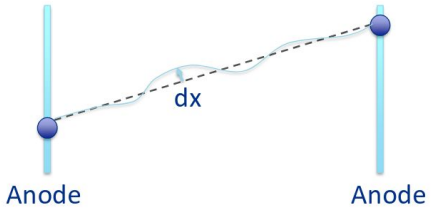
Differences in DENT vs Lane SCE method

How to Measure Field Distortions

- Start with two points that are in a straight line
- Measure distortions from that line
- A given track only measures the distortion perpendicular to its direction. Different tracks can be combined to get the full 3D dx. I use the uBooNE method: https://arxiv.org/abs/2008.09765



DENT method: anode-anode crossers for 3D data-driver correction

2 Calibration

2.1 Approach

To assess space charge effects at SBND, a sample of anode-cathode crossing cosmic muons has been used. Due to SCE, drift ionization electrons from these tracks will experience a delay in their arrival time to the anode. This can be quantified by comparing the positions of reconstructed SpacePoints to idealized positions that lie along a straight line drawn between the anode/cathode sides of the reconstructed track, as shown in Figure 1.

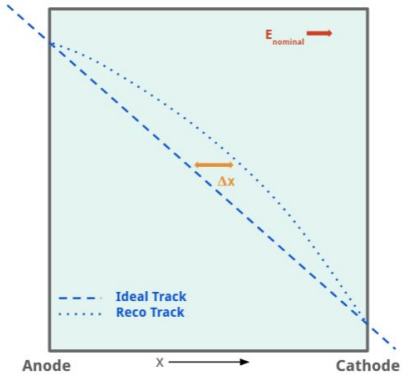
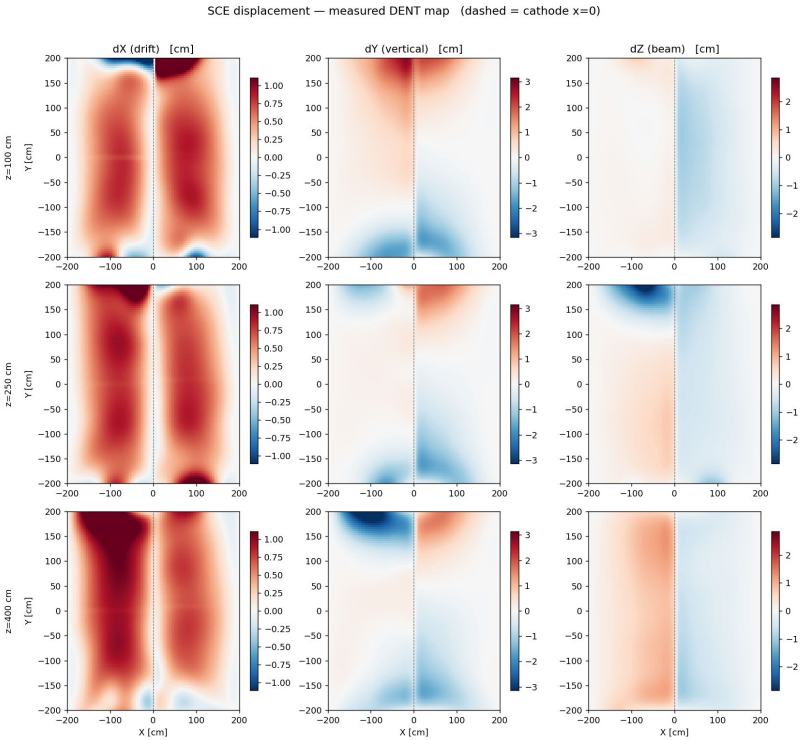
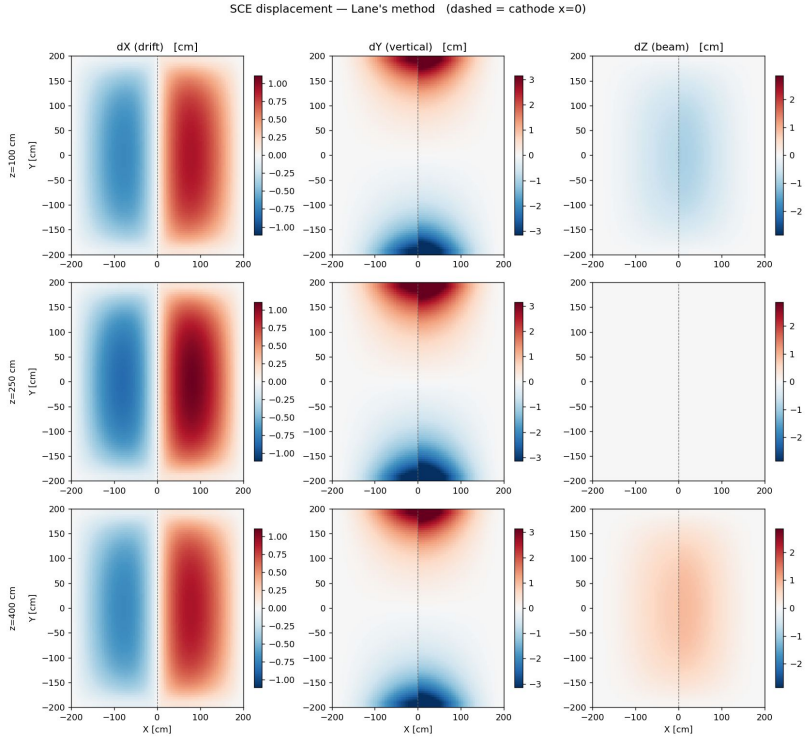


Figure 1: Illustration of approach used to calculate longitudinal spatial offsets.

Analytical method scaled by 1D data-driven correction in x-direction, using cathode-anode crossers

SCE effect maps provided by DENT and Lane are substantially different





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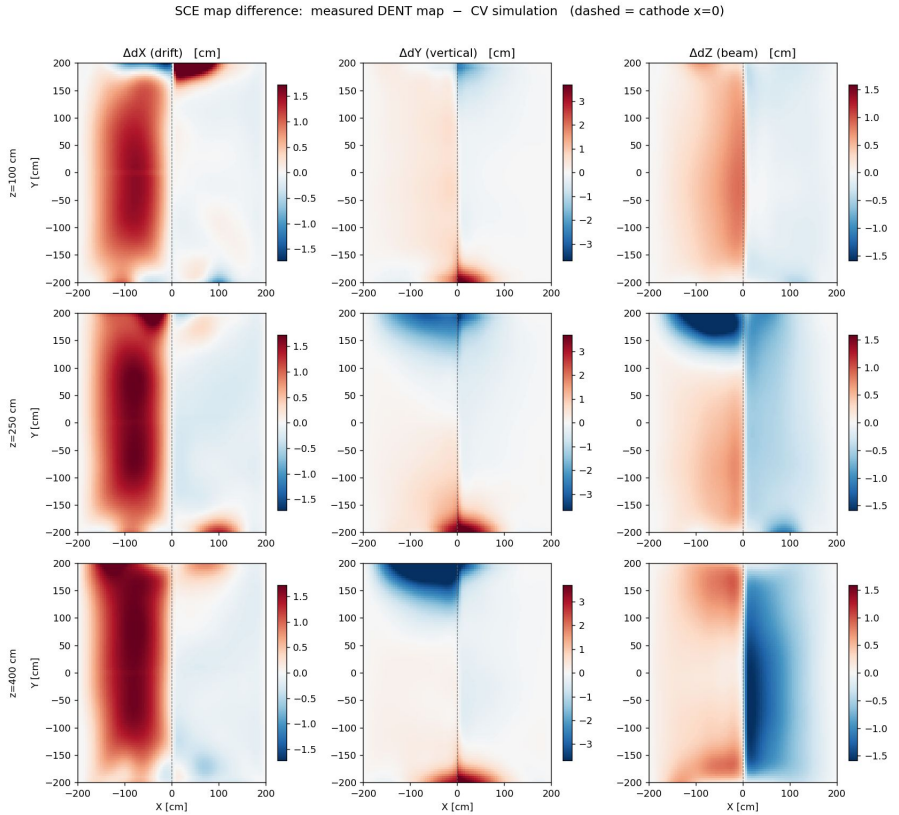
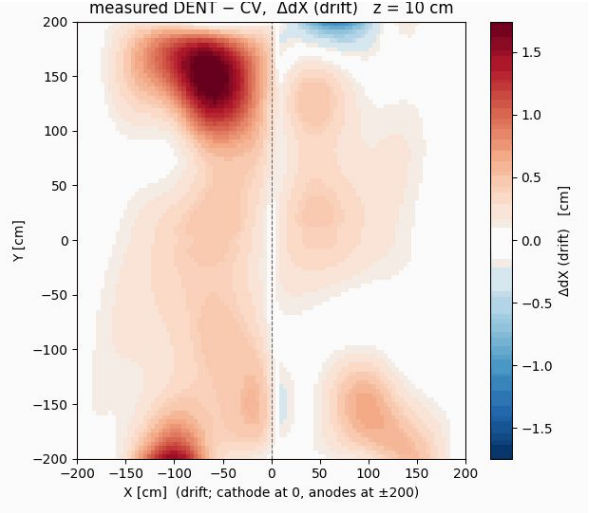
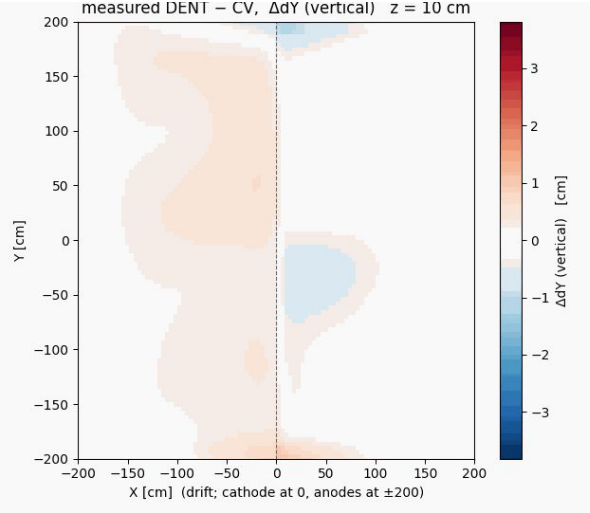
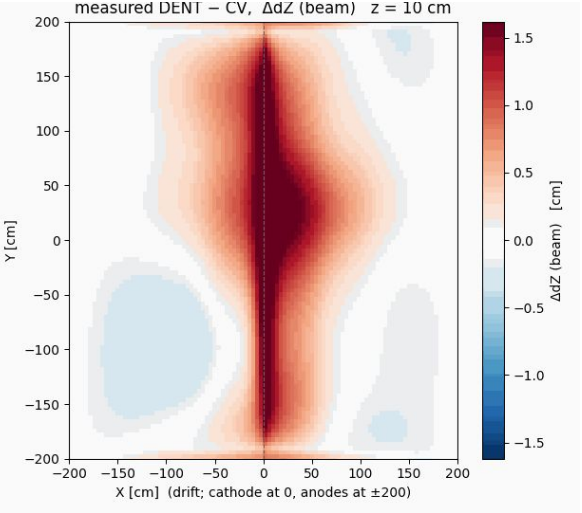


SCE effect maps provided by DENT and Lane are substantially different

This is DENT - Lane







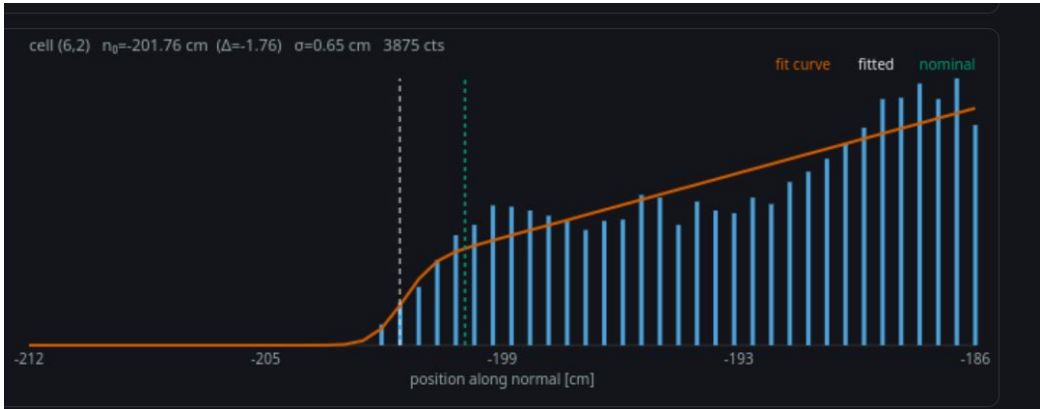
TPC structure inspection using real data

- I used 10,000 files (181,000 events) of run 1 crossing muon data, at reco 1 stage (data_MCP2025B_CrossingMuon_FullRun1_AfterLight_crossingmuon_v10_06_03_reco1_sbnd)
- I applied imaging, clustering, charge-light matching to correct T0 (wcls-img-clus-matching-xin-data.fcl), filtering ON with a larger filter margin (5cm)
- Apply Lane's SCE using Avinay's framework in WCT, to use DENT SCE, remove SCE and apply Zennamo v4 ROOT file
- Get BEE file (mabc.zip) with x, y, z points, and charge-weight points for further analysis
- (what additional information should I include here?)

Finding TPC boundary by fitting to edge spread function

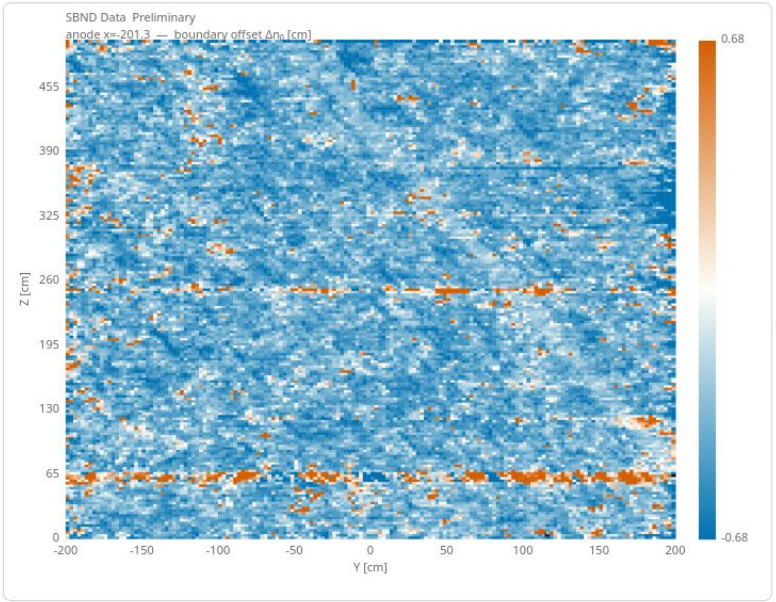
- Hull is not robust to outliers, reconstruction smear
- Alternative method: divide APA boundary into cells, and then fit the profile of points in the interior up to the boundary of that cell to an error function (edge-like) * linear (to capture internal structure to first-order) function. The difference between the center of the error function and the nominal position is the distortion of the boundary there.

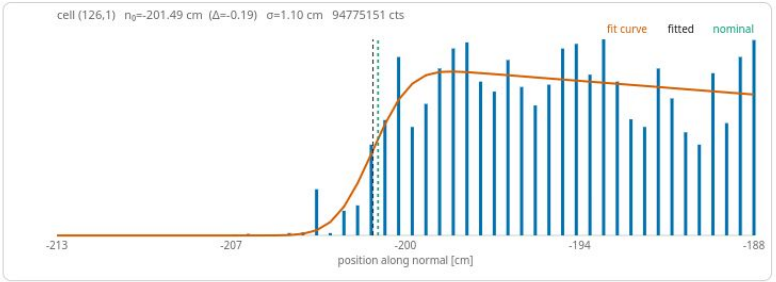
Relevant example that uses same method for turn-on curves : https://link.springer.com/article/10.1140/epjc/s10052-019-6841-1



I create a map of the boundary distortions by doing that at every one of those “cells”

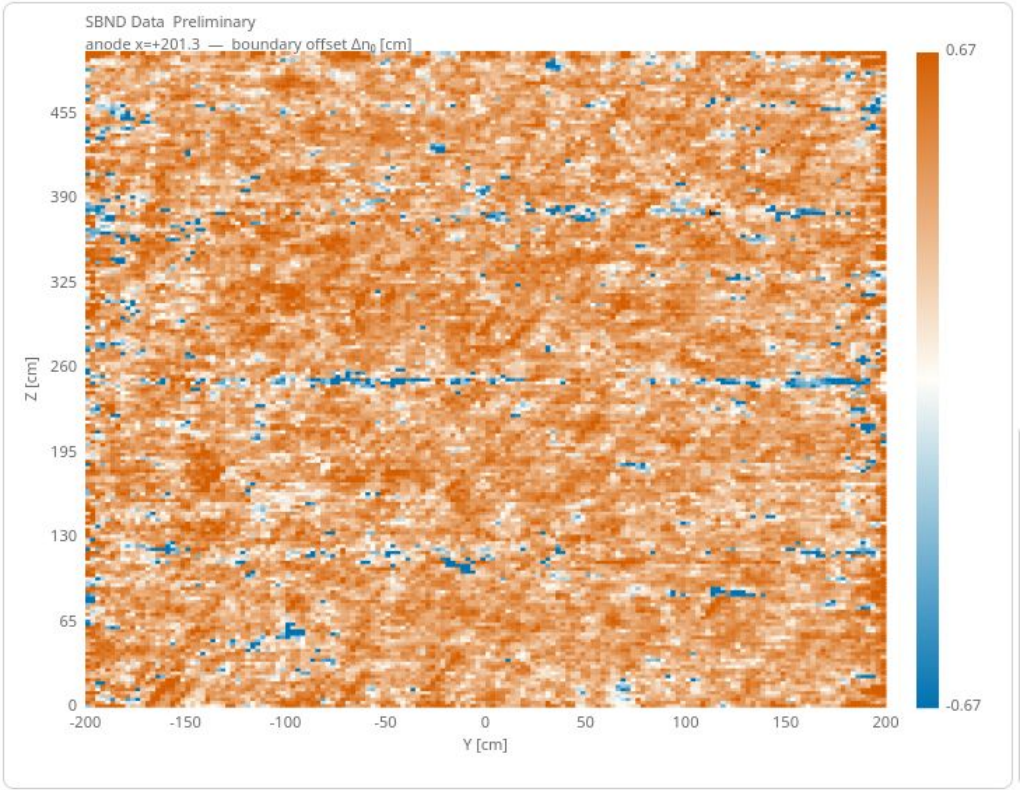
Here it is for the anode around x=-200. Switching SCE does not noticeably affect the boundary map, and the distortions are relatively small, although there are patterns, like some constant-z bands of distortion





Anode around x = +200

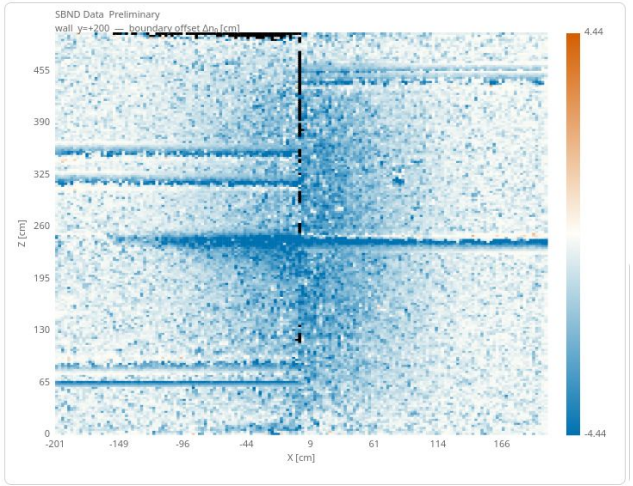
Similarly, SCE does not noticeably affect the boundary map, and the distortions are relatively small, although there are patterns, like some constant-z bands of distortion, probably detector structure as anodes aren't susceptible to effects from field distortions



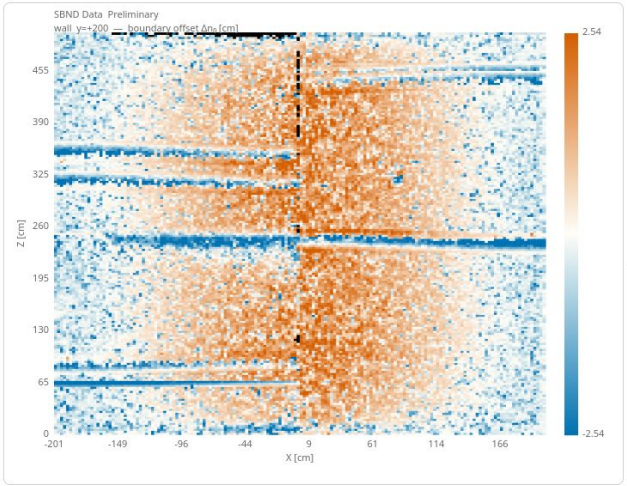
y=+200 wall

SCE choice has significant effect here

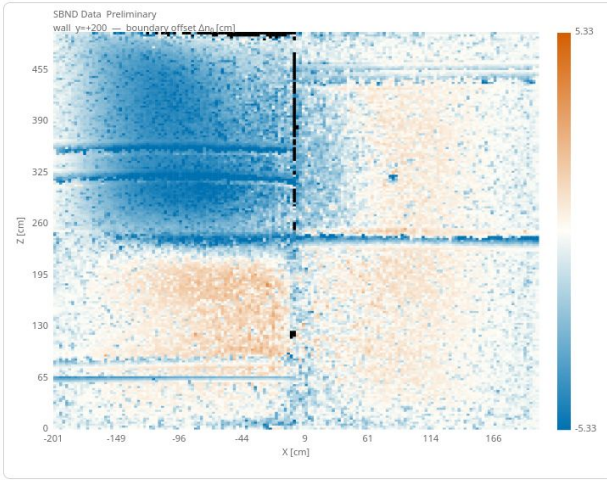
No SCE correction



Lane's correction



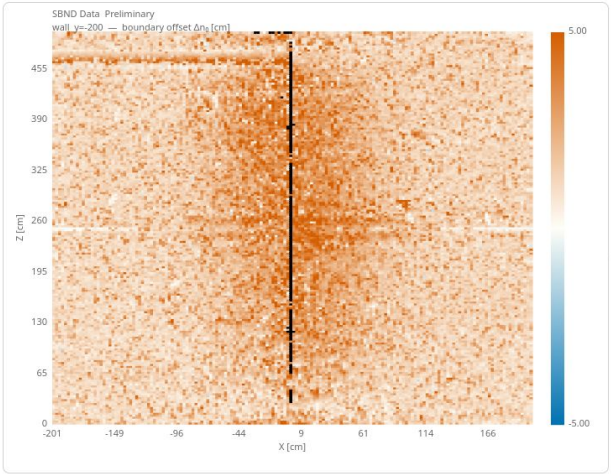
DENT correction



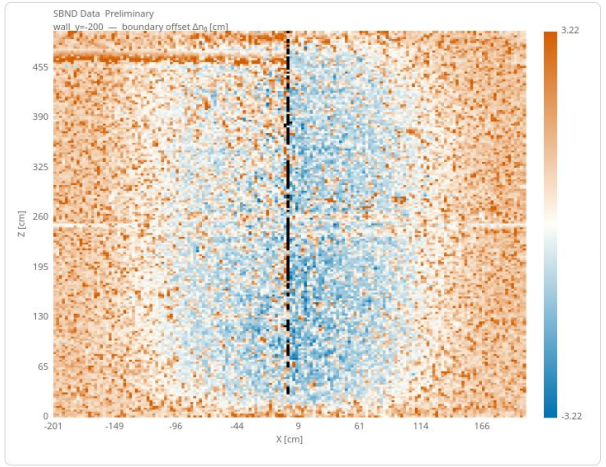
y=-200 wall

SCE choice has significant effect here

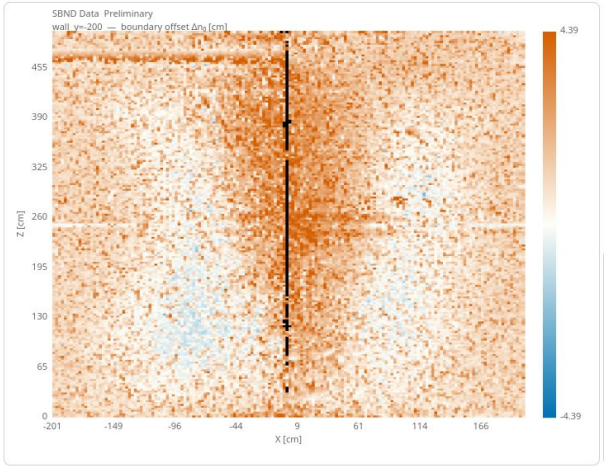
No SCE correction



Lane's correction



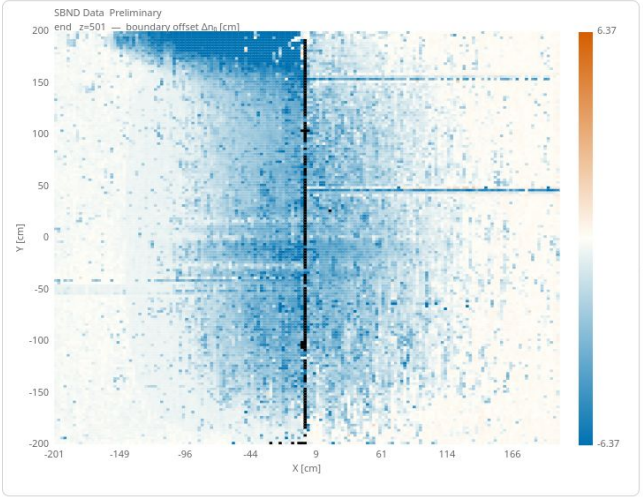
DENT correction



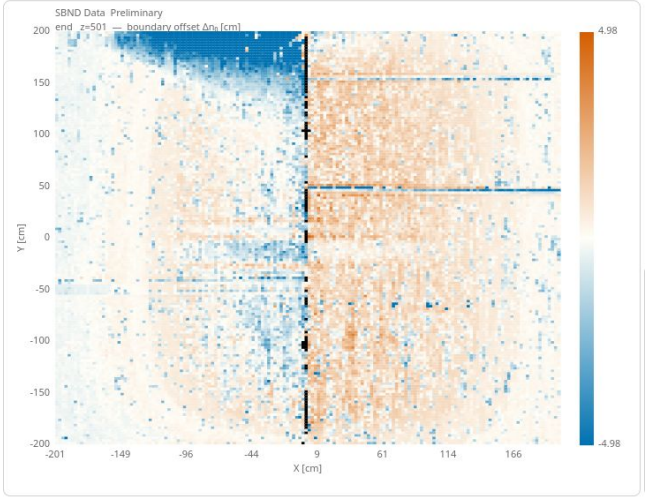
z=500 wall

High YZ distortion clearly visible here, even after DENT correction. DENT mentions that their correction is least precise around boundaries though

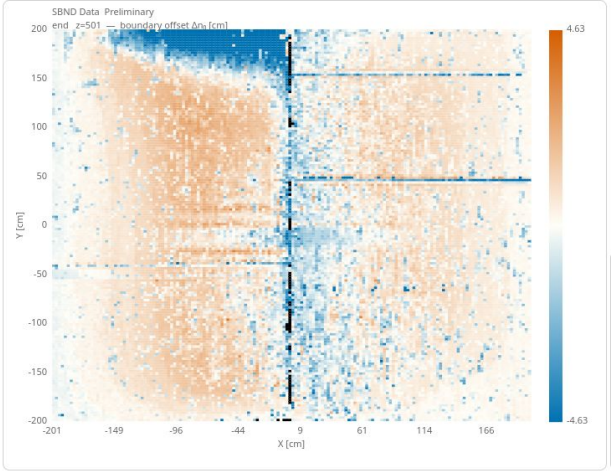
No SCE correction



Lane's correction

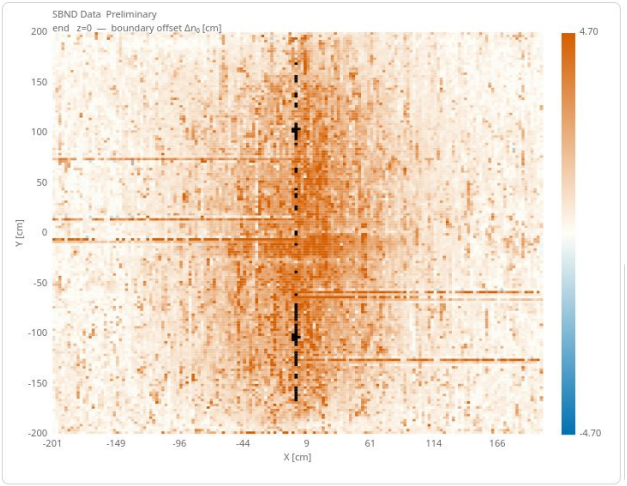


DENT correction

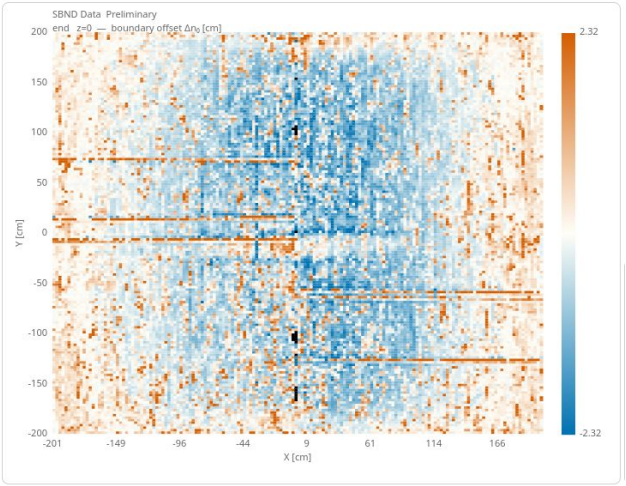


z=0 wall

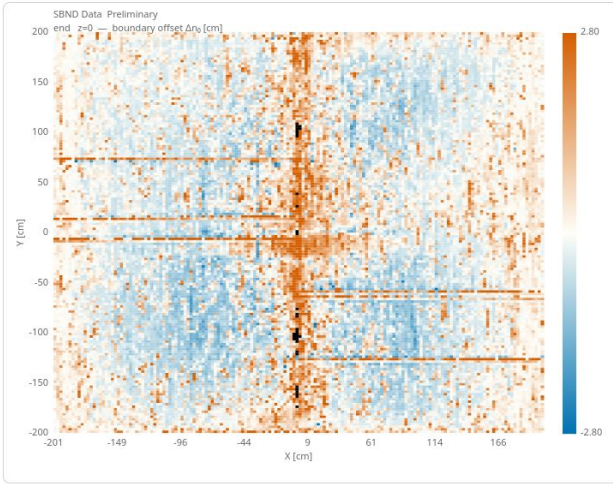
No SCE correction



Lane's correction

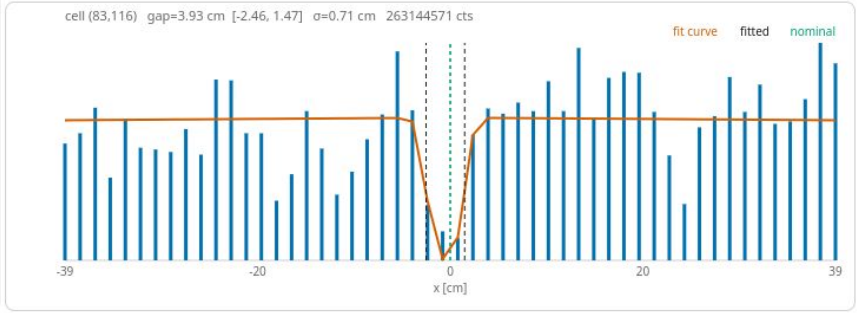


DENT correction

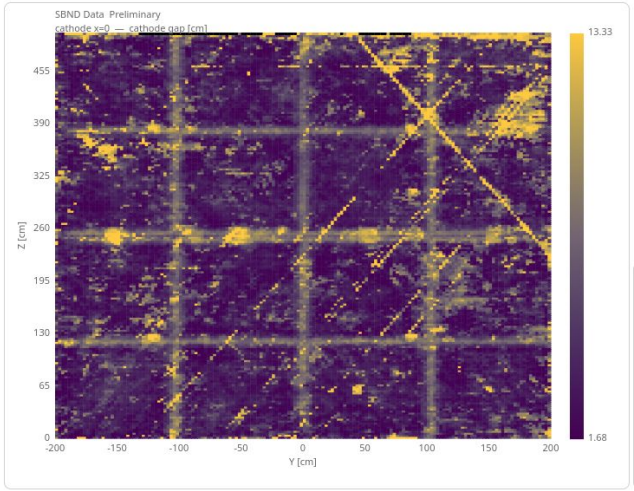


Measuring cathode gap

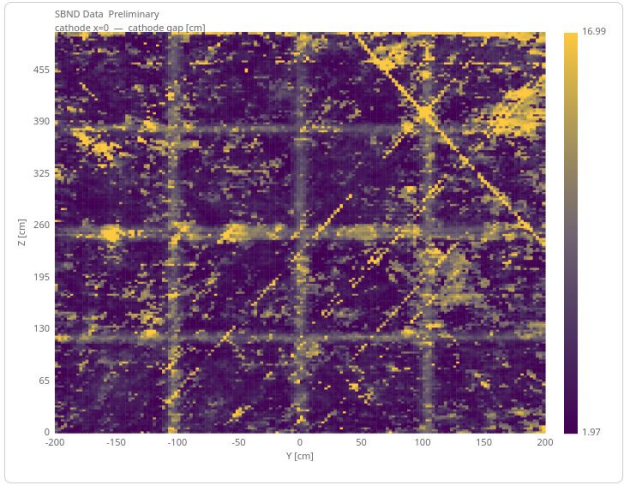
No significant difference between SCE correction choices here



No SCE correction



Lane's correction



DENT correction