PIXE Analysis of Aerosol, Soil, Artificial Turf, and Running Track Samples

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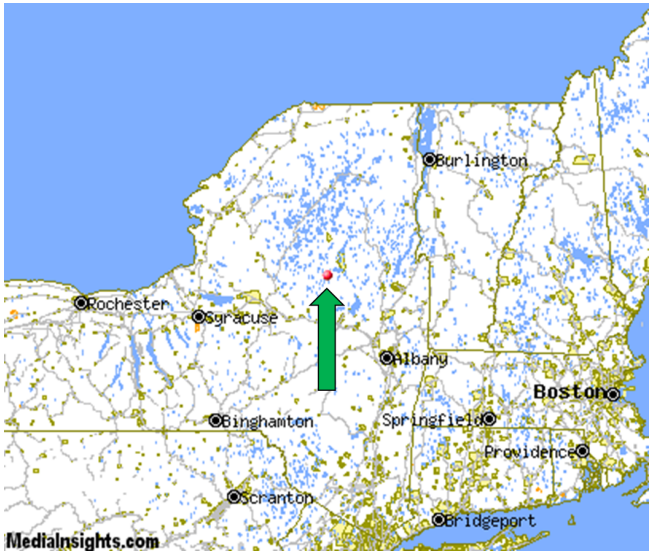
Steinmetz Presentation

Outline

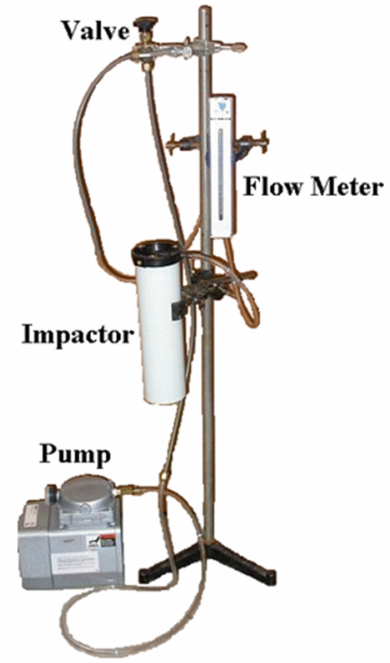
1. Piseco Lake
   - Background
   - Piseco Lake Experiments
   - PIXE Analysis
   - The Union College Pelletron Accelerator
   - Piseco Lake Results
2. Artificial Turf and Running Track
   - External Proton Beam Analysis
   - Artificial Turf and Track Experiments
   - Artificial Turf and Track Results
3. Conclusions
4. Acknowledgements
5. References
6. Questions?

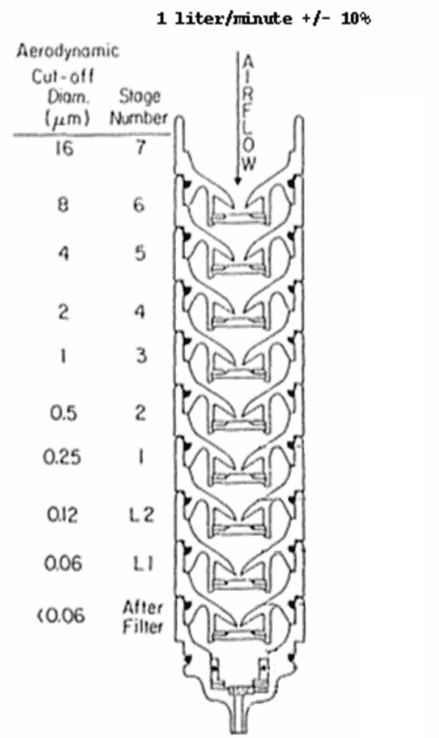
Piseco Lake



- Acid rain and the acidification of lakes has been a major and ongoing concern in the Adirondacks[1;2].
- One of the main causes of acid rain is sulfur dioxide, which can react with rain water to produce sulfuric acid.
- When acid rain falls over lakes, it can decrease the pH of the lakes, which can be life-threatening to any wildlife living in the lake[3].
- Piseco Lake has been a victim of acid rain and a target for environmental research.

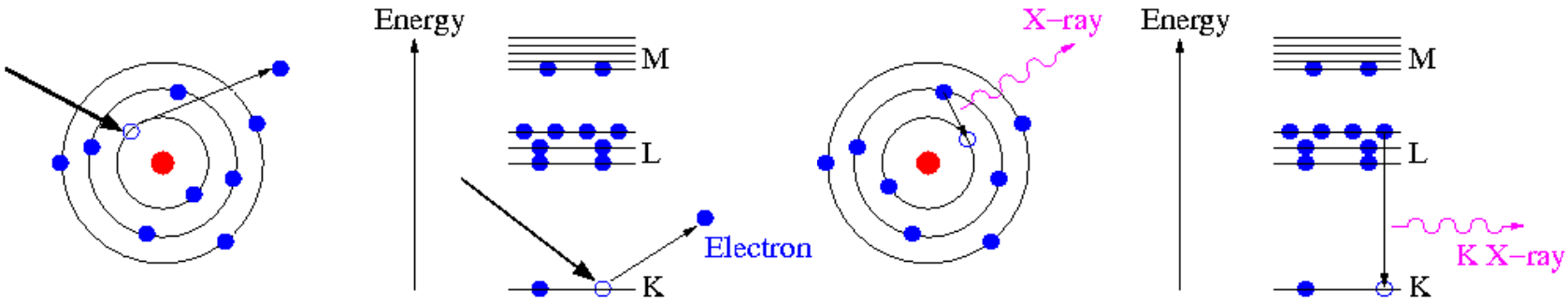
Piseco Lake Experiments





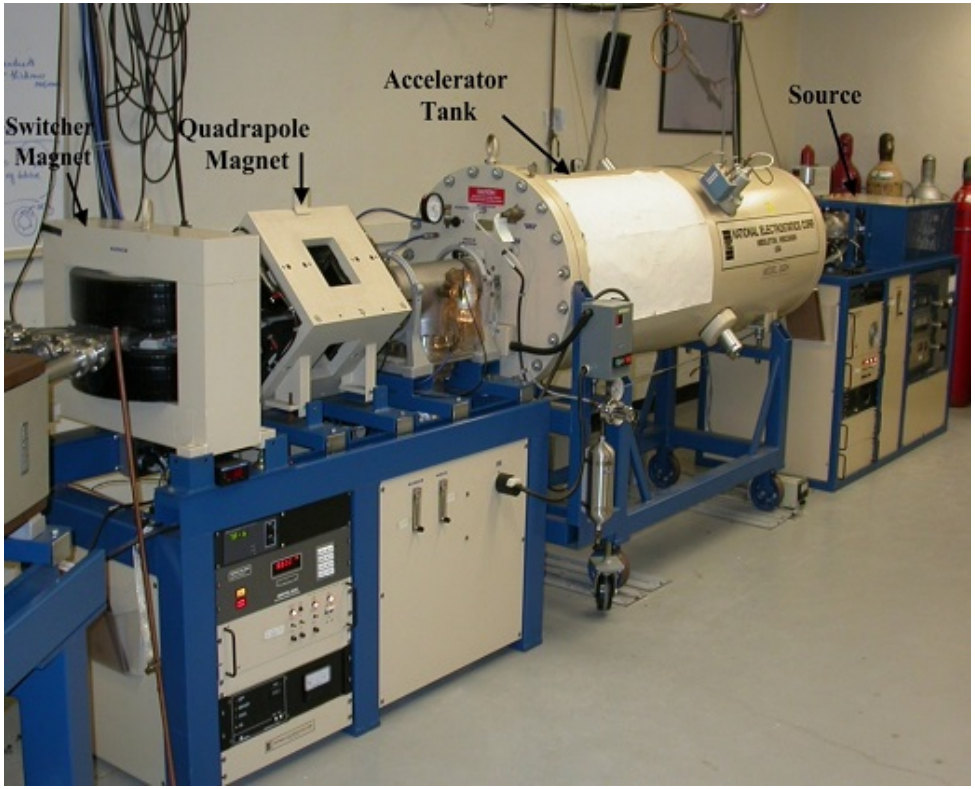
- Air samples were collected using a nine-stage cascade impactor, which distributes particulate matter in the air by particle size.
- The impactor collected particulate matter between 0.06μm and 16 μm in diameter.
- Soil samples were collected near the lake.

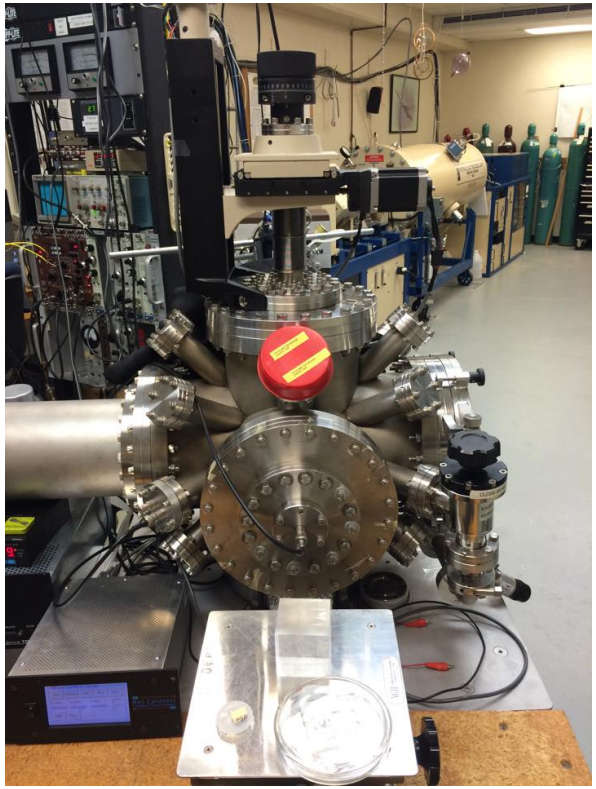
Proton Induced X-ray Emission (PIXE) Analysis



- A proton collides with an inner-shell electron, knocking it out of the atom.
- An outer shell electron fills the vacancy left by the knocked-out electron and loses energy in the form of an X-ray.
- Every element has characteristic X-ray energies associated with the element.
- The number of characteristic X-rays associated with an element corresponds to the concentration of that element in the sample.

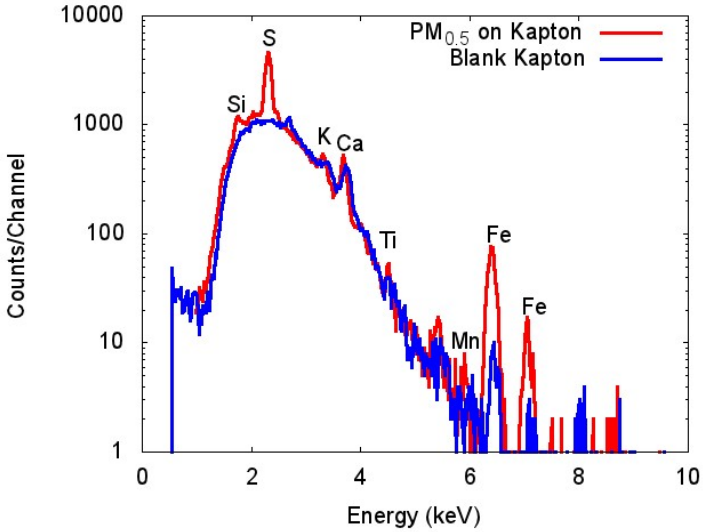
The Union College Pelletron Accelerator

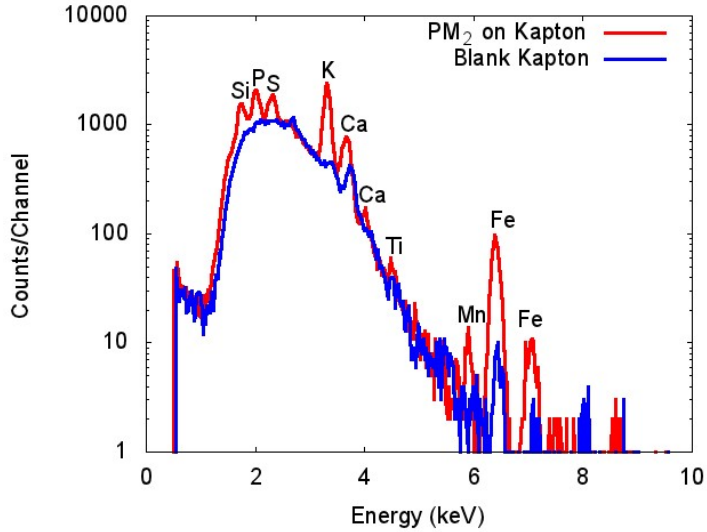


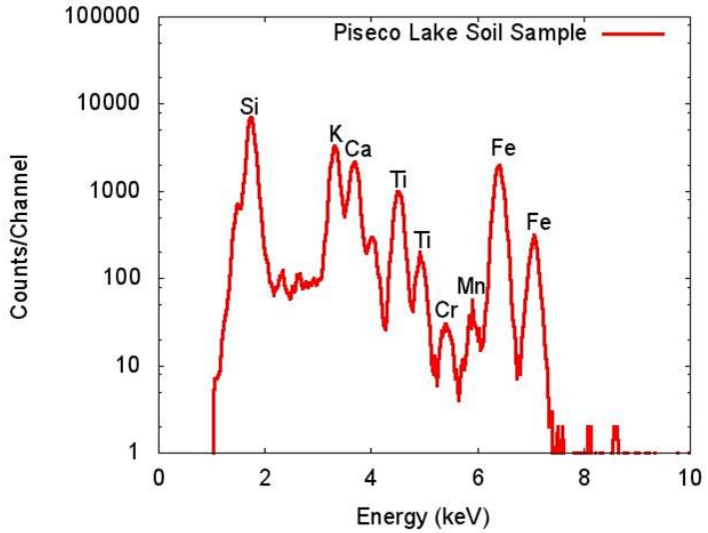


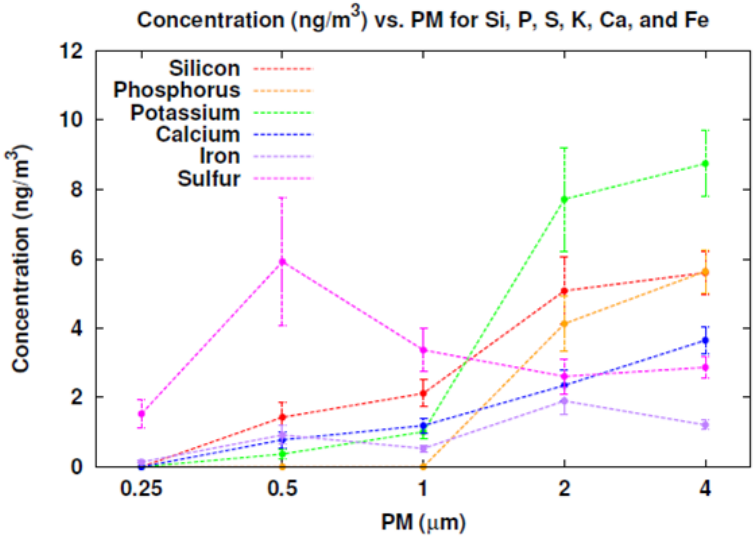
- The Union College 1.1-MV Pelletron Accelerator was used to perform an elemental analysis of all of the samples.
- The accelerator created a 2.2-MeV proton beam that was used for proton induced X-ray emission spectroscopy (PIXE).

Piseco Lake Results





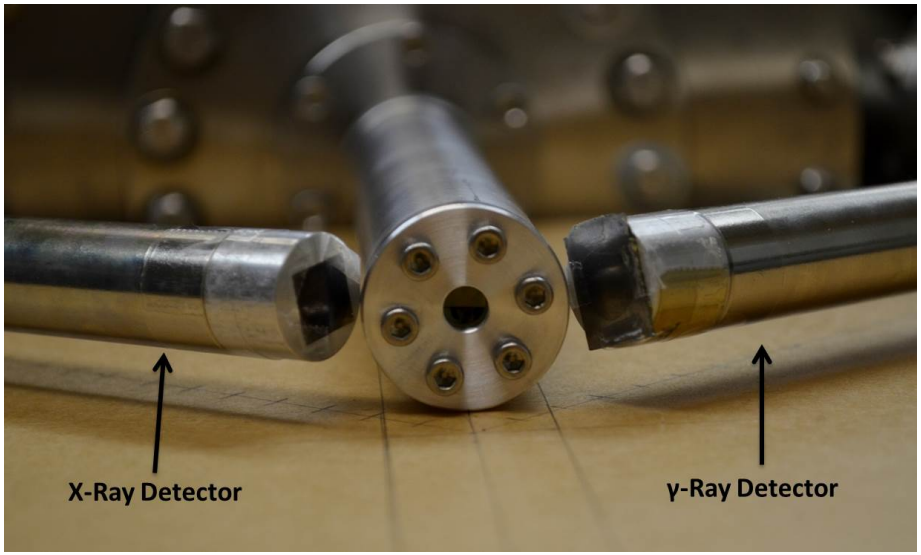


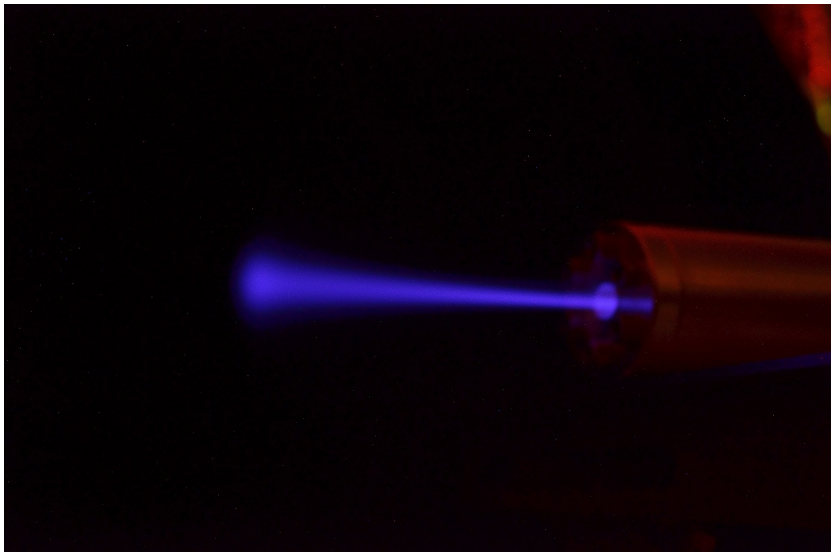


Artificial Turf and Running Track

- There have been recent concerns about the possibility of heavy metals such as lead being present in artificial turf infill and running tracks[6;7].
- When in use, the turf infill can be kicked up into the air and inhaled.

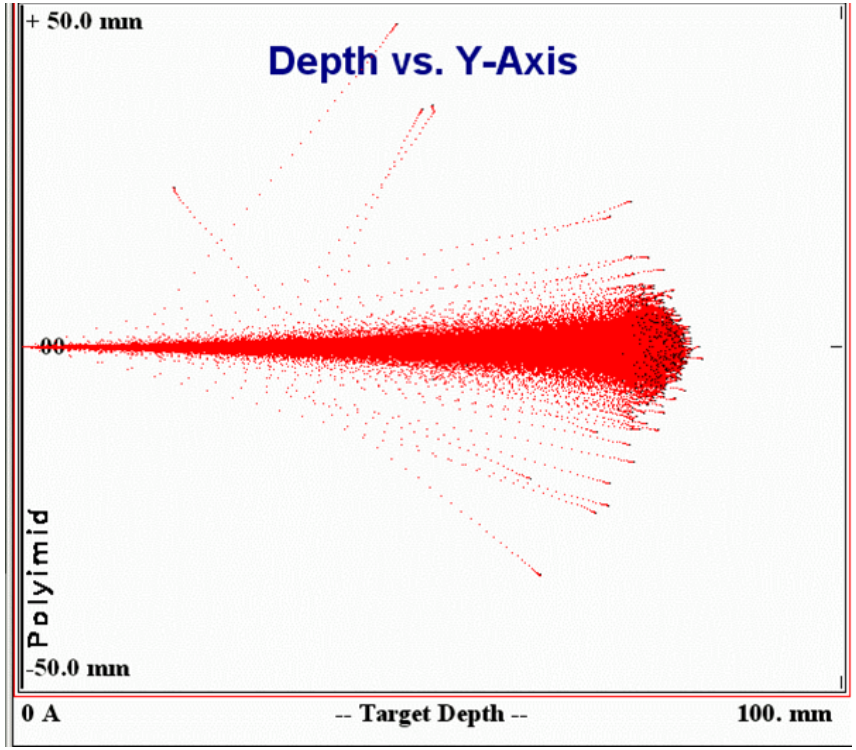
External Proton Beam Analysis





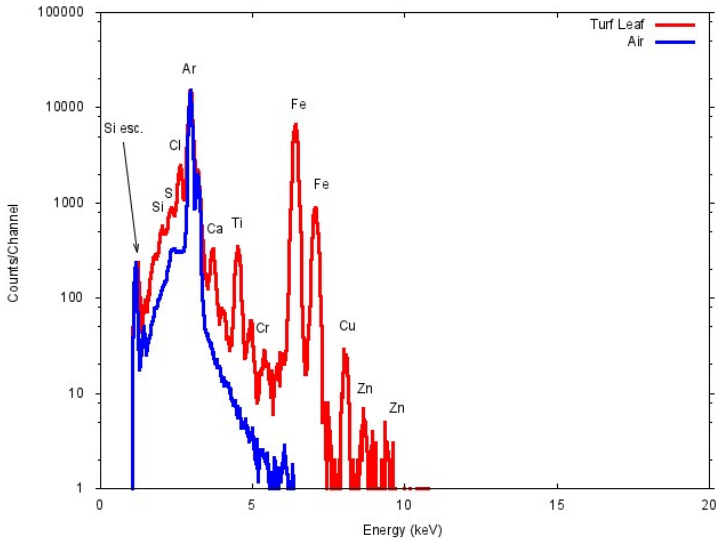
- An external proton beam allows us to analyze samples without having to put them under vacuum.
- Very little to no sample preparation is necessary for external beam analysis.

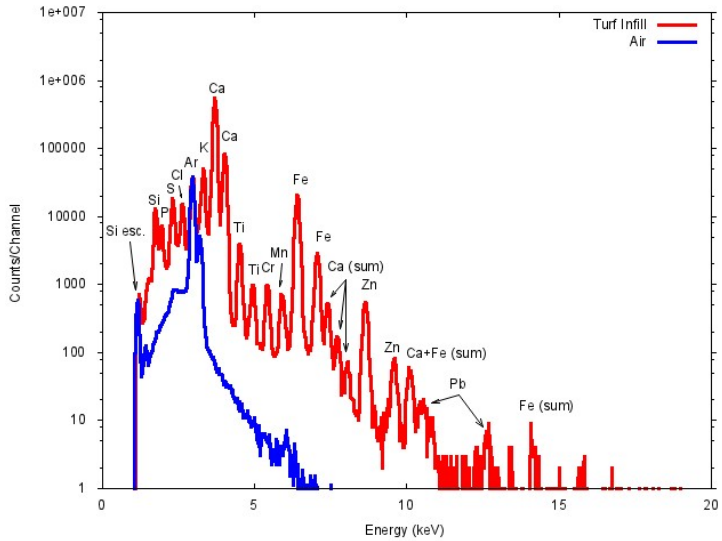
Artificial Turf and Track Experiments

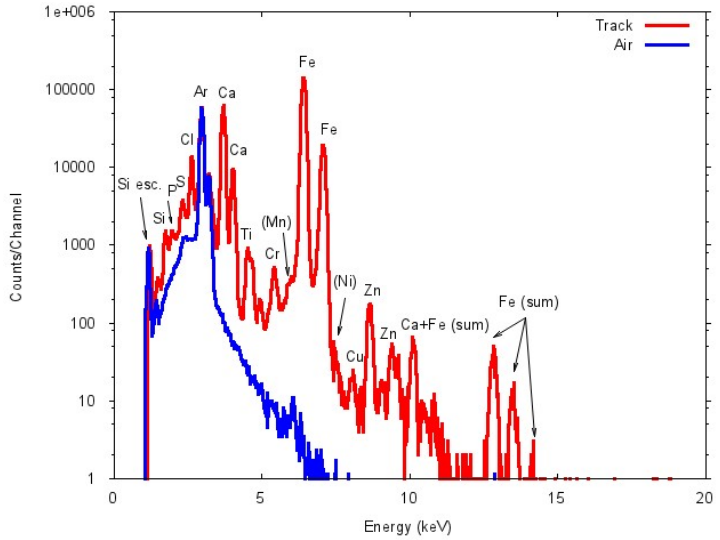


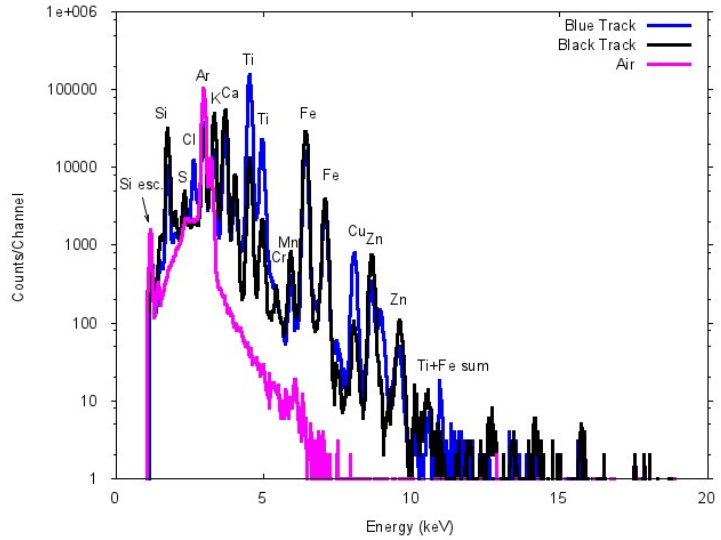
- Artificial turf and track samples were collected from the Union College football field and running track and the Lexington High School (MA) running track.
- The turf and track samples were analyzed using an external proton beam.
- A SRIM simulation was used to determine the average energy of the external proton beam 2cm away from the exit window.
- The average energy of the external proton beam 2cm away from the exit window was determined to be about 1.7 MeV.

Artificial Turf and Track









Conclusions

- High concentrations of sulfur were measured at small particles sizes in the air samples, indicating that the sulfur may have originated as far away as the Midwest.
- Concentrations of Si, P, K, Ca, and Fe were found at larger particle sizes, indicating that the elements are likely to have originated in the soil.
- Traces of lead were measured in the artificial turf infill, perhaps justifying recent concerns about the safety of artificial turf.
- No heavy metals were detected in the artificial turf leaf and running tracks.

Acknowledgements

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- NY NASA Space Grant program, the Lee L. Davenport Fellowship Program, the Union College Research Fellowship Program, and the Union College Department of Physics and Astronomy for funding my three years of research

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[2] "Acid Rain." *Adirondack Council,* accessed in March 2016. http://www.adirondackcouncil.org/page/acid-rain-86.html

[3] "Acid Rain and Acid Deposition." *Ocean World,* last modified 2008. http://oceanworld.tamu.edu/resources/environment-book/acidrain.html

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[6] Michael Goot, "School Seeks Answers on Health Risks of Artificial Turf." *The Post Star*, last modified November 7, 2014. http://poststar.com/news/local/school-seeks-answers-on-health-risks-of-artificial-turf/article_6d4a5d24-6616-11e4-97b5-bf53f782af9e.html

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Questions?

"Yes ... I believe there's a question in the back."