

# LHRS ANALYSIS FOR $d_2^n$

DATA QUALITY, LHRS  $\beta$ , AND  $A_1^n$  STATISTICAL ERROR

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# OUTLINE

## 1 DATA ANALYSIS

- Data Quality Code and Methodology
- Problematic Runs
- LHRS  $\beta$

## 2 CALCULATIONS

- Projected Statistical Error for  $A_1^n$

## 3 SUMMARY

# DATA QUALITY CODE AND METHODOLOGY (1)

CODE: DATACHECK

- The `DataCheck` Class:
  - Carries out analysis of diagnostic quantities for the gas Čerenkov, pion rejector, and VDC
  - Gas Čerenkov method now has plots of each PMT's TDC as a function of run number
  - Output (to date): three canvases of diagnostic plots
  - Functional for both negative and positive polarity data
  - Portable to BigBite (in theory—need to change the ROOT variables, output directory structure, etc.—more on this later...)

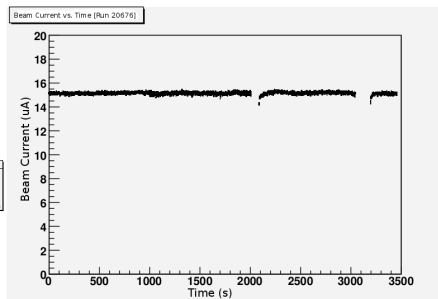
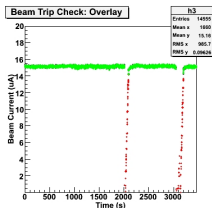
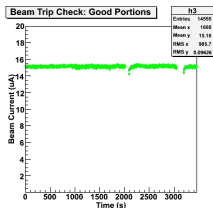
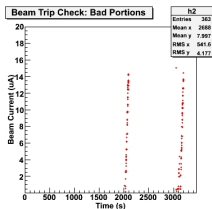
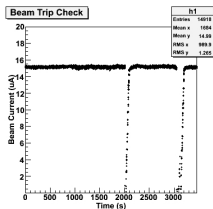
# DATA QUALITY CODE AND METHODOLOGY (2)

CODE: SKIM

- The `Skim` Class:
  - This code will carry out the 'skim' procedure
  - Each 'stage' will have a corresponding method
    - More on this shortly...
  - So far, **stage 1** has been implemented: **removing beam trips**
  - Output (to date): **skimmed** ROOTfile:  
`'e06014_det_L_skim1_20676.root'`, for example
  - Code is still fairly preliminary
    - Only BCM variables, 103.7 kHz clock time, run time, and calculated beam current are written to the output ROOTfile
    - Improving the code: A few extra classes, `RunManager` and `FileManager` have been developed – still working out some minor kinks...
    - These classes will be nice for future work too

# DATA QUALITY CODE AND METHODOLOGY (3)

## SKIM PROCEDURE: BEFORE AND AFTER (FOR RUN 20676)



# DATA QUALITY CODE AND METHODOLOGY (4)

## AVAILABILITY

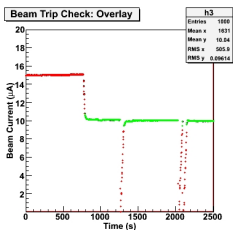
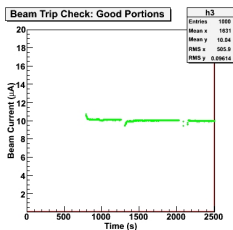
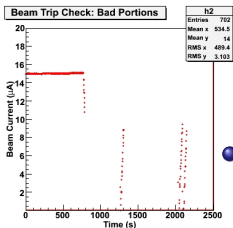
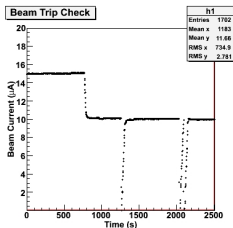
- Each class is comprised of three files: \*.C, \*.h, and main.C
- Each class also has **documentation**: A README and a CHANGELOG
- All code may be obtained from [my website](#)
  - This code is in working order, but no RunManager or FileManager just yet...

# DATA QUALITY (5)

## THE SKIM PROCEDURE: POINTS OF DISCUSSION

- Concerning the skimming process, we should agree on what exactly the stages should be (for example):
  - 1 Remove beam trips
  - 2 Remove detector trips
  - 3 Introduce kinematic quantities
- Which variables to retain upon each iteration of the skimming code?
- Which runs do we keep (or, what should be the criteria to throw it out)?
- Do we let some calibrations vary with time or run number?
- Kinematic quantities: At what point do we introduce  $x$ ,  $Q^2$ ,  $W$ , etc.?
- 'Good electron cuts': At what point are these applied?
- What should a 'final' ROOTfile look like?

# PROBLEMATIC RUN 20281



- It turns out that the beam current was lowered **mid-run** as the deadtime was too high on BigBite
- See HALOG entry [262241](#)



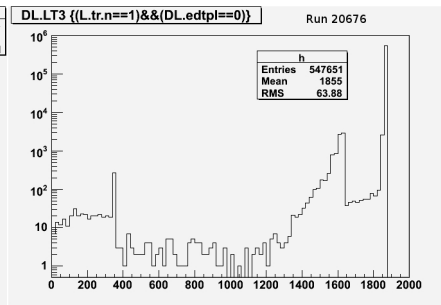
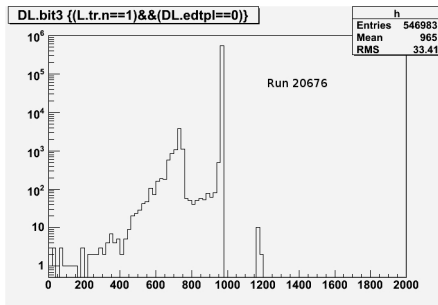
# PROBLEMATIC RUNS (1)

RUN NUMBERS BEFORE 20140

- The `DL.bitN` variable is missing
  - This corresponds to the **prescaled** trigger
  - Solution: can use the **unprescaled** trigger `DL.LTN`  
( $ps = 1$  for production runs)
- Let's look at some plots. . .

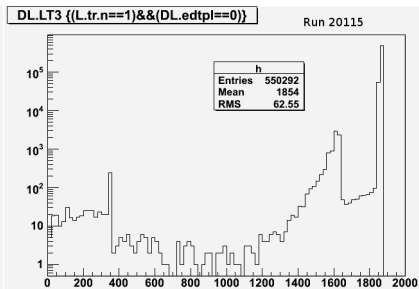
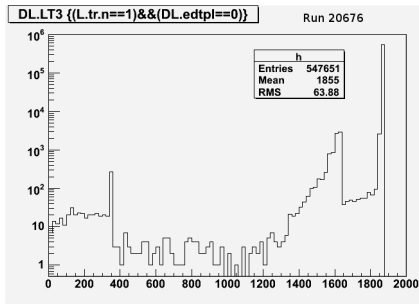
# PROBLEMATIC RUNS (2)

## COMPARING DL.BIT3 TO DL.LT3



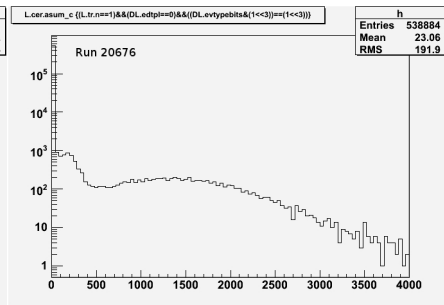
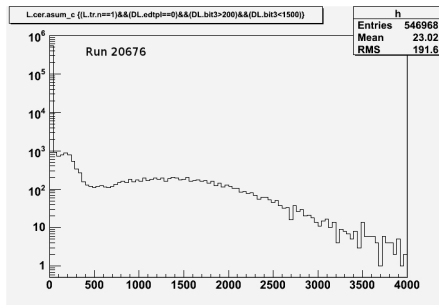
# PROBLEMATIC RUNS (3)

## COMPARING DL.LT3 FOR TWO DIFFERENT RUNS



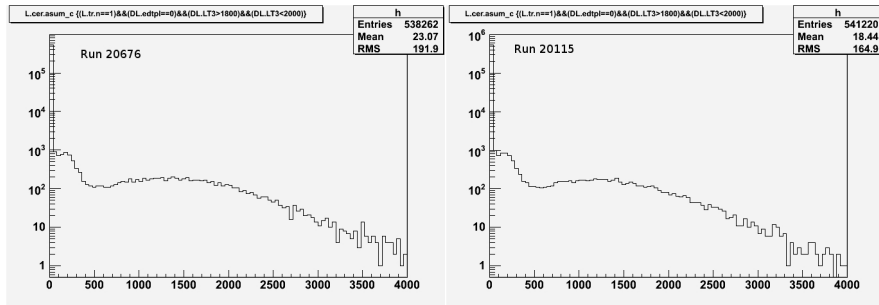
# PROBLEMATIC RUNS (4)

COMPARING CUTS ON `DL.BIT3` AND `DL.EVTYPEBITS`



# PROBLEMATIC RUNS (5)

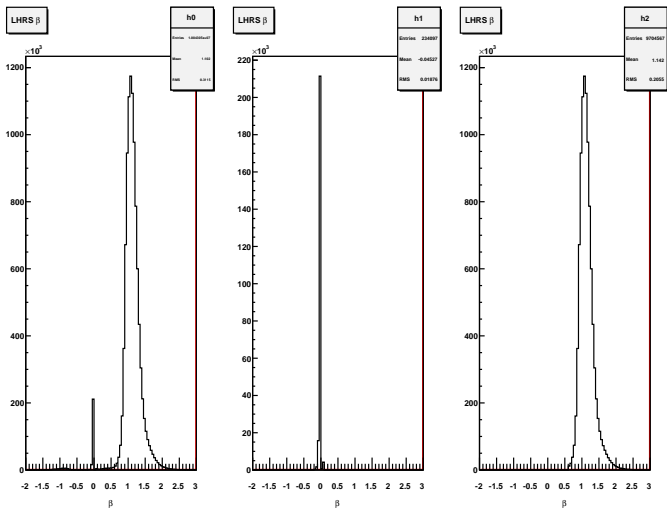
## COMPARING CUTS ON `DL.bit3` AND `DL.LT3`

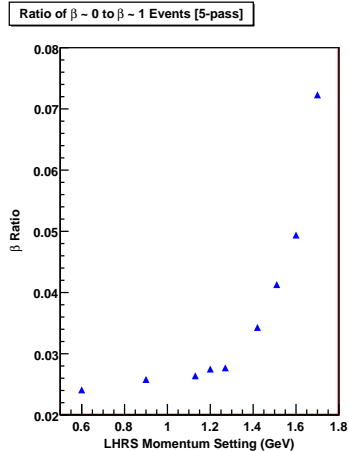
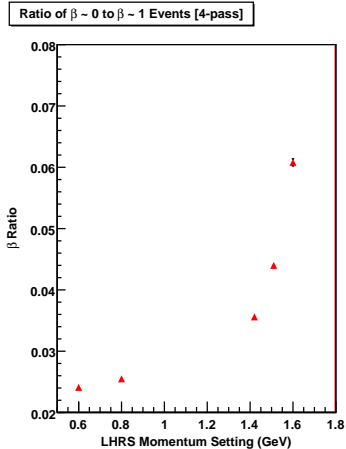


- It looks as if we can solve our trigger problem by utilizing the `DL.LT3` variable in place of the `DL.bit3` variable for the affected runs

# LHRS $\beta$ (1)

## INVESTIGATING EVENTS FOR $\beta \sim 0$ : CUTS TO GET EVENTS



LHRS  $\beta$  (2)INVESTIGATING EVENTS FOR  $\beta \sim 0$ : RATIOS AS A FUNCTION OF MOMENTUM

# LHRS $\beta$ (3)

## A 'MANUAL' APPROACH: GENERAL METHOD

- To construct  $\beta$ :
  - 1 Apply all cuts (GC, PR, VDC for good  $e^-$ )
  - 2 **For each event**: See if there's a hit in S2m **within  $61 \pm 5$  ns**
  - 3 When we find a hit for a given paddle ( $k$ ) in S2m, we then look for a **correlated** hit in one of the S1 paddles ( $j$ ) **within  $55 \pm 5$  ns**
  - 4 When these two conditions are satisfied, we fill the S1 and S2m time average histograms, in addition to the time difference, track- $x$ , and the paddle number histograms
    - If items 2 or 3 are **not** satisfied, we do not fill the histograms
  - 5 Calculate  $\beta$



# LHRS $\beta$ (4)

## A 'MANUAL' APPROACH: GENERAL METHOD

- $\beta$  is calculated as:

$$\beta = \frac{\ell}{c\Delta t}$$

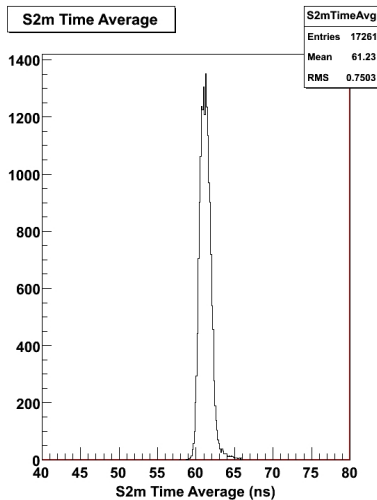
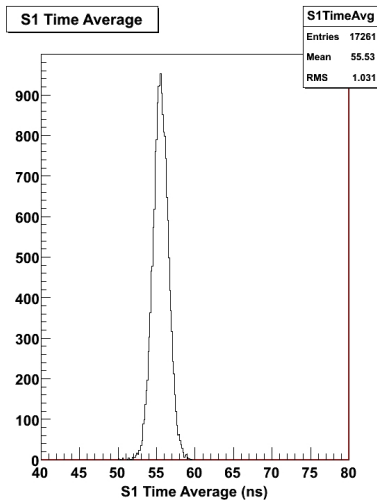
$$\ell = \text{pathlength between S1 and S2m} \approx 1.86 \text{ m}$$

$$\Delta t = \text{time difference between S1 and S2m}$$

- **Pitfall:** How to handle multiple hits in S1 or S2m?

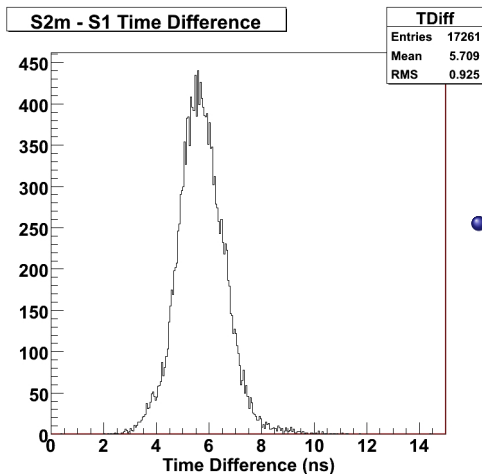
# LHRS $\beta$ (5)

## A 'MANUAL' APPROACH: RESULTS



LHRS  $\beta$  (6)

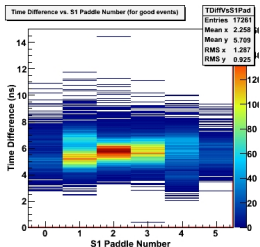
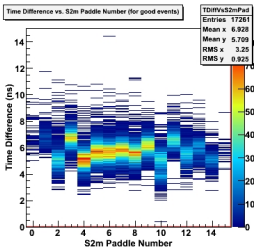
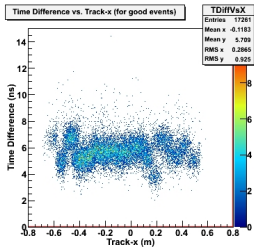
## A 'MANUAL' APPROACH: RESULTS



- This looks decent, but it's not **completely** symmetric

# LHRS $\beta$ (7)

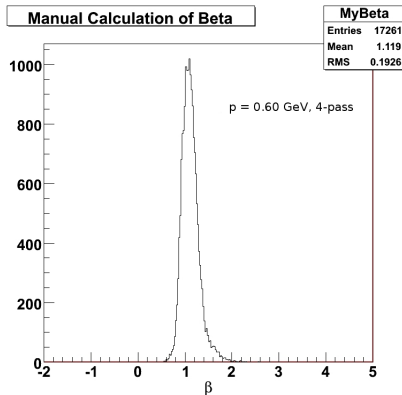
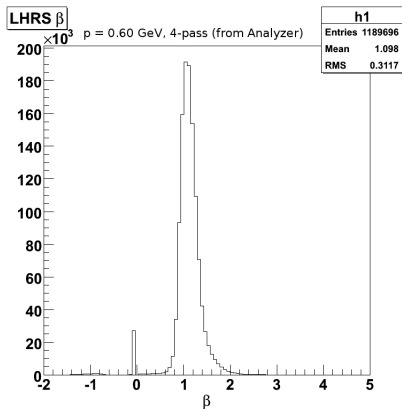
## A 'MANUAL' APPROACH: RESULTS



- We still see the jitter with track- $x$

# LHRS $\beta$ (8)

## A 'MANUAL' APPROACH: RESULTS AND COMPARISONS

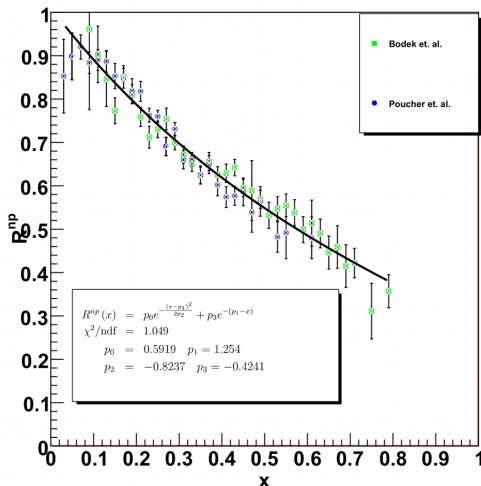


PROJECTED STATISTICAL ERROR FOR  $A_1^n$  (1)DETERMINING  $R$  AS A FUNCTION OF  $R^{np}$ 

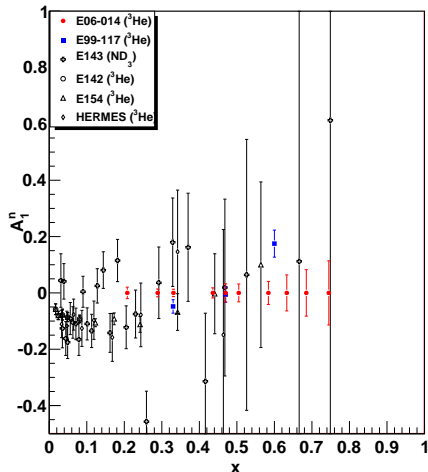
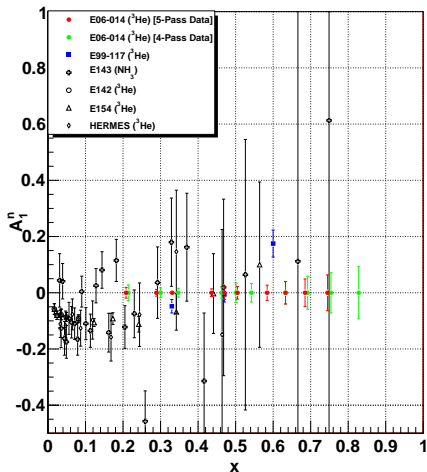
- We may express  $R$  as a function of the quantity  $R^{np}$ :

$$R = \frac{F_2^n}{F_2^{3\text{He}}} \approx \frac{F_2^n}{F_2^n + 2F_2^p}$$
$$R^{np} = \frac{F_2^n}{F_2^p}$$
$$R = \frac{R^{np}}{R^{np} + 2}$$

- We can fit the existing data for  $R^{np}$  to some function to obtain a parameterization for  $R^{np} \rightarrow R^{np}(x)$ 
  - This should be accurate enough for now (to first order, at least)

PROJECTED STATISTICAL ERROR FOR  $A_1^n$  (2)THE FIT TO  $R^{np}(x)$  **$R^{np}$  as a Function of  $x$**  **$R^{np}$  and  $R$  as a Function of  $x$** 

$x$	$R^{np}$	$R$
0.208	0.779	0.281
0.289	0.707	0.261
0.331	0.672	0.252
0.436	0.593	0.229
0.470	0.569	0.221
0.505	0.545	0.214
0.584	0.495	0.198
0.633	0.466	0.189
0.685	0.436	0.179
0.745	0.404	0.168

PROJECTED STATISTICAL ERROR FOR  $A_1^n$  (3)RESULTING ERROR BARS (LEFT = SEPT. 10<sup>TH</sup>; RIGHT = NOV. 9<sup>TH</sup>, 5-PASS DATA)



## SUMMARY

- Data Quality:
  - Coding for checking data and skim procedure is coming along nicely
- Problematic Runs:
  - Run 20281: Beam current changed mid-run due to downtime on BigBite
  - Can solve trigger problems (for runs < 20140) by using the DL.LTN histogram as the basis for the trigger
- LHRS  $\beta$ :
  - $\beta \sim 0/\beta \sim 1$  ratio tends to increase with  $p$
  - Manual approach to calculating  $\beta$  shows very similar (if not the same) structure as what is calculated by THaHRS
- $A_1^n$  Statistical Error:
  - $R \rightarrow R(x)$  gives a more accurate estimation of  $\Delta A_1^n$

# WHAT'S NEXT?

- Data Quality:
  - Continue work on `DataCheck` and `Skim` code
- Problematic Runs:
  - Figure out how to implement `DL.LTN` histogram (we need to offset this peak...)
- LHRS  $\beta$ :
  - For manual calculation: maybe consider some type of 'geometrical correction' as a function of track- $x$ ?
- $A_1^n$  Statistical Error:
  - Add three more data points:  $p = 0.7$  GeV,  $p = 1.00$  GeV,  $p = 1.34$  GeV – this will make the distribution of measurements more evenly spaced in  $x$
- SAMC:
  - Run it after changing `HRS_L` and see what happens...