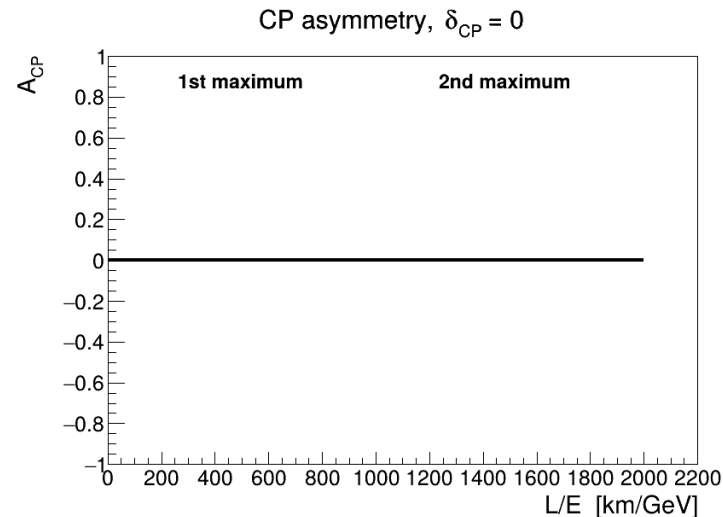
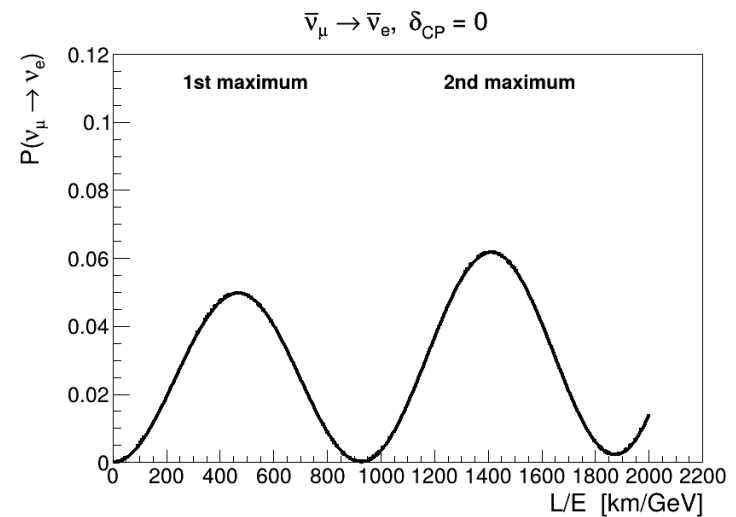
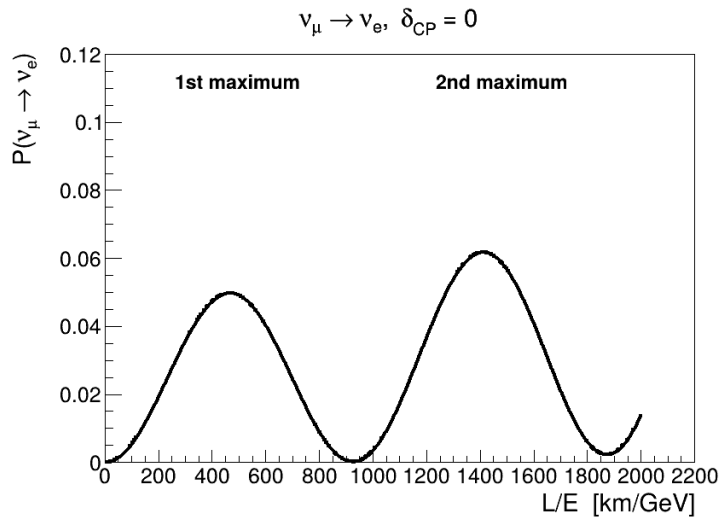




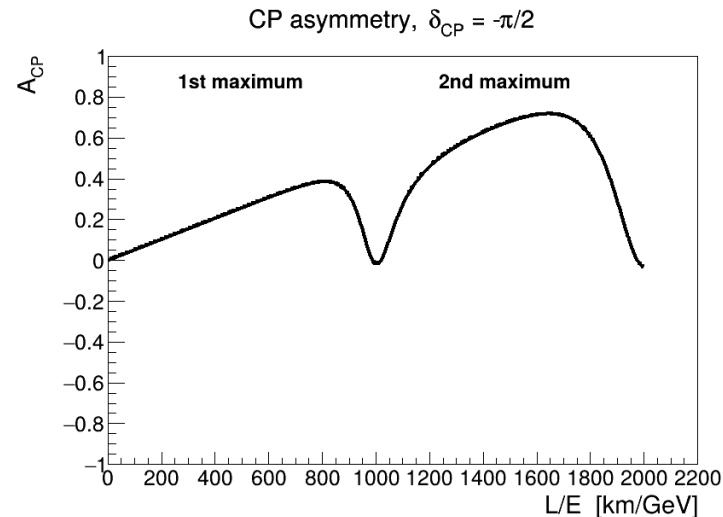
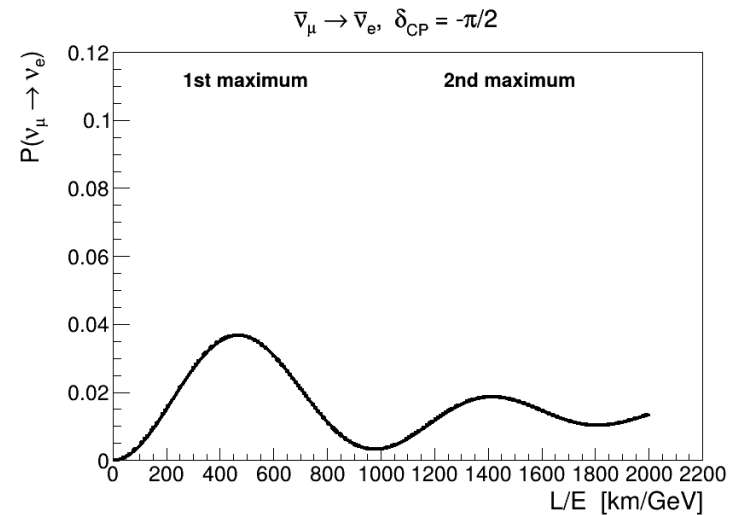
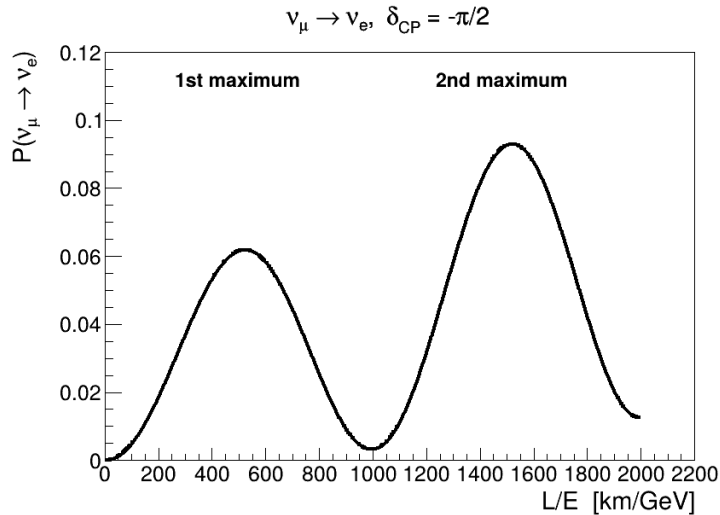
# What are neutrinos?

- Very weakly interacting neutral particles
  - About 100 trillion (100.000.000.000.000) neutrinos pass through your body every second.
    - Still one would have to wait about 100 years for a neutrino to interact in a detector the size of a person.
- They are for example produced in radioactive  $\beta$  decays:  $n \rightarrow p + e^- + \bar{\nu}_e$
- They come in three flavors:  $\nu_e, \nu_\mu, \nu_\tau$  (and their antiparticles)
- They can change flavor as they travel through space!

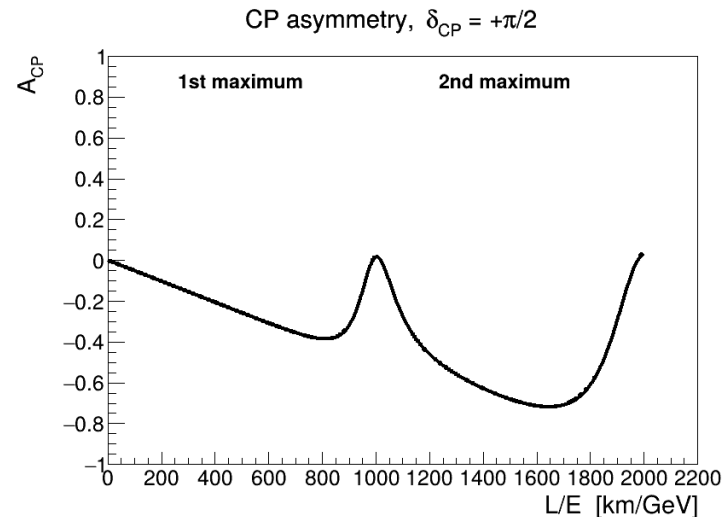
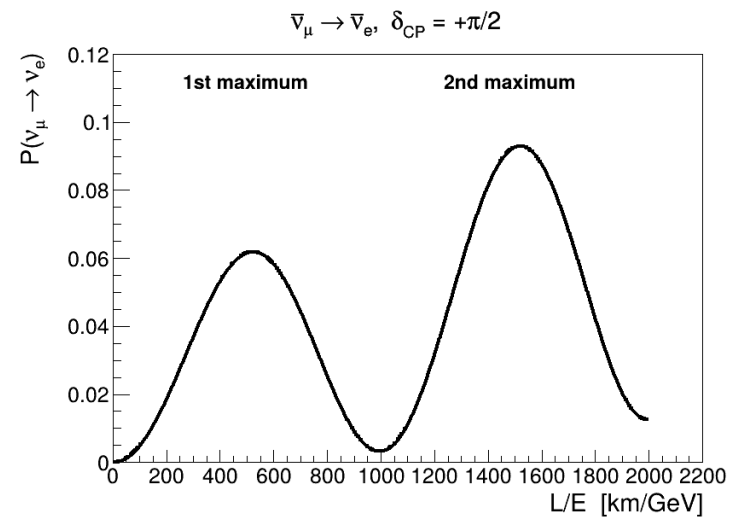
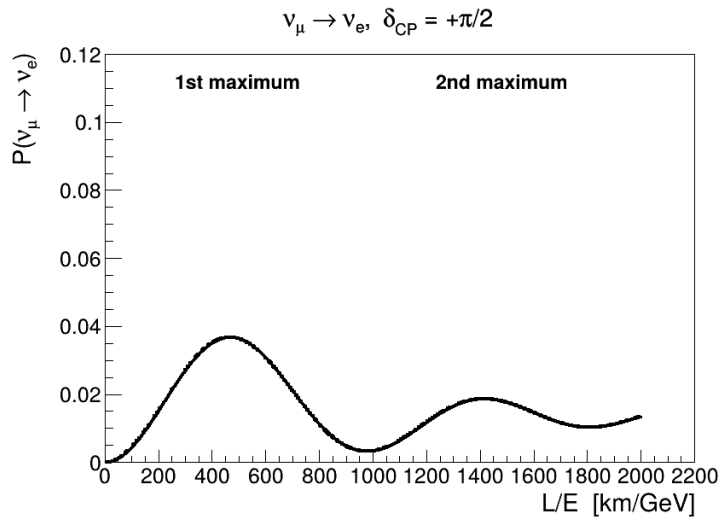
# Neutrinos and antineutrinos oscillate as they propagate



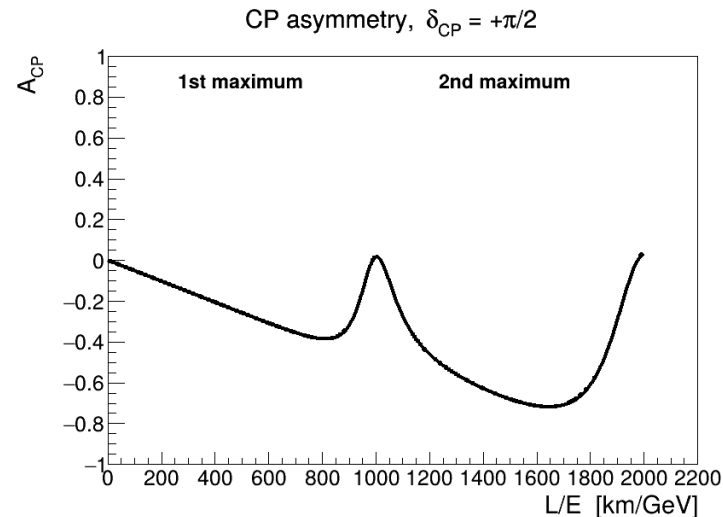
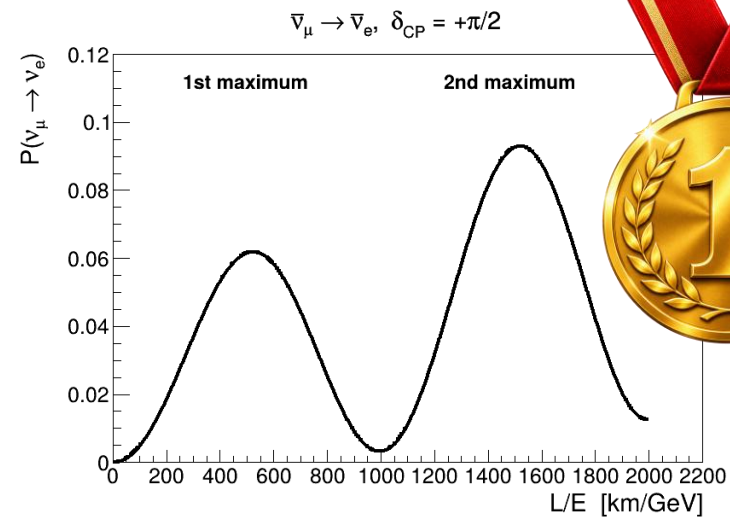
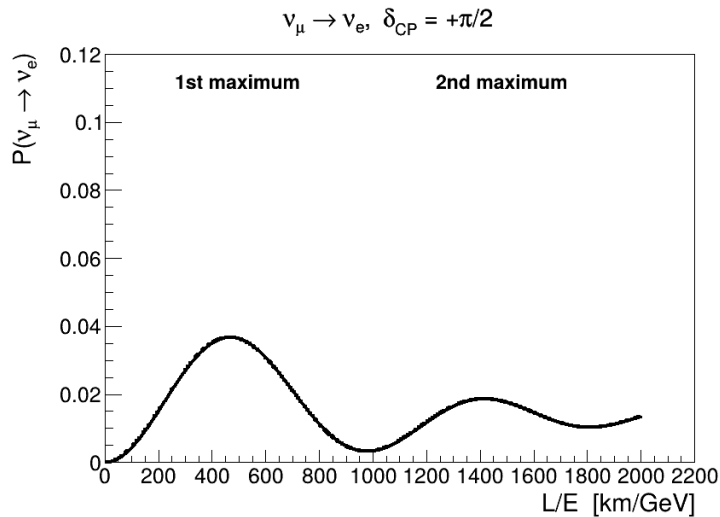
# Neutrinos and antineutrinos can oscillate differently!



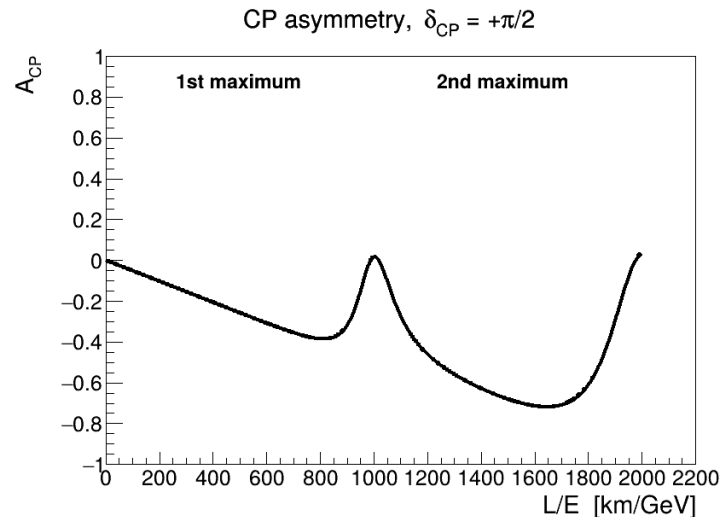
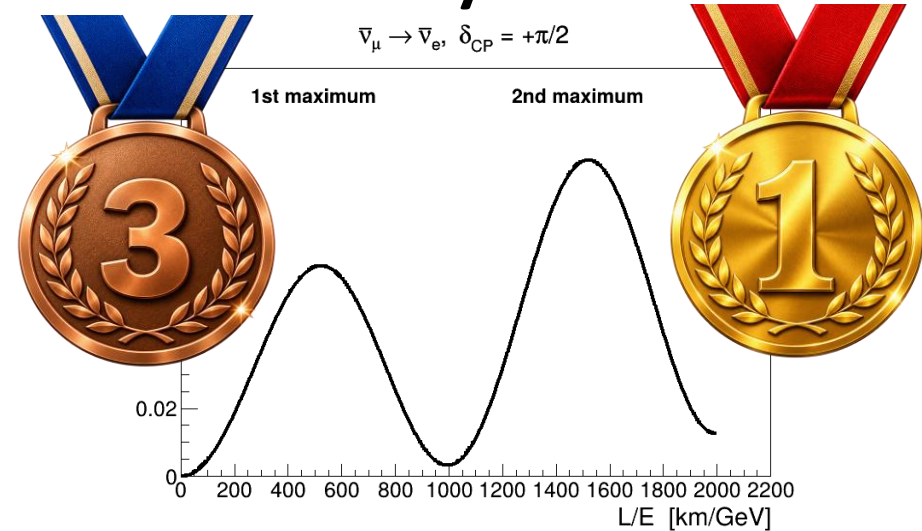
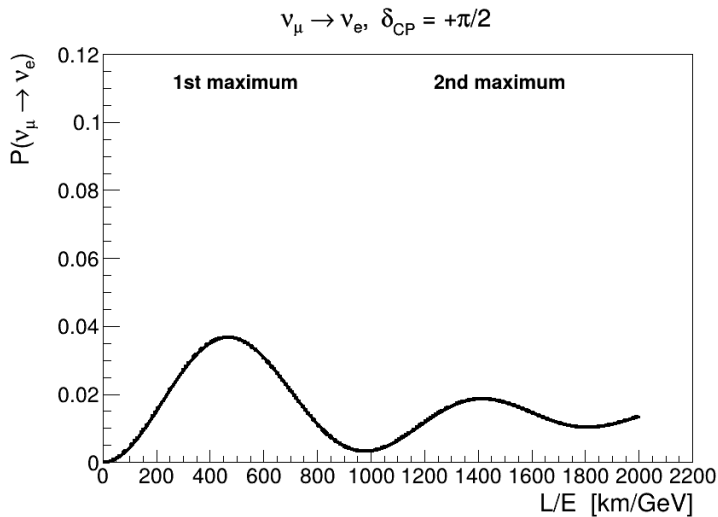
# Neutrinos and antineutrinos can oscillate differently!



# Neutrinos and antineutrinos can oscillate differently!



# Neutrinos and antineutrinos can oscillate differently!





# Why can we do better in Sweden?

- All other experiments in the world are being built to look at the first oscillation maximum!
  - We can build an experiment at the second maximum
- We have a powerful accelerator that is only used 1/28 of the time (else it would melt the target 🔥 )
- We have a mine for the detector in the right distance!



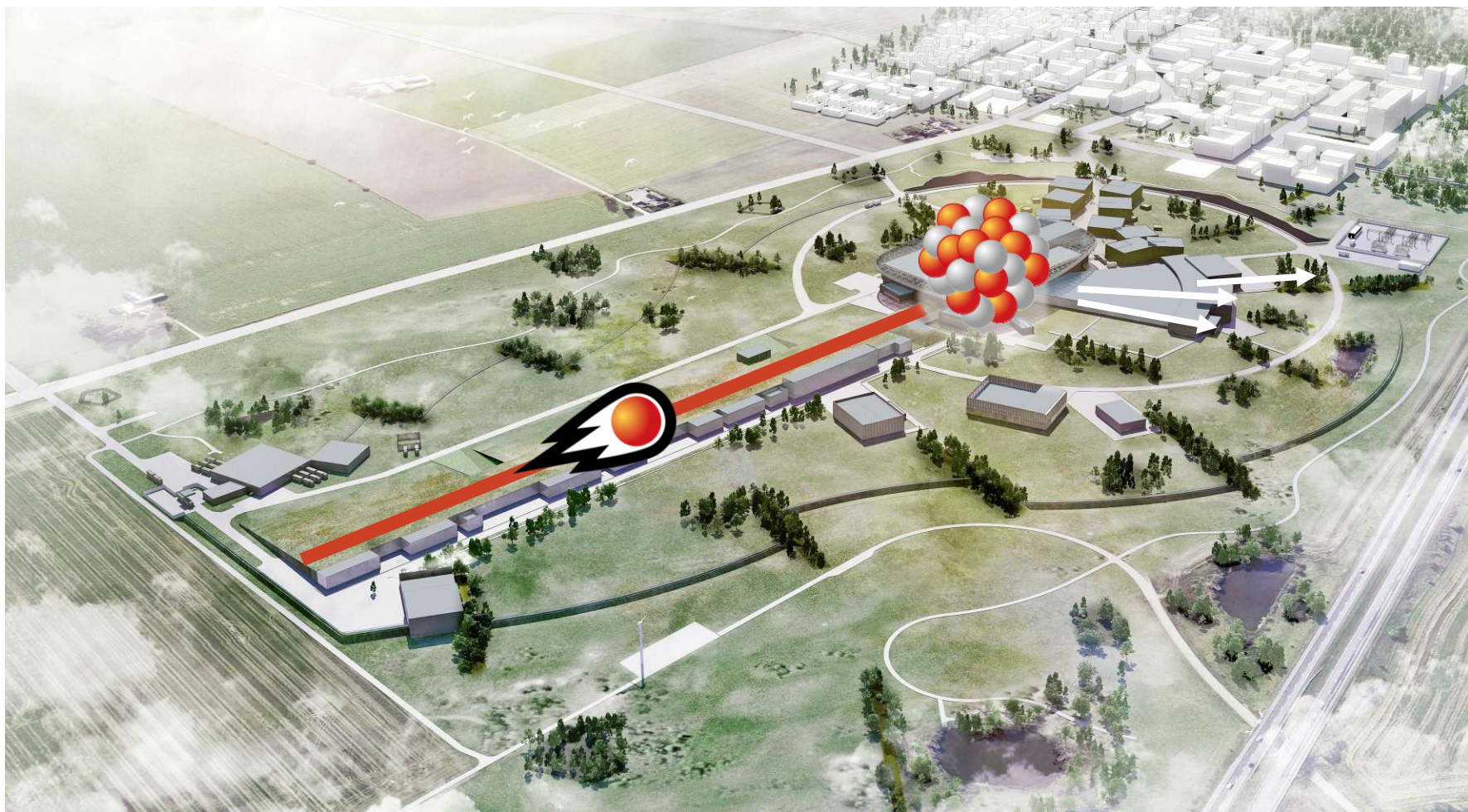
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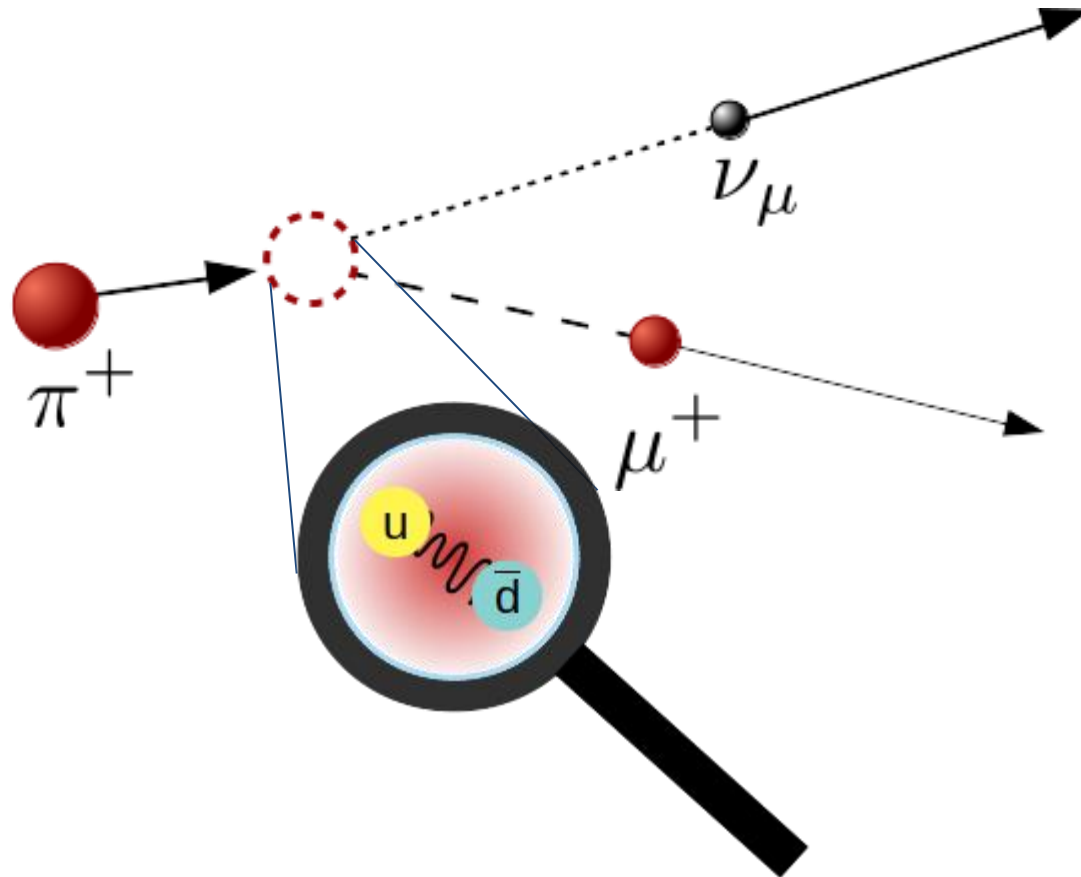
# ESS – the worlds most powerful accelerator(5 MW)



We want to double its power with another beamline!



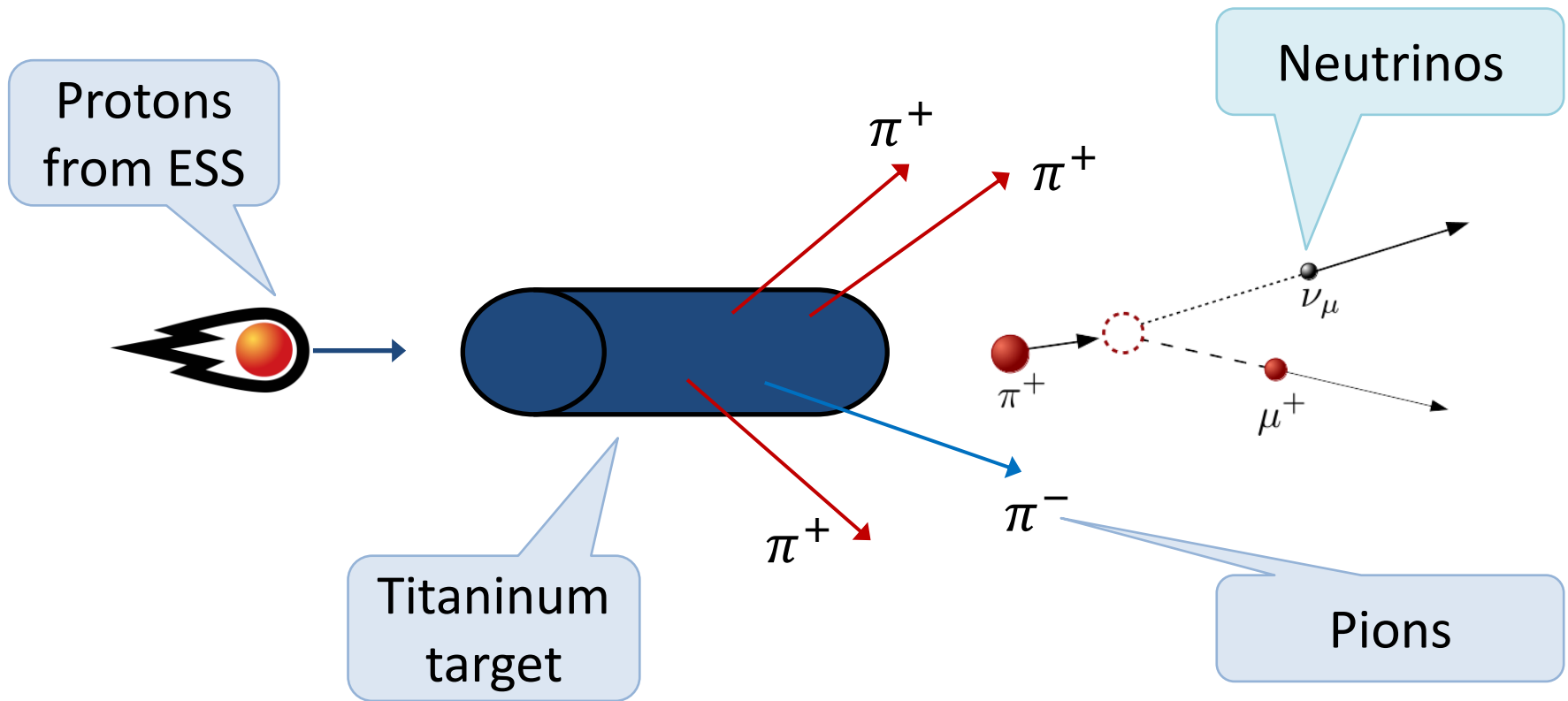
# How can we create a neutrino beam?



- Neutrinos are created by pion decays  
→ We need a lot of pions!



# From protons to pions to neutrinos



- We need a lot of protons to create a lot of neutrinos
  - ESS is the ideal proton beamline!