2016 Mass Resolution Re-Evaluation

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Background and Set Up

Re-Evaluate 2016 Mass Resolution

Due to a variety of simulation and reconstruction patches and updates.

- Signal samples generated and reconstructed by Cam
  - ▶ Added to sample list for Pass4b on confluence (▸ pass4b for 2016 MC)
- Applied momentum smearing with hpstr
  - ▶ Code in (▸ hpstr PR 187)
- Plotted and fit in notebook
  - ▶ Selecting vertices whose tracks have been strictly matched to truth-level "rad" electrons (i.e. not contaminated with recoil electrons)
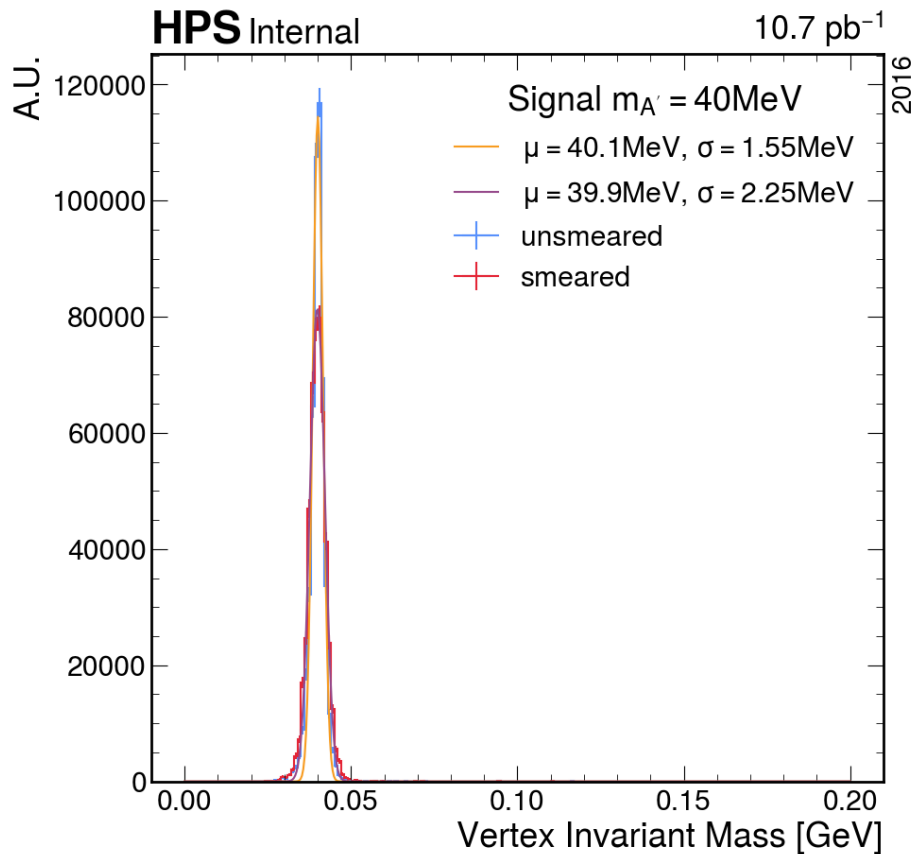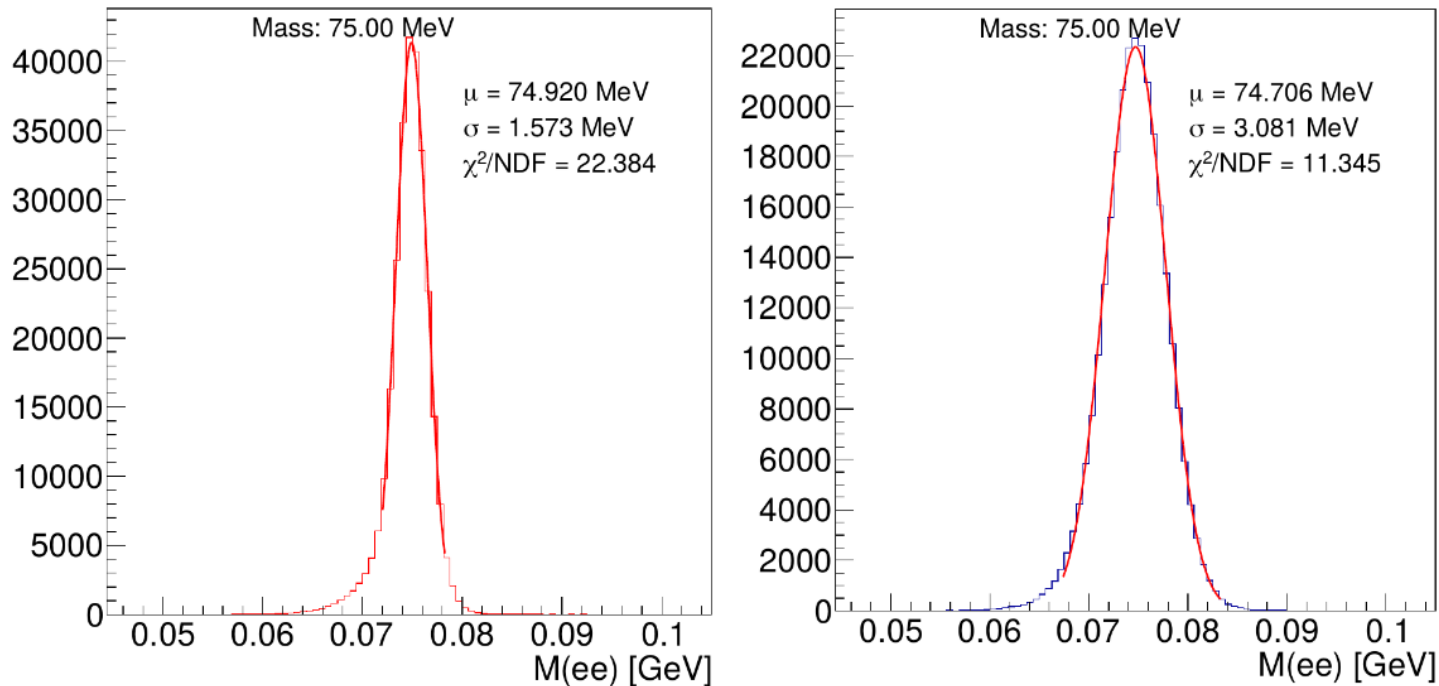
- Both smeared and unsmeared histograms show normal behavior
- Normal distributions fit well
- Resulting resolution σ closest to previously estimated by Rafo
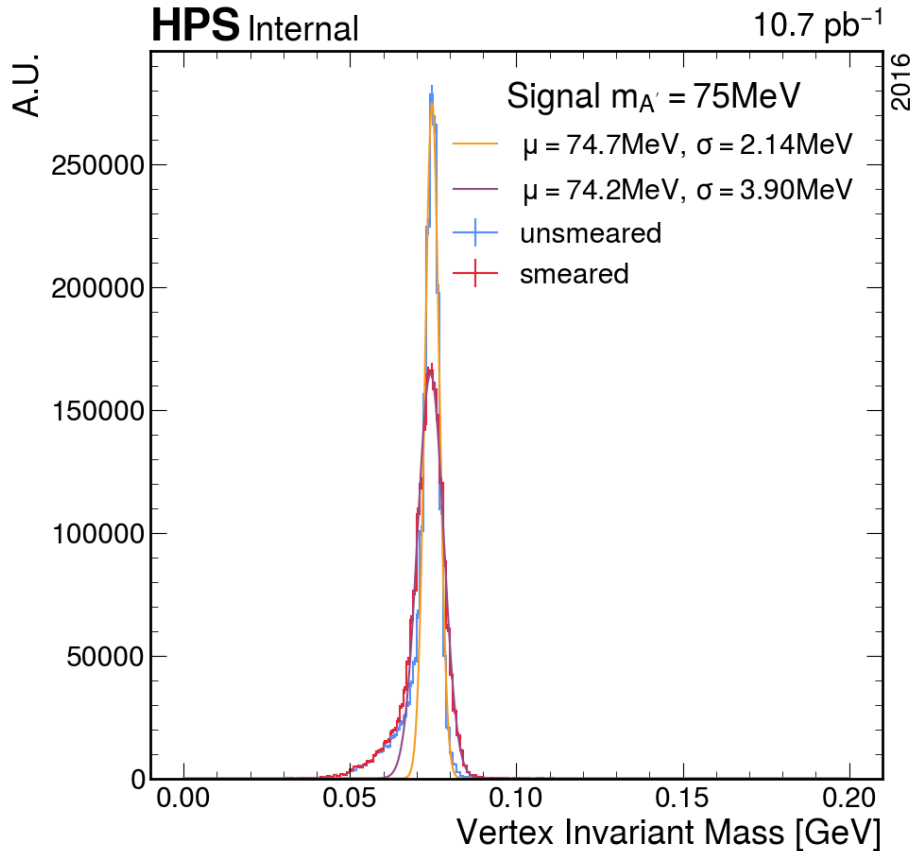
- Both smeared and unsmeared histograms show elongated low-side tail
  - ▶ Probably means issue with selection and not with smearing itself
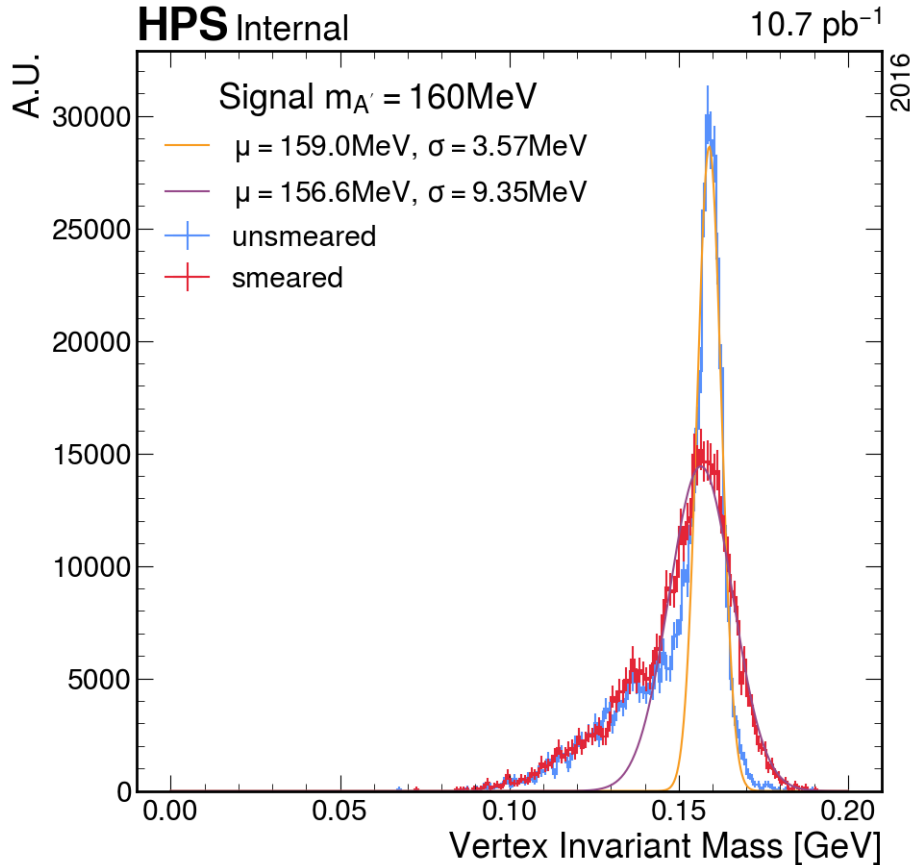- Resulting resolution σ deviating more from previous estimate

Figure 28: Mass distribution for 75 MeV A′ MC. Left: unsmeared mass, right: smeared mass

Looks like fit is restricted to mass peak (which makes sense and is something I am also doing)

Figure: From Rafo's 2016 Bump Hunt Internal Note end of Section 4.

HPS Internal   10.7 pb^{-1}

Signal $m_{A'}$ = 160MeV
- μ = 159.0MeV, σ = 3.57MeV
- μ = 156.6MeV, σ = 9.35MeV
- unsmeared
- smeared

- ■ Both smeared and unsmeared histograms large low-side tails
  - ▶ Still an issue with selection
- ■ Normal distributions not easily fitting peak
- ■ Resulting resolution σ far from previous estimate
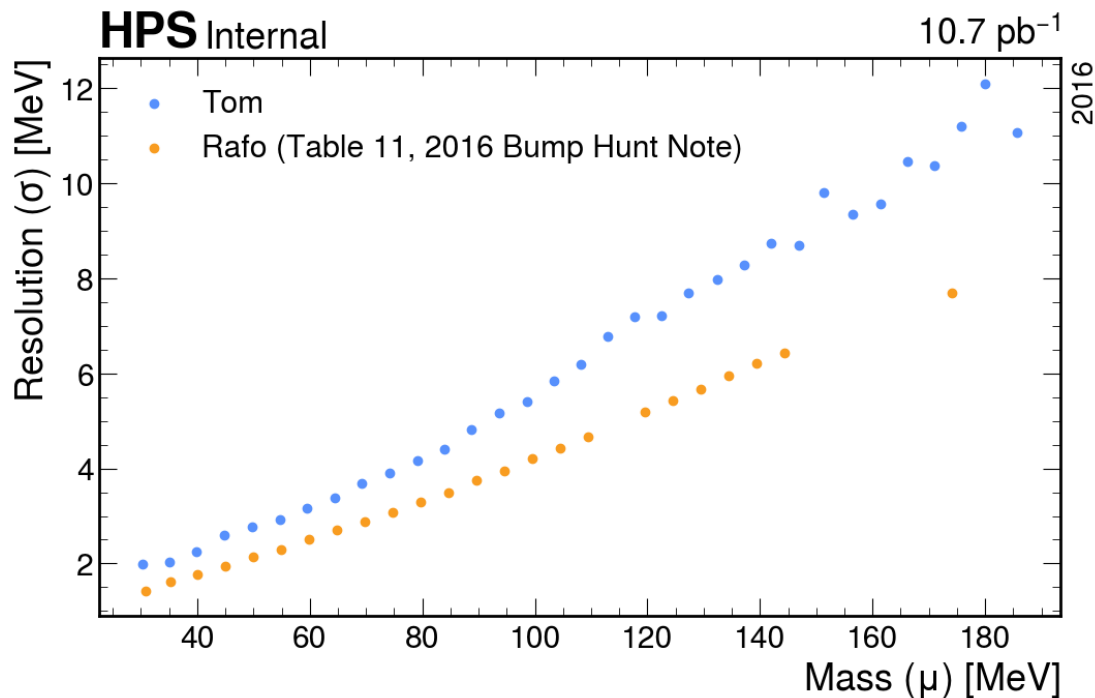
- Able to use newer generated samples to produce mass resolution estimates including track smearing
- Observing slight worsening in resolution (increase in σ) compared to previous estimate

Questions

Goal : Center (mean μ) and Width (std dev σ) of peak

Two stage process

1. Find Peak

Iterative approach

1. Calculate μ and σ from the bins
2. Remove bins further than $N\sigma$ away from μ
3. Repeat until stable (i.e. no bins are being removed)

For the results here, I chose $N = 2$.

2. Fit Normal Distribution

- Actually fitting a "scaled" normal distribution which is just a normal distribution multiplied by some scale (basically ends up being the integral of the fit range if fit is good).
- Only fitting to the range of bins selected in Stage 1 above.
- Using uncertainty on bin content as errors of data points in fit.
- μ and σ taken from this fit.