Research and Development of a Novel Acceleration Method using Forward Helical Vortex Magnetic Field with Rodin style toroidal electromagnet at University of Texas at Arlington Society of Physics Students (UTA SPS)

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Total Amount Requested:

$1930

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Abstract

High energy particle physics requires powerful accelerators and detectors to study the fundamental constituents of matter and the forces between them. Accelerators of various energies are used in many different areas, including material property studies, medicine and homeland security. One challenge faced is the difficulty of transferring energy from the accelerator to the particle to be accelerated. Traditionally, a radio-frequency cavity along with an electric field is used for charged particle acceleration. We propose to carry out research and development of a novel acceleration method using forward helical vortex magnetic field generated by a Rodin style toroid coil electro-magnet. Due to the shape of the field, we expect this scheme to not only accelerate but also focus charged particles. We will construct several prototype Rodin style magnets, characterize the magnetic fields generated by the prototypes and test their functionality on a low energy positron accelerator in the UT Arlington Physics department. Should this scheme work, we may have developed a new way of accelerating particles and fine-tuning their energies.

The students in the Society of Physics Students at the University of Texas at Arlington (UTA) propose to carry out research a new particle acceleration scheme using a vortex magnetic field generated by a Rodin style toroidal magnet. We will construct several prototypes of the Rodin style toroidal magnet, as designed by Marko Rodin, and study their field characteristics. We will test this proposed particle acceleration using the prototype magnets in conjunction with a positron accelerator from the physics department.

High-energy particle physics (HEP) is a field of physics that pursues understanding of the fundamental constituents of matter and the interactions between these fundamental particles. In order to probe smaller scales necessary to reach the fundamental level, HEP requires powerful accelerators and complex detectors to study the particles emerging from interactions in the accelerator.

Particle accelerators are not only used for fundamental sciences but also for material property studies, medicine and homeland security. The energy range and particle species used for these different accelerators differ but issues in particle acceleration such as acceleration, focusing and steering schemes are shared. The typical particle acceleration method is based on electric fields through radio-frequency (RF) cavities. These require a high level of vacuum and fine surface quality to prevent electric sparks a signal deformation. If, however, a magnetic field is used for acceleration, both acceleration and focusing can be accomplished by the same beam element. This reduces

design and execution complexity costs associated with RF cavities. Figure 1 below shows a schematic diagram of this novel acceleration and focusing approach. The red box represents the beam pipe, the blue rectangle represents the Rodin Magnet, blue

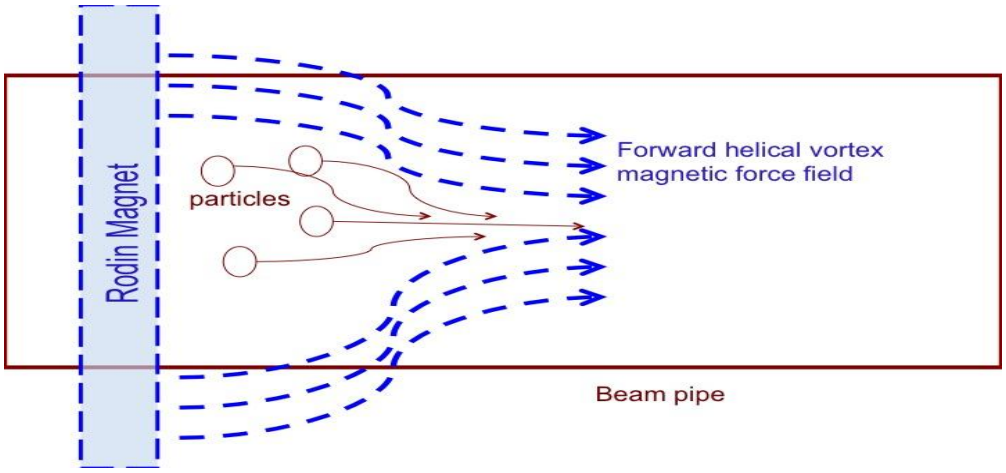


Figure 1 Forward helical vortex magnetic force based acceleration scheme.

dashed lines represent the forward helical electromagnetic field, the red lines represent particle trajectory, and the open red circles represent accelerating particles.

As shown in the diagram, charged particles are focused to the center of the beam pipe due to the force generated by the magnetic field. Further, the direction of the force also causes the particles to be accelerated forward.

When constructed, the Rodin Coil will measure 1.5 in diameter and will be wound with 14-gauge magnet wire and will be applied to a range of voltages and amperages to test its change in field when applied to a range of variables.

The coil is proposed to form a moving magnetic field as shown in Figure 1, this field, uncommon in magnetics has many possible uses and could be found to apply in

many fields of physics that have not been considered before. The coil was proposed by Marko Rodin and has been demonstrated to produce a rotating conical field, not frequently observed in magnetic field generation. The current through the copper wire wound through and around the torus are the defining factors which determine the force, size, and strength of the field. It is important that these variables are changed according to application in order to achieve optimum fields.

While other uses for rotating conical magnetic fields have been proposed, the main focus of our research on the coil will be directed in the field of particle physics. A possible use of the coil within physics is the redirection and acceleration of particles in a particle accelerator. Due to the field geometry, a particle could be pulled towards the center in a vortex-like manner then pulled through and passed to the other side of the coil to be further accelerated by a repulsing field. In effect, this coil design may accelerate particles in a similar manner as a toroid magnet with the advantage of reducing stray particles and focusing particle path.

We have chosen this thick type of copper wire so that the flux and force of the coil can be strengthened through the addition of more amperage and voltage, in normal wire and in smaller size copper wire it is possible that the wire can become unsheathed as well and break due to high amounts of heat and unstable amounts of voltage. This thicker weight wire also allows for the absorption of more heat, consequently, a cooling system will have to be devised for the coil to insure that it does not over heat, which can also distort and change the magnetic fields produced.

As well, the precision and accuracy of all windings contained within the coil are crucial to the even distribution of current around the torus, without the even distribution, it is possible for the field to become distorted and even dysfunctional. So to ensure the data resulting from our experiments are consistent, multiple renditions of the coil will be made, with constants throughout, such as number of windings, and wire size.

In order to control the input voltage into the coil we will construct an electrical panel to modulate and monitor the coil's voltage, amperage, and even the heat being produced to better conduct the research around vortex magnetics.

Signatures:

UTA SPS Officers:

Aaron Baca – President

Cezanne Narcisse – Vice President

Elijah Murphy – Treasurer

Erica Castillo – Secretary

Jaime Sterrett – Historian

UTA SPS Advisor:

Dr. Christopher Jackson

Sources:

http://www.seri-worldwide.org/id117.html

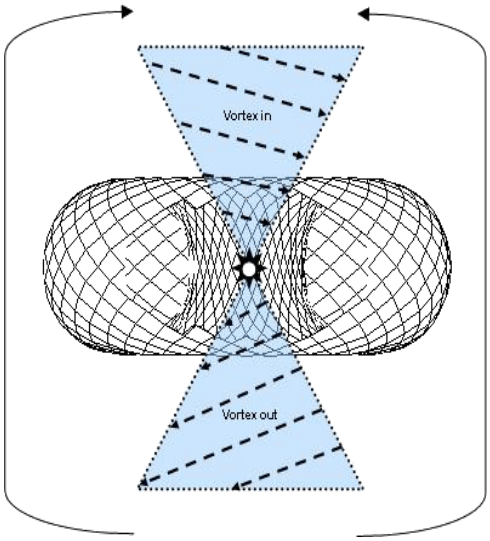
http://rodincoil.com/

http://peswiki.com/index.php/Directory:Marko_Rodin_Coil_/_Torus_/_Motor

Budget Request

Items	Unit price ($)	Number needed	Total ($)
AWG14 Essex Magnet Wire 11LB (6 Spools [1 Spool per coil)	$125	8	$1000
Wiring and Integration	$100	3	$300
Neodymium Magnets	$10	5	$50
Iron Torus Core	$30	6	$180
Control Panel Materials	$400	1	$400
Total budget and requested funds			$1930

Electromagnetic field shape distribution:



A completed Rodin style toroidal electromagnet:

Rodin winding pattern: