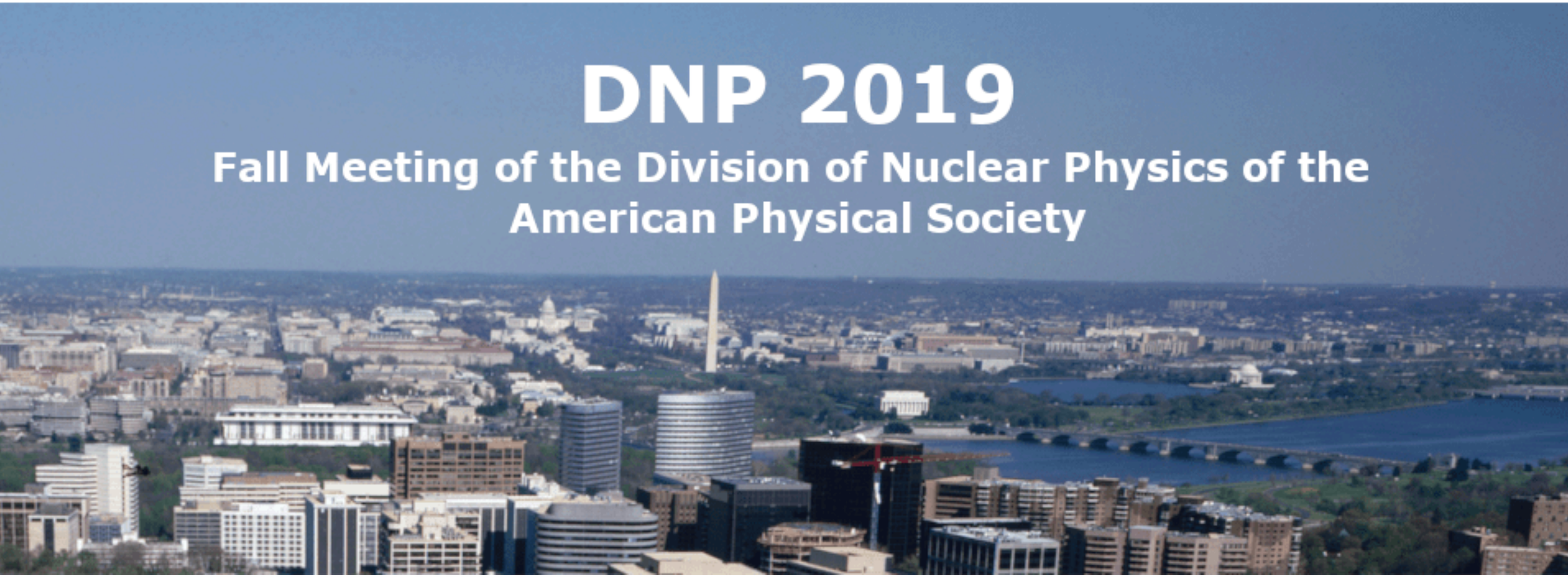
# Studies of a Central Membrane for the sPHENIX TPC



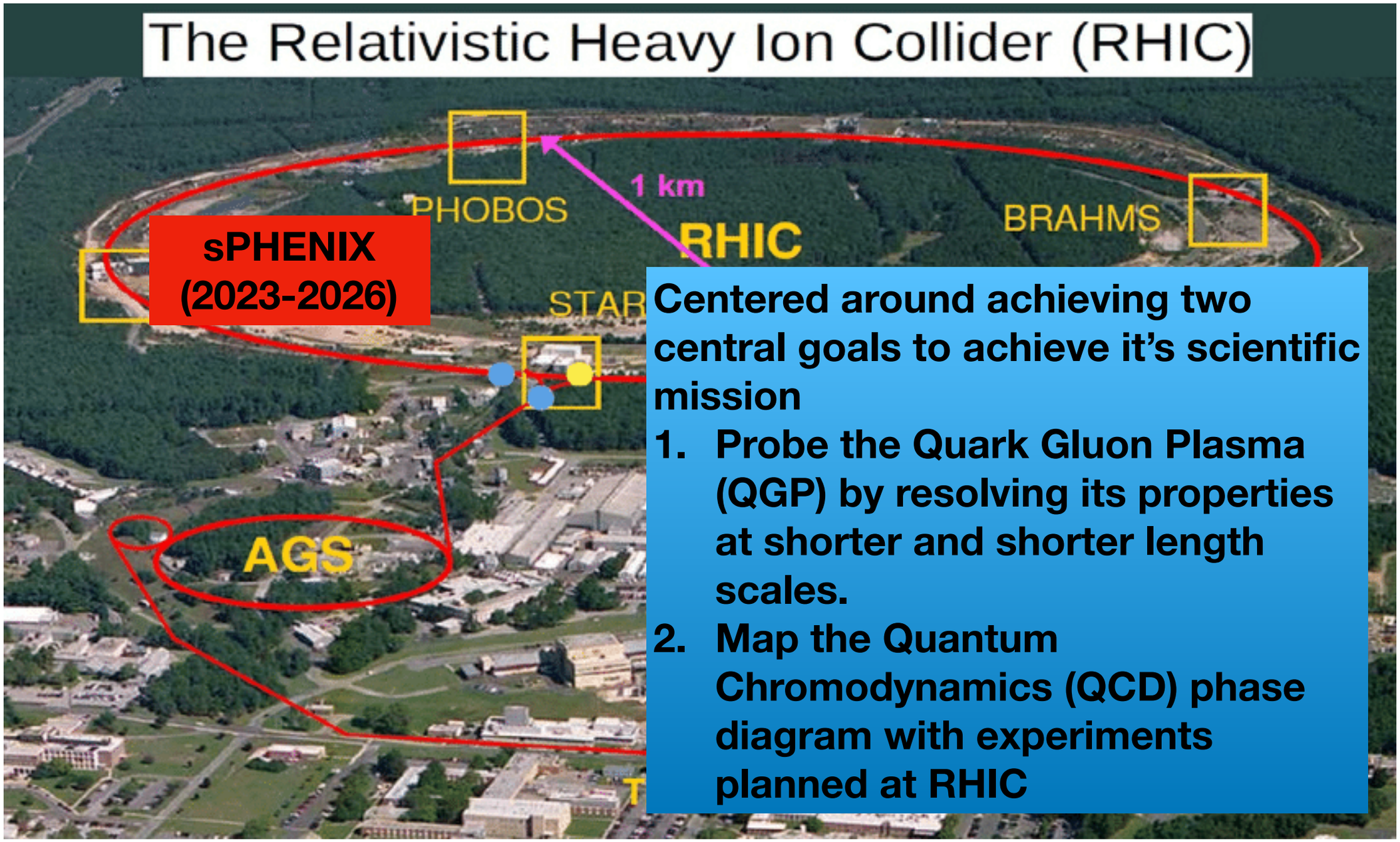

**Sourav Tarafdar (for sPHENIX)**
**Vanderbilt University**
**October 15, 2019**

sPHENIX

VANDERBILT UNIVERSITY

# sPHENIX Overview

Upgrade of recently concluded PHENIX experiment at RHIC in Brookhaven National Laboratory

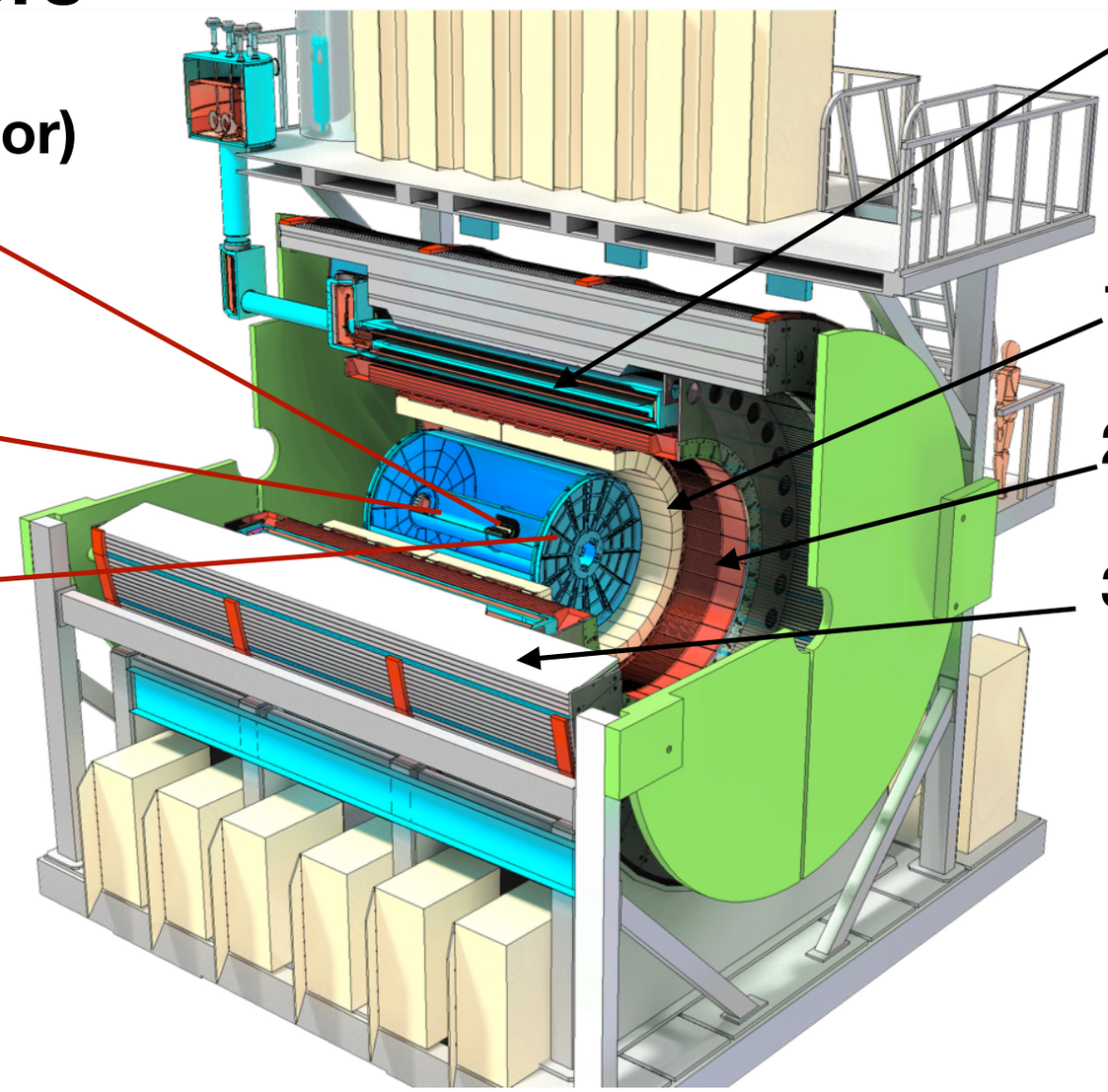


# sPHENIX Overview

Upgrade of recently concluded PHENIX experiment
at RHIC in Brookhaven National Laboratory

**Tracking Detectors**

1. **MVTX (vertex detector)**
2. **Intermediate Silicon layers**
3. **Time Projection Chamber (TPC)**



**Solenoid magnet**

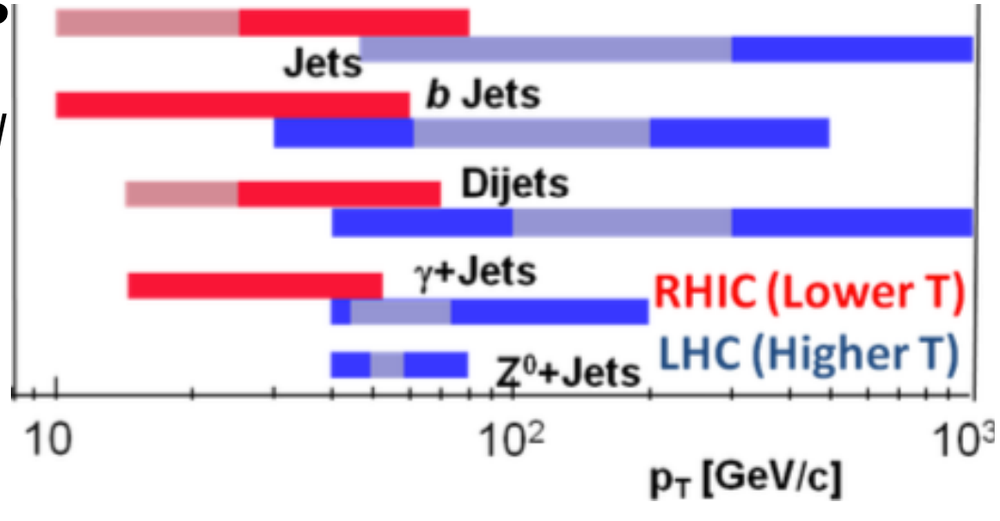
**Calorimeters**

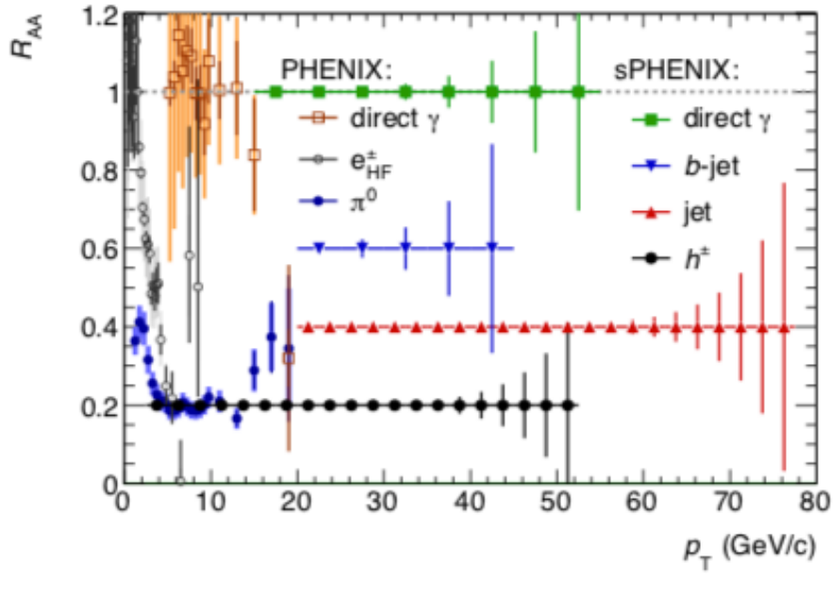
1. **EMCAL**
2. **Inner HCAL**
3. **Outer HCAL**

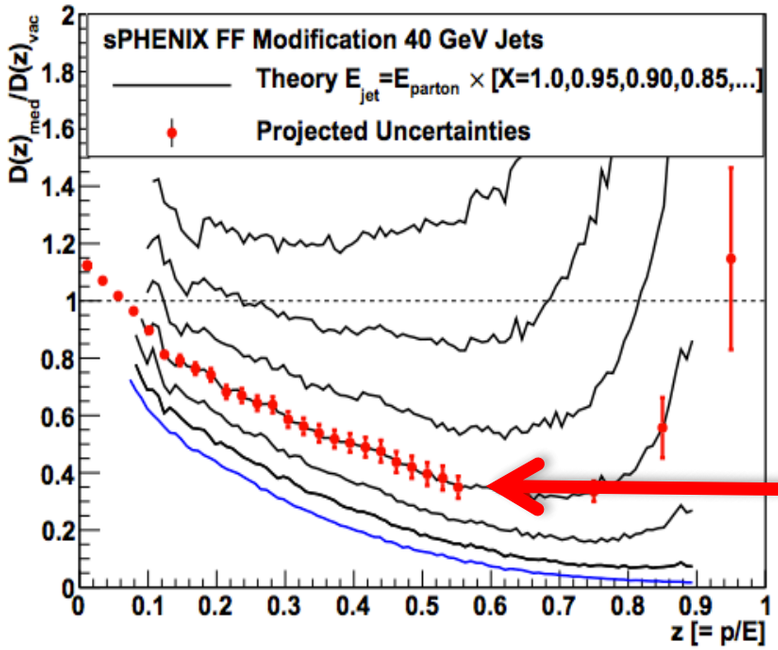
# sPHENIX Measurements

- **Jet measurements**

*Complementing LHC measurements at high pT and Low pT measurements at RHIC*



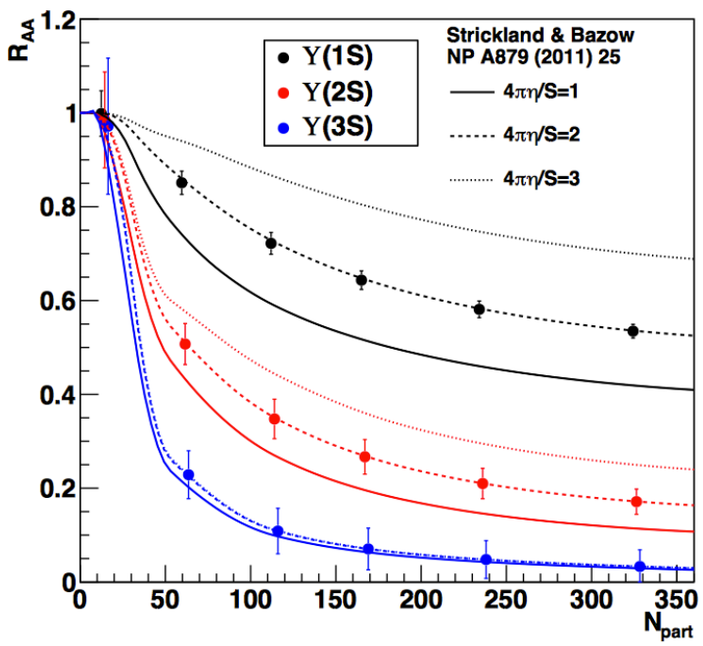



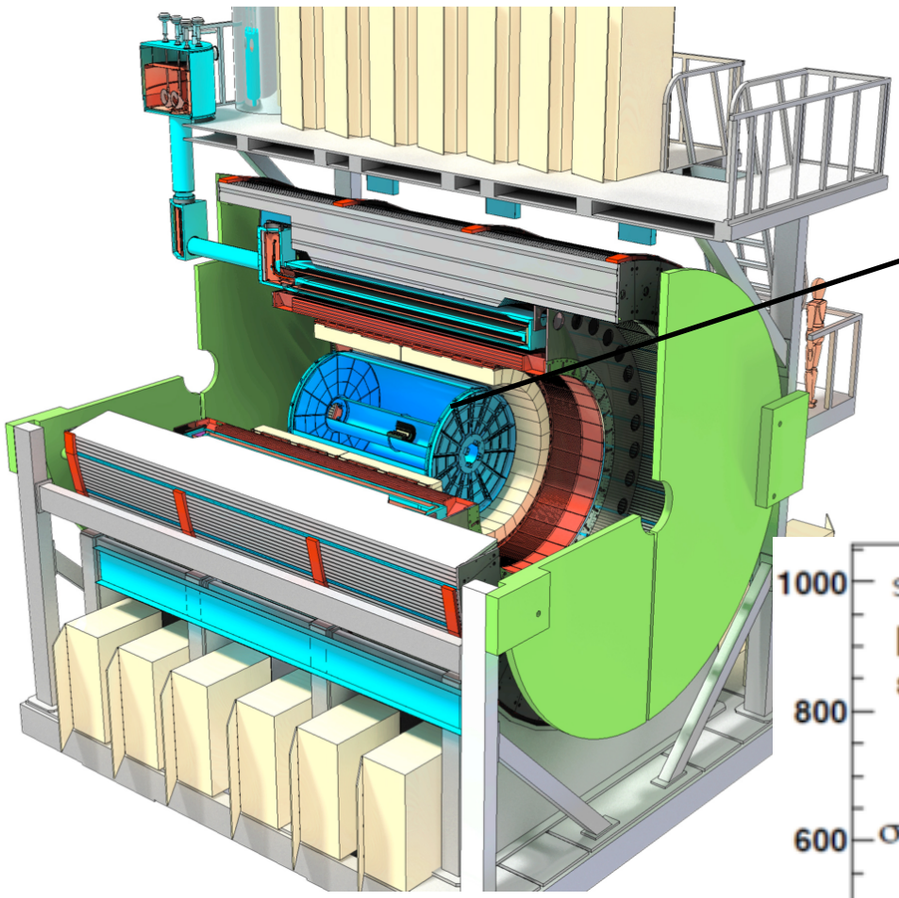

- **Fragmentation function**

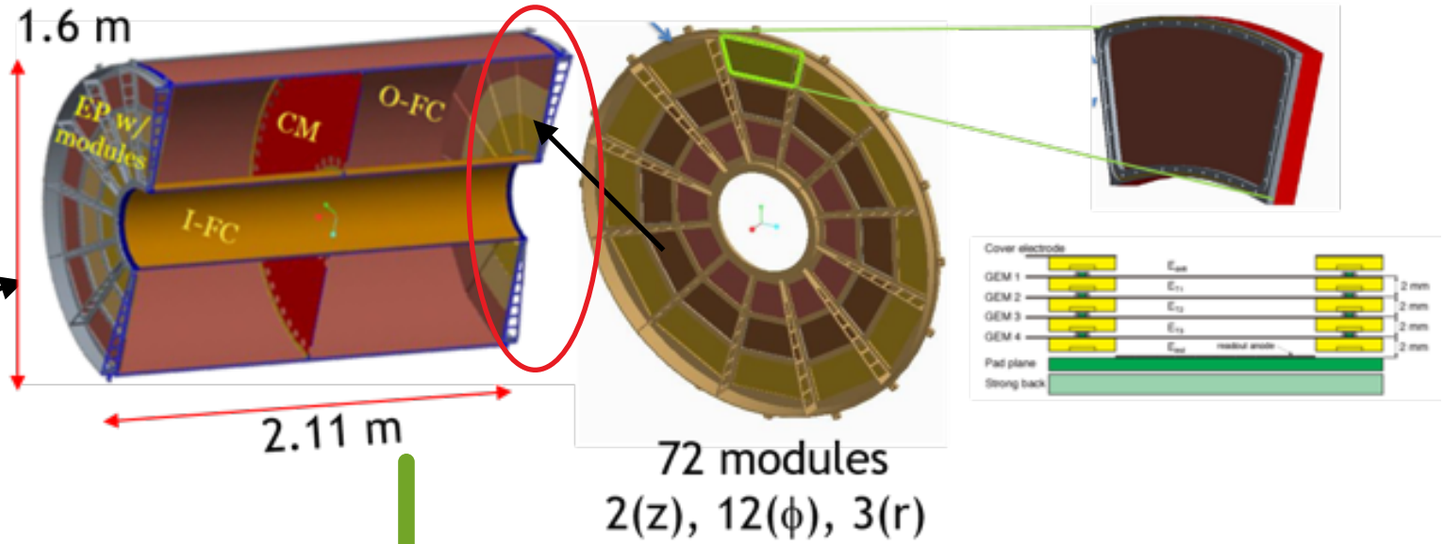
*Large statistics*

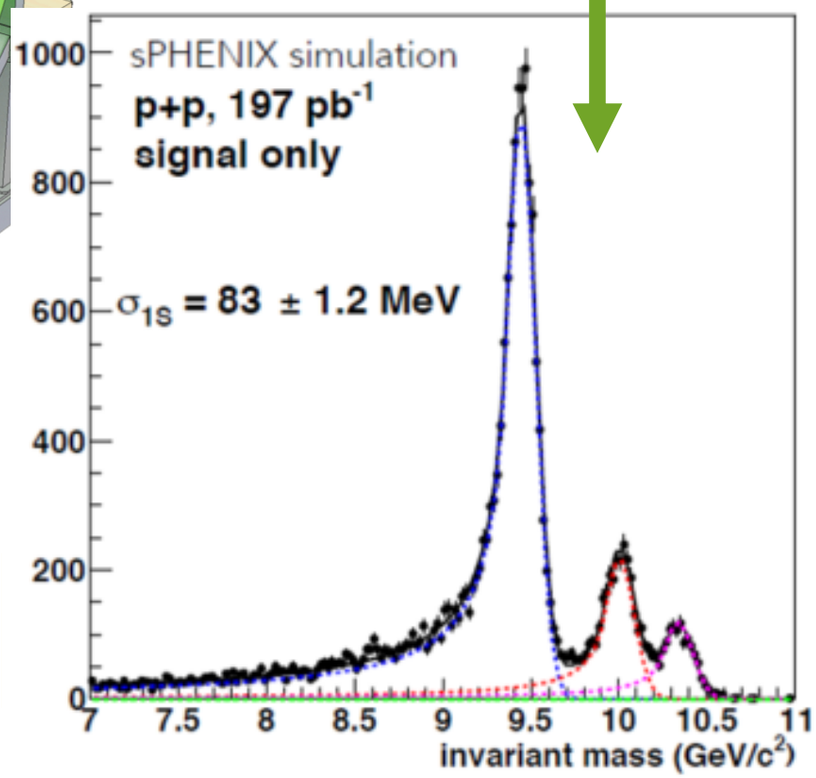
- **Quarkonia measurement**



# sPHENIX TPC





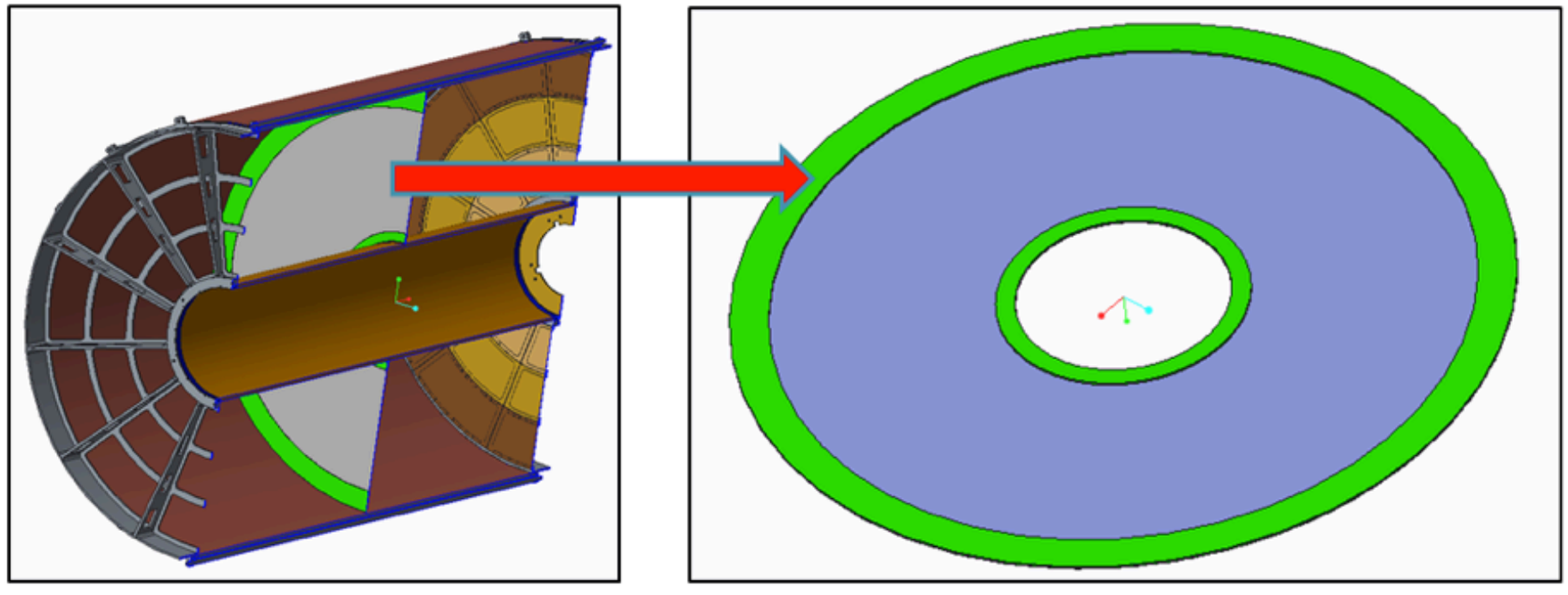

**Excellent p-resolution to resolve three upsilon states**

- **Next generation TPC operated in continuous mode using Gas-Electron Multiplier (GEM) avalanche w/ low Ion Back Flow (IBF).**
- **Front End Electronics (FEE) uses SAMPA chip (developed by ALICE). → Talk by Klaus Dehmelt.**

# sPHENIX TPC :Central Membrane

## Central Membrane Requirements

- **Capability of holding static high-voltage (40 kV) field with a uniformity within 0.1% in R and Z**
- **Remain flat and parallel within 0.002”**
- **Provide a means for laser calibration. (allignment of central membrane will be done using laser)**



# sPHENIX TPC :Central Membrane

## Central Membrane design evolution

- **Initial proposal : Thin stretched copper membrane**

**Disadvantages :**

1. Not stiff
2. Not immune to vibrations.
3. More number of HV contact to field cage due to the need of extra potential on the outside of membrane stiffener to smooth the E-field .
4. High probability of thermally-induced deflections.

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- **New concept : Thick honeycomb membrane with thin FR4 outer layer**

**Advantages :**

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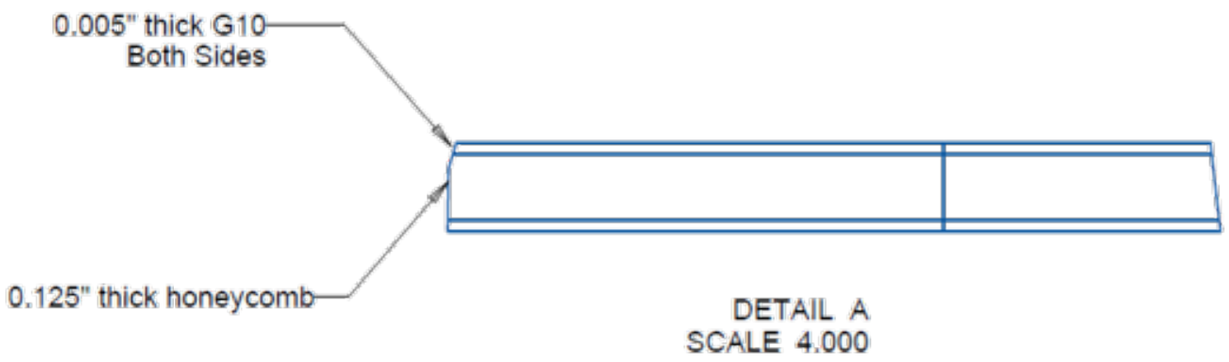

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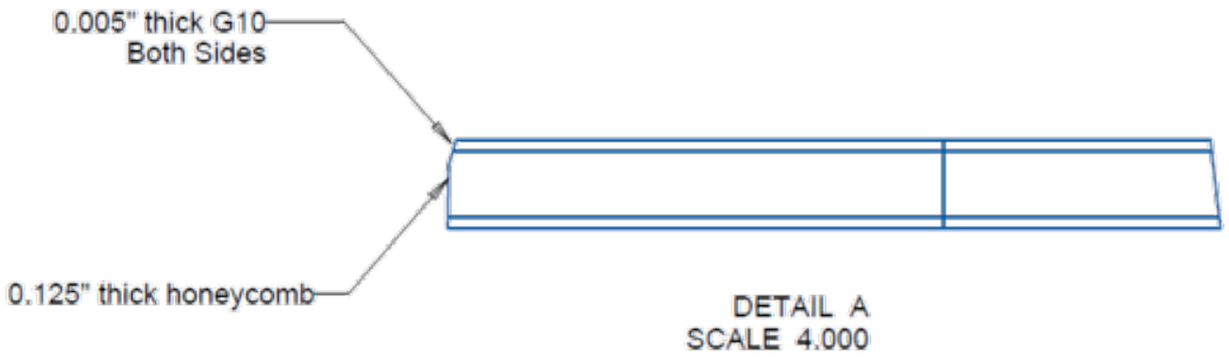


**Concerns :**

1. Mass-in the middle
2. Inactive area in the middle along z

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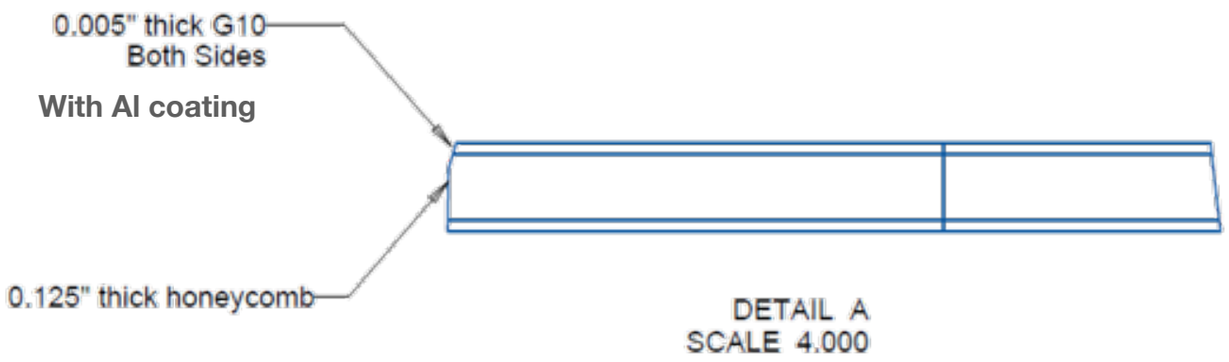


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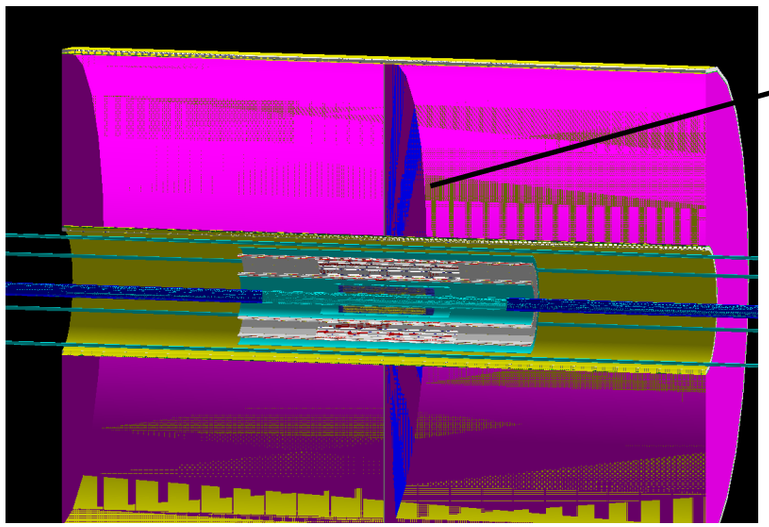
Addressed by simulation studies

# sPHENIX TPC :Central Membrane Simulation studies

Event display with new TPC central membrane



**Single particle Geant4 simulation :**

- *Pions within phase space of 0.1 < pT < 20 GeV , |eta| < 1.0 & |z vertex| < 20*

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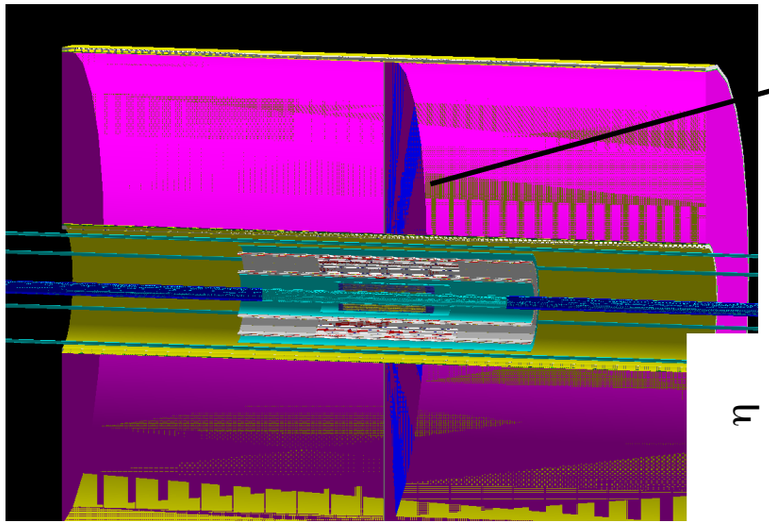

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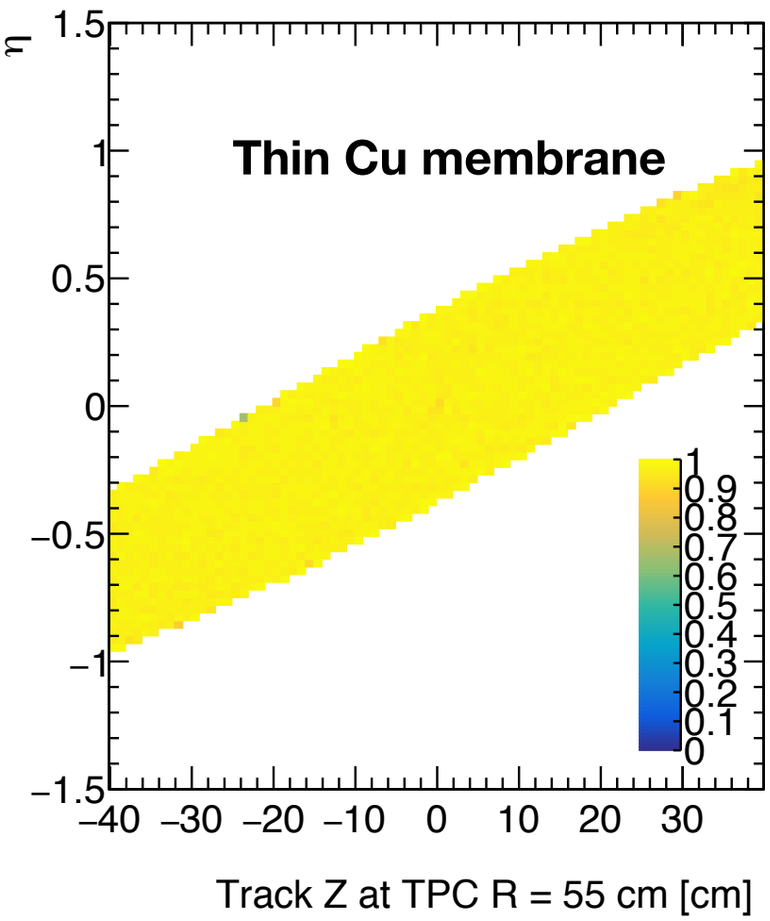
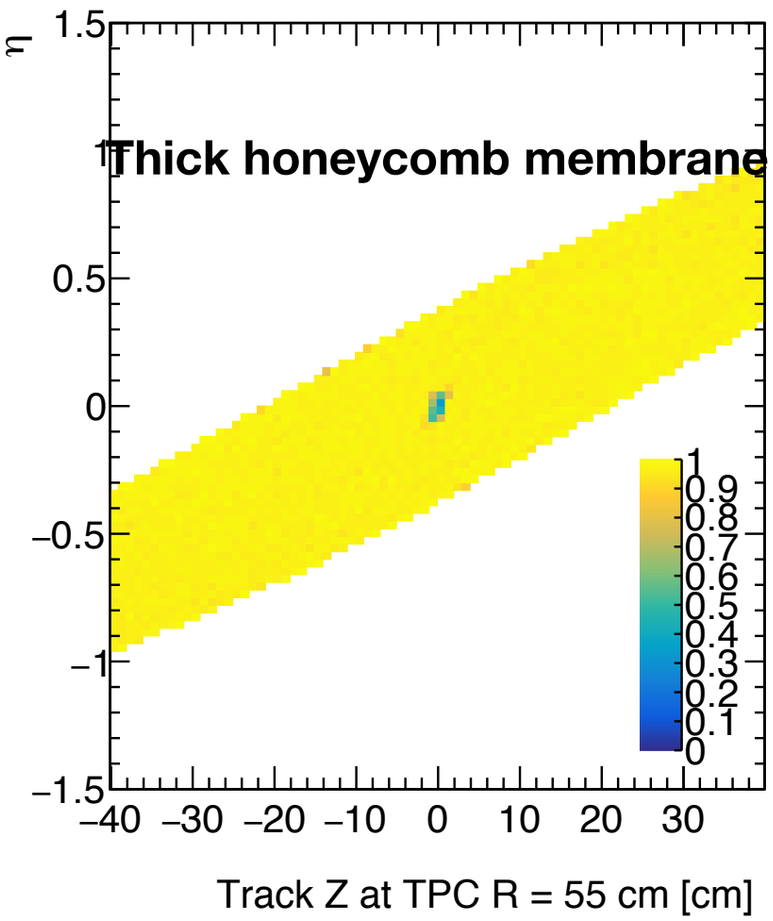
**Efficiency between eta and z of tracks at mid-TPC**



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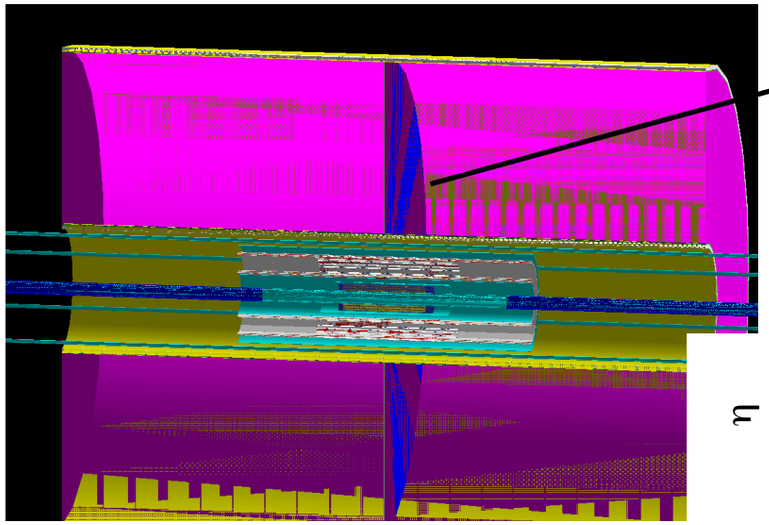

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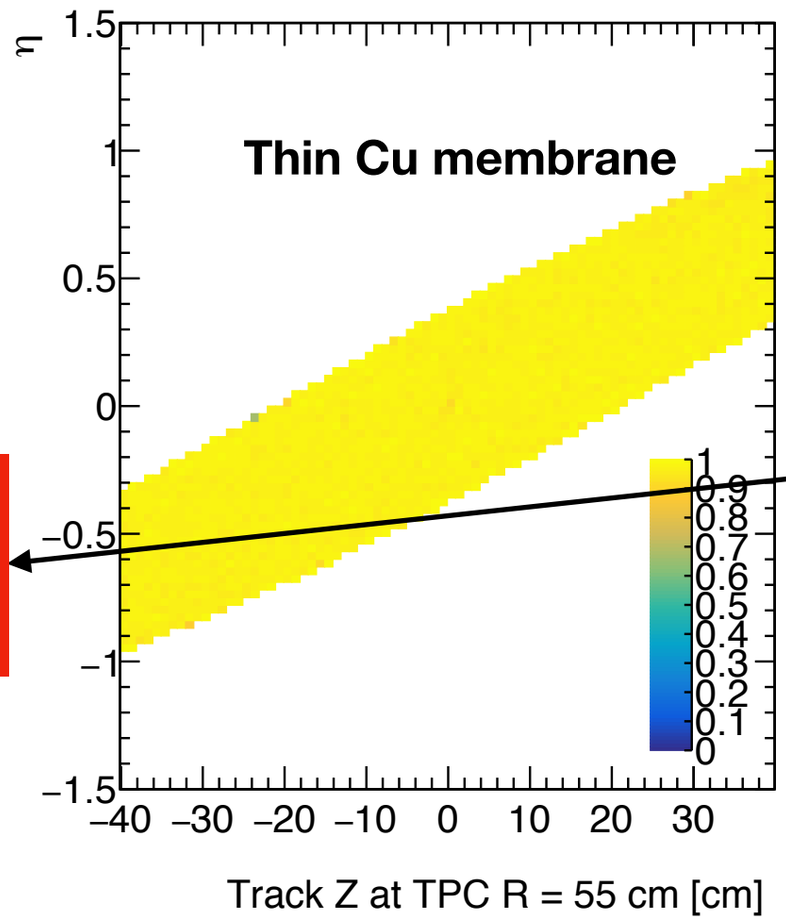


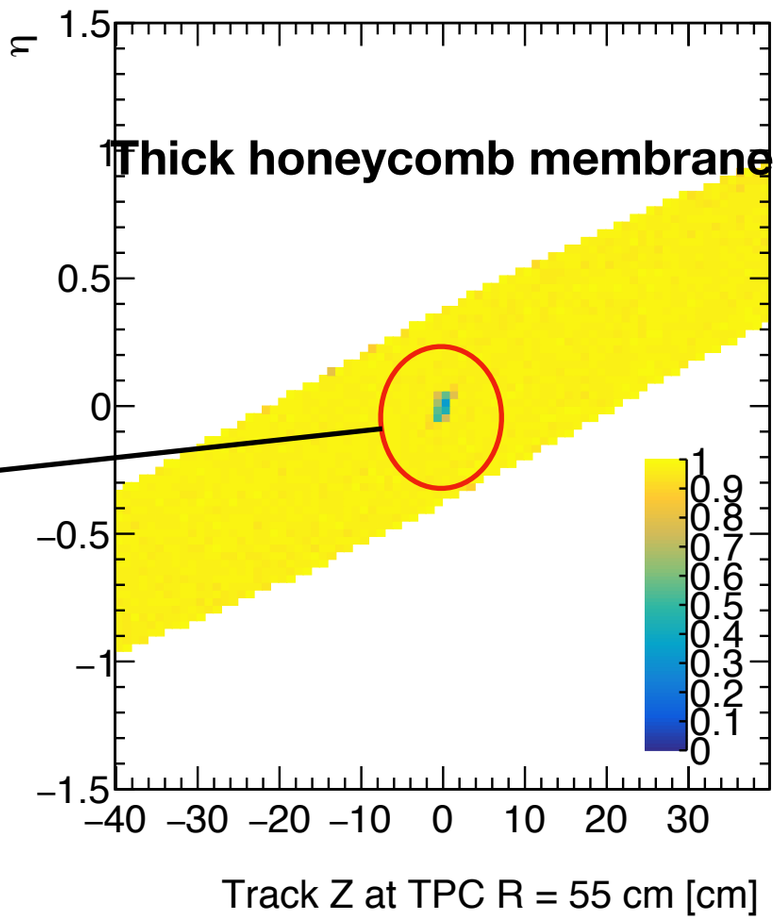


**Slight drop in efficiency at z vertex = 0 for thick honeycomb membrane**

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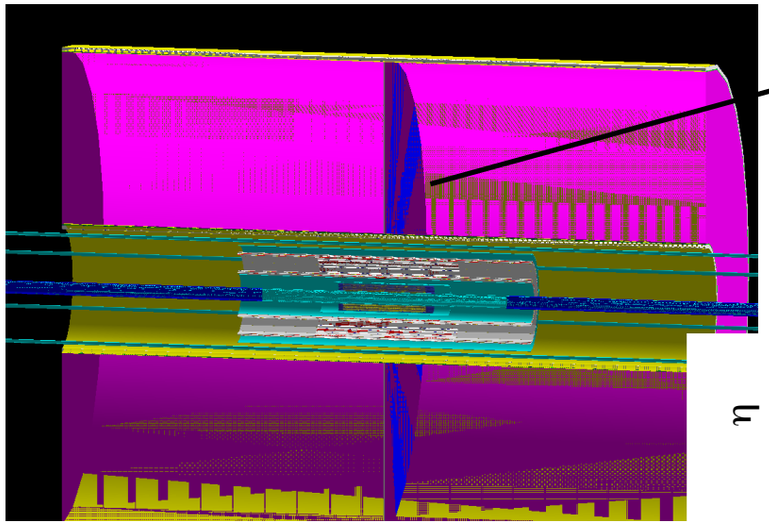

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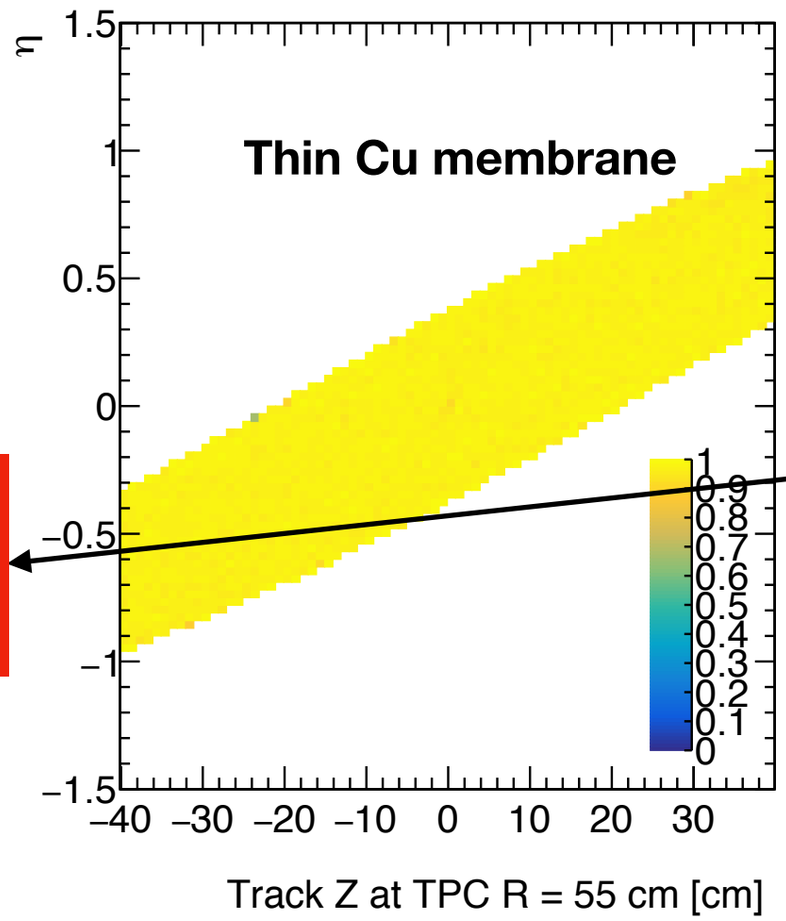
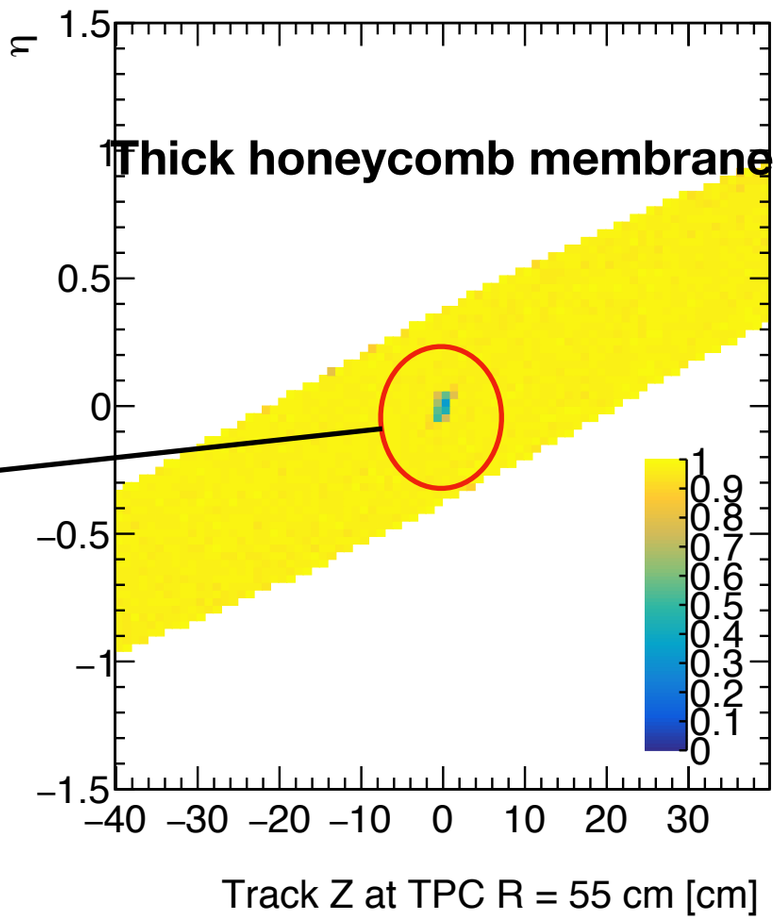



**Slight drop in efficiency at z vertex = 0 for thick honeycomb membrane**

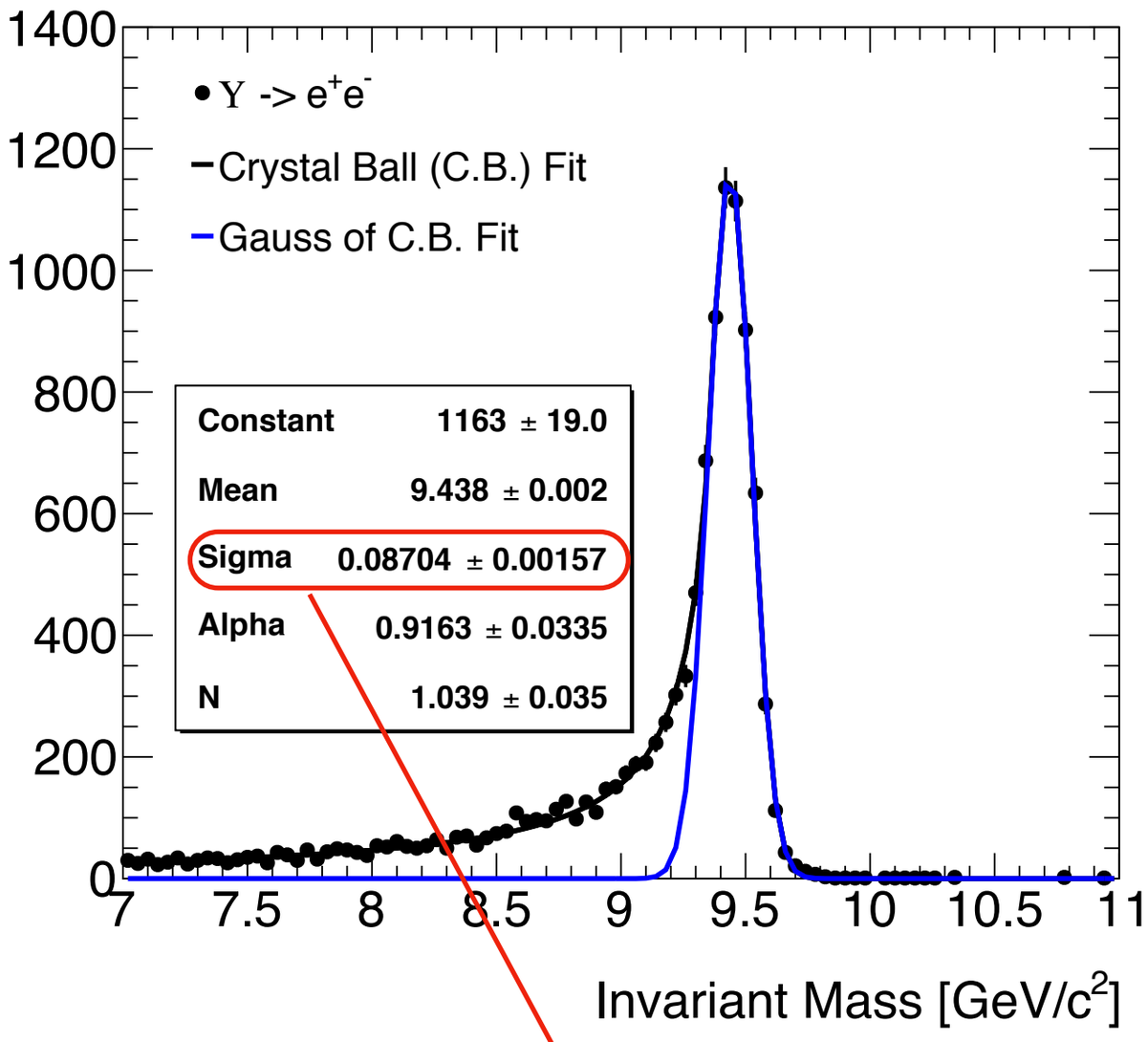
**Does it hurt sPHENIX PHYSICS cause ?**

# sPHENIX TPC :Central Membrane Simulation studies

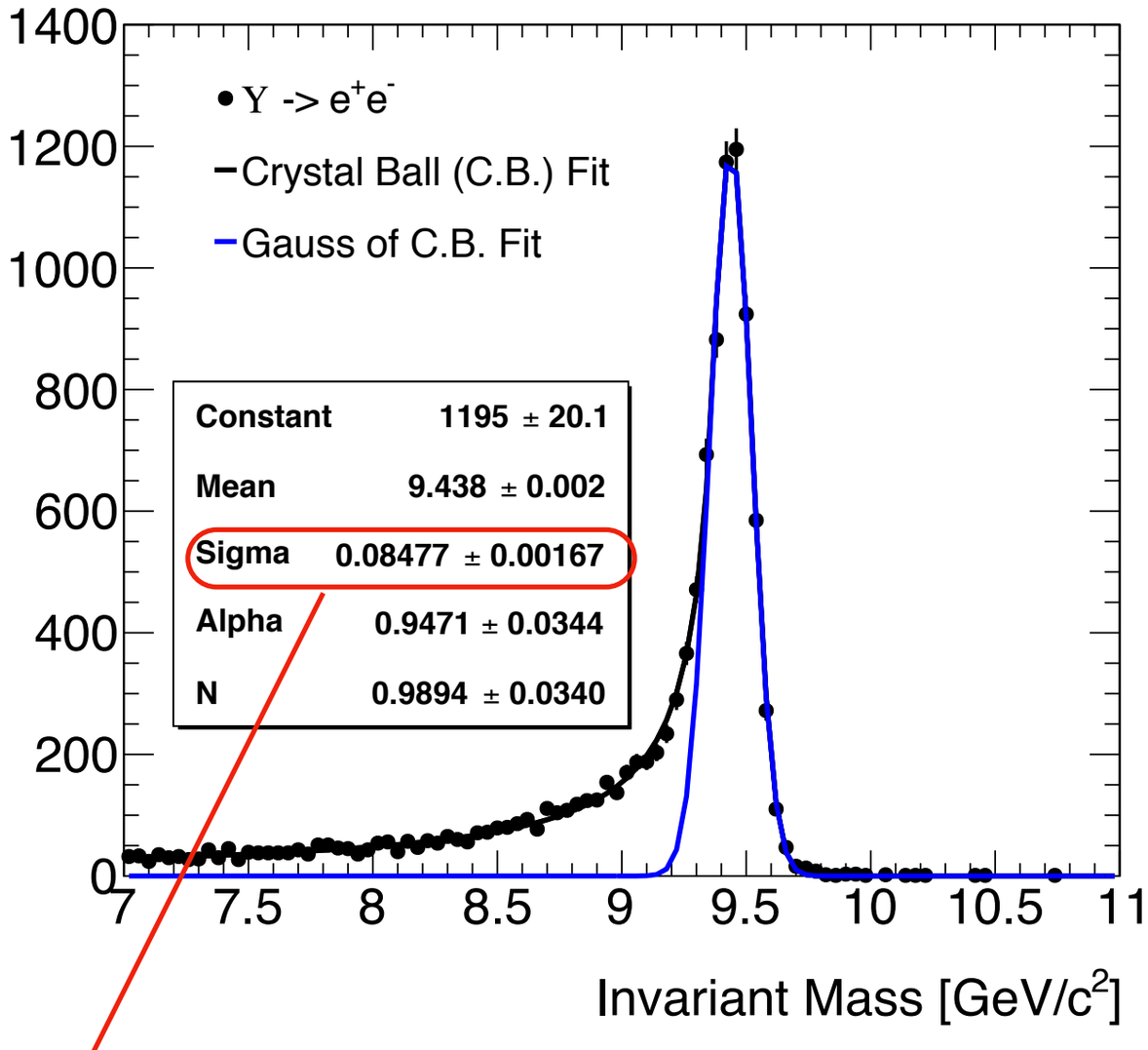
## Upsilon line shape study-

- *10 Y(1s) per event generated with |zvtx| < 10 cm*

**Thin Cu membrane**




**Thick honeycomb membrane**



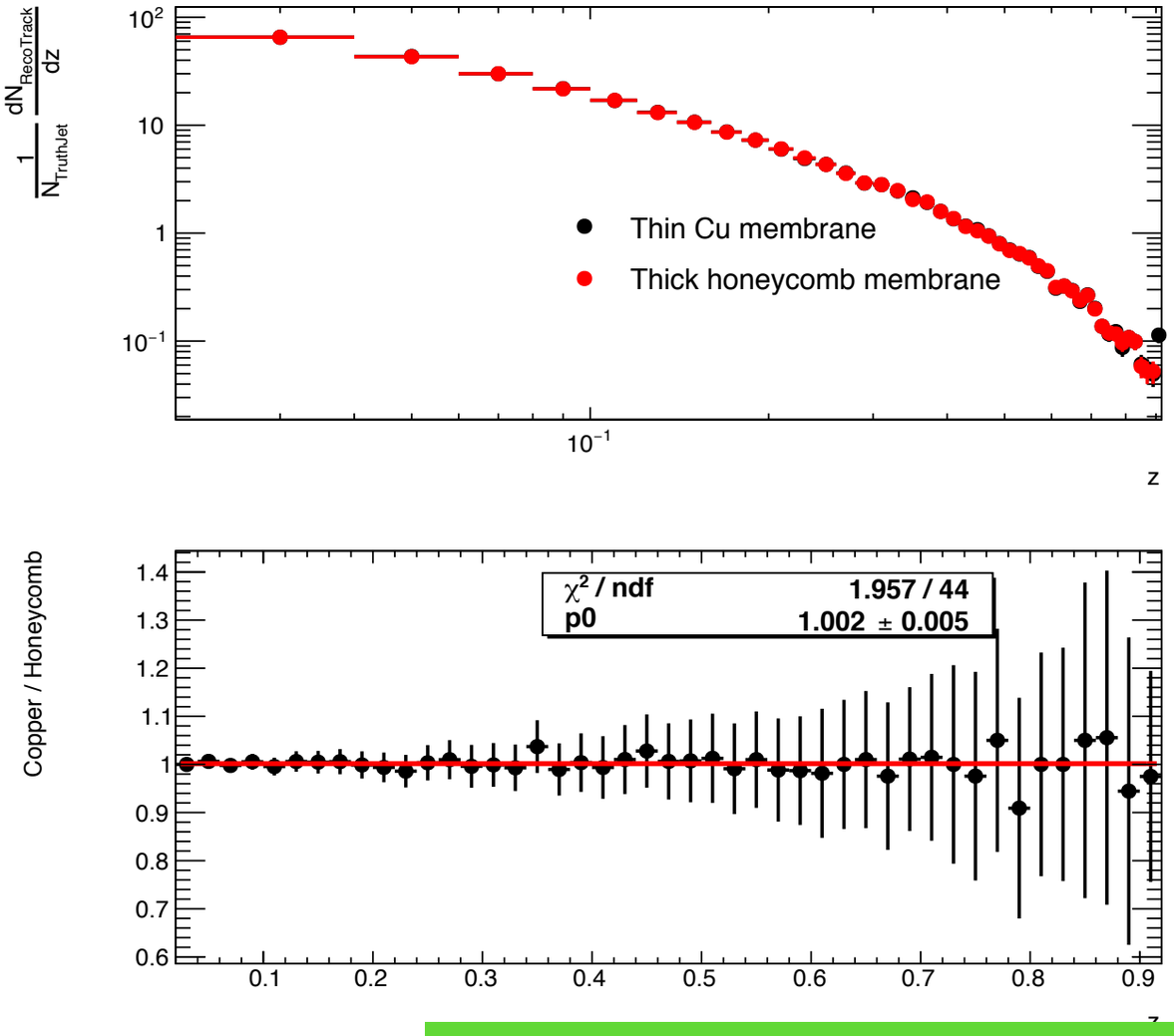

**No significant change in upsilon line shape with the use of thicker TPC central membrane**

# sPHENIX TPC :Central Membrane Simulation studies

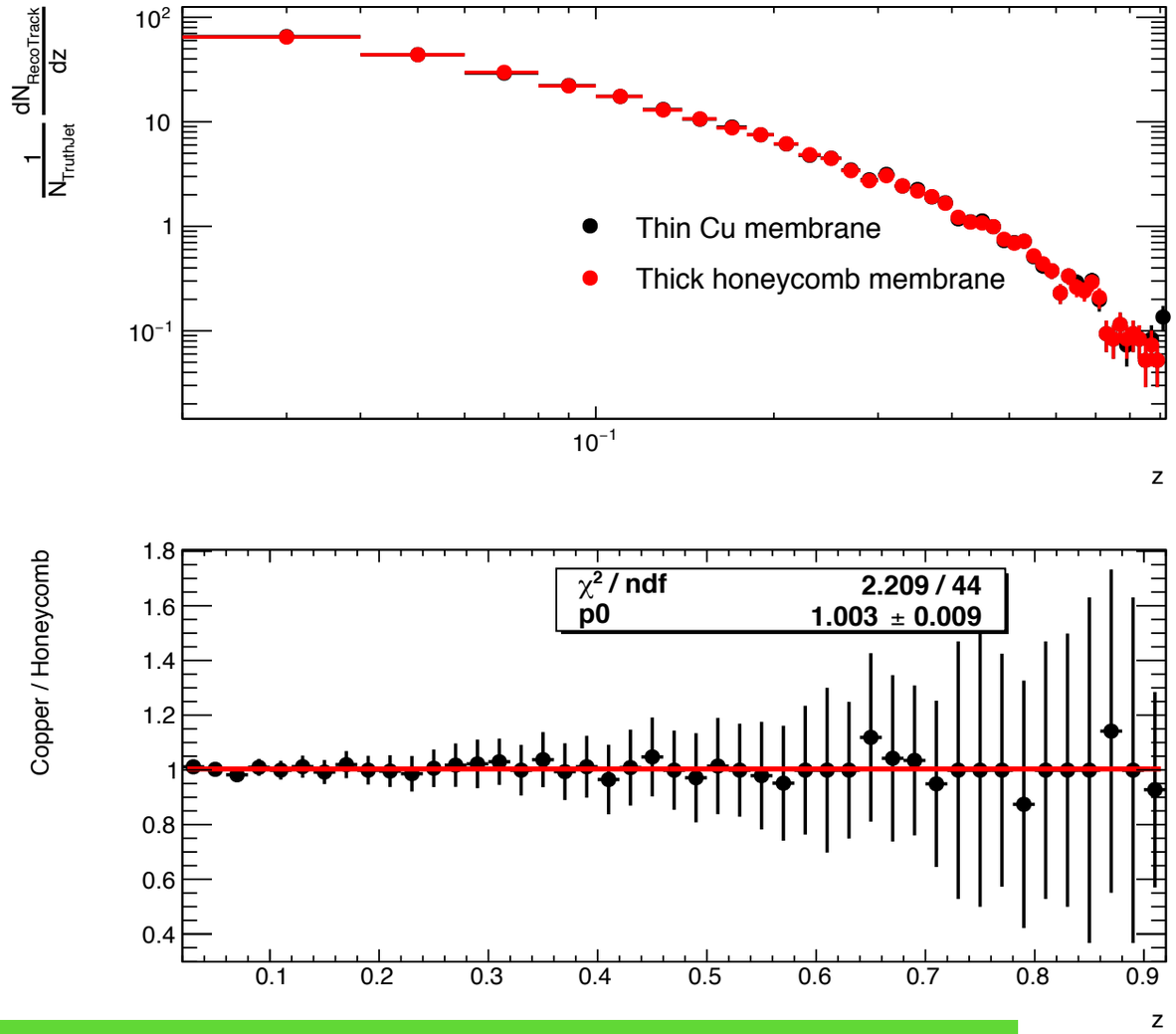
## Jets study (fragmentation function simulation)-

- ***Jet fragmentation function = Reconstructed track pT matched to truth jet/ truth jet pT***
- ***Pythia generated files were used for Geant simulation.***
- ***Study was done using two different conditions on truth jet selection***
  1. ***Truth jet pT > 50 GeV***
  2. ***Truth jet pT > 50 GeV & |eta |< 0.1 (jets mostly passing through the TPC central membrane)***

**Truth jet pT > 50 GeV**




**Truth jet pT > 50 GeV & |eta| < 0.1**




**New concept of TPC central membrane doesn't affect Jet performance**

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## Central Membrane design evolution

- **Initial proposal : Thin stretched copper membrane**

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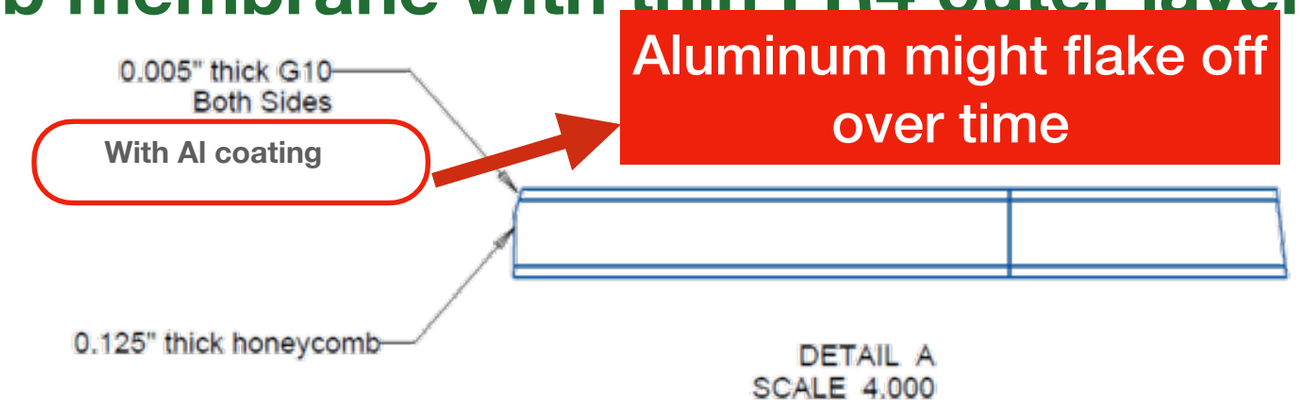


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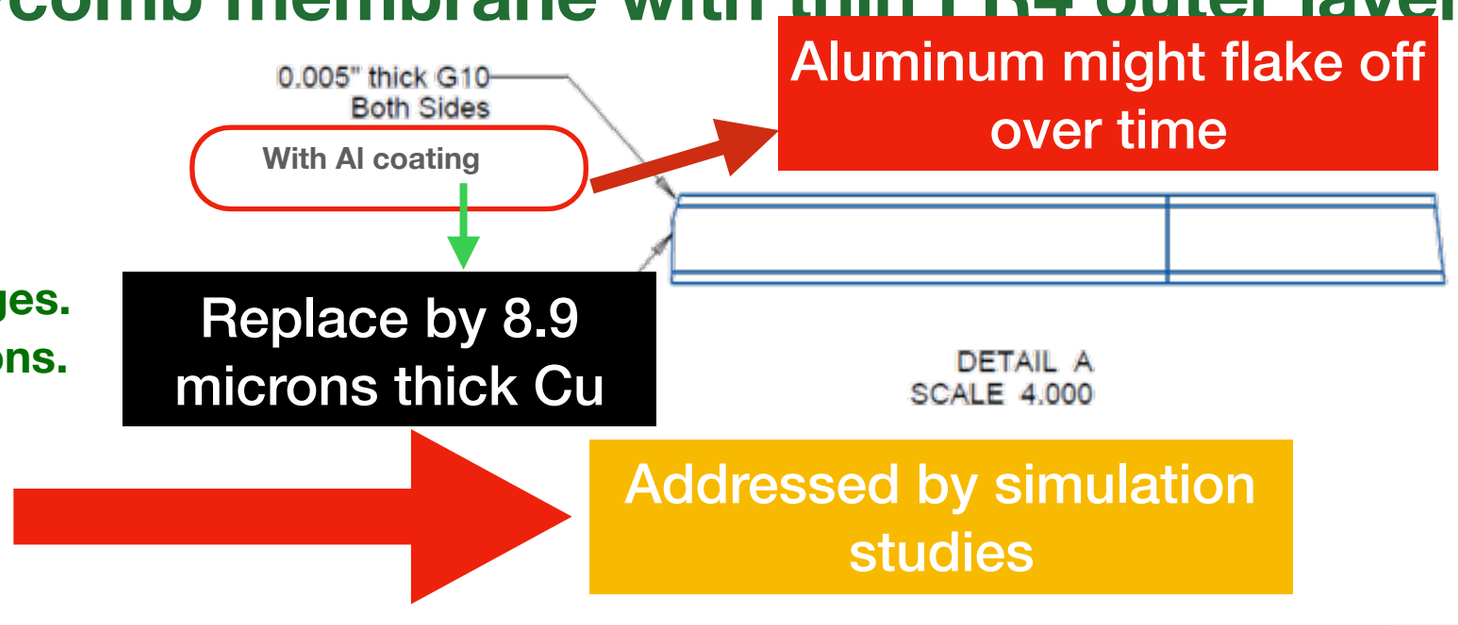
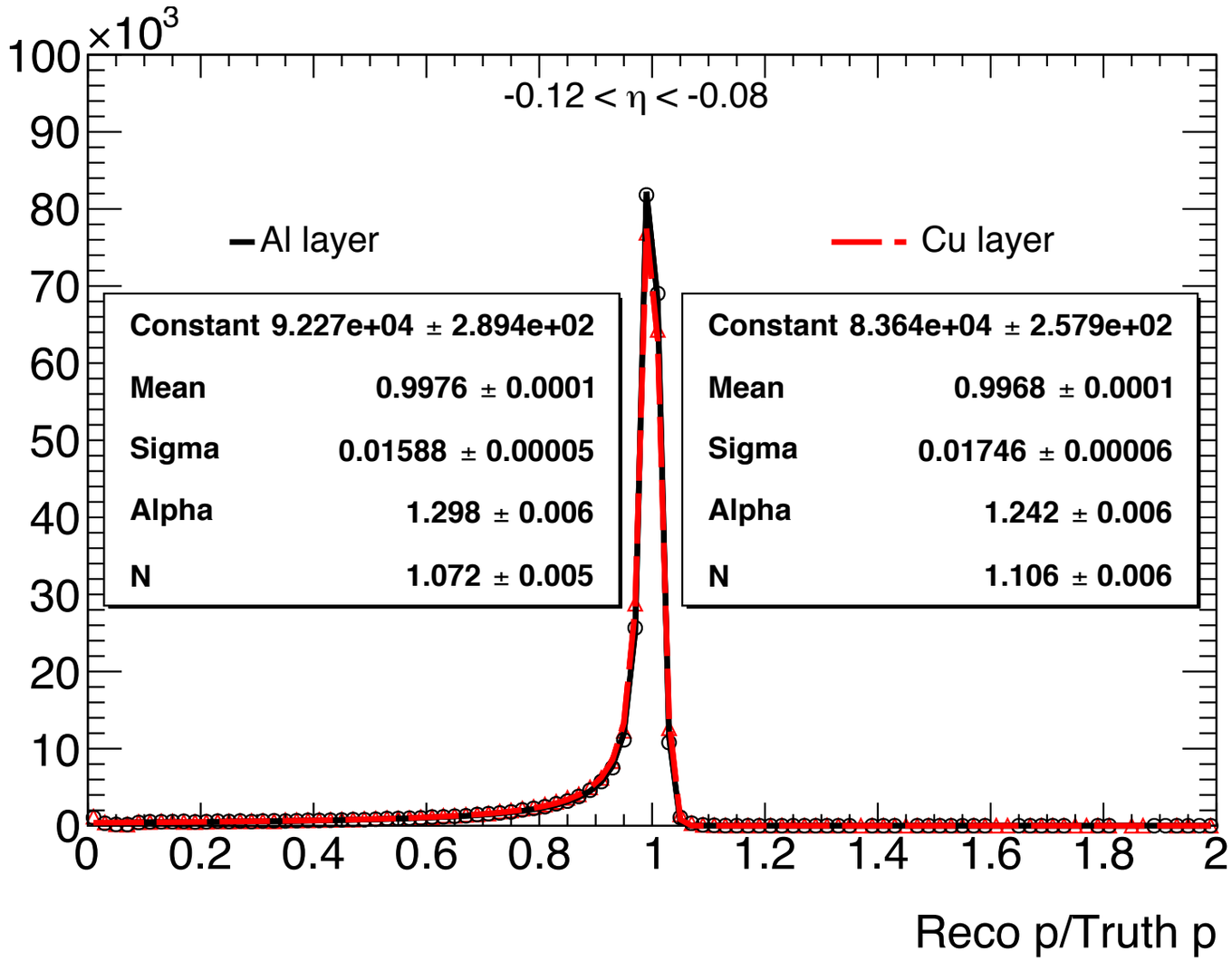


# sPHENIX TPC :Central Membrane Simulation studies

## Single electron Geant4 simulation (electron loss due to hard bremsstrahlung radiation) :

- *Electrons generated with z vertex = 5 cm, |phi| < pi, pT = 4 GeV , -0.12 < eta < -0.08 (tracks passing through central membrane )*



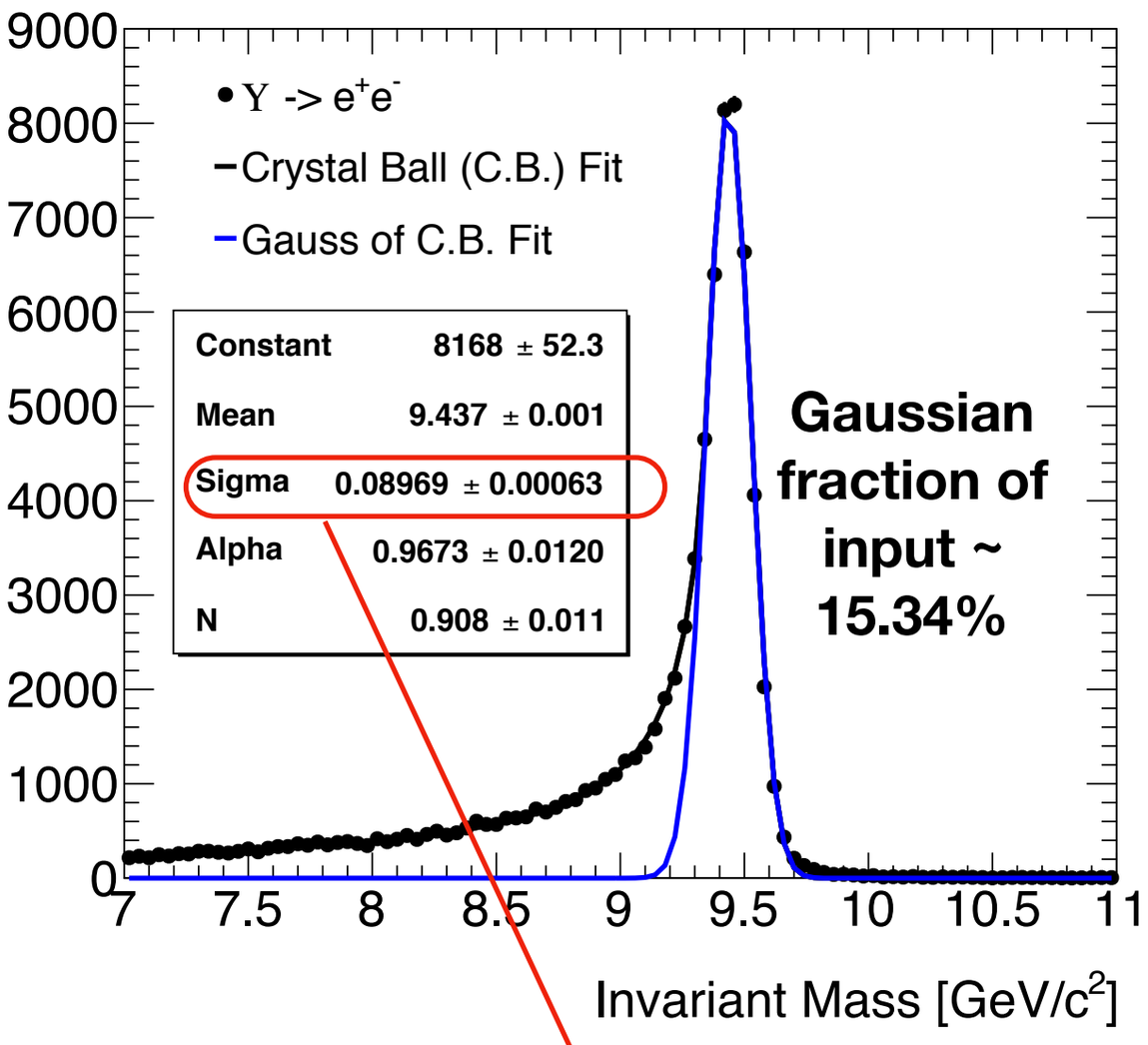

- **TPC membrane with Cu layer has wider sigma.**
- **More loss of electron due to additional hard bremsstrahlung radiation on central membrane with Cu layer.**

# sPHENIX TPC :Central Membrane Simulation studies

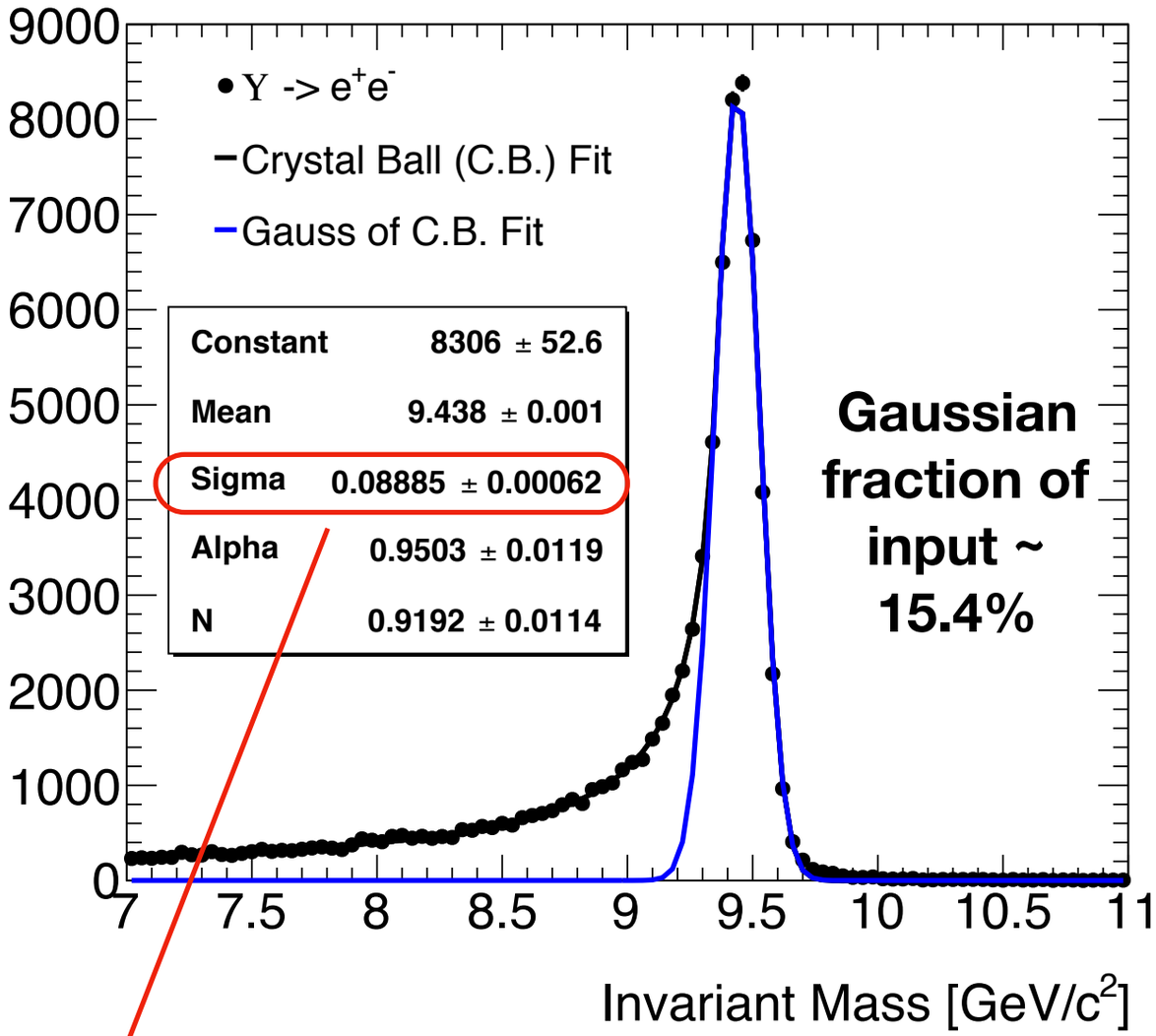
## Upsilons line shape study-

- *30 Y(1s) per event embedded in 100 pions per event generated with |zvtx| < 10 cm, |eta| < 1.0*

**TPC honeycomb central membrane with Al layer**




**TPC honeycomb central membrane with Cu layer**




**No significant change in upsilon line shape with the use of Cu layer on honeycomb TPC central membrane**

# Conclusions

- **The new concept of TPC central membrane doesn’t affect sPHENIX Physics program.**
- **Stiffer.**
- **Less issues with implementing HV contact.**
- **Will provide more reliable performance for sPHENIX TPC due to its immunity to vibrations and thermally-induced deflections.**