

# Misconceptions in UHE- $\nu$ Radio Experiments

## 1 Center of Mass Energy $\neq$ Neutrino Energy

The energy of a neutrino ( $E_\nu$ ) is its intrinsic energy ( $E_\nu = \sqrt{(p_\nu c)^2 + (m_\nu c^2)^2}$ ). The center-of-mass (COM) energy, which is useful in accelerators, has to do with the amount of energy involved in the collision, including not only the neutrino, but also the target; usually a nucleon.

Suppose a neutrino of energy  $E_\nu = 10^9$  TeV interacting with a proton at rest, then the center of mass energy ( $\sqrt{s}$ ) can be approximated to be

$$\begin{aligned}\sqrt{s} &\approx \sqrt{2E_\nu m_p} \\ &\approx 45 \text{ TeV},\end{aligned}$$

where  $m_p$  is the mass of the proton.

As a reference, the COM that the LHC can attain is 14 TeV, approximately 3 times smaller than what we just calculated for a neutrino. This can allow probes of the Standard Model at higher energies than what a human made accelerator can get.

## 2 ?