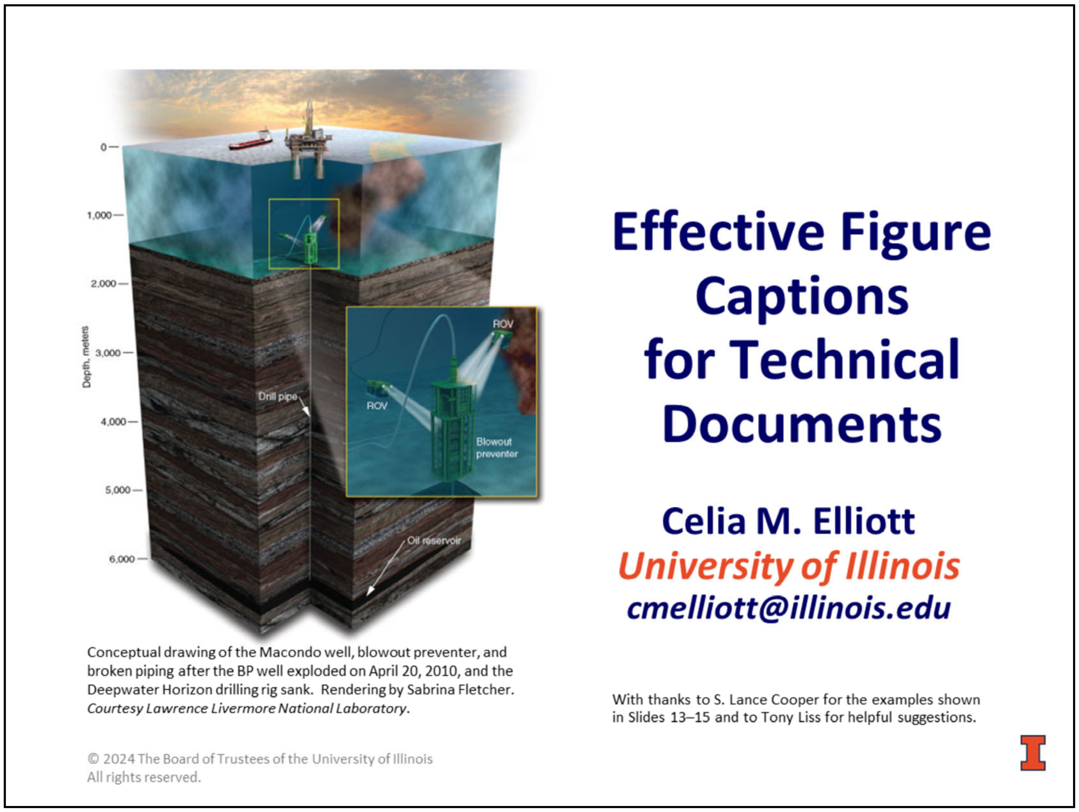


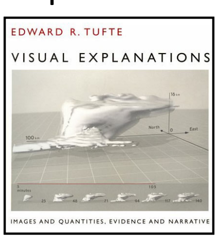

When feasible, put important points and conclusions in graphical form. Not everyone reads an entire article from beginning to end. When readers skim through an article, they are drawn to the figures. Try to make the figures and their captions

(1) tell the story.

(2) entice the reader to read the whole article.

***Highly recommended:***

If you're not acquainted with Edward Tufte's books, *Visual Explanations* should be required reading. He rules!




Edward R. Tufte, *Visual Explanations: Images and Quantities, Evidence and Narrative* (Cheshire, CT, Graphics Press, 1997).

***Also highly recommended:***

"Graphing Resources" (http://www.ncsu.edu/labwrite/res/res-homepage.htm), particularly their "Revising your Visuals" section.

## **Worst figure ever** (the caption doesn't help either)...

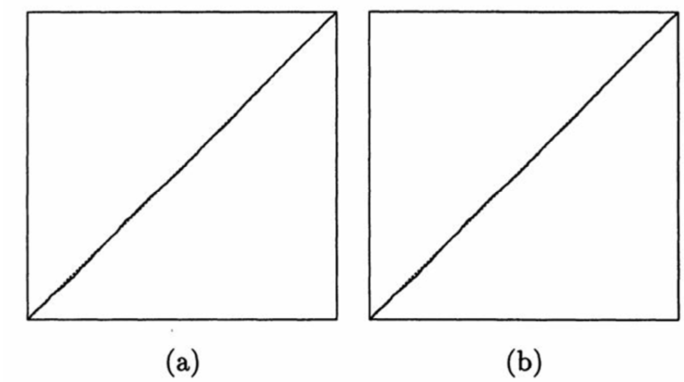
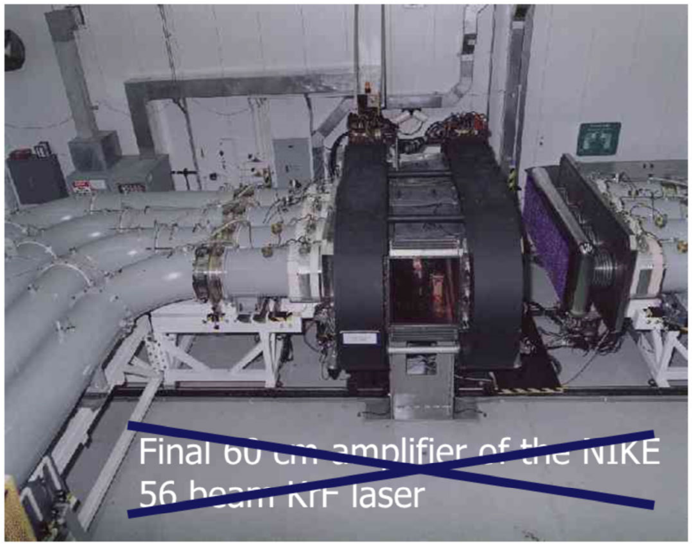



Figure 1. SRQ Plots of $T_i/T_n$ (Vertical Axes) Against $i/n$ (Horizontal Axes) for the Gibbs Sampler (a) and an Alternating Gibbs/Independence Sampler (b) for the Pump Failure Data Based on Runs of Length 5,000. Lines through the origin with unit slope are shown dashed; axis ranges are from 0 to 1 for all axes.

1. Per Mykland, Luke Tierney & Bin Yu (1995) Regeneration in Markov Chain Samplers, Journal of the American Statistical Association, 90:429, 233-241, DOI: 10.1080/01621459.1995.10476507. 1

**So that it can be copy edited, the caption should not be embedded into the artwork**




(*Image courtesy U.S. Naval Research Laboratory*)

2

Put figure captions (including the figure number) in separate text, not embedded into graphical files.

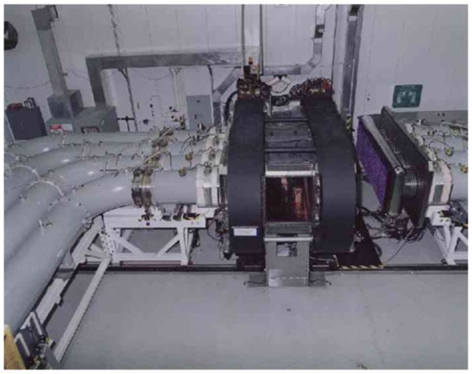
The caption embedded in the figure is inadequate, because it doesn’t identify the important parts of the figure.

## For photographs, crop out “background” to focus readers’ attention on important features

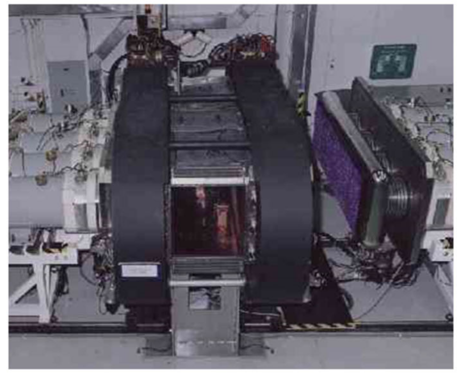
*(Image courtesy U.S. Naval Research Laboratory)*

3

## For photographs, crop out "background" to focus readers' attention on important features

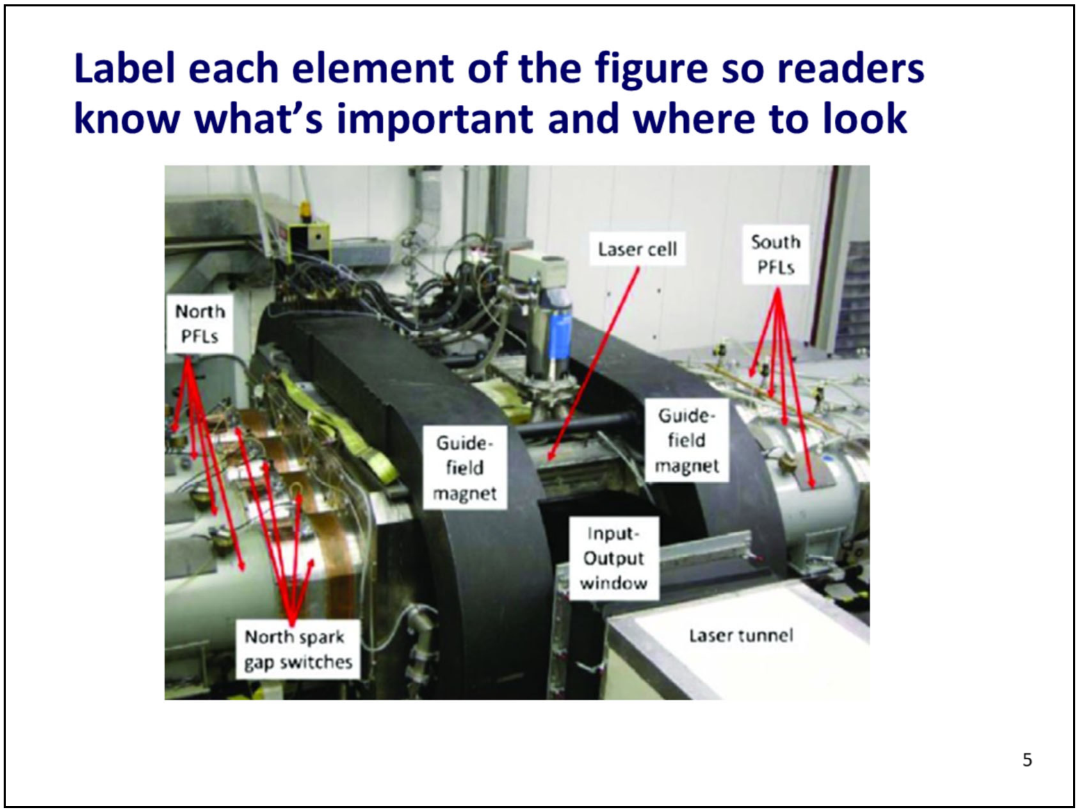


Before

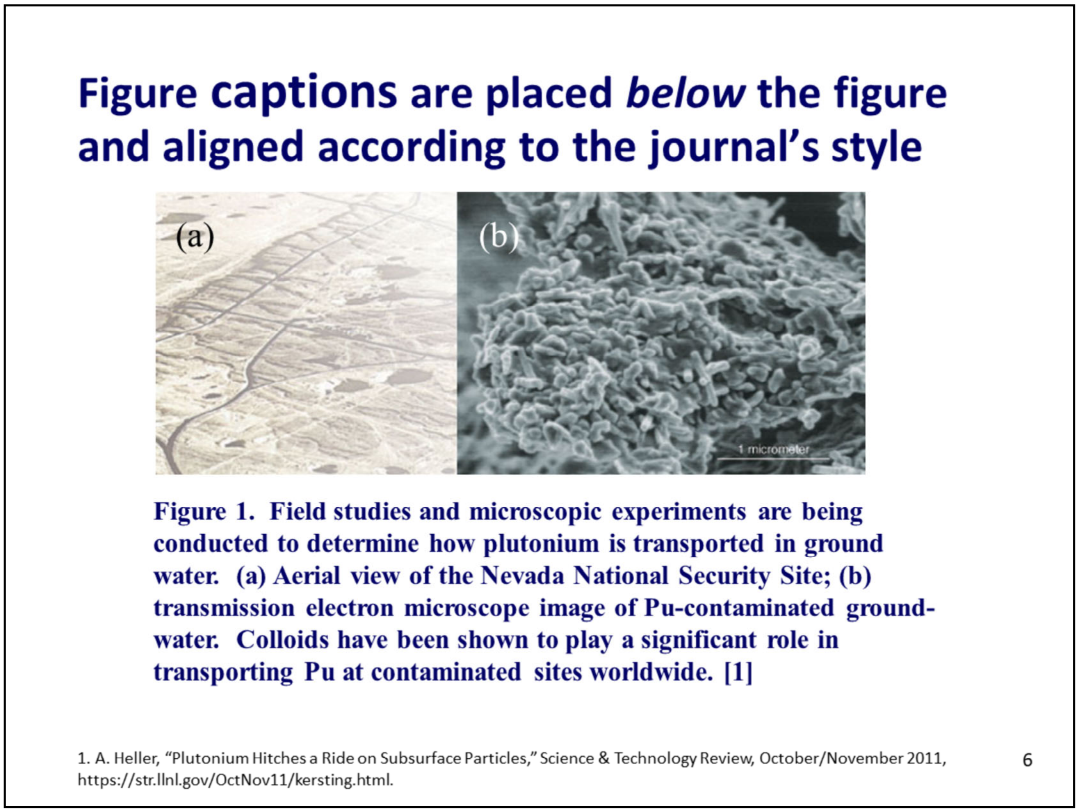


After

4




Point out each important element in the figure by labeling it, so that readers know what they're looking at.




Always begin the caption with the word "Figure" and the number assigned to that figure.

Use Arabic numerals and the word *figure* to denote figures and captions, e.g., Figure 1, Fig. 23.

*Figure* should be capitalized when combined with a numeral to form the title of a specific figure.

> "Temperature variation is shown in Fig. 3."
>
> "The figure clearly shows the temperature variation with elapsed time."

Some journals abbreviate Figure in the caption, and some don't. Check the journal's instructions for authors.

You can use the "caption" feature in Word (and the equivalent utility in LaTeX) to assign consecutive numbers to your figures and to automatically update the numbers in the captions and the text if you add or remove figures or move them around, such that what used to be Fig. 4 is now Fig. 6.

## Describe all elements of the figure without referring to material in the text

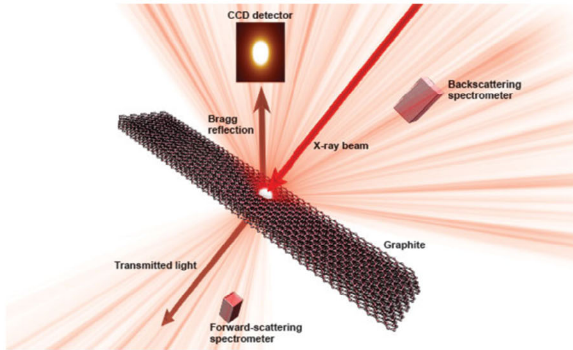



**Figure 2. Experimental setup to measure breakdown of solid-crystal graphite. A charge-coupled device (CCD) detector simultaneously collects Bragg-reflected x-ray laser light as crystal x-ray spectrometers collect light from inelastically scattered photons, enabling observation of extremely fast changes in graphite "melting." [1]**

1. "Graphite, a Quick-Change Artist," *Science & Technology Review*, Jan-Feb 2024, Lawrence Livermore National Laboratory. Published online at https://str.llnl.gov/january-2024/hau-riege.

7

Think about how scientists "read' a journal article—they read the abstract, scan the "introduction" and "conclusions" sections, and glance at the figures and tables.

Thus, figures must "stand alone"; a reader should be able to understand the main message in a figure without having to read the text.

## What's wrong with this caption?


**Figure 4. An image sequence from a dDAC experiment shows the growth of a dendritic ice-VI crystal in response to increasing compression. [1]**

- **dDAC not defined (caption must "stand alone")**
- **sample material not specified**
- **pressure range and the elapsed time not specified**
- **black "spots" in each image not identified**
- **label pointing out the "crystal" would be helpful**
- **"micrometers" should be "µm"**

1. Kristen Light, "Diamonds Put the Pressure on Materials," Science & Technology Review, June 2010, Lawrence Livermore National Laboratory. Published online at https://str.llnl.gov/June10/evans.html.

8

This caption is insufficient. It should probably define the dDAC acronym (dynamic diamond-anvil cell), tell what the sample material is (liquid water being cooled under high pressure to below the freezing point), and specify both the pressure range and the elapsed time shown in the series of images. The black "spots" in each image should also be identified (shadows of the ruby chips used to calibrate the pressure).

Ms. Particular quibble: the scale should be written as 45 µm. Units are always abbreviated when they are used with exact numbers that have been measured or calculated.

## If a figure is taken from another source, it should be referenced in the caption

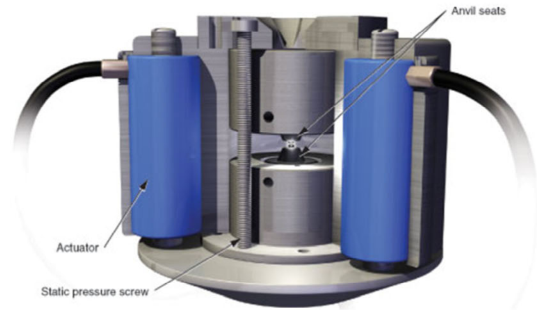



**Figure 3. Drawing of a dynamic diamond-anvil cell (dDAC). As diamond anvils compress micrometer-size samples, the piezoelectric actuator varies the static pressure, allowing researchers to examine how compression rates affect materials' behavior. [Taken from Ref. 1]**

1. Kristen Light, "Diamonds Put the Pressure on Materials," Science & Technology Review, June 2010, Lawrence Livermore National Laboratory. Published online at https://str.llnl.gov/June10/evans.html.

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Written permission must be obtained from the publisher—not the author—to ***reprint*** a figure in another publication. We'll talk more about this issue when we discuss copyrights later in the semester.

For purposes of this class, simply provide credit for figures you use. For a talk, identify the source of a figure on the slide on which the figure appears.

# If a figure is taken from another source, it should be referenced in the caption

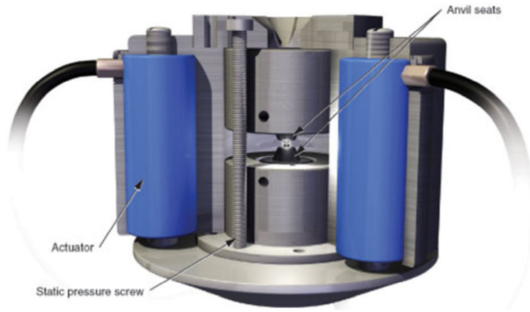
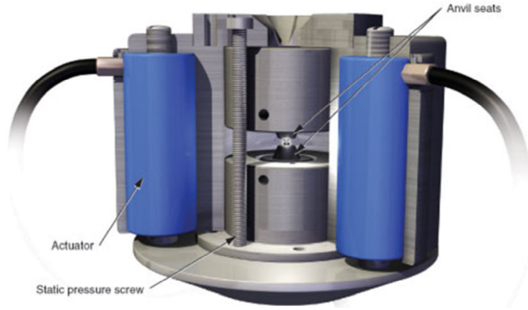



Figure 3. Drawing of a dynamic diamond-anvil cell (dDAC). As diamond anvils compress micrometer-size samples, the piezoelectric actuator varies the static pressure, allowing researchers to examine how compression rates affect materials' behavior. **[Taken from Ref. 1]**

10

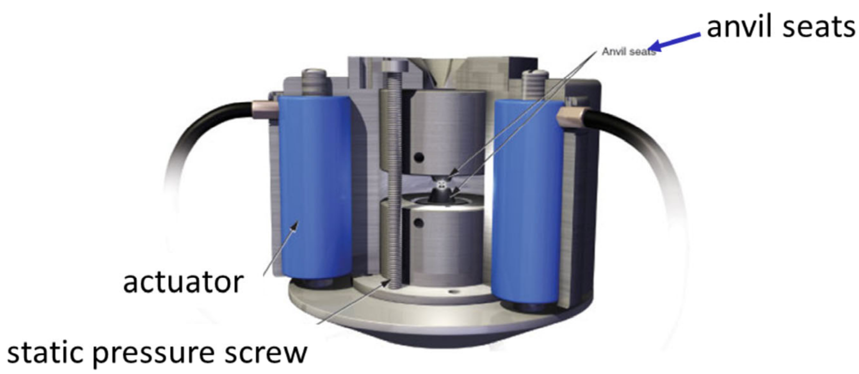
## Make sure the labels are big enough to be read



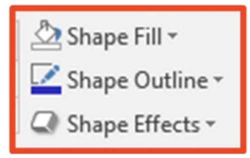

**These aren't.**

11

## For talks, superimpose a new label




**Insert a text box, no outline,
fill to match the background color**

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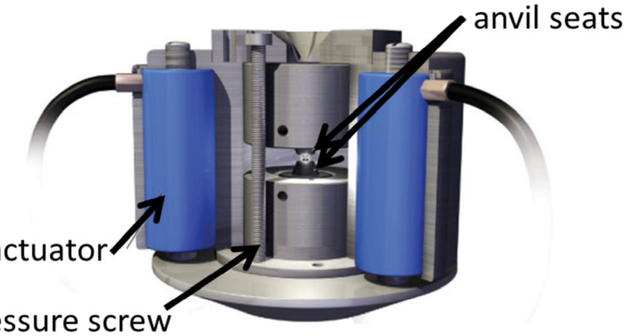
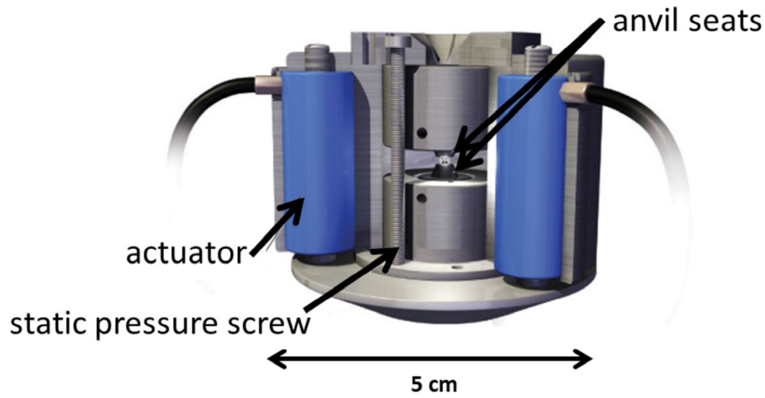
## Make the arrows big enough to see, too, by superimposing new arrows




13

## And always provide a scale






One of the most common mistakes authors make is not providing a reference scale for drawings and photographs. ***Always*** show a scale. While a reader might intuit that this device is pretty small, since it is used to compress mm-size samples, we have no way of knowing from the drawing whether the dDAC is 5-cm wide or 30-cm wide.

## State what the figure is showing before launching into an explanation of what it means

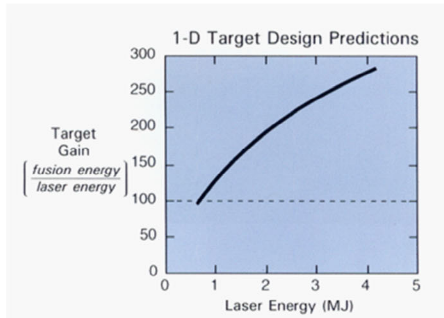



**Figure 3. The 1-D spherical target designs at NRL predict target gains of 100–300 for a few-MJ laser. This gain curve is an upper bound on possible target performance. A gain of at least 100 is required for fusion-reactor applications. (*Courtesy U.S. Naval Research Laboratory*)**

15

Always give the “title” of the figure first. Tell readers what they’re looking at before you start explaining the details.

# Here's the same figure and caption, but an explanation has been added to immediately orient the reader

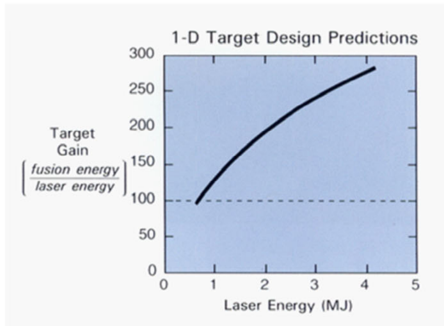



**Figure 3.** ***Plot of target gain as a function of input laser energy; the dotted line indicates the minimum gain required for fusion reactor applications.*** The 1-D spherical target designs at NRL predict target gains of 100–300 for a few-MJ laser. This gain curve is an upper bound on possible target performance. (*Courtesy U.S. Naval Research Laboratory*)

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# Here’s another example—what’s wrong?

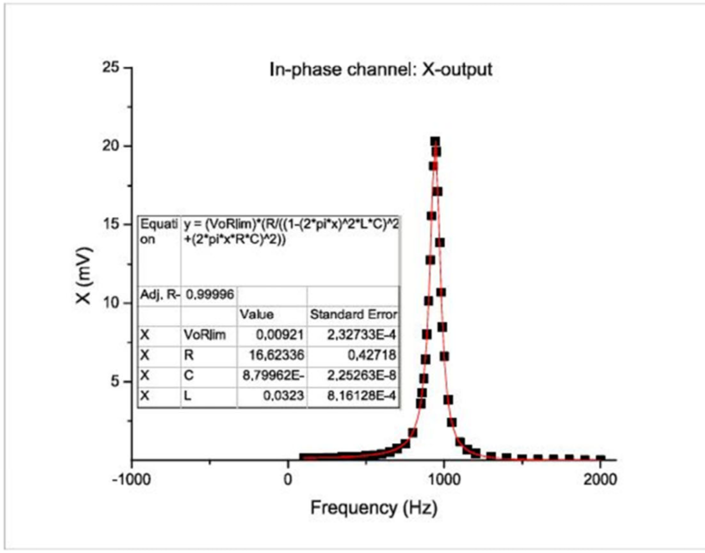


**Figure 4. The in-phase output voltage amplitude of an RLC circuit shows a clear resonant response frequency at a peak around 980 Hz.**

17

Here’s another example of an inadequate caption.

## First, say what the plot is depicting

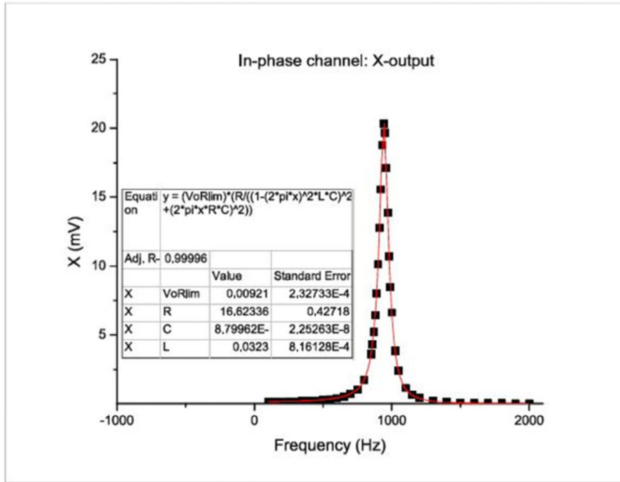


**Figure 4.** ***Plot of the in-phase output voltage X vs. frequency.*** **The in-phase output voltage amplitude of an RLC circuit shows a clear resonant response frequency at a peak around 980 Hz.**

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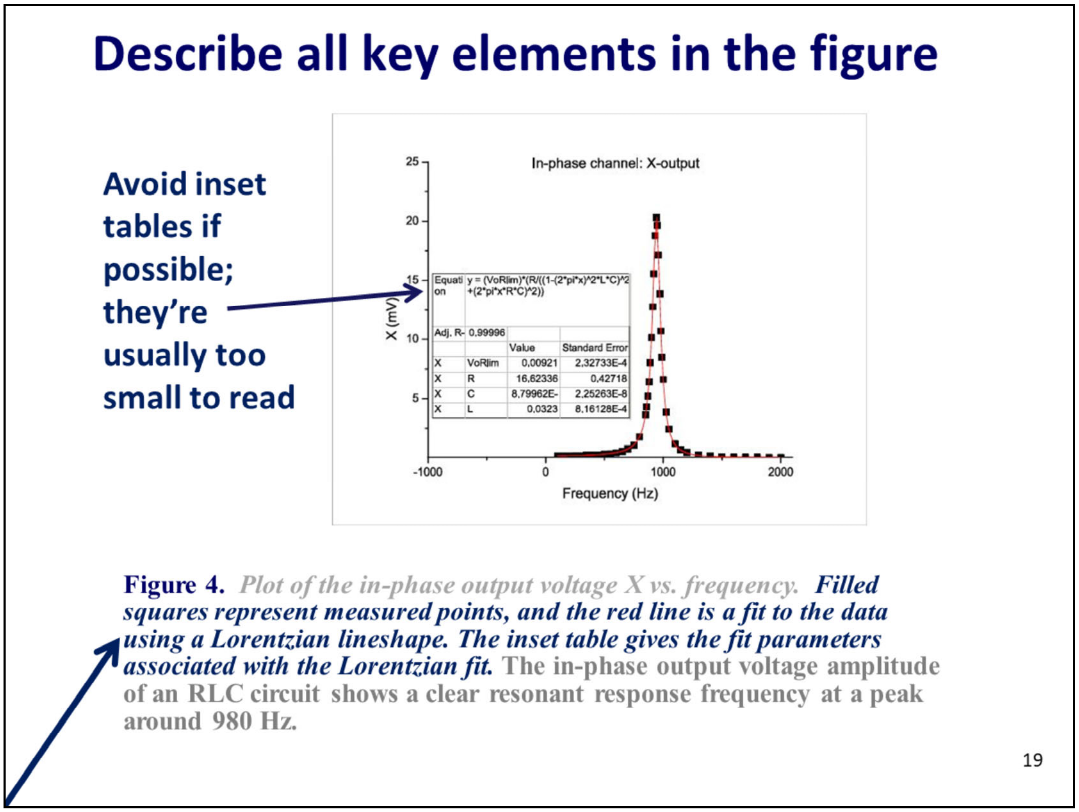
First, tell the reader what the figure represents.




The caption must describe every element of the figure. The original caption is insufficient, because it doesn't explain the significance of the filled squares on the plot, and it doesn't say what the inset table is for.

Other problems with this figure:

Why is the intersection of the *x* axis at –1000? It appears to be solely to allow extra space for the inset table! Start the *x* axis at 0, and place the insert to the right of the plot.

# What's wrong with this figure caption?

**Microphotographic images of pressure-induced dendritic crystals (top row) are remarkably similar to the patterns produced in computer simulations of temperature-driven dendritic crystal growth (bottom row). [1]**

1. Kristen Light, "Diamonds Put the Pressure on Materials," Science & Technology Review, June 2010, Lawrence Livermore National Laboratory. Published online at https://str.llnl.gov/June10/evans.html.

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## Number figures consecutively and "call them out" in the text

**Figure 6.** Microphotographic images of pressure-induced dendritic crystals (top row) are remarkably similar to the patterns produced in computer simulations of temperature-driven dendritic crystal growth (bottom row). [1] *(Courtesy Lawrence Livermore National Laboratory)*

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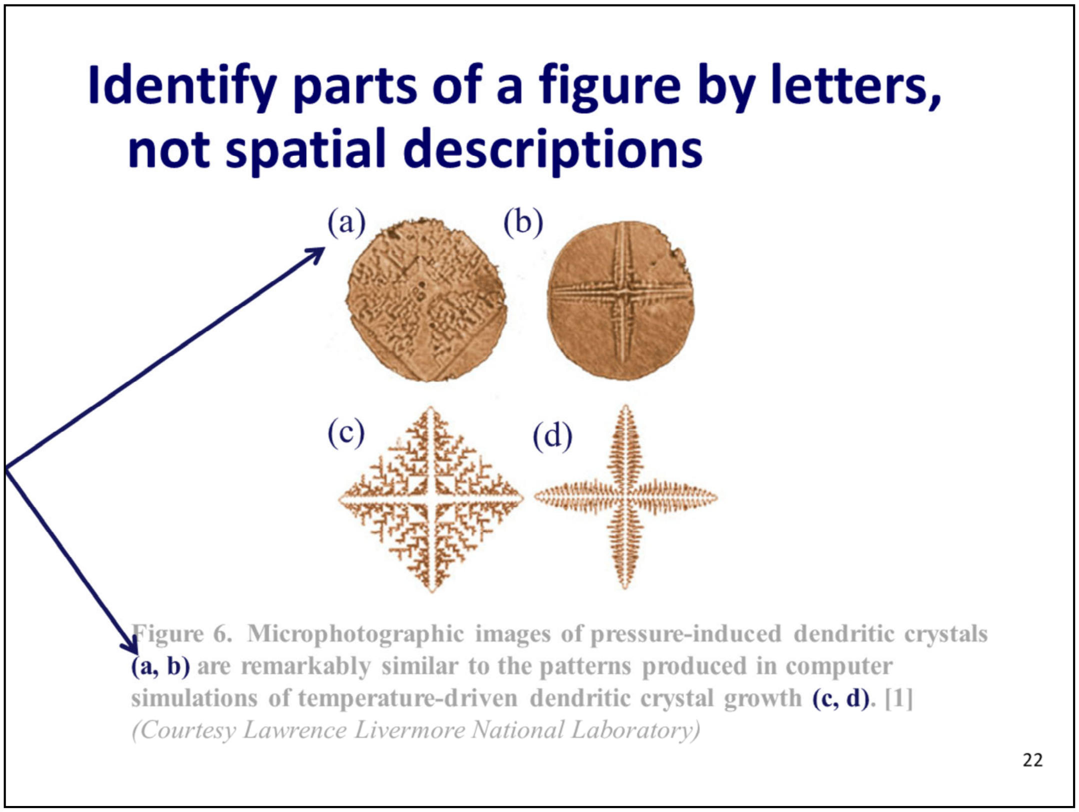
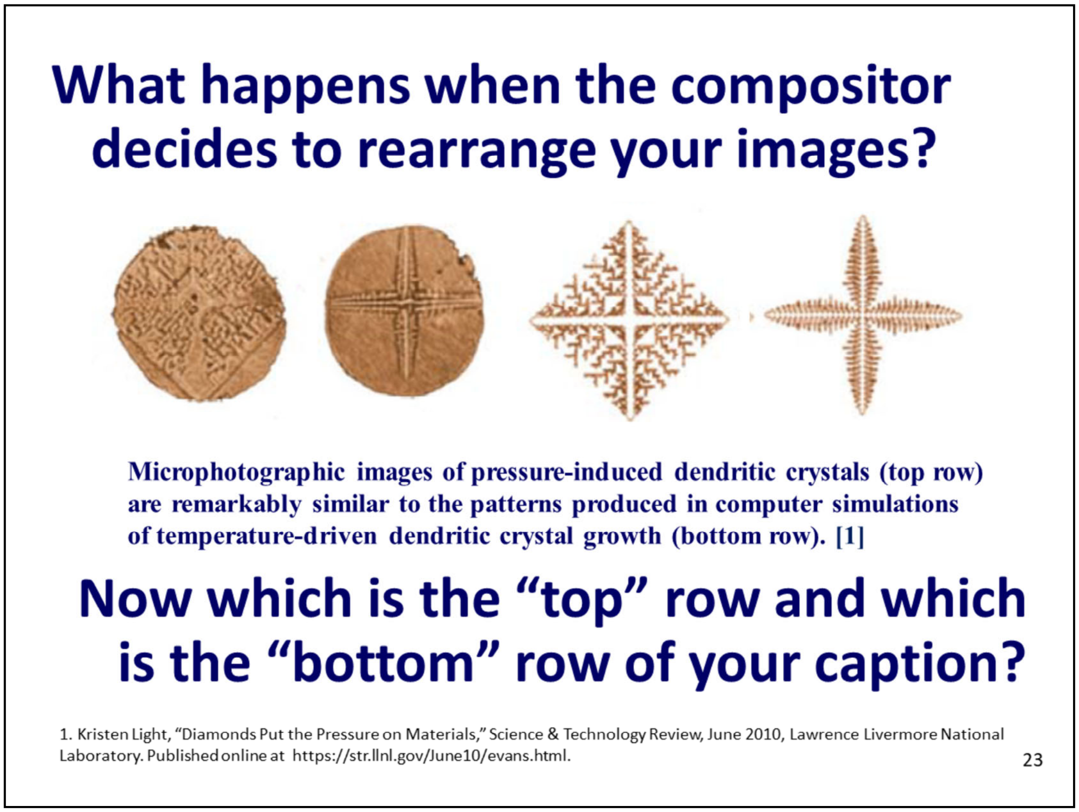
The caption must begin with the number assigned to it in the narrative text.




When you submit “camera-ready” copy, you control where the figures are located in relation to the text and how multiple figures are presented.

Designate sub-figures using letters, in alphabetical order. Arrange them left to right, top to bottom (the way English is read).




When you submit a paper to a journal that still typesets manuscripts, you don’t control how or where on the page figures are displayed. The compositor may decide that to save space and better fill up the page, she’s going to present your four photographs as shown on this slide.

Now what’s “top” and what’s “bottom”?

Never refer to spatial directions in the text of an article or in a figure caption.

## Don Ranly's Rules for Captions*

"Every picture requires ~~needs~~ a caption."

"Captions are read five times more than the text."

"Complement the image; say what it does not say."

"Give useful information."

"Connect the figures to the text. A good caption says 'see story' without saying it."

"Write complete sentences."

"Use active verbs in the present tense."

Ranly → The plot shows that a phase transition occurs at 77 K.

*cme* → A phase transition was observed at 77 K, as shown.

"Scale the caption to the size of the image; captions should be at least two lines, optimum three lines, maximum four lines."

***http://www.ranly.com** 24

Don Ranly, "Ranly on *Heads*," University Research Magazine Association Annual Conference, Florida State University, May 16–19, 2006.

Don Ranly is professor emeritus of the Missouri School of Journalism.
*http://www.ranly.com*

His remarks were intended for newspaper reporters and editors, but they're good advice for scientists, too.

Ms P quibbles:

I would rewrite Professor Ranly's Rule #1 to "Every picture MUST HAVE a caption," but that's a rant for another day. (Refer to Ms. Particular on "need.")

I would also say that the passive-voice construction is just fine, too, but I have enough trouble convincing physicists of the superiority of the passive voice for science writing. I'm not about to take on journalists. (Never argue with someone who buys ink by the barrel and paper by the ton.)

# Tables are not "figures"

**Table I. The weighted average magnitude of the variable star BI.**

| Delta Time / s | Weighted Average Magnitude | Error | Theoretical Magnitude | Residuals |
|---|---|---|---|---|
| 0.00 | 13.19423497 | 0.19501173 | 13.1705935 | -0.023641504 |
| 154.00 | 13.22865458 | 0.19501433 | 13.216023 | -0.012631614 |
| 336.00 | 13.26455548 | 0.1950244 | 13.2634119 | -0.001143626 |
| 559.00 | 13.29191041 | 0.19499902 | 13.3028718 | 0.010961429 |
| 739.00 | 13.26350107 | 0.19498535 | 13.3143448 | 0.050843759 |
| 876.00 | 13.30723823 | 0.19498516 | 13.3095757 | 0.002337472 |
| 1055.00 | 13.32218441 | 0.19499299 | 13.2864635 | -0.035720951 |
| 1235.00 | 13.26201206 | 0.19498149 | 13.2470764 | -0.014935677 |
| 1415.00 | 13.22281916 | 0.19498198 | 13.1970289 | -0.025790215 |
| 1594.00 | 13.14924188 | 0.19499765 | 13.1436517 | -0.005590137 |
| 1774.00 | 13.09732704 | 0.19499476 | 13.09386 | -0.003467013 |
| 1955.00 | 13.03136126 | 0.1949959 | 13.0547746 | 0.023413301 |
| 2134.00 | 13.00026859 | 0.19499774 | 13.0323898 | 0.032121215 |
| 2315.00 | 13.05791022 | 0.19499218 | 13.0293934 | -0.028516795 |
| 2495.00 | 13.01524894 | 0.19498413 | 13.046414 | 0.031165064 |
| 2675.00 | 13.08057076 | 0.19499074 | 13.0809861 | 0.0004153 |
| 2855.00 | 13.15262316 | 0.19499655 | 13.128249 | -0.02437417 |
| 3035.00 | 13.15894232 | 0.19499639 | 13.1815579 | 0.022615593 |
| 3215.00 | 13.27769133 | 0.19499966 | 13.2334179 | -0.044273377 |
| 3395.00 | 13.28167834 | 0.19498832 | 13.2765379 | -0.005140436 |
| 3574.00 | 13.25550453 | 0.19498195 | 13.3047474 | 0.049242885 |

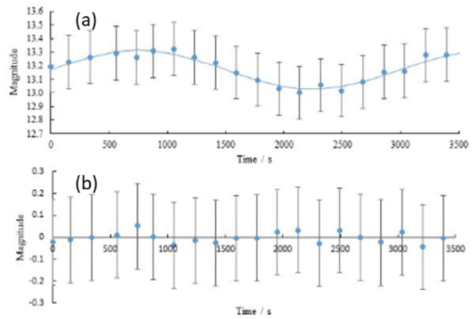



**Figure 1. (a) A light curve fit to the weighted average magnitude of the variable star BI. (b) One period, showing respective residual plot.**

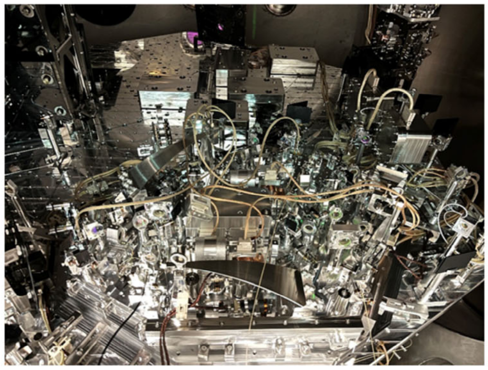
**"Titles" are placed *above* tables**
**"Captions" are placed *below* figures**

25

One of the most common mistakes authors make is to put the title of a table below the table.

## What about captions in talks?

**If the audience is not going to immediately recognize what a figure is, give it a short explanatory caption**



**Source of "squeezed" light in the LIGO vacuum chamber**
**(*Courtesy Wenxuan Jia, LIGO Collaboration*)**

**They're going to look at the figure first…** 25

A brief caption that identifies what the audience is seeing immediately orients the audience so they can go back to *listening* to you.

Whether the figure shown on this slide is a good one for a talk is debatable.

## What about captions in talks?

**Give the images a short explanatory caption**

**Caption in a paper:**

**FIG. 1. Schematics of the experiment. The NPRO laser provided up to 2-W output power at the wavelength $\lambda$ = 1064 nm for the two identical nonlinear cavities: squeezer and DOPO. The squeezed light was detected with a balanced-homodyne detector. EOM, electro-optical modulator; PBS, polarizing beam-splitter; DBS, dichroic beam-splitter.**

**Caption suitable for a talk:**

**Source of "squeezed" light in the LIGO vacuum chamber**
**(*Courtesy Wenxuan Jia, LIGO Collaboration*)**

**Figures are not numbered in talks**

**Credit the source of the image in the caption** 25

Figures must be numbered in papers, so a reader can associated a specific figure with the narrative description in the text. Numbered figures are not necessary for talks, because the caption is right there on the same slide with the figure.

In a paper, you *know* who created a figure—the authors! In a talk, if you use a figure from another source, even one of your own, you must credit the source.

## To recap:

Place the caption below the figure

Number figures consecutively and call them out in the text before displaying them

Identify what is being shown at the beginning of the caption

Describe all elements of the figure in the caption

Make labels big enough to be legible

Always provide a scale

*cmelliot@illinois.edu*
*http://physics.illinois.edu/people/Celia/*

NOTES: