

Group Meeting

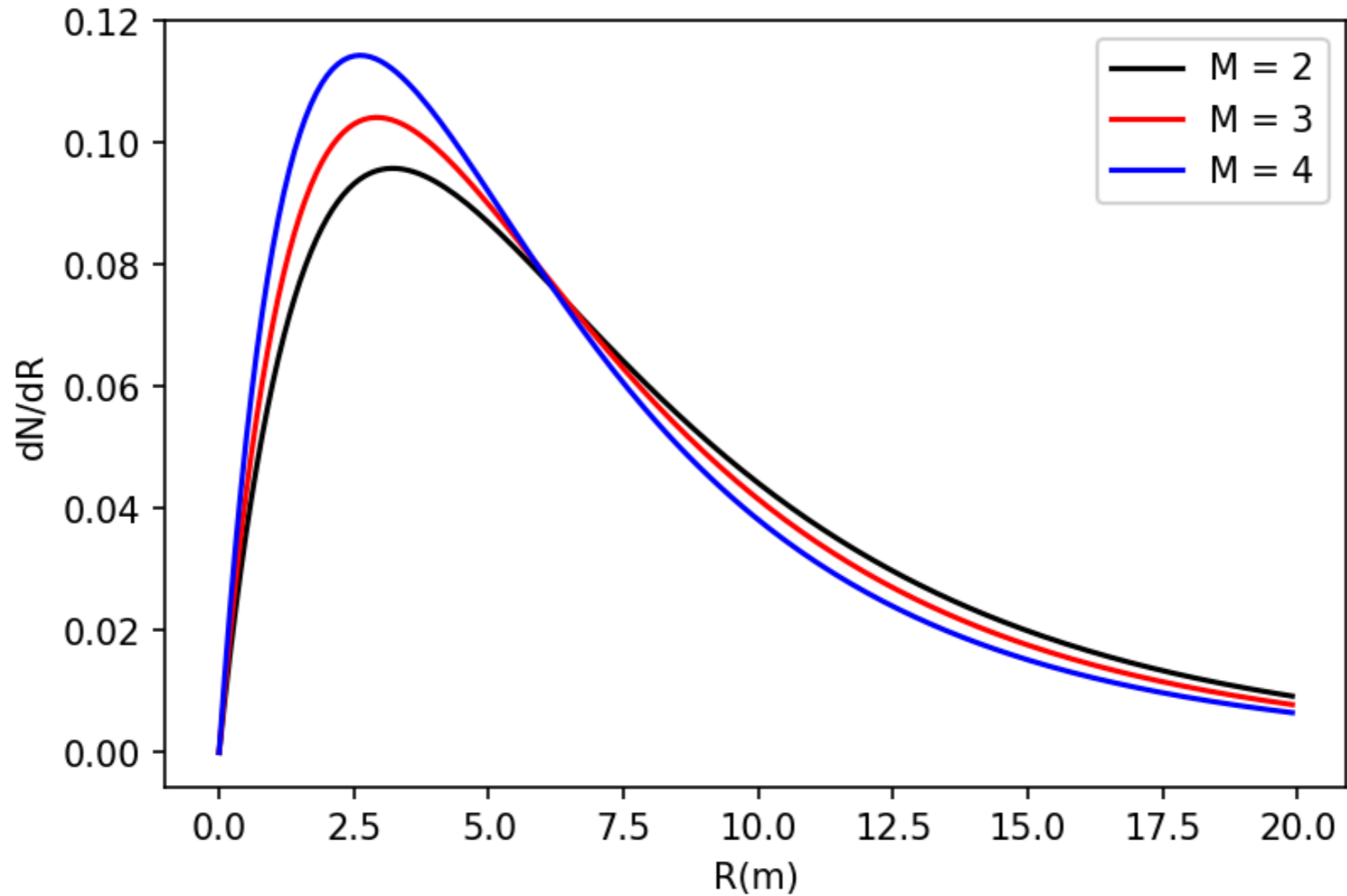
16/04/2020



MUPAGE tuning

- Many parameters to vary - <https://doi.org/10.1016/j.astropartphys.2005.10.005>
- Lateral Spread - distribution of radial distances from shower axis

MUPAGE tuning



Interactive look at the lateral distribution when one varies the depth h , zenith angle and multiplicity.

decay of secondary mesons and reaching a given depth of water follow the energy distribution of the parent mesons. As a consequence, in a muon bundle, the most energetic muons are expected to arrive closer to the axis shower. Therefore, in order to correctly parameterize the energy of muons in a bundle, the muon radial distance R from the shower axis must be taken into account.

The muon lateral distribution in a plane perpendicular to the shower axis can be described [11] as

$$\frac{dN}{dR} = C \frac{R}{(R + R_0)^\alpha} \quad (18)$$

The average value of the radial distribution $\langle R \rangle$ depends on the parameters R_0 and α : $\langle R \rangle = 2R_0/(\alpha - 3)$. Because of the simpler physical interpretation, $\langle R \rangle$, instead of R_0 , is used as fit parameter. In Eq. (18), C represents the normalization factor: $C = (\alpha - 1)(\alpha - 2) \cdot R_0^{\alpha-2}$. The parameters α and R_0 depend on the vertical depth h , the zenith angle θ and on the muon multiplicity m in the bundle. The (h, θ, m) phase space has been divided in 189 cells: the usual seven values of vertical depth, nine values of zenith angle and three multiplicities $m = 2, 3$ and >3 . In the following formulas the variable M is defined as

$$\begin{aligned} M &= m, & \text{if } m \leq 3 \\ M &= 4, & \text{if } m \geq 4 \end{aligned} \quad (19)$$

The radial distance R of each muon in a bundle of a given multiplicity M , reaching the seven vertical depth h and in a

6.1. The parameter $\langle R \rangle$

The average value $\langle R \rangle$ of the radial distribution depends mainly on the vertical depth (it decreases when h increases). Then, for a given h , $\langle R \rangle$ decreases with increasing of the muon multiplicity. Finally, $\langle R \rangle$ does not depend on the zenith angle θ up to $\sim 50^\circ$, then it decreases with increasing θ . $\langle R \rangle$ (in units of m) is parameterised as

$$\langle R \rangle = \rho(h, \theta, M) = \rho_0(M) \cdot h^{\rho_1} \cdot F(\theta) \quad (20)$$

where

$$\rho_0(M) = \rho_{0a} \cdot M + \rho_{0b} \quad (21)$$

$$F(\theta) = \frac{1}{e^{(\theta-\theta_b) \cdot f} + 1} \quad (22)$$

6.2. The parameter α

The parameter α increases with the depth h and, at a given depth, it shows a smooth decrease with increasing M :

$$\alpha = \alpha(h, M) = \alpha_0(M) \cdot e^{\alpha_1(M) \cdot h} \quad (23)$$

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$$\alpha_1(M) = \alpha_{1a} \cdot M + \alpha_{1b} \quad (25)$$

The value of all constants is reported in Table 5.

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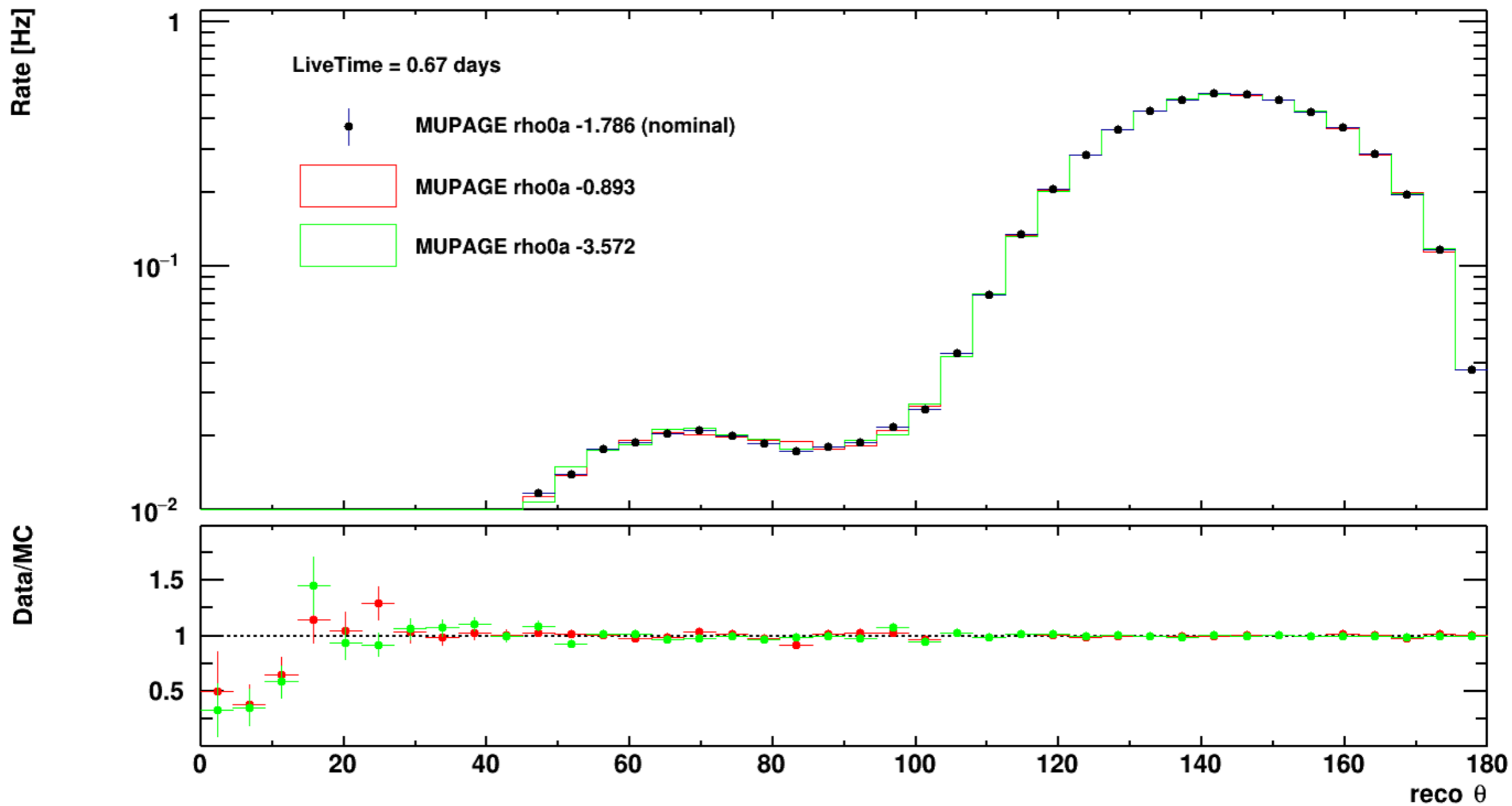
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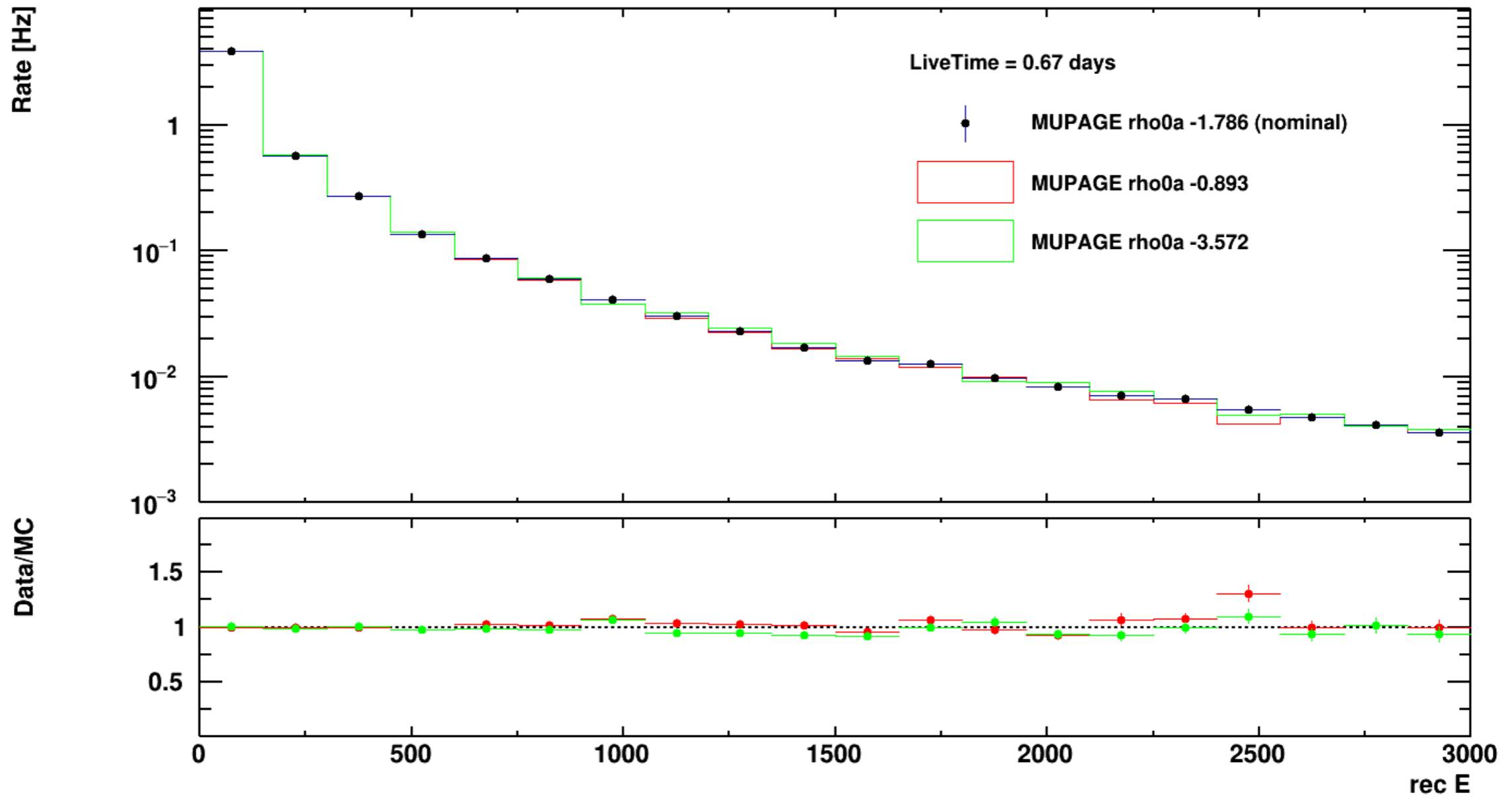
MUPAGE tuning

- Vary ρ
- Vary it and run MUPAGE -> JTE -> JRECO_CHAIN and check observables

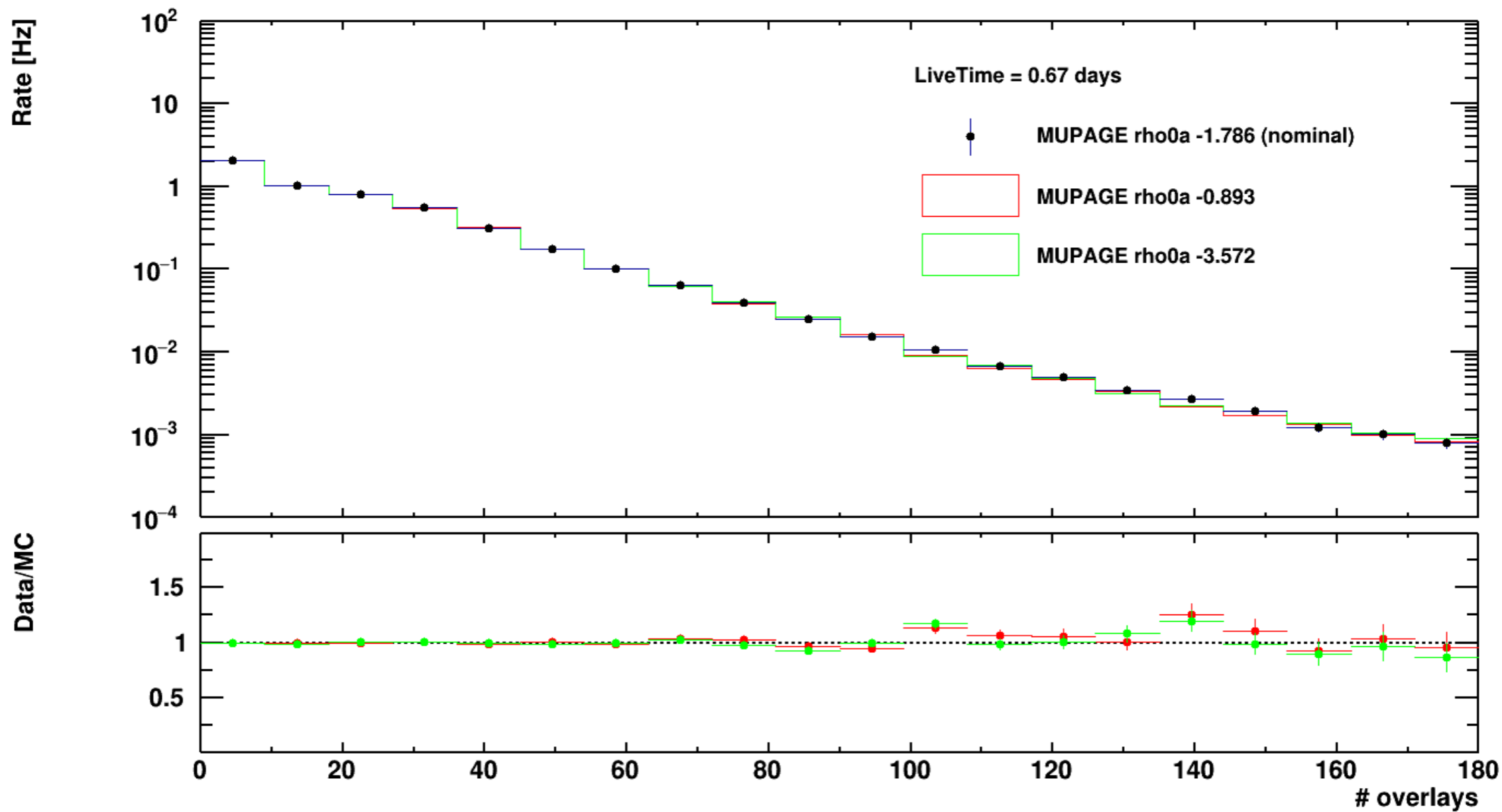
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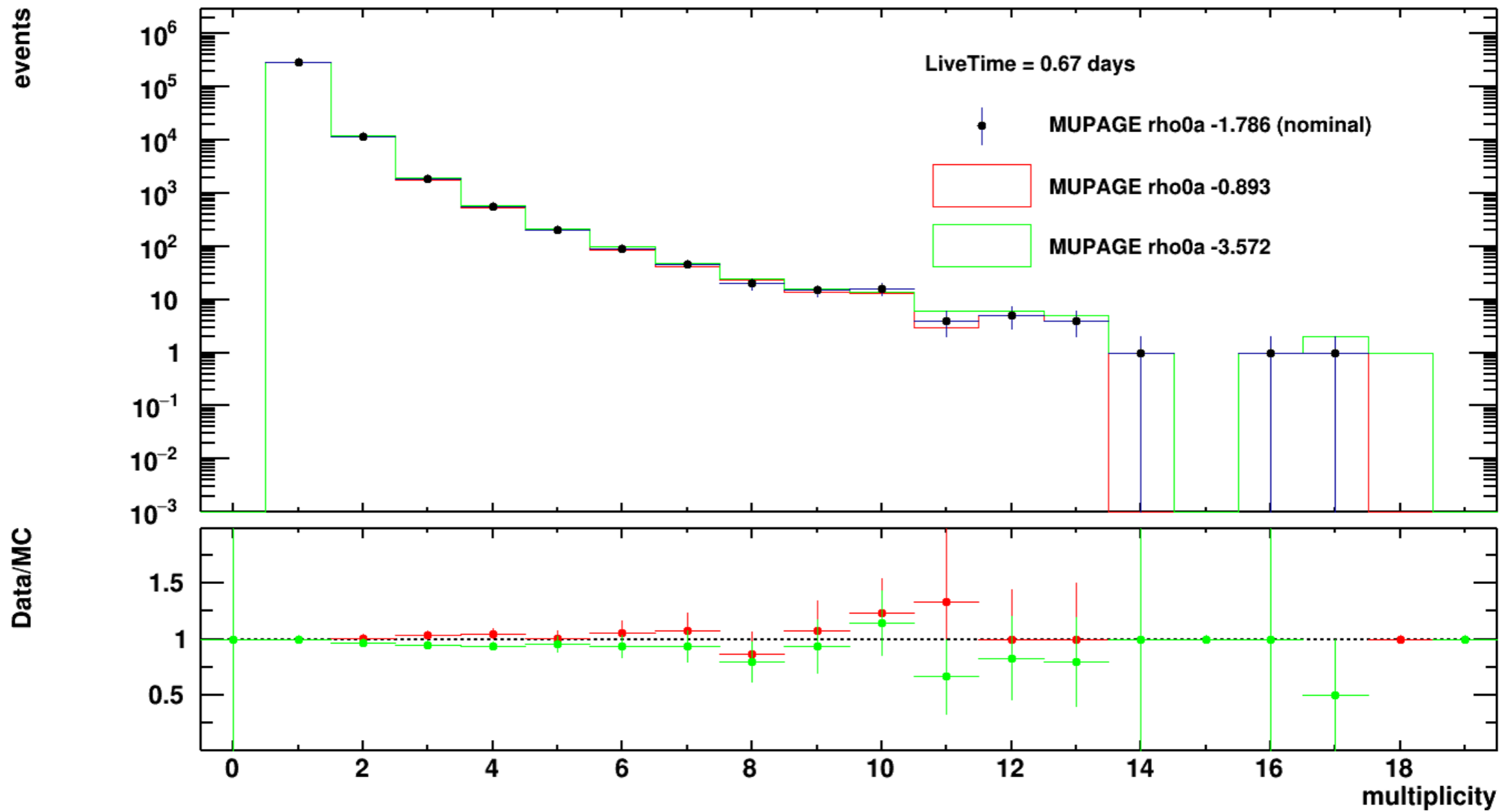
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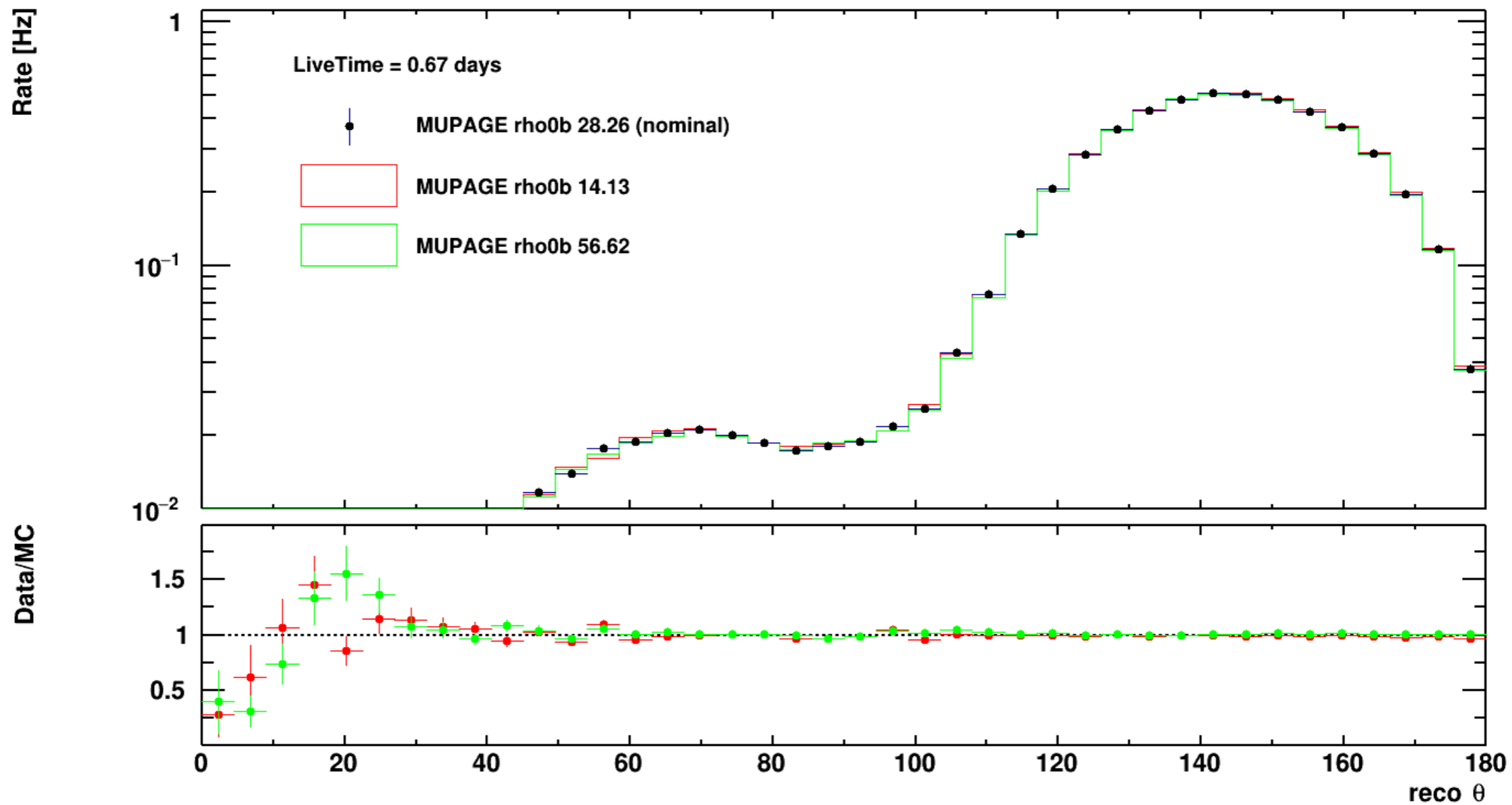
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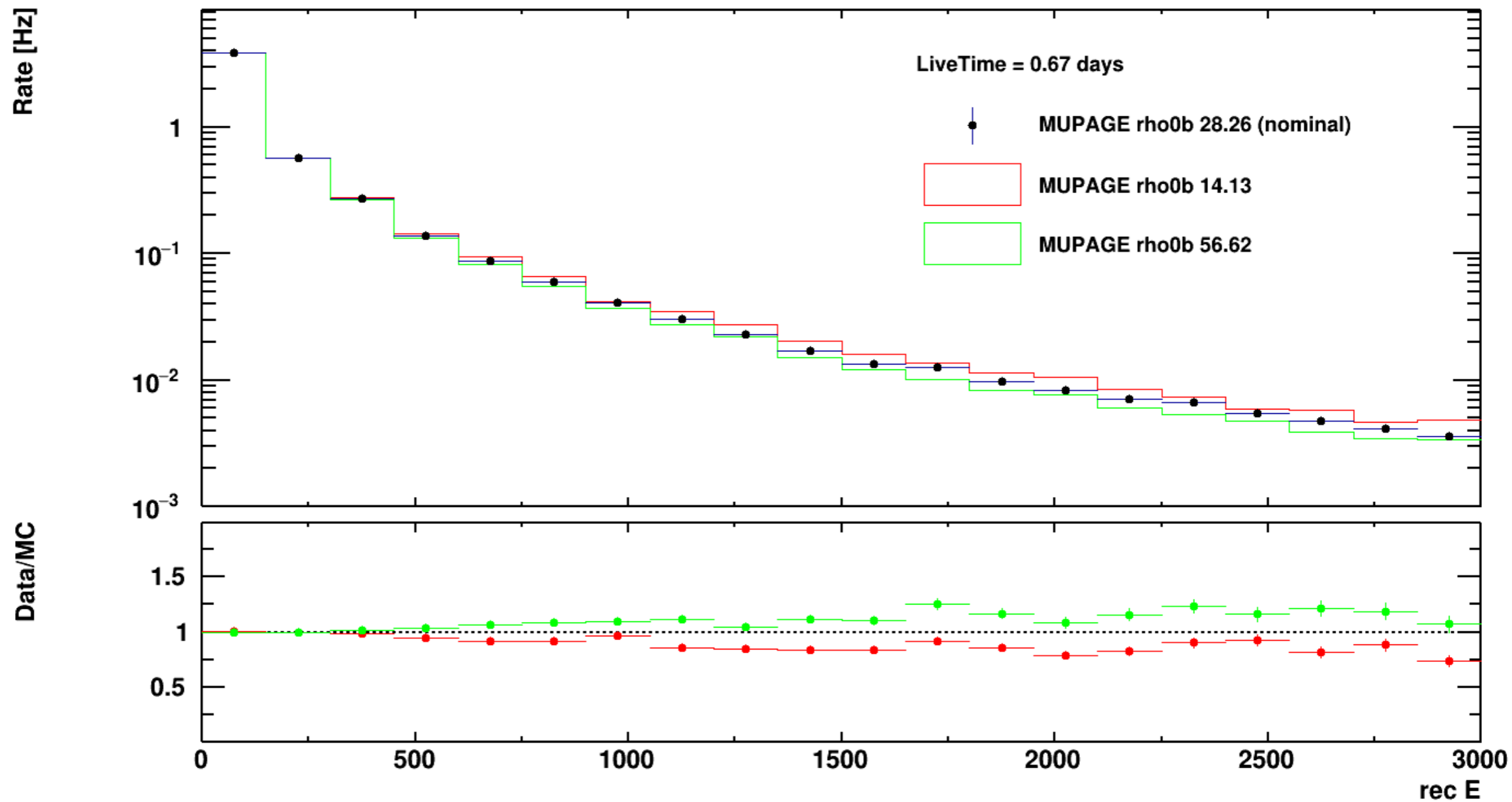
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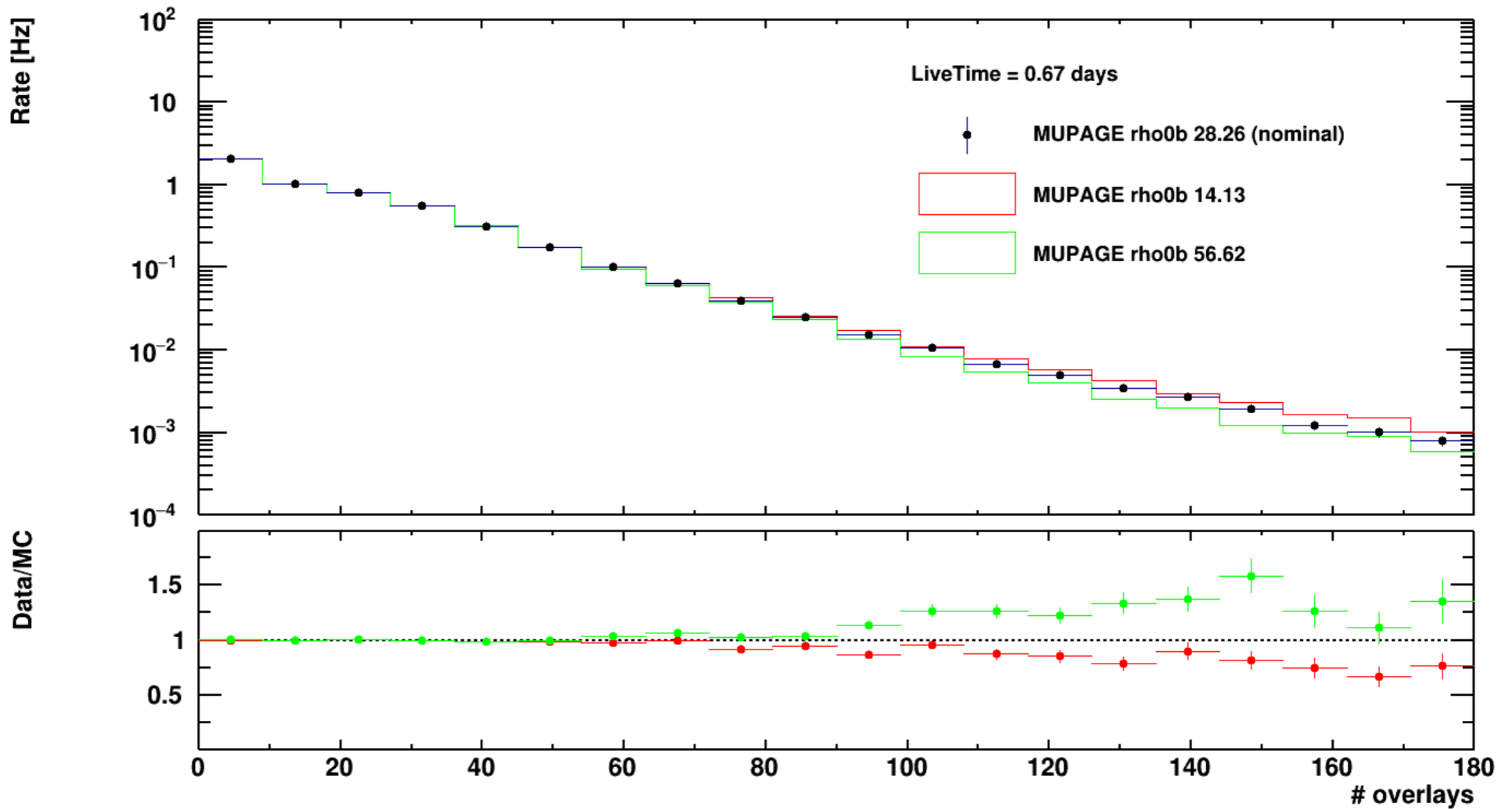
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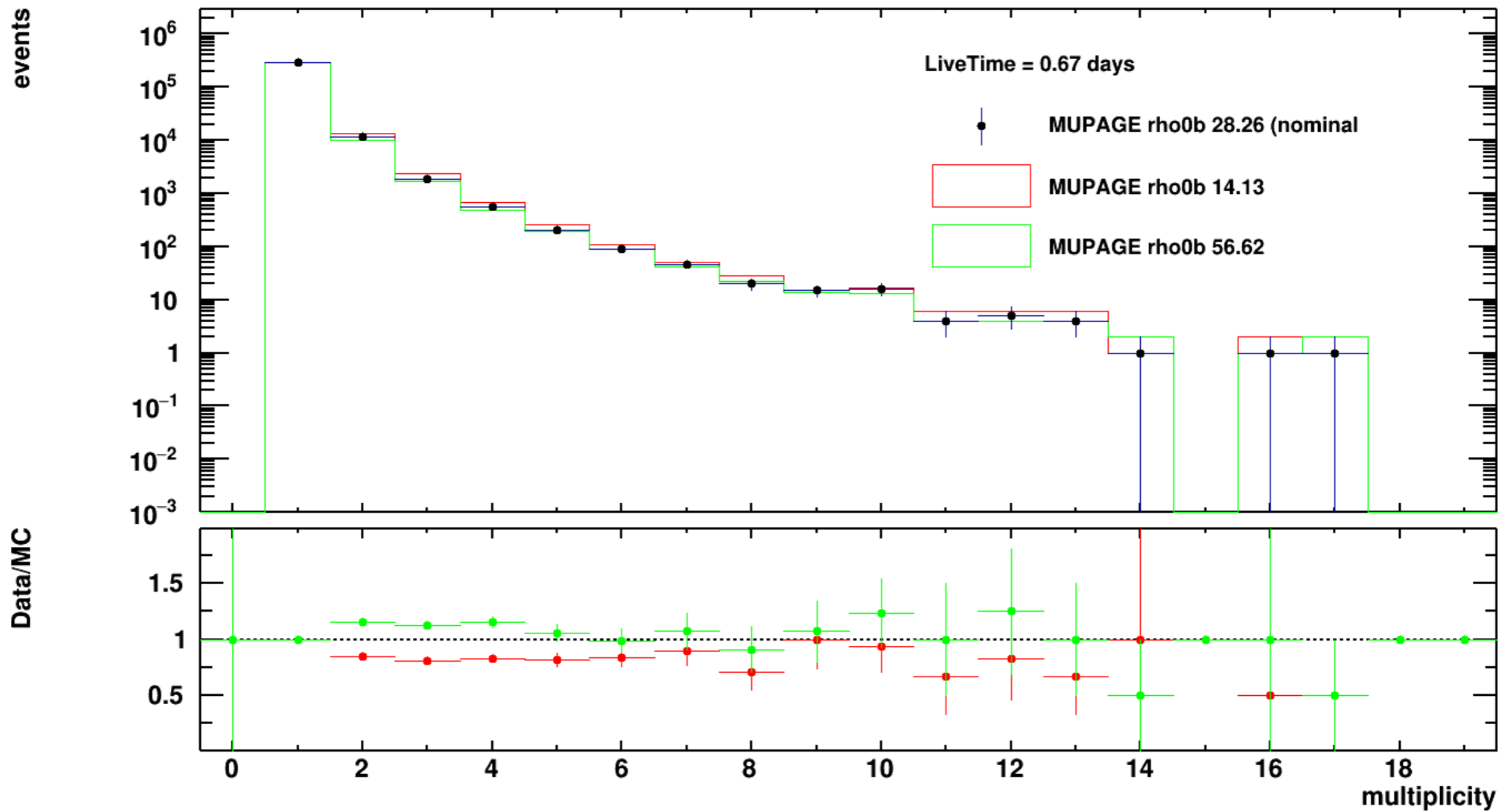
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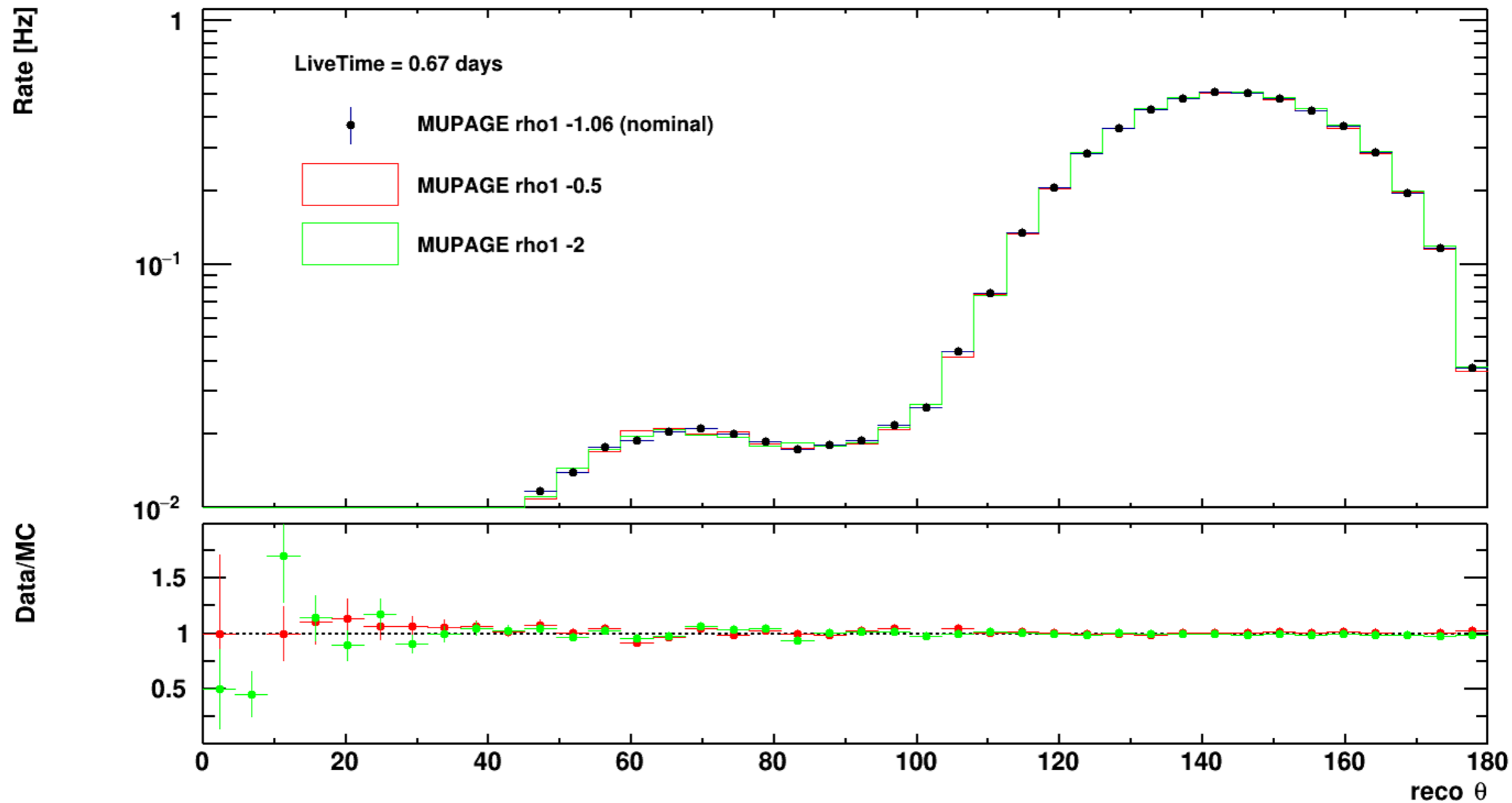
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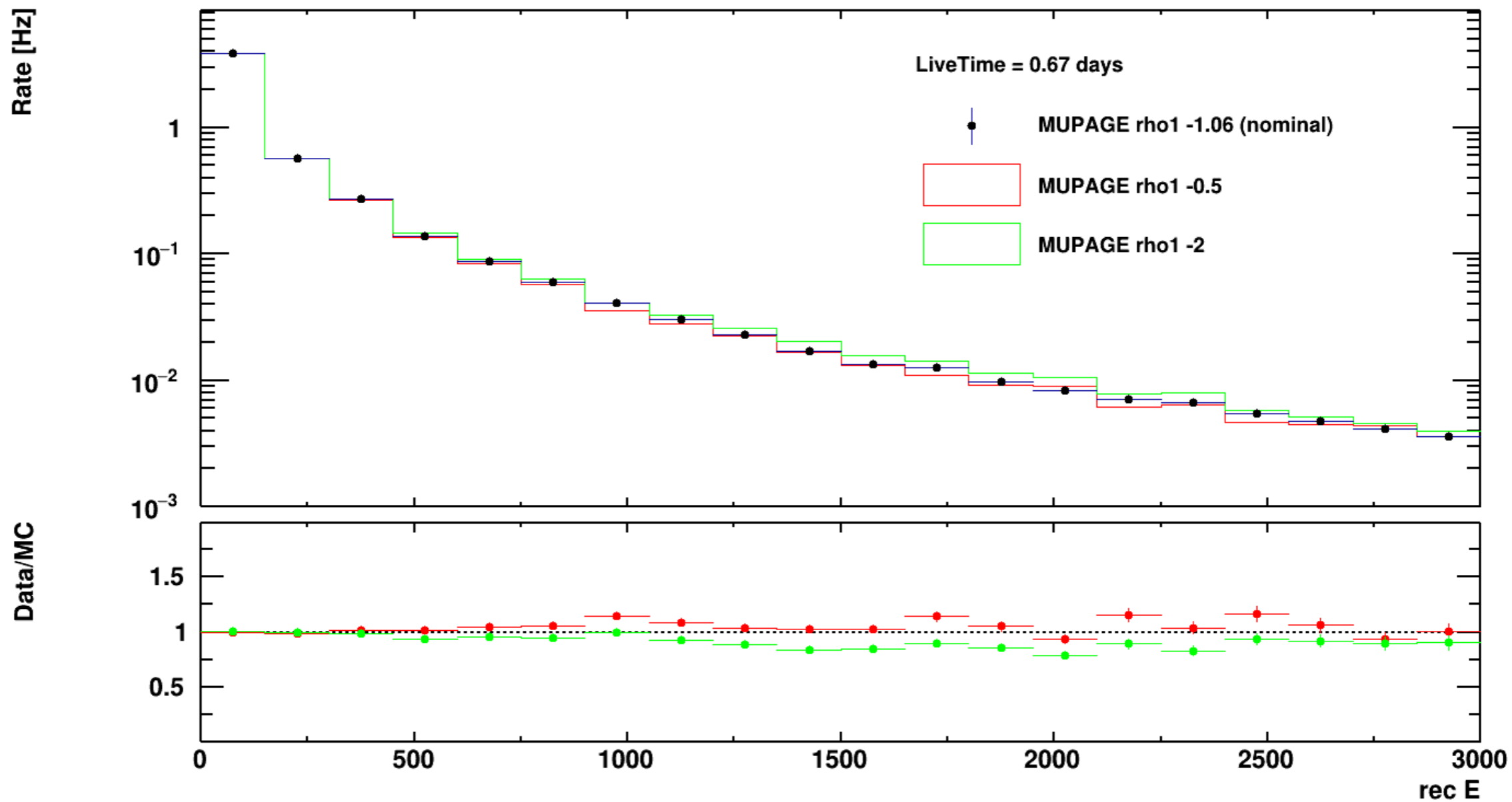
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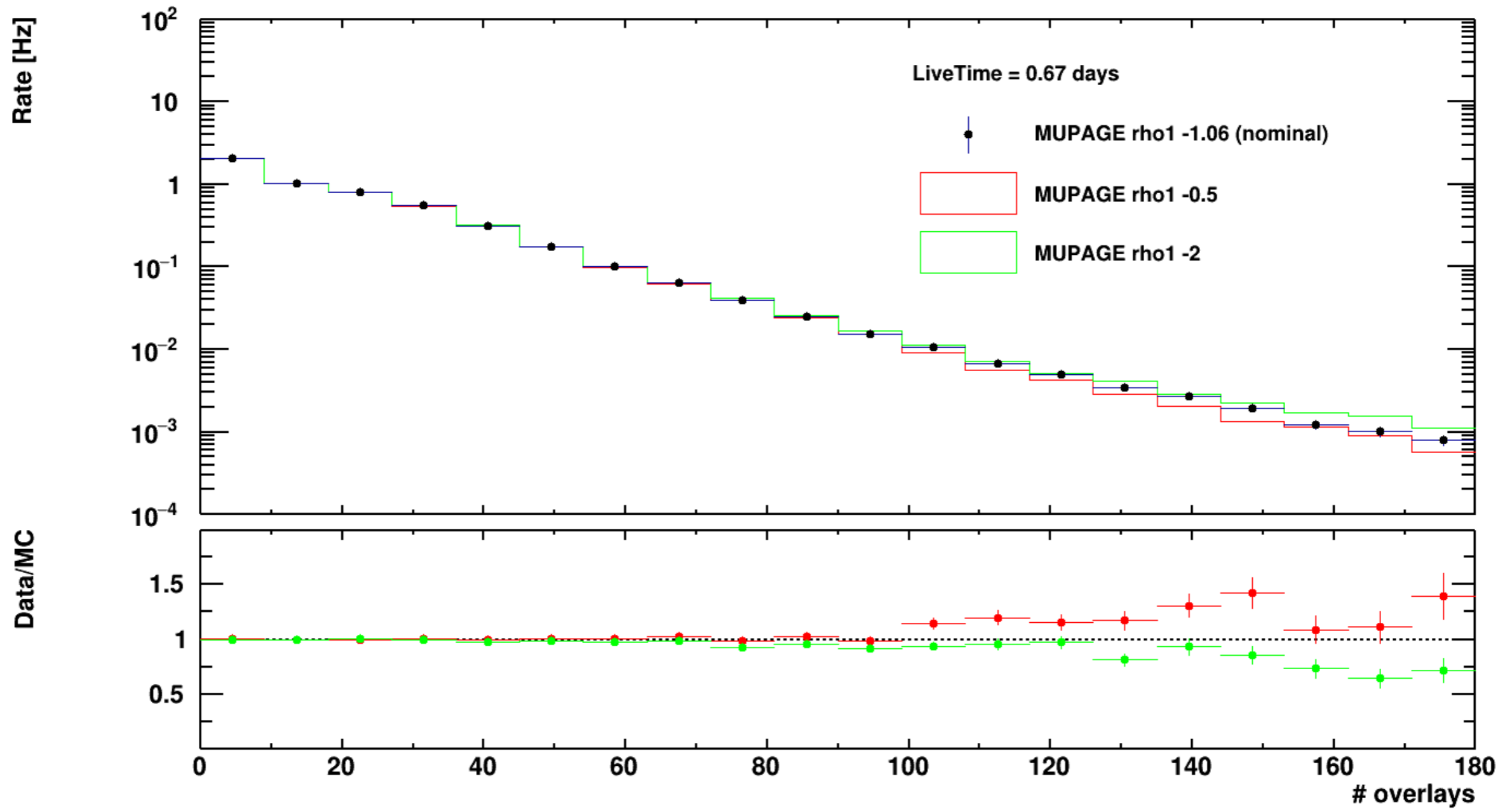
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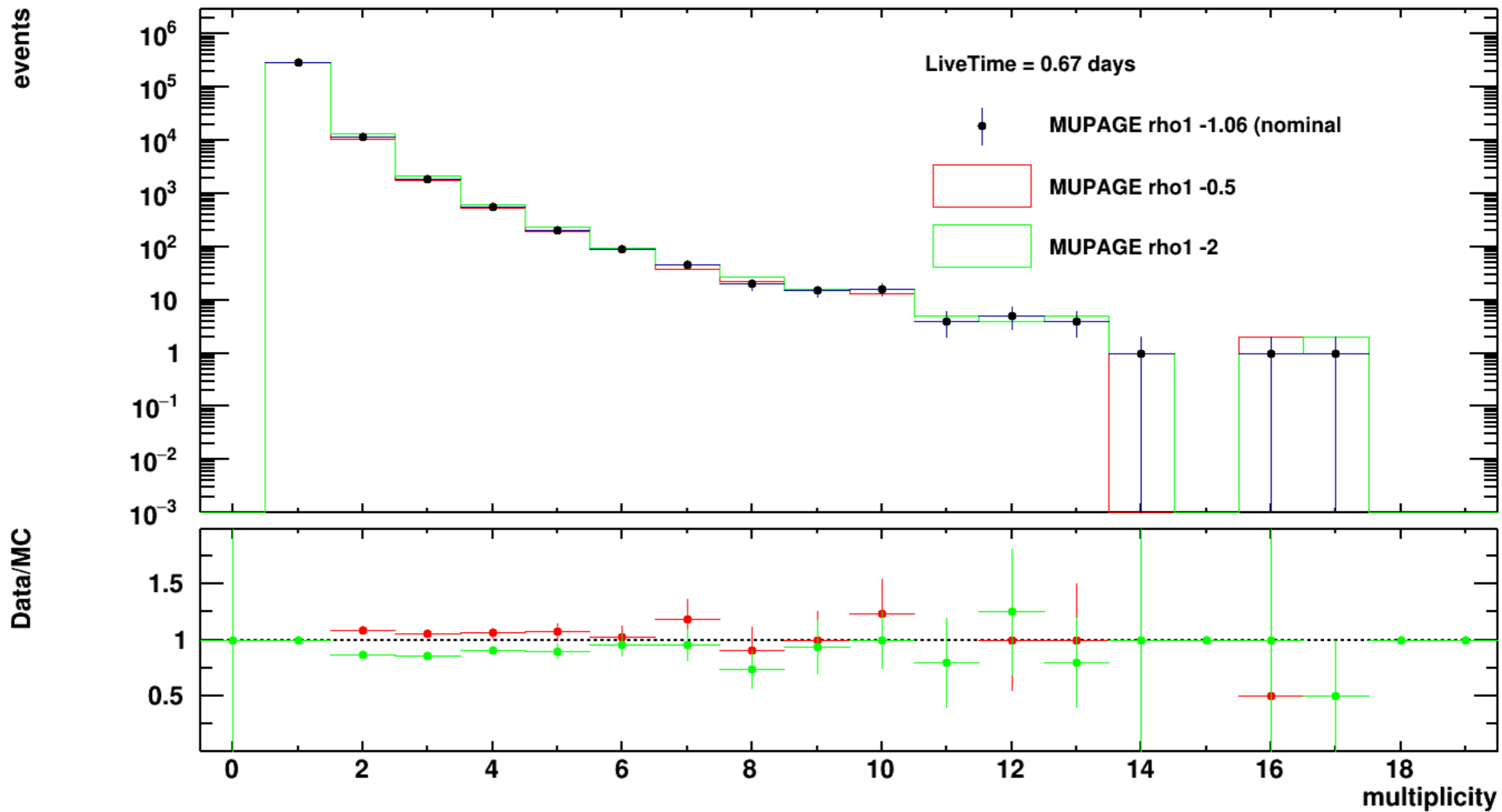
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- ρ_{0b} and ρ_1 have an effect on observables