# Video Transcript for the *Particle Detection* Activity:

Hi! My name is Michelle and I’m a member of the IBEX Education and Public Outreach team. We’ve designed a series of videos to show you how to facilitate the IBEX educational activities for informal audiences, such as museum visitors or after-school program participants. This video is for the activity titled *Particle Detection*.

The IBEX spacecraft orbits Earth, and studies the interaction between the material that streams off the Sun, called the solar wind, as it interacts with the material between the stars, called the interstellar medium. That process creates energetic neutral atoms, or ENAs, which are atoms that are moving really fast but have no charge. Some of those ENAs happen to come toward our vicinity of the solar system where the IBEX spacecraft collects them using its two sensors called IBEX-Hi and IBEX-Lo.

Now, *Particle Detection* shows how the IBEX spacecraft collects these particles and how we can create a map of the boundary of our solar system using this information.

So, the setup for *Particle Detection* is fairly simple, but you’ll need to do some prep work ahead of time to get all the materials ready.

First, you will need 16 clear plastic tubes. Now, these tubes work pretty well. They are 12 inches long and 3 inches wide. And you’ll want 16 of them because you’re going to be hooking four of them together - in this case we used clear packing tape – and you’ll want four sets of these, total. And so, we have attached these to heavy cardstock. And so, it just keeps it a little sturdier when you’re working with a big group of people. Also, you want to number each of the tubes: 1, 2, 3 and 4. So, just make four identical sets of these clear plastic tubes.

Alright, next, you’ll need masking tape. Now, the masking tape will be used to mark off the IBEX spacecraft on the floor. So, just have a roll handy. You won’t need a whole lot of it.

Then, you will need balloons. In this case, this is balloons filled with rice, or if you happen to have them, beanbags are fine. But, this is an inexpensive option. You’ll want to have certain colors. So, you want: red, orange, yellow, green and blue. And so these are representing the different energy levels of particles that the IBEX spacecraft is detecting using its IBEX-Hi and IBEX-Lo detectors.

Now, to represent those detectors we have buckets, and you want to have four buckets total. We have the lids for the buckets as well - that is also important to have. So, make sure you’ve got the lids for all of your buckets. Now, you want this bucket here, it is labeled “1,” and you want to color it red and orange. This one is labeled with a “2,” and you want it colored orange and yellow. Next, we have this bucket labeled “3” is yellow and green. Finally, we have this bucket labeled “4” is green and blue. And this is what the, representing the different energy levels that the IBEX-Hi and IBEX-Lo particle detectors are actually detecting at any one time.

So, the different colors, if you don’t have a bucket that you can use to take a permanent marker and actually color them, you can cover these with construction paper – whatever you have on hand – just to make sure that the colors are nice and bright so they’re easily seen.

Basically, once you’ve done all that, you are ready to go to set up *Particle Detection*.

So, *Particle Detection* takes up a bit of space. So, select a space that is at least 10 feet by 10 feet – but a little larger is even better. You’ll want enough room for as many as 15 to 30 people to stand and participate.

First, make an 8-sided masking tape figure on the floor. This represents the IBEX spacecraft. If you want to make the masking tape figure actual size, you can. IBEX is 38 inches across.

Next, set up each of the sets of tubes on the floor, one set for each quadrant.

Toss out a supply of beanbags, or balloons, to all parts of the quadrants so that everyone has at least a few. Make sure the colors are spread out randomly. When people pick them up, they should just grab them and not pay any attention to the colors.

Set up the buckets with their lids. The buckets labeled 1 and 2 represent the IBEX-Lo sensor. The buckets labeled 3 and 4 represent the IBEX-Hi sensor. Keep the buckets always in a straight line. IBEX-Hi and IBEX-Lo are on opposite sides of the spacecraft from each other.

Okay, now you should be ready to go!

*(Michelle addresses the crowd of participants taking part in the activity demonstration:)*

Alright everybody, we are going to do the activity called, *Particle Detection*. In this activity, we are investigating how the IBEX spacecraft detects particles coming from the edge of our solar system and, from that, how we can make a map of what’s going on there.

Now, you guys *(Michelle points to the participants)* are representing the edge of our solar system, but are you all to scale? Is this all to scale with the real solar system? No, definitely not. Our IBEX spacecraft isn’t too far away from being the right size, but, no, definitely the edge of our solar system is far beyond the orbit of Pluto – about 3 times farther than the orbit of Pluto on average.

So, what we’ve got here is our IBEX spacecraft and it has two sensors called IBEX-Hi and IBEX-Lo. And so, we’ve got our buckets representing the two sensors. You guys are representing the edge of our solar system, and the beanbags that we have here are representing our particles.

What you’re going to do is toss the particles toward the sensors when I say, “go,” and you’re going to try to get them into the bucket. Now, I don’t want you to pay any attention to color. I don’t want you to pay any attention to anything except “stop” and “go.” Alright?

And so, what we’re going to do is we’re going to toss them and we’re going to see what ends up in the buckets and I’ll talk a little more about that when we’re done doing that. Ok, you guys ready?

Ok. First of all, we’re going to have you guys toss. *(Michelle points to participants in two quadrants that are facing each other and in line with the buckets.)* So you are going to toss to these two buckets. You and I are going to toss to these two buckets and only these two, ok? *(Participants in each quadrant can only toss into the two buckets closest to them.)* Imagine there’s an imaginary wall in between these buckets so don’t try to hit the far one, alright? That would be good, but we’d have to take them out. So, you guys understand? Alright.

And when I switch, you’ll toss again. And then I’m going to turn the buckets and then you guys *(the participants in the remaining two quadrants)* are going to get to go. Alright? You ready? Ok.

So, on the count of 3 I just want you to grab a few particles, a few beanbags, go ahead. So on the count of 3, we are going to toss toward our buckets. So go ahead and grab some beanbags. Yep. Alright, like I said, don’t pay any attention to the colors in your hands, just toss randomly. Alright, you ready? 1, 2, 3, toss. *(participants toss balloons)*

And stop. Ok, I’m going to switch. *(Michelle uncovers the inner two buckets and places the lids on the outer most buckets.)* Now, I’m switching these lids because the IBEX sensors can detect certain energy levels of particles, but it doesn’t do it all at the same time. It can only detect certain energy levels at certain times. So, I just pretended we switched energy levels here, and so, we’ve got our buckets open again. So, on the count of 3 we are going to toss again. Ready? 1, 2, 3, Go. *(participants toss balloons)*

And sometimes some of them make it in, and sometimes some of them don’t. Stop.

Alright, now, let us figure out what’s going on here. So, these two buckets are representing the IBEX-Hi sensor. *(Michelle points to buckets 3 and 4)* Alright. These two buckets are representing the IBEX-Lo sensor. *(Michelle points to buckets 1 and 2)* When the, when this bucket *(Michelle is holding bucket #4)* is “on” – when I’ve got it uncovered – it can obviously only detect certain energies of particles. Which color balloons do you think we have to pay attention to? The green and blue. Exactly. So, do I have green and blue in my hand? One of each, or one blue, one not. So, we can’t count that one, so, IBEX didn’t detect that particle. So, we can count this, so this blue balloon is going to go in tube #4. So, I’m going to toss this over. There you go. Put it in tube #4.

And then *(Michelle picks up bucket #3)* green and yellow. Lo and behold, we did pretty good there. So, we’re going to put all of these in tube #3. Exactly!

Alright, for you guys, *(Michelle picks up bucket #2)* which energy level particles can we detect? Yellow and Orange, and so, can I detect all these? Just the orange one. Exactly. So, which tube is this going to go into? Tube #2. So, I’ll hand that over.

And then, which ones can we detect here? *(Michelle picks up bucket #1)* Orange and red. Do we have any orange and red? No, so nothing goes in that tube there.

Ok. So now, we’re going to switch the buckets. And you’ll see that I did put a few into some of the tubes ahead of time, just so you could see what this would look like. Alright, I’m going to switch because the IBEX spacecraft spins and so we are going to imagine that. We’re going to spin. There we go. *(Michelle spins the line of buckets to line up in front of the other two quadrants.)*

Alright. You guys get the idea? You ready to toss? Grab some beanbags, and I’m going to stay here. Alright. On the count of 3. Ready, wait, oh are you ready? Alright, 1, 2, 3, go. *(participants toss balloons)*

Alright, keep going, and stop. Alright, let me switch. We’re going to switch our energy level that the sensors can detect. *(Michelle uncovers the inner two buckets and places the lids on the outer most buckets.)* And, ready? 1, 2, 3, go. *(participants toss balloons)*

And stop. Ok. Alright. So, for this one, *(Michelle picks up bucket #4)* we’ve got certain particles. Can we count them all? Nope. I need to get rid of the orange and red. So this goes into tube #4. Very good!

And then, *(Michelle picks up bucket #3)* can we count them all? Nope, just that lonely green one. There we go. In tube #3. Alright.

And, *(Michelle picks up bucket #1)* can we count them all? Just orange and red, so, oh we did pretty well there. So we can put that in tube #1.

And then, *(Michelle picks up bucket #2)* orange and yellow, can we count them? Nope.

Ok. So what I want you to do is take a look around to all the tubes, around all the entire sky. Do we have exactly the same number of particles coming from all parts of the sky? No, we don’t. We have different parts of the sky, different particles from different energy levels coming from all different parts of the sky. Now what is important to the scientists then is to find out “why?” “Why do we have different numbers coming from different parts of the sky?” And that is something that the IBEX scientists are really interested in finding out, so, they make a map from this information. So if we were to say, make a map, maybe of energy level #1, we would look at all particles coming from different parts of the sky and make a map of everything – all the numbers from each tube with the #1. And then we could have a #2 map, and a #3 map, and a #4 map.

That’s it. So, that is *Particle Detection*. You have now explored how the IBEX spacecraft collects particles from different parts of the sky. It spins, and we can detect those different energy levels at different times. Thank you so much for participating in *Particle Detection.*

We hope you have enjoyed learning more about *Particle Detection*. For more information about this activity, and to download the lesson plan, please visit our website at www.ibex.swri.edu.

Thanks for watching!