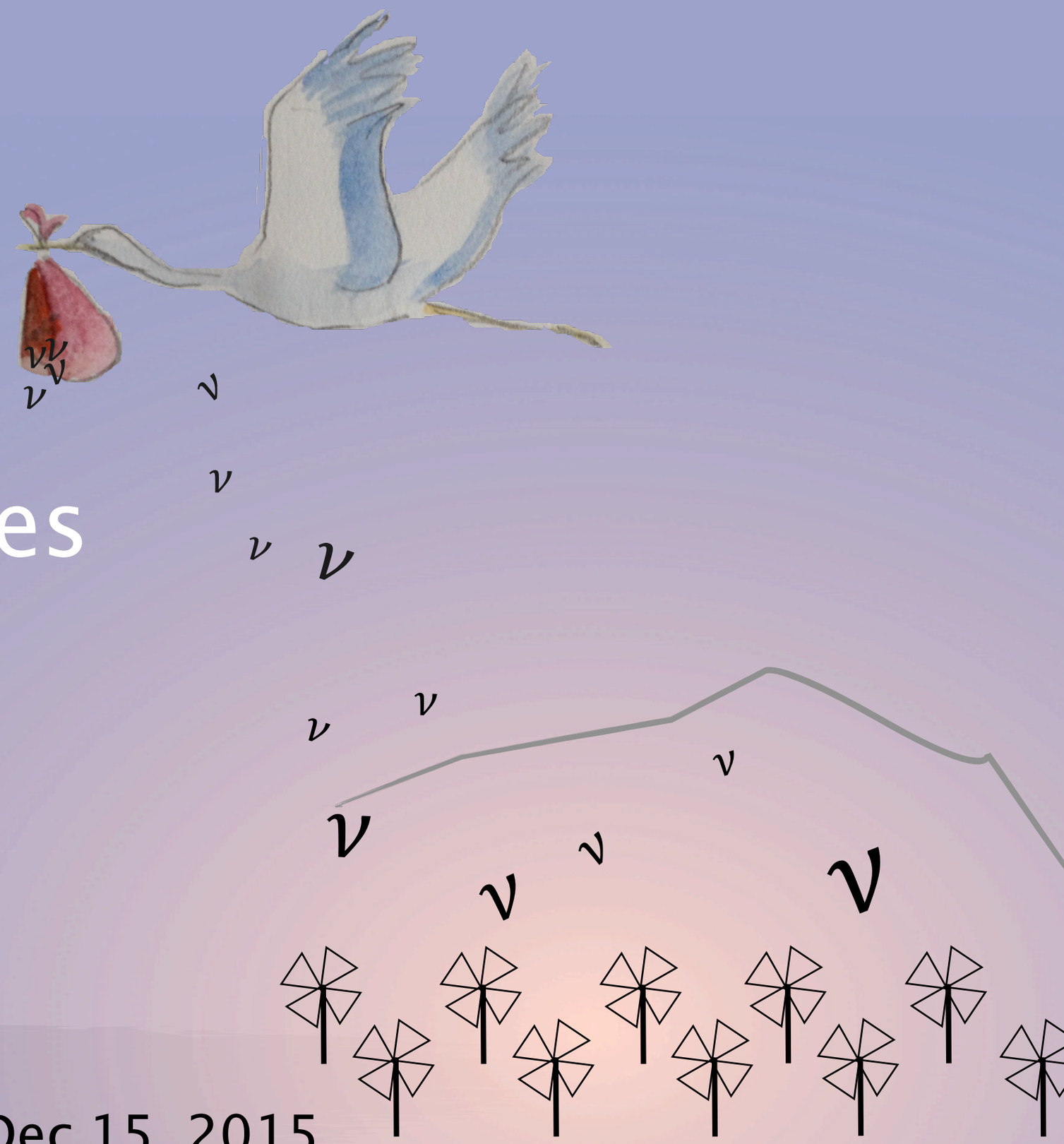
Signals from Neutrino Sources in GRAND



Ke Fang

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How many neutrinos do we expect?

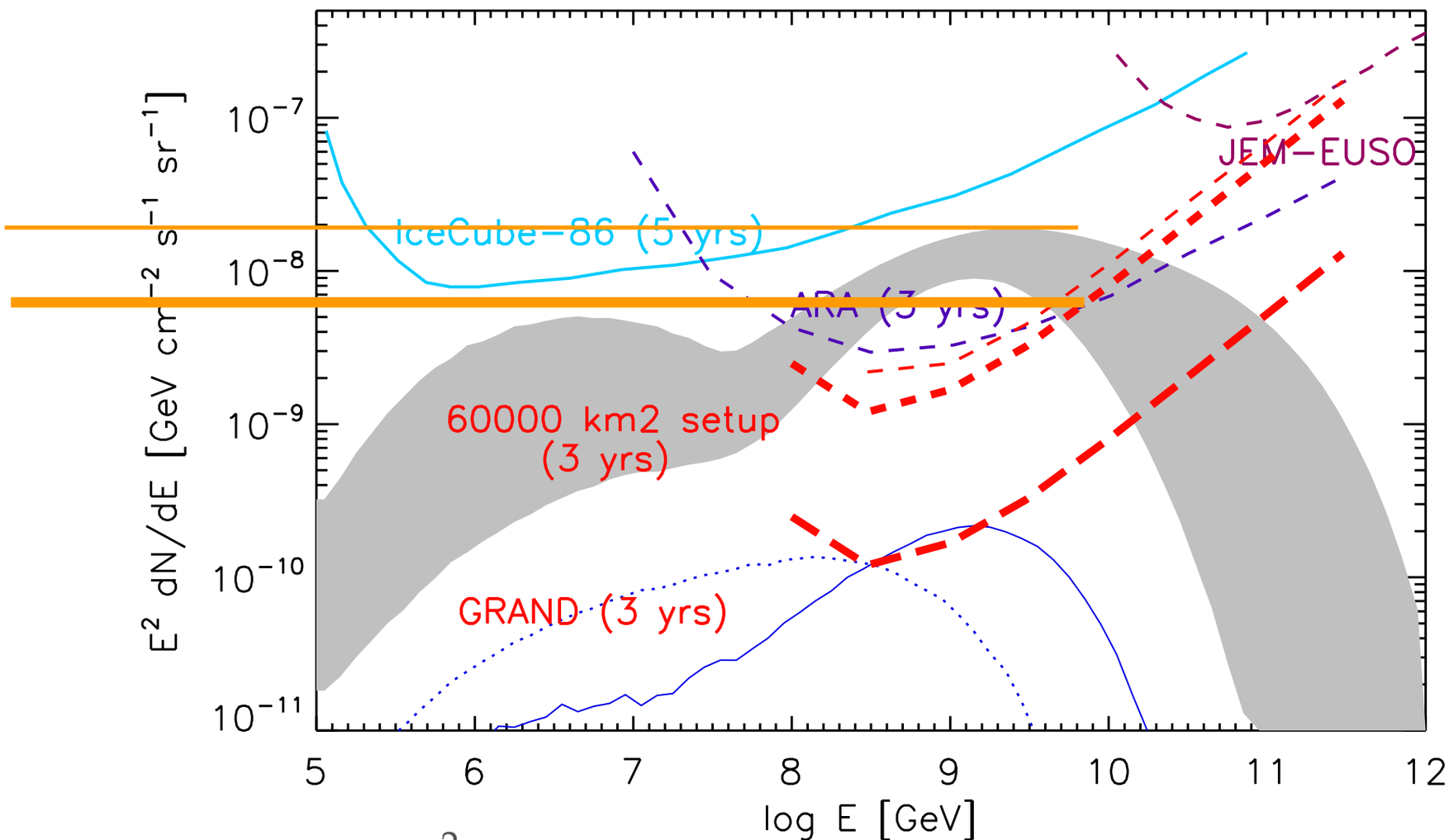
$$N = \frac{dN}{dE dA dt d\Omega} \times \Delta t \Delta A \Delta E \Delta \Omega$$

For GRAND, take

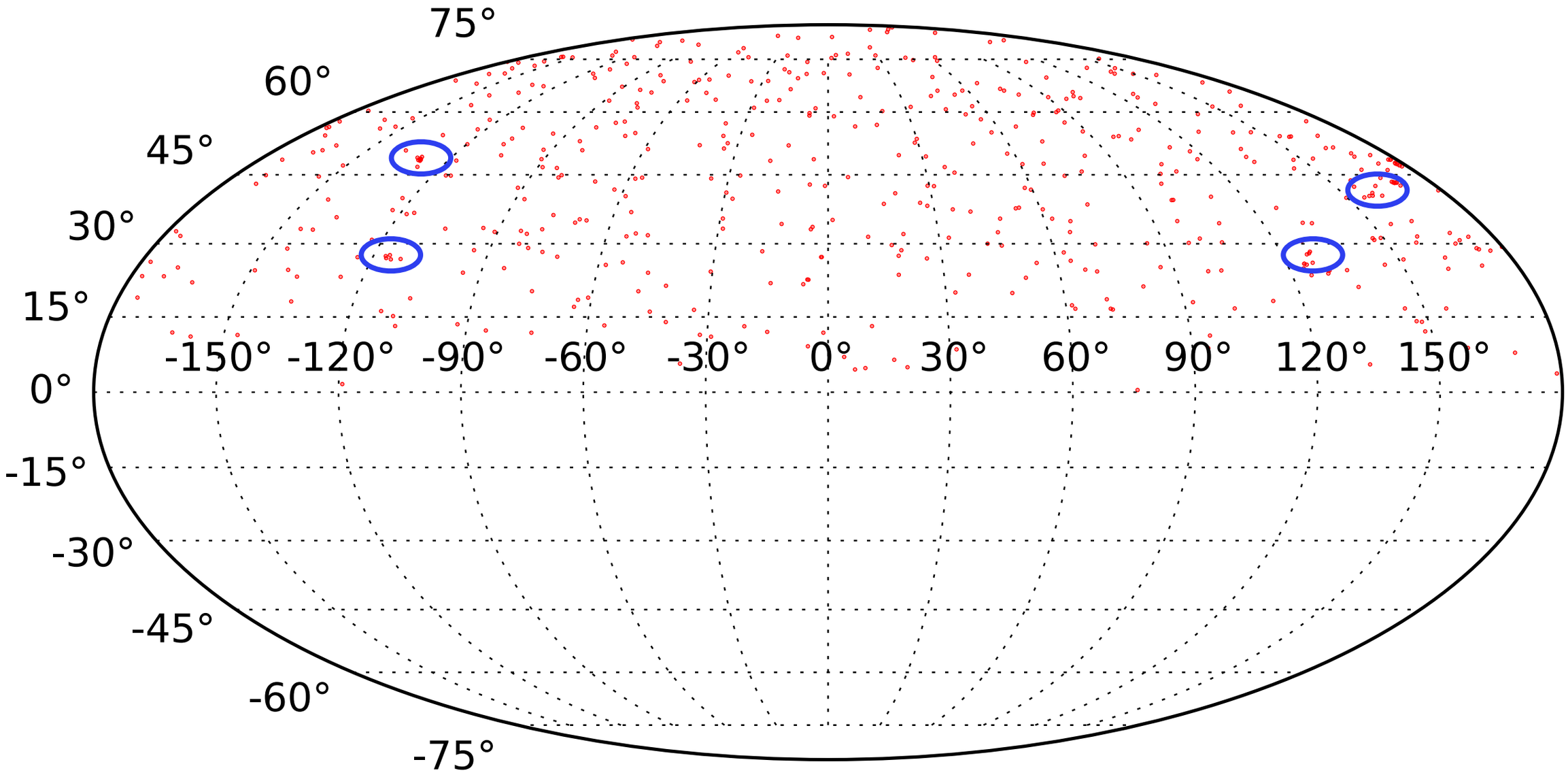
$$\left(\frac{\Delta t}{10\,\mathrm{yr}}\right)\left(\frac{\Delta A}{10^{12}\,\mathrm{cm}^2}\right)\left(\frac{\Delta E}{10^{18}\,\mathrm{eV}}\right)\left(\frac{\delta\Omega}{5\%\,4\pi}\right)$$

4000

1385



Detecting A Source On Top of the Background



Detecting A Source On Top of the Background

Great resolution => low background

$$\bar{N} = 4.8 \times 10^{-3} \left(\frac{N_{\rm tot}}{1000} \right) \left(\frac{(0.1^\circ)^2}{5\% \times 4\pi} \right)$$

A doublet has a p-value 1.2e-5 to be from different sources =>
4.2 sigma detection of a source on top of background

Doublet events are from the same source!

Events from One Source

Events from a nearby source

$$N_{1\mathrm{s}} = \frac{L_s}{4\pi D^2}\left(\frac{2-\alpha}{E_{\mathrm{max}}^{2-\alpha} - E_{\mathrm{min}}^{2-\alpha}}\right) E^{-\alpha}\,\Delta t\,\Delta A\,\Delta E$$

Events from entire source population

$$N_{\mathrm{tot}} = \frac{\Delta\Omega}{4\pi} L_s\, n_s\, D_{\mathrm{H}}\, \xi_z \left(\frac{2-\alpha}{E_{\mathrm{max}}^{2-\alpha} - E_{\mathrm{min}}^{2-\alpha}}\right) E^{-\alpha}\,\Delta t\,\Delta A\,\Delta E$$

maximum source distance

Uniform: 0.5
SFR: 2.4

detector size, time,
energy resolution

If all sources have the same Luminosity

$$\frac{N_{1\mathrm{s}}}{N_{\mathrm{tot}}} = \frac{1}{D^2\, n_s\, D_H\, \xi_z}$$

Possibility of Identifying the UHECR Source Location

$$\frac{N_{1\mathrm{s}}}{N_{\mathrm{tot}}} = \frac{1}{D^2\, n_s\, D_H\, \xi_z}$$

Promising doublet events

Doublets can constrain source properties