Air - Spaced Triplet

a) Paraxial Properties

Trace Potential Chief Ray
($\bar{u} = 0.1$ at stop)

$\bar{y} = 0$ at XP and EP

EP: 71.428 mm to the right of L1

XP: 100 mm to the left of L3

Trace Potential Marginal Ray
($u = 0$ and $y = 1$ in object space)

F' is 280 mm to the right of XP

F' is 180 mm to the right of L3

BFD = 180 mm

Scale the marginal ray to the proper stop radius

$y_{stop} = 0.875$ $r_{stop} = 10$

Scale factor = $10/0.875 = 11.428$

$r_{EP} = 11.428$ $D_{EP} = 22.86$ mm

$r_{XP} = 20.0$ $D_{XP} = 40.0$ mm

$\phi = -u'/y_0 = .00625/1 = .0714/11.428 = .00625$

$f_E = 160$ mm

For parts b) and c) continue the chief ray to F' and scale to a maximum image height of 50 mm

Scale = $50/14 = 3.57$

$\bar{u}_0 = .312$

b) Vignetting

For unvignetted

$$a \geq |y| + |\bar{y}|$$

L1: $y_1 = 11.428$

$\bar{y}_1 = -22.31$

$a_1 \geq 33.75$ mm

$D_1 \geq 67.5$ mm

L2: $y_2 = 8.57$

$\bar{y}_2 = -8.92$

$a_2 \geq 17.49$ mm

$D_2 \geq 34.98$ mm

L3: $y_3 = 12.86$

$\bar{y}_3 = 17.85$

$a_3 \geq 30.71$ mm

$D_3 \geq 61.42$ mm

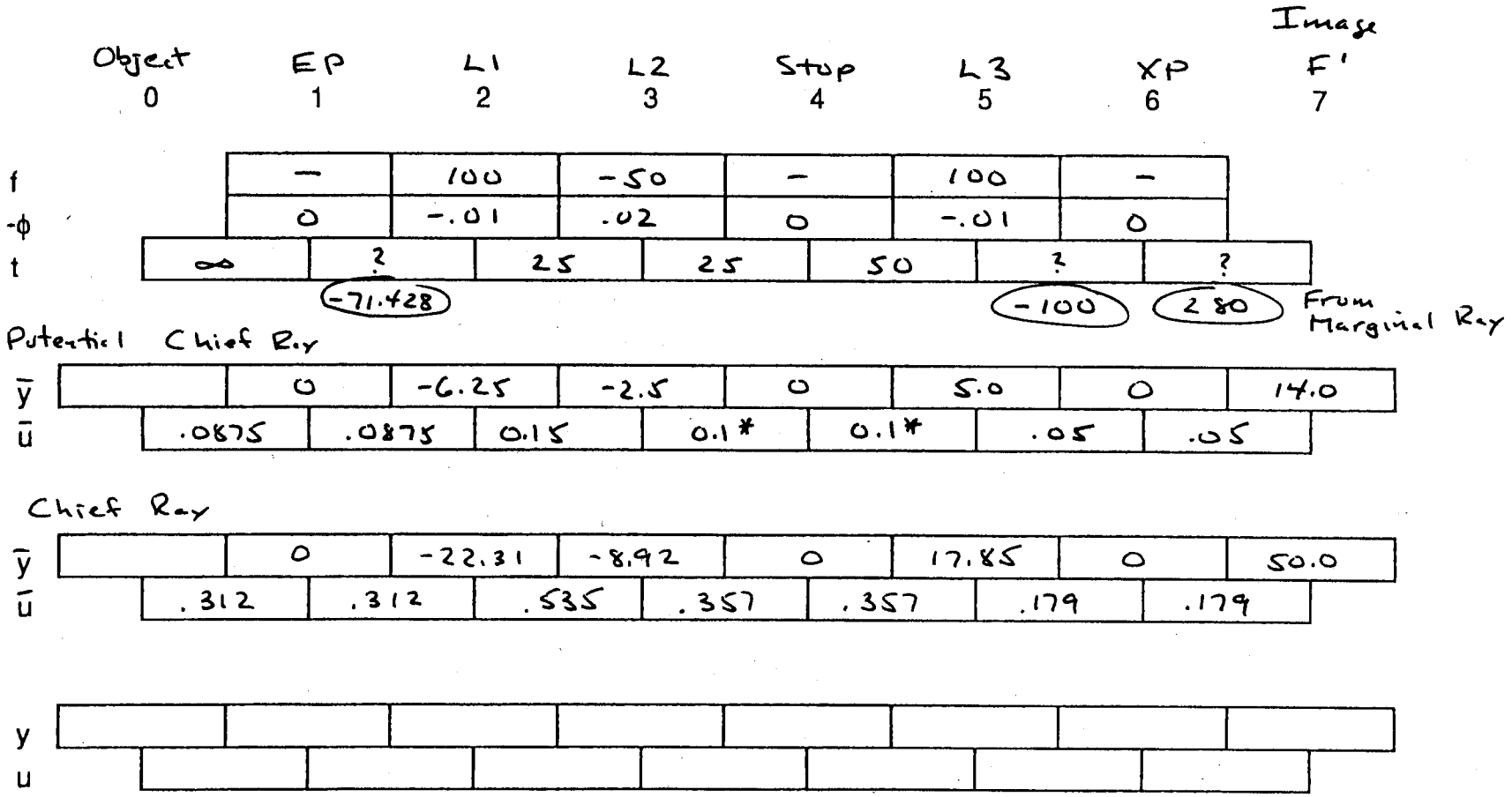
c) FOV

$\bar{u}_0 = .312 = \tan \theta_{1/2}$

HFOV: $\theta_{1/2} = 17.3°$

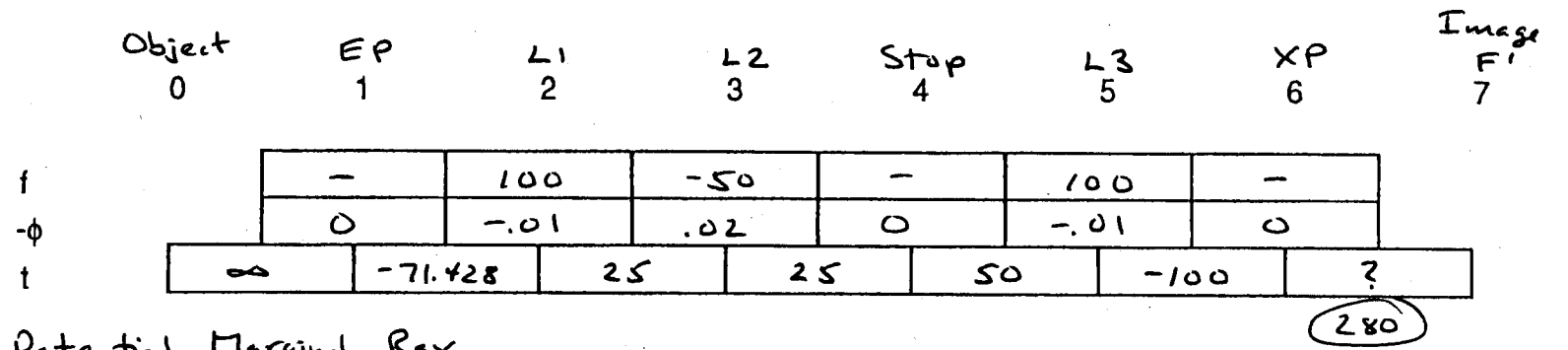
FOV: $\theta = 34.6°$

Thin Lens YNU Method



Chief Ray

Thin Lens YNU Method



Potential Marginal Ray

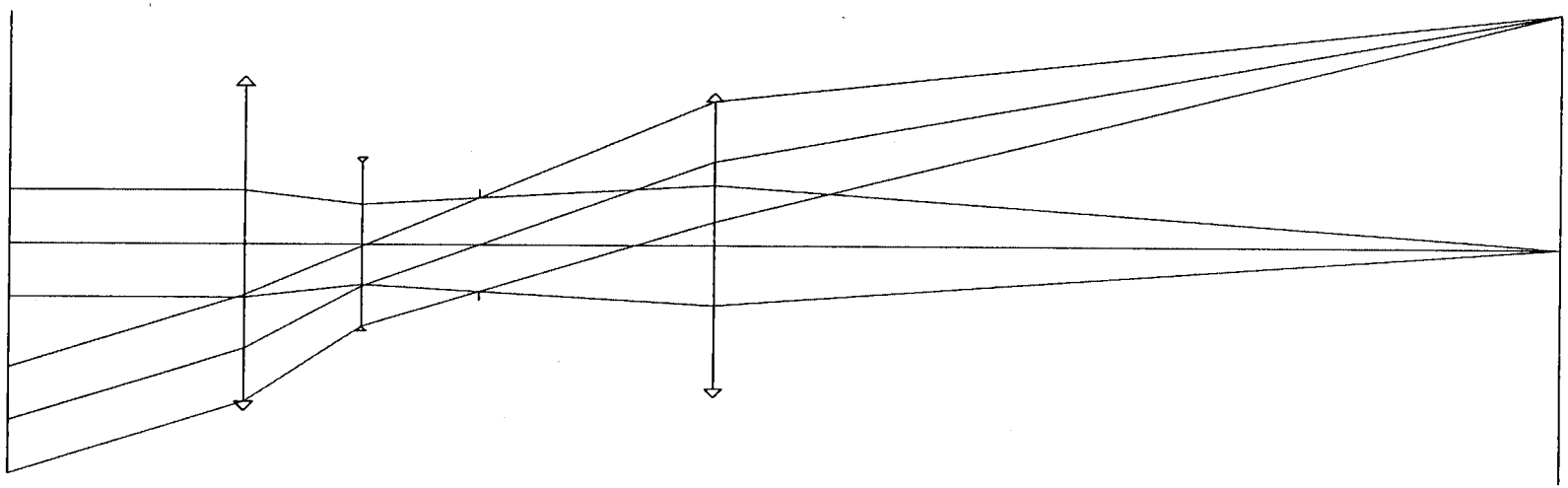
y	1	1	1	0.75	0.875	1.125	1.75	0
u	0	0	-.01	.005	.005	-.00625	-.00625	

Marginal Ray

y	11.428	11.428	11.428	8.57	10.0	12.86	20.0	0
u	0	0	-.1142	.0571	.0571	-.0714	-.0714	

y								
u								

Marginal Ray



LAYOUT

TRIPLET
SAT APR 12 2003
TOTAL LENGTH: 330.00000 MM

C:\ZEMAX\SAMPLES\LENS.ZMX
CONFIGURATION 1 OF 1

Alternate Solution for Pupil Diameters

The pupil sizes can be obtained directly from either chief ray using the LaGrange Invariant: and the stop radius ($y_{stop} = 10$ mm)

At a stop/pupil $H = n\bar{u}y$

Potential Chief Ray:

$$H_1 = \bar{u}_S y_{stop} = \bar{u}_{EP} y_{EP} = \bar{u}_{XP} y_{XP}$$

$$0.1\,(10) = .0875\,(y_{EP}) = .05\,(y_{XP})$$

$$y_{EP} = 11.4 \text{ mm} \qquad y_{XP} = 20 \text{ mm}$$

Chief Ray:

$$H_2 = \bar{u}_S y_{stop} = \bar{u}_{EP} y_{EP} = \bar{u}_{XP} y_{XP}$$

$$.357\,(10) = .312\,(y_{EP}) = .179\,(y_{XP})$$

$$y_{EP} = 11.4 \text{ mm} \qquad y_{XP} = 20.0 \text{ mm}$$

$$D_{EP} = 22.8 \text{ mm} \qquad D_{XP} = 40.0 \text{ mm}$$

A marginal ray is still needed for the BFD and focal length, but the need for a potential marginal ray and scaling is eliminated. A marginal ray through the edge of the EP can be traced.