

ANNA-MARIA HEYN  
DIRECT MEASUREMENT  
OF  $R^{\pm 0}$

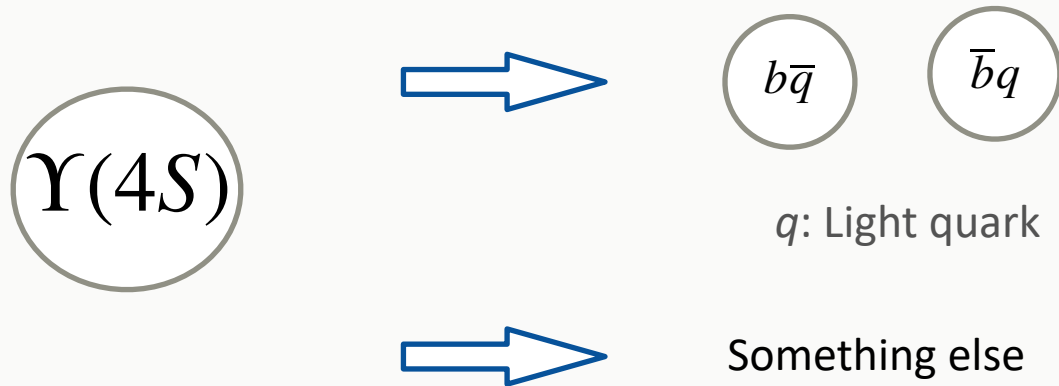


# WHY DO WE CARE ABOUT $R^{\pm 0}$ ?

- Do emerging structures from QCD care about QED charge?

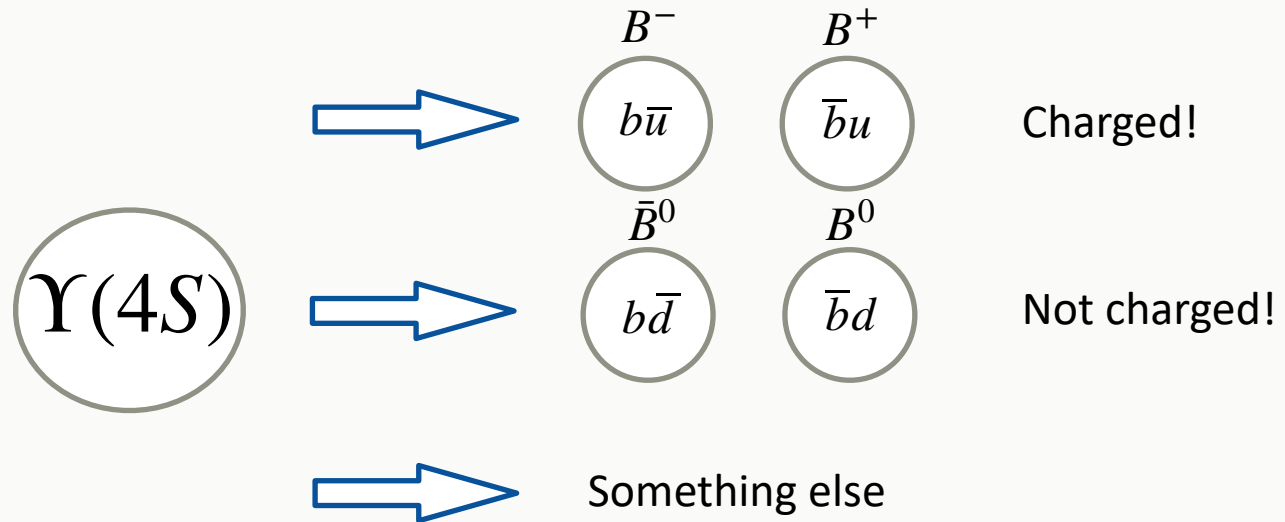
# WHY DO WE CARE ABOUT $R^{\pm 0}$ ?

- Do emerging structures from QCD care?
- Look at Belle II:



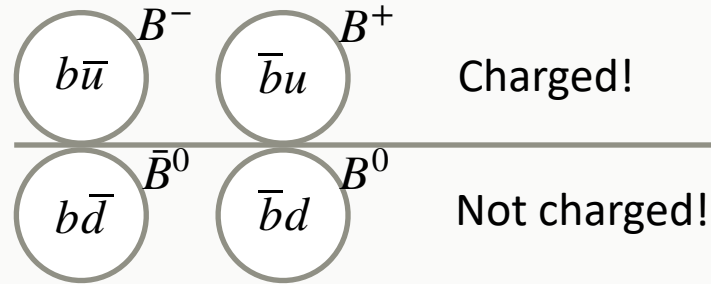
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# WHY DO WE CARE ABOUT $R^{\pm 0}$ ?

- Do emerging structures from QCD care?
- Look at Belle II:
- Ratio



$$R^{\pm 0} = \frac{\Gamma(\Upsilon(4S) \rightarrow B^+B^-)}{\Gamma(\Upsilon(4S) \rightarrow B^0\bar{B}^0)}$$

## WHY IS IT DIFFICULT?

- Currently:  $R^{\pm 0} = 1.057^{+0.024}_{-0.025}$  (HFLAV<sup>1</sup>)
- Phase space?
- So... do QCD emergent structures care?

## WHY IS IT DIFFICULT?

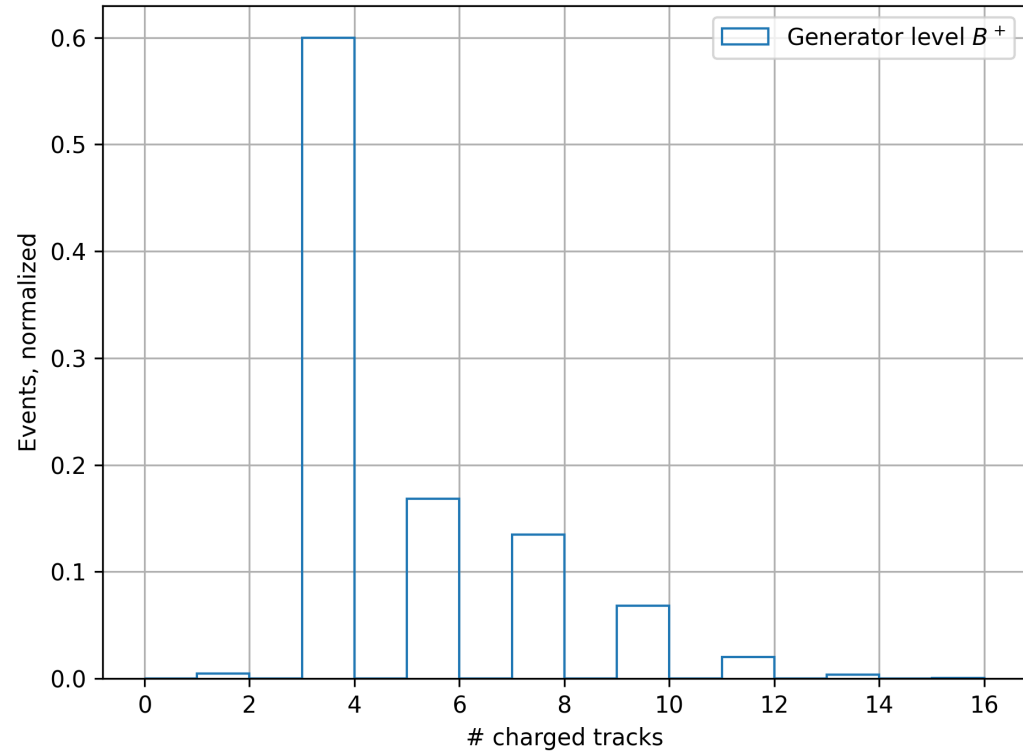
- Currently:  $R^{\pm 0} = 1.057^{+0.024}_{-0.025}$  (HFLAV<sup>1</sup>)
- Phase space?
- So... do QCD emergent structures care?
- But:
  - Theory predictions hard
  - B Mesons decay
  - Treatment of others than  $B\bar{B}$

# DIRECT MEASUREMENT WITHOUT RECONSTRUCTION?

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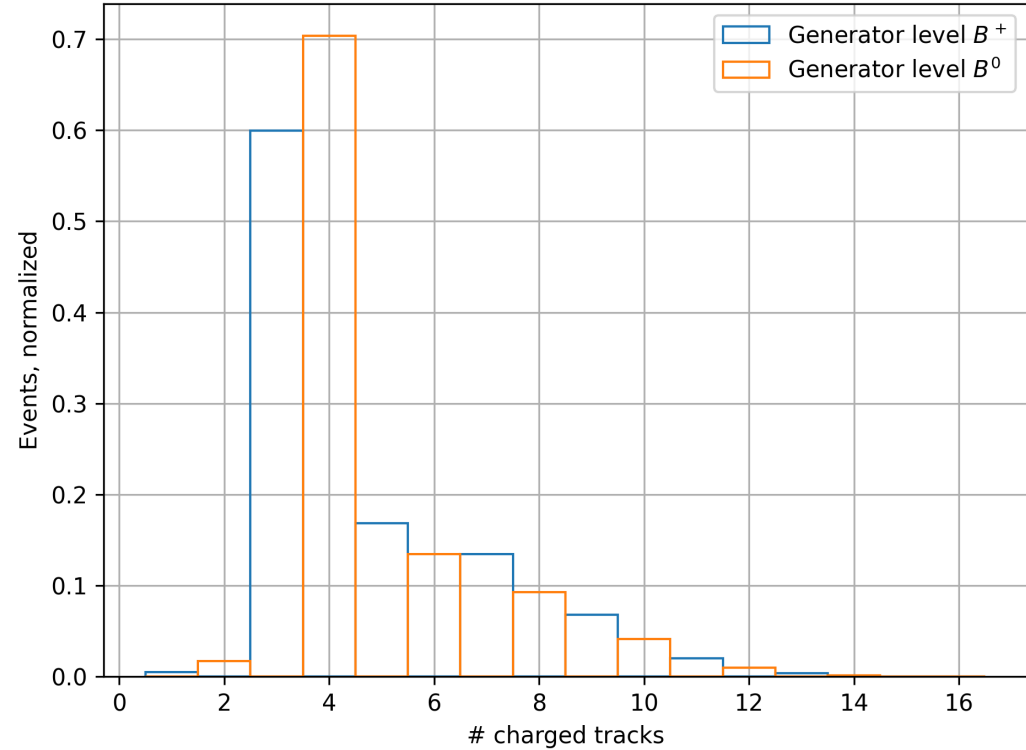
$B^+ \rightarrow 1, 3, 5, \dots$  charged daughters



# CONCEPT

$B^+ \rightarrow 1, 3, 5, \dots$  charged daughters

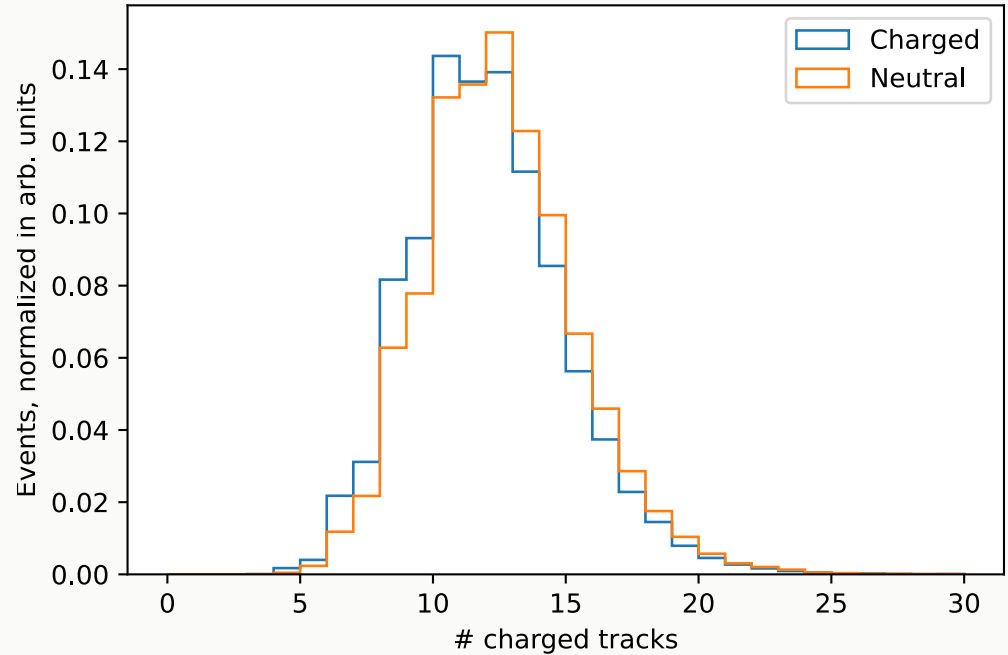
$B^0 \rightarrow 0, 2, 4, \dots$  charged tracks



$B^+ \rightarrow 1, 3, 5, \dots$  charged daughters

$B^0 \rightarrow 0, 2, 4, \dots$  charged daughters

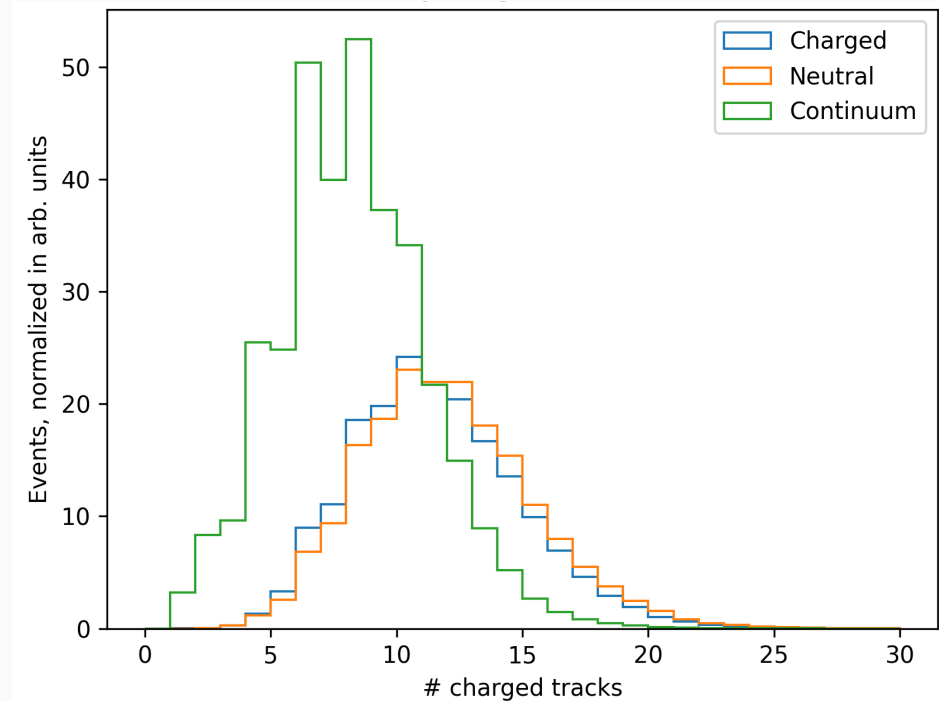
But: 2 reconstructed B Mesons



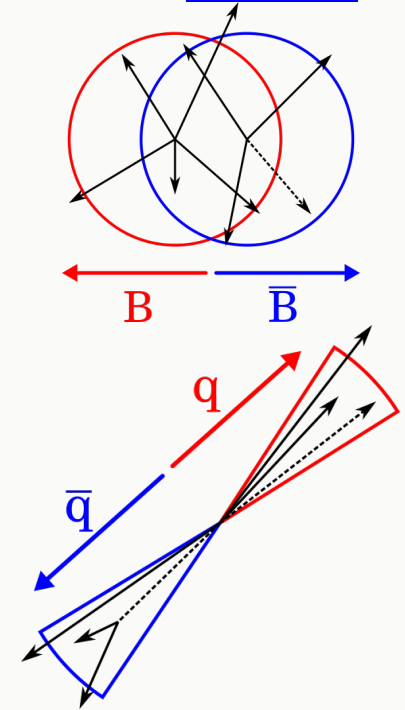
$B^+ \rightarrow 1, 3, 5, \dots$  charged daughters

$B^0 \rightarrow 0, 2, 4, \dots$  charged daughters

Two B Mesons  
With Continuum

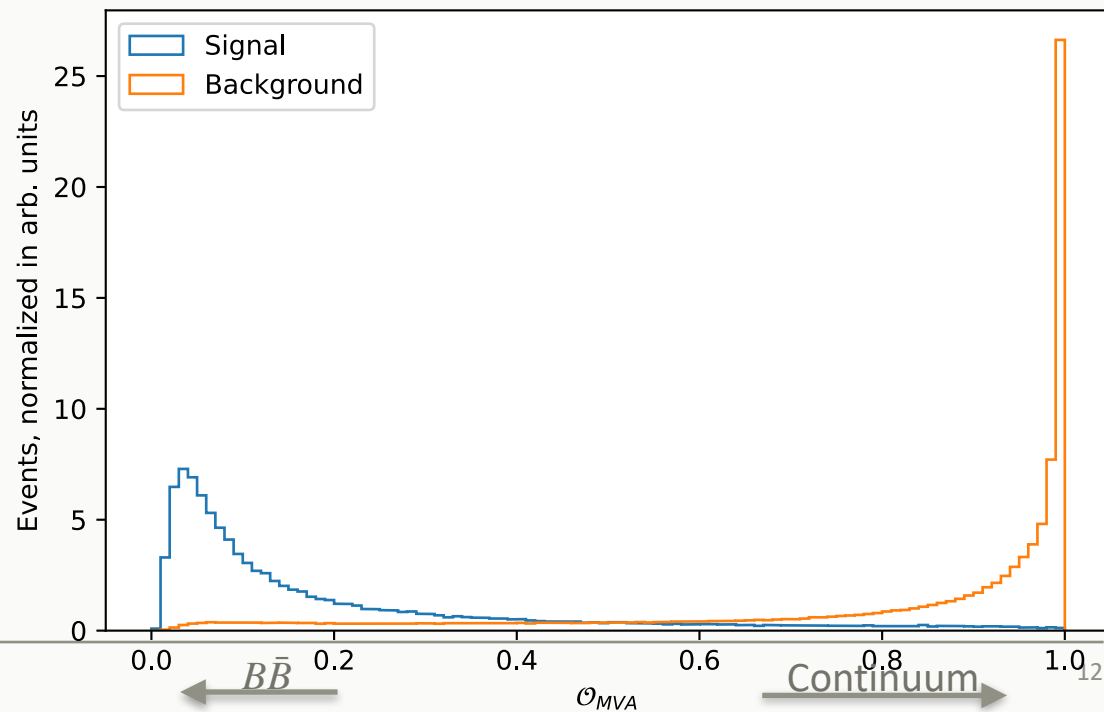


- Train BDT for Continuum Suppression
- Event shape variables:
  - Event thrust
  - Cosine of polar angle comp. of thrust axis
  - Fox Wolfram moments
  - CLEO cones



Adapted from Markus Prim

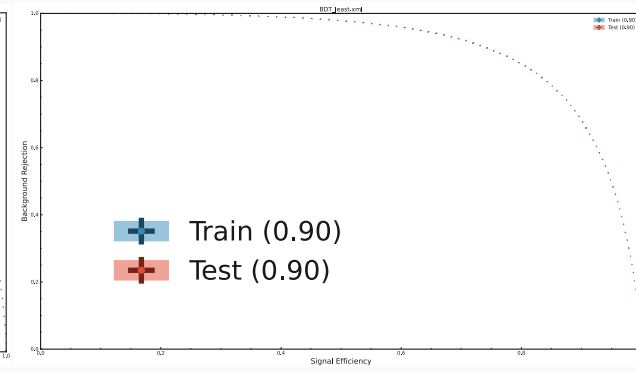
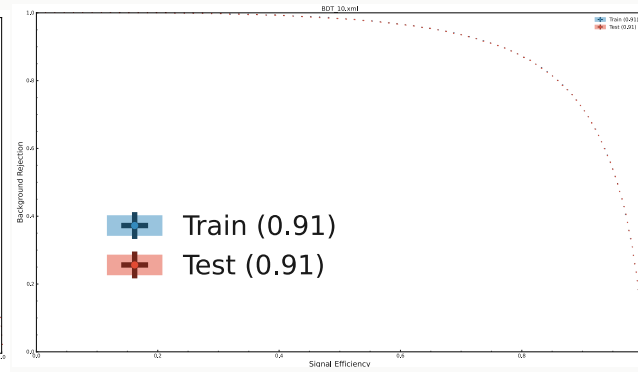
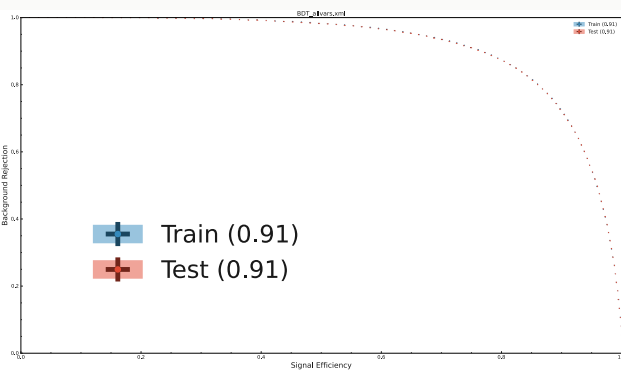
- Train BDT for Continuum Suppression
- Event shape variables:
  - Event thrust
  - Cosine of polar angle comp. of thrust axis
  - Fox Wolfram moments
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– Trained 3 BDTs:  
All Variables

Most important

Least Correlated Variables

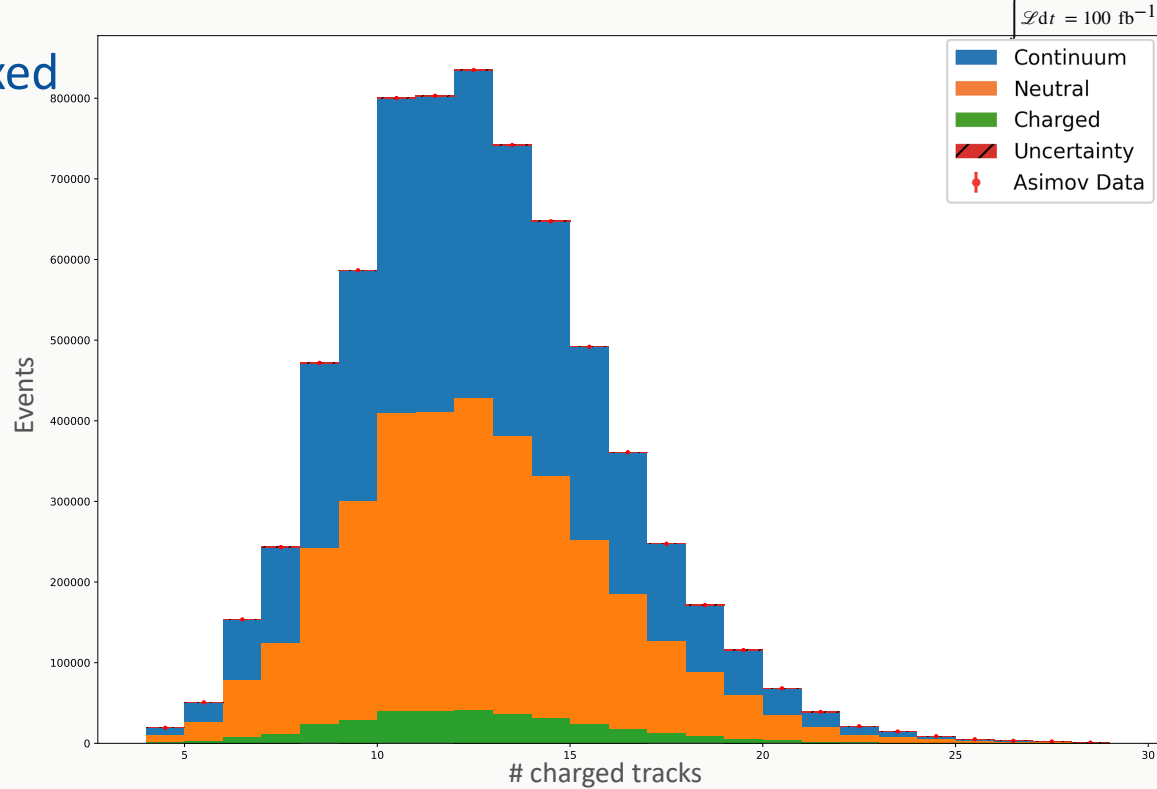


# HOW TO MEASURE $R^{\pm 0}$ ?

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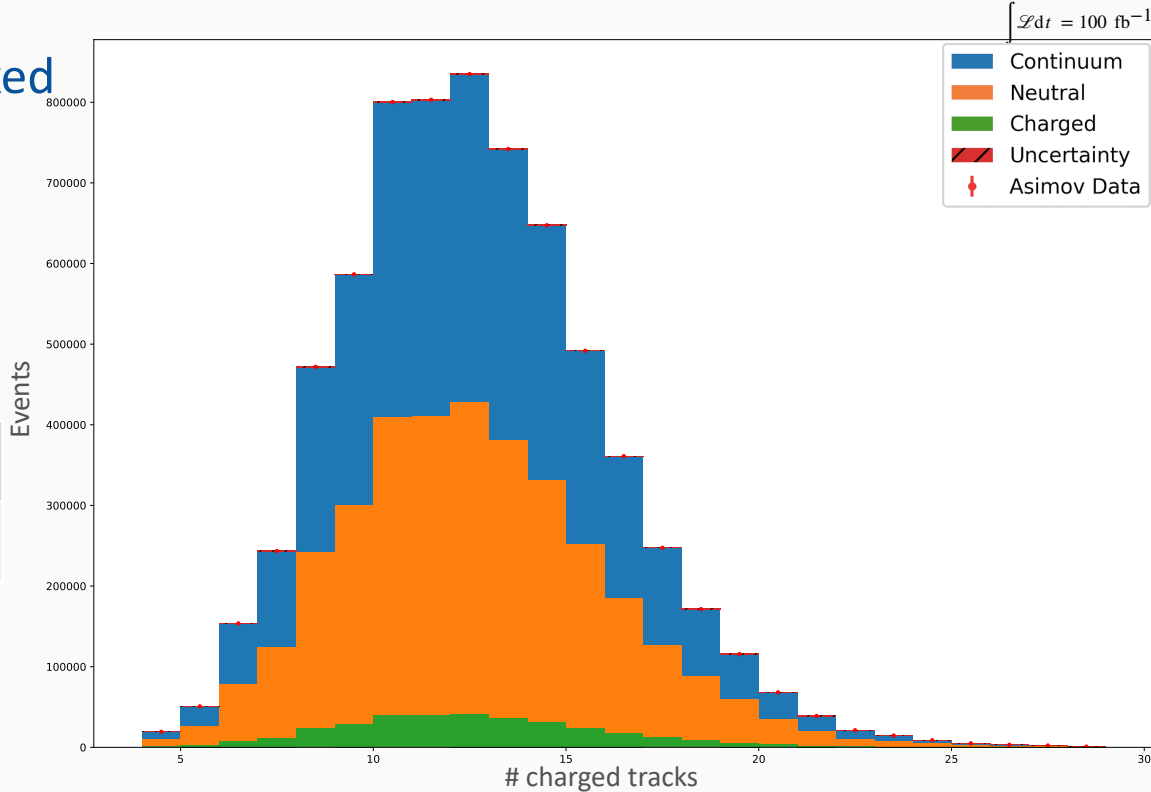


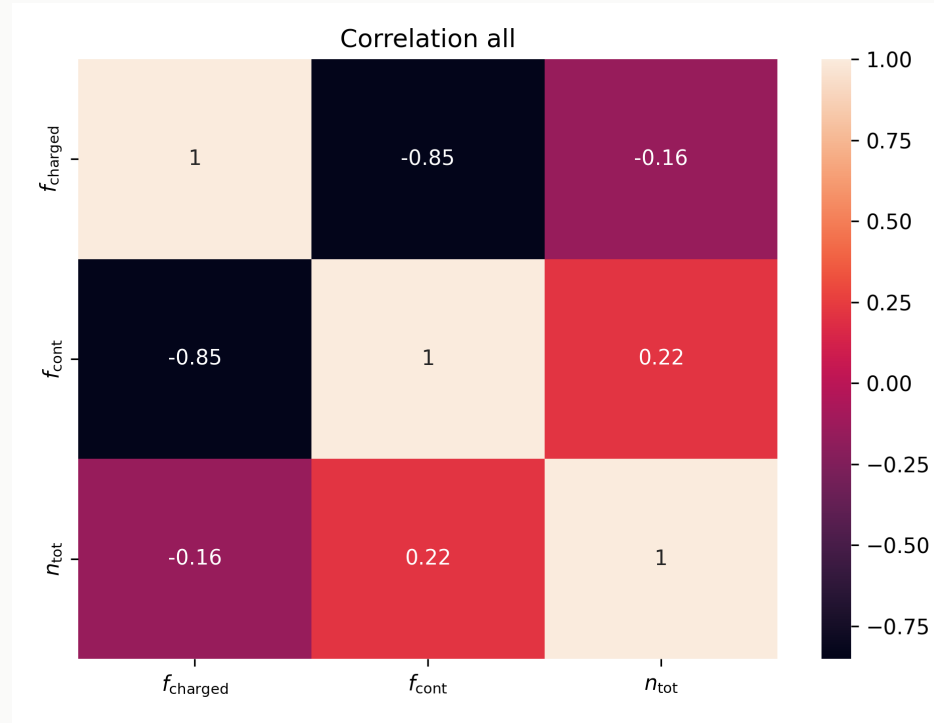
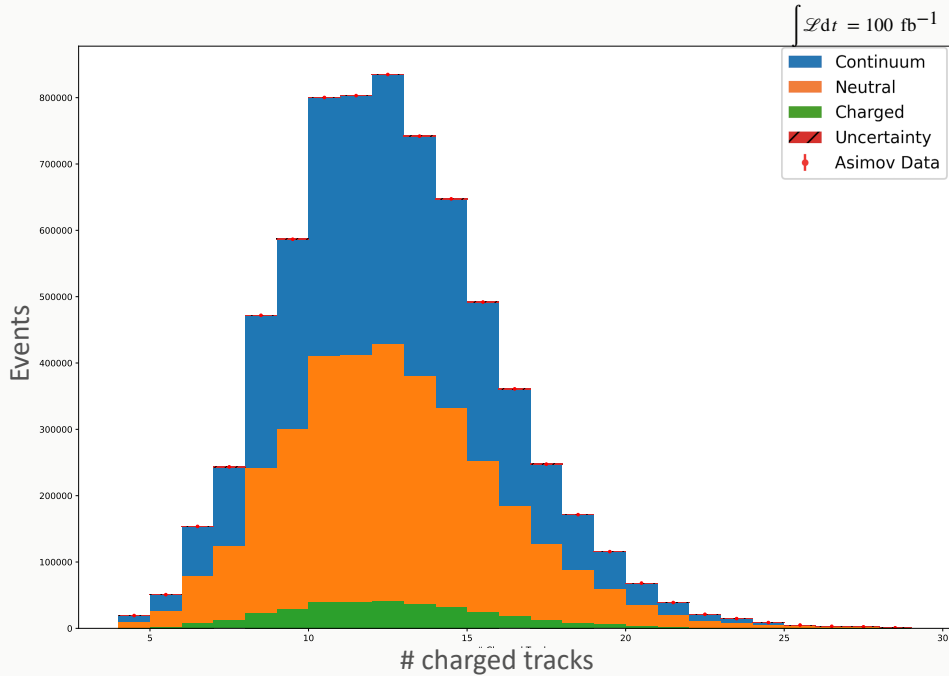
- Template fit with charged, mixed and Continuum contribution
- Get rates =>  $R^{\pm 0}$



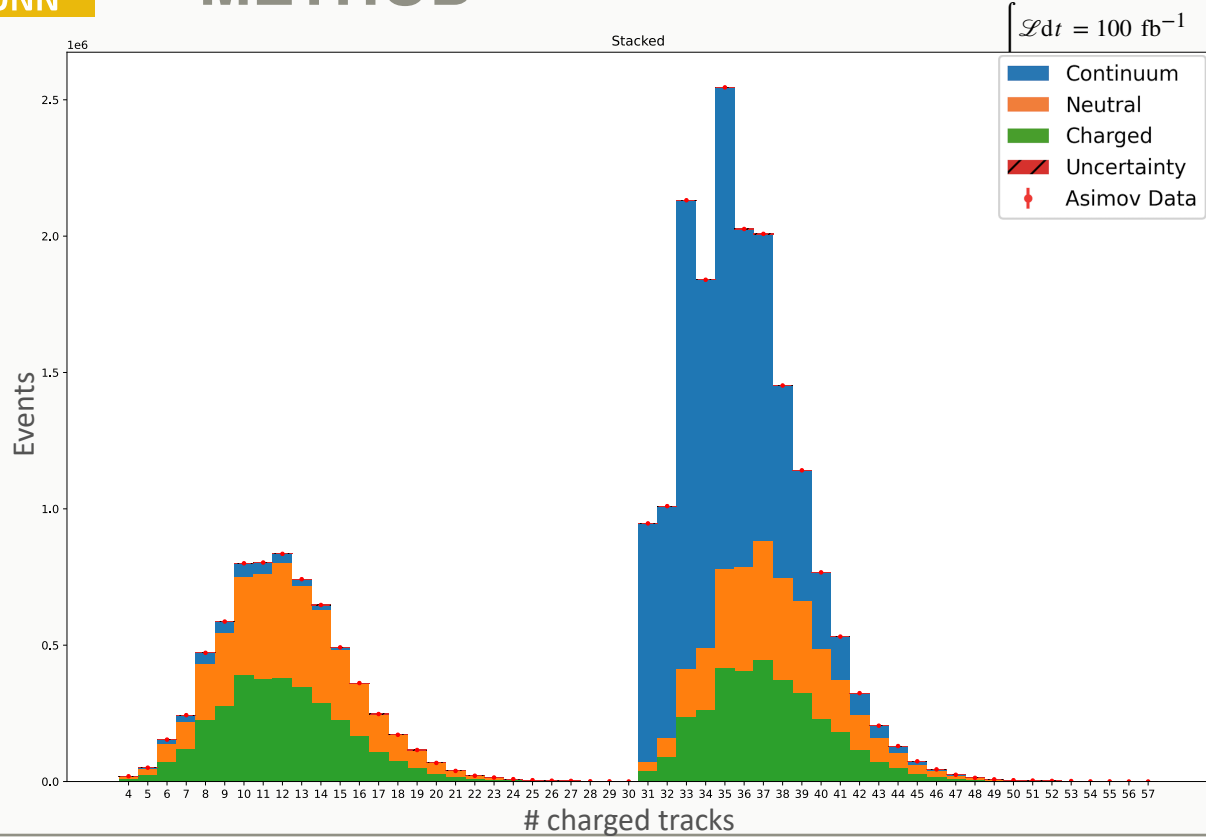
- Template fit with charged, mixed and Continuum contribution
- Get rates =>  $R^{\pm 0}$

|        |             |
|--------|-------------|
| Fitted | 0.993107(8) |
| Input  | 0.993101    |



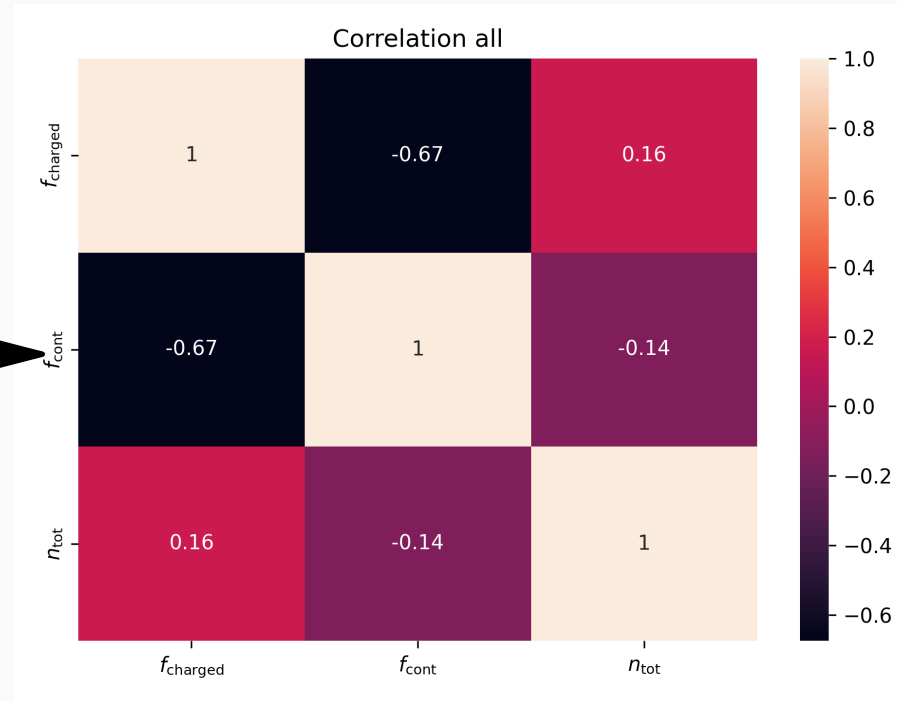
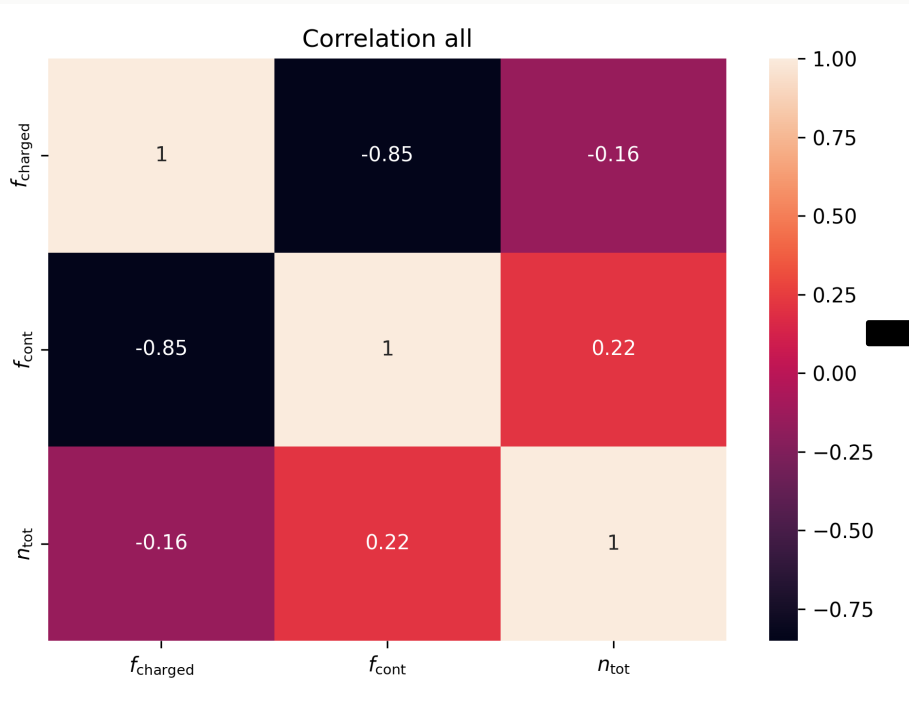


# METHOD



Cut region

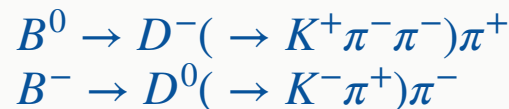
Anti-cut region



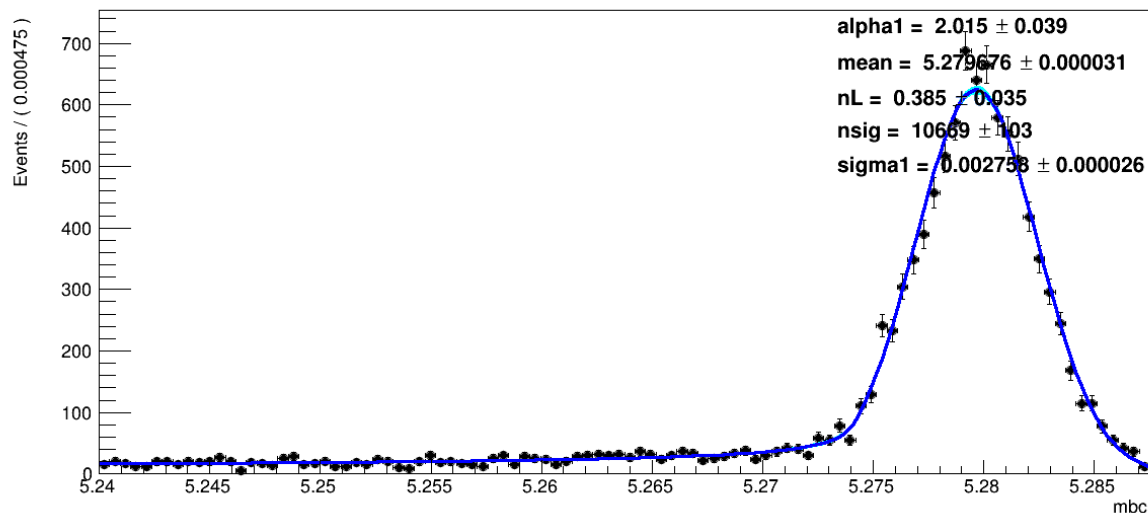
# UNCERTAINTIES

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- Uncertainties: Use calibration channel:
  - unbinned fit with roofit for # left-over events for each # charged tracks



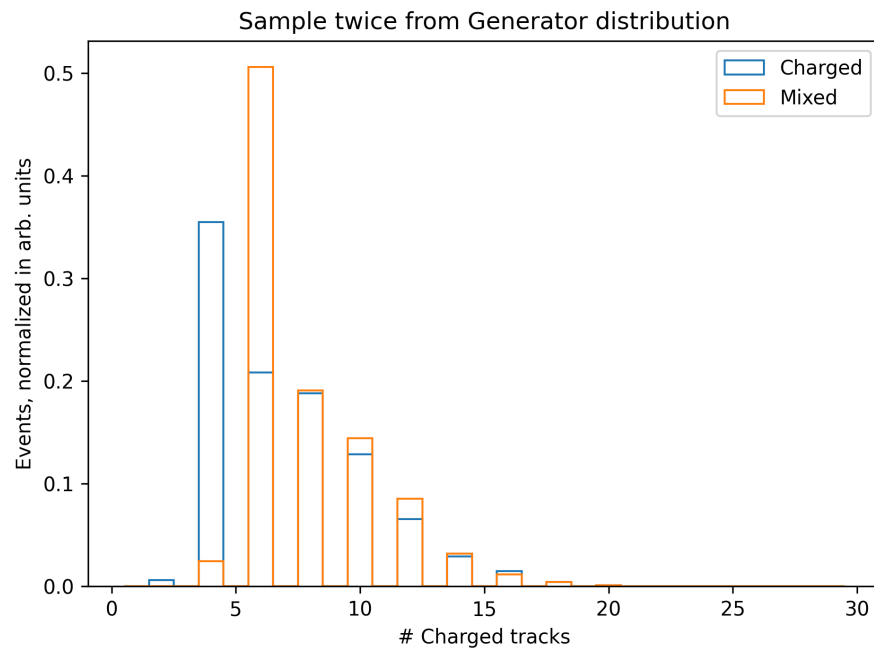
Signal only 5 charged tracks



- Uncertainties: Use calibration channel:
  - unbinned fit with roofit for left-over # events
  - Sample to get incl. distribution

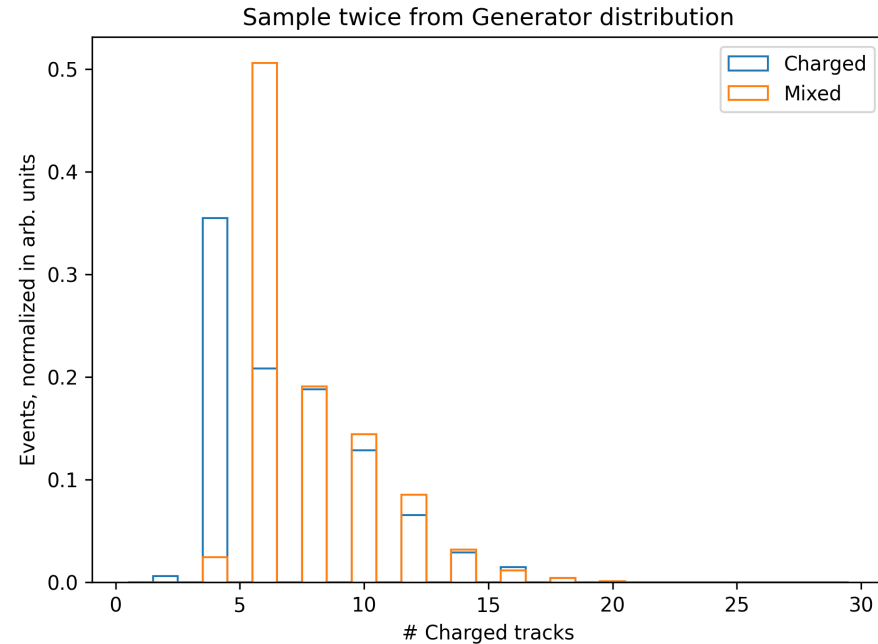
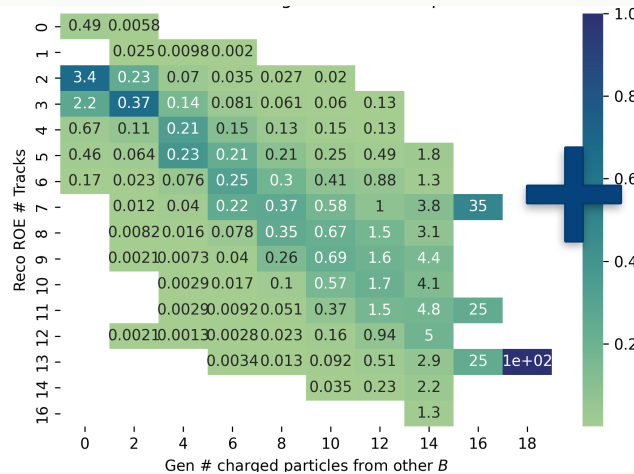
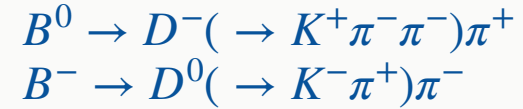
$$B^0 \rightarrow D^-( \rightarrow K^+ \pi^- \pi^- ) \pi^+$$

$$B^- \rightarrow D^0( \rightarrow K^- \pi^+ ) \pi^-$$

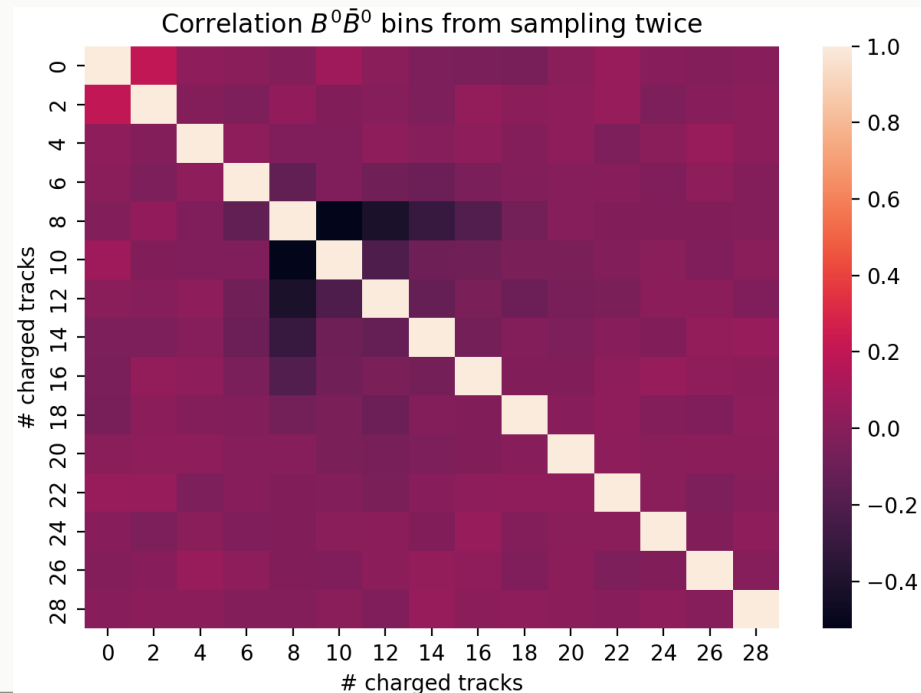




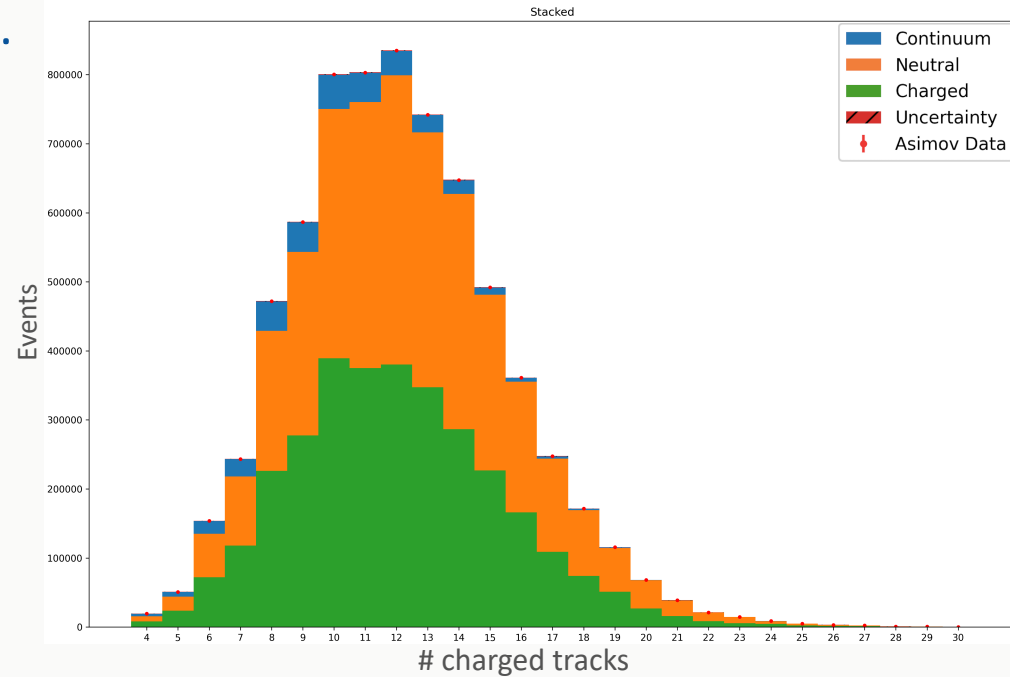
- Uncertainties: Use calibration channel:
  - unbinned fit with roofit for left-over # events
  - Sample to get incl. distribution
  - Migration



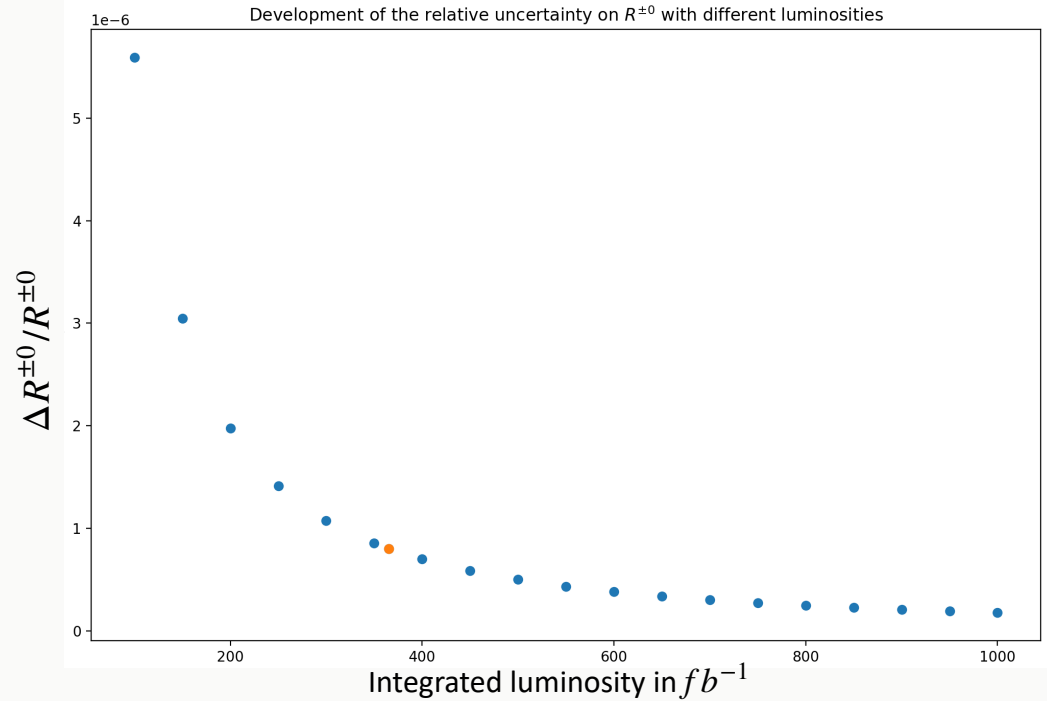
- Uncertainties: Use calibration channel:
  - unbinned fit with roofit for # events
  - Sample to get incl. distribution
  - Migration
  - bootstrap for errors
  - propagate



- Use covariance for template fit
- Tracking efficiency for systematic unc.
- Efficiency

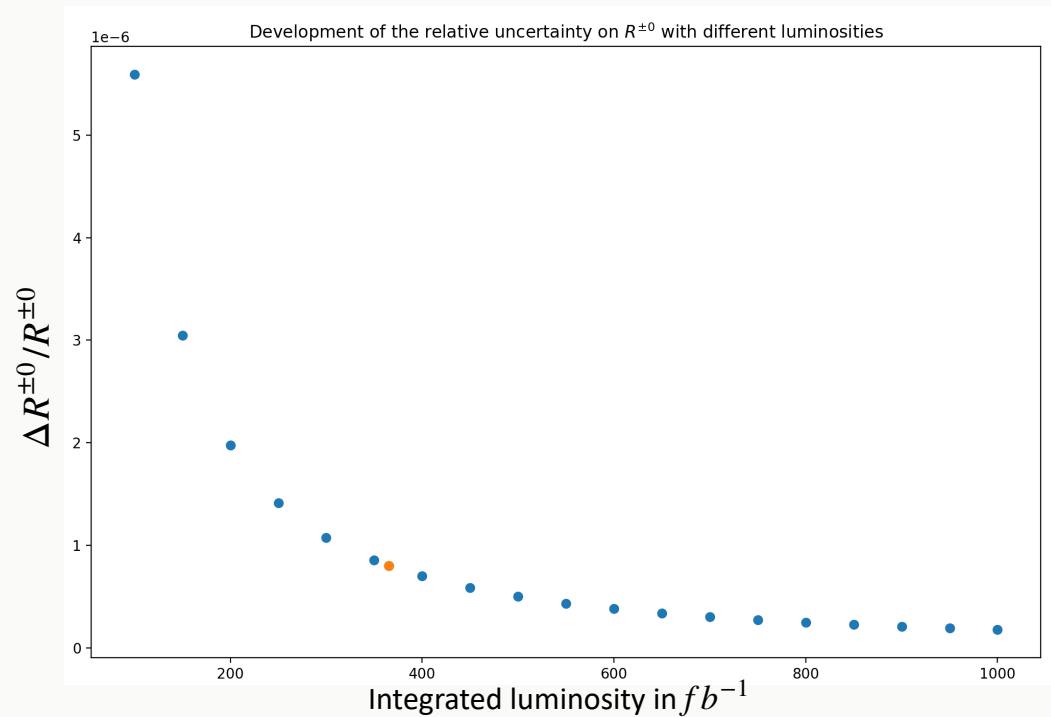


## – Development for different Luminosities



# CONCLUSION

- Promising method
- Will improve with more statistics!



# QUESTIONS?

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# BACKUP

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## METHOD - SELECTION

- $\Upsilon(4S) \rightarrow \pi^+ + X$
- Constraints:
  - $|dz| < 1\text{cm}, dr < 3\text{cm}, p > 0.2\text{MeV}$
  - $\geq 1$  hit in the drift chamber, angle in acceptance



# METHOD - BDT

