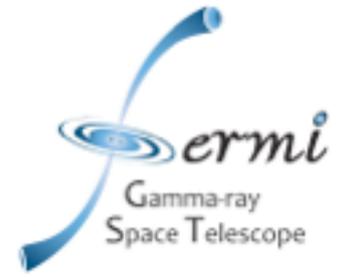




Fermi
Gamma-ray Space Telescope



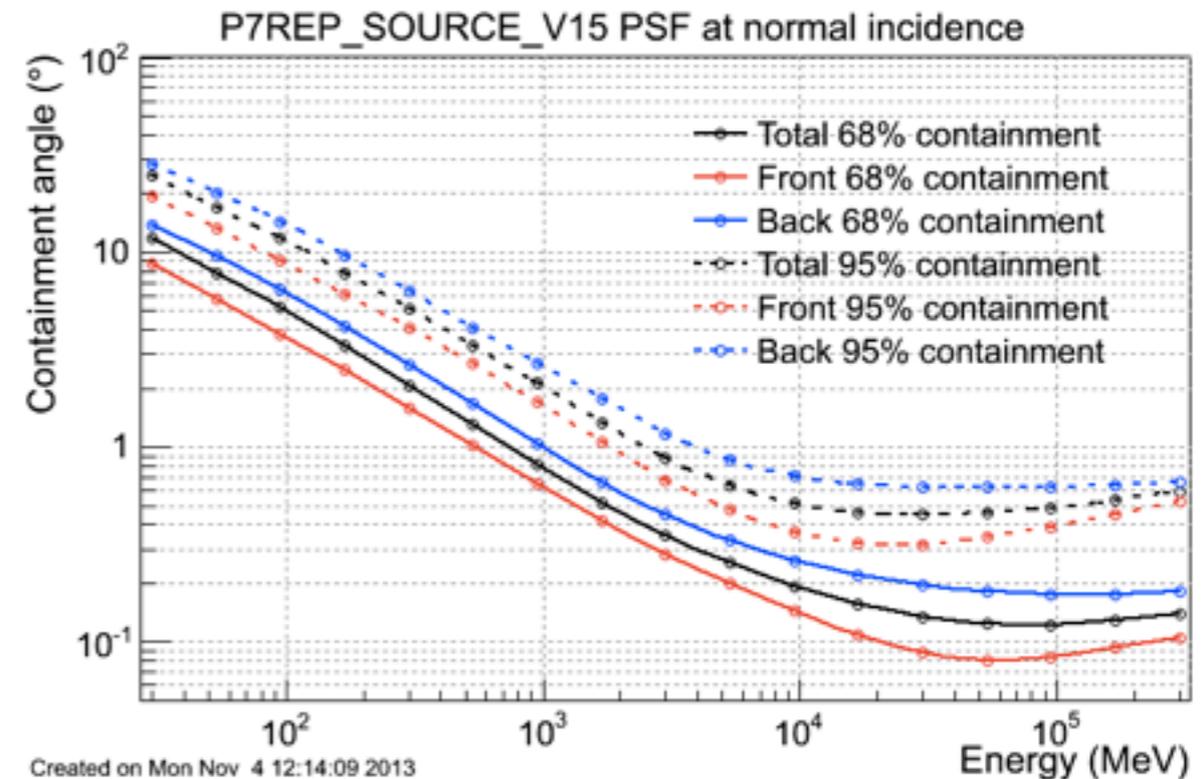
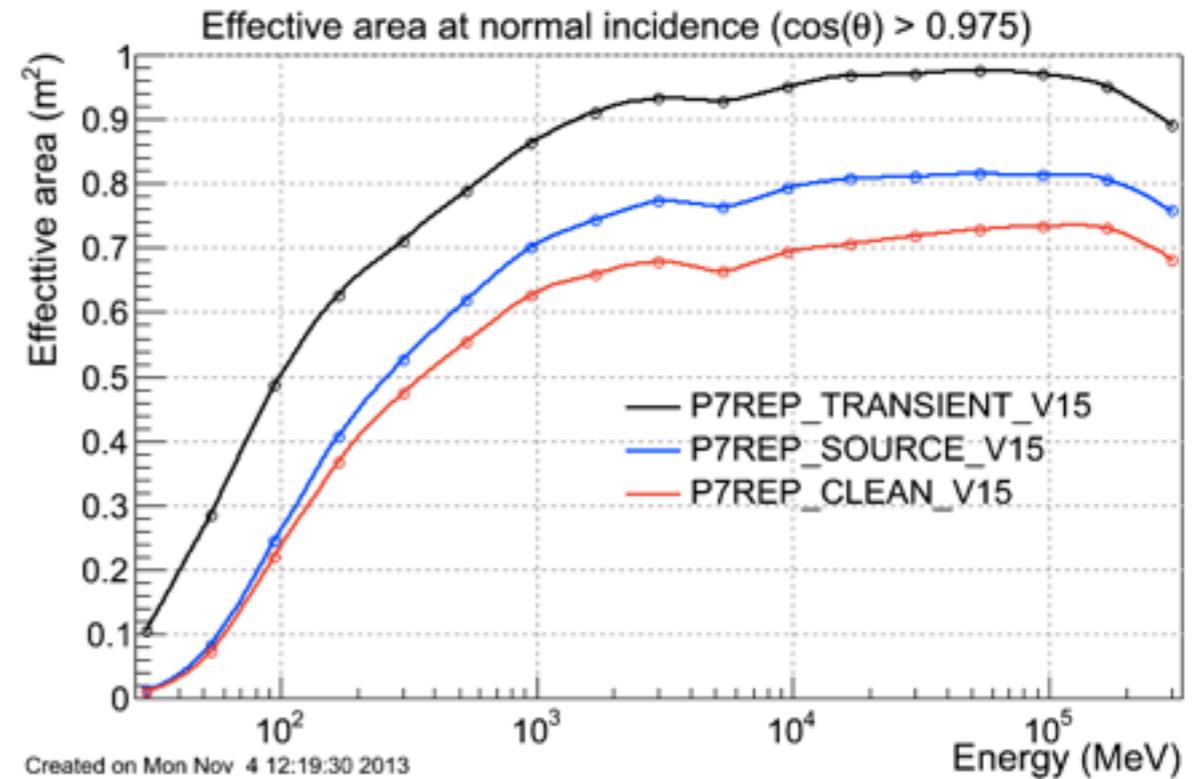
A Modified Likelihood Approach to Search for Faint Sources

Alex Drlica-Wagner
on behalf of the
Fermi-LAT Collaboration

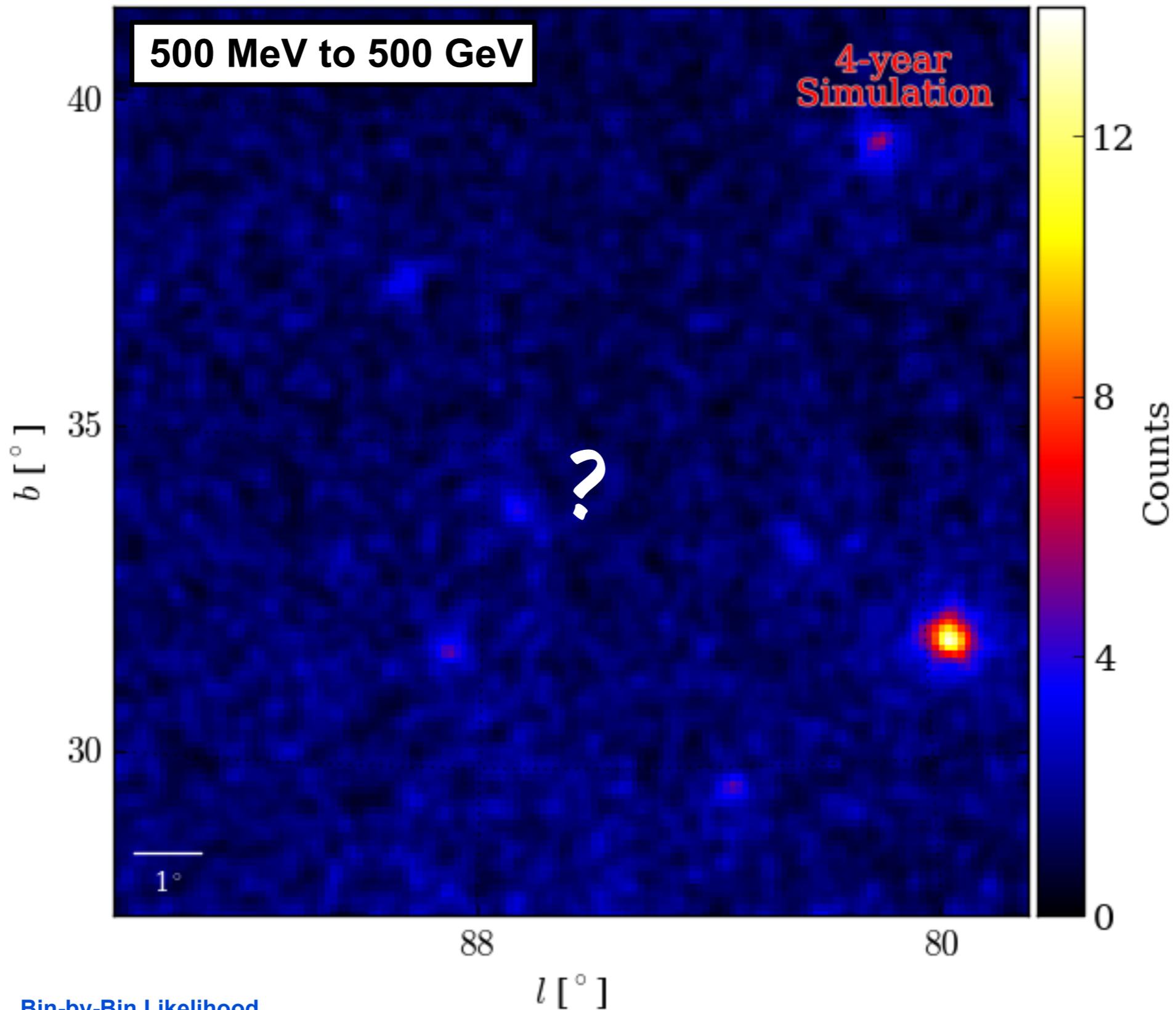
5th Fermi Symposium
October 22, 2014



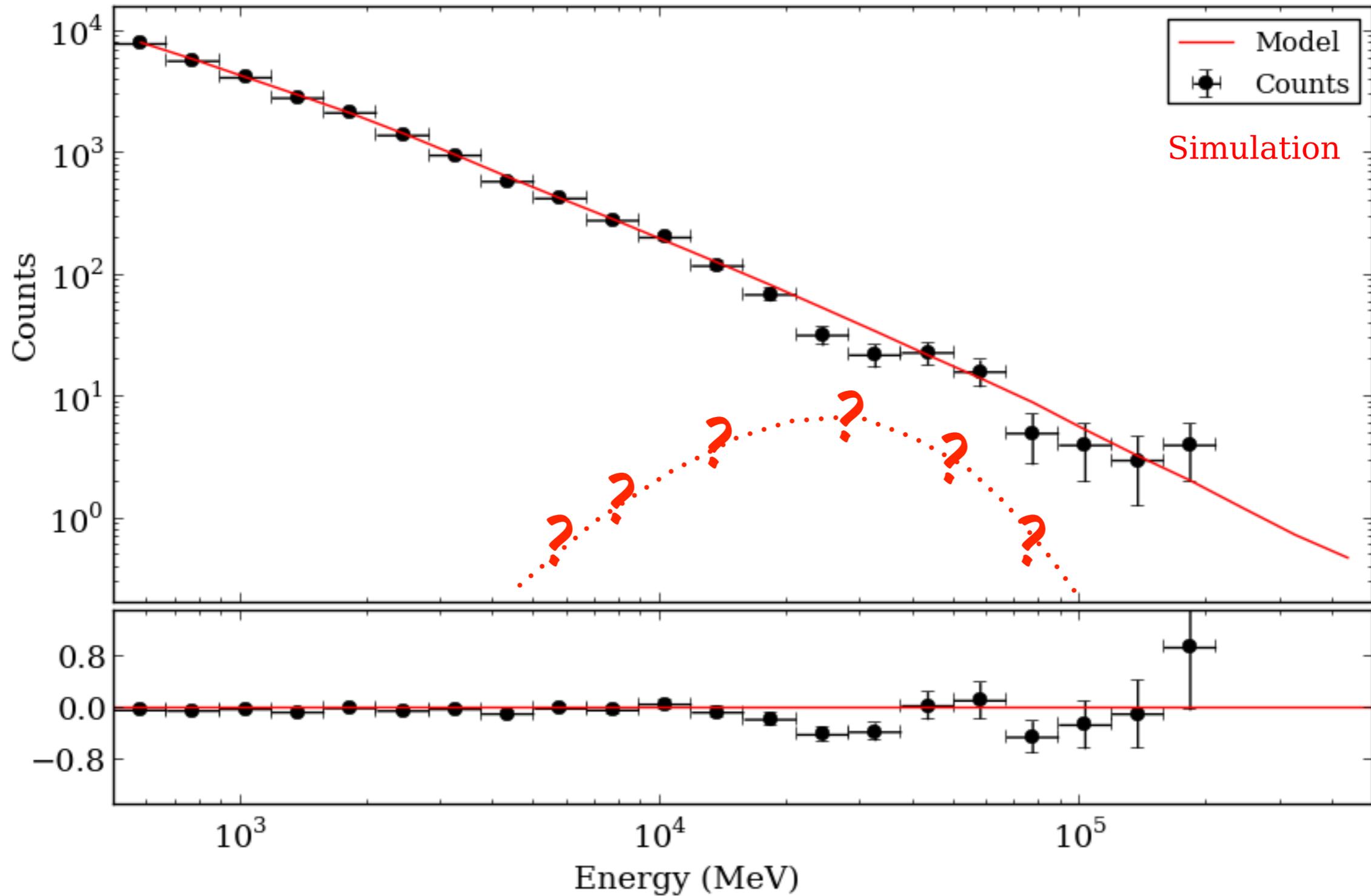
- The LAT data motivate likelihood-based analyses:
 - Strong dependence of instrument performance on energy and geometry
 - All-sky survey strategy
 - Structured gamma-ray backgrounds
- The sensitivity provided by likelihood-based analyses is especially important in searches for faint sources
- However, the likelihood formalism necessitates a model of the gamma-ray sky, **including** the putative source of interest.
- Often the spectrum of the putative source is **unknown**.



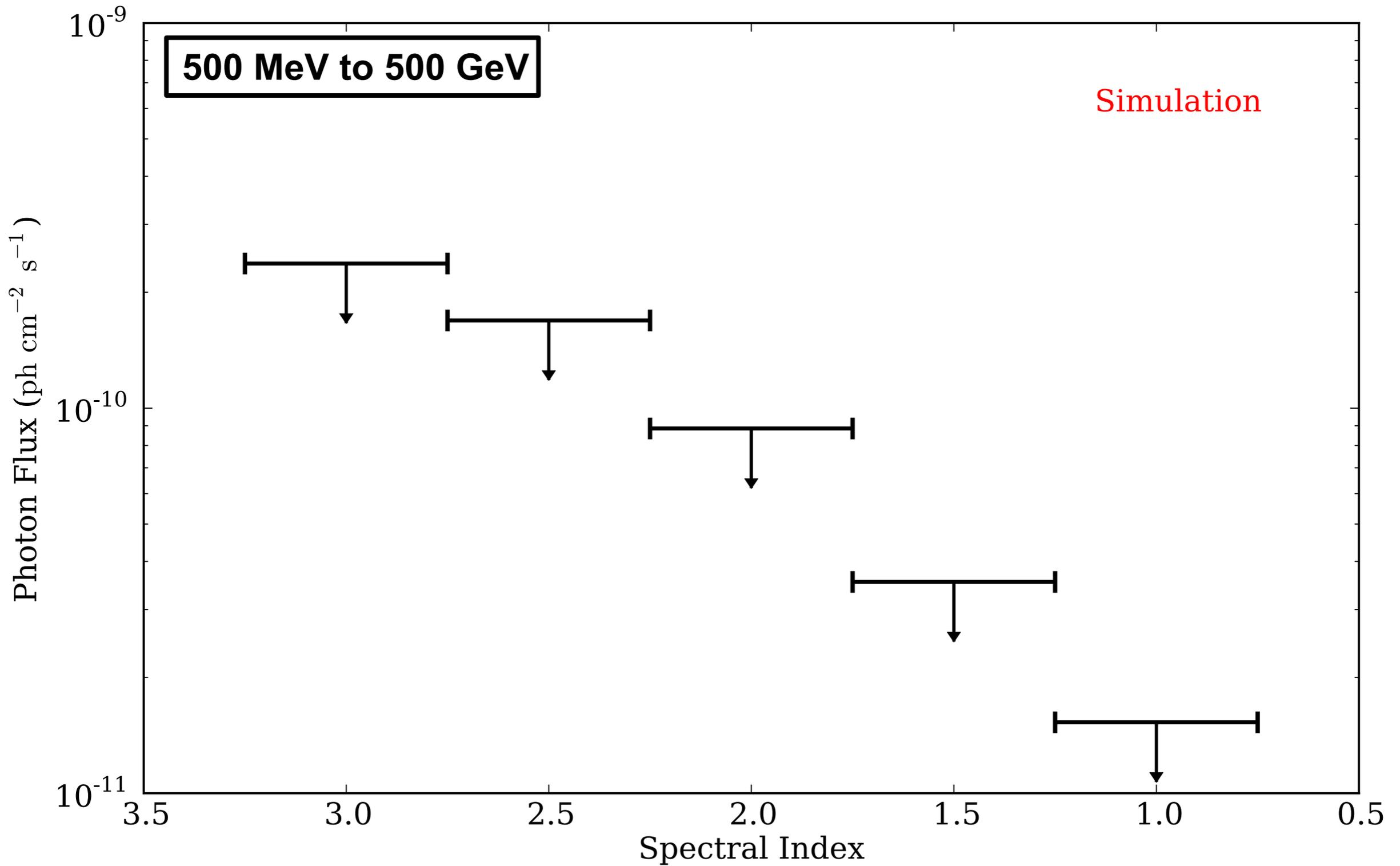
The Problem



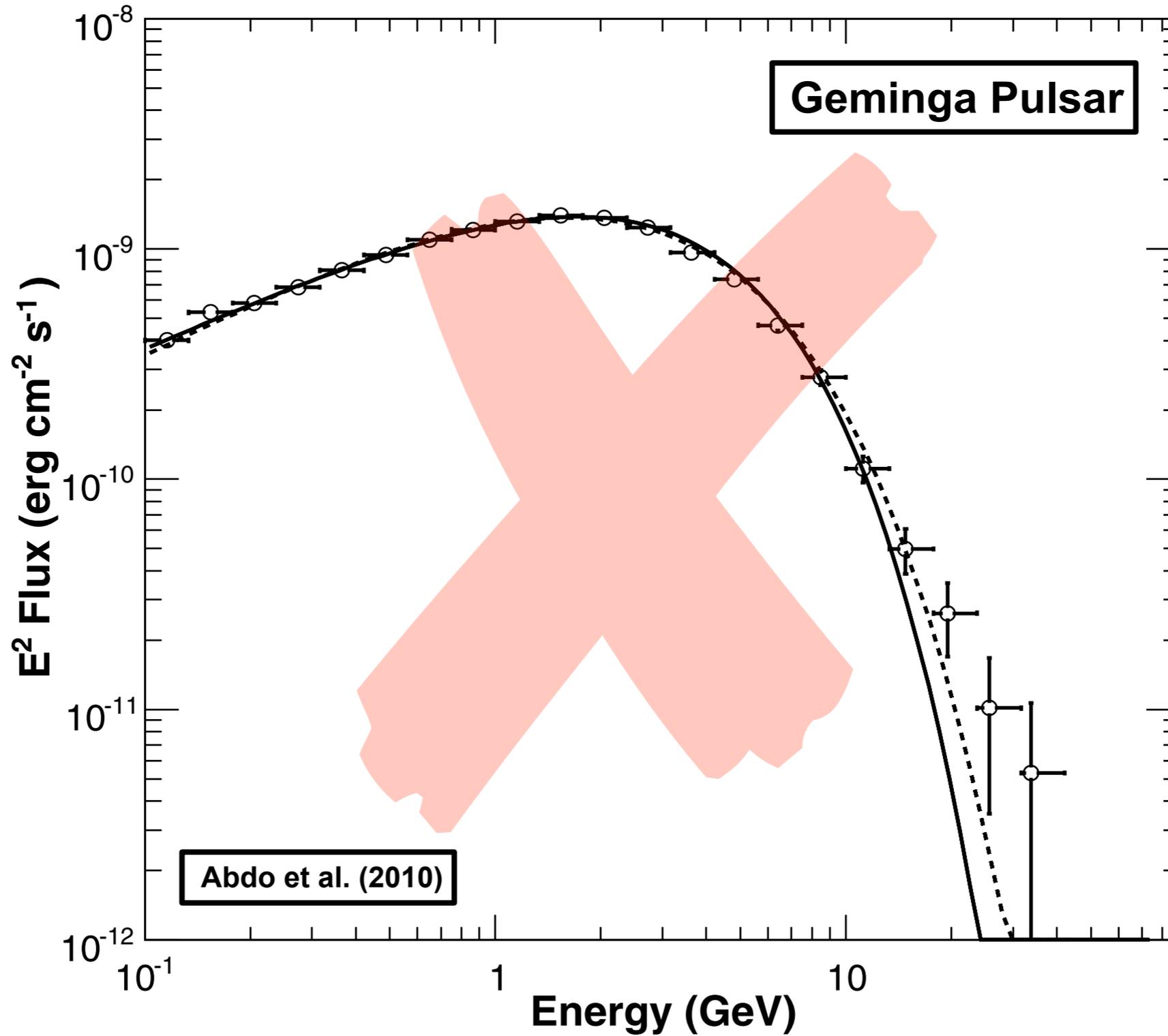
The Problem



The Problem



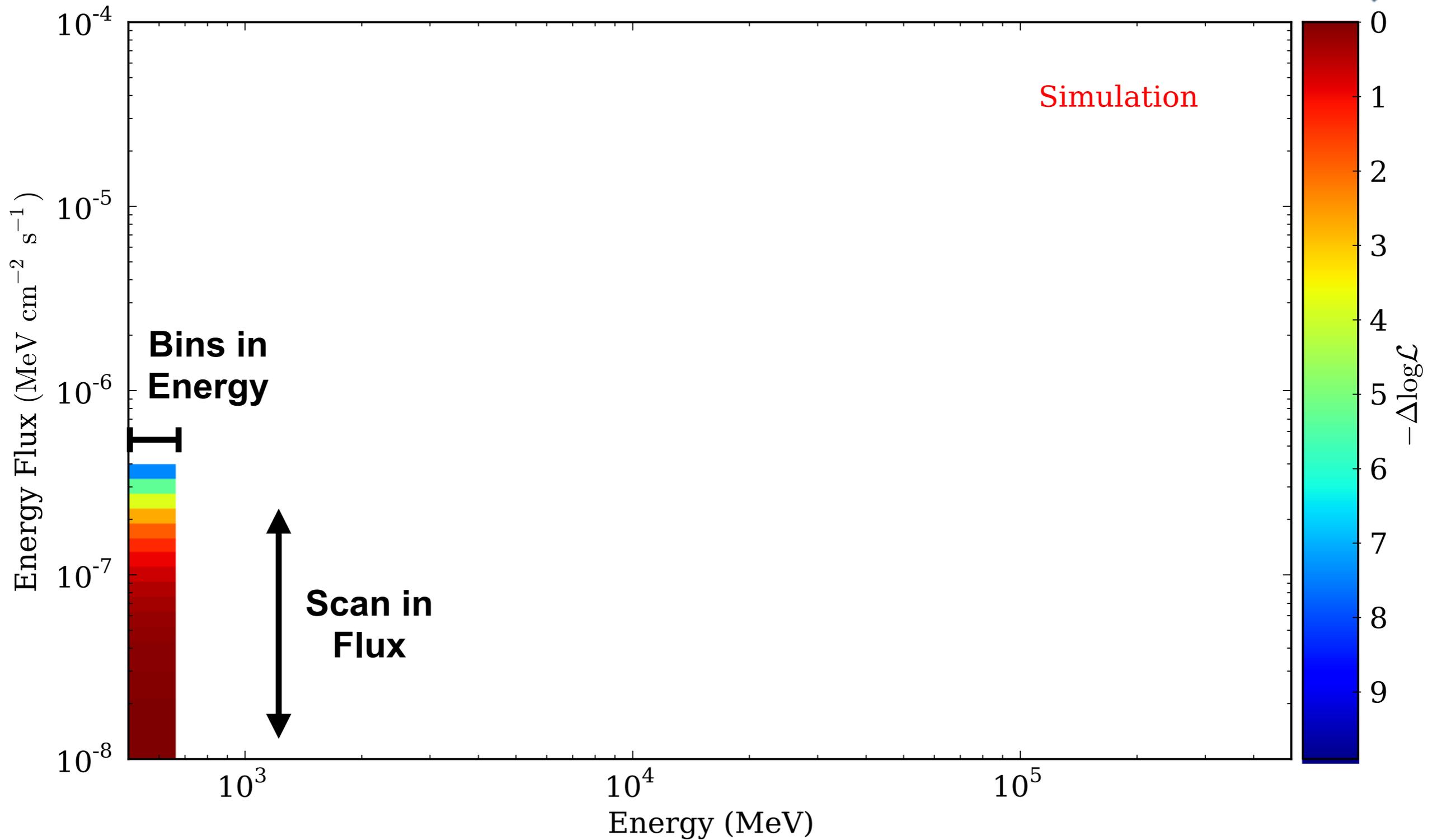
The Problem



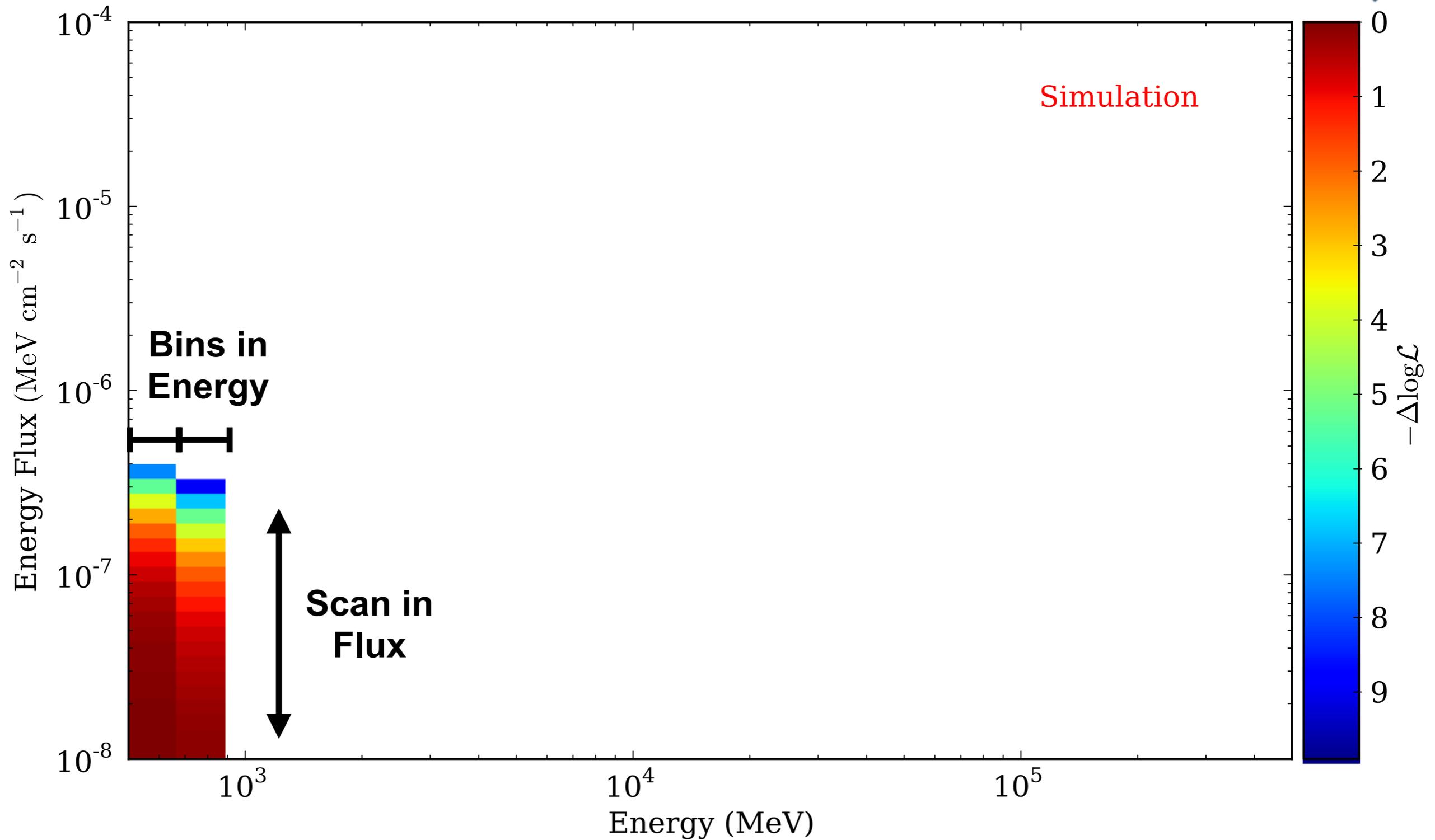


1. **Broad-Band:** Fit the background sources in the region of interest over the broad-band energy range.
2. **Bin-by-Bin:** Model the putative source with a fixed power law within each energy bin.
3. **Bin-by-Bin:** Scan the likelihood in each bin as a function of the putative source flux in that bin.
4. **Bin-by-Bin:** Assemble a 2D likelihood surface as a function of photon energy and putative source flux.
5. **Bin-by-Bin:** Measurements of (upper limits on) the putative source flux can be set in each energy bin individually.
6. **Broad-Band:** Assuming a broad-band spectrum for the putative source can compress the likelihood surface into the common 1D likelihood as a function of putative source flux.

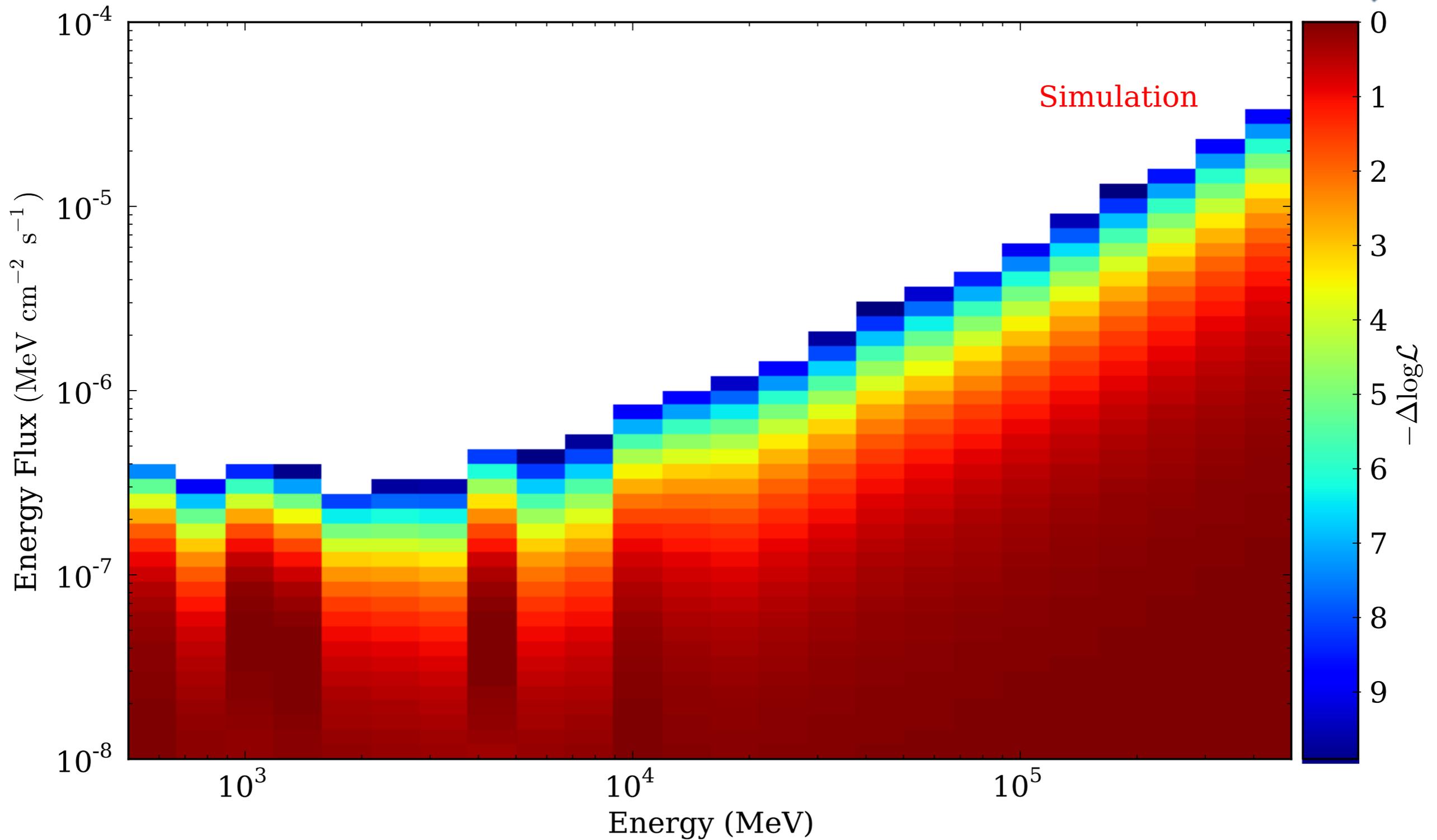
The Recipe



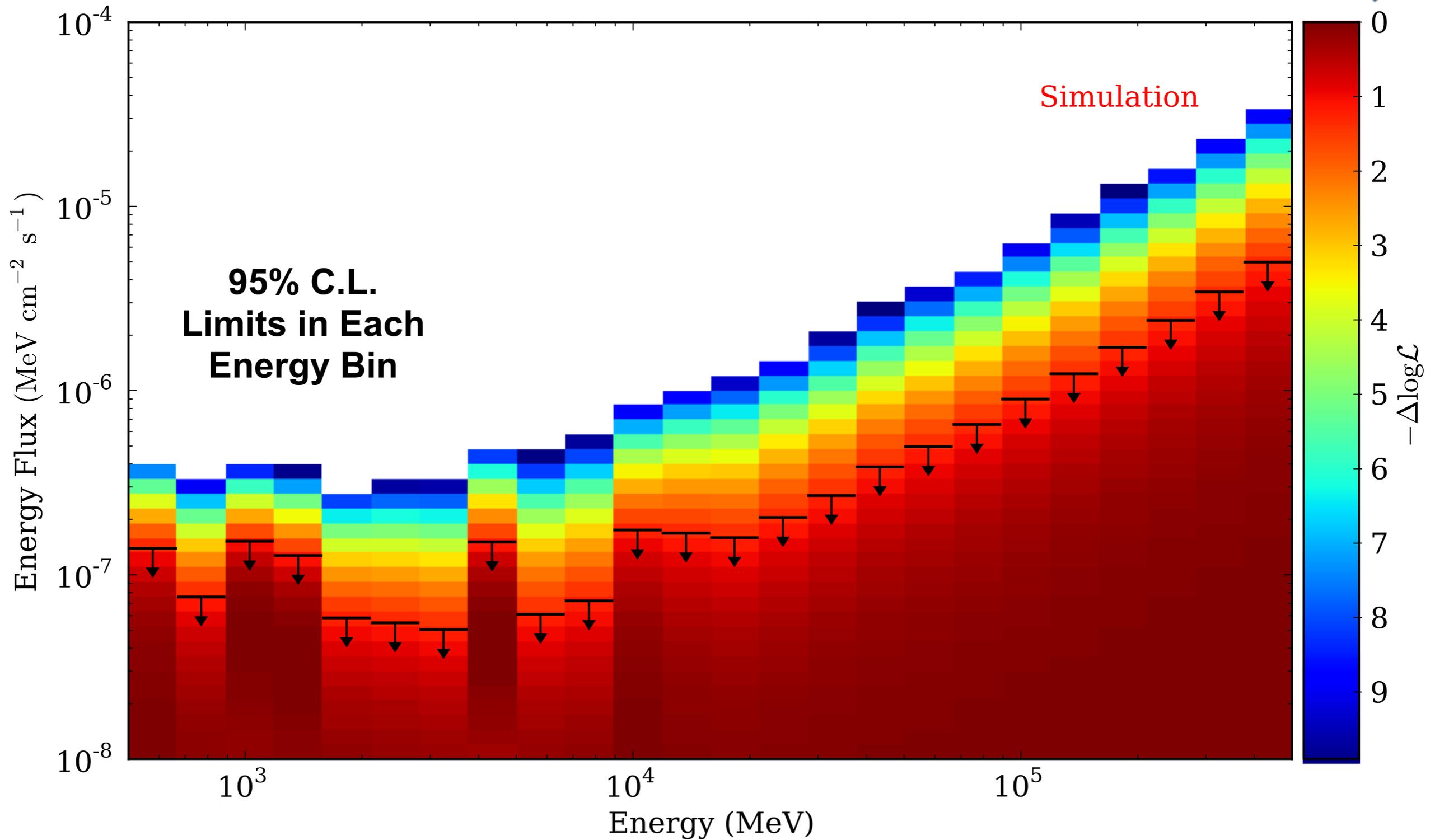
The Recipe

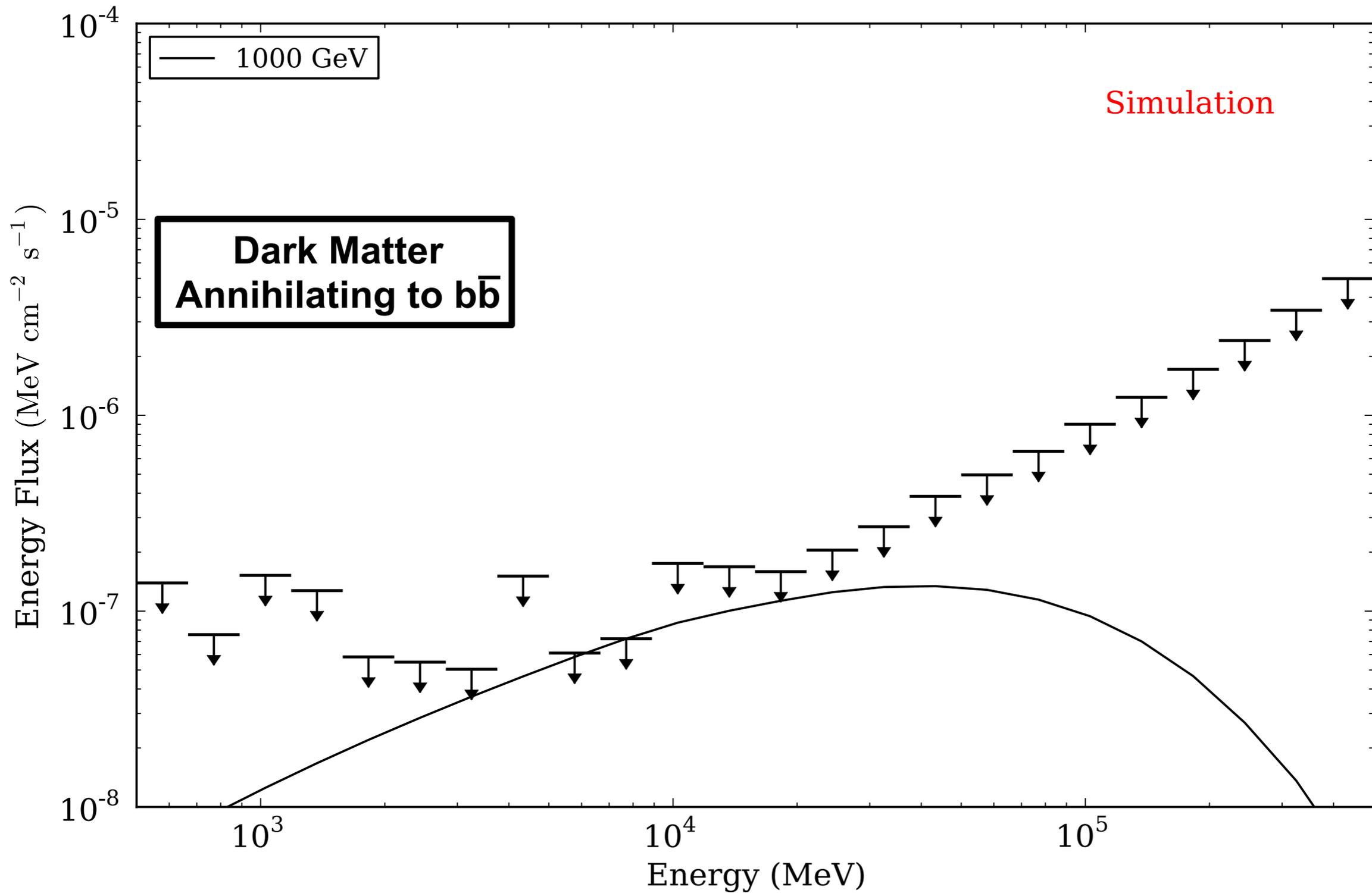


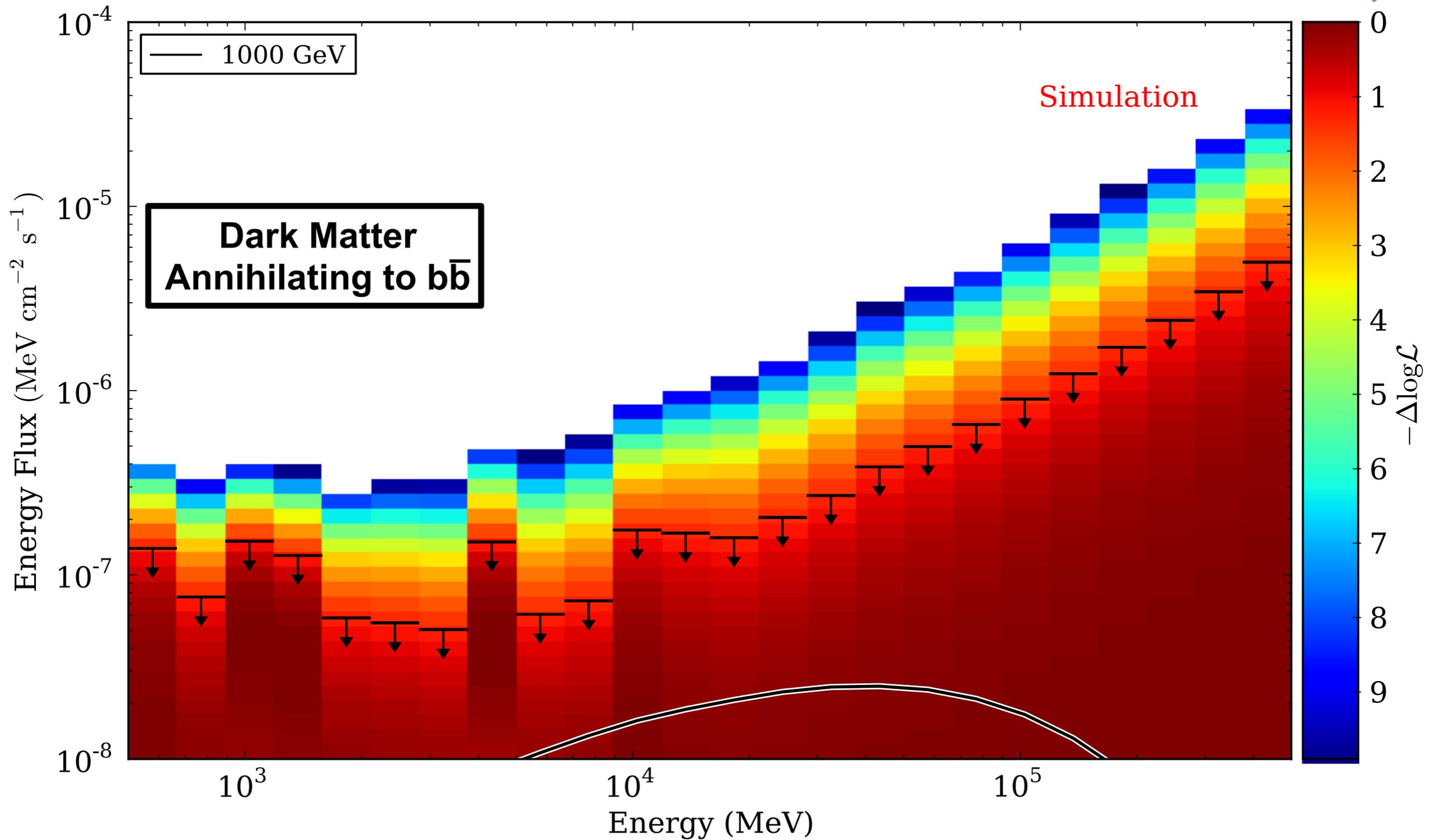
The Recipe



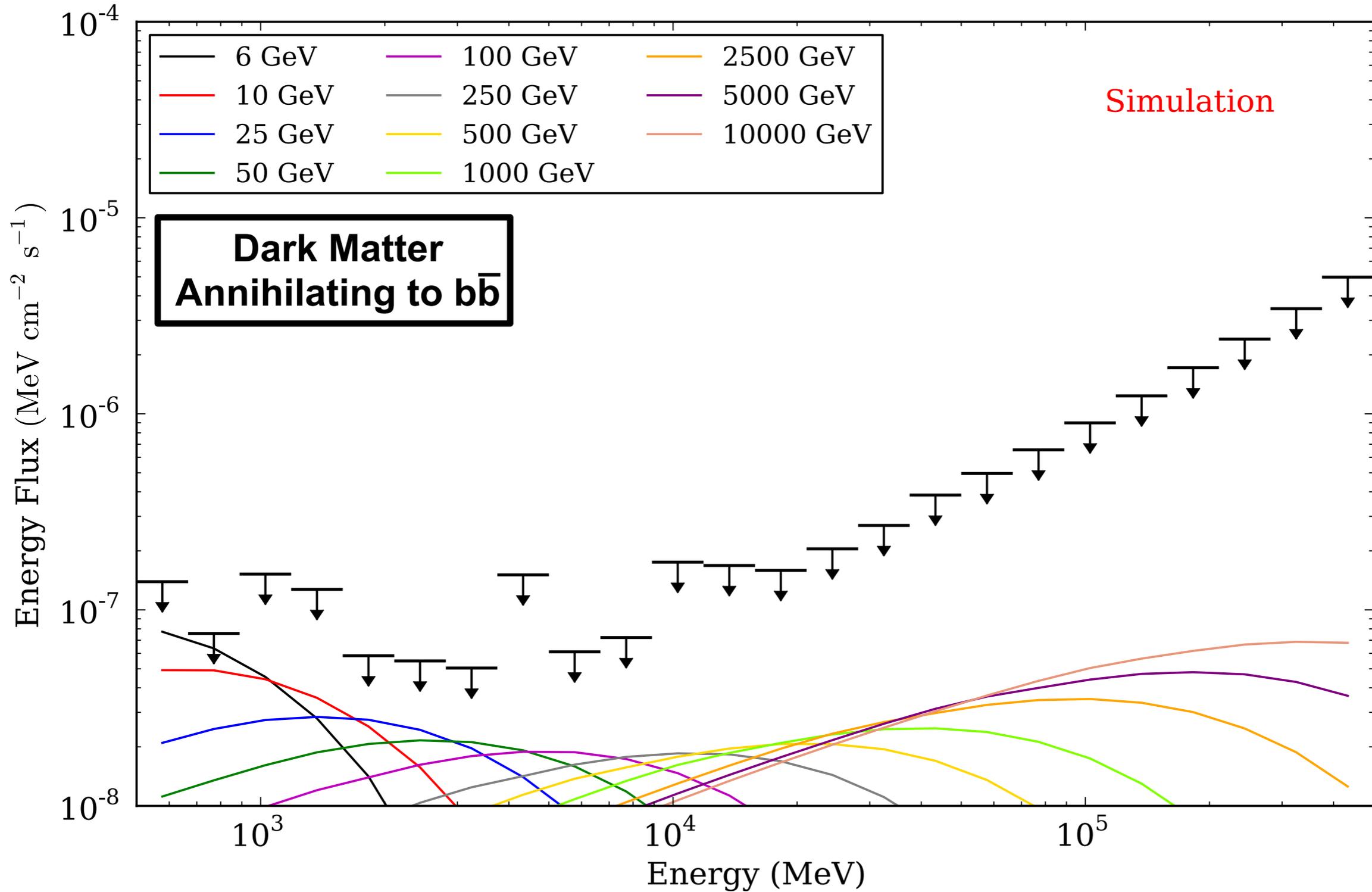
The Recipe



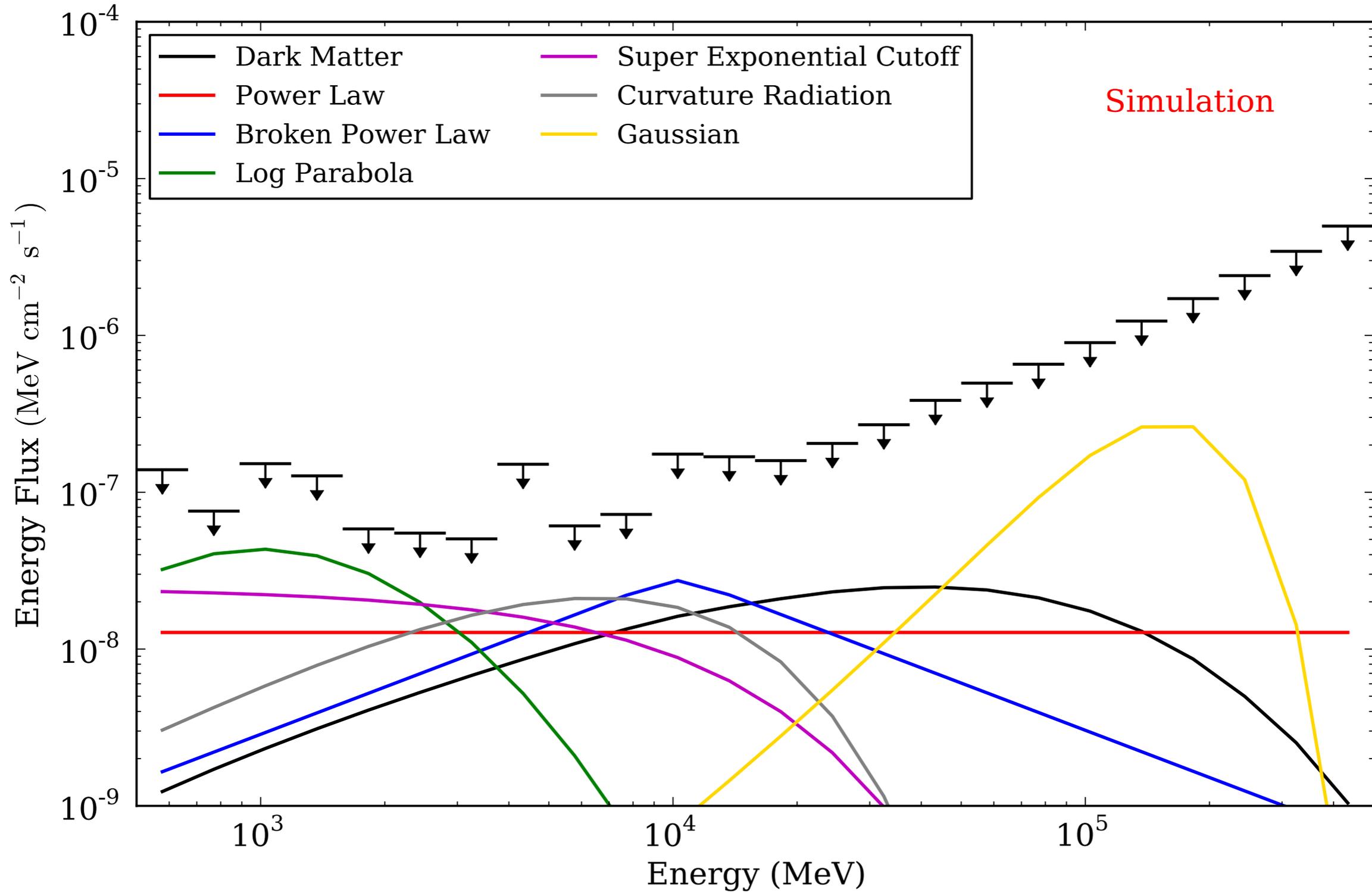




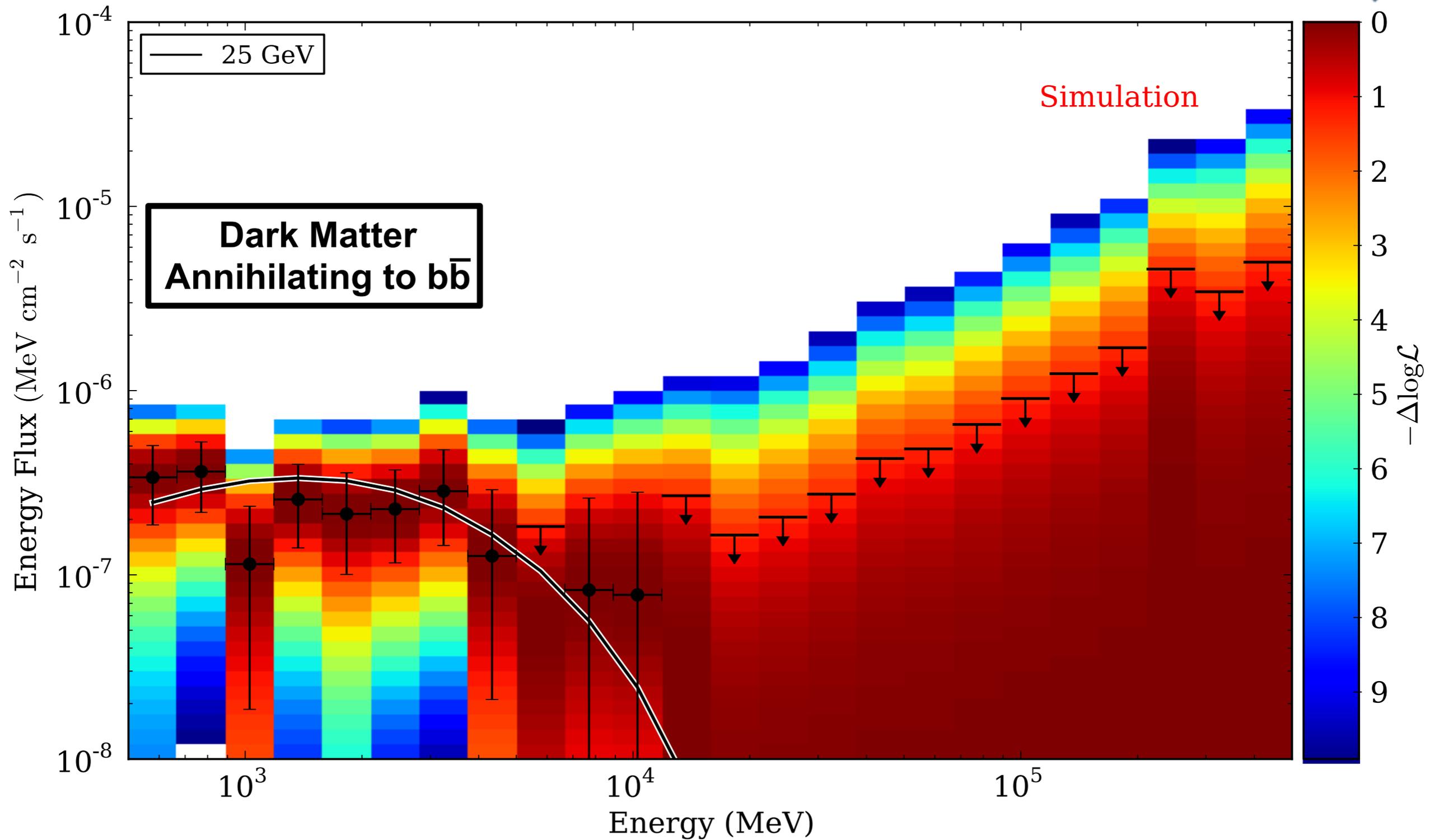
Testing Spectra



Testing Spectra



Detecting a Source

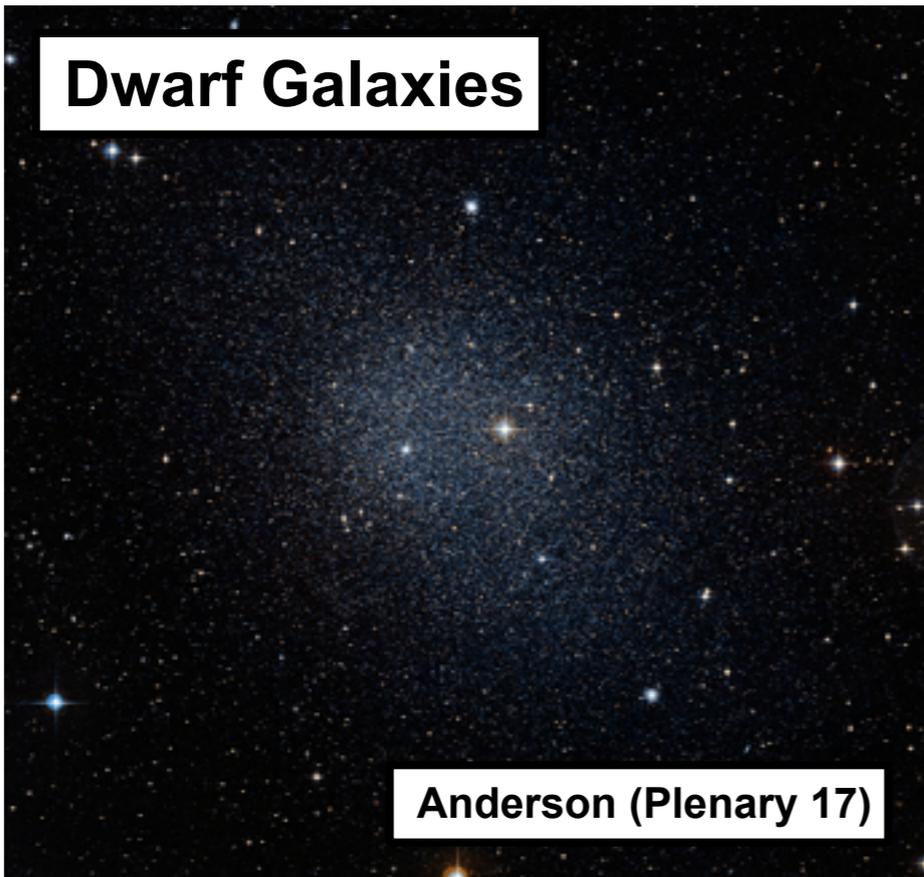




- **Assumed spectrum within each bin**
 - Assumed spectrum convolved by IRFs in each bin
 - If IRFs change rapidly within a bin, predicted counts will depend on spectrum
 - For ~8 bins per decade, this is <1% effect at >1 GeV
- **Nuisance parameters in the bin-by-bin fit:**
 - Fixed at broad-band values (avoid numerical degeneracies)
 - Free and unconstrained (includes correlated uncertainties)
 - Free with prior derived from broad-band fit
 - Choice depends on region of interest



Dwarf Galaxies



Anderson (Plenary 17)

Clusters of Galaxies



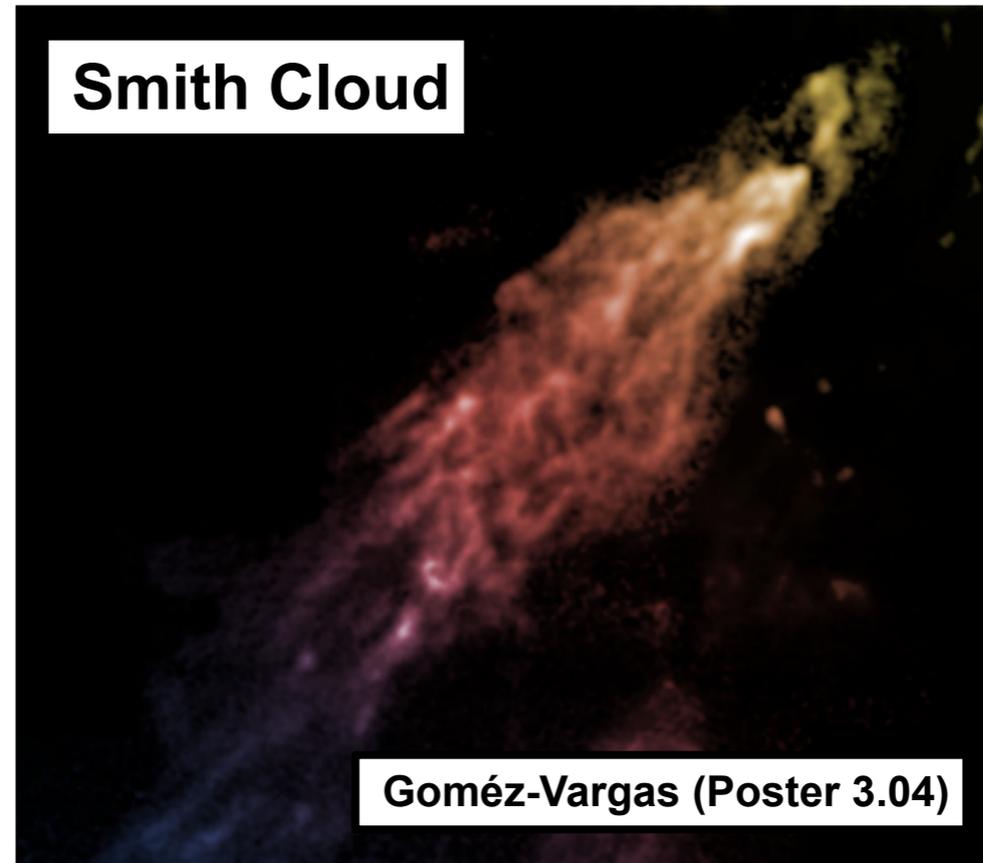
Zimmer (Poster 3.11)

Type IIIn SNe



Franckowiak (Poster 10.01)

Smith Cloud



Goméz-Vargas (Poster 3.04)



Extra Slides

References



- **Drlica-Wagner 2013, <http://purl.stanford.edu/sp070xz6450>**
- **Ackermann et al. 2014, PhRvD, 89, 042001**
- **Drlica-Wagner et al. 2014, ApJ, 790, 24**