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REFRACTIVE KERATOPLASTY*

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It is difficult to present a contribution on refractive keratoplasty which is anything but dwarfed by the contributions already made by Dr. José Barraquer.

Dr. Barraquer was the originator of the technique and following years of experimental work, he has now had clinical experience o several hundreds of cases.

It is a result of my visits to his clinic in Bogotá that I have obtained almost all my knowledge of the techniques involved, and I would particularly like to thank him for all the time and all the care he took in showing me every detail of the procedures. It is the techniques that I learned from him that I have assiduosly followed in my work in England. I think, therefore, that the most useful and informative line for me to take is to describe my own experiences and especially the problems I have encountered starting out in this field.

There are three stages in the operation: The keratectomy, the re-shaping of the disc, and the reconstruction of the cornea. Each of these stages will be considered separately.

(A) KERATECTOMY

Special instruments required

(1) Serial Microkeratomes to cut discs from 0.25 millimetres to 0.60 millimetres in the thickness, and a set of some 12-18 suction fixation rings to enable a range of discs of different sizes to be obtained from any size of eye. (Figs. 1 and 2.)

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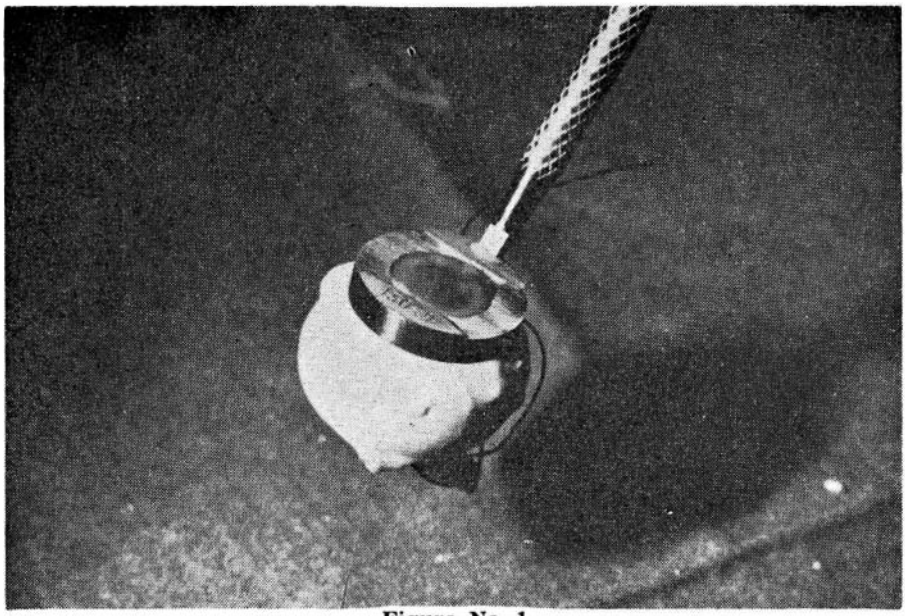

Figura No. 1

Suction ring holding excised eye. - (Note: the eye does not rest on the table)

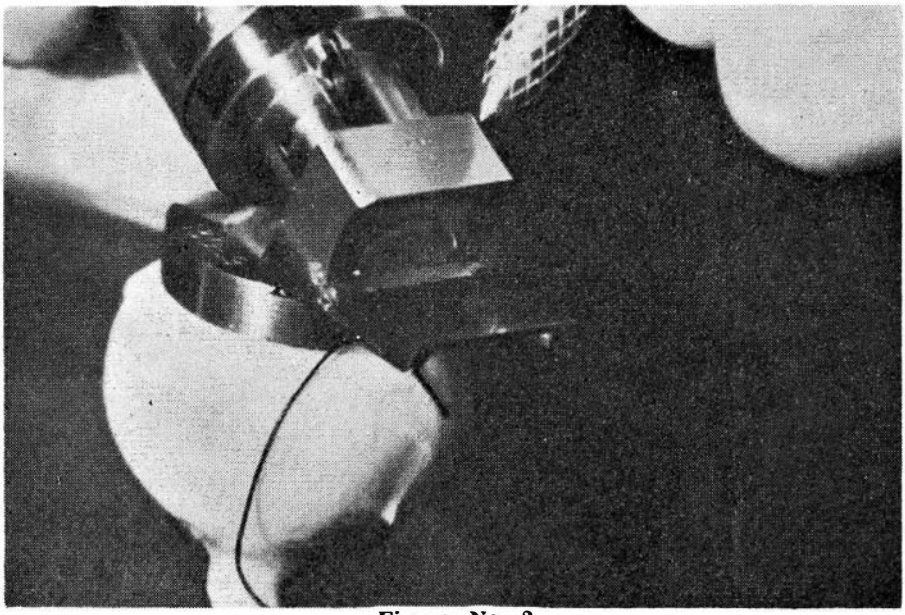

Figura No. 2

Microkeratome cutting disc. Clean cut disc edge visible.

(2) A set of calibrated applanation lenses to gauge the size of the disc to be cut.

(3) Applanation tonometer to cheeck the intraocular pressure immediately prior to keratectomy.

(4) An instrument for measuring accurately the thickness of the excised disc. (Fig. 3.)

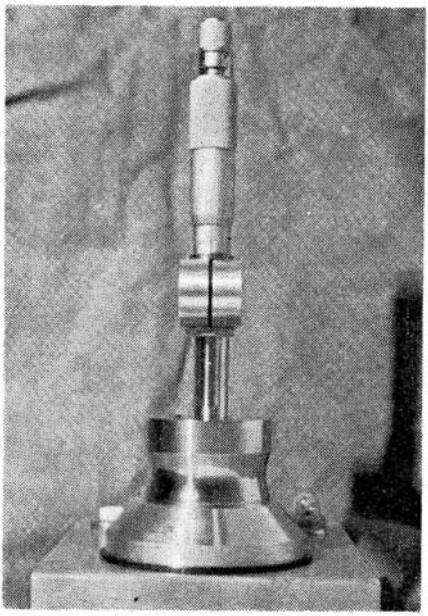

Figura No. 3

Thickness measure. Disc visible on base plate, weight on disc, micrometer plunger just touching.

The Use of the Microkeratome

The microkeratome will prepare a perfect disc with regularity provided the intraocular tensión is sufficiently high at the time of cutting. The fixation rings themselves increase the intraocular pressure when the suction is applied, but this alone is insufficient. In addition a well-placed retro-ocular injection is required. In an adult at least 4mls. must be injected accurately into the muscle cone. With a little experience it is possible to gauge the amount of retro-ocular injection required by observing the extent of the resulting proptosis. It is essential that all the fluid enters the retro-ocular

muscle cone as, should any fluid escape outside, chemosis will occur. Should this happen, the conjunctiva must be dissected close to the limbus to expose the sclera in the region which will be under the aperture for the suction tube which enters the fixation ring. If this is done, the operation can usually continue safely without fear of suction being lost during the keratectomy.

Although operating upon excised cadaver eyes is not identical with operating upon a patient, it is essential to practice many keratectomies in the cadaver before performing an operation on a patient. Only in this way can be learned the smooth advance of the microkeratome so necessary for an even section. Furthermore, the microkeratome keratectomy on a cadaver eye is an integral part of the operation for keratophakia where a homoplastic disc is required.

During practice, the cadaver eye should be held aloft by the suction of the ring alone, and not pressed on to the table. (Figs. 1 and 2). In this way the feel of operating upon the actual eye is more nearly achieved. When obtaining donor cornea for the carving of the lenticulus during the operation for keratophakia, however, the eye is always steadied upon the table.

Determining the size of the Keratectomy

This is performed by the application of the special calibrated applanation lens. These lenses are so constructed in relation to the microkeratome, that the area applanated corresponds exactly with the area of the keratectomy. The importance of dring the cornea completely before applanation is paramount, as otherwise a meniscus of fluid will form and lead to an over large reading and the cutting of too small a disc.

Dr. Barraquer has pointed out that the reading is more easily made when the applanation lens is cold, as the non-applanated area shows up in greater contrast since its surface appears steamy. This I have found to be of tremendous value and the lens is placed over a little ice bowl prior to use.

Checking the Thickness of the Disc.

The most accurate method I have found is by the thickness measure, designed, by Dra. Amida Saiduzzafar of the Institute of Ophthalmology, London, for measuring tissue thicknesses. The features of such an instrument, modified for use in the operating room, are well shown in the accompanying figure. (Fig. 3).

The disc to be measured is placed in the centre of the ring scribed on the stainless steel base. A very light weight is placed on the disc and the plunger screwed down by the micrometer. Immediately contact is made, and before any pressure has been exerted, the neon bulb illuminates. This method is very reliable and it is essencial in research work into the thickness of corneal discs. Either the general thickness of the disc or the thickness of individual parts can be measured by selecting a weight of appropriate design.

I have carefully checked the results of measuring the general thickness of discs with the Saiduzzafar measure against the results obtained using a light dial guage. The dial gauge has an accuracy greater than plus or minus 0.02 millimetres and its use is entirely satisfactory for the quick check of the disc thickness required during operation.

(B) RESHAPING OF THE CORNEAL DISC

Special instrument required.

A turning apparatus which consists of a lathe of the type used for corneal lens work and fitted with suitable freezing equipment.

My equipment is the same as Dr. Barraquer's except that the freezing is effected by the expansion of gaseous carbon dioxide rather than the volatilisation of the liquid. The freezing equipment is in fact identical with the Amoils cryo-probe ,but on a larger scale. (Fig. 4.) Freezing takes place slightly more slowly by this method but produces very good fixation of the disc which is well frozen and cuts cleanly. (Fig. 5).

If a Dellrin base is used, freezing takes place in about thirty seconds from the opening of the gas tap, but cutting is not started until 90 seconds after the tap is opened, to be perfectly sure of complete solidity and firm adherence. The cutting tool is cooled during the last thirty seconds before cutting the disc.

Freezing and Turning the Disc

Once the lathe has been set, the turning process presents no difficulty. Great care must be taken with the centering on the base and also perfect apposition of disc to base must be obtained. The freezing process causes a slight thickening of the centre of the disc but much more important is

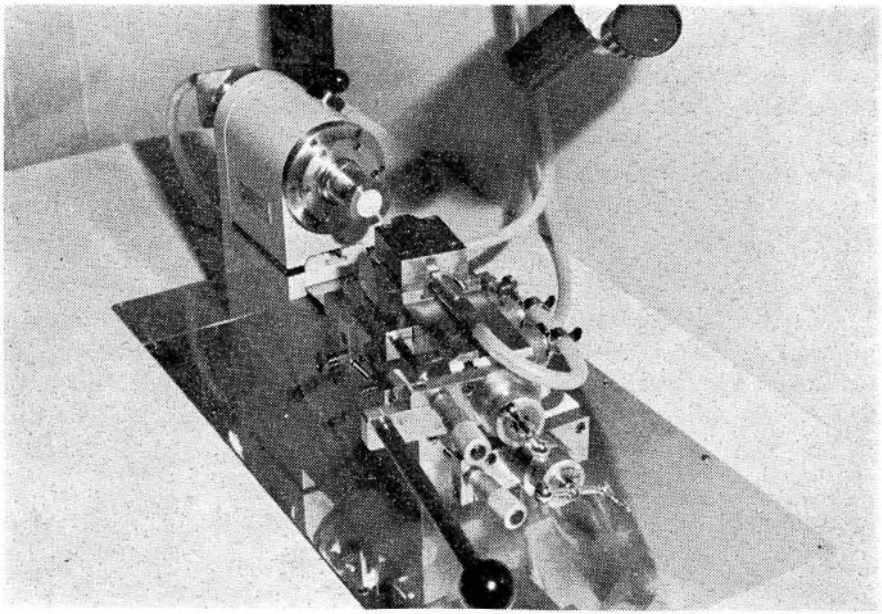

Figura No. 4

Late. Carbón dioxide gas enters by fine central tube, returns by larger tube around it.

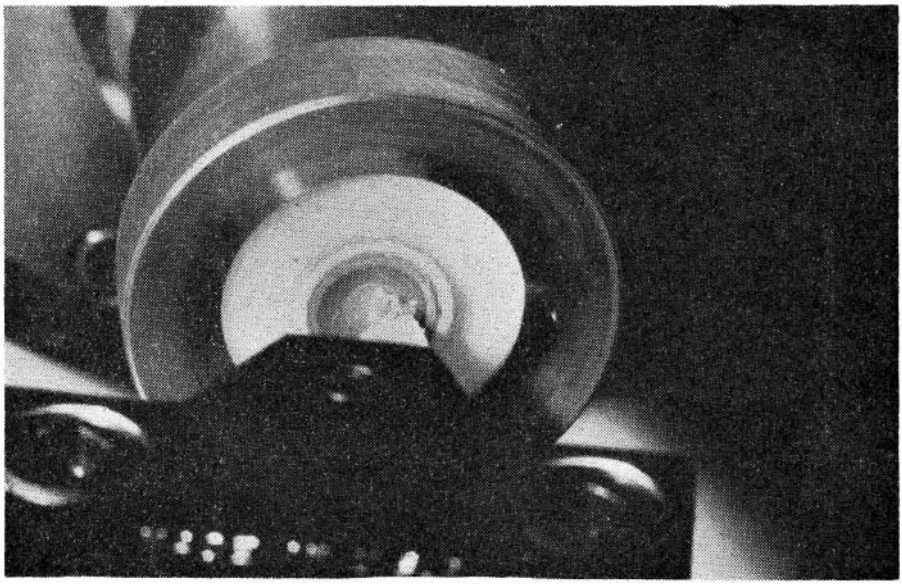

Figura No. 5

Cutting for the correction of myopia.

the overall contraction of the diameter of the disc which occurs on freezing. This is a consistent and considerable feature. The optical zone contracts in size so that the radius cut when the disc is frozen will become greater when unfreezing occurs. This factor leads to under-correction in keratomileusis for myopia and also in keratophakia. (Figs. 6 and 7. These two pictures and Fig. 8, were all taken from exactly the same angle and have the same magnification.)

This reduction in the disc diameter appears to be a major factor compared with the slight thickening of the centre of the disc, though in the correction of myopia, the two effects counteract each other to some extent. It is necessary to make a correction in the radius of turn to allow for the reduced chord diameter of the optical zone in the frozen state. Although after this correction the curve cut in the frozen state will be too steep, on unfreezing it will flatten out to the correct radius. (Fig. 8).

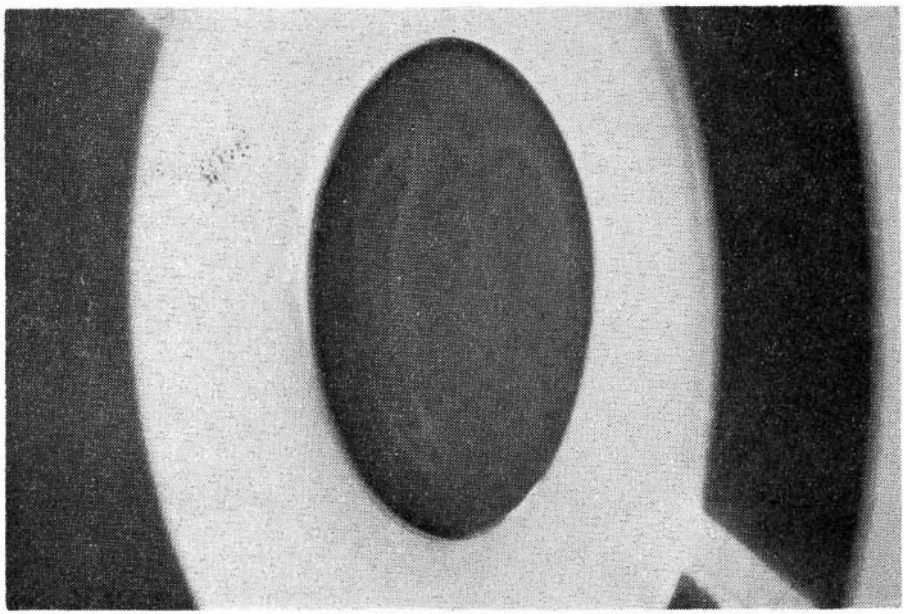

Figura No. 6

Corneal disc in position on lathe base prior to freezing. Base diameter 8 millimetres, disc diameter 8 millimetres.

At the present we are carrying out numerous measurements on discs cut from cadaver eyes in order to try to determine how constant is the change in shape which occurs on freezing. It is not possible at this stage to provide

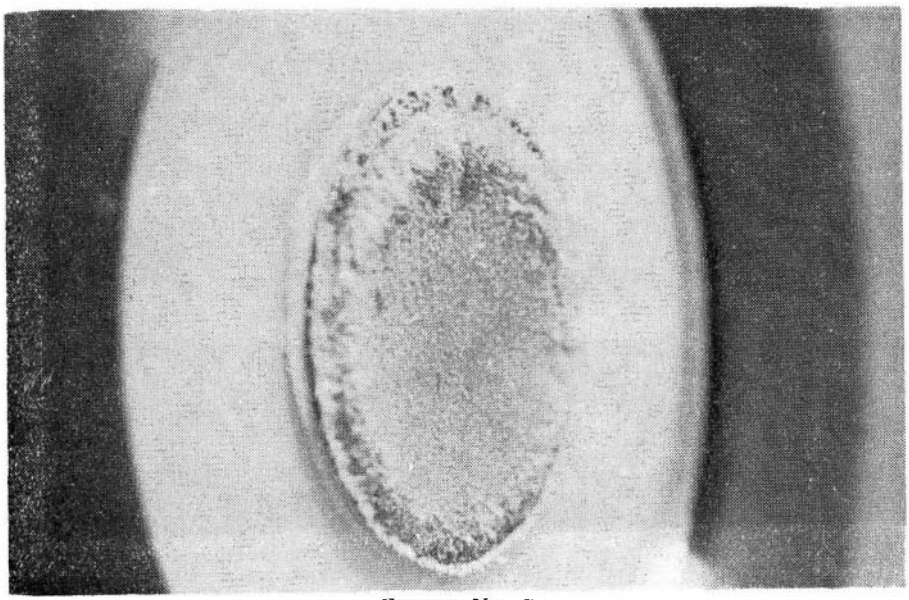

Figura No. 7

Disc frozen. Note reduction in diameter in relation to diameter of central button.

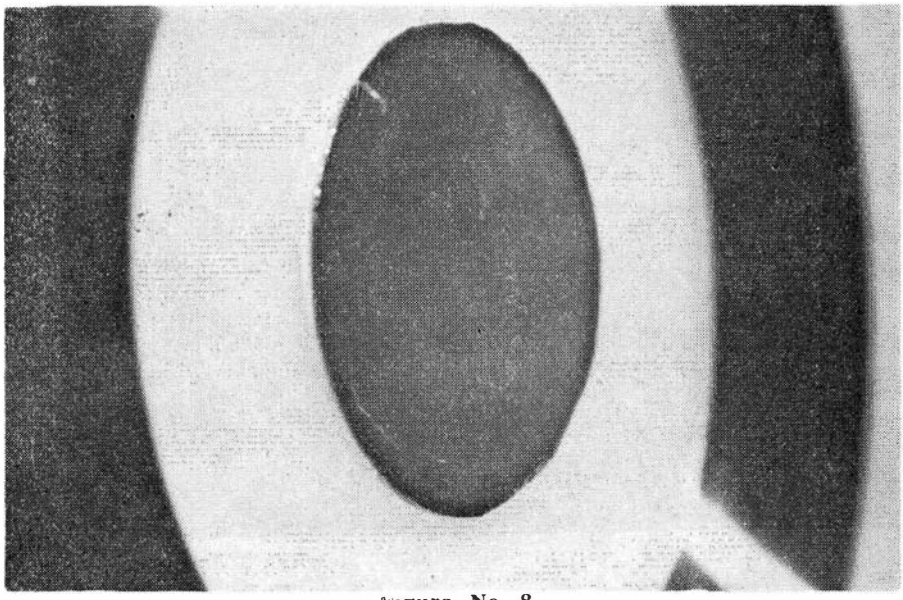

Figura No. 8

Disc unfrozen and remoistened. Note disc has returned to original size. This disc has not been cut on the lathe.

an accurate assessment, but it is our impression that individual corneal discs behave in a surprisingly similar manner.

The overall contraction of an eight millimetre disc is about 0.4 mm., but it is doubtful if this can be considered in simple linear terms. That a modification of the radius of turn along the lines discussed is helpful, appears to be borne out by early clinical results. The first few cases of keratomileusis for myopia, when no modification was made were considerably under-corrected. In subsequent cases I have corrected on the basis of a reduction in cord diameter of an optical zone of 6 millimetres to 5.7 millimeters on freezing. This has led to a great increase in the accuracy of correction achieved.

In keratophakia, before carving the lenticulus, it is necessary to take into account not only the above factors, but also the thickening of the disc of cadaver material resulting from post mortem oedema. In the frozen state, the centre thickness of the carved lenticulus must often be as much as twice the final thickness required.

(C) RECONSTRUCTION

Fine well curved cutting needles and 10/0 perlon required.
No special instruments.

(a) Keratomileusis

After unfreezing the disc, it is carefully replaced on the cornea and sutured with four perlon 10/0 stitches. Great care must be taken not to damage the disc as minimal damage leads to marked scarring in tissue that has been frozen.

In the earliest cases I used silk sutures, but this leaves a considerable permanent opacity. With perlon, the resulting nebula is very slight.

Following the initial suturing, a conjunctival flap, as described by Dr. Barraquer, has been used in all cases.

(b) Keratophakia

In keratophakia used for the correction of aphakia, a small convex corneal lenticulus is inserted into the corneal substantia propria. A disc of the patient's cornea is excised exactly as for keratomileusis, but it is replaced immediately and sutured in position with continuous perlon. The

ends of this continuous suture are, however, left untied. A disc of homoplastic cornea is obtained with the microkeratome and the lenticulus cut. The lenticulus is now slipped between the disc and the remaining part of the cornea. After careful centering of the lenticulus, the perlon suture is tied. Again, great care must be taken not to injure the lenticulus.

Undoubtedly, the most important part of the operation is the centering of the corneal lenticulus. Although accurate placement of the lenticulus is important, its final situation will be determined by the accuracy of the positioning of the excised disc of the host cornea. This in turn depends upon the accurate positioning of the fixation ring and the continuous perlon suture.

DISCUSSION

It is now nearly two years since my first visit to Bogotá. It took over a year to get the equipment together and assembled in perfect working order and it was necessary to follow this with many months of practice both with the microkeratome and the lathe, using cadaver eyes.

At the date of writing this article, (December 1968), I have had experience of actual operations for about six months. It has been necessary to proceed slowly, selecting cases only with absolute indications. Cases have been very carefully selected and have all been of high anisometropia. They have been cases in which there was hope of improvement in visual performance but where other means of correction for one reason or another had already failed.

All the cases of keratomileusis for myopia have from a technical point of view succeeded perfectly without any untoward occurence. There has in every case, been uneventful healing, a clean clear interface, perfect view of the fundus and an improvement in unaided visual acuity.

Furthermore, at the end of three months in no case of keratomileusis has the visual acuity **either corrected or uncorrected**, been lower than before the operation.

The first three cases were under-corrected by three to four diopters, but the more recent ones have been more accurate as a result, I think, of incorporating the correction in the radius of turn as mentioned in a previous section.

Only three cases of keratophakia have so far been performed (December, 1968). Two have been very successful and have had no serious complications. One of these developed transient superficial punctate epithelial erosions which cleared entirely in ten days. There has been very satisfactory reduction in the anisometropia, in one case from plus 13 to plus 1, and in the other from plus 12 to plus 2.

The third case also has good correction from plus 14 to plus 2, as estimated on the keratomer, but has developed a diffuse nebula in the anterior disc and at the anterior interface between the disc and the anterior surface of the lenticulus. The disc itself and the deeper interface are clear. This is the only case so far of either keratomileusis or keratophakia in which the visual acuity is less than before the operation. The vision at the last test was 6/60 with plus 2.00 DS/plus 1.00 cyl. ax. 55 degrees, as opposed to 6/36 with a plus 14.000 D. Sphere before the operation. It is now three months since this operation. The most likely explanation of the nebula formation is that the disc was cut too thin, leading to poor nutrition of this anterior lamellar during healing.

The two successful cases had discs of over 0.3 millimetres, while in this case it was 0.22.

It would be unwise to attempt to draw any firm conclusions at so early a stage my experiences in this new field of surgery. Nevertheless, added to the many successful results of Dr. José Barraquer, I think they constitute a further pointer to the value of the procedure. I hope, therefore, that this presentation will be of help to other beginners in this field and also stimulate further discussion among interested parties at the symposium in Barcelona in May. Pictures showing technical points and results will be shown at the Symposium.

ACKNOWLEDGEMENTS

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