Proposal for a Cosmic Ray Chandelier
To the MIT Art Council

Tess Smidt
blngeek@mit.edu

October 18, 2010

Abstract

I propose the creation of a Cosmic Ray Chandelier, a chandelier that will light upon being triggered by cosmic ray events passing through it. This chandelier would frame the entrance of the Laboratory for Nuclear Science on the 5th floor of Building 26. In this proposal, I explain my motivation for the project and describe the preliminary design and budget. The appendix of this proposal contains documents of correspondence with MIT administration, vendor price quotes, sketches and relevant information about myself as it pertains to my credibility to complete a project of this magnitude.

Contents

Chapter 1

Executive Summary

I am proposing to create an art installation that unites both of my undergraduate disciplines: physics and architecture. The inspiration for this project comes from my work with the MIT Neutrino group and has been fed by my passion of design. My hope is to illuminate a beautiful, mysterious aspect of nature that usually passes unnoticed.

Cosmic rays are high speed protons from outer space that bombard the Earth's atmosphere. When a cosmic ray crashes into the atmosphere, it causes a shower of muons and other delicious flavors of particle soup. Cosmic ray showers pour down on Earth's surface continuously. In fact, hundreds of these showers go through a person everyday. It's quite a spectacle when viewed on an oscilloscope, and I would like to put that spectacle on public display.

To do this, I want to build a contorted acrylic chandelier that would light when cosmic ray showers pass through it. The chandelier will consist of three major components: detectors, the lighting circuit, and acrylic rods. The notebook-sized detectors, called paddles, will be borrowed from the MIT Neutrino Group. When a muon goes through a paddle it outputs an electrical signal, the strength of which depends on the energy of the muon. This signal will then be sent to a circuit board that will control LEDs to light the chandelier.

The focus of the chandelier will be made out of translucent acrylic rods. Acrylic rods have a beautiful property: light shone on one end will illuminate the entire rod. This property still holds if the rod is gently bent. The LEDs will light up the rods depending on the signal from the paddles, and the color of the light will correspond to the energy of the muon. If there are multiple detectors, different parts of the chandelier will light up when different detectors fire.

The chandelier would hang in the walkway on the 5^{th} floor between buildings 26 and 16, the one of the entrances to the Laboratory for Nuclear Science. This first version of the chandelier is a very basic presentation and if it is successful I would like to create a larger, more detailed version to install along the Infinite Corridor.

The chandelier will translate the presence of cosmic rays into an accessible and aesthetically pleasing medium, so that viewers can be inspired by this natural phenomenon. The chandelier will serve as a public window to view these striking and secretive signatures from space, and show that our surroundings consist of much more than just what we see.

Chapter 2

Motivation

The Cosmic Ray Chandelier will be a unique way to visualize cosmic ray events. Not only will it be an interesting reinterpretation and intuitive nudge to those who are already familiar with the concept of cosmic rays, but it will also expose this phenomenon in an accessible manner to viewers who may not have a background in physics and are not aware that cosmic rays exist.

My personal motivation for this project is to work on a project through which I can apply both of my fields of study, physics and architecture. These two fields are traditionally thought to rarely intersect, but I believe I can use my dual skill set to look at physics topics from a different perspective and convey physics concepts to non-physicists through visual media.

This project gives me the opportunity to dive into areas unfamiliar to me such as circuit prototyping and working with administrative bodies to achieve a goal. This will be the biggest art project that I have ever undertaken and I am ready and eager to apply myself to the added difficulties involved in a project of this complexity.

Chapter 3

Preliminary Design

The Cosmic Ray Chandelier will consist of three systems handling the detection, interpretation, and visualization of cosmic ray events, respectively. The three systems combine to translate cosmic ray events into a responsive light display.

3.1 Detection

Cosmic ray events are identified by detecting the muons that are created when cosmic rays collide with the Earth's atmosphere. Since these muons are heavy, charged, and have lots of kinetic energy, they are easily detected by scintillator paddles, which emit light when they are excited by such particles. The light created in the scintillator paddle is then detected by a photomultiplier tube, which then creates an electrical signal proportional to the intensity of the light detected. The combination of the PMT and the scintillator paddle complete the detector.

To limit the number of cosmic rays used to trigger the chandelier, two paddles will be positioned parallel to each other with one approximately 30.5 cm (1 ft) above the other. A logic gate later down the signal chain can require that both paddles must fire for that event to trigger the other circuitry. This ensures that the cosmic rays being used to trigger the chandelier are coming almost directly above. This also takes care of random fluctuations within an individual paddle and PMT that might falsely induce a signal.

The MIT Neutrino has generously agreed to lend me the PMTs and scintillator paddles needed for this project. This greatly cuts project costs since PMTs cost approximate $1,000 each. The number of detectors that will be used for this project, either 2 or 4, is dependent on how many detectors, the combination of a PMT and a scintillator paddle, I am able to borrow from the MIT Neutrino Group.

The second most important matter concerning the detection system is supplying high voltage to the PMTs. PMTs on average require 1,500 V. This is usually supplied by a high voltage power source, but to eliminate the need to have high voltage cables running around the entire chandelier to each paddle, Cockcroft-Walton bases will be used. Cockcroft-Walton bases convert 5 V from a power supply to the 1500 V needed to a PMT. They attach to the PMT itself.

The signals from a PMT when a muon rushes through the scintillator is usually on the order of 10-100 mV. Because this is a relatively small signal for the interpretive circuitry to analyze, the signal will be amplified immediately after it comes out of the PMT. Once amplified, the signal is ready to be analyzed and converted into instructions to light the chandelier.

3.2 Interpretation

After detecting a cosmic ray event, the event has to be analyzed and translated into instructions for the LEDs that light the chandelier. While a better method might be found through additional research and testing, the current plan for doing this is to use

an Arduino board to receive the amplified PMT signal and run calculations that determine the lighted response and use PWM[1] driver chips to coordinate the signals to the approximately 100 LEDs that will light the chandelier. The remaining materials needed are just wires, resistors, capacitors, and transistors, all of which are fairly inexpensive.

An Arduino board consist of a micro-controller, analog to digital inputs, digital outputs and all the electronics in between to make everything work. Arduino boards are programable via USB using a specially tailored Arduino programming environment and have excellent documentation on their features and ways to use them. There is an existing Arduino library specifically for the PWM driver that I plan to use, the Texas Instruments TLC5940. That library will handle communication with the drivers; my task will be to design the code to calculate the light patterns to be produced.

3.3 Visualization

The centerpiece of this installation will be the chandelier comprised of contorted acrylic that will be illuminated with light patterns derived from the detected cosmic ray events. The shape of the chandelier, largely depends on how easily the acrylic can be manipulated into complicated twisting forms, but it will approximately be 4' wide x 4' long x 2.5' tall.

The acrylic pieces that will form the chandelier are acrylic rods that will be bent and curved with the aid of a heat gun owned by the MIT Neutrino group. The lab technician for Professor Janet Conrad's lab, Len Bugel has experience bending acrylic rods identical to the ones that will be used. Both of these resources will be used to complete this most aesthetically important part of the project.

The chandelier will be built out of as many as 100 separate pieces of acrylic rod, each of which will be attached to a metal frame that will bolted to the ceiling of the 5^{th} floor walkway between buildings 16 and 26 by Facilities. The LEDs that will illuminate the acrylic will be attached to the back of each rod.

The LEDs will be housed in a closed fitting that will attach to the back of each rod to direct the light from the LED most effectively. The proximity of the LEDs to the acrylic may seem like a cause of concern for the acrylic melting, but the LEDs will not be constantly on. Instead, they will flash in relatively brief pulses, so there will never be significant heat build up.

[1] Pulse-width modulation; a method for efficiently varying the amount of electrical power delivered to a device.

Chapter 4

Preliminary Budget

The following preliminary budget was submitted to the MIT Art Council on October 18, 2010.

Expense	Cost
Acrylic	$300
Electrical Outlet[1]	$700
Electronics	$300
Electronics Enclosure[2]	$200
Fastenings	$200
Installation Assistance	$300
Signage	$50
PMT HV[3]Bases and Cabling	$1200
Voltage Source	$50
Total	$3,300

The specifics of this budget will be discussed below.

NOTE: The Laboratory for Nuclear Science has kindly granted $1,000 to this project.

4.1 Acrylic

The acrylic used for the chandelier will largely, if not solely, consist of 3/16" x 1" x 6' clear extruded acrylic rods bought from McMaster-Carr (http://www.mcmaster.com). These rods cost $5.19 each. Since the expected size of the chandelier is approximately 4' wide x 4' long x 2.5' tall, I estimate that a maximum of 150' or 25 rods will be used for the chandelier. This sums to a total of $129.75 plus shipping costs of approximately $30.00. This leaves approximate $140 of padding to allow for testing and additional acrylic if needed.

Expense	Price	Quantity	Item Total
Acrylic rods	$5.19	54	$129.75
Shipping			$30.00
		Total	$159.75

4.2 Electrical Outlet

Due to the size and nature of the project, the installation space will need to have a high ceiling. The 5th floor walkway between building 16 and 26 satisfies this criteria and is an aesthetically ideal place for the installation because it frames one of the entrances to the Laboratory of Nuclear Science. While there are currently lights installed in this walkway, there are no outlets along the wall. During a meeting to discuss the safest configuration for the chandelier, Kathryn Blass, Assistant Officer of the Environment, Health, and Safety Department, and I decided that it would best to install an outlet in the walkway. We then consulted with Steve Gilligan, Senior Electrical Supervisor of the Department of Facilities, to see if such an installation was possible and how much it would cost. Steve Gilligan informed us that an outlet could be installed in the hallway and it would cost approximately $700 to do so.

[1] To be installed in the walkway on the 5^{th} floor between buildings 16 & 26.
[2] Mandated by MIT EH&S.
[3] Photomultiplier tube high voltage

4.3 Electronics

The electronic components for the interpretation circuitry consists of the Arduino board, transistors, capacitors, resistors, wires and LEDs. Only the LEDs and the Arduino board need to be carefully selected since they have the most impact on the circuitry and are the most expensive components. The other components are inexpensive and standardized and will be selected to fit the needs of the Arduino board and the LEDs. The Arduino board that will be used for this project is the Arduino Uno, their newest and one of their most economic models. Approximately 100 1.5W RGB LEDs will also be included in the circuit.

Expense	Price	Quantity	Item Total
Arduino Uno	$29.95	1	$29.95
RGB LEDs	$1.31	100	$131.00
Misc. Elec.			$100.00
Shipping			$16.00
		Total	$276.95

4.4 Electronics Enclosure

There will be 2-3 electronics enclosures, 1 for each set of detectors used and 1 for the interpreting circuitry. The enclosures will be acrylic boxes that will mount to the ceiling or to the wall, out of the way of foot and cargo traffic. These boxes will be approximately 1.5' x 1.5' x 1.25'. Two 3' x 6' x 1/8" thick acrylic sheets will be used to make the boxes. Fastenings for the boxes will consist L brackets and screws the sum of which will not exceed $60.

Expense	Price	Quantity	Item Total
Acrylic Sheet	$47.75	2	$95.50
Fastenings			$60.00
		Total	$155.50

4.5 Fastenings

Fastenings crucial for the construction of the chandelier are the metal frame that holds the acrylic rods and LEDS, the caps that connect and enclose the LEDs around the acrylic, and the connector between the metal frame and the ceiling. These pieces are heavily dependent on the resulting shape of the chandelier and will have to be made by hand. The piece for the frame can be cut from an aluminum plate and then welded together to form the desired shape. I estimate that this will take 2 12" x 12" x 1/4" thick aluminum plates. The pieces can be welded together by my father for no charge. The caps can be as complicated as specifically tailored metal fittings or as simple as electrical tape covering an acrylic LED holder. Heat dissipation is not a concern since the LEDs are not individually on for extended periods of time. The design of the connector will be coordinated with facilities to ensure that it will securely connect to the ceiling.

Expense	Price	Quantity	Item Total
Aluminum	$43.74	2	$87.48
Caps			$30.00
Connector			$80.00
		Total	$197.48

4.6 Installation Assistance

I have assumed that the final project will have to be installed by facilities and have estimated that installation cost will be $300. This is sufficient for 4-5 hours of work from facilites.

4.7 Signage

A sign will be installed next to the chandelier, offering a brief description of the project and space to thank donors. The sign will be made of acrylic and can be engraved with the laser-cutter in the architecture department, which I have access to as a architecture major.

Expense	Price	Quantity	Item Total
Acrylic Sheet	$7.38	1	$7.38
Shipping			$4.00
		Total	$11.38

4.8 PMT High Voltage Bases and Cabling

Cockcroft-Walton bases will supply high voltage to the PMTs. They will be identical to ones designed at Fermilab for use in particle detectors. I contacted Sten Hansen, electrical engineer at Fermilab, to get a cost estimate and documentation for the components of the bases. Sten Hansen estimated that the parts for the individual bases cost $50 and the custom circuit board with multiple layouts for the bases would cost $700. This sums to $900. The cabling for the bases will cost $100. The last $200 serves as padding in case the custom circuit board or other base components cost slightly more than Sten Hansen estimated.

4.9 Voltage Source

A 200W 40A power supply will be sufficient to supply 5V DC to the circuitry and LEDs. This type of power supply range in price from $50 - $60. The power supply used in this budget is listed in the *Appendix* under *Vendor Price Quotes*.

Expense	Price	Quantity	Item Total
Power Supply	$55.95	1	$55.95
Shipping			$10.00
		Total	$65.95

4.10 Additional Funding

On Monday, October 18th, I met with Professor Richard Milner, Director of the Laboratory for Nuclear Science, regarding funding for this project. He kindly agreed to contribute $1,000 to the project.

Chapter 5

Conclusion

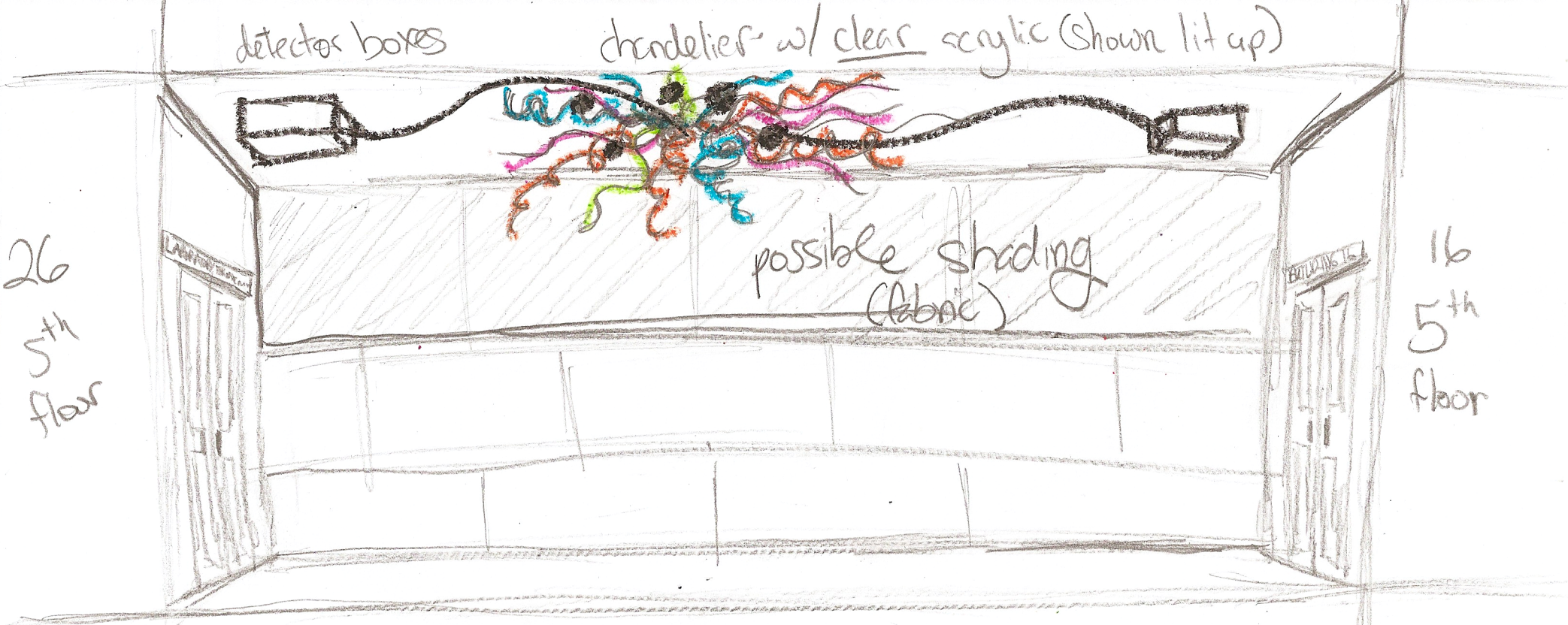
The Cosmic Ray Chandelier exemplifies the spirit of MIT: to integrate concepts from multiple fields to produce a innovative and unique solution. It will serve to inform those who view it about the particle soup we inhabit as Spaceship Earth treks through the cosmos. This project unions science and art to share one of the many mysteries of the universe in a way that is accessible to everyone, from children to physicists.

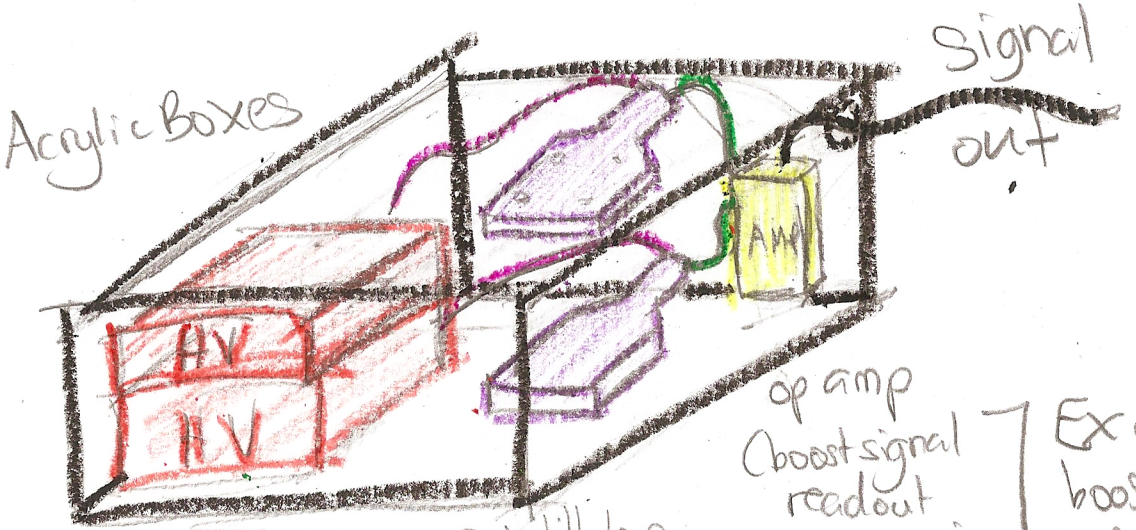
Through this project, I will learn how to design, construct, and program electronic circuits, further my own understanding of cosmic rays, and explore my abilities as a designer.

Chapter 6

Appendix

6.1 Additional Sketches

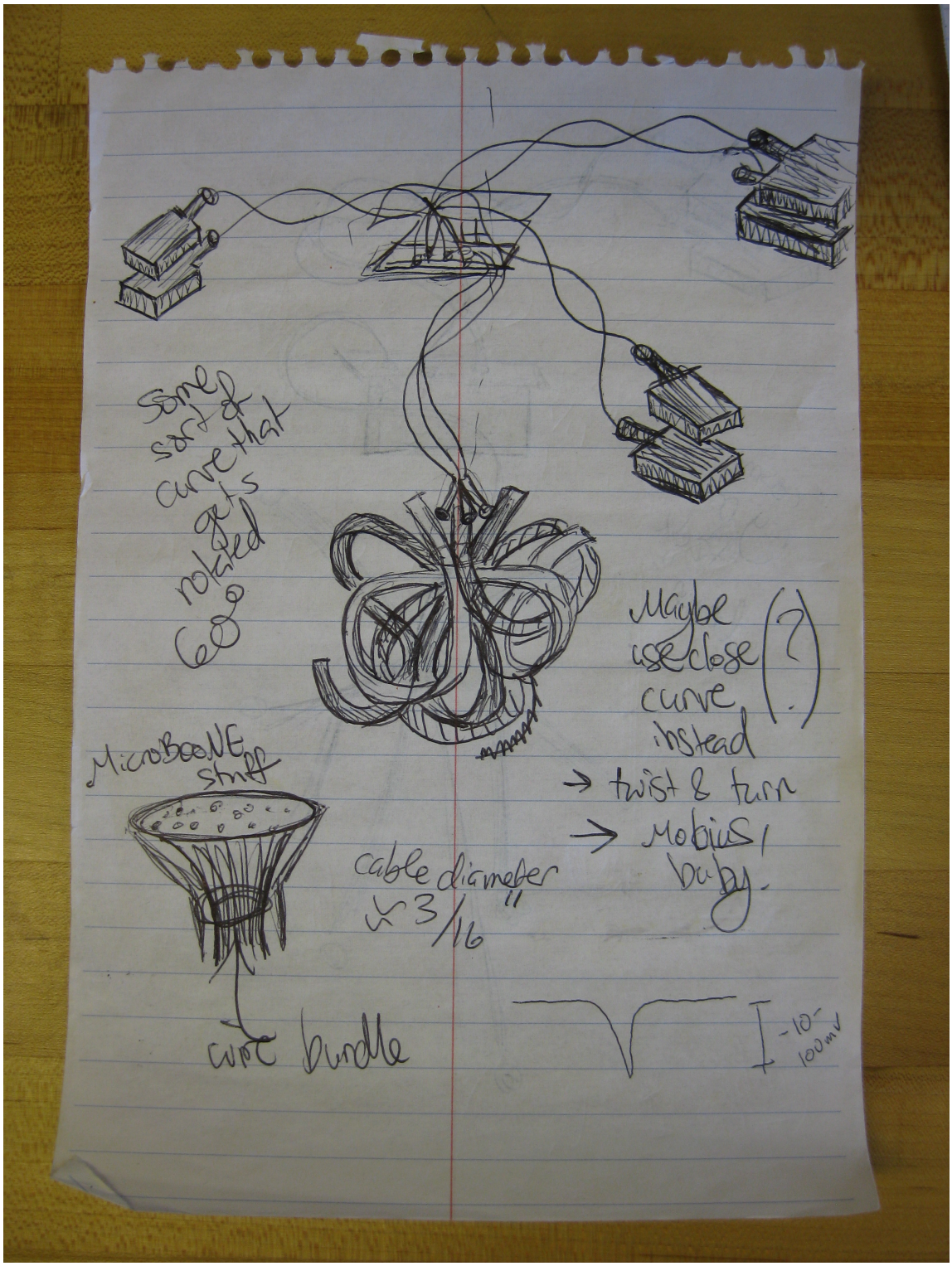


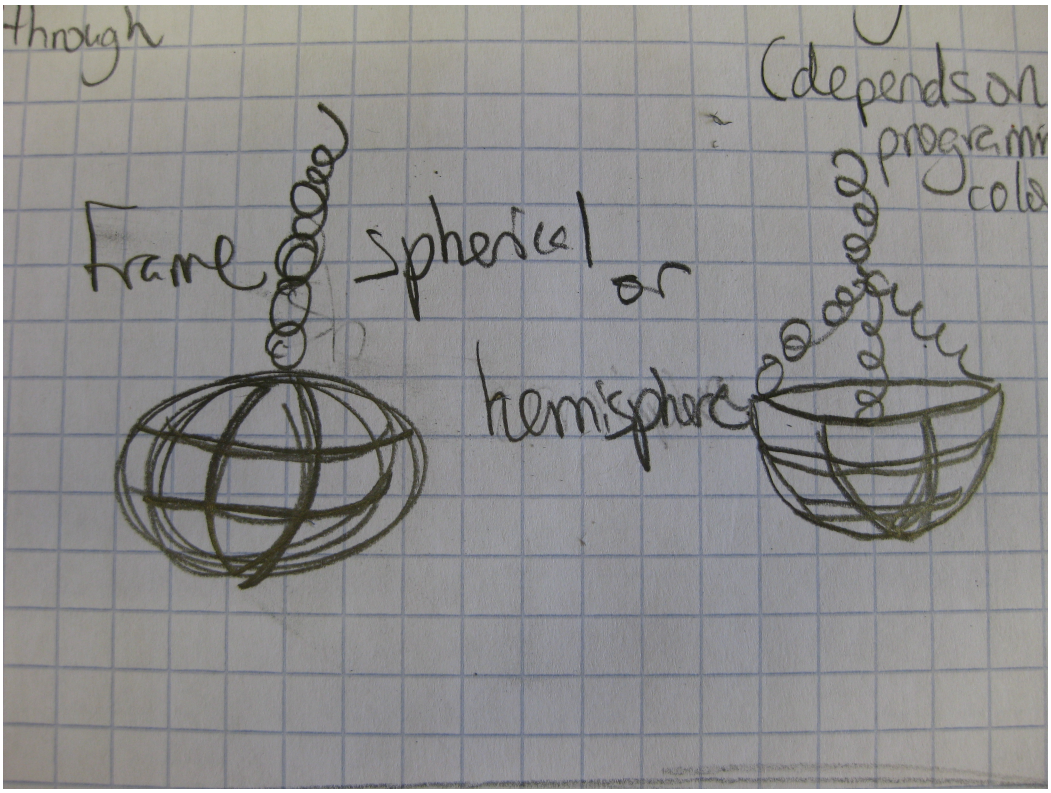


Detector box details:

Ex: boost signal from 10mV to 1V

Kelsey Schmidt 2010.09.10


Some sort of curve that gets rotated 60°
Maybe use close curve instead (?)
→ twist & turn
→ Mobius / bubby.
MicroBooNE stuff
cable diameter ~ 3/16"
cable bundle
-10-100mV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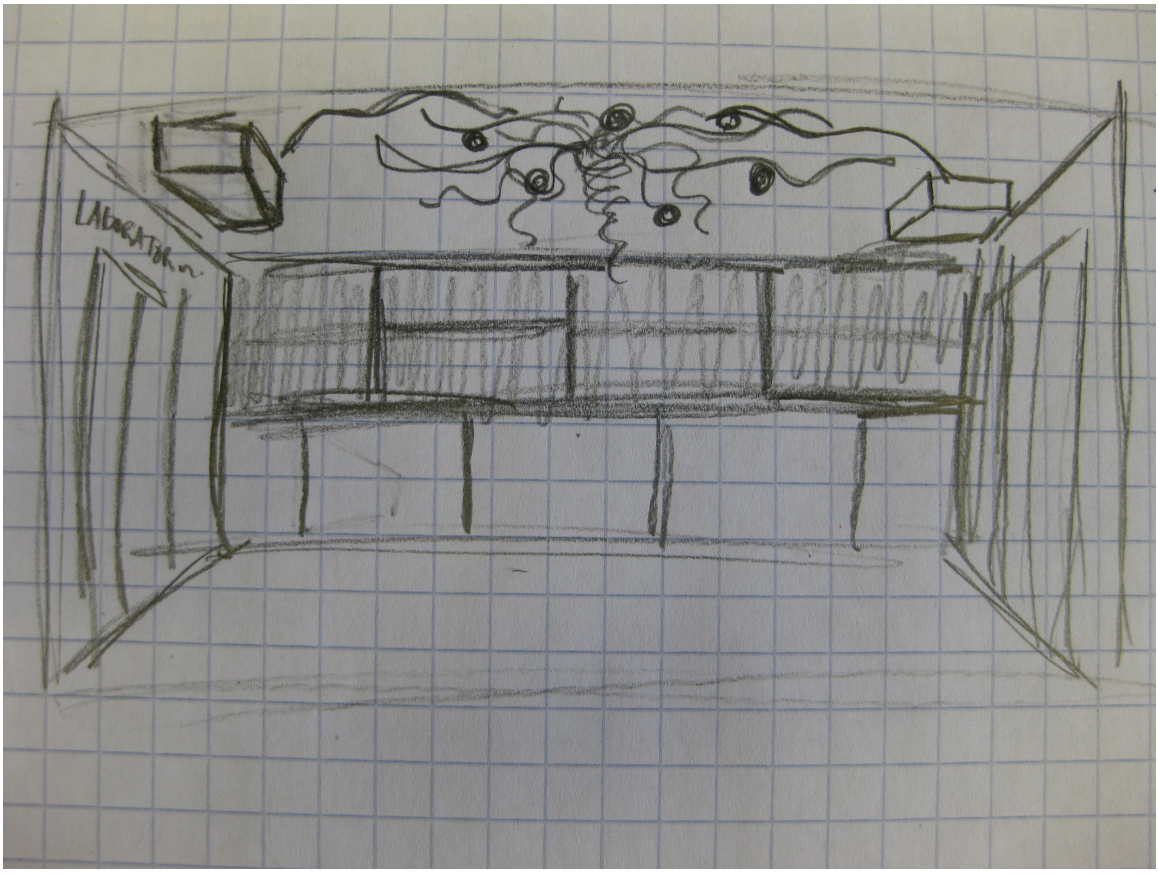

LABORATOR

6.2 Proposer's Curriculum Vitae

Tess Eleonora Smidt

Term Address:
229 Vassar St.
Cambridge, MA 02139

blngeek@mit.edu
760.207.5707

Permanent Address:
7933 West Lilac Road
Bonsall, CA 92003

EDUCATION

Massachusetts Institute of Technology, Cambridge, MA
(Projected Graduation Date: June 2012)
Candidate for B.S. in Physics and B.S.A.D in Architecture
Relevant coursework in Architecture: Intro. to Design Studio, Intro. to Design Computing, Intro. to Building Technology

ARTISTIC WORKS

MULTIMEDIA

MIT 2012 Ring Committee
(Fall 2009 – Spring 2010)

- Designed ring for Class of 2012, 2012 Ring Committee logo, and 2012 "Brass Rat" T-shirts.
  http://twentytwelve.mit.edu/ring/

blondegeek
(Summer 2003 – Present)

- T-shirt business and personal site.
- Designed website, t-shirt designs, marketing materials and orchestrated photo shoots.
  http://www.blondegeek.net

ARCHITECTURE

Writer's Boston Residence (Model)
(Spring 2009)

- Designed additions to a traditional Boston townhouse to create a public garden and private study and library.
  http://blondegeekdotnet.blogspot.com/2009/06/finishing-up-school-year-and-diving.html

Reading and Writing Space at the Border of a Beach and Meadow (Model)
(Spring 2009)

- Created of a reading and writing spaces by inserting pre-fabricated box-like forms into a pre-existing concrete structure.
  http://blondegeekdotnet.blogspot.com/2009/06/finishing-up-school-year-and-diving.html

TECHNICAL DESIGNS

Photomultiplier Rack for MicroBooNE
(Summer 2010)

- Designed the support structure for the photomultiplier tube (light detectors) to be used in MicroBooNE, a neutrino experiment that will be built at Fermilab.

TEXTILES

Blue and Silver Modern 1700s Dress
(Summer 2010)

- A dress that combines a modern hem and petticoat with an 18th century pattern and neckline.
  http://blondegeekdotnet.blogspot.com/2010/08/breadboard-crumbs.html

View onto a Japanese Garden
(Summer 2010 - Present)

- A quilt depicting the view from inside a traditional style Japanese house onto a garden.
  http://blondegeekdotnet.blogspot.com/2010/06/hello-from-fermilab.html

Mondrian Dress
(Summer 2007)

- Summer dress inspired by the works of Piet Mondrian.
  http://www.blondegeek.net/projects/sewing/mondrian.php

Starship Enterprise Quilt
(Summer 2007)

- A 4' x 4.5' quilt depicting the Enterprise D from the television series *Star Trek: The Next Generation*.

http://blondegeek.net/projects/sewing/startrek.php

REFERENCES

Professor Janet Conrad
Laboratory for Nuclear Science
Massachusetts Institute of Technology
Cambridge, MA 02139
617.324.6281
conrad@mit.edu

Eric Davy
Davy Architecture, Principal Architect
811 Tenth Avenue
San Diego, California 92101
619.238.3811
edavy@davyarchitecture.com

Jennifer A. Connolly
Assistant Registrar
Massachusetts Institute of Technology
77 Massachusetts Avenue, Room 5-111
Cambridge, MA 02139
617.258.6435
jconnoll@mit.edu

6.3 Samples of Proposer's Previous Works

Photos to Accompany CV

Tess E. Smidt

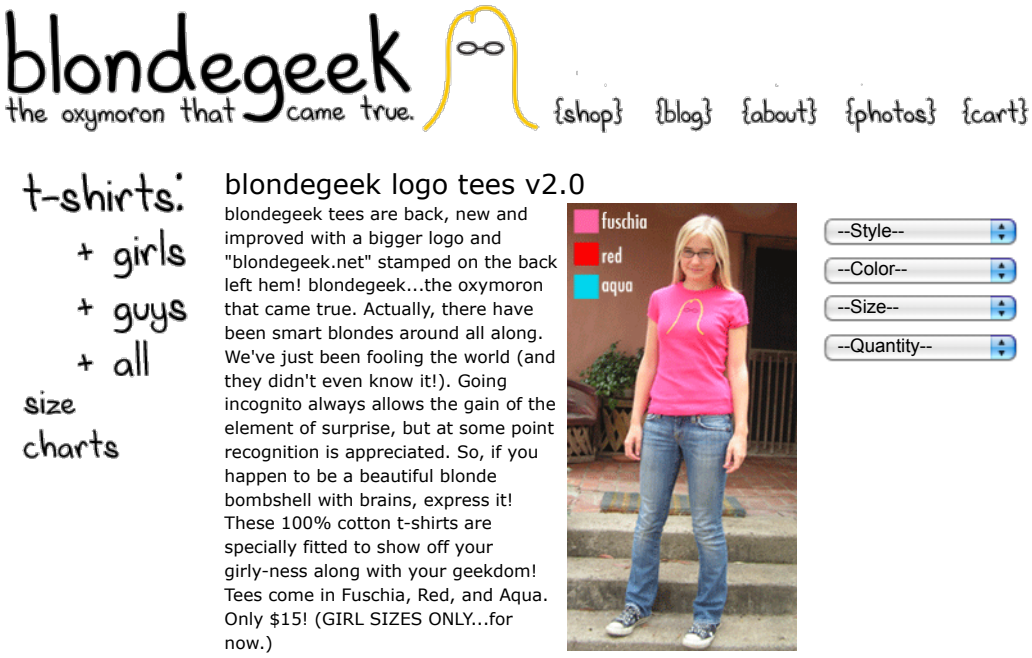
MIT 2012 Ring Committee

2012 "Brass Rat" Shirt

blondegeek

Storefront

Example Product Page



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2008/03
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2010/06
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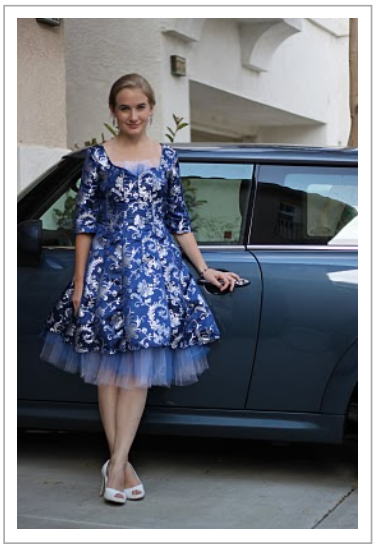
Friday, August 06, 2010

Breadboard Crumbs

After an incredible month at Fermilab, I'm back in San Diego. I'm a little late in reporting in since I returned to the West Coast a few weeks ago, but no matter. I've spent most of the past three weeks, taking advantage of the fact that it's summer and I don't have any immediate obligations. Still, I've had a few projects swimming around in my head, some even making it past the drawing board.

First, there was the unexpected opportunity to go to Comic-Con (major kudos to mi amigo Dylan) which naturally sparked my not necessarily reasonable need to sew a dress for the occasion. Forget cosplay, I just wanted to get dolled up!

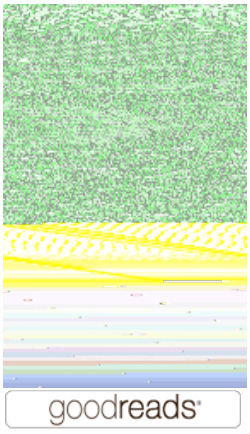


The original idea was a tad different...

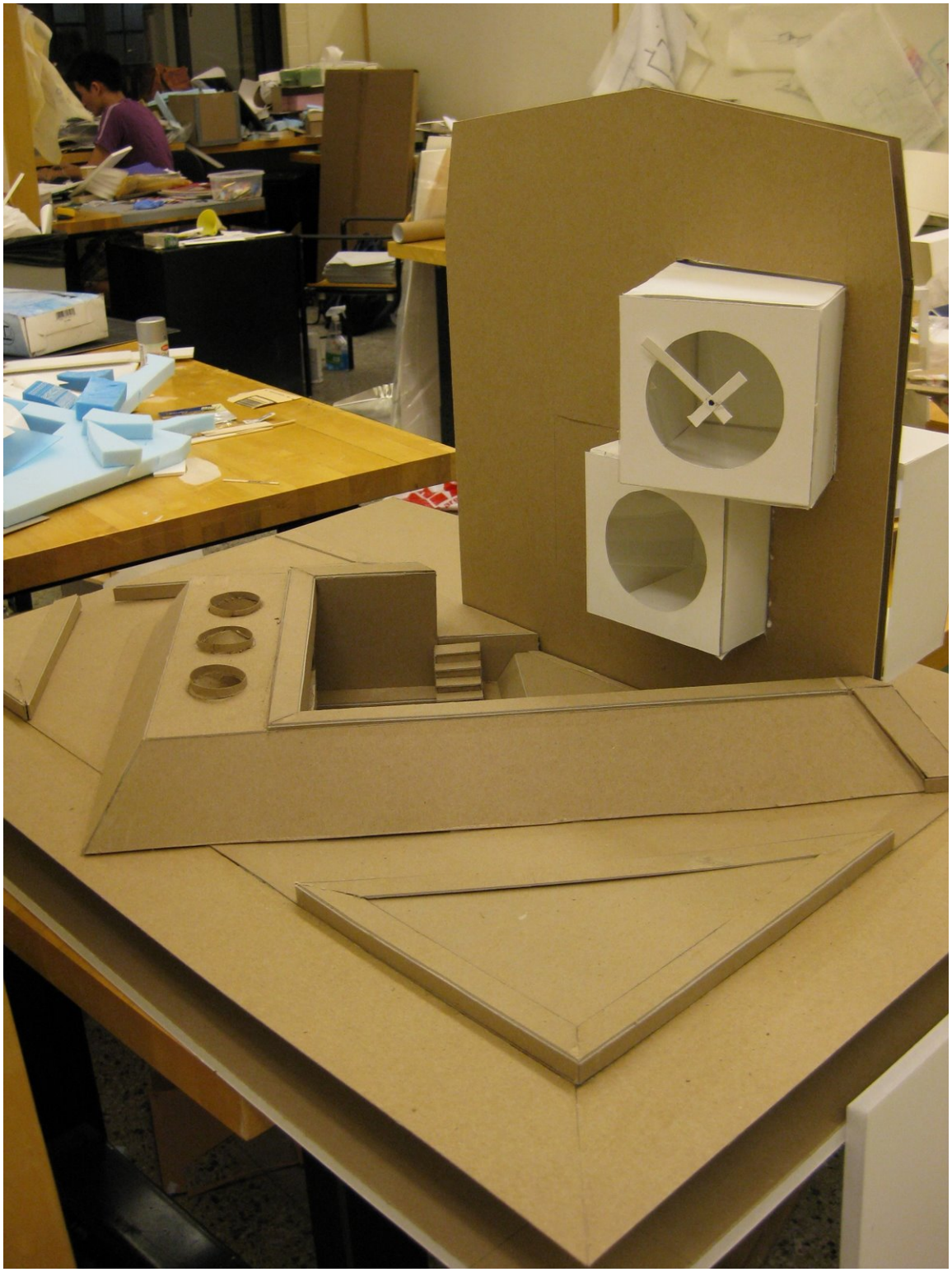
other archives.

>> projects 2006-2008
>> ye (olde)^2 stuff

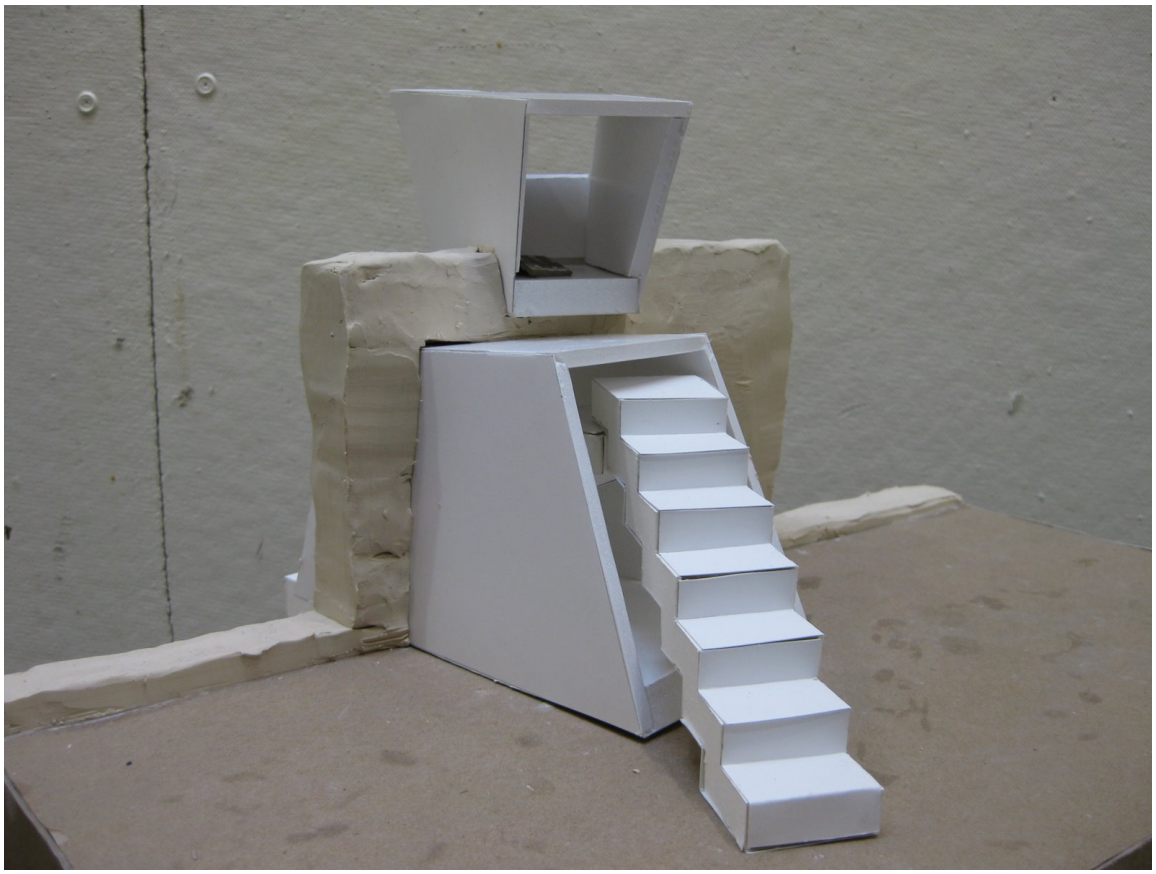
*these will open up in different windows due to the likelyhood of ancient broken links.



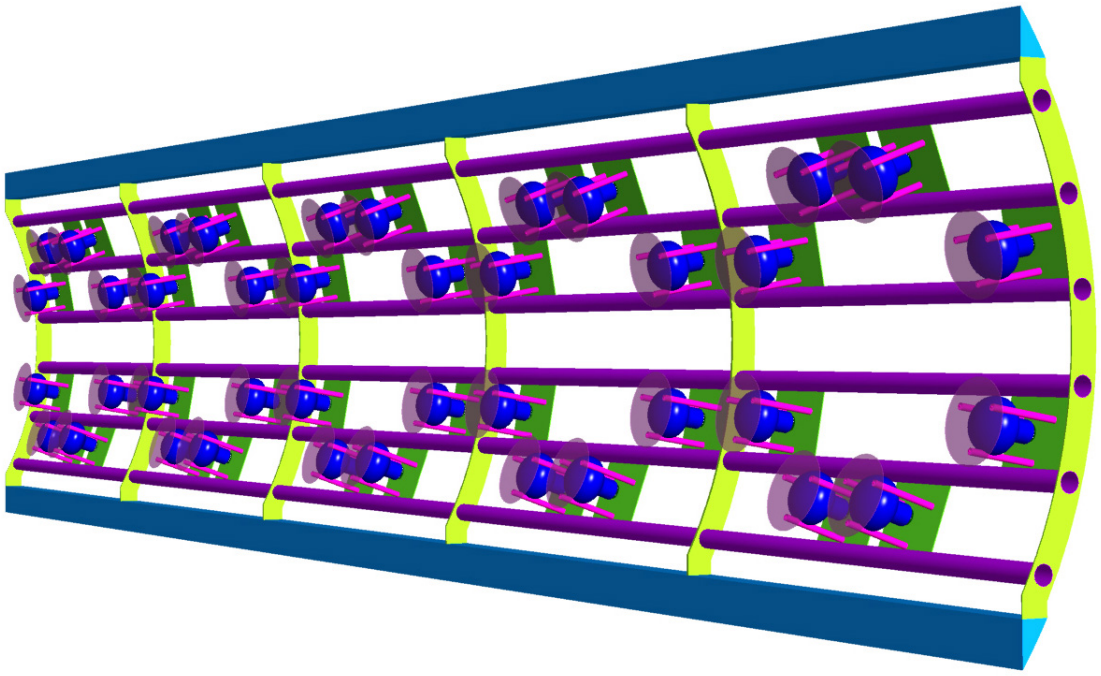
Writer's Boston Residence

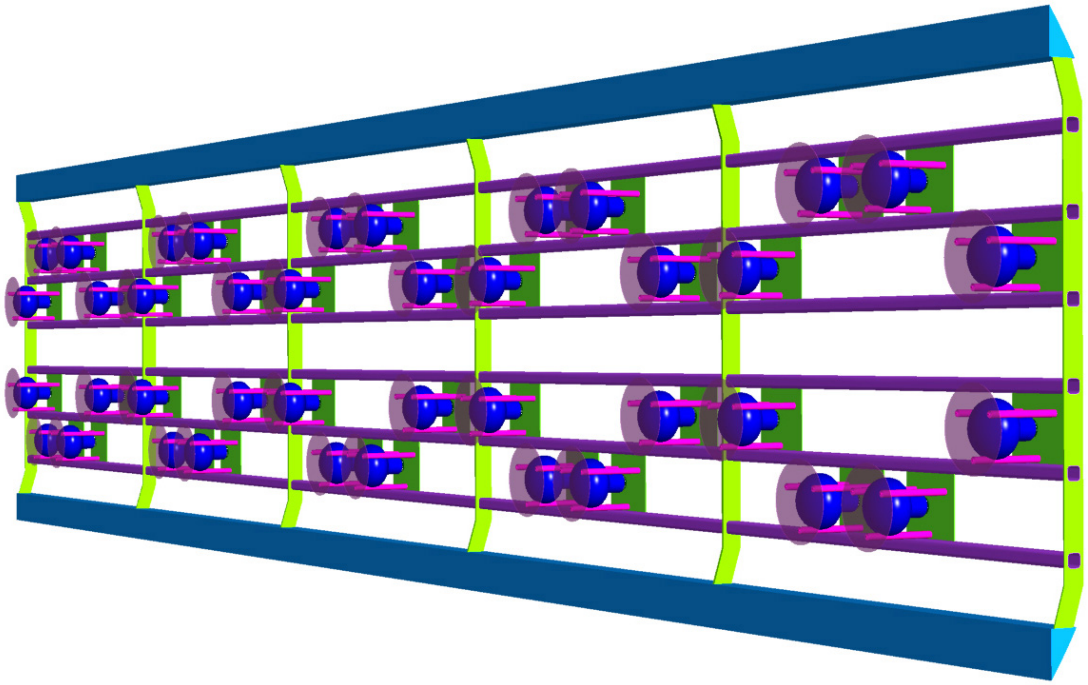


Reading and Writing Space
At the Border of a Beach and Meadow



Photomultiplier Rack for MicroBooNE



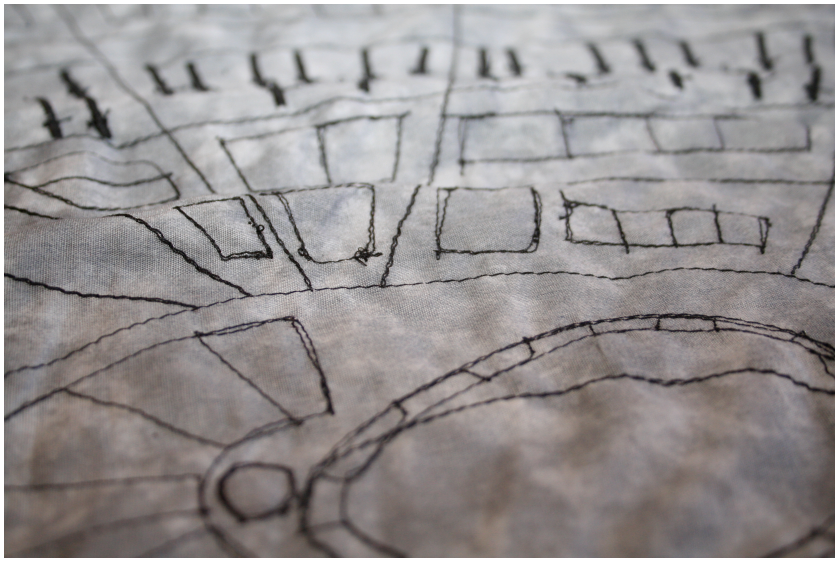


Blue and Silver Modern 1700s Dress

View onto a Japanese Garden

Mondrian Dress

Starship Enterprise Quilt



6.4 Letters of Correspondence and Permission to Use Public Space

From: Tess Smidt <blondegeek@gmail.com>
Subject: **PROJECT/ EXHIBIT REVIEW FORM**
Date: September 9, 2010 6:49:01 PM EDT
To: cust-coach@mit.edu
Cc: kblass@mit.edu, cohen@media.mit.edu

PROJECT/ EXHIBIT REVIEW FORM

Exhibitor Name: Tess Smidt
Department: Laboratory for Nuclear Science, Department of Physics
Professor/ Supervisor/ Sponsor: Janet Conrad
Project Description (also fill in the applicable safety info below):

I am proposing to create an art installation that unites both of my undergraduate disciplines: physics and architecture. The inspiration for this project comes from my work with the MIT Neutrino group and has been fed by my passion of design. My hope is to illuminate a beautiful, mysterious aspect of nature that usually passes unnoticed.

Cosmic rays are high speed protons from outer space that bombard the Earth's atmosphere. When a cosmic ray crashes into the atmosphere, it causes a shower of muons and other delicious flavors of particle soup. Cosmic ray showers pour down on Earth's surface continuously. In fact, hundreds of these showers go through a person everyday. It's quite a spectacle when viewed on an oscilloscope, and I would like to put that spectacle on public display.

To do this, I want to build a contorted acrylic chandelier that would light when cosmic ray showers pass through it. The chandelier will consist of three major components: detectors, the lighting circuit, and acrylic rods. The notebook-sized detectors, called paddles, will be borrowed from the MIT Neutrino Lab. When a muon goes through a paddle it outputs an electrical signal, the strength of which depends on the energy of the muon. This signal will then be sent to a circuit board that will control LEDs to light the chandelier.

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The chandelier would either hang in the MIT Neutrino Group hallway or another location deemed appropriate for the installation. This first version of the chandelier is a very basic presentation and if it is successful I would like to create a larger, more detailed version to install along the Infinite Corridor.

The chandelier will translate the presence of cosmic rays into an accessible and aesthetically pleasing medium, so that viewers can be inspired by this natural phenomenon. The chandelier

will serve as a public window to view these striking and secretive signatures from space, and show that our surroundings consist of much more than just what we see.

Date(s) and Time(s) that the exhibit/ project will be displayed :
Start - December 2010
End - Unknown (Not set. Up for discussion. Preferably, as long as possible)

Location of Exhibit requested:
1st choice: Walkway between 16 and 26 on the 5th floor
2nd choice: In the corridor of 26 on the 5th floor.

If the space administrator approves this request, they will change location requested to approved by (their name & dept), then forward this to safe-project@mit.edu and copy the exhibitor. If the space can not be used, the space administrator will reply to the exhibitor.
****
Exhibit Information reviewed by the Space Administrator and Safety Program
____Size: dimensions, at or above ground level, weight?
+ Approx. 3.5' x 3.5' x 2' (height). Attached to ceiling. Approx. 20-30 lbs.
____What materials will be used and are these treated with fire retardant?
+ Misc. electronics, photomultiplier tubes, acrylic, wire, metal fastenings.
____Will it be constantly attended? Is it interactive?
+ It will not be attended. It is not interactive.
____Any moving parts, sharp edges or points? How will these be protected?
+ No moving parts or sharp edges. All components will be out of reach of the normal hallway goers.
____If electricity, pressure, etc will be used, how will it be de-energized and made safe?
+ Electricity needed to power circuit board, LEDs and high voltage supply (estimated at 1200-1500V) for photomultiplier tubes. Safety precautions need to be discussed.
____I plan to remove, dispose &/ or clean-up my project by (exhibitor fills in date)
+ Yes, with the help of persons from my lab who have been trained to handle photomultiplier tubes and high voltage supplies.

Safety Program?s recommendations:
____Move project to a safer location
____Requires Electrical Approval, forward to dboyer@PLANT.MIT.EDU
____Requires Structural Approval, forward to kcollupy@plant.mit.edu,
____Requires MIT Police Dept Approval/ Notification, forward to cp-command@mit.edu
____Obtain a Permit from _____
____Other
Reviewed by (staff person?s name) MIT Safety Program, EH&S Office (N52-496, phone x2-3477, fax x8-6831) (Safety Program will forward this request and copy

the exhibitor.)
****
Requirements of other departments:
****
(When all approvals are completed, exhibitor & professor/ supervisor sign final message.)
EXHIBITOR STATEMENT: I understand the above requirements and will abide by them. I will post the original signed form next to/ on the exhibit. I will mail or fax a hard copy to the space administrator and the MIT Police Dept. I understand it is my responsibility to remove, dispose of and/ or clean up all materials and to pay for any removal/cleaning costs if this is not done immediately after the exhibit.
SIGNATURE & DATE _____

PROFESSOR/ SUPERVISOR/ SPONSOR STATEMENT: To my knowledge, I certify that the above individual(s) has/have complied with all of the above requirements and conditions. I understand my responsibility to ensure the safety of this exhibit/ project.
SIGNATURE & DATE _____

From: Tess Smidt <blngeek@mit.edu>
Subject: **Projects/Exhibits in Public Spaces Form - Cosmic Ray Chandelier**
Date: October 13, 2010 9:31:45 AM EDT
To: cust-coach@mit.edu
Cc: Kathryn Blass <kblass@mit.edu>, Susan Cohen <cohen@media.mit.edu>

PROJECT/ EXHIBIT REVIEW FORM

Exhibitor Name: Tess Smidt
Department: Physics
Professor/ Supervisor/ Sponsor: Professor Janet Conrad, Sponsored by the MIT Art Council
Project Description (also fill in the applicable safety info below):

The project is an art installation that includes a chandelier of contorted acrylic that is lit upon detecting cosmic ray events. Cosmic rays are protons from outer space that collide with the Earth's atmosphere and cause the create of several particles, the sum of which is called a cosmic ray event.

These particles are detected with scintillator paddles made of a piece of scintillating plastic attached to a photomultiplier tube that detects light created in the plastic by high energy charged particles that move through it. The photomultiplier tubes are supplied high voltage (approximate1500 V) through a base that only requires an input voltage of 5V and attaches directly to the photomultiplier tube. This eliminates any high voltage cabling and any risk associated with such cabling.

The signal from the phototube is then sent to a circuit involving a Arduino board (a pre-made board of analog -> digital inputs, digital outputs and a microcontroller) which does calculations based on the inputted signal and then outputs instructions for the LEDs that light the chandelier. The LEDs for the chandelier will be attached to the back of the acrylic rods that make up the chandelier. The circuitry for the detectors and signal interpretation will be enclosed and either installed on ceiling or off to the side in the hallway, out of the way of foot and cargo traffic.

The acrylic rods will be fastened to a metal frame that will then be attached to the ceiling. Facilities will be hired to install the chandelier and joining apparatuses to the ceiling as to ensure everything is secure by required standards.

Date(s) and Time(s) that the exhibit/ project will be displayed :

This will be a semi-permanent installation starting late in the spring semester.

Location of Exhibit requested:

The walkway between buildings 16 and 26 on the 5th floor. It is a walkway made mostly of glass windows and has a very high ceiling, perfect for this kind of project.

If the space administrator approves this request, they will change location requested to approved by (their name & dept), then forward this to safe-project@mit.edu and copy the exhibitor. If the space can not be used, the space administrator will reply to the exhibitor.
****

Exhibit Information reviewed by the Space Administrator and Safety Program
____Size: dimensions, at or above ground level, weight?
The bottom of the chandelier will be at least 8' above floor level. The chandelier will have approximate dimensions of 4' wide x 4' long and 2.5' tall (depending on ceiling height).

____What materials will be used and are these treated with fire retardant?
The materials of this project include: acrylic, electronics, metal fastenings. I do not believe that any of these require fire retardant, but if I am told otherwise I will apply it as required.

____Will it be constantly attended? Is it interactive?
The installation will not be constantly attended and is not interactive. At the beginning, I will check on it at least biweekly to ensure everything is working properly.

____Any moving parts, sharp edges or points? How will these be protected?
None.

____If electricity, pressure, etc will be used, how will it be de-energized and made safe?
Electricity will be used. An electric outlet will be specifically installed for this project. I will ensure that all the electrical components are properly grounded and dissipate heat as to not risk any chance of fire or melting.

____I plan to remove, dispose &/ or clean-up my project by (exhibitor fills in date)
Whenever MIT administration, facilities or the Laboratory for Nuclear Science ask me too.

********ADDITIONAL NOTES********

This project has already been reviewed by Kathryn Blass and Steve Gilligan.

****

Safety Program's recommendations:
____Move project to a safer location
____Requires Electrical Approval, forward to dboyer@PLANT.MIT.EDU
____Requires Structural Approval, forward to kcollupy@plant.mit.edu,
____Requires MIT Police Dept Approval/ Notification, forward to cp-command@mit.edu
____Obtain a Permit from _____
____Other
Reviewed by (staff person's name) MIT Safety Program, EH&S Office (N52-496, phone x2-3477, fax x8-6831) (Safety Program will forward this request and copy the exhibitor.)
****
Requirements of other departments:
****
(When all approvals are completed, exhibitor & professor/ supervisor sign final message.)
EXHIBITOR STATEMENT: I understand the above requirements and will abide by them. I will post the original signed form next to/ on the exhibit. I will mail or fax a hard copy to the space administrator and the MIT Police Dept. I understand it is my responsibility to remove, dispose

of and/ or clean up all materials and to pay for any removal/cleaning costs if this is not done immediately after the exhibit.
SIGNATURE & DATE _____

PROFESSOR/ SUPERVISOR/ SPONSOR STATEMENT: To my knowledge, I certify that the above individual(s) has/have complied with all of the above requirements and conditions. I understand my responsibility to ensure the safety of this exhibit/ project.
SIGNATURE & DATE _____

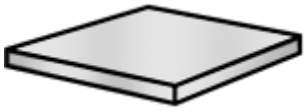
6.5 Vendor Price Quotes

Plastics

Part Number: **8725K16** $5.19 Each

Material	Acrylic
Acrylic Material	Extruded Acrylic
Backing	Plain Back
Finish	Smooth
Shape	Sheets, Bars, Strips, and Cubes
Sheets, Bars, Strips, and Cubes Type	Rectangular Strip
Thickness	3/16"
Thickness Tolerance	±.019"
Length	6'
Length Tolerance	+1"
Width	1"
Width Tolerance	±.030"
Clear	Clear with No Tint
Operating Temperature Range	+40° to +150° F
Softening Point	+191° to +239° F
Performance Characteristic	Weather Resistant
Tensile Strength	Good
Impact Strength	Poor
Tolerance	Standard
Hardness	Not Rated
Specifications Met	Not Rated
Note	UV-Resistant

Plastics



Part Number: **8560K239** $7.38 Each

Material	Acrylic
Acrylic Material	Cast Acrylic
Backing	Plain Back
Finish	Smooth
Shape	Sheets, Bars, Strips, and Cubes
Sheets, Bars, Strips, and Cubes Type	Square Sheet
Sheet Style	Standard
Thickness	1/8"
Thickness Tolerance	+.015", -.025"
Length	12"
Length Tolerance	±1/4"
Width	12"
Width Tolerance	±1/4"
Clear	Clear with No Tint
Operating Temperature Range	-20° to +170° F
Softening Point	+196° to +239° F
Performance Characteristic	Weather Resistant
Tensile Strength	Good
Impact Strength	Poor
Tolerance	Standard
Hardness	Rockwell M90-M103
Specifications Met	Not Rated

Current Items In Shopping Cart

Sign in and minimize your typing! Just enter your User ID and Password:

Log In

Item	Quantity	Qty to Ship	Unit Cost	Total
PWR SPLY,SW,ENCL,250W,5V@40A 90-132/176-264@47-63HZ,UL  **Part no. 2104621** Manufacturer: MEAN WELL Manufacturer no.: S-250-5 ***Non-Cancelable Non-Returnable***	1 Remove	1 on 10/19/10	$55.95	$55.95

Subtotal: $55.95

UPDATE CART CONTINUE SHOPPING PROCEED TO CHECK OUT

Need Assistance?

Order Questions

- Shipping Schedule & Rates
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My Account Questions

- How do I register?
- What if I forget my password?
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search Go

- Products
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- New Products
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- Books
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  - Beagle
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  - Cirrus
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  - LPC
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  - PICAXE
  - PSoC
  - Roomba
  - SAM
  - ST
  - STAMP
  - TMS
  - Wiring
  - WIZnet
  - XMOS
  - Zune
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- Gift Certificates
- GPS
- Kits
- LCDs
- Port-O-Rotary
- Programmers
- Prototyping
- Retired

Home | Development Tools | Arduino | DEV-09950

Product Info

RoHS✓

Arduino Uno

sku: DEV-09950

Description: Arduino is an open-source physical computing platform based on a simple i/o board and a development environment that implements the Processing/Wiring language. Arduino can be used to develop stand-alone interactive objects or can be connected to software on your computer (e.g. Flash, Processing, MaxMSP). The open-source IDE can be downloaded for free (currently for Mac OS X, Windows, and Linux).

This is the new Arduino Uno. In addition to all the features of the previous board, the Uno now uses an ATmega8U2 instead of the FTDI chip. This allows for faster transfer rates, no drivers needed for Linux or Mac (inf file for Windows is needed), and the ability to have the Uno show up as a keyboard, mouse, joystick, etc.

Can't decide which Arduino is right for you? Arduino buying guide!

Features:

- ATmega328 microcontroller
- Input voltage - 7-12V
- 14 Digital I/O Pins (6 PWM outputs)
- 6 Analog Inputs
- 32k Flash Memory
- 16Mhz Clock Speed

Documents:

- Arduino Home Page
- How To
- Programming Reference
- Arduino Forum

Pricing

728 in stock
backorder allowed

$29.95	price
$26.96	10-99 (10% off)
$23.96	100+ (20% off)

1 quantity

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USB Cable A to B - 6 Foot
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- Australian Dollar
- British Pound
- Euro

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What's on your mind?

Please include your email address if you'd like us to respond to a specific question.

submit

If you would like to tell us more, you can fill out our form if you need some psycho-suggestive questions. Go to the form.

Zoom View

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OPTIX 36 in. x 72 in. Acrylic Sheet

Model # MC-10 Internet # 202038046
Store SKU # 241923

$47.75/EA-Each

Ships FREE with $249.00 Order

Average Customer Rating
4 out of 5

Write a review for a chance to win a $1,000 Gift Card.

Read Reviews › Write a Review ›

$47.75/EA-Each

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SHOPPERS WHO VIEWED THIS ITEM ALSO VIEWED

48 in. x 96 in. 118 Acrylic Mirror

$190.00/Each

+ ADD TO CART

48 in. x 96 in. 220 Frosted Acrylic Sheet

$342.00/Each

+ ADD TO CART

48 in. x 96 in. 118 Frosted Acrylic Sheet

$192.00/Each

+ ADD TO CART

Description

The OPTIX 36 in. x 72 in. Acrylic Sheet is easy to work with, so you can use it for a variety of do-it-yourself projects. It is lightweight and cuts easily with a few common tools. Ideas for home projects include cabinet fronts, dollhouses and window boxes. The acrylic sheet's impact resistant and insulating properties make it a sound alternative to glass for such things as garage door windows and storm windows.

- Acrylic sheet is strong
- Clear sheet allows light into your garage or cabinet
- Lightweight and easy to handle
- Cuts easily with common tools
- Highly insulating
- Washes easily with a soft cloth and mild soap with water
- MFG Brand Name : OPTIX
- MFG Model # : MC-10
- MFG Part # : MC-10

Specifications

- **Assembled Depth (in.)** : 72 in
- **Assembled Height (in.)** : 0.093 in
- **Assembled Width (in.)** : 36 in
- No
- **Hardware Category** : Glass/Plexiglass
- **Item Package Type** : No Package
- **Item Weight** : 10.51 lb
- **Mirrored** : No
- **Product Length (in.)** : 72 in
- **Product Thickness (in.)** : .093 in
- **Product Weight (lb.)** : 12.29
- **Product Width (in.)** : 36
- **Shatter Resistant** : No
- **Store Sell UOM** : EA-Each
- **Surface Type** : Clear

More Info

Warranty

For warranty information on this product, please call our Internet Customer Service Center at 1-800-435-4654.

Product Detail

Images are for reference only
See Product Specifications

Mouser Part #:	720-LRTBG6SGT1V1U1AA
Manufacturer Part #:	LRTBG6SG-T1V1+U1AA-45+R1T
Manufacturer:	OSRAM Opto Semiconductors
Description:	Standard LED - SMD Red,Green,Blue 625, 528, 458nm

Learn More

Data Sheet

Order quantities greater than 350 may be subject to a minimum order quantity. If a minimum applies, Mouser will contact you.

Availability

Stock: 350 Can Ship Immediately

On Order: 0

Factory Lead-Time:

Enter Quantity: Minimum: 1

Buy Multiples: 1

Select Packaging Option Below

Pricing (USD)

Cut Tape

1: $1.97
10: $1.64
50: $1.48
100: $1.31
250: $1.15
500: $0.99

MouseReel™ Reel Service Fee $7.00
Price will be calculated in cart.

Full Reels of 1000

To purchase full reel, order in multiples of 1000:

1,000: $0.92
2,500: $0.887
5,000: $0.854

More: Get Quote

Full Reel and Broken Reel Options

Reel and Cut Tape

Reel and MouseReel™

Reel Service Fee $7.00

MouseReel™ price is calculated in the cart.
All MouseReel™ orders are non-returnable.

To add to a project, please Log In.

Customers Also Bought...

Specifications | Features | Product Comments | Documents | My Notes

Manufacturer:	Osram Opto Semiconductor	☑
Product Category:	Standard LED - SMD	☑
RoHS:	RoHS Details	
LED Size:	3.5 mm x 3.2 mm x 2 mm	☑
Illumination Color:	RGB	☐
Operating Voltage:	2.1 V, 3.2 V, 3.2 V	☐
Package / Case:	PLCC-6	☐
Wavelength:	625 nm, 528 nm, 458 nm	☐
Luminous Intensity:	1506 mcd	☐
Mounting Style:	SMD/SMT	☐
Operating Current:	70 mA, 50 mA, 50 mA	☐
Viewing Angle:	120 deg	☐
Packaging:	Reel	☐
Maximum Operating Temperature:	+ 100 C	
Minimum Operating Temperature:	- 40 C	
Part # Aliases:	Q65110A4974	

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Show Stocked Products With Similar Attributes.

Show stocked product(s), check and uncheck the boxes above.

Found: 1

Per above selection(s)

Customers Who Bought This Item Also Bought

10/14/2010 10:51 PM

Product Detail	Customer Part #	Order Qty.	Price (USD)	Ext. (USD)
Mouser #: 720-LRTBG6SGT1V1U1AA **Mfr. #:** LRTBG6SG-T1V1+U1AA-45+R1T **Desc.:** Standard LED - SMD Red,Green,Blue 625, 528, 458nm **RoHS:** RoHS Compliant		100 **Packaging Choice:** Cut Tape **Availability** 100 Ships Now	$1.31	$131.00

By submitting your order you agree to these **terms and conditions.**

For additional information on availability, click on the Mouser Part #.

MERCHANDISE TOTAL: $131.00 (USD)

†SHIPPING CHARGE: Estimate

† Mouser Electronics does not charge handling fees. For US shipment, you only pay the actual freight amount charged by the carrier which is determined at the time of shipment.

Checkout - Step 1 of 5

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Qty	Description - Size	Price	Total	Cut Fee
2 Delete	Aluminum 2024-T351 Bare Plate 0.25" Cut to: 12" x 12" **Mill Test Reports (MTR's) are available for this item. They can be requested on step 4.** Optional Reference Numbers	$43.74	**$87.48**	$0.00

Empty the Cart | Change Quantities | Continue Shopping | Continue to Checkout

Sub Total (before taxes if applicable): **$87.48**

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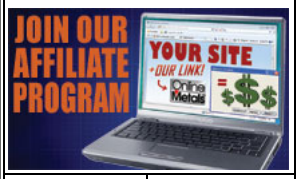

6.6 Roster of Participants

Roster of Participants

Name	Course	Year	MIT Affliation
Tess Smidt	8 and 4	2012	Undergrad.
Mike Stunes	6	2011	Undergrad.
Christy Schwartz	6	2013	Undergrad.
Rachael Batzer	2	2011	Undergrad.