LHRS Analysis for d_2^n

Triggers, Live Time and Raw ^{3}He Cross Sections

D. Flay

3/25/11

Outline

Trigger Study (1)
General Notes: Definitions

1. Latch Pattern: The bit-pattern that is set by the trigger supervisor (TS). The first trigger that reaches the TS and passes prescale starts an internal timer. Any other triggers that reach the TS input (subjected to their own ps value) within a certain time frame will also have their bit set.
2. Unprescaled Bit Pattern: Derived from copies of the raw trigger inputs to the TS. Plugged into a block of TDC channels.
3. Prescaled Bit Pattern: Derived from the output of the TS. Also plugged into a block of TDC channels. There should not be multiple hits in the relevant TDC channel, since it is derived from the TS. Its timing distribution is constrained by the internal time window of the TS.

Trigger Study (2)
Summary of Elastic and Inelastic Data

1. Elastic data: unprescaled bit pattern is not in agreement with $ps\cdot$`DL.bitN`
   - In fact, the unprescaled bit pattern is consistent w.r.t. the prescaled bit pattern to $\sim 2\%$
2. Inelastic data: unprescaled and prescaled trigger bit patterns agree to better than 99.5%
   - Can be explained by the fact that since $ps = 1$, a real T3 event will have the bit pattern set in both the unprescaled and the prescaled channels

Trigger Study (3)
Elastic Trigger Discrepancy

Trigger Discrepancy				
Run Number	Prescale	DL.bit3	DL.LT3	Percent Difference
1203	10	788418	827678	2.43
1230	4	542366	560377	1.63

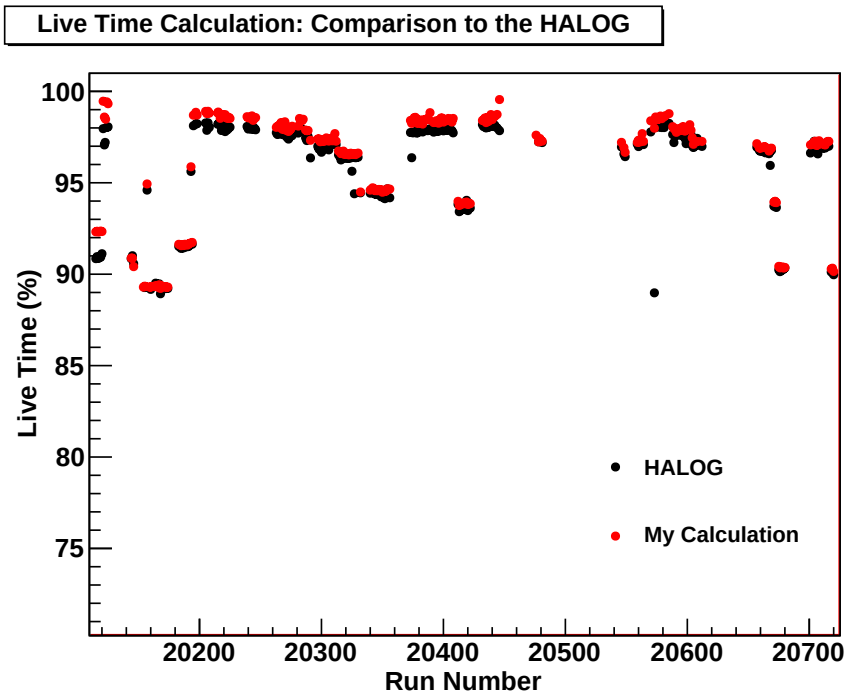
- Why is there a $\sim 2\%$ difference in the elastic case?
  - Consider a T5 event that arrives at the TS. It passes the prescale condition (since $ps = 1$ for T5), an L1A is generated and the bit pattern is set. (That is, we see ch. 5 on the TDC get a hit.) At this point, the variable '`DL.LT3`' also gets a hit. Alternatively, we could have a T5 and a T3 (that passes its prescale condition, $ps \neq 1$) arrive together at the TS. Therefore, bits 3 and 5 are set. In this case, both '`DL.LT3`' and '`DL.bit3`' get a hit.
  - Using an extra cut that explicitly removes the T5 events, we see 100% agreement between `DL.bit3` and `DL.LT3`.

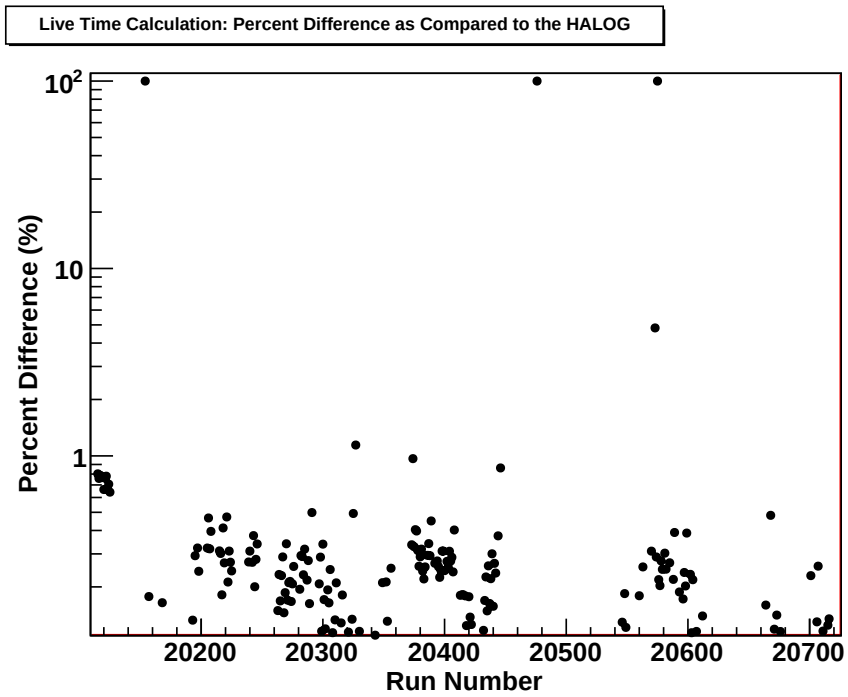
Live Time (1)
Method

- $LT = \frac{evtypebits3}{t3c}$
- Beam trips are removed in this study
  - Event-by-event, we check if it corresponds to a trip
    - No Trip: Does it pass our T3 cut? Record first (and last) non-trip scaler value for the number of triggers recorded (T3c)
    - Trip: Record first (and last) trip scaler value for the number of triggers recorded
    - At the end of each segment (either trip or no trip), push-back a vector for each case containing the most recent segment's scaler count (that is, the difference between the first and last scaler count value)
  - At the end of the event loop, sum over all entries in each vector for both T3 trigger events and T3c scaler counts

Live Time (2)

Results for Negative Polarity Production Data





- Spurious percent differences:
  - $\sim 5\%$: run 20573 – very long run, $\sim$ 4 hours
  - 100%: No end-of-run file for runs 20154, 20476, 20575

Raw ^{3}He Cross Sections (1)

A First Look: Definition

$$\frac{d\sigma_{\text{raw}}}{d\Omega dE'} = \frac{N_{\text{cut}}}{(Q/e)\rho LT\varepsilon} \frac{1}{w\Delta E'\Delta\Omega\Delta Z}$$

1. N_{cut} = Number of e^- that pass all cuts
2. Q/e = Number of beam e^- (N_{inc})
3. ρ = Target density [Amg]
4. LT = Live time
5. ε = Product of all detector (cut) efficiencies
6. w = Acceptance weight (from SAMC)
7. $\Delta E'$ = Energy width [MeV] $(2 \cdot p_0 \cdot \delta p/p)$
8. $\Delta\Omega$ = Solid angle [sr] $(\Delta\theta\Delta\phi)$
9. ΔZ = Full target length [m]

- Each term (except for N_{cut} and w) has been evaluated already and stored to separate databases
- $w = 1$ is assumed for this first calculation

Raw ^{3}He Cross Sections (2)

Statistical Error Calculation

- We calculate the statistical error in quadrature:

$$\frac{\delta\sigma_{\text{raw}}}{\sigma_{\text{raw}}} = \sqrt{\sum_{i=1}^{n}\left(\frac{\delta a_i}{a_i}\right)^2}$$

- Where a_i is each component mentioned on the previous slide
- Note for ε, we have:

$$d\varepsilon = \sum_{j=1}^{m} d\varepsilon_j \left[\prod_{k\neq j}^{m} \varepsilon_k\right] \Rightarrow \frac{\delta\varepsilon}{\varepsilon} = \sqrt{\sum_{j=1}^{m}\left(\frac{\delta\varepsilon_j}{\varepsilon_j}\right)^2}$$

Raw ^{3}He Cross Sections (3)

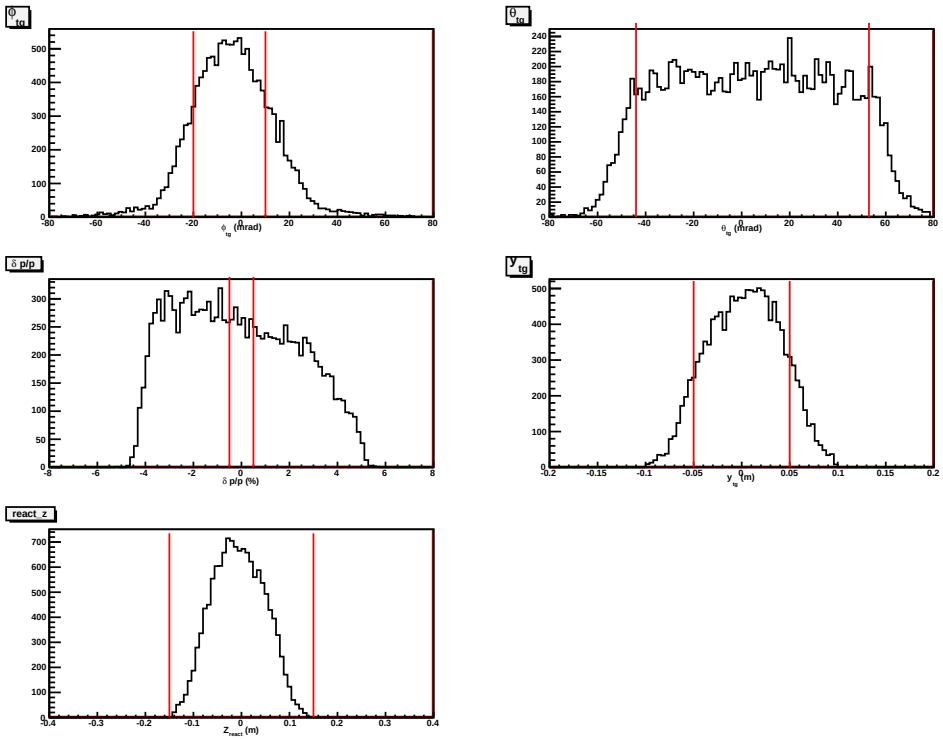
Good Electron Cuts

1. One track: `L.tr.n==1`
2. Triggers:
   `(DL.edtpl==0)&&((DL.evtypebits&(1<<3))==(1<<3))`
3. VDC: `L.vdc.u1.nclust==1` (same for U2, V1 and V2)
4. GC: `L.cer.asum_c>400` (2 p.e.) and TDC cuts
5. PR: `(prl_E_P>0.54)&&(L.prl1.e>200)`
6. β: `L.tr.beta>-0.15`
7. No beam trip: `skim_beam_trip==0`

Raw ^{3}He Cross Sections (4)

Good Electron Cuts

- How about the acceptance cuts?



- Choose a tight cut in ϕ_{tg} and $\delta p/p$ so as to minimize acceptance effects
  - $\Delta\theta = 97$ mrad
  - $\Delta\phi = 30$ mrad
  - $\Delta\Omega = 2.91$ msr
  - $\Delta Z_r = 0.30$ m
  - $\Delta y_{tg} = 0.10$ m
  - $\Delta p/p = 1.0\%$
- Note: $\Delta Z \neq \Delta Z_r$!
  - $\Delta Z = 0.356$ m

Raw ^{3}He Cross Sections (5)

Weighted Average by Run

- We do this calculation for each run for each p_0
- Take the weighted average over i runs

$$\bar{\sigma} = \frac{\sum_i \sigma_i / \delta\sigma_i^2}{\sum_i 1/\delta\sigma_i^2}$$

- What about the error on the weighted average?

$$\delta\bar{\sigma} = \sqrt{\frac{1}{\sum_i 1/\delta\sigma_i^2}}$$

Raw ^{3}He Cross Sections (6)

Weighted Average Results by Momentum Bin: 4-pass

Raw ^{3}He Cross Sections: $E_b = 4730$ MeV	
p (MeV)	$\frac{d\sigma_{\text{raw}}}{d\Omega dE'}$ $\left[\frac{\text{pb}}{(\text{MeV}\cdot\text{sr})}\right]$
600	11.2548 ± 0.1859
800	4.3215 ± 0.1103
1120	1.4088 ± 0.0392
1190	1.0765 ± 0.0309
1260	0.8377 ± 0.0254
1420	0.4630 ± 0.0164
1510	0.2977 ± 0.0108
1600	0.1979 ± 0.0082

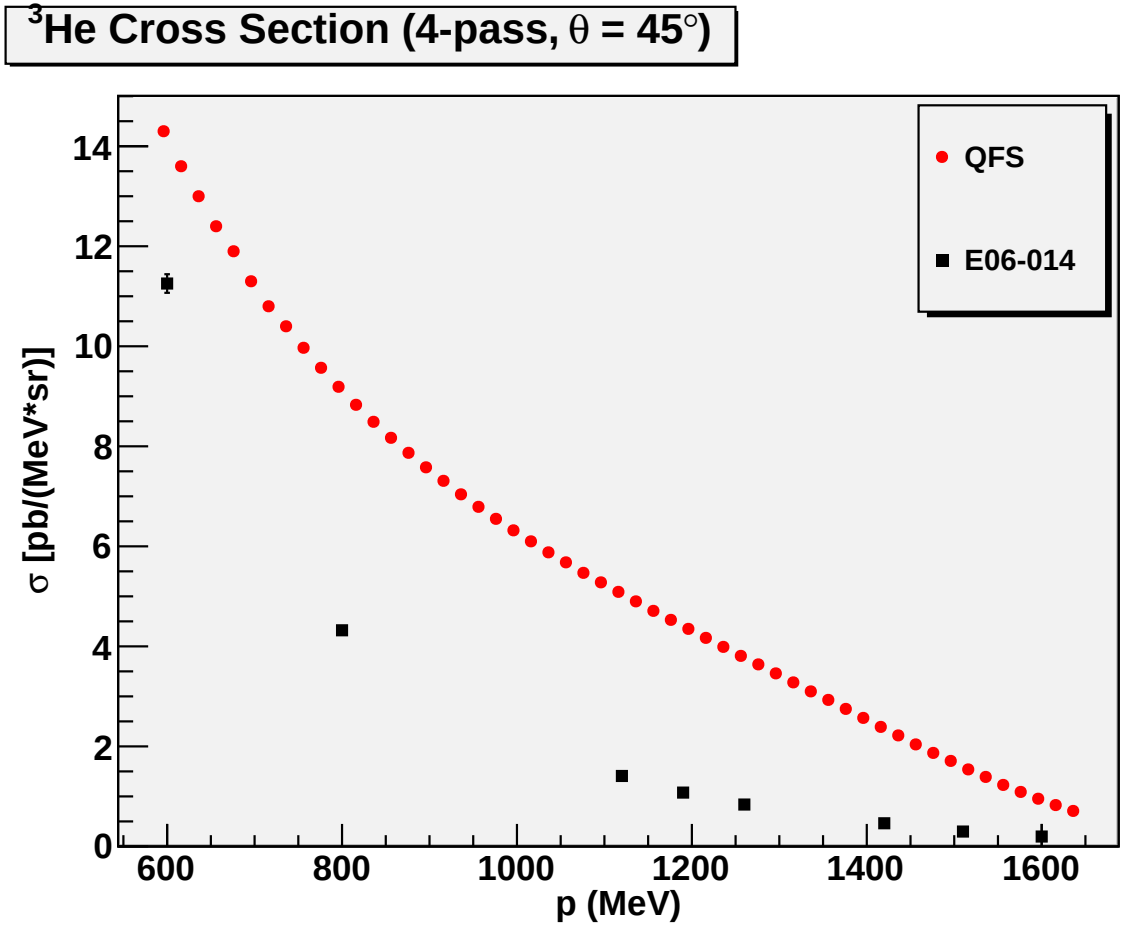
Raw ^{3}He Cross Sections (7)

Weighted Average Results by Momentum Bin: 5-pass

Raw ^{3}He Cross Sections: $E_b = 5890$ MeV	
p (MeV)	$\frac{d\sigma_{\text{raw}}}{d\Omega dE'}$ $\left[\frac{\text{pb}}{(\text{MeV}\cdot\text{sr})}\right]$
600	11.2205 ± 0.1097
700	6.2678 ± 0.0994
900	2.2154 ± 0.0529
1130	0.9350 ± 0.0262
1200	0.6477 ± 0.0247
1270	0.5344 ± 0.0162
1340	0.4360 ± 0.0190
1420	0.3035 ± 0.0105
1510	0.2144 ± 0.0096
1600	0.1450 ± 0.0064
1700	0.0952 ± 0.0063

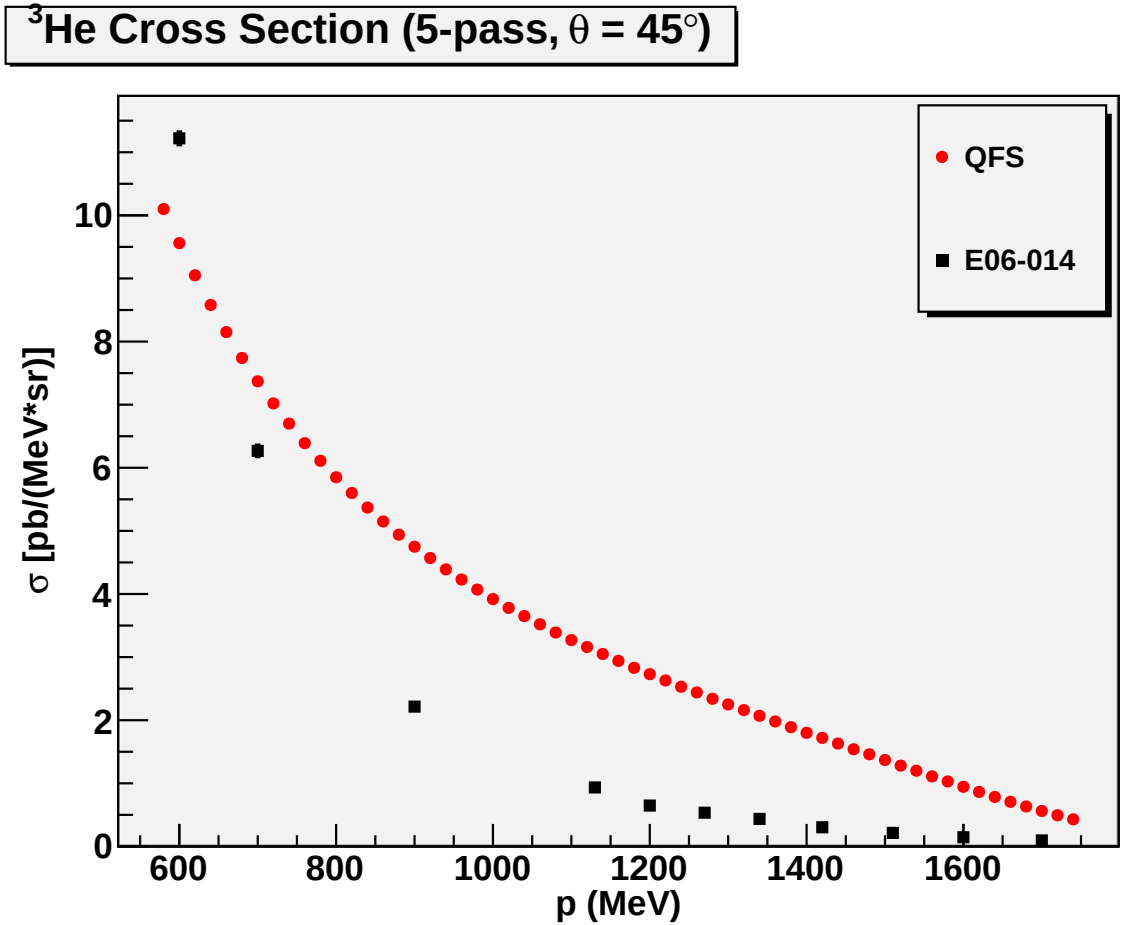
Raw ^{3}He Cross Sections (8)

Comparision to QFS at 4-pass



Raw ^{3}He Cross Sections (9)

Comparision to QFS at 5-pass



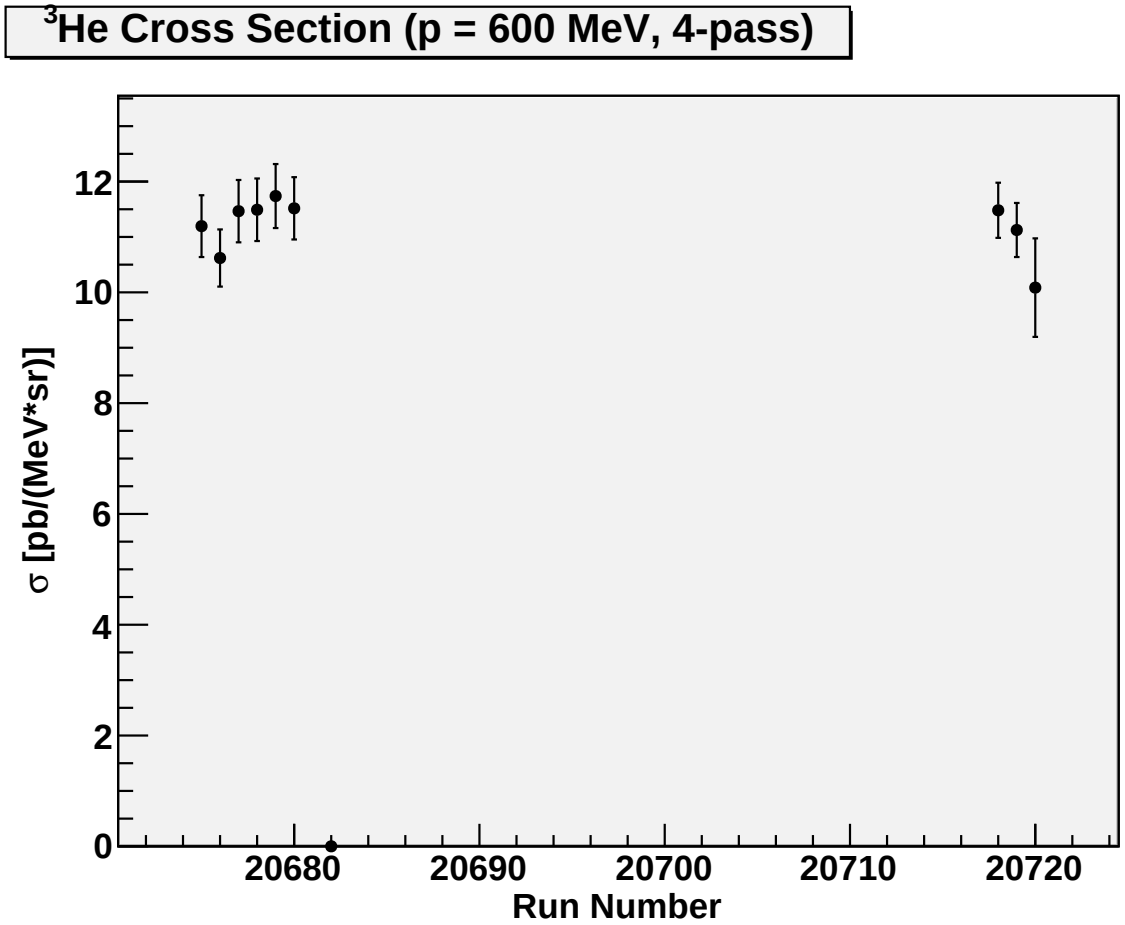
Summary

- Triggers:
  - We have a good handle on the reason why the elastic data had a discrepancy of $\sim 2\%$: T5s convolute the situation
- Live time:
  - Results of the calculation agree with the reported online dead time at the 1% level
- Raw ^{3}He Cross Section:
  - Follows the general trend seen in the QFS simulation
  - Still need detailed study of acceptance cuts

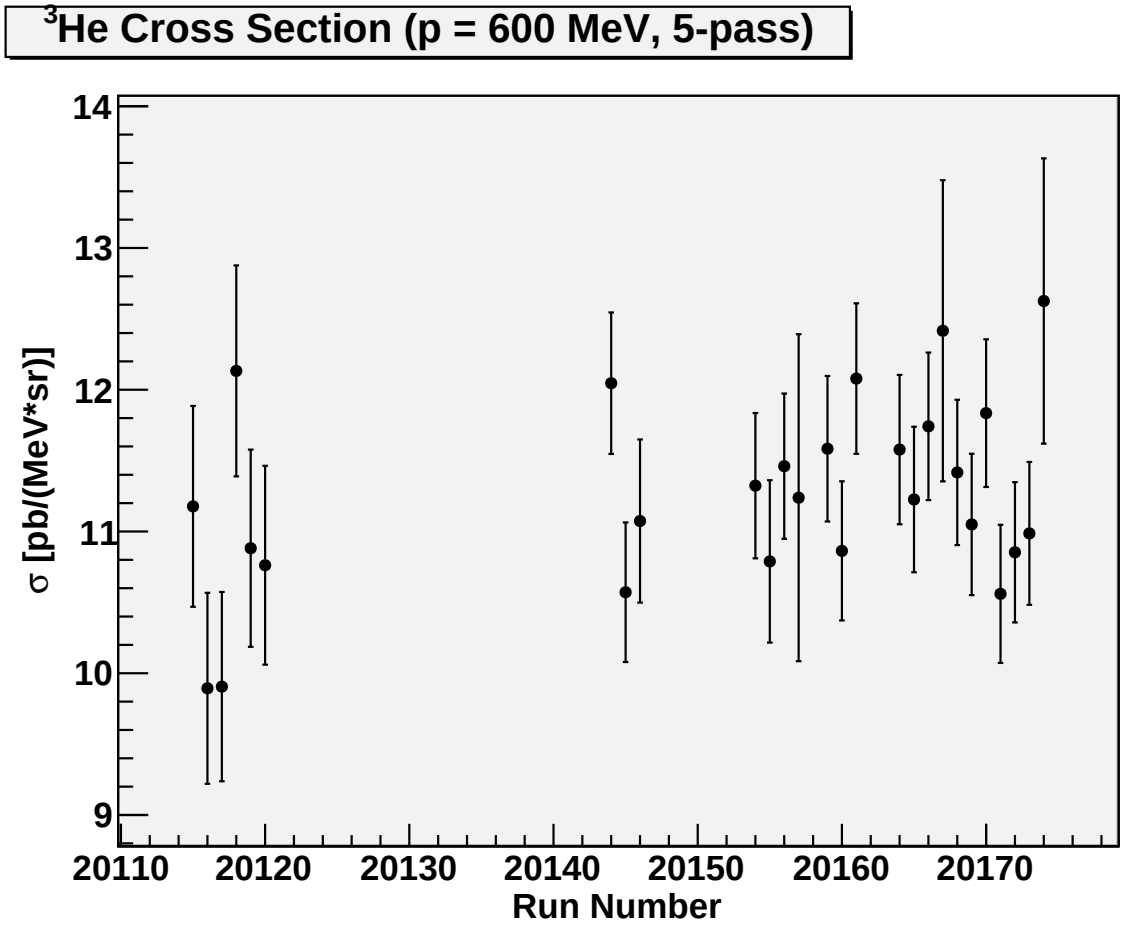
What's Next?

- Cross Sections:
  1. SAMC and acceptance studies
  2. Quasi-elastic
  3. Nitrogen
  4. Positive polarity
  5. We're still missing target densities for runs 20419 and 20216
- Asymmetries:
  1. Develop code for $A_{\parallel}$, $A_{\perp}$
  2. Determine run list based on target configuration (to give to Yawei for target polarizations)
- Data Quality:
  1. Finish off running skim code on positive polarity data

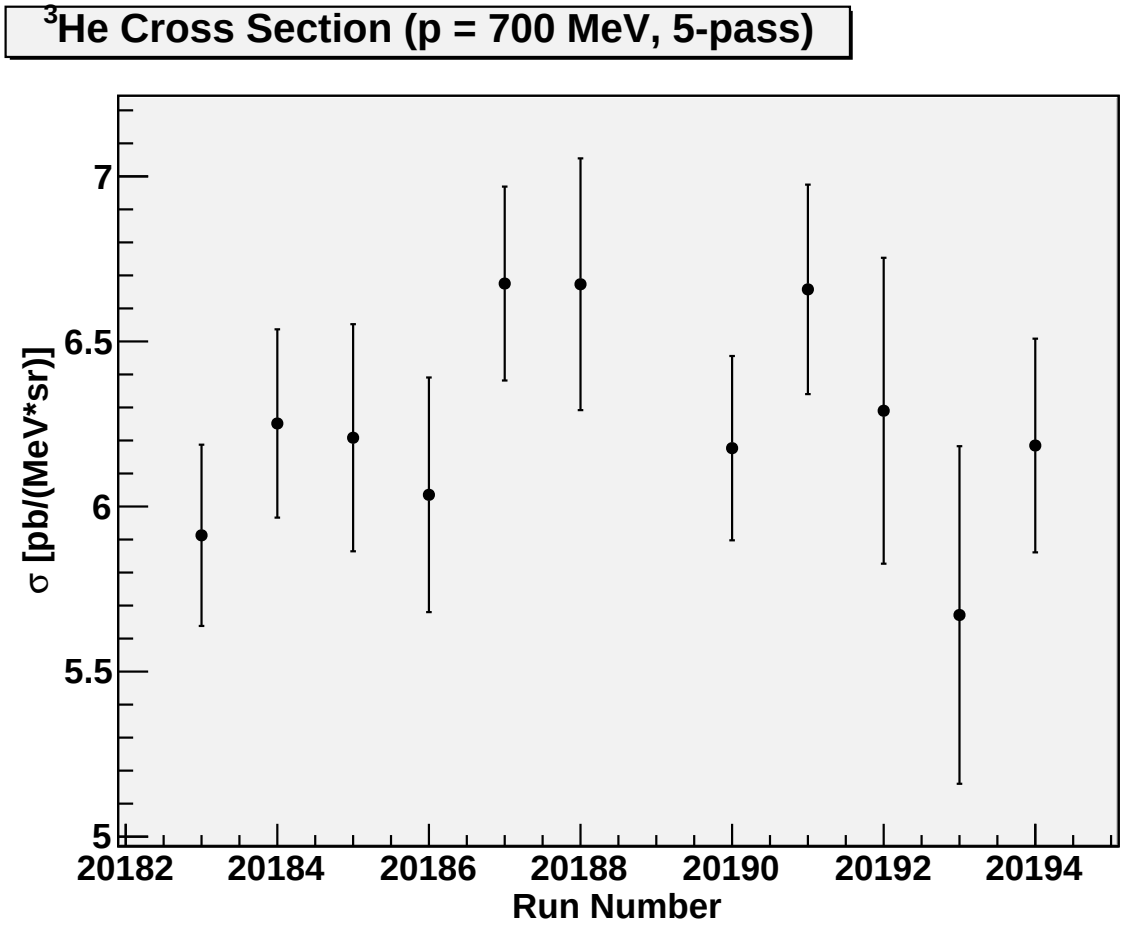
Appendix
Raw ^{3}He Cross Sections by Run



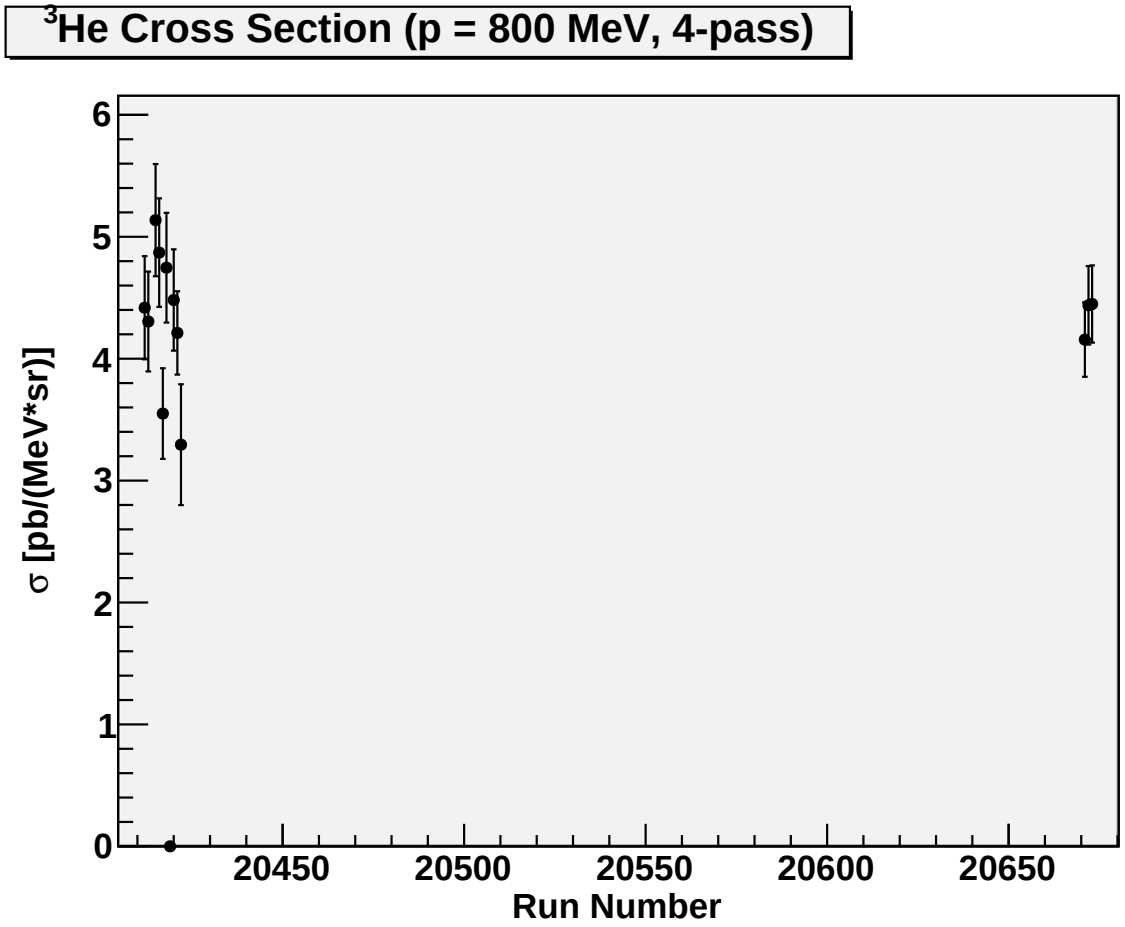
Appendix
Raw ^{3}He Cross Sections by Run



Appendix
Raw ^{3}He Cross Sections by Run

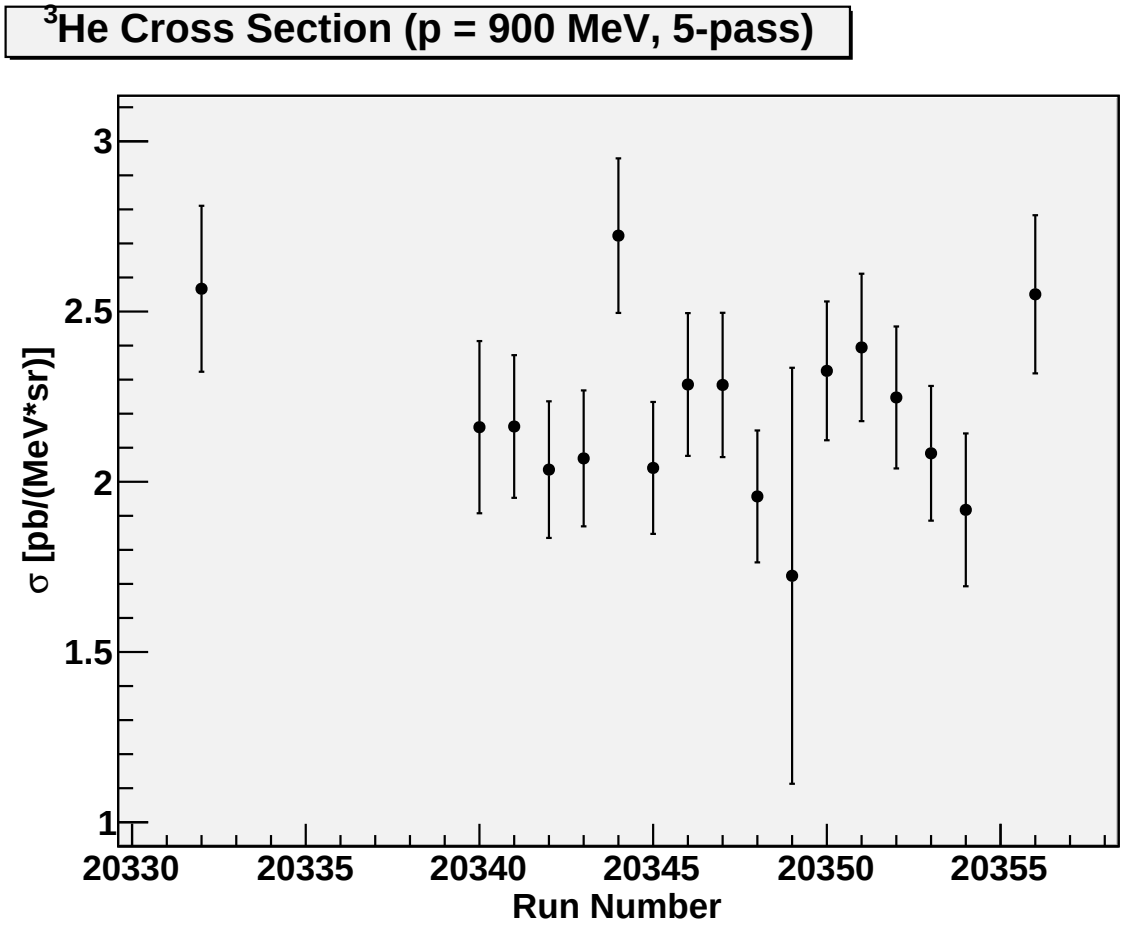


Appendix
Raw ^{3}He Cross Sections by Run

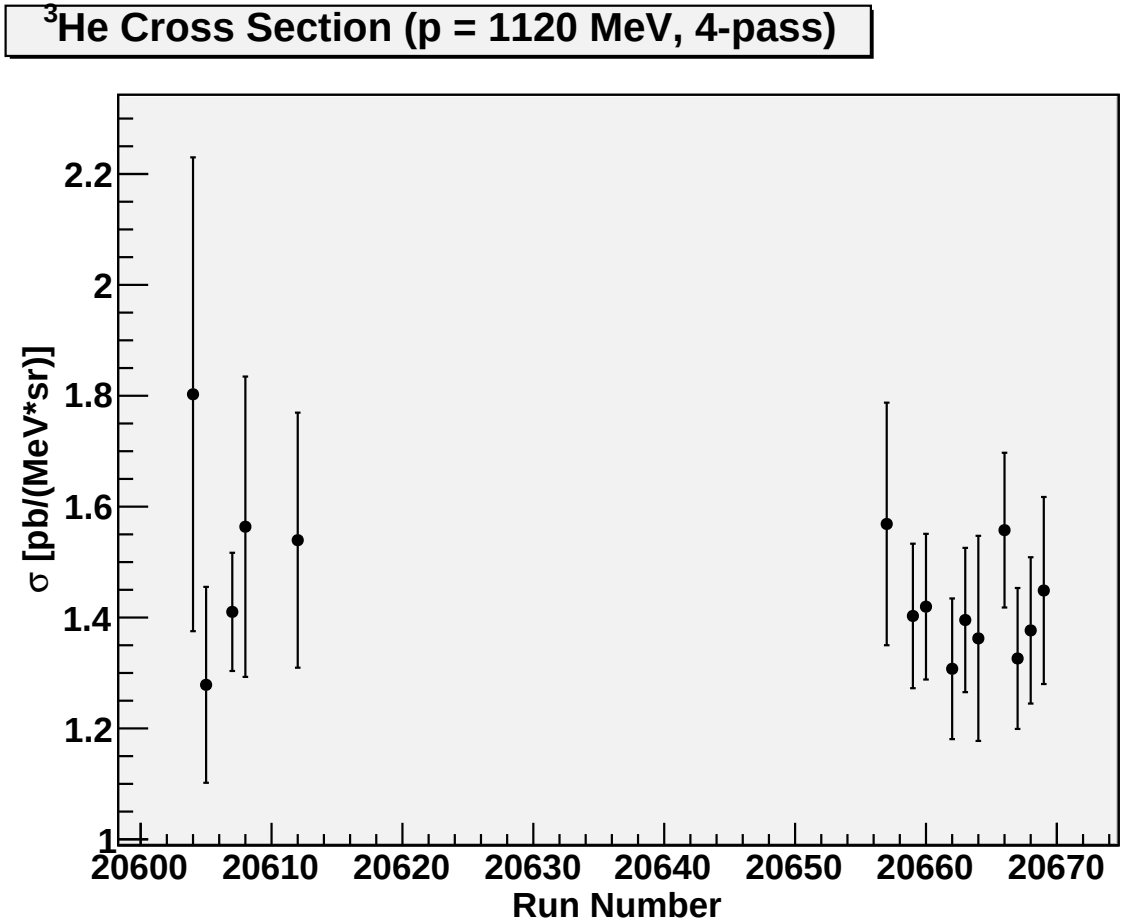


Appendix

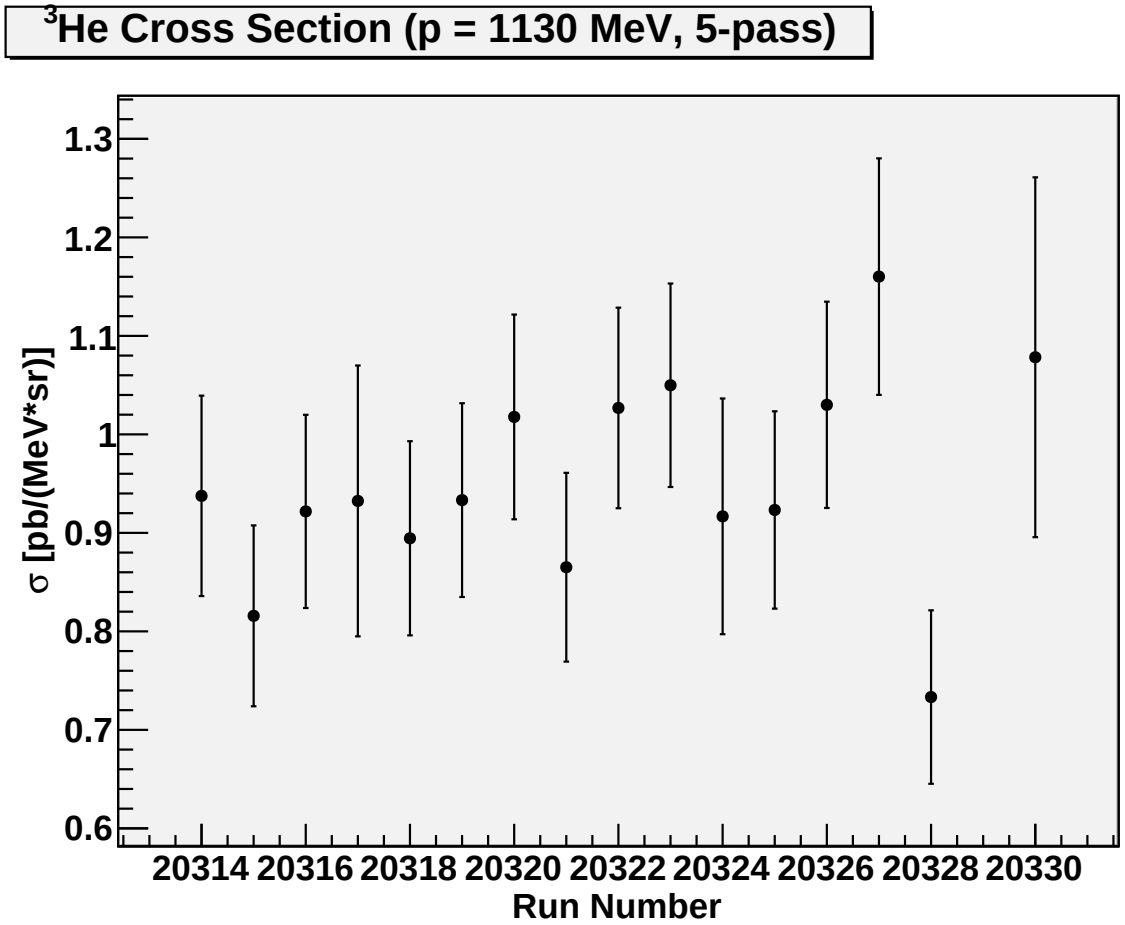
Raw ^{3}He Cross Sections by Run



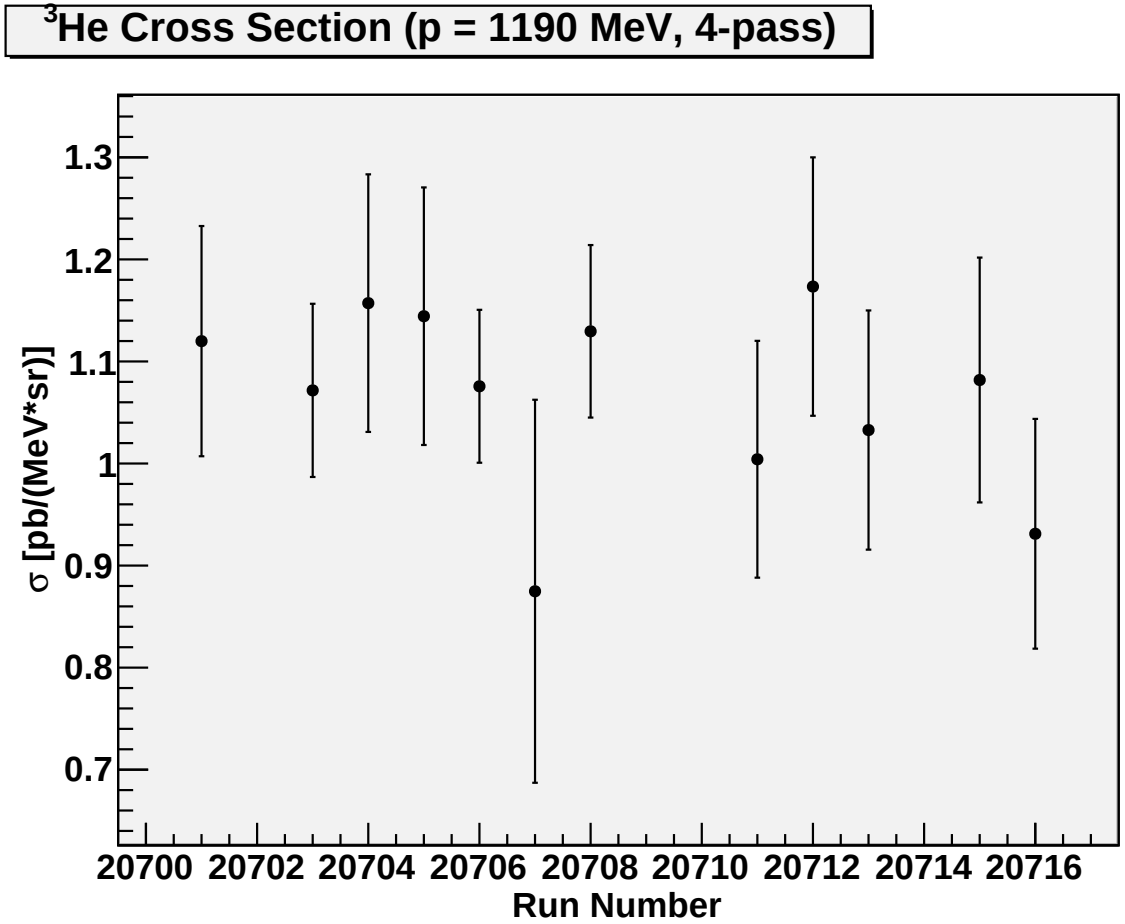
Appendix
Raw ^{3}He Cross Sections by Run



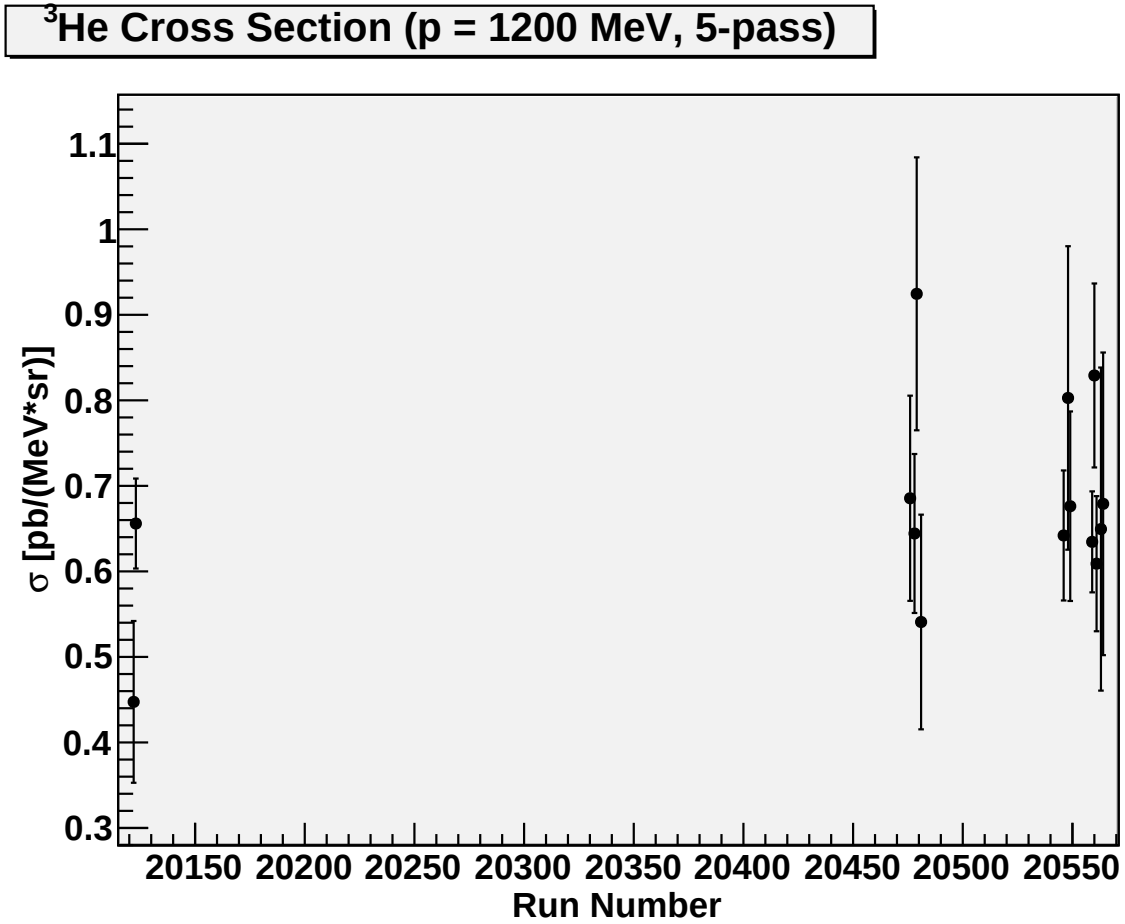
Appendix
Raw ^{3}He Cross Sections by Run



Appendix
Raw ^{3}He Cross Sections by Run

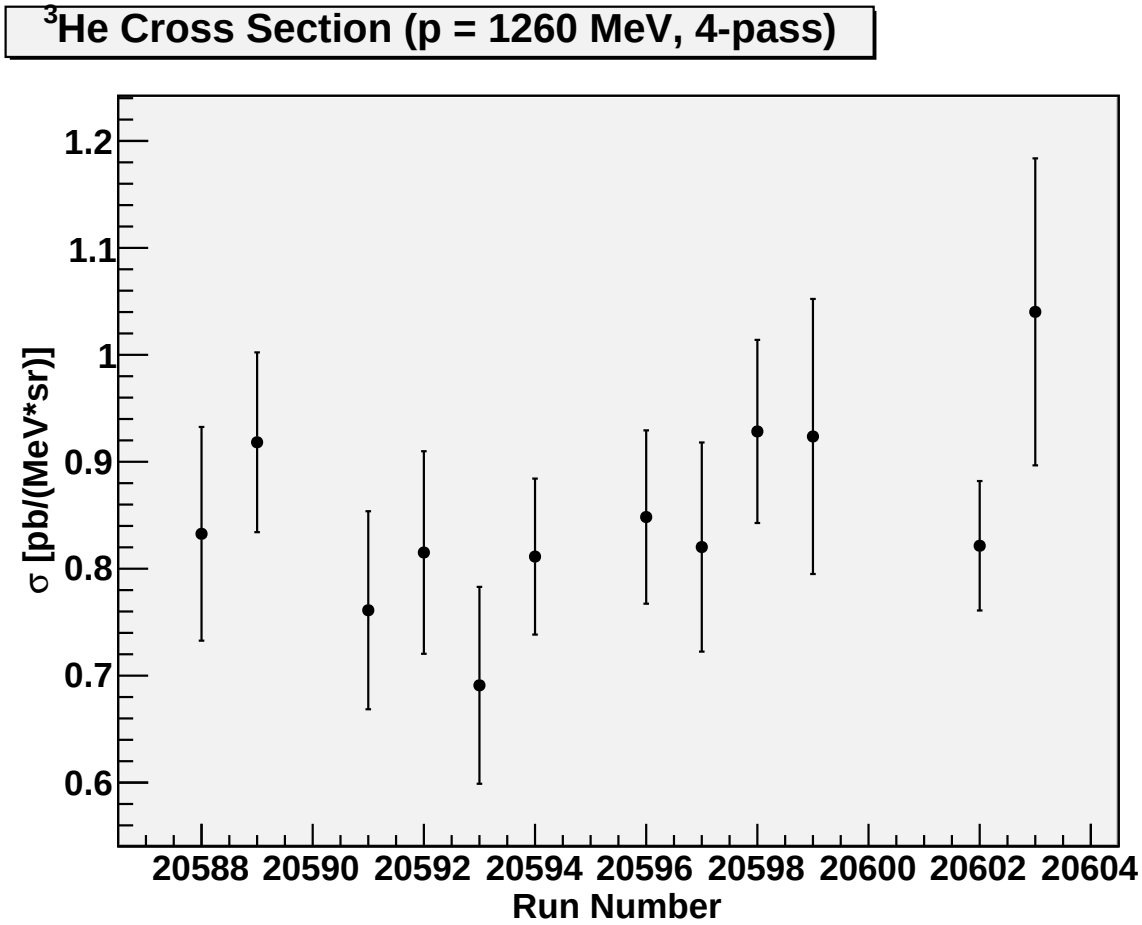


Appendix
Raw ^{3}He Cross Sections by Run

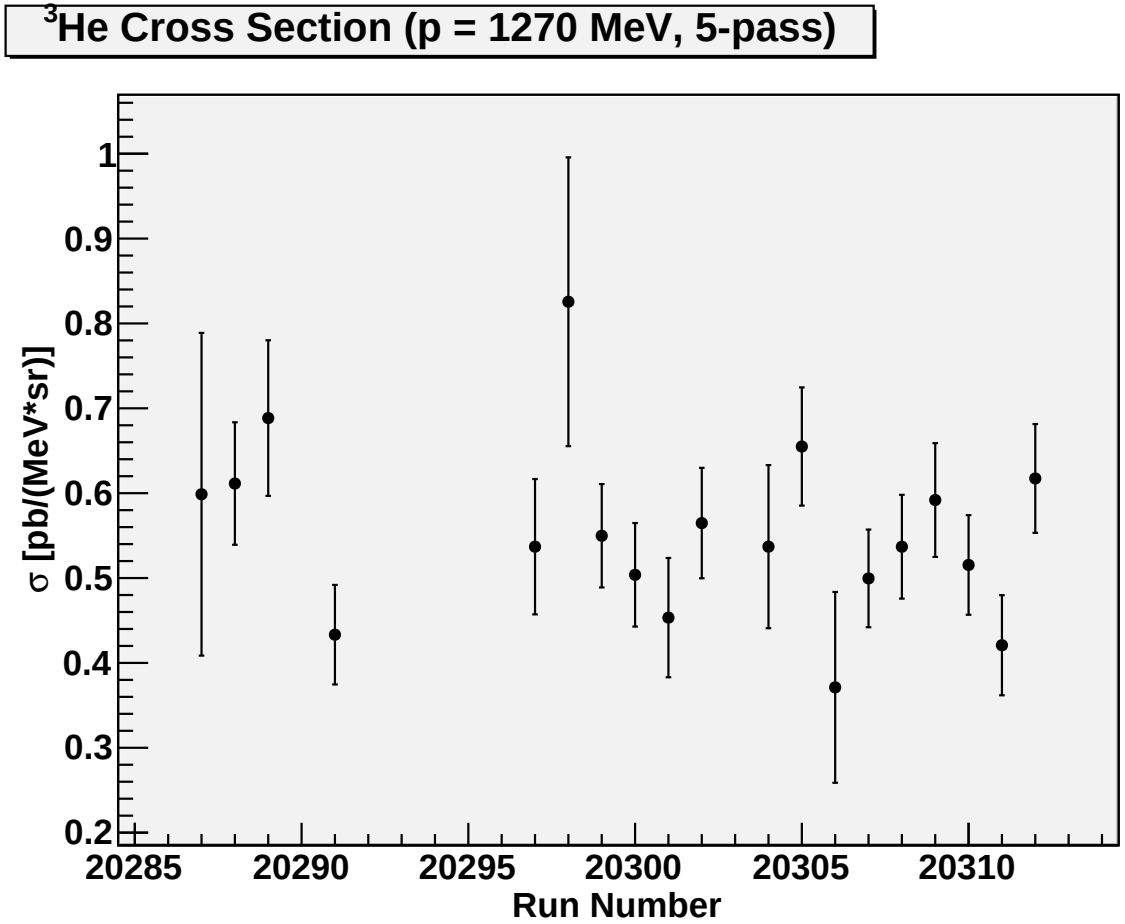


Appendix

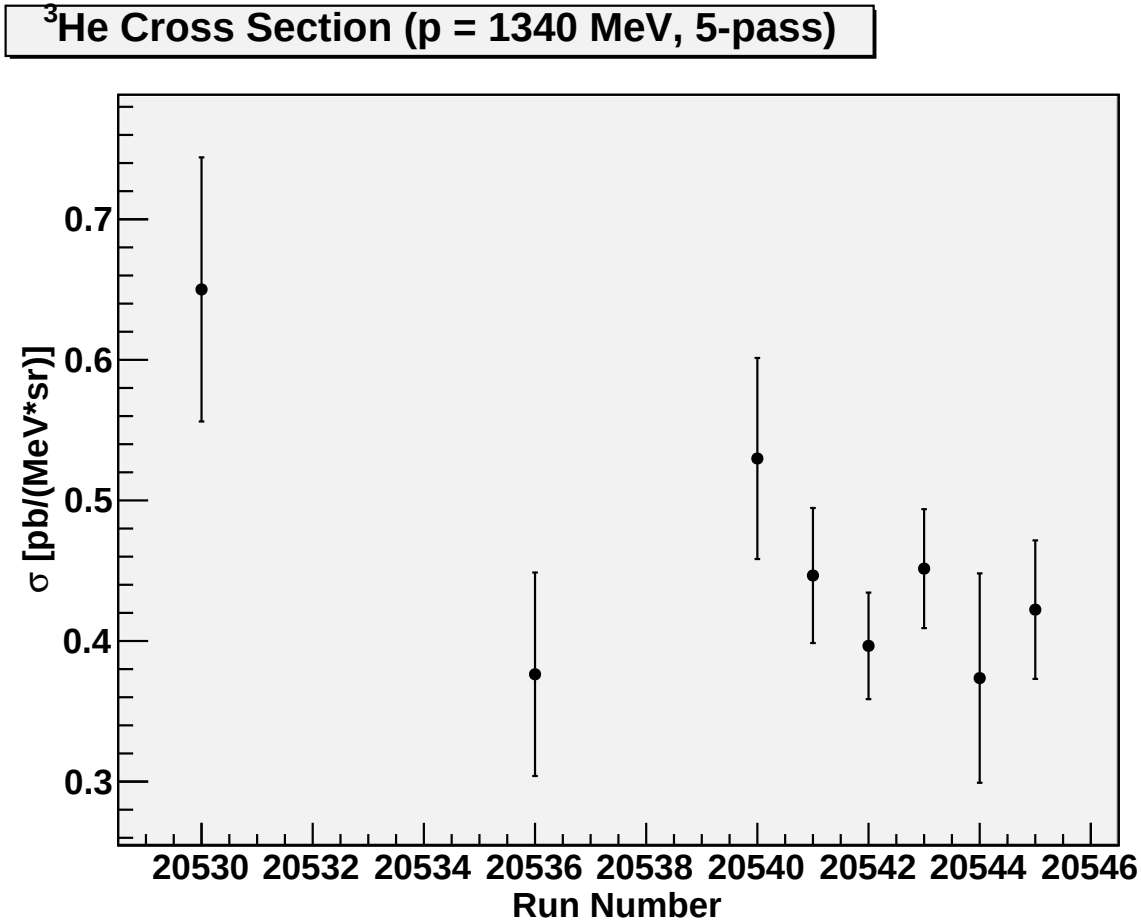
Raw ^{3}He Cross Sections by Run



Appendix
Raw ^{3}He Cross Sections by Run

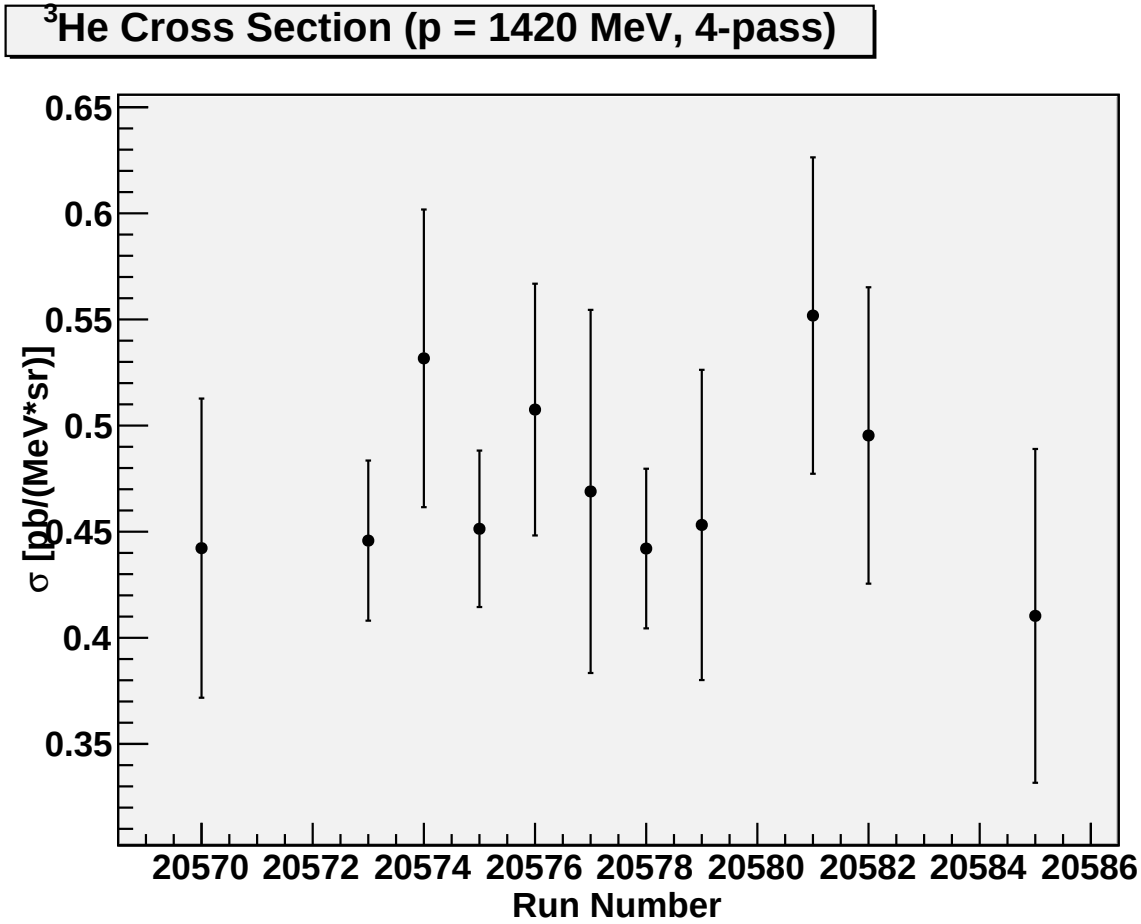


Appendix
Raw ^{3}He Cross Sections by Run

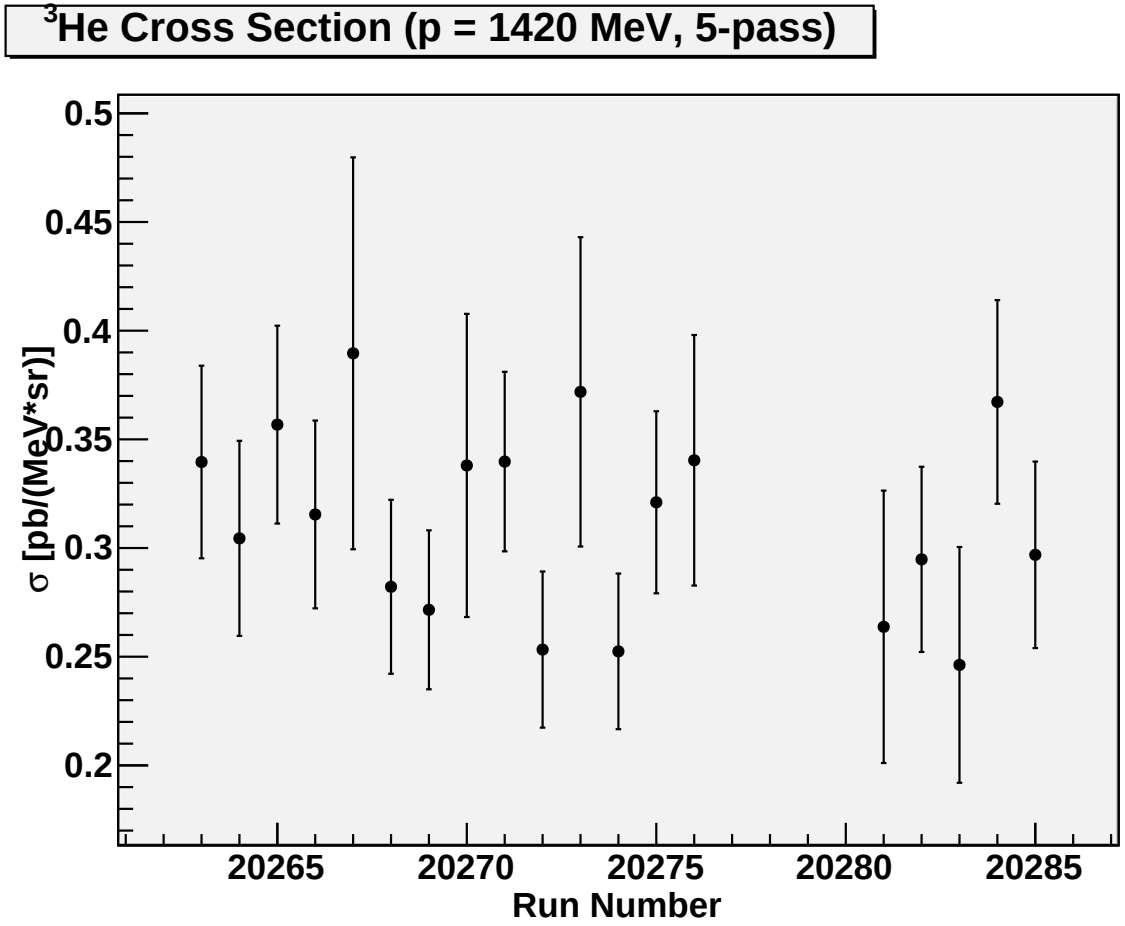


Appendix

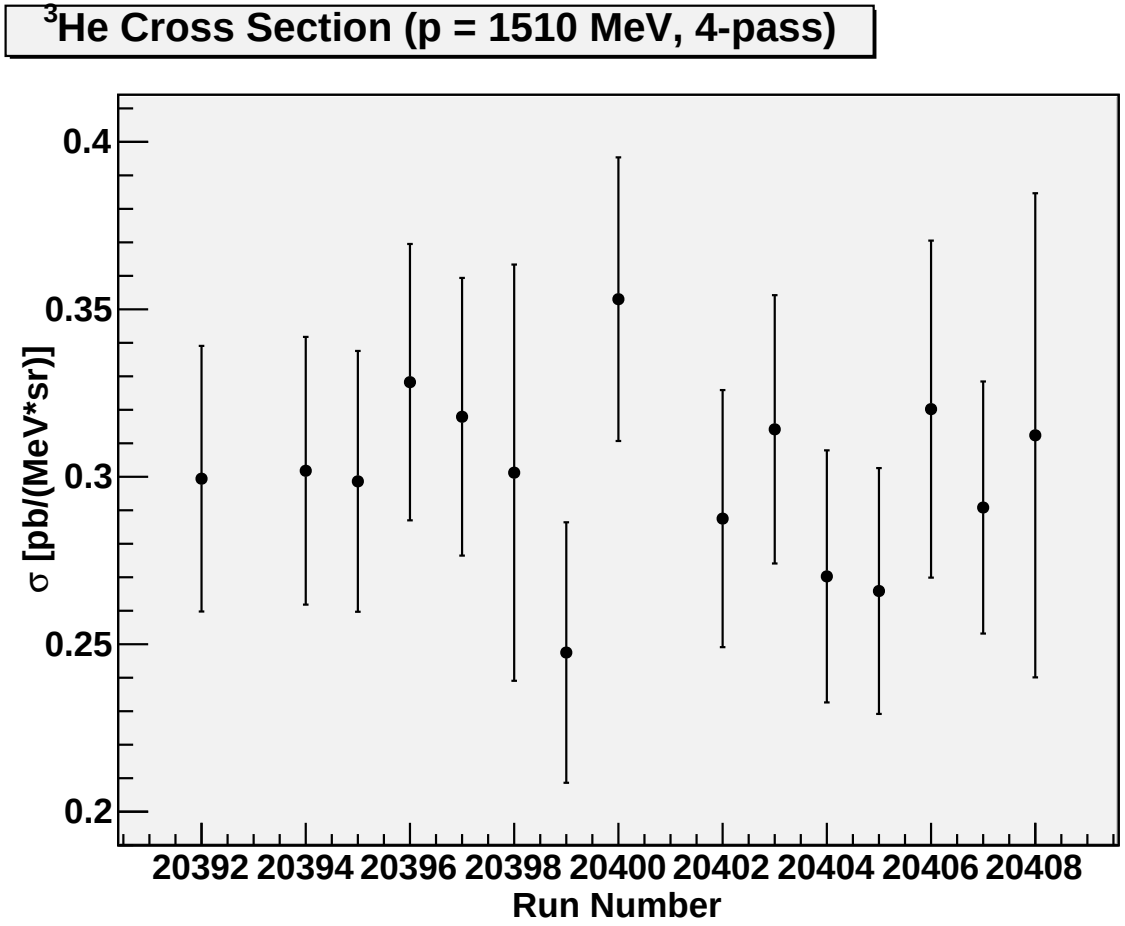
Raw ^{3}He Cross Sections by Run



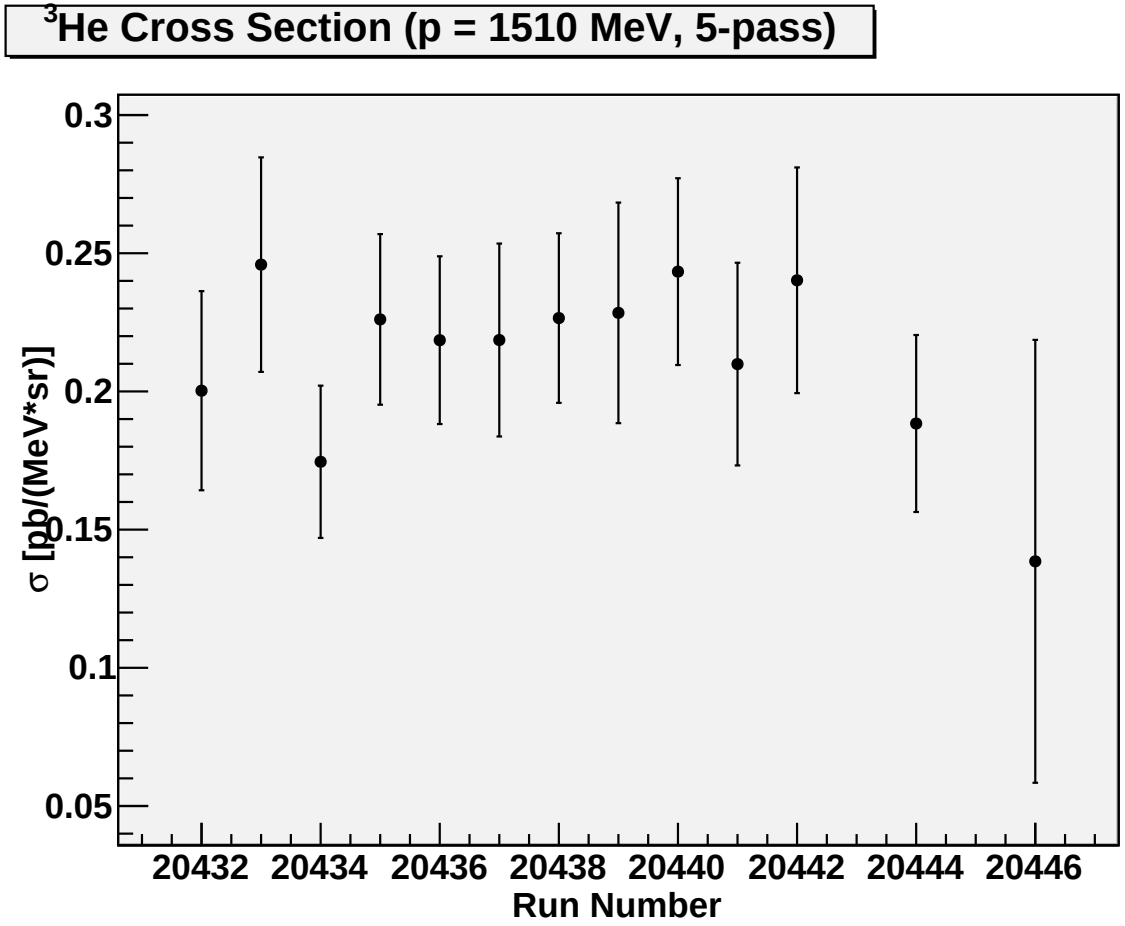
Appendix
Raw ^{3}He Cross Sections by Run



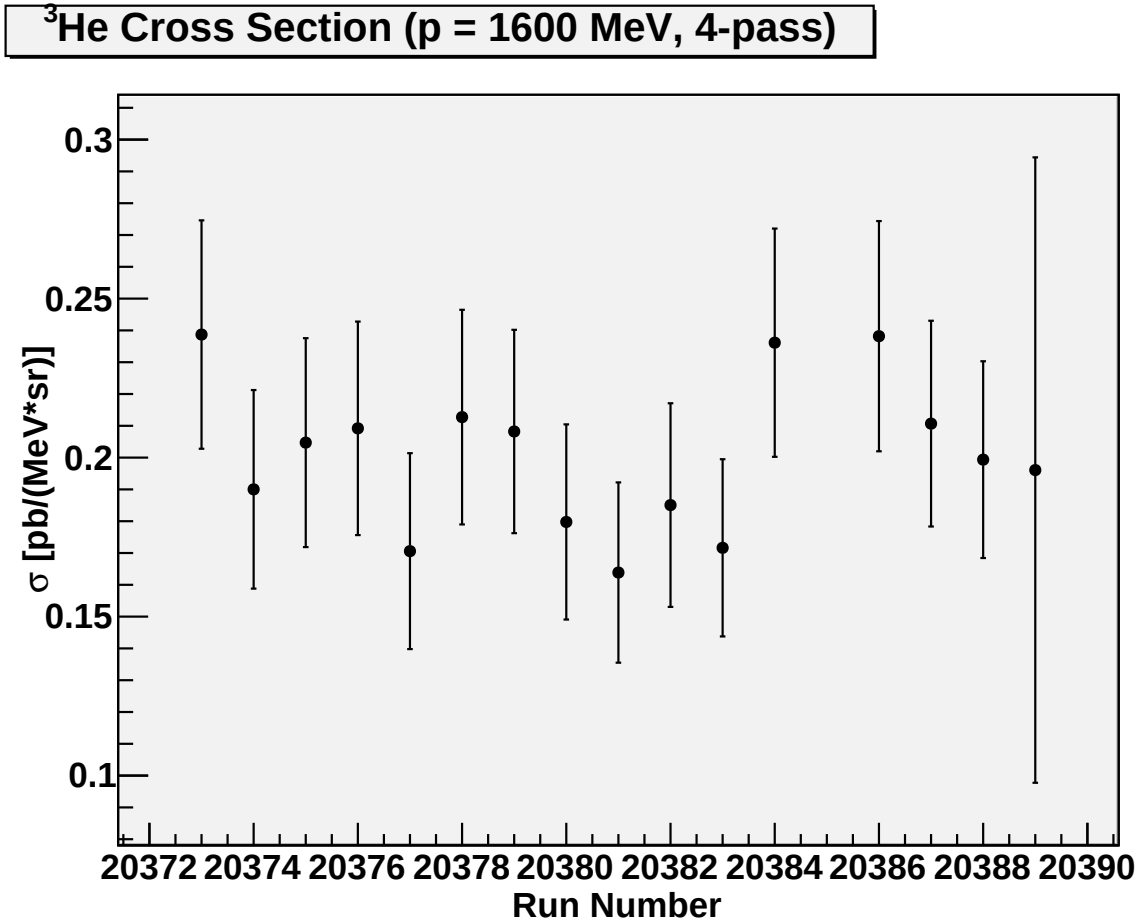
Appendix
Raw ^{3}He Cross Sections by Run



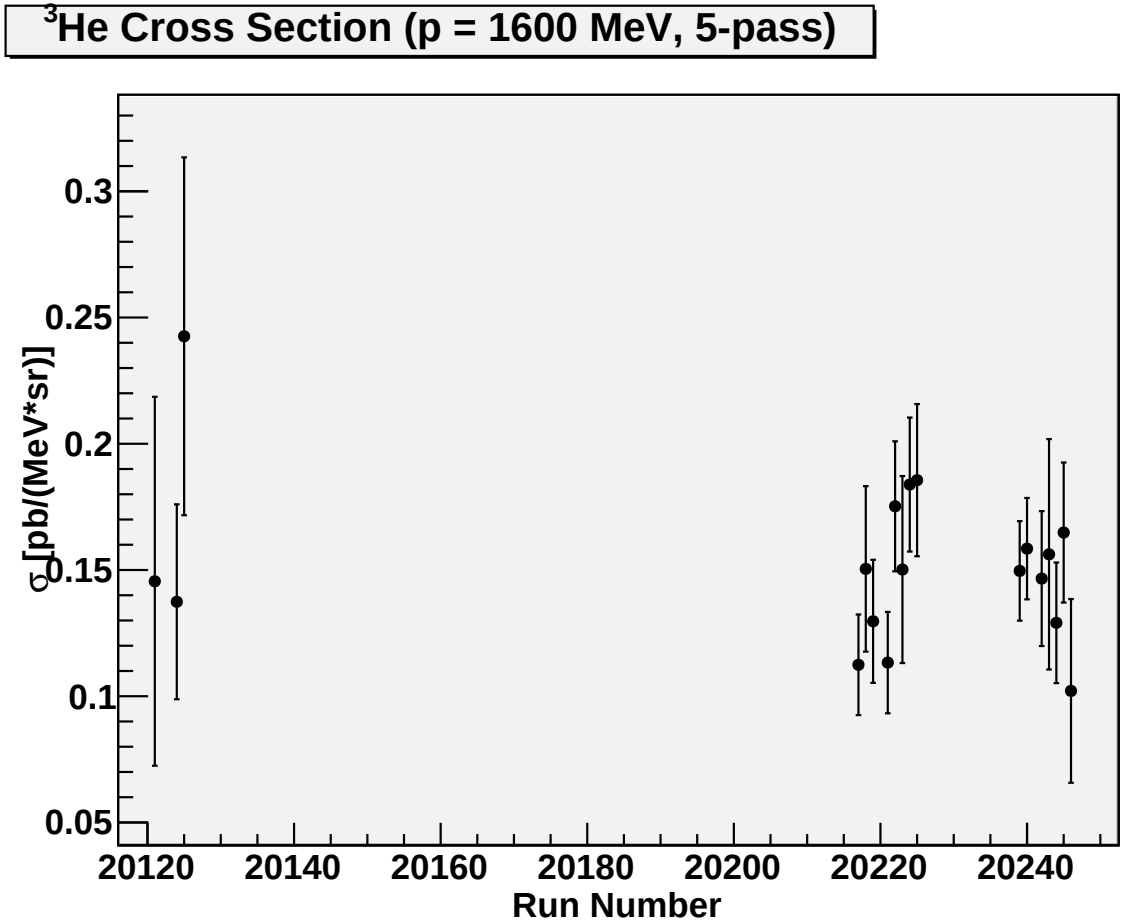
Appendix
Raw ^{3}He Cross Sections by Run



Appendix
Raw ^{3}He Cross Sections by Run



Appendix
Raw ^{3}He Cross Sections by Run



Appendix
Raw ^{3}He Cross Sections by Run