

# 3D Printer Error Analysis Using Monte Carlo Simulations

Robert E. Nee   Date = 16\_12\_2013   Time = 14:27:11   Test File = 3D\_Test-29\_16\_12\_2013.html

Test-29:609 mm cube :all errors:a1err,a2err,a3err theta: t1err t2err t3err <> 0 errors :  
add A1err,A2err,A3err = <> d: d1err,d2err,d3err <> 0, Rzerr <> 0, Ryerr <> 0

## D-H Fixed Link Parameters

Link	$\theta$	d	a	$\alpha$	Rz	Ry
1	0.000000	0.000000	609.000000	0.000000	0.000000	0.000000
2	0.000000	0.000000	609.000000	0.000000	0.000000	0.000000
3	0.000000	0.000000	609.000000	0.000000	0.000000	0.000000

## Error Estimation Basis

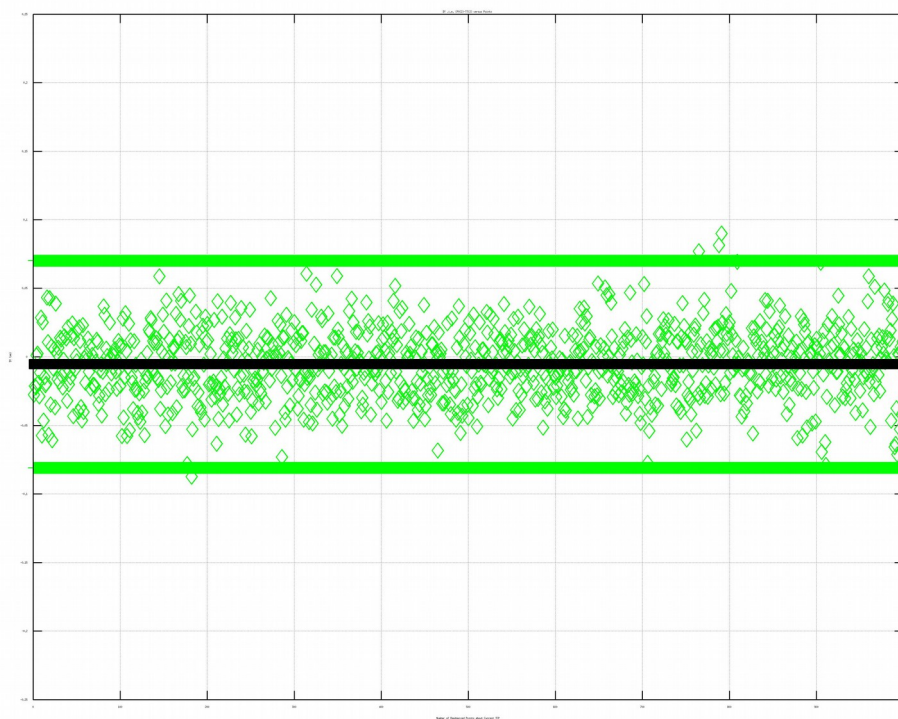
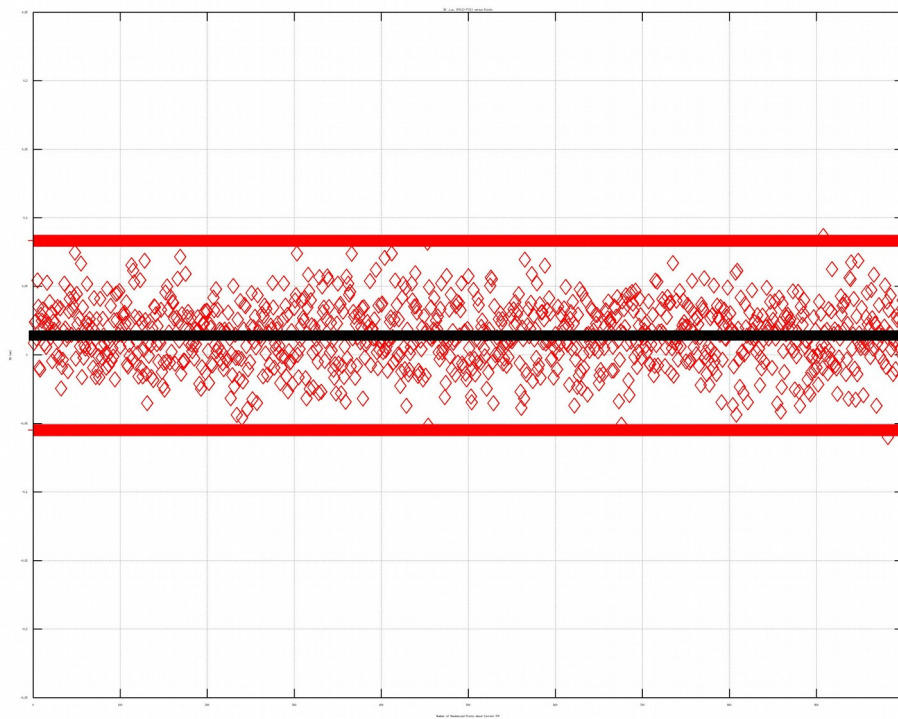
Error Types	$\theta$	$\alpha$	XYZ travel- a1,a2,a3	Link travel - d	Rzerr	Ryerr
Fixed Link Angle play	0.000025	0.000025			0.000025	0.000025
Link Distances			0.010799	0.012700		

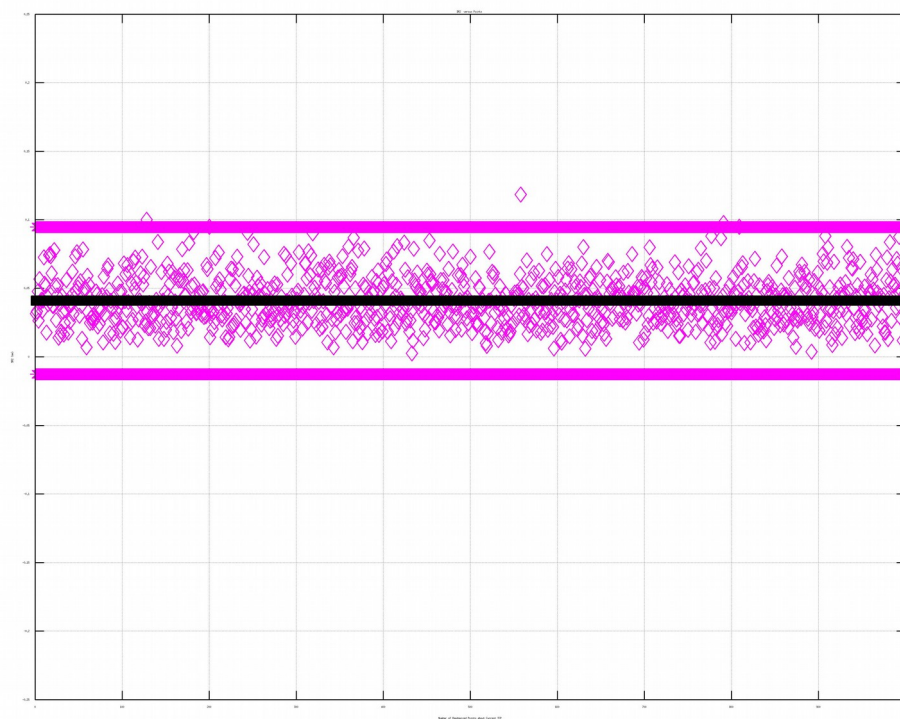
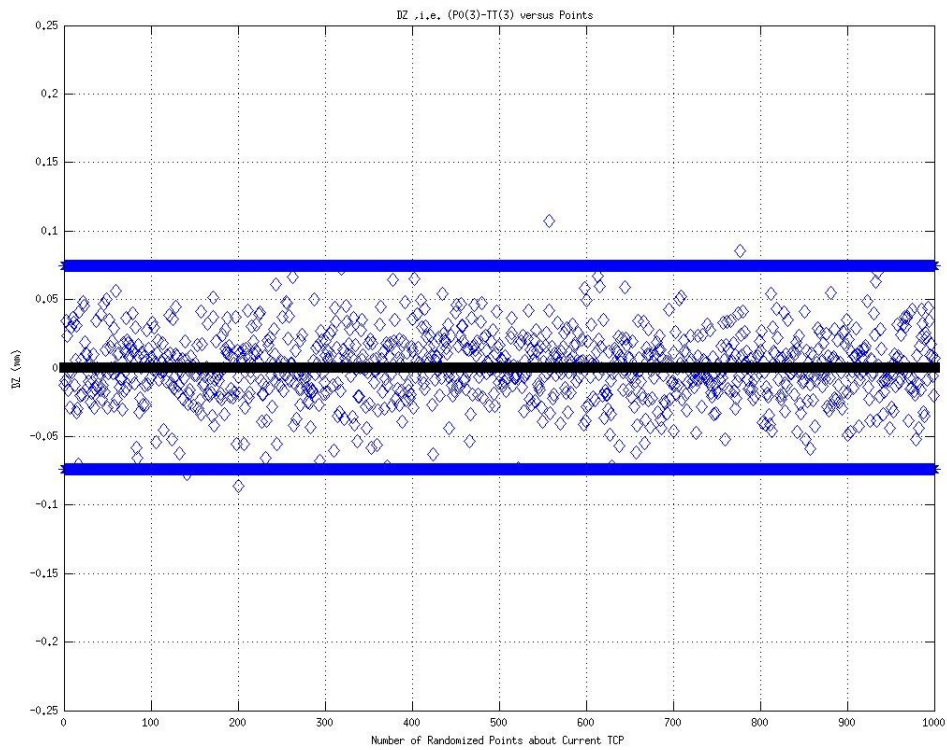
## Nominal $1\sigma$ errors

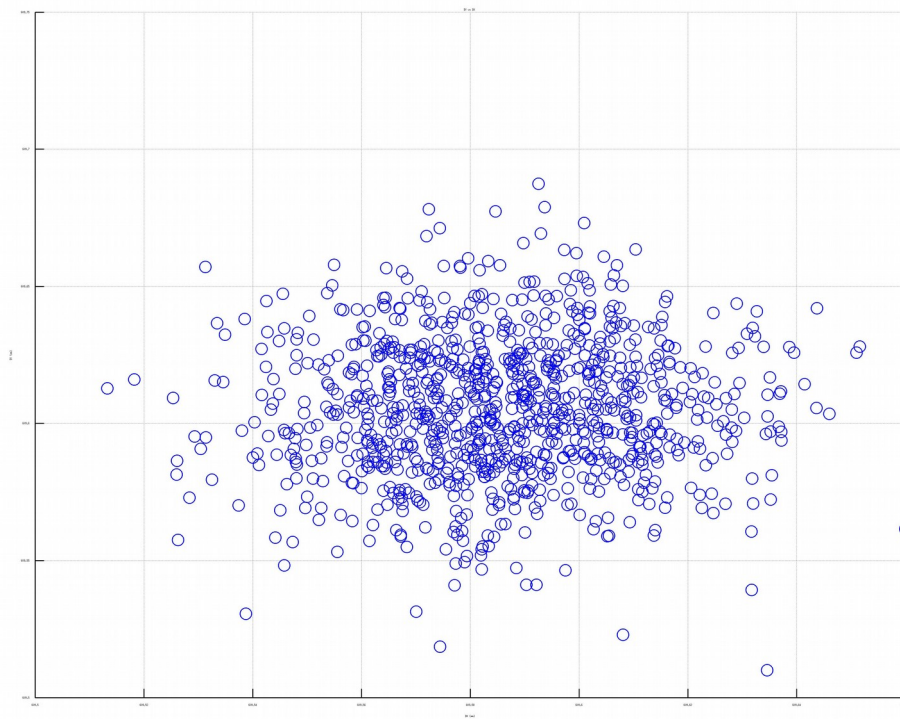
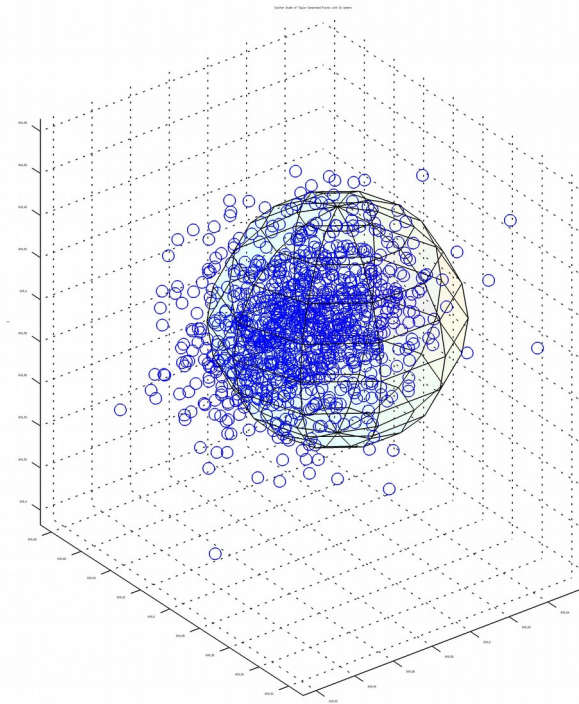
Link	$\theta$	d	a	$\alpha$	$\Delta$ Rz	$\Delta$ Ry
1	0.000025	0.012700	0.010799	0.000025	0.000025	
2	0.000025	0.012700	0.010799	0.000025		0.000025
3	0.000025	0.012700	0.010799	0.000025		

## Sample $1\sigma$ \* randn errors

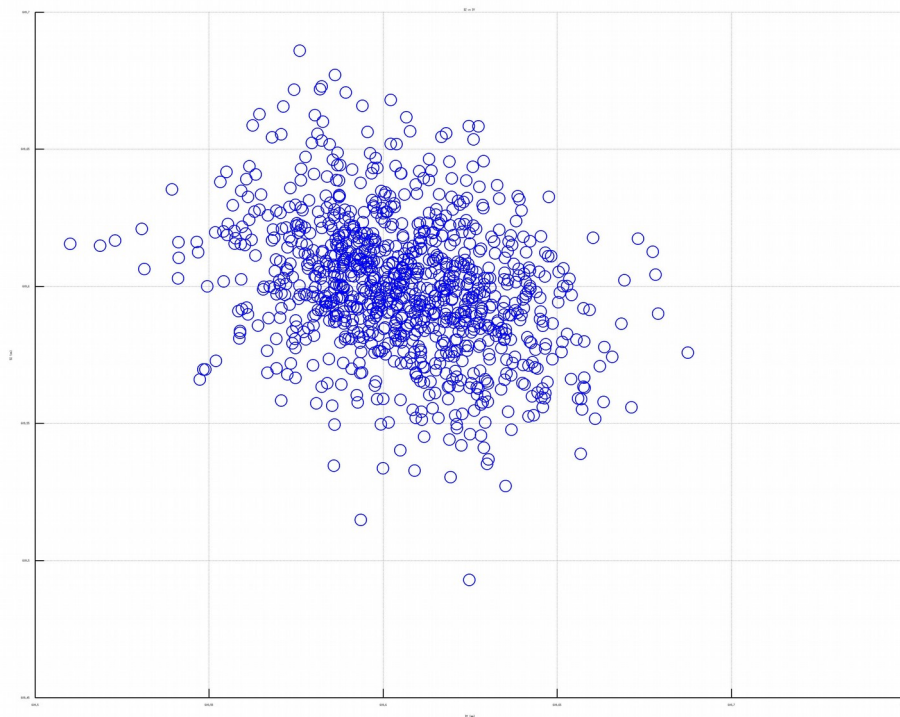
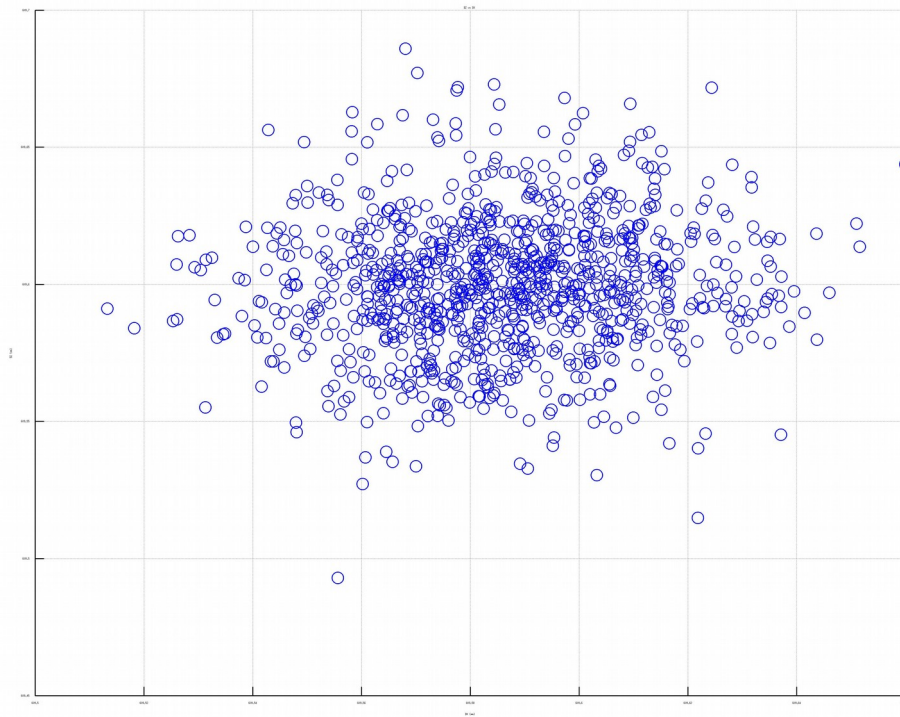
Link	$\Delta\theta$	$\Delta$ d	$\Delta$ a	$\Delta\alpha$	$\Delta$ Rz	$\Delta$ Ry
1	0.00000731	-0.02115292	-0.00467136	0.00000318	-0.00002912	
2	0.00000831	0.01510239	0.01286096	-0.00000096		0.00000444
3	0.00005545	0.00921754	-0.00201631	-0.00001494		











### Sample Point Calculations Comparison

Point Origin	X	Y	Z
Commanded	578.628735	140.763355	369.567133

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No Noise Forward Kinetic	578.628735	140.763355	369.567133
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Noise Taylor Expansion	578.610783	140.771314	369.575519
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mean  $\Delta R2 = 0.0345$

std  $\Delta R2 = 0.0168$

$3\sigma = 0.0504$

tolerance is  $\pm 3\sigma = 0.0504$

$\Delta R2$  range =  $-3\sigma + \text{mean}$  to  $\text{mean} + 3\sigma = -0.0160$  to  $0.0849$  ,  
estimatedIterations =  $1.412328\text{e}+03$