Study on High-Energy Astrophysical Electron Neutrino Search in Super-Kamiokande

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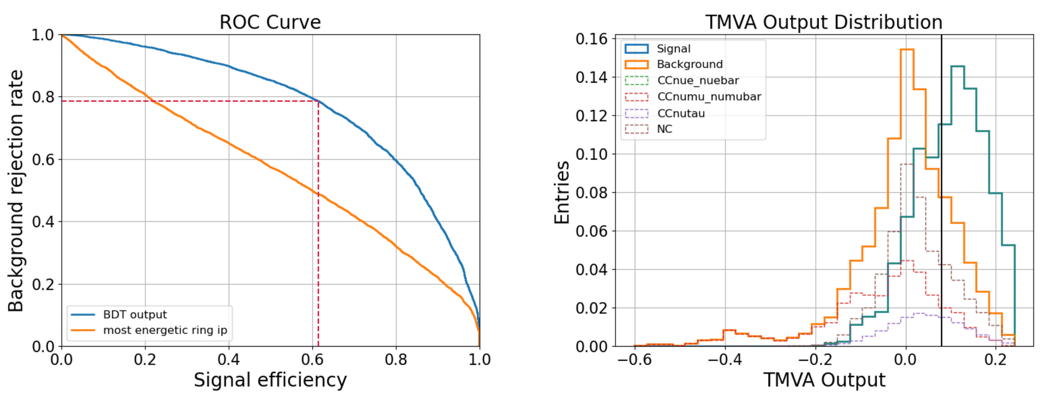
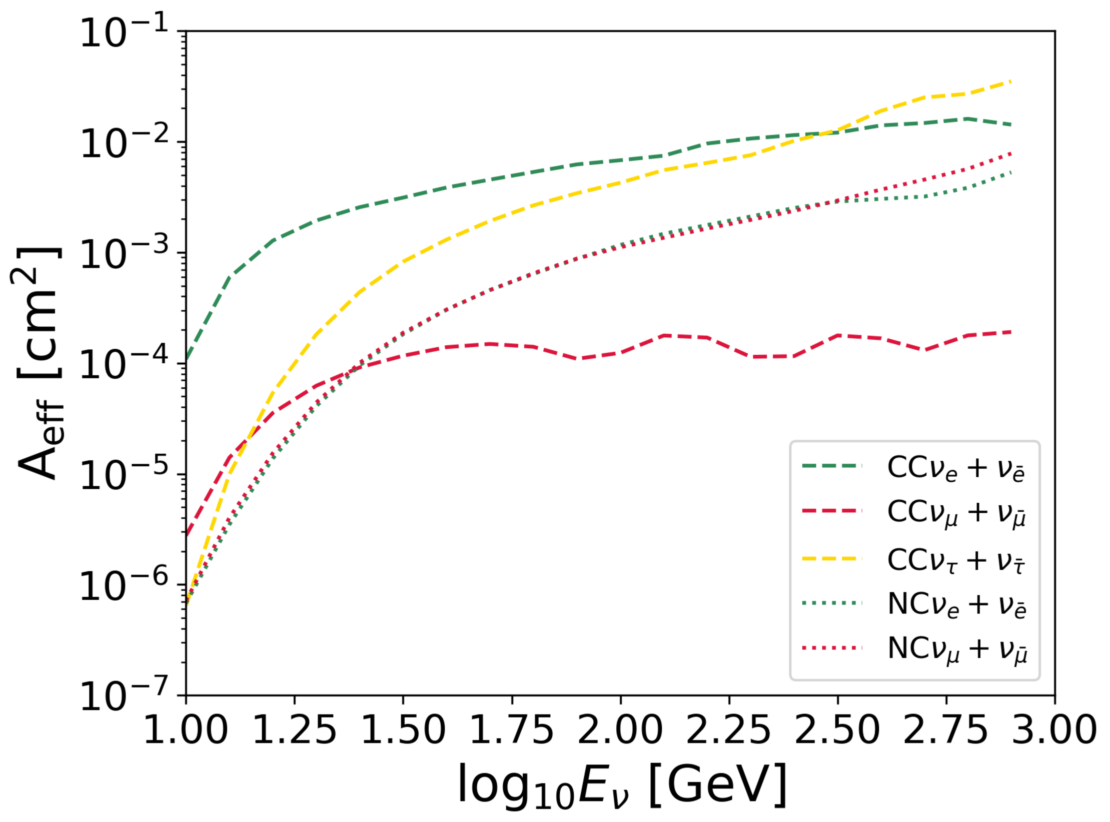
1 Motivation

- Astrophysical flux ratio $\nu_e : \nu_\mu : \nu_\tau$ at Earth depends on ratio at source and reflects source characteristics.
- Background atmospheric ν_e spectrum is much softer than ν_μ, so less background contamination is expected.

2. Data Sample

- 6619.1 live-days fully contained data with visible energies above 10 GeV from 1996 to 2019 in SK are searched with.
- Improved event classification algorithm implemented to separate CCν_e from CCν_μ, ν_τ and NC:
  - $\rightarrow$ Selection cut on PID likelihood optimized for $E_{vis} > 10$ GeV single ring events.
  - $\rightarrow$ Boosted decision tree based algorithm developed for multi-ring events:

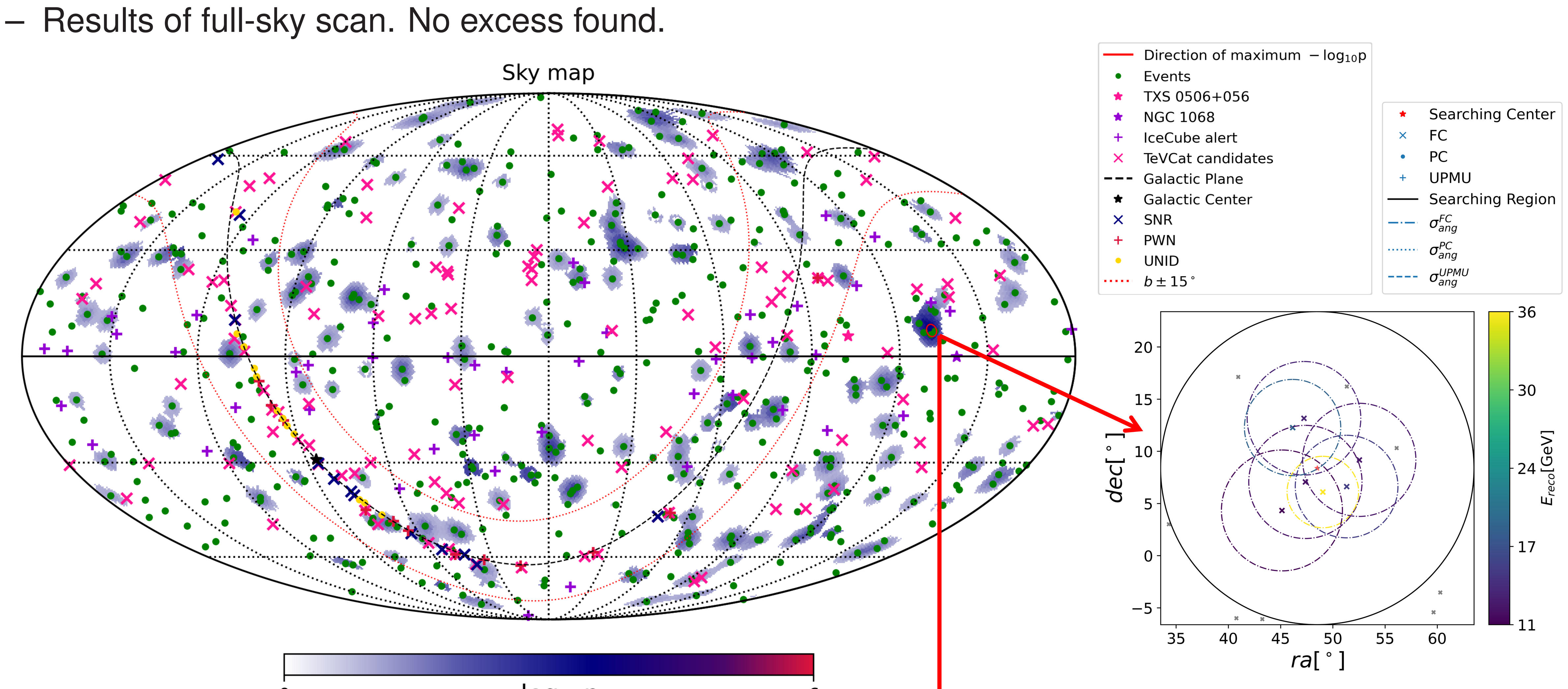




Effective area including selection efficiency vs. log ν energy

3. Point Source Search

- Results of full-sky scan. No excess found.

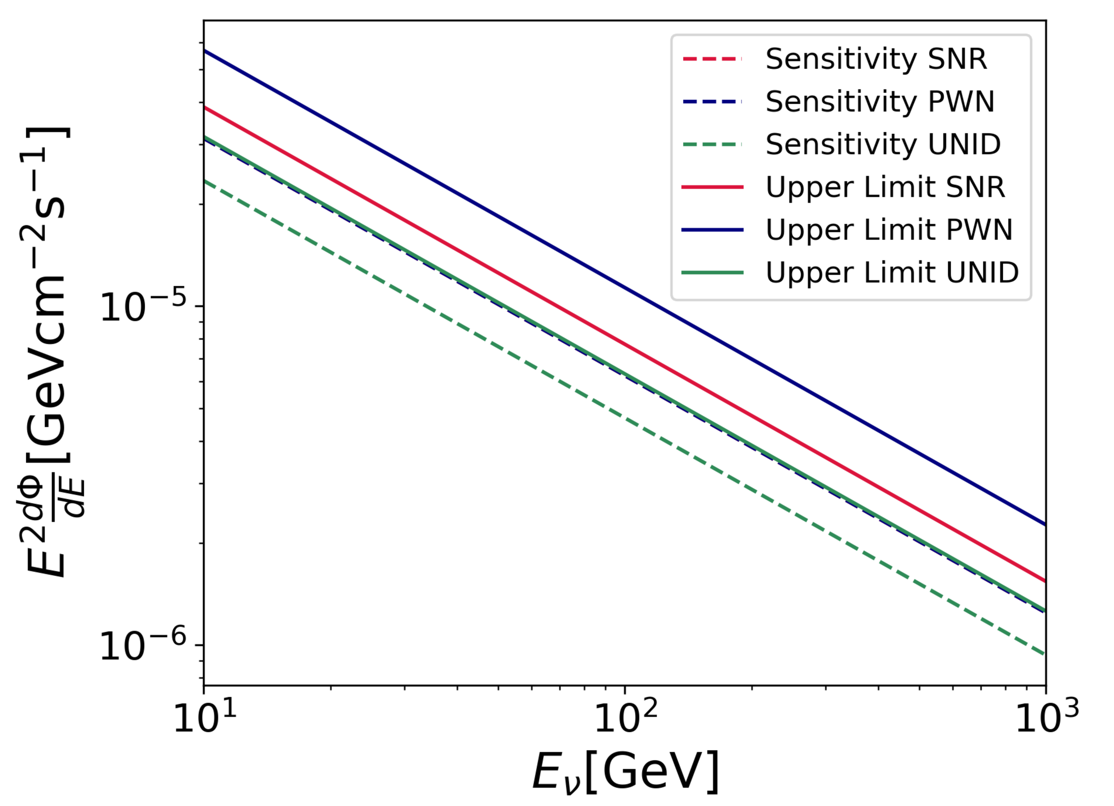


Event distribution.

$\hat{n}_S$	$\hat{\gamma}$	$\hat{\alpha}$ [°]	δ [°]	pre p	post p	$\Phi_0^{90\text{CL}}$ [GeV^{-1}cm^{2}s^1]
6.3	4.0	48.5	8.4	2.9×10^{-4}	54.7%	1.8×10^{-7}

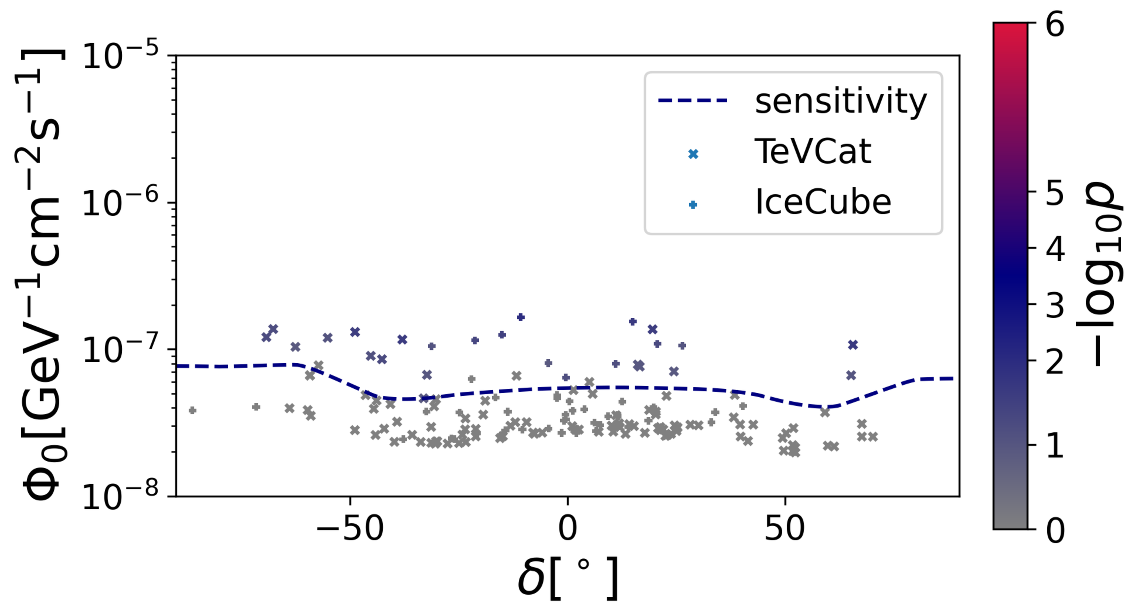
4. Stacked Sources in Galaxy

- Three types of sources in Galaxy (SNR, PWN and UNID, marked as blue cross, red plus and yellow dots in sky-map of Point Source Search), each of which includes 12 sources being stacked, are searched independently, with flux spectrum index $\gamma = 2.7$.
- No excess found. Neutrino flux upper limits set.

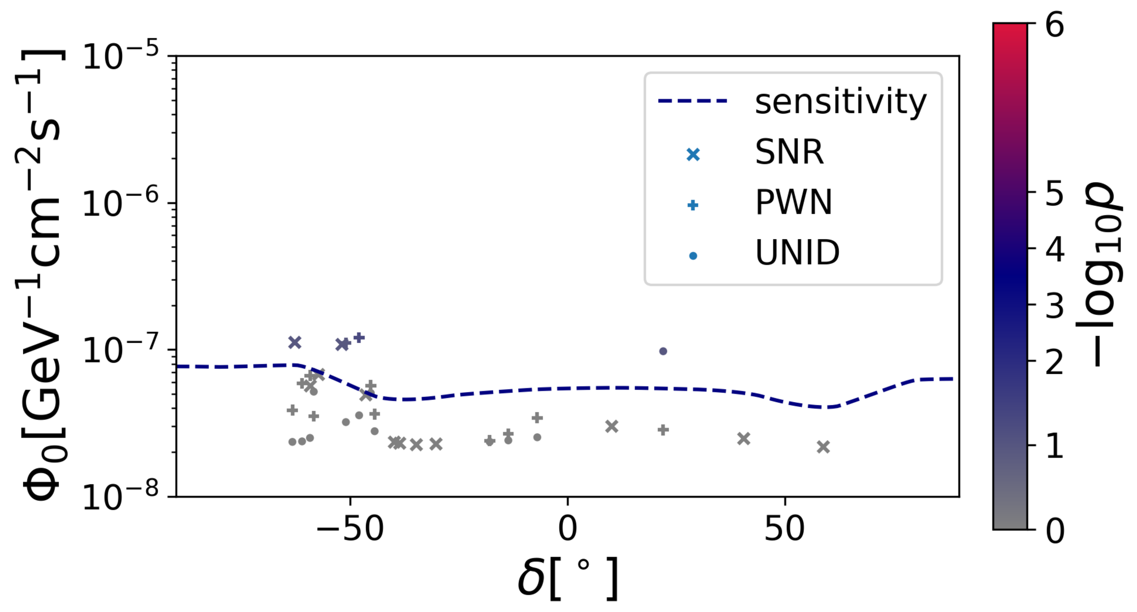


6. Source Candidate

- 114 source candidates from TeVCat[3](pink cross) and 49 high-energy event alert from IceCube[4](purple plus) are searched with.
- No excess found. Neutrino flux upper limits set:

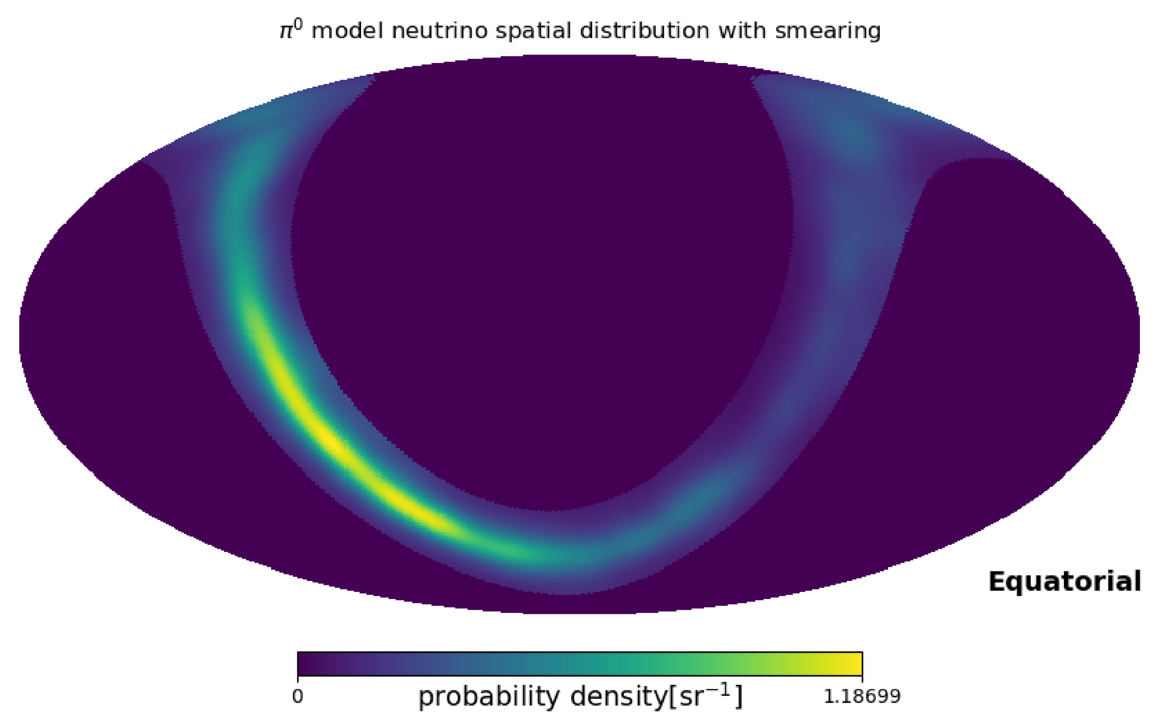


- Additionally 12 SNRs(blue cross), 12 PWNs (red plus) and 12 UNID (yellow dots) in galaxy used in stacked source search are searched with.
- No excess found. Neutrino flux upper limits set:

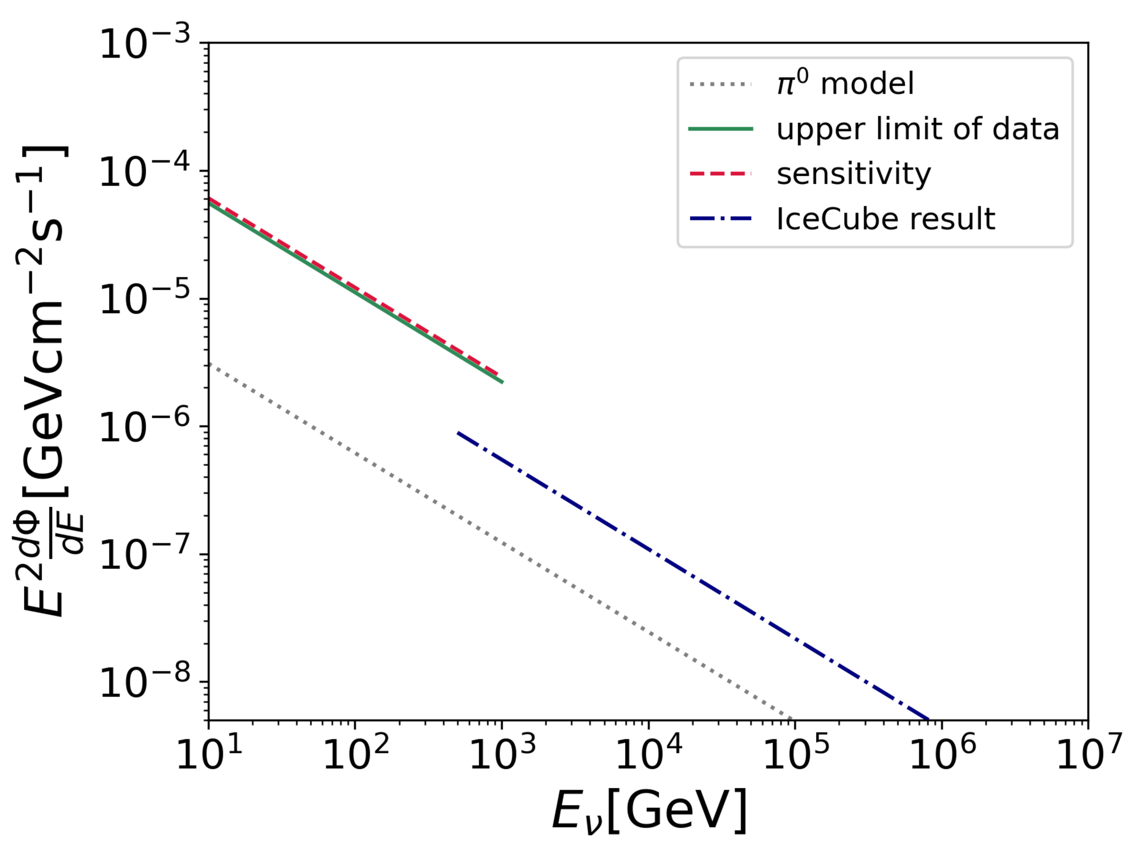


5. Diffuse Neutrino from Galactic Plane

- Neutrino spatial distribution from model prediction in [1], taking into account of acceptance and smeared with point spread function of SK detector, is used as signal events spatial probability (left figure), with flux spectrum index $\gamma = 2.7$.
- No excess found. Neutrino flux upper limit set.



Model predicted neutrino spatial distribution.



π_0 model prediction from [1], IceCube result from [2].

7. Summary

- Used developed event classification algorithm to perform searches for ν_e point sources, search for diffuse ν_e from Galactic Plane and stacked search for ν_e from sources in Galaxy.

REFERENCES

[1] doi: 10.1088/0004-637X/750/1/3
[2] doi: 10 . 1126 / science . adc9818
[3] URL:https://tevcat2.tevcat.org/
[4] URL: https://icecube.wisc.edu/data-releases/2018/07/icecube-catalogof-alert-events-up-through-icecube-170922a/