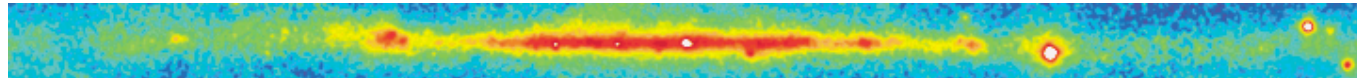




Introduction to a Search for a Neutrino Flux from the Galactic Plane



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Uppsala Collaboration Meeting

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Motivation

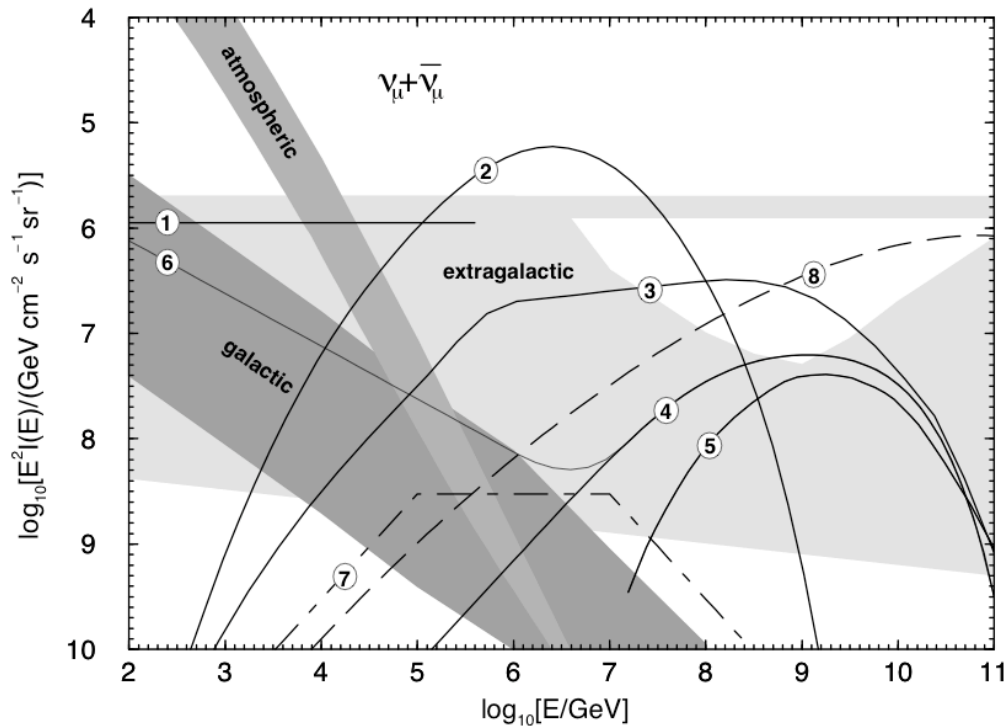


Figure: Learned & Mannheim, Annu. Rev. Nucl. Part.Sci.2000.50

- Cosmic rays interact with galactic ISM, produce γ , ν
- Similar to atmospheric neutrino flux — guaranteed at some level
- Lower density of ISM \Rightarrow spectrum follows CR primary spectrum, $E^{-2.7}$
- Event rates: 5-15 / yr in AMANDA (Berezinsky *et al.*)



Coordinate Systems



- Note shape of plane in celestial coordinates
- Plane is region around $b=0$
- $33^\circ < l < 213^\circ$ below horizon from South Pole

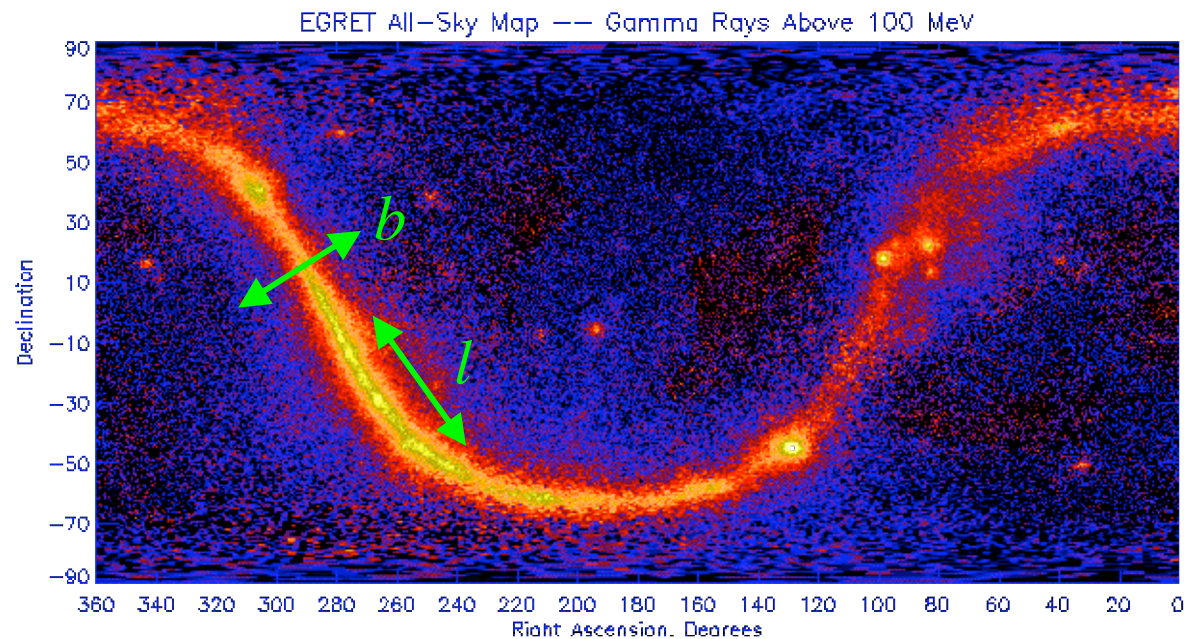


Figure: EGRET collab.



Analysis Outline

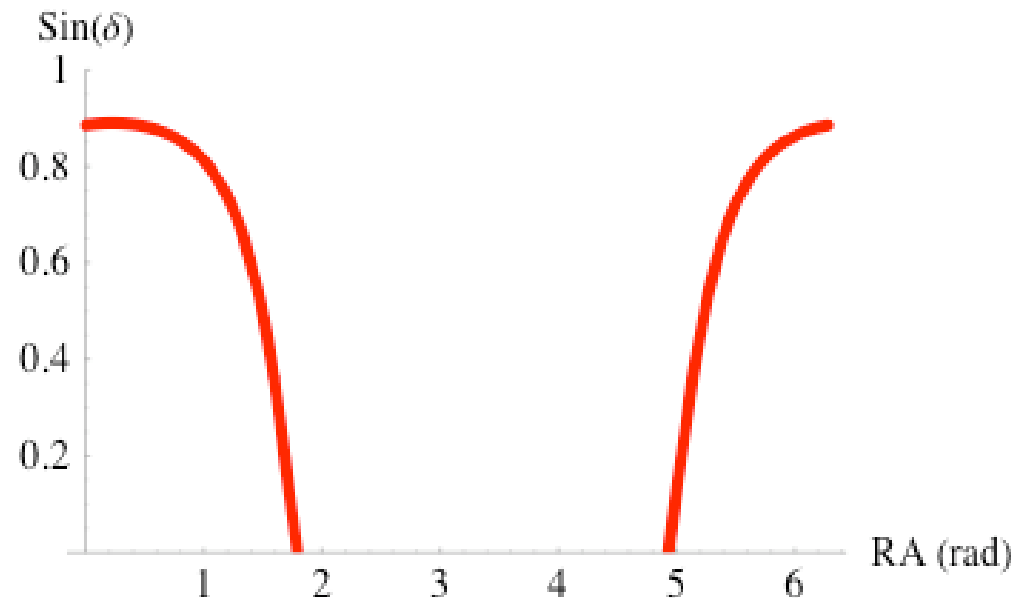
- Initial signal hypothesis
- Event sample and counting technique
- Signal simulation
- Future work: sensitivity and optimizations



Signal Hypothesis

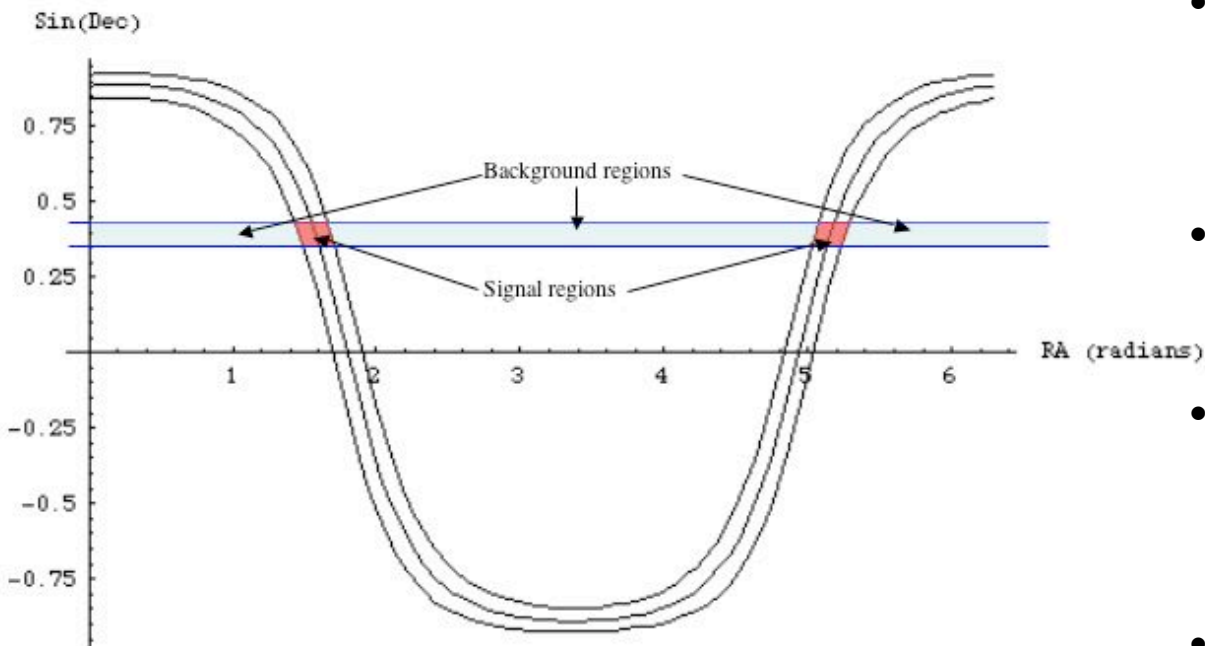


- Line source of neutrinos from galactic equator
- Isotropic in galactic longitude
- Could be elaborated upon (maps by Bloemen or Drimmel & Spergel)





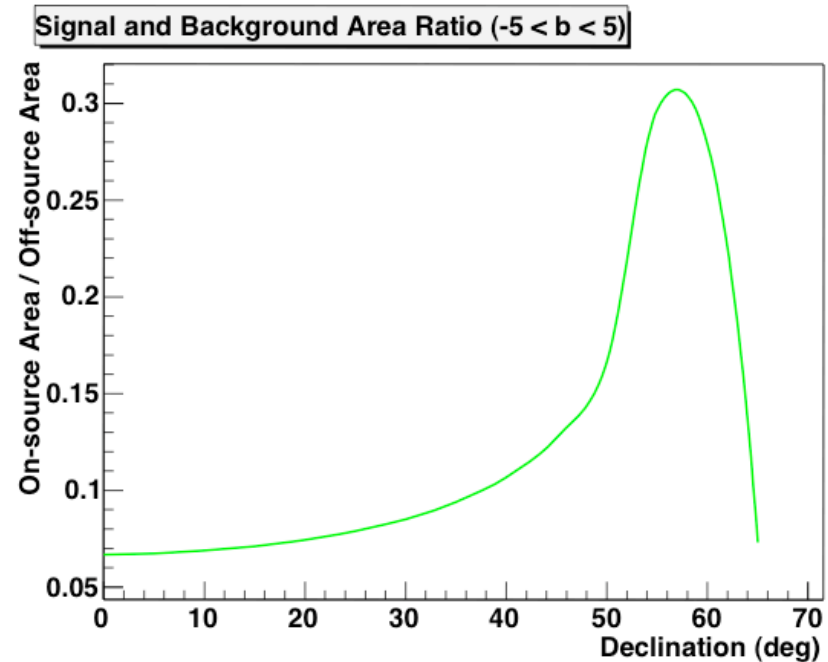
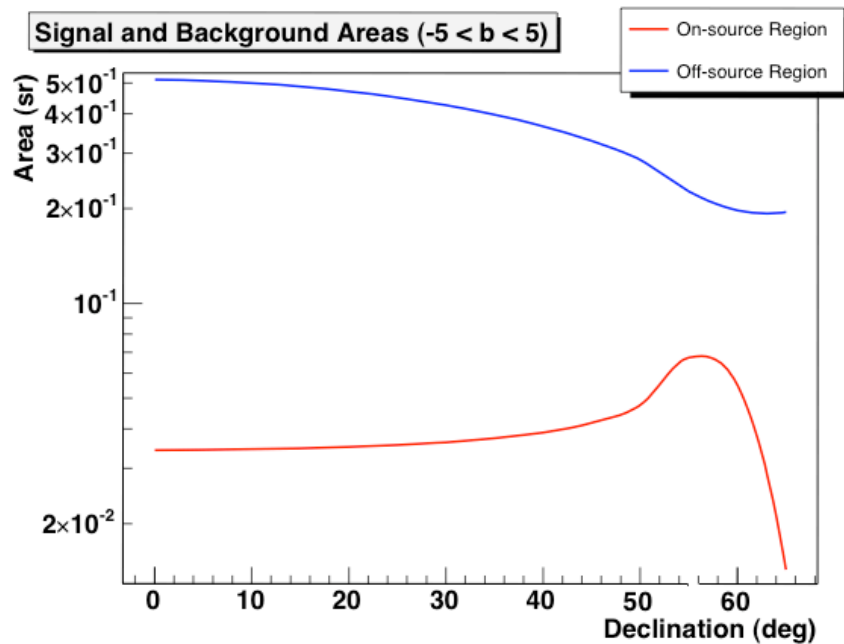
Event Counting



- Source is extended; background is declination-dependent
- Chop plane into 5° slices at a given declination
- Signal region is $-5^\circ < b < 5^\circ$, will be optimized
- Add signal and background events from each slice



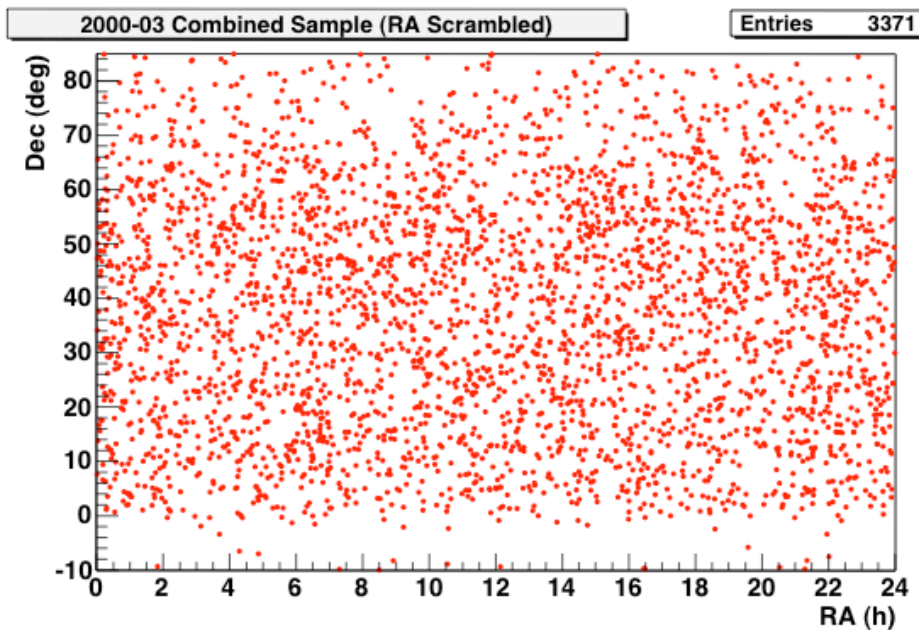
Signal / Background Areas



- Amount of solid angle in signal region is declination-dependent — maximum about 30% on-source, 70% off-source



Event Sample



- High-quality upgoing events, *not* optimized for E^{-2}
- Zeuthen 00-03 combined point source sample replicated in Madison*, RA scrambled for blindness

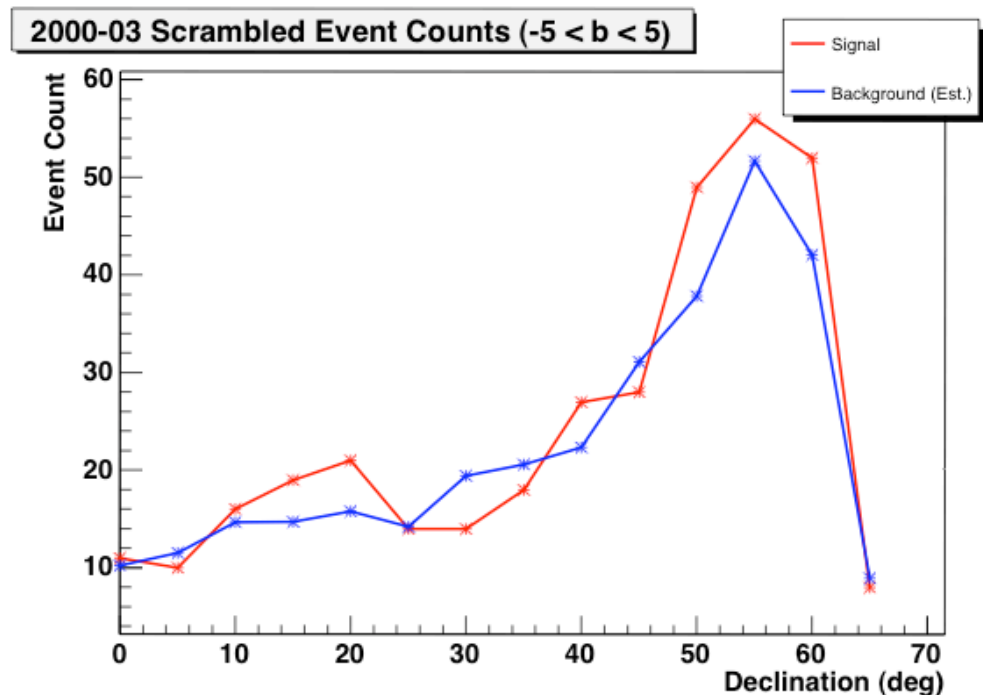
* Special thanks to M. Ackermann



Blind 00-03 “Results”



- Scrambled data still can be used to check methodology
- Total over all declinations: 343 “signal” events on 315.1 background
- As expected, consistent with no signal (fluctuation $\sim 1.6\sigma$)
- Also checked with large downgoing event sample





Signal Simulation

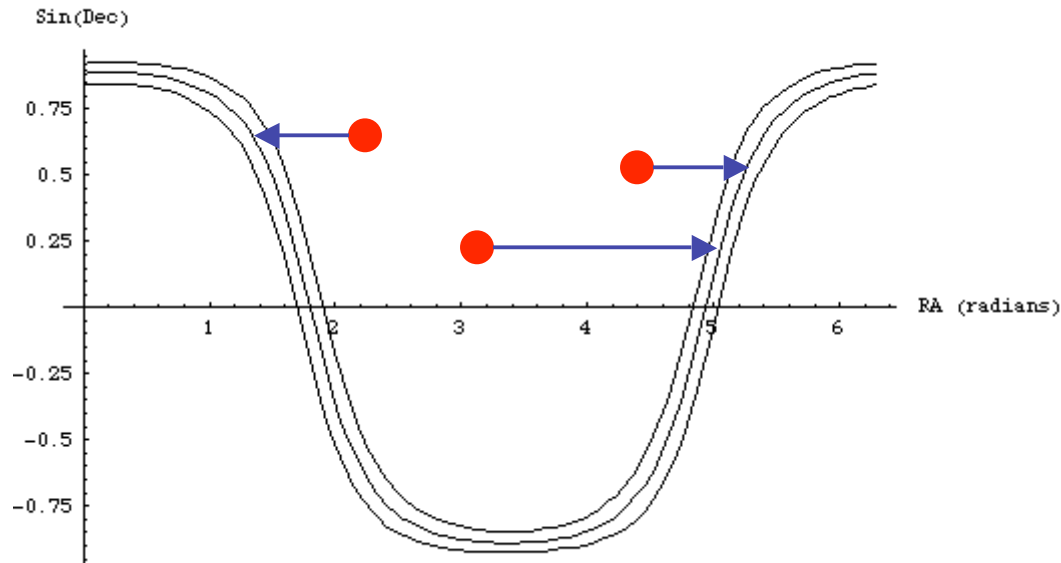


- Need signal simulation for sensitivity analysis, optimizations
- Strategy: modify and reweight existing high-level atmospheric MC output to simulate desired flux*

* Continuation of work with D. Steele



Step 1: Adjust Times

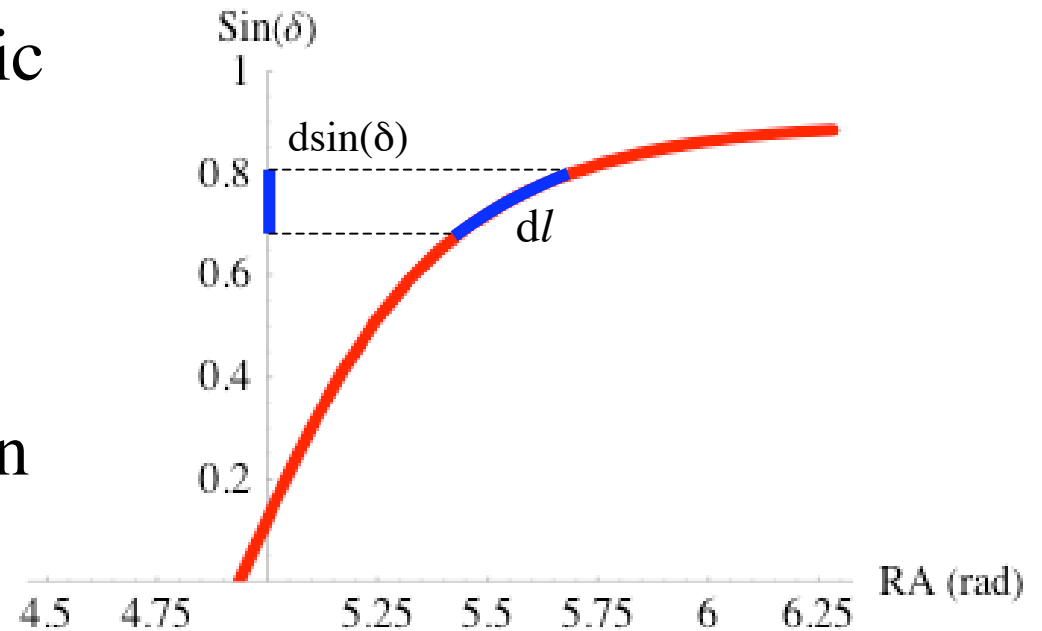


- Time is calculated for each event so that its ϕ lands on galactic equator
- Day of year, segment of plane (two choices) selected randomly



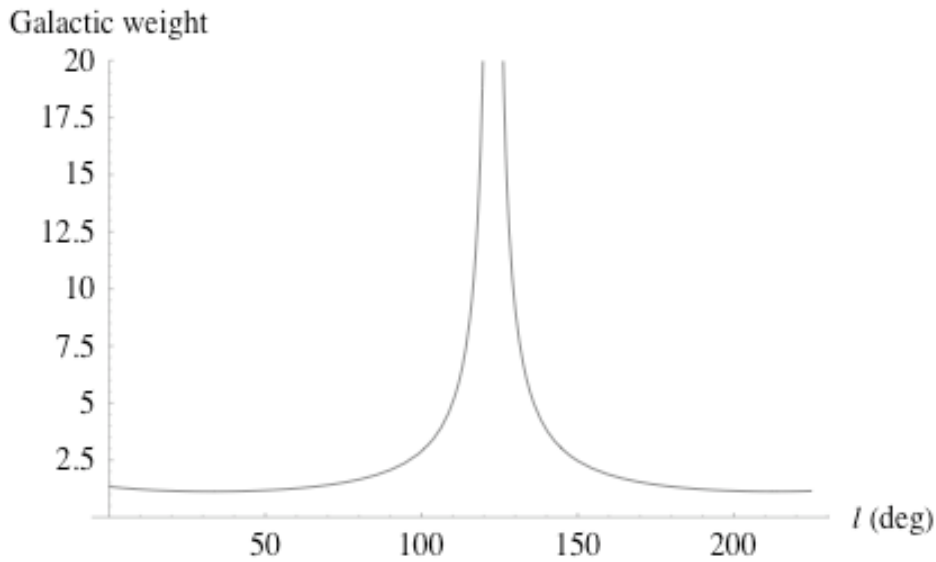
Step 2: Reweight Events

- Must transform distribution from isotropic in $\sin(\delta)$ to isotropic in l
- Weight is Jacobian of coordinate transformation at $b=0$: $\text{abs}(dl/d\sin(\delta))$

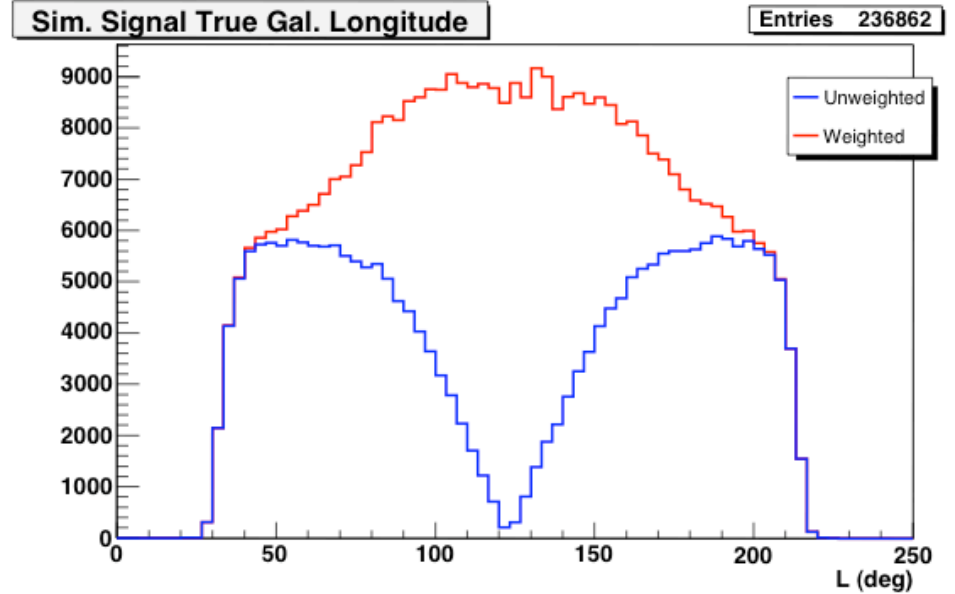




Reweighting Results



$$w(l) = \text{abs}(\cos(\delta_{\text{NGP}}) \cos(l - l_0))^{-1}$$



(2000-03 L4+Opt MC, not normalized)

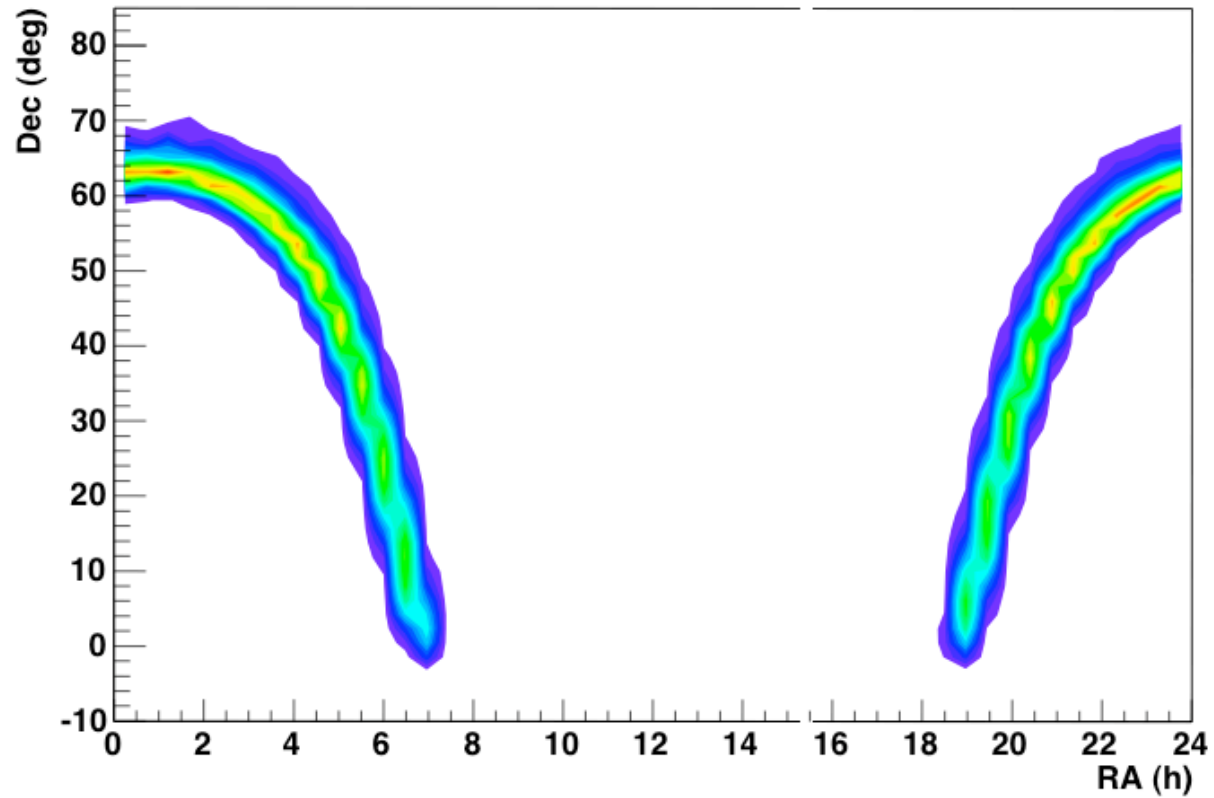


Signal Skyplot



Simulated Signal (Pandel, reweighted)

Entries 236862





Flux Normalization



- Must normalize signal MC to some *linear* flux Φ_{gal} ($\text{GeV}^{-1} \text{s}^{-1} \text{cm}^{-2} \text{rad}^{-1}$)
- Equivalent diffuse flux in normal weighting expression — $\Phi_{\text{eff}} = \Phi_{\text{gal}} / \pi$
- More details:
<http://amanda.wisc.edu/~jkelley/galactic/weighting.pdf>



Next Steps



- Calculate sensitivity for current choices of parameters
- Optimizations: width of signal region in b , possible nch cut
- Investigate sensitivity versus declination — perhaps need a more sophisticated way to combine slices
- More realistic signal hypothesis



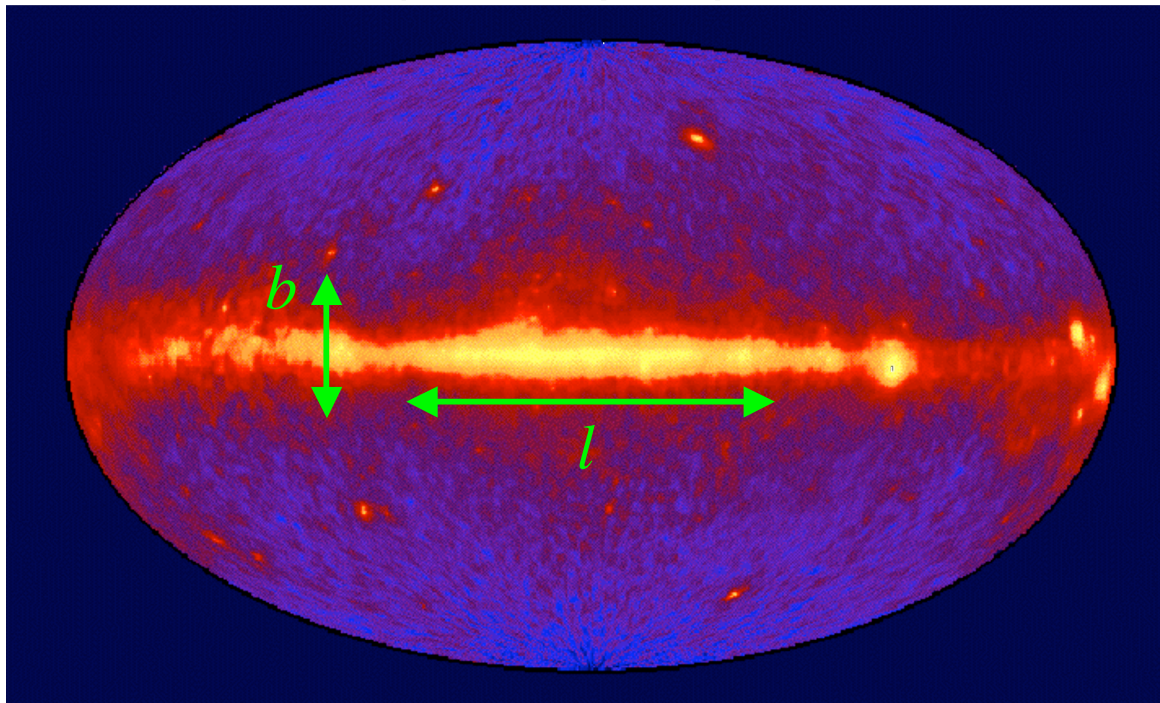
Extra Slides



Galactic Coordinates



EGRET All-Sky Gamma Ray Survey Above 100 MeV

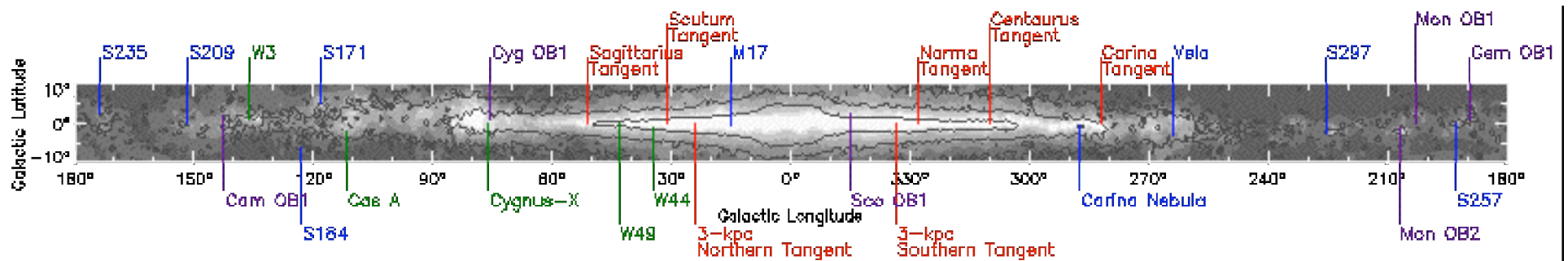


- Galactic equator is $b = 0$
- Galactic center is $l = 0$

Figure: EGRET collab.



Galactic Map





Event Processing

- Start with 2000-03 unified processing level 4
- Optimized cuts (some zenith dependent) from Zeuthen analysis:
 - Smoothness ($S_{\text{phit}}[\text{Pandel}]$)
(also exclude smoothness of exactly 0)
 - Paraboloid fit error ($P08\text{err}1$, $P08\text{err}2$)
(also exclude negative errors)
 - Likelihood difference ($jkchi[\text{Bayes}] - jkchi[\text{Pandel}]$)
 - Data only: flare cut and stability period cut