

The signals that stars send in our direction encounter little hindrance on their way to us. It is only when they enter the atmosphere that the problems begin. For signals from powerful stars a method already existed to correct the interference. With the development by TNO of the Star Separator, the same correction is now possible for dimmer stars.



Foto: ESO



## ILLUMINATING A BILLION YEARS OF SPACE

# Star Separator makes dim stars more visible

**T**he further a star is from Earth, the longer it takes the light from that star to reach us. Which means that the most distant stars give us the opportunity to look back in time billions of years and get information about the past of both that particular star and the universe as a whole.

But the more distant the star, the weaker the signal. And that leaves astronomers with a problem because the signal has to get through the Earth's atmosphere with all its interference before it reaches their telescopes. 'Wagging,' is how Jan Hopman, project supervisor of the Star Separator calls this effect. 'Techniques have since been developed to compensate for the interference but, in principle, they only work for stars that emit a powerful signal. For their weaker kin it takes a lot of time to compensate and so you're always chasing after the changes.'

Astronomers of the ESO, the European Southern Observatory, studying the southern

night sky from an Andes peak in Chile, came up with a solution: 'Take two stars, a brighter and a weaker one, in close proximity. If you know how to correct for atmospheric interference for the brighter star, then you can do it for the weaker one too.'

A nice idea but in practice awkward. Hopman: 'You have to separate the signal from the two stars, which is possible by using a mirror with a kink in it. You let the signal from the bright star hit one side of the kink and the signal from the weaker star the other side. You then get two signal sets that you can analyse separate from each other. Sounds easy enough but to do it you need a level of accuracy that can only be achieved using highly advanced engineering. And that's what we've incorporated into the Star Separator.'

Hopman sums up a couple of the challenges. 'The material for the mirror has to be as smooth as it can be, which requires a special diamond-polishing technique.

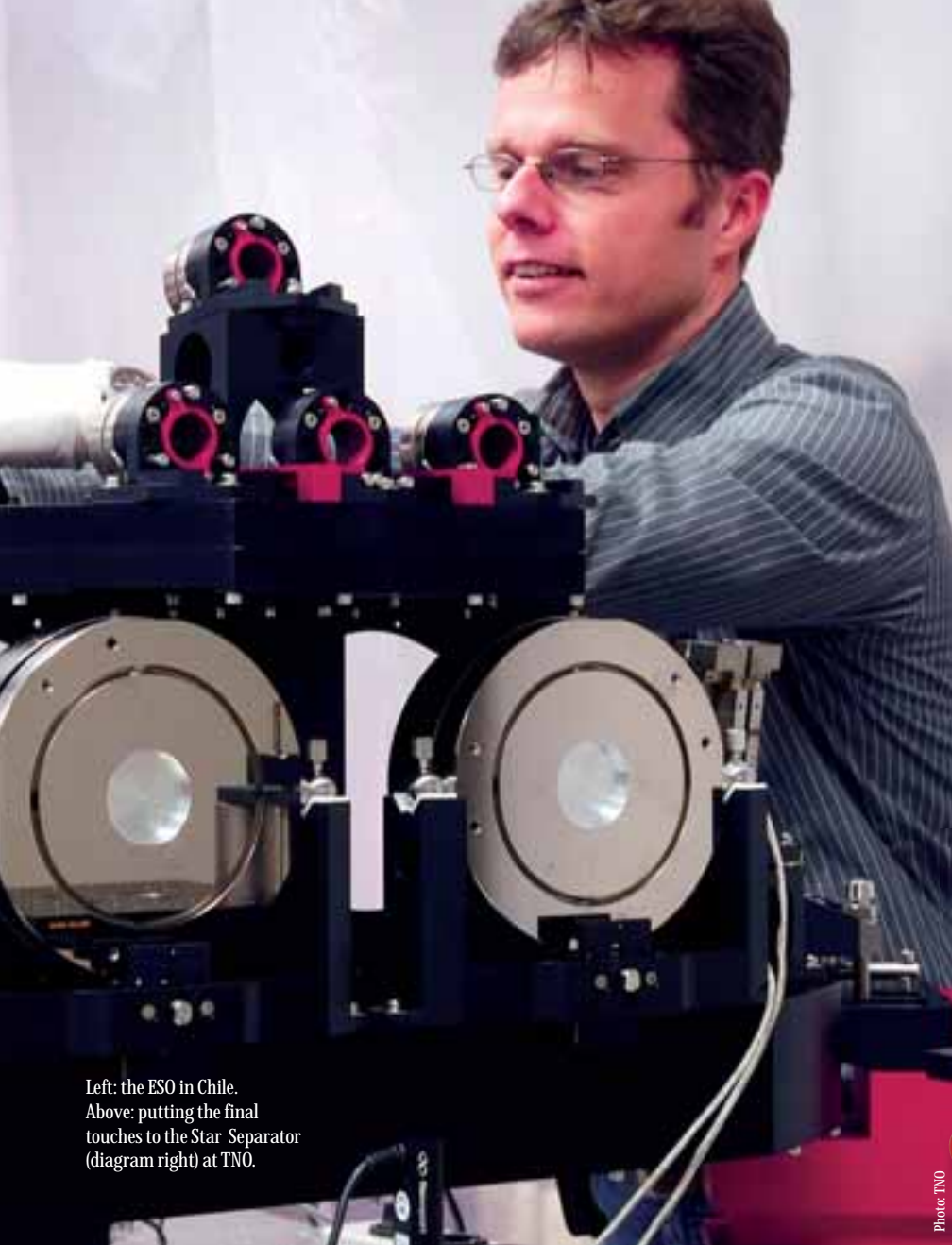
The separation edge of the kink has to be extremely precise. For the observations that the ESO astronomers want to make, the kink has to be not spherical but very sharp and yet even. A huge challenge. The mirror itself is an aluminium-based alloy; using this alloy for mirrors is new.

### On the edge

The first version of the Star Separator stands in an enclosed, clean room, almost ready

### Top rank

'We are working in the top rank of opto-mechanical instrumentation, and lead the world in that field in the broader terrain of applied engineering,' says marketing man, Ben Braam. 'It may sound somewhat arrogant, but I'm prepared to stand by the claim. And I'm not alone – reports by others, outsiders, back this up.'



Left: the ESO in Chile.  
Above: putting the final touches to the Star Separator (diagram right) at TNO.

## Polishing to the edge, and on the edge itself

Twenty micrometres wide, not spherical but as sharp as possible and a single piece. Those are the properties of the cutting face of the Star Separator. Project supervisor Jan Hopman: 'Those mirrors already have to be exceptionally even because you're dealing with weak signals from distant stars and want, therefore, to lose as little information as possible. But the ESO astronomers also want to make observations on the cutting face of the mirror, and that demands even greater precision.'

The cutting face is no more than a mere twenty micrometres wide, and it has to be polished. Hopman: 'We used a special method of diamond-polishing and it has put us on the edge of what is technically feasible and responsible. But tests have shown that it works.'



Photo: TNO

for transport to Chile. Hopman points to the engineering it contains: 'The mirrors have been hung tension-free so that no deformation can occur. The mirrors are, furthermore, bi-axial and the equipment set up in such an optical fashion that ultimately a signal set emerges that fulfils the requirements of the astronomers. An advanced design by Huib Visser, our optics specialist. We work on the edge of what is technically feasible, without incurring excessive risk.'

TNO is hard at work completing the assignment to build four Star Separators – two large and two smaller ones – and ESO is expected to place a further, similar order. But isn't that too little of a result for something that contains so much knowledge and intensity?

'I can imagine that it would prompt such a question,' admits Ben Braam, business

developer for TNO's space and astronomy activities. 'It is indeed a wonderful device. And yet that's its inherent problem. TNO is simply good at optomechanical instrumentation and solves complex problems for the space industry and science. The equipment we develop is customised for the problem presented, so it's unique. So it is not so widely applicable in other forms of business and industry.'

### Opportunity abounds

The engineering itself, says Braam, can be used elsewhere. 'For instance, for Philips or for the precision engineering for the wafer stepper manufacturer ASML, which has been working for years with the knowledge that TNO has acquired via the space industry. But for the short term, anyway, application of the gadgets we have thought up for the Star Separator will be largely restricted to

assignments for astronomers. The cost of using our advanced engineering should not have to be a problem, especially for customers who opt for quality and durability. With the Netherlands a leader in precision engineering for machine-building, opportunity abounds.'

ESO knew the value of the TNO expertise. Hopman: 'They came to us for our knowledge of optics, and the fact that we have the entire TNO organisation behind us, with its broad range of disciplines and the capacity to make use of this breath of knowledge. This assignment in itself was a challenge, in part because younger staff were able to gain and make knowledge with these kinds of projects. Thus the Star Separator becomes a building block for subsequent projects.'

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