Luminosity Studies

January 24th, 2019

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How am I finding my yields?

- Current is calculated per event with a threshold current of 2.5 uA for BCM4B [See Sangwa's Talk]
- I have not incorporated non-scaler EDTM based calculations so no electronic livetime included
- Yield is calculated by

$$\mathrm{Y} = \frac{N \times PS}{Q \times \varepsilon \times (cpuLT)} \pm \frac{\sqrt{N}}{N}\ \mathrm{Y}$$

  - N is number of reconstructed events passing cuts, PS is the prescale value, and ε are tracking efficiencies

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Let's look into how these four values are calculated

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Number of Events

- Two types of event selection
  - Using the event type leaf fEvtHdr.fEvtTyp where EvtType = 1 or 3 is a SHMS event and EvtType= 2 or 3 is a HMS event (previously used method)
  - Applying proper cuts to the TDC leaves to get the SHMS (3of4 in T.coin.pTRIG1_ROC2.tdcTime) and HMS (elreal in T.coin.pTRIG3_ROC1.tdcTime) event selection (more on this later)
  - In the end, these should result in the same event selection as long as fEvtHdr.fEvtTyp leaf is properly selecting events
- A number of cuts were applied as well
  - SHMS cuts: P_cal_etotnorm > 0.05, P_hgcer_npeSum > 1.5, P_aero_npeSum > 1.5
  - HMS cuts: H_cal_etotnorm > 0.6, H_cal_etotnorm < 2.0, H_cer_npeSum > 2.0

Prescale Values

- CODA produces the prescale factors to reduce the number of triggers.
- The prescale factors are read in from the report files after a replay.

CPU Livetime

- Originally this was calculated through purely scalers
  - cpuLT = L1Acc/[(ptrig1/ps1)+(ptrig3/ps3)]
- To improve this beyond the level one accepts the TDC leaves (described above) were used
  - The same cuts as the event selection were applied
  - cpuLT = (TDC_trig1cut+TDC_trig3cut)/[(ptrig1-EDTM/ps1)+(ptrig3-EDTM/ps3)]
- The latest improvement was to separate the HMS cpuLT and SHMS cpuLT and calculate them separately
  - cpuLT_HMS = TDC_trig3cut/[(ptrig3-EDTM)/ps3]
  - cpuLT_SHMS = TDC_trig1cut/[(ptrig1-EDTM)/ps1]

Tracking Efficiencies

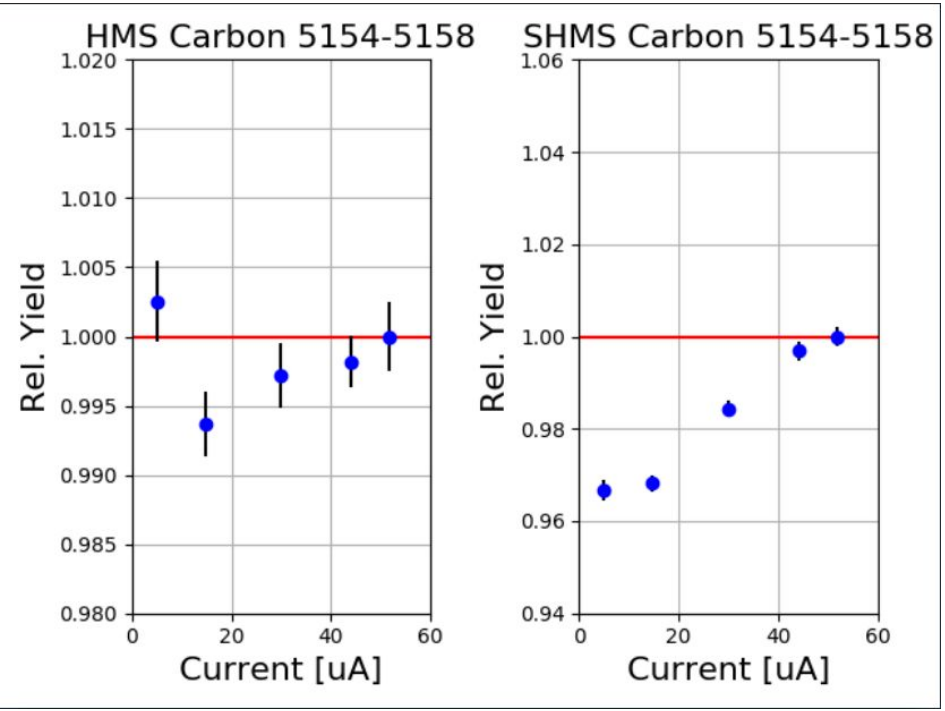
- The runs that I looked at had electrons in the HMS and pions in the SHMS
  - P_{HMS}=-3.266, Θ_{HMS}=12.50, P_{SHMS}=+6.842,Θ_{SHMS}=6.55
  - P_{HMS}=-4.204, Θ_{HMS}=14.51 P_{SHMS}=+6.053,Θ_{SHMS}=6.55
- HMS tracking was found by applying cuts to H.dc.ntrack
- SHMS tracking was found by applying cuts to P.dc.ntrack
- The HMS used the electron tracking efficiency while the SHMS used the pion tracking efficiency (note that originally the SHMS used the hadron tracking efficiency but there was little change going to pion tracking)

Tracking Efficiencies (con't)

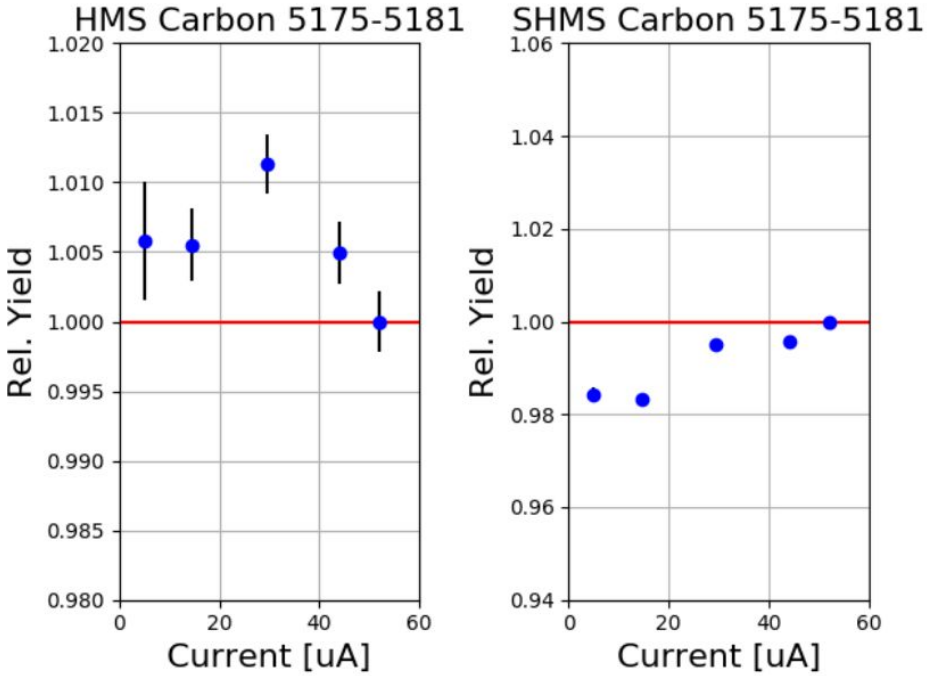
- Electron tracking efficiency cuts -> H_hod_goodscinhit == 1 & H_hod_betanotrack > 0.8 & H_hod_betanotrack < 1.3 & (H_dc_1x1_nhit + H_dc_1u2_nhit + H_dc_1u1_nhit + H_dc_1v1_nhit + H_dc_1x2_nhit + H_dc_1v2_nhit) < 20 & (H_dc_2x1_nhit + H_dc_2u2_nhit + H_dc_2u1_nhit + H_dc_2v1_nhit + H_dc_2x2_nhit + H_dc_2v2_nhit) < 20 & H_cer_npeSum > 0.5 & H_cal_etotnorm > 0.6 & H_cal_etotnorm < 2.0
- Pion tracking efficiency cuts ->P_hod_goodscinhit == 1 & P_hod_betanotrack > 0.5 & P_hod_betanotrack < 1.4 & (P_dc_1x1_nhit + P_dc_1u2_nhit + P_dc_1u1_nhit + P_dc_1v1_nhit + P_dc_1x2_nhit + P_dc_1v2_nhit) < 20 &(P_dc_2x1_nhit + P_dc_2u2_nhit + P_dc_2u1_nhit + P_dc_2v1_nhit + P_dc_2x2_nhit + P_dc_2v2_nhit) < 20 & P_cal_etotnorm > 0.05 & P_cal_etotnorm <= 0.6 & P_hgcer_npeSum > 10 & P_aero_npeSum > 3
- Hadron tracking efficiency cuts ->P_hod_goodscinhit == 1 & P_hod_betanotrack > 0.5 & P_hod_betanotrack < 1.4 & (P_dc_1x1_nhit + P_dc_1u2_nhit + P_dc_1u1_nhit + P_dc_1v1_nhit + P_dc_1x2_nhit + P_dc_1v2_nhit) < 20 &(P_dc_2x1_nhit + P_dc_2u2_nhit + P_dc_2u1_nhit + P_dc_2v1_nhit + P_dc_2x2_nhit + P_dc_2v2_nhit) < 20 & P_cal_etotnorm > 0.05 & P_cal_etotnorm <= 0.6

Most up to date plots (Carbon)

P_{HMS}=-3.266, Θ_{HMS}=12.50 P_{SHMS}=+6.842,Θ_{SHMS}=6.55

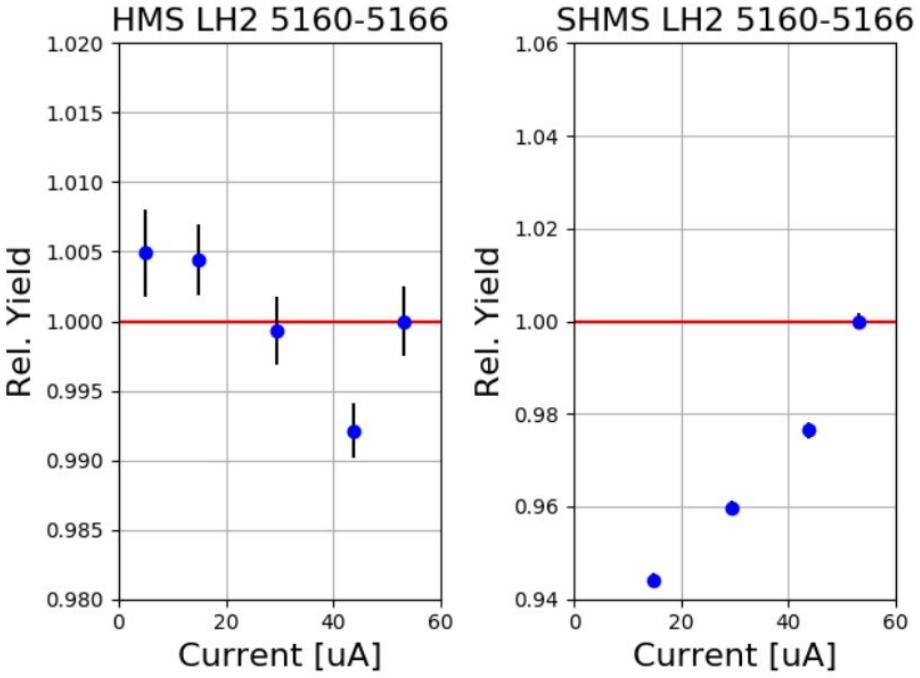


P_{HMS}=-4.204, Θ_{HMS}=14.51 P_{SHMS}=+6.053,Θ_{SHMS}=6.55

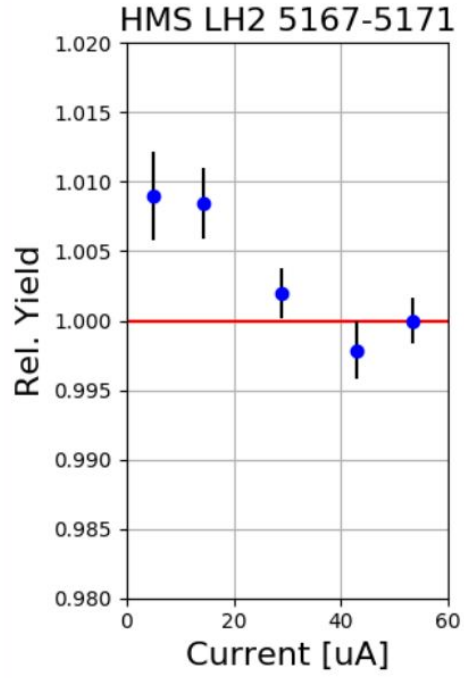


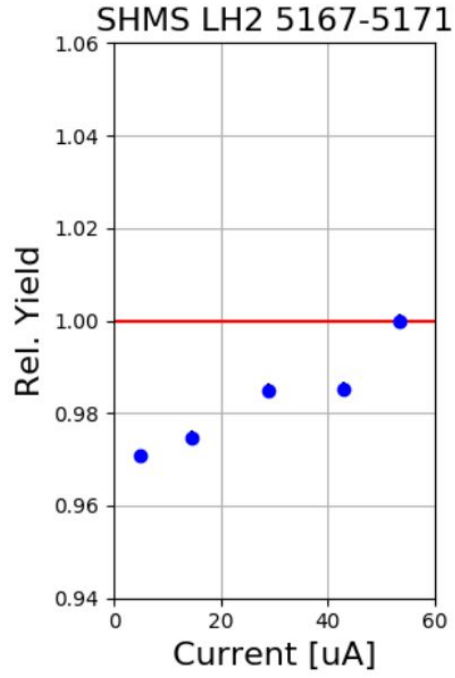
Most up to date plots (LH2)

P_{HMS}=-3.266, Θ_{HMS}=12.50 P_{SHMS}=+6.842,Θ_{SHMS}=6.55



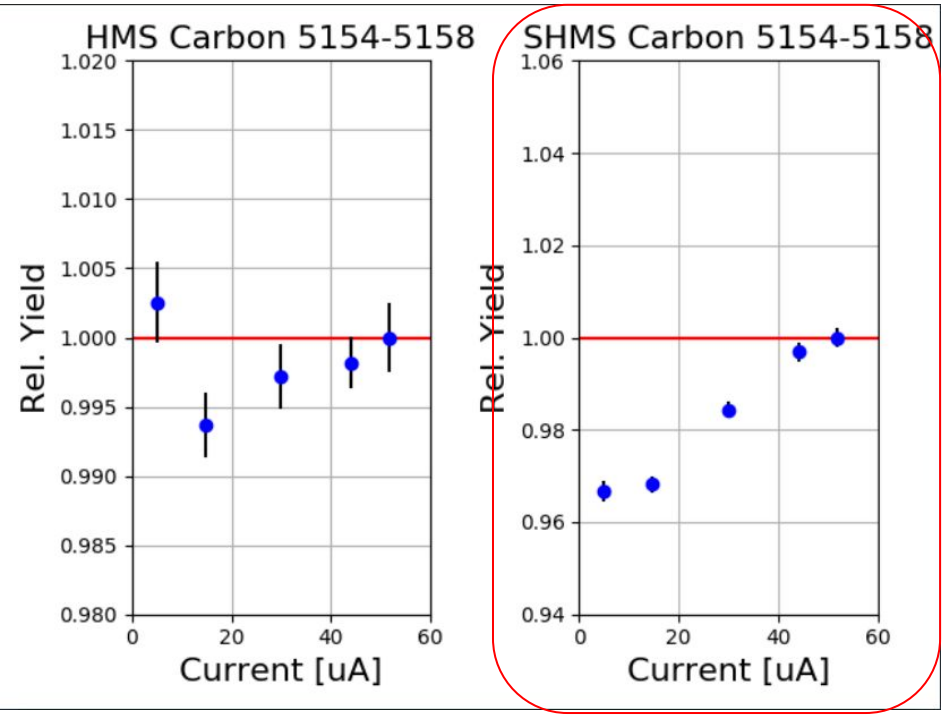
P_{HMS}=-4.204, Θ_{HMS}=14.51 P_{SHMS}=+6.053,Θ_{SHMS}=6.55

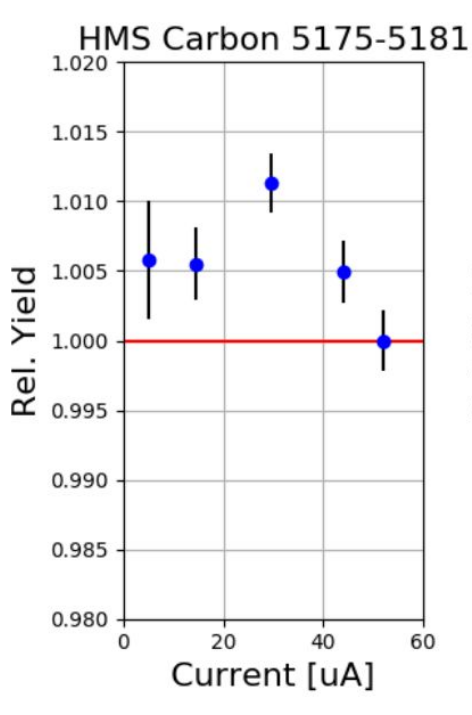


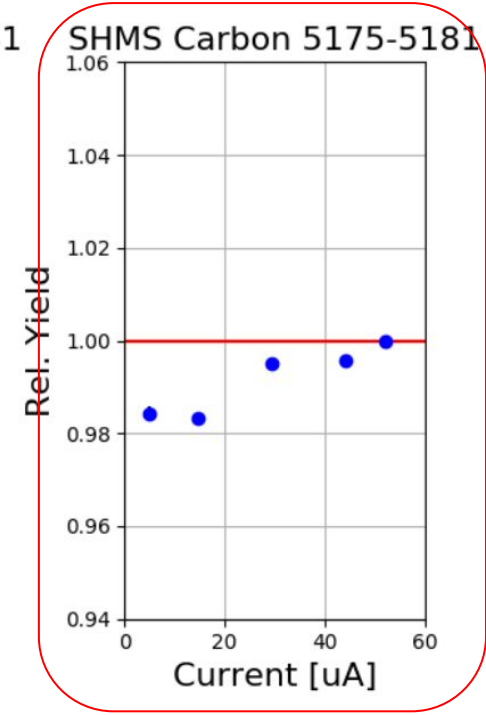


Looking back at carbon plots

Something's not quite right

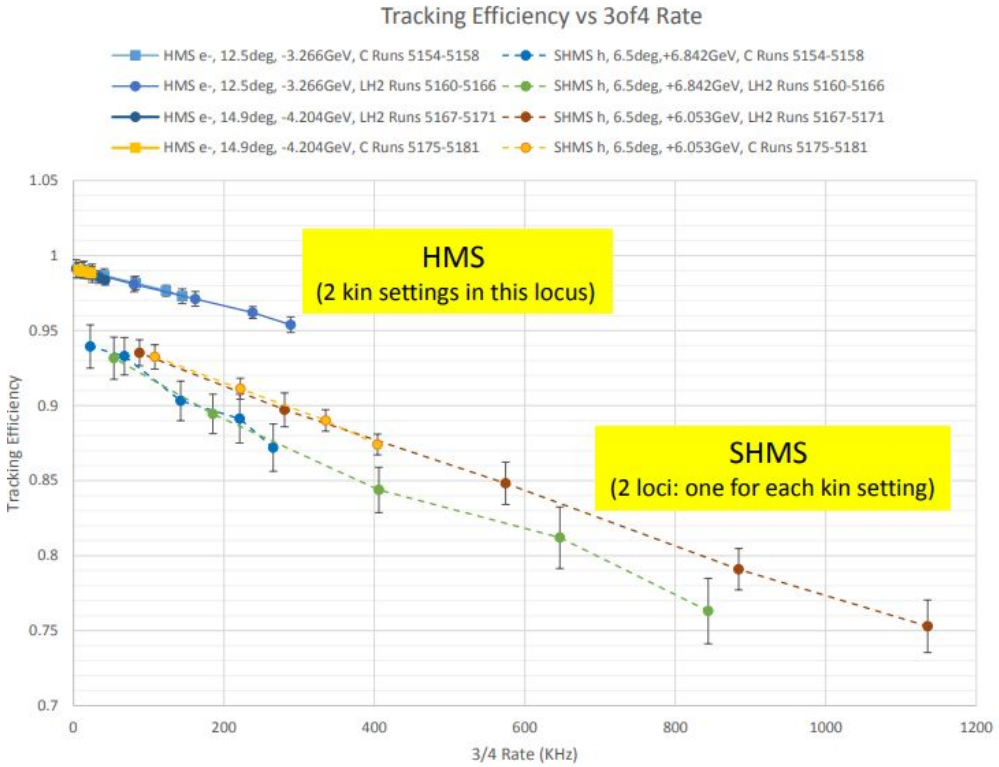






What could be causing this slope?

- Taking a look at Dave Mack's analysis of the tracking efficiencies [See elog entry]
- SHMS tracking efficiency seems low by 4-6%
- Only using pion tracking with clean pion cuts (P_hgcer_npeSum > 10 && P_aero_npeSum > 3) did not fix the issue with SHMS



TDC cuts vs Event type; really the same event selection?

- As stated before, applying proper cuts to the TDC leaves to get the SHMS (3of4 in T.coin.pTRIG1_ROC2.tdcTime) and HMS (elreal in T.coin.pTRIG3_ROC1.tdcTime) event selection. Using the event type should result in the same event selection, but is this true?
- Brad and Eric have made it clear how complex this can get so they suggested to begin at the basics.
- Well they were correct. It turns out physics is hard, especially when trying to correct for errors of 1% or less. To simplify things and try to gain a better understanding of the underlying physics, I have been looking at the singles runs we took during kaonLT
  - Runs: 5151, 5152, 5153, 5164, 5165
- There are still some issues I am working through, but getting there

Summary 1/24

- The luminosity yields are starting to look pretty good but we still have a ways to go
- The SHMS carbon slope did not improve much after applying clean pion cuts to the tracking efficiency
    - This issues still needs further investigation, possibly rethinking how I find the tracking efficiencies
- The comparison between TDC cuts and event type for event selection has been eagerly awaited, I am working hard on these singles so I can move onto the fun stuff!
- The lovely slides on EDTM total livetime by Dave and Eric will be very useful when I move onto the inclusion of electronic livetime. [See the presentation here]