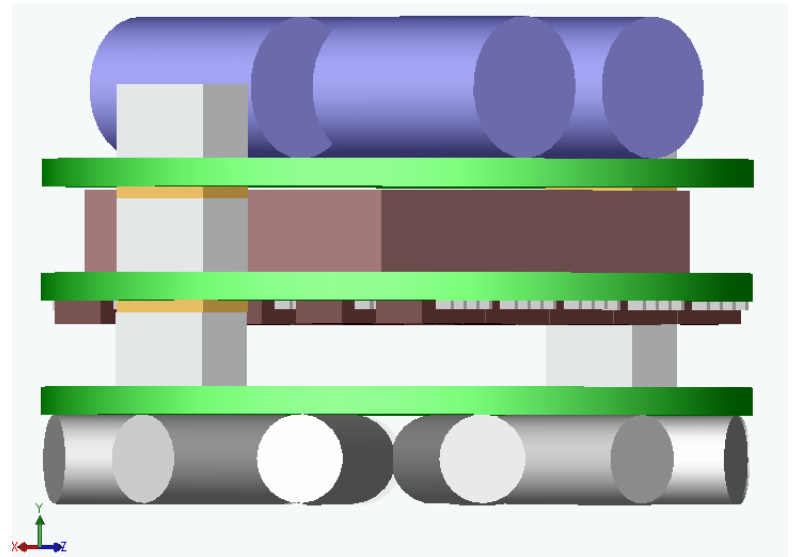
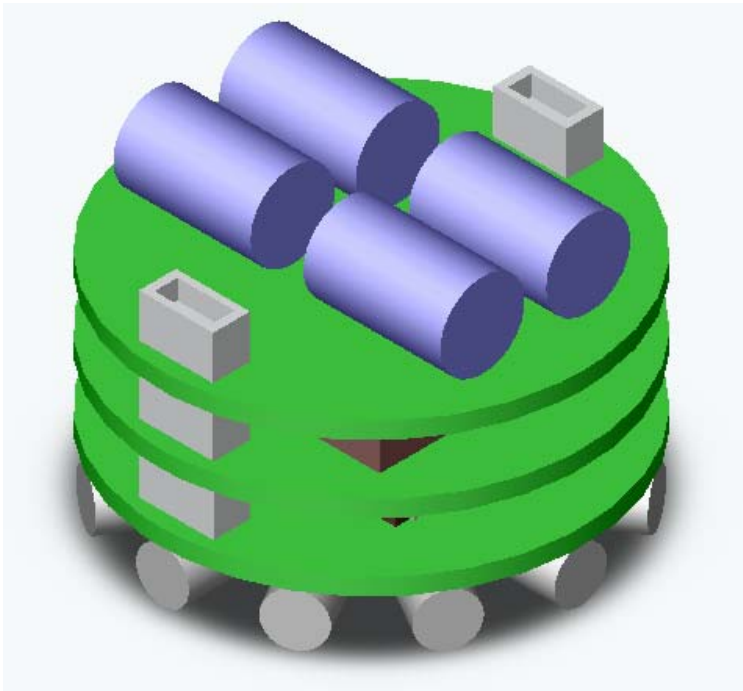


2D Claytronics Atom

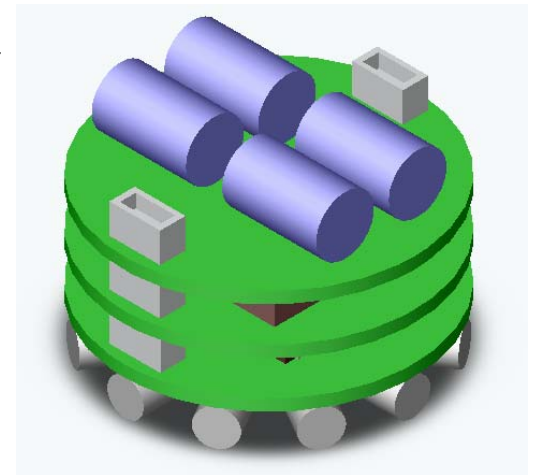


Claytronics Atom Design Goals

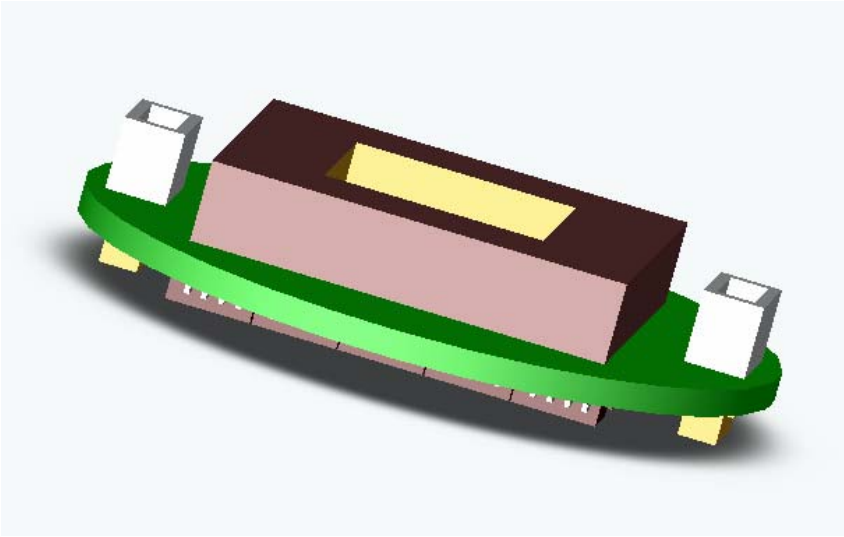
- Large groups of units able to form arbitrary shapes
- Each unit capable of relative movement to others
- Units are externally powered
- Passive holding mechanism - units hold position in absence on external power
- Units capable of local communication with other units and possibly global communication
- Units can display at least one pixel of color

2D Design Specifications

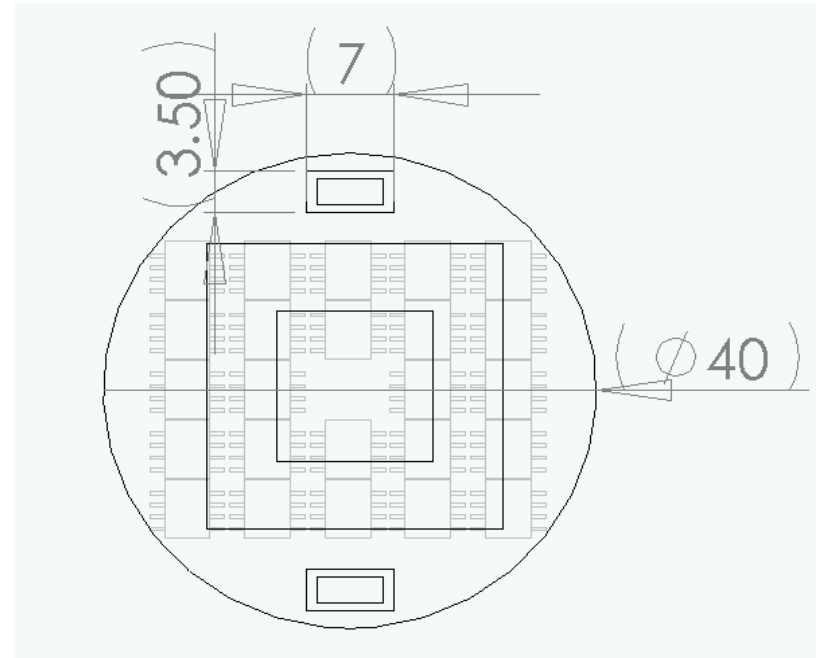
- Cylindrical base made of multiple stacked plates
 - Space efficiency in plane
- Electromagnetically controlled soft magnets
 - Active relative motion
 - Passive hold state in case of power loss.
- Specially constructed planar surface
 - External power bus
 - Communications



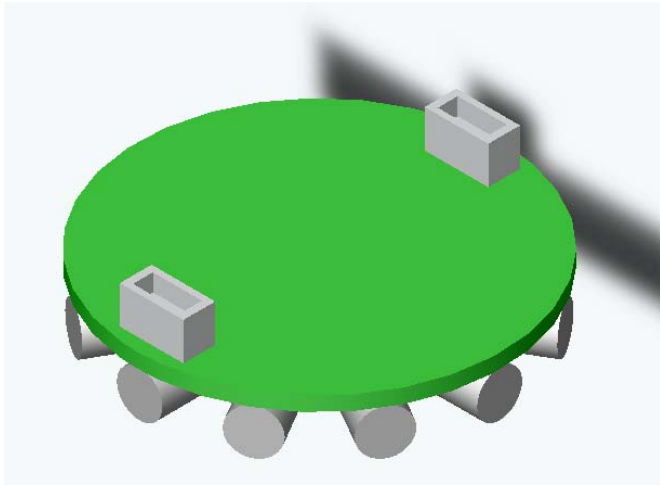
Controller Module



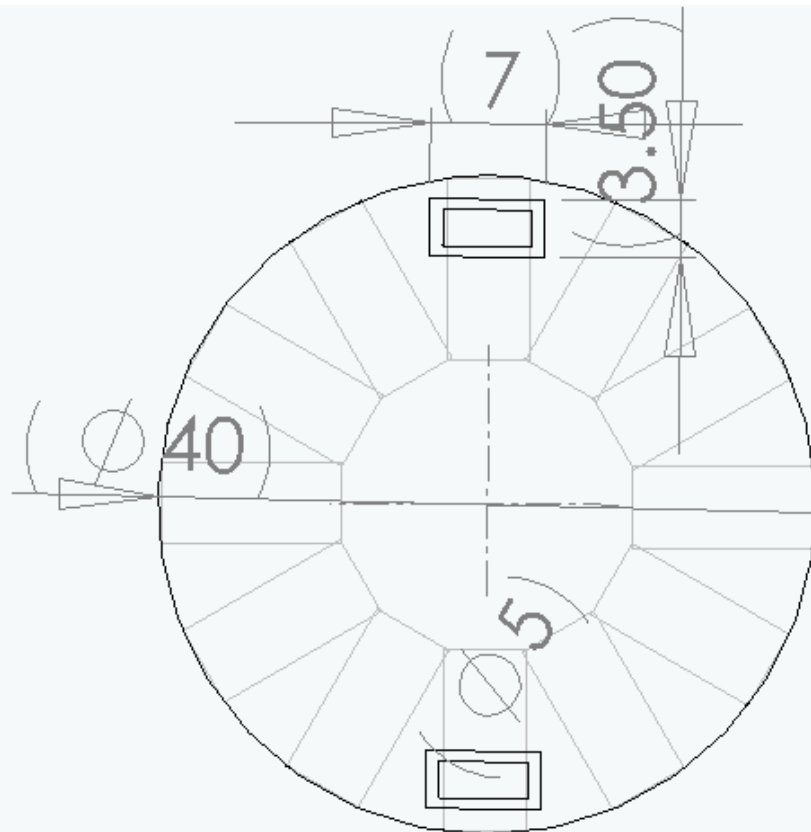
- 12 independent H-bridges for electromagnet control
- PIC 16F877 Microcontroller for high/low level interface
- Passthrough signal/control bus



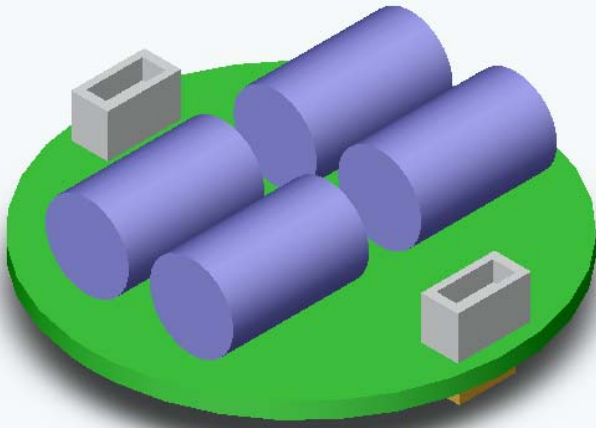
Locomotion Module



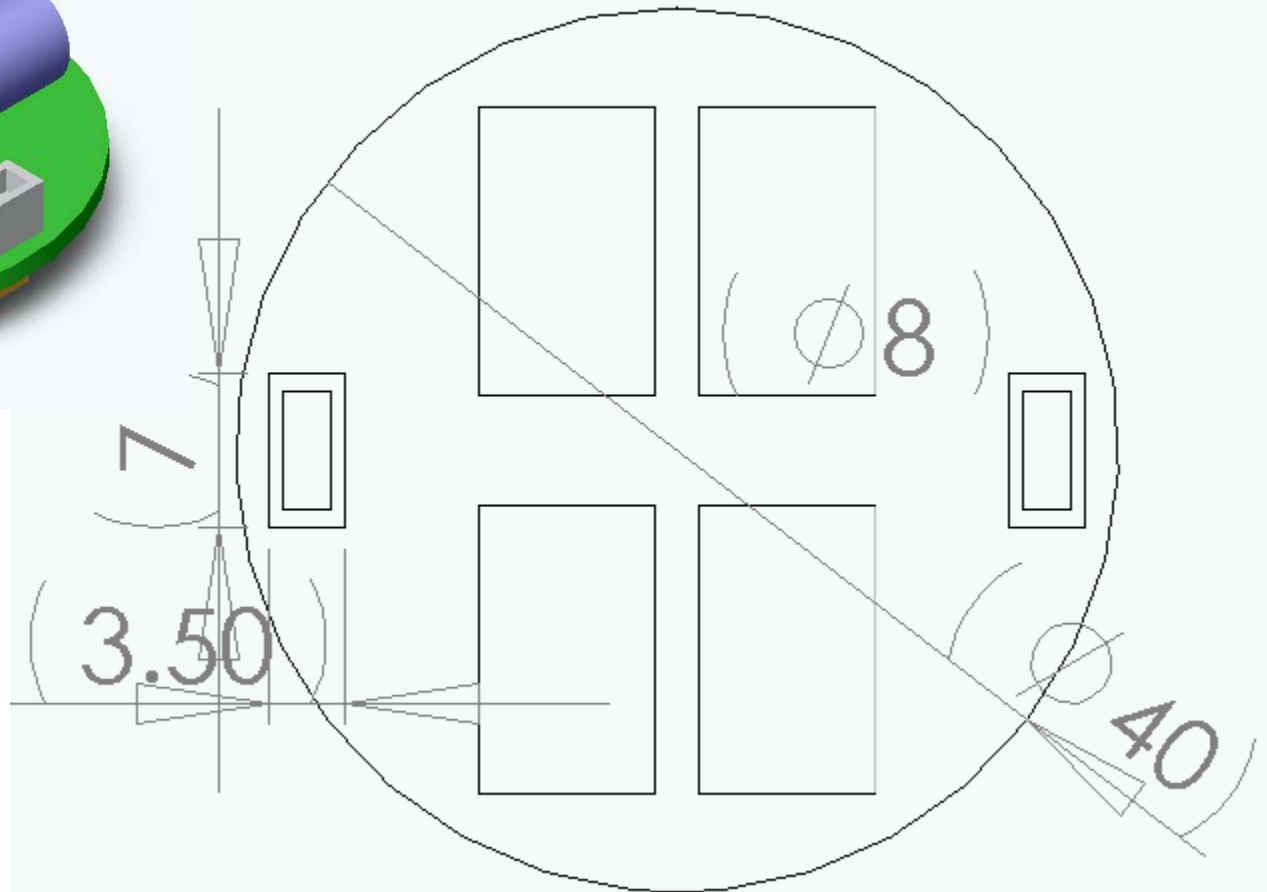
- 12 Soft Magnets surrounded by electromagnetic coils
- Passthrough signal/control bus



Power Storage Module



- High Capacity Capacitor Bank
- Passthrough signal/control bus



Initial Prototype

Can it move?



How it works

Electromagnetic coils around AlNiCo magnets

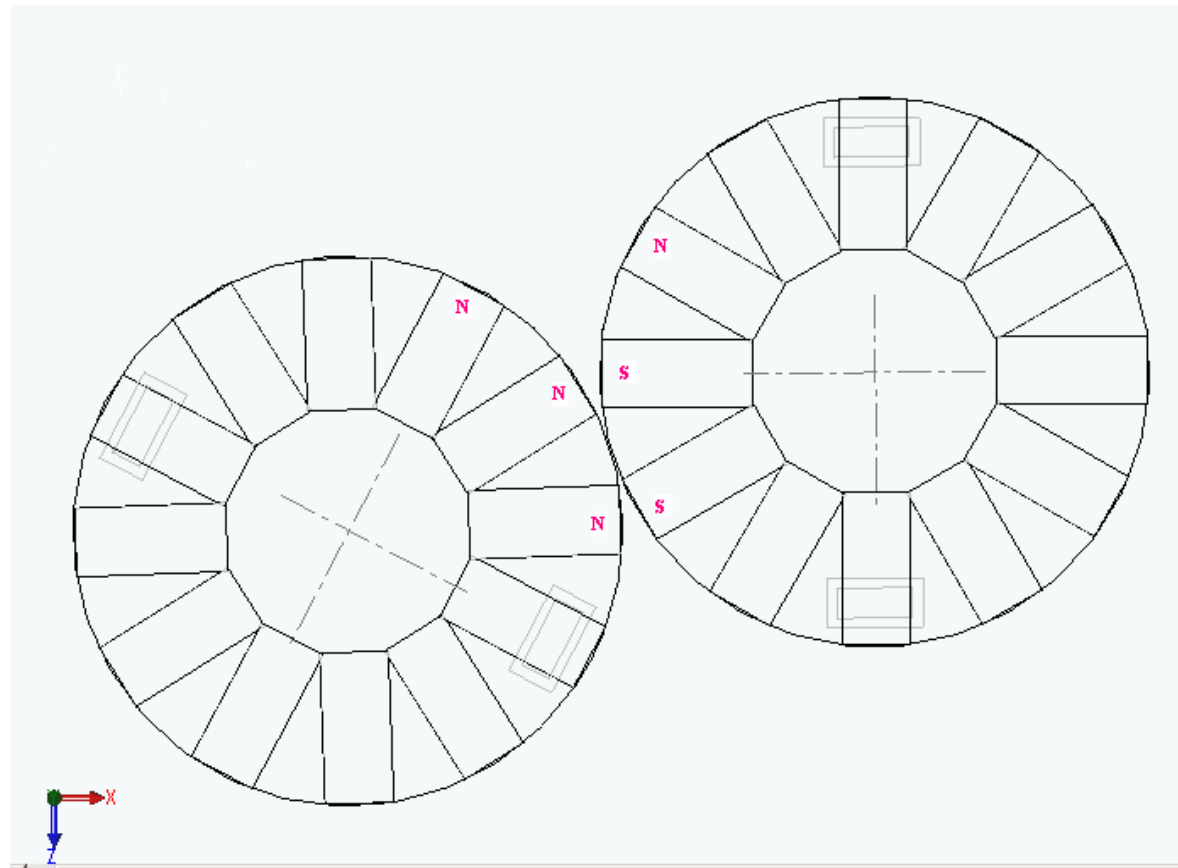
High current discharge through the coil induces a large electromagnetic field, strong enough to permanently reverse magnet

Duration of discharge less than 1 millisecond!

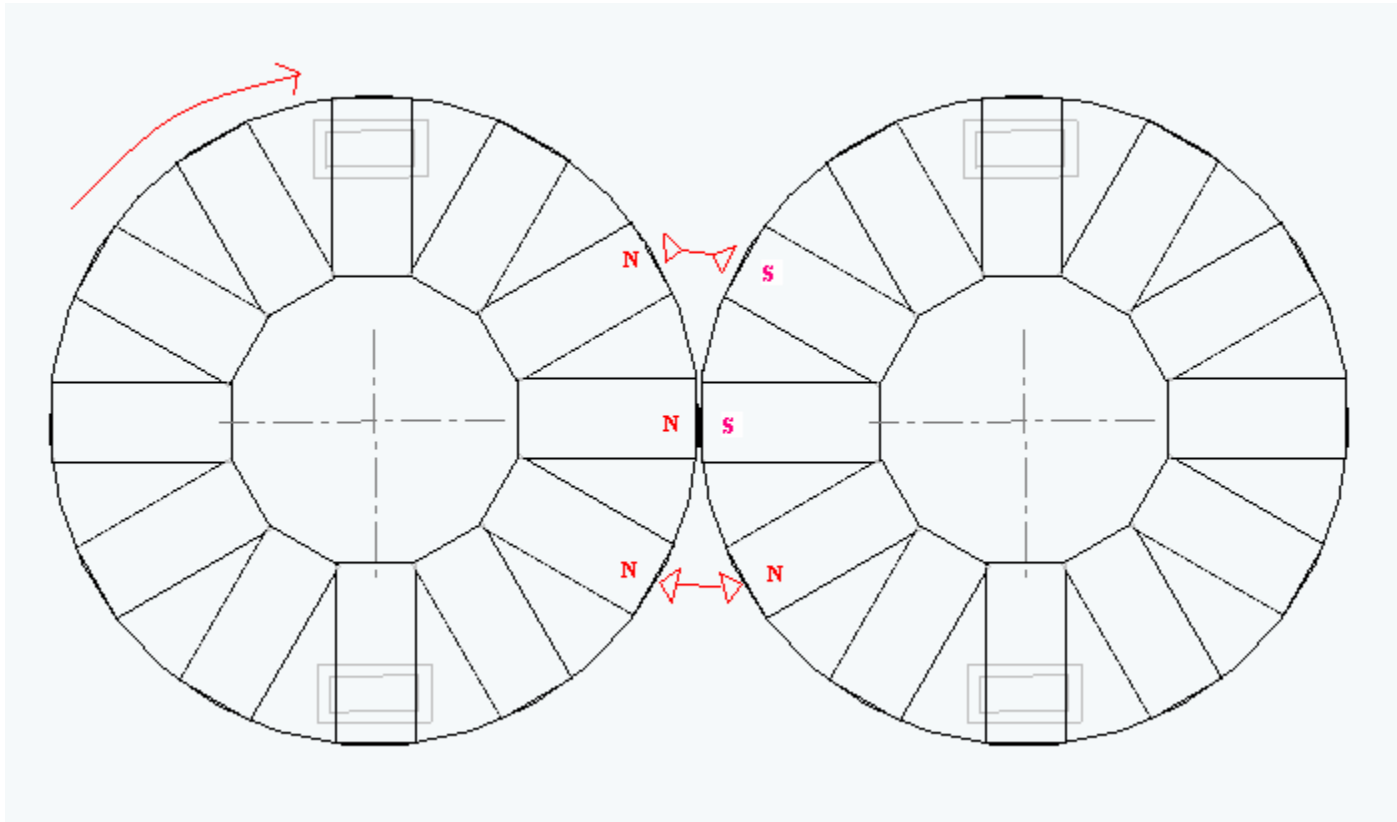
AlNiCo magnets in particular are both strong and very easy to reverse



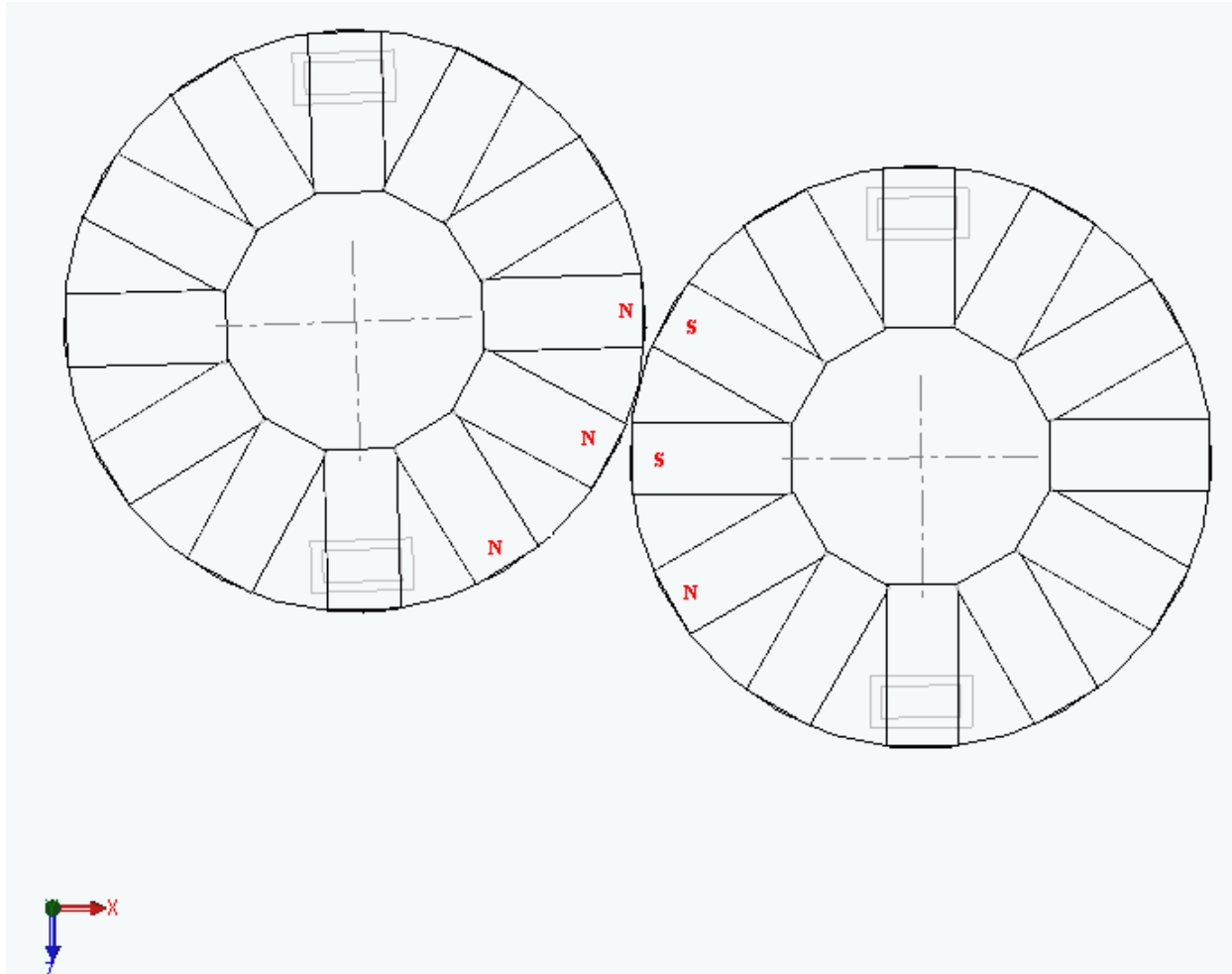
Start of rotation



Field reversal, movement

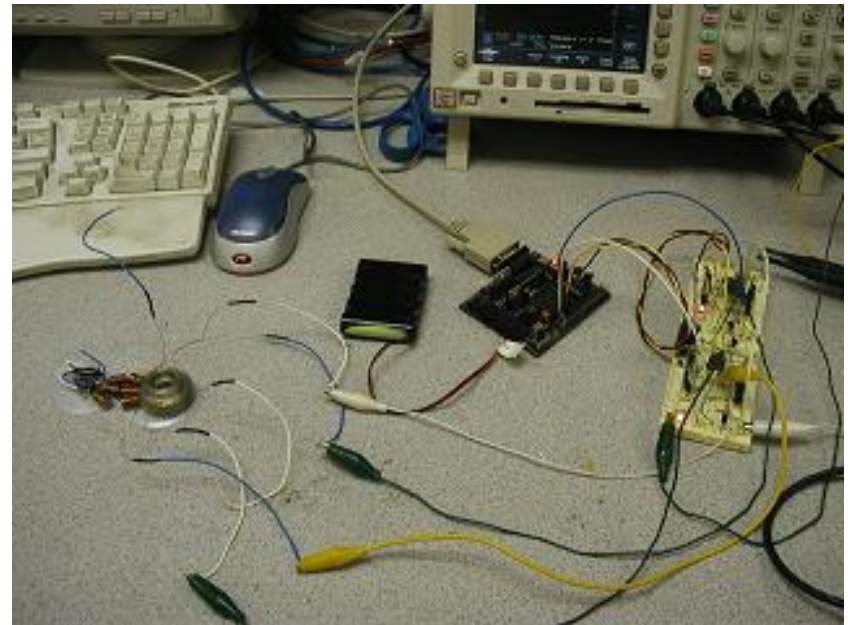
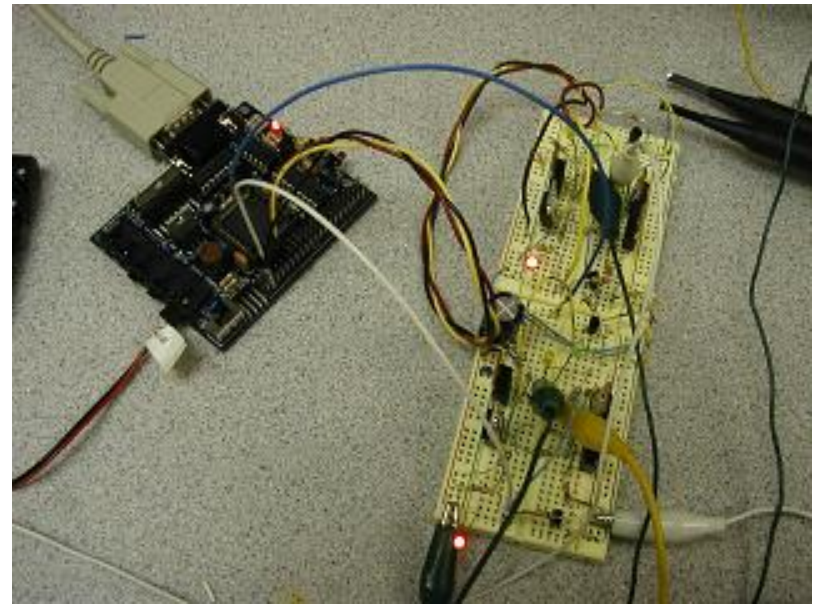


Final state



Test setup

- **Computer**
Keyboard interface
- **Cerebellum Microcontroller**
Low level PIC-based controller
- **Mosfet-based H-bridges**
High efficiency, scales down to small size
- **Gauss Meter**
Field readings, outputs to scope
- **Oscilloscope**
Monitors voltage, current, and gauss
- **Prototype Catoms**
Guinea pigs



Rough numbers from current test setup

- Magnet Field Strength: 800 G
- Power required for field reversal:
3A @ 15V for 10 ms (ten 1ms pulses)

Larger current → Higher field strength

Lower voltage → Easier to store onboard

Important Next Steps

- Mechanical measurements (force, torque)
- Planar surface & interface stack layer
- Maximize field while minimizing power
 - Coil construction
 - Different magnet geometry
- Create prototype stacks
- 3D!