ORAL HISTORY OF EUROPE IN SPACE

INTERVIEW WITH ROGER MAURICE BONNET

Conducted by John Krige

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Revised transcript

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JK: First I'd like you just briefly to remind us of your own experience as a space scientist beginning from your early days in the desert doing sounding rocket experiments with the French.

RB: This started early in 1961. I was a student at Paris University. I was strongly motivated by space after the launch of Sputnik-1. I decided to start a curriculum in astrophysics because astrophysics at that time opened the gate to space. I rejoined the laboratory of Jacques Emile Blamont, a French physicist who was leading the first space science institute in France. He was travelling back and forth across the Ocean so he had already a long experience when I reached his laboratory of cooperation with the United States, in particular with scientists in Goddard space flight centre and in several other places. I started my research by studying the yet uncovered ultraviolet spectrum of the sun. This required to observe from above 80 km in order to get rid of the absorption of the Earth's atmosphere and, to observe the Sun, the use of pointing systems to be mounted on board sounding rockets. In France, we had developed the French version of the V-2, called Véronique and, through a contract with the US Air Force, we were able to purchase two pointing systems, which were developed by the University of Colorado. So, from the very beginning there was obviously a strong connection between space science and the military. The launching range was located in the Sahara Desert on a military base where missiles and some kinds of automated planes like the V-1 were tested. My first launch occurred in 1963 and it was a complete failure. The parachute which was supposed to recover the nose cone of the rocket did not open. I made five successive attempts and got good results on several occasions. Nearly every six months a rocket was launched which carried my instruments, and several times the payload and the nose cone were recovered. By January 1967, just only four years after my first launch, I had all the necessary data to present my Ph.D thesis in July1968. My first trip to the United States was in January 1967. That was to attend the annual meeting of the American Association for the Advancement of Science, AAAS, in Washington. I had never been to the States before. Let me say that without the American cooperation, the French space science programme would not have had any chance to start on a competitive basis. I was pleasantly surprised by the generosity of the Americans, and also because of the links that they managed to establish with the military. That indeed surprised me. That was in short my first contact with space science and my first experience of the relations between Europe and the United States.

JK: Lets just concentrate on that a moment. Have you any idea why the United States Air Force was willing to help with you in that way? Did they have any interest in your work? Of course your work had to be published in the open literature, I presume that was a condition.

RB: Certainly, the study of the UV and infrared spectrum of the Sun and stars, was of interest to the military. Studies of the infrared spectrum of stars yielded the first surveys of the fixed dots in the sky which were not to be confused with rocket nozzle exhausts. The UV spectrum of the Sun was of interest for the military because solar UV radiation has an effect on the ionosphere, and they wanted to make sure that they understood properly the propagation of radio waves for communications. That was their main interest and I don't think they had any objections that the French used some of their systems through our contract with them. Our research would indeed support and complement theirs. But frankly, in my opinion, that was essentially disinterested. Certainly, there was an interest in pursuing this type of research both in the States and in France but there was no strong pressure on their side. You could not feel that you were obligated to them. That looked as some kind of generosity.

JK: Were there Americans present at your experiments in the desert?

RB: No. I just had a small team: one engineer, one technician for electronics and one technician for mechanics. We had to learn how to use the pointing system that we got from the US. We spent several months in the States to learn how to do this, but there were no Americans on the spot, no.

JK: I have seen a letter from Blamont to NASA in the early 1960s asking that he sends some French over to Goddard I think for training. [Arnold] Frutkin turned down this request saying that there was no need for these people to come to Goddard; they had no specific interest in what the Americans were doing there. Do you remember this event? You were not one of the people, maybe, that was mentioned?

RB: No, I was not one of these persons. Blamont was very keen to cooperate with the Americans. Indeed, Goddard was a NASA Centre where you could cooperate with competitive people. The problem you are referring to probably concerned my colleague Philippe Delache, who spent several months at the Naval Research Laboratory near Washington DC and at the Goddard Space Flight Centre where he worked on UV detectors which would later on be placed on board future US and French satellites like the Orbiting Geophysical Observatory series, the Orbiting Solar Observatory series or the French D2-A project. Blamont was keen to get experiments on these satellites. He was travelling very often to the States and established a strong link between the French and the American scientific communities. It may well be that they did not want that Philippe Delache or whoever get too close to American groups because it may have hampered some American scientists to work on the same topic, or that we could get access to technologies which they considered too sensitive.

JK: So, they wanted Europeans to work on independent topics, not to overlap with what Americans were doing.

RB: They were pleased and happy to be informed of what the Europeans were doing, therefore they were not against helping them to undertake these tasks and have an indirect control of what they were doing. When foreigners were doing that type of research they were not doing another one considered less acceptable to them. Most probably, when their own interests were at stake, there was a natural barrier not to go too far in the direction of cooperation.

JK: So you reckon that they supported your work in the desert because it was no threat to them and helped you build up a capacity there.

RB: Exactly! I think that in the background was the aftermath of the Second World War. The Americans got involved in this war in which they spent a substantial amount of money. They did not want to see that starting again. On the other hand, Russia is not very far from Western Europe. Russians developed a very successful space programme, and contrary to what is generally admitted they were quite open to cooperate. So there was some kind of competition to get the Europeans on one's side rather than letting them go too far hands in hands with Soviet Union. When in 1968 de Gaulle decided to open direct negotiations with the Soviets and started a cooperative programme, the Soviets offered very interesting possibilities of cooperation. World politics prevented Europe to fall too far in the camp of the Soviets. For the US, offering attractive opportunities to the Europeans offered a counterweight. At the same time, they could attract and involve the best foreign scientists in their programmes, directly or indirectly. Up to the point, as we have just seen, where that involvement contradicted their own political interests.

JK: We know the French physics community was extremely leftwing immediately after the war, and people like Joliot, for example, finally lost his job at the CEA because of his outspoken pro-Soviet position.

RB: He was communist, yes.

JK: Yes, exactly. Were there similar leftwing movements inside the French space science community pushing also for collaboration with Russia, of which the United States might have been aware and might have scared the United States a little?

RB: Certainly, the Americans knew what the French scientists individually were thinking politically, so much that some of them could not get to the United States because they had connections with the communist party.

JK: Ah. Even at that point? Even after 56-57, when many of them renounced their links to the communist party after Hungary? But it still persisted among some French scientists, didn't it?

RB: A famous radio astronomer, now retired, was not allowed to go to the Sahara because he was connected to the communist party, and others may have had difficulties to cooperate with the Americans because of that.

JK: Right.

RB: I have another example. In 1970, one of my technicians, who was an active trade union pro-communist militant, had to accompany me in the States for the preparation of an experiment which we were flying on the OSO 8 satellite. He asked for a visa at the American Embassy in Paris. After having filled the usual form, he was called at the Embassy for an interview. The person who interviewed him said "M. Barrère, in 1962 you were heading a strike in Paris at such and such places". That information was apparently correct. They had obviously access to all dossiers of the French police. The detailed history of his involvement in the unions and his political engagement were known to the American Embassy. At the end hopefully he got his visa. But it was interesting that they had access to all this information and that they could exert that control specifically.

JK: And you believe they got that from the French police themselves?

RB: ???

JK: Ok. This might be indiscrete but I think you yourself were pretty leftwing in the early 60s.

RB: Yes!

JK: Were you ever penalized for this as far as you know?

RB: Never! I never had any problem.

JK: You never had any problem. That's interesting. Amongst you young people was there pressure to collaborate with the Soviet Union as well as with the United States in the early 60s?

RB: There was no pressure whatsoever! In fact, we did not collaborate soon with the Soviets. My first trip to the Soviet Union, I did in the mid seventies. My first trip to the States was in 1967.

JK: It is just interesting because the French built Mirabelle for Dubna, they built Mirabelle for Dubna and they built that in 1967 so the physics community was working very closely with the Soviets on accelerators, apparently much earlier than the space science community.

RB: One of the reasons, I think, is that it was easier to cooperate with the Americans than with the Soviets. There were much less barriers. Today it is quite nearly the opposite. It was easier and also very appealing, even though at that time we were all impressed by the frantic competition which developed between the Russians and the Americans in the race to space. It was fascinating as far as I was concerned. I was listening to the radio each time the Soviets were launching something new and witnessed vividly all their first steps into space: the first intercontinental ballistic missile, the first Sputnik, and all what followed after. It was fantastic! But very soon we realized that the Americans adopted an open policy of information which we could not always get from the Russians. So, ultimately there was a greater appeal to cooperate with the Americans.

JK: Just a last thing on this little point. So how important do you think it was that the Americans collaborated with the French scientists in the early 1960s to keep them away from the Soviets? Not particularly important. An element but not a major element.

RB: No, because the French are essentially free-shooters. There was a lot of sympathy for the Americans in France after the war and of course the fantasy of the Americans and their way of living was always very appealing to the French. The French wanted to really get involved in space, so they went in bed with the Americans and the Soviets each time it was in their interest to do so.

JK: Right, [Pierre]Auger as the head of the CNES had no particular interest in one thing or the other.

RB: No, I think Auger was probably neutral in this respect. He was essentially European. French and European! He built with his Italian colleague Amaldi the first European [Space] Research Organization (ESRO). Both wanted to create a European scientific pole and a bridge between the East and the West.

JK: Right. And De Gaulle, what was his position in the early 60s on this matter?

RB: De Gaulle was, of course, not pro-communist, not pro-Soviet, but he could not accept the sole leadership of the Americans. Today for example, de Gaulle would probably be, as the great majority of European politicians, against the dominance of the US, materialized through the GPS, and he would logically support Galileo as a counterweight to the American dominance. The attitude of de Gaulle was to consider France as a great nation which could do as well as the Americans and the Soviets, and should not be tied to only a single one. His first visit to the Soviet Union in 1968 was an attempt to rebalance the political scene and to show to the rest of the world that he had no obligations whatsoever with either camp. Once the big boss had opened the door, of course, the scientists could get through the door and start cooperating.

JK: Right. But in the early 60s he didn’t push you particularly, he didn’t encourage you particularly?

RB: Oh no!

JK: This is only after the late 60s.

RB: Yes! But there were a lot of opportunities prior to that to get contacts with the Soviets, in particular on the occasion of the COSPAR scientific assemblies.

JK: Exactly.

RB: In that respect COSPAR was very useful. It was created to play exactly that role, and it played it well. I remember my first COSPAR meeting in July 1963 in Warsaw. I could at once meet and see all the most famous American scientists and also all the most famous stars of the

Soviet space programme. Each time the Soviets were presenting a new result, the room was filled with scientists and journalists who were keen to get new information on their programme. But let me go back to our previous topic, I mean de Gaulle's approach to balance the cooperation between the East and the West. I must say that his attitude always guided me in my career. I have always been keen to preserve my independence and certainly not happy to be considered as a second-class citizen. To be respected as an equal partner is a principle which has guided me constantly. The desire of being respected however should certainly not be seen as a manifestation of anti- Americanism.

JK: Exactly. The Americans mix these two things up in an absolutely terrible way. To go back again to your experiments, Frutkin is very clear that when you collaborated with other nations there would be no exchange of technology, and of course no access to any kind of military technology. Yet these pointing systems that you had on your sounding rockets sound as though you did have access to American technology and of some military interest, no?

RB: You are correct. Their pointing systems were developed in a university, but under American contracts. We purchased them through a US Air Force contract. There was a clear linkage between these devices and the American military system. They were quite rugged as far as I can judge. However there was never any problem to use them. Maybe Blamont, who was negotiating these contracts himself, has much more detailed information than I: I was just a 24 years old student at hat time.

JK: Ok. Tell me about Helios, the German project. Do you know anything about the German project? What is your perception of the American involvement with Germany and the launch of Helios?

RB: I have no recollection of this. I was not involved. I can give you only generalities. These were really pioneering projects. Why did the Germans get involved in this? I think it's as usual a mixture of strong sense of interest on the German side and of political willingness to cooperate with the Americans. Germany within Europe has always had special relations with the United States, because of the war: they felt somewhat guilty, indebted to the Americans for the Marshall Plan. So, they never adopted an antagonist position in front of the Americans. They were obedient! Probably the Americans had an interest in controlling what the Germans were doing in order to prevent them from doing other things.

JK: There is no doubt that the United States supported Germany very strongly, precisely because they were very concerned about France, obviously, and very very concerned about the force de frappe. And any technological support with France, which could feed over into force de frappe, was something they wanted to stop at all costs.

RB: That is true. But we never witnessed any sign of such an attitude directly as far as I remember. We never had any problem of this nature in cooperating in space science.

JK: Right. I mean, it is for sure that the Americans supported ELDO very strongly, and put enormous pressure on Britain not to leave ELDO in the mid-60s because they said, if we don't have ELDO, the French will develop an independent launch capability, and that will be linked to their force de frappe and we do not want that. So Germany was important as a counterweight to France and as a champion of ELDO, because Britain couldn't champion it and there is no doubt that that plays a very very significant role in American thinking. I'm writing on Helios and I'll send you my paper.

RB: I am interested because I never heard of that.

JK: Right. And this whole issue of actually ensuring that France does not acquire an independent launch capability is something on America's mind from 1965, well before Helios.

RB: Then it is very difficult to understand how they could not foresee that Ariane would be the natural response to the Symphonie crisis.

JK: Let's talk about the Symphonie crisis. What do you make of it? Frutkin puts it down to Lebeau's stupidity.

RB: What do you mean by Lebeau's stupidity?

JK: Yeah. Lebeau is an arrogant stupid person who refused to understand that the Americans were in fact willing, there is an amazing quotation by Frutkin in one interview, in which he says that Lebeau came in there and would not listen or accept that America was willing to make compromises to launch Symphonie. What's your reading of it? Let's not necessarily bother about Lebeau, I mean, you may if you wish.

RB: I know Lebeau since my first steps in space science and I owe him a lot. That he is a man of principle is clear, and consequently not an easy negotiator. Always in international cooperation, the nature and character of the people involved is an element which may turn cooperation into a success or into a failure. So if you have two rigid persons trying to negotiate something which is simple, at the end they may disagree when everything is simple. If you have two clever and open people (I maintain that Lebeau is clever) to solve a very difficult problem, at the end you have the best chance to get a spark of a solution.

JK: Right.

RB: So first of all it's clear that the control of the Americans over Intelsat was resented as an unacceptable pressure for the French. They developed the Symphonie programme together with the Germans somewhat independently of Intelsat, so that it could not be controlled by the US which controlled Intelsat. Indeed, to launch Symphonie required a US launcher, but the US conditioned their agreement to not having the satellite used commercially but only on an experimental basis. This indeed led the French to develop their launcher. The French undoubtedly had the will to develop a launcher. There were already developing missiles. So, I would not concur with Frutkin: there was a real problem. Unfortunately, our Americans friends have not learnt from that experience and we may witness a repetition of such mistakes. In addition, there exists a tendency in Europe and in some other parts of the world, not to cooperate as tightly as we did in the past with the Americans, because of the difficulties everybody faces with the strict implementation of the ITAR regulations. They are dissuasive, and then naturally, there is a tendency to look more to the East, Russia again and now China. The Americans, if they pursue this line, are making a mistake. In the not too distant future, the Russians, who still have a strong intellectual and technological capability, and the Chinese who are coming along extremely fast, have an interest to cooperate. In a few years, they may be involved in major and challenging programmes with Europe, while we have more and more difficulties to cooperate with the Americans.

JK: Sure. Sure. You have alternative tables to play on now, which are less difficult to deal with. (RB: exactly) But if I were to say, to go back to Ariane, that we know that CNES had developed L3S. We know that CNES is a big, very powerful institution. We know that they would of course have loved to develop a launcher anyway. Say I was to say that the whole Symphonie issue and the way in which it was arranged by Lebeau and the French was just a pretext really because of the enormous internal bureaucratic and technical pressure to develop a French launcher anyway, and that with or without the Symphonie saga they would have gone ahead and done it. It just provided them with a useful way out to blame the Americans.

RB: You may be right. I have no proof to support this statement. As I said, there has always been a culture in France and more specifically at CNES to develop launchers. This again fits the Gaullist attitude that we are equal to the Americans and the Soviets. Therefore, we have to prove that we are able to develop a launcher by ourselves. This is why the French were so keen to be the third nation to put a satellite in oRB:it.

JK: Sure, sure. Indeed Lebeau has implied something like that. He said, "We read the American refusal in a way which suited us". It has to be said that the Americans obviously did make trouble. If the Americans had said straight off "no problem" the issue would have died. But the Americans did make trouble and Lebeau has said in public that he and the French negotiators read that in a way which suited their interests. And I think that's probably the fairest evaluation.

RB: This is a very interesting point, just one day before the launch of the new Ariane 5 ECA. If this fails, it may probably be the end of the Ariane 5 programme.

JK: Really?

RB: I think so. I think the Gaullist attitude is fading away, at least as far as the launchers are concerned. It is not true of Galileo. Also, Russian launcher technology is now becoming available and we are becoming less dependent as we were from the US.

JK: But shouldn't they restart Ariane 4, one of the world's most successful launches? I never understood why they stopped that. I mean, well, I understood why they stopped it but I found that a tragedy. And you had a satellite on Ariane 5 01, which also must have been not too heavy.

RB: That was a very tragic moment.

JK: I remember, I've seen the movie and of course…

RB: But I made all what I could to recover from that. Out of this major failure we made a success. Thanks to the use of Soyuz.

JK: Oh really. You put your Cluster on a Soyuz the second time?

RB: Yes, we launched two pairs of satellites, in July 2000 and August 2000 on board two consecutive Soyuz launchers. It worked very well. Let's come back to Ariane 4. Yes, in my opinion it was not wise to stop what had became a very successful program. The reason was given that Ariane 4 was not any more adapted to the market and to the increasingly larger size of telecommunications satellites. It could launch only 2.5 or 3 tons in geostationary orbit, while the prospects were for much bigger satellites. For that capacity, the price and the cost were much too high to be attractive. Nevertheless, that was an absolutely successful and reliable launcher and it might have been better to adapt it and to make it cheaper.

JK: And there's also this push to getting ever bigger technologies. We see it with AiRB:us 2. I hope that plane works.

RB: Yes.

JK: I have my worries, especially about ground handling problem. Not flying, but dealing with people on the ground.

RB: Me too!

JK: Now let me go back to [inaudible], and the proposals to the Europeans to collaborate in that programme. Many people see that as a way of diverting European money away from development of an independent launcher. Is that the way you read it?

RB: The launcher was probably what worried most the Americans. They did not like to see Europe developing an independent launching capacity. That was what they tried to avoid! Read the American Space Act of 1958: cooperation with the allied powers was essentially a way to control them and avoid that they develop what would not be in the interest of the United States. At least this rule was clear but, probably, it exacerbated the willingness to start programmes with the Russians as well as a European programme, nevertheless benefiting of the partnership with the United States. For the US, getting the Europeans involved in the space transportation system (including the space shuttle and Spacelab), and spending a substantial amount of money for that, indirectly controlled by them, was one mean of achieving that goal. The negotiations to identify which part of the space transportation system would fit the American interest, were harsh.

JK: So Europeans have gone along with this controlling policy because they have no alternative, because that's the only way they can learn to do management and technology that is required for this kind of programme. That's the idea. We've had no option but to play that game, that junior game, and accept these controlling practices. [inaudible] position of such weakness vis-à-vis the Americans.

RB: Certainly the French attitude of avoiding total dependence on the United States was a key element toward European leadership, first in the launcher area and now in the GPS with Galileo. The Americans are pragmatic humans when they reach the point where there is no way to bend the attitude of their partners, that there is no possibility to control them anymore, then they play a much more friendly game. It's difficult to say that even if the Americans were completely open and friendly, the Europeans would not have developed themselves a purely autonomous system. The attitude of the Americans anyway helped enormously Europe to embark on such a development.

JK: Exactly. It backfired. The whole thing backfired. But they don't seem to change their behaviour.

RB: But the Americans are very pragmatic. We see that on many occasions.

JK: You're clear that the Americans have a very distinct interest in collaborating with the Europeans and in controlling them. Why is it that we're surprised, then, when things go totally wrong, like in the ISPM project? Isn't it to be expected that since the Americans are in a certain sense wanting to maintain control over us that they feel that they can treat us as they choose? Isn't that not surprising? Why is there the shock?

RB: Well, Ulysses was the first true crisis. Not a crisis of individuals but one of institutions. The cooperation has always been very friendly between the individual investigators, but on top of that, you have politics and you had the administration of NASA at that time trying to cope with their budget pressure. The Americans took their decision without informing *a priori* the Europeans. Ulysses was a major programme of cooperation which involved the Americans and the Europeans very tightly. From one day to the next, you learn that NASA has decided on their own to cancel the mission for internal budgetary reasons. Clearly, they had complete freedom to take that decision. Nevertheless, the Europeans were shocked. They suddenly realized how the system worked and they had not anticipated that this could have happened. They knew that the budget was voted every year and that every year you had a new agenda in the NASA programme. But they were not prepared. The whole mission had to be redefined involving the European satellite only. The crisis came late in the

development of the system, and the scientists on both sides had little time to react. From the distance, and trying to look more positively at cooperation, I will choose a counterexample, which was illustrated recently by the spectacular success of the landing of the Huygens probe on Titan. ESA developed a 350-kg probe to be carried on board NASA's Cassini mission, and spent the equivalent of 350 million Dollars to build it. The Americans spent probably more than 2 billions of Dollars on their satellite. That number I do not know for sure. The share between ESA and NASA was not 50-50 but more in line with the respective resources and commitments which both sides were supporting. When the project started, both sides were keen that the other start. The American scientists were happy to have the Europeans because that participation was a solidifying element, a strong point in strengthening the programme.

JK: Inside NASA?

RB: Vice versa, the Europeans wanted to put their probe on Cassini because they could not do the mission without it. So, there was a mutual interest. The scientific communities on both sides were also well aware of the Ulysses syndrome. On three occasions, however, I remember Carl Sagan calling me on the phone from California asking for help because NASA was trying to stop the mission. Three times ESA intervened and asked its ambassadors to interact with the Sate Department in order to make the Americans understand that they could not stop Cassini, with such a big involvement of Europe, both on the payload of Cassini, and through the provision of the Huygens probe. The existence of Huygens has been a major element to maintain the programme alive. When Dan Goldin took the responsibility of NASA in 1992, again, he decided that he should stop the mission because it was too big and certainly not in line with the "faster, better and cheaper" approach that he had directed NASA to adopt. Cassini as the last mammoth mission in the NASA programme was logically a project to abandon. It was only through the pressure of ESA, and its 15 member States, plus Italy which was developing the high gain antenna of Cassini, that the programmes survived. International cooperation played here an extremely positive role. We had learnt from the Ulysses crisis. Also, the international community knew how to cooperate better, and to use the assessment of each other's side. For the Europeans to be involved in a prestigious American programme was something nobody could dispute, because the Americans were the best and it was glorious to get involved for both. For the Americans, the provision of the probe was a unique opportunity to do outstanding novel science and furthermore, the Europeans represented 15 nations with 15 ambassadors, and that proved much more powerful during the crisis than cooperating with just one nation represented by only one ambassador.

JK: Ah. That really helped in this case, because generally when America says help, they mean help us now, so we can get this thing past congress, and once they've got it past congress, they say, oh well, to hell with Europe, we don't need you anymore. You didn't feel there was the danger of being abused in this way again?

RB: No. I don't think so. Using the international connection has always paid off scientifically when the missions were in danger of being cancelled. This has always been a tool which was efficiently used, with the exception of Ulysses, which came so abruptly that it was not even thought that it might be possible. The counterexample of Cassini is exemplary in that respect.

JK: And you think this is the aftermath of the lessons learnt from Ulysses ISPM?

RB: I think so, and the experience gained by both sides helped saving the mission and increased the mutual respect.

JK: But you also write out conditions into your MOUs [Memorandum of Understanding] now, don't you? You have much tighter constraints in your baseline agreements

RB: Yes, but it is clear nobody is obliged to abide with negotiated agreements if the money is not there. Agreements are based always on the availability of funds. If the funds are not available one way or another, if NASA decides the funds are not available, even though we think that they are, they have the right to stop their part of the mission, saying that the funds are not available. This is what was disputed in Ulysses: NASA decided that the funds were not available because they had attributed them to other programs. That was their decision. To us in Europe, it was not fair in that sense.

JK: What kind of exchange goes on in that kind of project? The old principle of no exchange of hardware, no exchange of funds, that remains intact?

RB: The principle of no exchange of funds remains intact. In reality, you have to look at this a little more carefully. For example, in the case of the Hubble Space Telescope, ESA's share was based at the origin on a 15% participation. But 15% of what? At the end, if we had to pay 15% of the overall cost-at-completion of the Hubble Space Telescope, we would not have been able to participate in the project. The capacity of the science budget of ESA would be largely insufficient. The total cost-at-completion of the Hubble Space Telescope is above 6 Billions US dollars and ESA's share today represents maybe a few percent of that through the provision of hardware and assistance to the Space Telescope Science Institute in Baltimore. We never paid 15% of the 500 million dollars that a shuttle launch costs. So, in that case, I do think that the agreement was interpreted quite generously by NASA.

JK: Ok, ok. Basically so in Cassini-Huygens, you exchange information, mostly you exchange information, freely and openly on both sides.

RB: In the case of Cassini-Huygens, there were two types of cooperation. One, between NASA and individual scientists and their Member States placing experiments on board Cassini. That was officialised through individual agreements between each Member State and NASA. The second one was the ESA/NASA cooperation at the level of the Huygens probe. Of course, the non exchange of funds principle did not plays penny by penny. For example, when NASA had to redefine the orbit of Cassini to cope with a problem onboard the probe which had a difficulty to communicate with the orbiter due to a faulty design, that involved a lot of work at JPL, a lot of time, a lot of travel. The Americans paid a substantial amount of money to correct an unforeseeable problem affecting the European hardware.

JK: Did the Department of Defence have experiments on these probes?

RB: Not as far as I know. Nevertheless, the RTGs which are used on Cassini and also on Ulysses, have been developed if I am not wrong by the Department of Defence.

JK: Ok. What is an RTG?

RB: An RTG is a Radio-isotope Thermal Generator, which provides a spacecraft with the energy it needs when it is too far away from the Sun, e.g. beyond the orbit of Jupiter where you cannot use any more solar panels to feed energy to your system. You have to use nuclear energy.

JK: Ok. And these technologies were given to Europeans?

RB: No, they were not given to the Europeans. They are some kinds of black boxes that you cannot launch from outside the United States territory. If you want to use an American RTG, you have automatically to use an American launcher. They are not exported. They are not for sale on the market. Only through cooperative agreements can you use them on board non-US missions. Ulysses had an RTG. It is virtually impossible to launch an RTG on an Ariane launcher from French Guyana. The Department of Energy and probably the DoD, and the State Department would have to agree.

JK: So, integrating this RTG into the satellite, you didn't do that, they did that?

RB: No, we did on Ulysses. But that was a real black box.

JK: So you saw the technology, you could handle the technology, you could not learn about the technology?

RB: Something like that!

JK: Yeah, right. I thought so.

RB: But, everything of an RTG is known. It's a fairly simple device. It uses plutonium and the heat of the radioactivity of plutonium is used to generate electricity.

JK: Still, how to do that might be difficult.

RB: Especially while dealing with the safety aspect. This must be extremely reliable and the risk of failure must be minimal.

JK: You spoke a lot about control, and the United States pushing Europe in certain directions and not in others. And this works very well with technology, this I understand. But, in terms of the science programme, does this make any sense? I mean, did you find them more willing to collaborate in science programmes which were clearly sort of coupled into their science programmes, rather than in other programmes? How does it work in science? How does this notion of control, in steering Europe, work in the science programme?

RB: In general you may be right. However, for example, in the domain of infra-red technology, which is essentially of interest to both Europe and the US, we were not able to import US detectors for ISO and this led Europe again to develop their own technology, like in the case of Ariane. To my opinion, this approach is not positive at the end, because from the American point of view it leads to creating rival technology, sometimes more efficient than theirs!

JK: Is that something like ISPM? I mean, they steered you towards ISPM and stopped you doing other things?

RB: We wanted to do ISPM and were happy to do it. However, what you said is probably true in the case of Spacelab.

JK: Space lab is a perfect example, of making Germany spend, and France as well.

RB: Yes, to a certain extent!

JK: But the Titan probe is again an independent sort of coming as equals to decide what can we do together.

RB: Absolutely. The other one was SOHO which I mention here because it is also a unique example. On SOHO, ESA was developing the satellite and NASA was providing the launcher, plus some key experiments, as well as the operations. At the beginning of the programme, certainly, the major amount of money was spent in Europe. And Europe was controlling the programme. For the first time in the history of the cooperation, the roles were reversed. NASA had to go through the same experience that Europeans had to go through before: we were instructing them how to do their work the same way as we do our own. At the beginning, that was not easy for them. They had a hard time not to be in the driving seat. It was somewhat tense in the first year. But then, naturally, human relations played their role. Through discussions, friendship and good will, we made it a perfect example of success. That excellent cooperation spirit among the engineers of ESA and of NASA was key to the success of this remarkable programme.

JK: When you drew up your Horizon programme the first time, you didn't think what will the United States accept and what will the United States not accept?

RB: No, absolutely not! But, based on the Ulysses experience, we wanted to see a programme that could survive independently of any US connection. Europe does not grant enough money to space science. We cannot do everything, so we have to make priorities. In designing Horizon 2000, we defined what we called the cornerstones of the programme. We selected four areas of science. We could have selected five, but we selected four because we were pragmatic and realist: we could not select more! We also said that to develop them, we could not be dependent on the US. We wanted to have total control of our goals. Being dependant on the US, might have placed the plan in a risky situation. These four cornerstones representing major areas of science, incorporated the majority of space scientists in Europe. If you had dropped one, the whole plan would have been completely unbalanced. So, we needed to control that. We said that if we had cooperation with the US on some of these missions – and we had cooperation in SOHO and Cluster –, we must be able to replace the American contribution at any time. In addition to the cornerstones, we also planned for introducing smaller projects, like Cassini/Huygens. There we took the risk because these smaller missions were of a smaller financial or strategical importance. If Cassini had been stopped by NASA, we would not have been able to launch Huygens by ourselves. But we managed. We said that for these smaller projects, in case they would have been abandoned, the whole stability of the programme would remain untouched by this failure.

JK: Foreign policy is embedded in this everywhere. And the relationship between the American administration, not just the NASA administrator, but the American administration, and Europe is fundamental at every point.

RB: Yes.

JK: You can't predict this. I mean, for example, no one could predict the attitudes of the Bush Administration towards Europe after 9/11 and after the war in Iraq. This is felt in your space collaboration programmes and makes them very fragile, fragilizes them, vulnerabalizes them in unexpected ways, I presume.

RB: It is felt on both sides, because the US scientists have also more difficulties to cooperate with the Europeans due to the ITAR regulations.

JK: What regulations? ITAR?

RB: Yes! ITAR!

JK: Ok. International trade regulations. It's to do with trade, it's not to do with ….

RB: Trade with arms: the A of ITAR is for arms [International Traffic in Arms Regulations].

JK: Oh, arms. A is arms.

RB: The implementation of these regulations results in absurd situations such as non-US scientists being asked to leave the meeting room at meetings in the US when someone decides that ITAR rules apply when the topics which are discussed are connected with arm regulations.

JK: Oh. And this happens out of the blue?

RB: Yes, this has happened!

JK: And this is a post-9/11 phenomenon.

RB: No, I think that these regulations have been implemented before. They started under the Clinton's administration I think. We were already severely controlled before and of course the 9/11 effect, and on top of that all anti-terrorist measures, accelerated that process. It is quite dissuasive. For example, some scientists here in Switzerland who used to cross the ocean often feel more and more discouraged to cooperate due to all these measures and controls which are fairly unpleasant, I must admit.

JK: Is this because of trade secrets and the fear of trade secrets [inaudible]?

RB: I am not so sure of that. It is the fear that you trade military sensitive information on instrumentation and technology plus the consequences of 9/11. Entering the Goddard Space Flight Centre or the JPL, becomes more and more problematic!

JK: Have the controls increased?

RB: Yes, quite substantially! This is really dissuasive to the point that everybody complains about it.

JK: Now, I just happen to know this because one of my graduate students went to work for the diplomatic service and I was interviewed about her by a member of the FBI, probably, about what kind of person she was. She was exemplary, but at the end of the interview he said to me, "Well of course you know, the biggest problem that we now have is industrial espionage, and the biggest cheaters are the French". So you might as well know that that is what the FBI thinks and this must be impacting your dealings with American industry, your dealings with [inaudible]…

RB: Maybe industry knows that better than I, but I have never seen this.

JK: You've never heard of it. The fear of industrial espionage must be omnipresent in this, or perhaps you never get into industry, do you?

RB: Certainly, there is industrial espionage but not necessarily in favour of the countries you may think of. I saw that when we cooperated with the Soviets on their Vega missions which were launched to explore Halley's Comet in 1986. The Soviets had developed a CCD of their own that they used in the camera that took the picture of the nucleus of the comet. They came to Paris for a meeting with CNES. Their hotel was located in the southern part of the city. One day, they went to do their shopping. When they came back to their hotel the rooms had been visited and all the blueprints of the CCD and their drawings showing the mounting of the CCD had disappeared…

JK: Do you know who took those?

RB: [laugh].

JK: Do you suspect the French secret service?

RB: Probably, but how can you be sure of that? It was indeed amazing that we feared that the Soviets would spy on us while it is the opposite that occurred.

JK: Yes. So these constraints that you face in America today, these are simply the normal constraints against people because of the anti-terrorist scare or do you think there's more behind it? An attempt to exclude you from certain information in the American space programme, certain technologies in the American space programme?

RB: I have never seen that there was any more discrimination against the French than on the Germans or on the Swiss. Everybody in Europe is a potential suspect. And, in the States also!

JK: The Americans themselves?

RB: The Americans themselves! And this is why the two sides feel more and more difficulties to cooperate, because these regulations affect both the American scientists and the European scientists. This is why I say it would probably be more difficult today to start such a successful cooperation as we did on Cassini-Huygens, because these regulations, plus the anti-terrorist measures are very dissuasive. They discourage people to cooperate. It is in the nature of science that you exchange information, that you discuss, but to do that nowadays with our US colleagues in the States is more and more difficult, especially in the technical domain.

JK: Just one last question about the space station, in which Germany, for one, has made a massive commitment. Are the tensions between America and Germany over Iraq affecting the attitude which the Americans have towards the space station and a lack of respect or concern for Germany's contribution to that station? Or, in general what do you feel about the prospects for the space station utilisation now?

RB: As to the first part of your question, I have not heard of any feedback. But I must admit that I am not directly involved in that program. You should interview the people who manage ESA's contribution to the space station. As far as I know, I have never heard of anything of the nature you mention.

JK: In general, what do you feel about European collaboration in the space station and the space station as such?

RB: My feelings are of a purely personal character. I do think that Europe did the right thing in not contributing more than they did on the space station. The space station was designed too big. It would have been better to have something similar to MIR, associating the East and the West, Europe and the US, Russia, Japan and Canada.

JK: As a political symbol?

RB: As a political symbol, which would have been cheaper.

JK: [inaudible] scientific interest in this?

RB: The space station is tied to a given orbit so it limits your freedom of doing exploratory science. Secondly there is nothing which is planned on the space station that you cannot do on a free-flying satellite, excepted for medicine and human adaptation to space flights. Material sciences for example, can be done on board automatic non-manned stations which in fact offer a better degree of microgravity.

JK: Biology?

RB: Indeed, one area in which I think that the space station is very unique is the study of the behaviour of living organisms including human beings, in an environment where gravity is not any more governed by the one-g vector, but a very small fraction of that: one milionth. In my opinion, if we are serious about sending human beings to Mars, the space station is the best place to properly assess and simulate in the best possible way, the long-duration flights to Mars. It would be something very useful. You may also do fundamental research on the physiology of organisms if you start eliminating the influence of gravity , and how the heart behaves in this way (too many cups clashing and doors banging) and so on. I do believe that life sciences are the best winners of science on the space station.

JK: Ok. But Mars itself is not really a project that excites you. Sending human beings to Mars. You think in terms of opportunity costs it's a massively…

RB: I would certainly not say that they do not excite me. Certainly, I see many difficulties to send humans to Mars, but if I were offered the opportunity to go there and spend only a few

days for the travel instead of the six or nine months it now takes, I would go. But certainly the difficulties to send human beings there are enormous. At the end, the cost will have to be judged and weighted against the advantage. But there are many things to do before you send humans there. The first one is indeed to check that Mars is a safe place to go. If there are still living bacteria there, which can be harmful, you'd better know before landing a crew. They may be located in some hidden individual underground resorts. Therefore, you must sample the whole planet to be sure. If not, you might run the risk of being contaminated by these unknown organisms and you may in turn also contaminate them. Certainly, I see a certain advantage in showing the political will expressed so clearly. But because it is such a remote goal it should not threaten us too much. The goal helps defining an orientation and a road map. It also gives a strong incentive to develop science which otherwise would not necessarily be developed to the same extent, like weather forecasting for example. You cannot land on Mars if you have fog or dust storms there for two months. You would have your astronauts waiting in orbit until the weather calms down. The bacteria problem represents another area where science is essential. You will find that you have to solve a lot of issues, which at the end will lead to substantial progress in scientific knowledge of the red planet, which otherwise would not be pursued with the same vigour. Having a political support is quite helpful, definitely.

JK: Ok. I think we should stop there. Thank you very very much.