

# Performance of the STAR Event Plane Detector



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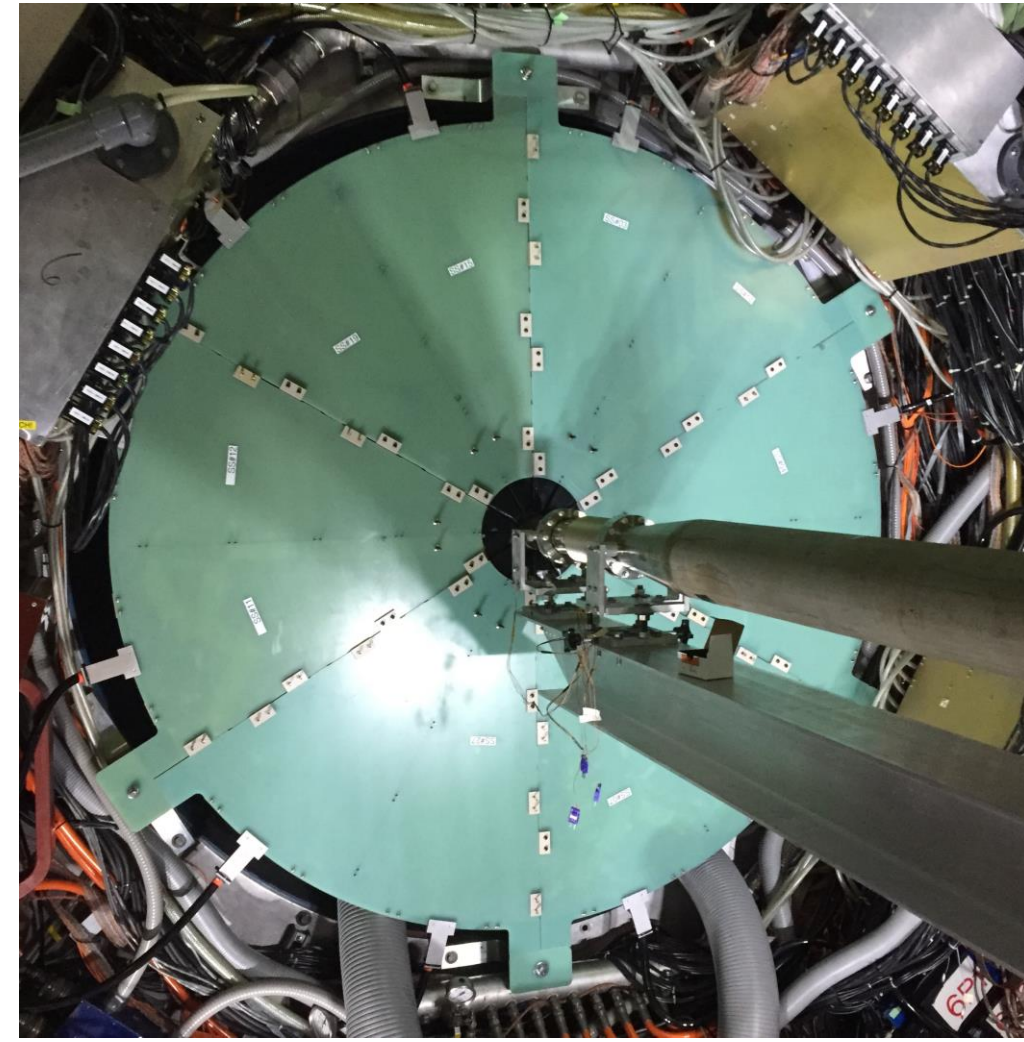
## Abstract

The Beam Energy Scan (BES) program at the Relativistic Heavy-Ion Collider has shown hints of a critical point and first order phase transition at the BES energies. Key measurements for locating the critical point and determining the first order phase transition are limited by poor event plane resolution, limited statistics and a TPC-only centrality determination. A new event plane and collision centrality detector (EPD) is planned to replace the existing detector, the Beam-Beam Counter (BBC), with higher granularity and acceptance. The design of the EPD consists of two scintillator discs at  $z = \pm 3.75\text{m}$  from the center of STAR, covering  $2.1 < |\eta| < 5.1$ . The EPD is estimated to increase 1st order Reaction Plane resolution by a factor of at least 1.5 and has timing resolution on the order of 1ns. One quarter of a single disc was installed in STAR for the 2017 run for commissioning. We will discuss the detector performance during the 2017 commissioning run in AuAu collisions at  $\sqrt{s_{NN}} = 54.4\text{ GeV}$  and the 2018 isobar run. Outlook on the performance of the EPD in BESII will also be discussed.

East = Negative Rapidity  
West = Positive Rapidity

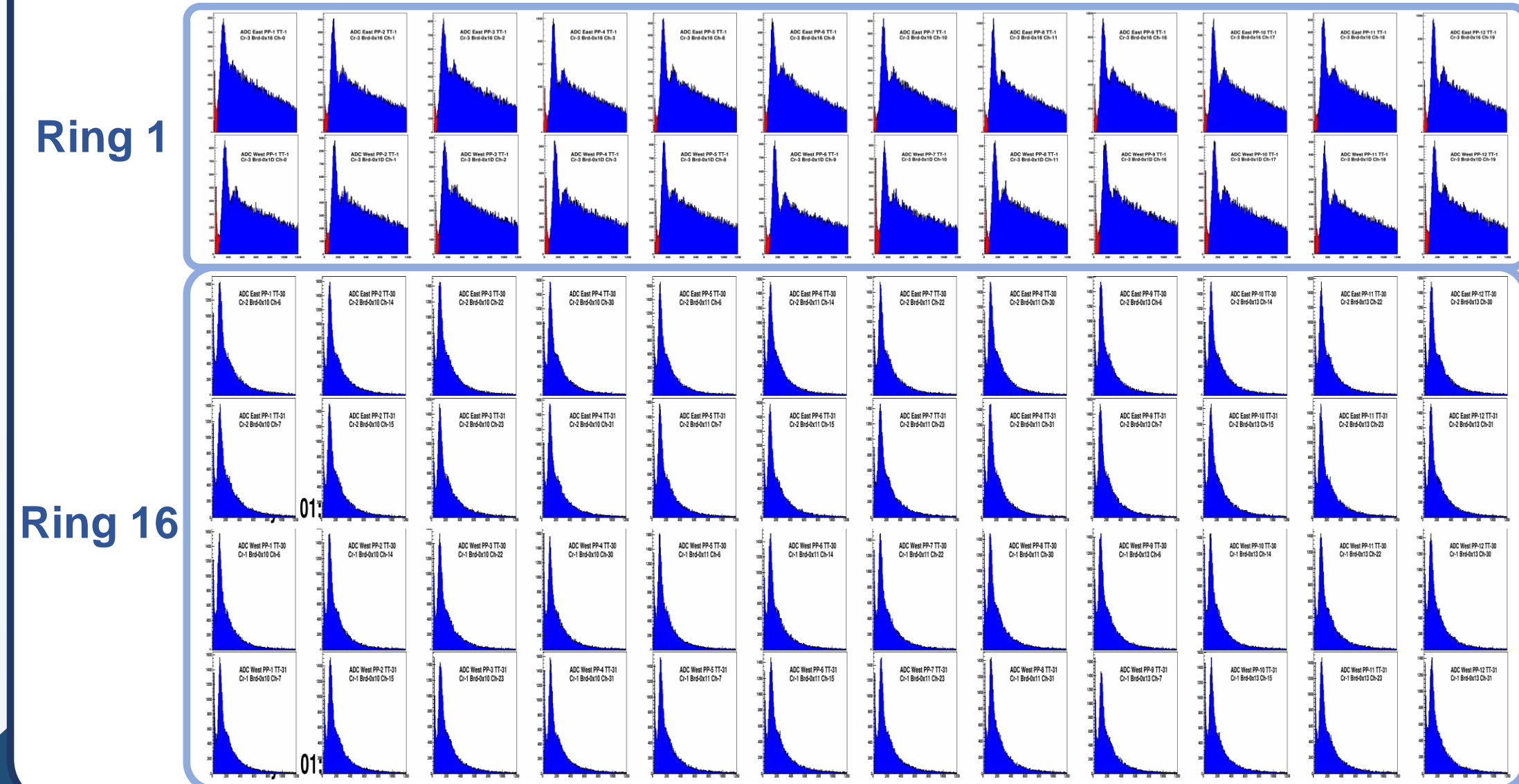
## Specifications

- The EPD is a **replacement for the existing BBC** detector at STAR.
- Comprised of **2 wheels** of 12 supersectors each.
- Each supersector is made up of 31 optically isolated channels, for a **total of 744 channels**, split into 16 rings, with ring 1 the innermost ring and ring 16 the outermost ring.
- Each channel is embedded with **wavelength shifting (WLS) optical fiber** wound 3 times within the tile. This is coupled to clear optical fiber which is then **coupled to SiPMs** and finally read out by STAR FEEs/QTs.
- Each wheel has a diameter of 1.8 meters, and is placed at  **$z = \pm 3.75\text{m}$**  inside the pole tip.
- For **Triggering, Centrality** and **Event Plane Determination**.



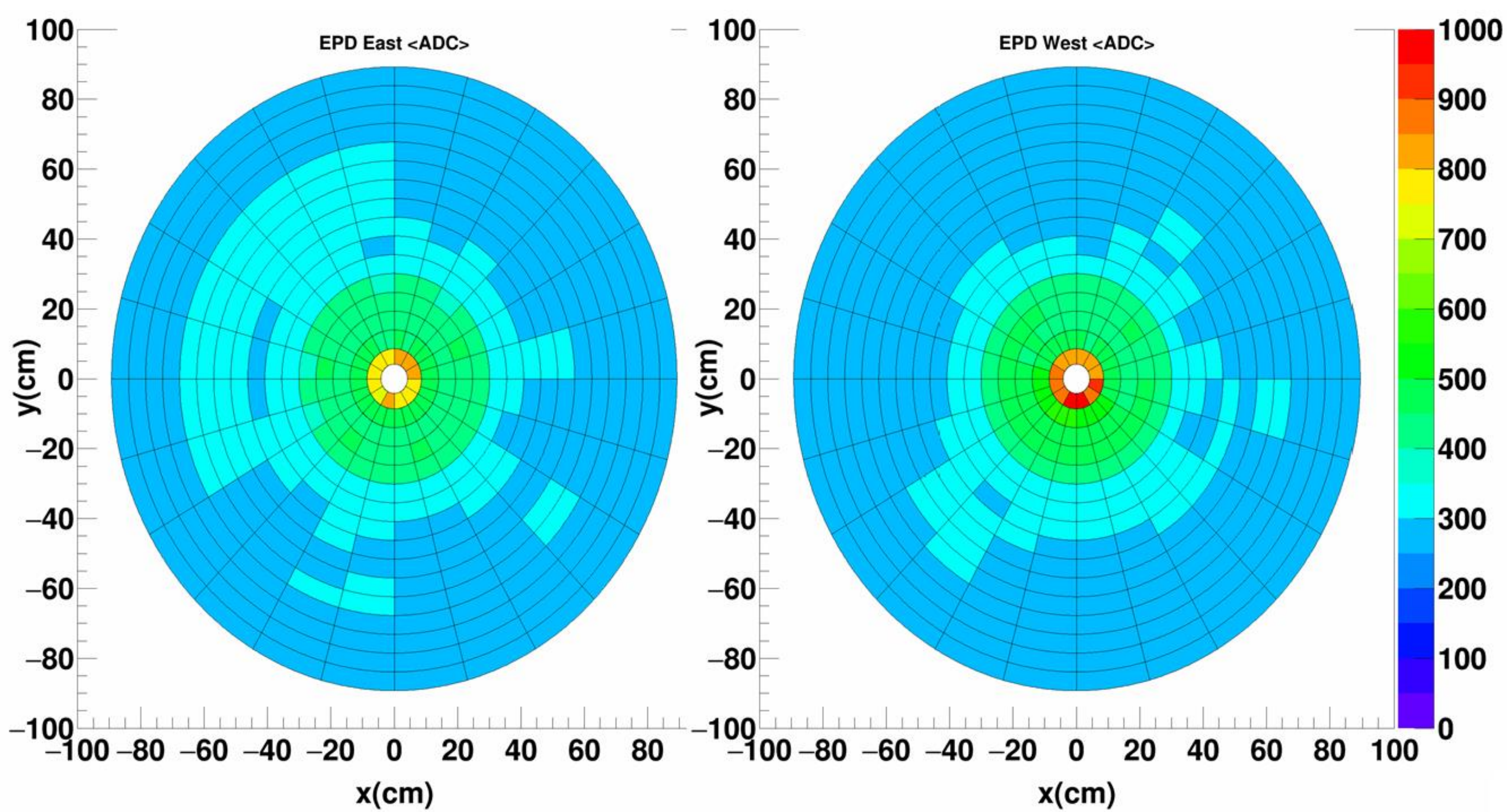
West EPD Wheel Installed

## ADC Spectra for Inner and Outermost Rings



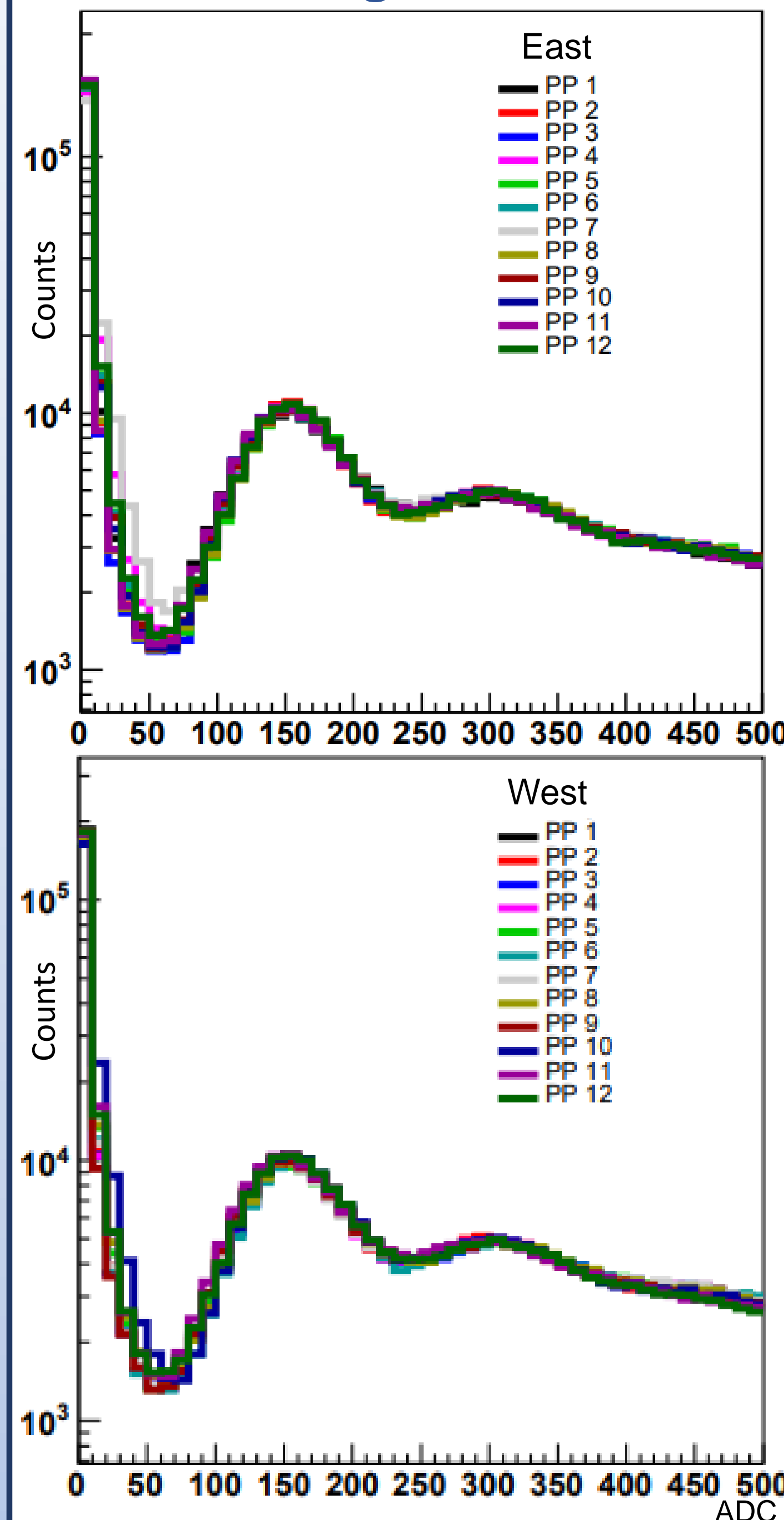
**Extremely uniform performance across all channels.** Red region in Ring 1 is from out of time signal. Ring 16 has no TDC. Ring 1 has visible multi-MIP peaks as well as longer tails due to higher multiplicity in the tiles.

## Average ADC for East and West Wheels



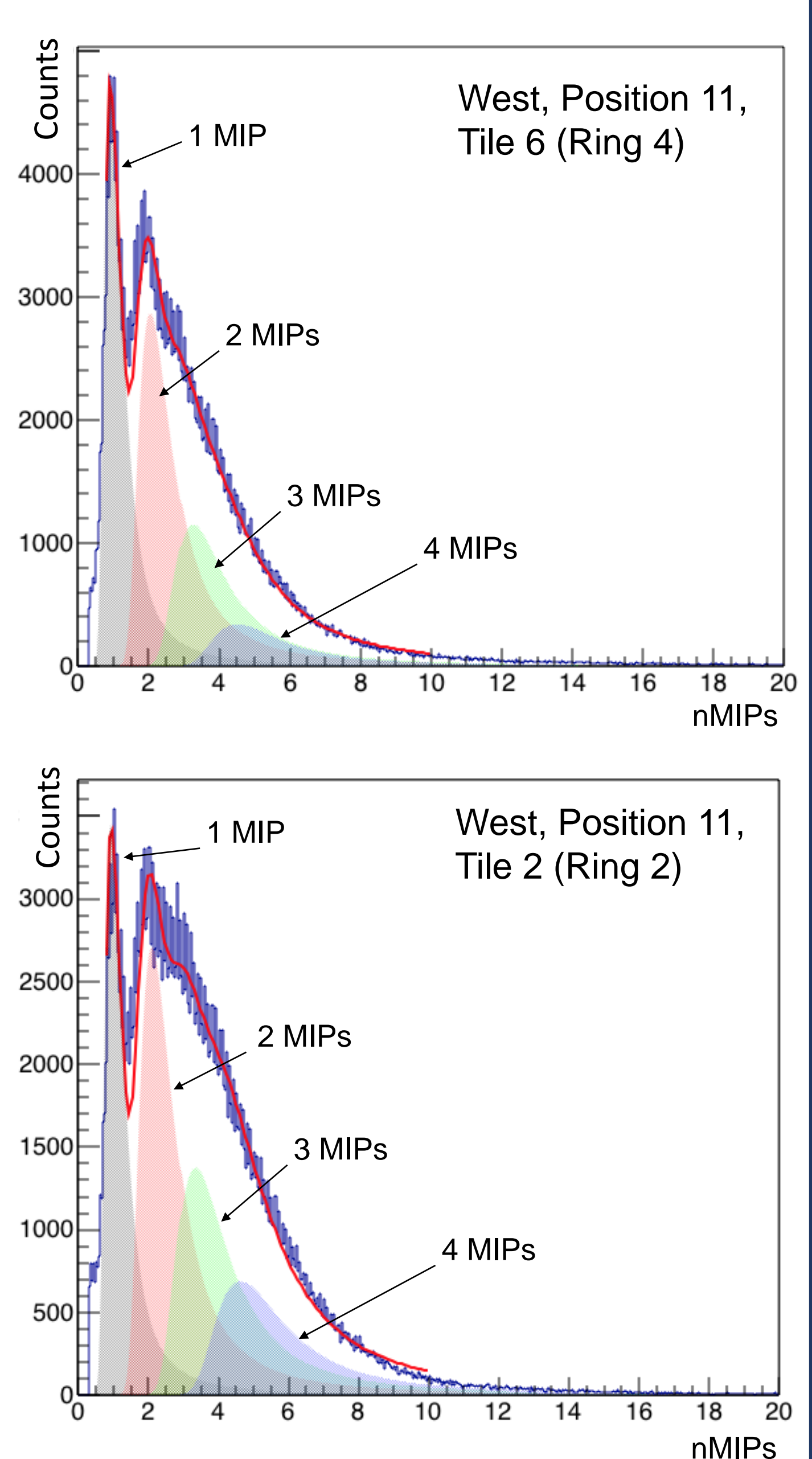
Inner tiles see more particles on average, leading to a higher average ADC. Only rings 1 through 5 have TDC, which are used for triggering. The full coverage of the EPD is  $2.1 < |\eta| < 5.1$ . Ring 1 contains half the number of tiles as other rings, due to the minimum bend radius of the fiber.

## ADCs for Single Tile Position



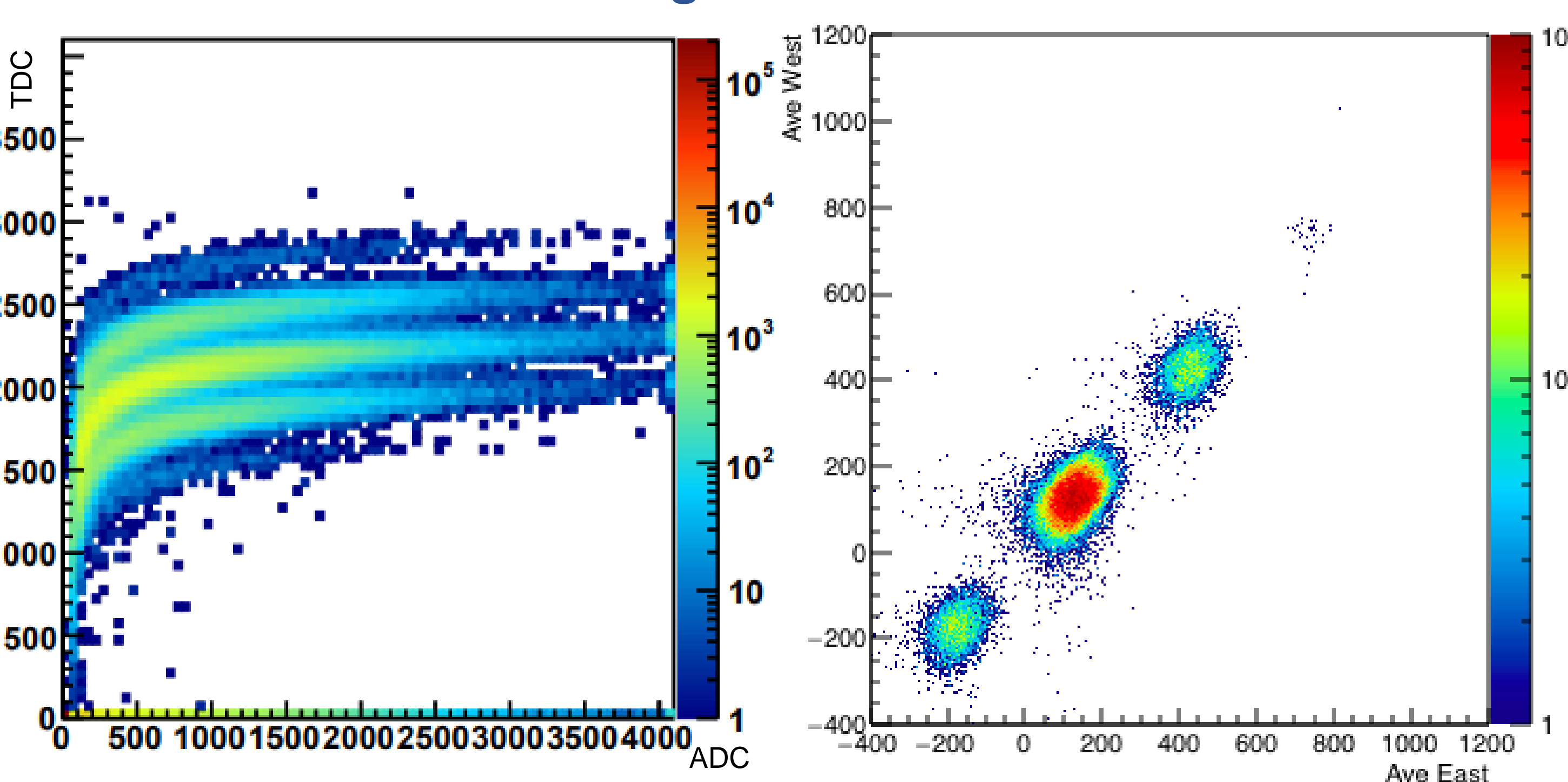
Bias voltages have been adjusted so the first MIP peaks are aligned with each other. **No corrections are made offline to match peaks, spectra are extremely uniform with no corrections required.**

## From ADCs to nMIPs



Sample ADC spectra with **multi-Landau fits, corresponding to number of MIPs**, for a tile in the fourth ring (top) and a tile in the second ring (bottom). The tile in the inner ring has more multi-particle events than the outer. A minimum RefMult cut of 100 was made for these plots.

## Timing Performance



ADC vs. TDC for East, Position 1, Tile 1. The **beam profile can be clearly seen.**

Average TDC East vs. West, after QA cuts and slewing corrections, the beam profile can be seen, including the **satellite peaks.**

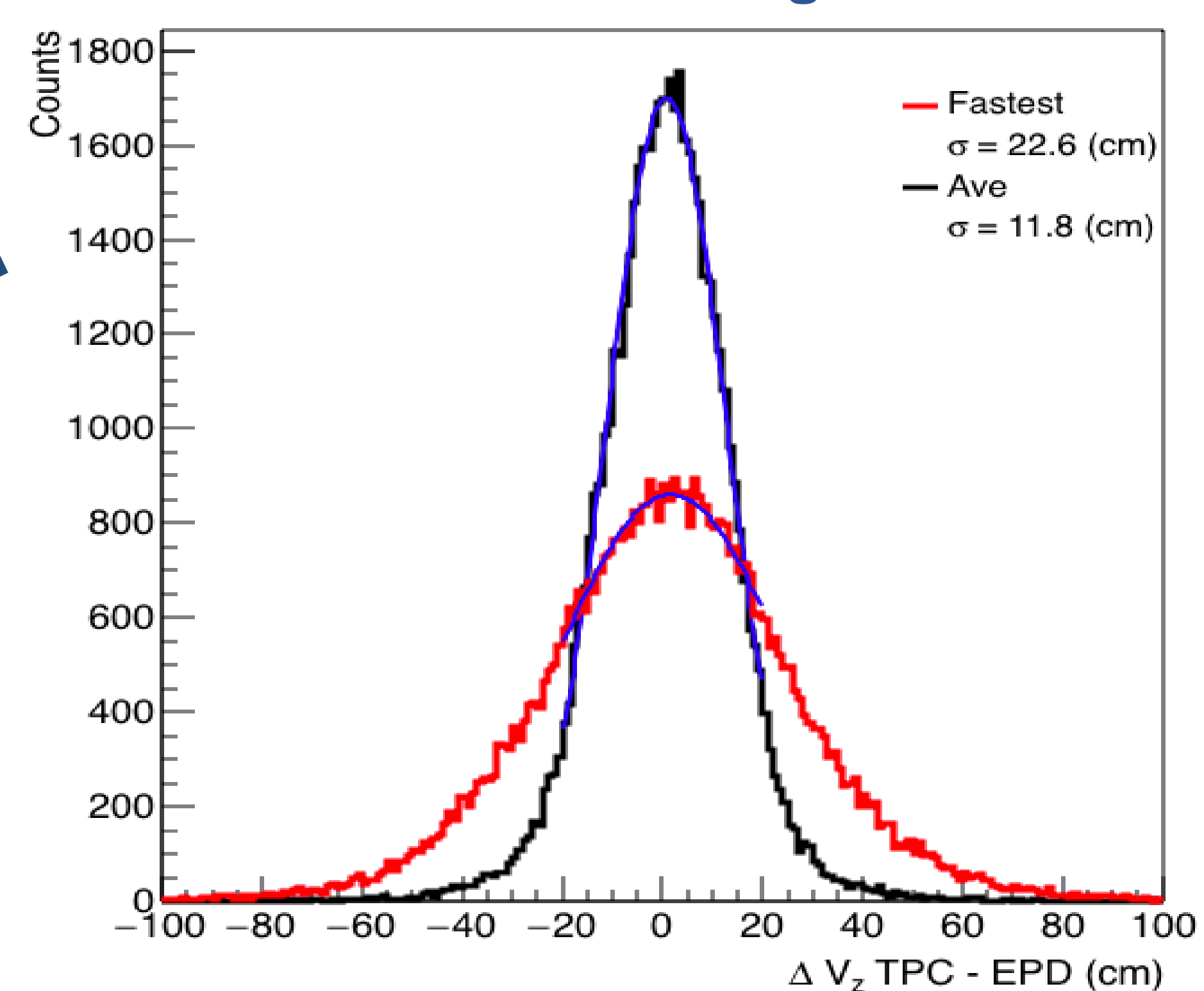
## Conclusions

- All 744 channels working** with good signal.
- MIP peaks visible in every channel, with inner tiles seeing **multiple MIP peaks** in ADC spectra.
- EPD has been **used as a Trigger detector** for STAR during the current run.
- Offline timing resolution of **0.39ns** after corrections.
- See Isaac Upsal's poster (ID 527) for Event Plane and Centrality Resolution and Joseph Adams' poster (ID 20) for Construction details.
- All data shown is for the 200 GeV Isobar run at STAR. Based on these results, the performance for the Beam Energy Scan is expected to be excellent.

## Acknowledgements

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## Timing Resolution



Difference in offline z-Vertex position between TPC and EPD, with rough slewing corrections. Fitting with a gaussian, this gives the z-vertex spatial resolution of the EPD as 11.8cm, which corresponds to a **0.39ns time resolution**, which is well within the design specification of 1ns. This is from MinBias data with no centrality cuts.