VALOR/TARGET Beamline Simulation: Building Models for Different Beamlines - Accelerator Division

Presenter Name: Bryan Mann, Giancarlo Ortega and Lianne Marrero Perez

Final Presentation

7/26/2024

About Giancarlo - VALOR Intern

- Incoming freshman at Marquette University
  - Major in Computer Engineering
- Major Interests
  - Coding and Computer Hardware
  - STEM Research
  - Sports: Volleyball and Soccer

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About Lianne - TARGET Intern

- Rising Senior at Geneva Community High School
- I am interested in majoring in Pharmaceutical Sciences or Chemical Engineering as a Pre-Pharmacy major.
- My favorite hobbies are crocheting, playing my flute and doing taekwondo

Why Fermilab?

I decided to apply to the TARGET internship because I have an interest in quantum physics theories like the wave particle duality theory. I also thought it would be a fantastic opportunity to gain some experience before going to college.

About Bryan - TARGET Intern

Rising Junior at Waubonsie Valley High School

Interests:

- Track & Field
- Games
- Aviation
- Space exploration

Why Fermi?

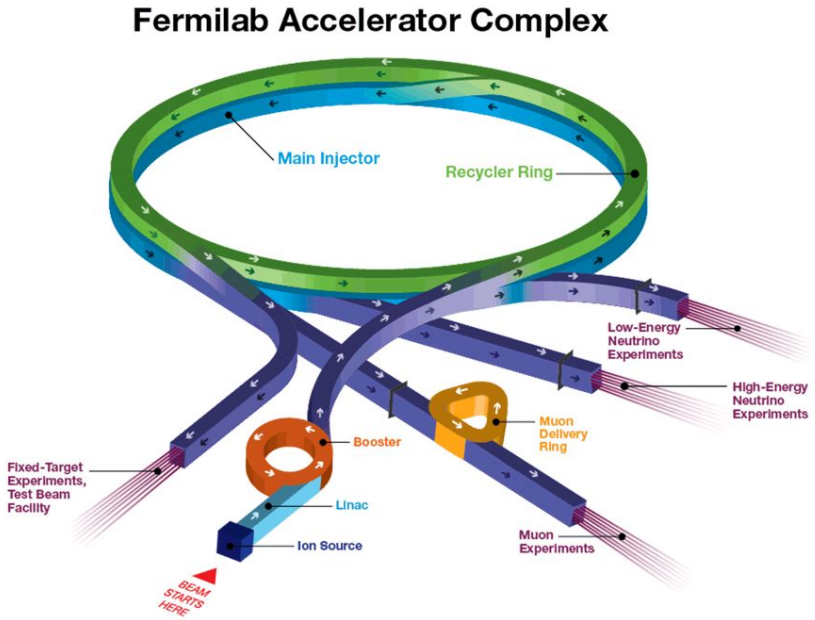
- I was presented a great opportunity to work with like-minded individuals and expand my knowledge of STEM careers and topics.

Extracurriculars:

- Track
- BSA (Black Student Alliance)
- ACT-SO (Science Olympiad)

The Accelerator

- Step 1: Proton Ion source
- Step 2: Higher Energy
- Step 3: Directed to Experiment
  - Magnets



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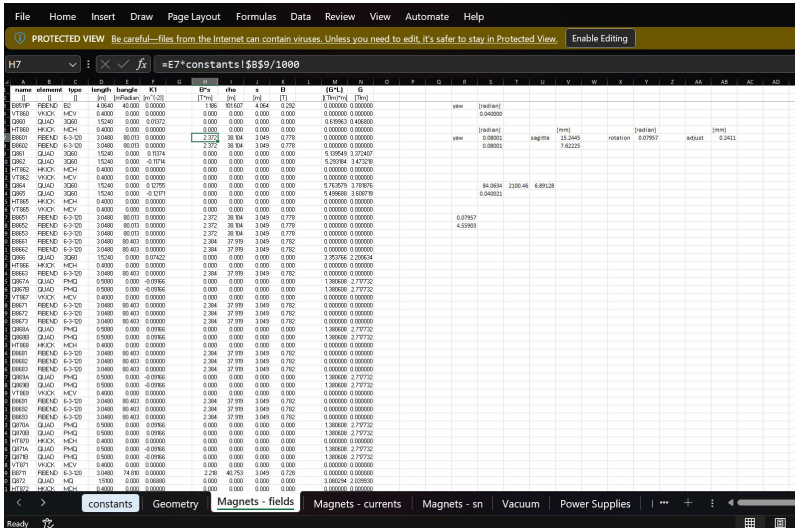
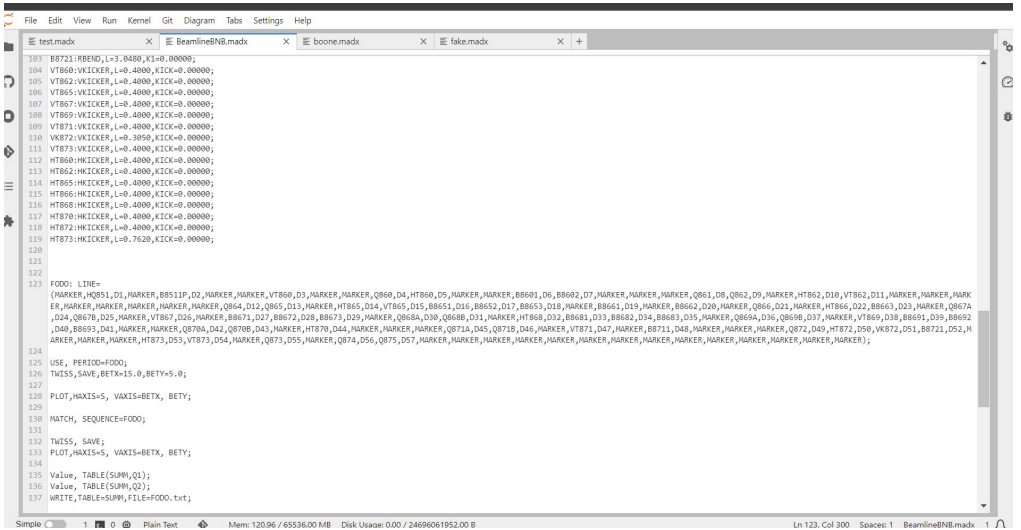
Our Project: Building Models for Several Beamlines

- Supervisor- Jason Crnkovic
  - Lessons
- Located in the LINAC with Geoffrey Donaldson
- Modeled and simulated beamlines with the use of JupyterHub Notebook and MadX program
  - Why?
    - Simple flat files
    - Supporting particle physics experiments
- NUMI beamline (Neutrinos at the Main Injector)
- BNB beamline (Booster Neutrino Beam)
- Switchyard (sends particles to three external beam areas)

What did it look like…





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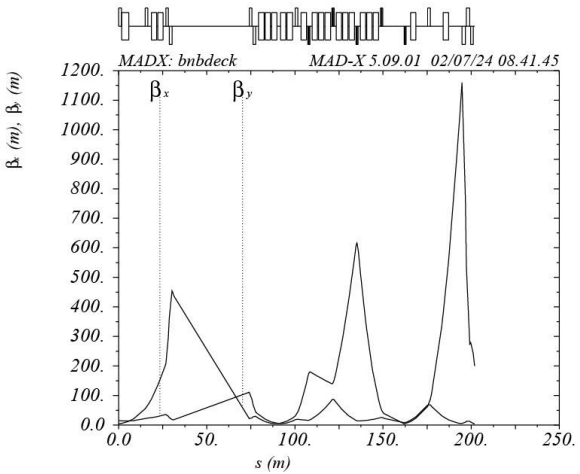
Detailed View of Code

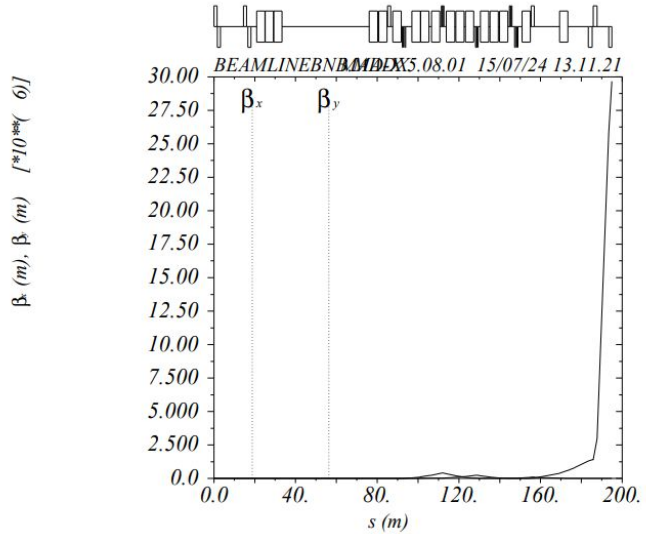
```
14
15 DZERO:     MARKER;
16 Q701:      QUAD,     L=3.048000,    K1=K1P1Q1;
17 Q60_END:   DRIFT,    L=0.152400;
18 VP701:     MONITOR,  L=0.203200;
19 DCQ1A:     DRIFT,    L=0.106830;
20 MRVC_END:  DRIFT,    L=0.068260;
21 VT701:     VKICK,    L=0.152400,     ANGLE=0.000000;
22 MRVC_END:  DRIFT,    L=0.068260;
23 DCQ1B:     DRIFT,    L=0.038490;
24 MRVC_END:  DRIFT,    L=0.068260;
25 VT701:     VKICK,    L=0.152400,     ANGLE=0.000000;
26 MRVC_END:  DRIFT,    L=0.068260;
27 DCQ1C:     DRIFT,    L=0.027740;
28 MRHC_END:  DRIFT      L=0.041270;
```

Our Project: What did it look like

Examples :



Our first time running the code.
(for the BNB line)



More attempts to reach an accurate beamline

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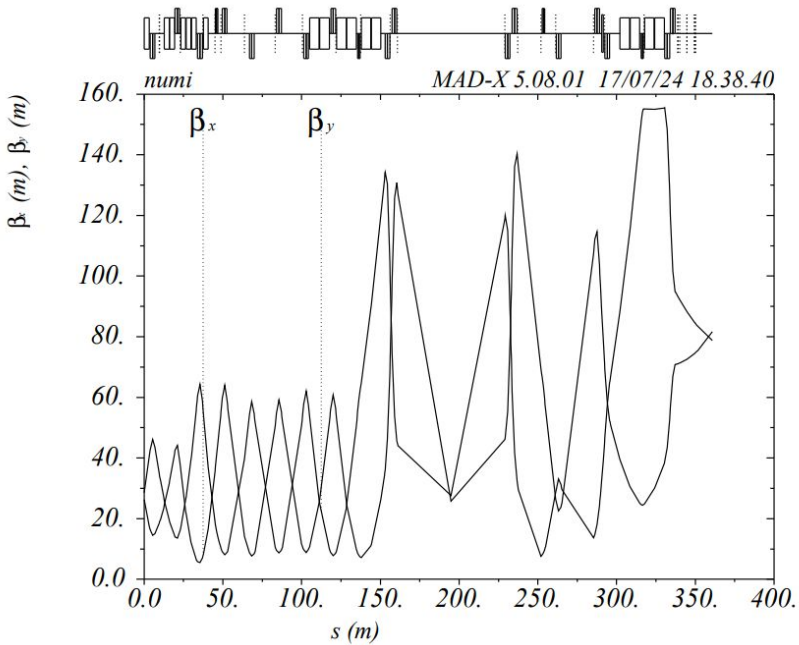
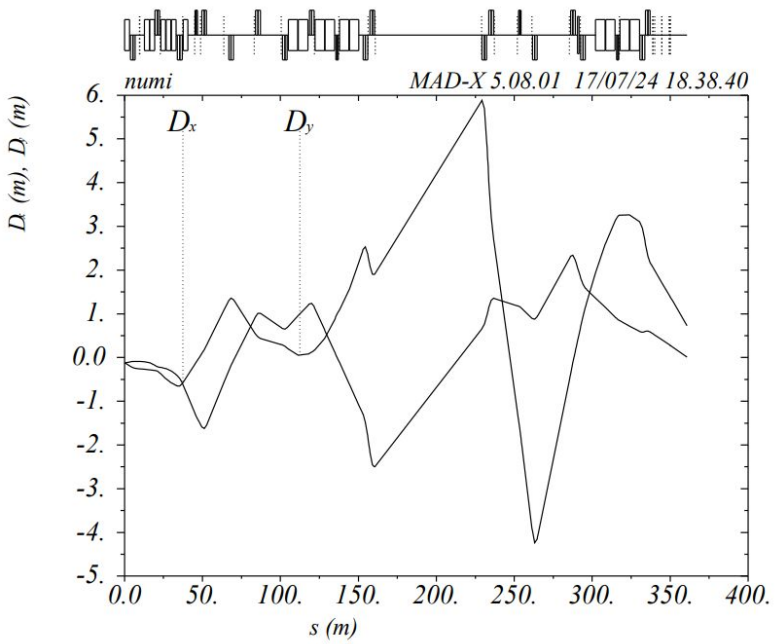
Accurate Simulation of a Beamline



Beta Function



Dispersion Plot

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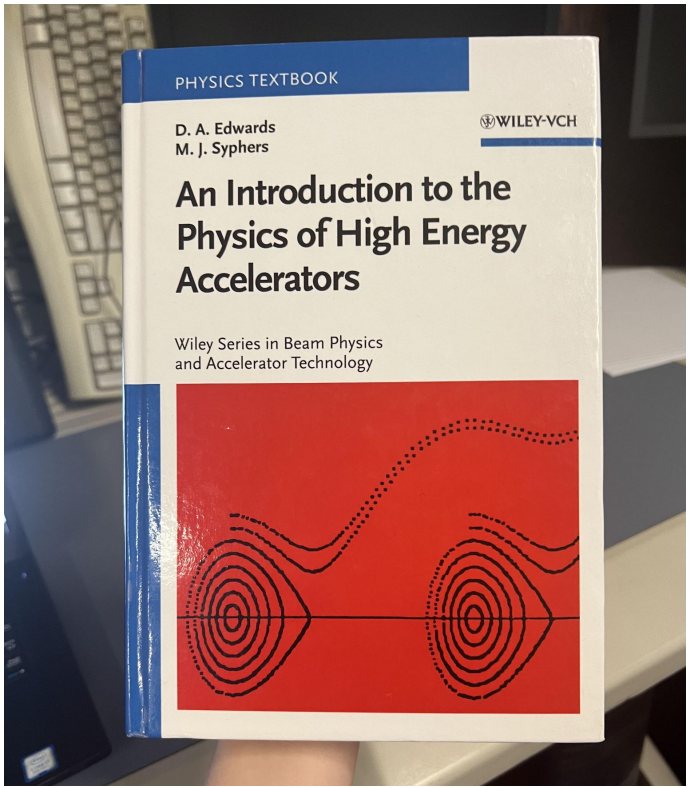
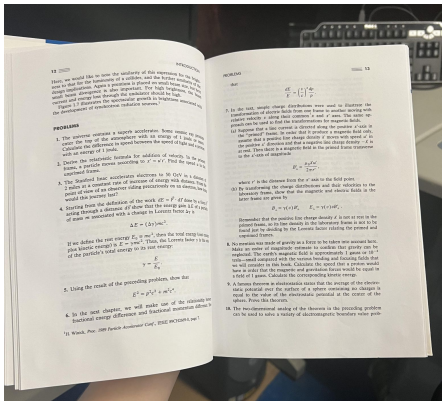
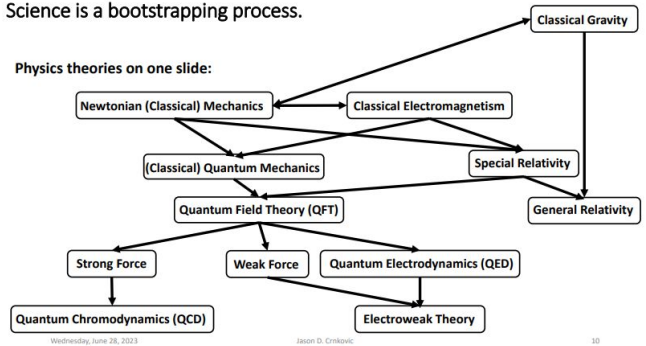
Learning Accelerator and Particle Physics

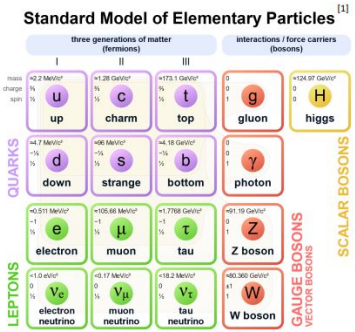






Standard Model:

- SM explains the interaction of matter & forces at large energies & small distances.
- Matter & forces are both treated as particles in the SM.
- Particles can be created & destroyed.
- Fermions & bosons are the two basic types of quantum particles.



[1] MissMJ and Cush, "File:Standard Model of Elementary Particles.svg", https://en.wikipedia.org/wiki/File:Standard_Model_of_Elementary_Particles.svg , Accessed June 21, 2023.

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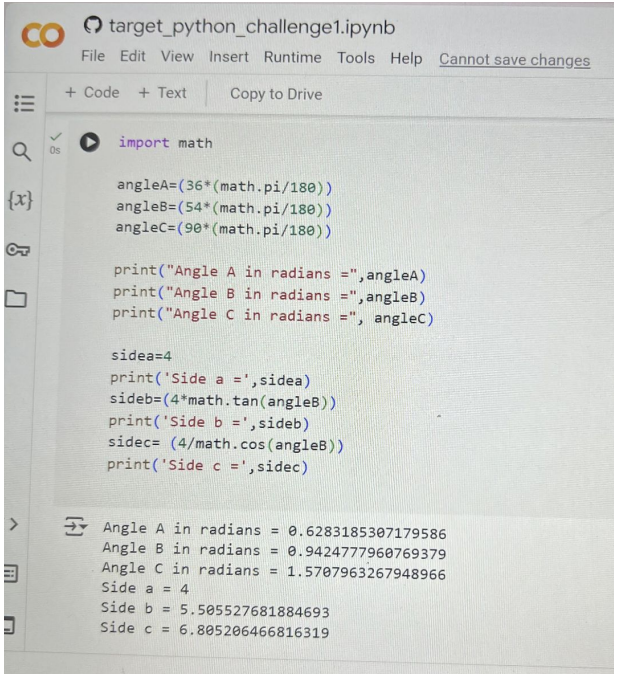
Workshops

- Python Workshop-
  This workshop taught us the basics of coding on Python. There were challenges (practice problems) to apply the knowledge that was taught in the lectures.

- Resume Workshop-
  Taught us how to make resumes that highlighted our best qualities and gave us tips on how to make our resume concise.

- College Admissions Workshop -
  Helped us understand what it takes to be a competitive candidate for the college admission process



This was one of the challenges in the Python Workshop. In this challenge we worked to find the missing sides and angles of a triangle.

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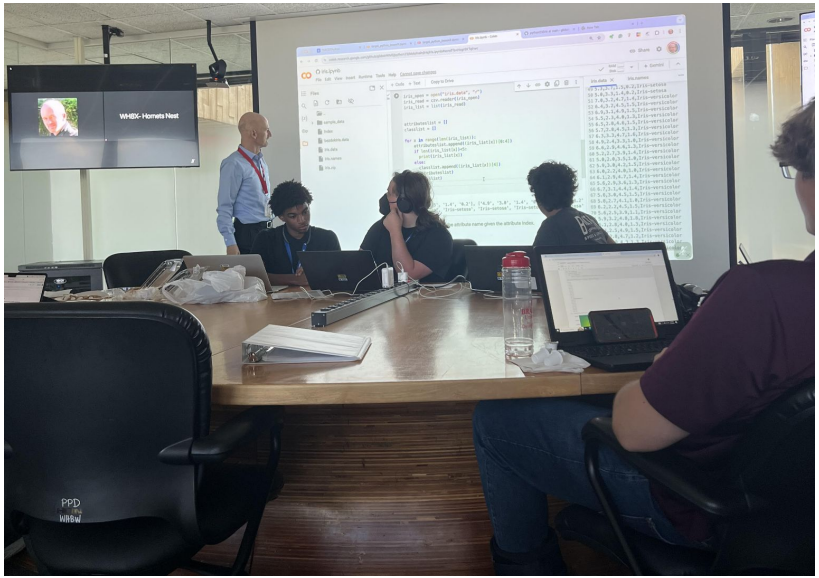
Workshops



Python

College Admission

Tours

We attended many tours during these internship. Some of these tours were:

- Integrated Engineering Research Center (IERC)
- Superconducting Quantum Materials and Systems Centers (SQMS)
- Fermilab Tour (Wilson Hall + driving tour)

Dilution fridge (part of the SQMS tour)

Tours


U.S. DEPARTMENT OF
ENERGY
SQMS
SUPERCONDUCTING QUANTUM
MATERIALS AND SYSTEMS CENTER
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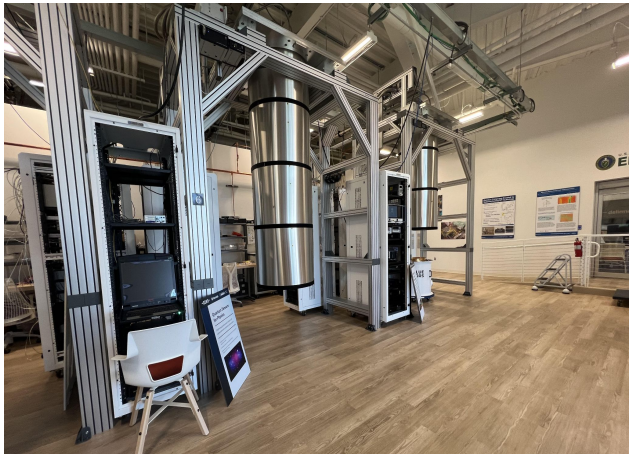


Reflection

Lianne

Takeaways:

- Narrowed down my career interests.
- Given me a deeper understanding of particle physics and particle accelerators.

Favorite Moments:

- Touring the LINAC building
- Going to the prairie
- Touring the rest of the site

Goals:

- Become a pharmacist
- Major in chemical engineering or pharmaceutical sciences.

Gian

Takeaways:

- Professional Environment within Fermilab
- Advice for my everyday life
  - Presenting yourself
  - Career advice
- Opportunities after the internship

Favorite Moments:

- Tours to different parts of the lab.
- Learning about the Main Control Room

Goals:

- Pursue Computer Engineering and work for reputable company

Bryan

Takeaways:

- Exposure to various fields of physics and engineering
- Realistic view of STEM jobs

Favorite Moments:

- Meeting the people here
- Learning what different people work on at the lab

Goals:

- Continue to pursue engineering interests

Acknowledgements

Thanks!

Anahi Ruiz Beltran : Program lead for the Target Internship

Cortez Watkins : Program lead for the Valor Internship

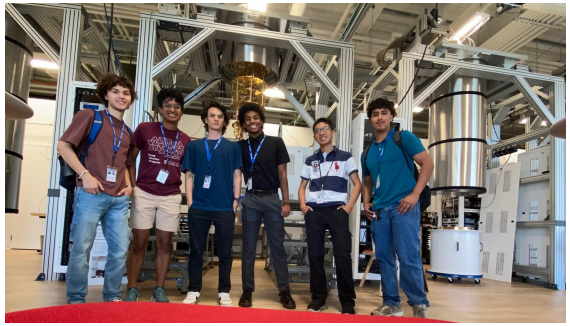
Jason Crnkovic : Beams Division, External Beam Delivery Department

Susan McGimpsey : Beams Division, External Beam Delivery Department

Marco Mambelli : Scientific Computing Division

Geoffrey Donaldson: Technician in the Beams Division

Fermilab Friends



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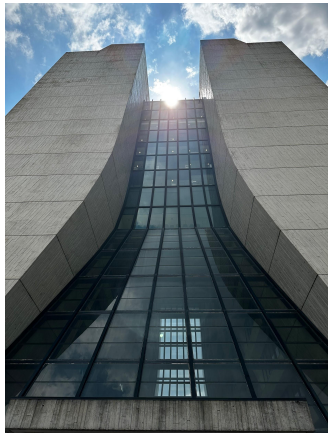

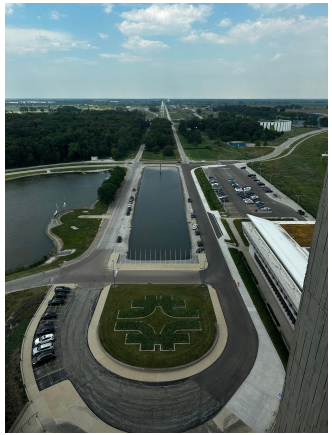



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Thank you!