tegrations for the fainter stars. This is a rule which is easily forgotten when programming the sequences in automatic mode, especially if the telescope is used by people with limited observing experience in photometry.

In the framework of the Long Term Photometry of Variables programme at ESO (Sterken, 1983), a lot of observing time has been attributed on the SAT. Several observers have carried out the observations with varying degrees of success. Each observer had about one month of observing time, and would design the programme on the spot (eventually along the lines of a programme made by a predecessor).

The graph shown in Figure 1 gives the rms value of the differential results obtained for pairs of constant stars having more than 10 measurements. This is probably the best estimate of the overall accuracy of each run. All observations occurred according to the same instructions, except for the first and last run, which are the only runs carried out by the same observer (C.S., but with a very different observing programme). The run indicated with a cross is an observing run carried out at the ESO 50-cm telescope, and is given for reference only. "Automatic" operation started in December 1987. It is clear that rather large variations occur between the DAN50 and SAT block of runs (in spite of completely comparable observing missions).

Though we cannot rule out a hardware effect, such as an incorrect centring procedure (which in the case of a spectrophotometer of this type would introduce larger scatter), we think that a large factor affecting the overall accuracy of the result may probably be found in the programmation of the SAT. The worst cases were obtained by inexperienced astronomers who wanted to write long programmes and leave the telescope alone during a major part of the night. It is absolutely necessary to do such programming very carefully and test the code exhaustively in order to avoid unpleasant errors. This shows the importance of the software in developing APT systems. A lot of planning has to be done before efficient observations are carried out. We conclude that automatic telescopes are an improvement only when they are being programmed by observers who have extensive experience in manually conducted observations.

## 3. Conclusion

The SAT telescope unveils the promises of automatic telescopes. It is a substantial improvement compared to the old Danish 50-cm configuration in almost every aspect. The experience we got on the SAT is certainly positive, but we believe that most of the problems we encountered would not appear in the APT environment.

Three major lessons have been learned.

(i) Automatic telescopes are only as good as the software that runs them. The programming language has to be highly sophisticated to allow very flexible operation during the observations. This is a clear example of a situation where expert-systems or "artificial intelligence" is needed. The similarity with satellite operation is striking.

(ii) A good programming language is not enough. Not only the instructions given by the astronomer must make sense, also the command files written by the user or the controller should be complete and well-tested.

(iii) Refurbishing an old telescope for automatic operation is not the only solution. The costs of retrofitting may even be comparable to the cost of building or buying a very compact specifically-designed photometric telescope.

Implantation and operation costs of automatic telescopes of the one-metre class are very small compared to the scientific return. Such photometric telescopes are fundamental as support for large ground-based telescopes and – as more and more astronomers have found out during the last years – also for observations from space. In addition, they can perform tasks that are too tedious to be undertaken by astronomers, such as monitoring of objects during several months. Moreover, such telescopes can be linked in a local or global network. A cluster of small automatic telescopes at ESO may become a crucial node in such a global network, and eventually provide a unique opportunity for European astronomers for collecting photometric data.

### *References*


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# New Literature in the La Silla Library

**Excerpt from TORUS by James Follett (Mandarin Paperbacks, London 1990), p. 205 to 217)**

". . . There were more celebrations at the end of 1989 when the excavation of the line of four thirty-metre-square pits was completed. Each of the huge pits was twenty metres deep. The model of the finished telescope in the planning office showed the four telescopes that made up the system aiming their lattice frameworks at the heavens like the projectors of a science fiction battle cruiser in a big budget space movie.

. . . It was the first telescope and not due to start observation work until 1999. The entire system of the four linked telescopes with their giant ten-metre diameter mirrors was not scheduled to be fully operational until 2002. Diem could only wonder at the determination of a people who, in their ceaseless quest for knowledge, were prepared to spend such vast amounts of money and resources. And it wasn't only the Soviets; giant telescopes were being built all over the Pacific by different nations, such as the mighty Geck telescope on Hawaii, although none rivalled the Kuro Multiple Mirror instrument that Diem's employers were building.

. . . Hundreds of computer-controlled actuators hooked to the back of the giant floppy mirror to maintain its parabolic curve – providing continuous compensation for distortions caused by wind, temperature changes and gravity. It was the design breakthrough that had made the ten-metre supertelescopes possible."

Like the person in this science fiction paperback playing in the late 1990's, did you never wonder at the *real* reason why we are prepared to sink so much money into supertelescopes? Here the stunning answer is revealed, together with design details that were till now not available in the open literature. Read all about CCDs, active optics, site selection techniques, mirror making and much more at a level *you* understand. The first two hundred pages are a bit dreary and consist of the usual staff thrillers are made of: determined men, beautiful women, violence and sex. After having plodded through this part, you'll be rewarded by insights into VLT budget fiddles and personalities of some key personnel.

Insiders will easily see through the obvious trick to replace ESO by a certain country and will have fun matching the book's characters (communists, crooks and mad scientists, sometimes all at once!) with their ESO counterparts. The ending of the novel is not to be revealed here. Let it suffice to say that it ends like all mad scientist projects.

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