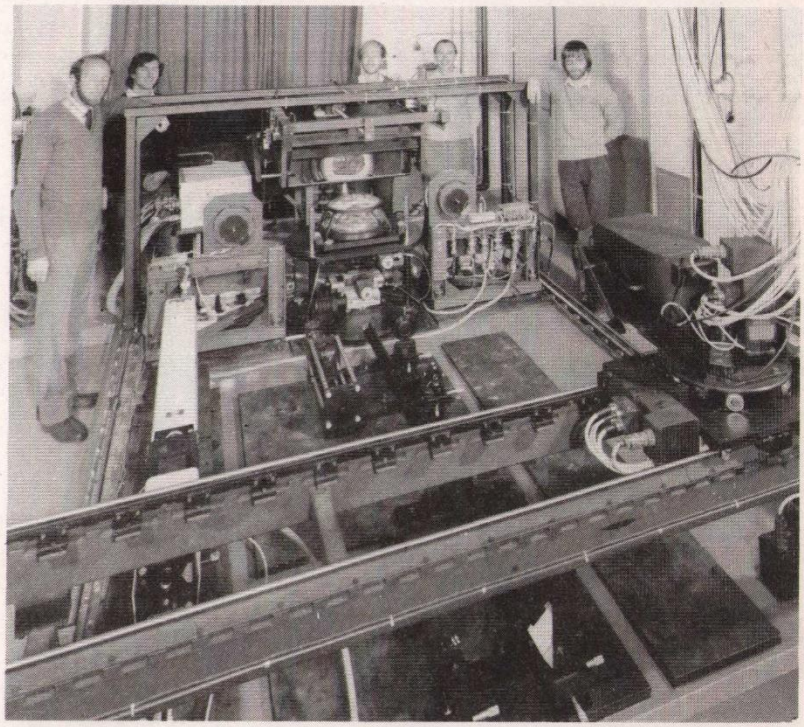
Bulletin
of the Rutherford Appleton Laboratory 2 Dec 1985 No.15

HOLRED Replays Bubble Chamber Holograms

An intriguing new machine is seeing the light of day for the first time in an annex to the bubble chamber scanning laboratories. Mounted on travelling stages straddling a concrete slab of impressive size, a TV camera hunts images in a space illuminated only by a faint glow of laser light. The machine, HOLRED, is being used to replay holograms taken in the 15' Bubble Chamber at Fermilab, near Chicago, and when the camera comes to rest in its travels, the image of a bubble chamber interaction, with tracks diverging from an interaction point, can be seen on the TV monitor in the neighbouring control room.

Why use holography to record bubble chamber events, and what determines the design of a machine from which useful images can be reconstructed?

Conventional photography has been used in bubble chambers since the early days of the technique, but it has one unavoidable drawback, namely the decrease in depth of focus as the resolution is increased. High resolution is much desired however, in many of today's experiments, including the experiment at Fermilab, where neutrinos from the world's highest energy neutrino beam enter the bubble chamber. Because neutrinos are neutral particles, they cannot be focused into a plane or pencil beam; they might interact anywhere in the volume of the 15' chamber. On the other hand, it is what happens near the interaction point where decays might be seen of "new" particles - with charm or beauty, or of the τ-lepton - that is of greatest interest. Holography provides the solution to the problem of recording with high resolution over a large depth. It uses an entirely different imaging technique from that used in photography, by "freezing" the wavefront of light coming from an object on the holographic recording medium placed in its path. The "freezing" is achieved by using coherent light, such as is produced by a laser, to record photographically the interference between the object light and light from a standard, reproduceable "reference" beam. The hologram can then be developed like a normal photograph and replayed in one of two ways.



HOLRED, with some members of the design team. The system to transport bubble chamber holographic film, the replay fisheye optics and the cameras used to detect images can be seen. 85FC 6388

If illuminated with a beam optically identical to the "reference" beam, a virtual image is produced which can be focused by the eye. This is the type of replay technique used in display holograms such as those which are now to be seen in such diverse places as in art galleries or on credit cards.

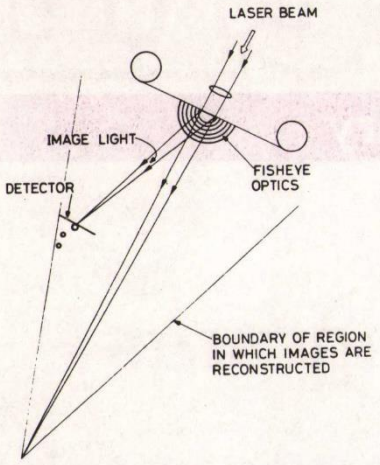
Alternatively, the hologram can be illuminated with a "time-reversed" version of the original reference beam (ie one travelling in the opposite direction) and an image of the object, which can be shown on a screen or photograph or projected on a TV camera, appears in the space behind the hologram with its original size and position. It is this method of replay which is used in HOLRED, and it is because images appear in their original places that the machine is so large. (In fact, replaying into air rather than into a medium of refractive index of the bubble chamber liquid causes some demagnification; this is lucky, or the machine would be still bigger than its current 4 x 3 metres!).

A complex and novel machine of this sort can take a long time to develop and can be costly. This problem was countered by sharing the effort and

(Cont'd Over)

HOLRED (Cont'd from p1)

HOLOGRAPHIC REPLAY-REAL IMAGE



Principle of holographic replay to provide a real image of the object, detectable on a screen or by TV or photographic camera. 85MB 5284

cost between all the UK and European particle physics groups participating in the Fermilab experiment. The various parts of the machine - film drive and positioning mechanisms, electronics and software, lasers and lenses, stages for computer-controlled driving in the 3D replay space, and TV and photographic cameras - were provided by the collaboration of Imperial College, Oxford and Birmingham Universities and RAL from the UK, and Saclay, Max Planck Institute Munich, Brussels University and CERN in Europe. Much of the optics development was done in a full-scale optical model at Oxford, and with RAL providing the overall co-ordination and infrastructure, the machine is now starting its job of looking at holograms taken at Fermilab during the Spring and Summer of this year.

One last point can be made about the machine design. In order to obtain good images, the replayed light must be put back through all the aberrating optics it encountered on its way to the hologram when it was recorded. This explains the presence of the hemi-spherical bubble chamber fisheye lens seen in the accompanying diagram. Also, the replay light must be of the same wavelength as that used in recording. At that time, light from a pulsed ruby laser was used. A dye laser, tuned to the same wavelength, is being used for replay. So for HOLRED, the light of day is dawning ruby-red.

R L Sekulin

Sales to Employees

The sale of scrap metal and plastics to RAL employees will take place from 1200 - 1230 hrs in the R24 scrap compound on 6 and 20 December.

RAL TECHNOLOGY LECTURES

The next lecture in this series will be held on Thursday 19 December 1985 at 3.15 pm in **Conference Room 12 Building R68.**

HOLOGRAPHY - WHERE IS IT GOING

by

DR NICHOLAS J PHILLIPS
DEPARTMENT OF PHYSICS
LOUGHBOROUGH UNIVERSITY OF TECHNOLOGY

The subject of holography has led to much speculation in the field of optics often based on weakly understood physical principles. This lecture will examine some of the frontiers of holography and how, as a technique, it interfaces with modern areas of visual display, such as computer graphics. Its true limitations are very much imposed by recording material problems and advances in that area will be discussed, together with a fascinating set of optical regimes that make this subject so interesting.

FOR YOUR DIARY: The next lecture in the series will be held on Thursday 23 January 1986

Internal Events

NEUTRON DIVISION SEMINARS
R3 CONF ROOM - 1330 hrs

10 Dec Ed Samulski/Cambridge
'Deuterium NMR Studies of Oriented Fluid Polymers'

12 Dec Manuel Cardona/Stuttgart
'Raman Spectroscopy vs Neutron Scattering: Applications to Semiconductor Physics and Technology'

LASER SUPPORT FACILITY SEMINAR
CONF ROOM 3 - 1400 hrs

5 Dec Prof C Flint & Dr J Darwent/ Birkbeck
'The Photophysics and Photochemistry of the Europium Polytungstate Anion'

ASTROPHYSICS EVENTS
R68 CONF ROOM - 1400 hrs

11 Dec Dr Robert Speer/I.C.
'Gratings, Holograms and Zone Plates'

GEOPHYSICS SEMINARS
R68 CONF ROOM - 1400 hrs

10 Dec Dr D Eccles/RAL
'The RAL Ocean Surface Current Radar (OSCR)'

17 Dec Dr D Hartmann/Oxford
'The Earth's Radiation Budget Experiment-Purpose and Method'

Obituary

Wendy Turley

It is with deep regret that we have to announce the sudden death of Wendy Turley at her home in Wallingford on Wednesday 30 October. Wendy was only 24 years old.

Wendy joined the Laboratory during October 1984 and worked in the Wages Section of Finance and Accounts Group. She was a very popular member of the group, with a cheerful disposition that will be sadly missed by friends and colleagues alike. She was known throughout the Wallingford area because of her involvement with the Sinodum Players Dramatic Society, the Wallingford and Didcot Choral Society and her local church choir. Wendy also took a keen interest in charity work.

We extend our deepest sympathy to Wendy's parents, Mr & Mrs S J Turley.

Safety Film

The film 'You'll Soon Feel Better' will be shown in the R22 Lecture Theatre at 12.45 and 13.30 hrs on Monday 2 December.

It is really directed at employees of the Pharmaceutical Industry but its strictures apply equally to all of us, particularly those involved in labelling or handling chemicals.

Euro-journalists See IS

Europe, in the shape of thirty or so scient work last month. On a tour of the UK to se end' of British science and technology, the 31 October.

Some of the party are pictured here being i by Colin Carlile.

UK Astronauts at RAL

The UK astronauts meet some of RAL's spacemen. From left to right, Dr Eric Dunford,(RAL) Liz James (Astronauts' Press Officer), Richard Holdaway (RAL), Cdr Peter Longhurst, Sqn Ldr Nigel Wood, Dr John Harries (RAL), Lt Col Richard Farrimond, Dr Peter Barker (RAL), and Mr Christopher Holmes. 85RC 5415

The four British astronauts currently undergoing training for flights on the Space Shuttle next year visited RAL on 6 November.

All are involved in the Skynet IV communications satellite programme, though only two will fly. Sqn Ldr Nigel Wood should become the first Briton in space as payload specialist on the June 1986 Shuttle launch, his back-up being Lt Col Richard Farrimond. In December 1986 Cmdr Peter Longhurst will also fly as payload specialist with Mr Christopher Holmes as back-up.

The visit, arranged by Dick Holdaway, started with an introduction to the work of RAL, given by Dr John Harries (Associate Director, ASR).

Mr Holmes gave a short talk on what it was like to train as a payload specialist. Surprisingly, he informed us, relatively little of their training had been related to "how to be an astronaut", rather had it been focussed on a detailed training programme in the technical details of the satellites.

An extensive tour by the astronauts covered RAL's programmes in astro-physics, geophysics and radio propagation, and also took in the ISIS pulsed neutron facility and the Laser facility.

Discussions on the general nature of RAL's space programme and the possible impact of the forthcoming British National Space Centre, rounded off a most interesting and satisfying day for both the astronauts and their RAL hosts.

SIS

ific journalists, came to see RAL at e what was happening at the 'sharp y visited the Laboratory on

nitiated into the mysteries of ISIS

85RC 5401

Halley's Comet

Halley's Comet as seen from Stanford in the Vale on the night of 15 November The Comet was passing close to the Pleiades Cluster when photographed by Peter Wroath and Laurie Lintern using a 300mm f 5.6 mirror lens on Tri-X film. The guide telescope was a Celestron 8 inch Schmidt-Cassegrain which was used to track the Comet accurately during the exposure.THe exposure time was 30 minutes during which time the stars trailed due to the motion of the comet against the background of stars.
Guidance on where to look for the comet can be found in the RAL Library.

G3UKS Calling the World

Almost exactly one year ago four intrepid explorers from the Rutherford Appleton Laboratory Amateur Radio Club braved temperatures of 82°F and a luxury villa to take part in one of the biggest events in the amateur radio calendar. Joined by five other fellow enthusiasts from the UK they travelled to the Caribbean Island of Montserrat to enter the famous CQ World-wide DX Phone Contest. This contest, which lasts for 48 hours, attracts entrants from all over the world and the competition is fierce. The team, led by Dave Vizard (G3UKS), worked in eight hour shifts and made approximately 5700 contacts in 150 different countries, an average of over 2 per minute. Months of careful planning before the event paid off. The results have just been released and the group attained FIFTH in the world.

Montserrat is a small volcanic island in the Leeward Isles. A British Crown colony with a population of 10000, it rests majestically in the Caribbean Sea close to Antigua. Its inhabitants greeted us with great friendship and warmth. Many western touches have crept into the sleepy island e.g. 'Red Lion' pub and there is a strong Irish connection with Cork Hill, St Patrick's and Galway Estate.

One of the first tasks was to erect a couple of antennas in the villa's garden. Perhaps I should point out that the villas belonged to Radio Amateurs so they weren't at all perturbed when two rather large 40m beams appeared outside their back door! The task was more time consuming than originally thought and was completed only hours before the contest was due to start.

Operating in contests in this country can be equivalent to pulling teeth, painful, slow and laborious. After all Britain is hardly a rare country - in fact it has a large number of Radio Amateurs. But in Montserrat, where there are few licensed amateurs, things are very different. Often you would hear dozens of stations trying to contact you it was very difficult to pick out the individual call-signs. The scoring system is so complex and with such a large entrance that the results of the contest are not known for 11 months. The logs are checked for duplicated or incorrect entries before submission. This took about 4 weeks even with the help of a computer! The countries contacted included USA, USSR, Japan, Australia, most of Europe, South America, and parts of Africa.

Of course after the contest had finished we had to take down all except one of the antennas we had so carefully placed the previous week. But then it was time to relax in the warm sun or swim in the crystal clear sea and enjoy some more of the island. By the end of the two weeks we were well known in Montserrat (well you couldn't miss Drew in his kilt) and the tables were turned - people started to ask us if they could take our photograph!!! So if you ever visit the island please go to the Iguana Restaurant and have a look at the photos on the wall. Between Paul McCartney and 'Dire Straits' you might just see us!!

This years contest has just ended - Dave (G3UKS) operated from the Radio Club here at Rutherford - of course we will have to wait a year for the results .....!!

For the record, the four intrepid explorers were, Jean Mills (author), Dave Vizard, Steve Cherry and David John.

Missing

The following items are the subject of loss reports and knowledge of them should be relayed to the enquirer.

Dictaphone Pocket Memory Type - 124
RAL No. 026785
Contact N J Lawrence, R1, Ext. 5507

SONY Colour TV. RAL No. 006337
Contact S Quinton Ext. 5534

GEC 12" Electric Fan R 006560
Contact J Cooper Ext. 5287

NOT the subject of a loss report, but much missed - 2 mascot bears. These were abducted from R63. Let's have them back please.

Film Badge Notice

It is period 13. Colour Stripe BROWN Please be sure you are wearing the correct dosimeter and return all old ones.

NEXT FILM ISSUE

1 January 1986.

A Scientists Approach to Faith

Recordings of Dr J Polkinghorne's recent talk may be obtained by sending a blank C90 cassette to Meyrick Wyard, R68, G14, Ext. 6185.

Barn Dancing Club

The Club is now in full swing for the 1985-86 season, so if you would like a fun lunch hour why not come along and give us the once over.

Everyone is very friendly and the approach is totally informal. We are now meeting at 12.30 pm every Tuesday in the Games Room of the RecSoc building R56, and would be very pleased to see you.

A Date for Your Diary - the Christmas Party is on Monday 16 December in the Upton Village Hall. Details from Kay Knight, Ext. 5123.

If you want to get the atmosphere of what the Barn Dancing Club is all about, this ode by Daphne Barrand says it all.

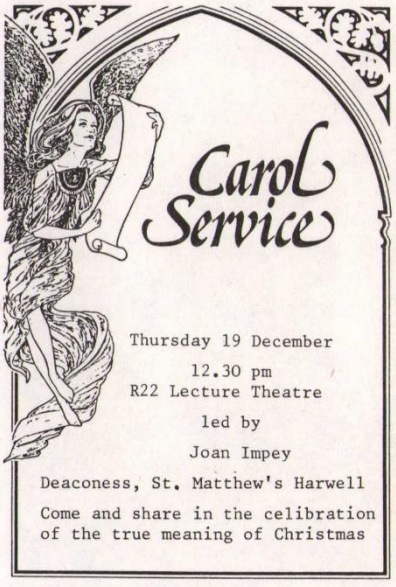
Oh come with us a dancing
Upon a Tuesday noon
We merrily trip and hop and skip
To a good old English tune

There's Derek, Mike and Peter too
Who take us through our paces
While we do-si-do and puff and blow
With grim, determined faces

We dance with dedication
You should see our 'Reel of three'
Our balance and swing is just the thing
To fill you full of glee

So come with us a-dancing
In the middle of the day
And merrily trip and dance and skip
And dance your cares away

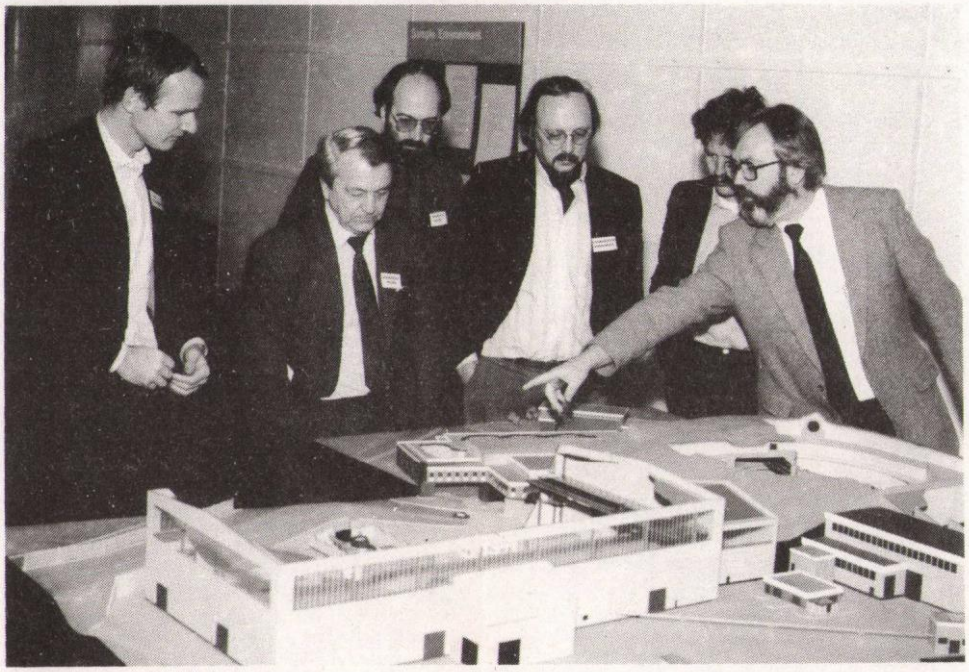
Derek Cragg



Bulletin

Editor: Jean Banford
Building R1
Rutherford Appleton Laboratory
Chilton, Didcot, Oxon OX11 0QX
Abingdon (0235) 21900 ext 5484

Euro-journalists See ISIS



Europe, in the shape of thirty or so scientific journalists, came to see RAL at work last month. On a tour of the UK to see what was happening at the 'sharp end' of British science and technology, they visited the Laboratory on 31 October.

Some of the party are pictured here being initiated into the mysteries of ISIS by Colin Carlile.

85RC 5401