Paper about common calculations for discovery fluxes and sensitivities

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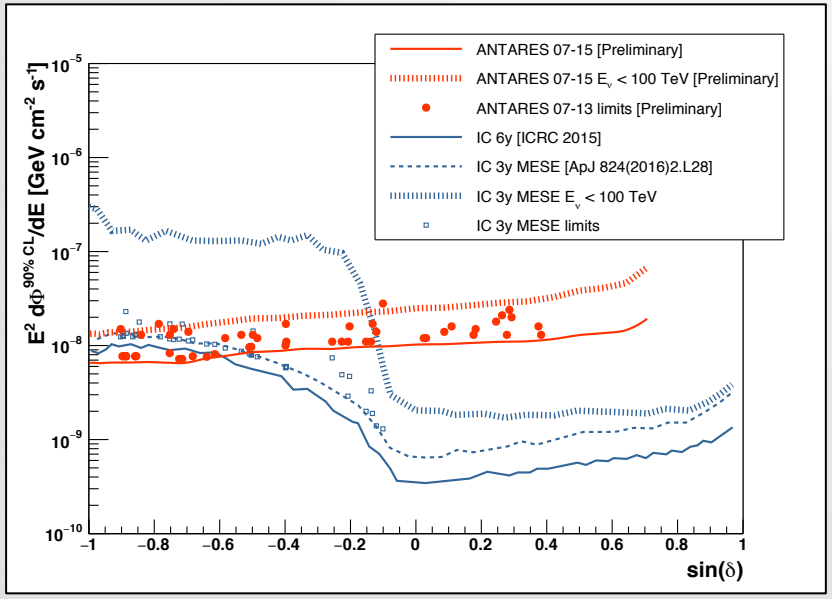
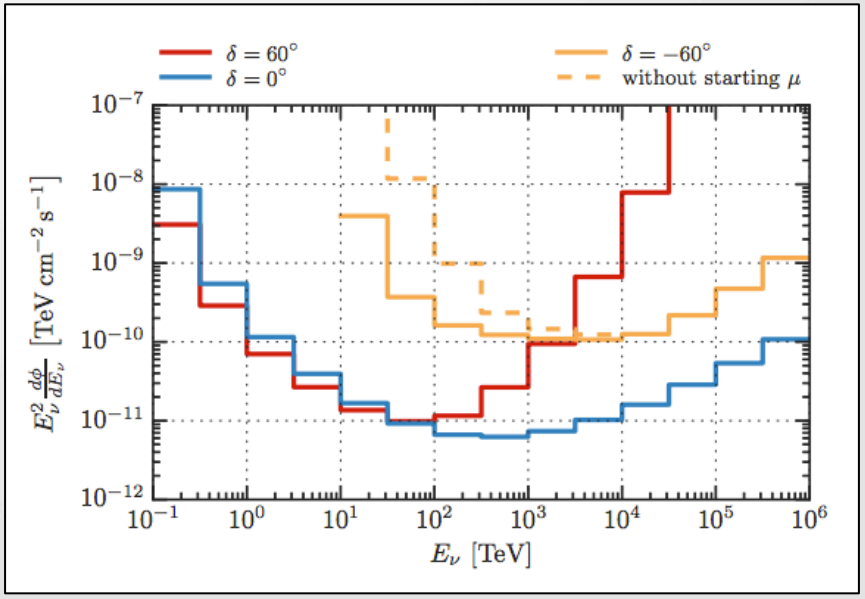
Paper on comparisons

- Aim: How to perform comparisons between different experiments?
  - Started from PS
  - Different methods
  - Different features we want to show from each experiment





Paper on comparisons: The 2x3 matrix

	Steady point source	Steady extended source	Transient point source
(Diff) Discovery flux			
(Diff) Sensitivity			

Outline for paper

- First part: Methods
  - Likelihood definitions, **differences**
  - The ns feature for E^{-2} likelihood
  - Procedure in simulations
  - Differential sensitivities
  - …
- Second part: Contributed plots from the collaborations

- Draft (mostly with first part) begun

Likelihood definitions / considerations

- Likelihood definitions:

$$L\left(n_{sg}\,|\,\gamma\right)=\prod\left(\frac{n_{sg}^{S}}{N}\cdot P_{s}(\vec{x}_{i}\,|\,\gamma)+(1-\frac{n_{sg}^{S}}{N})\cdot P_{b}(\vec{x}_{i})\right)$$

- In ANTARES and KM3NeT, source spectrum is fixed.
- In IceCube, they fit the spectrum between -4.0 and -1.0.
- Also, in ANTARES/KM3NeT the extended likelihood has been used, but no significant differences are seen:

$$\log L\left(n_{s}\right)=\sum_{i}\left(n_{s}\cdot P_{s}(\vec{x}_{i}\,|\,\gamma)+N_{b}\cdot P_{b}(\vec{x}_{i})\right)-n_{sg}-N_{bg}$$

- Possibly it would be (slightly) better if spectrum was also fitted?

Likelihood definitions / considerations

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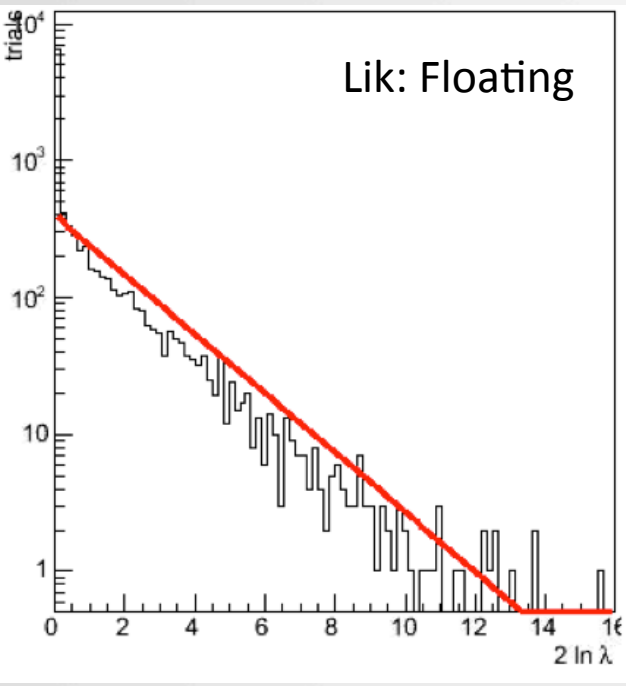
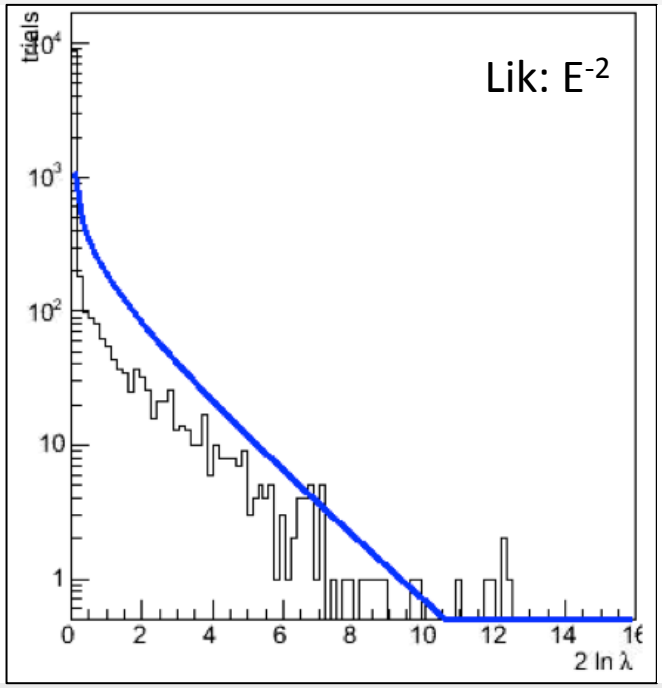
- In ANTARES and KM3NeT, source spectrum is fixed.
- In IceCube, they fit the spectrum between -4.0 and -1.0.

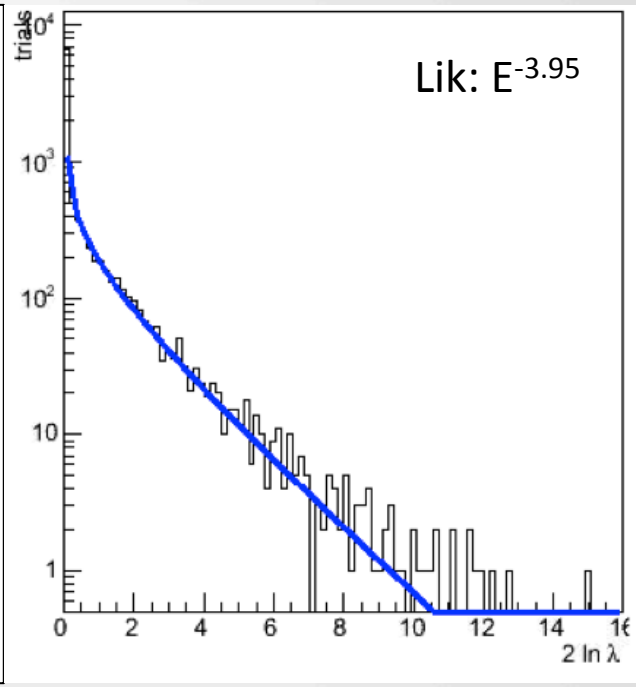
$$TS=-2\left(\log L_{\max}(n_{s},\gamma)-\log L_{bg}(n_{s}=0,\gamma)\right)$$

- TS distributions for background case change significantly in the two approaches (E^{-2} fixed vs fitted spectrum). Reason: E^{-2} extremely different from background

Likelihood definitions / considerations



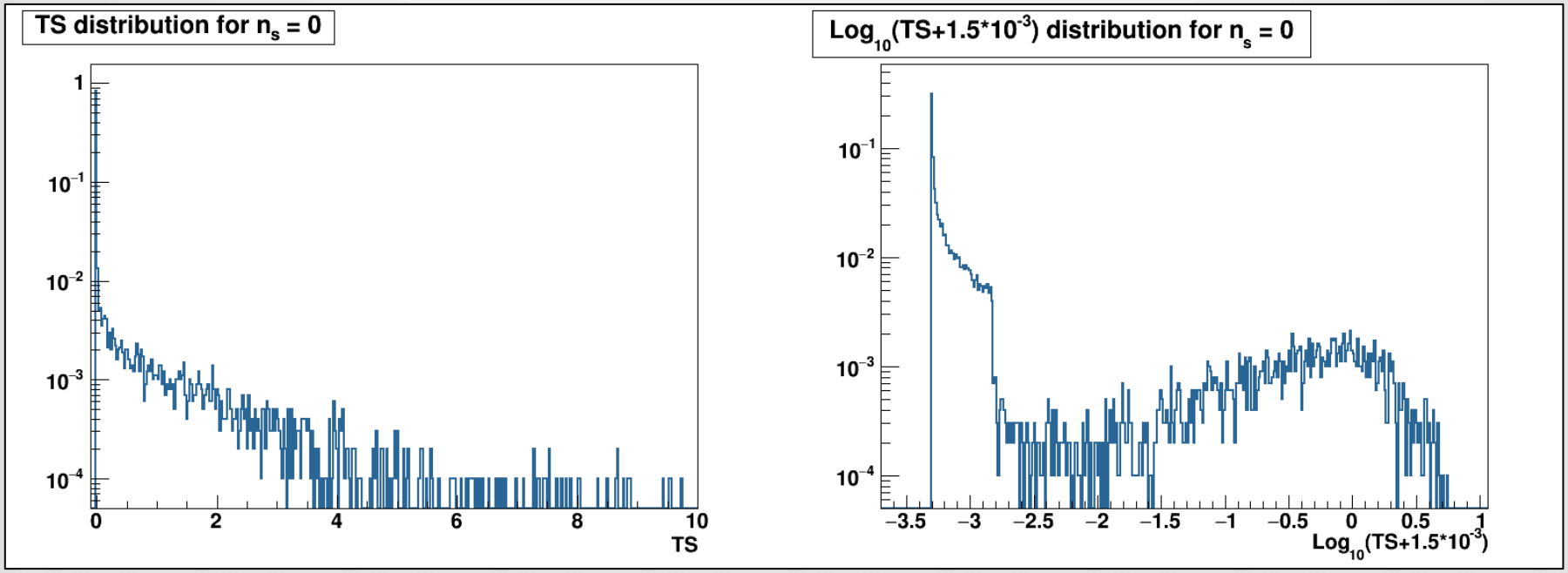




TS distributions for fixed-source search when simulating only background. Left: E floating likelihood. Middle: fixed E^{-2} spectrum. Right: $E^{-3.95}$ spectrum. Red line denotes the Chi^2 distribution for 2 dof. Blue line for 1 dof. Plots performed by Chad Finley.

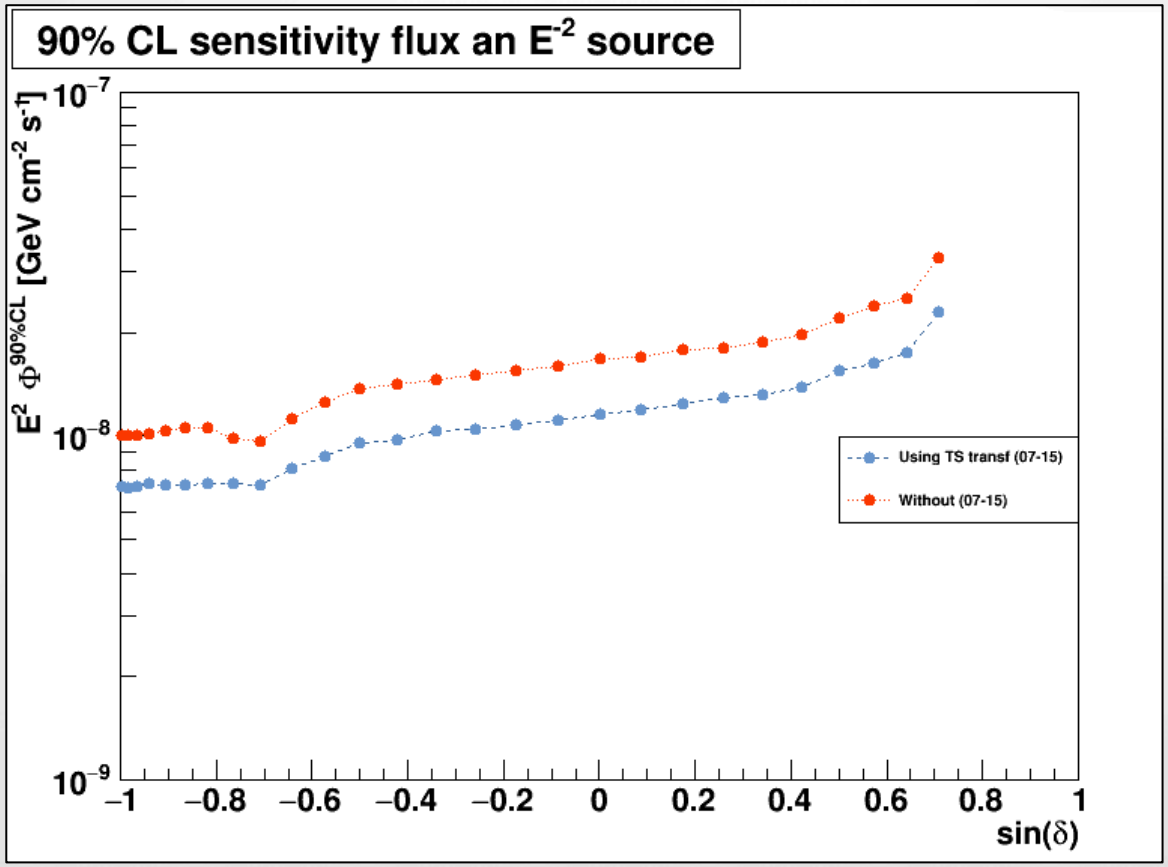
Likelihood definitions / considerations

- In the likelihood, set minimum of n_s to 0.001
  - If real maximum value for likelihood corresponds to $n_s < 0.001$, L_b will be larger than the calculated maximum, leading to a non-zero, negative TS value.
  - Possibility to see the "structure" of the first bin so to avoid overcoverage (i.e., possibility to calculate median TS value for background)



Likelihood definitions / considerations

- Differences in use of $n_s > 0.001$ feature?



Differential sensitivities

- Simulations:
  - Source generated in pseudoexperiments with information of energy range (typically, step of 0.25 or 0.5 on $\log_{10}(E)$)
  - Source assumption needed

$$N_s(\Delta E,\delta) = \int_{\Delta E} \frac{d\phi}{dE dt dS} A_{eff}(E_\nu,\delta) dE\, dt$$