

# LTCC performances

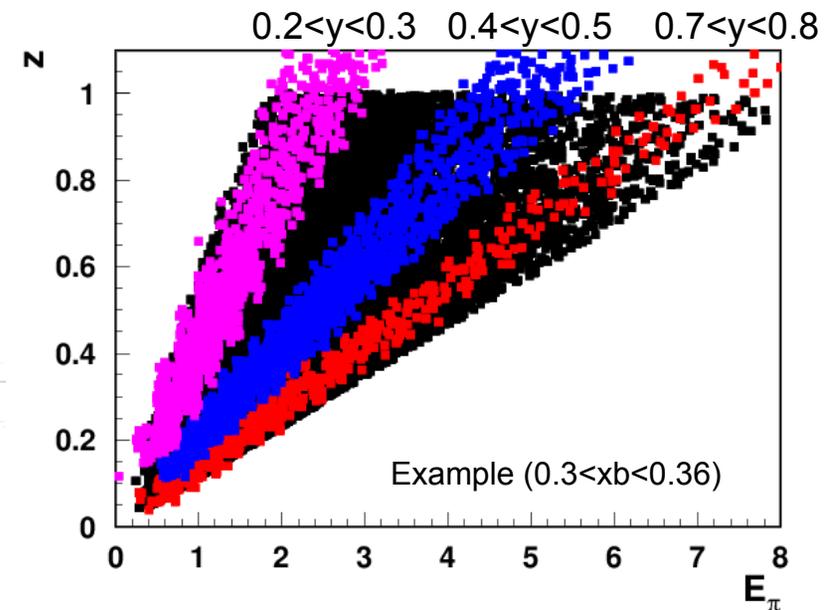
Harut Avakian

JLab, CLAS Collaboration meeting, June 19

$$\frac{d\sigma}{dx dy d\psi dz d\phi_h dP_{h\perp}^2} = \sum_{l=1}^L SF_l$$

$$y = v/E$$

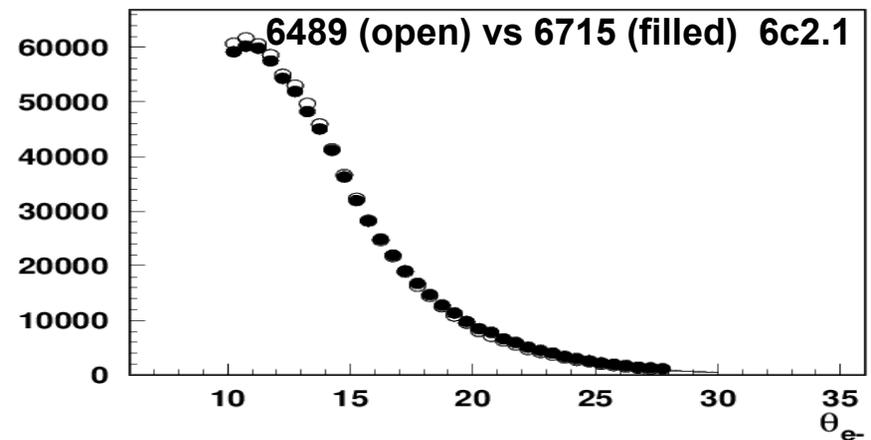
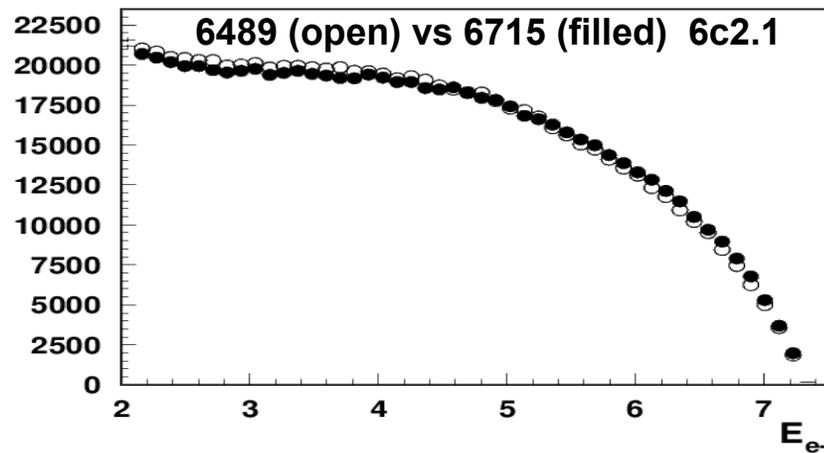
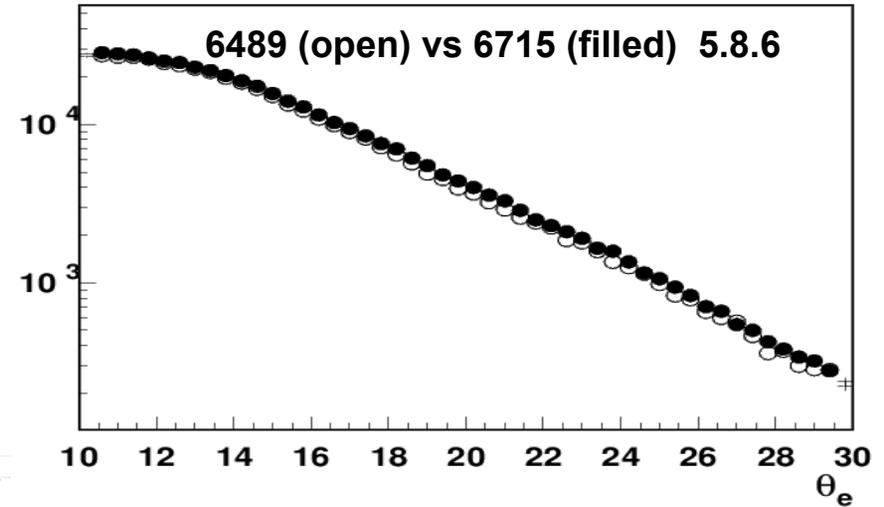
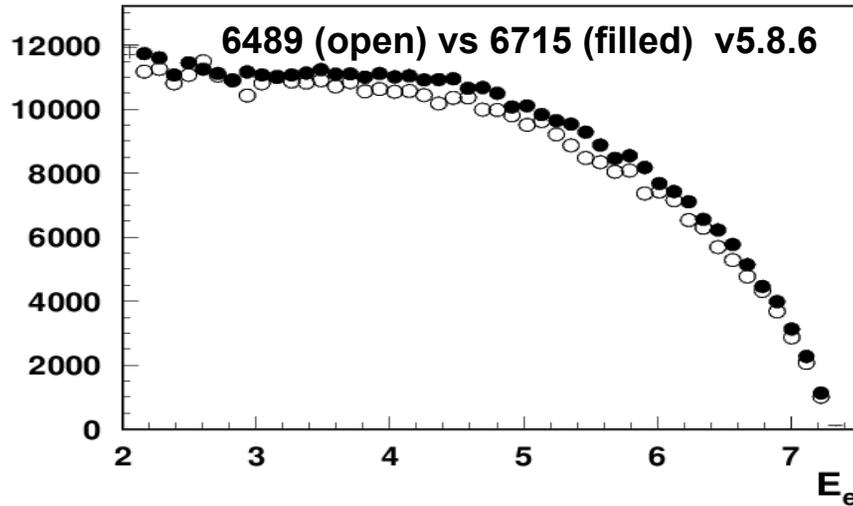
For multidimensional binning in  $x/y/z/P_T$  all energies are relevant at large  $P_T$  and  $z$  ( $0.7 > z > 0.3$ )



For charged pions need LTCC to cover multidimensional binning

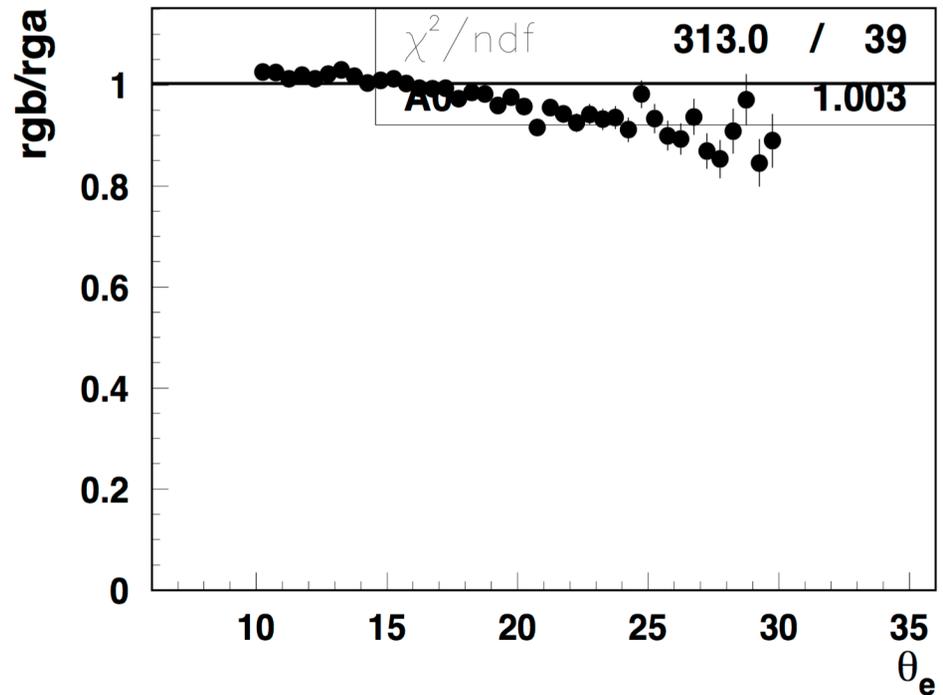
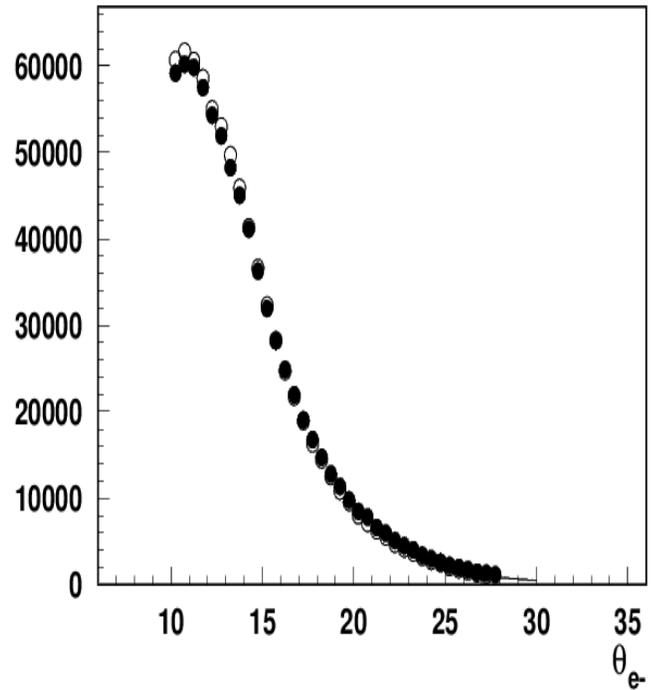
- 1) LTCC role in separation of pions
- 2) Role of LTCC in validation of TOF pion ID at large momenta (2 data sets with LTCC compared )

# LTCC in RGB vs RGA: old 5.8.6 vs new 6c2.1.



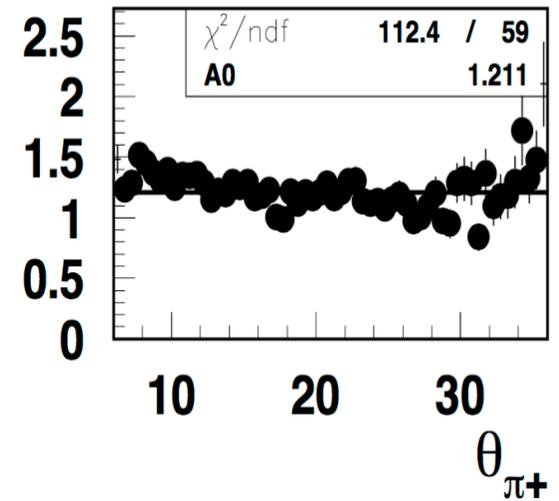
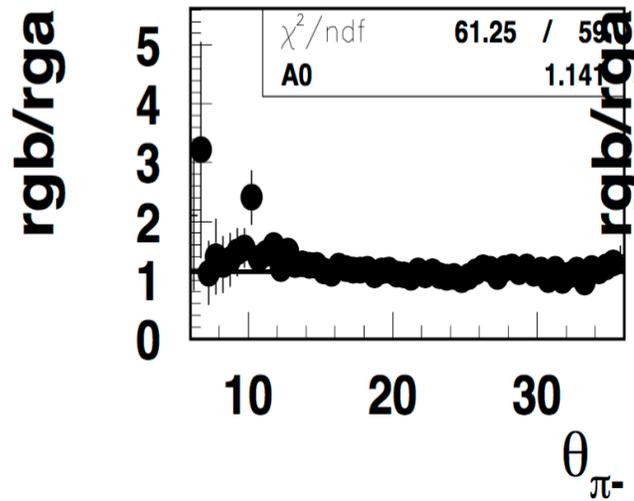
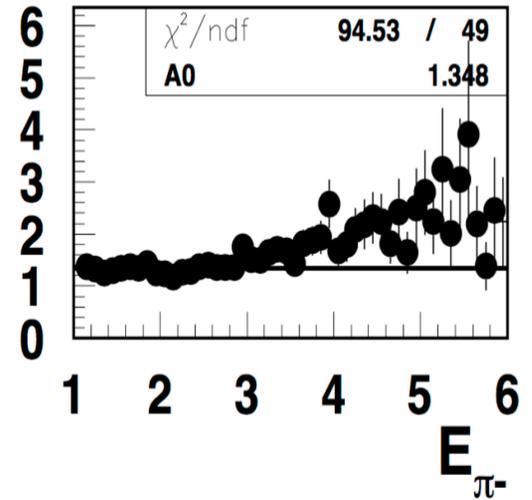
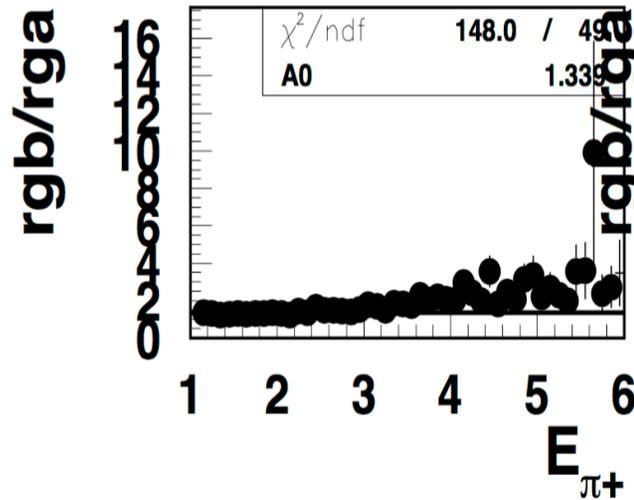
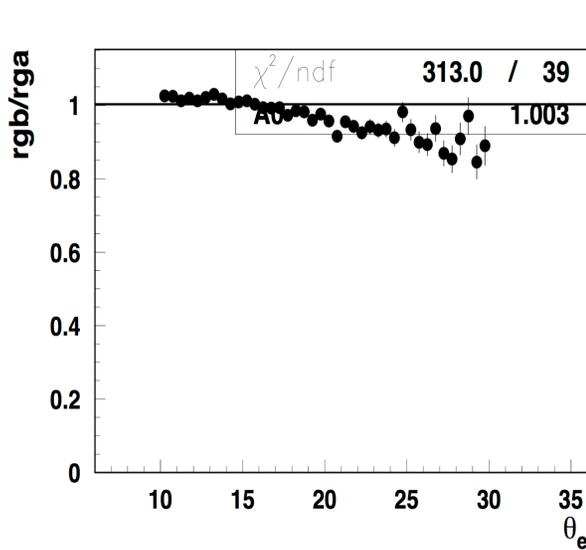
RGB compared with RGA for the same number of electrons

# LTCC in RGB vs RGA: new 6c2.1.



Small differences in  $e'$  distributions due to proton and neutron PDFs

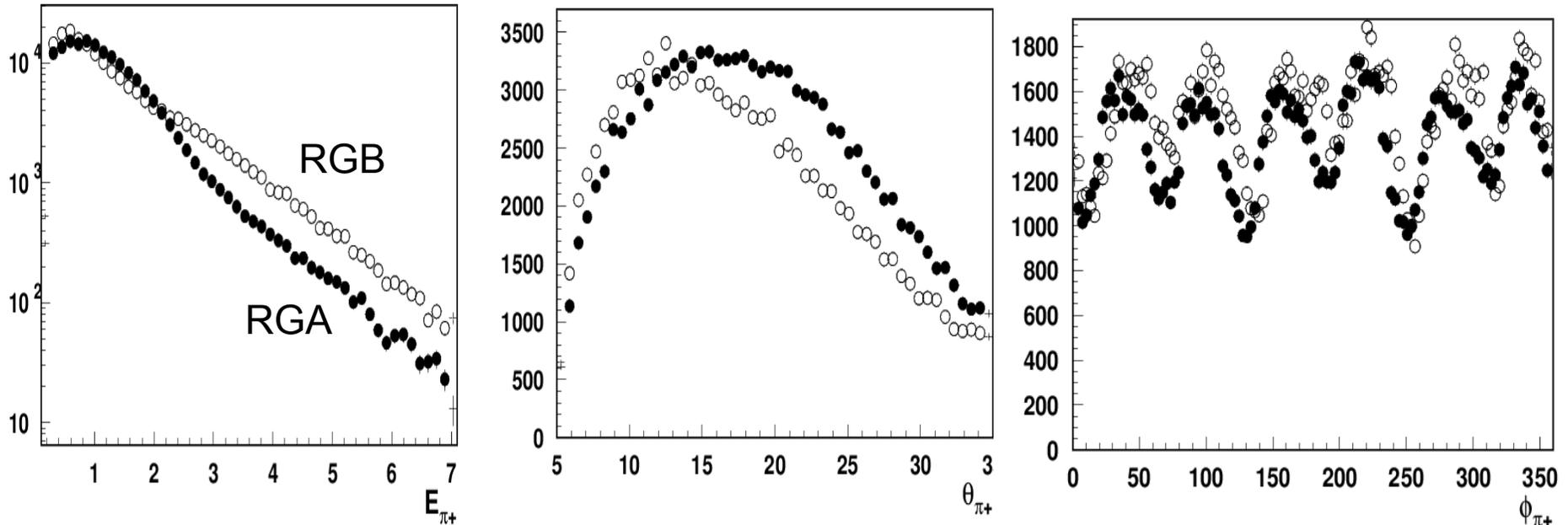
# LTCC in RGB vs RGA: new 6c2.1.



Big differences in pion counts could not be due to proton and neutron, mainly  $\pi$  ID

# Identified pions in RGB vs RGA

6489 (open) vs 6715 (filled) v.5.8.6

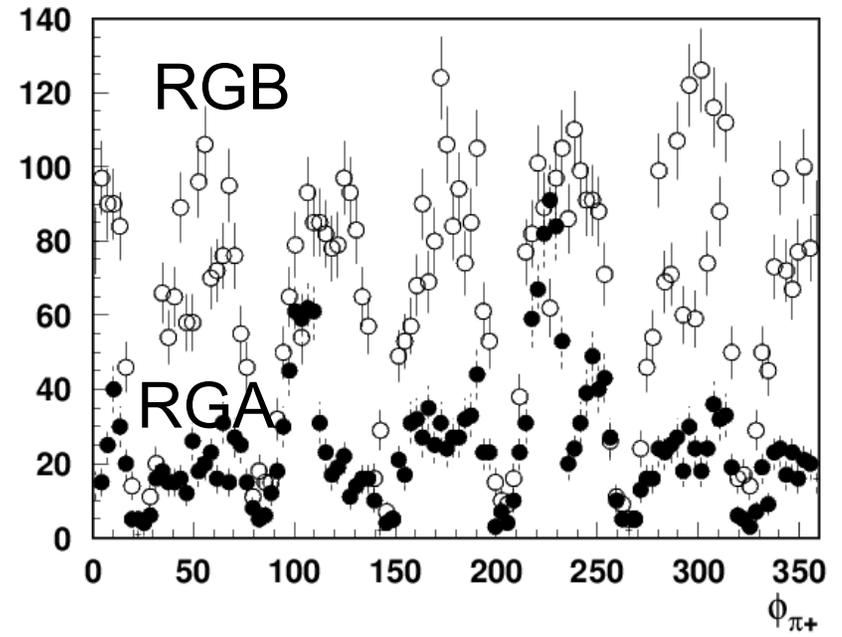
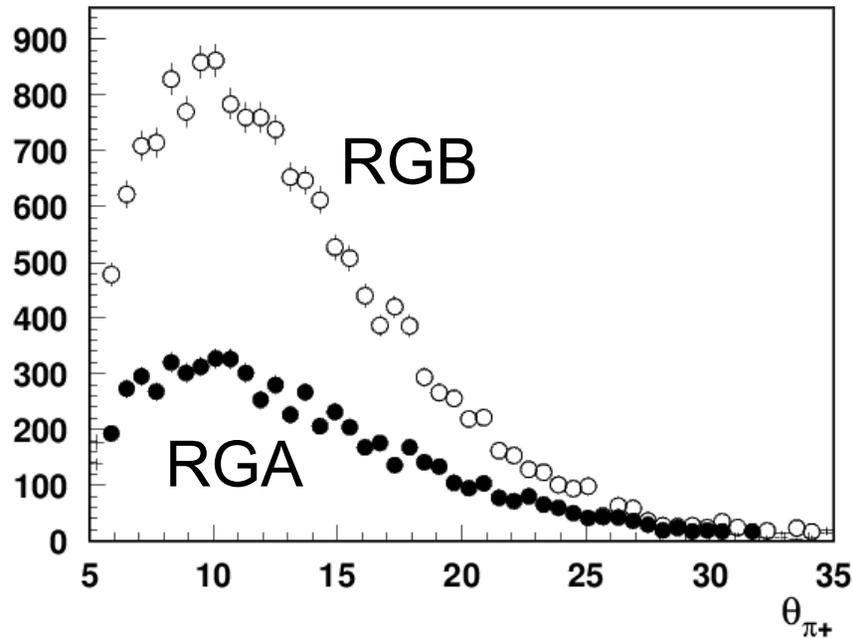


## sensitivity to timing calibration

There are less low energy pions per electron in RGB (may be)  
There are significantly more high energy pions, indicating that most high energy pions are IDt as 211 (could not be)

# LTCC in RGB vs RGA ( $E_{\text{pion}} > 3 \text{ GeV}$ )

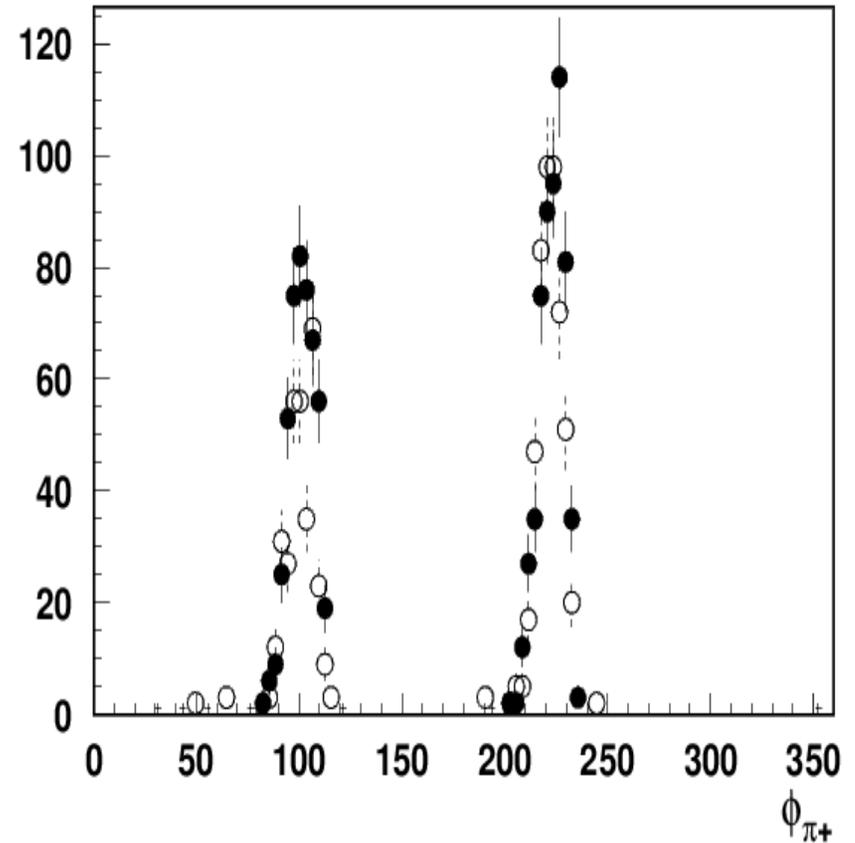
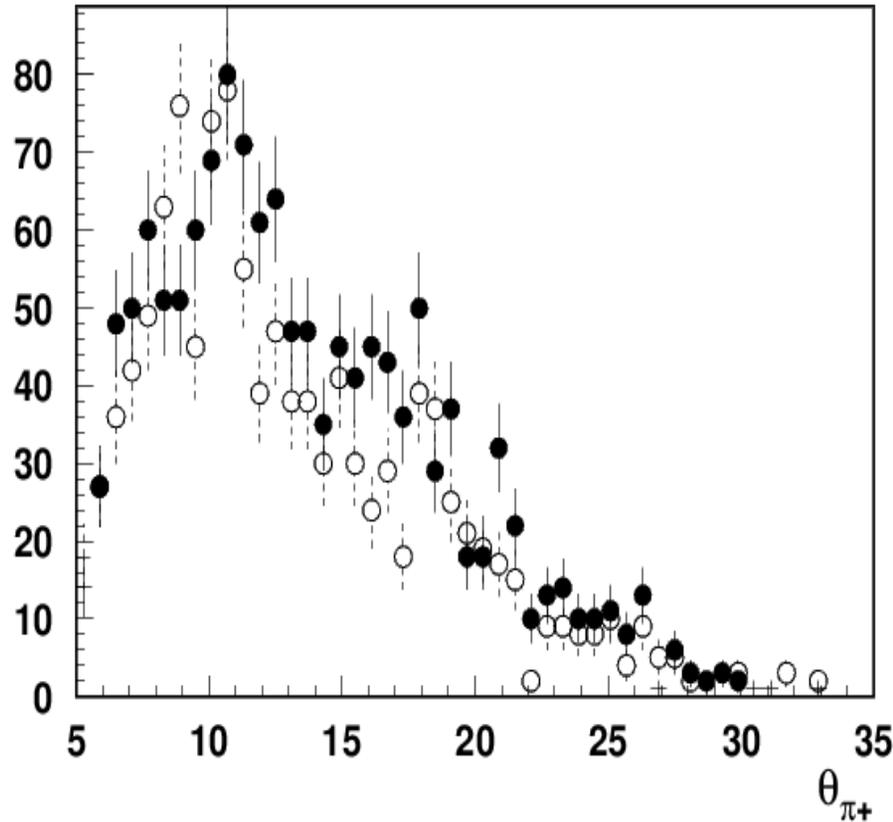
v5.8.6



- Significantly more high energy pions (x3), indicating practically all high energy hadrons are IDt as 211 in RGB (LTCC not visible)
- In older versions of rec. software (<6c2.1) ½ of LTCC missing

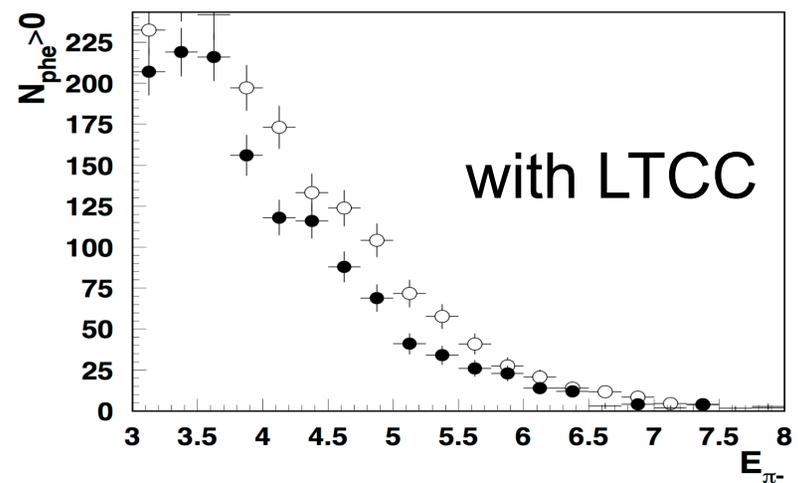
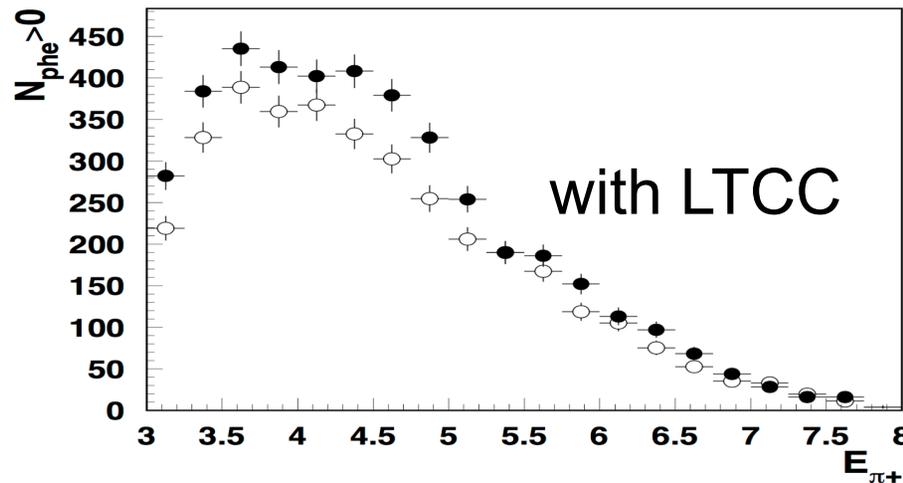
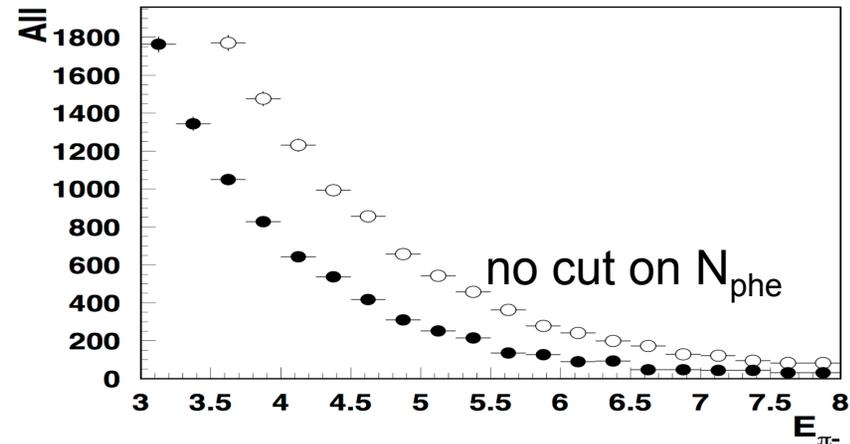
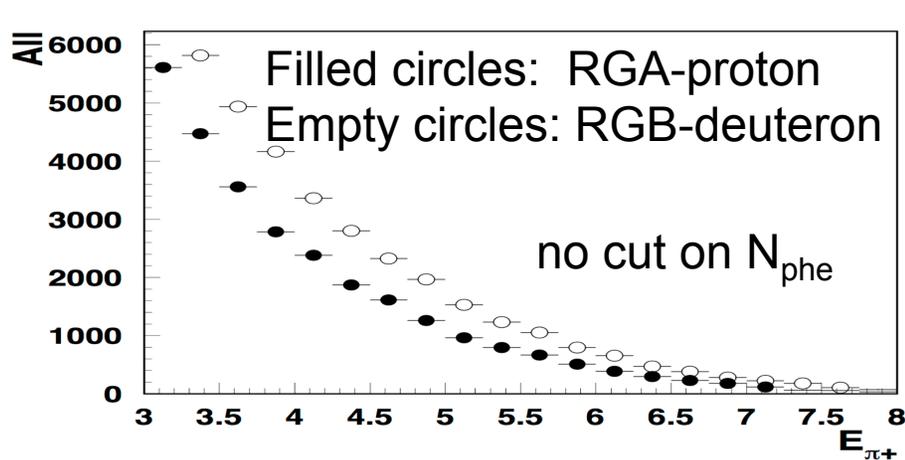
# LTCC in RGB vs RGA ( $N_{phe}>0$ )

6489 (open) vs 6715 (filled) 5.8.6



- With requirement  $N_{phe}>1$  both sets perfectly agree in counts.
- LTCC is critical to control the real fraction of pions for  $E>3$

# LTCC in RGB vs RGA ( $v.6c2.1 E_{\text{pion}} > 3 \text{ GeV}$ )



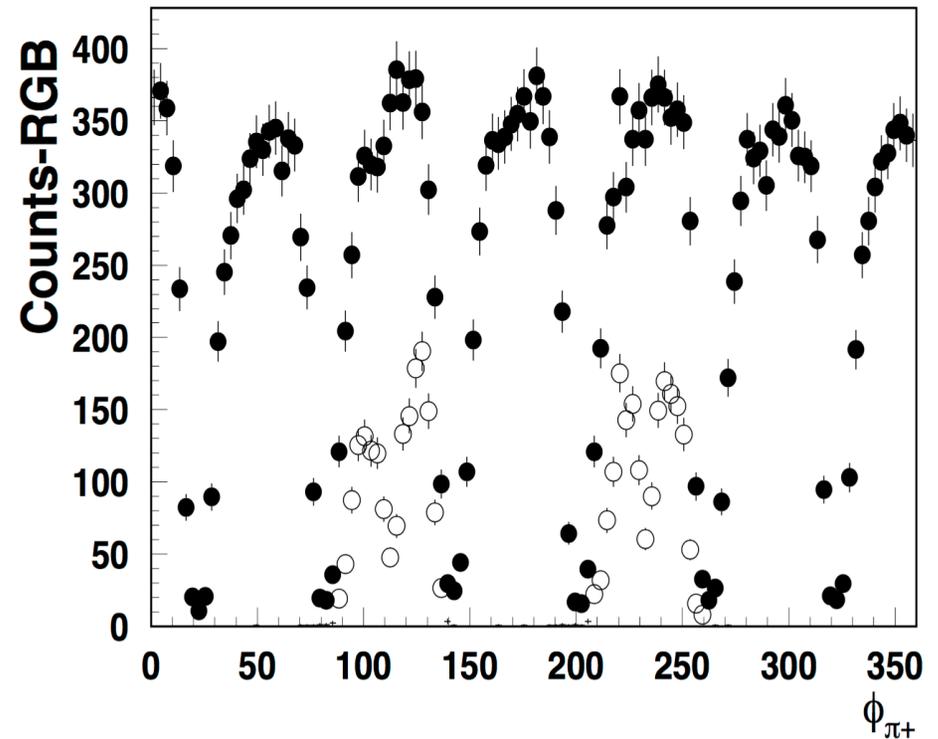
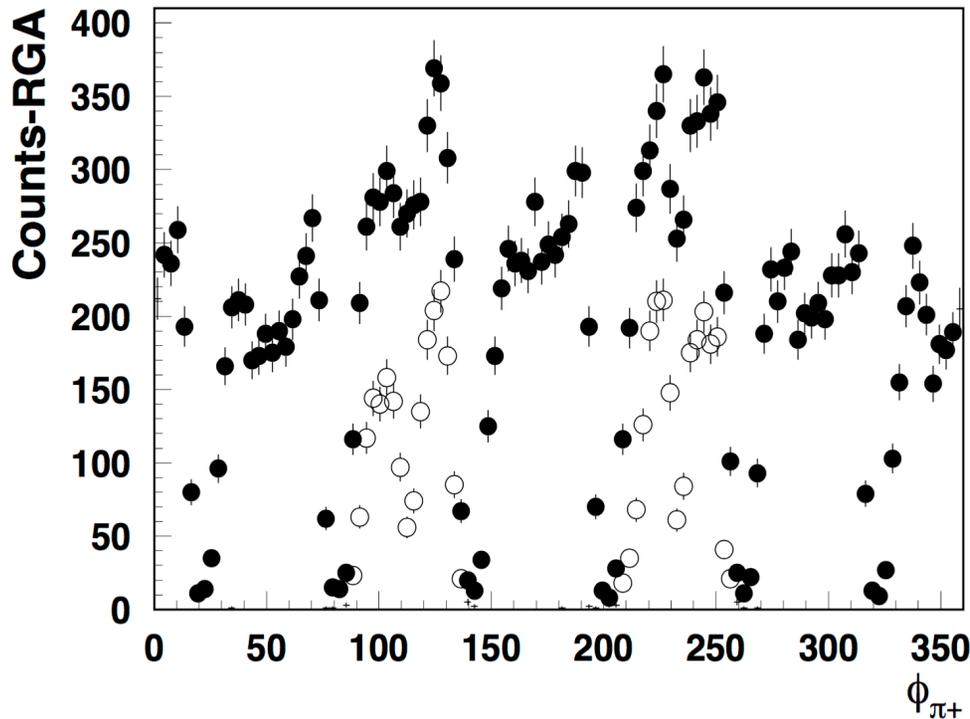
New calibration reduces big differences in counts (still RGB higher for TOF  $\pi^+$ )

With LTCC, per electron we have more  $\pi^+$  and less  $\pi^-$  in RGA-proton vs RGB-deuteron, as expected

# LTCC: $\pi^+$ in RGB vs RGA (v.6c2.1 $E_{\text{pion}} > 3 \text{ GeV}$ )

Filled circles: RGA-All  
Empty circles: RGA-Nphe>0

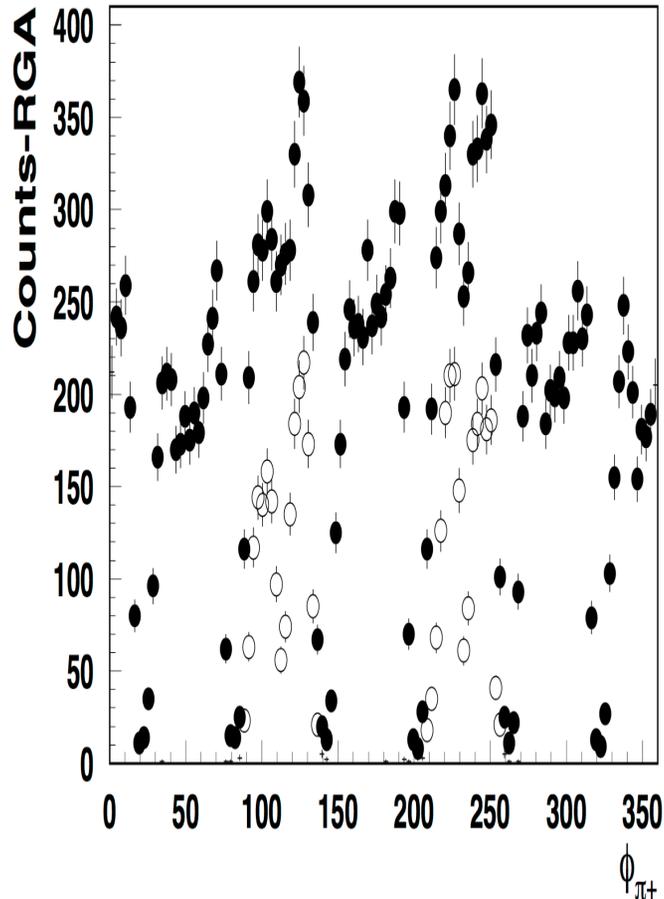
Filled circles: RGB-All  
Empty circles: RGB-Nphe>0



- The LTCC software fixed (bot sides of sectors reconstructed)
- Some inefficiency visible in the center of sectors
- Even at  $E > 3$  most hadrons identified as pions in RGB

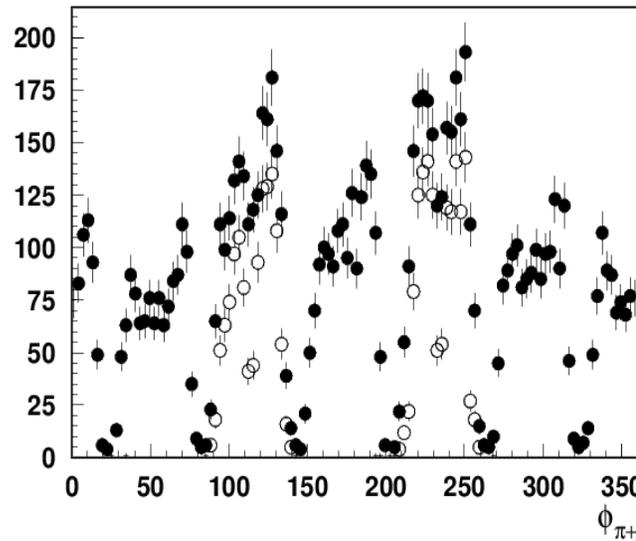
# $\pi^+$ RGA: LTCC Energy Dependence (v.6c2.1)

$E_{\pi^+} > 3 \text{ GeV}$

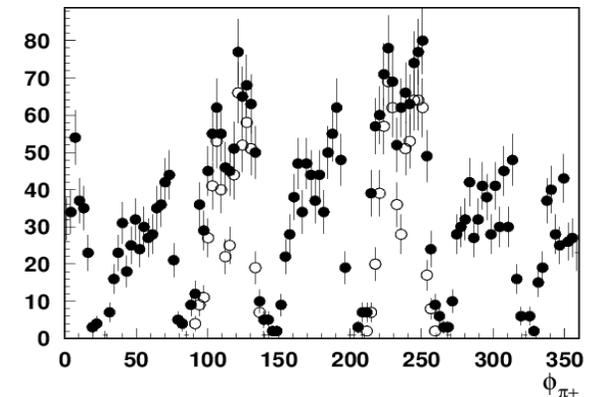


Filled circles: RGA-All  
Empty circles: RGA-Nphe>0

$E_{\pi^+} > 4 \text{ GeV}$



$E_{\pi^+} > 5 \text{ GeV}$

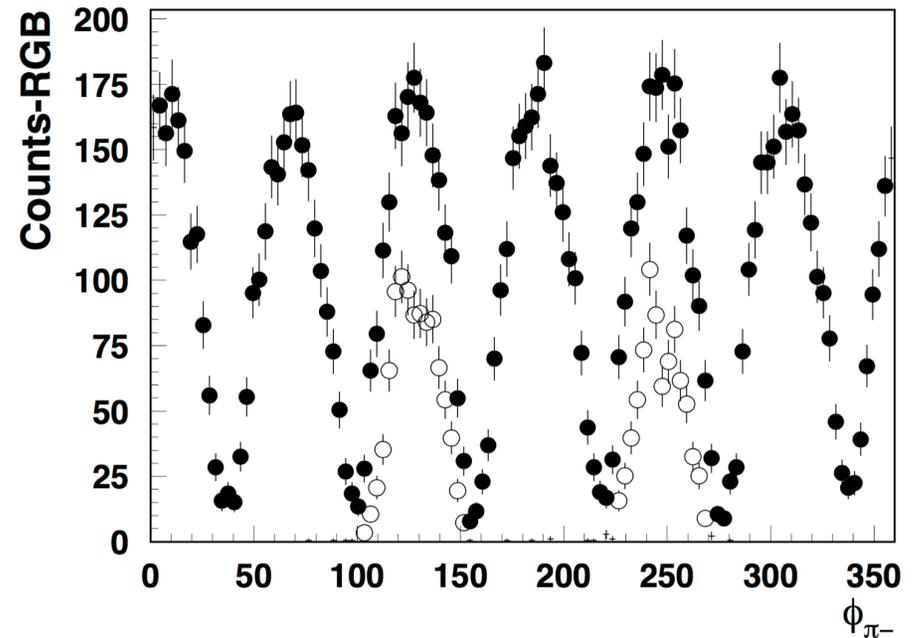
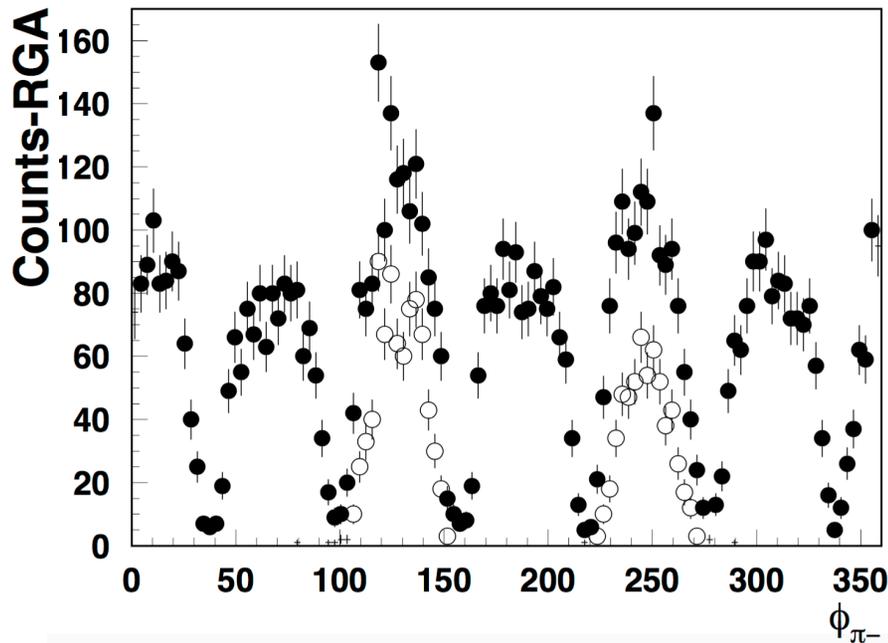


Efficiency improving with energy (holes in center)

# LTCC: $\pi^-$ in RGB vs RGA (v.6c2.1 $E_{\text{pion}} > 3$ GeV)

Filled circles: RGA-All  
Empty circles: RGA-Nphe>0

Filled circles: RGB-All  
Empty circles: RGB-Nphe>0

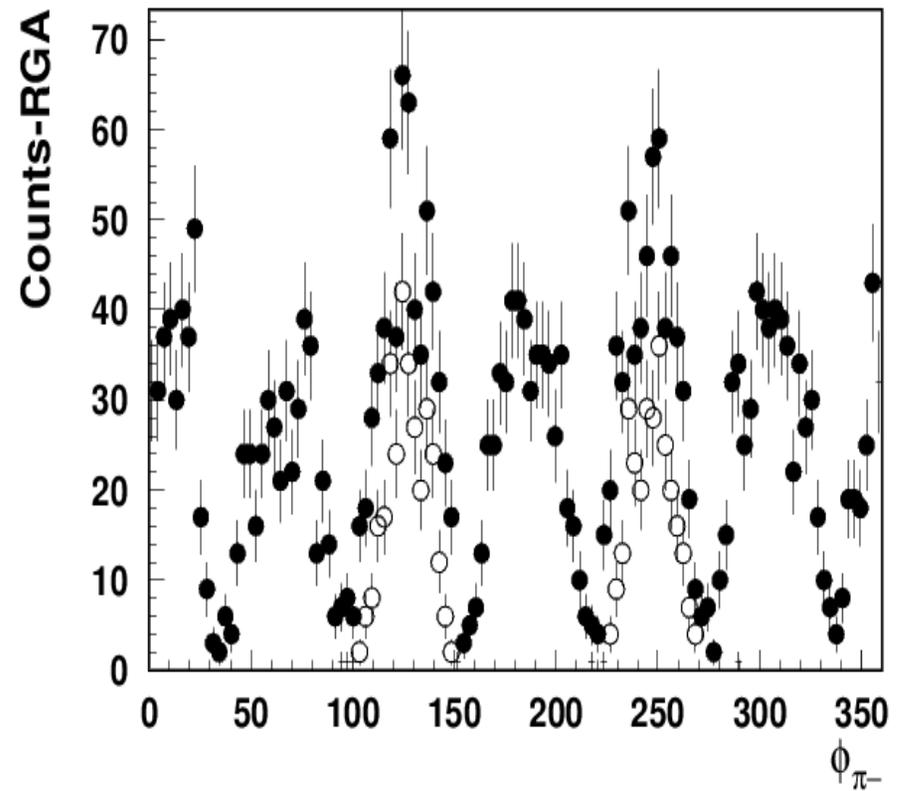
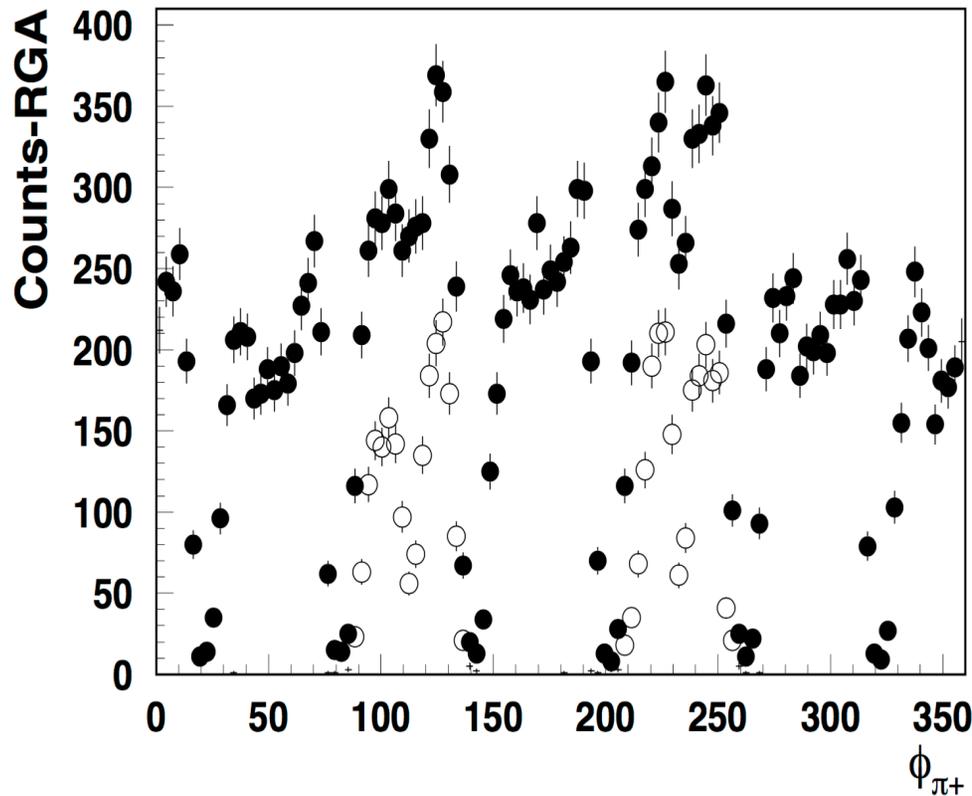


Similar to  $\pi^+$ , with holes in the center less visible

# $\pi^-$ RGA: LTCC Energy Dependence (v.6c2.1)

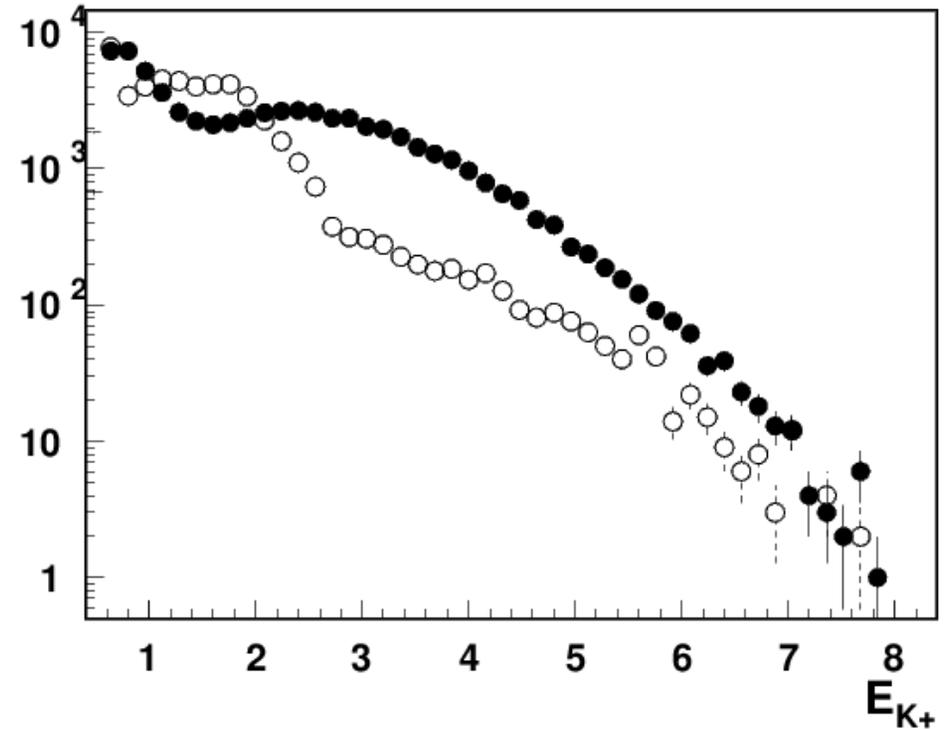
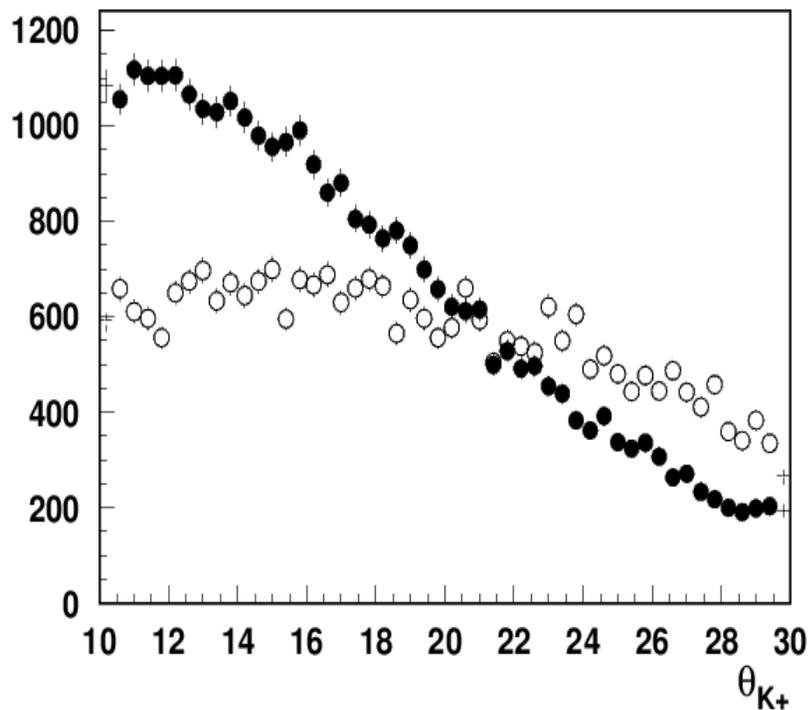
Filled circles: RGA-All  $E_{\pi^-} > 3$  GeV  
Empty circles: RGA-Nphe > 0

Filled circles: RGA-All  $E_{\pi^-} > 4$  GeV  
Empty circles: RGA-Nphe > 0



Efficiency improving with energy

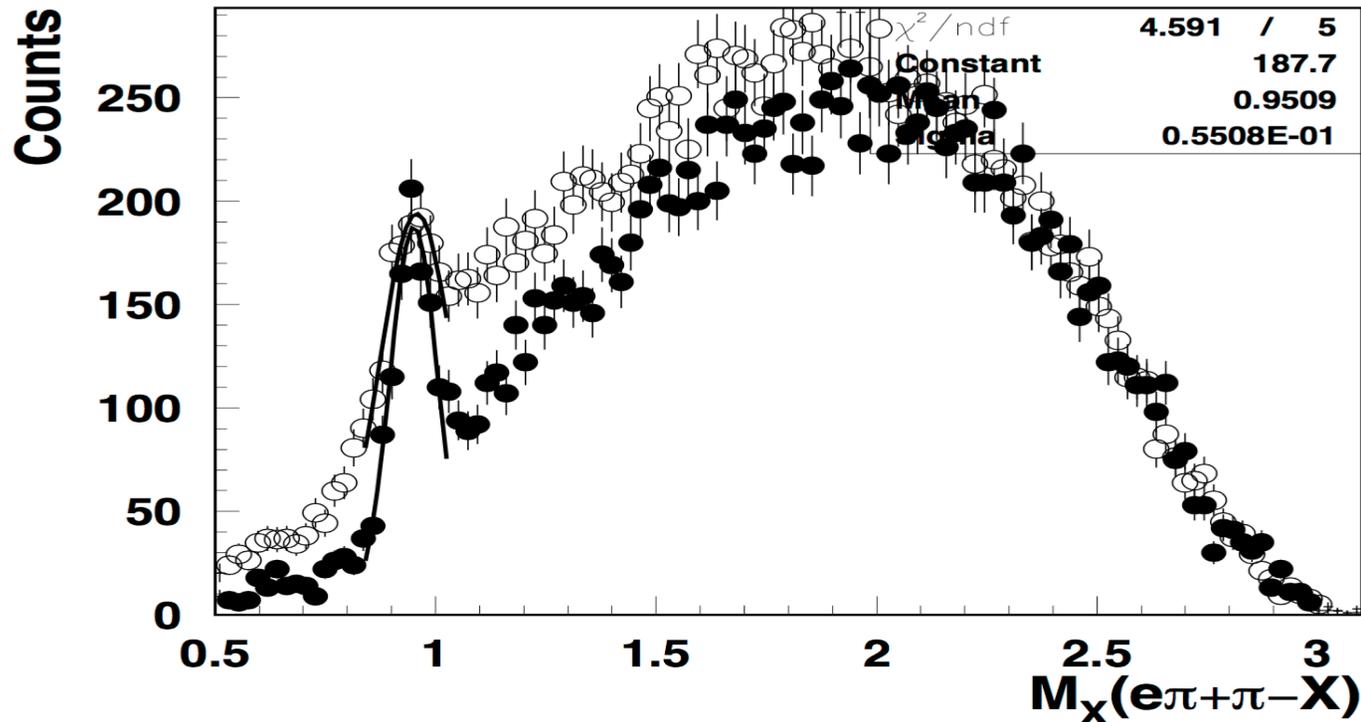
# LTCC in RGB vs RGA: Kaons



- More Kaons in the RGA at small angles and high energies.
- With improved calibration (to be checked with RICH) TOF ID should get more reliable
- At high energies fraction of Kaons is high, and LTCC signal may be useful for pion/Kaon separation (to be cross checked with RICH)

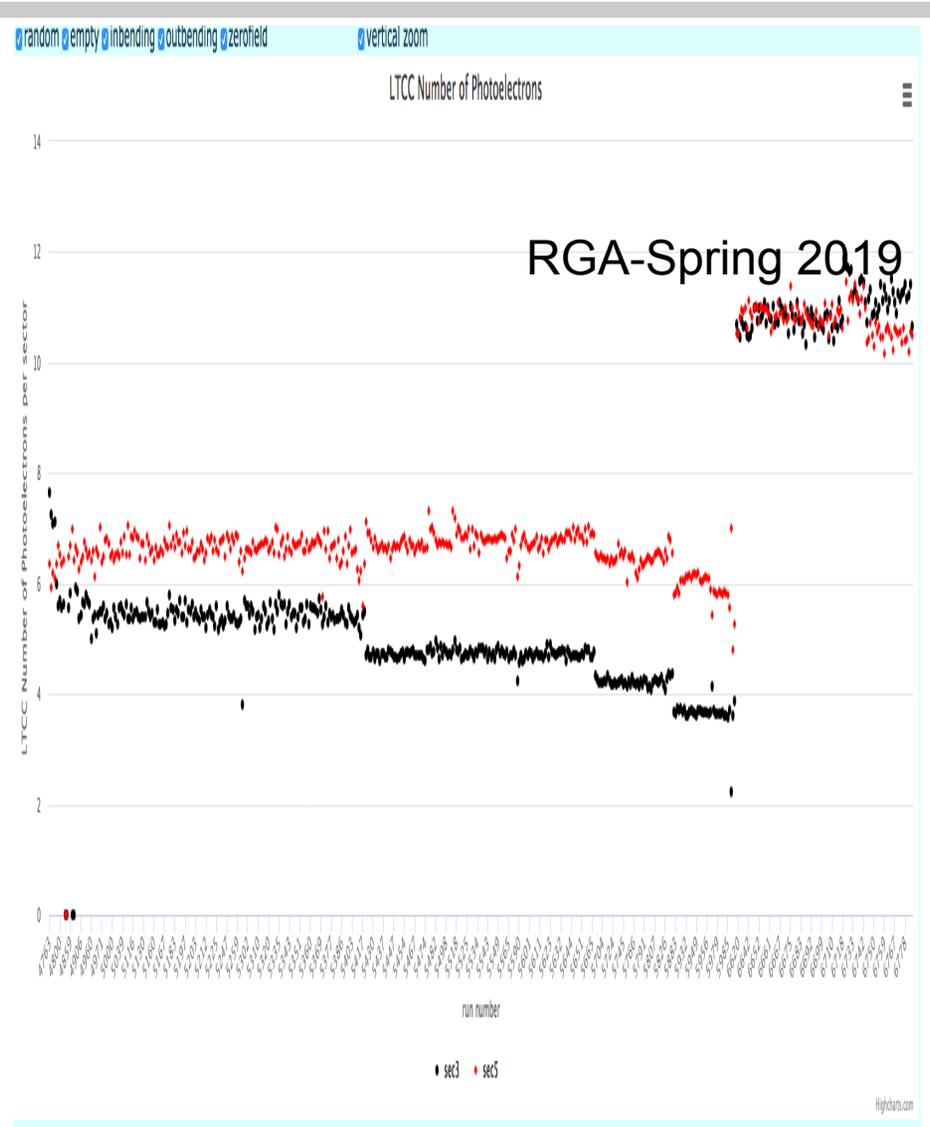
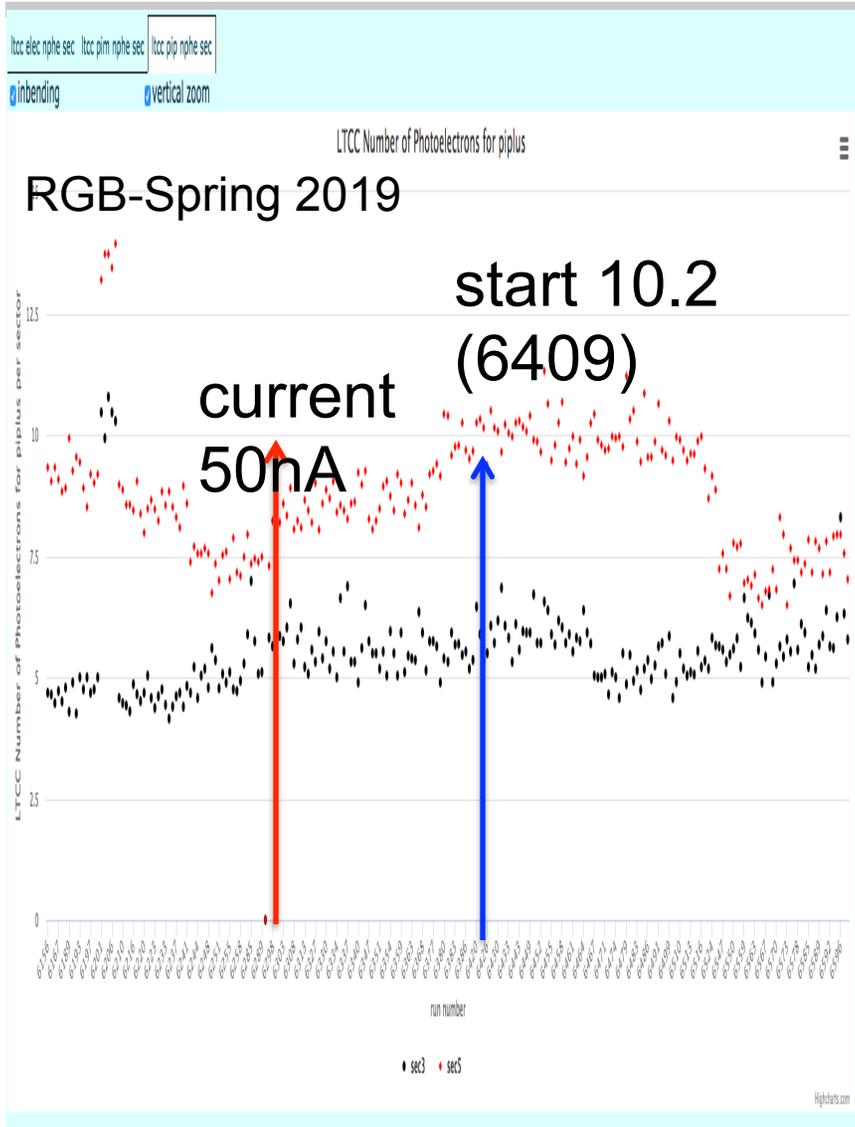
# LTCC in RGB vs RGA (v.6c2.1 $E_{\text{pion}} > 3 \text{ GeV}$ )

Filled circles: RGA-proton  
Empty circles: RGB-deuteron

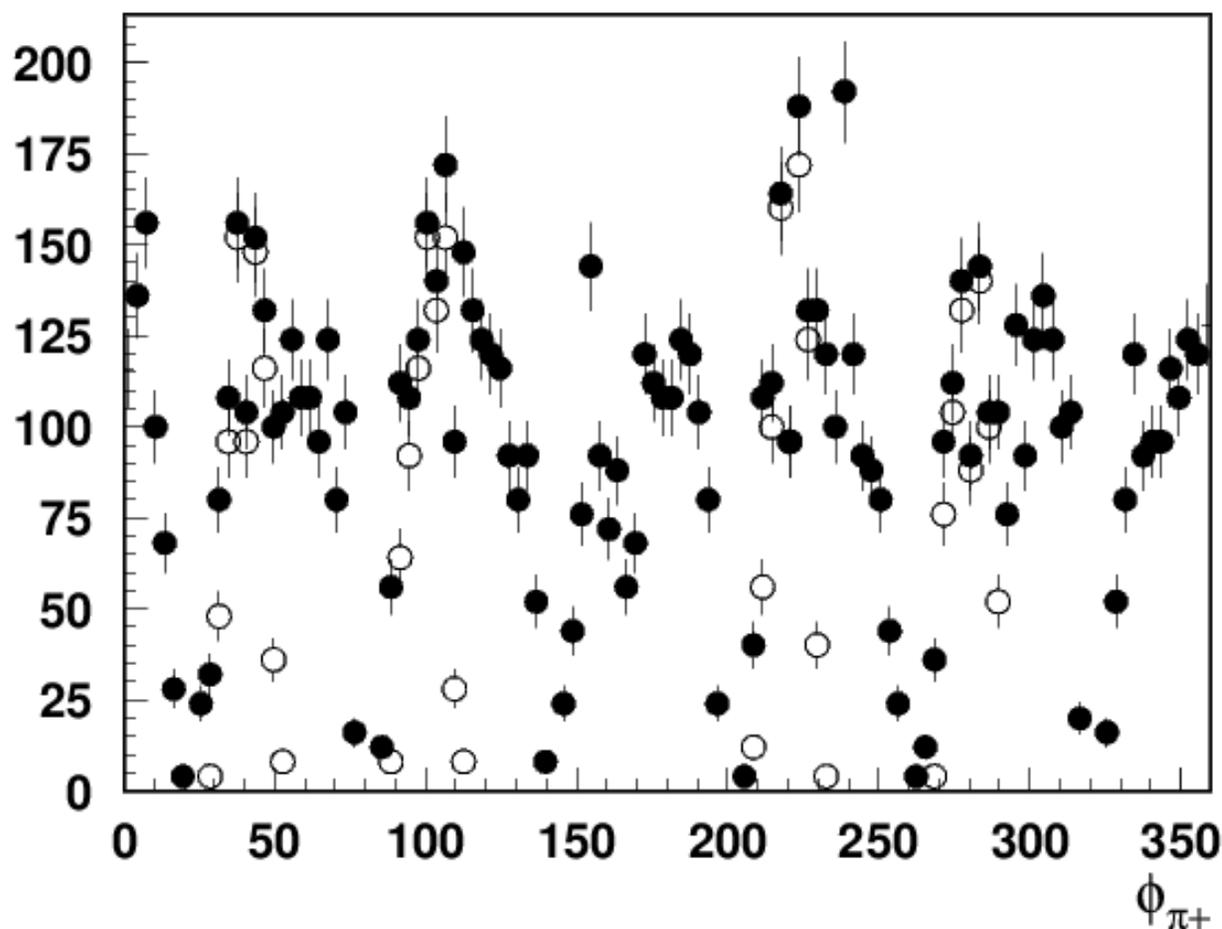


- Part of the nucleon peaks RGB/RGA may improve with better PID for pions
- Need more statistics with LTCC signal to check the reduction of the background
- Exclusive  $ep\pi^+\pi^-$  can be used to monitor efficiencies (PID,rec. eff.) and resolutions

# LTCC response vs time



# LTCC response MC v.6b2.0



In MC practically all pions with  $E > 3$  have response in LTCC  
More detailed comparison between MC and data needed

# SUMMARY

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The latest coatjava ( $\geq v.6c.2.1$ ) has proper LTCC reconstruction  
LTCC plays a crucial role in pion ID at energies  $> 3$  GeV

LTCC can provide a clean sample of pions

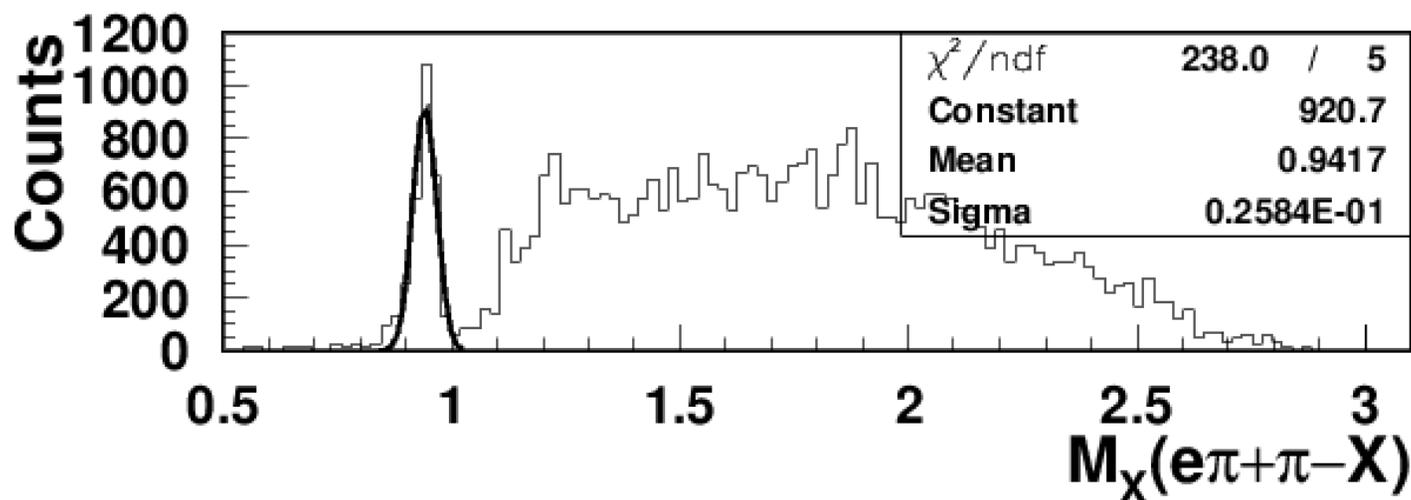
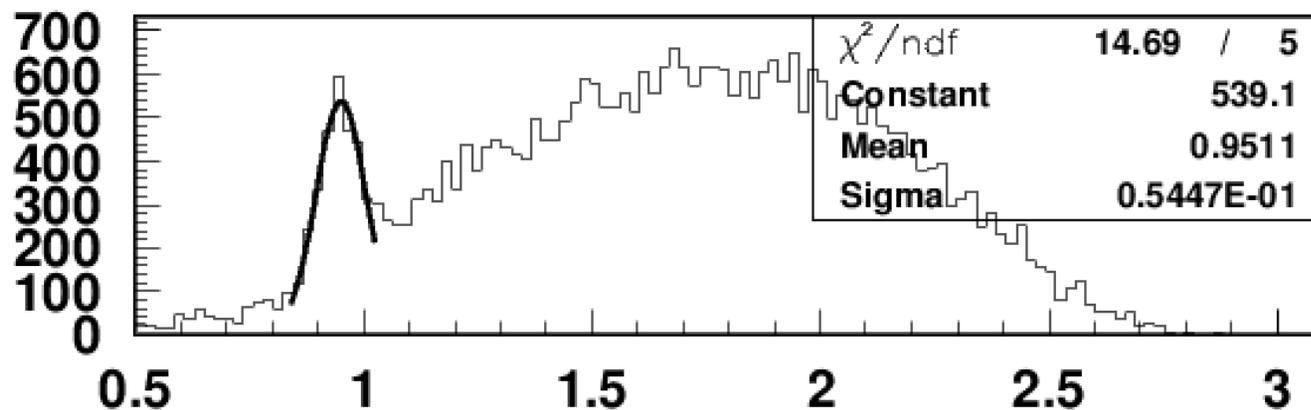
- a) can be used in analysis
- b) check the quality of TOF pion ID at high energies, where the TOF ID becomes very sensitive to timing calibrations

- Need further improvement of LTCC calibrations  
(V.Mascagna, M. Ungaro)
- Improved description in gemc and reconstruction (S. Joosten)

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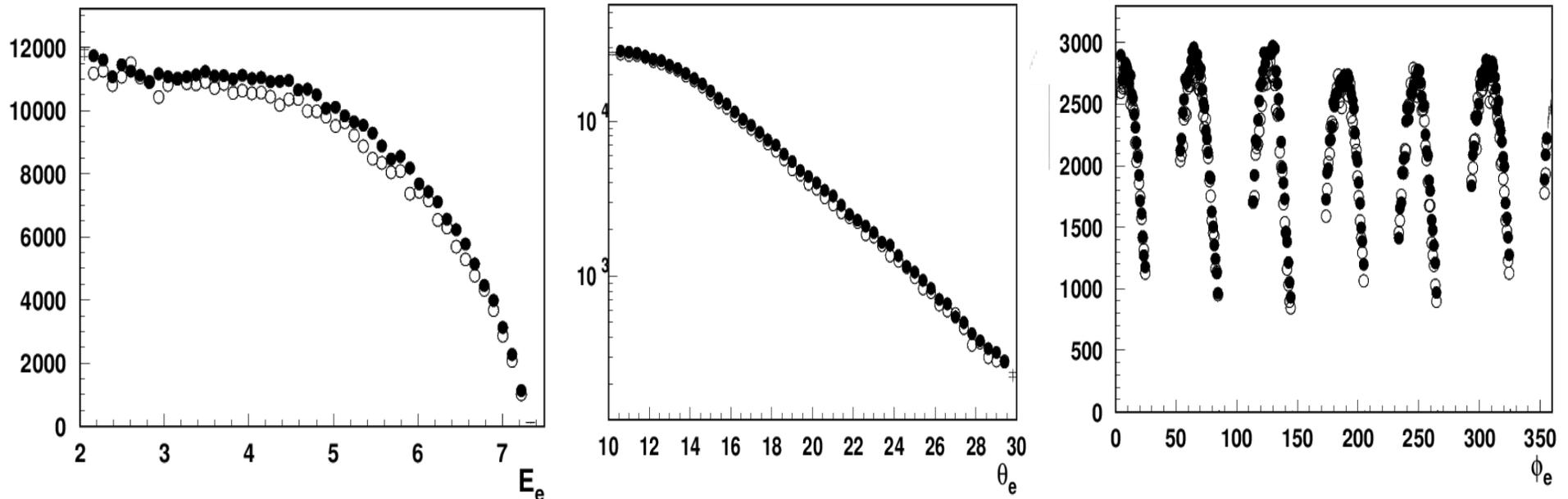
# Support slides

# Comparing MC and data (6715) v.6b2.0



# LTCC performances

Comparing the same number of electrons  
RGA-6715 (filled) vs RGB 6489 (empty)



In fiducial region good agreement in electron counts for  
momentum and angles