Mark SubbaRao – Adler Planetarium
i-Lab Report at I2U2 Meeting
Jan. 8, 2009 (Liz Quigg notes)

Classroom Activities:

The Adler started with classroom (high-school) activities – hour-long classes.
They addressed the science process goals.
Twenty – Thirty classes per year.

Cosmic Ray Class
First: background on Cosmic Ray provided by Mark
Next: Tasks to do with detector. Counts at different angles. Comparing flux rates.
Tasks using data.
Each student calculates their own data point and then they combine their points on a large graph.
Students learned how to do a graph and that science is collaborative.

Example class - see his talk. I2u2_presentation_new

More detail on activity:
Mark identified cosmic ray counts from database
Students converted them to flux (either using an e-Lab or a simple calculation)
humidity data from National Weather Service
Do plot of flux vs. humidity
See CR_lab.pdf

Observations: (nobody reads anything! – students don't listen or read!)

I2u2_presentation_new

Balloon Flight Data Class
2nd Class used balloon flight data – (takes an hour) See 12-15-08 ppt.

Mark thinks it is important for students to take ownership of task to motivate them to do a task. Give them some decisions to make. (in this case, how tall a space elevator could the Adler build without safety jeopardized by radiation.

Science Briefing provided by Mark
Used visualization – atmosphere breaking them up.
Mark pointed out that astronauts in flight claim to have experienced cosmic rays. Perhaps they could record an interview with an astronaut who experience this.

Balloon data – geiger counter
Goes up to 90,000 feet from Kankakee airport
Time series.

Give everybody a piece of data from 25 data points Mark chose carefully). Students put colored stickies on a large plot where the color based on how dangerous they think it will be.
Flash applet provides information on radiation doses.

Mark has not saved any of these plots (e.g., photographing them)

Discussion – how to get more students involved.

Could do more, but someone else would have to do Mark's part.

Prepare a little in advance. Give teachers material in advance.

What should the handouts be? Accounts for e-Lab?

Tom J. suggested workshops for teachers and then they could bring their students in.

Marge suggested an orientation day and materials.

Many suggested making the e-Lab as an entry point to the i-Lab and vice versa.

Mark would like to track what happens to these groups. Do they come back?

This does not include the grid-enabled part.

Exhibits

The Adler is putting the CRL in the telescope gallery exhibit that is being constructed. Mark showed a picture of how it will look.

It will distribute cards to get people to try online experience.

Strings of LEDs will pulse with every Cosmic Ray pulse.
The CRL is encased in the exhibit right now so visitors cannot make it rotate.

Other discussion: Fermi people need to talk to Dan K. about controlling CRL; it also has possibilities for use in the iLabs that the MIT people are developing.

Cosmic Ray Interactive Laboratory

The particles we observe in our detector are secondary cosmic rays, which are produced after a cascade of particle interactions in our atmosphere.

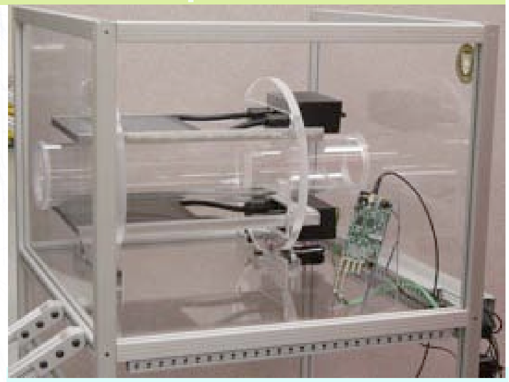
In this investigation we will examine how the humidity of the air effects the cosmic ray flux we measure at ground level.

Cosmic Ray Flux

Our detector simply counts events. The longer we count, the more events we get. Similarly, larger detectors will count more cosmic rays than smaller ones. In order to compare measurements taken over different times and with different detector sizes we measure flux. The cosmic ray flux is the number of flux = counts / time / detector area.

Humidity

The humidity is a measure of the amount of water vapor in the air. Therefore it provides a measure of the amount of water vapor a cosmic ray has to pass through before hitting the ground.



Cosmic Ray Detector

This cosmic ray detector is part of a network of detectors at high schools and museums all across the world.

It is a scintillation detector: when a charged particle passes through the paddle a small pulse of light is emitted. That signal is then amplified and recorded.

Cosmic Ray Flux

Retrieving the Cosmic Ray Flux from the Database

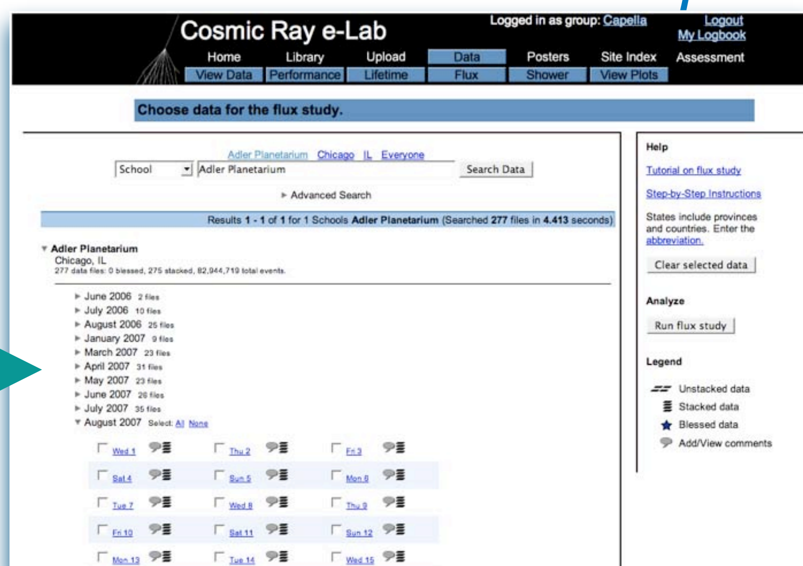
- Log on to eLab: Use the provided Username and Password to log onto the electronic lab .
- Select Data
- Select Flux
- Select Detector
- Use the drop down boxes to select the dates you want
- Press Run Flux Study
- Records Counts in Channel 1
- Click on Geometry and record detector Area
- Calculate Flux (see below)

Click on the triangles next to the detector and months to open up the selection boxes.

Measuring the Current Cosmic Ray Flux

- Measure the counts in 1 minute using the stopwatch and detector readout.
- Calculate the Flux (the area of our detector is 0.0645 m^2)

Cosmic Ray e-Lab



Calculating Flux

The Flux = counts / time /detector area

We will measure the flux in units of counts per meter squared per minute.

For example say the Adler detector gets 100,000 counts in a day.

The area of the detector is 645 cm^2 or .0645m^2.

There are 24*60=1,440 minutes in a day, so the flux is:

100,000 / (0.645m^2 * 1,440 min) = 1076 counts per m^2 per minute.

Humidity

Retrieve Information from the National Weather Service

- Go to the National weather Service site for the appropriate location
- Select Daily Climate Report
- Select location
- Select timeframe
- Press ‘GO’
- Record relative humidity(average)

National Weather Service

Select Most Recent for the current humidity reading or Archive Data for older readings.

NWS Forecast Offices

www.weather.gov/climate/index.php?wfo=

weather forcast offices:
Chicago wfo=lto
Grand Junction Colorado wfo=gjt

Further Consideration

We are attempting to perform a real scientific study in only 20 minutes. In order to do this we've needed to cut some corners. If you have time after you finish your data analysis please try and investigate some of these issues. Understanding the corners we've rounded is critical in interpreting the validity of our results.

Examine the Literature

The Adler detector is part of a network of cosmic ray detectors across the country. Click on the Posters Button to see what analyses students across the country have done. Are any similar to ours? Read their write-ups - do you trust the results?

Errors

In order for a scientific measurement to be meaningful we need to understand how accurate that measurement is. Cosmic rays are random events, and a good estimate of the error of the counts is simply the square root of the number of counts. How significant is the error in comparison to the flux measurement?

Which Humidity

We've been plotting the relative humidity which is the amount water vapor in the air compared to the maximum amount of water vapor the air can hold. Should we be using absolute rather than relative humidity?

How much does the cosmic ray flux vary throughout the day?

We are plotting cosmic ray flux values that are averaged over an entire day. Is that two long? Make a plot of the cosmic flux over the course of a dat to see how much it varies.

Does a day equal a day?

The cosmic ray flux values are broken into days using Universal time (UTC) whereas the NOAA barometric pressure measurements are broken into days according to local time. For example: UTC - CST (Chicago) = 6 hrs, UTc-MST(Aspen) = 7hrs. How much of a problem do you think this is?

Image Credits: NOVA

Welcome to the Space Research Lab at the Adler Planetarium

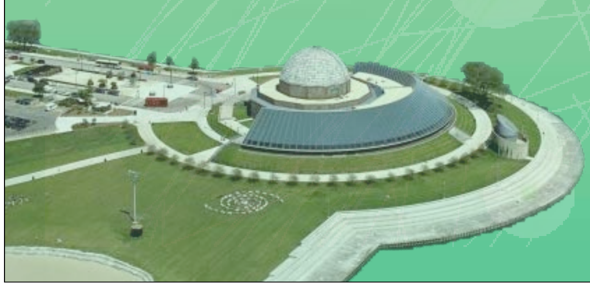
ADLER PLANETARIUM

PHYSICAL SCIENCES INFORMATION TECHNOLOGY EDUCATION

NSF

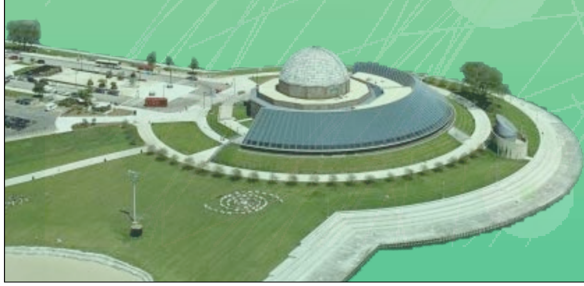
Overview

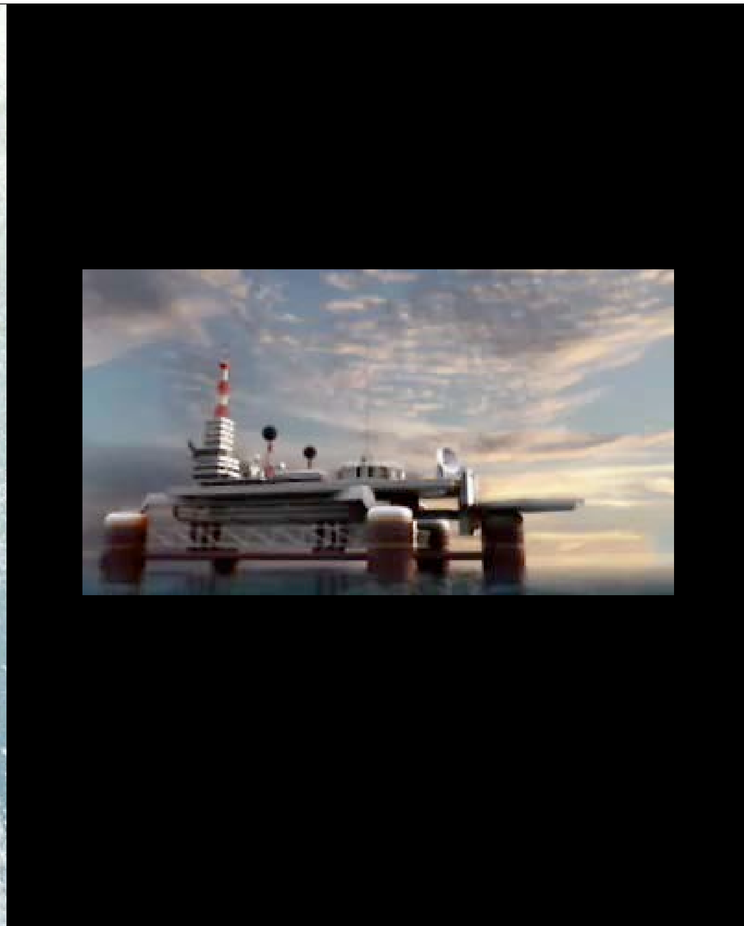
- Mission Briefing
- Science Briefing
- Analysis Task
- Recommendations



Mission Briefing

- Adler expansion plans
- A new Museum on the Space Elevator
- Project description [link]
- How high can we build?
- Cosmic Ray radiation





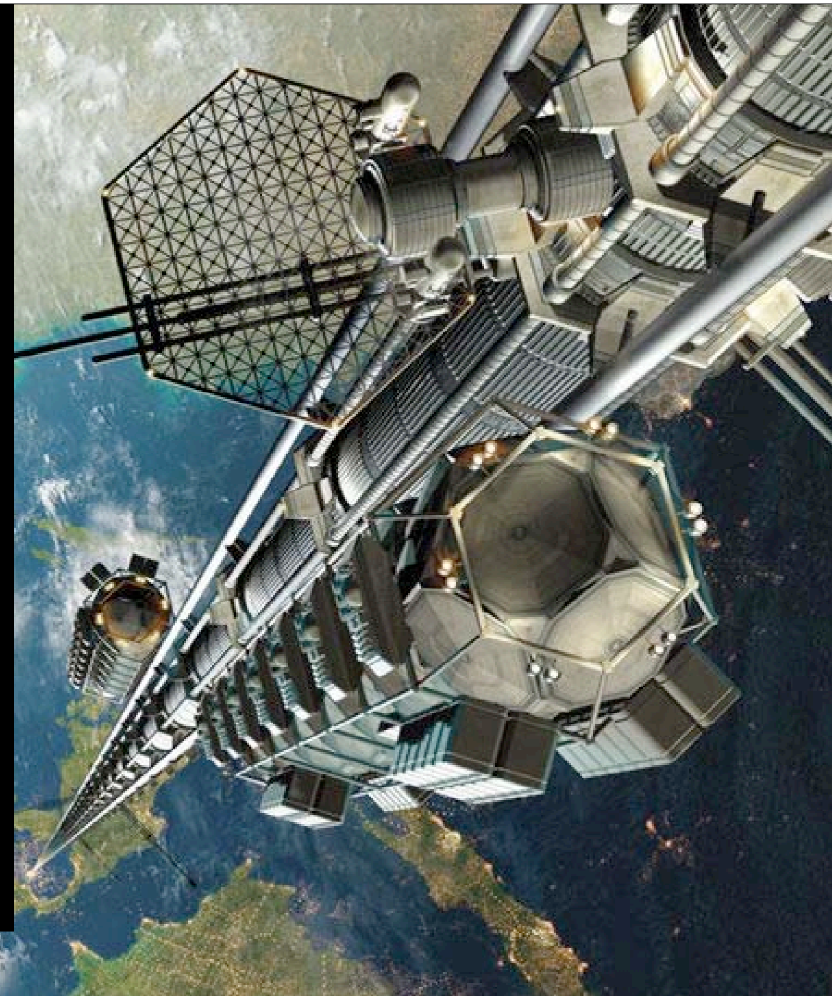


Image Credits: NOVA

Cosmic Ray Science Briefing

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Look around

- Do you SEE any cosmic rays?
- Do you FEEL any cosmic rays?
- Do you HEAR any cosmic rays?

- Cosmic Rays are invisible
- Cosmic Rays are passing through us all the time

What Are Cosmic Rays?

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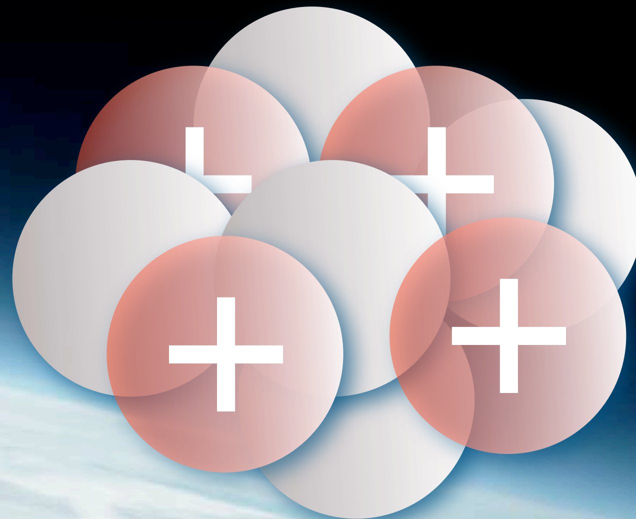
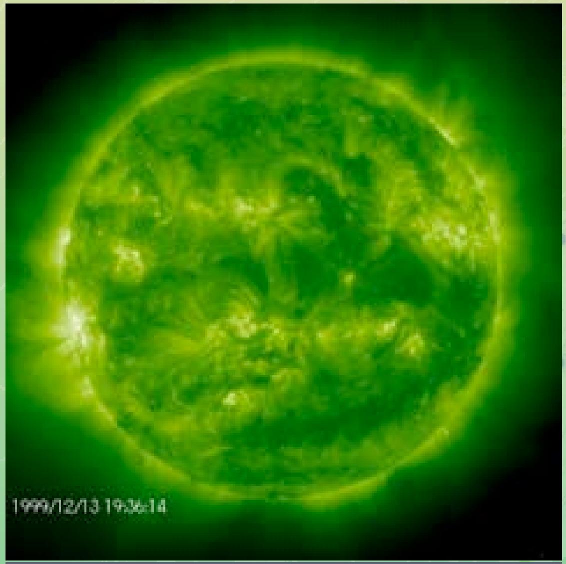
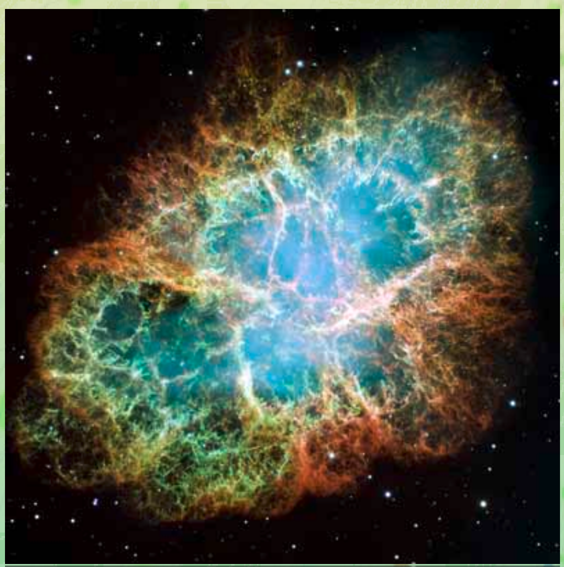


- Cosmic rays are high-energy, elementary particles from space (protons, atomic nuclei)

Where Do They Come From?





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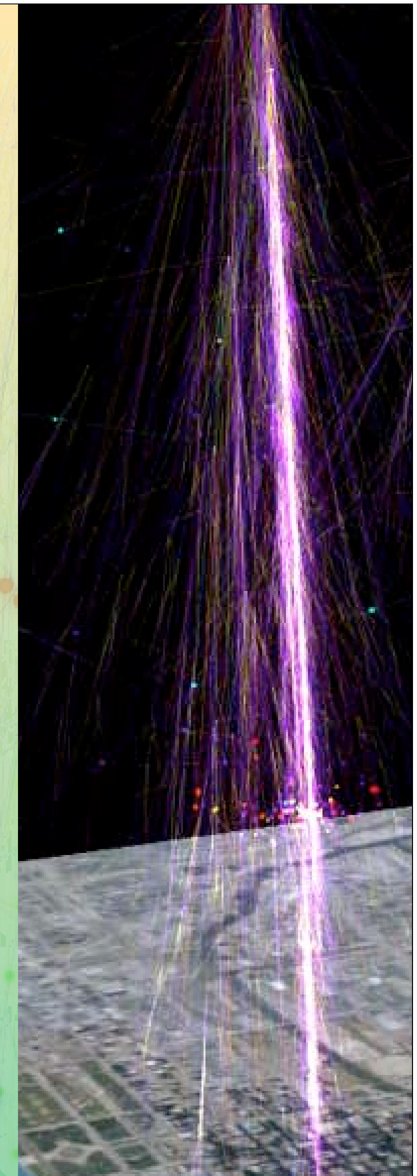
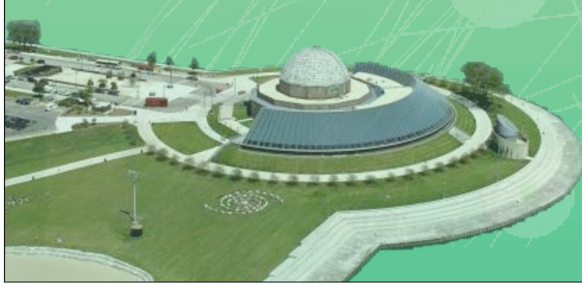
Simulation

- Follow a cosmic ray "trail"
- What do you see?





Why do we care about cosmic rays?

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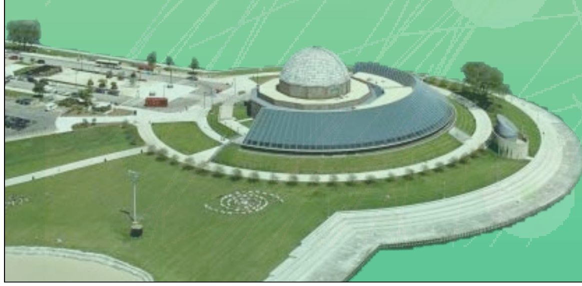
Why do we care about cosmic rays?

Radiation levels are safe on the ground, but increase with altitude.

Instruments on planes, satellites, and spacecraft can be disrupted.

Cosmic rays can disrupt communications.



How do we detect cosmic rays?

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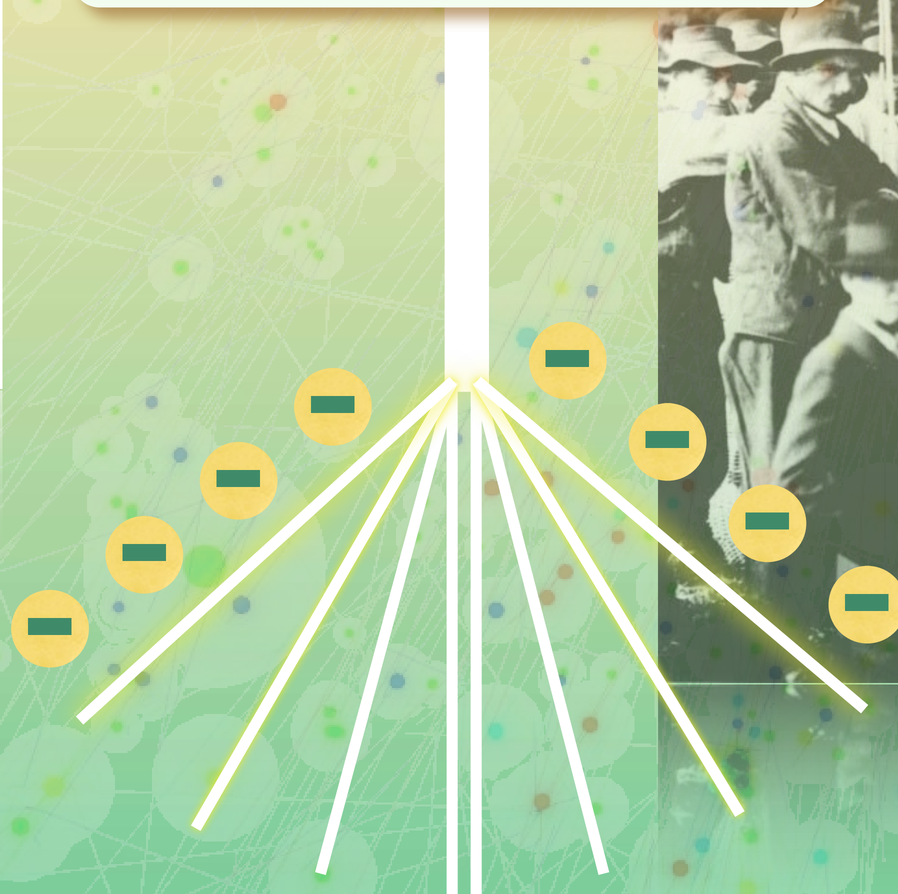
Electroscope



Victor Hess, 1911-12

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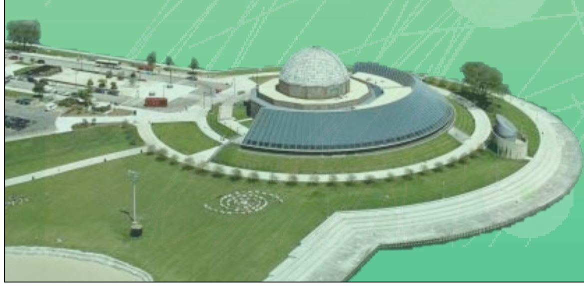
Balloon Flight

We've launched research balloons to 100,00 feet with a Geiger counter to measure cosmic rays. You are going to analyze this data.



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Balloon Flight

Off to the Analysis Task...

Radiation and Health

The dosage of radiation is measured in Sieverts. This depends both on the number and energy of cosmic rays.

Since a Sievert is a lot (1 Sv starts to be deadly) we will measure the dosage in mSv (1/1000 of a Sv).

We get more cosmic radiation the longer we are exposed, so what we will measure is a rate (mSv/year)

Radiation and Health

Rates:

0.3 mSv/yr - radiation from cosmic rays on the ground
2.4 mSv/yr - total natural radiation
50 mSv/yr - US limit for workers

Effects:

500 mSv - Mild radiation sickness
2000 mSv - 10% fatalities, temporary male sterility
4000 mSv - 50% fatalities, internal bleeding
10000 mSv - near 100% fatal

Factor of Safety

The factor of safety is a multiplier we apply to guarantee a safe design.

We will pretend that the design is X times as dangerous

Some safety factors:

- 3-4 Steam Boilers
- 2 Buildings
- 1.5 Airplanes (USAF)
- 1.4 Manned Space Vehicles (USAF)

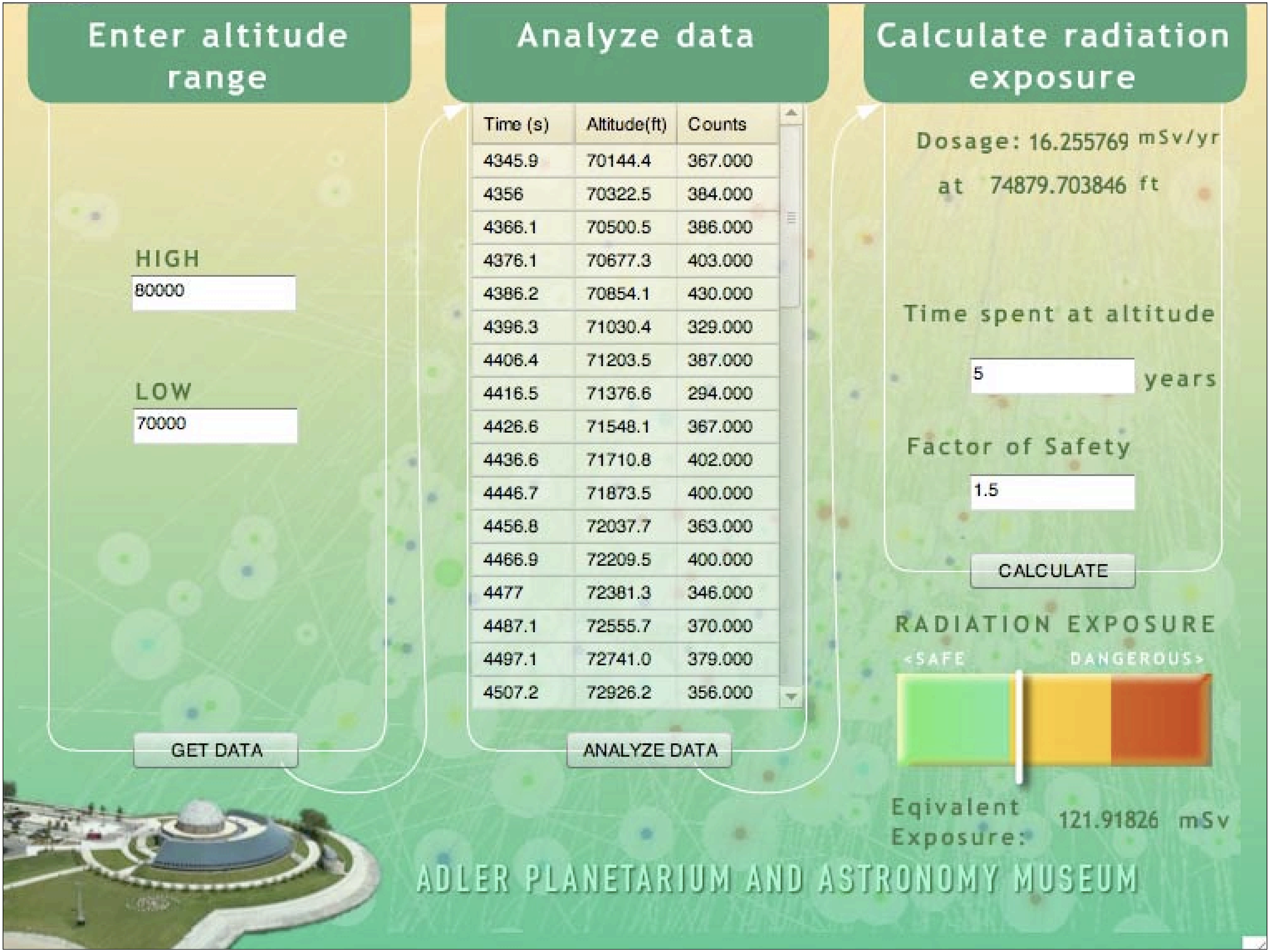
Your Job as an Analyst

Figure out how long people will be exposed.

Choose a factor of safety

The system will tell you if this altitude if safe given your choices about time and safety
(Green= Safe, Yellow=Caution, Red=Danger)

Plot your dots on the chart at the front of the room.


Enter altitude range
HIGH
80000
LOW
70000
GET DATA
Analyze data

Time (s)	Altitude(ft)	Counts
4345.9	70144.4	367.000
4356	70322.5	384.000
4366.1	70500.5	386.000
4376.1	70677.3	403.000
4386.2	70854.1	430.000
4396.3	71030.4	329.000
4406.4	71203.5	387.000
4416.5	71376.6	294.000
4426.6	71548.1	367.000
4436.6	71710.8	402.000
4446.7	71873.5	400.000
4456.8	72037.7	363.000
4466.9	72209.5	400.000
4477	72381.3	346.000
4487.1	72555.7	370.000
4497.1	72741.0	379.000
4507.2	72926.2	356.000

ANALYZE DATA
Calculate radiation exposure
Dosage: 16.255769 mSv/yr
at 74879.703846 ft
Time spent at altitude
5 years
Factor of Safety
1.5
CALCULATE
RADIATION EXPOSURE
<SAFE
DANGEROUS>
Eqivalent Exposure: 121.91826 mSv
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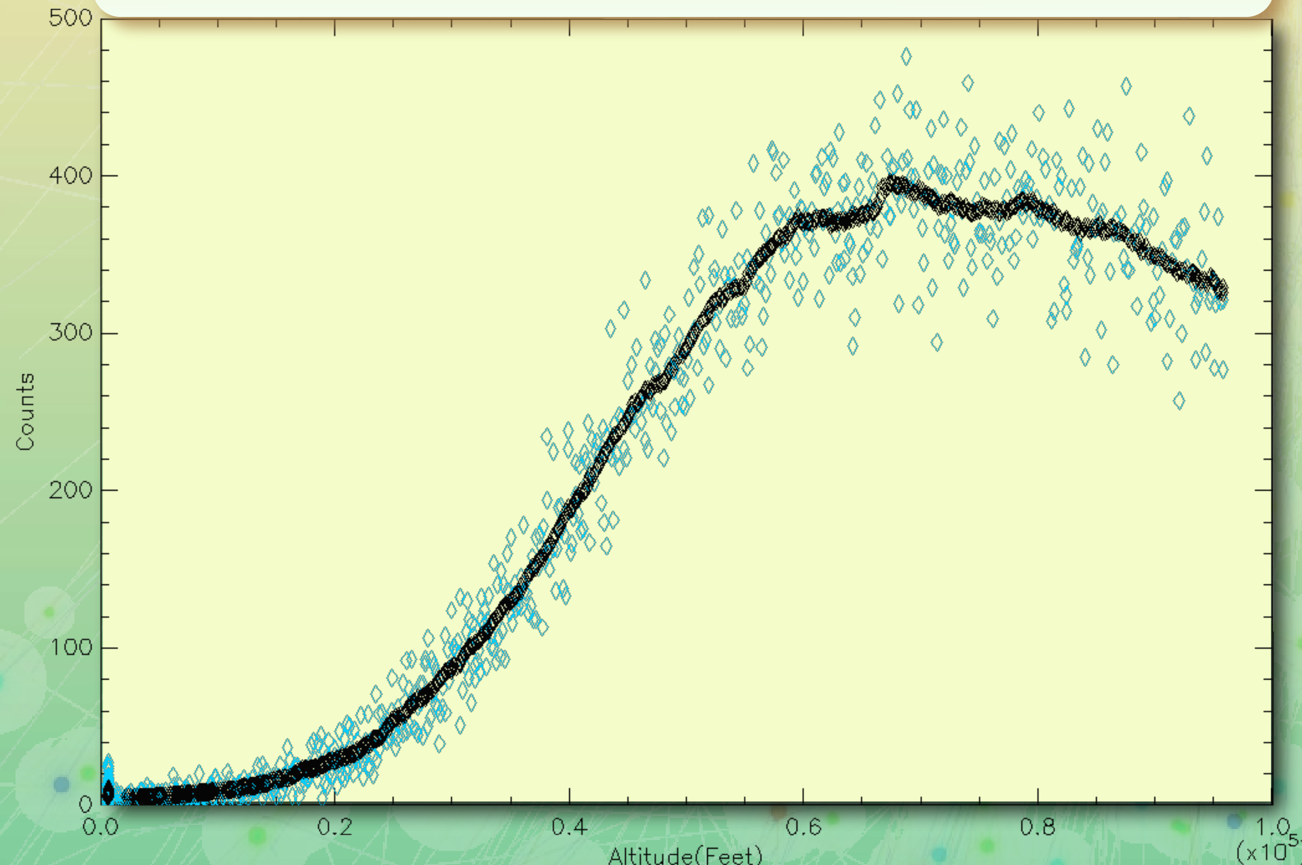
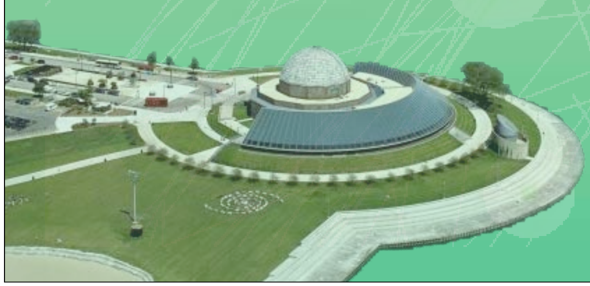
Adler Space data





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