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ULTRASIM User's Manual for Advanced Functions ver 2.0, Program for Simulation of Ultrasonic Fields

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Contents

Document History:

ver 2.0	13. Sept 2006	1.5D transducer material extracted from ver 1.0 + updated
ver 1.0	16. August 1996	Advanced functions taken from User's Manual ver 1.1

1 INTRODUCTION

The Advanced User's Manual contains information not found in the UL-TRASIM User's Manual on how to setup 1.5D arrays

2 CONFIGURATION

2.1 Transducer Parameters

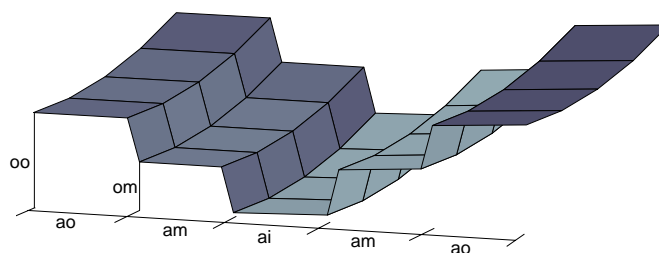### 2.1.1 1,5D Rectangular and Curved Array

Figure 1: Example of an 1,5D transducer

An example of a 1,5D transducer with 5 elevation elements is given in Fig. 1. The transducer is made of 4 elements placed symmetrically around a middle element; 2 at each side. If there are 3 elevation elements, there is only one element on each side of the middle element. The example in Fig. 1 may be described as 3 different transducers possibly with different fixed focii and apertures. The central parts of the outer transducers are removed to make room for the inner transducer. The parameters necessary to describe the transducer are labelled in the figure. ai is the aperture of the inner element, am is the aperture of the middle elements, and ao is the aperture of the outer elements. In addition you may set a z-offset, om on the middle elements and a z-offset, oo, on the outer elements relative to the inner element; see Fig. 1. Also a fixed focus should be defined for the inner, the two middle and the two outer elements.

If a 1,5D Rectangular or Curved Array is used, the Elevation part of the **Transducer** submenu is:

ELEVATION (1.5-D):

5)	Elevation array-aperture ai+2*(am+ao)	a	= 5.00 mm = 22.73 lambda
12)	Elevation array-aperture, inner,	ai	= 1.00 mm = 4.55 lambda
13)	Elevation array-aperture, middle,	am	= 1.00 mm = 4.55 lambda
14)	Elevation array-aperture, outer,	ao	= 1.00 mm = 4.55 lambda
6)	Elevation # elements	Me_el	= 5
7)	Elevation # points	Mp_el	= 10
9)	Elevation Fixed focus, inner,	ri	= 100.00 mm = 454.55 lambda
10)	Elevation Fixed focus, middle,	rm	= 100.00 mm = 454.55 lambda
11)	Elevation Fixed focus, outer,	ro	= 100.00 mm = 454.55 lambda
15)	Elevation offset, middle,	om	= 0.00 mm = 0.00 lambda
16)	Elevation offset, outer,	oo	= 0.00 mm = 0.00 lambda

In the example given above *# elements* is set to 5. The menu will be somewhat modified if 3 elements are selected. These modification are clarified below.

Elevation array-aperture {ai+2(am+ao)}* is not possible to set. It simply shows the total aperture calculated from the values set in the subsequent options. Note that when *Elevation # elements* is set to 3 the *Elevation array-aperture* will be calculeted as $a = ai + 2 * ao$, as *am* is no longer a valid option.

Elevation array-aperture, inner is the aperture of the inner element, ai, as depicted in fig. 1.

Elevation array-aperture, middle is the aperture of the two middle elements, am; see fig. 1. Note that when there are only three elevation elements this option is redundant.

Elevation array-aperture, outer is the aperture of the 2 outer elements, ao, as shown in fig. 1.

Elevation # elements allows you to set the number of elevation elements. It must be set to 3 or 5 for an 1,5D transducer. Other choices are commented on in the preceding subsection.

See also the preceding subsection for an explanation of *Elevation # points*.

Elevation Fixed focus, inner holds the value of the distance to the focal point of the inner element.

Elevation Fixed focus, middle lets you choose a distance to the focal point

of the 2 middle elements. Note that when there are only three elevation elements this option is redundant.

Elevation Fixed focus, outer is the value of the distance to the focal point of the 2 outer elements.

Elevation offset, middle allows you to set an offset along the z-axis on the middle elements relative to the inner element, om; see fig. 1. Note that when there are only three elevation elements this option is redundant.

Elevation offset, outer allows you to set an offset along the z-axis on the outer elements relative to the inner element, oo, as shown in fig. 1.

Note that when the transducer is focused in the elevation dimension, offsets are computed at the center of the elevation aperture, i.e. from the apex of the inner focused surface to the apex of the middle or the outer focused surfaces repsectively.
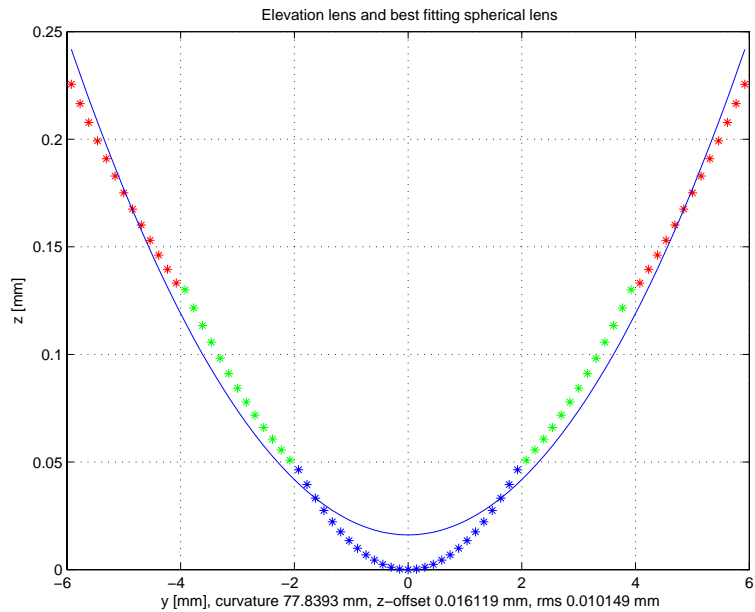

Figure 2: Elevation profile of an 1,5D transducer with fitted circle

When one leaves the 1.5D setup menu, ultrasim generates a plot of the elevation profile as shown in Fig. 2. This is a five element 1.5 D transducer with a central aperture of 4 mm, a middle aperture of 2 mm on each side, and an outer element with width 2 mm on each side, so the elevation aperture is a total of 12 mm. The inner curvature is focused at 40 mm, the middle at 70 mm and the outer at 100 mm depth. The fitted curve shows that the combined lens has its focus in between these values, at about 78 mm.

This example can be loaded as e10-15d.cnf and corresponds approximately to the 1.25 D example of Fig. 4 in Wildes, Chiao, Daft, Rigby, Smith, Thomenius, "Elevation performance of 1.25D and 1.5D transducer arrays," IEEE Trans. Ultrason., Ferroelec and Freq. Control, Sept 1997.

A   ULTRASIM VARIABLES

A.1   Introduction

This appendix describes the additional parameters used for storing setups. It should be read together with the appendix in the User's Manual.

A.2   Transducer

A.2.1   Rectangular and Curved Arrays

Transducer parameters are stored in the transducer array. Note that in the table below, t() means transducer(). When a 1.5 D transducer is described, i.e. when flagg(2)=1 and the number of elevation elements (transducer(6)) is either 3 or 5, the meaning of the additional elements are:

a (b)	t(5)	Array aperture in elevation-dimension
M_elem_el	t(6)	Number of elements in elevation-dimension
M_pts_el	t(7)	Number of points in elevation-dimension
ri (F)	t(9)	Focal length in elevation-dimension for inner lens
ai	t(12)	Array aperture in elevation-dimension for inner lens
am	t(13)	Array aperture in elevation-dimension for middle lenses
ao	t(14)	Array aperture in elevation-dimension for outer lenses
om	t(15)	Lens offset for middle lens
oo	t(16)	Lens offset for outer lens
rm (F)	t(10)	Focal length in elevation-dimension for middle lenses
ro (F)	t(11)	Focal length in elevation-dimension for outer lenses

The number of elevation elements, $t(6)$, is used to specify a 2D array with equal elements in the elevation dimension when $t(6) > 1$. For the special case of t(6) = 3 or t(6) = 5 a 1.5 D array is meant. For a 1.5 D array the other parameters such as apertures, lens offsets and middle and outer foci are relevant and this dependency applies: $t(5) = t(12) + 2 * (t(13) + t(14))$.