Bulletin

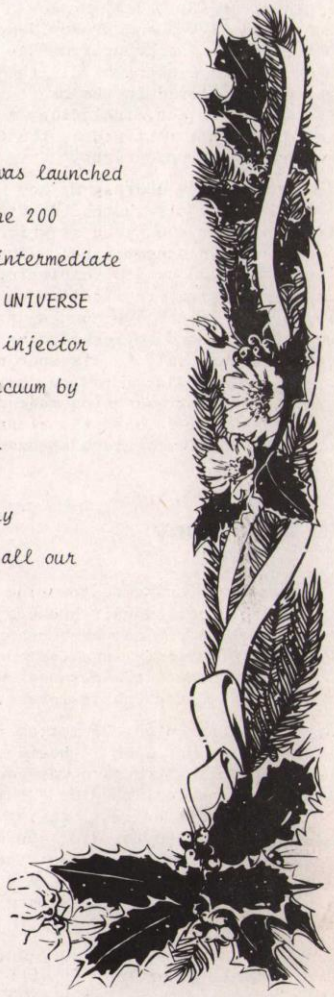
of the Rutherford Appleton Laboratory 20 Dec 1983 No.20

A Christmas Message

Nineteen Eighty Three has been an extremely good year for RAL. IRAS was launched on January 26 and the helium supply lasted for 300 days rather than the 200 predicted. The project has been a great success. The $W^{\pm}$ and the Z^{o} intermediate vector bosons have been detected at the $p\bar{p}$ collider at CERN. Project UNIVERSE has successfully completed its repertoire of 14 experiments. The SNS injector has operated and the synchrotron ring should be completed and under vacuum by the end of the year.

Congratulations to all for an excellent year's work. I wish you a Merry Christmas and a Happy New Year. May 1984 bring continuing success in all our endeavours.

Geoff Manning



MT Carousel on View

Thursday 24 November proved to be a red letter day in the diary of the UK/NL Millimetre-wave Telescope (MT) project teams. On that day yet another significant stage was reached in the construction of the telescope, with the completion of the trial-erection of the carousel which will house it: this event occuring only days after the massive foundations for it had been finished on the mountain of Mauna Kea, Hawaii.

To mark this historic stage in its development a special viewing ceremony was arranged jointly between the Council Works Unit (CWU) and Robert Watson, the manufacturers at the factory site near Bolton to which many of the people involved were invited. The importance of the MT's place in the history of Radio Astronomy was emphasised by the attendance at the event by both The Astronomer Royal Professor Graham Smith and The Astronomer Royal for Scotland, Professor Malcolm Longair. Dr Geoff Manning, Director RAL was also present as were,a team from the Royal Observatory Edinburgh who will administer the working telescope; Dr Hills the Project Scientist and his team from Cambridge University; representatives of the Hawaiian contractors who will erect the carousel on Mauna Kea and a contingent from RAL led by Mr Roy Tolcher, Head of CWU and Dr Ron Newport, Project Leader. The group from RAL was made up from members of all the design teams involved in the many facets of the project, including design consultants retained by the CWU and several Dutch scientists.

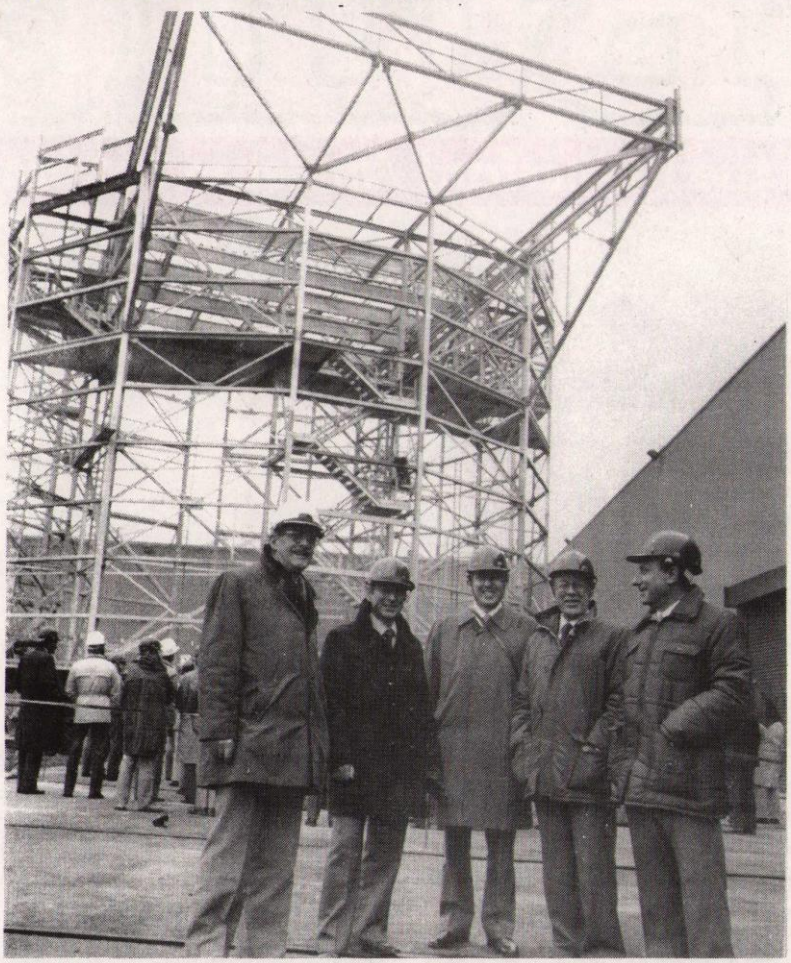
In his introductory address Mr Roy Tolcher expressed his thanks to Messrs Robert Watson for the speed at which the task had been accomplished. They had done a tremendous job completing the detailed design, fabrication and trial-erection of the 400 tonnes of structural steel and bogies forming the rotating carousel, in six months. Professor Longair also expressed his delight at the progress being made and proposed a general vote of thanks and offered his sincere congratulations to all involved.

With Ceremony

With the massive structure towering above him Professor Longair broke a ceremonial bottle of Champagne on one of the bogies (the only level he could reach) and 'launched' the carousel before it was put through its paces.

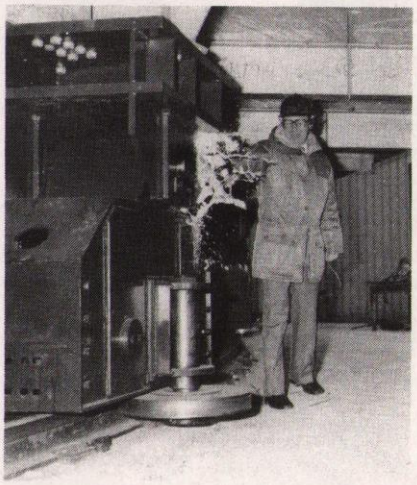
Twenty five metres high, 28 metres in diameter and supported on 14 bogies, the huge 400 tonne structure was gently revolved on its circular guiding rail by three 8 kilowatt drives, taking 4 minutes to complete its 360° journey. The enormous doors which protect the telescope slid smoothly apart and the roof rolled back in two stages opening the structure to the sky.

Picturing this immense structure under the inhospitable conditions it will have to survive on Mauna Kea, 14,000ft above sea-level, buffeted by winds up to 200 km/hr in temperatures varying between 20°C and -15°C, one could at last comprehend the enormous amount of thought and research that had been put into the design.



The skeleton of the telescope enclosure towers above a relieved party of spectators. (from left to right) Alan Watson, Geoff Manning, Ron Newport, Graham Smith and Roy Tolcher. 83RC5611

A few words with Mr Fred Gilbert, one of the enclosure design engineers made clear how diverse were the problems overcome. Minimum maintenance is essential, and the cladding panels have been specially coated inside and out, to withstand the abrasive action of wind-driven pumice and to minimise temperature fluctuations within the enclosure. The motors driving the bogies are of a very special design, the system being derived from the drive developed for the NASA Moon Buggy Project, which incidentally, we understand, had its trial on Mauna Kea. The control system uses the most advanced component technology available and the overall design allows the motors to produce maximum torque through the entire speed range of 6-3000 rpm. The protective membrane, although still in the design stage, will utilize a special PTFE woven fabric originally designed for the filtration of concentrated acids. This was fortuitously stumbled upon, due to one of the teams athletic pastimes - the Abingdon Marathon required watherproof clothing.



The 'launch'. 83RC5604

Since the ceremony, the carousel has been commissioned, and is at the time of writing being dismantled, ready for shipment to Hawaii in early February.

Accelerators - The Next 40 Years

John Lawson looks back over 36 years in the accelerator field, and asks whether the next round of large accelerators is the 'end of the road', or whether some new breakthrough will open the way to even higher energies.

It is not far short of forty years ago that my wartime group leader, Don Fry, asked me to join his small team which was setting out to build two entirely new types of accelerator, a microwave travelling wave linac and a synchrotron. These relied on the principle of 'phase stability' which had very recently been propounded independently by Veksler in the USSR and McMillan in the USA. My own work was on the 30 MeV synchrotron, with a 10 cm orbit radius; electrons were injected at 10 kV and accelerated to relativistic energies by a 'betatron core', which then saturated when the particles became relativistic and the r.f. took over. Our synchrotron first worked in 1948, but two years earlier Frank Goward had made the first ever synchrotron, doubling the energy of the 4 MeV Kerst betatron, part of US 'lease-lend' being used at the Woolwich Arsenal for X-raying armour plate. He used an old radar oscillator, and built a cavity out of soldered wires, placed outside the vacuum chamber. Frank was a real enthusiast, brimming with ideas, and his untimely death a few years later was a tragic loss to the accelerator community. 'Accelerator physics' was on a smaller scale, and most of us felt thoroughly amateur in our approach. Harry Aram and 'Wally' Walford will remember our extracted beam, the first time ever from a synchrotron, but not very reliable and almost impossible to focus. I'm sure no one at that time could have forseen the staggering growth in accelerator building to occur in the next few decades. Our synchrotron was, admittedly, partly a design study for a really large machine, with orbit radius one metre, to be built at Glasgow to produce mesons. (That there were *two* types of meson, μ and π was not yet appreciated!).

In 1948, the idea of strong focusing and quadrupole lenses was still to come, but I think that the real thing that we could not forsee in those post war 'austerity' days was the incredible wealth that would be at our disposal for research in the coming decades. Nor could we have imagined the extraordinary advances in technique to be brought about by the transistor and digital computer, which is able to do an astronomical amount of 'knob-twiddling' to keep our accelerators under control. Modern high vacuum technique, which has made storage rings possible, could hardly have been envisaged in those days of black wax, cone joints and J-oil. (And liquid *oxygen* in the cold traps!)

Over the five decades since the 'accelerator age' began in the early thirties, with the Cockcroft-Walton accelerator in the UK and Lawrence's first cylotron in the USA, the maximum energy has increased by some 25 times per decade. During the same period, owing to technical advances and new ideas the cost has decreased by about 16 per decade. The logical outcome of this trend, assuming that the rate of funding is now roughly constant, is 'fewer and bigger' machines at the highest energies. We are now evidently at this stage, and many people are asking whether this is the end of the road. Are we in the 'dinosaur age' with accelerator-based energy physics facing imminent extinction?

Following the present trend will lead to real difficulty early in the next century. It is not enough to carry on as at present, we must do much better! People are asking: is there some radically new technique or concept which we can turn to in the future? Since new technologies take a decade or two to develop, we should start doing something *now*. Like Mrs Beeton, we must 'first catch our hare', and there is now intensive discussion and speculation on what hares might have some real flesh on them. The subject was discussed and debated between accelerator experts and high energy physicists at Oxford last year.

Many ways of accelerating particles, radically different from our conventional synchrotrons and linacs, have been proposed over the years but most have fallen by the wayside. These days a popular focus for new ideas is the laser. Modern lasers can produce enormous electric fields; the electric field of the RAL laser near the target reaches hundreds of megavolts per centimetre. (This may be compared with a few megavolts per metre in the SNS injector). Cannot this somehow be geared to produce a super-high field accelerator?

'Laser Accelerators'

The first suggestion for a 'laser accelerator' was made by K. Shimoda in Japan over twenty years ago. Since then many ideas have been discussed, but all have problems. A simple laser beam does not interact in the right way with a beam of charged particles; in the first place the light waves move faster than the particles, and secondly the electric field of a light wave is perpendicular to the direction of motion, rather than along it. What can we do about this?

By introducing an array of magnets with alternating polarity to 'wiggle' the electrons sideways a form of continuous interaction can be achieved. This is the 'inverse free electron laser' mechanism. Unfortunately the effect is weak, and makes inefficient use of the laser field. To make a wave with field pointing along its direction of motion, and velocity that can match that of the particles, some matter must be introduced. This matter can be in the form of a gas, in which case the interaction is via the 'inverse Cherenkov effect', again very weak unless the gas is dense enough that the accelerated particles would be scattered, and the gas 'broken down' by the laser. Alternatively the matter can be in the form of an organised metal structure, as a grating for example. This is closely related to a miniature linear accelerator, where the particles must be within a fraction of a wavelength from the surface. Again there are breakdown limitations, and difficulties in efficiently launching the kind of wave that is needed.

The most spectacular suggestion, the 'beat-wave accelerator', made in the USA by Tajima and Dawson in 1979, relies on longitudinal 'Langmuir' waves which can be generated in a plasma by 'beating' together two laser beams of nearly equal wavelength. This really does show promise of very high fields, but formidable difficulties appear if one tries to 'engineer' the concept into a credible ultra-high energy accelerator.

These are just a few of the 'new ideas' now being tossed around in the accelerator community. Unfortunately the outlook for any revolutionary idea to furnish the breakthrough we are seeking does not seem bright. Electromagnetism and plasma physics are too well understood, and our requirements on beam current and beam quality as well as energy too demanding. Five hundred years ago it was perhaps reasonable to investigate the chemical transformation of lead to gold. Now, unfortunately, we know too much.

[*For more details see Oxford Meeting Proceedings ECFA 83/68 or (more concisely) RL 83-082.*]

RAL TECHNOLOGY LECTURES

The January Lecture in this series, scheduled to take place on 5 January, has been cancelled. The next one will now be on Thursday 2 February and is by Mr D A Gray entitled "The Spallation Neutron Source."

Internal Events

COMPUTING SEMINARS
ATLAS COLLOQUIUM - 1515hrs

10 Jan Dr John Fox/Imperial Cancer Research Fund Laboratory

'IKBS and Industry'

ASTROPHYSICS SEMINARS
R61 CONF RM - 1400 hrs

11 Jan Dr Geoffrey M Brown/UC Wales
"Some Solar Activities: Predicting Cycles and Finding Tropospheric Signals"

Gone to the Dogs

For fourteen years a stalwart of the Operations group, Johnny Peterson was bidden a fond farewell by his colleagues on Wednesday 30 November.

To remind him of his happy, busy days in the Atlas Centre, his friends had rallied round and produced a set of glasses and a decanter, which were presented to him amidst much hilarity and badinage by Doug House.

Doug thanked Johnny for all his hard work, and wished him well in his new career as a full-time greyhound trainer. Apparently he has about 60 of them to look after. "We all hope you are highly successful with this venture", he said, "don't forget to send us some tips."

In reply Johnny thanked everyone for the gifts and good wishes. "It's been an honour to work with you, thank you", he said.

With the tools of the trade? *83RB5721*

Safety Film

The third safety film to be shown in the Winter series is 'MOVING ON' which is about manual handling and combines three short films in one. The three films deal with:-

1. Awkward places
2. Awkward loads
3. Helping hands

A number of accidents in the Laboratory occur during the handling of goods, the methods shown apply to all whether at work or at home.

The film will be shown in R22 Lecture Theatre on 10 JANUARY 1984 at 12.30 hrs, 13.10 hrs and 13.50 hrs.

Bulletin News

Due to the editors involvement in the production of the Annual Report, the normal fortnightly schedule of the *Bulletin* will at times be disrupted. We apologise for any inconvenience that may occur.

Trade Exhibition

There will be a one-day exhibition by C.V.T. Engineering Ltd on Tuesday 10 January in R12 Conference Room from 10am to 4pm. On display will be a selection of the firm's range of standard UHV components, surface science instrumentation, sample manipulation, cryo pumps and mass quadrupoles."

A New Old Custom

An old Moravian custom now gaining popularity in Britain, is the 'Christingle' Service.

The Christingle is made from an orange into the top of which is placed a white candle. Four cocktail sticks laden with dried fruit and nuts surround the candle and around the equator of the orange is tied a red ribbon. The orange represents the world; the fruit and nuts, the fruits of the Earth and the ribbon the Blood of Christ.

Families gathered together in their Parish Church and the children were given Christingles. By the light of these alone they sang their favourite carols. The Christingles were then taken home by the children and lighted on Christmas Day to remind them of its meaning.

Library Notice

The Proceedings of the International Europhysics Conference on High Energy Physics held at Brighton 20-27 July 1983 are now available in the Library, price £15. Prepayment is required.

Missing

Casio Calculator type M, label No RO26732 belonging to Mrs G Tate, R63, Ext 6599 has been mislaid. Would anyone finding this item please contact her.

Thanks from Jean

As this will be the last *Bulletin* of 1983, it seems an opportune moment to thank the many people who have, in the past year, given so much help in its publication.

To all, I proffer my sincere gratitude, especially my colleagues in the Typing Centre, Photographic and Reprographic sections with whom I have shared some anxious moments as dead-lines closed in. I also thank all contributors and those who dropped pearls of information into my very receptive hands.

May you have a very Happy Christmas and I wish you every success in the coming year.

Jean Banford

Congratulations

The colleagues of George Pullinger would like to congratulate him on becoming a proud grandfather. This happy event coming just prior to his "50th" Birthday on the 22 December.

PCJW, SFJC, AFG, GPW, RW, JD, SEB

Film Badge Notice

It is period 13. Colour strip GREEN.
The next film badge change is due on Tuesday 3 January.
Please change your dosimeter promptly.

Bulletin

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Deadline for insertions: