R-Functions for Hall A L-HRS Acceptance

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HRS Acceptance

- Want to select events passing through a well understood region of the HRS acceptance
- The HRS acceptance is a 5-D region of space, depending on the variables $\{x_{tg}, y_{tg}, \theta_{tg}, \phi_{tg}, \delta p\}$
- These variables are correlated, making the 5-D acceptance region impossible to visualize
- Want a way to make a single cut, that considers all acceptance parameters at once, and their correlations— use R-Function

R-Function

- The R-Function will assign a numerical R-value to each event for given $\{x_{tg}, y_{tg}, \theta_{tg}, \phi_{tg}, \delta p\}$
- A cut can be made on the R-value, to accept only events with R-value >= R-cut
- R-cut can be varied to accept more or less events
- Corresponds to stretching/contracting acceptance region

R-Function for DVCS

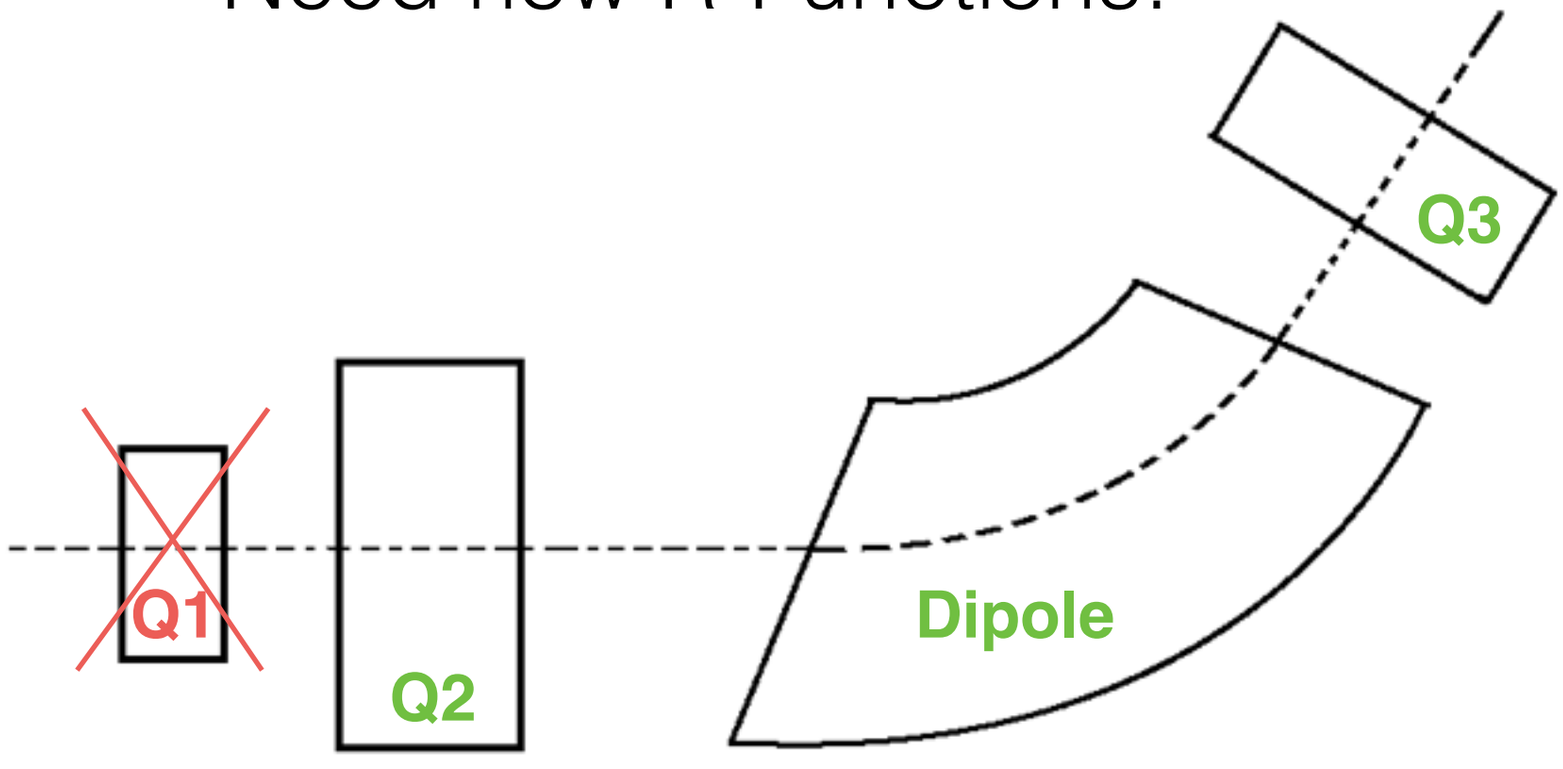
Q1 detuned for most of Spring 2016

↓

HRS Acceptance region is different for each kinematic setting

↓

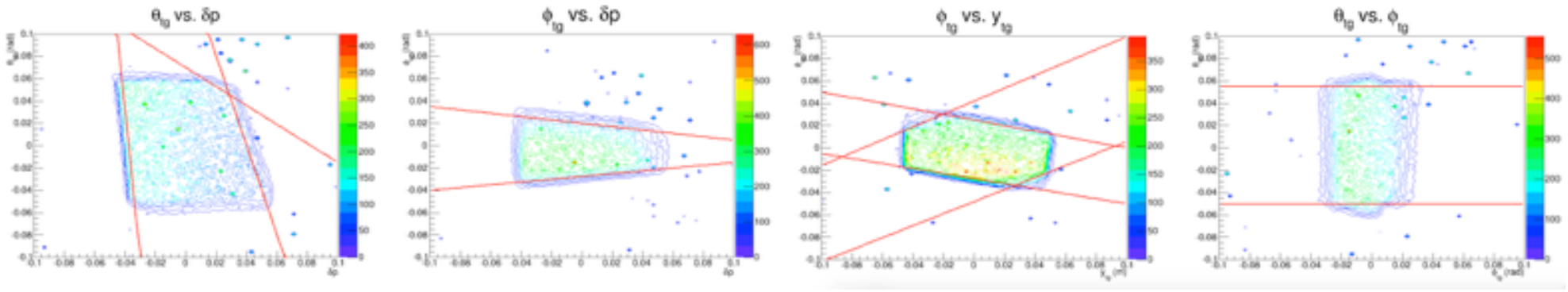
Need new R-Functions!



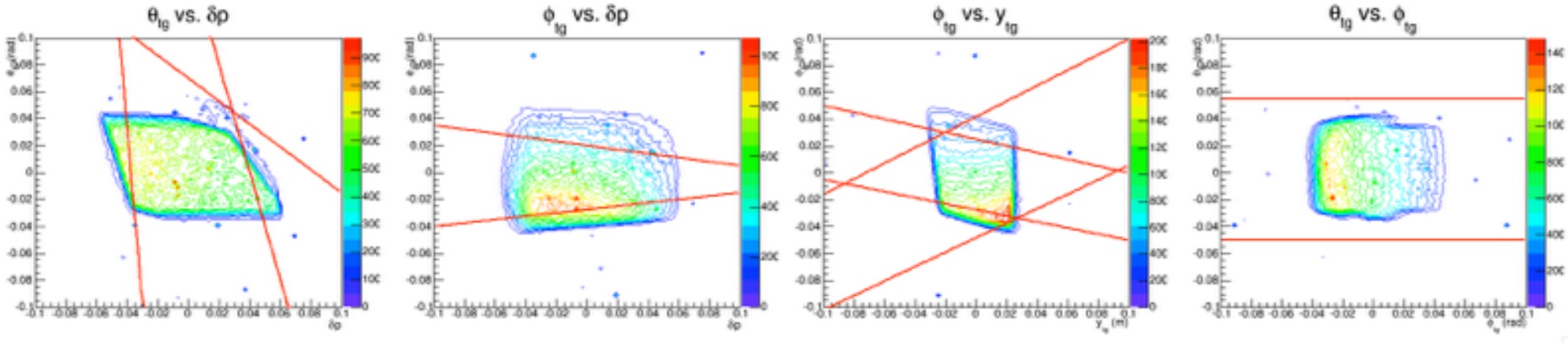
Spring 2016

	HRS Central Momentum
Kin-48-1	1.485 GeV
Kin-48-2***	3.996 GeV
Kin-48-3***	2.920 GeV
Kin-48-4***	3.360 GeV

Kin-48-1



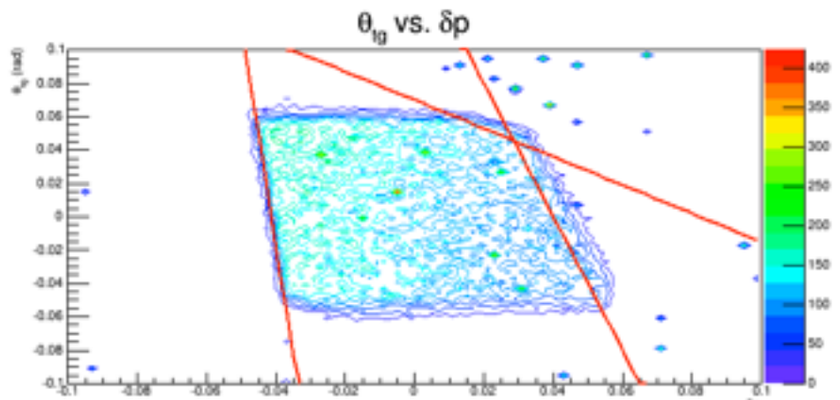
Kin-48-2

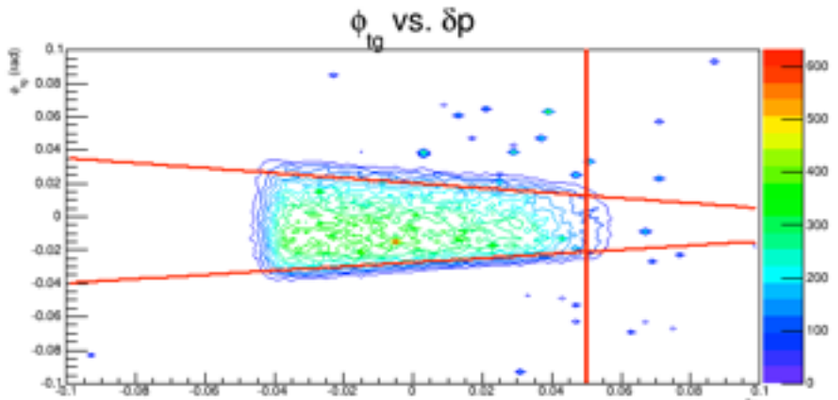


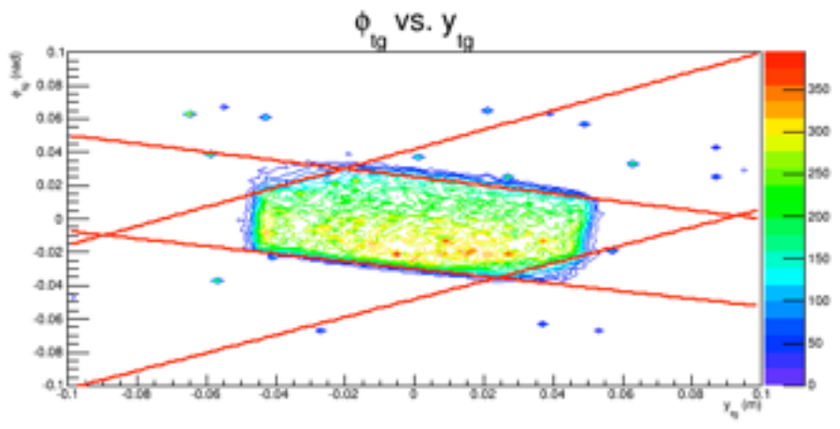
***Q1 detuned; set for central momentum of P = 2.5 GeV

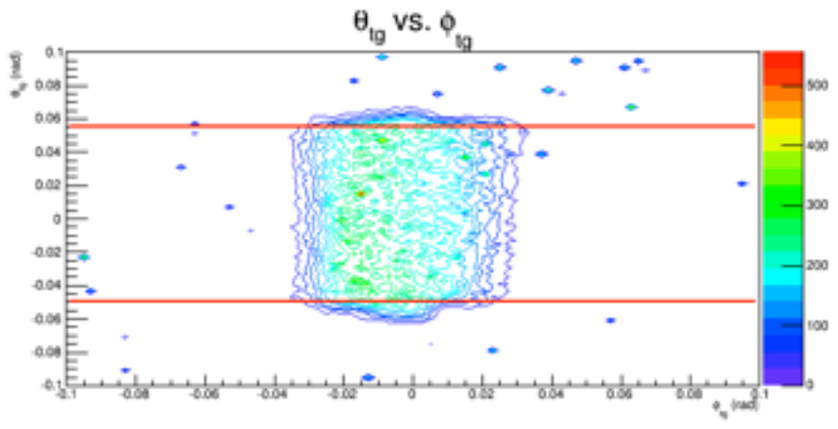
Constructing the R-Function

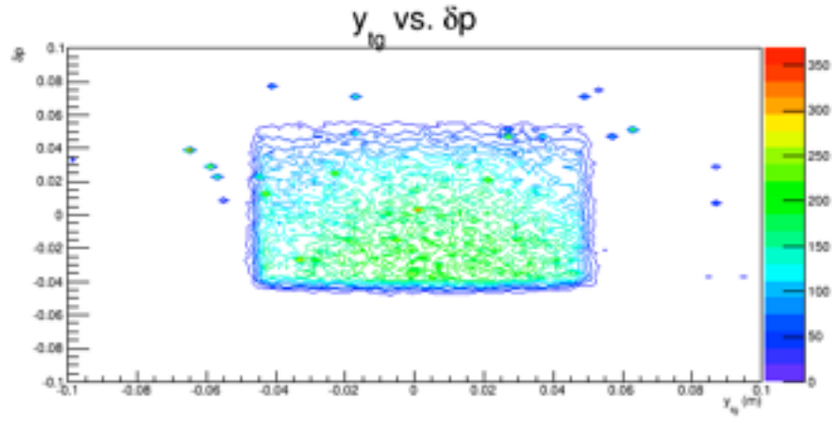
Look for correlations in the 6, 2-D planes
of acceptance parameters.

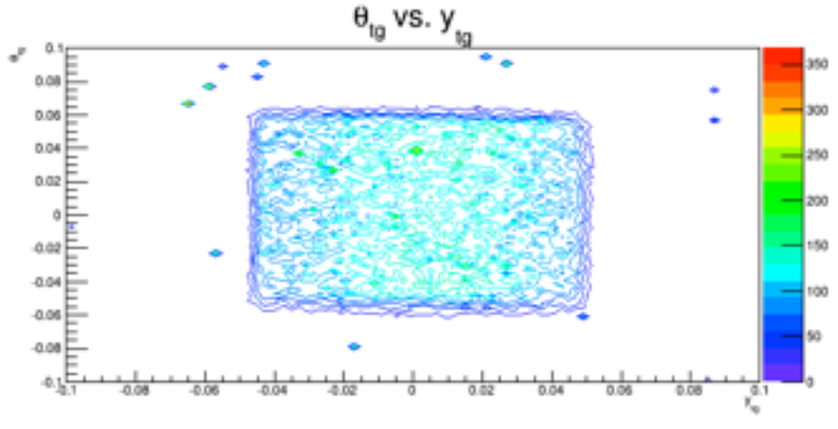












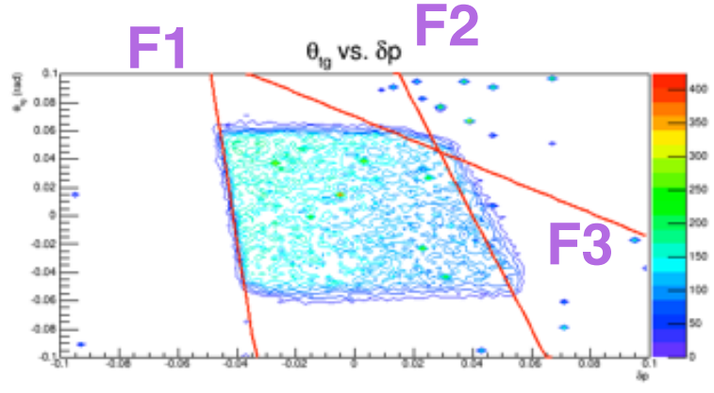
Defining the R-Function

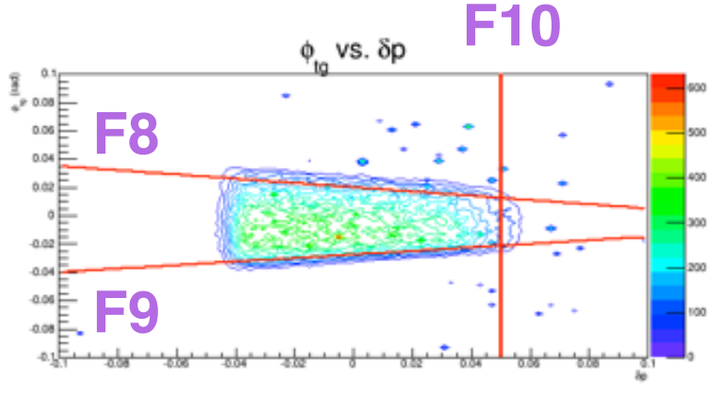
$$C1 = min(F1, F2)$$
$$C2 = min(F3, F10)$$
$$C3 = min(F4, F5)$$
$$C4 = min(F6, F7)$$
$$C5 = min(F8, F9)$$
$$C6 = min(F11, F12)$$

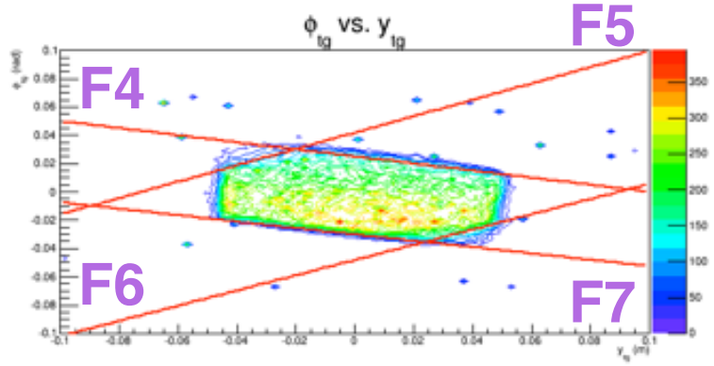
$$P1 = min(C1, C2)$$
$$P2 = min(C3, C4)$$
$$P3 = min(C5, C6)$$

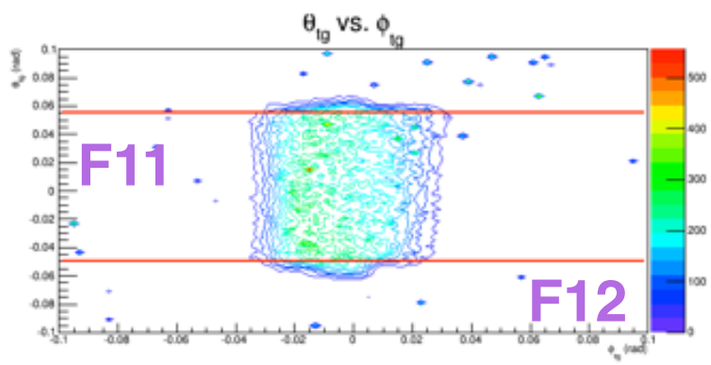
$$D1 = min(P1, P2)$$
$$D2 = min(D1, P3)$$

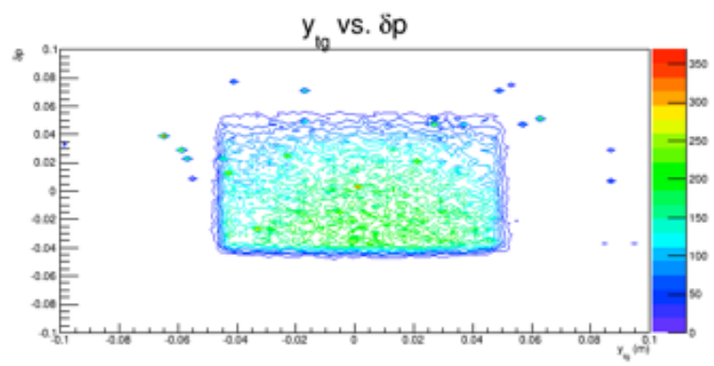
$$\boxed{R = min(D1, D2)}$$

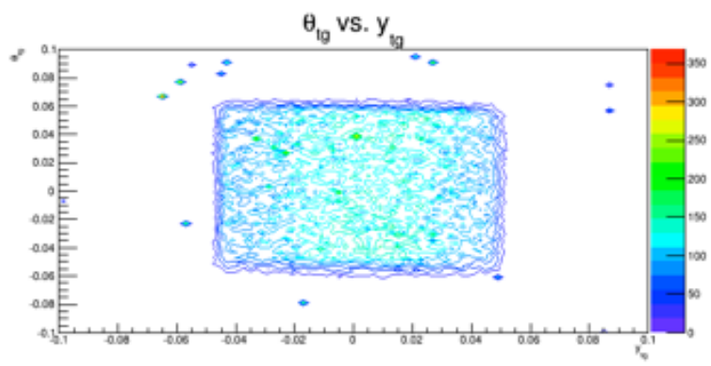






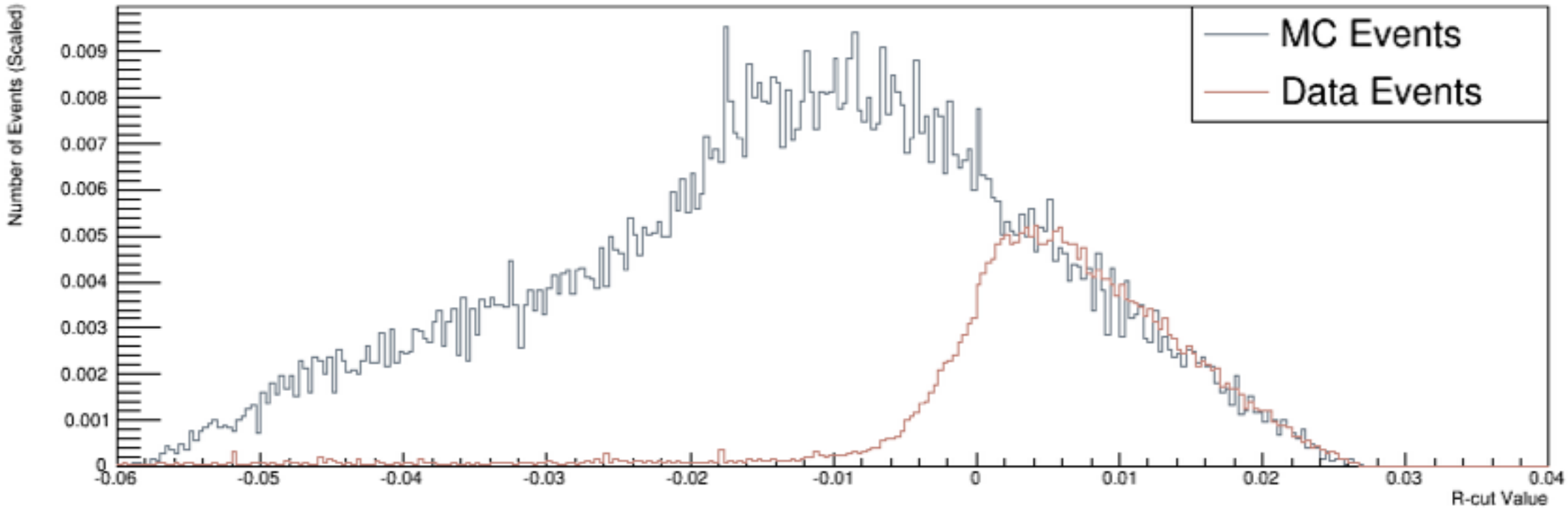




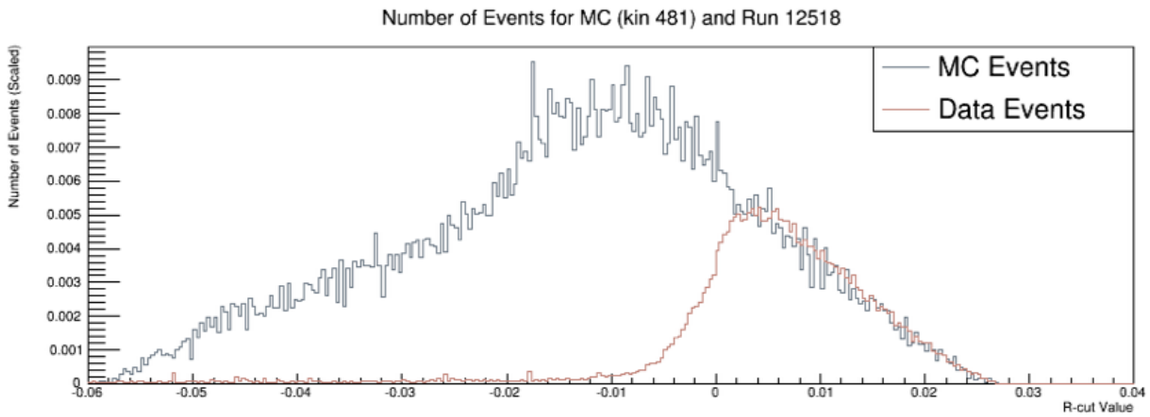


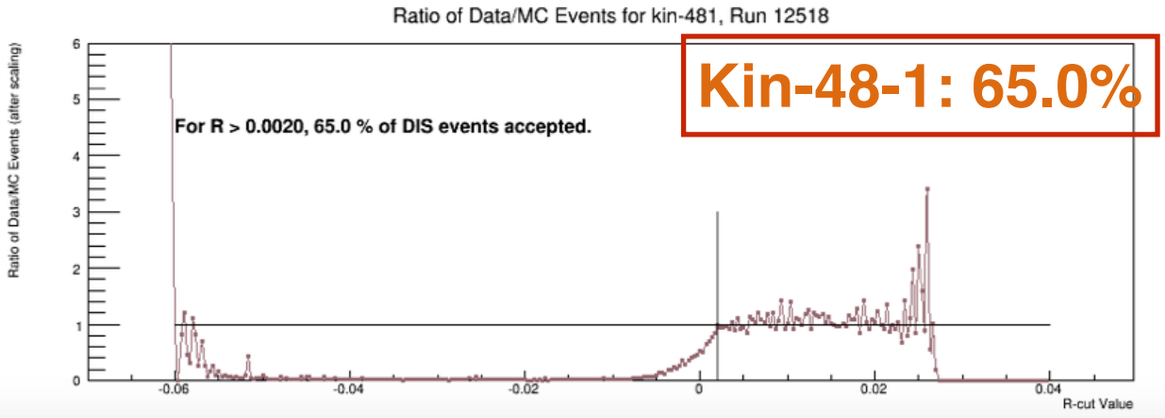
Finding best R-Cut

- Find R-Value for both experimental and simulated events, using the same R-Function
- Consider a range of R-Cut, where events with R-Value> R-Cut are accepted
- Find R-Cut where experimental data begins to agree with simulated data (above which the cross section will stabilize)

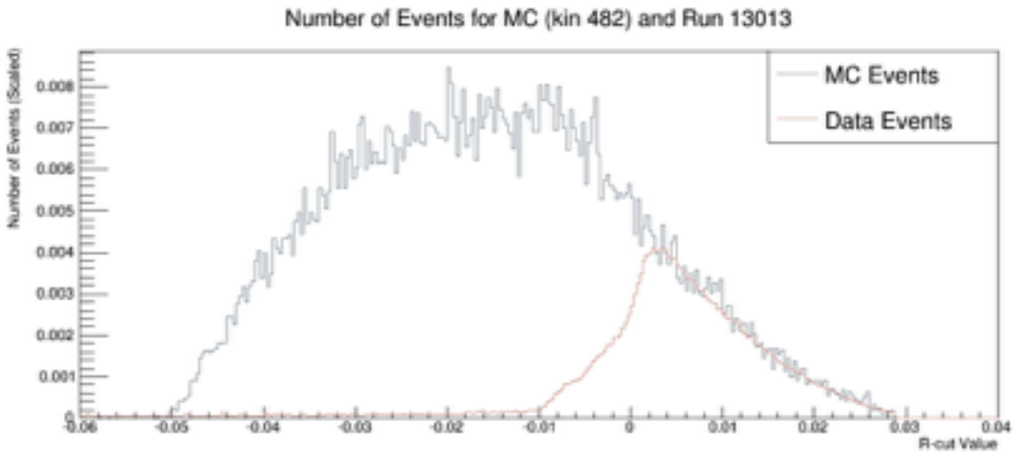

Number of Events for MC (kin 481) and Run 12518
Number of Events (Scaled)
MC Events
Data Events
R-cut Value
Ratio of Data/MC Events for kin-481, Run 12518
Ratio of Data/MC Events (after scaling)
For R > 0.0020, 65.0 % of DIS events accepted.
R-cut Value

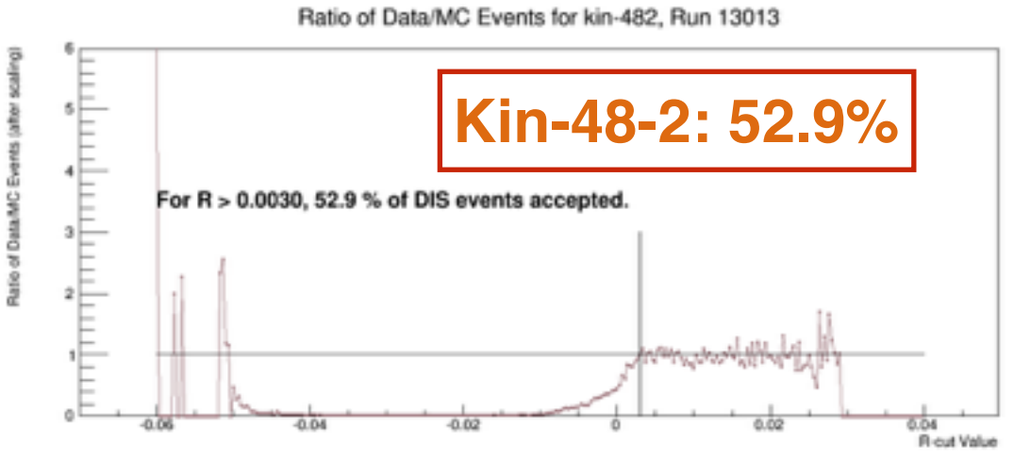
R-cut = 0.002



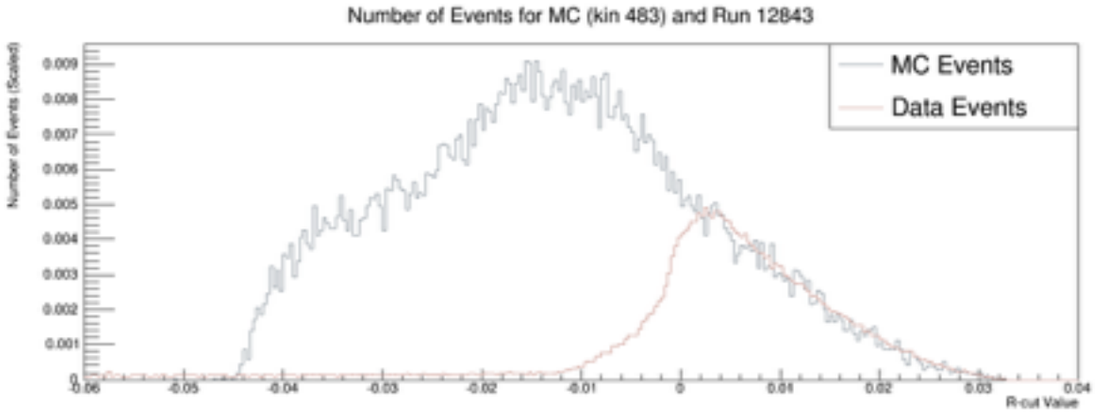


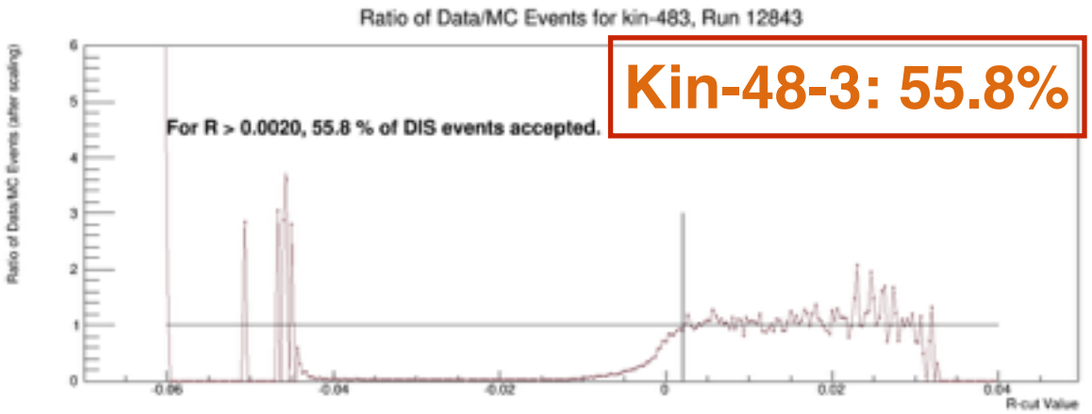
Kin-48-1: 65.0%



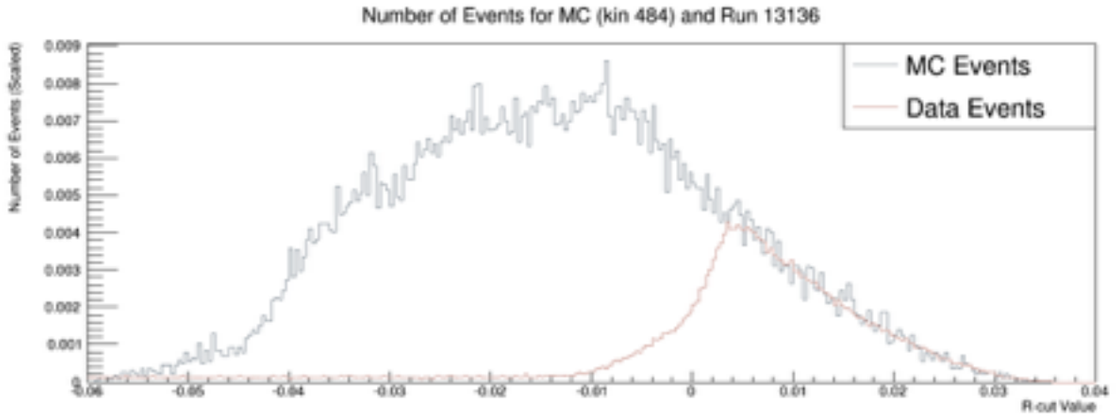


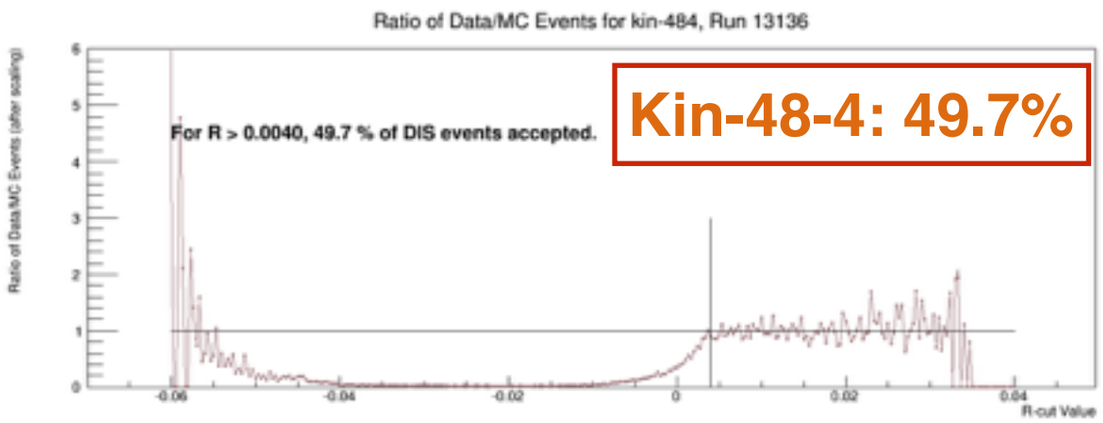
Kin-48-2: 52.9%





Kin-48-3: 55.8%

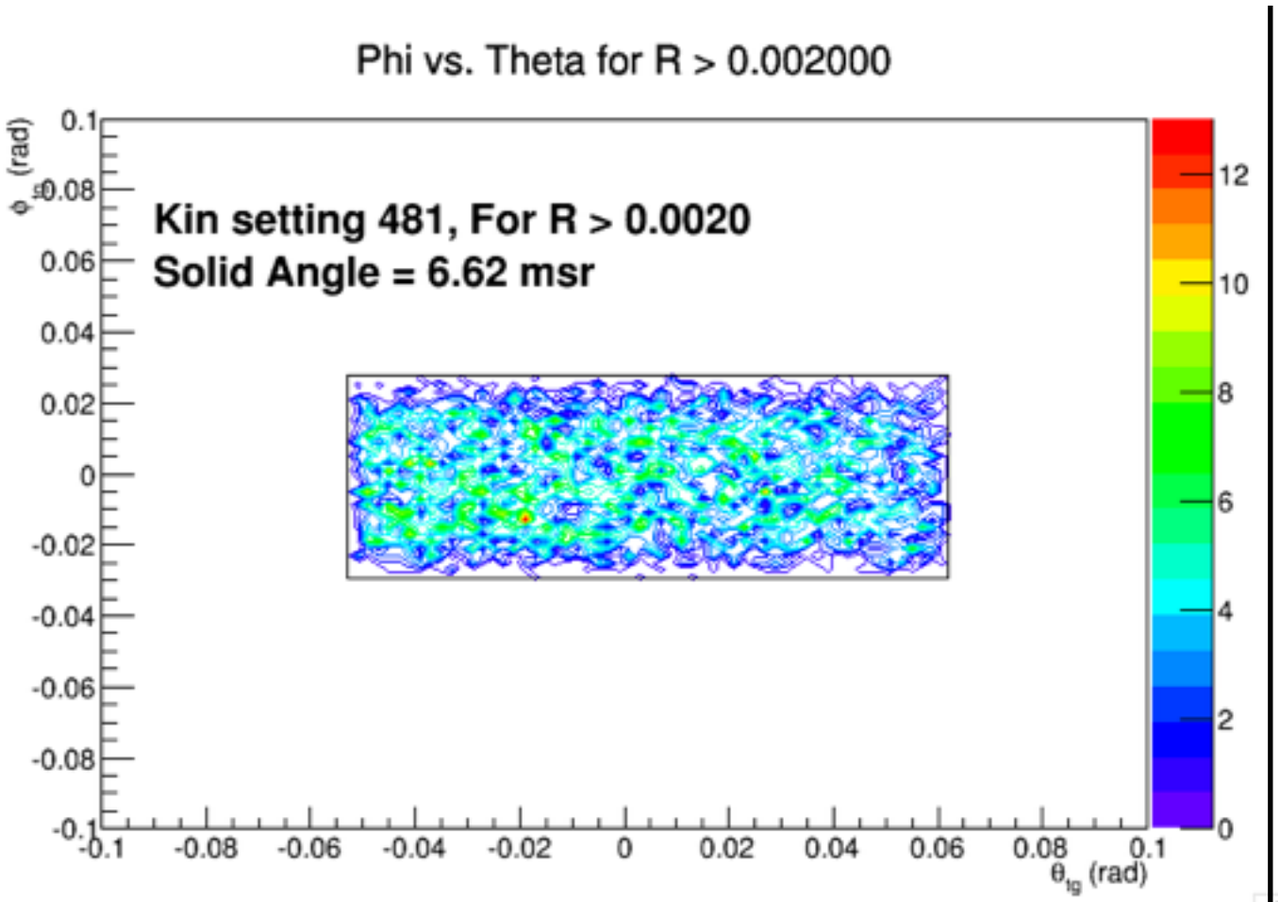


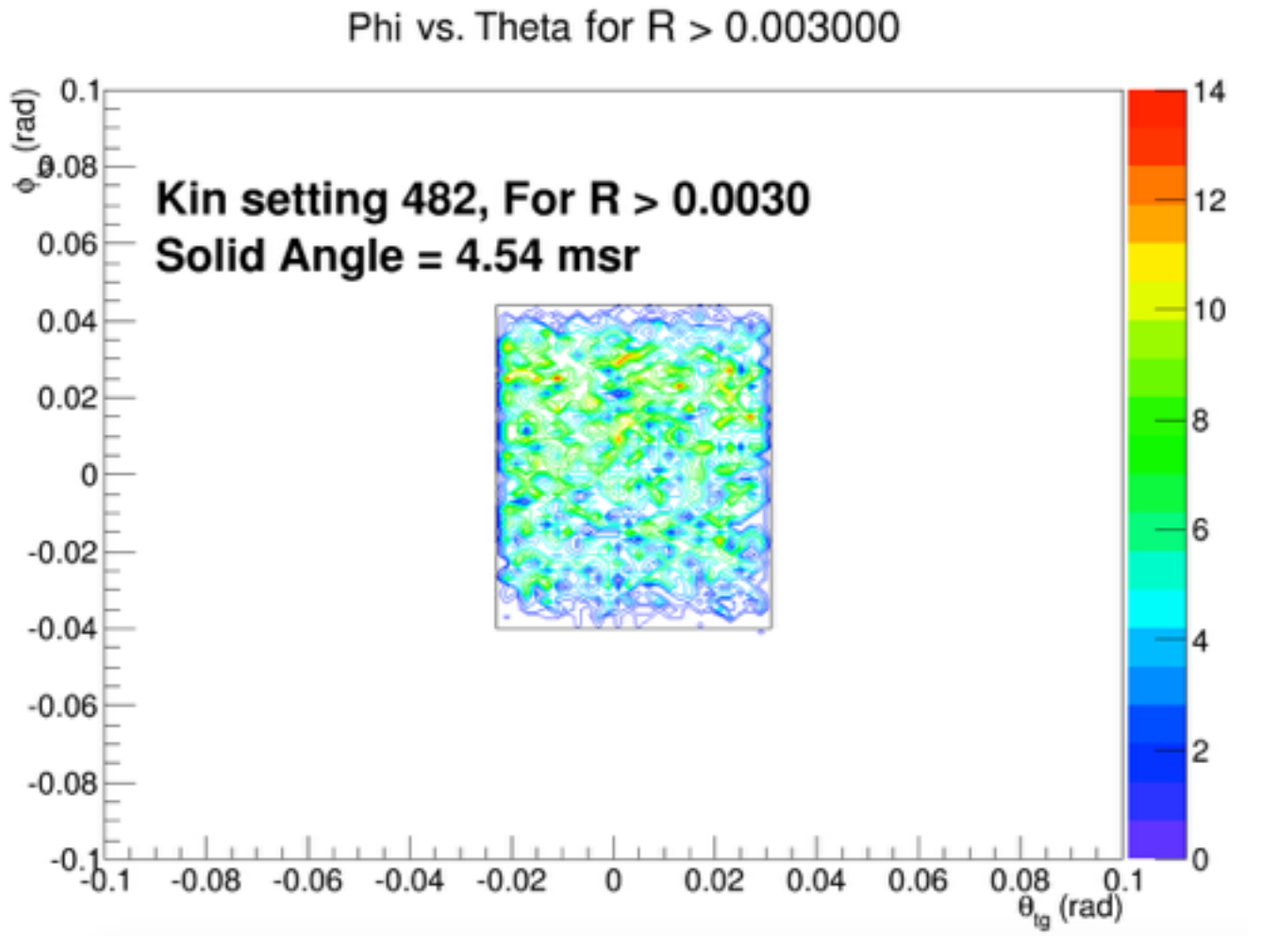


Kin-48-4: 49.7%

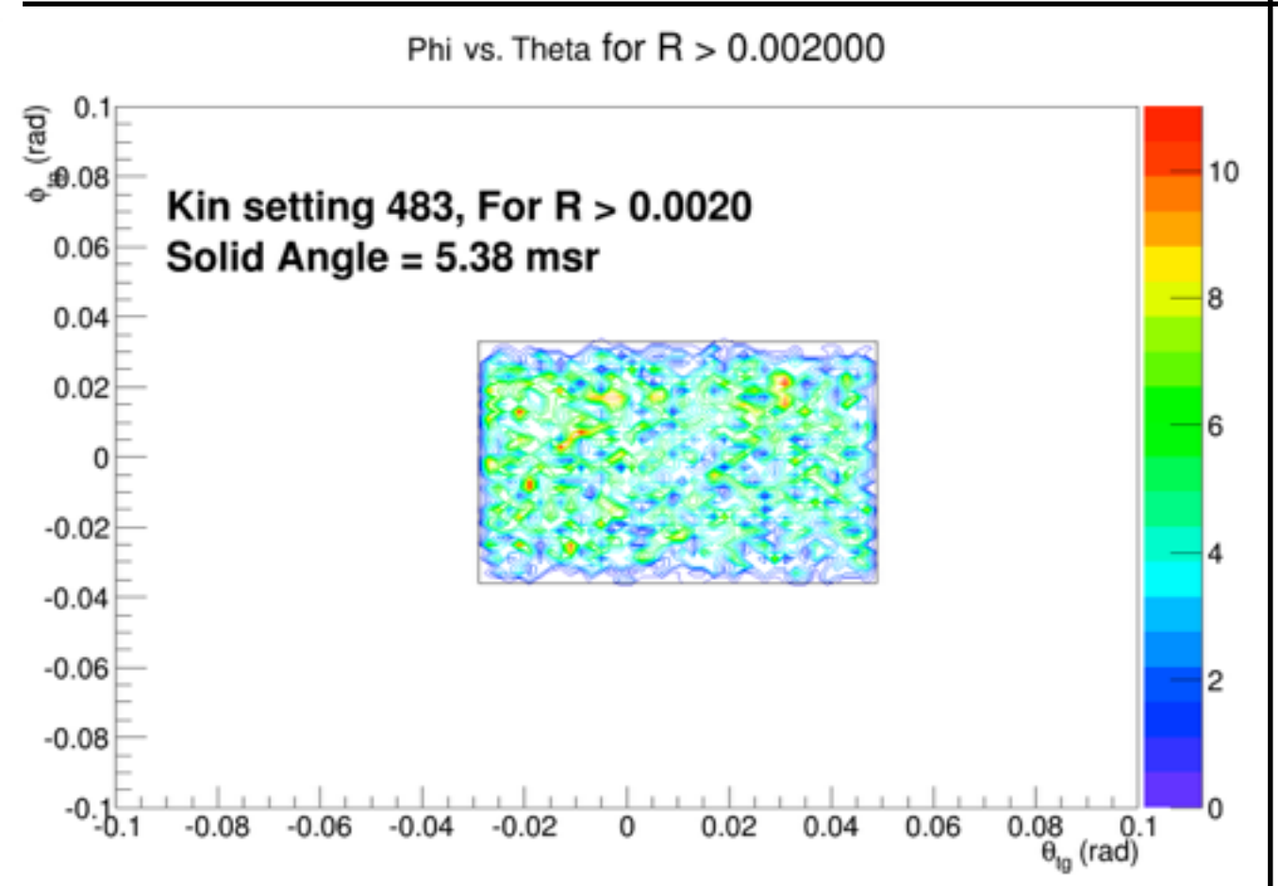
Extracting the HRS Solid Angle

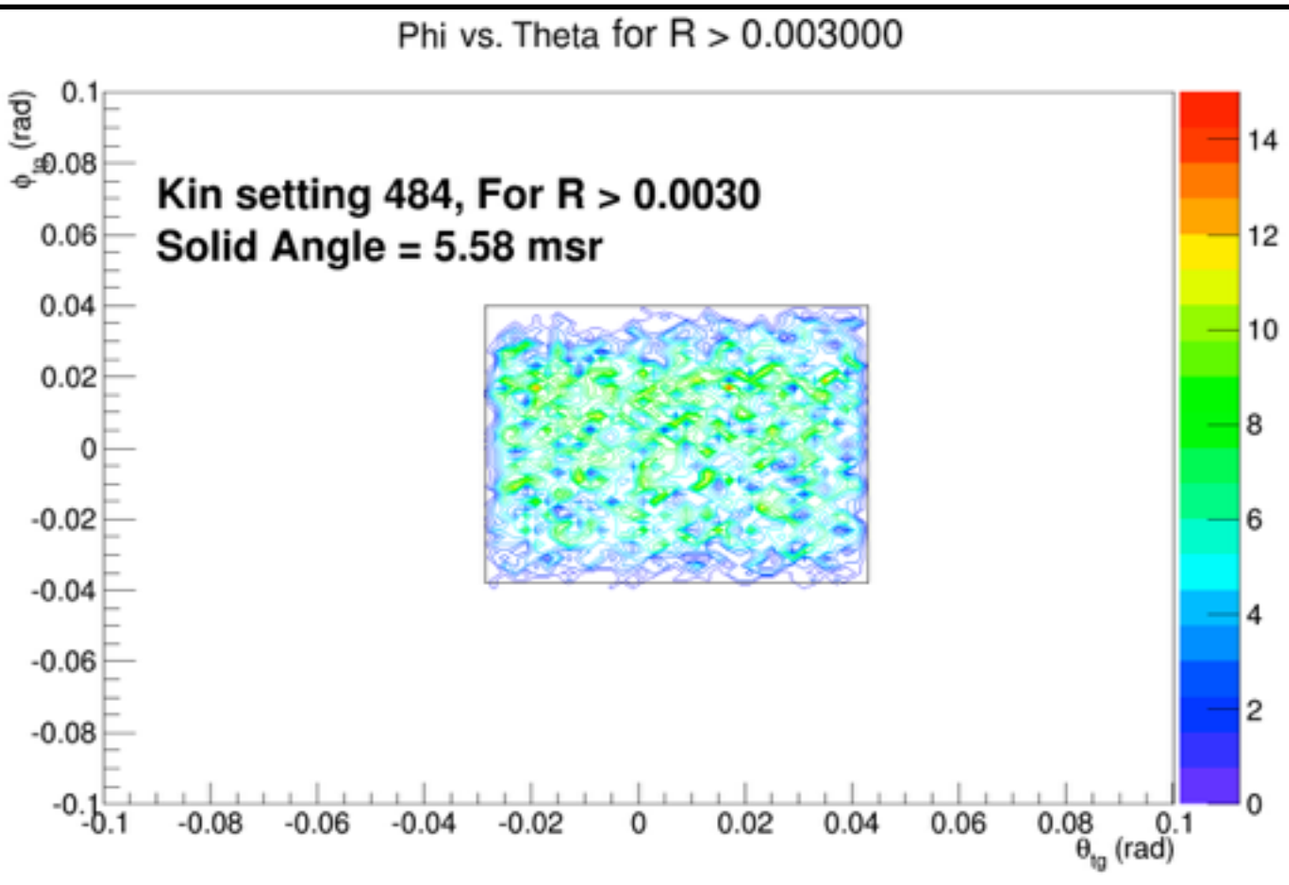
- Decide on a good R-Cut to use
- Plot ϕ_{tg} vs. θ_{tg} for events with R> R-cut
- Use rectangular approximation for solid angle





Note: these plots are for all values of momentum, p!!





Initial cuts: too many or too few?

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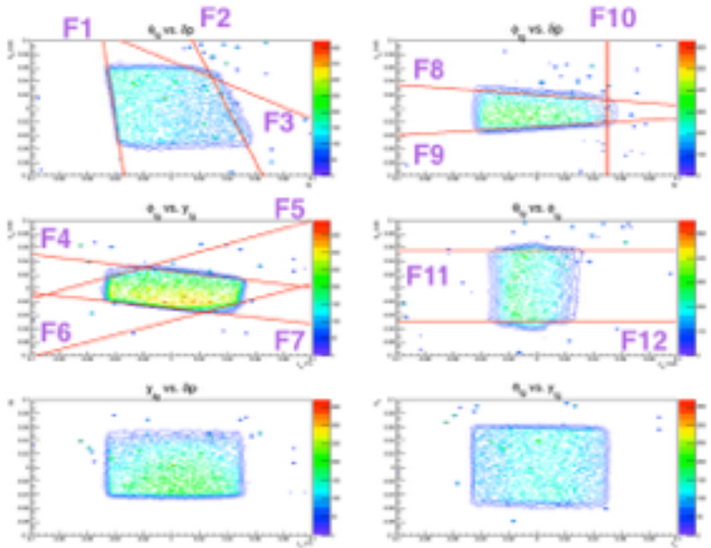
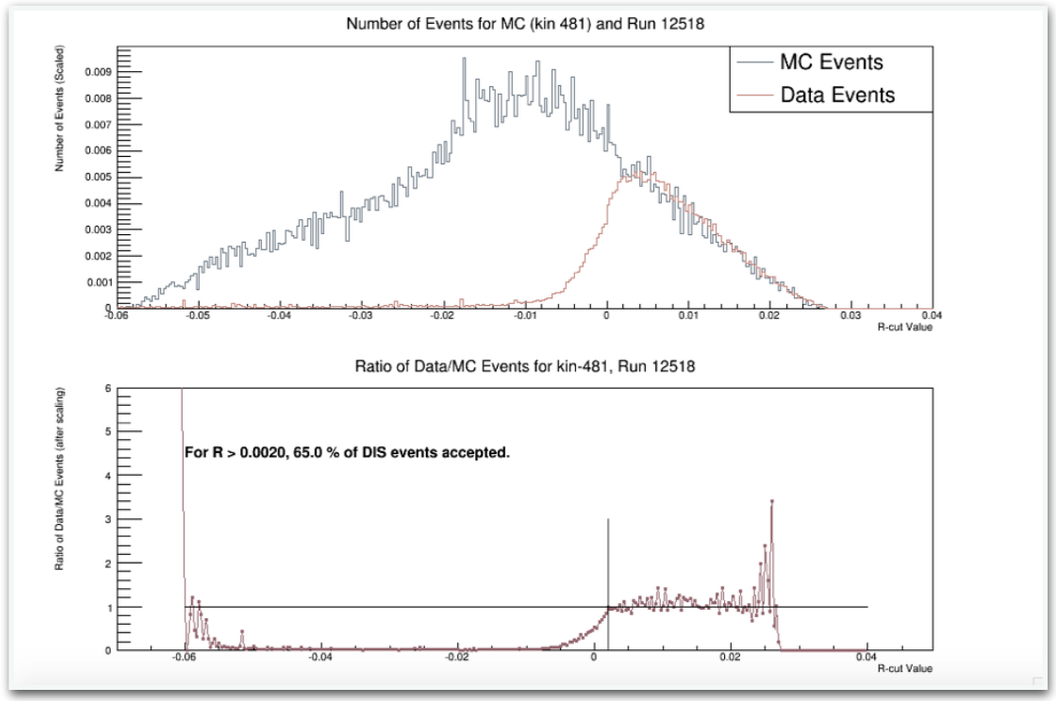
$$D1 = min(P1, P2)$$
$$D2 = min(D1, P3)$$

$$R = min(D1, D2)$$



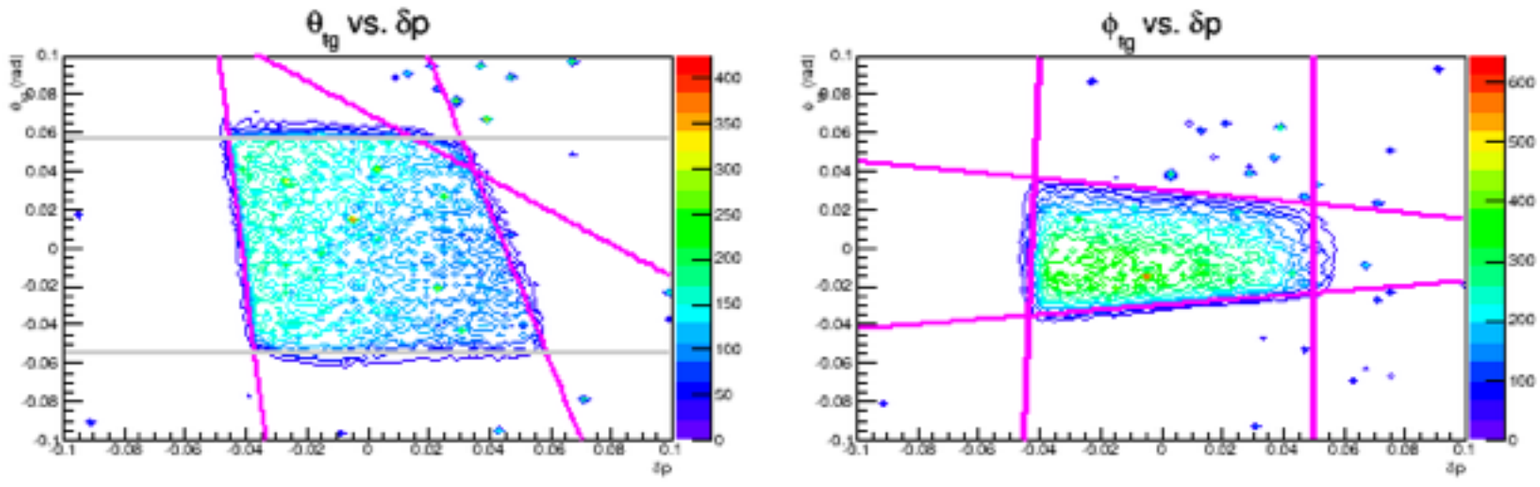


Test: Make cuts on **every edge** in **every 2D plane**.

***If removing a cut does not change the % of events accepted, cut is considered redundant.

Gray lines = redundant cuts

Magenta lines = necessary cuts

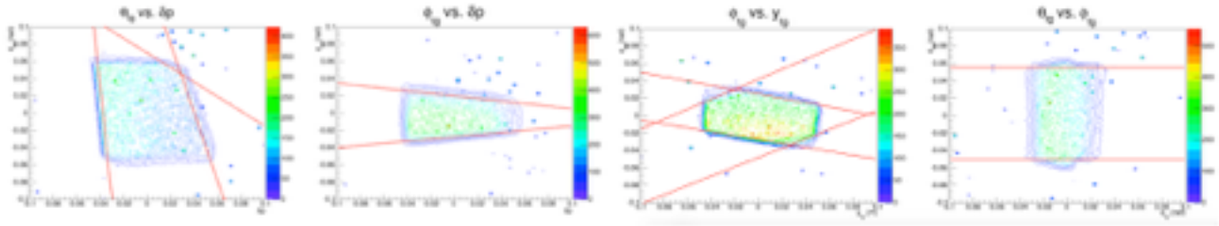


Kin-48-1 — Q1 correctly tuned

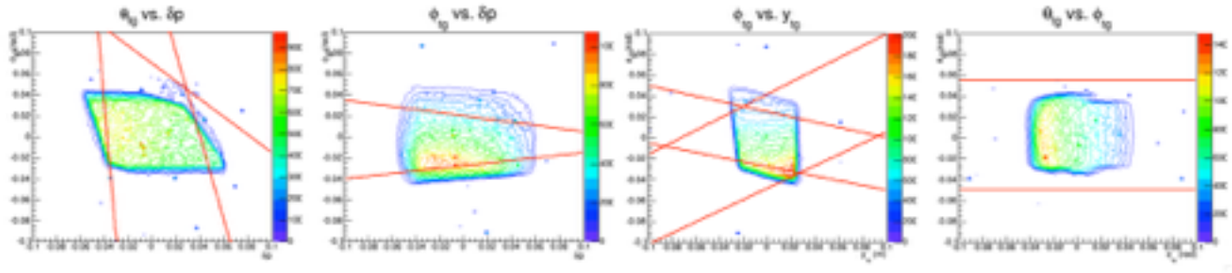
Spring 2016

	HRS Central Momentum
Kin-48-1	1.485 GeV
Kin-48-2***	3.996 GeV
Kin-48-3***	2.920 GeV
Kin-48-4***	3.360 GeV

Kin-48-1



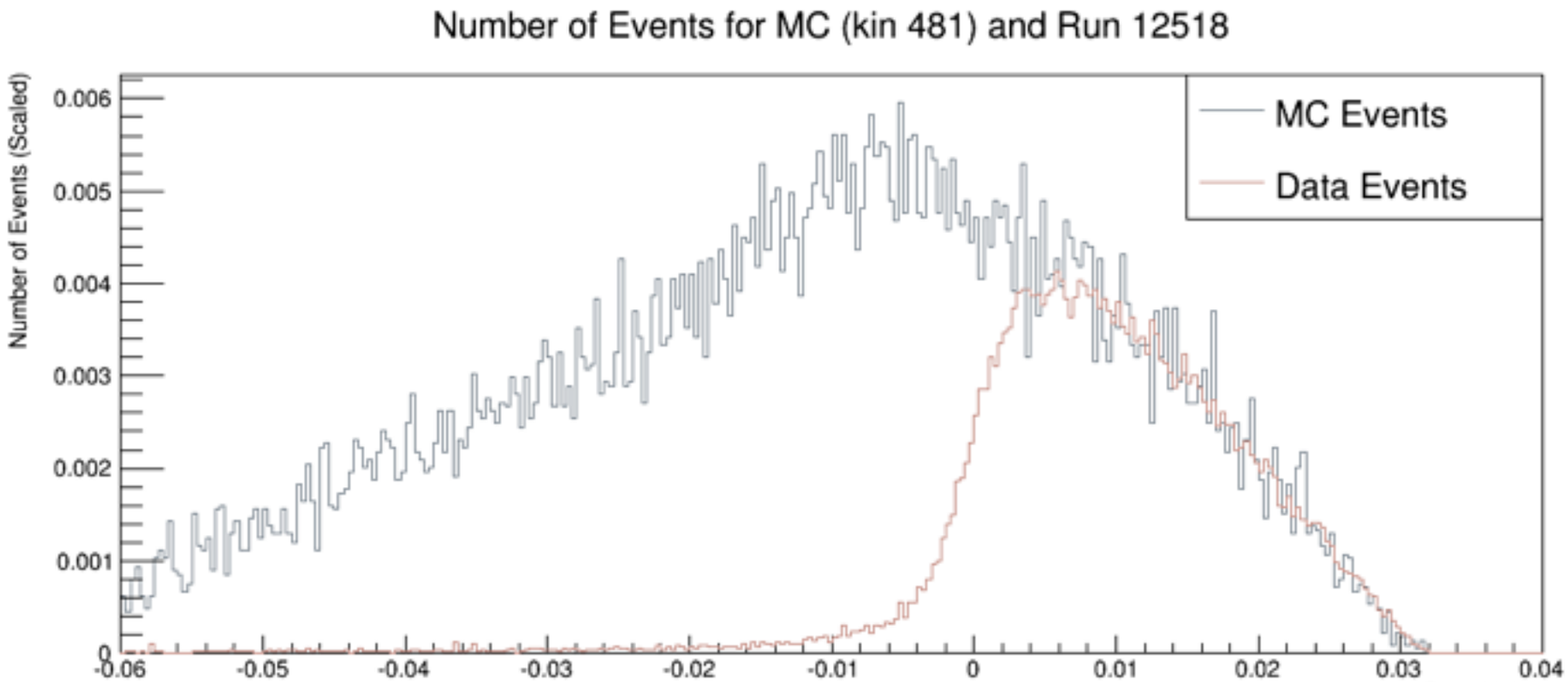
Kin-48-2

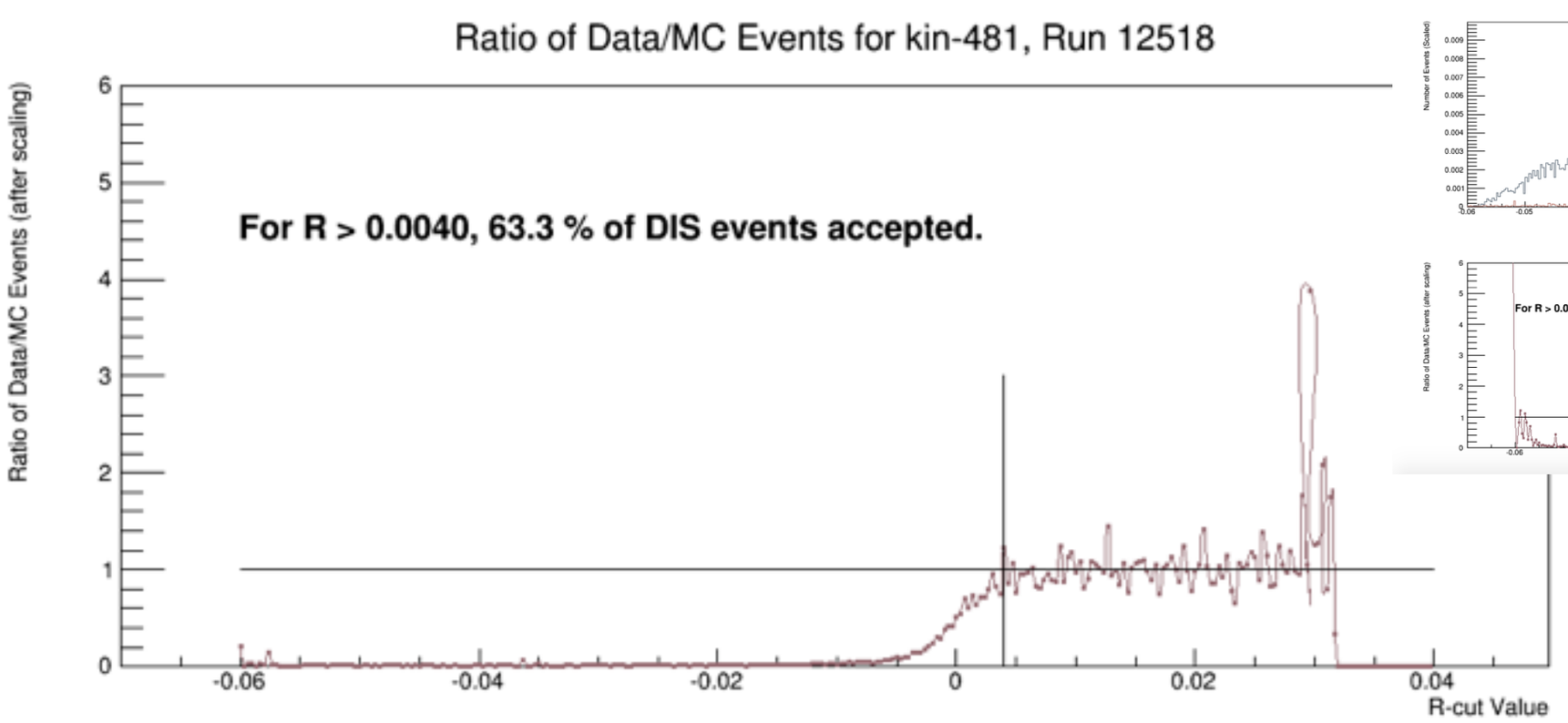


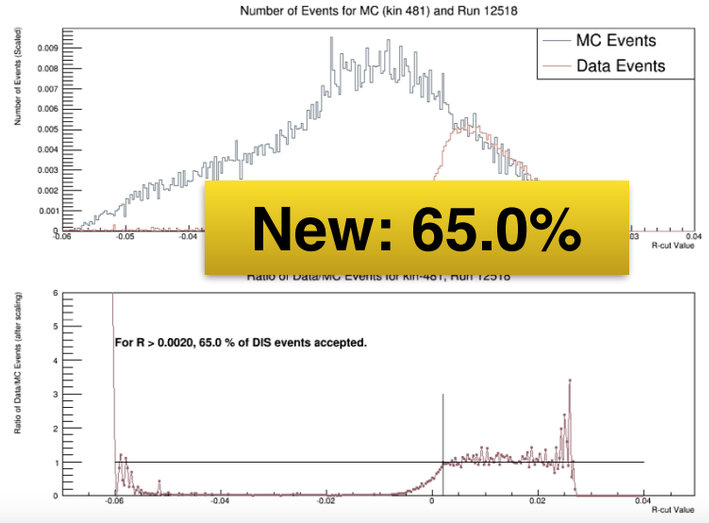
***Q1 detuned; set for central momentum of P = 2.5 GeV

Compare results of new R-Function to old R-Function

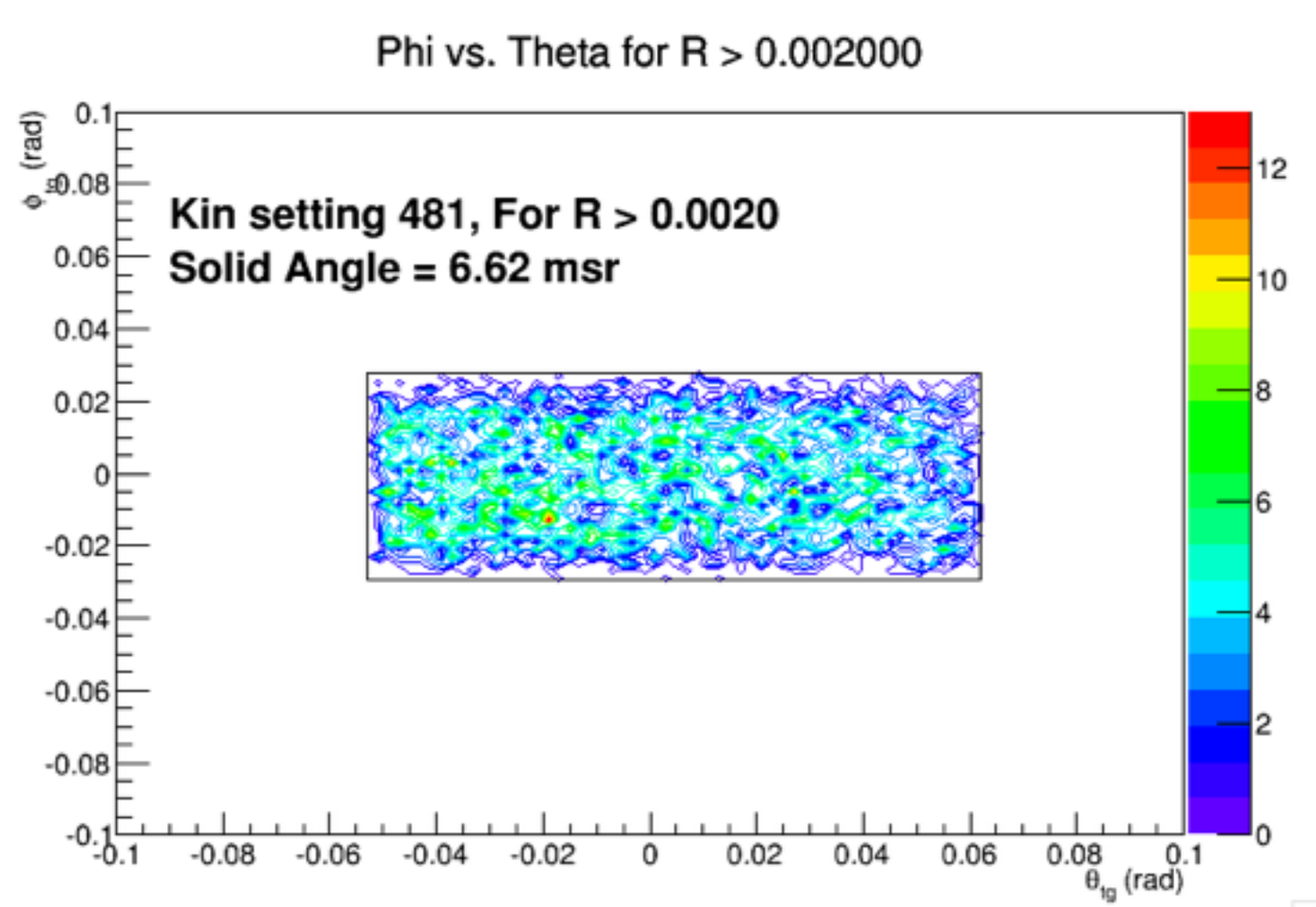
Old R-Function analysis: **63.3%** accepted





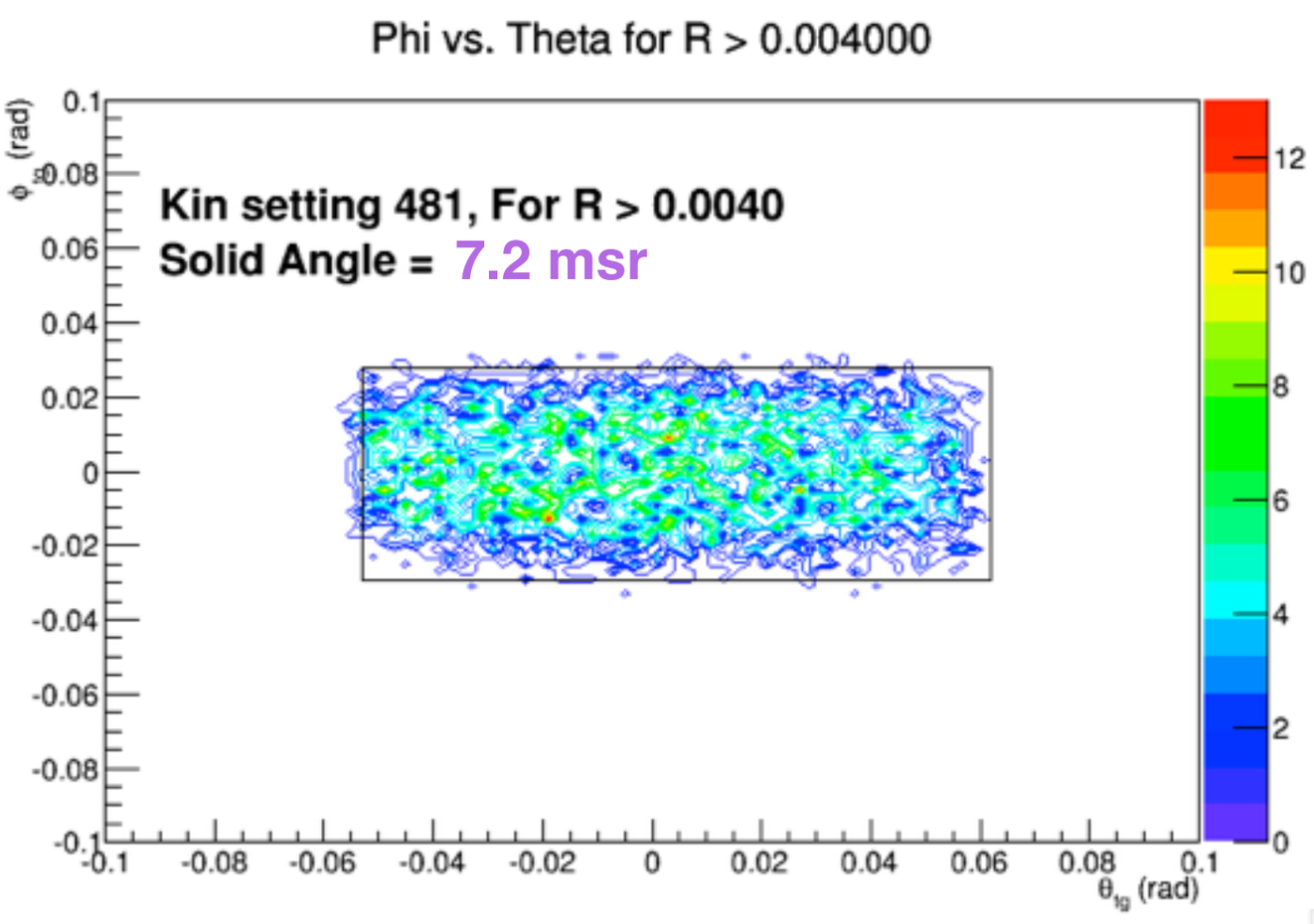


New: 65.0%



New R-Function

Compare extracted HRS Solid Angle



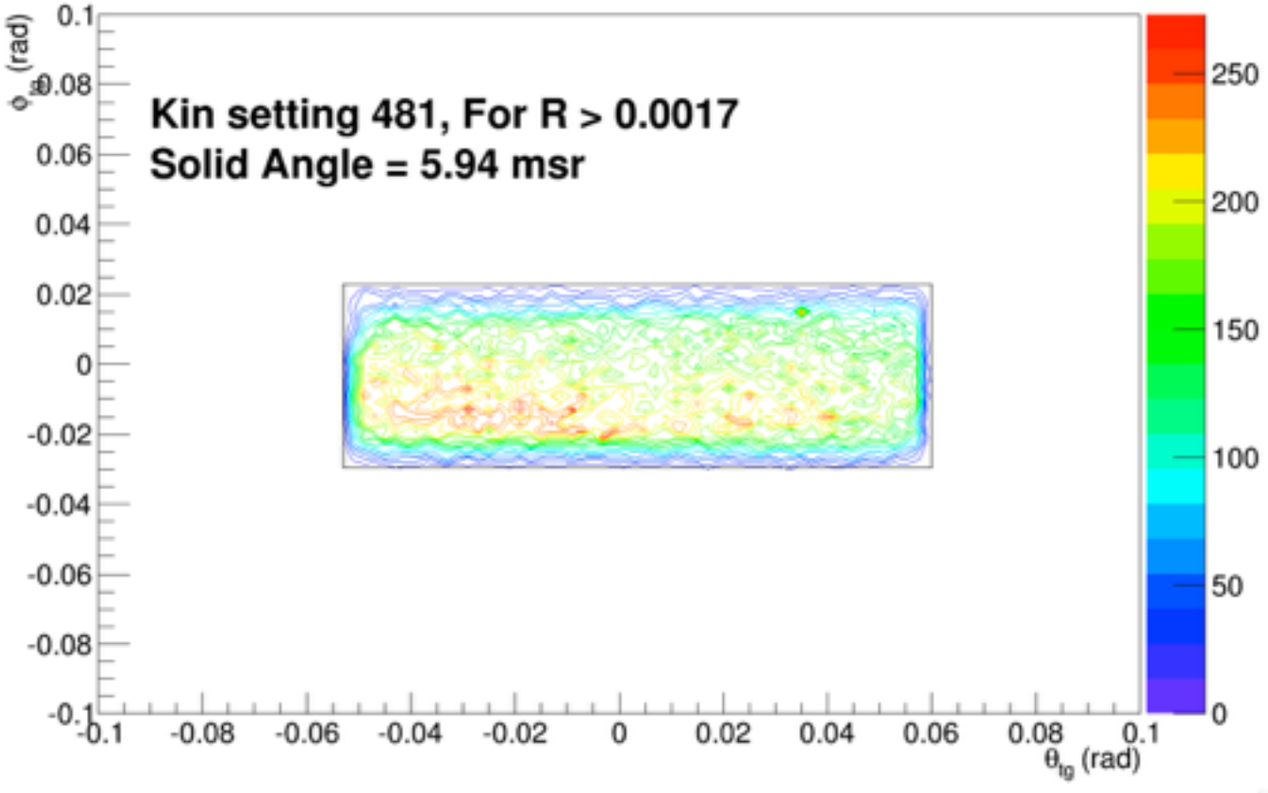
Old R-Function

Future Tasks

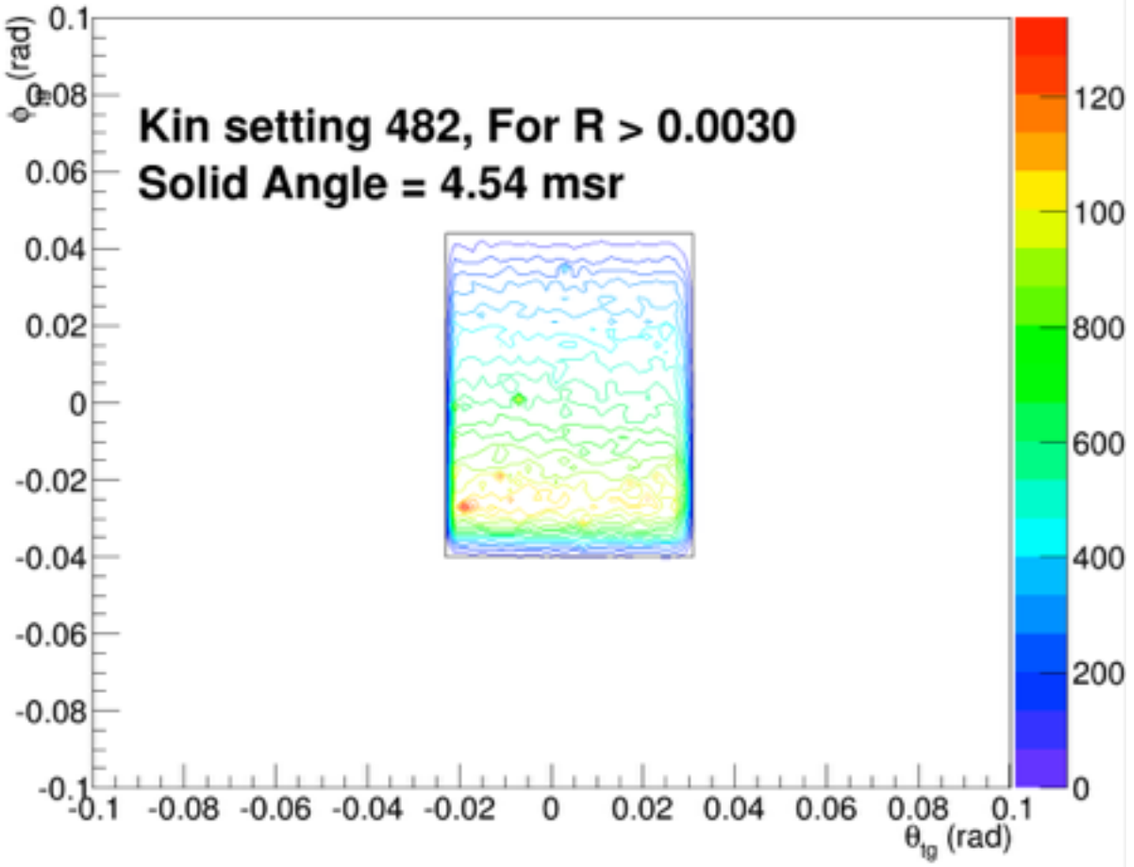
- Find redundant cuts for Kin-48-2,3,4
- Repeat plots of ϕ_{tg} vs. θ_{tg} for different ranges in δp
- Implement new R-Functions into DVCS analyzer library
- Confirm DIS cross-section remains stable above R-Cut
- Calculate errors

Extra Slides

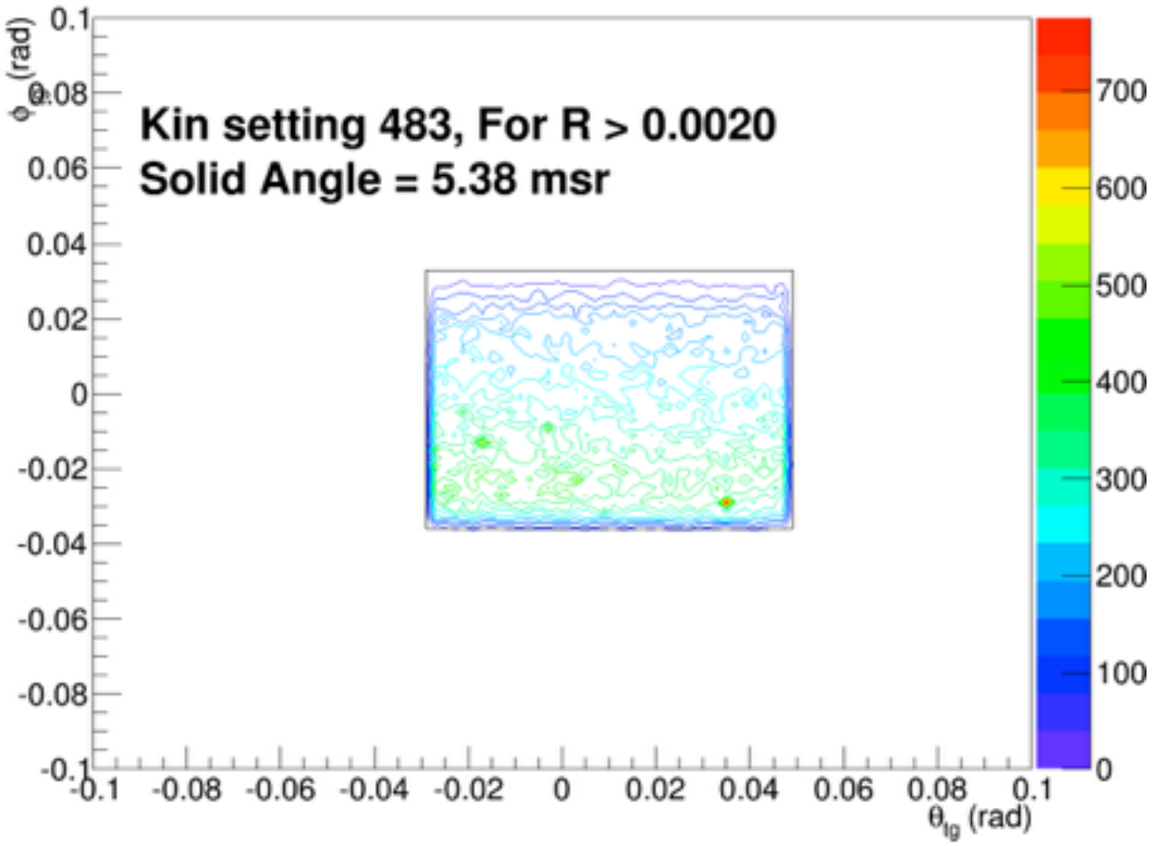
Theta vs. Phi for R > 0.001700



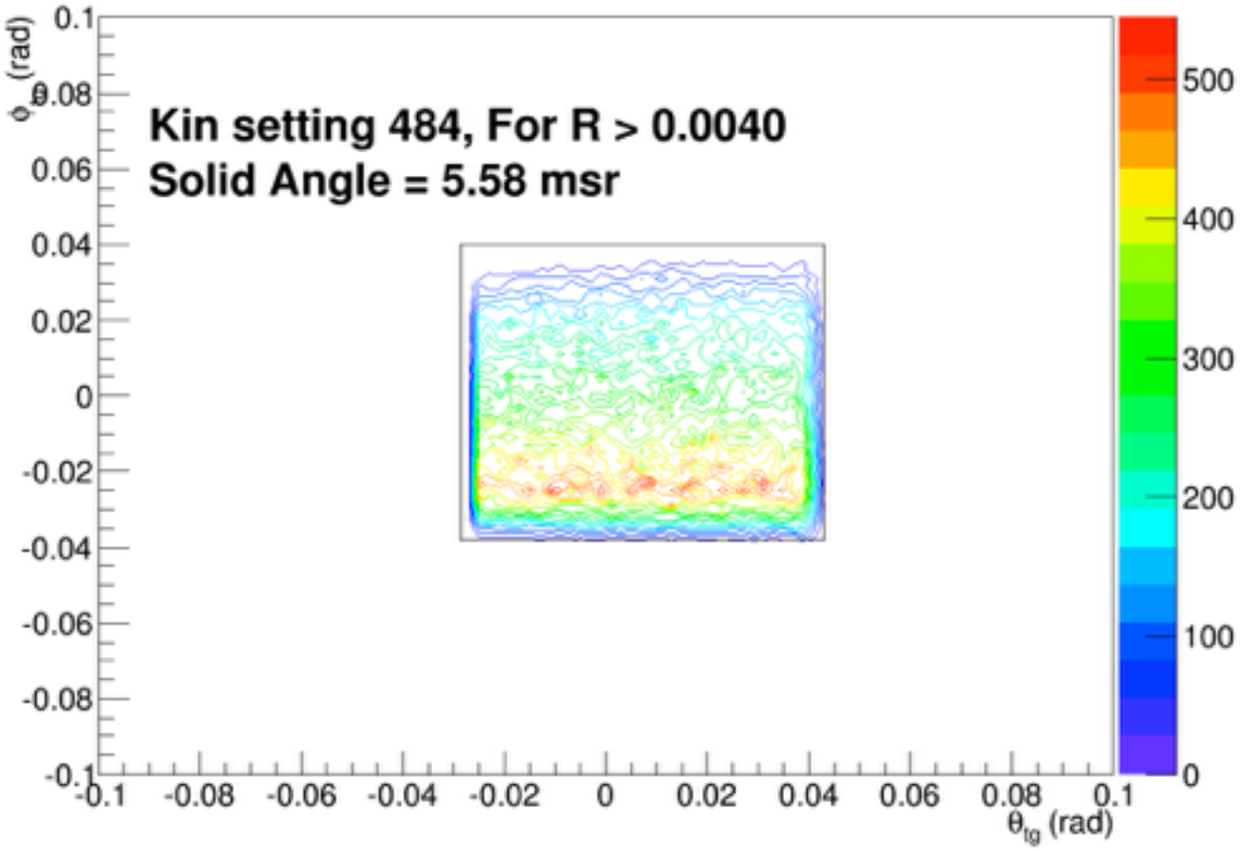
Theta vs. Phi for R > 0.003000



Theta vs. Phi for R > 0.002000



Theta vs. Phi for R > 0.004000



DIS Cross-Section

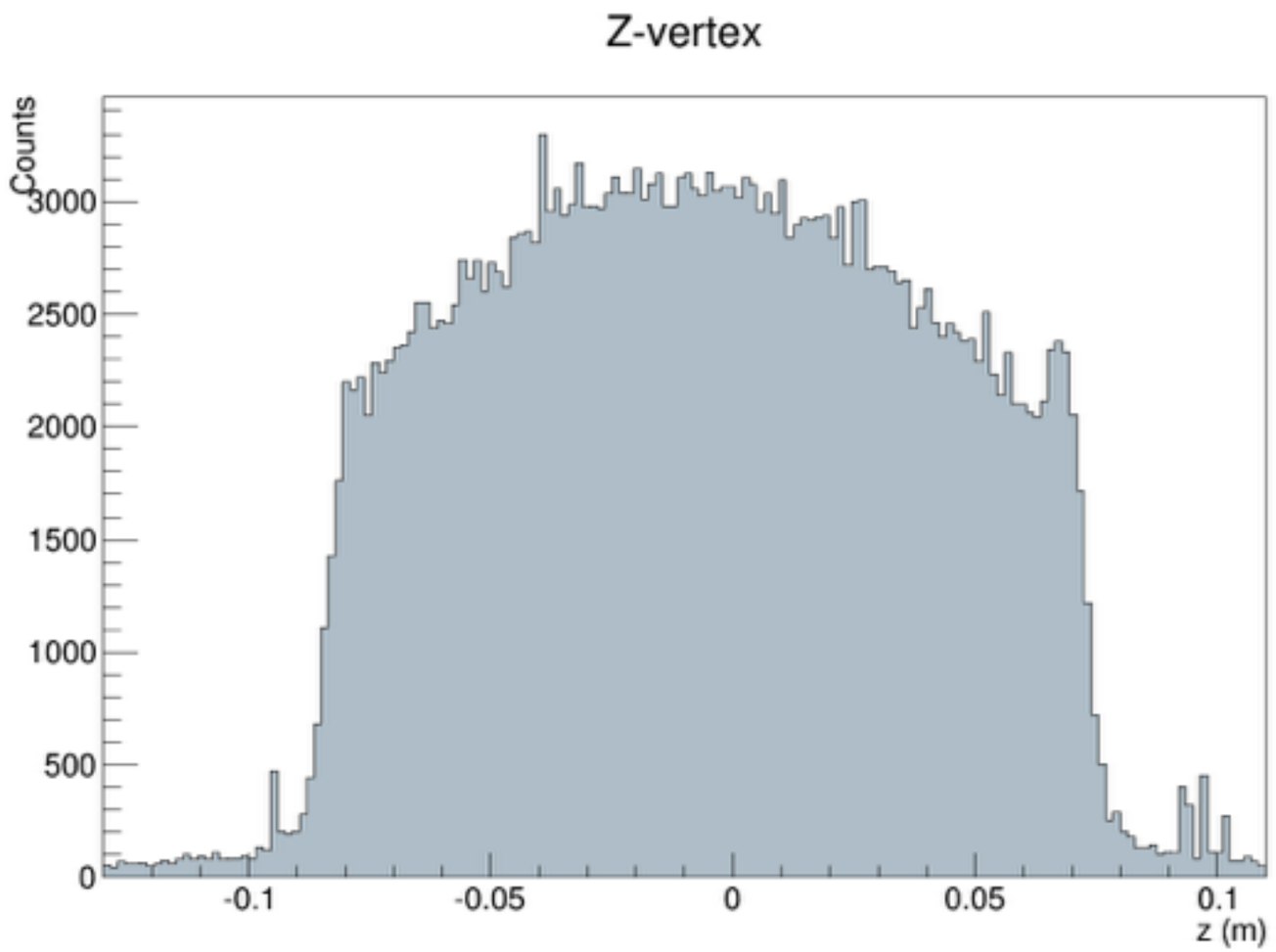
$$\left(\frac{d\sigma}{d\Omega dE}\right)_{DIS} = \frac{N_{acc}}{\mathcal{L}} \times C_{norm}$$

$$C_{norm} = \frac{1}{\eta_{DT} \times \eta_{efficiency} \times \eta_{cuts} \times \eta_{corrections} \times \Gamma_{DIS}}$$

$$\Gamma_{DIS}(r_{cut}) = \frac{N_{acc}(r_{cut})}{N_{total}} \Delta\Omega\Delta E$$

From MC!!

Before cut



After cut