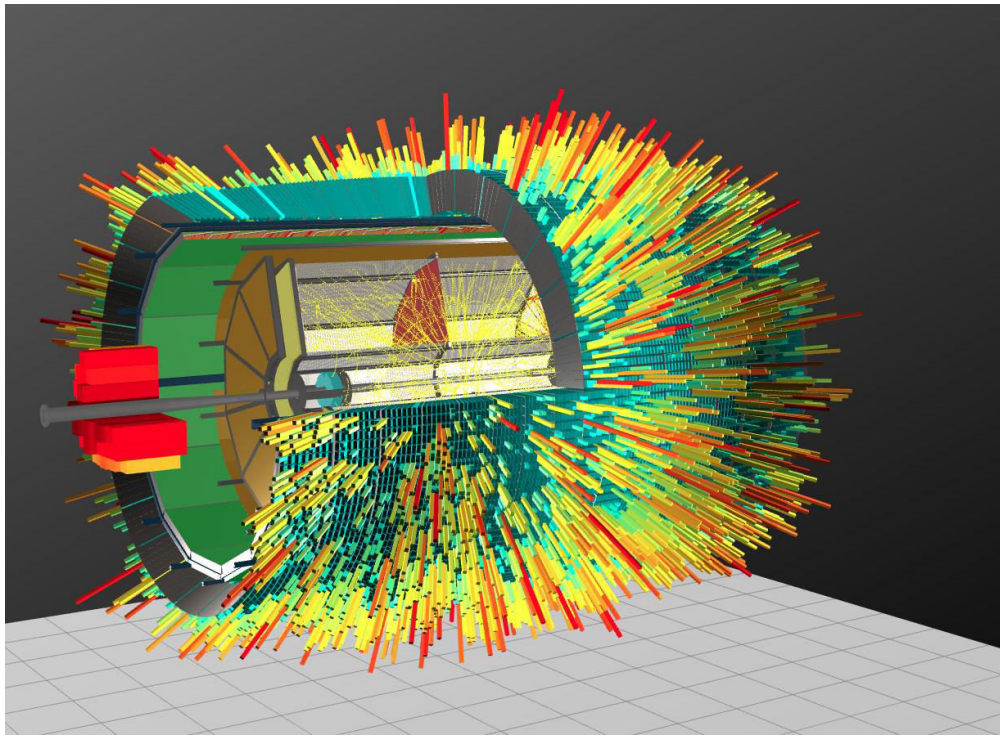
NICA
Nuclotron-based
Ion Collider fAcility

# PWG4 summary

V. Riabov and C. Yang for the PWG4



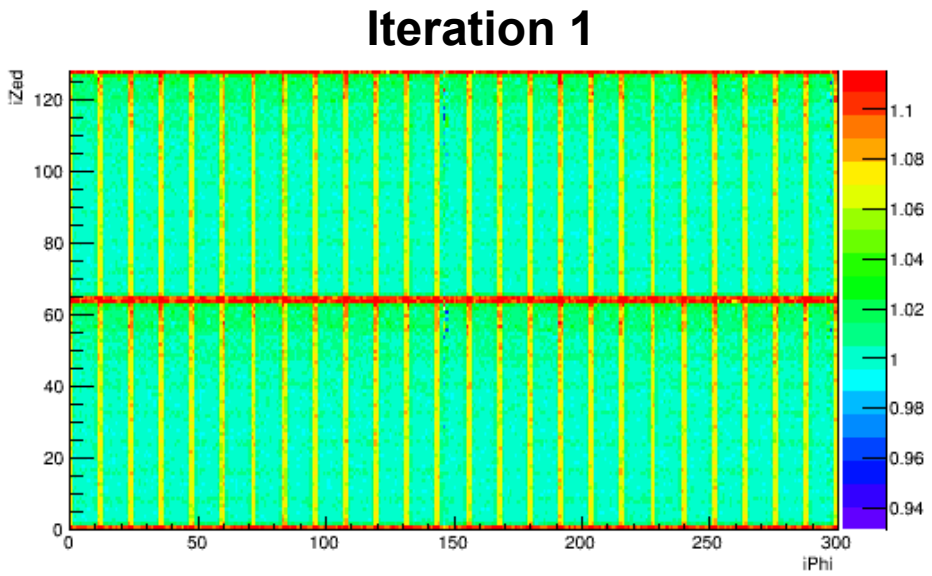
# Status & structure

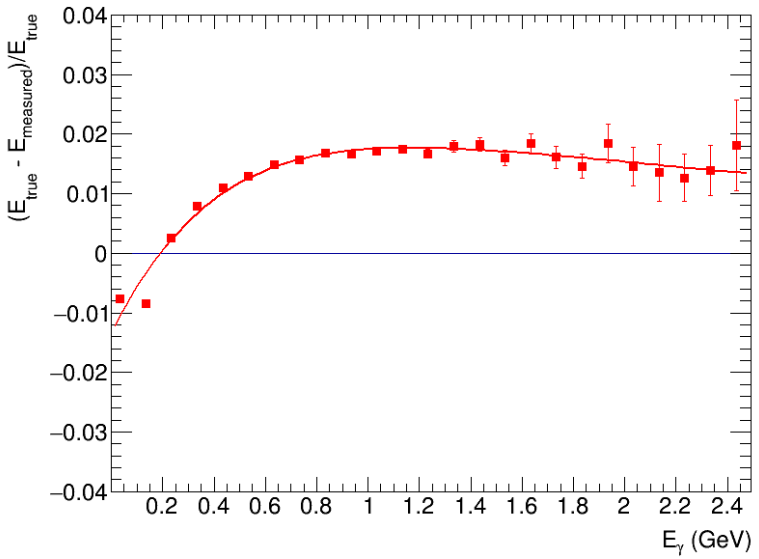
- PWG4 scope - electromagnetic probes:
  - ✓ electromagnetic calorimeter (ECAL) reconstruction software
  - ✓ reconstruction of photons and neutral meson
  - ✓ dielectron continuum and LVMs
  - ✓ estimation of direct photon yields and flow
- Conveners: V. Riabov, Chi Yang
- Talk outline: most recent results and activities

# Ongoing activities

# Preparation for analysis of mass productions

- Calibration of ECAL: channel by channel + global energy scale



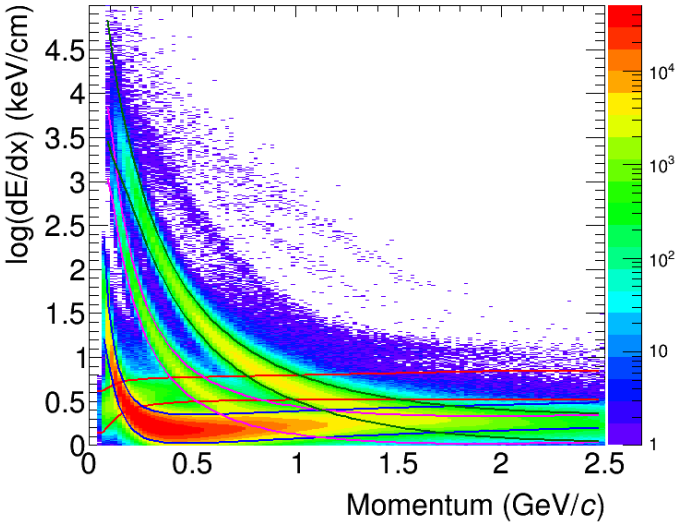




- Corrections are evaluated as a ratio of generated to reconstructed cluster energies → two iterations
- After tower-by-tower calibration the absolute scale variation is significantly reduced
- Reconstructed photon energy does not exactly match the generated one → non-linearity of ~ 3%
- Non-linearity is parameterized as a function of reconstructed energy and thus reduced to ~ 0.5%

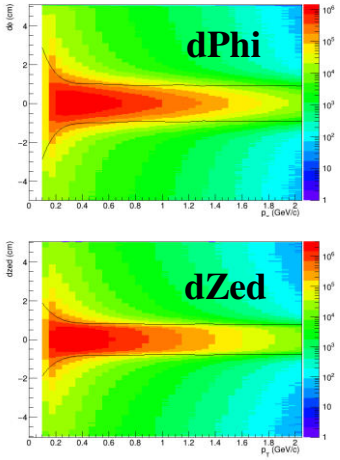
# Preparation for analysis of mass productions

- Optimization of eID-selections in the TPC and TOF

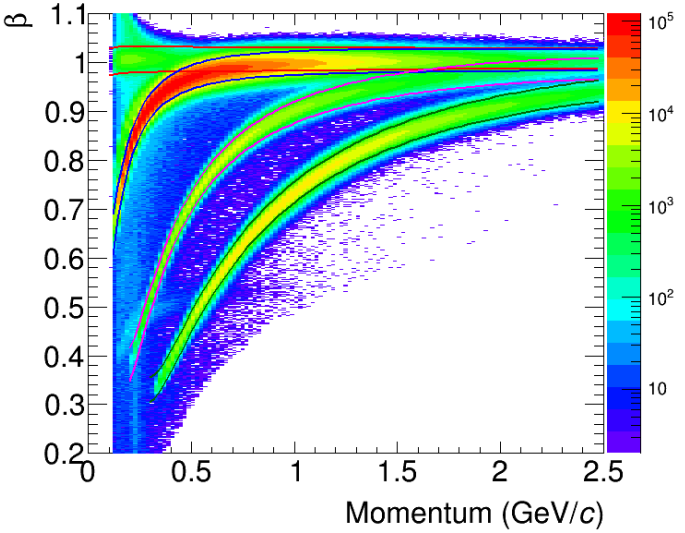
**n-sigma dE/dx parameterization**



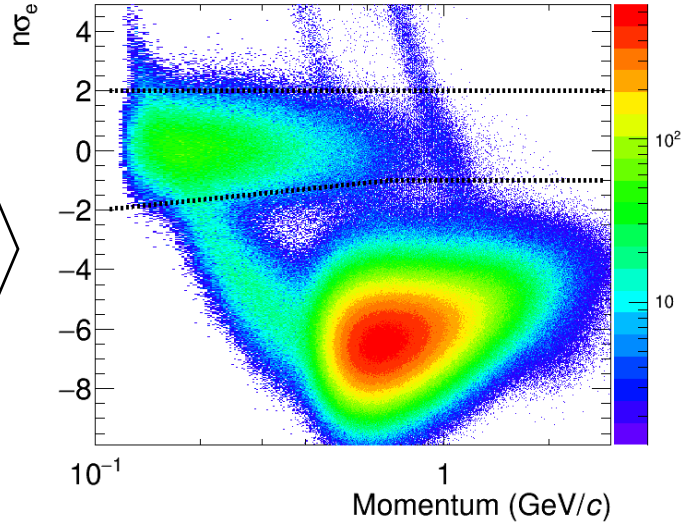

**n-sigma track-to-TOF parameterization**




**n-sigma β-TOF parameterization**

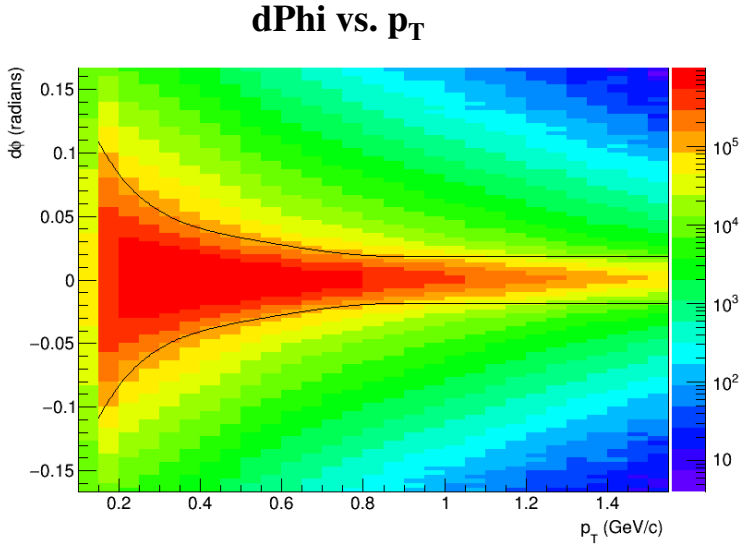


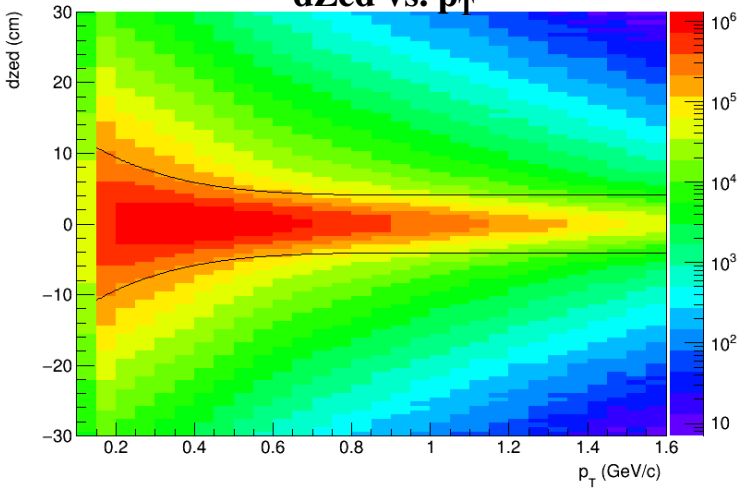

**Sigmalized dE/dx distribution for tracks matched to TOF and identified as electrons**



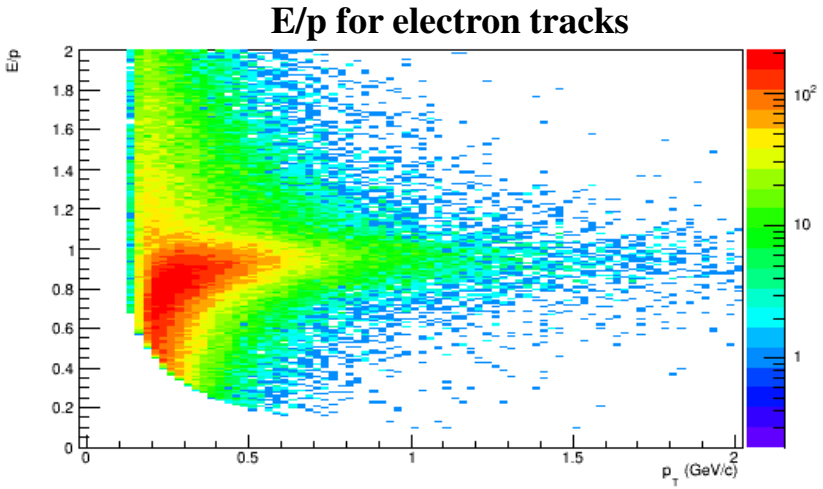
# Preparation for analysis of mass productions

- Optimization of eID selections in the ECAL




- Track-to-cluster matching relates cluster information (E, tof, shower shape) to tracks
- Only tracks with $p_T$ > 150 MeV/c effectively reach the ECAL




- ECAL e-ID for 2σ-matched tracks:
  - ✓ Sigmalized time-of-flight (δ ~ 500 ps)
  - ✓ E/p ~ 1
- Turns on at $p_T$ > 200 MeV/c
- TOF ([-3σ,2σ]) & E/P ( [-3σ,2σ]) cuts provide high eID efficiency in a wide $p_T$ range

# Preparation for analysis of mass productions

- Preparation of analysis Wagons for the Train

- Test Wagon for $\pi^0/\eta \to \gamma\gamma$, $\pi^0/\eta \to \gamma(e^+e^-)$, $\pi^0/\eta \to (e^+e^-)(e^+e^-)$ has been created, committed to MpdRoot (mpdroot/physics/photons)

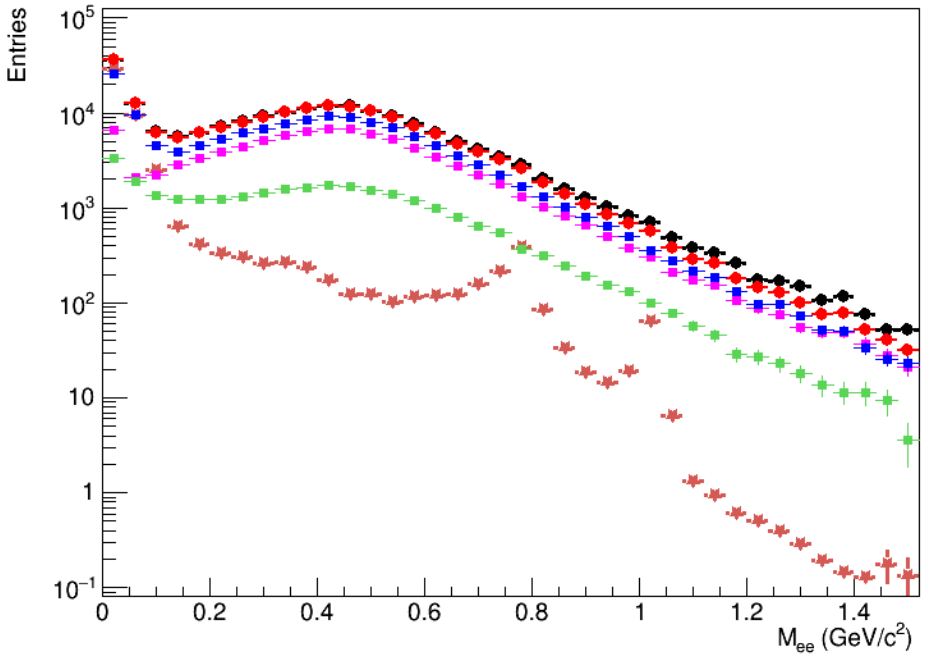
- Analyses in the pipeline:
  - ✓ $\pi^0/\eta \to \gamma\gamma$, $\pi^0/\eta \to \gamma(e^+e^-)$, $\pi^0/\eta \to (e^+e^-)(e^+e^-)$
  - ✓ $K_s \to \pi^0\pi^0$
  - ✓ $\omega \to \pi^0\gamma$, $\omega/\eta \to \pi^0\pi^+\pi$
  - ✓ $\eta' \to \eta\pi^+\pi^-$
  - ✓ $\Sigma^0 \to \Lambda\gamma$, $\Sigma^0 \to \Lambda(e^+e^-)$, $\Sigma^+ \to p\pi^0$
  - ✓ inclusive and direct photons
  - ✓ dielectron continuum and LVMs
  - ✓ single $e_{HF}$

- Study of analyses with full/reduced magnetic field

- Many vacant tasks → please consider to join the efforts !!!

# Advances in dielectron studies

# Challenges




**Dielectron continuum (TPC-TOF eID)**
**Dielectron continuum (perfect eID)**
**Pairs with $\pi^0$ Dalitz electron(s)**
**Pairs with conversion electron(s)**
**Pairs with $\eta$ Dalitz electron(s)**
**True $e^+e^-$ signal to be measured**

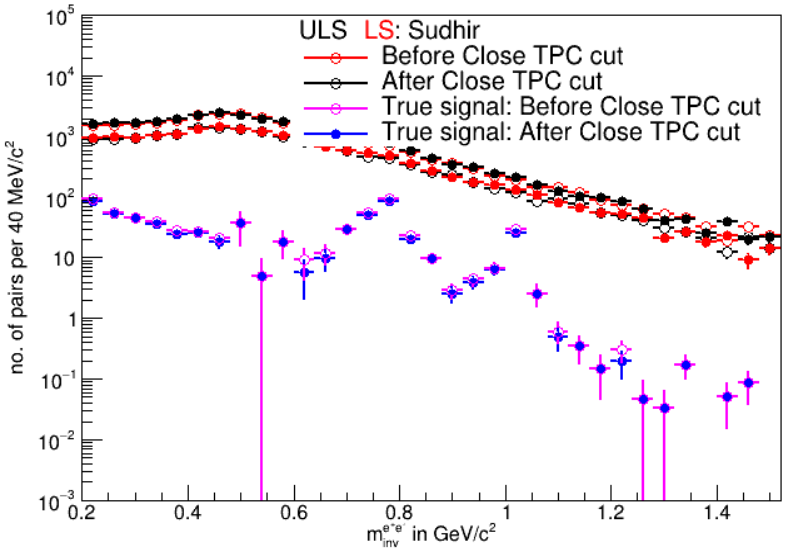
- Good e-ID and e-purity
- Huge combinatorial background from pairs where at least one of the electrons is from Dalitz decays or conversion
- Identification of Dalitz and conversion electrons is complicated:
  - ✓ with current track reconstruction algorithm, low $p_T$ tracks with $p_T$ < 30-50 MeV/c are not reconstructed → major source of CB
  - ✓ tracks with $p_T$ < 100 MeV/c do not reach TOF → not fully identified
- Task: develop procedures for more efficient identification of conversion and Dalitz electrons

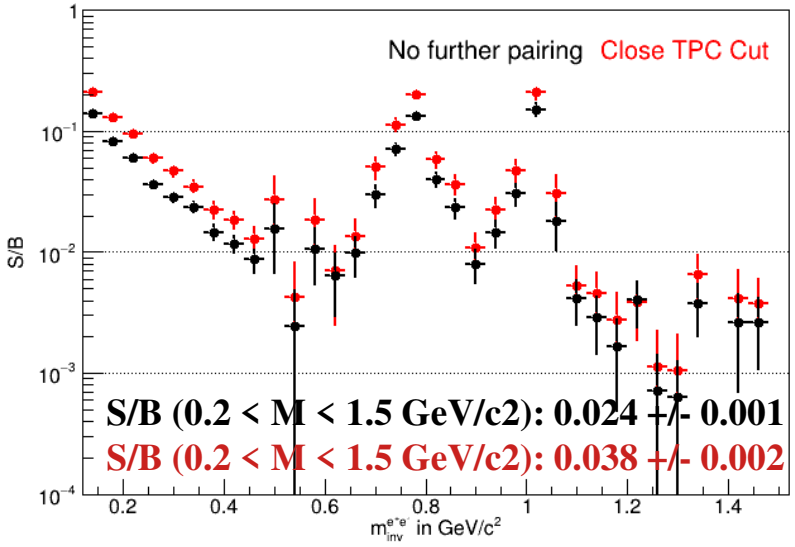
# Strategy

- Latest Request 25 mass production for 50 M events (UrQMD)
- $e^+e^-$ correlated signal is scaled to PHSD predictions
- Use three types of e-track selection: “tight”, “loose1” and “loose2”
- “Tight” cuts for better e-purity:
  - ✓ $p_T > 100$ MeV/c
  - ✓ DCA x,y,z < 2σ
  - ✓ Nhits > 39
  - ✓ $|\eta| < 0.3$
  - ✓ TPC n-σ e-ID: [-2, 2] at p = 0; [-1, 2] at p > 800 MeV/c
  - ✓ TPC 2-σ veto for π-ID
  - ✓ TOF 2-σ matching + TOF 2-σ e-ID
  - ✓ EMCAL 2-σ matching + EMCAL 2-σ e-ID (optional)
- “Loose 1” cuts for reasonable (subject to optimization) e-purity:
  - ✓ $p_T > 50$ MeV/c
  - ✓ Nhits > 10
  - ✓ $|\eta| < 2.5$
  - ✓ TPC 2-σ e-ID
  - ✓ TOF 2-σ e-ID if track is 2-σ matched to TOF
- “Loose 2” cuts for reasonable (subject to optimization) e-purity:
  - ✓ $p_T > 50$ MeV/c
  - ✓ DCA x,y,z < 3.5σ
  - ✓ Nhits > 10
  - ✓ $|\eta| < 0.3$
  - ✓ TPC 2-σ e-ID
  - ✓ TOF 2-σ e-ID if track is 2-σ matched to TOF

# Strategy

- Combine “tight” + “loose 1” oppositely charged pairs, check for consistency with conversion pair:
  - ✓ V0 topology
  - ✓ distance between tracks in the SV + Chi2
  - ✓ pointing angle
  - ✓ pair mass
  - ✓ PV-to-SV distance
- If a pair is consistent with conversion → tag both tracks and reject
- Combine “tight” + “loose 2” oppositely charged pairs, check for consistency with $\pi^0$ Dalitz:
  - ✓ pair mass < 100-150 MeV/$c^2$
- If a pair is consistent with $\pi^0$ Dalitz → tag both tracks and reject
- Pair all remaining “tight” + “tight” oppositely charged pairs to build the foreground invariant mass distribution

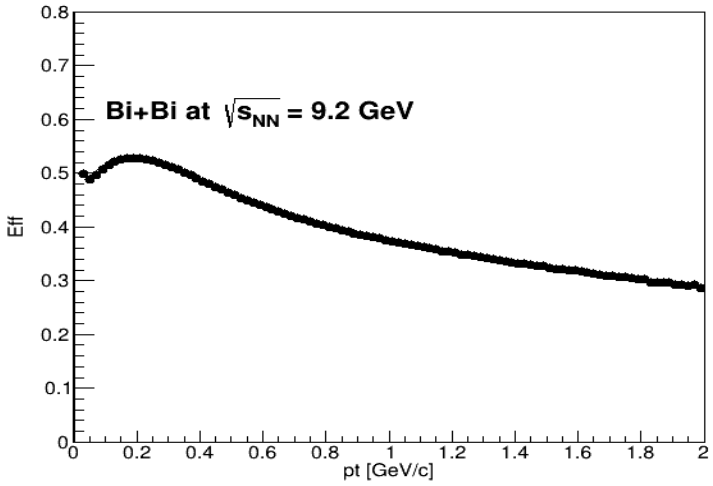


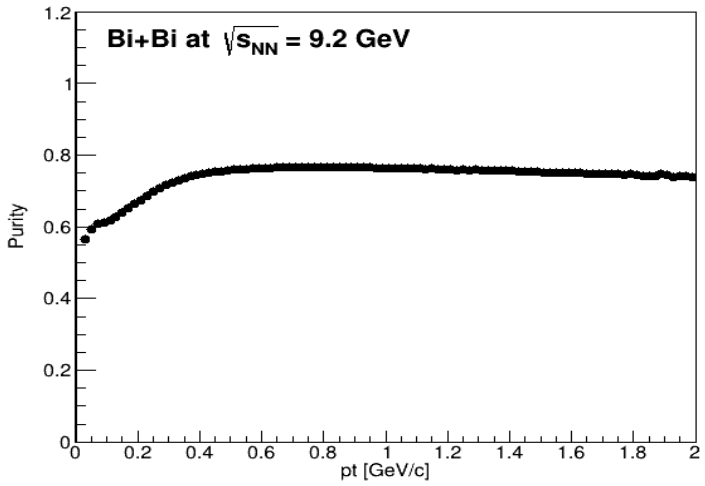
# Current efforts

- Identification of $\pi^0$ Dalitz decays by pairing ECAL photons with TPC-TOF electrons
- For true Dalitz decays the invariant mass of $\gamma e^+$ and $\gamma e^-$ pairs is a narrow peak with $M_{inv} < 140$ MeV/$c^2$
- Photon identification in the ECAL:
  - ✓ Chi2 < 4
  - ✓ Tcl < 2 ns.
  - ✓ Charge Particle veto
  - ✓ E > 50 MeV.
  - ✓ number of towers > 2

**Efficiency**




**Purity**




- Tests with the reduced-field mass production

# Summary

- PWG4 is preparing for analysis of new mass productions
- Advances in dielectron and LVM analyses
- Many vacant tasks, extra man power is needed
- Contact conveners if you wish to join or have any questions

# BACKUP