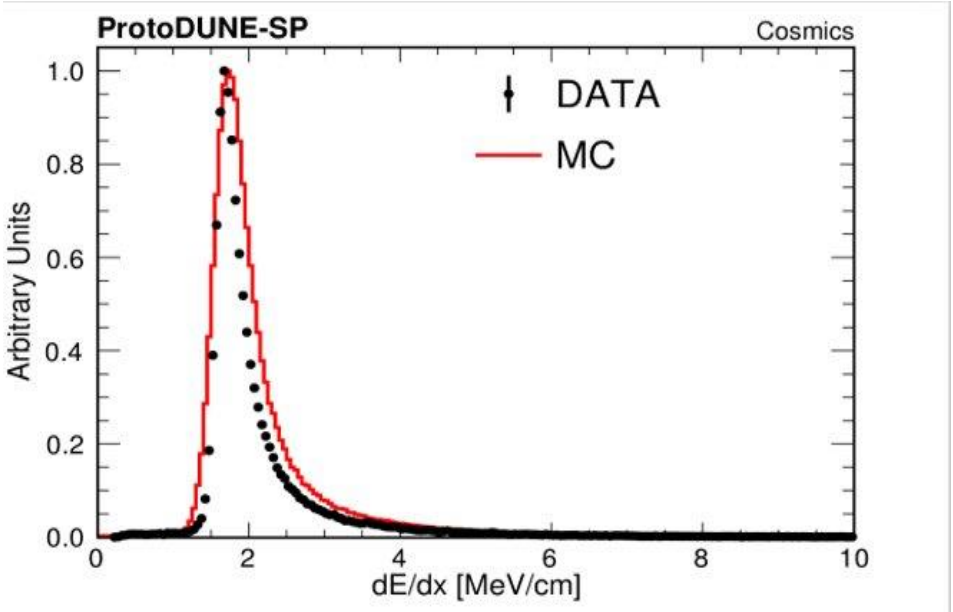
Previously:

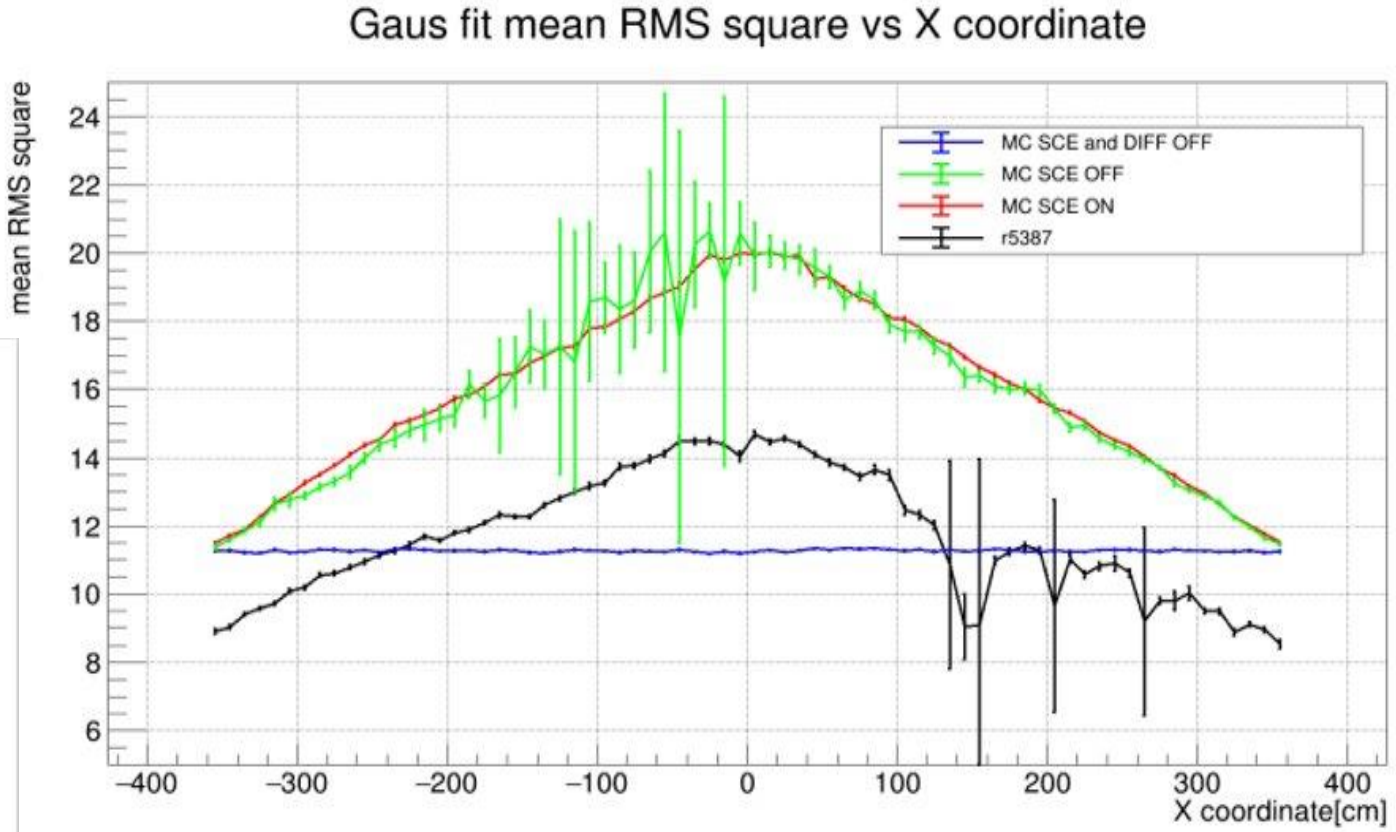
https://indico.fnal.gov/event/22125/contribution/2/material/slides/0.pdf

We tried to estimate the diffusion constants fitting sigma_t square vs drift distance(x) for different samples and data:





Width of dE/dx for data and MC doesn't agree

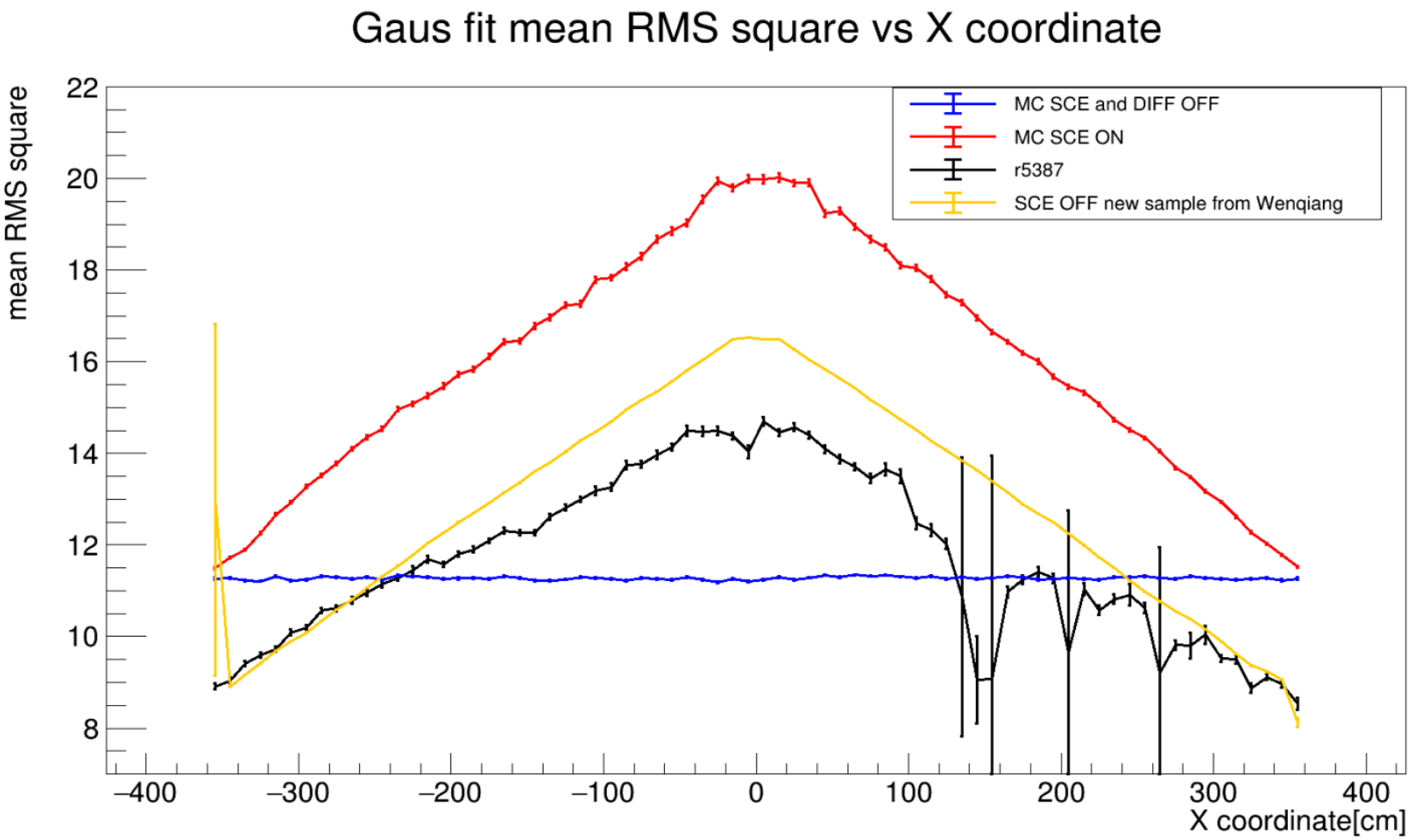


We found the inherent pulse width of data and Monte-Carlo doesn't agree.

Updates:

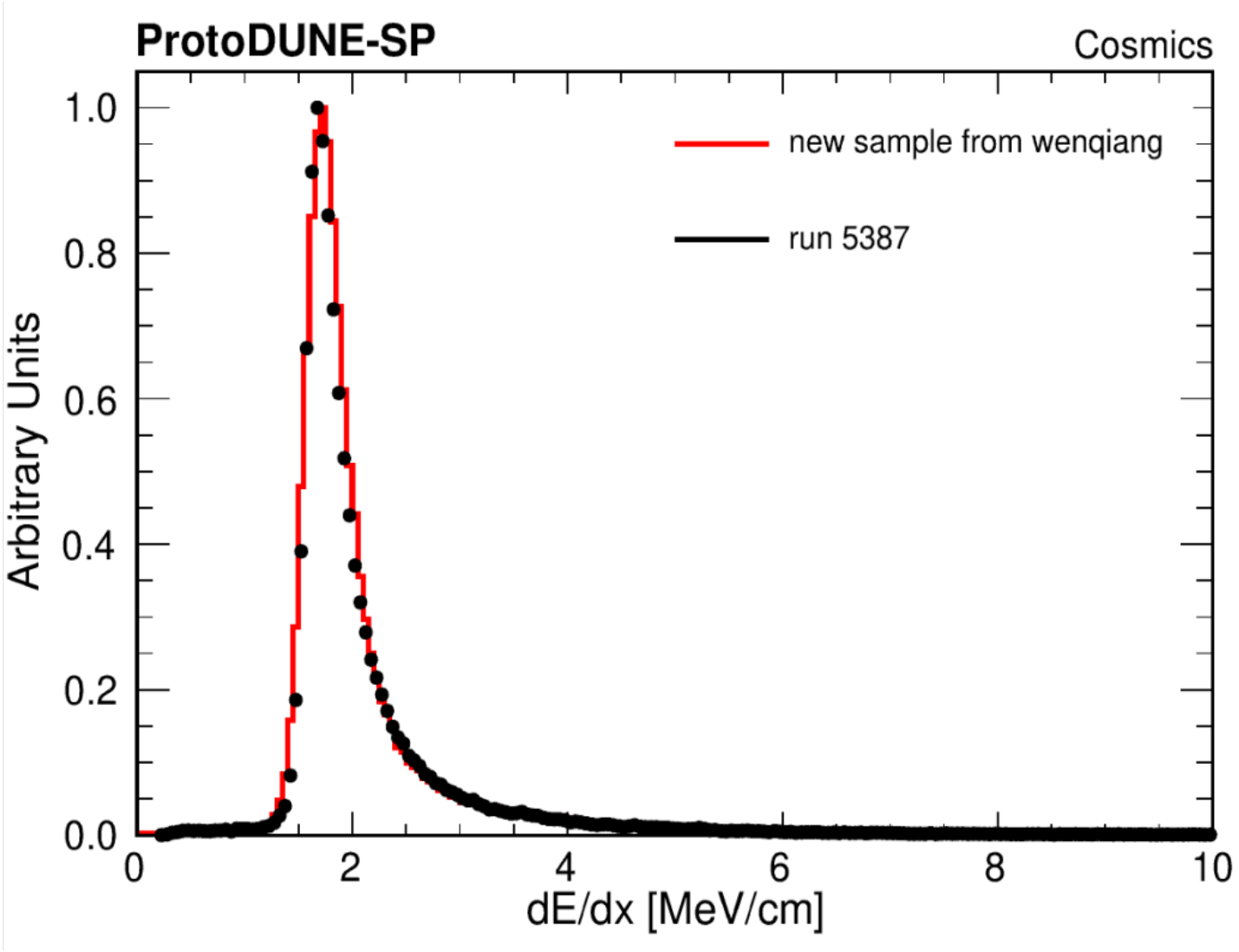
Wenqiang generated some new Monte-Carlo sample.

I made a similar sigma_t square vs X coordinate plot for the new sample,



We can see the inherent term in the plot for new sample agrees better with data.

I made dE/dx plot for the new MC sample Wenqiang generated:



The new MC sample dE/dx and data dE/dx width are in much better agreement compared to earlier MC samples.

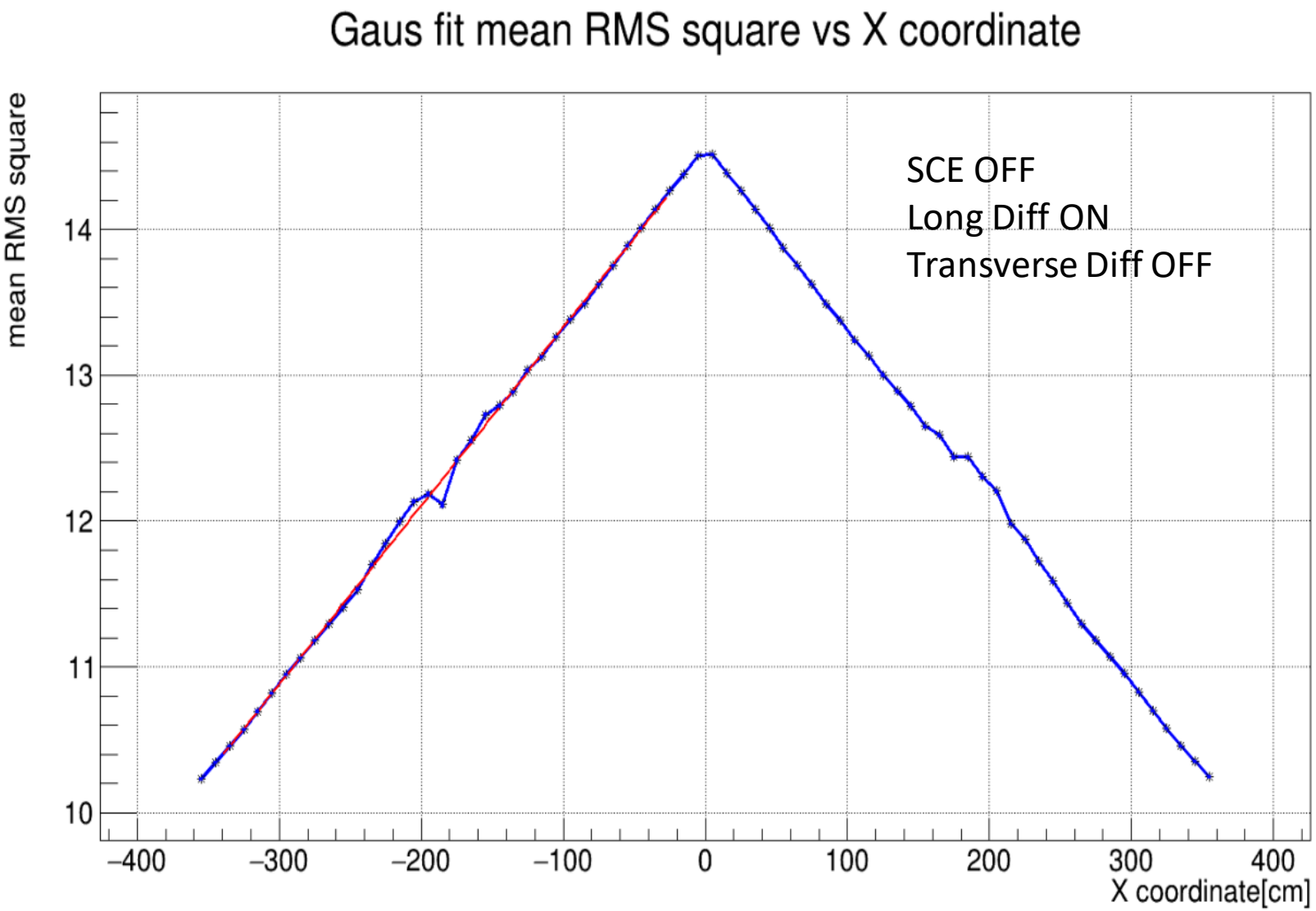
Diffusion study continued:
These were the values of longitudinal diffusion constant from my previous talk.

Sample Type or Data Run	Observed Longitudinal Diffusion constant
MC SCE ON	12.2 cm^2/sec
MC SCE OFF	12.9 cm^2/sec
Data RUN 5387	8.1 cm^2/sec

While the input longitudinal diffusion for MC samples is 6.2 cm^2/sec

We did some more study to find out the reason for measured value being around twice the input value.

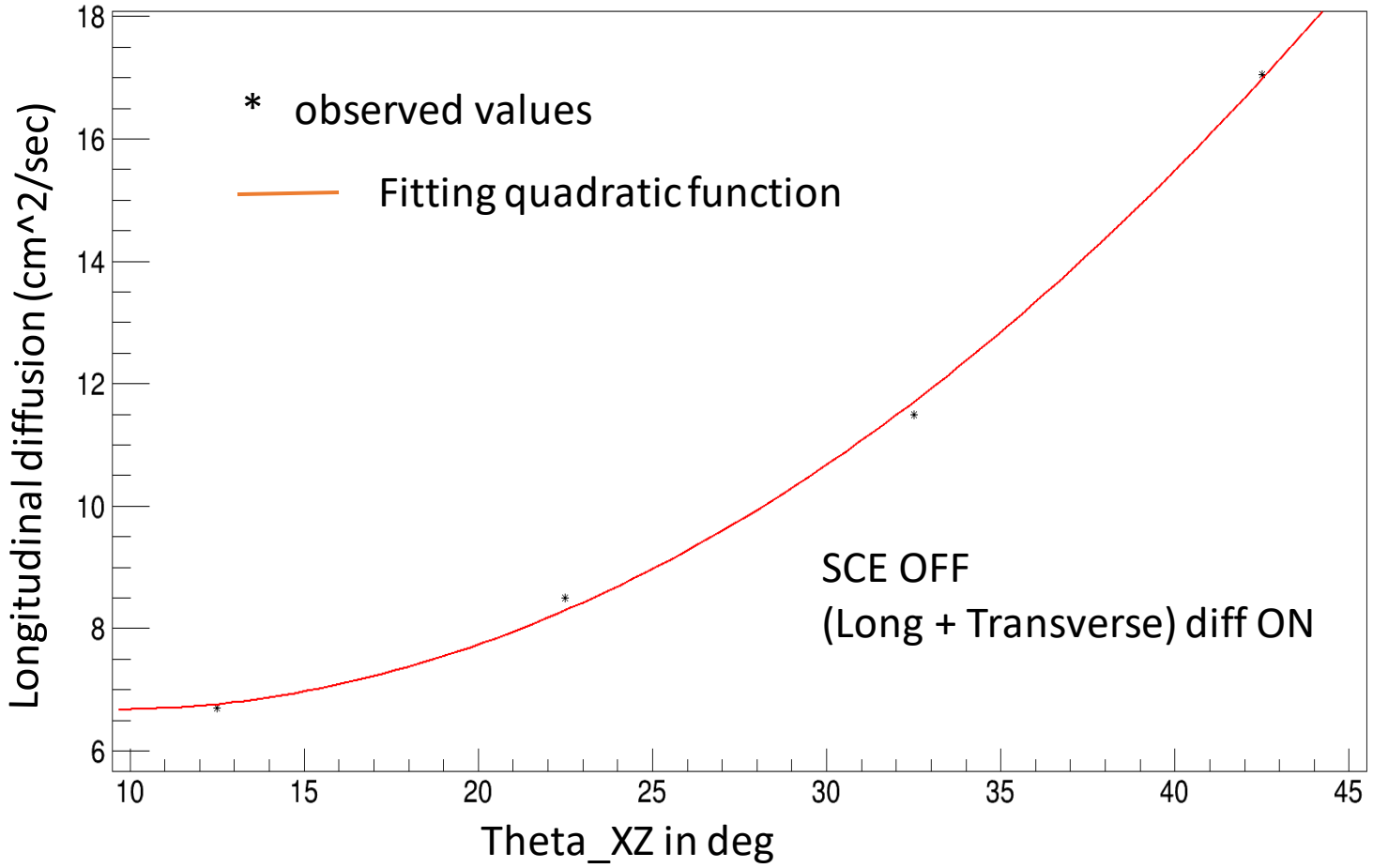
Tingjun generated MC SCE OFF sample with transverse diffusion turned off and used longitudinal diffusion of 6.2cm^2/sec:



From the fit
Longitudinal diffusion= **5.85cm^2/sec**

In the absence of transverse diffusion observed value is close to the input value

Angular dependence of observed diffussion constant (SCE OFF, longitudinal and transverse diffusion both ON sample):



For 10deg<abs(thetaXZ)<15deg

We get longitudinal diff= 6.7cm^2/sec

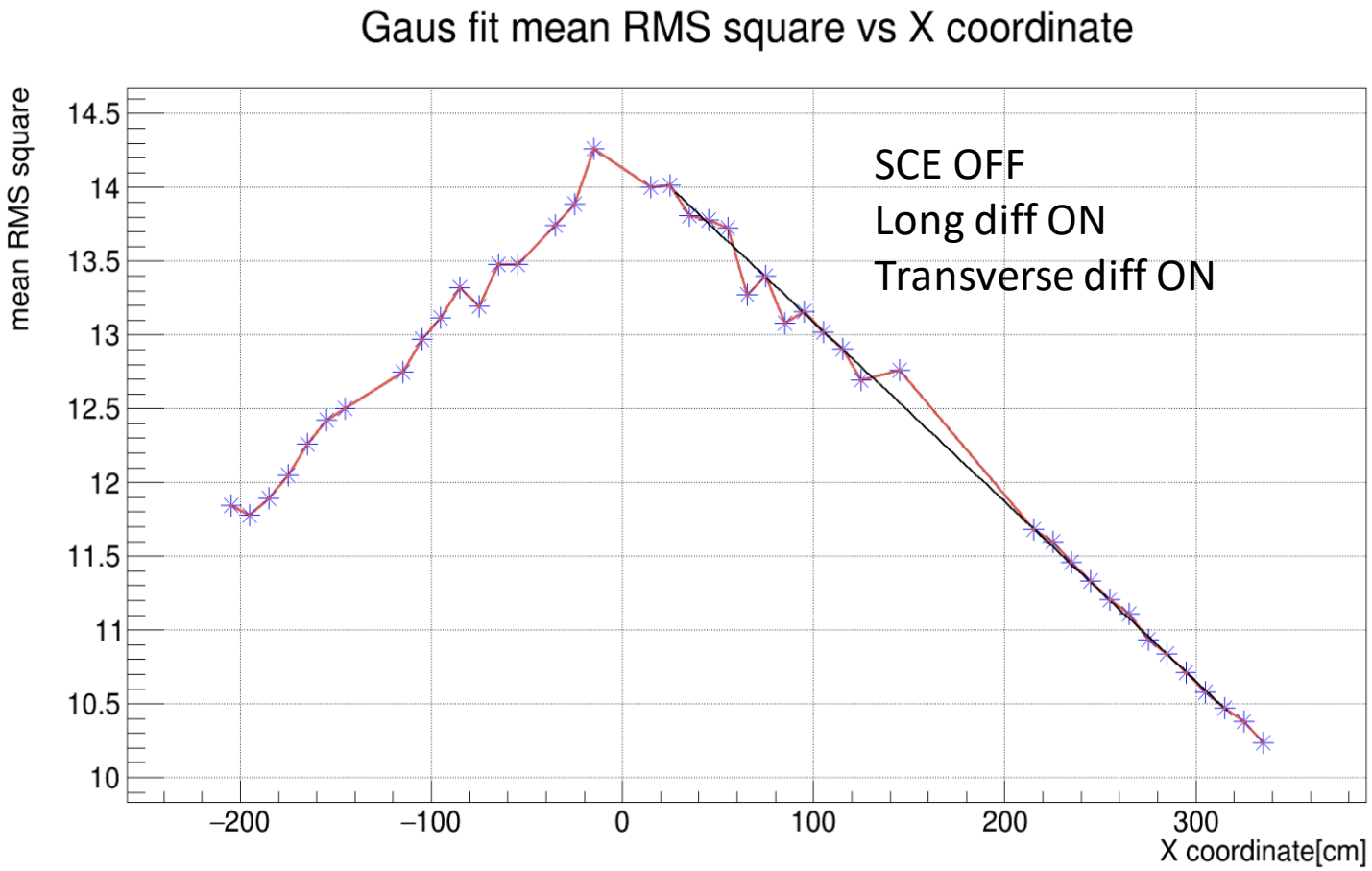
Which is close to the input value of 6.2cm^2/sec

As these are cathode crossing tracks at lower angle statistics is pretty low .

Another point to mention is for the transverse diffusion off sample, observed longitudinal diffusion was found to be independent of angle.

From the previous slides it appears if we use tracks at small angle we can accurately measure longitudinal diffusion constant.

We used CRT tagged tracks:



Here I used CRT tagged tracks with abs(thetaXZ)<1.0 deg

Input long diff=6.2cm^2/sec

Observed long diff=5.8cm^2/sec

Note: there are some regions where CRT tagged tracks are absent

Summary:

- Improvement in the MC-data dE/dx width comparison in recent simulation.
- Using tracks at small angle gives a reasonable estimate of longitudinal diffusion constant.
- CRT tagged tracks better suited to measure the diffusion constant.
- Working on measuring diffusion constant for SCE ON sample and protoDUNE data using CRT tagged tracks.

Backup slides: Theta_XZ definition