Preflight Interview: Gerhard P. Thiele

Before we get into the specifics of this particular flight, I want you to tell me a little bit about yourself. Why did you want to become an astronaut?

I wanted to become an astronaut since I was a boy age ten. When I was ten years old, the space program had just started here in the U.S. The first launch that I remember is the one with Gus Grissom and Virgil Ivan Grissom. I was very young, but I wanted to become an astronaut. Of course, this was a dream for a ten year old boy at that time, especially one not of American or Russian nationality. I never pursued the dream actively in the sense that I said, "I have to become an American citizen and go there," but the dream stayed alive, of course, and I just was lucky that things changed, that we are now doing international cooperation also in the realm of space. And so here I am.

Give me a little bit of an overview of your career that got you to this point. How did you get here?

Space always fascinated me, and it's not space only but the universe in general. The logical thing for me was to study astronomy and physics. I did that in my native country, in Germany, in Munich first and then in Heidelberg, and I got my Masters and Ph.D. in physics. I spent two years at Princeton University, doing some work on climate research and the role that the oceans play for our climate. And then there was this unique opportunity in Germany. The German Space Agency, DLR at that time, looked for astronauts to support the D-2 mission, the American-German Spacelab Mission, and I applied, and I was selected. I was in the selection process for the German astronaut in Germany in 1987. In the meantime, the European effort had been concentrated into the European Space Agency, and since about one year, I'm a member of the European Astronaut Team as well. But I came here to NASA and trained as a Mission Specialist in '96 and got assigned to STS-99.

Briefly summarize for me what you'll be doing during this particular flight. What are your primary responsibilities?

My primary responsibilities are that I am the payload lead on the Red Shift. The most difficult part, or the part that is crucial to mission success, is the on-orbit checkout. Everything has to go like clockwork, and the Red Shift will deploy the mast, calibrate the radar, verify that both are okay – the antenna in the cargo bay as well as the cutboard mast – take a look at the same point on Earth, and we calibrate it with the help of the ground stations. Once that is done, and that will be the beginning of the Blue Shift basically, the mission will be rolling.

Now this shuttle mission will look back at the Earth using radar interferometry to acquire topographic data. Please explain to me, what exactly is radar interferometry?

Radar interferometry describes a principle where we look basically in stereo wave onto the Earth. We have two antennas. One antenna in the cargo bay illuminates the Earth very much like a flash does during flash photography. However, we have two lenses, if you will, with which we look at this illuminated spot. One is the antenna in the cargo bay that has also sent out that flash, and the other one is outside on a 60-meter long mast. By combining the fuse from the two different lenses, we can, if we know the distance between the two lenses, we can determine, not only the resolution and latitude and longitude, but also, the height. So we will receive [a] topographic map of the Earth.

The Shuttle Imaging Radar-C and the X-band Synthetic Aperture Radar, X-SAR, flew in the shuttle in April and October of 1994. What are the innovations for SRTM which separate it from the first two Space Radar Lab missions?

During the first two Shuttle Radar Lab missions, we did not have the secondary antenna. So all we could do at that point in time was look at the Earth with just one of the two antennas, and we received the same information as we did with respect to latitude and longitude, but we had absolutely no height information. And this is what will be new on this flight.

What kind of resolution do you expect, and how does this compare to other forms of spaceborne imaging?

We will have a resolution on the order of 30 meters times 30 meters in latitude and longitude and about 15 meters in height, and the height resolution is completely new and unachieved from space radars so far. There is another way to do interferometry, which is called multiple pass interferometry, and that is what ERS-1 and -2 are doing, in such a way that you are just a small distance away from where you were on your previous orbit, you could try to overlay the two pictures from two different orbits. However, this has its limitations, and the limitations result from the fact that the reflectance might have changed and is not completely identical. So you have to make some assumptions and that, of course, limits the resolution that you will achieve. So, the technique of interferometry requires that you have so the signals don't overlap as accurately as if you do a single pass interferometer and that just means you send a signal and you receive it at the same time.

You mentioned your responsibilities in deploying the mast. Explain to me what the process is of mast deploy. What happens and how long does the whole process take?

The whole process takes about 17 minutes, and, really, the mast is an engineering masterpiece if you look at the details. The mast is about 200 feet long or 60 meters, and it's stowed in a comparatively small canister that is barely four feet wide. The mast is deployed by a rotating nut, basically, that grips the edges and corners and pushes the material out. As it does, the longerons are deployed, and the longerons are held in place and stiffened. The mast can be looked at as a sequence of almost perfect cubes. As a matter of fact, it will be 86, and each single cube is stiffened by a series of ropes on the surfaces of the cubes, and it's altogether a very tricky design. The retracting the mast on the other side and in just the reverse thing. To me even more miraculous [is] that it folds in that canister so that just everything fits in there. It's really a very neat engineering design.

What happens if the mast does not fully deploy? Could you do an EVA to help fix the problem?

If the mast would not fully deploy, [then] EVA might be an option. There might be other options as well. It depends on the specific failure that we will see. So we could think about something that is again and try a second time to see whether that will work there. EVA is certainly an option, and we have talked about it. But depending on the failure, to accomplish our scientific goal. The reason is not so much that we could not live with a shorter baseline. We would still receive, maybe, somewhat degraded science, but the key thing here [are] safety aspects. The mast has to be firmly locked in place in order to maintain a safe vehicle. We have to be able to fire the thrusters to maintain a certain attitude, which means we will fire our thrusters at a regular time, and for the mast to stay in its position, it has to be firmly locked in place. And if the mast is not fully deployed, it's not locked in [place]. So we won't be able to do the mission in this case.

I understand the length of the boom creates its own problems, and you were touching on this a little bit just now. What exactly is the gravity gradient force and how does the boom affect that? And then what do you do then to counteract that?

The gravity gradient force is a very interesting thing that you have to account for if you fly in space. It's not a new force that we haven't heard about in physics. It results from the very simple fact [that], in order to orbit the Earth, two forces have to be compensated for. And one is the gravitational pull that is still there, and it's exactly compensated by the centrifugal force that results from your motion on a circular motion that everyone experiences when you go on a merry-go-round. You feel the pull outward, and the two forces balance exactly. However, this is true only for just one point and not for the entire orbiter or space system, in our case the orbiter plus the mast. So for the center of gravity of the orbiter, this equation is fulfilled exactly. But the mast has a certain dimension and, if you are a little bit closer to the Earth than the center of gravity, then, if you look at what we said that the mast is about 200 feet long, then you would like to go a little bit slower in order to be on the perfect circular orbit. But we are forced, because we are connected with the shuttle, to go at that speed [the same speed. And this is where [the] gravity gradient force comes from. It is a force that results from the fact that the gravitation pull at the center of our system is slightly different than further away or closer to Earth. So, in order to – the mast, in order to, I'm sorry, in order for that the system tries to erect itself into a radial position. The counteract for that for the mast by a very smart system. We have what we call a cold gas system that continuously flows nitrogen at the outboard antenna out of very small thrusters and it's just enough to keep the mast from trying to erect itself. So it pushes the mast down continuously. It's a very smart engineering design to help us to keep the mast in place.

I've read about the fly cast maneuver. Why are you using that? What is it exactly?

The fly cast maneuver is another great way the Mission Control Center came up with, and the flight dynamics officers, to help us do the mission. What happens if the shuttle fires it thrusters [is] the mast – the mast is connected to the shuttle, of course, and the mast receives a forward pull. For us, it looks like the mast is bending backwards. And then, because it's a stiff mast, it would start to swing and slowly ring out, and, of course, we would like to minimize these motions. So what we are doing during these fly cast maneuvers is we give a short pull, and the mast swings back. Now we know when the mast wants to come forward again, and at that time, we do the real firing of the thrusters to – and we do that, of course, we do that at that right there at the edge. And, once the thruster firing stops, the mast comes forward again, and we give the final pulse with our thruster system to keep the mast basically in the middle position where it's supposed to be. And this way, we have only small ringouts and not big movements.

You mentioned briefly a while ago the process of mast retraction – how it's basically the reverse of the deploy. Give me a little more detail exactly how that process works.

In principle it's indeed just the reverse of the mast deploy. There's a rotating nut that just goes the other way and pulls the mast slowly in bay after bay. And the way the mast is constructed, the longerons get – they are folded, and they are folded in such a way that, in the other, so that everything just fits into that small canister. It's difficult for me to explain it without having a model here, but it's, as I said before, a remarkable design. But in principle, retracting the mast is just the reverse.

What could be done if there was trouble with the retraction? What if it gets stuck part way back?

Since the retraction is basically the same or the reverse from the deploy, we basically have the same options. So one would be [to] deploy it again and go out a little bit and then try [to] do it a second time. Another option is, of course, to do an EVA and try to retract it manually. And the third one that I would hate to see happen is, of course, then to jettison the system but if everything else fails, we have to close the door in order to come back. So that would be the worse case scenario.

On the surface, this flight has similarities to the Tethered Satellite System flights. You have a long system sticking out of the cargo bay. Do you anticipate having any concerns similar to the issues associated with those flights?

Not really. On the Tethered Satellite System, yes, we had a mast as well, but that mast was fairly short as compared to ours, and they had no problems with the mast at all there. Now a tether is a completely different thing than a mast. The mast is really about 100 percent rigid structure, whereas a tether can bounce back and forth and creates all its own problems. So the two things really cannot be compared. Our problems will be different ones than we had on the Tethered Satellite System.

On this flight, do you have any specific mapping targets of the Earth's surface as the SRL missions did?

No. On our flight this is different. The purpose of our flight is to map the Earth between 60 degrees north and about 56 degrees south. We're not aiming for specific targets. Whenever we fly over land the radar will be on to map the Earth's terrain. So the answer is no. There are no specific targets. It's just the entire Earth between the two latitude bands.

But you did mention that it was only over land so you're not turning the radar on at all while you're over the oceans?

This is true in principle. We take some calibration data takes over the oceans, of course, but the radar will be switched on as soon as it's landmass. And it, for instance, we run across the North Sea or the Baltic or some smaller ocean areas, we just keep the radar running. So yes, there will be some ocean data takes but not to map the ocean. They serve the purpose of calibrating the radar.

Will it be turned on as well when you go over islands?

Yes, it will definitely be turned on when we go over islands.

Why is all the data being recorded instead of downlinked live?

It has to do with the fact that we are digitizing the data, and the digital data are just an extremely huge quantity of data. We are recording 207 megabits per second, which clearly outnumbers the shuttle downlink capability, which is an impressive 45 megabits per second. So, although the shuttle is already impressive with its capabilities, it's not enough for such a mission, and this is why we need to record the data.

What type of tapes are you using to record the data?

The tapes are special tapes that we have. Also the recorders are special. They are a Japanese-U.S. development, and the tape is special. Although, they look very much like an old VCR tape we seen maybe in the late seventies or early eighties. They are somewhat bulky. The interior design is much more sophisticated. But the sheer amount of data that have to be recorded every second is so tremendous that this is, just by itself, an astonishing piece of engineering.

We're talking about this massive amount of data. How long is going to take to process all of this data?

It will take between 18 months to 2 years to process all the data that we will be creating, and the amount is just mind-boggling. The final products will fit on something like fifteen thousand CDs so this is the amount of data that will be produced during that flight.

Now you have X-band data and you have C-band data. Are they processed in a similar manner?

They are basically processed in a very similar manner. Yes, that's correct.

Now the two ASTRO astronomical observation flights used the Star Tracker, and SRTM utilizes it in a new way. Can you tell me about the Star Tracker and then how this flight is using it?

The Star Tracker is a device that determines, with high accuracy, where we are, what the shuttle's attitude is in space, and this is very important. Of course, we talked about the radar interferometry earlier. Now the stereo process that is done in the visible lens with cameras that we are all familiar with is done simultaneously, just the lenses and the film and the recording media. Here everything has to be done very accurately, and the Star Tracker is very important for the position of the outboard antenna and its orientation with an accuracy of three millimeters with the accuracy of just a few arc seconds. Now it's 9 arc seconds to be specific. What does that mean? If we would look at a car with headlights on in the night from a distance of 40 kilometers or 22 miles, we would be able to determine the two headlights of the car, not just the car, but the two headlights. And this is the resolution that we need to have in order for the Star Tracker for. That's what the Star Tracker will do for us. It will determine the look angle that we have of the shuttle nose, and from there, we can determine, basically, the look angle of the entire system of both antennas.

We've talked a lot about the hardware and all the data. What are you hoping to learn about the Earth from the data you do acquire in this mission, and what kind of applications are there for this technology?

First of all, humans always want to know about their environment, and for the first time we will generate a coherent pixel set, a picture of the Earth. We don't have that yet, which is pretty surprising. Of course, the data will be used for many, many, many applications. We will be able to by digitize the various topographic data, they were generated using different tools, different references, so you see that the overlaps don't match. You have sharp corners in them, and so, basically, that means you have errors in there. While each map might be consistent within the map itself, or the data set itself, they are not necessarily consistent among each other. So for the first time, we will achieve that for the entire Earth. This will be a very, very important dataset for Earth and Mars but not of the Earth. So this is an advancement in itself that is of importance, for instance, for every geoscientific field. The hope is also that these data can be used by governmental agencies for planning purposes. If you want to build a street or develop a certain area, you have to move mass, and to get an idea [of] how much mass you actually have to move, you have to know how much terrain there is. And this is what we will be able to do. We will have the terrain in a digitized forms means that the data are readily available for computations in the computer and do your planning in the computer.

What happens if a volcano erupts while you guys are on orbit, or there's some other natural disaster? Will you be able to pay any sort of attention to it?

Yes, in case we fly over it. We cannot change our orbit just in order to go over it, but, as we said earlier, the radar's always on when we pass over a landmass. So the radar will be on if we pass over that volcano, and we certainly could pay special attention to it. [Then] we play back the data that we [took] while we were flying over the volcano, so that the ground can take [an] immediate look [at what] the data looked like. But if our pass does not lead over the site, no, we won't see it.

Once the payload is functioning properly, the crew slips into what seems to be a pretty regular routine. Do you think the work will ever get boring or tiring for you at all?

As a first time flyer, I just cannot imagine that going into space will ever be boring. So the answer to that is a clear no. It will not be boring.

Obviously, your presence here shows that we have the international partners involved in this with NASA. What are the international partners contributing to this flight?

The Japanese Space Agency is providing my dear colleague, Mamoru Mohri. The German Space Agency, as well as the Italian Space Agency, they are providing the C-band antenna, which is, we have a SIR-C and X-SAR flight so we are referring to two wavelengths that we are using in our radar. So it's not only one antenna in the cargo bay and one outside on the mast. It's basically a second antenna. It's just one structure, but it's a second wavelength. And the second wavelength is contributed by the European Space Agency. So it's a major contributor there. And what we are seeing in the composition of the crew is what we have been in the past and what will be the way it will be in the future. We will see more and more internationals, and there will be family flights into space without international participation.

How would you describe the relationship on this particular flight between all the international partners?

I think it's wonderful. International cooperation is the way to go, and if we, in the space business, can be a leader to show what we can achieve, what we can accomplish together, I think that would be, maybe, one, of the biggest benefits that we will have from going into space.

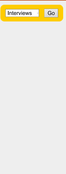
You've got a secondary payload called EarthKam. Is it comparable in any way to the flight's primary payload?

I wouldn't call it comparable, but it's a secondary payload that is very dear to my heart. What EarthKam does, it has a digital camera system that allows [it] to take pictures [of] the Earth and downlink them in a very short time to the ground. The specific thing about it is that it's operated by students around the world and space is our future. The best symbol for our future, for me, [is] our children, and we get them involved, at a very young age, [in] a great opportunity; they get their hands on something that is going on in space. And this is why I think this is really a very valuable experiment that we have onboard there, and I'm looking forward to supporting it.

If you would, sum up for me. How would you characterize the long-term importance to science of the work you and your crewmates are going to be doing on STS-99?

Well, the long-term importance is difficult to judge, but having such a unique data set available will help science in many, many ways. I mentioned earlier that during my career, I was working on climate research and the role the oceans play in climate research. And, in the past fifteen years that I am now in the space program, the computer models that we make of our Earth have improved significantly, and the resolution became better and better and better as the computers became faster and faster and faster to just cope with a huge amount of data. And, of course, the better the resolution, the better climate science will use these models. They can directly use these models and fit them into their models that they need to compute atmospheric ocean interaction and many other things in geoscience. And it's hard to predict what the benefit of this is, but one thing is clear: the better we can model things, the better we understand our Earth, and this was the trend in the past. Therefore, I think it will pay off in great ways that we don't even foresee yet.

Greetings



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