Conclusions

Using a simple χ^2 two-sample test, we have found that after one week of data acquisition the SAND detector should be able to identify a displacement of +0.05 mm in the Y coordinate of the second horn of the neutrino beam with a confidence level of:

$$\text{C.L.(reco)} = 3.80\sigma \tag{5.41}$$

This was achieved by studying the reconstructed momenta of muons from CC interactions in SAND's front calorimeter modules. The application of a fiducial volume selection and two cuts on the quality of the momentum reconstruction were crucial to reach this level of separation.
Our estimated upper value for the confidence level, obtained with true momentum and vertex position information, was:

$$\text{C.L.(ideal)} = 5.09\sigma \tag{5.42}$$

This leads us to believe that higher levels of beam monitoring precision should be accessible to SAND. One immediate improvement might be considering the CC events having vertex in the STT. We expect this sample to be particularly clean, since it is not affected by smearing in the lead layers of the calorimeter modules.
Other improvements could be made by considering other observables. The most obvious one would be the reconstructed position of the interaction vertexes on the XY plane, either in the front calorimeter modules or in the STT. We expect that an anomaly in the beam production would induce a change both in the position of the space distribution centre and in its spread. The flux histograms used to simulate the neutrino interactions for this thesis, contained no spatial informations, making it impossible to consider the vertex position distribution in the study. An easy fix would be to use $dk2nu$ format files, which are also produced by the DUNE beam collaboration and contain all the informations on the neutrino flux production, necessary to simulate the beam spread.