FERMILAB-POSTER-20-077-AD

MAGIS-100 Laser Transport Vacuum Simulations and LED Atom Tracker

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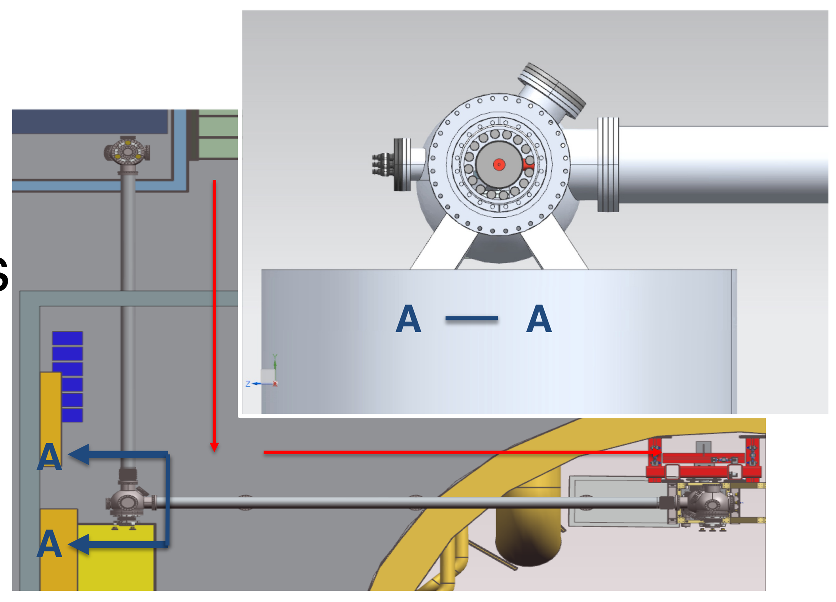
Vacuum Simulations on the Laser Transport System (LTS)

Purpose

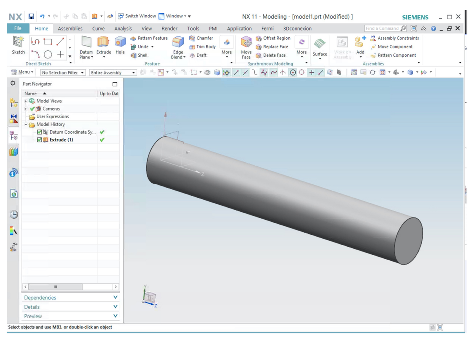
MAGIS-100 uses atom interferometry to measure the distance between the Sr atoms traversing the shaft. The laser must travel through vacuum to measure accurately. Project ensures the vacuum system has low enough pressure to meet experimental requirements.

Inside look at the LTS

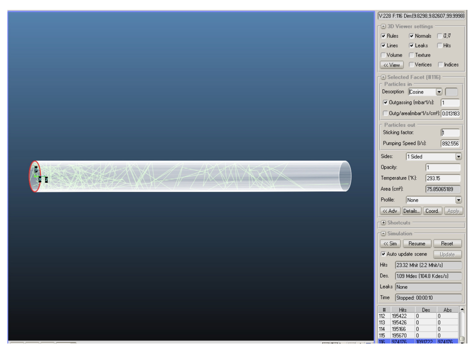


Laser goes through the LTS to the top of the shaft

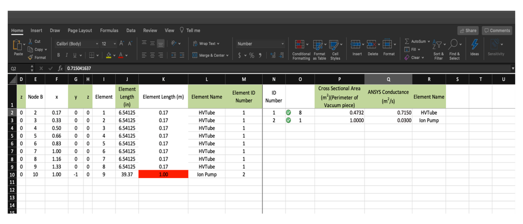
Procedure



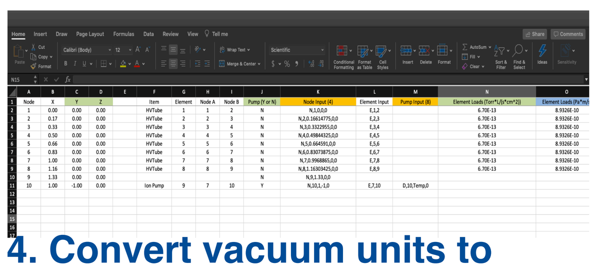
1. Create vacuum tube in NX



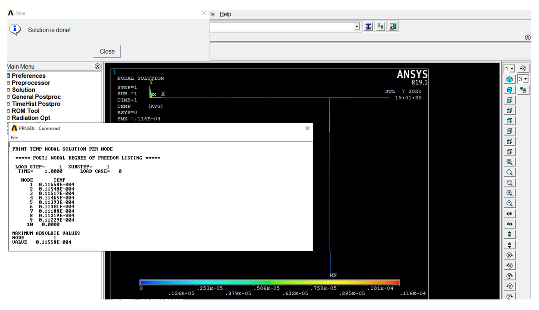
2. Find conductance in Molflow



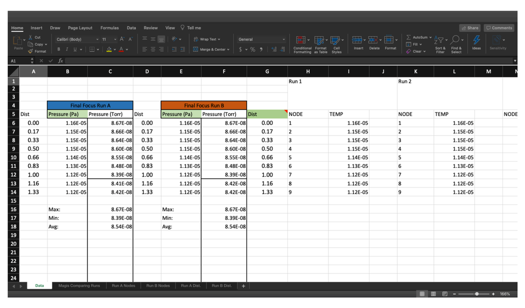
3. Complete spreadsheet with nodes and conductance data, spreadsheet format courtesy of Jesse Batko, Fermilab



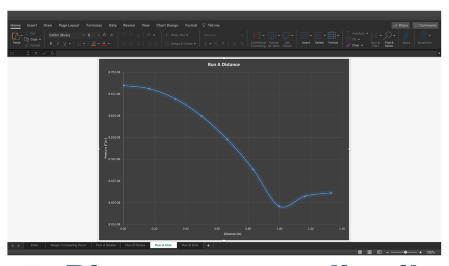
4. Convert vacuum units to thermal units and generate code



5. Run thermal simulation in ANSYS



6. Convert data back to vacuum



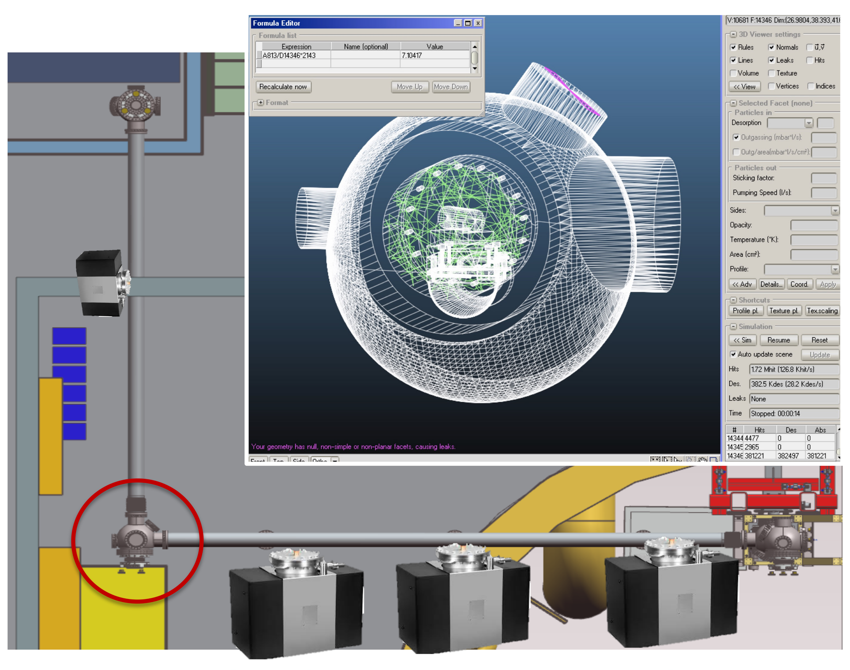
7. Plot pressure distribution

Create and analyze the parts of the vacuum system.

Variables

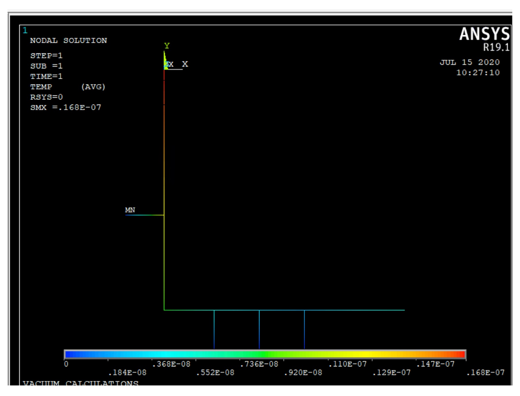
The pressure profile was characterized with variations in pump size, pump spacing, and orifice size. It was found that a system with smaller orifice holes and more ion pumps will have a lower pressure profile.

Middle mirror box's orifice

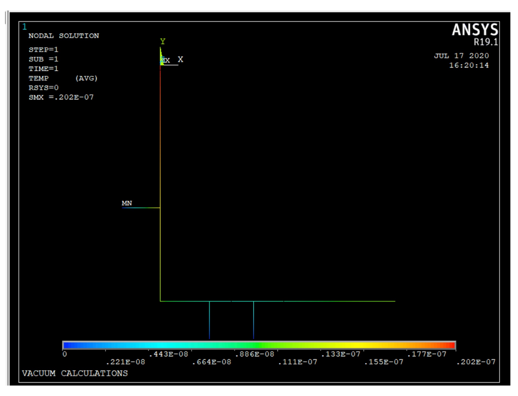


Ion Pumps, Photo: Ideal Vacuum Products. Ion pump quantity, placement, and speed effect the vacuum.

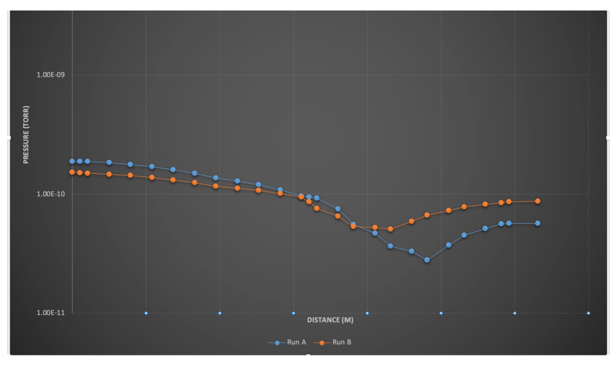
Results



Initial design: 4 ion pumps, 0.8" orifice holes

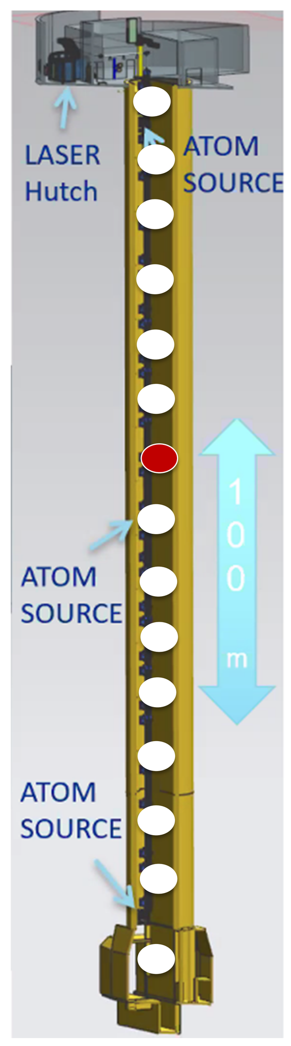


Final design: reduced orifice hole diameter to remove an ion pump



Blue-initial, orange-final. Final design meets experimental requirements at 8.67E-11 torr

LED Atom Tracker



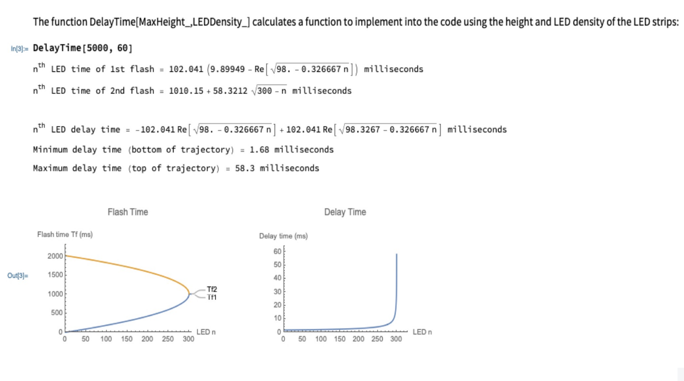
Where is the Sr?

Purpose

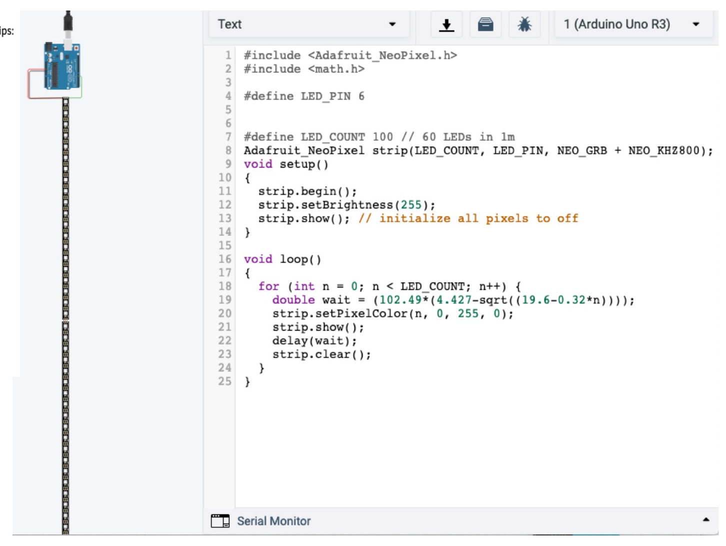
To allow spectators to see where the Sr atoms are while the experiment is running.

Procedure

Use classical physics to model the atoms' trajectory and implement in a software program

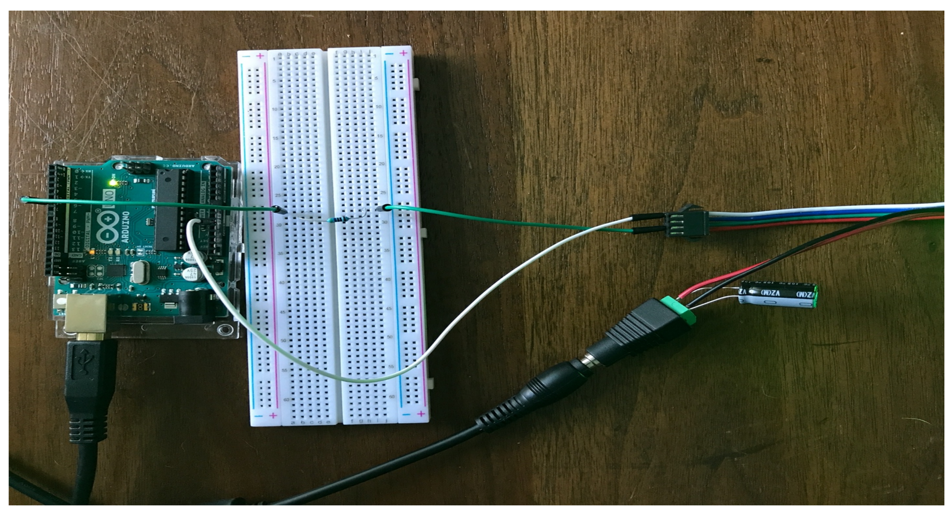


1. Calculate atoms' trajectory, Mathematica Notebook courtesy of Sam Carman, Stanford



2. Design in TinkerCAD

3. Create program in Arduino IDE



4. Connect Arduino to LED strip

5. Run the Circuit

- Program the circuit
- Connect the circuit
- Test the circuit on actual Arduino and LED strip

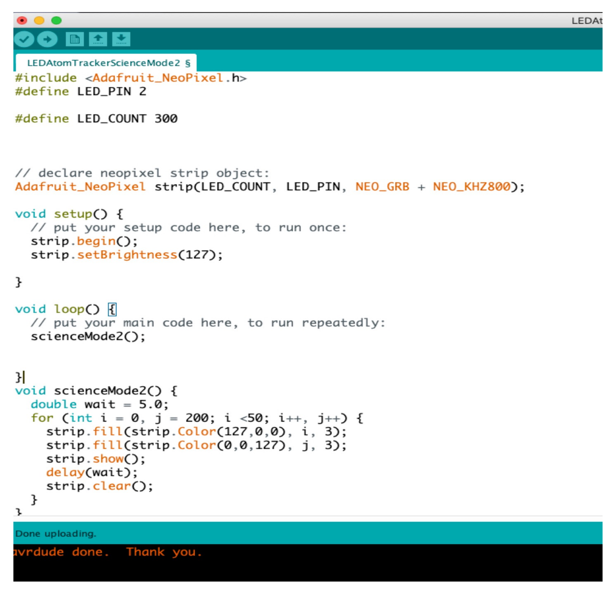
Results

A 5m section of the system completed, software programs for the different science modes in progress, power requirements calculated, and recommendations on how to scale up to 100m.

Future

Scale the system up to 100m by connecting 20 5m LED strips, power injection every 10m, include all LEDs in the code, complete software for all science modes, and ensure the system meets safety specifications.

Connection for power injection



Program for science mode 2

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