Trigger Studies for $\eta' \rightarrow e^+e^-\gamma$

Michael C. Kunkel / Daniel R. Lersch / James Ritman

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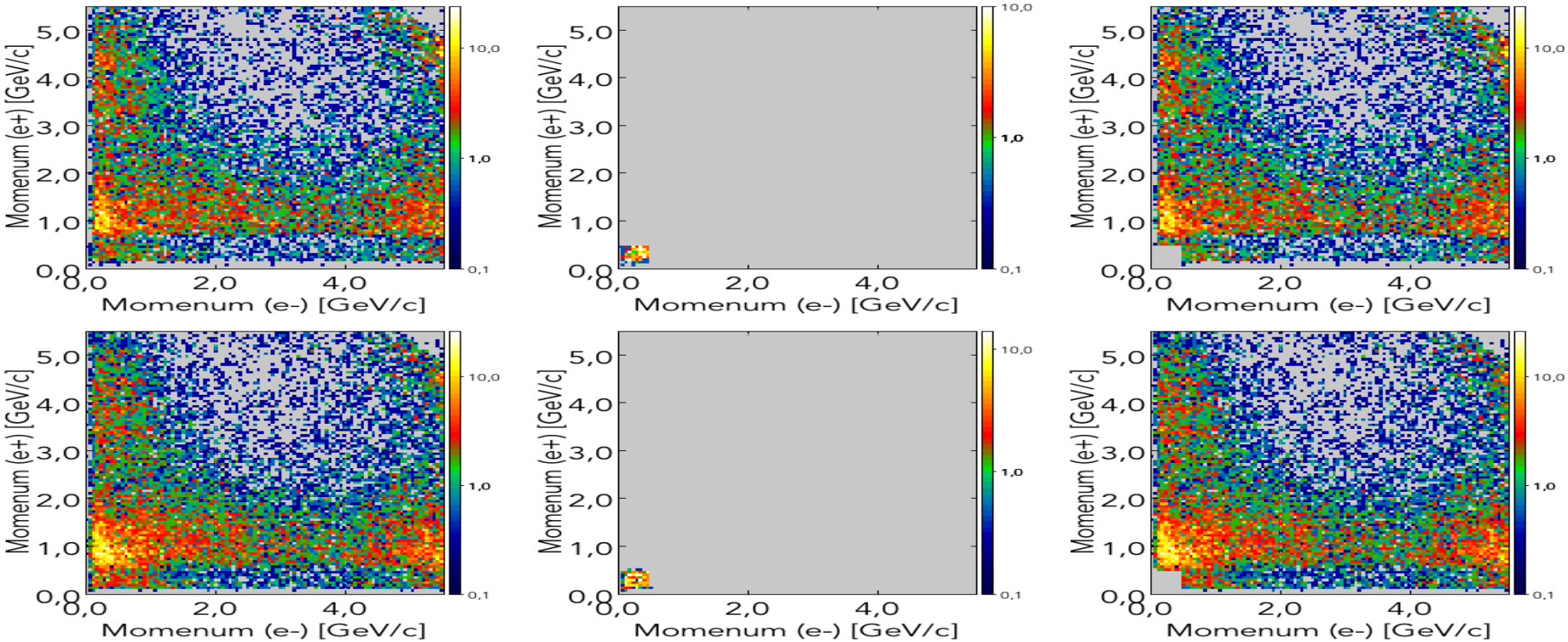
Overview

- Trigger proposed for the upcoming CLAS12 spring run (20 days):
  i) NPHE(HTCC) $> 5...10$
  ii) ΔE(PCAL + ECAL) $\geq 150\,\mathrm{MeV}$
- This configuration would suppress e^- with: $p \lesssim 0.7\,\mathrm{GeV/c}$
  $\Rightarrow$ Implemented in the actual CLAS12 PID-algorithm
  $\Rightarrow$ We can do better than that
- Idea:
  - Momenta of dilepton-pair are predominantly distributed such that: one low momentum lepton + one high momentum positron
  - Look at p(e^+) vs $p(e^-)$ for different cuts on both lepton momenta (corresponding to the trigger)
    $\Rightarrow$ Determine ratio of rejected / accepted events
  - Also look at NPHE(LTCC), NPHE(HTCC) and ΔE(PCAL + ECAL) for those different momentum cuts
- Look at different torus-settings: -100% and -75%, Solenoid: 60%

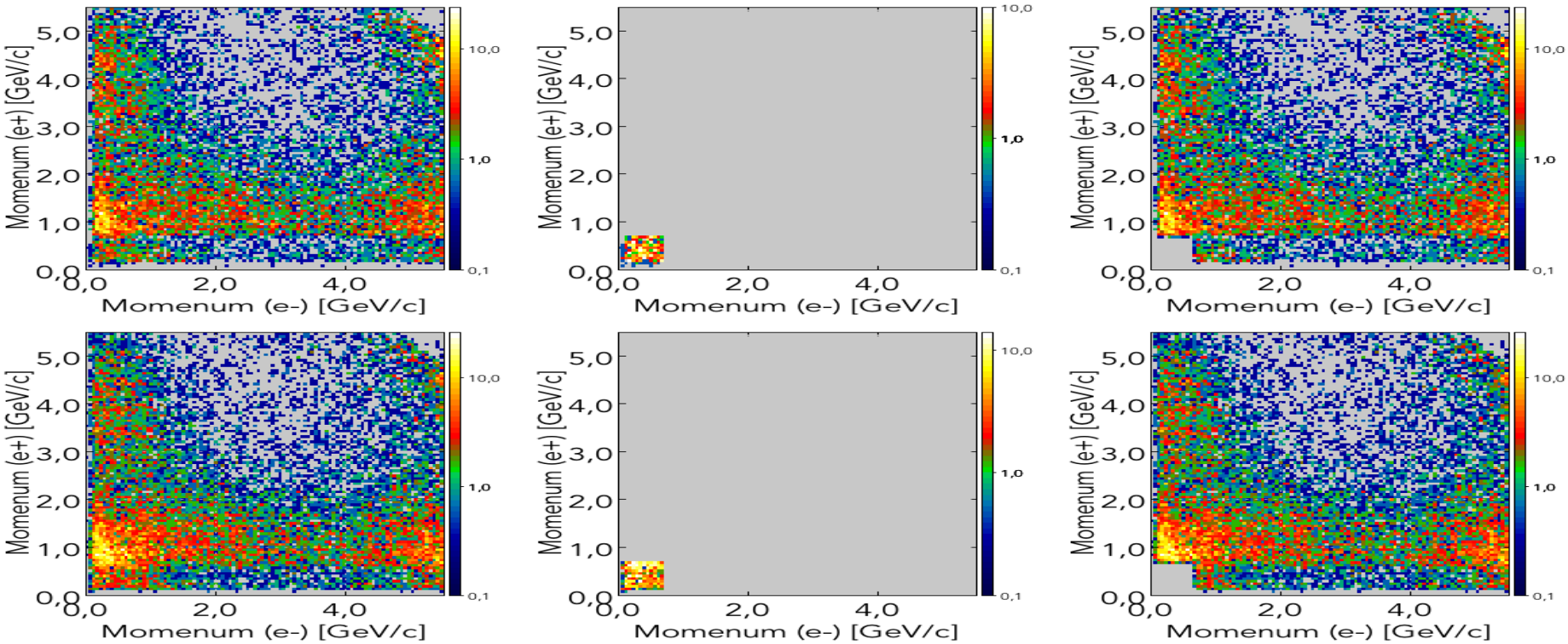
$p(e^+)$ vs. $p(e^-)$ for Torus: -100% || -75% and Solenoid: 60%

reaction $ep \to pe'e^+e^-\gamma$ was simulated $e^\pm$ PID based on TOF



- Left: not cut
- Centre: $p(e^+) \leq 0.5\,\mathrm{GeV/c}$ and $p(e^-) \leq 0.5\,\mathrm{GeV/c}$
- Right: $!(p(e^+) \leq 0.5\,\mathrm{GeV/c}$ and $p(e^-) \leq 0.5\,\mathrm{GeV/c})$

$p(e^+)$ vs. $p(e^-)$ for Torus: -100% || -75% and Solenoid: 60%



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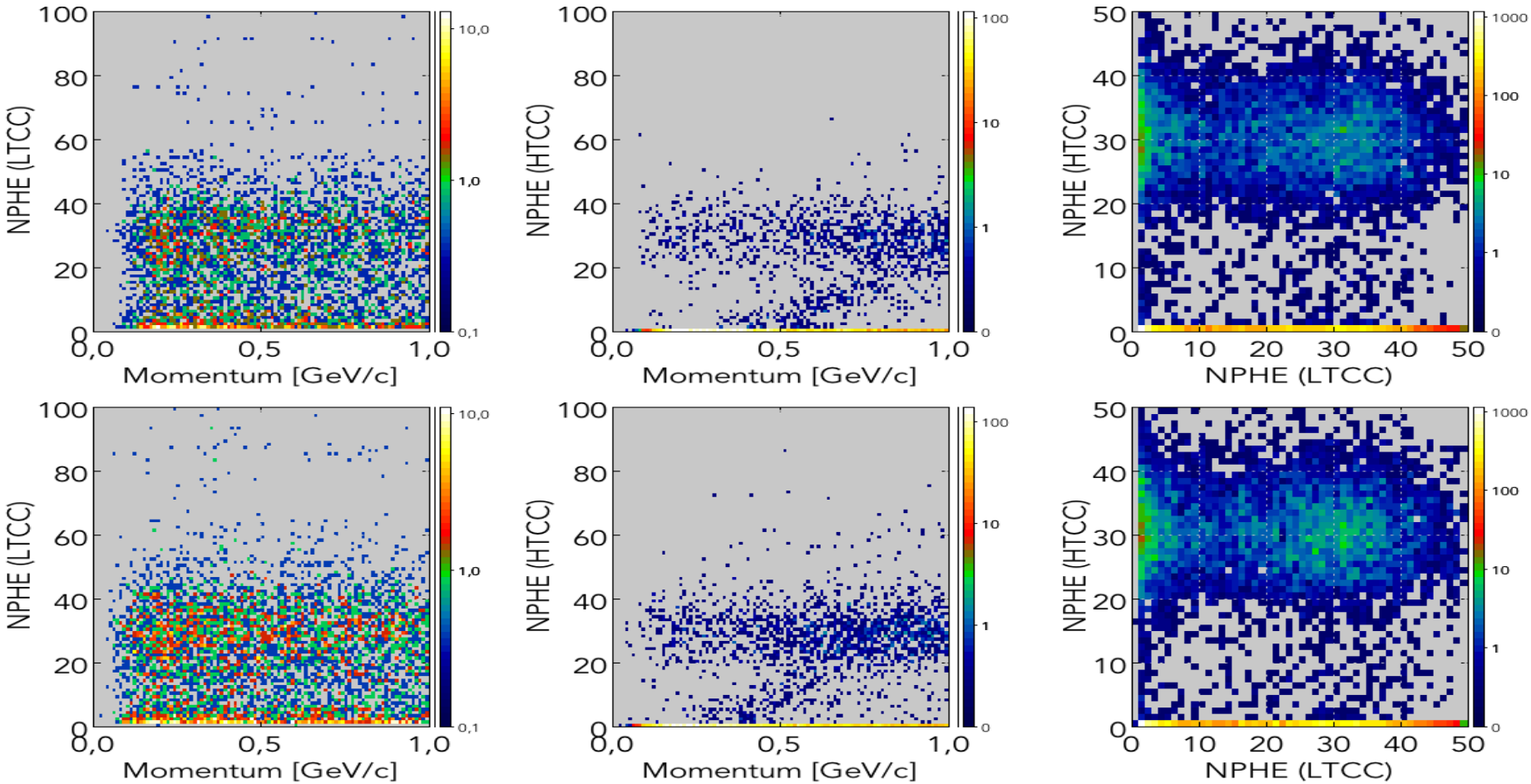
- Centre: $p(e^+) \leq 0.7\,\mathrm{GeV/c}$ and $p(e^-) \leq 0.7\,\mathrm{GeV/c}$
- Right: $!(p(e^+) \leq 0.7\,\mathrm{GeV/c}$ and $p(e^-) \leq 0.7\,\mathrm{GeV/c})$
- Top: Torus: -100% / Bottom: -75%

LTCC and HTCC vs. Momentum

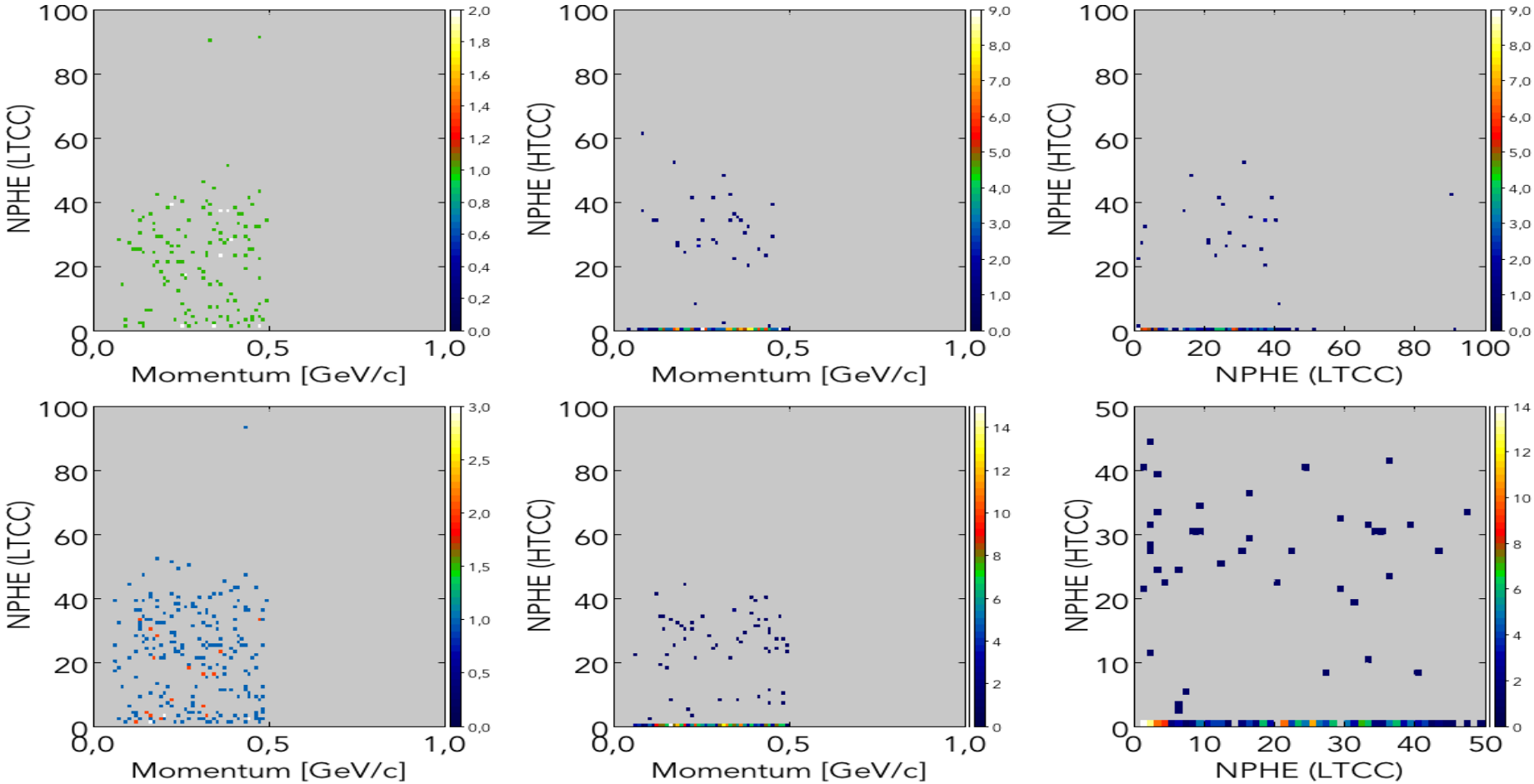
No cut on $p(e^+)$ and $p(e^-)$



Top: Torus: -100% / Bottom: Torus: -75%

LTCC and HTCC vs. Momentum

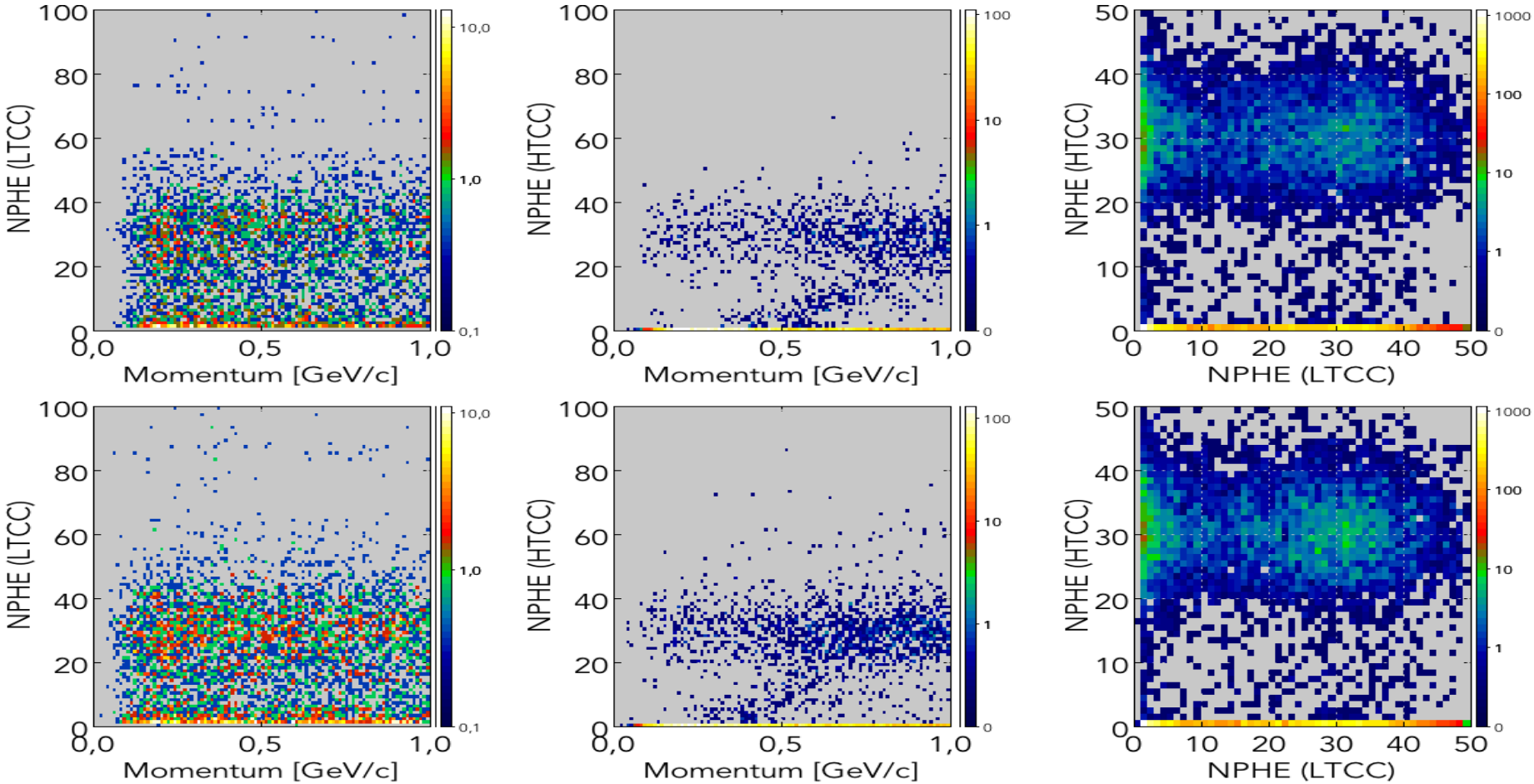
$p(e^+)$ AND $p(e^-) \leq 0.5\,\mathrm{GeV/c}$



Top: Torus: -100% / Bottom: Torus: -75%

LTCC and HTCC vs. Momentum

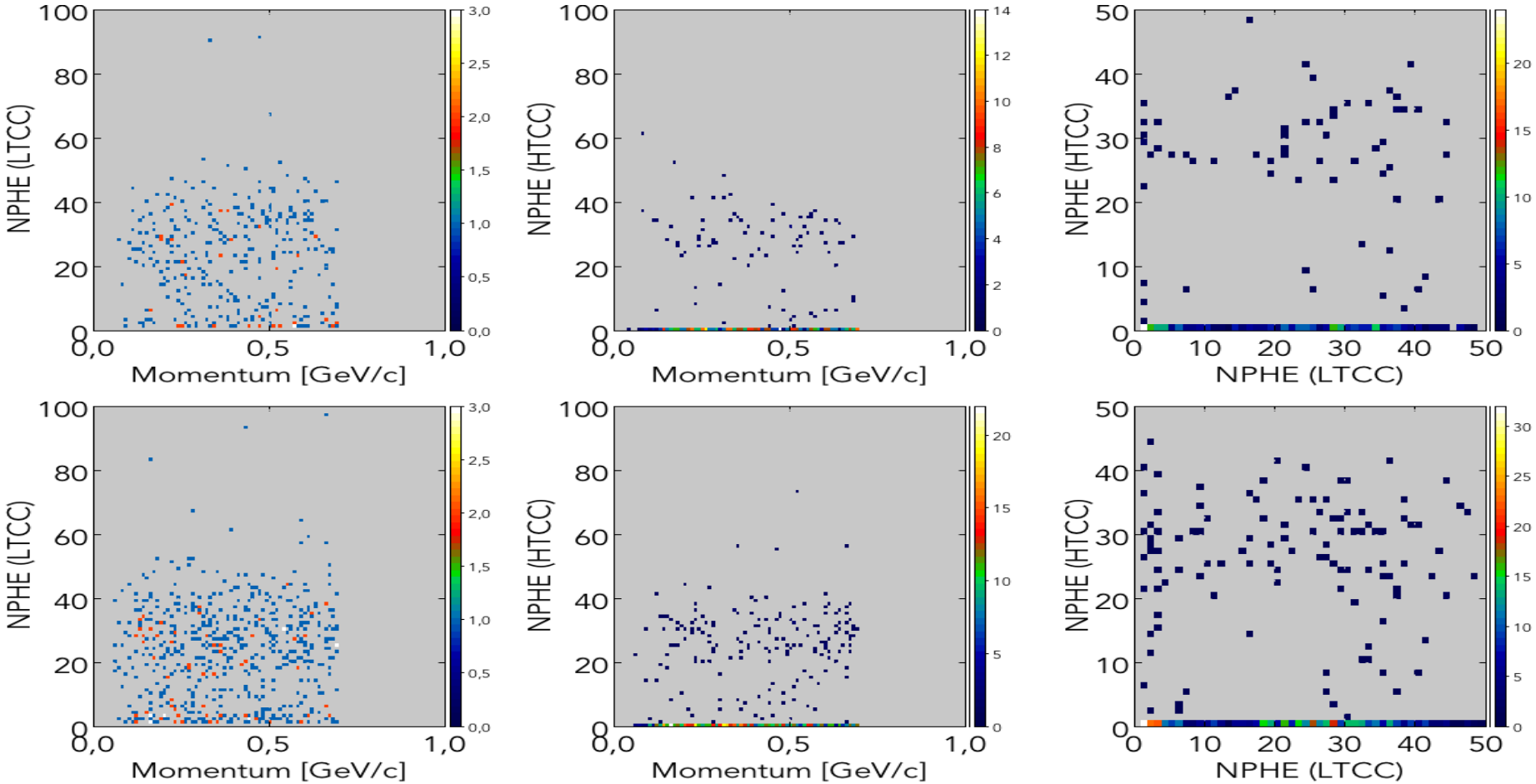
$p(e^+)$ OR $p(e^-) \leq 0.5\,\mathrm{GeV/c}$



Top: Torus: -100% / Bottom: Torus: -75%

LTCC and HTCC vs. Momentum

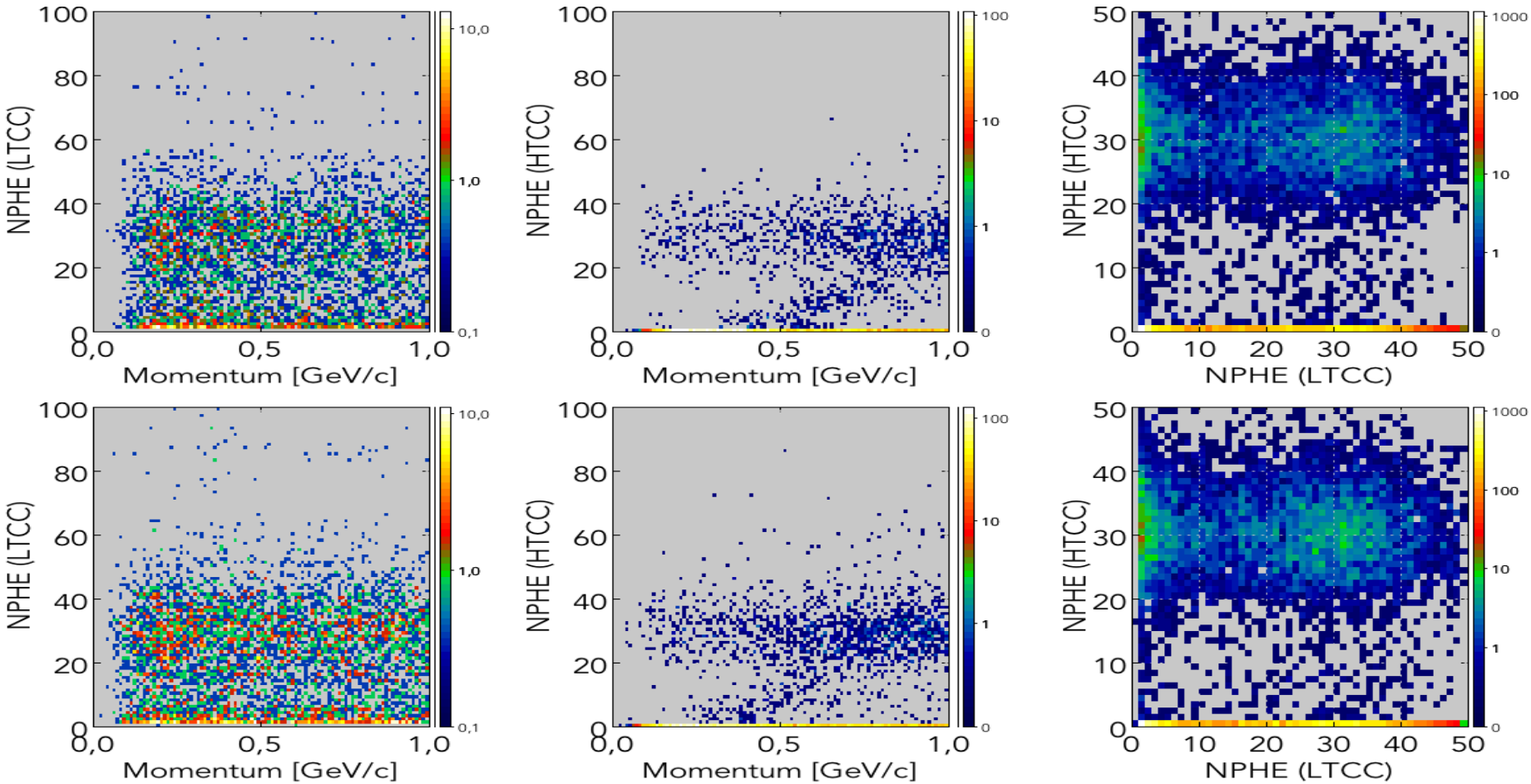
$p(e^+)$ AND $p(e^-) \leq 0.7\,\mathrm{GeV/c}$



Top: Torus: -100% / Bottom: Torus: -75%

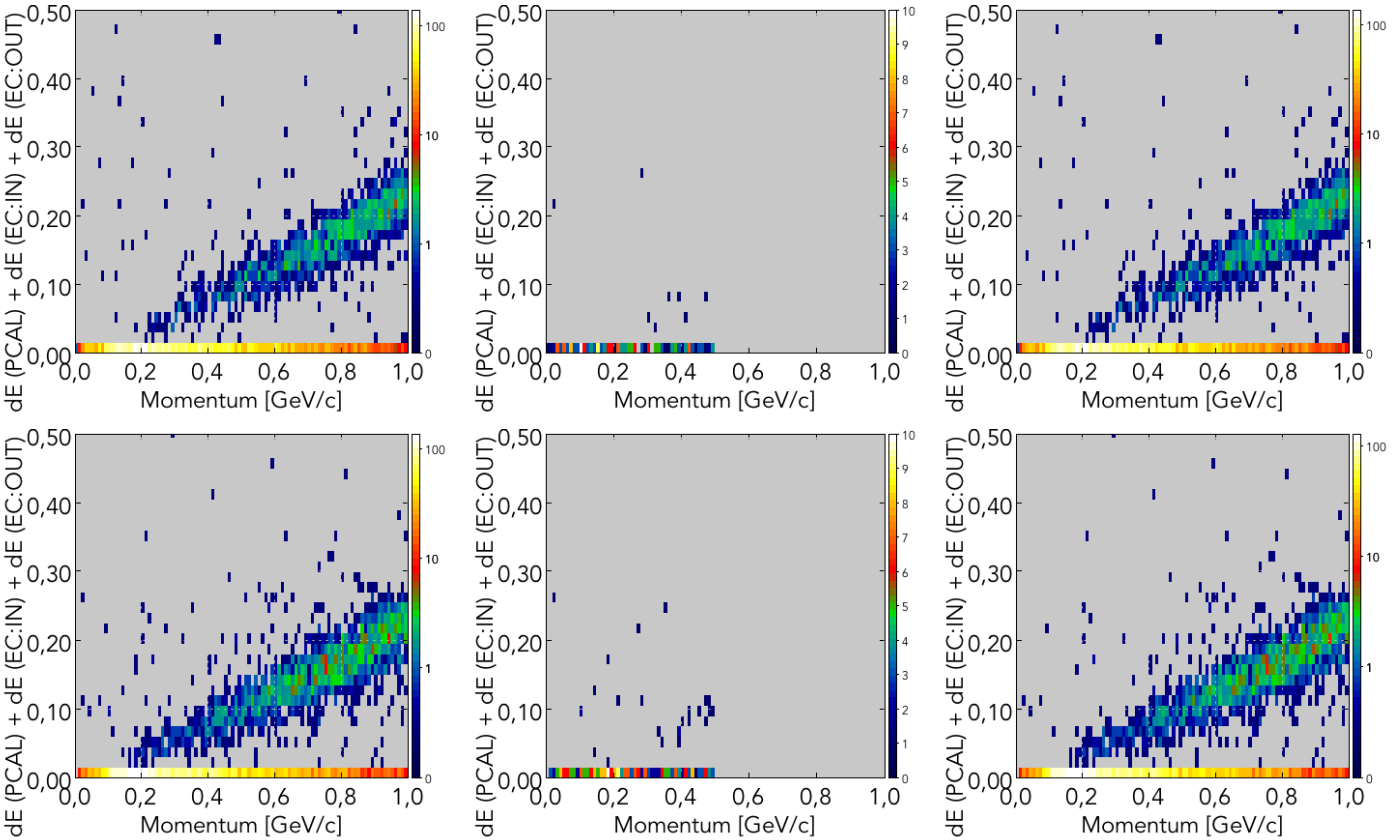
LTCC and HTCC vs. Momentum

$p(e^+)$ OR $p(e^-) \leq 0.7\,\mathrm{GeV/c}$

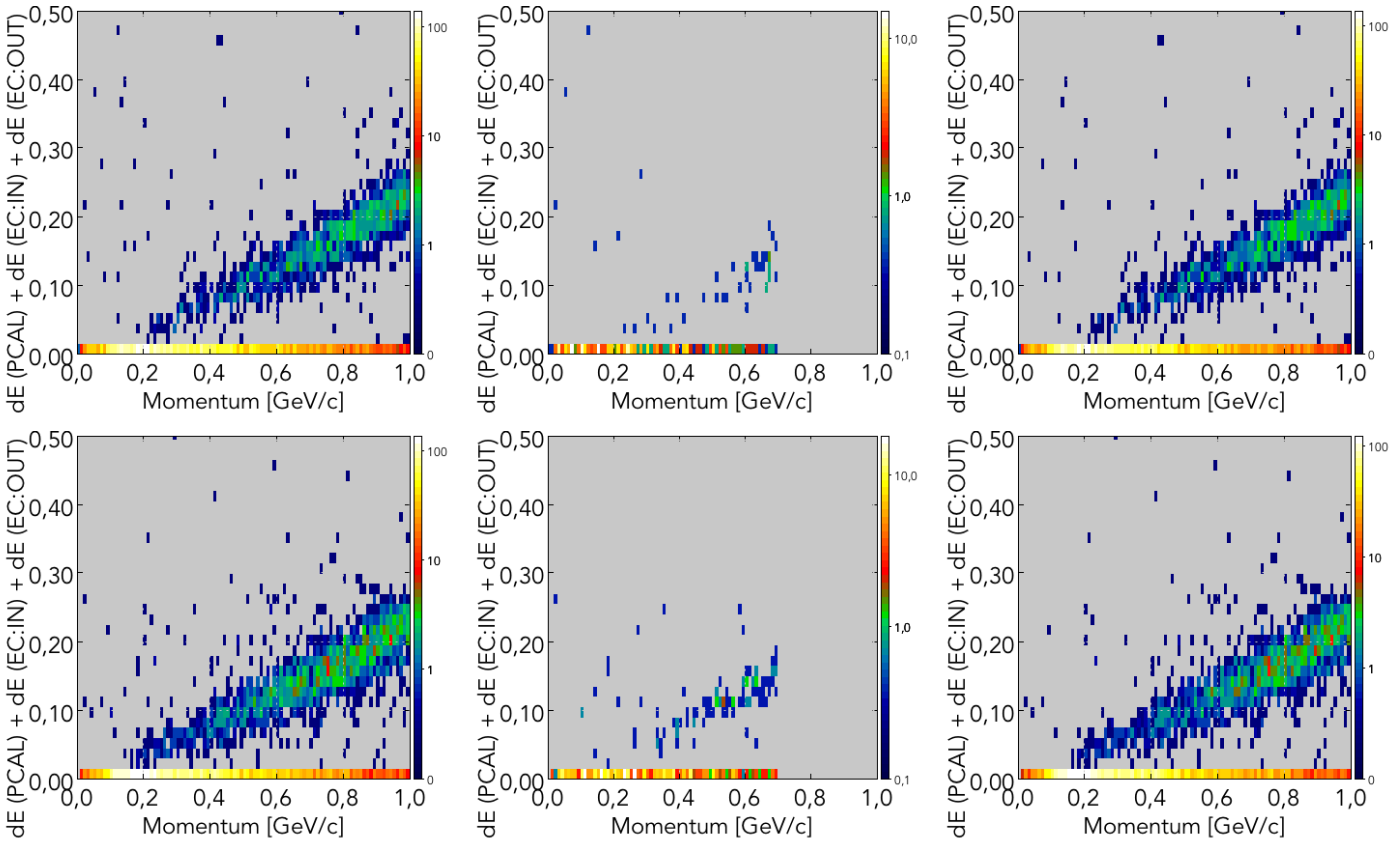


Top: Torus: -100% / Bottom: Torus: -75%

ΔE(PCAL + ECAL) vs. Momentum



- Left: not cut
- Centre: $p(e^+) \leq 0.5\,\mathrm{GeV/c}$ and $p(e^-) \leq 0.5\,\mathrm{GeV/c}$
- Right: !($p(e^+) \leq 0.5\,\mathrm{GeV/c}$ and $p(e^-) \leq 0.5\,\mathrm{GeV/c}$)
- Top: Torus: -100% / Bottom: -75%



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- Centre: $p(e^+) \leq 0.7\,\mathrm{GeV/c}$ and $p(e^-) \leq 0.7\,\mathrm{GeV/c}$
- Right: $!(p(e^+) \leq 0.7\,\mathrm{GeV/c}$ and $p(e^-) \leq 0.7\,\mathrm{GeV/c})$
- Top: Torus: -100% / Bottom: -75%

Summary

Torus [%]	Cut:	Momentum Range	[%] inside cut	[%] outside cut
−100	$p(e^+)$ & $p(e^-) \lesssim 0.5\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 5]\,\mathrm{GeV/c}$	1%	99%
−100	$p(e^+)$ & $p(e^-) \lesssim 0.5\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 4]\,\mathrm{GeV/c}$	2%	98%
−100	$p(e^+)$ & $p(e^-) \lesssim 0.5\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 3]\,\mathrm{GeV/c}$	2%	98%
−100	$p(e^+)$ & $p(e^-) \lesssim 0.5\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 2]\,\mathrm{GeV/c}$	4%	96%
−100	$p(e^+)$ & $p(e^-) \lesssim 0.7\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 5]\,\mathrm{GeV/c}$	2%	98%
−100	$p(e^+)$ & $p(e^-) \lesssim 0.7\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 4]\,\mathrm{GeV/c}$	3%	97%
−100	$p(e^+)$ & $p(e^-) \lesssim 0.7\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 3]\,\mathrm{GeV/c}$	5%	95%
−100	$p(e^+)$ & $p(e^-) \lesssim 0.7\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 2]\,\mathrm{GeV/c}$	8%	92%

- Percentage inside cut: $\frac{\#\textbf{Events inside the cut}}{\#\textbf{Events within Momentum Range}} \equiv$ Percentage of rejected events
- Percentage outside cut: $\frac{\#\textbf{Events outside the cut}}{\#\textbf{Events within Momentum Range}} \equiv$ Percentage of accepted events

Torus [%]	Cut:	Momentum Range	[%] inside cut	[%] outside cut
−75	$p(e^+)$ & $p(e^-) \lesssim 0.5\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 5]\,\mathrm{GeV/c}$	1%	99%
−75	$p(e^+)$ & $p(e^-) \lesssim 0.5\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 4]\,\mathrm{GeV/c}$	2%	98%
−75	$p(e^+)$ & $p(e^-) \lesssim 0.5\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 3]\,\mathrm{GeV/c}$	3%	97%
−75	$p(e^+)$ & $p(e^-) \lesssim 0.5\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 2]\,\mathrm{GeV/c}$	5%	95%
−75	$p(e^+)$ & $p(e^-) \lesssim 0.7\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 5]\,\mathrm{GeV/c}$	2%	98%
−75	$p(e^+)$ & $p(e^-) \lesssim 0.7\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 4]\,\mathrm{GeV/c}$	5%	95%
−75	$p(e^+)$ & $p(e^-) \lesssim 0.7\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 3]\,\mathrm{GeV/c}$	7%	93%
−75	$p(e^+)$ & $p(e^-) \lesssim 0.7\,\mathrm{GeV/c}$	$p(e^+), p(e^-) \in [0, 2]\,\mathrm{GeV/c}$	12%	88%

- Percentage inside cut: $\frac{\#\textbf{Events inside the cut}}{\#\textbf{Events within Momentum Range}} \equiv$ Percentage of rejected events
- Percentage outside cut: $\frac{\#\textbf{Events outside the cut}}{\#\textbf{Events within Momentum Range}} \equiv$ Percentage of accepted events

IKP Trigger Request for η' Dalitz channel

- HTCC NPE > 5
- PCAL + EC sum > 150MeV
- This would be a 12% loss of signal for dilepton pairs that correspond to momentum of 0.7GeV/c each in the momentum range $0 - 2 GeV/c$.