HUD Gonio Utility
USER MANUAL

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Bentham Instruments Software
Version 1.0.0

First printed June 2010

BACKGROUND INFORMATION

The software for the gonio system will be implemented as a Utility in Benwin+. Within the Utility, the following options are available to the user.

Manual Mode

The user can chose to move the individual axes of the goniometer by changing one or more of these settings:

- X Position on plate
- Y Position on plate
- Angle of Incidence at plate

HUD Mode

Vertical Eye Displacement

The eye can be thought of as the source on the left of figure 1. To see the top of the plate he rotates his eye upwards and to see the bottom of the plate, he looks downwards. In this example one eye position is considered. It can be seen that for this eye position it is possible to look at multiple points on the plate at the top, middle and bottom of the plate. Each of the 3 points are different X positions.

Vertical eye displacement however, is shown in figure 2. The nominal or zero vertical eye displacement (VED) is determined by the distance of the eye to the base of the plate and the angle subtended by the line from the eye to the plate. When VED is changed, the sample angle is changed. This is to simulate the height of the viewer's eye in relation to the plates (see figure 2). When X is changed, both the x position of the plate and the sample angle are changed. This is to simulate the movement of the viewer's eye looking down at a different x position (see figure 1). Since the collimator is fixed in this plane, the sample angle itself is altered to account for this. So changing x is the equivalent of a viewer changing the point on the plate they are looking at, while changing VED is the equivalent of changing the height of the viewer. When a VED scan is chosen the secondary reflectance or periscope transmission is taken in to account where they occur.

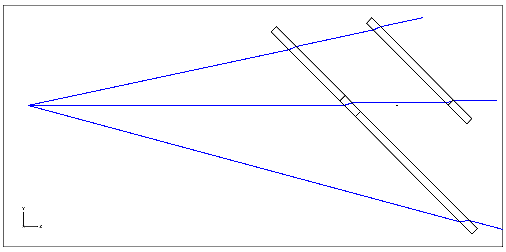


Figure 1. Changing X

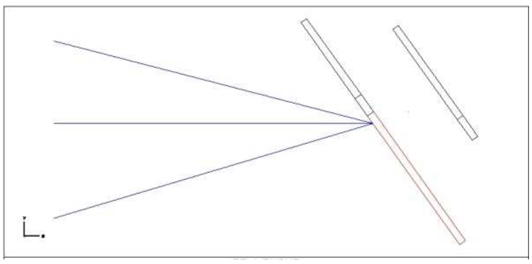


Figure 2. Changing VED

Reflection Measurement

This will carry out spectral scans for user selectable VED's, X positions or Y positions or any combination of the three. The detector is automatically placed in the position of the reflection from the first plate, according to the sample angle and whether the beam hits the coating on the plate (see figure 3). The detector will then take a number of measurements across a small change in angle (2 degrees for example) at zero order, to find the maximum signal available before taking a spectral scan.

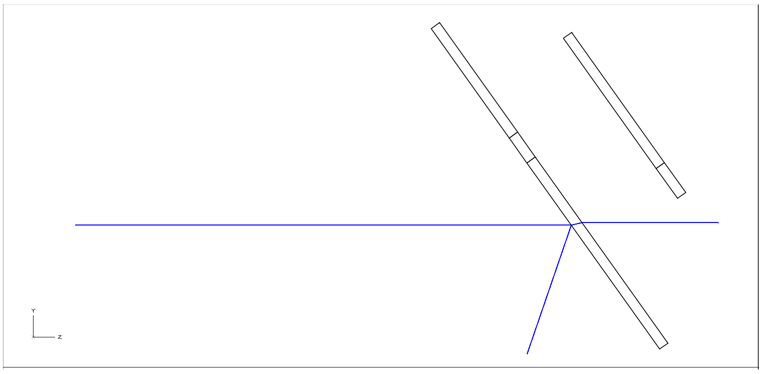


Figure 3. Primary Reflection

When applicable, if the beam passes through the first plate and reflects off the second, a secondary reflection measurement (see figure 4) will be taken and added with the primary reflection for each (X, Y, Angle) point. It is possible for a point on the plate to only exhibit a secondary reflection due to the position of the coating on the plates. The files for each spectral scan will be saved with a relevant file name for the X, Y and Angle of the plates.

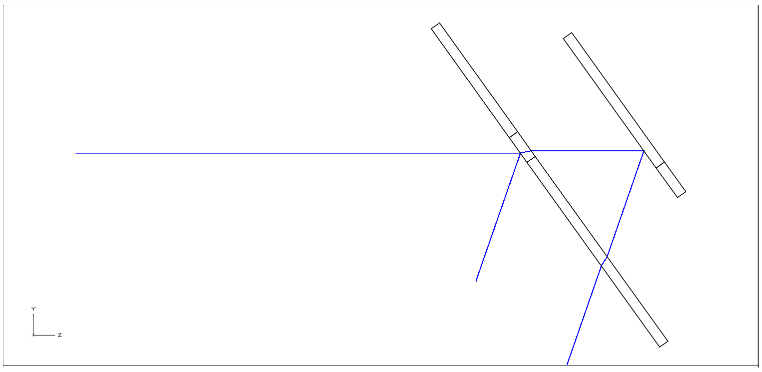


Figure 4. Secondary Reflection

Transmission Measurement

This will carry out spectral scans for user selectable VED's, X positions or Y positions or any combination of the three. The detector will automatically be placed in the location of the transmission through the two plates according to the refractive index, thickness and sample angle of the plates (see figure 5). The software will also calculate whether the beam has passed through one plate or two. The detector will then take a number of measurements across a small change in angle at zero order, to find the maximum signal available before taking a spectral scan.

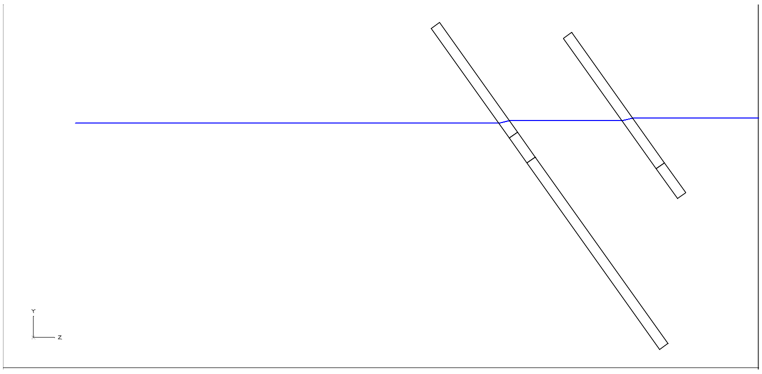


Figure 5. Direct Transmission

When applicable, these measurements will also take in to account any periscope transmission (if it occurs), caused by reflection between the two plates and add this spectra together with the direct transmission for each (X, Y, Angle) point (see figure 6). The files for each spectral scan will be saved with a relevant file name for the X, Y and Angle of the plates.

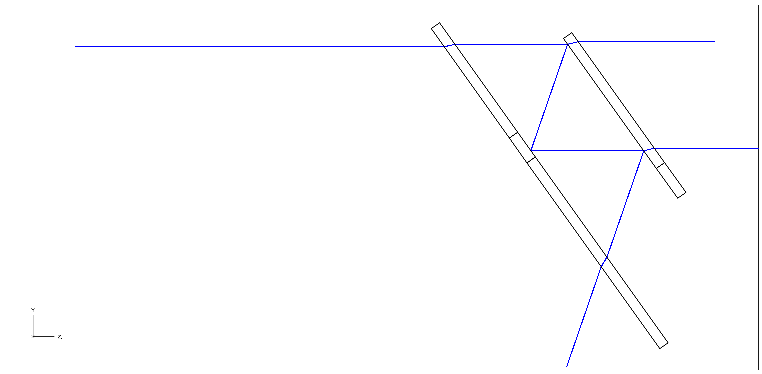


Figure 6. Periscope Transmission

Gonio Mode

In gonio mode, the vertical eye displacement is simply replaced with the Incident Angle of the beam on to the plate. As the incident angle is changed, the angle of the plates change accordingly. Changing X will no longer change the angle of the plates as well, since there is now no concept of measuring the plates as an HUD. The user is again able to choose between reflection or transmission measurements. In gonio mode *only* the primary reflection or primary transmission is measured; there is no account made for secondary reflection or periscope transmission. This mode may be useful for mapping a single plate.

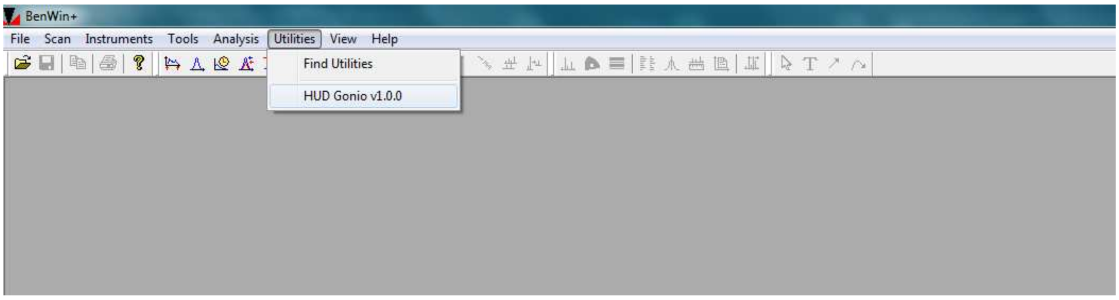
100% Spectra

Every spectrum taken by the goniometer will be divided by the 100% spectrum. This is the result of placing the detector directly in line with the collimated beam and taking a spectrum. The user may choose when to retake a new 100% spectrum, by selecting to retake one every 'n' spectra. One will always be taken as the first measurement of a goniometer scan.

HUD GONIO UTILITY V1.0.0

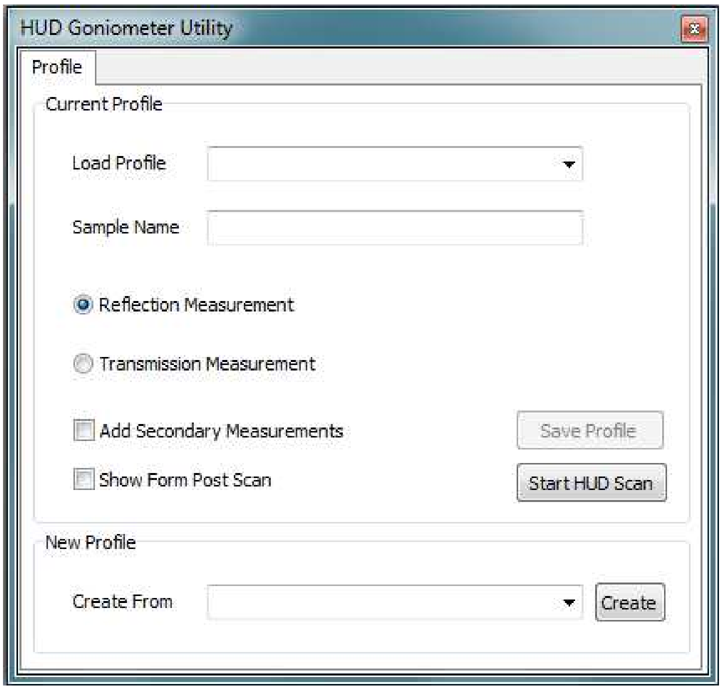
The HUD Gonio Utility version 1.0.0 has been written in conjunction with Benwin+ version 3.1.0.2

The utility can be run by selecting it from the utilities menu (Note that Benwin+ must first be initialised).



UTILITY WINDOW

When loaded, the Gonio will Park (if it hasn't already done so) and then the following window will appear:



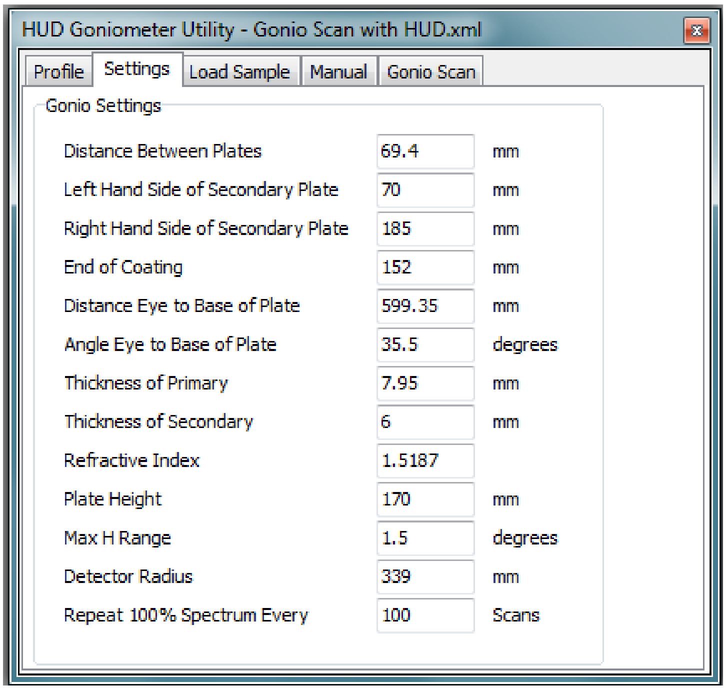
The Add-On works using Profiles. Each profile contains information regarding the settings of the Gonio, the plates on it and the Scan information. All of this information can be changed manually and saved if required. The user is also able to create new profiles from existing ones and save them as a new profile.

To run a Scan, a profile must first be loaded. The gonio and scan settings may then be altered as required. To begin a New Scan, click the 'Start HUD Scan' or 'Start Gonio Scan' button (based on which type of scan profile is loaded).

Once a profile has been loaded, the following tabs will appear:

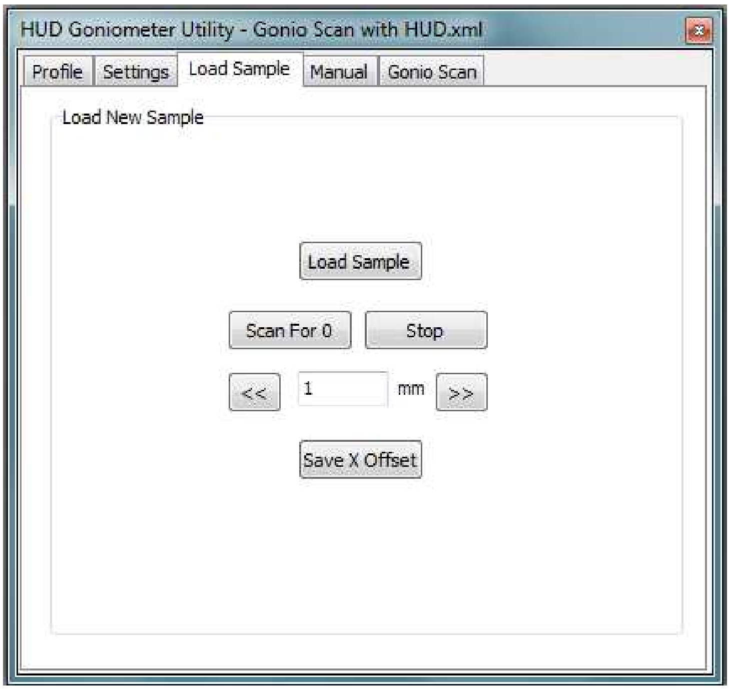
- Settings
- Load Sample
- Manual
- Gonio Scan or HUD Scan (depending upon the Scan Type of the profile)

- Settings Tab



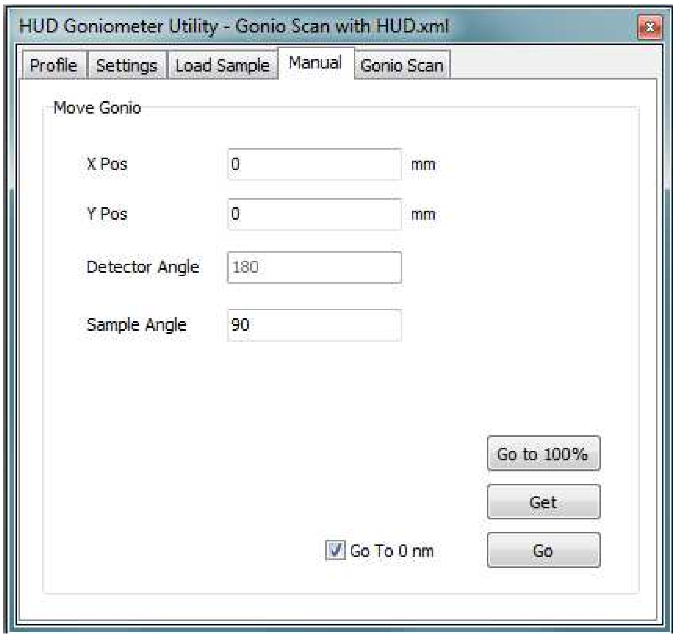
The settings tab contains information regarding the plates that have been loaded on to the Gonio. The user must ensure these settings are all present and correct before starting a new scan.

- Load Sample Tab



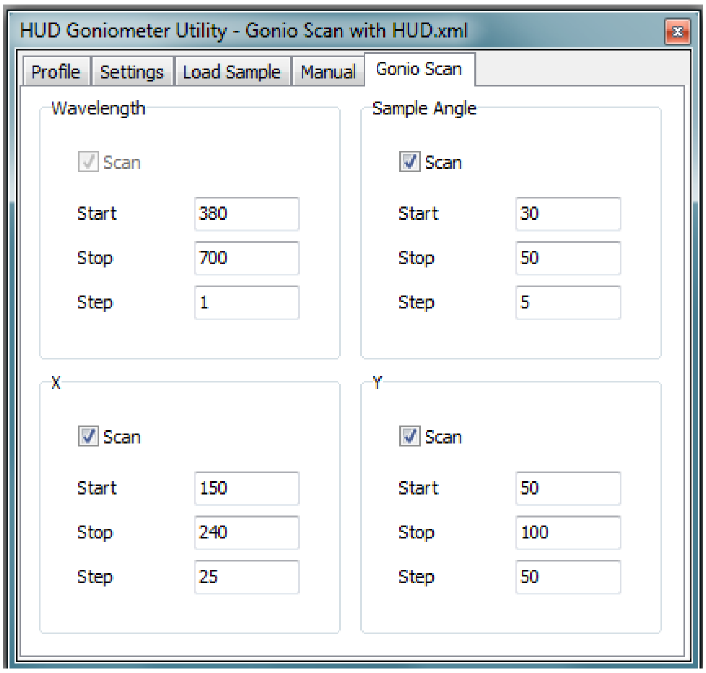
The Load Sample tab is for setting up a new pair of plates on the gonio. To do this, first click Load Sample – this will move the gonio round to a convenient loading position. The user can then physically attach the new plate(s). So that the software knows where the first X position is, the gonio can be moved in the X axis such that the light from the collimator falls on the edge of the first plate. When the user is happy with this position for zero X, click 'Save X Offset'. The gonio is now ready to perform measurements.

- Manual Tab



The Manual tab is used to move the gonio to a particular point. In Gonio mode, the user can choose an X position, Y position and a Sample Angle. In HUD mode, the user can choose an X positon, Y position and a Vertical Eye Displacement (VED). The user may wish to use this tab to check where a particular spot of reflection or transmission occurs.

- Gonio Scan / HUD Scan Tab



The Scan tab is used to set the parameters for a scan. A wavelength range must be selected. The three other parameters can be scanned or set to a static position.

In Gonio mode the parameters are X position, Y position and Sample Angle. The scan is implemented with Sample Angle incremented first, then X, then Y.

In HUD mode, the parameters are X position, Y position and VED. The scan is implemented with VED incremented first, then X, then Y.

RESULTS

When a Scan is taken, a Sample Name must be given. The utility then creates a new folder to store the results of the scan. This results folder will be placed in C:\Program Files\Bentham\BenWin+\Spectra\ (or the benwin+ installation directory if different).

The results folder will be named with the Sample Name followed by the date and time of the beginning of the scan (eg. TestSample_07.06.2010_11.20).

Within this results folder will be a number of folders and files:

- 100% Spectra Folder
  Contains all 100% spectra taken during the measurement.

- Raw Data Folder
  Contains each spectrum taken by the gonio. Each file is given a unique name based on the position of the gonio and whether the spectrum was a primary measurement or a secondary measurement.

- Excel Files
  Also located in the results folder will be one or more excel files. The results are set out in the following way:

  Gonio Scan:
  A new workbook is created for every Y position.
  A new worksheet is created for every Sample Angle.
  Each worksheet contains results for each X position measured.
  A surface graph is automatically rendered for each worksheet.

  HUD Scan:
  A new workbook is created for every VED chosen.
  A new worksheet is created for every Y position.
  Each worksheet contains results for each X position measured.
  A surface graph is automatically rendered for each worksheet.

- Text file version of the results
  Flat text file versions of the results are also saved in the results folder. A new file is created for every VED or Sample Angle, and every Y.

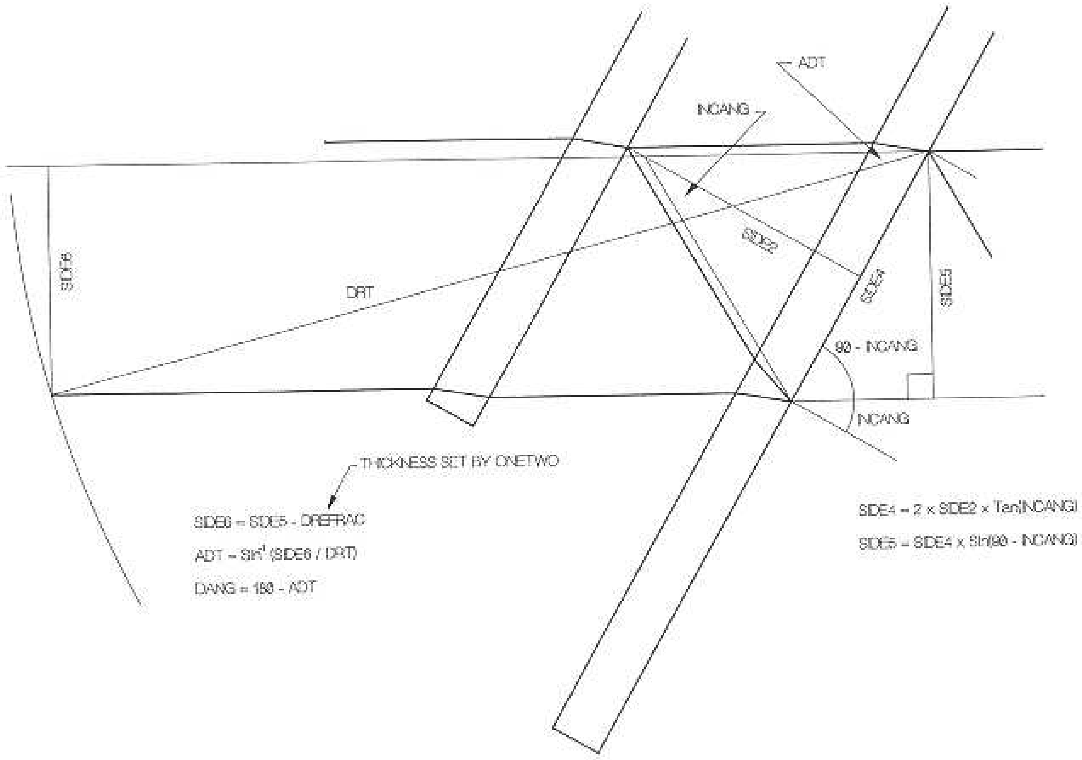
- ErrorReport.txt
  The ErrorReport.txt contains a brief summary of the scan undertaken, the time it took, and any points that the gonio could not reach.

- LogFile.txt
  The LogFile.txt contains information regarding the settings chosen and the calculations of where the gonio should be for each point measured, including whether the spot hits one plate or two, and whether a secondary measurement was required.

APPENDIX A

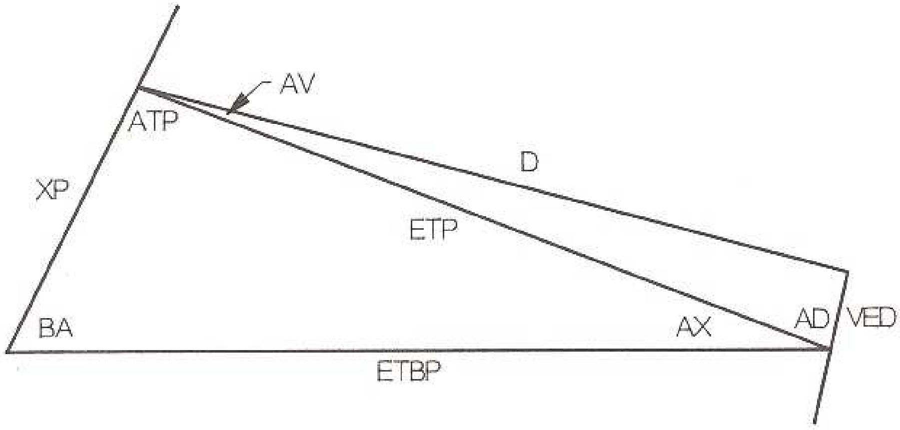
The following diagrams show the maths to locate the position of the spot on the detector.

DOES DOUBLE TRANSMISSION OCCUR (SUB 3800).   WHERE IS IT FOR DOUBLE TRANSMISSION (SUB 3900)



FIND ANGLE OF INCIDENCE (SUB 3200)

VED = vertical eye displacement
ETBP = distance from eye to bottom of plate
BA = angle subtended by eye at bottom of plate



By Cosine rule :-

$$ETP^2 = XP^2 + ETBP^2 - 2 \times XP \times ETBP \times Cos(BA)$$

By Sine rule :-

ETP / Sin(BA) = ETBP / Sin(ATP)

AX = 180 - ATP - BA

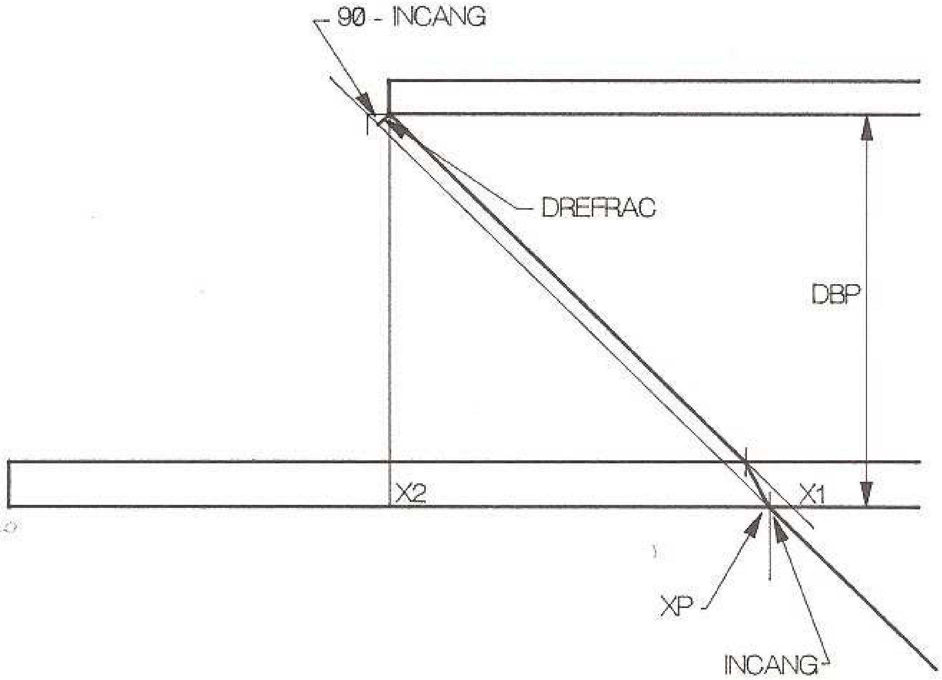
AD = 90 - AX

$$D^2 = ETP^2 + VED^2 - 2 \times ETP \times VED \times Cos(AD)$$

D / Sin(AD) = VED / Sin(AV)

ONE PLATE OR TWO (SUB 3300)

LHS = X coordinate of left hand side of secondary
DBP = distance between plates
XP = X coordinate of incident beam



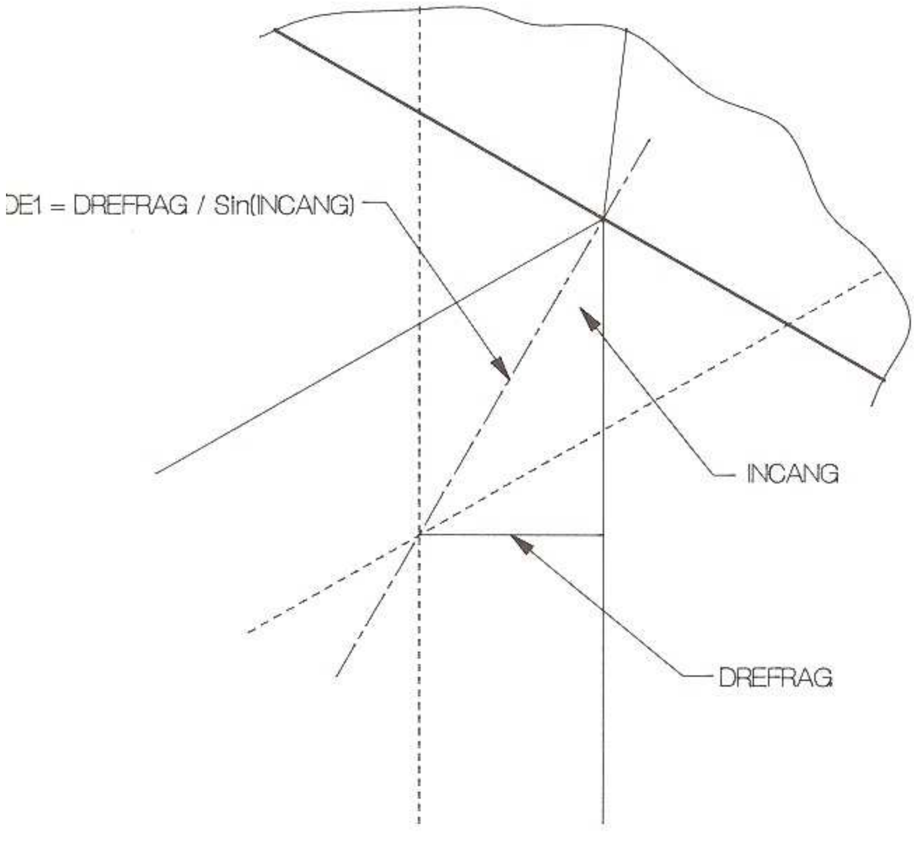
X position of beam relative to edge of rear plate =

X1 = XP - DREFRAC / Sin(90 - INCANG)

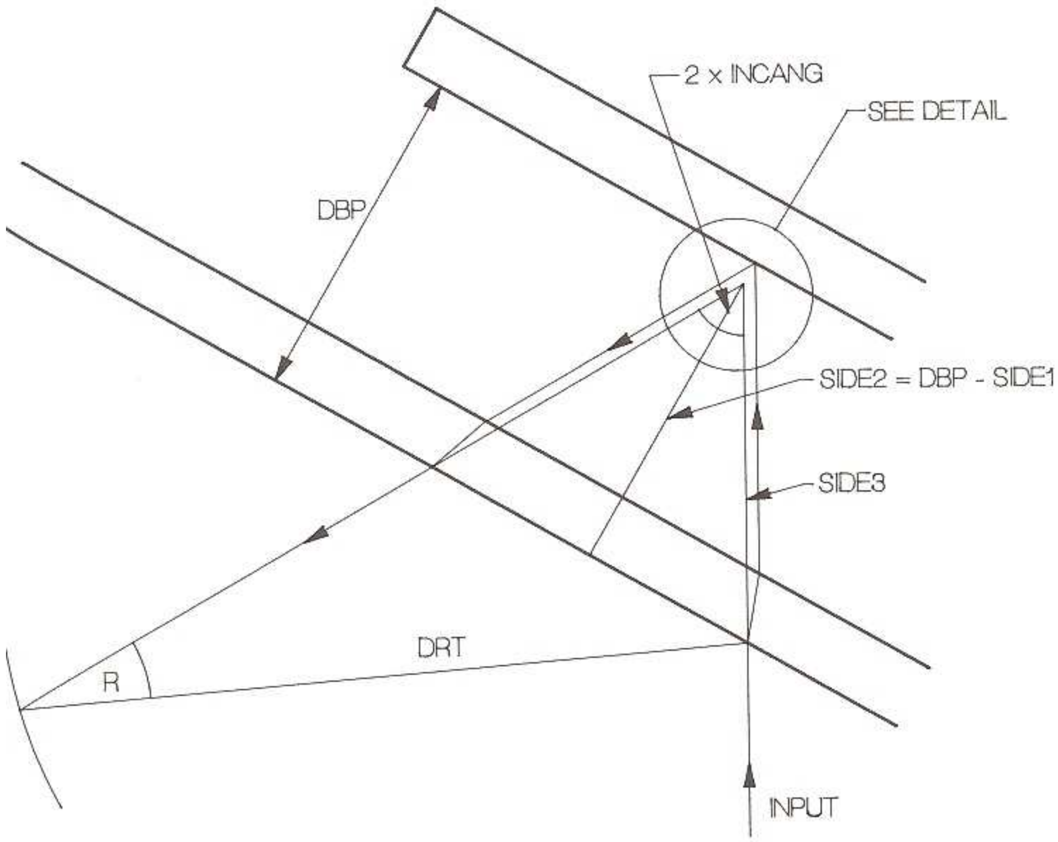
X position of edge of second plate =

X2 = LHS + DBP x Tan(INCANG)

WHERE IS IT FOR REFLECTION FROM SECONDARY (SUB 3700)
DETAIL



WHERE IS IT FOR REFLECTION FROM SECONDARY (SUB 3700)



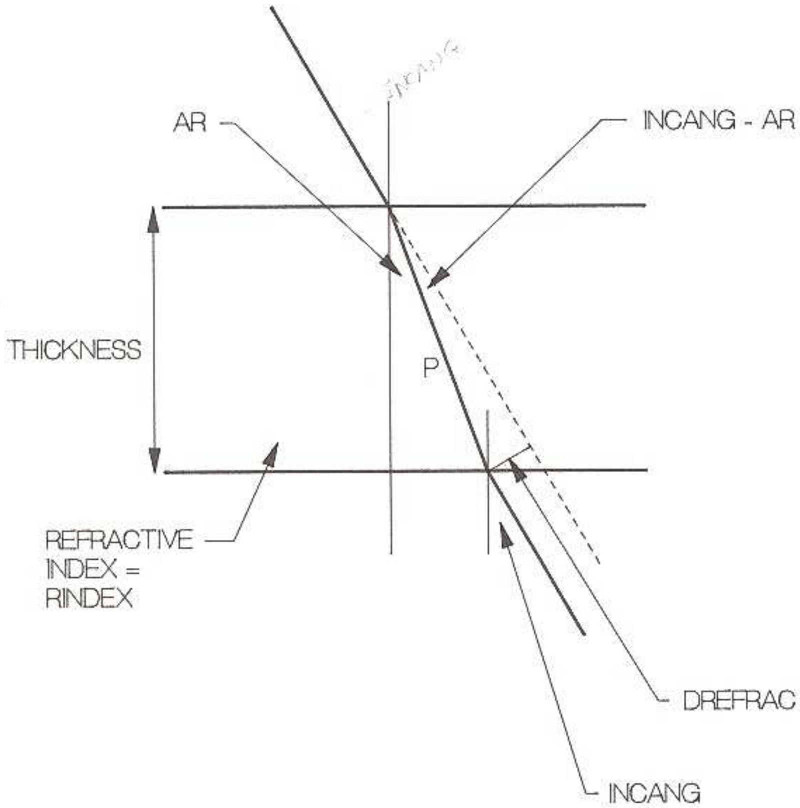
SIDE3 = SIDE2 / Sin(90 - INCANG)

DRT / Sin(2 x Incang) = SIDE3 / Sin(R)

DANG = R + 2 x INANG

REFRACTION OFFSET (SUB 3400)

INCANG = Angle of Incidence
AR = angle of refraction



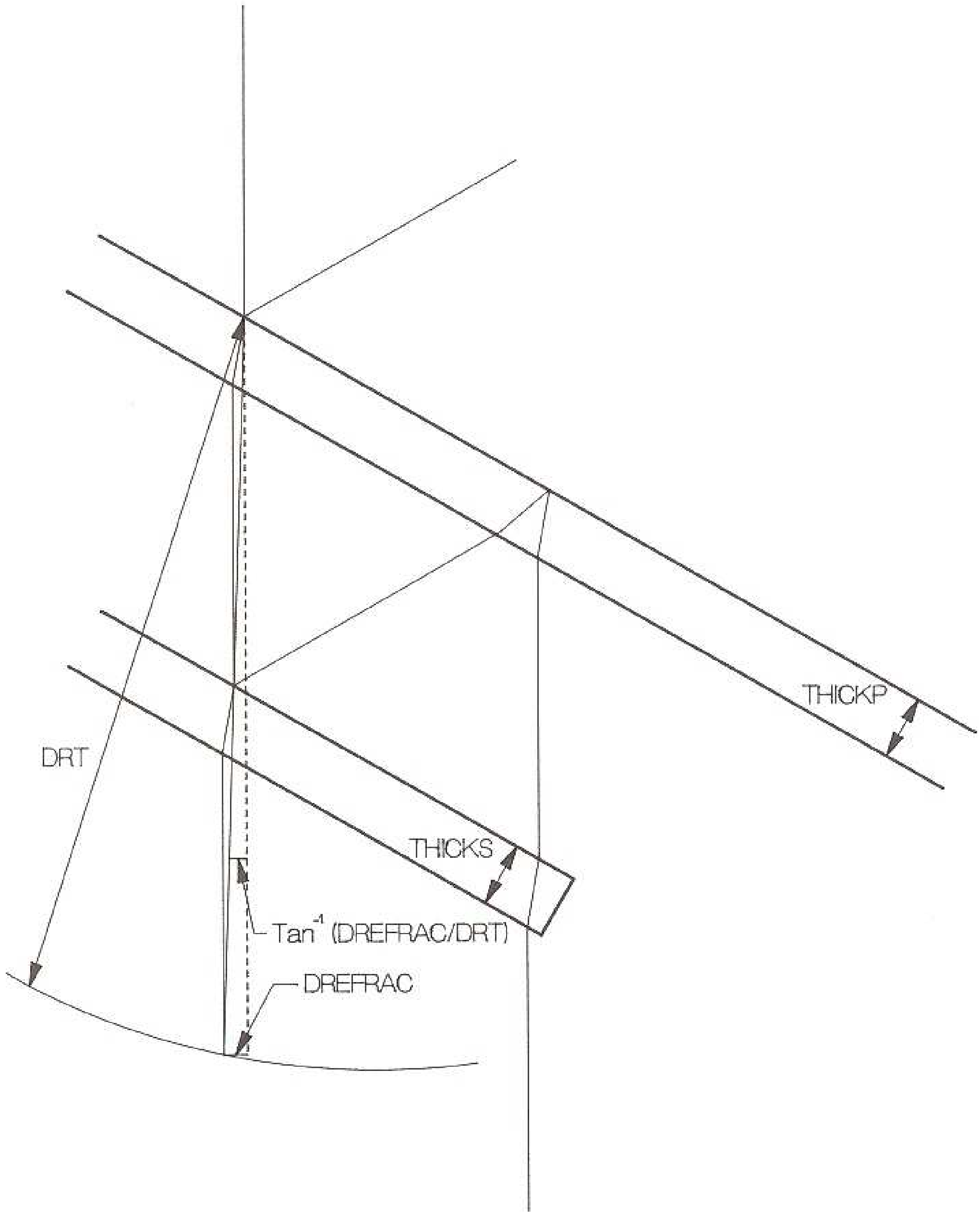
Sin(AR) = Sin(INCANG) / RINDEX

P = THICKNESS / Cos(AR)

DREFAC / P = Sin(INCANG - AR)

DREFRAC = THICKNESS x Sin(INCANG - AR) / Cos(AR)

WHERE IS IT IN SINGLE TRANSMISSION (SUB 3500)



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