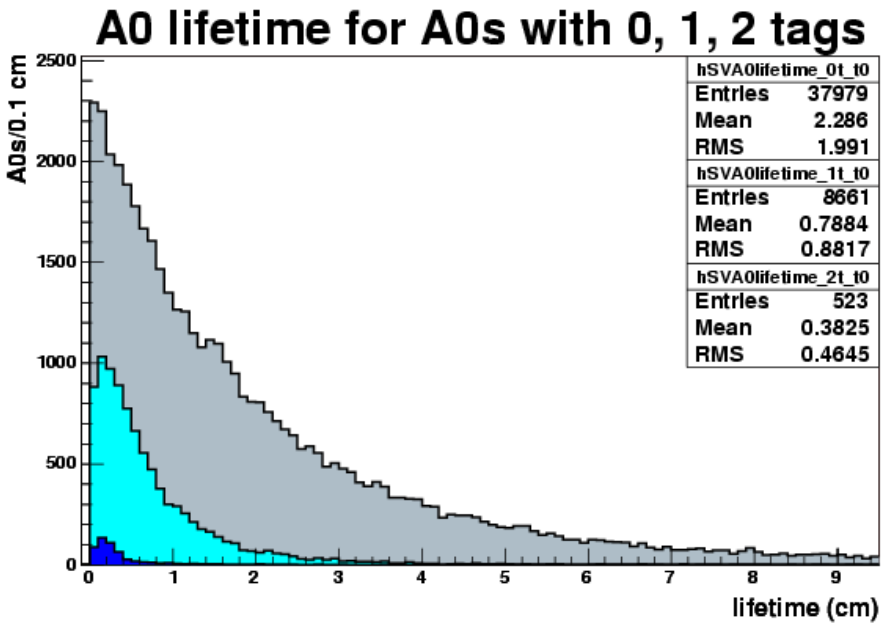
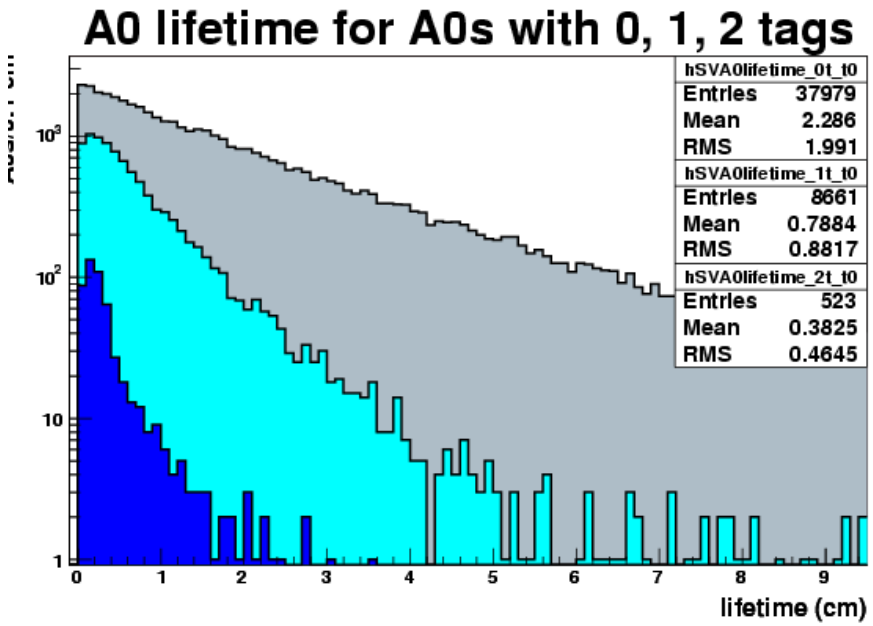
Signal MC Details

- $H_0 \rightarrow A_0, A_0 \rightarrow bb, bb$
  - The A_0 represent a heavy scalar S in the hidden valley model
  - H_0 mass = 130 GeV and the A_0 has a lifetime parameter of 1.0 cm, mass of 40 GeV





- Stacked histograms
  - Blue = 2 tags Cyan = 1 tag Gray = 0 tags associated with each A0

Review of SecVtx

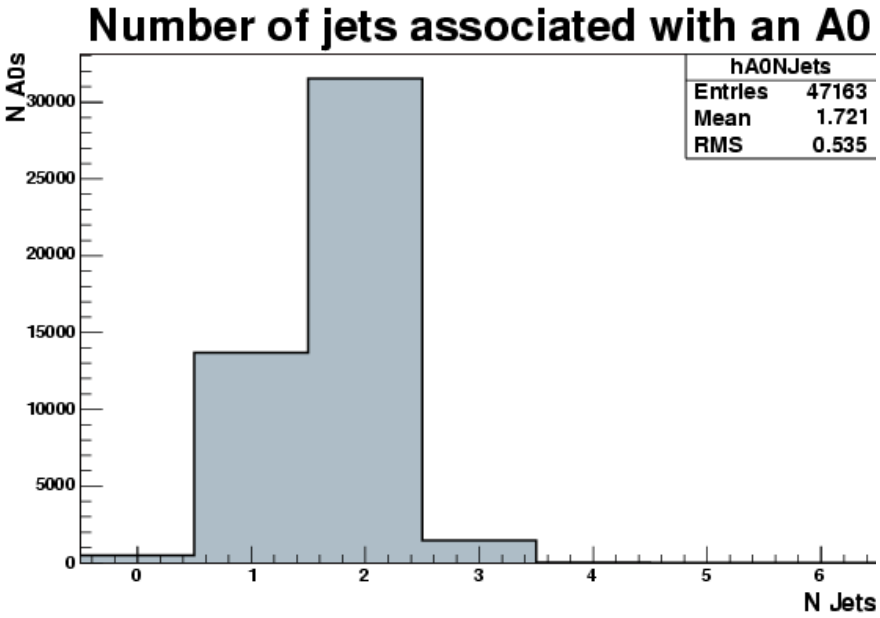
- Starts by looking at jets w/ $E_T > 10$ GeV, $|\eta| < 2.4$
  - Finds all tracks within a 0.4 ΔR cone around jet
  - Selects tracks as Good, Pass1, and Pass2
    - Good Tracks
      - |corrected d_0| < 0.15 cm
      - |corrected z_0| < 2.0 cm
      - $S_{z0} \equiv$ |corr z_0/err z_0| < 50,000
      - no lifetime tracks - eliminates Λ and K_s
      - Good Silicon hits
        - different requirements OI or Standalone track
        - uses: number hits in SVX, number of good hits, number misses, χ^2
      - Pass1 Tracks
        - $P_T > 0.5$ GeV
        - $S_{d0} \equiv$ |corr d_0/err d_0| > 2
      - Pass 2 Tracks
        - $P_T > 1.0$ GeV
        - $S_{d0} > 3.5$
        - More stringent requirements on Silicon hits
  - Performs a Pass 1 strategy
    - Creates a 2 track seed vertex.
      - One of the two tracks must have $P_T > 1.0$ GeV
      - Seed vertex $\chi^2 < 50.0$
    - Remaining tracks are added singly
      - $S_{d0} < 4.0$ w/ respect to seed vertex, it is attached
      - If tracks χ^2 contribution is 45.0 to vertex, it is removed

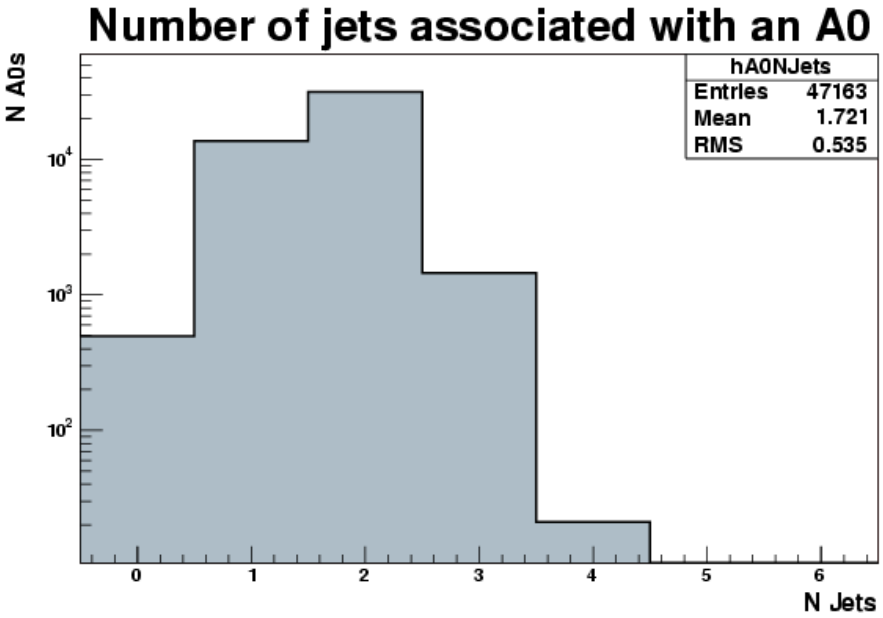
Review of SecVtx

- Pass 1 continued, it must have three or more P1 tracks
  - Vertex must pass final cuts
    - $S_{Lxy} > 7.5$
    - $L_{xy} < 5.0$ cm
    - $\langle z_0 \rangle < 5.0$ cm
    - Pseudo-$c\tau < 1.0$ cm
    - Normalized $\chi^2 < 50.0$
    - Vertices from material and nuclear interactions are removed, as are K_s and Λ
- Pass 2 strategy is performed
  - The list of tracks are vertexed simultaneously
  - Vertexing and pruning of tracks is performed in a similar way as Pass 1
  - Either the two highest seed tracks must have $P_T > 1.5$ GeV
  - No attachment S_{d0} cut (due to simultaneous vertexing)
  - Tracks are removed if the contribute more than 30.0 to the overall χ^2
  - Final vertex cuts are the same as Pass 1
- L_{2d} is used to determine if a tag is to be positive or negative
  - L_{2d} is the displacement from the primary to the secondary vertex projected onto the jet momentum vector
  - If the dot product of the displacement from the primary to the secondary vertex and the jet's momentum vector is positive, then the tag is positive
  - The secondary vertex is in the same hemisphere of the detector as the jet
  - Negative tags are most likely the result of finite tracking resolution

A_0 Details and Taggability

- Match b partons to jets in my data sample ($\Delta R < 0.7$)
  - Look at number of jets per A_0, number of taggable jets, and finally the number of tags
  - I have three taggability definitions
    - 0: same fiducial requirements as SecVtx: $E_T > 10$, $|\eta| < 2.4$
    - 1: addition $|\eta| \leq 1.0$ (due to our data trigger), A_0 lifetime <= 3.0 cm
    - 2: 2 or more SecVtx good tracks in the jet
  - Number of jets w/ tags shown is out of taggable jets

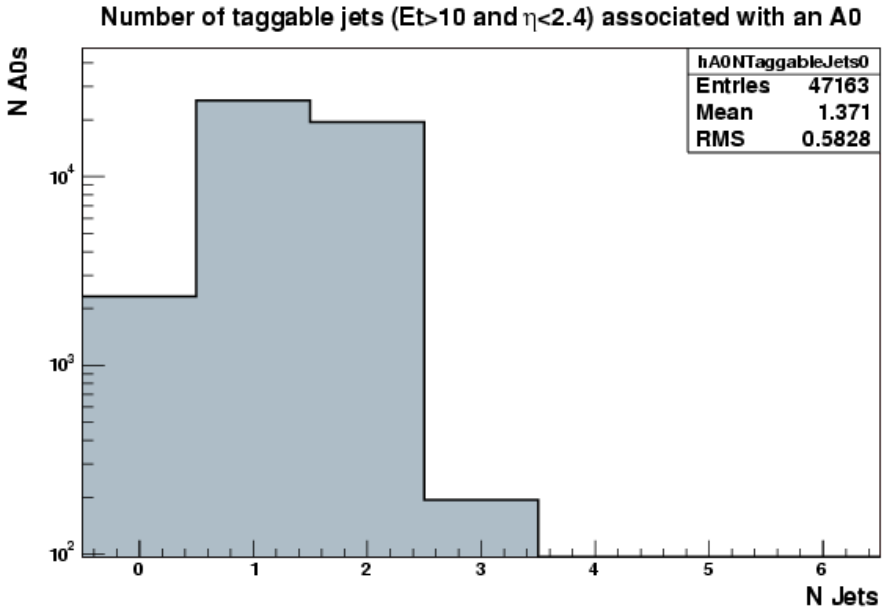


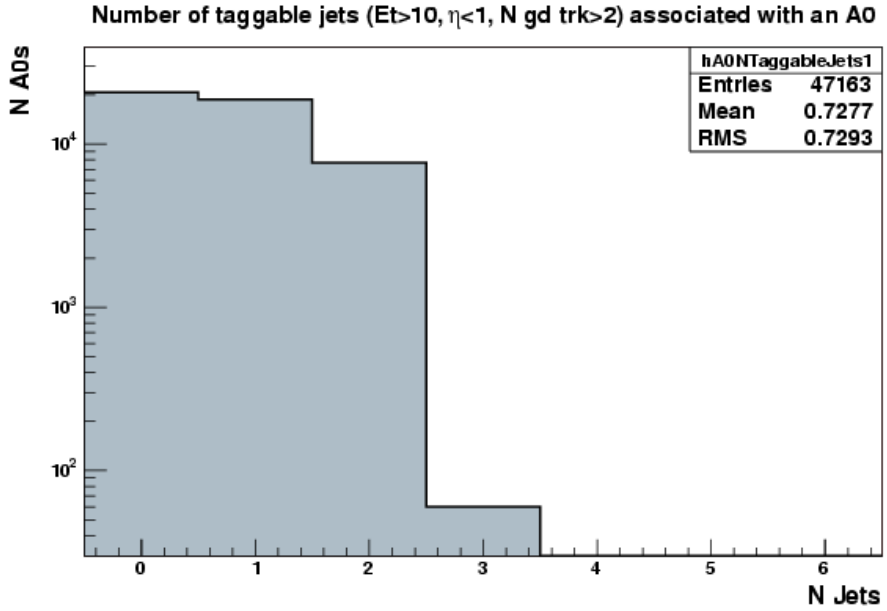


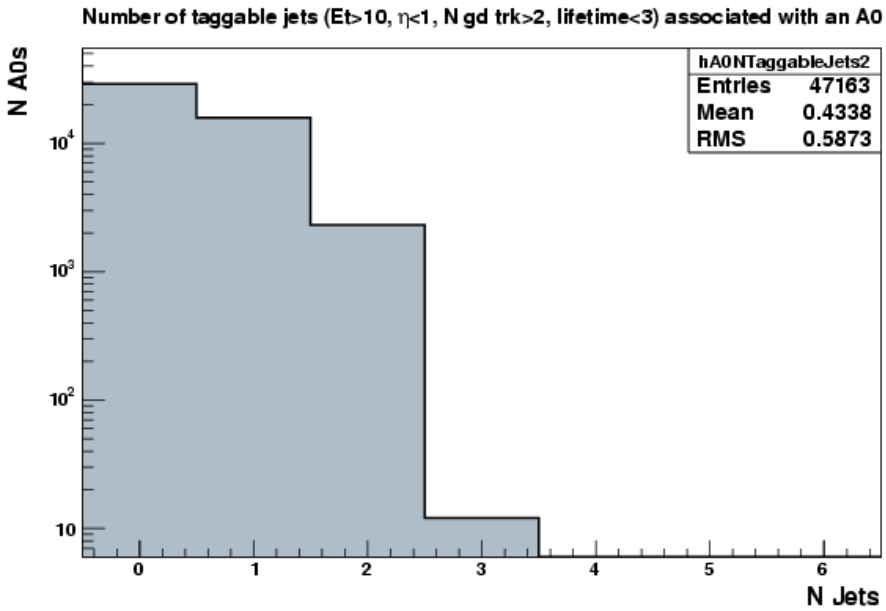
Number of A0s w/ N Jets

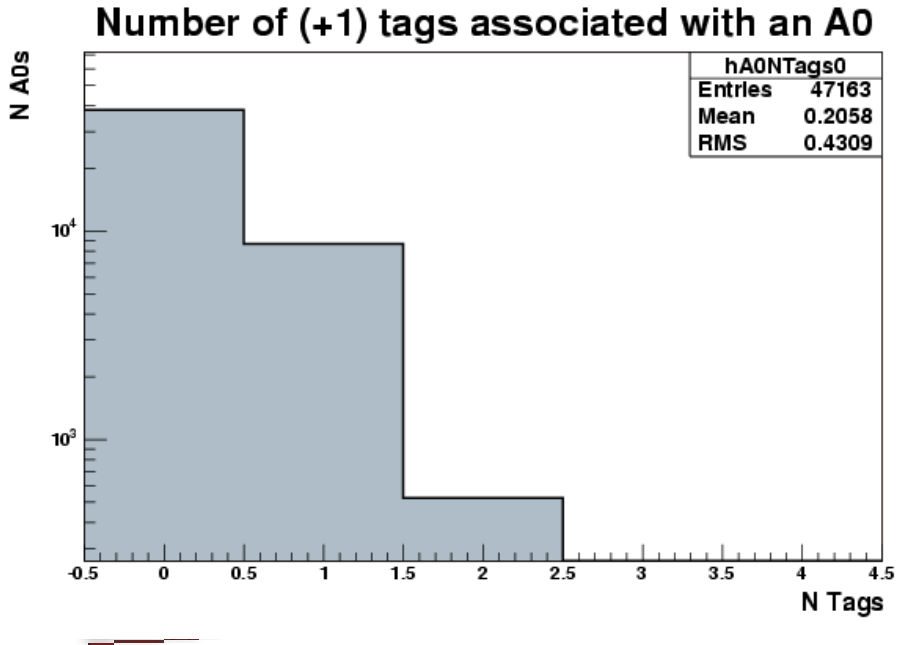
0:	493
1:	13,664
2:	31,534
3:	1,451
4:	21

A_0 Taggability









A_0 Taggability

- Same information in table format:

	0	1	2	3	4
N Jets	493	13664	31534	1451	21
N Taggability0	2315	25249	19406	193	0
N Taggability1	20653	18759	7691	60	0
N Taggability2	29031	15815	2305	12	0
N Tags 0	37979	8661	523	0	0
N Tags 1	37714	7075	374	0	0
N Tags 2	37714	7075	374	0	0

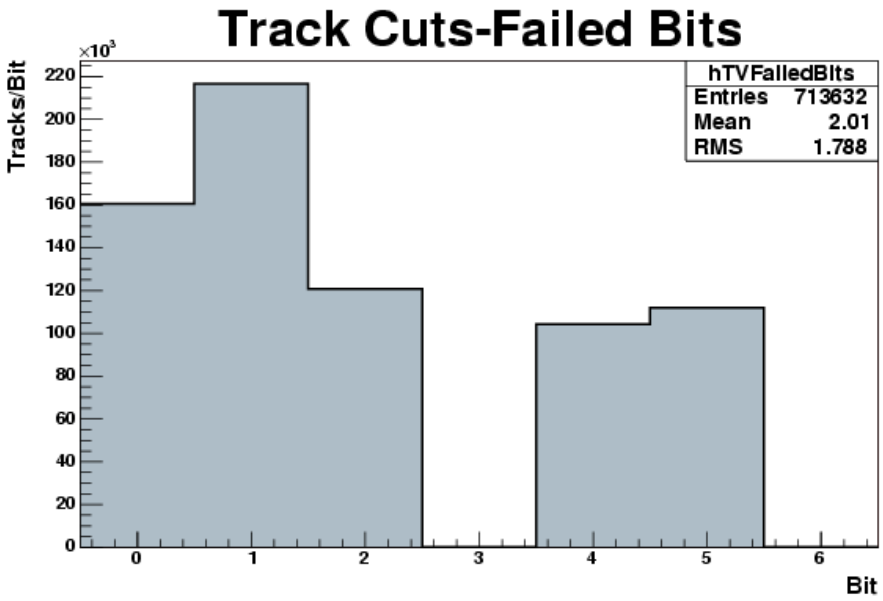
- Unsurprisingly, as you tighten the requirements for taggability, the number of taggable jets decreases.
- The number of 2 tagged jets, which is important for this analysis shrinks rapidly

Efficiency	
Tag0/Taggable0	15.15%
Tag1/Taggable1	22.91%
Tag2/Taggable2	38.30%
(t2/t2) w/ 2 p1 trk	59.01%

- c.f. SecVtx efficiency is approximately 40% ± 10%
  - From CDFNote 8265
    - But this is comparing apples to oranges; it is measured using dijet data and MC
    - The efficiency is not constant in E_T, η, or ϕ.

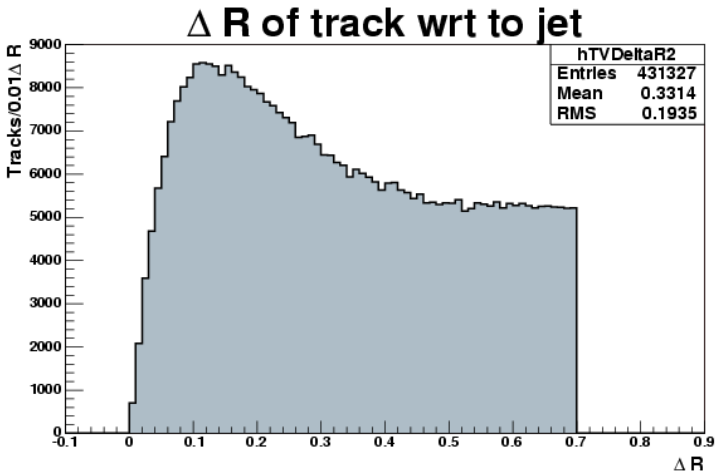
SecVtx Track Efficiency

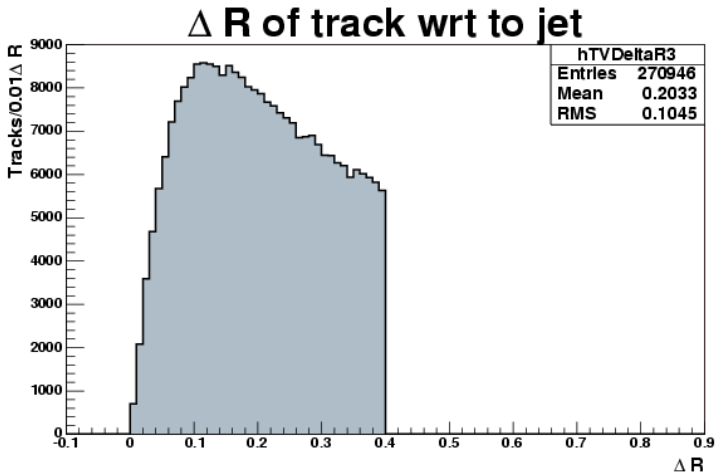
- Study of SecVtx algorithm efficiency for my unique decay topology
- Looked at the different SecVtx track cuts used to determine a good/pass1 track.
- First did it simply, looked at the 6 parameters we can control via SecVtx TCL file
  - ΔR
  - |corrected d_0| < 0.15
  - |corrected z_0| < 2.0
  - |corr z_0/err z_0| < 50,000
  - P_T > 0.5
  - |corr d_0/err d_0| > 2
- The S_{z0} cut did nothing, 50,000 is really huge

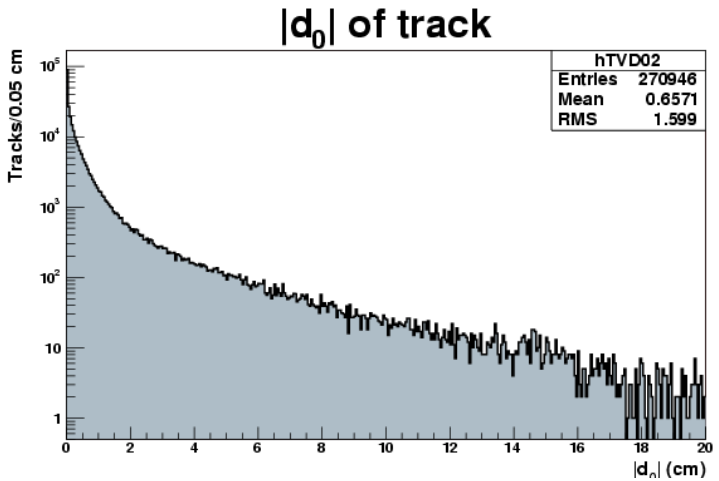


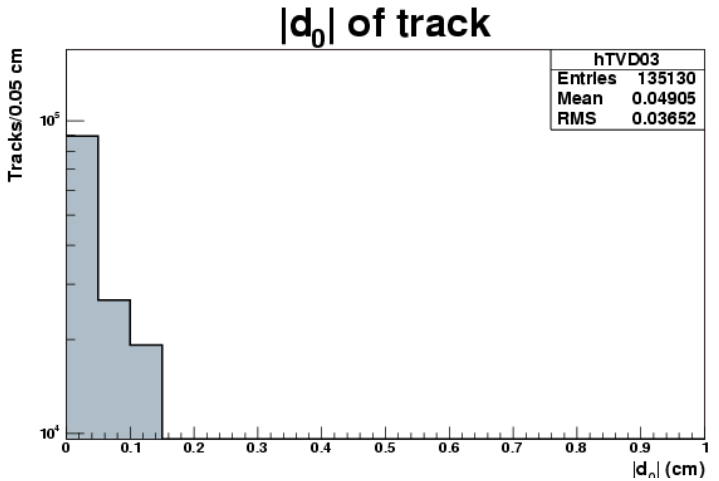
Legend	
0	ΔR
1	d_0
2	z_0
3	S_{z0}
4	P_T
5	S_{d0}

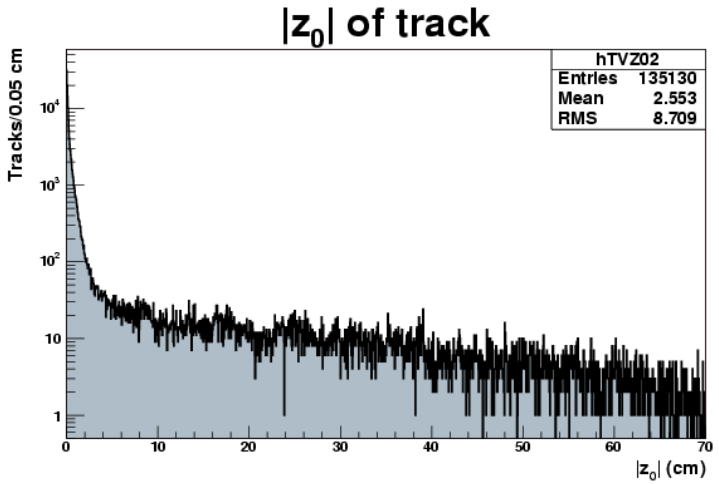
SecVtx Track Efficiency

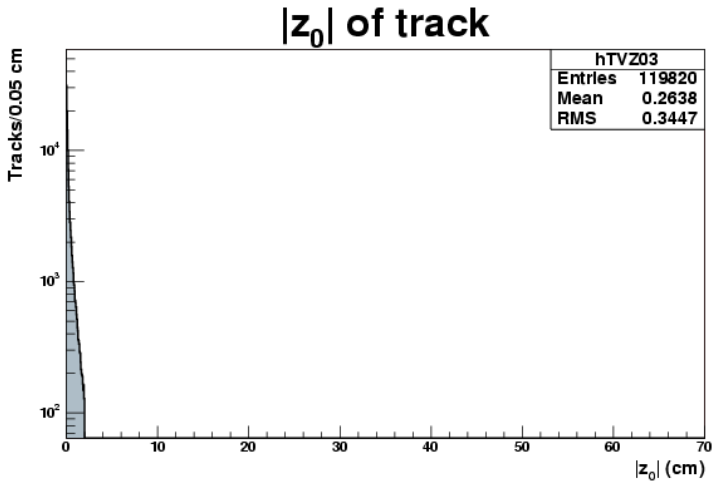




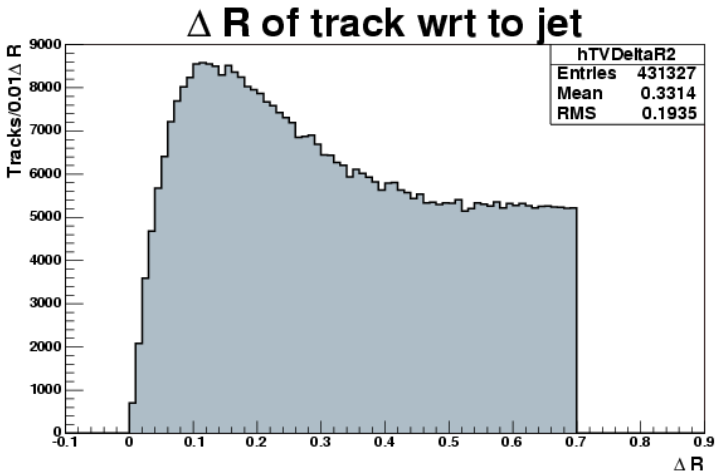


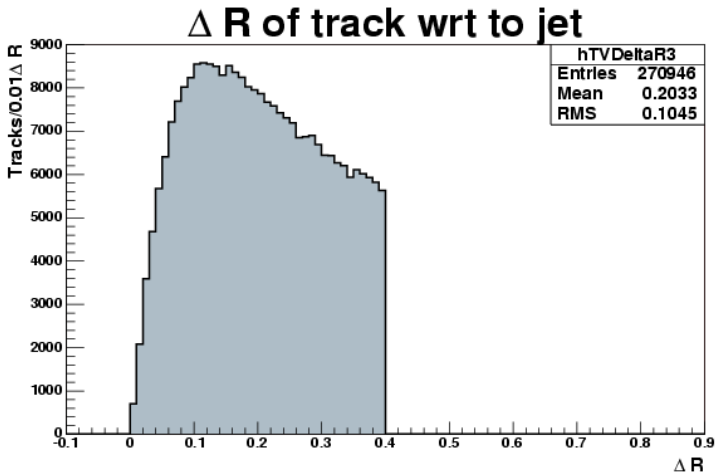


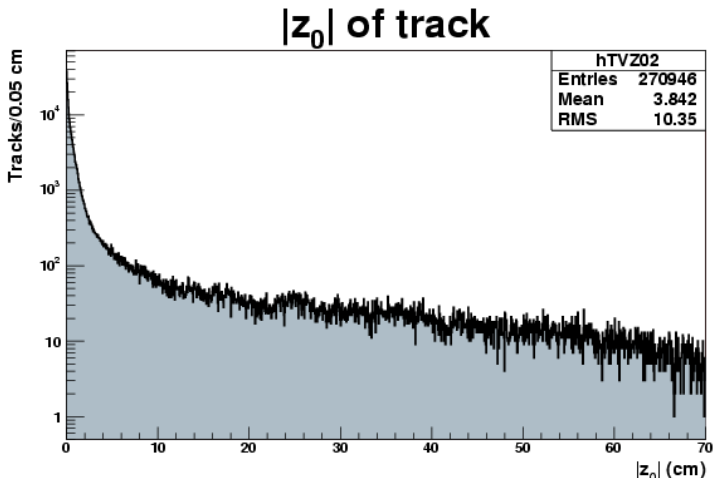


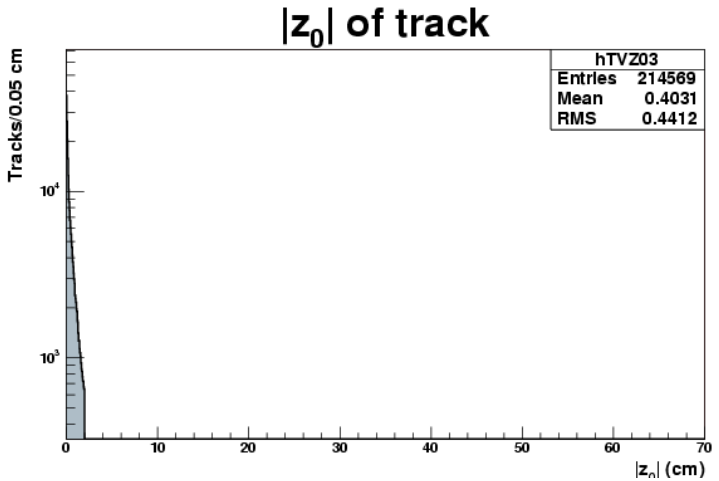


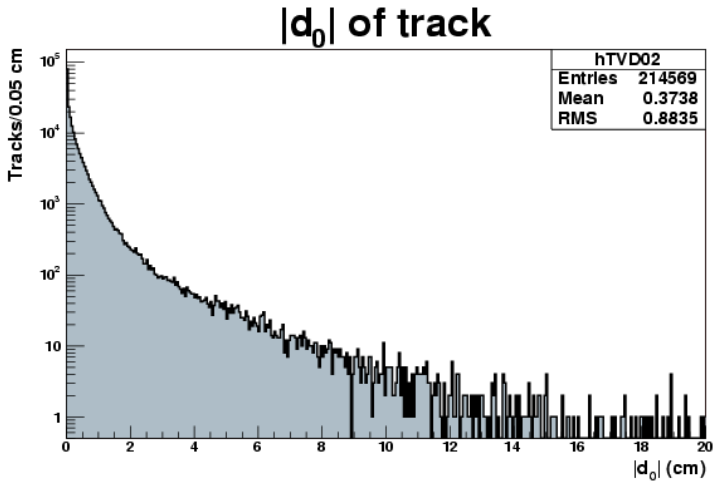
SecVtx Track Efficiency

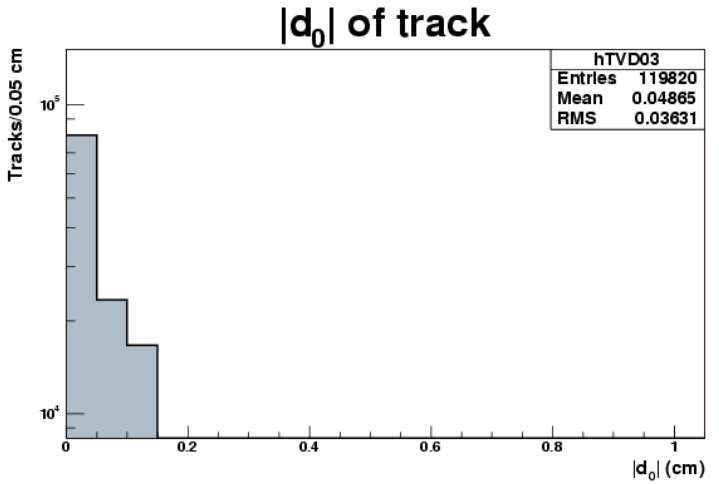












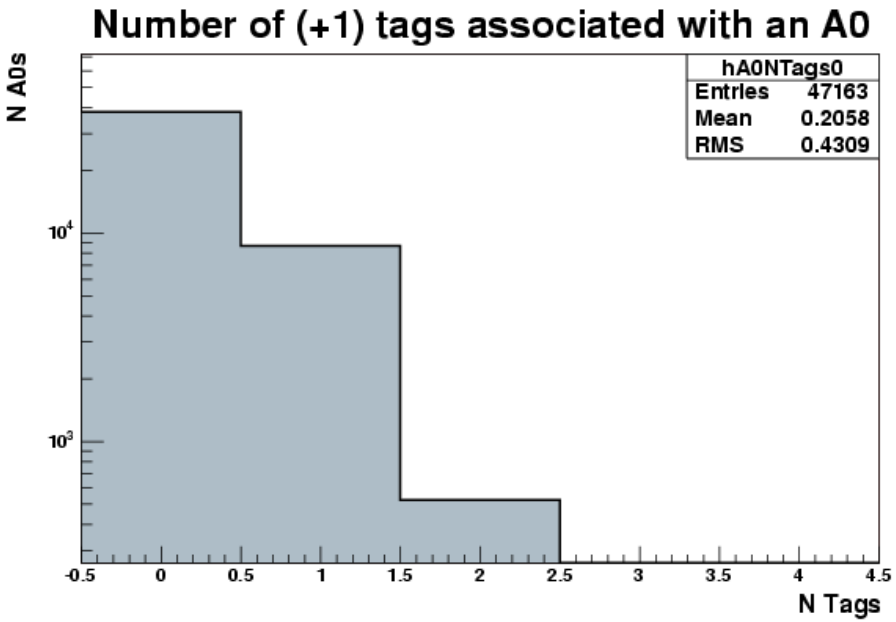
SecVtx Track Efficiency

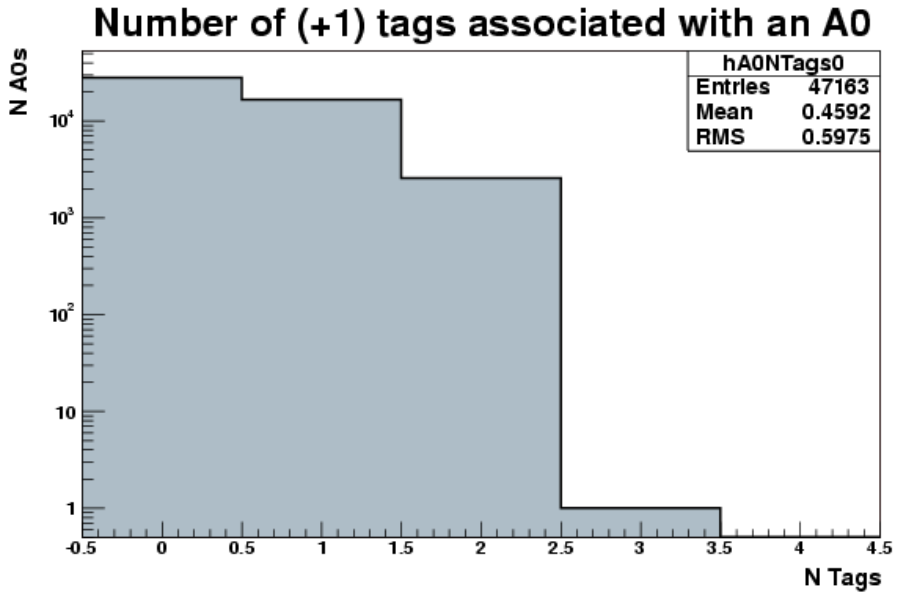
- The d_0 cut removes ~45%-50% of the tracks
- The z_0 cut removes ~10%-20% of the tracks

N Tracks	N PreGd Trks	N Good Trks	N P1 Tracks	N P2 Tracks
697382	n/a	128042	69005	51591
431327	119820	90907	51336	39144
277452	n/a	85402	49078	37549

- This shows that the Silicon hits and lifetime track removal only removes 25% of the tracks
- The d_0 requirement cuts the largest number of tracks
- To test that I could change SecVtxModule, I re-tagged the signal MC w/ the d_0 and z_0 parameters changed; multiplied each cut x10.
  - |corrected d_0| < 1.5 cm
  - |corrected z_0| < 20.0 cm

Custom SecVtx





	0	1	2	3	4
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N Taggability0	2315	25249	19406	193	0
N Taggability1	20653	18759	7691	60	0
N Taggability2	29031	15815	2305	12	0
N Taggability2	24518	17148	5464	33	0
N Tags 0	37979	8661	523	0	0
N Tags 0	28070	16532	2560	1	0
N Tags 1,2	37714	7075	374	0	0
N Tags 1,2	32269	13034	1860	0	0

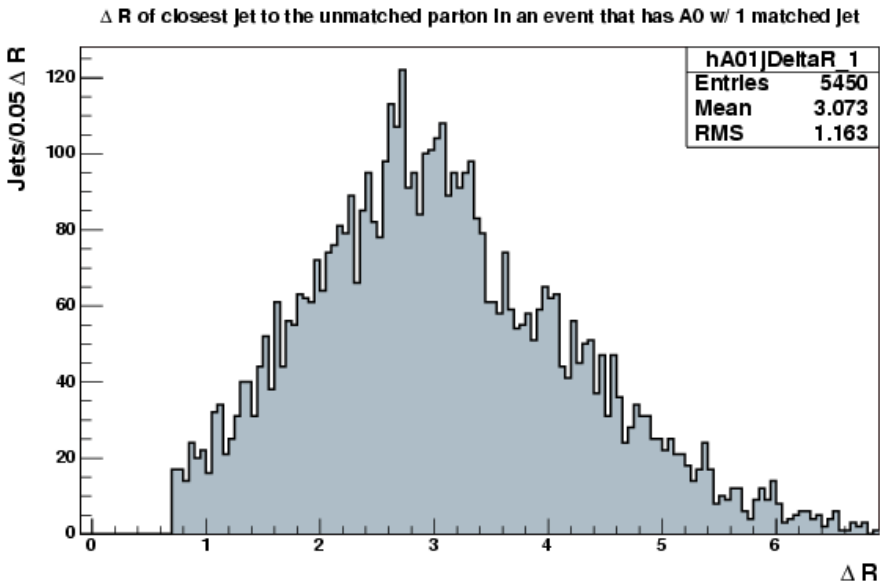
Efficiency	
Tag0/Taggable0	33.80%
Tag1/Taggable1	49.07%
Tag2/Taggable2	59.67%
(t2/t2) w/ 2 p1 trk	67.80%

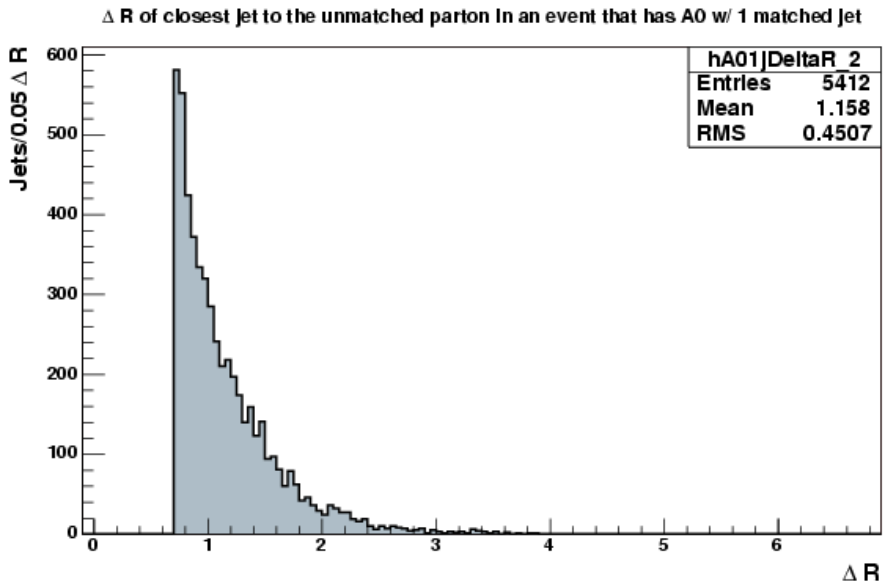
Summary

- Improvements to the efficiency will most likely be made in loosing the d_0 requirement
- It is possible to improve SecVtx efficiency of the signal MC sample
  - There are pros and cons to doing so:
  - Pro-obviously we need as much signal as possible
  - Con-we will need to convince our collaborators regarding changing SecVtx parameters

Missing b partons from A_0s

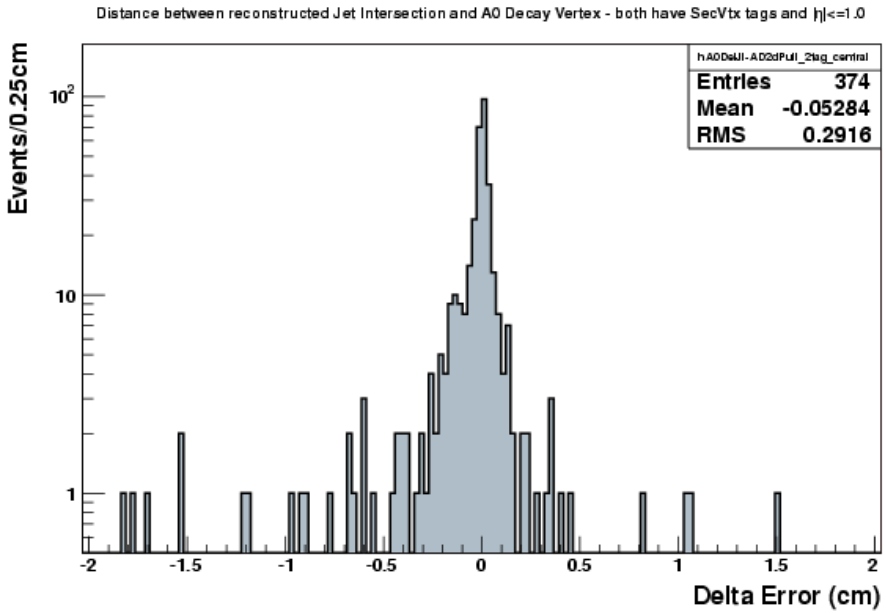
- All cone-sizes are $\Delta R = 0.7$
  - Same cone as the current A_0 622
  - Same cone as a jet from the other A_0 2,140
  - Closest jet is the same jet from this A_0 1,754
  - Closest jet is a jet from the other A_0 3,696
  - Closest jet is a jet not associated with any A_0 5,412

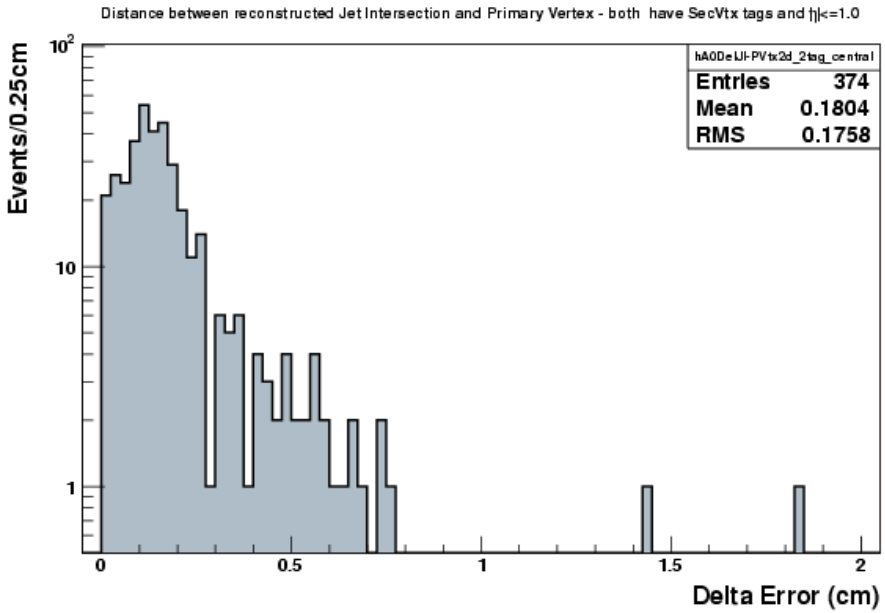




ΔS of Jet Intersection

- SecVtx gives the momentum of each secondary vertex, with a point (the secondary vertex) and a direction (the momentum), we have a line in 2dim Euclidean space.
- With two such lines, they will always intersect unless they are parallel or coincident.





- Left: ΔS between this intersection and the HEPG decay vertex of the A_0.
  - The +/-1 is determined by projecting the 2dim vector of the intersection onto the vector of the A_0 decay vertex.
  - If the magnitude of this projection is less than the magnitude of the A_0 decay vertex vector, ΔS is negative. Likewise, a larger magnitude is a positive ΔS.
- Right: ΔS between this intersection and the primary vertex.