

Matt's wish list for ~~Moving forward with~~ physics analysis

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HPS Collaboration Meeting
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A very important milestone...

- A quick turnaround between data taking and publication is very important:
 - The DOE likes this very much; they have impressed upon us that it's important to them
 - The graduate students like this too, for some reason
 - This is a hot topic in the community and *a*) there will be a lot of attention given to us (negative, if we wait a long time to go public with results) and *b*) there is competition for some of the phase space we're chasing
- I have said, in a few talks, that having a paper out ~ 1 year after data taking is a good goal (some people have laughed)

The first published HPS A' search?

Here's what we need (at a minimum), this is just my opinion...please protest & comment:

- well defined dataset = X days of data at a single energy (e.g. 7 days @ 2.2 GeV)... there will likely be a natural cutoff;
- a decently aligned SVT
- reasonable estimates (i.e. verified, if not measured, in data) of:
 - momentum resolution
 - angular resolution (or mass resolution)
 - ideally these are over a range of momenta
 - trigger efficiency (vs mass?)
 - tracking efficiency
 - detector acceptance
 - electrons-on-target (eot)
 - a loose verification of the MadGraph calculated radiative & full trident cross-section
- Note, these are not specific to the “analysis”...these are tasks/numbers/distributions we need in order to do a search and set limits



****** I expect the first publication will be the 2.2 GeV bump-hunt search**

What “analysis” tasks & choices do we have?

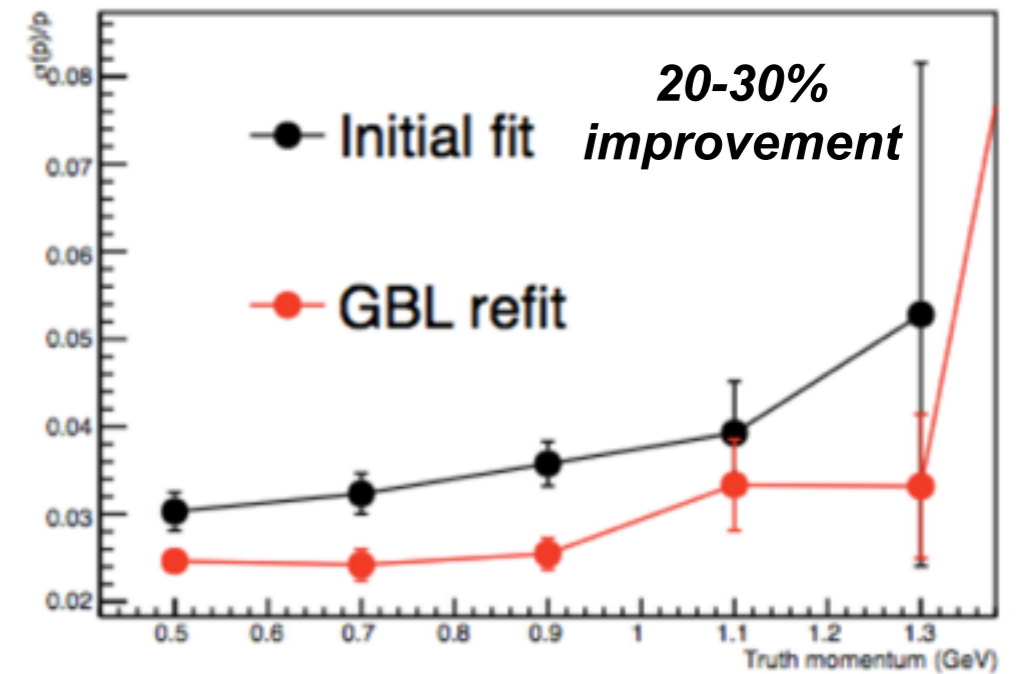
- A few improvements to reconstruction:
 - use GBL-ed tracks & covariance in vertexing
 - incorporate ECal cluster into reconstructed particle
 - adding recoil-electron tracking (and include in vertex)
- Track selection
- Event selection
- Signal extraction & limit setting methods

- As Sho said, we have significant samples of MC data coming in for the MDC in order to develop analysis tools

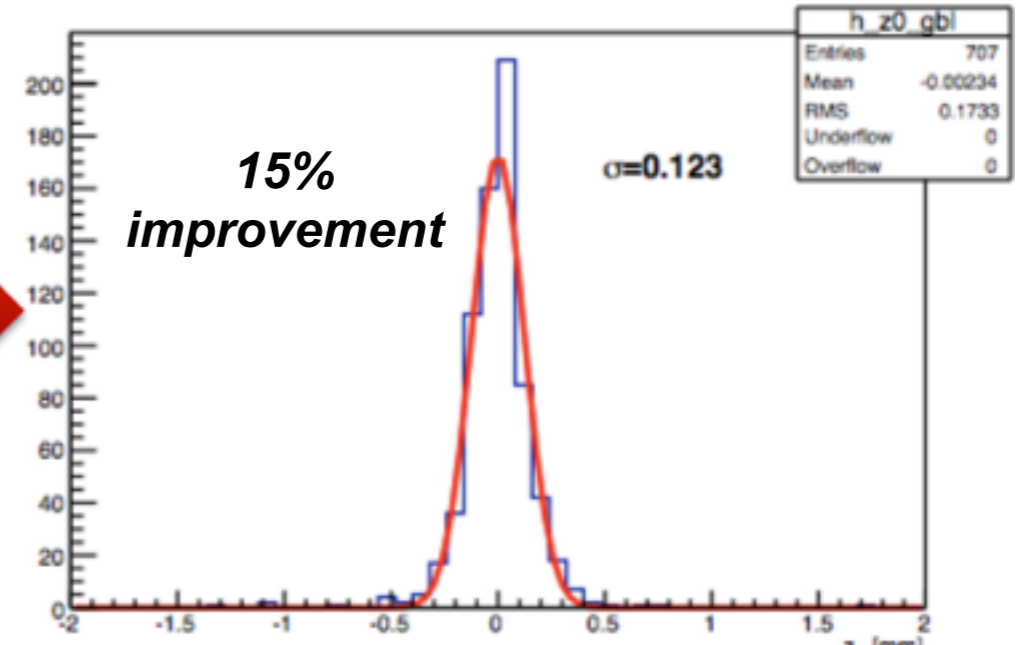
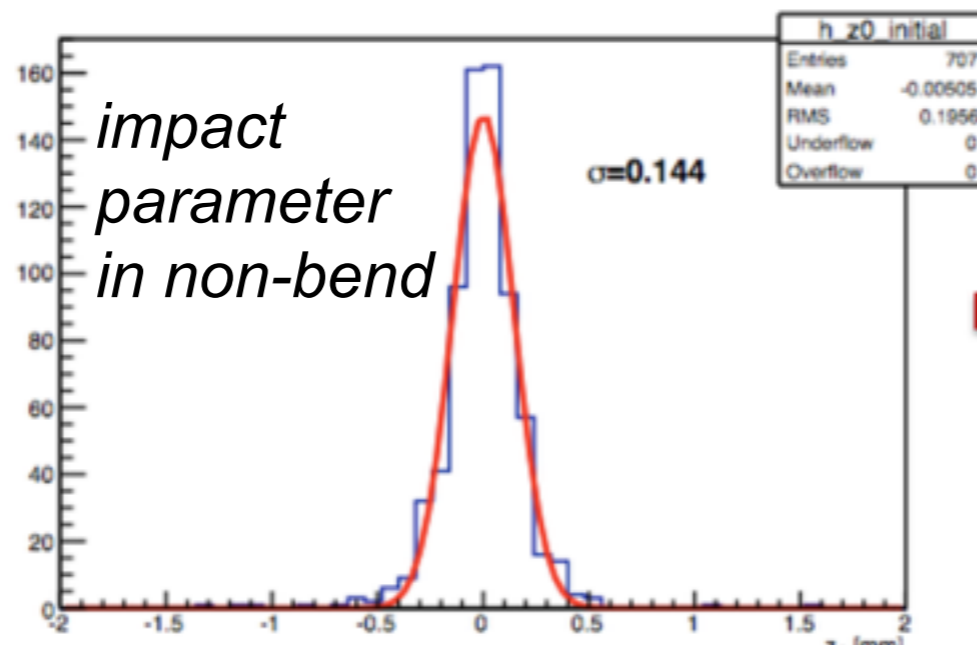
Track reconstruction improvements: GBL

P. Hansson

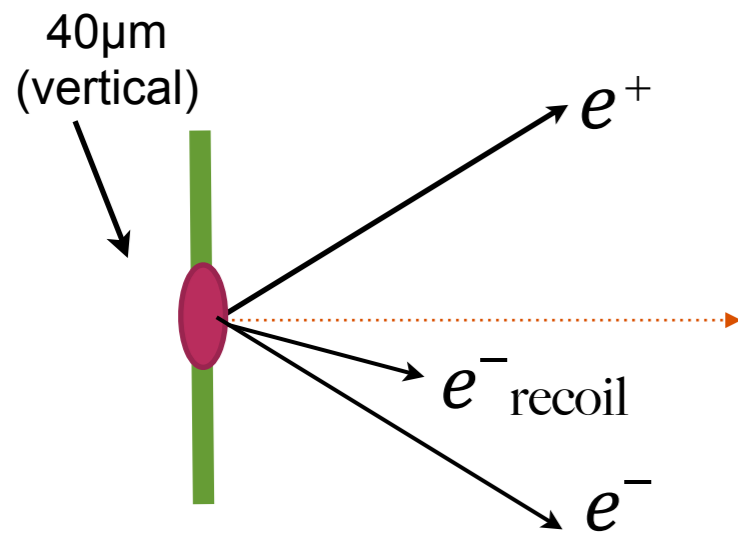
- We don't treat MS correctly in our track fitting; MS errors just added in quadrature downstream
- Pelle talked about GBL, mostly in terms of alignment—equivalent to Kalman filter—more correct treatment of MS
- Using GBL, track parameters measured more precisely→improve mass & vertex resolution
- **BUT, need to get this in hps-java first... sign up!**



free!



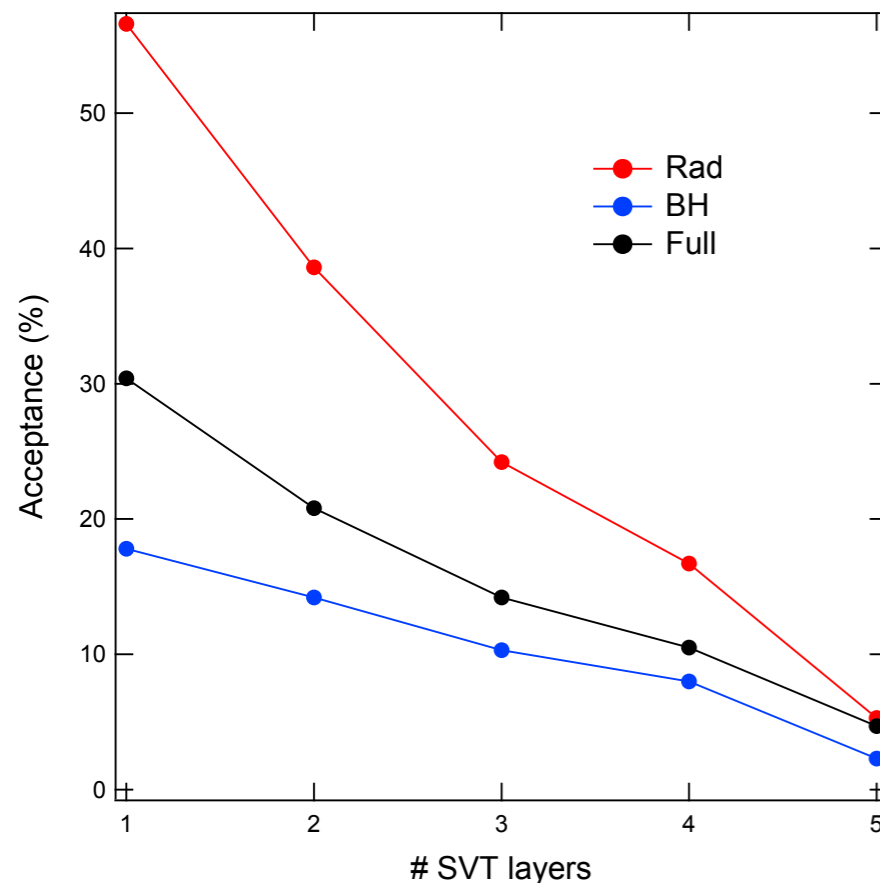
Track reconstruction improvements: Recoil Tracks



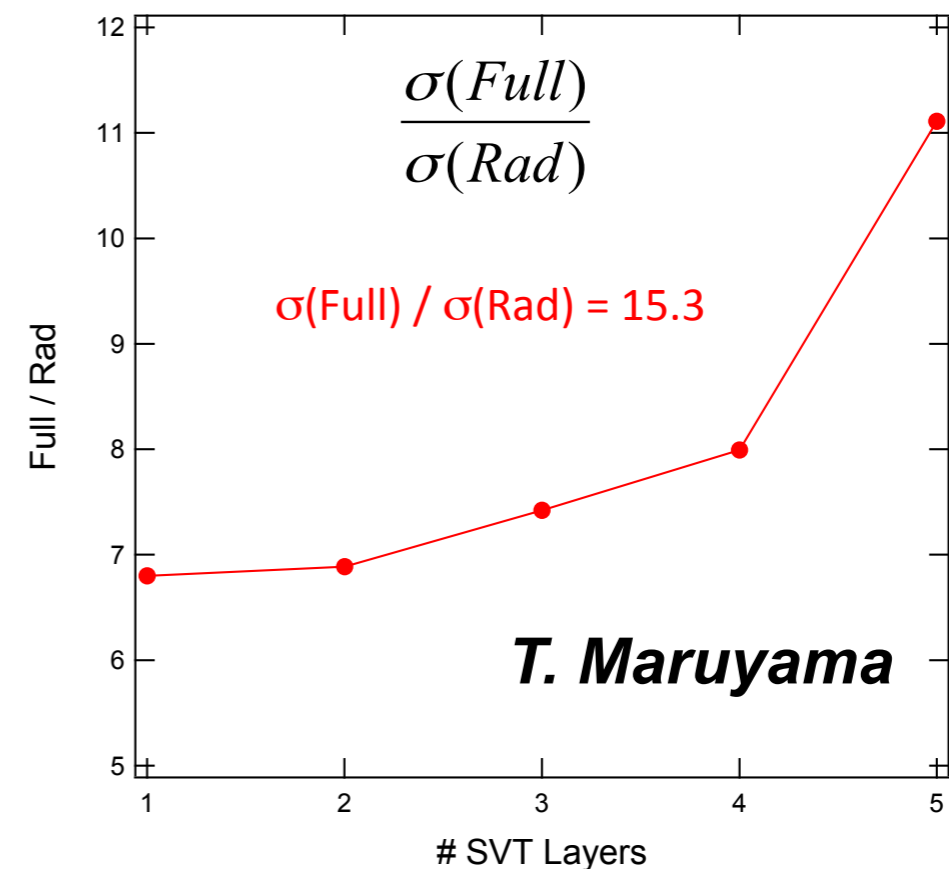
Takashi has shown that reconstructing the recoil electron can help us differentiate radiative background from BH...

recoil typically low momentum → doesn't go through ≥ 5 layers required for main tracking

some development needed to implement this in our reconstruction chain correctly



free!



Vertex reconstruction improvements

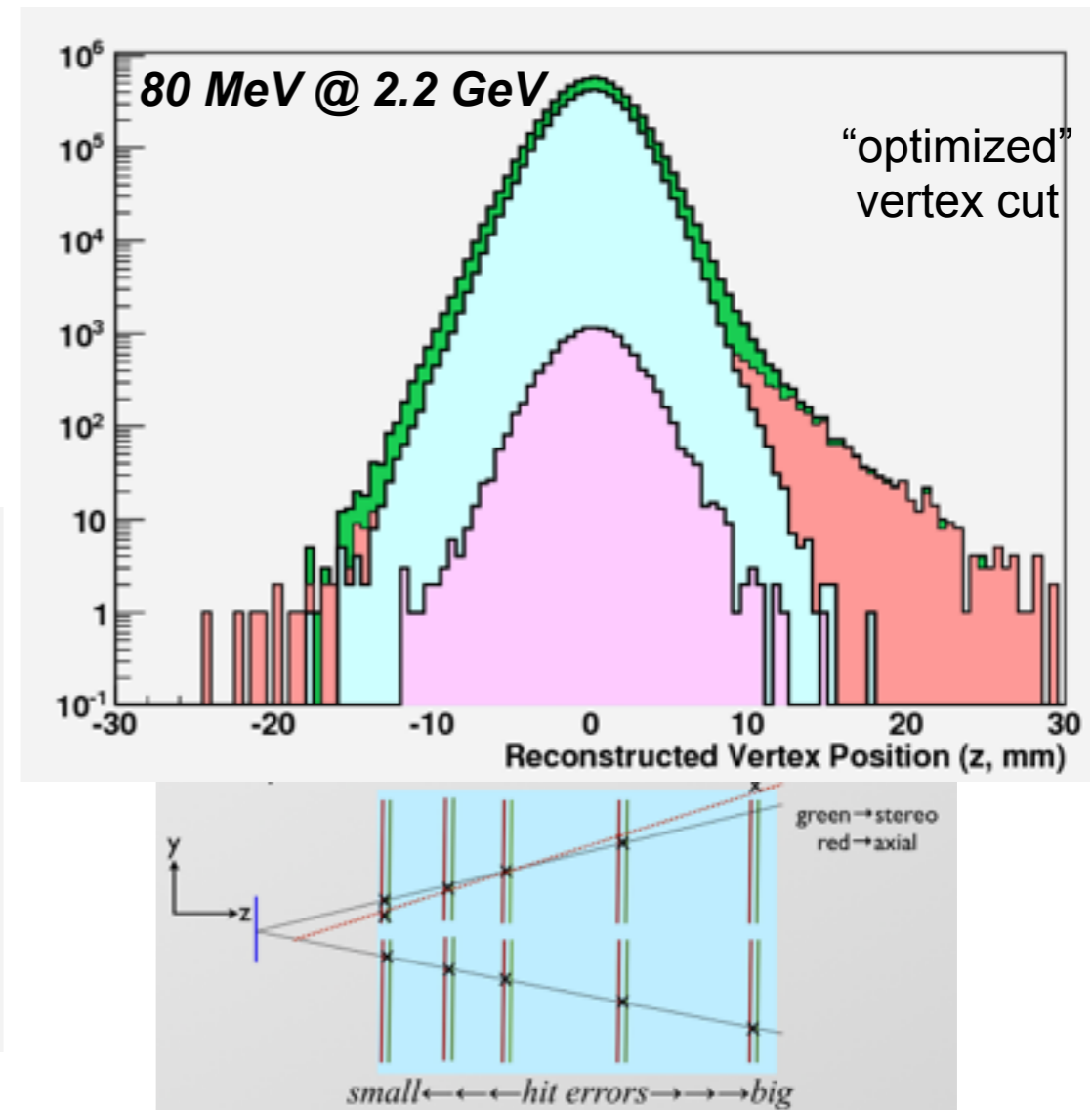
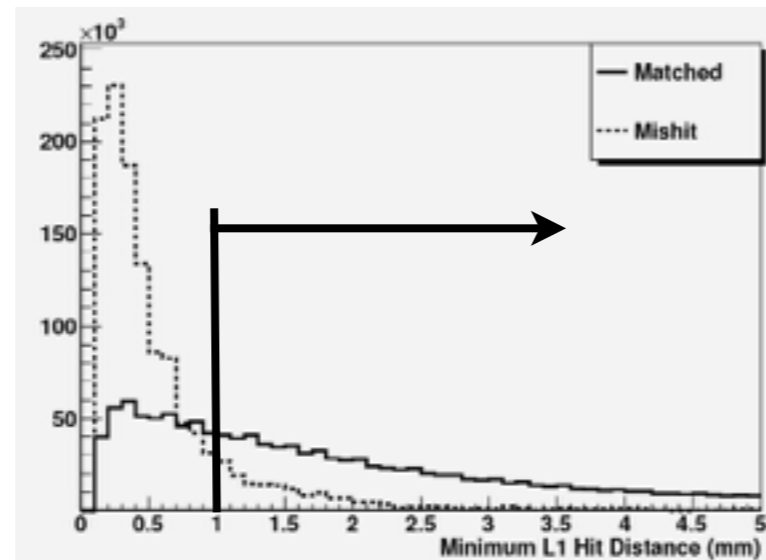
- Use track parameters & covariance from GBL
 - should improve mass & vertex position resolutions
 - **free!**
- Add recoil electron (when found) in the vertex
 - should improve mass resolution in some region of phase space...probably not much help in vertex resolution
 - **free!**
- Track extrapolation/vertexing in varying B-field
 - **N. Graf** is working on this

Track selection optimization

Here \longrightarrow
 is an example
 of a useful cut on
 tracks (at least it's useful
 for vertexing analysis)

free!

- Vertex position of e^+e^- pairs is determined
- dark green: “reasonable” cuts ... e.g. track χ^2 , vertex χ^2 etc
- dark red: >0 hits not matched to the true e^+ or e^- ; “mishits”
- light green: all pairs after isolation cut
- light red: mishits after isolation cut

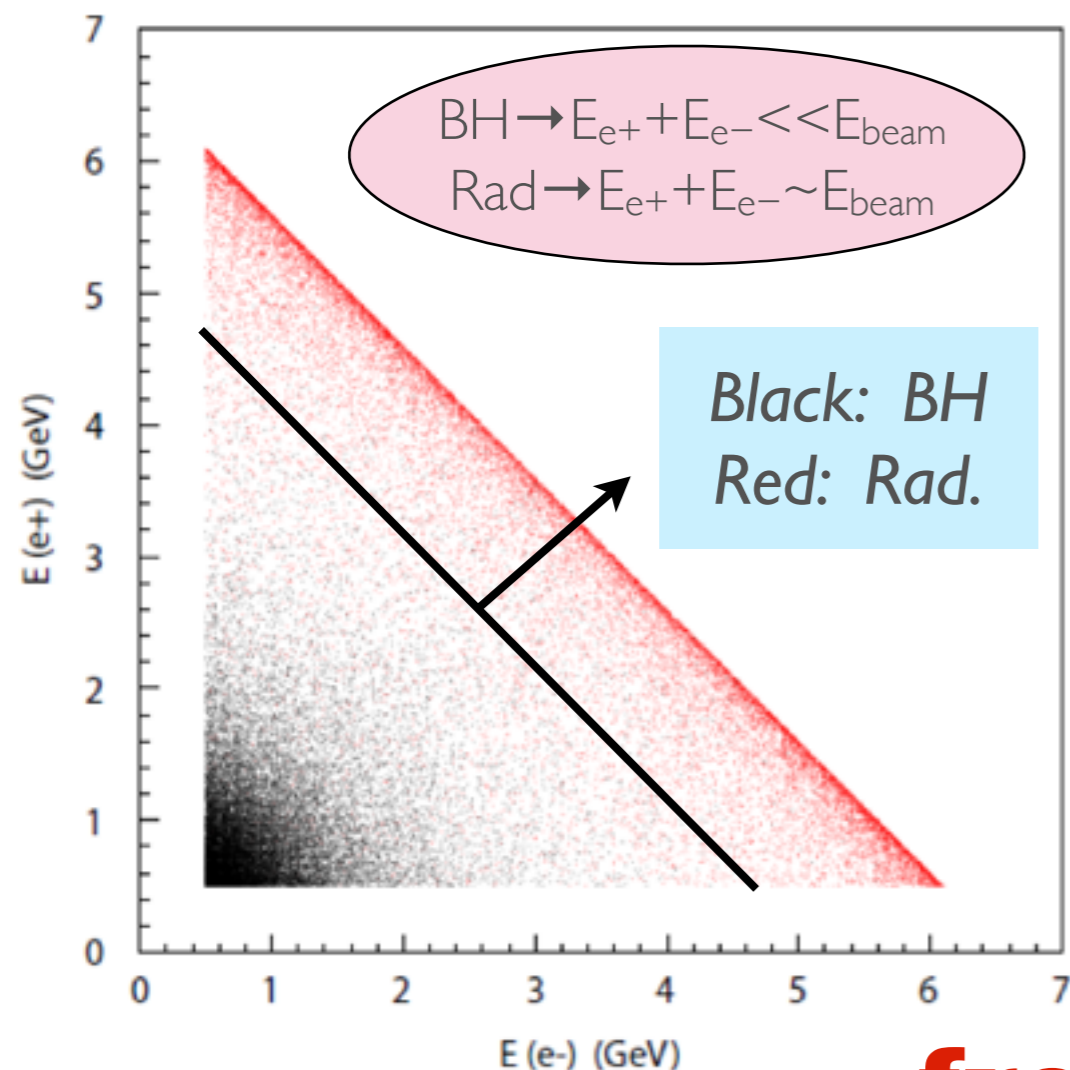


Some track handles: χ^2 , timing, ECAL matching, hit residuals, “kinks” etc...
 bump-hunt & vertexing selection will be different
 I think we should try to standardize these cuts...make separate lists in recon lcio

Event/vertex selection optimization; kinematics

Similar to track selection, there are lots of possible hooks in the event; much of them not explored much:

- most important set of hooks: kinematics... $E(e^-)$ vs $E(e^+)$ for sure; angular information; recoil energy & angle etc;
 - I think there is room here to improve on what was done...figuring out how to use this info in an optimal way could be lots of fun!

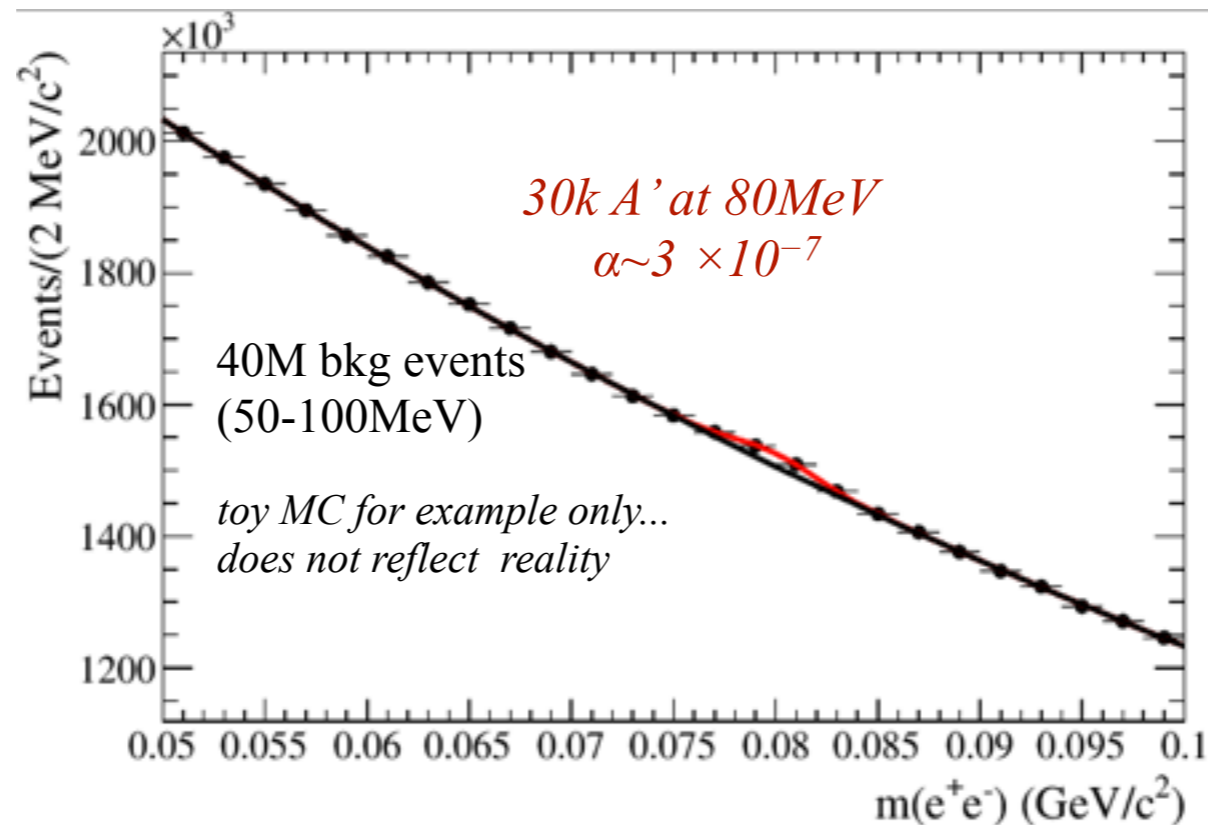


free!

Signal extraction

After event selection, a bunch of choices to make ... e.g. for the bump hunt:

fit or cut-& count? **binned** or unbinned? bin size? fit window size?
fit window step-size? signal PDF? background PDF? What to float/fix?



Limit setting & discovery conditions

APEX did this recently (I helped!)

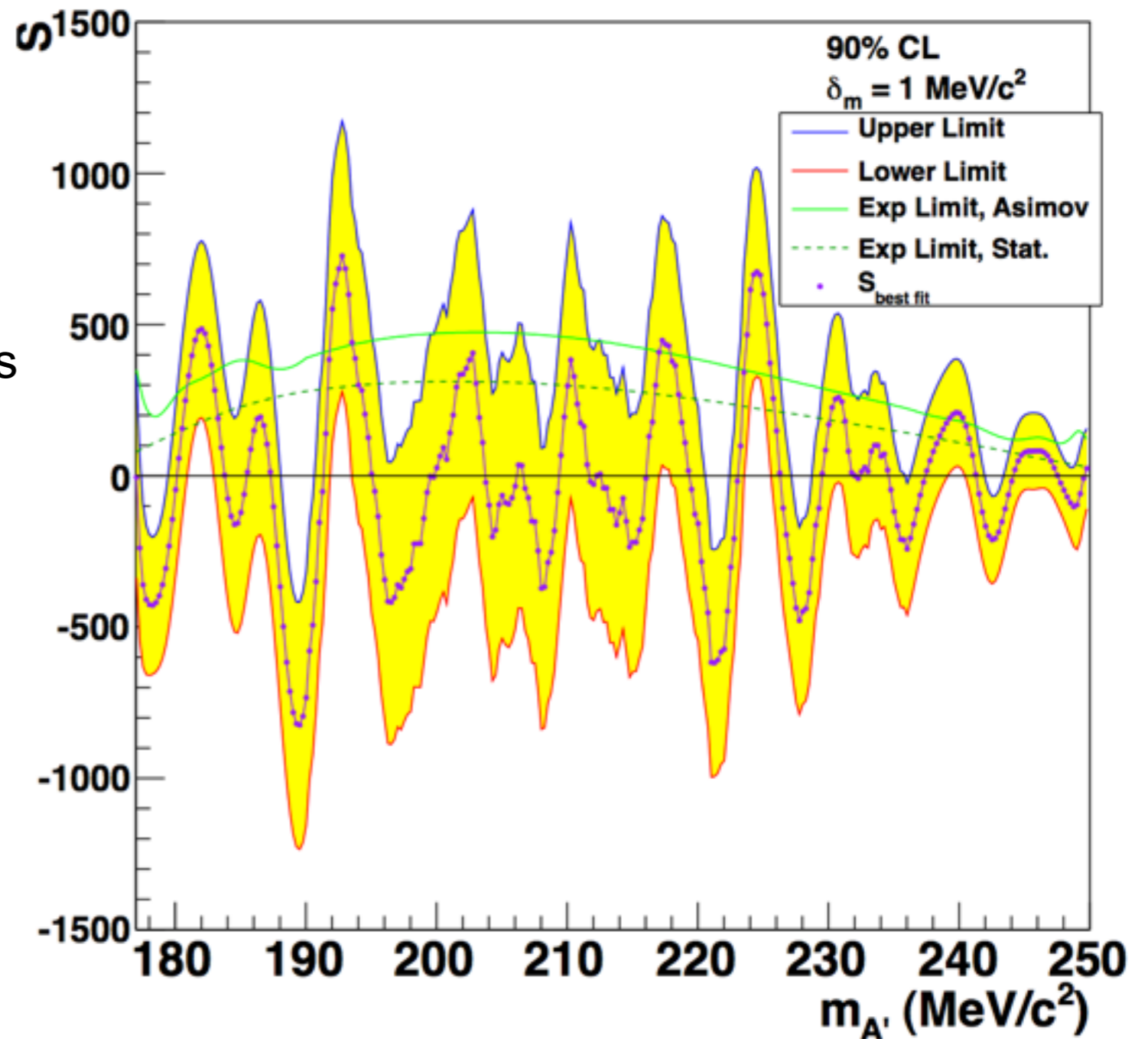
APEX Test Run Data, Two-Sided Central Limit

profile likelihood

$$\lambda(S) = \frac{L(S, \hat{B}, \hat{a}_i)}{L(\hat{S}, \hat{B}, \hat{a}_i)}$$

integrate likelihood → confidence levels

For discovery conditions, take into account trials factor; I think best plan is to generate many toy datasets and run analysis...



Conclusions

- Not as much progress as I'd hoped
 - too much time building detector and making reconstruction work
- Not too late! No time like the present...mock data is becoming available. Want lots of eyes looking at it to get familiar and spot weird stuff.
 - the stuff listed on slide 3 are really important; each one of those is an analysis task unto itself

