sPHENIX Report

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TPC Event Display in low ZDC rate running

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1 Time Projection Chamber Status

The data was taken on Saturday 05/25/24 while the BNL C-AD peformmed a scan over increasing beam separations. C-AD scanned over separation corresponding to the following sPHENIX ZDC/MBD coincidence rates:

1. ZDC: 1.70 kHz, MBD: 131 kHz (Run 43856)
2. ZDC: 1.40 kHz, MBD: 113 kHz (Run 43857)
3. ZDC: 1.00 kHz, MBD: 85 kHz (Run 43859)
4. ZDC: 0.67 kHz, MBD: 57 kHz (Run 43861)
5. ZDC: 0.36 kHz, MBD: 33 kHz (Run 43863)
6. ZDC: 0.11 kHz, MBD: 12 kHz (Run 43865)
7. ZDC: 0.61 kHz, MBD: 50 kHz (Run 43867)
8. ZDC: 1.30 kHz, MBD: 99 kHz (Run 43869)

During the data taking period, the sPHENIX magnet was operated at its full field of 1.4 T. The sPHENIX TPC operated with a 403 V/cm drift field and 4100 V potential between the top GEM foil and padplane for all 72 of its modules. The TPC operated in triggered readout mode using coincidences in the 2 halves (north and south) of the MBD. 601/624 FEEs were consistently read out while 612-615/624 were linked.

2 Event display

2.1 Run Condition

The run 43865 was taken on May 25th, 2024 from 22:41:42 to 22:51:46 for approximately 10 mins. The TPC, TPOT, MBD were enabled with the Global Level 1 (GL1) trigger. The run type was declared as *physics*.

2.2 Analysis

The data is first transferred to Scientific Data and Computing Center (SDCC) as PRDF (sPHENIX raw data format) files. Data in each sector of TPC are stored in a separate EVT file; a total 24 EVT files (for 12 sectors in the South and 12 sectors in the North side) are constructed. The EVT files for the TPC data are located here in RCF:

```
/sphenix/lustre01/sphnxpro/physics/tpc/physics/TPC_ebdc{00-23}_physics-00043865-000{0-3}.evt
```

Events are then reconstructed from the EVT files to the DST format files with an automated procedure. This *event combining* procedure combines data from different detectors (including streaming readout and triggered readout) and syncs them using the GL1. The combined event files, so-called production files, are located here in RCF:

```
/sphenix/lustre01/sphnxpro/physics/slurp/streaming/physics/run_00043800_00043900
DST_STREAMING_EVENT_run2pp_new_2024p001-00043865-00{00-01}.root
```

The ADC waveform of each channel consists of 360 time bins (*tbin*). The time bin can be translated to drift length of the charge produced in the TPC volume and then the Z position is calculated from the drift length. The drift velocity (v_d) is 8.0×10^{-3} cm/ns and each time bin is separated by 53 ns. The total distance between the central membrane and the readout pad plane is 105 cm. The Z position of a hit is calculated by 105 cm - 8.0×10^{-3} $cm/ns \times 53$ $ns \times tbin$ for the south side and the value is multiplied by -1 for the north side. Each channel is mapped in (X,Y) position using PHG4TpcCylinderGeom module which maps channel's ϕ and r position in its cylindrical coordinate.

In each channel, pedestal mean values and standard deviations (σ) are determined using the most probable value of the waveform distribution and its variance. This process is performed in TpcCombinedRawDataUnpacker module. Noisy channels such as all ADC values in a given waveform are stuck at one value are not passed to the clusterization algorithm. The clusters are reconstructed in TpcClusterizer using the code Fun4All_FieldOnAllTrackers.C.

Figures 1 - 6 show alternative views of the same TPC cluster event display for event 1 in Run 43865. The (X,Y,Z) position of the clusters are stored in a JSON file which can be passed to the sPHENIX Event Display website to view in 3 dimensions. The JSON file can be found here:

```
https://github.com/sPHENIX-Collaboration/sPHENIXDisplayEventCache/blob/main/
TPCEventDisplay_43865_1_ALL_CLUSTERS.json
```

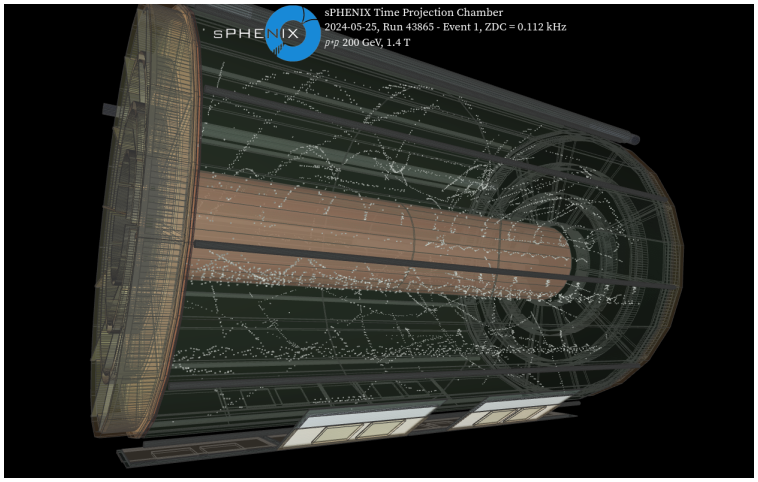

Figure 1: TPC cluster event display for Run 43865 pp $\sqrt{s} = 200$ GeV. Clusters that come from hits with pedestal-mean-subtracted ADC counts (ADC - pedestal mean) above at least 5 σ are shown.

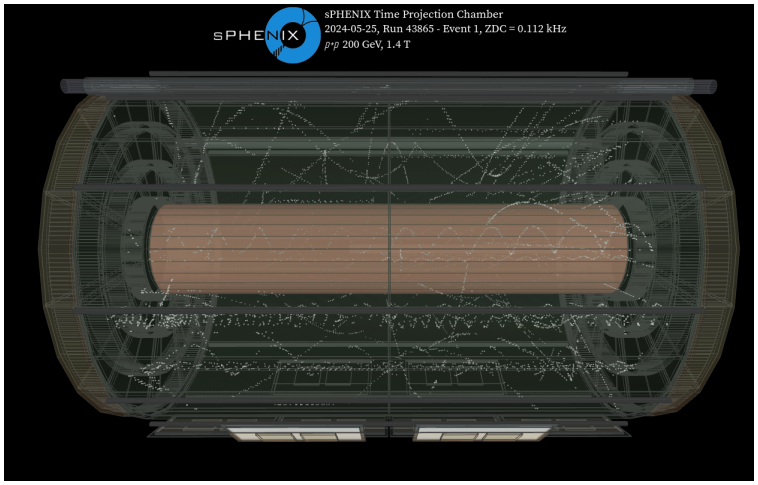

Figure 2: TPC cluster event display for Run 43865 pp $\sqrt{s} = 200$ GeV. Clusters that come from hits with pedestal-mean-subtracted ADC counts (ADC - pedestal mean) above at least 5 σ are shown.

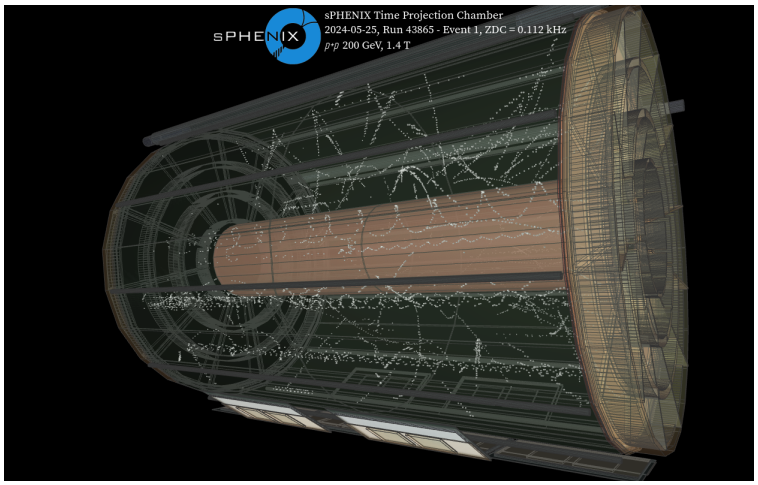

Figure 3: TPC cluster event display for Run 43865 pp $\sqrt{s} = 200$ GeV. Clusters that come from hits with pedestal-mean-subtracted ADC counts (ADC - pedestal mean) above at least 5 σ are shown.

References

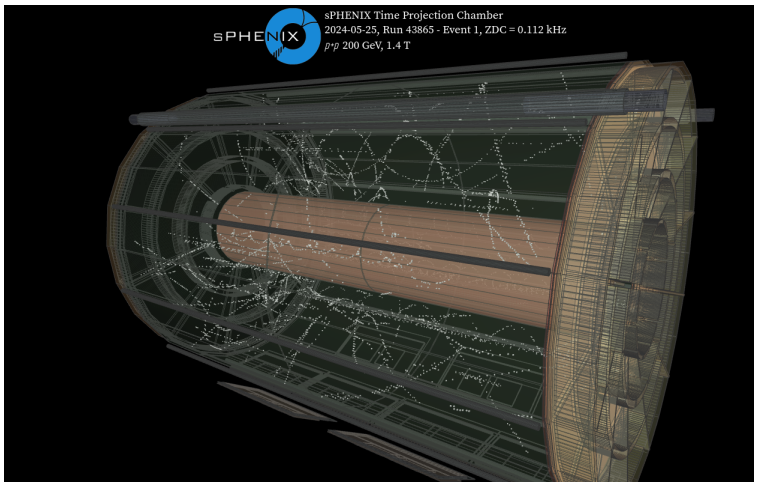

Figure 4: TPC cluster event display for Run 43865 pp $\sqrt{s} = 200$ GeV. Clusters that come from hits with pedestal-mean-subtracted ADC counts (ADC - pedestal mean) above at least 5 σ are shown.

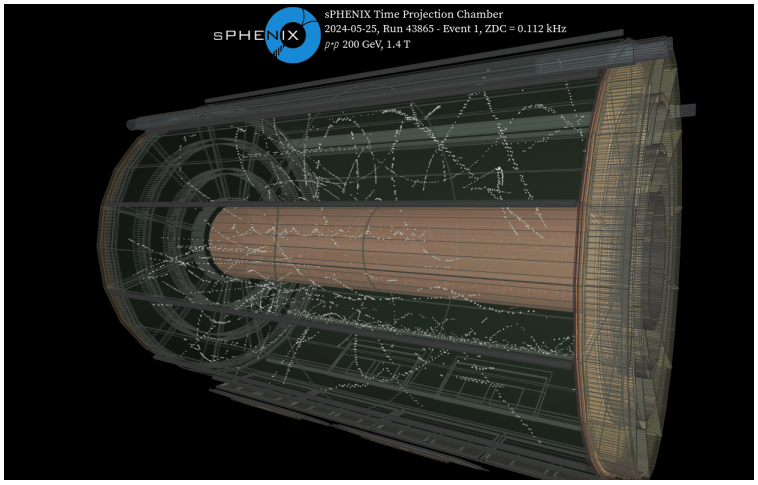

Figure 5: TPC cluster event display for Run 43865 pp $\sqrt{s} = 200$ GeV. Clusters that come from hits with pedestal-mean-subtracted ADC counts (ADC - pedestal mean) above at least 5 σ are shown.

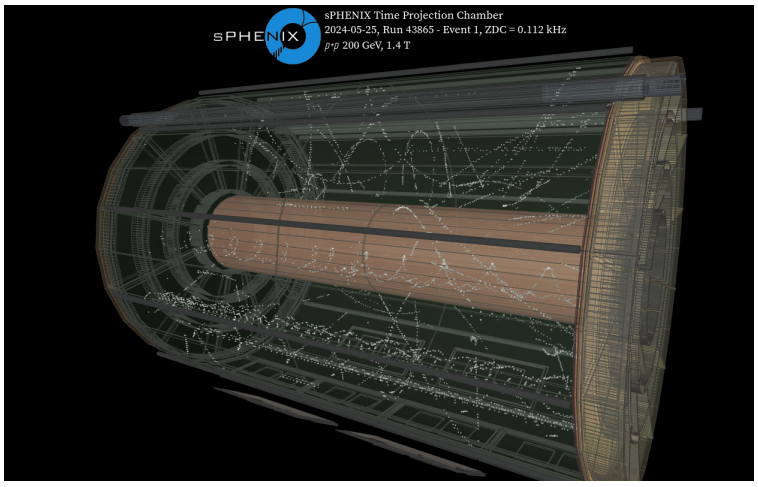

Figure 6: TPC cluster event display for Run 43865 pp $\sqrt{s} = 200$ GeV. Clusters that come from hits with pedestal-mean-subtracted ADC counts (ADC - pedestal mean) above at least 5 σ are shown.