Characterization of background noise in muography using the Muon Telescope (MuTe)

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and the MuTe Collaboration

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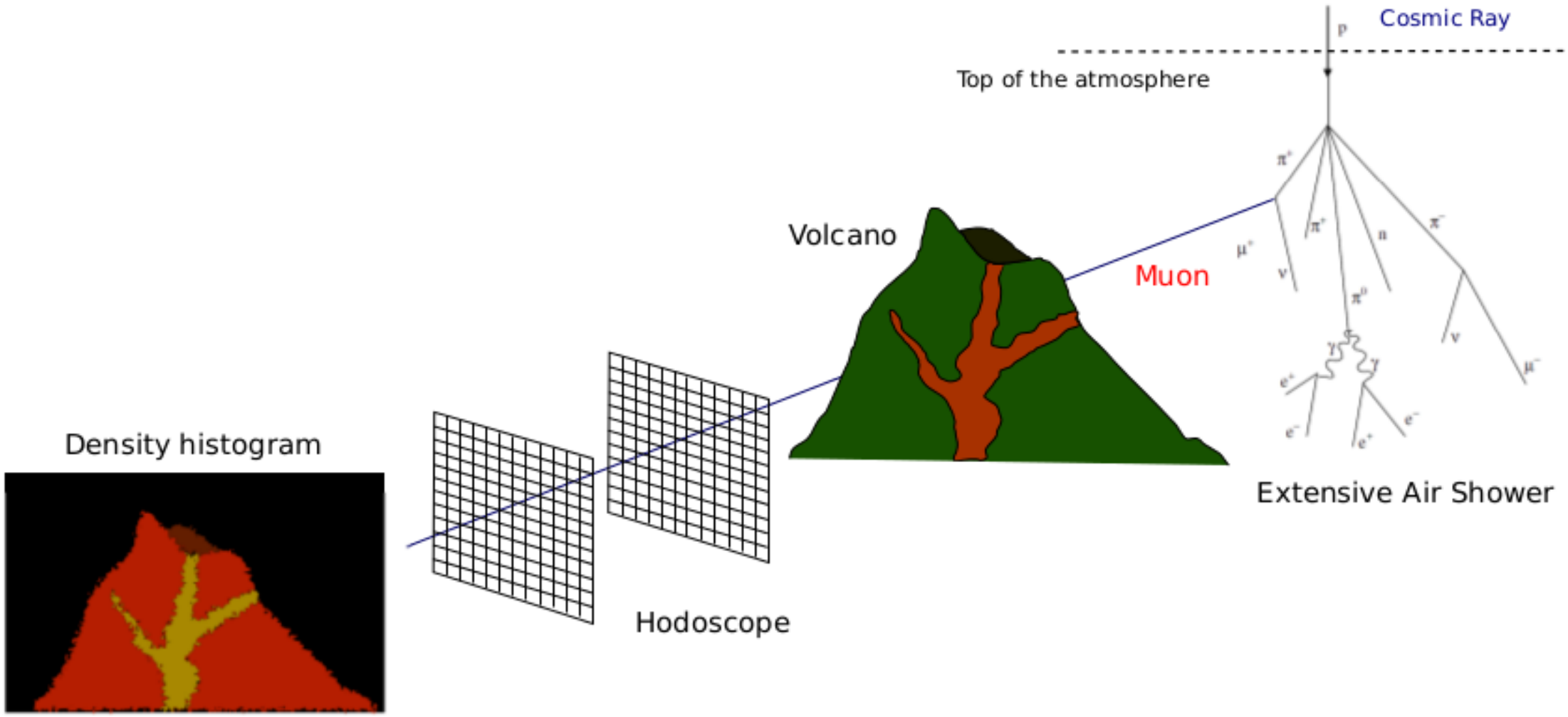
Muography



Lambert-Beer law

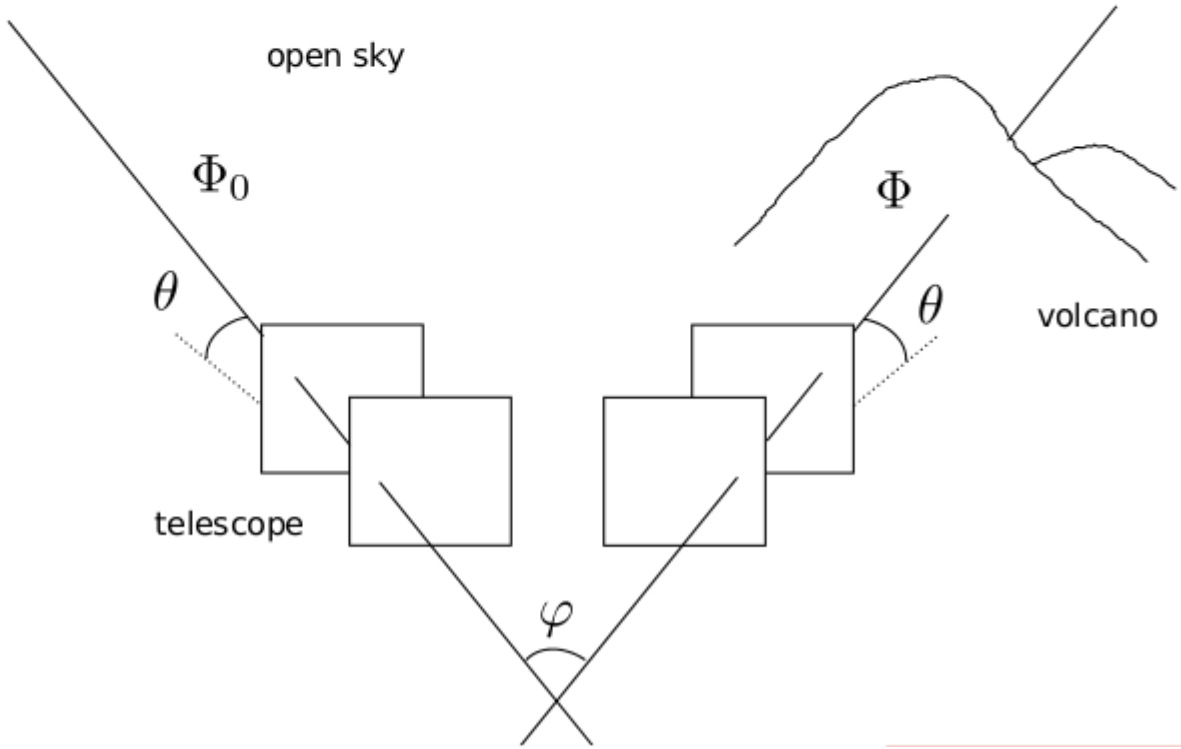
$$\Phi = \Phi_0 e^{-\int_L \mu dx}$$

Transmittance

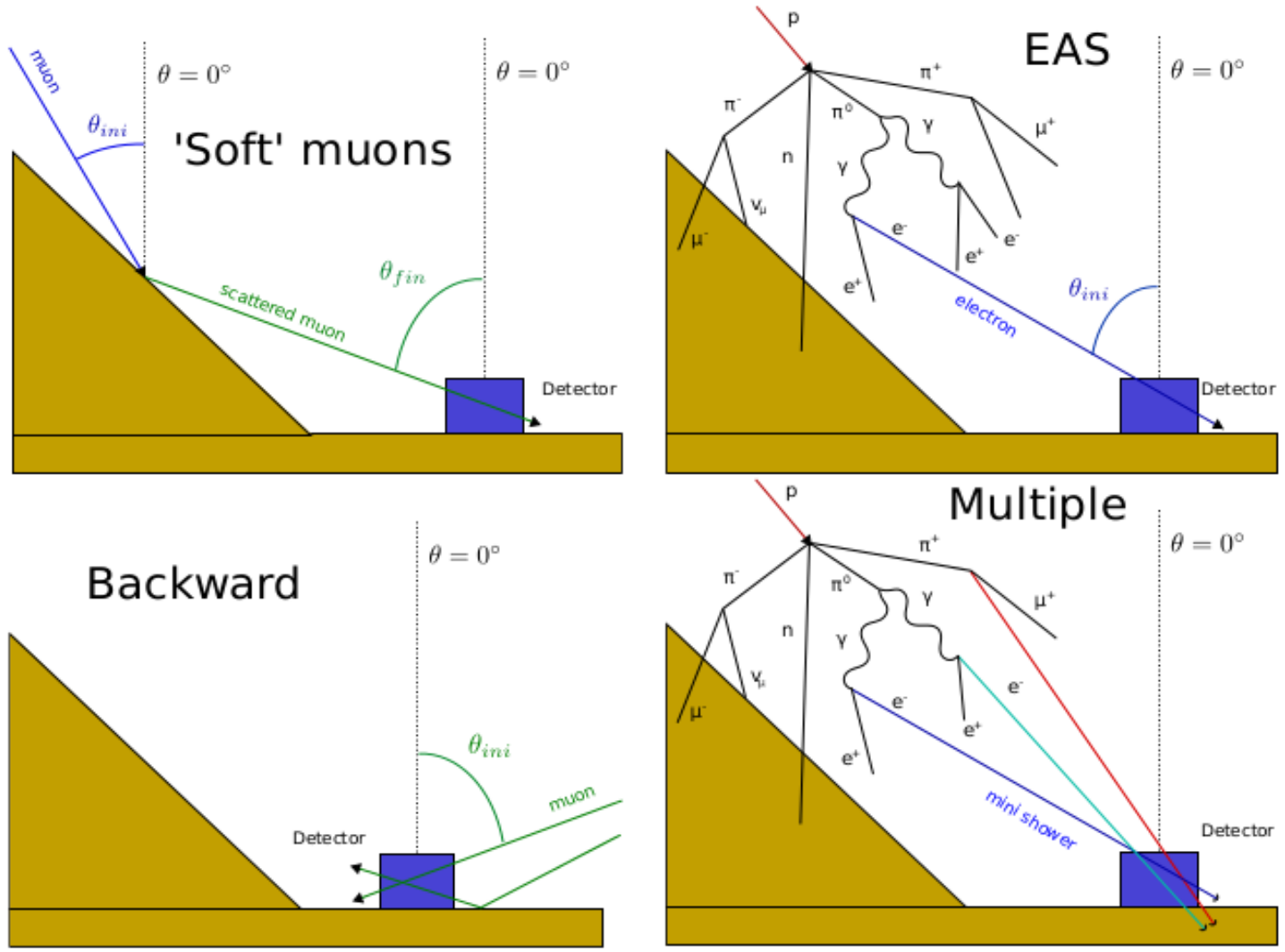
$$T = \frac{\Phi}{\Phi_0}$$

Opacity (**Lesparre. Geophysical Journal International. 2010**)

$$\varrho = \int_L \rho dx \rightarrow \varrho = -\frac{1}{\kappa} \ln T \ [gcm^{-2}]$$



Background in muography



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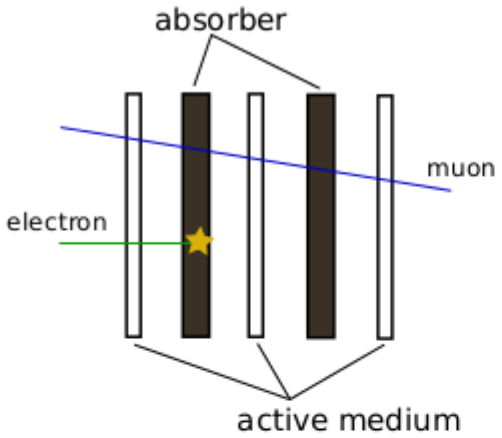
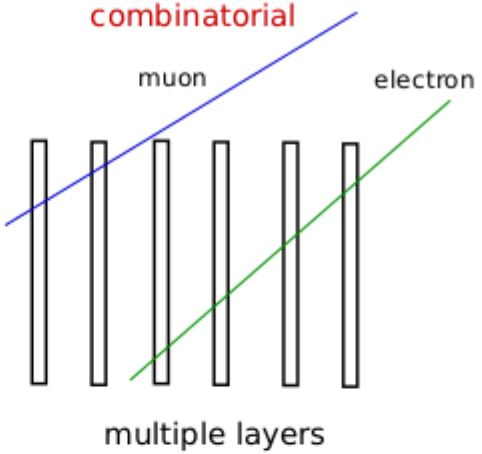
Background rejection methods

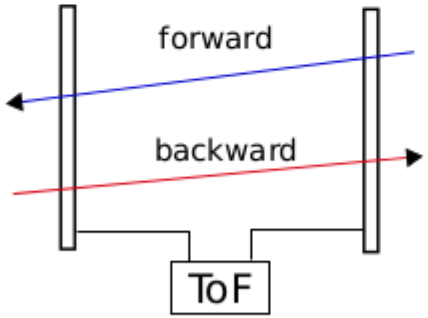
low energy particles



combinatorial



backward scattered

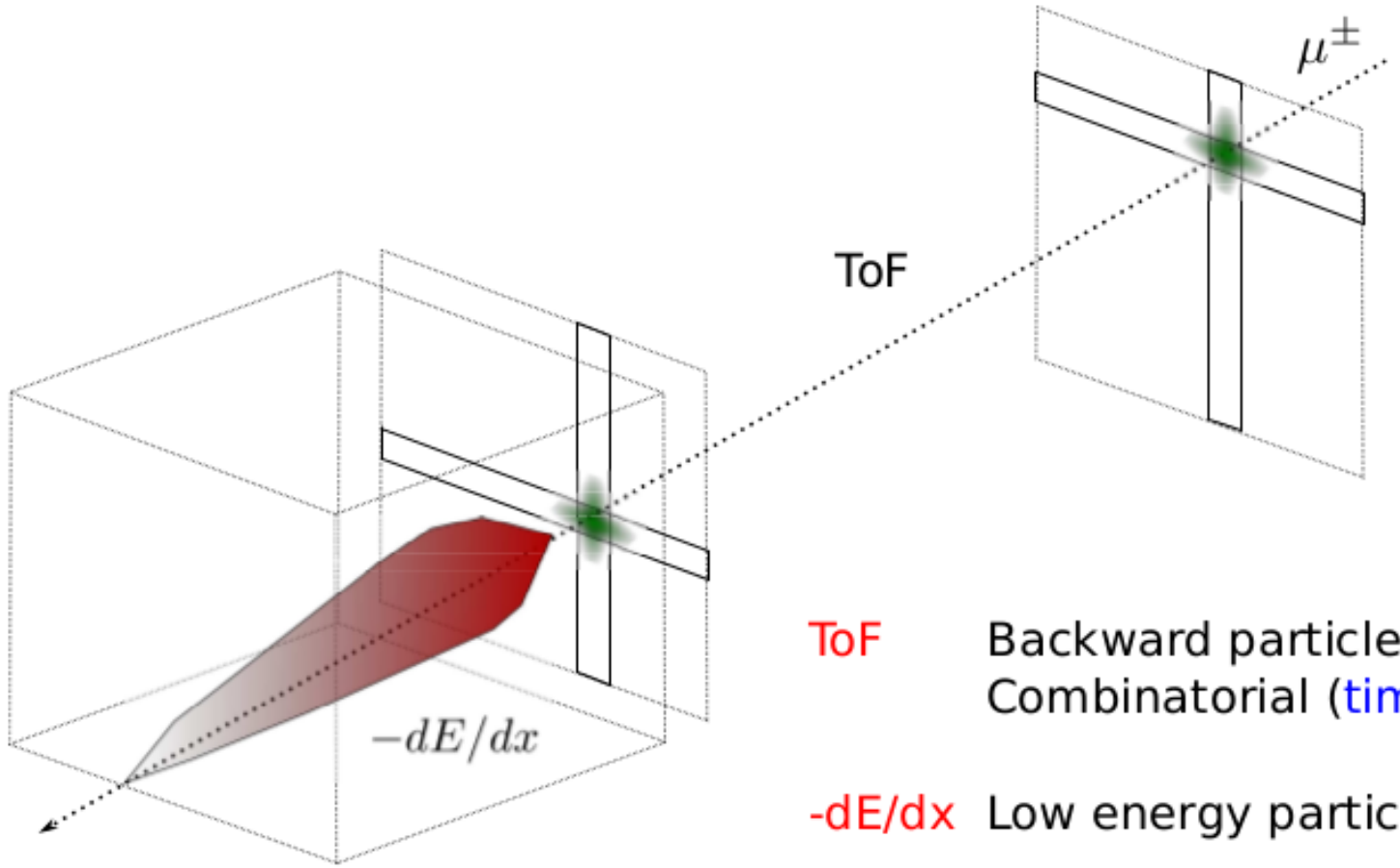


Let's use

Particle Identification Techniques

L. Olah et al. Scientific Reports. 2018
R. Nishiyama. Geoscientific Instrumentation, Methods and Data Systems. 2014
K. Jourde et al. Geophysical Research Letters. 2013

MuTe detection principle



ToF Backward particles (direction)
Combinatorial (timming)

-dE/dx Low energy particles

-dE/dx + ToF Scattered muons (momentum)
+ tracking

The Muon Telescope (MuTe)

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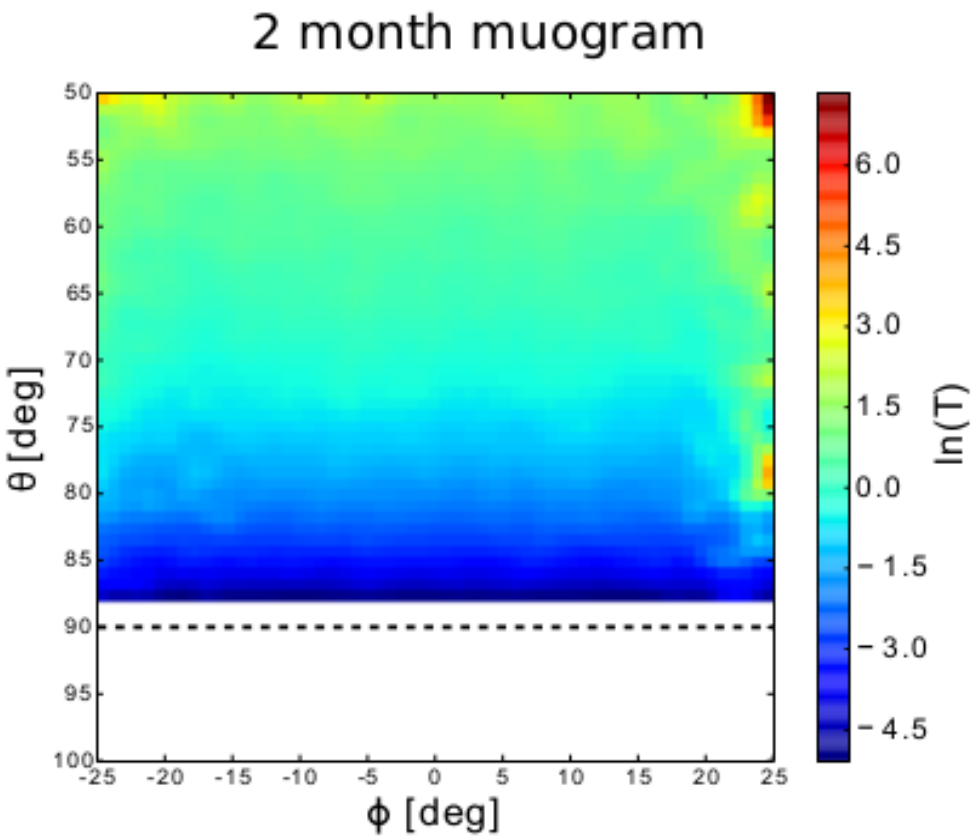
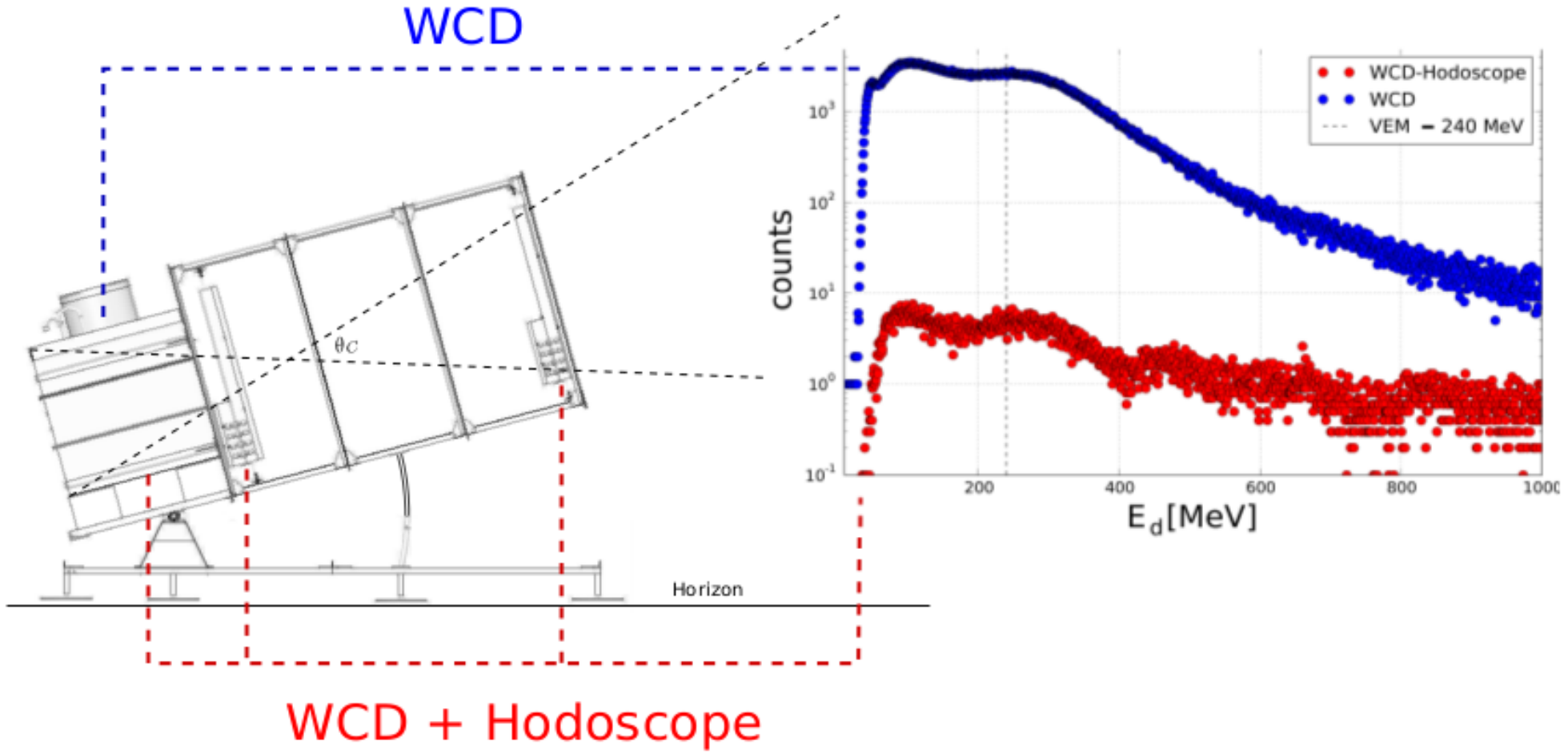
First muogram

MuTe view



Muography background characterization



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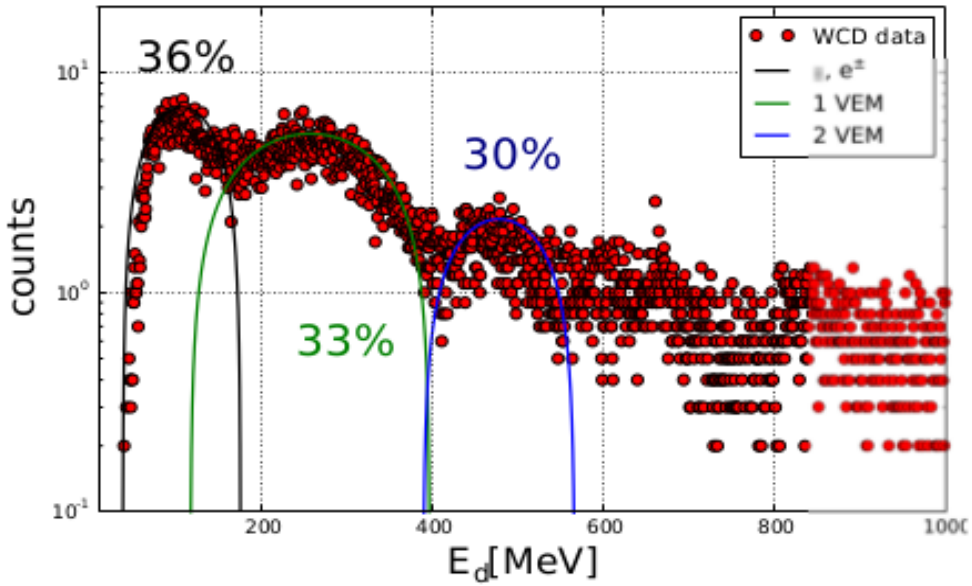
A. Vasquez-Ramirez et al. JINST. 2020

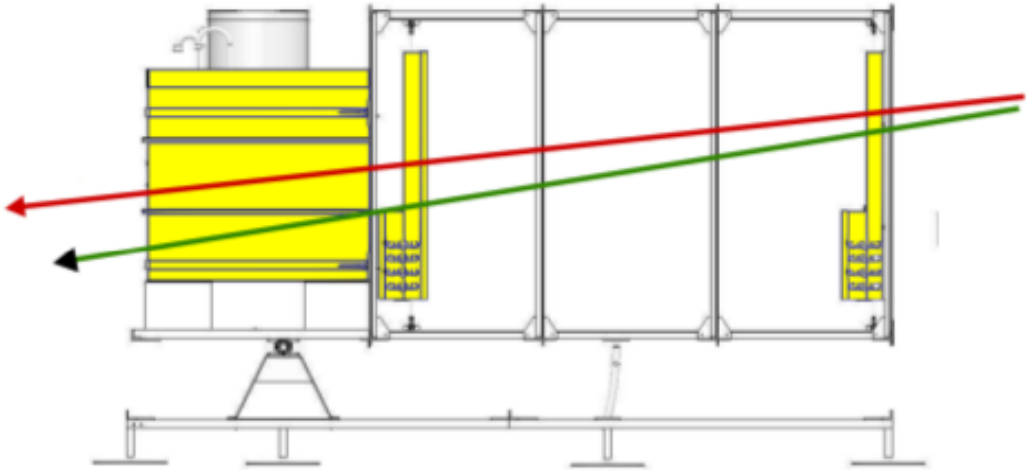
Deposited energy



Correlated muons

$\Delta t \sim 300ns$

same Extensive Air Shower



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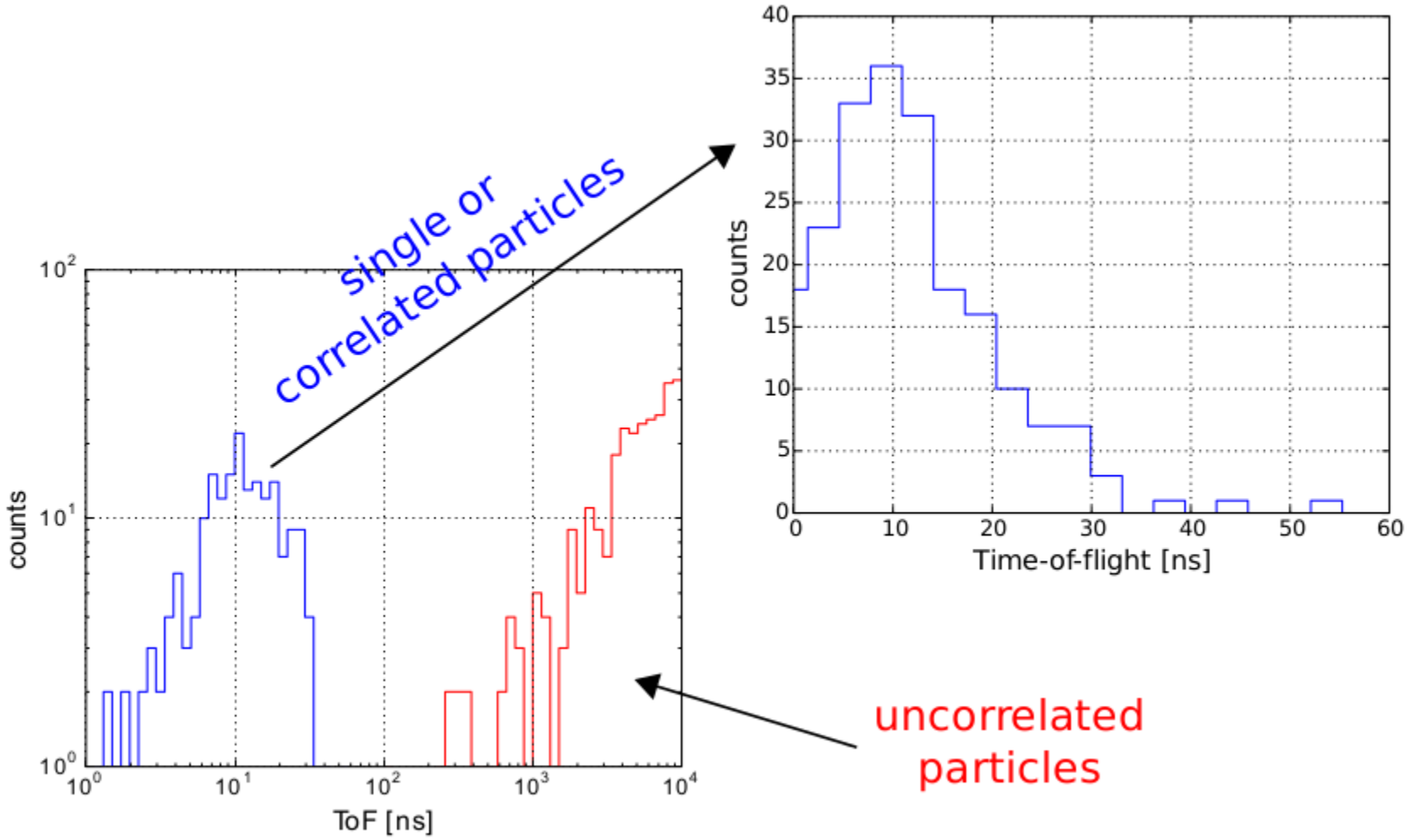
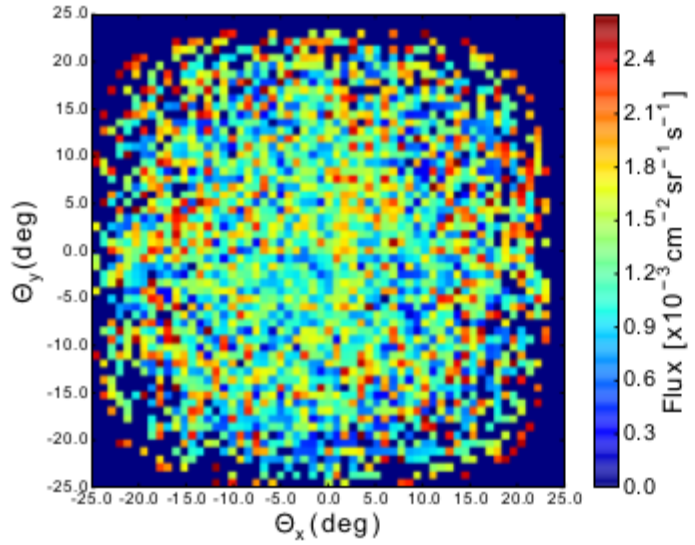
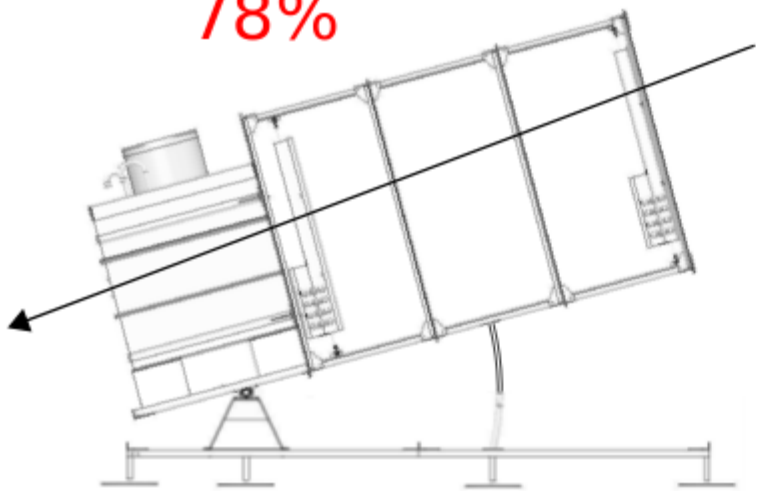
Multiple particle events

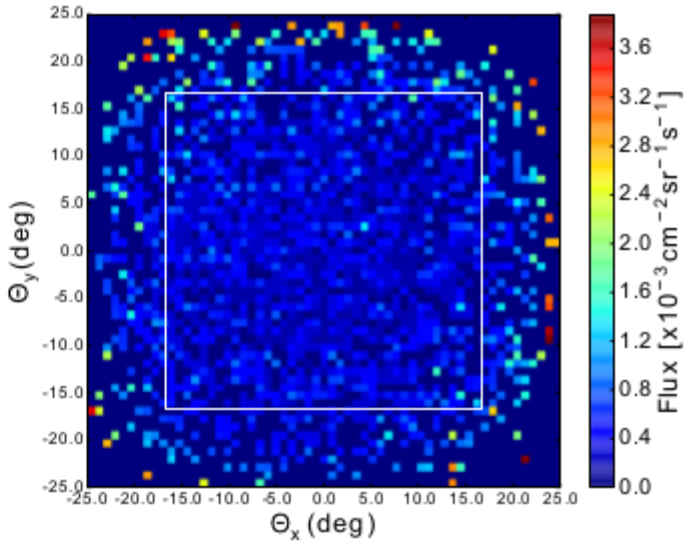


Forward and backward flux

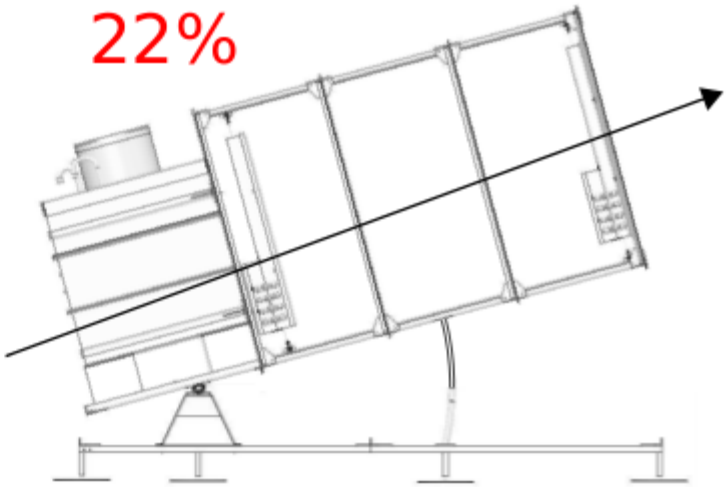


78%





22%



Particle momentum estimation

PID -> mass

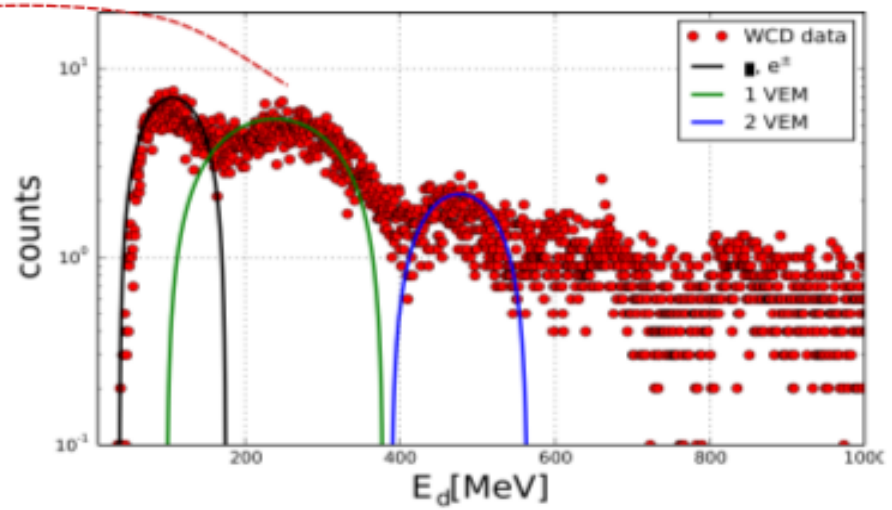
$$p_i = \frac{m_0 c d_i}{\sqrt{c^2 t^2 - d_i^2}}$$

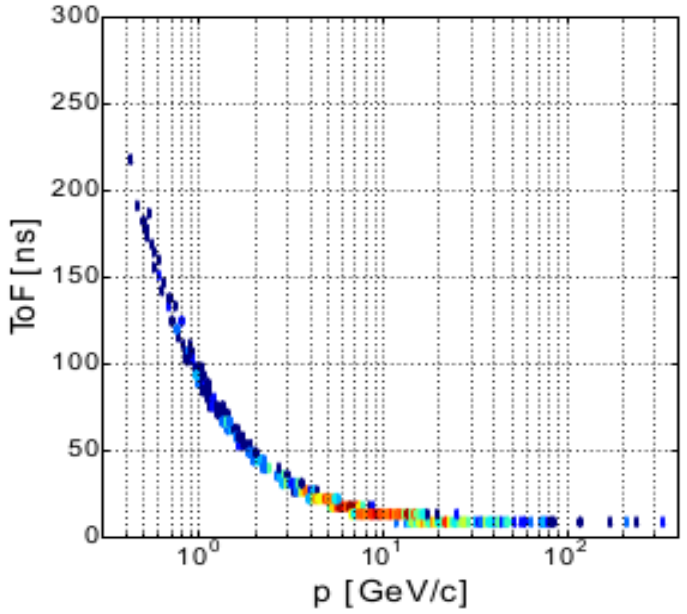
ToF Tracking

$$\sigma_p^2 = \left(\frac{\partial p}{\partial t}\right)^2 \sigma_t^2 + \left(\frac{\partial p}{\partial d}\right)^2 \sigma_d^2$$

~138 ps ~5.6 cm

54% > 1 GeV/c





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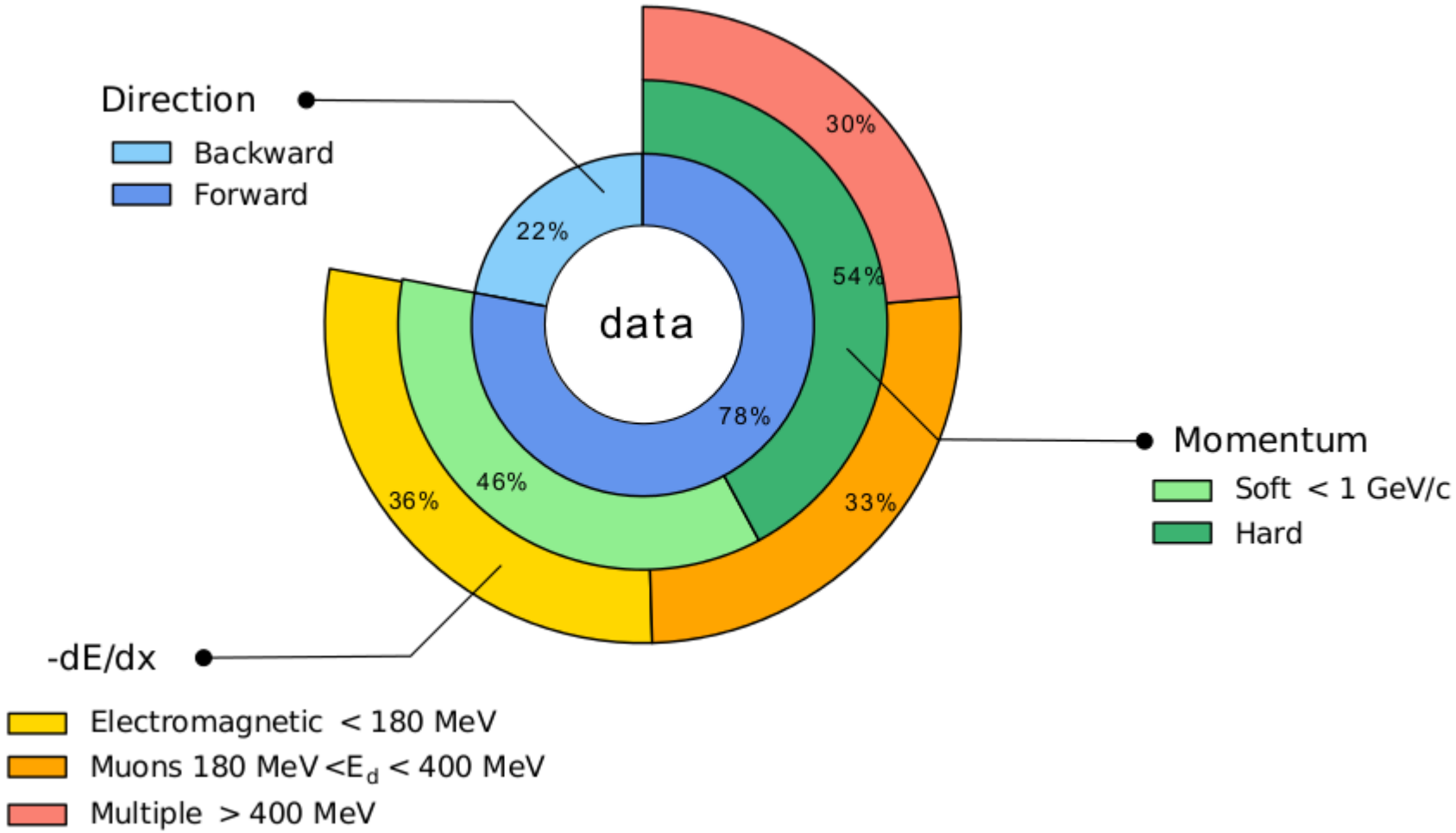
Background classification



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