Tritium in Fermilab Surface Waters

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Chair, Surface Water Quality Task Force

Savannah Community Association Meeting
February 7, 2006

Overview

- November 2005: For the first time ever, levels of tritium in Indian Creek and in our cooling ponds rose above the limits of detection.
- Appointment of a Surface Water Quality Task Force, chaired by the Associate Director for Accelerators
- December 8, 2005: Fermilab Director letter to Savannah residents:
  - Commitment to stay well below the regulatory requirements, aiming for levels as low as reasonably achievable.
- Begin dialog with neighbors and other stakeholders to specify long-term goals and their implementation

Outline

- Overview of Communications to Date
- Answers to Questions
  - What is tritium?
  - What is the risk?
  - What was released?
  - Where did it come from?
  - How has Fermilab responded?
  - What can I expect in the future?
- Prospects

Communications to Date

- Meeting with Savannah Community Association president and letter to all homeowners.
- Informed offices of Hastert (plus briefing), Biggert, Durbin, Obama, state and local representatives as well as DOE, Illinois EPA
- Met with the Community Task Force for Public Participation
- Website developed and updated frequently

  http://www.fnal.gov/pub/about/community/IndianCreek.html
- Some modest press coverage (starting with the Beacon News)
- Establishing contacts with residents
- Meeting with Savannah Community Association (tonight)

What is Tritium?

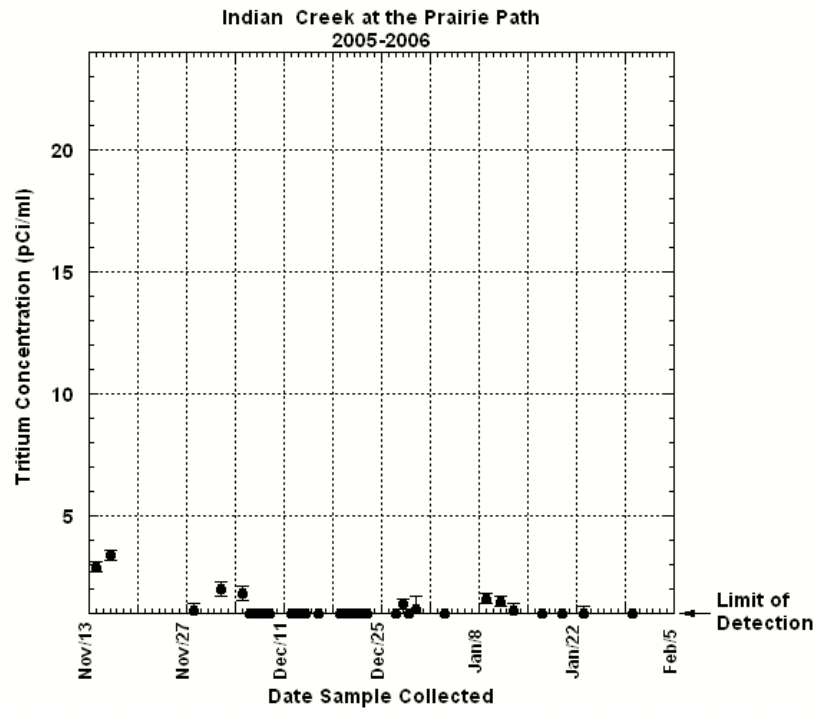
- Tritium is an isotope of hydrogen containing two neutrons plus one proton.
- It is weakly radioactive, with a half-life of 12.3 years.
- It decays into helium and a very low-energy beta particle (electron)
- In water, tritium typically forms an HTO molecule, rather than ordinary H_2O.
- The unit we use for measuring tritium concentration in water is pCi/ml (picocuries per milliliter).

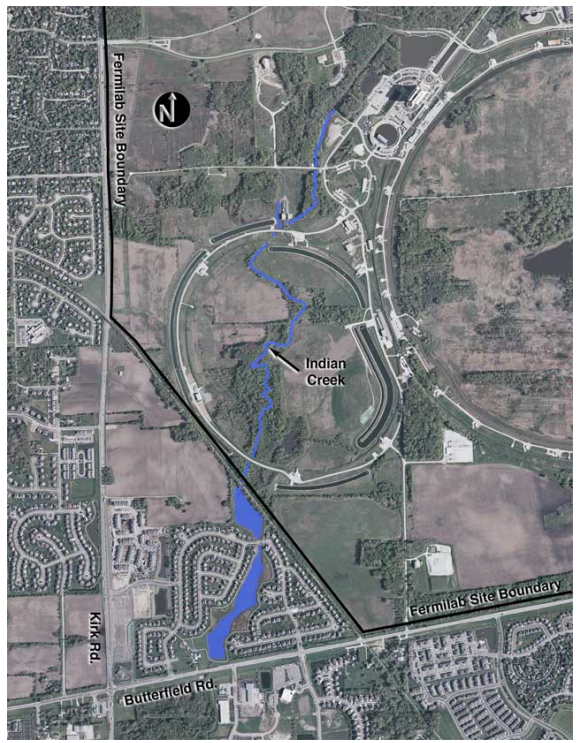
What is the Risk?

- Tritium emits low-energy beta particle that cannot penetrate the skin
  - The primary hazard is internal exposure, e.g. by drinking water containing tritium.
- Ingestion in large quantities over extended period of time can cause cancer.
- Tritium does not accumulate: it leaves the body with a biological half-life of about 10 days.
- In order to protect the public, federal agencies set upper limits on the amount of tritium in water.
  - The Department of Energy health standard for surface water (such as Indian Creek) is 2000 pCi/ml (picocuries per milliliter).
  - When tritium is in drinking water the health standard is 20 pCi/ml.
- The low levels of tritium in Indian Creek pose no health risk.

What was Released?

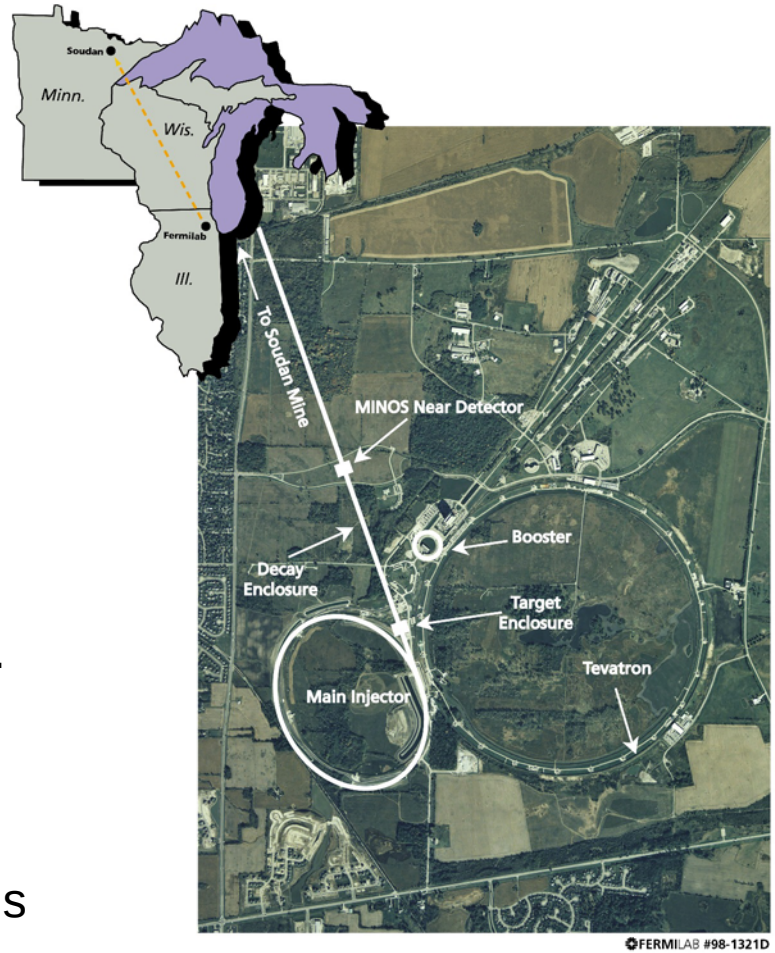
- Nov. 2005: Indian Creek had 3.3 pCi/ml.
- Fermilab took specific actions to lower the level, and the level since has been fluctuating around the detection limit of 1.0 pCi/ml.





Where does it come from?

- Tritium is produced as a by-product at all accelerators.
  - At Fermilab NuMI/MINOS is the primary source.
  - Initiated operations in February 2005.
- MINOS is looking for “quantum oscillations” of neutrinos.
  - We make neutrinos with a certain “flavor”, and they arrive in Minnesota with a different “flavor”.
- Results lead to insights into:
  - How did the universe evolve?
  - Where did all the antimatter go?
  - What is the dark matter that seems to shape galaxies?



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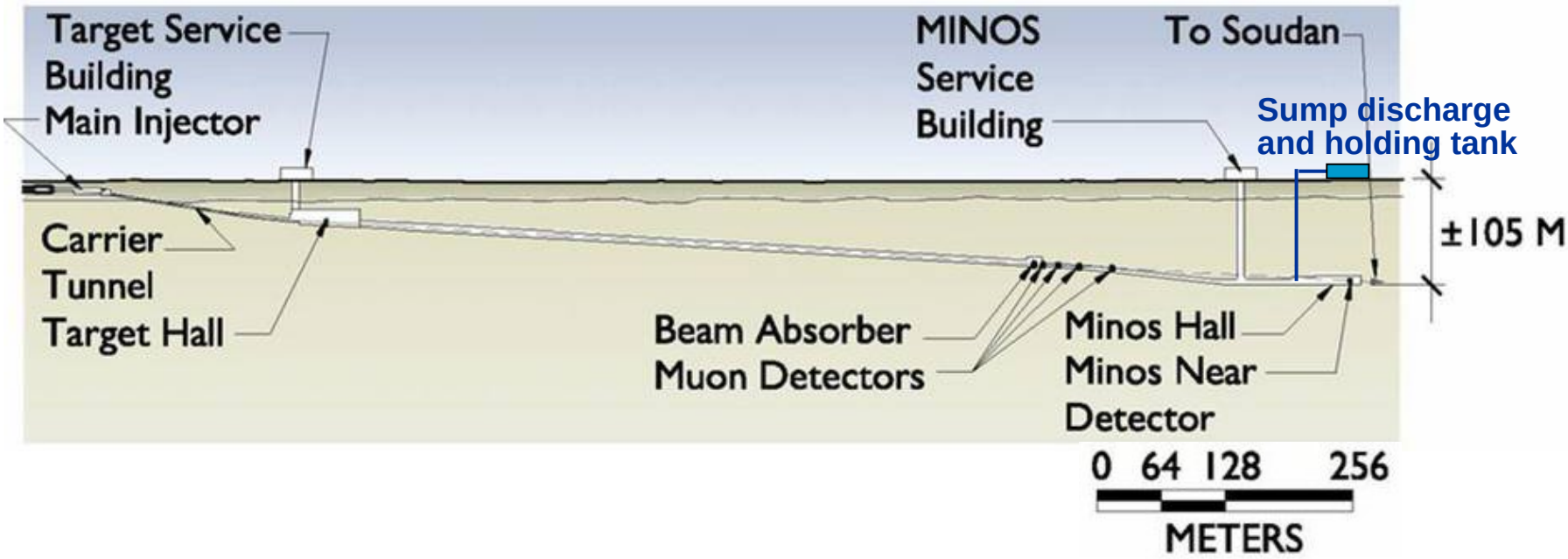


- Water flowing into the NuMI enclosure is collected and pumped to the surface to protect the aquifer
  - About 175 gallons per minute
- The water is used in Fermilab cooling system, including ponds

How has Fermilab Responded?
Approach

- Established a Surface Water Quality Task Force to lead investigation, to develop a strategy and to take action.
- Consulted the Community Task Force for Public Participation and asked a CTF member to join the Task Force (Mike McCoy, former chair of the Kane County Board)
- Strategy
  - Identify all current and potential future sources of tritium.
  - Develop minimization strategies.
  - Develop a water management plan to minimize site discharges.
  - Establish near, intermediate, and long-term goals for site discharges.
  - Develop a monitoring program that will assure goals are being met.
  - Develop a communication plan for interacting with our neighbors.

How has Fermilab Responded?
Mitigation Measures Taken to Date

- Plugged leaky pipe connecting Main Injector cooling ponds C & D.
- Identified major tritium source as the water being pumped from the NuMI enclosure
  - 175 gallons per minute at 10-15 pCi/ml (regulatory limit: 2000 pCi/ml)
- Identified and eliminated a major (60%) contributor to the NuMI source: We now capture the water condensate from an air conditioning unit in the NuMI target area, keeping it out of the cooling water.
- Monitor flow of water on site and reroute as necessary.
- Conducting a series of measurements and analyses to identify the remaining source(s).

How has Fermilab Responded?
Water Management

- Usually, very little water leaves the Fermilab site
- Fermilab imports water from the Fox River to meet cooling demands of accelerator equipment (up to 1000 gallons per minute)
- A water tritium concentration model is under development for use in planning water distribution in Fermilab cooling system
- On-site surface waters currently shows tritium levels of 2-6 pCi/ml
- The current strategy:
  - Protect the creeks by holding NuMI water in our ponds
  - Use precipitation and Fox River water to dilute tritiated water.
  - If discharges are necessary (e.g., after heavy rains), direct discharges towards Kress Creek, which has more water flow.
  - Reconfigure flow of NuMI water to evaporate about 40% of the water through direct use in cooling system. (Work starts 2/27.)

How has Fermilab Responded?
Monitoring

- Monitoring program redesigned for more comprehensive and timely feedback (taking more samples and more frequently).
- Monitoring Indian Creek bi-weekly and posting all results on the Web

  http://www.fnal.gov/pub/about/community/chart.html
- Monitoring ponds that could be sources to Kress and Ferry Creeks daily to weekly.
- Monitoring Kress Creek daily (no detectable tritium)
- Ferry Creek cannot be monitored yet as it is dry at this time.
- Establishing contacts with residents along Ferry Creek and Kress Creek.

Fermilab's Goal

- We will seek to keep surface water releases of tritium well below the regulatory limit, and at levels that are as low as reasonably achievable.

- Specific long-term goals and their implementation will be developed through a dialog involving Fermilab, the public, the U.S. Department of Energy, and Illinois regulatory agencies.

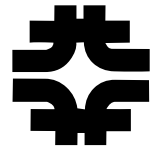
Prospects

- Levels in Indian Creek may from time to time be above detection limits (1 pCi/ml). We will strive to keep these releases to a minimum.

- Long-term solutions need to address a factor of ten increase in the number of protons hitting the NuMI target ten years from now.

- Possible solutions could involve any or all of the following:
  - Modify NuMI target region so that less tritiated water is formed
  - More effective means of isolating tritiated water for capture and offsite disposal
  - Maximize dilution by utilizing water from the Fox River.

Our Commitment to the Public



- To go beyond merely satisfying the regulatory limits and to reduce tritium discharges to as low as reasonably achievable

- To keep the public informed

  http://www.fnal.gov/pub/about/community/IndianCreek.html

- To engage the public in the establishment of goals and formulation of plans