

Rapid Sample Insertion/Extraction Systems for Gamma Irradiation (aka The Rabbit System)

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Overview



- ▶ What is the “rabbit” system?
- ▶ Design
- ▶ Testing
- ▶ Results
- ▶ Improvements



What is the “Rabbit” System?

- ▶ A system of PVC piping that allows a quick and efficient transfer of materials into/out of one of the irradiation chambers in the GIF (Gamma Irradiation Facility) through the use of a 3-D printed “rabbit”
- ▶ The “rabbit” encapsulates material to be irradiated and carries it from a position outside of the chamber to the basket inside of the chamber
 - ▶ This saves time and provides more exact data without delay
- ▶ The “rabbit” is sent through the PVC piping with an advanced bi-directional, high throughput pneumatic system (i.e. a shop-vac)

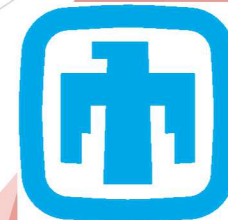
What is the GIF?

- The GIF simulates nuclear radiation environments to test components/materials
- Irradiation takes place in the three test cells—This system will take place in one of the smaller cells



What experiments might this be used with?

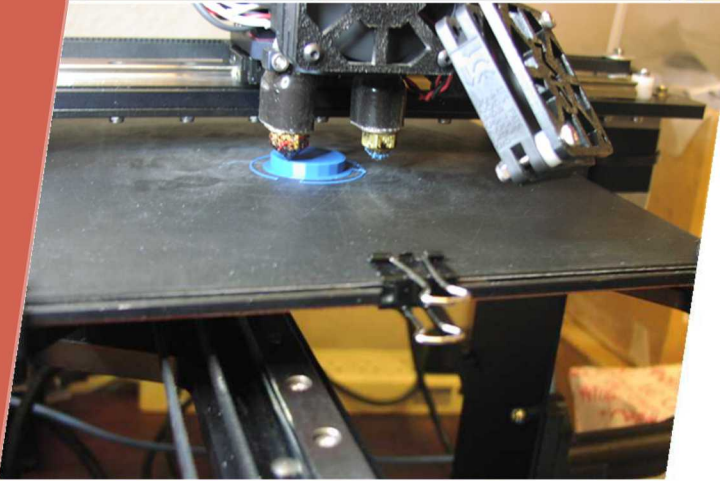
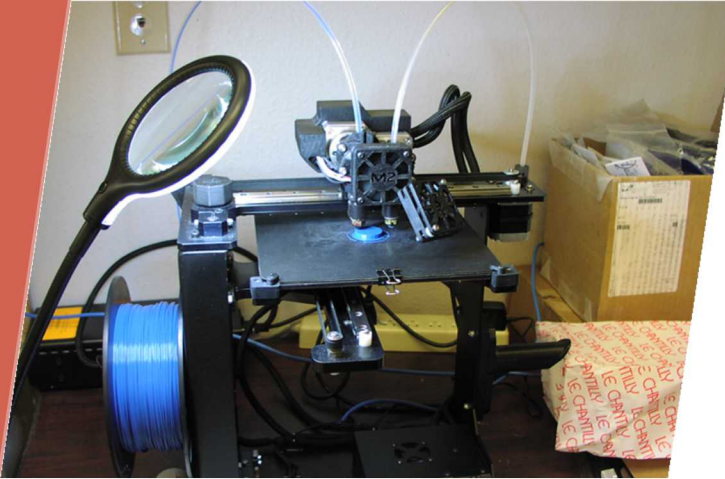
- Testing for electronic-component hardness
- Materials-properties testing
- Investigations of various physical and chemical processes
- Testing and radiation certification of satellite and weapons system electronic components
- Dosimetry calibration
- Investigations of radiation damage to materials.

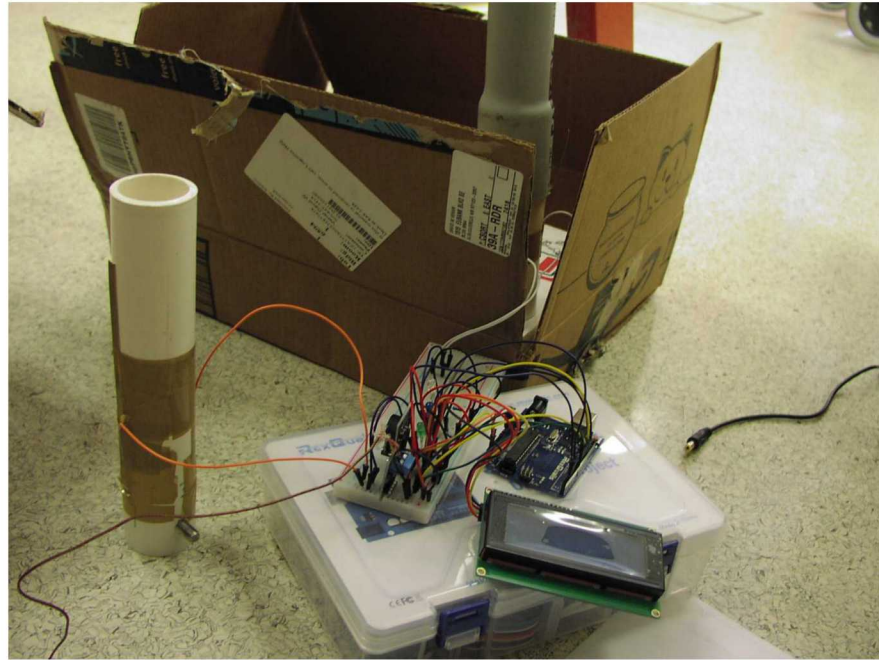
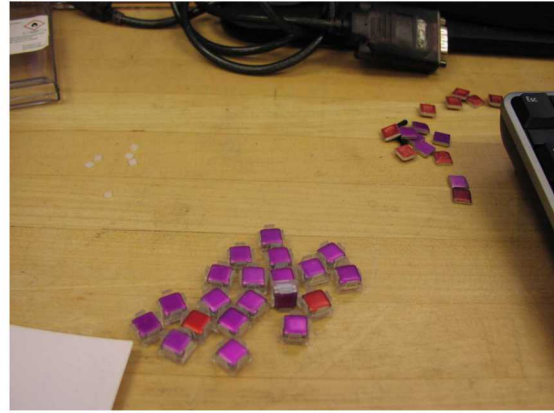
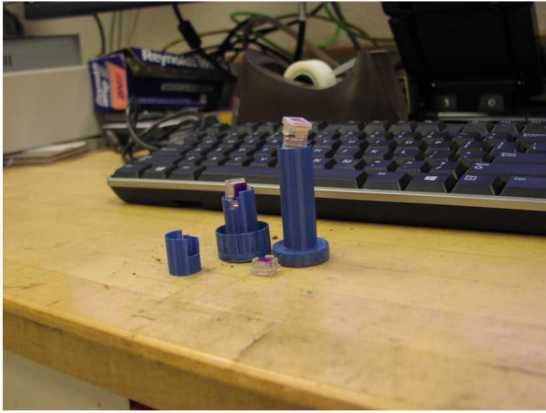


**Sandia
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Design of the “Rabbit”

- ▶ Small shape & curved edges to fit through turns in the pipes
- ▶ Metal to be conductive for measurement of irradiation timing
- ▶ Large enough to both fit objects that need to be irradiated and provide adequate cross sectional area to be pushed/pulled by air currents



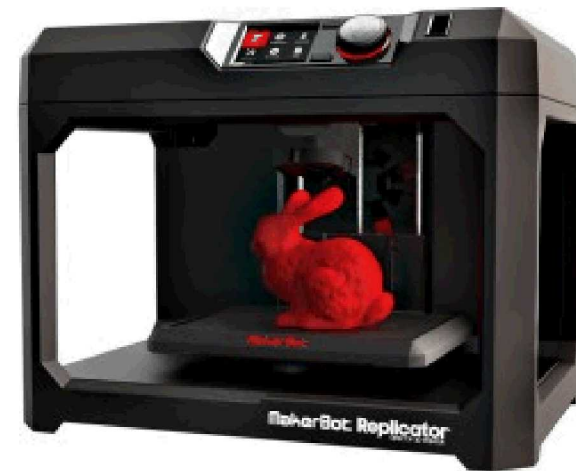
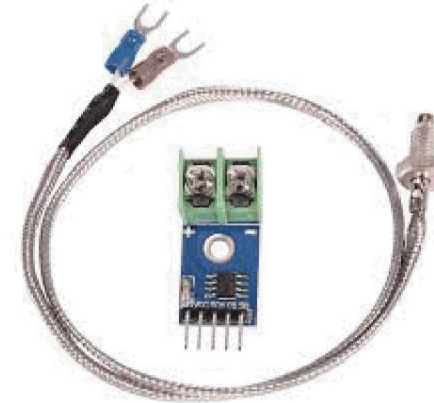
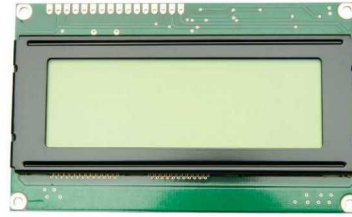
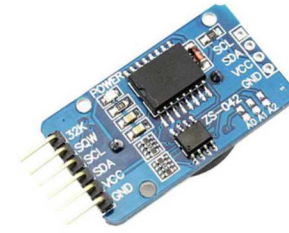


Testing

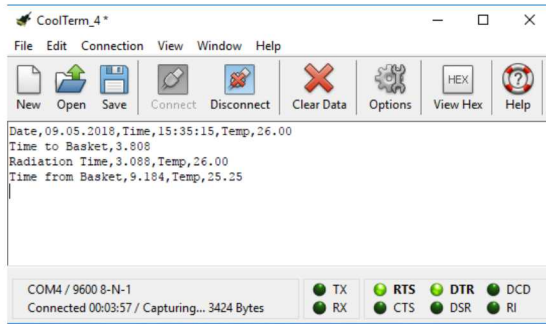
- ▶ Slowing down the rabbit
- ▶ Ensuring the rabbit and the objects inside do not get ruined
- ▶ Field testing the Arduino code to ensure it works perfectly every time

Parts Used

- ▶ Arduino
 - ▶ LEDs
 - ▶ LCD screen
 - ▶ Temperature Sensors
 - ▶ Real Time Clock
- ▶ PVC piping including turns and Y tubes
- ▶ 3-D Printer



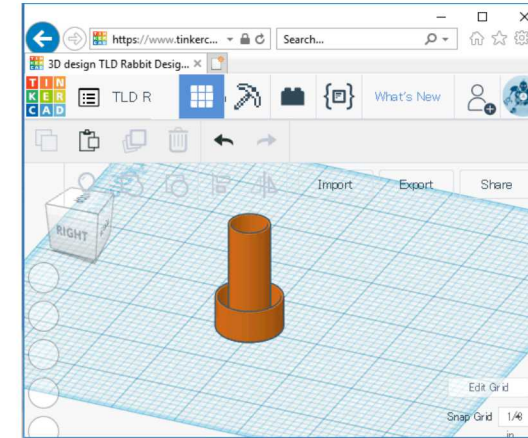
Websites/Programs



```
final | Arduino 1.8.3  
File Edit Sketch Tools Help  
final  
void setup() {  
  pinMode(ledPin, OUTPUT); //Buttons are inputs, LEDES are outputs  
  pinMode(interruptPin, INPUT_PULLUP);  
  pinMode(ledPin2, OUTPUT);  
  pinMode(interruptPin2, INPUT_PULLUP); //Two interrupts for each time that there is a change in either button  
  attachInterrupt(digitalPinToInterrupt(interruptPin), test, CHANGE);  
  attachInterrupt(digitalPinToInterrupt(interruptPin2), test2, CHANGE);  
  lcd.init(); //Initialize the LCD, 20 columns and 4 rows  
  lcd.backlight();  
  rtc.begin(); // Initialize the RTC object  
  lcd.begin(20, 4);  
  Serial.begin(9600); //Initialize the Serial Monitor  
}  
  
void loop() {  
  < >  
}
```

Done uploading
Sketch uses 10618 bytes (32%) of program storage space. Maximum is 32256 bytes.
Global variables use 648 bytes (31%) of dynamic memory, leaving 1400 bytes for local variables. Maximum is 2048 bytes.

114 Arduino/Genuino Uno on COM4



- ▶ Arduino used to keep track of time, temperature, and when the “rabbit” makes it to an end point
- ▶ CoolTerm used to store data from the Arduino in a document
- ▶ Tinkercad used to design objects to 3-D print

Failures

- ▶ High speeds crush rabbits that are sent into the tubing
- ▶ 3-D printing required constant improvements due to changing measurements and weak parts



Results

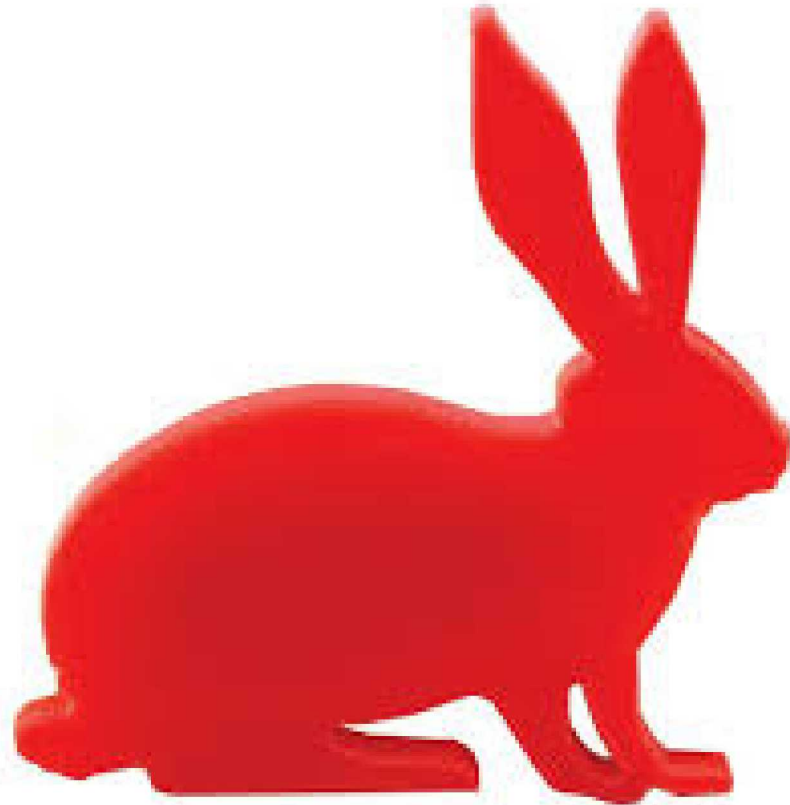
- ▶ A shop-vac can be used to get a “rabbit” holding TLDs through a PVC pipe maze in a short amount of time
- ▶ The time and temperature readings were taken with the Arduino Uno

Improvements

- ▶ Cushion and slow down the rabbit as much as possible to avoid destroying parts of the rabbit or the TLDs inside of it



Questions?



Sources

- ▶ Google.com for every kind of question about Arduino and for images
- ▶ <http://www.instructables.com/id/Setup-for-DS3231-AlarmTimer-Function/>
- ▶ <https://playground.arduino.cc/Code/Stopwatch>
- ▶ <https://cdn.instructables.com/ORIG/FWP/GANS/IDC6NW3L/FWPGANSIDC6NW3L.ino>
- ▶ <https://www.youtube.com/watch?v=NDwSrgfsiYQ>
- ▶ tinkercad.com
- ▶ <http://henrysbench.capnfatz.com/henrys-bench/arduino-temperature-measurements/max6675-temp-module-arduino-manual-and-tutorial/>
- ▶ http://www.sandia.gov/research/facilities/gamma_irradiation_facility.html