GEn Analysis Notes 7/31/25

Update from Vimukthi:
- GEM calibration document has some more documentation
- Front Y and Track phi show a slightly different pattern as expected
  - Reflect the long target
- Track value - constraint
  - Constraint == centering offset
  - This needs to be redetermined every time BBCal energy calibration is done
  - Front x is usually the only one that needs a significant offset
- Front constraint is dictated by the calorimeter energy calibration - centering and width
- Back constraint is less sensitive to quality of energy calibration
- Timestamp is db_bb.dat was written incorrectly
  - Runs effected are 5044-5785 (GEN4b)
  - Might be due to a git merge? Unclear what happened, but in the future, we should just double check our database
- DB corrected, and the peaks are looking as expected
- 70% increase in coincidence events that pass global cuts
- Only a 26% increase when further QE cuts are applied
- Still need to go through the analysis to estimate how many "good" neutrons were recovered
- Timing changes: tdiff = t_primary - t_secondary [for HCal]
  - Can add cut for abs(tdiff)<2ns or <6ns
  - Can these cuts be incorporated into a dx analysis?
- How would this impact the data replay?
  - **Eventually** need to rerun the 4b runs that were affected
  - ==Need to use these improvements to redo the 4b BBCal energy calibration==

Missing Neutron Discussion (Andrew and Gordon)
- Number of neutrons from 4a and 4b are approximately equal?
  - This issue found by Vimukthi effects 4b not 4a, so how does this change our perspective on the missing neutrons in 4a?
  - We need to look at integrated charge comparison between the two kinematics
- What might cause us to be missing tracks?
  - Are we not selecting the correct QE track in our search region?
  - Are there other tracks that are candidates?

- Short answer: if GEMs are efficient and the good signals are not contaminated by overlapping bckgd, there is little chance of the algorithm finding a "wrong" track
  - You are only looking at ~2-3% of the active area of the GEMs
  - At the SH layer +/-6cm in x and y (12x12cm square)
    - At front see +/-10-12cm horizontally
- More than one good track found in the search region, and every track beyond the first one is almost always a false track - can know by looking at ch^2 of straight-line fit
  - We typically have 4-5 hits to make a line, and things get murky when we only have 3 hits
- In GEn, the probability of finding another good charged particle track within the search region defined by BBCal is **not** big enough to worry about
  - Other detectors provide such strong constraints that we can be confident
- HOWEVER, if the individual GEMs are inefficient, and our good hits fail basic hit quality or timing criteria, then you may fail to find any track at all or find false tracks
  - Probably not an issue in Andrew's opinion
- GEM efficiency is likely around 80-90% with how they were operated in GEn
  - Intrinsic detection efficiency
- In the proposal for ERR committee, did we take into account that HCal was placed improperly?
  - This would be before GEn started
  - Summer of 2023 projections account for GEN3 as we actually ran it
    - Check the date of the report that Gordon used for his rate estimates
- How efficient is the trigger?
- Check hydrogen data?
  - Are our H2 data at the same luminosity as we had for He3?
    - Check beam currents and such
- 3-hit tracks may include false tracks - need to consider this
  - Grinch track correlation cuts can help with this
  - Hit quality criteria within the tracking algorithm are stricter for 3-hit tracks than for 4- or 5-hit tracks
    - Already baked into the tracking algorithm
- Try excluding 3-hit tracks?

- - Check dx and dy and W2 and vz and coin - compare for 3-hit vs 4+-hit tracks
    - 3-hit tracks should have a flat distribution of background false tracks
  - ==What are timing and asymmetry cuts that reject background hits on the GEMs==
    - Make sure they aren't too aggressive
  - ==Look at software thresholds in the GEM analysis==
    - Make sure they aren't too high
  - Where were events recovered in GMn?
    - Mostly improved calibration of BBCal
      - Allowed a narrower search region
    - Filtering criteria
    - GMn had higher luminosity
    - Similar GEM background rates