

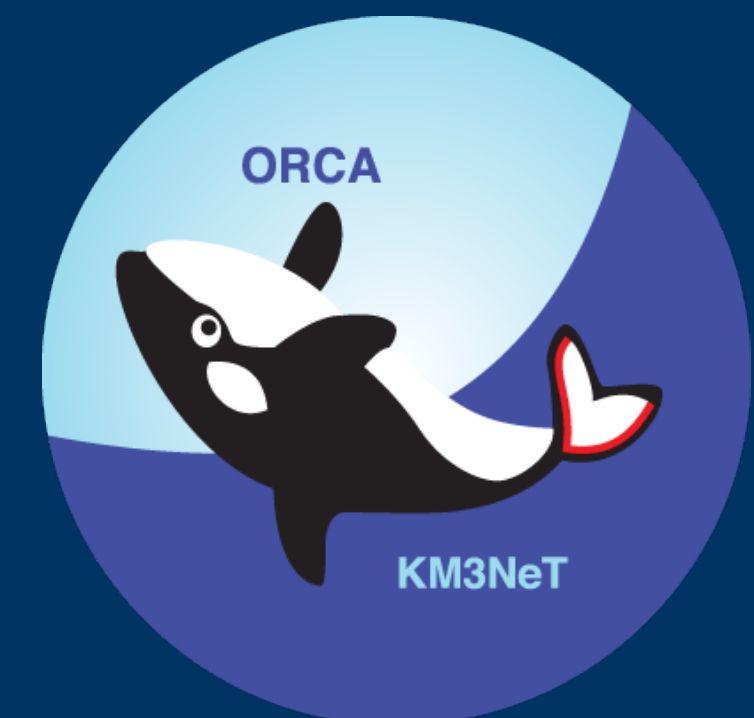


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Tuning parametric models of the atmospheric muon flux in MUPAGE to data from the KM3NeT detector

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On behalf of the KM3NeT Collaboration

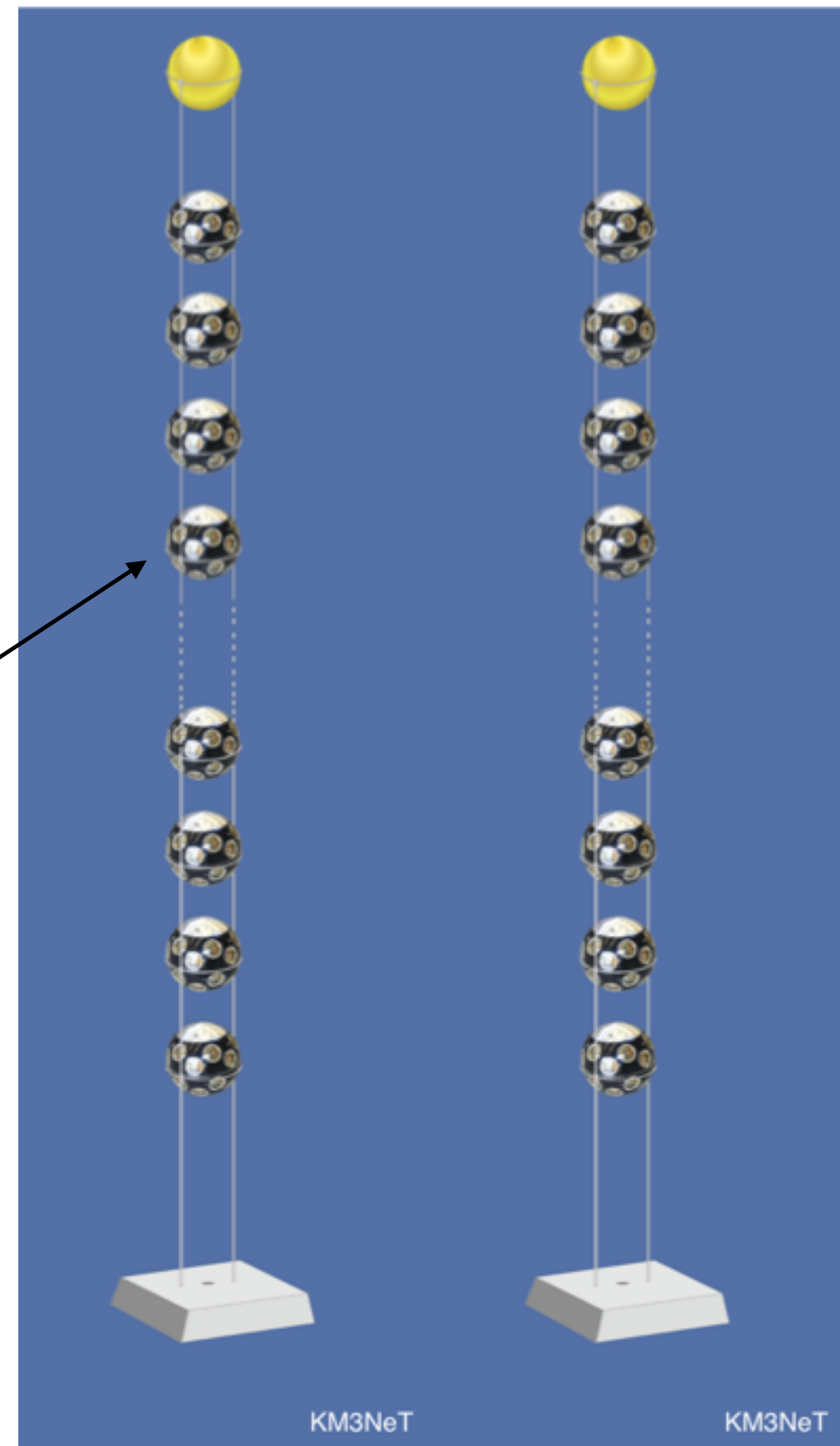


Introduction

KM3NeT/ARCA and KM3NeT/ORCA

18 optical modules form a detection unit

Optical modules with 31 PMTs



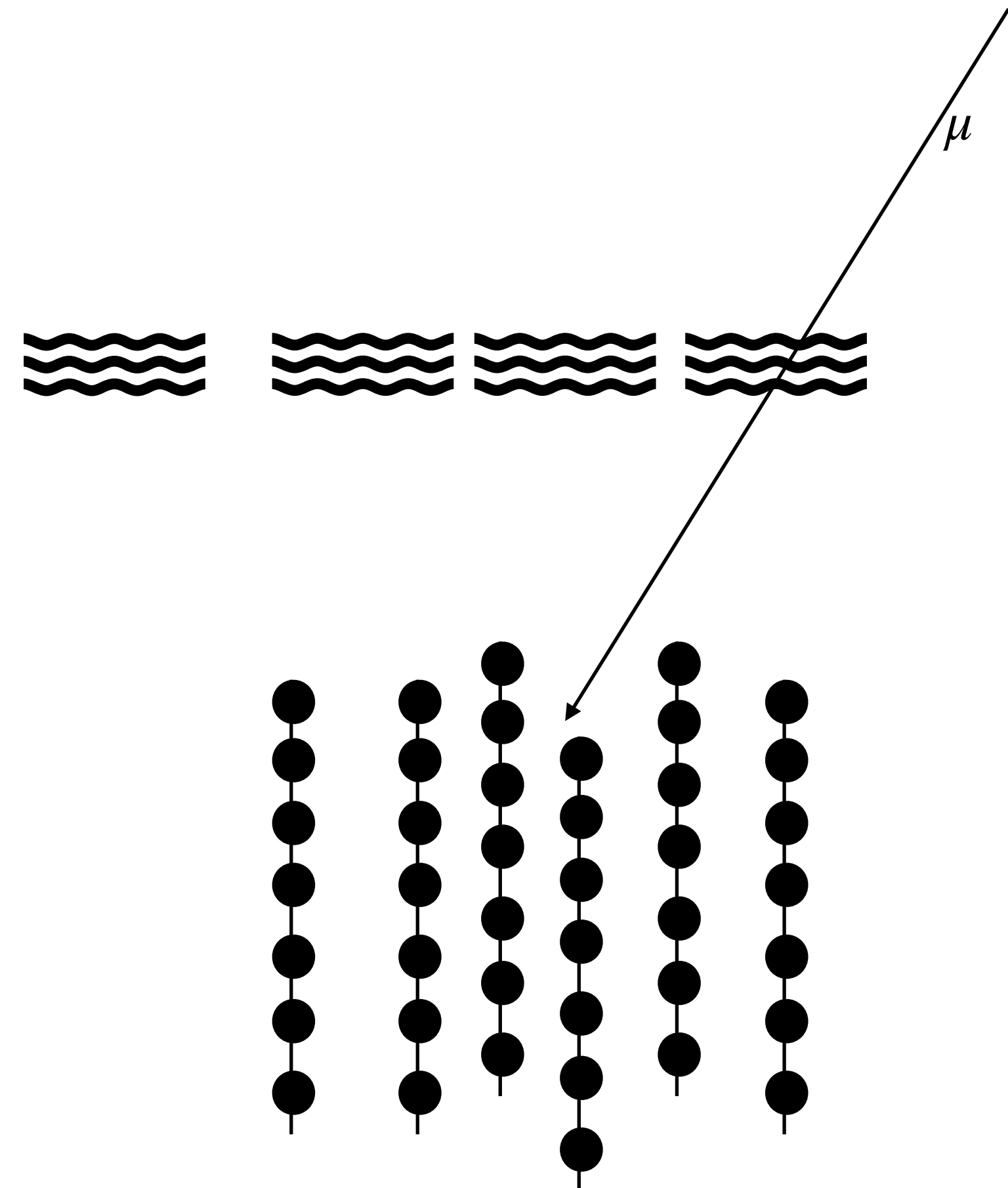
- ARCA
 - carry out neutrino source searches
 - instrument $\sim 1 \text{ km}^3$ of sea water as 2×115 detection units.
- ORCA:
 - study neutrino oscillations/mass ordering
 - instrument $\sim 7 \text{ Mt}$ of sea water as 115 detection units.
- KM3NeT also detects atmospheric muons
 - cosmic ray studies.

From <https://arxiv.org/pdf/1601.07459.pdf>
<https://arxiv.org/pdf/2103.09885.pdf>

Introduction

Measure Observables

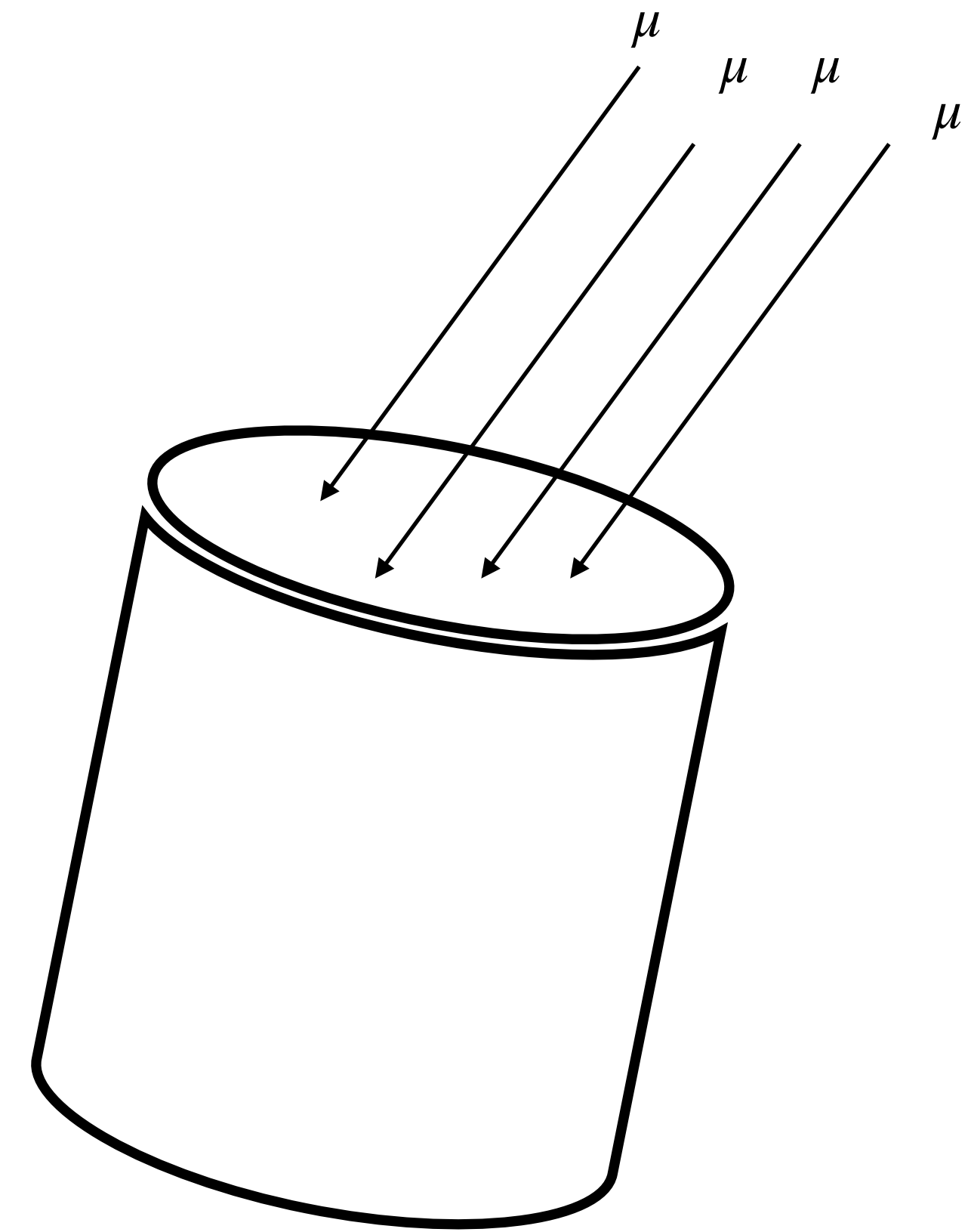
- KM3NeT/ARCA and ORCA currently operate with 6 detection units taking data continuously.
- From this data, we get distributions of observables, e.g.
 - energy
 - direction
 - number of hits
- We want to simulate these observables as precisely as possible.



MUPAGE

Atmospheric muon generator

- MUPAGE generates atmospheric muons according to parametric formula on the surface of a virtual cylinder.
- Its internal parameters can be manipulated
 - change the shape of the generated distributions so that simulation better describes the data



<https://arxiv.org/pdf/0802.0562.pdf>

[https://www.sciencedirect.com/science/article/abs/pii/S092765050500157X?
via%3Dihub](https://www.sciencedirect.com/science/article/abs/pii/S092765050500157X?via%3Dihub)

Compare Distributions

Grid Scan

- Preliminary scan of MUPAGE parameter space.
- Vary 6 MUPAGE values of these parameters, *independently* from each other, and carry out the simulation chain
- To find the simulations which best agree with data, we use the significance test

$$S = \frac{1}{N} \sum_{i=0}^N \frac{|a_i - K \cdot b_i|}{\sigma^2(a_i + K^2 \cdot \sigma^2(b_i))}$$

- $S = 0$ when two distributions are the same.

Compare Distributions

Proof of Method

- Preliminary results for values which give better data-MC agreement compared to MUPAGE nominal values.
- Proof of method.
- Multi-dimensional scan intended.

