DISCOVERY PROGRAM ORAL HISTORY PROJECT
ORAL HISTORY TRANSCRIPT

DR. MICHAEL A'HEARN
INTERVIEWED BY SUSAN NIEBUR
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NIEBUR: This is the beginning of the interview with Dr. Mike A'Hearn. He has signed the release form. It is March 11, 2009, and we are in his office at the University of Maryland.

NIEBUR: Well, Mike, when we do oral histories, I'm learning, through the NASA Archives, they like to start with some biographical information. I won't make you go through all of that, but one of the things I found interesting is that unlike a lot of planetary scientists you started working on comets and you kept working on comets all the way through your career, at least that is my perception. Can you tell me a little bit about how you got started and why comets grabbed your attention?

A'HEARN: Well, sure. I started in the second year of graduate school, maybe even the end of the first year, Don Osterbrock gave me a comet project to do. I enjoyed it. I ended up writing a couple of papers on comets. I didn't do my thesis on comets, because there weren't any bright ones in the right year. Then when I came to Maryland I actually started working on the interstellar medium. I worked on that for several years and then realized that I was tackling a very difficult problem that still hasn't been solved today, namely diffuse interstellar bands. I realized that there is a lot that you can do on comets and because they don't come around frequently not very many people work on them. So I

figured I could make a bigger contribution there and I started doing that about 1970, I think, and have worked on comets and asteroids both ever since. You know, predominantly comets, but a number of different things on asteroids as well.

NIEBUR: Excellent. What was your first mission experience?

A'HEARN: My first mission experience was with the famous CRAF mission, the Comet Rendezvous Asteroid Fly-by, that was going to share a common spacecraft bus with Cassini and they were both going to be built combined for one and a half billion dollars.

NIEBUR: Right (laughter). We know how that turned out.

A'HEARN: Yes.

NIEBUR: Okay. And how did you get involved with them? Were you… were you here at the time?

A'HEARN: I was here, yeah, I've been here ever since 1966.

NIEBUR: Wow. It's a wonderful place to be. That's cool to hear. Okay, so how did you get mixed up with them? Over at JPL?

A'HEARN: I was asked to be a Co-I on the neutral mass spectrometer team basically to be more of a comet person, as opposed to an instrument person that's on the mass spectrometer team. And then I worked on a couple of working groups for that mission, for… for as long as it lasted, which wasn't very long.

NIEBUR: Right, but they did last long enough to do an interesting report that I understand formed part of the basis for the DI [Deep Impact] mission. Is that true?

A'HEARN: Yeah, I'm not sure any of us can find that and they also did other things…here is the scale model of the penetrator from CRAF [hands me an orange golf tee].

NIEBUR: Really?

A'HEARN: It's labeled.

NIEBUR: That's cool (laughter).

[Jessica Sunshine, a Deep Impact Co-Investigator, walks in; after a brief chat, the interview continues.]

A'HEARN: So anyway, they did do a study on what to do at the end of the mission and I don't think any of us can find copies of that report now but we looked at crashing the spacecraft into the nucleus.

NIEBUR: You did? On CRAF even?

A'HEARN: On CRAF.

NIEBUR: Oh, I didn't know that.

A'HEARN: Yeah.

NIEBUR: That must have been a wild idea at the time.

A'HEARN: Mike Belton was on the little group that looked at that. I wasn't, but I remember hearing about it in the science team meetings.

NIEBUR: Excellent. And so how did the heritage go? I know that Mike Belton did a proposal for the San Juan Capistrano meeting, Small Asteroids and Comets. Were you a part of the team then?

A'HEARN: Yes.

NIEBUR: I see. And then…

A'HEARN: That was, of course, a completely different concept. That was a diversity thing, go to many different comets with the same payload on different rockets.

NIEBUR: I couldn't tell much by the title. I of course don't have access to predecisional records. I wouldn't want access to them. Okay, so that was a comet mission, but it was unrelated.

A'HEARN: Yes.

NIEBUR: And then, in 1994 there was, I couldn't tell, there was either a follow on to that concept or the precursor for DI. Was DI's first proposal in 1994?

A'HEARN: No, DI's first proposal was 1996.

NIEBUR: You got it on the first try?

A'HEARN: No. We got it in 98. (Laughter)

NIEBUR: No, you got it in 98, sorry. I didn't think there was anybody up until the end that was like that, so I was very surprised. So you did propose it in 96.

A'HEARN: 1994 was the follow on to the San Juan Capistrano one.

NIEBUR: Gotcha. And then DI was in 1996. Where you the PI at that point?

A'HEARN: No, Mike Belton was the PI then.

NIEBUR: But you were on the science team.

A'HEARN: I was on the science team.

NIEBUR: Excellent. And then as a Co-I, I guess you weren't exposed to as much of the whole review process at that point. You probably got told …

A'HEARN: Yes.

NIEBUR: …what the results were and what changes needed to be made, if any, and things like that…

A'HEARN: Right.

NIEBUR: What was it like as Co-I on a team?

A'HEARN: I think, I may have made it to the debriefing. I can't remember now. But in general, no, I wasn't involved so closely in the reviews.

NIEBUR: And of course, at the debriefs they simply read the form A, B and C as we always have, although they give you a copy now. So what was it like as a Co-I, showing up and hearing these things?

A'HEARN: Well about half of us were involved at the very outset. Mike Belton… I recall, the first team meeting was about 6 of us, maybe 8 of us, over dinner at a restaurant in Pasadena. I don't even remember now, everyone who was there or where it was. But that's where we tossed around the original ideas of what to do. Mike Belton and Alan Delamere were there because they originally came up with the concept. I think Jay Melosh might have been there, but I couldn't swear to it. So we tossed around the ideas of what we thought we could and couldn't do and then most of us were given assignments to go off and worry about our own part of the task, while Mike Belton organized everything and managed all of the reviews and things like that. So I was not closely involved in any of the reviews. I just wrote my little pieces of text. Much as I'm doing now for Paul Weissman, which was due yesterday.

NIEBUR: Oh, I'm sorry.

A'HEARN: That's alright, that's alright. I told him he wasn't going to get it until tomorrow anyway. (Laughter)

NIEBUR: Excellent. Well, I bet all of that experience, being part of that team in the 1996 proposal, then really made the 1998 proposal a little more straightforward to you.

A'HEARN: Yes.

NIEBUR: And Belton was on your team?

A'HEARN: Yes. Basically after we got turned down. Mike Belton came to me and asked, would I take over as the PI. So we did two things then. Number one, we took the advice of the review panel to make it a smart impactor not a dumb impactor.

NIEBUR: Mm-hmm?

A'HEARN: Because with a dumb impactor we know you can hit it but you'll probably have to hang on to it so late that you won't have time to slow down and see what happens.

NIEBUR: Sure.

A'HEARN: So we made it a smart impactor. We also recast the proposal to sell it in a very different way. I think that was my main contribution. I mean selling it and saying we really don't know what's going to happen, rather than saying we do know what's going to happen.

NIEBUR: Ah, it makes it a little more exciting that way, I guess.

A'HEARN: Yeah, exactly.

NIEBUR: Interesting.

A'HEARN: It turns out that what we had said would happen and what we still listed as the most likely scenario is what happened. But we more emphasized all the alternatives and tried to make it robust against all the alternative scenarios for the physics on the nucleus.

NIEBUR: Excellent design. I've seen it referred to as an experiment. And I think that's a really nice way to characterize it. Was that a part of the original proposal, characterizing it that way?

A'HEARN: Right. Characterizing it as an experiment. Absolutely, yeah.

NIEBUR: I liked that very much, rather than just a "go see" kind of thing. So at that point, so you had already proposed it once, so at that point, you didn't have, in 1996, you didn't have a lot of trouble getting the team on board then, I suppose.

A'HEARN: Oh no.

NIEBUR: It was still the same team that it had been before JPL which had started looking at this way back with CRAF and Ball…. When did Ball get involved?

A'HEARN: They were the lead for the 1996 proposal.

NIEBUR: Oh, were they.

A'HEARN: Yes.

NIEBUR: Sorry, without access I didn't know that.

A'HEARN: Early on Mike Belton started working with Ball and Mike and Ball put the concept together and then went to JPL.

NIEBUR: Ahhhh.

A'HEARN: Which is something JPL no longer likes people to do, they'd rather have you come to them and then they decide whether it's in house or given to Ball or given to Lockheed.

NIEBUR: Right. Right. There's a lot to manage. Now Maryland. I don't know how things work on this, but was it a hard sell to Maryland to get you as PI, to have them sign on to responsibility of being a PI institution, or was that any different from being a Co-I?

A'HEARN: Um….

NIEBUR: I'm just curious because I don't know how that works.

A'HEARN: Getting them to sign on to being a PI institution for the most part was trivial because they had even less clue than I did of what it involved (laughter). They just didn't know. They did not realize.

NIEBUR: Gotcha. So it probably went more like a research proposal than anything else.

A'HEARN: Yeah, like a research proposal. Getting them to cough up some matching funds that was more of a challenge, but they saw it as a big enough opportunity that they did agree to provide some matching funds.

NIEBUR: And clearly it was a good investment; they are very proud of you now. The signs that used to hang around the campus are wonderful.

A'HEARN: (Laughter) Yeah, they are happy.

NIEBUR: (Laughter) Absolutely. What else can you tell me about the team when you started out and did it stay pretty much the same, or did you add people along the way?

A'HEARN: The team stayed almost the same. I mean the big expansion was in 1996 so we went from the original group of 6 up to about a dozen. I remember Jessica [Sunshine] was the last one Mike Belton brought on. I think in 1998, the only things that changed, we

dropped one Co-I who was going to provide the cameras and we built them inside Ball. Actually he wasn't going to build the cameras he was going to be the one in charge of selecting them on a bid. We decided for 1998 it was better to build the whole thing, the cameras plus the spacecraft in one place.

NIEBUR: And that was to keep it simple, or cost contained?

A'HEARN: That was the goal, not that we succeeded, but that was the goal (laughter), and to simplify interfaces.

NIEBUR: Also very important.

A'HEARN: between the instrument and the spacecraft

NIEBUR: Very important when you are trying to ensure success for a small cost

A'HEARN: Right.

NIEBUR: Sounds smart to me.

A'HEARN: And we added one. We added Lucy McFadden for the E/PO, which had been being done at Mike Belton's institution at NOAO where he was at the time and we agreed

that it made sense to have it done at the PI institution. I think those were the only two changes on the 1998 proposal.

NIEBUR: Excellent. That proposal was successful.

A'HEARN: Yes.

NIEBUR: So you got through, you were selected as a concept study….

A'HEARN: Yes.

NIEBUR: You completed the concept study ….

A'HEARN: Yes. There was one lesson I drew from that, though, before we go on to the next step. Proposals go through a huge amount of review before you ever submit them, and I often think that it is excessive. Very few people realize that when we wrote the 1998 proposal, it was due on a Monday, Alan Delamere and I sat down at Ball on the previous Thursday and we said this whole science section doesn't flow. We rewrote a 25-page section from scratch on that Thursday, Friday, and Saturday (laughter).

NIEBUR: (gasp) Wow. That was a challenge.

A'HEARN: Pretty much the same content, I mean everything was designed so it was relatively easy, but …

NIEBUR: Right, but you recast, it in a more …

A'HEARN: …in a way that it flowed better, it made it easier for the referees to understand.

NIEBUR: That kind of thing can make an amazing difference.

A'HEARN: I am not convinced that many stages of review are necessarily a good thing.

NIEBUR: Interesting. Interesting. I think about my own very, very limited experience at proposal I've been doing a little proposal work since I left and uh, yeah, I can see how that could be quite an undertaking at the last minute, but clearly it worked.

A'HEARN: Yeah, exactly.

NIEBUR: Great (laughter).

A'HEARN: (laughter) It wouldn't work for everybody but it worked for Alan and me. And I wouldn't have dreamed of trying it…. I guess Rich was involved at that stage. He was the original concept spacecraft designer.

NIEBUR: Rich Reinert [Ball spacecraft designer in the new business area]. Then, you were selected for a concept study and you were told here's some little money, and some time, little time, to go off and do the concept study.

A'HEARN: Yeah.

NIEBUR: Did you find there were major surprises that happened during the concept study? Things that you hadn't expected when you were designing the mission on paper, as it were?

A'HEARN: I'm trying to think. I don't think so… the substantive changes actually came after we were selected, not during the concept study. It was just filling in details in the concept study.

NIEBUR: Did you feel constrained at all at that point by the short time and short [small] cost or was it you just did what you could do in the time….

A'HEARN: At that point we just did what we could, and I was too naïve at that point to recognize what else should be done.

NIEBUR: And later you had thoughts that more, more drilling down should have been done or more work with the partners? What do you think would have helped?

A'HEARN: Well, later on, after we were selected was when we first had the time to have real team meetings. That is when we commissioned some studies on cratering and realized that we needed to completely redesign the impactor.

NIEBUR: Why so?

A'HEARN: Because it was originally designed as a tin can, a front and a back, and the simulations that we got actually from Tom Ahrens at Caltech , actually Dugan O'Keefe working under Tom Adams, showed that what happens is when you go in, the can just penetrates deeply and the front end gets pushed to the back end inside the can. You end up expending a lot of energy heating material. Stuff comes out very fast… and very hot, and that is what we didn't want. Putting all the mass in the front end, a large fraction of it, is what we ultimately redesigned it to, in trying to do impedance matching, reducing, or boring out the copper so that it had roughly the same density, well a lower density that bulk copper, but not as low as the common one. That led to much lower ejection velocities and much cooler ejection in the simulations. So we had to redesign that. Then we also had to redesign fly-by spacecraft because that's when Brian Muirhead was project manager du-jour and discovered that the spacecraft as designed wouldn't quite fit inside the faring.

NIEBUR: Oh dear. Had… Now you did change launch vehicles at some point, right?

A'HEARN: Yeah, that was most… yes, we did, that was one of our descopes to save some money, but that was just changing from a Delta-II heavy to a Delta-II normal. So we threw away some of the outside strap on boosters.

NIEBUR: So that wouldn't have changed the fairing. Well that's interesting and that just hadn't been caught by your original project manager?

A'HEARN: Yes.

NIEBUR: You started with someone besides Brian,

A'HEARN: Jim Graf

NIEBUR: Thank you.

A'HEARN: And by now I've been through, with the extended mission, I've been through 8 project managers.…

NIEBUR: Have you been through 8?

A'HEARN: Yes.

NIEBUR: Can you name them all?

A'HEARN: Sure.

NIEBUR: Tell me who they were.

A'HEARN: I will. There was Jim Graf, there was Brian Muirhead, there was John McNamee, and there was Rick Grammier, who got us through the last of Phase C/D and through all of ops…then there was officially hibernation when there wasn't a project manager…although we went through Rick. When we did the extended mission we got Tom Duxbury, to do both EPOXI and Stardust NEXT at the same time.

NIEBUR: That's right.

A'HEARN: It was a good deal. That's how we tried to keep the costs down.

NIEBUR: That was very efficient.

A'HEARN: But then Tom [Duxbury] retired from JPL, and the mission manager said that I should become the project manager (laughter).

NIEBUR: Oh dear. (laughter)

A'HEARN: And NASA Headquarters said no we want somebody at JPL to point the finger at (amused).

NIEBUR: You don't want that job.

A'HEARN: You are right. I didn't, although we functioned fine without any project manager for 4 months.

NIEBUR: You were in operations.

A'HEARN: Then we had Chris Jones as the project manager

NIEBUR: Really?

A'HEARN: In an acting capacity for 4 months. Then he had back problems and sort of disappeared. Then Rick Grammier was promoted to Chris' deputy and he did a Grover Cleveland and became Project Manager again.

NIEBUR: Oh my goodness. Wow.

A'HEARN: And now we are on Tim Larson.

NIEBUR: I haven't met him yet.

A'HEARN: He was the mission assurance manager that Rick Grammier brought on in the prime mission a little late in Phase CD, then he was off doing other things.

NIEBUR: But at least he's familiar with the spacecraft and the mission.

A'HEARN: Oh, yeah, yeah.

NIEBUR: Excellent.

A'HEARN: … a good choice in that sense. And having Rick back was a good choice too just because he already knew everything and didn't have to come up to speed.

NIEBUR: Exactly, well it must take a lot of extra time having to train new project managers…

A'HEARN: Yes.

NIEBUR: As to what the spacecraft is doing and what the important parts are and things like that. Did you find that there were a lot of unexpected duties that you ended up having to do that you didn't expect?

A'HEARN: Oh yes. Lots and lots.

NIEBUR: Yeah. What did you expect the role would be?

A'HEARN: I probably thought….that I would be in charge of the science and the project manager would make the mission happen.

NIEBUR: Right, I think you would not be alone in that assumption, particularly when it was chosen.

A'HEARN: That was the misconception.

NIEBUR: Yeah. How early did you have to get really involved with the hardware, or with the plans for the hardware?

A'HEARN: Well I didn't get involved early enough. I should have been going to Ball at least every month from the start of Phase CD.

NIEBUR: Really? That kind of a presence?

A'HEARN: I was going every two or three months. In Phase B I didn't realize how much I had to go there, early Phase C/D I didn't realize how much I had to go there and it was only when we got deeper into Phase C/D that I realized I needed to be going more often.

NIEBUR: Wow.

A'HEARN: Part of that, of course is we were managing the instrument contract from here, not from JPL. We had to transfer it from JPL to here as one of our many cost savings.

NIEBUR: Was that in 2002? At the cost review?

A'HEARN: Uh…that's right. That sounds vaguely familiar.

NIEBUR: I remember there were a lot of difficulties at that time…

A'HEARN: JPL had something like a 50% overhead on the contract and universities were making subcontracts that had this pittance attached -full rate for the first $25k of the subcontract even though it is a 40-million-dollar subcontract….

NIEBUR: Right. Oh I'm remembering a lot of that now.

A'HEARN: So we saved a million dollars basically.

NIEBUR: But you didn't have the support people here that you would have had at JPL.

A'HEARN: Right.

NIEBUR: So, did that make it

A'HEARN: Ah, well we kept Bill Smythe who was sort of the instrument manager and he trained Dennis Wellnitz here on how to be an instrument scientist overseeing the contract.

NIEBUR: Mm-hmm

A'HEARN: We couldn't have done it without Bill.

NIEBUR: Really?

A'HEARN: I fight with the JPL managers over whether I need a project scientist at JPL and they bring up the Bill Smythe case and I say we couldn't have done it without him, but he wasn't functioning as a project scientist.

NIEBUR: Interesting.

A'HEARN: He was functioning in a rather different role that we absolutely needed.

NIEBUR: Right, right, that is very interesting. I can see that. Well, before we get to 2002, something happened when you guys were finishing…you finished the concept study and you were moving towards development and I think you were in formulation when the whole NIAT report came down.

A'HEARN: Yes.

NIEBUR: I know that is a very infamous report, at this point. It was a very difficult time for everybody who was active in Discovery, even those who were in the middle of their studies, as we came to find out later. The NIAT reports came about, of course, as a result of the Mars failures and they had a lot of recommendations that were supposed to help, um, but what we at Headquarters heard a lot was the words unfunded mandate.

A'HEARN: Yes.

NIEBUR: and I think that was right. I absolutely do. I came in near the end of that and I think you guys absolutely had a point. When you saw all that stuff coming down the pike did you understand at first it was going to be a big deal? Was it really impacted by the Mars failures, did everybody start to duck and cover?

A'HEARN: Yes. Some of the mandates were things like in West Virginia

NIEBUR: IV&V [Independent Verification and Validation].

A'HEARN: Supervised IV&V. We were in the fortunate state that Headquarters said we could have more money to cover it. But I think we badly underestimated how much we should have asked for to cover it.

NIEBUR: For the record, everybody did. Nobody had any idea how much that was going to affect things. In fact it was the whole change in risk posture that really caused a lot of changes to the program and the current missions

A'HEARN: It was more of a change in overall risk posture, I think, even than having IV&V involved. I think we did cover their costs, but the whole change in risk posture. What kind of risks do we take? That changed, and that put up a lot of other costs that we never could predict far enough in advance to actually ask for the money on those grounds.

NIEBUR: Right, right and you guys had margin trouble too as I recall. I know that JPL was coming up with new design principles at that time. I don't know if you got caught in changing design principles, or if it was simply that those are high margins?

A'HEARN: design principles on cost reserves you mean?

NIEBUR: Cost, schedule…

A'HEARN: …. Ours were not caught by it, the ones right after us were.

NIEBUR: Okay

A'HEARN: Schedule margin we didn't have enough of.

NIEBUR: Was that from the beginning? Or was that because things happened later on?

A'HEARN: It was because things happened. There were lots and lots of changes in the design. Driven mostly by JPL demanding changes in the design as we went along.

NIEBUR: because of things like the fairing size that were there from the beginning?

A'HEARN: Well, that was the first one; that was there from the beginning. The others were approaches to things. One simple one was that the impactor started out with the front end being a thermal radiator. As we went along Ball decided to change it, so they covered it with blankets.

NIEBUR: Ball decided that?

A'HEARN: Yes.

NIEBUR: Based on those studies? Or something entirely…

A'HEARN: Just on their internal engineering of the thermal modeling.

NIEBUR: Boy, interesting, okay.

A'HEARN: I didn't catch this early on. Then I realized that we don't want thermal blankets on the front end that are going to be penetrated by this dust because that puts chaff out in front of your camera.

NIEBUR: Right.

A'HEARN: So then we had a fight with Ball, actually not for me, but between Ball and JPL about how to deal with that issue.

NIEBUR: Sure. Sure.

A'HEARN: Ball was quite prepared to deal with it, but they wanted to do it their way, JPL wanted them to do it a little different way.

NIEBUR: You guys had trouble with that. I mean this was Ball's first planetary mission, as I understand.

A'HEARN: Yes, this was their first planetary mission. Yeah. I mean the bigger problem was, due to the fact that Ball had never done a planetary mission, was that on a planetary mission test beds play a very different role than they do in orbital missions, they have to be much, much higher fidelity and nobody ever spelled that out adequately.

NIEBUR: I remember McNamee coming and talking to us about testbeds. That is one of the things that remain very clear to me all these years later.

A'HEARN: That was one of the big test drivers. The other one was what's the nature of the sequence? And that's associated with the testbed and Ball has a philosophy from their earth orbital heritage of putting as little money as possible into testbeds, but once you're in orbit around the earth you can fix things in software. You can't do that on planetary missions. I mean you can do it, but there are so many one-shot events where you don't know the problem until you get there if you don't have really good testbeds and by sequences, they thought of it sort of as conceptual sequences rather than detailed command by command sequences that have to get reviewed very thoroughly and run through a test bed over and over. This was just a lack of communication between JPL and Ball.

NIEBUR: Somewhat of a culture difference too, is that....

A'HEARN: It is a culture difference and it, they would use the same terms thinking they meant same thing, like testbed and it didn't mean the same thing on the one side of the Rockies and the other, the words mean different things.

NIEBUR: Right. I remember you bringing it up as being one of your first major lessons learned at the community workshop. That you really not only have to know that you are using the same words, but to understand whether the words mean the same thing. You must have had to learn a lot.

A'HEARN: I did. I know more about test beds than I ever wanted to know (laughter)

NIEBUR: Excellent.

A'HEARN: I can't say that I'm any happier with JPL managing my test beds. Well recently, well last year they broke an 8x8 sheet of glass right over the test bed and showered it with broken glass. They were doing construction around it, which they never should have been doing.

NIEBUR: Oh, no. Wow.

A'HEARN: You never should be doing construction around a testbed.

NIEBUR: There certainly are a lot of challenges, which I guess is really the theme of what I'm trying to get at. I know that putting a mission together is exciting and many faceted and terrible and difficult and wonderful all at the same time. Do you, off the top of your head, does anything stand out to you as the biggest challenge of doing this mission to hit the comet very precisely in this small cap [program]?

A'HEARN: The biggest challenge for me was getting up to speed on what you have to do.

NIEBUR: Really?

A'HEARN: By far.

NIEBUR: Really?

A'HEARN: Yes.

NIEBUR: Coming from the university community,

A'HEARN: Right.

NIEBUR: and being immersed dropped into all of a sudden into this industry

A'HEARN: This heavy engineering and industrial field … and learning all the business stuff you have to learn to manage the contracts and stuff like that.

NIEBUR: Is any of it the kind of thing a PM or somebody, going off track here, that somebody else could be trained to do to kind of facilitate the role of PI? It seems strange to me.

A'HEARN: Sure, sure.

NIEBUR: I shouldn't say that but it does.

A'HEARN: Someone could easily be trained to do that. But there is nobody here that's been trained and if you've never had a PI you also never had a PM.

NIEBUR: You really need to have someone on the side of the PI.

A'HEARN: Yes.

NIEBUR: If you were to delegate that kind of a thing.

A'HEARN: Yes. That's my view. I don't want to delegate now. I don't want to delegate the spacecraft to someone--

NIEBUR: Oh, no, you know how to do it now.

A'HEARN: --along at JPL. I want it to be managed by someone here. I do delegate to Dennis [Wellnitz] at lot of the instrument contract that's here.

NIEBUR: And do you think being a Co-I on a mission exposes you to anywhere near that kind of information or is it always going to be a "learn on the job" kind of thing?

A'HEARN: It's always going to be a "learn on the job" kind of thing. The only one, well, you do get exposed to it, if you are in the same institution. If you are in the same, or your office is in a close proximity of the PI you get exposed to it.

NIEBUR: Sure. Which is the most informal of the--

A'HEARN: It matters. It really works. You get it more. What we did on EPOXI, on the DIXI side of EPOXI, I made Jessica [Sunshine] my deputy. So in essence, it forced me to keep her involved and get her exposed so that then she could be a PI.

NIEBUR: Which is a great move, we don't see enough deputies. Across the Discovery program there have only ever been 3 deputies ever appointed.

A'HEARN: Really, because I had on one on DI that was Mike Belton and that was primarily because he had the experience I didn't have.

NIEBUR: There are very few. And even on proposals I recall there are, looking at the set as a whole, very few and far between. It seems to me that kind of thing, a Deputy PI on the science side, and Deputy PM perhaps on the PM side can really help in terms of growing the knowledge base so that next time you don't get someone fresh or if your PM falls through for whatever reason, you have another option. Certainly you've gone through several yourself of course. Then you have someone who has been involved. But basically

these are things that get dropped by the wayside when you are dealing with a small cost cap and a focused mission and trying to get it done.

A'HEARN: You can't afford to have these extra people who are learning.

NIEBUR: Exactly. Boy that is tough. So. Let's see here, we've gone through a lot of what I had. I'm pretty happy about that.

A'HEARN: Since you mentioned small cost caps. Let me point out something that became clear to me only a week or two ago. Back in the early stages, back when we created New Frontiers.

NIEBUR: I remember that well. Yes.

A'HEARN: The coarse bands were Discovery, New Frontiers, flagship - each was a factor of 2.

NIEBUR: It was very pretty….. on paper.

A'HEARN: Now the ratio of New Frontiers to Discovery is less than a factor of 2 and the ratio of New Frontiers to flagship is more than a factor of 4. Because we are looking at 3 billion dollars for a next flagship; it is not all NASA it will be ESA partly but

NIEBUR: Yeah, the NASA share isn't nearly as much.

A'HEARN: It is the mission that matter. NASA worries about its own budget, but the cost of the mission is actually the right way to compare them.

NIEBUR: That is a really interesting perspective. I looked at the next outer planet flagship. I know a lot about it. I had not thought of it in those terms. In my opinion New Frontiers has been underfunded from the beginning….for the scope of the mission as it has been defined and I think it was pretty well known.

A'HEARN: Yeah, I think this mission that [we're] working on is going to have a problem with the cost cap.

NIEBUR: But when you look at the studies that were done beforehand on the New Frontiers program, you notice that those that had previous studies were not estimated to fit within the cost cap that was announced. It was an immediate problem in New Frontiers. I don't know how they are going to solve that. I wish them a lot of luck. I wish all of you guys luck.

NIEBUR: I guess one of the things that we didn't talk about was when things first started to happen with confirmation and then later on with the cost problems in 2002. It seems to me that one of the major struggles with something like that is keeping a team motivated and moving forward fast and effectively and not making mistakes when their decisions

may be called in to questions or things may be changing. Did you have a lot of insight into that? Or was that maybe the PM's job to regroup and shepherd them on so that they don't worry about what was going on?

A'HEARN: It was the PM's job, but I got involved. I was dragged in.

NIEBUR: You were changing PM's at that time too. At least once. So how did you do that?

A'HEARN: One thing that helped, I think. That was when I started going to Ball regularly. I am amazed about the enthusiasm that the Ball people have about science.

NIEBUR: Really. That's great.

A'HEARN: The troops have tremendous enthusiasm for it. If you walk around the corridors they have, lots of them will come up and ask you questions.

NIEBUR: Really. About implementation or what you expect to find?

A'HEARN: About why things are the way they are for science, what's the science driver? You also get the administrative questions too, but, and one of the strongest more frequent one to raise questions every time I showed up is Tom Bank, who is now the project systems engineer on the extended mission. I went around and said, if you don't understand

something call me. I never once, ever, had a single phone call from all the people who would ask me questions while I was there.

NIEBUR: That really underscores the importance of being on site and walking the halls and being available.

A'HEARN: Right. And it does motivate them. That's one of my strongest pieces of advice to any future PI, is to spend time with the engineering team that is doing the work.

NIEBUR: Excellent. And the science team, they weren't nearly as involved at the at point in time, to my understanding, but they did get discouraged by all the um, the difficulties, the trials?

A'HEARN: I don't think they ever got discouraged. They certainly got worried, frequently, as we went in for cancellation reviews.

NIEBUR: That would tend to worry, yes, but there wasn't a lot that they could do. It was right near falling on the engineering at that point, correct?

A'HEARN: Yes

NIEBUR: Cost and schedule are not scientific issues, so it would not fall on the science. It was selected on the science, it was confirmed on the science in the plans, so the science

was secure. I guess the only question was what kinds of things might be taken off the spacecraft. Would you have to go to a dumb impactor things like that?

A'HEARN: Yes.

NIEBUR: It was more concern about the impact, not whether it would actually fly.

A'HEARN: The science team wasn't involved at the detail level. They just knew we were in trouble. They weren't involved in decisions as what to what we would descope in particular.

NIEBUR: Really.

A'HEARN: I did that myself. With the project manager.

NIEBUR: Why?

A'HEARN: Why? I figured that was my job as PI.

NIEBUR: Excellent, Excellent.

A'HEARN: And I thought I understood well enough all the science behind it that I could make the judgments intelligently. In retrospect, I don't think I made any wrong decisions in that area.

NIEBUR: Well, clearly, the mission worked. This is all for perspective that is a very good perspective, which is that the mission worked; it was wonderful.

A'HEARN: There were other places that I made wrong decisions.

NIEBUR: When you say things like that you make me ask. Is there anything else that you'd like to share for the record that you wish you would have done differently?

A'HEARN: I made one wrong decision that I'm aware of that affected the science. That was the focus of the HRI telescope. We had done two different tests that were pretty much independent, both of which showed that the focus should be here [gestures] when we got to space and got cold, and of course we had to set the focus at room temperature, so we had to rely on how much it was going to [change]. So we had two independent tests that agreed with each other very well on where it should be. And Ball had a theoretical model for the extension that said it should be somewhere else.

NIEBUR: Tough.

A'HEARN: So they said okay. They came to me with a recommendation. They recommended that we accept the results of the two independent tests. But they didn't really trust the model.

NIEBUR: Was it an in-house model?

A'HEARN: It was based on details from the people who built the telescope structure. For example, mostly the expansion of the two and the changes on the focuses of the carbon fiber epoxy structure. That was viewed as, the thermal expansion coefficients of that were viewed as the weakest part of the model. So they came with the recommendation that we ignore it. I probed bit on how independent the tests were, keeping in mind the HST experience where the two tests disagreed. And so originally, I said okay, we've got a tight delivery. We are already over budget Let's accept the results of the two tests. It turned out there was one common optical element in the two tests that none of us, neither Ball nor I, remembered. Namely, the flat they put in the vacuum chamber to set things up and to take out the curvature of the window in the vacuum tank. To correct for the fact that when you pump the vacuum down the window gets curved you use a flat inside. The flat was inherited from Spitzer. Turns out the flat gets curved when it gets cold.

NIEBUR: No.

A'HEARN: It turns out it didn't matter for what the way Spitzer was using it, but it mattered for us. If I had realized at that time, that the instruments were not going to be the schedule

driver, that the spacecraft was what was going to be a year late, and if I'd realized that probably by this point cost was not the real driver at NASA Headquarters anymore, I would have said do a third test. That is the one different thing that I probably would have decided anywhere along the line.

NIEBUR: Interesting. That makes a lot of sense.

A'HEARN: Ball took a lot of the blame for that because it was their recommendation, but ultimately it was my decision not theirs.

NIEBUR: The two tests agreed.

A'HEARN: Yep.

NIEBUR: I certainly see why you made that decision. Interesting, hindsight.

A'HEARN: It's always wonderful

NIEBUR: So the spacecraft was the limiting factor. Do you want to talk any about how the schedule changed? There is so much history there in terms of in terms of what happened but I hear you talk a lot about spacecraft and Ball and I understand they were new and we've had new people on other programs. That is very difficult. Culture changes are very difficult. Culture mismatches are very difficult. But engineering wise were there

engineering problems that caused the delay in the spacecraft. I admit [Steve] Brody kind of took care of that stuff I don't remember. Or was it Tony [Carro, another PEs at Headquarters at the time]?

A'HEARN: Not that I'm aware of. It was mostly simply not taking into account all the things that had to be done.

NIEBUR: So nothing broke, nothing was dropped, nothing changed.

A'HEARN: The one thing that broke was actually part of one of the instruments. They broke the primary mirror in the shake test.

NIEBUR: Oh.

A'HEARN: Had a spare, they put the spare in.

NIEBUR: So it wasn't a big impact?

A'HEARN: No. The instruments were delivered on time.

NIEBUR: Right, when was that? Do you remember? Just before sometime in the testing.

A'HEARN: It was early in the testing. It was the first shake test.

NIEBUR: Interesting.

A'HEARN: It was before the instruments were fully assembled. It was the test of the mirror amount of vibration.

NIEBUR: Luckily you had a spare.

A'HEARN: On the whole most of that stuff was well managed. There were prudent decisions on where to cut costs. Part of the driving thing was JPL's focus on getting it right and Ball's focus on trying to stay in cost. That drove part of the conflict.

NIEBUR: I suppose it didn't help when Gavin and JPL people went out to try to check out what was going on with Ball. Did you find that you had difficulty with having two partners? It sounds like you were managing a lot out there directly. Or you were present out there a lot directly …

A'HEARN: But I wasn't actually managing.

NIEBUR: Okay Thank you for the clarification.

A'HEARN: I was letting the project manager manage. Well I was managing instruments, but sort of jointly with the project manager of the spacecraft. The project manager was managing. I wasn't.

NIEBUR: Thank you for the clarification. So your role was, at that point was getting out there and checking the instruments. But being present, so that spacecraft people talked to you…

A'HEARN: Oh yeah. When Tom Gavin started going out, we went out there and ran reviews. They were generally helpful.

NIEBUR: Okay. Well we'll leave it at that. So what changes did you make? A lot happened in 2002 starting with the cost reviews in August and then all the reviews you were called in for. And in fact you were called in….. I'm having trouble here because I don't want to necessarily talk about termination, about details and things that are predecisional. I don't want to put you on the spot, or get into things that are predecisional, but just in terms of context I guess I'm curious how the team regrouped what major changes you made I know there were personnel changes, there were cost changes. There was some discussion of Ball's fee change which again was not unique to your mission. Certainly has happened on other missions.

A'HEARN: Happened on Dawn for example.

NIEBUR: For example this definitely happened on Dawn. And very publicly on Dawn as well. So that's always something that is on the table. You had other things on the table too like the impactor which as I understand went back and forth a bit. Was it a threat, was it ever a threat from your perspective that it would be made a dumb impactor again or was that something you held on to very tightly?

A'HEARN: That was something that was brought up repeatedly by the engineering team and immediately vetoed by me. It came up many times but it was never actually on the table.

NIEBUR: Excellent and it came up because of cost or schedule?

A'HEARN: Cost.

NIEBUR: Cost.

A'HEARN: Well, both.

NIEBUR: I mean they're related, right, days of schedule equal cost and what not.

A'HEARN: I don't know which was the bigger driver. It came up several times and I just said "no."

NIEBUR: But it was never on the table

A'HEARN: Not in my mind, it wasn't.

NIEBUR: (laughter)

A'HEARN: It stuck its nose over the corner of the table a couple of times.

NIEBUR: And it was critical to you so that you would actually understand what happened just before impact. In fact the results bear you out; there are absolutely amazing things that happened just before impact and just after impact. Do you want to talk any more about that time?

A'HEARN: I don't think so. At that time, I was still not coming to grips with how badly things had been underestimated in cost. I had no idea that they had underestimated as much as they had. I don't know how much of that was changes driven by design and how much was just actual bad bid.

NIEBUR: Underbid, or just optimism? Interesting.

A'HEARN: It was pretty late when I realized how bad, how badly things had been estimated.

NIEBUR: Really, was it delving into details yourself or was there an "A ha!" moment?

A'HEARN: Well it was more statements, accumulation of many statements made by various high-level people, both at JPL and at Ball.

NIEBUR: Okay. Well let's leave that. Were there any other big surprises before launch, after all that, or did things proceed pretty smoothly after you did the replan, you got most of what you needed, and people started doubling down trying to get things done.

A'HEARN: I would say they proceeded pretty smoothly then. Once we got to the point of saying we are delaying the launch. From then on things went fairly smoothly.

NIEBUR: And one impact is that you didn't actually have that year of orbit to do testing. Did that play into any future concerns about whether all the instruments were going to work, or was that just something you were able to compensate for?

A'HEARN: No, the net result from that was that the instruments were poorly calibrated. The cameras were okay. The IR was very badly calibrated. Even on the extended mission we were taking more observations because we don't understand. IR spectrometers are really hard to calibrate. Outer planets you must know about NIMS… There aren't many calibrated data for the NIMS.

NIEBUR: Were there any major concerns as you got there. You had a really interesting trajectory, not the trajectory part, but the encounter. I don't think I fully appreciated how very cool it was to come right up under it and kind of wait for the comet to impact. I was still thinking more propulsive entry. It is a fantastic, fascinating design. That was always part of the design?

A'HEARN: Oh yeah.

NIEBUR: That was clever. That was really clever. That came out of some studies at JPL?

A'HEARN: That comes automatically out of celestial mechanics. You put the spacecraft at aphelion and the comet at perihelion the comets and they are at the same place. The comets going a lot faster, so it impacts…

NIEBUR: We'll just pretend I didn't ask that question. When you got close to encounter, I know that there was another operations team setup, a second one, the encounter working group. Were people concerned about the impact or was that just to be on the safe side?

A'HEARN: I wasn't, but they were.

NIEBUR: It was kind of second guessing or did they have any indications that there was something?

A'HEARN: I don't know. Lindley Johnson and I had a running joke every week: Do you need a new navigator, Mike? Everybody was worried that it wouldn't work. Nick Mastrodemos, I thought had done an incredible job of testing the algorithms. We had made one complete change in the algorithm after the DS1 flyby of Comet Borrelley. If you look at the images of Comet Borrelley, the nucleus is sort of banana shaped. There is a big bend in it. Up until then we were targeting on the center of brightness … but the center of brightness could actually miss. That's when we had to go to more sophisticated targeting algorithms, but Nick, I thought, did a tremendous job of designing and testing the algorithms. So I had lots of confidence. Nick was white as a sheet on that day before.

NIEBUR: I bet he was. Would you like to talk about impact?

A'HEARN: Well impact. I was isolated from everybody at impact. I was the one to officially declare success, when we hit. They gave me a terminal in the standard ops [operations] building away from everyone else off in a dark corner where I could sit and watch quietly and declare impact. I was late declaring impact because I wanted to see it in pictures. At first it was just pretty faint in the images that showed it. It could have been an artifact. The team was sitting over there wondering why hasn't he said success.

NIEBUR: Well that was very cautious. And then the pictures just kept coming down and they just kept becoming more and more amazing. How would you characterize that?

A'HEARN: I would say it was just tremendously exciting.

NIEBUR: I bet. Of course, there has been so much post impact science and special issues of this and that. You've done just amazing science work on that and I'm not going to focus much on that, unfortunately, I'm going to refer to things, but I am thrilled.

A'HEARN: Do you have one of my books? Do you want one?

NIEBUR: Yes.

A'HEARN: We have a box and I'll make sure and get you one before you leave.

NIEBUR: Thank you. I don't know how I missed that. He is referring to the book Deep Impact at Comet Tempel 1.

A'HEARN: That's a reprint of everything that appeared in Icarus related to Deep Impact.

NIEBUR: That's helpful. I have a ton of the individual ones. Excellent, fantastic. I'll go through and work through that. This is mostly going to be about development but I do want to highlight some of the most exciting things. Of course post impact, you guys did something really pretty exciting that you just said that we want to reuse the spacecraft and do this again. I remember getting e-mails from you even before impact saying well how should we plan to do that. You were planning at least a year in advance before impact, asking procedure…

A'HEARN: When we did the concept study, we knew the secondary target then…

NIEBUR: Did you really, wonderful. Well I was very glad that it ended up working out and Andy [Dantzler] made the decision that you would put it in hibernation and go through the procedures that we had done. Because we wanted to be very careful that the Discovery [competition] money was open and to compete. Clearly DIXI won, EPOCH did well, Stardust NEXT won. That was kind of new. We've never done extended missions that way before. Was it a lot of work to prepare extended mission proposals for those? You were on both of them.

A'HEARN: It was a huge amount of work, given that we had to do a proposal and do a concept study report, a phase A study for a mission phase E. Then a site visit from the review team…

NIEBUR: You did have to do that part?

A'HEARN: I personally thought that was excessive. Now I sit on the senior review board for the extended mission of WISE [an Explorer mission], which hasn't even launched yet. I just sent in my report this morning. In comments to NASA, [I wrote that] I wish Deep Impact had been able to get away with as little as this.

NIEBUR: Yeah, but Planetary [Division] doesn't regularly do senior reviews. And we struggle with that.

A'HEARN: I understand that this was an unusual circumstance. I think we did far more work than Cassini did for its extended mission. That was a senior review.

NIEBUR: Yes it was. And they just had another one as a senior review, and yes, I 'd have to say that is true. And they are worried about diverting resources, and wearing people out…

A'HEARN: I understand the worry and I understand wanting to make sure you are getting good science out of an extended mission I'm all for that. I just thought the two-step process, site visits and all that, was a bit much.

NIEBUR: I don't know, I wasn't part of it at that point. I had already left, but I think yes for the official selection, the proposal stage, I think was important to make sure there was something more to do rather than just, "This is cool; let's ride it out."

A'HEARN: I agree with that.

NIEBUR: I don't have any idea why it couldn't have been selected at step one. Alright, well skipping forward. If you have a few more minutes, I would like to hear more about

EPOXI and Stardust NEXT. You were involved in the Stardust NEXT proposal. But you were a PI of DIXI and I noticed that the DIXI team was exactly the DI team.

A'HEARN: Um, yes that is correct it was.

NIEBUR: At least there was nobody new attached to it.

A'HEARN: When it became EPOXI two new people were added.

NIEBUR: Interesting.

A'HEARN: I added Dennis Wellnitz and I added Don Hampton, two instrument people we needed to be the bridge to EPOCH.

NIEBUR: Oh very smart. I didn't have any idea about how all that happened. I'll be honest, when I saw that DIXI and EPOCH had been selected for concept study and all of a sudden, they were combined... Was that your idea, or an idea on the part of the proposers? Did that come down as a direction?

A'HEARN: As I have characterized it…..

NIEBUR: Oh dear, that was a hard question, I'm sorry (laughter)

A'HEARN: No I'm trying to think of the delicate way to answer it. I have characterized it as a shotgun marriage by Headquarters, but, as with most shotgun marriages, the principals have had previous interactions.

NIEBUR: Fascinating.

A'HEARN: Drake and I both anticipated that they would be combined. We coordinated writing the proposals so that they would be easy to combine, but kept them separate in case NASA wanted to pick one but not the other.

NIEBUR: Very smart, very smart.

A'HEARN: We knew we couldn't do both of them under the mission of opportunity budget, either.

NIEBUR: Right, which has never been changed. It has always been 35 million, for what it is worth. So was it at the concept study level that it was combined?

A'HEARN: Right. The two proposals were selected and we were told to combine them in the concept study to comply. We had expected to have to do that.

NIEBUR: Did the teams meet together for anything, for any science meetings or anything or has it really been run kind of separately?

A'HEARN: It has been largely separate with enough overlap. There are four of us from the DIXI side who routinely participate in the EPOCH discussions. At least three: Dennis, Don Hampton, to some extent, myself, Casey Lisse, all participated in EPOCH. On the DIXI side there is less overlap although we usually ask Drake to periodically brief the DIXI team on what EPOCH has been doing.

NIEBUR: It is kind of an interesting model, actually, because you've got the opportunity to compare a team that has been working intimately, that built the instruments, that built the spacecraft and then you have got a team that just kind of came from somewhere else that wants to operate the spacecraft. And so I suppose it makes a fascinating case study, I don't know if anyone has looked at it, in terms of how that actually works day to day. You guys knew everything about the spacecraft, you knew its quirks you knew what it was capable of, you knew all of that. Epoch just arrived, in my perspective. I don't know if that is fair.

A'HEARN: That's fair.

NIEBUR: Was it difficult? How did you approach that?

A'HEARN: Well mainly by having people who overlapped the two teams. So EPOCH would come in and want to do this, and we would know, some of us, typically Dennis, who has this infinite memory capacity, would know immediately no you can't do that for this

reason. So you can't do it the way you wanted but here is a way you can effectively get the same thing.

NIEBUR: Interesting. So it really does require some personnel overlap on the science side as well as anything engineering.

A'HEARN: I think so.

NIEBUR: Do you have any recommendations that you would make for future proposers trying to do an extended mission on a spacecraft that's not theirs? I mean that's an awkward thing to say, it's an awkward thing to do I suppose.

A'HEARN: I think anyone that wants to do that would be stupid if they did not involve people from the prime mission.

NIEBUR: Yes, absolutely. But the people are enough, you don't need to be sure you match processes or things like that, just the people are enough, the people here make the difference?

A'HEARN: Yes. I think so.

NIEBUR: That's actually really good to hear, so I'm a big proponent of bringing new people in, I'm also a big proponent of having people available to explain and to move things along.

A'HEARN: I don't think there is any process that can help very much, can help nearly as much as just having people from the prime mission brought into your team when you are doing an extended mission on somebody else's spacecraft.

NIEBUR: The more I talk about this the more I imagine how awkward it could have been, I don't know if it was.

A'HEARN: It wasn't awkward in the least. Because Drake and I get along well together. We had known each other for 40 years, well 30 years anyway

NIEBUR: Long enough. Oh excellent. So it really wasn't, there weren't moments where you had conflicts. I know they were separated in time.

A'HEARN: We designed it to be separate in time

NIEBUR: Very smart.

A'HEARN: We designed the priorities and made it clear that EPOCH would not interfere with DIXI from the outset, from the proposal stage. So to my knowledge there has never been an issue that we disagreed on.

NIEBUR: Excellent wonderful. Now you've been on Stardust NEXT too. Was anything about running that kind of an extended mission really remarkably different form the way you approached DIXI?

A'HEARN: Okay, the things that are different…. Stardust NEXT has PI owned instruments. Deep Impact did not. They are all facility instruments. So the whole team owns all the data. That's not true on Stardust NEXT. Stardust NEXT was much easier to fly, for two reasons. Number one, it is built and flown by Lockheed. It is not flown by JPL. Lockheed flies a low budget operation. Secondly, the spacecraft is far less capable and therefore designing observance sequences is trivial.

NIEBUR: Because there aren't as many choices.

A'HEARN: Yeah, exactly.

NIEBUR: Interesting.

A'HEARN: There is one camera that you can use at encounter in parallel with the dust counter that takes data: the COSIMA analyzes its particles and that's it. You don't have enough memory storage to do very many images. So the observing sequence is trivial compared to the DIXI going by Hartley 2 where we still have a huge amount of work.

NIEBUR: Would you like to talk about the science results from any of them so far?

A'HEARN: Sure.

NIEBUR: As a scientist I should definitely give you the opportunity to brag a little…

A'HEARN: I think the most important thing to remember about science results is, I have two slides of bullet points of important scientific results. Many of which bear directly on the question of origins. One slide is the results that you learn from impact; the other slide is results that have nothing to do with impact and come from what I'd call the Martin Harwit principle. Martin Harwit wrote a book 20 years ago called Cosmic Discovery. Going back and looking at all the big projects in astronomy and what science was used to justify them, or what you remember them or what science remembered them for…and the overlap is small. The reason is there are important questions that you are trying to address when you design the mission, but what you remember them for is the surprises which come almost automatically when you make measurements in a new regime were you've never made measurements before. That new regime can be wavelength, it can be time resolution, it can be spatial resolution or any other aspect of technique that's new. And that is something that people often lose sight of. That second page of bullets of mine didn't get more than a paragraph in the 25-page science proposal.

NIEBUR: Right But it paid off in ways that you didn't have any right to …

A'HEARN: Even at that time I wasn't fully aware of it. I read the book but I hadn't fully absorbed it.

NIEBUR: Well you can never predict what you are going to accidently discover. That is the way science has always worked. That is exciting. Would you be willing to send me those slides/ those two charts? I'd love to see them, just to help summarize what the top pieces were. Well that's exciting. Now, I'm sorry I can't remember were you a Co-I on Stardust?

A'HEARN: No.

NIEBUR: So this was your first experience with the Stardust spacecraft. Did you find that just as an individual it was difficult to get up to speed? Or is it pretty much…..you want to do observations and they helped you translate it?

A'HEARN: Yes, it wasn't difficult because I had spent a huge amount of time working on Stardust images in the past, both because we run the PDS small bodies node here and we archived them all and because one of my post docs has a DDAP grant to analyze cometary nuclei, including Comet Wild 2, and he was the one uncovered the calibration problem and calibrated the Stardust camera.

NIEBUR: As part of the DDAP grant?

A'HEARN: Yes

NIEBUR: Oh that is fantastic.

A'HEARN: And now PDS small bodies node is having to go fix the calibration and recalibrate all the data. Ken Klaasen at JPL will do it right for the extended mission, but he wasn't involved in the prime mission either.

NIEBUR: Right. That's great. Which of your post docs?

A'HEARN: Jian-yang Li.

NIEBUR: He was selected after I left; I don't know him.

A'HEARN: Yes, he's just about to start the third year on that grant.

NIEBUR: Nice.

A'HEARN: He's the one that's not allowed to know the technical information about the spacecraft, because he doesn't yet have his green card.

NIEBUR: Lovely. The last thing I'll ask you then actually is the PDS. Clearly you are a big proponent of the PDS. You spend a lot of time here on the PDS, making sure that other

people can use the data. I'm sure it is a huge, huge issue. But it makes possible the fact that anyone can use the data. Anyone who is trained and ready and all of that can actually access the data from Deep Impact and Stardust. Have you seen…. there has been…. I've seen interest in the Deep impact data. You've seen a lot of interest in the Deep impact data. Would you like to characterize that at all?

A'HEARN: There has been less interest than I would have liked.

NIEBUR: Really?

A'HEARN: There is a paper must by now have been accepted by Icarus by Bjorn Davidsson's group reanalyzing all our thermal data. A tremendous work. He went to the PDS, found the data all on his own, reanalyzed it took the calibrated individual spectra, and did everything from there to do a complete thermal model of the nucleus as we had done with Olivier Groussin earlier, but getting some different results.

NIEBUR: Which is exactly how you hope it would work.

A'HEARN: Yes, exactly.

NIEBUR: That's the goal. (laughter)

A'HEARN: And I'm disappointed that there hasn't been more of that. A lot of the interest in the Deep Impact data is from people who were in one way or another associated with the mission. The only other one I know of the top of my head who has a DDAP grant is Keith Holsapple.

NIEBUR: It has been that limited?

A'HEARN: There are probably others that are working on the ground-based data to correlate, but they are working largely on their own ground-based data

NIEBUR: Which of course is a big part of the campaign I should have mentioned.

A'HEARN: It has surprised me that more people weren't prepared to go in and propose to do that, what is now PMDAP, to do these analyses. I thought there would be more.

NIEBUR: But you've been talking about it, as both a PI and a PDS node person. That really surprises me. I remember, when I ran DDAP, that most of the proposals we dealt with were from Co-Is whose funding had run out, frankly. That happened on Lunar Prospector, that happened on NEAR, on the early missions that were providing data then. I guess I just thought that as things matured and more of an effort was made by Headquarters to support the deposition of data in the PDS at the six-month mark, if not earlier, and the proper calibration, and all the tools … I thought people would come.

A'HEARN: I thought so too. I mean they are coming, but just not as many as I thought would come.

NIEBUR: Really.

A'HEARN: I attribute that in part to many people who would really rather get funding to keep on doing what they've been doing than do something new. To some extent you can see that because Keith Holsapple proposed, and he is doing more of what he's already done: cratering. It surprised me that there had not been more interest from other cratering people and more importantly from other comet people.

NIEBUR: I'm stunned too. Do you think it is because there is a wealth of data out there? Just all of a sudden everybody got mission data.

A'HEARN: It may just be that there is so much data out there that …

NIEBUR: Let's not say too much (laughter)

A'HEARN: So much.

NIEBUR: Right and all, and everything was in planning for so long and all of a sudden everything happened at once. There was a lot of data returned. I wonder what they've seen on the Stardust side. Do you know anything about that?

A'HEARN: Well see that runs to a different program primarily. It runs to the sample analysis program.

NIEBUR: Well that part of course. I mean they had some images, but not much, I suppose.

A'HEARN: To my knowledge the only one analyzing images like Stardust is my postdoc.

NIEBUR: Well. I've learned a lot.

A'HEARN: And that I think needs to be changed. I mean I have tried to preach that to people. That they really ought to be going into the PDS and analyzing small bodies data. There is a ton of it there now.

NIEBUR: And they don't propose to DDAP. DDAP struggles every year. It is not oversubscribed.

A'HEARN: It was significantly oversubscribed only in the year right after Deep Impact when the Co-I's alone were oversubscribed laughter)

NIEBUR: Which is what you would expect, I suppose. Great. Did I miss anything that you want to talk about?

A'HEARN: I can't think of anything else at the moment.

NIEBUR: Well I've got another two years left on my grant, although I hope to be done with this part of it significantly sooner. But, if you think of anything or if questions come up as far as accuracy, would you mind if I came back and asked you again?

A'HEARN: Fine.

NIEBUR: Wonderful. I've really enjoyed talking to you on the record. I always enjoy talking to you. It's kind of funny isn't it, but I'm just glad I get the chance to do this because there were unanswered questions for me. So, cool. Well thank you very much. Oh, last question is there anybody else for Deep Impact that you would recommend that I talk to particularly? I'm trying to talk to at least the PI and the PM. In this case I don't know who I'd choose for the PM but as far as the science team…?

A'HEARN: I would choose Rick.

NIEBUR: Would you choose Rick?

A'HEARN: Yes.

NIEBUR: He said very interesting things to ASK magazine and to some other publications. He seems to have a really good grasp of what happened.

A'HEARN: He does, he has a tremendous grasp of what went wrong and what went right.

NIEBUR: Excellent. Is there anybody else that might have a perspective or just have good stories?

A'HEARN: Mike Belton would have good stories.

NIEBUR: I bet he would. Well, thank you. Thank you for your time today.

A'HEARN: I need to go around the corner and get you a book.

NIEBUR: All right.

[End of transcript.]