The Origins of Synchrotron Radiation research at Daresbury Laboratory

by Ian Munro

The speed with which the Daresbury SRF, a new, essentially unfunded and untested, working laboratory was set up in the late 1960s and early 70s was remarkable. Manchester Physics Department in the 1960s followed largely in the traditions of Bragg, Rutherford and Blackett in terms of elementary particles (nuclear physics)and although the successes of Jodrell Bank and radio astronomy generated at least some activity in new areas such as low temperature and Optical Physics the Department management remained somewhat fixed in the past. Optical physics, primarily concerned with the interaction of light with matter would lead to a massive change in the priorities and direction of physics research during the succeeding thirty years, moving from the realm of the nucleus to the physics of macromolecules and now even to 'wet' biology and graphene!

In the early 1960s Birk's group at Manchester was already attempting to correlate some spectroscopic or photophysical property with the carcinogenicity index, that is the probability and potency for any chemical to generate skin cancers (on mice). The materials under investigation were a variety of aromatic hydrocarbons including benzene and a range of multi-ring compounds including naphthalene and benzopyrene among many others. This research was initially supported by the British Empire Cancer Campaign for Research for which I became a postdoctoral Research Associate, following my tenure as Lecture Demonstrator in Physics, which position existed mainly to provide slides and other material for Brian Flowers (Langworthy Professor at Manchester, and later to be Lord Flowers). I subsequently became Assistant Lecturer and then Lecturer with John Birks in his Atomic and Molecular Physics Group as well as dealing with a number of administrative roles as Departmental Tutor in Physics

(admissions, courses for Medical students, Chair of Experimental programme committee, Diploma in Advanced studies work etc) Most of the aromatic hydrocarbon compounds exhibit fluorescence in the visible and ultra violet and have short (nsec) lifetimes which could be stimulated with ultraviolet light and also by x-rays. Many of them were subsequently shown to form 'excited dimers' or excimers in which regard the Manchester group were pioneers in terms of their dynamics for their creation and excited state behaviour, which in turn would eventually lead to the creation and understanding of tuneable UV and VUV lasers.

The only feasible laboratory sources to achieve their excitation and probe their excited states then available were a Hg 2537Å discharge lamp or a new shorter wavelength (near VUV) source developed by Garton and Wheaton in Imperial College and used to study the spectra of atoms and small molecules in the context of astronomy. This source comprised a hydrogen discharge through a 1mm platinised capillary in quartz and was difficult to set up and use. At that time I was working in Manchester with Andreas Kanaris who returned from a trip to the DESY synchrotron in Hamburg where he met Haensel attempting to use a new kind of VUV radiation called 'synchrotron radiation'. Kanaris soon left Manchester to work in the USA to set up a travel company called Delta Travel exploited by his friends from Cyprus and Greece. The first comprehensive and complete description of the subject was contained in a 1945 paper on synchrotron radiation by Nobel Prize winner Julian Swinger in the USA.

Fortunately and coincidentally, at this time the UK Government had agreed to establish two major research laboratories, one in the North (based around an electron synchrotron called NINA) and a second in the South of England (based around a proton synchrotron, NIMROD) to be built at Harwell, at the Rutherford Laboratory), both accelerators to be used for studies of particle (high energy) physics. The Northern site called Daresbury Laboratory was named after the adjacent small village lying over a substantial bed of Triassic sandstone and offering excellent structural stability for any accelerator. Daresbury is also the village where the Rev Charles Dodgson (aka Lewis Carroll) created many of the characters in his book 'Alice in Wonderland'. The choice might, of course, just have also been influenced by the fact that it lay in the Huyton Parliamentary Constituency of the then Prime Minister, Harold Wilson. Wilson's Parliamentary Constituency Manager Michael Moore, a technician engineer at Liverpool University Physics Dept would become Head of Engineering at Daresbury and join in the construction and operation of the new 5 Gev electron synchrotron to be given the name NINA (supposedly, Northern Institutes Nuclear Accelerator), to be built on the site. The attractive location, bisected by the Bridgewater Canal and near to the Manchester Ship Canal is close to Liverpool and Manchester Universities and conveniently accessible to Lancaster, Leeds, Sheffield and even Glasgow Universities.

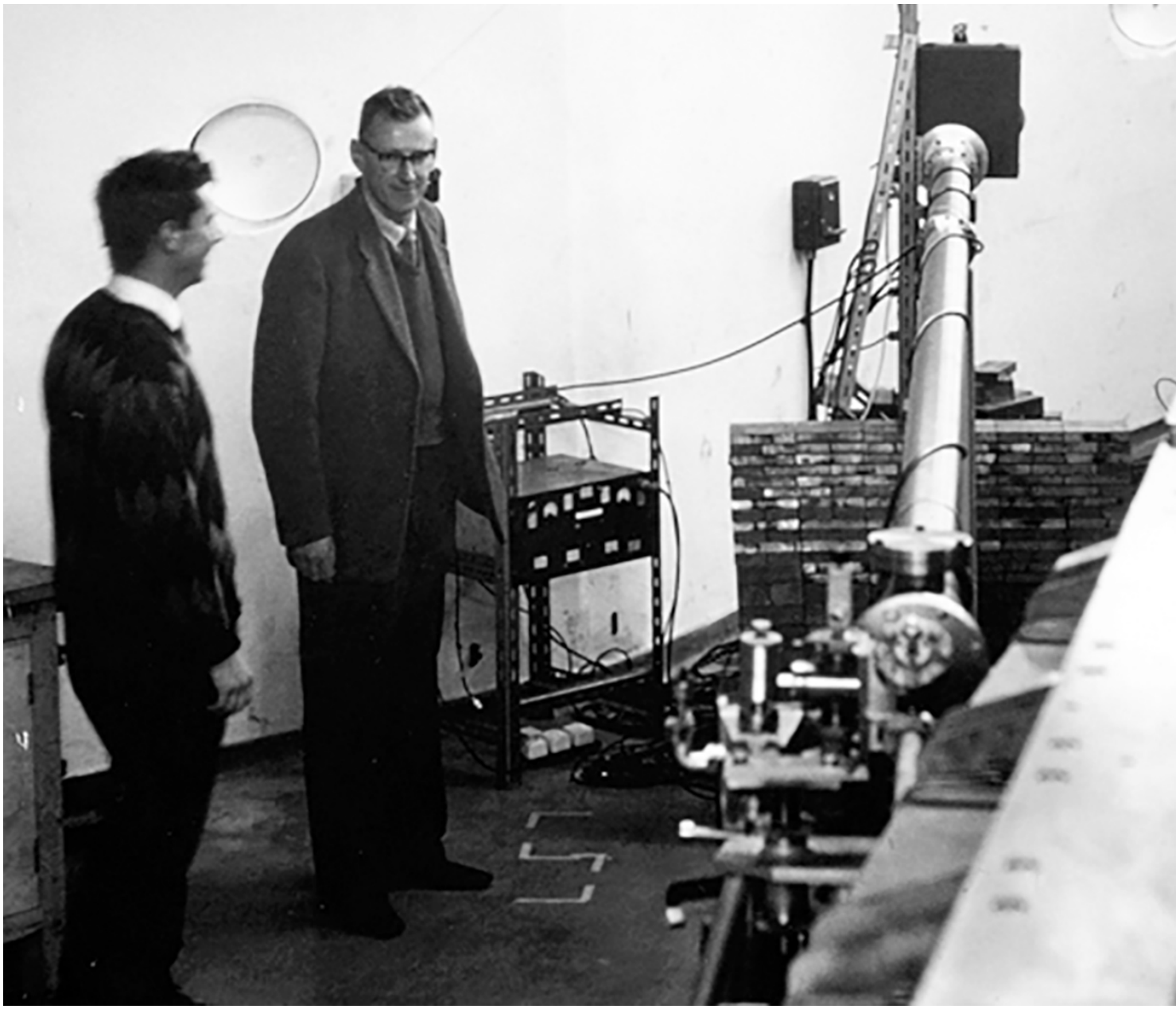
The project grew rapidly - despite breaking through the canal banks on one occasion during construction - and subsequently NINA and Daresbury Laboratory were formally opened by

Harold Wilson in 1964 in that halcyon era when Science was recognised to be a ‘’white hot’ topic by Lord Bowden, the Vice Chancellor of UMIST. The Director appointed to oversee this new project was Alec Merrison (later, Sir Alec who become VC of Bristol University and a science adviser on box girder bridges to the Thatcher Government). At this crucial time and before Daresbury Lab had become fully operational (in early Spring1966) I wrote a letter from Manchester hoping to arrange an early tour of the new Laboratory for members of the Manchester branch of the Institute of Physics. This single letter would ultimately lead to a massive change in the nature and conduct of physical research within UK science departments, to the creation of almost ten thousand science publications, to the expenditure of several hundred million pounds of public money (essentially from the Research Councils) to the direct award of at least one Nobel Prize and importantly, to a totally new research centre where academic physicists, chemists and bioscientists could work freely together and engage also with world class computing facilities and computational scientists.

The crucial Letter and the subsequent reply read: "It sounds to me as though such emission (synchrotron radiation) might provide an ideal source of excitation for our experiments, although I have at present little idea of the experimental problems in extracting such emitted radiation from a large accelerator." The reply from Alec Merrison to me simply stated "My attitude to such work at Daresbury is that if there is good physics in it then I would be very enthusiastic." The members of the Manchester branch of the Institute of Physics duly enjoyed their visit and the Director's enthusiasm for the new science potential was particularly welcome, so I lost no time in pushing the project onward. The response and encouragement of the Director also included my access to Daresbury engineering staff just sufficient to help realise the feasibility and likely cost of the project. All this even before the NINA accelerator had been fully launched on its particle physics primary programme funded by the Nuclear Physics Board!

Any resources needed for synchrotron radiation studies would however have to be sought separately from the Physics Committee of the Science Board. All was not ‘sweetness and light ‘ in those early days between some senior staff at Daresbury and the University. An argument at the very first meeting between Birks and myself and the Daresbury Directors (Merrison, Voss, Moore, Zacharov, Eggington and Rothwell were present) was about the relative ease of access to money from the Nuclear Physics vs. the Science Board. The acrimonious discussion at that meeting led to the total separation of Birks from the synchrotron radiation programme, who would thereafter concentrate at Manchester on electron, rather than photo-excitation of organic materials, a programme which was to be led very successfully by Frank Read. Therefore Scott Hamilton (a Senior Lecturer and friend of Birks from his South African days) and I were left by ourselves to manage the new Daresbury programme. Birks never once visited the SRF although he did attend the first SR Users meeting; he sat on the back row! Initially we (myself and Scott Hamilton) were fortunate to have already' inherited' Hans Seifert in Manchester, an outstanding PDRA, as well, later, as a number of talented Manchester PhD students in Physics (Hasnain, Pantos, Tissier, Smith, Taleb among others). The construction, operation and exploitation of the initial trial experiment using NINA to demonstrate its feasibility was an

immediate priority and was very difficult because apparatus adjacent to NINA in the NINA tunnel was bathed in high energy radiation and thus access to it was only possible when NINA was switched off. Therefore we were forced to attempt remote operation of all equipment (NINA lay in a 200m annular concrete tunnel which is in turn totally buried in the earth). The photograph below shows the equipment of this early experiment in the NINA ring tunnel, with myself on the left of the picture and Scott Hamilton closer to the beamline.



These early challenges incidentally would generate two significant firsts: (1) A computer-

controlled monochromator had to be built (Naylor, Munro, Zacharov: Quebec Conference); (2) it was clearly realised that any future SR users would be scientifically effective only if they were not required to be radiation workers but could have safe access at all times to their experiments. Both of these principles in due course were to be built in 'ab initio' in the design thinking of the later SRS, making it both the world's first purpose built medium energy X-ray storage ring. It was also hugely innovative in terms of the potential exploitation of SR for the succeeding forty years even when the brilliance of both the SRF and the the SRS would ultimately be superceded by other accelerators. The initial tests on NINA were conducted between 1965 and1969, involving a large number of trips between Didsbury (south Manchester) and Daresbury on my 1963 Norton 650 SS twin motor bike, recently sold for £2500. Later I would graduate to a Mini van to keep drier! By 1968/9 we felt that sufficient material had been acquired to justify a formal bid to the Science Board in 1970 for sufficient funds to do the job properly. This first beamline would eventually yield the rather sparse spectral data which had laboriously been gathered from NINA and which was combined with calculations on the full spectral potential of NINA if used as an absolute source of radiation, based on the paper by Schwinger. The application was submitted to the Physics committee of the Science Board in 1969, which in 1970 took the far reaching and rapid decision to support it to the tune of £370k. Phil Burke of Belfast among others was a vital supporter of the project. This was quite remarkable news to a physics Department that was actually waiting to exploit the potential of NINA for high energy particle physics research! The decision led within three years to the construction of the SRF, a 'First Generation' Synchrotron Radiation Facility on NINA which would go on to produce approximately 100 publications until NINA and therefore the SRF were both finally closed in April 1977 for financial reasons.

The SRF would generate within the space of a few years an exceptionally vibrant world class SR science community from an admixture of physicists , chemists, and biology researchers who had until that time only carried out experiments on their own in separate departments, had never seen a large synchrotron and still less, never worked in such a 'factory- like' environment so unlike that of their own departments. The benefits arising from such an academic environment however could be considerable because it led for the first time to the daily (at coffee time usually) mixing of exceptional individuals from widely differing science backgrounds and styles including Maths and Computational Science, all focussing on related problems. Sir David Phillips, Sir John Randall and Hugh Huxley were all early visitors and users of the facility, which grew very rapidly. However, after that first meeting with Merrison at Daresbury and following his letter of encouragement, the problems of working 'parasitically' on such a large machine in a very large laboratory would become painfully clear. Working at the SRF was undertaken 'parasitically' on NINA, which meant that although NINA was potentially a good source of SR, its operating parameters, particularly the beam energy and its time tabling, were entirely selected and frequently changed by the Nuclear Physics Board users. The creation of a proper 'Facility' clearly would become an urgent necessity following the approval in principleof the case to exploit synchrotron radiation by the Science Board. In fact in the 1960s Geoff Marr of Reading University in Ditchburn's department, also Peter Key of NPL, had previously been given resources to work parasitically for short periods at a small synchrotron in the Physics Dept of Glasgow University and Geoff Marr had sought funds to continue this work

at East Kilbride using a superconducting magnet; this was never realised.

This activity was initially unknown to the Manchester group and therefore when the substantive grant was announced to Manchester it was made conditional on attempting to meet the larger collective needs of this growing user community. Early discussions were held in SRC State House London, chaired by Peter McWirter from Culham Labs, with David Thatcher from SRC as Secretary. Despite some conflicting needs among users and with limited resources, a synchrotron radiation users group was soon based at Daresbury under the chairmanship of Geoff Marr with myself as Secretary. This was to provide the outline plan for the Facility In 1972/3 Following Alec Merrison's move to Bristol University as Vice Chancellor in 1969, Professor Alick Ashmore from Queen Mary College was appointed to be Director of Daresbury Laboratory. As his predecessor had been, Alick was also interested in and very supportive of the diverse Synchrotron Radiation research programme. He set up and Chaired a Daresbury Synchrotron Radiation Research Committee (DSRC); I was the Secretary. During this period I was lecturing at Manchester and also acting as Departmental Tutor in Physics although I spent much time working on the preliminary design for the Facility. I drew up the initial layout for beamlines and experimental stations and shielding jointly with Bill Jones, a DL senior engineer. To minimise costs we chose to use an existing 'beam dump' building accessed by two beam tubes already in existence which were previously associated with Diamond Targets in NINA. At this time there were no Daresbury science staff directly associated with the programme until Bob Voss (Deputy Director) and Alick Ashmore approached Prof Willmott of Manchester Physics Department actively seeking my appointment to become the ‘User Coordinator ‘of this exciting new project at Daresbury and oversee it with a Daresbury hat on. It was with relish I resigned my position as Departmental Tutor and Lecturer at Manchester and accepted a position of Principal Scientific Officer at Daresbury (at roughly twice the salary!).

All early material relating to the setting up of the SRF, including my notebooks which describe the first layout and tests on NINA has been deposited in MOSI, the Museum of Science and Industry in Manchester in the 'Munro Archive'. The Daresbury SRF truly made its presence felt when Geoff Marr and I decided to hold and organise the world’s first Conference on Synchrotron Radiation which was held at Daresbury Laboratory in 1973 [1]. The meeting was held during a period of amazingly dense fog – probably worse than Manchester or London. It caused considerable chaos for the attendees and made travel between Manchester, Liverpool and the Laboratory impossible; this was, of course pre-motorway.

[1] Proceedings of the International Symposium for Synchrotron Radiation Users, Daresbury

4-7th January 1973, DNPL R26, G V Marr and I H Munro eds