Characterization of Time Dependent Distortions in the sPHENIX TPC using the Central Membrane
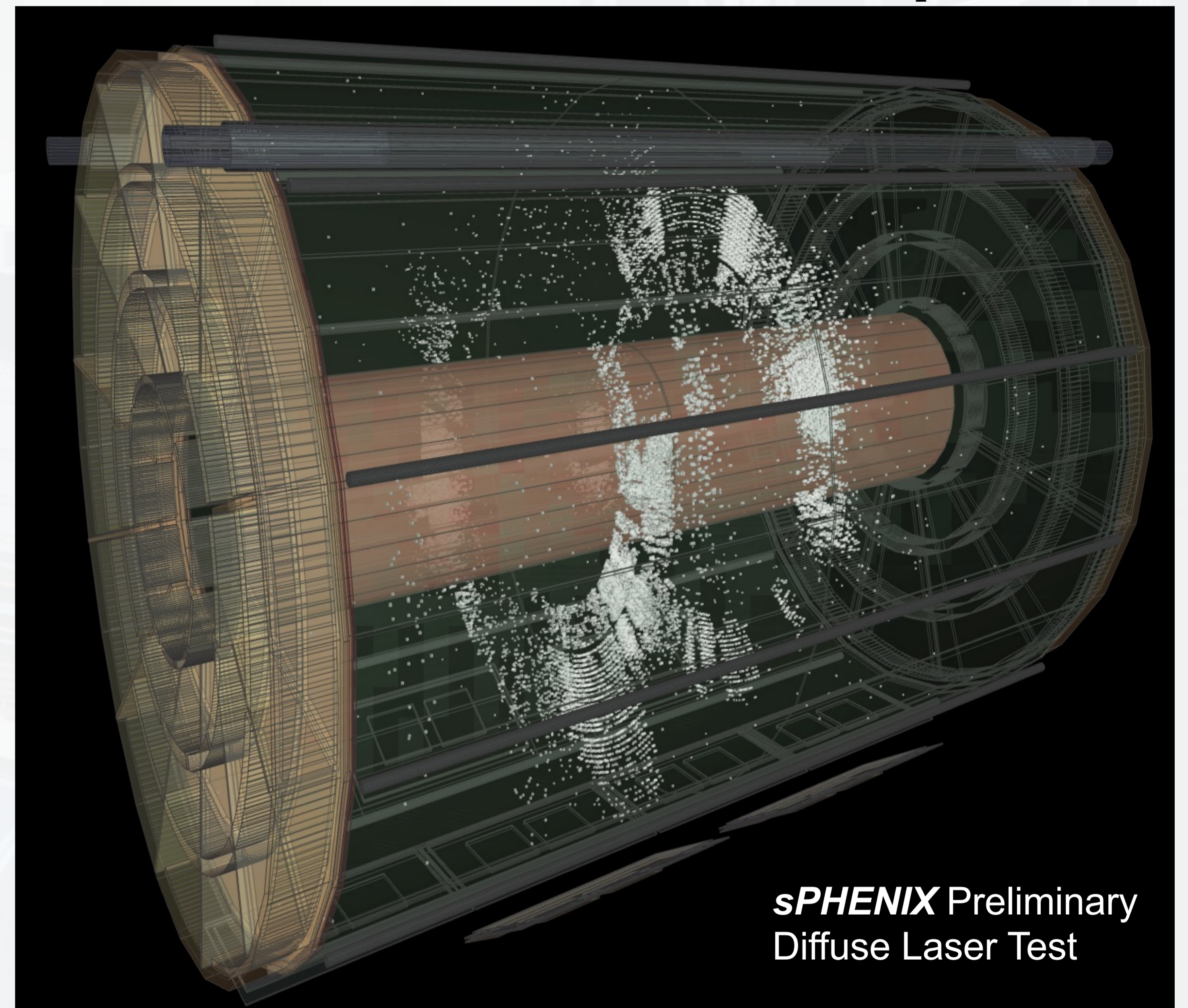
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The Time Projection Chamber (TPC) is the main tracking detector in sPHENIX. Charged particles which pass through the TPC ionize the gas, with the transverse position being given by the readout pad and the time for the ionization electrons to drift to the endcaps defining the z position. The ionization electrons are then clustered together in order to track particles and determine their momenta. In order to accurately track particles, calibrations must be performed and the performance of the TPC must be understood. As part of normal operations, space charge builds up within the TPC, leading to tracking distortions. These distortions must be accurately characterized over time such that they can be corrected as they evolve. Several calibration systems are used for this, including a set of diffused lasers which illuminate the Central Membrane of the TPC. Aluminum stripes, deposited on the Central Membrane at well-surveyed positions, emit photoelectrons when struck by the diffuse laser. The resulting pattern can be reconstructed and used to characterize the 3-dimensional distortions at the position of the Central Membrane. These distortions are then extrapolated to the endcaps of the TPC in order to provide corrections throughout its entire volume. This poster will discuss the design, algorithm, and performance of the time dependent distortions corrections in the sPHENIX TPC and identify how this effort fits into the broader sPHENIX TPC calibration scheme.
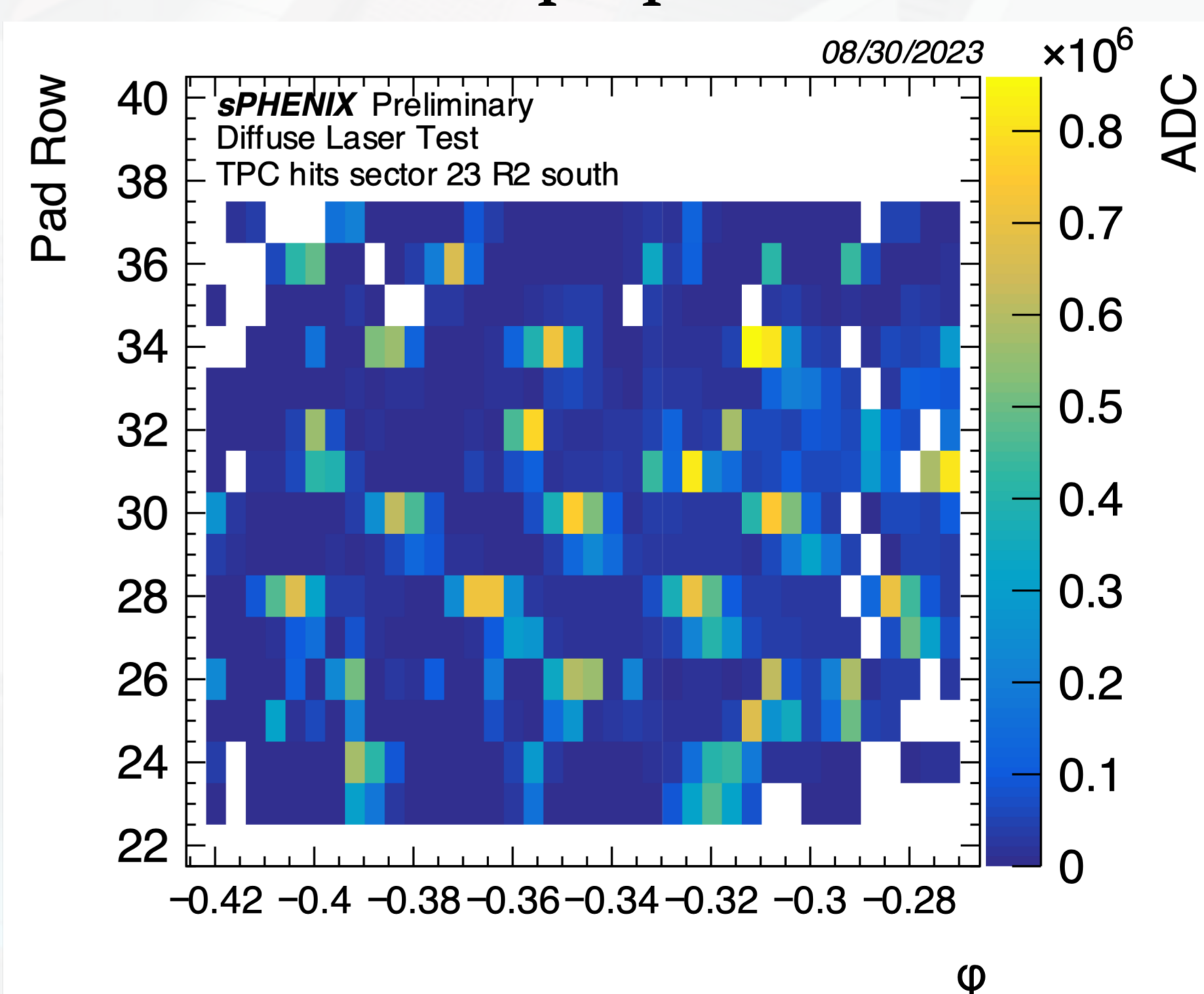
Al stripes on Central Membrane petals in well-defined pattern, each row is offset in φ from adjacent ones
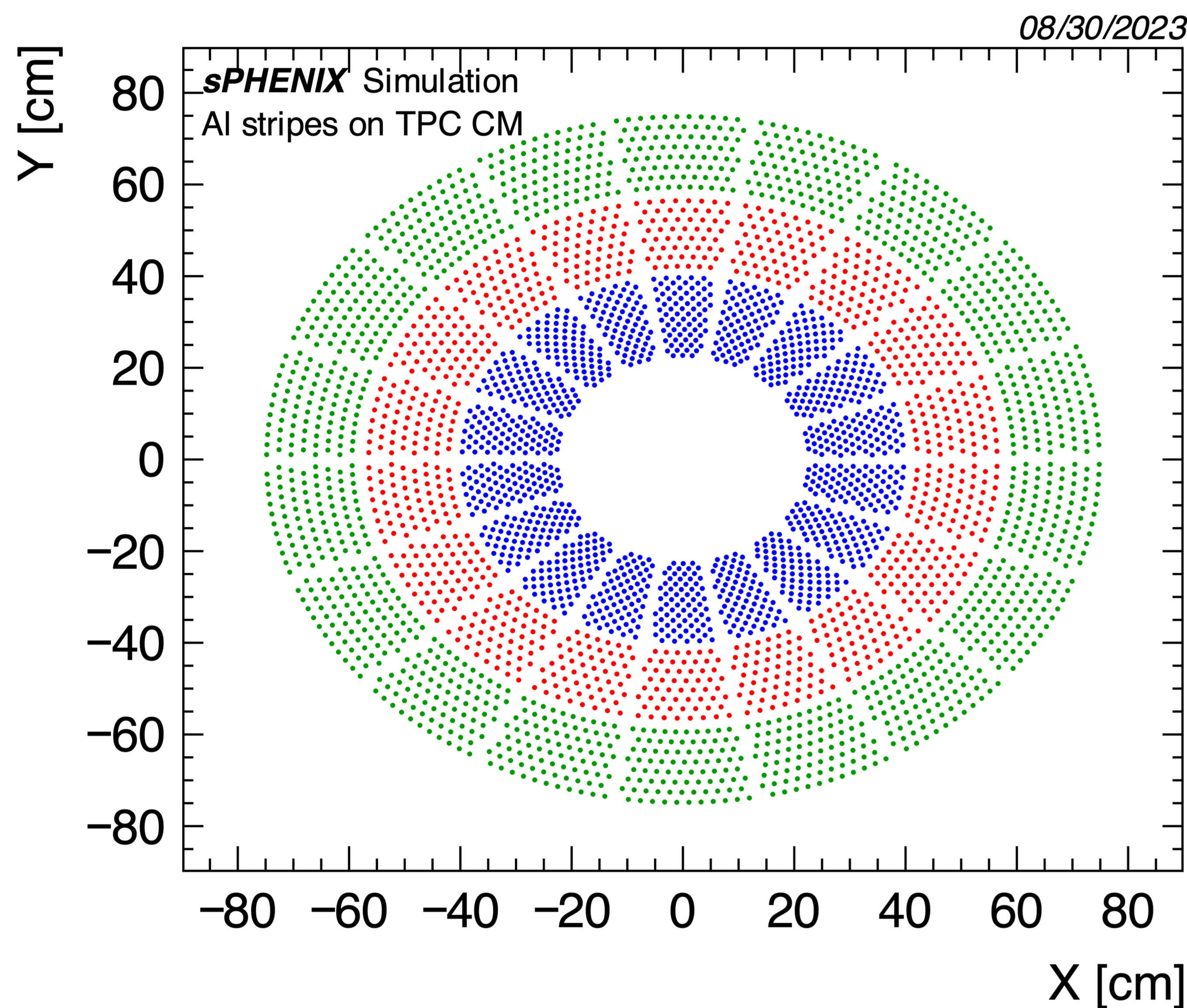
Diffuse lasers incident on Al stripes create sheets of electrons that drift to TPC endcaps

sPHENIX Preliminary
Diffuse Laser Test

Differences in R, φ, and Z between matched clusters and stripe truth positions define the 3D distortions

Simulated distortion fluctuations. A time series of space charge in the TPC, generated from a large min-bias simulation, is used to generate 3D distortion maps used to distort individual simulated events. Fluctuations are the residual distortions when the time-averaged distortion is subtracted from these maps
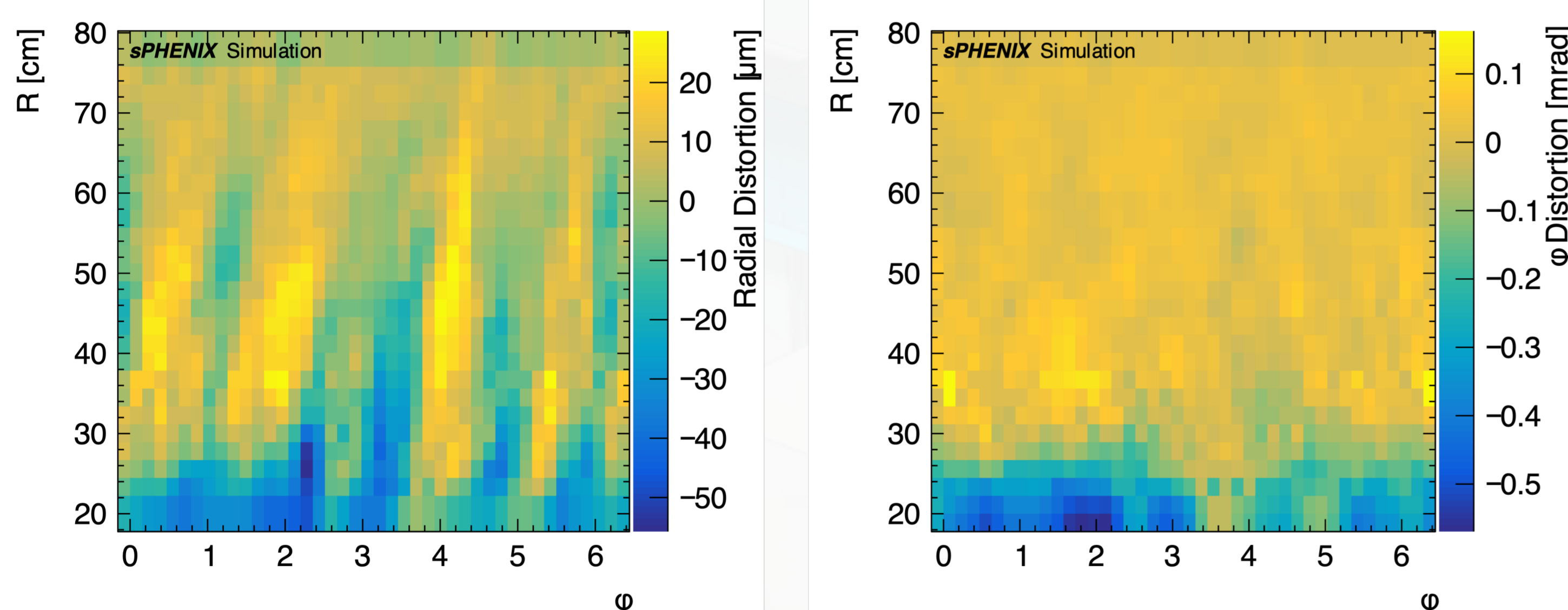

Reconstructed hits show signature of stripe pattern

- First full test of diffuse laser system
- 5 of 6 lasers active
- GEM gains below nominal
- Mapping of channels to coordinates still being verified
- Survey data not yet incorporated into pad or truth positions

Time-Ordered Distortions

- Aluminum stripes on Central Membrane are matched to the radial size of the readout pads. Charge sharing between adjacent pad rows allows a precise radial position to be determined
- Hits from each laser flash are matched to truth pattern, the differences in positions give the distortion vectors at the Central Membrane
- An interpolation is performed to make distortion continuous from discrete measurements
- Distortions from every laser flash averaged over large number of flashes to obtain average distortion at Central Membrane, which is extrapolated through TPC volume using distortions measured with TPOT
- Static, average, and time-ordered distortions applied and then track fitting is performed on corrected clusters

Conclusions

- The framework for understanding time-ordered distortions in the TPC is well defined and has seen significant progress over the past several months
- Hits from test laser flashes on the TPC Central Membrane have been reconstructed and show signatures of the stripe pattern on the Central Membrane
- Work is ongoing to efficiently match the reconstructed hits to the stripe pattern to determine the magnitude of the distortions