Updating A' generator to MG5

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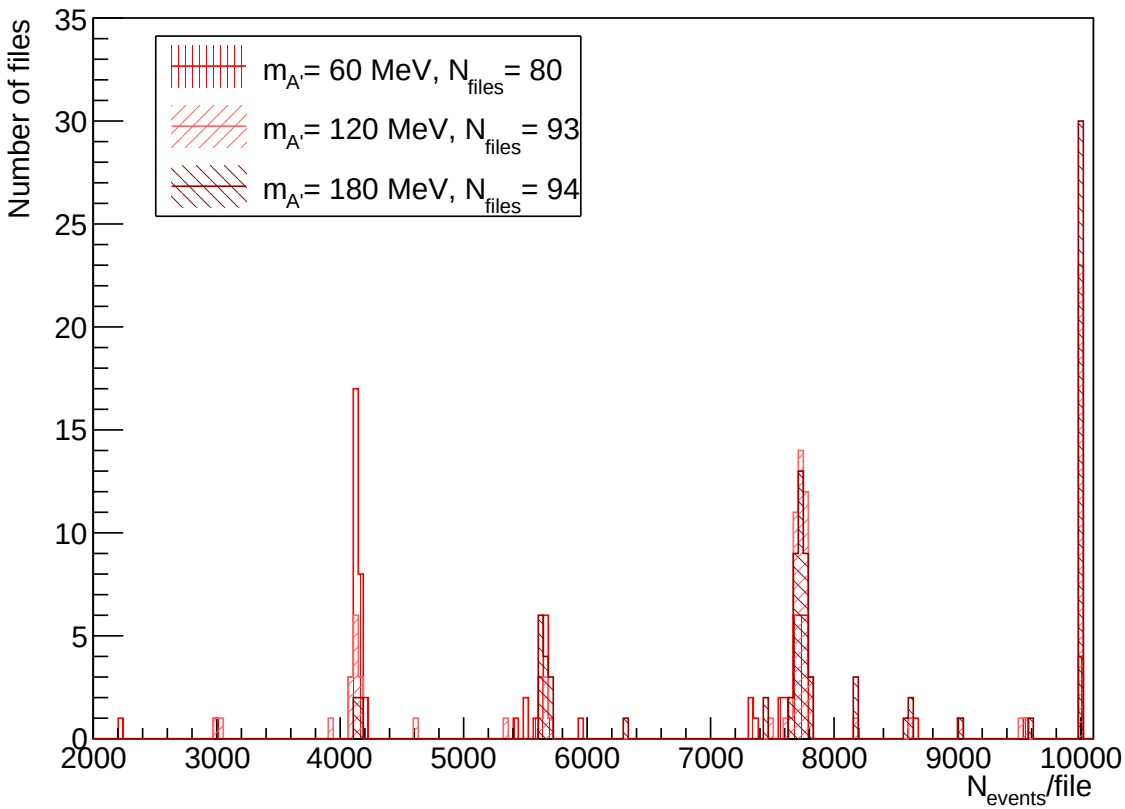
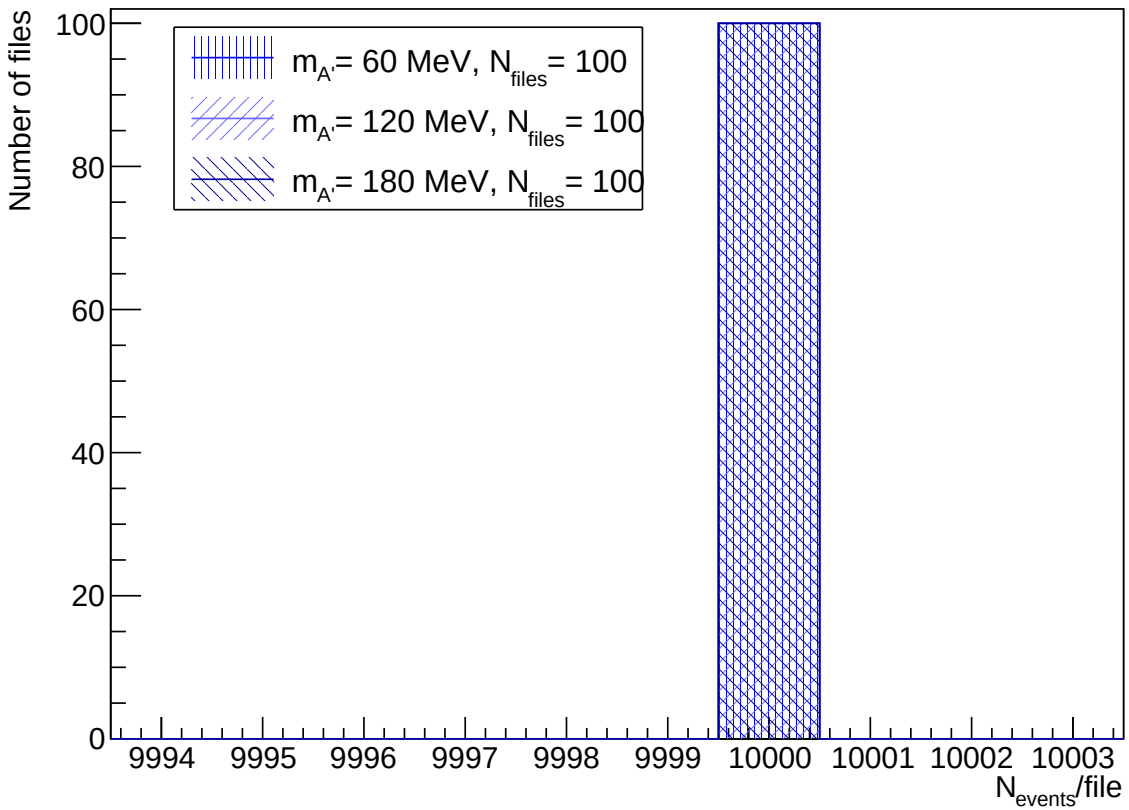
A' samples – MG4 and MG5

- All event types are generated in MG5 (or egs5) except for A'
- Also, I noticed that the MG4 A' generator doesn't always generate all the requested events



A' samples – MG4 and MG5

- All event types are generated in MG5 (or egs5) except for A'
- Also, I noticed that the MG4 A' generator doesn't always generate all the requested events
- When running MG5 for the same process, I get all requested 10 000 events

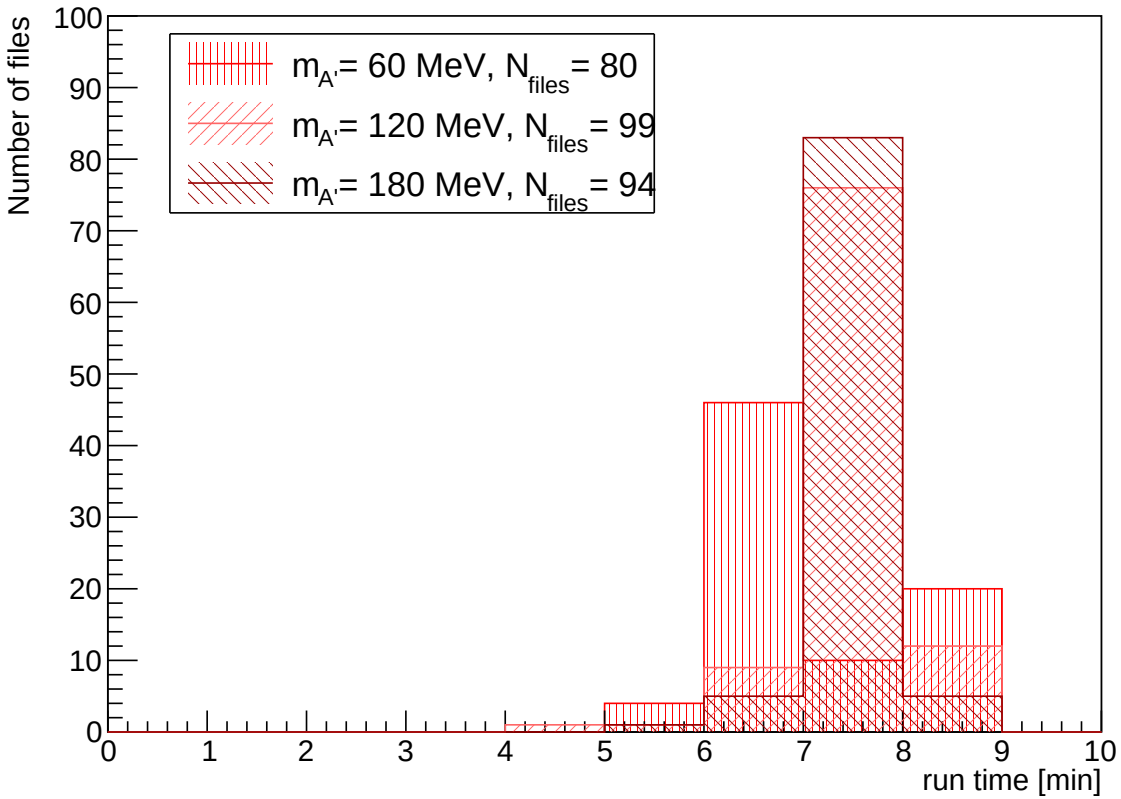


A' samples – MG4 and MG5

SLAC

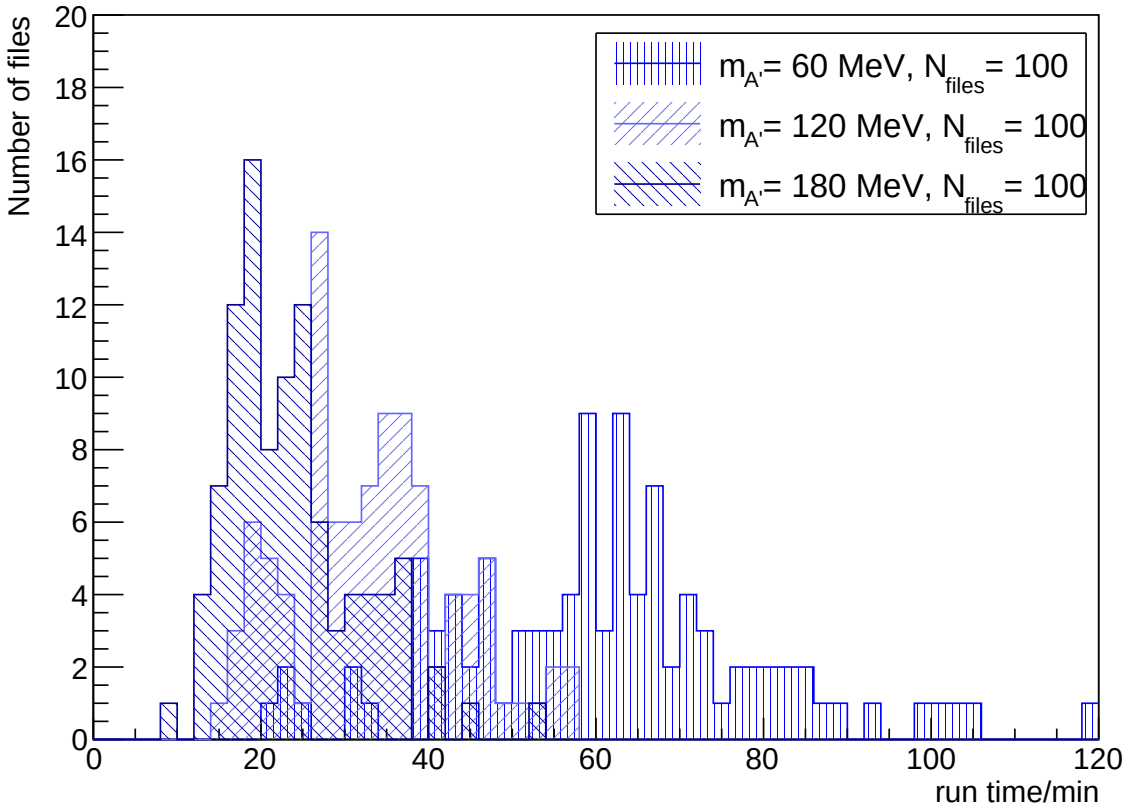
- I migrated the A' generator to MG5
- After some initial struggle, I managed to implement a MG5 version without any kinematic cuts
  - This is analogous to the MG4 A' generator that also has no kinematic constraints
- In MG4, the fermions from the decay of the A' are defined as a new type of particle with ID 611.
  - These particles are just like electrons but without electric charge.
- Initially, in MG5, I let the A' decay in e^+e^- and assigned a new ID to the A' which later caused SLIC to crash.
  - Now both MG versions use the same particles and particle IDs.
  - The following results have been generated after this fix.

Runtime for 10 000 events



- Runtime of A' generation for MG4 is around 6 min to 9 min per file
  - However, the files often contain $\ll$ 10 000 events
- Unfortunately, MG5 is much slower with runtimes up to 2 h

Runtime for 10 000 events



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  - However, the files often contain $\ll$ 10 000 events
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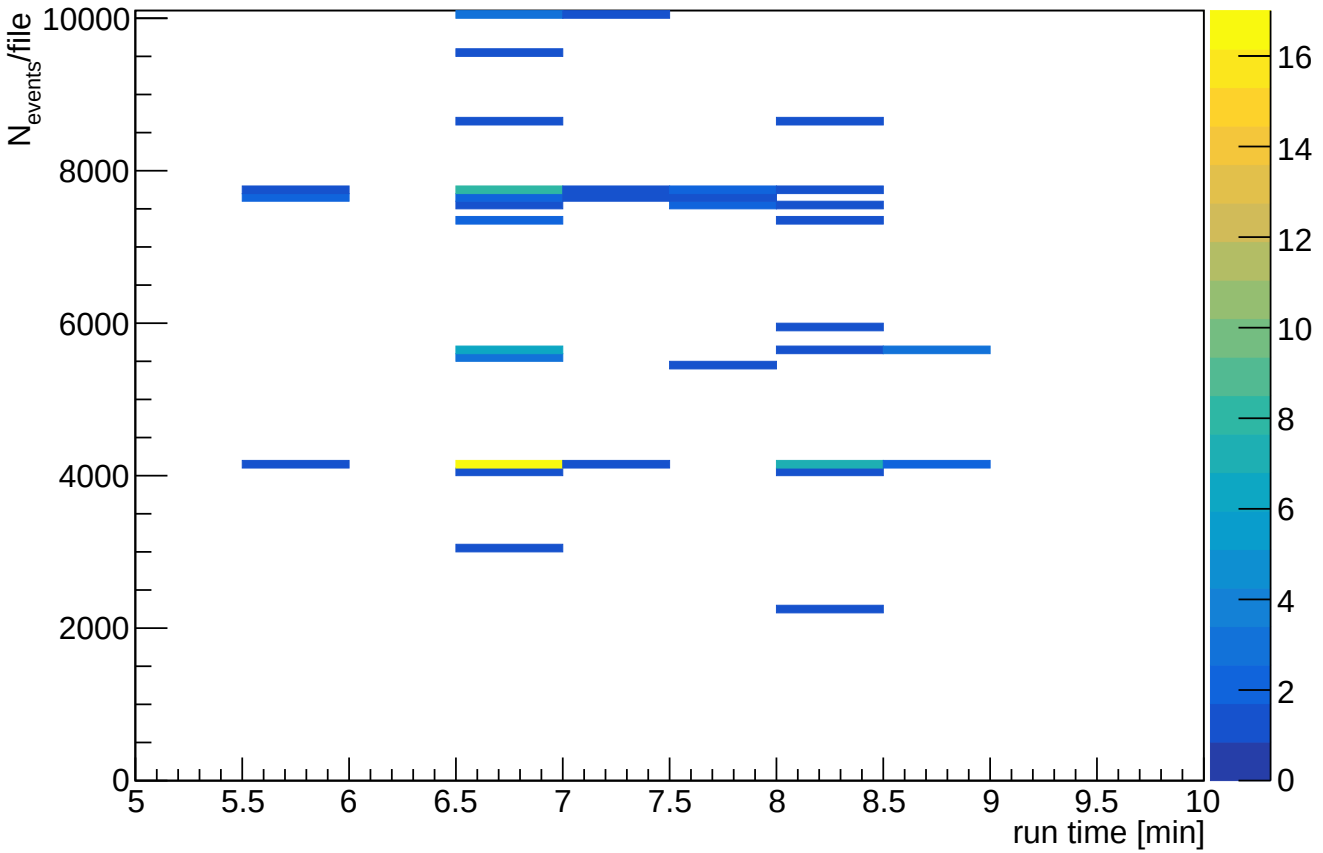
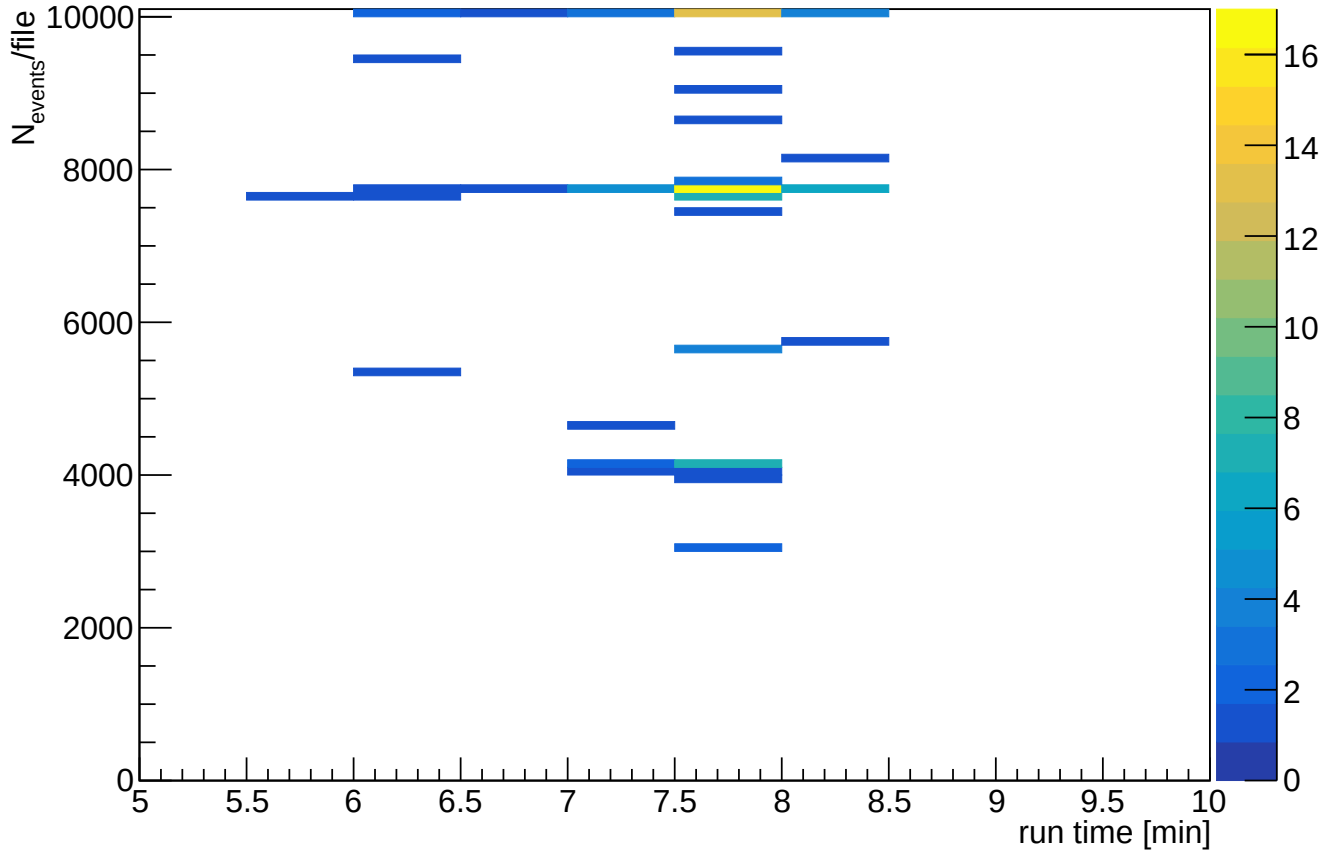
MG4 number of events vs runtime



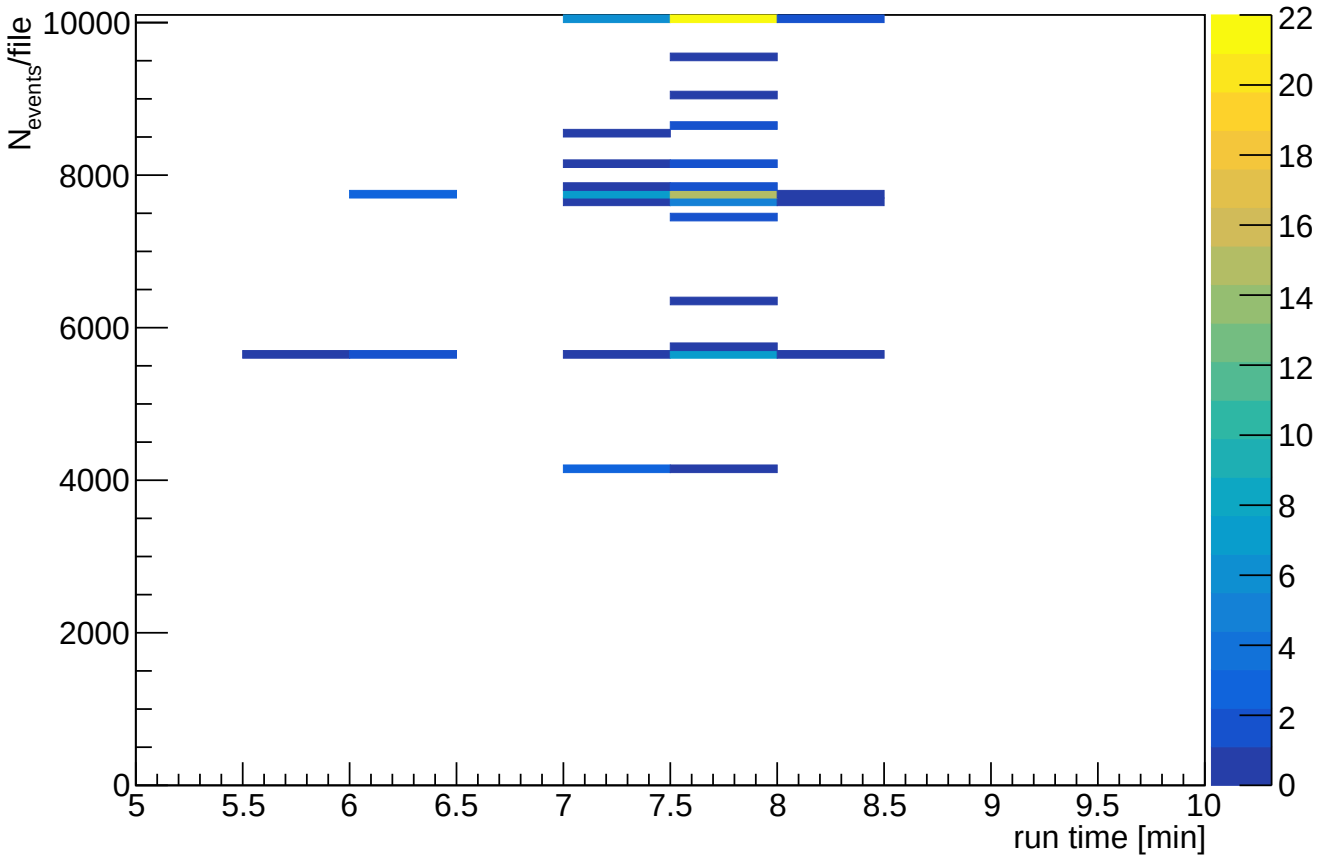
- $M_{A'} = 60\,\text{MeV}$
- There seems to be no direct correlation between runtime and number of generated events for MG4

MG4 number of events vs runtime



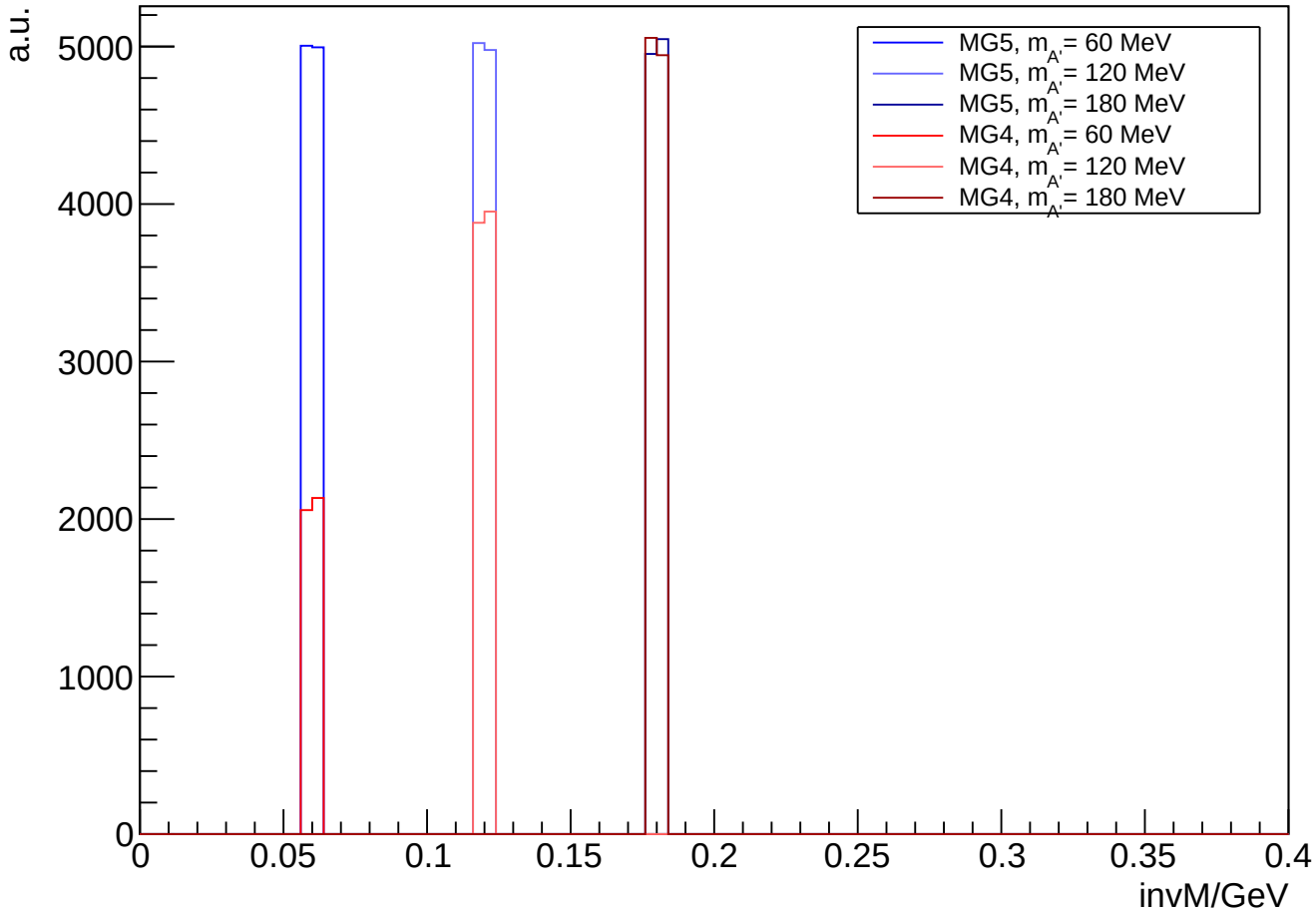
- $M_{A'} = 120\,\text{MeV}$
- There seems to be no direct correlation between runtime and number of generated events for MG4

MG4 number of events vs runtime



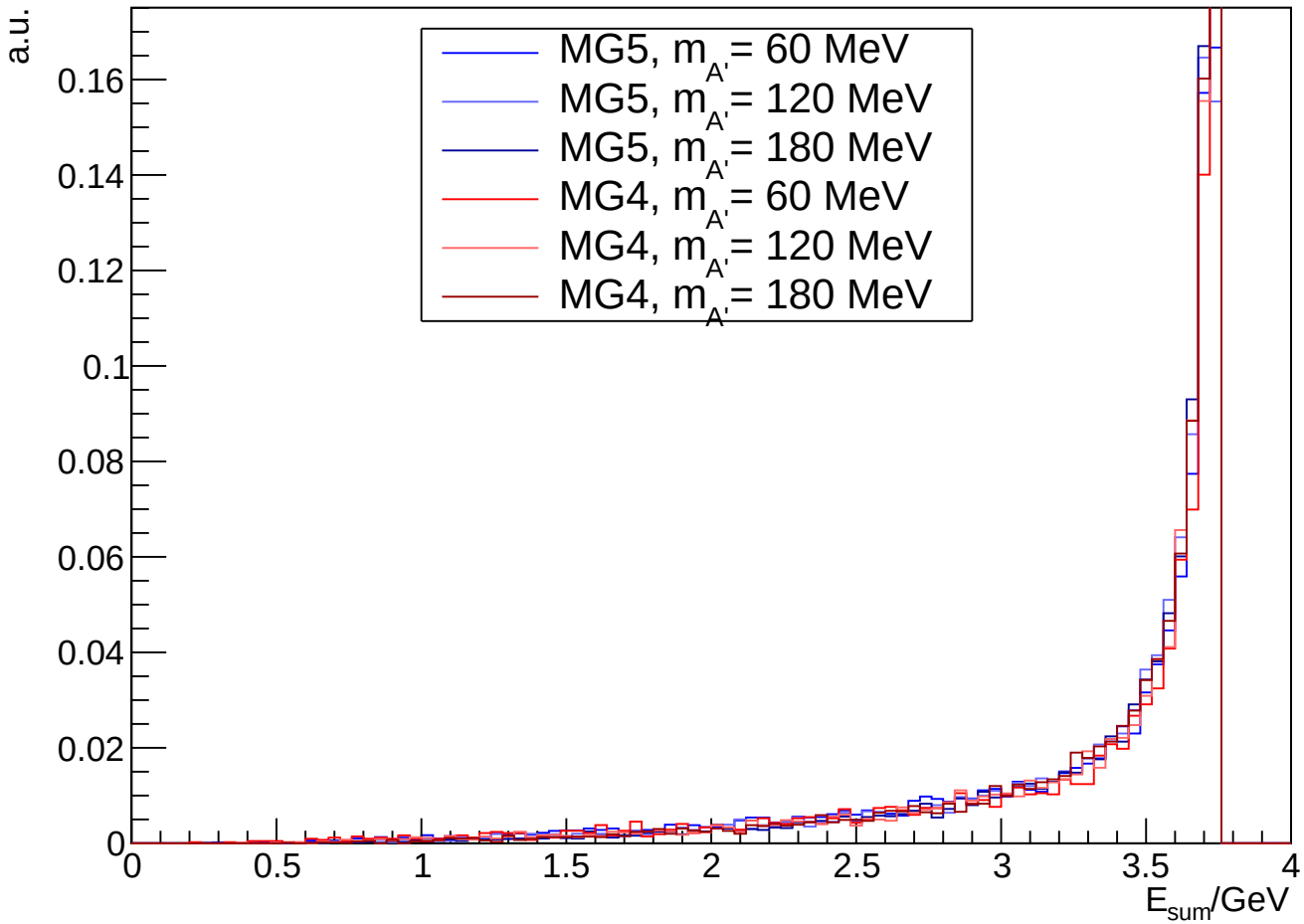
- $M_{A'} = 180\,\text{MeV}$
- There seems to be no direct correlation between runtime and number of generated events for MG4

Invariant mass



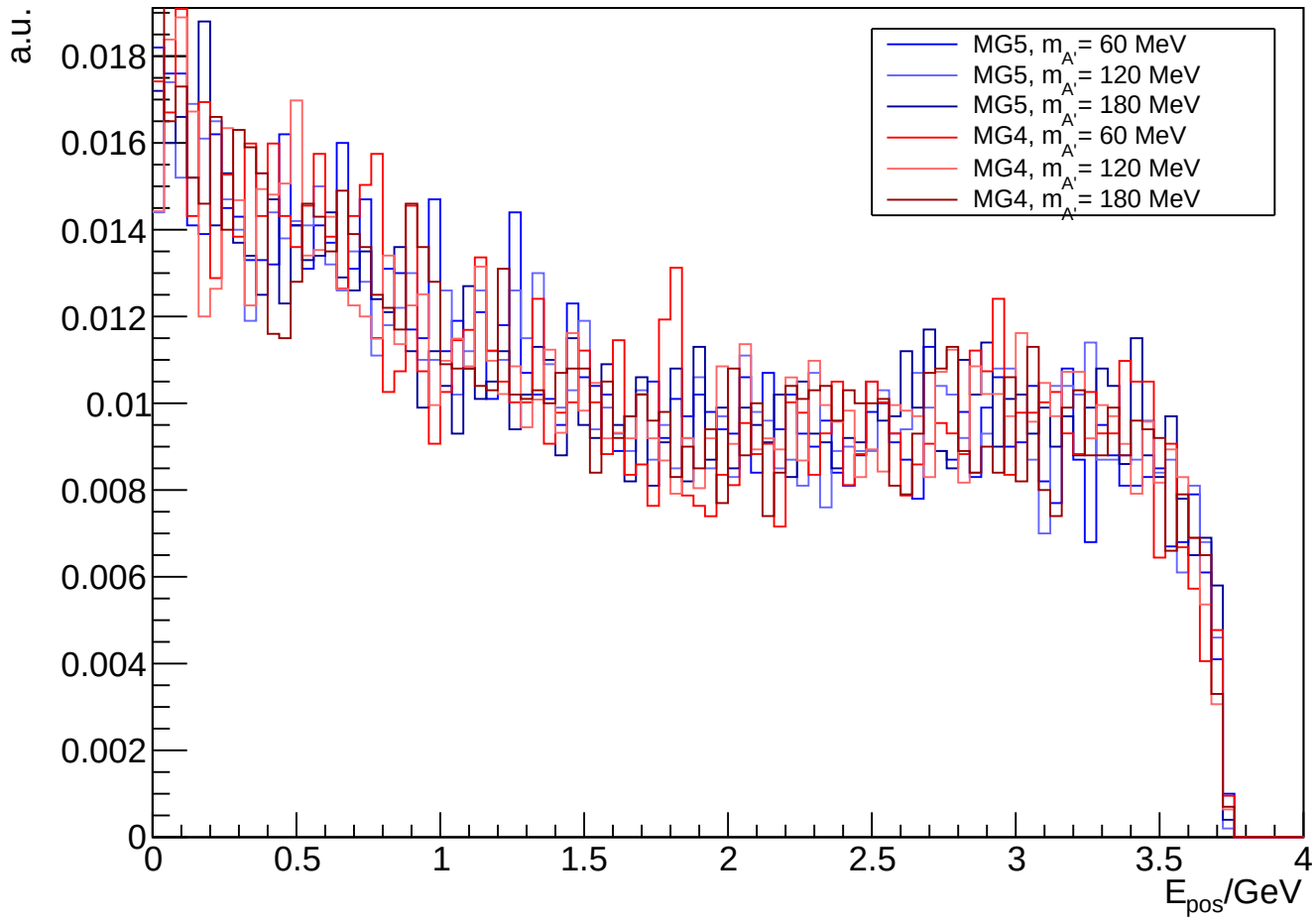
- Invariant mass of positron and electron coming from the decay vertex
- Both versions generate events at the correct invariant mass

Energy sum



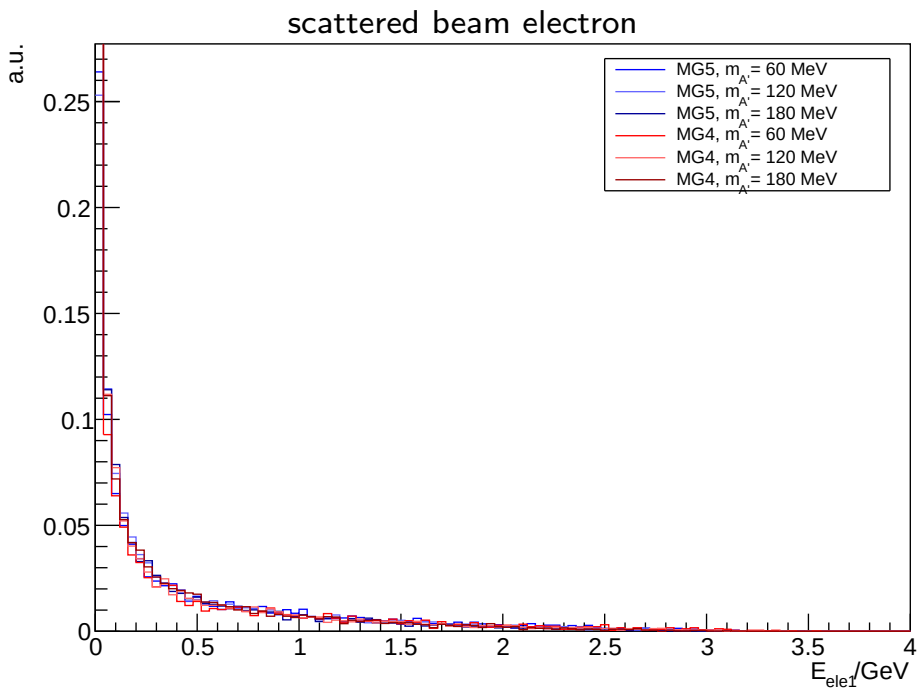
- Energy sum of particles from A' decay – peaked towards beam energy
- This and the following distributions are normalized to an integral of 1.

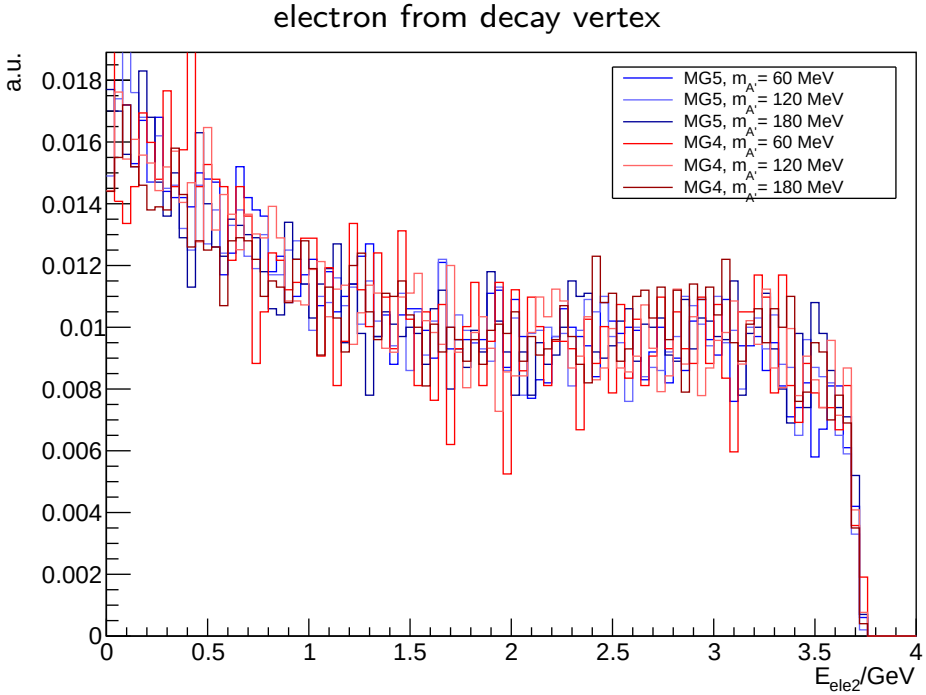
Positron energy



- Flat distribution with slight peak at low energies
- Same shape for MG4 and MG5 generated events

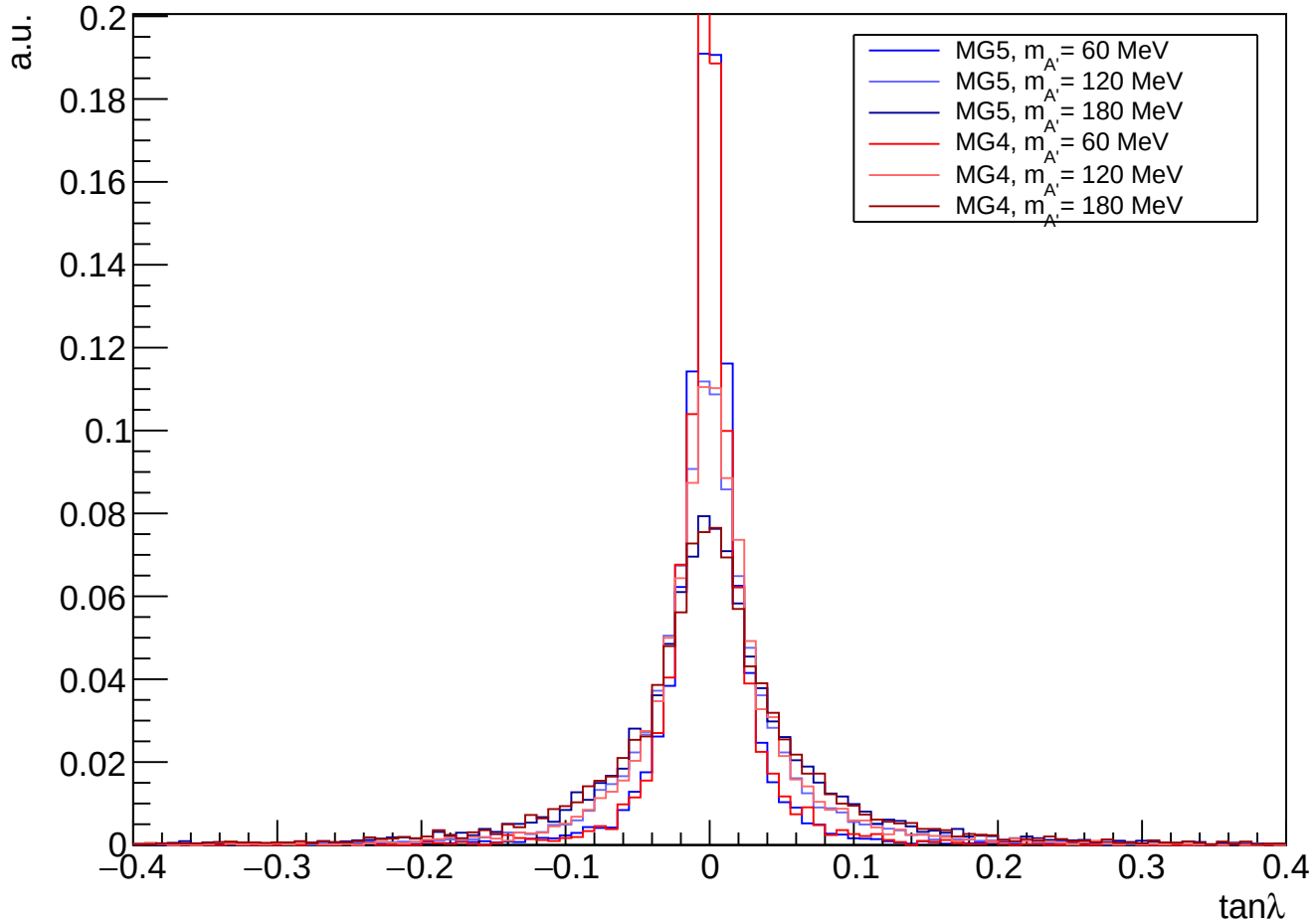
Electron energy





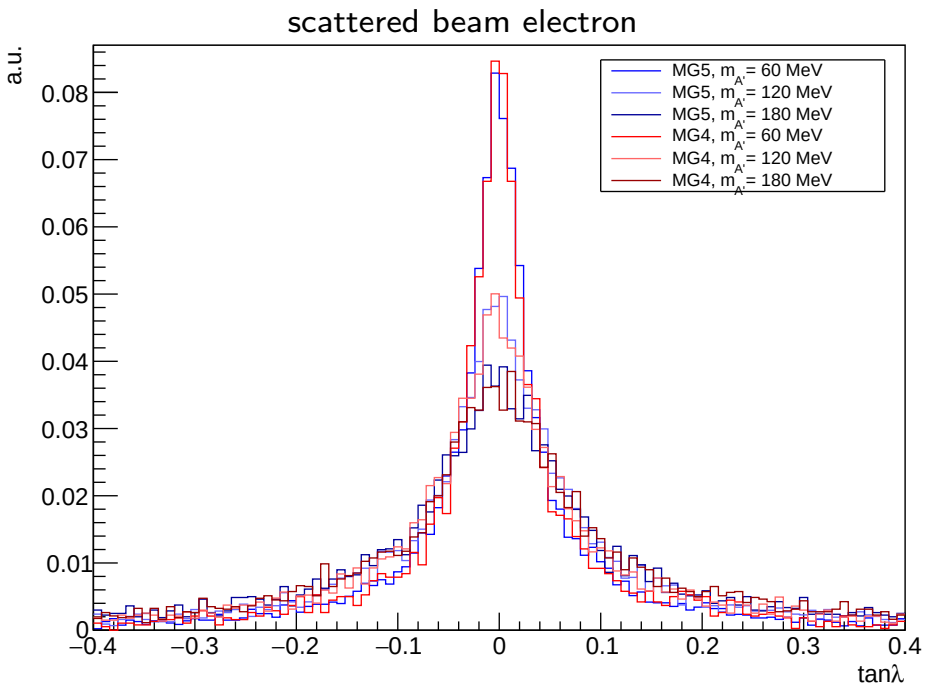
- Beam electron
  - Mostly low-energetic electrons with long tail to high energies
- Vertex electron
  - Flat distribution with slight peak at low energies
- Same shape for MG4 and MG5 generated events

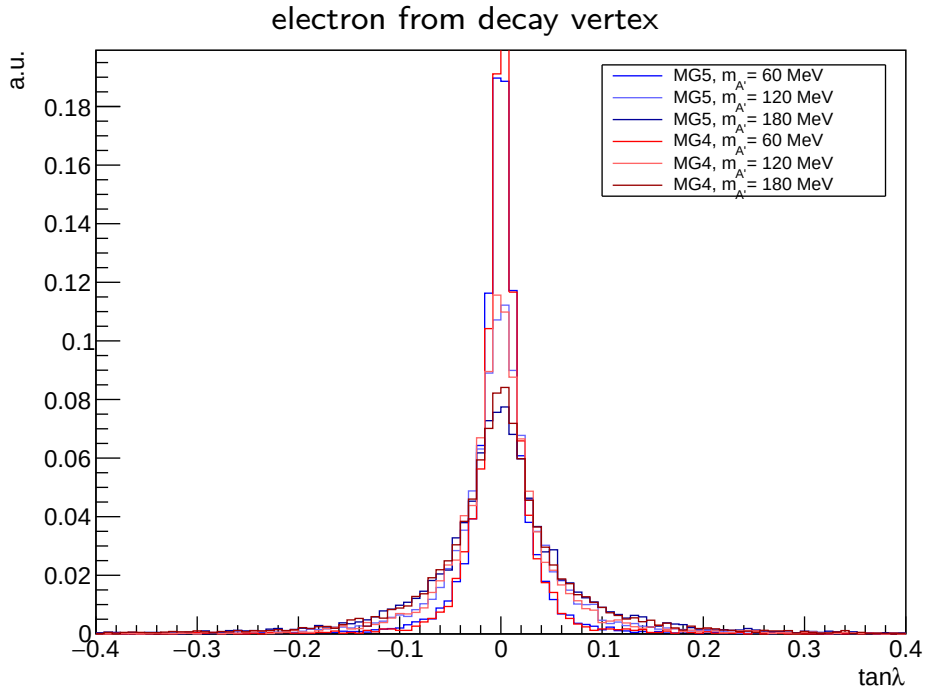
Positron tanL



- Peak at zero with tails up to $|\tan\lambda| = 0.2\,\text{rad}$
- Same shape for MG4 and MG5 generated events

Electron tanL



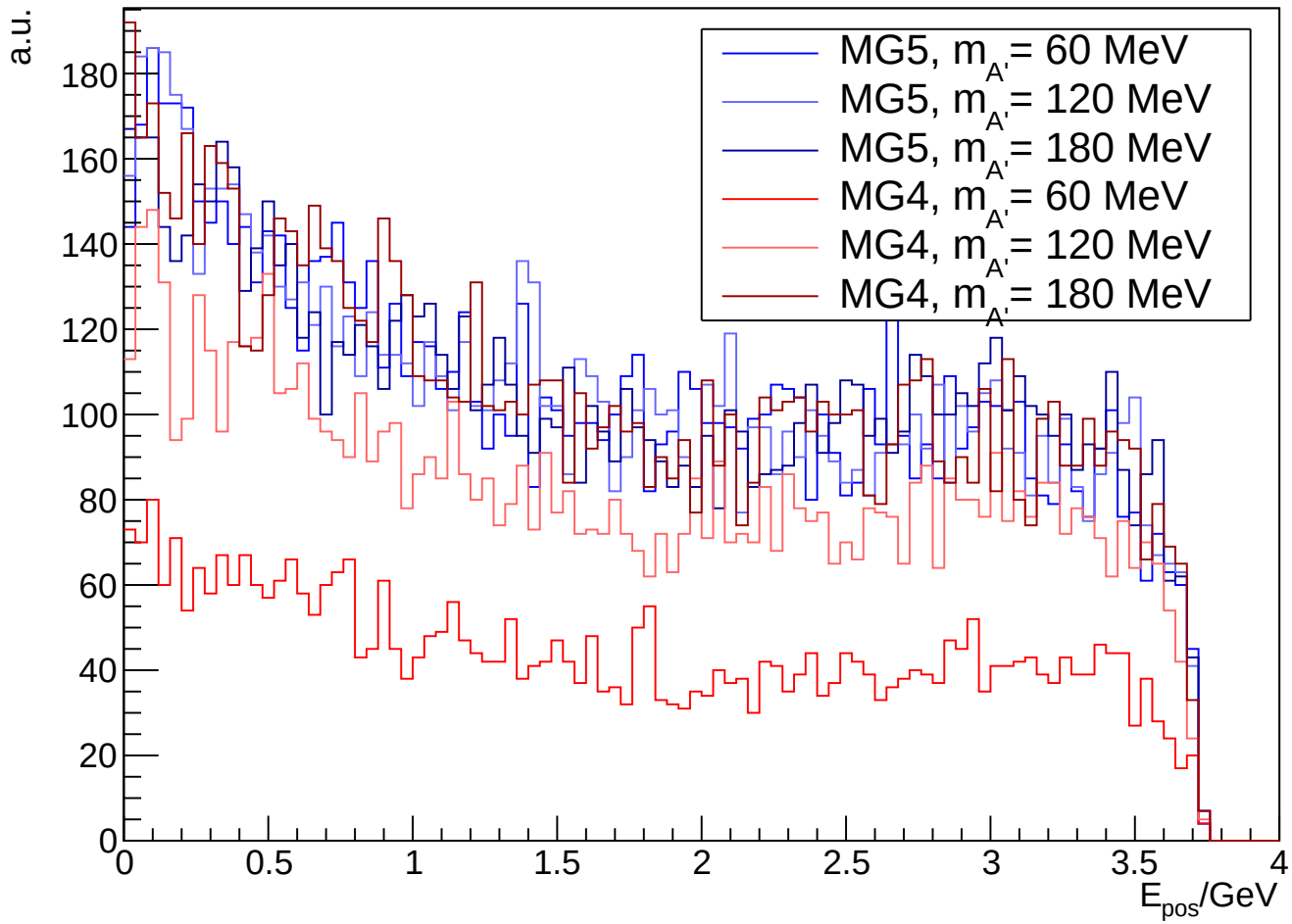


- Beam electron
  - Broader shape, peak at zero with tails up to $|\tan\lambda| = 0.4\,\text{rad}$
- Vertex electron
  - Peak at zero with tails up to $|\tan\lambda| = 0.2\,\text{rad}$, same as positron
- Same shape for MG4 and MG5 generated events

Summary

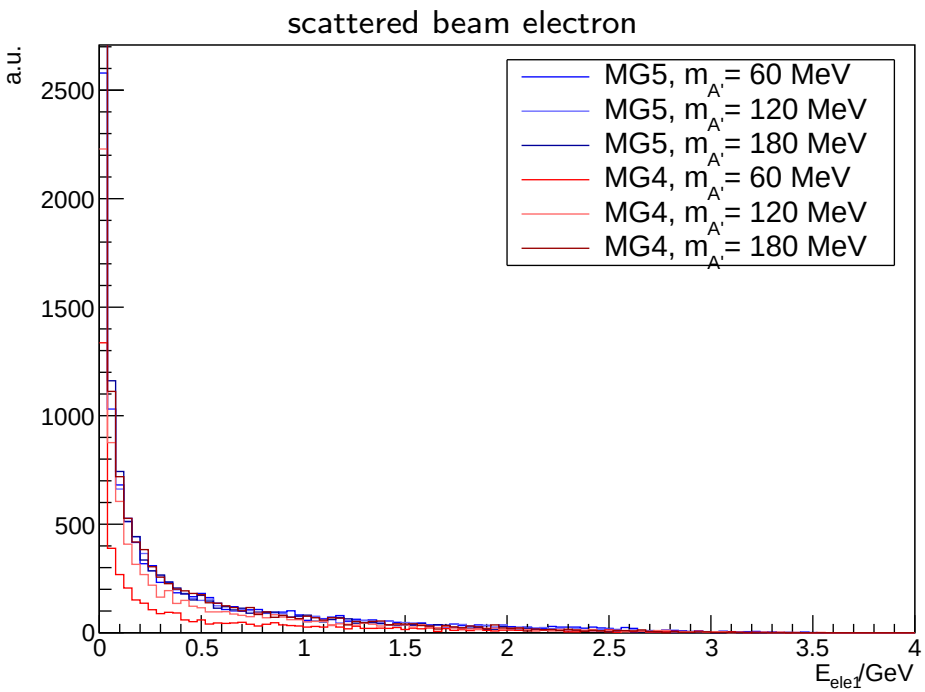
- MG5 generator is already integrated into hps-mc
  - I needed to fix some issues, here is a PR for this
- Ran MG4 and MG5 samples through rest of overlay, readout, and reconstruction pipeline
  - After fixing an issue with the particle ID number, this seems to work for all files.
  - This did not finish running in time so I will present the new results next week.

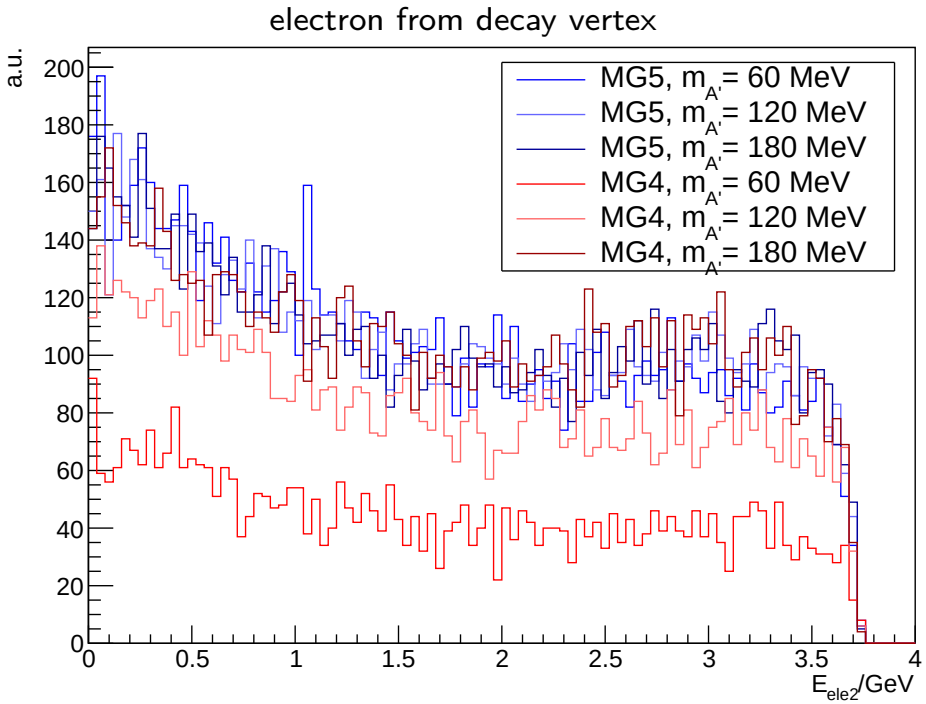
Positron energy – not normalized



- Flat distribution with slight peak at low energies
- More events for MG5, same shape

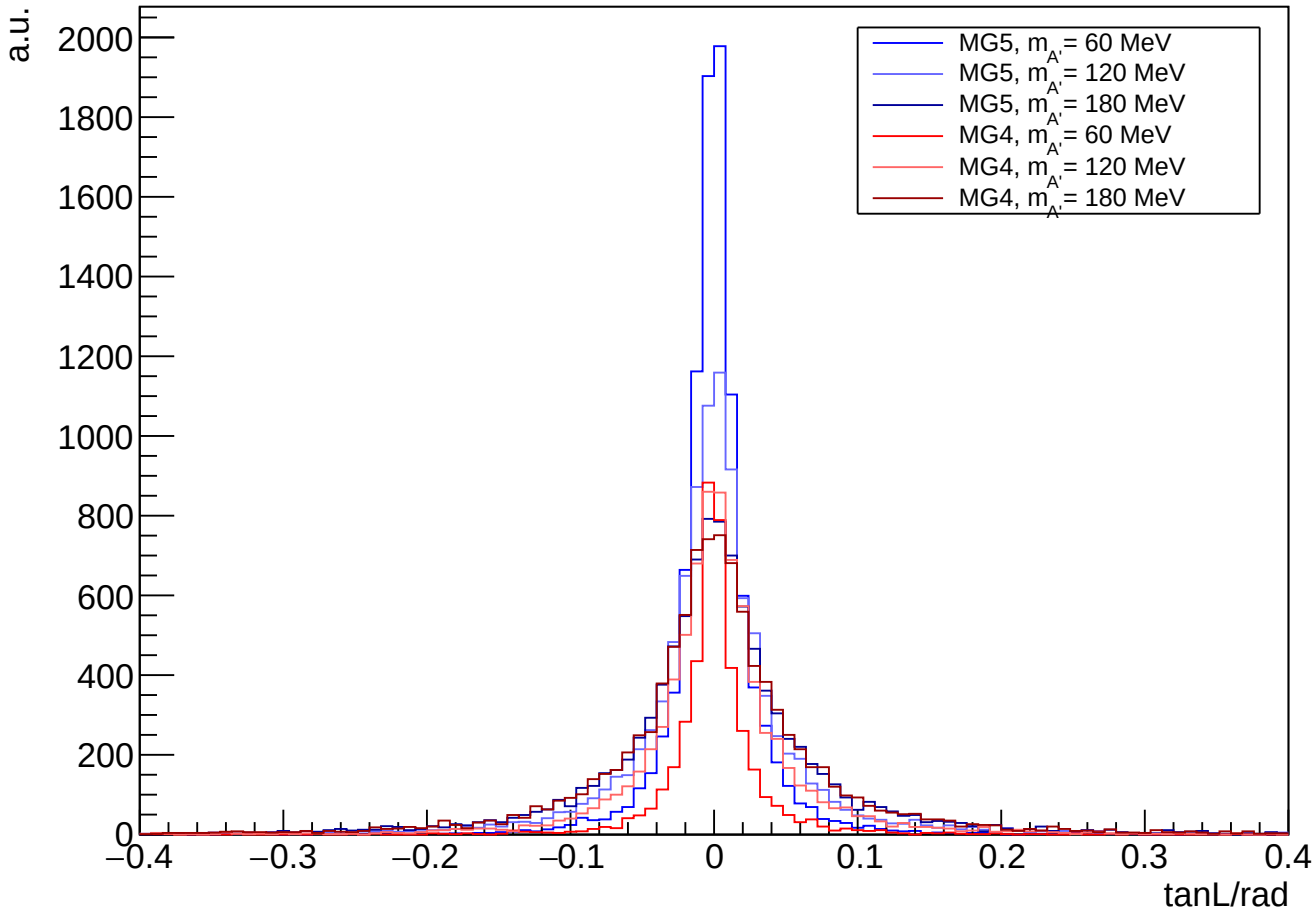
Electron energy





- Beam electron
  - More events for MG5, same shape
- Vertex electron
  - More events for MG5, same shape

Positron tanL



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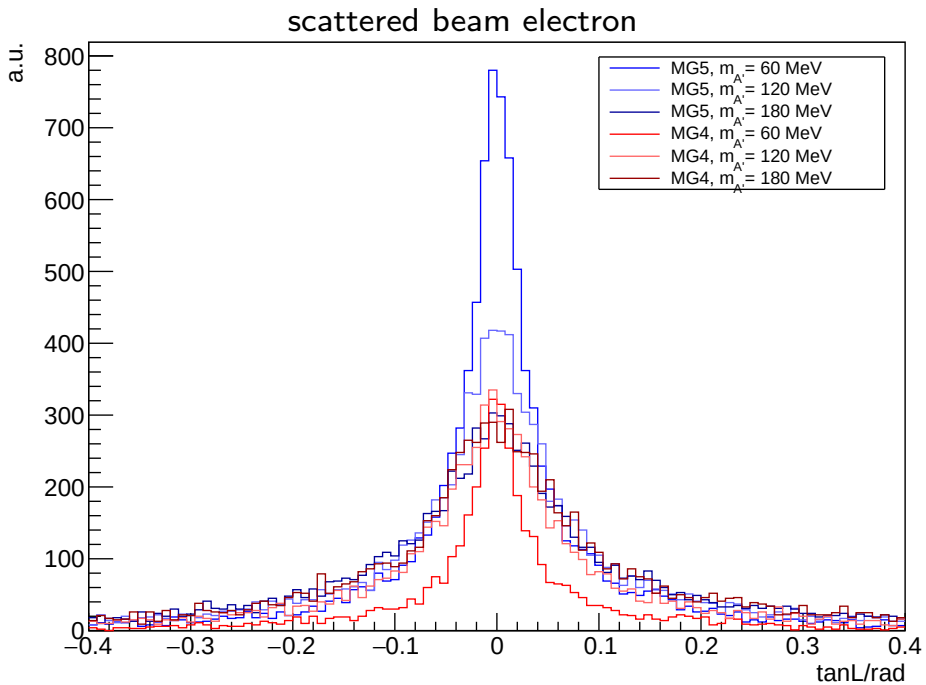
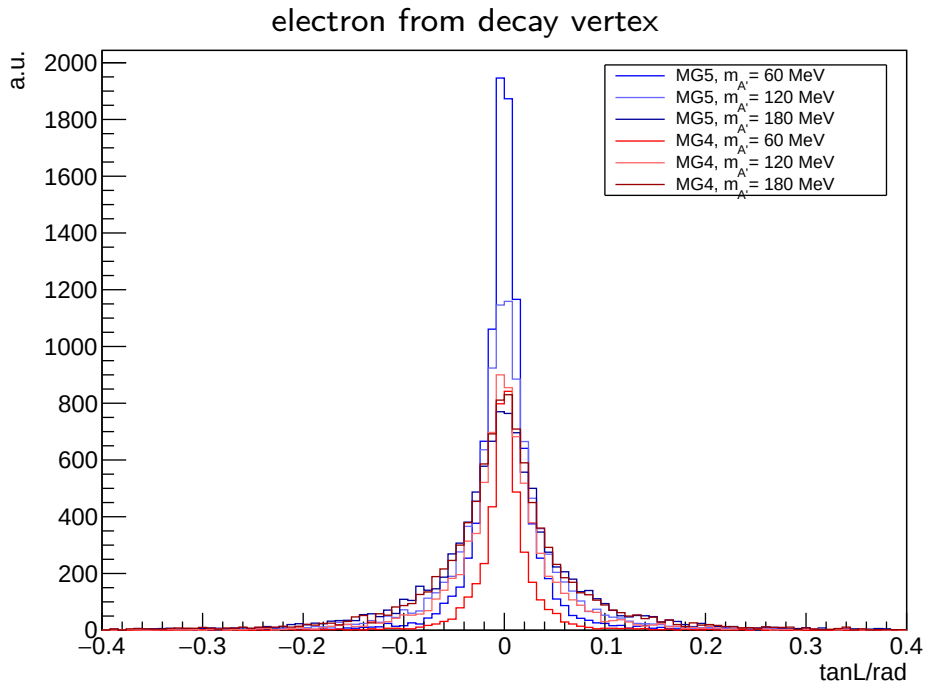
- More events for MG5, same shape

Electron tanL





- Beam electron
  - More events for MG5, same shape
- Vertex electron
  - More events for MG5, same shape