Jlab d_2^n Collaboration Meeting

BigBite Analysis Update

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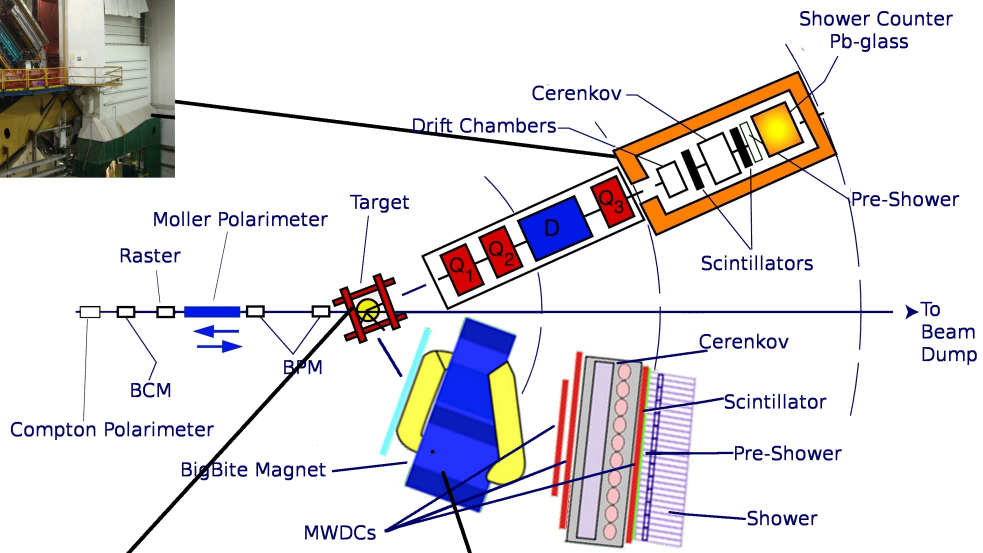
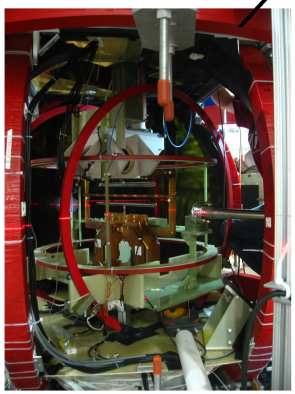
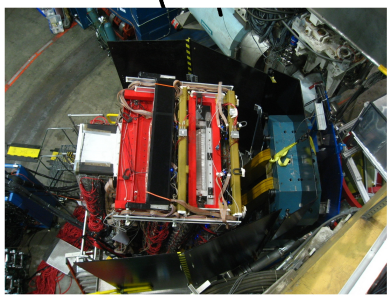
05/23/2012

Outline

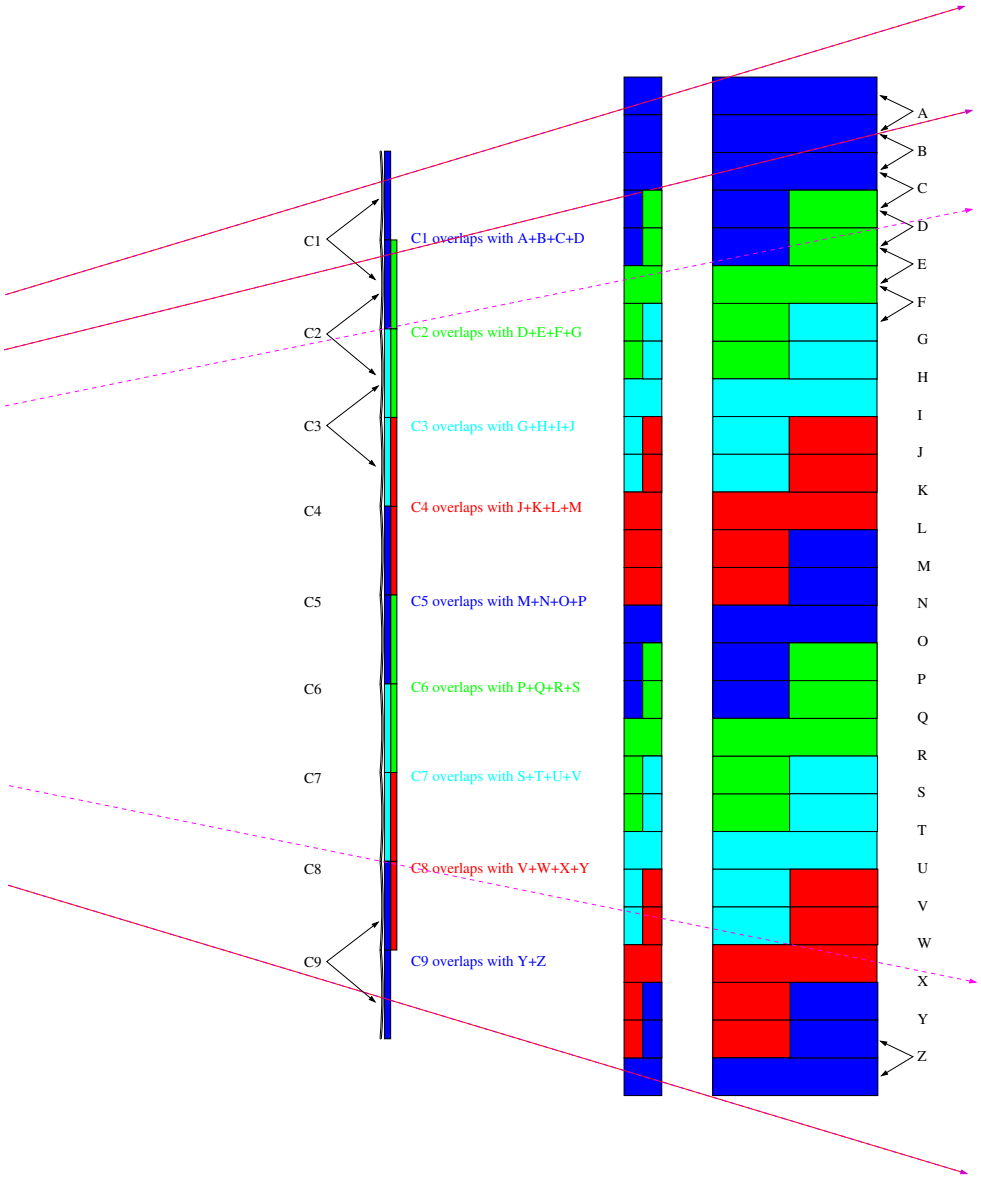
The E06-014 Setup





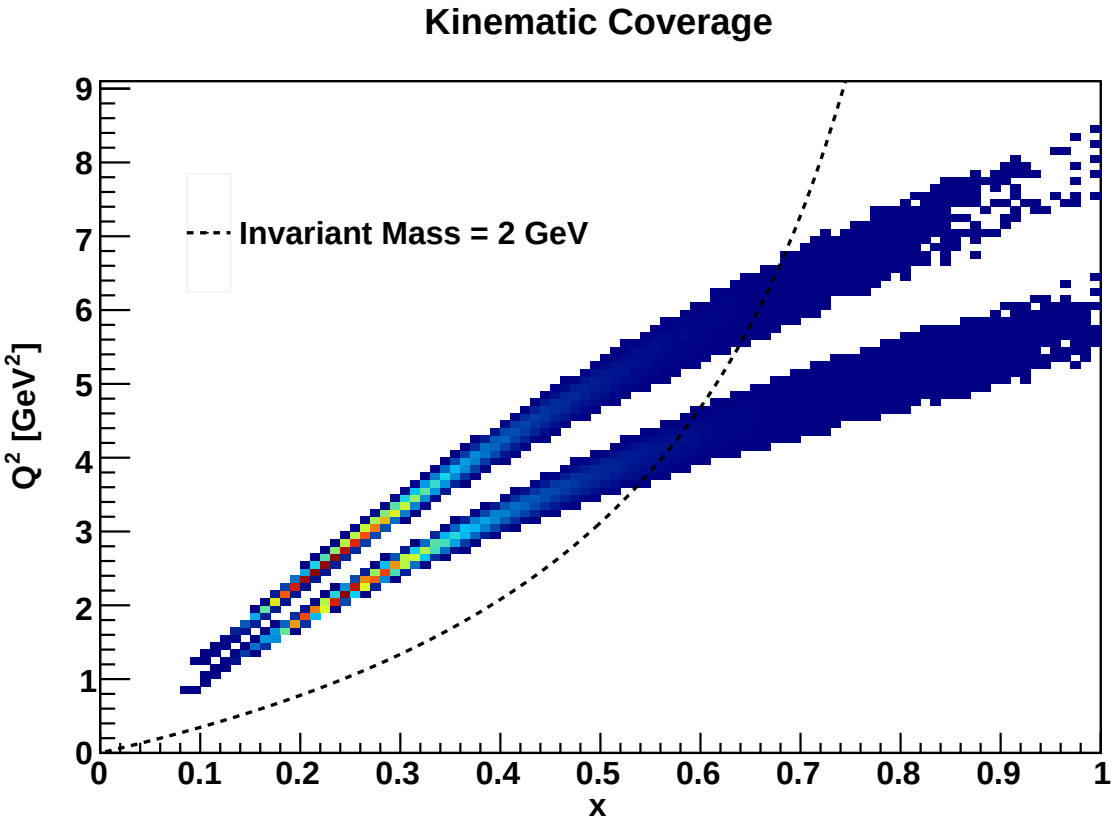


Main Electron Trigger: T2



Sh/PSh Sum#	Short patch cable	Long patch cable
26	N4–24L	20
25	N2–24L	24
24	N3–21L	52
23	N6–36L	–
22	N3–22L	6
21	N4–21L	17
20	N4–23L	–
19	N1–21L	S6–1NAU
18	N1–22L	23
17	N3–24L	–
16	N2–21L	2
15	N2–22L	14
14	N1–24L	–
13	N4–22L	51
12	N2–23L	11
11	N3–23L	–
10	N7–32L	1
9	N5–32L	9
8	N1–23L	–
7	N6–33L	53
6	N6–31L	5
5	N5–36L	–
4	N7–33L	3
3	N6–32L	21
2	N6–35L	–
1	N5–31L	50

Coverage



$0.2 < x < 0.7 \quad 2\ GeV^2 < Q^2 < 6\ GeV^2$

5 and 4 Pass BigBite Run Stats

Target Spin [Deg.]	Number of Runs	WP=IN	WP = OUT	Total Charge [C]
0	35	18	17	1.058
90	141	76	65	4.177
270	130	54	76	3.845
Total	306	-	-	9.08

Table: 5.89 GeV BigBite runs stats.

Target Spin [Deg.]	Number of Runs	WP=IN	WP = OUT	Total Charge [C]
0	24	11	13	0.691
90	26	21	5	0.804
270	51	22	29	1.879
Total	101	-	-	3.374

Table: 4.7 GeV BigBite run stats.

- **Current Statistical Uncertainty on δd_2:**
- $E_{beam} = 4.74$ GeV 5.9×10^{-4}
- $E_{beam} = 5.89$ GeV 3.7×10^{-4}
- Proposal: 10^{-3}

Trigger and Setup Change Locations

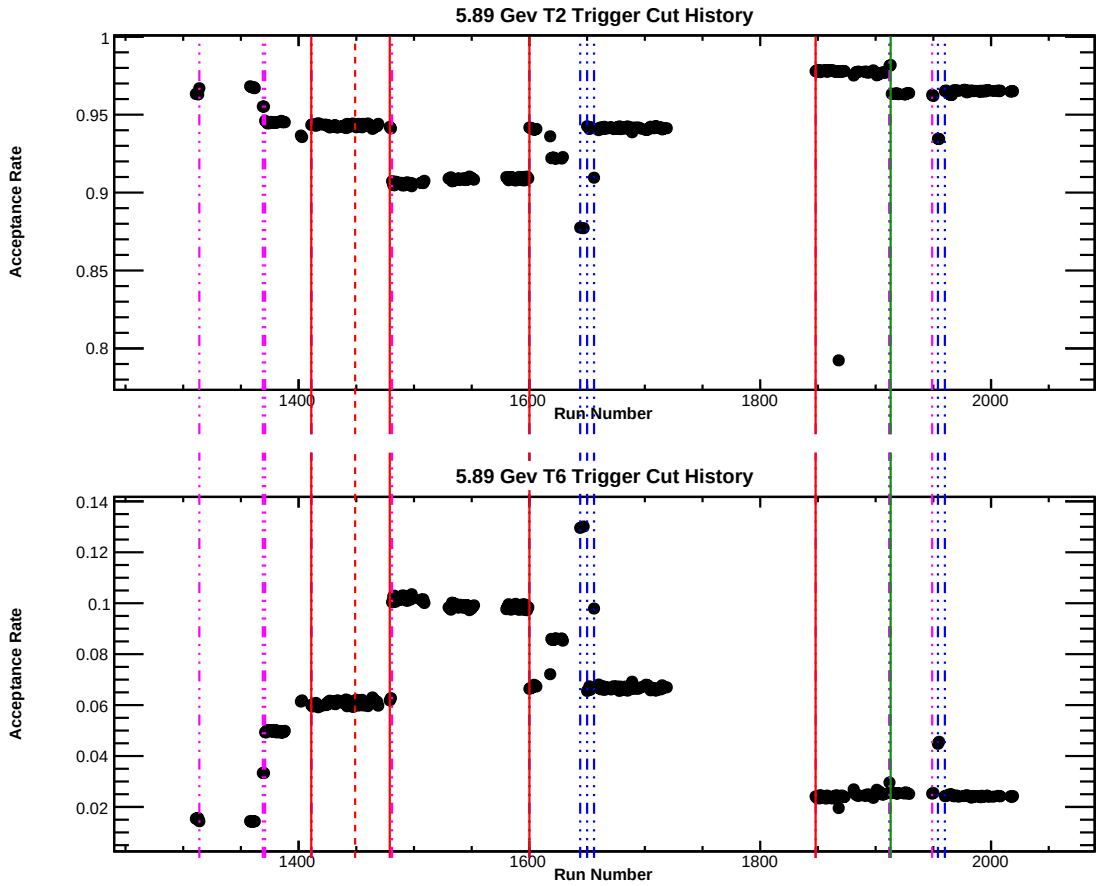
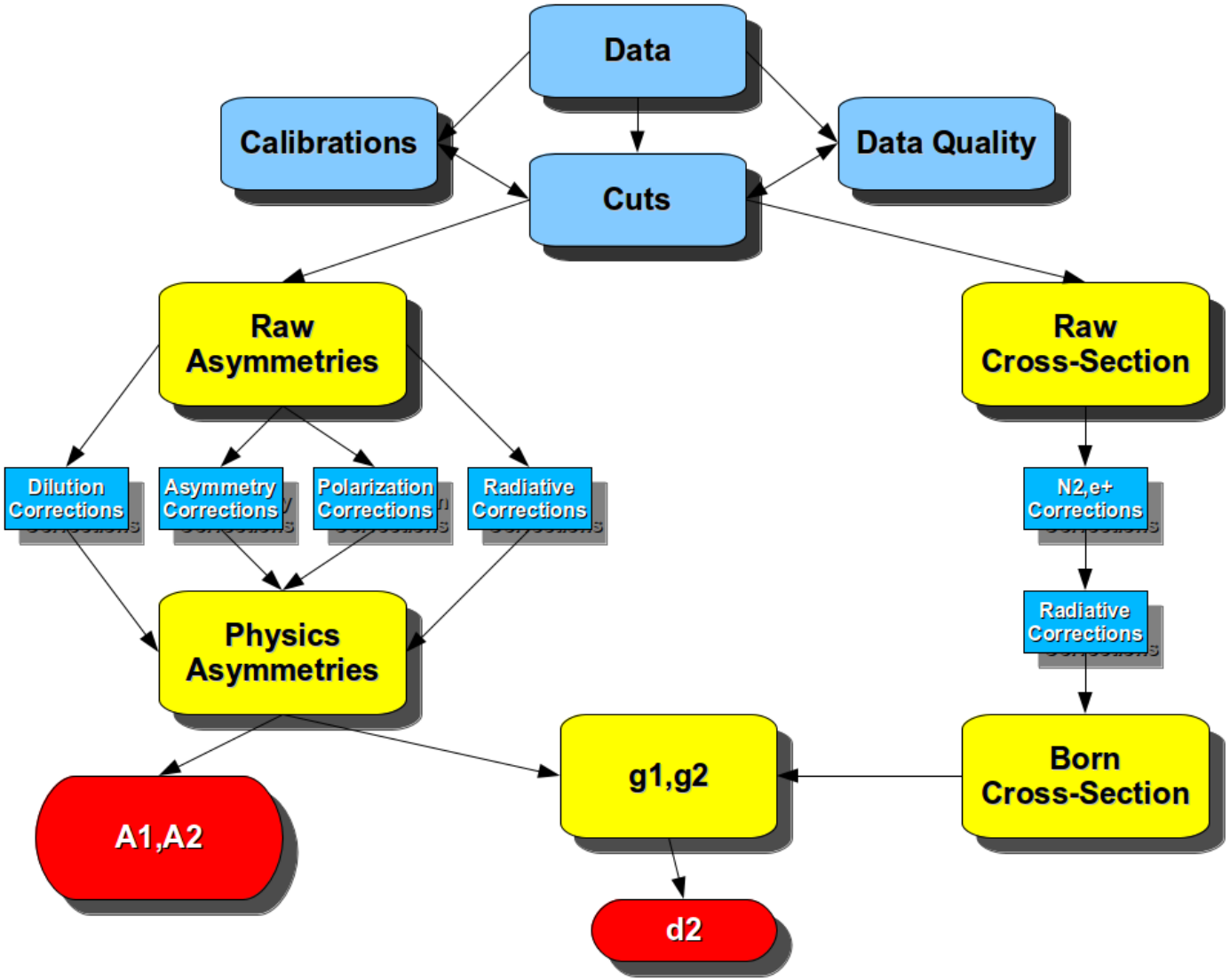
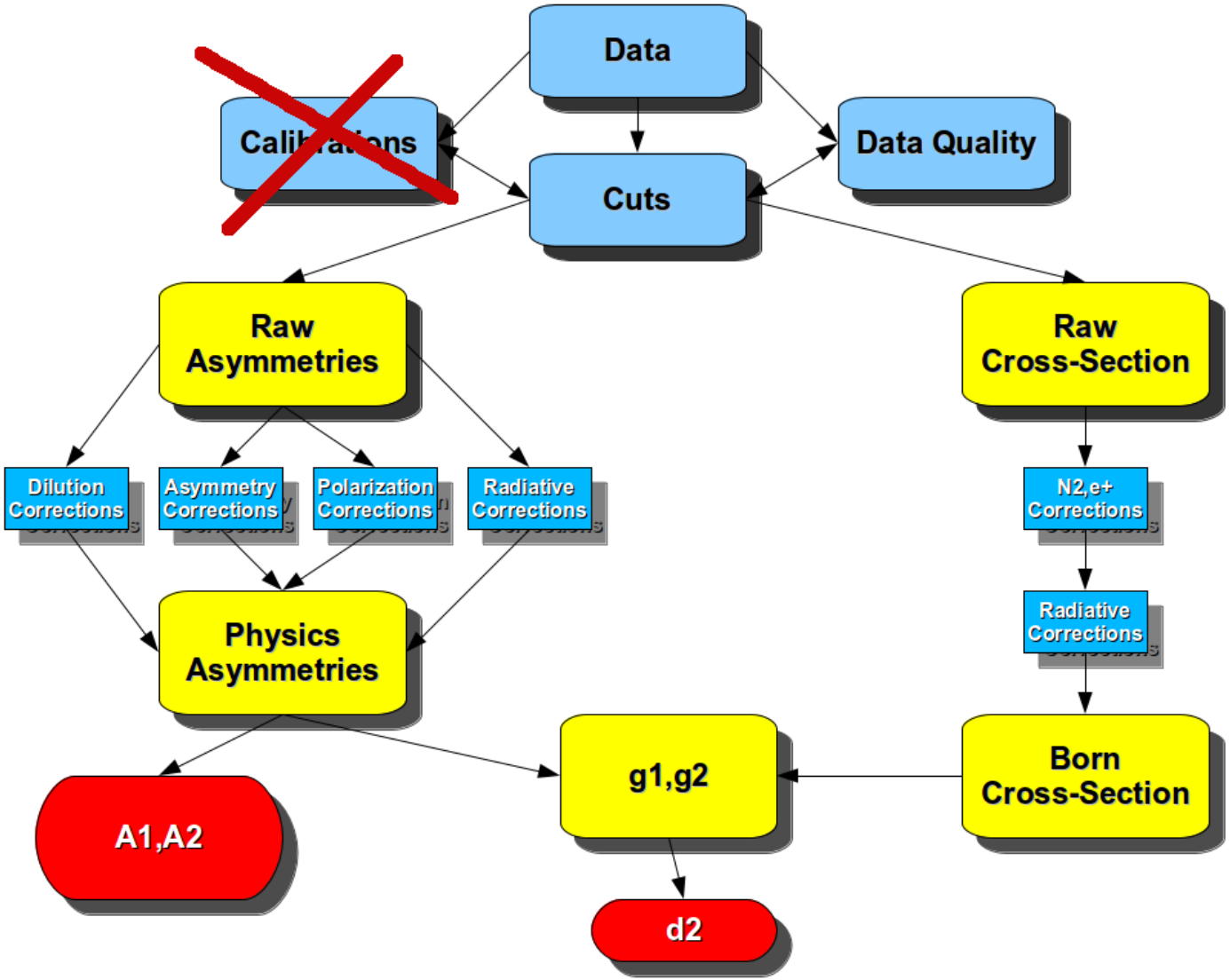


Figure: Location of shower (red solid lines) and pre-shower (green solid line) threshold changes, T2 (blue dash-dot) and T6 (magenta dash-dot) pre-scale changes for various cuts. The red dashed line shows a shower threshold change when the summing mod. was fixed.

Analysis Overview



Analysis Overview



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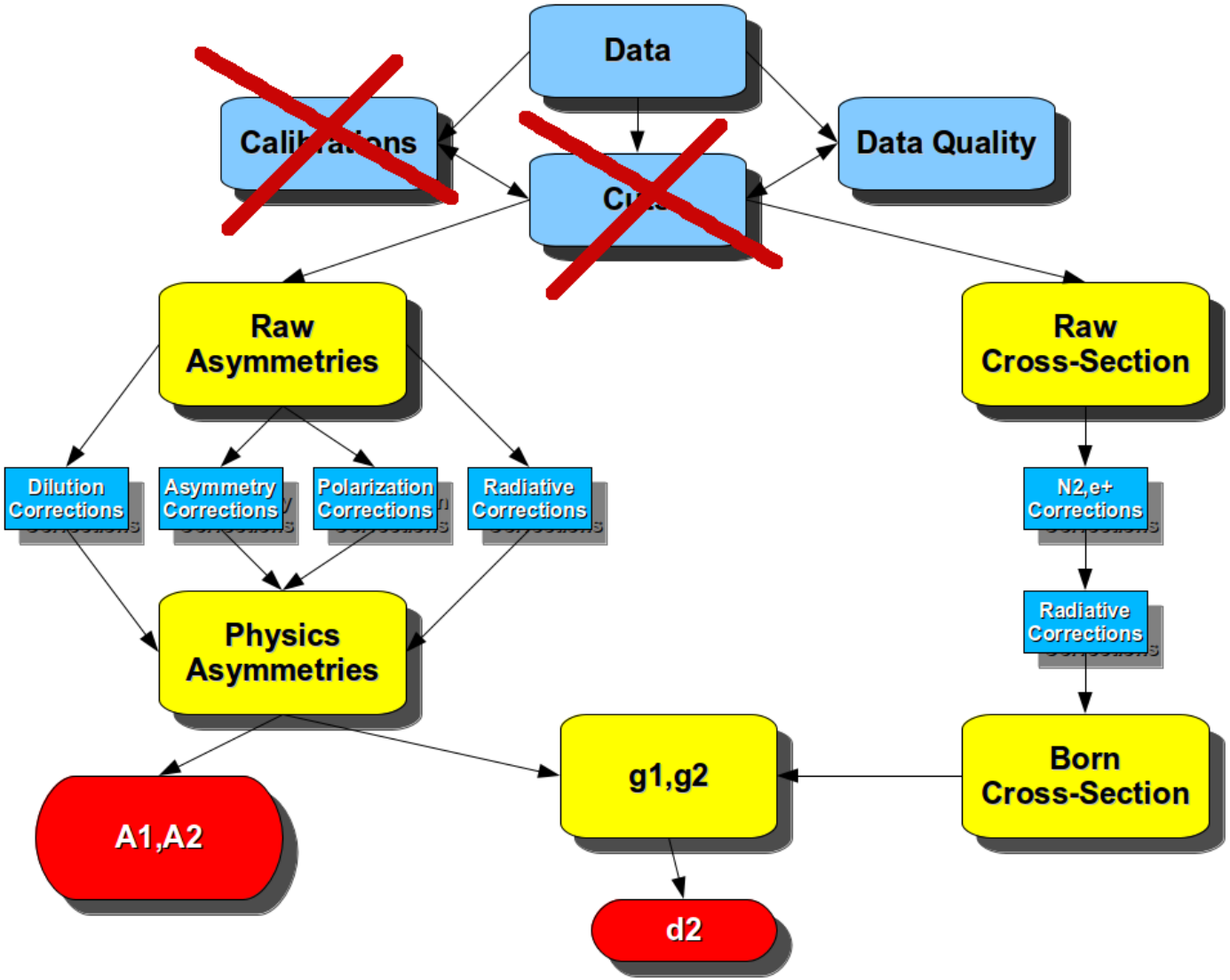

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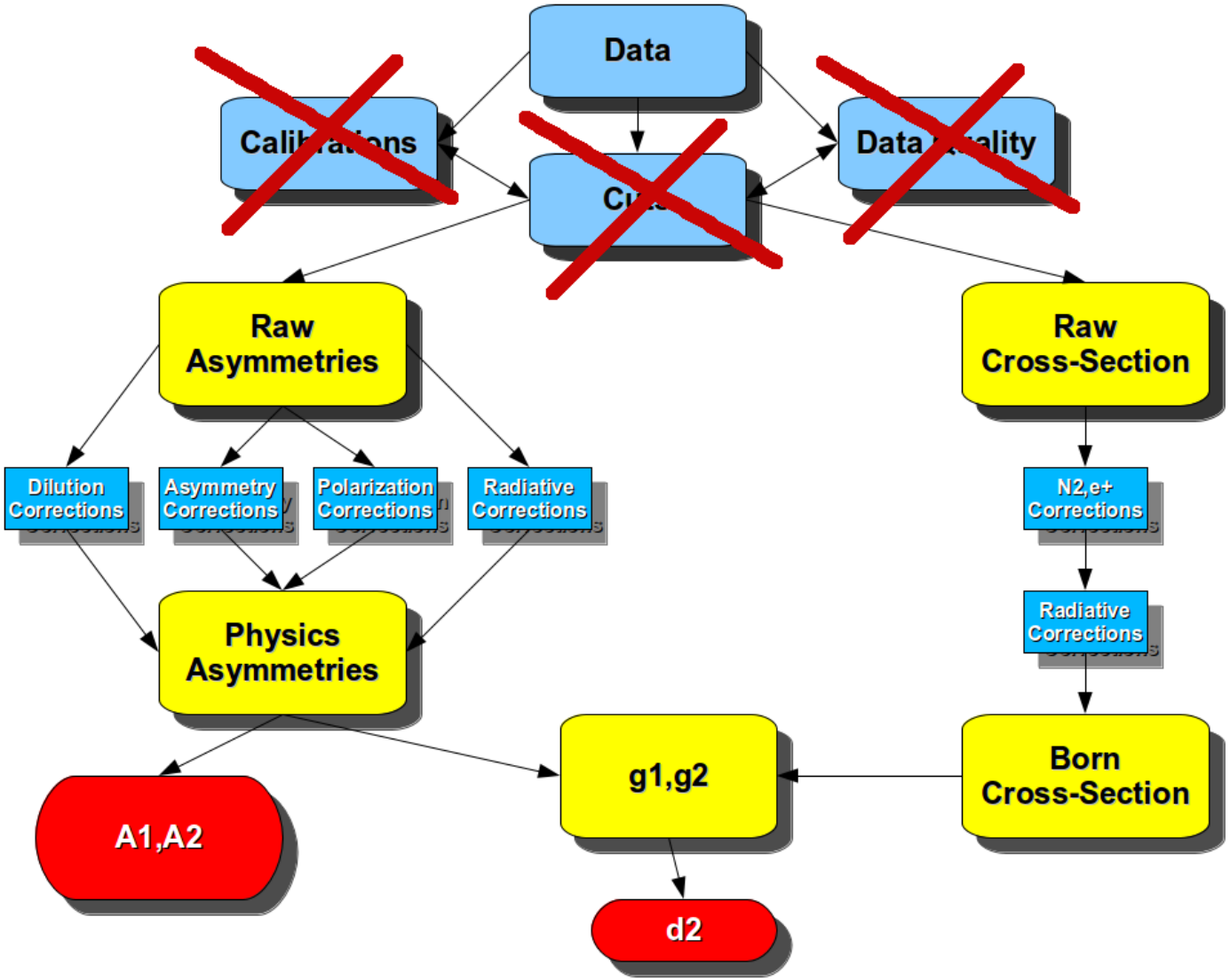

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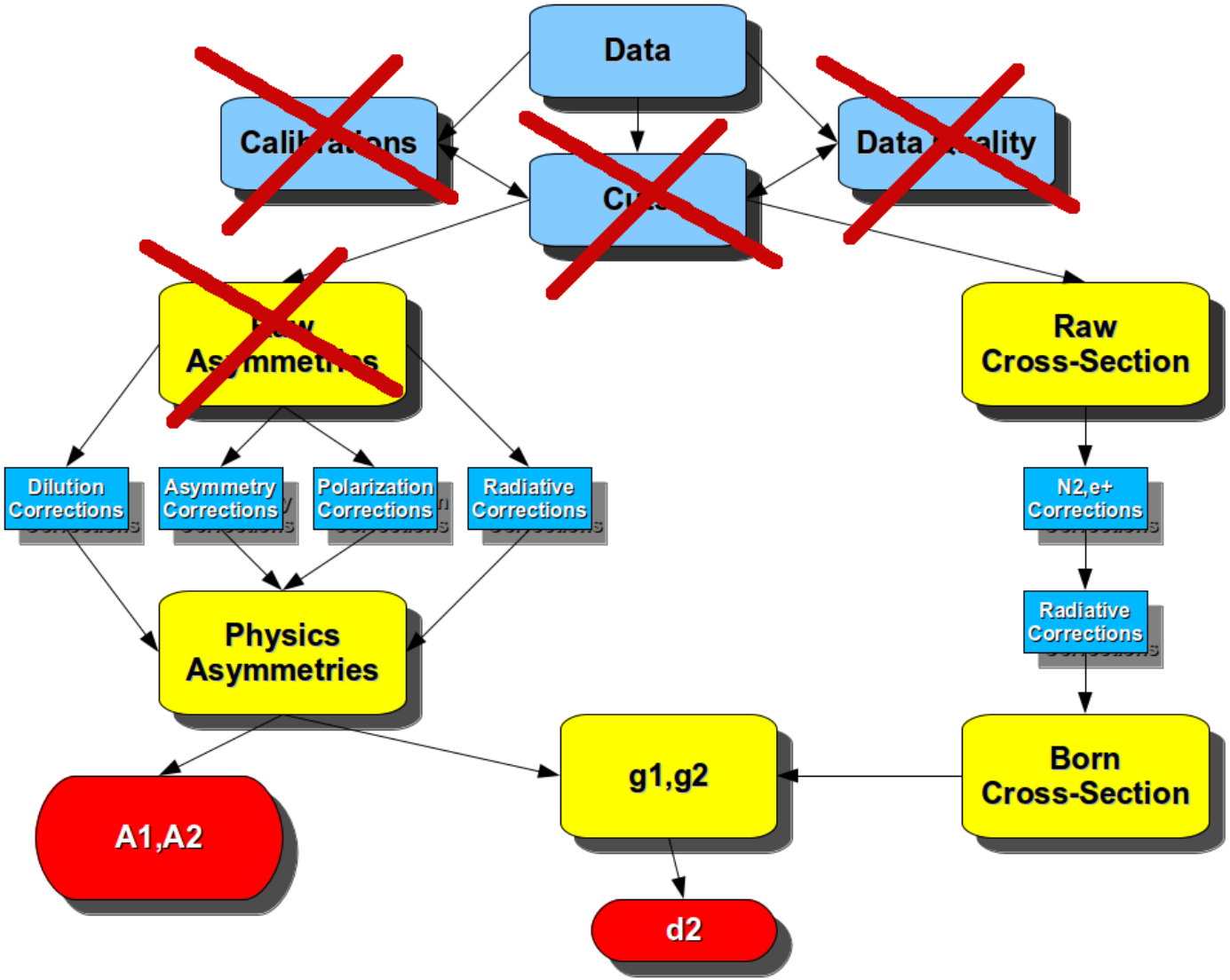
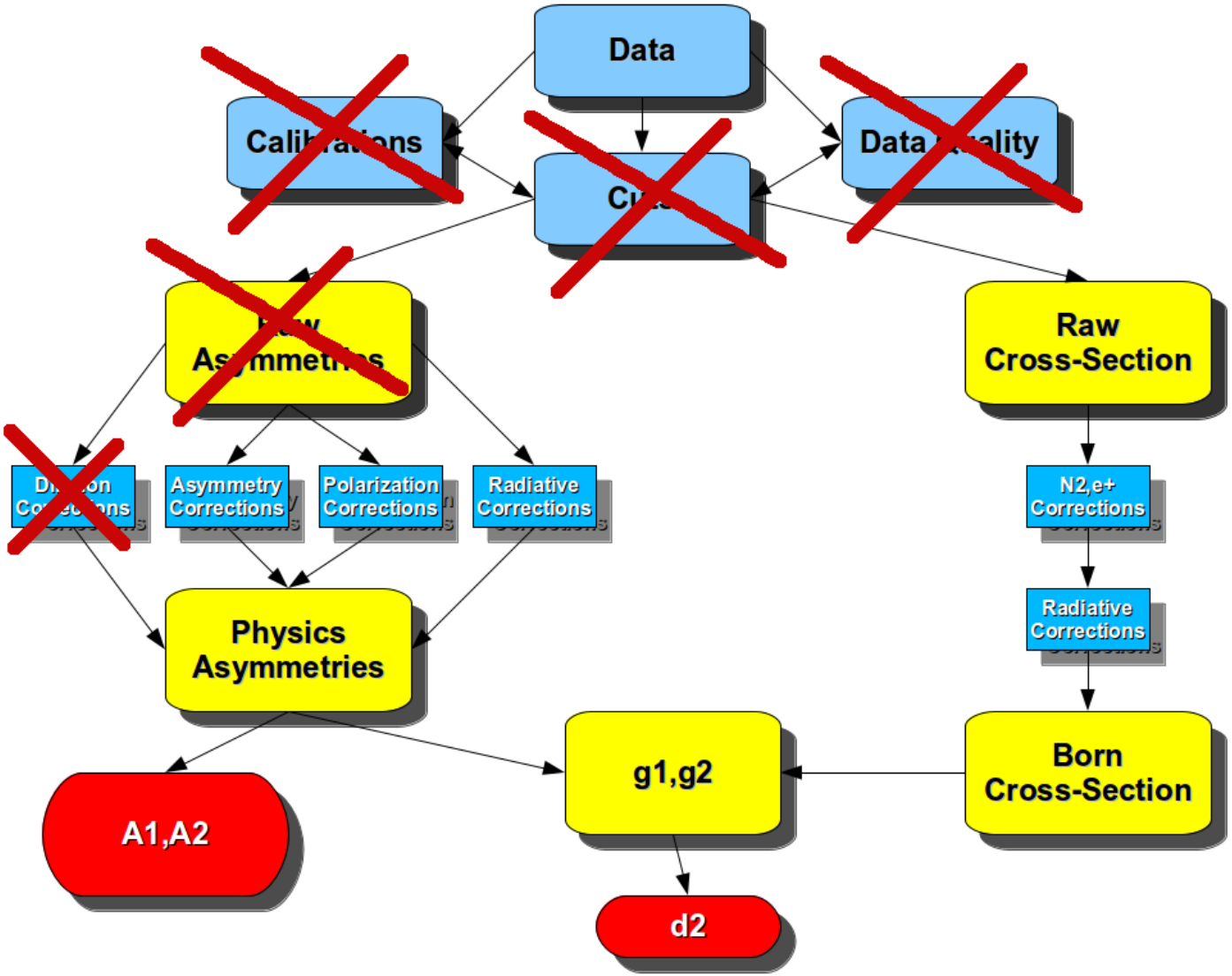
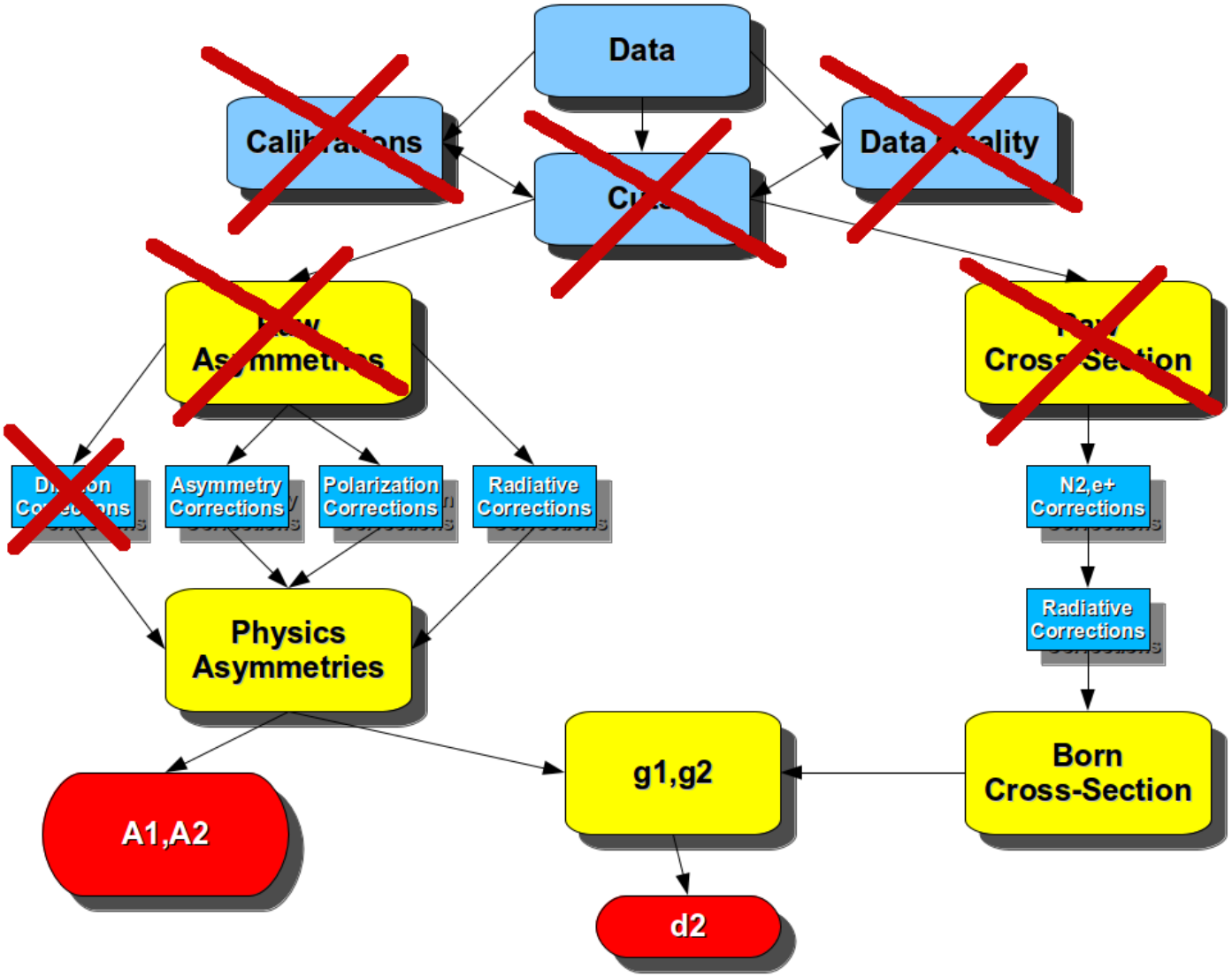


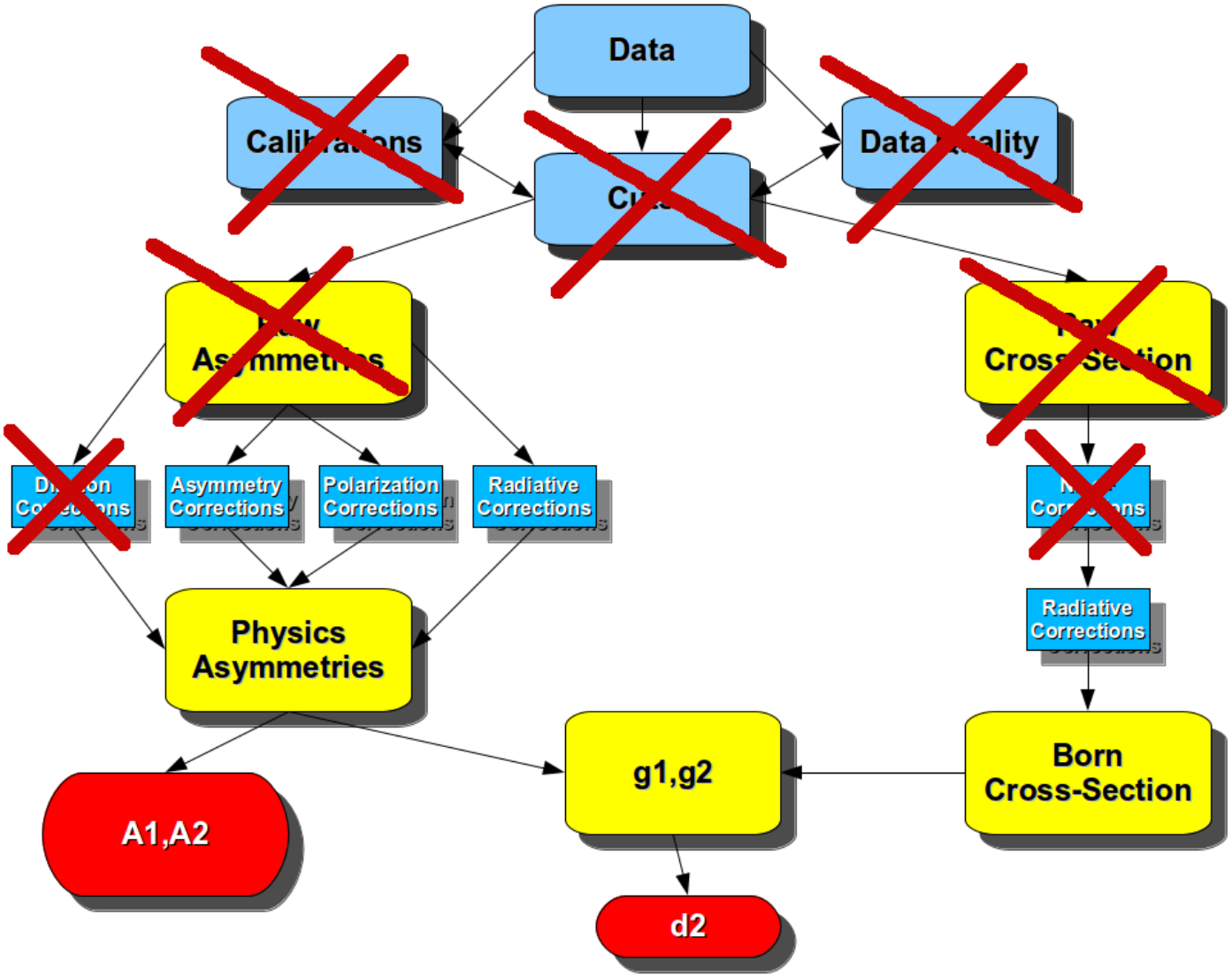
Analysis Overview



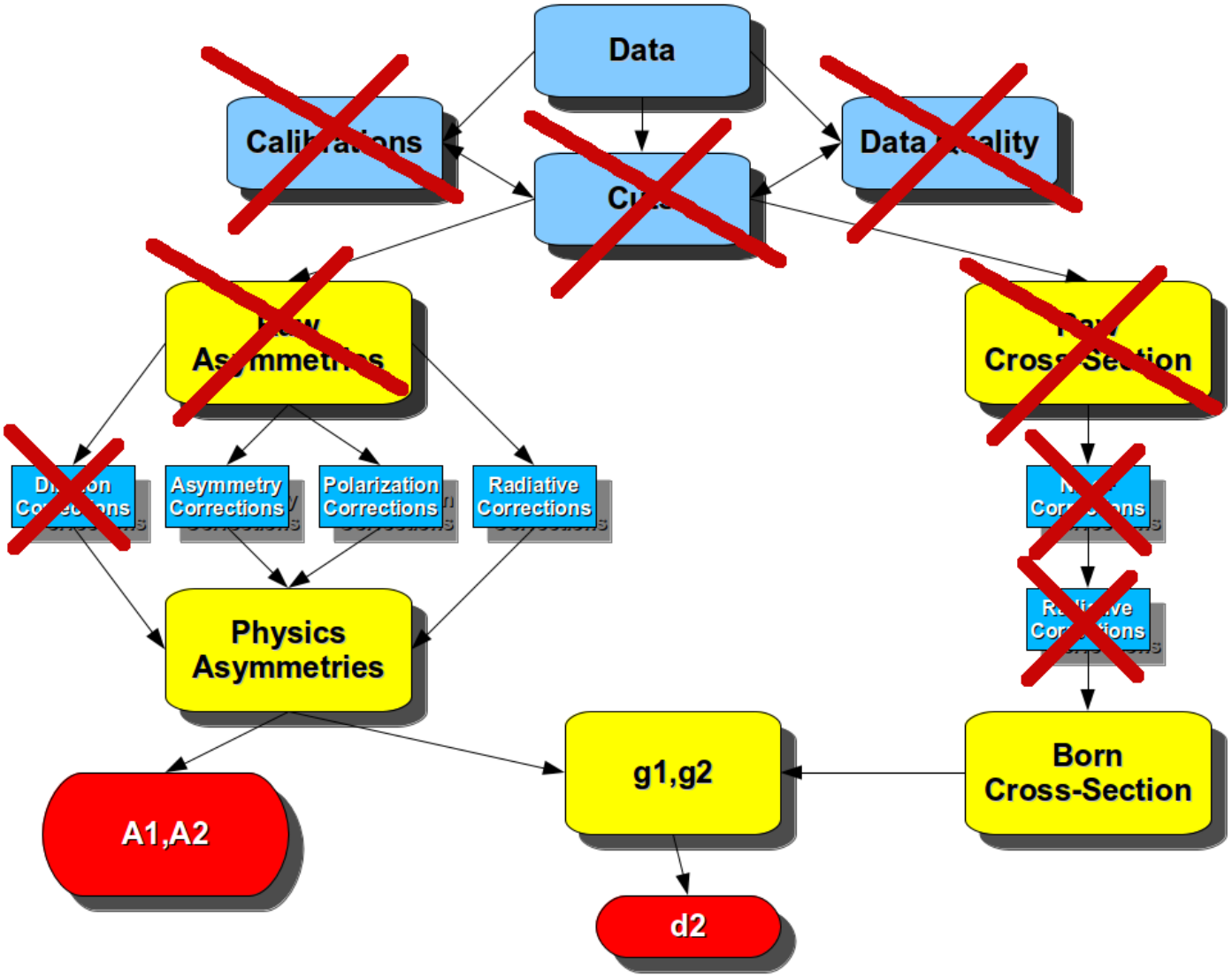
Analysis Overview



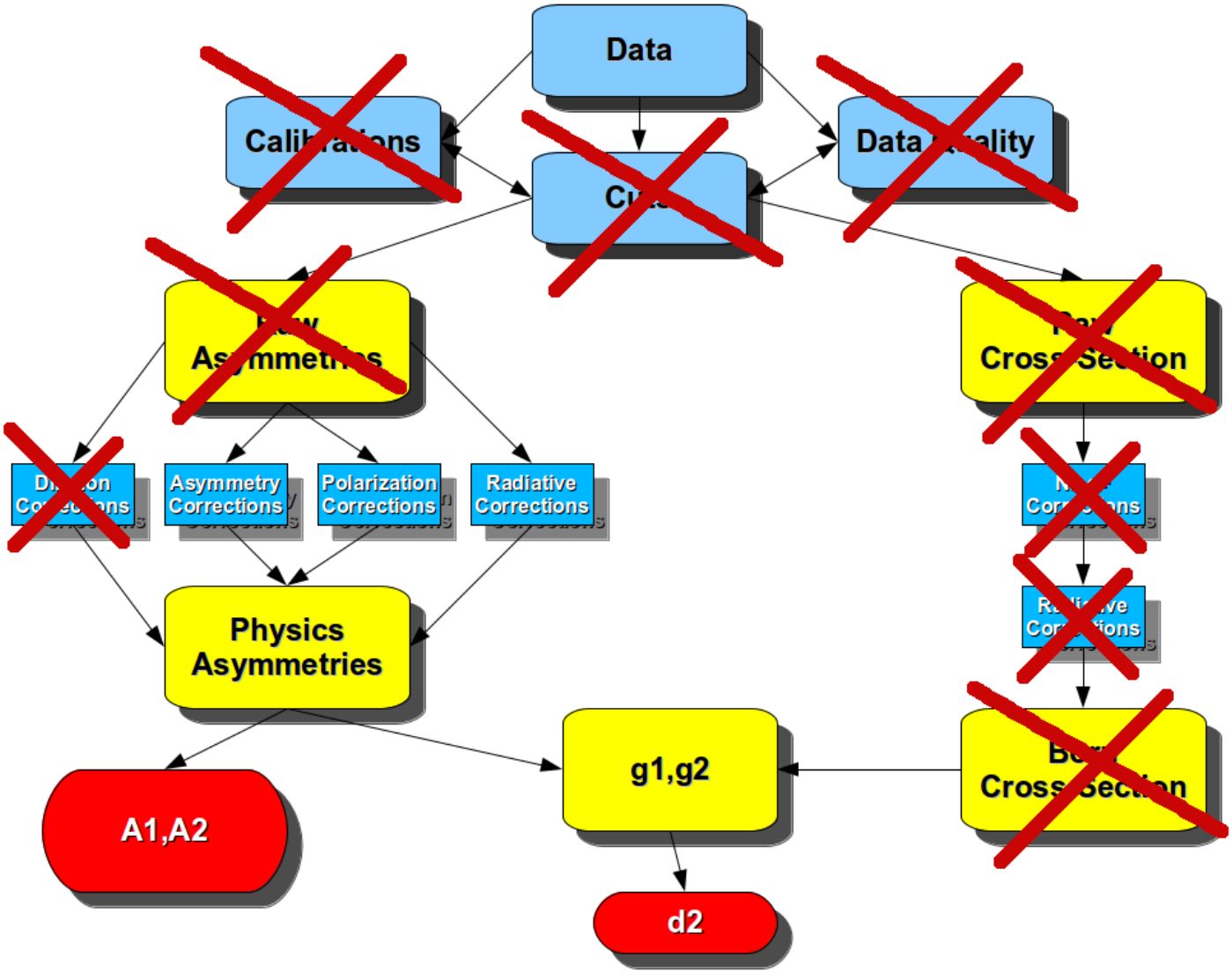
Analysis Overview



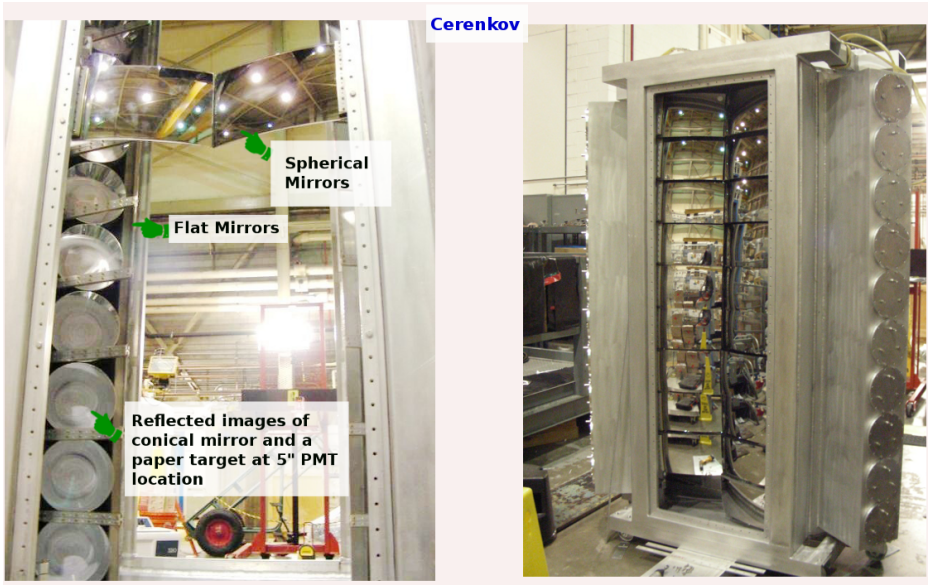
Analysis Overview

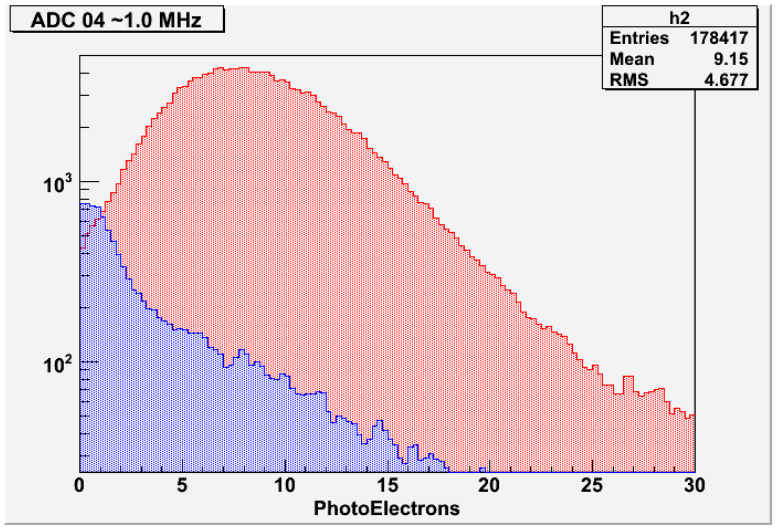


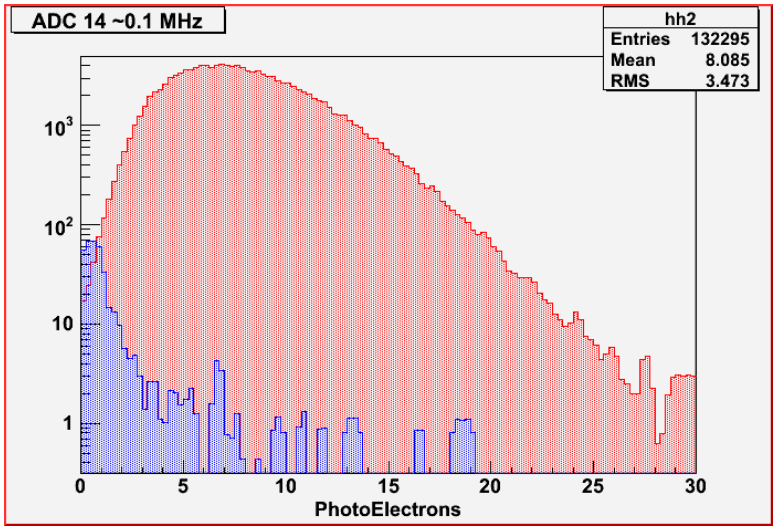
Analysis Overview



Čerenkov Rates

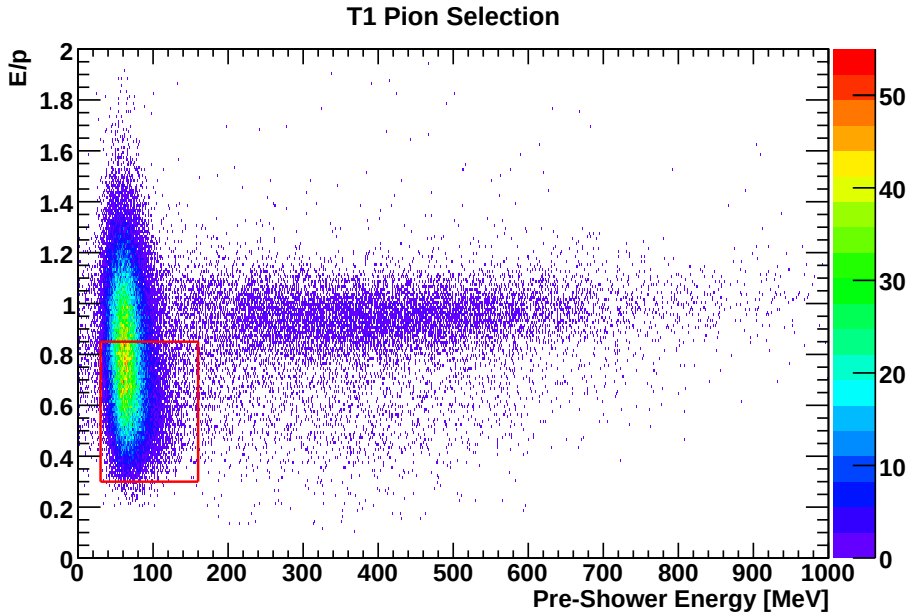






- Rate $\sim$ 10 times higher on small angle side
- Results in larger background on small angle side

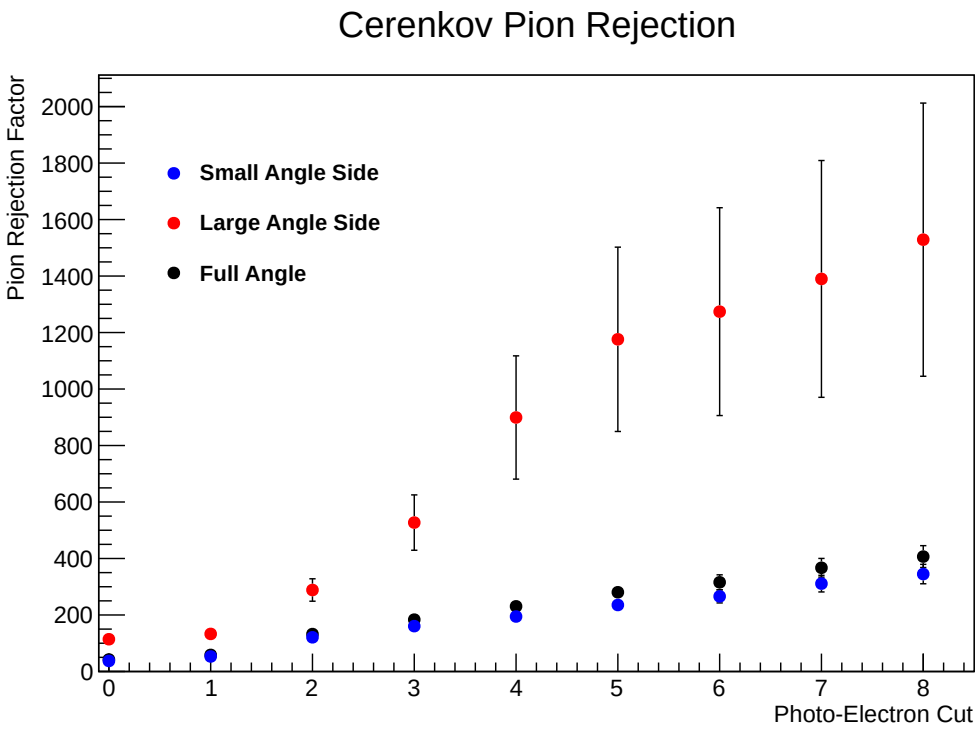
T1 Trigger Čerenkov Pion Selection



- T1 trigger at $1\mu A$ on ^{3}He
- $\epsilon_\pi = \frac{N_{cer}}{N_\pi}$

- Also used Scintillator cut to select pions
- N_π: Number of events in pion sample
- N_{cer}: Number of events in pion sample that survive the Čerenkov electron cut

Preliminary T1 Trigger Čerenkov Pion Rejection



- At 0 photo-electron cut:
  - Small angle $\epsilon_\pi = 37$
  - Large angle $\epsilon_\pi = 114$
  - Full acceptance $\epsilon_\pi = 42$

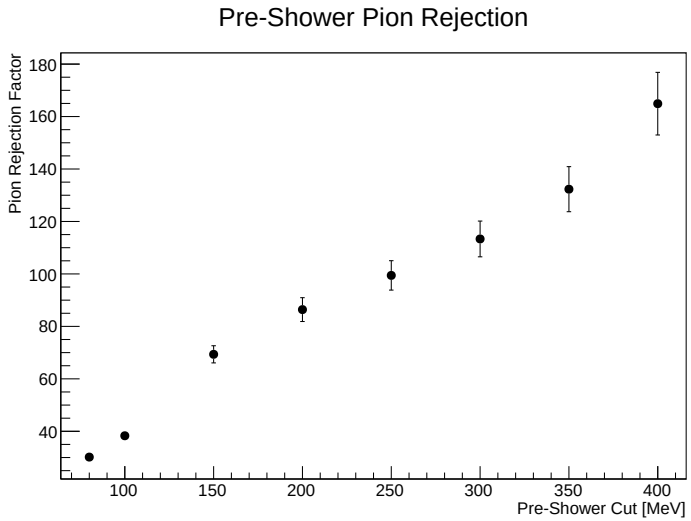
- Proposal 3 p.e: 10^3
- Experiment 3 p.e:
  - Small angle: 160
  - Large angle: 527
  - Full acceptance: 183

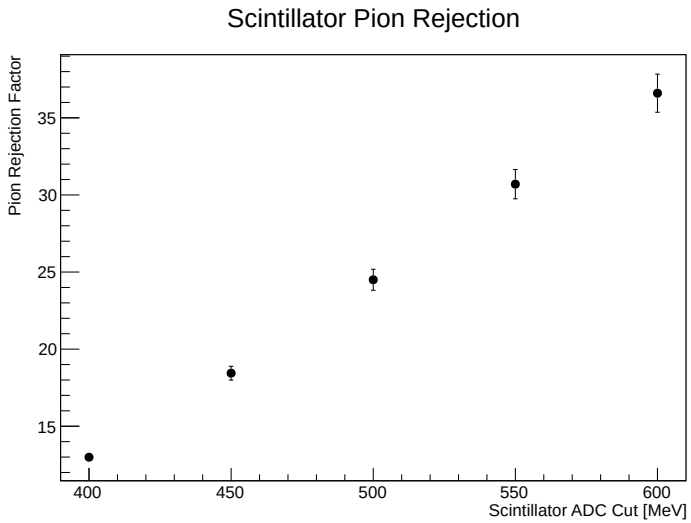
Preliminary T1 Trigger Pion Rejection

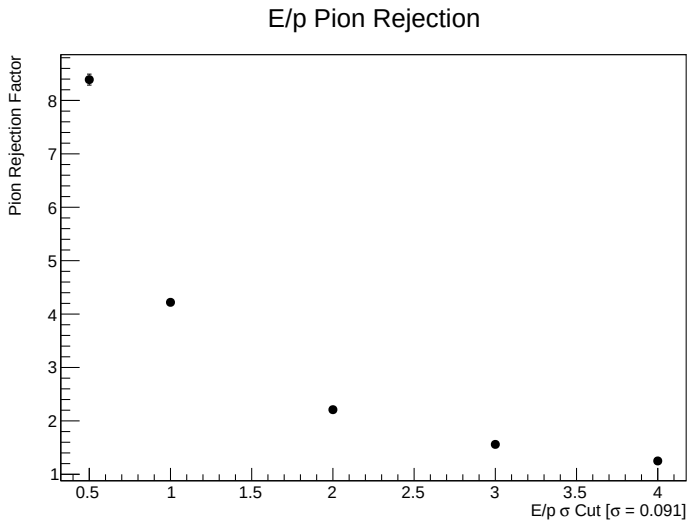
- T1 trigger at 1 μA on ^{3}He

Pion PID Cuts:

- Pre-Shower: Čerenkov + Scintillator
- Scintillator: Čerenkov + Pre-Shower
- E/p: Čerenkov + Scintillator



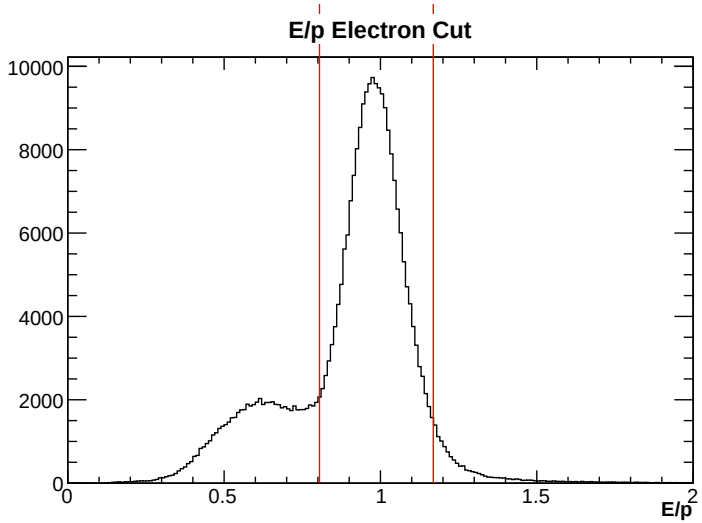


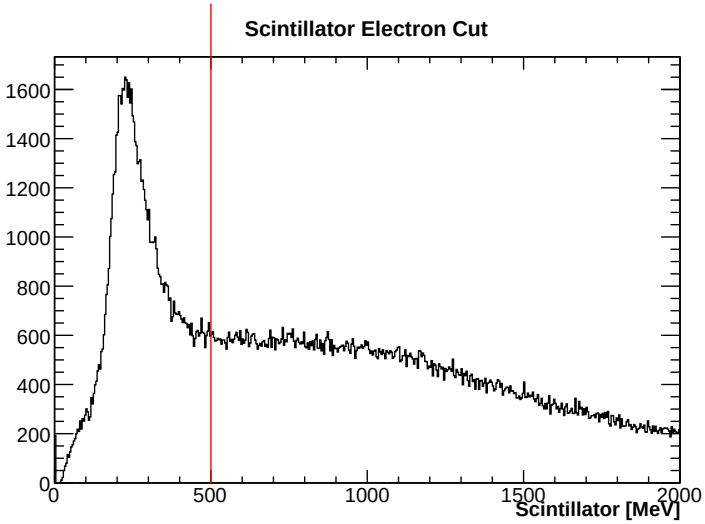


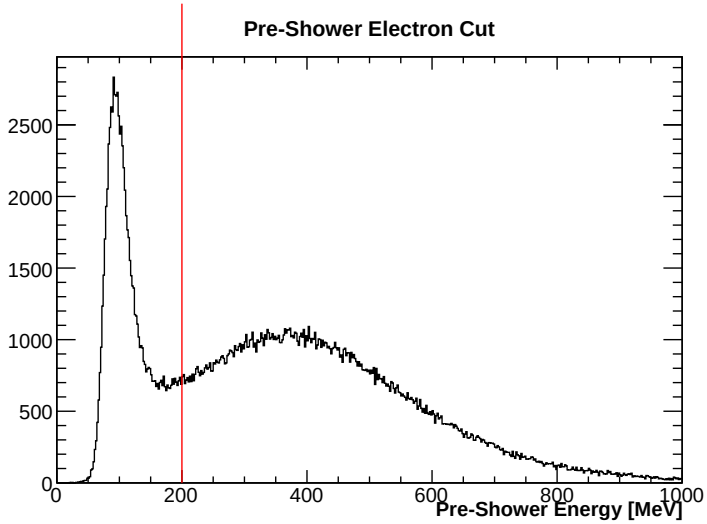
Total T1 Trigger BigBite Pion Rejection

Detector	**Cut Value**	**Pion Rejection Factor**
Pre-Shower	200 MeV	86.0
Scintillator	500 MeV	24.5
E/p	2σ	2.2
Čerenkov	0 p.e.	42.4
Total	Proposal: 10^5	Experiment: 1.97×10^5

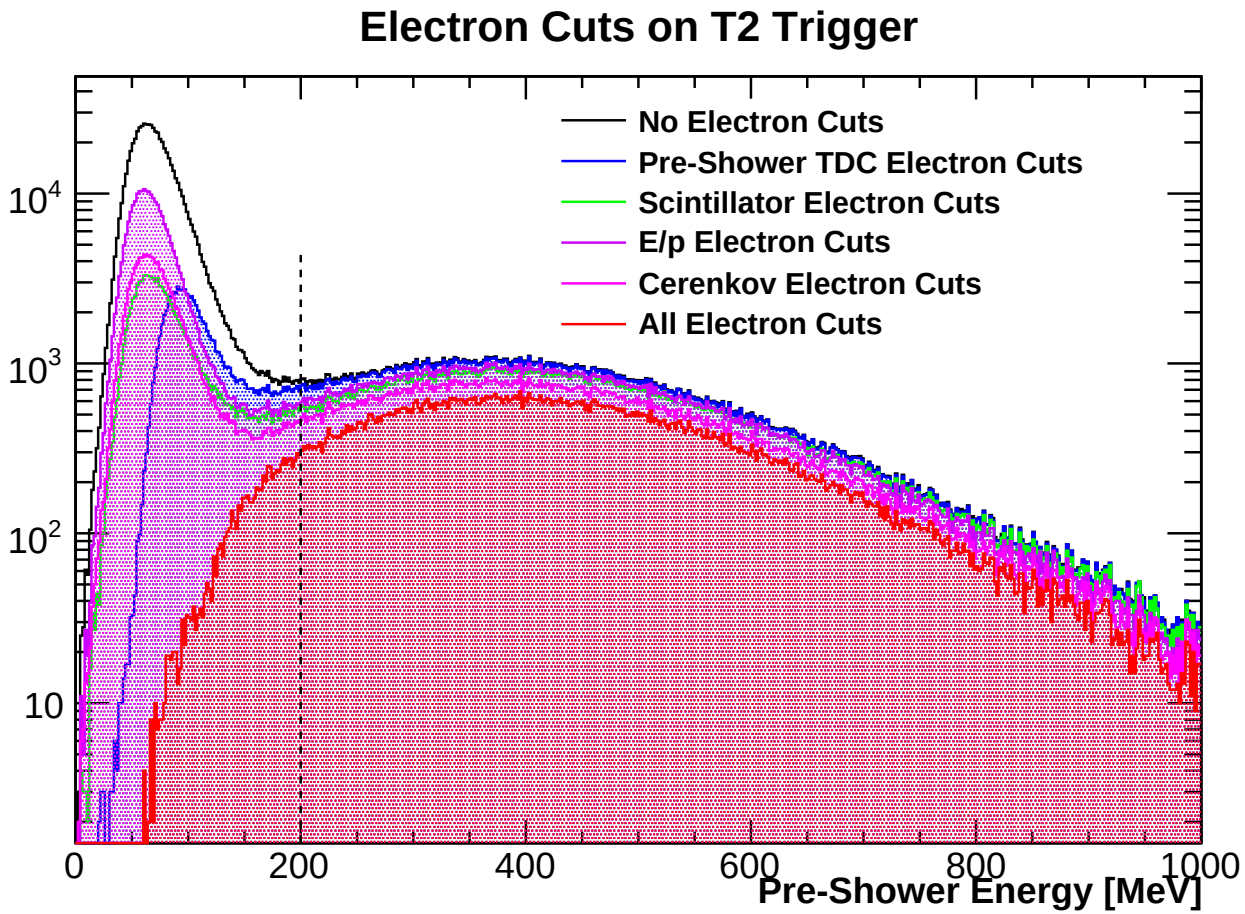
T2 Trigger Electron PID Cuts







BigBite T2 Trigger Pion Rejection



Asymmetry Definition

$$A_{\parallel} = \frac{1}{P_t P_b D_{N_2}} \frac{N^{\downarrow\Uparrow} - N^{\uparrow\Uparrow}}{N^{\downarrow\Uparrow} + N^{\uparrow\Uparrow}} \quad (1)$$

$$A_{\perp} = \frac{1}{P_t P_b D_{N_2} cos(\phi)} \frac{N^{\downarrow\Rightarrow} - N^{\uparrow\Rightarrow}}{N^{\downarrow\Rightarrow} + N^{\uparrow\Rightarrow}} \quad (2)$$

where

- $\downarrow(\uparrow)$: negative(positive) electron helicity
- $\Uparrow(\Rightarrow)$: target polarization parallel S = 0° to beam(towards BigBite S=270°)
- $P_t(P_b)$: electron beam (target) polarizations
- D_{N_2}: nitrogen dilution factor
- ϕ: out of scattering plane angle

4.74 and 5.89 GeV Longitudinal and Transverse Electron Asymmetries on ^{3}He

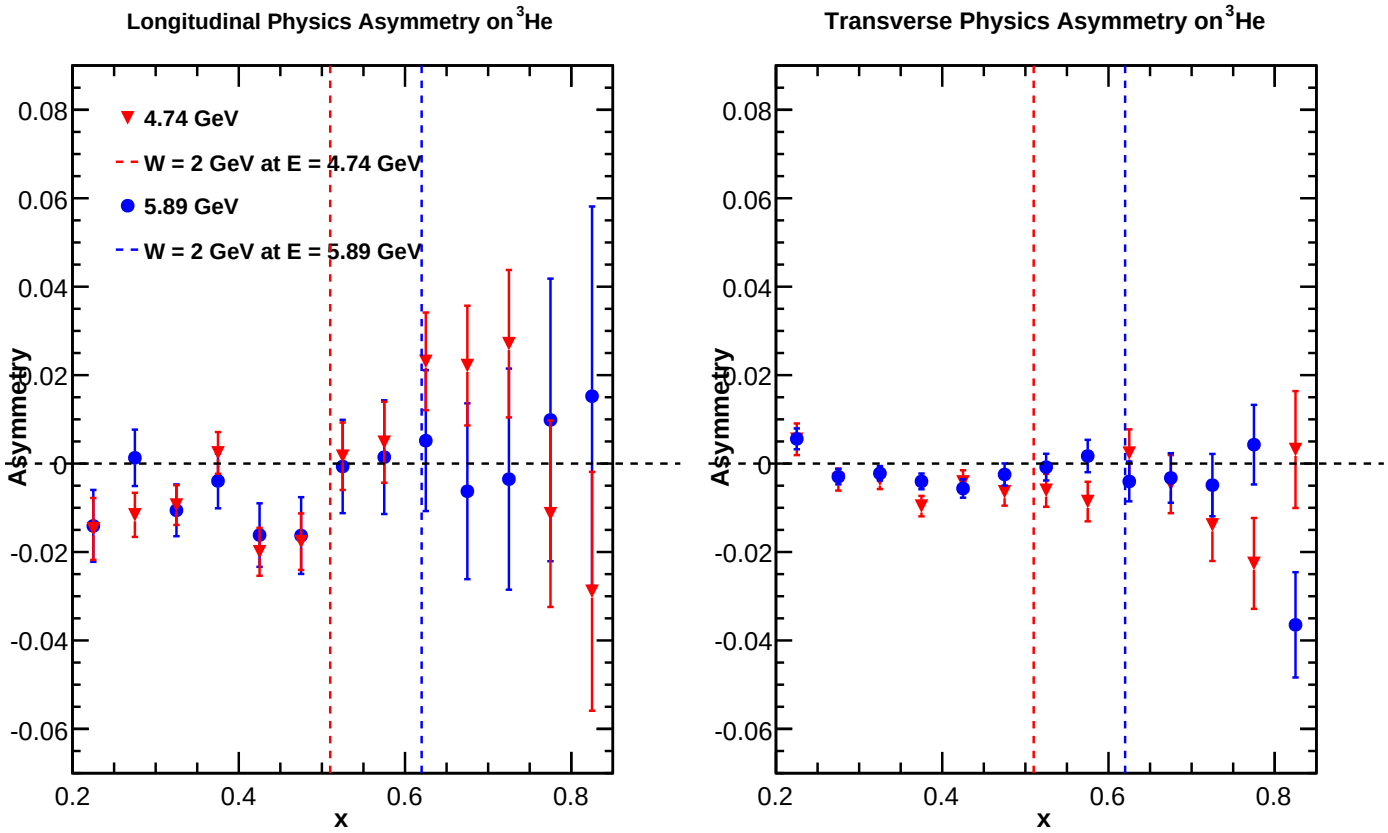


Figure: 4.74 and 5.89 GeV longitudinal and transverse electron asymmetries on ^{3}He.

4.74 and 5.89 GeV Raw Pion Asymmetries on ^{3}He

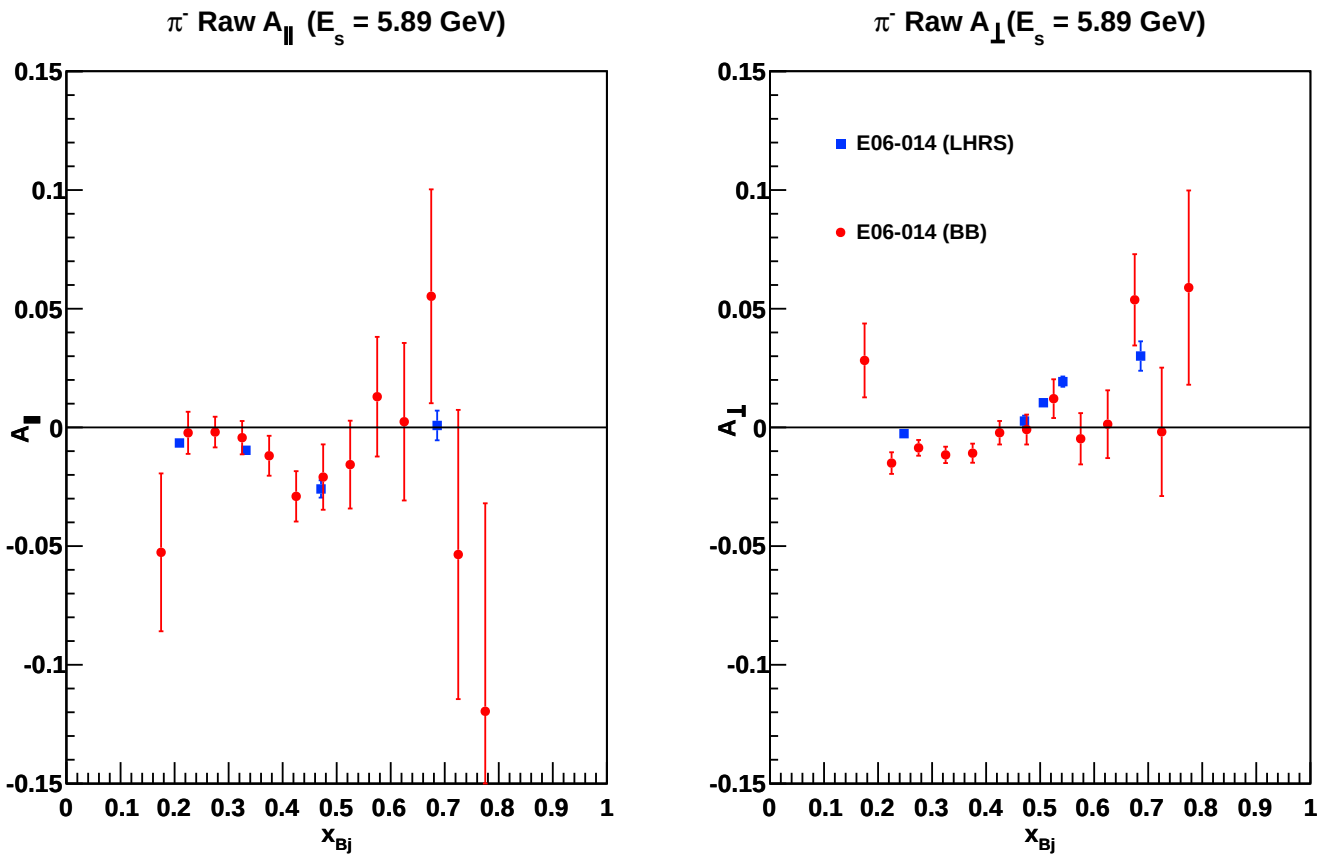


Figure: 4.74 and 5.89 GeV longitudinal and transverse pion raw asymmetries on ^{3}He.

4.74 and 5.89 GeV Raw Pion Asymmetries on ^{3}He

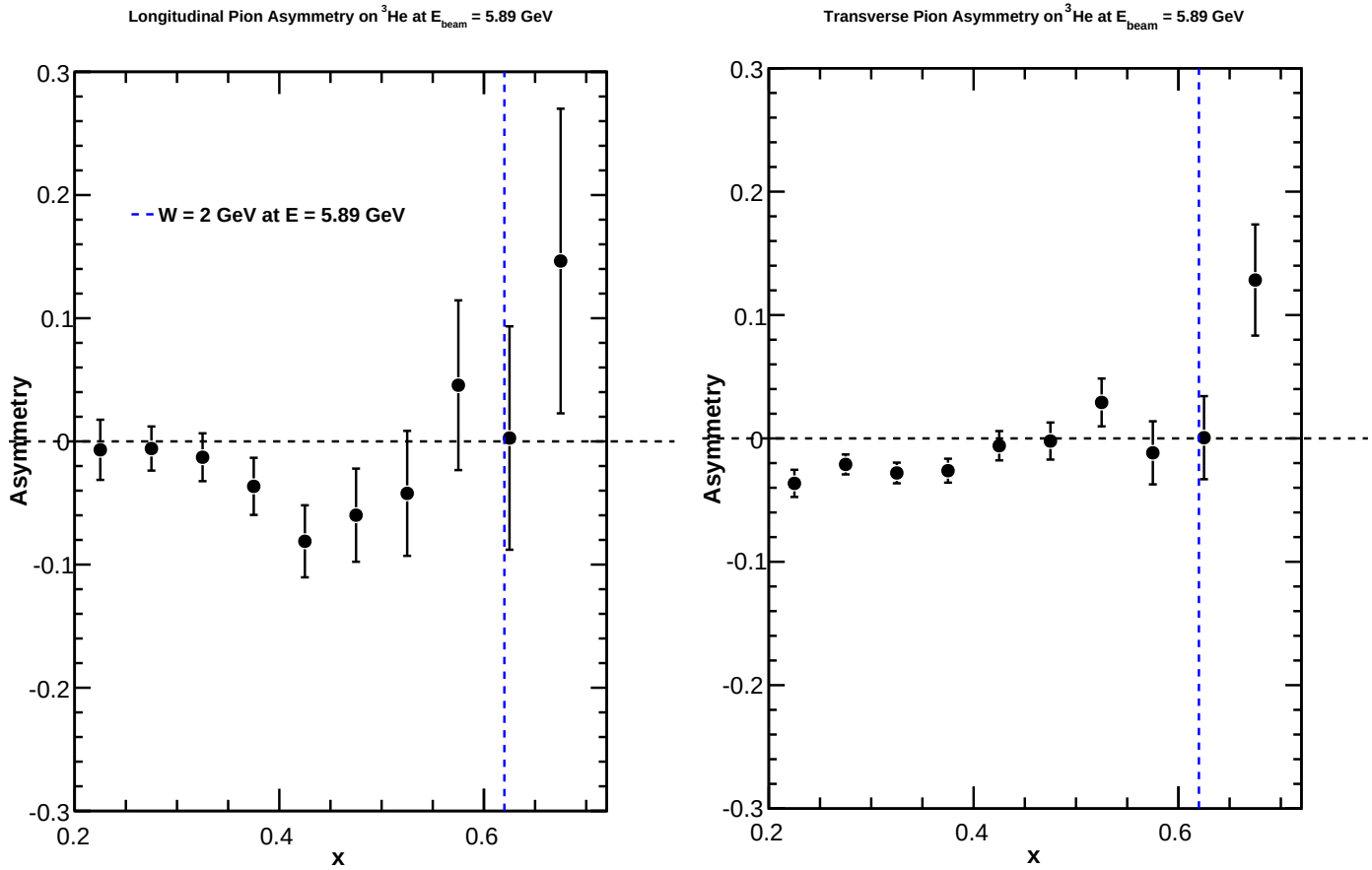
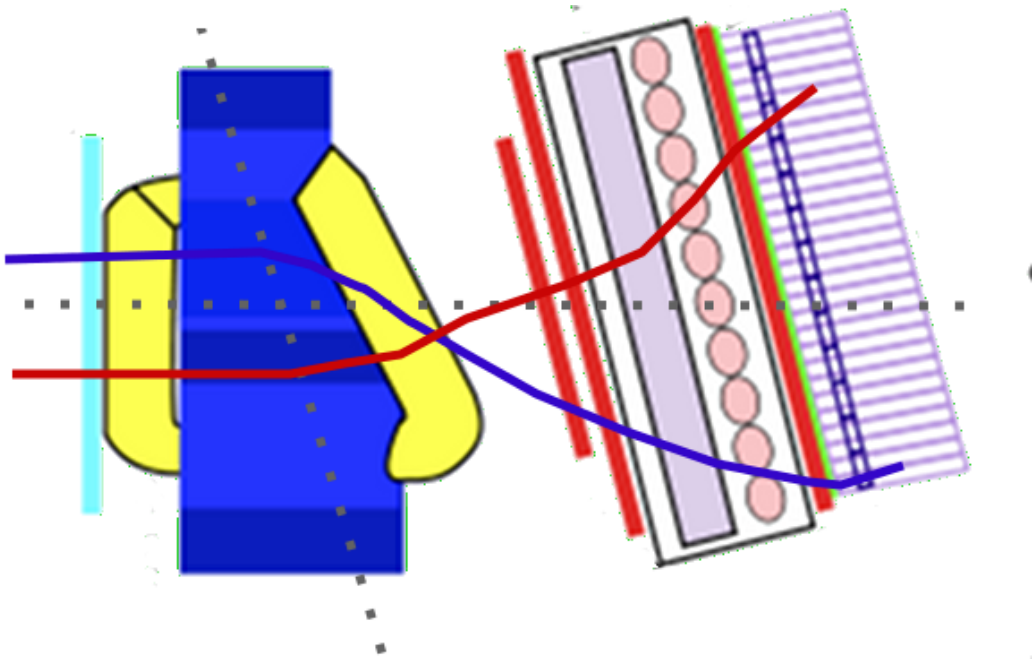


Figure: 4.74 and 5.89 GeV longitudinal and transverse pion physics asymmetries on ^{3}He.

BigBite Particle Acceptance



- Two particle acceptance types:
  - Bend-up (particle charge same as BigBite polarity)
  - Bend-down (particle charge opposite BigBite polarity)

Positron Asymmetry Correction

$$A_m = \frac{N_e^- - N_e^+ + N_p^- - N_p^+}{N_e^- + N_e^+ + N_p^- + N_e^+} = \frac{\Delta N_e + \Delta N_p}{N_e + N_p}$$

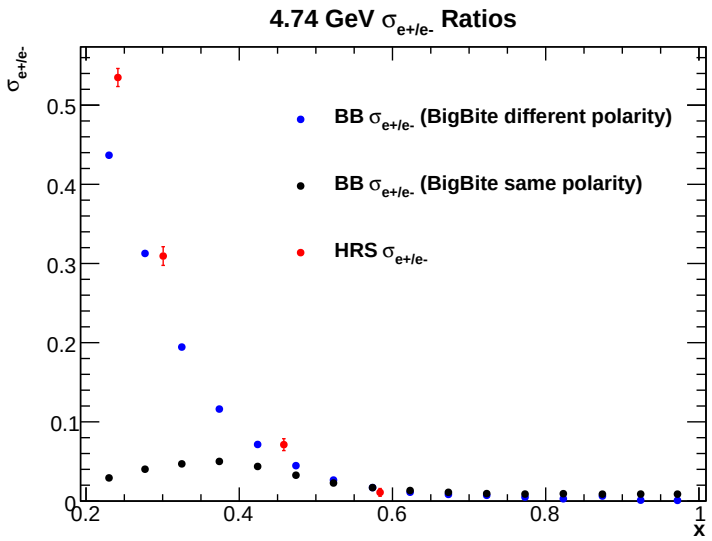
where e = electron, p = positron and $-(+)$ is negative (positive) helicity
ΔN is $N^- - N^+$ and N is $N^- + N^+$

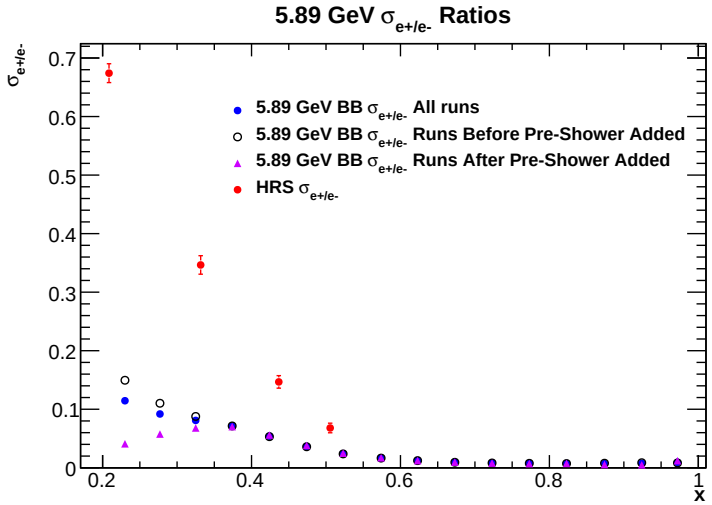
$$A_m = \frac{\frac{\Delta N_e}{N_e} + \frac{\Delta N_p}{N_e}}{1 + \frac{N_p}{N_e}} = \frac{A_e + \frac{\Delta N_p}{N_e}\frac{N_p}{N_p}}{1 + \frac{N_p}{N_e}} = \frac{A_e + RA_p}{1 + R}$$

where:

- A_m = measured asymmetry
- A_e = clean electron asymmetry
- A_p = positron asymmetry
- R = e^+/e^- ratio

e^+/e^- Ratios





- Only Bend-up positrons at E = 4.74 GeV and S = 270°
- Correct bend-down ratio using BigBite bend-up ratio

- Bend-down ratio turn over due to acceptance (w/pre-shower in the trigger)

LHRS e+/e- Compared to CLAS

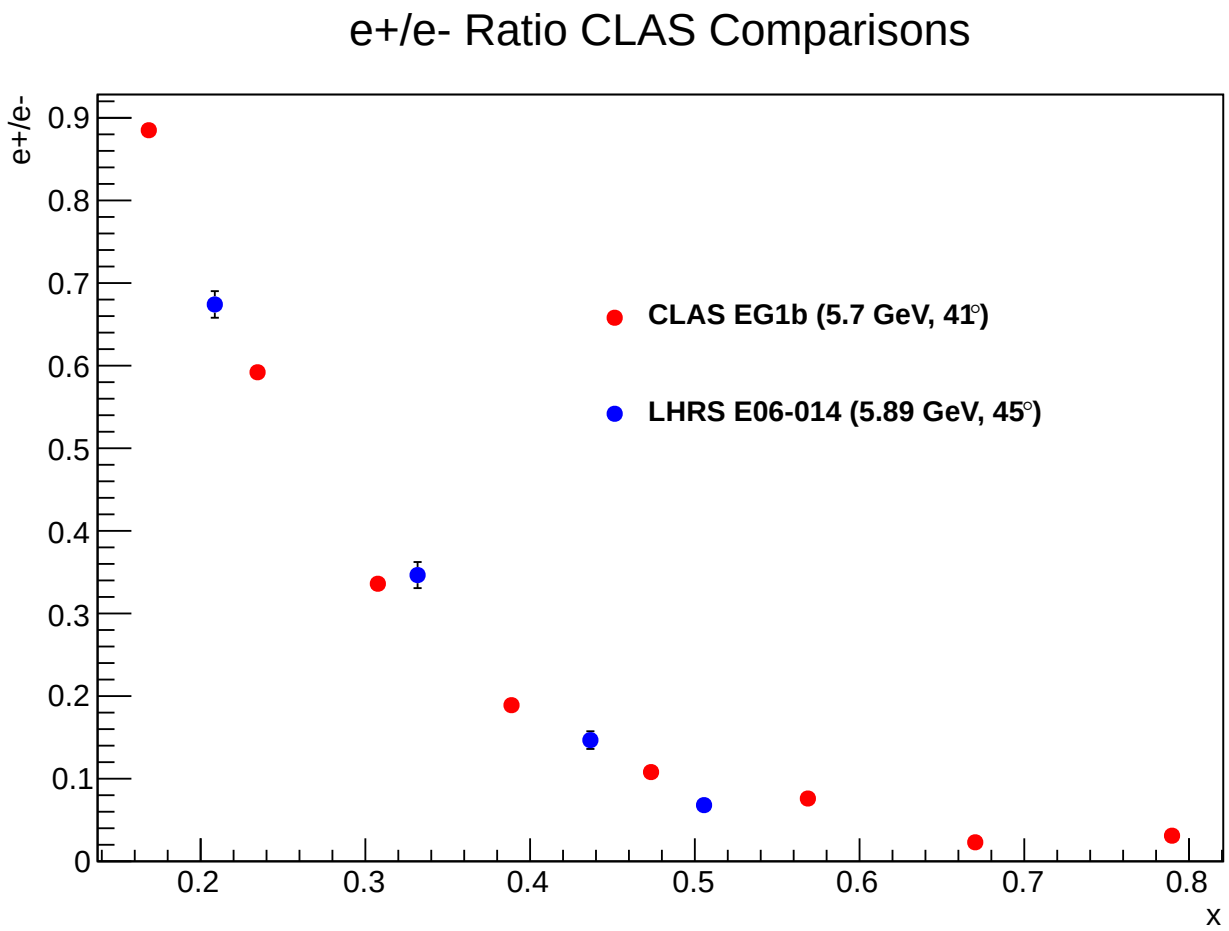


Figure: Comparison of LHRS e+/e- ratios to CLAS EGb1 e+/e- ratios.

4.74 Target Spin of 270° Bend-Up and Bend-Down Positron Asymmetry Comparison

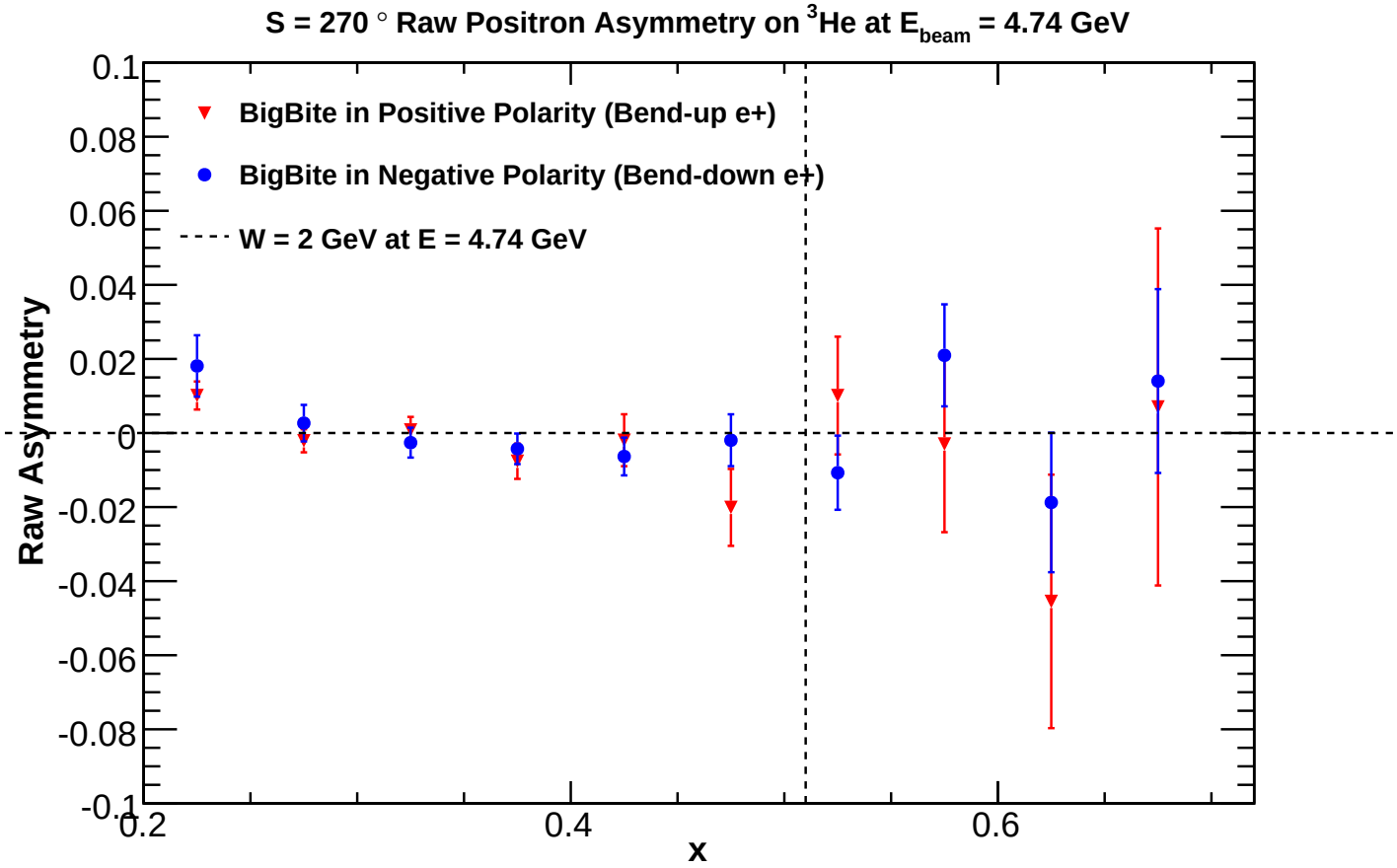


Figure: 4.74 GeV Bend-up and bend-down positron asymmetries on ^{3}He.

4.74 and 5.89 GeV Positron Asymmetries on ^{3}He

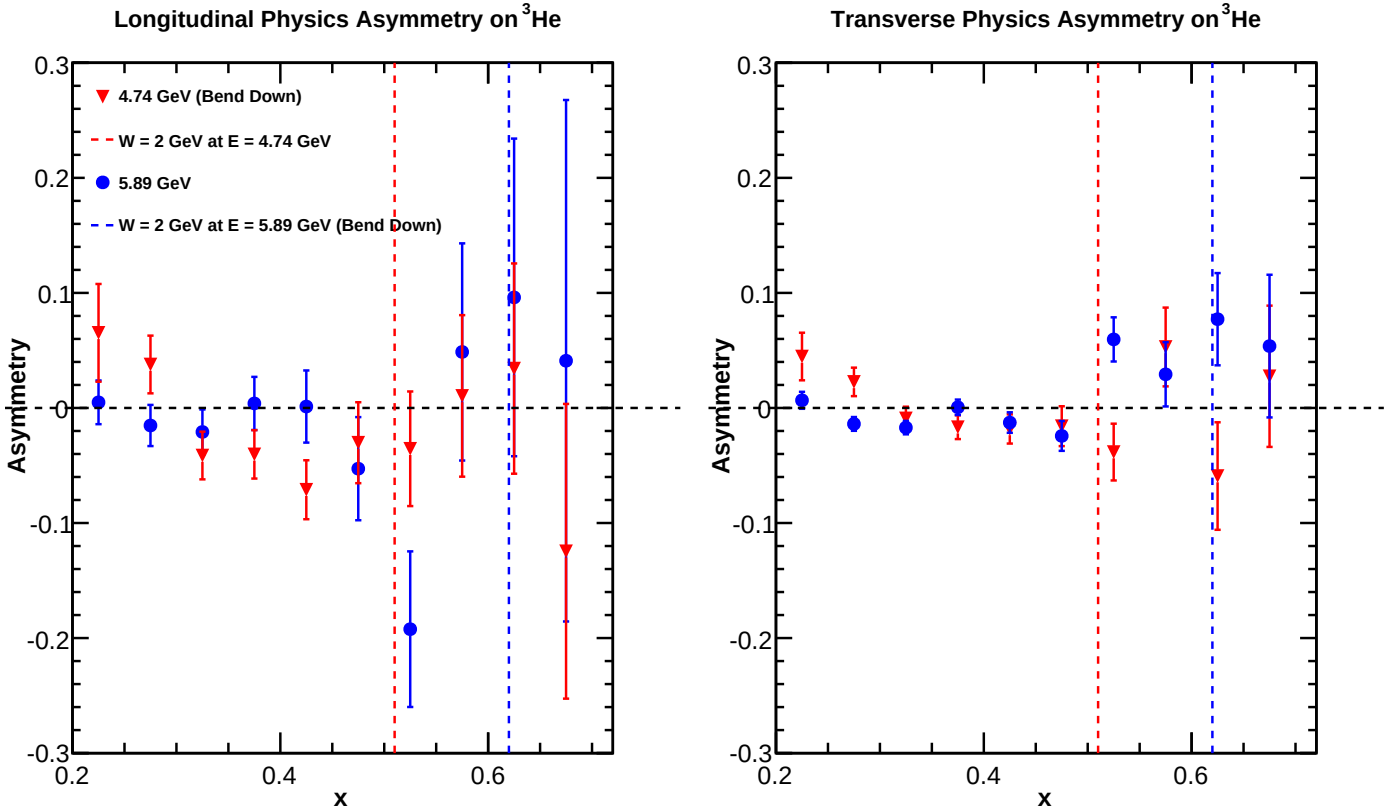


Figure: 4.74 and 5.89 GeV longitudinal and transverse positron asymmetries on ^{3}He.

To Do

- Apply positron asymmetry corrections
- Compute pion asymmetry contamination
- Apply radiative corrections
- Verify BigBite acceptance with GEANT4 simulation
- Verify positron and pion background with GEANT4 simulation
- Apply DIS cuts

Nitrogen Dilution Factor

$$D_{N_2} = 1 - \frac{Y_{ref}}{Y_{prod}} \tag{3}$$

where

- To compute the dilution factor counts from the N_2 reference cell and ^{3}He production cell need to be corrected for:
  - Charge (Q)
  - T2 trigger pre-scale factor (ps)
  - T2 trigger live time (t_{LT})
  - Density of N_2 in the (reference,production) target cells ($\rho_{N_2}^{ref}$,$\rho_{N_2}^{prod}$)
  - $Y = \frac{Nps}{t_{LT}Q\rho}$

5.89 GeV N_2 Dilution: Dependent Quantities Per Run

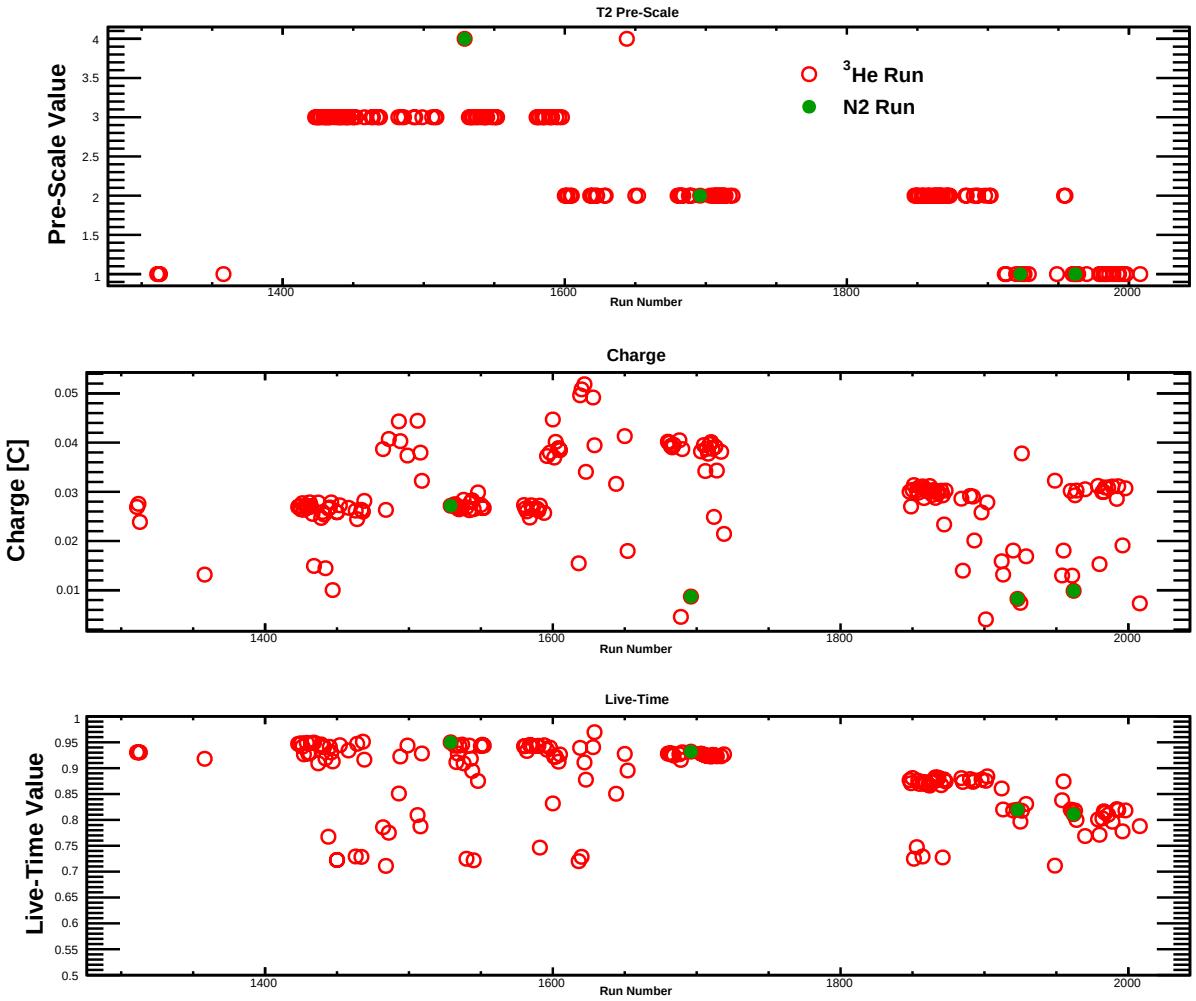


Figure: T2 trigger Pre-scale factor (top), charge (middle) and live time (bottom) as a function of run number.

5.89 GeV Densities

Run	Cell Type	Temp (°C)	Pressure (psig)	Pressure (amg)
1529	N_2 Ref.	41.7	22	2.17
1696	N_2 Ref.	42.0	100	6.77
1923	N_2 Ref.	41.6	113	7.54
1962	N_2 Ref.	41.9	120	7.95
-	Production	-	-	0.113

Table: Nitrogen reference cell densities for some 5.89 GeV runs.

5.89 GeV Yields Per Bin

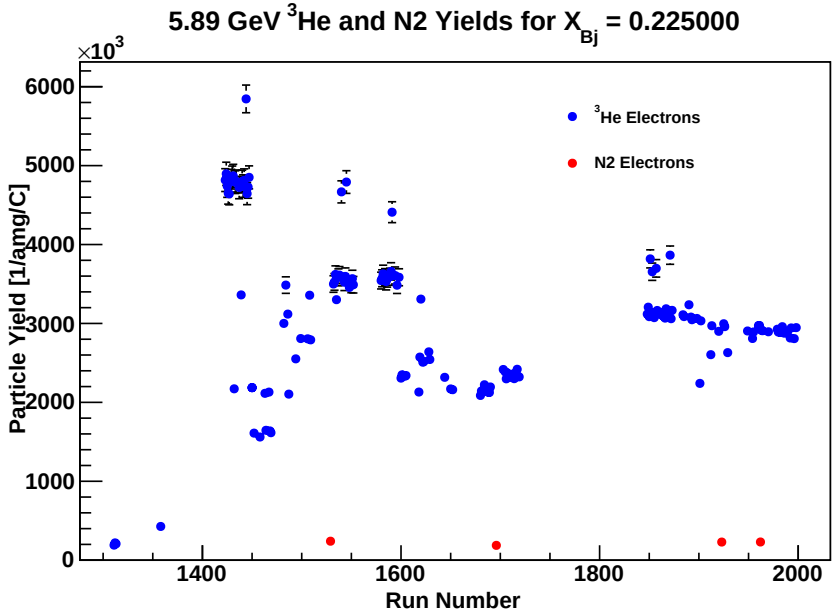


Figure: Yields in bin 5 for electrons scattering off of nitrogen in the reference and production cells.

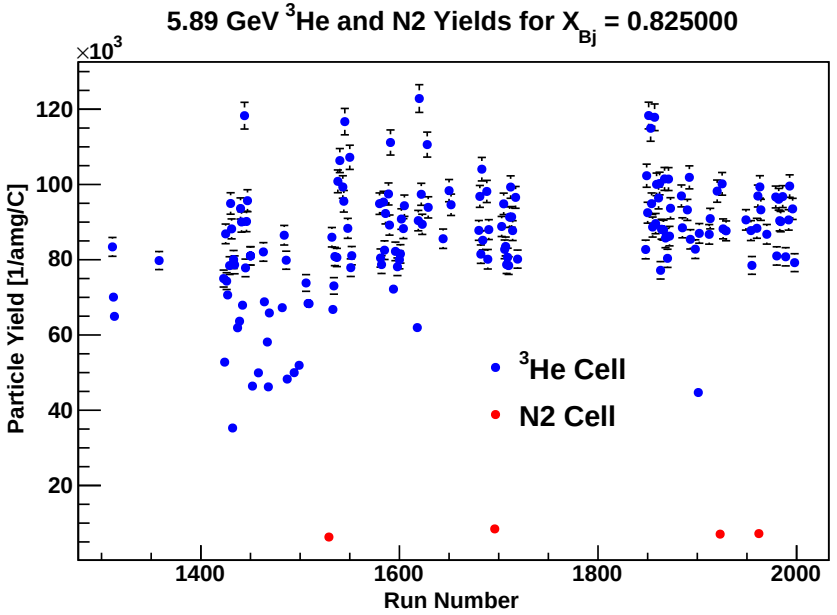


Figure: Yields in bin 17 for electrons scattering off of nitrogen in the reference and production cells.

4.74 and 5.89 GeV N_2 Dilution Factors

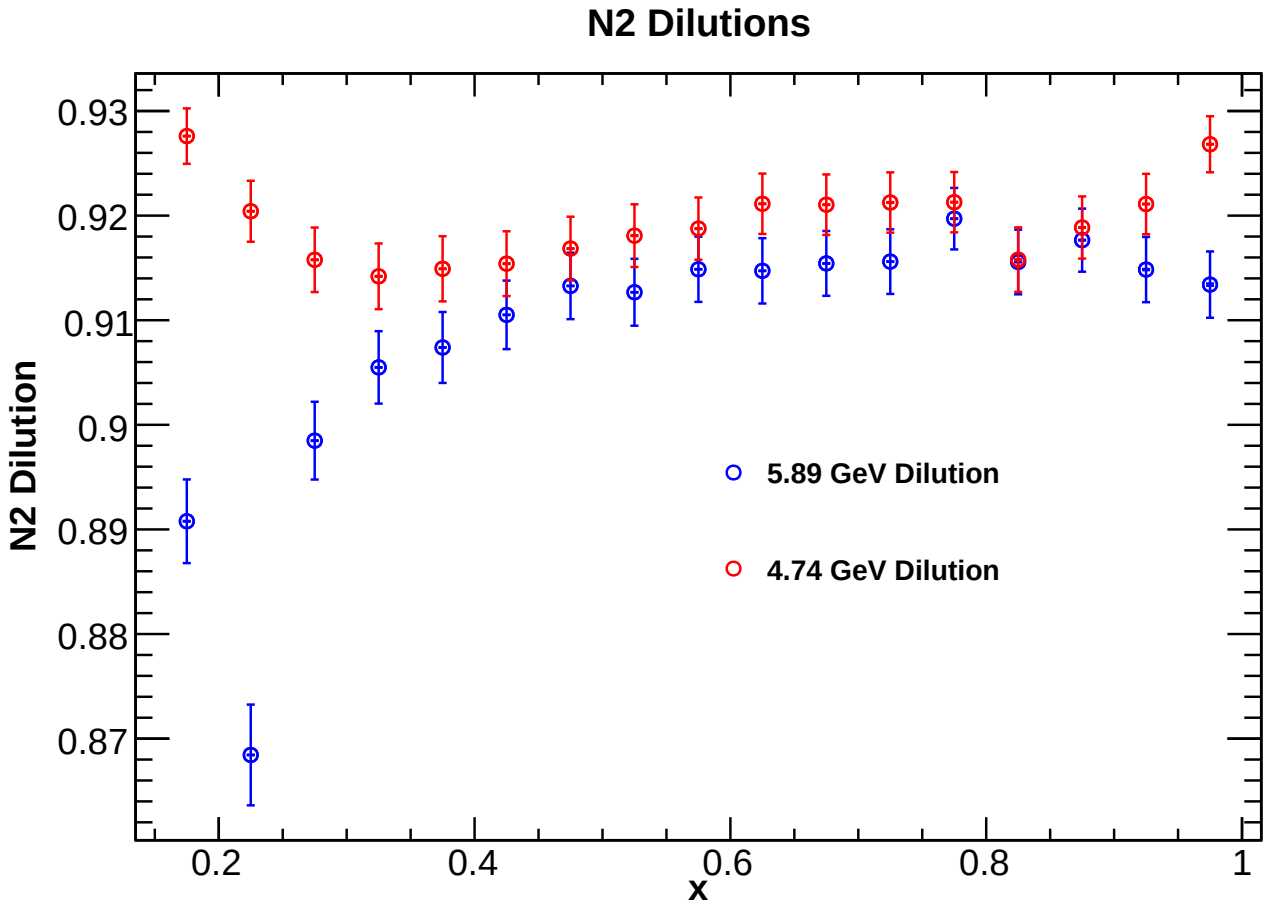


Figure: Comparison of the 4.74 GeV nitrogen dilution factor with live time corrections (red markers), see talk from 03/01/2012 and 5.89 GeV nitrogen dilution factor with live time corrections (blue markers)