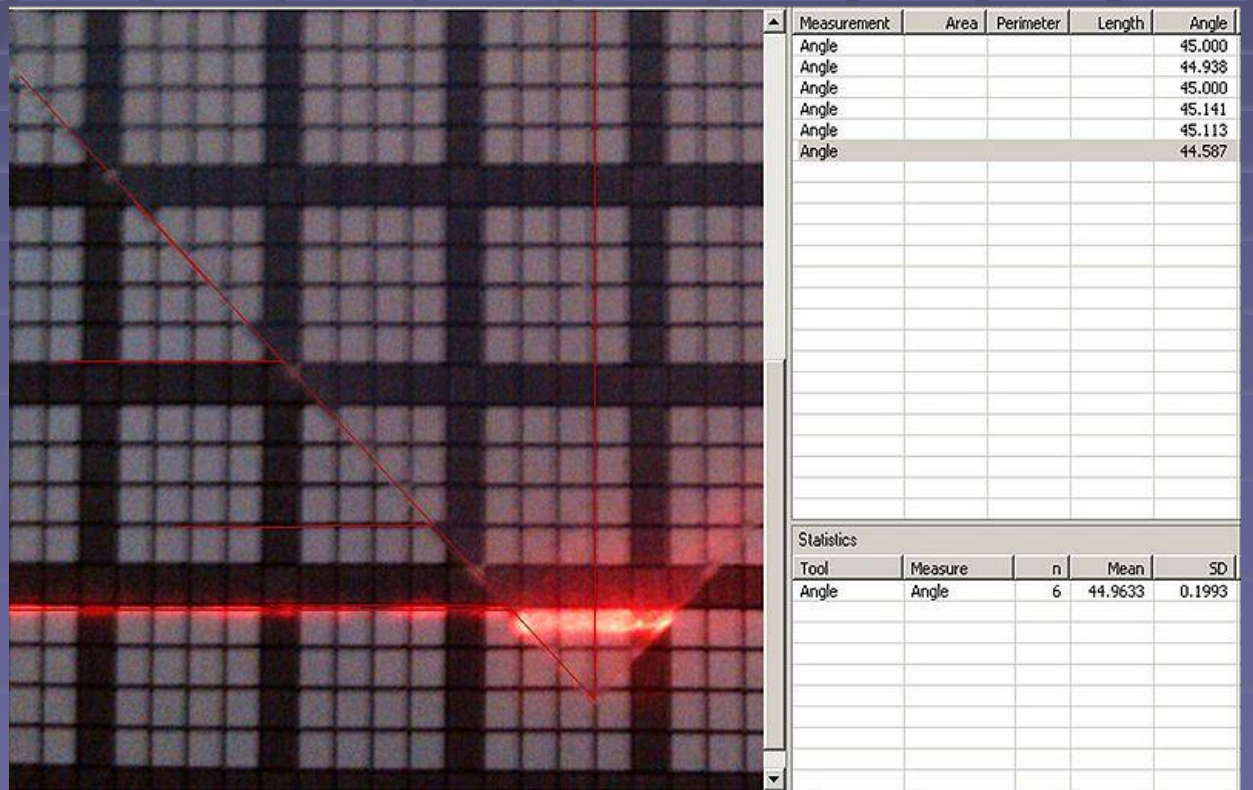
# Progress Report

July 23, 2012

# Uncertainty Measurements

- We started using image analysis to reduce our error and provide more accurate results.

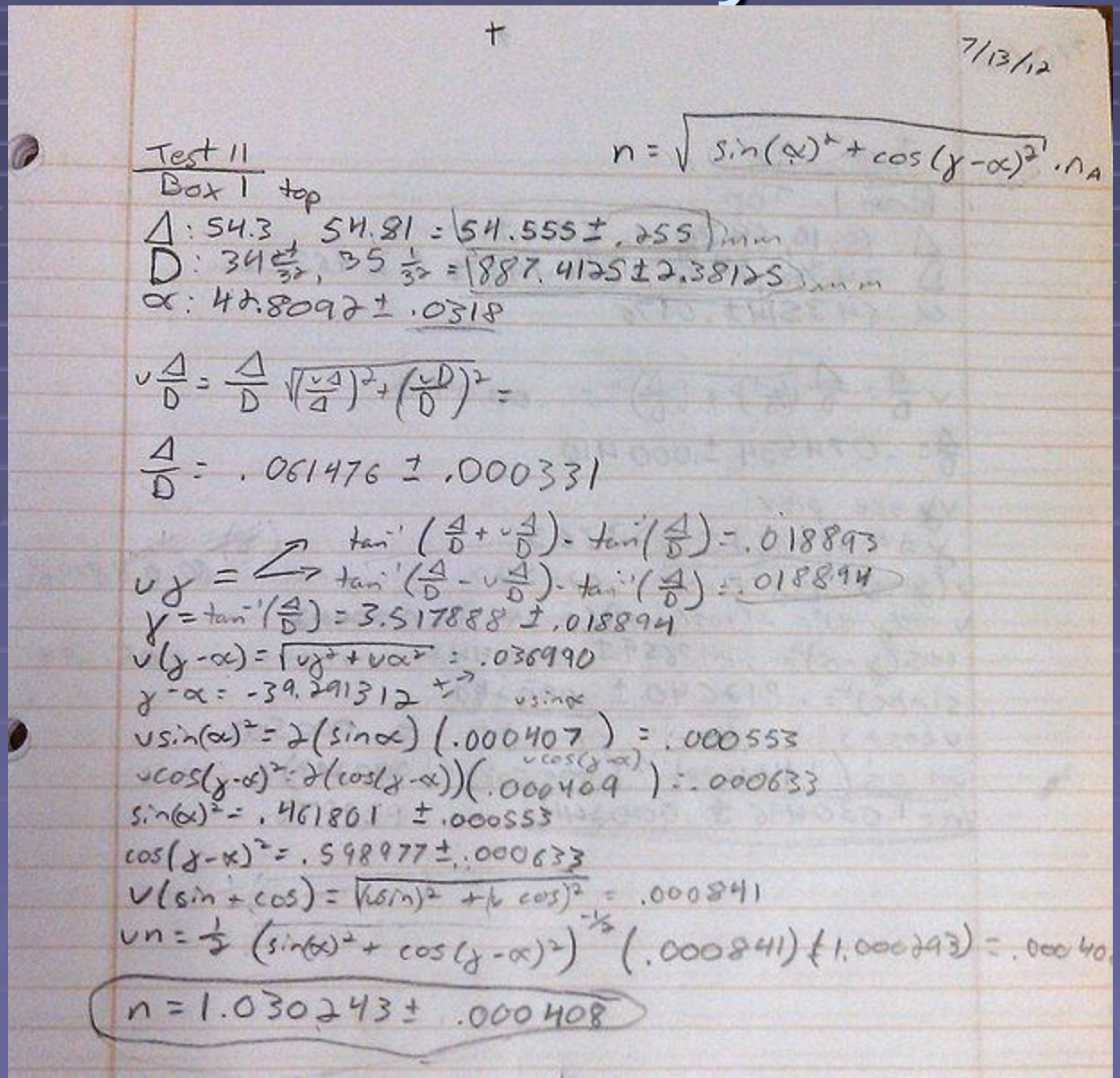


| Measurement | Area | Perimeter | Length | Angle |
|---|---|---|---|---|
| Angle | | | | 45.000 |
| Angle | | | | 44.938 |
| Angle | | | | 45.000 |
| Angle | | | | 45.141 |
| Angle | | | | 45.113 |
| Angle | | | | 44.587 |

Statistics

| Tool | Measure | n | Mean | SD |
|---|---|---|---|---|
| Angle | Angle | 6 | 44.9633 | 0.1993 |

# Calculations by Hand



7/13/12

Test 11
Box 1 top

$n = \sqrt{\sin(\alpha)^2 + \cos(\gamma-\alpha)^2}\ n_A$

$\Delta$: 54.3, 54.81 = 54.555 ± .255 mm
D: 34 $\frac{1}{32}$, 35 $\frac{1}{32}$ = 887.4125 ± 2.38125 mm
$\alpha$: 42.8092 ± .0318

$v\frac{\Delta}{D} = \frac{\Delta}{D}\sqrt{\left(\frac{v\Delta}{\Delta}\right)^2 + \left(\frac{vD}{D}\right)^2} =$

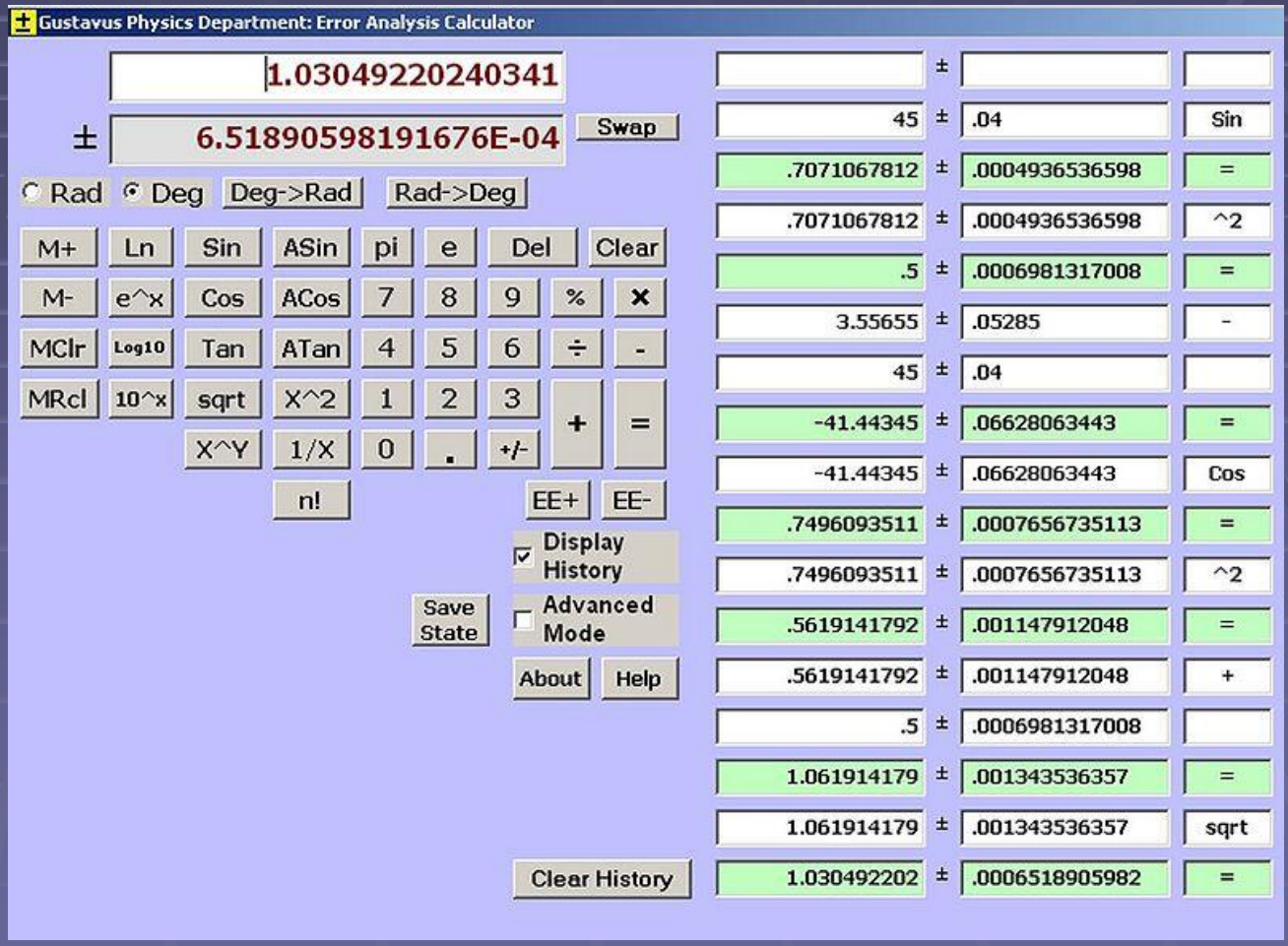
$\frac{\Delta}{D} = .061476 \pm .000331$

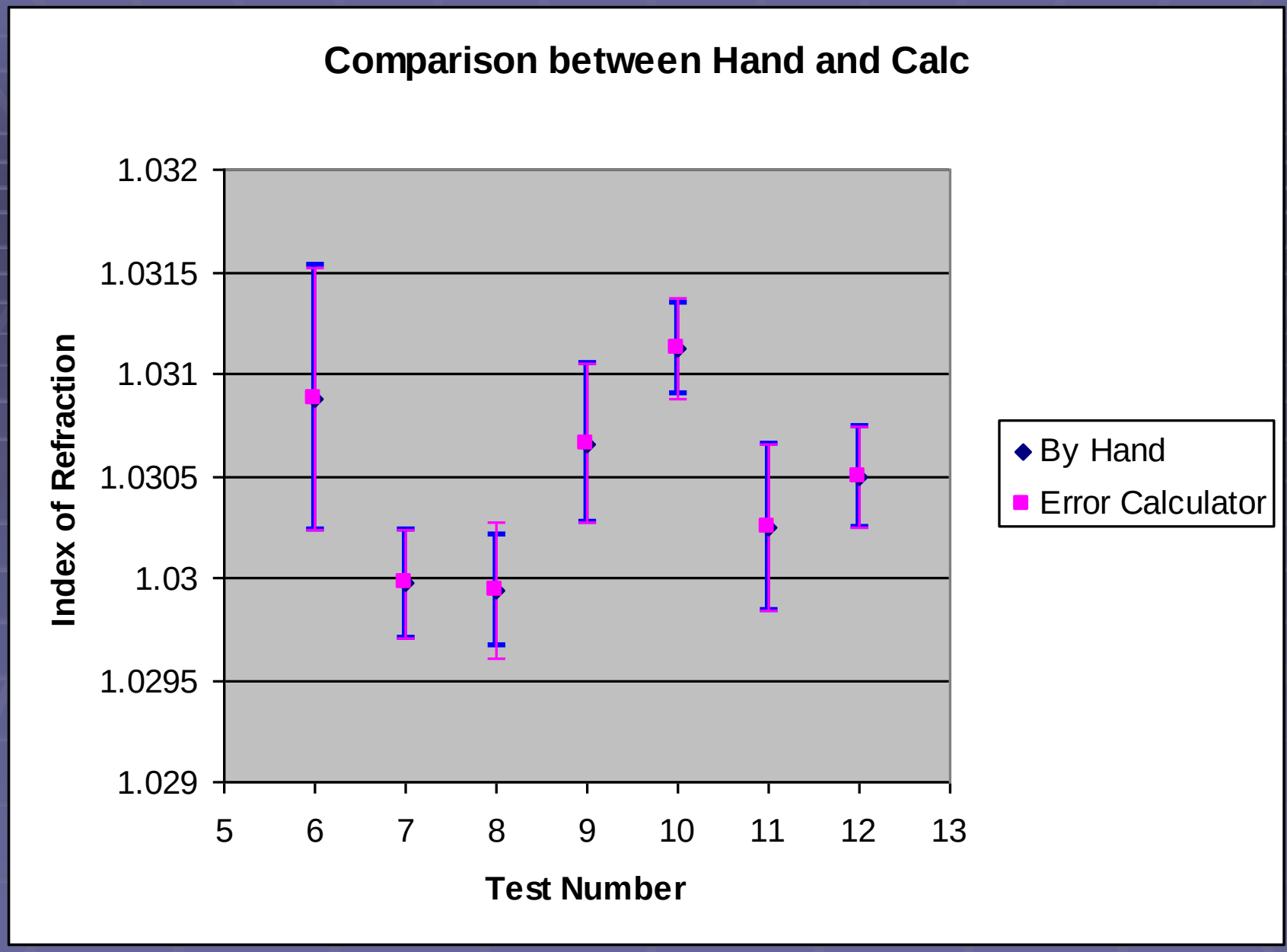
$v\gamma = \tan^{-1}\left(\frac{\Delta}{D} + v\frac{\Delta}{D}\right) - \tan^{-1}\left(\frac{\Delta}{D}\right) = .018893$
$\tan^{-1}\left(\frac{\Delta}{D} - v\frac{\Delta}{D}\right) - \tan^{-1}\left(\frac{\Delta}{D}\right) = .018894$
$\gamma = \tan^{-1}\left(\frac{\Delta}{D}\right) = 3.517888 \pm .018894$
$v(\gamma-\alpha) = \sqrt{v\gamma^2 + v\alpha^2} = .036990$
$\gamma - \alpha = -39.291312 \pm$
$v\sin\alpha$
$v\sin(\alpha)^2 = 2(\sin\alpha)(.000407) = .000553$
$v\cos(\gamma-\alpha)$
$v\cos(\gamma-\alpha)^2 = 2(\cos(\gamma-\alpha))(.000409) = .000633$
$\sin(\alpha)^2 = .461801 \pm .000553$
$\cos(\gamma-\alpha)^2 = .598977 \pm .000633$
$v(\sin+\cos) = \sqrt{v\sin)^2 + v\cos)^2} = .000841$
$vn = \frac{1}{2}\left(\sin(\alpha)^2 + \cos(\gamma-\alpha)^2\right)^{-1/2}(.000841)(1.000243) = .000408$

$n = 1.030243 \pm .000408$

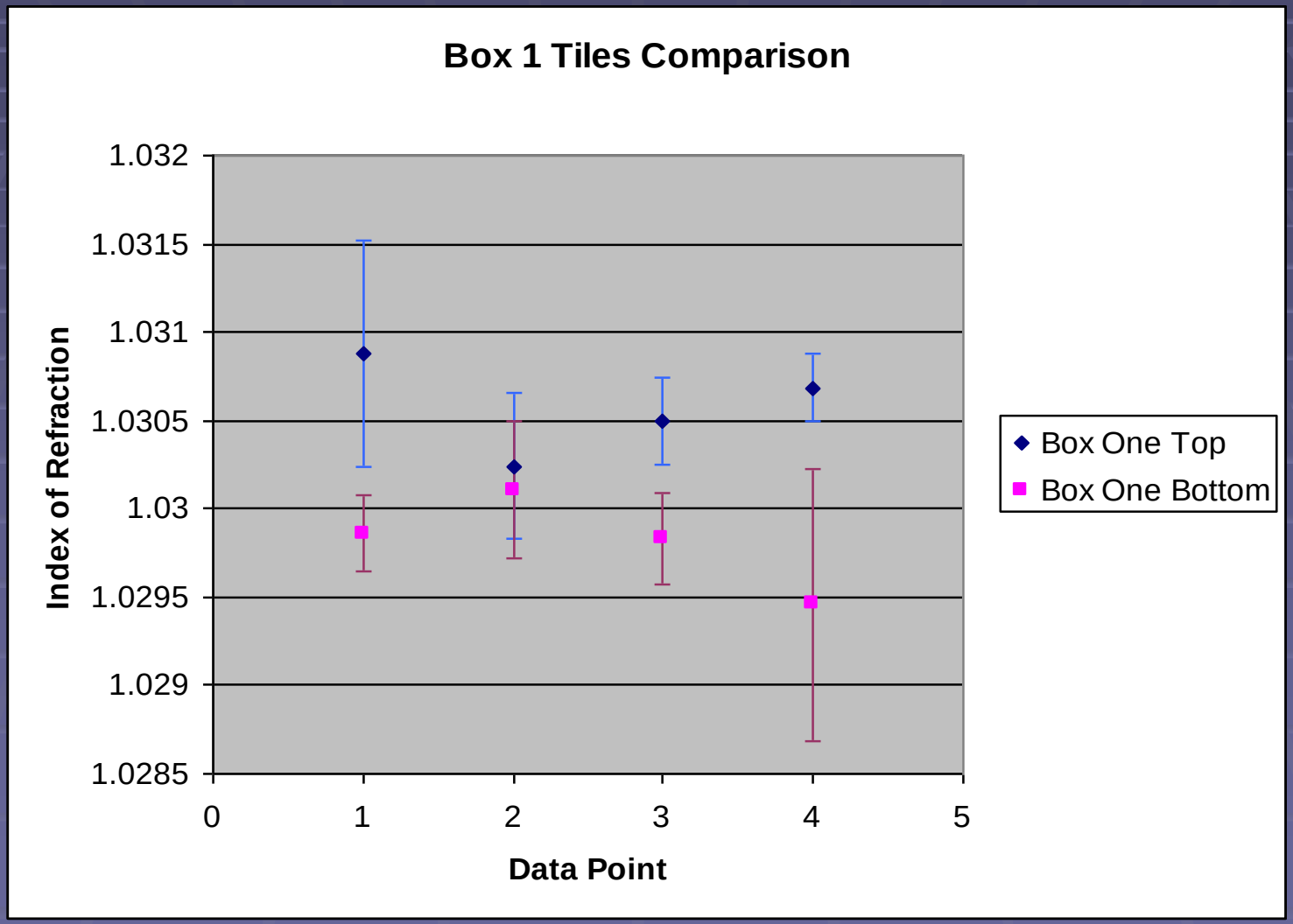
# The Error Calculator

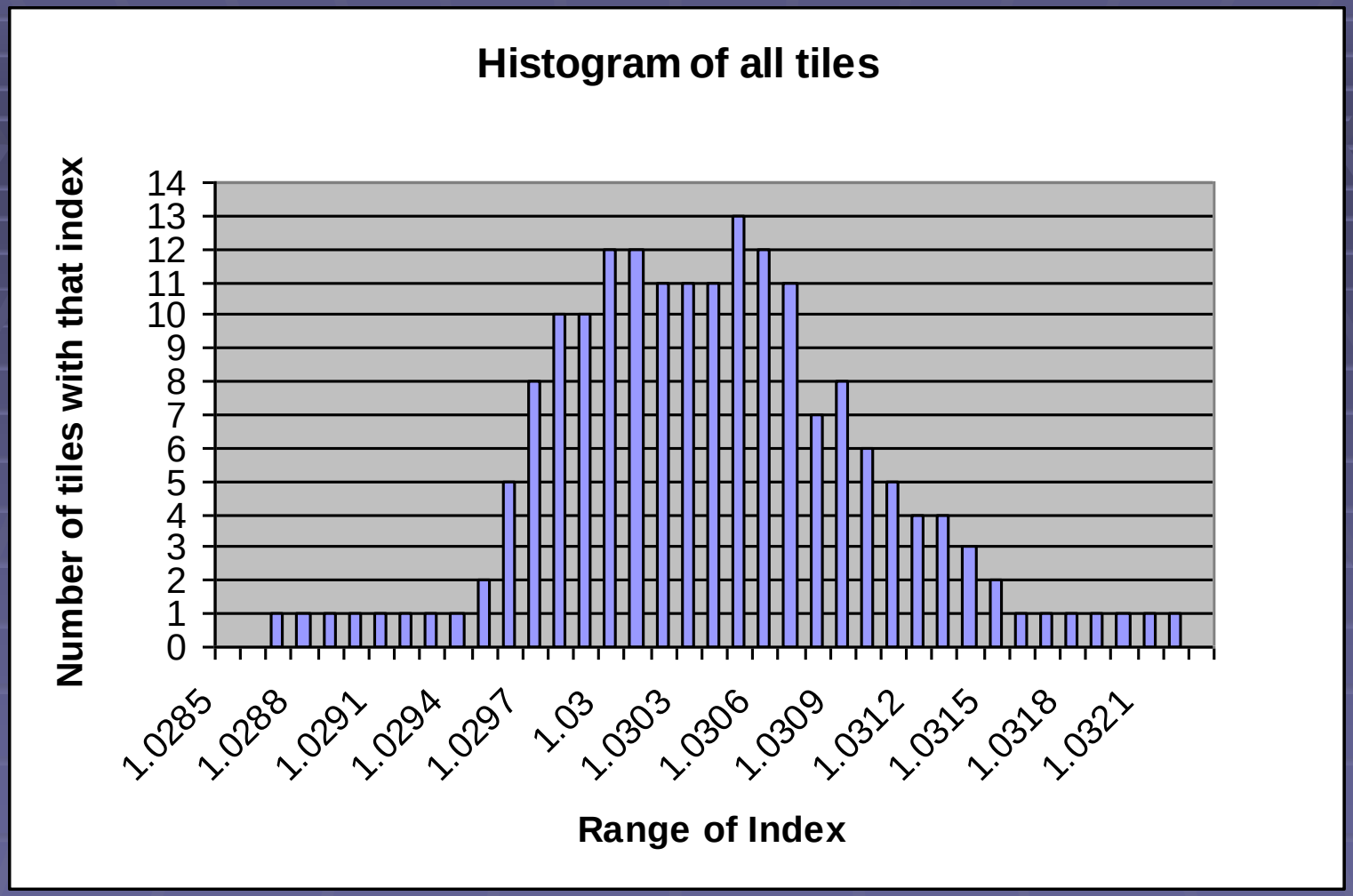
- A snap shot of the error calculator we have been using.



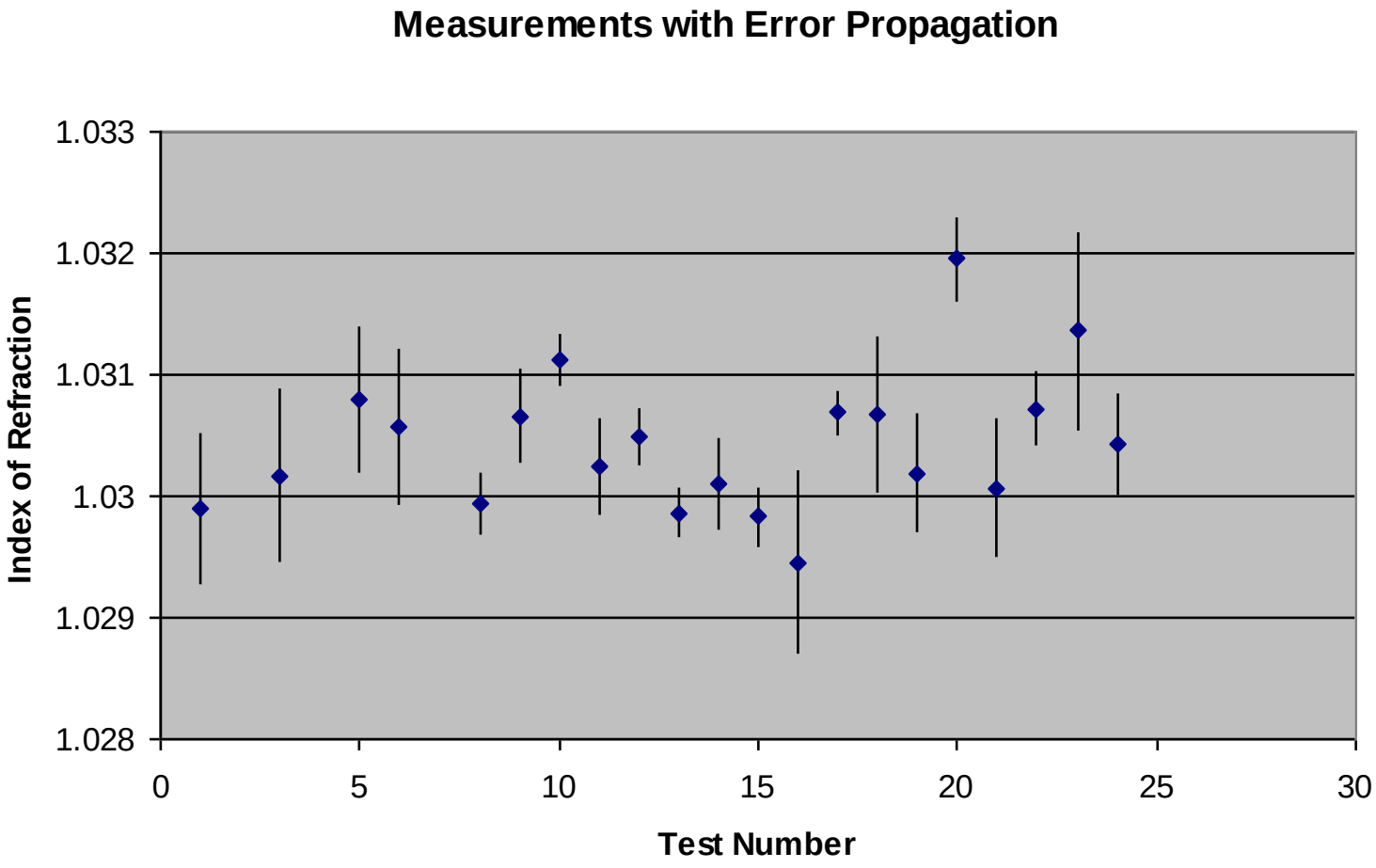

Comparison between Hand and Calc
Index of Refraction
1.032
1.0315
1.031
1.0305
1.03
1.0295
1.029
5
6
7
8
9
10
11
12
13
Test Number
By Hand
Error Calculator

# Comparison of Two Tiles




Histogram of all tiles
Number of tiles with that index
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
1.0285
1.0288
1.0291
1.0294
1.0297
1.03
1.0303
1.0306
1.0309
1.0312
1.0315
1.0318
1.0321
Range of Index

# Results


Measurements with Error Propagation
Index of Refraction
1.033
1.032
1.031
1.03
1.029
1.028
0
5
10
15
20
25
30
Test Number