SUBJECT: **Proposed shapes for Spectrometer baffle apertures at SBS1 and SBS2.**

PREPARED BY: **A G Richards**

KEYWORDS:

COMMENTS: **This document shows how boundaries are derived for apertures in baffle plates located where spectrometer beams cross at the locations of both beam-splitters, SBS1 and SBS2.**

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1. INTRODUCTION

Figure 1 shows an assembly of some of the 20% oversize beam envelopes that enclose the geometrical optical beams passing through the SPIRE spectrometer. The spectrometer beams are shown in red. Some of the photometer beam sections are also shown in blue. Two proposed baffle plates are also shown and they are coloured green.

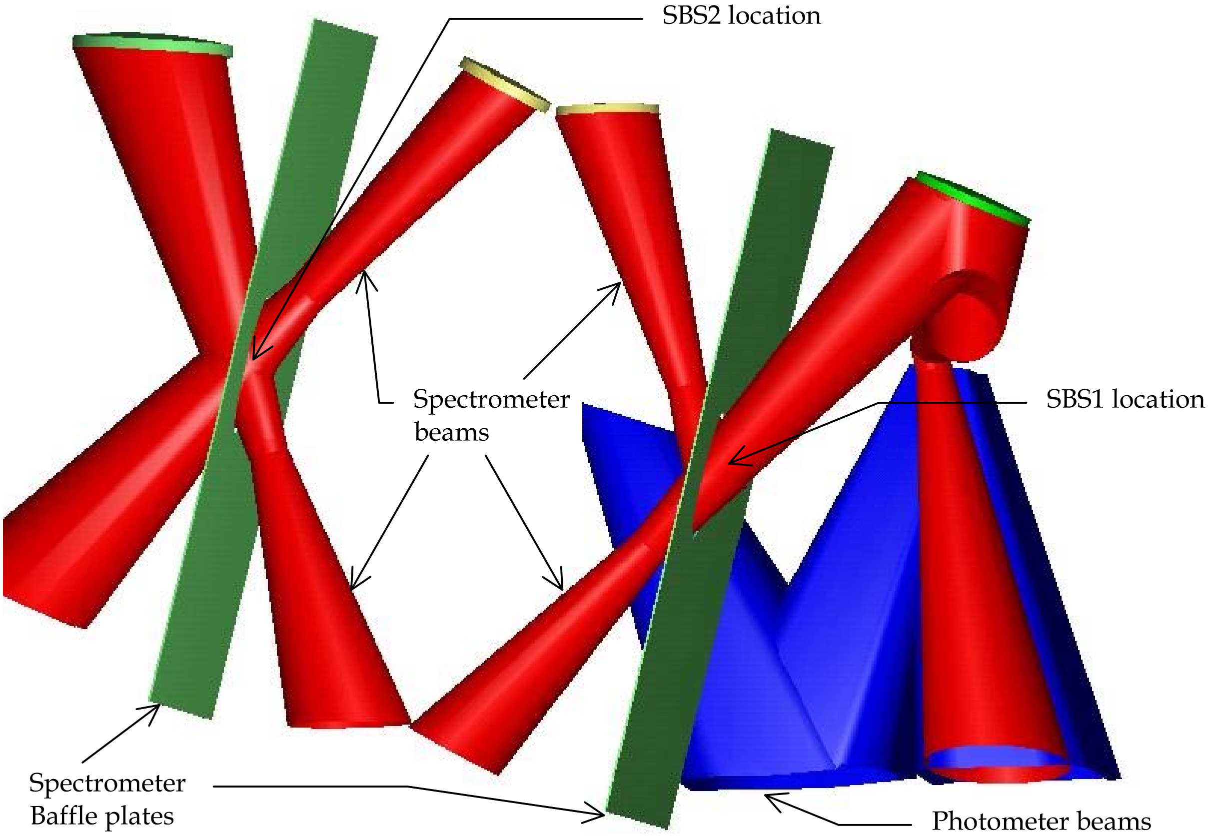

Figure 1 SPIRE Spectrometer beam envelopes showing proposed baffle plates.

The baffle plates are located in planes which cross the spectrometer at the locations of the two beam splitters, SBS1 (on the right) and SBS2 (on the left). This note describes how the dimensions were determined for the apertures needed in each plate so as to clear the oversized optical beams that cross at each beam splitter.

2. THE MODELLING METHOD

The method involved identifying all the beam envelopes involved at each beam splitter, selecting those made 20% oversize compared to the geometrical beams traced from both of the spectrometer detectors[1]. The beams crossing at SBS1 were input to MATHCAD file

[1] Separate beams were generated with the corner cube assembly shifted to both extremes of travel.

SBS1BEAMS.MCD and the beams crossing at SBS2 were input to MATHCAD file SBS2BEAMS.MCD. For each beamsplitter, sectional planes such as P1 and P2 in figure 2 were identified, passing through the extreme points E1 and E2 that exist inside the two 'elbows' made by the crossing beams above and below the plane of the beam-splitter.

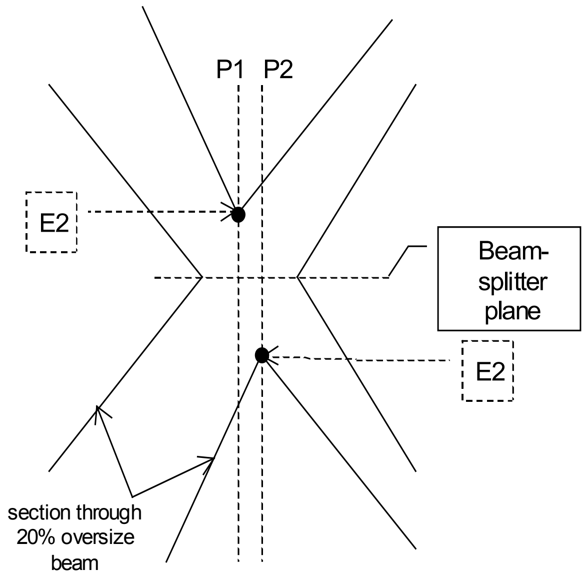

Figure 2 Schematic showing 'elbows' where oversized beams cross at a beam-splitter

At SBS1, the lateral separation between P1 and P2 was found to equal 0.2 mm. At SBS2 it was found to be 0.6 mm. These separations were small enough to permit a baffle plane to be located midway between P1 and P2 at each location, with a specified baffle plate thickness of 1 millimetre, such that the two faces of the baffle plate straddled the elbow vertexes as shown in figure 3.

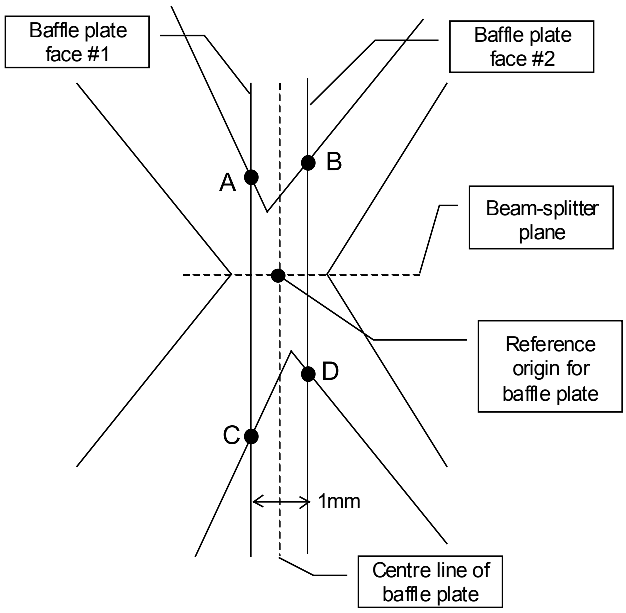

Figure 3 Schematic showing sectional planes defined by a proposed baffle plate

The choice of boundary for the aperture to be cut in the baffle plate was driven by which of the points A, B, C or D was furthest from the line defined by the beam-splitter. A reference origin was defined where this beam splitter plane cut the plane through the centre of the baffle plate. In the example shown in figure 3, the cross-section through the beam in the plane of baffle plate face #1 extending from the beam-splitter plane out to point C drives the aperture size. In order to ensure a minimum clearance between the edges of an aperture and the 20% oversize beams, an additional clearance Δ = 3 mm was added.

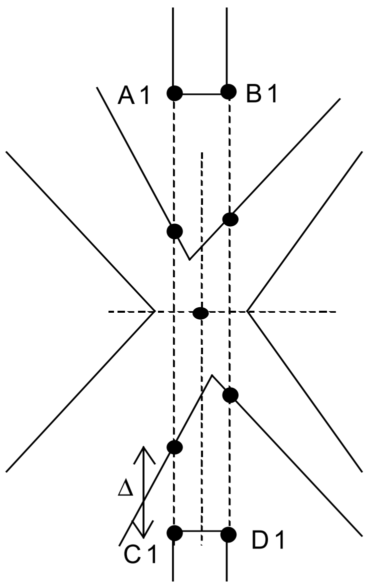

Figure 4 How the clearance aperture in the baffle plate is defined.

In figure 4, the points C1, D1, A1 and B1 are equidistant from the beam splitter line through the reference point in the section shown. In figure 5 we show the composite boundaries of actual cross-sections through beams together with the clearance aperture boundary chosen for the baffle plate at SBS1. Figure 6 shows the same for SBS2

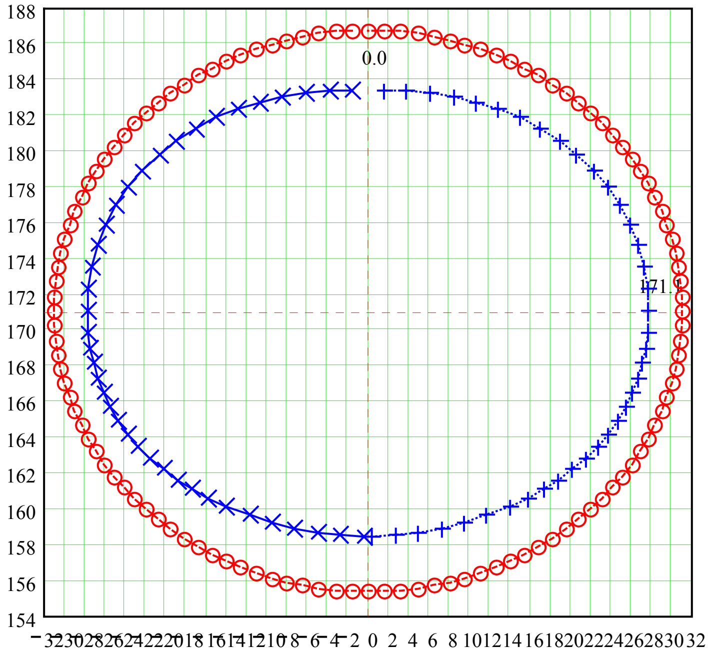

Figure 5 Elliptical clearance aperture boundary in SBS1 baffle plate

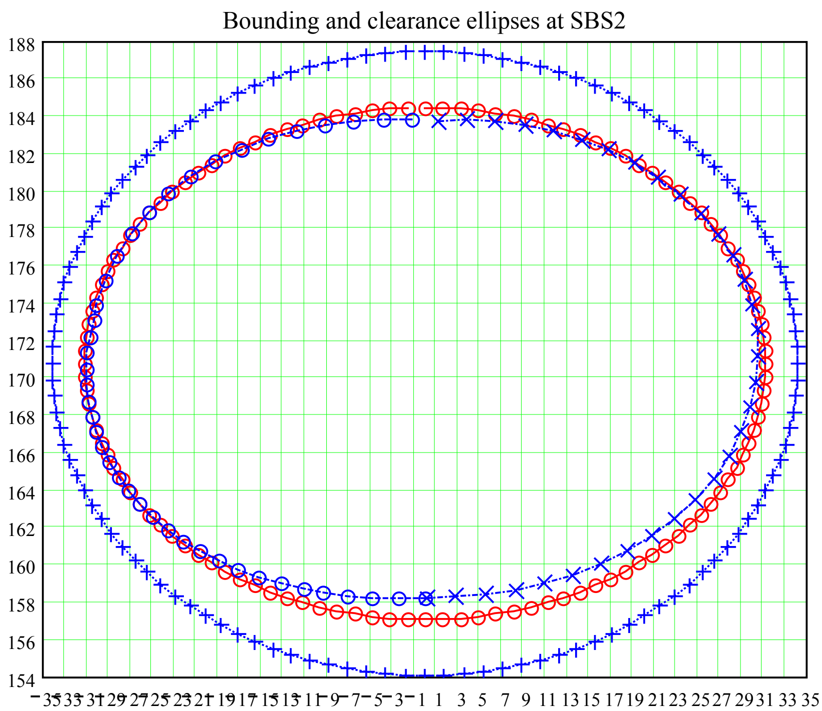

Figure 6 Elliptical clearance aperture boundary in SBS2 baffle plate

The details of each elliptical aperture boundary are given in table 1. The reference points at the centre of each ellipse are given in one of the two co-ordinate systems shown in figure

7. The reference points are in a plane equidistant from both faces of the particular baffle plate. Since the baffle plates are selected to be 1 mm thick in the Ycv direction, the reference points for the apertures in each baffle plate face will be located at Ycv+0.5 and Ycv-0.5 mm.

	Ellipse centre co-ordinates			Semi-major axis	Semi-minor axis
Baffle	Xcv	Ycv	Zcv	'a'	'b'
SBS1	171.1	-323.498	223.128	31.0	15.7
SBS2	170.8	-541.596	223.128	33.2	15.7

Table 1 Spectrometer Baffle plate elliptical boundary data

Optical beam and aperture data is originally generated in a 'CODEV' reference frame labelled 'cv' in figure 7. The beam and aperture data (including IGES formatted data) are eventually transformed to a 'SPIRE' reference frame labelled 'spire'. The elliptical apertures are in a plane parallel to the Xcv-Zcv plane (or Yspire-Xspire) with the semi-major axis 'a' aligned with Zcv (or Xspire) and the semi-minor axis 'b' aligned with Xcv (or Yspire), as shown in figure 8.

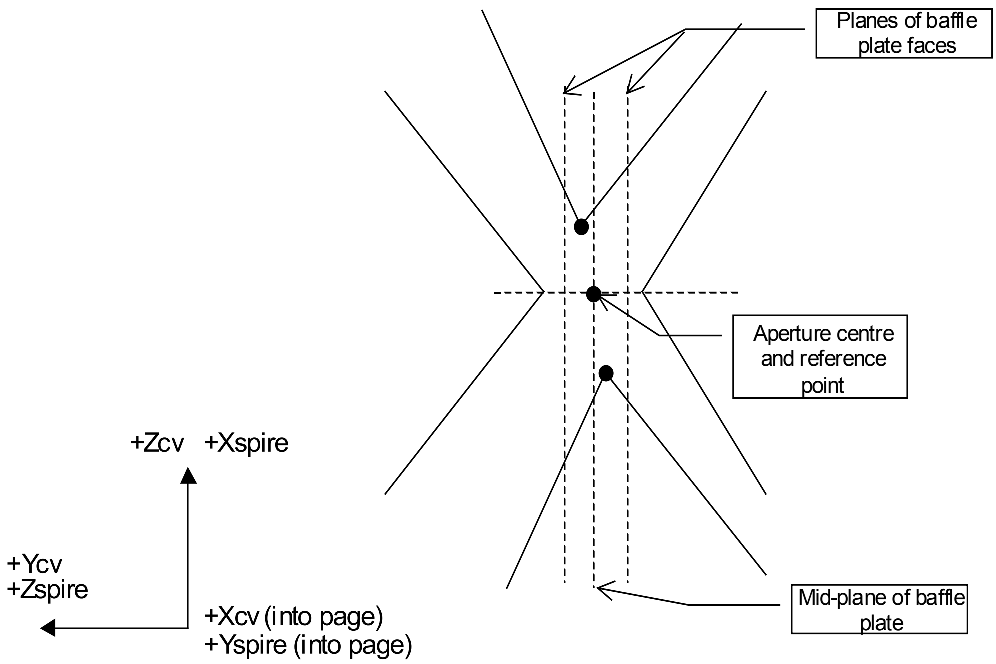

Figure 7 Reference co-ordinate systems used

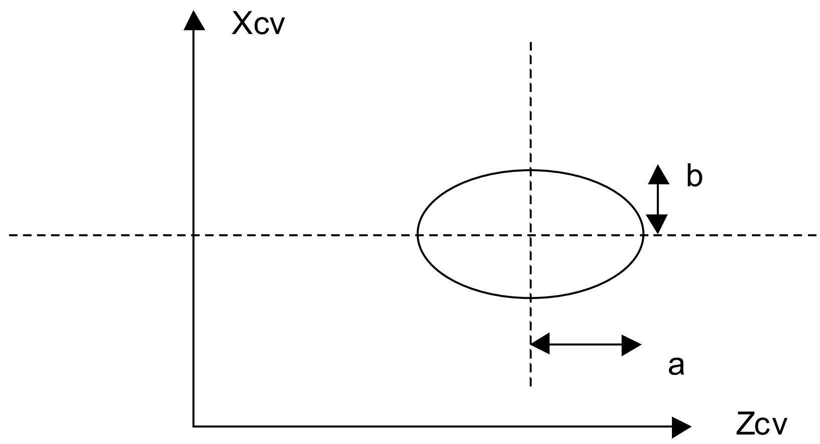

Figure 8 Relationship of ellipse axes to reference co-ordinates

3. GENERATING 3-D MODELS OF THE BAFFLE PLATES WITH APERTURES.

A 3-D model of each baffle plate, along with its aperture, in the form of an IGES-format file, was generated so that it could be incorporated into the CAD model of SPIRE. This was achieved by expressing each elliptical aperture boundary as four linked cubic spline curves and by imposing a rectangular outer boundary, also described by four cubic spline curves. This allowed the surface between the inner aperture boundary and the outer bounding rectangle to be represented as four 'ruled surfaces', each defined and generated by a pair of spline curves, one drawn from each set of four boundary curves.

In order to provide a 3-dimensional aperture, a thickness THICK = 1.0 mm was specified for each plate and a second aperture surface was created in a plane located at this thickness displaced from the first aperture plane. The points defining this second aperture boundary were generated from the points on the spline curves making up the first boundary by projecting them a distance THICK mm normal to the plane of the first aperture. This was done by just incrementing the co-ordinate normal to the plane of the aperture by THICK mm. The spline curves making up the rectangular outer boundary in this second aperture plane were generated from the spline curves making up the rectangular boundary of the first aperture in the same way.

The surface making up the second aperture surface was generated using four ruled surfaces in the same way as the first aperture plane. The surface of the 'hole' in the baffle plate was generated using four ruled surfaces, this time each ruled surface was generated using a pair of spline curves with one drawn from each of the two groups of 4 splines generating the inner boundaries of both apertures. The surfaces making up the four edges of the rectangular aperture plate were generated using corresponding pairs of edge splines.

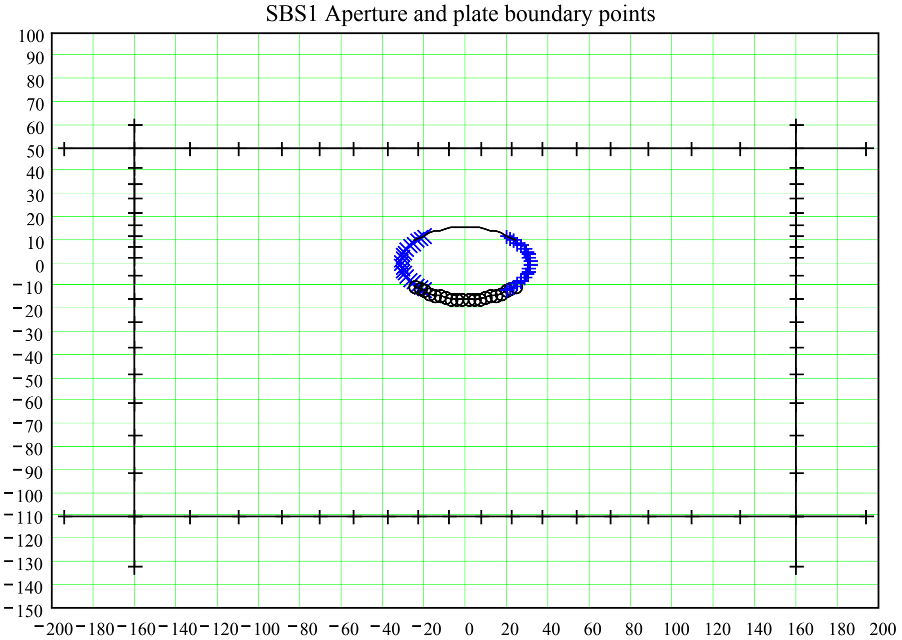

Figure 9 SBS1 Aperture and plate boundary points

The computation of the spline data was carried out in the two MATHCAD documents SBS1BEAMS.MCD and SBS2BEAMS.MCD, which also generated data defining the points of a wireframe model for each plate. Figure 9 shows the points defining the SBS1 aperture inner boundary curves and the plate edges, taken from SBS1BEAMS.MCD. Figure 10 shows a plot of the wireframe model that was generated at the same time and figure 1 shows the 3-D model generated from the IGES file that was created using the SPLINEIGS application. The applications used and data files generated are listed in table 2.

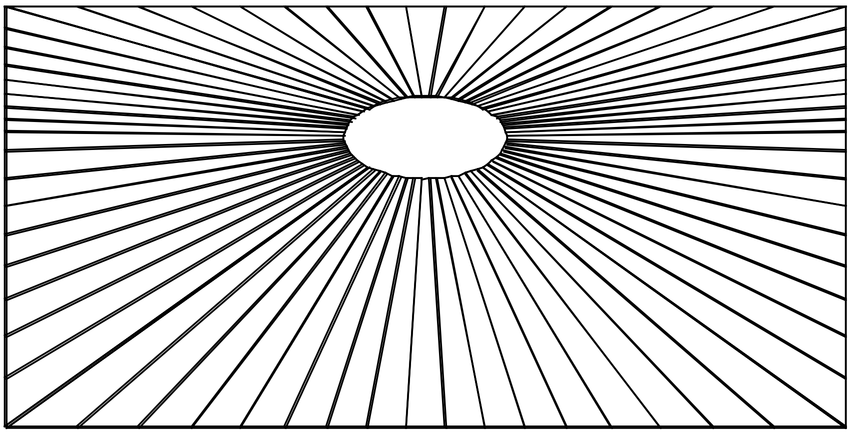

Figure 10 Wire-frame model of the aperture in the SBS1 baffle plate

The wire-frame model illustrates how corresponding points on pairs of spline curves are joined when generating the 2-dimensional ruled surfaces that make up one of the baffle plate surfaces.

Application/file	Inputs	Outputs
SBS1BEAMS.MCD (MATHCAD document)	CODEV beam envelope data SBS1 reference point Aperture plate thickness	SBS1BAFFAP.WIR SBS1BAFFAP.BOU
SBS2BEAMS.MCD (MATHCAD document)	CODEV beam envelope data SBS2 reference point Aperture plate thickness	SBS2BAFFAP.WIR SBS2BAFFAP.BOU
SPLINEIGS.EXE	SBS1BAFFAP.BOU SBS2BAFFAP.BOU (spline curve data)	SBS1BAFFAP.IGS SBS2BAFFAP.IGS
WIREFRAME.EXE	SBS1BAFFAP.WIR SBS2BAFFAP.WIR	Wire-frame display
3DVIEW.EXE	SBS1BAFFAP.IGS SBS2BAFFAP.IGS	3-D view

Table 2 Applications and files used to create 3-D models of the baffle plates

4. SUMMARY

A method for determining the dimensions and shape required for apertures in baffles to be located at both beam-splitters the SPIRE spectrometer has been described. 3-D representations of 1-mm thick rectangular baffle plates with unbevelled elliptical apertures have been constructed in the form of IGES-formatted files.