“The Cyclotron Kids” 2 MeV Proton Cyclotron

Heidi Baumgartner, MIT Class of 2014
Cyclotrons ’13, Vancouver,
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It began at summer camp...

Kopernik Observatory, Binghamton NY

Heidi Baumgartner, Peter Heuer and German Diagama met in their freshman year of high school
Some Googling convinced us it couldn’t possibly be that hard. Right?

After all, the design that won the Nobel Prize in 1939 was small enough to fit into a hand, and was made with sealing wax.
Previous amateur accelerators: Fred Neill

His homemade vacuum system had a thermocouple gauge in a jar

Top-down view of his cyclotron chamber
Previous amateur accelerators: Tim Koeth

Physics Today: “Building a Cyclotron on a Shoestring” – about Tim Koeth’s machine at Rutgers
A high school cyclotron project launched him on his career in engineering.


“Local lawmakers rushed to introduce emergency legislation banning the use of cyclotrons in home businesses”
First funding attempts

This was our first design. We really wanted $5000 to build it.

Published a post in the blog “symmetry breaking.”

Got a donated vacuum pump

Sent out letters asking for sponsorship to enter a science fair
It worked! Jefferson Lab sponsored us

Some lines from the original email we received from Andrew Hutton, Head of the Accelerator Division of JLab:

“We have talked it over here at the lab and we have decided to help you realize your goal by being your sponsors.”

“I must say that I really appreciated the enthusiasm you have shown in developing the project and your nerve in approaching the President of the America Institute of Physics for money!”

“Safety and security are paramount here, as in the rest of the country, so we are not comfortable with the idea that you build the cyclotron in your basement - I can't imagine how many zoning laws that might violate! “

“We are looking forward to making your dream a reality.”
Electromagnet design

1.6 Tesla
100A, 120V (12 kW)
4 Tons
Slight taper for weak focusing
Simulations with POISSON
Electromagnet construction
Vacuum Chamber

- Approximately 2’x3’; large area for good vacuum conductance
- Two inches (10cm) high due to magnet constraints
- Large plates bowed in: needed internal supports
- One dee, one grounded “dummy dee”
Vacuum Chamber

RF pickup
RF feedthrough
Dee cooling feedthroughs
Hydrogen inlet
Ion source power
Linear motion feedthrough
RF System

3kW Plasma Therm tube-based power amplifier at 24MHz
Matching network couples power to the dee
Resonant circuit made with the capacitance dee and an inductor, power inductively coupled into this LC circuit
Ion Source

“Chimney” Ion source design
Current in and out, and hydrogen discharge into the middle of the cyclotron.

We tested an oxide-coated nickel filament
Chamber problems

Problems arose from the welding of a thin plate to the frame.

An attempt was made to fix frame warping using flame treatment.

Eventually the bottom plate was ground off, and a viton sheet was used to seal the plate against the frame.
The state of our cyclotron

- Most pieces complete
- Moved to Old Dominion University
- Waiting for the necessary equipment or infrastructure (e.g. distilled water lines)
- And for additional motivated students to continue work on it
We are all “Cyclotron Kids”

If the allure of high energy particles, RF, strong magnetic fields, or vacuum systems has captured your imagination...

It’s up to you to inspire the next ambitious students!

Join the forum and help inspire others:

http://cyclotrons.net

Passcode: cyc-code-123456