2016 Reach Estimate using 10% Data (Blinded)

Analysis Meeting 08/29/2023

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Introduction

- Deciding if 10% blinded SIMPs analysis is appropriate
- If yes, what are the rules?
- Show Reach Estimate using 10% data (blinded, **only looking at Control Region**)
- *Found bug in ctau units, fix improves expected signal
- ~22 Max Events Expected, wide range of sensitive A'/VD masses
- Discuss strategies for optimizing high-z cuts blinded

10% Data Reach Estimate – Components

From 2016 MC
Full Lumi
Reach Estimate

10% Data
Control Region
Reco Background Rate

Re-calculated as
$f(m_{VD},\varepsilon)$
Efficiency Vertex

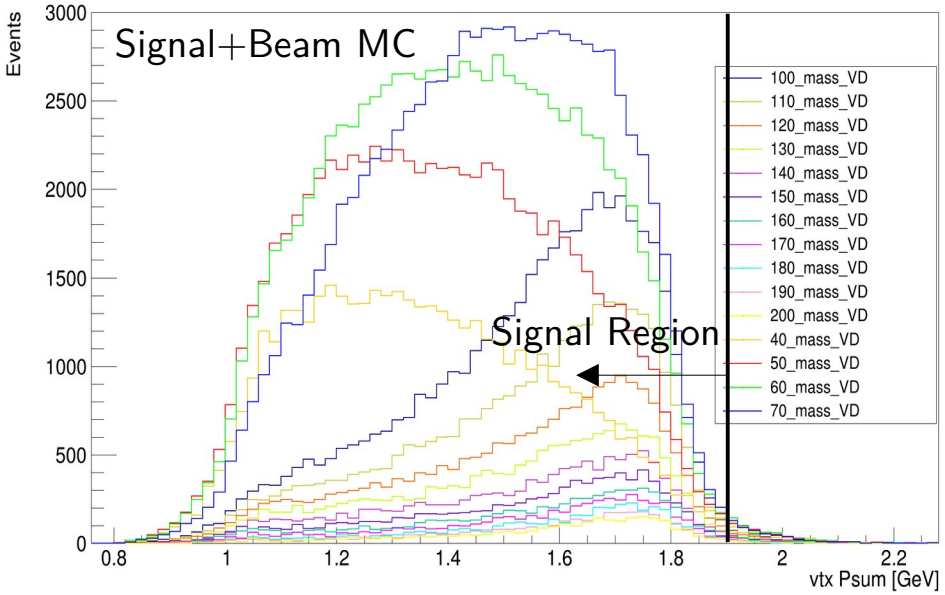
Radiative Fraction

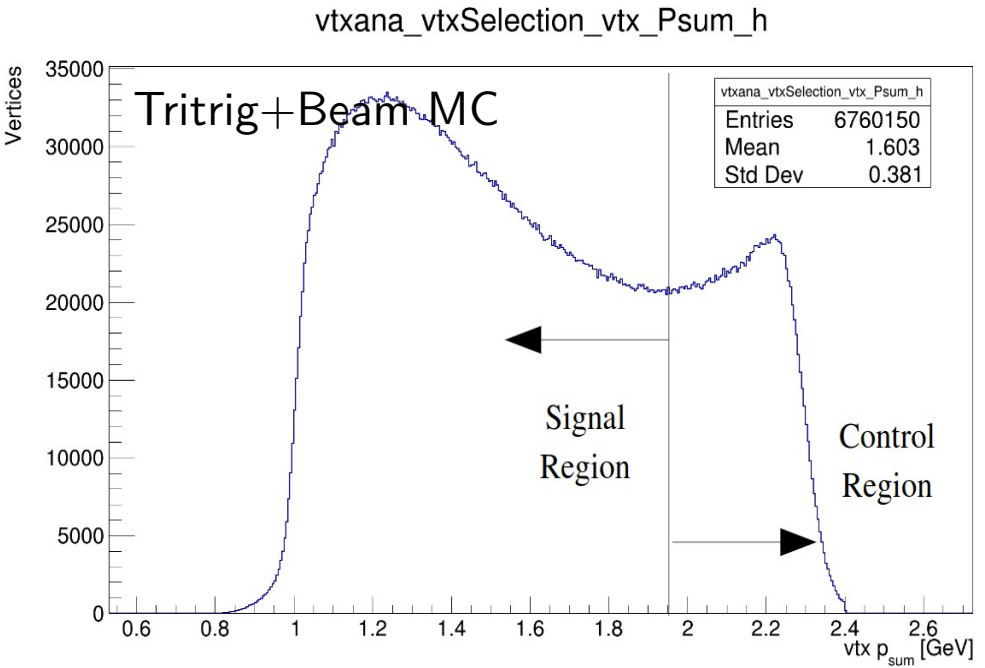
$$N_{A'sig} = \frac{3\pi m_{A'}\epsilon^2}{2N_{eff}\alpha}\frac{f_{rad}}{\zeta}\frac{dN_{CR}}{dm_{reco}}\Theta\int_{z_{tar}}^{\infty}\frac{exp^{(\frac{z_{target}-z}{\gamma c\tau})}}{\gamma c\tau}F(z)dz$$

Total Rad Acceptance

BR(A'→$V_D\pi_D$) and BR(V_D → e^+e^-)
Fixed

10% Data Reach Estimate – Signal/Control Regions

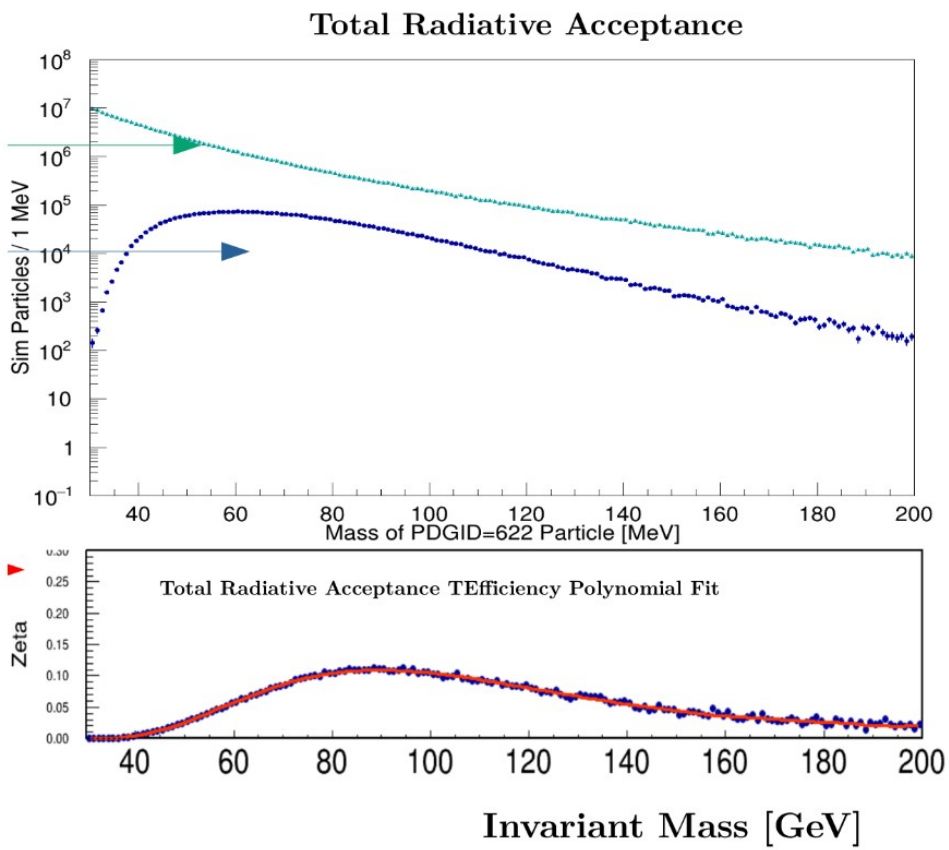


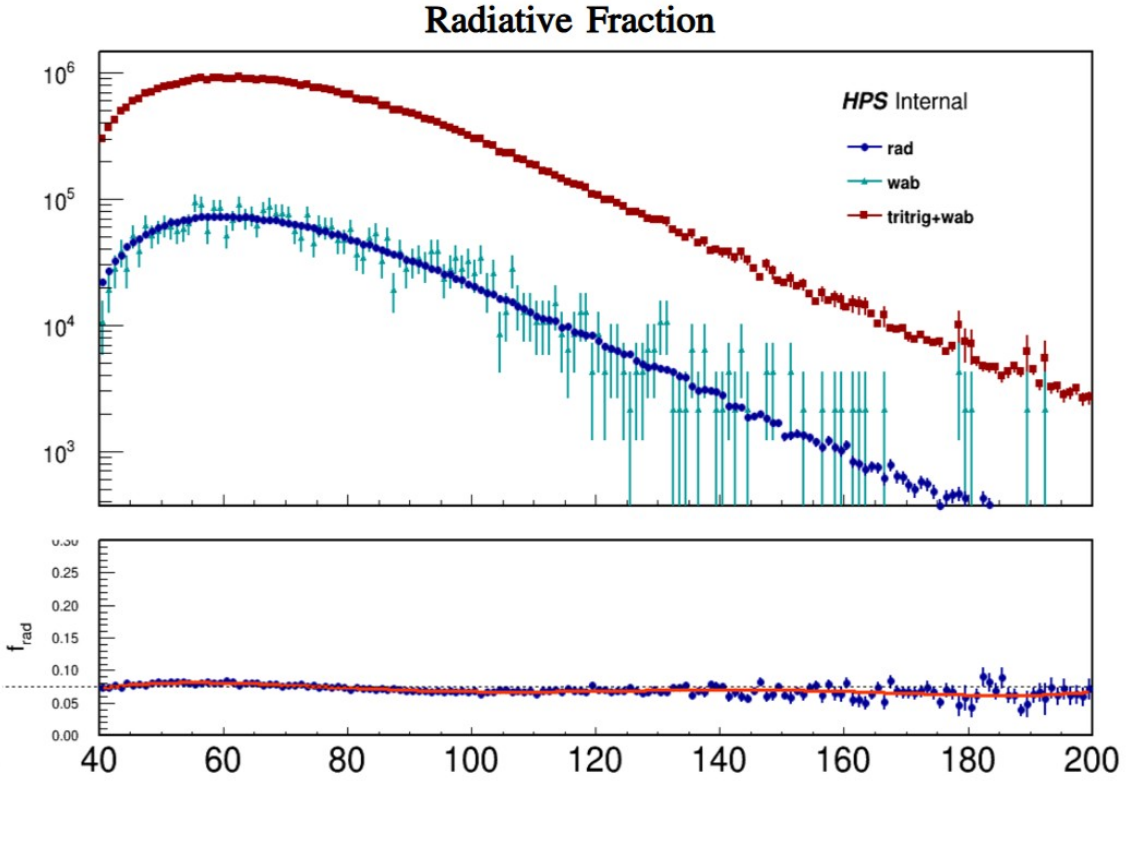


Control Region: 1.9 GeV $<$ Psum $<$ 2.4 GeV

- **10% Data Sample Signal Region is Still Blinded**
- The following Reach Estimate only uses 10% Control Region

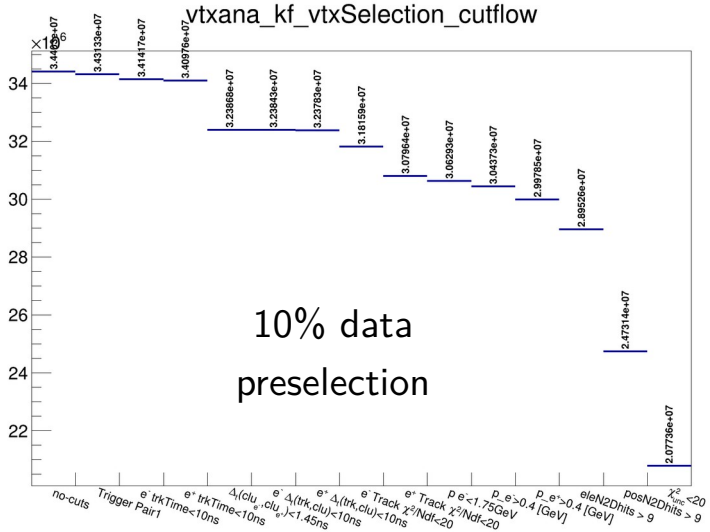
10% Data Reach Estimate – RadFrac and RadAcc

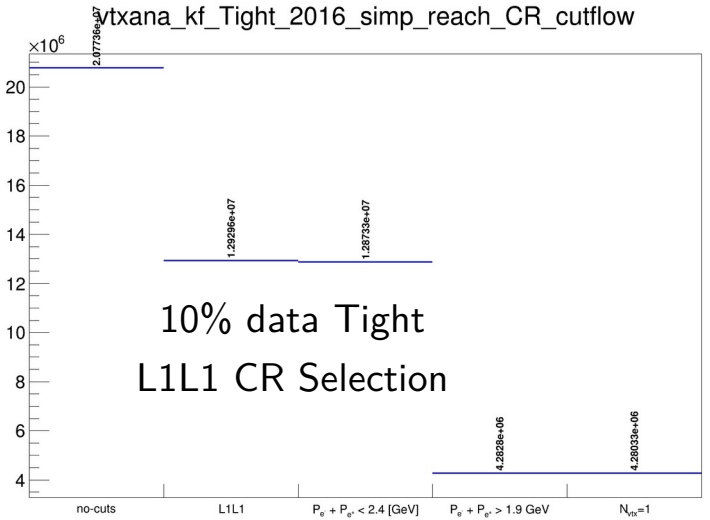


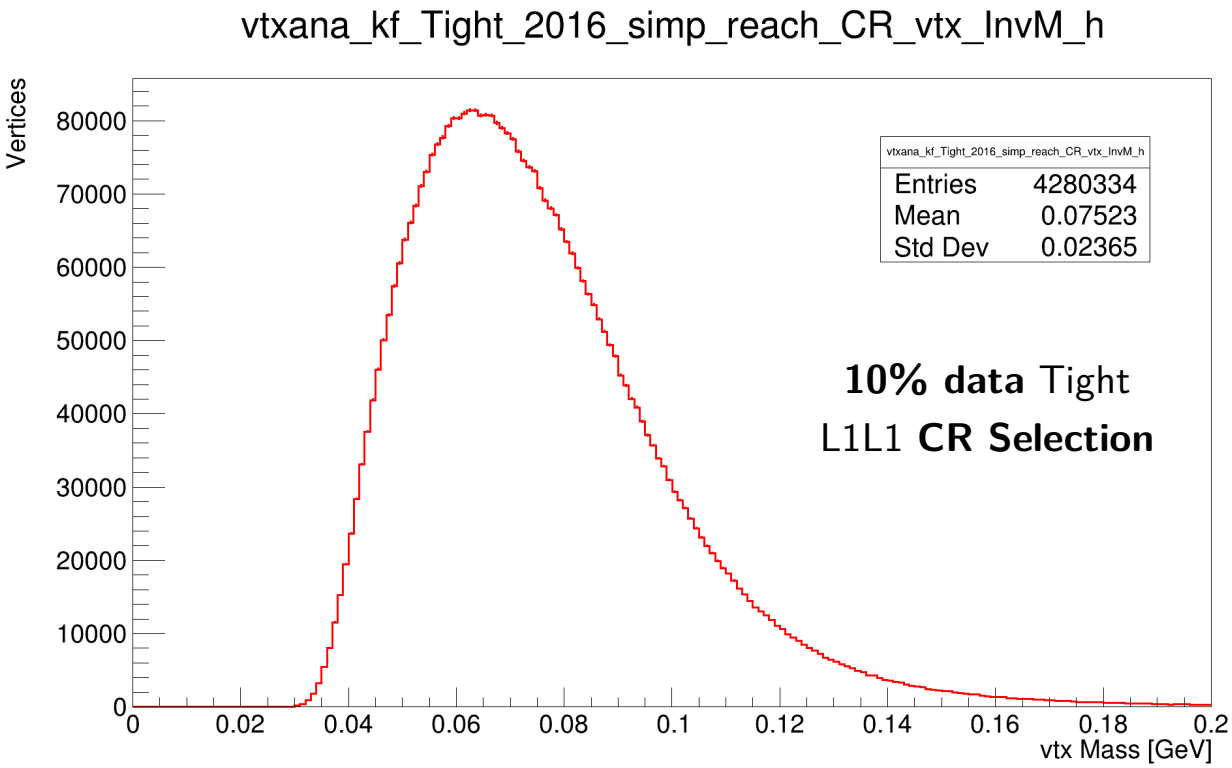


Both terms calculated using CR MC

10% Data Reach Estimate – Control Region Bkg Rate

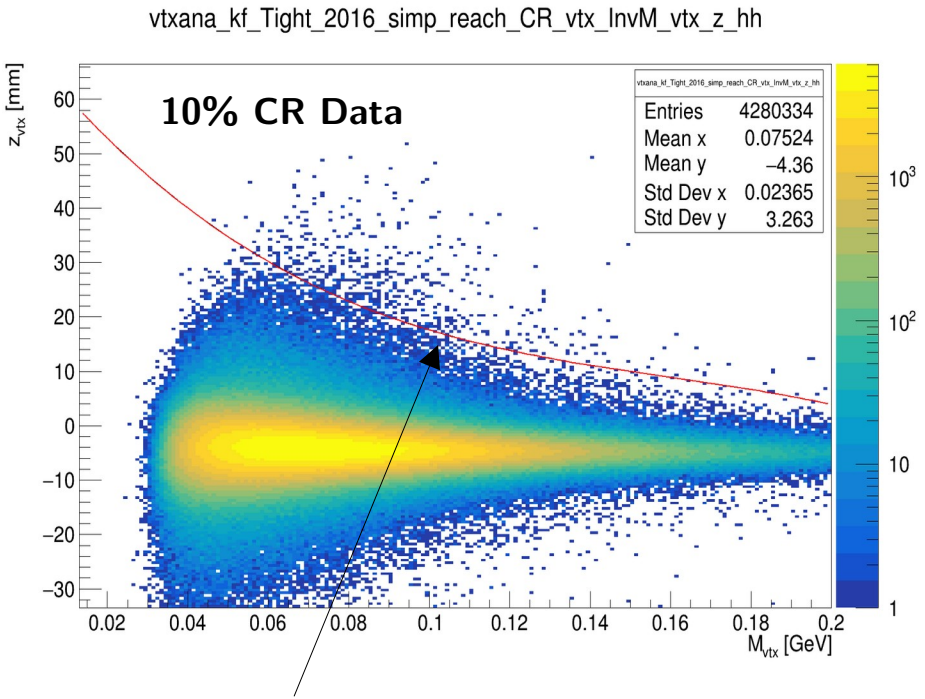


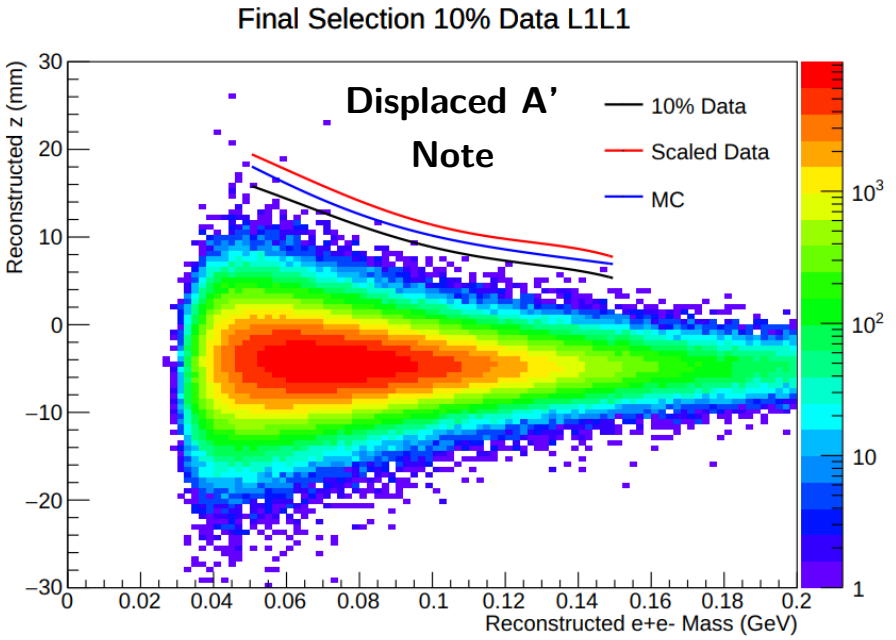




10% Data Expected Signal is proportional to dNdm in CR

10% Data Reach Estimate – Zcut

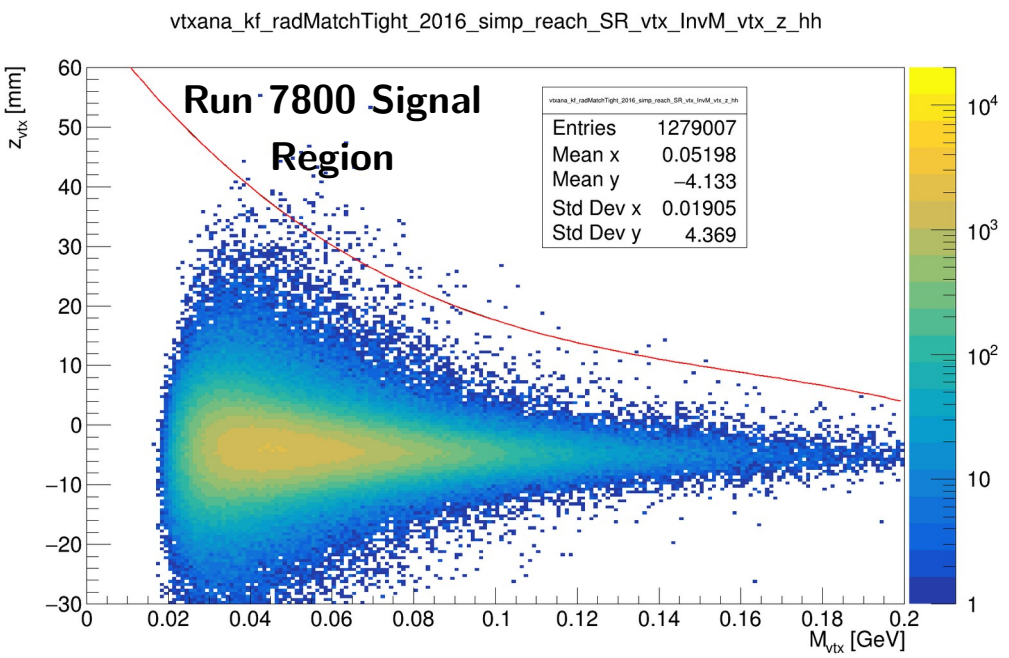


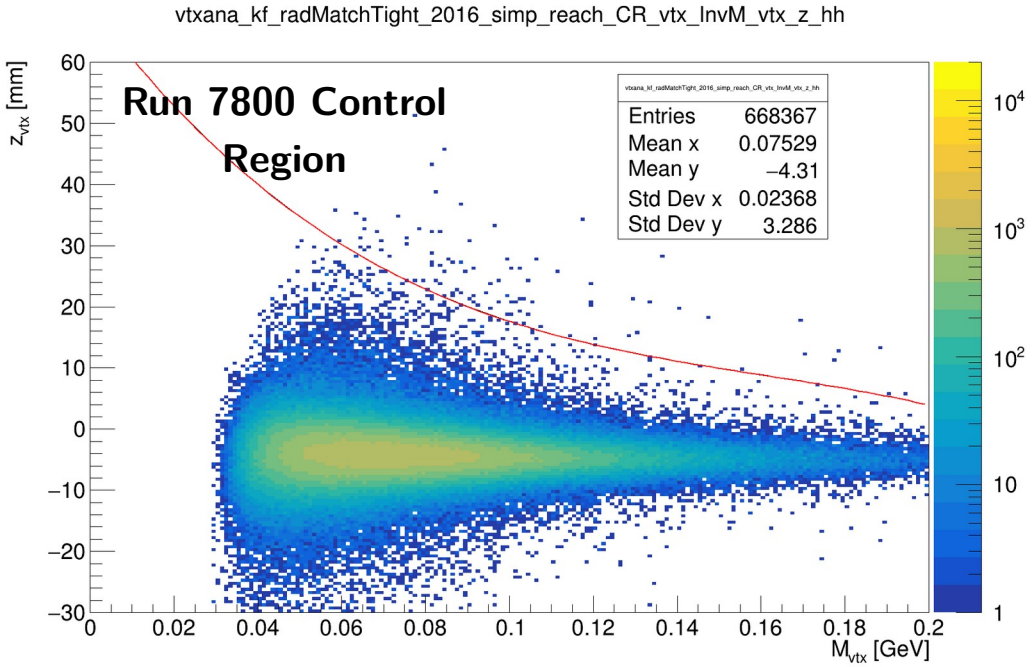


'Eyeball' Zcut from original Reach Estimate

- Used Displaced A' Zcut as guide, but made it more conservative for SIMPS
- SIMPS (left) has more background because no high-z cuts applied yet....

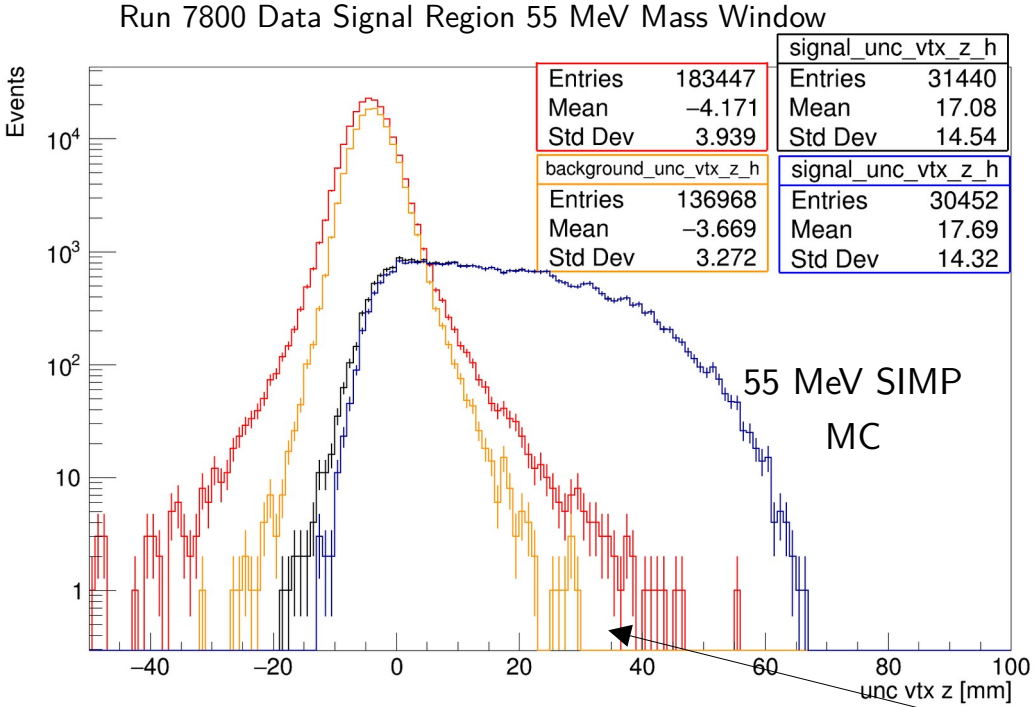
10% Data Reach Estimate – Zcut

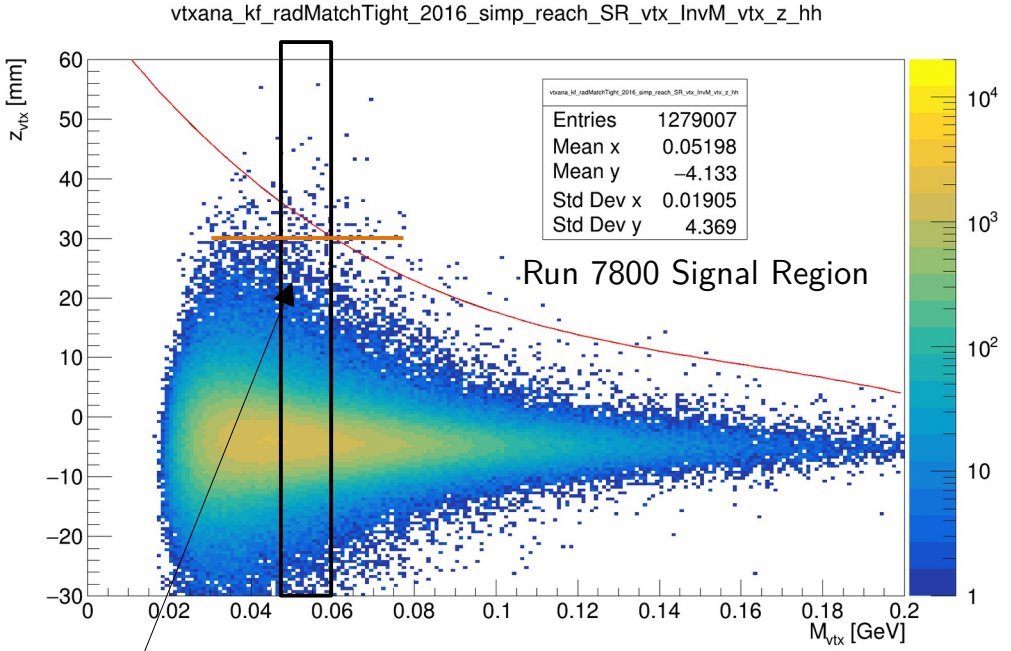




- Run 7800 Signal and Background Regions (Still blind to 10% SR)
- Tails are a bit messier at lower mass, but overall regions are comparable

10% Data Reach Estimate – Zcut



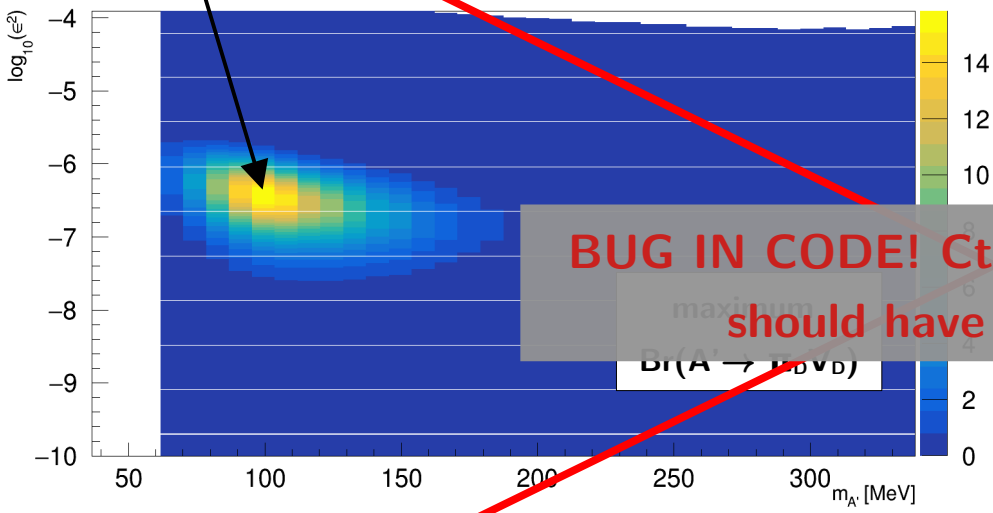


High-z background in Signal Region expected to decrease significantly with high-z cuts (z0/tanlambda shown)

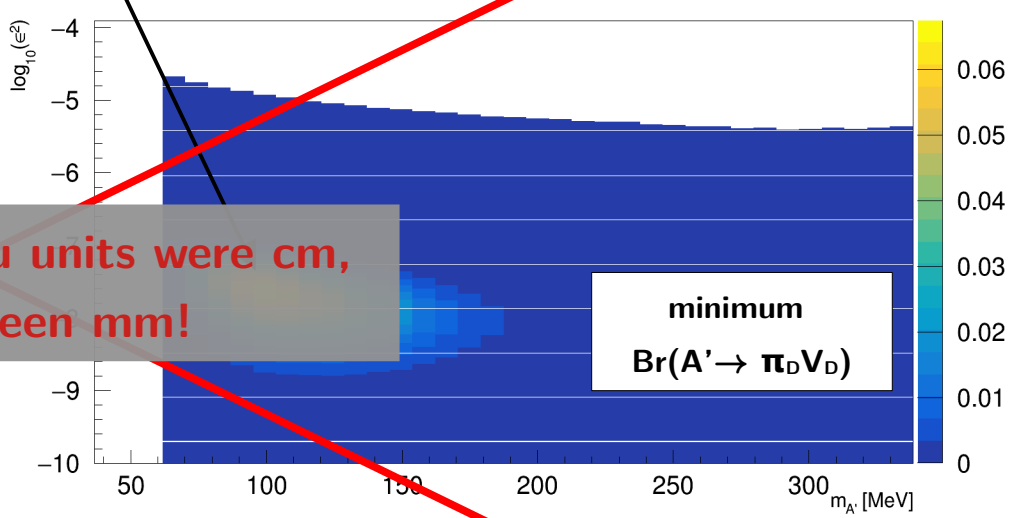
For example: 55 MeV Zcut ~30mm looks okay

OLD SIMP Reach Estimate – Expected Signal

Max ~15 Events Expected!



Expected Events << 1

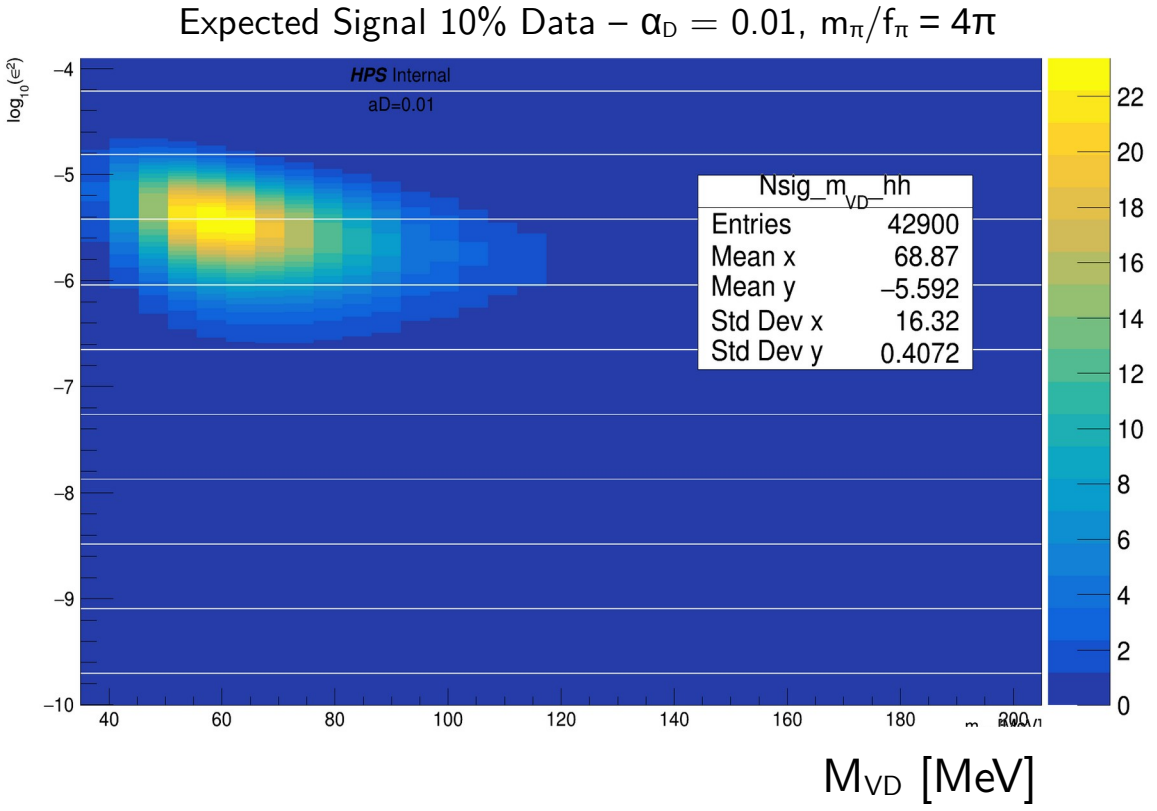


BUG IN CODE! Ctau units were cm, should have been mm!

Previously shown 2016 SIMP Reach Estimate

10% Data Reach Estimate Results

- Reach Estimate using 10% Data Lumi
- Max events ~23 expected
- 40-100 MeV (V_D mass) looks sensitive



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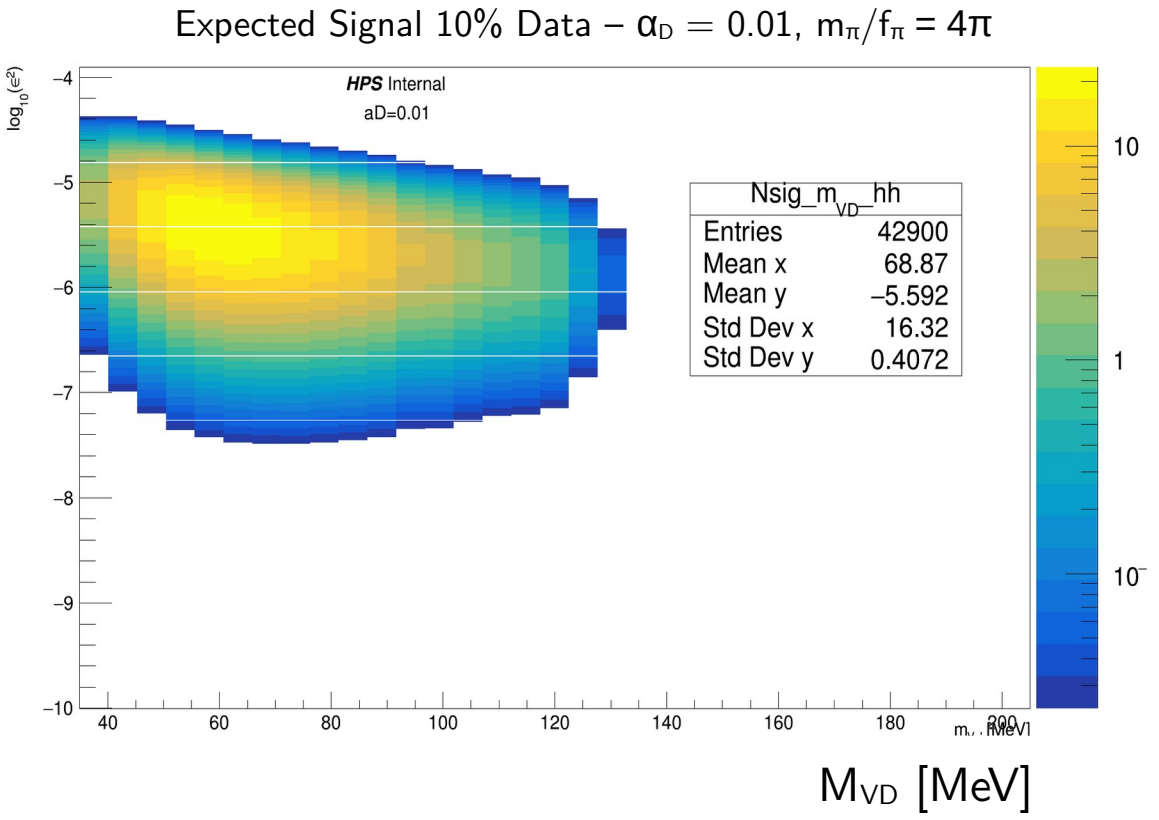

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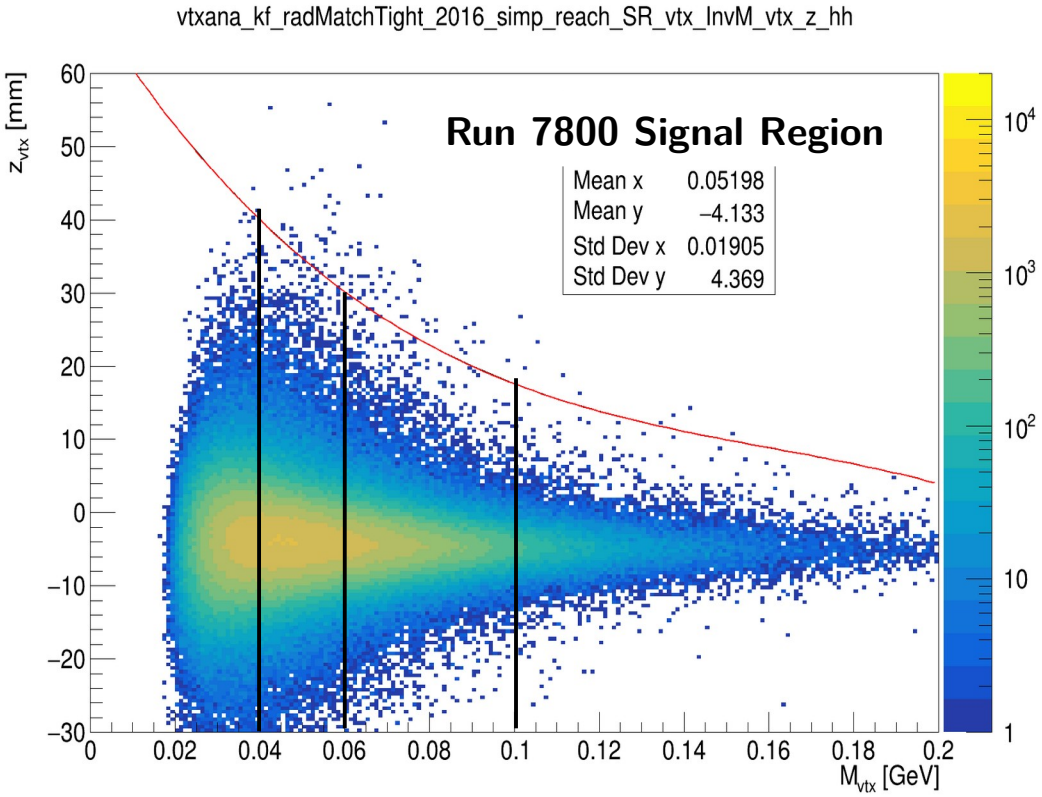
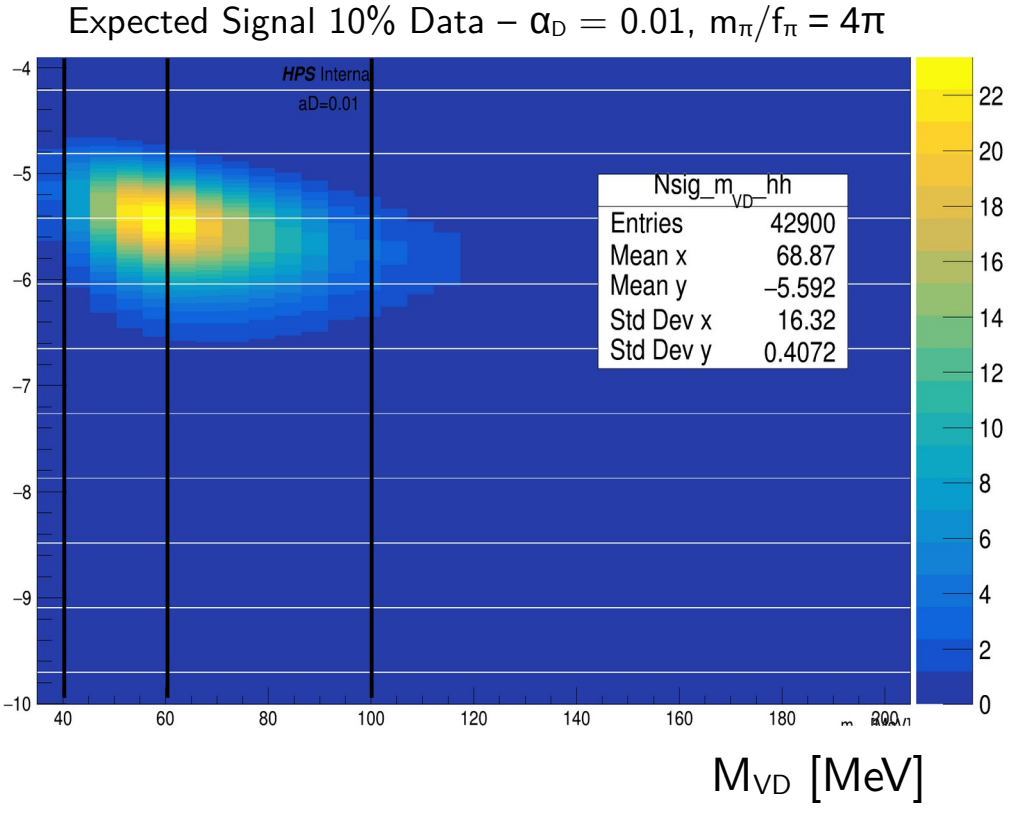
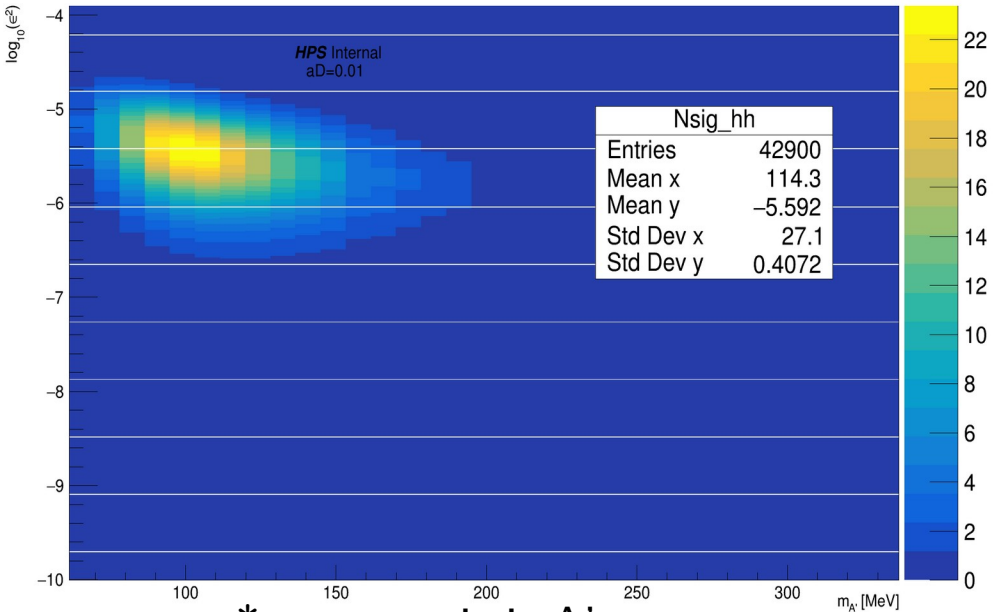




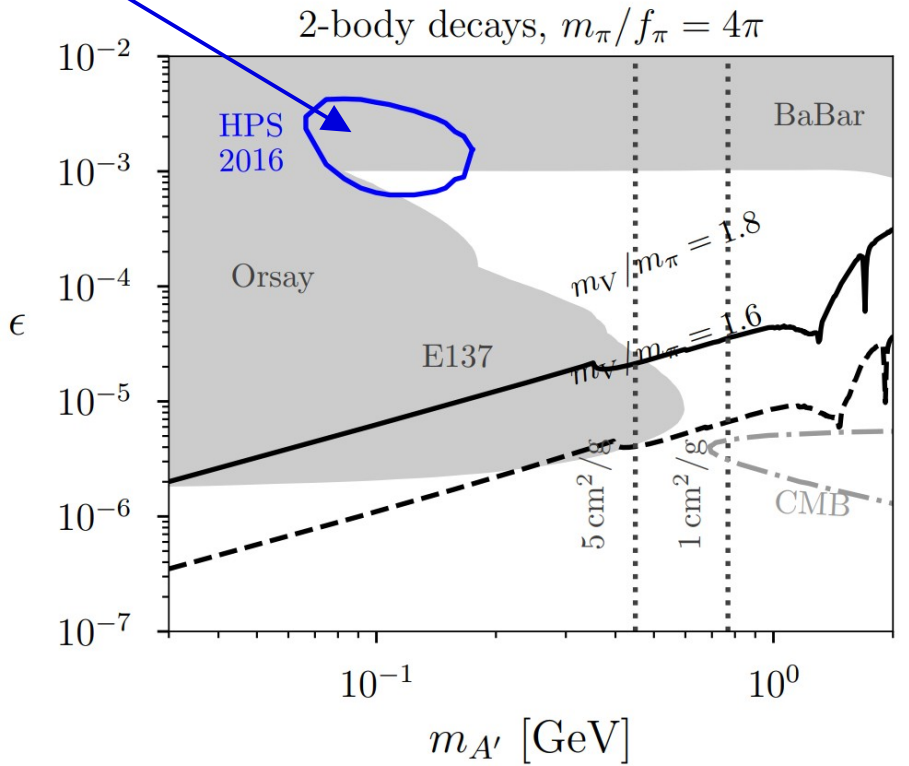
10% Data Reach Estimate Results

Expected Signal 10% Data – $\alpha_D = 0.01$, $m_\pi/f_\pi = 4\pi$



*note: x-axis is A' mass

Exclusion Contour for 10% Data Analysis



Benchmark case SIMP parameters

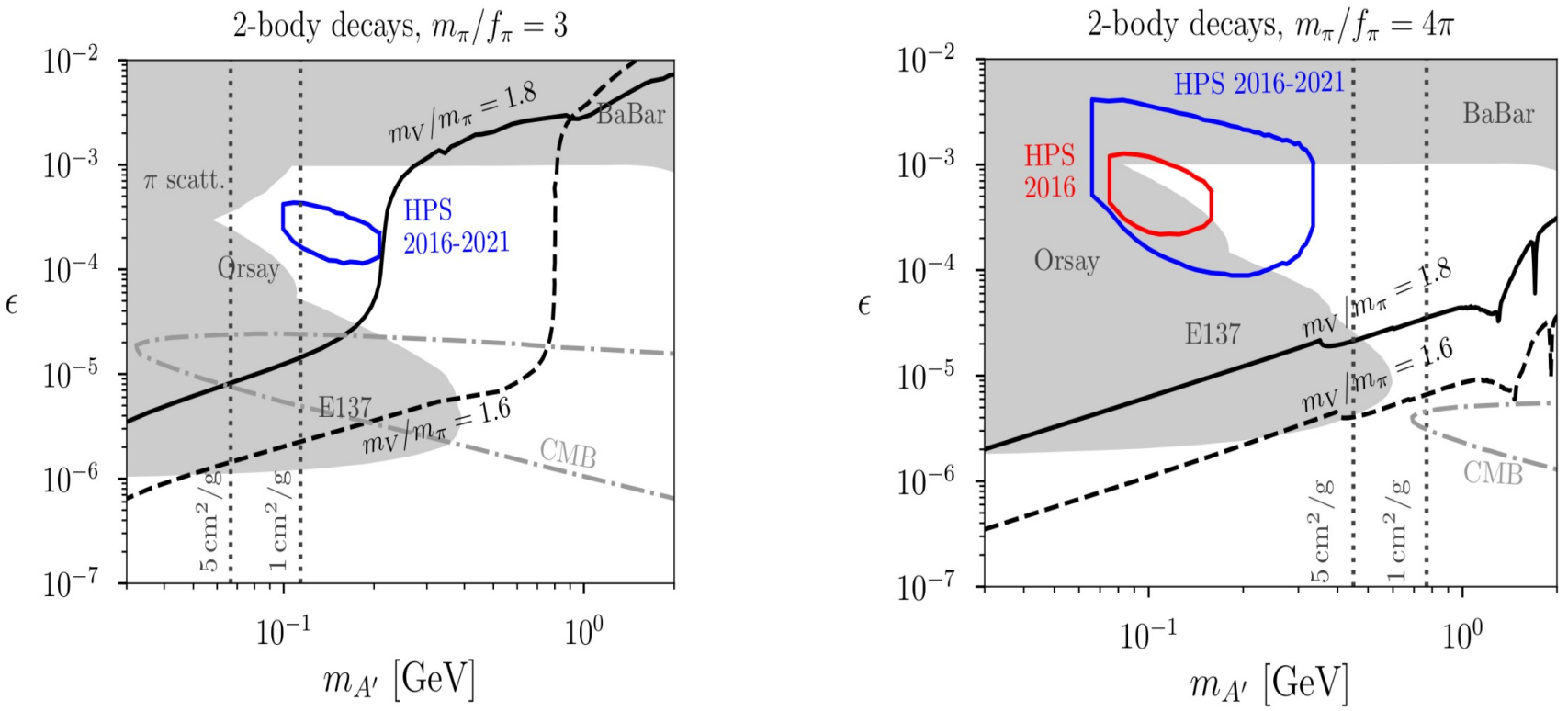
$\alpha_D = 10^{-2}$, $m_{A'}/m_{\pi D} = 3$, $m_{VD}/m_{\pi D} = 1.8$

Steps towards analysis

- Re-make reach plots for 2016,2019, 2021 with correct lifetime
- Do we think a blinded 10% analysis is the way to go?
- Strategies for optimizing high-z cuts if blinded?

Backup

SIMP Reach Estimate – 2016 + 2019 + 2021



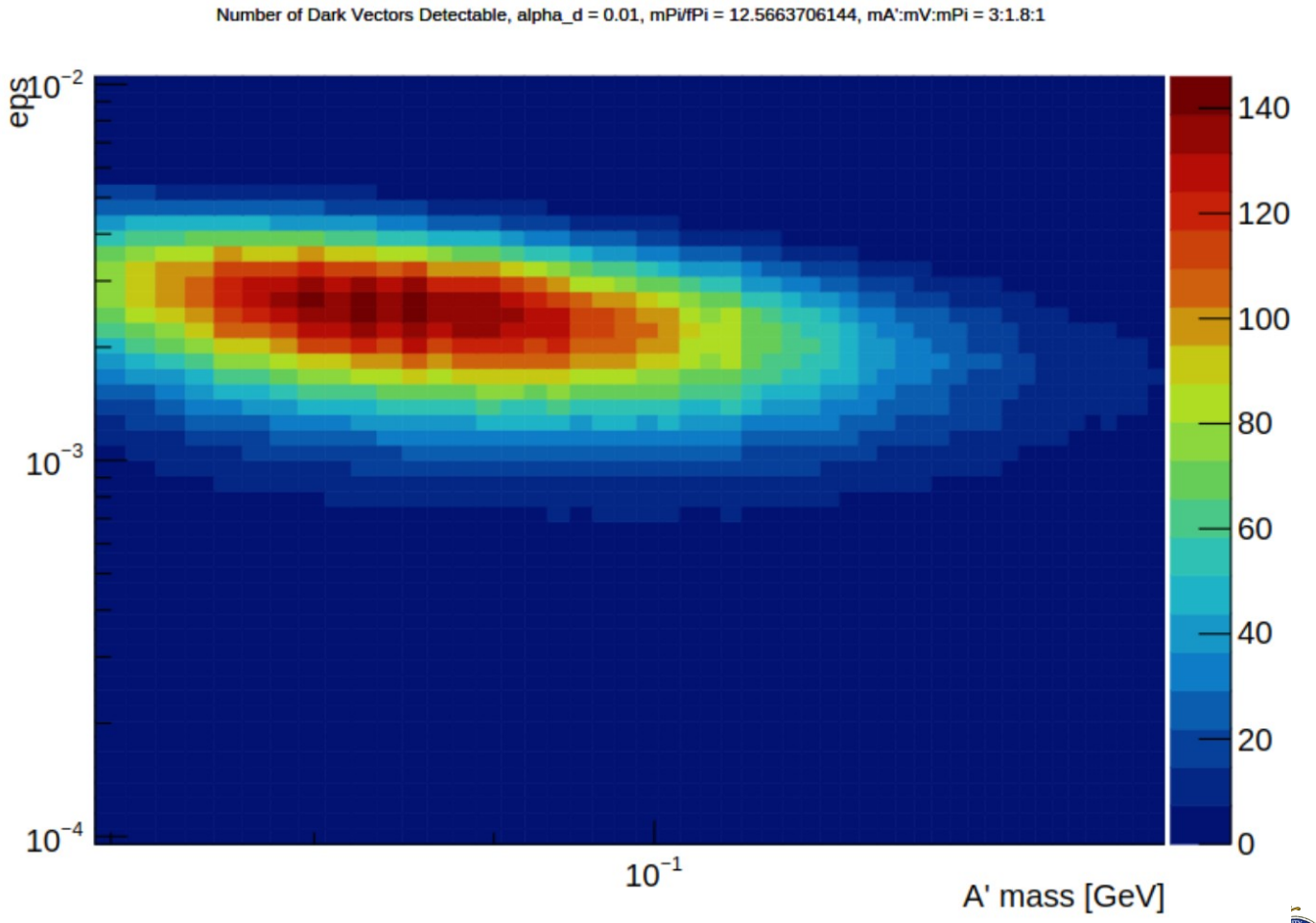
Contours represent $N_{A'sig}$ threshold > 2.3 Events

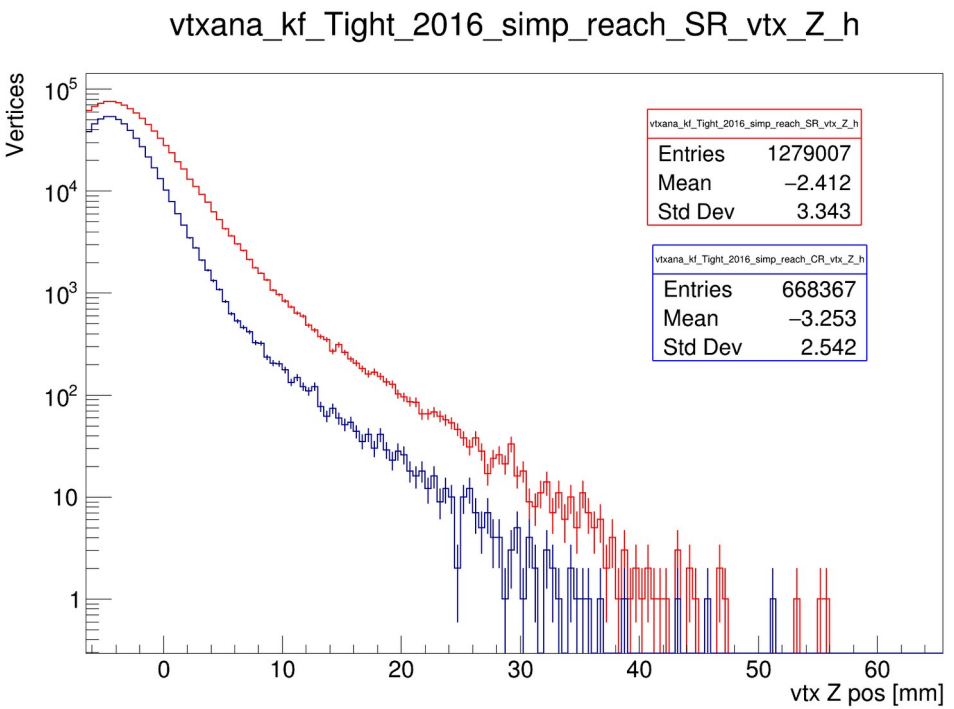
Benchmark case SIMP parameters

$\alpha_D = 10^{-2}$, $m_{A'}/m_{\pi D} = 3$, $m_{VD}/m_{\pi D} = 1.8$

Matt Solt's 2016 Full Lumi Simp Reach Estimate

- Different Zcut shape
- Peak ~140 events
- Fairly in-line with 10% Data prediction of ~23 max events




vtxana_kf_Tight_2016_simp_reach_SR_vtx_Z_h
Vertices
10^5
10^4
10^3
10^2
10
1
0
10
20
30
40
50
60
vtx Z pos [mm]
vtxana_kf_Tight_2016_simp_reach_SR_vtx_Z_h
Entries 1279007
Mean −2.412
Std Dev 3.343
vtxana_kf_Tight_2016_simp_reach_CR_vtx_Z_h
Entries 668367
Mean −3.253
Std Dev 2.542