

Neural Population Inference for High-Energy Neutrino Astronomy

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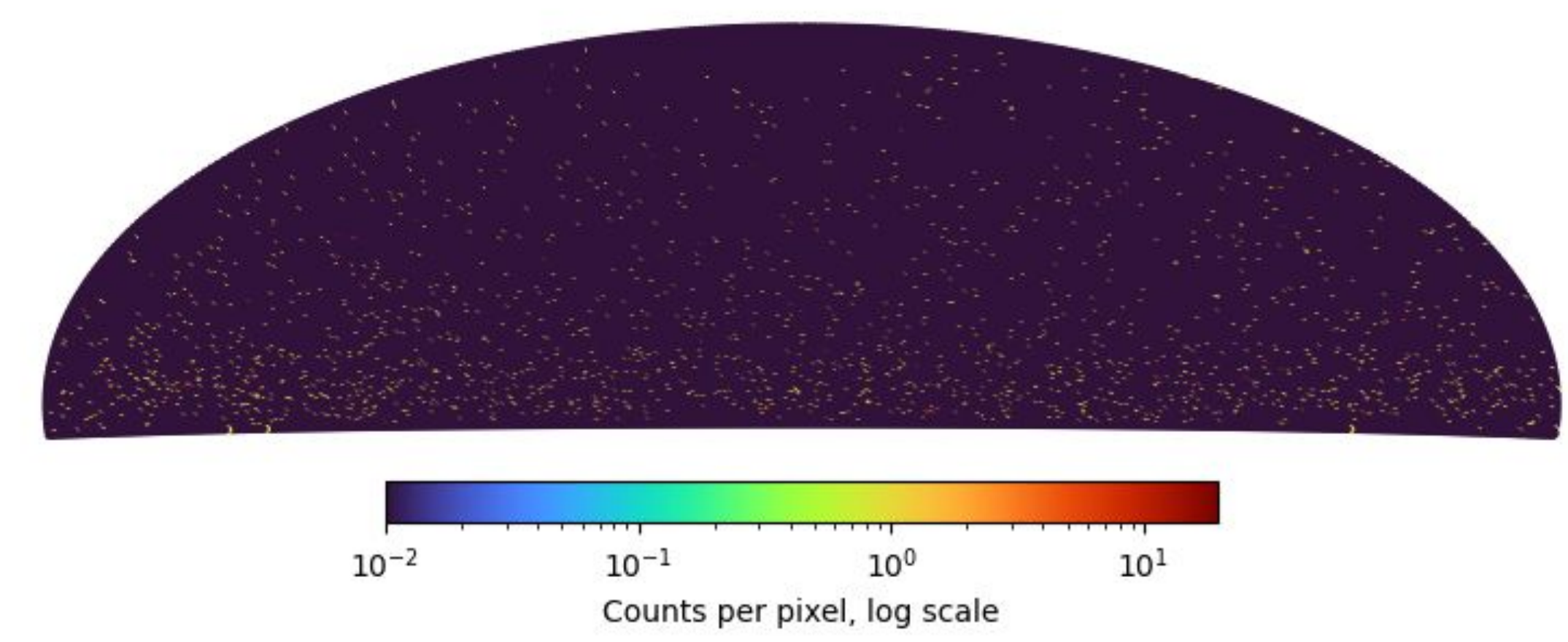
Workflow

Population Parameters

$\gamma, n_0, L, p_1, p_2, z_c$

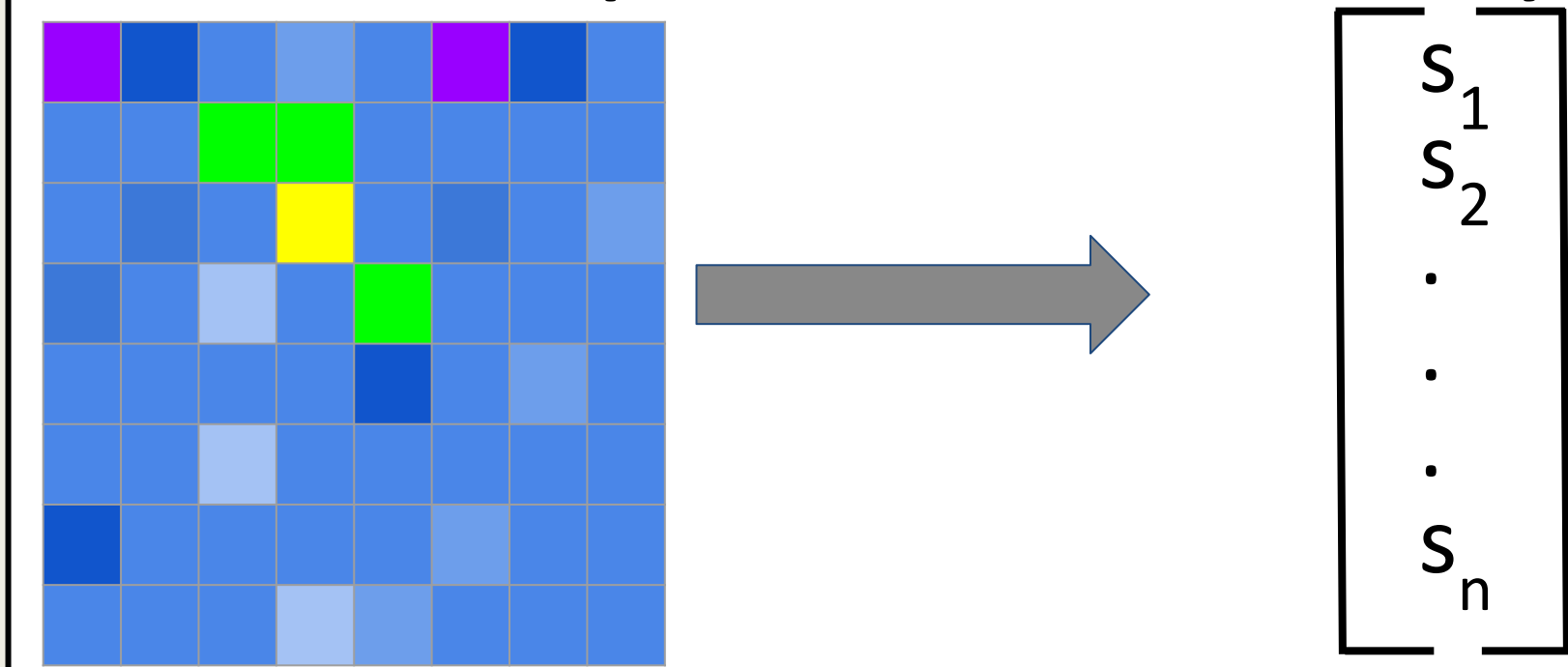
Simulated Source Population

Representative simulated sky map
Summed over reconstructed energy, Dec > -5°



IceCube Detector Response

Compressed Summary



Posterior Distribution

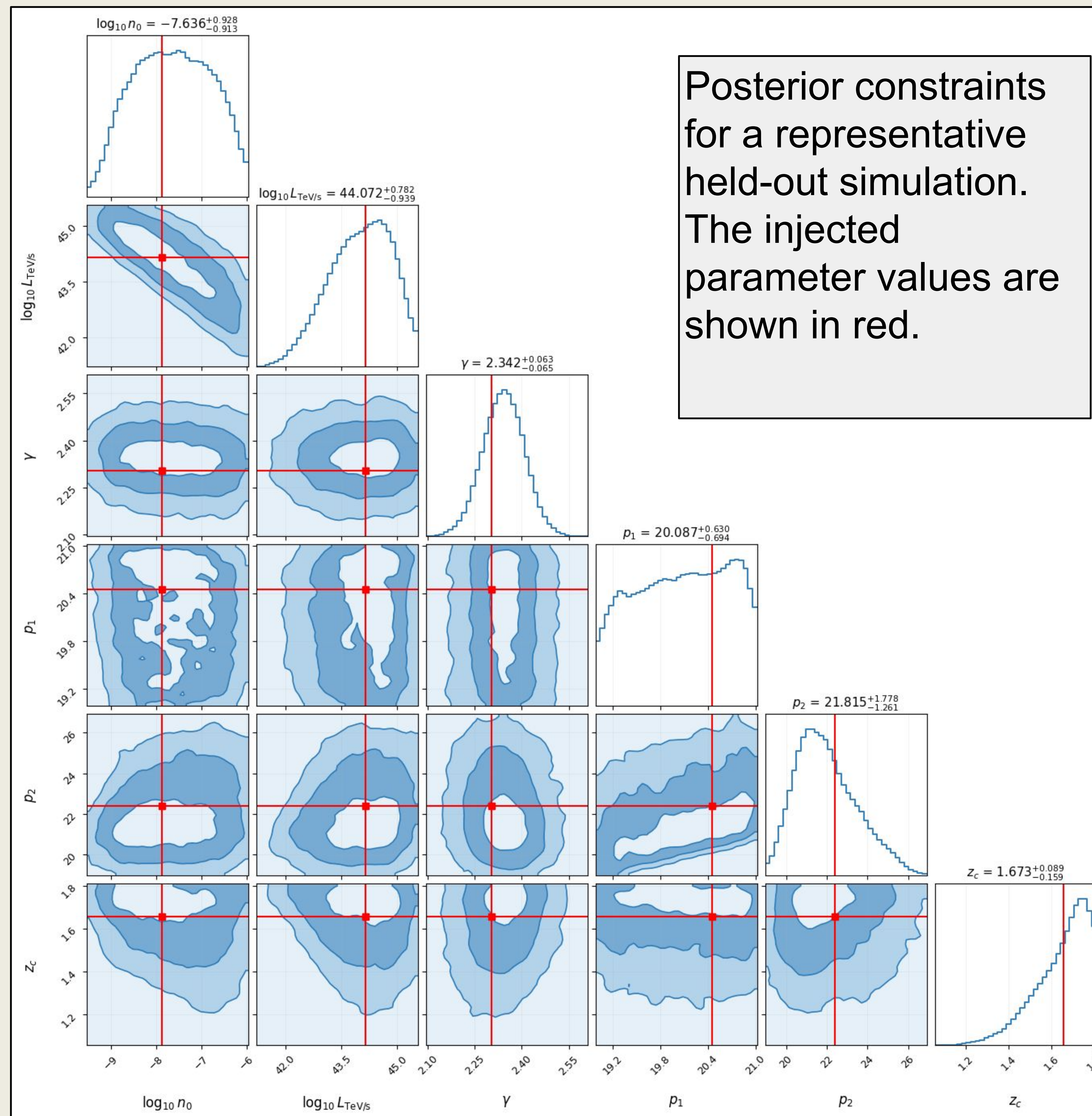
Inferred Population Parameters

$$\frac{d\bar{N}_s^{\text{tot}}}{dV} = n_0 \frac{(1+z)^{p_1}}{(1+z/z_c)^{p_2}}$$

Source density evolution

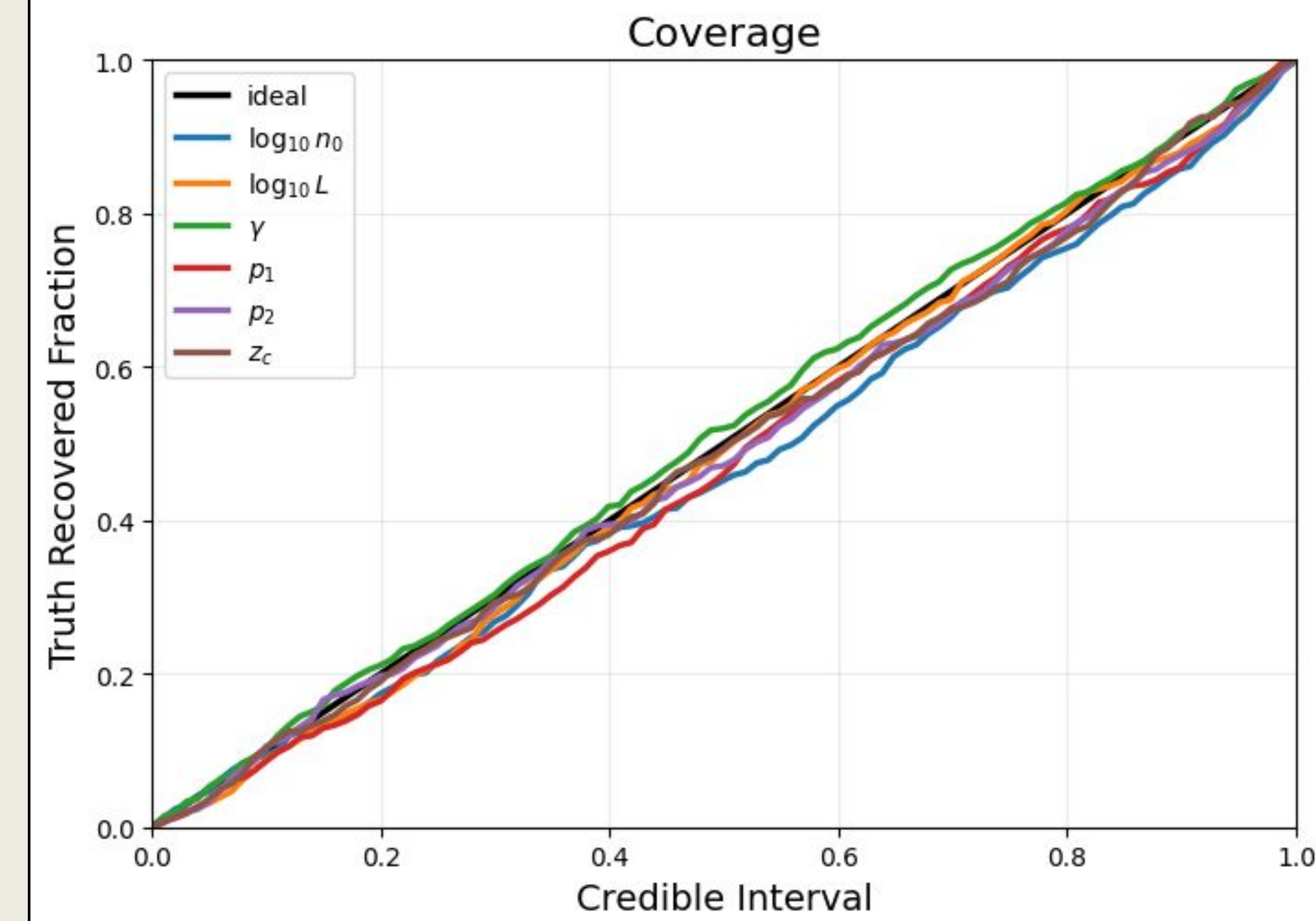
$$\frac{dN}{dE} \propto E^{-\gamma}$$

Source energy spectrum



The inferred posterior recovers the true parameter values of the simulated population and captures correlations between population parameters.

Validation



Nominal credible levels recover the injected truth at approximately the expected frequency over held-out simulations.

Outlook

Next steps:

- Robustness tests
- Alternative source evolution models
- Detector-systematics studies
- Application to public IceCube samples