

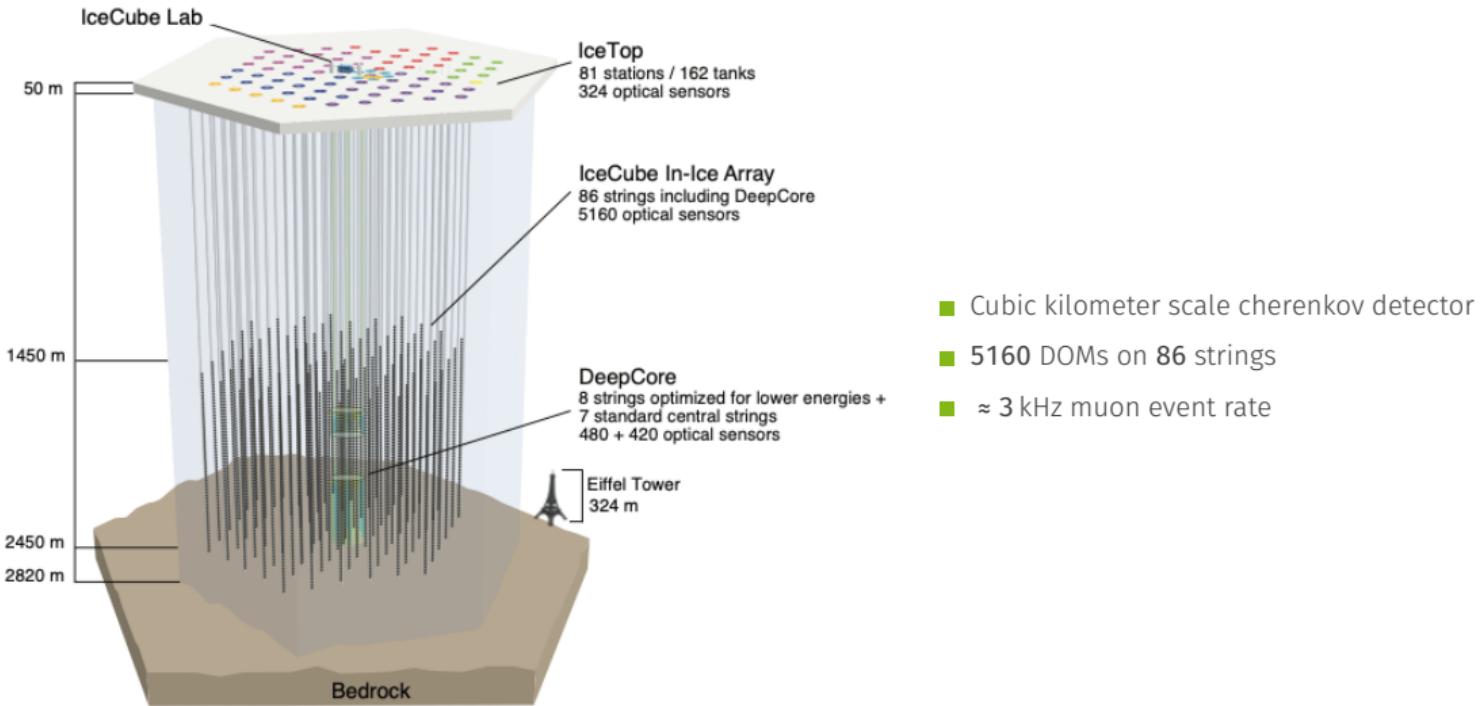
ICECUBE
NEUTRINO OBSERVATORY

Observing the Prompt Component of the Atmospheric Muon Flux Using IceCube

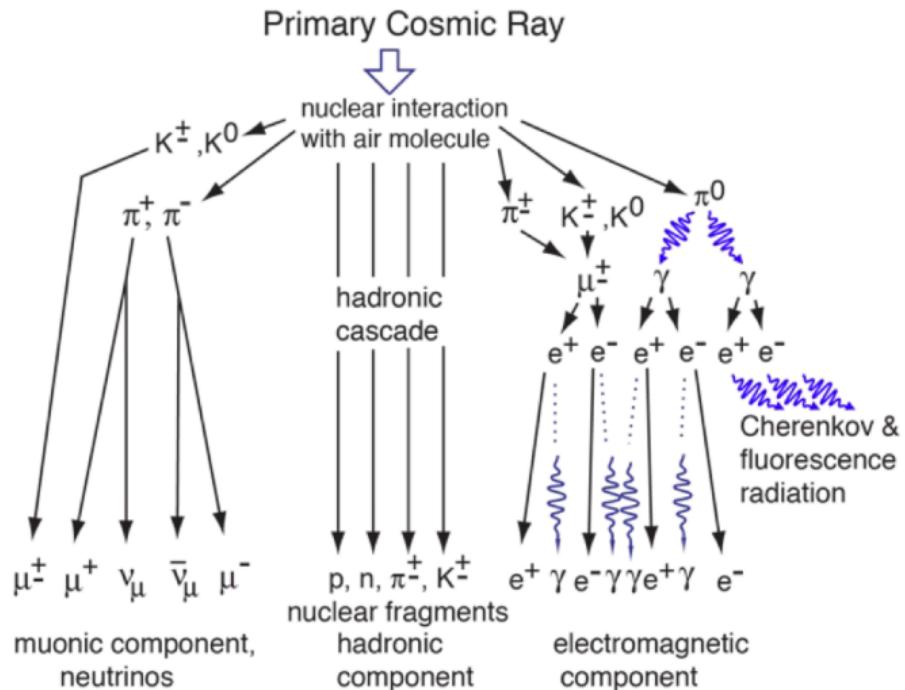
Leander Flottau

3 April 2025

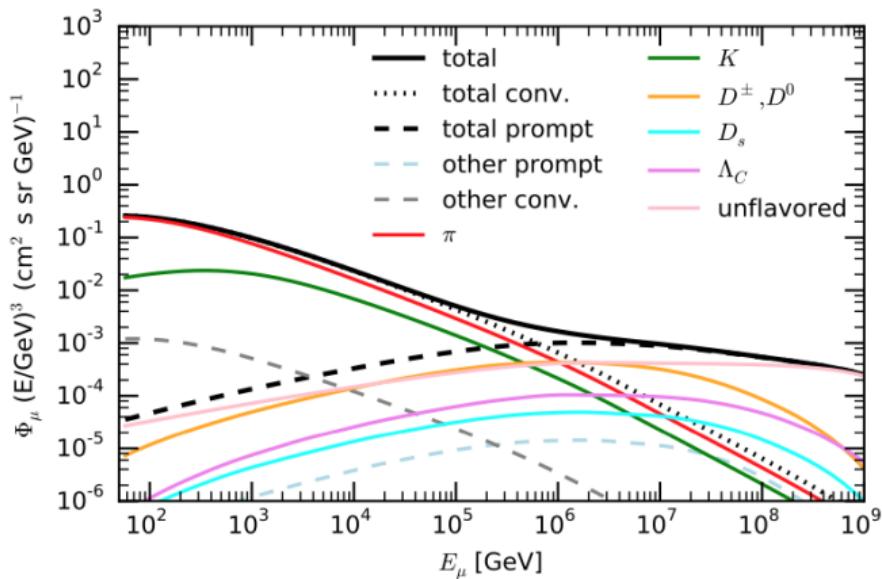
IceCube Neutrino Observatory



Atmospheric Air Showers

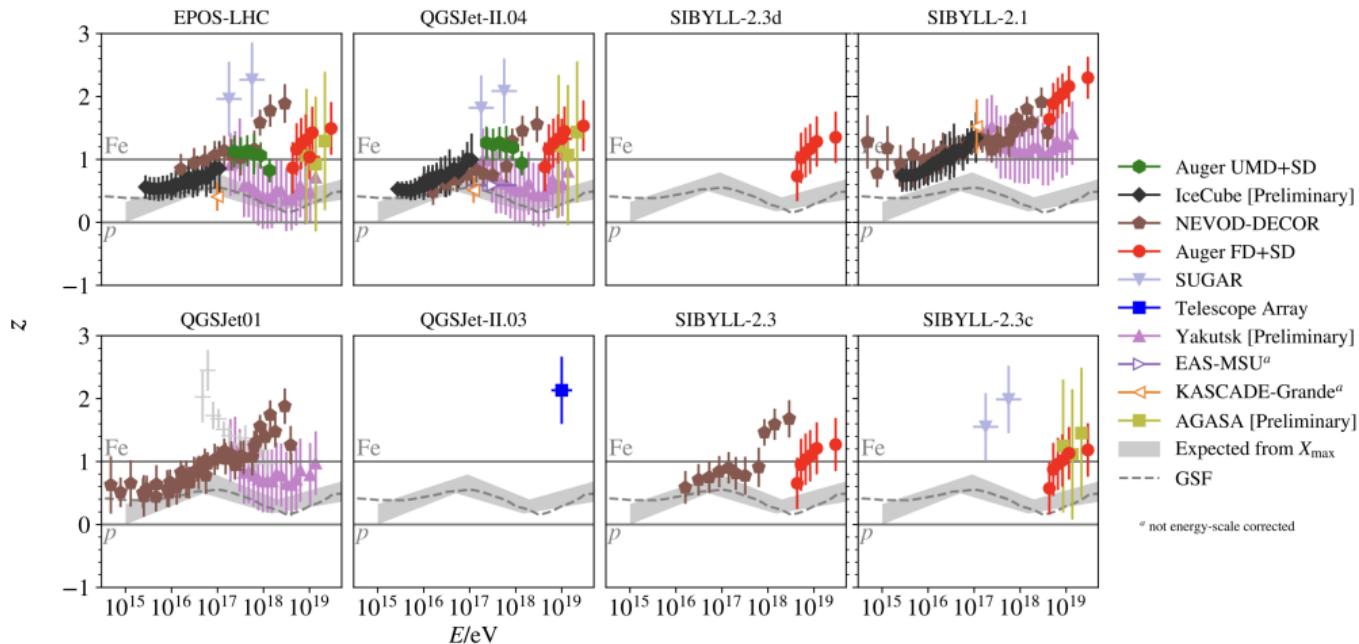


The Prompt Component

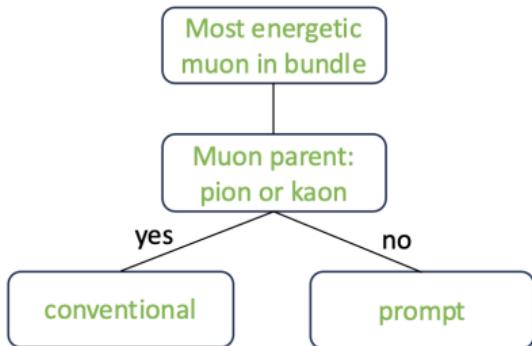


- Conventional: produced by K^\pm/π^\pm
- Prompt: produced by short lived particles
- Prompt dominant at high energies

The Muon-Puzzle

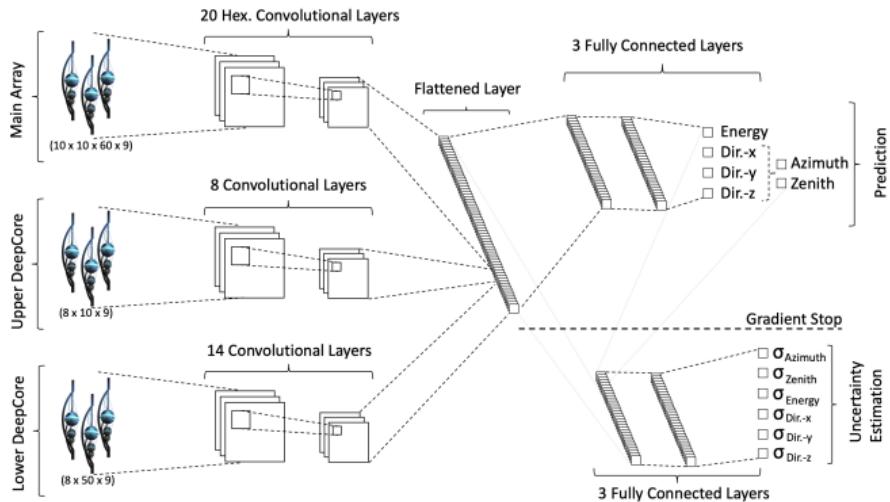


Simulations and tagging



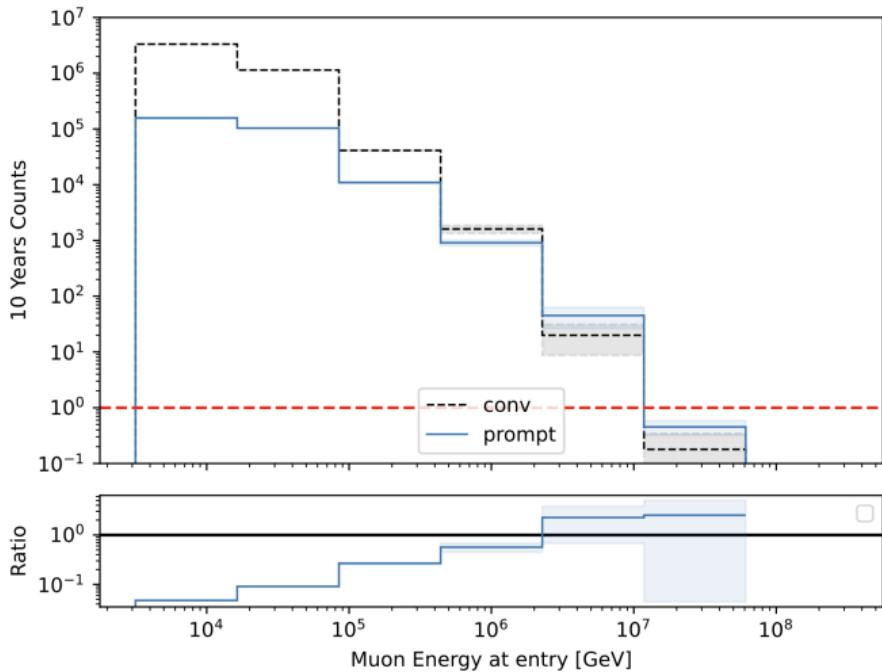
- Tagging of parent particles in CORSIKA simulations
- Prompt definition based on parent of leading muon
- Simulation up to extremely high energies

Reconstructions



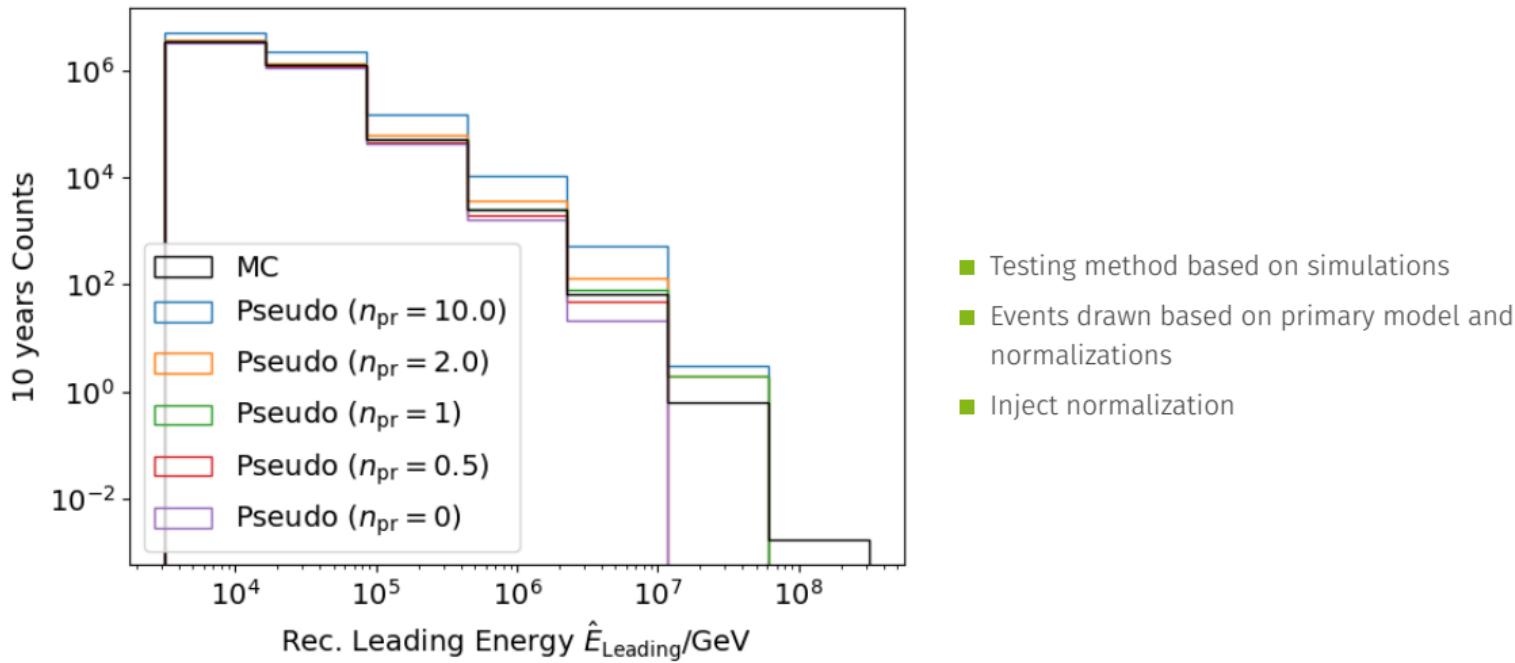
- Neural network based
- Zenith angle, bundle energy and leading muon energy

Forward Folding

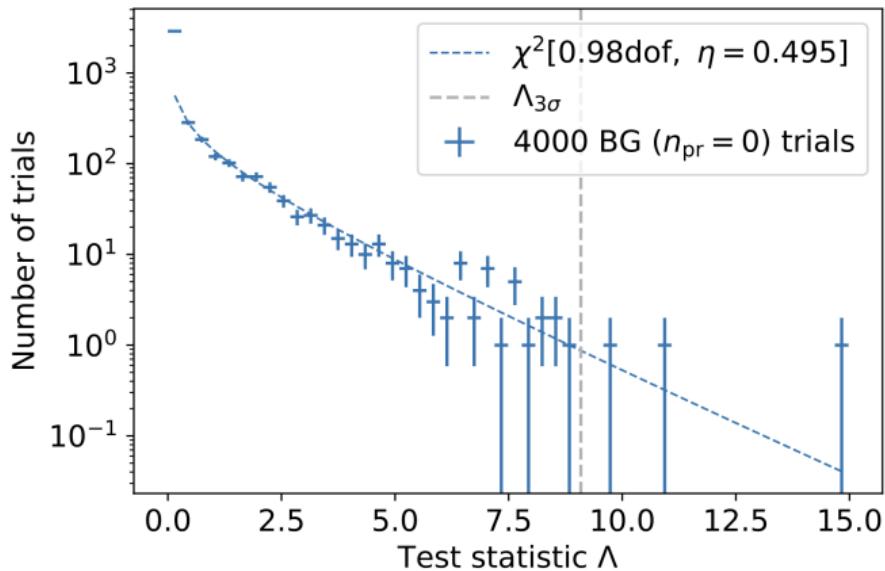


- Prompt normalization: fraction of prompt component relative to current MC-simulation n_{pr}
- Poisson likelihood in each histogram bin
- Rescale with normalization factors
- Strong model dependency

Pseudo experiments

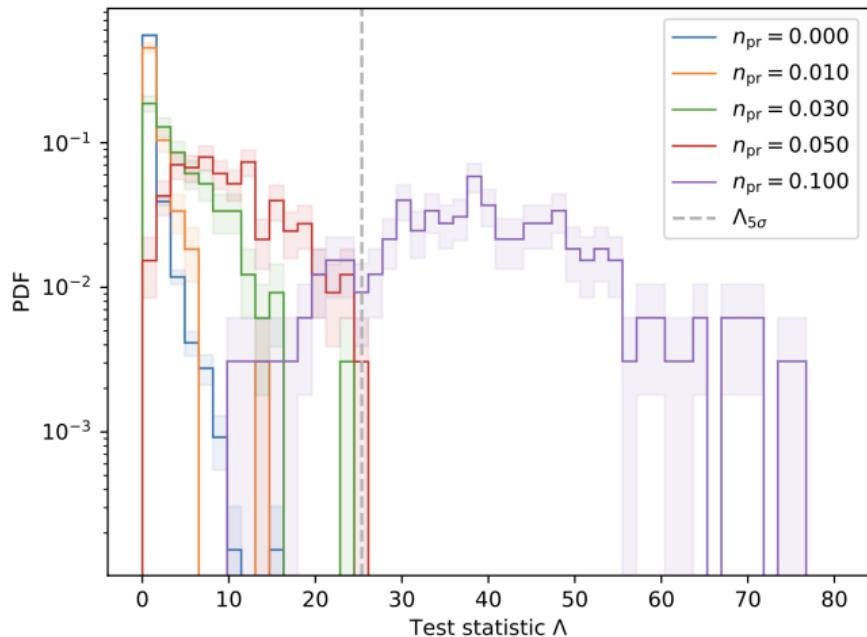


Background Estimation



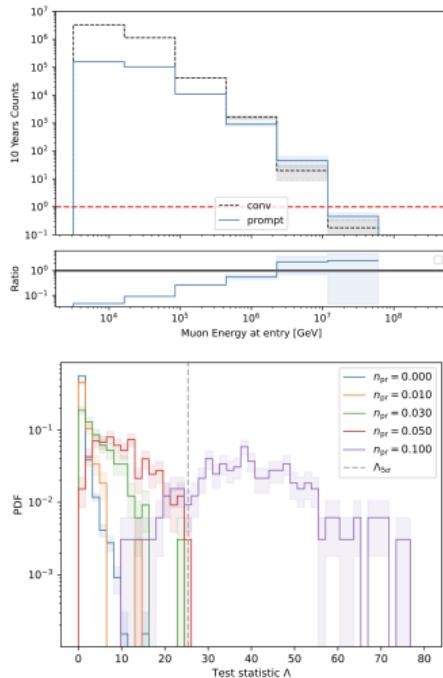
- Likelihood ratio test
- Draw background samples with $n_{pr} = 0$
- Wilks' theorem: fit χ^2 -distribution

Discovery Potential



- Prompt norm required to be to detect it with the current method?
- Discovery potential: Norm at which half the generated trials yield 5σ significance in the likelihood ratio test
- Sensitive to input parameters, binning etc
- Caution: Systematics are not yet included

Summary



- Generate prompt tag in simulation
- Simulate up to high energies
- Forward fit of prompt normalization
- Use MC to estimate significance