Presentation of Point Source Results in IceCube

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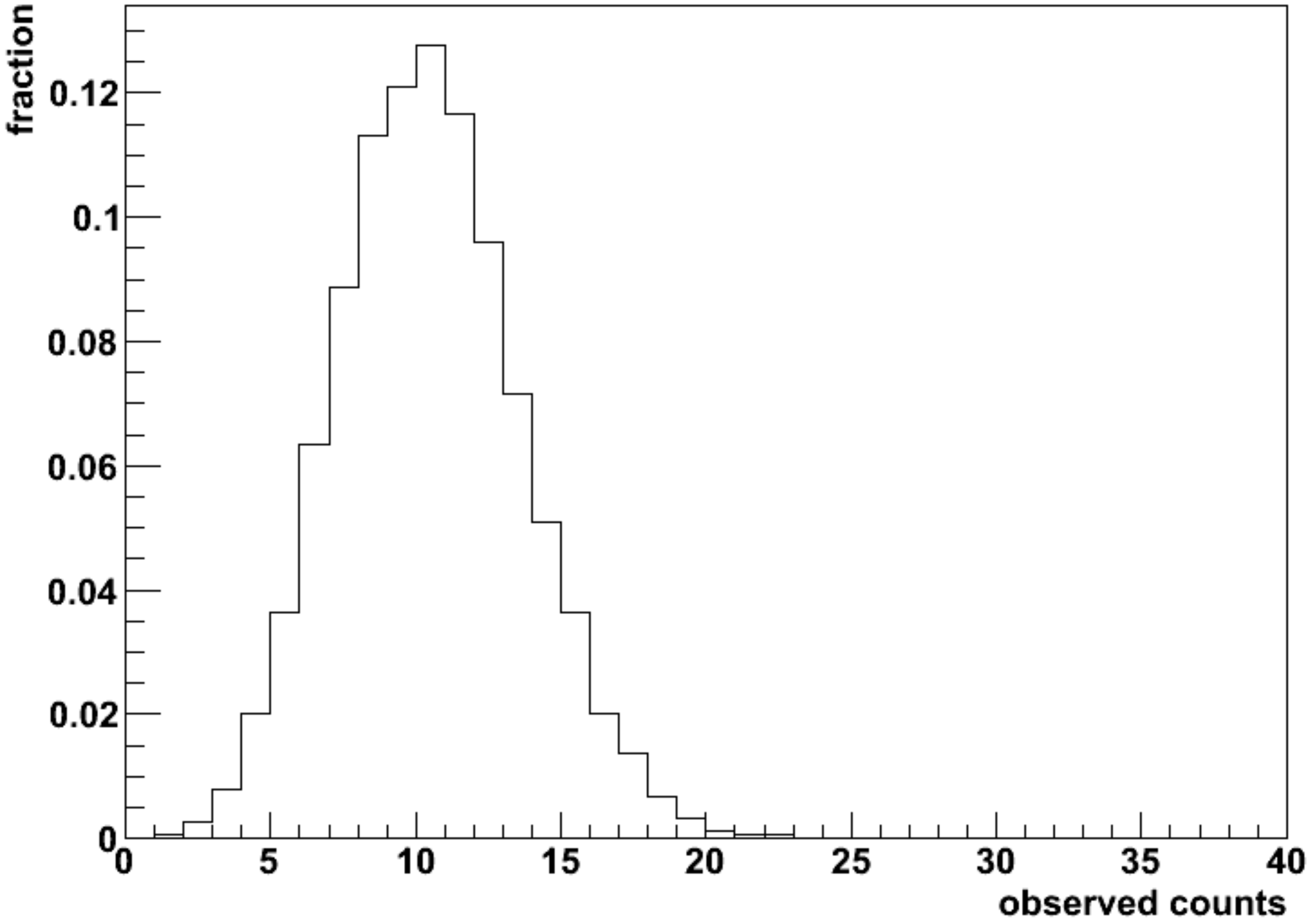
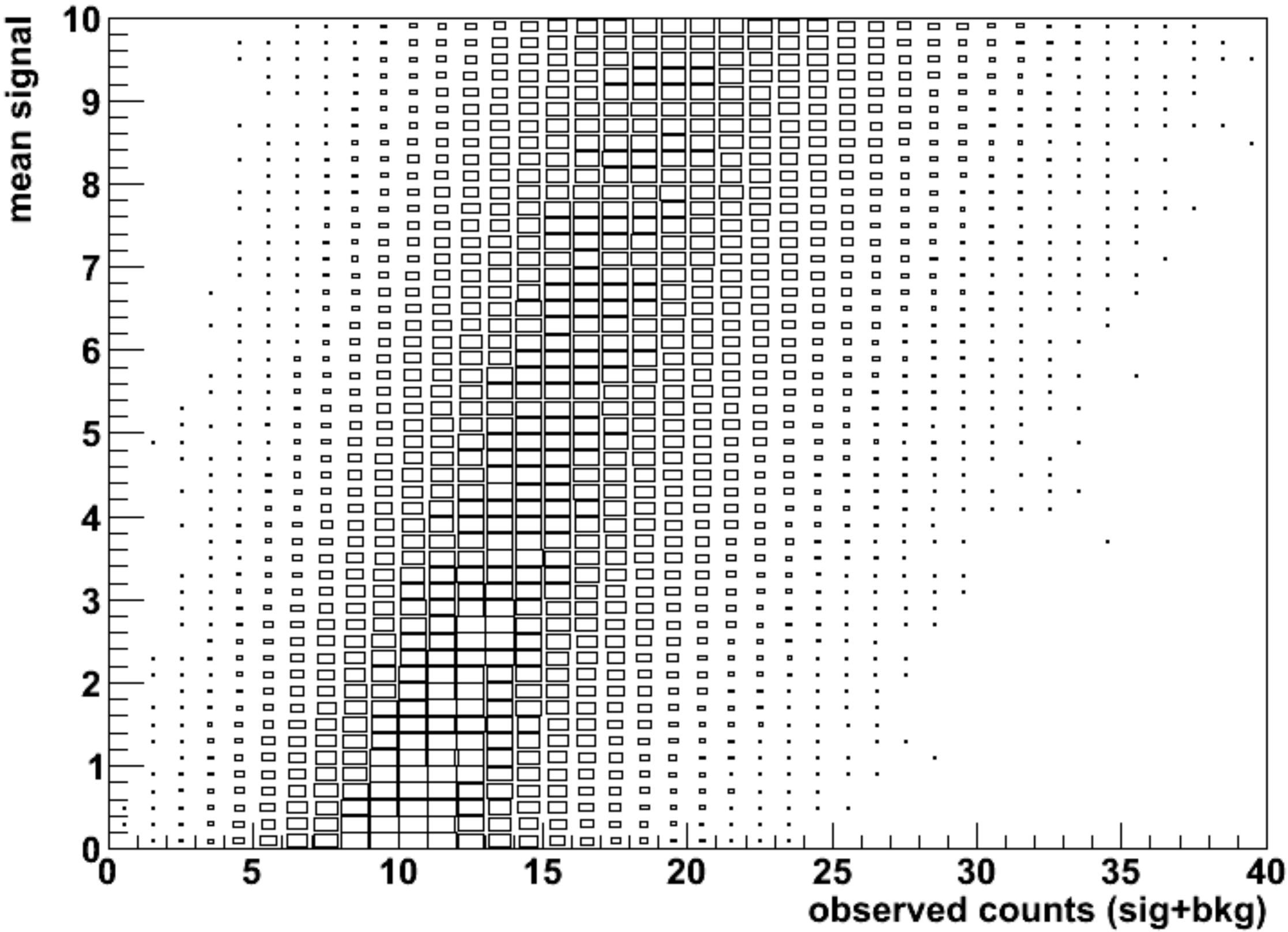
Photo: Freija Descamps

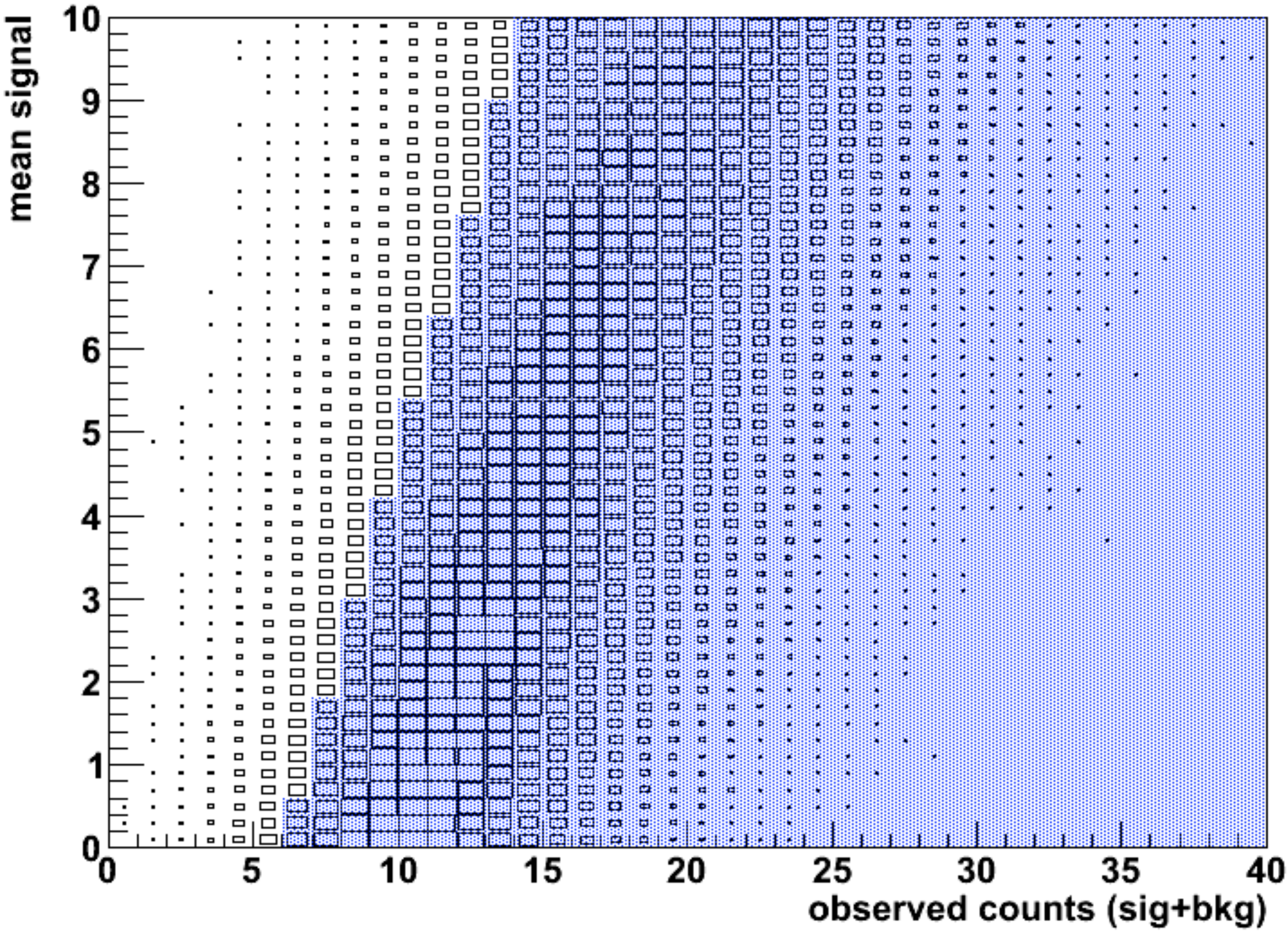
PDF for Counting Experiment with <Bkg>=10



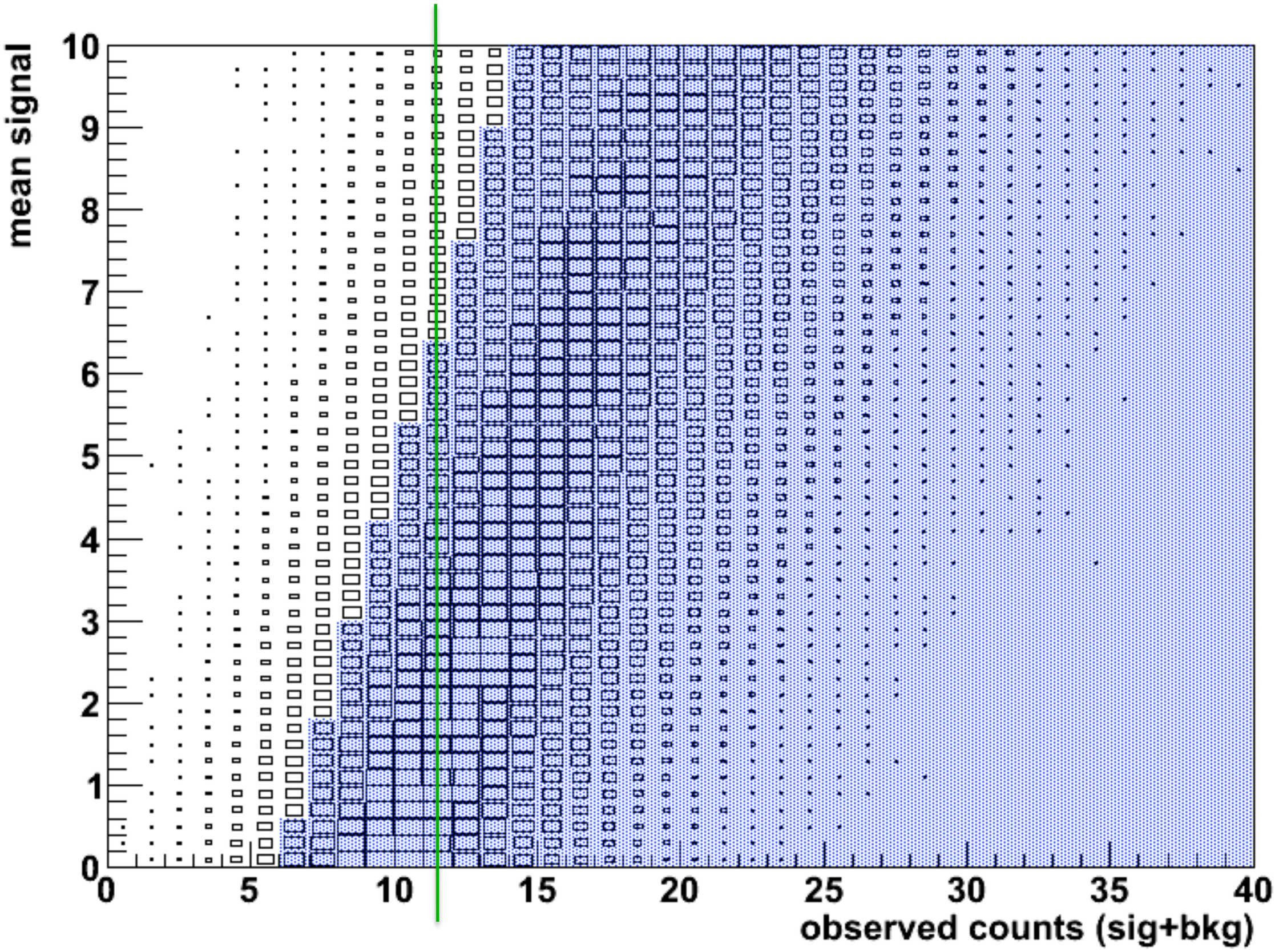
PDFs for S+B for with <Bkg>=10



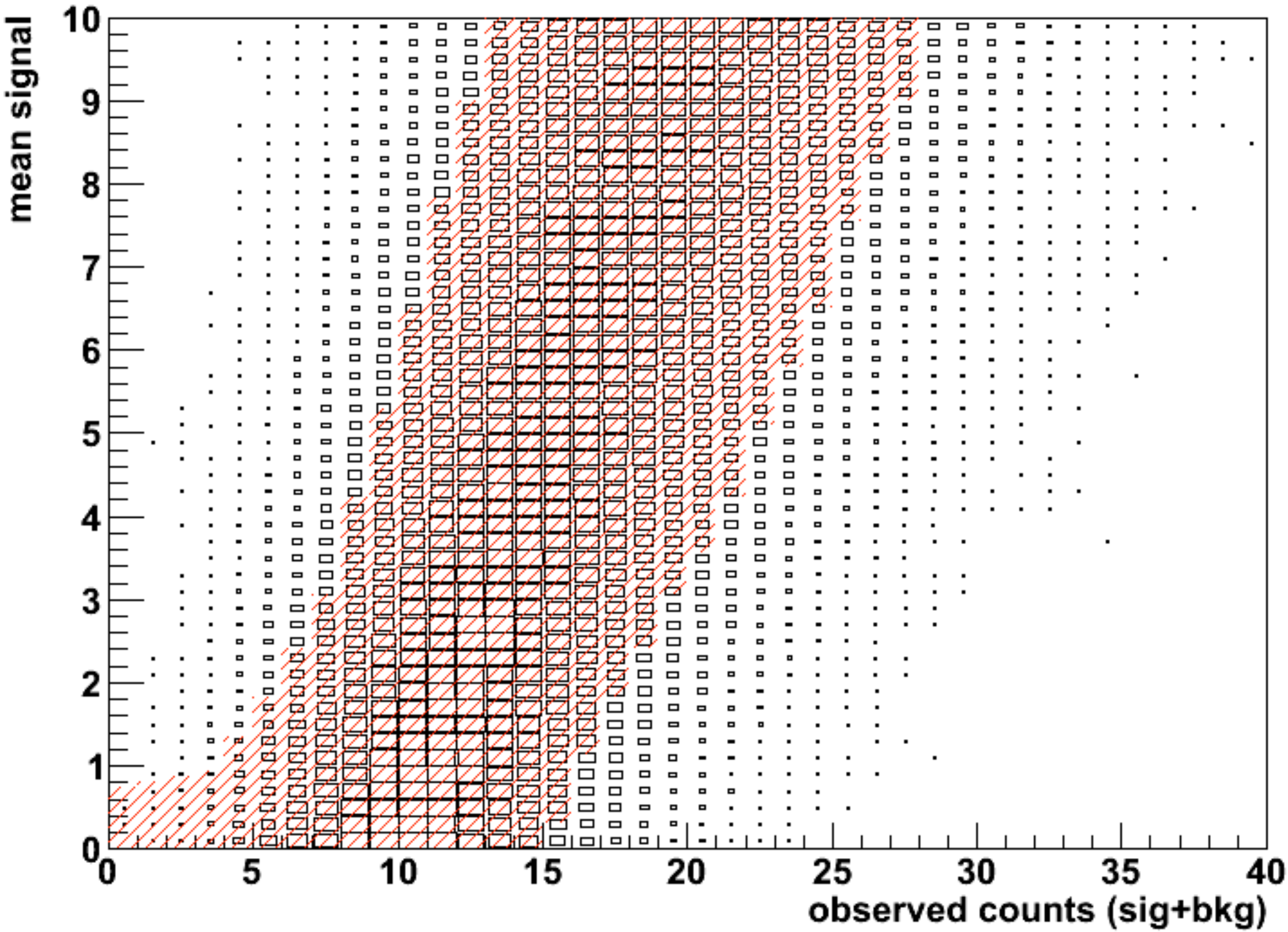
Classical Frequentist (Neyman) Upper Limit



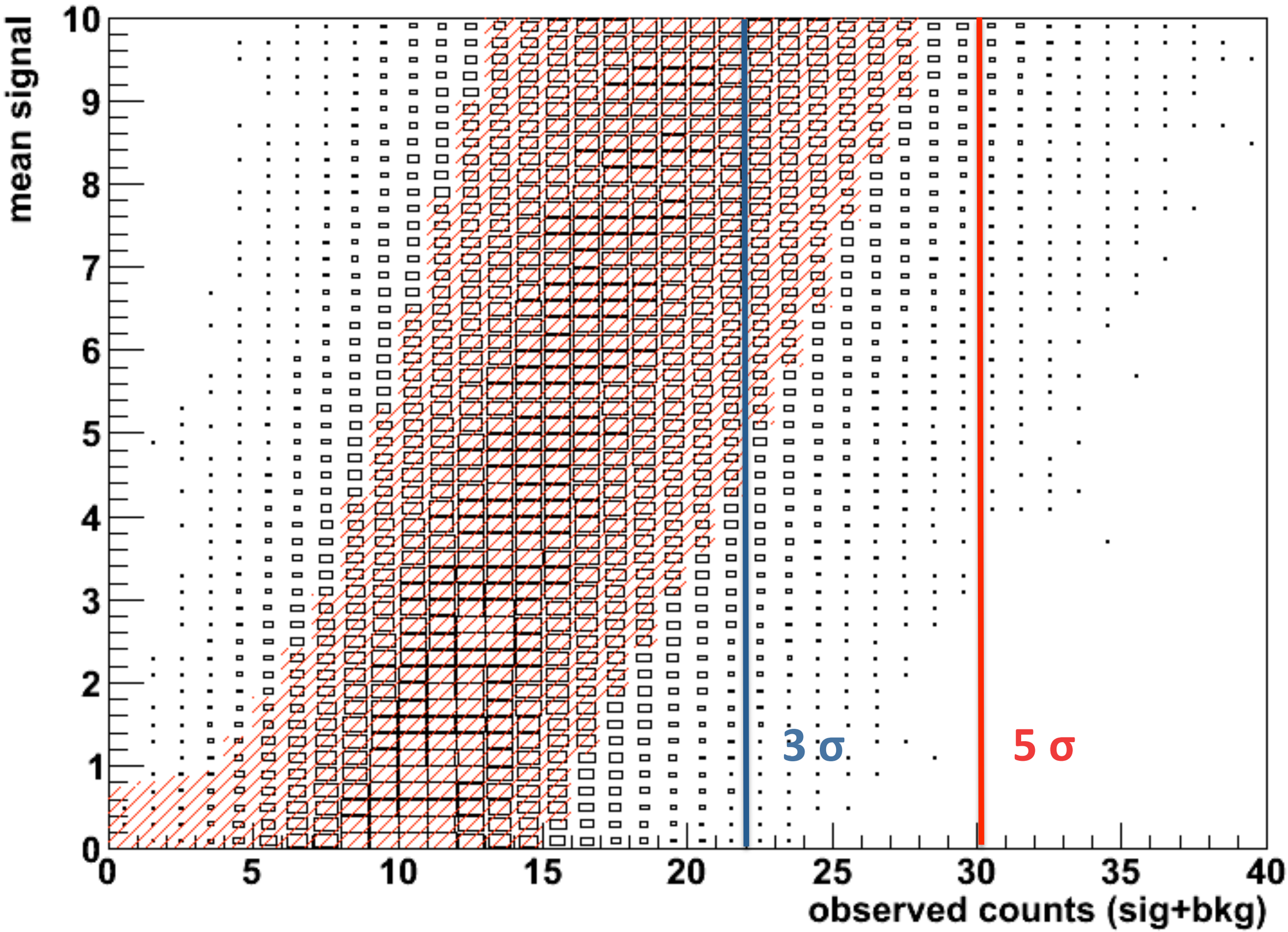
Classical Frequentist (Neyman) Upper Limit

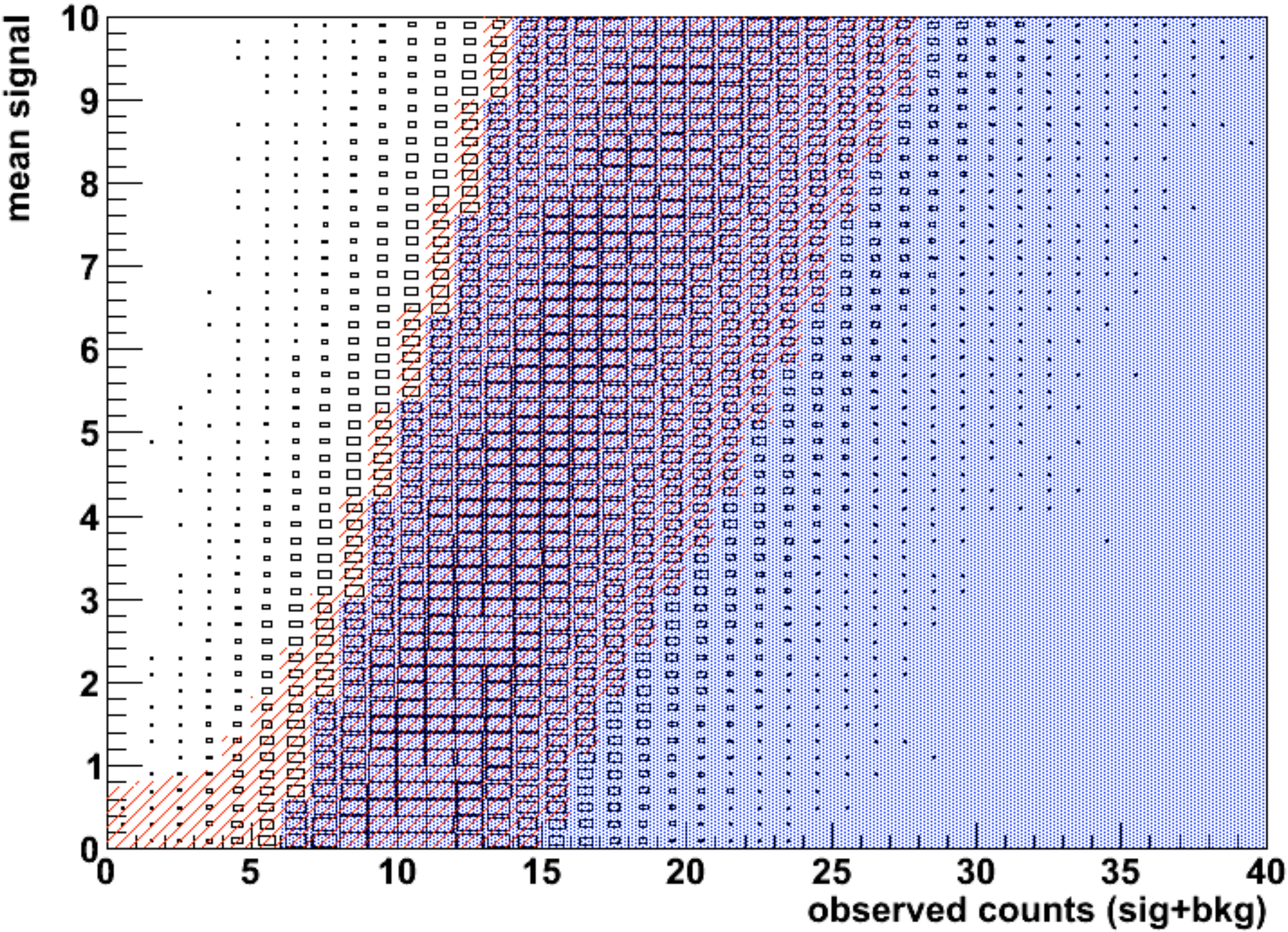


Feldman-Cousins Confidence Intervals

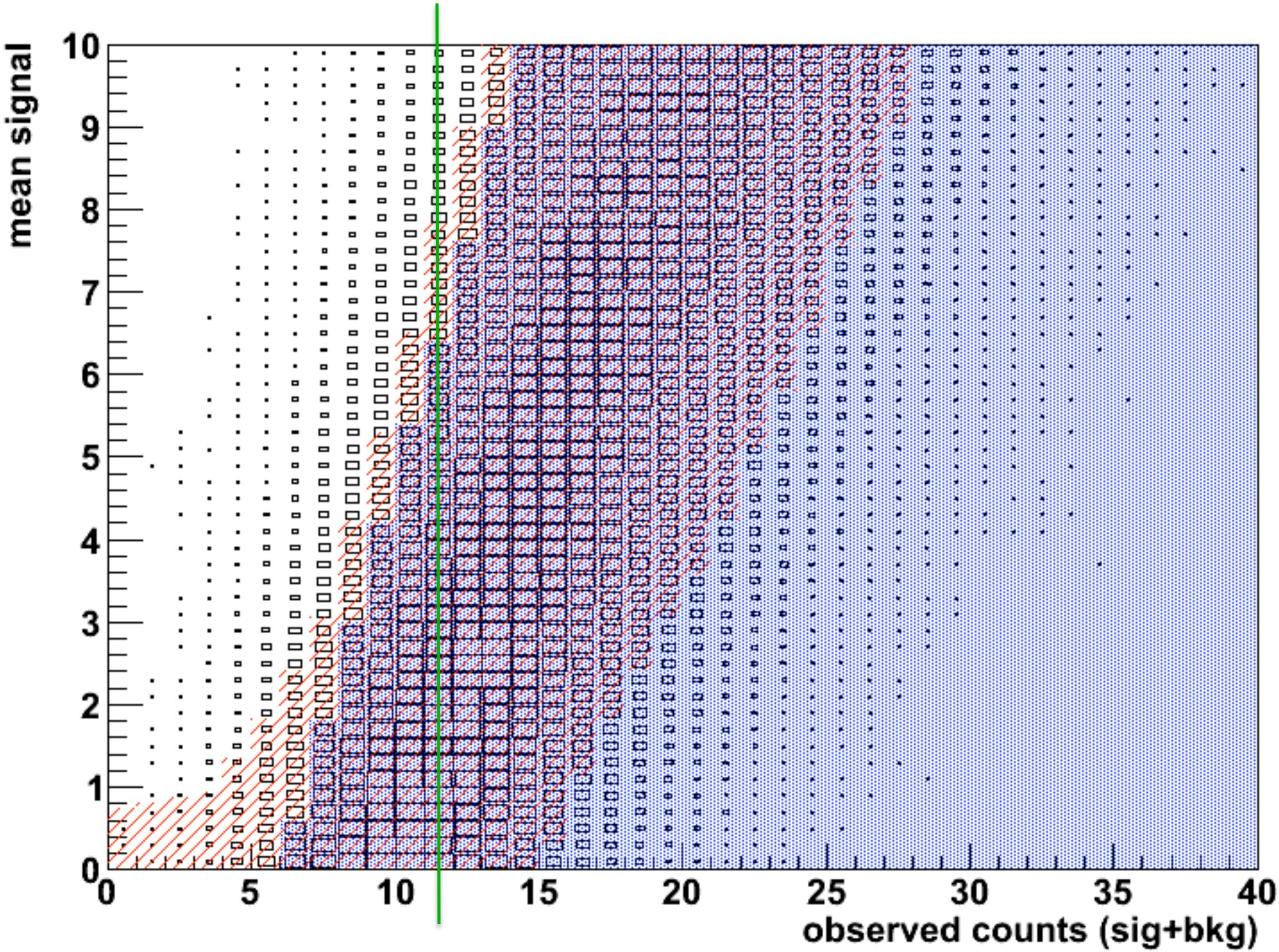


Feldman-Cousins Confidence Intervals

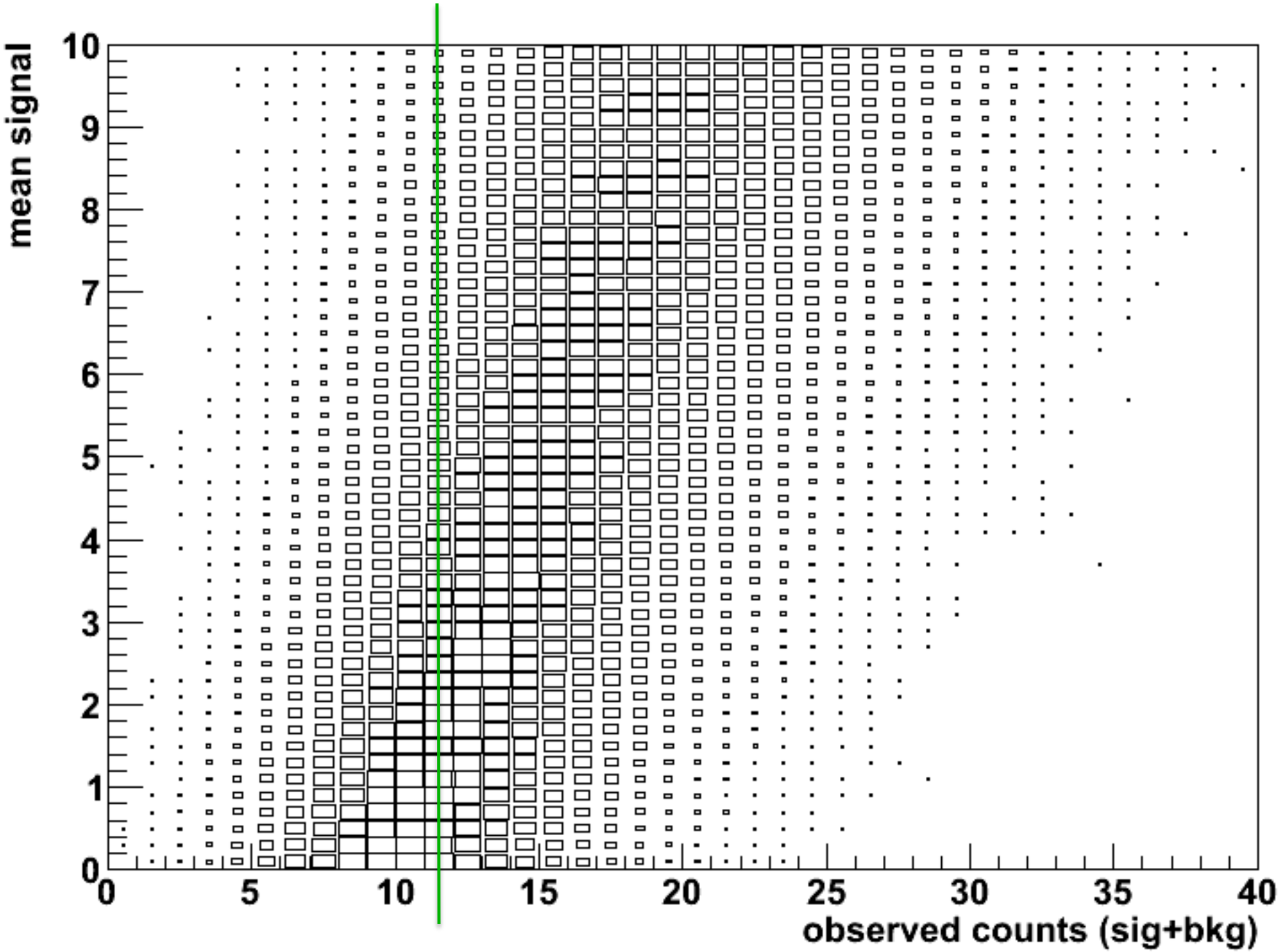



mean signal
0
1
2
3
4
5
6
7
8
9
10
0
5
10
15
20
25
30
35
40
observed counts (sig+bkg)

Different Limits for, e.g., N_{obs} =12



Limits are different reductions of full information



What is used in IceCube Point Source Analyses?

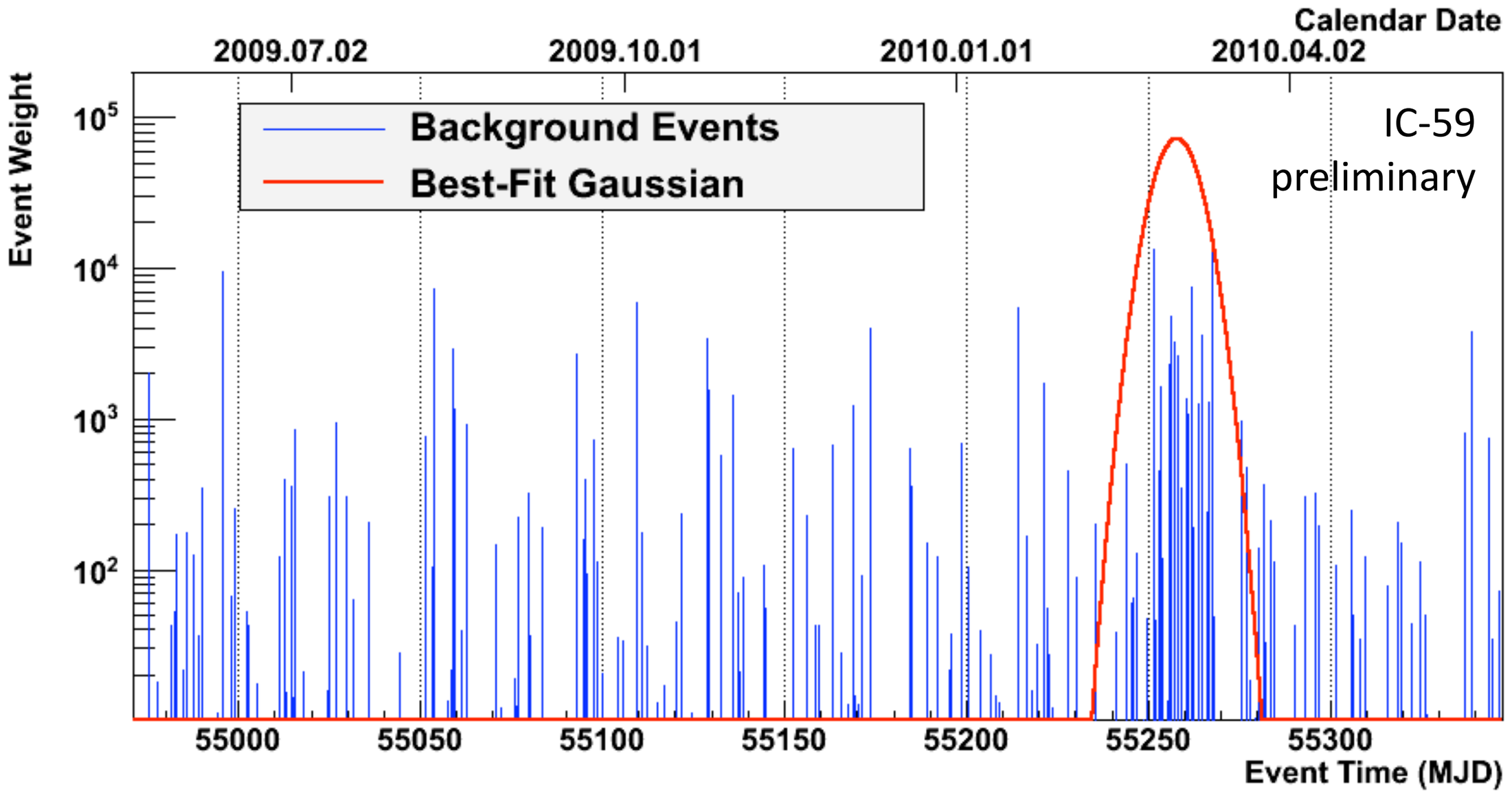
IC40 "Steady" Point Source Paper (ApJ)

- Uses **Feldman-Cousins** Construction of Confidence Intervals (i.e. F&C up. Lim.)
- States and includes **convolution of systematic uncertainties** into limits
- Calculates limits on both ν_μ and **$\nu_\mu + \nu_\tau$ combined**

IC40 Time-Dependent Point Source Paper (ApJ)

- Classical Frequentist Upper Limit (not F&C)
- States (but does not convolve) systematic uncertainties
- ν_μ flux limits only

Time-Dependent Search: Untriggered Flare Search

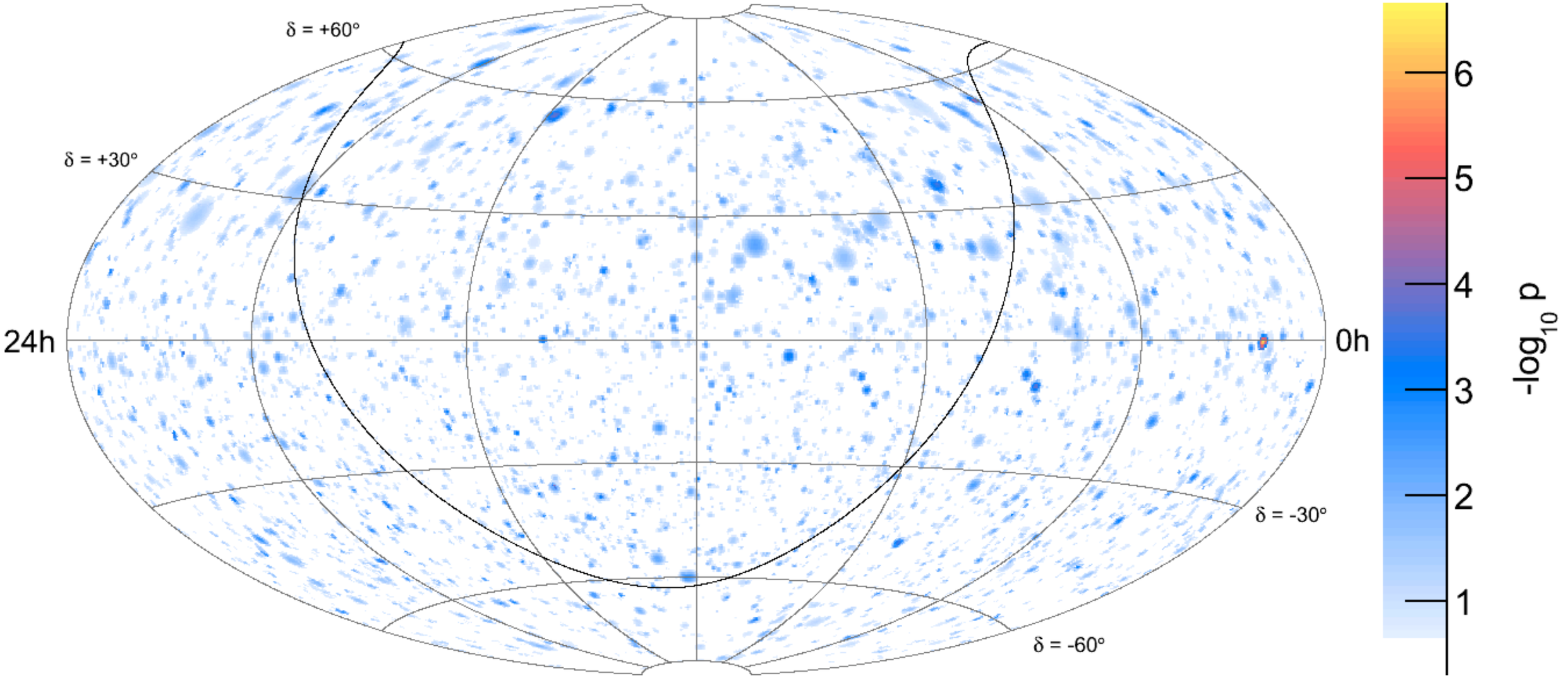


Likelihood analysis

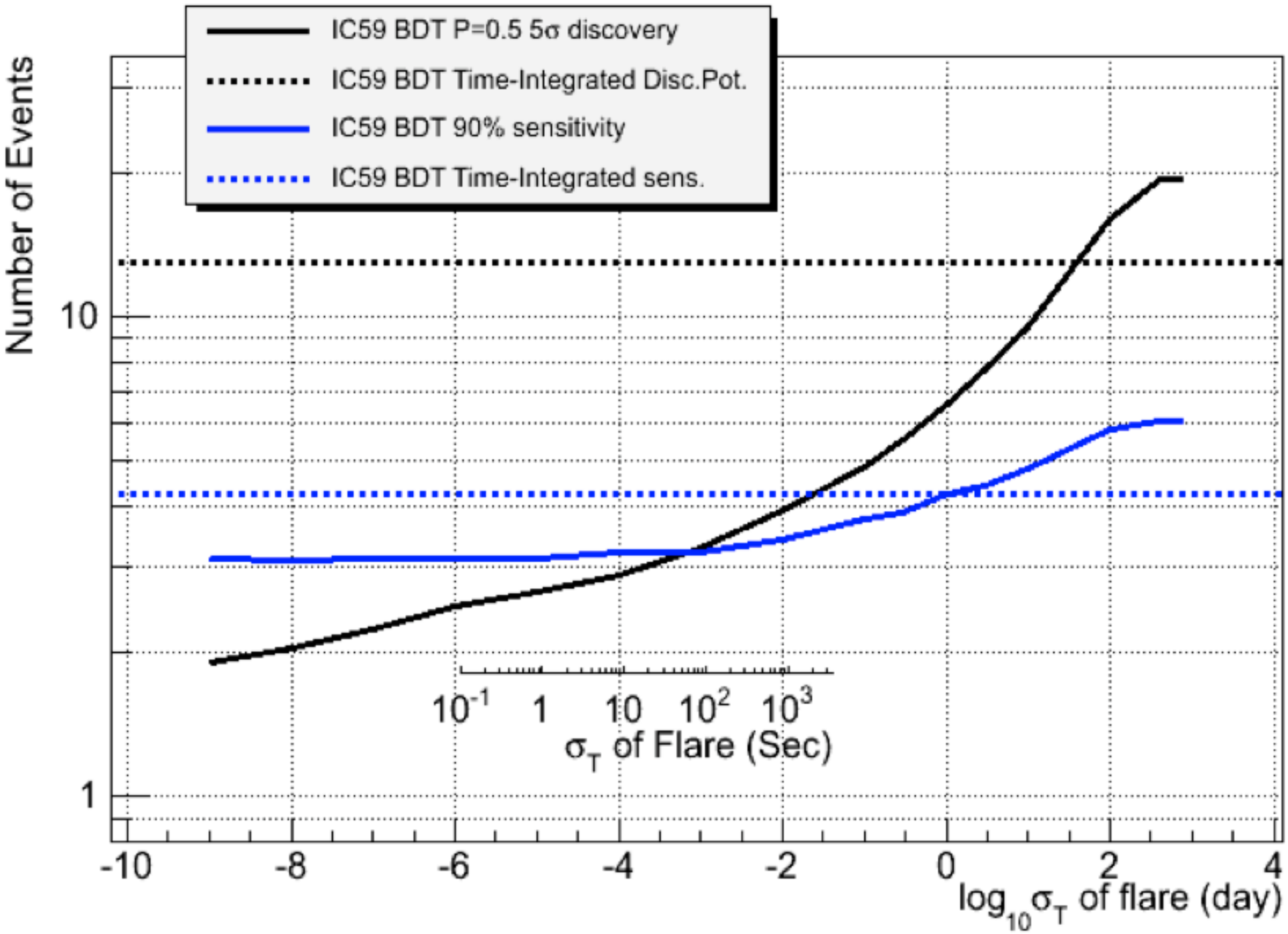
using: direction, angular unc., energy, time

fitting 4 params: Nevents, spectral index, mean time of flare, width of flare

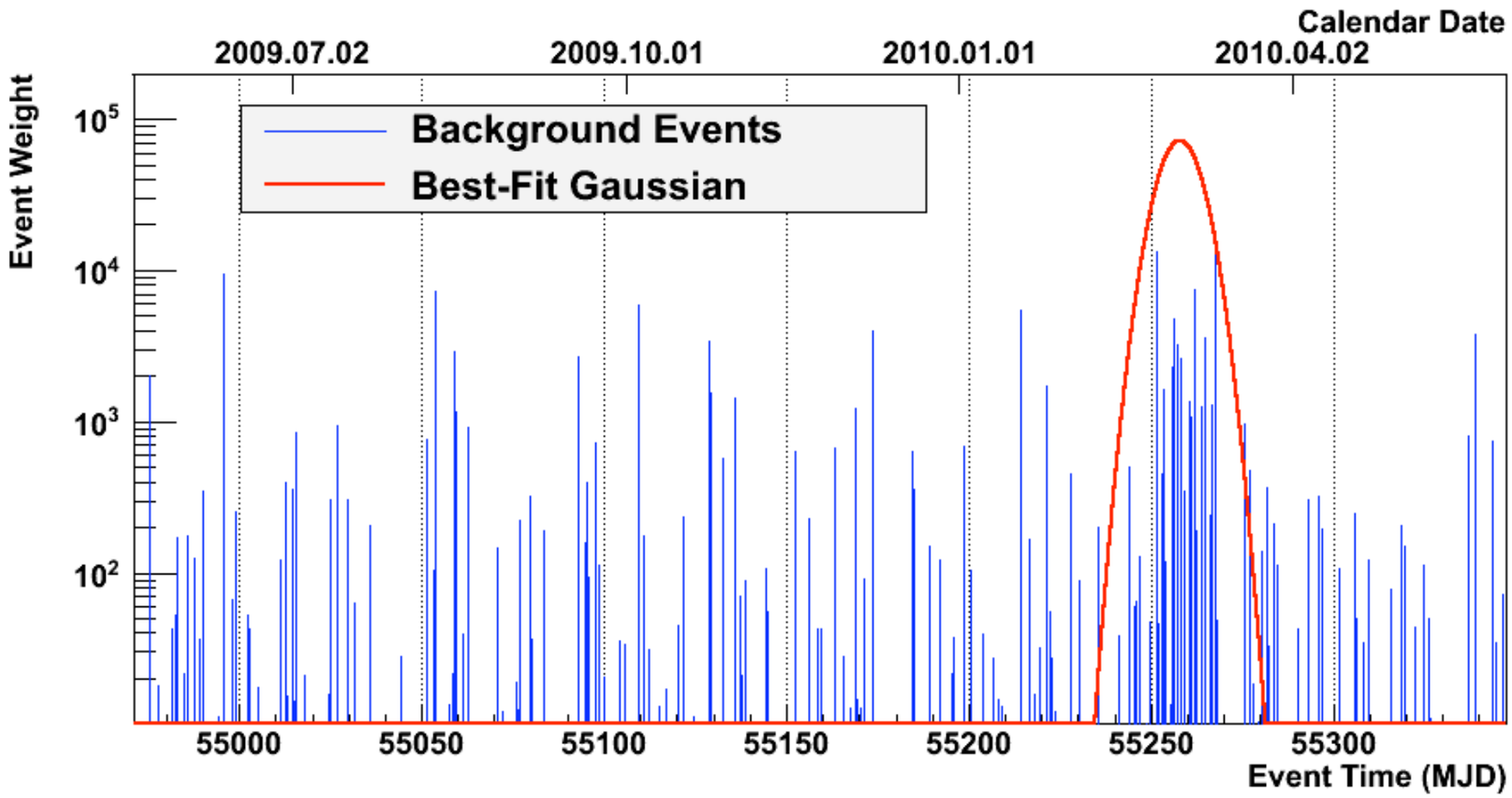
All-sky Search: Report most significant “flare” at each dir.



Sensitivity of Flare Search at one Direction



Untriggered Flare Search: Limits



How do we present upper limits?

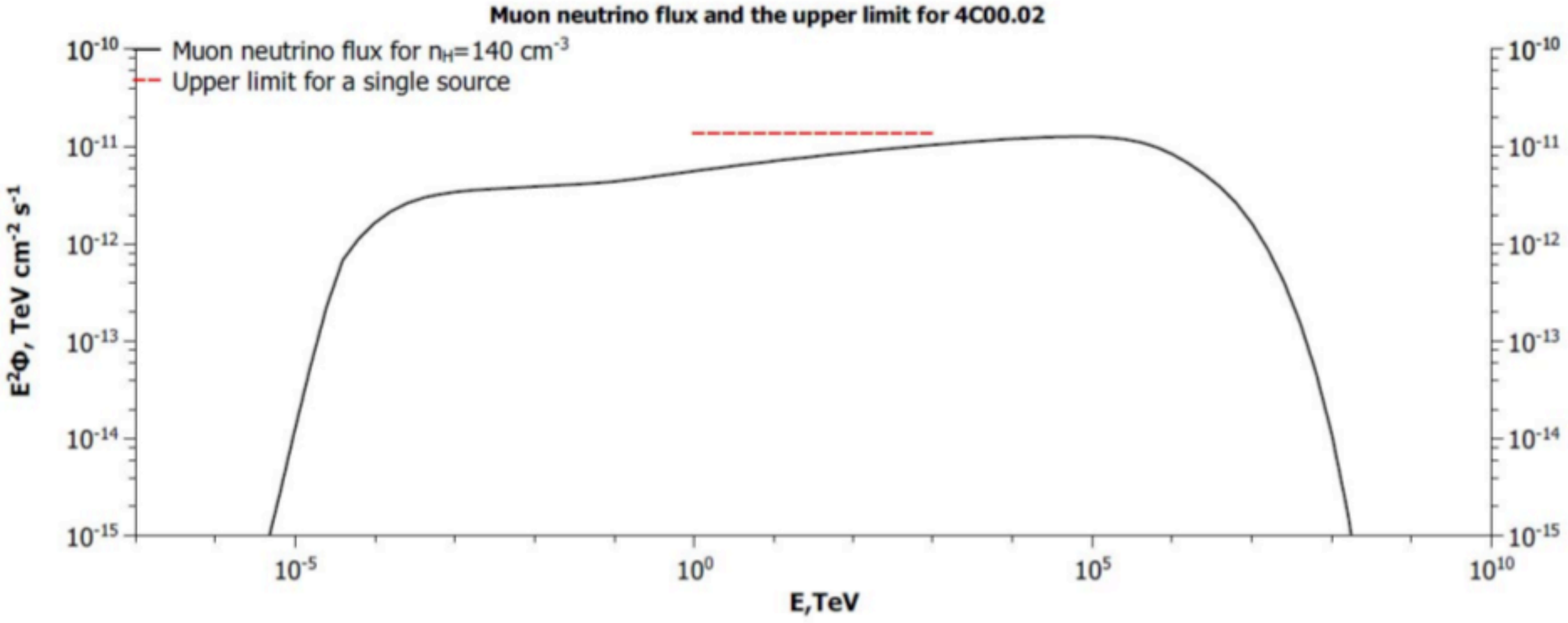
Currently: **report upper limit for window corresponding to flare**

Of course, can calculate upper limit for any time-range within the data sample

Although these are “only” limits, it is still a time-dependent map of the sky with additional constraining power when combined with astro observations

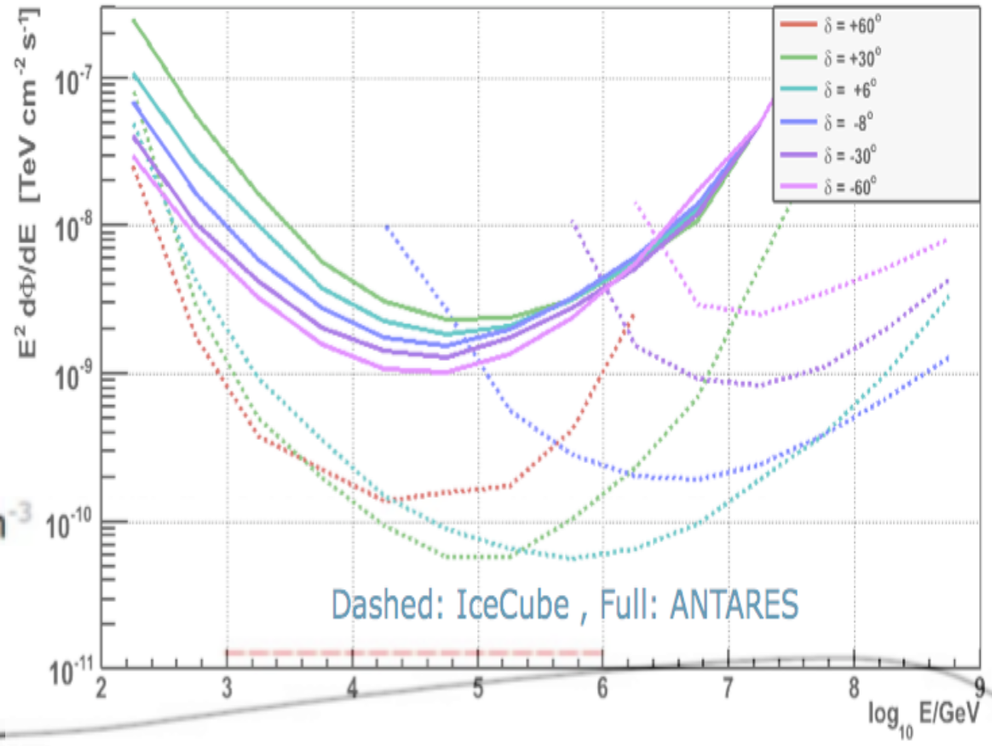
Limits for Specific Energy Spectra

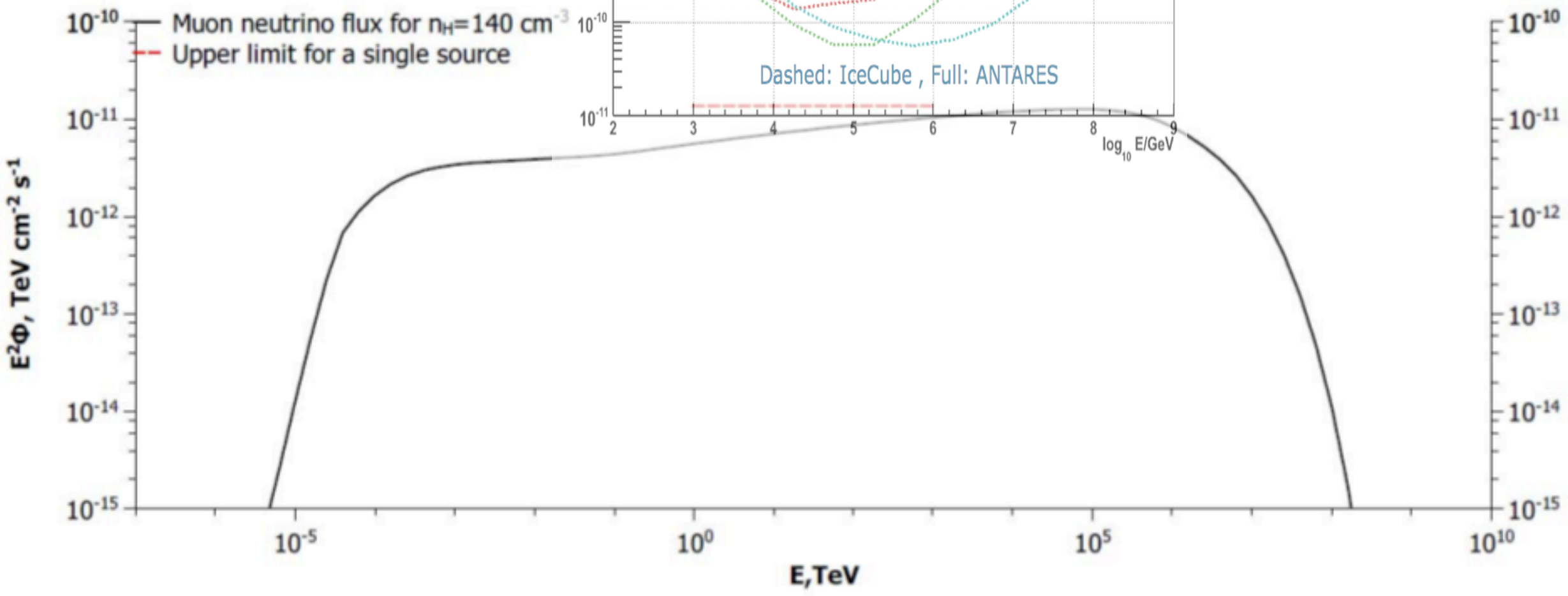
J.K. Becker



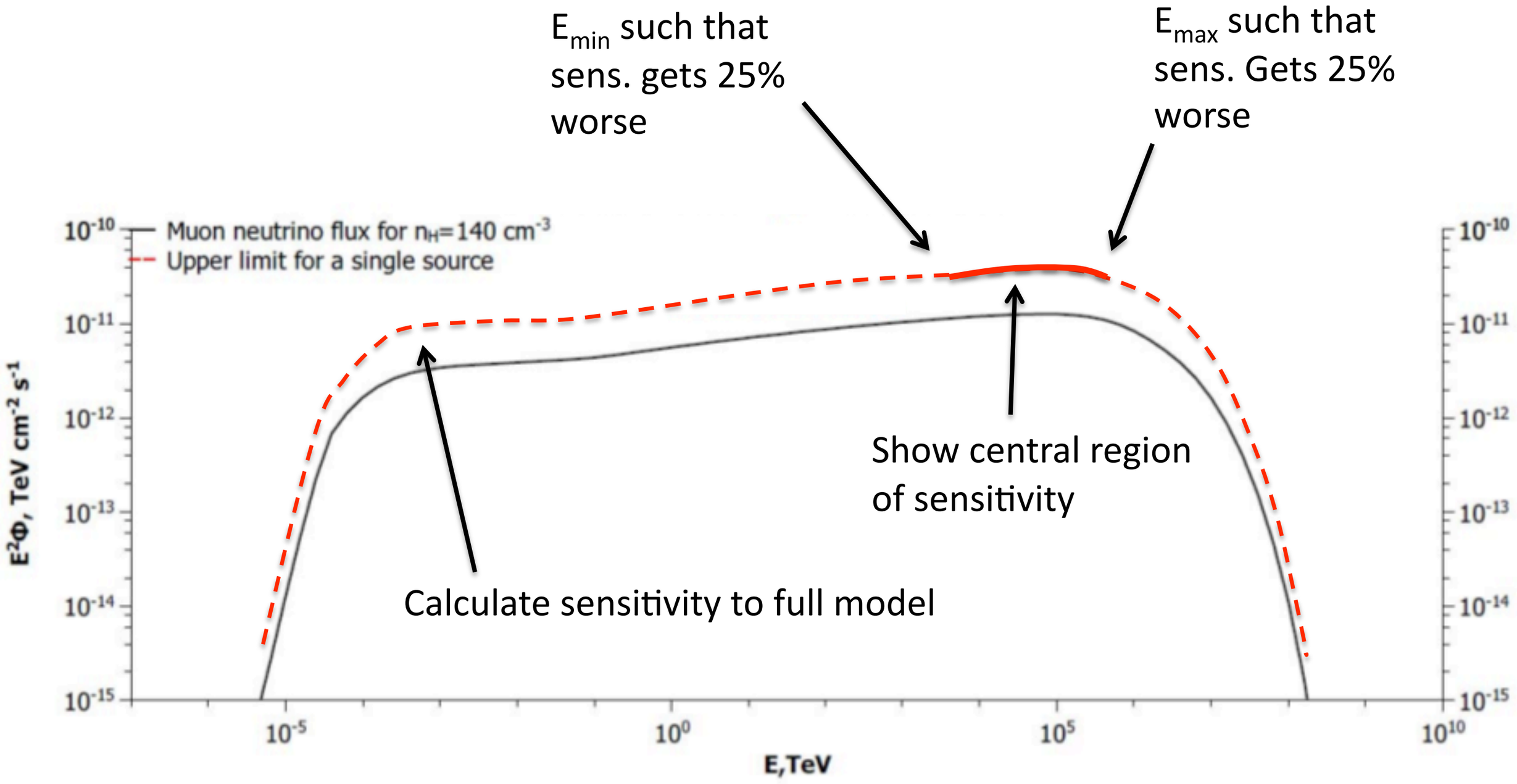
… with IceCube & ANTARES discovery potential

J. Brunner





Show limit for model and indicate peak sensitivity range



For IceCube, sensitivity to model peaks in different energy ranges, depending on declination

Summary

- Limits reduce information in full set of S+B pdf's into 1 (or 2) numbers
- Many choices how to do it; always lose information

- **If speed is important**, then classical Neyman frequentist upper limits much faster than: Feldman-Cousins + systematics + $\nu_\mu + \nu_\tau$
- (Maybe not an issue with complete detector…. Then again maybe still an issue for online analyses…)

- Multi-dimensional analyses have much more information than we currently convey: (make available online?)

- Convey energy-range sensitivity, e.g., by finding restriction to E_{min} E_{max} such that sensitivity becomes x% worse