

(ALL VIRTUAL)

JLAB A.I. TOWNHALL

MONDAY JULY 26, 2021 @ 2PM

5 minute Lightning Talks

- ongoing and near future projects

Have a project to present?

Contact: David Lawrence

davidl@jlab.org

HACK-A-THON

TUESDAY JULY 27, 2021 (ALL DAY)

- Single Day Event
- All skill levels
- Tutorial on JLab Jupyterhub and GPUs

watch the JLab AI page for details: <https://www.jlab.org/AI>

Application of t-SNE analysis to 2 pion data analysis

M.Battaglieri (JLab)

A(i)DAPT Working Group

LDRD program + ODU ML

Y. Li (co-PI) (ODU, CS prof.)

Y. Alanazi (ODU, CS grad.)

M. P. Kuchera (Davidson College, CS prof.)

R. Ramanujan (Davidson College, CS prof.)

L. Velasco (U. Dallas, Physics undergrad)

P. Ambrozewicz (JLab, post-doc)

T. Liu (JLab, Theory post-doc)

W. Melnitchouk (PI) (JLab, Theory)

N. Sato (co-PI) (JLab, Theory)

Other collaborators

A. Blin (JLab)

A. Szczepaniak (IU/JLab)

A. Pilloni (ECT*)

C. Fanelli (MIT)

G. Costantini (UniBs)

L. Biondo (UniME)

L. Marsicano (INFN-GE)

T. Roark (ODU)

T. Viducic (ODU)

N. Tyler (SCU)

M. Arratia (UCR)

S. Paul (UCR)

Hall-B Data Preservation

Task Force

H. Avakian (PI)

G. Gavalian (core)

M. Ungaro (core)

V. Mokeev (core)

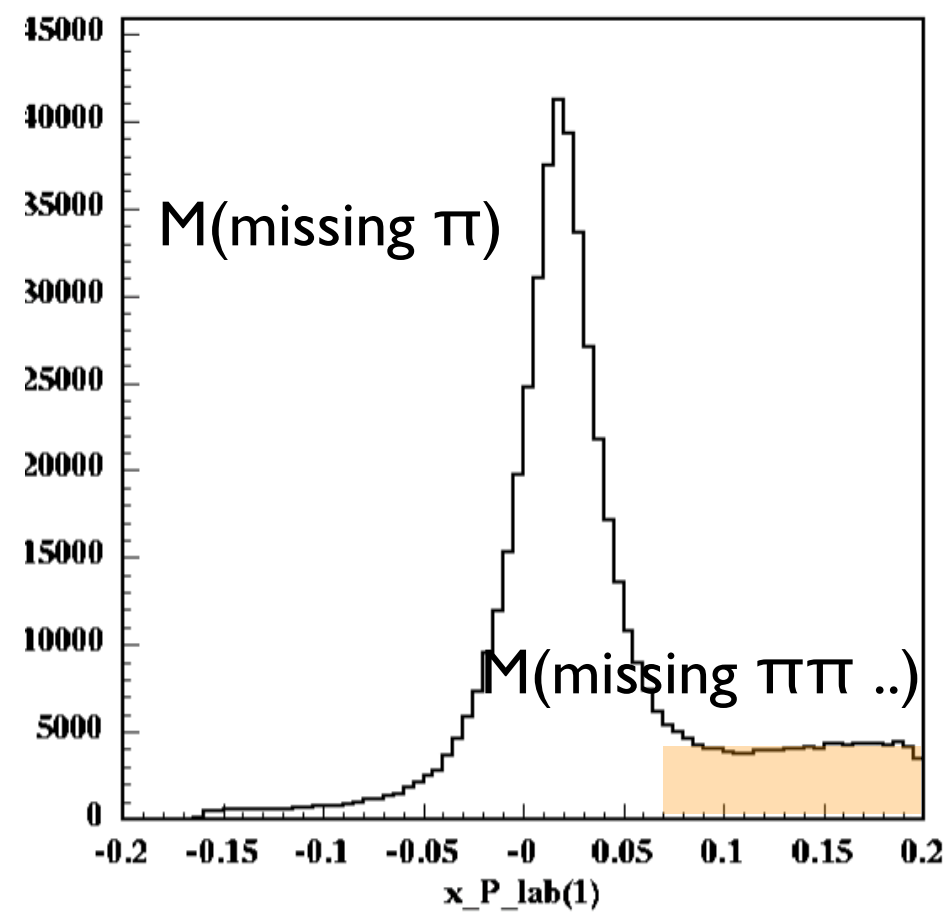
N. Baltzell (external)

A. Vossen (external)

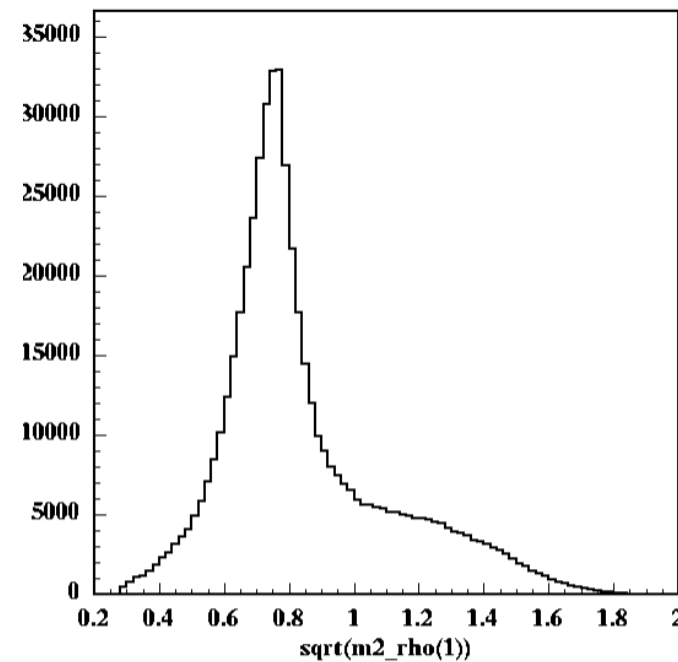
CLAS g|I 2pi photo production data

- **Data set**

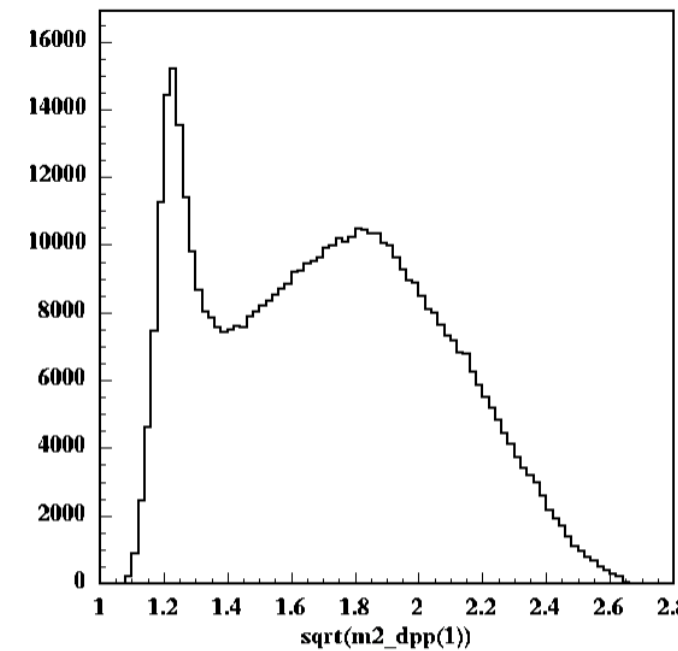
- g|I CLAS photo production data
- $E_\gamma = (3.0 - 3.8)$ GeV
- $\gamma p \rightarrow p \pi^+ \pi^-$ exclusive reaction
- data set analyses so far $\gamma p \rightarrow p \pi^+ (\pi^-)$ + small contamination of $\gamma p \rightarrow p \pi^+$ (more than a missing π^-)
- complicated dynamic for the overlap of $(p\pi)$ to form Δ baryon resonances and $(\pi\pi)$ to form meson resonances



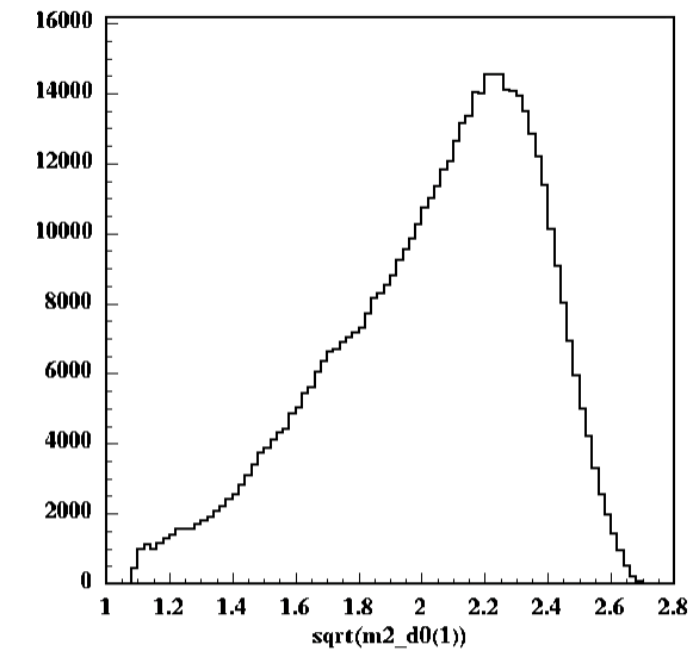
$M(\gamma p \rightarrow p \pi^+ X)$



$M(\pi\pi\pi)$



$M(p\pi^+)$



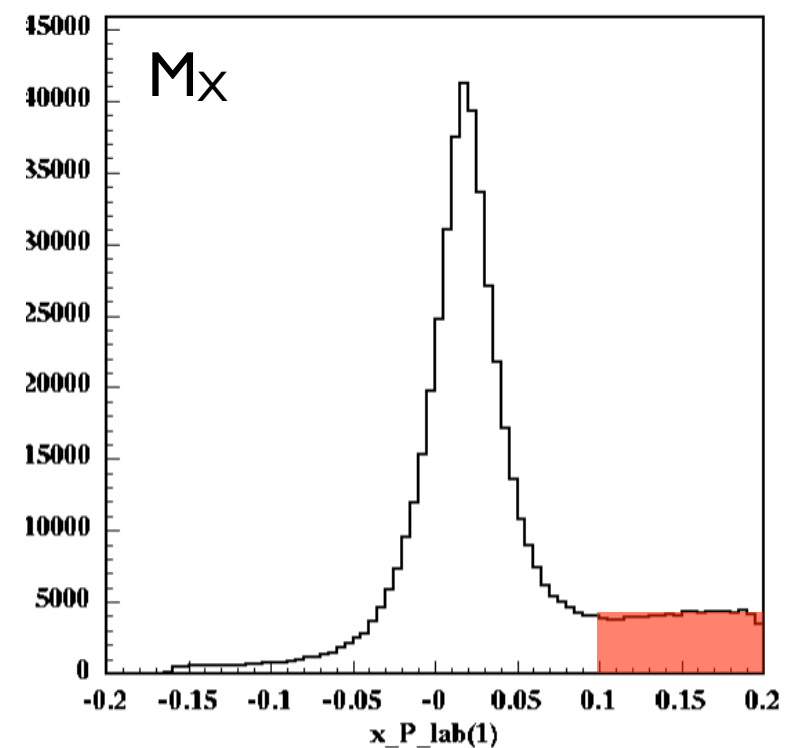
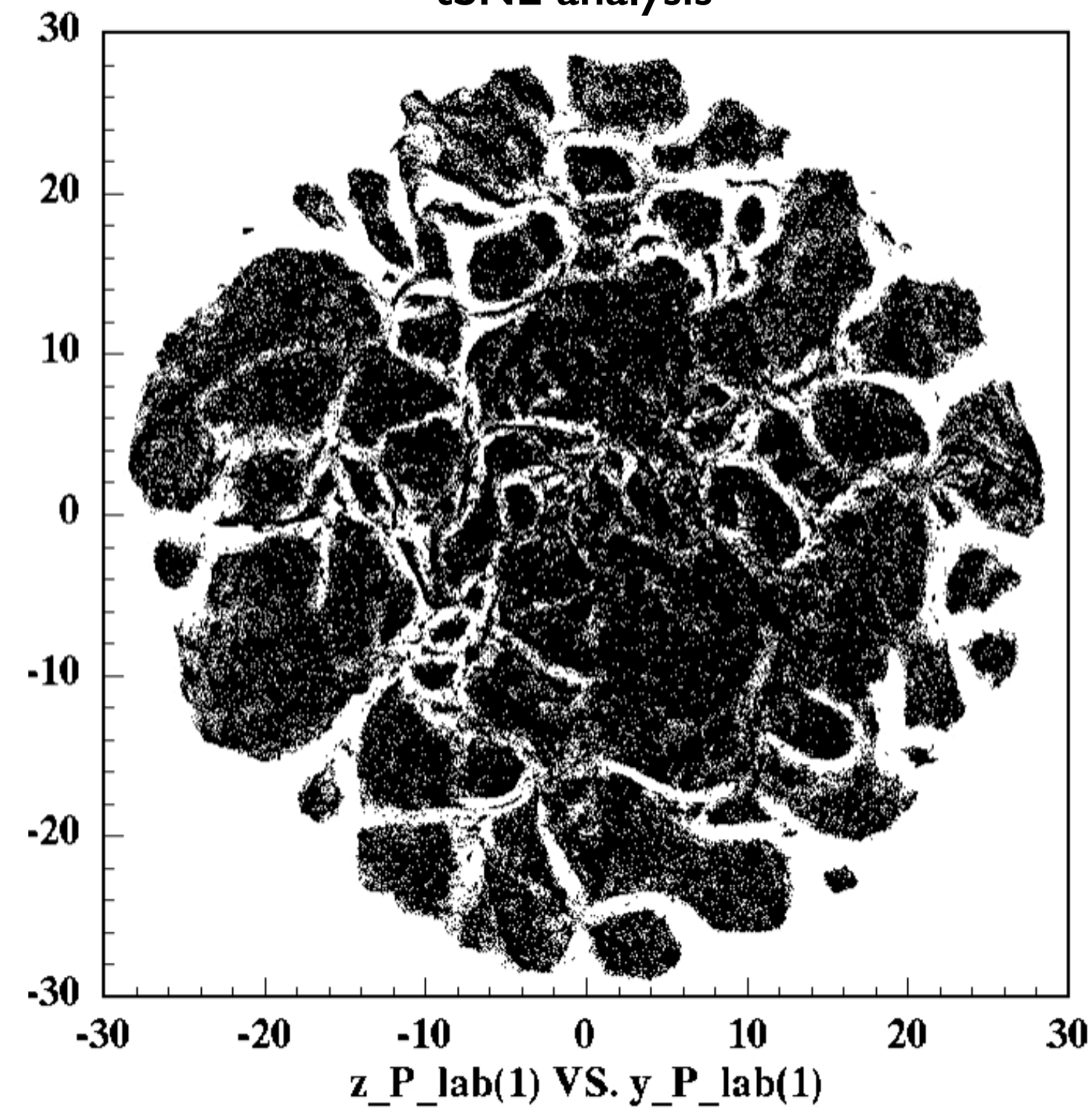
$M(p\pi^-)$

t-SNE analysis strategy

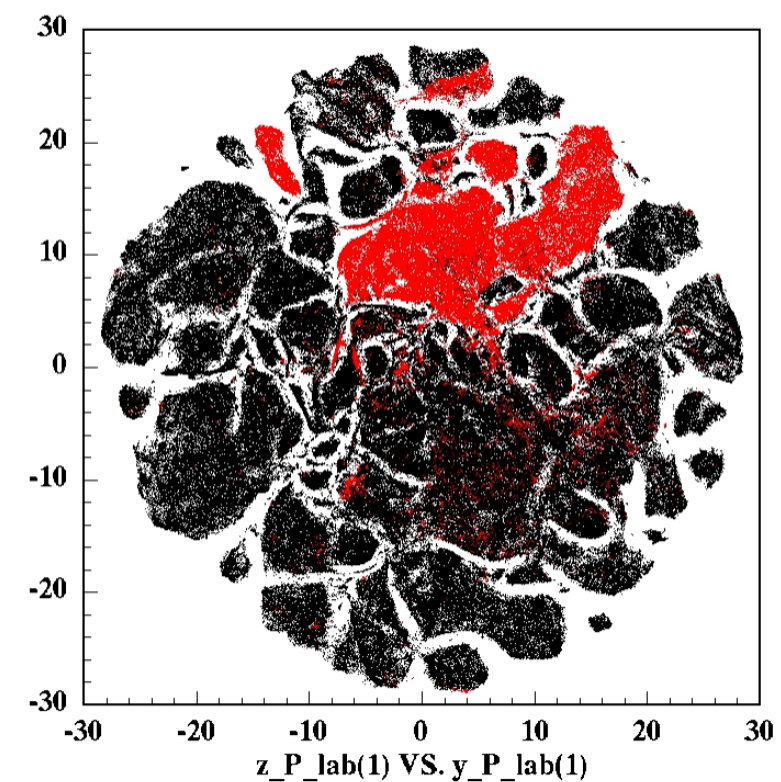
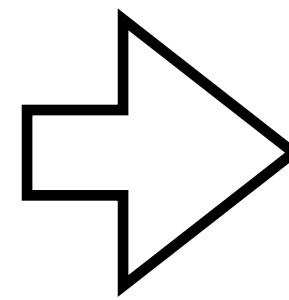
- explore correlations with multi-pion final states using the ω as a reference: $\gamma p \rightarrow p \omega \rightarrow p \pi^+ (\pi^- \pi^-)$
- Select the prominent $\Delta^{++}(1232)$ peak and check correlations
- Select areas of t-SNE1 vs. t-SNE2 space to demonstrate meson/baryon systems separation

Sub-leading multi-pion contamination

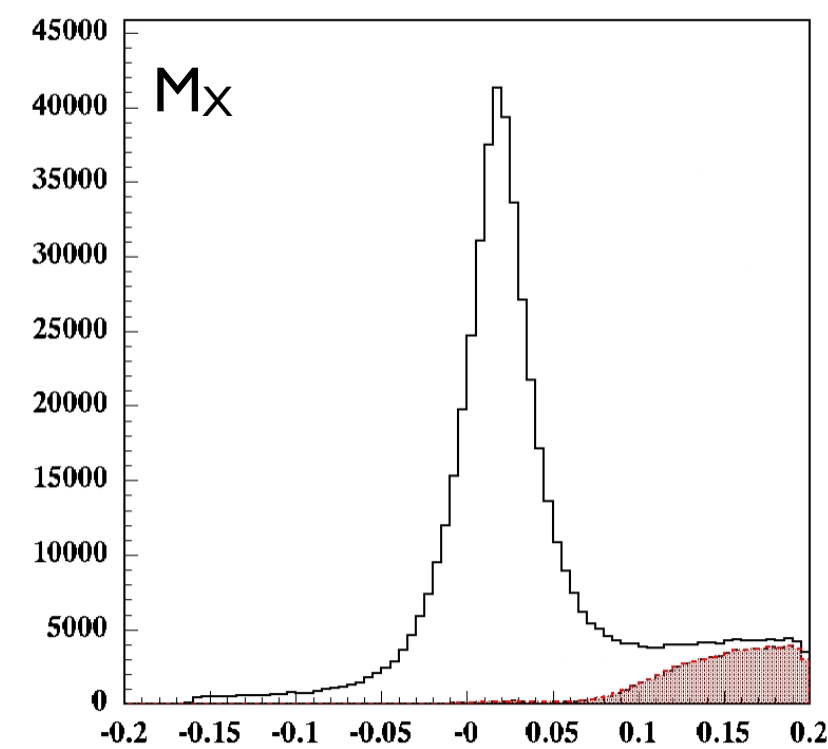
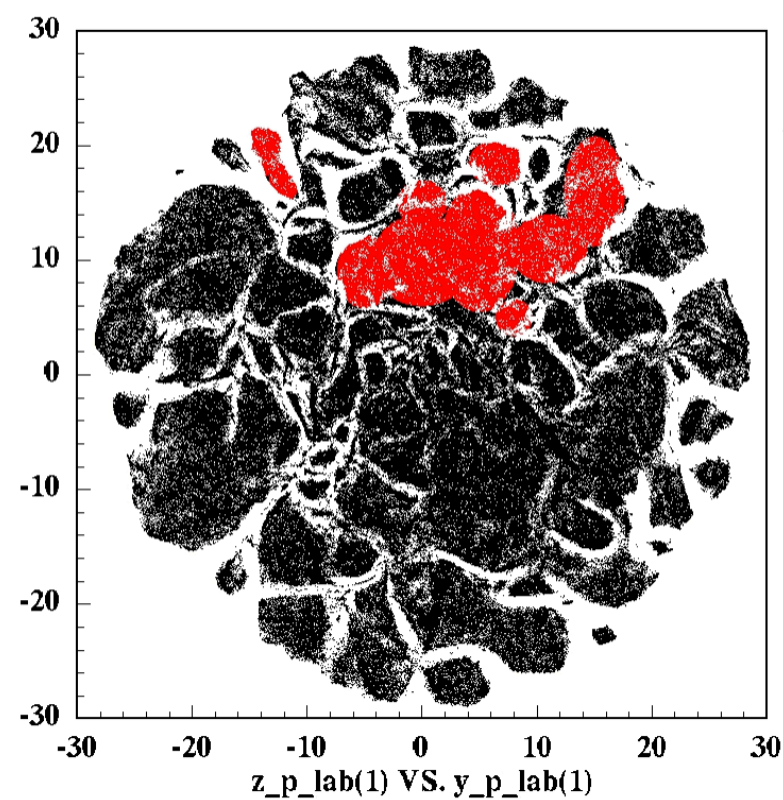
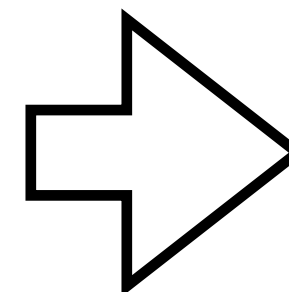
tSNE analysis



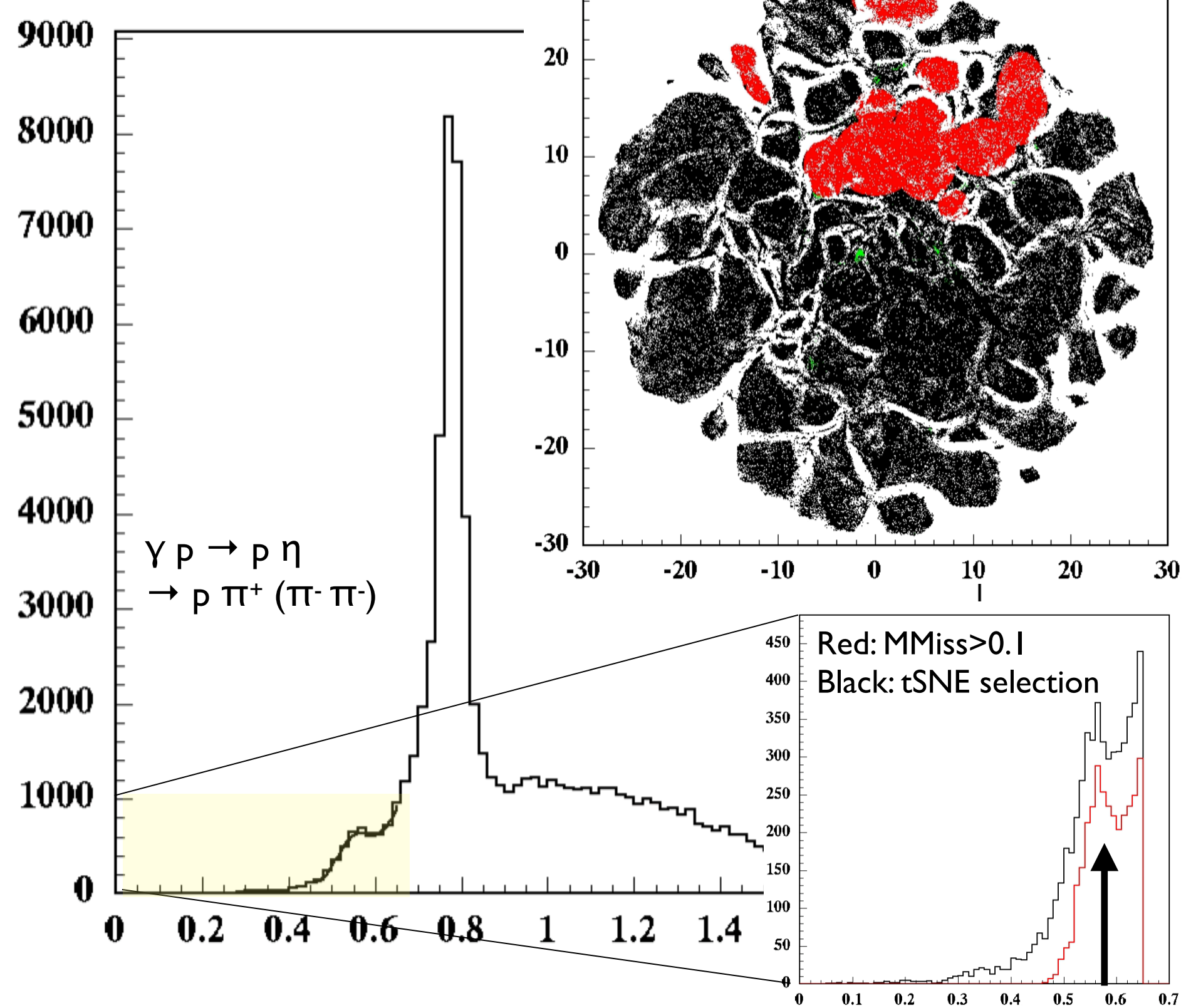
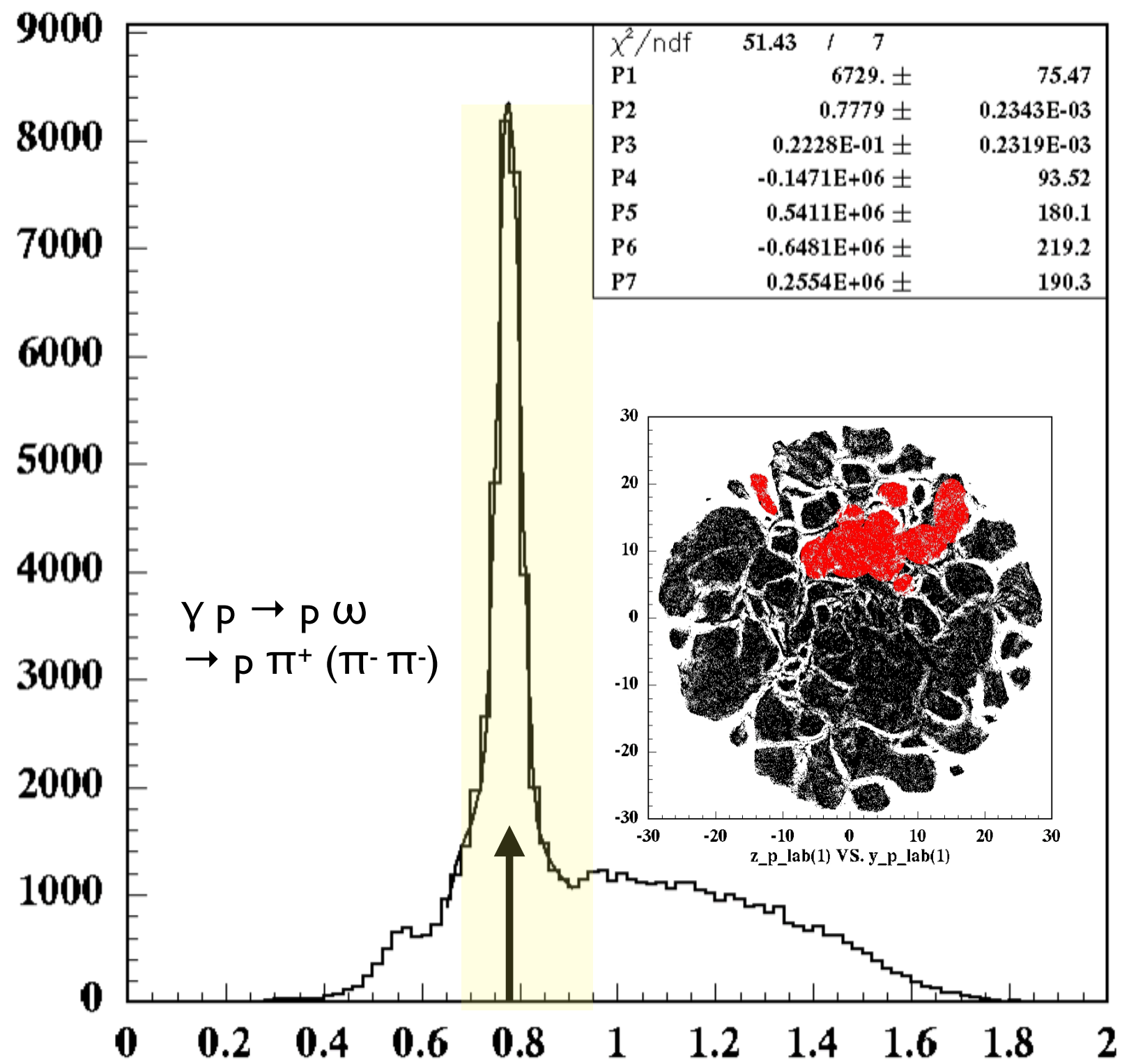
TRADITIONAL
sharp cut in M_X
 $\Upsilon \rho \rightarrow \rho \pi^+$ (X)



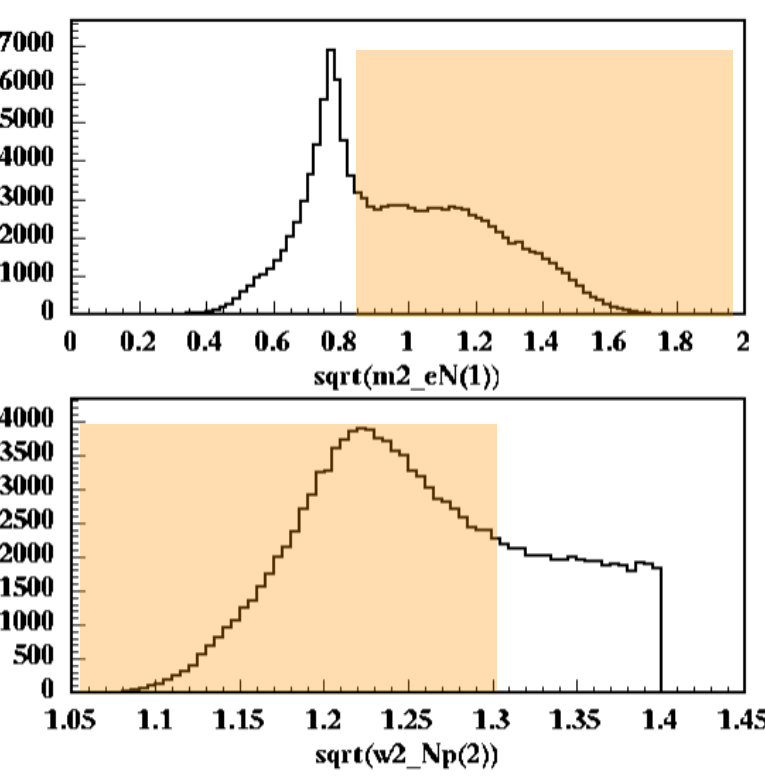
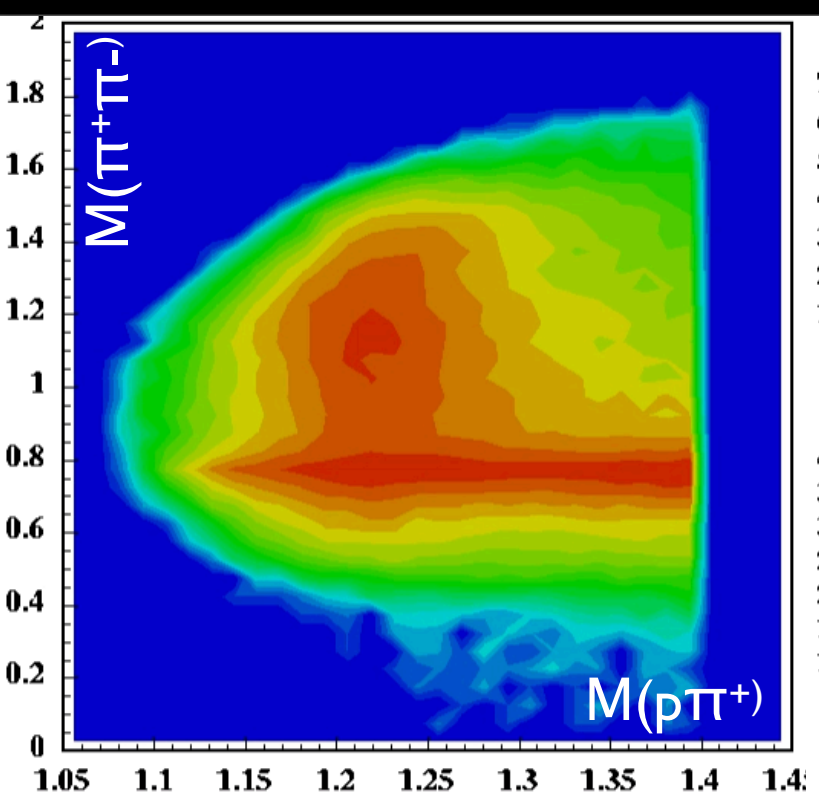
tSNE analysis
identify separated
islands



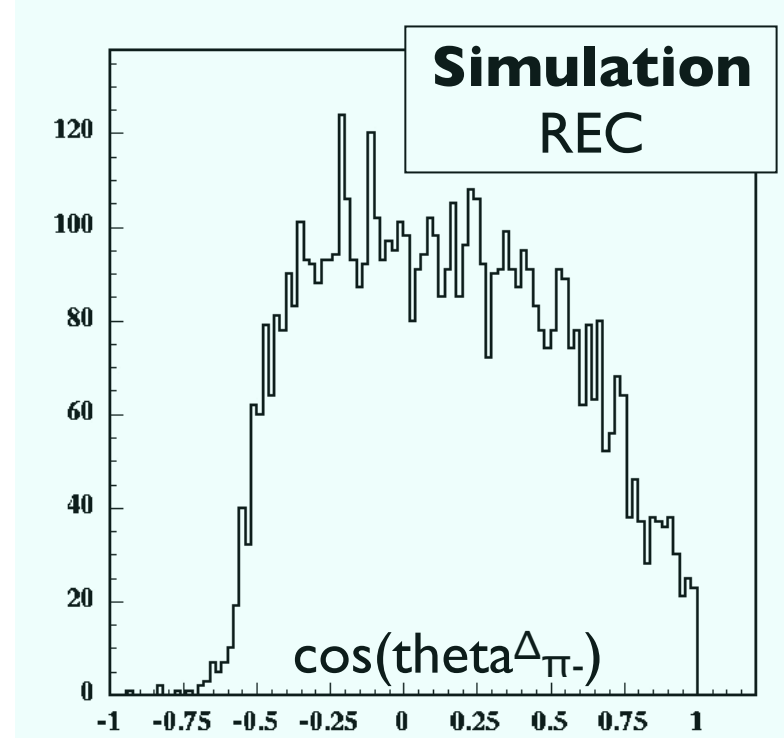
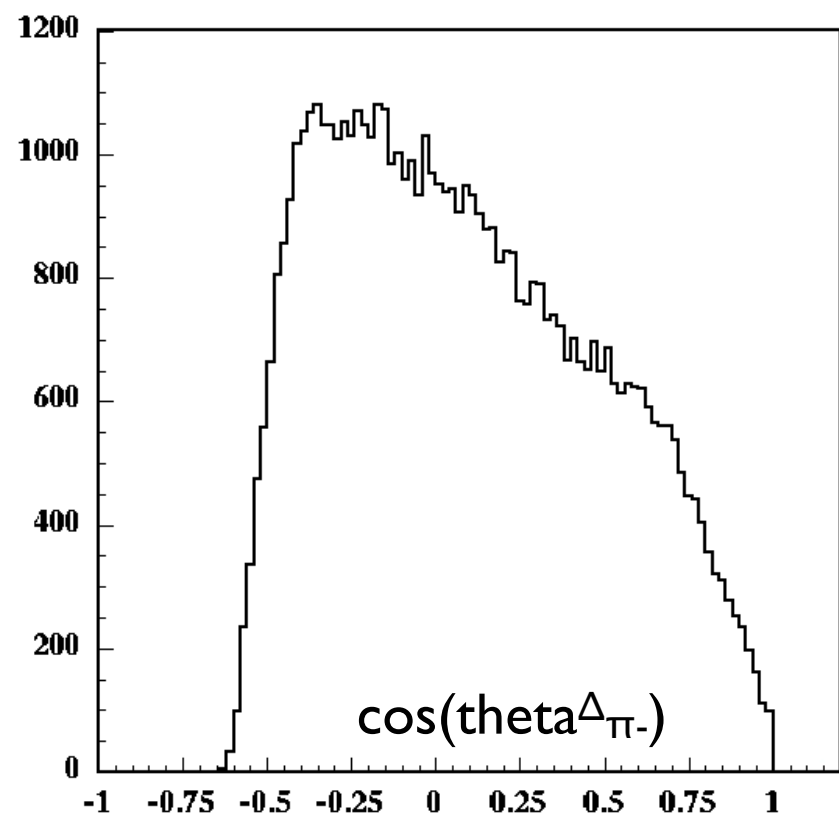
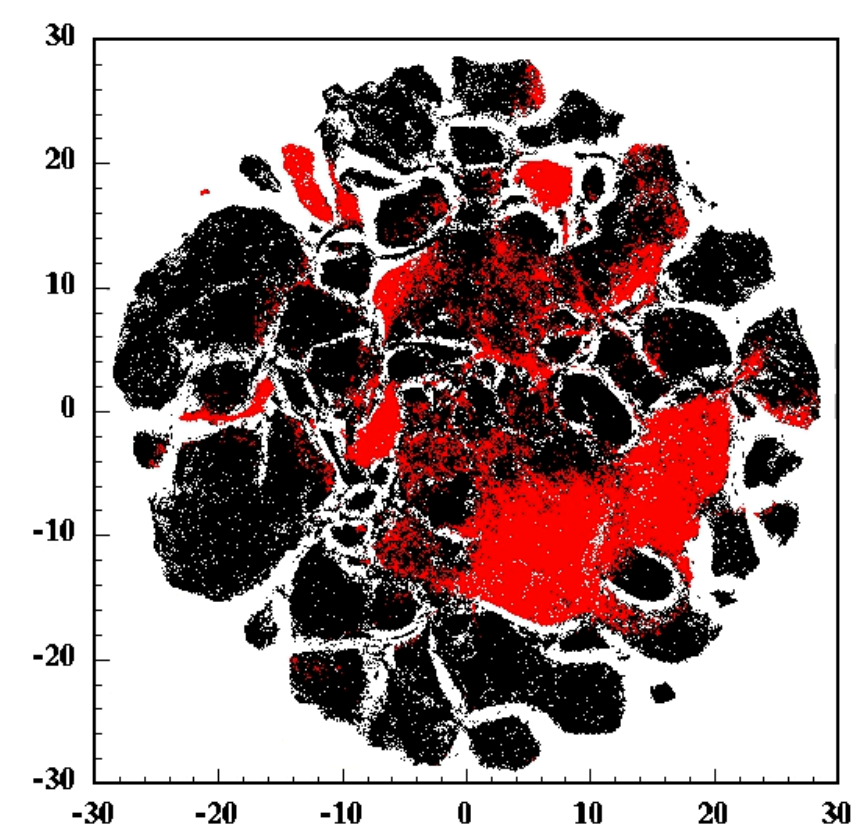
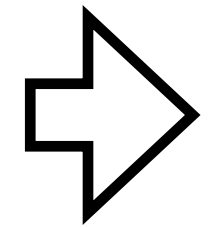
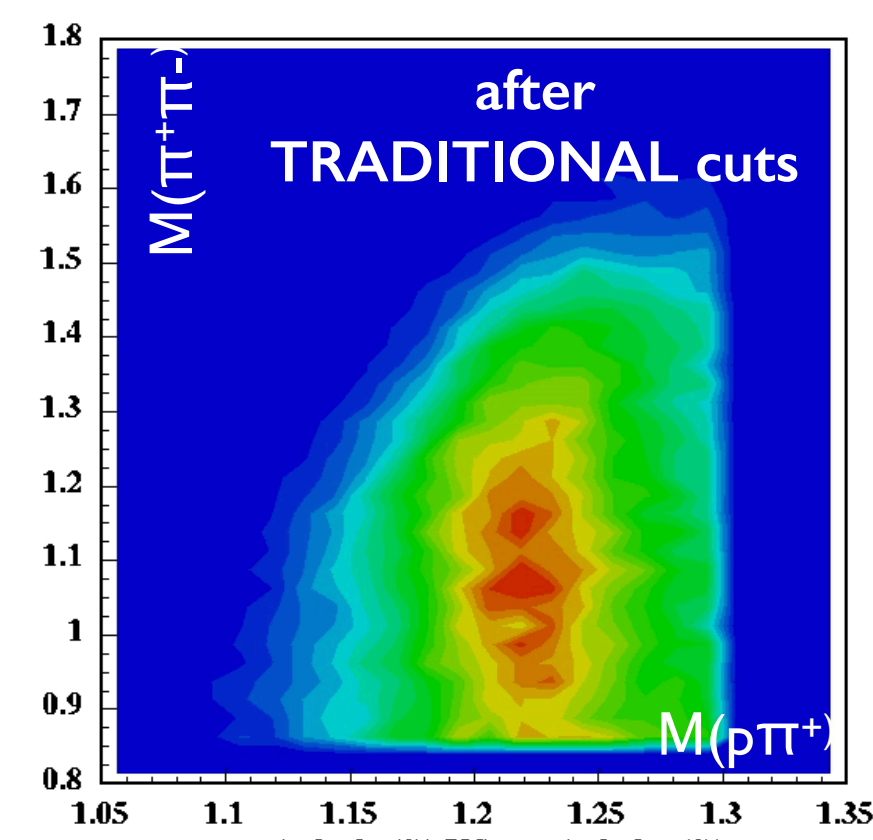
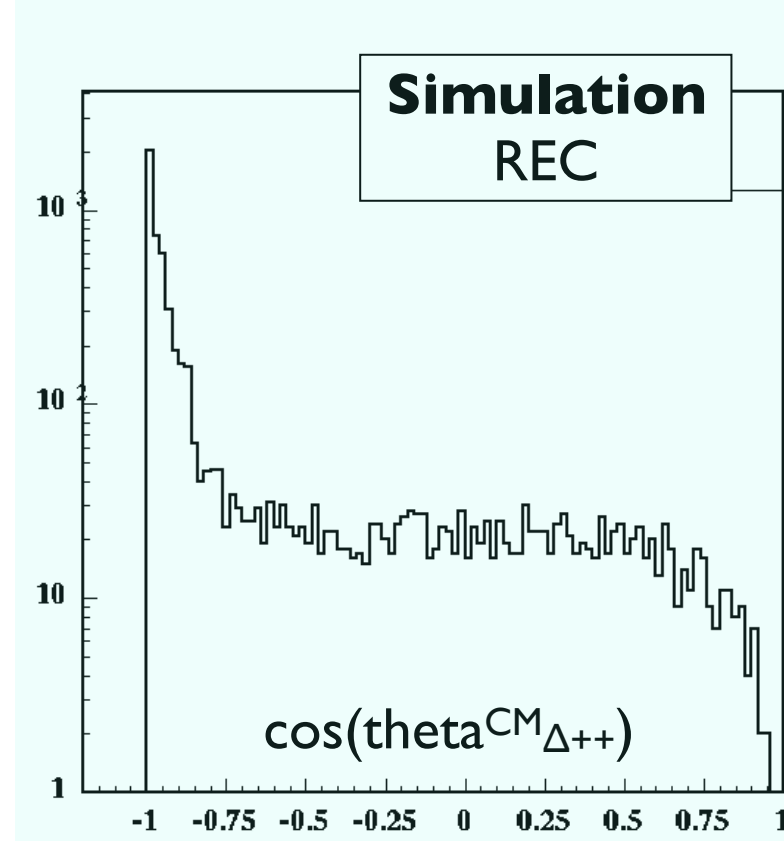
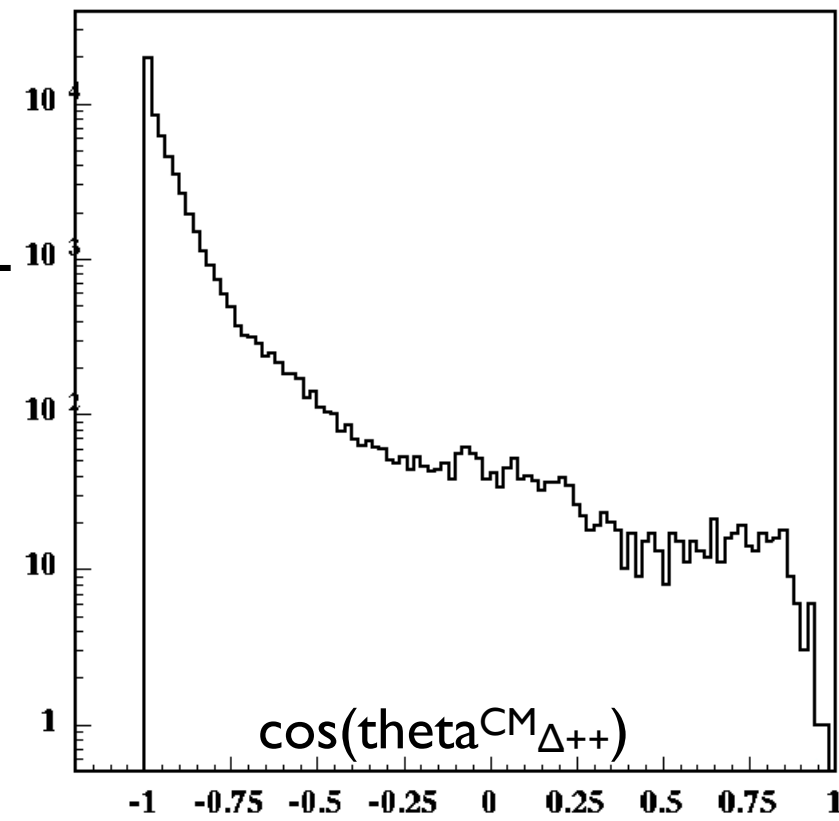
Omega identification



Delta++ Identification $\gamma p \rightarrow \Delta^{++}(1232) X \rightarrow p \pi^+ (X)$: TRADITIONAL analysis

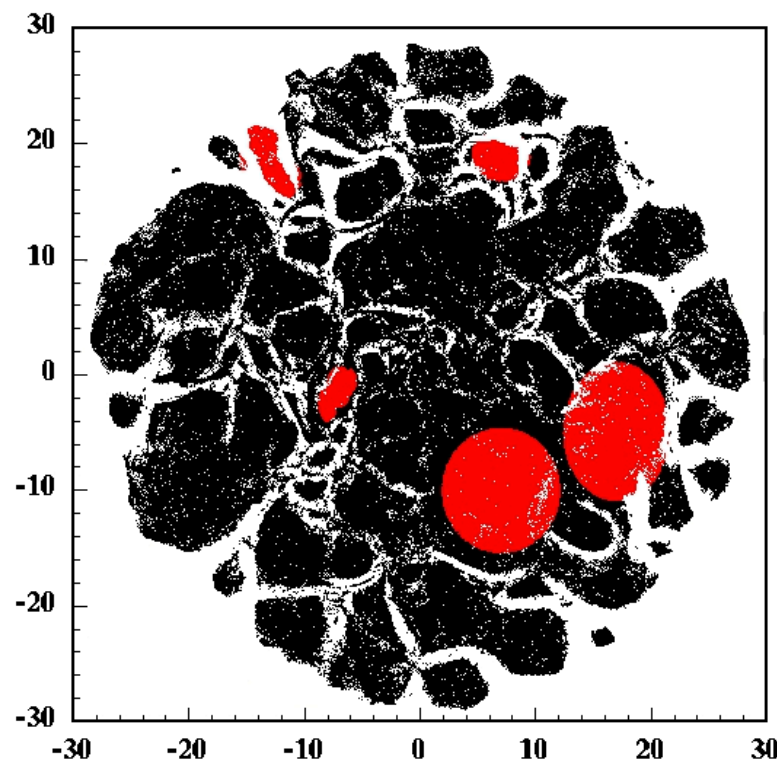
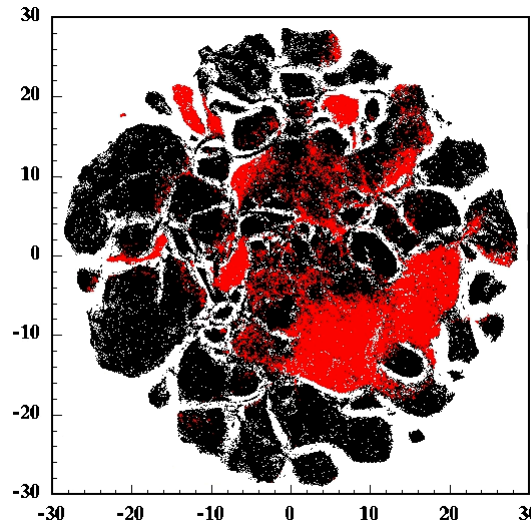


TRADITIONAL sharp cuts in $M_{\pi\pi}$ and $M_{p\pi}$ to select $\Delta^{++}(1232)$



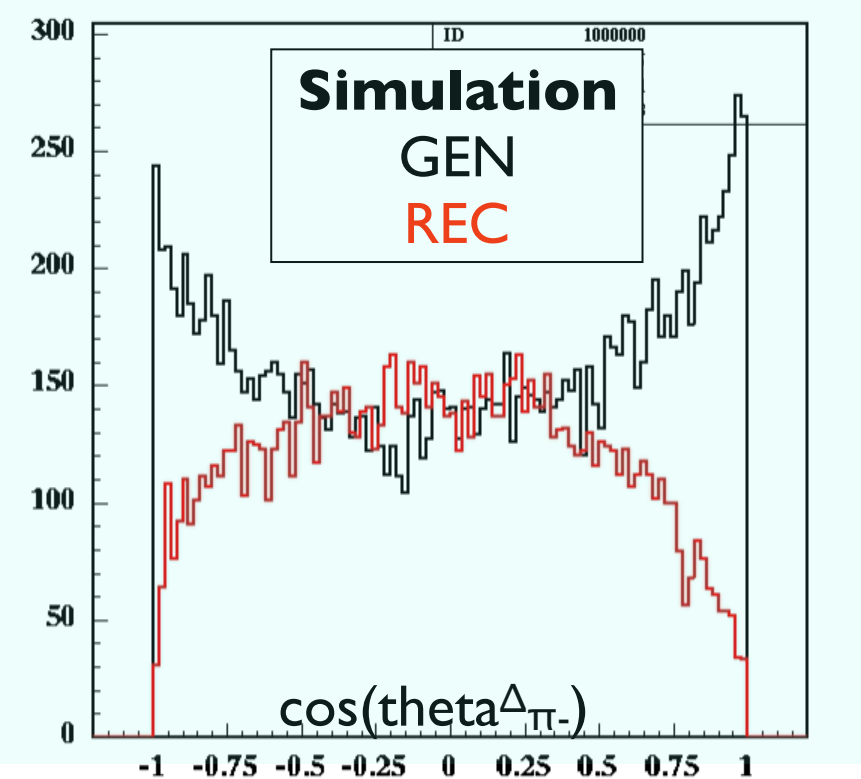
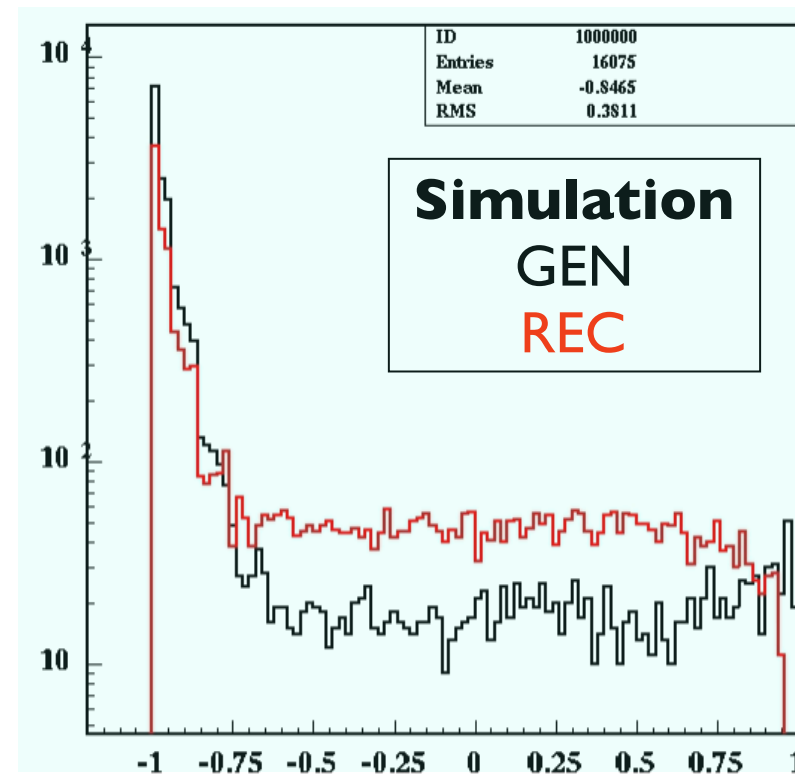
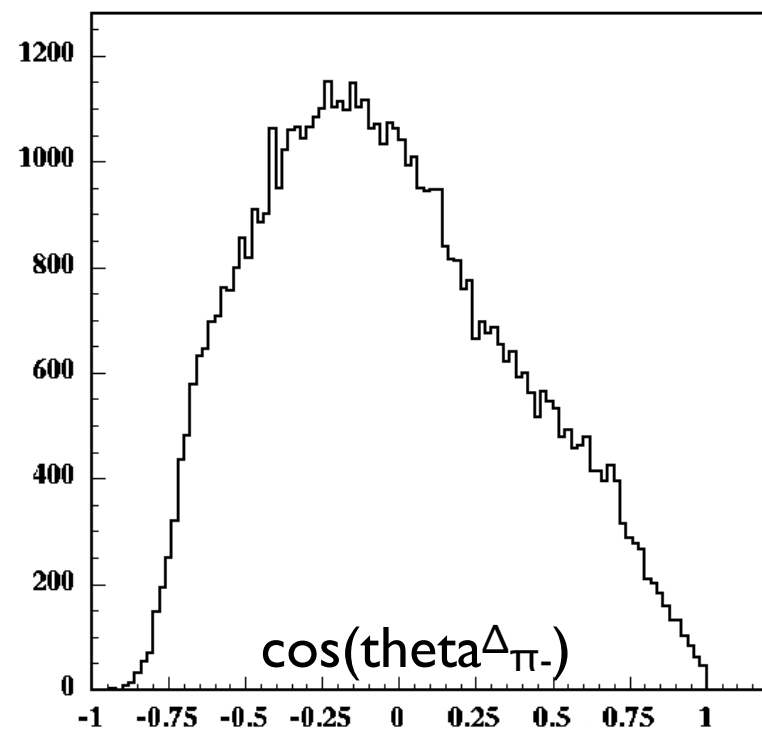
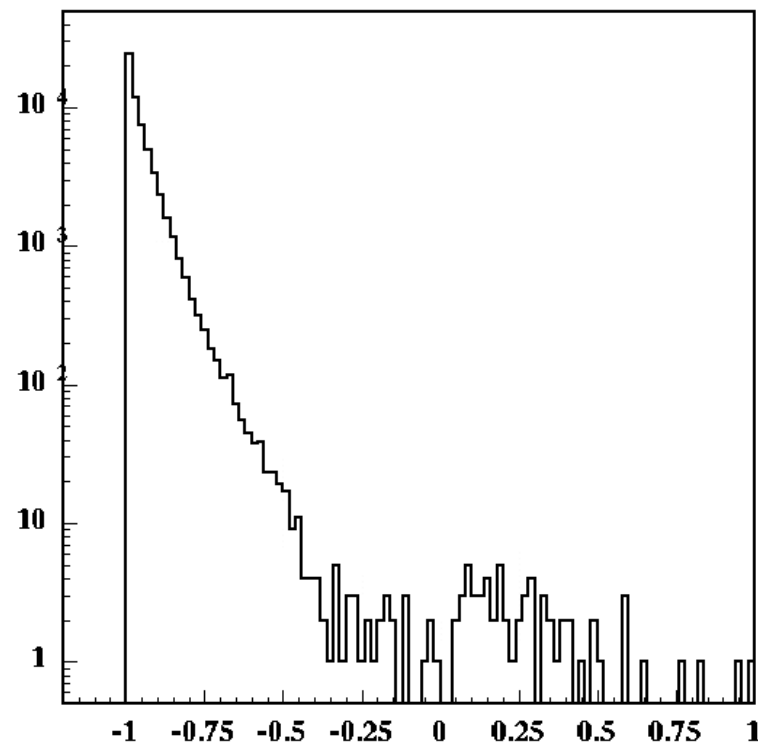
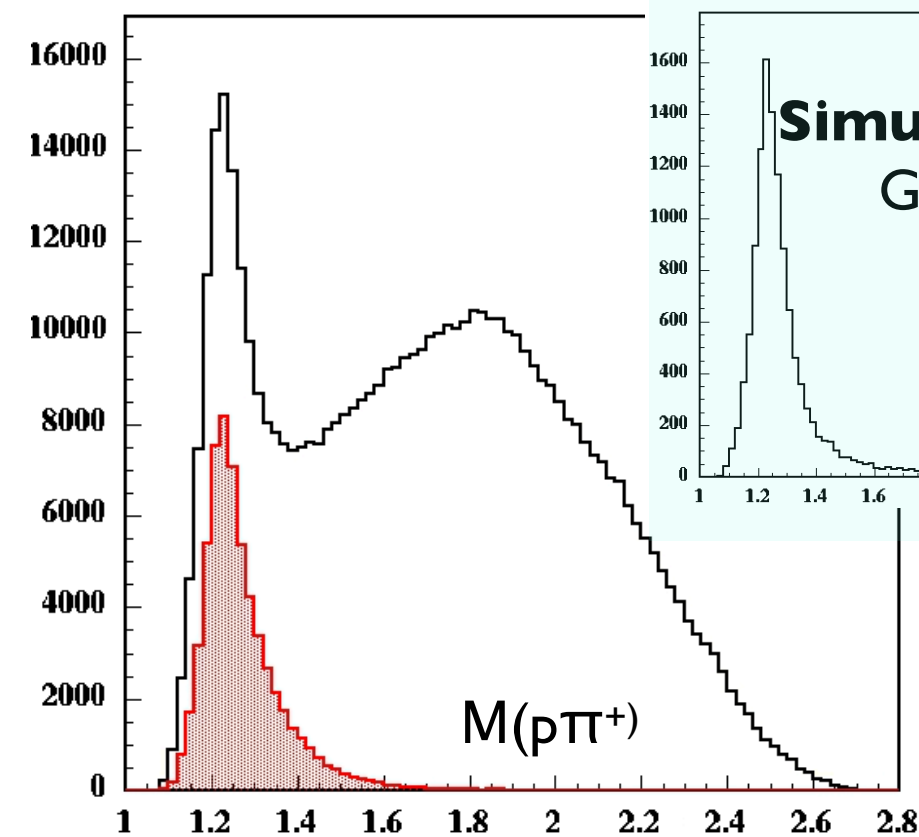
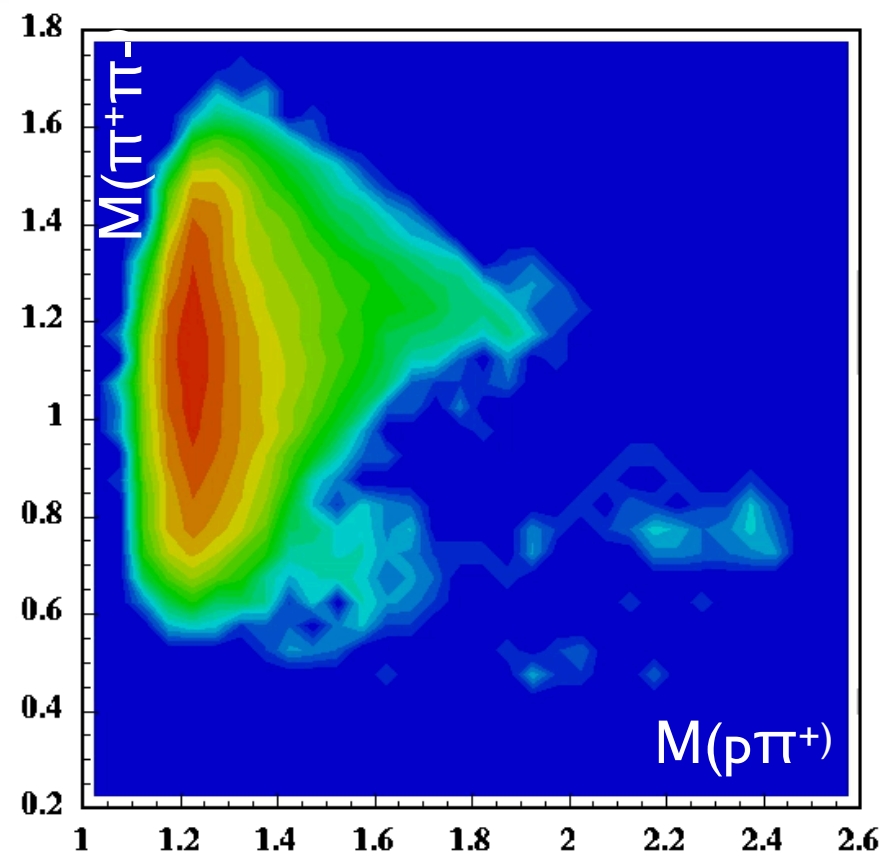
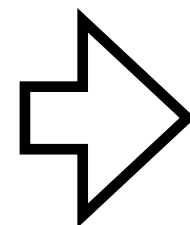
Delta++ Identification $\gamma p \rightarrow \Delta^{++}(1232) X \rightarrow p \pi^+ (X)$: tSNE analysis

tSNE areas activated
identified by
TRADITIONAL cuts



$\cos(\theta_{\Delta^{++}}^{CM})$

$M(p\pi^+)$

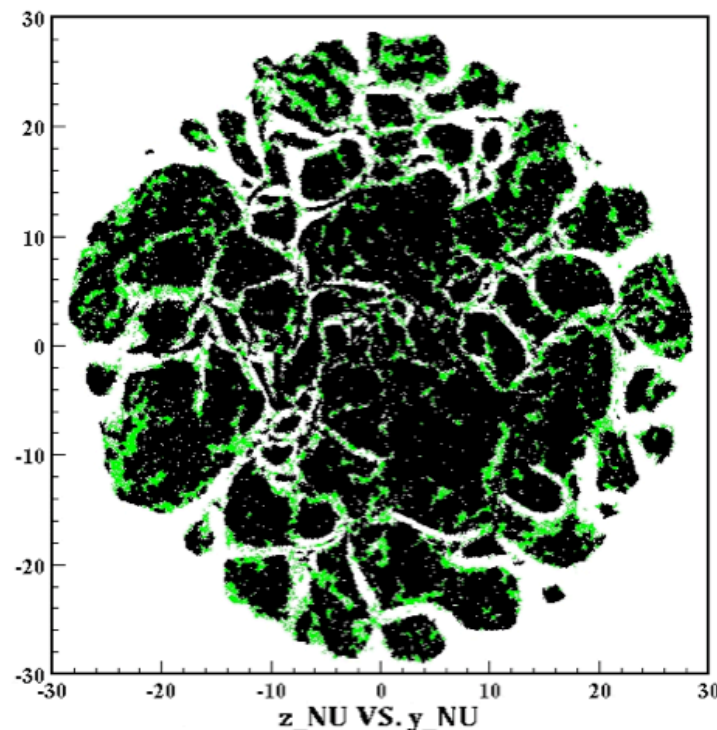
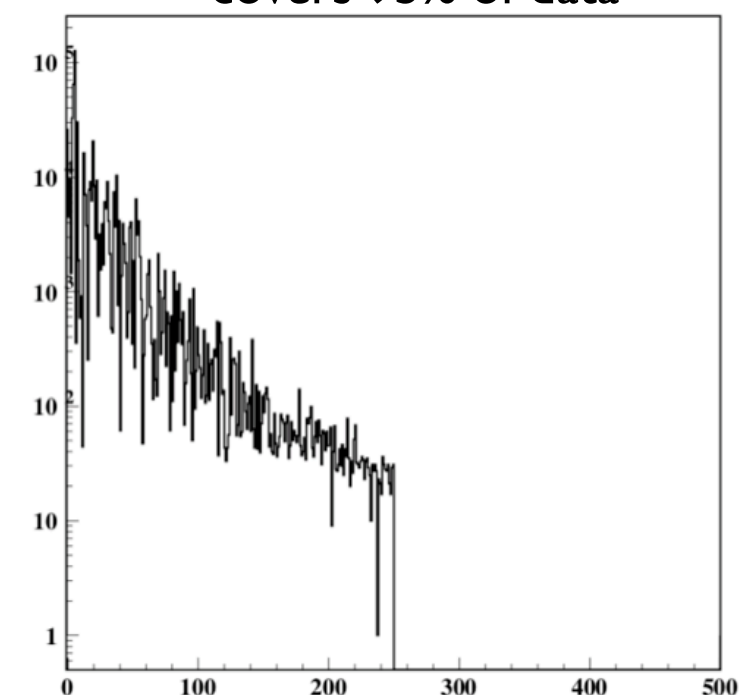


tSNE analysis status

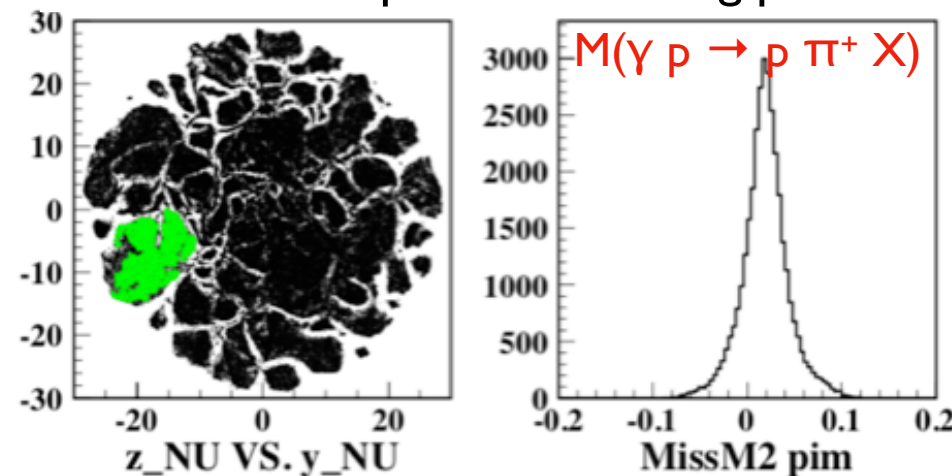
- ML-based classification of islands (work in progress)

events per island: 60 islands covers 95% of data

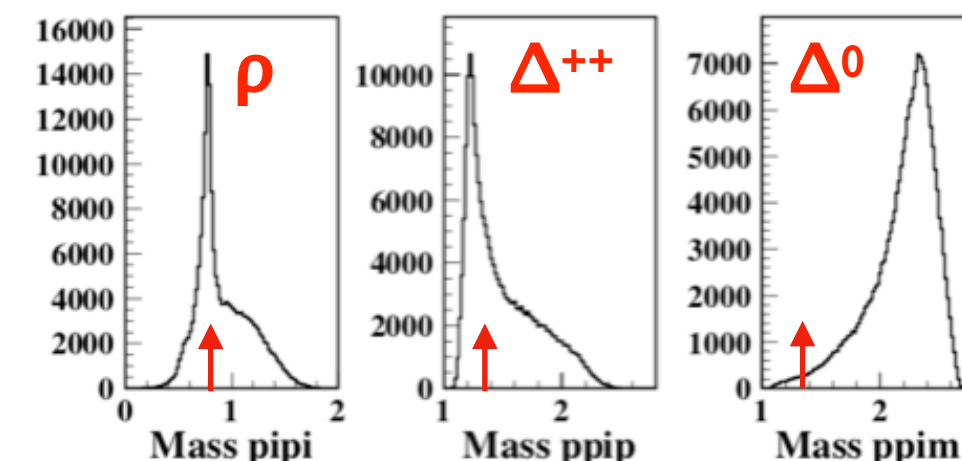
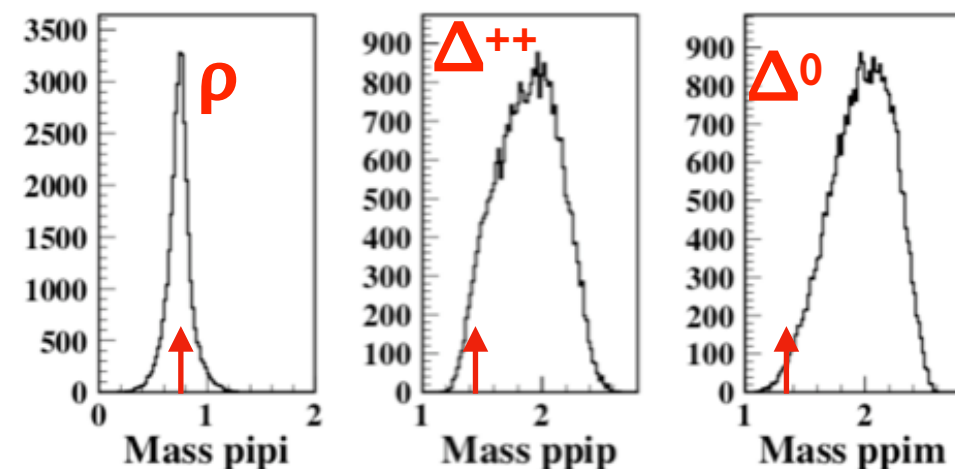
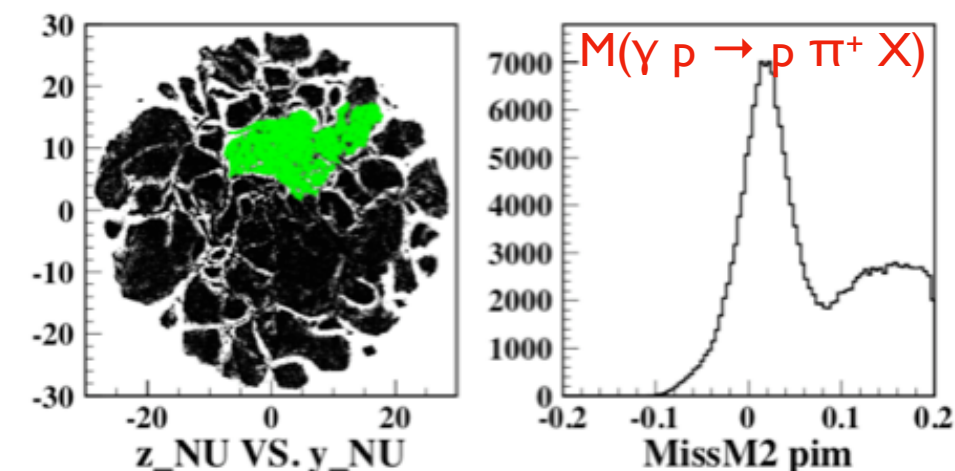
in green events not assigned



example good selection
clean rho peak and missing pion



example bad selection
leak of multipoint contamination



- tSNE analysis aims to identify clusters in multi-d space and project into 2-dim tSNE space **Y.Alanazi talk**
- First attempt to correlate NN hidden layers weights to different physics process present in the data set via tSNE analysis
- Sub-leading features are conserved and identified (eg omega and eta contamination in the sample)
- Larger signals (eg Delta++) are identified
- ML-based classification of different islands for a systematic assessment
- Check on MC data set to verify it in a controlled environment