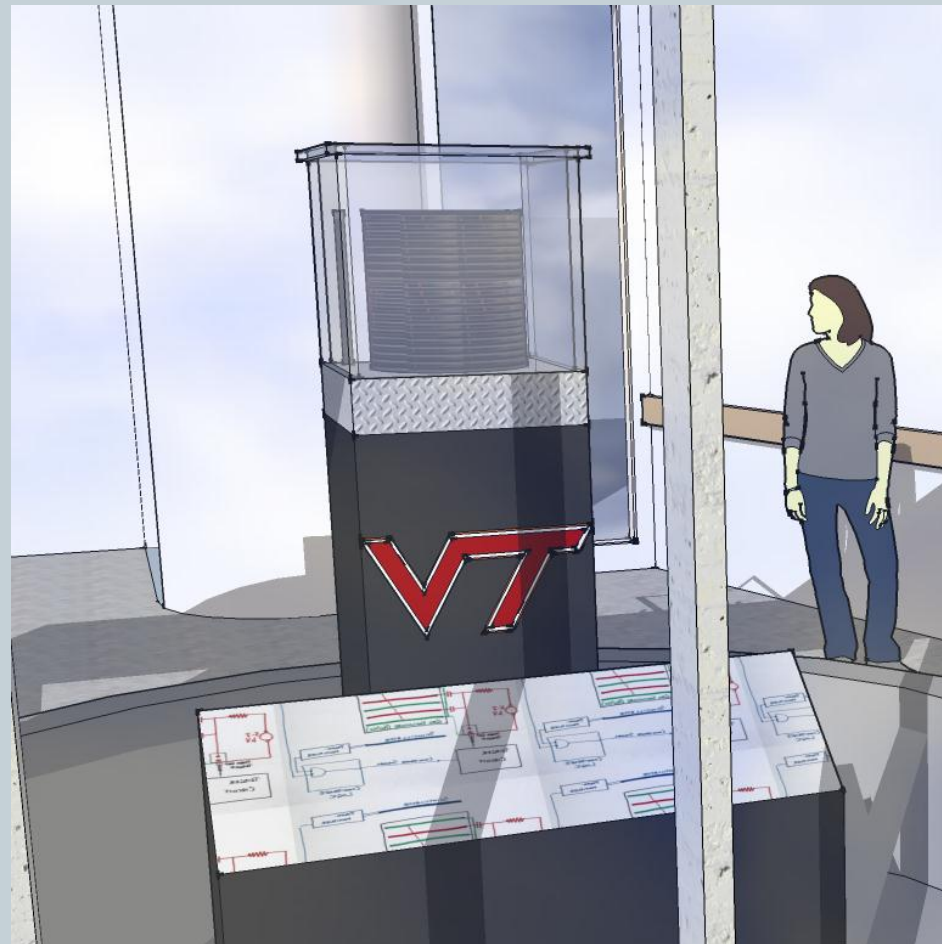


Research and Investigation in Science



NICHOLAS MERRILL

Conceptual Design Report For the Virginia Tech Senior Lab Spark Chamber



Goal for the semester



- To produce a document to describe the conceptual design of a spark chamber for muon detection and display.
- Spark chamber when completed, ideally by the Spring of 2013, will be displayed in the windowed area of Hahn Hall North room 103, the main lab room.
- Serve as a visual display and muon educational tool for the general public.

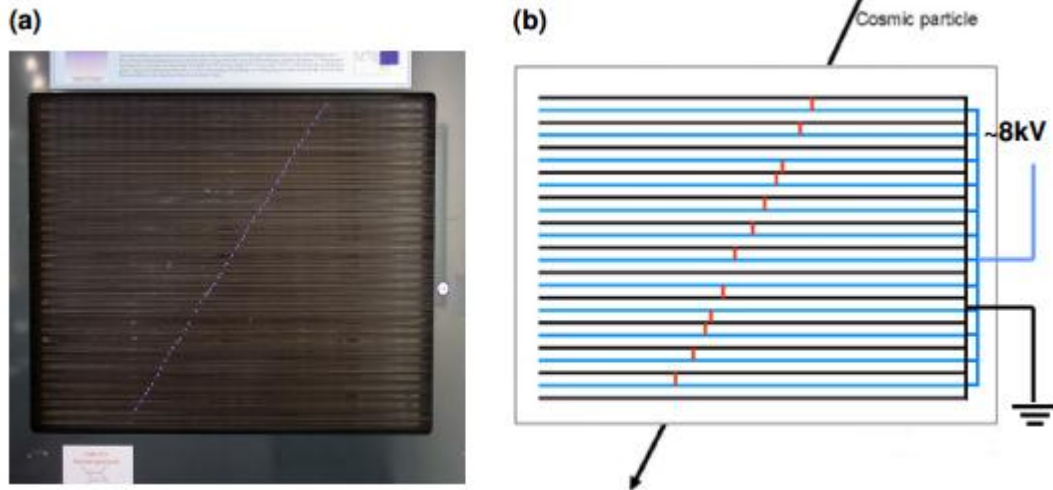
What is a Spark Chamber?



A spark chamber detector is most basically is a stack of alternating high voltage and grounded aluminum plates, meant to discharge along the ionized track left in the wake of a charged cosmic particle, such as a muon, passing through the detector.

Previously used for research. Now used only for demonstration purposes.

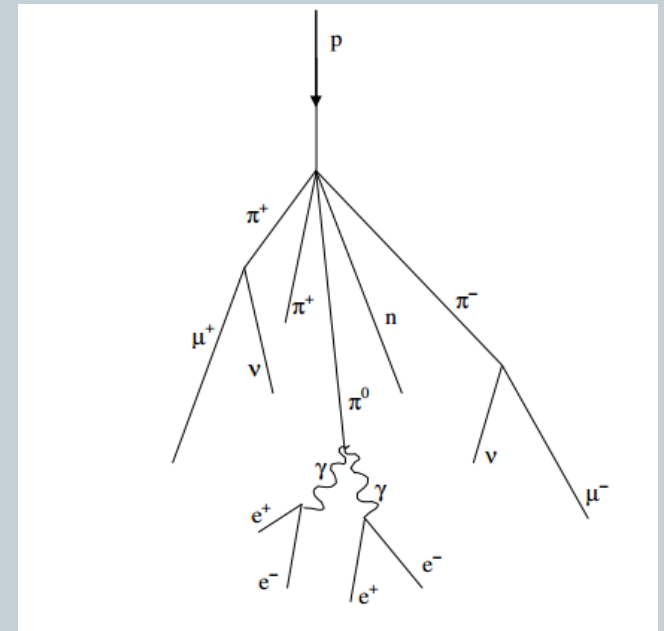
<https://www.youtube.com/watch?v=DpWo8xV3RI8>



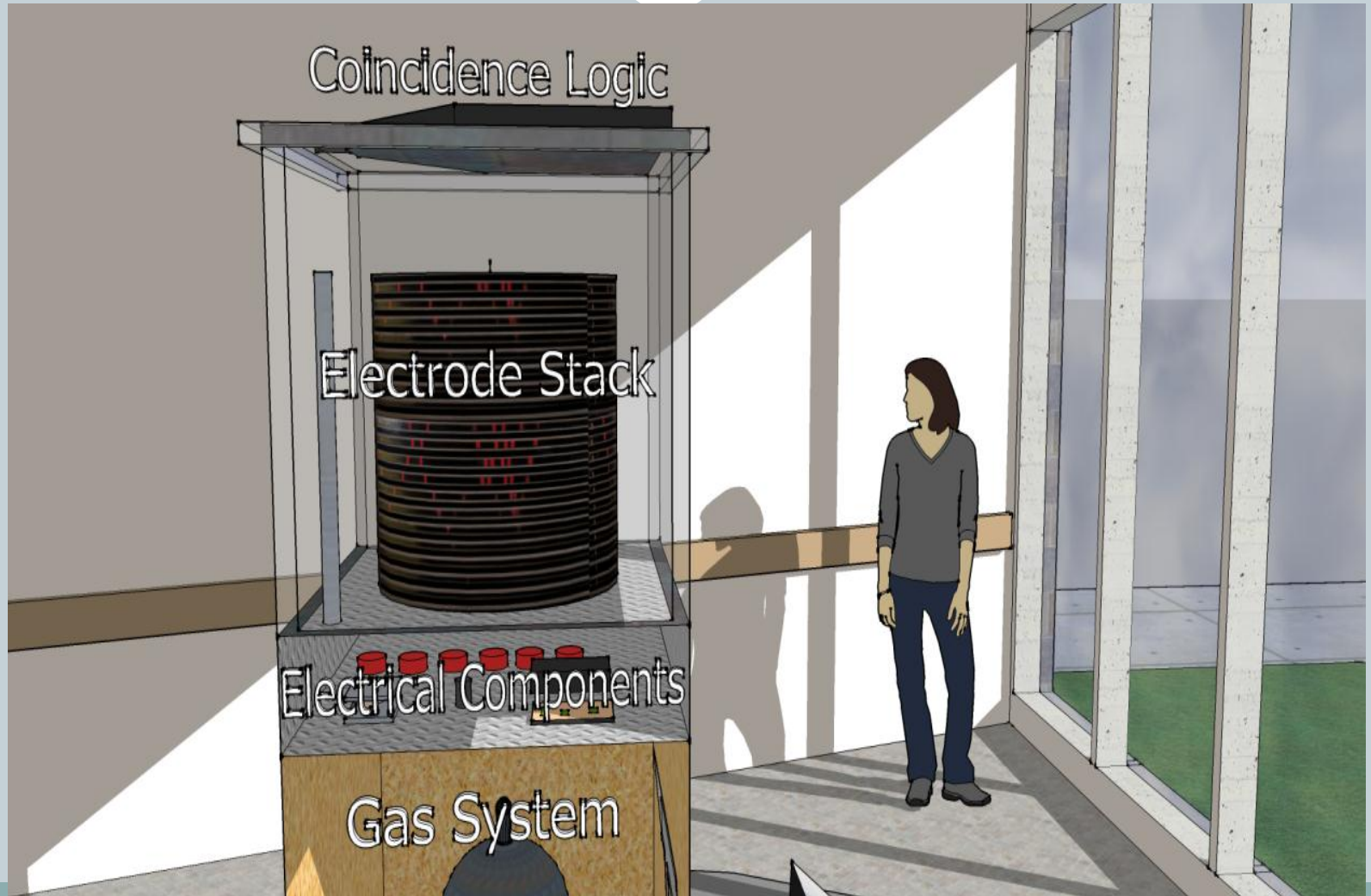
What is a muon?



- The top of earth's atmosphere is bombarded by a flux of high energy being protons, produced in the other parts of the universe.
- Muons are the heavy cousins of electrons naturally produced in a decay chain in the upper atmosphere and survive long enough to make it to the ground
- Roughly 110 per m^2/s at sea level



A Visual Breakdown of the Separate Systems

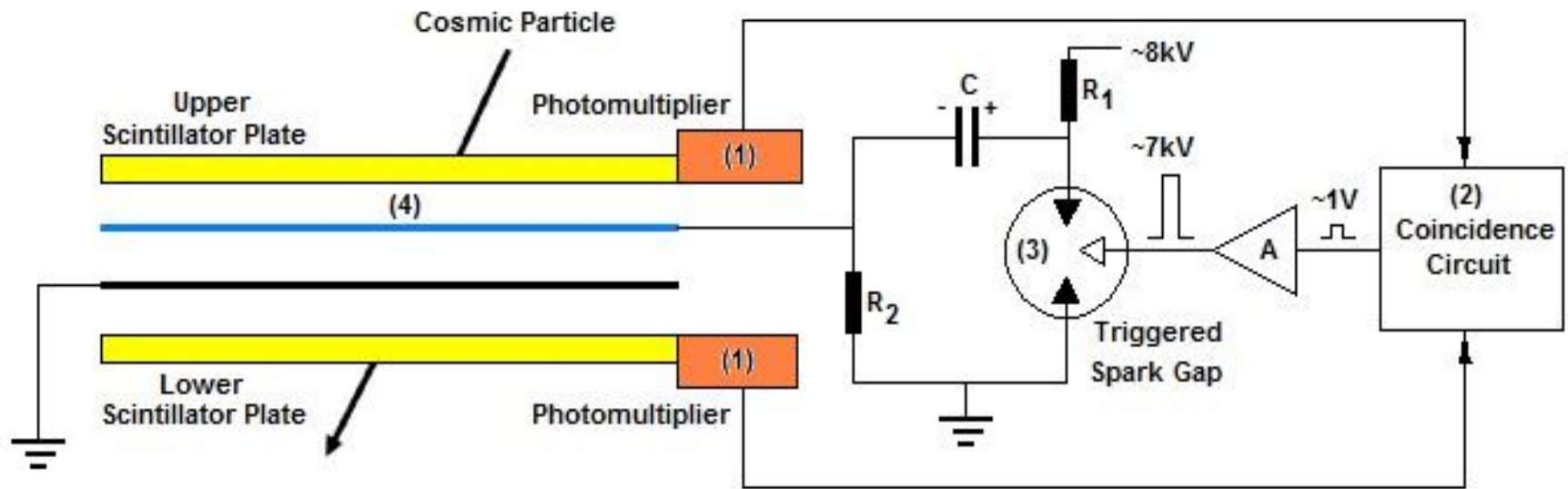


Role of Separate Systems

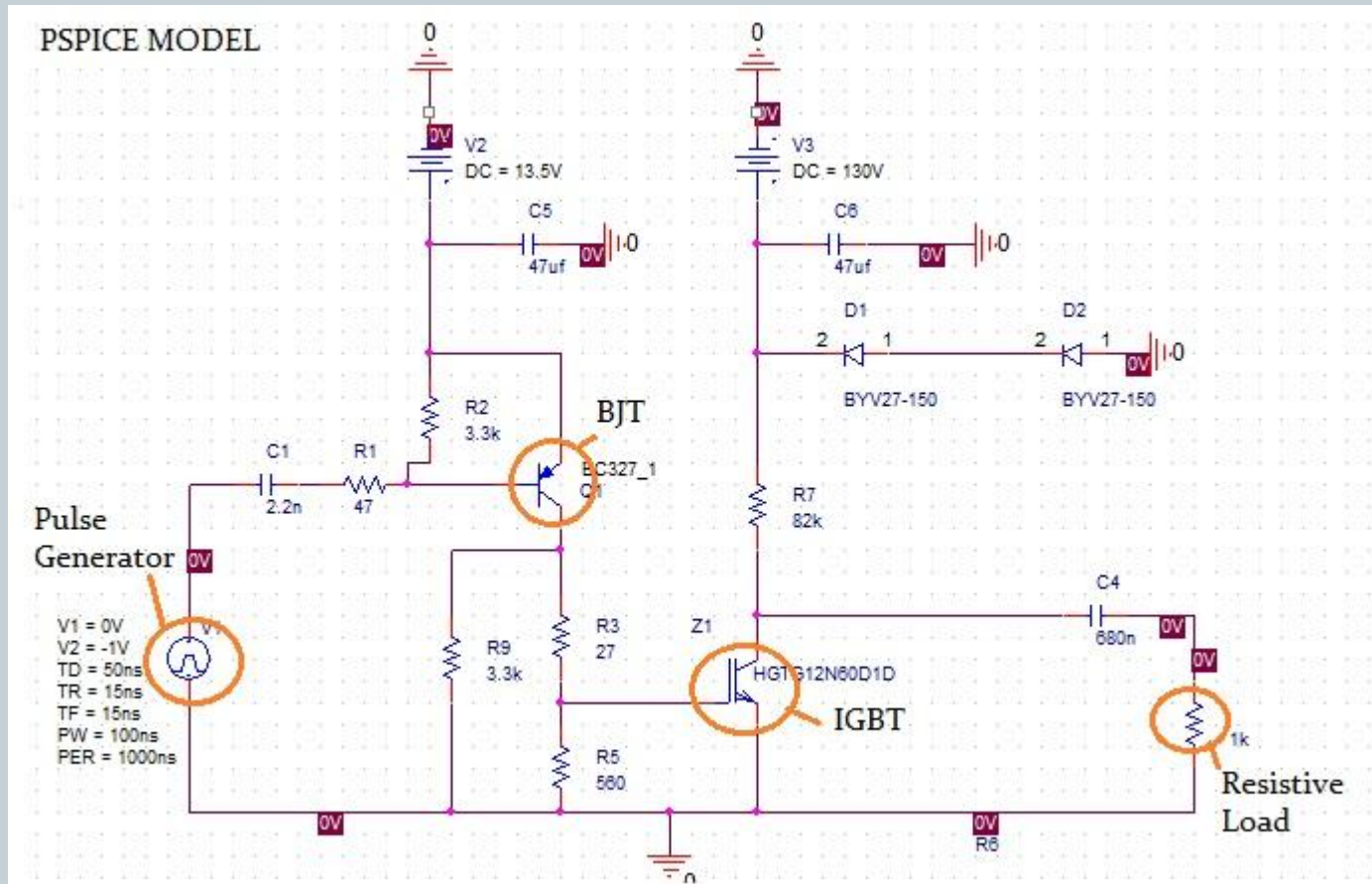


- **Coincidence logic** detects a muon has just past through the top of the chamber and exited the bottom.
- **Electrode Stack** supports 41 aluminum plates or electrodes
- **Electrical Components** amplify coincidence signal and implement transistor logic to fire a spark gap. The fire spark gap grounds one side of a bank of HV capacitors, allowing for spark formation.
- **Gas Systems** maintain an air tight environment filled with an inert gas.

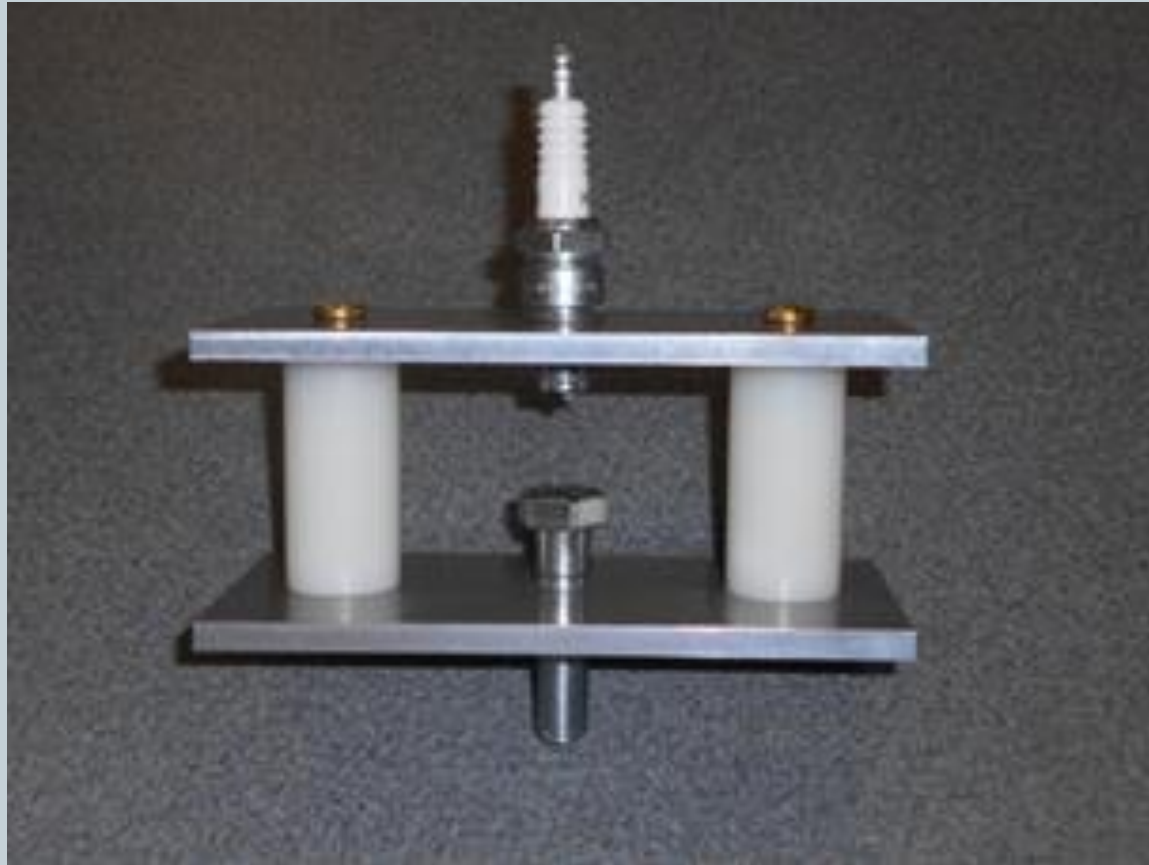
Simplified Circuit



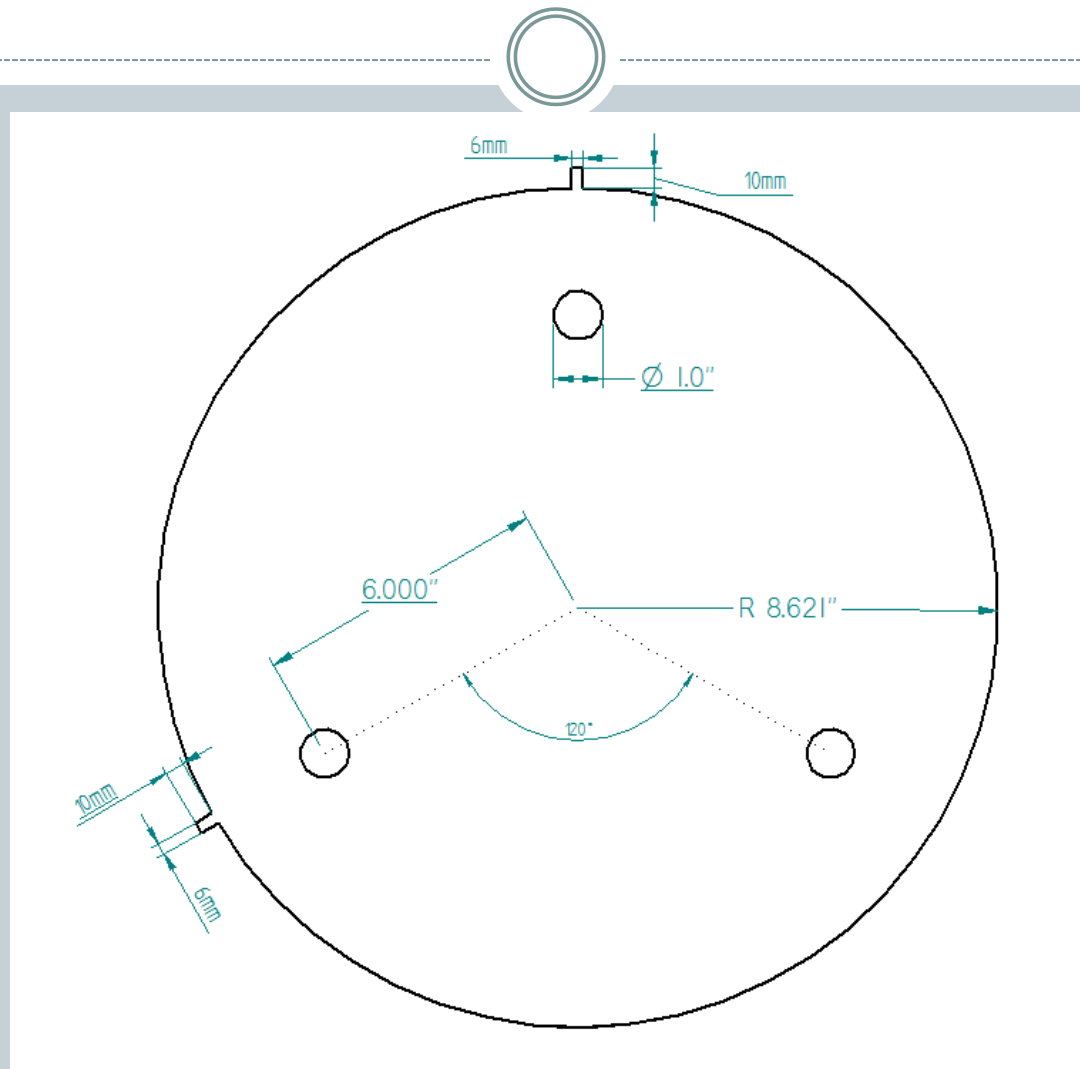
PSPICE MODEL



Custom Spark Gap



Uniquely Circular Electrode Design



Build your own for the low low price of \$2500. (Really that's pretty cheap)

Reference	Item	Part Number	Supplier	Price per Unit	Quantity	Cost
Set Costs						
2	Electrode Material and Machining Quote*	10016	Mountain Precision Tool	\$22.15	40	\$886.00
3	20KV 3.3nF Ceramic Capacitor*		HV stuff	\$21.63	19	\$410.97
1	Lexan Sheet 0.375" x 23.625" x 24"	POLCE ST	Interstate Plastic		4	\$190.88
2	Delrin Tube 1" ID x 1.5" OD x 8 Foot		Professional Plastics	\$118.78	1	\$118.78
1	IP Shipping		Interstate Plastic		~	\$61.88
2	Delrin Rod 1" Diameter		Professional Plastics	\$6.44	6	\$38.64
1	Lexan Sheet 0.375" x 24" x 24"	POLCE ST	Interstate Plastic	\$34.40	1	\$34.40
1	Lexan Polycarbonate Glue	IPS40-PT	Ridout Plastics	\$34.32	1	\$34.32
3	Aluminum Threaded Rod	94435A346	McMaster-Carr	\$16.42	2	\$32.84
1	Gray PVC sheet 0.5" x 24" x 24"	PVCGE	Interstate Plastic	\$27.01	1	\$27.01
2	PP Shipping		Professional Plastics		~	\$24.95
1	Lexan Sheet 0.375" x 0.75" x 24.75"	POLCE ST	Interstate Plastic		4	\$20.60
1	Gray PVC sheet 0.5" x 0.5" x 25"	PVCGE	Interstate Plastic		4	\$16.52
1	RP Shipping		Ridout Plastics		~	\$15.00
2	SS Shipping		Stainless Supply		~	\$14.47
1	Gray PVC sheet 0.375" x 0.25" x 25"	PVCGE	Interstate Plastic		4	\$14.00
3	Self Sealing Washer	335-1067-ND	Digi-Key	\$3.00	4	\$12.00
3	Female Tab Quick Disconnect 0.25"	1855C	Repair Connector		100	\$9.99
1	O-Ring Cord Stock 10'	31985435	MSC Industrial Supply Co.	\$0.81	10	\$8.10
3	Digi-Key Shipping		Digi-Key		~	\$6.98
1	PVC Cement Oatey 8oz.		Local		1	\$4.44
Estimated						
5	Gas System		~		estimated	\$350.00
5	Wooden Support Structure		~		estimated	\$150.00
7	EMP Insulating Structure with Lock		~		estimated	\$50.00
					Set Costs	\$1,982.77
					Estimated Costs	\$550.00
					Projected Total	\$2,532.77

Addressing NSTA standards (1d, 1e)



- Researching and synthesizing a large number of designs to produce one unique to our goals. (Visibility, Cost, Safety, Feasibility, Trigger/Fire Rate)
- Modeling a functioning electrical system
- Combining many areas of physics (Nuc/Particle, Circuits, Statics, Spark Formation)
- Working and organizing as a group (10 students and on Faculty Advisor)
- Real world applications with real world limitations

Implications for the classroom



- Visual anchor to an abstract concept
- Circuit can be built on the cheap and demonstrate both AC and DC components.
- Real world open ended project constrained to budgets to spark problem solving
- A conceptual design report is a way for students to gain a strong understanding real problems without the need to spend real money