UAMS
UNIVERSITY OF ARKANSAS FOR MEDICAL SCIENCES

Department of Neurobiology and Developmental Sciences
Center for Translational Neuroscience
College of Medicine

Neuronal Signals - NBDS 5161
Session 6: Analyzing & Plotting Data

Abdallah HAYAR

Lectures can be downloaded from
http://hayar.net/NBDS5161

Updated Tentative Schedule for Neuronal Signals (NBDS 5161)
One Credit–Hour, Summer 2010
Location: Biomedical Research Building II, 6th floor, conference room,
Time: 9:00 -10:20 am

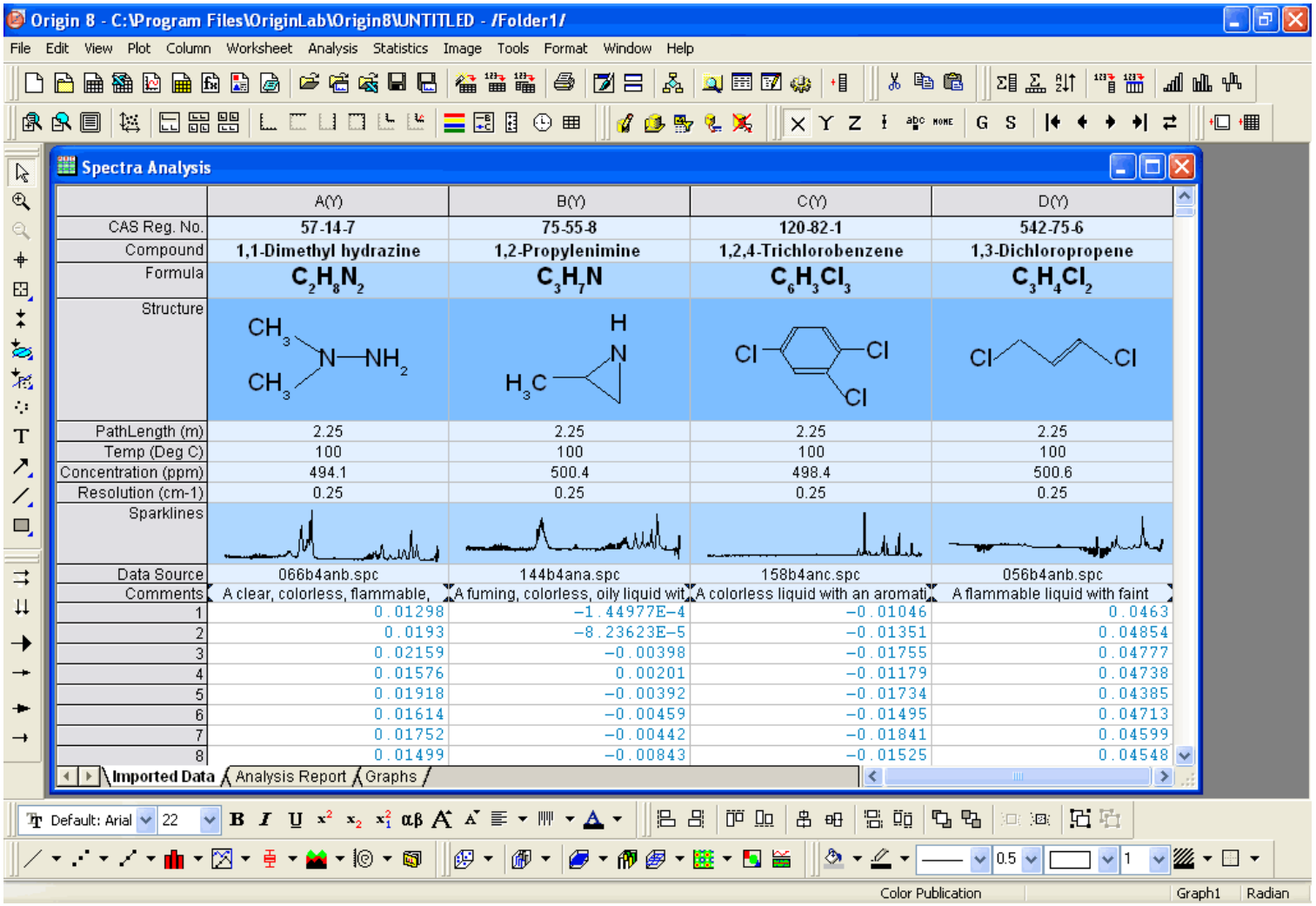
Session	Day	Date	Topic	Instructor
1	Tue	6/1	Design of an electrophysiology setup	Hayar
2	Thu	6/3	Neural population recordings	Hayar
3	Thu	6/10	Single cell recordings	Hayar
4	Fri	6/11	Analyzing synaptic activity	Hayar
5	Mon	6/14	Data acquisition and analysis	Hayar
6	Wed	6/16	Analyzing and plotting data using OriginLab	Hayar
7	Fri	6/18	Detecting electrophysiological events	Hayar
8	Mon	6/21	Writing algorithms in OriginLab®	Hayar
9	Wed	6/23	Imaging neuronal activity	Hayar
10	Fri	6/25	Laboratory demonstration of an electrophysiology and imaging experiment	Hayar
11	Fri	7/9	Article presentation I: Electrophysiology	Hayar
12	Mon	7/12	Article presentation II: Imaging	Hayar
13	Wed	7/14	Exam and students' survey about the course	Hayar

Student List

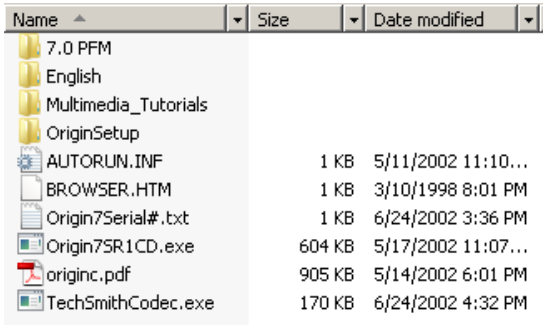
	Name	E-mail	Regular/Auditor	Department	Position
1	Simon, Christen	CSimon@uams.edu	Regular (form signed)	Neurobiology & Developmental Sciences	Graduate Neurobiology – Mentor: Dr. Garcia-Rill
2	Kezunovic, Nebojsa	NKezunovic@uams.edu	Regular (form signed)	Neurobiology & Developmental Sciences	Graduate Neurobiology – Mentor: Dr. Garcia-Rill
3	Hyde, James R	JRHyde@uams.edu	Regular (form signed)	Neurobiology & Developmental Sciences	Graduate Neurobiology – Mentor: Dr. Garcia-Rill
4	Yadlapalli, Krishnapraveen	KYadlapalli@uams.edu	Regular (form signed)	Pediatrics	Research Technologist – Mentor: Dr. Alchaer
5	Pathan, Asif	APATHAN@uams.edu	Regular (form signed)	Pharmacology & Toxicology	Graduate Pharmacology – Mentor: Dr. Rusch
6	Kharade, Sujay	SKHARADE@uams.edu	Regular (form signed)	Pharmacology & Toxicology	Graduate Pharmacology – 4th year - Mentor: Dr. Rusch
7	Howell, Matthew	MHOWELL2@uams.edu	Regular (form signed)	Pharmacology & Toxicology	Graduate Interdisciplinary Toxicology - 3rd year - Mentor: Dr. Gottschall
8	Beck, Paige B	PBBeck@uams.edu	Regular (form signed)	College of Medicine	Medical Student – 2nd Year - Mentor: Dr. Garcia-Rill
9	Atcherson, Samuel R	SRAtcherson@uams.edu	Auditor (form signed)	Audiology & Speech Pathology	Assistant Professor
10	Detweiler, Neil D	NDDETWEILER@uams.edu	Auditor (form not signed)	Pharmacology & Toxicology	Graduate Pharmacology – 1st year
11	Thakali, Keshari M	KMThakali@uams.edu	Unofficial auditor	Pharmacology & Toxicology	Postdoctoral Fellow – Mentor: Dr. Rusch
12	Boursoulian, Feras	FBoursoulian@uams.edu	Unofficial auditor	Neurobiology & Developmental Sciences	Postdoctoral Fellow – Mentor: Dr. Hayar
13	Steele, James S	JSSTEELE@uams.edu	Unofficial auditor	College of Medicine	Medical Student – 1st Year – Mentor: Dr. Hayar
14	Smith, Kristen M	KMSmith2@uams.edu	Unofficial auditor	Neurobiology & Developmental Sciences	Research Technologist – Mentor: Dr. Garcia-Rill
15	Gruenwald, Konstantin	kjoachimg@gmail.com	Unofficial auditor	Neurobiology & Developmental Sciences	High school Student – Mentor: Dr. Hayar
16	Rhee, Sung	RheeSung@uams.edu	Unofficial auditor	Pharmacology & Toxicology	Assistant Professor
17	Light, Kim E	LightKimE@uams.edu	Unofficial auditor	Pharmaceutical Sciences	Professor

http://www.originlab.com

Product	Unit Price[1]	Annual Maintenance[2] (25% of the Unit Price)	Upgrade from 7.0, 7.5 and 8.0
Origin 8.1	$500	$125	Contact a Sales representative: Email, Chat
OriginPro 8.1	$700	$175	



Download OriginLab Software



- Download zip file (127 Mbytes)
- Unzip file into a new folder, Enter the password:
- Click on **Origin7SR1CD.exe** to install program
- Serial # can be found in this file: **Origin7Serial#.txt**
- Do not register the software, do not distribute

Axon Text File (ATF format)

ATF is a tab-delimited ASCII text format that can be read by typical spreadsheet programs such as Microsoft Excel. Thus, ATF files are easily imported into spreadsheet, scientific analysis, and graphics programs, and can also be edited by word processor and text editor programs.

An ATF text file consists of **records**. The group of records at the beginning of the file is called the file header. Each line in the text file is a record. Each record may consist of several **fields**, separated by a field separator (column delimiter). The tab and comma characters are field separators. Space characters around a tab or comma are ignored and considered part of the field separator.

The file header describes the file structure and includes column titles, units, and comments. Text strings are enclosed in quotation marks to ensure that any embedded spaces, commas and tabs are not mistaken for field separators.

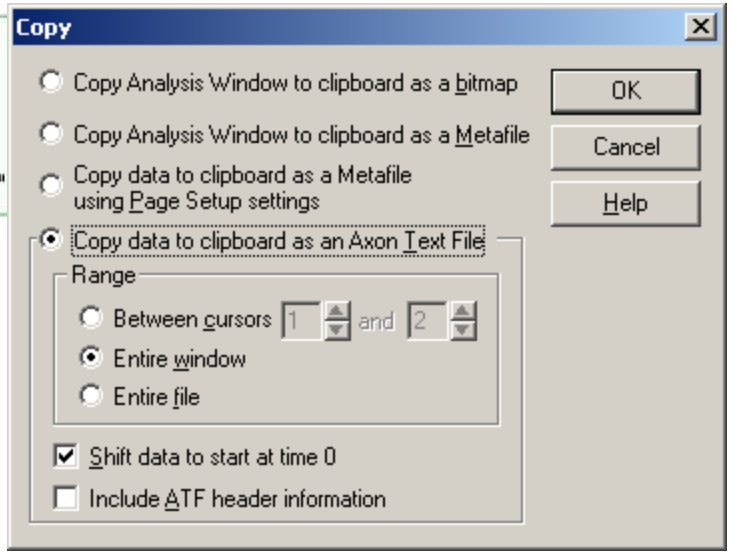
Note: Data stored in a text format occupies much more disk space than data stored in a binary format

Header

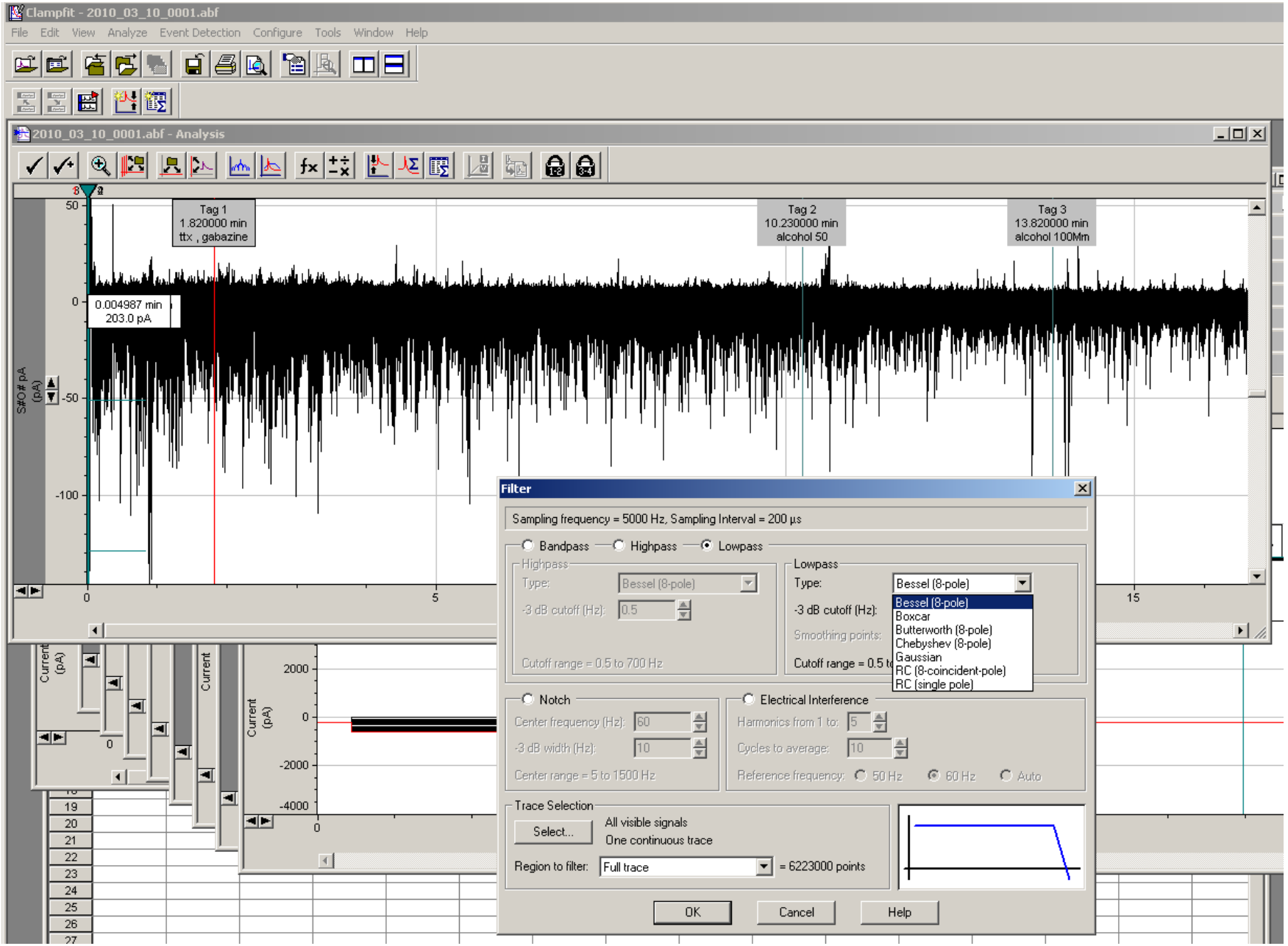
Optional header records

Data records

```
ATF  1.0
5    3
"Type=Sums File"
"DataFileName=SINGLES.DAT"
"Comment="
"SumCount=18"
"SumsEpisodes=1,3,5,7,9,11,12,13,14,21,22,23,24,25,27,29,31,32,33"
"Time (ms)"     "Amplitude (pA)"     "Comment ()"
0               -1.75665             ""
.2              -1.796178            ""
.4              -1.834542            ""
.6              -1.848493            ""
.8              -1.774089            ""
1.0             -1.700846            "Applied pulse"
1.2             -1.728748            ""
1.4             -1.817104            ""
1.6             -1.822917            ""
1.8             -1.805478            "Removed pulse"
```



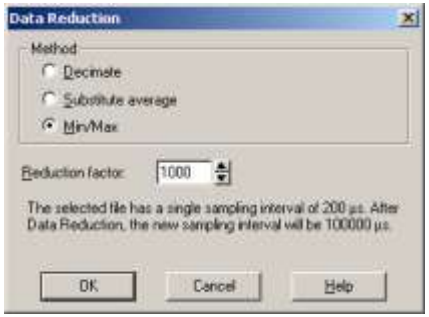
Digital Filtering: Analyze-Filter



Data reduction

Decimate

In this operation the first point of every n points is retained (n being specified by the reduction factor). The remaining points are discarded. This method is the least suitable for noisy data as the noise in the signal might be aliased, depending on the acquisition lowpass filter setting.
The first point of every n points (where n is the reduction factor) for each signal, is copied to the output data record.



For example, if the following hypothetical data are present in 2 signals:
Signal 0: 100, 140, 160, 170, 171, 172, 173, 173, 173, 174, 175, 175
Signal 1: 400, 380, 360, 340, 320, 300, 280, 260, 240, 220, 200, 180
then, for a reduction factor of 3, the output data record contains:
Signal 0: 100, 170, 173, 174
Signal 1: 400, 340, 280, 220

Substitute average

Each successive group of n points (n being specified by the reduction factor) is averaged to yield a single point that is retained. This method is recommended for noisy data as it minimizes noise and transients in the reduced data.
A group of n points (where n is the reduction factor) for each signal is averaged to give one point in the output data record.

For example, if the following hypothetical data are present in 2 signals:
Signal 0: 100, 140, 160, 170, 171, 172, 173, 173, 173, 174, 175, 175
Signal 1: 400, 380, 360, 340, 320, 300, 280, 260, 240, 220, 200, 180
then, for a reduction factor of 3, the output data record contains:
Signal 0: 133, 171, 173, 175
Signal 1: 380, 320, 260, 200

Min/Max

The smallest and largest values in each successive set of n reduction points are retained. The remaining points are discarded. Note that this method generates two points for each n points specified by the reduction factor. Consequently, the minimum reduction factor for this method is 2.
The minimum and maximum of each group of n points (where n is the reduction factor) for each signal are written to the output data record. Within the group of n data points, the minimum and maximum values are written to the new file in their order of occurrence. The exact time of occurrence of the minimum and maximum values is not preserved, but is assigned as equally spaced within the n data point time period. Note that with Min/Max reduction, two data points are written to the file for each n points in the original file.

For example, if the following hypothetical data are present in 2 channels:
Signal 0: 100, 140, 160, 170, 171, 172, 173, 173, 173, 174, 175, 175
Signal 1: 400, 380, 360, 340, 320, 300, 280, 260, 240, 220, 200, 180
then, for a reduction factor of three, the output data record contains:
Signal 0: 100, 160, 170, 172, 173, 173, 174, 175
Signal 1: 400, 360, 340, 300, 280, 240, 220, 180

Different Windows Types in an Origin Project

Worksheet

	A[X]	B[Y]	C[Y]	D[Y]	E[Y]	F[Y]	G[Y]	H[Y]
1								
2								
3								
4								
5								

Excell

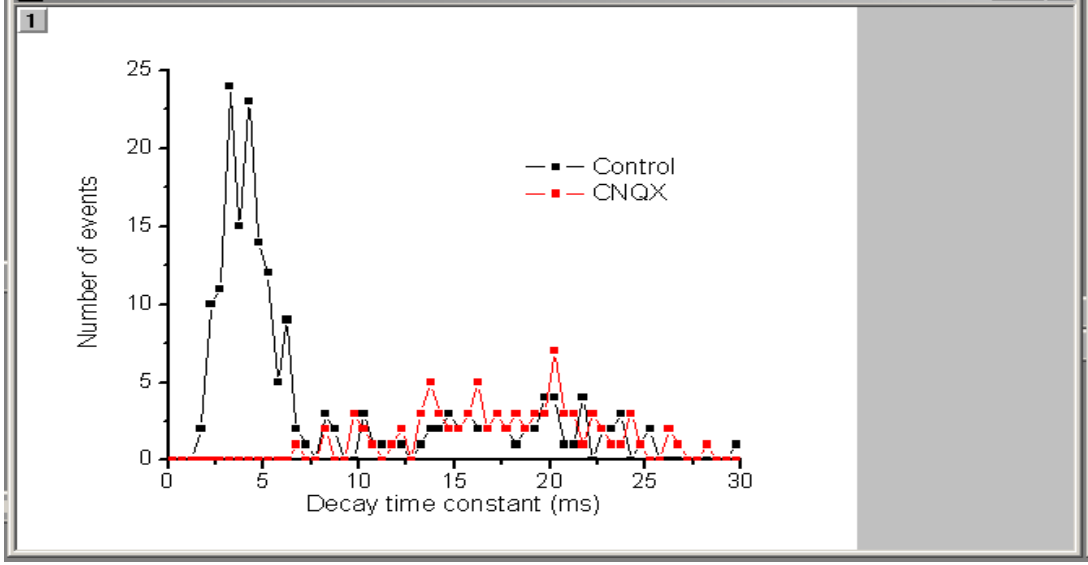
	A	B	C	D	E	F	G	H	I	J
1										
2										
3										
4										
5										
6										

Sheet1 Sheet2 Sheet3 Sheet4

Matrix1

	1	2	3	4	5	6	7	8
1								
2								
3								
4								
5								
6								
7								
8								

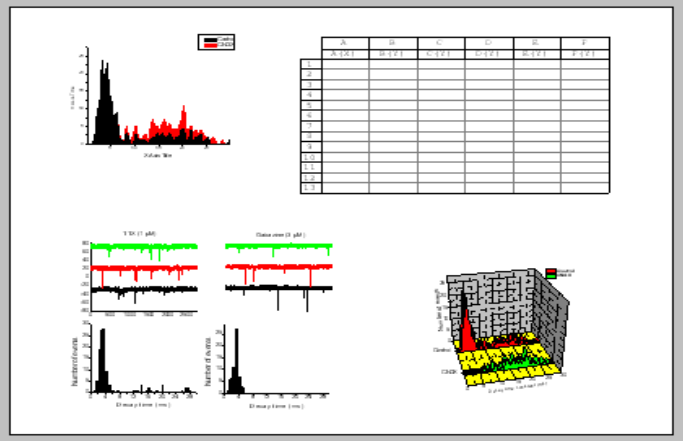
Graph2



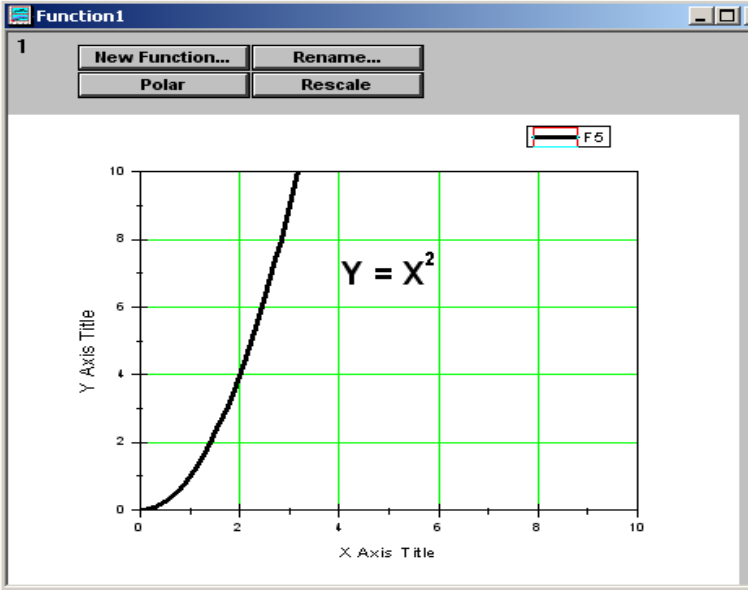
Notes

```
M=495000;T=1000;B=1;V=2;S=xindex1(0,col(2));E=600000;
col(8)=data(B/2,T,B);
for(i=S,j=1;(col(1)[i]<E)&&(j<M);i++){
C=col(1)[i];R=C+T;
for(x=i+1;col(1)[x]<R;x++){Data2_A[j]=col(1)[x]-C;j++}};
wcol(6)[1]=i-S;wcol(7)[1]=j;
wcol(9)=histogram(Data2_A,B,0,T)*(T/(j*B));
ave -n V wcol(9);mark -m Data2_A;
```

Layout1

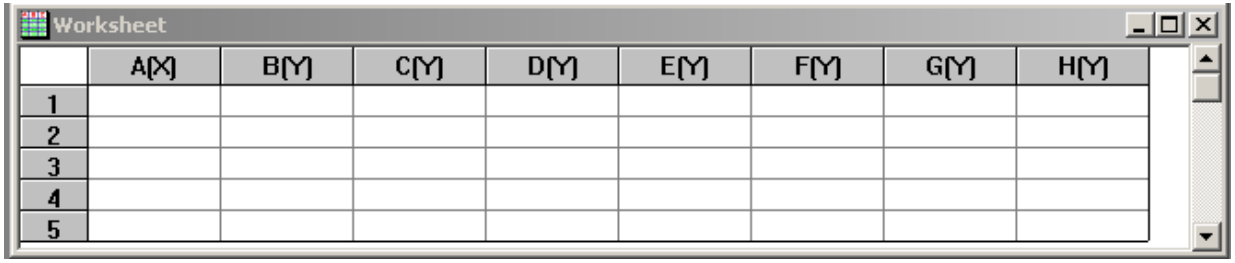


Function1

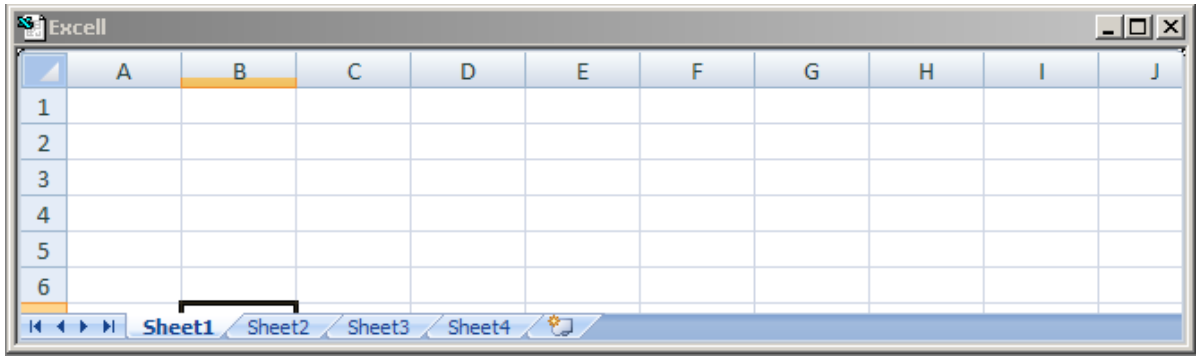


Different Windows Types in an Origin Project

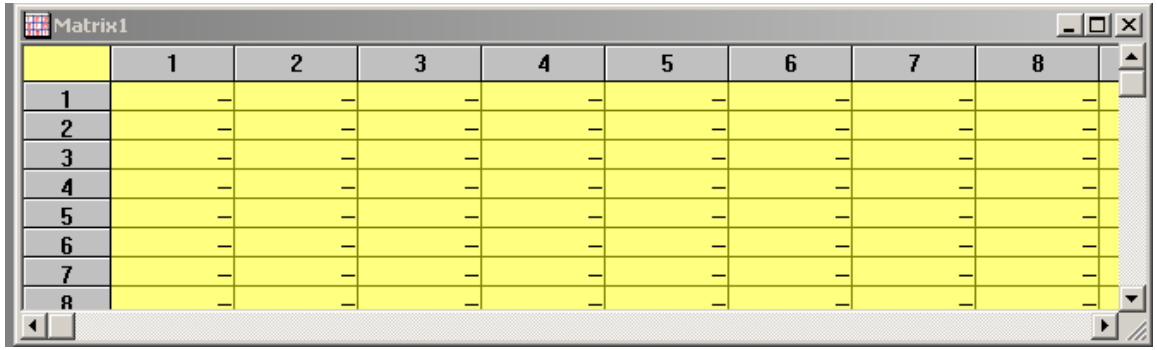
A worksheet's primary function is to hold and organize the data that you bring into Origin, and to provide tools for data manipulation, exploration, statistics, analysis, and plotting.



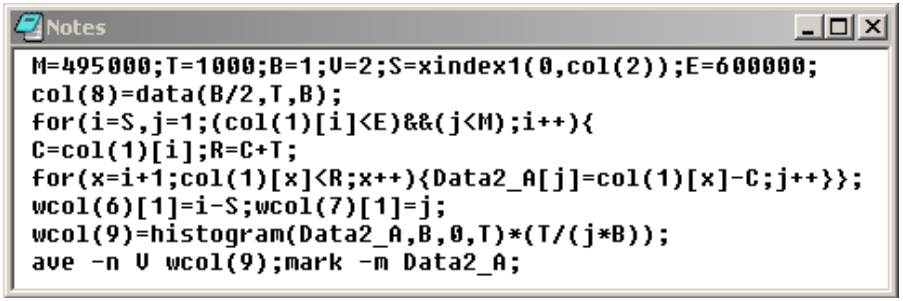
You can open Excel workbooks inside Origin, combining Origin's plotting and analysis power with Excel's spreadsheet tools.



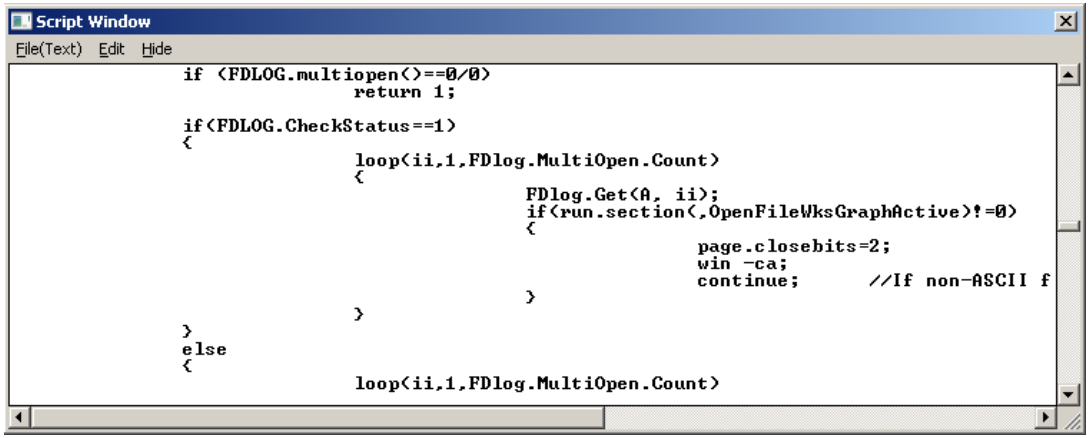
A matrix displays a single data set containing Z values. Instead of displaying the data set as a column in a worksheet, a matrix displays the data in a specified dimension of rows and columns.



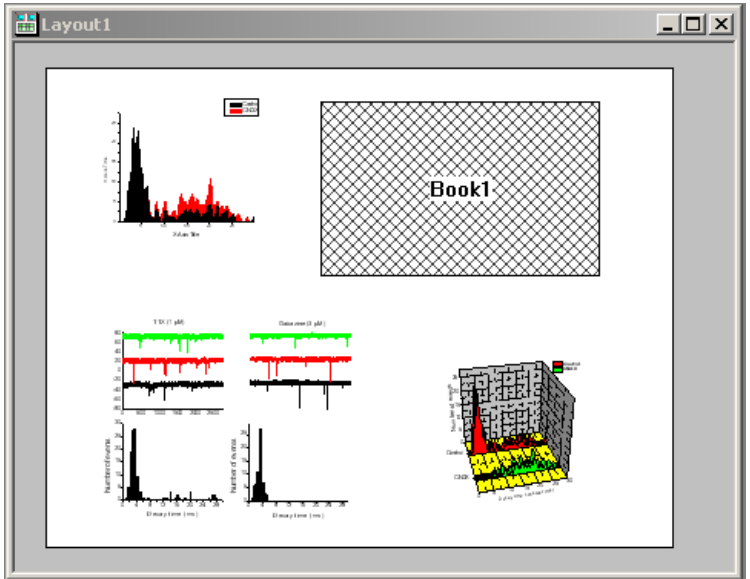
Notes windows can contain only text, and are thus used for recording information.



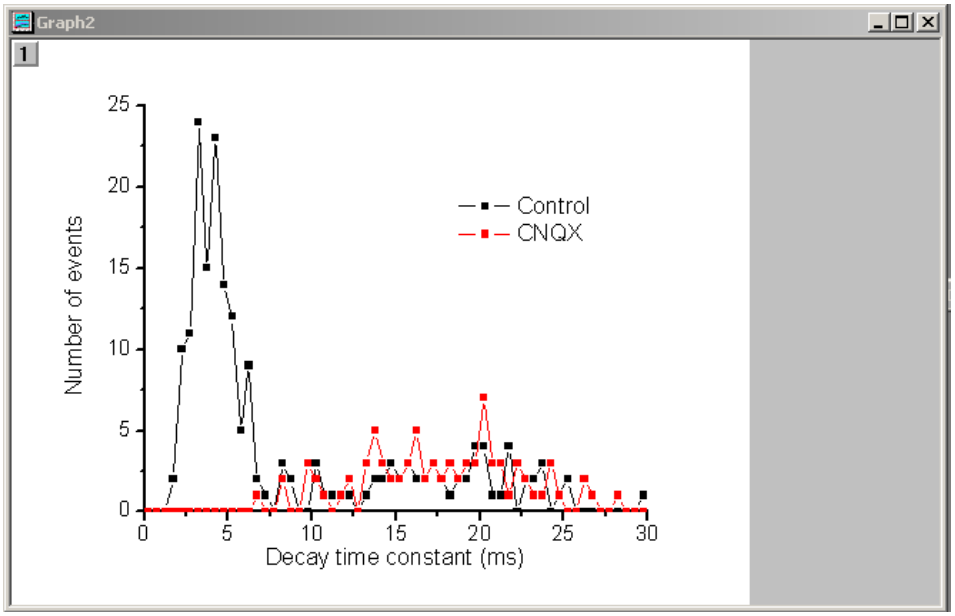
The Script Window is available for executing LabTalk commands. LabTalk is Origin's "historic" programming language. It has been available in versions up to and including Origin 7. However, Origin 7 introduced the new Origin C programming language. Whereas LabTalk scripts are interpreted during execution by Origin, Origin C code is compiled to byte code form and therefore executes much faster than LabTalk.

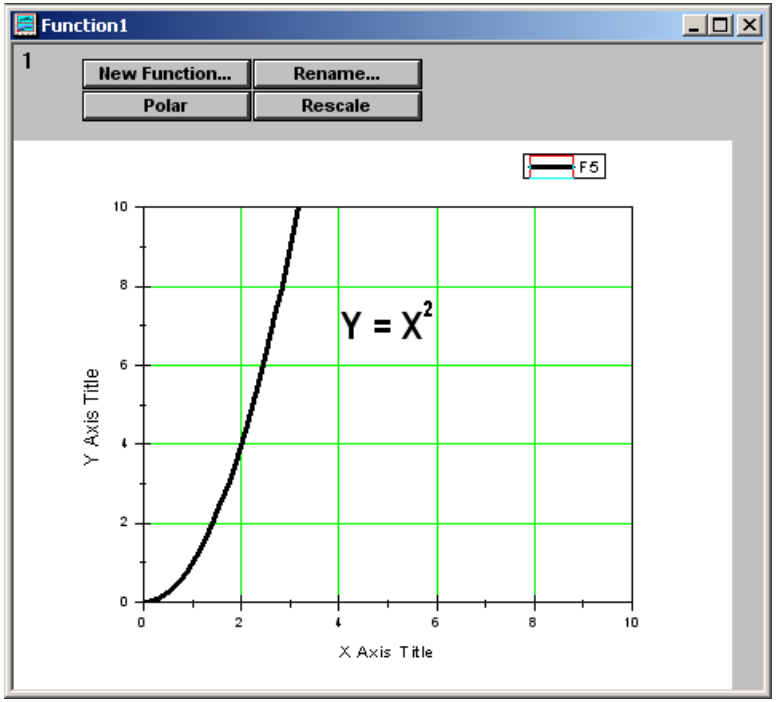


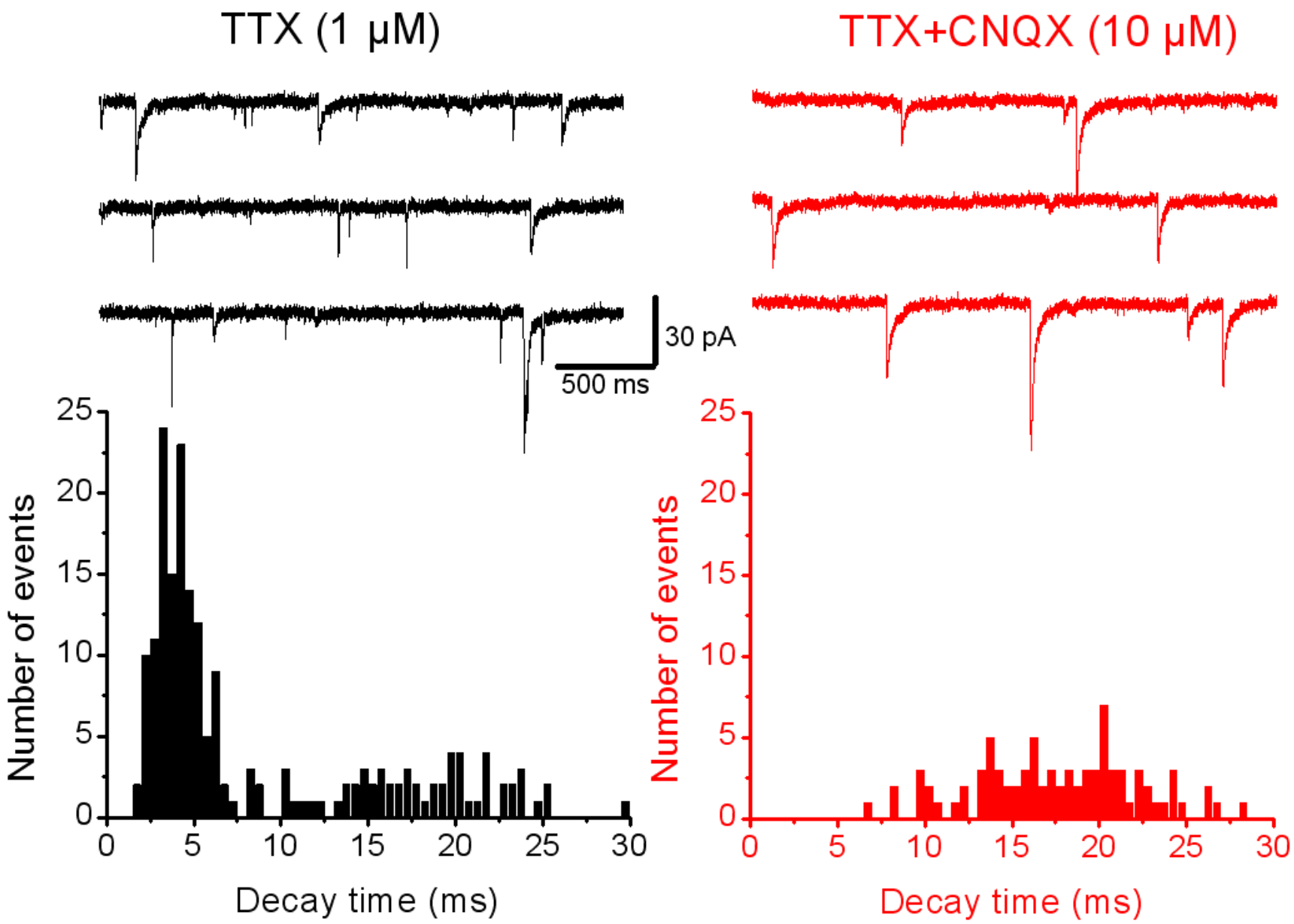
A layout page window is a "display panel" for graphs and worksheets that have been created in other windows. You can add and arrange worksheet and graph pictures in a layout page, as well as text and other annotations.



A graph window is a container and editor for creating graphs. Each graph window contains a single editable page. The page serves as a backdrop for the various graph objects, including layers, axes, annotations, and data plots.

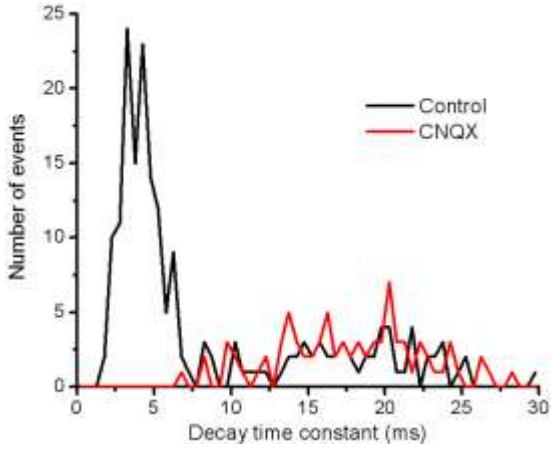




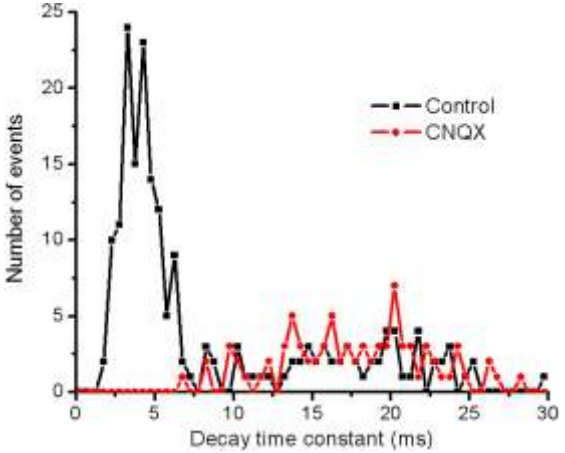

TTX (1 μM)
TTX+CNQX (10 μM)
30 pA
500 ms
Number of events
Decay time (ms)
0
5
10
15
20
25
30

2D Plotting

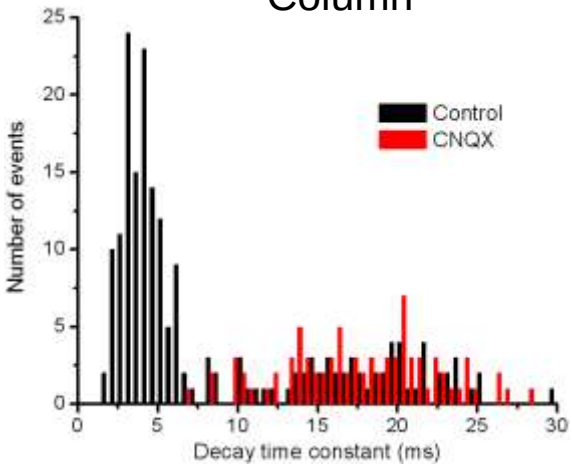
Line



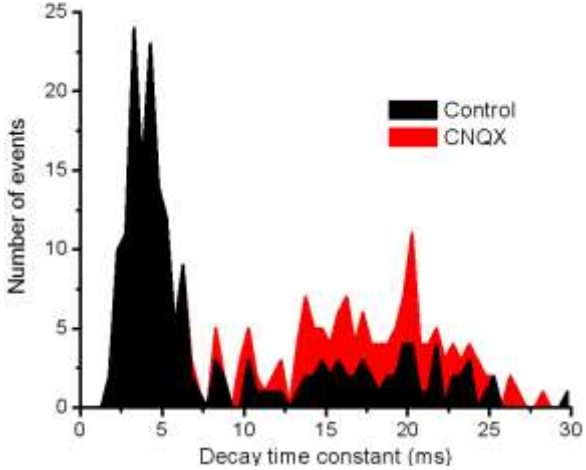
Line + Symbol



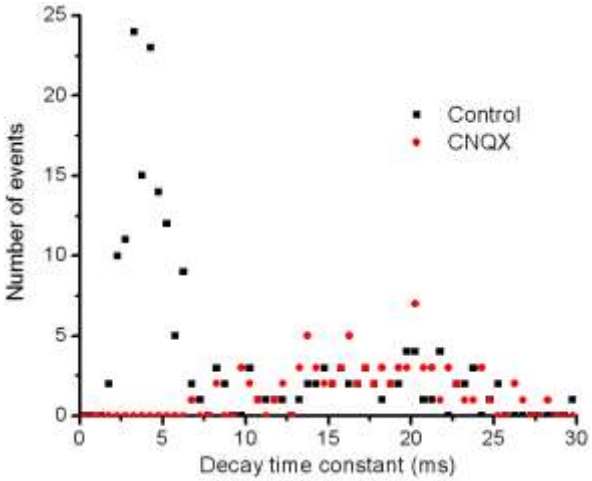
Column



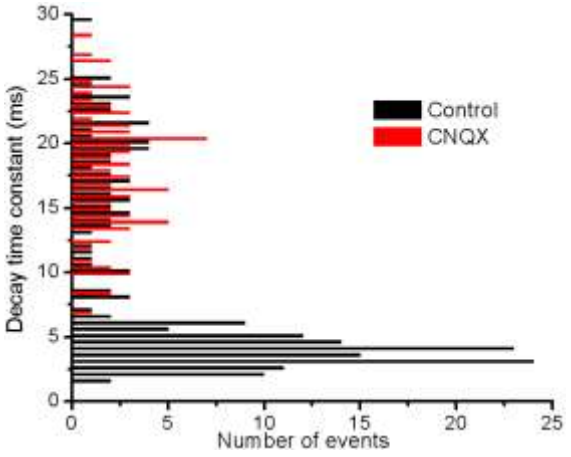
Area



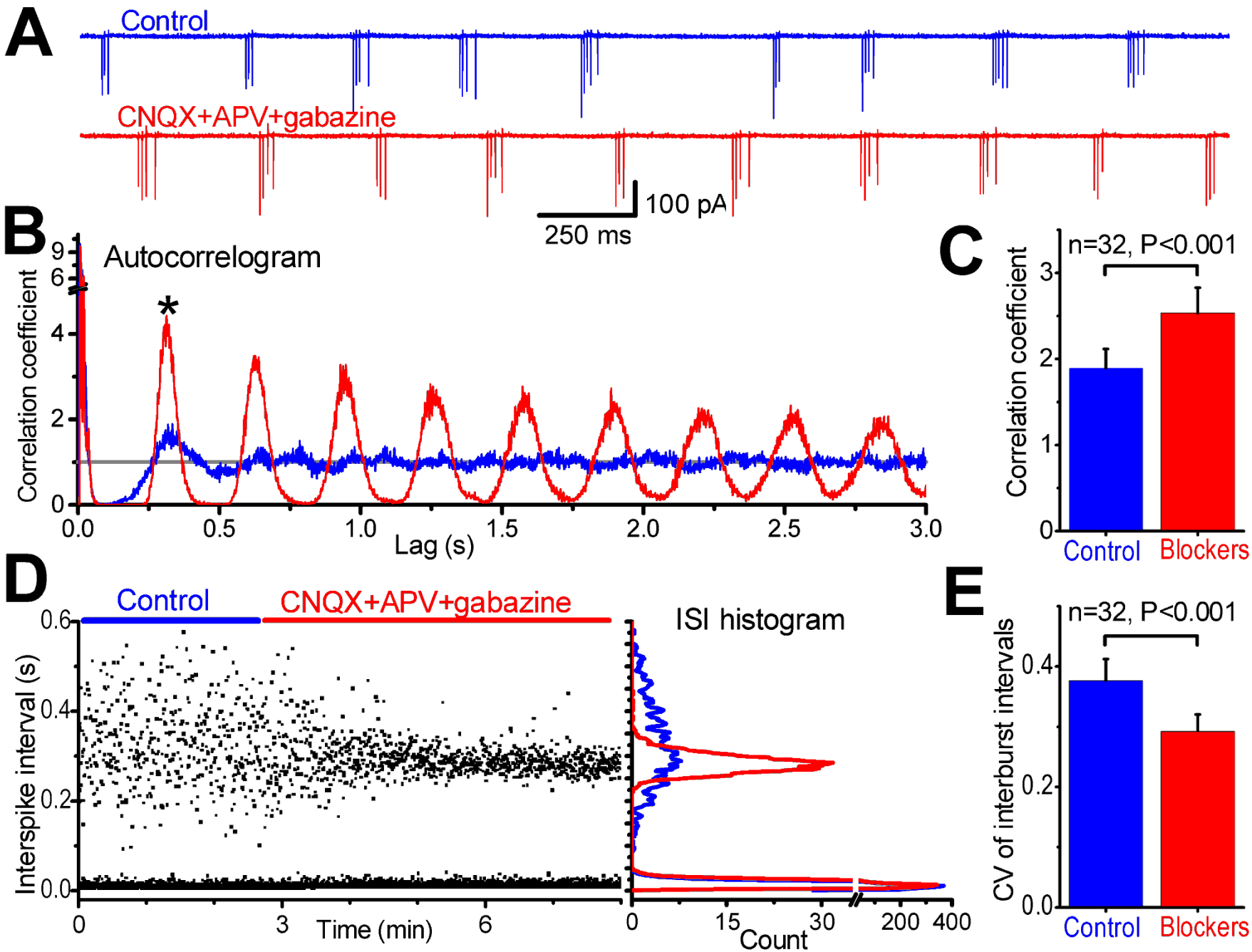
Scatter



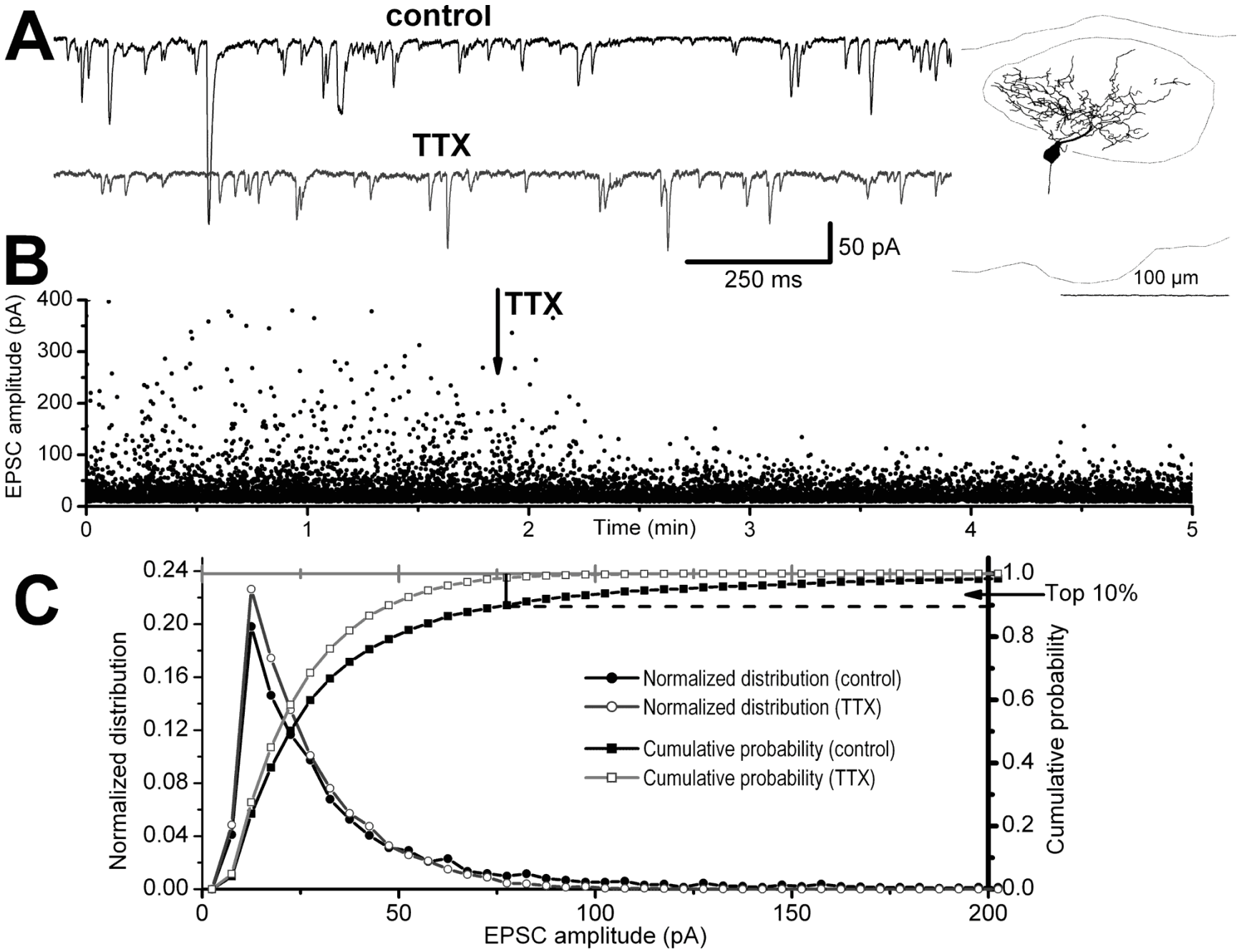
Bar



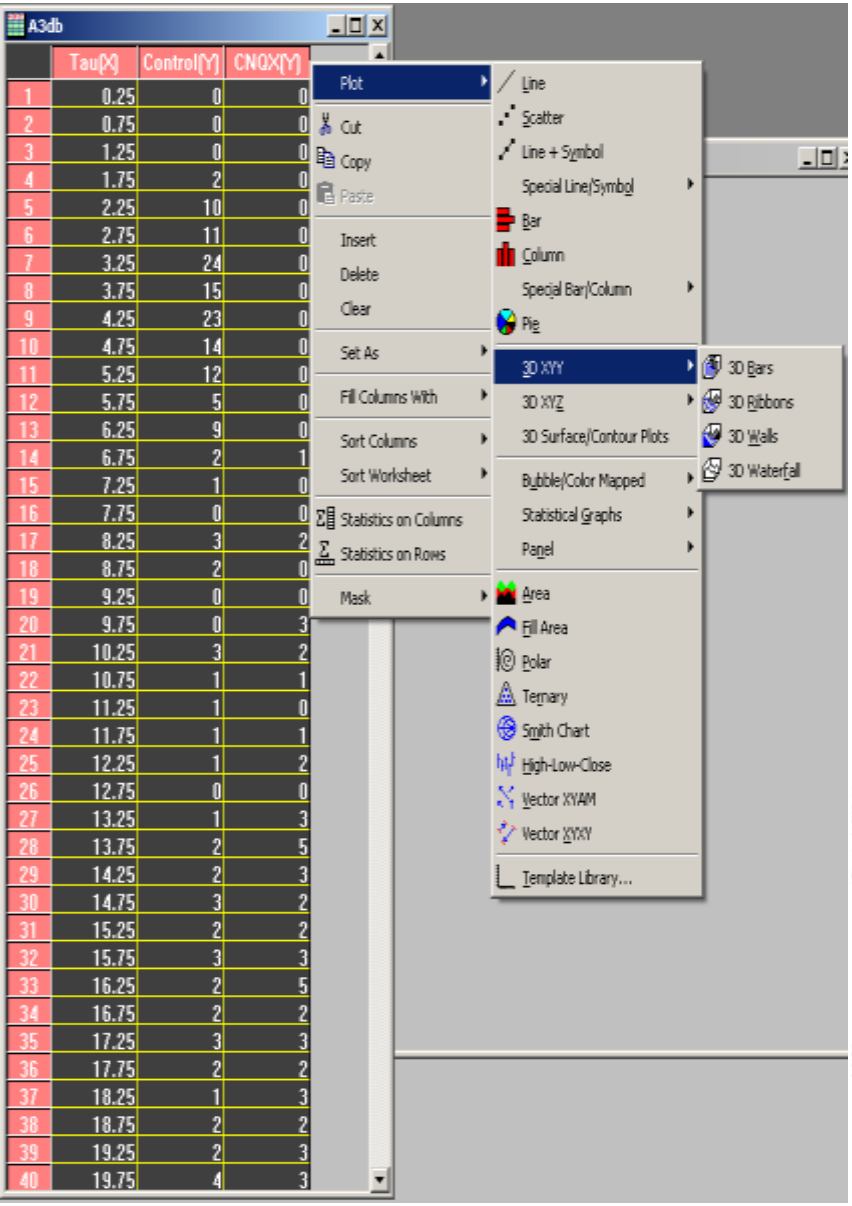
Bursting persists and is more regular in blockers of fast synaptic transmission



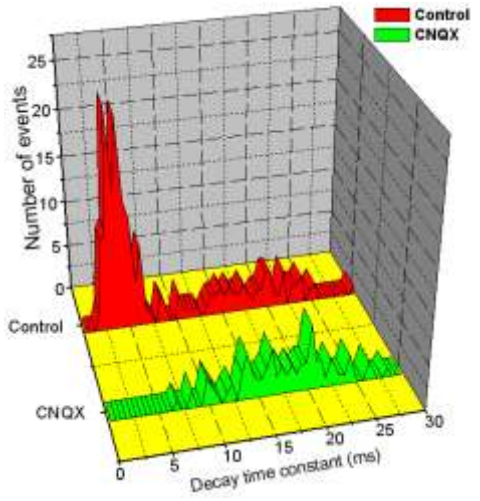
ET cell large EPSCs are driven by presynaptic action potentia



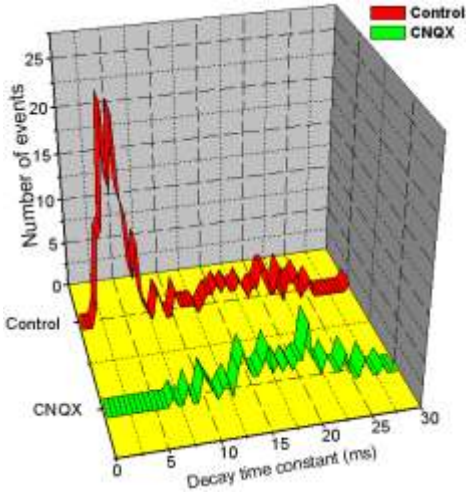
3D XYY Plotting



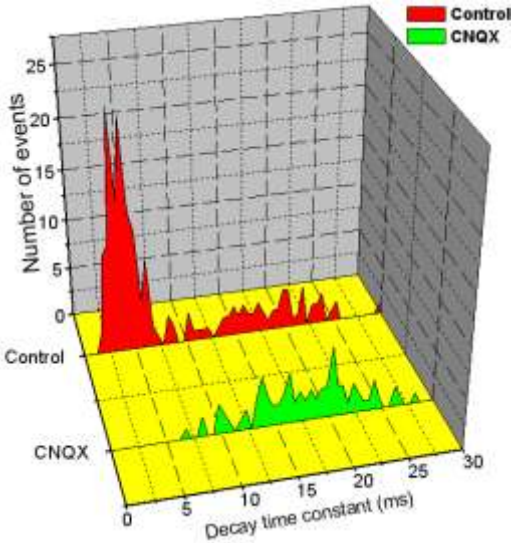
3D Wall



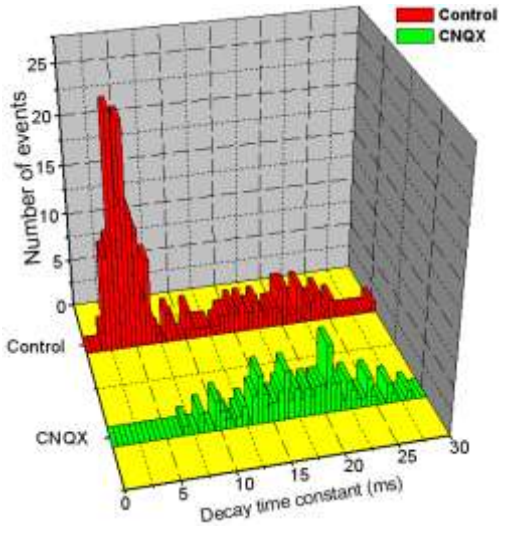
3D Ribbon



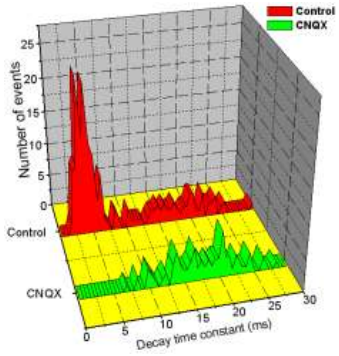
3D Waterfall

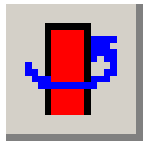


3D Bar

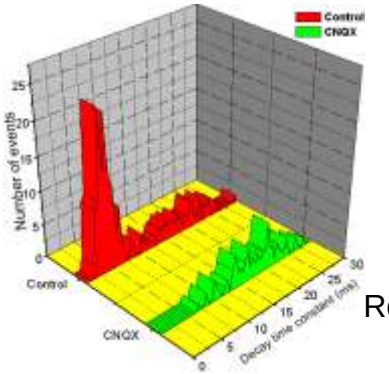


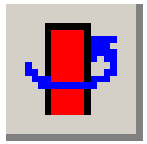
3D Rotation



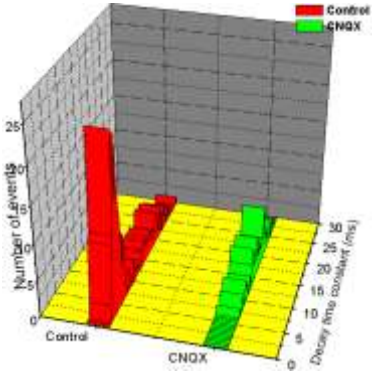


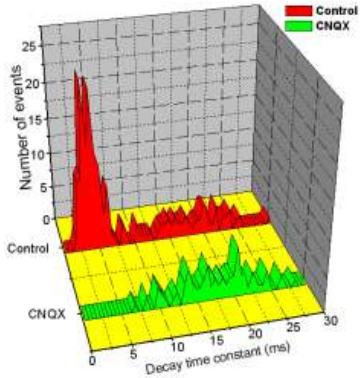
Rotate counterclockwise

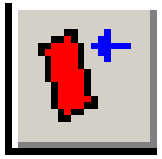




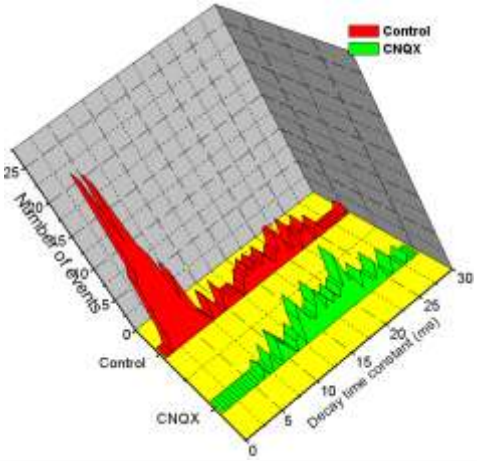
Rotate counterclockwise

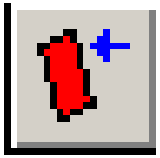




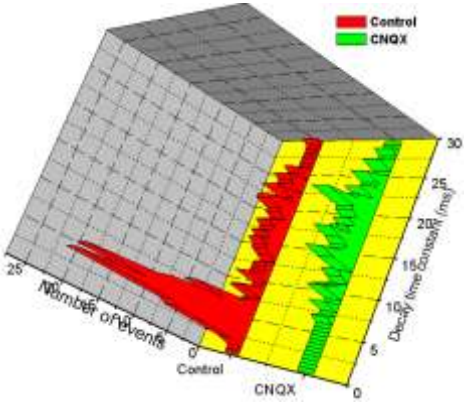


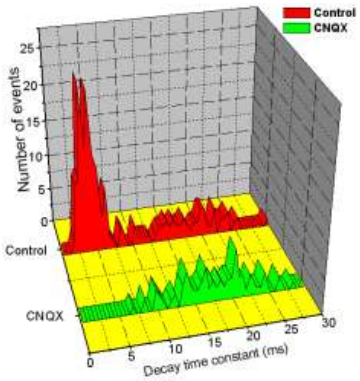
Tilt left

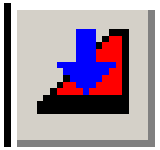




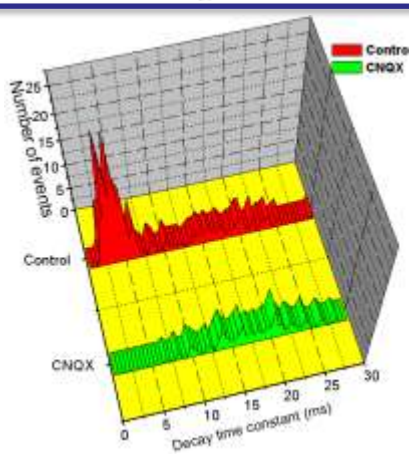
Tilt left

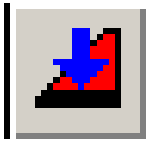




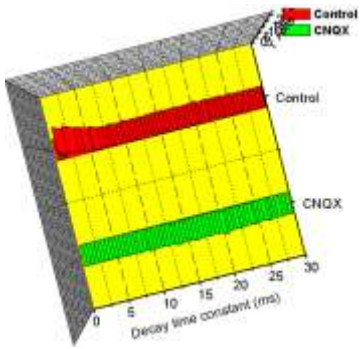


Tilt down

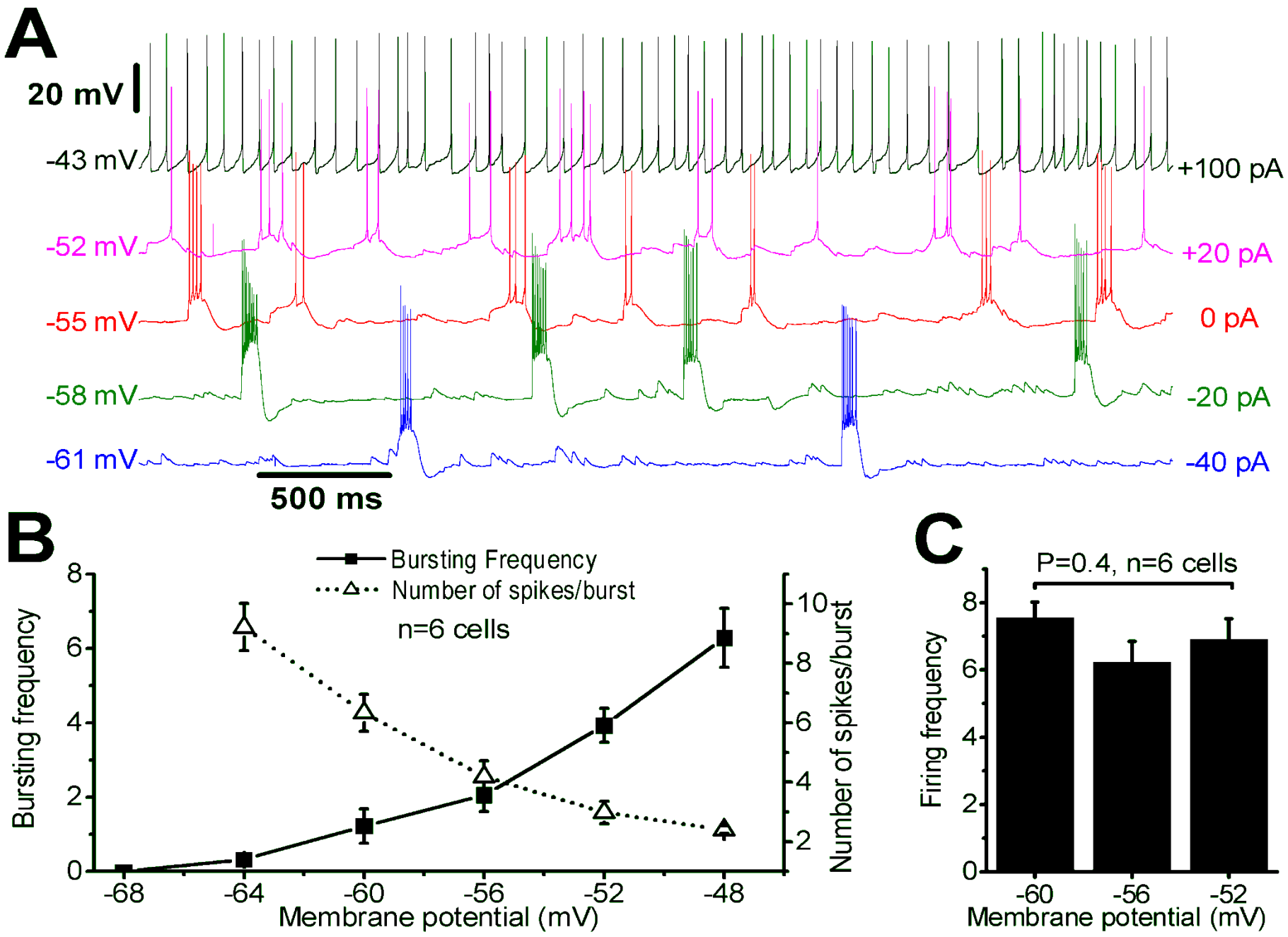




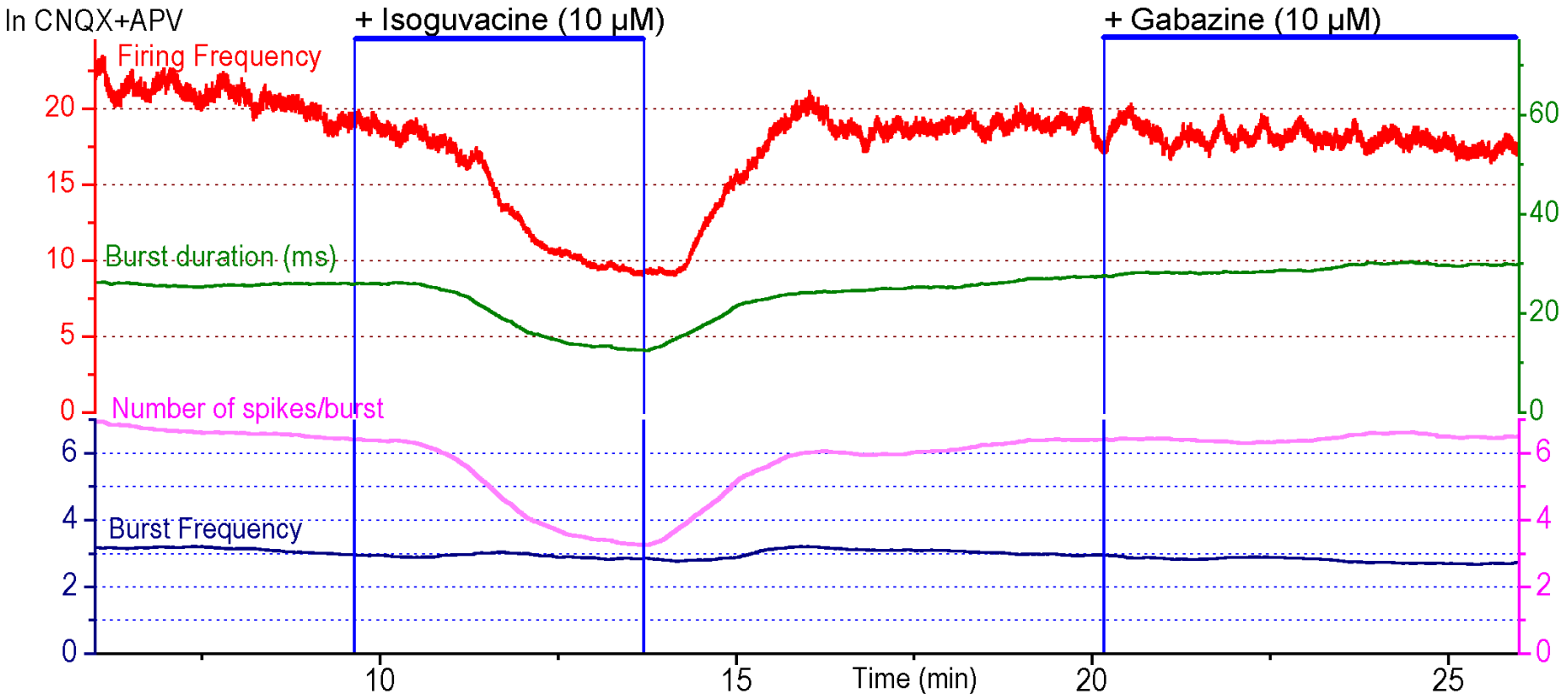
Tilt down

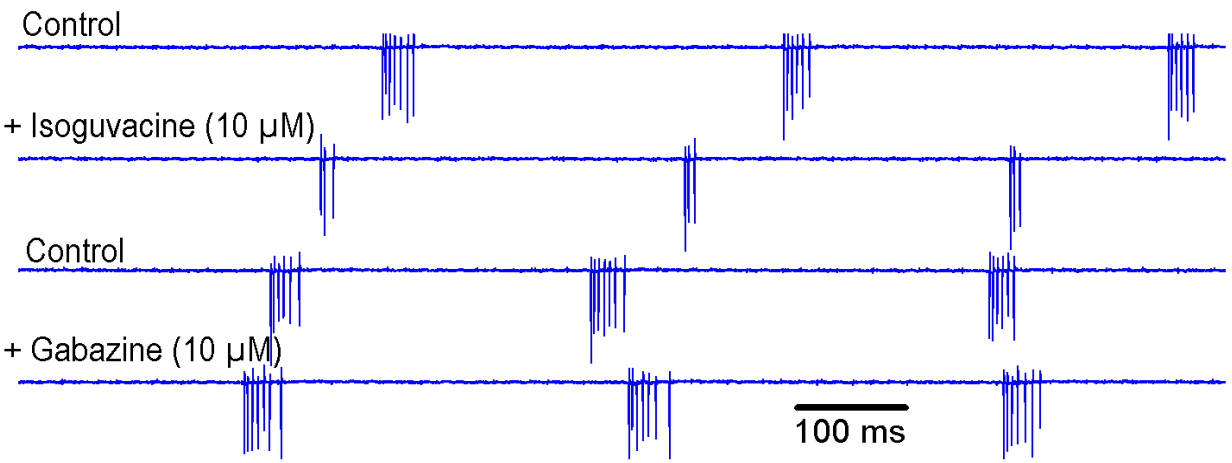


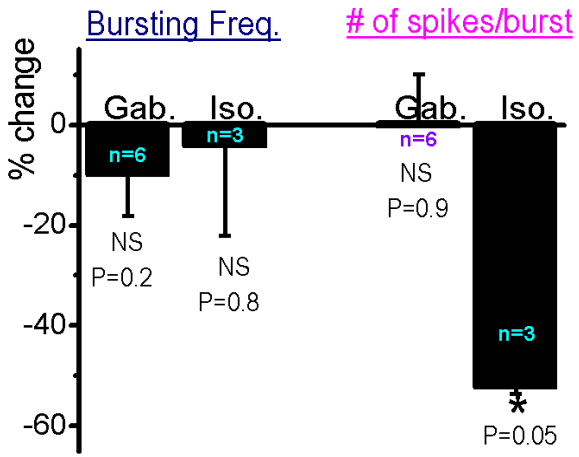
Bursting frequency and strength are voltage-dependent

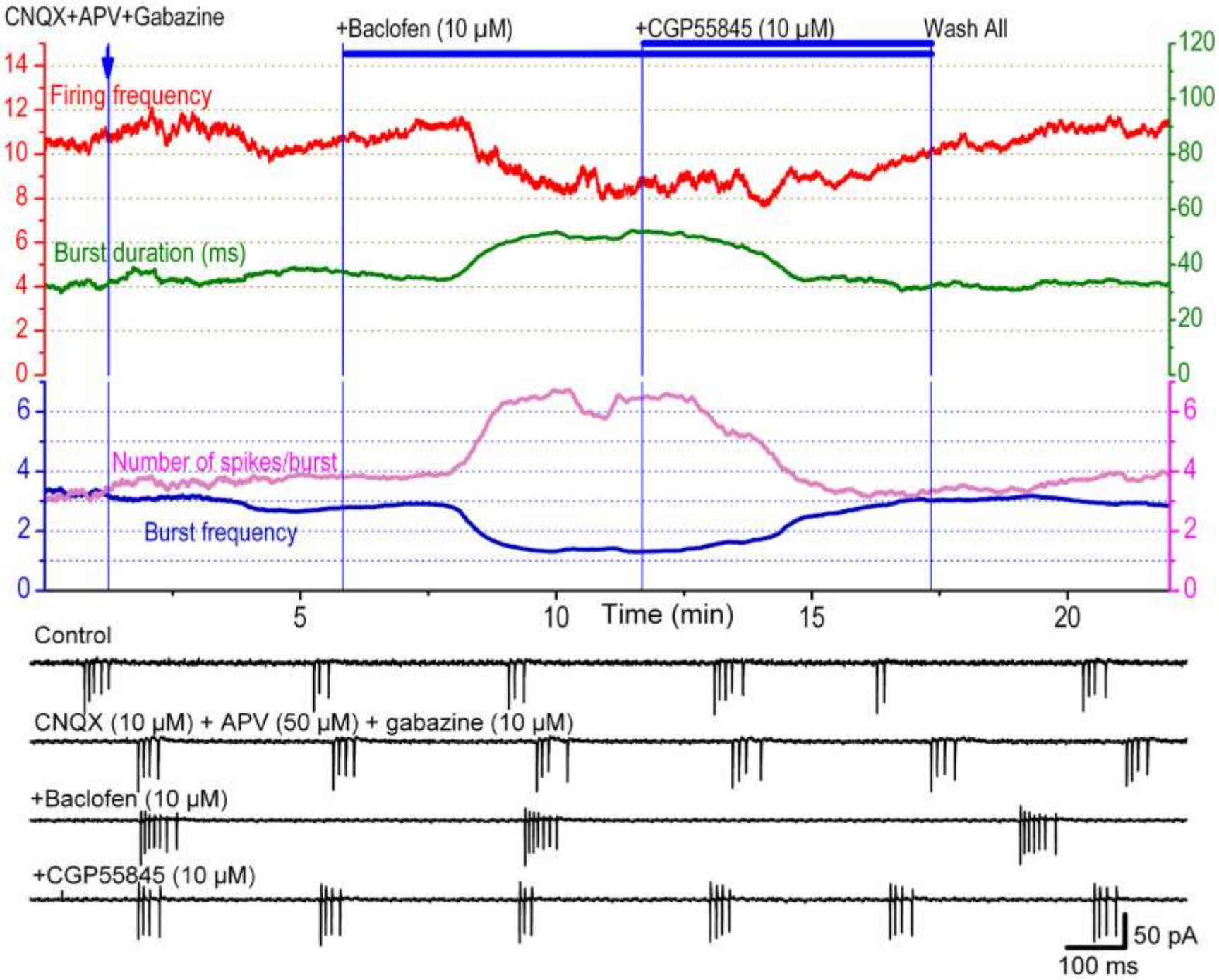


$GABA_A$ receptors shunt bursting but are not tonically active at res

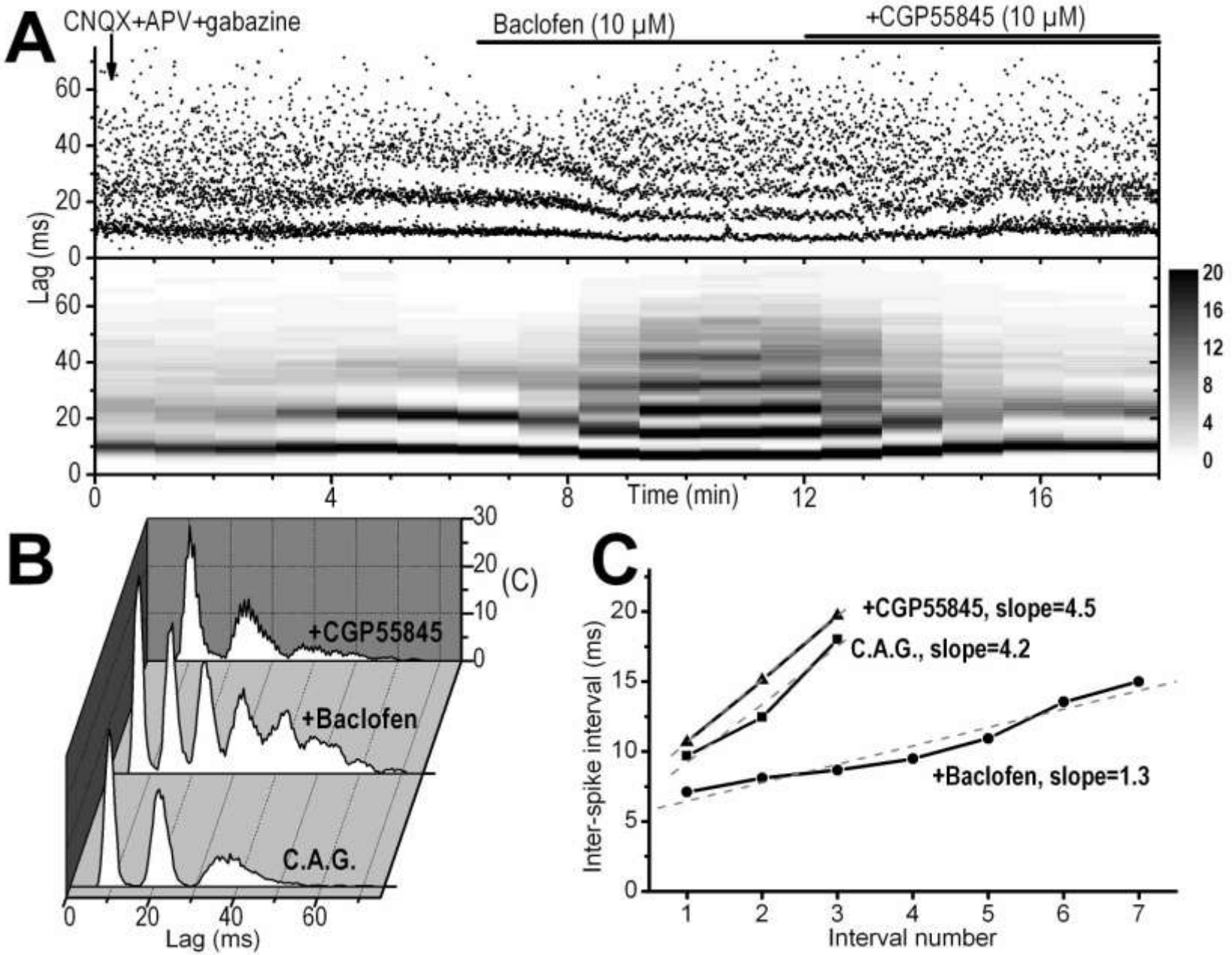






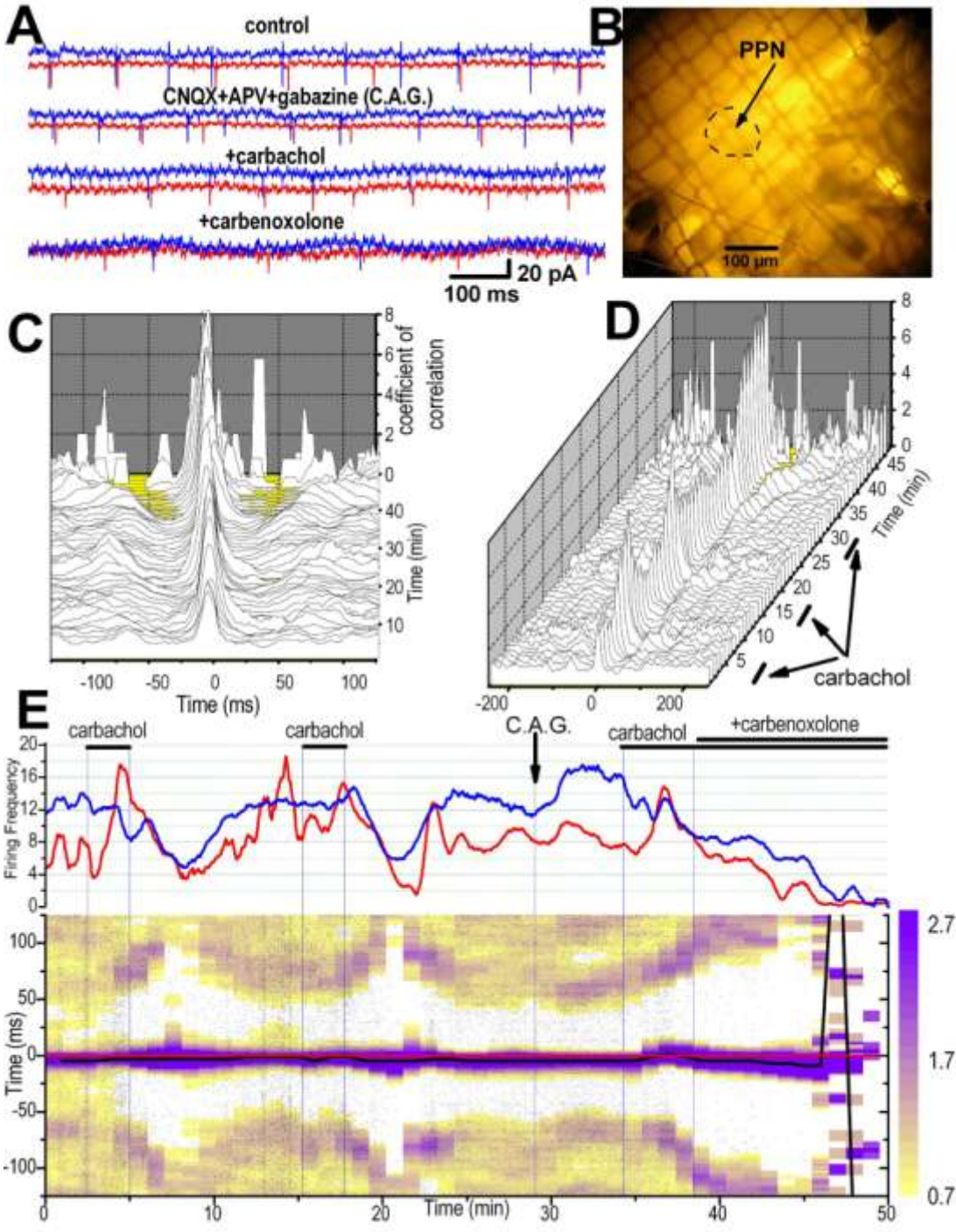

CNQX+APV+Gabazine
+Baclofen (10 µM)
+CGP55845 (10 µM)
Wash All
Firing frequency
Burst duration (ms)
Number of spikes/burst
Burst frequency
Time (min)
Control
CNQX (10 µM) + APV (50 µM) + gabazine (10 µM)
+Baclofen (10 µM)
+CGP55845 (10 µM)
50 pA
100 ms

Modulation of intra-burst properties by baclofen



Karpuk N, Hayar A. Activation of postsynaptic GABAB receptors modulates the bursting pattern and synaptic activity of olfactory bulb juxtaglomerular neurons. J Neurophysiol. 2008 Jan;99(1):308-19.

Synchronous activity in PPN, effects of CAR. Data from the same pair of cells. **A.** Simultaneous extracellular recordings (1 sec samples) from 2 PPN cells (red and blue traces). The occurrence of APs coincided in both cells even in the presence of fast synaptic blockers (CNQX, 10 µM + APV, 50 µM + gabazine, 10 µM). CBX (300 µM) reduced AP frequency and desynchronized the cells. **B.** Photograph (2X) showing the location of dual PPN recordings. **C.** Sliding 3D crosscorrelogram of APs indicated significant synchronous activity throughout 50 min. The crosscorrelation coefficient peak was near zero time lag and the significant correlation window was ~25 msec (i.e. APs in both cells tended to coincide within a 25 msec interval). **D.** Same crosscorrelogram as in (C) but tilted to show effect of CAR on the peaks of coefficient of correlation. The first 2 applications of CAR were in aCSF and the third in CNQX+APV+gabazine as in (E). Note sharp increases in correlation with CAR, especially after fast synaptic blockade. **E.** Upper panel is a frequency histogram of both cells (red and blue traces) during 50 min recording. CAR produced multiphasic responses on the first cell (red) and inhibition on the second cell (blue). Lower panel is a scatter crosscorrelation. Each dot represents the interval between a spike in cell #1 and a given spike in cell #2 in a time window of ±125 msec. The color-coded superimposed matrix represents the density of dots and is equivalent to a sliding crosscorrelation. The crosscorrelation peak increased after CAR (Dark blue denotes higher coefficient of correlation per color-coded scale on right). The peak of correlation (black horizontal line) remained close to center (horizontal red line) except after application of CBX, which reduced the activity of the cells and desynchronized them (at 47-50 min). The persistence of a significant crosscorrelation coefficient in the presence of synaptic blockers and its reduction by CBX suggest that these cells were coupled by gap junctions.



Statistics on Columns

Data8 - Data from Data7

Data from Data7

Recalculate

Entire Dataset

Use Rows

Advanced Statistics

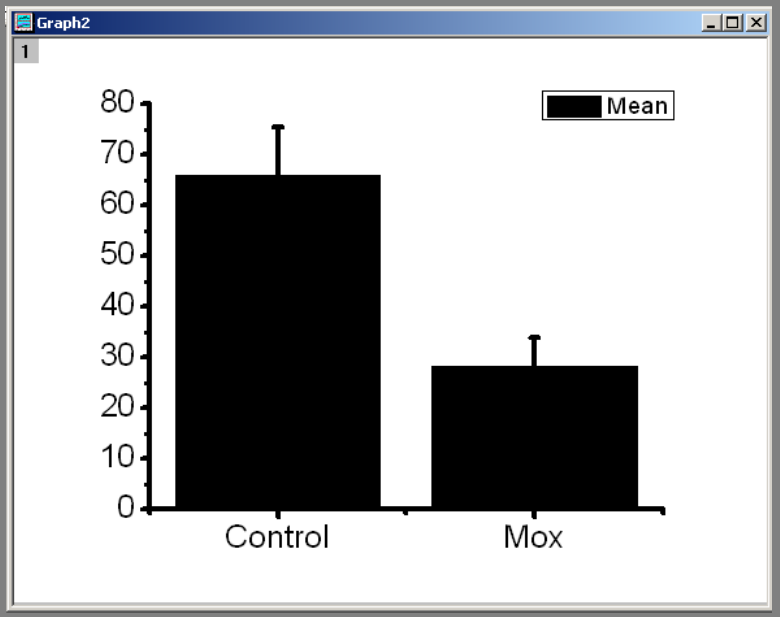
Percentile 95.00

	Col(X)	Rows(Y)	Mean(Y)	sd(yEr±)	se(yEr±)	CIL(Y)	CIU(Y)	P25(Y)	P75(Y)	IQR(Y)	P95(Y)	Min(Y)	Imin(Y)	Max(Y)	Imax(Y)	Range(Y)	Sum(Y)	Median(Y)	Var(Y)	CoefVar(Y)	Kurt(Y)	N(Y)
1	Control	[1:15]	65.86667	37.36283	9.64704	45.17579	86.55755	30	108	78	127	21	15	127	5	106	988	53	1395.98095	0.56725	-1.34754	15
2	Mox	[1:15]	28.26667	21.67443	5.59631	16.26375	40.26959	13	36	23	94	12	1	94	5	82	424	21	469.78095	0.76678	5.81621	15
3																						
4																						

Plot
Cut
Copy
Paste
Insert
Delete
Clear
Set As
Fill Columns With
Sort Columns
Sort Worksheet
Statistics on Columns
Statistics on Rows
Mask

Line
Scatter
Line + Symbol
Special Line/Symbol
Bar
Column
Special Bar/Column
Pie
3D XYY
3D XYZ
3D Surface/Contour Plots
Bubble/Color Mapped
Statistical Graphs
Panel
Area
Fill Area
Polar
Ternary
Smith Chart
High-Low-Close
Vector XYAM
Vector XYXY
Template Library...

Graph2

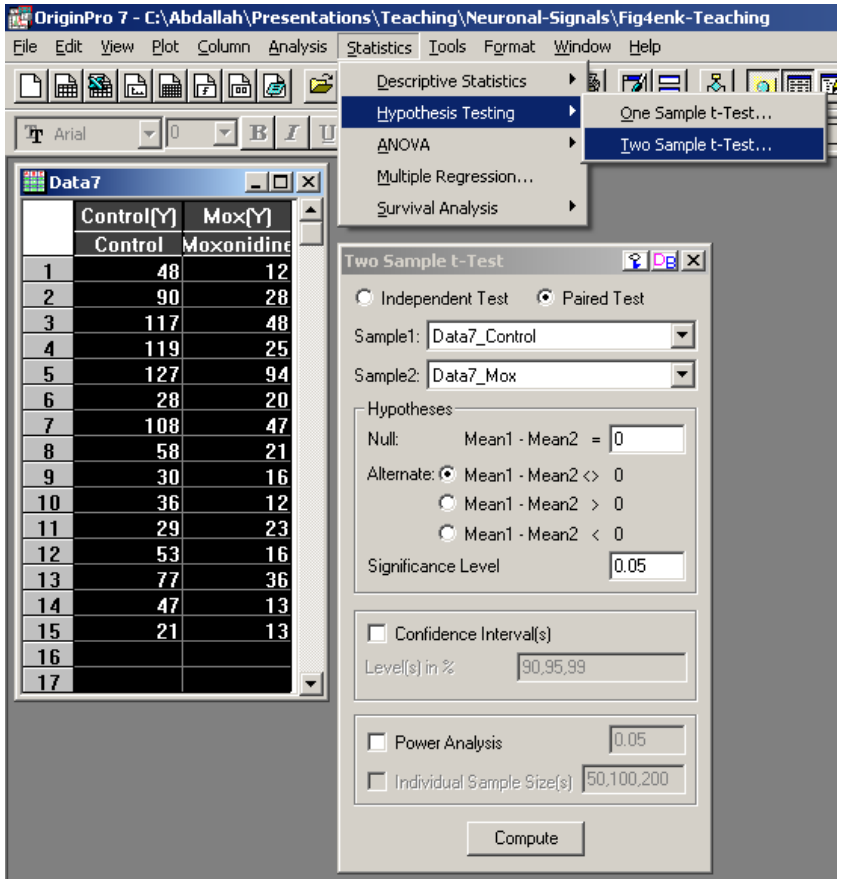


Data7

	Control[Y]	Mox[Y]
	Control	Moxonidine
1	48	12
2	90	28
3	117	48
4	119	25
5	127	94
6	28	20
7	108	47
8	58	21
9	30	16
10	36	12
11	29	23
12	53	16
13	77	36
14	47	13
15	21	13
16		
17		

Plot
Cut
Copy
Paste
Insert
Delete
Clear
Set As
Fill Columns With
Sort Columns
Sort Worksheet
Statistics on Columns
Statistics on Rows
Mask

Statistical Significance



Two Sample Paired t-Test

Summary Statistics

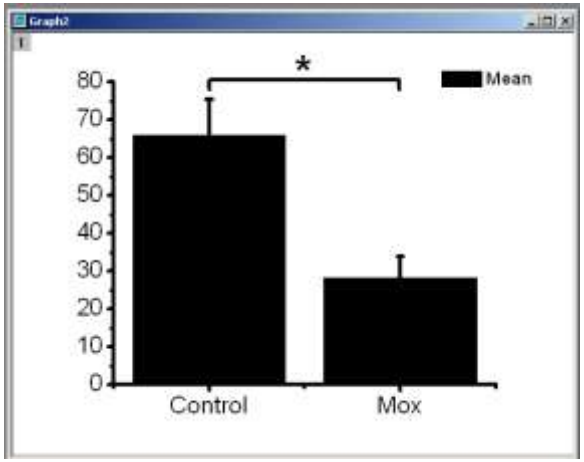
Sample	N	Mean	SD	SE
1. Data7_Control	15	65.86667	37.36283	9.64704
2. Data7_Mox	15	28.26667	21.67443	5.59631

Difference of Means: 37.6

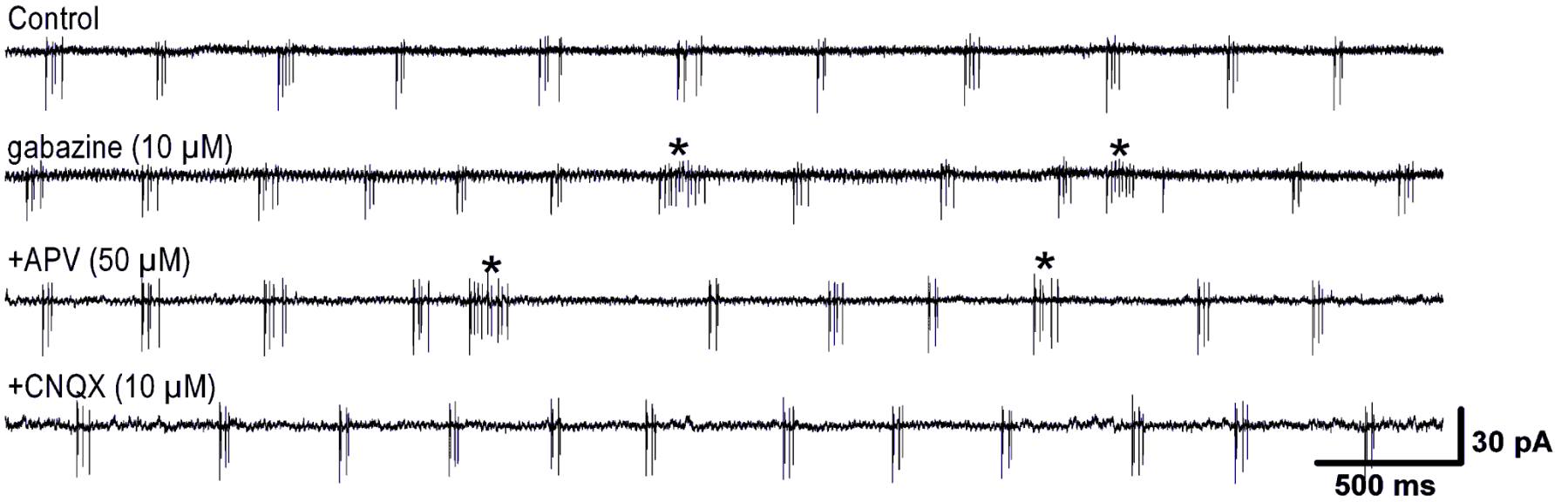
Null Hypothesis: Mean1 - Mean2 = 0
Alternative Hypothesis: Mean1 - Mean2 <> 0

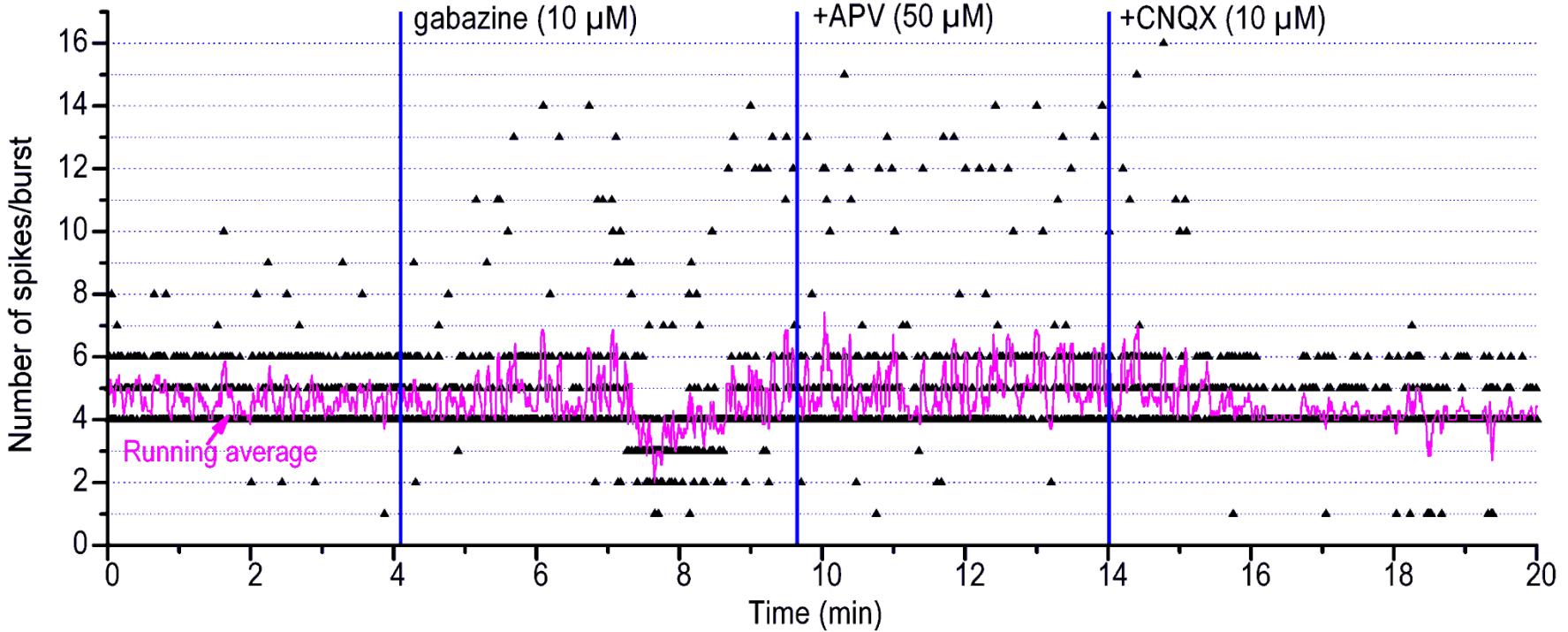
t	DoF	P Value
5.79144	14	0.00005

At the 0.05 level, the difference of the population means is significantly different than the test difference (0).



Excitatory & inhibitory synaptic input modulate burst strength

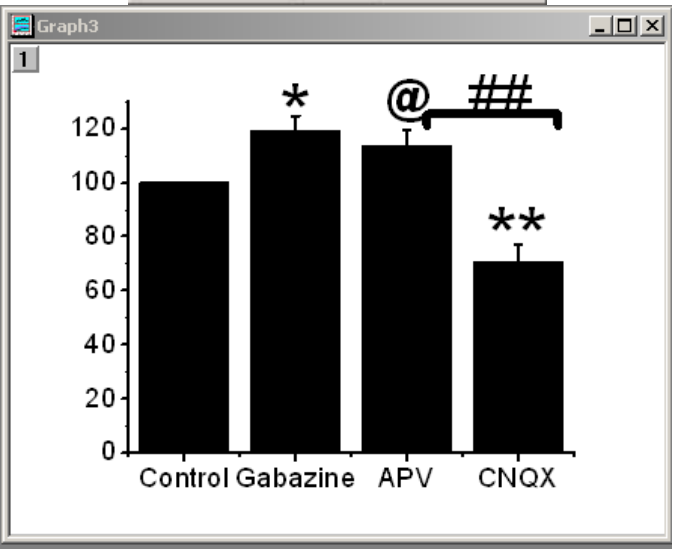




One-Way-ANOVA

Data14

	Control(X)	Gabazine(Y	APV(Y)	CNQX(Y)
2	100	109	109	87
3	100	105	91	72
4	100	109	111	87
5	100	100	86	69
6	100	111	113	29
7	100	100	95	84
8	100	142	142	111
9	100	150	140	50
10	100	120	110	50
11	100	143	149	77
12	100	138	113	75
13				
14				



Summary Statistics

Dataset	N	Mean	SD	SE
Data14_APV	12	113.80928	19.96705	5.76399
Data14_CNQX	12	70.85949	21.65057	6.24998
Data14_Control	12	100	0	0
Data14_Gabazine	12	119.41435	18.35865	5.29969

Null Hypothesis: The means of all selected datasets are equal
Alternative Hypothesis: The means of one or more selected datasets are different

ANOVA

Source	DoF	Sum of Squares	Mean Square	F Value	P Value
Model	3	16951.3772	5650.45906	18.76496	0.00000
Error	44	13249.1713	301.117529		

At the 0.05 level, the population means are significantly different.

Means Comparison using Tukey Test

Dataset	Mean	Difference between Means	Simultaneous Confidence Intervals Lower Limit	Upper Limit	Significant at 0.05 Level
Data14_APV	113.80928				
Data14_CNQX	70.85949	42.94979	24.03486	61.86472	Yes
Data14_Control	100	13.80928	-5.10565	32.72421	No
Data14_Gabazine	119.41435	-5.60507	-24.52	13.30986	No
Data14_CNQX	70.85949				
Data14_Control	100	-29.14051	-48.05544	-10.22558	Yes
Data14_Gabazine	119.41435	-48.55486	-67.46979	-29.63993	Yes
Data14_Control	100				
Data14_Gabazine	119.41435	-19.41435	-38.32928	-0.49942	Yes

*p < 0.01, **p < 0.001 compared with control; ##p < 0.001 compared with respective pre-blocker baseline

Standard deviation

The standard deviation of a discrete random variable is the root-mean-square (RMS) deviation of its values from the mean.
If the random variable *X* takes on *N* values $x_1, \cdots, x_N$ (which are real numbers) with equal probability, then its standard deviation σ can be calculated as follows:

1.Find the mean, $\overline{x}$, of the values. $$\overline{x} = \frac{x_1 + x_2 + \cdots + x_N}{N} = \frac{1}{N}\sum_{i=1}^{N} x_i \,.$$

2.For each value x_i calculate its deviation ($x_i - \overline{x}$) from the mean.
3.Calculate the squares of these deviations.
4.Find the mean of the squared deviations. This quantity is the variance σ^2.
5.Take the square root of the variance.

This calculation is described by the following formula:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2}\,,$$

Example

Suppose we wished to find the standard deviation of the data set consisting of the values 3, 7, 7, and 19.

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{N}(x_i - \overline{x})^2},$$

Step 1: find the arithmetic mean (average) of 3, 7, 7, and 19,

$$\frac{3+7+7+19}{4} = 9.$$

Step 2: find the deviation of each number from the mean,

$$\begin{aligned} 3-9 &= -6 \\ 7-9 &= -2 \\ 7-9 &= -2 \\ 19-9 &= 10. \end{aligned}$$

Step 3: square each of the deviations, which amplifies large deviations and makes negative values positive,

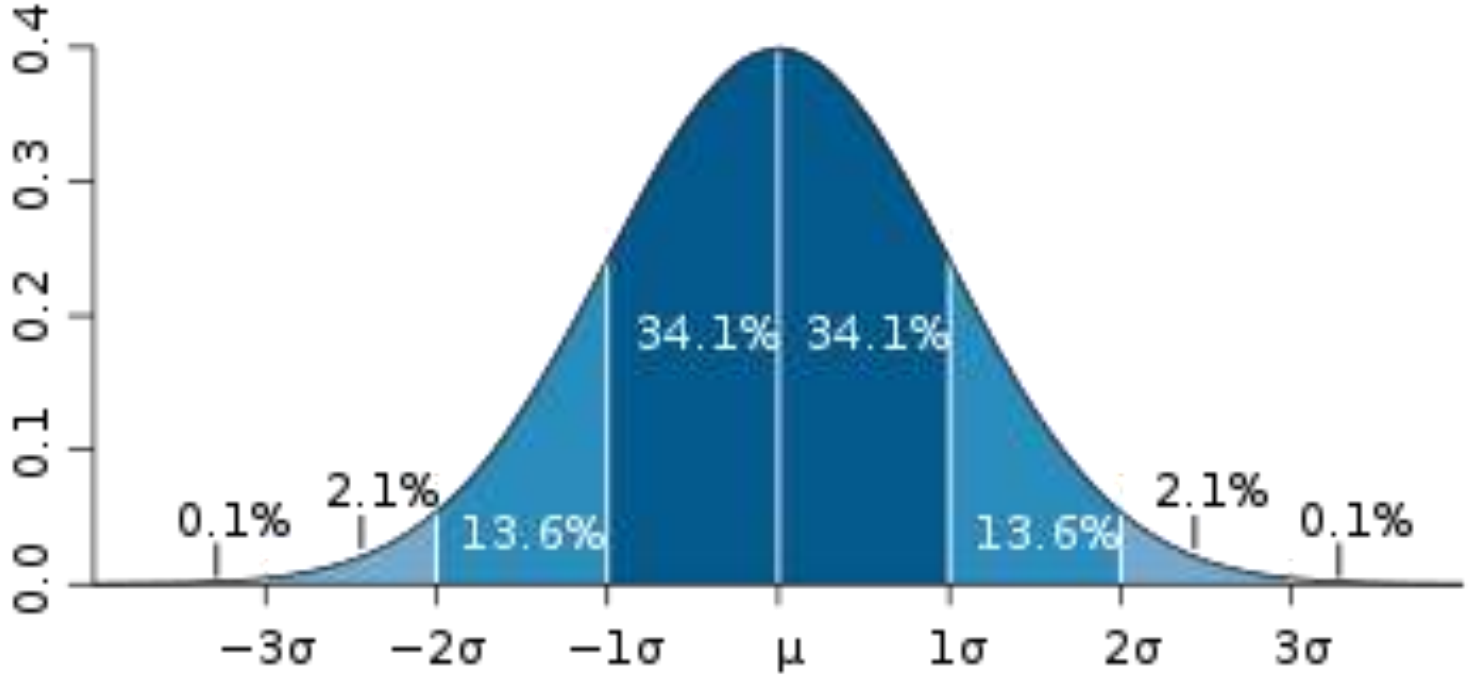
$$\begin{aligned} (-6)^2 &= 36 \\ (-2)^2 &= 4 \\ (-2)^2 &= 4 \\ 10^2 &= 100. \end{aligned}$$

Step 4: find the mean of those squared deviations,

$$\frac{36+4+4+100}{4} = 36.$$

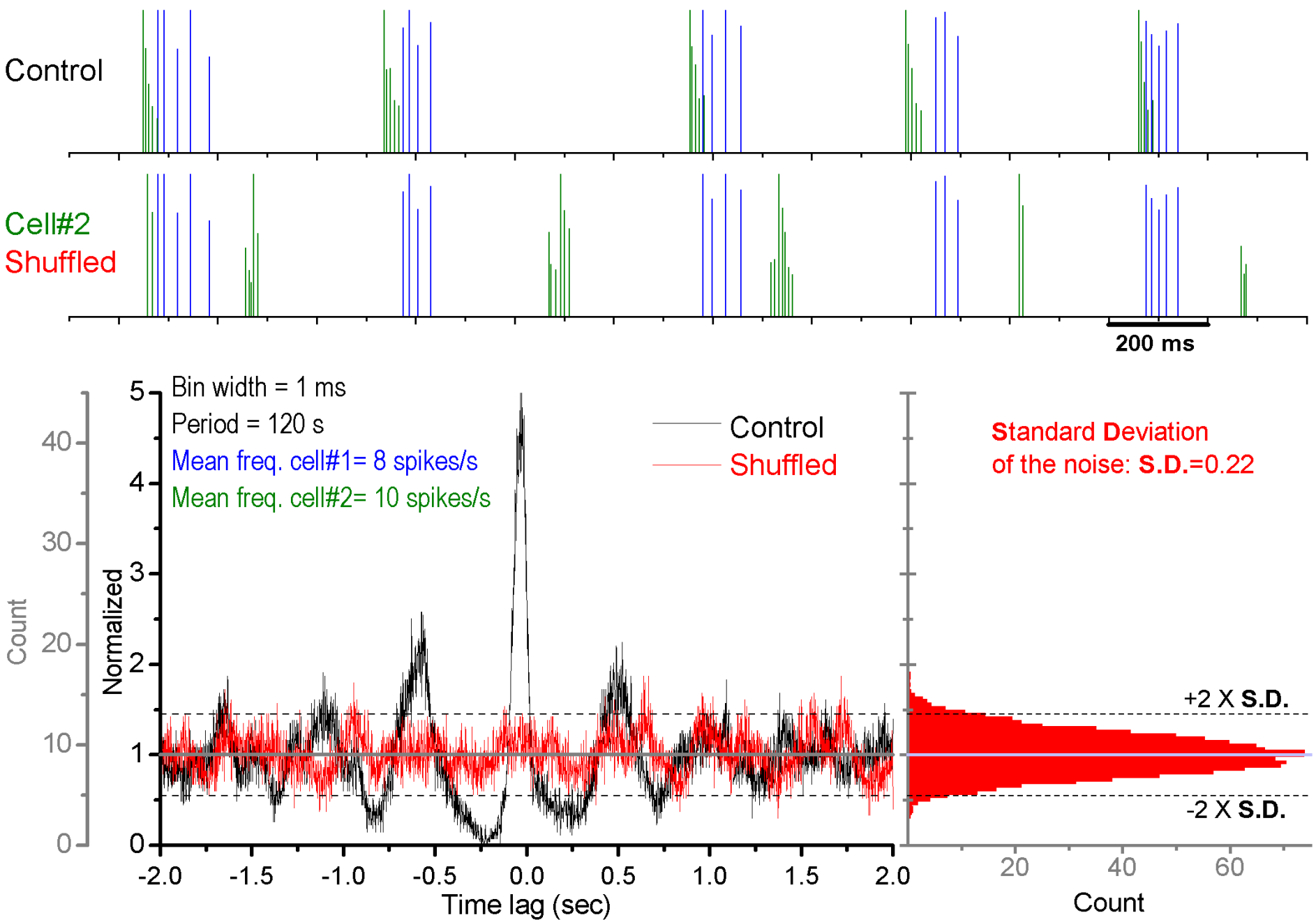
Step 5: take the non-negative square root of the quotient (converting squared units back to regular units),

$$\sqrt{36} = 6$$



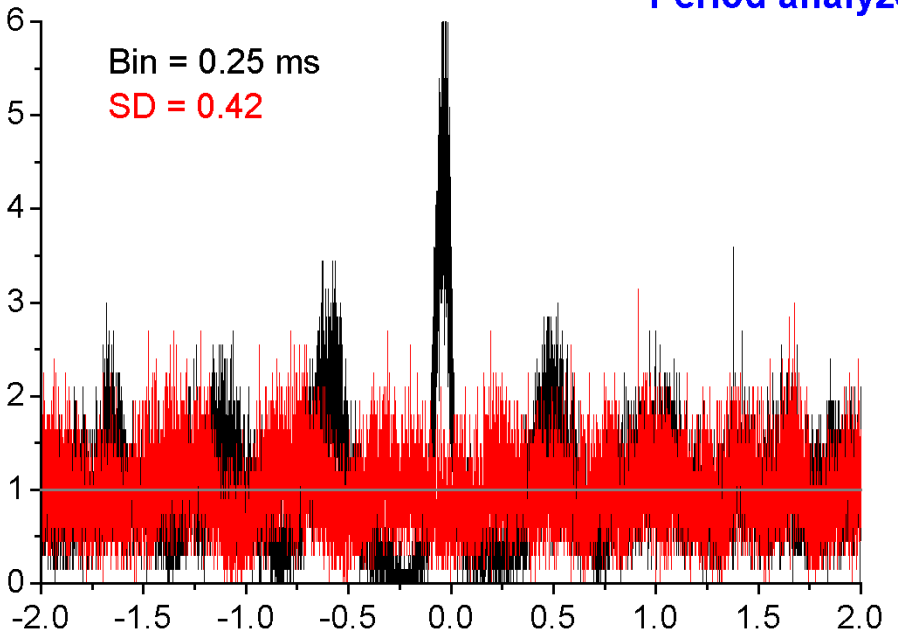
Dark blue is less than one standard deviation from the mean. For the normal distribution, this accounts for 68.27 % of the set;
while two standard deviations from the mean (medium and dark blue) account for 95.45%;
three standard deviations (light, medium, and dark blue) account for 99.73%;
and four standard deviations account for 99.994%.
The two points of the curve which are one standard deviation from the mean are also the inflection points.

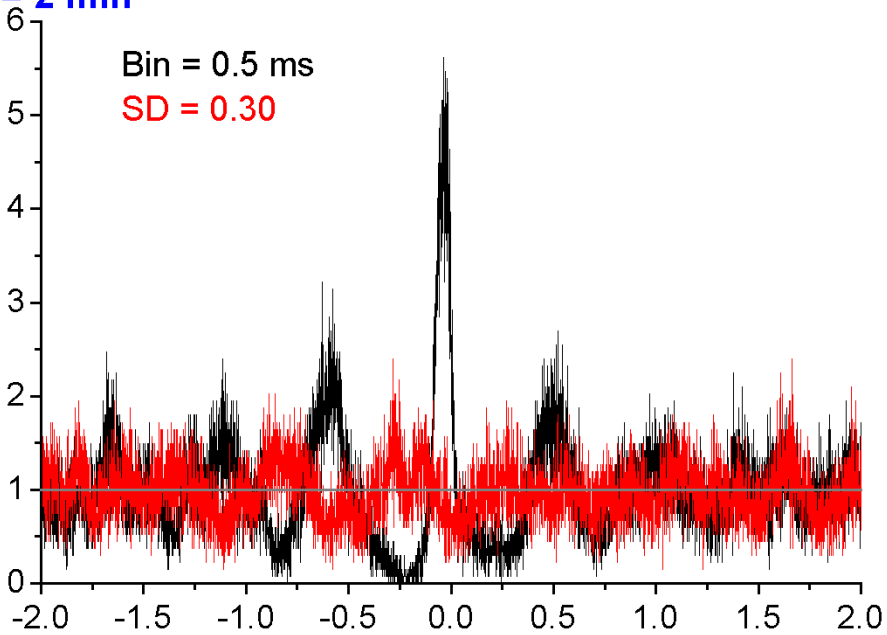
Events (spikes, EPSCs) cross-correlograms: Normalization and significa

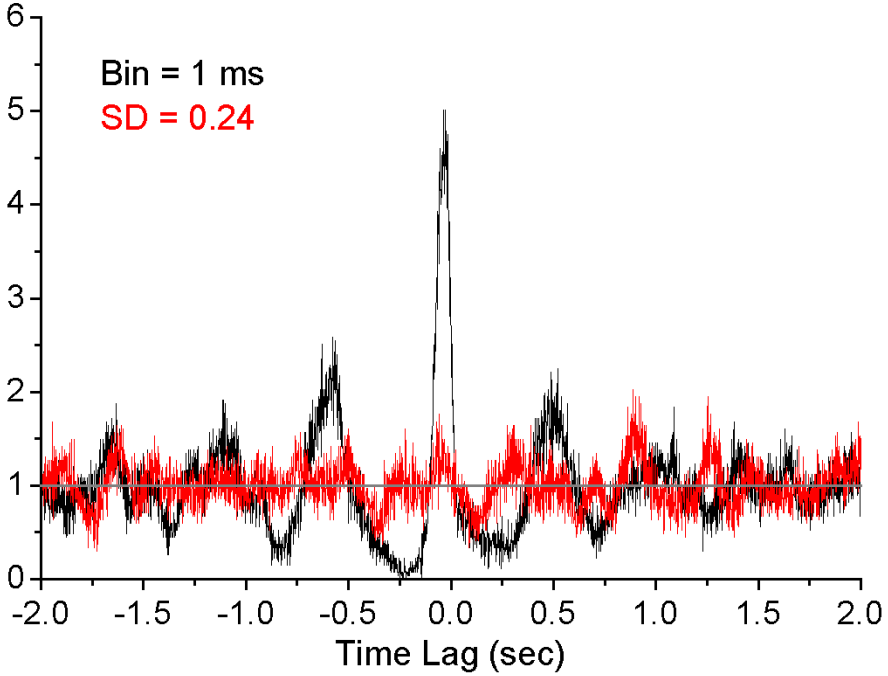


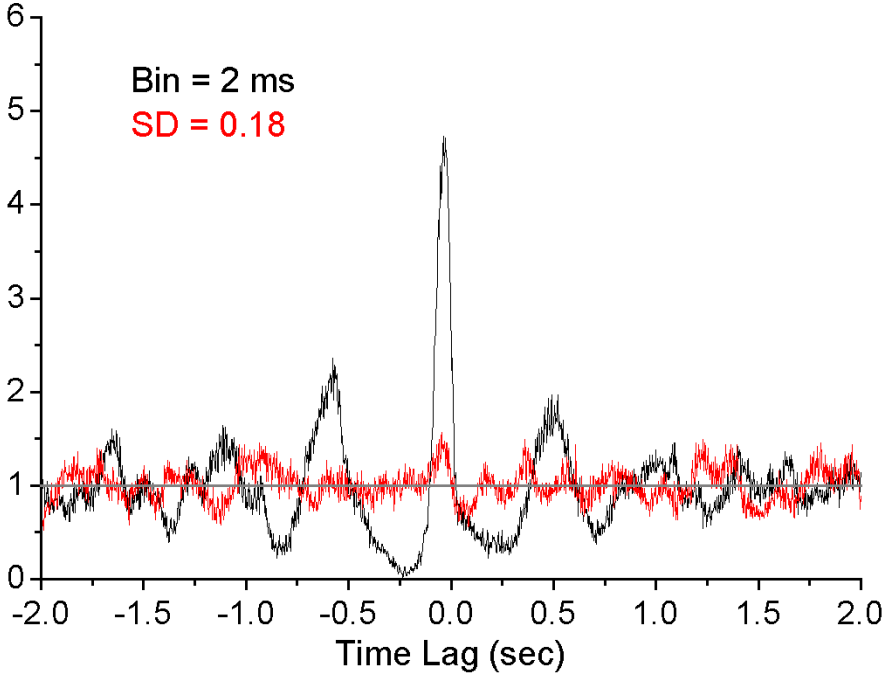
Increasing the bin width increases the signal/noise ratio of crosscorrelation

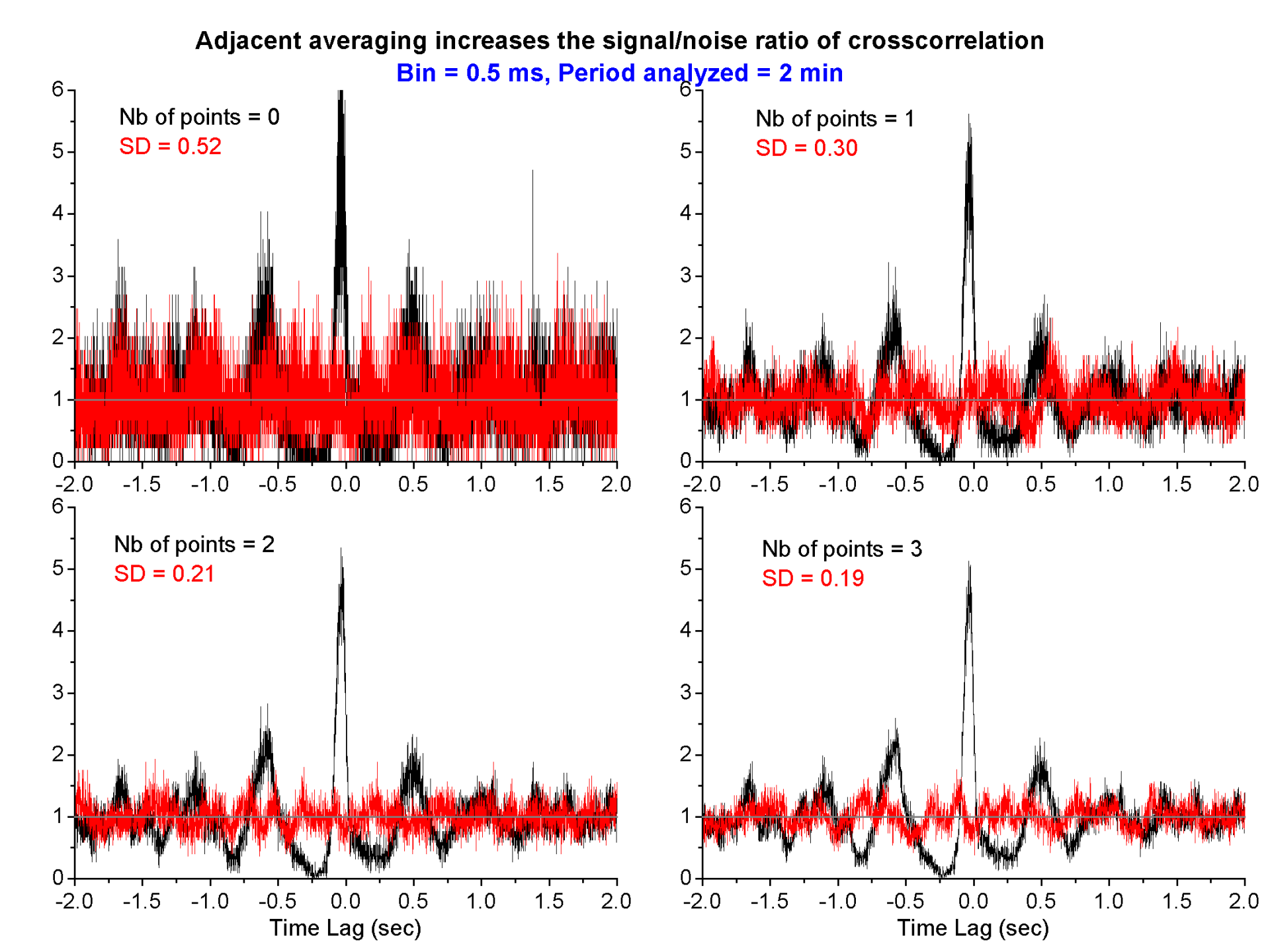
Period analyzed = 2 min



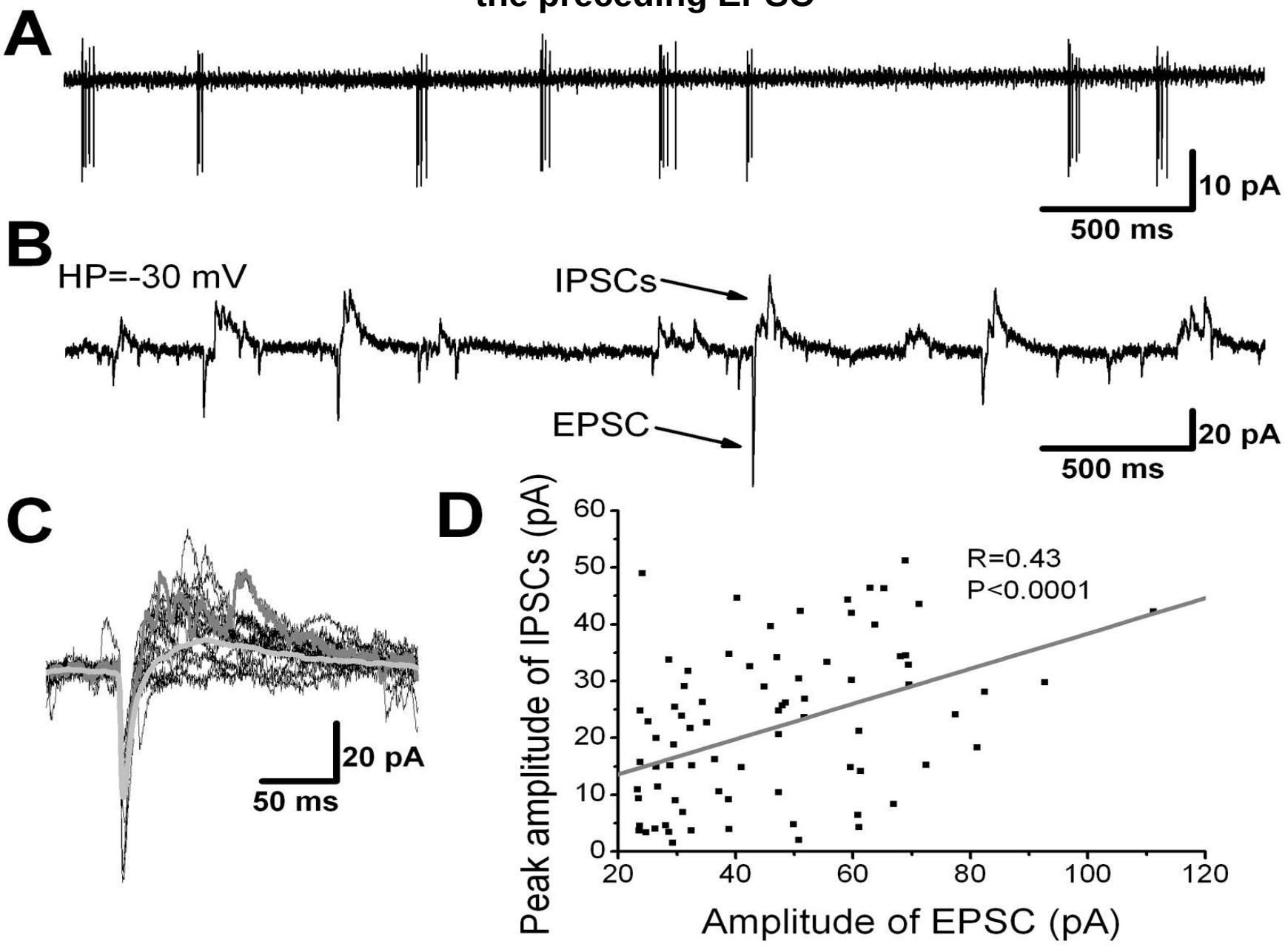







Adjacent averaging increases the signal/noise ratio of crosscorrelation
Bin = 0.5 ms, Period analyzed = 2 min
Nb of points = 0
SD = 0.52
Nb of points = 1
SD = 0.30
Nb of points = 2
SD = 0.21
Nb of points = 3
SD = 0.19
Time Lag (sec)
Time Lag (sec)

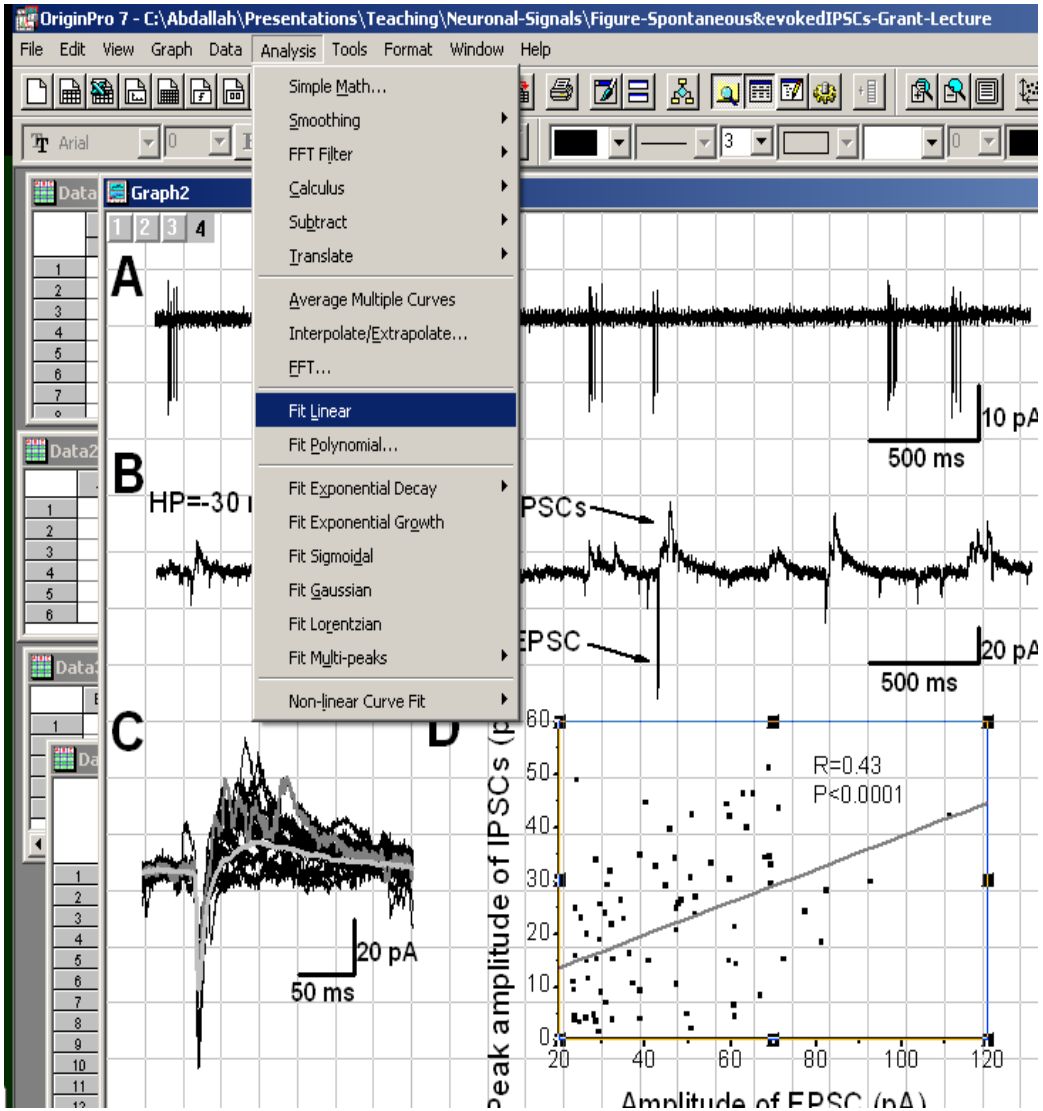
The amplitude of the spontaneous burst of IPSCs is correlated with that of the preceding EPSC



How to perform linear regression fit

Data6 - 040604c3F1...

	A(X) Amplitude of EPSC (pA)	C(Y) Amplitude of IPSCs (pA)
1	46	40
2	26	20
3	51	30
4	39	9
5	32	4
6	93	30
7	24	49
8	33	15
9	33	15
10	41	15
11	37	11
12	68	34
13	34	26
14	32	32
15	71	44
16	29	34
17	69	35
18	48	26
19	82	28
20	65	46
21	39	35
22	70	33
23	24	25
24	72	15
25	50	5
26	25	23
27	47	21
28	32	22
29	20	2
30	35	23

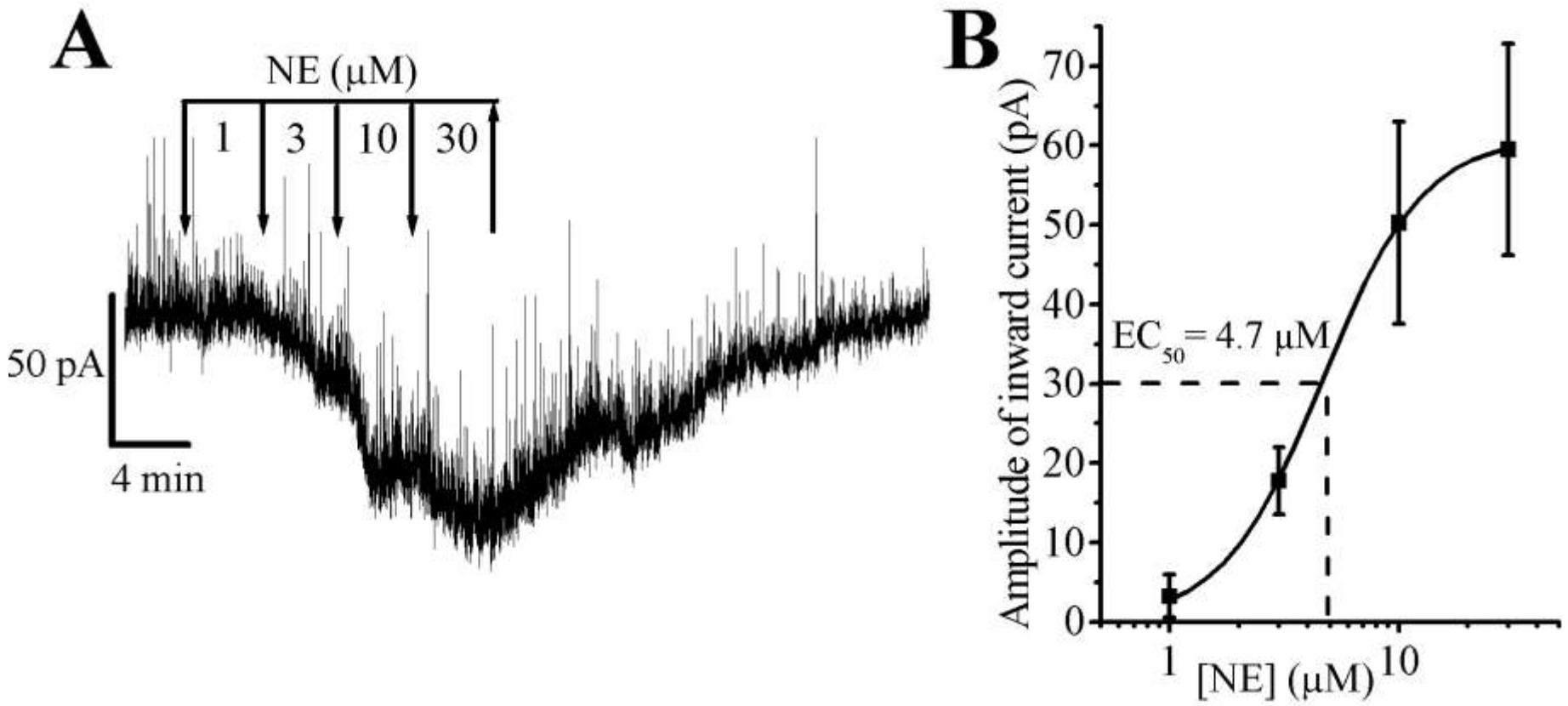


Linear Regression for Data3B_C:
Y = A + B * X

Parameter	Value	Error
A	7.41759	3.51864
B	0.30974	0.07148

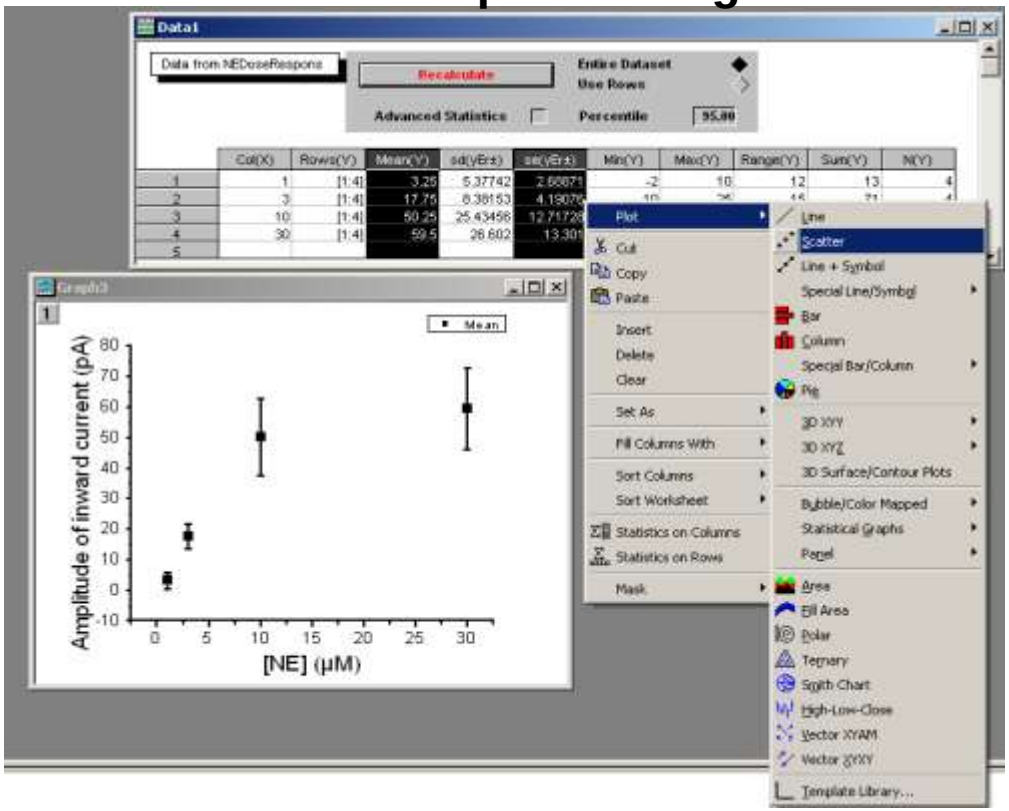
R	SD	N	P
0.43602	12.55515	82	<0.0001

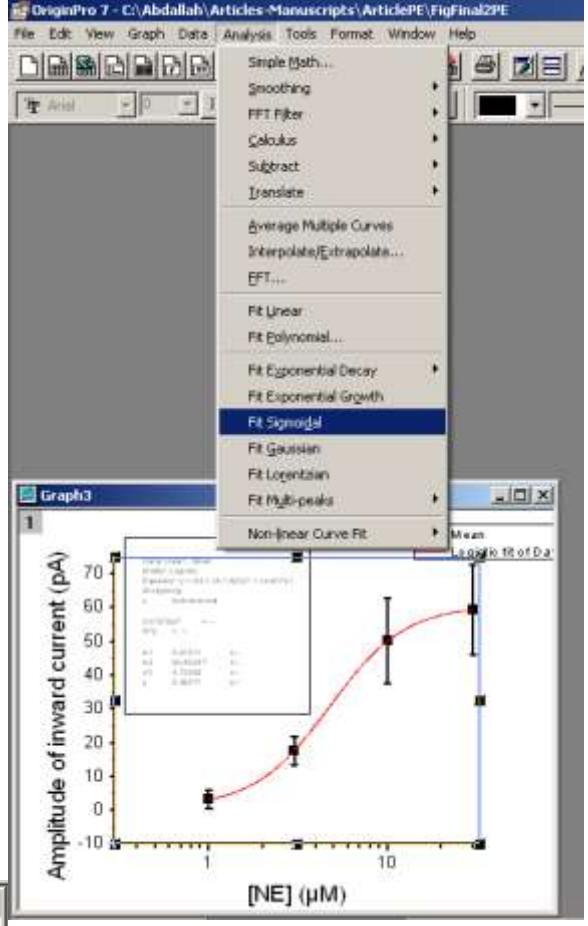
Fitting Concentration-Response Data

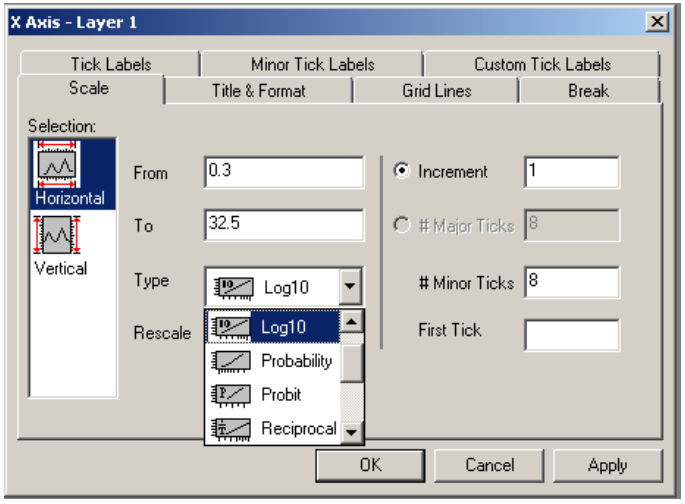


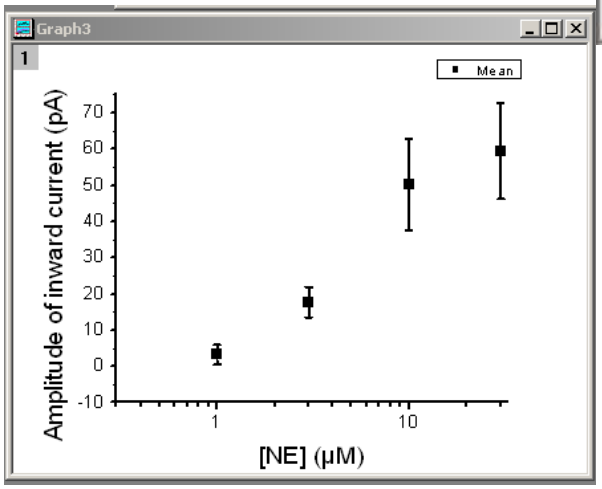
Effect of norepinephrine (NE) in voltage-clamp recordings. A. Inward currents evoked by NE at different concentrations (1, 3, 10, 30 μM added cumulatively, 4 min at each concentration). B. A sigmoidal curve was fitted to the NE concentration-response data obtained from 4 cells. The holding potential was –60 mV.

How to perform sigmoidal fit







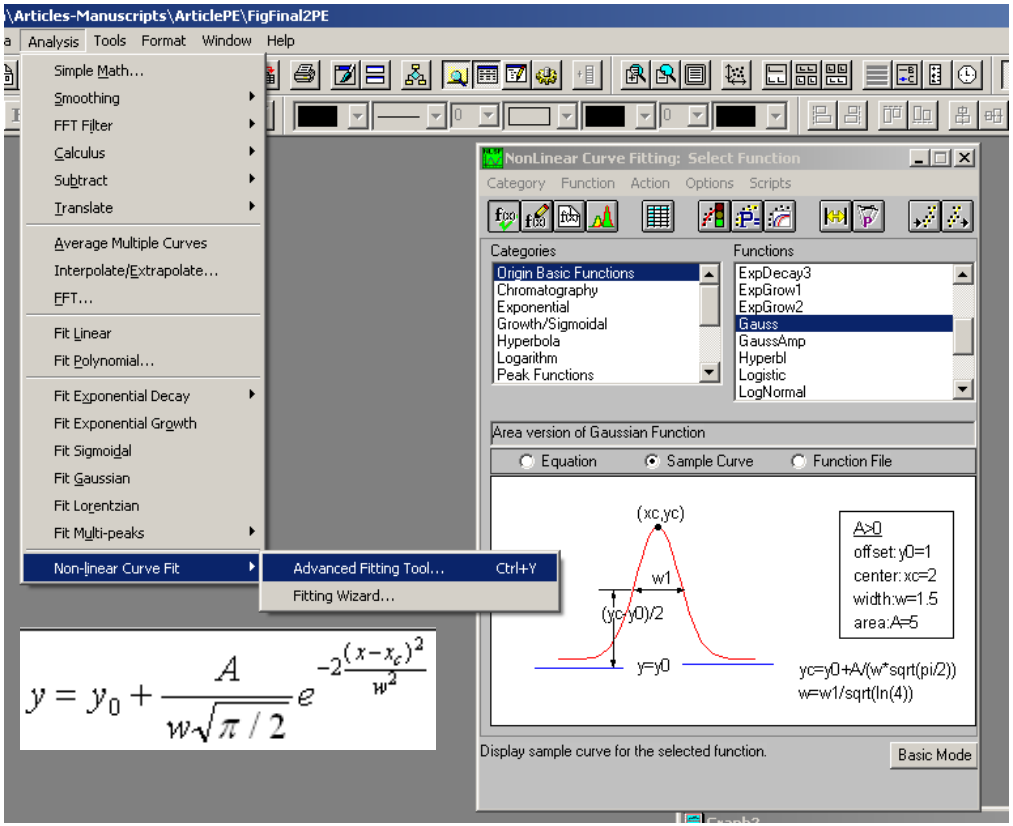


Dose Response Analysis for Data1_Mean:

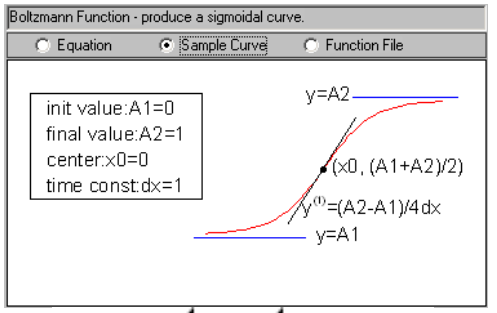
Model: Logistic

Parameter	Value	Error
Chi^2	0.34319	
Initial(A1)	0	0
Final (A2)	61.07219	0.782
EC50 (x0)	4.66088	0.13305
Power (p)	1.98713	0.08076

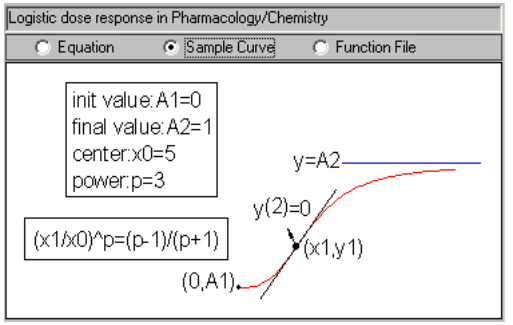
Advanced Fitting Tools



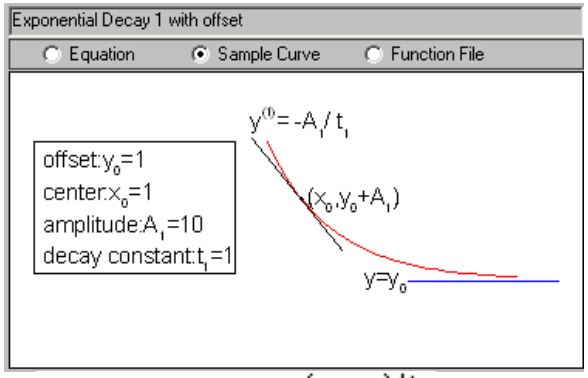
$$y = y_0 + \frac{A}{w\sqrt{\pi/2}} e^{-2\frac{(x-x_c)^2}{w^2}}$$



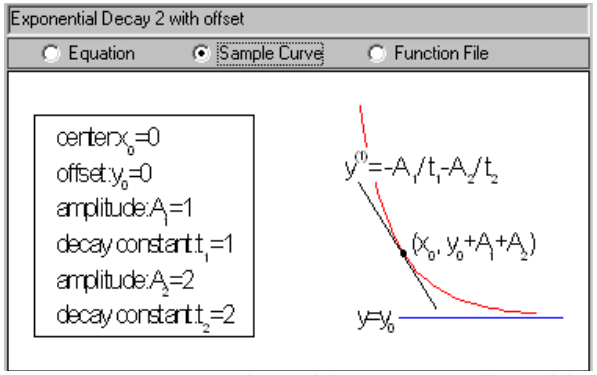
$$y = \frac{A_1 - A_2}{1 + e^{(x-x_0)/dx}} + A_2$$



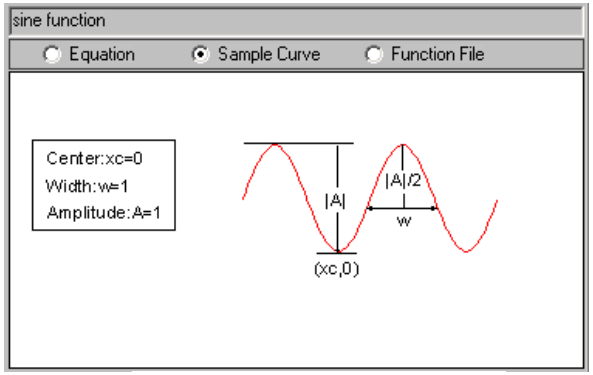
$$y = \frac{A_1 - A_2}{1 + (x/x_0)^p} + A_2$$



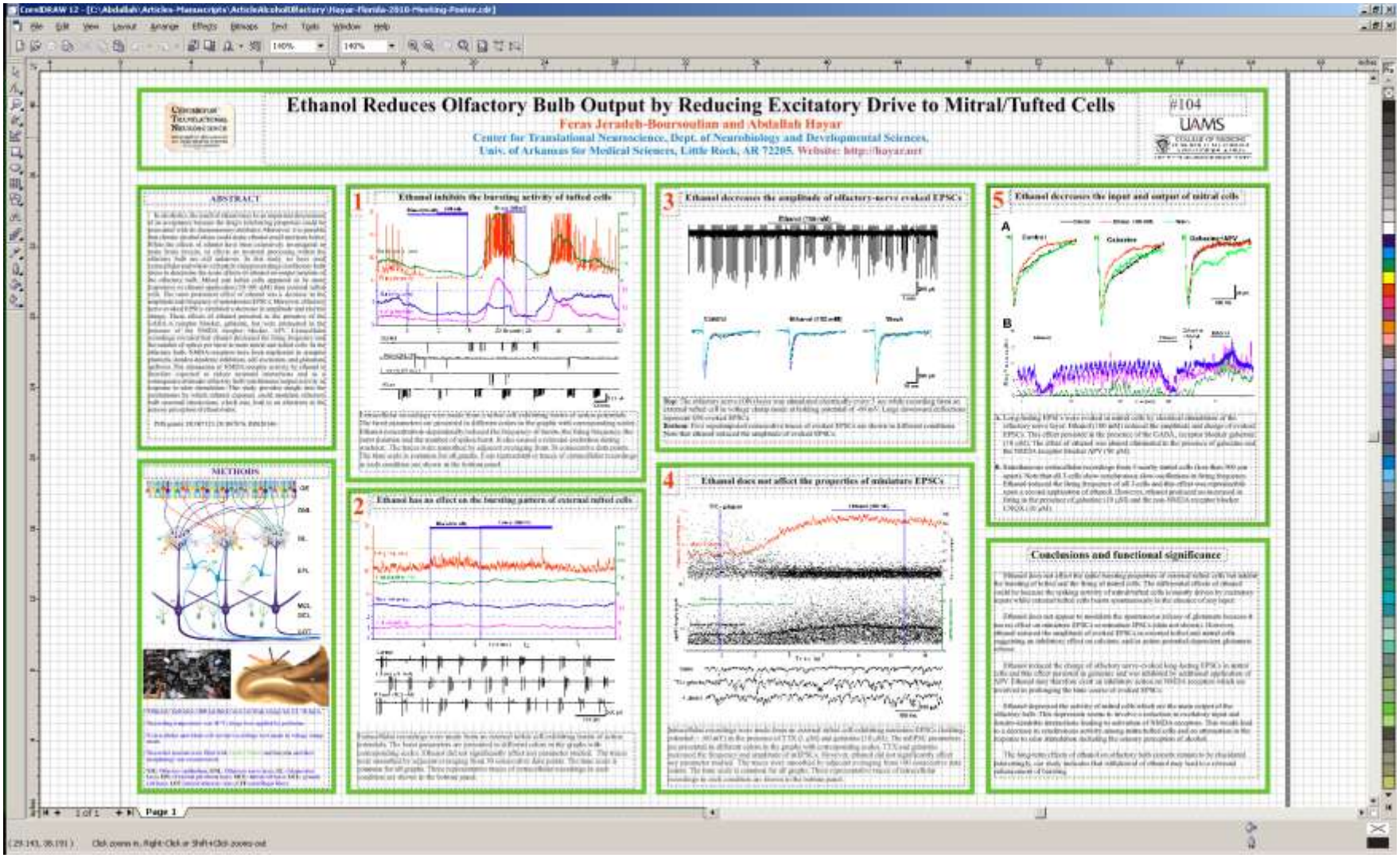
$$y = y_0 + A_1 e^{-(x-x_0)/t_1}$$



$$y = y_0 + A_1 e^{-(x-x_0)/t_1} + A_2 e^{-(x-x_0)/t_2}$$



$$y = A\sin(\pi\frac{x - x_c}{w})$$



The Olfactory Bulb Network

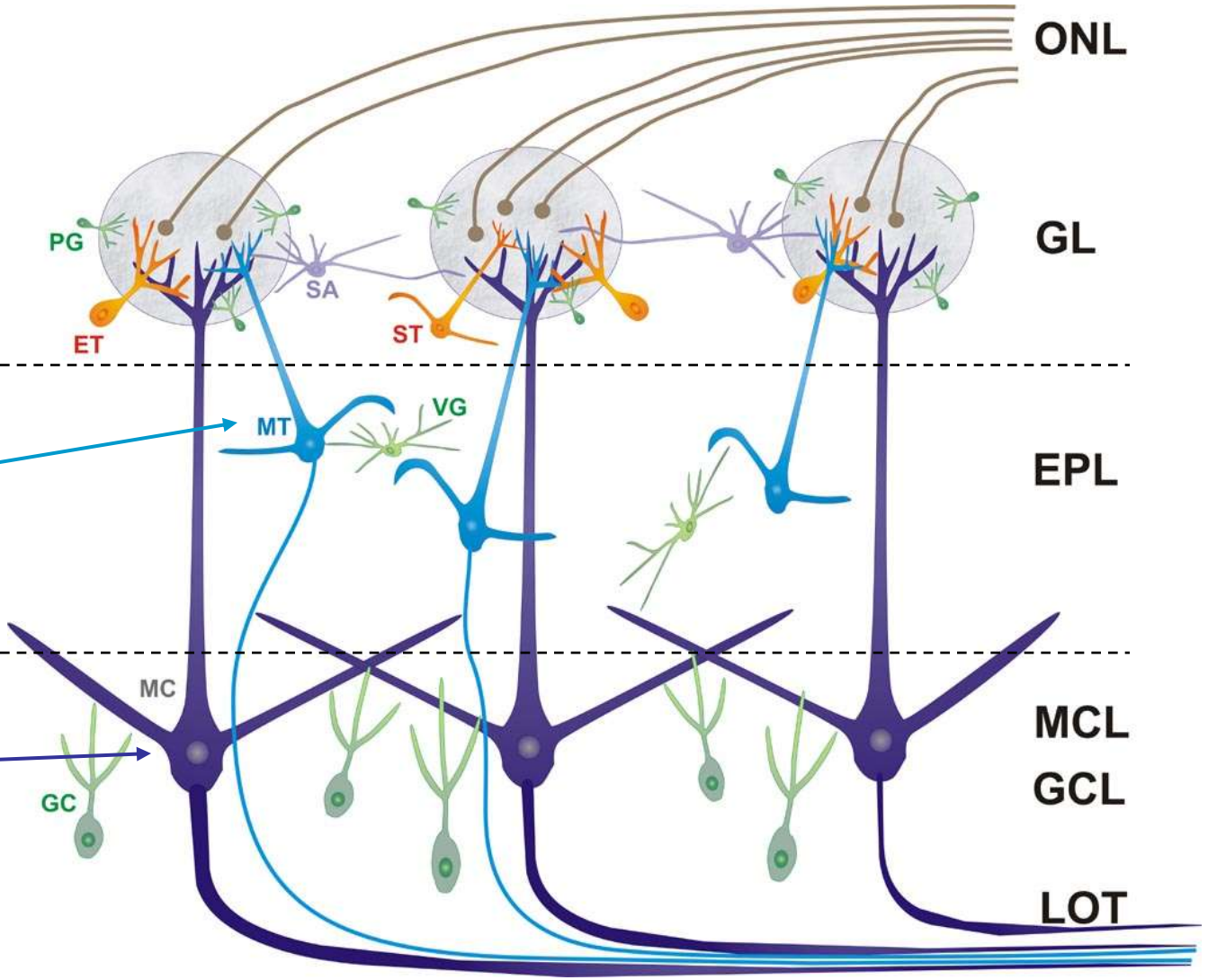
Each glomerulus is innervated by:

10,000 olfactory axons,

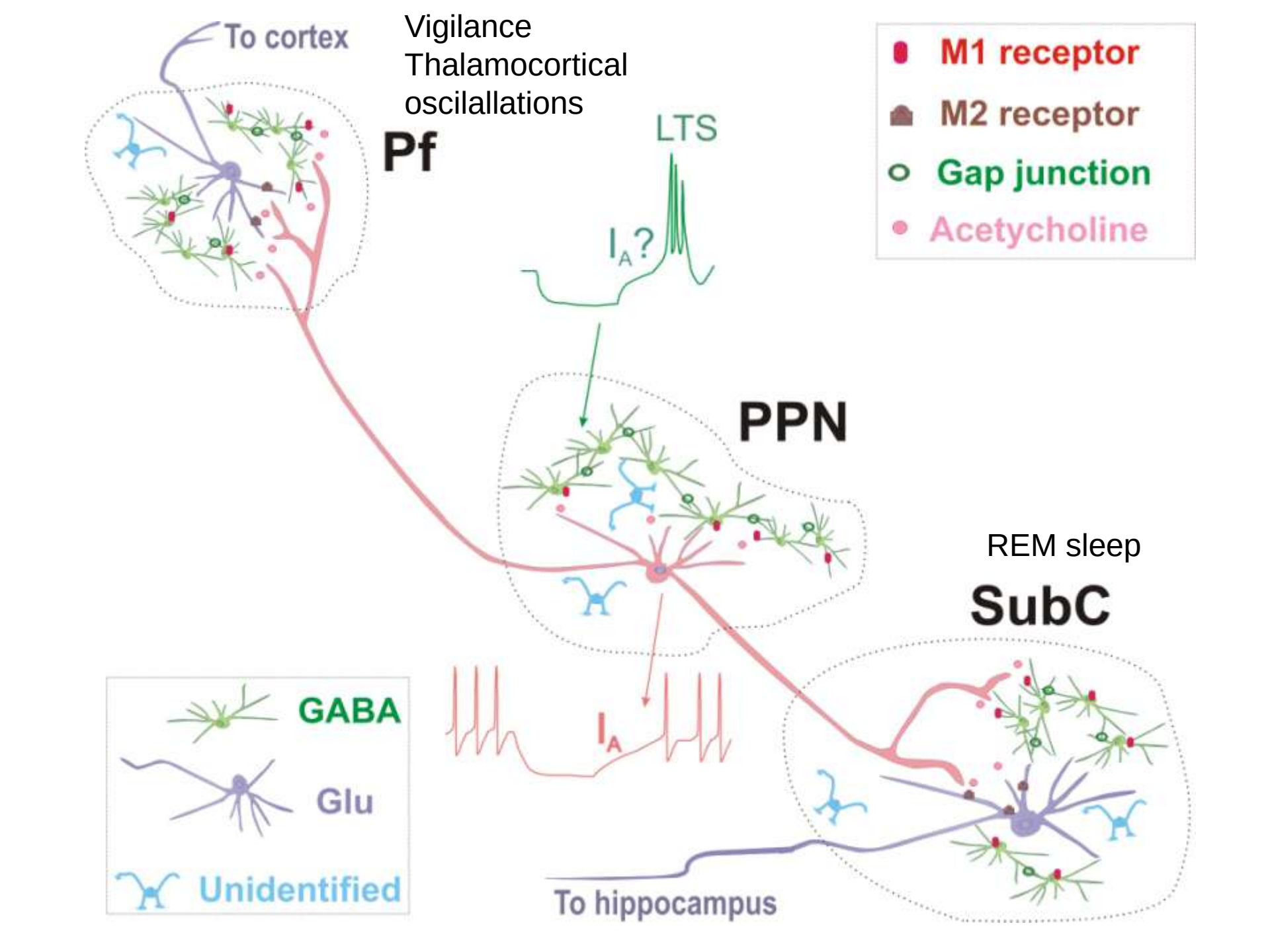
1000 juxtaglomerular cells

50 tufted cells,

25 mitral cells,



Thus, juxtaglomerular cells outnumber mitral/tufted cells by 20-40x


To cortex
Vigilance
Thalamocortical
oscilallations
Pf
LTS
I_A?
M1 receptor
M2 receptor
Gap junction
Acetycholine
PPN
REM sleep
SubC
GABA
Glu
Unidentified
I_A
To hippocampus