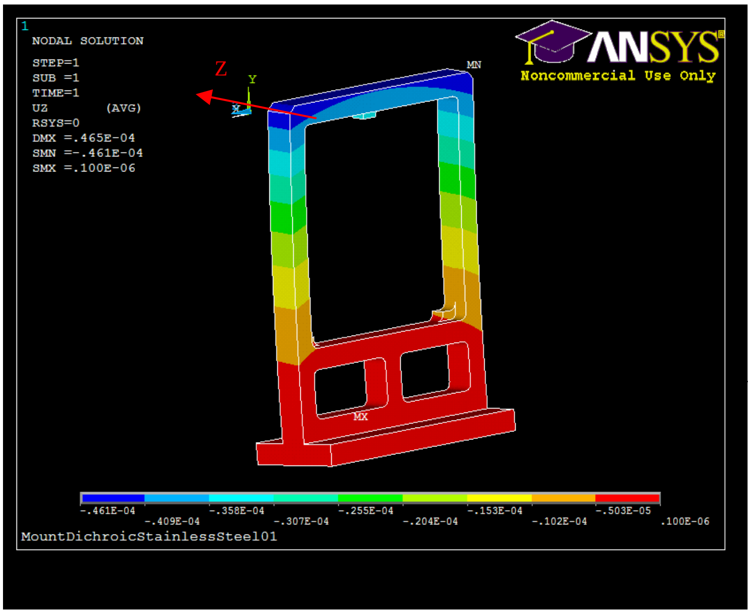
High Priority Tasks

- Repeat previous analysis of dichroic mount under temperature gradient for a stainless steel mount - find acceptable temperature gradients

(1) Acceptable temperature difference between the left and right surfaces of the dichroic mount for 0.05´´ tilt angle of optics

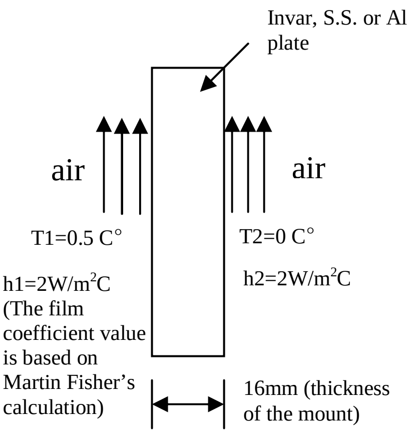


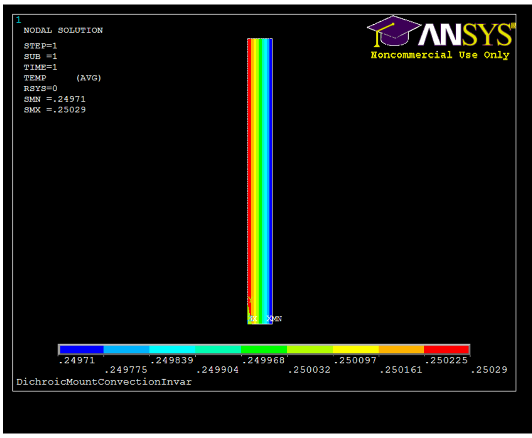
Stainless Steel for example: 0.002 C° was applied on the left vertical surface of the mount while 0 C° was applied on the right vertical surface. The contour picture shows the displacement of the mount along the Z direction (the unit is in millimetre).

Table 1:

	Invar36	Stainless Steel 304	Aluminium6061
Acceptable temperature difference	0.05 C° (the CTE was selected as 0.7 for the FEA)	0.002 C° (the CTE was selected as 17.2 for the FEA)	0.0015 C° (the CTE was selected as 23 for the FEA)

(2) Analysis of the temperature gradients of the mount generated by an ambient temperature difference of 0.5 C° on both sides of the mount





Invar for example: This FEA shows that when the difference of the air temperature is 0.5 C° on both sides of a 16mm thick invar plate, the temperature difference between the two vertical surfaces is 0.00058 C°.

Table 2:

	Invar36	Stainless Steel 304	Aluminium6061
Temperature difference between the left and right surfaces of the mount generated by the 0.5 C° ambient temperature difference	0.00058 C°	0.0004914 C°	0.000056 C°

More FEA have been done which shows that the temperature difference between the left and right of the mount is proportional to the film coefficient value and the ambient temperature difference.

- Calculate bending under thermal gradient of invar or stainless steel baseplate, sized for any of the 3 (plus 1 variation) candidate layouts

Assuming that the thickness of the plate is 12mm, the ambient temperature difference between the top surface and the bottom surface is 0.5 C°, and the film coefficient value is 10W/m^2 C° for both sides of the plate, the temperature difference between the top and the bottom surfaces of the base plate is calculated as 0.00218 C°, 0.00184 C° and 0.00021 C° for Invar, Stainless Steel and Aluminium respectively based on the values on Table 2. As the distance between the dichroic and the far optics, i.e. Folding Mirror 1 or OAP, is either about 560mm (for the DLT and the DT Two lenses Compact) or about 1000mm (for the RF and the old version DT), the bending of the base plate can be obtained according to equation $\theta = W \times \Delta T \times k / h$. The results are shown on Table 3.

Table 3:

	Invar36 (k=0.7)	Stainless Steel 304 (k=17.2)	Aluminium6061 (k=23)
Temperature difference between the top and the bottom surfaces	0.00218 C°	0.00184 C°	0.00021 C°
Bending angle of the 560mm long plate (arc sec)	0.0145	0.305	0.0475
Bending angle of the 1000mm long plate (arc sec)	0.026	0.545	0.085

- Estimate material and machining costs for invar baseplate, sized for any of the candidate layouts

Table 4 shows the cost estimation for the components made of Invar. The CCR and CCD camera mounts are not included on the table as they may not use Invar material. Some possible jigs which may be used for component alignment are not included either. Table 5 shows the estimated cost of the base plate related components with different layouts. Stainless steel material is added to Table 4 and 5 for comparison with Invar.

Table 4:

S.S./Invar36	Material cost	Machining cost	Cost
Dichroic mount (2 major parts)	£180/£900	£300/£540	£480/£1440
Folding mirror 1 mount (2 major parts)	£160/£800	£280/£500	£440/£1300
Folding mirror 2 mount (2 major parts)	£160/£800	£280/£500	£440/£1300
Positive lens mount (2 major parts)	£160/£800	£280/£500	£440/£1300
Negative lens mount (2 major parts)	£150/£750	£280/£500	£430/£1250
OAP mount (2 major parts)	£200/£1000	£300/£540	£500/£1540
Small base plate	£380/£1900	£1000/£1800	£1380/£3700
Large base plate	£760/£3800	£1500/£2700	£2260/£6500
Parts for clamping the optics on each mount	£30/£150	£120/£220	£150/£370
Parts for supporting and clamping the base plate*	£120/£320	£400/£580	£520/£900

*this is based on an assumption that some clamping parts are commercially available. Otherwise, the cost should be higher.

Table 5:

	DLT with a dichroic, a positive lenses and two folding mirrors and a small base plate	DT1 with a dichroic , a positive lens and a negative lens, a folding mirror and a small base plate	DT2 with a dichroic, a positive lens, a folding mirror and a large base plate	RF with a dichroic, a OAP, a folding mirror and a large base plate
Total cost (S.S./Invar)	£4300/£11420	£4290/£11370	£4590/£12550	£4650/£12790

As Invar 36 has a very close CTE to fused silica, the design of the interface between the optic and the mount can be simple. Stainless steel (or aluminium) mounts could be more complex than invar parts as the mount/optics interface needs to be dealt with due to a large CTE difference. The above tables did not take the complexity into account at this moment.

When machining Invar components, heat treatment may be needed to incorporate the machining procedure as the heat generated by the metal cutting may disturb the CTE value. Our workshop may have problem on the machining as our machine tool do not have a coolant supply (the machining of stainless steel also needs flood coolant to avoid a very quick cutter wear). After machining, nickel or chromium plating may be needed to protect the invar parts from corrosion. The costs for plating the parts should be quite cheap as long as they are plated in one go.