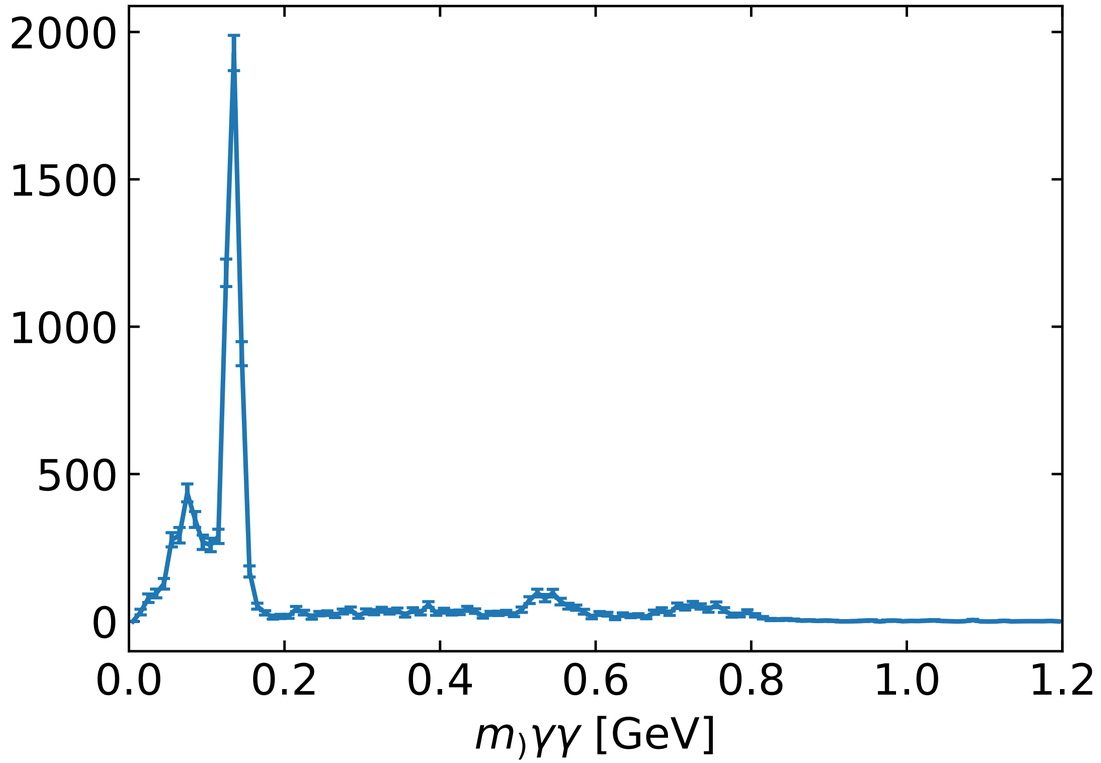
Diphoton Cut Optimization

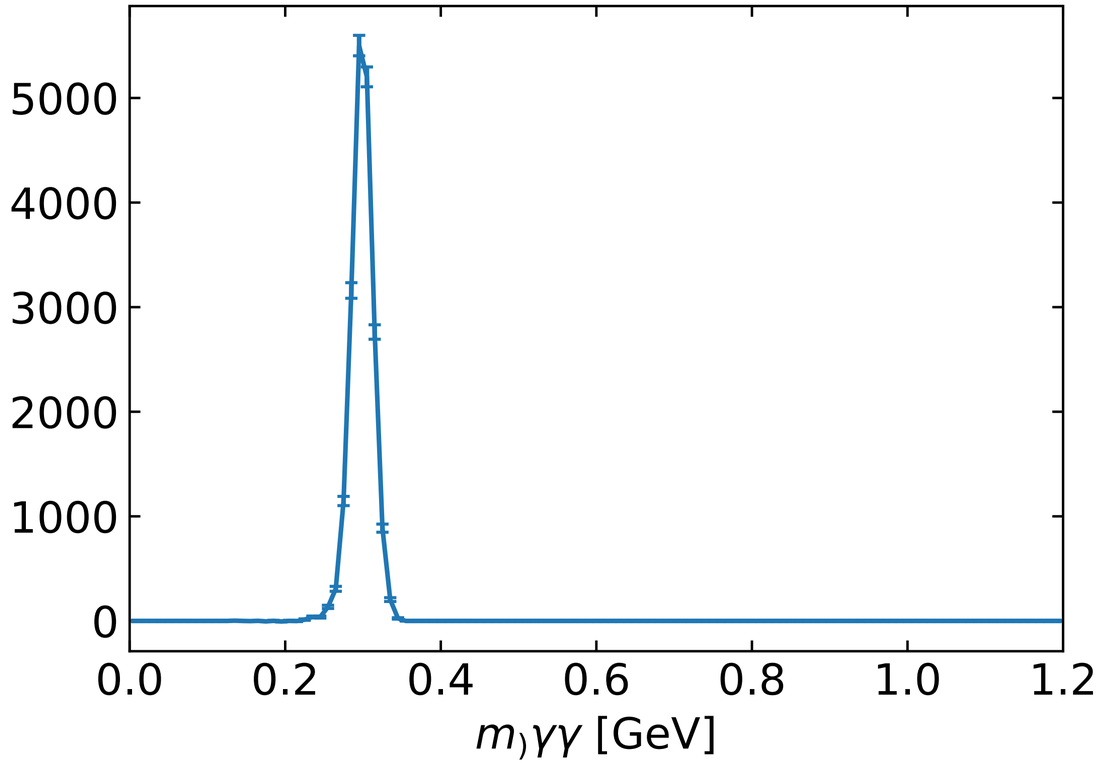
Jackson Pybus

Objective: Maximize prominence of diphoton mass peak at a given ALP mass value

Data



Simulation, $m_{ALP} = 300$ MeV



Devising a Figure-of-Merit

- Bin our events in the diphoton mass $m_{\gamma\gamma}$
- Within a given mass bin i:
  - Number of signal counts S_i, background counts B_i
  - Noise level given by total Poisson count uncertainty $\sqrt{S_i + B_i + 1}$
  - Signal significance is given by signal-noise ratio: $z_i = \dfrac{S_i}{\sqrt{S_i + B_i + 1}}$
- Total signal significance over all bins is the sum: $Z = \sum_i z_i = \sum_i \dfrac{S_i}{\sqrt{S_i + B_i + 1}}$

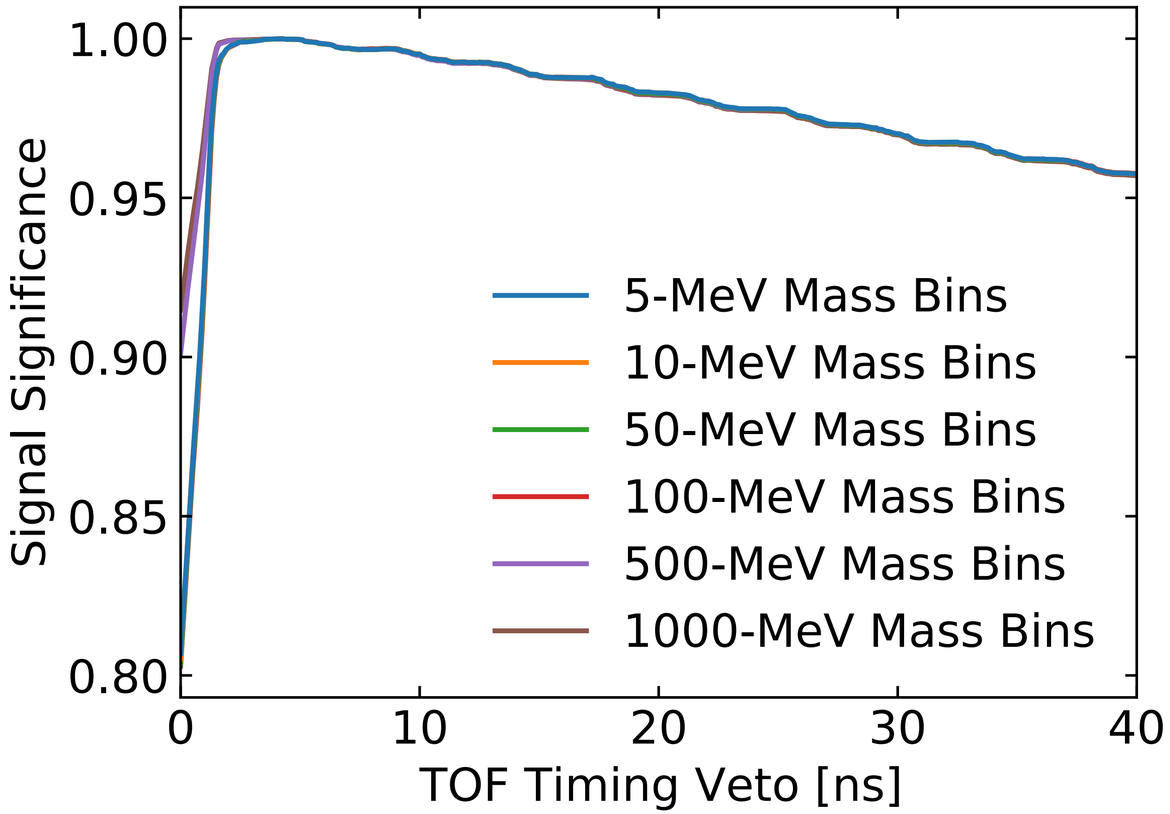
Devising a Figure-of-Merit

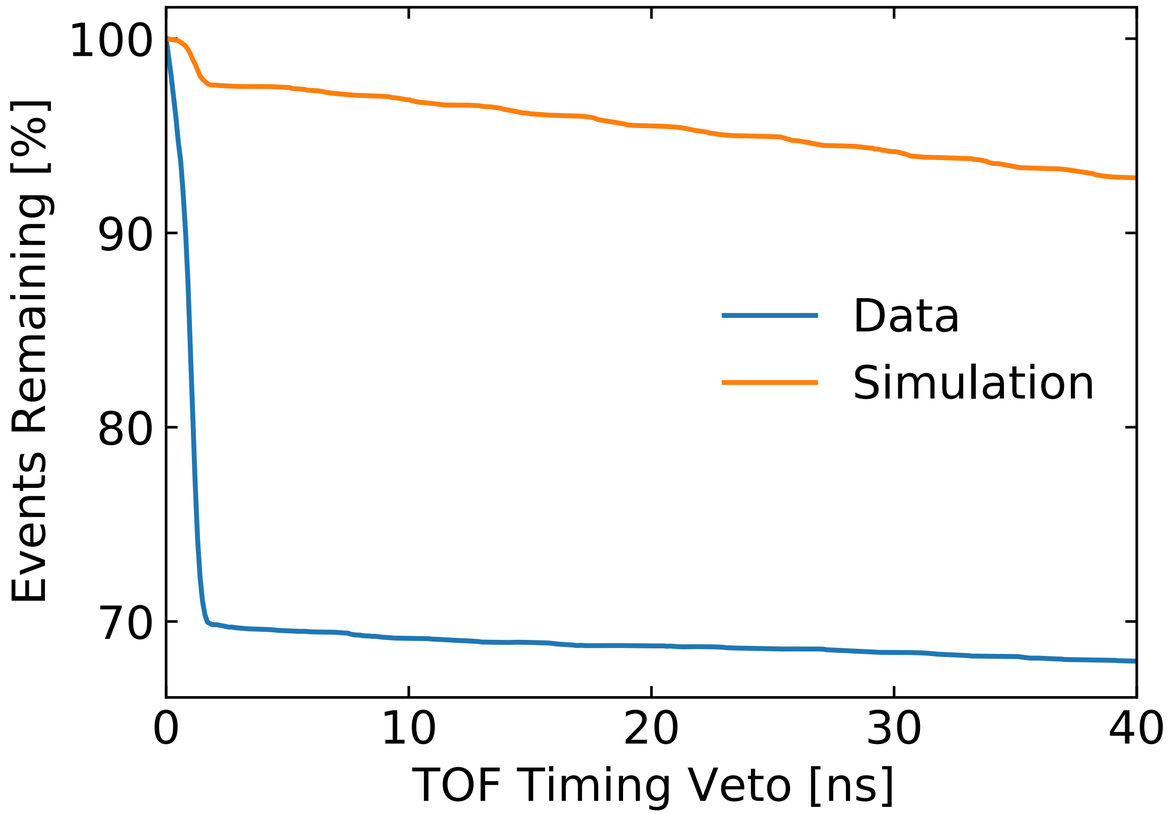
- We can compare:
  - Simulation count proportional to signal: $k_i = \mu S_i$
  - Data counts equal to signal + background: $N_i = S_i + B_i$
- We can combine these into a figure-of-merit proportional to the signal significance:

$$FOM = \sum_i \frac{k_i}{\sqrt{N_i + 1}} \propto \sum_i \frac{S_i}{\sqrt{S_i + B_i + 1}}$$

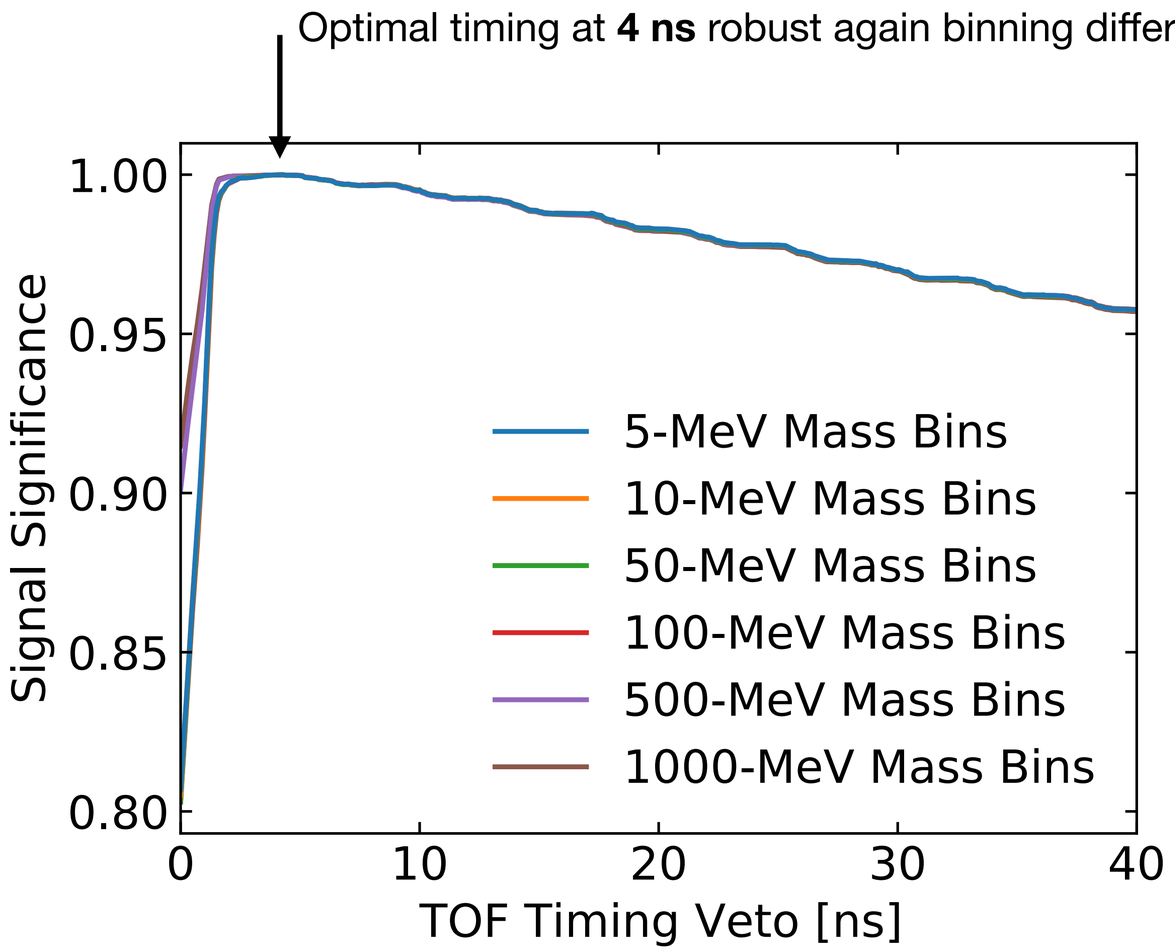
- Tested with small sample of data and simulation with $m_{ALP} = 300$ MeV

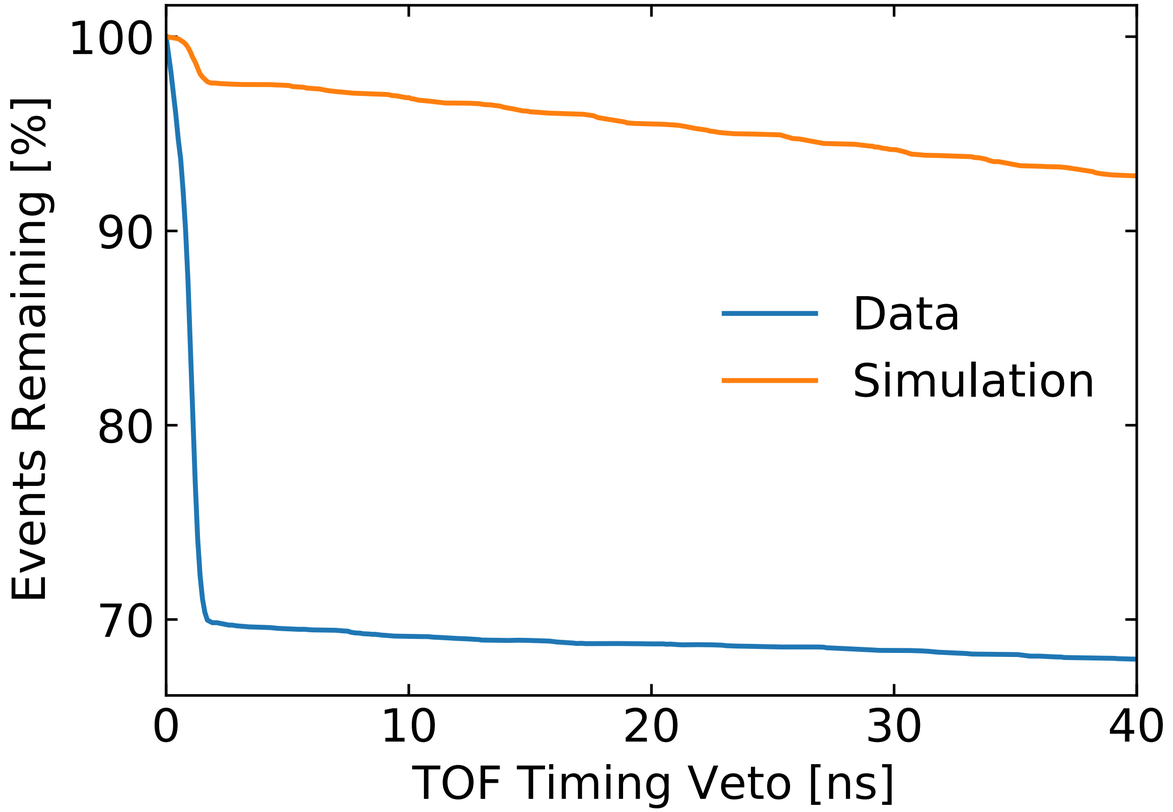
TOF veto timing window





TOF veto timing window





Track veto timing window