Fragmentation Box

Demo instructions

Don't worry about having to talk with people about the lab... you know more about it that they do!

Stick to the positive messages FRIB wants to convey:

- *We do world-leading research*
- *We educate new nuclear scientists (#1 grad program in US)*
- *Our safety record is excellent*
- *We are good for Michigan: high-tech jobs and federal funding*
- *We are awesome*
- *If you're not sure of an answer, it's OK to say "I don't know"*

Before the demo

If you expect to have a large volume of visitors, it makes sense to use a target that's glued together so you don't have to reconstruct it every time you do the demo!

They may notice that the target doesn't fragment - it's OK to admit that you're "cheating" a bit. After all, it's a model, not a fully-accurate nucleus!

During the demo

If there are lots of visitors, you can give each a nucleus and do the introduction for all at once, then have them smash one at a time, moving on to the chart of the nuclides after they collect their beam and the other fragments from the box.

If the line at the chart gets long, you can lengthen the explanation at the box, asking more questions!

Thanks for volunteering! This demo (courtesy of JINA) is a pretty simple way to show people the world-leading research that we do at FRIB. You'll need some or all of the following equipment (provided by Zach Constan, outreach coordinator):

- Fragmentation box (contains accelerator stand, target suspension)
- Demo case (contains several marble nuclei, dry-erase markers/eraser, Zach's card, repair equipment, stickers)
- Glued target (optional)
- Marble Nuclei postcard
- Other FRIB freebies?
- Easel, Chart Nuclides poster
- FRIB standing sign, poster
- Printer labels & sharpies

Figure 1. Your marble accelerator.

Build a carbon-12 beam nucleus (6 yellow protons, 6 green neutrons). Set up a carbon-12 target nucleus by hanging it from the nail in the box. The real target IS a carbon (graphite) disk.

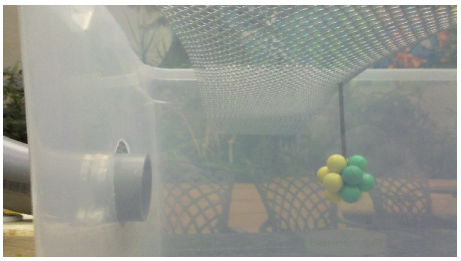

Figure 2. The "target" nucleus attached to a nail hanging from gutter guard that spans the plastic box, beam tube on left.

Invite people to try it! Emphasize that they get to "smash stuff and get free stuff." The parts in italics below are the kind of things you could say, but do what's comfortable, especially considering the audience you have.

Everything is made of tiny particles called atoms (you, me, the floor, the air...), and the nucleus of the atom is incredibly small, so you can't see it. So we use marbles as a "model", to imagine what it looks like and how it acts. Show the visitor the model!

In the Facility for Rare Isotope Beams at MSU, we do world-leading research on the nucleus. Let them hold the model, have them count protons (*Six protons is a carbon nucleus*) and neutrons (*Six more, plus six protons is how many? This is a carbon-12, a very common and stable nucleus*).

At FRIB we study rare isotopes, which are very unusual versions of the elements and not found on earth, so we have to make them before we can study them. Thus, we take a common, stable isotope like this one, make it go fast using the powerful linear accelerator at FRIB, then smash it. With this model nucleus, we can do the same with an accelerator tube.
Show the visitor where the beam goes in, and parts of the demo.

What will happen when you drop it in? From what height do you want to drop it? Why? You need a lot of energy (go fast) to break a nucleus. What will happen to your "beam" when it hits the "target" nucleus in the box? Try it. Were you right?

Pull out the new isotope (remains of the beam on box floor), removing any marbles that aren't **directly** touching the core silver magnet. Put the new isotope in one of the visitor's hands and the leftover marbles in their other hand, emphasizing to not recombine them. *Now go see the volunteer at our Chart of Nuclides to find out what you made!*

Figure 3. Before, during, and after fragmentation. The new isotope is on the floor of the box (bottom right).

At the chart: have them count the yellow protons on their nucleus. *What element is it?* Show how each row of the chart has a different number of protons and equivalent element. Have them count the green neutrons and add the numbers together. *What isotope is your beam nucleus now? Mark it with a check-mark on the chart of the nuclides.*

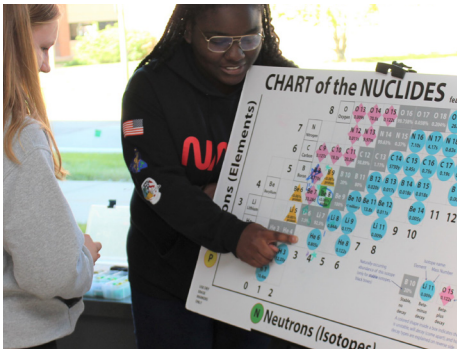

Figure 4. Identifying your nucleus

Have them mark it in a color of their choice - the more colors you have, the more interesting it looks! Talk to them about their isotope - if it's stable, explain why it's hard to make unstable isotopes. If unstable, make them feel like they produced something interesting. If it doesn't appear on the chart, make a big deal about how they just "discovered" it and give them a Nobel Prize sticker! *Your "beam" started as (what?) a stable nucleus… is your final isotope stable? This is like what FRIB can do, smashing nuclei at up to half the speed of light to produce nuclei that you won't find on Earth.* Direct them to the next volunteer at the freebies table.

At the freebies table, help the visitor make a label to wear that says "I made <isotope>". Also ask if they want to try Isotopolis (if available).

The FRIB accelerator that opened in May 2022 can do amazing experiments right now because it smashes the most heavy nuclei in the world! It will discover lots of new isotopes and do experiments no one has ever been able to do.

Want to know more? Have a postcard, and some FRIB freebies! Offer them the free stuff, most importantly postcards that have the laboratory web address. Use the poster to point out the applications of nuclear science and the economic impact on Michigan. Suggest they can contact Zach or the website for more information, including tours and summer programs.

During the demo con't

You can call the fragmentation box a "cheap Home Depot accelerator that uses gravity" - adults really love that one.

You have lots of flexibility in positioning the target nucleus for optimal fragmentation! Move it around if necessary, especially to prevent too much fusion.

If you have high traffic, the identification at the chart of the nuclides can really slow things down. One option is to have several gather at the chart, show them how to identify the nucleus, and let them do the work.

Much of this is optional, beyond the "fragmentation makes rare nuclei for science, and we're really good at it!" message. Tell the story in the way you are most comfortable doing!

If a kid wants to do it again, and there's a line, just send them to the back. They're usually more than happy to!

If you are getting lots of questions and have more people waiting, encourage them to take Zach's card and send email!