2016 Mass Resolution Re-Evaluation

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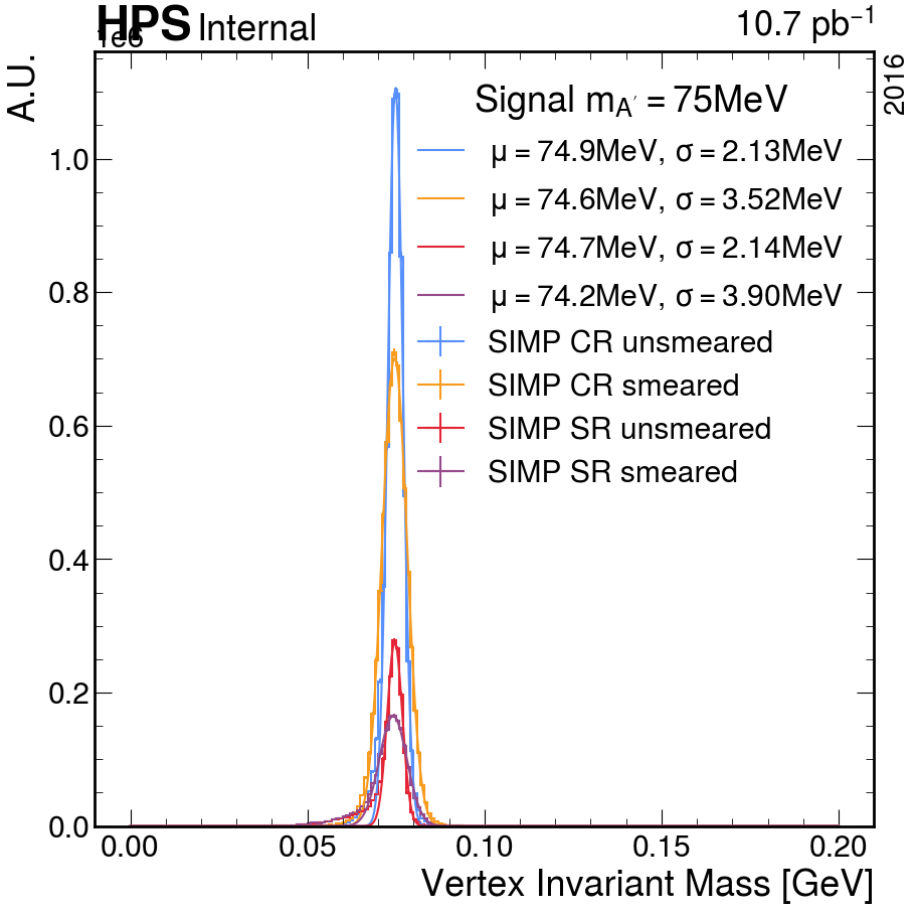
April 2, 2024

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)

More Similar Selection



- Reduction in low-side tail distorting results
- Resulting resolution σ still deviating more from previous estimate, but at a much smaller scale

For Comparison

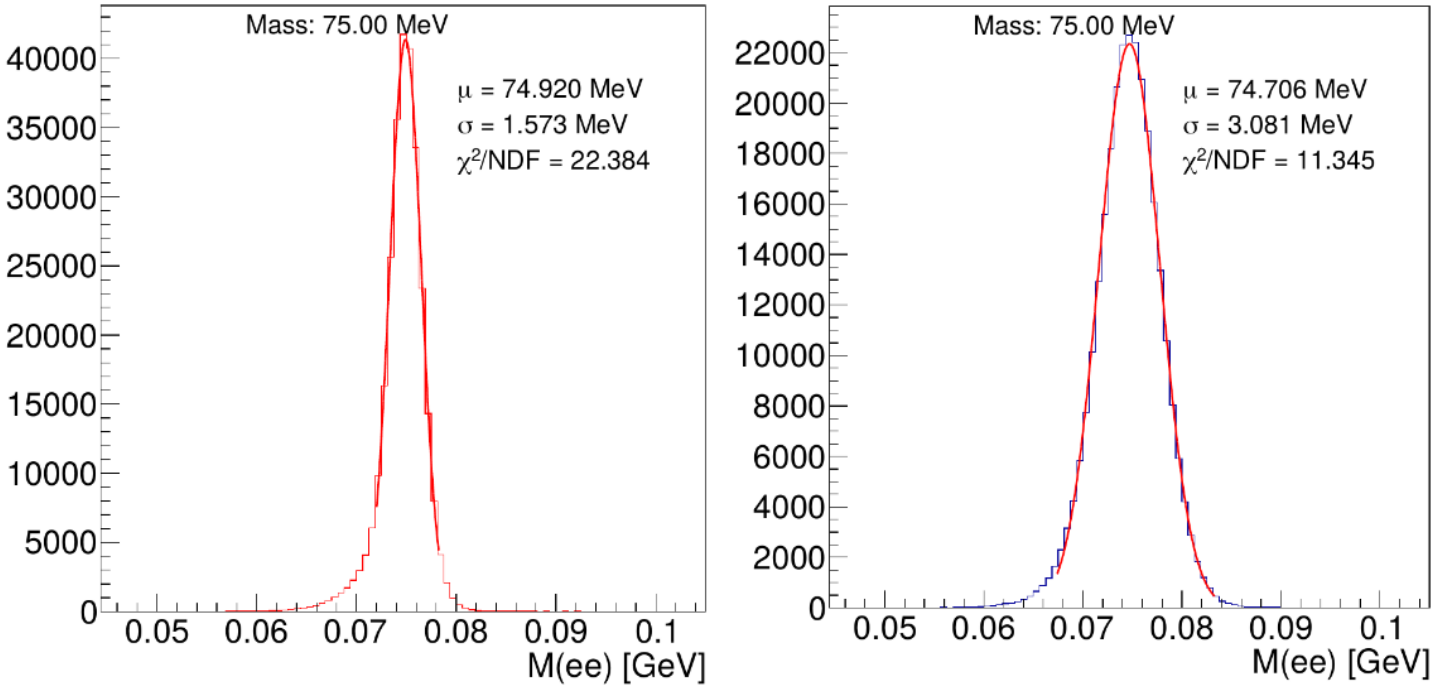
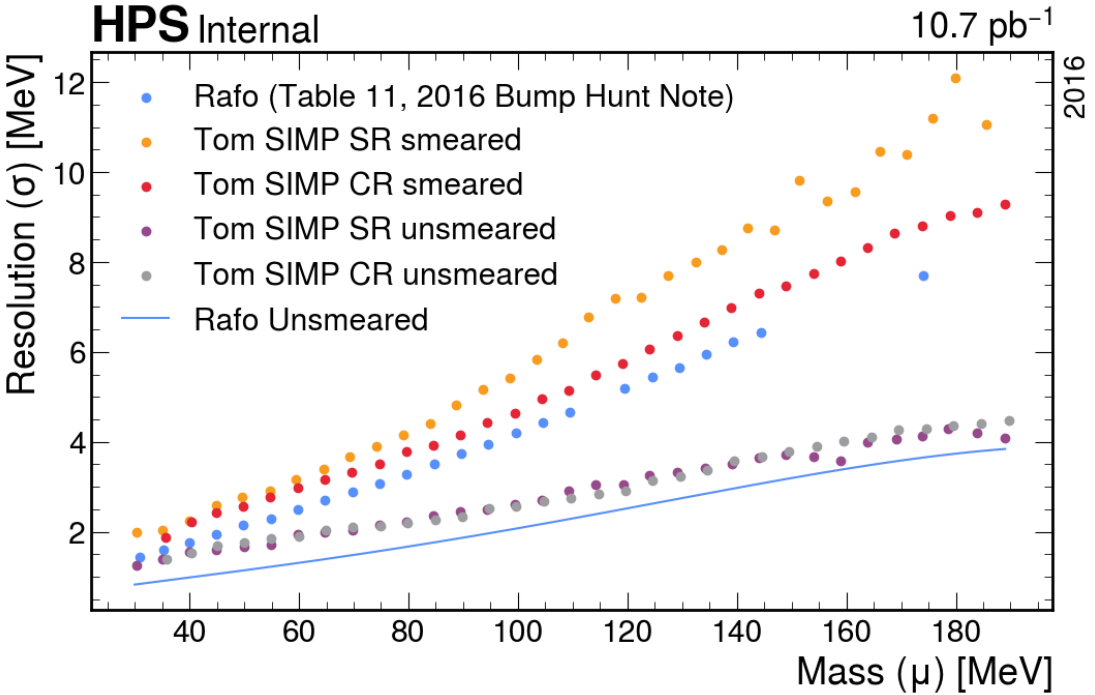


Figure 28: Mass distribution for 75 MeV A′ MC. Left: unsmeared mass, right: smeared mass

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.

Summary



- 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

How I evaluated the resolution

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 $N = 2$.

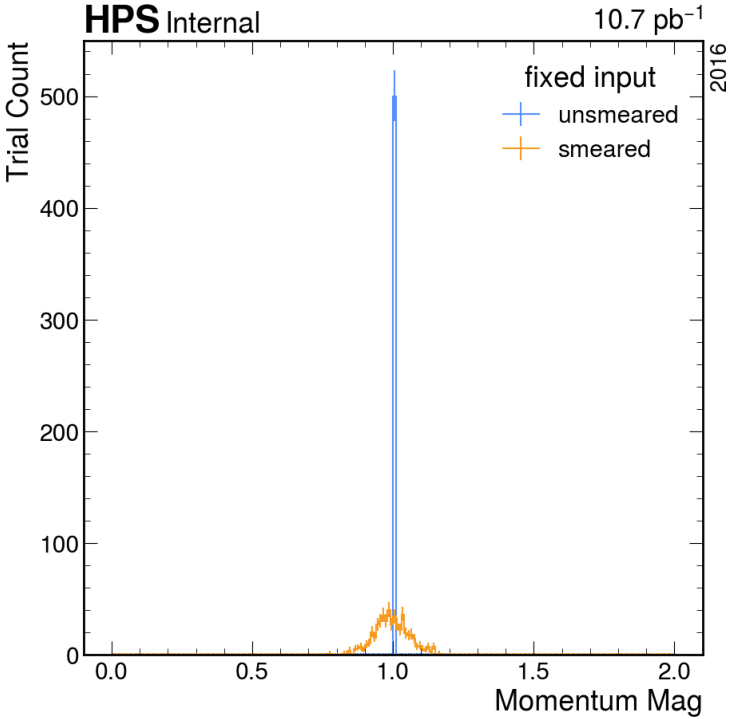
2. Fit Normal Distribution

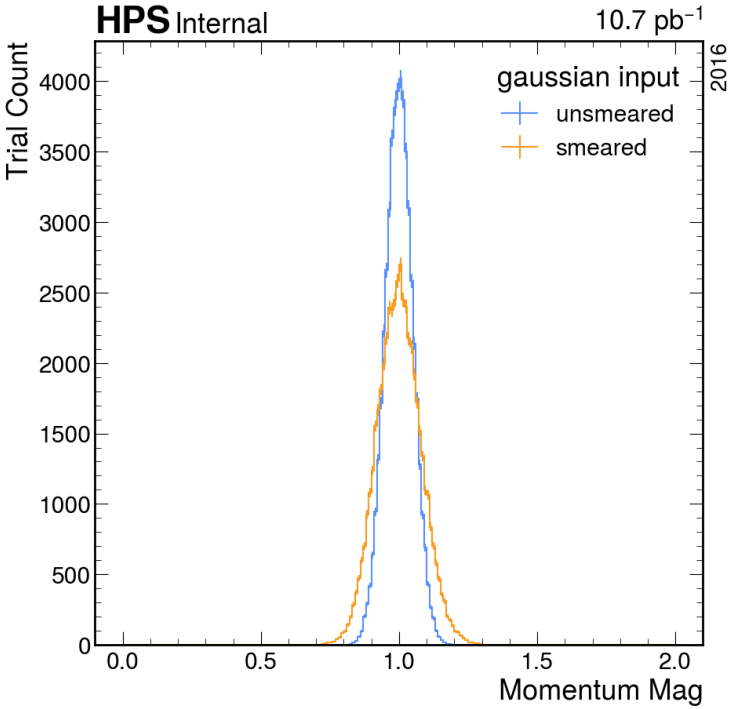
- Actually fitting a "scaled" normal distribution which is just a normal distribution multiplied by some scale (basically ends up being the integral of the fit range if fit is good).
- Only fitting to the range of bins selected in Stage 1 above.
- Using uncertainty on bin content as errors of data points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

Direct Testing of Smearing Tool

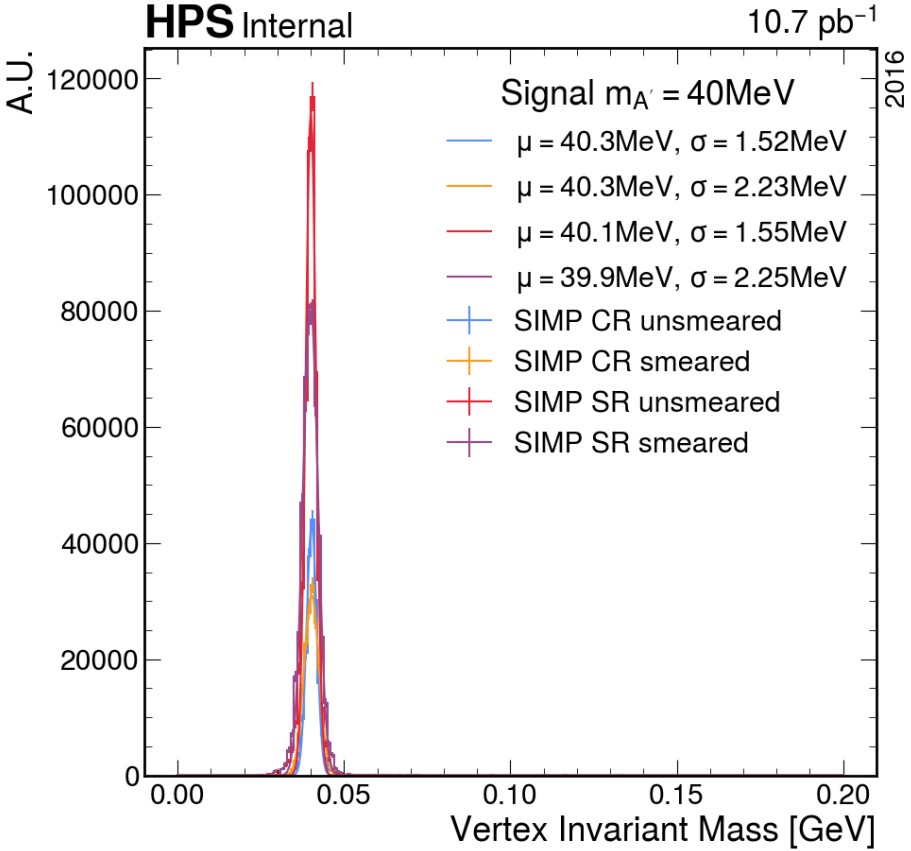
Manually constructing tracks with known input momenta and then applying smearing.

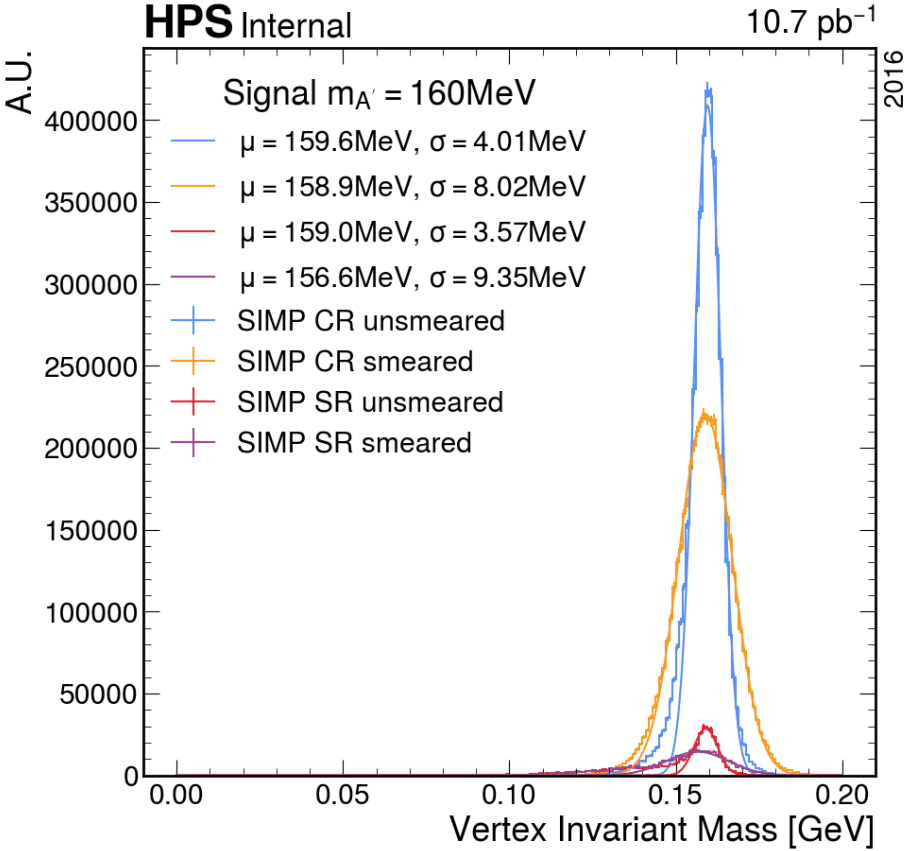
✓ Get expected results ✓





Mass Extrema





Selection Comparison

Not thoroughly checked!!

SIMP CR

1. L1 Requirement
2. $P_{\text{sum}} > 1.9$ GeV
3. Electron matched to truth rad electron
4. Single Vertex Candidate

SIMP SR

1. L1 Requirement
2. $P_{\text{sum}} < 1.9$ GeV
3. $P_{\text{sum}} > 1.0$ GeV
4. Electron matched to truth rad electron
5. Single Vertex Candidate

Rafo Tables 4 and 7

1. Preselection
   - $\chi^2 < 12$, Goodness of PID < 10, cluster-track time diff < 6 ns for both tracks
   - Electron track has $P < 2.15$ GeV
2. $P_{\text{sum}} < 2.4$ GeV
3. $P_{\text{sum}} > 1.9$ GeV
4. $|\Delta t_{\text{cluster}}| < 1.43$ ns
5. Single Vertex Candidate