U.S. Dept of Energy's 20-Year Road Map

Priority: Tie for 21

Super Neutrino Beam

The Facility: The Super Neutrino Beam will allow more comprehensive studies of neutrino properties by producing a neutrino beam 10 times more intense than those available with current accelerators.

Background: Neutrinos are the most poorly understood of the elementary particles but may be the most important for answering fundamental questions ranging from why there is any matter in the universe at all, to how all particles and forces in the universe "unify" into a simple picture. Because neutrinos rarely interact with matter (many billions pass through each of us every second), the ability to generate controlled beams containing large numbers of neutrinos greatly increases the ability to study them.

What's New: **The Super Neutrino Beam will be powered by a new, megawatt class "proton driver"** which will be able to provide an intense, well-controlled neutrino beam - with 10 times more neutrinos per second than are available from any existing facility - to detectors hundreds or thousands of miles distant.

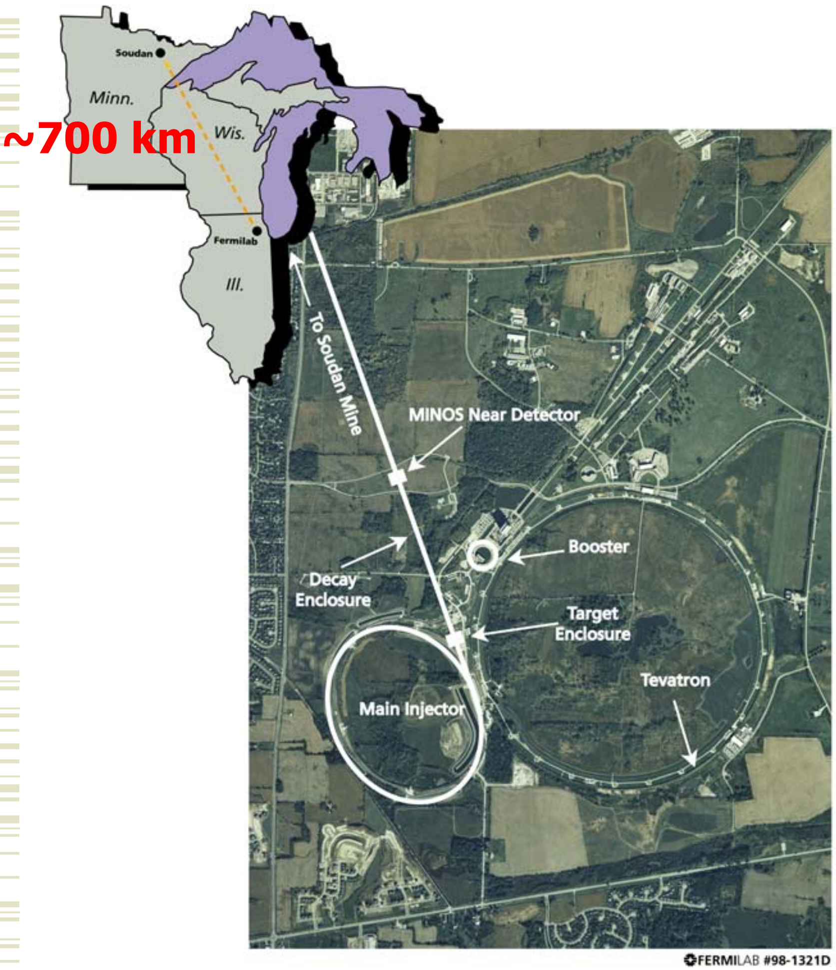
Applications: The 2002 Nobel Prize in physics was shared by two scientists—one American and one Japanese—for their path-breaking measurements of solar and atmospheric neutrinos. Their research strongly suggested that neutrinos have mass and oscillate among three types as they travel through space. These oscillations have recently been confirmed, and the properties and behavior of neutrinos are now ripe for measurement. The results will have profound implications for our understanding of the fundamental properties of matter and the evolution of the early universe.

What is Super Neutrino Beam?

- "Super" means high flux
- "Super" also means long baseline
- But it is NOT neutrino factory beam
- It is *conventional* neutrino beam, i.e., neutrinos from pion decay (not from muon decay)

Neutrinos

neutrinos@fermilab: MiniBooNE and NuMI

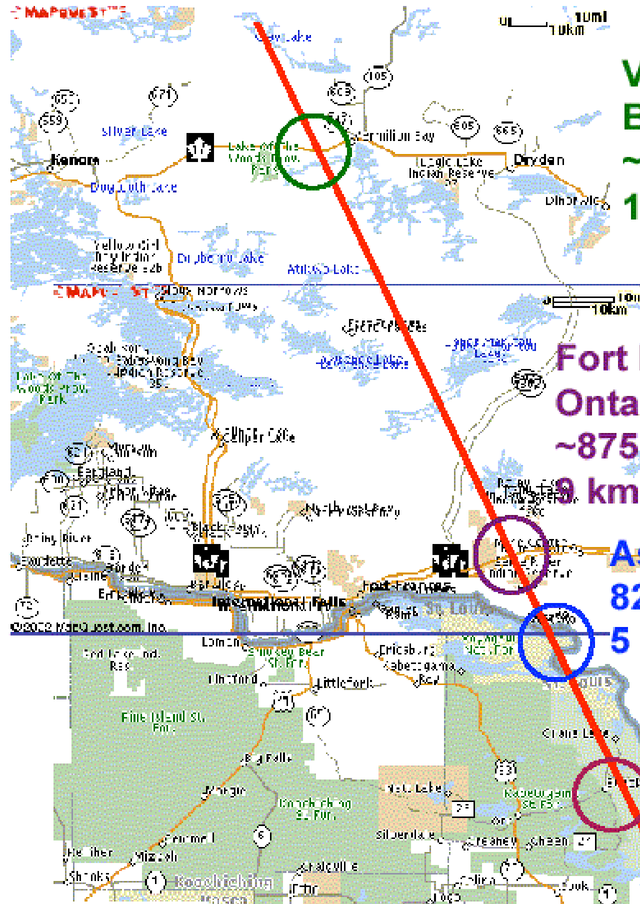


- **MiniBooNE: 8 GeV Booster protons, ν short baseline**
- **NuMI: 120 GeV Main Injector protons (0.3 MW), ν to Soudan**

New Proposal: Off-Axis Experiment

FLRP

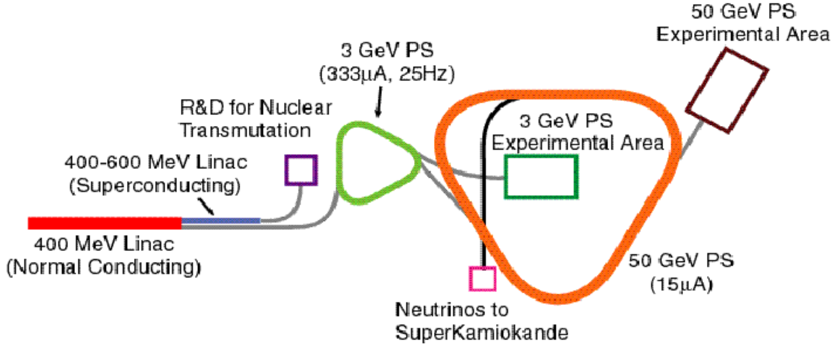
We are now focusing on the Ash River site.



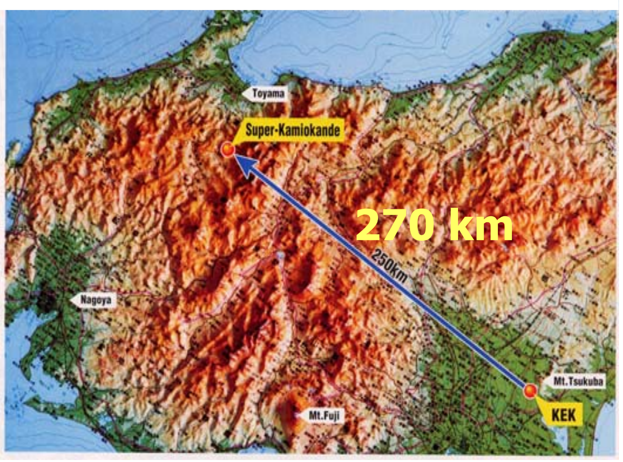
NuMI extension: Off-axis neutrino experiment with a new detector at a new location

Japan: K2K and JPARC-K

(H. Yokomizo's talk)



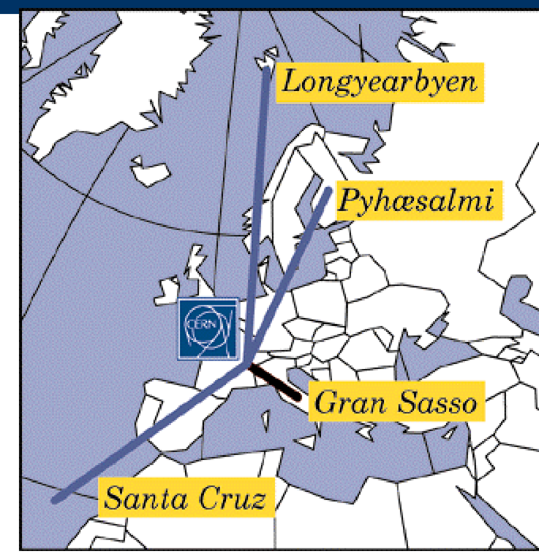
- **KEK: 12 GeV PS protons, ν to Kamiokande**
- **JPARC: 50 GeV protons (0.75 MW), ν to Kamiomande**

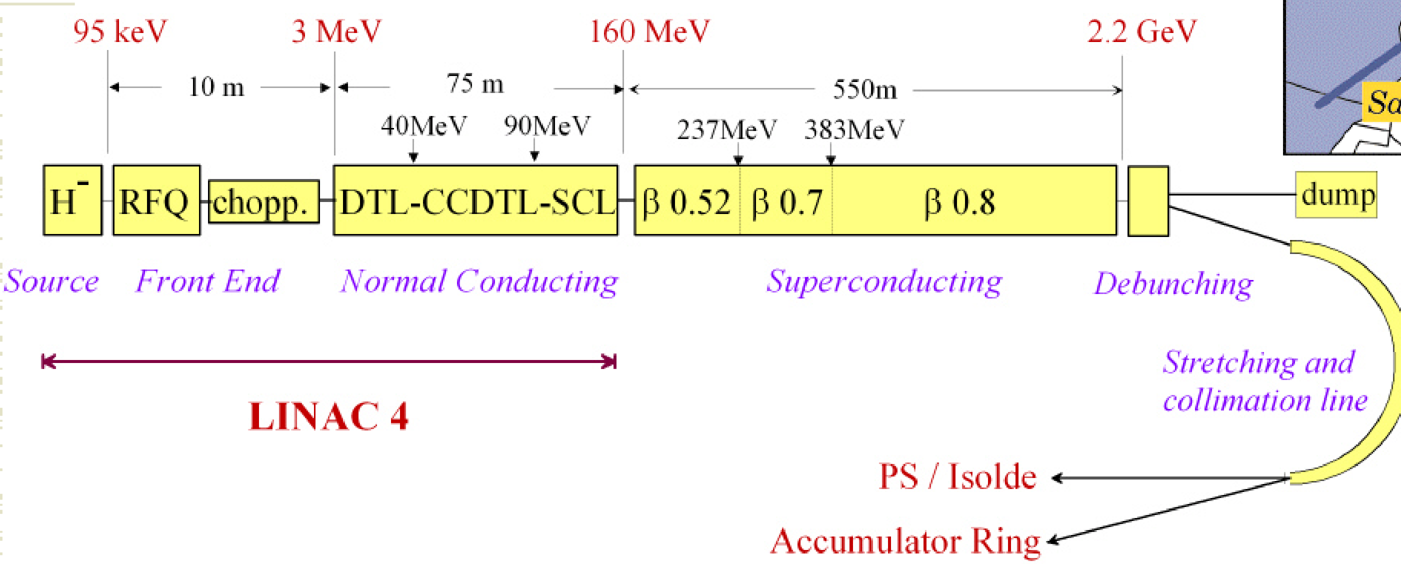


CERN: CNGS and SPL

(E. Metral's talk)

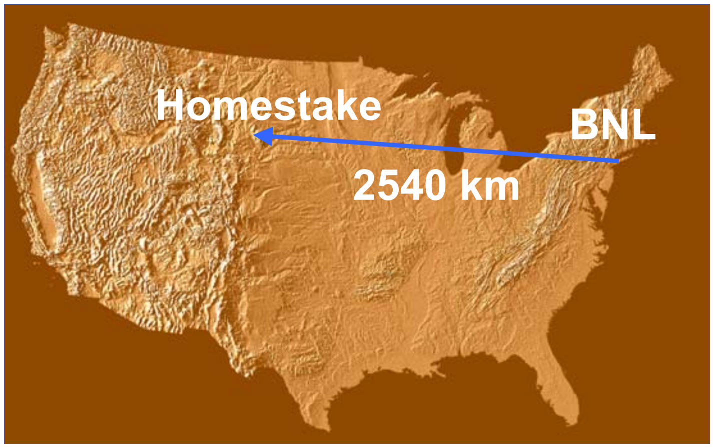
- **CNGS: 450 GeV SPS protons, ν to Gran Sasso**
- **SPL: new 2.2 GeV sc proton linac**



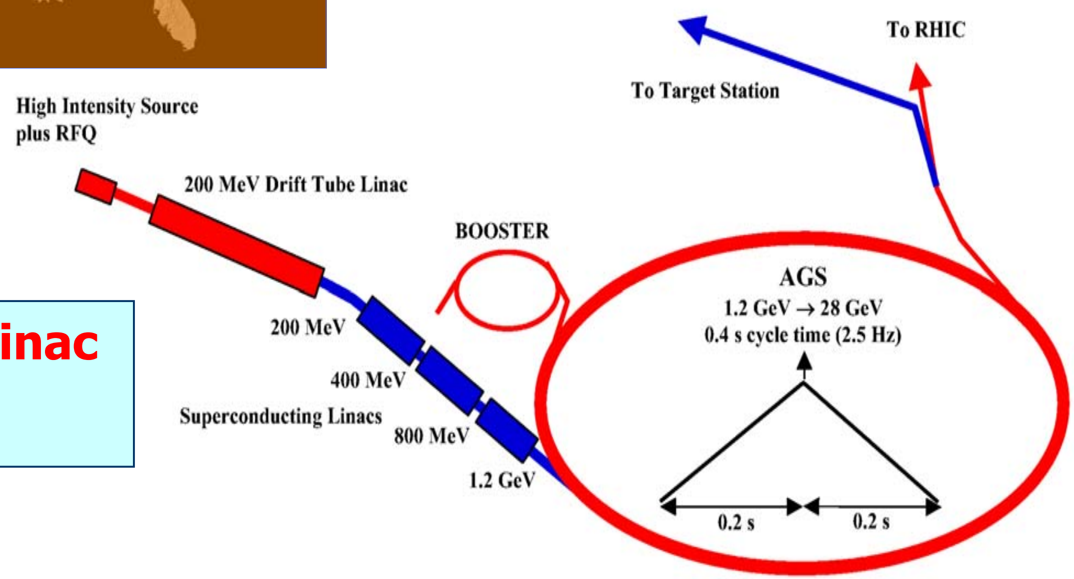


BNL: AGS Upgrade

(B. Weng's paper)



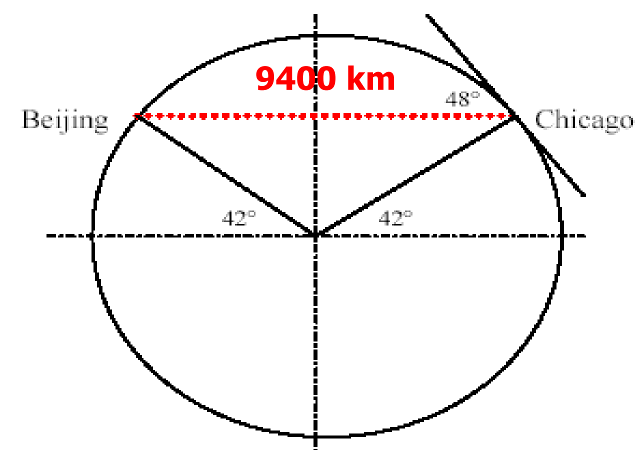
BNL- Homestake long baseline



- **New 1.2 GeV sc proton linac**
- **1 MW AGS upgrade**

New Study: Fermilab – Beijing Long Baseline

	Latitude	Longitude
Chicago	41:50:13 N	87:41:06 W
Beijing	39:55:00 N	116:23:00 E
Tokyo	35:41:00 N	139:44:00 E



Adam Para's Talking Points

Physics motivation:

Disappearance: at such a long distance the first minimum occurs at 17 GeV. High energy NuMI beam is the preferred choice. Good, as the event rates are a lot higher. Energy resolution is good, can get very precise mass determination. Oscillation pattern will be very spectacular, second minimum at 5.5 GeV should be clearly visible.

Appearance: higher energy: higher rates. Tau appearance may be an achievable experiment. Kinematics the same as Gran Sasso, but the oscillation probability is one and not a very tiny number. Nue appearance may be harder, as the tau to e background may be prohibitive if the angle theta13 not very large (worth checking).

Relatively high energy - energy resolution should be quite good compared to the size of the oscillation features.

Comparison of nue apperance on JHF baseline and Fermilab baseline may be a source of important physics info (CP vs matter effects).

Adam Para's Talking Points (cont…)

Detector issues:

Underground or above the ground? Backgrounds are small for JHF baseline, no cosmic ray backgrounds at the energies of the Fermilab beam. Choose the most convenient location.

JHF baseline calls for several GeV energy, NUMI much higher. Events mostly inelastic, with fairly complicated final states. Probably too complicated for water Cerenkov even for JHF, certainly water Cerenkov is not a good detector for NuMI. Very fine grained calorimeter might do for electrons. Certainly not for taus.

Very likely a liquid argen TPC is an optimal detector: have a shot at taus using kinematical approach as ICARUS. Underground location would help to broaden the physics reach by having a better proton decay capability.

Liquid argon is quite a matrure technology, but little expertise exists outside the ICARUS group. I am about to propose an vigorous R&D effort towards a NuMI off-axis experiment. Large detectors will share all the technological problems irrespective of the location: common R&D can help very much. I would be delighted if our Chinese collegues would be interested in joining the letter of intent.

Dixon Bogert's Questionnaire

1) What neutrino energy(s) should the beam provide? (In asking this question I am asking in comparison to the "low" – "medium" – "high" energy options provided in the NuMI neutrino production for the Soudan MINOS experiment.)
2) It is possible that shielding requirements might be reduced if production originated from a lower energy proton beam. Should this be a serious consideration?
3) The flux at Beijing will be reduced in comparison to that at Soudan for MINOS proportional to the square of the relative distances. What event rate is required by the experimentation in Beijing, and what fraction of the offset in the loss of flux to geometry is recovered by: A) Increase in proton intensity on the target? B) Increased efficiency of production (i.e. more horn, Hadron Hose, whatever)? And C) Increase in detector mass?
4) What power is the target going to receive? #Protons on Target? Rep rate? Single turn extraction?
5) Is a near detector required?

Dixon Bogert's Questionnaire (cont…)

6) Must the neutrino energy be variable?
7) Must the targeting geometry be variable? Narrow band beam? Off axis production?
8) Length of decay pipe?
9) Diameter of decay pipe?
10) Muon monitors?
11) Access to Absorber, near detector, etc.
12) Access to target hall/service and reconfiguration of production geometry?
13) Is simultaneous operation of NuMI and Beijing envisioned?
14) May I have some money for some drafting sketches in FESS and for consultation with Chris Laughton, etc.?
15) May I have access to some help from Beam line designers?