Physics 496
Introduction to Research

Lecture 4.0: Figures for Scientific Documents & Presentations

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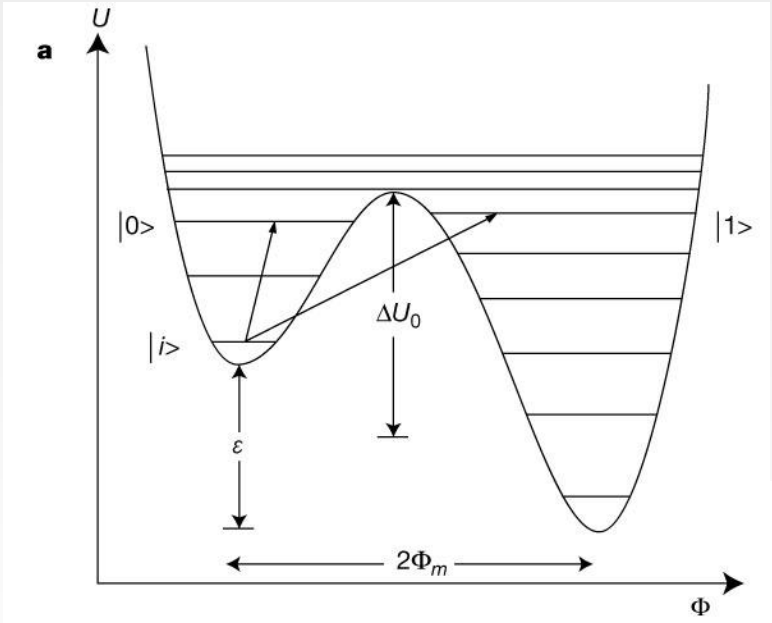
The Importance of Figures

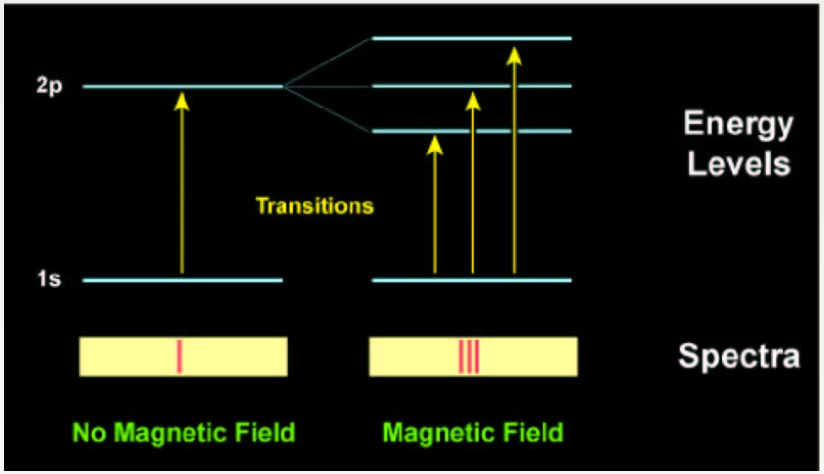
“Graphic excellence is that which gives to the viewer the greatest number of ideas in the shortest time with the least ink in the smallest place” - Edward R. Tufte -

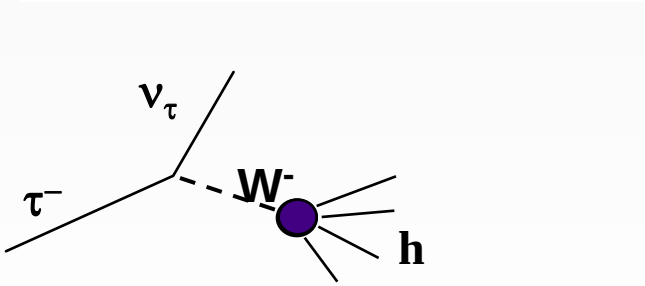
“Figures play a significant role in the expression of scientific ideas” - APS Style Guide -

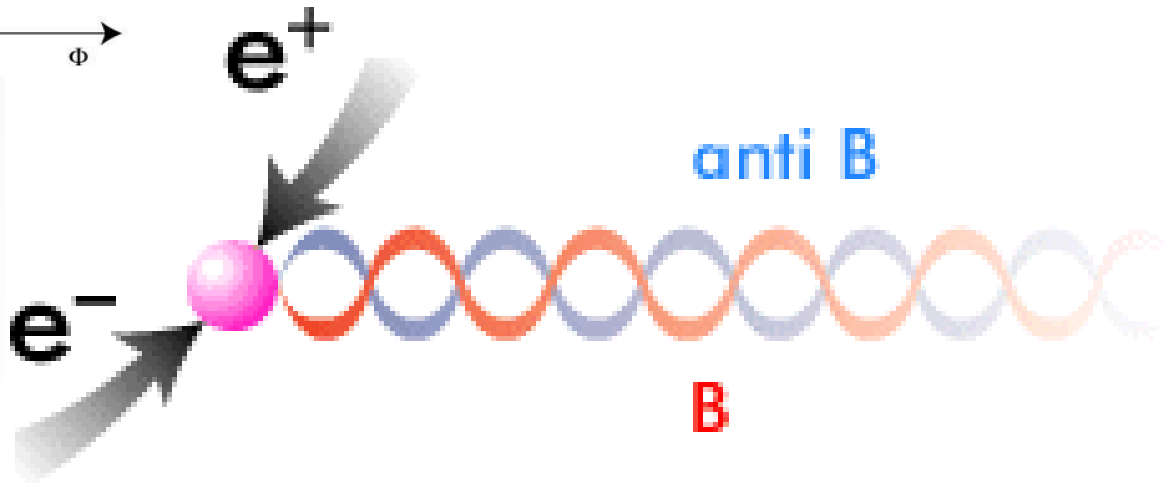
Imagine, presentations without figures…

Figures that show physics processes

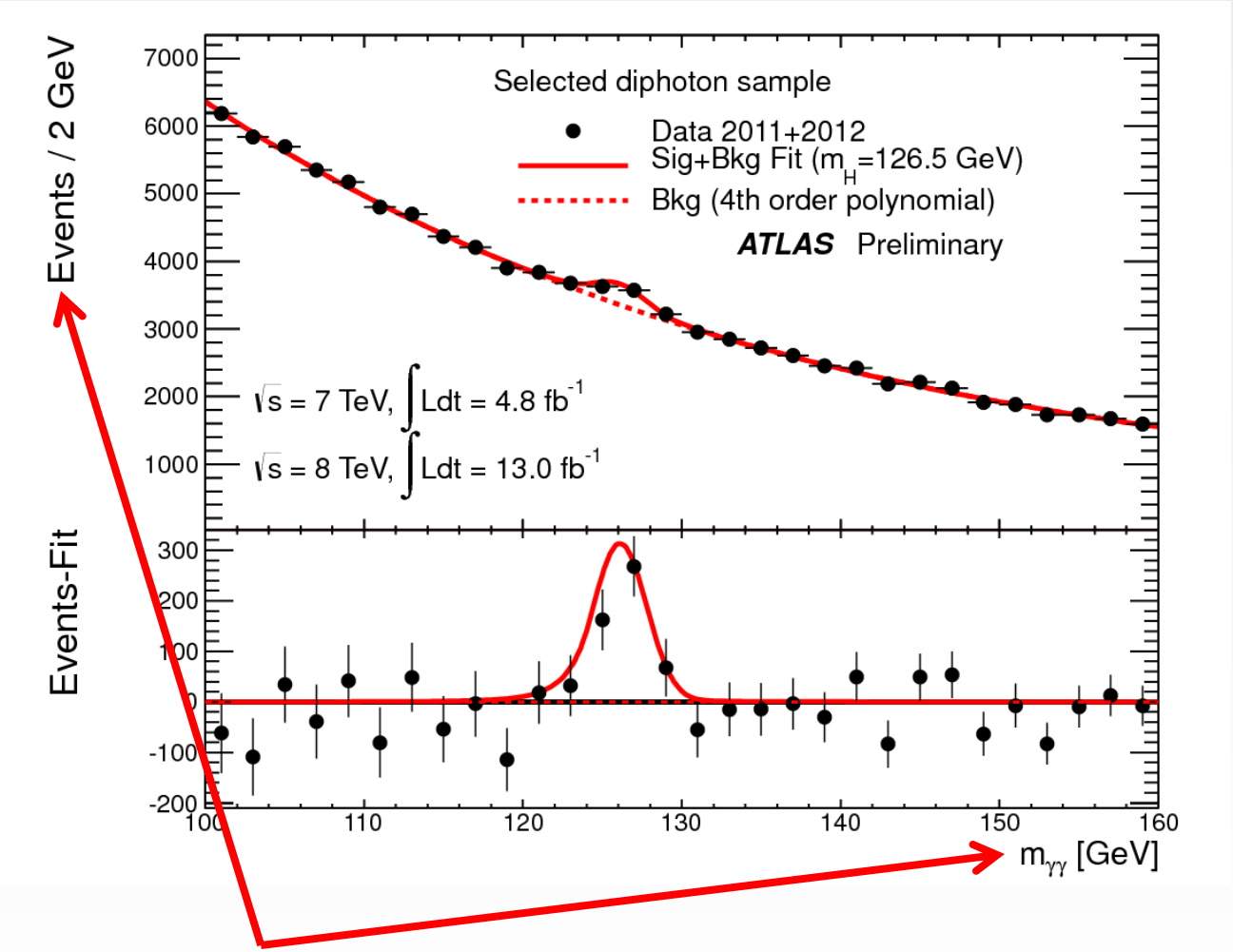






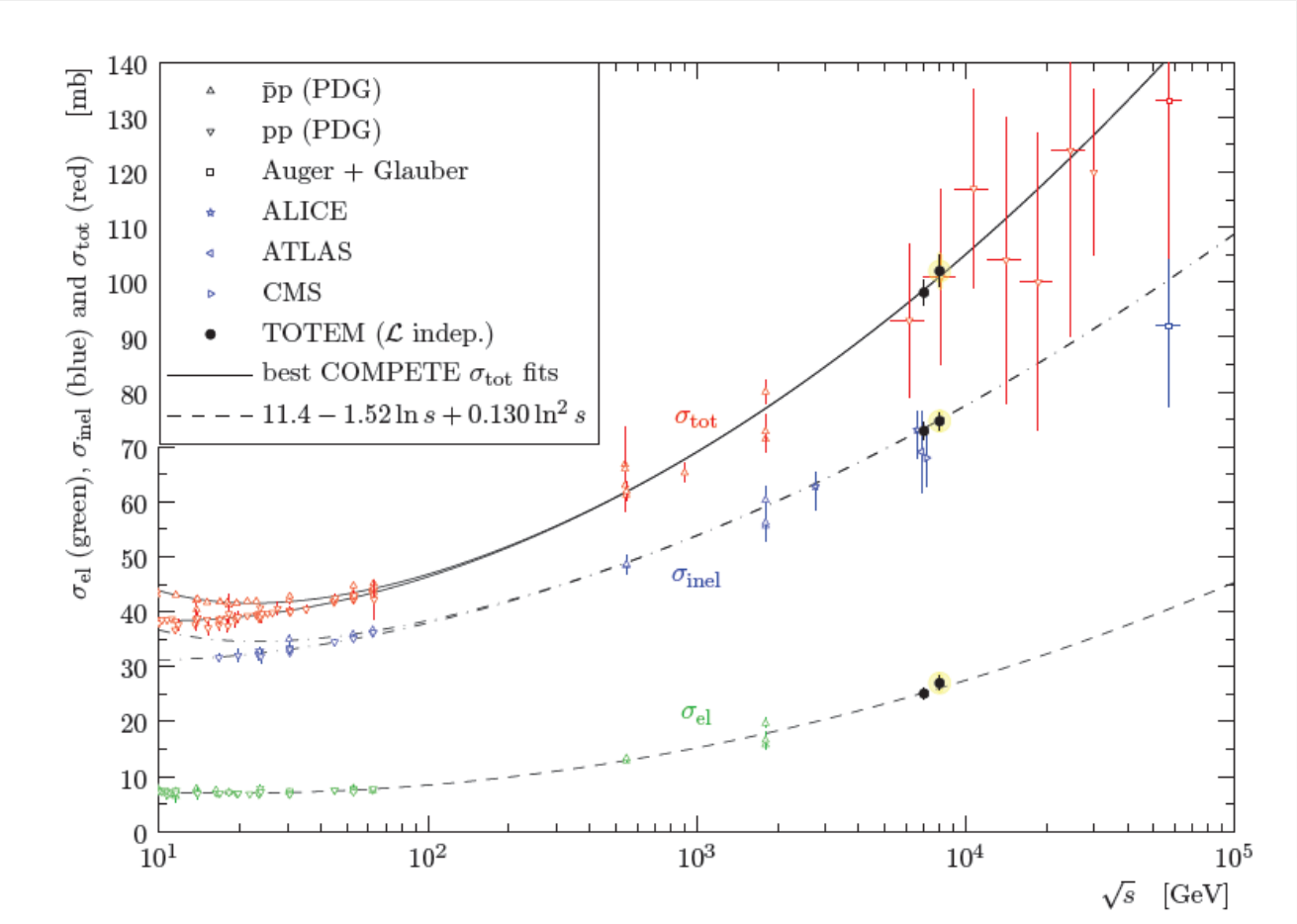


Figures that display data



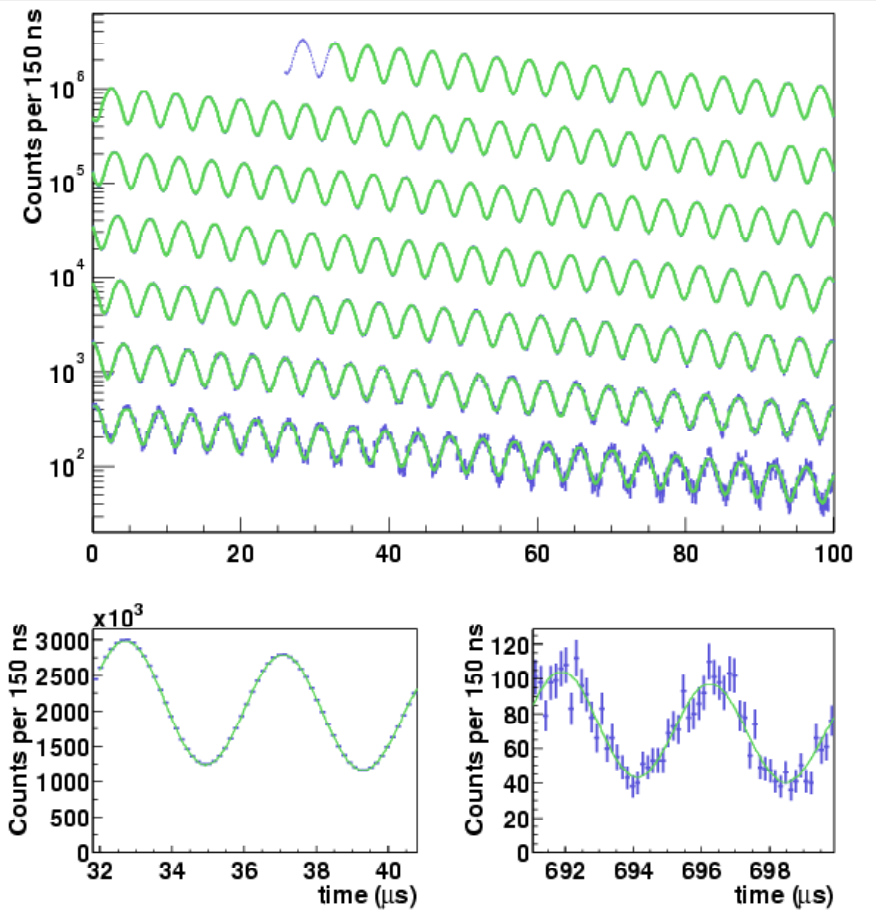
Labels & Units!

Figures that display data

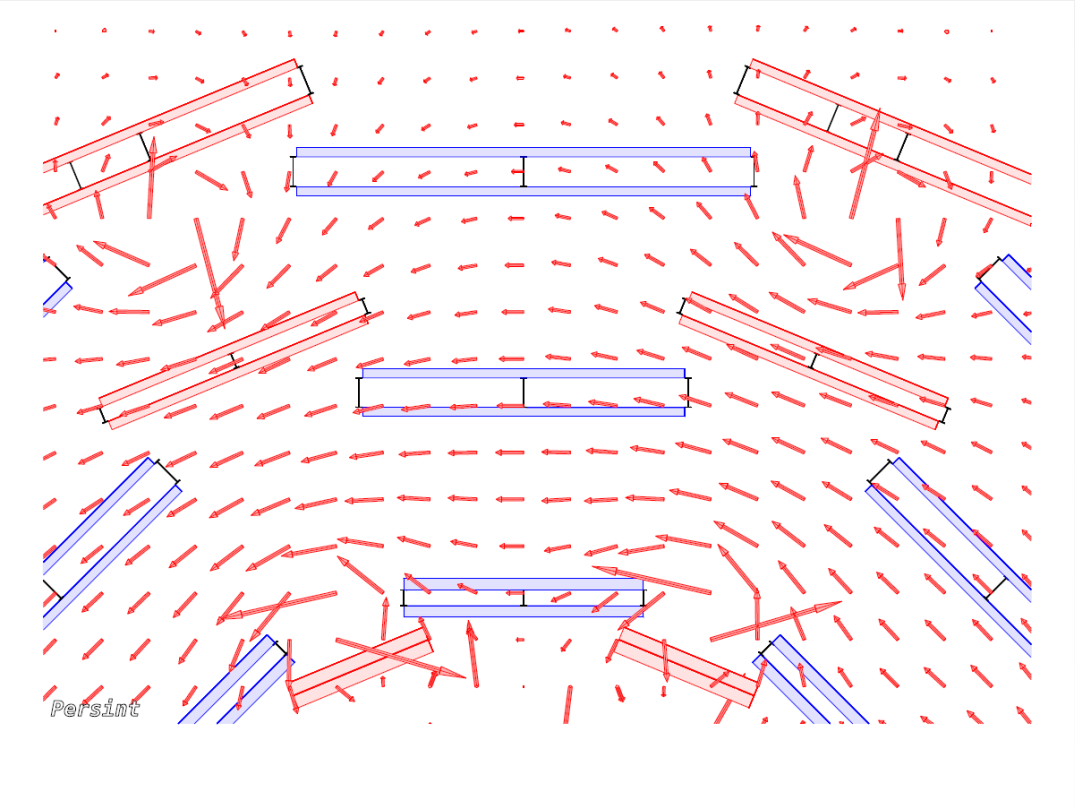


CERN-PH-EP-2012-354

Figures that display data



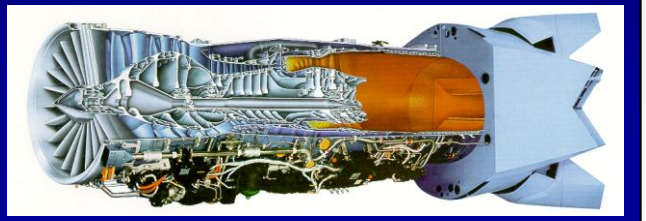
Figures that display data

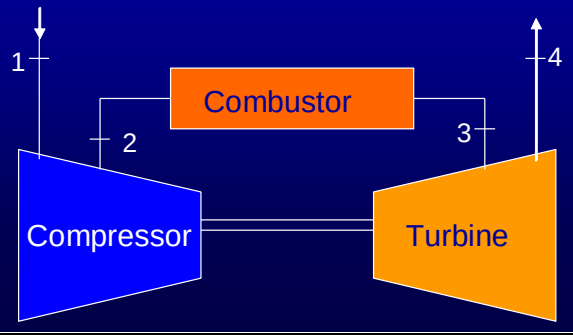


Magnetic field vectors in the ATLAS muon spectrometer

Illustrations

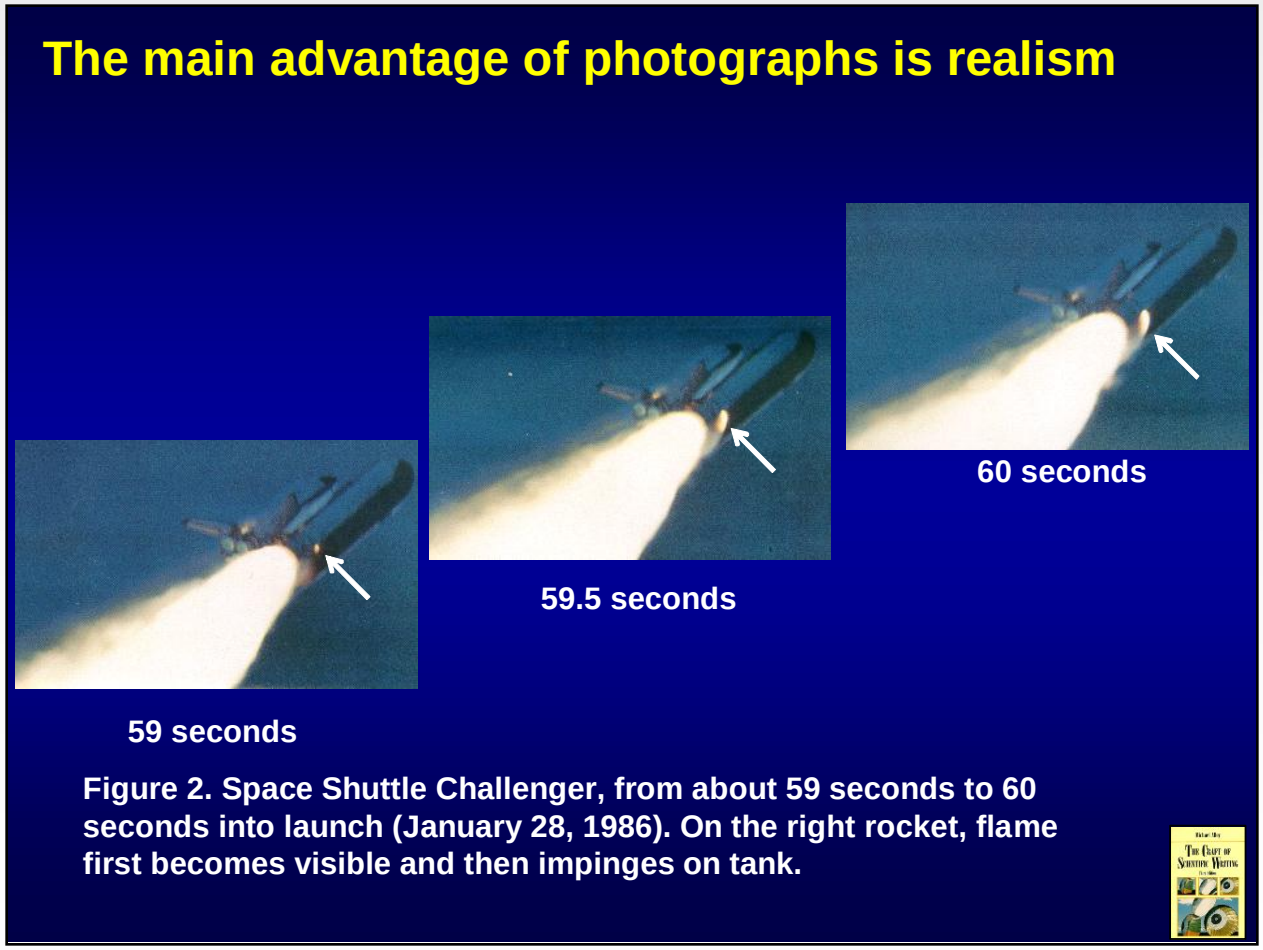
When presenting images, you choose between photographs, drawings, and diagrams





- Source: The Craft of Scientific Presentations, Michael Alley
- and http://www.writing.eng.vt.edu/handbook/visuals.html

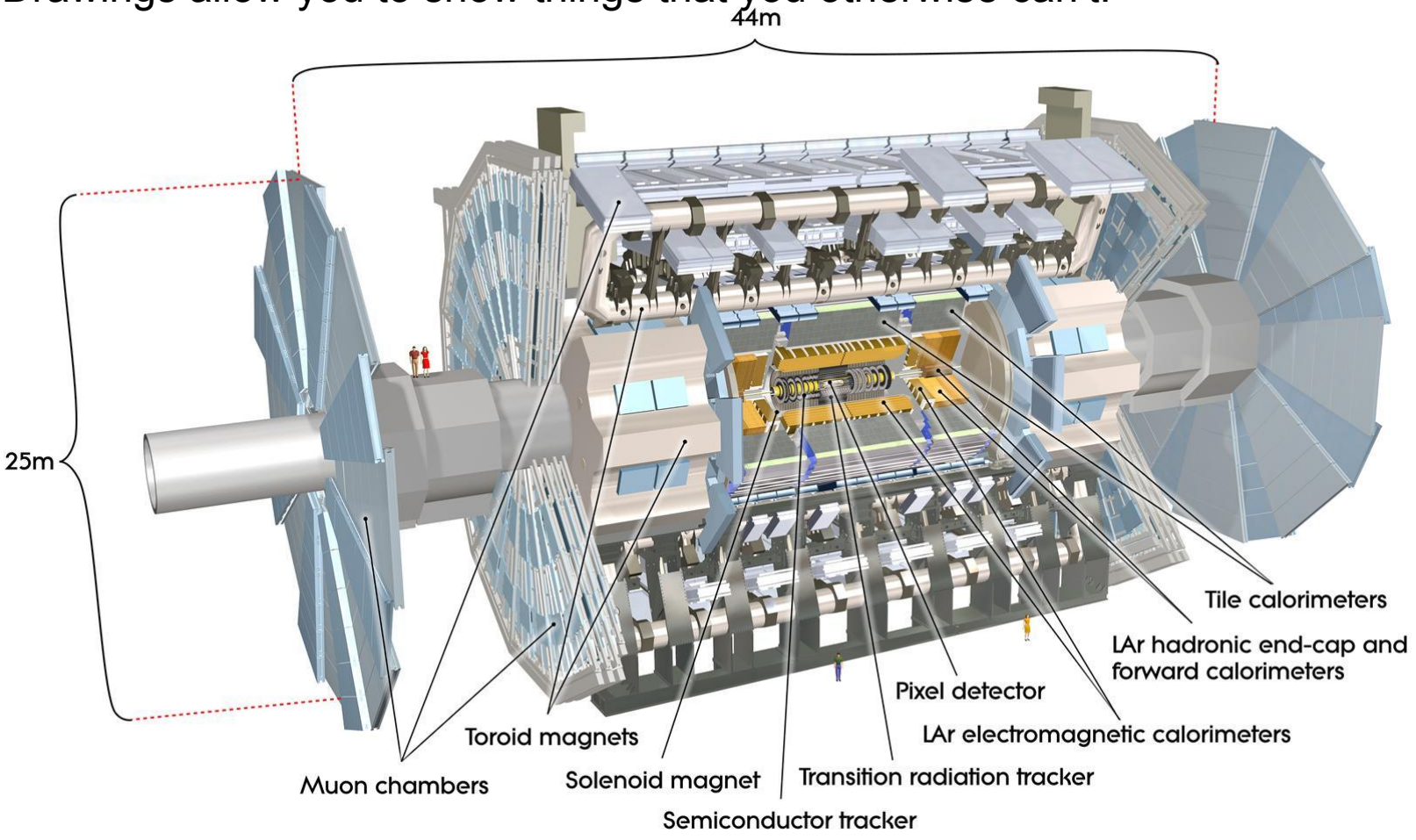
Illustrations



- Source: The Craft of Scientific Presentations, Michael Alley
- and http://www.writing.eng.vt.edu/handbook/visuals.html

Illustrations

Drawings allow you to show things that you otherwise can't.



http://www.atlas.ch/photos/full-detector-cgi.html

Illustrations

The main advantage of a diagram is the ability to show flow of a variable through a system

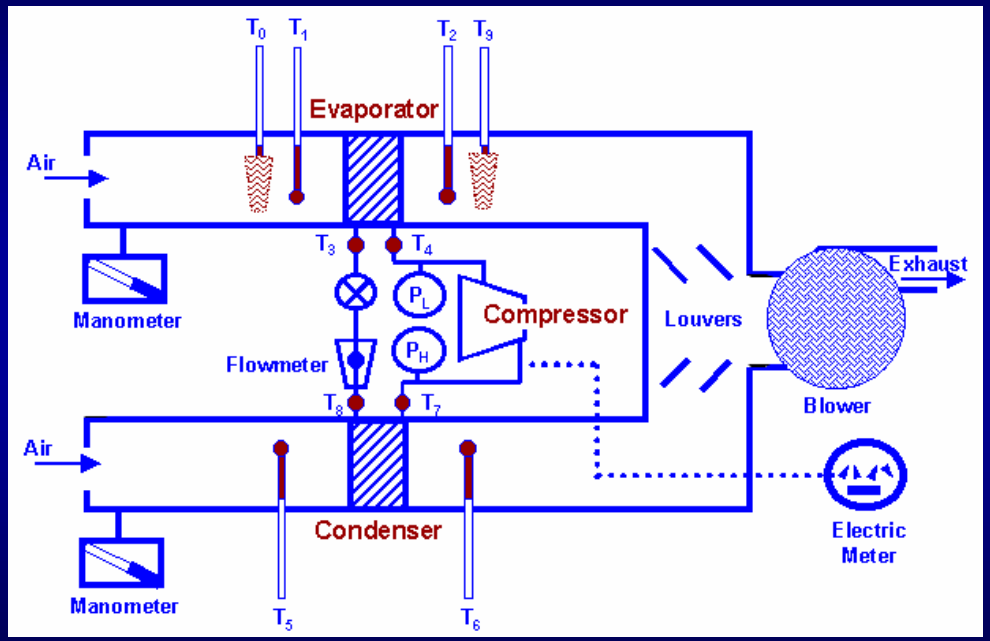
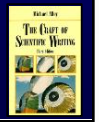


Figure 8. Schematic of test stand for evaluating components of an air conditioner design.



- Source: The Craft of Scientific Presentations, Michael Alley
- and http://www.writing.eng.vt.edu/handbook/visuals.html

Illustrations

Scientists and engineers often use illustrations that are too complex for the text

The thermal storage system stores heat in a huge, steel-walled tank. Steam from the solar receiver passes through heat exchangers to heat the thermal oil, which is pumped into the tank. The tank then provides energy to run a steam generator to produce electricity. A schematic of this system is shown in Figure 5.

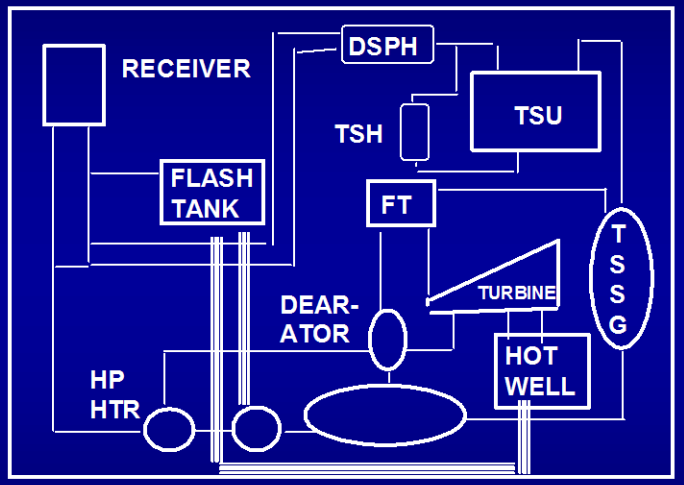


Figure 5. Schematic of thermal storage system.

- Source: The Craft of Scientific Presentations, Michael Alley
- and http://www.writing.eng.vt.edu/handbook/visuals.html

Illustrations

The precision of the illustrations should reflect the precision of the text

The thermal storage system, shown in Figure 6, stores heat in a huge, steel-walled tank. Steam from the solar receiver heats a thermal oil, which is pumped into the tank. The tank then provides energy to run a steam generator to produce electricity.

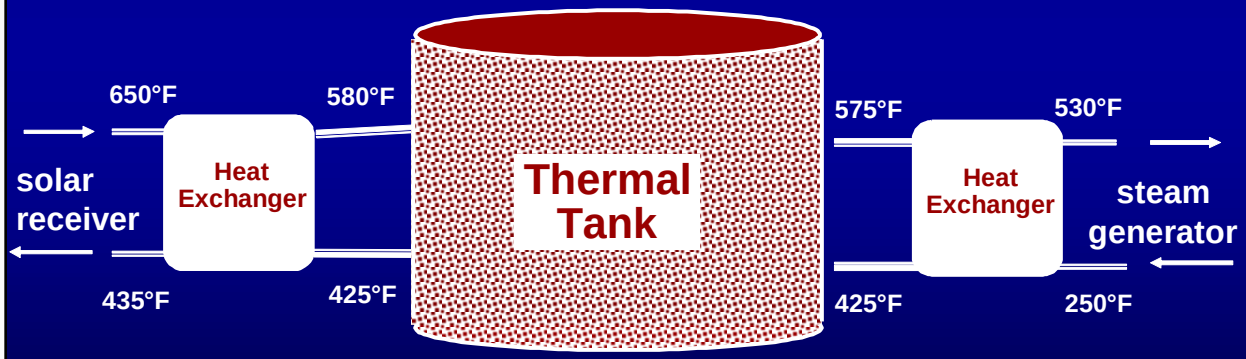


Figure 6. Schematic of thermal storage system for the solar power plant.

- Source: The Craft of Scientific Presentations, Michael Alley
- and http://www.writing.eng.vt.edu/handbook/visuals.html

Illustrations & Figures

For clarity, illustrations and figures must be referred to and explained in the text.

The momentum can be written as $p = k\int Bd\ell \Big/ \Delta\theta$, where *k* is a constant. The resolution on *k* is measured as a function of momentum. As an example, Figure 2 shows the results for inner-middle 2-station muons. These results from the data are then compared to those from the simulation to derive a smearing function for the simulation (which tends to have better resolution than the data). The difficulty is that the data extend only a little above 100 GeV/c, while typical muons from a heavy Z' have momenta close to or above a TeV. The extrapolation to high momentum introduces a systematic uncertainty that will become better controlled using the full 2012 dataset to provide the maximum reach in momentum in the data.

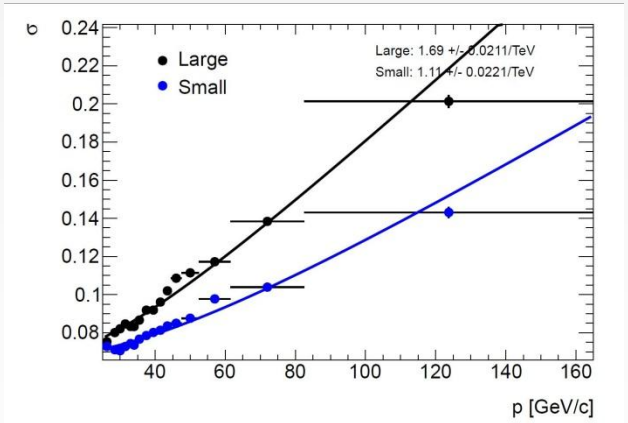


Figure 2 Resolution vs. p for inner-middle 2-station muons. Black points are for the large sectors and blue for the small.

Illustrations

Inconsistencies between text and images disrupt fluidity

The testing hardware of the rocket shown in Figure 8 has five main components: camera, digitizer, computer, I/O interface, and mechanical interface. Commands are generated by the computer, then passed through the I/O interface to the mechanized interface where the keyboard of the ICU is operated. The display of the ICU is read with a television camera and then digitized. This information is then manipulated by the computer to direct the next command.

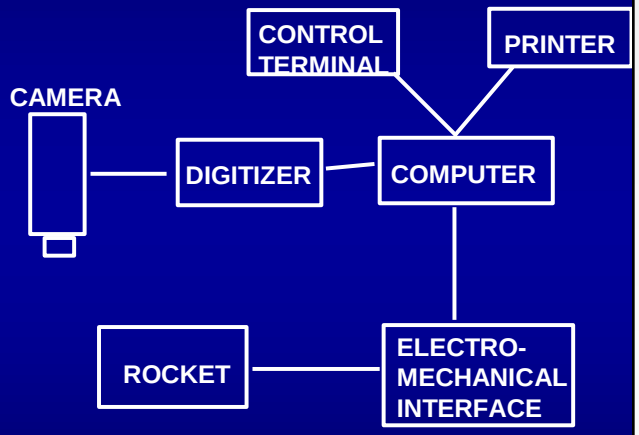
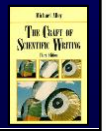


Figure 8. Testing hardware.



- Source: The Craft of Scientific Presentations, Michael Alley
- and http://www.writing.eng.vt.edu/handbook/visuals.html

Figures that show how something works

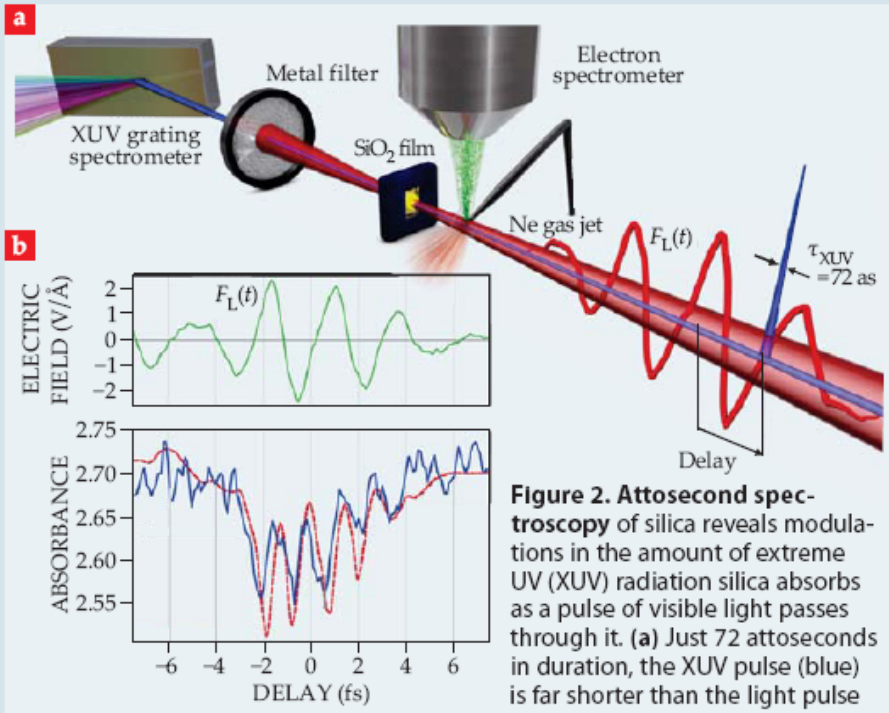
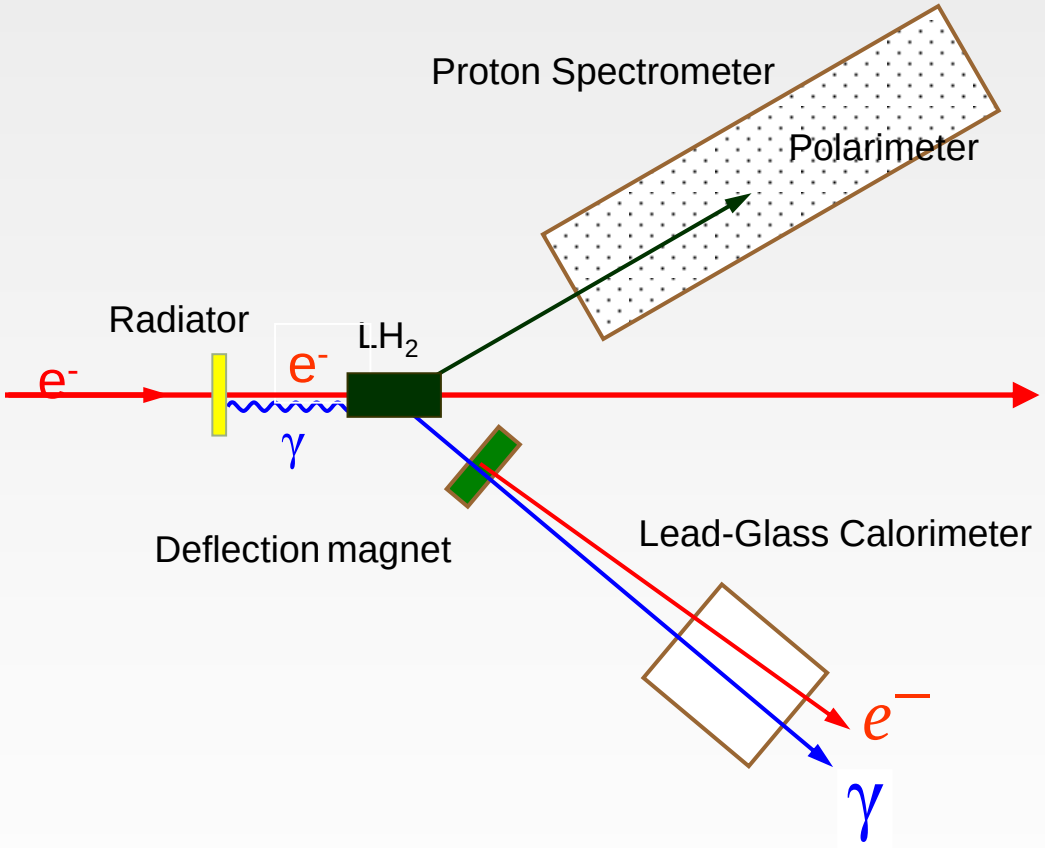
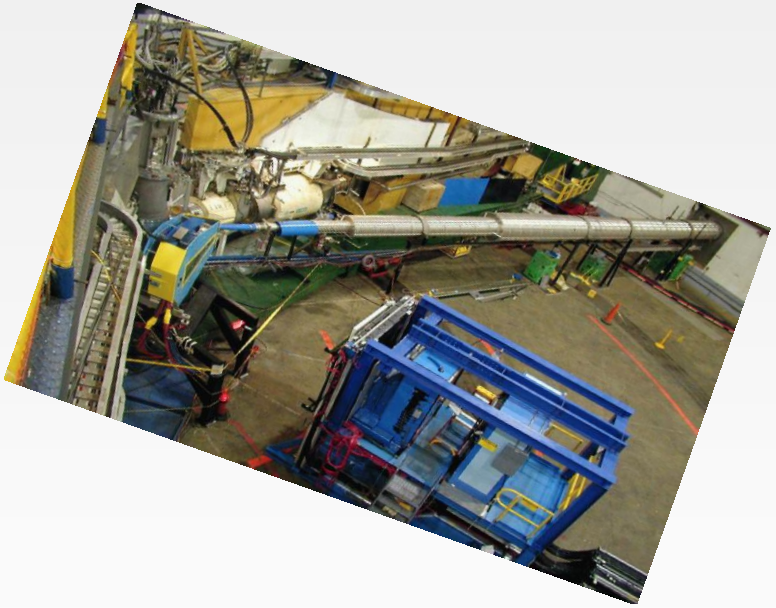


Figure 2. Attosecond spectroscopy of silica reveals modulations in the amount of extreme UV (XUV) radiation silica absorbs as a pulse of visible light passes through it. **(a)** Just 72 attoseconds in duration, the XUV pulse (blue) is far shorter than the light pulse (red) and can be delayed by a controllable amount to monitor the absorption at different instants in the light's waveform. Both pulses travel from right to left. Some of the XUV photons excite a neon gas jet whose spray of photoelectrons can be used to map the light's electric field as a function of delay (see PHYSICS TODAY, October 2004, page 21). The rest of the XUV and visible photons then interact with silica and continue downstream. A metal film filters out the visible and transmits the XUV, which is then spectrally dispersed and measured. **(b)** The XUV absorbance (blue) drops whenever the electric field F_L (green) peaks and is a maximum whenever the F_L goes to zero. The near-instantaneous response to the oscillating electric field corroborates an ultrafast rise and fall in conductivity. Reassuringly, the experimental data follow theoretical prediction (red). (Adapted from ref. 2.)

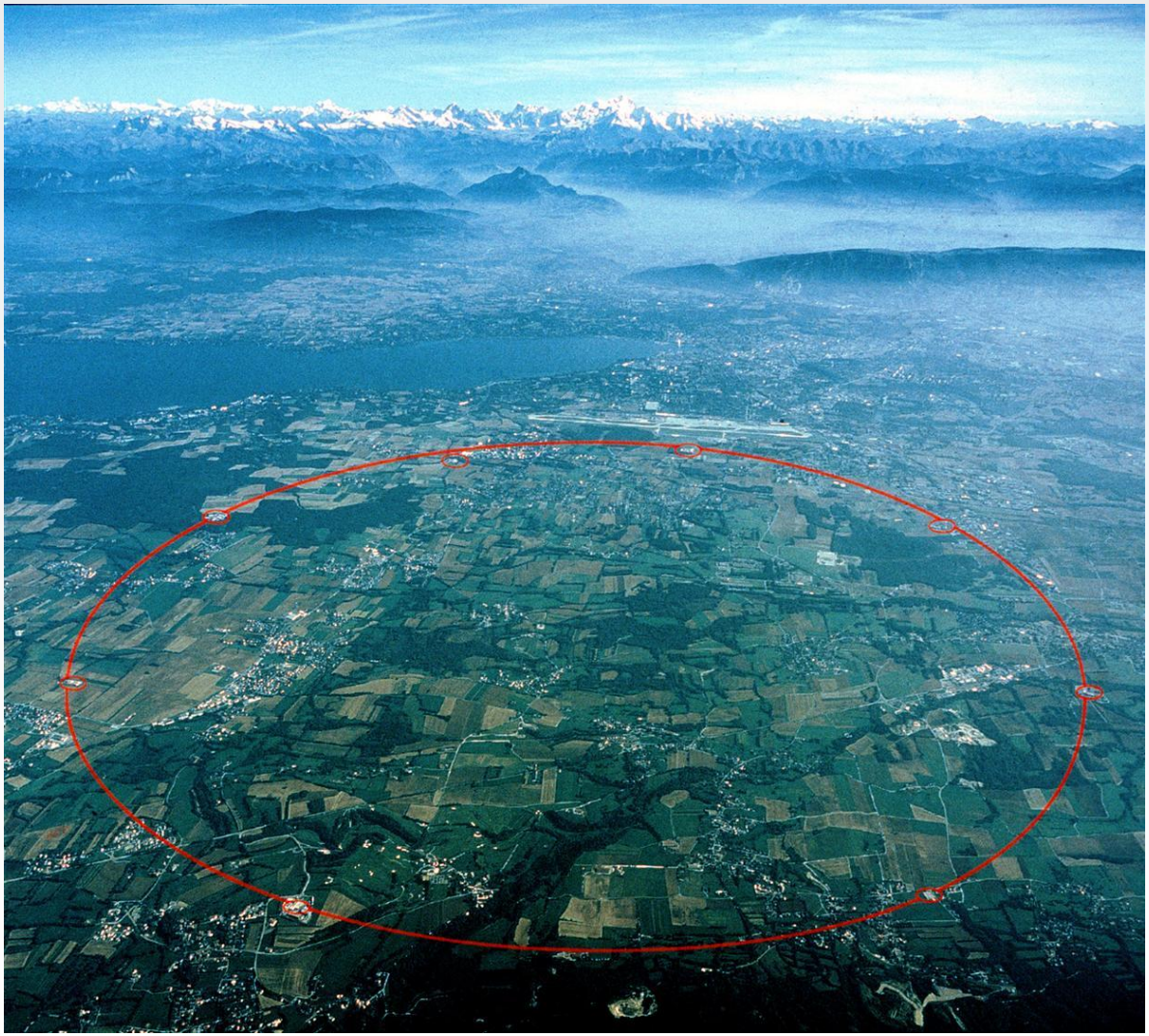
Phys. Today 66(2), 13 (2013); doi: 10.1063/PT.3.1873

Figures that show how something works



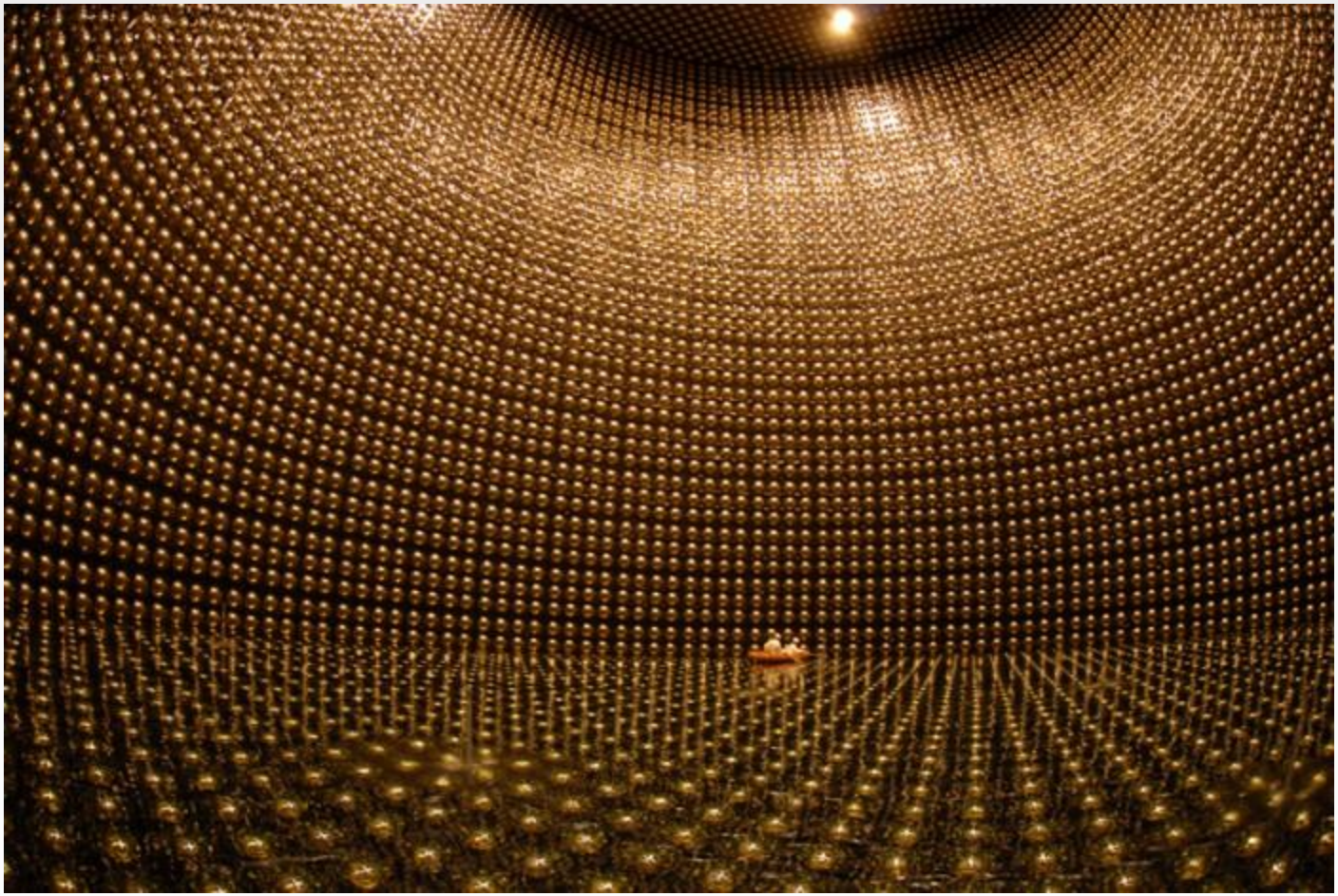


Figures that show scale



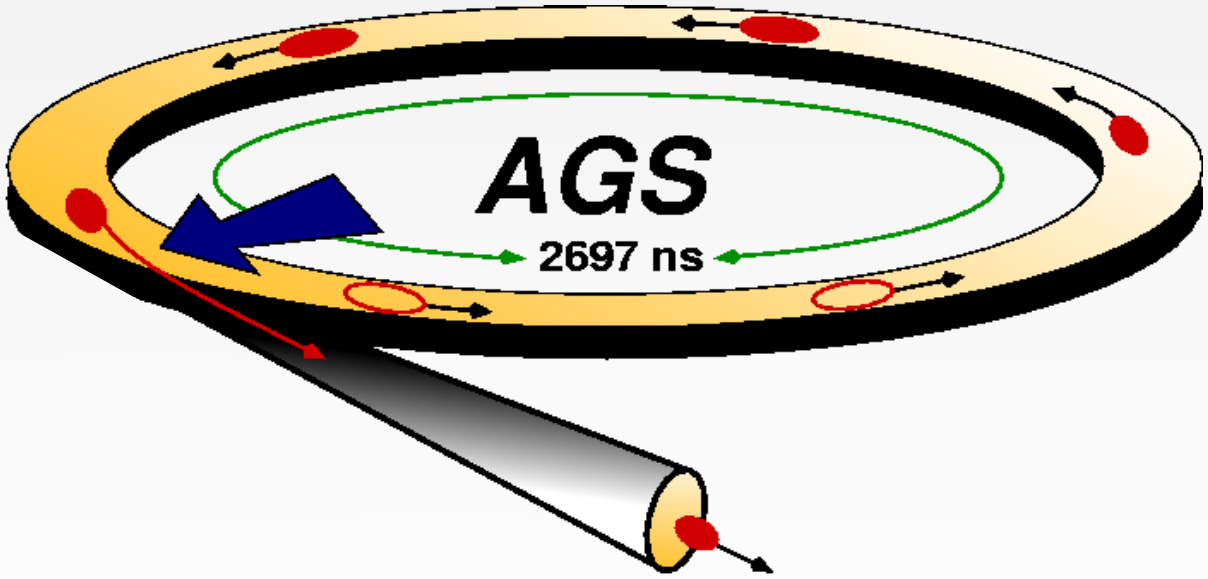
http://www.atlas.ch/photos/detector-site-surface.html

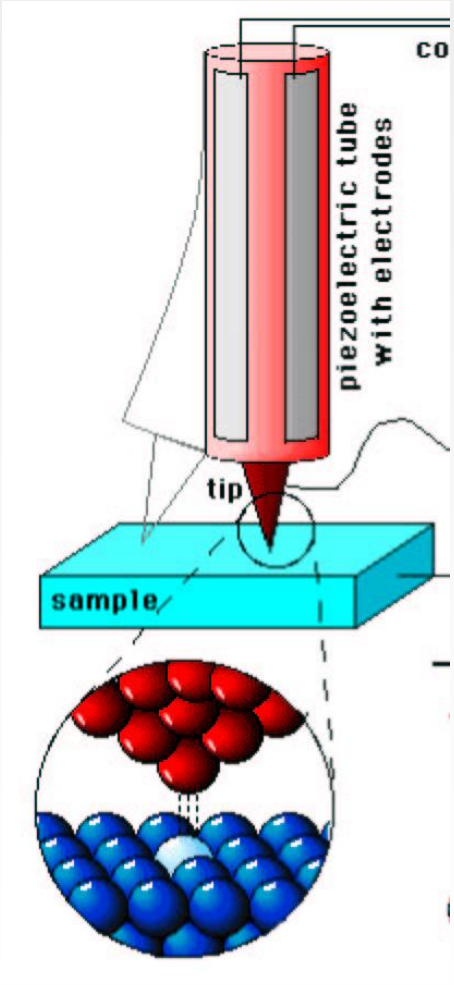
Figures that show equipment



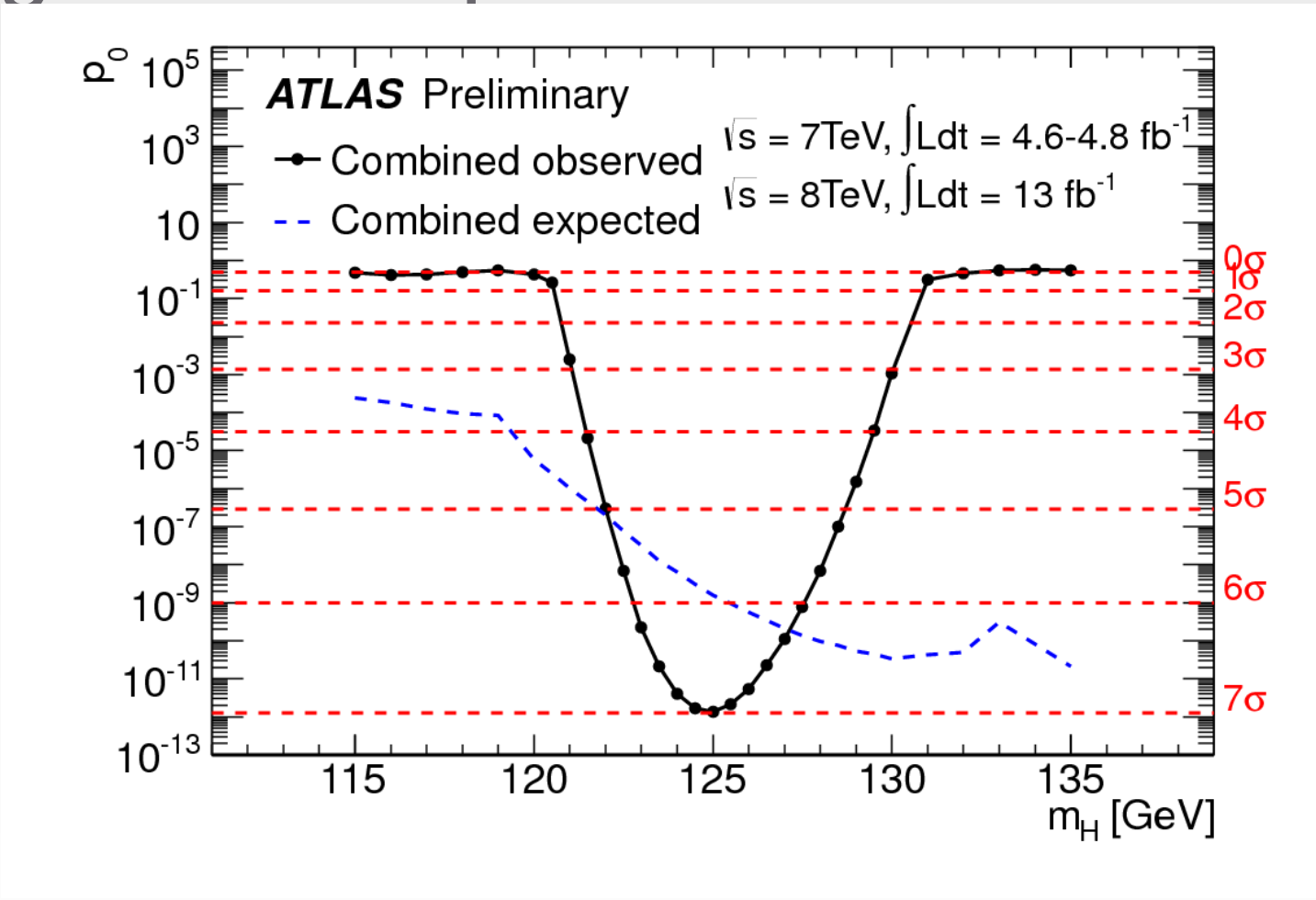
http://t2k-experiment.org/

Figures that peer inside



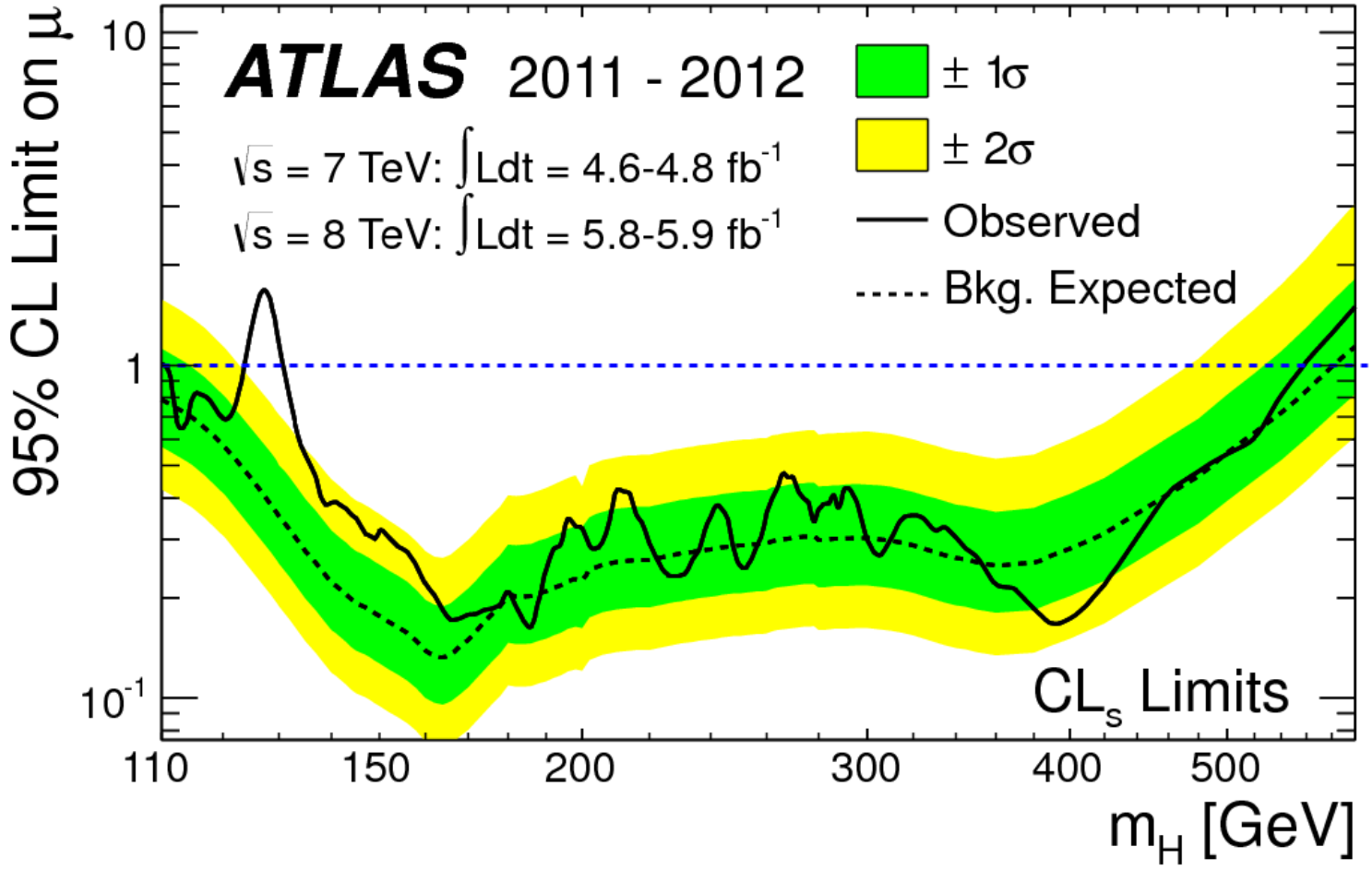


Figures that persuade

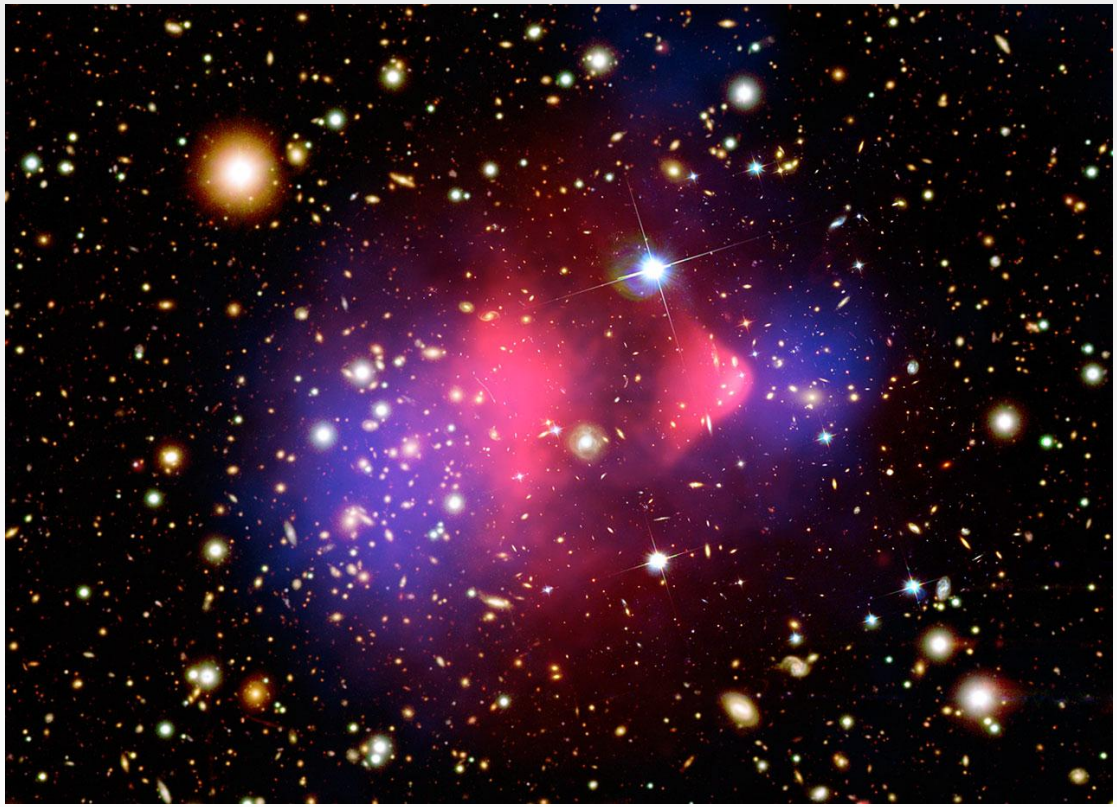


https://atlas.web.cern.ch/Atlas/GROUPS/PHYSICS/CONFNOTES/ATLAS-CONF-2012-170/

Figures that confuse



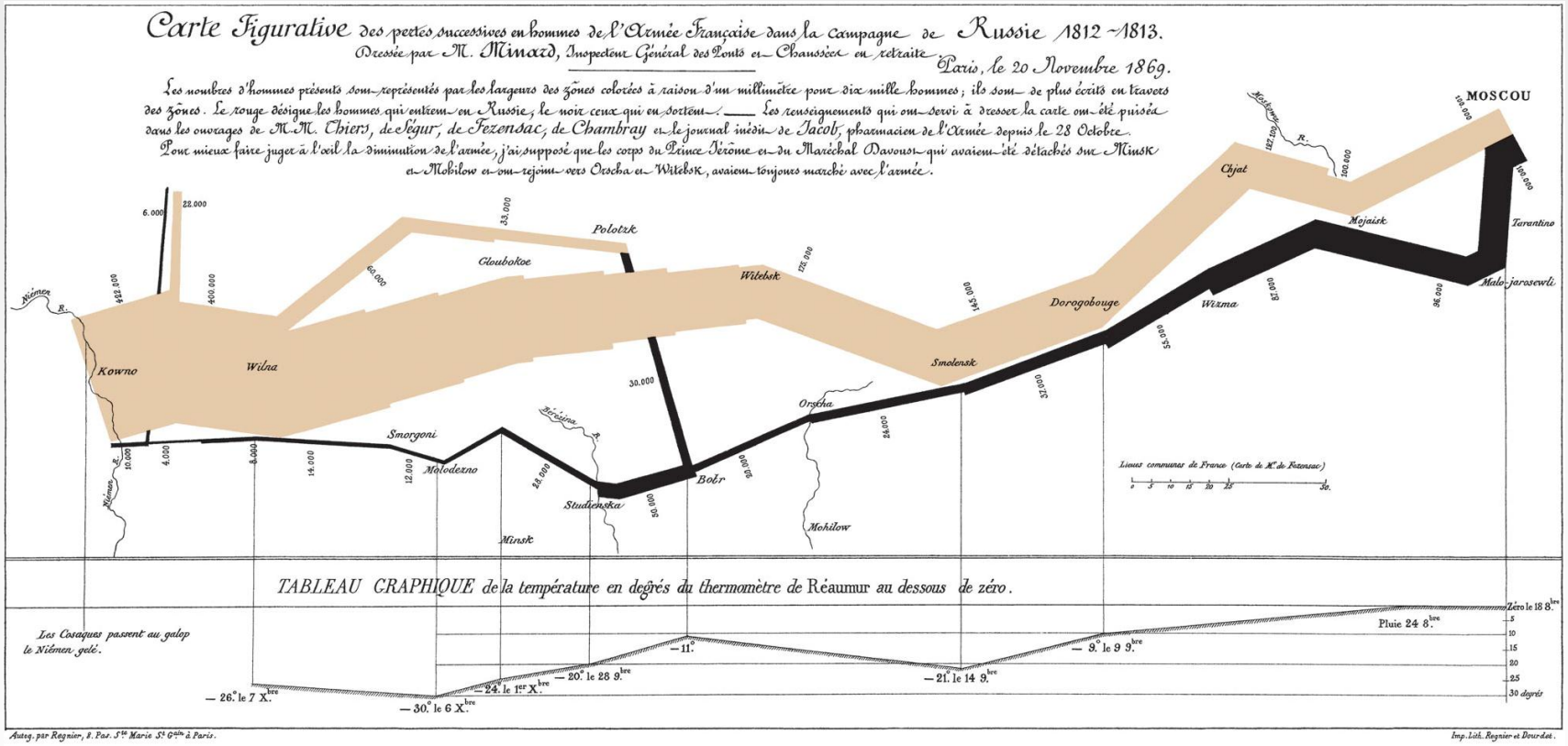
Figures that are doctored



http://www.spacetelescope.org/images/opo0639a/

But still totally amazing.

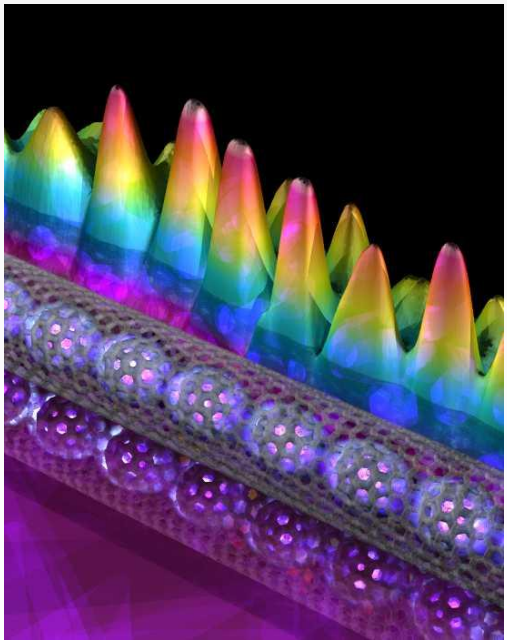
Figures that tell a story



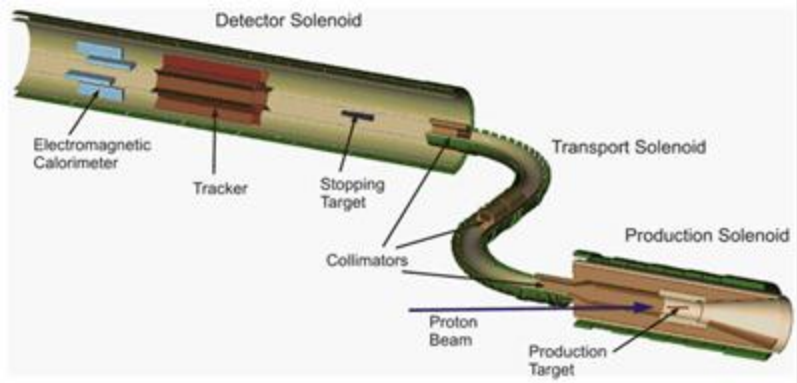
Napoleon's invasion of Russia.
Drawn by French engineer
Charles Joseph Minard

Some final tips

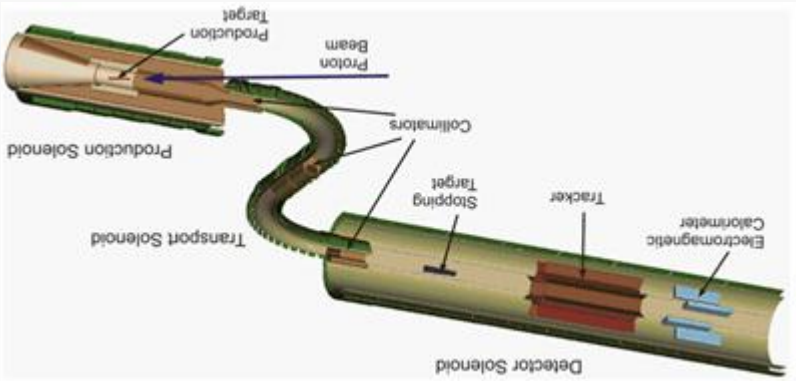
- **Use figures to add interest to your papers & talks.**
- **Make them clear, simple and memorable.**
- **Remove the words you don’t need.**
- **Label all your plots !!**
- **Most photographs and drawings should have a scale.**
- **If a process is shown, make it clear where it starts and ends.**
- **Arrange figures so that the “flow” the way people read (top left to bottom right).**



This:


Detector Solenoid
Electromagnetic Calorimeter
Tracker
Stopping Target
Transport Solenoid
Collimators
Production Solenoid
Proton Beam
Production Target

Or this?


Production Target
Proton Beam
Collimators
Production Solenoid
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