

**From:** db106@hermes.cam.ac.uk on behalf of David Buscher [dfb@mrao.cam.ac.uk]  
**Sent:** Wednesday, April 27, 2005 3:58 AM  
**To:** Chethan Parameswariah  
**Cc:** 'Chris Haniff'; Jonathan Kern  
**Subject:** Re: Resolution of the optics in beam relay pipes

No such formal document exists, but the requirements can be relatively briefly set out:

We are concerned about two parameters, beam shear and beam tilt. In all cases, it is the worst case of these two we will use as setting the requirement.

For the beam shear the goal is less than 1% of the beam diameter, i.e. less than 0.95mm for a 95mm beam diameter (beam relay), less than 0.15mm for a 15mm beam diameter (BCA). For the beam relay, the worst case path length is 600m, so the optical tilt requirement is  $0.95\text{mm}/600\text{m} = 1.6$  microrad. The mirror tilt gets multiplied optically by a factor of 2 so the mirror tilt resolution requirement is 0.8 microrad.

In the BCA, the requirement is 0.15mm over 20m giving 7.5microrad, and applying our factor of 2 we get 3.75 microrad.

Note that in terms of the actuator linear resolution requirement, the BCA and the beam relay requirements are approximately the same, because the lever arm across the mirror is smaller by about a factor of 8 in the BCA (the mirror is smaller), but the angular requirement is about a factor of 8 more lax.

For beam tilt, the requirement is a visibility loss of less than 1%. This leads to a requirement of an optical tilt error of less than  $0.0885 \cdot \lambda/D$  where  $\lambda$  is the wavelength and  $D$  is the beam diameter. Taking  $\lambda$  as 1.6 microns, and dividing by two to allow for the difference between mirror tilt and optical tilt we get an allowed mirror tilt of 0.75 microrad for  $D=95\text{mm}$  and 4.7 microrad for  $D=15\text{mm}$ .

The other question is the tilt \*range\*. This is given by the worst-case beam shear than needs to be taken out over the smallest pathlength. This occurs in the beam relay on the west arm. If the telescope is placed incorrectly by 5mm, we have a path of order 5m over which to correct this before it must be travelling exactly along the center-line of the delay lines, and so we must be able to introduce a mirror tilt of at least  $5\text{mm}/5\text{m}/2 = 0.5$  milliradian.

David

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On Tue, 26 Apr 2005, Chethan Parameswariah wrote:

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> Hi David or Chris,
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> Can you point me to the document that specifies the angle resolution of the
> optics in beam relay pipes?
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> Chethan
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> --
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