



College of
Engineering,
Computer Science,
And Construction Management

Automated High Vacuum Chamber

Dr. Eric Ayars, CSU, Chico Physics Dept.

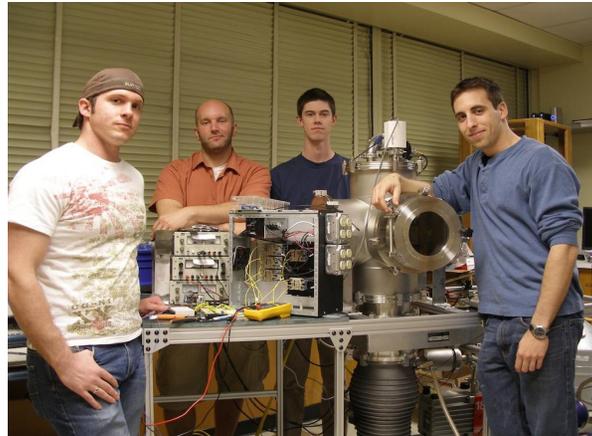
Richard Barry Ian Coltrin Joseph Vranich Alex Wallace
Advisor: Dr. Jimmy Tan-atichat

Project Overview

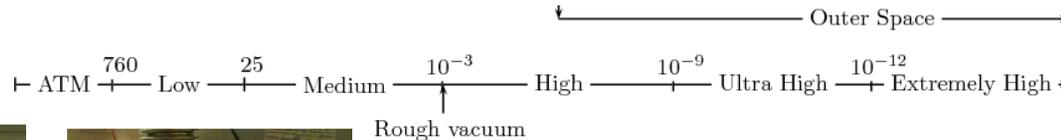
Vacuum chambers are used in advanced research labs for experiments with nuclear scattering, optics, and semiconductor manufacturing. This project was focused on providing a system to expose undergraduate students to vacuum chamber operation to better prepare them for graduate level research. It includes fault-sensitive control software which allows for a more forgiving learning environment. The system can reach pressures of 600 ntorr and was designed to be extremely versatile in its configuration to allow for maximum experimental freedom.

The Chamber

The experiments conducted with this system are carried out in the six-way chamber which sits on top of the diffusion pump. The vacuum system only requires two ports on the six-way, leaving the others for use in experiments. The inside of the chamber is kept completely sterile so the system can reach the highest vacuum possible.



The Chamber (10^{-6})



How It Works

At low enough pressures regular mechanical pumps become ineffective because in a vacuum regular fluid laws no longer apply; flow becomes molecular. An oil diffusion pump is used to capture remaining molecules that mechanical pumps cannot. The pump operates by generating an oil-mist spray which is directed towards the bottom of the pump. The mist knocks molecules at the pump inlet towards the bottom of the pump where they are removed by a roughing pump. Since diffusion pumps are molecular pumps and cannot operate at pressures above rough vacuum a mechanical roughing pump is used to lower the system pressure (down to about 10^{-3} torr) before the diffusion pump can go to work. The pumps work in series to lower the chamber pressure even further.

Mechanics

The mechanical operation includes the valves which maintain pressure isolation throughout the system. The valves are pneumatically actuated and controlled by an on-board computer. A compressor is included on the cart to maintain pneumatic pressure.



Power Distribution and Control Software

Vacuum systems of this size require a lot of power. This system can consume up to 6.7kW. Additional power was installed on-site to support the system. The power is distributed and controlled by solid state relays (SSR). The SSR's are interfaced to the control system with a driver board. The Power Distribution Unit allows the computer software to control the operation of the pumps and valves. The entire design is completely automated through LabVIEW®. The control system monitors the system state using various sensors. The system state is then fed into the control algorithm which determines what to do next.

