

d_2^n H2 Coin

Rough H2 Cross-Section

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Outline

1 Absolute Cross-Section Definition

2 N Protons in LHRS

- Cuts
- "Good" Protons

3 Obtaining the other quantities

- Charge
- Live Time
- Charge/Live Time Results
- Acceptance
- Target Parameters
- H2 Cross-Section

4 BigBite Comparison

5 Summary

Experimental Absolute Cross-Section

$$\sigma_0^{raw} = \frac{d\sigma^{raw}}{d\Omega dE'} = \frac{ps_5 N}{N_{in} \rho LT} \frac{1}{\Delta\Omega \Delta E' \Delta Z}$$

- N is the total number of scattered protons detected in the LHRS with the chosen cuts
- ps_5 is the prescale factor for events of type $T5$
- $N_{in} = \frac{Q}{e}$ is the incident electrons determined by the charge
- ρ is the target density
- LT is the livetime correction, in this case $T5$
- $\Delta\Omega \Delta E' \Delta Z$, are the angular acceptance, momentum acceptance and the target length seen by the detector.

Acceptance Cuts

LHRS Acceptance Cuts

The following cuts were made on the LHRS acceptance (see next slide for plots)

- $abs(L.tr.tg_y) < 0.05$
- $abs(L.tr.tg_ph) < 0.02$
- $abs(L.tr.tg_th) < 0.05$

Note that there is some **odd structure** in the **tracking theta**. More on this in a minute...

Acceptance Cuts

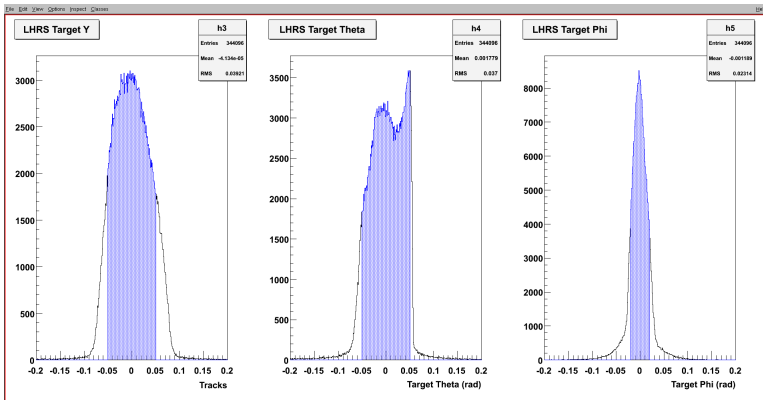


Figure: LHRS acceptance cuts for H2 runs. Target y(Left), target theta(middle) and target phi(right)

Acceptance Cuts

LHRS Momentum/Energy Cuts

The following cuts were made on the LHRS momentum and energy (see next slide for plots)

- $abs(L.tr.tg_dp) < 0.035$
- $(ExTgtCor_{L.p} < 0.9) \&\& (ExTgtCor_{L.p} > 0.83)$
- $(L.prl2.asum_c + L.prl1.asum_c) < 400 \&\& (L.prl2.asum_c + L.prl1.asum_c) > 0$

Same structure in **momentum** as seen in the **theta** distribution

Acceptance Cuts

LHRS Momentum/Energy

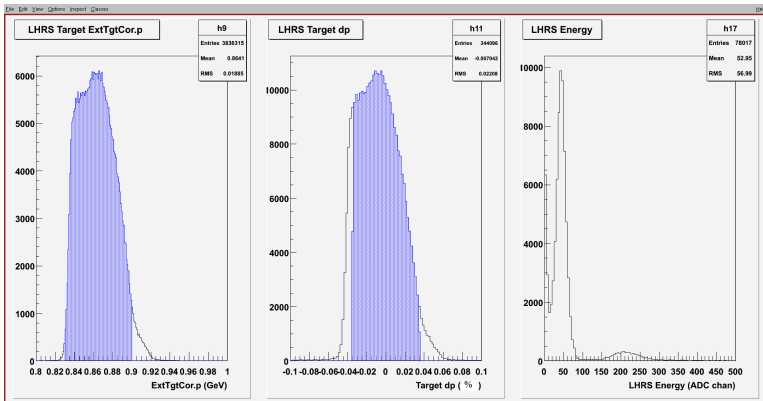


Figure: LHRS momentum/energy cuts for H2 runs. Extended target momentum(Left), target $\delta p/p$ (middle) and pion rejectors energy(right)

Acceptance Cuts

Theta Distribution(1)

- structure seems to be appear in both the **momentum** and the **theta**

After talking to Zein-Eddine:

- Reference cell is $\sim 40cm$
- Scattering from front and end of cell may have different energy, due to energy loss
- Checking particle hand book for 0.1-1 GeV protons through liquid H2 we are on a slope of the energy loss curve

The kinematics of the **LHRS/BB** are also checked...

Kinematics

LHRS/BB Kinematics(1)

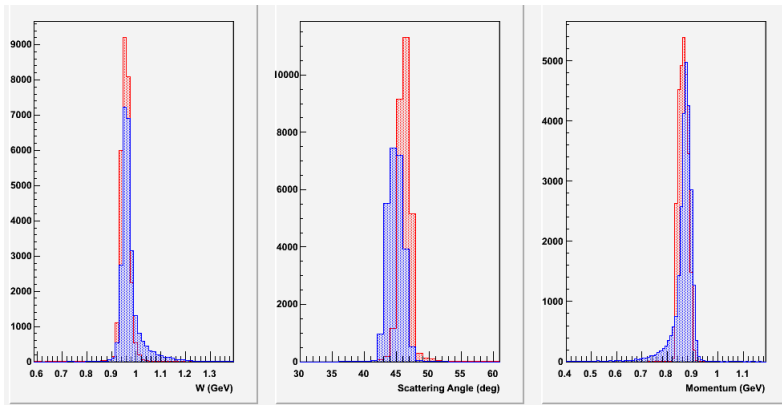


Figure: LHRS(red), BB(blue):invariant mass(left),scattering angle (center),momentum(right)

Kinematics

LHRS/BB Kinematics(2)

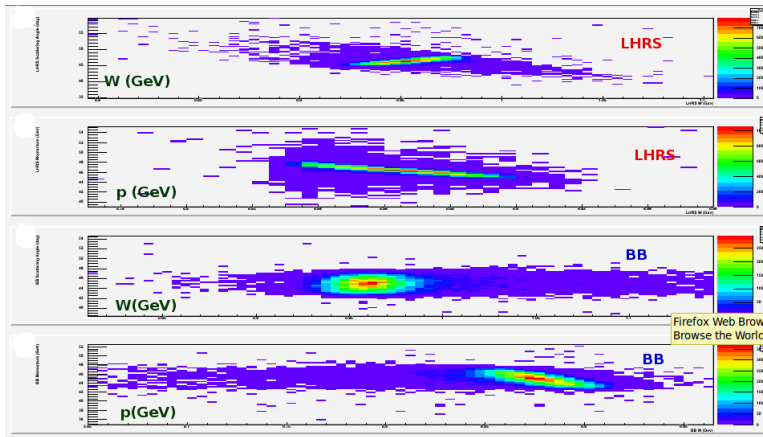


Figure: LHRS and BB kinematics

Acceptance Cuts

Theta Distribution(2)

The **elastic** peak in **BigBite** was selected and then the **theta** distribution in the **LHRS** was looked at...

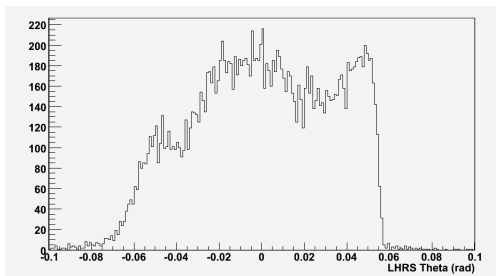


Figure: LHRS theta distribution with BB elastic peak cut

LHRS Cuts

Other LHRS Cuts

The following cuts were also made on the LHRS

Coin Trigger cut:

- $(DL.evtypebits \& 1 \ll 5) == (1 \ll 5) \& \& (DL.edtpl == 0)$

one reconstructed track in LHRS:

- $(L.tr.n == 1)$

require VDC cluster hit:

- $(L.vdc.u1.nclust == 1) \& \& (L.vdc.v1.nclust == 1)$
- $(L.vdc.u2.nclust == 1) \& \& (L.vdc.v2.nclust == 1)$

Čerenkov cut:

- $(L.cer.asum_c == 0)$

beam trip cut, **Avg. Current $14.75 \mu A$** :

- $abs(((evbbite_u3r - 453.393)/6480.30) - 14.75) < 1.0$

N Protons

Protons in LHRs

The following Shows the number of protons in the LHRs with just a coin trigger cut and then those that satisfy all the previous LHRs cuts.

There are **89,447** "good" protons in the LHRs.

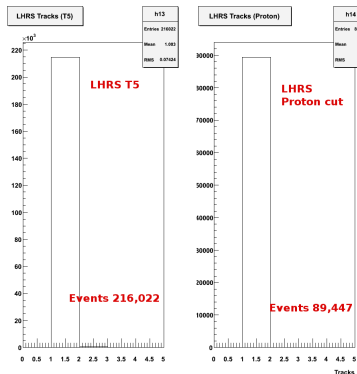


Figure: Events in LHRs that pass T5 coin cut(Left).
Events that pass all cuts(right)

Charge Calculation

Charge was computed by using the **BCM** scalers and Diana's calibrated BCM coefficients.

$$charge[Coulombs] = \left(u3c - off_{u3} \times \frac{clock \times 1000}{103.7} \right) \frac{10^6}{calib_{u3}}$$

- *u3c* is the scaler u3 counts (count difference of last and first events)
- *clock* is the scaler 103.7KHz clock (gives run time, difference of last and first events)
- *off_{u3}* = 453.393 and *calib_{u3}* = 6480.30 calibrations to BCM from Diana.

Live Time Calculation

Live time was computed by using scalers and trigger cuts. Very similar to charge calculation.

$$LT_{T5} = \frac{event_{T5}}{T5c}$$

- $event_{T5}$ are number of T5 type events (events that pass T5 trigger cut)
- $T5c$ are scaler counts of T5 type events (difference of last and first events)

Charge/Live Time Results

Table row **Total/Avg.** shows total charge and average live time.

Run #	PreScale	Charge (C)	Live Time
1258	1	0.01434	0.802972
1260	1	0.01418	0.761411
1261	1	0.01412	0.767407
1262	1	0.01425	0.781923
Total/Avg.	1	0.05689	0.77842825

LHRS Acceptance Parameters

- In order to obtain the actual acceptance parameters $d\Omega, dE'$ and dZ Monte-Carlo simulations need to be done
- However since we are looking for only a rough estimate of the H^2 σ_0 , I will take those that match my cuts

Acceptance Cuts

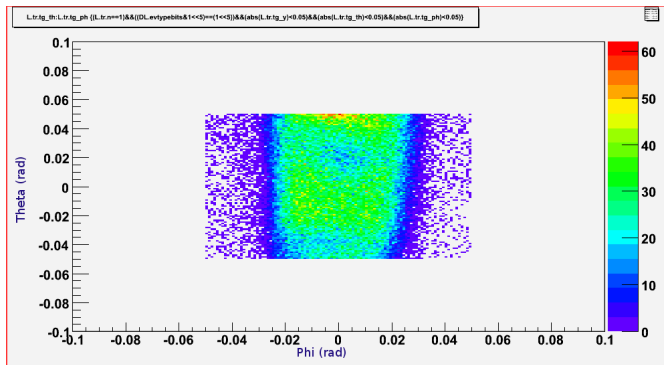


Figure: LHRs acceptance theta and phi cuts

LHRS Acceptance Parameters Values

- Solid Angle: $d\Omega = 4\text{msr}$
- Momentum Acceptance: $dE' = 3.5\%$, $p_0 = 0.870\text{GeV}$
 - Momentum Acceptance Value : $2 \times 0.035 \times 0.87 = 0.061\text{GeV}$

Target Length

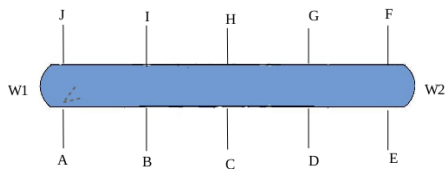


Figure: H2 ref. cell

$w1 \rightarrow E + w2 \rightarrow F$	39.4cm
$w1 \rightarrow A + w2 \rightarrow J$	39.9cm
Avg.	39.65cm
dZ at 46.2	27.44cm

Target Density

$$\rho[amg] = \frac{P}{P_0} \frac{T_0}{T}$$

- P_0 amt pressure 14.706 psi (from Lamiaa)
- P target pressure 140 psi
- T_0 273K
- T target temperature 314.6K (from Lamiaa)
- $1amg = 2.687 \times 10^{25} m^{-3}$

$$\rho_{H_2} = 8.26amg = 2.22 \times 10^{26} m^{-3}$$

H2 Cross Section

$$\frac{d\sigma}{d\Omega dZ'} = 0.217 \frac{\mu b}{\text{GeV sr}}$$

BigBite Track Comparison

It is still worth while to check out how the **LHRS** compares to the **BigBite**:

- Select "good" proton events in the **LHRS**
- Since the **BigBite** and **LHRS** are in coin mode, ideally for every "good" proton track in the **LHRS**, there should be a "good" electron track in **BigBite**
 - This is done by plotting all **BigBite tracks** that satisfy "good" proton cut
 - Then plot all **BigBite one track events** with "good" proton cut
 - If ideal **LHRS "good" proton** tracks will match **BigBite one track events** with proton cut

LHRS/BB Events

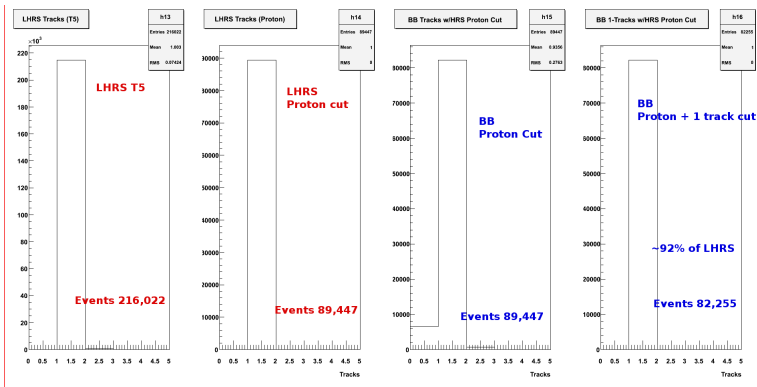


Figure: LHRS tracks T5 only (left), LHRS tracks proton cut (mid-left), BB tracks proton cut (mid-right), BB one tracks +proton cut (right)

BigBite Track Comparison Results

- We see that $\sim 92\%$ of the LHRs "good" proton tracks are reproduced in the BB with one track + proton cut
- The open nature (large solid angle) of the BigBite detector could be a reason for the difference in tracks
 - BigBite is exposed to more background
 - is open to a wide electron momentum range
 - Tracking efficiency of the BigBite could be less than the LHRs

Summary

- Odd structure to the *L.tr.tg.th* variable
- Have all information to compute the H2 cross-section
- Comparison of the LHRS tracks to those in the BB look encouraging
- 92% of tracks left in LHRS show up in BB

What's Next?

- Compute **H2 cross section** error and compare to world data
- Calibrate MWDC