On the origin of the α-distribution

Doing particle physics with Cosmic Rays

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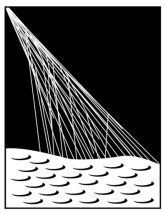
Summer Internship 2018

[1]Laboratório de Instrumentação e Física Experimental de Partículas

[2]Pierre Auger Observatory

September 4, 2018



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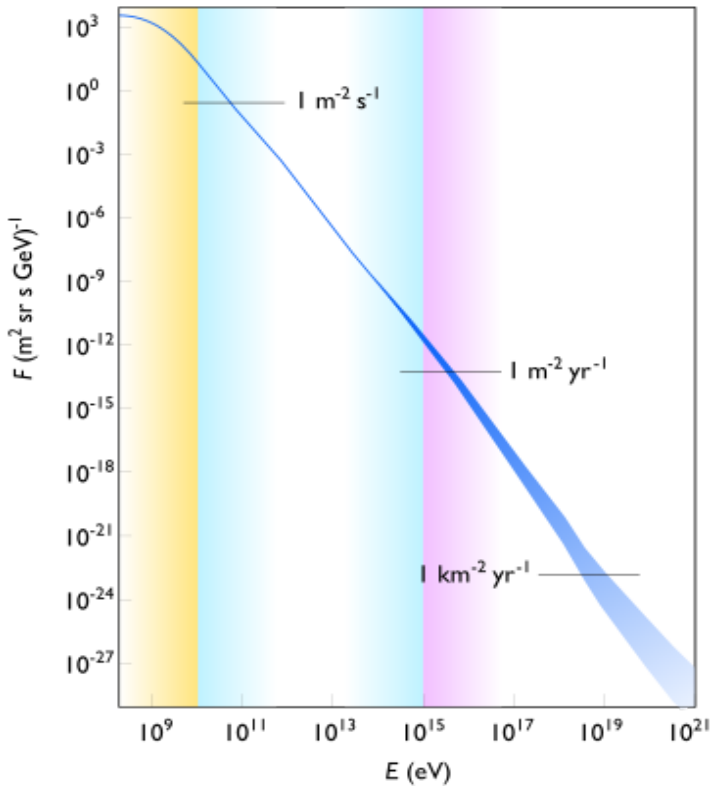

Figure: Cosmic ray energy spectrum

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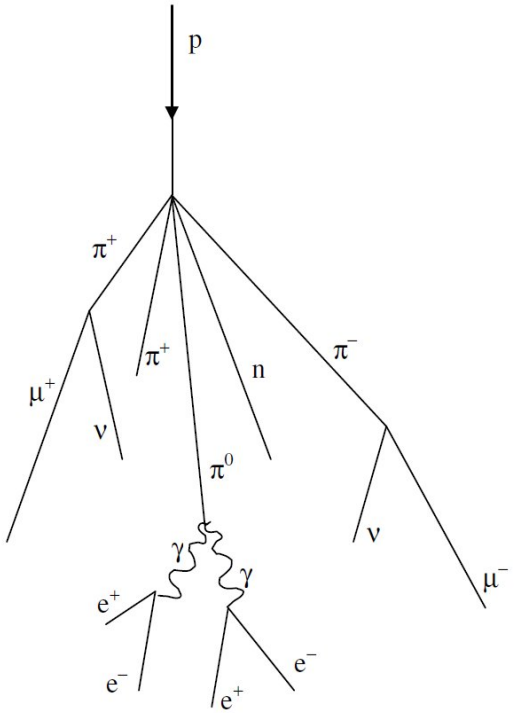

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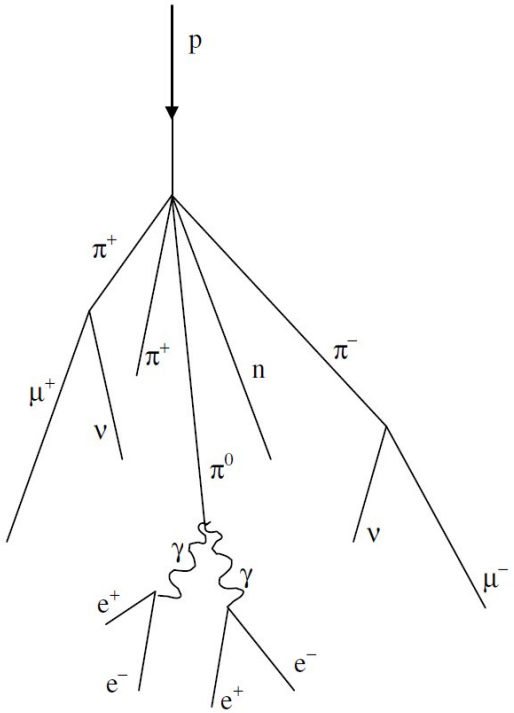

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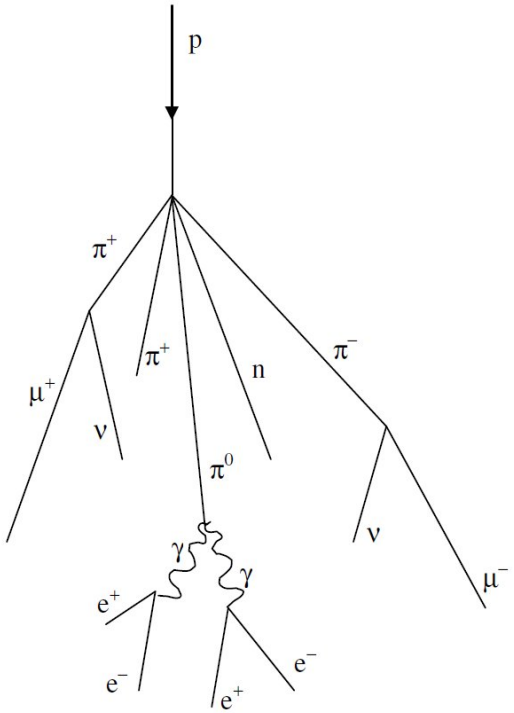

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- The particle shower has **eletromagnetic** (γ, e^-, e^+, π^0,...) and **hadronic** components (p,n,π^+,π^-,μ^+,μ^-,...)

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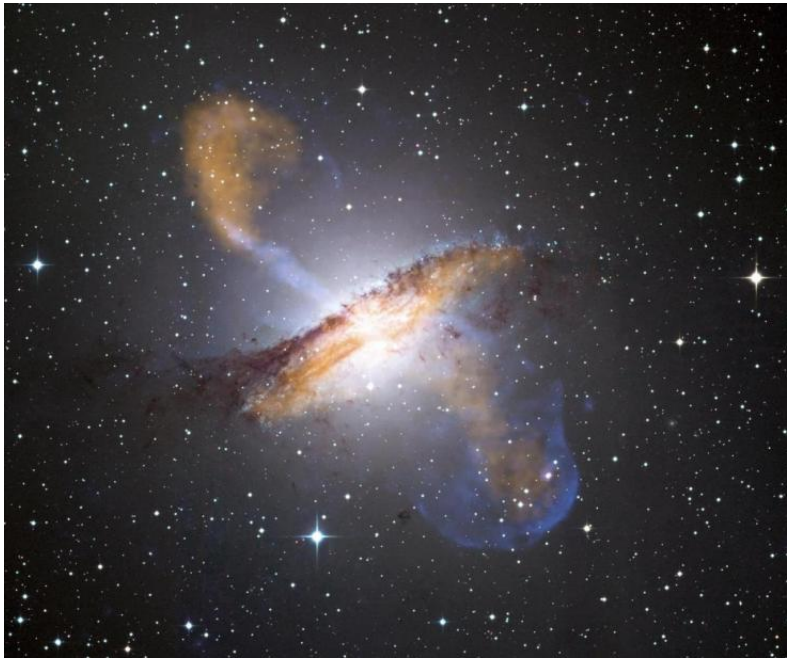

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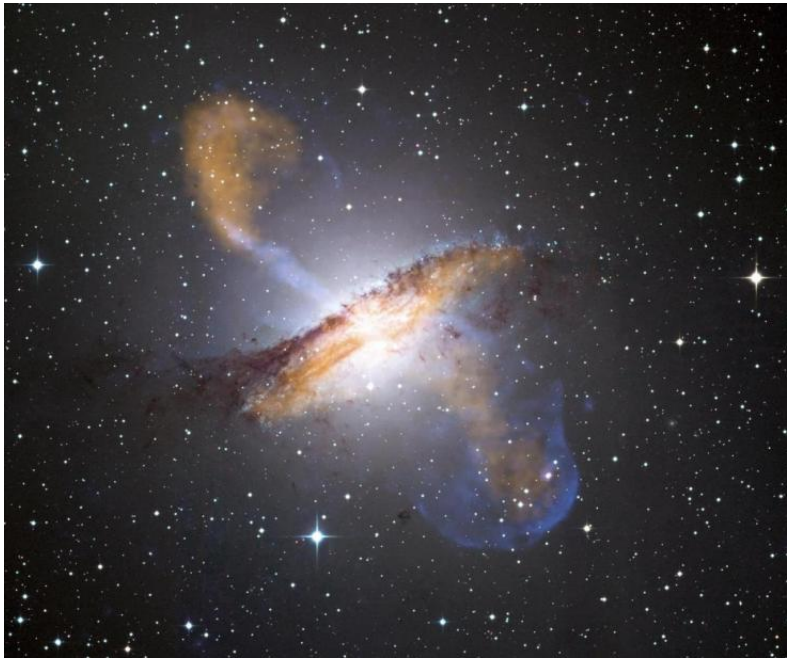

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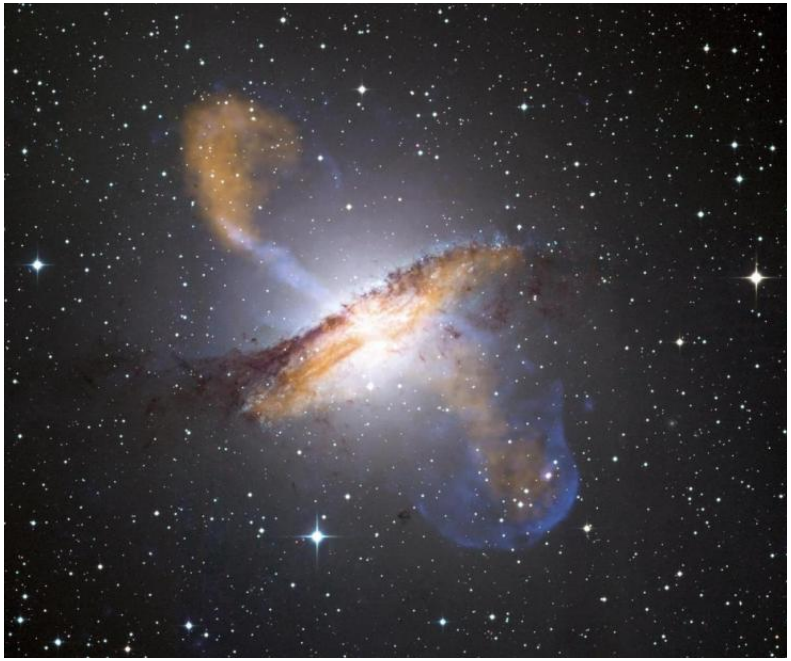

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Indirect study of **UHECR** through:

- Measurements of the shower's content and shower reconstruction - **Pierre Auger Observatory**
- Monte Carlo simulations - **Hadronic Interaction Models (HM)**

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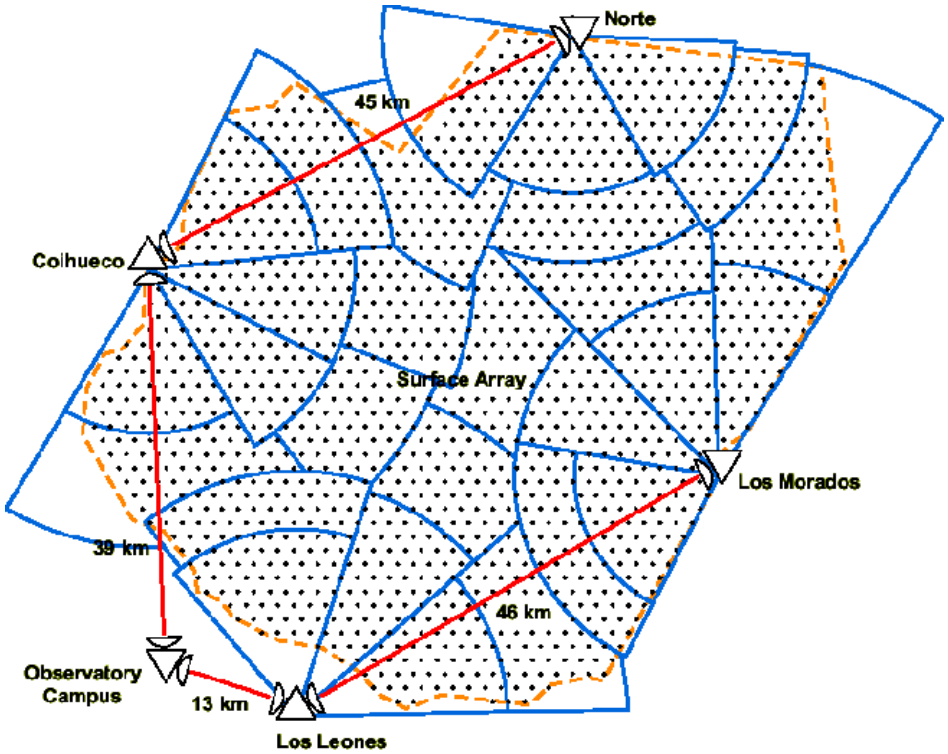

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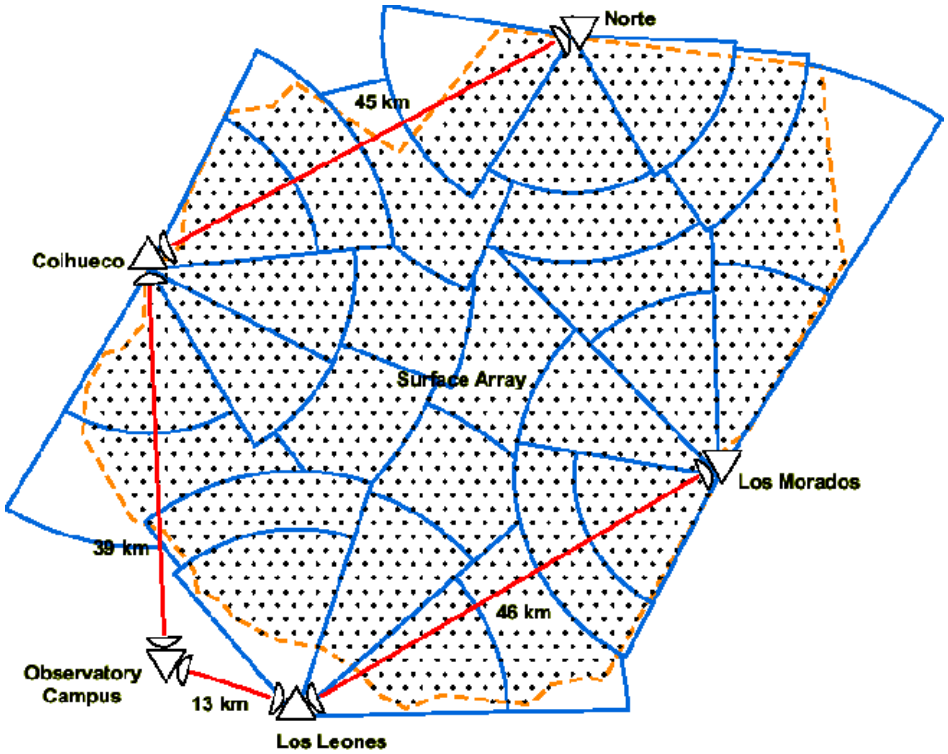

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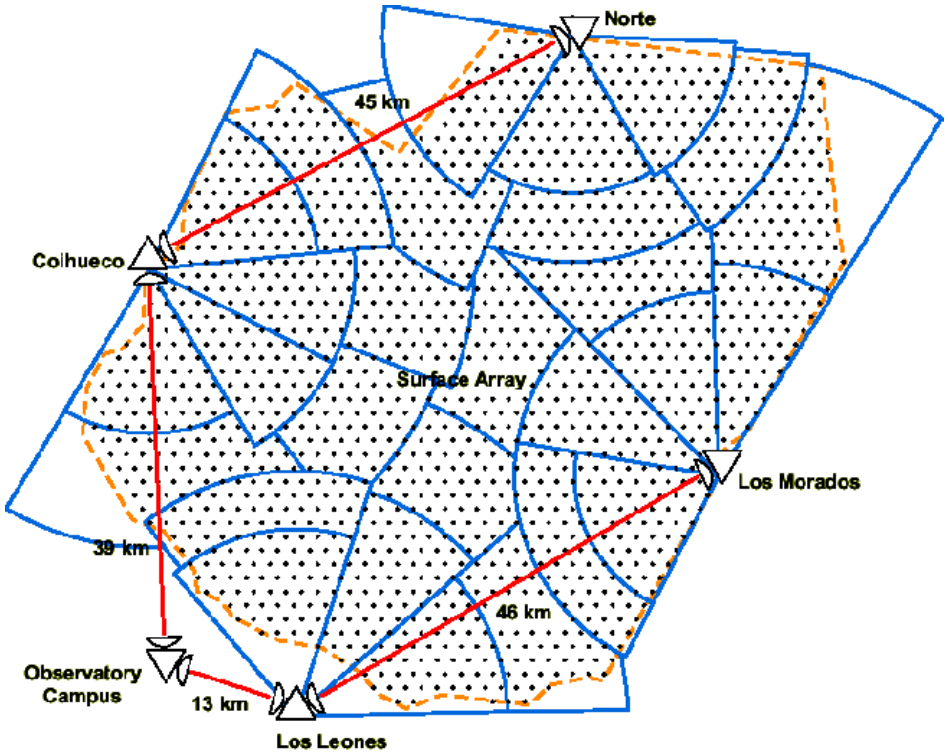

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(a) Surface detector

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- **HM** that simulate ultra-high energy interactions, based on lower energy events - **known physics** - such as the ones from LHC

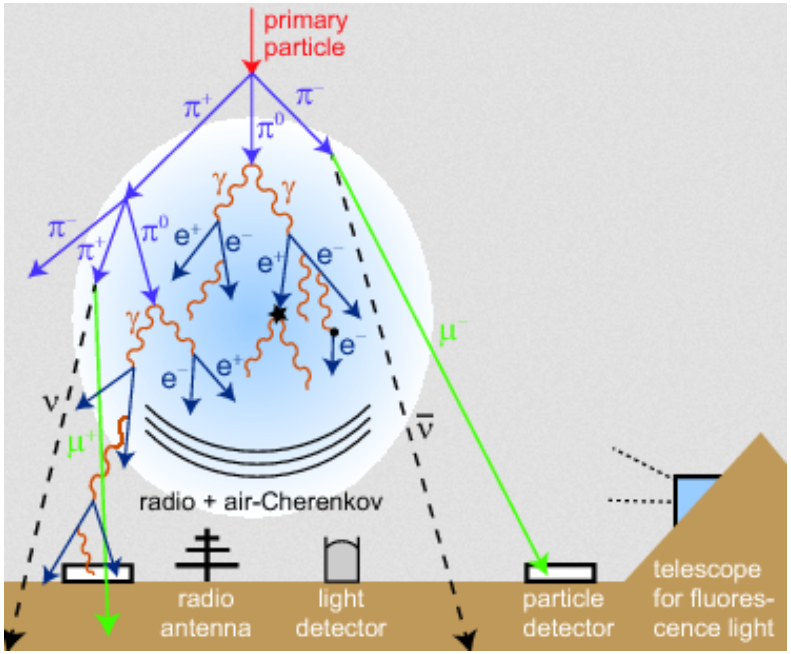

Figure: Muon detection

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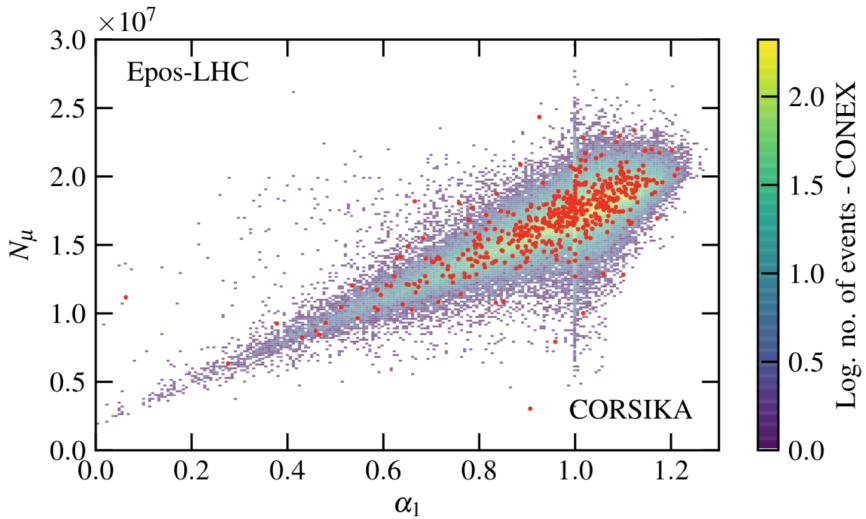

Figure: Correlation between N_μ and α_1

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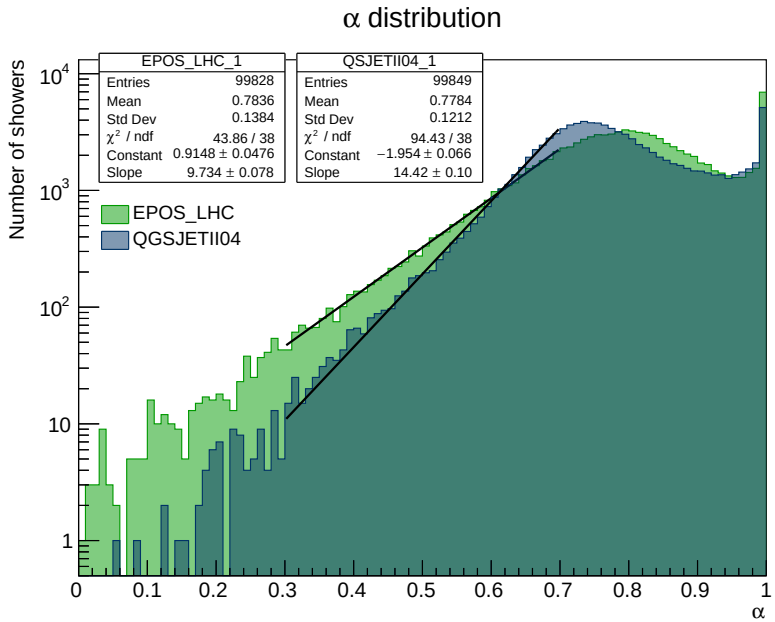

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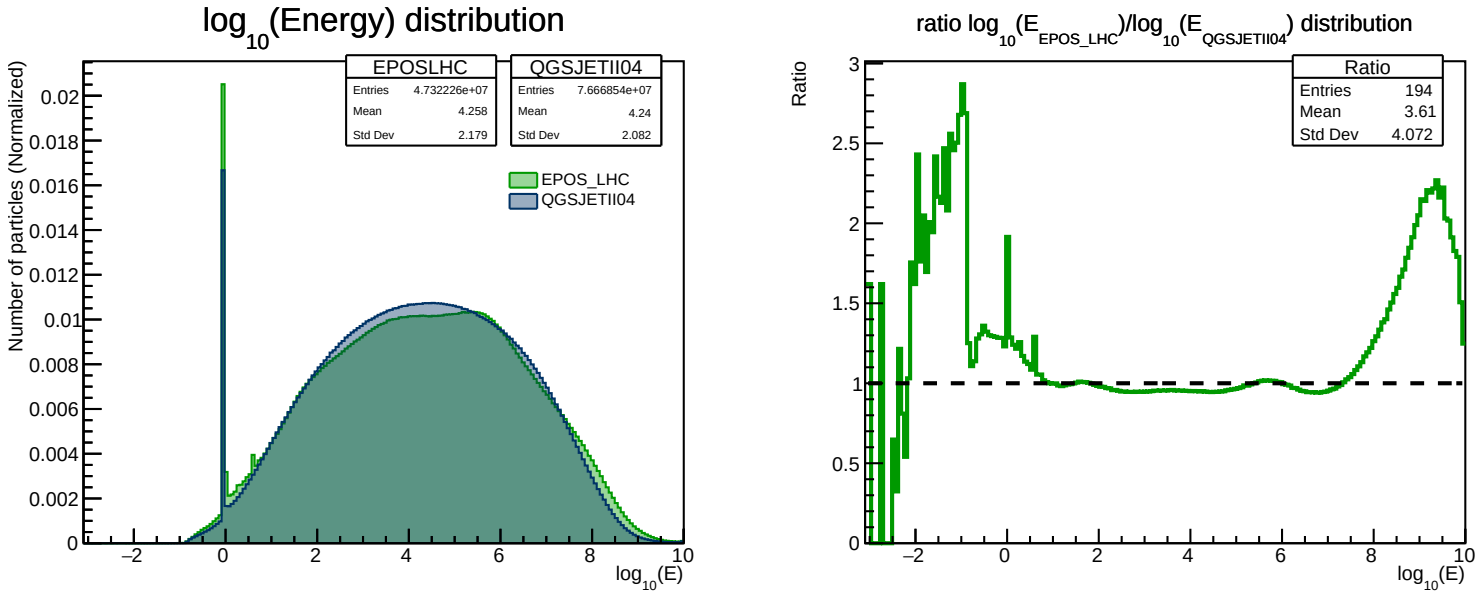

Figure: Energy spectra of both models and ratio $\frac{\log_{10}(E_{\text{EPOS-LHC}})}{\log_{10}(E_{\text{QGSJET II}-04})}$

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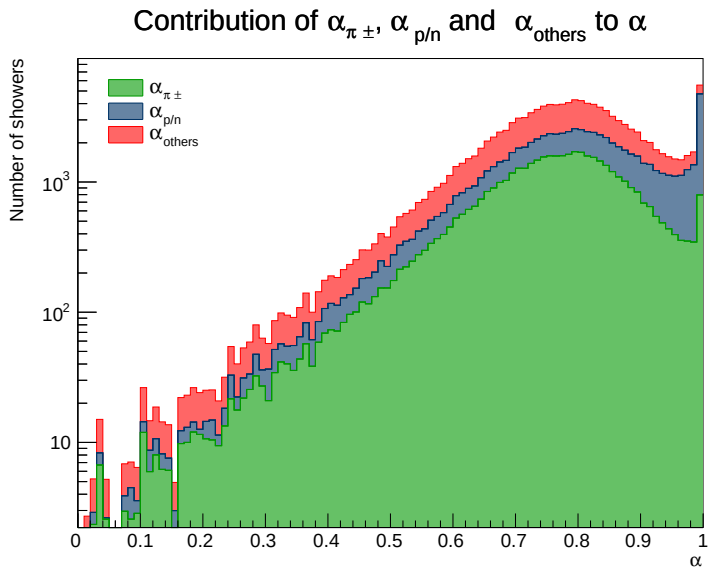

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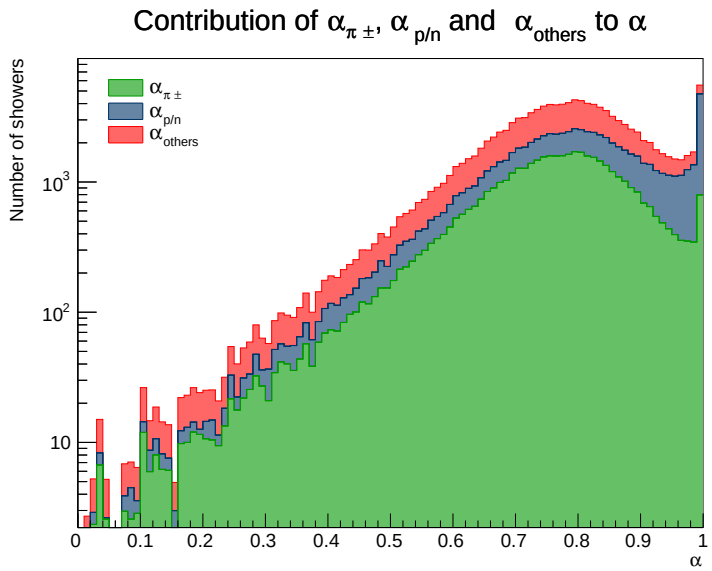

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All α_{type}s contributed to the tail. Hence, α **tail fluctuations DO NOT depend on the particle's type.**

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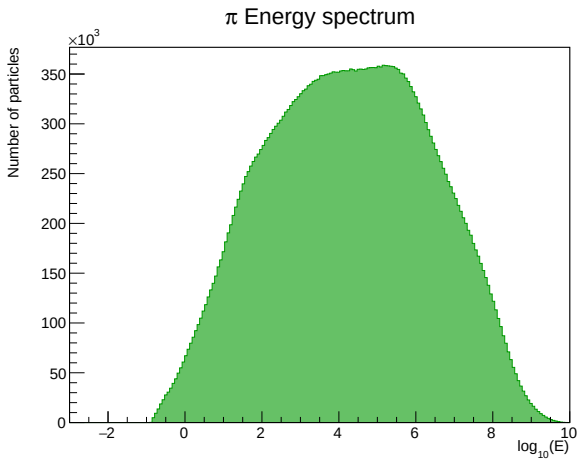

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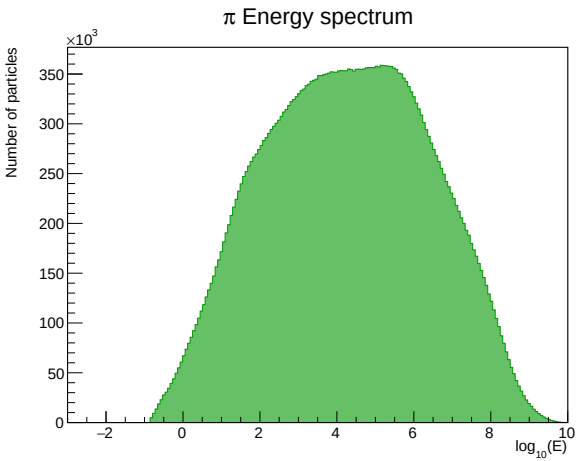

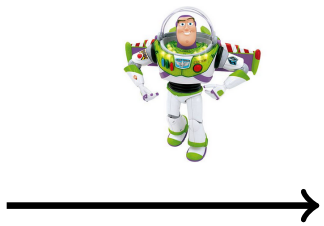

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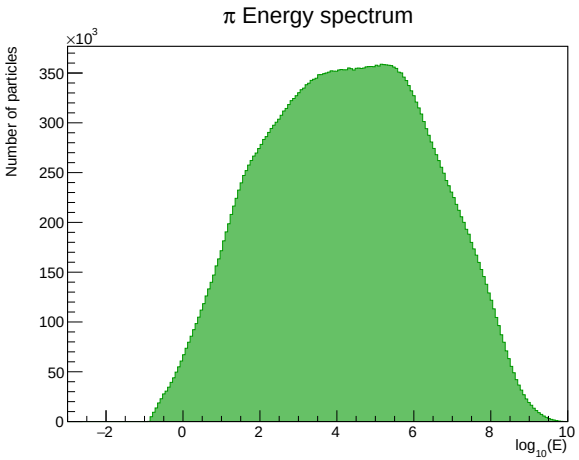

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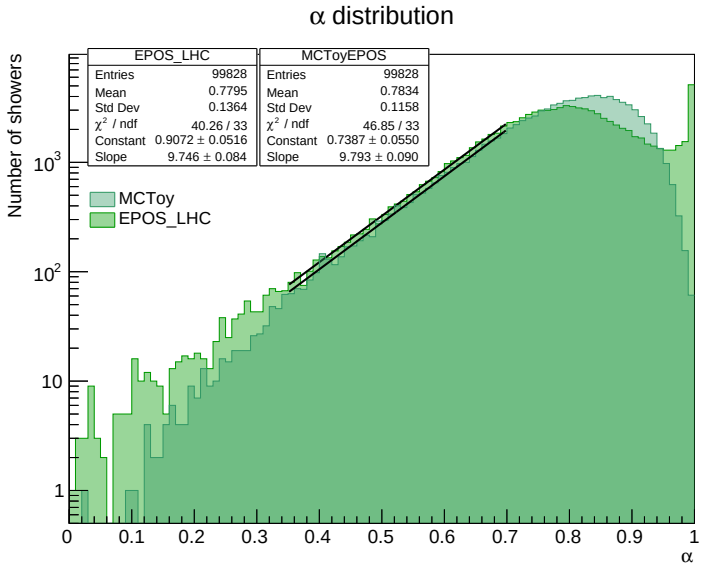

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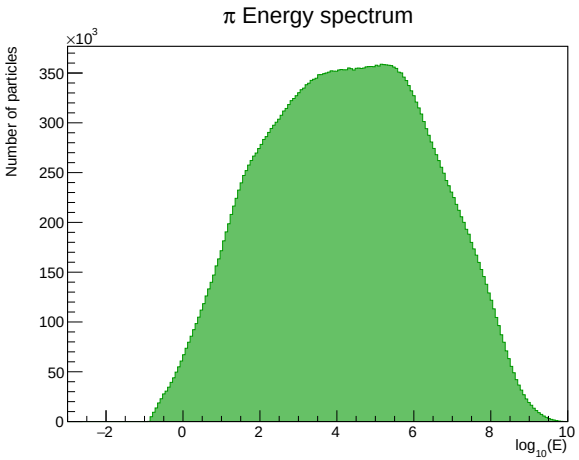

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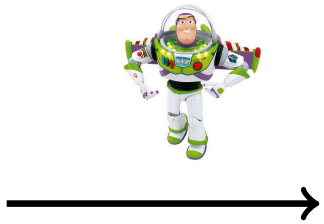

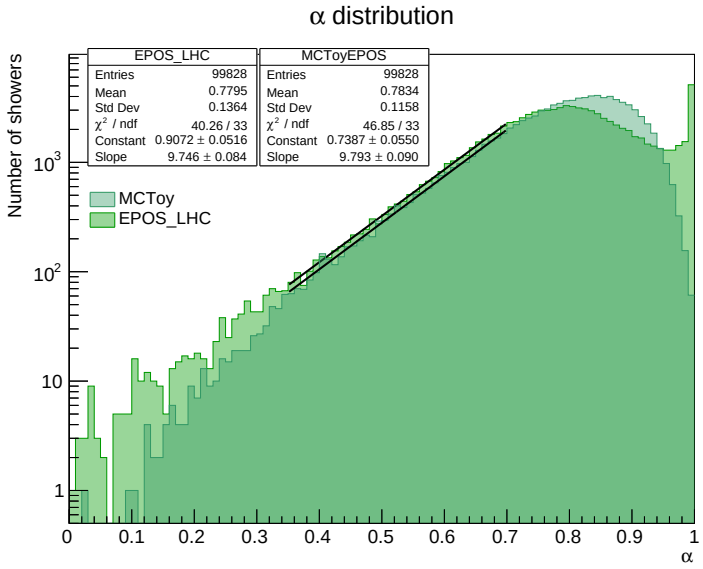

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Accounting for the fraction of energy carried by charged pions, Toy model's α, we successfully obtained the desired α tail structure. **The α's distribution tail is shaped by the pions energy spectrum.**

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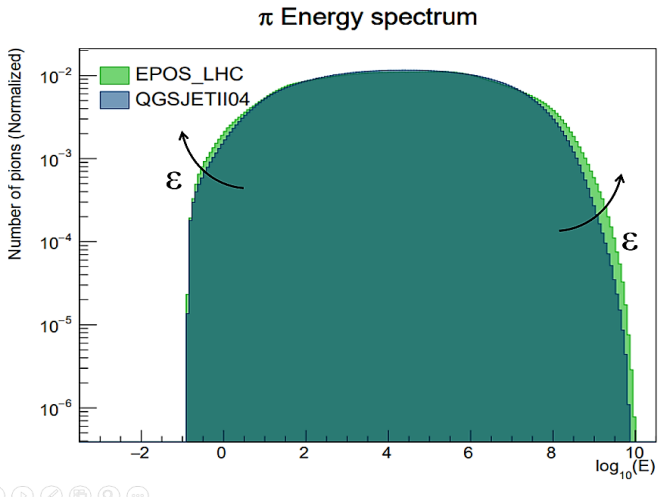

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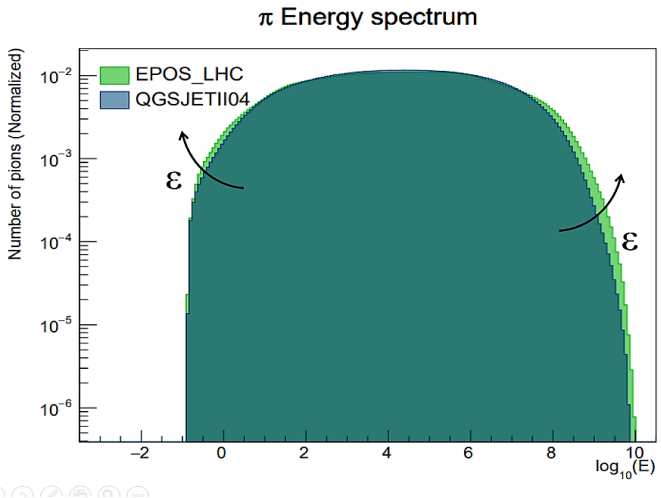

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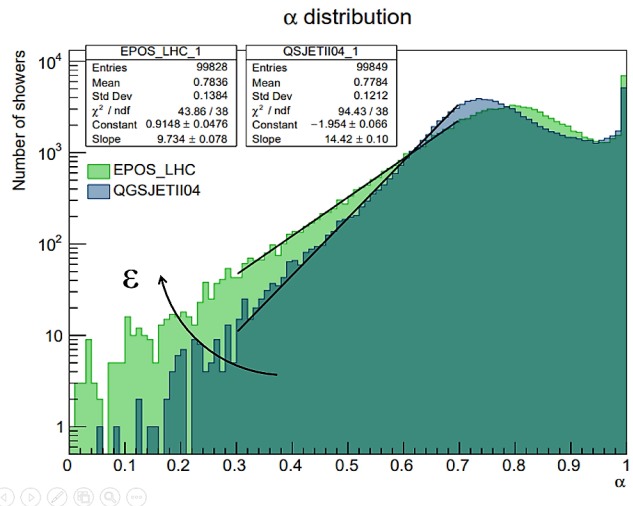

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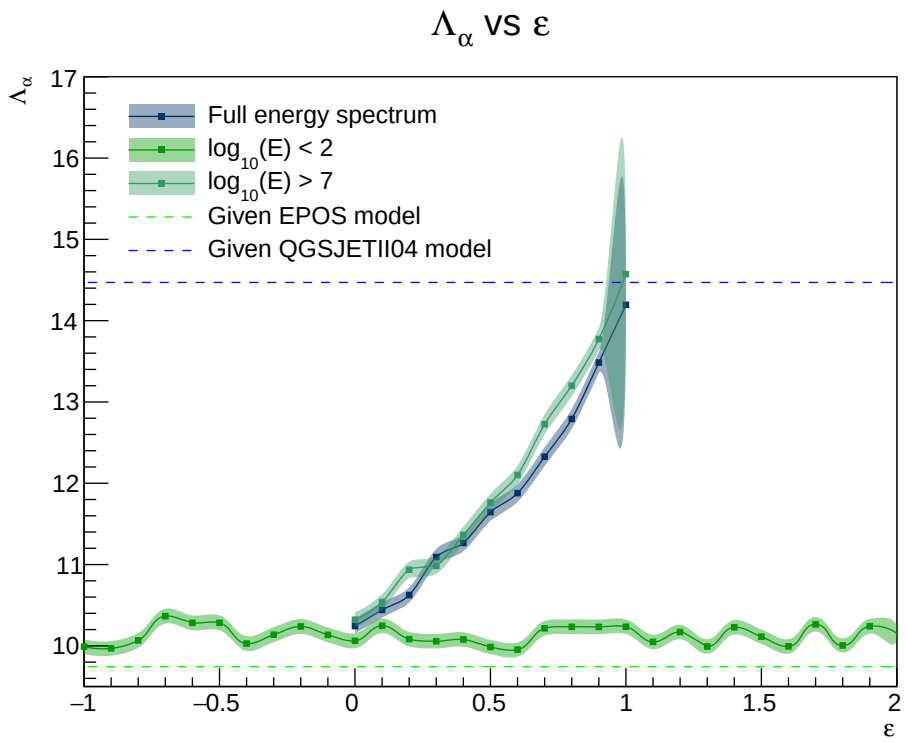

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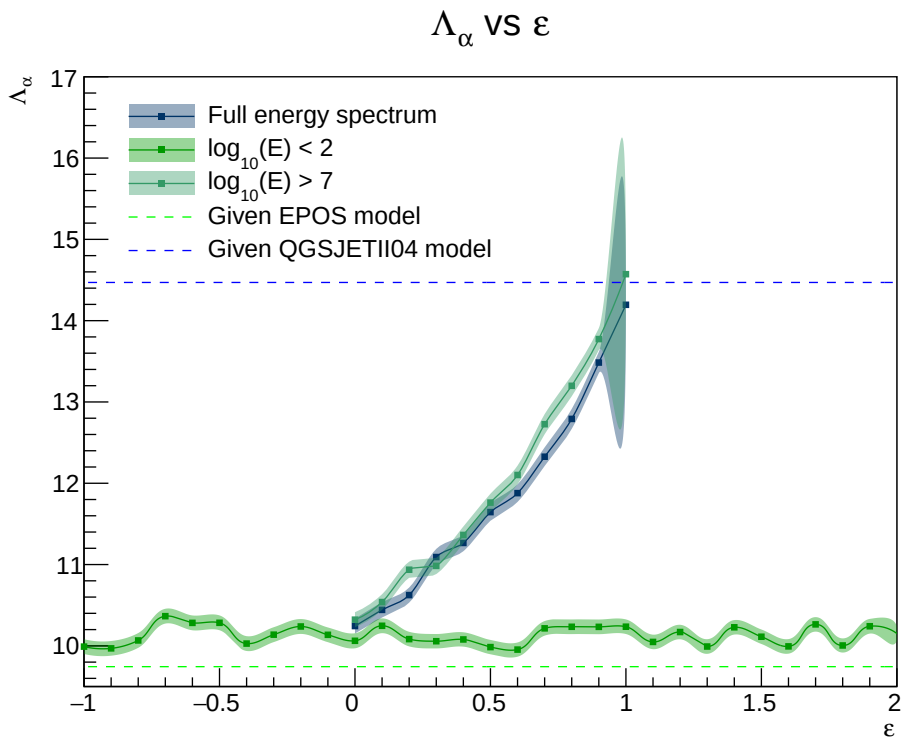

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Changing the forward region is enough to reproduce QGSJET II-04's α tail structure form the EPOS-LHC one. **The tail of the α-distribution is only sensible changes in this region of the pions ES**

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