

Uncertainty Propagation

- All measurements have uncertainty
- Provides a way to accurately combine two measurements and their uncertainties

7/13/12

+

Test 11
Box 1 top

$\Delta: 54.3, 54.81 = 54.555 \pm .255$ mm
 $D: 34 \frac{1}{32}, 35 \frac{1}{32} = 1887.4125 \pm 2.38125$ mm
 $\alpha: 42.8097 \pm .0318$

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

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

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

$$v_{\gamma} = \begin{cases} \tan^{-1}\left(\frac{\Delta}{D} + v_{\frac{\Delta}{D}}\right) - \tan^{-1}\left(\frac{\Delta}{D}\right) = .018893 \\ \tan^{-1}\left(\frac{\Delta}{D} - v_{\frac{\Delta}{D}}\right) - \tan^{-1}\left(\frac{\Delta}{D}\right) = -.018894 \end{cases}$$

$$\gamma = \tan^{-1}\left(\frac{\Delta}{D}\right) = 3.517888 \pm .018894$$

$$v(\gamma - \alpha) = \sqrt{v_{\gamma}^2 + v_{\alpha}^2} = .036990$$

$$\gamma - \alpha = -39.291312 \pm .036990$$

$$v \sin(\alpha) = 2(\sin \alpha)(.000407) = .000553$$

$$v \cos(\gamma - \alpha) = 2(\cos(\gamma - \alpha))(.000409) = .000633$$

$$\sin^2(\alpha) = .461801 \pm .000553$$

$$\cos^2(\gamma - \alpha) = .598977 \pm .000633$$

$$v(\sin + \cos) = \sqrt{v \sin^2 + v \cos^2} = .000841$$

$$v_n = \frac{1}{2} (\sin^2(\alpha) + \cos^2(\gamma - \alpha))^{-\frac{1}{2}} (.000841) (1.000743) = .000408$$

$n = 1.030243 \pm .000408$

The calculations for one test done by hand

An Uncertainty Calculator

Gustavus Physics Department: Error Analysis Calculator

1.03024272579445
± 4.08286348952722E-04 Swap

Rad Deg Deg->Rad Rad->Deg

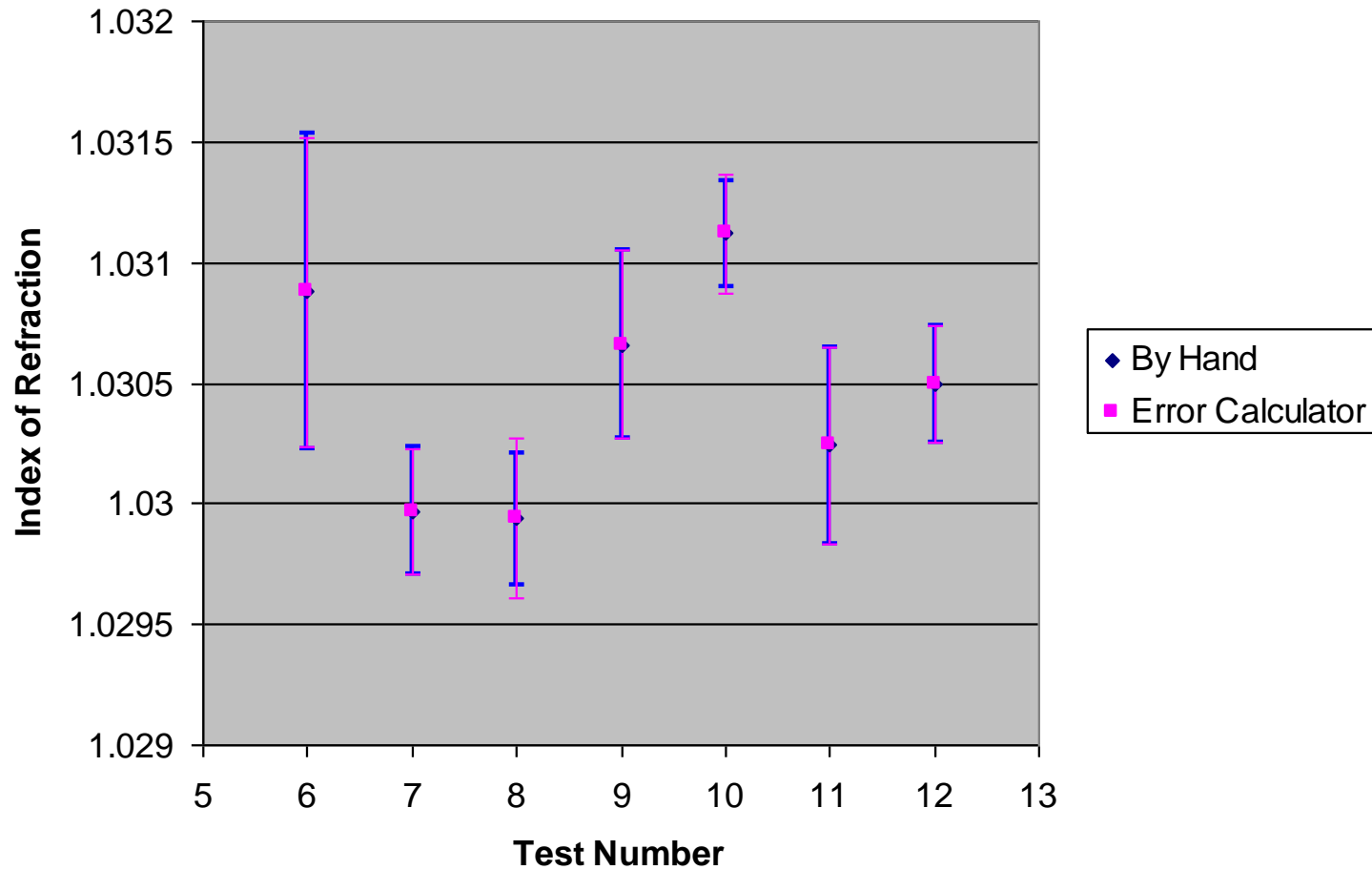
M+ Ln Sin ASin pi e Del Clear
M- e^x Cos ACos 7 8 9 % x
MClr Log10 Tan ATan 4 5 6 ÷ -
MRcl 10^x sqrt X^2 1 2 3 + =
X^Y 1/X 0 . +/-
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Display History
Advanced Mode
Save State
About Help
Clear History

-39.29128431 ± .03699908106	=
-39.29128431 ± .03699908106	Cos
.773936549 ± .0004089333428	=
.773936549 ± .0004089333428	^2
.5989777819 ± .0006329769202	=
42.8092 ± .0318	Sin
.6795591107 ± .0004071703059	=
.6795591107 ± .0004071703059	^2
.461800585 ± .000553392582	=
.461800585 ± .000553392582	+
.5989777819 ± .0006329769202	
1.060778367 ± .0008407753156	=
1.060778367 ± .0008407753156	sqrt
1.029940953 ± .0004081667561	=
1.029940953 ± .0004081667561	x
1.000293 ± 0	
1.030242726 ± .000408286349	=

- This quickly reduced ten minute calculations down to twenty second ones

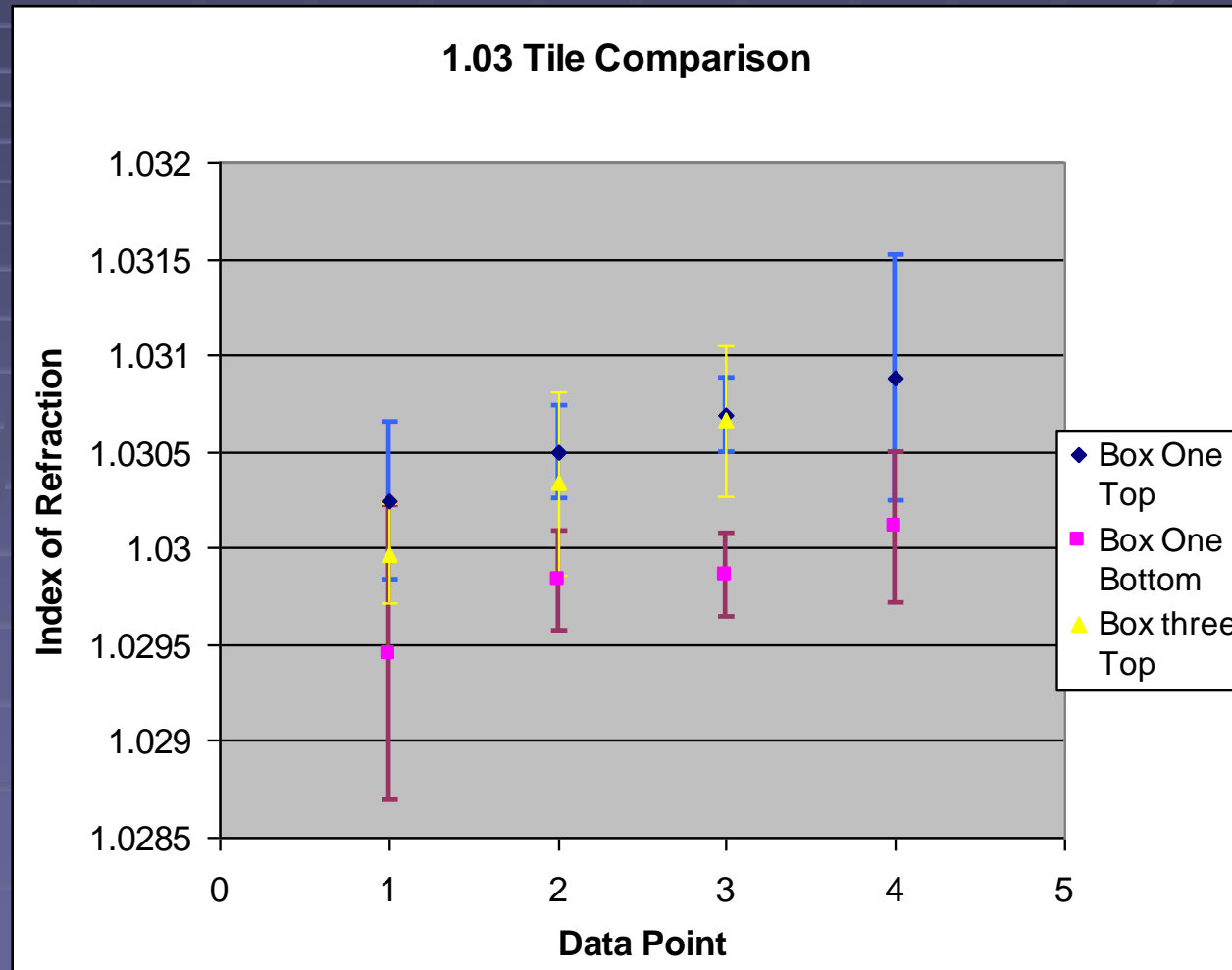
Calculator Consistency

Comparison between Hand and Calc



Tile comparison

- There is a difference between the individual tiles despite them having the same manufacturer labeled index



Tile comparison

