JOULE LECTURE

The Saga of X-Rays and Sy Radiation in the North

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1. Genesis. The origins in Manchester and

The great tradition of X-ray science in the begin almost immediately after the epoch- x-rays by the German physicist Roentgen in That event was to influence the lives of countless peop but at the time, the dramatic phenomenon which e taken within and through the the bulk of the hum all understood, hence the title 'X' rays. This great d what concealed and publication initially delayed by recognised the immense significance of his find. Alr 1896 Prof Oliver Lodge working in the Physics Depa jointly with a G.P. from South Lancashire had lea discovery from a friend who was a correspondent of t tific Society (a rival to the Manchester and the Liv Societies, perhaps?) With his experience of Crookes own equipment to take x-ray pictures of the wrist o

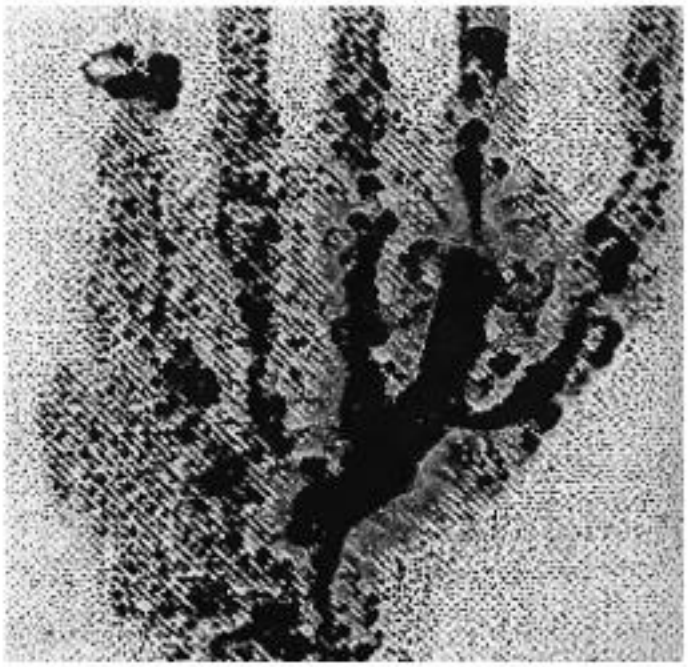

Figure1: (a) Picture of a boy's hand taken by Prof Oliver
University Physics Dept. (reported in the Lancet, 22
(b) The head of Mrs Hartley taken by Prof Arthur Schus
University Physics Dept. (reported in the Burnley Expr
29 April 1896, p3, courtesy also 'Lancashire Lantern). The R
by kind permission of the Wellcome Trust Medical Phot

most difficult location from which to attempt an x-r
was located but,unfortunately Mrs Hartley was to
surgery and died on 4 May (see Fig. 1b).

Schuster later gave demonstrations of these new
Technical School in Nelson using as subject a wor
fragment of broken needle in her hand for two ye
about five minutes and plates about half an hour to

These early x-ray photographic images revealed,
England,the tremendous benefit of x-ray imaging as

It was about the same time in Manchester that S
Rutherford, then working in Canada, to become hi
of Physics in 1912. Within a few years under Rut
Manchester would become the leading Physics
world in its pursuit of an understanding of the atom
particles. Among Rutherford's early staff was
Moseley from Cambridge whose initial experimen
of x-rays identified an important correlation betwee
and individual elements and their properties. His
full recognition of the significance of Mendeleev'
Elements. It also initiated a comprehensive revision
and was used to predict the properties of hitherto
The work was published initially as Moseley's Tables
of his powers, Moseley was killed in battle in the D
of 27 years.

Also at the same time J.J. Thompson, born in Cru
the discoverer of the electron and a close friend of
working in Manchester alongside Hans Geiger who
first particle detector (Geiger Counter.) It was this e
first recognised and proved with Rutherford the exis
of the atom, following a series of elegant back sca
using energetic helium nuclei (alpha particles). S
ford himself appeared not to be especially interest
of x-rays. Nevertheless,his talented group was then
W. L. Bragg who would lay the foundations for a fu
the principles of the diffraction and scattering of x-
the Braggs (father and son) were jointly awarded the

Their work marked the creation of chemical (and a

mathematical ability and wide practical experienc
member of the Manchester team. He would later bec
John Chadwick (born in Cheshire, discoverer of the
recipient of a Nobel Prize.) Together they became
British nuclear physics research and would lay the
UK's Nuclear industry, including both the Nuclear
and weapons development policies. Their influence
UK academic research funding in the physical scien
on the importance of elementary particle research
still identifiable today.

3. Particles

By the 1940s it was recognised that the very high
energies were better achieved via incremental repea
circular synchronous accelerators rather than in a 'sim
accelerator. The construction of such machines was
level of skill and financial resource available in a typ
ment and they were soon to be constructed by specia
as G.E.C.(the General Electric Corporation of A
vicks in Manchester. Following the invention of C
Metrovicks established a world class laboratory for
high voltages for power transmission purposes. Im
focussed on the development and understanding of
tron devices, a decision which would lead to their cr
first mass spectrometer to be followed later by the in
tron microscope! Metrovicks also designed and proc
tron linear accelerator, a device which would play a
biophysics research at the Patterson Laboratories a

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In the UK in the early 1960s, particle physics was
be of highest priority by the Physics community an
participation by the UK in a massive multi- nation
to be based at CERN in Geneva and which is sti
At that time with strong input from members
Manchester physics group the UK created a new
NIRNS (National Institute for Research in Nuclear
two Laboratory sites: one in the North of Englan
Warrington (DL) a rural area with very stable sa
second in the South at Harwell near Didcot, an ol
by the UKAEA to be called Rutherford-Appleton
Each laboratory would house a major accelerator: N
at Daresbury and NIMROD (for protons) at Ruthe

The work at Daresbury on the construction of
synchrotron drew upon skills from Metrovicks and
surrounding UKAEA sites at Risley, Capenhurst a
Daresbury synchrotron to be called NINA (Norther
Accelerator) reflected the customer research base it w
since it was easily accessible from the universities
Liverpool, Manchester and Birmingham as well as
at Glasgow, Sheffield and elsewhere. NINA and Dar
constituency (Huyton) of the then Prime Minister
would open the new Laboratory in 1963.

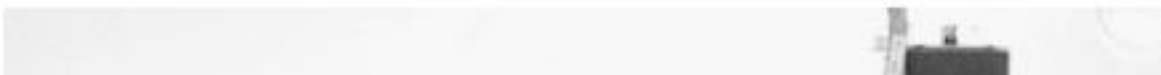
NINA was speedily constructed and achieved its
Spring of 1966. During the early 1960s the strong
physics in Manchester started by Rutherford and c
had begun to shift towards the study of atomic and m
ature and solid state physics and also to include the

The Saga of X-Rays and Synchrotron R

My attitude to such work at Daresbury is that if the
I would be very enthusiastic.'

It was this positive response which led directly to
of a £500m UK research programme in synchrotr
and the dominance of Daresbury and the North
research and technology for over forty years – fr
2008. It was thus while the NINA experimental pr
physics was still being commissioned that pilot st
synchrotron radiation studies had already begun!
proposal had been prepared and submitted to the
of the Science Board by the Manchester group. T
favourably received by the Science Board that Ma
a grant of £370k and in 1971, with others, were in
hand the creation of a wholly new Synchrotron Ra
SRF, to be based on NINA at Daresbury Labora
sought initially as a source for spectroscopic exper
(vacuum ultraviolet) region, but was soon used by m
including Manchester, Reading, Oxford, MRC
NPL, Warwick, Strathclyde, Leicester, Ulster, Oxfo
and Culham Labs

The success of the SRF was important and althou
closure of NINA by the Nuclear Physics Board looke
reasons. The Science Board of the SRC (Science Rese
its Chairman Geoffrey Allen then Professor of C
Manchester, had already taken the vital decision to c



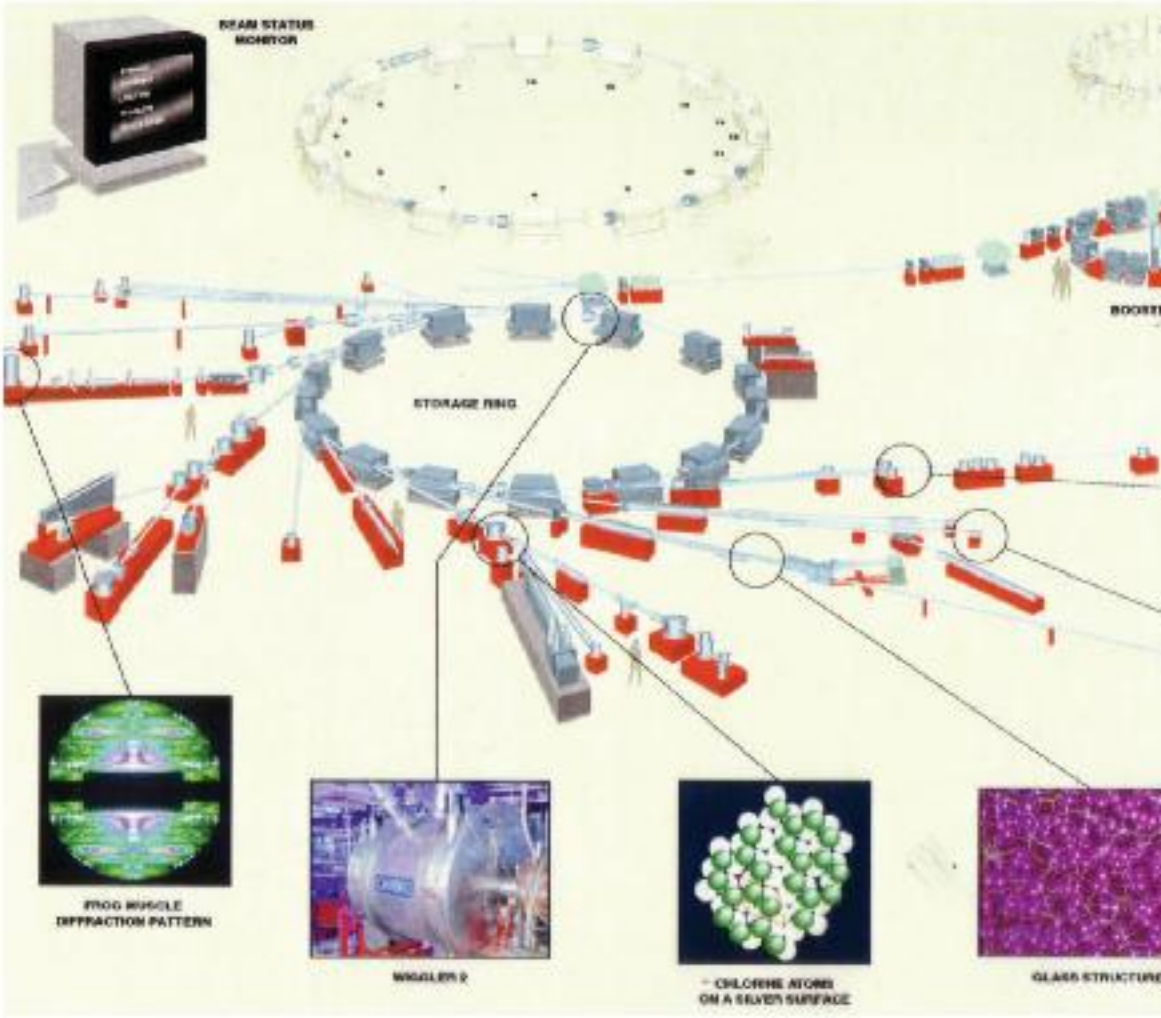


Figure 3: The SRS at Daresbury (STFC, Daresbury La

Facility specifically designed for and dedicated to sy
(x-ray) research.

The new source would be based on a 2Gev elec
be called the SRS (Synchrotron Radiation Source) a
planned and constructed at Daresbury also incor
class engineering, scientific and computing facilitie
the Laboratory for NINA. It would be the first tru
research institute in the country. When completed i
actually the world's first purpose-built source of sy

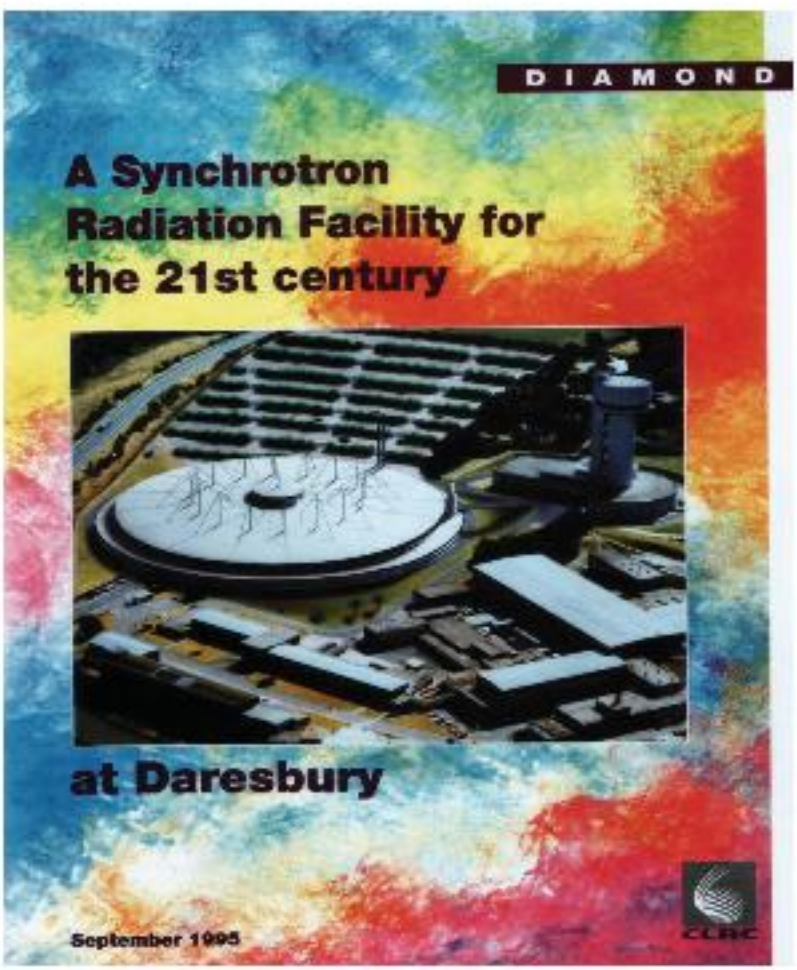


Figure 4: Going for DIAMOND. Hard, brilliant and
(STFC, Daresbury Laboratory Archives

x-ray working range and the minimal divergence of t
source. Even the first generation of synchrotron ra
as the SRF on NINA possessed a brilliance more t
greater than that of any simple laboratory source an
the merit of being useful over a huge range of x-ray
wide range of timescales (from days to nanoseconds)

Throughout the 1990s many new x-ray techniques
taneous measurement of wide- and small-angle x-
developed at the SRS to enable the most challengin

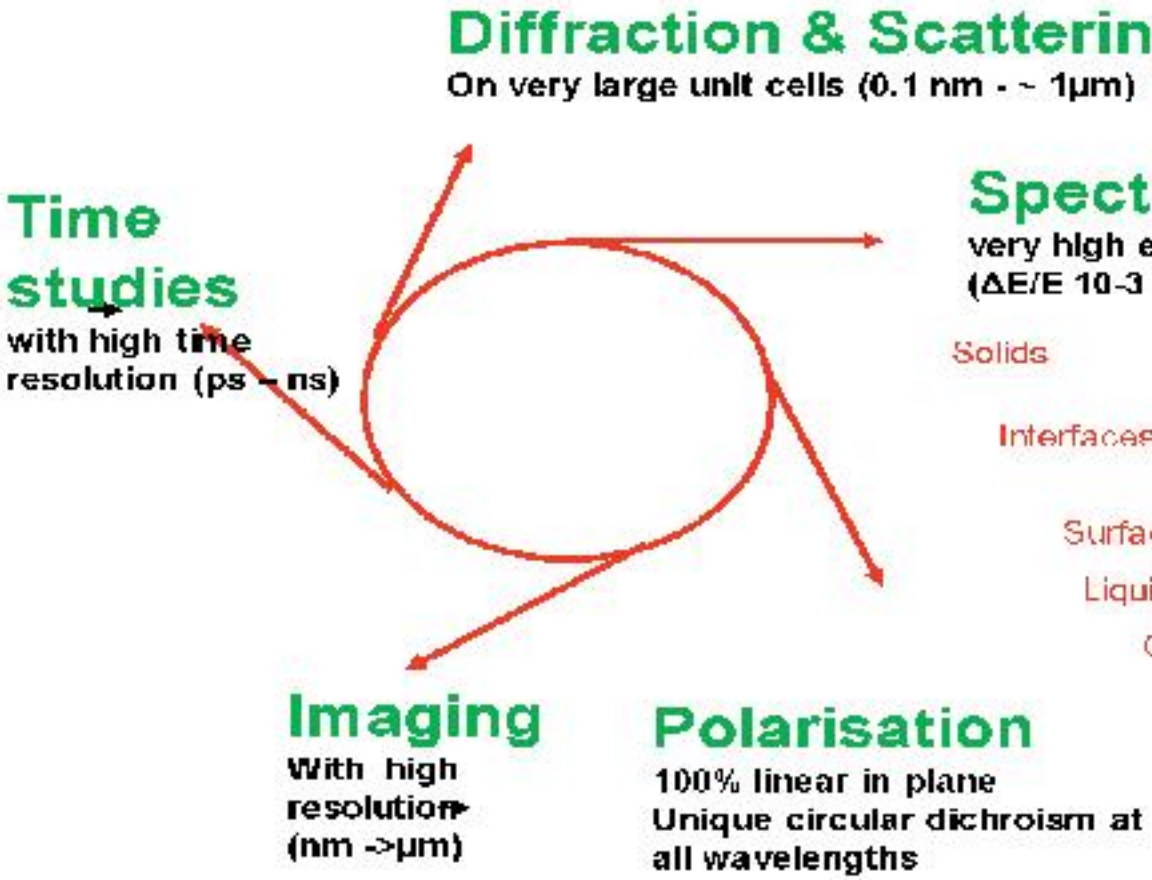


Figure 5: Synchrotron Radiation Applicat

(DIAMOND) had already been chosen at Daresbur
good diamond, much like an x-ray source, should be hard
sive!'. With planning approval already granted by
application was also made to the Millennium Comm
help catalyse the start of the new Facility. However,
"*... the proposal met our key criteria,...but was judged n*
tive a public interest as the others "! However, in 1996,
awarded to Daresbury jointly by all UK research co
and Physical Sciences, Particle Physics and Astronom
Environmental, Biological and Biotechnology,) to

government. The new 'Third Generation' source wo
crystallography research as its highest priority. A ch
forced by the Nobel prize awarded to John Walker
was strongly supported by the MRC based in Ca
Wellcome Foundation both of whom would provi
toward the construction and operation of the new so
Scotland and the University of Sheffield and others al
host to the DIAMOND site as did MRC Laborator
also RAL the sister laboratory of DL. DL and RA
run jointly by CCLRC (Council for the Central
Research Councils. RAL has no history of X-ray re
unable to secure funding for any substantial long ter
not chosen be the site for a new European Spallat
spallation source, ISIS, of course retains the original
NIMROD. Clearly it might offer an advantage to
Laboratory were to be displaced as first choice an
instead constructed at the RAL site.

There were many visits to Daresbury Laboratory
to admire the work of the SRS and view the by now a
DIAMOND at Daresbury including those by mem
Stephen Byers, the Duke of Edinburgh and the Mini
Sainsbury. He attempted but failed to obtain suppo
from the French science funding Agency CNRS). Th
construct their own 3rd generation source (SOLEI
had always planned and which would become an
itor to DIAMOND. This period of frantic activit
concluded finally at a closed meeting between the Pr
Blair) and his Minister for Science (David Sainsb

During forty years of operation the SRS gene
research papers by some 11000 users from academe
and industry. It has solved more than 1200 protein s
numerous patents and licences, and spent about £7
wages, the rest to local industry.)

8. Epilogue

The decision to locate DIAMOND close to Oxfo
political outrage in the Commons and the North
tial financial losses to the North West possibly co
ment to establish the NWDA, the North West D
with a budget of £ 450m. Since then Manchester
totally restructured and the Daresbury site now ho
Daresbury Science and Innovation Centre (65 high t
£10m. sales based on spin off from the SRS), the C
International Centre for Accelerator Science and T
Hartree Centre (Institute for Advanced Computati
staff from Daresbury SRS and the North West now
in the USA, Canada, Australia and Europe, our lega
x-rays is world wide.