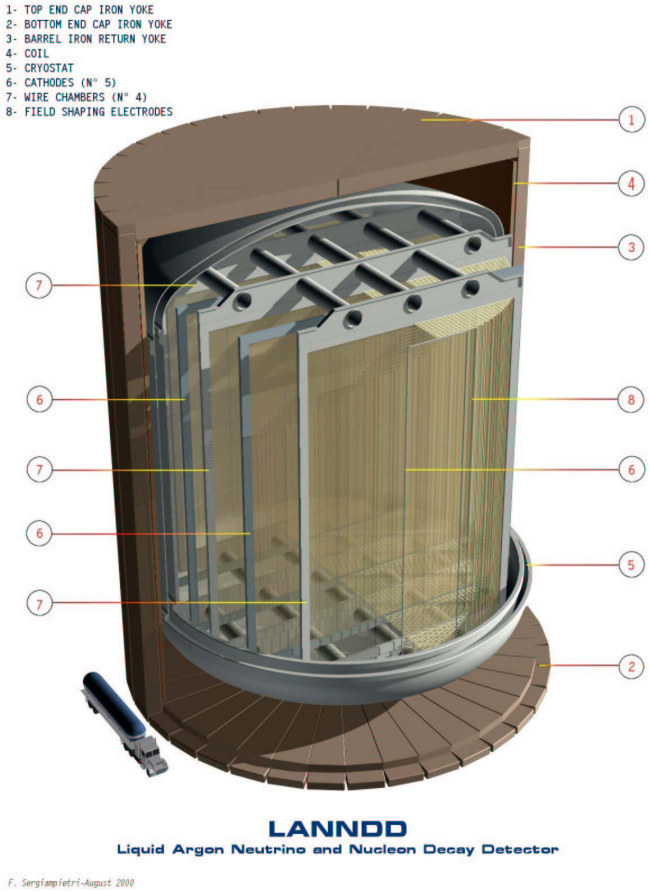
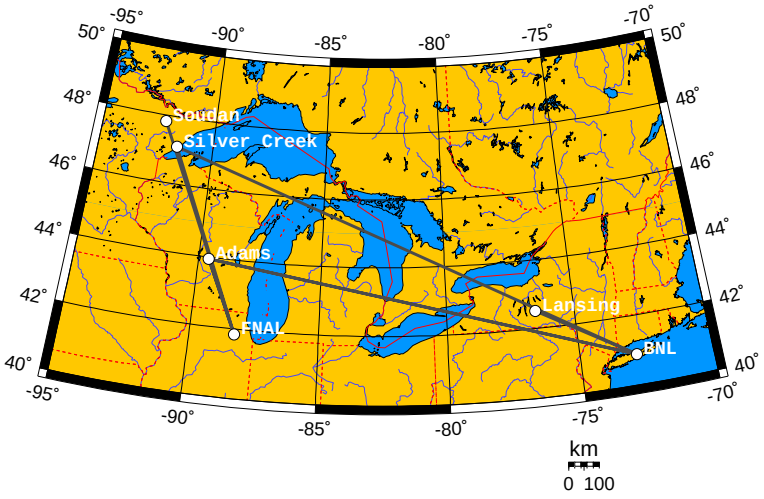
A Strategy for Accelerator-Based Neutrino Physics in the USA





Kirk T. McDonald

Princeton U.

mcdonald@puphep.princeton.edu

May 2, 2002

http://puhep1.princeton.edu/~mcdonald/nufact/

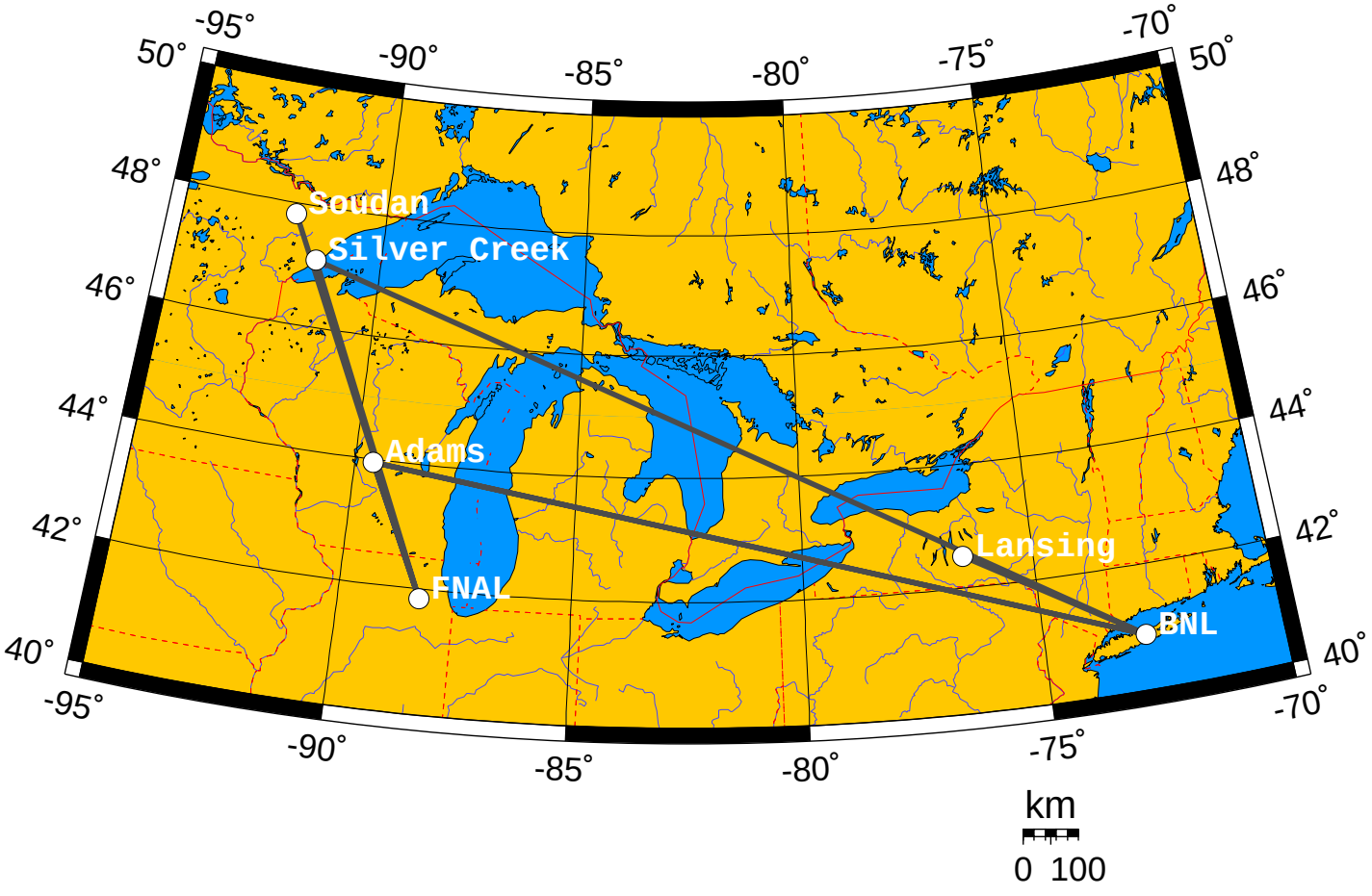
Overview

- Super-K and SNO $\Rightarrow$ 3-generation neutrino mixing with Large Mixing Angle (LMA) solution to the solar neutrino problem.
- $\Rightarrow$ Should search for $\sin^2 2\theta_{13}$ and CP violation, and measure sign of Δm^2_{23}, via $\nu_\mu \rightarrow \nu_e$ appearance.
- Phase I: Use a 1° off-axis NUMI beam at $\approx$ 2 GeV with a 20-30 kton liquid argon detector sited under a bluff at Silver Creek, MN, 640 km from FNAL, 1640 km from BNL.
  $\Rightarrow \sin^2 2\theta_{13}$ to 0.01, $\tau/B(p \rightarrow K^+\bar{\nu})$ to 10^{34} year.
- Phase II, Option A:
  1. Build 100-200 kton liquid argon detector near Adams, WI, 260 km from FNAL, 1410 km from BNL.
  2. Upgrade FNAL beam with a 4-MW, 8-GeV proton driver.
  3. New ν beam at BNL with a 1-4 MW proton driver.

  $\Rightarrow \sin^2 2\theta_{13}$ to 0.001, $\tau/B(p \rightarrow K^+\bar{\nu})$ to 10^{35} year, search for CP violation and measurement of sign of Δm^2_{23}.

Overview, cont'd

- Phase II, Option B:
  1. Build 100-200 kton liquid argon detector near Lansing, NY, 350 km from BNL.
  2. New ν beam at BNL with a 4 MW proton driver.
- Phase II, Option B cheaper than Option A, but must study CP violation with Lansing detector during separate runs from measurement of sign of Δm^2_{23} with Silver Creek detector.

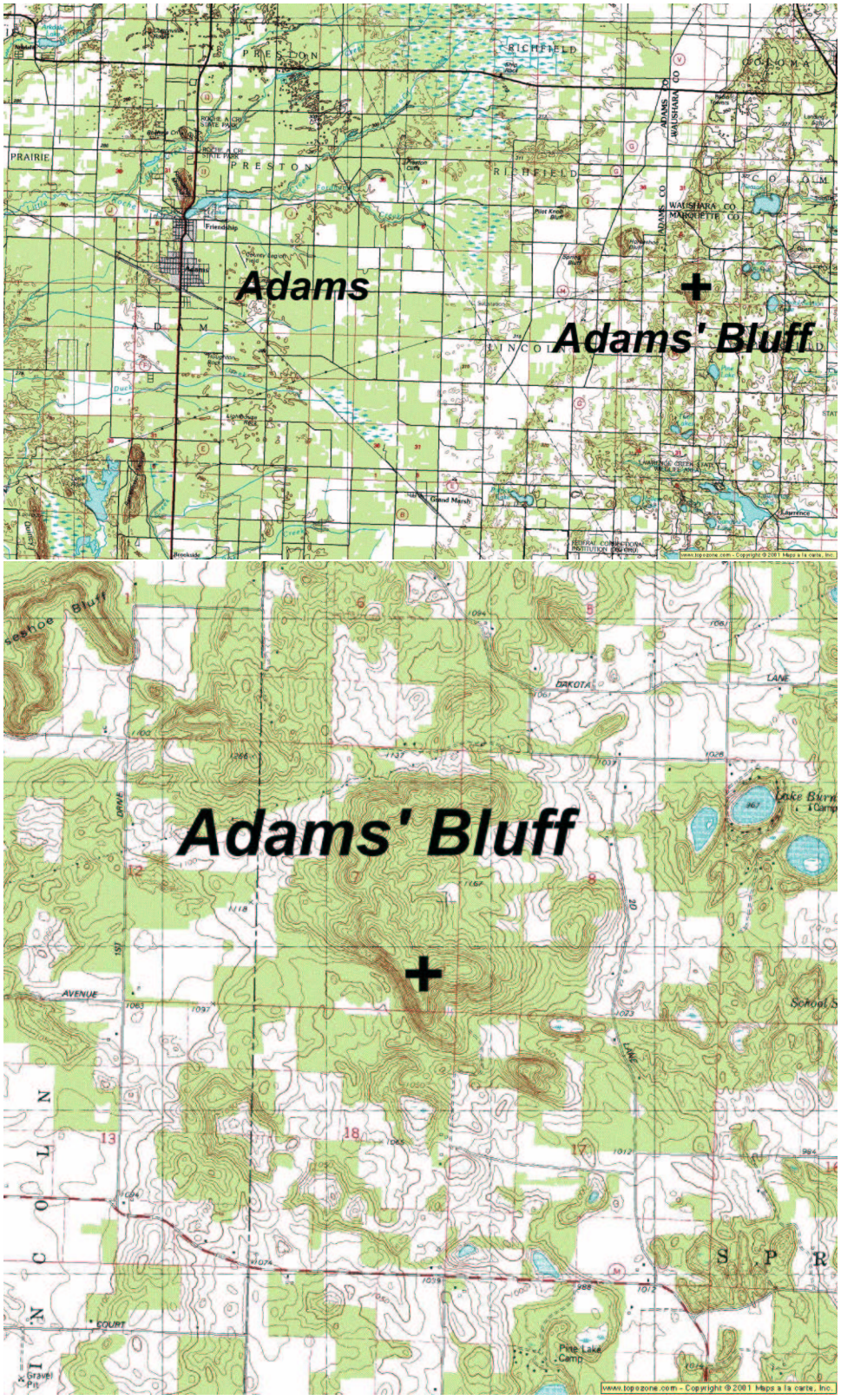


Silver Creek, MN, lat. 47.11°, long. −91.58°



500′ overburden with horizontal tunnel.

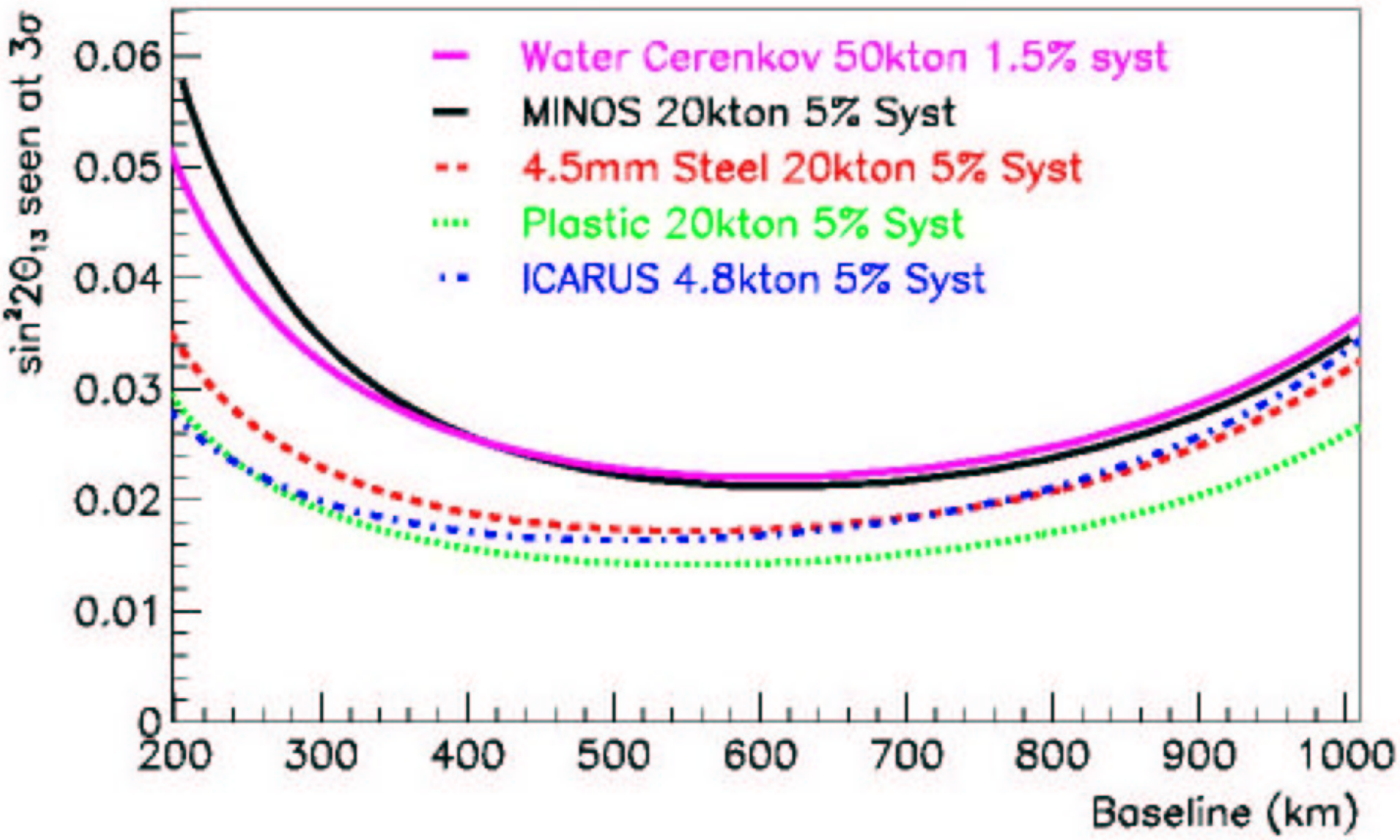
Adam's Bluff, WI, lat. 43.95°, long. −89.59°



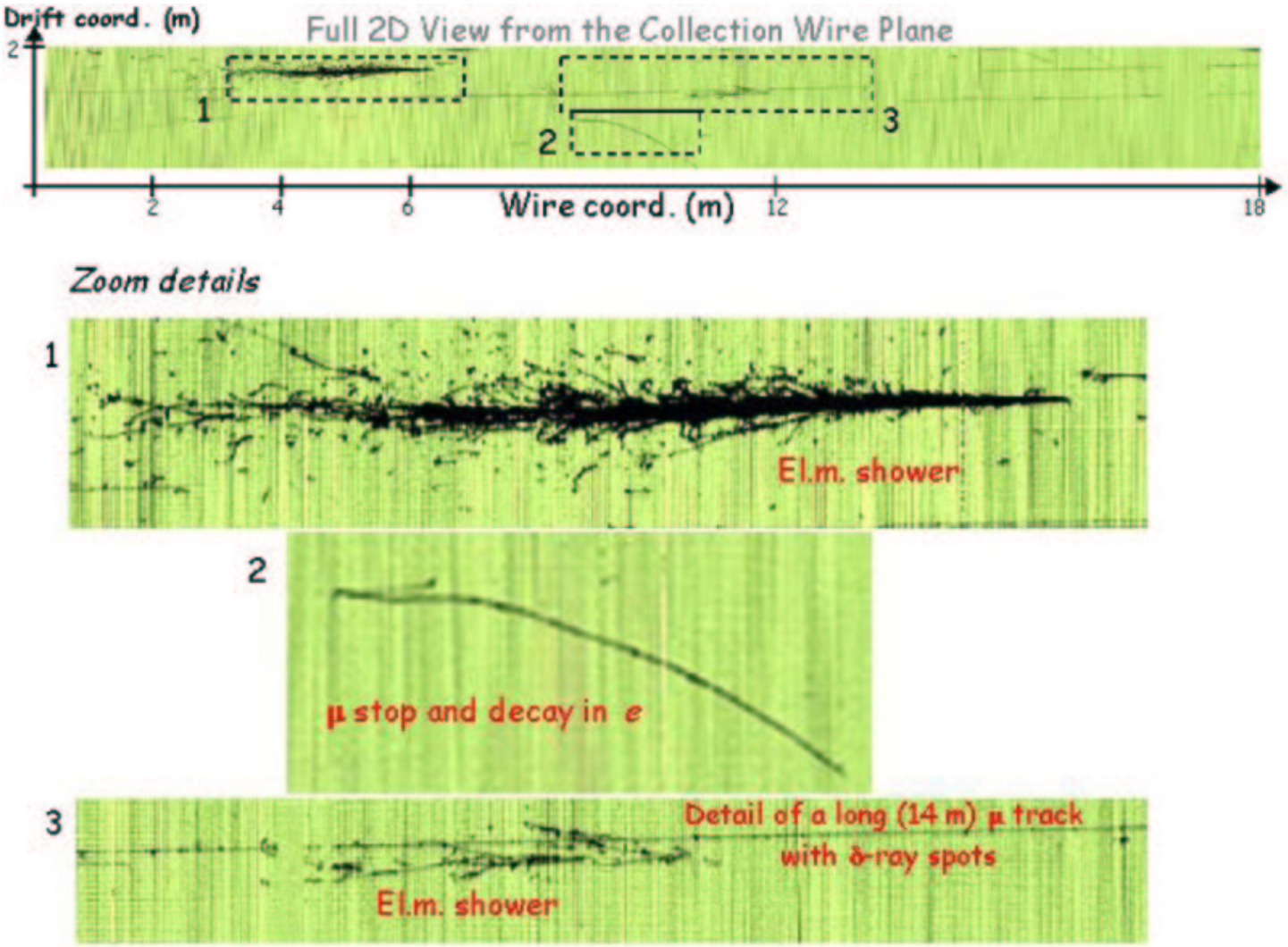
300′ overburden with horizontal tunnel.

Liquid Argon is the Best Detector Choice

- Density = 1.4; X_0 = 14 cm; can drift electrons 2-4 m.
- 100% sampling tracking and calorimetry.
- Construction is simplest of large neutrino detector options.
- Best rejection of neutral current backgrounds, including soft π^0's.
- 10 times better per kton than water Čerenkov for $\nu_\mu \rightarrow \nu_e$ appearance (Harris).



ICARUS – a Working Liquid Argon Detector



- Operates at the Earth's surface with near zero overlap of cosmic ray events.
- Operates with deadtimeless, selftriggering electronics.
- Liquid argon costs $\approx \$1M$/kton.
- Minimize cost of a large detector by building a single module.

LANNDD – Liquid Argon Neutrino and Nucleon Decay Detector

