

Other Neutrino Initiatives at Fermilab

PEANUT

Liquid Argon TPC

Long Baseline Study

DUSEL

Concluding slide from Gina Rameika's talk on "Other Neutrino Program Related Activities" from May 25, 2005 DOE Review

It is still relevant.

- "The activities I just described represent a small amount of Fermilab effort being invested in support of neutrino related activities around the world.
- We are able to contribute our expertise and facilities to advance on-going programs and develop ideas for future facilities and experiments
- These connections are a valuable part of our overall physics program and we try hard to be able to support them and others that may come our way"

PEANUT

Petit
Exposure At
NeUTrino
beamline

The PEANUT
detector sits
in front of the
MINOS near
detector.



<http://flab.phys.nagoya-u.ac.jp/peanut/>

PEANUT: Purpose

From the PEANUT MoU August 3, 2005

In preparation for OPERA we would like to expose the OPERA target modules to a beam of neutrinos. This will allow us to test many of our analysis procedures and techniques as well as to validate the simulation of neutrino interactions, both for the production of forward and backward particles. Although the HE (high energy) beam of NuMI would be a better match to the CNGS energy, data acquired with NuMI LE (low energy) beam would serve the same purpose, albeit more challenging. Given the high interaction rate from the NuMI beam, the test detector target mass can be kept low and additional detectors can easily be built around a small target. These measurements are

OPERA is a tau neutrino appearance experiment in the CERN to Gran Sasso (CNGS) neutrino beam.

PEANUT History (in a nutshell*)

- A little over 10 years ago ... there was a scintillating fiber detector.
 - It was made in Japan for DONuT @ Fermilab.
 - “First direct evidence of tau neutrino interactions” in 1997
- After DONuT’s success, the detector was returned to Japan.
 - Part of it was sent to a museum (“tau neutrino discovery”).
 - Part of it was sent to Nagoya and revamped for PEANUT.
- Emulsion films for the target modules (see next slide) have been made in Japan.
 - 48 bricks were installed in PEANUT from Aug – Dec 2005.
 - They have been exposed to the **high intensity NuMI beam**.
- PEANUT has taken initial data and is analyzing the data (see next slides).

(*Pun intended and ... there are similarities to SciBooNE)

PEANUT Emulsion Brick

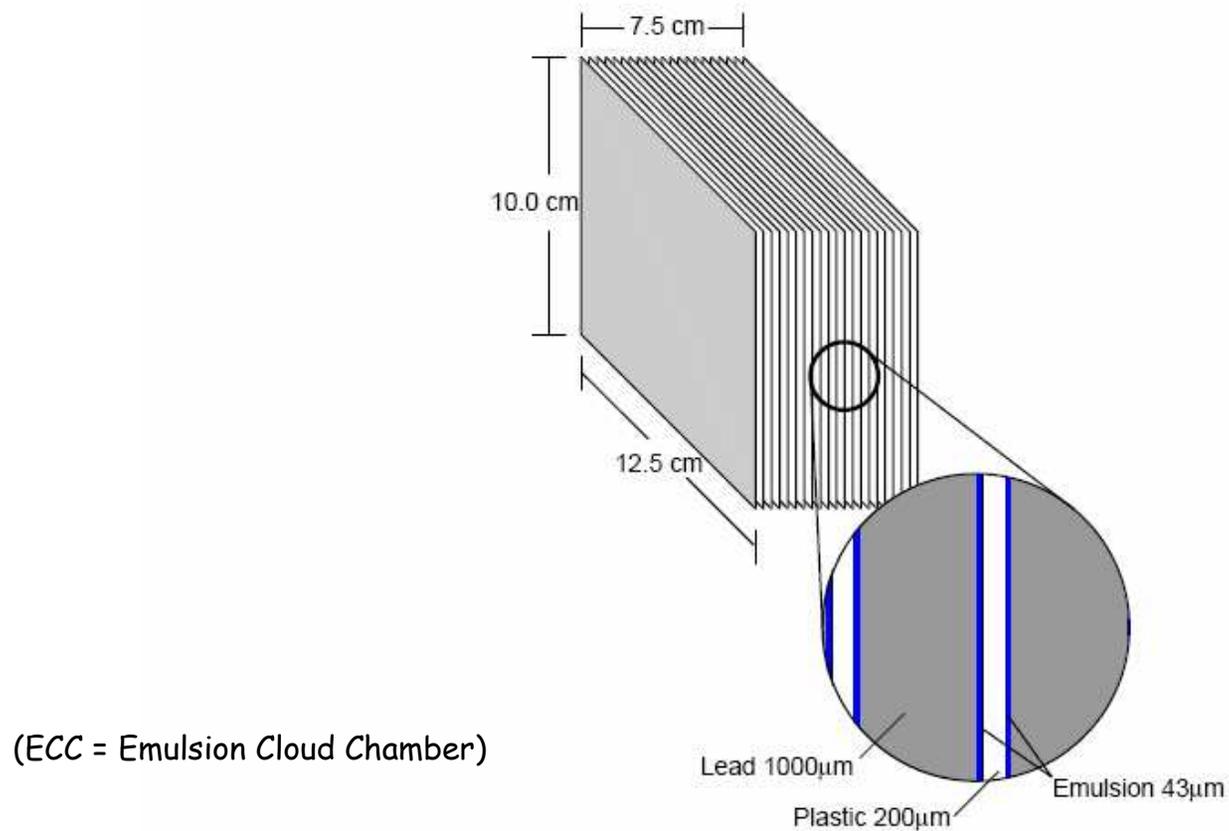
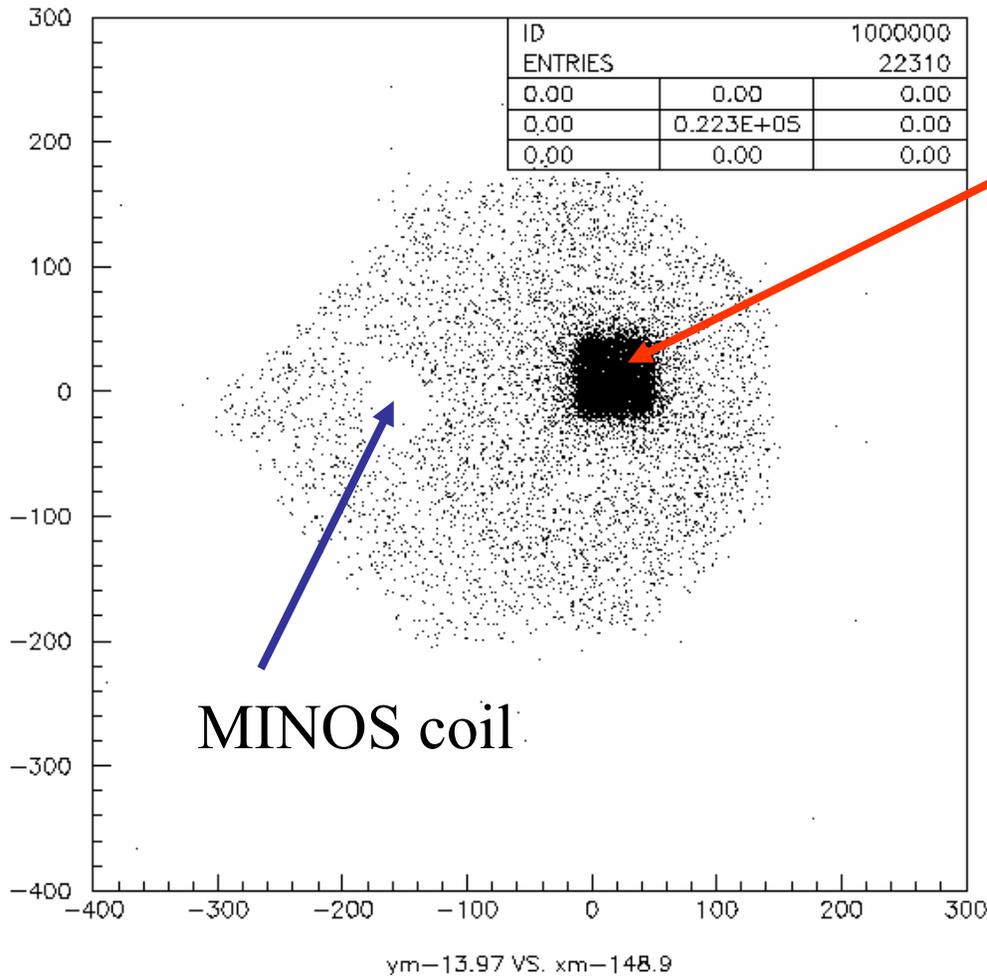


Figure 1: An OPERA ECC brick consists of 56 1 mm thick passive target material plates alternated with emulsion films (43 μm emulsion layer on both sides of a transparent 200 μm thick plastic film). The passive target material can be changed from lead to iron.

PEANUT Data

Time stamp and PEANUT angular best match to MINOS



PEANUT SFT
(scintillator fiber
tracker) data

MINOS coil

Liquid Argon TPC Overview for NuSAG

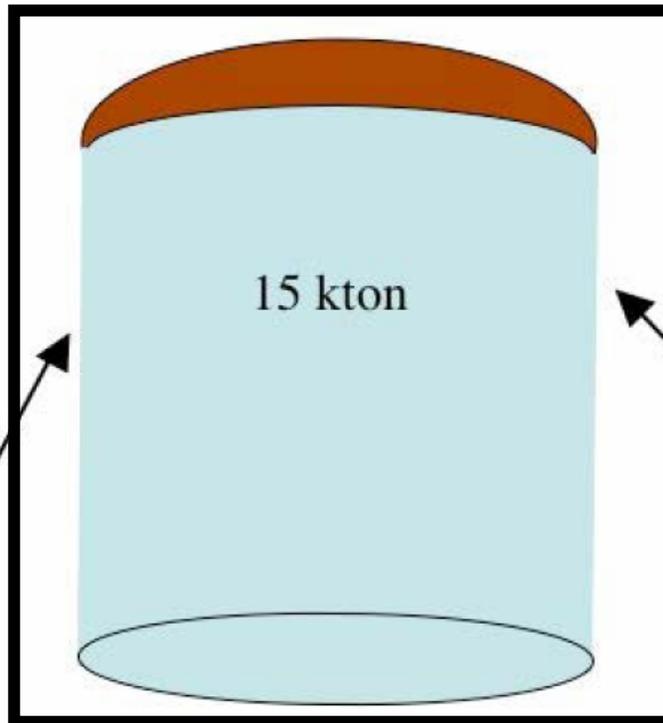
Note: At this point in time ...

"15" could be "50"

"1" could be "3"

etc

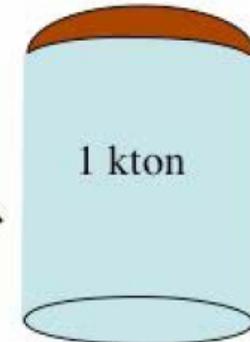
The optimum choices depend on the goals.



Submitted to NuSAG by the LArTPC group

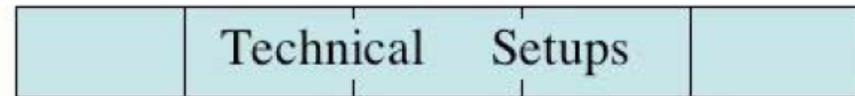
Summer 2005

The "LArTPC group" is Fermilab plus 6 universities



Physics Development using existing technology
 Record complete neutrino interactions: (ν_e & ν_μ)
 Establish **Physics Collaboration**
 Develop **Event Identification**,
 Develop **Reconstruction**,
 Develop **Analysis**,
 Establish successful **Technology transfer**

Engineering Development:
 Construction of Tank
 Argon Purity
 Mechanical Integrity of TPC
 Readout S/N
 Microphonics due to Argon Flow



Purity Monitor Development Materials Tests 5 m Drift Demonstration Long Wires Tests Electronics Development

Fermilab efforts on LArTPC

- Focusing technical effort on issues related to the “Big Tank”
 - Finish the assembly of a Purity Test Station to qualify materials for the Big Tank
 - Model and measure how well one can use argon gas, as a first step, to purge oxygen from large tanks similar to the Big Tank
 - Understand the issues for integrating a TPC with long wires into the Big Tank (mechanical issues, electrical issues, the TPC surviving in a big bath of LAr, achieving and maintaining LAr purity with a TPC in it, etc)
- Building on FLARE Lol of August 23, 2004
- Forming people connections which should lead to collaboration(s) including people from INFN, ICARUS, universities and elsewhere

Purity Test Station

Setup at PAB (Proton Assembly Building at Fermilab)

A test station to study (a) the contamination of LAr by various materials and (b) the efficacy of various 'filters' for the removal of oxygen (and other electronegative species)



Mostly recycled equipment

May 5, 2006
Milestone

With only a purity monitor immersed in LAr in the test dewar, *we measured a purity better than that required for a ~15 kton Big Tank.*

(Spec: 3 meter drift has less than a 20% loss of signal.)

Purging a “small” tank

- The “Village water tank” was built for the village of Weston in the 1960’s, and has a volume the same as ~1,000 tons of liquid argon (1.40 g/cm^3).

- We intend to explore its use to get data to challenge models and ideas for purging big tanks with argon gas.



- starting from atmospheric conditions
- without evacuating the tank, or using clean room conditions to assemble the TPC (unlike what ICARUS has done)

Only the first step towards a Big Tank with ~30 ppt with a LAr purification system (note: ppt)

Steps on the Liquid Argon TPC Path

- Workshop on cryogenic detectors
 - held at Gran Sasso March 13-14, 2006
 - <http://cryodet.lngs.infn.it/>
 - focus on **cryogenic detectors of all types** probing neutrino physics, dark matter searches etc
 - **Three speakers from the LArTPC group**
- Next workshop
 - at Fermilab June 11-13, 2006
 - focus on **the next credible steps towards a large liquid argon TPC** based on more global collaboration (“large” means “much larger” than ICARUS’ 600 Tons)
 - One of the next steps could use one of the **Fermilab high intensity neutrino beams**.
- What to focus on following the formation of collaboration(s)
 - **Lols** to Fermilab and INFN with clear physics and/or engineering benefits of these next steps
 - **MoUs** between various universities and institutions etc
 - **More credible goals, schedules, costs, etc**
- Long Baseline Study.

Long Baseline Study

- Charge from Hugh Montgomery and Sally Dawson:
 - “Compare the **neutrino oscillation physics** potential of:
 1. A broad-band proposal using a either [sic] an upgraded beam of around **1 MW** from the current Fermilab accelerator complex or a future Fermilab Proton Driver neutrino beam **aimed at a DUSEL-based detector**. Compare these results with those previously obtained for a high intensity beam from BNL to DUSEL.
 2. Off-Axis next generation options using a **1-2 MW** neutrino beam from Fermilab and a **liquid argon detector** at either **DUSEL** or as a **second detector** for the Nova experiment.”
- A few very specific options should appear as the study evolves, such as liquid argon at the second oscillation maximum using the NuMI beam line, etc.

Long Baseline Study: Schedule

- March 6-7, 2006
 - kickoff / organizing meeting at Fermilab
- http://www.fnal.gov/directorate/DirReviews/Neutrino_Wrkshp.html
- From charge:
 - “It would be desirable to see results of this **U.S. Long Baseline Neutrino Experiment Study** before October 2006, with a preliminary report by July 15, 2006.”
- This schedule facilitates coordination with NuSAG.

Long Baseline Study: Kickoff

Monday, March 6, 2006

Session Chair: G. Rameika - **FNAL**

Welcome, Why are we here? [S. Dawson](#) – BNL, H. Montgomery – FNAL

Getting the Most from Long Baseline Neutrino Experiments at Fermilab [O. Mena](#) – FNAL

Comparison of Physics of Wideband/Off-Axis Beams [P. Huber](#)- **U Wisconsin**

The International Scoping Study: Status, Plans, and Prospects [K. Long](#) **Imperial College / London**

Session Chair: S. Aronson **BNL**

NuMI Beam Characteristics [J. Hlyen](#) – FNAL

Proton Driver: Emphasis on Deliverables [G. Apollinari](#) – FNAL

Main Injector and NuMI Upgrades and Beyond [A. Marchionni](#) – FNAL

Session Chair: D. Finley - FNAL

Long Baseline Experiments with Wideband Beams [M. Diwan](#) - BNL

Liquid Argon and the Second Oscillation Maximum [B. Fleming](#) – **Yale**

8 institutions

14 speakers

at kickoff

Discussion of Study Organization, Setup of Working Groups, etc. M. Diwan – BNL, R. Rameika - FNAL

Tuesday, March 7, 2006

Session Chair: N. Samios - BNL

Notes on DUSEL [J. Kotcher](#) - **NSF**

Henderson DUSEL: Vision, Infrastructure and Plan for Large Multipurpose Detectors C.-K. Jung **SUNY/Stonybrook**

The Homestake Underground Laboratory: Options for Large Detectors in the Underground [K. Lesko](#) **LBL**

Session Chair: S. Geer - FNAL

Water Cerenkov [C. Yanagisawa](#) SUNY/Stonybrook

Concluding Talk [S. Parke](#)-FNAL

Note: 3 DUSEL talks

DUSEL

- Deep Underground Science and Engineering Laboratory
- Henderson Colorado or Homestake South Dakota
- The Long Baseline study includes aiming a neutrino beam from Fermilab to DUSEL
- The DUSEL Paradigm:

“Eye towards developing a common detector to do a super neutrino beam-long baseline experiment with a super detector which could do proton decay and super nova neutrino physics.”

Fermilab and DUSEL on a map

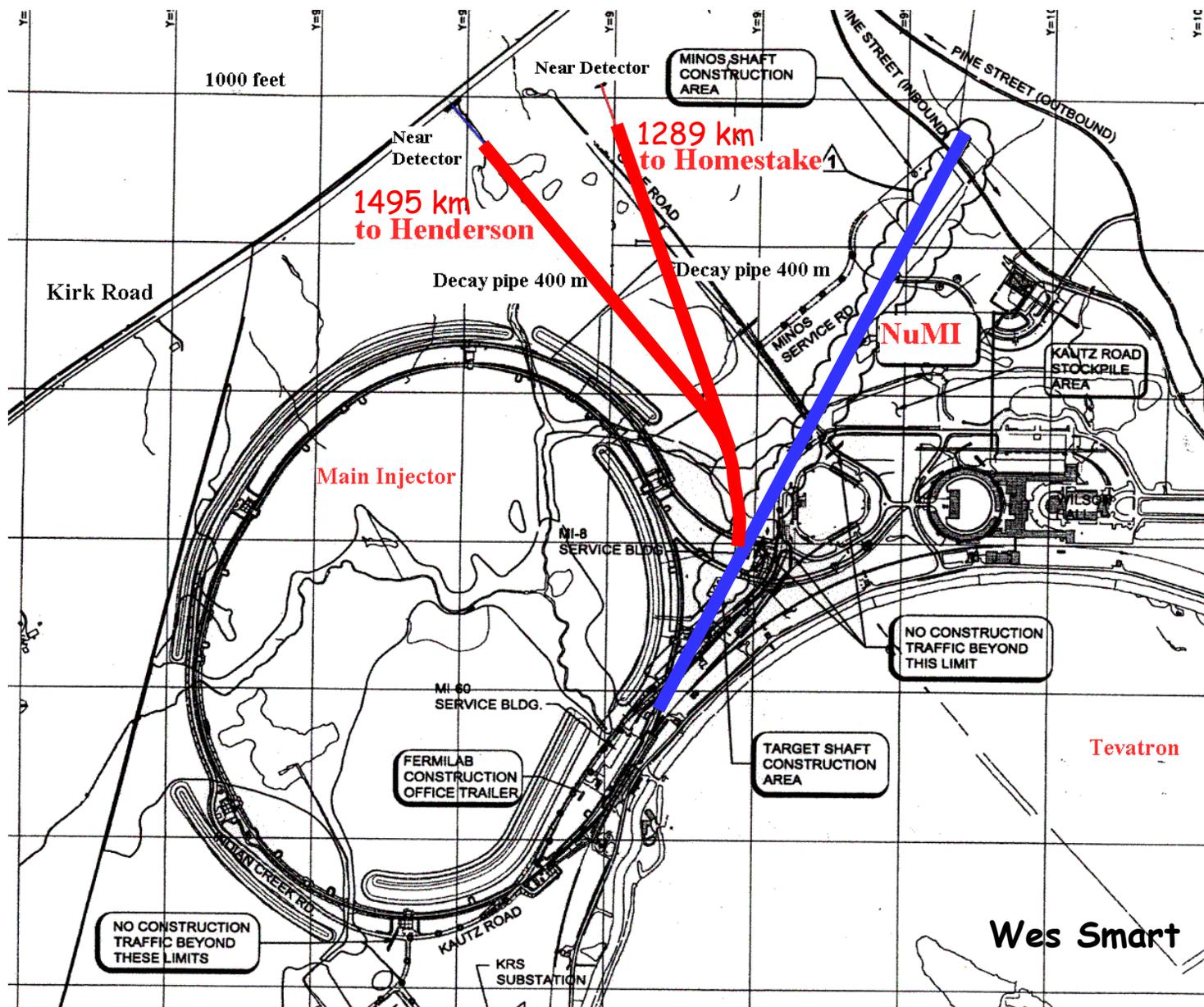
☀ Homestake South Dakota

☀ Henderson Colorado

☀ Soudan Minnesota



1000 km < L < 2500 km



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Thanks for your attention.

PEANUT

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