# Transcript

### Planet Mercury – BepiColombo’s MIXS instrument

**EMMA BUNCE:**

MIXS is the Mercury Imaging X-ray Spectrometer. So the clue is sort of in the name, although it's quite a long and complex name. What it will do is measure fluorescent X-ray photons coming from the surface of the planet Mercury. So MIXS will stare at the planet's surface, and from the measurements, can work out what the surface is made of.

**ADRIAN MARTINDALE:**

So from orbit around the planet, we can look down at the surface and determine what the rocks are made of that are making the surface. That cuts across so many different areas of science, because there is the planetary geology aspect. But planetary geochemistry, which is what we're talking about, really tells you about the whole of the planet, as well. So if we can look at very high resolution, we can see inside small craters, which can tell us things about the depth profile and how concentration of elements on the surface changes as a function of depth, how it changes as a function of the evolution history of the surface, as well.

We're in the Watson Clean Room at the University of Leicester. And we're here to look at the MIXS qualification model instrument, which is this thing that you can see behind me here. The instrument is split into two parts. So there are basically two devices that you can see here, which both together form the MIXS instrument.

So this is called MIXS-C. And the C stands for collimator. This larger device here is MIXS-T, and T stands for telescope. The collimator uses a passive device to restrict the field of view of the instrument. So this is what allows us to determine where the X-rays have come from on the surface of mercury. It restricts the amount of the sky that you can actually see. So very much like having tunnel vision, you can only see in one direction.

That's the way this device here works. We have millions and millions of microscopic tubes that are looking out towards Mercury. And they restrict the field of view of this detector so that we can say where the X-ray's come from. This is a passive device. It's not actually focusing the X-rays onto the focal plane, so you're not increasing the signal that you're getting within a particular area of the detector.

The aperture of the MIXS-T optic is significantly bigger than the MIXS-C collimator. And what the optic does is it actively steers the X-rays onto the focal plane. That gives us much higher sensitivity than we have for MIXS-C. This device has very high spatial resolution, a high collecting power, but it has a very small field of view.

This device has a large field of view with a smaller collecting power. And that gives us global scale features that we want to look at on the surface of mercury. This gives us much more localized features, and allows us to do the really high resolution science that we're interested in at Mercury.

So going on the two things that you can see at the back of each of the instruments are called the focal plane arrays. These are basically like a camera. And they're identical for the two devices. The reason we did that was to minimize the cost.

So these two devices are exactly the same, which means that we only need to hold one spare in case of problems during the testing of the instrument. If one of them were to break, we can just swap it out for the flight spare model. The main electronics box, that's where the real number crunching is done.

That's like our computer. So this thing does the preprocessing of the signals from the detector. This thing really works out what the energies are and packs it into a really nice compact form so that we can send it back to Earth.

This kind of measurement is most powerful when you combine it with a whole suite of instrumentation. And that, I think, is what BepiColombo has done really, really well. It's a mission that will give us a whole range of different observations of the surface.

**EMMA BUNCE:**

I firmly believe that the best science that we ever do is when we combine data sets together. We learn by putting data sets together. But on its own, a data set is just a measurement. So it's much better if we combine it with the other instrumentation and the other visible images, infrared spectrometer, data, et cetera, to try and build up this bigger picture of the history of Mercury. And I think that that feeling of being the first person to look at something is actually what really excites me about the work that we do. So the first mixed data that will come back from Mercury, we'll be the first people to see that data.

**ADRIAN MARTINDALE:**

I think we get kind of blasé in this business about the environment that we're really designing the thing to cope with. But the first thing that it will really see is the vibration environment of the launcher. And this is quite terrifying, to be honest, when you've spent so much time building an instrument like this, and then you take it to a huge machine that will shake at up to something like 20 Gs.

So this thing has to be designed to such high tolerances that it can cope with that level of stress. But at the same time, it needs to be light enough that we can put it onto the satellite. So you're constantly battling these two competing requirements.

The two telescope tubes have to be designed to be extremely lightweight. These are made out of carbon fiber. And they were made by a company that specialize in making carbon fiber components for Formula 1 racing cars. So they're well used to making things as lightweight and as strong as they possibly can. And that's exactly what we wanted them to do for MIXS.

So there's the vibration envelope of the launch. Also during launch, you have a huge acoustic load, so the rocket is obviously a very, very loud firework. Also during launch, you have very fast depressurization. So as you go up through the atmosphere, you have to be able to get the air that's held inside your instrument out of the instrument without damaging anything. So again, that's another thing that we need to design for. And that's before it's even been switched on, OK?

So once we get into orbit, we then go through a whole series of checkouts. We have to ensure that the whole thing is working as it's supposed to do. And then it gets injected into the transfer orbit to take it to Mercury. And obviously, because Mercury is so close to the sun, it's extremely hot. So we need to be able to cope with huge temperature extremes.

So during the cruise phase and when the satellite is eclipsed by the planet, things get very cold. But when the whole satellite is sat there in full view of the sun, things get extremely hot. So we've had to design the system to be able to cope with some really extreme thermal cycling. So every time you go around the planet, the optic of this instrument will oscillate between a couple of 100 hundred and maybe 0 degrees. You have to be able to design the system to cope with that kind of environment.

**JONATHAN MCAULIFFE:**

We've squeezed so many different instruments from so many different scientific disciplines into one spacecraft. And even though we take seven years to get there, when we are there, we only have one year, as I said, maybe two, do what we need to do. And we don't get many second chances to do this. So we need to do a lot of planning beforehand, a lot of rehearsal, and make sure that everything runs smoothly. And if it doesn't, come up with multiple contingencies, which we can select the correct one depending on what goes wrong, and replace that with the correct contingency.