CDC tracking and $B \to X_s\gamma$ with Belle 2

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Brief introduction

- Recent PhD student: started in August.
- Plan to work on $B \to X_s\gamma$ using a hadronic(?) tag.
- Currently on a service task with the tracking group.

Motivation for CDC wire efficiency study.:

- Larger than expected backgrounds observed in the CDC.

$\longrightarrow$ Local efficiency drops in wires?

Developing a wire monitoring tool would help in any case.

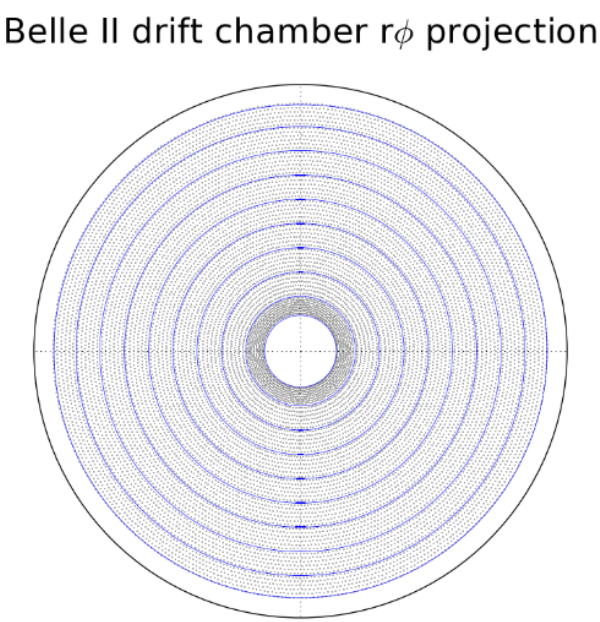
CDC and CDC wires

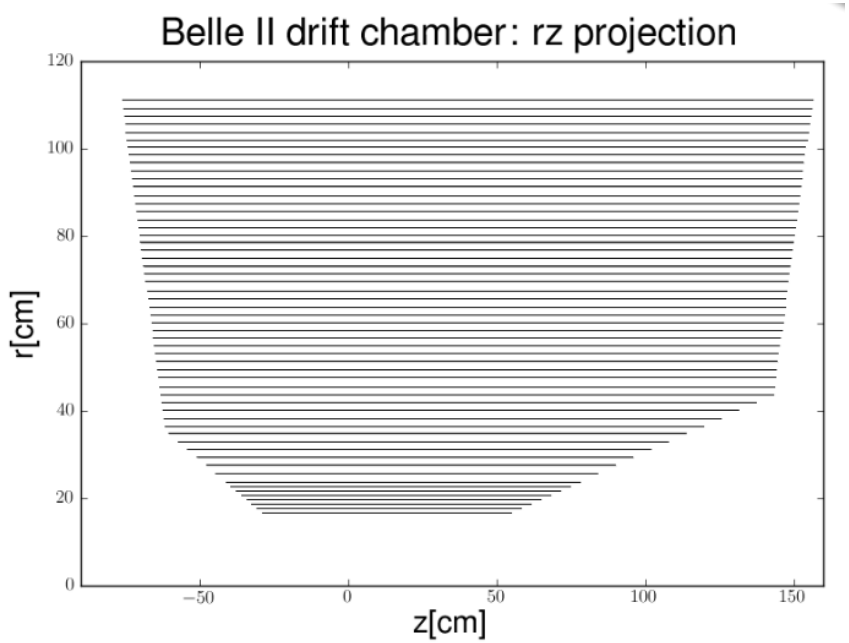
CDC is composed of:

- 9 super layers

which consist of

- 56 layers (grouped to 1x8 and 8x6)
- 14336 wires (160 - 384 wires in a layer).



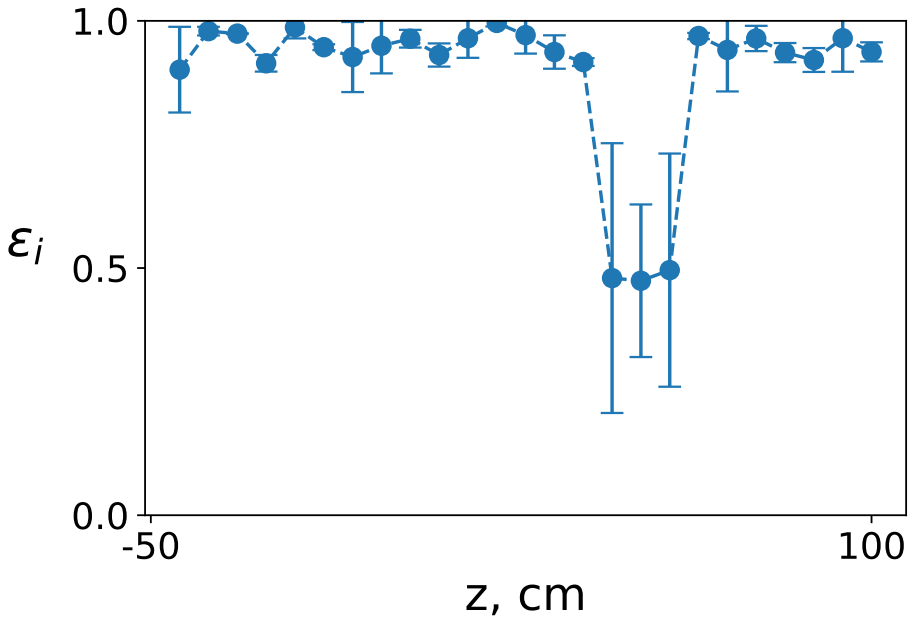


Starting points

Goal is to monitor 'Hit Efficiency' vs z for each Wire ID:

- For local low-eff in a wire.
- Low-eff throughout the whole wire.
- Low-eff persisting through several wires.
- 'Dead' wires.

So for each wire a plot is needed - but 14000+ wires!



Just a sketch
(no data, or simulation shown here)!

Method

This analysis uses:

- Dimuon pre-selected data.

from

- Experiments 3, 7, **8** and **10**.

Exp <10

`/group/belle2/dataprod/Data/release-03-01-04/DB00000607/PromptSkim/e_*/4S/r_*/skim/hlt_mumu_2trk/raw/sub00/`

Exp 10

`/group/belle2/dataprod/Data/release-04-00-02/DB00000711/PromptSkim/e_*/4S/r_*/skim/hlt_mumu_2trk/raw/sub00/`

Further cuts applied on tracks in events:

- $p_T > 1$ GeV.
- $|d_0| < 2$ cm.
- $|z_0| < 5$ cm.

I.e. straight tracks, that originate near the interaction point.

Efficiency calculation

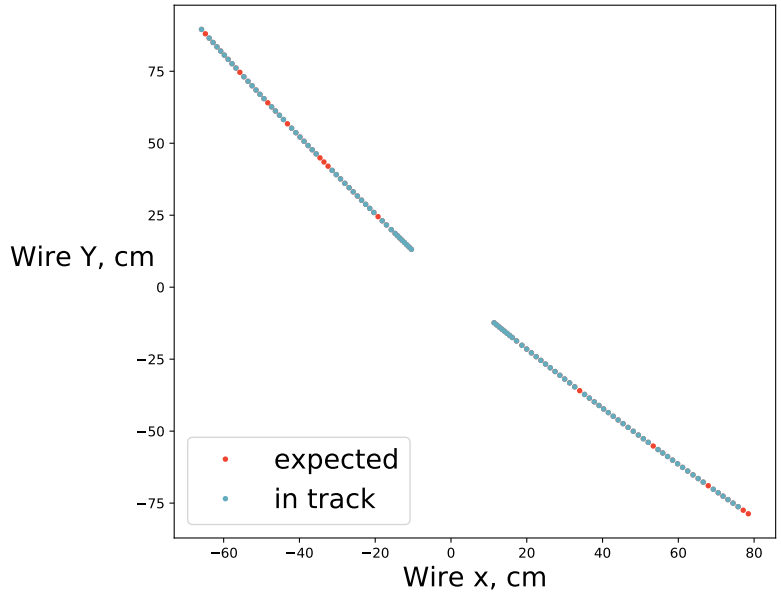
To calculate 'efficiencies' need two sets of hits:

- Hits forming muon tracks.

→In `PyStoreObj("CDCTrackVector")`.

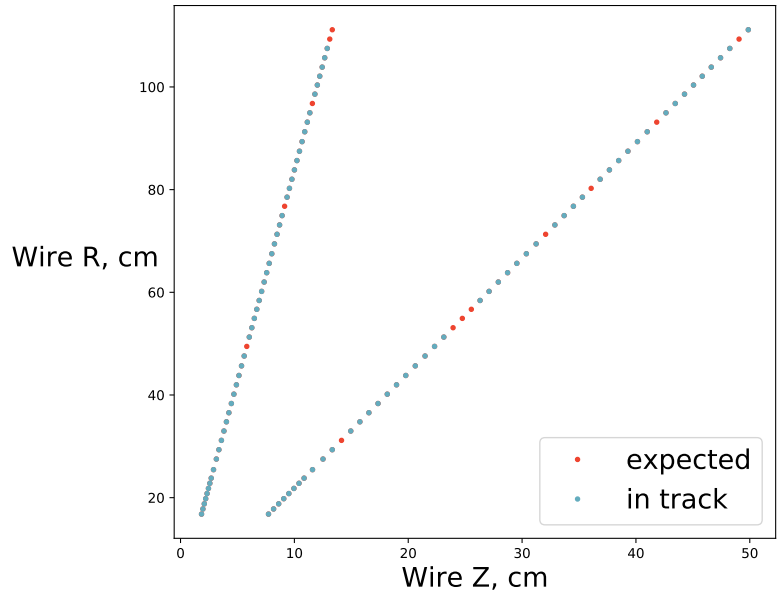
- Hits 'expected' in muon trajectory

→Extrapolate trajectory to see the wires it 'crosses'



First can be used as the numerator, the second as the denominator to define

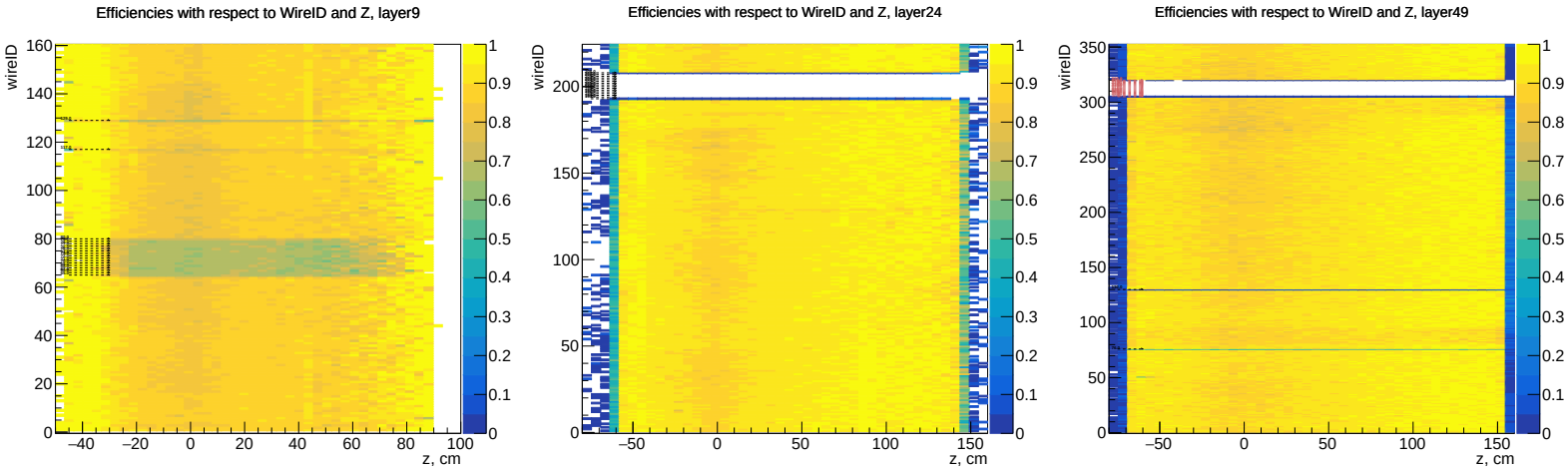
$$\varepsilon \equiv \frac{N_{\text{in track}}}{N_{\text{expected in track}}}. \qquad (1)$$



Wire efficiencies for layers

- For this ROOT TEfficiency is used.
- Combine hit data with all (or certain) runs combined

$\rightarrow$ 56 (1 per layer) plots $\varepsilon(\mathrm{z}, \mathrm{wireID})$ per dataset:



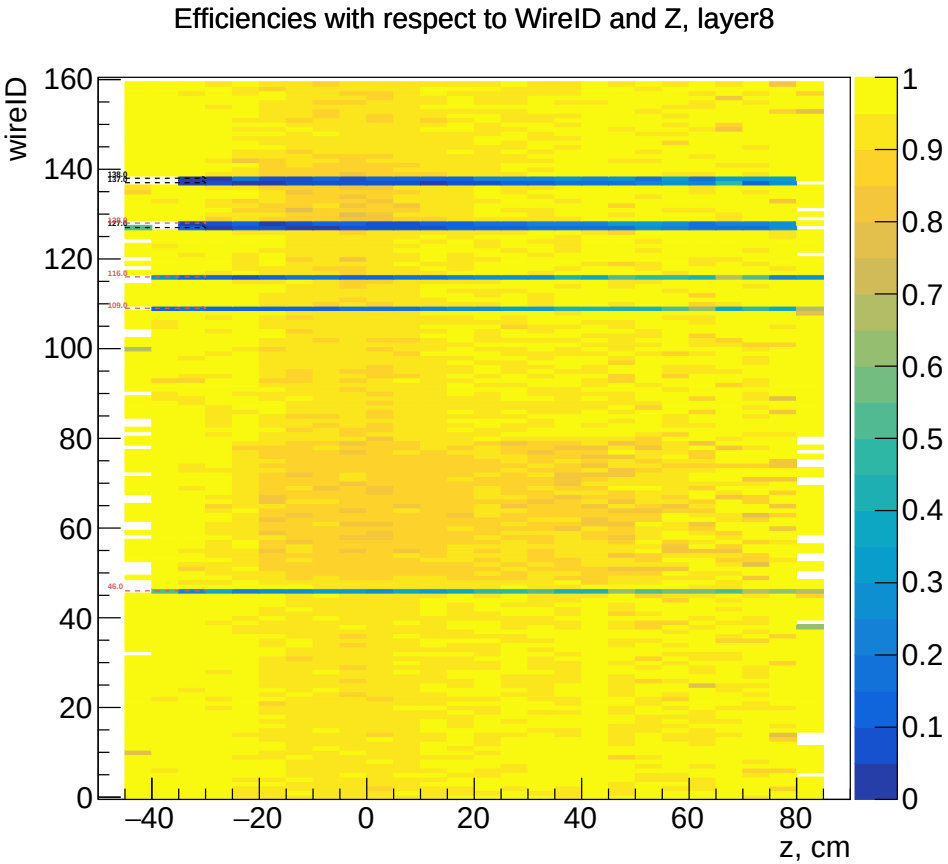
Faulty wire identification:

- χ^2 check for each wire against the layer projection.
- Also checks average efficiency of the wire.

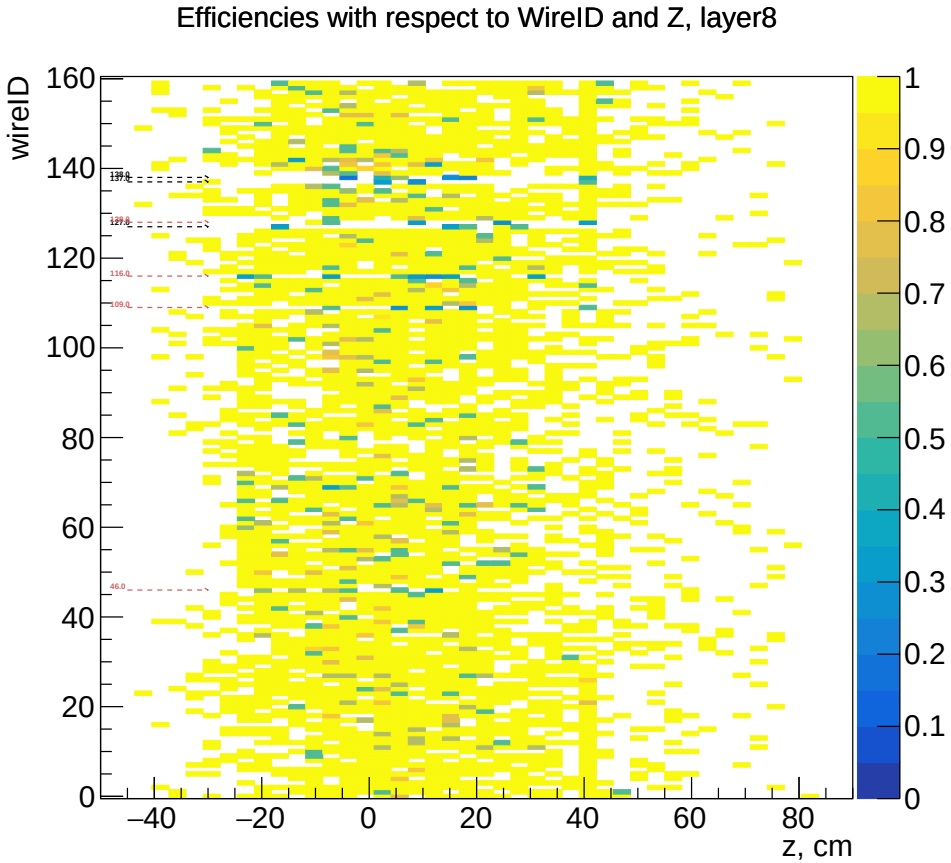
Performance on low stats

Good performance on low statistics as well

50 runs combined



1 run



RED arrows: in CDCBadWires payload most recent rev.

Black arrows: foudn by my tool, not in payload

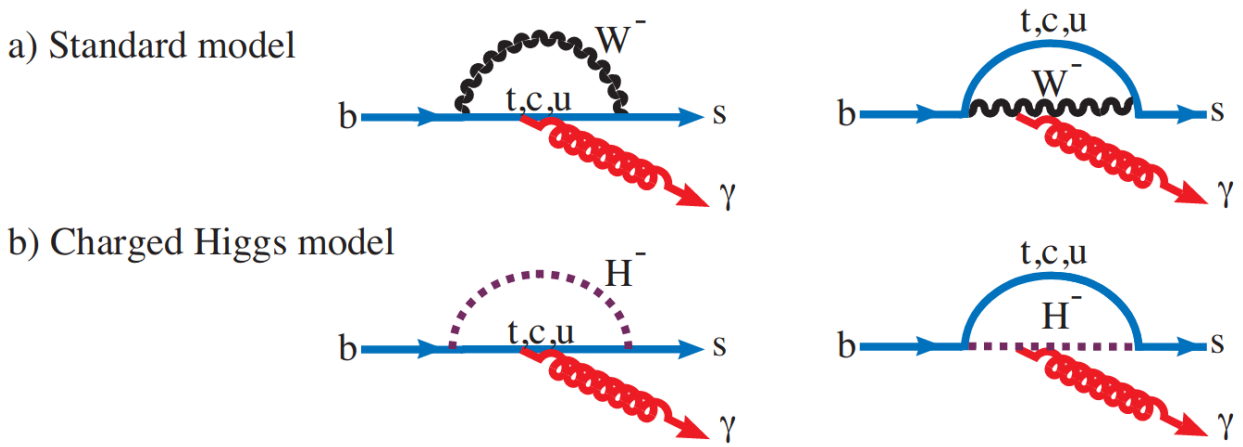
Main topic: $B \to X_s\gamma$

Future plans:

$B \to X_s\gamma$ analysis. Measurement of the γ energy spectrum.

Yet to have started

- Possible BSM contributions.
- m_b\shape func. useful in V_{ub} measurements



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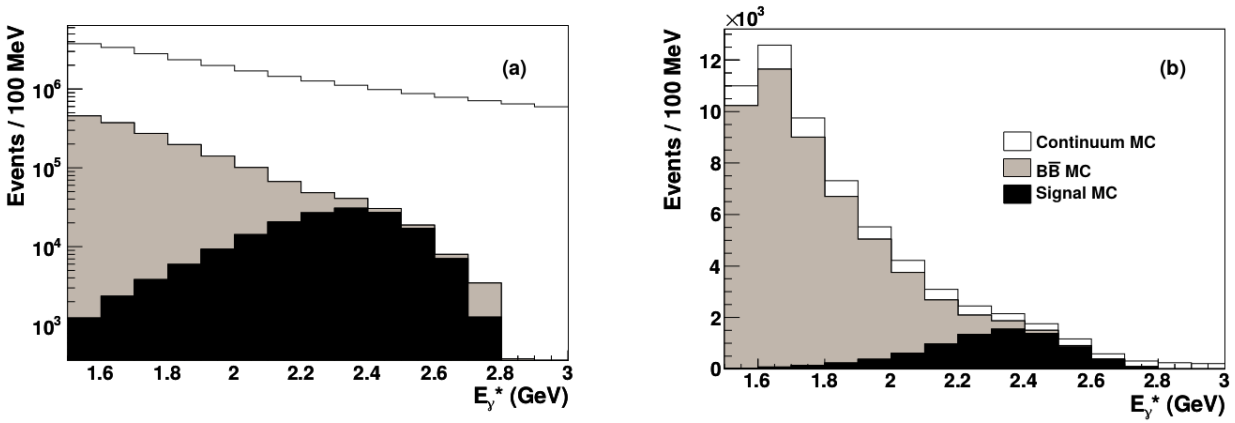
Using the upcoming Belle 2 dataset:

- Fully-inclusive.
- Tagged analysis planned.



BABAR estimations, 1207.5772

Summary

- Started studying the CDC wire efficiency.

$\rightarrow$ developing a semi-automatic "monitoring tool"

- Tool to be used for offline DQM monitoring.

- For analysis: Plan to use Belle 2 data for $B \rightarrow X_s\gamma$

Thank you!

Backup: Empty Slide

BACKUP: Considerations of uncertainty evaluation

Using pyROOT for analysis due to the `TEfficiency` class:
$\rightarrow$ uncertainty calculation is mostly taken care of.

By default Clopper-Pearson method calculates 'exact' confidence interval of a binomial distribution.
$\rightarrow$ asymmetric errors in each bin.

Clopper-Pearson method

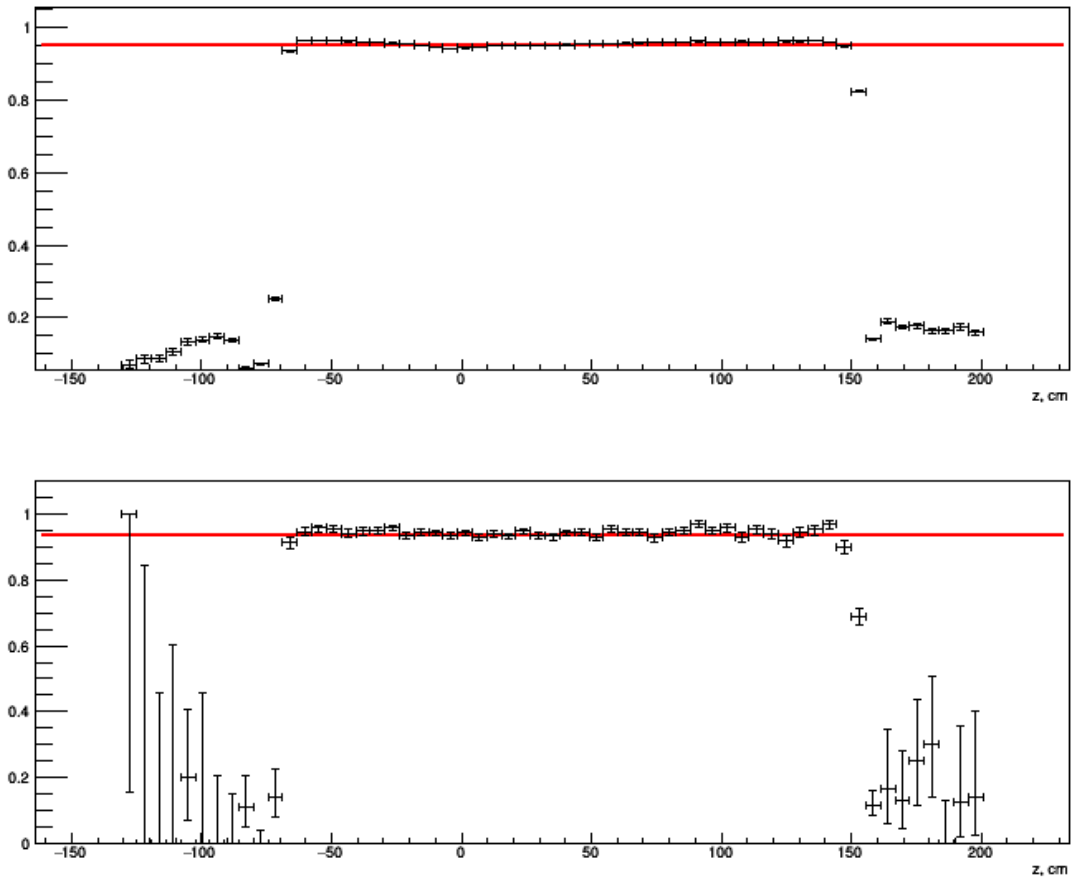
If n trials and k successes in trials, and confidence level α:

$$\begin{aligned} P_{UE} &= 1 - \mathrm{BetaInv}(\frac{\alpha}{2}, n-k, k+1) \\ P_{LE} &= 1 - \mathrm{BetaInv}(\frac{1-\alpha}{2}, n-k+1, k) \end{aligned} \tag{2}$$

Think this is the correct approach for error calculation in this case.

Backup:Projection fits

STEP 1: Make an X projection of all wires and the wire currently in question.



→ check for fit overlap

→ separately calculate chi2 value for average and single-wire efficiency histograms