SAFETY FIRST

1. **Stay with your group.** You must remain in visual and audible contact with your Escort at all times.

2. **Pay attention to the Safety Briefing.** Your Escort will give the briefing, and you acknowledge that you received and understand it when you sign-in.

3. **Wear a Hardhat** while underground.

4. **Take off your hardhat before looking over the guardrail around the top of the shaft!** Also hold securely to glasses and cameras. Dropping anything into the shaft is a serious safety issue.

5. Be aware of hazards. Steel plates lie over the sump covers just outside the elevator enclosure underground. Pay attention that you do not trip on their edges. No open-toed or high-heeled shoes are allowed.

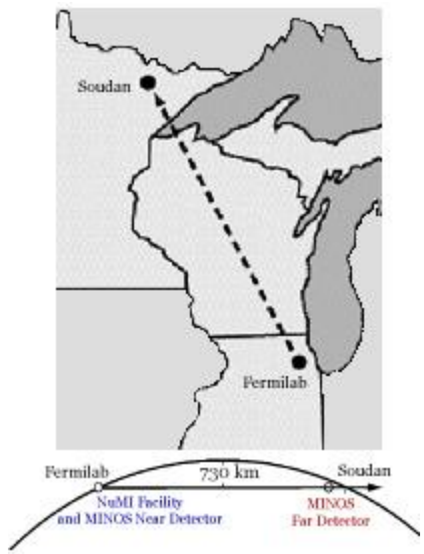
6. The experiment detectors are usually in operation at all times. Do not touch! Do not bump cables or push any buttons or knobs.

IN AN EMERGENCY

Call x3131, the Lab's emergency operator, for assistance.

If a power outage occurs underground it will be quite dark for a few moments! Stand still. Within 30 seconds, the emergency generator will come on and lights and elevator power will be restored. Proceed directly to the elevator and exit.

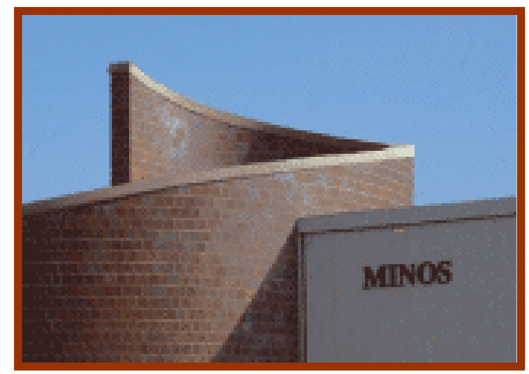
If a fire or other alarm occurs, an automated PA announcement will tell your Escort which exit to proceed to. Obey your Escort's instructions.



Fermilab

MINOS UNDERGROUND AREAS

Information for Visitors



MINOS AREAS

The MINOS Areas are part of the NuMI Facility at Fermilab. NuMI stands for Neutrinos at the Main Injector, and is a specialized beam facility which creates a beam of muon neutrino particles. The MINOS Areas are the portion of the NuMI facility which holds experiments. As shown in the diagram below, the MINOS Areas are a small part of the whole NuMI Facility. MINOS stands for Main Injector Neutrino Oscillation Search, and is the name of the first experiment installed here, and the one for which the NuMI beam was designed. There are now additional experiments installed in the MINOS Areas, with more coming.

HOW NEUTRINOS GET MADE

Protons accelerated in the Main Injector are extracted into the NuMI Beamline, and in the Target Hall they strike a target – a 1-meter-long piece of graphite. All sorts of particles spray out, but most of what comes out are particles called pions. These will decay, after some distance, to a muon and a neutrino – and this is how the beam of neutrinos is obtained. Most of the length of the NuMI Facility is this Decay Tunnel, which holds a 6-foot diameter pipe where the pions turn into muons and neutrinos. At the end of the Decay Tunnel is a beam Absorber – a pile of aluminum, steel and concrete – which captures any of the remaining pions and other similar particles. Neutrinos just keep going straight through.

You cannot tour most of the NuMI facility, because like other beamline areas at Fermilab, the accelerated protons, pions, and other similar particles make these into radiation areas. Neutrinos, however, are not like these other particles.

STUDYING NEUTRINOS

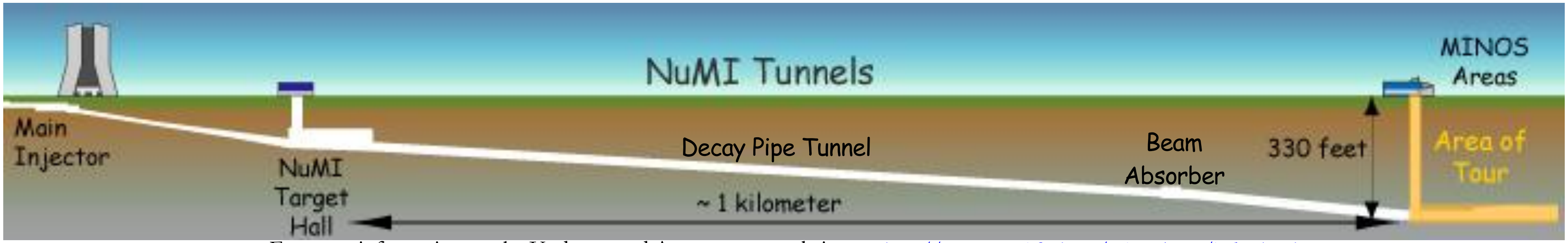
Neutrinos do not do very much – they have a very low "interaction probability". That means they can pass through matter – rock, steel, yourself – without affecting it. The NuMI Beam is very likely operating during your tour, and you have billions of NuMI neutrinos passing through you now! Billions of neutrinos which come out of the sun are also always passing through you every second! Scientists can only learn things about neutrinos when they interact with matter – by looking at what happens. While the interaction probability is low, it is not zero. So you play a numbers game. You make a large number of neutrinos and you send them into a dense detector – something like steel, to increase the chances of an interaction happening. And then you wait. For the MINOS detector you see here, about 10 billion neutrinos pass through it every 2 seconds, and out of those, a handful interact in the detector – between 1 and 5. That's all! But from those few interacting neutrinos, a lot of things are learned.

THE MINOS EXPERIMENT

MINOS is two detectors, one here at Fermilab and the other in the Soudan Underground Lab in northern Minnesota. The NuMI beam of neutrinos points down in order to aim them to this location – see the diagram on the back of the brochure.

Between Fermilab and Soudan, some of the neutrinos have a personality change. Neutrinos come in 3 types, or "flavors". Because of the way the NuMI beam makes neutrinos, all of the ones made here are of a single flavor – all muon neutrinos. However, some of these, after traveling all the way to Minnesota, have become another flavor. Scientists do not know which – but they do know that a significant number of the muon neutrinos which leave Fermilab do not show up at Soudan! This flavor-changing is an effect of quantum mechanics. By measuring how many neutrinos change flavor, scientists indirectly measure their mass. Mass is an important property in understanding neutrinos and how they fit into the Standard Model, and in the universe in general. Their mass may be very tiny, but there are a lot of neutrinos!

The MINOS Detector sees neutrino interactions by using strips of plastic scintillator – particles made by an interaction create light when they pass through the scintillator. The light is captured and turned into an electrical pulse by using a phototube. The strips of plastic are laid out and wrapped up in flat modules, and attached to steel plates. The MINOS Detectors are made of hundreds of these plates. The display in the MINOS Building shows one of the Near detector plates with a cut-away scintillator module. A phototube box, light cables, and electronics are also at the display.



For more information on the Underground Areas see our website at: http://www-numi.fnal.gov/MinosAreas/index.html