DIDACTIC QUADRUPOLE

Student: Edgar Daniel Ocampo Ortiz
Advisors: Dr. Georfrey Humberto Israel Maury Cuna
Ing. Fermín Perez Suarez

Situation

1. USPAS counts with Didactic Quadrupole Magnets for experimental practices and courses in which students analyze the magnetic field.
2. MePAS doesn't count with didactic experimental materials nor with experimental courses.
3. Buying a Didactic Quadrupole Magnet for MePAS from a third party is too expensive.

Solution

- Build Didactic Quadrupole Magnets for usage in MePAS experimental courses.

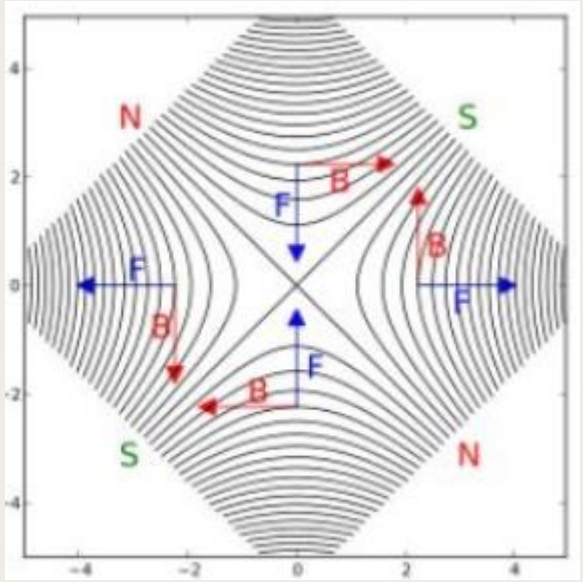
1. USPAS stands for "United States Particle Accelerator School", site: http://uspas.fnal.gov/
2. MePAS stands for "Mexican Particle Accelerator School", site: http://mepas2.wixsite.com/mepas2015

Quadrupole Magnet

Important parts of particle accelerators.

There are two different types of Quadrupole magnets.

“F Quadrupoles” and “D Quadrupoles”.



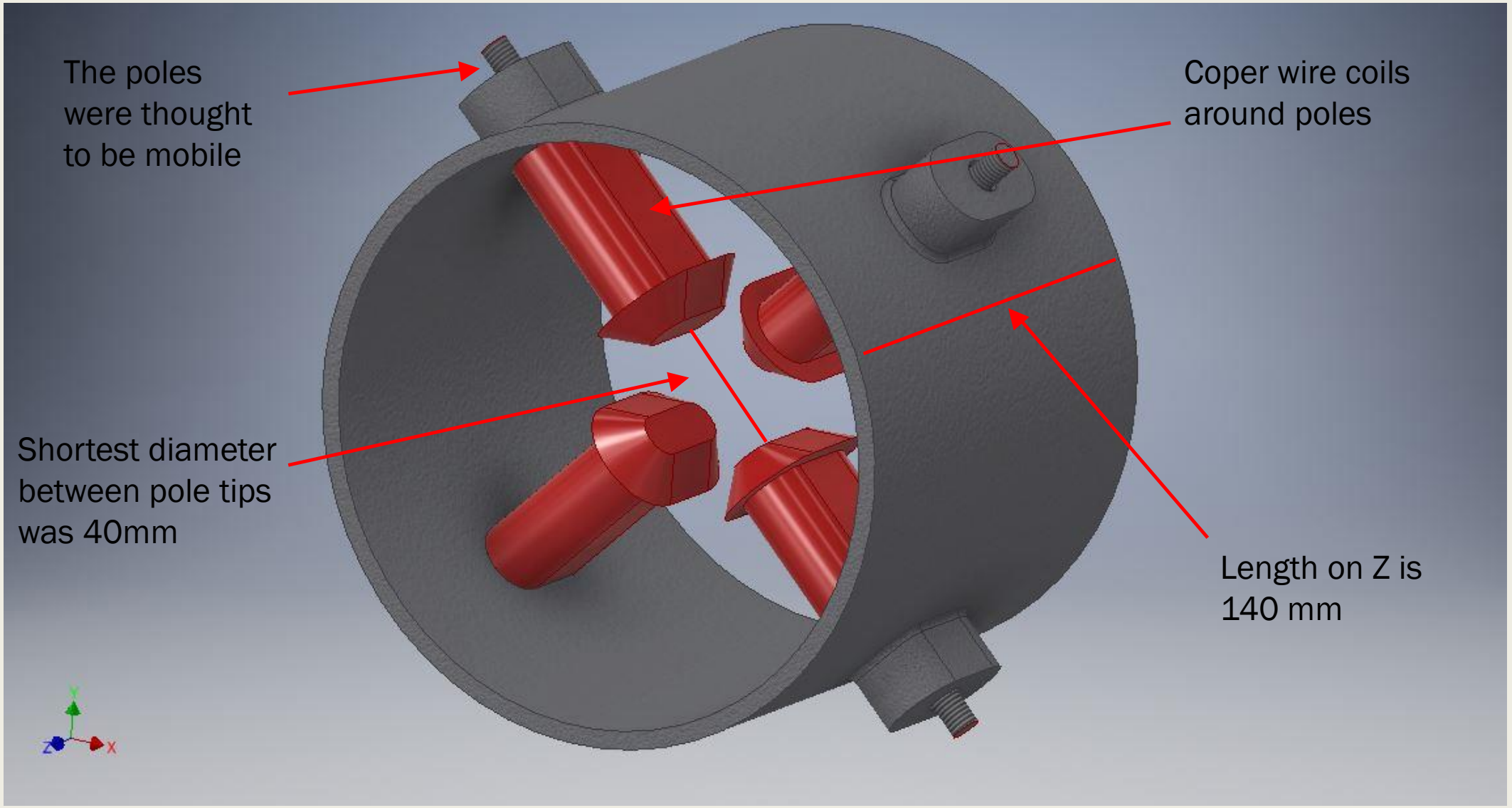
$$\mathbf{F} = q(\mathbf{E} + \mathbf{v} \times \mathbf{B})$$

Equations for the field in x and y if the poles are 45° from vertical position and 45° between each other.

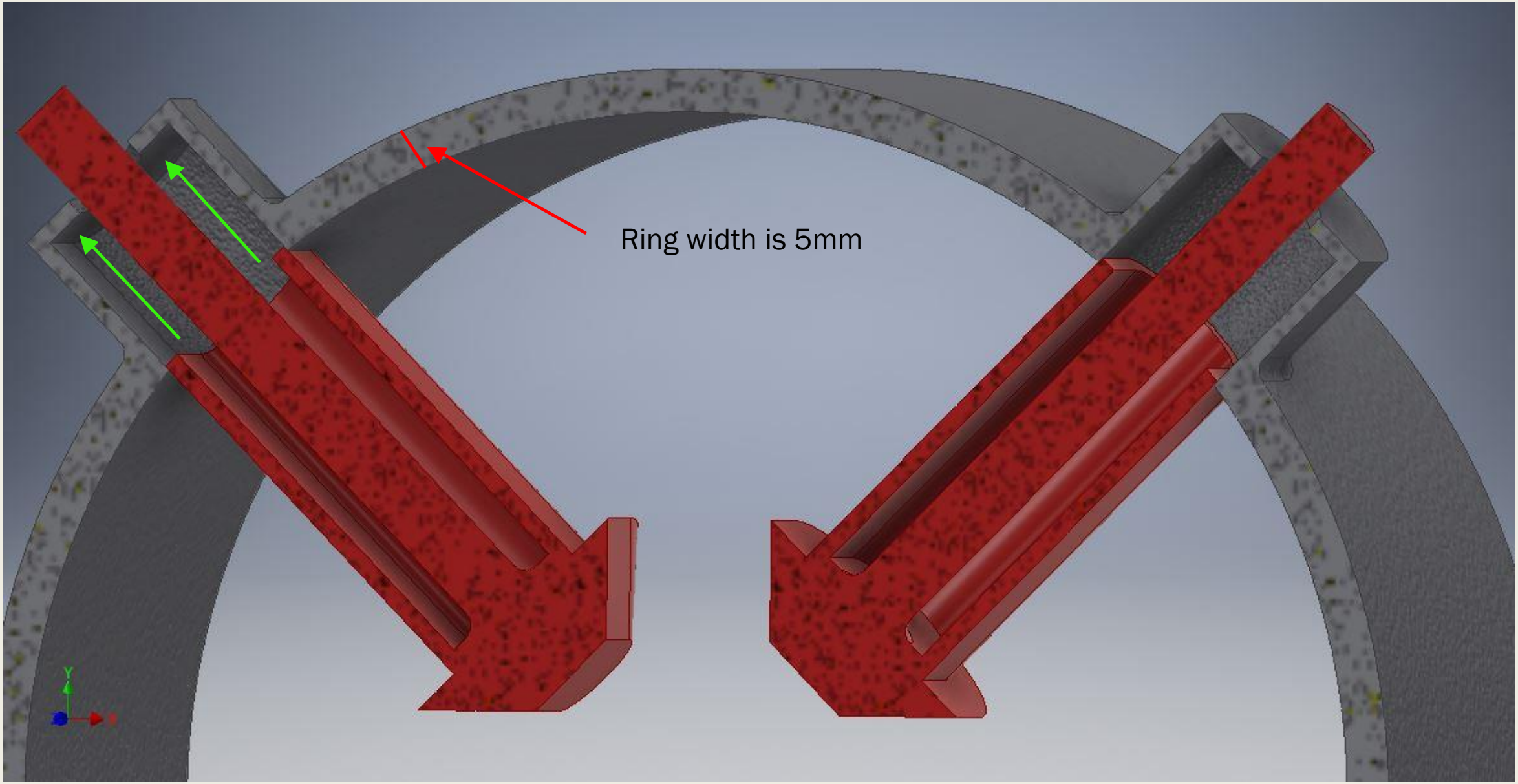
$$B_y = K \cdot x \qquad B_x = K \cdot y$$

FIRST QUADRUPOLE DESIGN

There is no background on Quadrupole Magnets in Mexico, so measurements were made based on a USPAS Experimental Practice

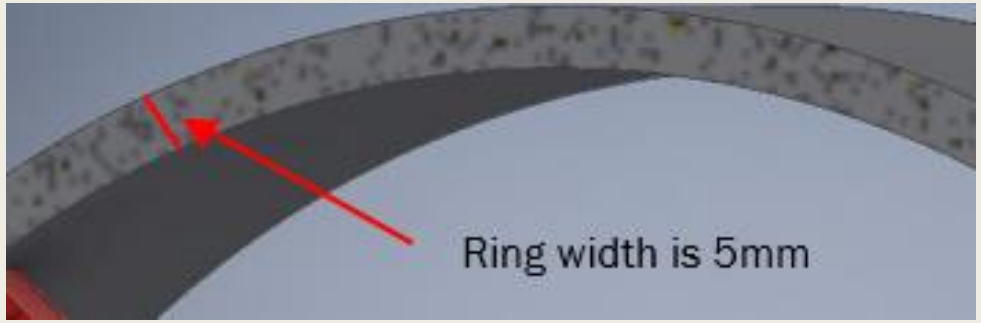


A mobile pole meant changing the Diameter between pole tips and the possibility of studying how the field behaved, maximum diameter between pole tips was 70mm.

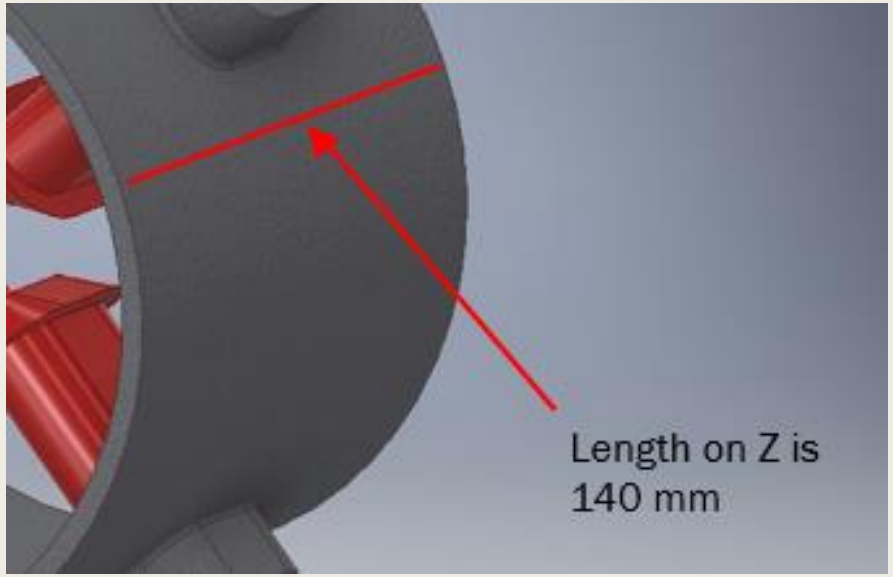


Issues with first design

- The ring width was too short.

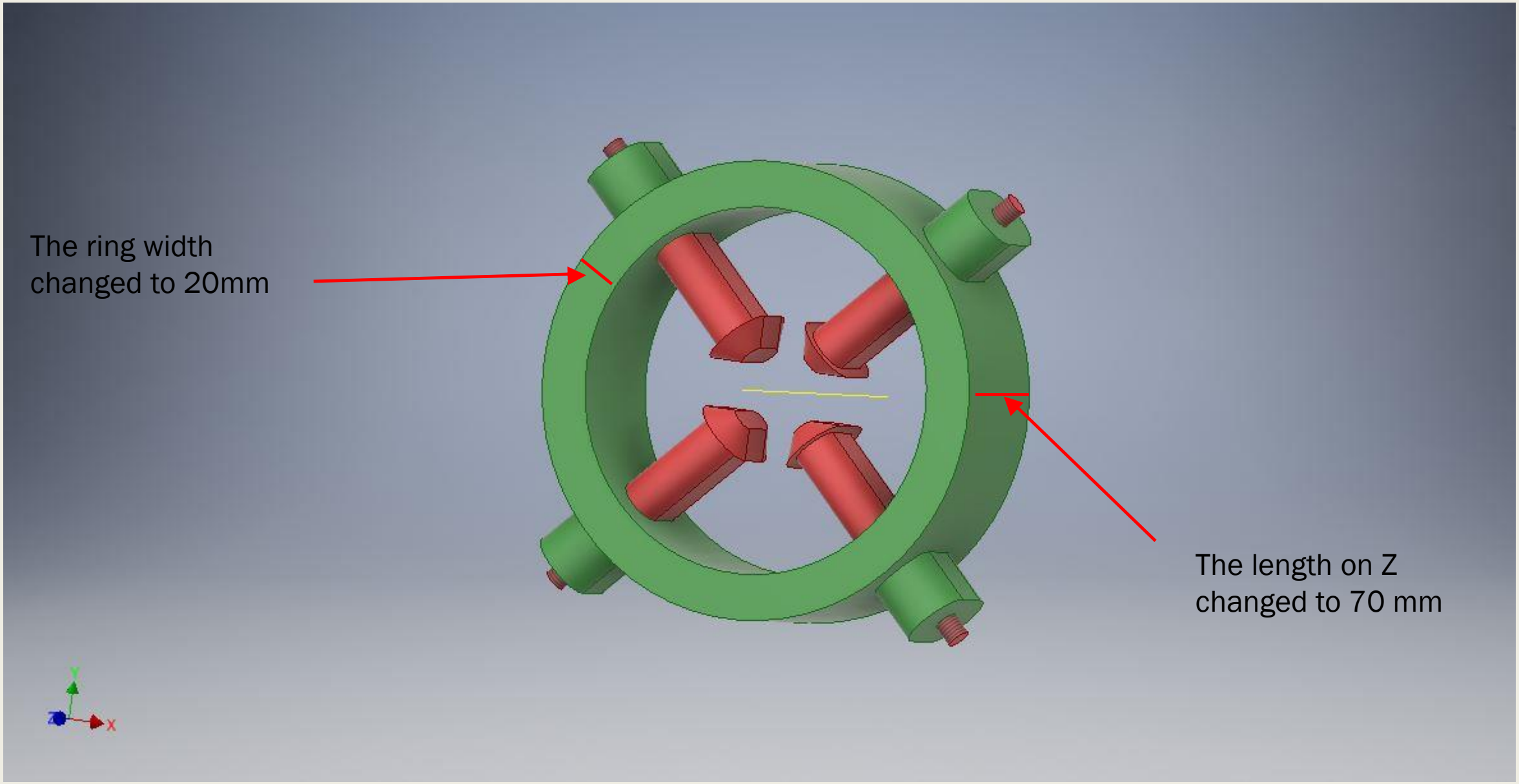


- The length on Z was too big.



SECOND QUADRUPOLE DESIGN

For the second design, the idea of mobile poles remained and a few changes were made.

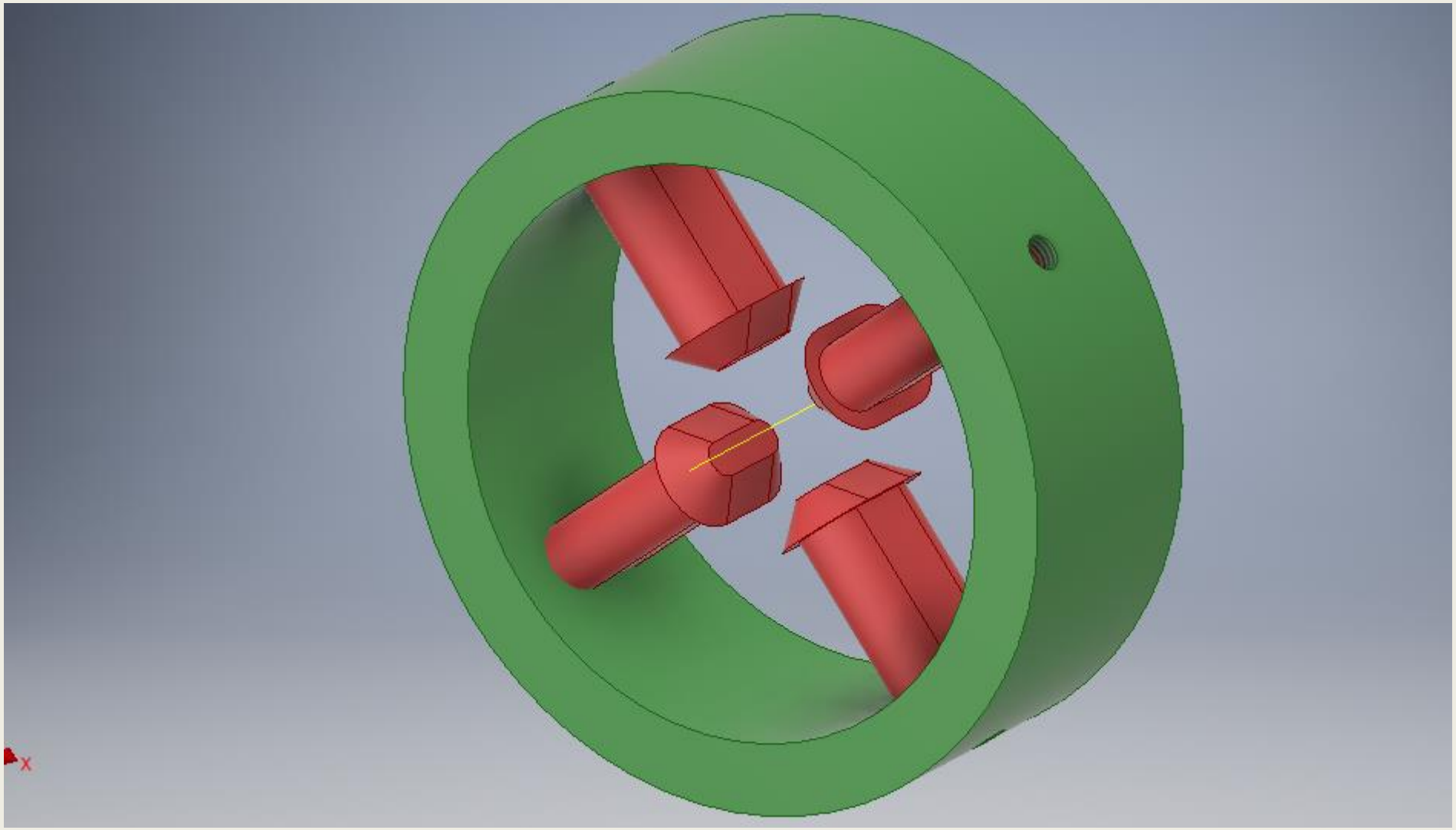


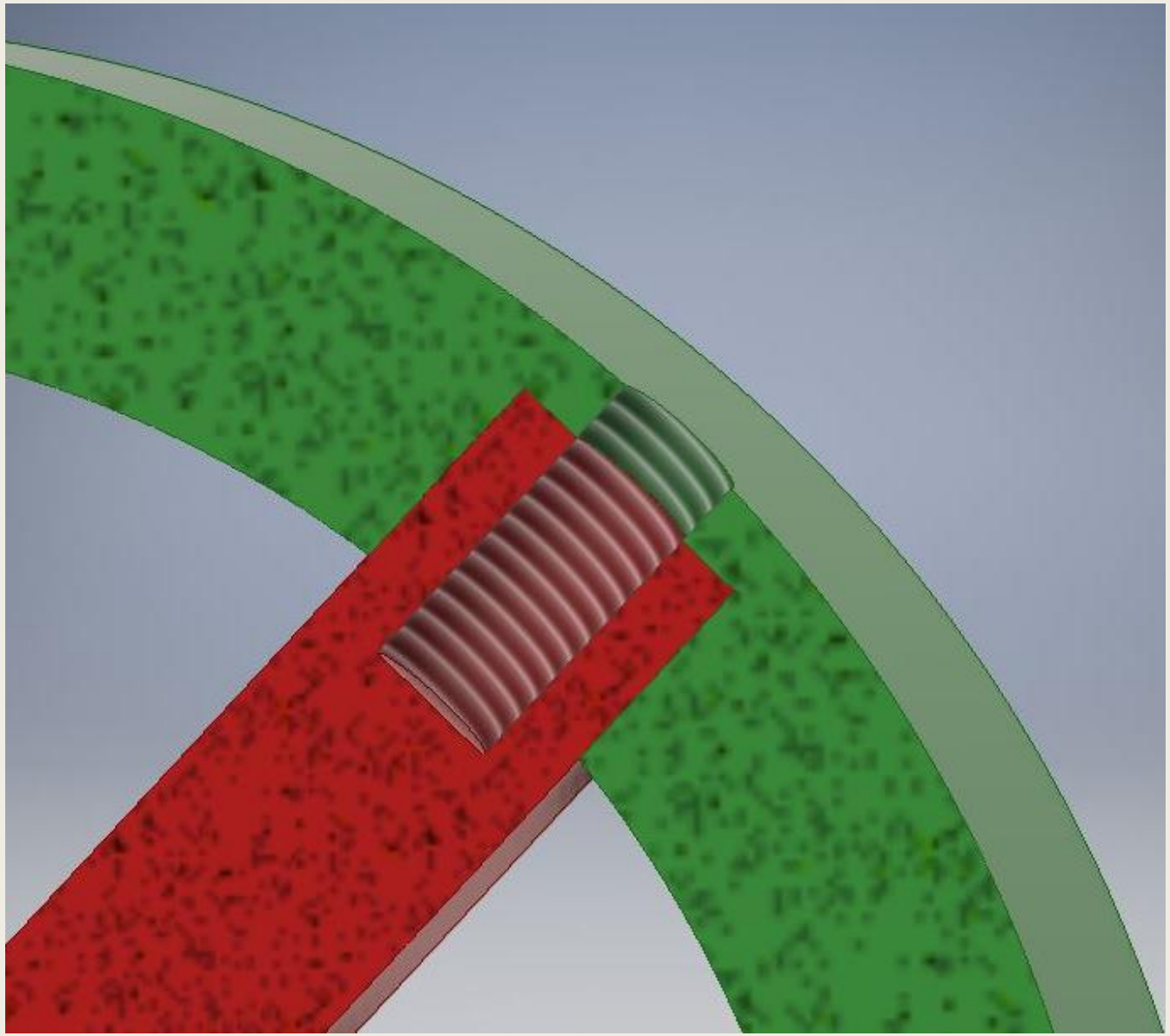
Issues with Second Design

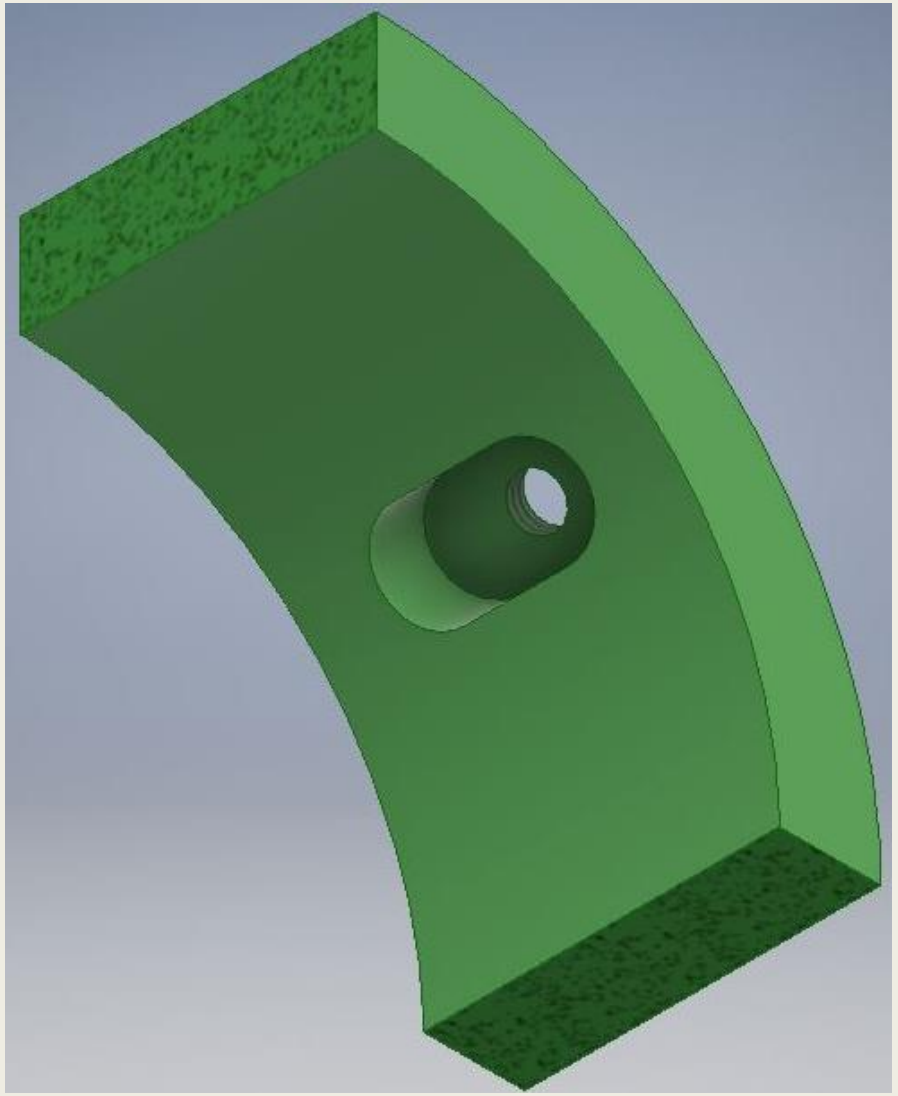
- The major issue was with having mobile dipoles, whenever the diameter length changed, the copper coil had to be changed or the pole had to be left with a section without copper coil.

THIRD QUADRUPOLE DESIGN

In this third design the mobile pole feature was removed, the poles now fit on a hole and are secured by an external screw. The length on Z remained the same as well the ring width

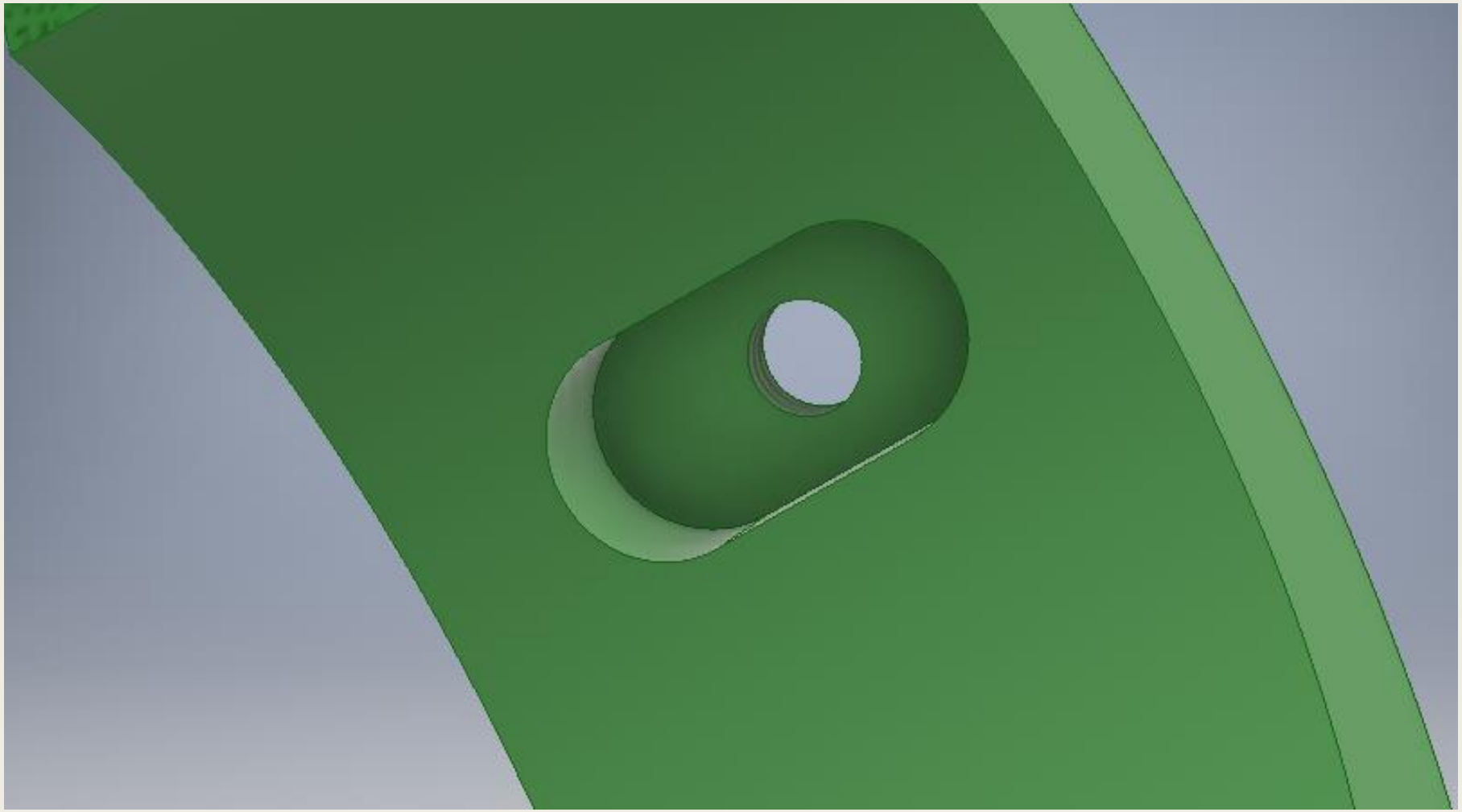






Issues with third design

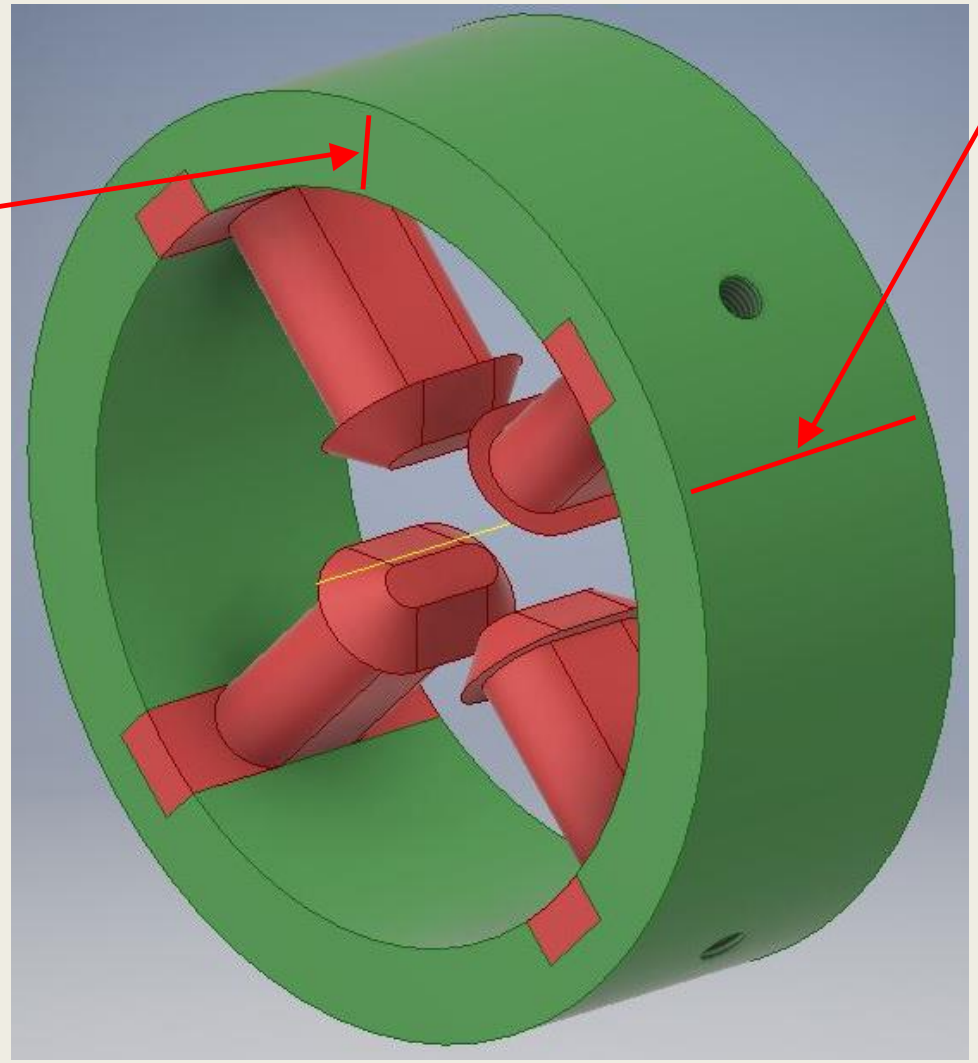
- Manufacturing the holes where the poles would fit on the ring was very difficult, there is no machine in the workshop capable of doing that cut, and there was no way of building the ring without welding.



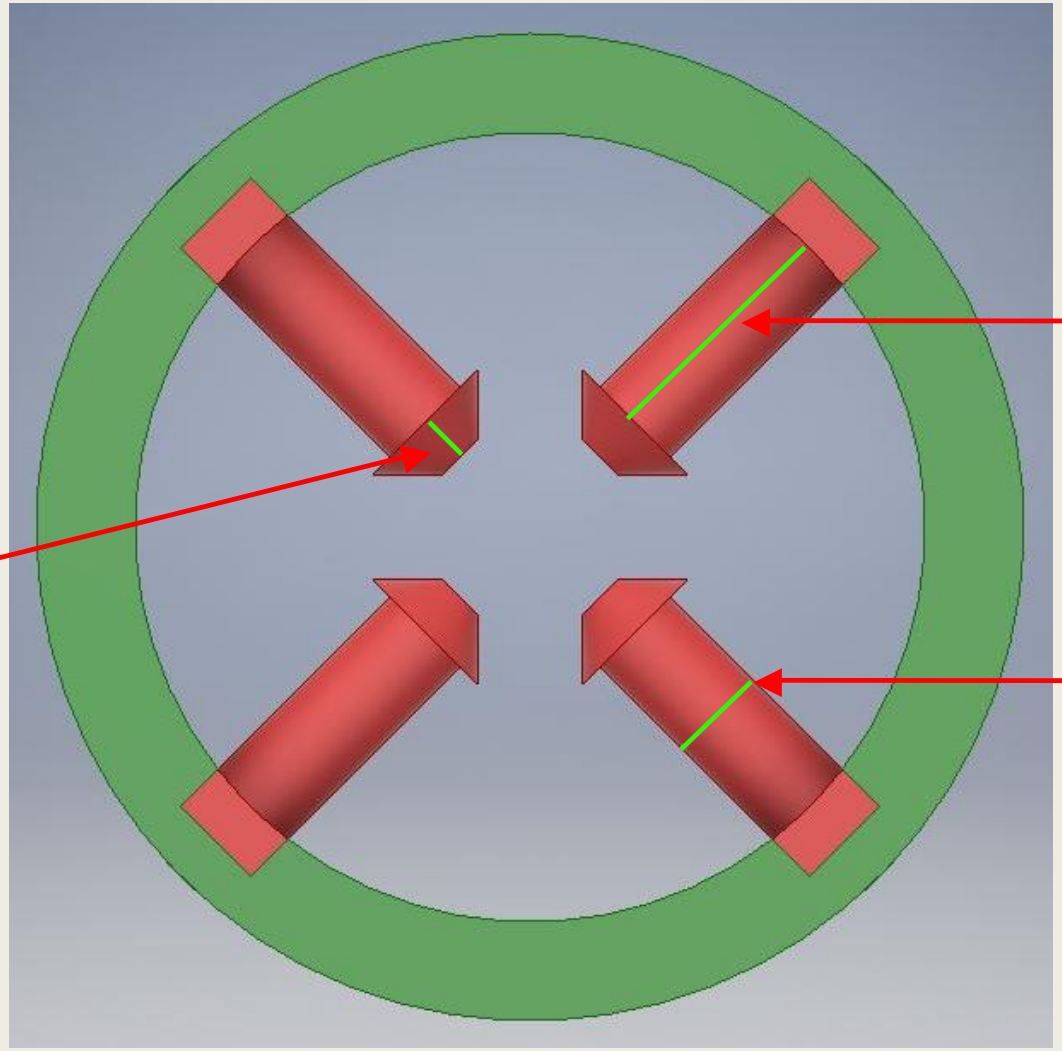
FOURTH QUASIFINAL QUADRUPOLE DESIGN

In this fourth design the poles were designed to fit from the side of the ring with their “T” shape, and when they reach their position, a bolt can secure them in place. This design prevents stress and is adapted to the capabilities of the workshop. All measures remained

The ring thickness is 20mm



The length on Z axis is 70mm



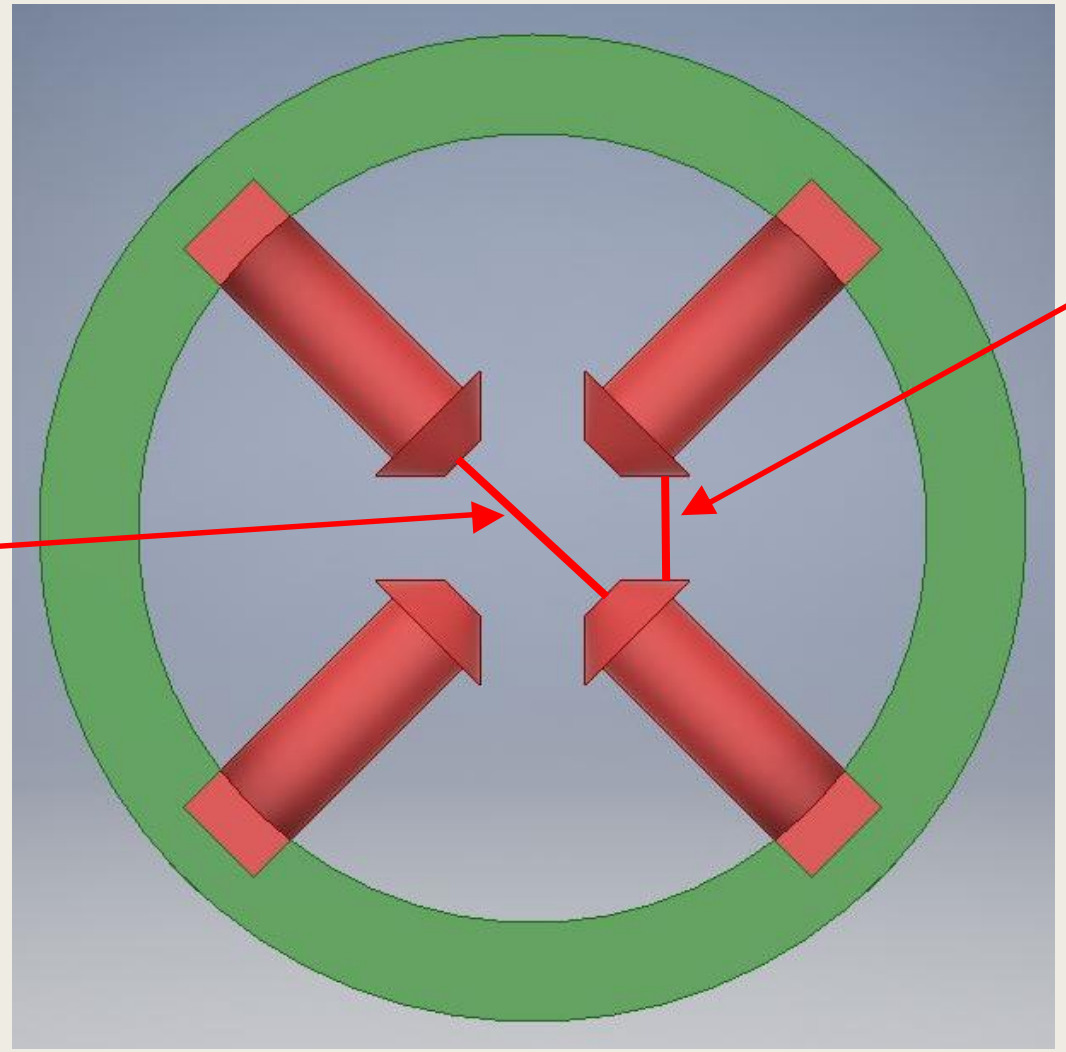
The length of the pole, were the copper wire coils, is 50mm

The legth of the pole tip is 10mm

The width of the pole is 20 mm

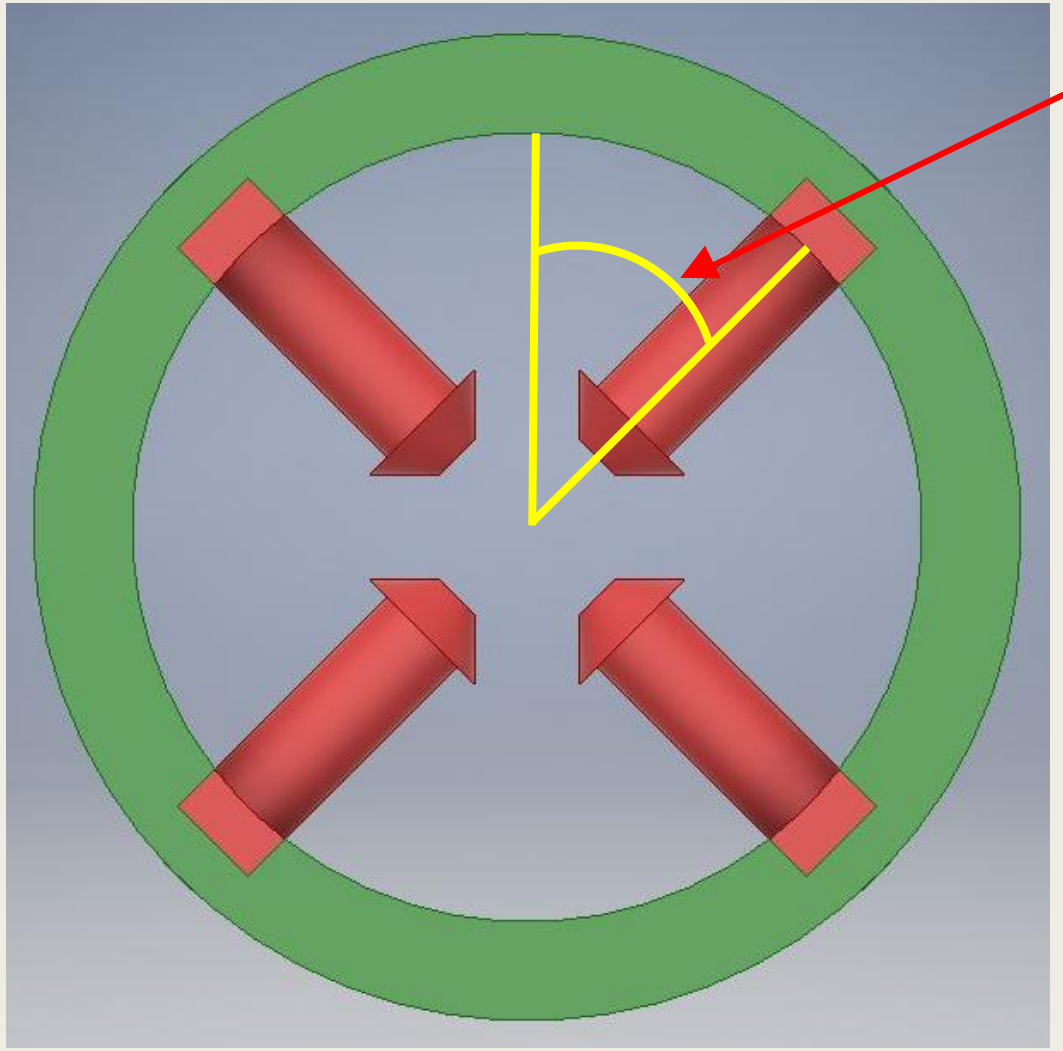
For the copper wire, the AWG number is 12, the diameter in mm is 2.05232, the current in Amps is 9.3

This distance is 40 mm.



This distance is 21.213 mm

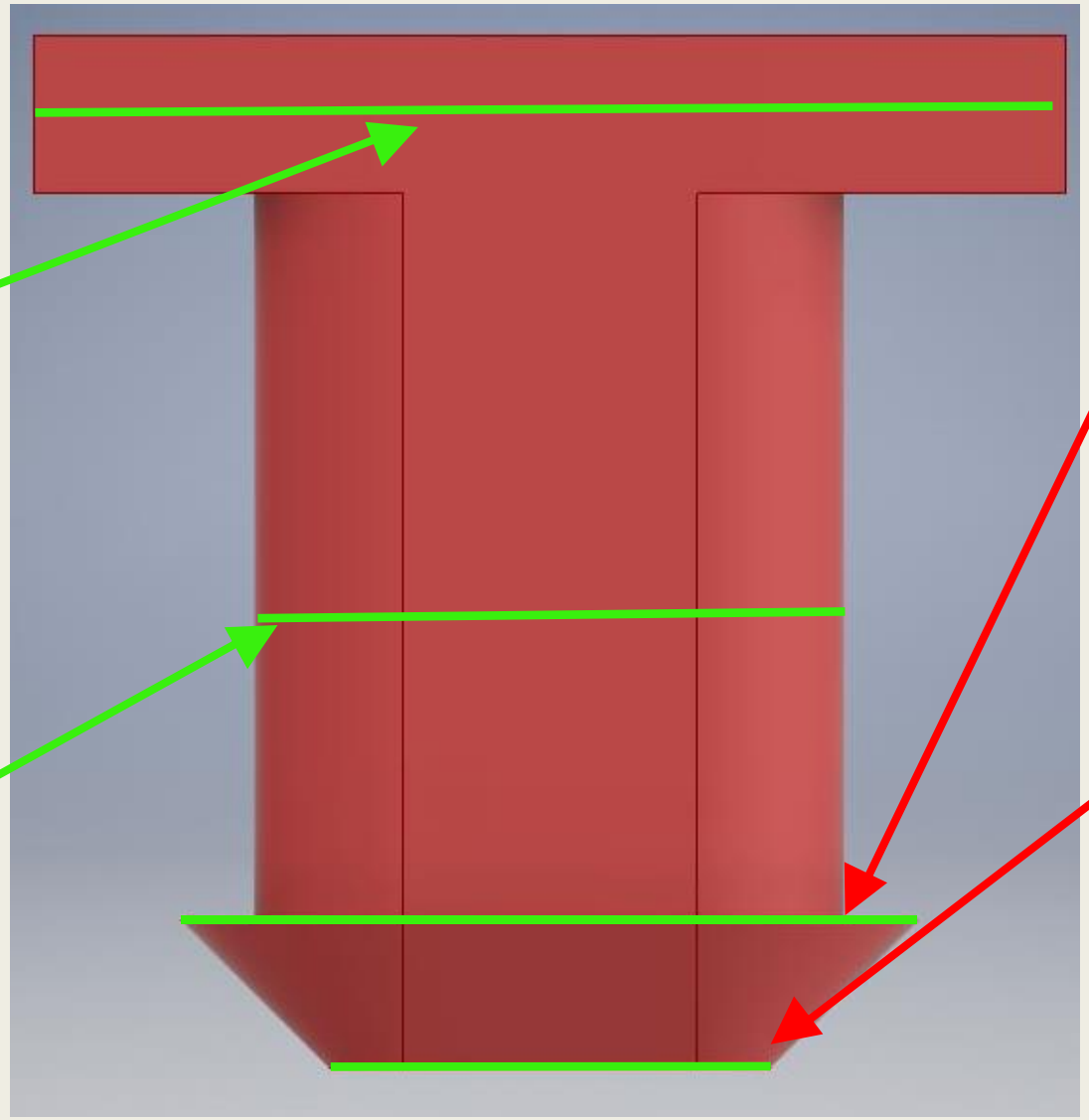
Each pole is 90° from each other



This angle is 45° from vertical y.

This length is 70mm

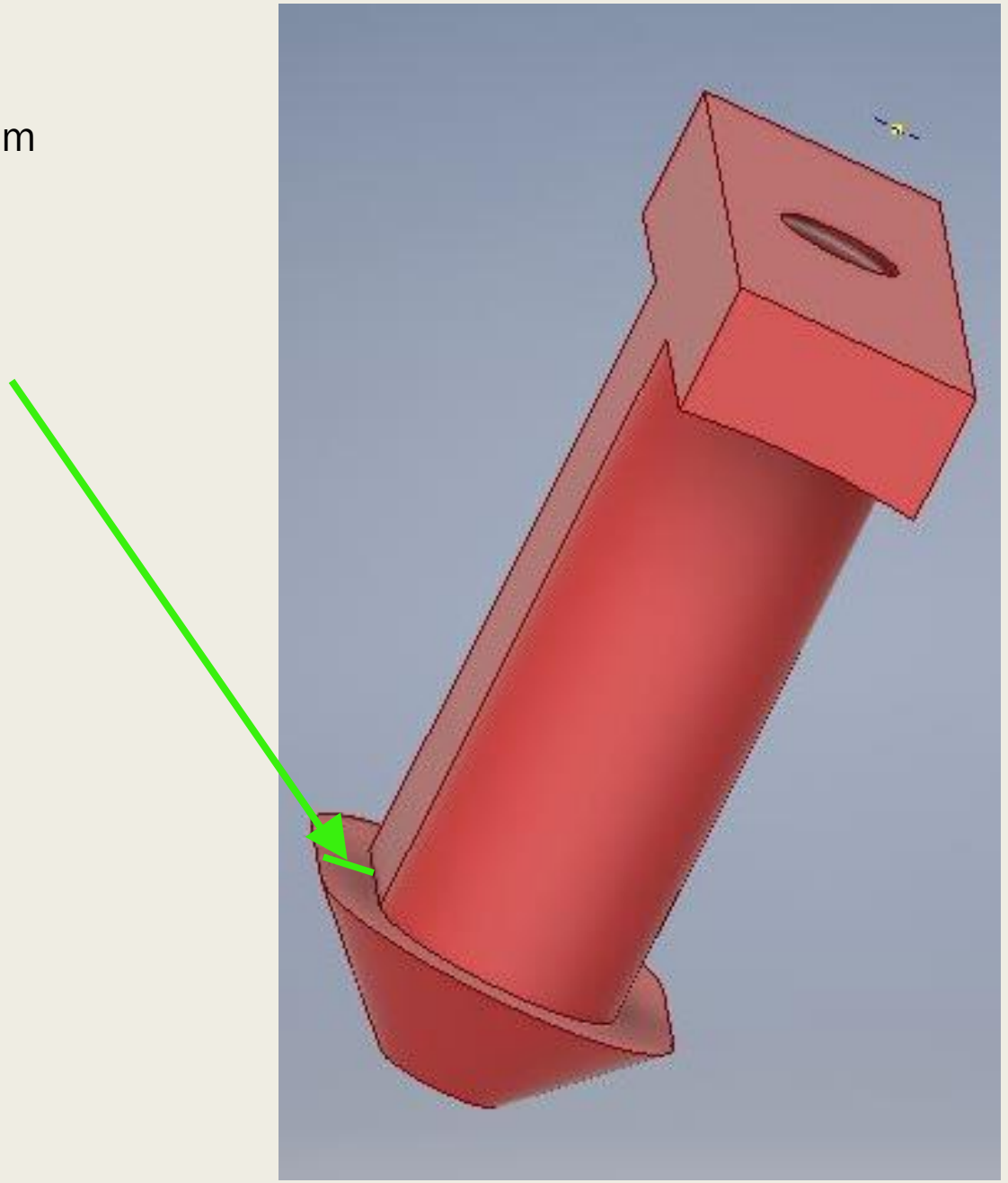
This length is 40 mm



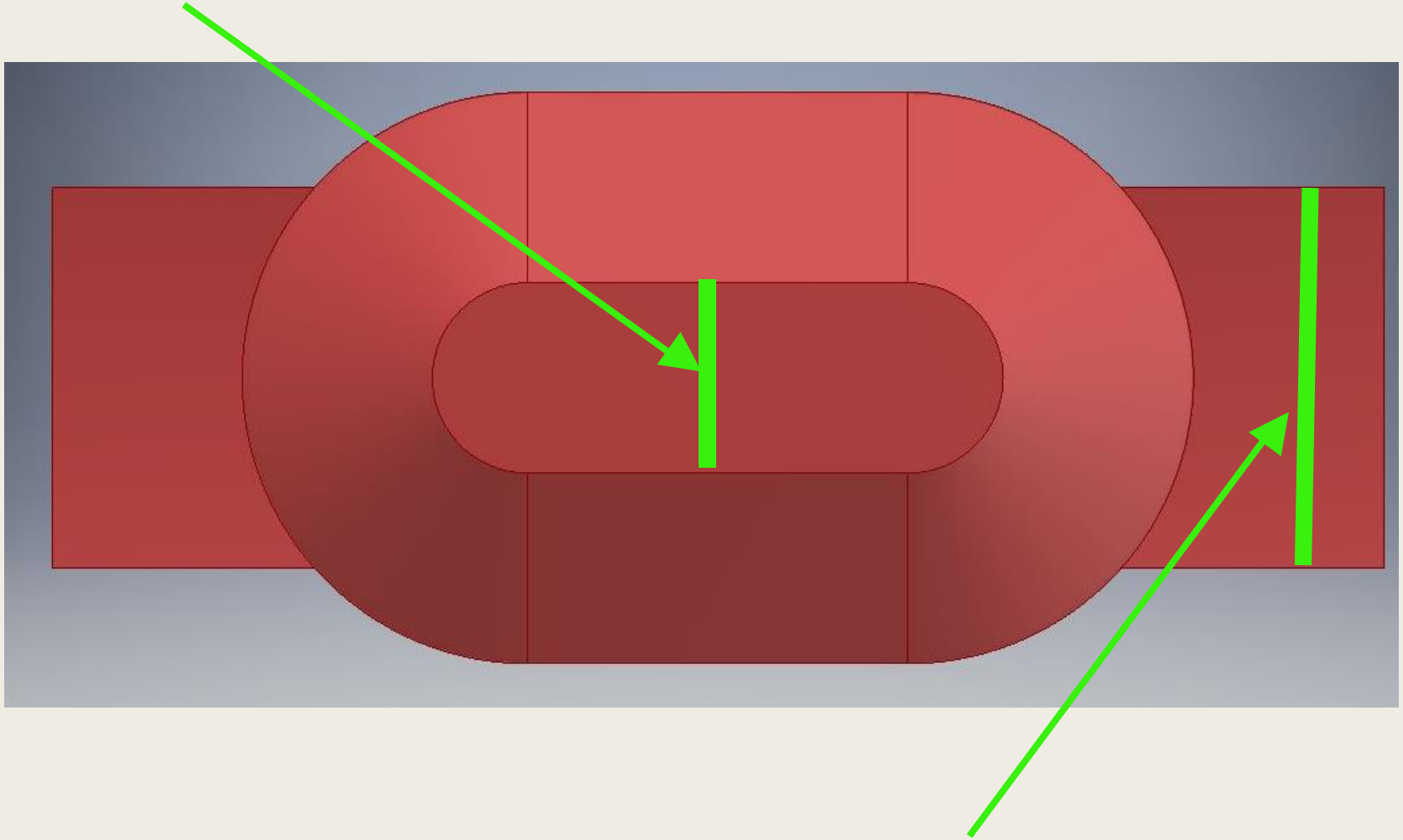
This length is 50mm

This length is 30mm

This distance is 5mm



This width is 10 mm



This width is 20 mm