Erratum: Constraints on Ultrahigh-Energy Cosmic-Ray Sources from a Search for Neutrinos Above 10 PeV with IceCube [Phys. Rev. Lett. 117, 241101 (2016)]

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In a recent Letter [1], we stated that two neutrino-induced events were detected. The observed events were, because of their estimated energies, interpreted as background in the original analysis searching for neutrinos above 10 PeV. One of two events was described as a particle shower with a deposited energy of $(7.7 \pm 2.0) \times 10^5$ GeV. Later investigation revealed that this event was a detector artifact caused by a spurious flash from the in-ice calibration laser during the warm-up period before a calibration run. We have updated the current analysis excluding all of the runs overlapping with the laser warm-up period. The total lifetime difference with the update is less than 0.5%. The other neutrino-induced event, an

TABLE I. Cosmogenic neutrino model tests: Expected number of events in the effective lifetime, p values from model hypothesis test, and 90% C.L. model-dependent limits in terms of the model rejection factor (MRF). See the caption of the original Letter for full citations.

ν Model	Event rate per lifetime	p value	MRF
Kotera *et al.* SFR	$3.6^{+0.5}_{-0.8}$	$6.0^{+2.9}_{-1.0}$%	1.04
Kotera *et al.* FRII	$14.7^{+2.2}_{-2.7}$	< 0.1%	0.23
Aloisio *et al.* SFR	$4.8^{+0.7}_{-0.9}$	$3.2^{+2.8}_{-0.7}$%	0.80
Aloisio *et al.* FRII	$24.7^{+3.6}_{-4.6}$	< 0.1%	0.15
Yoshida *et al.* $m = 4.0$, $z_{\max} = 4.0$	$7.0^{+1.0}_{-1.0}$	$0.1^{+0.4}_{-0.1}$%	0.43
Ahlers *et al.* best fit, 1 EeV	$2.8^{+0.4}_{-0.4}$	$13.4^{+9.2}_{-2.2}$%	1.33
Ahlers *et al.* best fit, 3 EeV	$4.4^{+0.6}_{-0.7}$	$3.2^{+1.8}_{-1.4}$%	0.76
Ahlers *et al.* best fit, 10 EeV	$5.3^{+0.8}_{-0.8}$	$1.1^{+2.5}_{-0.3}$%	0.63

TABLE II. Astrophysical neutrino model tests: Same as Table I. See the caption of the original Letter for full citations.

ν Model	Event rate per lifetime	p value	MRF
Murase *et al.* $s = 2.3$, $\xi_{CR} = 100$	$7.4^{+1.1}_{-1.8}$	$0.3^{+1.3}_{-0.2}$%	0.62 ($\xi_{CR} \leq 62$)
Murase *et al.* $s = 2.0$, $\xi_{CR} = 3$	$4.5^{+0.7}_{-0.9}$	$4.8^{+4.9}_{-2.2}$%	1.32 ($\xi_{CR} \leq 4.0$)
Fang *et al.* SFR	$5.5^{+0.8}_{-1.1}$	$1.6^{+3.0}_{-0.8}$%	0.88
Fang *et al.* uniform	$1.2^{+0.2}_{-0.2}$	$78.2^{+2.4}_{-3.9}$%	4.0
Padovani *et al.* $Y_{\nu\gamma} = 0.8$	$37.8^{+5.6}_{-8.3}$	< 0.1%	0.12 ($Y_{\nu\gamma} \leq 0.13$)

upward going track with a deposited energy of $(2.6 \pm 0.3) \times 10^6$ GeV, is unaffected. A further search identified no other high-energy neutrino candidates affected by the calibration laser.

The atmospheric background-only hypothesis of detecting the one surviving event is rejected at 2.2σ. The observed event is compatible with a generic astrophysical E^{-2} power-law flux with a p value of 86.4% and the hypothesis that this event is of cosmogenic origin is rejected with a p value of 2.2%. The corresponding evaluation of representative models is given in Tables I and II as well as the model-dependent limits presented in Fig. 1. The quasidifferential limit and a model-dependent upper limit on an unbroken E^{-2} power-law flux, shown in Fig. 4 of the original Letter, become stronger. An updated version of this plot can be found in Fig. 2.

An updated exclusion contour from a generic scanning of the parameter space for the source evolution function, $\Psi_s(z) \propto (1+z)^m$, up to the maximum source extension in redshift $z \leq z_{\max}$, is shown in the upper panel of Fig. 3. The lower panel of Fig. 3 provides a generic constraint on these astrophysical fluxes as an exclusion region in the parameter space of E^{-2} power-law neutrino flux normalization ϕ_0 and spectral cutoff energy E_ν^{cut}.

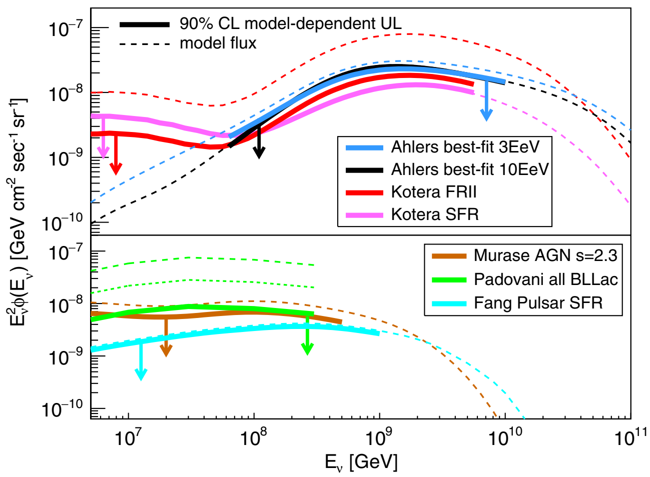

FIG. 1. Model-dependent 90% confidence-level limits (solid lines) for cosmogenic and astrophysical neutrino predictions. The range of limits indicates the central 90% energy region. See the caption of the original Letter for full details.

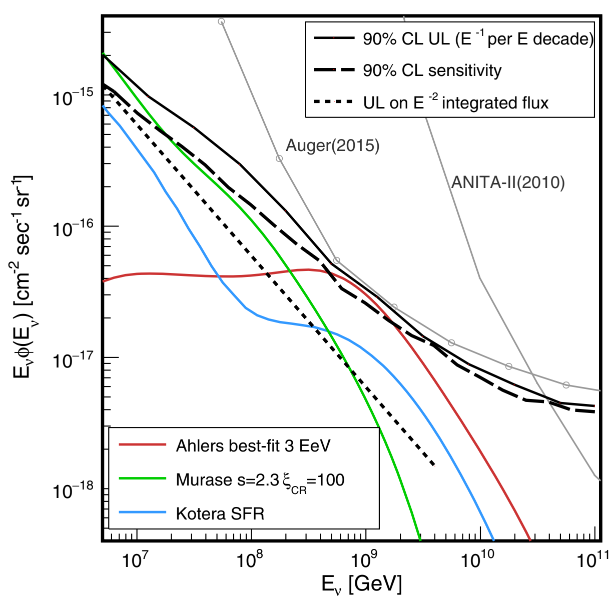

FIG. 2. All-flavor-sum neutrino flux quasidifferential 90% C.L. upper limit on one energy decade E^{-1} flux windows (solid line). A model-dependent upper limit on an unbroken E^{-2} power-law flux from the current analysis ($E_\nu^2\phi < 5.9 \times 10^{-9}$ GeV/cm^2 s sr) is also shown (dotted line). See the caption of the original Letter for full details.

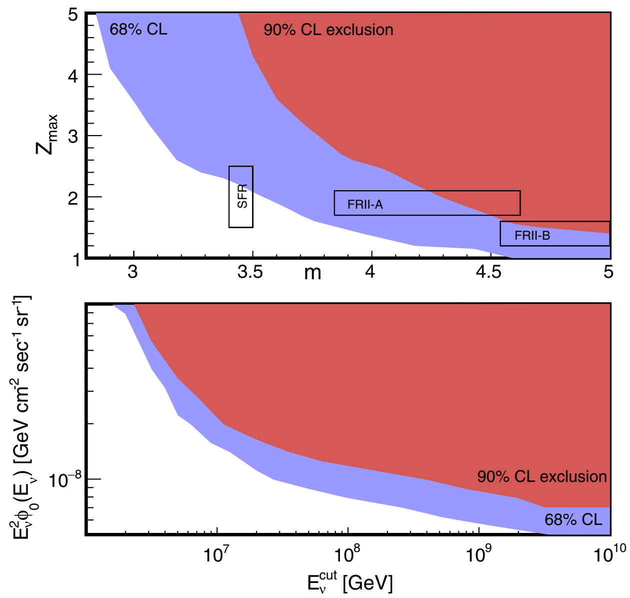

FIG. 3. Constraints on the ultrahigh-energy cosmic-ray (UHECR) source evolution model and all flavor E^{-2} power-law flux model parameters. The colored areas represent parameter space excluded by the current analysis. (Top) Cosmogenic flux parameters m and $z_{\max}$ of UHECR-source cosmological evolution function of the form $\psi_s(z) \propto (1+z)^m$. (Bottom) Upper limits on E^{-2} power-law neutrino flux normalization ϕ_0 and spectral cutoff energy E_ν^{cut}. See the caption of the original Letter for full details.

[1] M. G. Aartsen *et al.* (IceCube Collaboration), Phys. Rev. Lett. **117**, 241101 (2016).