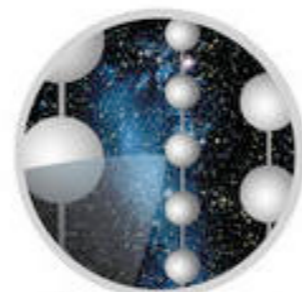




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Long-Term Stability of Backgrounds in the IceCube Neutrino Observatory

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ICECUBE



Outline



- Motivation
- A First Hint
- Backgrounds
- Backgrounds Effects
- Atmospheric Background Stability
- Detector Noise Stability

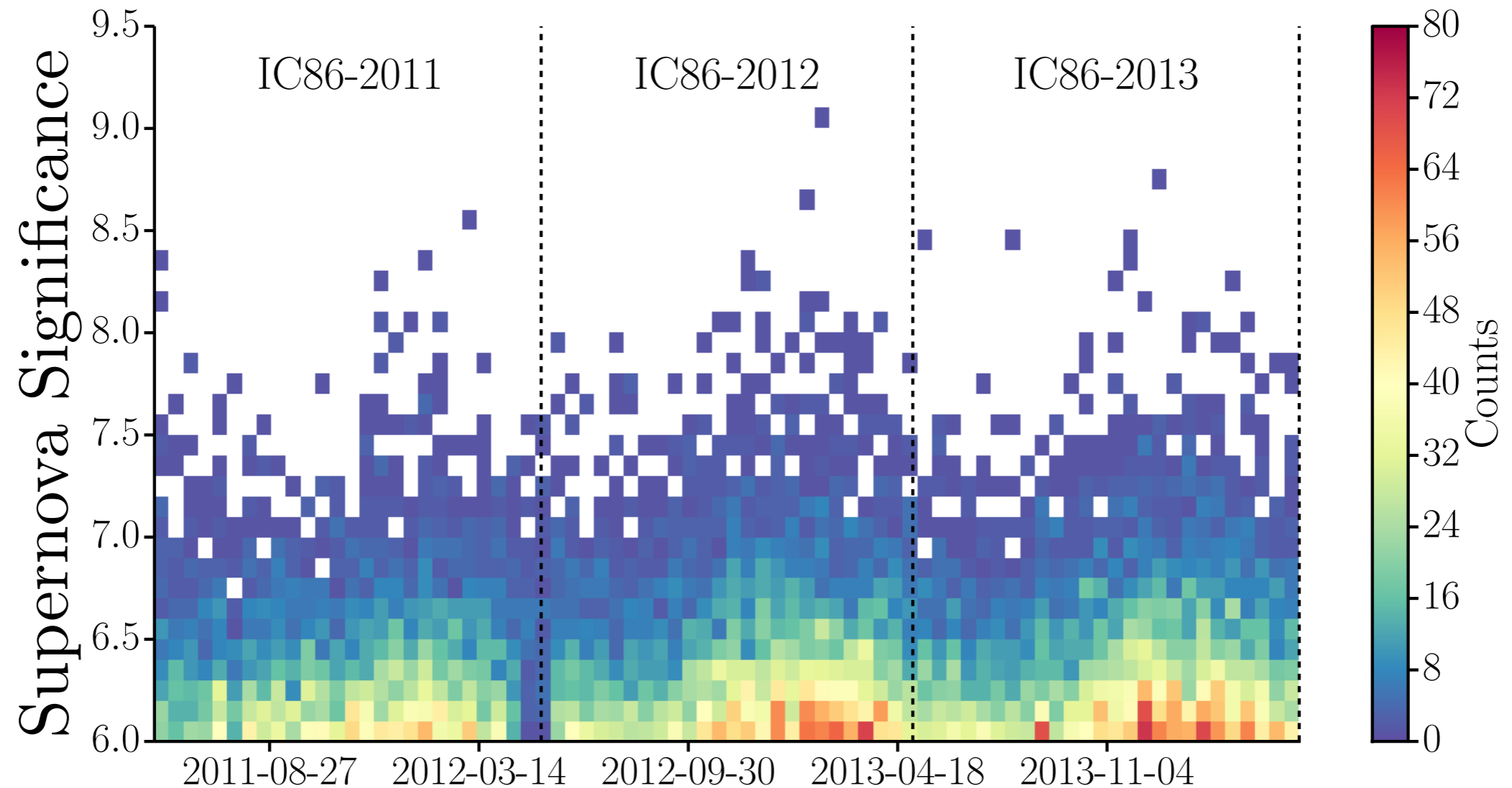


Motivation

- “Low-“energy analyses, e.g. neutrino oscillations, are susceptible to additional detector backgrounds compared to “medium-“ and “high-“energy
- Need to understand long-term detector backgrounds to perform multi-year analyses - Search for supernovae, neutrino oscillations, etc.
- Future low-energy detectors could be susceptible to same effects



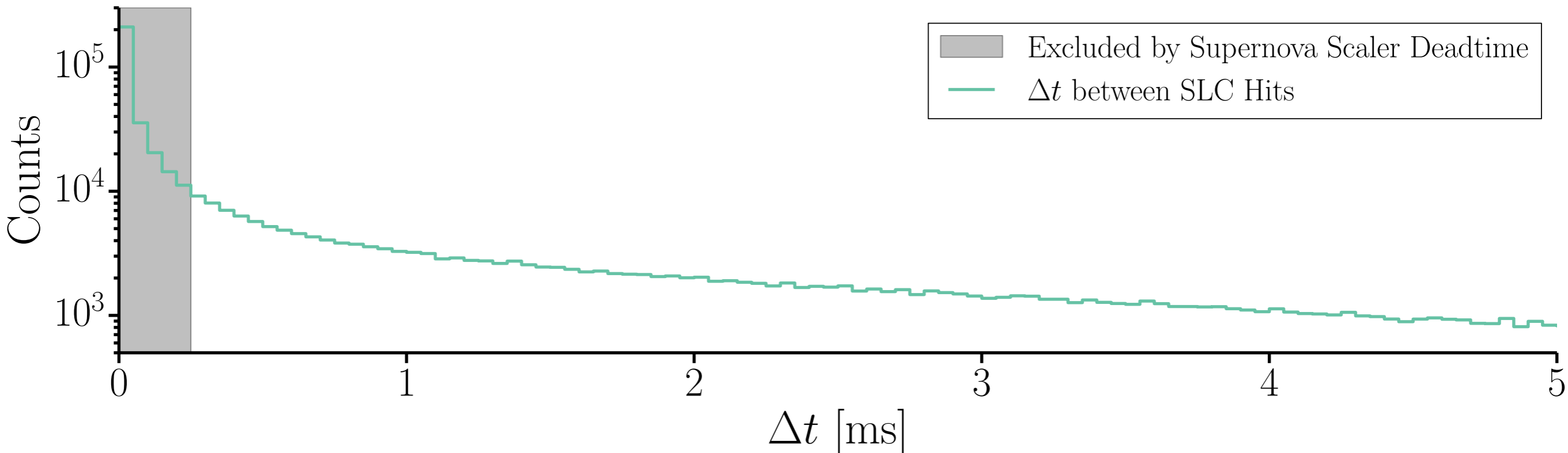
A First Hint



- Expected background contamination is present
- Background contamination increasing with time: Already observed in partial detectors
- Changes in atmospheric muons or the detector?



Backgrounds — DOM



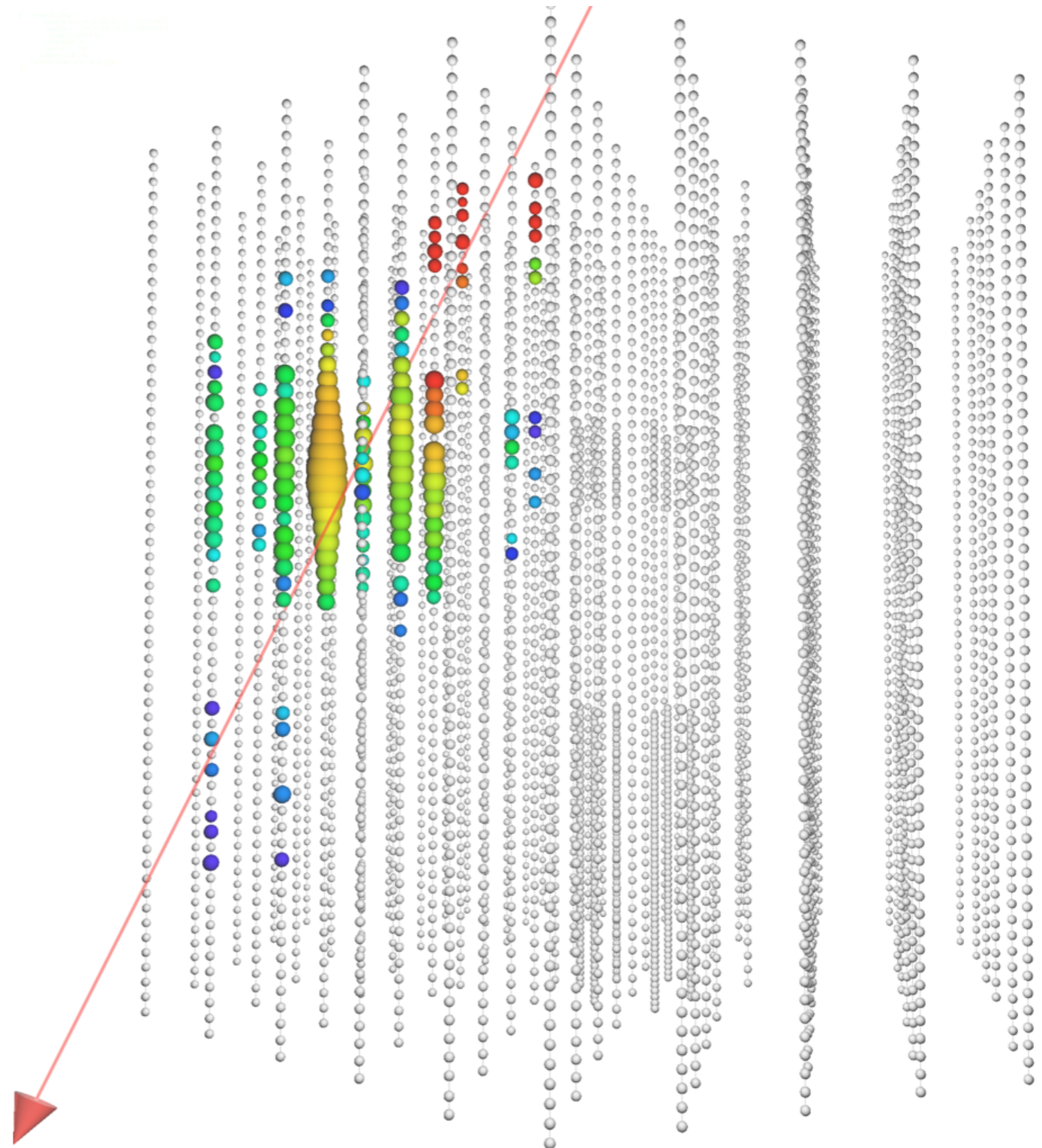
- 500 Hz DOM Noise has two main components - Poissian and Non-Poissonian
- Non-Poissonian believed to be scintillation from radioactive decays
 - Non-Poissonian behavior proportional to glass around PMT
 - IceCube-predecessor (AMANDA) pressure sphere produce light when exposed to radioactive source
- Non-triggering outside of DeepCore
- Deadtime in Supernova system needed to reduce Non-Poissonian noise



Backgrounds – Atmospheric Muons



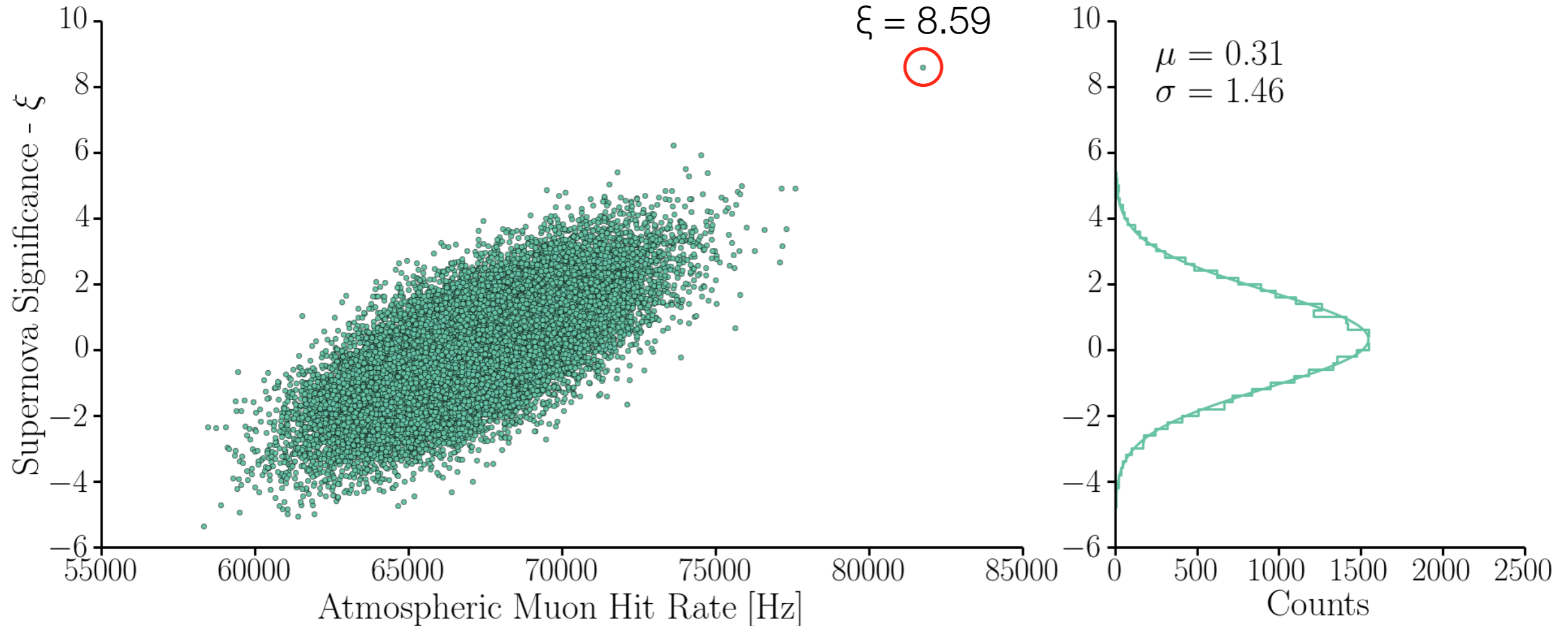
- Muons from cosmic ray air showers
- Main triggering background - $\sim 3\text{kHz}$
- Mimic a supernova signal because of long integration windows





Background Effects

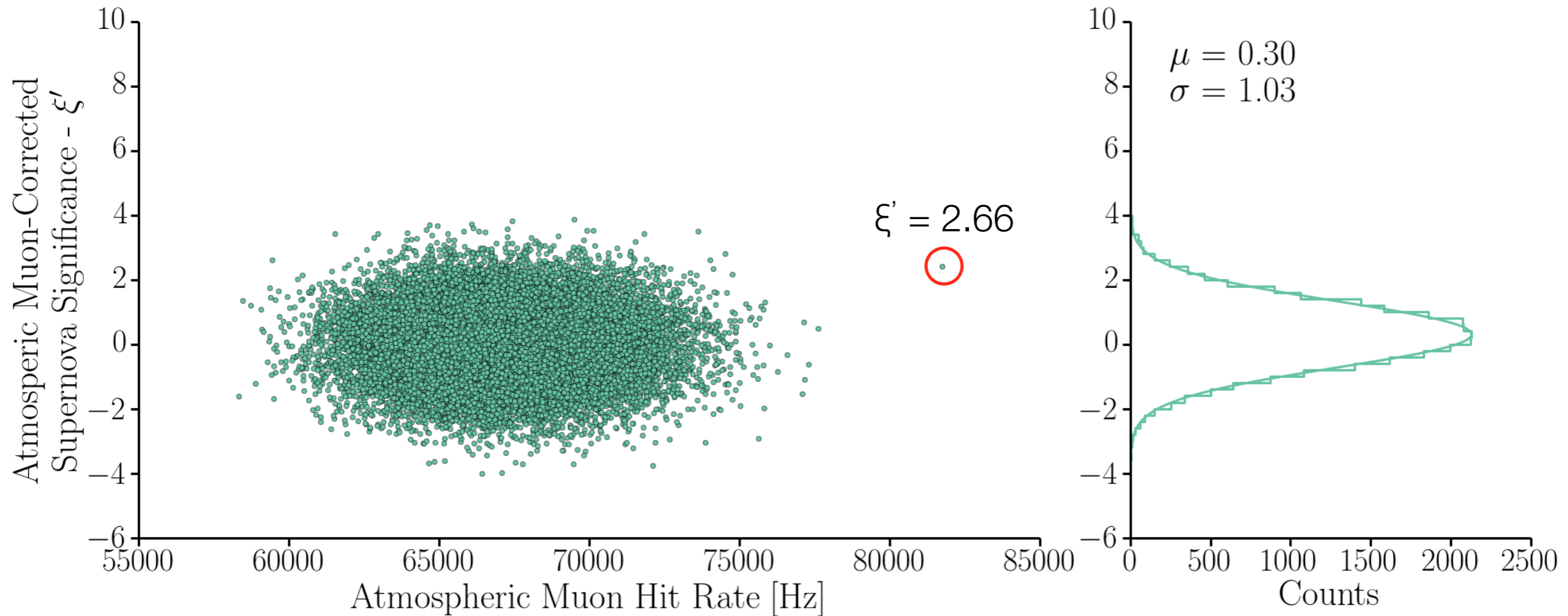
Atmospheric muons cause DOM-to-DOM correlated noise, widen the significance distribution





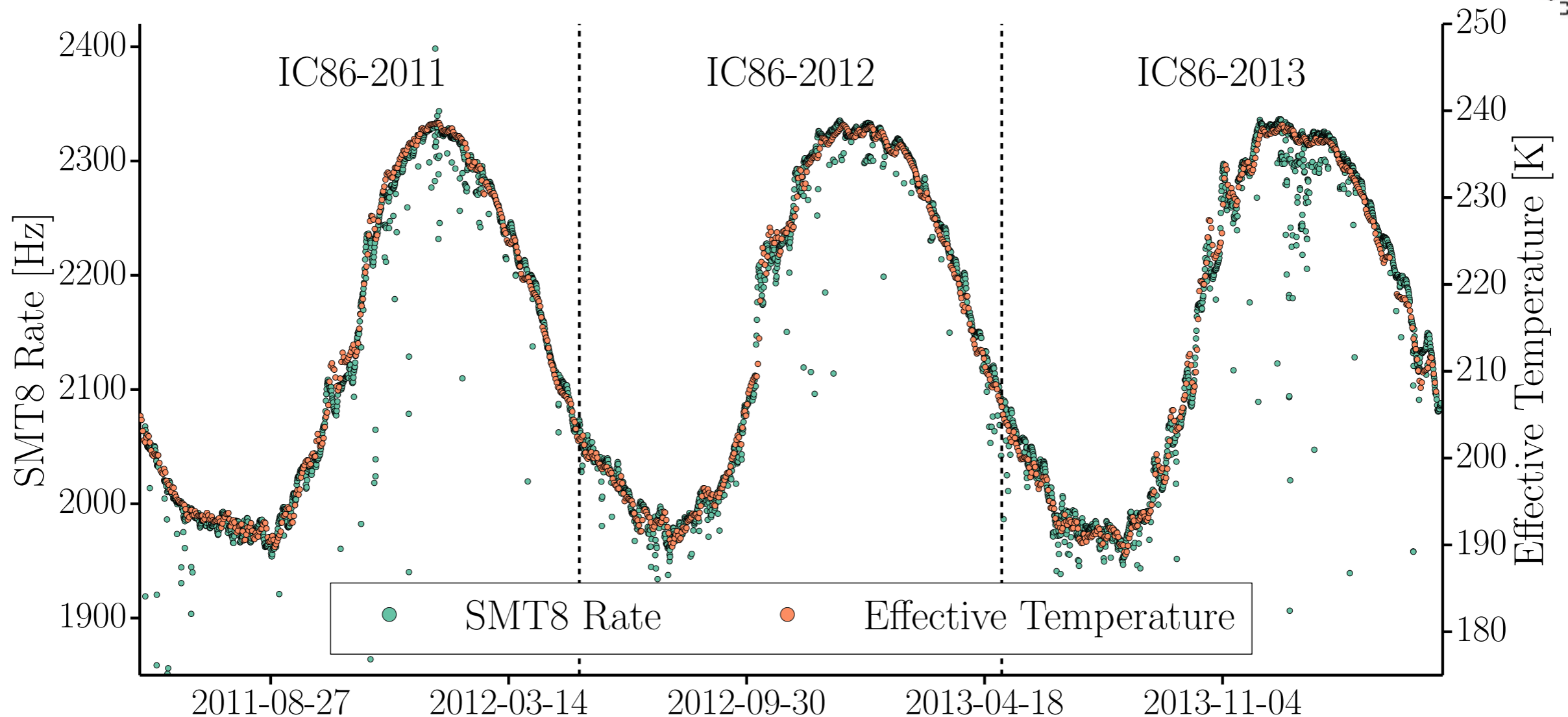
Background Effects

Removing atmospheric muons removes background contamination, shrinking significance distribution to correct width





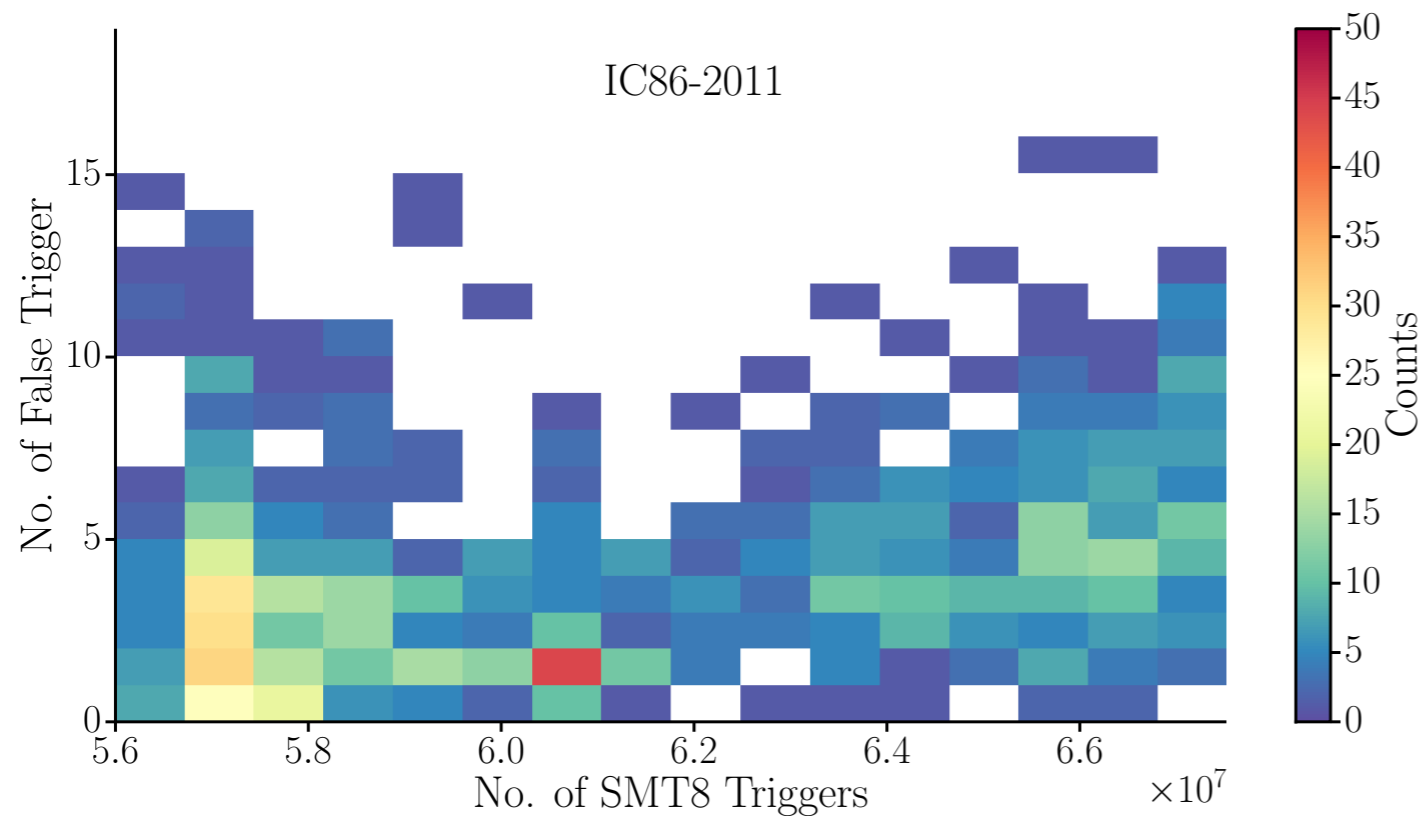
Atmospheric Background Stability



- SMT8 Trigger - Main IceCube trigger, vast majority of triggers are atmospheric muons
- Difference between detector years is caused by variations in atmospheric temperature, i.e. atmospheric properties: Produce a seasonally dependent effect
- Time-series does not show same trend as seen in supernova significance

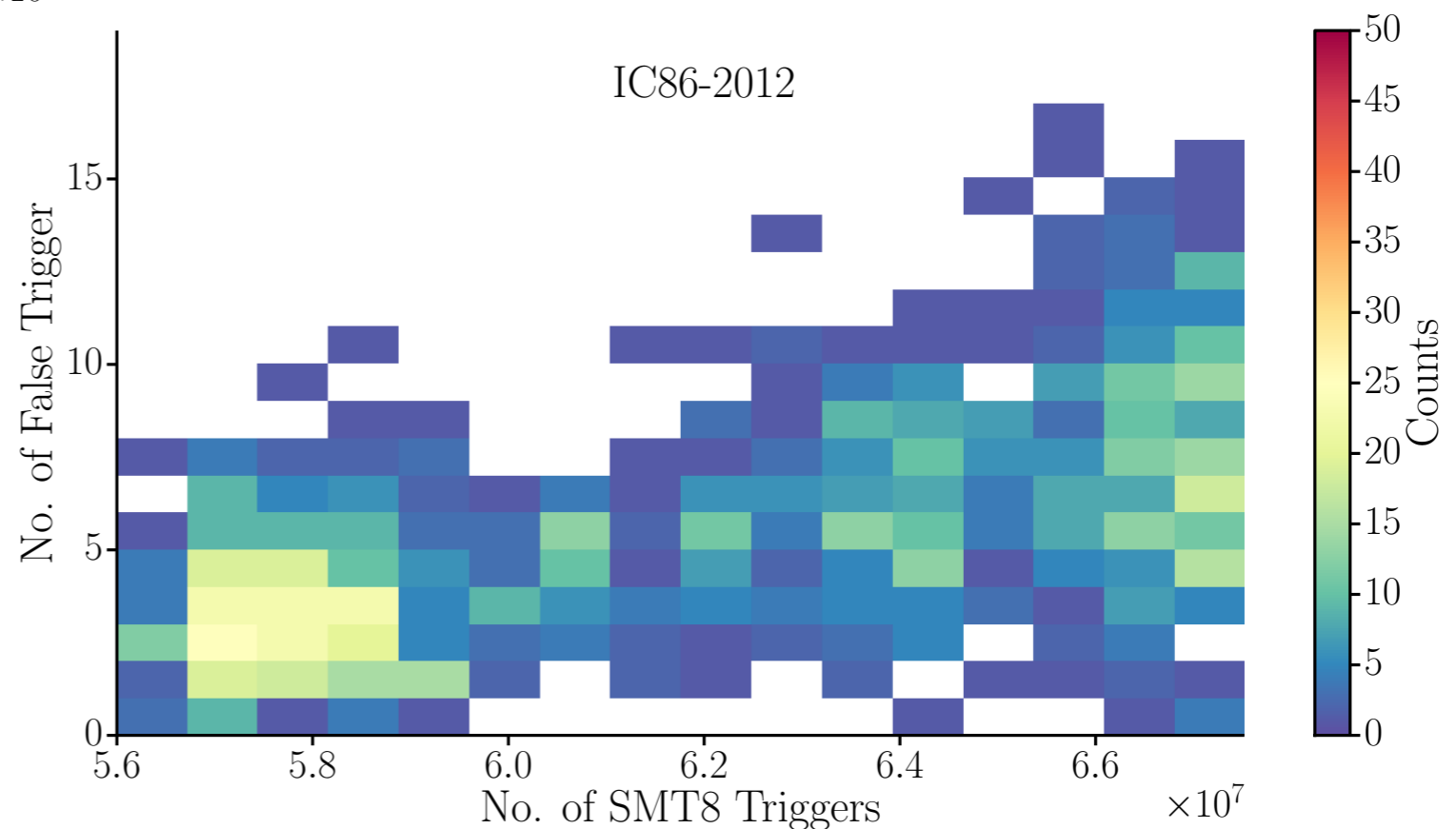


Atmospheric Background Stability



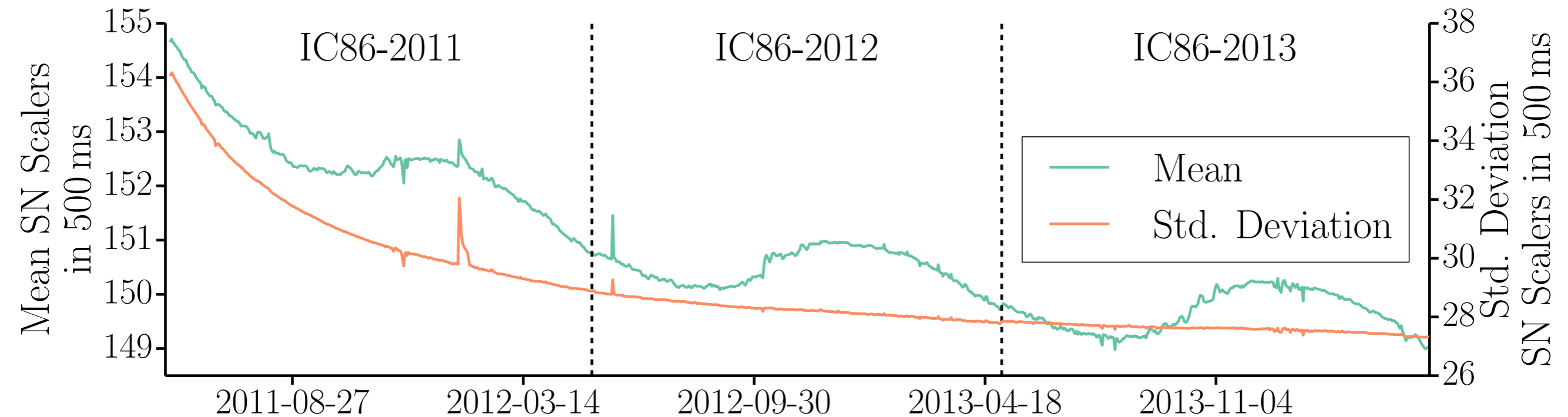
Increased correlation between muon trigger rate and “interesting” event rate

Year	Pearson's r
IC86-2011	0.38
IC86-2012	0.56
IC86-2013	0.69





Detector Noise Stability



- Over the course of 3 years:
 - 3.5% decrease in the mean noise rate
 - 25% decrease in the standard deviation of the detector noise rate distribution



Source of Instability



- Freezing of ice is known to produce light
- IceCube observed a spike in the noise rate that decayed quickly with the bore hole freezing in
- Process appears to continue as the column settles down - Gas pockets being squeezed out, etc.





Conclusion



- Atmospheric muon background is stable modulo changes in the atmosphere
- Decrease in the detector noise rate over the course of several years discovered
- Source of decay cannot be established