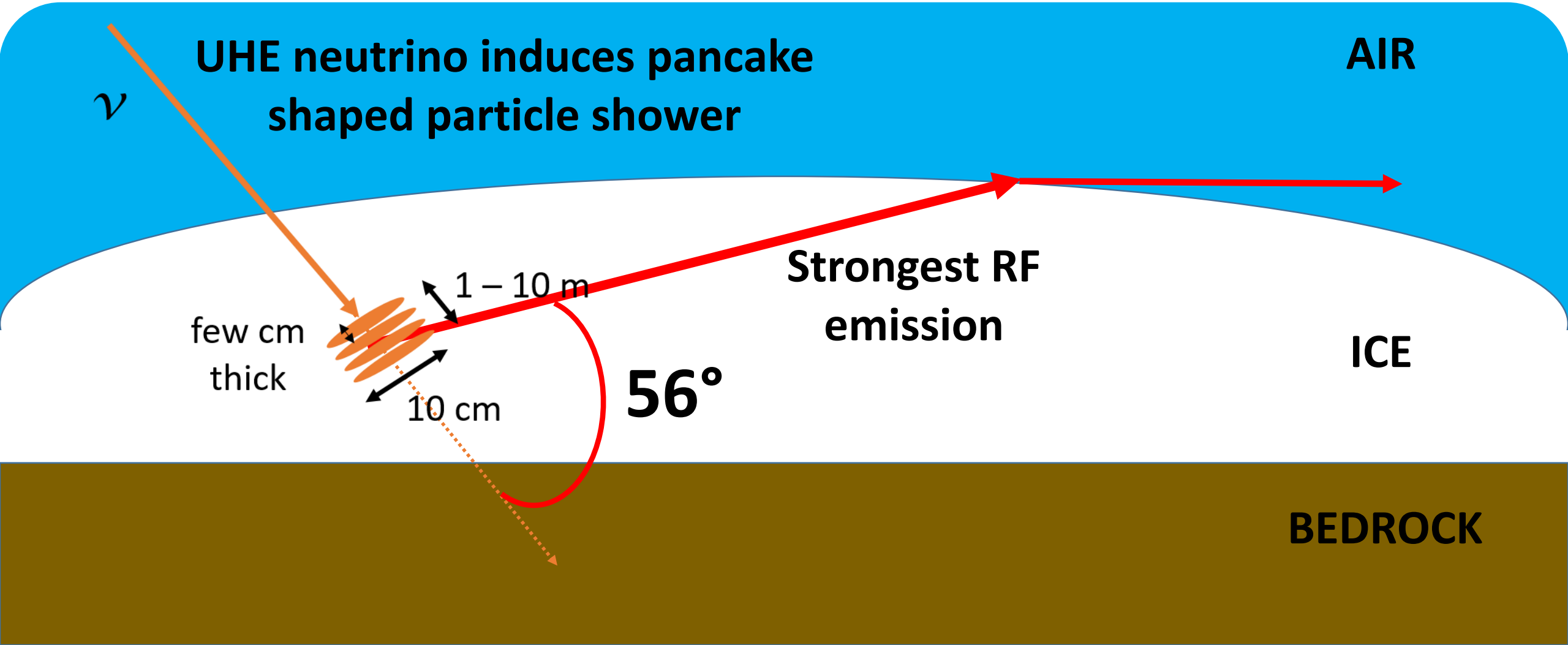
ULTRA-HIGH ENERGY NEUTRINOS INTERACTING IN ICE

OINDREE BANERJEE

CONNOLLY GROUP

THE OHIO STATE UNIVERSITY

Neutrino induced particle shower and the Askaryan effect



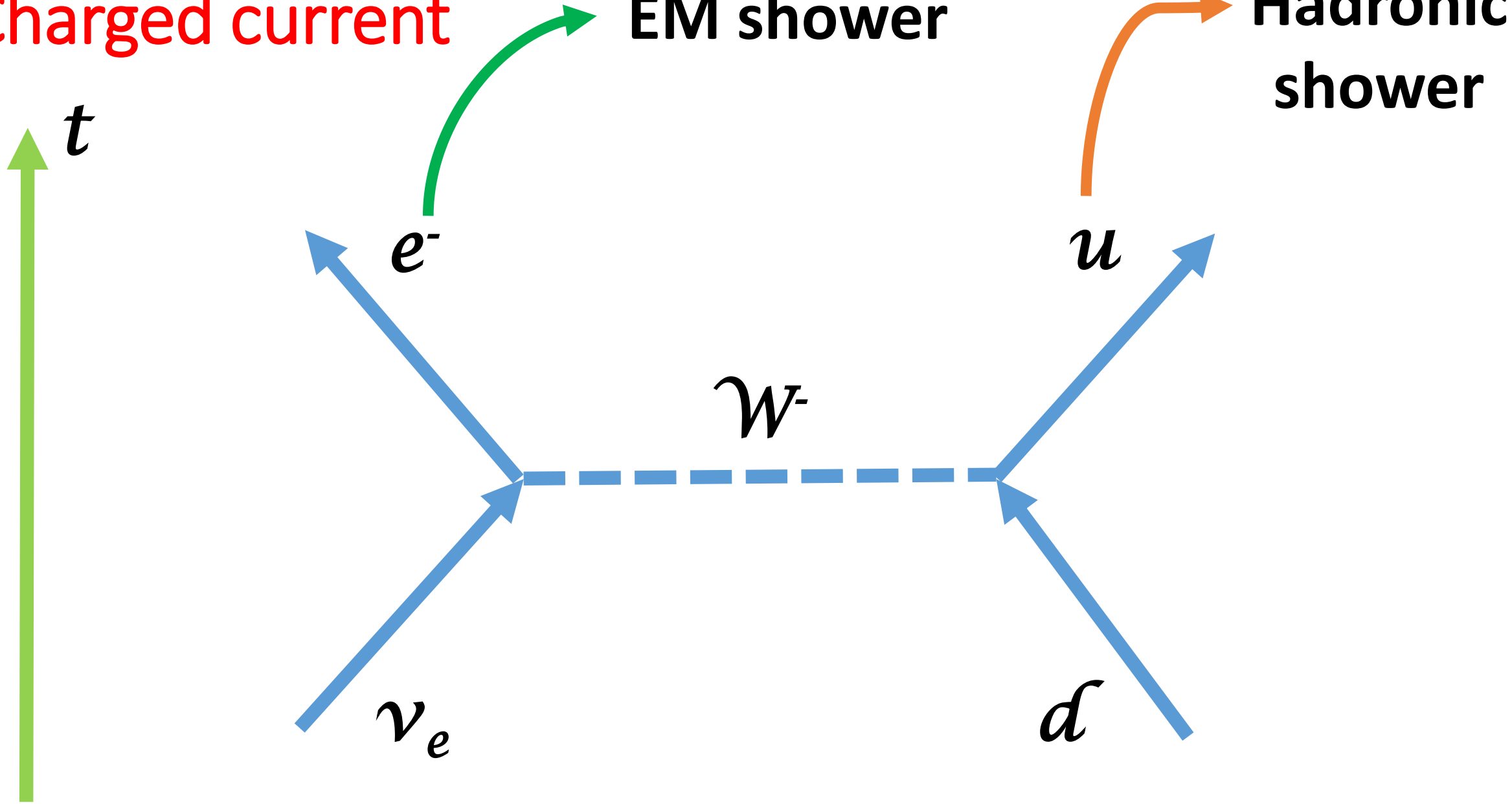
Neutrinos only interact via the weak interaction

Type	Mediator	Mass	Probability at UHE
Charged current (CC)	W^+ and W^- bosons	~ 80 GeV/c^2	68%
Neutral current (NC)	Z^0 boson	~ 92 GeV/c^2	32%

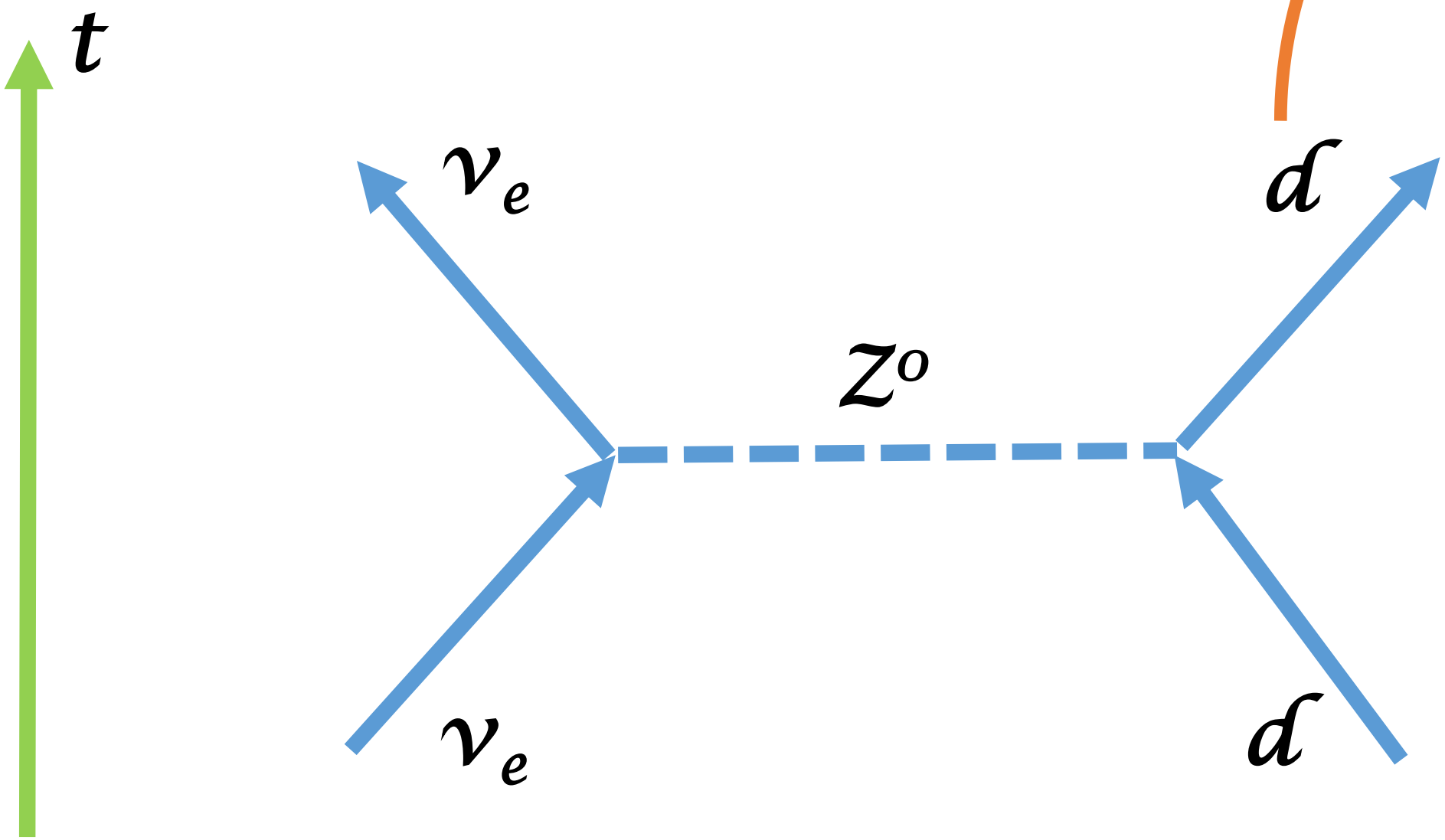
Probabilities come from CC and NC cross-sections for neutrino-nucleon interactions at UHE

Electron neutrino interaction in ice

Charged current



Neutral current

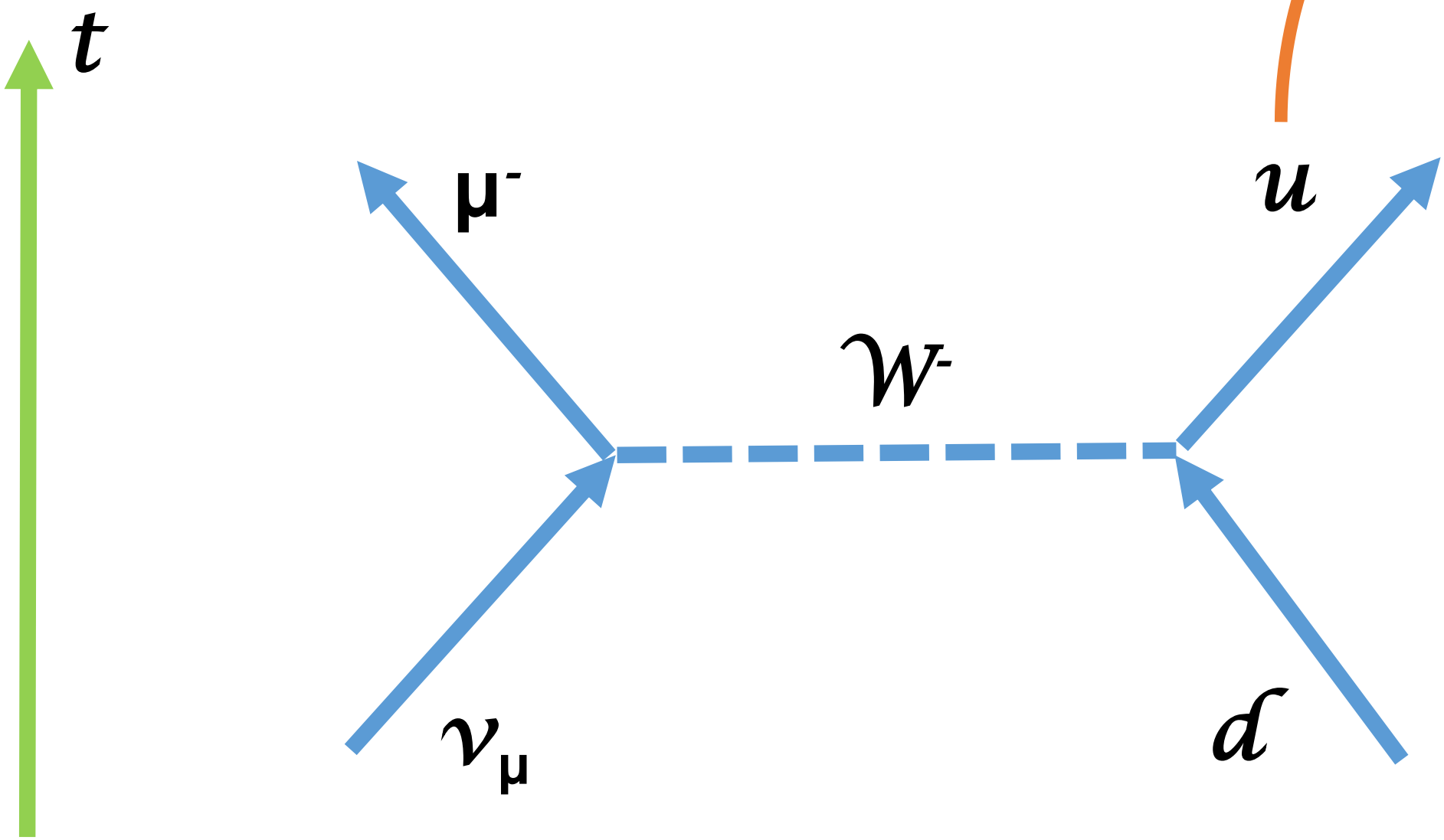


Summary

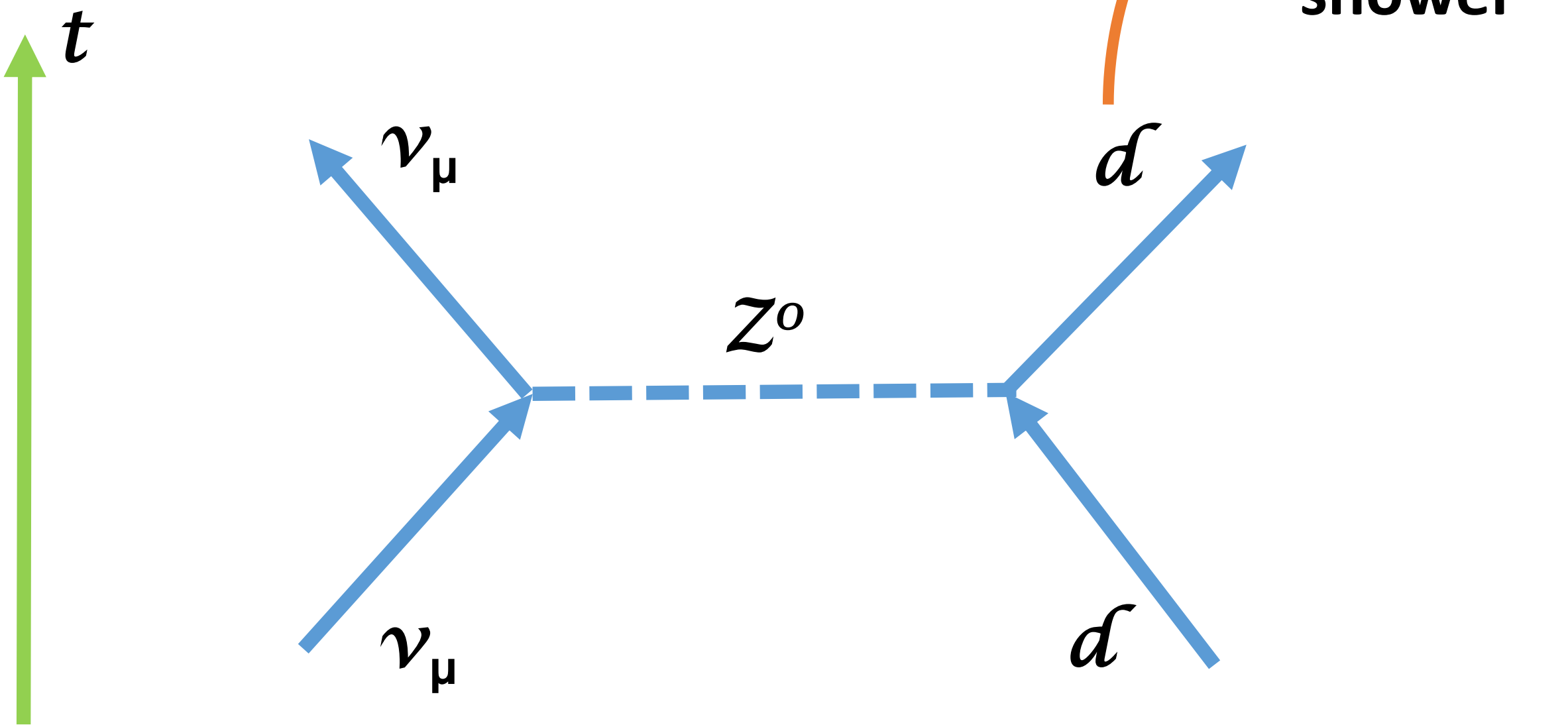
- Produces an electron or positron which causes:
  - **EM showers**
    - **Bremsstrahlung**
    - **Cerenkov**
    - **Compton Scattering**
- Interacts with quark which causes **hadronic showers**
- Pair production → more hadronic showers
- ANITA can see showers

Muon neutrino interaction in ice

Charged current



Neutral current

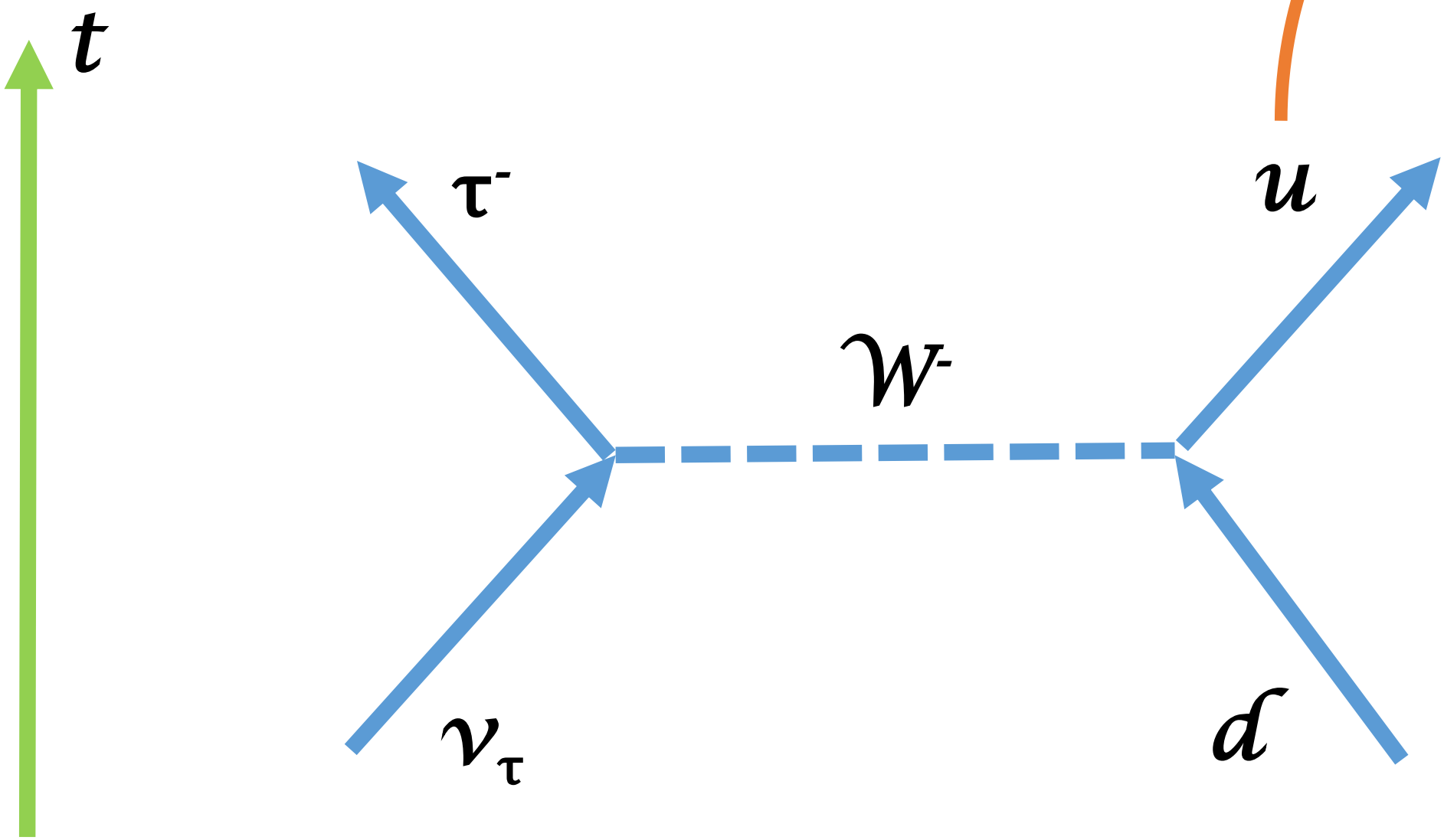


Summary

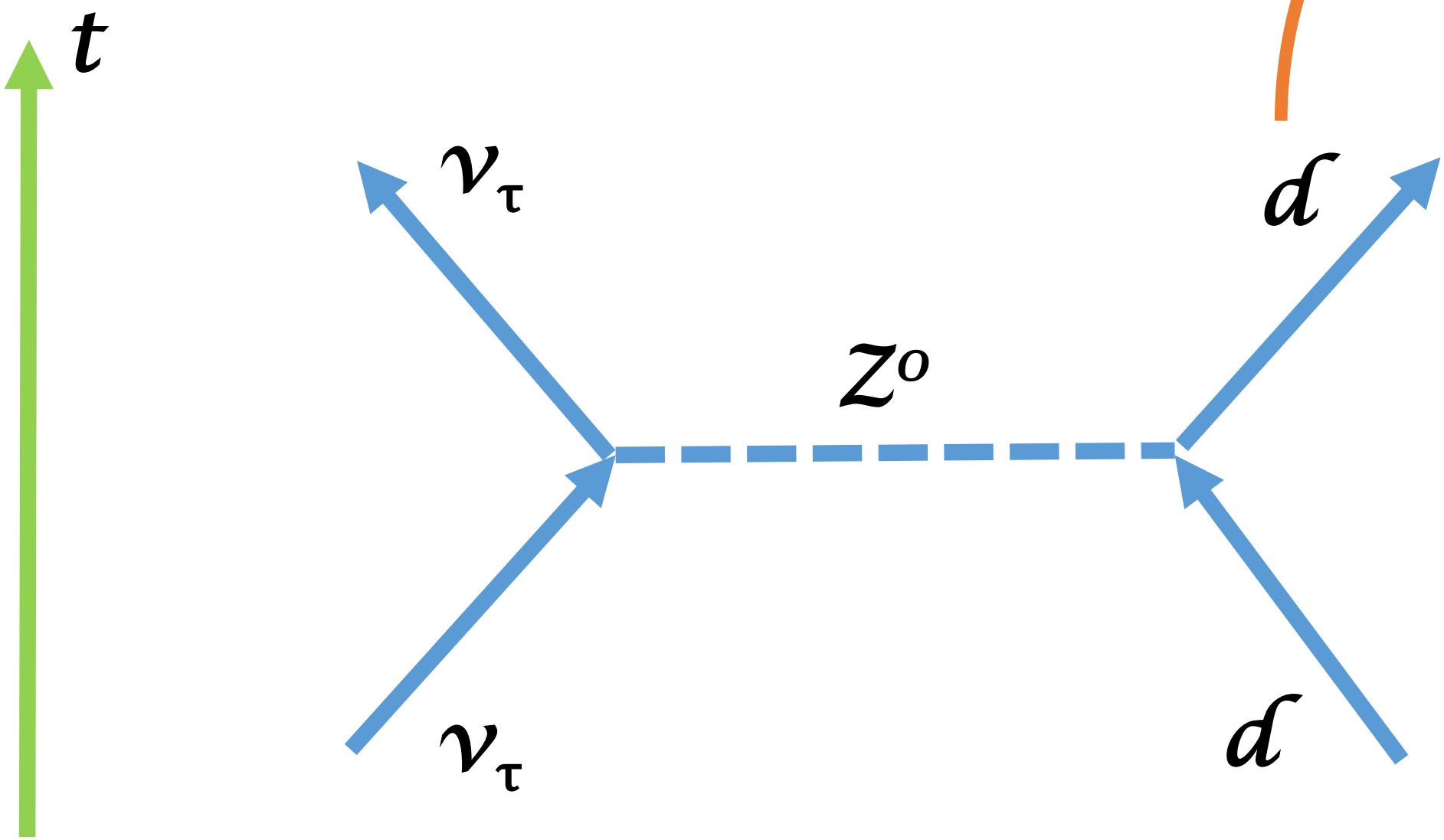
- Produces a **muon** or **antimuon**
- Interacts with quark which causes **hadronic showers**
- Muon decay length ~ **6.3×10^9 km at 10^{18} eV**
- ANITA doesn't see shower from muon decay

Tau neutrino interaction in ice

Charged current

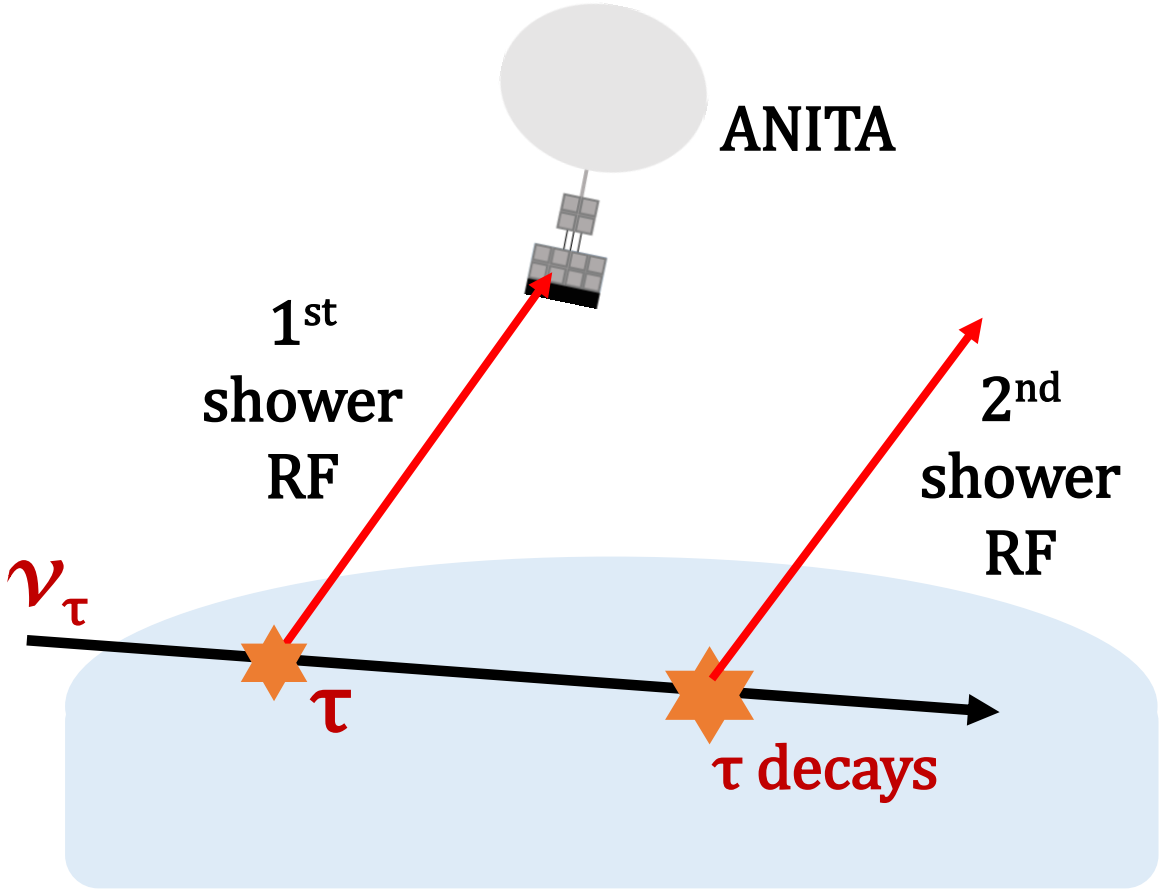


Neutral current



Summary

- Produces tau or antitau
- Interacts with quark:
  - **hadronic showers**
- Tau decay length ~ **50 km at 10^{18} eV.**
- Tau decays, causing another shower
- ANITA *might* see 1st shower, unlikely to also see the 2nd shower.



Hadronic – 65% Leptonic – 35%

Leptonic τ decays:

$\tau \rightarrow e^- + \overline{\nu}_e + \nu_\tau$

$\tau \rightarrow \mu^- + \overline{\nu}_\mu + \nu_\tau$

Thank you. Any questions?

References

- Group members
- Griffiths Particle Physics book
- Brian Mercurio's PhD thesis
- Wikipedia