Key tools for in-class experiments related to Earth's climate and weather

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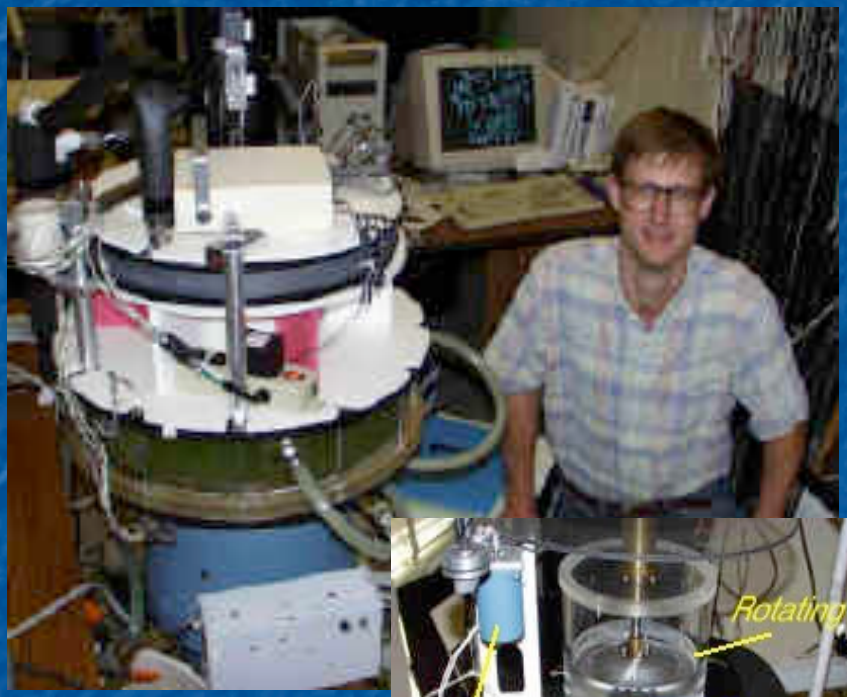
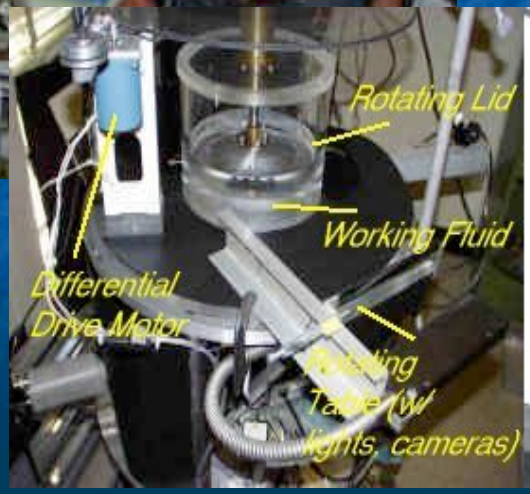
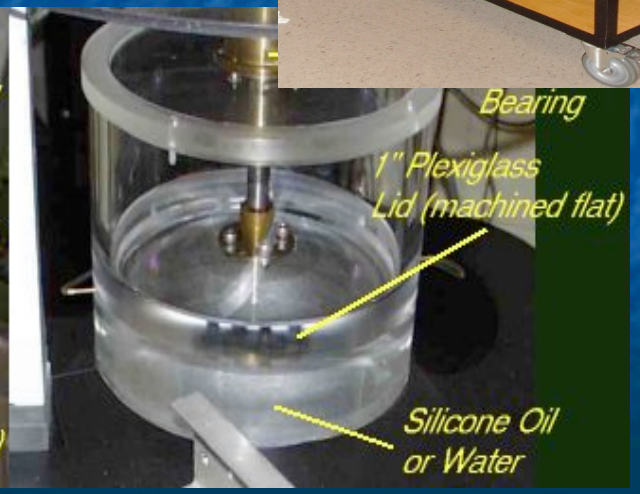
From the research laboratory of John Hart to the classroom







The art of the in-class experiment

- Demonstration or experiment?
  - Lots of negative research on the introduction of demonstrations into the classroom.
    - If not done well they can lead to confusion
  - Try to do as an in-class experiment
    - Ask the students what they expect will happen
    - At CU we use a student response system
  - Pre and post questions for immediate assessment of understanding

Simple is good

- Simple experiments create a lasting impression
- Enables a broader base of students
- Try the latent heat packs as an example Exp.
  - Note energy to move 1 kg air or increase its T by 10 Celsius
- Spin up Spin down is a great experiment to do for those new to presenting rotating fluids in the classroom
- What's the main point here
  - Long term retention of information
  - Minimize confusion

Technologies necessary to deliver content

- Dependent on class size
  - NTSC video connection to projector
  - DVD player
  - Computer and internet access
  - Student response system

Some of the classroom tools I use most often

University of Colorado version of an in-class rotating table →

Mobile rotating table

- Main features
  - Load capacity (~ 40 kg)
  - Variable rotation rate
    - Tb = 2 – 20 seconds
  - Electrical slip rings
    - AC power for lighting Etc.
    - Six signal lines
  - Video

Mobile rotating table

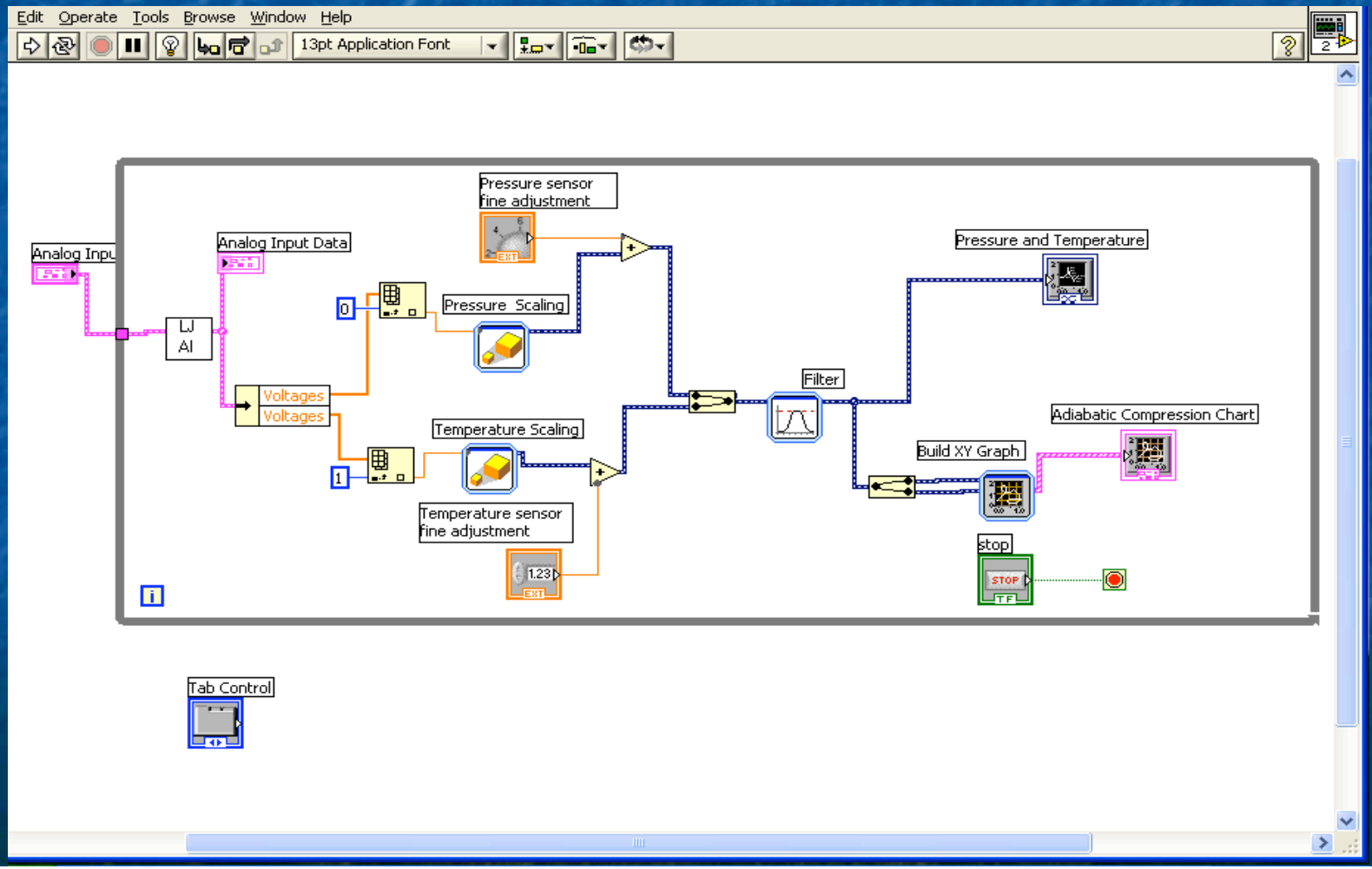
- Easy to prepare before class and roll into the lecture hall during a 10 minute transition period.
- Can remove just the turntable for transportation to outreach venues.

Lighting is very important for clear illustration of fluid flows

- Fiber optic light source
- Slit light
- Adjustable beam
- For the rotating table
  - Fluorescent ring light
  - Can lights with fluorescent bulbs
    - Lower current, lower temperature
  - Backlighting light box

Data acquistion software & hardware

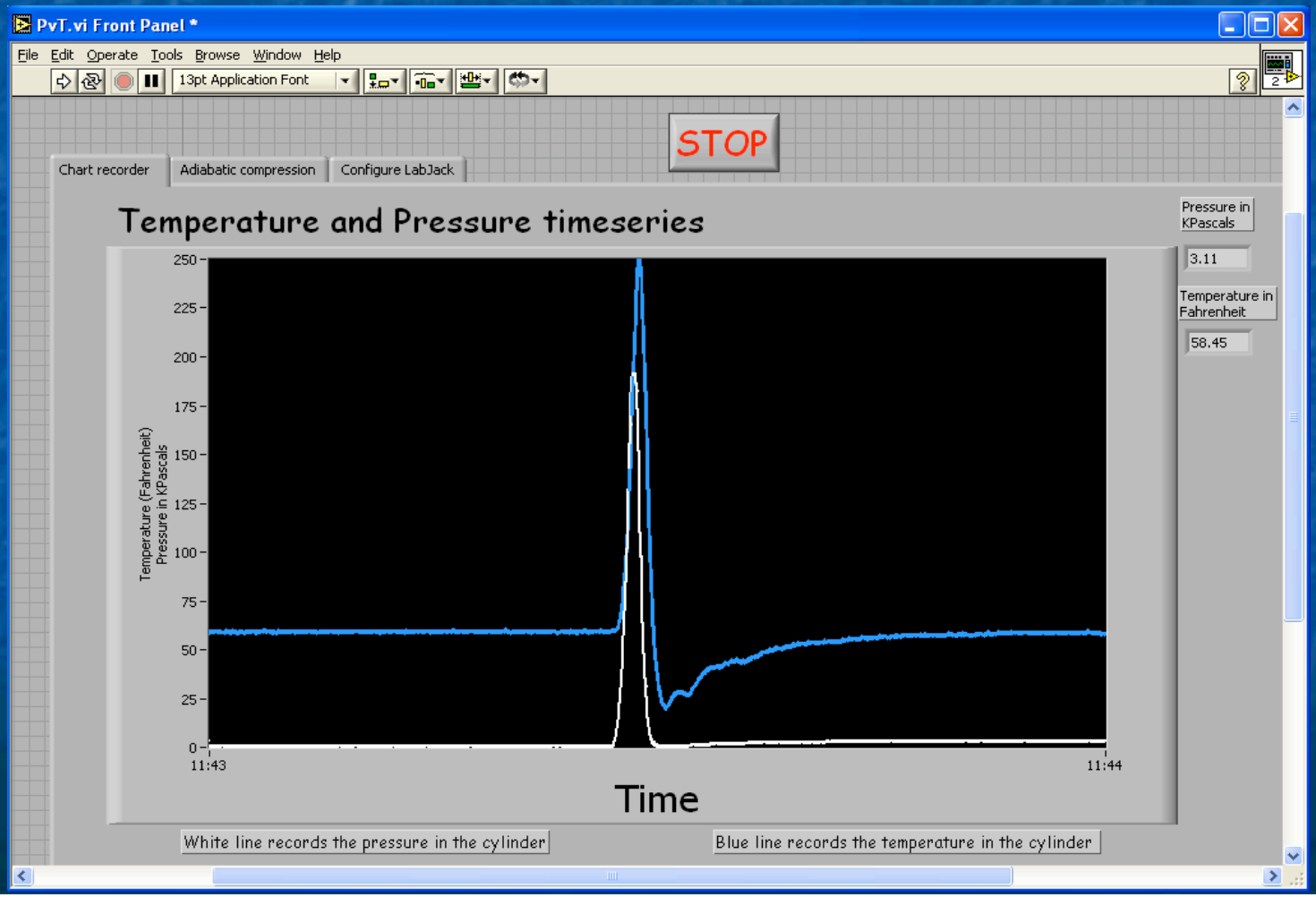
- Needs to be easily Adapted – The constant is change
- I use National instruments Labview and a Labjack USB data acquisition system



Data acquisition

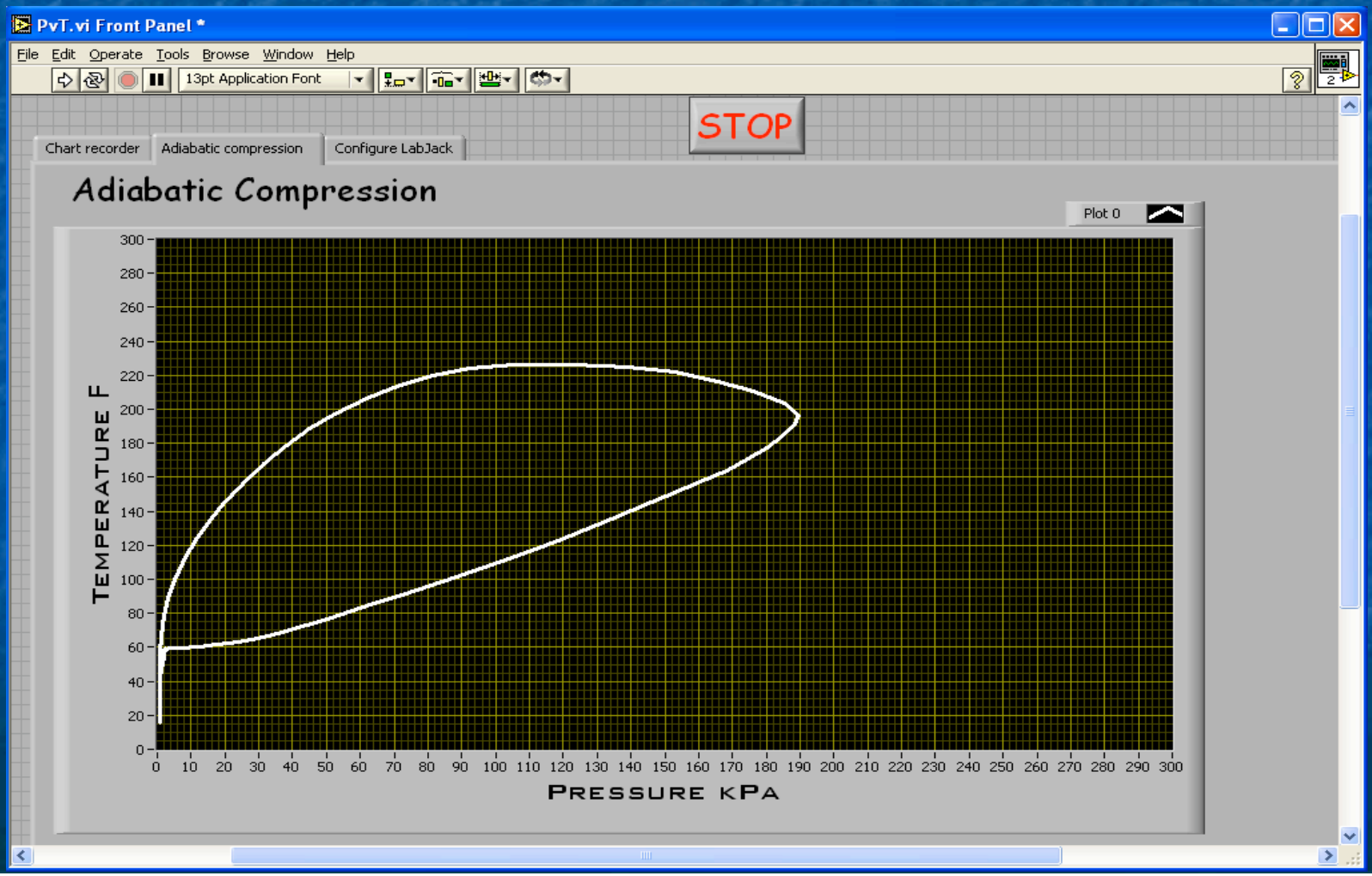
Example program from Paul Bunyan's Piston Experiment

- Time series plot



Data acquisition

- X–Y plots



Data acquisition

- Other useful features
  - Stacked plots
  - Fourier transforms
  - Filtering
  - Histograms
  - Statistics

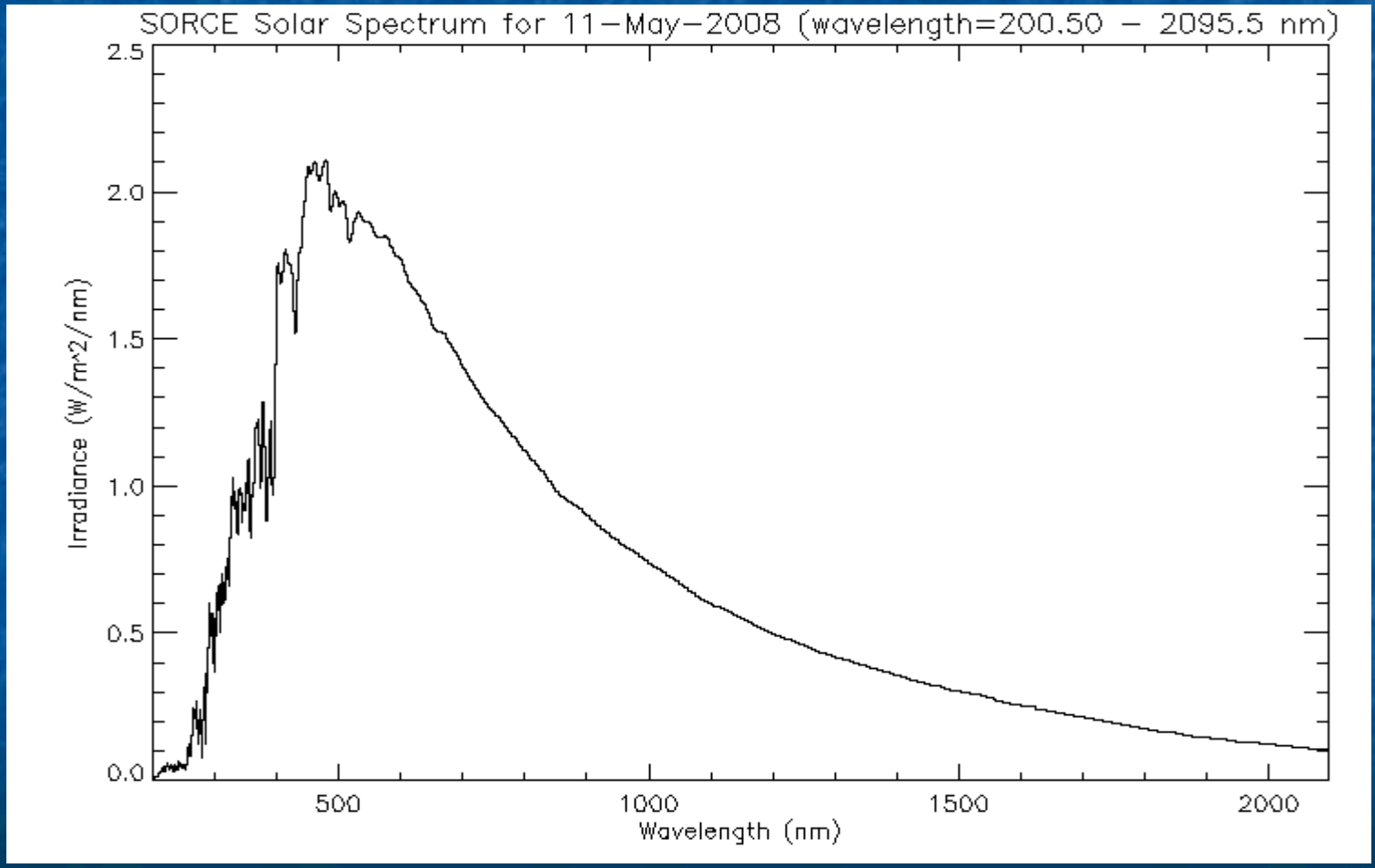
Topics in Atmospheric and Oceanic Sciences DVD

- Video of experiments in greater detail
  - And time lapsed
- Observations
  - Polar water vapor channel satellite imagery
  - 500 mbar charts
  - Etc.

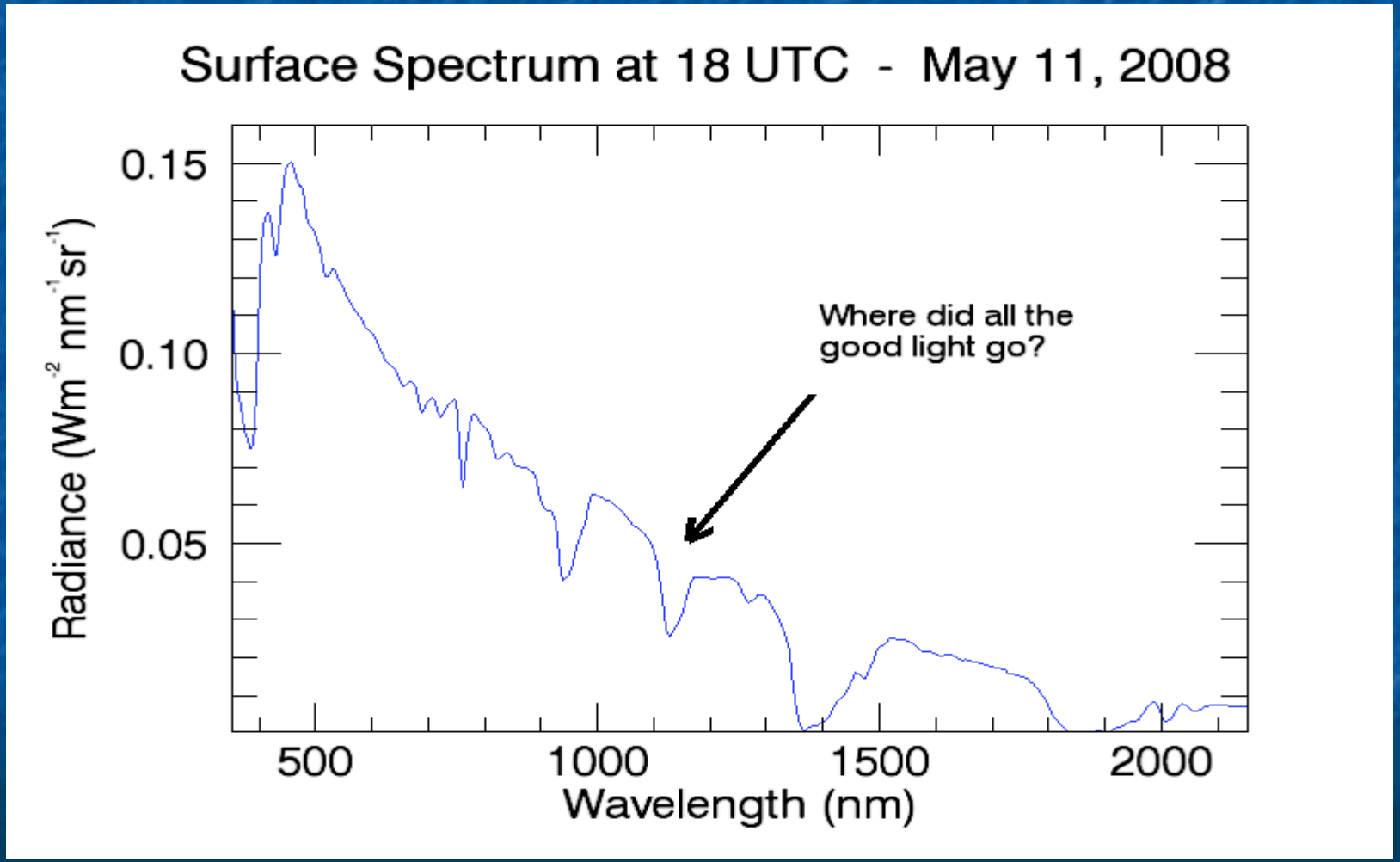
An example of conducting an experiment using classroom video and an infrared camera

- Selective absorption of light by the atmosphere.
- You will have to use your imagination here. Unfortunately, I had to leave the camera at home.

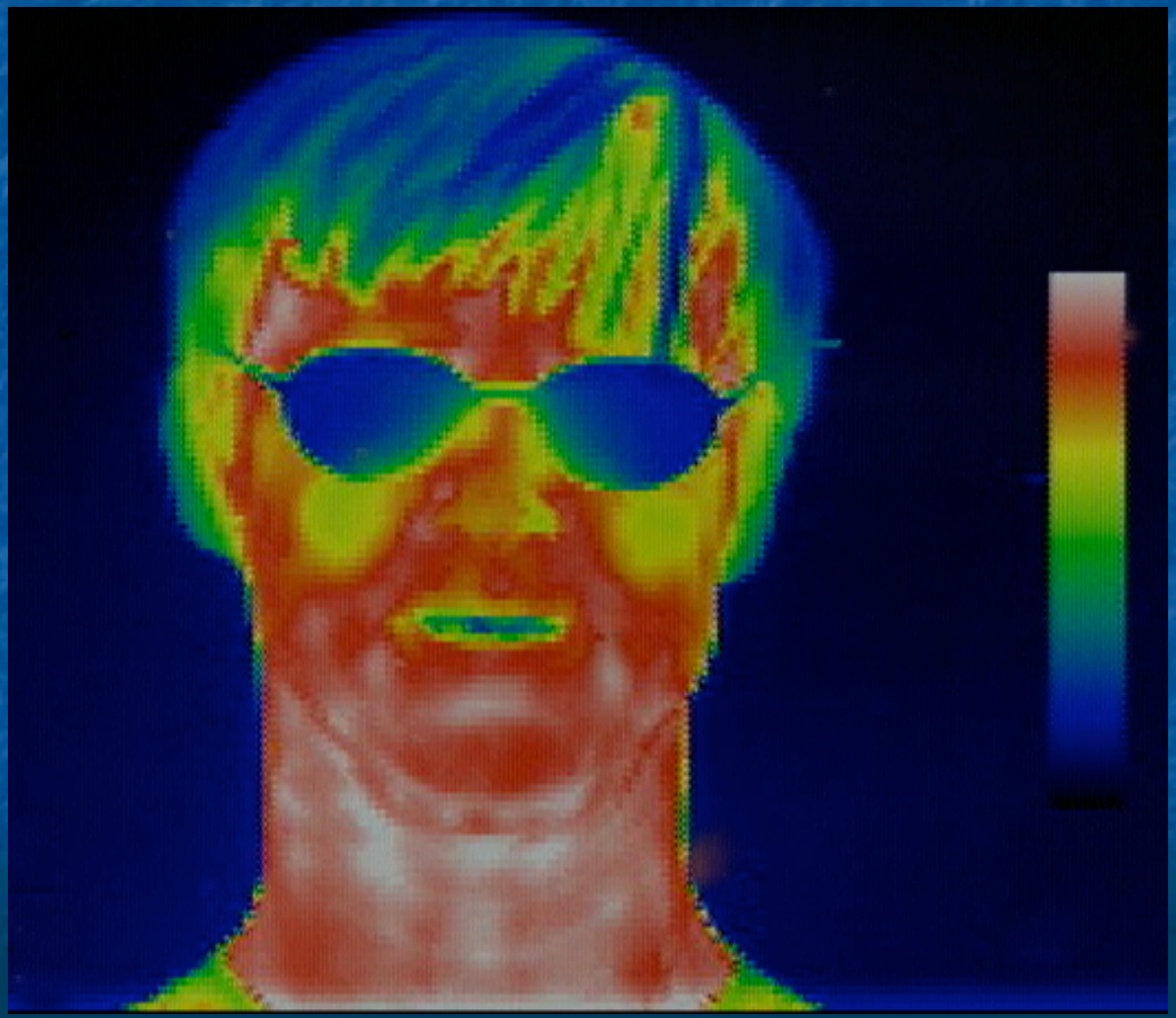
Irradiance at 645 km above the Earth's surface



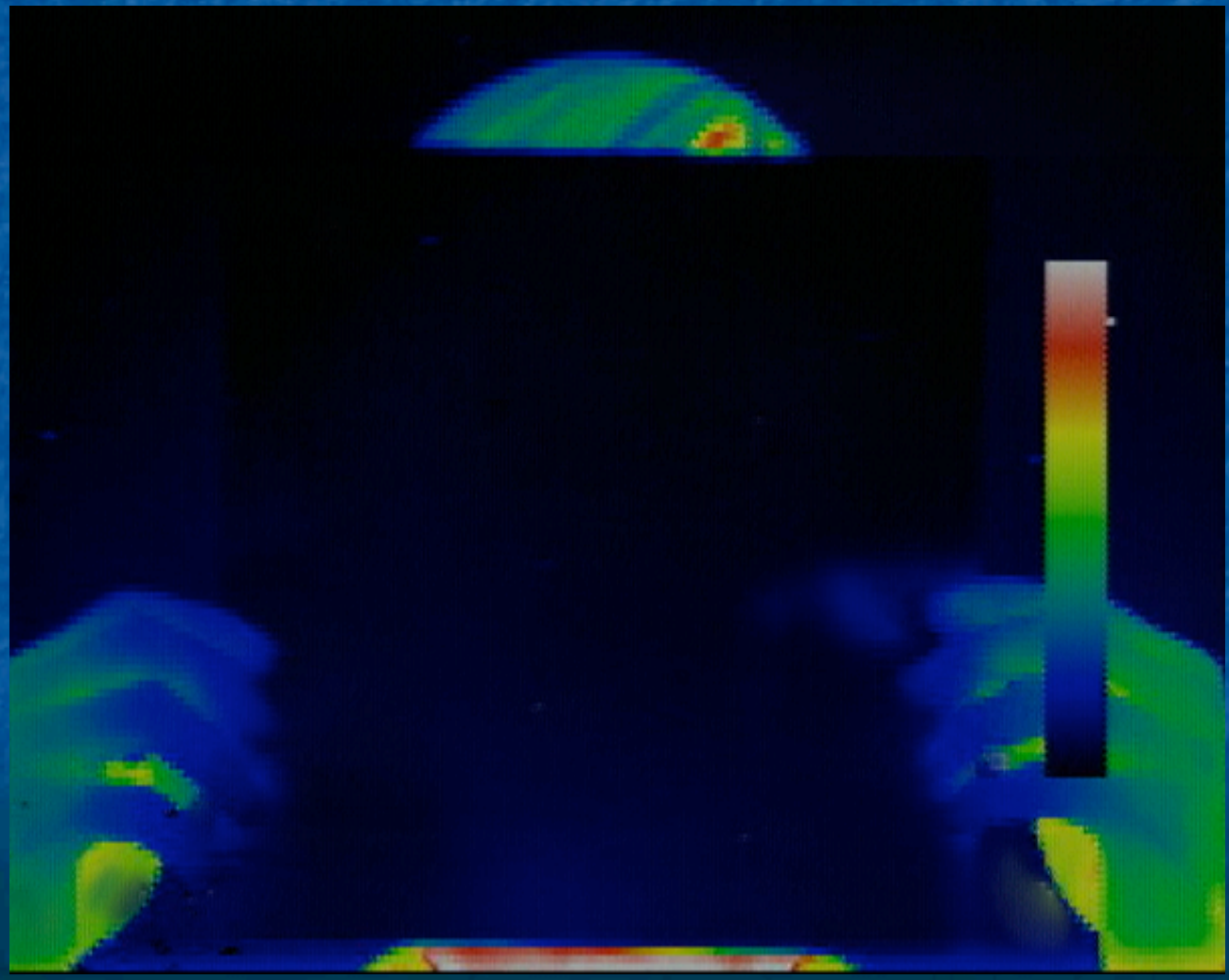
Atmospheric absorption at the Earth's surface



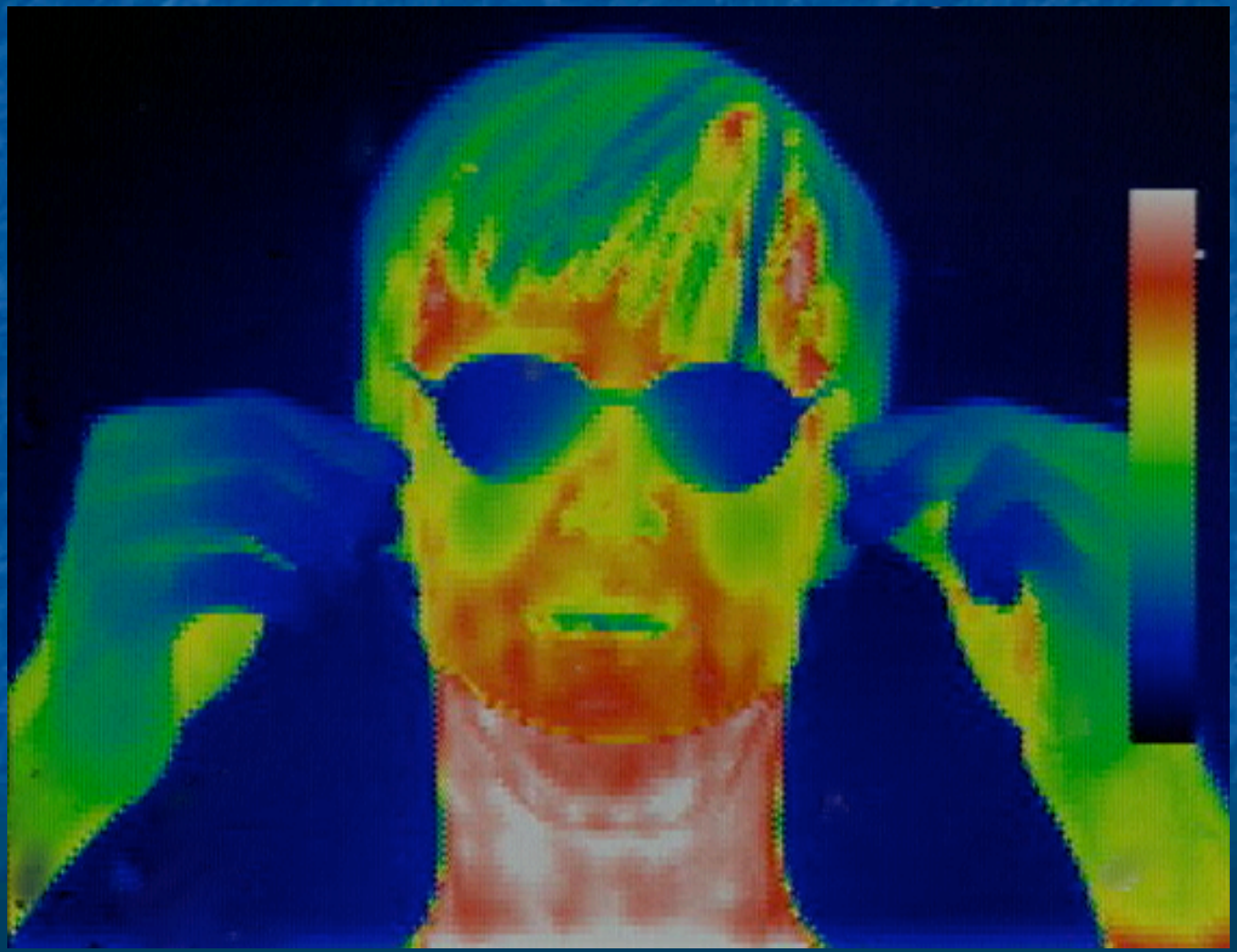
Yes, I do emit photons.



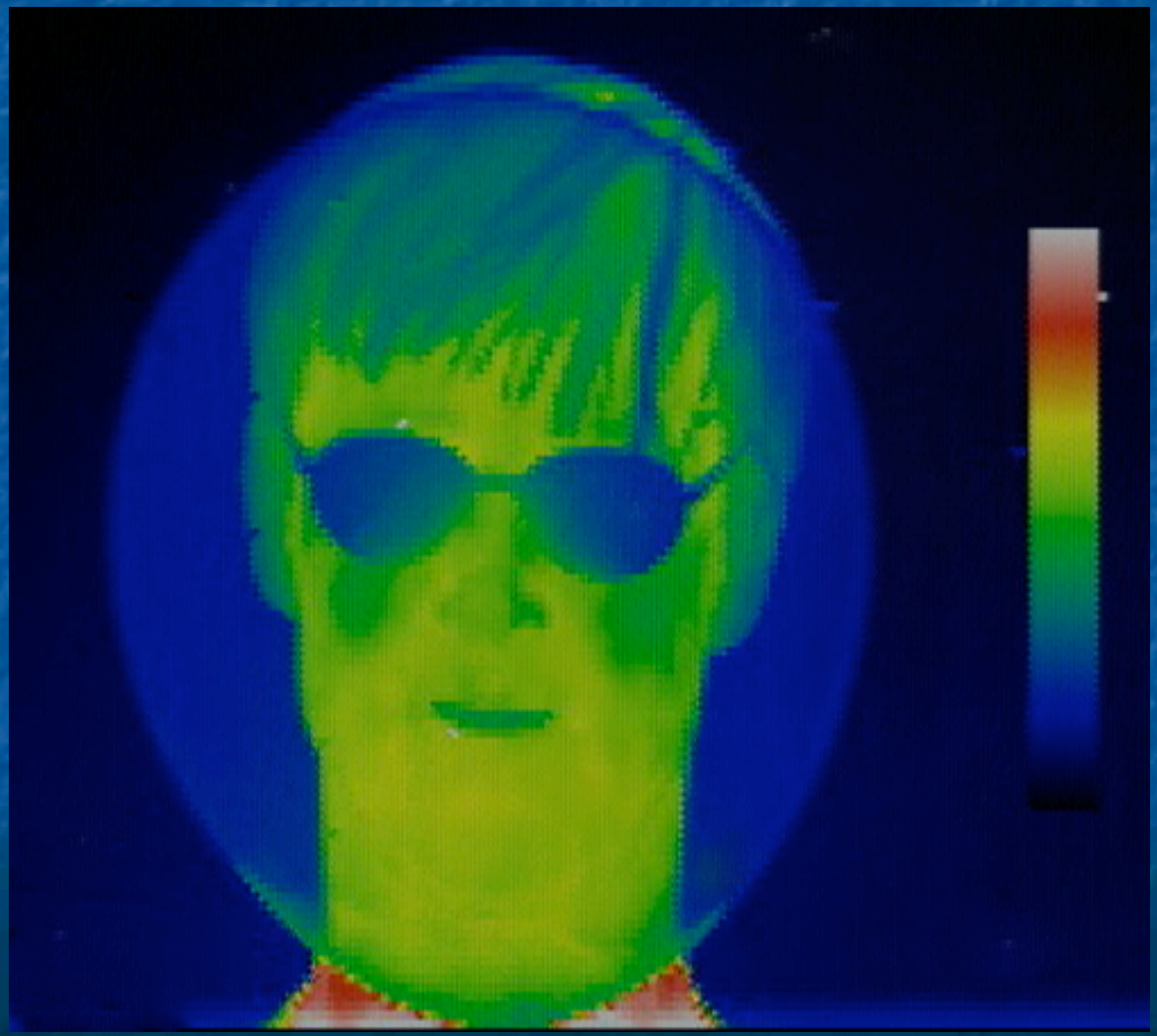
Is clear acrylic a selective absorber?



What about sapphire?



What about a colored balloon?



Questions?