A Skylark in Oz (SL-1306)
(a contribution to '50 years of Space Physics' at Leicester University, UK, 1960 - 2010)

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1 Introduction

I hope this description of a single Skylark campaign compliments Roger Cooper's (Coops) longer term view of Skylarks at Leicester ('Rocket Man'). Writing this now, nearly 35 years after the events described, seems in some ways rather bizarre in terms of Woomera security aspects. One can now just look at Google Maps and 'fly' down the range road and visit all sorts of formerly 'secret' locations. Younger ex-Leicester folk might be surprised at how dynamic the events of this 'primitive' time in the history of X-ray astronomy actually were. Present desk-bound satellite-data-analysis PhD students may marvel at the risk involved and the fleeting set of data obtained, for a lot of effort, even if things went well. The rocket era at Leicester is a very substantial part of the first third of the history of the Space Physics Group and I hope that this narrative gives some idea of what it was like to be a real 'rocket scientist'.

2 Early History

SL-1306 started its life before I joined the X-ray astronomy group at Leicester as a PhD student in October 1973. In the terminology used for Skylarks, it was the 6th (06) mission approved in 1973 (13 since 1960). Originally it was intended to study the X-ray source Circinus X-1 and planned to have a similar detecting area to previous 'large' area detectors developed at Leicester - somewhere around the 1500 cm^2 range.

The target was changed to Cygnus X-1, the early and famous stellar mass black hole candidate, after the dramatic announcement of the discovery of millisecond X-ray bursts from this source by the NASA/GSFC team of Rothschild et al. in 1973/74. Following my rookie period assisting with the UK5 satellite (before launch) and Skylark SL-1304, I took over responsibility for the SL-1306 development in late-1974. With a combination of input from various group members the performance of the planned design was greatly improved in both its detection area and its electronic data processing capability.

3 Development at Leicester

The detector area was increased to ~ 4000 cm^2 in two ways. Optimised mechanical design, with assistance from John Spragg, allowed the cross section of three, X-ray proportional counter, detector panels to be fitted within the relatively narrow Skylark diameter. Figure 1 shows a detector panel undergoing tests in the lab. at Leicester. An ingenious combination of hinges, springs, dampers, release and catch mechanisms designed by Dave Watson (Watto) allowed these three panels to deploy after the nose cone was jettisoned. The shocks, chain and sprockets were an unusual use for motor cycle parts. Figure 2 shows the panels in the stowed position and Figure 3 in a partially deployed state. Figures 4 & 5 show the fully deployed panels in the lab at Leicester just prior to shipment to Bristol. Watto did much of the basic design while out in Australia on the SL-1105 campaign in 1975 and sent drawings back to Leicester which a contract draftsman interpreted into real drawings for the workshop to build. A substantial amount of machining from solid aluminum billets was required and most of this was done by Harold Chapman in the Physics Department workshop. The final detector area was also increased by incorporating the novel idea of a 2-stage nose cone. I am not sure exactly where this concept originated from but BAC (British Aircraft Corporation, now BAE) were very enthusiastic. Basically, a standard 20" bay was sawn length ways in half, then strengthened and fitted out with a similar set of pistons and butting connectors as the regular nose cone. The bay split axis was orientated at 90 degrees to the nose cone split. As far as I am aware this system never presented any serious difficulties and performed well in tests and flawlessly during the actual flight.

A close-up of Watto's neat design is shown in Figure 6. The solid bar across the detector in Figure 2 marks the top of the 20" split bay which had pads to help restrain the long detector panels. A wire loop round all three detector panels also held them shut after the nose cone and split bay were jettisoned. This wire was cut by dual-redundant pyrotechnic squibs to initiate the actual deployment. This was driven by springs in two of the four black 'top-hats', two of which are visible in Figure 6. The other two were simple idlers to support the chain which kept the opening panels in synchronism. The two dampers cushioned the end of the deployment motion and an over-centre catch locked the panels in the open position. The panels were not deployed until after the ACU had acquired target lock since this action substantially increased the moment of inertia of the head in the roll axis.

With such a large detector area, the anticipated X-ray photon count rate was getting rather high and was likely to become extreme during any millisecond bursts when scaled up from the earlier GSFC results. Crucially, data was likely to be lost at the very moment that it was of most interest. The initial Circ X-1 proposal had envisaged limited data return but by now the Skylark 125 kbit PCM telemetry system was available. Almost all of the experiment electronics was designed by Coops and the main module is shown in Figure 7. A rather clever concept incorporating a FIFO (first in - first out) buffer memory with a variable 'data rate dependent' loading of the available PCM telemetry capacity was suggested by Chris Whitford. Chris's detailed design was incorporated into Coops overall electronic design. There were no microprocessors involved as they were only just becoming available back then and the whole FIFO card visible in Figure 8 only has 1536 bytes (all those chips). The telemetry and buffer handling performance (queuing simulations and modelling) were subsequently published in IEEE Aerospace and Electronic Engineering. Individual X-ray photons were timed to 2 microseconds accuracy. The circuit board layout was done by Dave Johnson and the wiring by John Dowson in the X-ray group electronics lab. Various items,

in particular the special ground test equipment, were constructed by Roy Daldorph.

4 Another target change

Both mechanical and electronic work proceeded smoothly and relatively rapidly with a target launch date around early November 1976. The sun pointing Skylark attitude control system (ACU) used gave two launch windows per year when the target was 90 degrees from the Sun on the sky plus or minus a few days. Then the SAS-3 satellite started finding Type I X-ray bursts from some X-ray sources and the so called 'rapid burster' (MXB 1730-335) was discovered and a paper submitted to ApJ Let. in March 1976. This seemed an exciting target option for our powerful experiment with a launch date around 15 September being required. It was determined that we could be ready in that time frame and approval for the target switch was submitted to London at the end of March. This concept was rapidly approved leading to a rather accelerated time frame for all the final integration and test activities at BAC in Bristol.

It transpired that the rapid burster spent periods of time when it was not in a bursting state and this presented a problem. The final plan was to be in Australia and ready to launch for the rapid burster window. SAS-3 would be monitoring the target to determine if it was in a bursting state, and if we passed through our window without a launch we would revert back to the Cyg X-1 target window $\sim$ 6 weeks later. The monitoring and communication by the SAS-3 team was headed by Jeff Hoffman (ex-Leicester, by then back at MIT) who I had worked with earlier on SL-1304 in Spain.

5 Off to OZ

With all tests complete it was only necessary to deliver any remaining items to Bristol for packing and shipment to Australia. I had noticed that during our expected time in Oz there happened to be a total eclipse of the Sun on 23 October. What a lucky break ! So various items of dual-use alignment equipment, the sort of items that just might be of use in observing and photographing a solar eclipse, joined our pile of stuff in Bristol to be sent out to Australia. During my last visit to Bristol I managed to get a tour of the Concorde assembly area. Although, due to security reasons, I could not actually get on the shop floor itself I was able to see quite a lot and also sit in the full size mockup.

Although the 'yellow banana' (Monarch Airlines Britannia) aircraft was still used to send freight out to Australia, the experimenters had started travelling on regular commercial flights a year or two earlier. So it was a Qantas 747 from Heathrow for Watto and I - rather boring in comparison to some of the earlier trips that Watto, Coops and the others had experienced. I see from my records that the air ticket cost 620 pounds. We eventually arrived in Adelaide, having left London on 28 July. Since my sister and some cousins were living in Adelaide that was rather nice. So Watto went off to the the famous Mrs. Heal's (spelling ?) lodgings where I gather she looked after 'her boys' (experimenters and BAC staff out from the UK) with typical Aussie style. I went to stay with my sister for the weekend and Watto and I then flew up to Woomera on the Monday morning.

6 Woomera activities

Woomera was a 'closed town' back then and one needed a pass even to be in the village. So the first task, on arriving at the airport, was to be escorted to the Federal Police station for a mug shot, finger prints and pass issue. This pass allowed one to get through the check points on the range road plus Range E and Test Shop 1 (TS1) where the integration work on Skylarks was carried out. Although the Skylark program was a civilian operation it had been necessary to get prior security clearance in the UK before setting off. A montage of my set of passes is shown in Figure 9

We also picked up a government 'Z' car from the pool after they checked our drivers licenses. Oz government cars had, and still have, a red Z at the start of the number plate. Watto had arranged for us to stay in some flats for this trip rather than the usual ELDO Mess (European Launcher Development Organization, mess as in military jargon). These flats had only become available due to the continuing run-down and contraction of the range activities which meant that the population of Woomera was decreasing fast. So we went to, I think it was the officers mess, and were issued with a raft of domestic stuff - pots, cutlery, blankets etc. It was all listed and signed for and of course we had to formally sign it all back in again before we could leave at the end of the trip. We did some cooking ourselves in our adjoining flats but not much. Full lunch time meals were available on the range at Koolymilka (see Coops - Rocket Man) and there were also evening options at the ELDO mess plus jugs of cold beer ! Actually I just remembered that, with the run down in activities, Koolymilka was closed at weekends and we used to apply for sandwich and fruit lunch packs instead.

The run down in Woomera's population was countered through these years by increasing numbers of Americans who were supporting a US military tracking base (Narrungar, Joint Defense Facility) at nearby Island Lagoon. This was graphically brought home during our Woomera sojourn by the removal of the snooker table from the main bar area at the ELDO mess to a side room. It was replaced by two pool tables. Island Lagoon closed a long time ago, and Woomera itself is a normal open 'tourist' town these days though the huge prohibited area is still in place and used for various military purposes.

SL-1306 arrived on the range on 5 August a few days after we did. It travelled up from Adelaide by truck which was a vibration test of sorts (see later comment on Port road). We then settled into the usual routine, working quite a few evenings and weekends. The range road from the village into the prohibited area to the range head was a sealed but narrow road. On this $\sim$ 50 km trip our Z car (a Chrysler Valiant made in Adelaide, see Figures 10 & 11) could just manage to reach 100 mph if there was no head wind. Normally one drove much slower than that especially at night due to the risk of large roos sitting on the road. There were also of course the Feds at the start and end of the range road logging and clearing all through traffic. I believe earlier Leicester 'artists' had added embellishments to their vehicles to have a 'go faster' appearance but I cannot say who.

We did all our experiment preparations in a small air-conditioned mobile hut (Siegal Van) that was positioned just outside TS1. Imagine my surprise 10 years later when, in Oct - Nov 1986, I worked in the same hut controlling a high-altitude balloon payload. The continuing range run-down had resulted in this hut being 'salvaged' and trucked up to the balloon launching facility on the edge of the main airport at Alice Springs.

7 Woomera diversions

Most Skylark BAC(A) (Australian arm of BAC) staff lived in Adelaide (Salisbury) and commuted up for the week on a charter aircraft. This was an Ansett Airlines F27 (Fokker Friendship) and the trip could be quite bumpy as the twin engine piston aircraft did not fly very high. It did however have huge windows which gave great views. If there were seats available (always seemed to be) we could go to Adelaide for the weekend and get the charter back on the Monday morning. Alternatively one could drive down to Adelaide, 470 km away, in the Z car. This was a bit more adventurous than it sounds as the first 170 km south to Port Augusta was a dirt road known as the 'Port road' - see Figures 10 & 11. Miles and miles of almost flat nothing and impassable after heavy rain. I travelled the Port road three times. Once to Adelaide for the weekend and once to the Flinders Ranges, sleeping overnight in an estate version Z car. The third trip was a lot more interesting.

Watto and I drove down to Adelaide on a Friday afternoon and stayed overnight with my sister. Next morning we drove another 300 miles south to near Mt Gambier to get on the centre line for the total solar eclipse. How convenient to have it on a Saturday afternoon. Not so convenient were the clouds. We were snookered in all directions and ended up with a last minute dash on the coastal sand dunes near Millicent (see Figure 12). We saw totality through cloud but it was not a complete wipe out. It inspired me to go to Papua New Guinea in 1983 and, amazingly, near Woomera in 2002 where I saw unobscured total eclipses (there is another total eclipse across north Queensland in 2012). On the Sunday it was a 600 mile drive back to Woomera.

Other excursions might involve a short road trip down range for a barbeque. I remember one location, near an ionospheric sounder station (at Red Lake I think), where there were a lot of attractive, naturally sculptured, sandstone features. While some struggled to lift pieces into a car for return to Adelaide gardens I had to be content with a more modest sample. It came back with all the experiment gear and was in my house at Countesthorpe, just south of Leicester, for several years. When I emigrated to Oz in early 1981 it seemed silly to bring it back and I believe it might still be found in Richard Jameson's greenhouse.

8 Launch activities

Eventually all the preparations and tests were complete. One of the most interesting tests was the nose cone jettison test. Due to the novel 2-stage nose cone, the whole sequence was filmed which might still exist somewhere at BAE. It was quite a dramatic moment and a lot of preparation was required to get everyone ready with ropes attached to the four pieces so folks could stop them falling on the TS1 floor or swinging back into the round.

Although we never had a personal camera at TS1 our experiment contained a 35 mm Robot film camera to take a series of star field photographs during the flight to check the ACU pointing. The precise alignment of this camera to the X-ray collimator axis was determined at night. The head was mounted vertically on an air bearing and viewed a distant car headlight through the open doors of TS1. Figure 13 shows one of the frames from this exercise. Watto is not in this view as he operated the camera shutter on its B setting while illuminating the onlookers with a moving torch. The camera was mounted in our power supply bay and the round lens cone is visible in Figure 14 which shows the complete head (experiment plus ACU etc.) standing in TS1. The total weight of the head was 336 kg.

The head was loaded onto the motor in the launch tower on 13 September and a trial countdown, known as a GIMIC, conducted the next day. That day (14 September) and the next four days the message came through from Jeff that the burster was off. I think we used to get a daily TELEX (long before email) but I can't remember the details.

So back to plan B and a return to Cyg X-1.....

9 Getting lost.....

It took a few days to mothball everything and then Watto returned to Blighty for several weeks of urgent design work (can't remember on what). I, on the other hand, being a mere student, was told to get lost for three weeks. These may not have been his exact words, but I have to pause here and thank Alan Wells for this decision which changed my life far more than SL-1306 did. I got an AussiePass (Greyhound bus type pass) and went right round eastern Australia - Coonabarabran (AAT visit - Andy Longmore, a longtime ROE staffer, was with the UK Schmidt unit and was ex-Leicester) , Canberra, Sydney, Brisbane, Cairns - Great Barrier Reef, Alice Springs - Ayres Rock). Boy, did I have a great time and I celebrated my 25th birthday in Canberra.

It's not appropriate to go into details here. Suffice to say that although I was at Leicester for another $\sim$ 4 years, mostly doing ground-based IR astronomy, I have been an Australian citizen for >26 years.

10 Back on the range

Watto and I were both back on the range on 18 October and the whole round and experiment were checked out again. It was about this time when I gave a set of short lectures to several groups of mid-ranking military officers. A big group from the Australian air force, army and navy had flown in to do a tour of the Woomera facilities. This was part of a national assessment of what was going on and what use might be made of the facilities in the future. Several of them seemed quite interested in black holes and perhaps they found our little civilian experiment a bit unusual and more interesting than all the military and classified stuff that formed the bulk of range operations. Another GIMIC was performed on 1 November which had a strange interruption. In Australia, the biggest horse race of the year is known as the Melbourne Cup and 'the race that stops a nation' is a much bigger deal than the Grand National in the UK. Anyway, Watto had told me about this and sure enough when the race started at about 3 PM in the afternoon the GIMIC was suspended and the race commentary was piped live round the range intercom network.

Once again we had information on the state of the target source though this time it was not a critical factor in a launch decision. In any case the information was several days in arrears. The data was provided in a TELEX from Steve Holt at NASA / GSFC and was a summary of the recent source intensity as seen by the ASM experiment on the Ariel 5 satellite.

On 2 November, our first launch attempt was scrubbed due to high winds and cloud. Skylark was designed to have a modest acceleration (<12 g), to limit payload stress, and this made it susceptible to cross winds while still travelling slowly. The canted fins only work once it had really got moving (the three Imp spin motors also help stability - see Figure 15). The aiming stability is important on a ballistic (unguided) vehicle to ensure

that the experiment follows an optimum trajectory, during its parabolic coast, and also minimises the impact dispersion which aids in ground recovery.

As the ACU was a sun pointing system we had made several precision offset wedges in the 0 - 3 degree range. These small angles did not present a problem in terms of any cross-coupling of the control axes. The wedges were to be placed under the sun sensor, at the top of the central detector panel, in appropriate order and orientation, as we progressed through the set of launch window days. But swapping the wedges meant ascending the launch tower and removing the nose cone. We had got advance permission to do this and in order to assist Watto, I had attended an explosives safety handling course in the UK. Without the course certificate one could not go up, or near, the launch tower with a semi-live round in place (see passes in Figure 9). By this stage the igniter assemblies were installed in the Raven motor and Goldfinch booster but not the arming / fusing circuits. Astute readers may by now have noticed the author's gradual descent into the militaristic jargon of ordnance and munitions but that was the nature of the beast. BAC(A) of course handled the actual nose cone removal and we did the wedges. The following day was also scrubbed for the same weather related reasons.

The next day, 4 November (shame it was not the 5th !) we finally launched at 18:15 local time into a sky that was still very cloudy (see Figure 15). During these critical few minutes of a trial the range head goes 'radio-quiet' and all traffic stops to absolutely minimise any possible RF interference. These brief moments have an air of dreamlike unreality about them. A weird kind of excitement - once experienced, never forgotten. In fact a bit like experiencing a total solar eclipse.

During the final countdown Watto and I were in the underground bunker at the side of the launch area. This blockhouse had a door, facing away from the actual launch location, which was left slightly ajar. The round leaves the launch tower rather quickly, like a firework rocket, so at the instant of zero it's clear that ignition has occurred and the potential 'bomb' has left the immediate area. Then it's a quick rush for the door and a rapid turn round to see the Goldfinch burn-out (burn duration only six seconds) and the following Raven ignition. Then it's straight back into the blockhouse to monitor the unfolding events for the next few minutes.

There was a big red button on the wall in the blockhouse control room that anyone could press to halt the countdown. You would have needed to be a brave person and very sure of yourself to press that button.

11 Actual flight

The sequence of events during a Skylark flight was controlled by a program timer unit. This electro-mechanical device had precision cut cam discs that closed contact switches at the appropriate times. The actual event sequence for SL-1306 is given in Table 1. Note that the Raven motor only burns for about 35 seconds so most of the flight time is a parabolic coast. I took these times from my copy of the BAC(A) Post Firing Report dated 30 November 1976. The typical duration of usable on-source data is only about 4 minutes.

Because the Woomera range operated in such a serious security environment there were very strict rules - no cameras, telescopes, etc. or any recording devices. However, on our flight we used an FM instrumentation recorder to log the flight PCM data so that we could replay it into the ground check-out electronics a few times to more fully assess the quality of

Table 1: SL-1306 Fkight event sequence.

TIME		EVENTS	EVENTS
Min	Sec	Skylark System	Experiment Action
0	0	Goldfinch ignition	
0	6	Raven ignition	
0	57		Detector EHT's on
1	14	Despin	
1	16	Nose cone jettison	
1	18	20* bay jettison	
1	20	Head/motor separation	
1	21		Calibration source on
1	22	ACU gas on	
1	38	ACU roll acquired	
1	41		Detector deploy
1	44		X-rays from Cyg X-1
1	48	Roll acquire recovery	
1	55		Cal. off
3	46	Apogee (191 km alt.)	
5	58		Cal. on
6	8	Pneumatic bay separation	
6	18		Cal. off
9	15	Parachute deploy	
8	15	Motor impact	
11	15	Head and chute impact	
		($\sim$ 130 km down range)	

Table 2: SL-1306 real-time audio recording - comments list.

TIME			COMMENTS
Min.	Sec.	Person	Transcript
		Range	Time call at intervals plus
			1 second beeps
-1	-12	Watto	'SL-1306 test recording'
	-10	Range	Single long beep
	-5	Range	Five short beeps down to launch
	0		Distant noise of launch roar
	+58	Watto	'EHT on'
1	13	Bazza	'HT on'
2	32	Bazza	'Terribly low rate'
4	11	Bazza	'sig back on'
11	10	Watto	'That's your lot Barry'

the science data. This recorder had an audio channel and Watto arranged for the microphone to pick up the range intercom so that the tape would contain a useful time marker signal. Back at Leicester, some time in 1977, I copied this to a Phillips audio cassette, which I have kept ever since. I have now copied this to a DVD which has been read into a PC where a filtering program has been used to clean up some of the background noise. You can listen to it now (see button on web page). It runs for about 12 minutes. Don't forget that this was never meant to be a 'quality' memento or carry important verbal comments but it does capture the moment. There are not many clear comments, beyond clock ticks and the regular time-calling, of the range officer, but I list them in Table 2. Marvel at how brief the whole thing was ! As mentioned previously, all the deployment aspects worked well and we also had three good detectors. Unfortunately, after initially locking onto the target the ACU system failed to hold the experiment on target for the whole flight and a rather shortened data set was obtained.

12 Round recovery

The launch was rather late in the day so recovery operations occurred the next morning. I was the experimenter representative for this, as Watto had done it many times before, so I went out to the Woomera township airfield not long after sunrise on the following day. There we had a short preflight briefing and then it was off down range at 2000 ft in an Alouette helicopter. This was exciting. There were three of us in the chopper - the pilot, an experienced range recovery officer and me. A ground crew truck had gone out overnight to the vicinity of the estimated impact site but had not located the payload by the time we arrived some 130 km down range. The pilot then commenced a low-level zigzag search pattern. My brain thought this was great but my stomach was not so keen. After a while we had to land to refuel. The aviation fuel was transferred to the machine from several 44 gallon drums on the truck using a rotary hand pump.

Spotting the remains from the air is not easy, apart perhaps from the parachute if it is well laid out. Some of the recovery photos are shown in Figures 16 - 19. These were taken by the recovery officer and are unclassified (it says so on the card). Eventually we found the Raven (see helicopter just under Raven fin in Figure 17). When we found the head the two outer panels had been torn off by aerodynamic forces during re-entry (see Figures 18 & 19). The Raven and head were separated by several kilometers, mainly due to parachute drift. Flight wreckage was customarily tidied up but both outer detectors had to be recovered as they contained small radioactive calibration sources. One panel was found fairly quickly but the other one took quite a bit of searching and was only found after we had left. The experiment part of the head was detached and was just within the size and weight limit to travel back to Woomera on the back seat of the chopper. The main prize on recovery trips was to get the small screw-on nose cone tip, usually spirited away, and I never even saw the cone split halves. Later, the experiment was carefully packaged up and eventually returned to Leicester.

The only copy of the recovery pictures I ever had was a high quality B/W contact print of 9 shots in a 2.25 sq. inch format. It is interesting to contemplate that, in scanning this single print at high resolution to create Figures 16 - 19, we generated much more digital data than the actual SL-1306 flight recording !

13 Post launch

Watto and I attended a post firing briefing in TS1 on 10 November. There was some preliminary discussion on the ACU failure to stay on target for the whole flight and it was stated that this was the first failure of this type of sun pointing ACU for 33 flights. It only remained to pack up and leave but we had one final treat just before doing so. During our second period of time at Woomera a Canadian team had arrived with another X-ray astronomy payload. This was primarily a University of Saskatoon team and they had previously sent over a Canadian Black Brandt rocket. This is a similar sized rocket system to Skylark (also similar to the US Aerobee). The Black Brandt diameter was so similar to that of Skylark that the BAC(A) engineers only had to fix new shoes to enable it to run up the rails inside the launch tower. We managed to see a spectacular night launch just before we finally left for Adelaide.

On returning to the UK, I was half way through a three month extension to my standard three year SRC PhD grant. I spent three months unemployed before starting as a research associate in the IR Astronomy group which, back then, was part of the separate Astronomy Department. I must pause here to thank Dave Adams (alas like Watto no longer with us) for allowing me some time to finish 'writing up' and I submitted my PhD on the SL-1306 work in March 1978.

This was the last of Watto's many Skylark trips to Australia and he never returned to Oz. I on the other hand, went on to have a long and on-going relationship with Australia.

14 Big Picture Perspectives

There are a number of additional relevant comments I can make about the whole SL-1306 experience and I list these below.

A proposal to refly the SL-1306 payload on a Skylark was made in early 1976 but not approved. This was probably a premature idea as the experiment had not yet flown and might have been destroyed during the flight if the parachute system failed.

A detector array of several square meters area, derived from SL-1306 technology, was briefly considered to fly on a very large Aries sounding rocket (converted ICBM - second stage of Minuteman I). A German group (MPE) were considering the use of such opportunities and a detector demonstration was made to Prof. J. Trümper in mid-1976 just before the dispatch of the experiment to Australia. My recollection is that he was quite impressed with the experiment but they decided to concentrate on mirror-based detector systems and I don't think the Aries concept went anywhere in the end.

A proposal to fly a payload derived from SL-1306 on a space shuttle orbital test flight was produced in June 1976 but also went nowhere. In retrospect, this seems an incredibly naïve idea but back then it was not clear exactly what was involved in getting on a shuttle ! The idea was to deploy a modified Skylark head / experiment from the cargo bay for perhaps a 30 minute data set with no recovery.

Later, following the actual flight, another proposal to refly the SL-1306 payload on a Skylark was made with a launch date in March 1979 but was not approved. The UK was winding up its sounding rocket program by this time and any additional flights became expensive due to the very high fixed costs per round.

The detectors have been on display in the City of Liverpool Museum for many years.

The electronics bay is part of the Skylark standing in the Physics department since the late 1970's. The main electronics package was in storage for many years in the department. I last saw it during a visit to the UK in 1996. It was stored in a box under the Charles Wilson Building and Watto was 'saving it' for use as a possible future display item (state of the art mid-70's electronics).

After I emigrated to Australia, I travelled past Woomera several times in the 1980's while on the way to Alice Springs for high energy X-ray astronomy balloon launches. I actually visited Woomera in 1992, staying overnight in the tourist ELDO hotel and driving down the range road to Range E (I got permission). I visited again in 2002 while on a total solar eclipse trip. I now see on Google that the flats where Watto and I stayed have been demolished.

What of the existence or reality of millisecond bursts from Cyg X-1 ? Some readers will know that I had a four year (1993-1996) period living in the USA and working on the Rossi X-Ray Timing Explorer (RXTE). I was one of the the six scientists working on the PCA experiment at NASA/GSFC. This satellite (launched in late 1995) was arguably the only experiment to have exceeded the timing performance of SL-1306 which was flown some 20 years earlier. RXTE is still operating, though with reduced detecting area, but has of course been working for rather longer than just four minutes. In a sense this was sort of unfinished business for me though that was not my main motivation at the time for moving to the USA. Does Cyg X-1 have millisecond bursts ? That's rather outside the scope of this particular narrative - another continent. another decade, another story.

15 Acknowledgements

I should like to thank several colleagues at the University of Tasmania for assistance. Jan Lieser, Rob Massom and James Culverhouse helped resurrect old photographic prints and slides. Kym Hill seemed to enjoy himself cleaning up the old audio recording. All the photographs were taken by the author except where credited to BAC.

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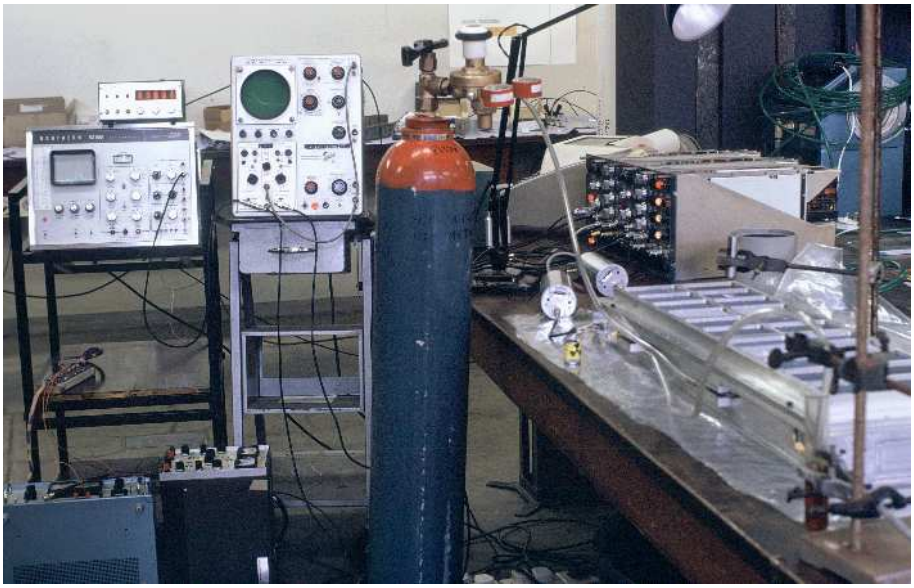

Figure 1: Testing a detector panel on the bench in Leicester.

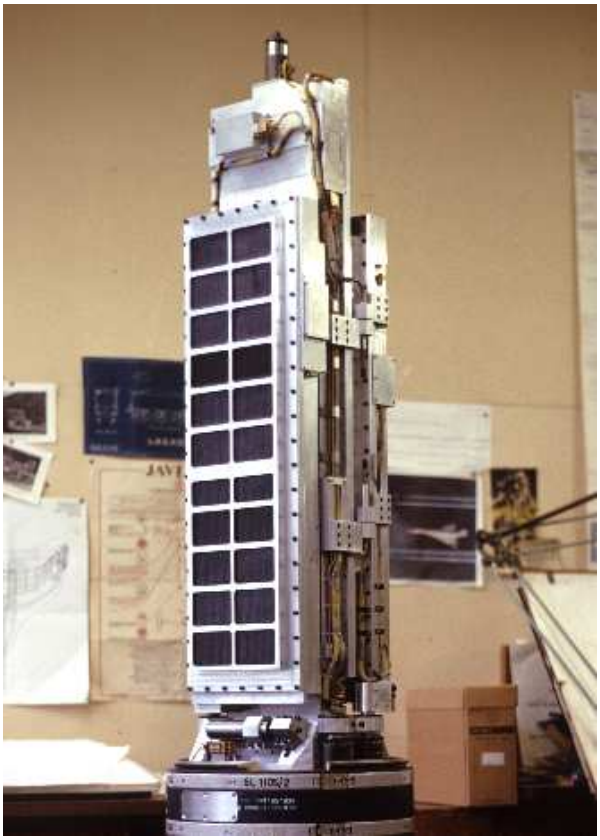

Figure 2: Experiment - stowed panels.

Figure 3: Experiment - partially deployed panels.

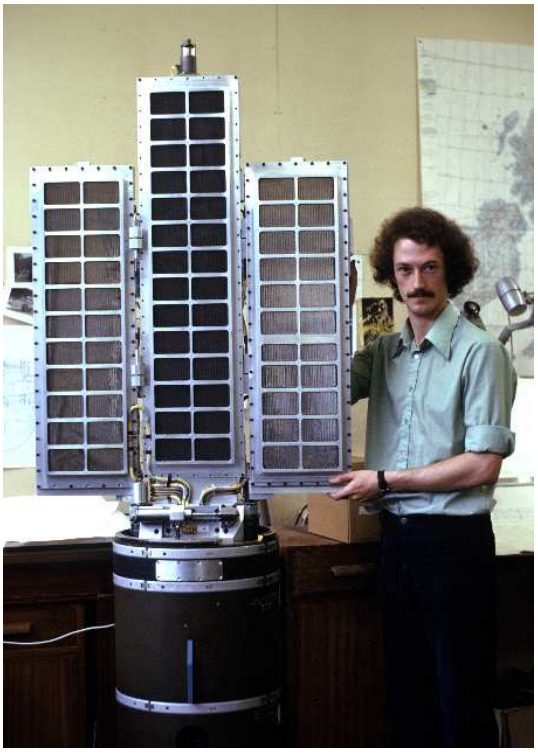

Figure 4: The author plus SL-1306 at Leicester.

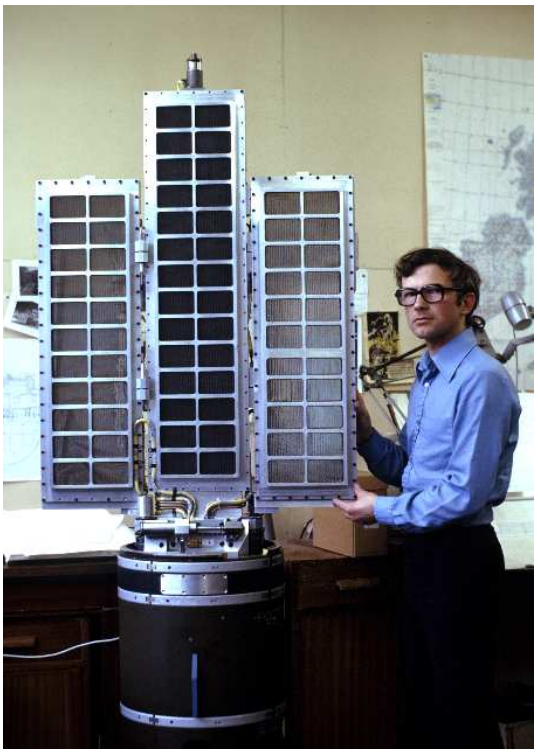

Figure 5: SL-1306 and Watto at Leicester.

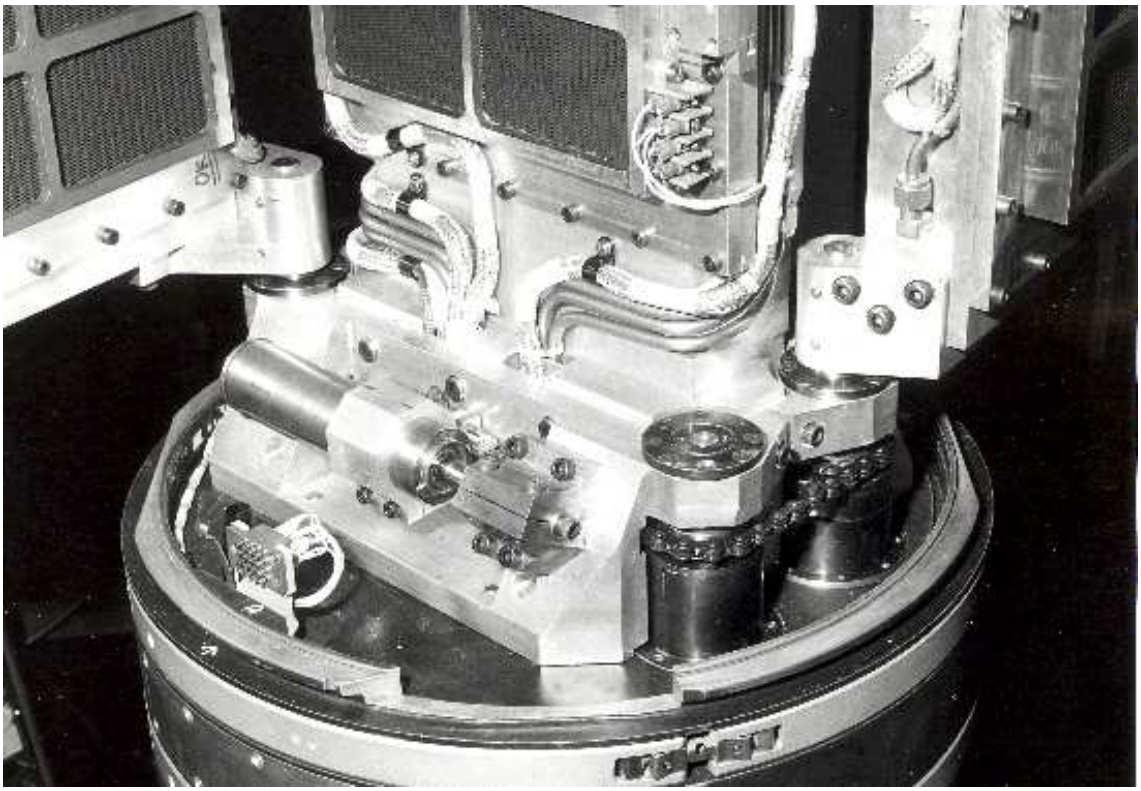

Figure 6: A close up of Watto's neat deployment mechanism (BAC photo).

Figure 7: The main electronics assembly consisting of 8 vertical cards.

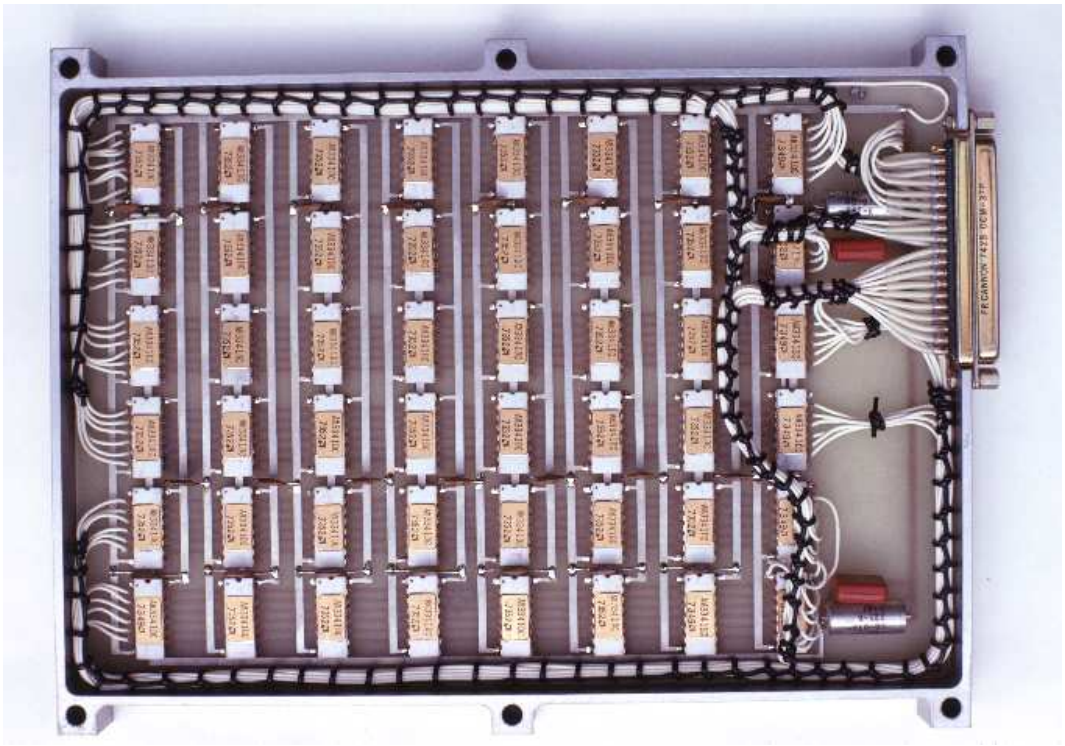

Figure 8: The FIFO card - a 1536 byte memory. 48 Fairchild chips (each 64 x 4 bit). This card is positioned at the right hand 'green spot' connector in Figure 7.

Figure 9: Woomera documentation. Clockwise from top left - Woomera Commonwealth Bank book, Hatfied UK explosive course certificate, Launch tower pass, Rnage E pass, Commonwealth car licence.

Figure 10: A typical stretch of the Port Road.

Figure 11: The Valiant Z car looking north out of Port Augusta. Just on the sealed road with distances in km.

Figure 12: Watto and I running across sand dunes near Millicent, South Australia. Taken by my sister just before the total eclipse of the Sun on 23 October 1976. Note lack of shadows - it was rather cloudy.

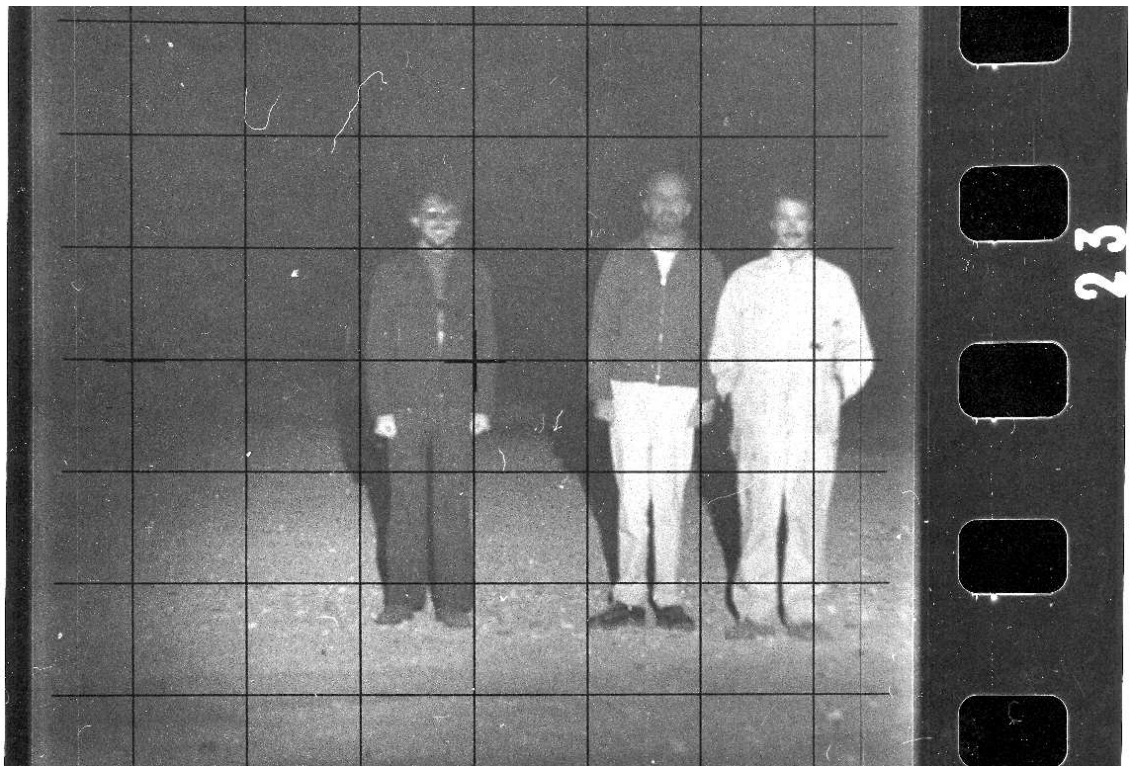

Figure 13: Part of a frame from the star field camera test. From left - two BAC engineers working on another Skylark, Alan ? and Jock, the author on right in boiler suit.

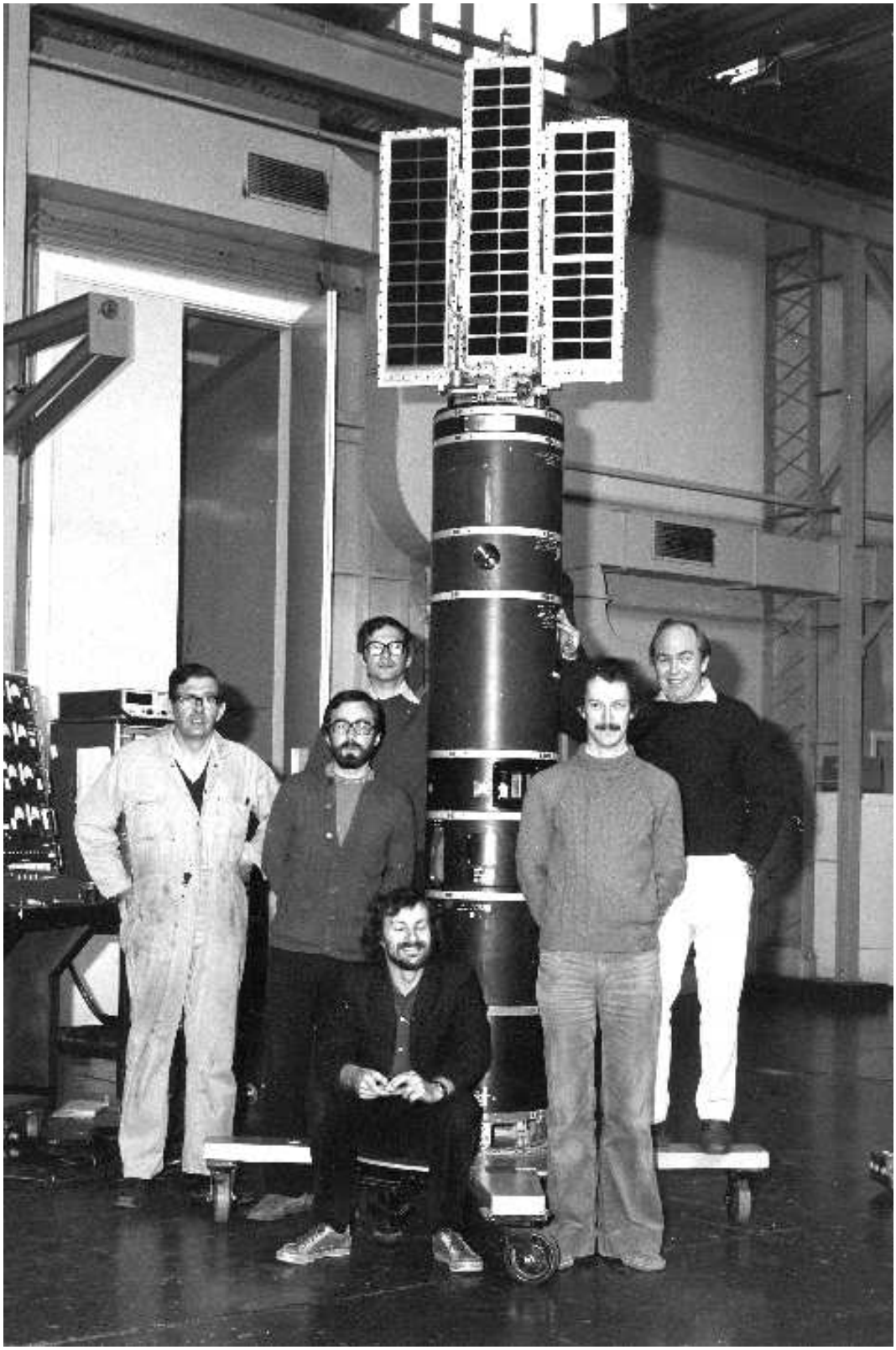

Figure 14: SL-1306 head in TS1. From left - Dave Gallery BAC(A), M. Cross BAC, Watto at back, Mike Tayler BAC(A), the author, Tony Emmett BAC. The experiment starts at the manacle ring just above Tony Emmett's right hand (BAC photo).

Figure 15: The launch of SL-1306 on 4 November 1976 (BAC photo).

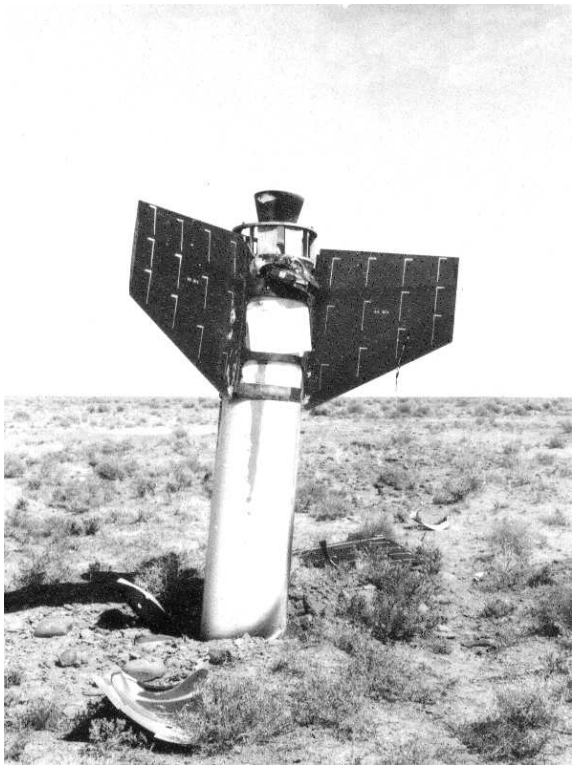

Figure 16: Raven impact with third fin on ground (all recovery shots are BAC photos).

Figure 17: Raven with Alouette recovery helicopter under right fin.

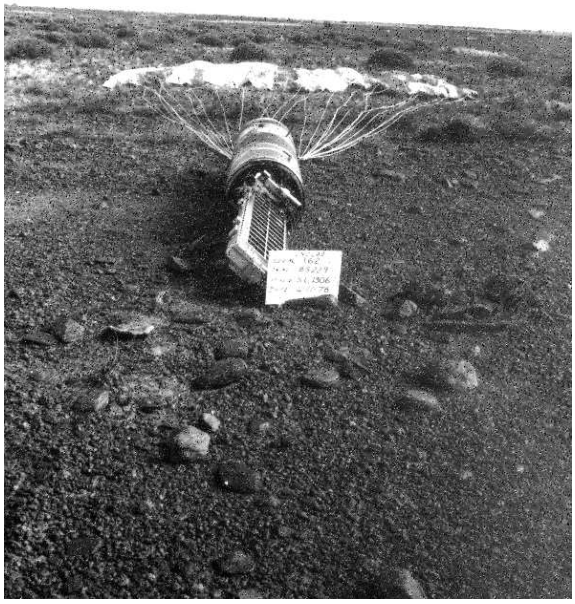

Figure 18: Experiment - missing both outer pannels.

Figure 19: Experiment with author in background.