# Possible $\Delta R$ extraction from MARATHON+ data

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# Relevance of $R$

- $R$ is the absorption cross section ratio for longitudinally to transversely polarized photons:

$$R = \sigma_L/\sigma_T$$

- Knowledge of $R$ required to obtain $F_2$ from absolute cross section (typically obtained from SLAC parametrization, R1990)

- Cross section ratio only equal to $F_2$ ratio if $R$ is independent of nucleus (often assumed based on SLAC and CERN measurements)

# Sensitivity to $\Delta R$

Difference in $R$ between nucleus $A$ and deuterium can be found from cross section ratios using a Rosenbluth separation style method:

$$\frac{\sigma_A}{\sigma_D} = \frac{\sigma_A^T}{\sigma_D^T}\left[1 + \frac{\epsilon}{1 + \epsilon R_D}(R_A - R_D)\right]$$

where

$$\epsilon = \left[1 + 2\left(1 + \frac{\nu^2}{Q^2}\right)\tan^2\frac{\theta}{2}\right]$$

For MARATHON:

- EMC measurements in tritium, helium-3 care about $R_T - R_D$, $R_H - R_D$
- $F_2^n/F_2^p$ measurement cares about $R_T - R_H$
    - Could be obtained directly if $R$ data exists for helium-3
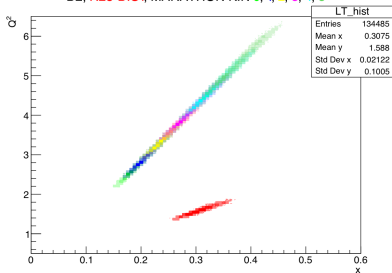
# Overview of data

Spring 2018 data (MARATHON):

|        | $E_0$ (GeV) | $E'$ (GeV) | $\theta$ (°) |
|--------|-------------|------------|--------------|
| KIN 0  | 10.6        | 3.1        | 16.807       |
| KIN 1  | 10.6        | 3.1        | 17.755       |
| KIN 2  | 10.6        | 3.1        | 19.115       |
| KIN 3  | 10.6        | 3.1        | 20.578       |
| KIN 4  | 10.6        | 3.1        | 21.930       |
| KIN 5  | 10.6        | 3.1        | 23.213       |

Fall 2018 data:

|          | $E_0$ (GeV) | $E'$ (GeV) | $\theta$ (°) |
|----------|-------------|------------|--------------|
| R28-DIS1 | 4.3         | 1.58       | 28.004       |
| R28-DIS2 | 4.3         | 1.71       | 28.004       |
| R28-DIS3 | 4.3         | 1.91       | 28.004       |

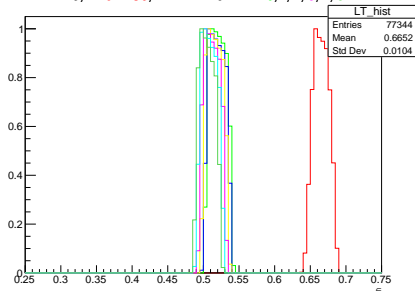# $x$ vs. $Q^2$ coverage (deuterium)
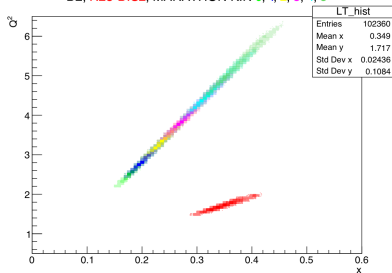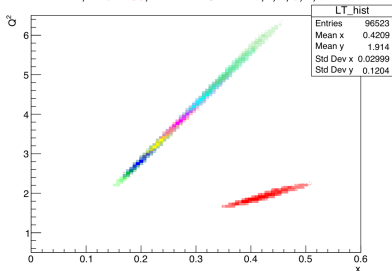


- Good overlap in $x_{Bj}$

- No overlap in $Q^2$...evolve result with DGLAP equations

- DGLAP up or DGLAP down?
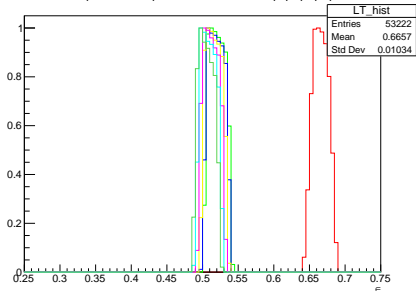
# $\epsilon$ separation (R28-DIS3, all targets)

## Issues
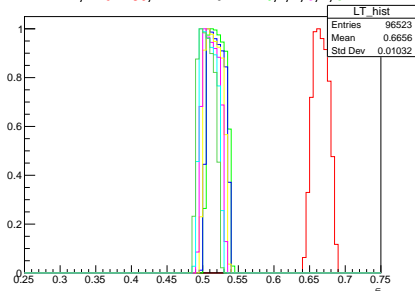
- $\Delta\epsilon \approx 0.15$ smaller than desired, but could still be useful
- Extract ratio in similar manner to MARATHON analysis, but bin in $\epsilon$ instead of $x_{Bj}$
- Concern: result could be very sensitive to small analysis changes due to short lever arm