The NOνA Experiment
http://www-nova.fnal.gov

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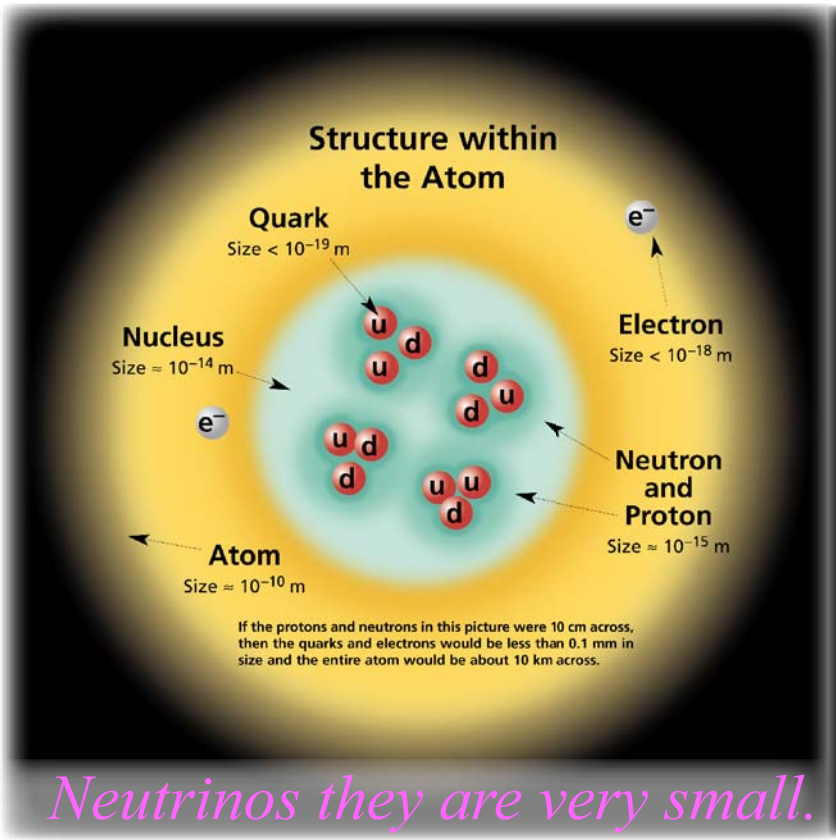
for the NOνA Collaboration
International Falls, MN
24 May 2006

What is a neutrino?

"...the most tiny quantity of reality ever imagined by a human being".

- Fred Reines



FERMIONS matter constituents spin = 1/2, 3/2, 5/2, ...

Leptons spin = 1/2

Flavor	Mass GeV/c^2	Electric charge
ν_e electron neutrino	$<1\times10^{-8}$	0
e electron	0.000511	–1
ν_μ muon neutrino	<0.0002	0
μ muon	0.106	–1
ν_τ tau neutrino	<0.02	0
τ tau	1.7771	–1

Quarks spin = 1/2

Flavor	Approx. Mass GeV/c^2	Electric charge
u up	0.003	2/3
d down	0.006	–1/3
c charm	1.3	2/3
s strange	0.1	–1/3
t top	175	2/3
b bottom	4.3	–1/3

Neutrinos they are very small.

They have no charge and have no mass

And do not interact at all.

The Earth is just a silly ball

To them, through which they simply pass...

-John Updike

Not a bad start, but they *do* interact and they just might have mass!

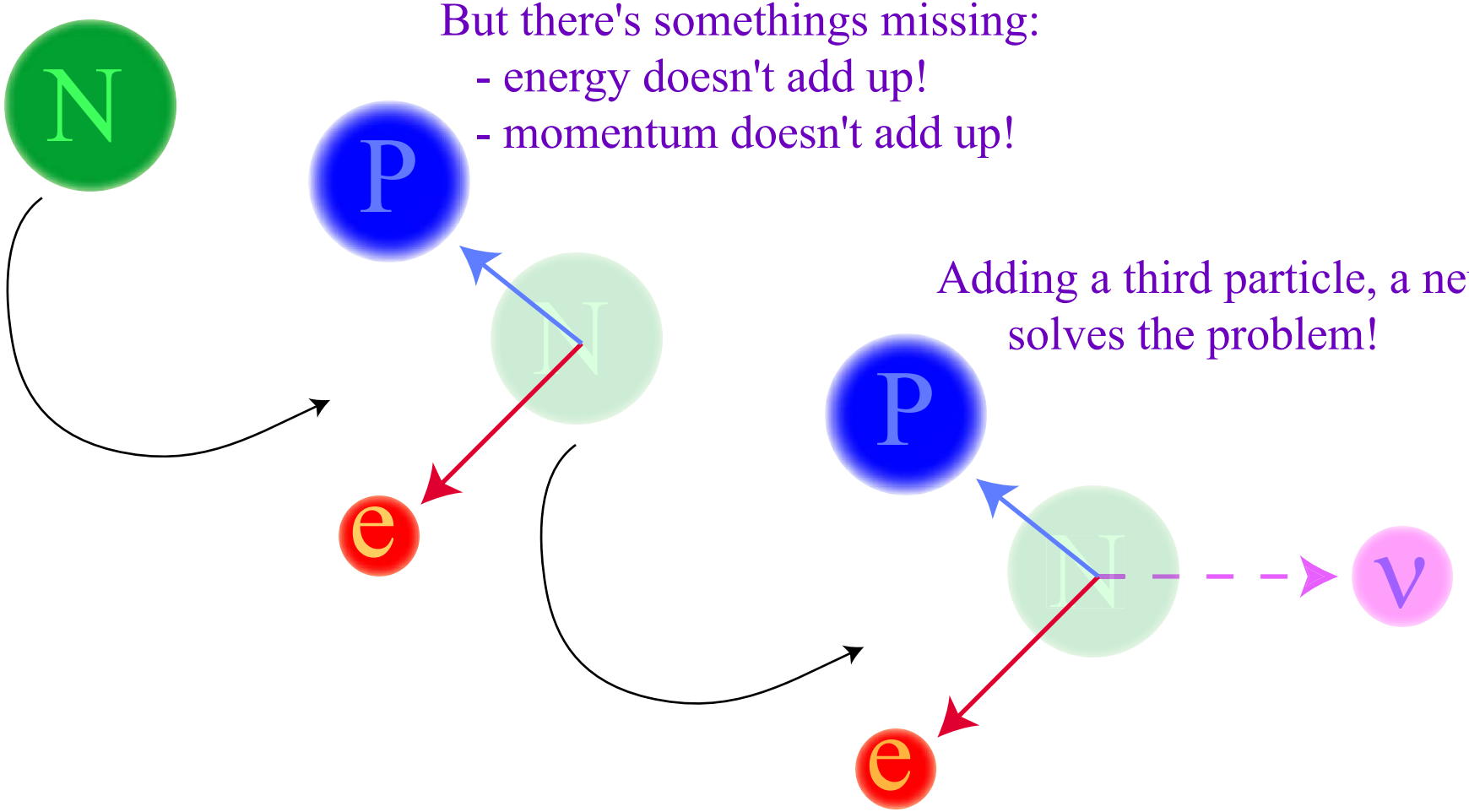
Where Do Neutrinos Come From?

Neutrinos are produced when other particles decay.

In fact, that's how it was first realized that they might exist!

Neutron at rest...

Decays to proton and electron.
But there's somethings missing:
- energy doesn't add up!
- momentum doesn't add up!



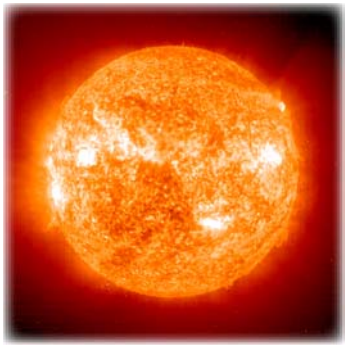
Adding a third particle, a neutrino, solves the problem!

First suggestion neutrinos exist

Dear Radioactive Ladies and Gentlemen,

As the bearer of these lines, to whom I graciously ask you to listen, will explain to you in more detail, how because of the "wrong" statistics of the N and Li6 nuclei and the continuous beta spectrum, I have hit upon a deseperate remedy to save the "exchange theorem" of statistics and the law of conservation of energy. Namely, the possibility that there could exist in the nuclei electrically neutral particles, that I wish to call neutrons, [...] The continuous beta spectrum would then become understandable by the assumption that in beta decay a neutron is emitted in addition to the electron such that the sum of the energies of the neutron and the electron is constant... I agree that my remedy could seem incredible because one should have seen those neutrons very earlier if they really exist. But only the one who dare can win and the difficult situation, due to the continuous structure of the beta spectrum, is lighted by a remark of my honoured predecessor, Mr Debye, who told me recently in Bruxelles: "Oh, It's well better not to think to this at all, like new taxes". From now on, every solution to the issue must be discussed. Thus, dear radioactive people, look and judge. Unfortunately, I cannot appear in Tubingen personally since I am indispensable here in Zurich because of a ball on the night of 6/7 December. [...] - Wolfgang Pauli 1930

*Neutrinos are **everywhere**!*



The Sun produces about 2×10^{38} ν/s.
That's ~400,000 billion/s/m^2 on Earth!

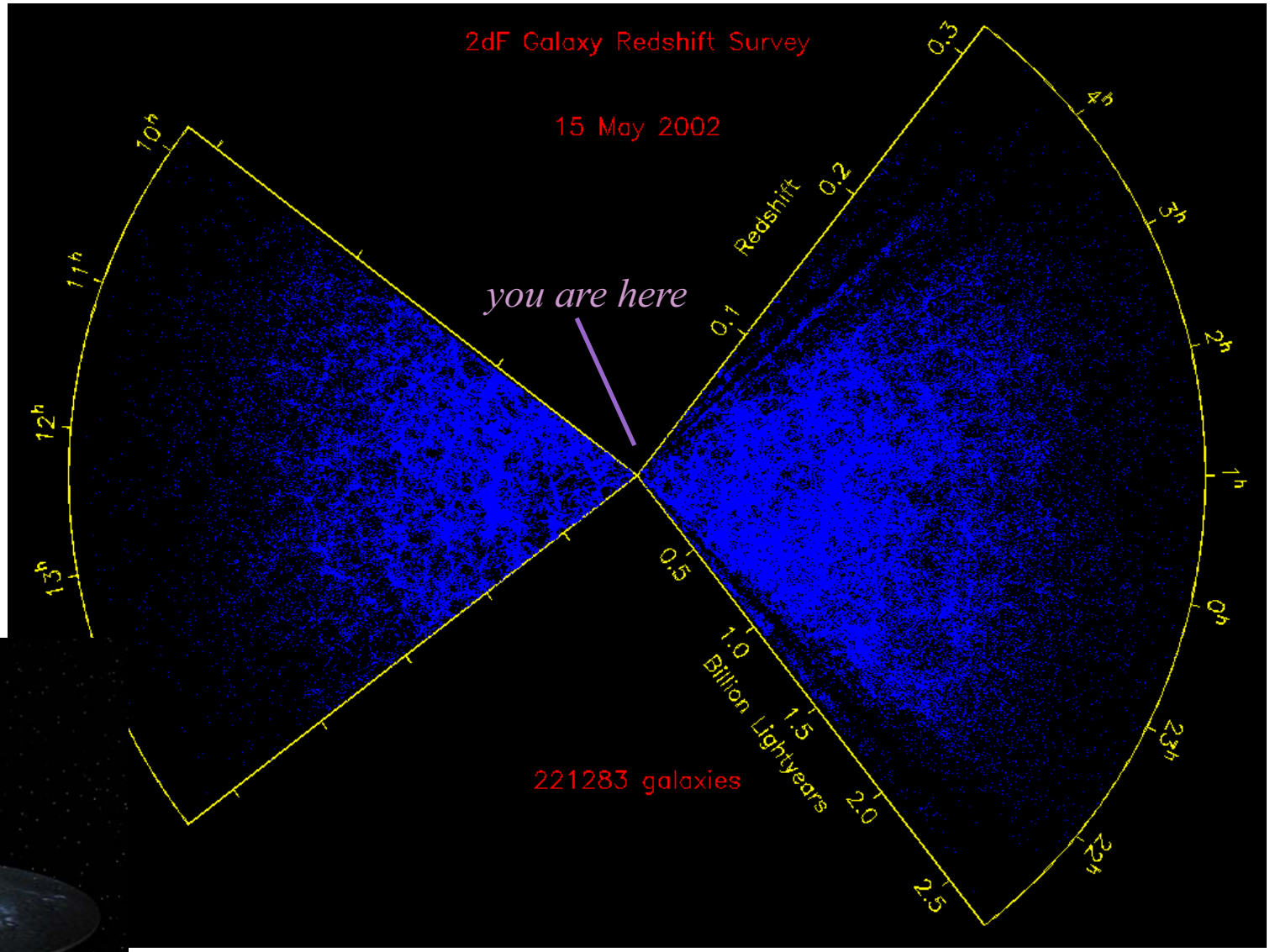
The Earth produces ~100 billion/s/m^2

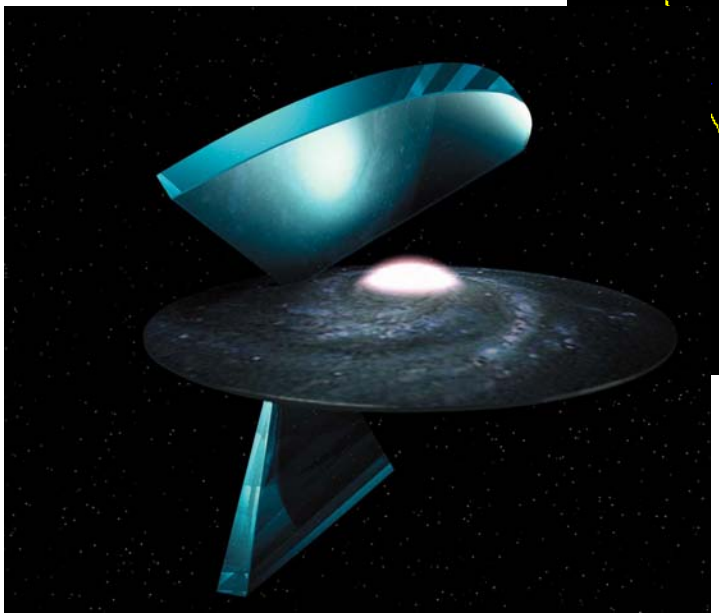
You and I produce about
350 million neutrinos/day!

In deep space there are about 330 million neutrinos/m^3 left over from the Big Bang. Neutrinos are the #2 most common particle in the universe (photons are #1 at 1,000 million, protons are #3 at 0.5)

From the very small to the very big

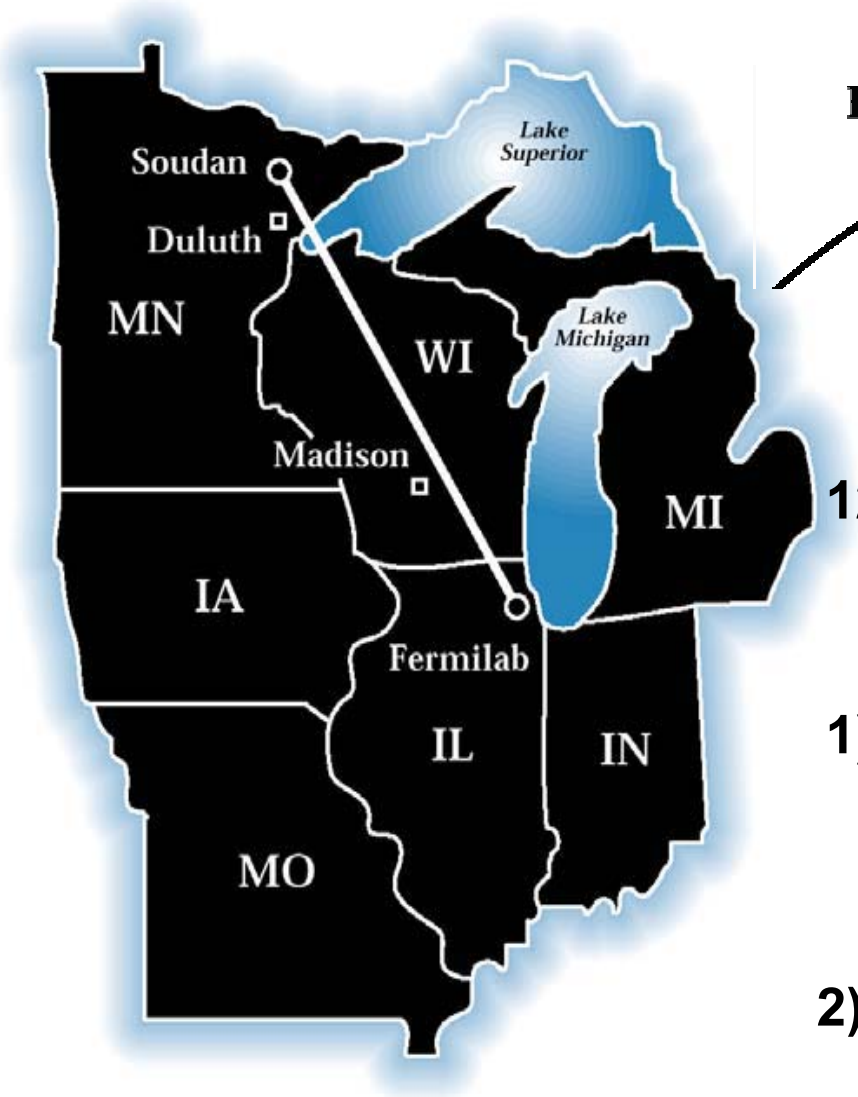
Largest scale structures of universe determined (in part) by neutrino mass

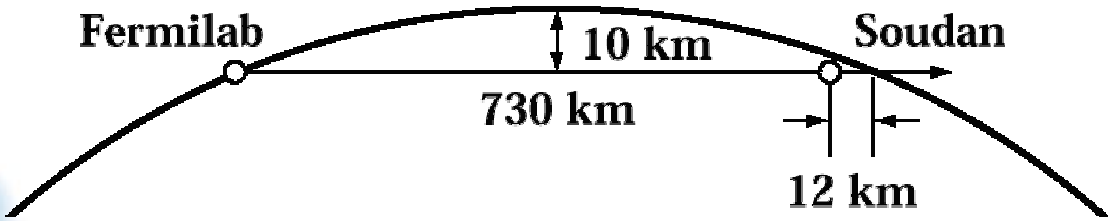




Large neutrino mass = smooth universe
small or zero neutrino mass = "clumpier" universe

The MINOS Experiment





source: (NuMI)

120 GeV protons from FNAL Main Injector

detectors: (MINOS)

1) 'Far' detector:

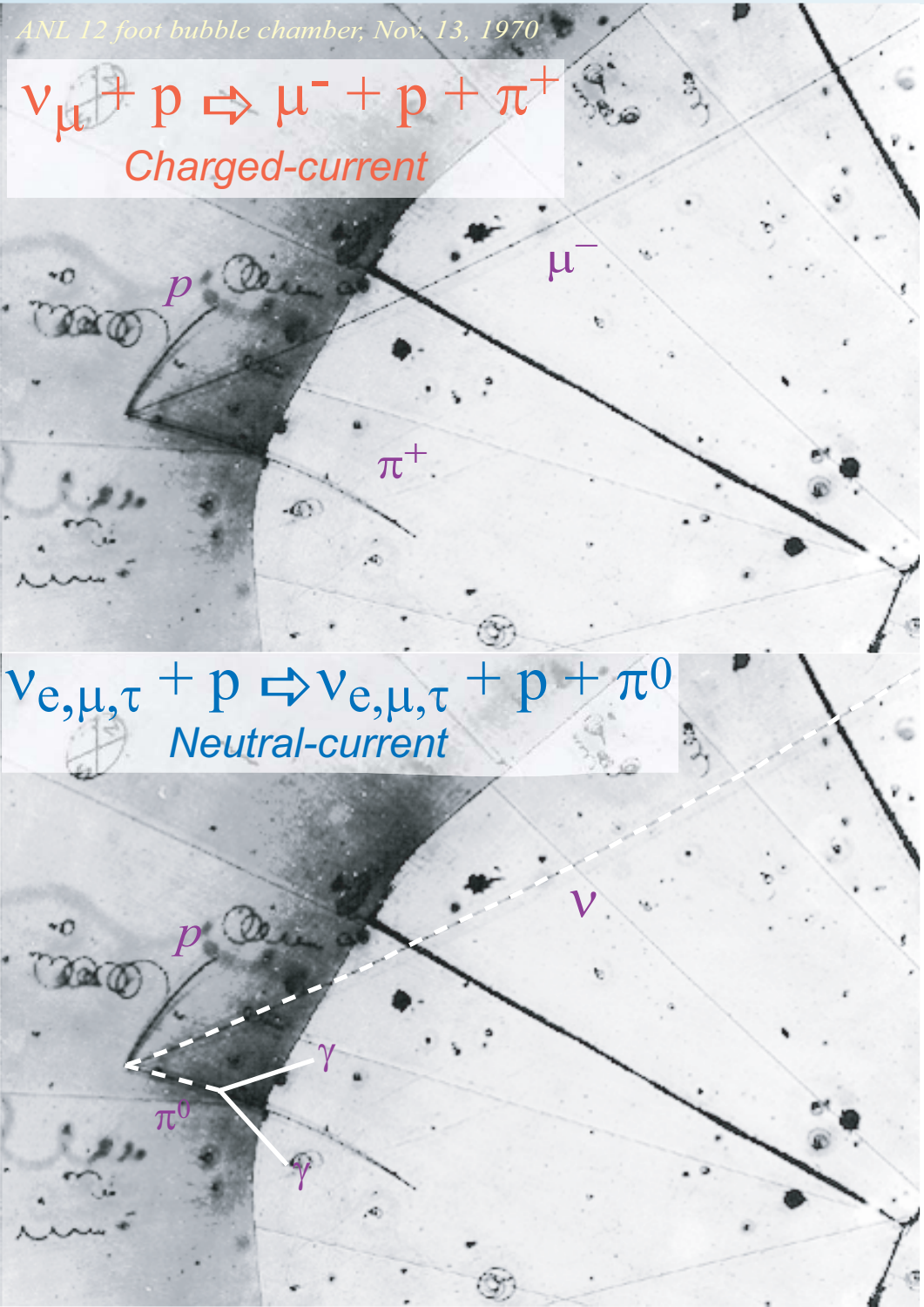
5.4 kT magnetized iron/scintillator tracker/calorimeter in Soudan mine

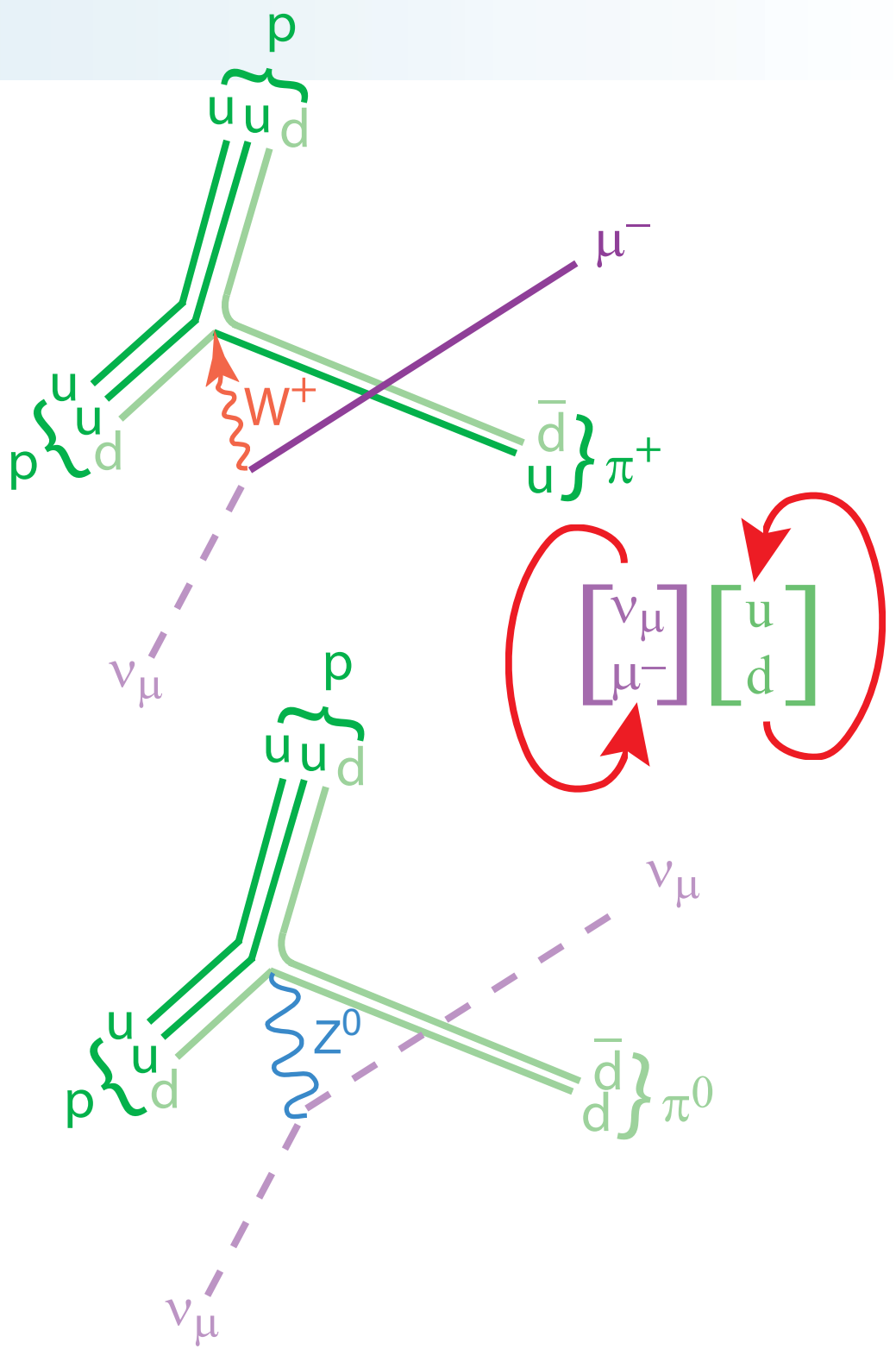
2) 'Near' detector:

980 T version of far detector at FNAL

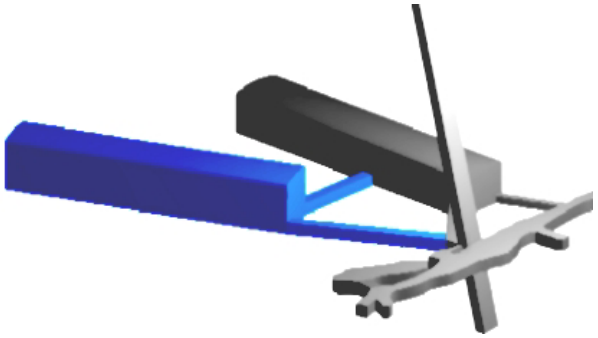

Chicago
Fermi National Accelerator Laboratory
Batavia, Illinois
To Minnesota

Neutrino Interactions





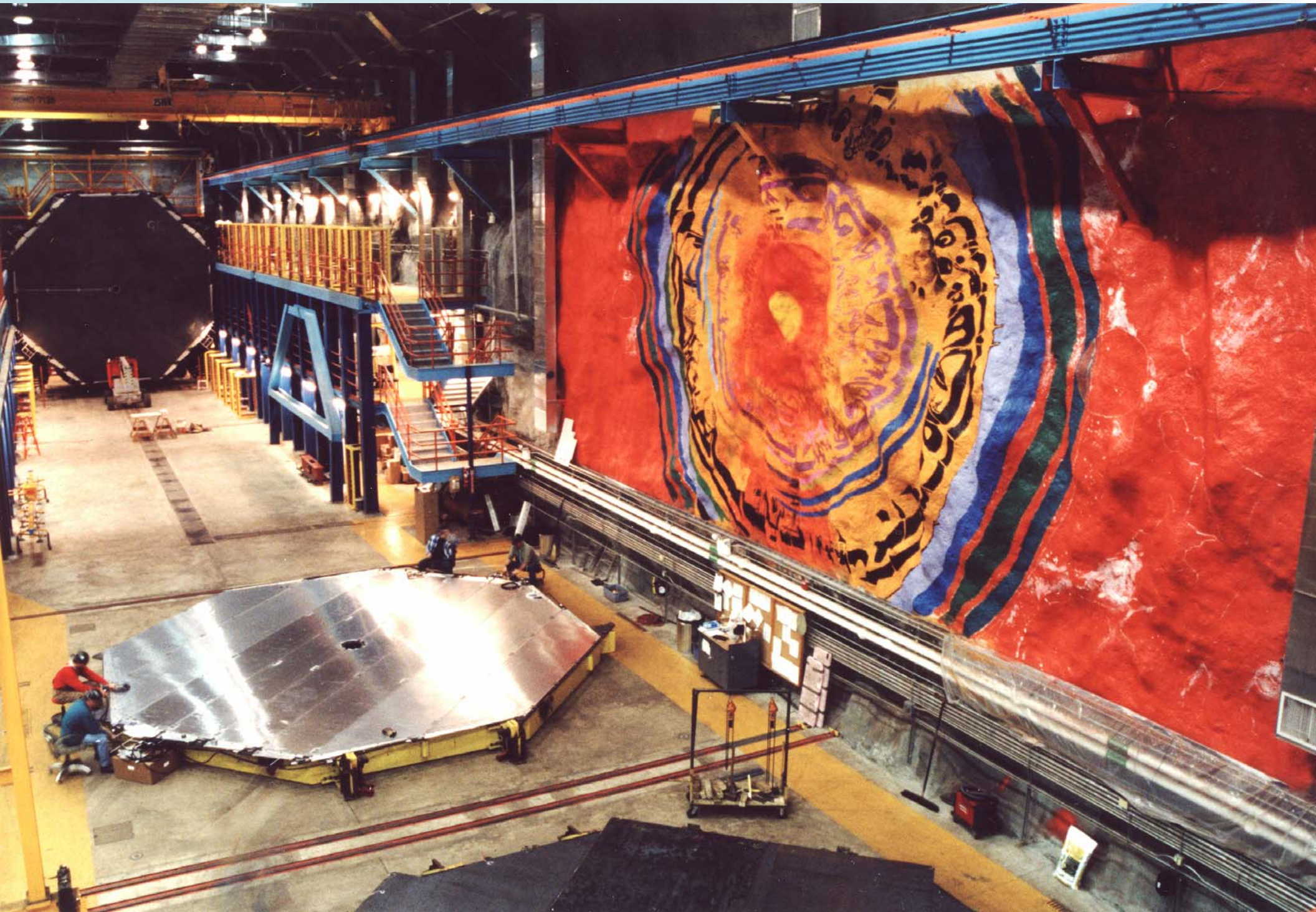
MINOS: Underground at Soudan, MN



former iron mine, now a state park,

home of: Soudan-1 & 2 , CDMS-II , and MINOS expts

MINOS Experiment Under Construction



MINOS Result

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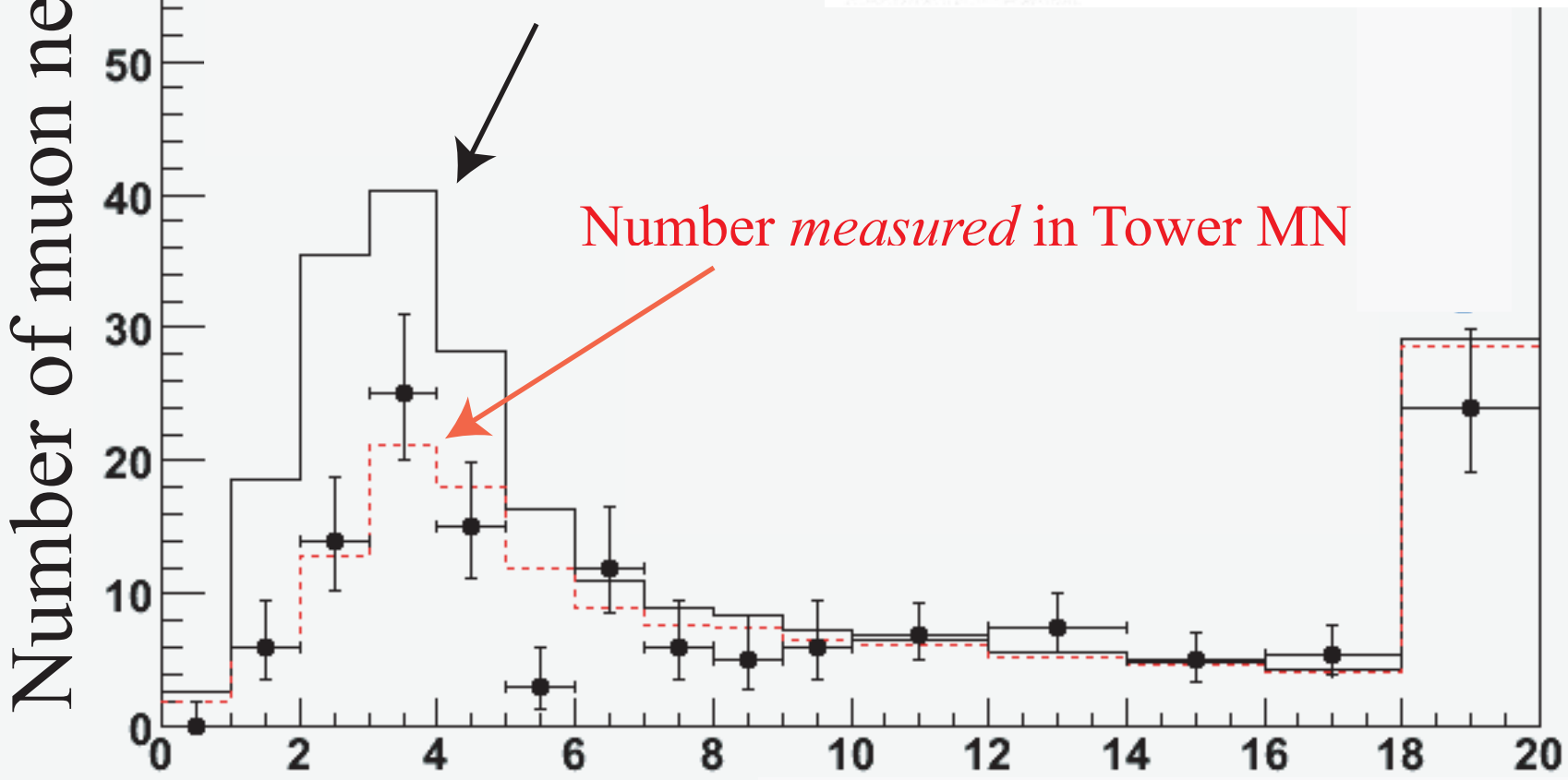
Physicists Lose Some Neutrinos, Gain Some Information

Monday, April 03, 2006
By Sara Goudarzi



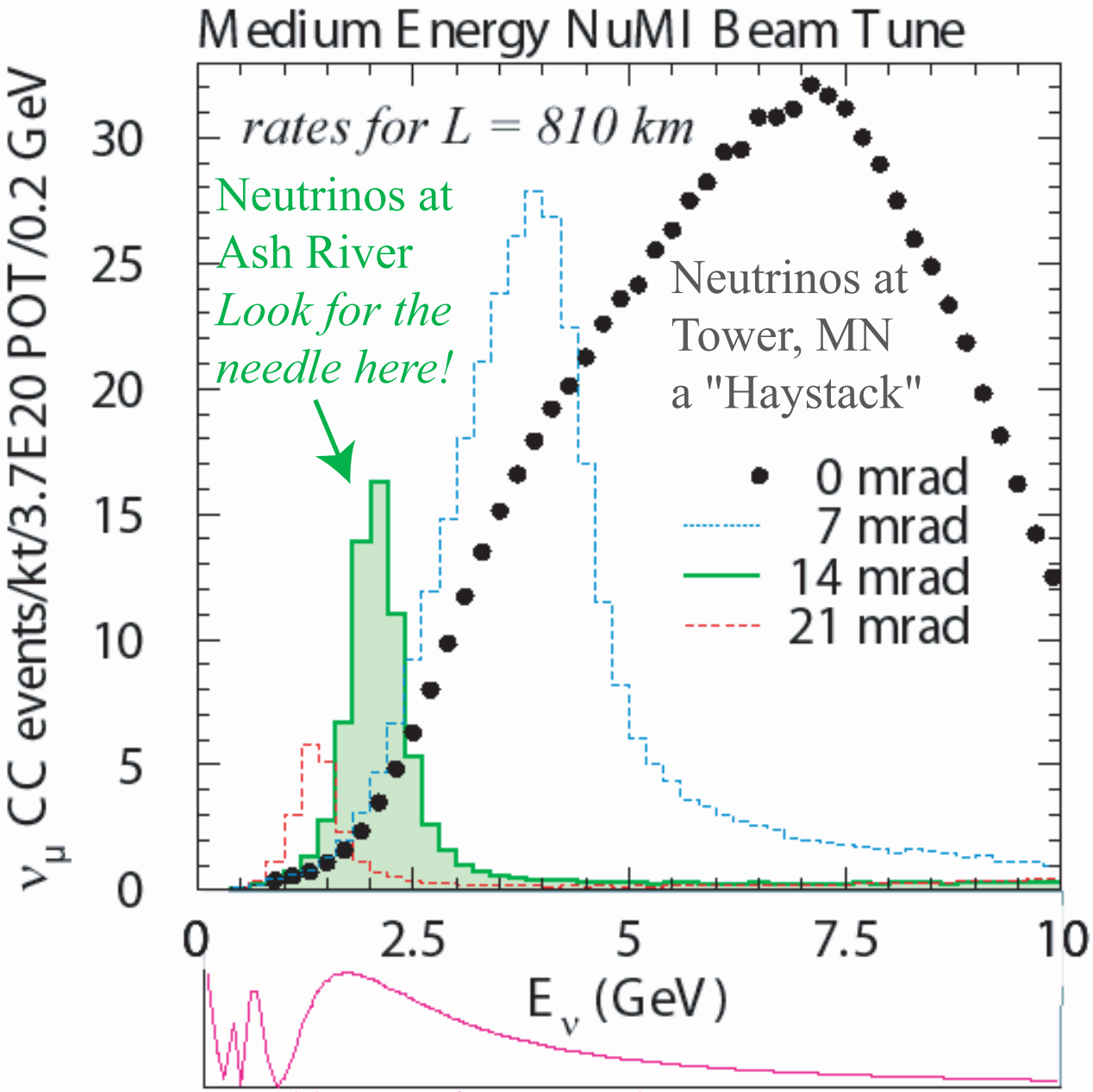
Why here?

We think most of the missing neutrinos are changing into tau neutrinos
Can some of them also change into electron neutrinos? No one has seen this yet.

Normally you point the beam right at your detector.

In our case, we're looking for a needle in a haystack. We *want* to off to the side.

We also want to be as far away from Fermilab as possible to study possible effects of matter on the muon to electron conversion rate.

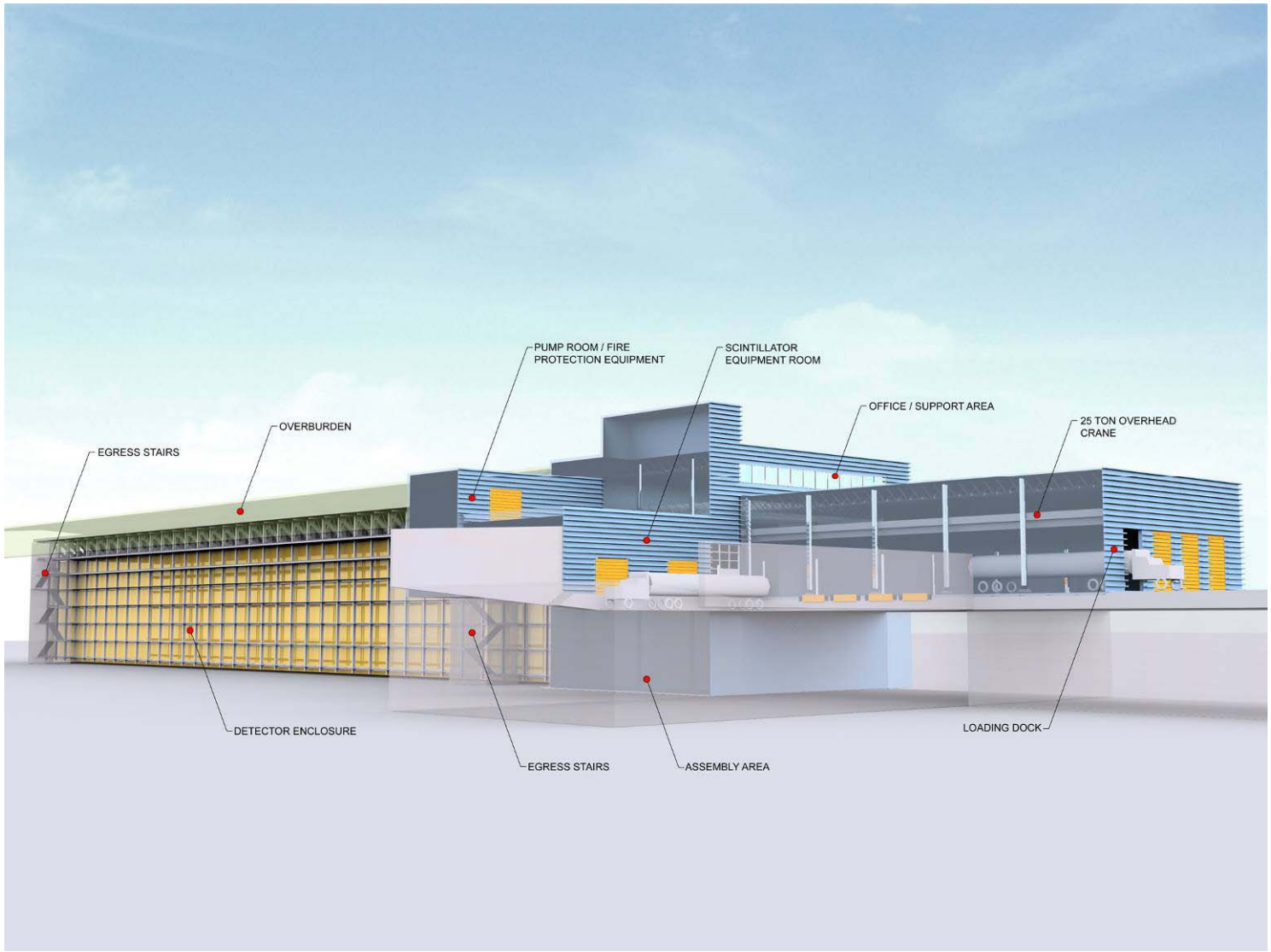


Possible rate of muon to electron neutrino conversion

The NOvA Collaboration
International Falls
22-25 May 2006

Gary Feldman (Harvard)
Mark Messier (Indiana)
co-spokespeople

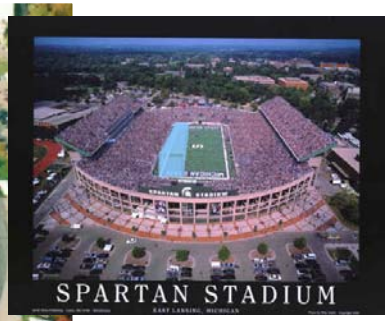
Building

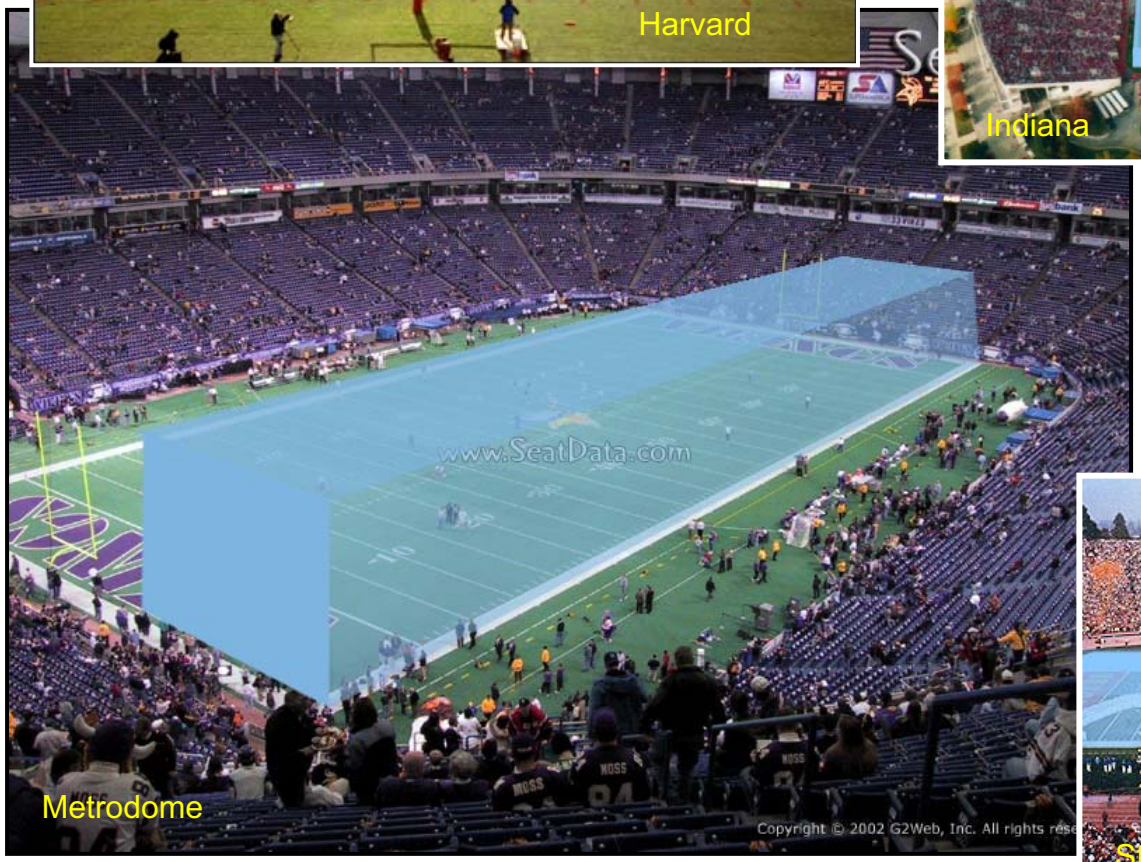

PUMP ROOM / FIRE PROTECTION EQUIPMENT
SCINTILLATOR EQUIPMENT ROOM
OFFICE / SUPPORT AREA
25 TON OVERHEAD CRANE
OVERBURDEN
EGRESS STAIRS
DETECTOR ENCLOSURE
EGRESS STAIRS
ASSEMBLY AREA
LOADING DOCK

Scale


Harvard


Indiana


SPARTAN STADIUM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Metrodome
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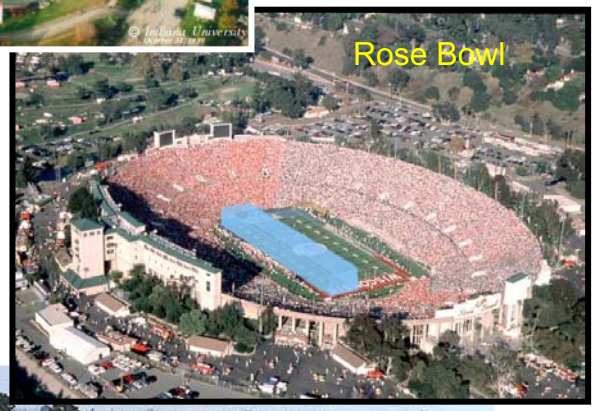
Rose Bowl


Stanford

Schedule

April 2006:	Past first review
October 2006:	Second review
October 2007:	Begin detector building
June 2009:	Building completed
November 2010:	Start data taking
November 2011:	Complete detector
2017:	End of first run


Thank you!
For your interest and attention
Thank you!
For hosting us this week