widths for the emitter stripes in interdigitated structures of the order of 1 μm are now possible. To extend performance even further would require the use of electron beams to generate the mask patterns and possibly soft X-rays to project these patterns onto the semiconductor slice. New technologies such as ion implantation and proton-enhanced diffusion are being developed so that the doping profiles can be accurately controlled, for base widths as small as 0.1 μm are required.

R. C. Aubusson (Ferranti Ltd, Manchester) considered the use of polycrystalline silicon as an overlay for the emitter contact sites in order to introduce current sharing resistors to reduce the formation of hot spots and thus diminish the risk of thermal overload damage. Using this technique some 5 W at 2 GHz is now available. T. C. Denton (GEC Hirst Research Centre, Wembley) discussed the introduction of similar current sharing resistors into a mesh emitter silicon transistor, which allows pulse powers of the order of 150 W at 1 GHz to be obtained. Further advances in the gallium arsenide field effect transistor (FET) were described by J. A. Turner (Plessey, Allen Clark Research Centre, Caswell); changes in the structure from a one layer to a two layer epitaxial device have improved the mobility of the carriers in the active layer so that useful gain and noise performance up to 10 GHz is now available. Again the results are dependent on narrow gate widths of the order of 1 μm and further improvements depend on the smaller dimensions available from masks generated by electron beams.

Significant also was the extent to which computer simulation and new theories about the internal physics of the devices have been able to explain discrepanies between previous predictions and the actual performance of devices as reported by J. A. G. Slatter (Mullard Research Laboratories, Redhill). There has long been an unexplained difference between the predicted cut-off frequency (f_T) and current gain for bipolar silicon microwave devices, and a significant contribution from Dr H. De Man and R. Mertens (Laboratorium Voor Fysika En Elektronika Der Halfgeleiders, Leuven) showed that the phenomena can be explained by band tailing and formation of impurity bands. The effect produces a strong increase in the intrinsic carrier density in the emitter region and increases the charge storage of minority carriers, particularly in the emitter side wall of double diffused devices.

A further example of the use of computer simulation was given by J. C. Henderson, R. J. D. Scarbrough and Dr J. Earney (Post Office Research Department, Dollis Hill) who compared two identical bipolar transistor models, one in silicon and the other in gallium arsenide. Here was a case where predictions and comparisons could be based on the most recent advances in the two technologies. A plea was made that the recent gallium arsenide laser technology should be extended to the field of bipolar devices where even better performance is predicted.

Dr M. Merkel (Nuclear Research Centre, Grenoble) discussed the problems that arise when the more normal one-dimensional computer models are extended to cover the two-dimensional properties of practical devices. Many of the characteristics of FETs, for example, can only be adequately described in this way and can pose difficult problems if economical computer programs are to be devised.

One of the remaining problems that confront the designer of devices is that of the reduction of the package limitations that restrict the inherent frequency and power output of the active device. This was the theme of a contribution by J. R. Twistleton (GEC Hirst Research Centre, Wembley) who pointed out that the effect of parasitic reactances is particularly severe in microwave power devices because of their inherent low impedance.

EARTH STRAIN

Inland Tides

from our Geomagnetism Correspondent

THAT part of the Earth between Bradford and Halifax in the north of England is unlikely to be subject to accumulation of strain in the long term, but, as Bilham *et al.* (*Geophys. J.*, **29**, 473; 1972) have now discovered, the region is not free from short term nonlocal variations in strain. So much, at least, is clear from a survey involving 28 months of continuous strain recording. In July 1969, Bilham and his colleagues installed a prototype invar wire strainmeter in the disused Queensbury railway tunnel which lies in the north-east—south-west direction. As it soon became clear, the instrument possessed several deficiencies which prompted the development of an improved version. In the meantime, however, the prototype was kept in operation and proved to have a sufficiently high signal-to-noise ratio to record Earth tides clearly and thus to demonstrate the importance of tidal loading at a site well inland.

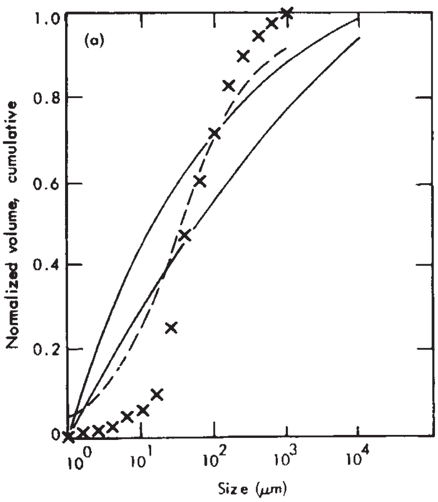
The strainmeter itself, fixed to the tunnel wall by expanding rock bolts, comprised a 10 m invar wire maintained under constant tension by gravity acting on a steel weight. Strain changes in the Earth produced a small rotation of the tension weight, representing

Surveyor Spacecraft Results Verified

ESTIMATES of the sizes of particles of lunar soil based on data relayed back to Earth by the Surveyor spacecraft, particularly Surveyor 3, have proved to be remarkably accurate. In next Monday's *Nature Physical Science* (January 15) Jaffe and Strand compare these calculations, made before lunar material was ever brought back from the Moon, with laboratory measurements of samples returned from the site of Surveyor 3 by the Apollo 12 astronauts (see diagram).

Methods used for the remote measurement of particle sizes included a measurement of the change in the photometric function of the surface when the soil was compressed by the spacecraft on landing. This led to the conclusion that the fine structure of the lunar material was smaller than 1 mm (which could just be resolved by the television cameras aboard Surveyor 3) and "larger than the order of 10 μm". Yet other estimates involved the laboratory simulation of the reproduction in the lunar soil of tiny ridges 50 to 70 μm high on the bottom of one of the footpads of Surveyor 3.

When the relevant data from all Surveyor spacecraft are taken into account, the agreement with laboratory measurements is quite close in the middle of the logarithmic range of particle sizes, but diverges somewhat at each end of the range. Jaffe and Strand conclude that their results augur well for the determination of soil sizes on other planets by means of automatic spacecraft landing there.



X, Laboratory measurements reported by Jaffe and Strand; ——, on-surface measurements (Surveyor 3); — — —, on-surface measurements (all Surveyors).