



ERROR CHARACTERISATION OF POSIT MATH FUNCTIONS

POSIT ERROR CHARACTERIZATION SUMMARY

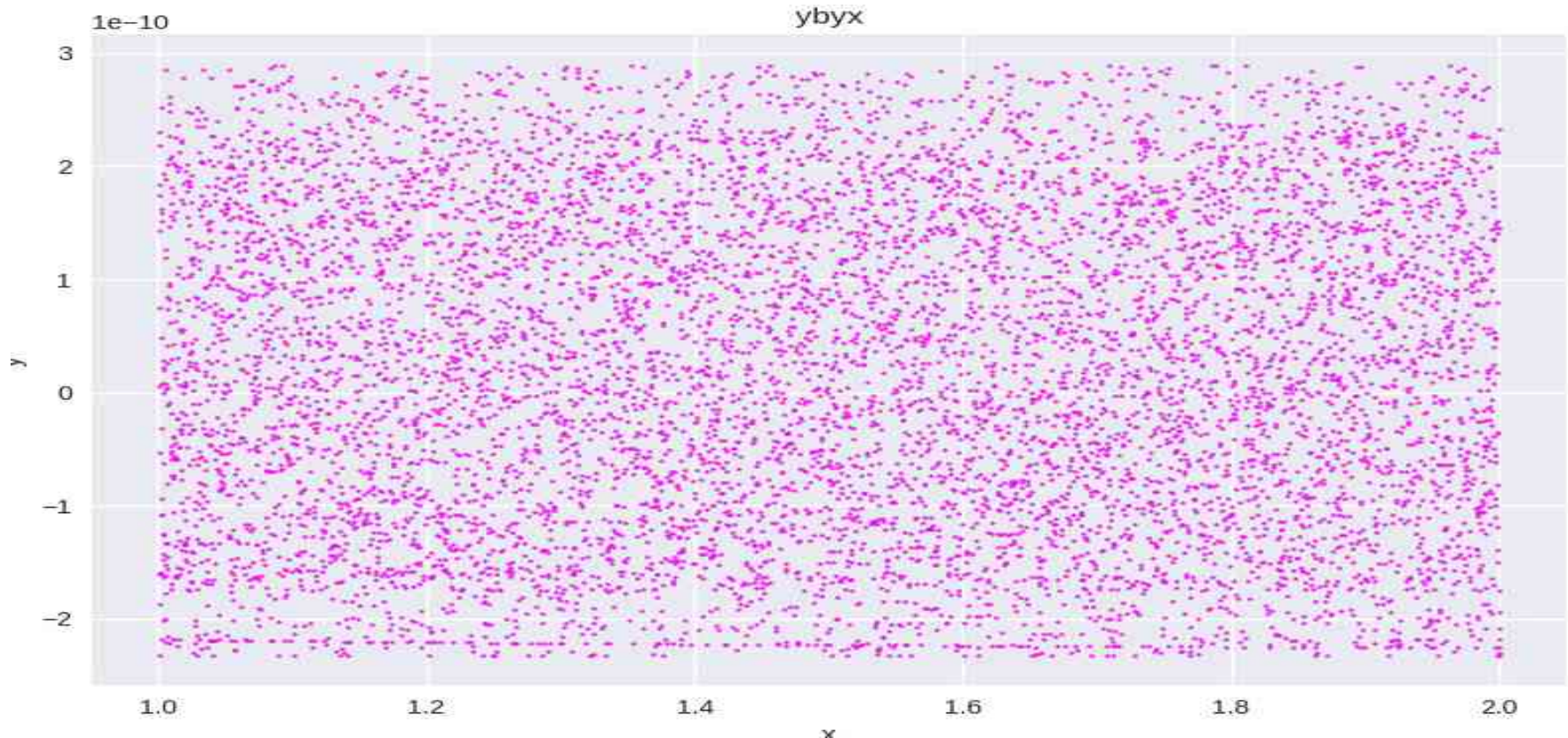
POSIT Function Summary

Functions and their Cycle latency

Function	Cycle latency	Input Range	+Error	-ve error
1/x	7	$y=1, 1 \leq x \leq 2, \Delta=2^{-12}$	3.00E-10	-2.30E-10
y/x	8	$y=1, 1 \leq x \leq 2, \Delta=2^{-12}$	4.50E-10	0
Cos(x)	10	$0 \leq x \leq \pi/2, \Delta=2^{-13}$	1.60E-10	0
Sin(x)	10	$0 \leq x \leq \pi/2, \Delta=2^{-13}$	1.65E-10	0
Sqrt(x^2+y^2)	9	$y=1, 0 \leq x \leq 1, \Delta=2^{-13}$	1.40E-9	0
1/Sqrt(x^2+y^2)	13	$y=1, 0 \leq x \leq 1, \Delta=2^{-13}$	1.0E-09	-1.20E-09
Atan(y/x)	9	$y=1, 0 \leq x \leq 1, \Delta=2^{-13}$	4.50E-10	-4.50E-10
Sinh(x)	10	$0 \leq x \leq 1, \Delta=2^{-13}$	2.50E-09	-1.50E-09
Cosh(x)	10	$0 \leq x \leq 1, \Delta=2^{-13}$	4.50E-09	-2.50E-09
Sqrt(x^2-y^2)	19	$x=1, 0 \leq y \leq 1, \Delta=2^{-13}$	0	-2.00E-05
Atanh(y/x)	19	$x=1, 0 \leq y \leq 1, \Delta=2^{-13}$	0.029	-0.015
1/Sqrt(x^2-y^2)	20	$x=1, 0 \leq y \leq 1, \Delta=2^{-13}$	0	-0.089
Ln(x)	19	$1 \leq x \leq 2, \Delta=2^{-13}$	1.7E-09	-1.67E-09
Sqrt(x)	20	$1 \leq x \leq 2, \Delta=2^{-13}$	1.4E-09	-2.10E-09
1/Sqrt(x)	21	$1 \leq x \leq 2, \Delta=2^{-13}$	2.40E-09	0
Acosh(x)	37	$1 \leq x \leq 2, \Delta=2^{-13}$	2.30E-09	-5.20E-08
Asinh(x)	37	$0 \leq x \leq 1, \Delta=2^{-13}$	0.0015	-0.001
Acos	25	$0 \leq x \leq 1, \Delta=2^{-13}$	6.10E-08	-6.10E-08
Asin	25	$0 \leq x \leq 1, \Delta=2^{-13}$	6.10E-08	-6.10E-08
Tan(x)	15	$-1 \leq x \leq 1, \Delta=2^{-13}$	1.57E-09	-5.00E-10
Tanh(x)	17	$1 \leq x \leq 2, \Delta=2^{-13}$	2.00E-09	-1.50E-09
Exp(x)	11	$0 \leq x \leq 1, \Delta=2^{-13}$	5.70E-09	-1.00E-10
x^y	30	$y=1, 1 \leq x \leq 3, \Delta=2^{-12}$	6.50E-09	-2.00E-09
$x^{(1/y)}$	30	$y=1, 1 \leq x \leq 2, \Delta=2^{-12}$	6.50E-09	-2.00E-09

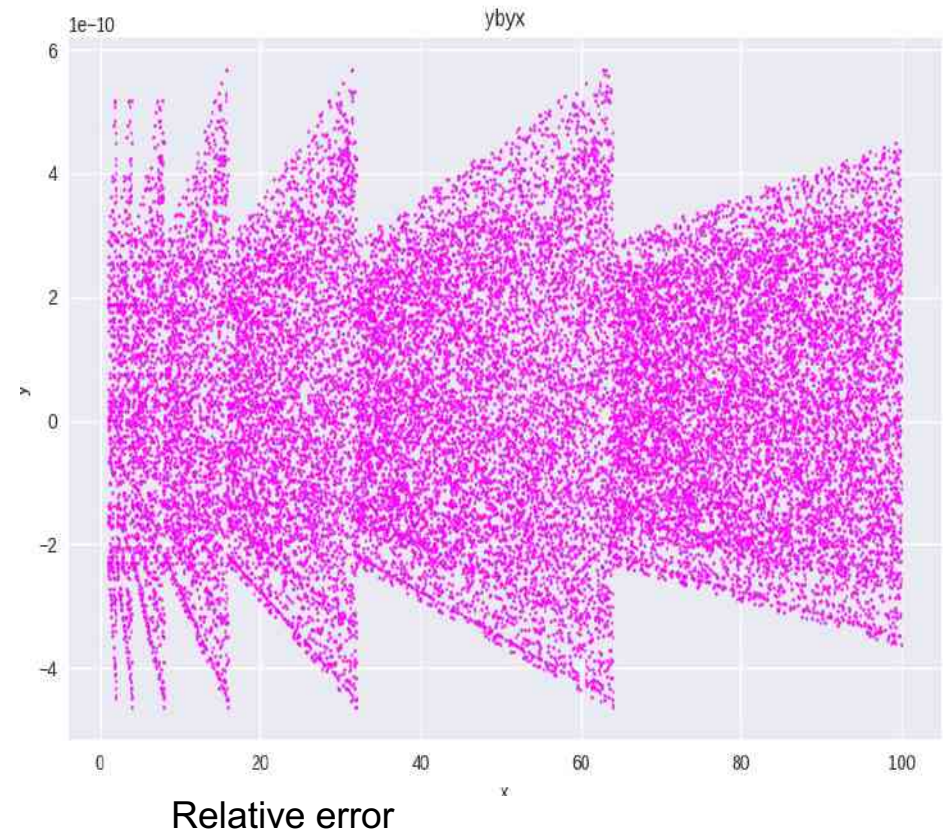
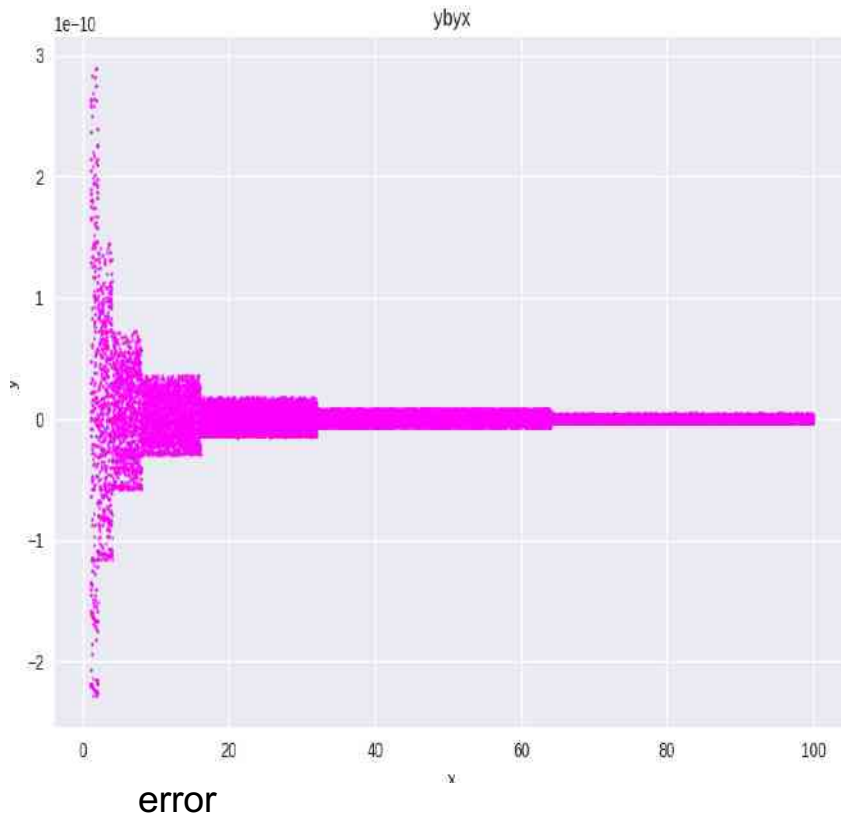
ERROR CHARACTERIZATION – POSIT DIVIDE

Pseudo $\text{div}(1/x) = 1/x$ error Plot (inputs $1 \leq x < 2$ $\Delta = 2^{-13}$); Number of cycles ~ 7 .



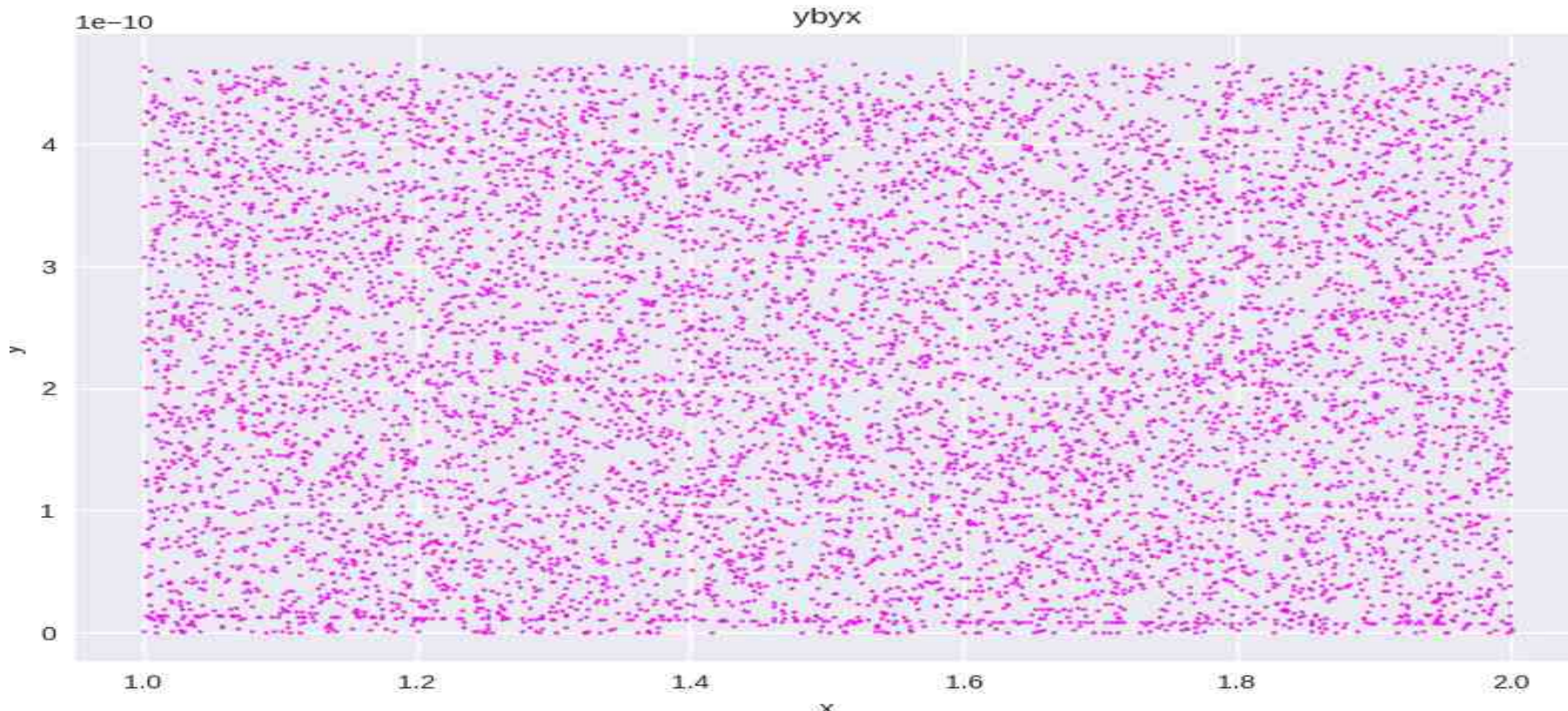
ERROR CHARACTERIZATION – POSIT DIVIDE

Div(1/x) = 1/x error Plot (inputs $1 \leq x \leq 100$ $\Delta = 2^{-8}$); Number of cycles ~ 7 .



ERROR CHARACTERIZATION – POSIT DIVIDE

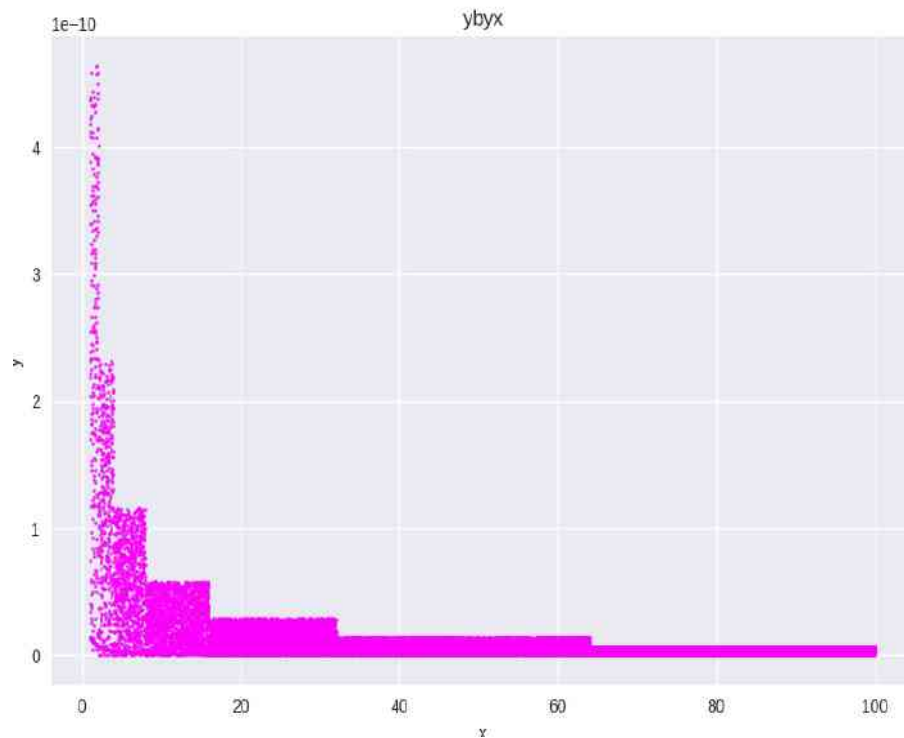
$\text{div}(y/x) = \text{div}(1/x)*y$ error Plot (inputs $y=1, 1 \leq x < 2 \Delta = 2^{-13}$); Number of cycles ~ 8 .



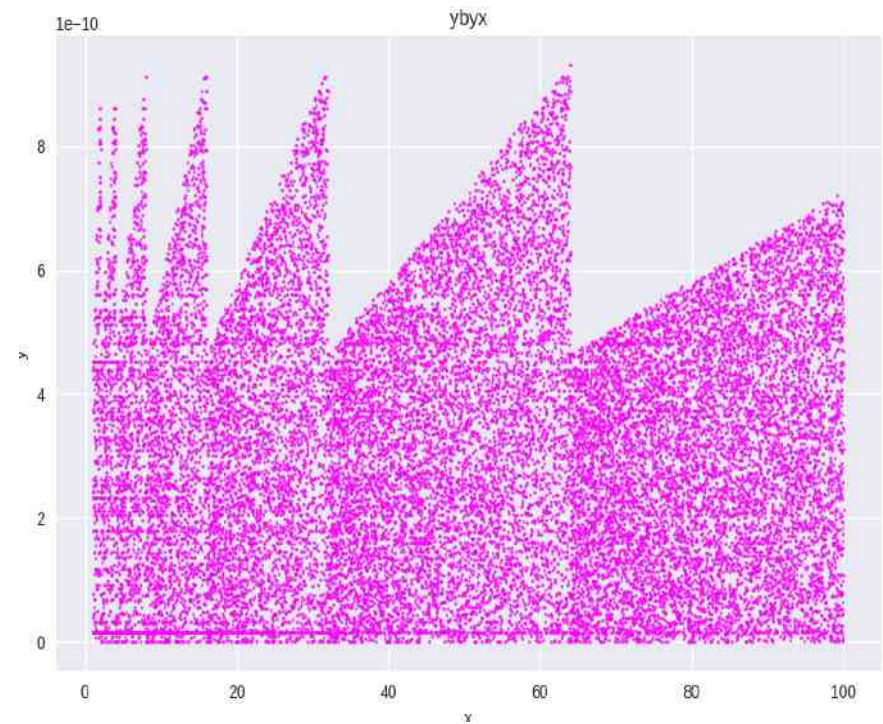
Function is same as $1/x$ but a $1*1/x$ multiplication step adds a bias compared to $1/x$ plot

ERROR CHARACTERIZATION – POSIT DIVIDE

$\text{div}(y/x) = \text{div}(1/x) * y$ error Plot (inputs $y=1, 1 \leq x < 100$ $\Delta = 2^{-8}$); Number of cycles ~ 8 .



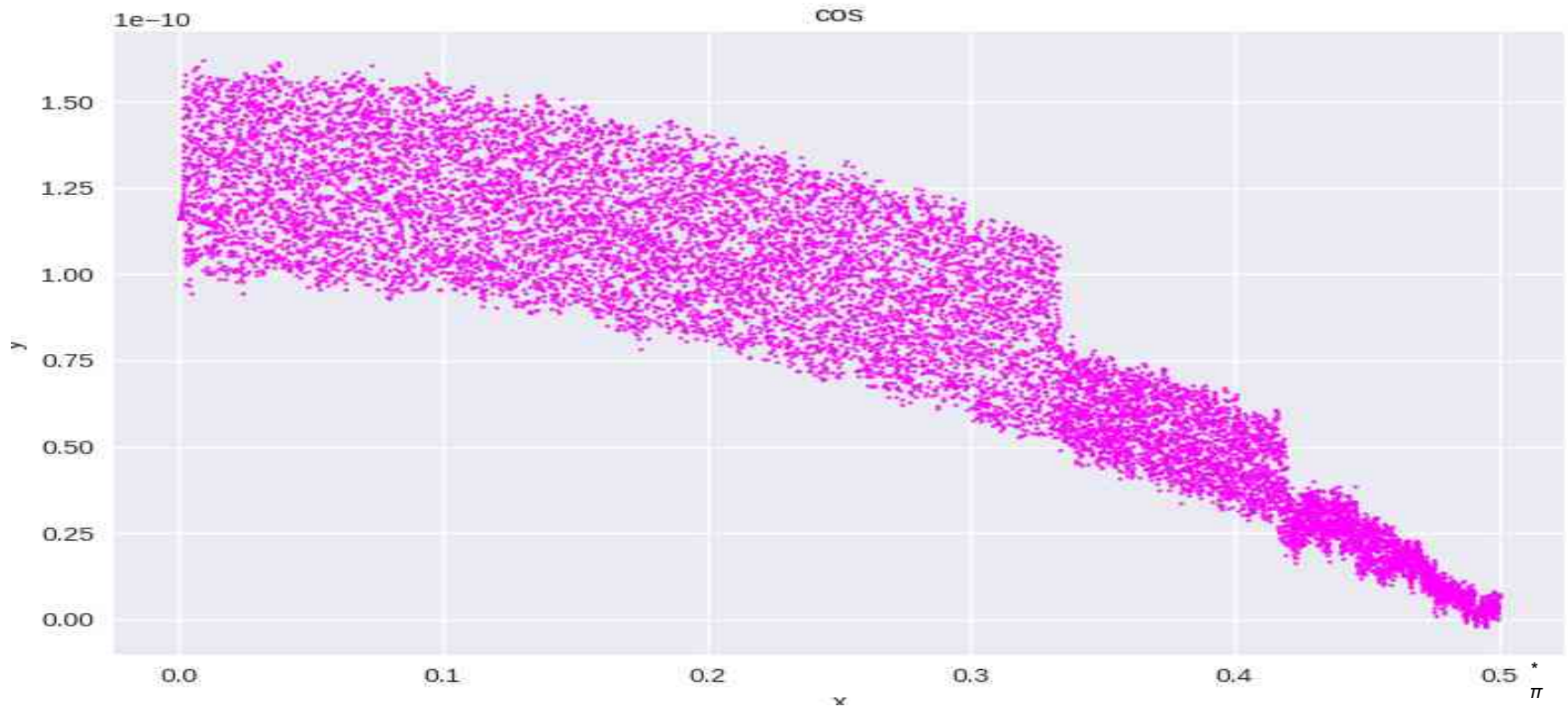
Absolute error



Relative error

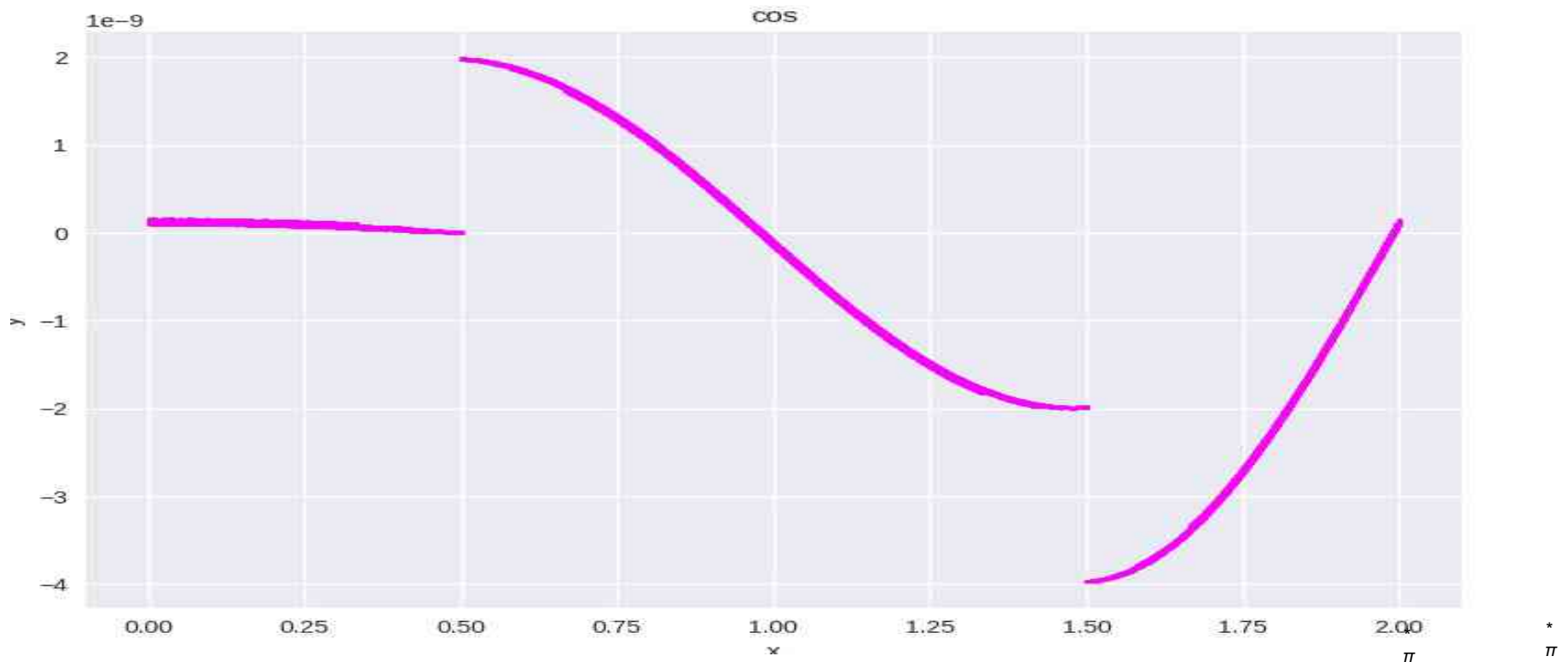
ERROR CHARACTERIZATION – POSIT COSINE

Cos error plot $0 \leq x \leq \pi/2$ $\Delta = 2^{-13}$; Number of cycles ~ 10



ERROR CHARACTERIZATION – POSIT COSINE

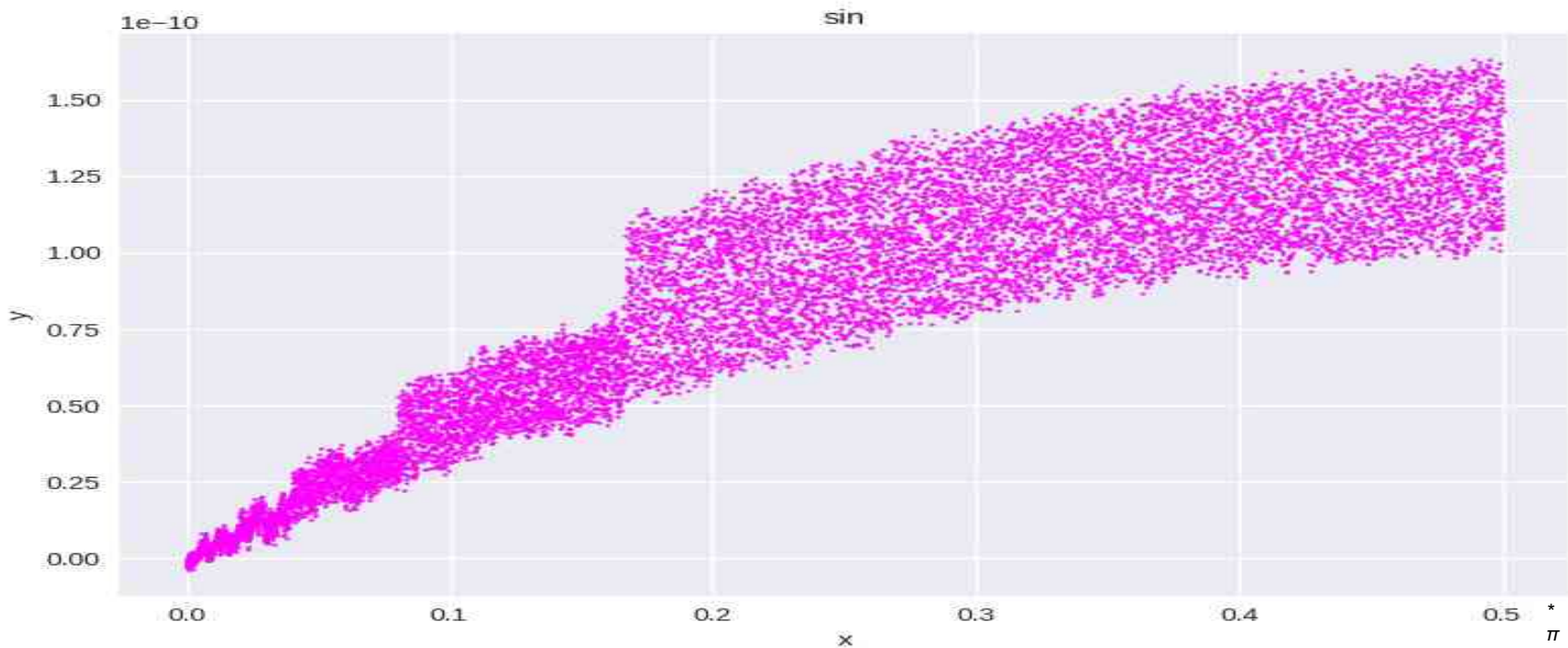
Cos error plot $0 \leq x \leq 2\pi$ $\Delta = 2^{-13}$; Number of cycles ~ 10



*
 π

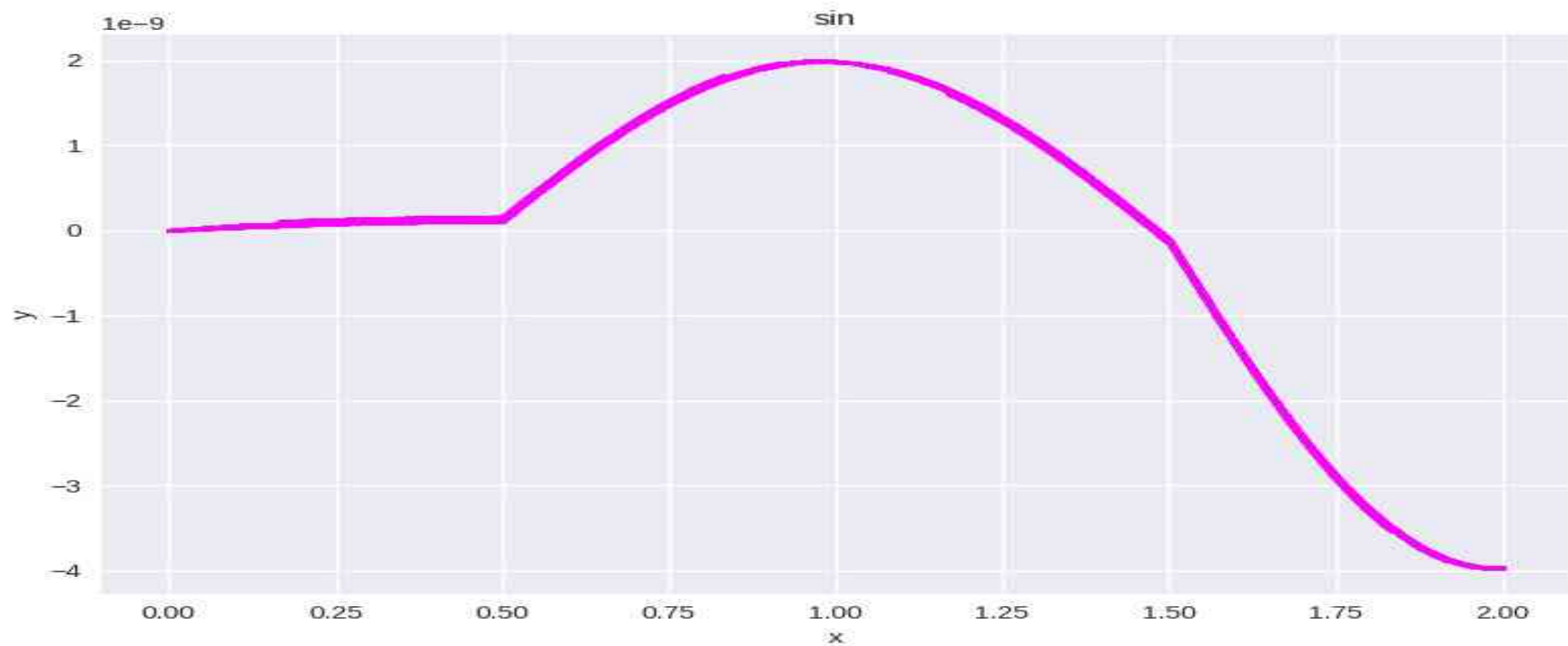
ERROR CHARACTERIZATION – POSIT SINE

Sin error plot ($0 \leq x \leq \pi/2$ $\Delta = 2^{-13}$); Number of cycles ~ 10



ERROR CHARACTERIZATION – POSIT SINE

Sin error plot ($0 \leq x \leq 2\pi \Delta = 2^{-13}$); Number of cycles ~ 10

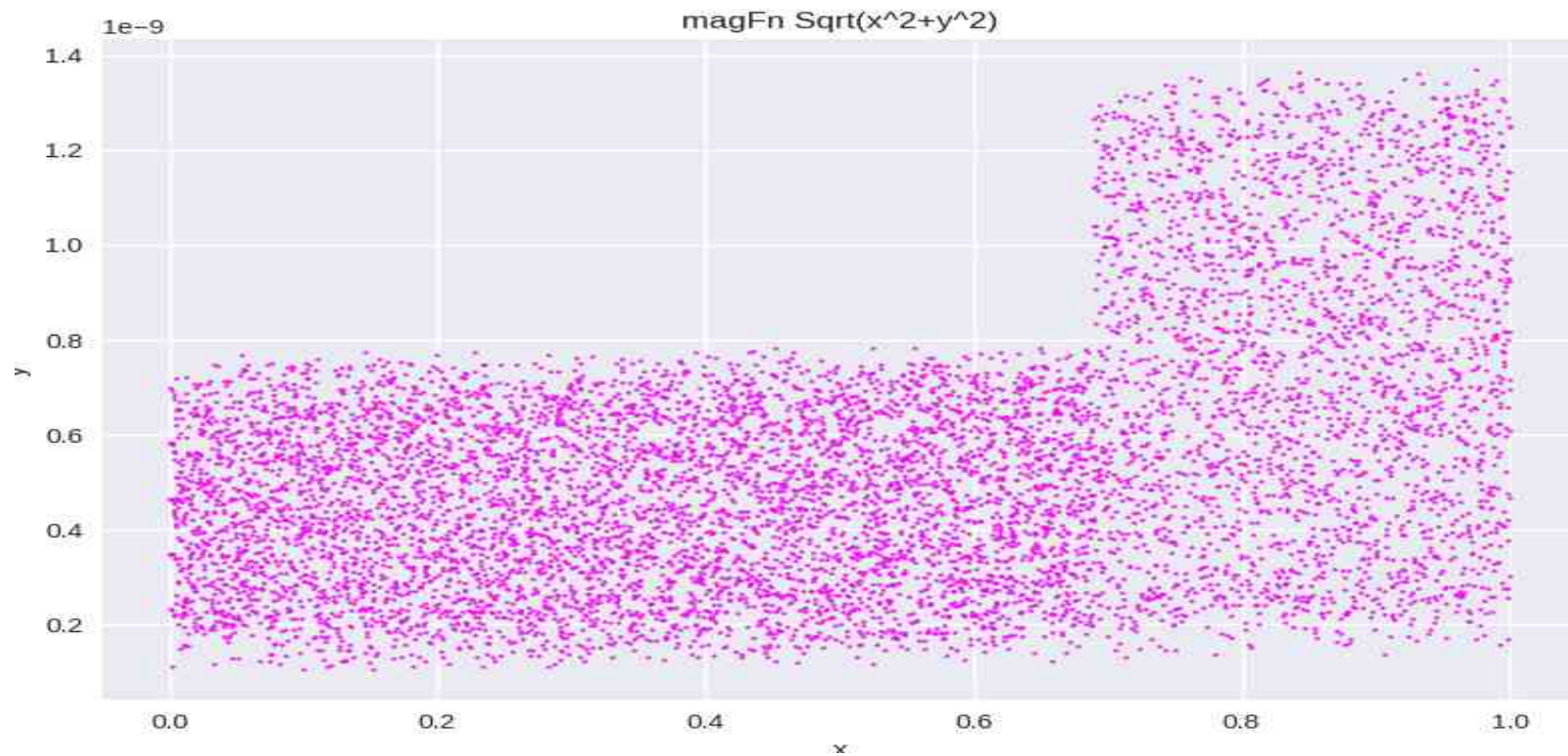


With error correction. Multiplication add bias

*
 π
 π

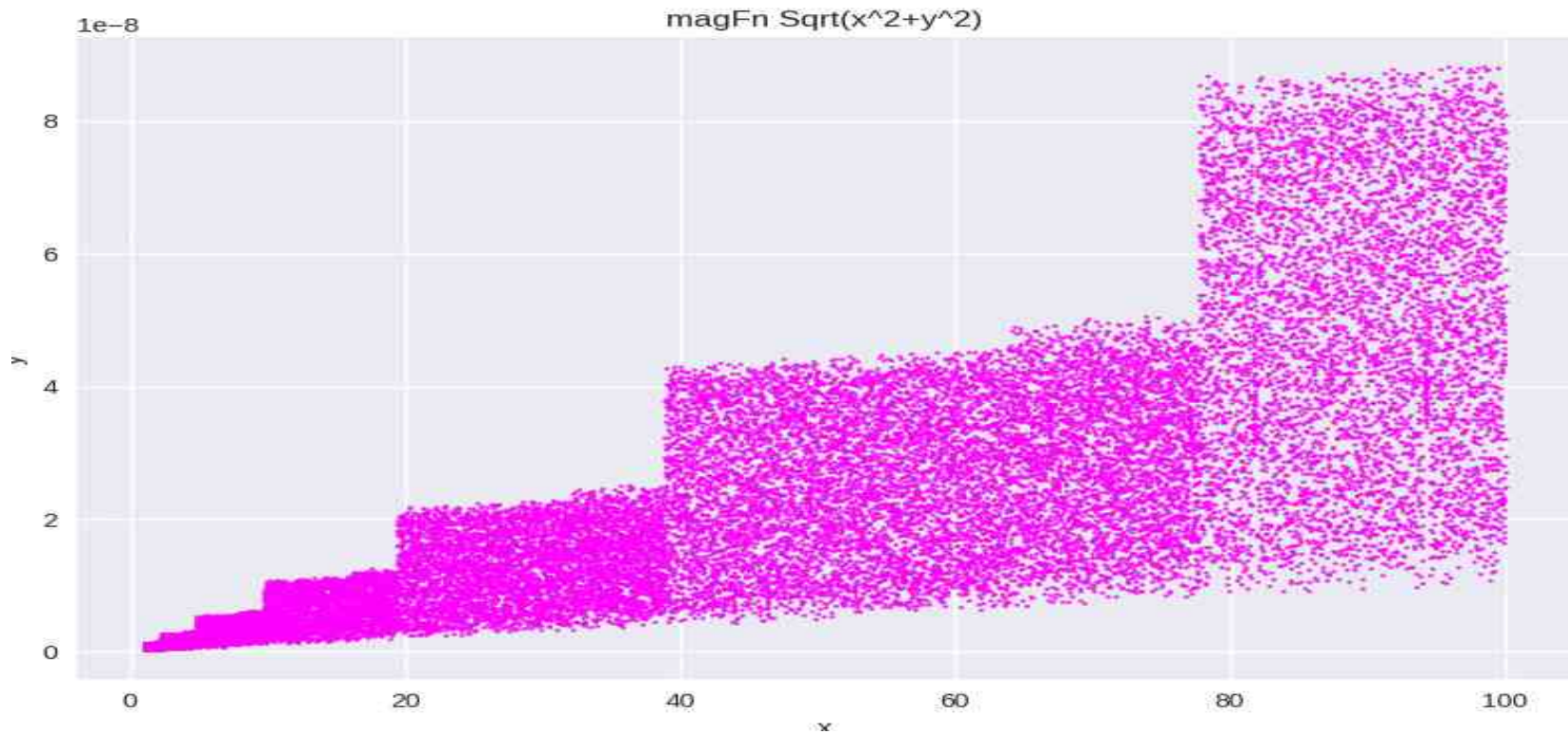
ERROR CHARACTERIZATION – POSIT MAGNITUDE FUNCTION

Magnitude Function ($=\sqrt{(x^2+y^2)}$) error plot (inputs $y=1$, $0 < x \leq 1$ $\Delta = 2^{-13}$); # of cycles ~ 9



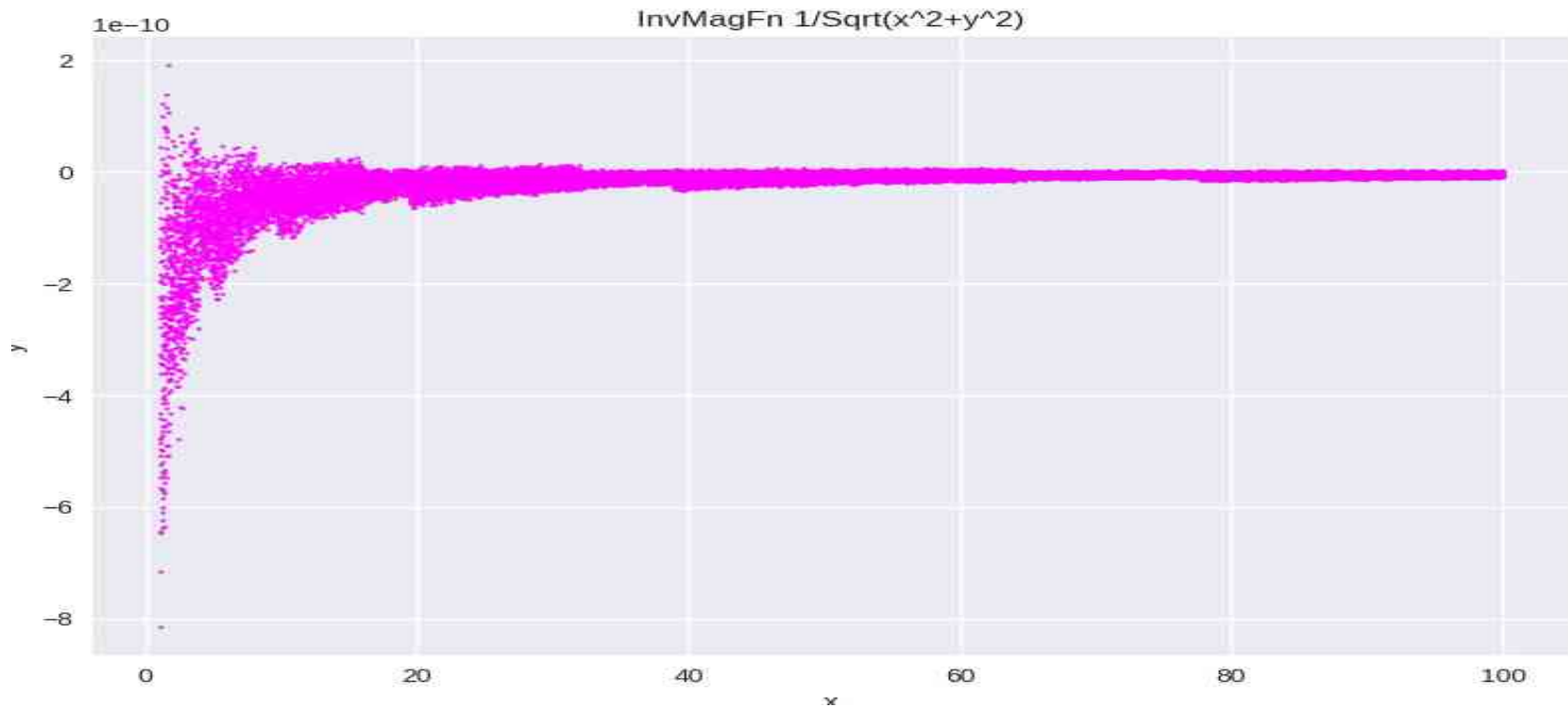
ERROR CHARACTERIZATION – POSIT MAGNITUDE FUNCTION

Magnitude Function ($=\sqrt{x^2+y^2}$) error plot (inputs $y=1, 1 \leq x \leq 100$ $\Delta = 2^{-8}$); # of cycles ~ 9



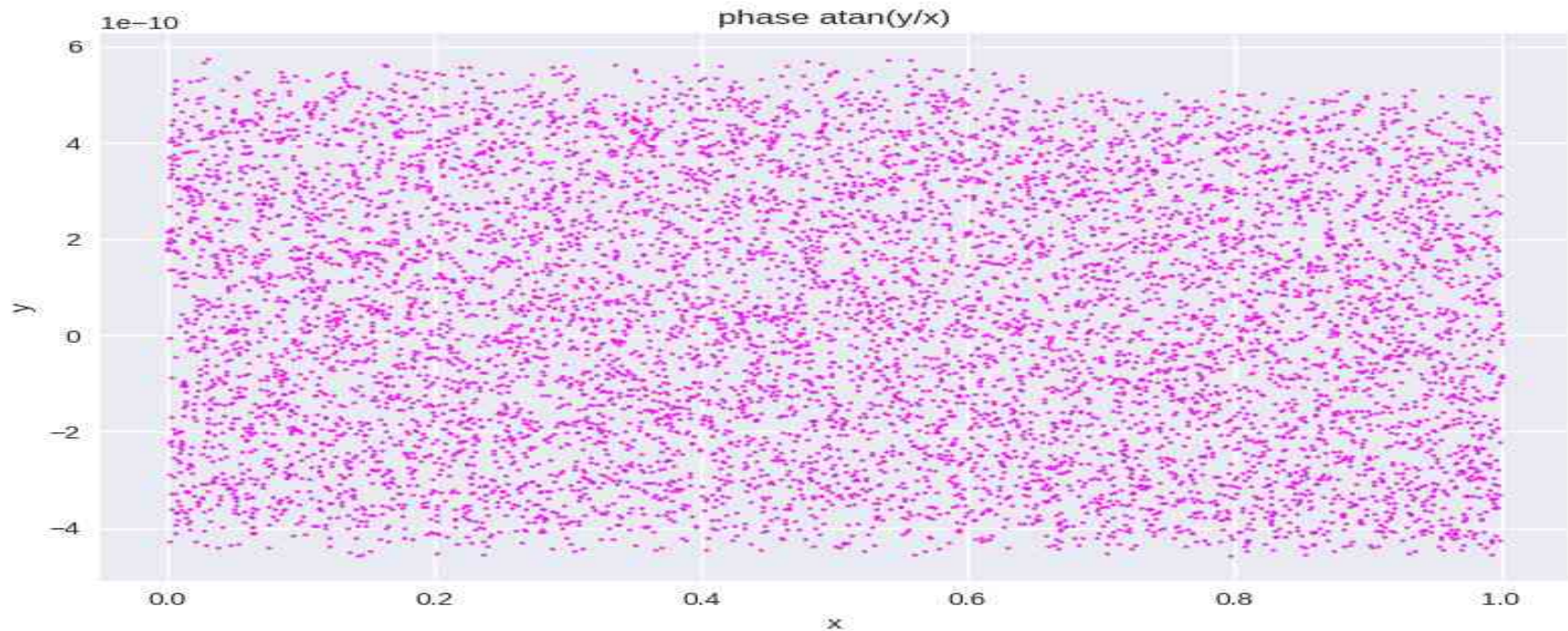
ERROR CHARACTERIZATION – POSIT INV MAGNITUDE FUNCTION

Inverse Magnitude Function ($=1/\sqrt{x^2+y^2}$) error plot (inputs $y=1, 1 \leq x \leq 100$ $\Delta = 2^{-8}$); # of cycles ~ 13



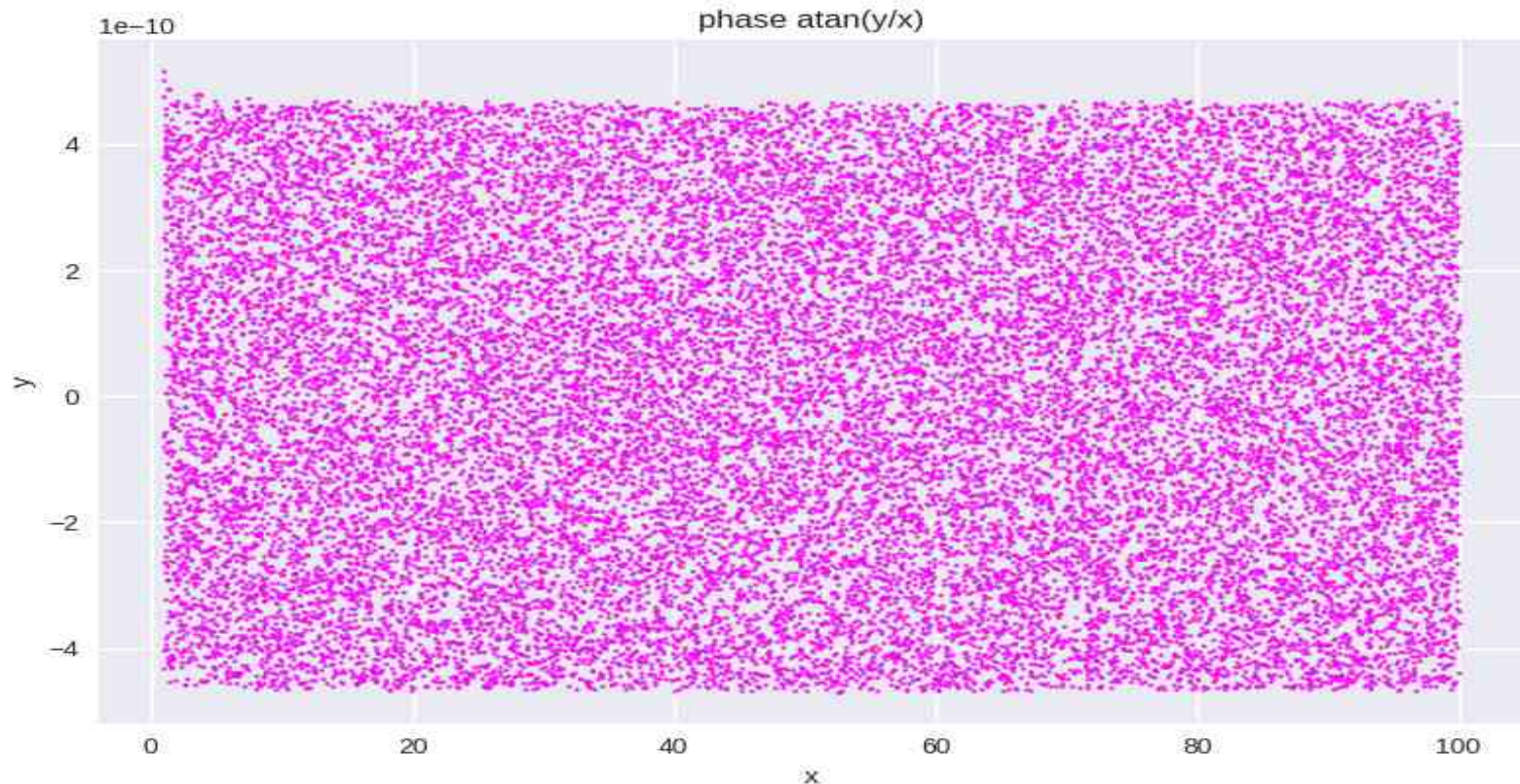
ERROR CHARACTERIZATION – POSIT PHASE FUNCTION

Phase Function ($= \tan^{-1}y/x$) absolute error plot (inputs $y=1, 0 < x \leq 1$ $\Delta = 2^{-13}$); # of cycles ~ 9



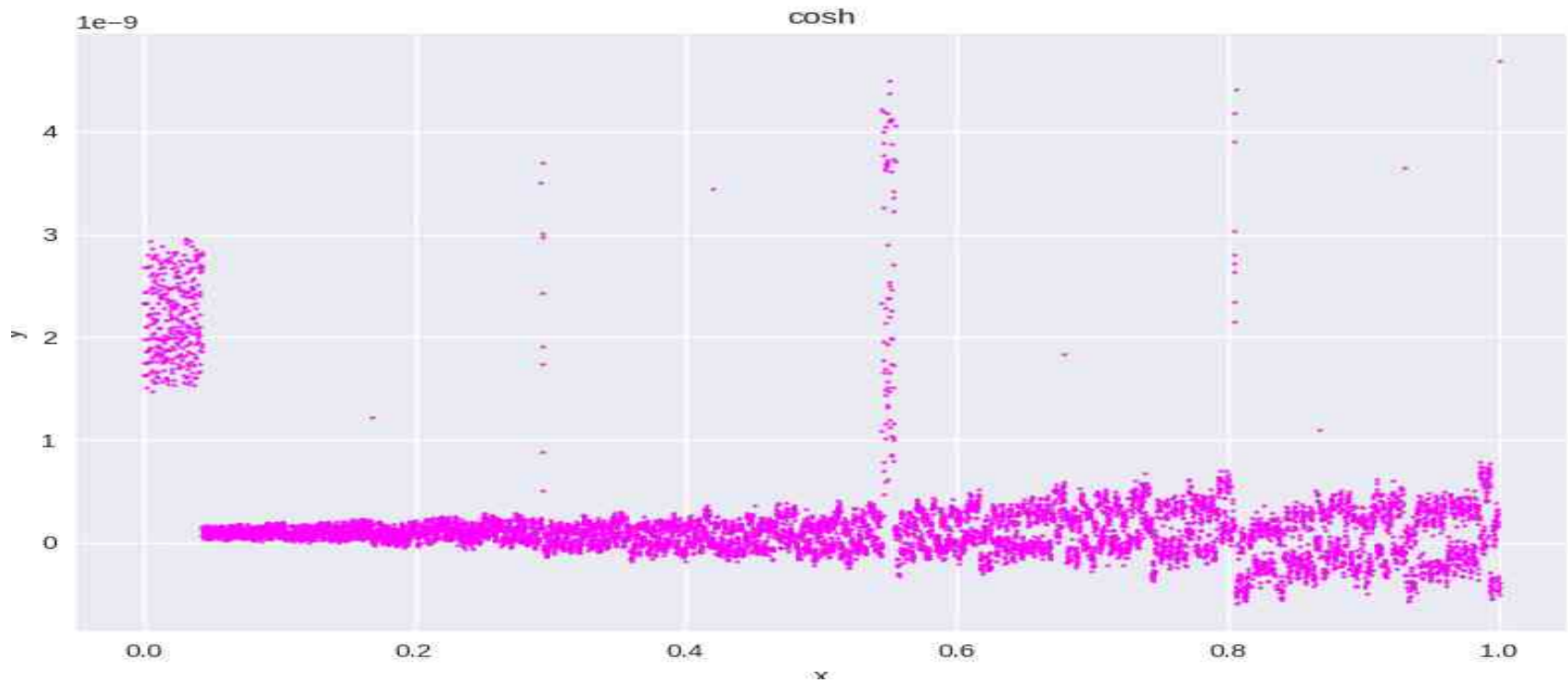
ERROR CHARACTERIZATION – POSIT PHASE FUNCTION

Phase Function (= $\tan^{-1}y/x$) absolute error plot (inputs $y=1, 1 \leq x \leq 100 \Delta = 2^{-8}$); # of cycles ~ 9



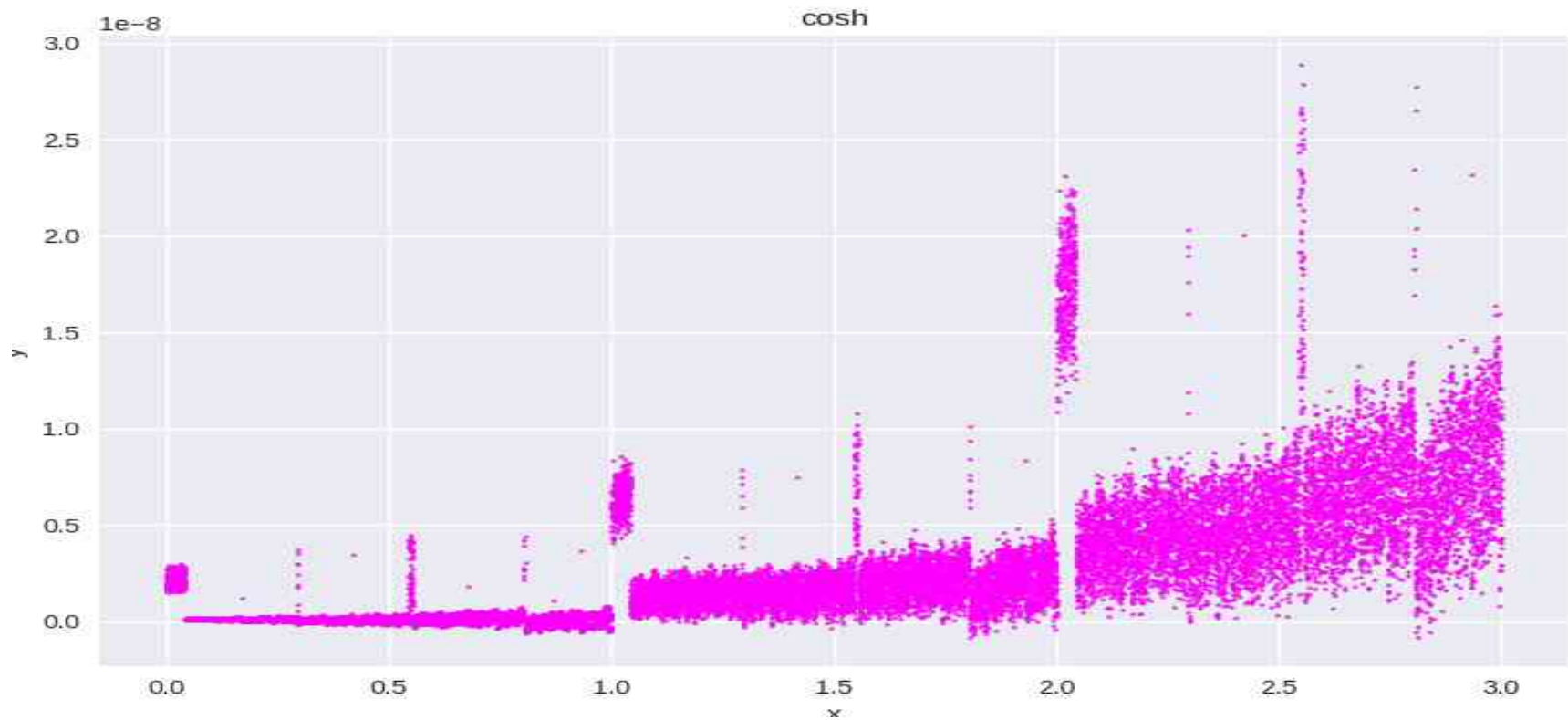
ERROR CHARACTERIZATION – COSH

COSH (= Cosh x) error plot (inputs $0 \leq x \leq 1$ $\Delta = 2^{-13}$); Number of cycles ~ 10



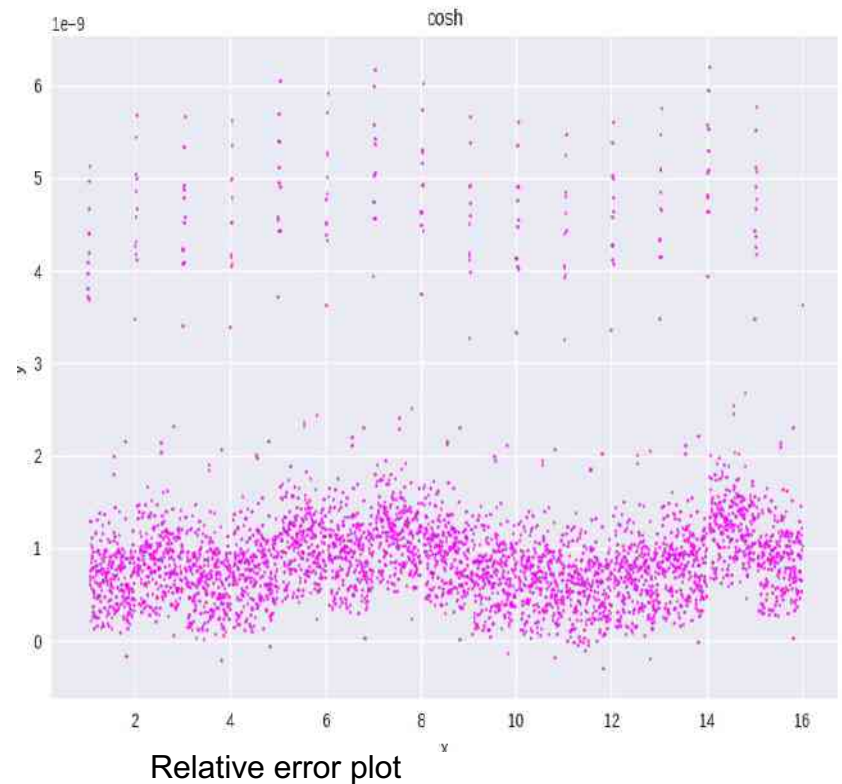
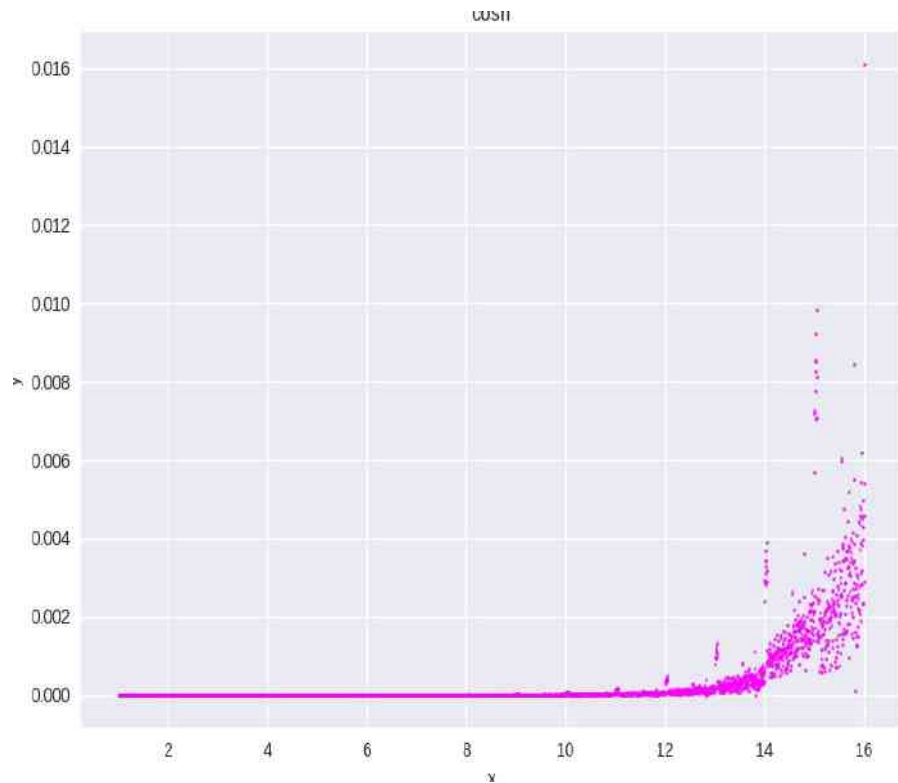
ERROR CHARACTERIZATION – COSH

COSH (= Cosh x) error plot (inputs , $0 \leq x < 3 \Delta = 2^{-13}$); Number of cycles ~ 10



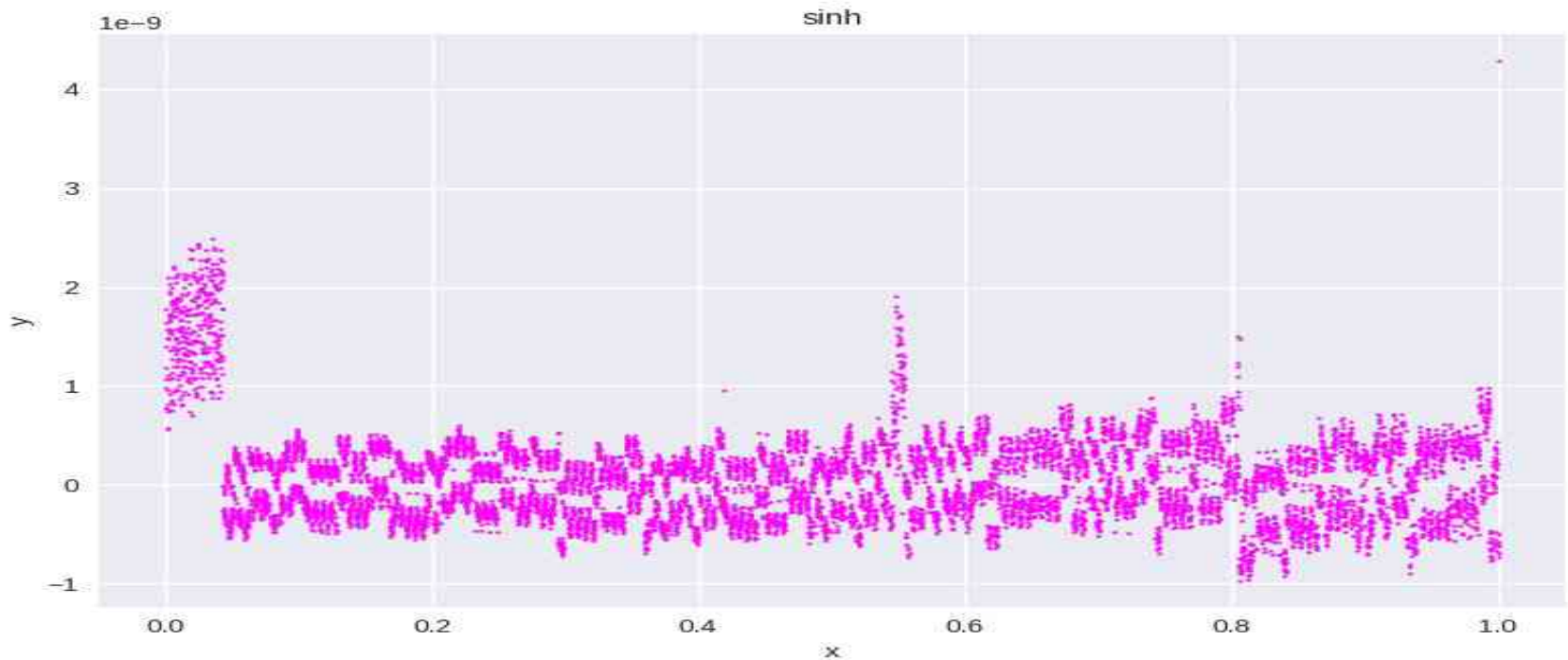
ERROR CHARACTERIZATION – COSH

COSH (= Cosh x) error plot (inputs , $1 \leq x < 16 \Delta = 2^8$); Number of cycles ~ 10



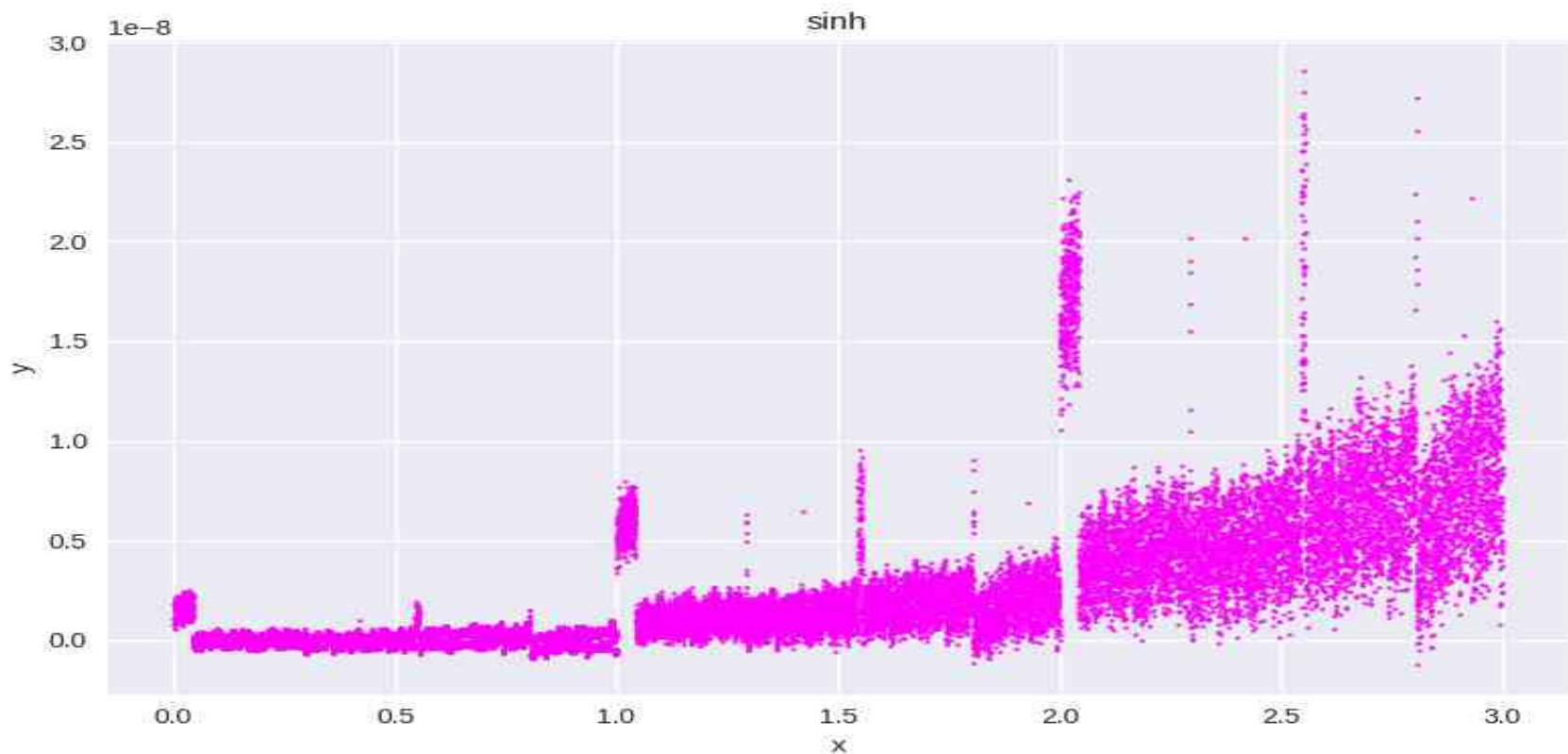
ERROR CHARACTERIZATION – SINH

SINH (= Sinh x) error plot (inputs $0 \leq x \leq 1$ $\Delta = 2^{-13}$); Number of cycles ~ 10



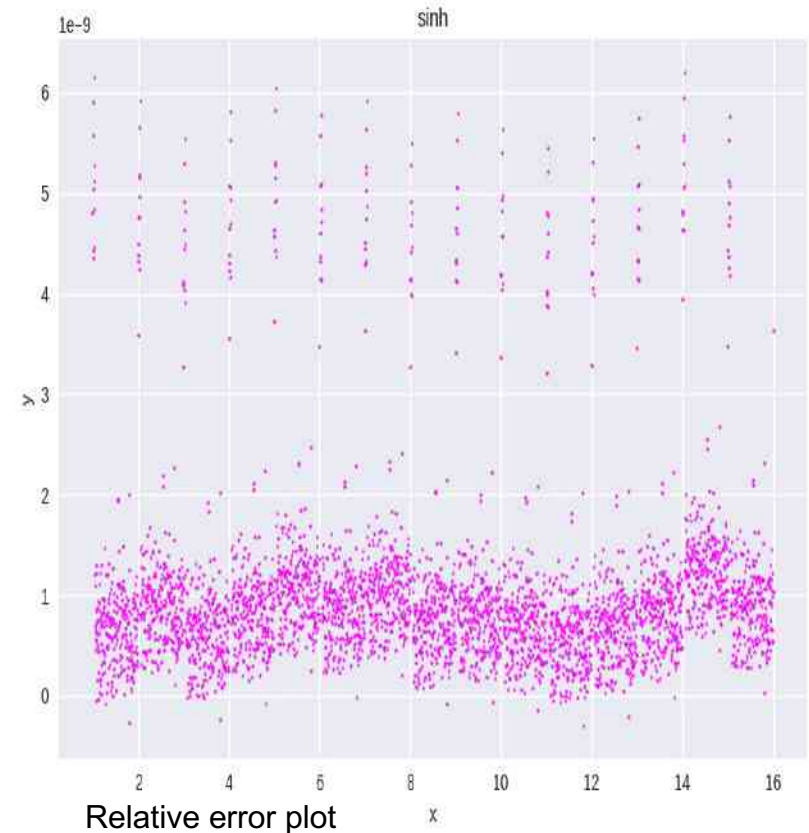
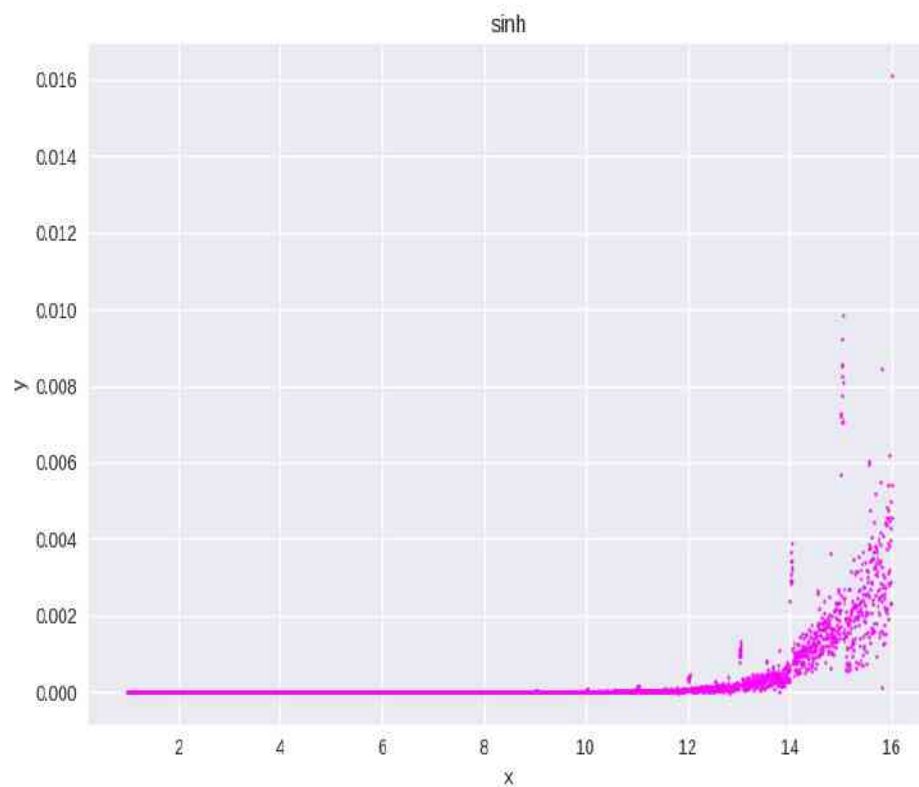
ERROR CHARACTERIZATION – SINH

SINH (= Sinh x) error plot (inputs $0 \leq x \leq 3$ $\Delta = 2^{-13}$); Number of cycles ~ 10



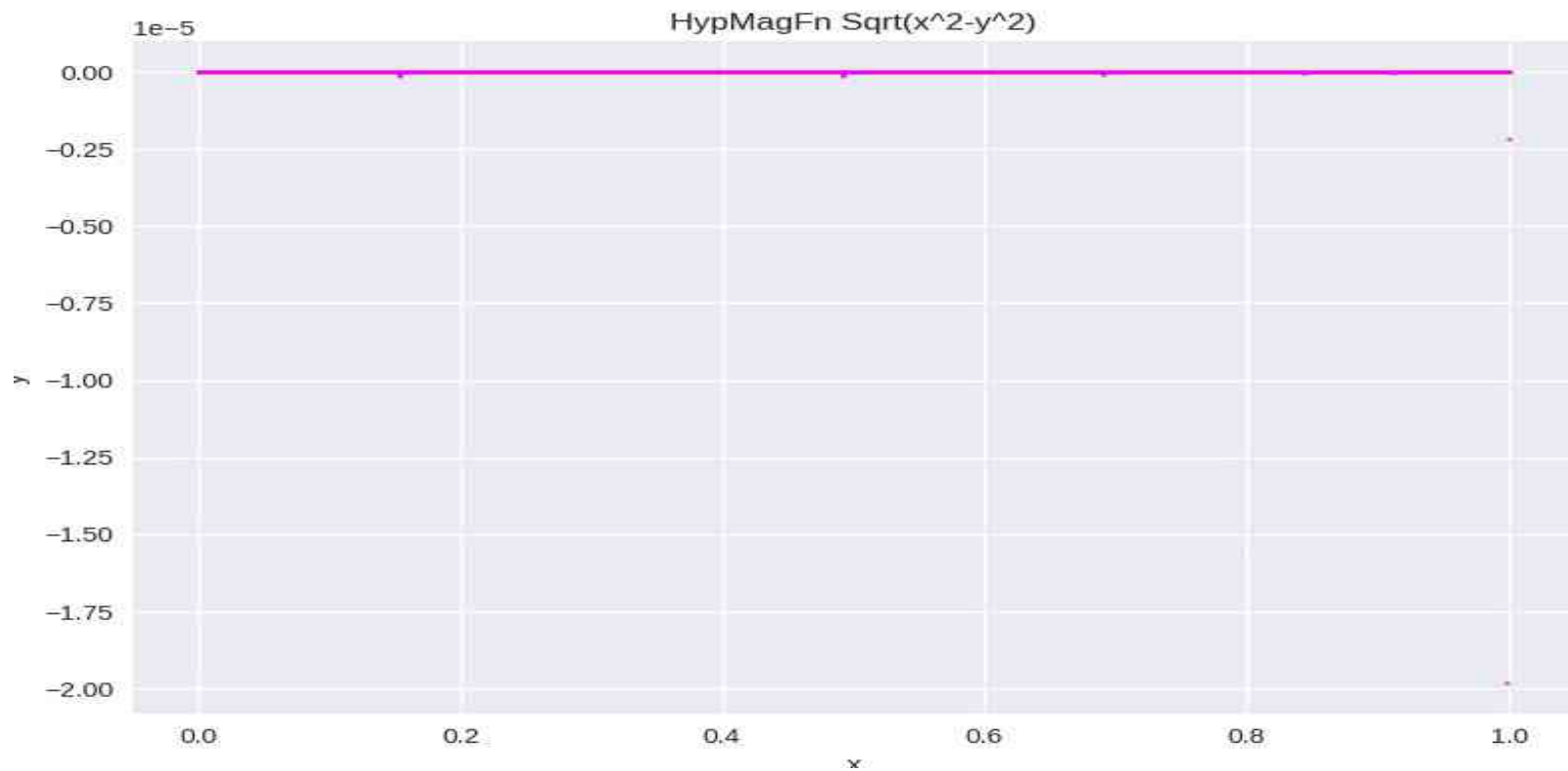
ERROR CHARACTERIZATION – SINH

SINH (= Sinh x) error plot (inputs $0 \leq x \leq 16$ $\Delta = 2^{-8}$); Number of cycles ~ 10



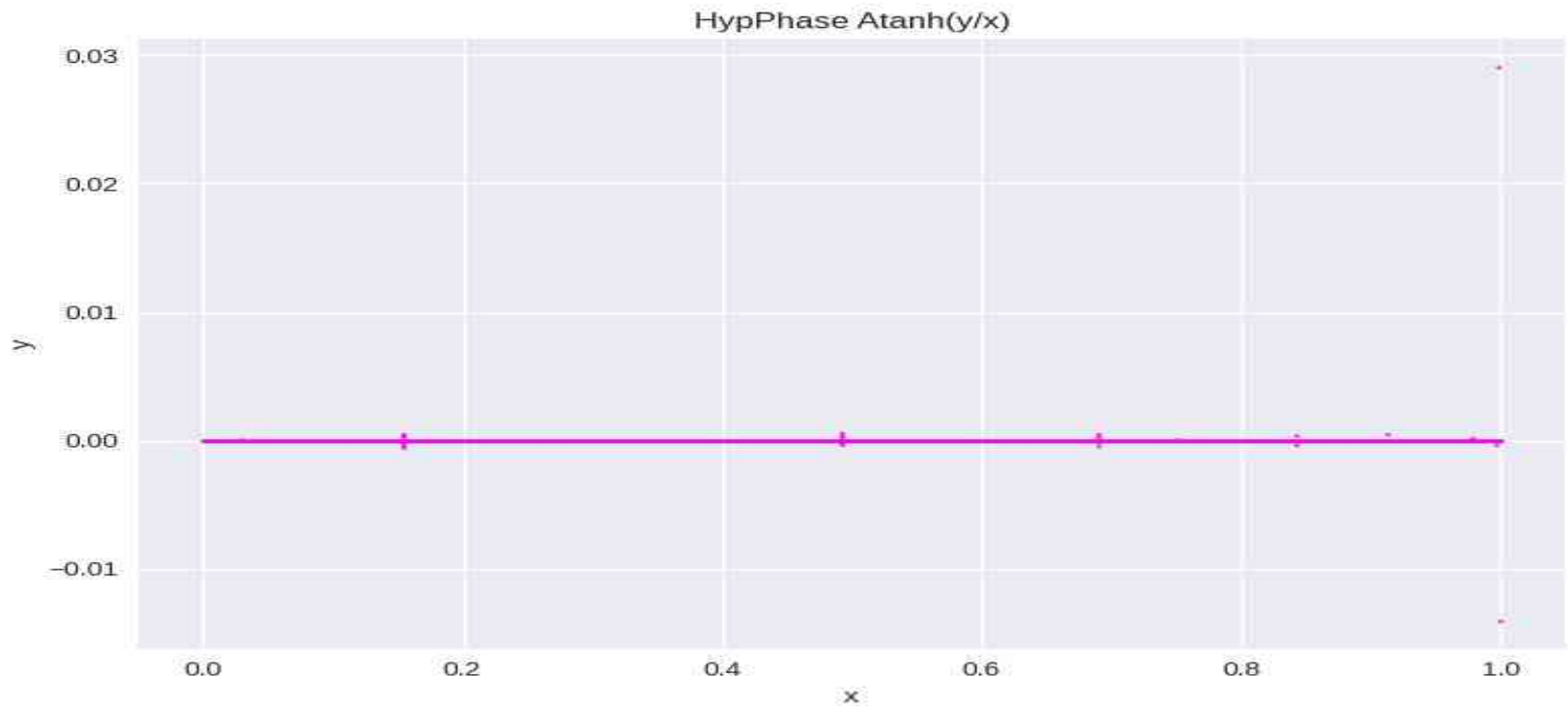
ERROR CHARACTERIZATION – POSIT HYP MAG FUNCTION

Hyp Mag ($=\sqrt{x^2-y^2}$) error plot (inputs $y = 1, 0 \leq x \leq 1 \Delta = 2^{-13}$); Number of cycles ~ 19



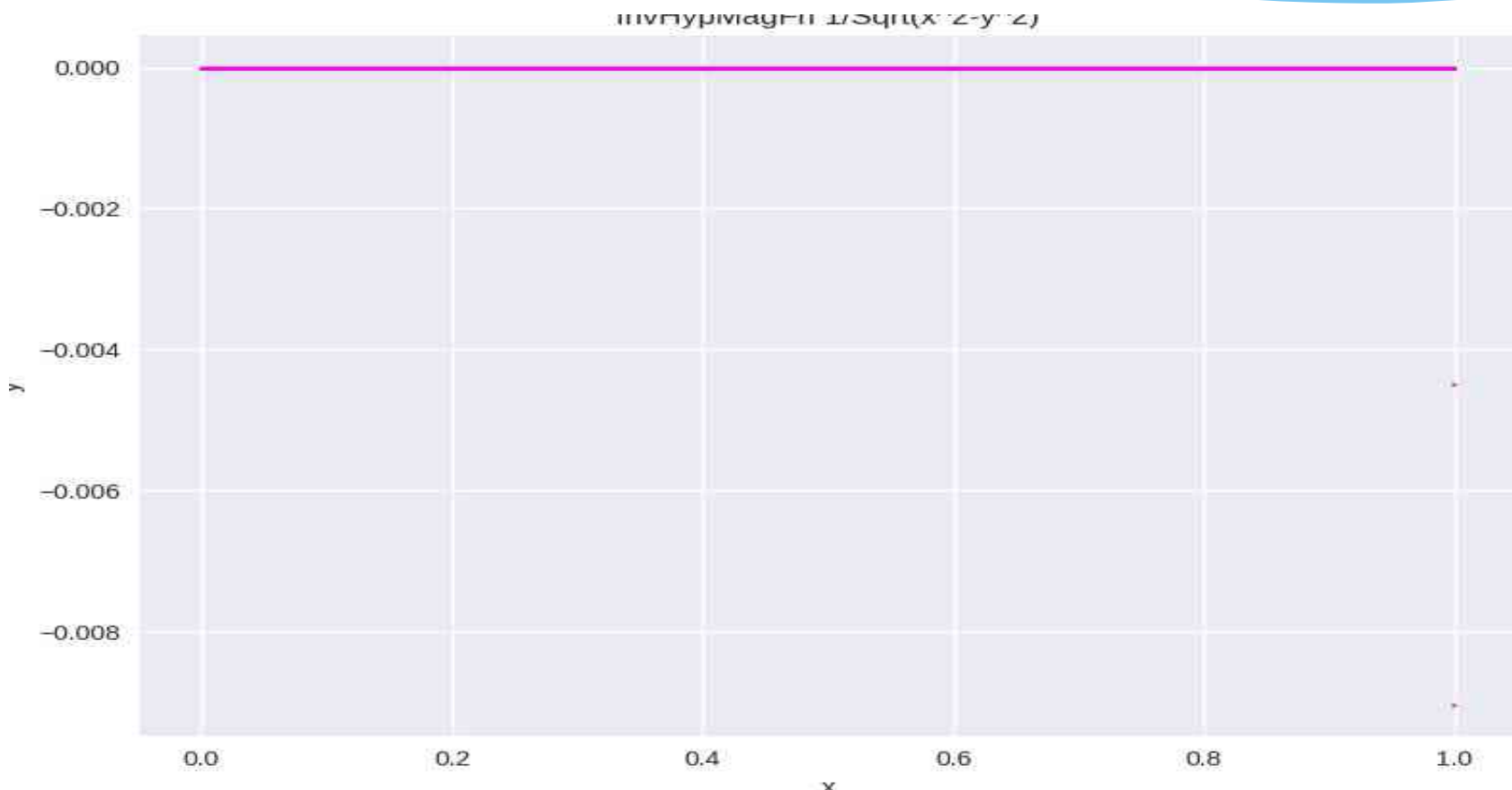
ERROR CHARACTERIZATION – POSIT HYP PHASE FUNCTION

Phase ($= \tanh^{-1}y/x$) error plot (inputs $y=1, 0 \leq x \leq 1 \Delta = 2^{-13}$); Number of cycles ~ 19



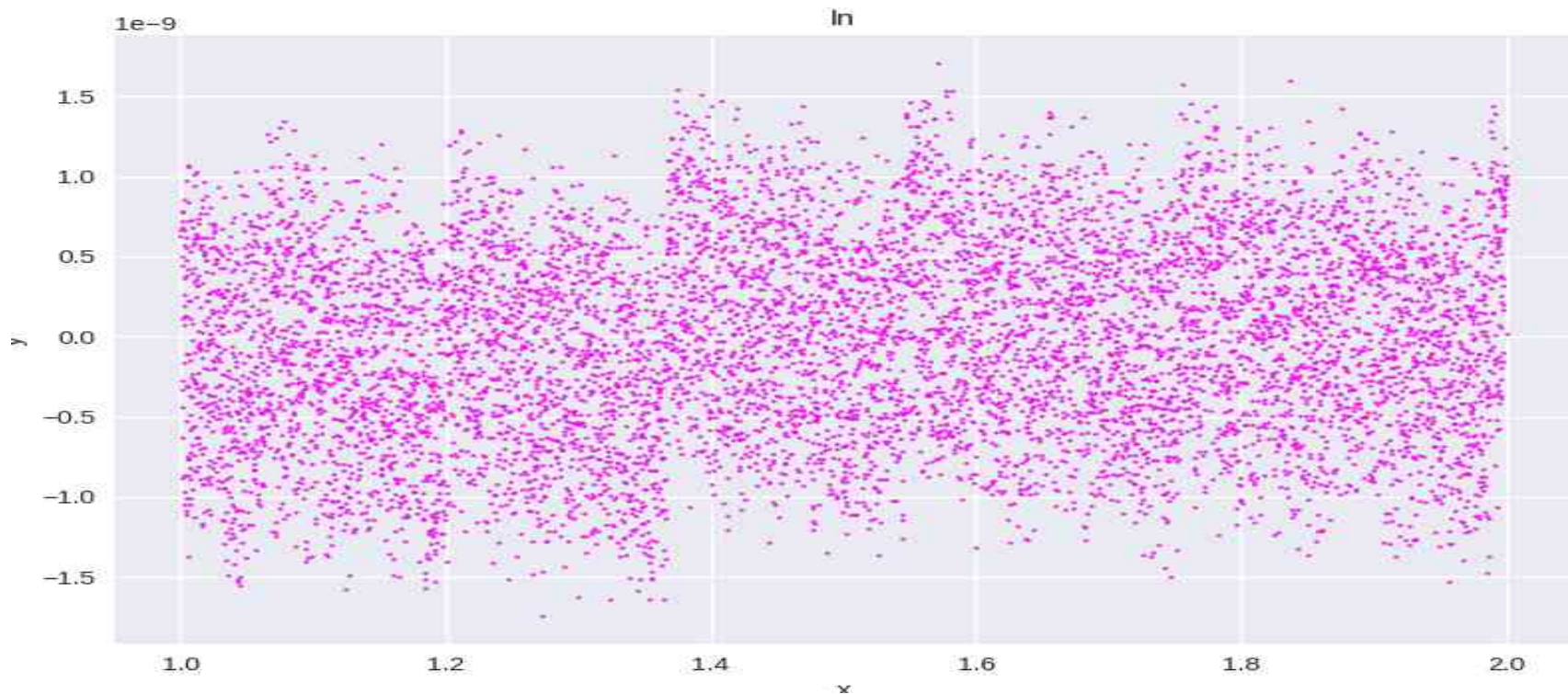
ERROR CHARACTERIZATION – POSIT INVHYP MAG FUNCTION

Inv Hyp Mag ($=1/\sqrt{x^2-y^2}$) error plot (inputs $x = 1, 0 \leq y \leq 1 \Delta = 2^{-13}$); Number of cycles ~ 20



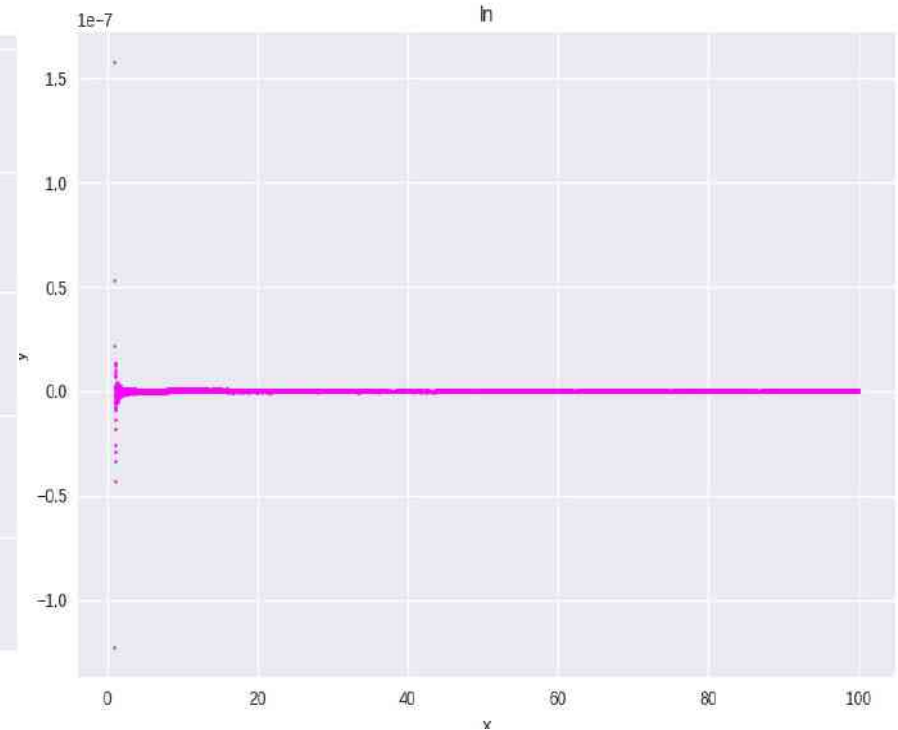
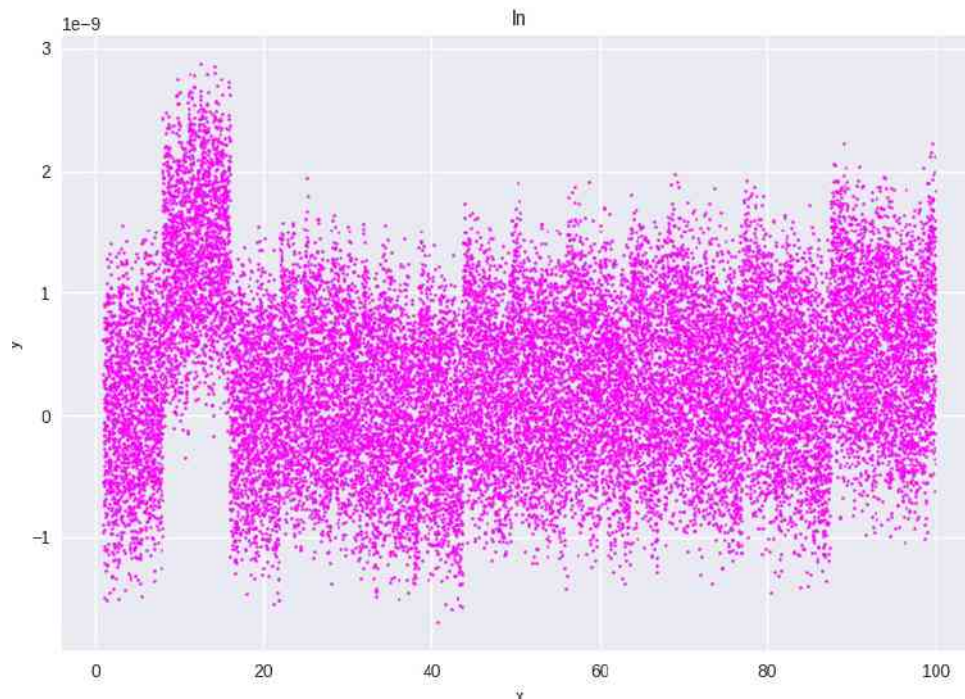
ERROR CHARACTERIZATION – LOGARITHM FUNCTION

Ln x error plot (inputs $1 \leq x \leq 2$ $\Delta = 2^{-13}$); Number of cycles ~ 19



ERROR CHARACTERIZATION – LOGARITHM FUNCTION

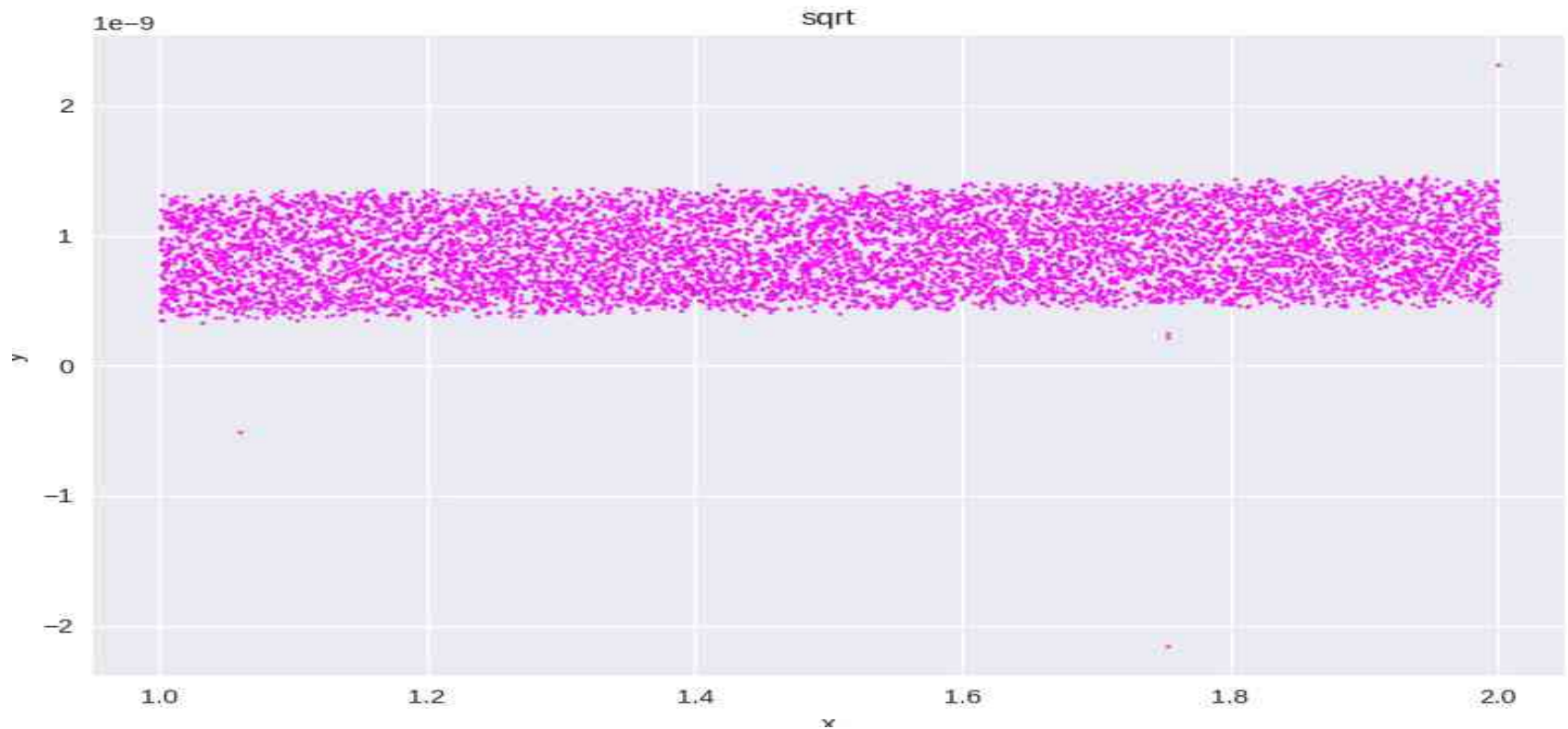
Ln x error plot (inputs $1 \leq x \leq 100$ $\Delta = 2^{-8}$); Number of cycles ~ 19



Relative error plot

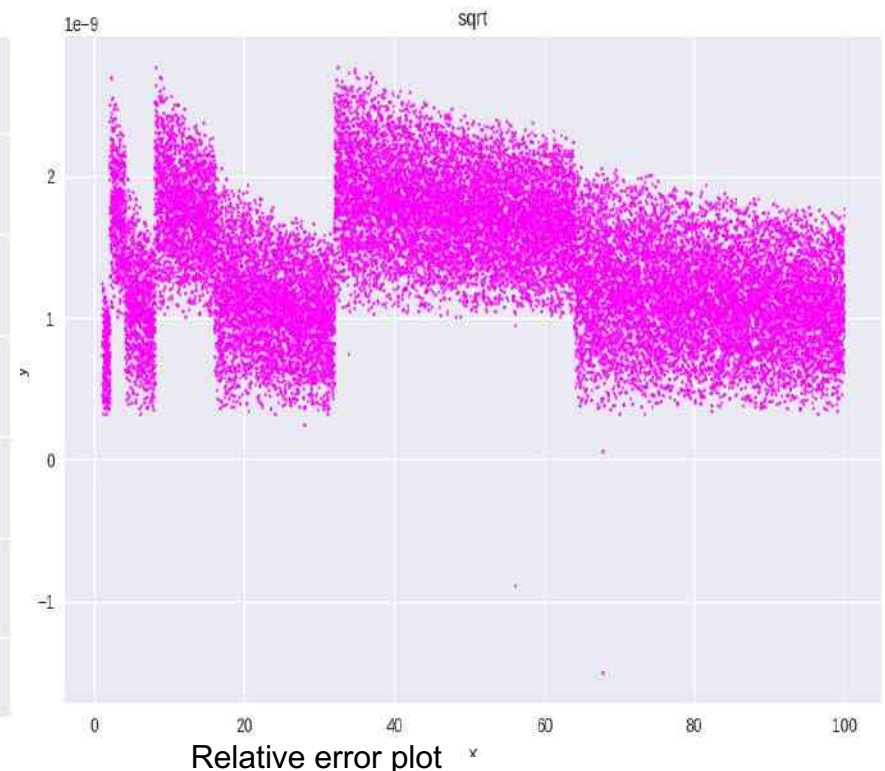
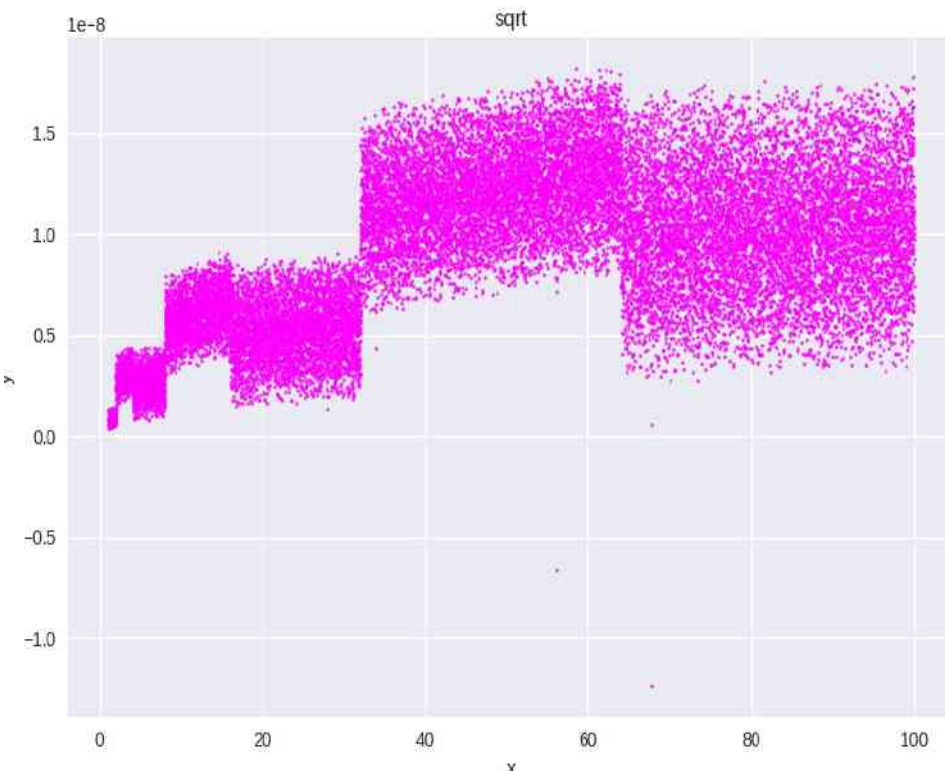
ERROR CHARACTERIZATION – POSIT SQUARE ROOT FUNCTION - 1

Square root error plot for $1 \leq x < 2$ $\Delta = 2^{-13}$; Number of cycles ~ 20



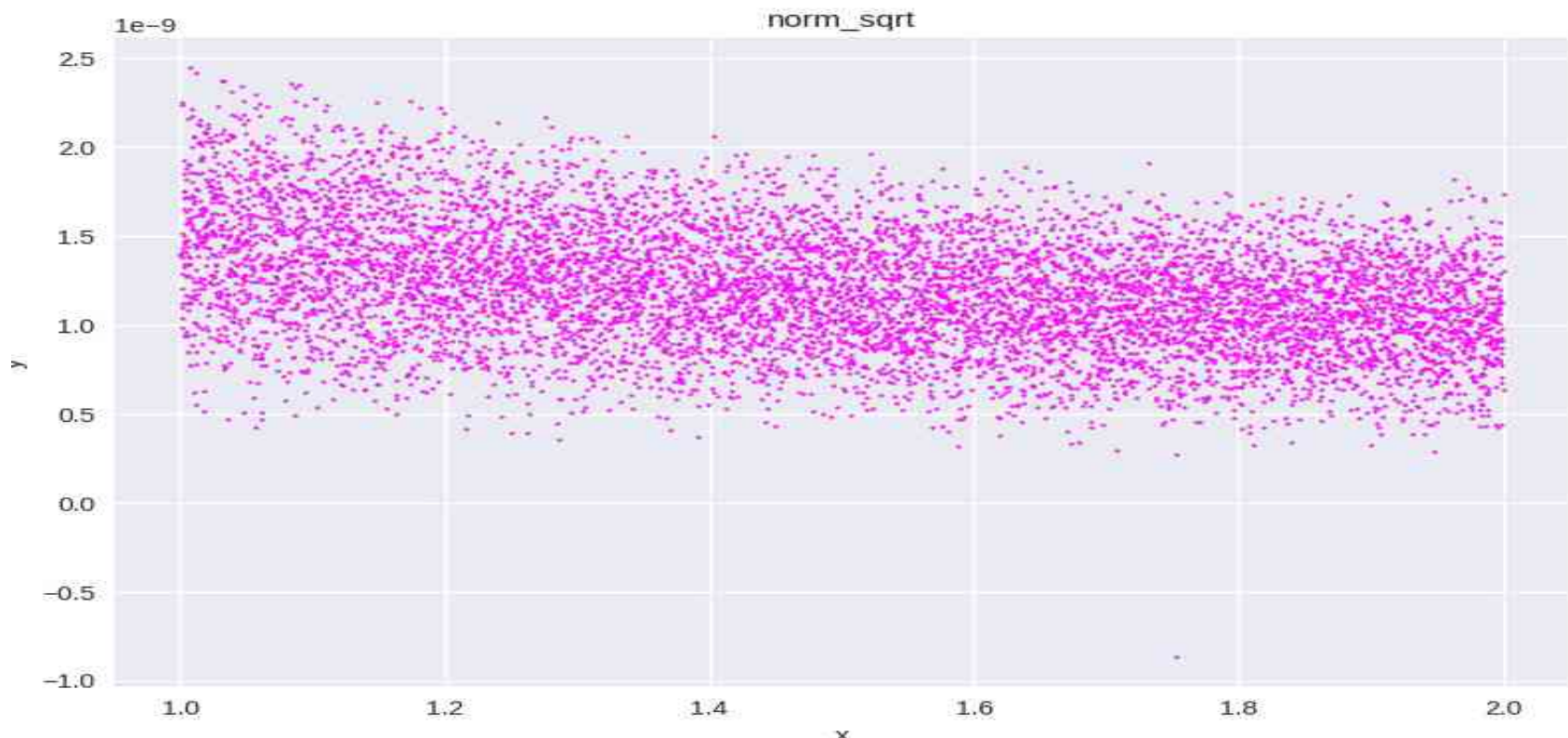
ERROR CHARACTERIZATION – POSIT SQUARE ROOT FUNCTION - 2

Square root error plot for $1 \leq x < 100$ $\Delta = 2^{-8}$; Number of cycles ~ 20



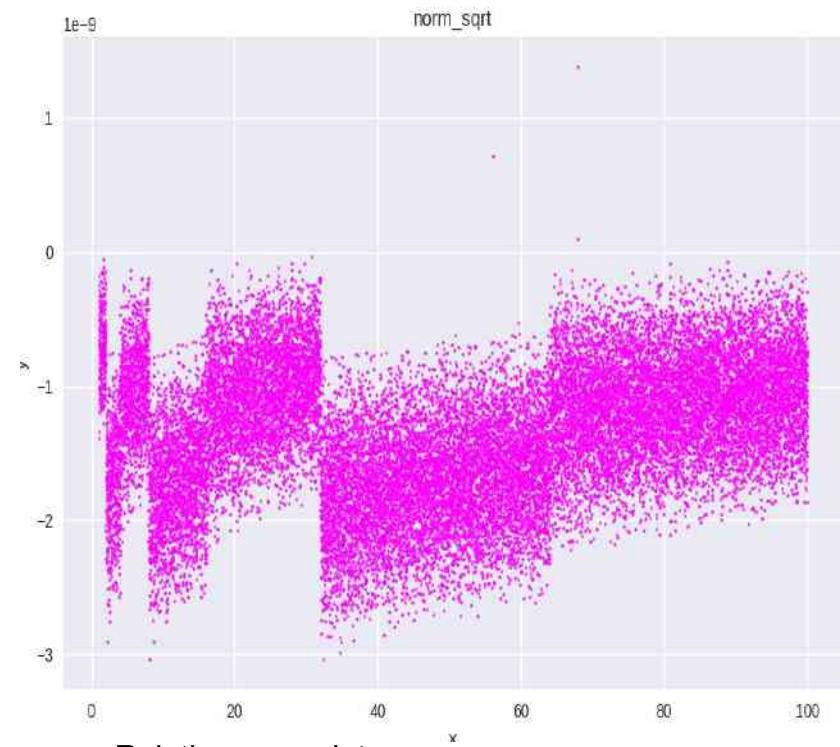
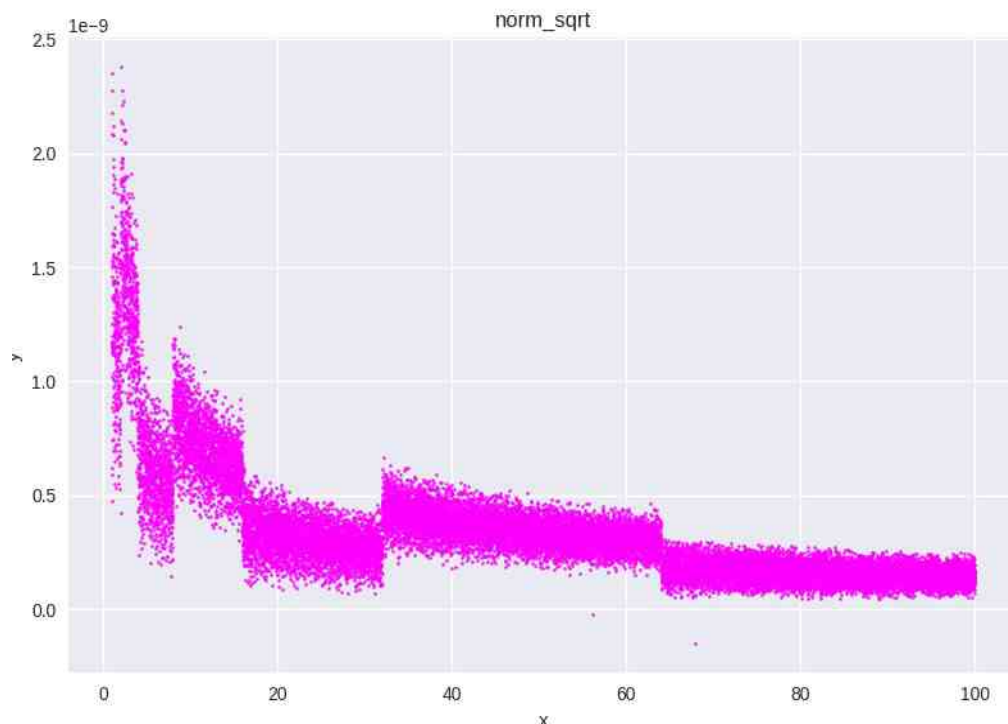
ERROR CHARACTERIZATION – POSIT INVERSE SQUARE ROOT

Inv Square root error plot for $1 \leq x \leq 2$ $\Delta = 2^{-13}$; Number of cycles ~ 21



ERROR CHARACTERIZATION – POSIT INVERSE SQUARE ROOT

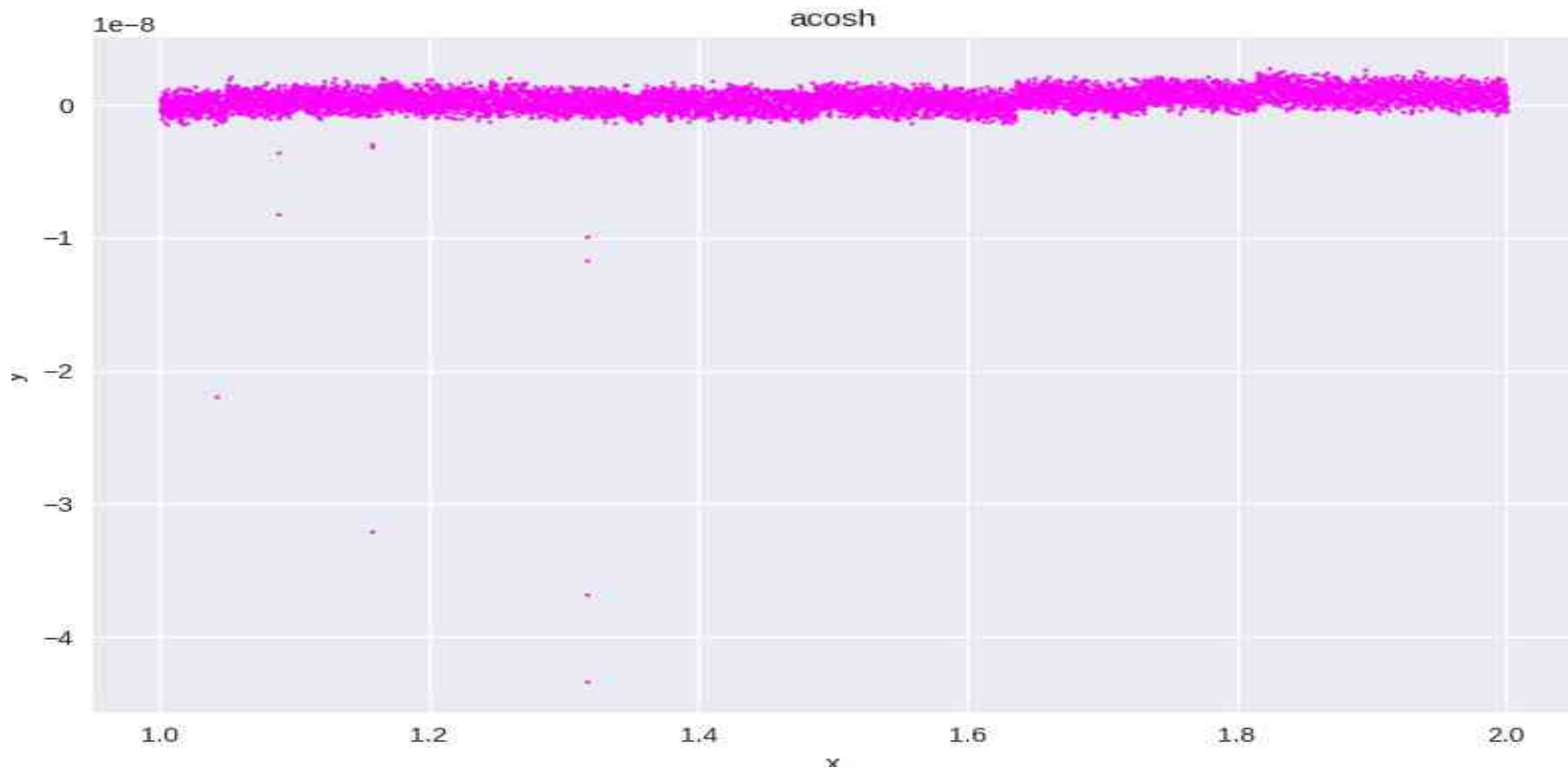
Inv Square root error plot for $1 \leq x \leq 100$ $\Delta = 2^{-8}$; Number of cycles ~ 21



Relative error plot

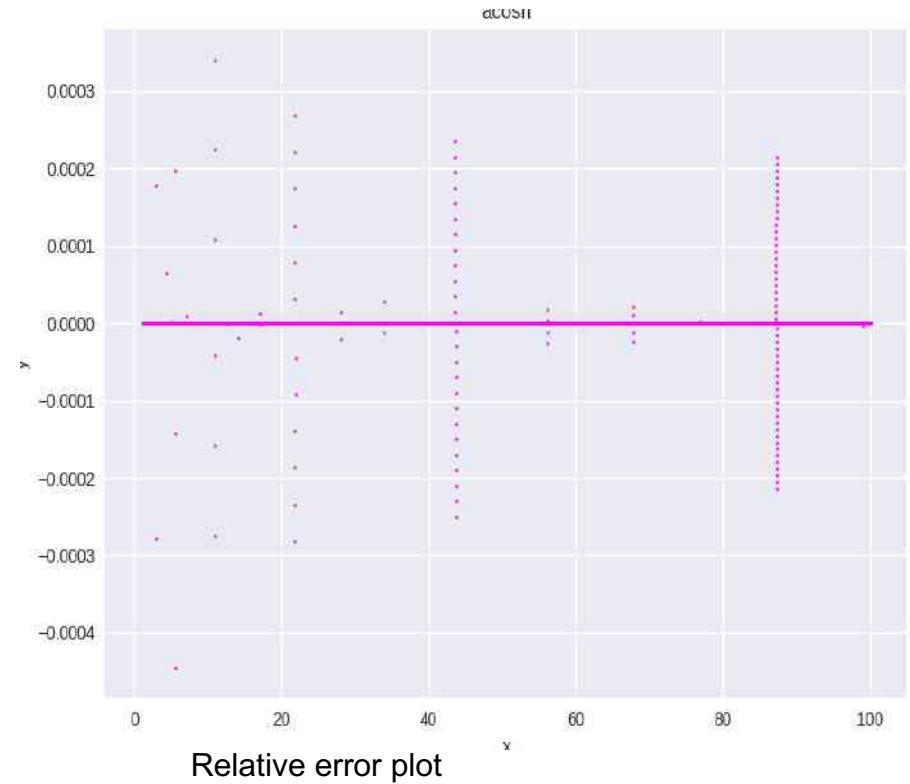
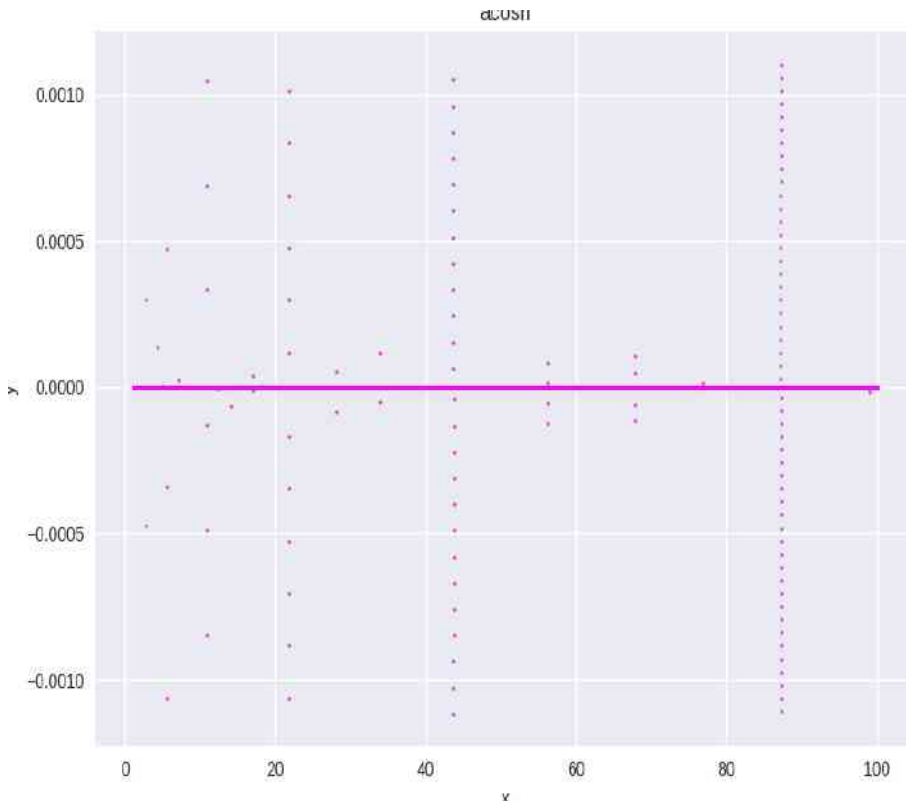
ERROR CHARACTERIZATION – ARC COSH

Arc COSH (= Cosh⁻¹x) error plot (inputs $1 \leq x \leq 2$ $\Delta = 2^{-13}$); Number of cycles ~ 37



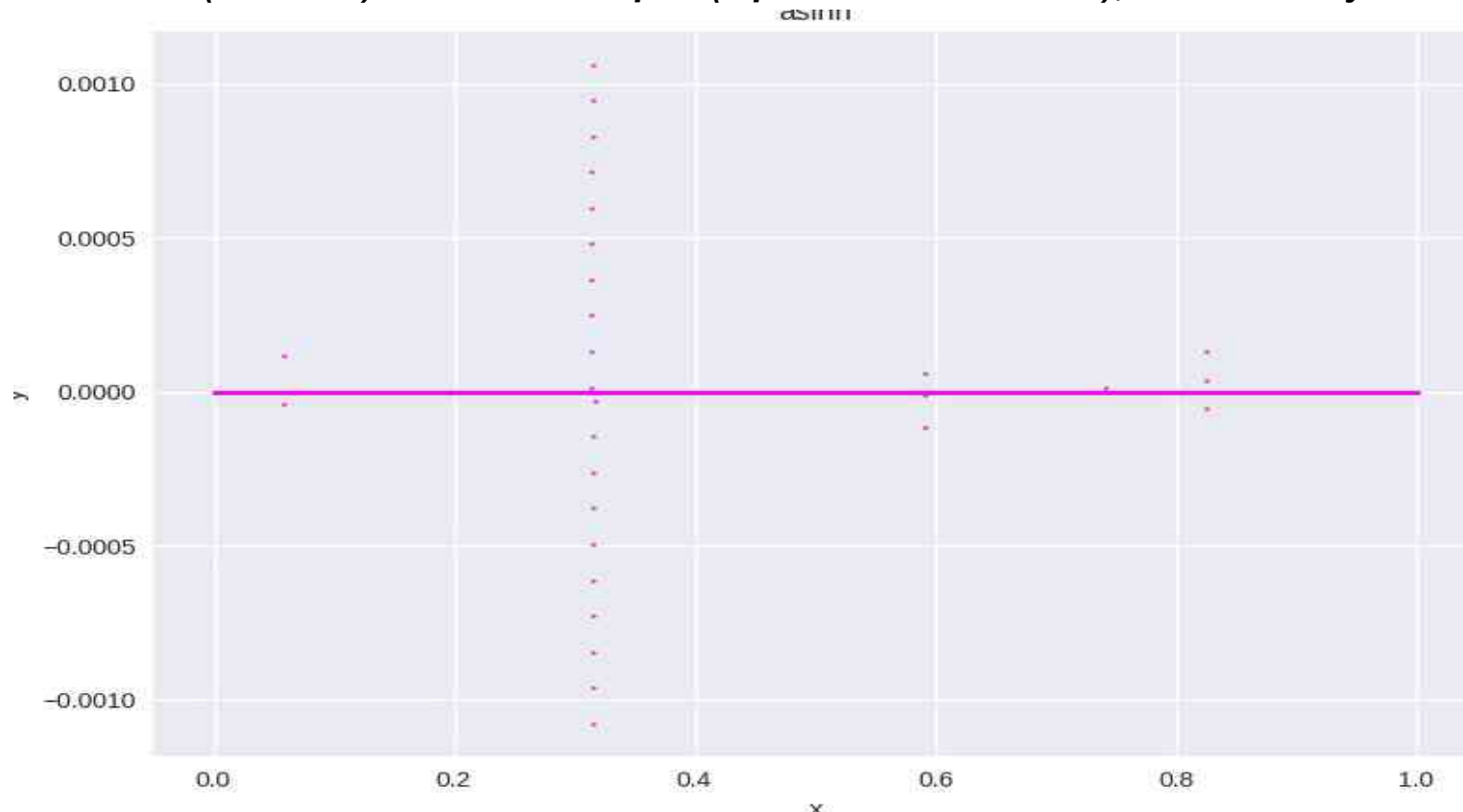
ERROR CHARACTERIZATION – ARC COSH

Arc COSH (= Cosh⁻¹x) error plot (inputs $1 \leq x \leq 100$ $\Delta = 2^{-8}$; Number of cycles ~ 37)



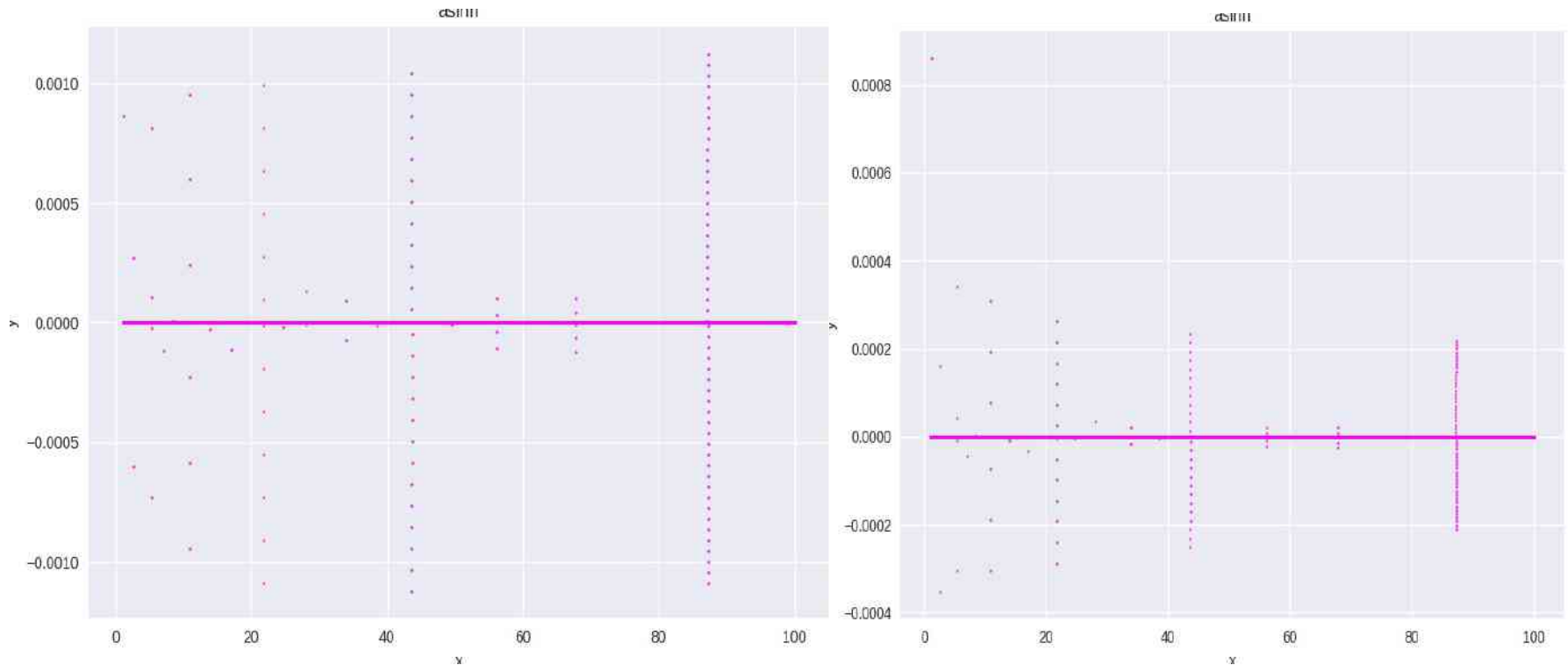
ERROR CHARACTERIZATION – ARC SINH

Arc SINH (= $\text{Sinh}^{-1}x$) absolute error plot (inputs $0 \leq x \leq 1$ $\Delta = 2^{-13}$; Number of cycles ~ 37)



ERROR CHARACTERIZATION – ARC SINH

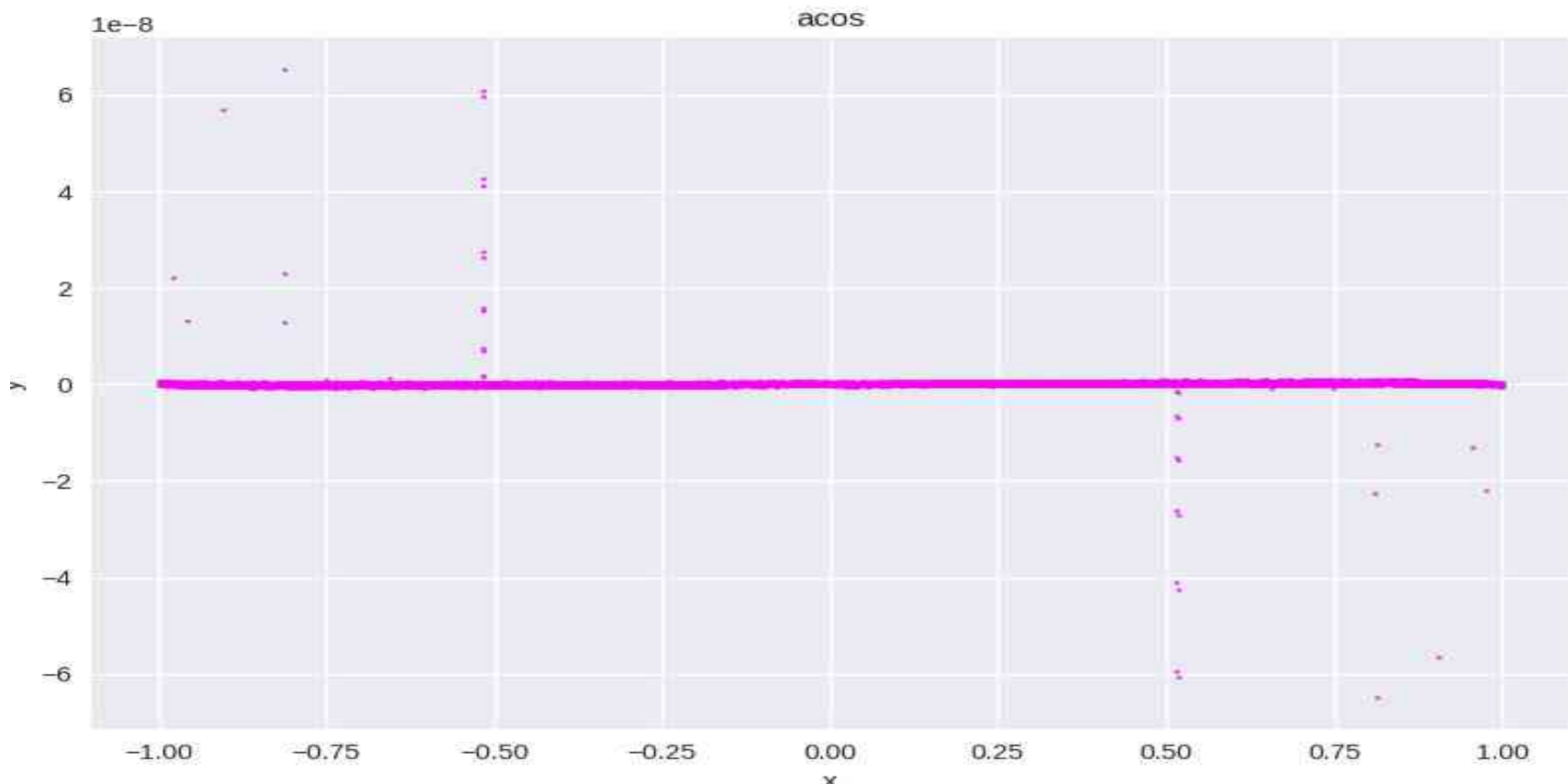
Arc SINH (= $\text{Sinh}^{-1}x$) absolute error plot (inputs $1 \leq x \leq 100$ $\Delta = 2^{-13}$); Number of cycles ~ 37



Relative error plot

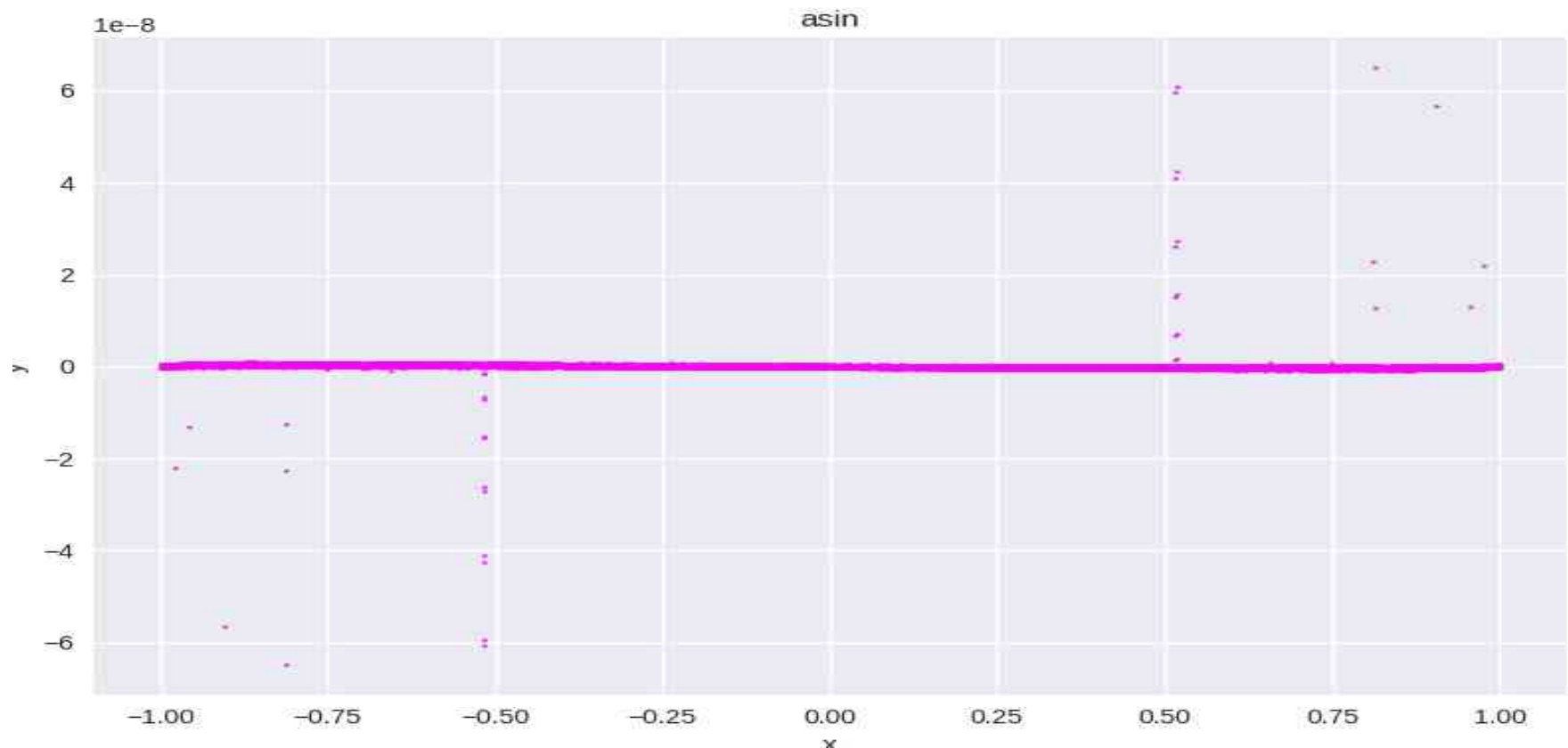
ERROR CHARACTERIZATION – ARC COSINE

Arc Cosine ($\text{Cos}^{-1}x$) error plot (input, $-1 \leq x \leq 1 \Delta = 2^{-13}$); Number of cycles ~ 25



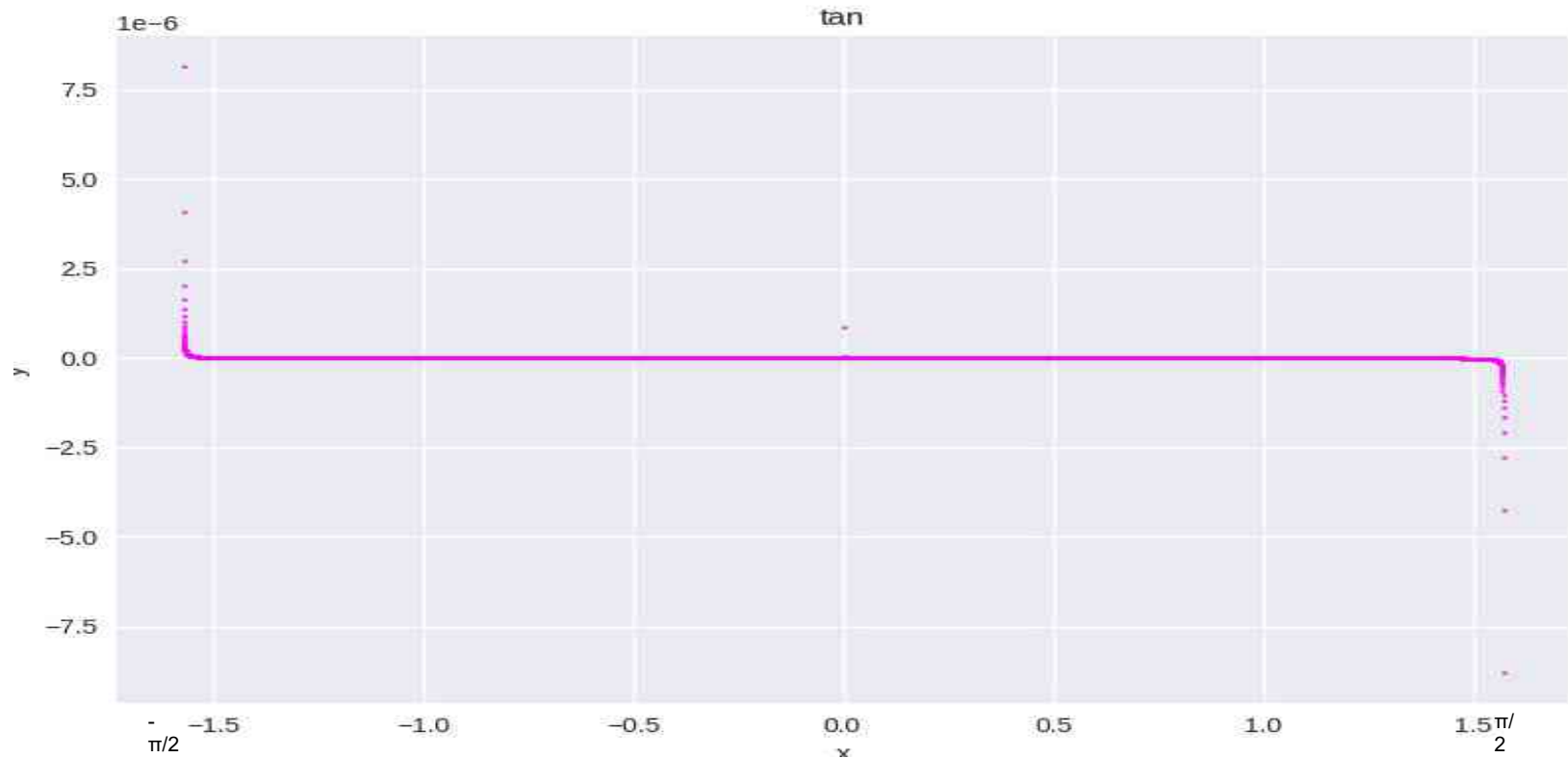
ERROR CHARACTERIZATION – ARC SINE

Arc Sine ($= \sin^{-1}x$) error plot (input $-1 \leq x \leq 1$ $\Delta = 2^{-13}$); Number of cycles ~ 25



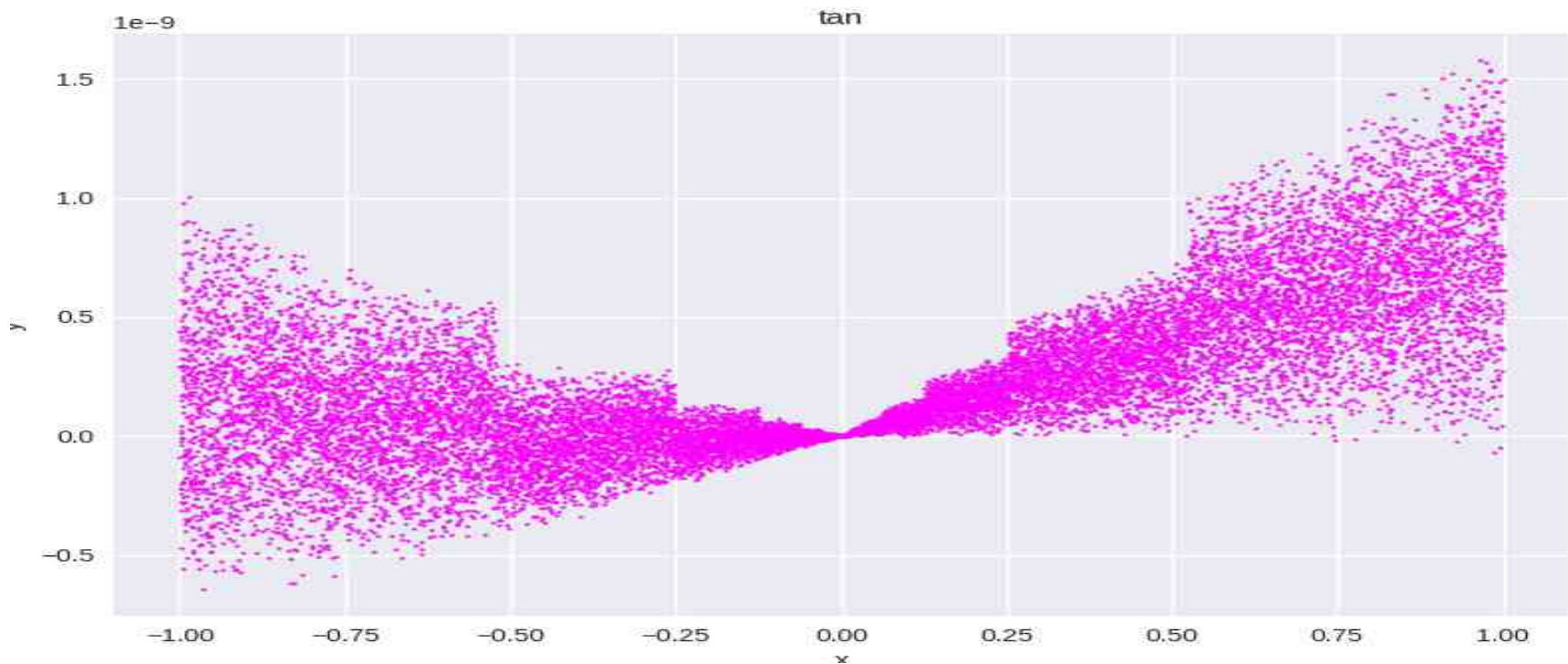
ERROR CHARACTERIZATION – POSIT TAN

Tan relative error plot(input $-1.57 \leq x \leq 1.57$ $\Delta = 2^{-13}$); Number of cycles ~ 15



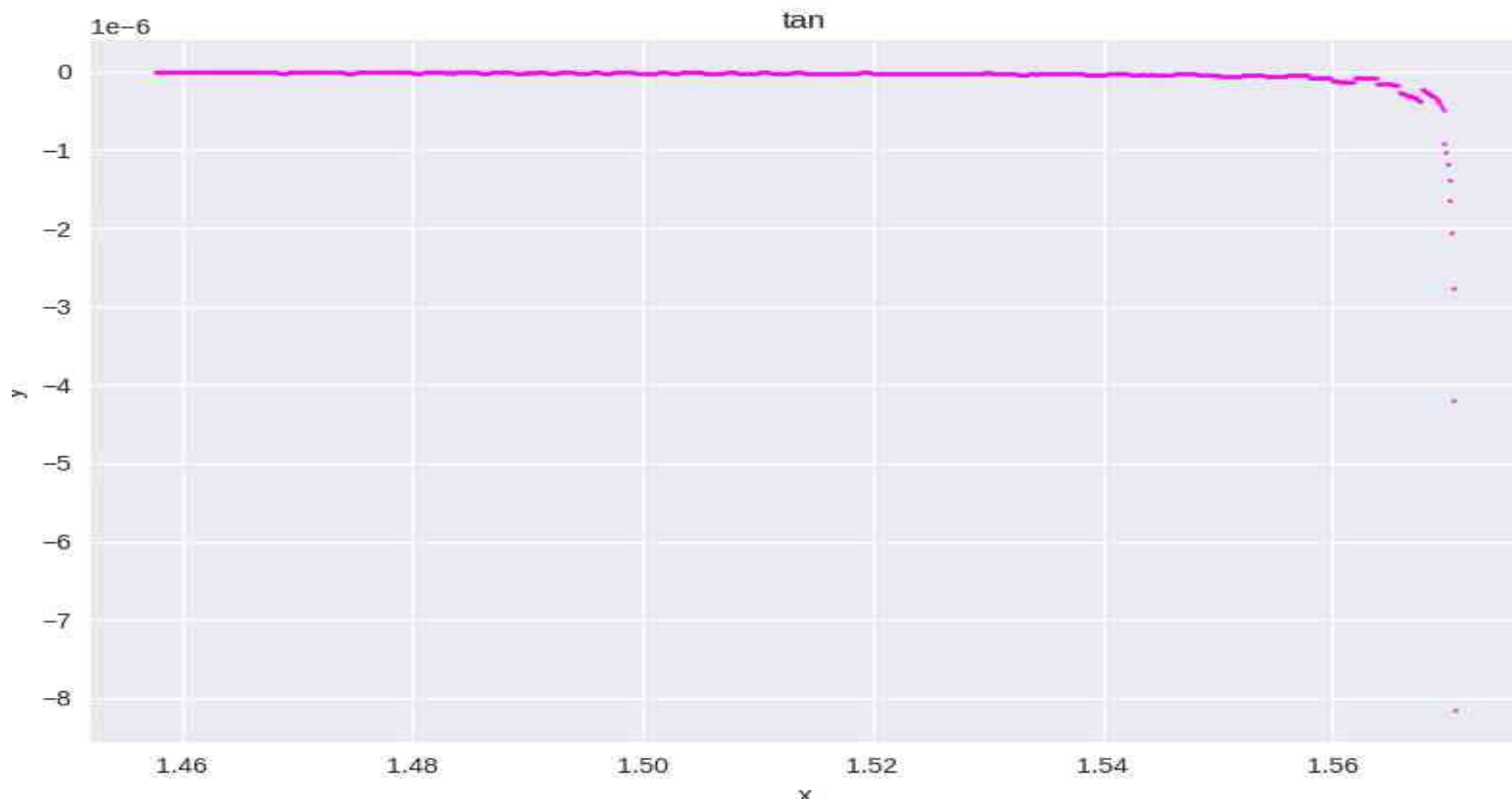
ERROR CHARACTERIZATION – POSIT TAN

Tan absolute error plot($-1 \leq x \leq 1$ $\Delta = 2^{-13}$); Number of cycles ~ 15



ERROR CHARACTERIZATION – POSIT TAN

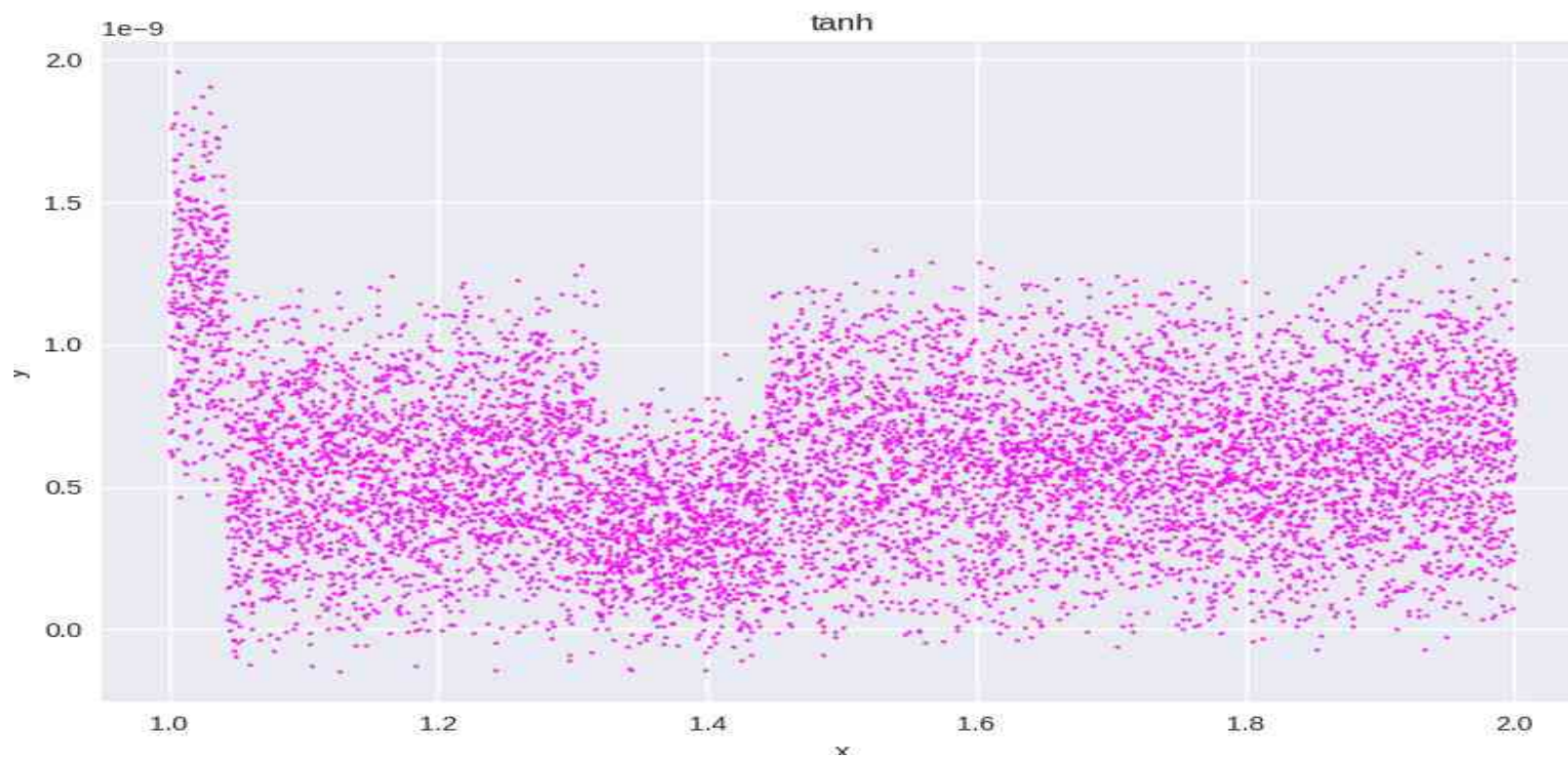
Tan relative error plot($1.457 \leq x \leq 1.57 \Delta = 2^{-13}$); Number of cycles ~ 15



Plot shows tan error near $\pi/2$

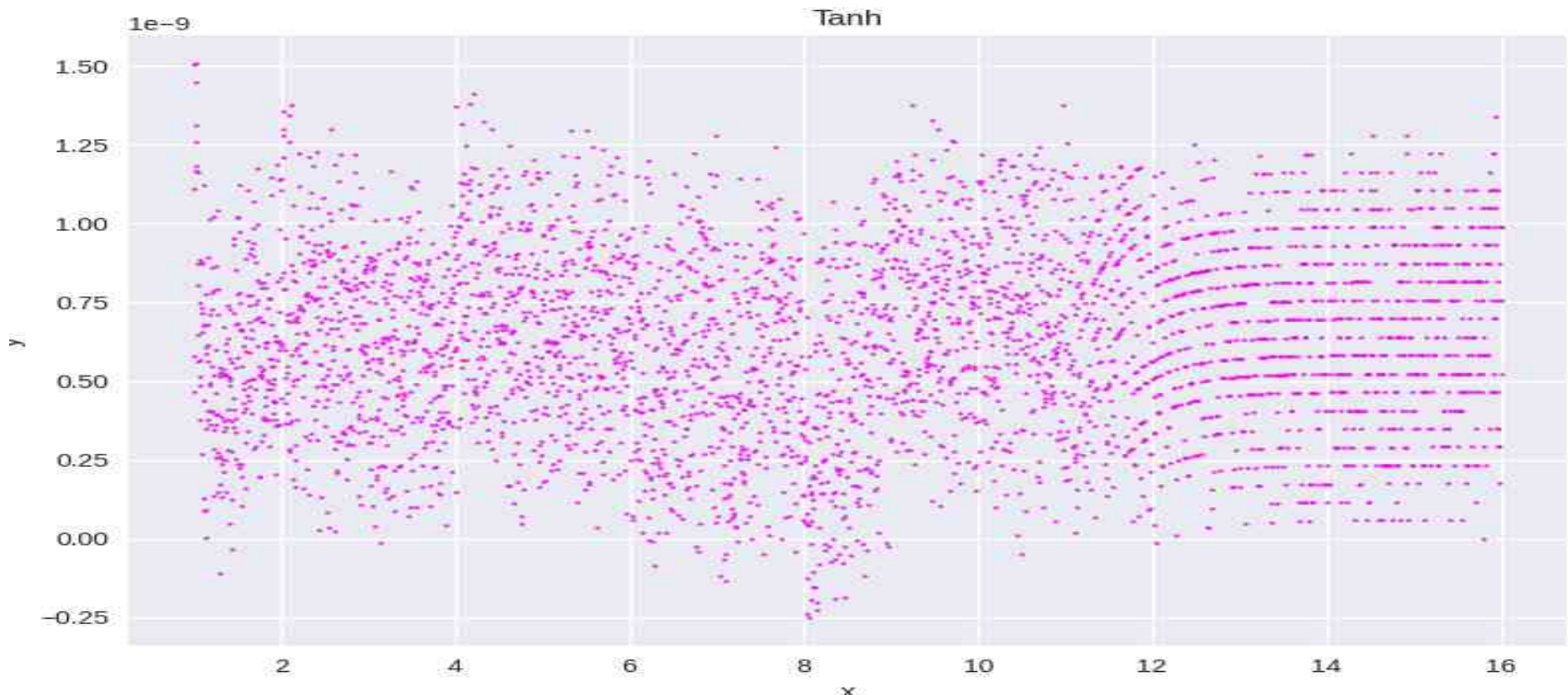
ERROR CHARACTERIZATION – TANH

TANH (= Tanh x) absolute error plot (inputs $1 \leq x \leq 2 \Delta = 2^{-13}$); Number of cycles ~ 17



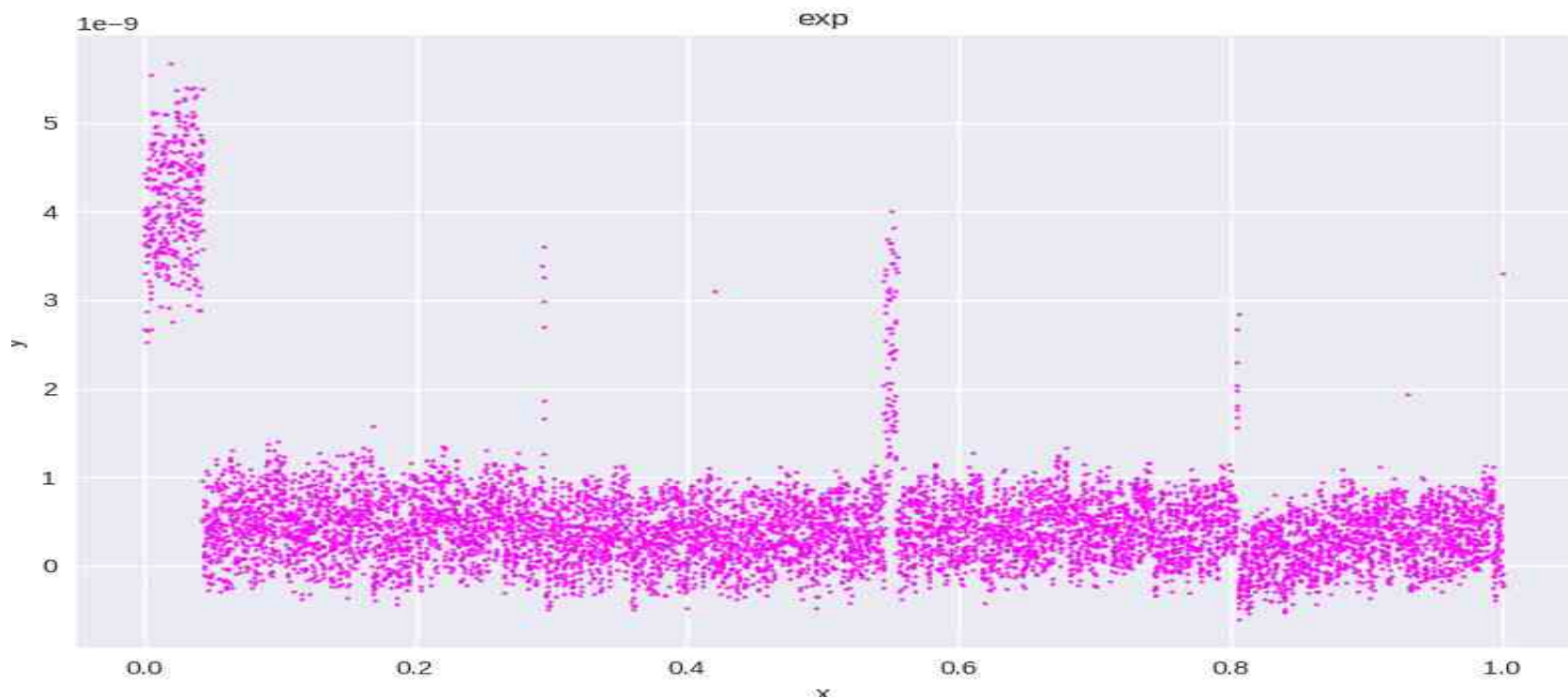
ERROR CHARACTERIZATION – TANH

TANH (= Tanh x) absolute error plot (inputs $1 \leq x \leq 16$ $\Delta = 2^{-8}$); Number of cycles ~ 17



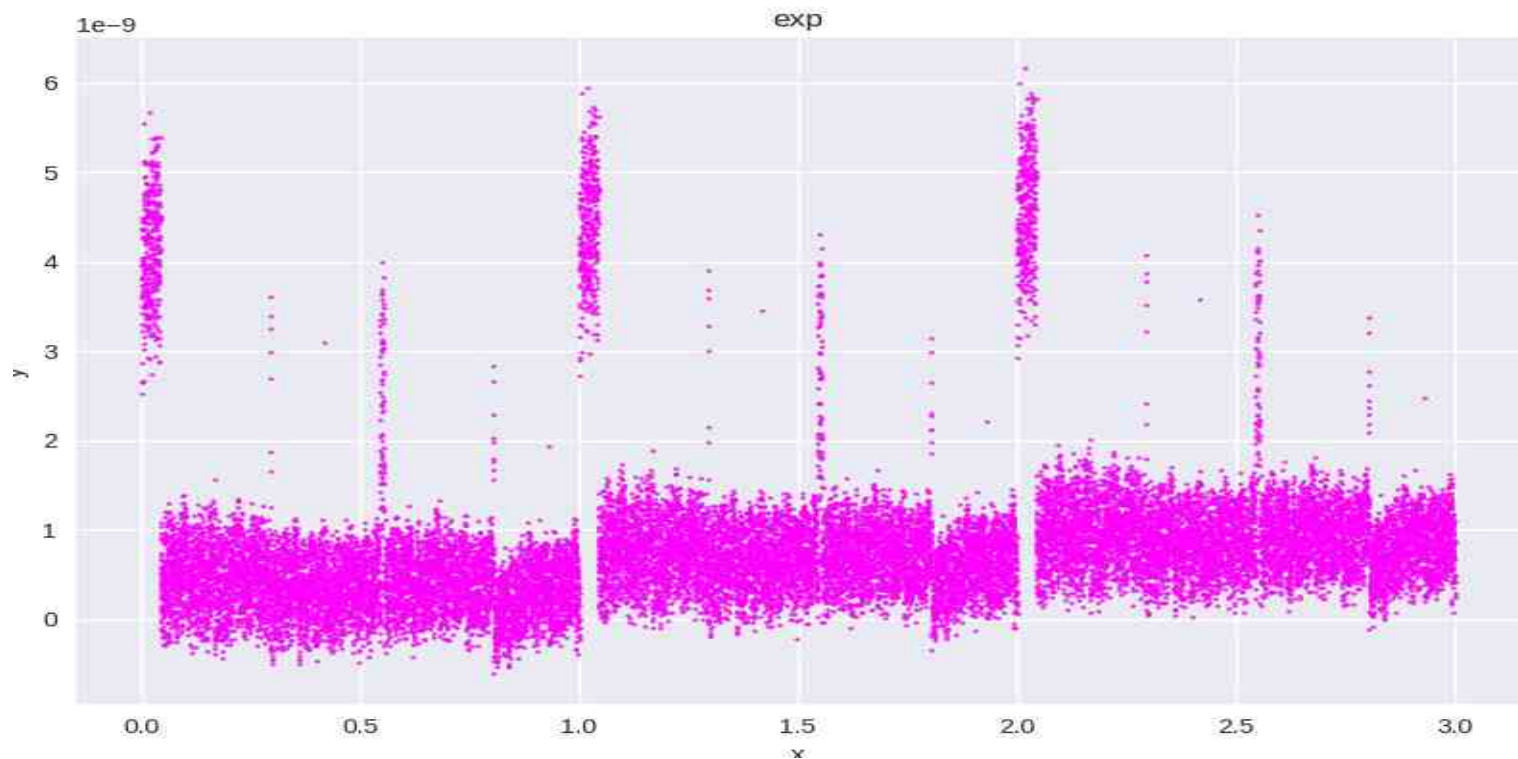
ERROR CHARACTERIZATION – EXPONENT FUNCTION

e^x error plot (input $0 \leq x \leq 1$ $\Delta = 2^{13}$; Number of cycles ~ 11)



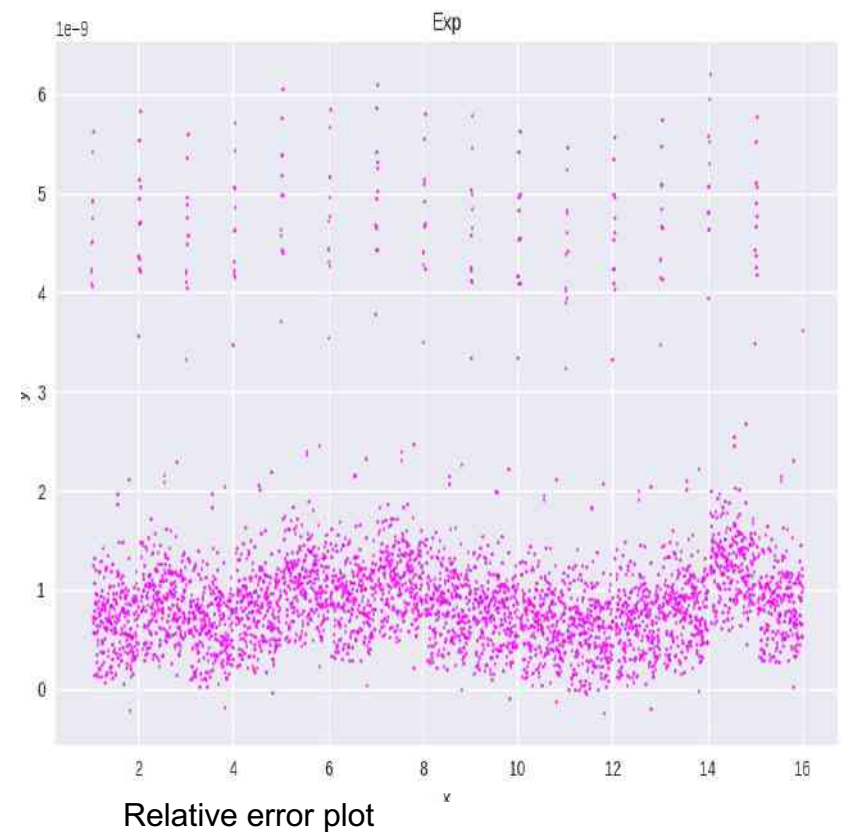
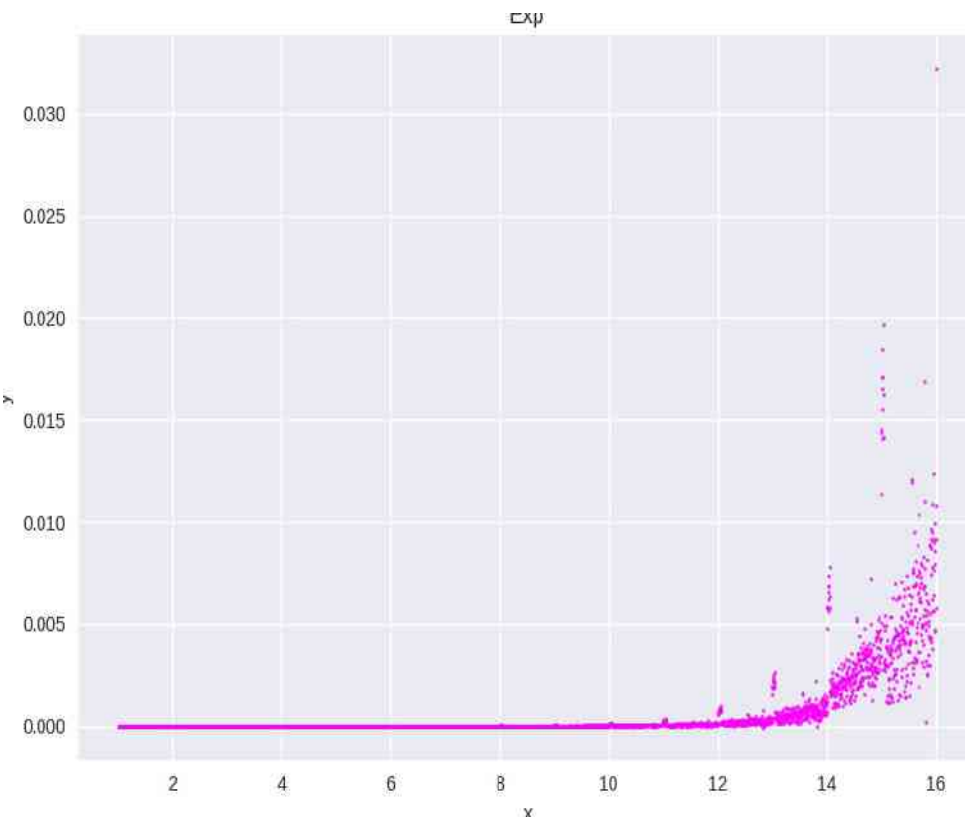
ERROR CHARACTERIZATION – EXPONENT FUNCTION

e^x absolute error plot (inputs $0 \leq x \leq 3$ $\Delta = 2^{-13}$; Number of cycles ~ 11)



ERROR CHARACTERIZATION – EXPONENT FUNCTION

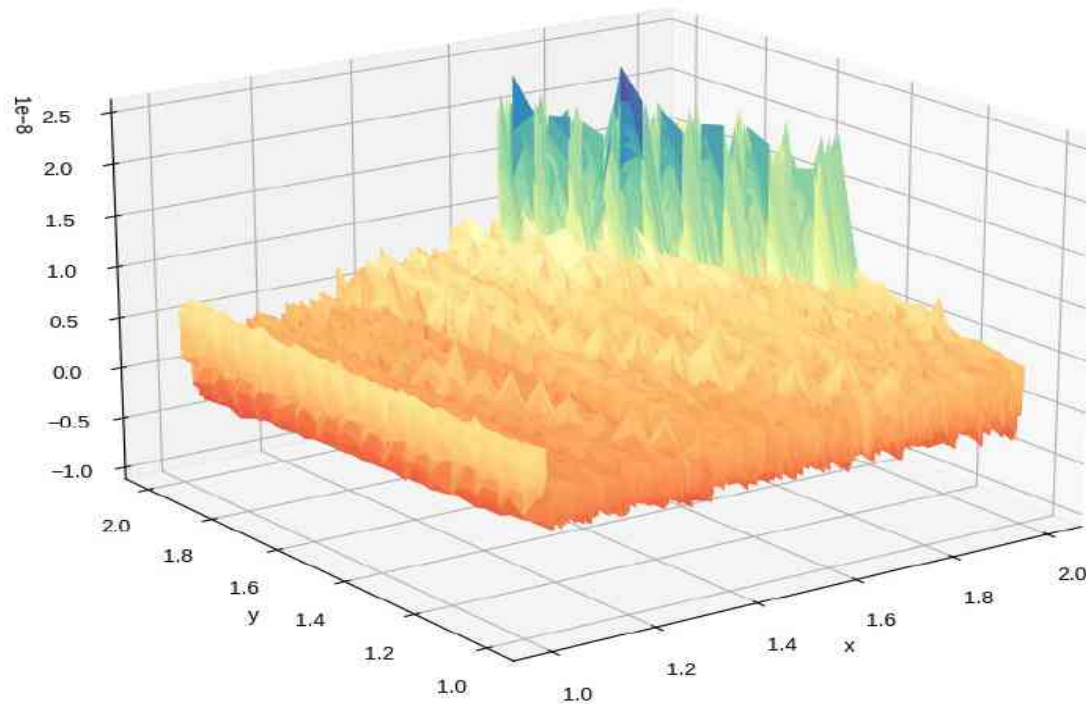
e^x absolute error plot (inputs $1 \leq x \leq 16$ $\Delta = 2^{-8}$); Number of cycles ~ 11



ERROR CHARACTERIZATION – X POWER Y FUNCTION

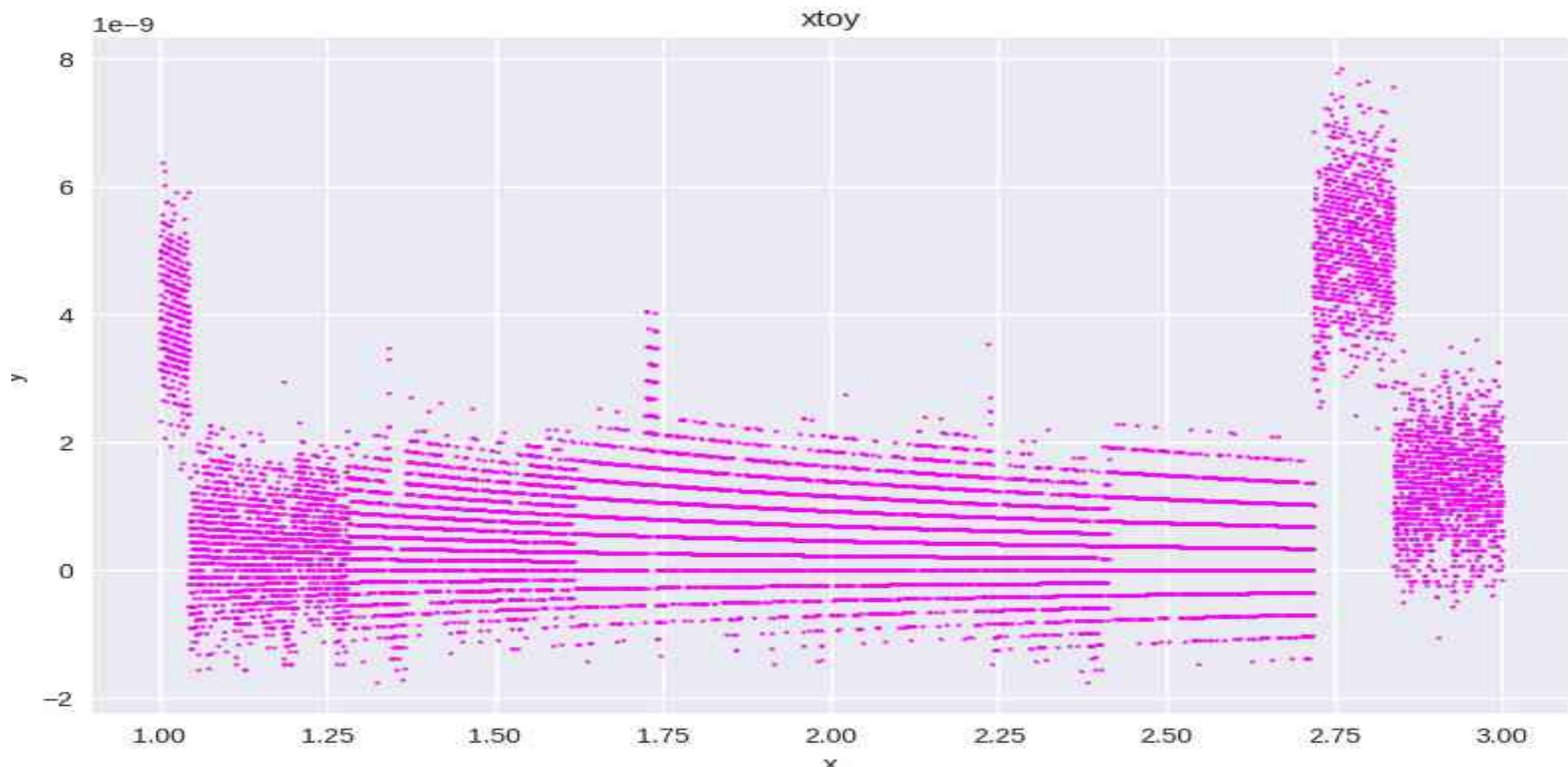
x^y absolute error plot (inputs $1 \leq x \leq 2 \Delta = 2^{-13}$, $1 \leq y \leq 2 \Delta = 2^{-4}$); Number of cycles ~ 30

x^y



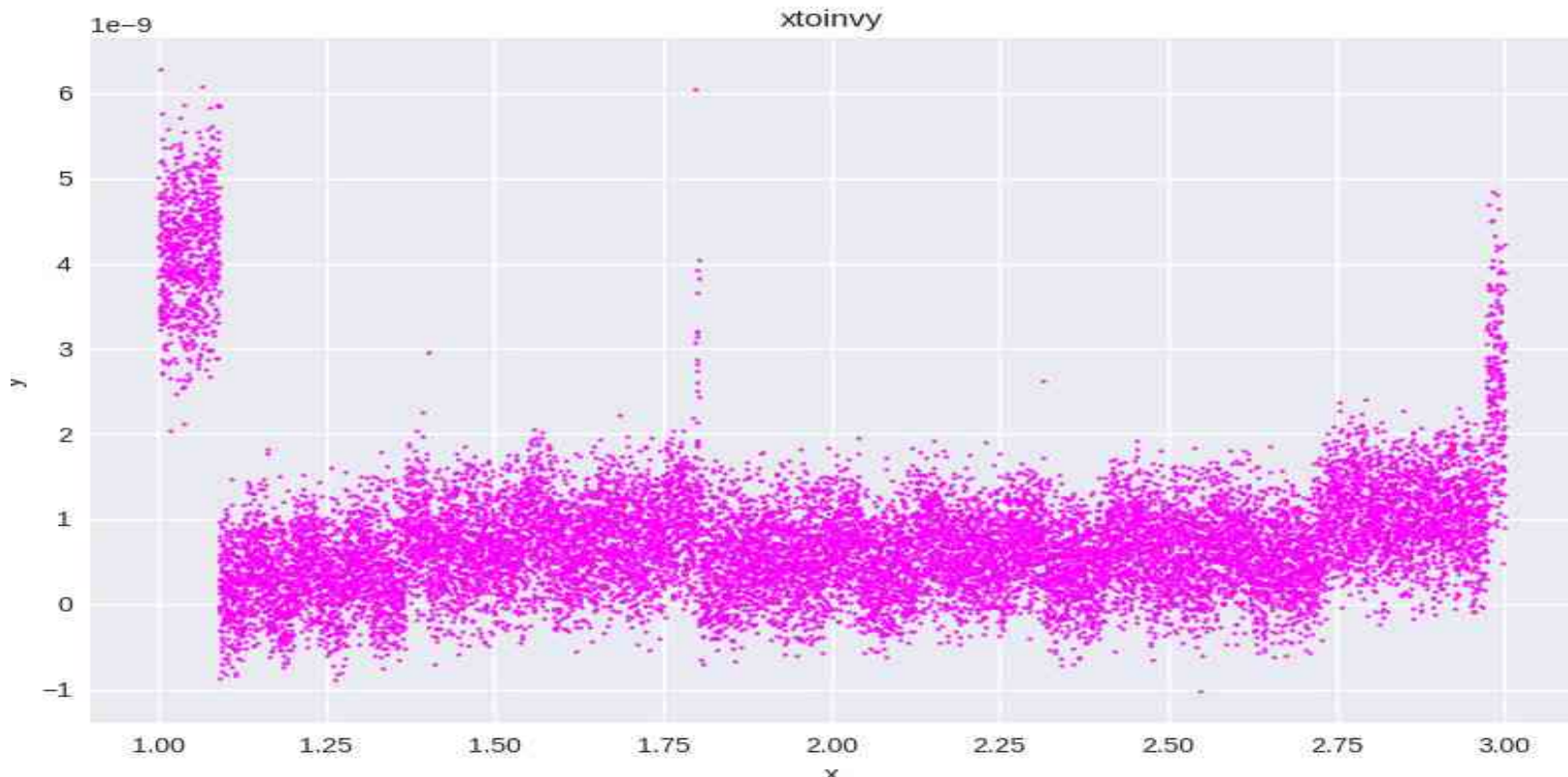
ERROR CHARACTERIZATION – X POWER Y FUNCTION

x^y error plot (inputs $1 \leq x \leq 3$, $y = 1 \Delta = 2^{-13}$); Number of cycles ~ 30



ERROR CHARACTERIZATION – X POWER Y FUNCTION

$x^{1/y}$ error plot (inputs $1 \leq x \leq 3$, $y = 2 \Delta = 2^{-13}$); Number of cycles ~ 30



*Interested?
Questions?
Suggestions?
Please contact us at:
enquiry@sensonics.in*