U.S. DEPARTMENT OF ENERGY | Office of Science
BROOKHAVEN NATIONAL LABORATORY

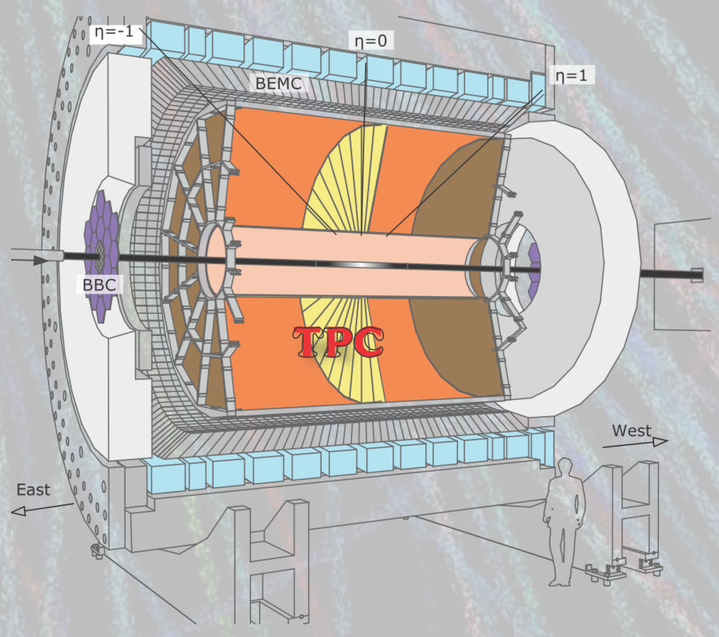
Irakli Chakaberia
For the STAR Collaboration
RHIC/AGS Meeting, 2016

THE BRIGHTER STAR

The Solenoidal Tracker at RHIC (STAR) is the multi purpose detector that started collecting, high energy, heavy ion and proton, collision data in the year 2000. Since then **STAR has shed light** on many of the most fundamental properties of the quark-gluon interactions. Time projection chamber (TPC) of the STAR detector proved to be a very capable tracker for high multiplicity events provided by heavy ion collisions. It also clearly showed the **path forward** to the new physics. To follow this path the upgrade of the inner sectors of the TPC was proposed. Ensuring increase in efficiency towards the high rapidity / forward tracks, that may enable STAR to shed **brighter light** on quark-gluon plasma including its, thus far elusive, critical point.

STAR Detector

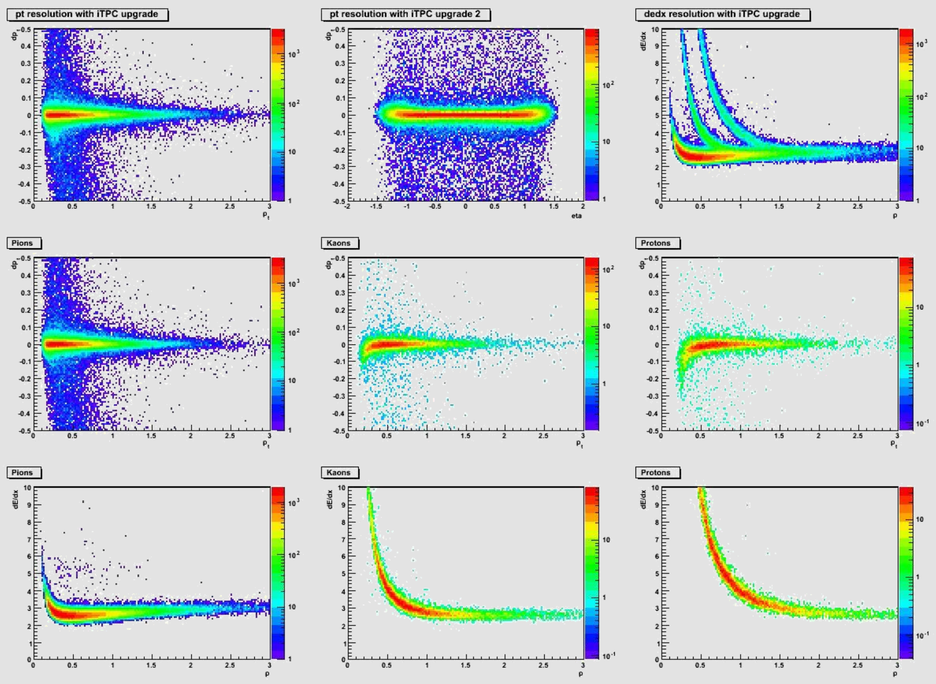
TPC is the main tracker detector of the STAR. It consists of 4 meter long and 4 meter diameter cylinder filled with the P10 gas. Both sides of the cylinder are almost hermetically covered with sensitive electronics. Each side consists of 24 sectors of multi-wire proportional chambers. Each sector is divided into inner (**iTPC**) and outer parts that could be separately replaced.



Track reconstruction in TPC is based on the ionization of the gas in the TPC volume, by the traversing particles, and collection of the energy loss $\left(\frac{dE}{dx}\right)$, during the ionization, carried by the electrons knocked out of the gas atoms.

TPC Simulation

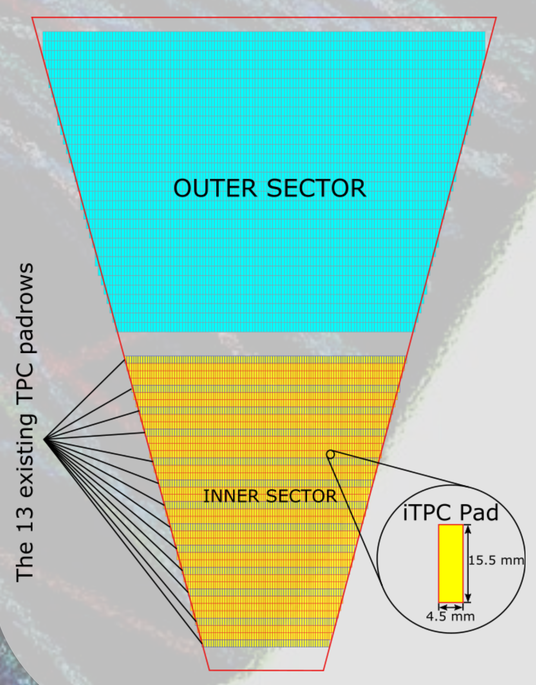
Plot below shows the main characteristics of the track reconstruction to demonstrate that the new padplane design could be successfully paired with existing clustering, $\frac{dE}{dx}$ measurement, and reconstruction algorithms.



The simulation study was performed for various iTPC configurations and size and density of the pads were optimized to achieve the highest momentum resolution.

iTPC Upgrade

In order to increase the forward track reconstruction efficiency, $\frac{dE}{dx}$ resolution and reach to the tracks with lower momenta, the multi-million dollar upgrade project of the iTPC was proposed.

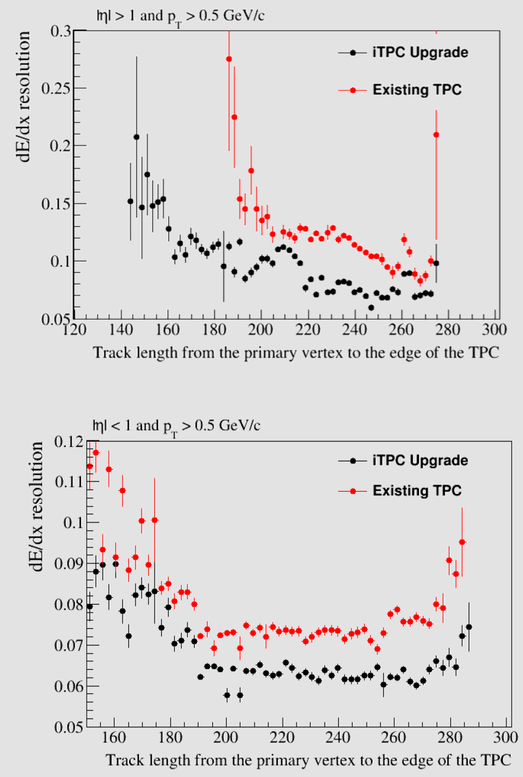


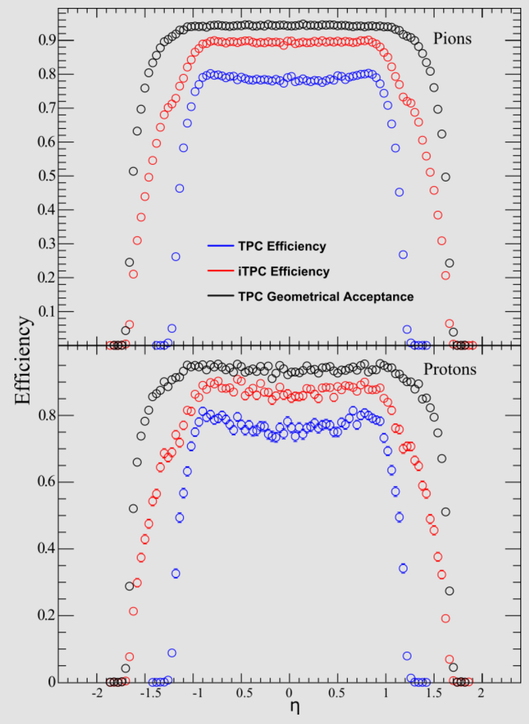
Crude way of visualizing proposed upgrade is shown on this picture.
Existing inner sectors of the TPC only furnish 13 padrows, which limits the reconstruction efficiency of quality tracks in the forward direction. The upgraded iTPC will have hermetic coverage of the region with 40 padrows.

In order to justify the proposal and illustrate the physics outcome of the upgrade, rigorous simulation work was performed. The design of the new iTPC was optimized using these simulations.

Results of the Simulation

The simulation shows that $\frac{dE}{dx}$ resolution is significantly improved due to the effective increase of the measured track length in TPC. The pseudorapidity coverage is nearing the geometrical acceptance limits of the detector, which at the same time enables reconstruction of the low transverse momenta particles that, in current setup, were unable to accumulate enough registered hits due to the magnetic field confining their tracks into a tighter central region.





Summary

In conclusion, the simulation studies confirm that additional pad rows on the inner sectors improve momentum resolution, $\frac{dE}{dx}$ resolution and increases the acceptance of the detector. It is important to have complete coverage of the inner sectors. The upgraded inner sectors will have 40 pad rows (instead of existing 13) and a total of 3370 pads per sector. This roughly triples the number of padrows, hence the number of registered hits from the tracks, therefor results in **brighter STAR** to produce brighter results. The proposal was approved and work is being carried out to have new sectors installed for the run in 2019.