4.8 ASAP Analysis of Ghosts Caused by Optional IR ADC

The proposed alternate IR ADC for Altair is composed of two prism pairs of barium fluoride (BaF_2) and zinc sulphide (ZnS). Incident light to the ADC is partially reflected at each of the surfaces by an amount depending on the coating used for each substrate. In the ASAP analysis the beam splitter (fused silica) was included -- the coating on all 6 surfaces was MgF_2.

For this study, ghosts arising from only 2 reflections for any light ray are considered. Table 4.8 shows that the straight-through light makes up 99.1968 percent of all the light hitting the detector and its image occurs close to the centre at (–0.0202, -0.0199). Ghosts are listed in order of their intensity.

Ghost contributions come from various component surface pairs, the strongest originating from the boundary of the ZnS and BaF_2. The refractive index difference between these two materials is the cause of the ghost and with an appropriate coating, such as hafnium oxide, the percentage contribution is reduced from 0.2 to 0.03 percent. The resulting improvement can be seen in Figure 2.

Figure 4.14 gives the relative placements of all ghosts above 0.01 percent contribution. Note that the ghosts from the beam splitter are near the centre but are slightly offset. Actual locations of the origins of all ghosts can be found by comparing the designations and relative positions in Figure 4.14 and Figure 4.17. Plots of the individual ghosts at large scale have been omitted for brevity. Their locations are plotted on a reduced scale at the detector in Figure 4.14.

Figure 4.15 shows the non-ghosted light at the detector when the ADC and beam splitter are coated with MgF_2 (1.3 µm, ¼ wave). Also shown is the throughput of the whole system assuming the MgF_2 on the beam splitter and ADC and perfect reflections on the flat mirrors in the rest of the system. Very little absorption occurs in any of the substrates used: fused silica, ZnS, or BaF_2. Another curve in the Figure shows that, if hafnium oxide is used between the ZnS and BaF_2 substrates, then the contribution from the ghosts is significantly reduced. Instead of the direct (non-ghosted) light making up 99.2% of the total incident light it increases to 99.8%. The strongest (in terms of flux, not brightness) ghost decreases from 0.2% to 0.03% of the total incident light on the detector. It is obvious that a judicious selection of coating materials for the various substrates will increase the throughput and non-ghosted light significantly.

Figure 4.16 is an enlarged view of the non-ghosted light on the detector at a range of wavelengths. For the present analysis the ¼ wavelength thicknesses of the coatings refers to 1.3 µm.

path	percentage	First reflection	Second reflection
1	99.1968	Straight through	
2	0.2020	G…BAF2-ZNS	D…ZNS-BAF2
3	0.0716	G…BAF2-ZNS	F…AIR-BAF2
4	0.0696	E…AIR-BAF2	D…ZNS-BAF2
5	0.0690	G…BAF2-ZNS	E…AIR-BAF2
6	0.0670	F…AIR-BAF2	D…ZNS-BAF2
7	0.0534	D…ZNS-BAF2	C…AIR-ZNS
8	0.0534	H…ZNS-AIR	G…BAF2-ZNS
9	0.0449	G…BAF2-ZNS	C…AIR-ZNS
10	0.0449	H…ZNS-AIR	D…ZNS-BAF2
11	0.0297	B…FS-AIR	A…AIR-FS
12	0.0244	F…AIR-BAF2	E…AIR-BAF2
13	0.0161	E…AIR-BAF2	C…AIR-ZNS
14	0.0161	H…ZNS-AIR	F…AIR-BAF2
15	0.0156	F…AIR-BAF2	C…AIR-ZNS
16	0.0156	H…ZNS-AIR	E…AIR-BAF2
17	0.0100	H…ZNS-AIR	C…AIR-ZNS

Table 4.8 – Relative Percentages of the Total Light Incident on the Detector for the Altair IR ADC

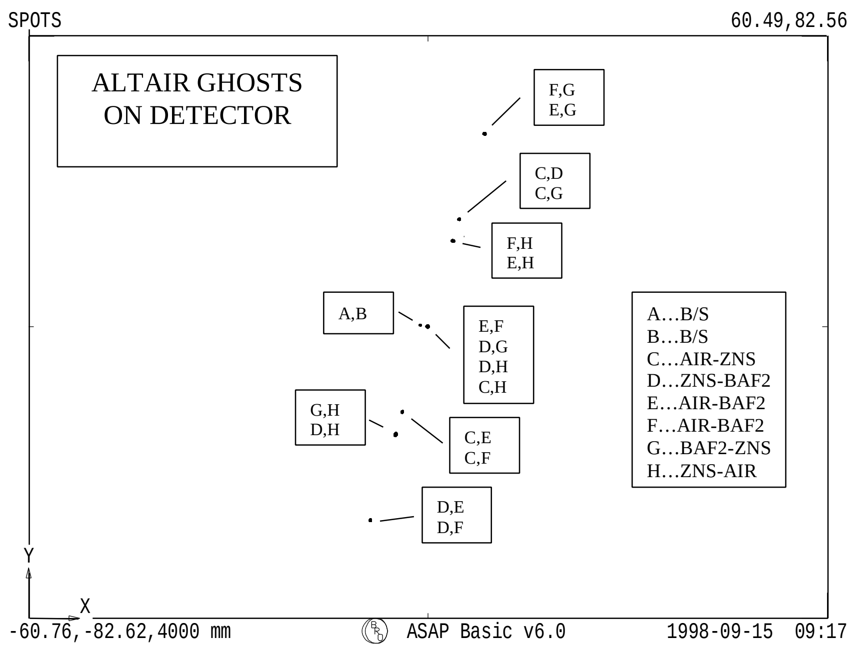

Figure 4.14 – Position of the Altair IR ADC Ghosts on the Detector

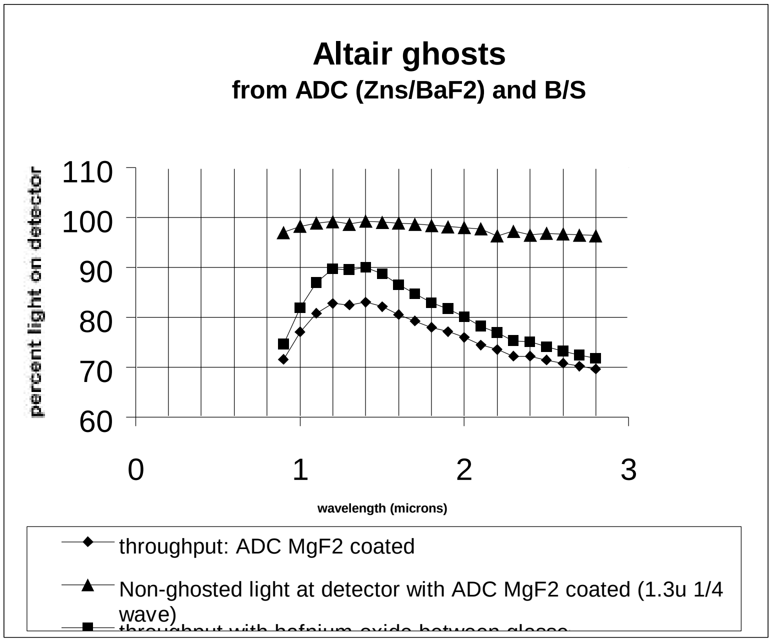

Figure 4.15 – Throughput and Non-ghosted Light for the Altair IR ADC Path

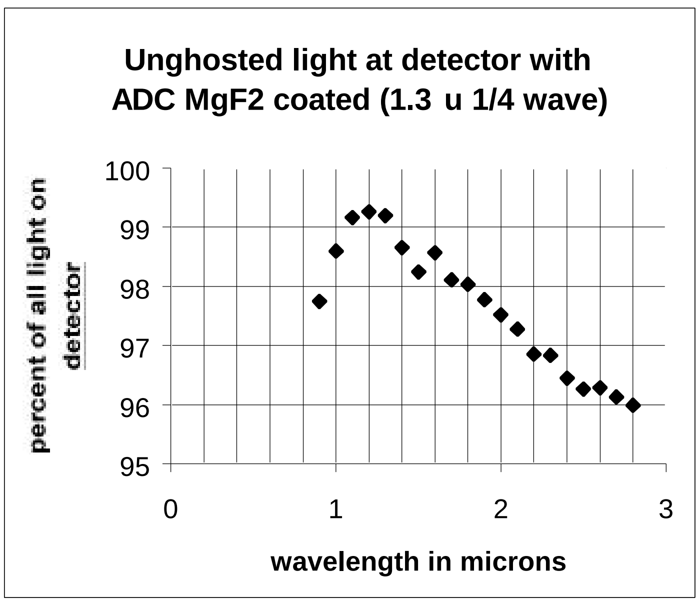

Figure 4.16 - Non-ghosted Light at the Detector of the Altair IR ADC Path

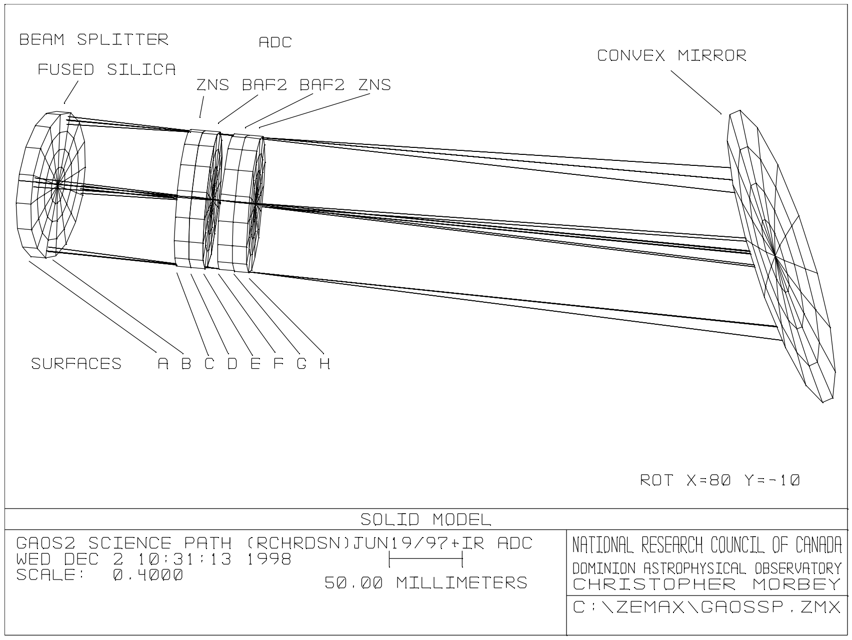

Figure 4.17 – Portion of the Altair Science Path Including the IR ADC