MC production status update

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U.S. DEPARTMENT OF ENERGY | Stanford University

SLAC NATIONAL ACCELERATOR LABORATORY

Tritrig generator settings

- Tritrig events are generated using MG5
  - Cuts on minimum tanL and energy of leptons

```
0.16 = elminsp        ! min E for l+ & at least one l-
1.6 = eltotsp         ! min total E for l+ & at least one l-
0.01 = mmllminsp      ! min invariant mass for at least one l+l- pair
100.0 = mmllmaxsp     ! max invariant mass for at least one l+l- pair
0.005 = thetaylminsp  ! min angle (y direction) for l+ and at least one l-
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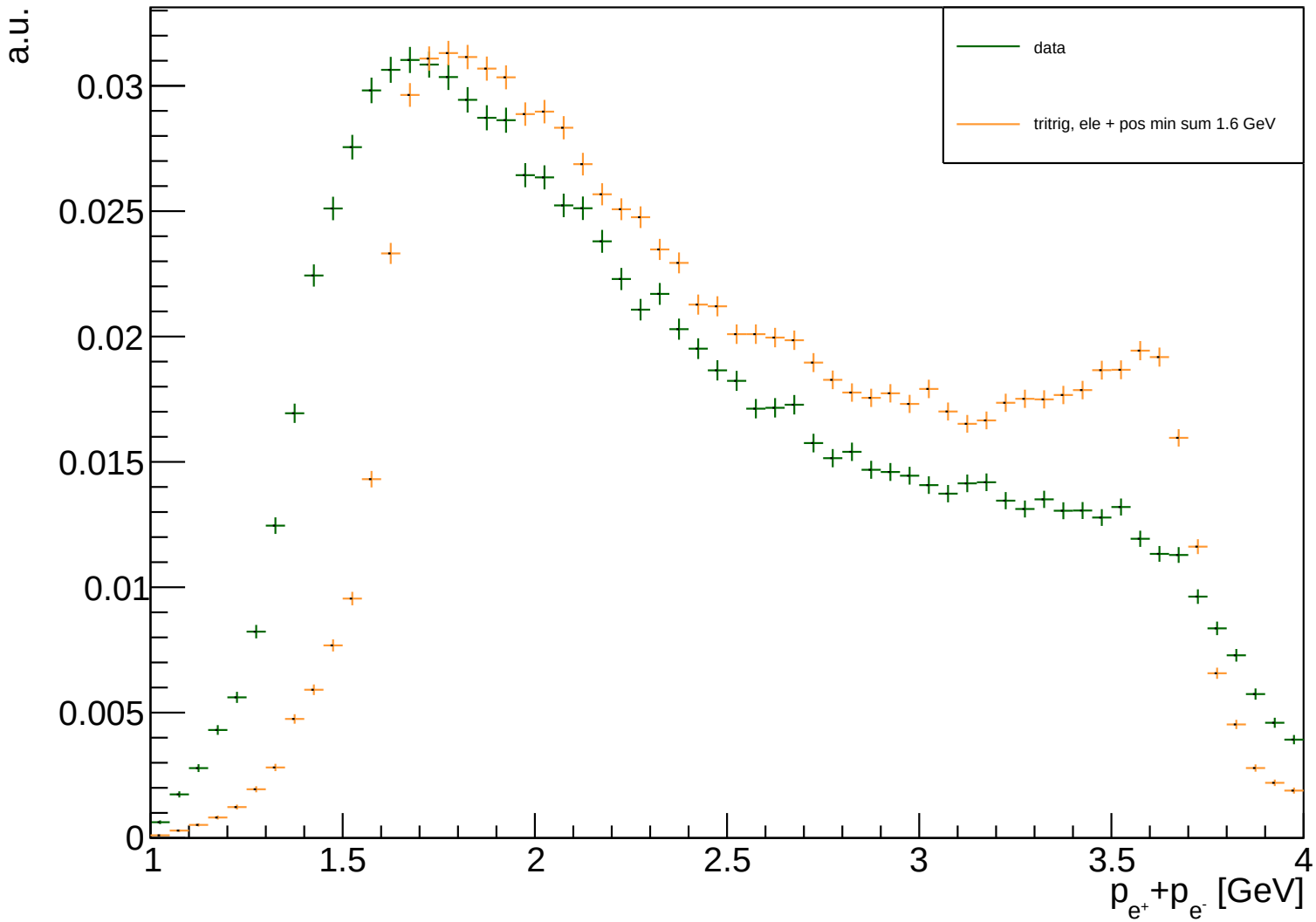
- Problem: low psum distribution in MC different from data
  - Where is this deviation coming from?

Preselected tritrig+pulser vs. data



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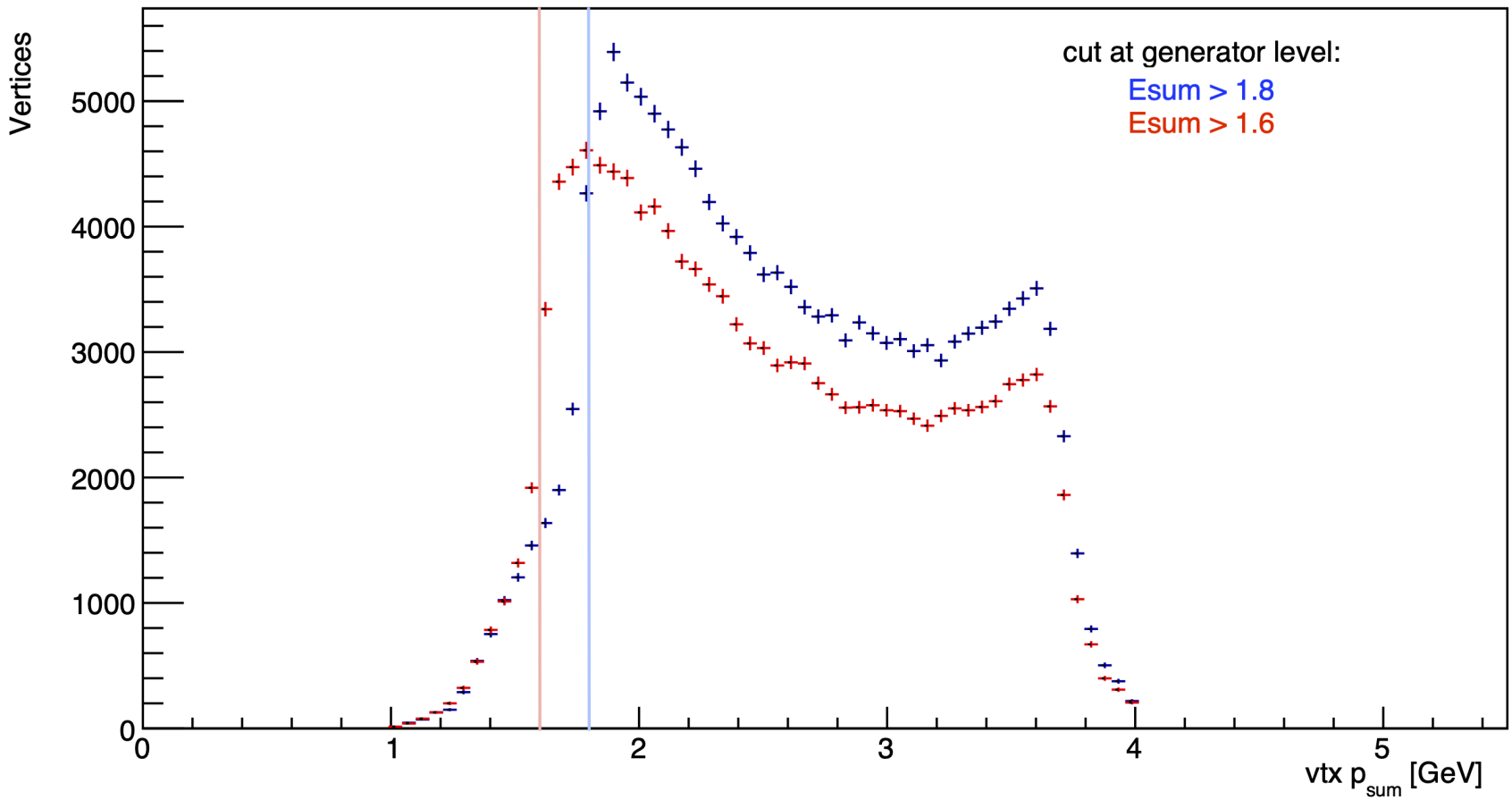
  - Where is this deviation coming from?
- Missing events at low esum/psum at generator level
  - Rising edge of distribution around $E_{\text{min}}^{l^+ + l^-} = 1.6\,\text{GeV}$

Preselected tritrig+pulser – $E_{\text{min}}^{l^+ + l^-}$ dependence



- Rising edge moves towards higher psum for $E_{\text{min}}^{l^+ + l^-} > 1.8\,\text{GeV}$

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- Problem: low psum distribution in MC different from data
  - Where is this deviation coming from?
- Missing events at low esum/psum at generator level
  - Rising edge of distribution around $E_{\text{min}}^{l^+ + l^-} = 1.6\,\text{GeV}$
- Naïve solution: move $E_{\text{min}}^{l^+ + l^-}$ to lower values
  - Try to lower eltotsp, but **MG5 fails to generate events** for all $E_{\text{min}}^{l^+ + l^-} < 1.6\,\text{GeV}$
  - Why? Probably problem with integration over pole in Bethe-Heitler

Tritrig generator settings

- How can we access lower momenta?
  - I played around with this for a bit and most things don't work
  - Best failure so far: splitting e^- and e^+ energy requirements

```
1.0 = elminsm          ! min E for at least one l-
0.2 = elminsp          ! min E for l+
100.0 = elmaxsm        ! max E for at least one l-
100.0 = elmaxsp        ! max E for l+
0.1 = eltotsp          ! min total E for l+ & at least one l-
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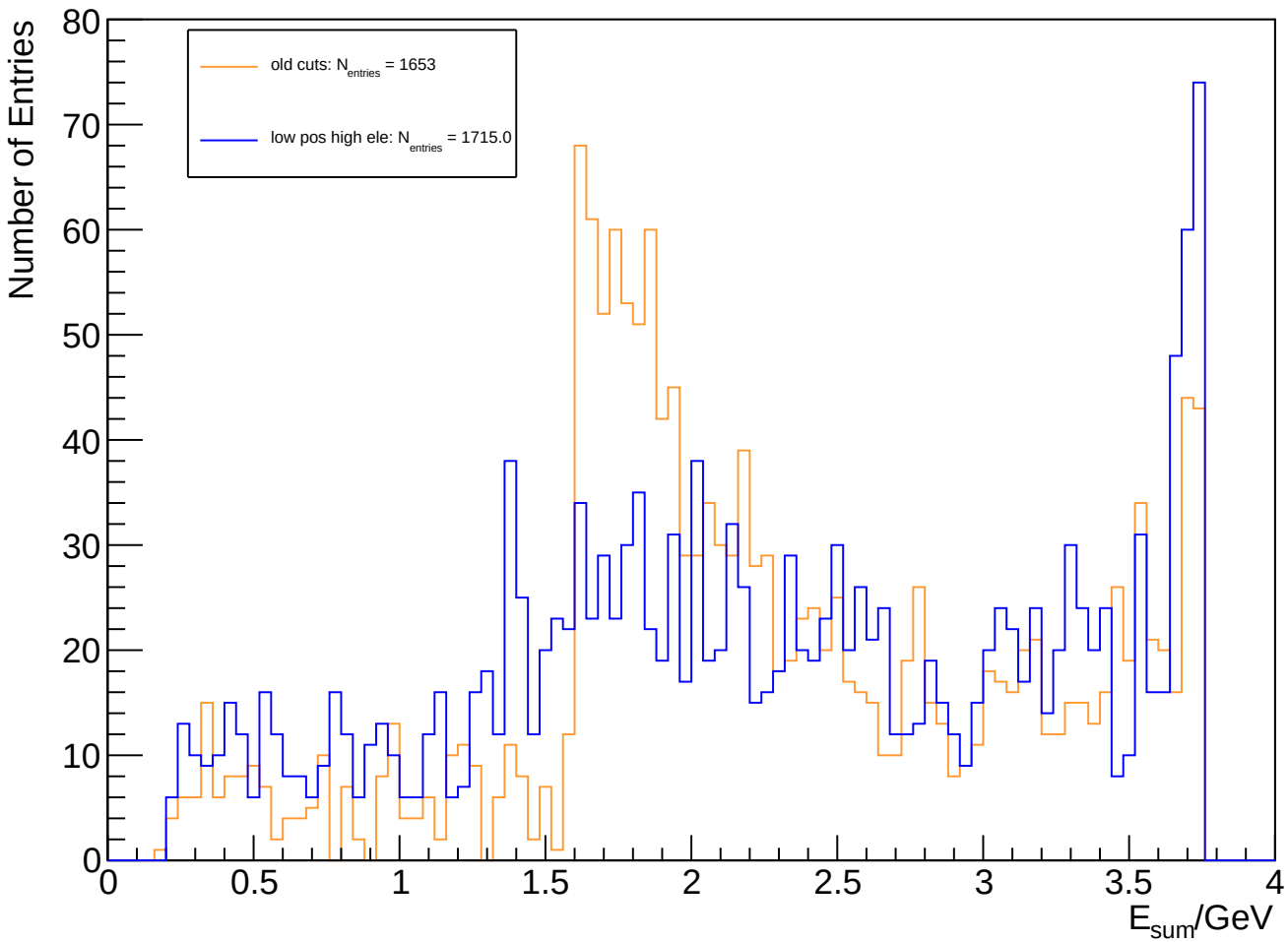
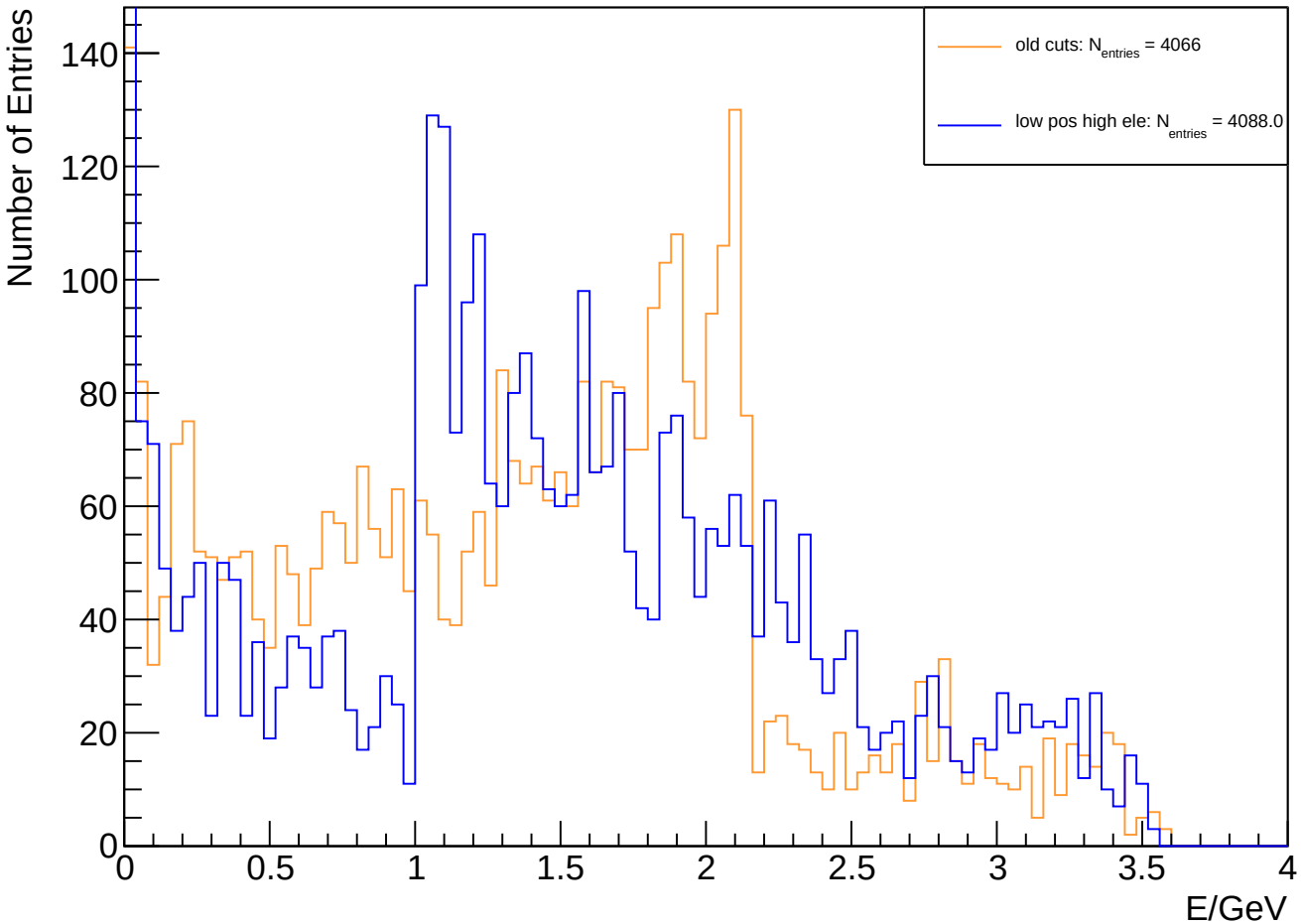
- Observations:
  - Need $E_{\text{min}}^{e^-} \geq 1.0\,\text{GeV}$
  - $E_{\text{min}}^{e^+}$ can be low
  - If high $E_{\text{min}}^{e^-}$ given, $E_{\text{min}}^{l^+ + l^-}$ can be low

Esum at generator level



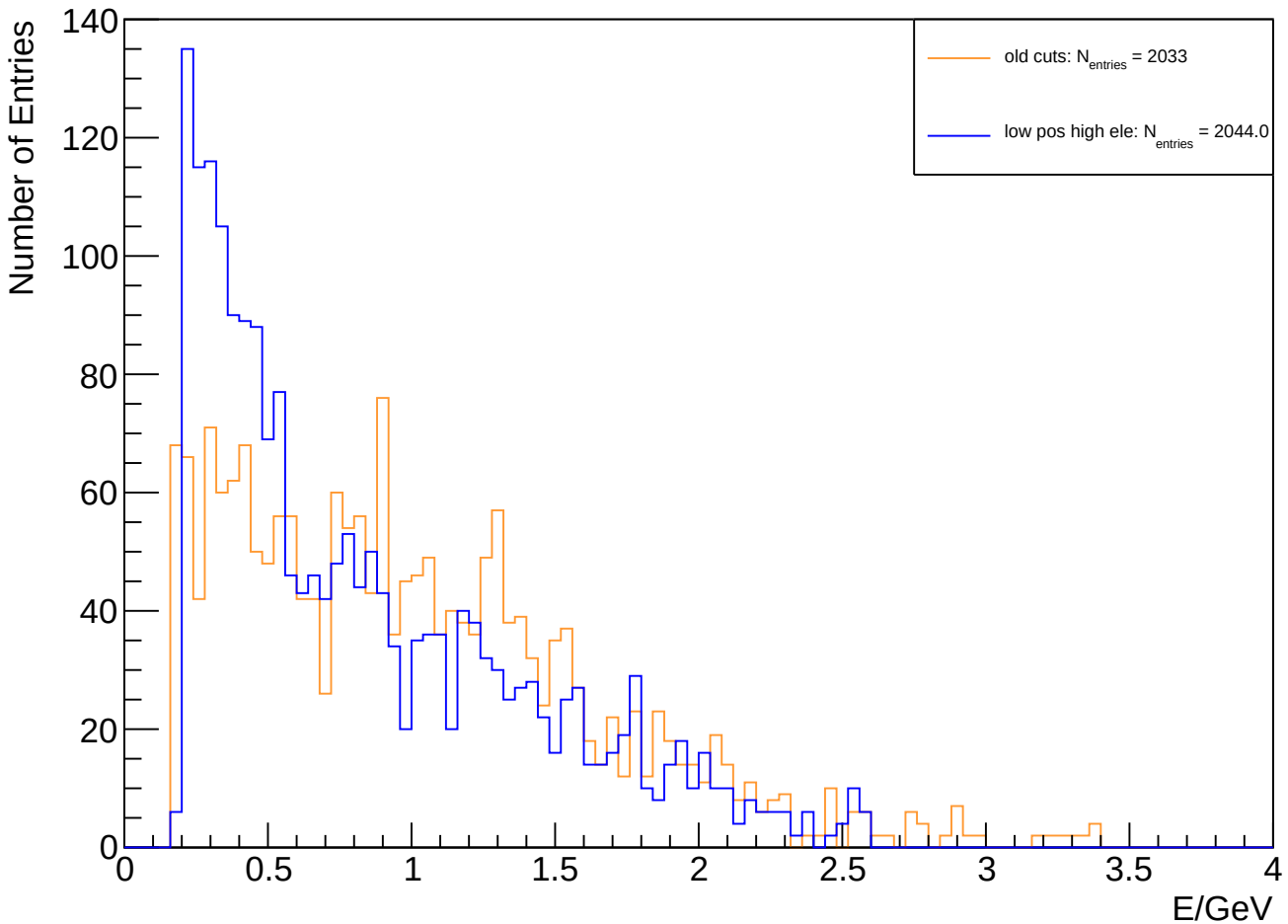
- Modified MC has more low Esum events, stronger peak at beam energy

E_{e^-} at generator level



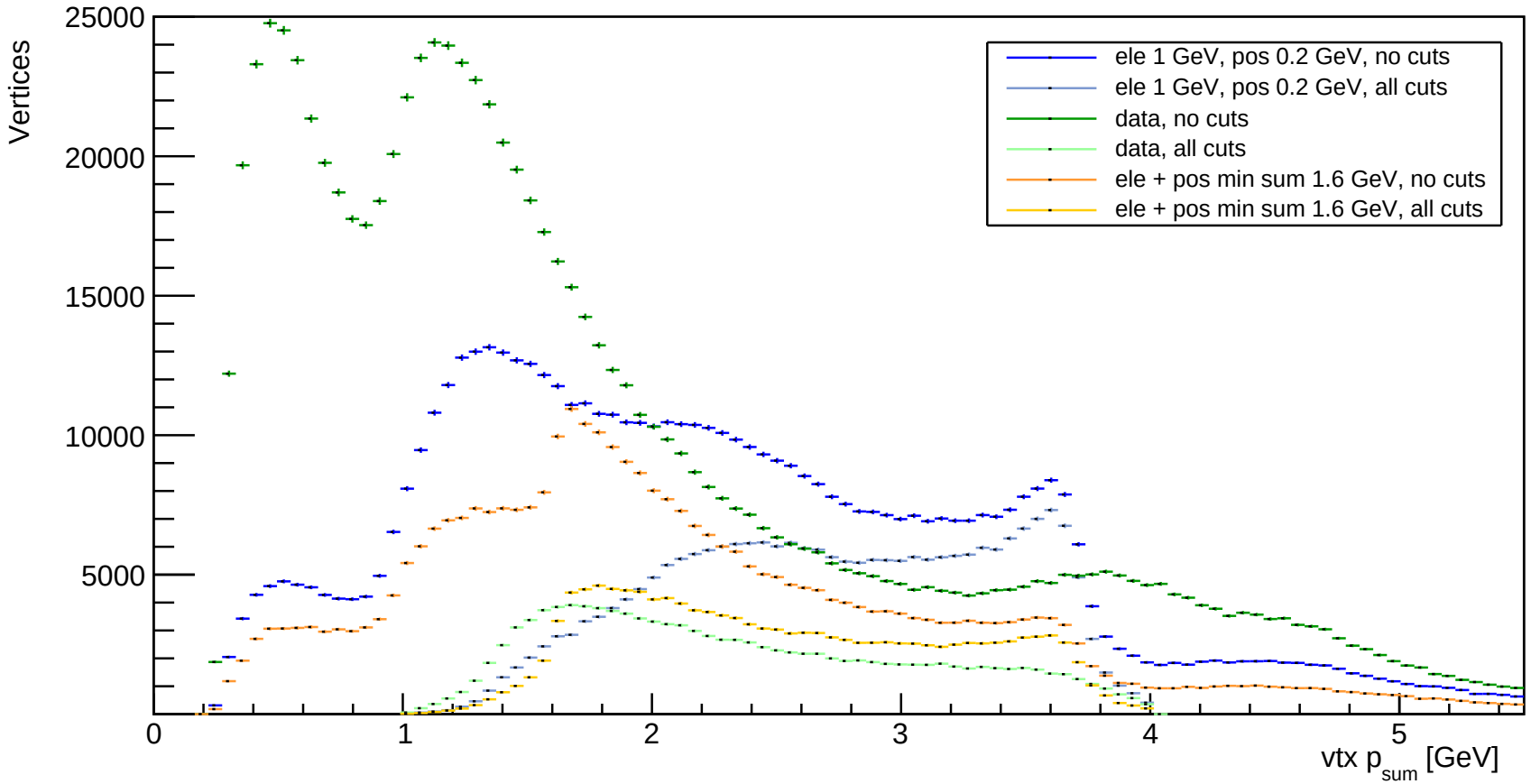
- Modified MC has sharp cut at 1.0 GeV as expected
- Standard MC has sharp cut at 2.1 GeV

E_{e^+} at generator level



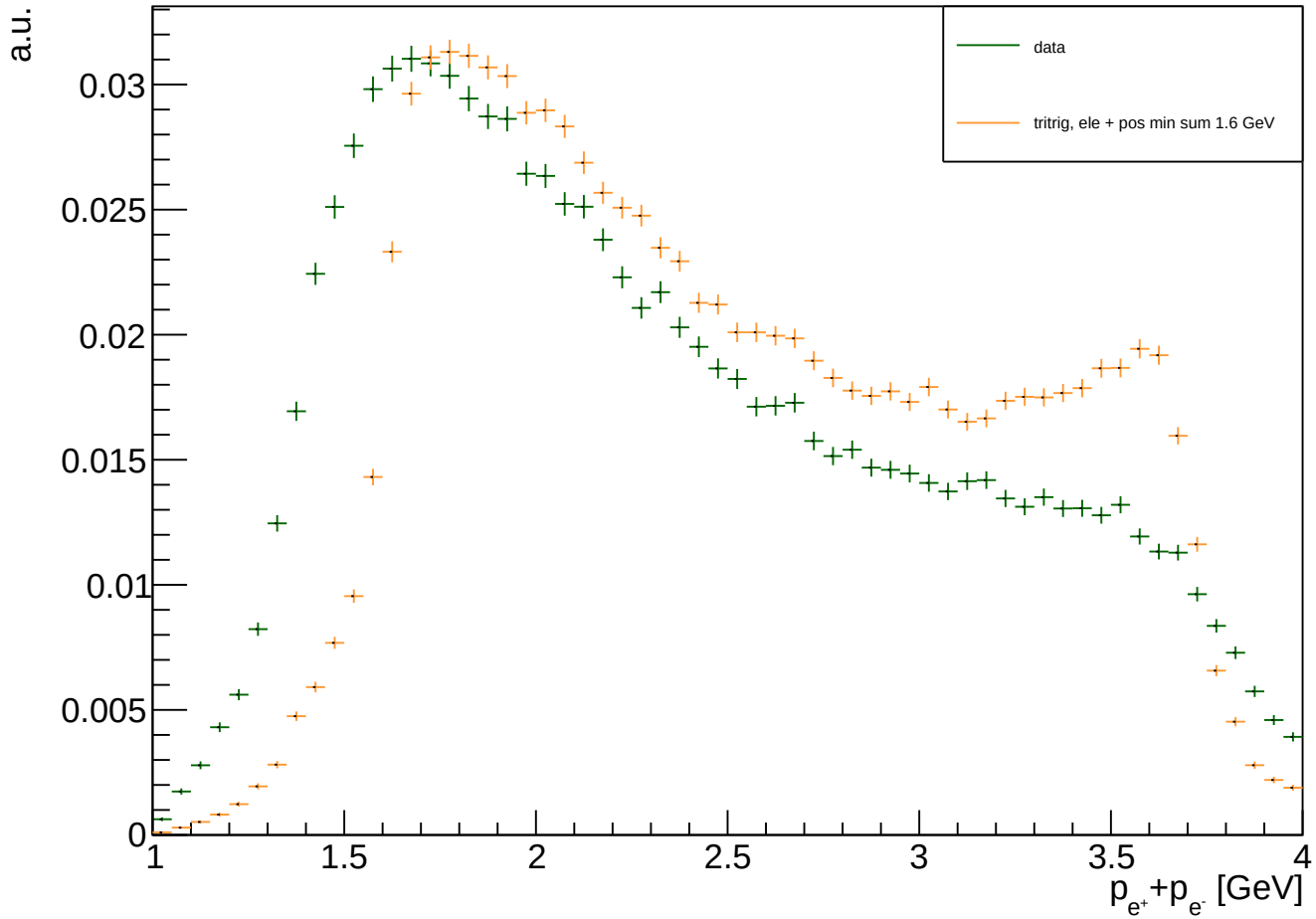
- Modified MC peaks stronger towards low energies

P_{sum} distribution - comparison MC and data



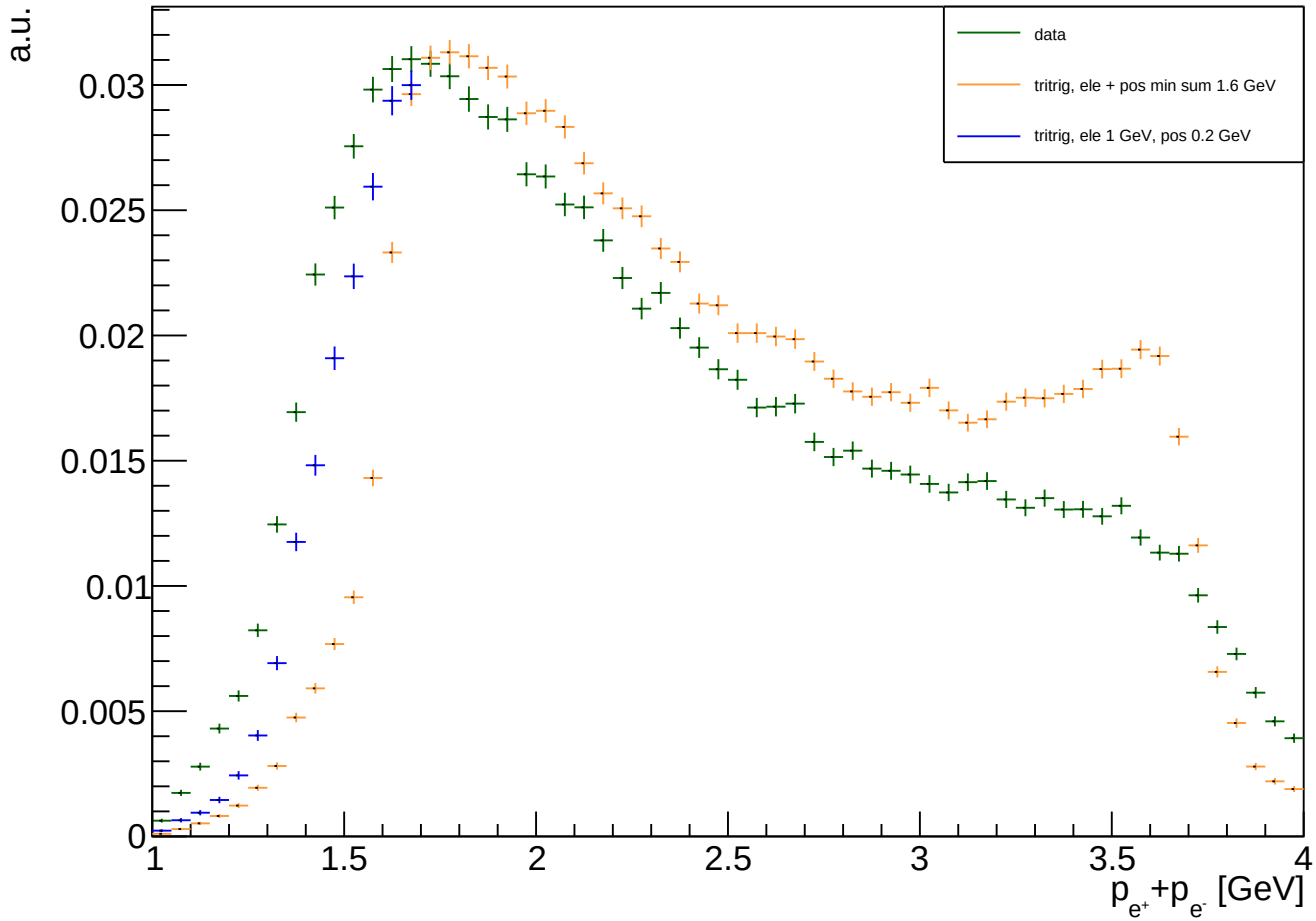
- Distributions not normalized
- For data: peaks at $p_{\text{sum}} = 0.5\,\text{GeV}$ and $p_{\text{sum}} = 1.2\,\text{GeV}$

P_{sum} distribution - Frankenstein



- Data and standard MC not matching for low psum

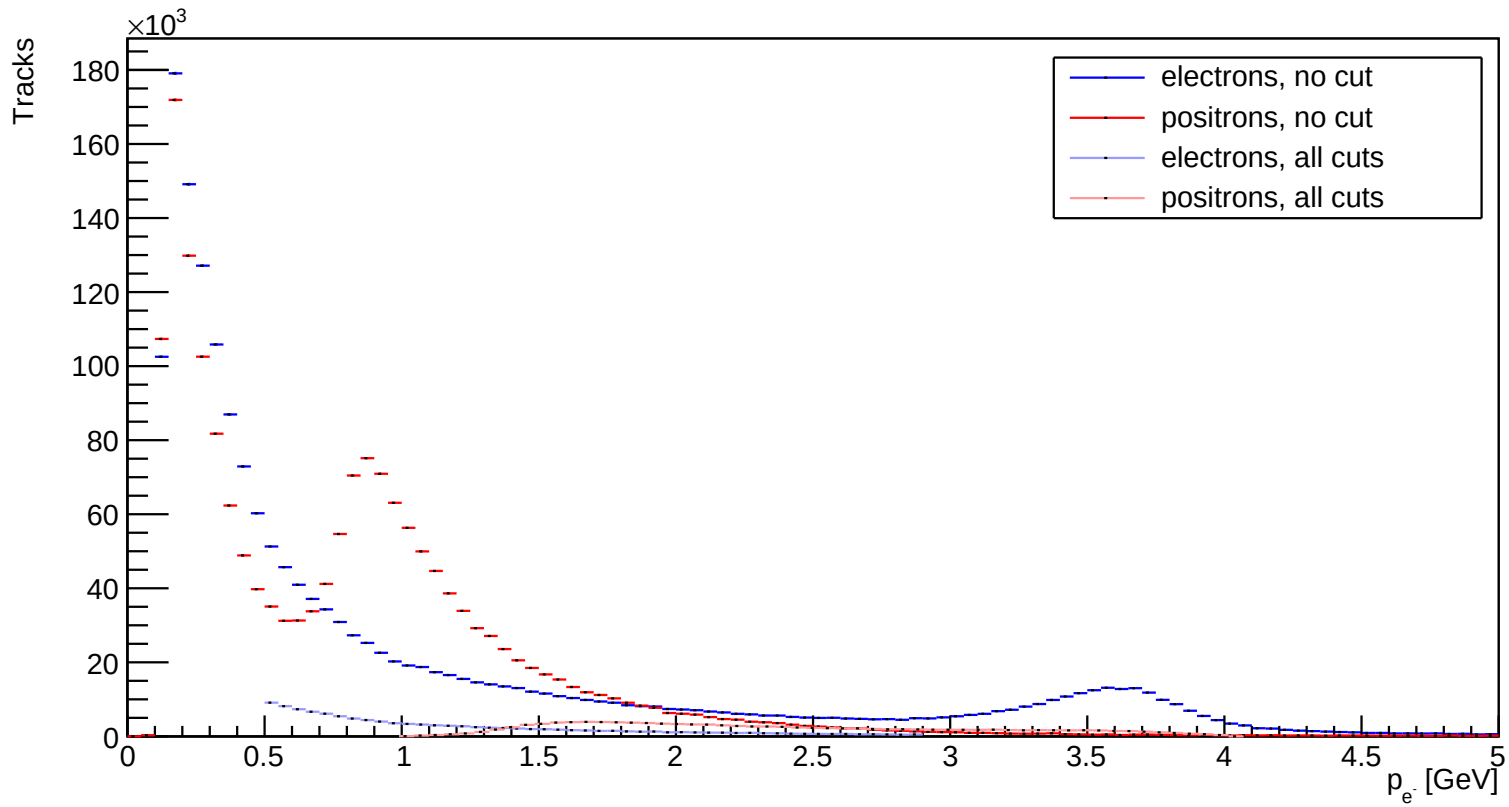
P_{sum} distribution - Frankenstein



- Data and standard MC not matching for low psum
- We could piece together the MC distributions as needed
- But probably not worth the effort

Momentum distribution on data and MC

- Looking at momentum distributions (p_{e^-} and p_{e^+}) in data and MC
- Before preselection: find peaks at
  - $p_{e^+} = 0.9\,\text{GeV}$ for data



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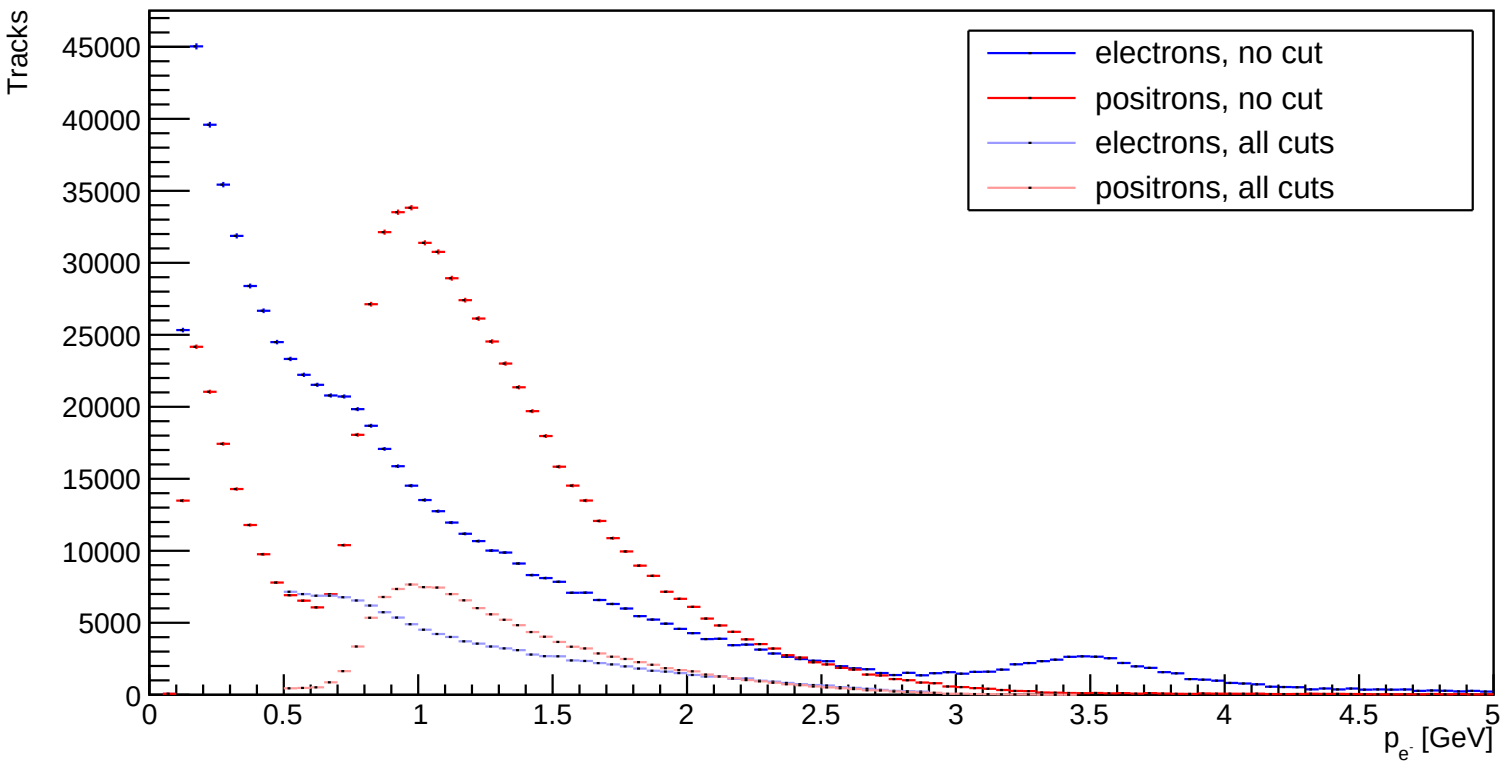
  - $p_{e^+} = 0.9\,\text{GeV}$ for data
  - $p_{e^+} = 1.0\,\text{GeV}$ and $p_{e^-} = 0.8\,\text{GeV}$ for standard MC



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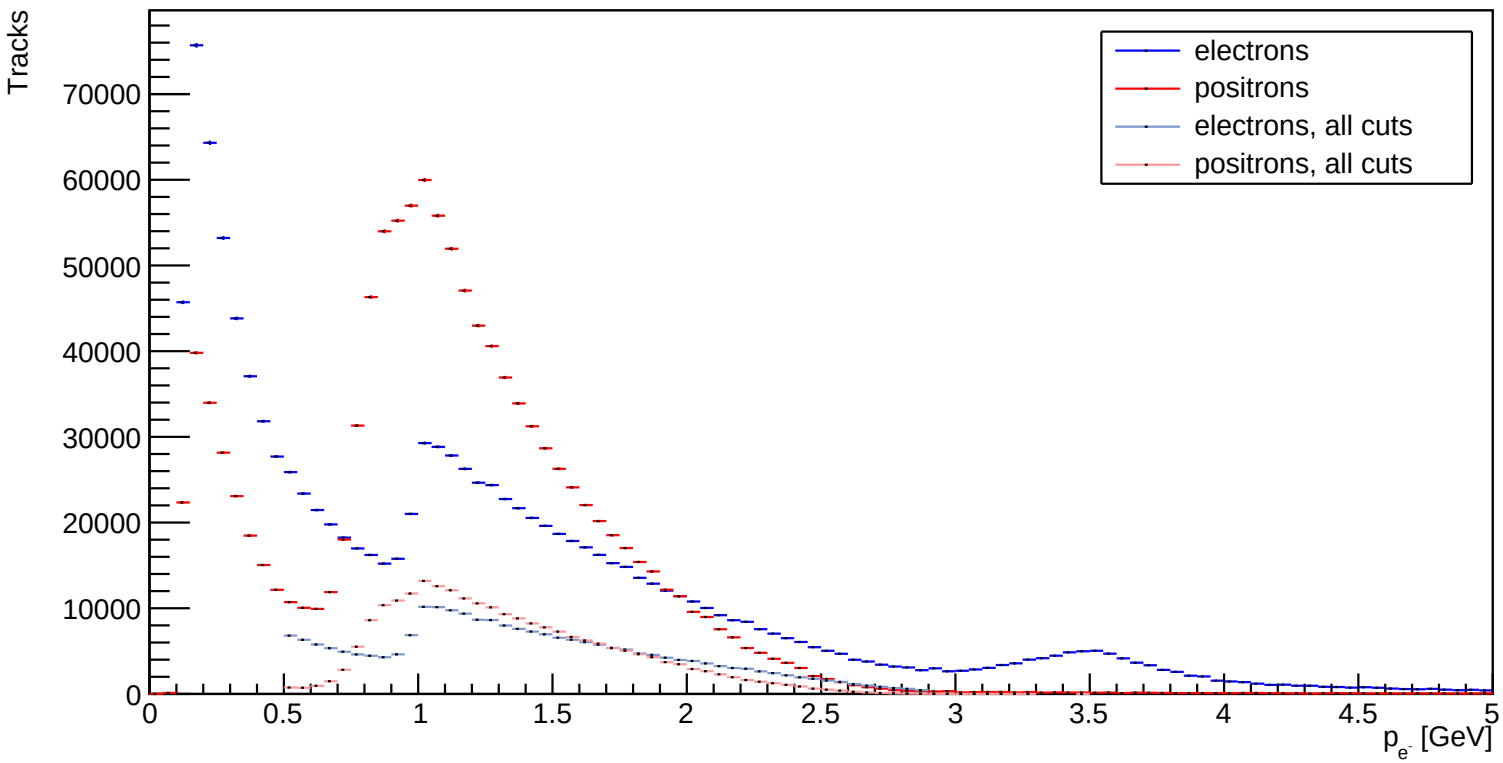
  - $p_{e^+} = 1.0\,\text{GeV}$ and $p_{e^-} = 0.8\,\text{GeV}$ for standard MC
  - $p_{e^+} = 1.1\,\text{GeV}$ and $p_{e^-} = 1.0\,\text{GeV}$ for modified MC



Momentum distribution on data and MC

SLAC

- Looking at momentum distributions (p_{e^-} and p_{e^+}) in data and MC
- Before preselection: find peaks at
  - $p_{e^+} = 0.9\,\text{GeV}$ for data
  - $p_{e^+} = 1.0\,\text{GeV}$ and $p_{e^-} = 0.8\,\text{GeV}$ for standard MC
  - $p_{e^+} = 1.1\,\text{GeV}$ and $p_{e^-} = 1.0\,\text{GeV}$ for modified MC
- Cuts on $E^{e^-}_{\text{min}}$ change shape of momentum distribution
  - This is really not surprising...
- 'Peak' around 1.0 GeV from trigger threshold at 0.5 GeV

Tritrig generator settings

- What about switching electron and positron energy requirements?

```
0.2 = elminsm          ! min E for at least one l-
1.2 = elminsp          ! min E for l+
100.0 = elmaxsm        ! max E for at least one l-
100.0 = elmaxsp        ! max E for l+
0.1 = eltotsp          ! min total E for l+ & at least one l-
0.01 = mmllminsp       ! min invariant mass for at least one l+l- pair
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0.005 = thetaylminsp   ! min angle (y direction) for l+ and at least one l-
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```
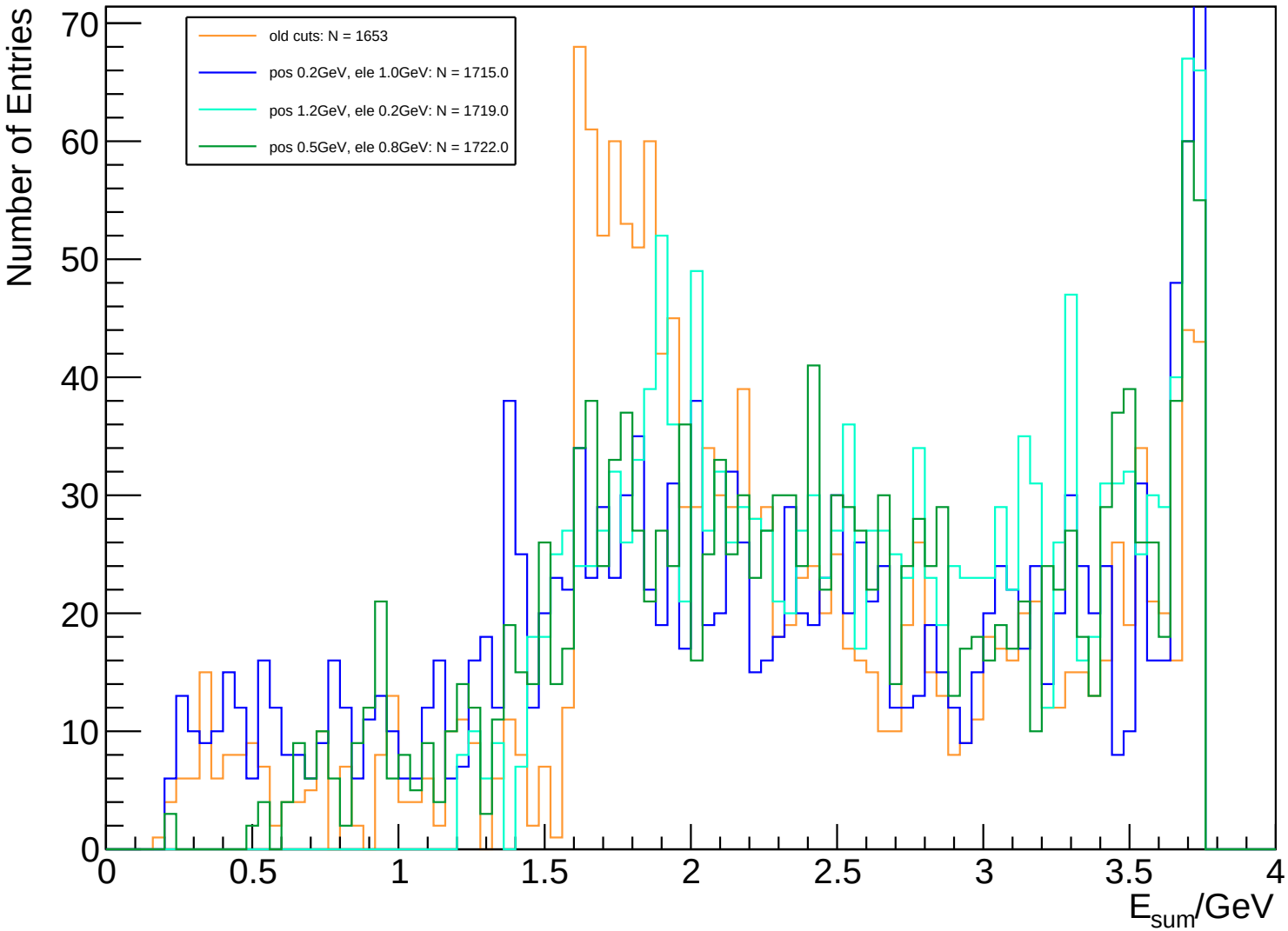

- What about having both at mid-low energies?

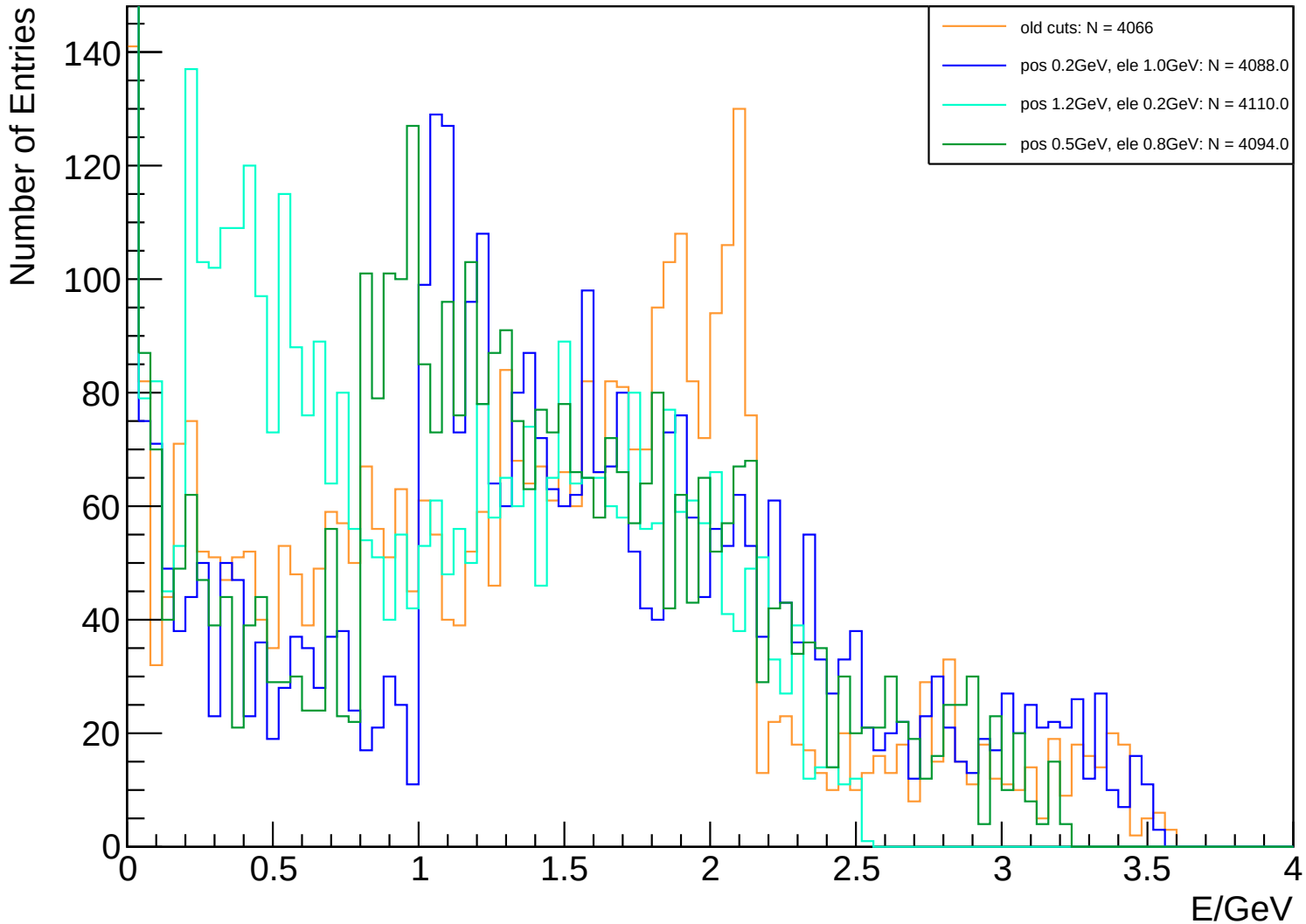
```
0.8 = elminsm          ! min E for at least one l-
0.5 = elminsp          ! min E for l+
0.1 = eltotsp          ! min total E for l+ & at least one l-
```

- Observations:
  - Need $E_{\text{min}}^{e^+} \geq 1.2\,\text{GeV}$ so that $E_{\text{min}}^{e^-}$ can be low
  - $E_{\text{min}}^{l^+ + l^-}$ can be low

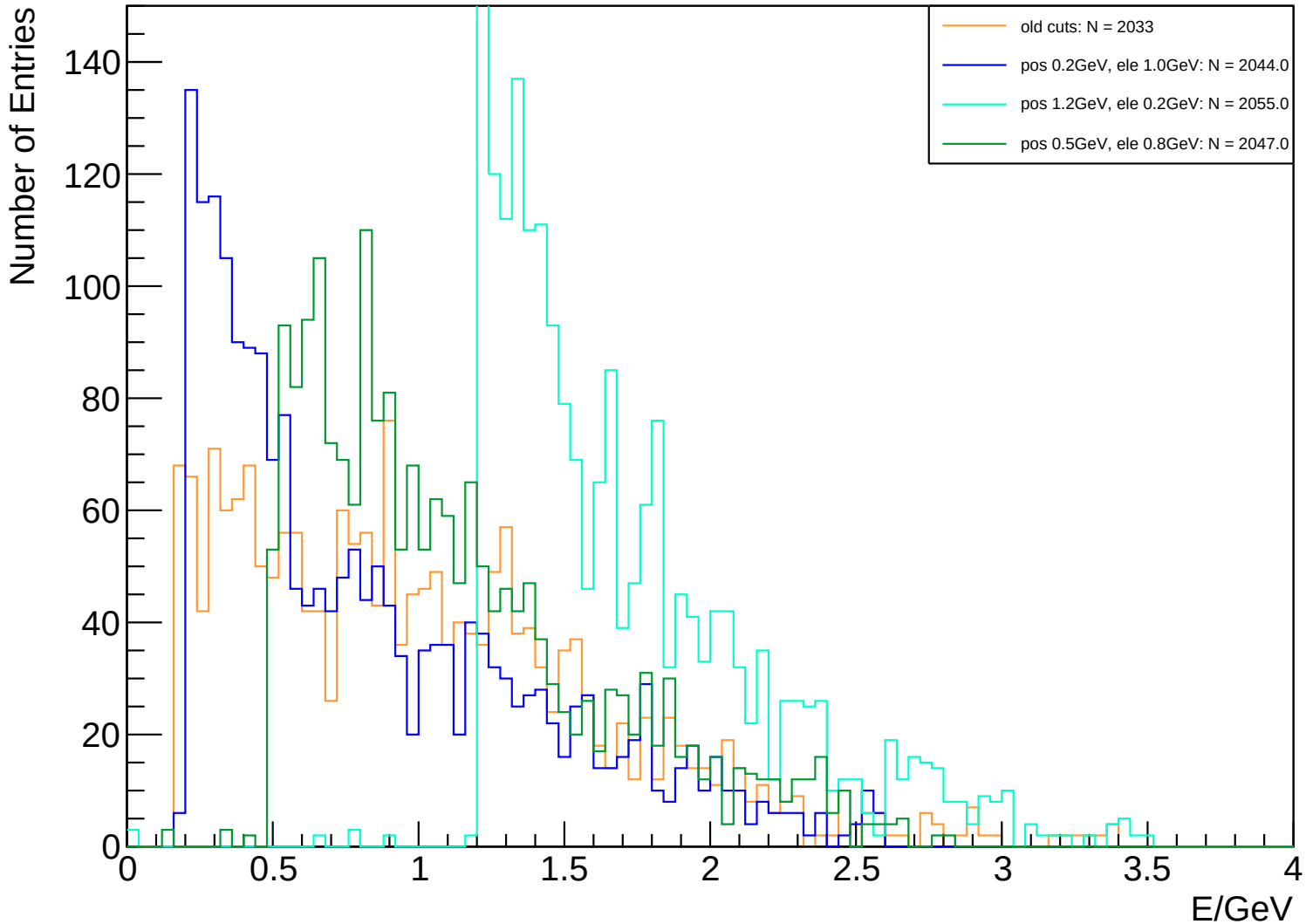
Esum at generator level



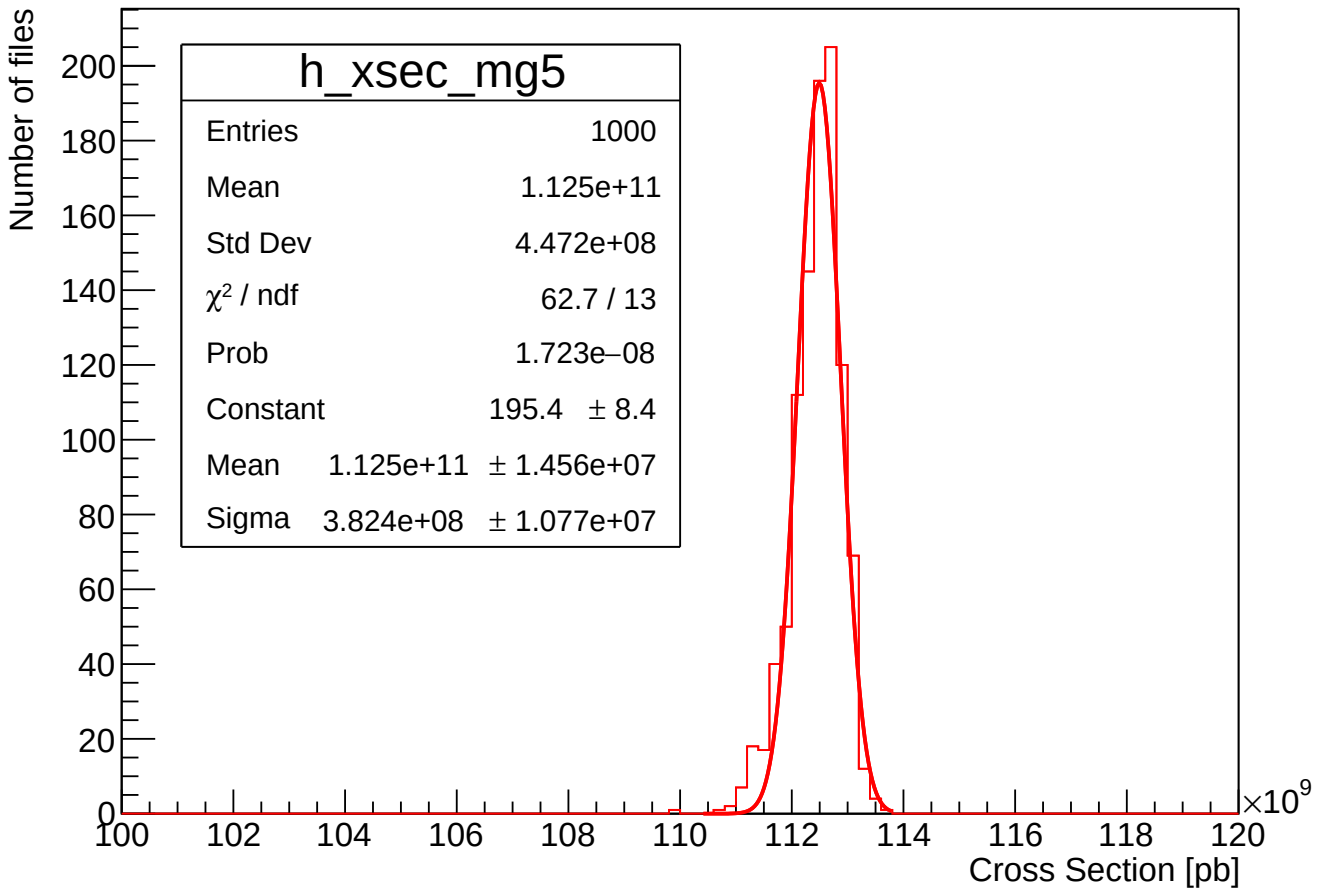
E_{e^-} at generator level



E_{e^+} at generator level



Switching gears – generated cross sections



- $\sigma_{\text{gen}}^{\text{WAB}} = 1.125 \times 10^{11}$ pb

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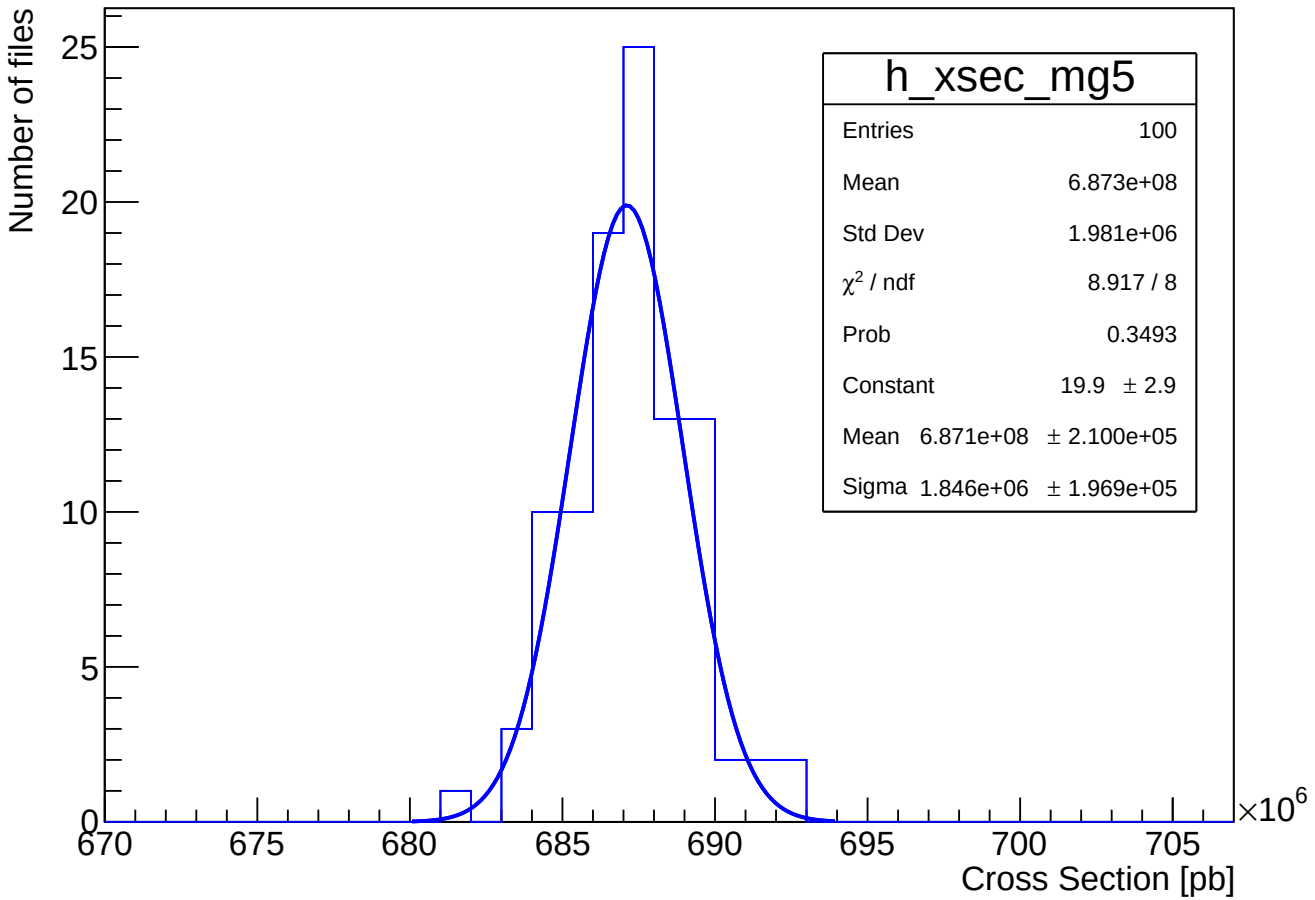
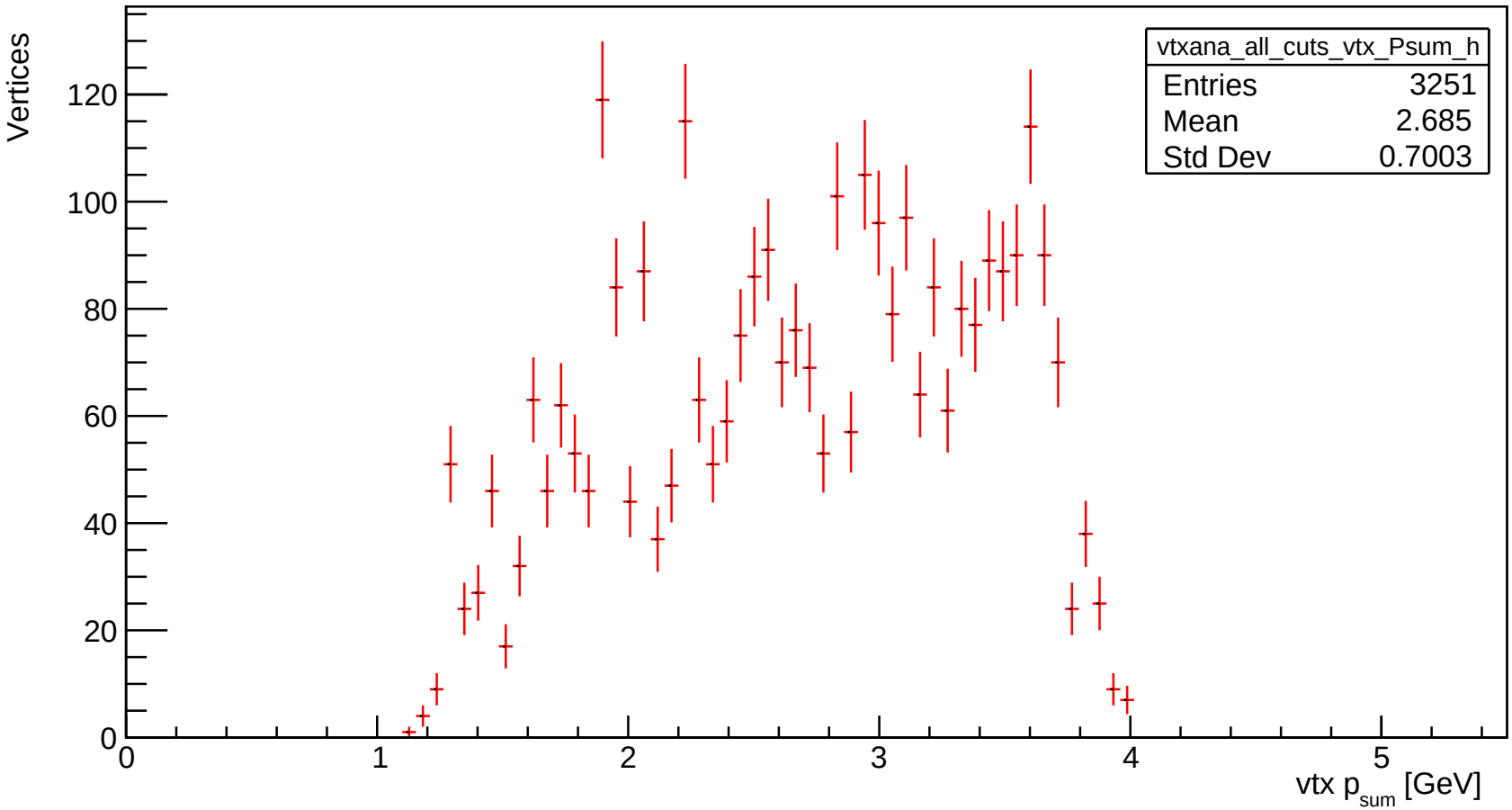


- $\sigma_{\text{gen}}^{\text{WAB}} = 1.125 \times 10^{11}\,\text{pb}$
- $\sigma_{\text{gen}}^{\text{tritrig}} = 6.871 \times 10^{8}\,\text{pb}$

Effective cross sections

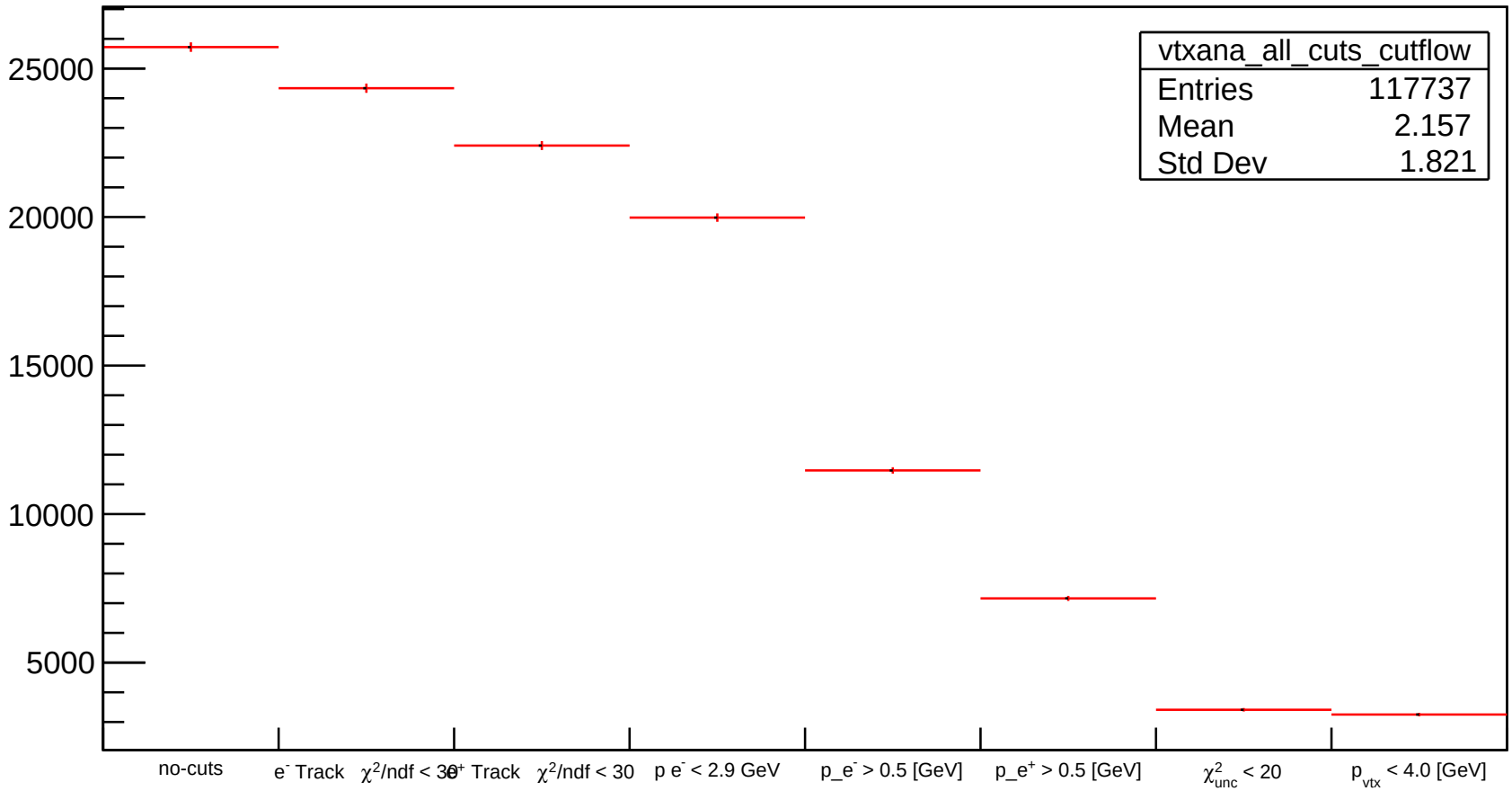
- WAB
  - generated events: $300 \times 10 \times 10\,000 = 3 \times 10^7$
  - events post preselection: 3251
  - effective xsec: $\sigma_{\text{eff}}^{\text{WAB}} = \sigma_{\text{gen}}^{\text{WAB}} \times \frac{3251}{3 \times 10^7} = 1.219\,125 \times 10^7$ pb
- tritrig
  - generated events: $50 \times 10 \times 10\,000 = 5 \times 10^6$
  - events post preselection: 129 920
  - effective xsec: $\sigma_{\text{eff}}^{\text{tritrig}} = \sigma_{\text{gen}}^{\text{tritrig}} \times \frac{129920}{5 \times 10^6} = 1.785\,361 \times 10^7$ pb
- ratio WAB : tritrig $= 0.406 : 0.594$

WAB production



- Statistics are too low still to reasonably use WAB MC

WAB production

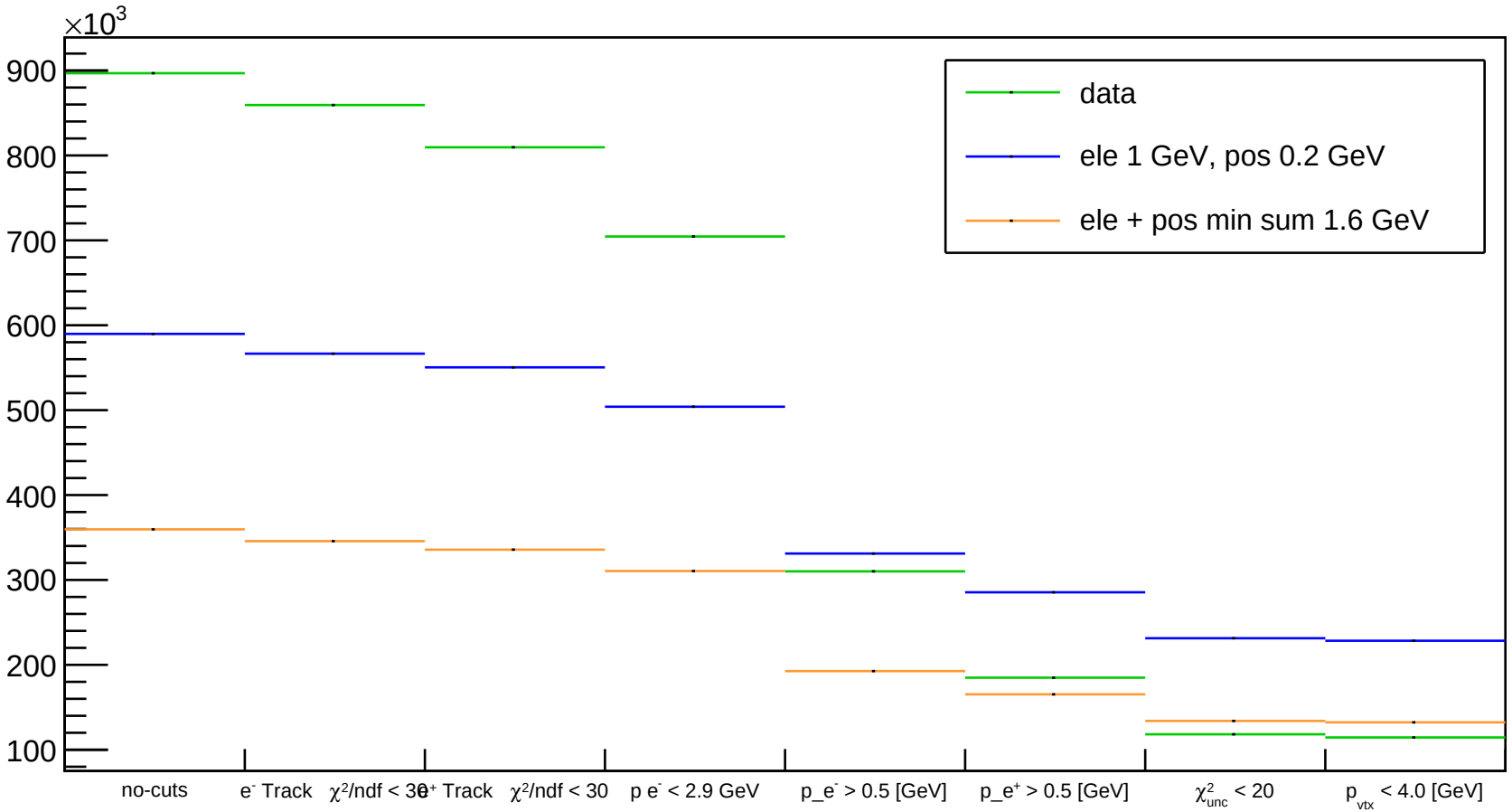


- Statistics are too low still to reasonably use WAB MC
- Most events are cut out at $p_{e^-} > 0.5\,\text{GeV}$ and $p_{e^+} > 0.5\,\text{GeV}$
  - Lots of low momentum tracks reconstructed

Next steps

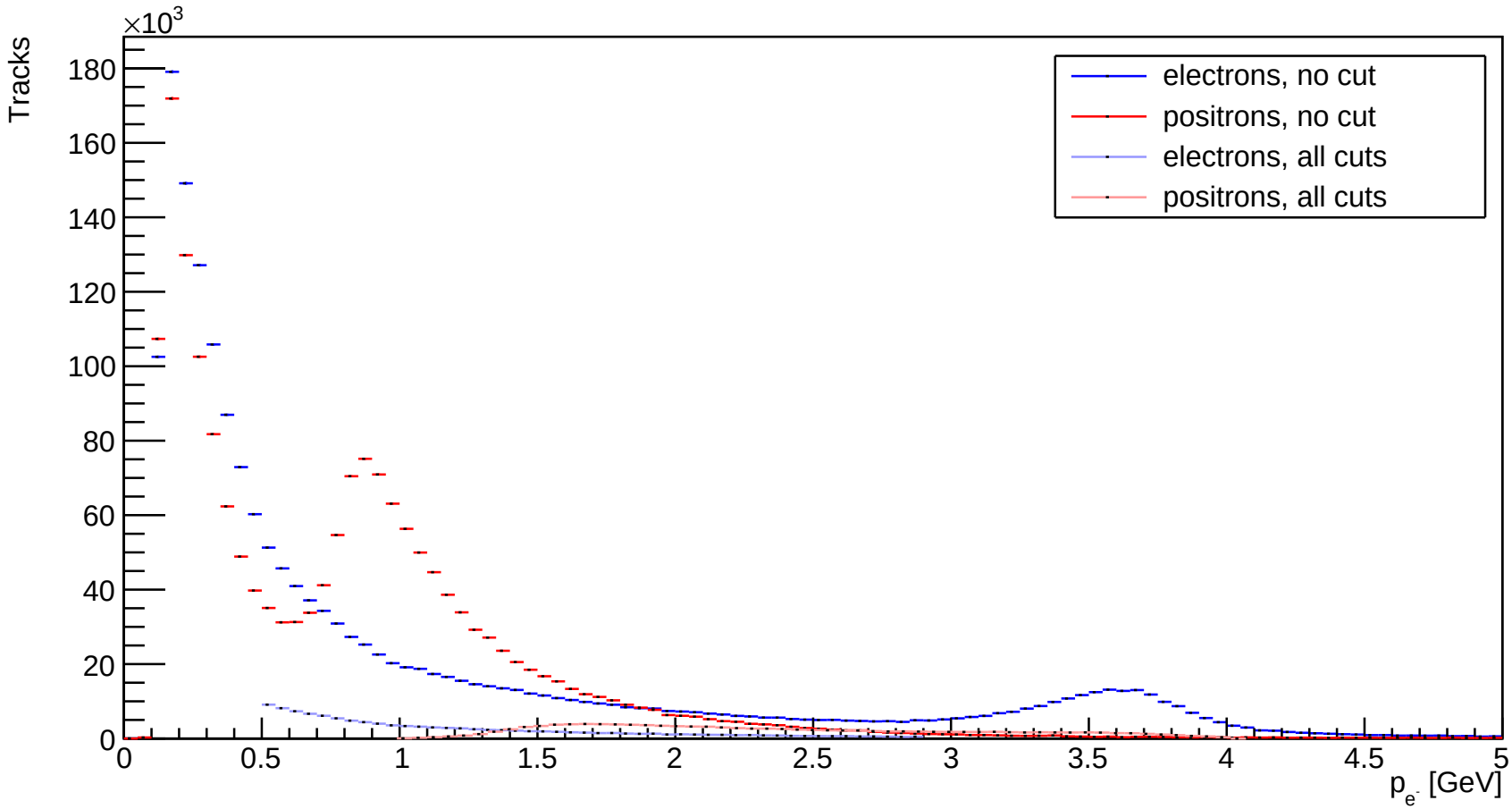
- Generate bigger WAB sample
  - I didn't pay as much attention to this as I should have during the last two weeks...
- I could generate test samples for different tritrig generator configs
  - Takes a lot of time and might be pointless
  - Could also make lower psum accessible to us

Preselection cutflow



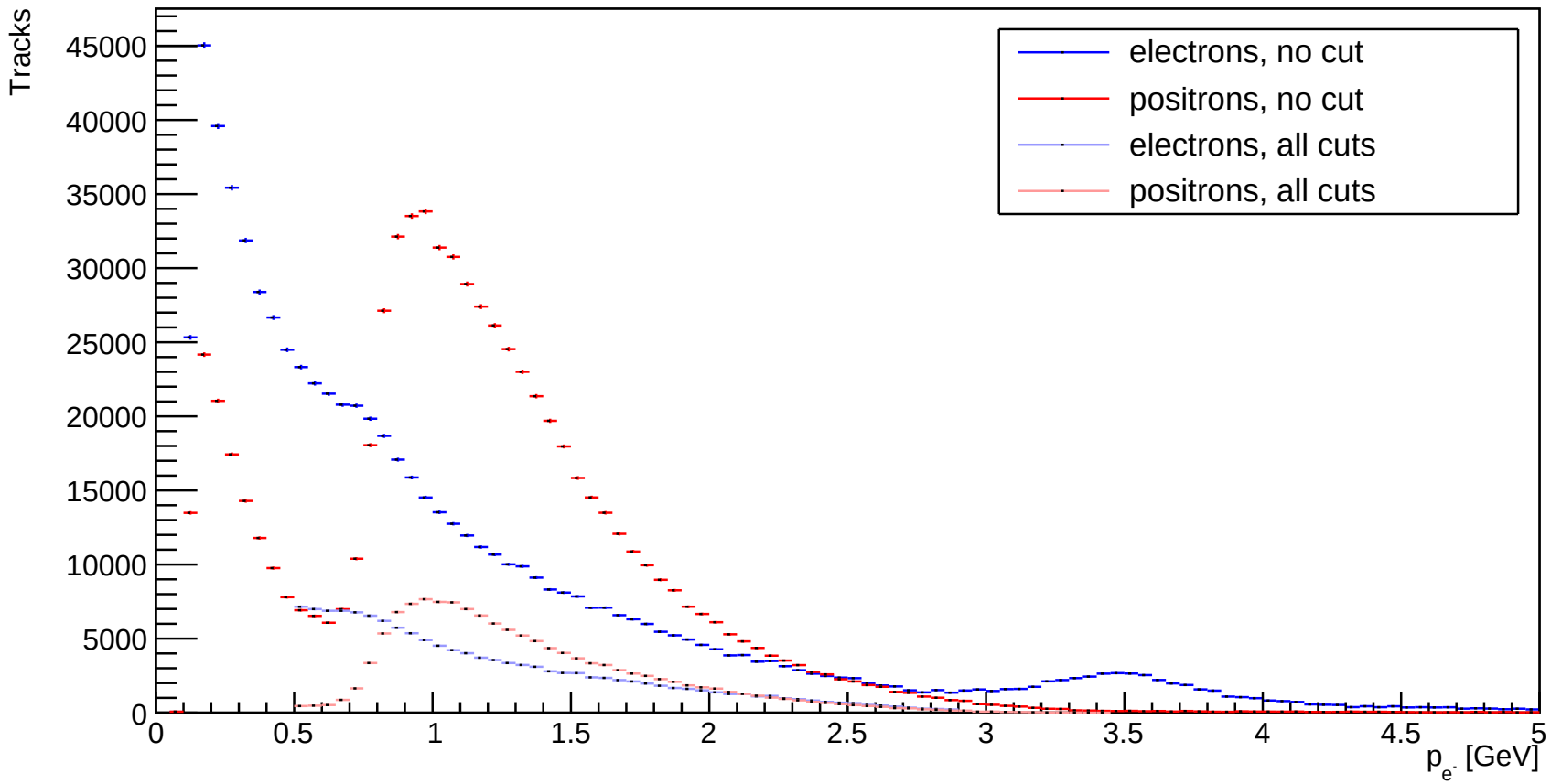
- Comparison of cutflow for data, standard, and modified MC

Momentum distribution – data



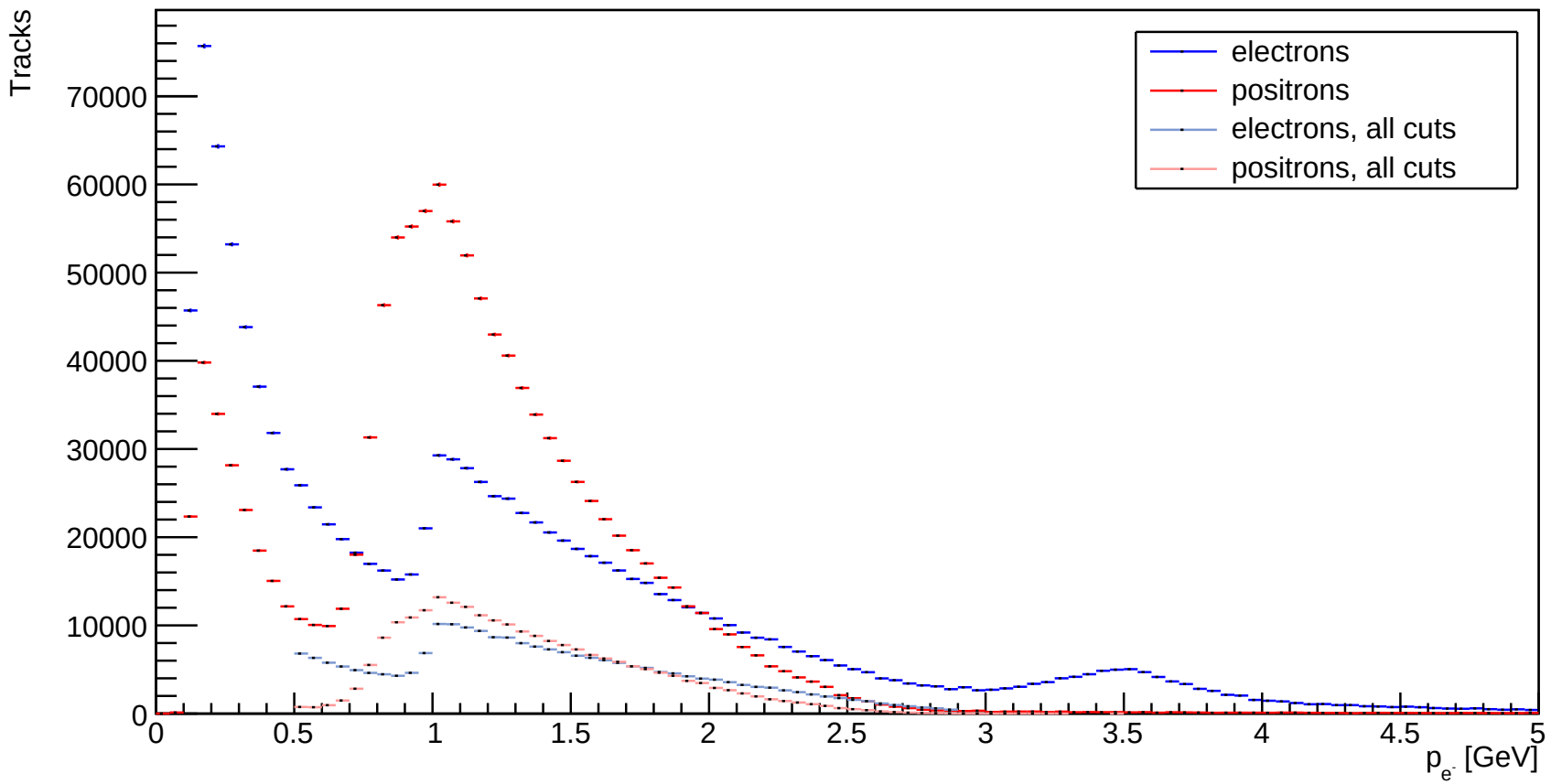
- Distributions with and without preselection cuts

Momentum distribution – standard MC



- $E_{\text{min}}^{l^+ + l^-} = 1.6\,\text{GeV}$ and $E_{\text{min}}^{l^{+/-}} = 0.16\,\text{GeV}$
- Distributions with and without preselection cuts

Momentum distribution – new MC



- $E_{\text{min}}^{e^-} = 1.0\,\text{GeV}$, $E_{\text{min}}^{e^+} = 0.2\,\text{GeV}$, and $E_{\text{min}}^{l^+ + l^-} = 0.1\,\text{GeV}$
- Distributions with and without preselection cuts