Bulletin
of the Rutherford Appleton Laboratory
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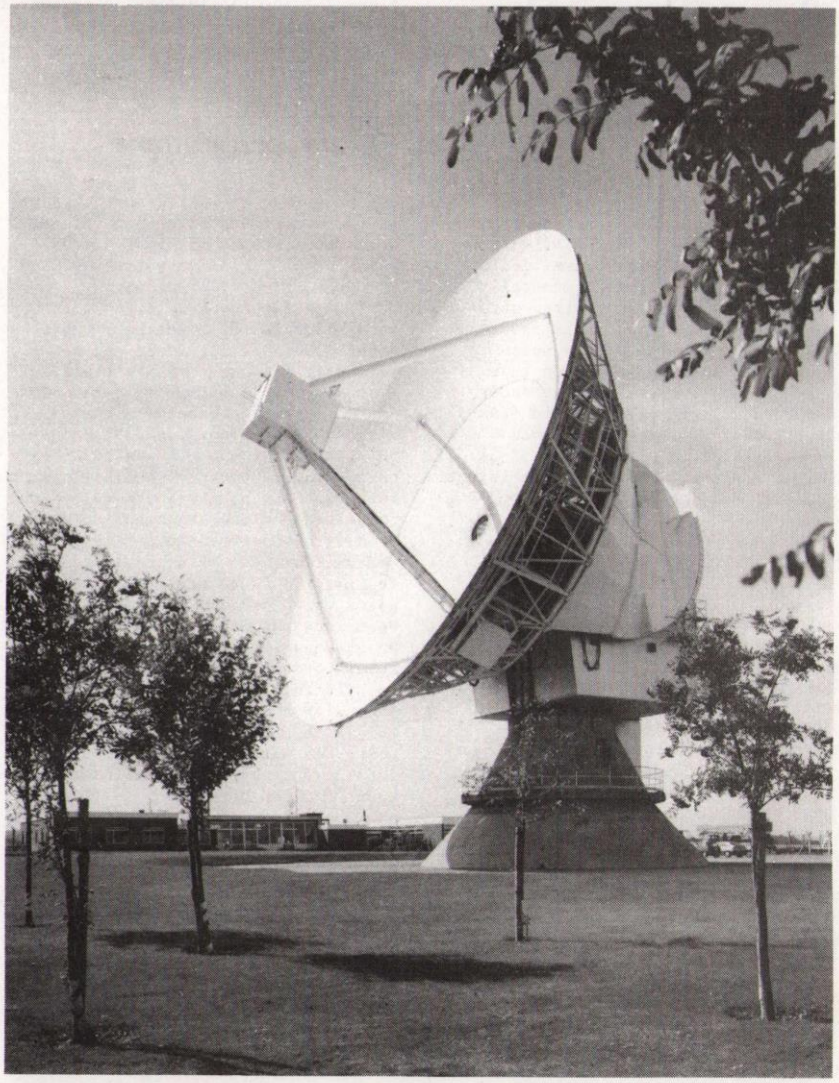
Chilbolton's Rain-radar leads the world

The world's largest 10cm wavelength meteorological radar at RAL's Chilbolton Observatory, is about to become operational again after a major refurbishment. The radar, which uses the 25m diameter antenna at Chilbolton, is used to remotely sense raindrops and other hydrometeors such as snow, hail and ice crystals. The primary purpose is to predict the effect of hydrometeors on microwave communications with satellites, but there is also considerable interest in the work from cloud phycisists.

The radar uses a dual-polarisation technique which has been pioneered at the Laboratory to quantify the size and number of hydrometeors in a given volume and to determine whether the particles are raindrops, snow or hail etc. The very high angular resolution (0.25 degree) afforded by the large antenna and the dual-polarisation technique make the Chilbolton rain radar a uniquely powerful facility for investigating the detailed structure of raincells.



The Chilbolton 25m antenna. 86FC 4346

Rain radar technique

The use of radar to investigate raincells is not new and dates back to World War 2 when strange radar echoes were seen on the first radars to operate at wavelengths of 10cm or less. These echoes were clearly not from aircraft or ships, the expected targets, but were soon found to come from rain. Radar technology has progressed a long way since then but until relatively recently the major developments have been in civilian and military surveillance radars. Most radars to observe meteorological effects have been modified surveillance radars and so limited to the techniques they could provide. Over the last ten to fifteen years meteorological radars have developed considerably with new techniques and one of these has been the dual-polarisation technique which has been developed at the Laboratory.

The principal of the technique is to measure the scatter from hydrometeors, with horizontally and vertically polarised waves. The shape of raindrops depends on their size and with the increasing size of drops the scatter with horizontal polarisation becomes increasingly greater than that for vertical polarisation. Hence the difference (strictly power ratio) with polarisation, known as Zdr, is a measure of drop size and is independent of the number of drops per unit volume. This can be compared with power received on one polarisation, which depends on the combination of drop size and number of drops per unit volume, to separate the two effects. This in turn allows a more accurate estimate of rainfall-rate or microwave attenuation to be made from radar data, particularly for short time intervals (a few minutes) when very intense local rain can occur. The scattering properties of ice and liquid water are quite different at microwave frequencies and this has an effect on

Chilbolton Rain-Radar (continued from p1)

the differential scatter with polarisation. The height at which large ice particles melt to form raindrops is often shown clearly by a change in the value of Zdr even though little change can be seen in the absolute level of scatter.

It may be thought that the transition from measuring scatter with one polarisation to measuring it with two is technically not a big step, so why has it only been done recently? The major problem has been to measure the difference in scatter between the two polarisations accurately enough. The ratio needs to be measured to better than 5% but the radar echo from hydrometeors is inherently noisy and must be averaged in time and/or space to reduce fluctuations on the measurement. The fluctuations can only be reduced to about 20% if excessive averaging is to be avoided which would reduce the time and spatial resolution of the radar. The technique to overcome this problem was first employed on the Chilbolton radar in 1978 (and the first anywhere) and works by sampling the scatter on horizontal and vertical polarisations with alternate pulses transmitted by the radar. That is, a horizontally polarised pulse is transmitted and echoes received on that polarisation, then a vertically polarised pulse is transmitted and the echoes on that polarisation received. After about 64 pulses on each polarisation (takes about 0.25s) a sufficiently good average of Zdr to better than 5% is available although the absolute values are still only to about 20%.

Enhanced performance

The key component which allows the measurement with alternate pulses to be made is the switch which connects the radar transmitter/receiver to the horizontal and vertical polarisation ports of the antenna. It has to switch between polarisations at the pulse rate of the radar (610 Hz) and carry 560KW of power at 3GHz during the transmitted pulse. These power levels at 3GHz are beyond semiconductor switches and just within the technology of switches using ferrites. However the solution for Chilbolton has been solved by the use of a mechanical switch which uses a rotating chopping disc at 6000rpm to direct the microwave energy. Although the technology may seem old it is capable of superior electrical performance to ferrite switches and enabled the Laboratory to start measurements of Zdr several years ahead of other groups with meterological radars throughout the world. Groups within the USA, Germany, Austria are now using or building radars to measure Zdr.

The original mechanical switch, (the prototype!) is being replaced this year with a new mechanical/semiconductor hybrid switch. The mechanical switch is being retained for switching the transmitter power while the received signals are selected by semiconductor PIN diodes. Apart from operational advantages the new switch will also allow the measurement of echoes received on the polarisation at right-angles to the transmitted one, and so give still more information about hydrometeors. Like the old switch the new switch has been designed and built in house, with the production of mechanical parts largely through R25 workshop.

Another development at Chilbolton concerning the radar is a complete replacement of the computer system which is used to steer the 25m antenna and to collect data. The GEC 4080 system has been replaced with a number of microprocessors and this has increased the flexibility to changes in experimental needs considerably so making the overall radar system an even more powerful tool.

Future programme

The programme of work with the radar is to predict the effect of raincells on communications with satellites which use frequencies between 10 and 30 GHz. Strong raincells can attenuate the power of signals from satellites in this frequency range by a few orders of magnitude and so seriously degrade communications. Also scattering by hydrometeors can cause interference between one microwave radio service and another. This can occur when two users operate on the same frequency and hills or the curvature of the Earth are relied on to shield the two transmission paths from each other. Scatter via hydrometeors can then provide an indirect route between the transmission paths which circumvents the shielding. Up to now the programme has concentrated on attenuation prediction, but the future programme will concentrate on interference aspects and this is in step with a current European cooperative programme called COST 210 which is concerned with the problems of interference between radio users by weather effects.

S M Cherry

Internal Events

HEP SEMINARS
R61 CONF ROOM - 1100hrs

1 Oct	F Lizzi/RAL 'Quantisation of null string
8 Oct	A D Krisch/Michigan 'Large spin effects in hard pp scattering' (to be confirmed)
15 Oct	H Miyazawa/Tokyo 'Multi-valued wave functions and the Bohm-Aharanov effect'
22 Oct	D Morgan/RAL 'Have AFS found the lightest scalar glueball?'

ASTROPHYSICS SEMINARS
R61 CONF ROOM - 1400hrs

15 Oct	Dr Bernard F Schutz/Cardiff 'Gravitational waves: Sources and Detectors'
29 Oct	Dr Richard Harrison/RAL 'Solar coronal mass ejections during flares'

RAL Lectures

The next lecture in this series will take place on Thursday 9 October at 3.15 p.m. in the R22 Lecture Theatre.

NIELS BOHR AND
20TH CENTURY PHYSICS
by
SIR RUDOLPH PEIERLS

The centenary of Niels Bohr's birth on 7 October 1985 has been an occasion for recalling his unique contributions to physics. Every physicist has heard of the Bohr atom, and perhaps of Bohr's work on the interpretation of quantum mechnics and complementarity. But he made contributions to a greater variety of topics; from the electron theory of metals, to the compound nucleus theory of nuclear reactions and from the passage of charged particles through matter to the theory of fission.

The talk will outline his work briefly and attempt to describe the spell of his personality on the many who came to his Institute for inspiration and guidance.

Computing seminars

BLEND and QUARTET
Scholarly Communication by
Electronic Means
by

Peter Dodd
University of Birmingham

Atlas Centre Colloquium
3.15 p.m.
Tuesday 7 October

Since 1980 the British Library, research and development department have been funding a research programme into the use of "electronic journals", using a computer teleconferencing system.

The first half of this talk will review the aims of this programme and describe the achievements of the first phase (BLEND) which terminated in 1984. Recently a second phase (Quartet), building on the experience of BLEND and incorporating developments in communications, storage and microcomputer technology, has commenced and the second part of the talk will describe what we hope to achieve. Emphasis will be given to the way in which the study has been influenced by the particular teleconferencing system and how our needs have resulted in modifications to that system.

ICP Million Dollar Award

Sales of one million dollar's worth of the RAL developed computer package TOSCA were marked by the presentation of the 'IPC Million Dollar Award' to the exploiting partnership of RAL, Vector Fields and British Technology group, at a banquet held by the sponsors, recently.

TOSCA is based on a prizewinning paper by Bill Trowbridge and John Simkin of RAL's Computing Applications Group. The software, assigned to British Technology Group by SERC for commercial exploitation six years ago, has since been acquired by leading research centres and manufacturing companies in several countries including the USA, Canada, France, Japan, Germany and Italy. Vector Fields of Oxford, a company first set-up by RAL staff responsible for the development of electromagnetics software, market the package.

Proudly displaying the Award (left to right) John Simkin (Vector Fields), Gordon Walker (RAL), Peter Tanner (BTG), Bill Trowbridge (RAL), Paul Williams (RAL), John Whitney (Vector Fields), and George Davis (BTG).

RAL Safe Drivers

Six RAL Drivers, award winners in the RoSPA National Safe Driving scheme, have clocked-up over 2.6 million accident-free miles between them. This, in spite of an increasing number of journeys to and from Gatwick and Heathrow made during a year and the expanding volume of traffic on the M4 and M25.

1985 Awards go to:

	Award	Accident-free
J Culley	- 1st bar to 20 yr medal	- 21 yrs
MD Fitzgerald	- 2nd bar to 5 yr medal	- 7 yrs
A Shoebridge	- 1st yr Diploma	- 1 yr
E Smith	- 3rd bar to 20 yr medal	- 23 yrs
D Stock	- 4th bar to 15 yr medal	- 19 yrs
B Turner	- 4th yr badge	- 4 yrs

The national scheme, started in 1927 by the Royal Society for the Prevention of Accidents, attracts huge entries each year and the awards are highly valued.

Civil Service Benevolent Fund

The 1986 centenary Appeal raised £312.50 amongst SERC staff, £184.30 of that sum being collected at RAL. Your support is much appreciated.

Dr Stafford - President Institute of Physics

Old RAL friends and colleagues of Dr Godfrey Stafford, now Master of St Cross College, Oxford and formerly Director-General of the Laboratory will be pleased to hear of his election as President of The Institute of Physics.

At the same meeting, held on 1 July, Dr Jim Valentine (Laboratory Secretary) was re-elected Hon. Treasurer to the Institute.

We wish them both a successful term in office.

RAL Wives Group

Coffee mornings at the Cosener's House, Abingdon will take place on the following dates:

Thursday 9 October (changed from 8 October)
" 13 November
Tuesday 16 December (sherry and mince pies)!

Coffee is available from 10.30 am to noon and pre-school children and babies are always welcome, so do pop in.

Please contact:
Celia Lockwood Abingdon 847266
or Kath Pearce Abingdon 23767

for further details or information on how to find us!

Sales to Employees

The sale of scrap materials to RAL staff will take place on 3, 17 and 31 October from 1200 - 1230 hrs in the R24 scrap compound.

Lunchtime Darts League

Stores 'A' won the league, and the 'Britvic Shield', with an unbeaten record. An exciting play-off between runners-up 'R18 26ers' and 'Stores B' on the evening of Tuesday 9 September in R58, produced some good darts and close singles and R18 just deserved their 4-3 victory.

Peter Simon of 'Britvic' very kindly came along to present the shield donated by his company, also the individual trophies to the winners and runners-up.

The evening was quite well supported and our thanks are due to Peter Craske for running the bar.

A new league will start early in 1987 - with any luck. Let's hope we have a few new teams putting their arms to the test.

A Napper

The winning team of (left to right) Daryl Taylor, Richard Owen, Andy Napper, and Mark Bond, (missing Phil Walton).

RAL Sunday XI

Look to your laurel's all Upper Thames Valley Sunday League sides, RAL's Sunday footballers are now playing in the 4th Division.

Starting the season with four 'friendlies', (just to loosen-up, you understand) they beat 'White Hart', Headington 7-1, the 'George and Dragon' Upton, 4-1, and narrowly lost to AERE, 2-1 and Clifton Hampden 4-1.

So, the big day arrived, - RAL's first league fixture, played away against Oxford Exiles Reserves. The lads started nervously and a couple of errors in defence allowed the home side to go 1-0 up. But this seemed to spur our lads into action and after ten minutes of sustained pressure, Simon Lees created a gap and set-fly with one of his cannon balls. Half time, 1-1.

At the start of the second half, RAL again sat back and relaxed, giving away a very sloppy penalty, for Exiles to regain the lead. RAL sprang to life again, and with Martin Purling and Dave McPhail completely dominating the right hand side of the pitch, an equaliser was always on the cards. Then Alan Saxby was brought down in the penalty box and Ken Chapman stepped up to knock in a rebound off his own penalty shot. Full-time 2-2.

On Sunday 14 September RAL's second game was played, against AC Nielson (2nd Division) at Oxford, in the 'Devenney Cup'.

For twenty minutes RAL pressured the home side only to be caught out by a corner. Still RAL applied pressure to Neilson's defence, Melvin Simpson with a header against the bar and Simon Lees with a shot kicked off the line. Then a penalty for handling on the line was given, to be pushed just wide of the post by Alan Saxby.

Disaster followed, with a complete collapse of RAL in the second half. Only the agility of keeper Barry Brett kept Neilson to one goal and though RAL threw everybody forward in the last 10 mins it was to no avail. Neilson won 2-0.

However the season is still young - and you too could join in the excitement. Budding soccer stars should get in touch with RAL's Security Lodge (ask for Mick, Brian or Ken). Training sessions are on Wednesday evenings at 5.p.m.

Ken Chapman

Atlas win cricket final

The 'Dave Craddock Cup' holders for 1986 with David Gray. (left to right top row) Steve Morley, Steve Cooke, D.G. Sean Howard and Robert Patterson. (bottom row) Simon Amos and Melvin Simpson (captain).

A new name appears on the 'Dave Craddock Cup' this year. 'Atlas' now hold the trophy after a narrow victory over 'Rats' (the apprentice team) in the Final of the competition, played on 29 August.

Rats lost the toss and, asked to bat, started well with both openers reaching 20 runs before dismissal. The wicket was damp and whilst the quicker bowlers were unable to extract much life out of the pitch, the Atlas slow bowler, Simon Amos, turned the ball on a number of occasions. At the end of their 10 eight-ball overs 'Rats' had reached a total of 80 for the loss of four wickets with Dave Rippington remaining undefeated on 13.

Atlas had to score at a run a ball to win.

Openers, Melvin Simpson and Bob Patterson reached a score of 30 and the less experienced Rats' bowlers seemed to be letting the game slip away from them when on came Dave Rippington. In his two-over spell he took four wickets for only five runs, including one great catch to dismiss Bob Patterson.

One over to go, one wicket left, and eight runs wanted.

Some sharp fielding by Mark Wheeler kept things tight, but in the end Atlas scraped home by one wicket with two balls to spare, the not-out batsman on 23 runs being Sean Howard.

After the match, David Gray (head of ISIS Division) presented the Cup to the Atlas Skipper Melvin Simpson, ending another year of cricket at RAL.

Let's hope it will be as enjoyable again next year, with one improvement - the weather!

A Napper.

Thanks

Cathy Costain would like to thank everyone who contributed to her leaving presents (a short-wave radio), a fez and a cheque) and sent their best wishes for her foreign venture. "I'm only sorry I couldn't see them all before I left. There's a copy of my address with the Library if anyone would like to keep in touch;" she writes.

Film Badge Notice

It is period 10. Colour strip GREEN. Please be sure you are wearing the correct dosimeters and return all beta-gamma films and fast-neutron badges promptly.

NEXT FILM ISSUE

Monday 6 October.

Bulletin

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