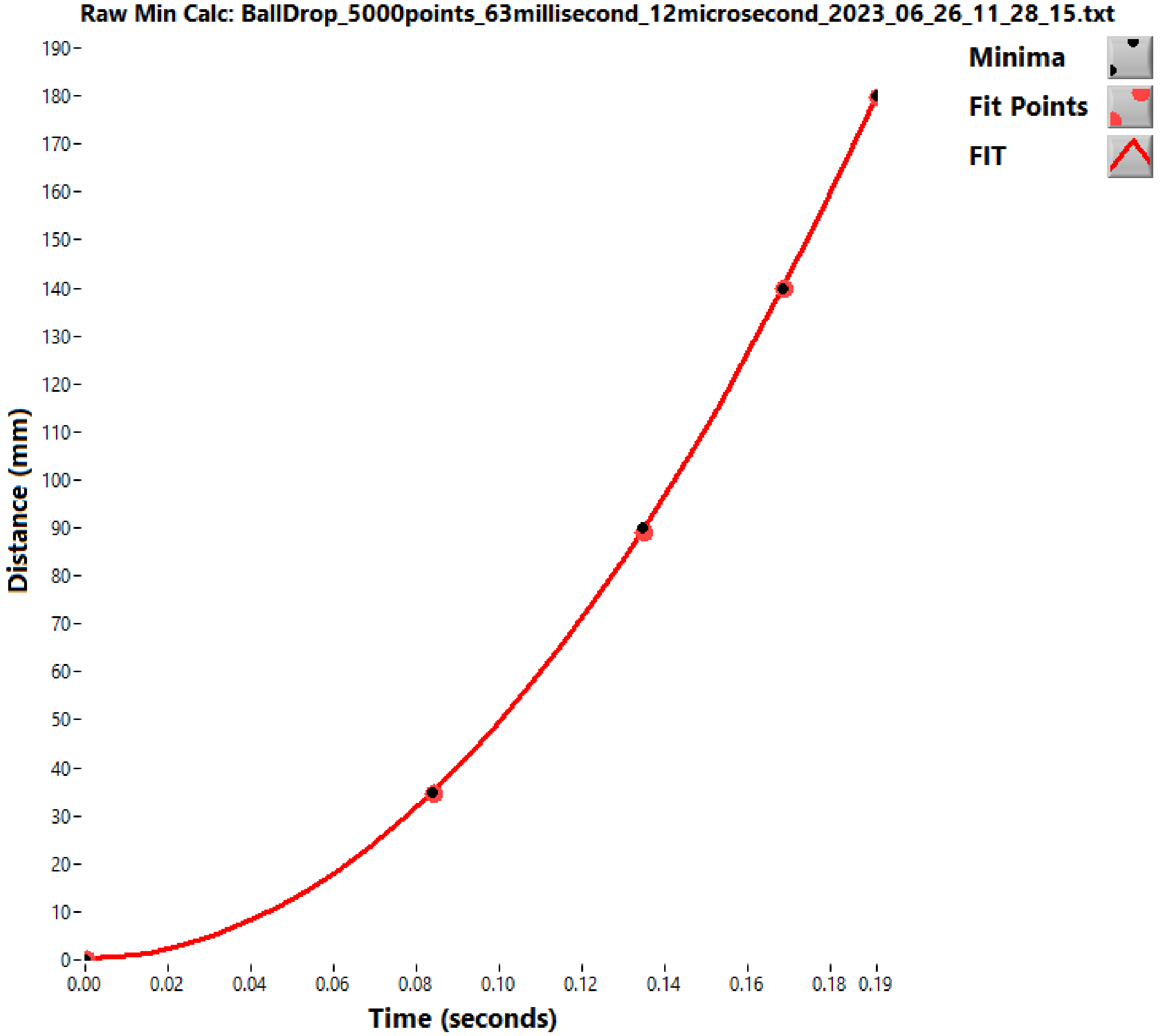
$$g_{calc} = 9.85117\frac{m}{s^2}$$

Raw Min Calc



$$g_{expected} = 9.79472\frac{m}{s^2}$$

$$g_{calc} - g_{expected} = 0.05645\frac{m}{s^2}$$

Therefore: g_{calc} has a **0.576% difference** from $g_{expected}$

Parabolic Equation Fit To Tower Drop Data

$$X = 0.317mm + \left(0.000\frac{mm}{s}\right) * t + 0.5 * \left(9851.166\frac{mm}{s^2}\right) * t^2$$

X calculations from above parabolic fit will be within $\pm\mathbf{0.317mm}$ of the measured X data ~95% of the time using the 2sigma rule of thumb.

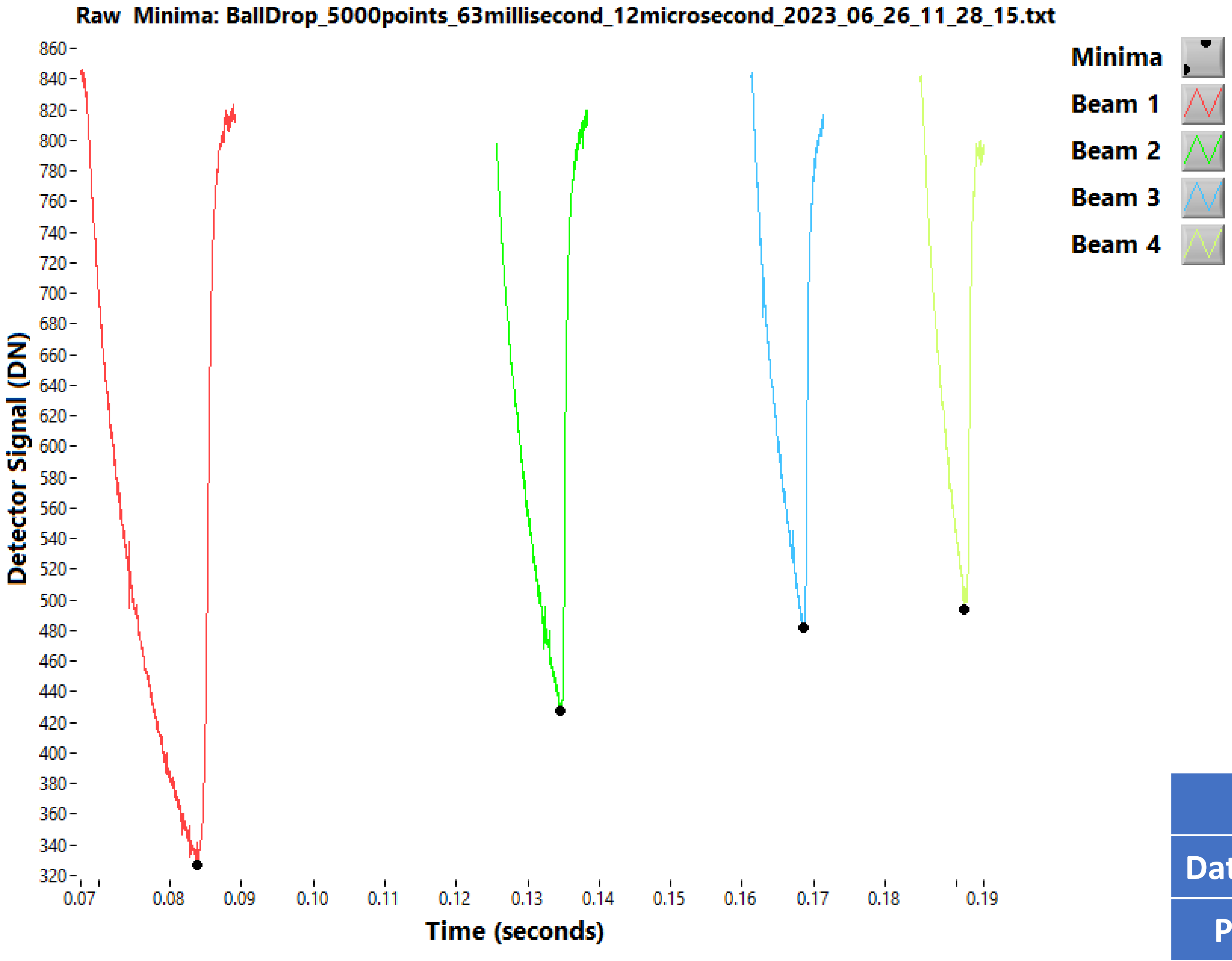
The formula for this 2sigma (2 σ or 2 Standards of Deviation) calculation is detailed below

$$\sigma = \sum_{i=0}^{n-1}\left(\frac{(x_i - \mu)^2}{n-1}\right) \quad \textit{with mean equation:} \quad \mu = \sum_{i=0}^{n-1}\left(\frac{x_i}{n}\right) \textit{ where } n = 5$$

This σ equation assumes a normally distributed sample population.

	Start	Beam 1	Beam 2	Beam 3	Beam 4
Minima Time (seconds)	0	0.083759	0.134566	0.168488	0.191078
Ball Top FIT (mm)	0.317	34.873	89.510	140.146	180.154
Ball Top (mm)	0	35.000	90.000	140.000	180.000
$X_{fit} - X_{ball\ top}$ (mm)	0.317	-0.127	-0.490	0.146	0.154

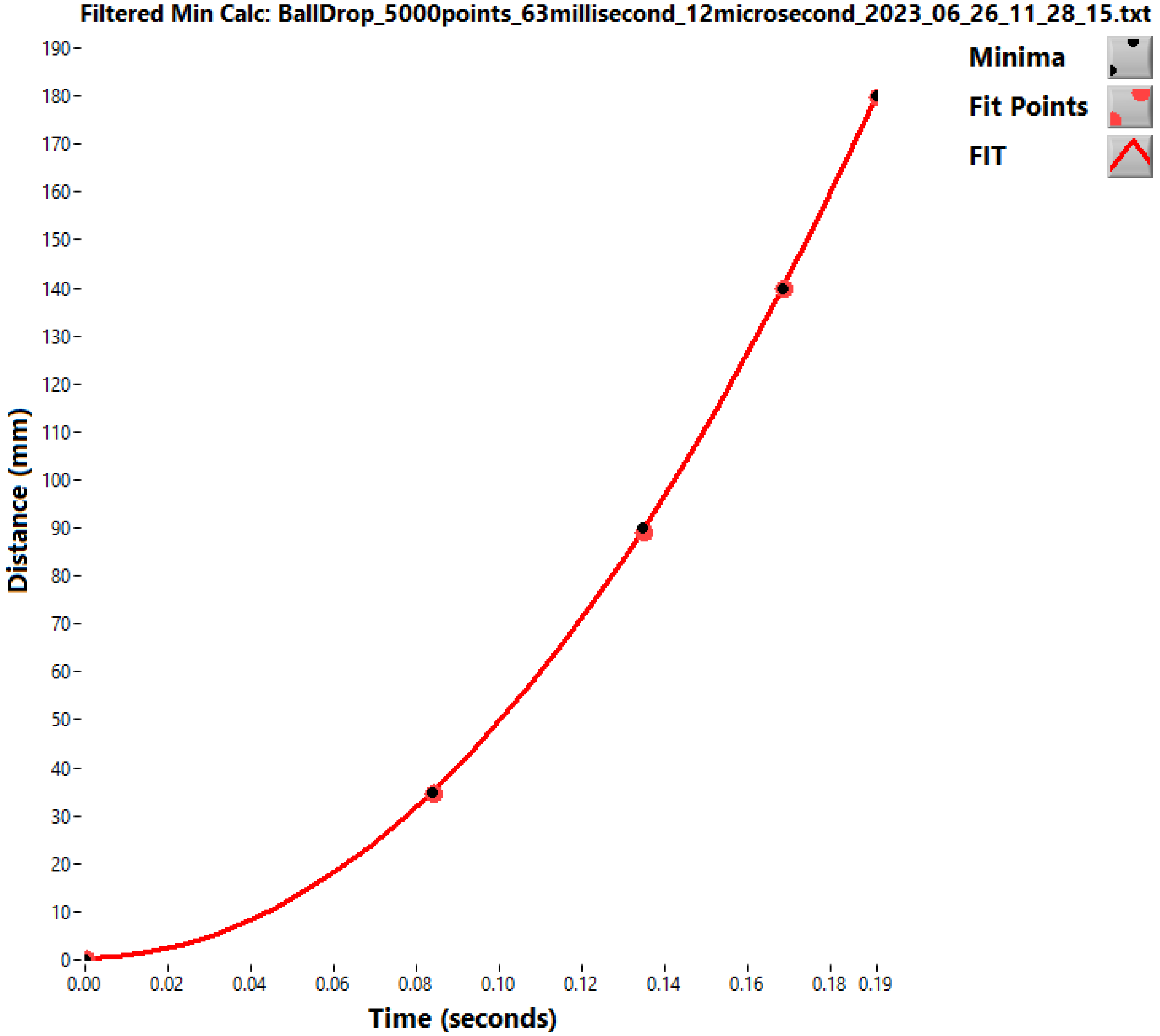
Data Analysis Method (Raw Minima)



Fit Option	V0 = 0
Data Manipulation	Raw
Point Selection	Minima

$$g_{calc} = 9.82715 \frac{m}{s^2}$$

Filtered Min Calc



$$g_{expected} = 9.79472 \frac{m}{s^2}$$

$$g_{calc} - g_{expected} = 0.03243 \frac{m}{s^2}$$

Therefore: g_{calc} has a **0.331% difference** from $g_{expected}$

Parabolic Equation Fit To Tower Drop Data

$$X = 0.375mm + \left(0.000 \frac{mm}{s}\right) * t + 0.5 * \left(9827.153 \frac{mm}{s^2}\right) * t^2$$

X calculations from above parabolic fit will be within $\pm\mathbf{0.388mm}$ of the measured X data ~95% of the time using the 2sigma rule of thumb.

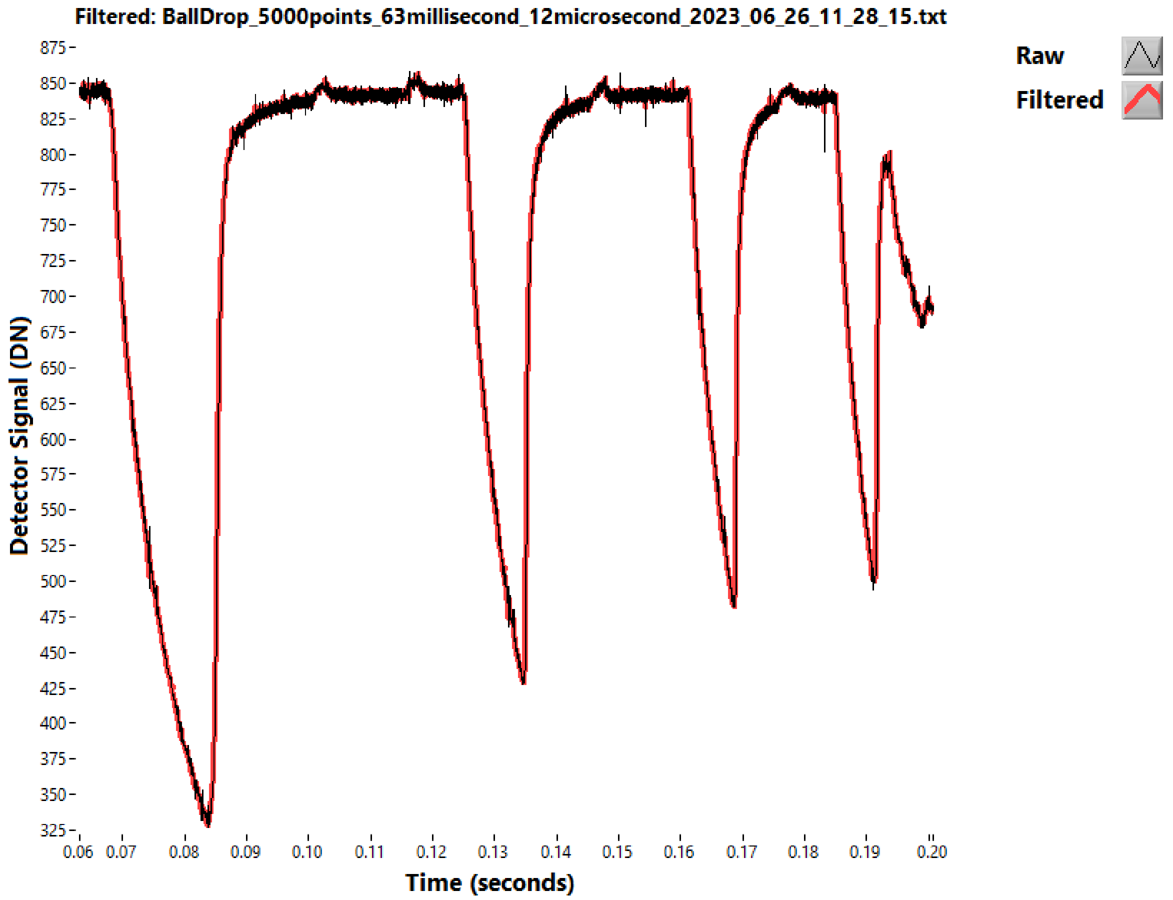
The formula for this 2sigma (2 σ or 2 Standards of Deviation) calculation is detailed below

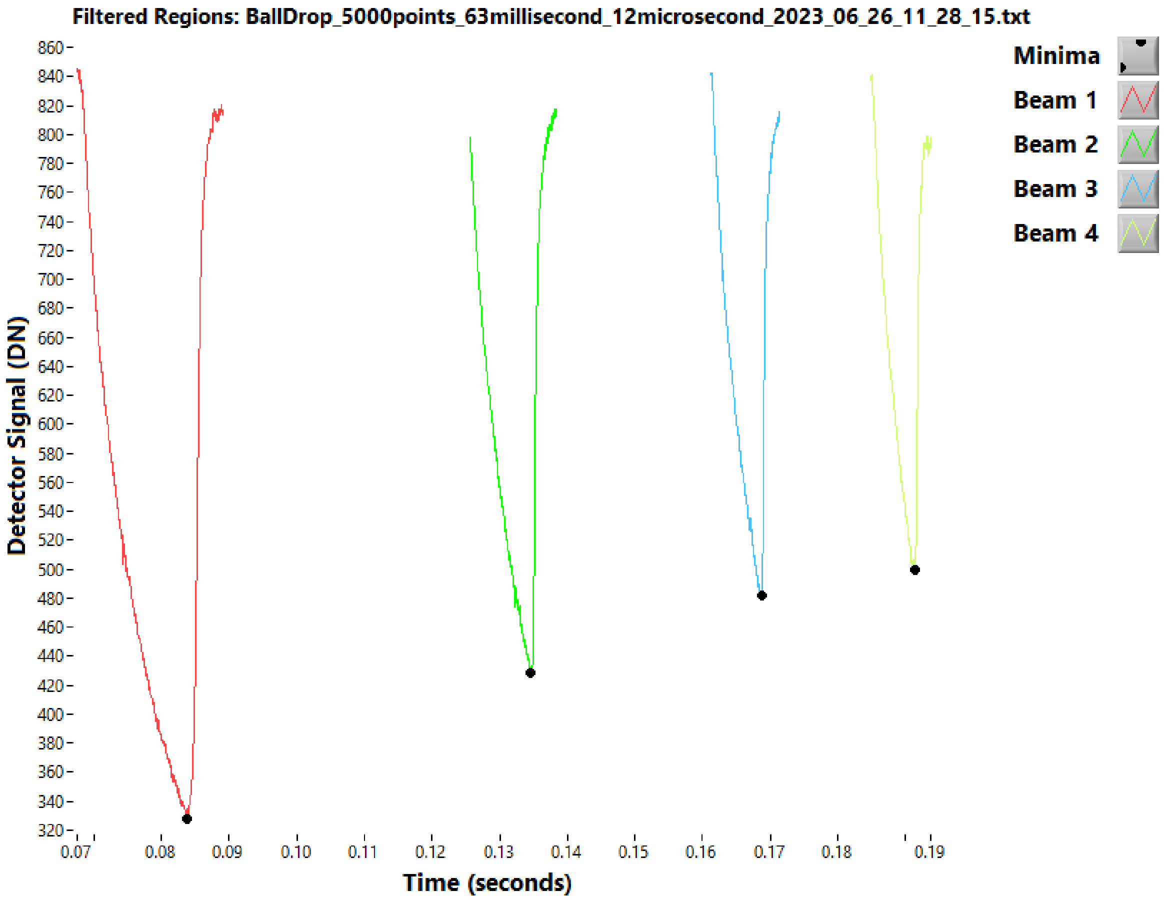
$$\sigma = \sum_{i=0}^{n-1} \left(\frac{(x_i - \mu)^2}{n-1}\right) \quad \textit{with mean equation:} \quad \mu = \sum_{i=0}^{n-1} \left(\frac{x_i}{n}\right) \textit{ where } n = 5$$

This σ equation assumes a normally distributed sample population.

	Start	Beam 1	Beam 2	Beam 3	Beam 4
Minima Time (seconds)	0	0.083786	0.134593	0.168680	0.191298
Ball Top FIT (mm)	0.375	34.869	89.386	140.181	180.188
Ball Top (mm)	0	35.000	90.000	140.000	180.000
$X_{fit} - X_{ball\ top}$ **(mm)**	0.375	-0.131	-0.614	0.181	0.188

Data Analysis Method (Filtered Minima)

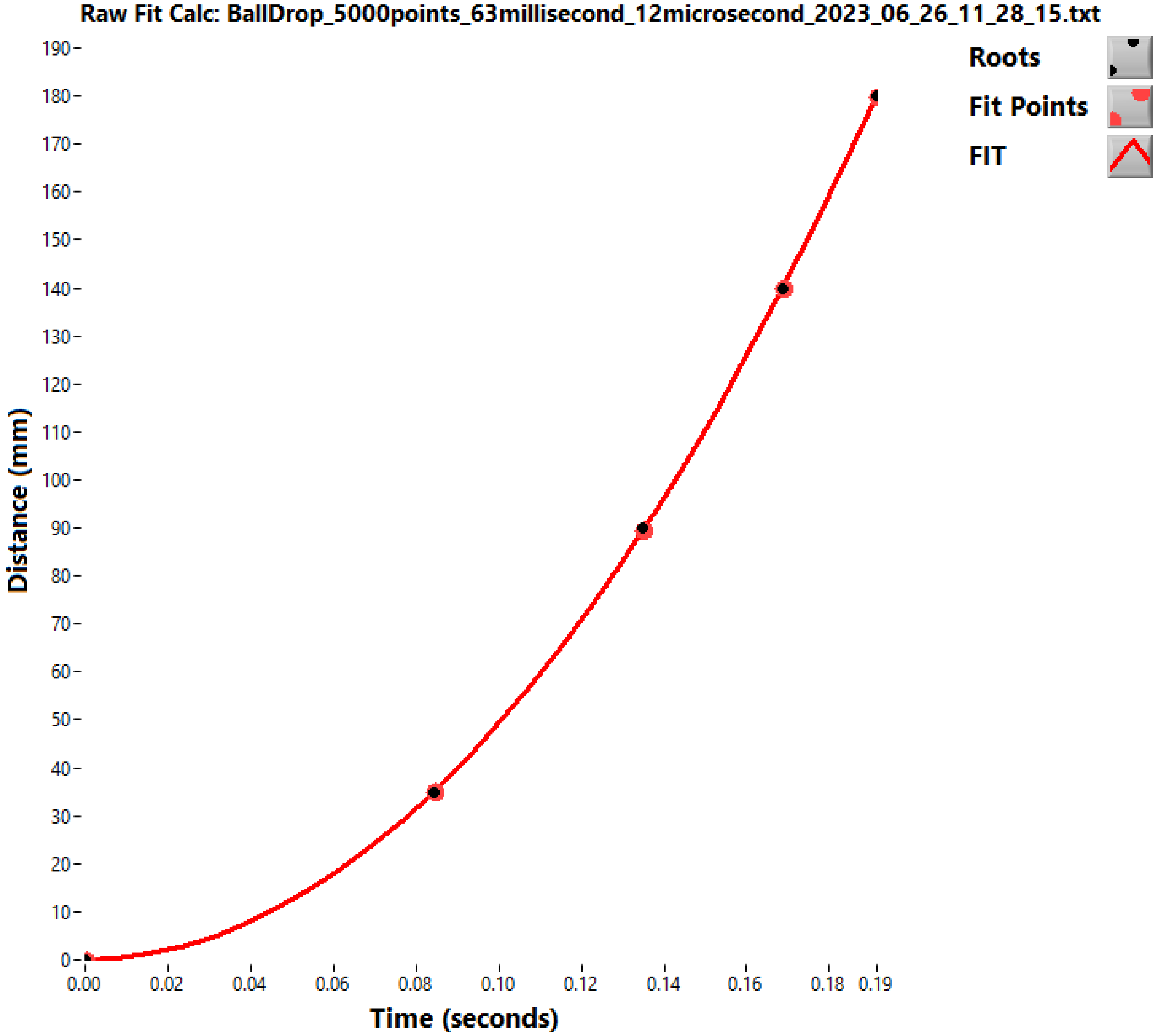




Fit Option	V0 = 0	**Box Car Size**	3
Data Manipulation	Filtered	**Point Selection**	Minima

$$g_{calc} = 9.82625\frac{m}{s^2}$$

Raw Fit Calc



$$g_{expected} = 9.79472\frac{m}{s^2}$$

$$g_{calc} - g_{expected} = 0.03153\frac{m}{s^2}$$

Therefore: g_{calc} has a **0.322% difference** from $g_{expected}$

Parabolic Equation Fit To Tower Drop Data

$$X = 0.104mm + \left(0.000\frac{mm}{s}\right) * t + 0.5 * \left(9826.246\frac{mm}{s^2}\right) * t^2$$

X calculations from above parabolic fit will be within $\pm\mathbf{0.261mm}$ of the measured X data ~95% of the time using the 2sigma rule of thumb.

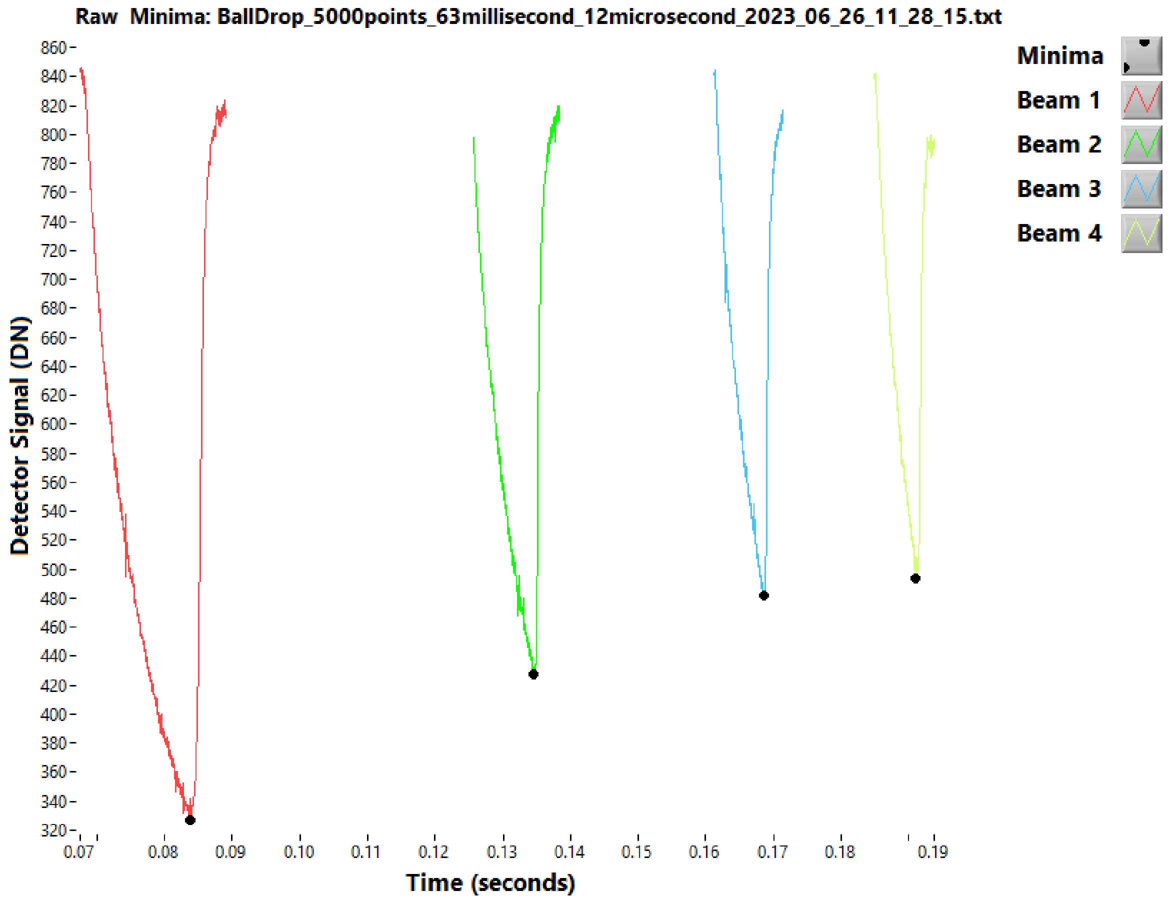
The formula for this 2sigma (2 σ or 2 Standards of Deviation) calculation is detailed below

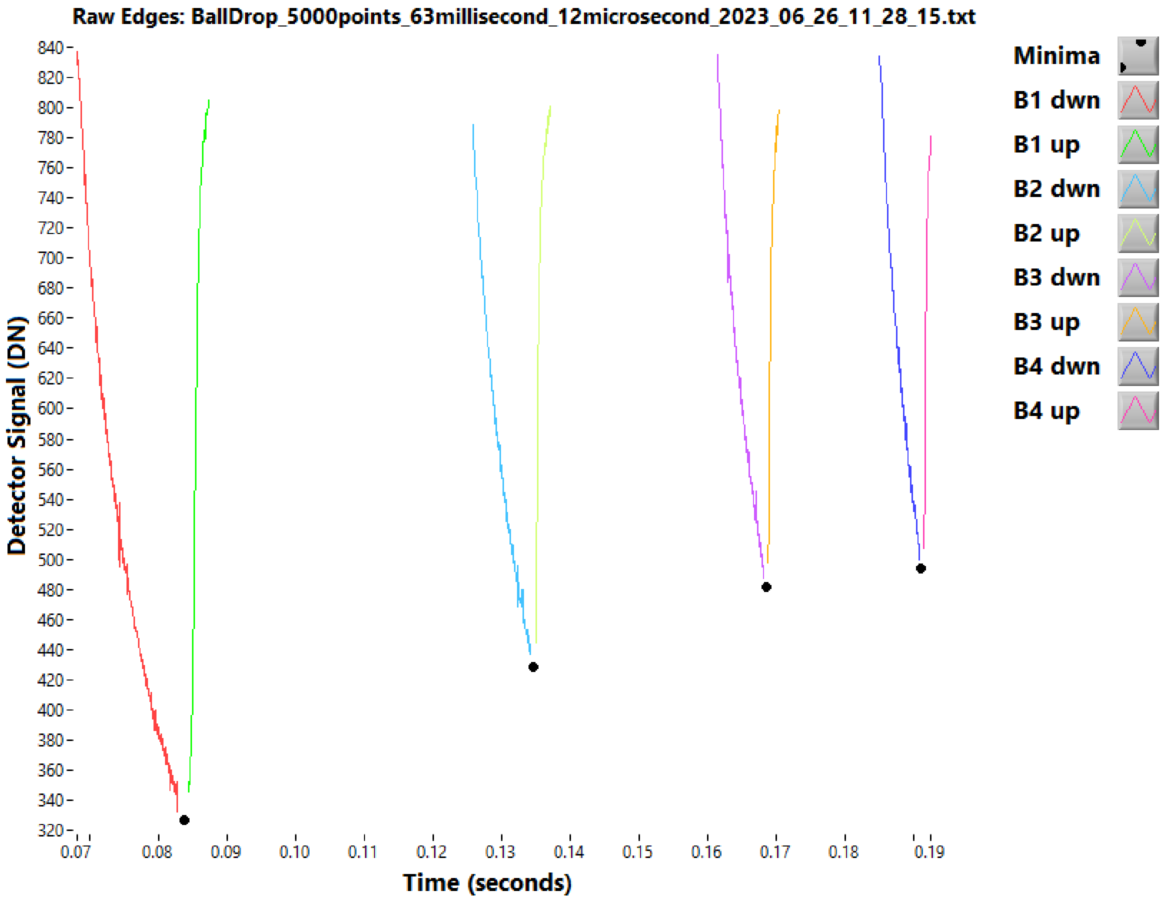
$$\sigma = \sum_{i=0}^{n-1}\left(\frac{(x_i - \mu)^2}{n-1}\right) \quad \textit{with mean equation:} \quad \mu = \sum_{i=0}^{n-1}\left(\frac{x_i}{n}\right) \textit{ where } n = 5$$

This σ equation assumes a normally distributed sample population.

	Start	Beam 1	Beam 2	Beam 3	Beam 4
Roots Time (seconds)	0	0.084428	0.134915	0.168826	0.191405
Ball Top FIT (mm)	0.104	35.125	89.533	140.139	180.100
Ball Top (mm)	0	35.000	90.000	140.000	180.000
$X_{fit} - X_{ball\ top}$ (mm)	0.104	0.125	-0.467	0.139	0.100

Data Analysis Method (Raw Poly Fit)

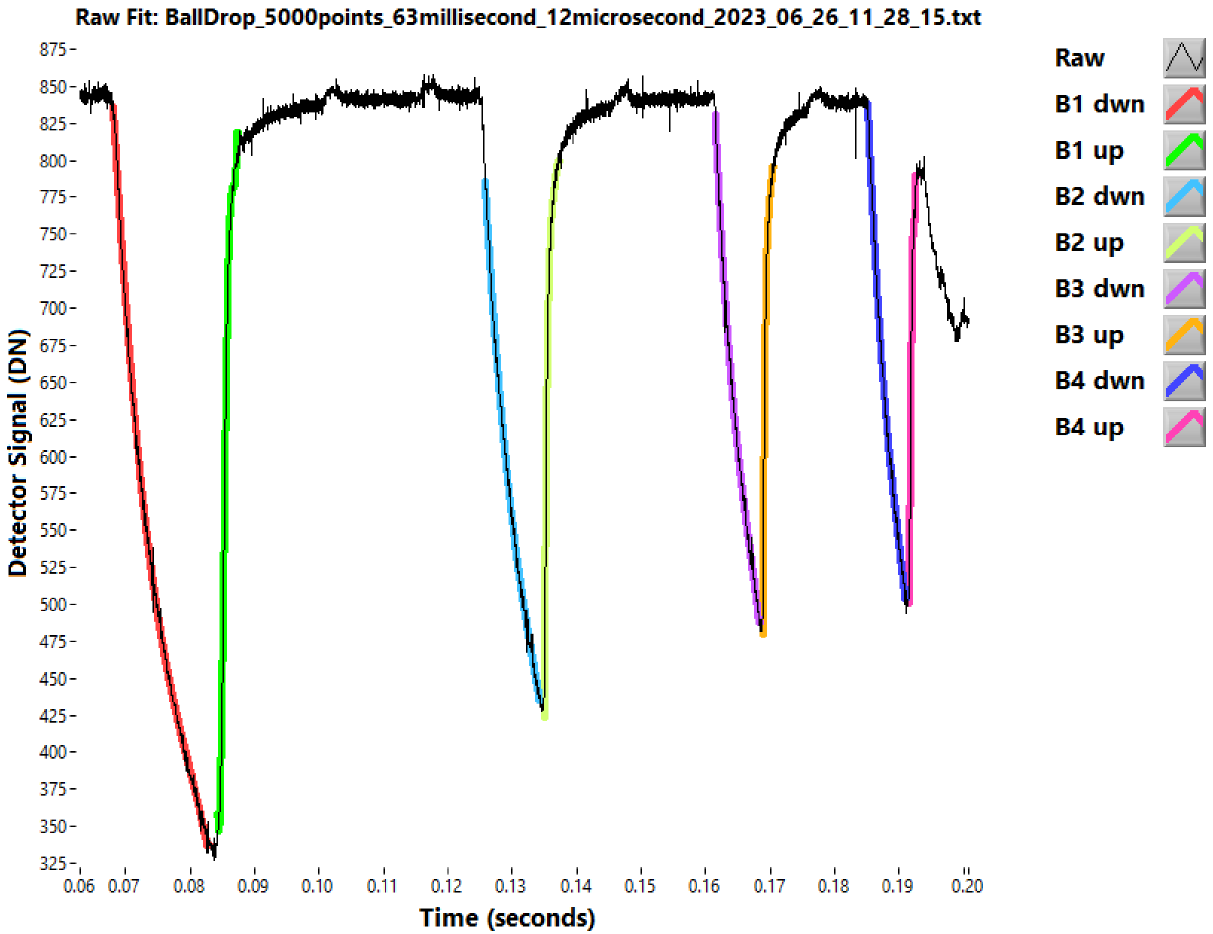


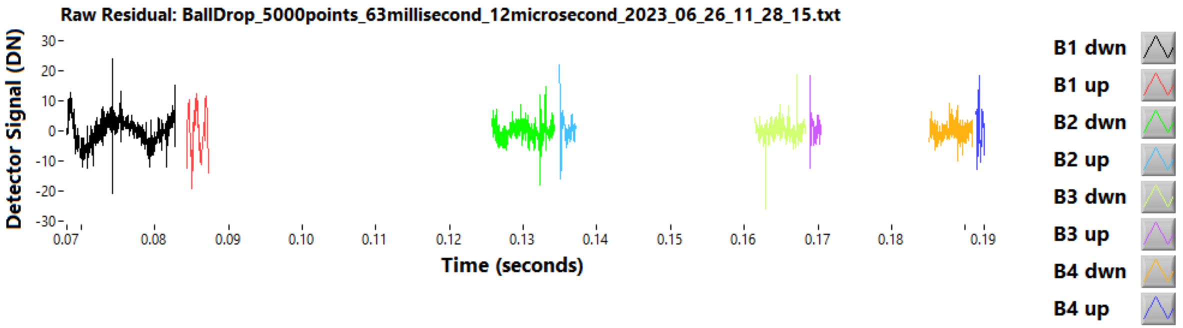


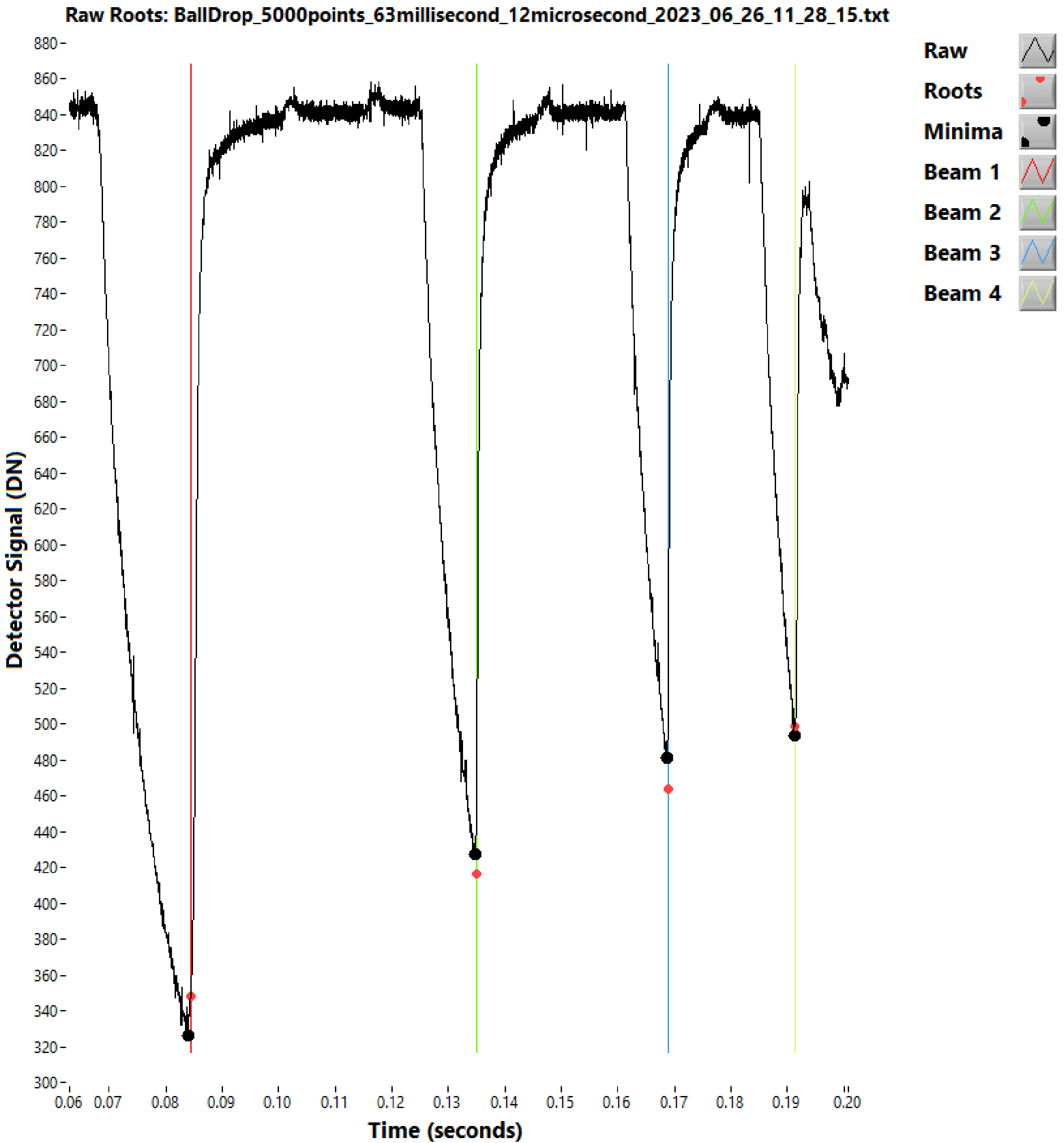
Fit Option	V0 = 0
Data Manipulation	Raw
Point Selection	Polynomial intersection

Polynomial Order Down	3 Orders
Region Down Start	10 Digital Number
Region Down End	10 Digital Number
Polynomial Order Up	4 Orders
Region Up Start	20 Digital Number
Region Up End	20 Digital Number

Data Fit Roots and Residuals





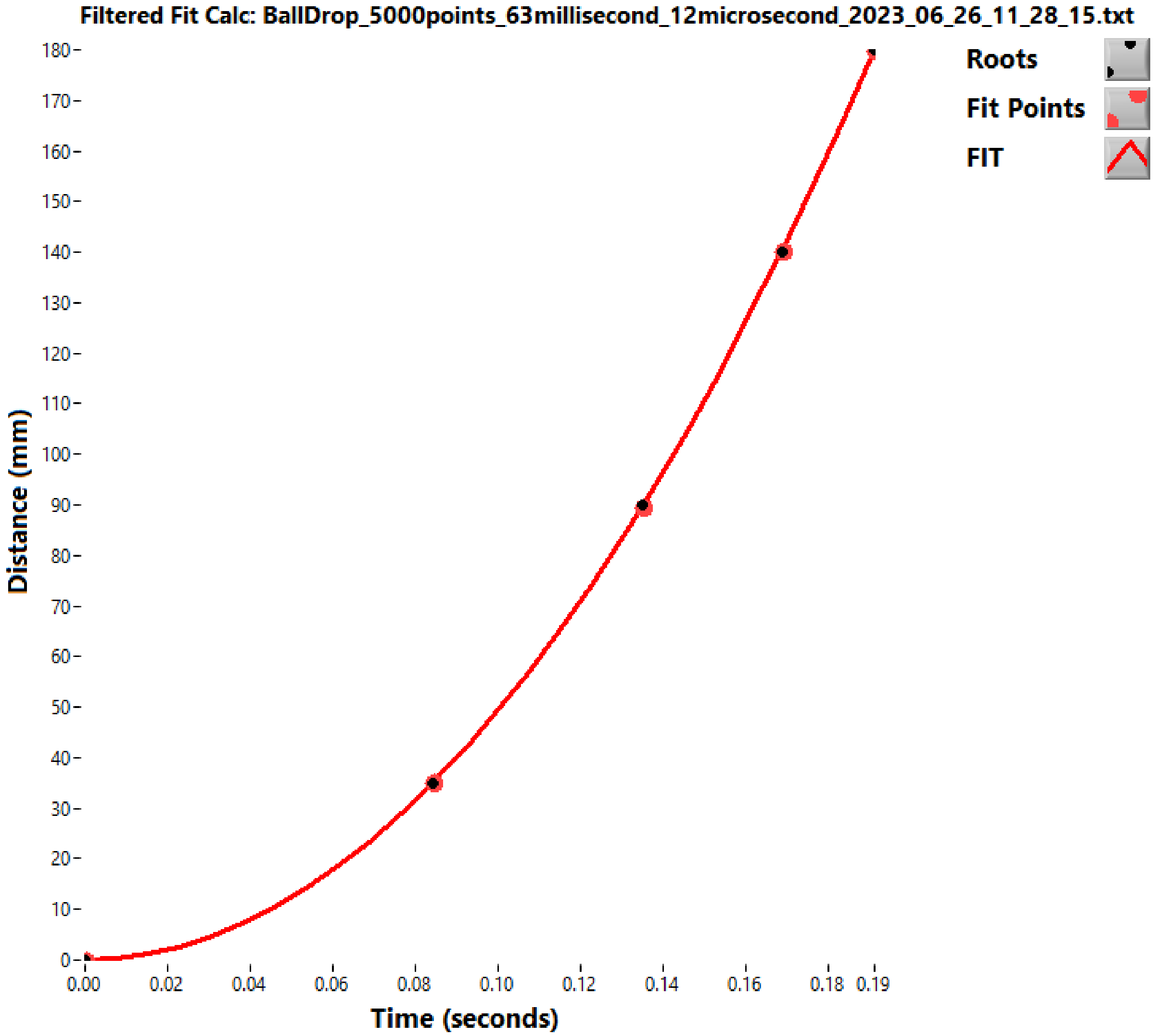


Polynomial Fit Equations

Beam 1 Down	$Y = 73238.962\ DN + \left(-2694954.947\frac{DN}{s}\right) * t + \left(33444416.332\frac{DN}{s^2}\right) * t^2 - \left(139256559.277\frac{DN}{s^3}\right) * t^3$
Beam 1 Up	$Y = 2821369655.092\ DN + \left(-131306065843.793\frac{DN}{s}\right) * t + \left(2291434273437.613\frac{DN}{s^2}\right) * t^2 - \left(17771108950875.441\frac{DN}{s^3}\right) * t^3 + \left(51679765298998.391\frac{DN}{s^4}\right) * t^4$
Beam 2 Down	$Y = 659155.903\ DN + \left(-14741933.041\frac{DN}{s}\right) * t + \left(110165551.779\frac{DN}{s^2}\right) * t^2 - \left(274896185.526\frac{DN}{s^3}\right) * t^3$
Beam 2 Up	$Y = -12998209053.397\ DN + \left(+380608802429.585\frac{DN}{s}\right) * t - \left(4179321007211.404\frac{DN}{s^2}\right) * t^2 + \left(20396254591977.691\frac{DN}{s^3}\right) * t^3 - \left(37327306950566.102\frac{DN}{s^4}\right) * t^4$
Beam 3 Down	$Y = 3338957.657\ DN + \left(-59951101.873\frac{DN}{s}\right) * t + \left(359064516.508\frac{DN}{s^2}\right) * t^2 - \left(717245410.474\frac{DN}{s^3}\right) * t^3$
Beam 3 Up	$Y = -80352173814.908\ DN + \left(+1889406342604.371\frac{DN}{s}\right) * t - \left(16660357427374.064\frac{DN}{s^2}\right) * t^2 + \left(65292105574492.984\frac{DN}{s^3}\right) * t^3 - \left(95955135459086.797\frac{DN}{s^4}\right) * t^4$
Beam 4 Down	$Y = 6295120.800\ DN + \left(-99328479.788\frac{DN}{s}\right) * t + \left(522671320.000\frac{DN}{s^2}\right) * t^2 - \left(917131516.728\frac{DN}{s^3}\right) * t^3$
Beam 4 Up	$Y = 1782579321355.564\ DN + \left(-37136655710629.695\frac{DN}{s}\right) * t + \left(290126228834841.312\frac{DN}{s^2}\right) * t^2 - \left(1007366921479368.370\frac{DN}{s^3}\right) * t^3 + \left(1311652101984458.000\frac{DN}{s^4}\right) * t^4$

$$g_{calc} = 9.83727 \frac{m}{s^2}$$

Filtered Fit Calc



$$g_{expected} = 9.79472 \frac{m}{s^2}$$

$$g_{calc} - g_{expected} = 0.04255 \frac{m}{s^2}$$

Therefore: g_{calc} has a **0.434% difference** from $g_{expected}$

Parabolic Equation Fit To Tower Drop Data

$$X = 0.053mm + \left(0.000 \frac{mm}{s}\right) * t + 0.5 * \left(9837.265 \frac{mm}{s^2}\right) * t^2$$

X calculations from above parabolic fit will be within $\pm\mathbf{0.252mm}$ of the measured X data ~95% of the time using the 2sigma rule of thumb.

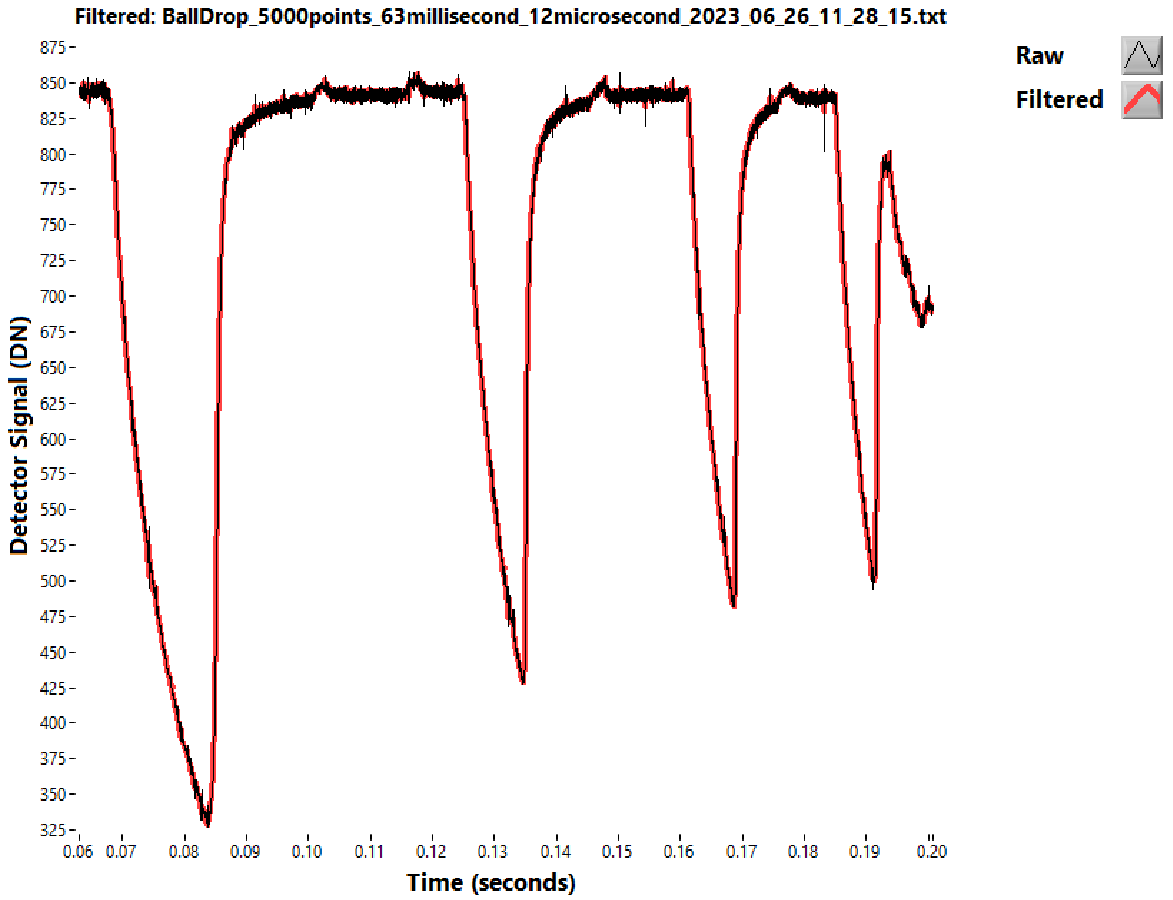
The formula for this 2sigma (2 σ or 2 Standards of Deviation) calculation is detailed below

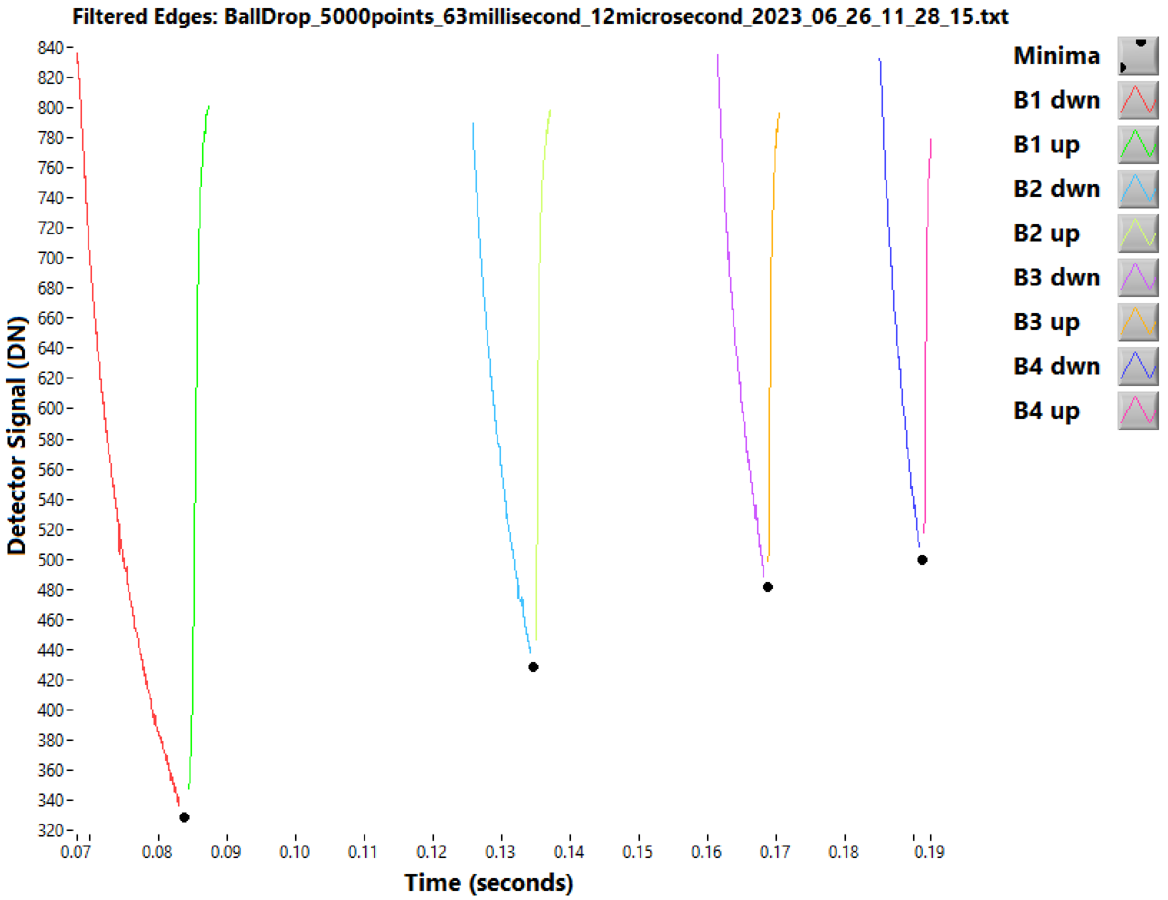
$$\sigma = \sum_{i=0}^{n-1} \left(\frac{(x_i - \mu)^2}{n-1}\right) \quad \textit{with mean equation:} \quad \mu = \sum_{i=0}^{n-1} \left(\frac{x_i}{n}\right) \textit{ where } n = 5$$

This σ equation assumes a normally distributed sample population.

	Start	Beam 1	Beam 2	Beam 3	Beam 4
Roots Time (seconds)	0	0.084448	0.134915	0.168826	0.191268
Ball Top FIT (mm)	0.053	35.129	89.581	140.244	179.993
Ball Top (mm)	0	35.000	90.000	140.000	180.000
$X_{fit} - X_{ball\ top}$ **(mm)**	0.053	0.129	-0.419	0.244	-0.007

Data Analysis Method (Filtered Poly Fit)

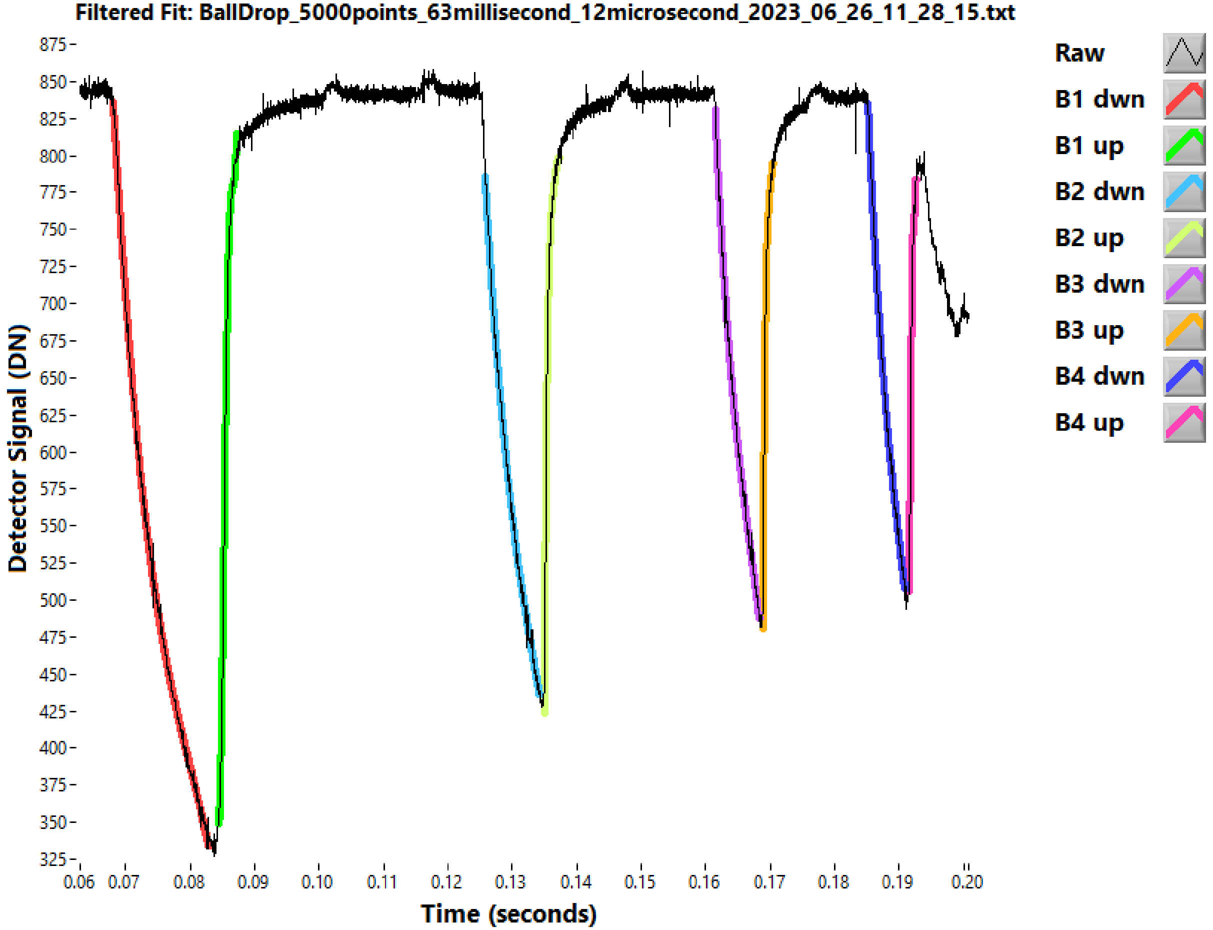


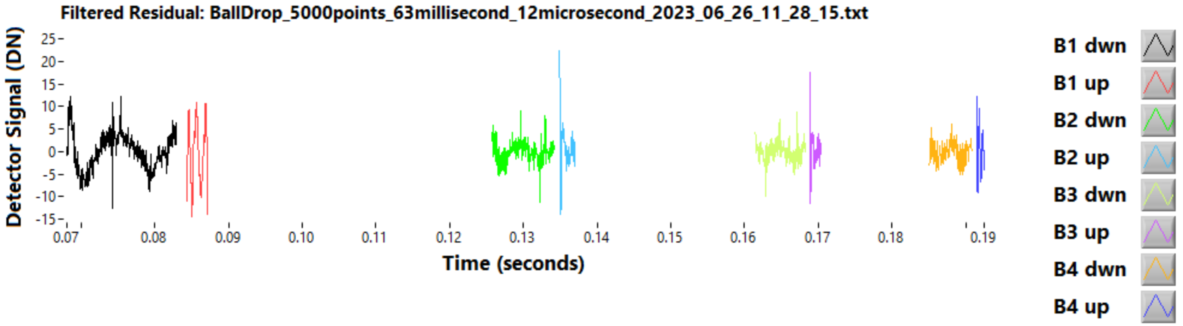


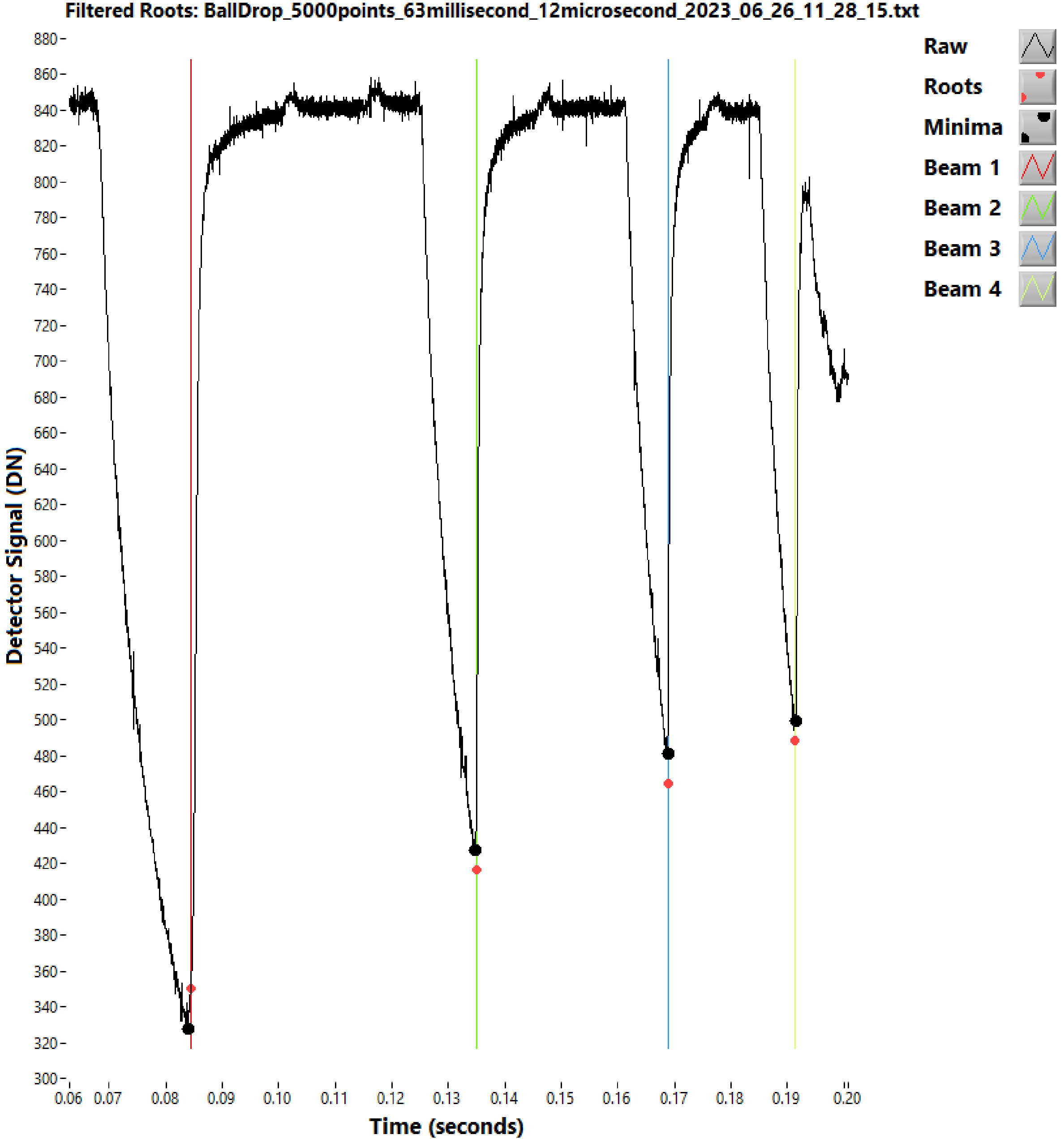
Fit Option	V0 = 0
Data Manipulation	Filtered
Box Car Size	3
Point Selection	Polynomial intersection

Polynomial Order Down	3 Orders
Region Down Start	10 Digital Number
Region Down End	10 Digital Number
Polynomial Order Up	4 Orders
Region Up Start	20 Digital Number
Region Up End	20 Digital Number

Data Fit Roots and Residuals



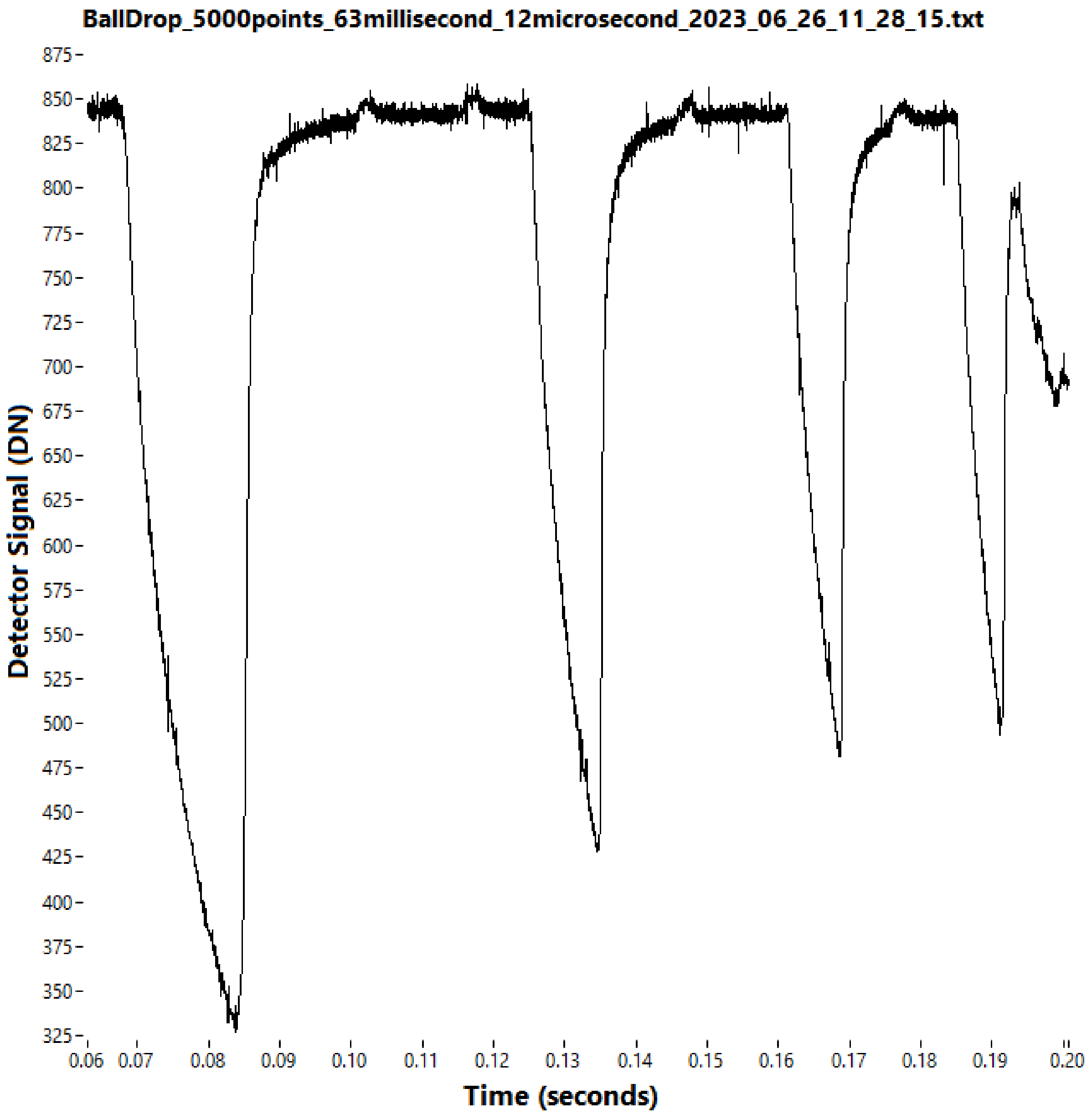




Polynomial Fit Equations

Beam 1 Down	$Y = 72499.253\ DN + \left(-2665076.461 \frac{DN}{s}\right) * t + \left(33042723.235 \frac{DN}{s^2}\right) * t^2 - \left(137459109.601 \frac{DN}{s^3}\right) * t^3$
Beam 1 Up	$Y = 3099515517.970\ DN + \left(-144288440273.888 \frac{DN}{s}\right) * t + \left(2518657520765.446 \frac{DN}{s^2}\right) * t^2 - \left(19538589732512.617 \frac{DN}{s^3}\right) * t^3 + \left(56835300041587.625 \frac{DN}{s^4}\right) * t^4$
Beam 2 Down	$Y = 663502.842\ DN + \left(-14841324.830 \frac{DN}{s}\right) * t + \left(110922853.061 \frac{DN}{s^2}\right) * t^2 - \left(276819006.061 \frac{DN}{s^3}\right) * t^3$
Beam 2 Up	$Y = -12748162372.790\ DN + \left(+373269763909.349 \frac{DN}{s}\right) * t - \left(4098544952592.409 \frac{DN}{s^2}\right) * t^2 + \left(20001126673769.273 \frac{DN}{s^3}\right) * t^3 - \left(36602506940588.836 \frac{DN}{s^4}\right) * t^4$
Beam 3 Down	$Y = 3318228.232\ DN + \left(-59572402.066 \frac{DN}{s}\right) * t + \left(356758636.633 \frac{DN}{s^2}\right) * t^2 - \left(712565776.668 \frac{DN}{s^3}\right) * t^3$
Beam 3 Up	$Y = -80570178139.223\ DN + \left(+1894640563942.718 \frac{DN}{s}\right) * t - \left(16707469119649.684 \frac{DN}{s^2}\right) * t^2 + \left(65480507823423.484 \frac{DN}{s^3}\right) * t^3 - \left(96237586154468.719 \frac{DN}{s^4}\right) * t^4$
Beam 4 Down	$Y = 6353839.155\ DN + \left(-100260878.386 \frac{DN}{s}\right) * t + \left(527606274.503 \frac{DN}{s^2}\right) * t^2 - \left(925837510.676 \frac{DN}{s^3}\right) * t^3$
Beam 4 Up	$Y = 1509853826143.980\ DN + \left(-31458527003198.949 \frac{DN}{s}\right) * t + \left(245794421568468.531 \frac{DN}{s^2}\right) * t^2 - \left(853536381392982.250 \frac{DN}{s^3}\right) * t^3 + \left(1111481450163357.620 \frac{DN}{s^4}\right) * t^4$

Tower Drop File: BallDrop_5000points_63millisecond_12microsecond_2023_06_26_11_28_15.txt



Name	
Description	
Date	06/26/2023
Time	11:28:15
Mean Point Spacing	27.555µsec
DN min	327
DN max	327
point count	5000
Point to Point STDEV	0.544µsec
Latitude	39.921°
Altitude	5856ft
G Expected	$9.794719 \frac{m}{s^2}$
Mag Delay(msec)	63msec
Programmed Point Delay	63µsec
Ball Top Position	-25.000mm
Ball Diameter	12.690mm
Beam Diameter	3.800mm
Beam 1.000	10.000mm
Beam 2.000	65.000mm
Beam 3.000	115.000mm
Beam 4.000	155.000mm