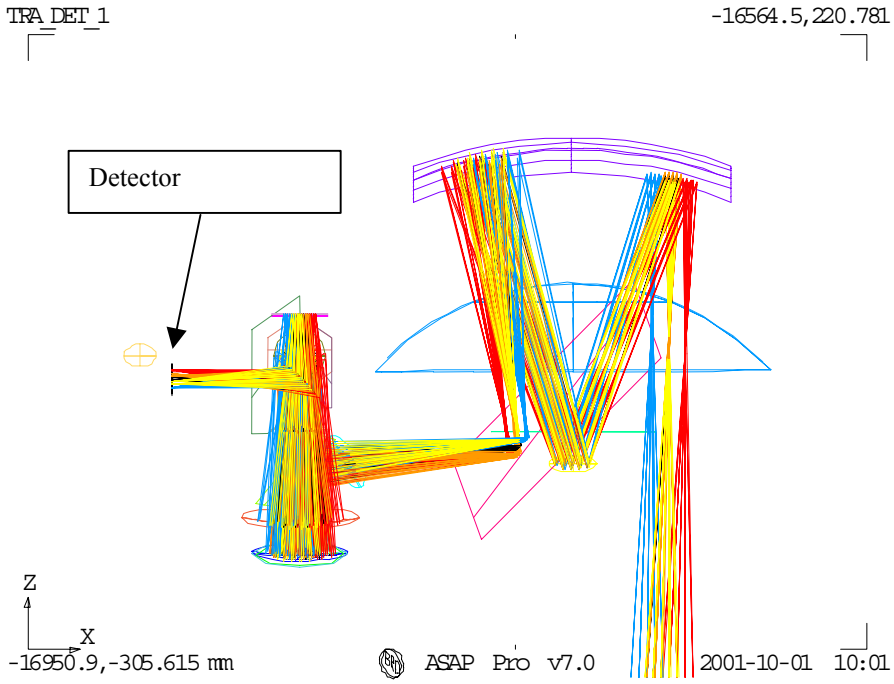
SPIRE Technical Note
SPIRE-RAL-NOT-001135
Martin Caldwell – RAL
Issued 1/10/2001

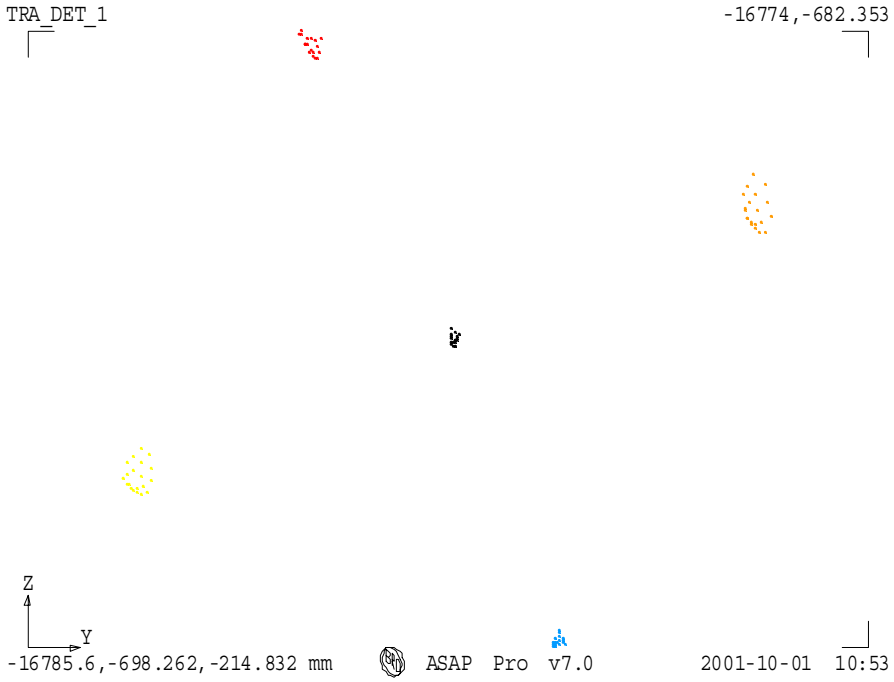
Notes on Re-design for Telecentric FTS Focal Plane.

1. Use of silica field lens

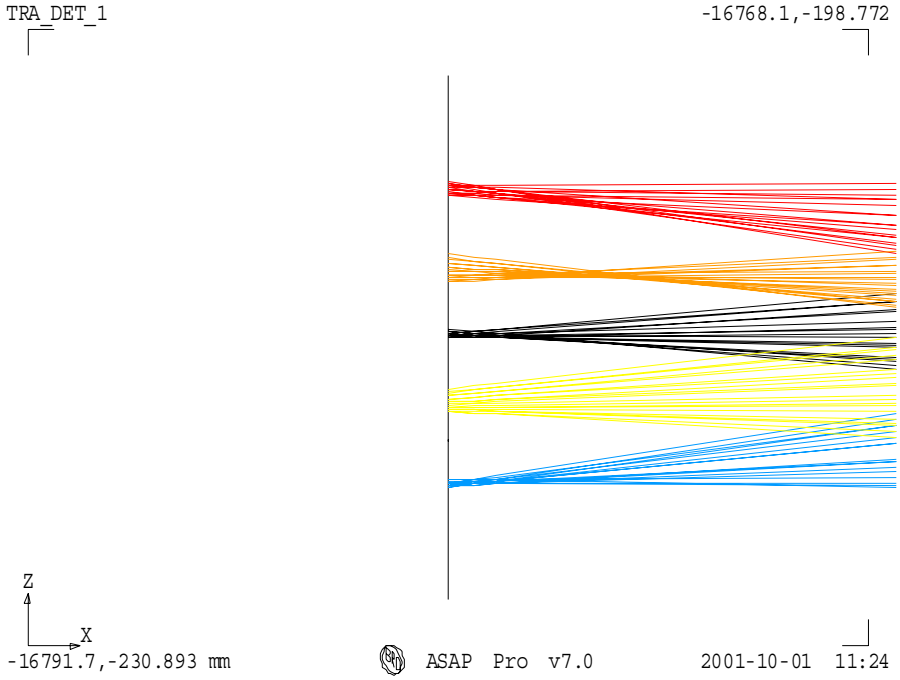
The current SPEC design bolsp502 is shown below, in a detector side-view.

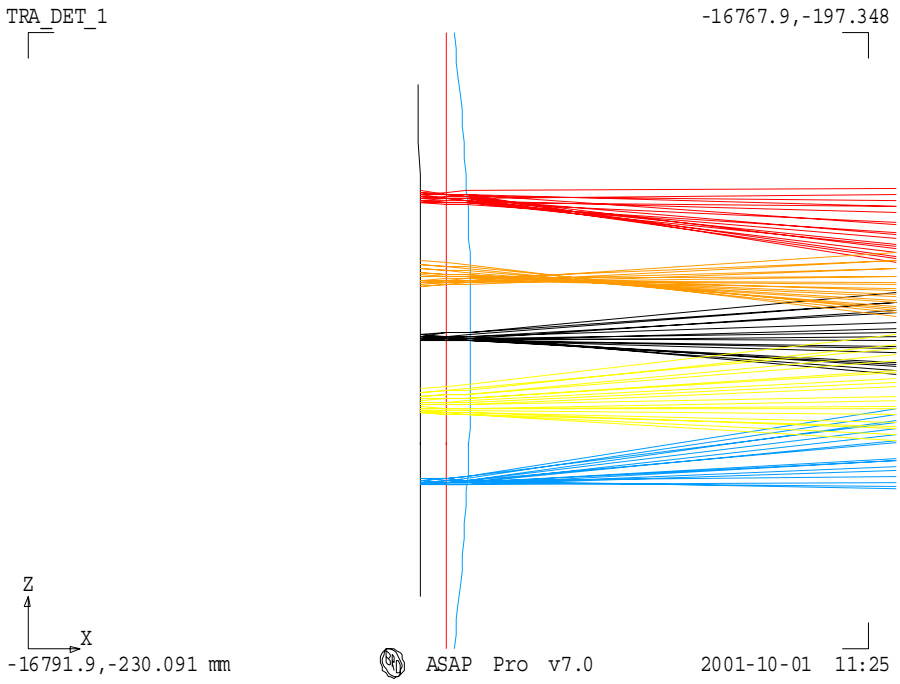


The spot diagram at the detector, for +-Y & +-X fov of 1.3arcmin radius agrees with the synopsis model:-



The next two figures show a close-up side-view of the detector area, with & without a pupil-correcting field lens in place.





Field-correcting lens at detector.

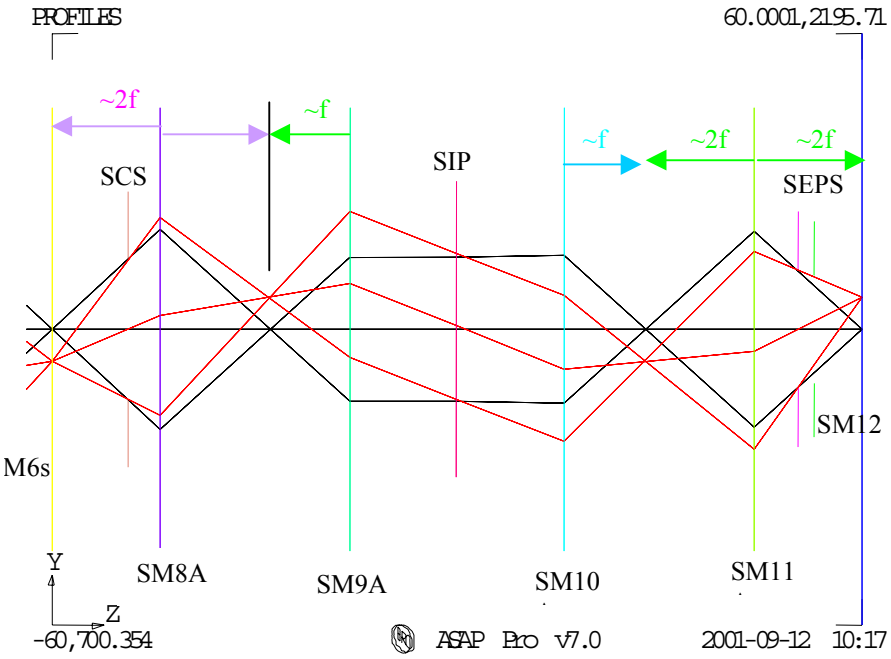
The lens is plano-convex made from silica with n=1.9 at the SPIRE wavelengths. It is 1mm thick & placed 1mm ahead of the image plane. Its focal length is set equal to the exit pupil distance. The effect on pupil position is somewhat masked by the aberrations that are present, but gauged from ray direction statistics the deviation in the centroid direction of each ray bundle from the on-axis beam is found to be < 1/6 of that without the lens. For best performance in pupil aberration the lens would be placed the other way round, if that isn't a problem for mounting on the filter.

The lens does produce a de-focus effect, which is similar to that produced by the finite horn lengths & can be calculated using the same gaussian beam equations (NOT-566). For a 350um centre wavelength the effect is a

shift of 1.7mm in the optimum horn position, in +ve X of the diagram. To avoid this effect the lens would have to be made as an array of wedges, one per detector.

2. Re-arranging mirror powers.

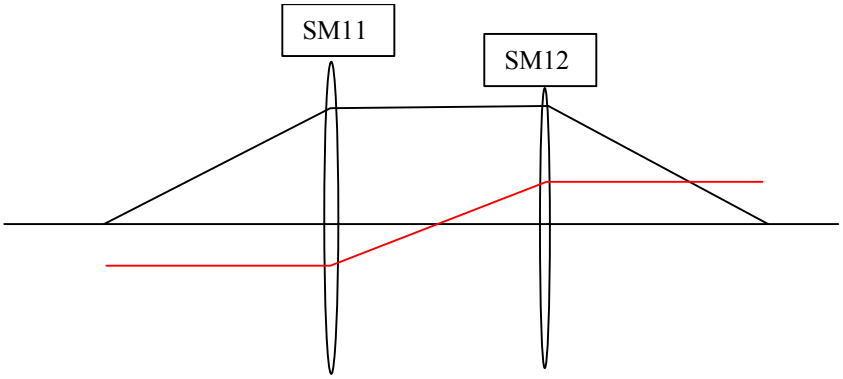
The unfolded imaging scheme is in the figure below, where the mirror spacing in terms of mirror focal lengths is shown to illustrate the imaging scheme.



So approximately: SM8 is a 1:1 relay, SM9 & SM10 are collimate & re-focus, SM11 is a 1:1 relay.

The question is whether by adding power to SM12, the system could be made (more) telecentric. To maintain the f-number & plate-scale it would be necessary to also change the power on another mirror to compensate. The only possibility is SM11 if the change is to be not too dramatic for the whole system (Changing SM10 would break the I/F symmetry).

For a re-design of SM11 & SM12, the problem is that the rays are already almost telecentric on leaving SM10, since the distance SIP-SM10 is close to the SM10 focal length. Plus the beam is close to the required f-number. (The focus of SM10 wouldn't be a bad place to put the detector if we weren't still in the interferometer section at this point!). With a single 'lens' at SM11 as in the current design the 1:1 imaging required for the f-number turns the approx. telecentric input to non-tele output. With a two-lens scheme (SM11+SM12) the arrangement which keeps the 1:1 imaging & telecentricity is shown in the fig. below.



Black= on-axis beam imaged 1:1, extreme (~f/5) ray.
Red= off-axis beam, chief ray.

The total length of such a system is 6f where f is SM11 focal length. The distance SBS - SM11is ~200mm in the design & can't be significantly reduced. This would be a distance 2f, leading to an overall length of ~ 600mm which is much too large to be accommodated.