

The STAR iTPC Upgrade

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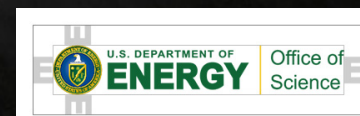


Fifth Joint Meeting
of the Nuclear Physics Divisions
of the APS and the JPS

第5回 日米物理学会 合同核物理分科会

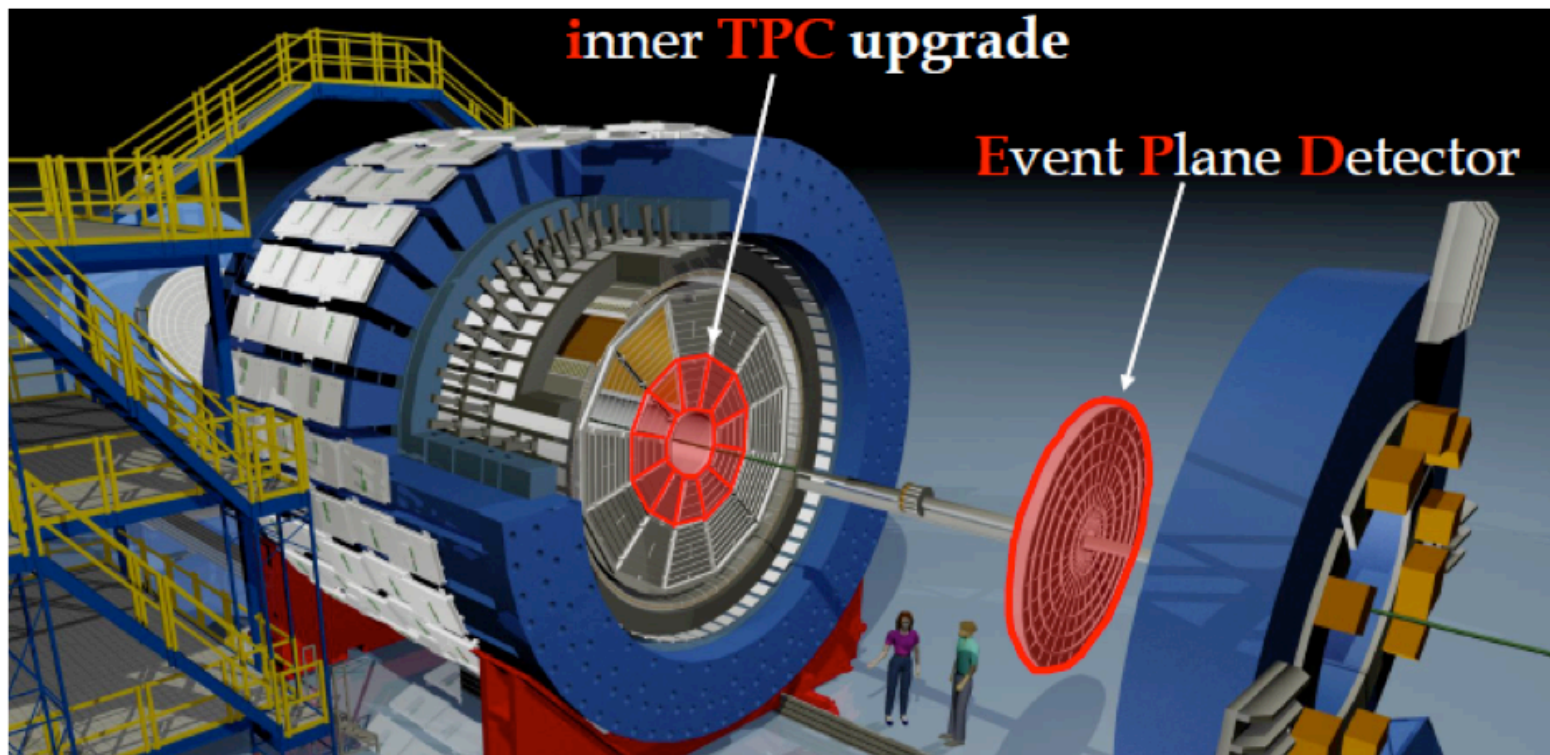
OCTOBER 23–27, 2018

Hilton Waikoloa Village,
Hawaii Island



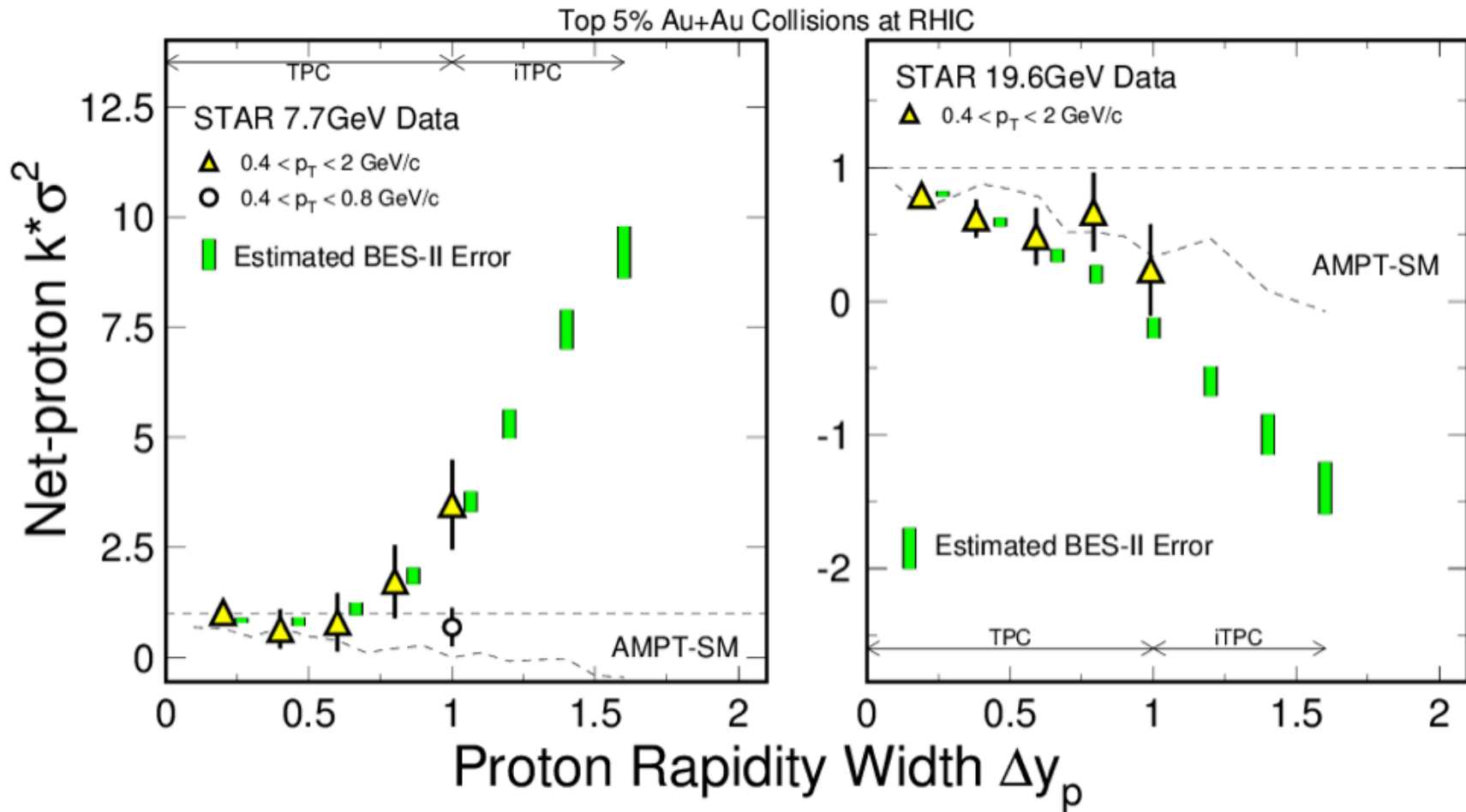
STAR: Solenoidal Tracker at RHIC

iTPC: inner Time Projection Chamber



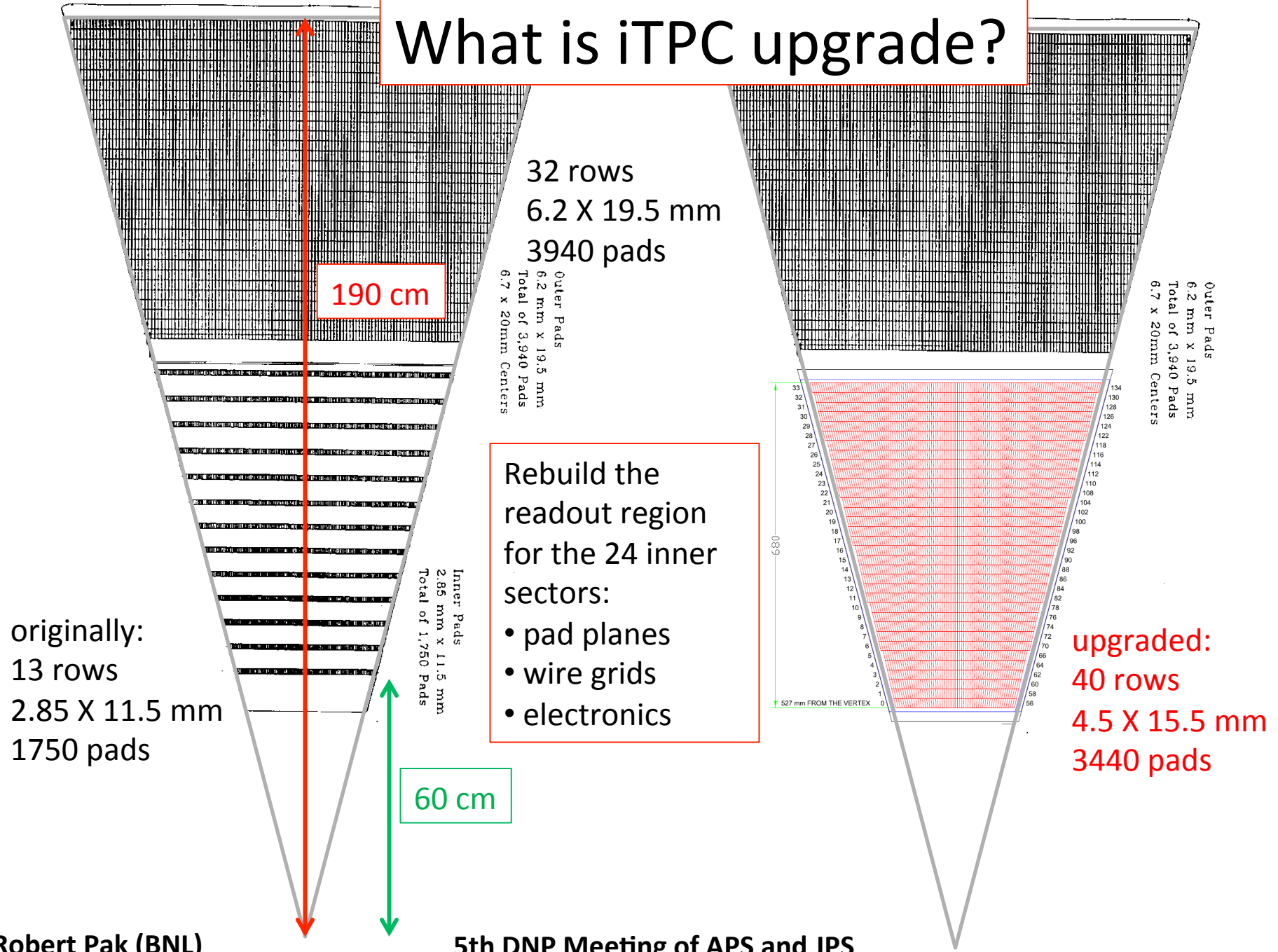


upgrade in “one plot”



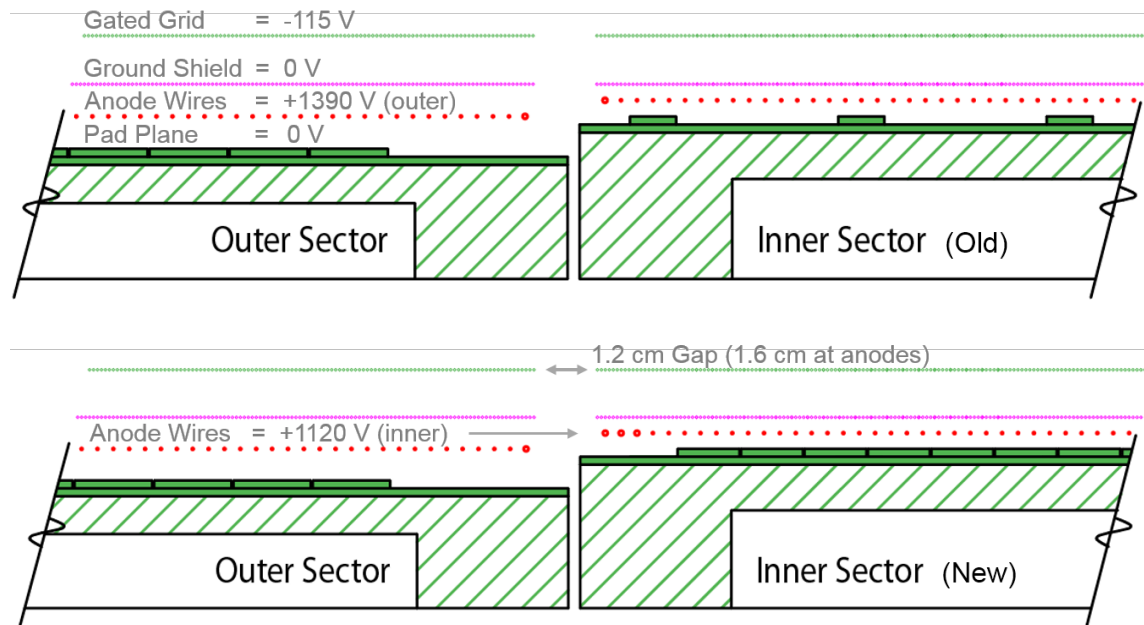
Expanding the coverage to $y = 0.8$ increases the significance by a factor of 3.
Low energy cooling from LEReC reduces uncertainty due to higher luminosity.

What is iTPC upgrade?



close-up cross section

anode wires spaced 4 mm apart, ground shield and gated grids spaced 1 mm apart

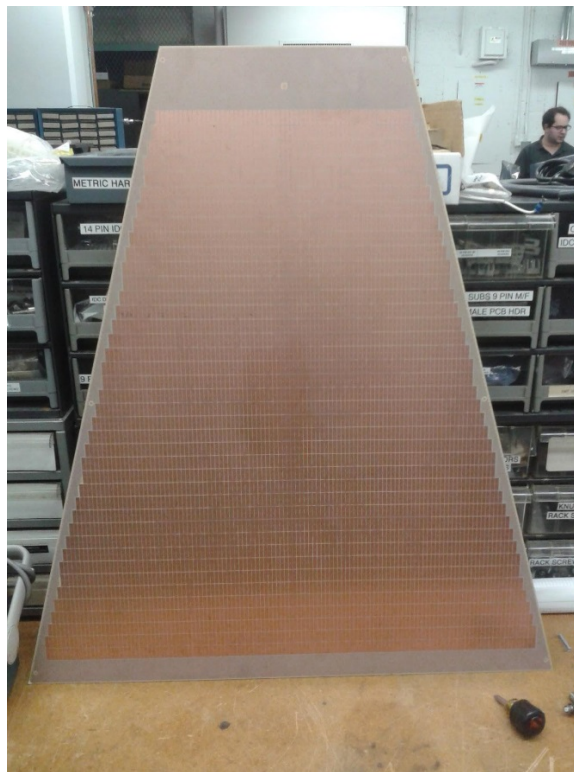


- 40 pad rows fit perfectly with existing grid
 - identical pad response function on both ends of the grid
 - no need to change the grid; wire locations remain the same
 - no need to add more wire mount channels

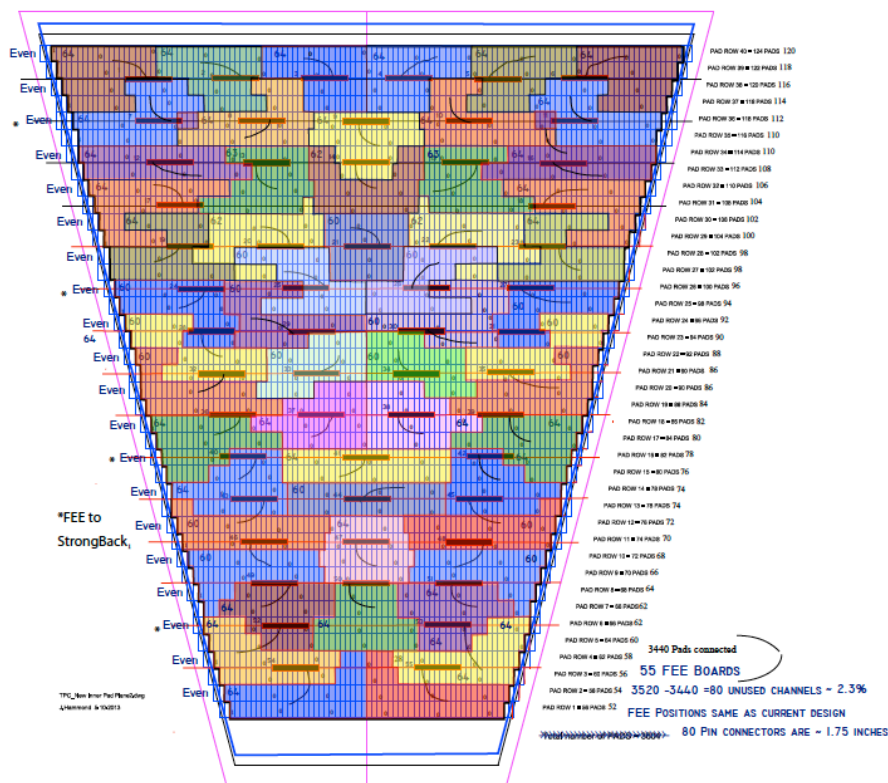


new iTPC pad plane

- increase coverage with higher density front end electronics
- relatively large area printed circuit board was challenging
 - minimize trace lengths to reduce capacitive noise
 - same number of connectors as original inner sectors
 - same number of even/odd pads per connector for backward compatibility
 - same mounting brackets and cooling manifolds



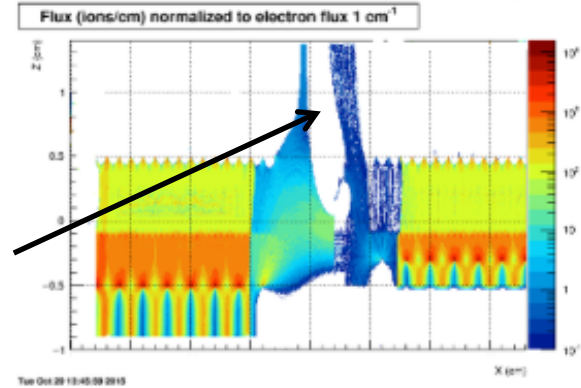
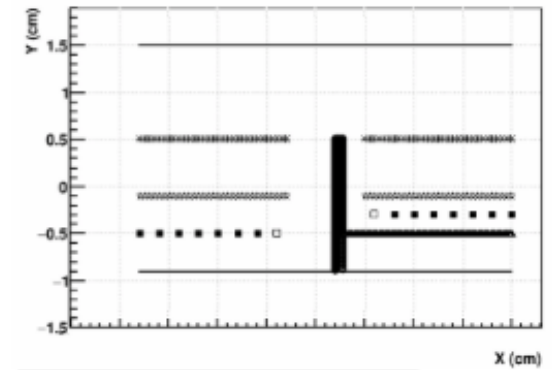
pads on the front



pad plane connector layout on the back

strongback

- aluminum support frame for iTPC sector
- original drawings (circa 1993) used to create 3D CAD model
- slight modifications:
 - slots for iFEE cards moved by 5.6 mm
 - walls to mitigate grid leak added

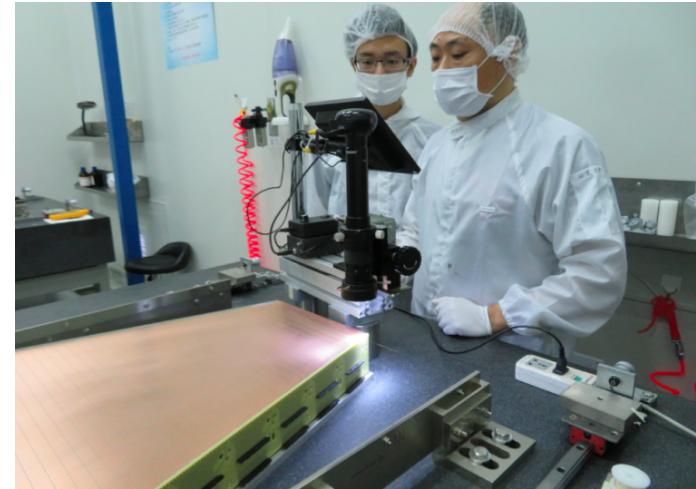


strongbacks fabricated at IMT Precision in Hayward, CA



MWPC assembly process

- @ LBNL:
 - bond pad plane to strongback
 - machine O-ring groove
 - prefit wire mounts
- In China – SDU, USTC, SINAP
 - wire grid plane production started Feb 2017
 - 1st production version arrived at BNL in Sept 2017
 - sector tests (HV burn-in, gain uniformity and stability)
 - 24 sectors + spares delivered (last shipment Oct 2018)
- @ BNL:
 - testing of all fully assembled modules before installation

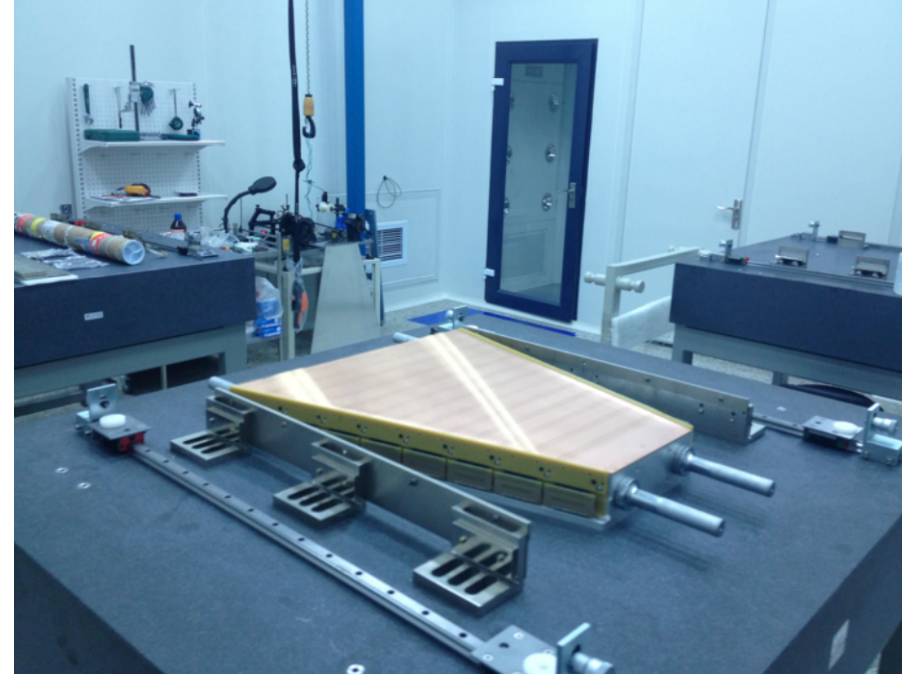




facilities at Shandong University



wire pitch and tension controlled by
wire winding machine



clean room with granite tables for assembly

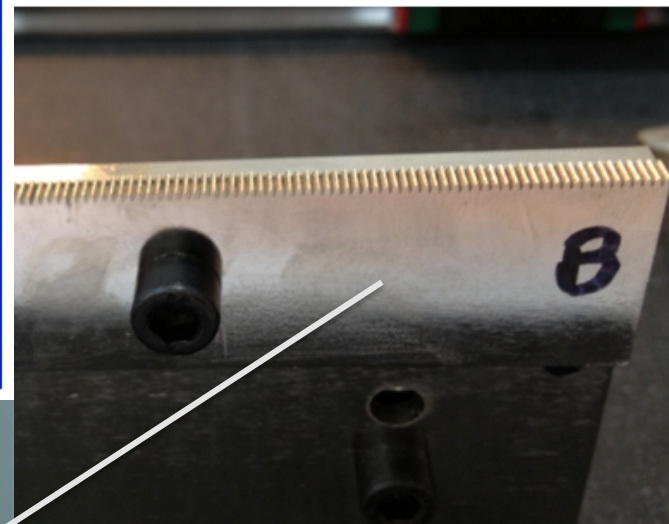
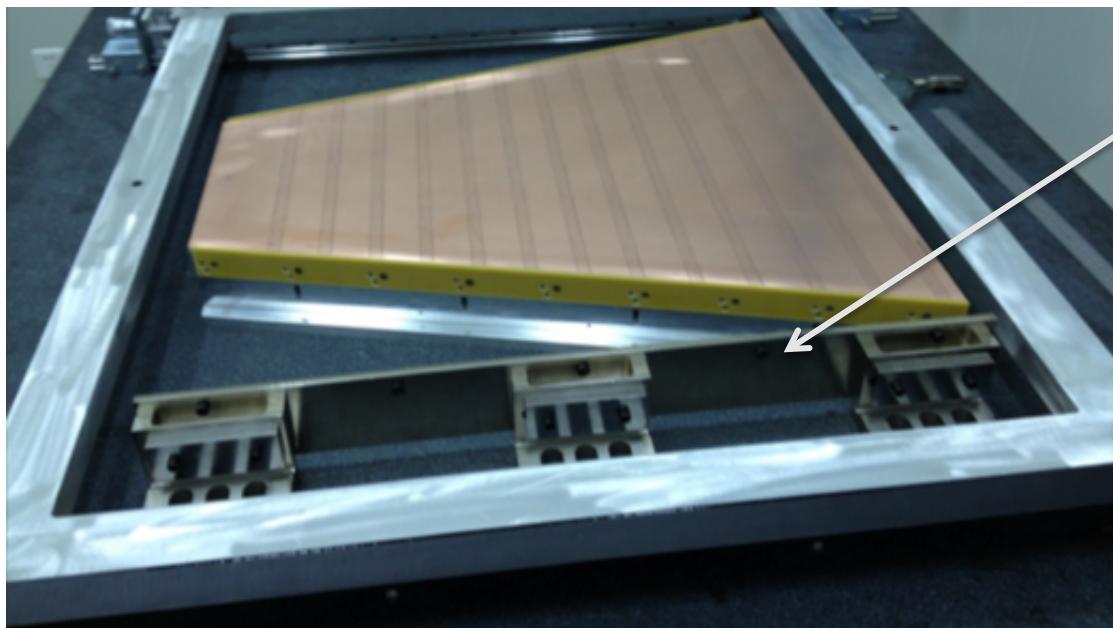
not shown: wire tension measurement system and cosmic ray test stand



mounting of wire grid planes

anode, ground shield and gated grid planes mounted at SDU

Wire	Diam. (μm)	Pitch (mm)	Composition	Tension (N)
Anodes	20	4	Au-plated W	0.50
Anodes— last wire	125	4	Au-plated Be-Cu	0.50
Ground plane	75	1	Au-plated Be-Cu	1.20
Gating grid	75	1	Au-plated Be-Cu	1.20

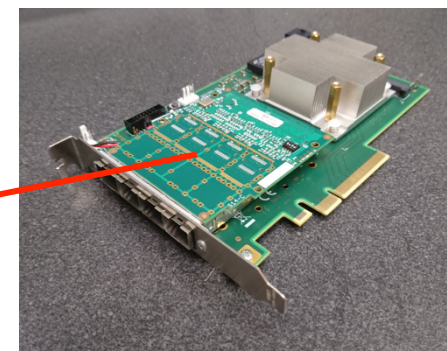
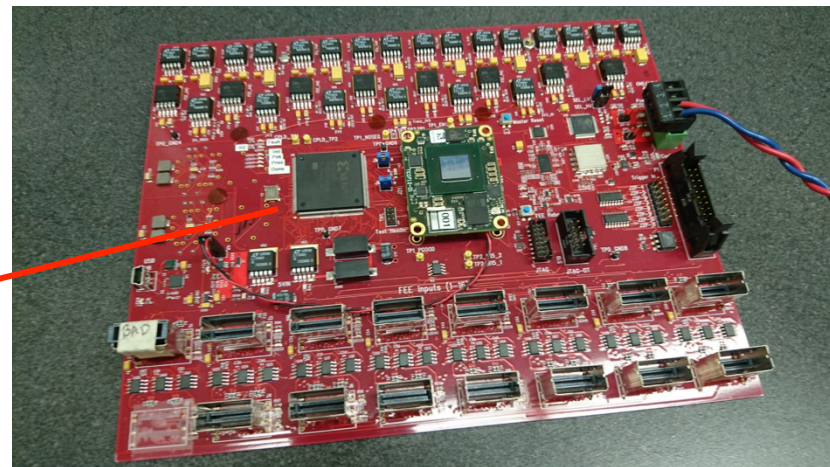
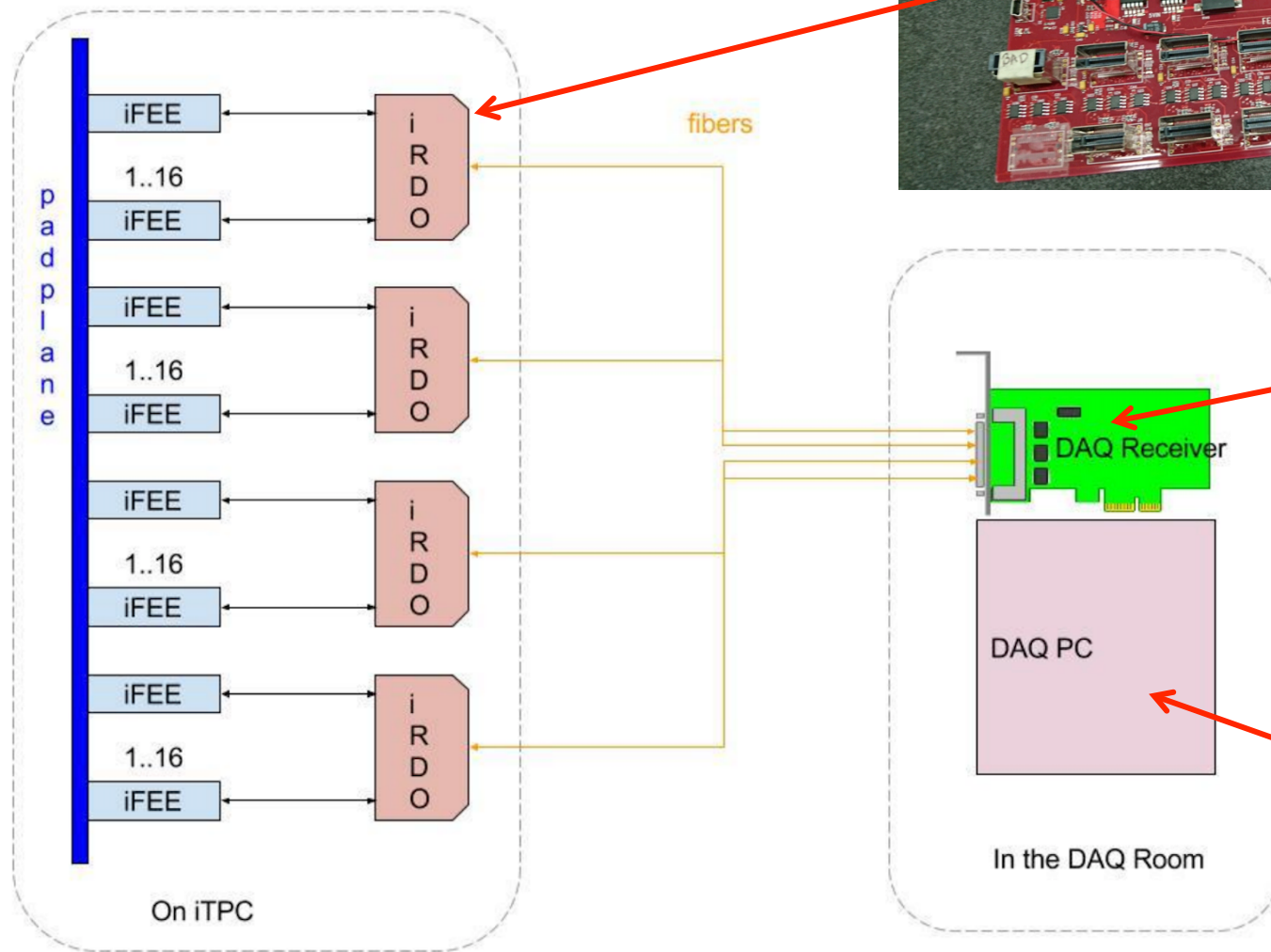


combs for final wire alignment

10 micron tolerance
achieved on wire pitch and
height above pad plane

iTPC electronics

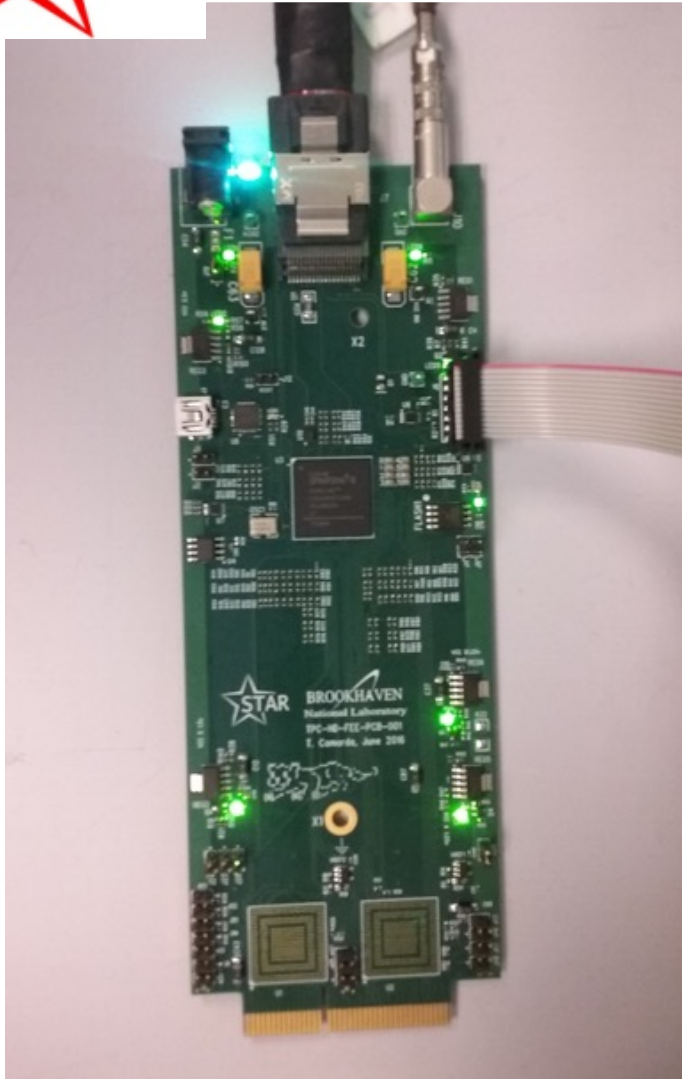
designed by STAR Electronics Group



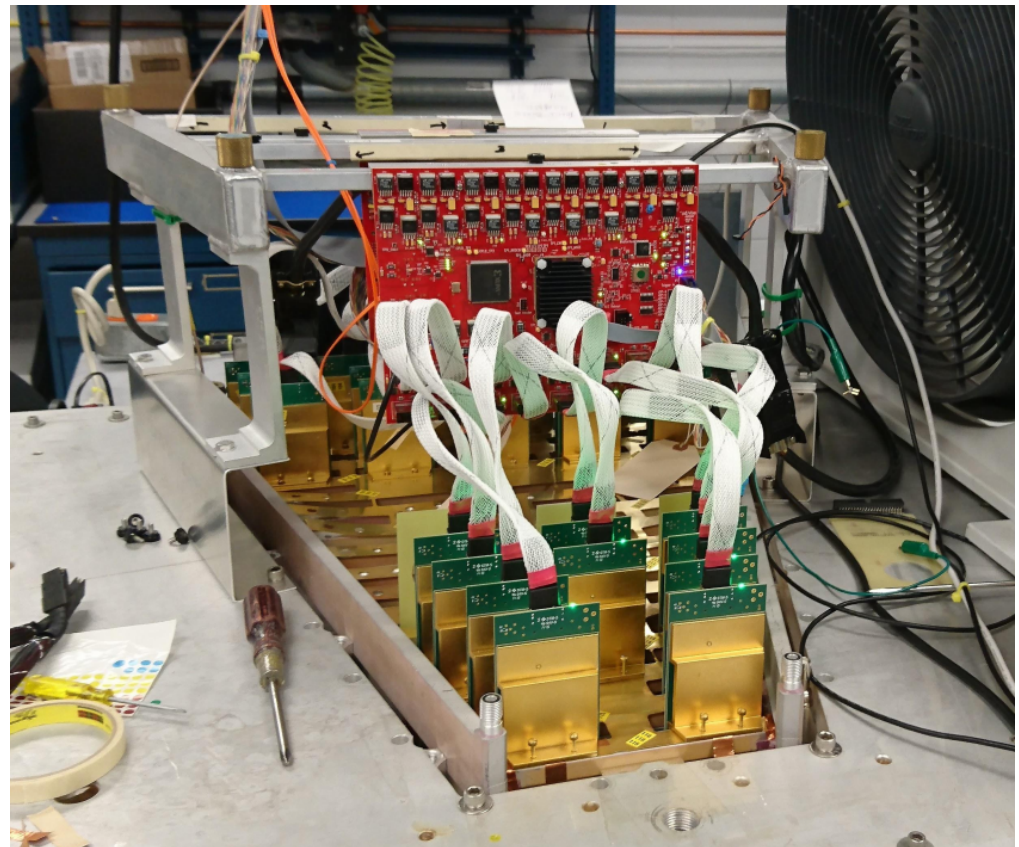


electronics

- iFEE based on current FEE layout, but using SAMPA ASIC
- twice the number of channels per FEE as compared to previous FEE



prototype iFEE card sans SAMPAs

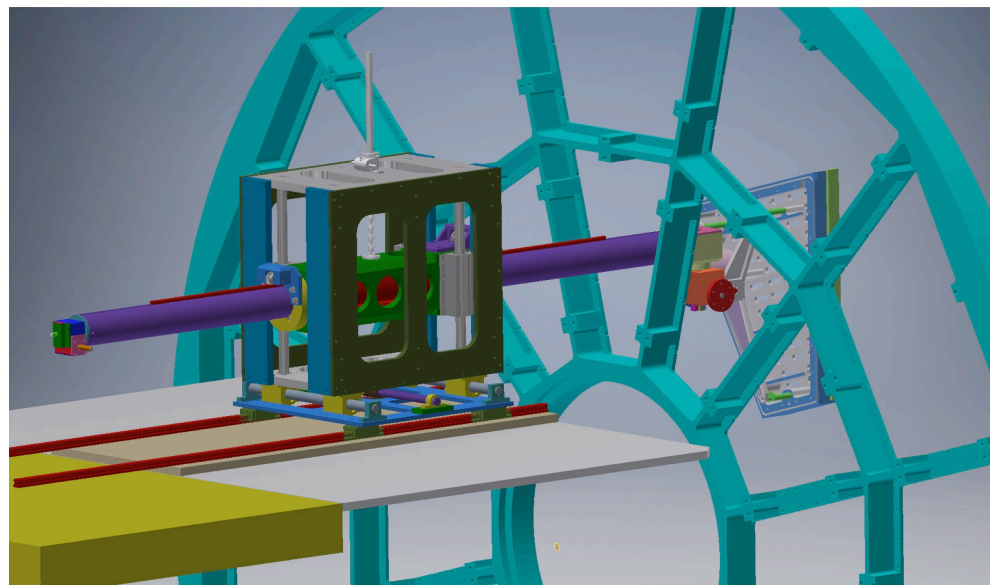


test bench set up at BNL



installation tool and platform

designed by STAR Technical Support Group



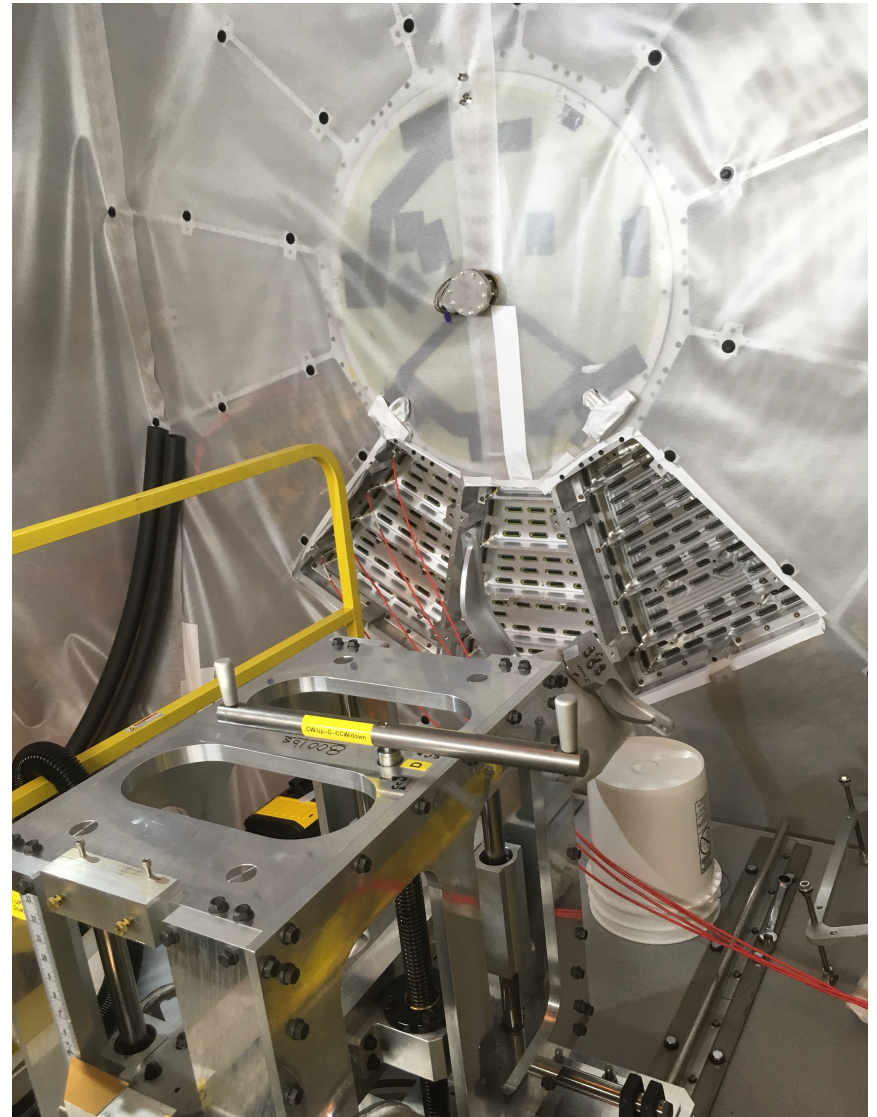
fabricated at LPI Lift Systems

machined at UIC and BNL shops





installation of iTPC sectors



all 24 iTPC sectors have been successfully installed

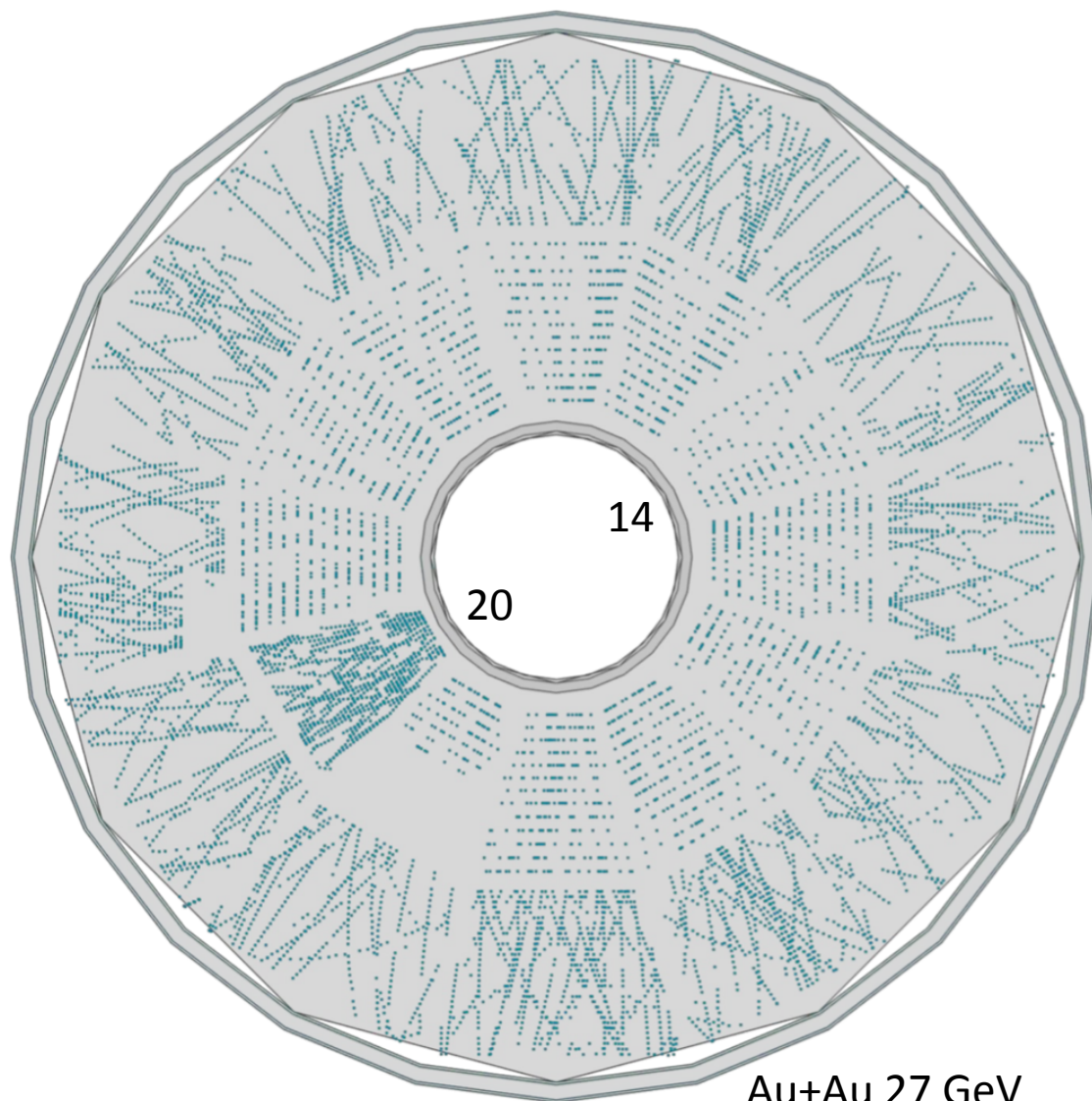


basic performance improvements

The iTPC upgrade:

- 1) extends the accessible rapidity range
- 2) reduces the low p_T cut-in threshold
- 3) improves dE/dx resolution

During the 2018 RHIC run an iTPC sector was installed at the 8 o'clock location (sector 20) on the east side of STAR detector.



Au+Au 27 GeV



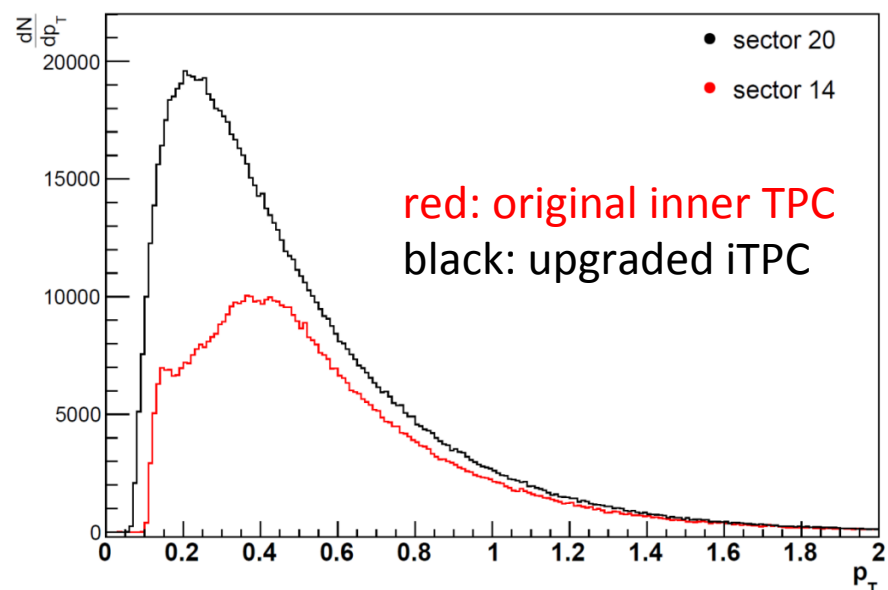
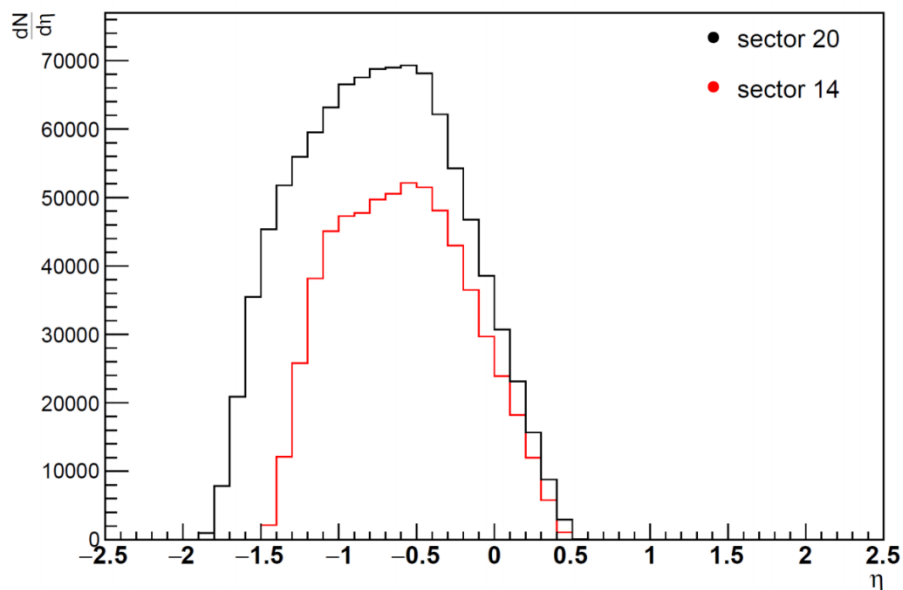
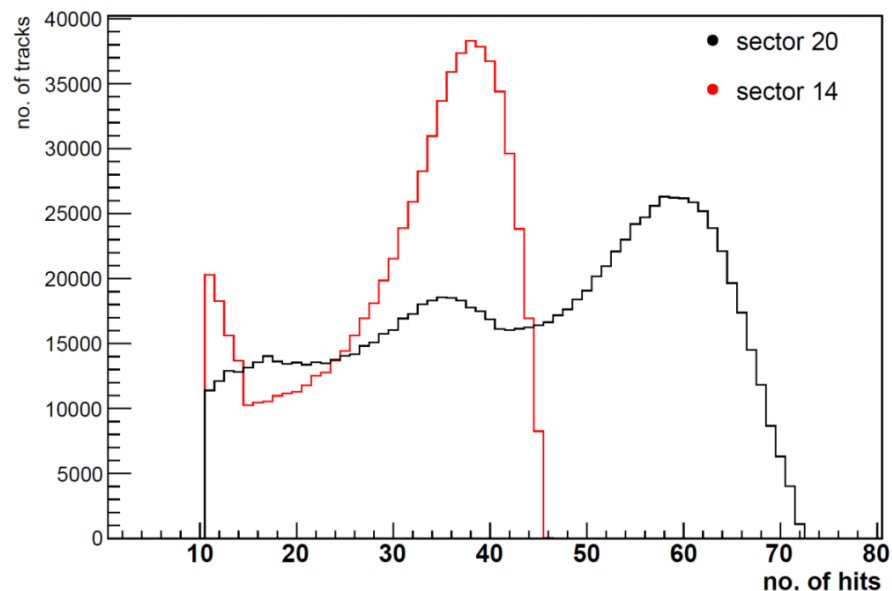
results from the 2018 RHIC run

Number of hits per track increases in the iTPC sector compared to an original inner sector for 27 GeV Au+Au data from 2018 RHIC run



The iTPC upgrade:

- 1) extends pseudorapidity range to 1.7
- 2) reduces p_T threshold to 60 MeV/c

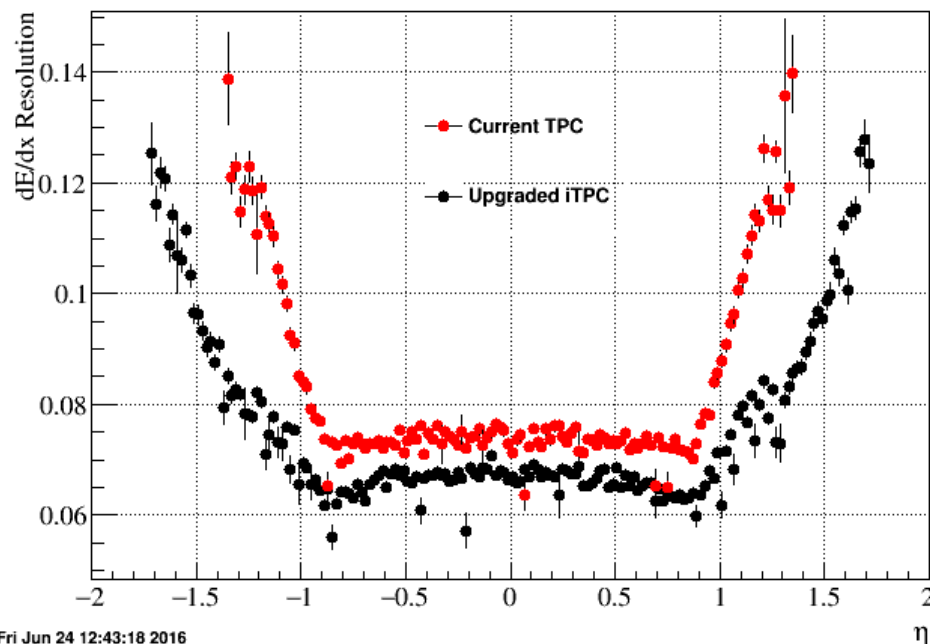




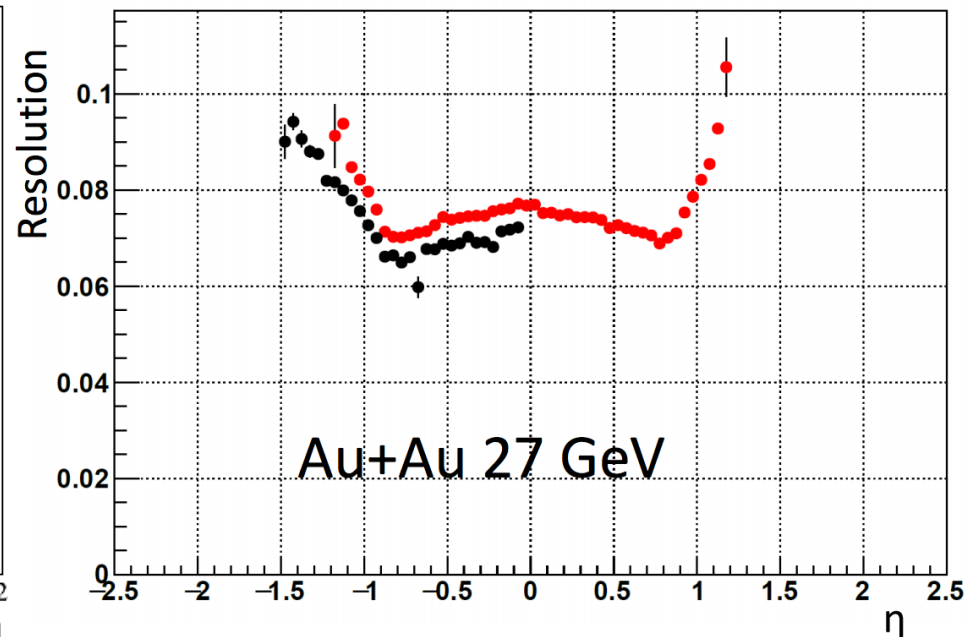
results from the 2018 RHIC run

The iTPC upgrade improves the dE/dx resolution:

simulation



actual data



Summarizing:

- Successful engineering run for iTPC project in the 2018 RHIC run
- All 24 iTPC sectors have now been successfully installed, electronics are next
- Stay tuned for results from the beam energy scan starting Feb 2019