

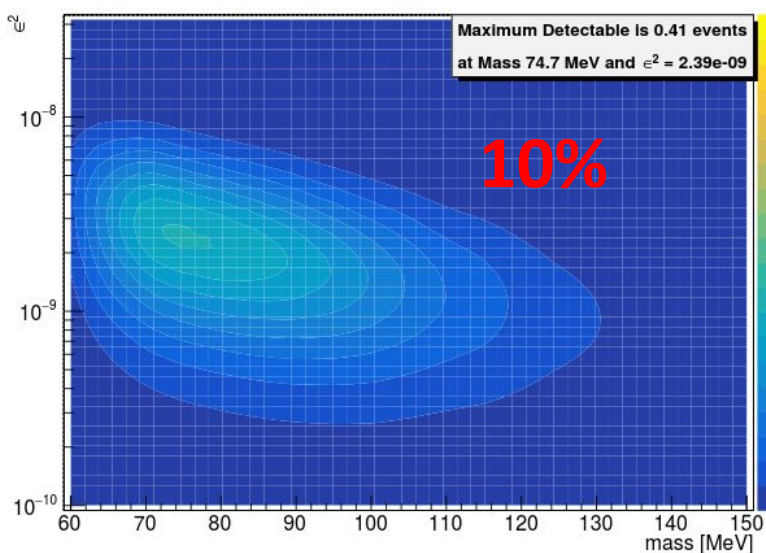
# Unblinded 2016 L1L1 Vertexing Analysis

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June 17, 2020

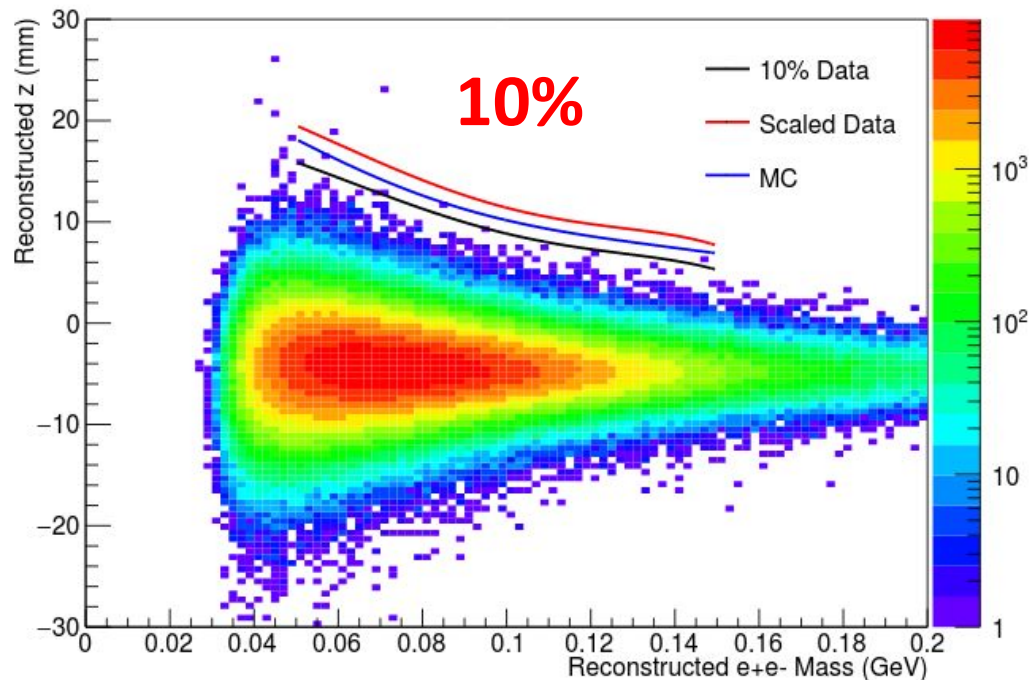
- The 2016 Displaced Vertexing Analysis L1L1 subset has been unblinded
- Results are reasonable and generally consistent with projections
  - However, there are still a few things to think about...
- What can we claim and what do we want to show in the next ~2 weeks?
- There is more work to be done with this dataset - understanding high  $z$  backgrounds, systematics, testing for signal, etc.
- In order to get the “complete” picture, there is more work to be done with L1L2, L2L2, and SIMPs

# Projected Results from 10% Data

Expected A' Rate L1L1 Data 10% Scaled



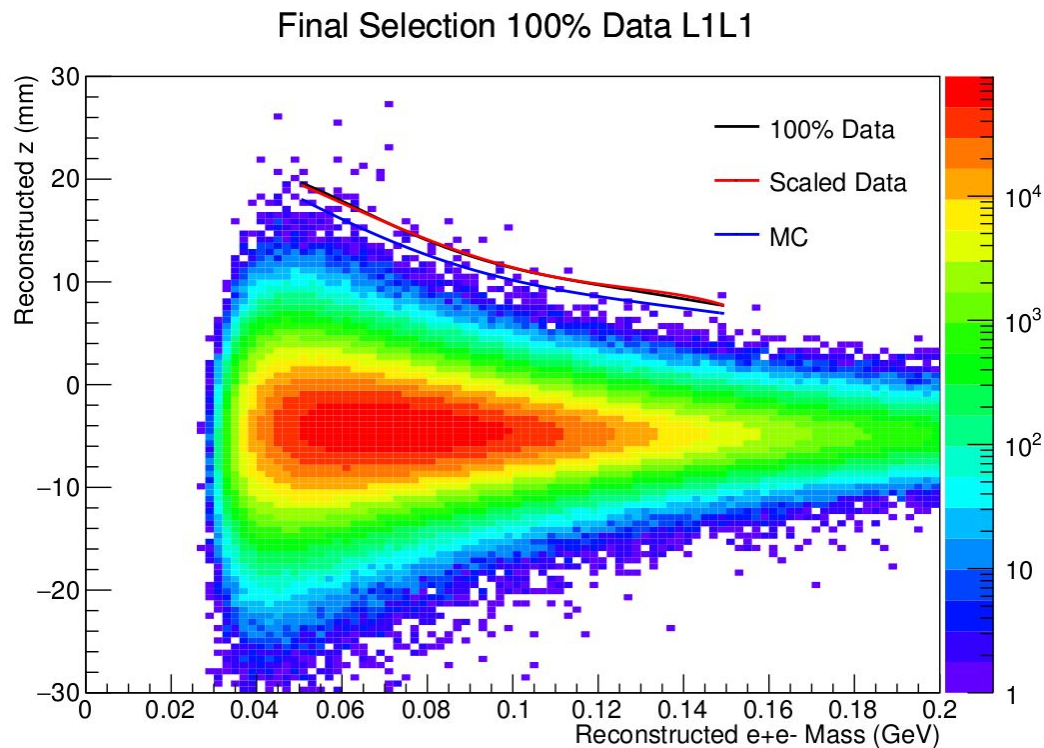
Final Selection 10% Data L1L1



\*Projections include the latest radiative fraction correction

# Final Selection 100% Data L1L1

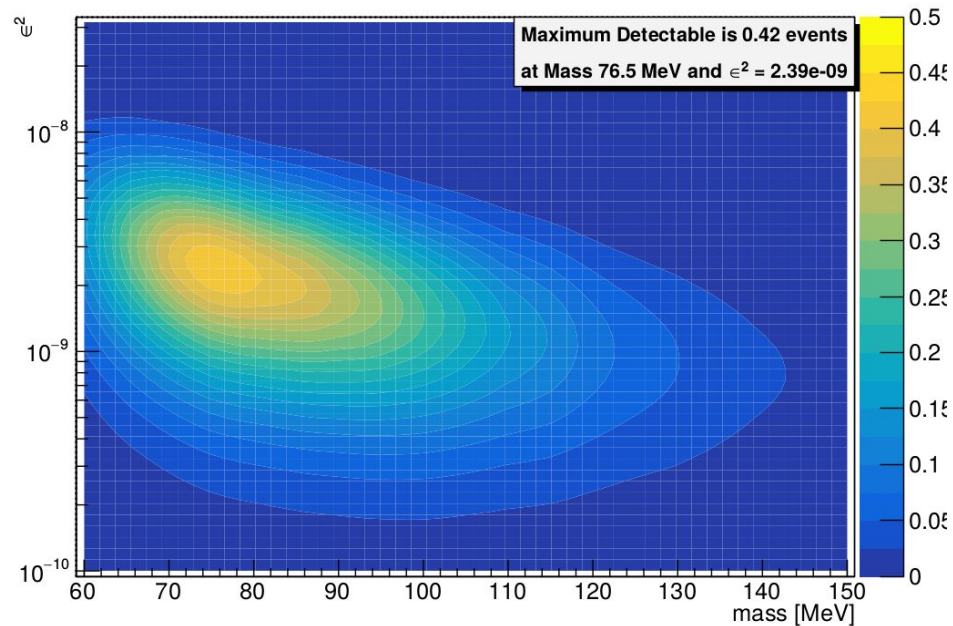
- Final zcut agrees remarkably well with projected zcut
- Zcut tends to undershoot at low mass and overshoot at high mass
- Larger number of events at lower mass (these bins are always trickier)
- A few mass bins warrant a closer look ( $\sim 60 - 70$  MeV), though I don't think this is a signal for several reasons



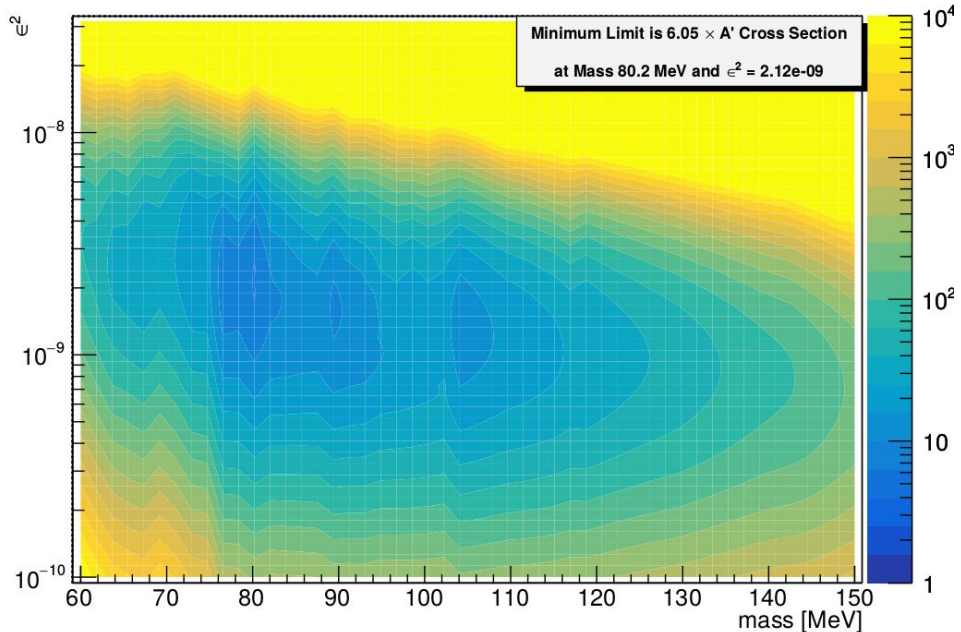
# 2016 Displaced Vertexing Final Results L1L1

- Peak of **0.42 expected  $A'$  events** and optimal limit of  **$6.05 \times A'$  Cross-section**
- Expected  $A'$  rate agrees remarkably well with projections, since zcut was so

<sup>close</sup>  
Expected  $A'$  Rate L1L1 Data 100%



OIM Scaled Limit L1L1 Data 100%

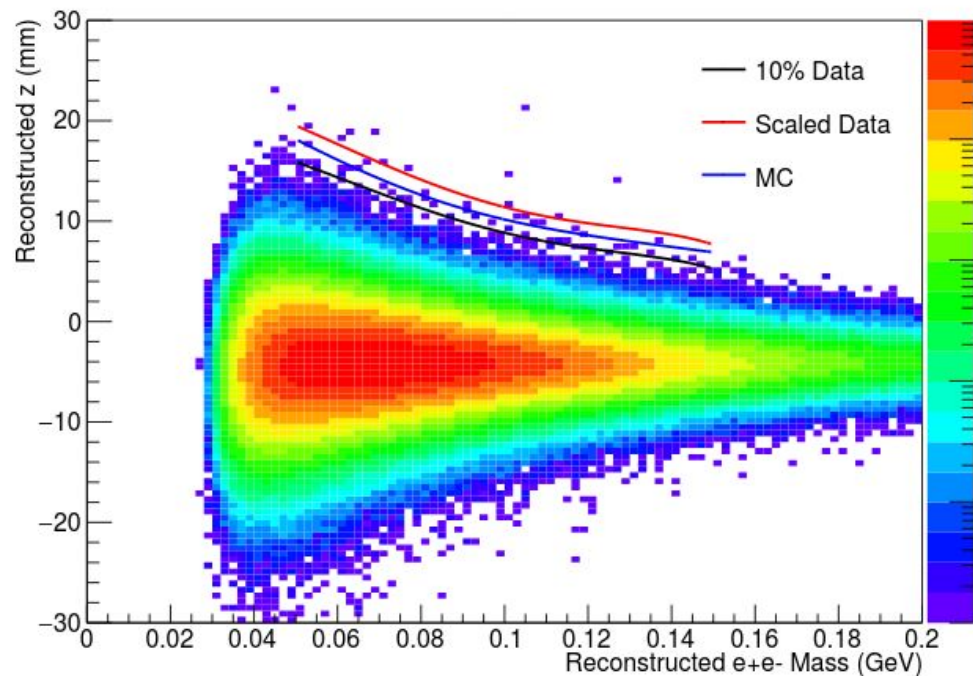




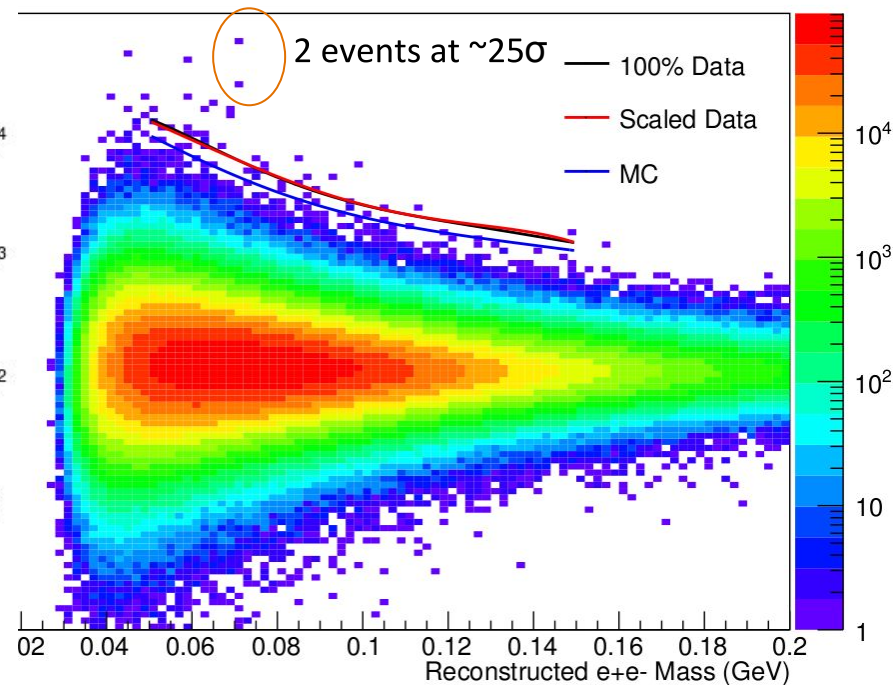
# Final Selection 100% Data Comparison to MC L1L1

SLAC

## Final Selection 100% tritrig-wab-beam



## Final Selection 100% Data L1L1



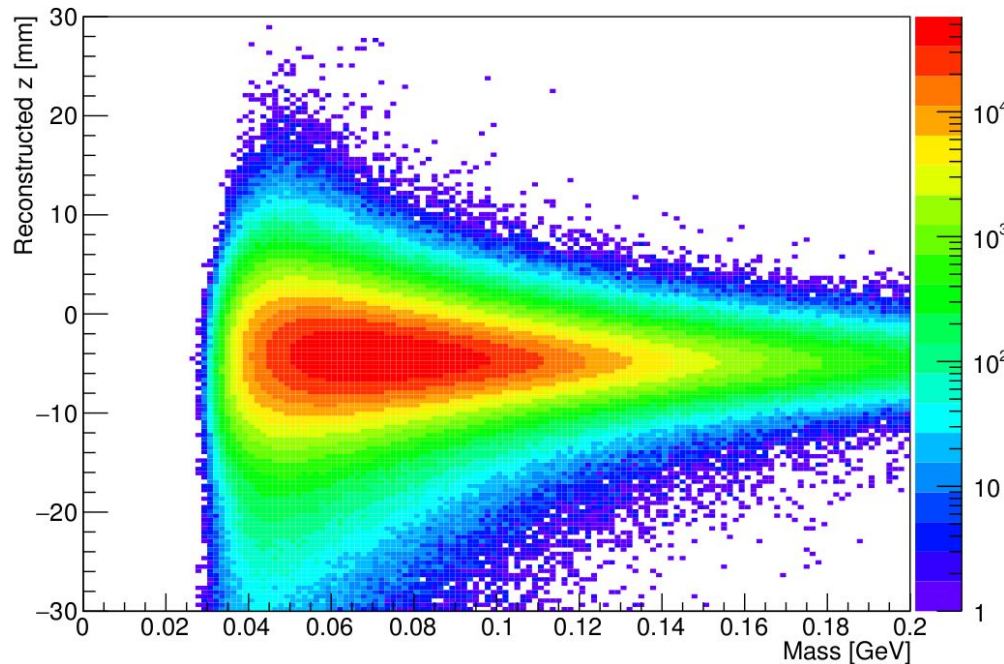
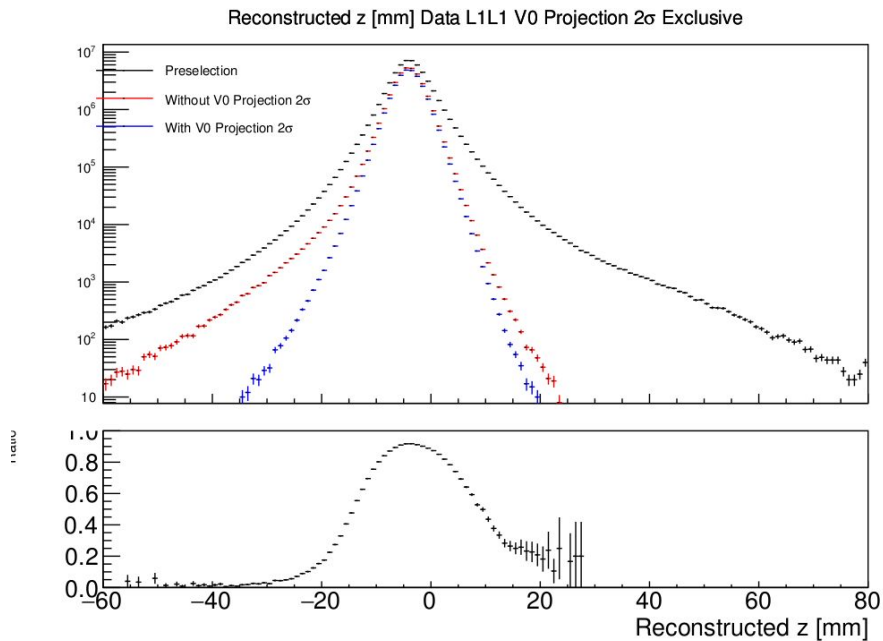
# How Well Did the Tight Cuts Work?

- Was each tight cut effective?
- I can't evaluate the layer requirements or the radiative cut since we must remain blinded
- Look at the 1D  $V_z$  and 2D  $V_z$  vs Mass  $n-1$  plots for of the remaining cuts
  - $V_0$  Projection to target
  - Isolation Cut
  - IP Cut
- Preliminary analysis shows that each of these cuts was successful

Cut Description	Requirement
Layer 1 Requirement	$e^+$ and $e^-$ have L1 hit
Layer 2 Requirement	$e^+$ and $e^-$ have L2 hit
Radiative Cut	$V_{0p} > 1.85$ GeV
$V_0$ projection to target	Fitted $2\sigma$ cut
Isolation Cut	Eq. 7
Impact Parameters	Eq. 10

# V0 Projection to the Target

## Vz vs Mass V0 Projection 2 $\sigma$ Exclusive

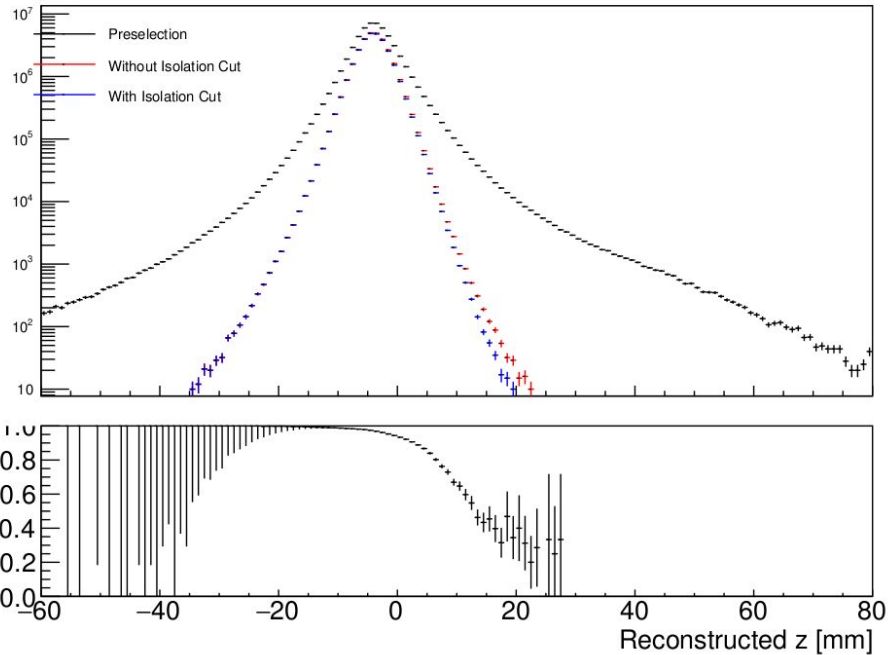




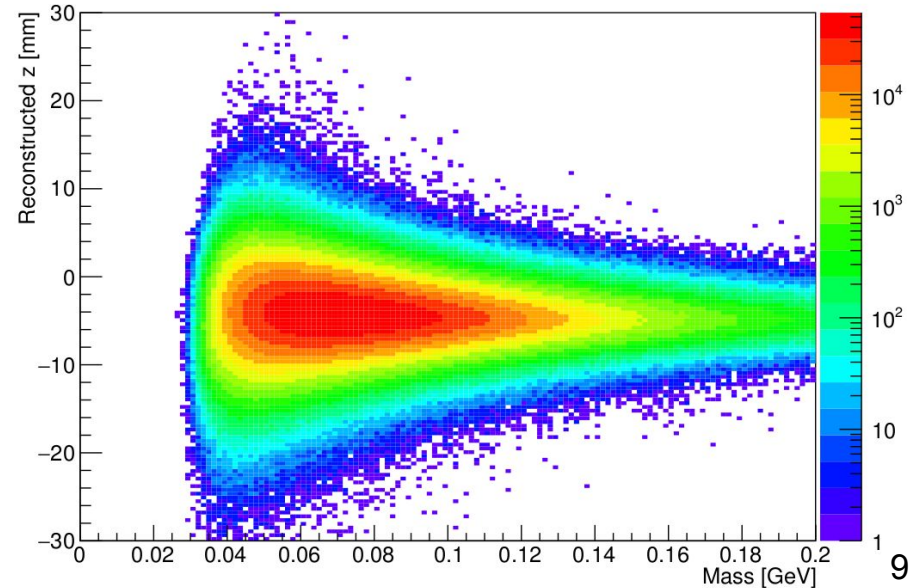
# Isolation Cut

- There is no evidence of high  $z$  events due to mistracking
  - This is a success from 2015 analysis, but I cannot exclude hit efficiency effects

Reconstructed  $z$  [mm] Data L1L1 Isolation Cut Exclusive

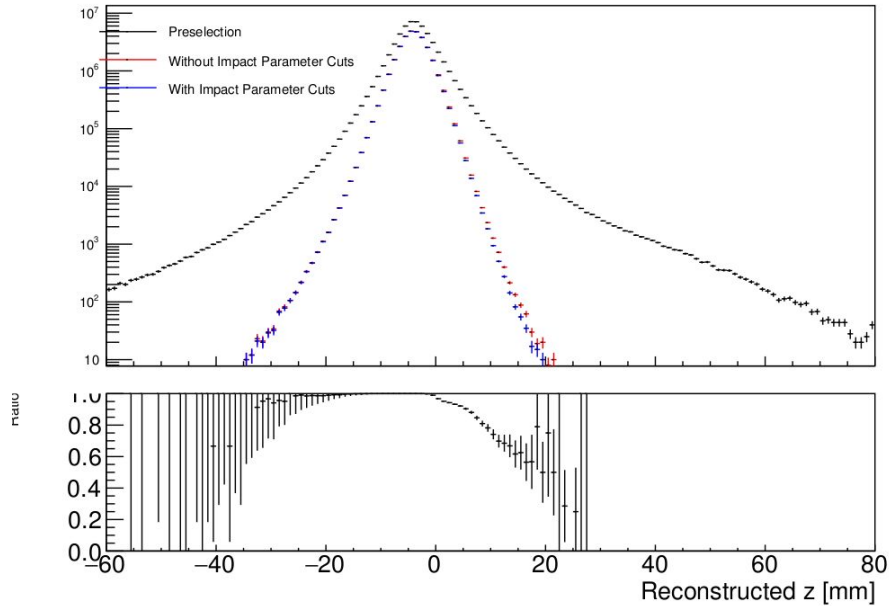


$V_z$  vs Mass Isolation Cut Exclusive

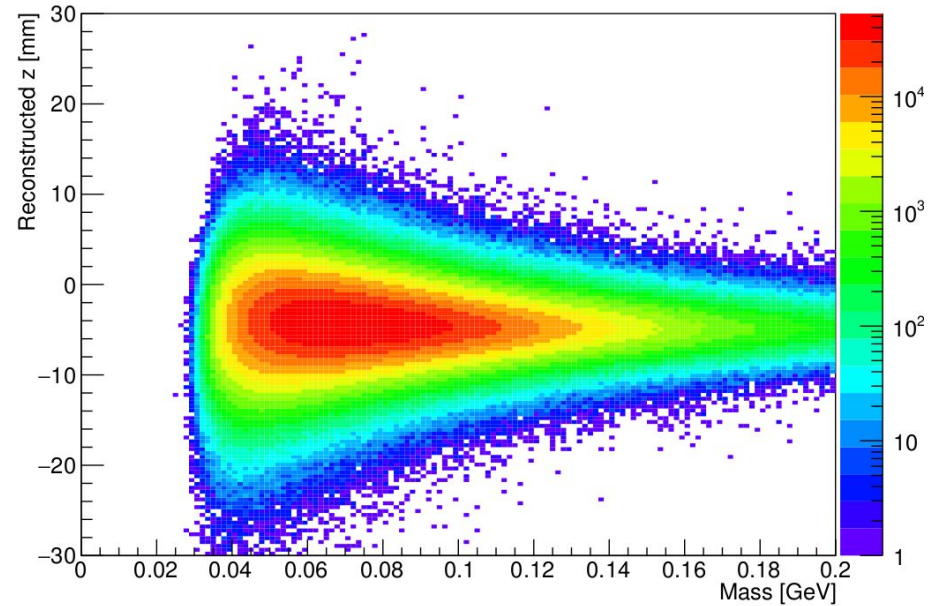


# Impact Parameter Cuts

Reconstructed z [mm] Data L1L1 Impact Parameter Cuts Exclusive



Vz vs Mass Impact Parameter Cuts Exclusive



# Preliminary Look at High Z Events

$\Delta z_{cut}$	VZ (mm)	Mass (MeV)	Run	Event	$\chi_{unc}^2$	V0 Proj Y ( $n_\sigma$ )	VY ( $n_\sigma$ )	$\Delta e^- z_0$ (mm)	$\Delta e^+ z_0$ (mm)
0.08	12.62	89.95	7780	68384585	0.49	1.37	1.22	0.88	0.43
3.80	20.03	68.19	7781	138205858	4.63	0.28	0.55	0.74	1.10
3.54	15.05	98.57	7796	26862757	4.55	0.61	0.06	0.88	0.64
2.22	15.62	84.02	7800	134296298	8.65	0.68	1.04	0.90	0.60
0.32	11.12	105.89	7803	62089760	1.76	0.58	1.82	0.41	1.05
0.44	17.67	63.17	7803	105453502	8.55	0.65	0.18	0.84	0.74
0.28	13.62	84.37	7805	149492432	1.63	0.80	0.50	0.76	0.42
3.35	20.58	63.19	7947	47657629	2.25	1.78	0.54	0.78	1.26
0.50	17.12	66.21	7970	25752733	7.90	1.71	1.41	1.11	0.47
1.08	13.92	87.78	7988	97203933	1.92	0.79	0.17	1.03	0.66
7.75	23.33	71.48	8029	4393084	1.52	1.24	2.95	1.07	1.38
0.74	10.97	112.86	8040	62210614	2.24	0.78	0.51	0.71	0.43
11.74	27.27	71.71	8046	81085838	0.12	0.34	2.49	1.09	2.31
4.51	20.72	68.24	8055	9714720	0.13	1.08	3.61	0.67	1.25
2.24	14.27	93.91	8095	17884977	0.00	0.03	1.13	0.56	1.17

Table 24: A table of relevant variables for events past  $z_{cut}$  for 100% of the data in the L1L1

category.

\*Only includes high z events between 60 - 150 MeV

# Do We See Signal?

- Background possibilities - beam-gas interactions, **mistracking+inefficiencies**
- $A'$  rates are small, we do not expect to see an  $A'$  from the minimal  $A'$  model
- Can we say anything about  $A'$ -like models or generalized displaced vertices?
- Is there a signal lurking in any of these mass bins? Here are things to check:
  - Check details of high  $z$  events - seem consistent with what we know about the Coulomb tail from previous table
  - Check the various distributions in a mass bin (Checking distributions is actually tough since background could be mixed in)
    - Exponential  $V_z$  distributions
    - **$P$  sum distributions** - should be “peaked” at the beam energy if  $A'$ -like
    - Other distributions -  $V_x$ ,  **$V_y$** , Projection X, Projection Y, mass, **vertex quality**, etc.
- In my opinion, we should wait for the SIMP analysis to say anything about models beyond the minimal  $A'$  model





- All things considered, **this L1L1 analysis was a success!**
  - Improvement over the results from 2015 by a **factor of ~5**
  - New cuts were a significant improvement
    - Updated isolation cut shows **no evidence for high z events due to mistracking**
    - Impact parameter cut significantly reduced high z backgrounds and background tails
  - This analysis isn't over, we still have L1L2 and SIMPs to come
  - There is more to explore in a few mass bins of interest
- What do we want to show and what can we claim in the next ~2 weeks?
  - How does this help us with our projected 2019 sensitivity?
  - Can we claim the strongest limits in this phase space? Claim exclusions on an  $A'$ -like model with 10x the cross-section?