

EEGLAB Tutorial In MATLAB

Armin Abdollahi



مقدمه ای بر سیگنال EEG و ابزار EEGLAB

- سیگنال های EEG توسط جریان های یونی در نورون های قشر مغز تولید می شوند. الکتروانسفالوگرافی (EEG) یک روشی است که فعالیت الکتریکی مغز را اندازه گیری می کند. این به طور گسترده در تنظیمات بالینی و تحقیقاتی برای مطالعه عملکرد مغز و تشخیص اختلالات عصبی استفاده می شود.
- ابزار EEGLAB یک ابزار Open Source برای پردازش EEG، MEG و سایر داده های الکتروفیزیولوژیکی مرتبط. این شامل تجزیه و تحلیل مؤلفه های مستقل (ICA)، تجزیه و تحلیل زمان / فرکانس، حذف چندین نوع artifact غیر مغزی از داده های EEG، و چندین حالت مفید دیگه است.
- رابط گرافیکی EEGLAB رویکرد کاربرپسندتری دارد اما برای استفاده کامل از پتانسیل EEG، باید درک اولیه ای از زبان برنامه نویسی متلب داشته باشید.



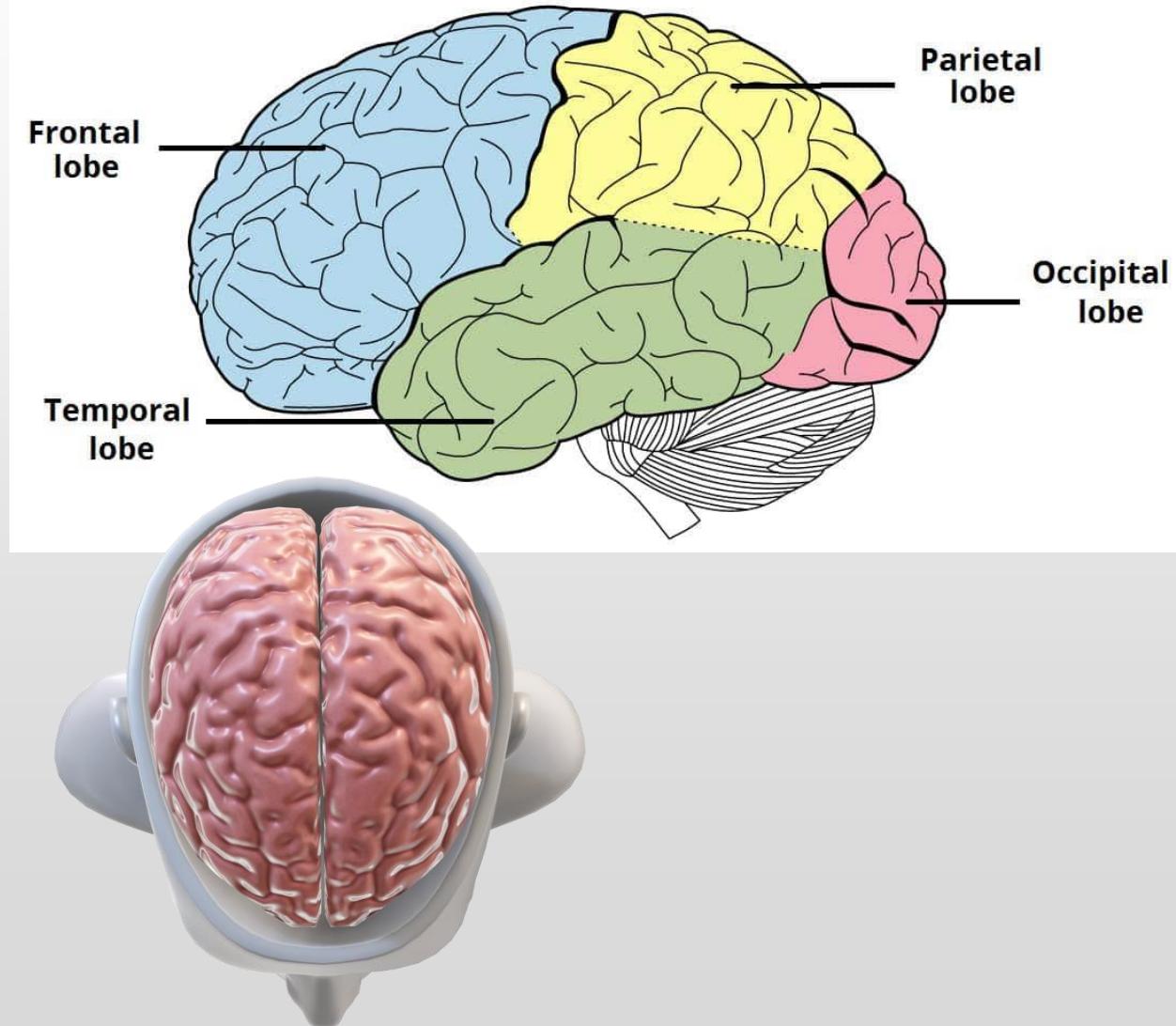
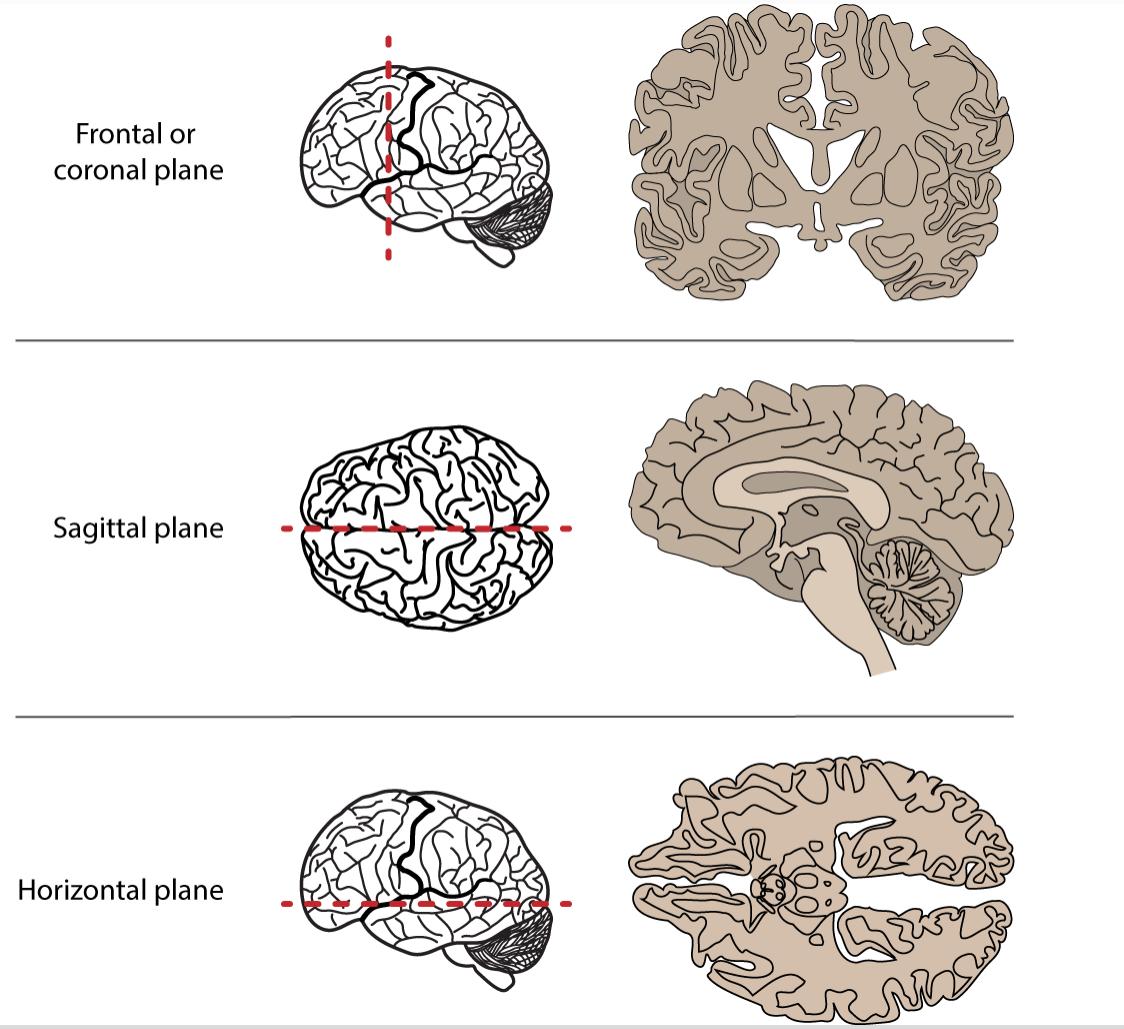
تقسیم بندی مغز

جلوی سر قرار دارد و مسئول توجه، تمرکز و ادراک است.

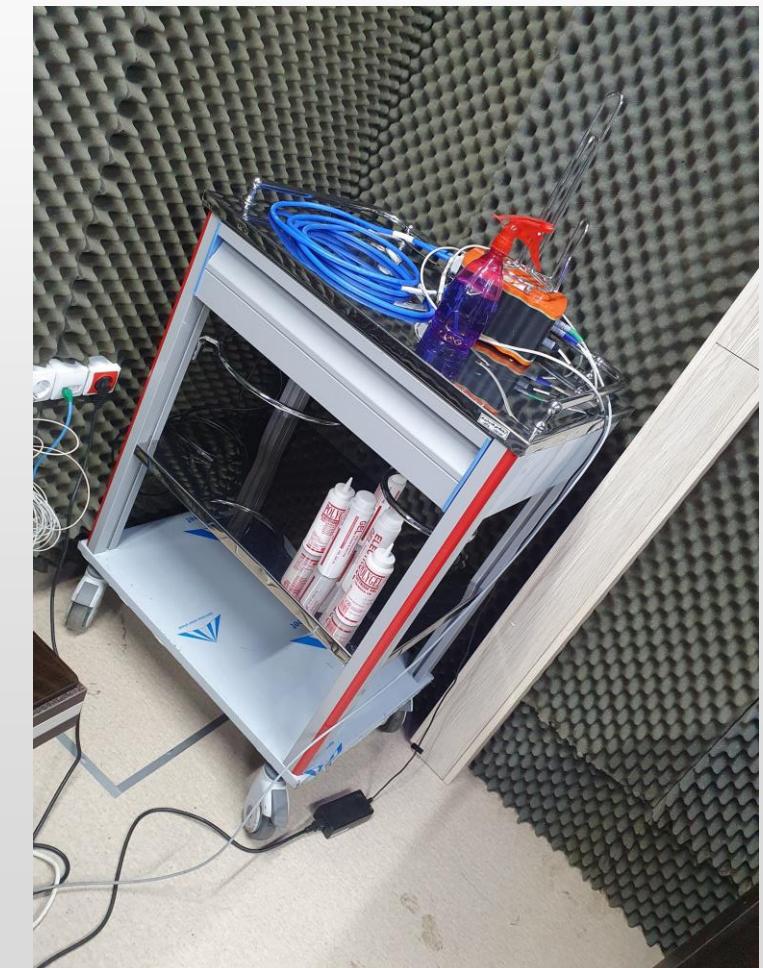
بالای گوش دو طرف قرار دارد و مسئول شنوندایی است.

پشت سر، بالای گردن قرار دارد و مسئول بینایی است.

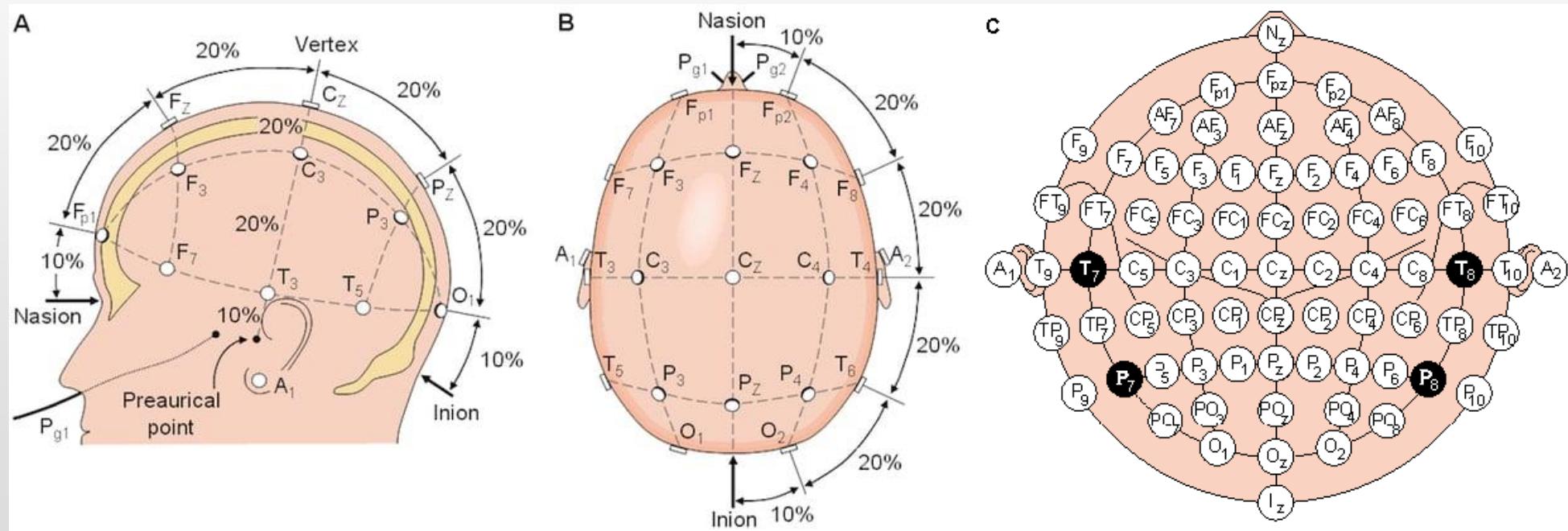
بالای سر، پس سر قرار دارد و مسئول کنترل حرکت های ما است.



نحوه ثبت سیگنال های EEG



نام گذاری الکترودها و انواع استانداردها



Download and Install EEGLAB

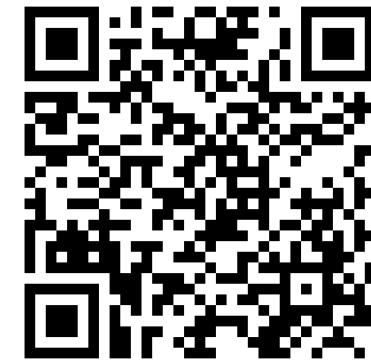
Where can we download EEGLAB?

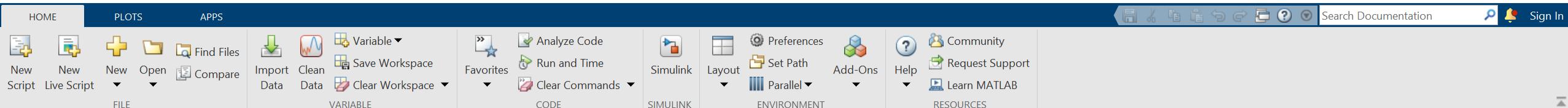
<https://sccn.ucsd.edu/eeglab/downloadtoolbox.php/download.php>

Size: 90 MB

How to install EEGLAB?

1. Unzip the EEGLAB zip file in the folder of your choice
2. Start MATLAB
3. Change the MATLAB path to the EEGLAB folder you have just uncompressed
4. Type "eeglab" and press enter on the MATLAB prompt





C:\> Users\ASUS\Downloads>

Name	Value
ALLCOM	1x1 cell
ALLEEG	[]
CURRENTS...	0
CURRENTS...	0
EEG	1x1 struct
globalvars	8x1 cell
LASTCOM	'[ALLEEG EEG ...
PLUGINLIST	1x9 struct
STUDY	[]
tmpEEG	1x1 struct

Command Window

```
>> eeglab
```

Some menus items hidden. Use Preference menu to show them all.
eeglab: options file is C:\Users\ASUS\eeg_options.m
Retrieving plugin versions from server...
Retrieving download statistics...
EEGLAB: adding "Biosig" v3.8.1 to the path
EEGLAB: adding "Fileio" v20230402 to the path
EEGLAB: adding "ICLabel" v1.4 (see >> help eeg
EEGLAB: adding "MFMatlabIO" v4.1 (see >> help eeg
EEGLAB: adding "bva-io" v1.71 (see >> help eeg
EEGLAB: adding "clean_rawdata" v2.8 (see >> he
EEGLAB: adding "dipfit" v5.0 (see >> help eegp
EEGLAB: adding "firfilt" v2.7.1 (see >> help e
EEGLAB: adding "neuroscanno" v1.6 (see >> help
You are using the latest version of EEGLAB.

fx>>

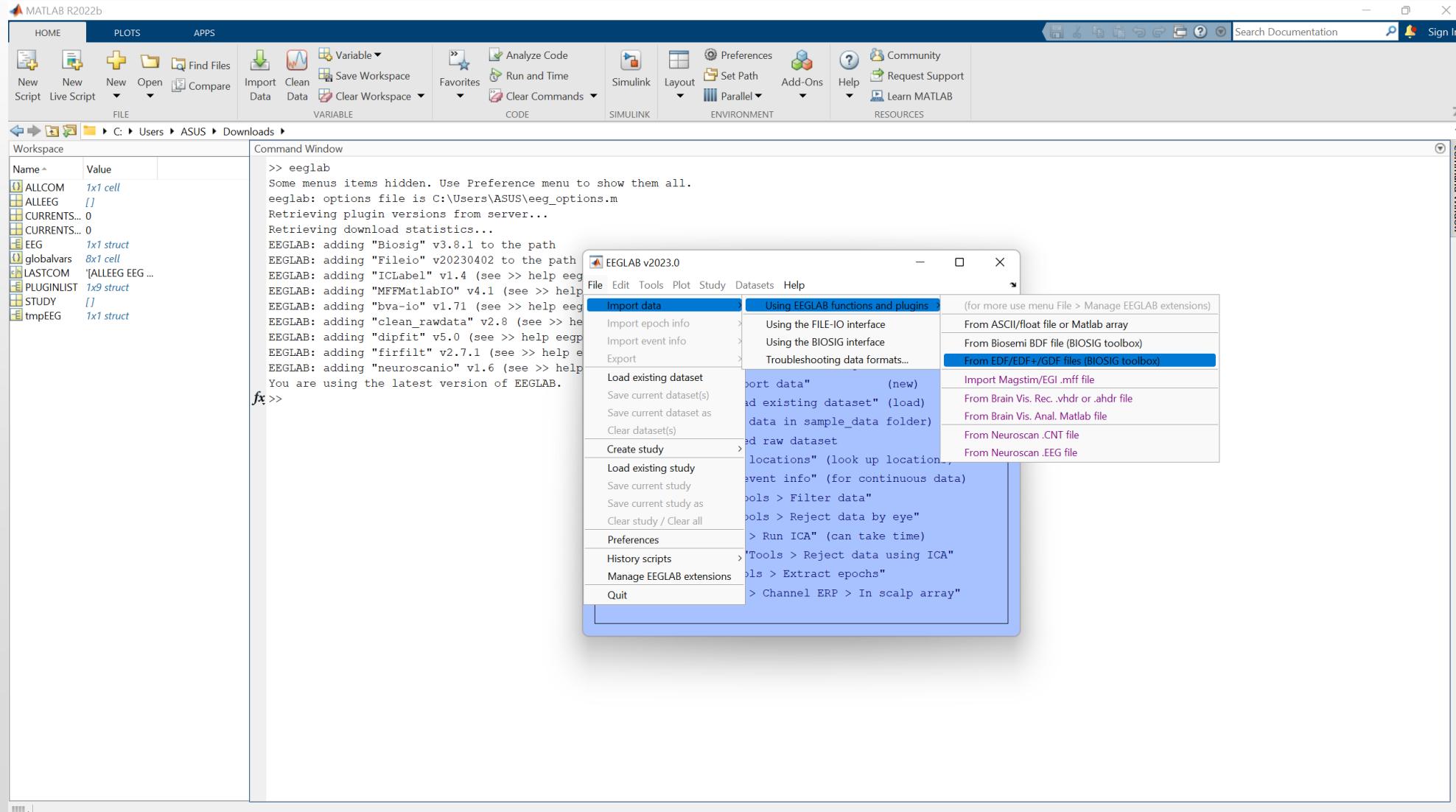
EEGLAB v2023.0

No current dataset

Suggested steps to get started

- Create a new or load an existing dataset:
Use "File > Import data" (new)
Or "File > Load existing dataset" (load)
(find tutorial data in sample_data folder)
- If newly imported raw dataset
"Edit > Channel locations" (look up locations)
"File > Import event info" (for continuous data)
- Filter data: "Tools > Filter data"
- Reject data: "Tools > Reject data by eye"
- Run ICA: "Tools > Run ICA" (can take time)
- Reject by ICA: "Tools > Reject data using ICA"
- Epoch data: "Tools > Extract epochs"
- Plot ERP: "Plot > Channel ERP > In scalp array"

Import the signal to EEGLAB





Workspace

Name	Value
ALLCOM	1x1 cell
ALLEEG	[]
CURRENTS...	0
CURRENTS...	0
EEG	1x1 struct
globalvars	8x1 cell
LASTCOM	"
PLUGINLIST	1x9 struct
STUDY	[]
tmpEEG	1x1 struct

Command Window

```
>> eeglab
Some menus items hidden. Use Preference menu to show them all.
eeglab: options file is C:\Users\ASUS\eeg_options.m
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EEGLAB: adding "bva-io" v1.71 (see >> help eeg
EEGLAB: adding "clean_rawdata" v2.8 (see >> he
EEGLAB: adding "dipfit" v5.0 (see >> help eeg
EEGLAB: adding "firfilt" v2.7.1 (see >> help e
EEGLAB: adding "neuroscanno" v1.6 (see >> help
You are using the latest version of EEGLAB.
```

fx >>

EEGLAB v2023.0

Choose a data file -- pop_biosig()

This PC > This PC > Desktop >

Organize New folder

This PC

- Desktop
- Documents
- Downloads
- Music
- Pictures
- Videos
- Local Disk (C:)

Dataset Master PN05-3.edf Standard-10-10-Cap47.locs

File name: PN05-3.edf

All Files

Open Cancel

Document1 - Word

Armin Abdollahi

File Home Insert Draw Design Layout References Mailings Review View Help Foxit PDF Tell me what you want to do

Cut Copy Format Painter

Paste

Font Paragraph Styles

Clipboard

Find Replace Select Add-ins

Editing Add-ins

Number	labels	theta	radius	X	Y	Z	sph_theta
	sph_phi	sph_radius					
1	FPZ	0	0.511 0.999 -0	-0.0349	-0	-2	1
2	FZ	0	0.256 0.719 -0	0.695 -0	44	1	
3	Cz	90	0 3.75e-33	-6.12e-17	1	-90	90
4	PZ	180	0.256 -0.719	-8.81e-17	0.695 -180	44	1
5	C3	-90	0.256 4.4e-17	0.719 0.695	90 44	1	
6	T3	-90	0.511 6.12e-17	0.999 -0.0349	90	-2	1
7	C4	90	0.256 4.4e-17	-0.719	0.695 -90	44	1
8	T4	90	0.511 6.12e-17	-0.999	-0.0349	-90	-2
9	FP1	-18	0.511 0.95 0.309 -0.0349	18	-2	1	
10	FP2	18	0.511 0.95 -0.309 -0.0349	-18	-2	1	
11	F3	-39	0.333 0.673 0.545 0.5	39	30	1	
12	F4	39	0.333 0.673 -0.545 0.5	-39	30	1	
13	F7	-54	0.511 0.587 0.809 -0.0349	54	-2	1	
14	F8	54	0.511 0.587 -0.809 -0.0349	-54	-2	1	
15	P3	-141	0.333 -0.673 0.545 0.5	141	30	1	
16	P4	141	0.333 -0.673 -0.545 0.5	-141	30	1	
17	T5	-126	0.511 -0.587 0.809 -0.0349	126	-2	1	
18	T6	126	0.511 -0.587 -0.809 -0.0349	-126	-2	1	
19	O1	-162	0.511 -0.95 0.309 -0.0349	162	-2	1	
20	O2	162	0.511 -0.95 -0.309 -0.0349	-162	-2	1	

Seizures-list-PN05 X +

File Edit View

PN05

Data Sampling Rate: 512 Hz

Channels in EDF files:

Channel 1: Fp1
Channel 2: F3
Channel 3: C3
Channel 4: P3
Channel 5: 1
Channel 6: F7
Channel 7: T3
Channel 8: T5
Channel 9: Fc1
Channel 10: Fc5
Channel 11: Cp1
Channel 12: Cp5
Channel 13: F9
Channel 14: Fz
Channel 15: Cz
Channel 16: Pz
Channel 17: F4
Channel 18: C4
Channel 19: P4
Channel 20: O2
Channel 21: F8
Channel 22: T4
Channel 23: T6
Channel 24: Fc2
Channel 25: Fc6
Channel 26: Cp2
Channel 27: Cp6
Channel 28: F10
Channel 32: EKG 1
Channel 33: EKG 2
Channel 34: Fp2

Seizure n 2:

File name: PN05-2.edf
Registration start time: 06.46.02
Registration end time: 09.19.47
Seizure start time: 08.45.25
Seizure end time: 08.46.00

Ln 1, Col 1

Seizures-list-PN05 X +

File Edit View

Channel 11: Cp1
Channel 12: Cp5
Channel 13: F9
Channel 14: Fz
Channel 15: Cz
Channel 16: Pz
Channel 17: F4
Channel 18: C4
Channel 19: P4
Channel 20: O2
Channel 21: F8
Channel 22: T4
Channel 23: T6
Channel 24: Fc2
Channel 25: Fc6
Channel 26: Cp2
Channel 27: Cp6
Channel 28: F10
Channel 32: EKG 1
Channel 33: EKG 2
Channel 34: Fp2

Seizure n 2:

File name: PN05-2.edf
Registration start time: 06.46.02
Registration end time: 09.19.47
Seizure start time: 08.45.25
Seizure end time: 08.46.00

Seizure n 3:

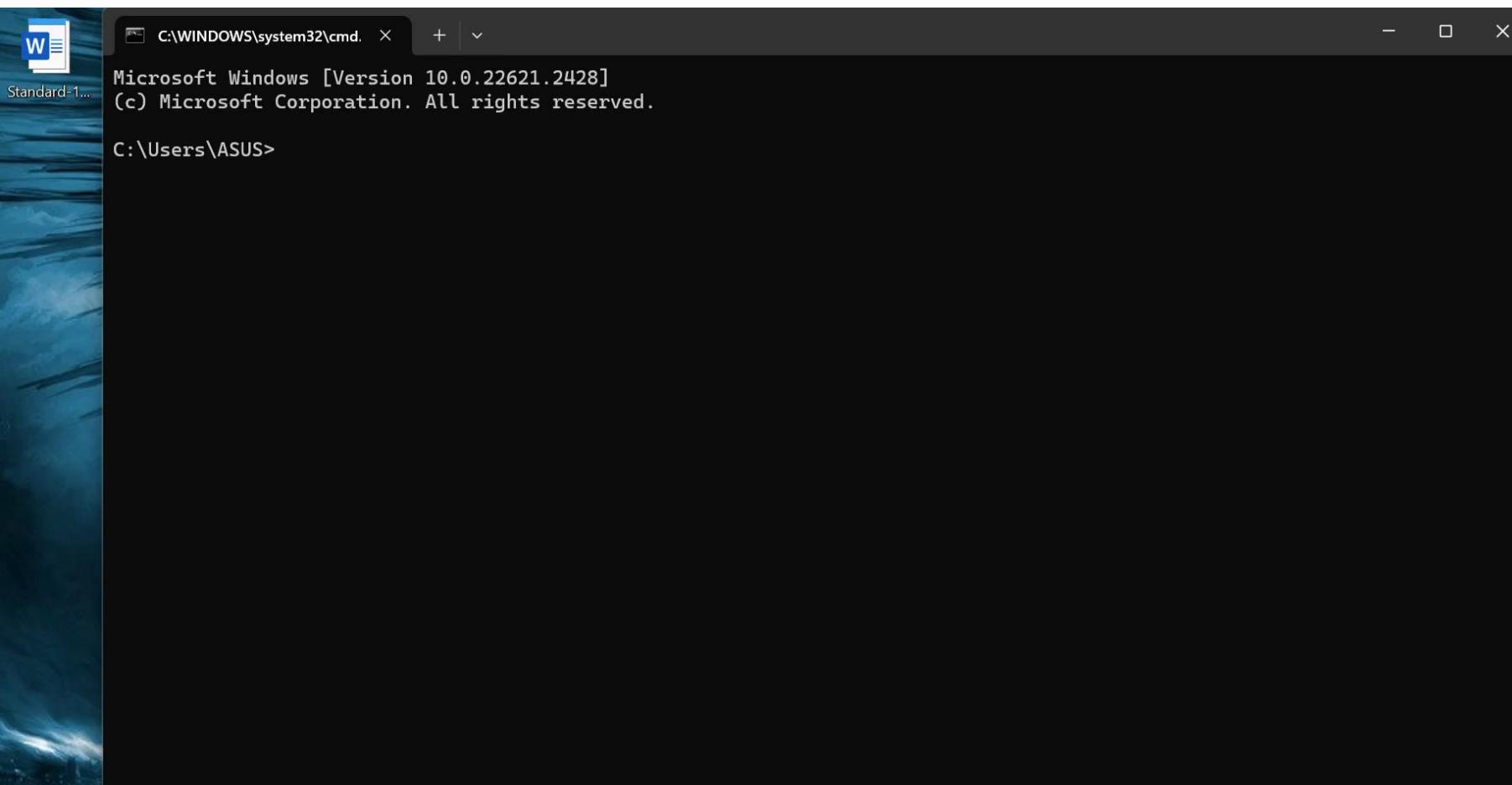
File name: PN05-3.edf
Registration start time: 06.01.23
Registration end time: 08.06.57
Seizure start time: 07.55.19
Seizure end time: 07.55.49

Seizure n 4:

File name: PN05-4.edf
Registration start time: 06.38.35
Registration end time: 08.00.23
Seizure start time: 07.38.43
Seizure end time: 07.39.22

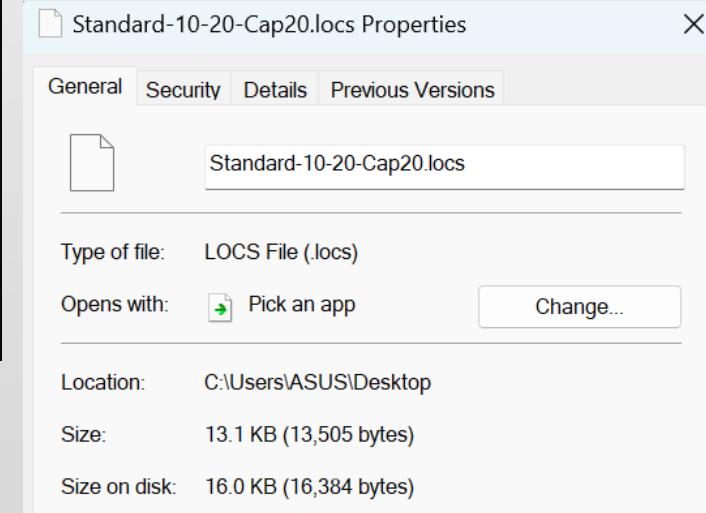
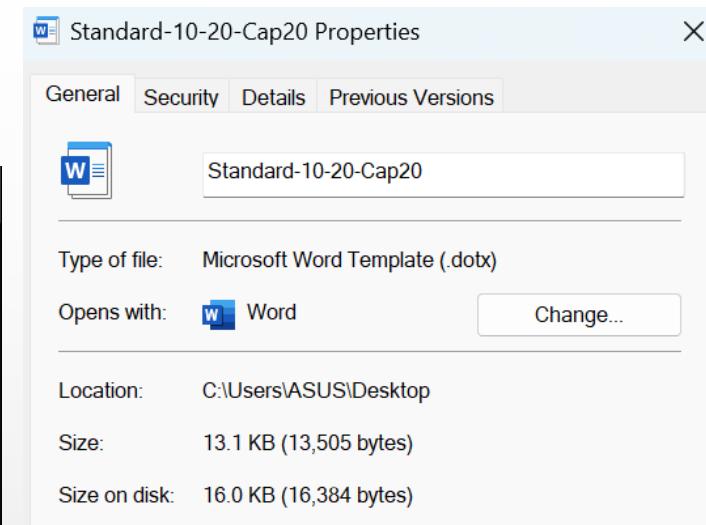
Ln 1, Col 1

rename/ren [<drive>:] [<path>] <filename1> <filename2>



```
C:\WINDOWS\system32\cmd. x + v
Microsoft Windows [Version 10.0.22621.2428]
(c) Microsoft Corporation. All rights reserved.

C:\Users\ASUS>
```





Workspace

Name	Value
ALLCOM	1x3 cell
ALLEEG	1x1 struct
CURRENTS...	1
CURRENTS...	0
EEG	1x1 struct
globalvars	10x1 cell
LASTCOM	[ALLEEG EEG ...]
PLUGINLIST	1x9 struct
STUDY	[]
tmpEEG	1x1 struct

Command Window

```
>> eeglab
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EEGLAB: adding "dipfit" v5.0 (see >> help eegp
EEGLAB: adding "firfilt" v2.7.1 (see >> help e
EEGLAB: adding "neuroscanno" v1.6 (see >> help
You are using the latest version of EEGLAB.
Reading data file header...
sopen mode is "OVERFLOWDETECTION:OFF"
Reading data in EDF format...
eeg_checkset note: upper time limit (xmax) adj
Detected/removing 'EEG' prefix from channel la
Extracting events from last EEG channel...
eeg_checkset warning: number of columns in dat
eeg_checkset note: creating the original event
Creating a new ALLEEG dataset 1
Done.
```

fx >>

EEGLAB v2023.0

#1: EDF file

Filename:	none
Channels per frame	36
Frames per epoch	3867648
Epochs	1
Events	5
Sampling rate (Hz)	512
Epoch start (sec)	0.000
Epoch end (sec)	7553.998
Reference	unknown
Channel locations	No (labels only)
ICA weights	No
Dataset size (Mb)	587.9



Workspace

Name	Value
ALLCOM	1x3 cell
ALLEEG	1x1 struct
CURRENTS...	1
CURRENTS...	0
EEG	1x1 struct
globalvars	10x1 cell
LASTCOM	'[ALLEEG EEG ...
PLUGINLIST	1x9 struct
STUDY	[]
tmpEEG	1x1 struct

Command Window

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EEGLAB: adding "MFMatlabIO" v4.1 (see >> help
EEGLAB: adding "bva-io" v1.71 (see >> help eeg
EEGLAB: adding "clean_rawdata" v2.8 (see >> he
EEGLAB: adding "dipfit" v5.0 (see >> help eegp
EEGLAB: adding "firfilt" v2.7.1 (see >> help e
EEGLAB: adding "neuroscanio" v1.6 (see >> help
You are using the latest version of EEGLAB.
Reading data file header...
sopen mode is "OVERFLOWDETECTION:OFF"
Reading data in EDF format...
eeg_checkset note: upper time limit (xmax) adj
Detected/removing 'EEG' prefix from channel la
Extracting events from last EEG channel...
eeg_checkset warning: number of columns in dat
eeg_checkset note: creating the original event
Creating a new ALLEEG dataset 1
Done.
```

fx >>

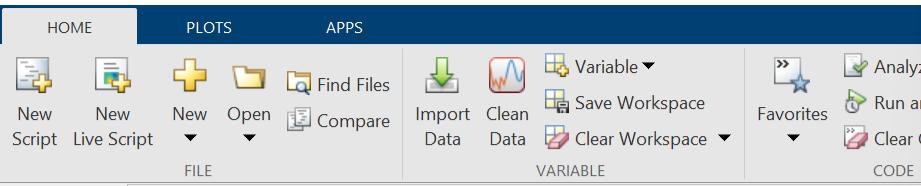
EEGLAB v2023.0

File Edit Tools Plot Study Datasets Help

#1: E... Channel locations > Channel data (scroll) **Plot the signal**

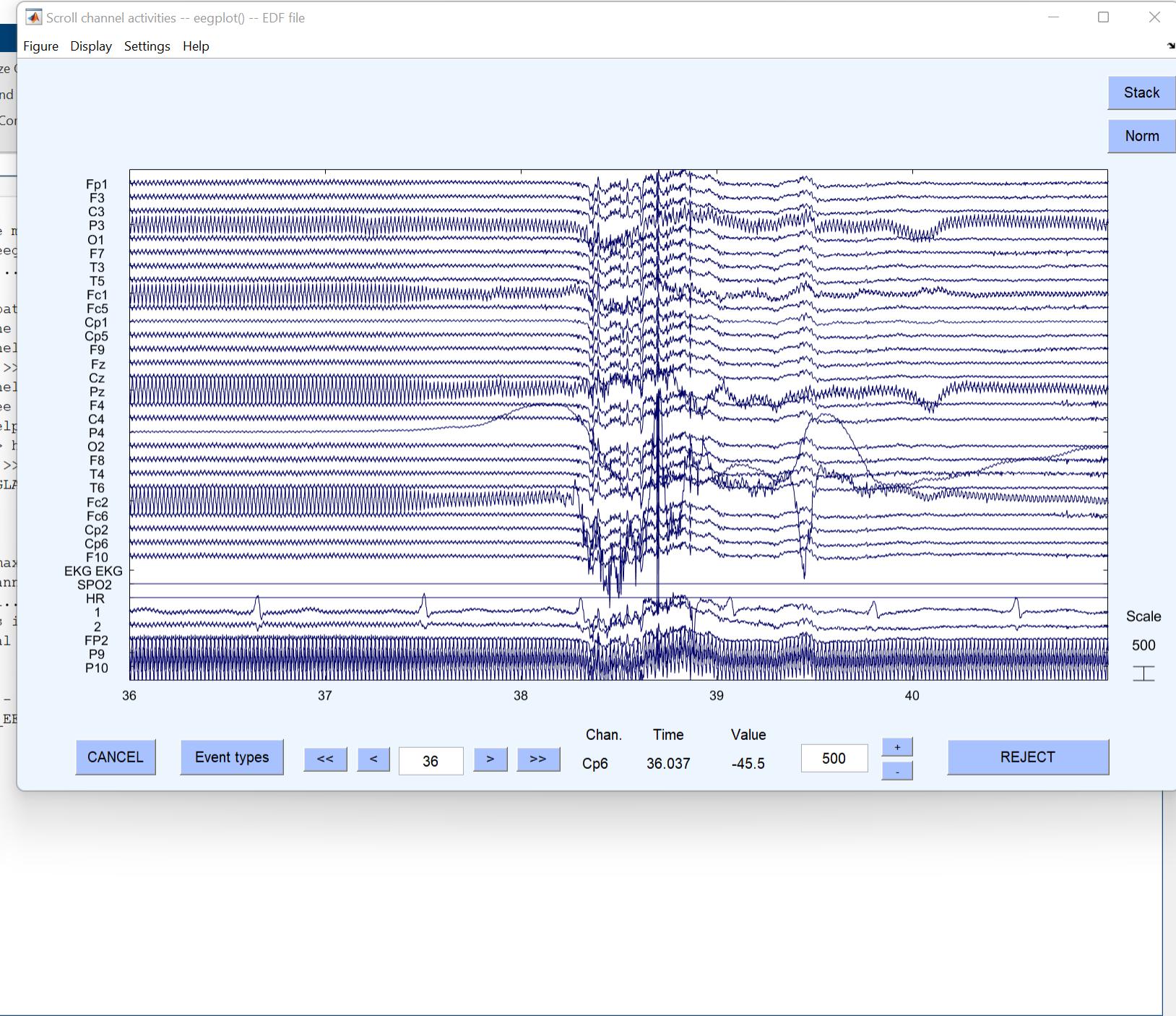
Channel spectra and maps
Channel properties
Channel ERP image
Channel ERPs > 648
ERP map series
Channel time-frequency
Component activations (scroll)
Component spectra and maps
Component maps > 00
Component properties .998
Component ERP image
Component ERPs > own
Component time-frequency
ICA weights NO

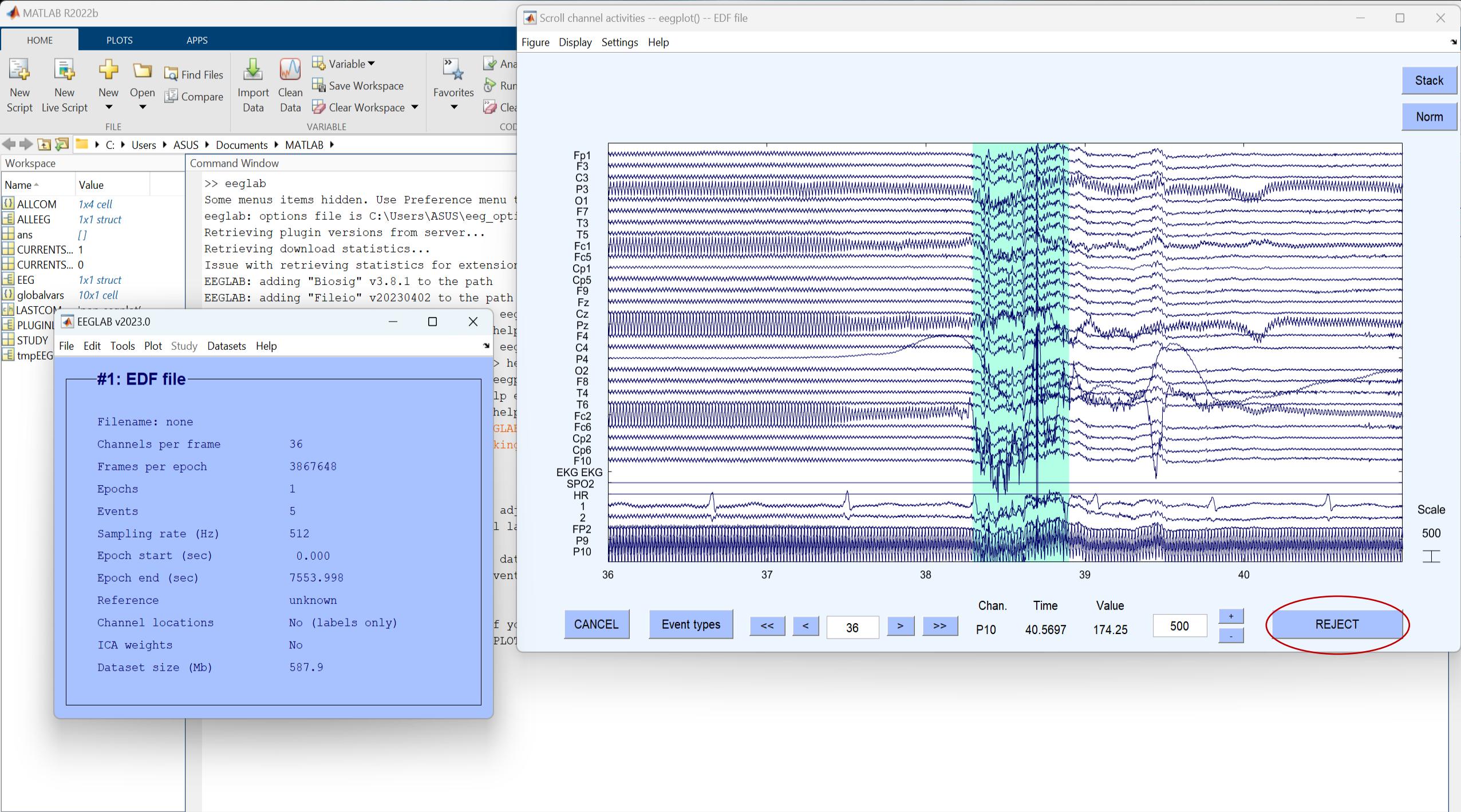
Dataset size (Mb) 587.9

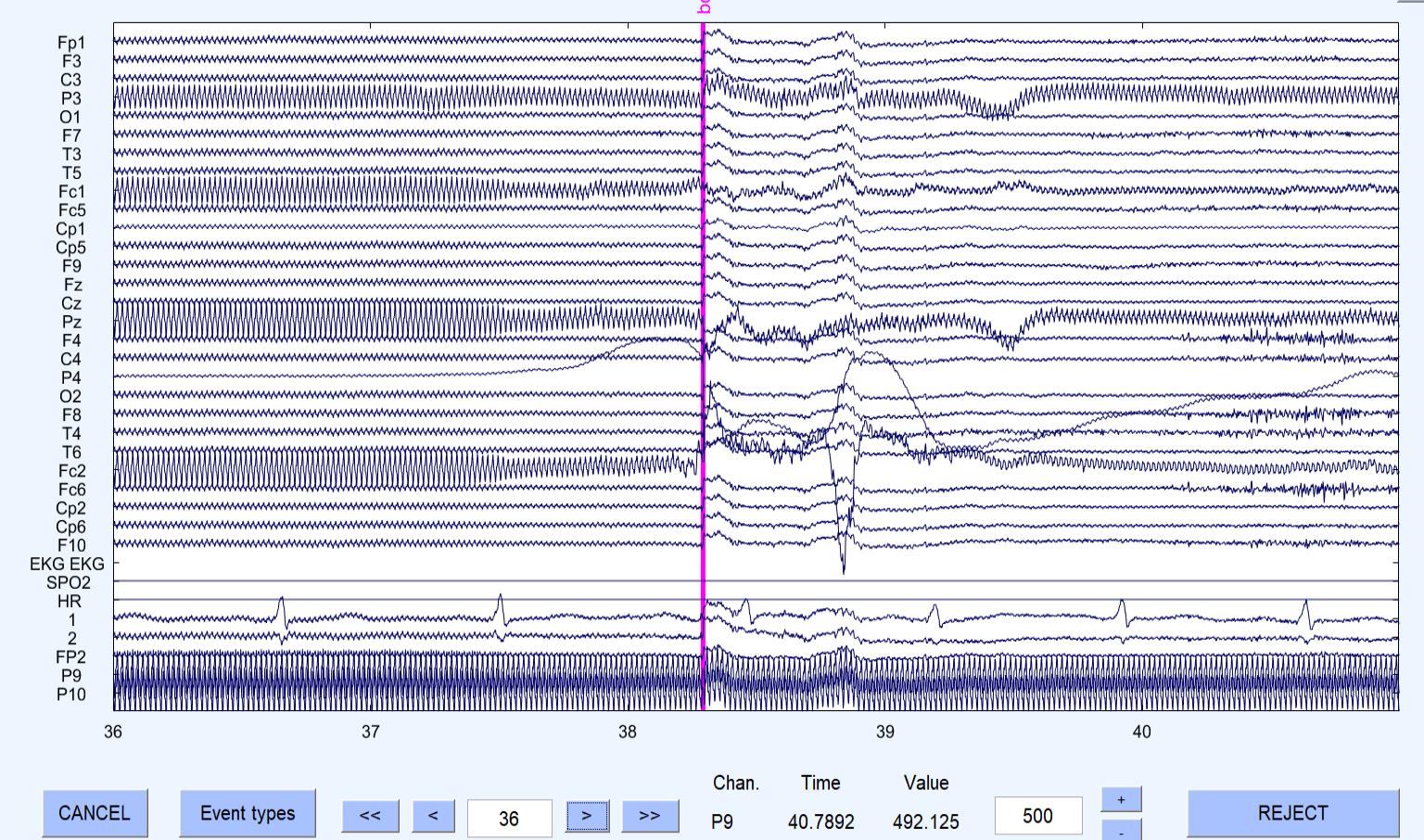
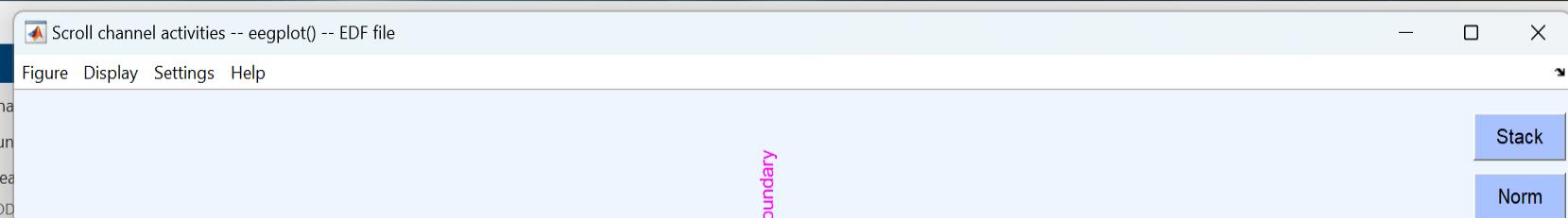
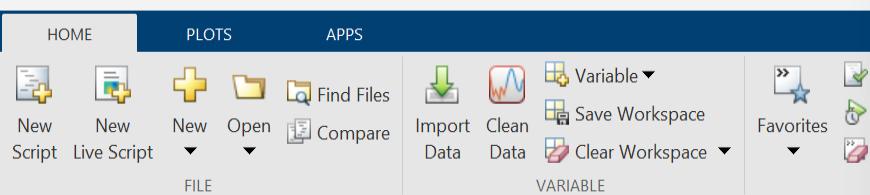


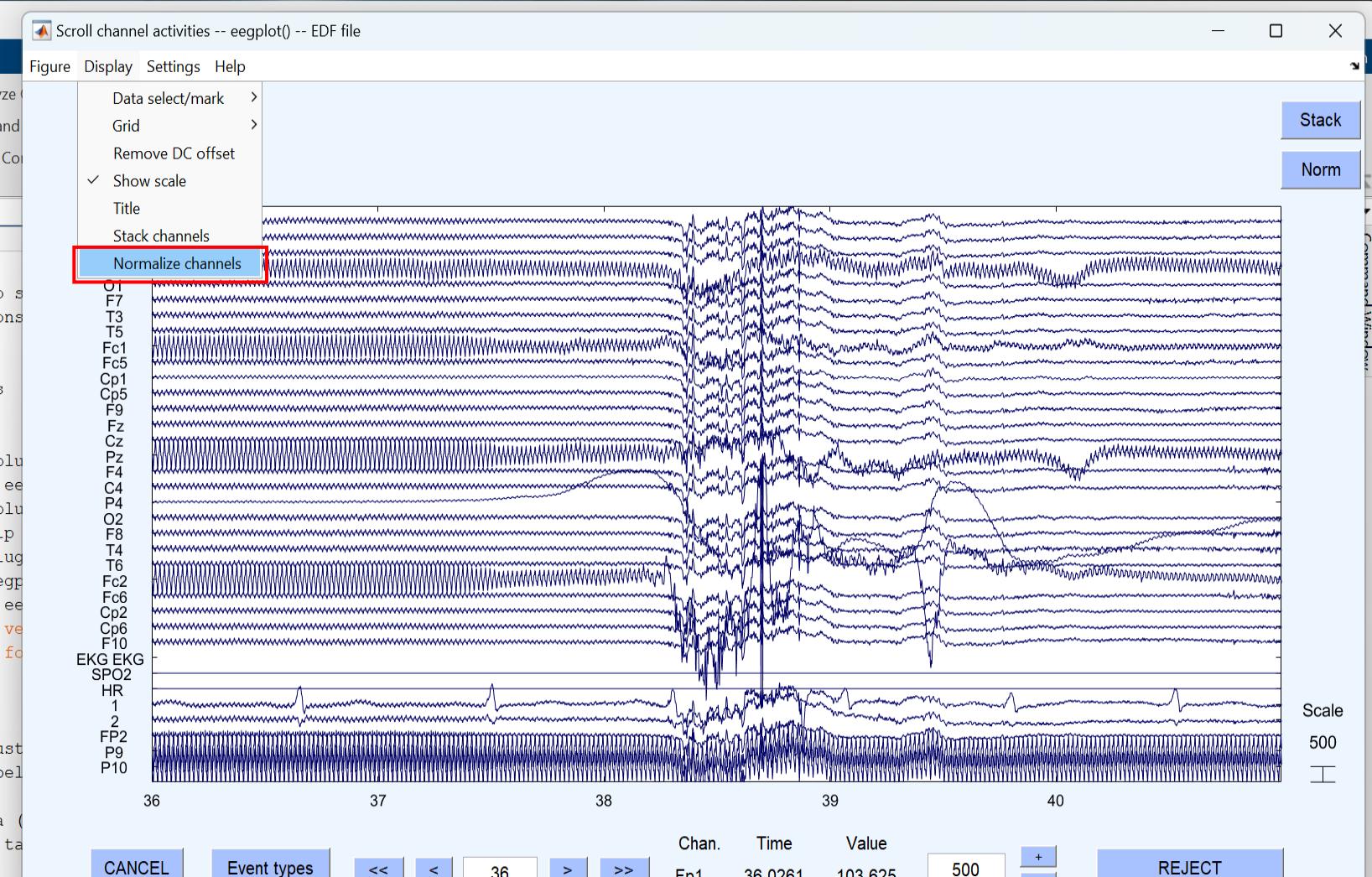
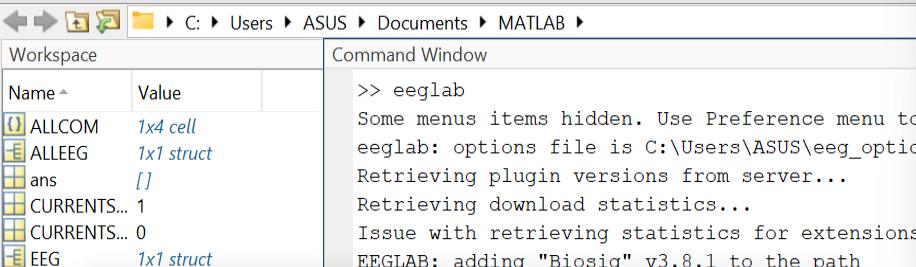
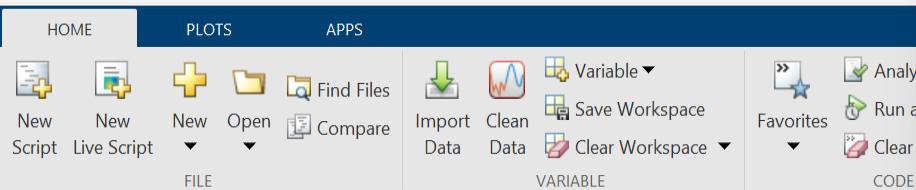
C:\Users\ASUS\Downloads>

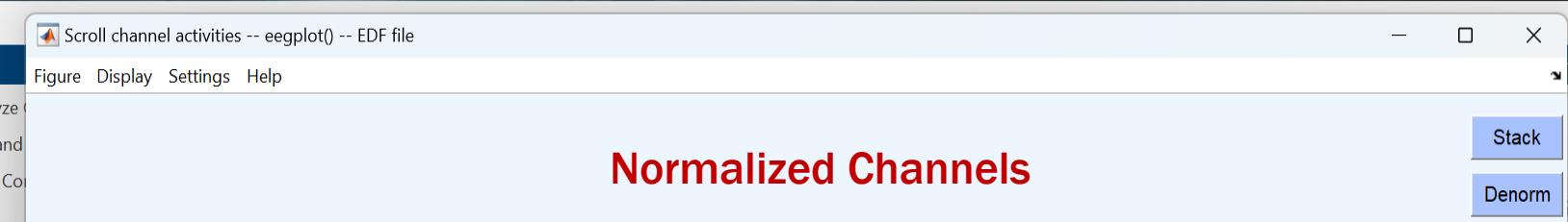
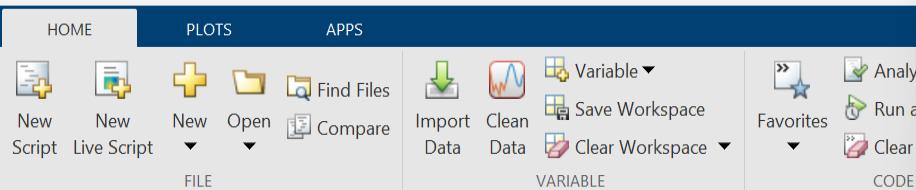
Workspace		Command Window
Name	Value	
ALLCOM	1x4 cell	>> eeglab Some menus items hidden. Use Preference m...
ALLEEG	1x1 struct	eeglab: options file is C:\Users\ASUS\eed...
ans	[]	Retrieving plugin versions from server...
CURRENTS...	1	Retrieving download statistics...
CURRENTS...	0	EEGLAB: adding "Biosig" v3.8.1 to the pat...
EEG	1x1 struct	EEGLAB: adding "Fileio" v20230402 to the
globalv		>> hel (see >> help) 8 (see >> help) of EEGLAB
LASTCO		>> help (see >> help) of EEGLAB
PLUGIN		>> help (see >> help) of EEGLAB
STUDY		>> help (see >> help) of EEGLAB
tmpEEG		>> help (see >> help) of EEGLAB

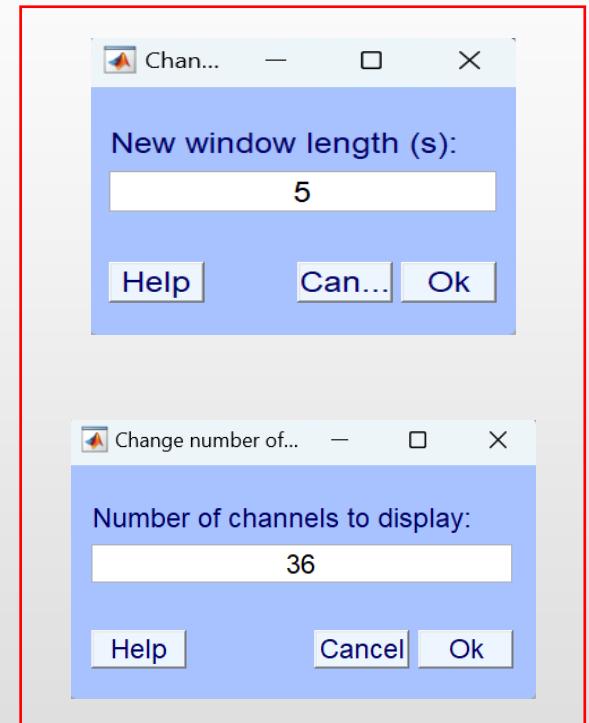
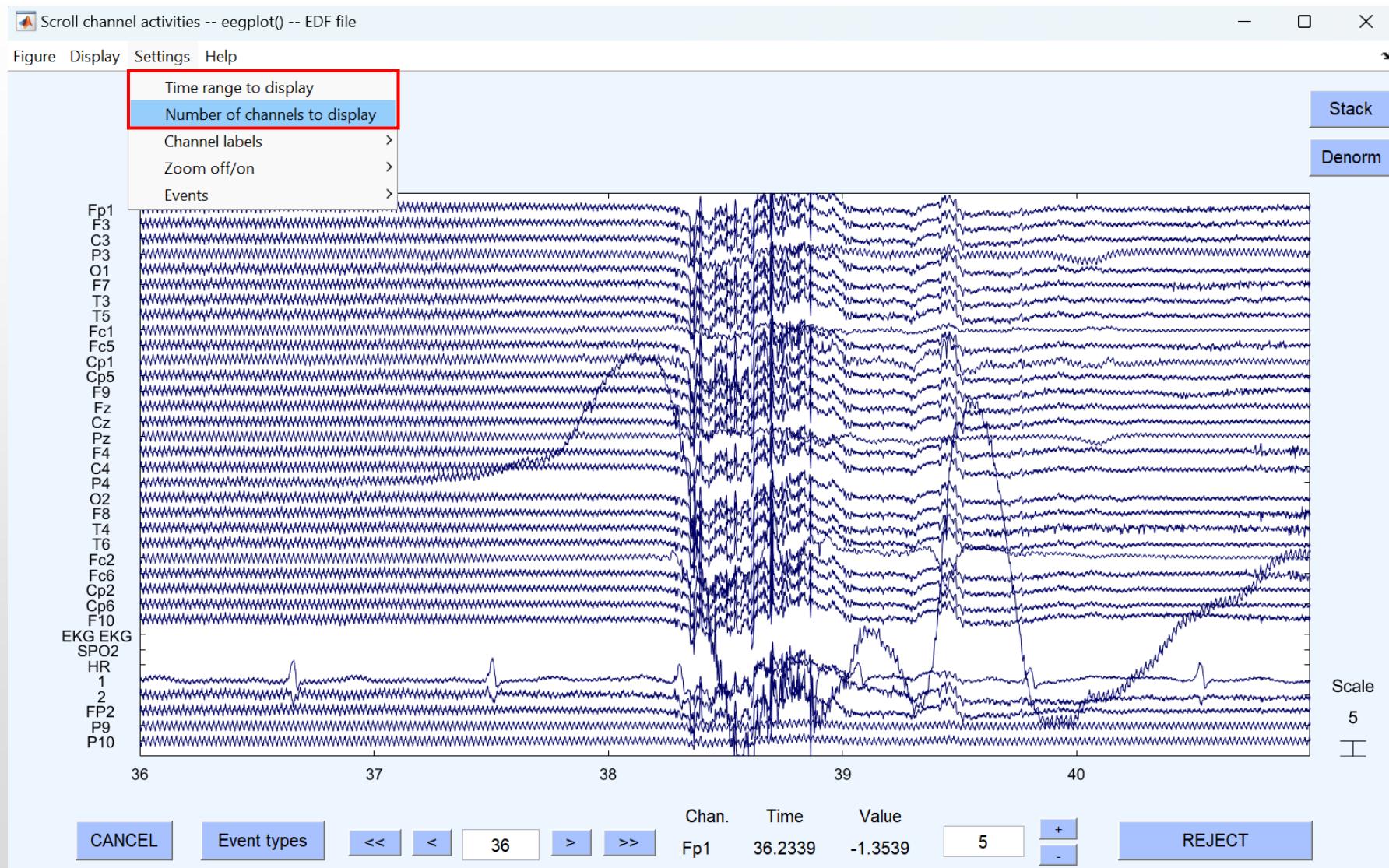


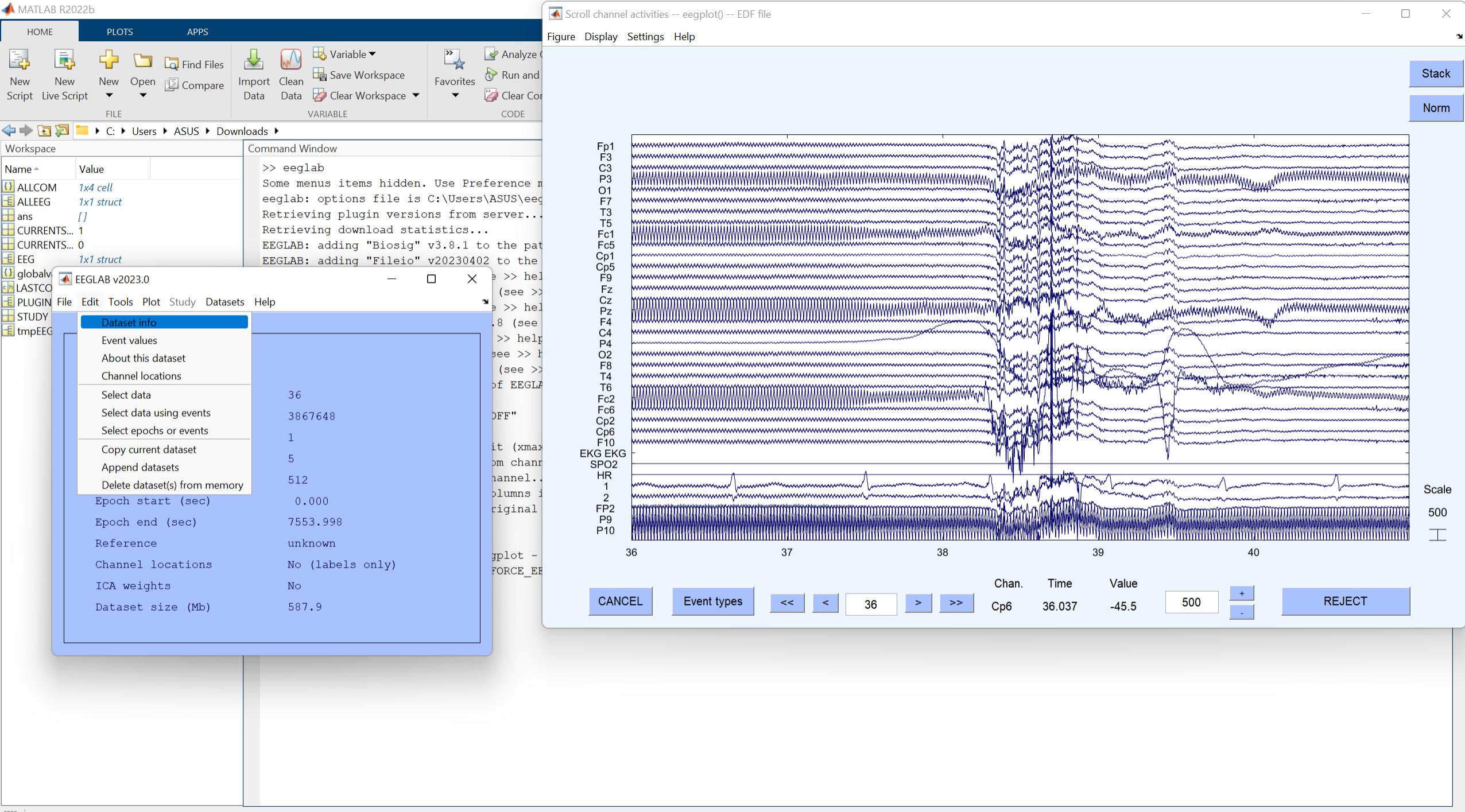


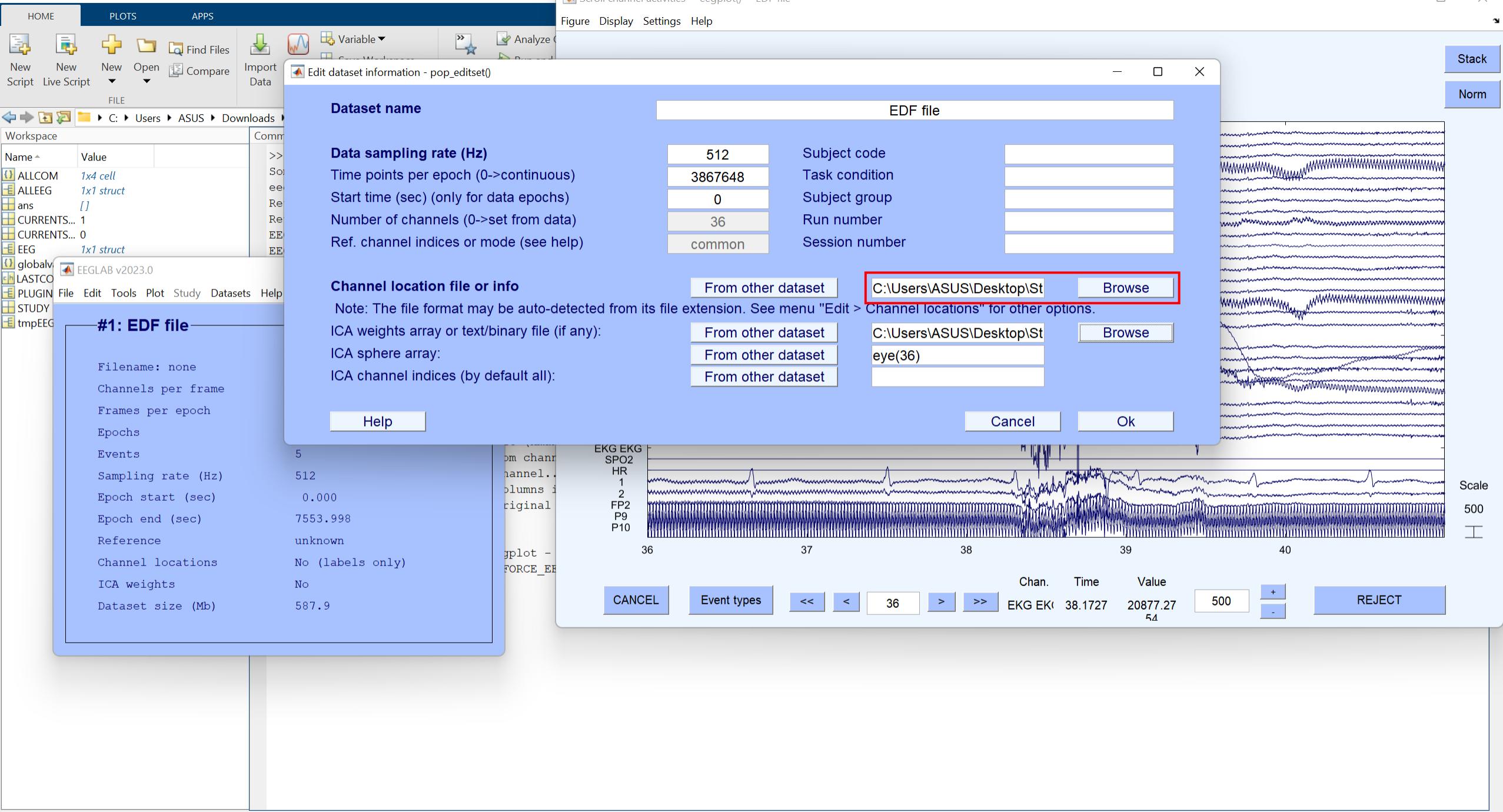


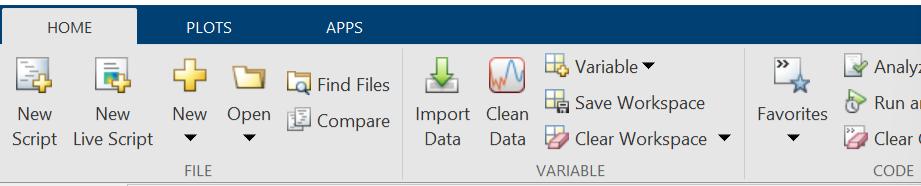






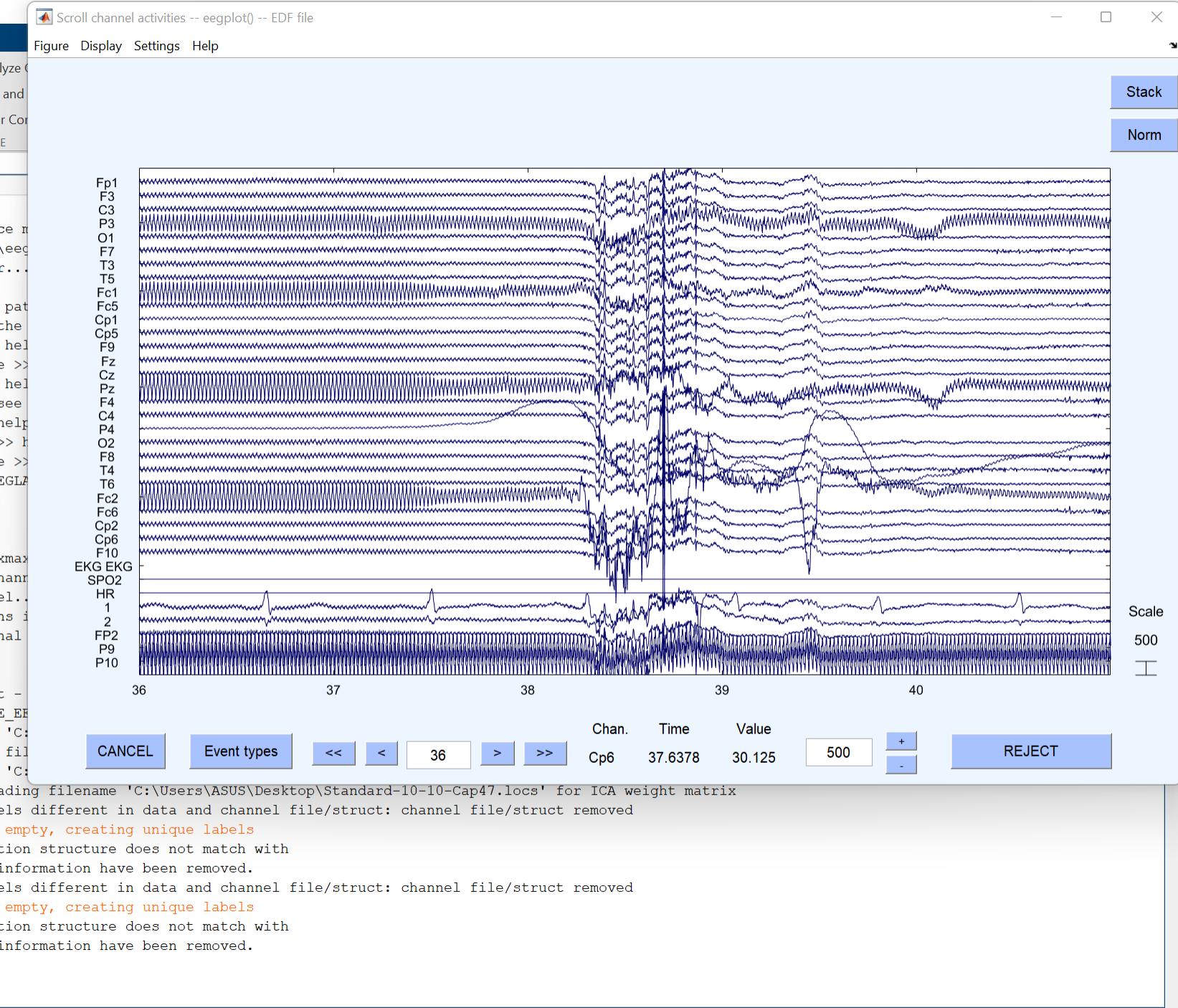


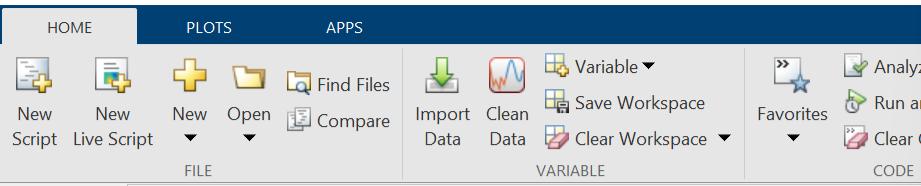




C: > Users > ASUS > Downloads >

Workspace		Command Window
Name	Value	
ALLCOM	1x6 cell	>> eeglab Some menus items hidden. Use Preference menu to show them.
ALLEEG	1x1 struct	eeglab: options file is C:\Users\ASUS\eedglab\options.edg
ans	[]	Retrieving plugin versions from server...
CURRENTS...	1	Retrieving download statistics...
CURRENTS...	0	EEGLAB: adding "Biosig" v3.8.1 to the path
EEG	1x1 struct	EEGLAB: adding "Fileio" v20230402 to the path
globalv		
LASTCO		>> help eeglab (see >> help eeglab)
PLUGIN		>> help eeglab (see >> help eeglab)
STUDY		of EEGLAB
tmpEEG		OFF"





<

>

C:

Users > ASUS > Downloads >

Workspace		Command Window
Name	Value	
ALLCOM	1x6 cell	>> eeglab Some menus items hidden. Use Preference menu to show them.
ALLEEG	1x1 struct	eeglab: options file is C:\Users\ASUS\eeglab\options.edf
ans	[]	Retrieving plugin versions from server...
CURRENTS...	1	Retrieving download statistics...
CURRENTS...	0	
EEG	1x1 struct	EEGLAB: adding "Biosig" v3.8.1 to the path
globalv		EEGLAB: adding "Fileio" v20230402 to the path
LASTCO		
PLUGIN		
STUDY		
tmpEEG		

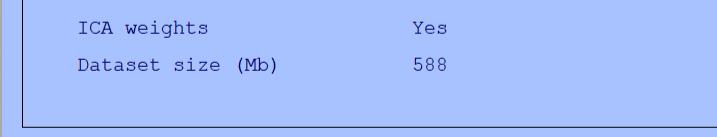
EEGLAB v2023.0

File Edit Tools Plot Study Datasets Help

STUDY

tmpEEG

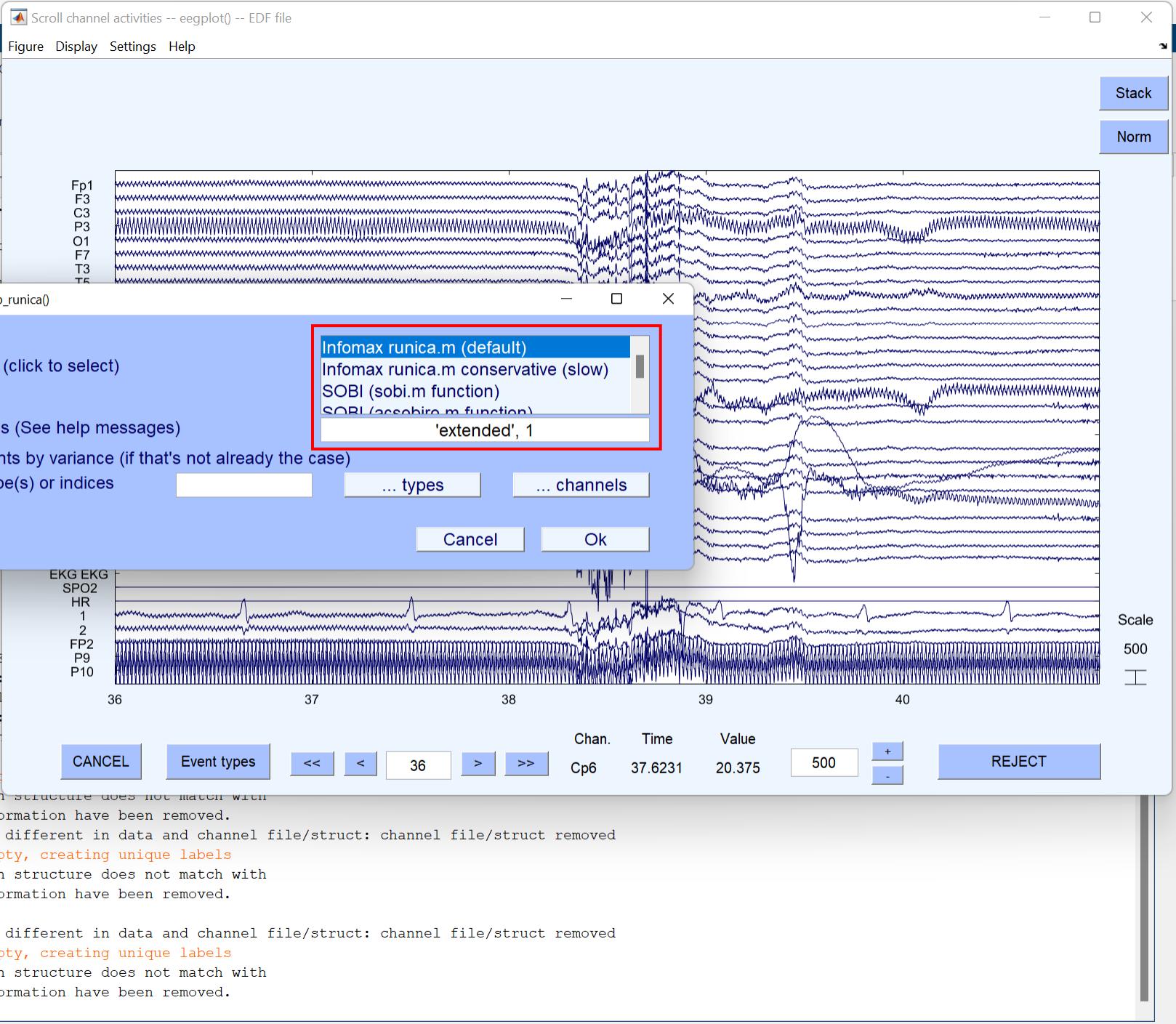
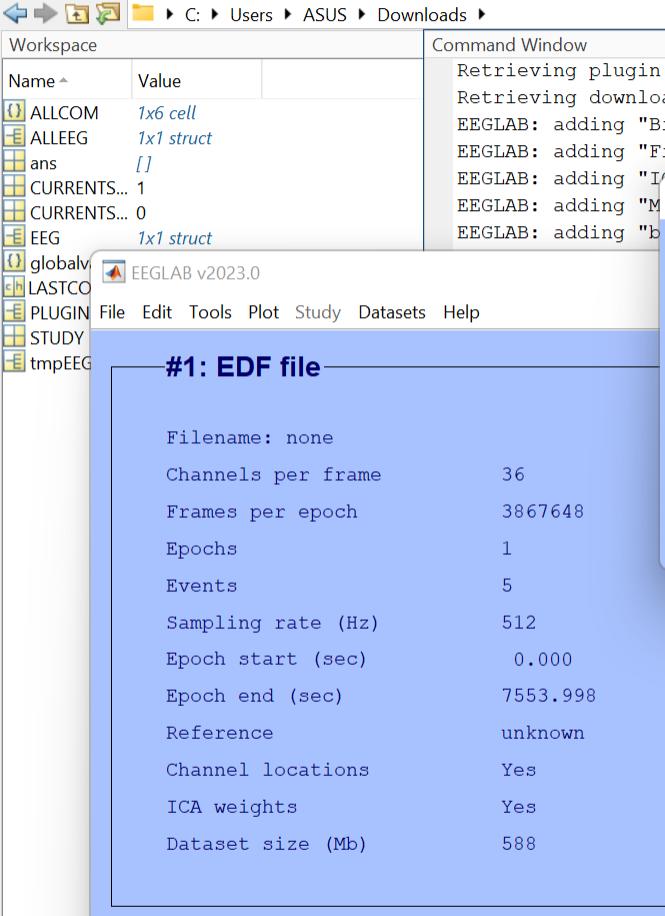
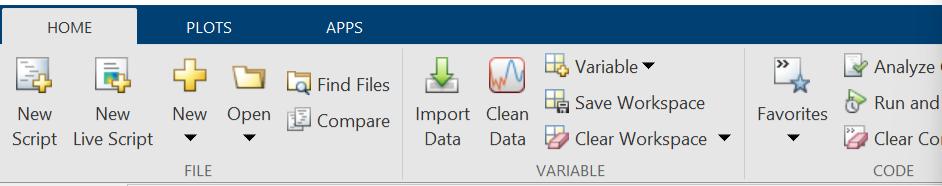
- (Expand tool choices via "File > Preferences")
- #
 - Change sampling rate
 - Filter the data
 - Re-reference the data
 - Interpolate electrodes
 - F
 - Inspect/reject data by eye
 - EJ Reject data using Clean Rawdata and ASR
 - EJ Decompose data by ICA
 - EJ Inspect/label components by map
 - S Classify components using ICLLabel
 - EJ Remove components from data
 - EJ Extract epochs
 - R Remove epoch baseline
 - C Source localization using DIPFIT
- | | |
|-------------------|-----|
| ICA weights | Yes |
| Dataset size (Mb) | 588 |

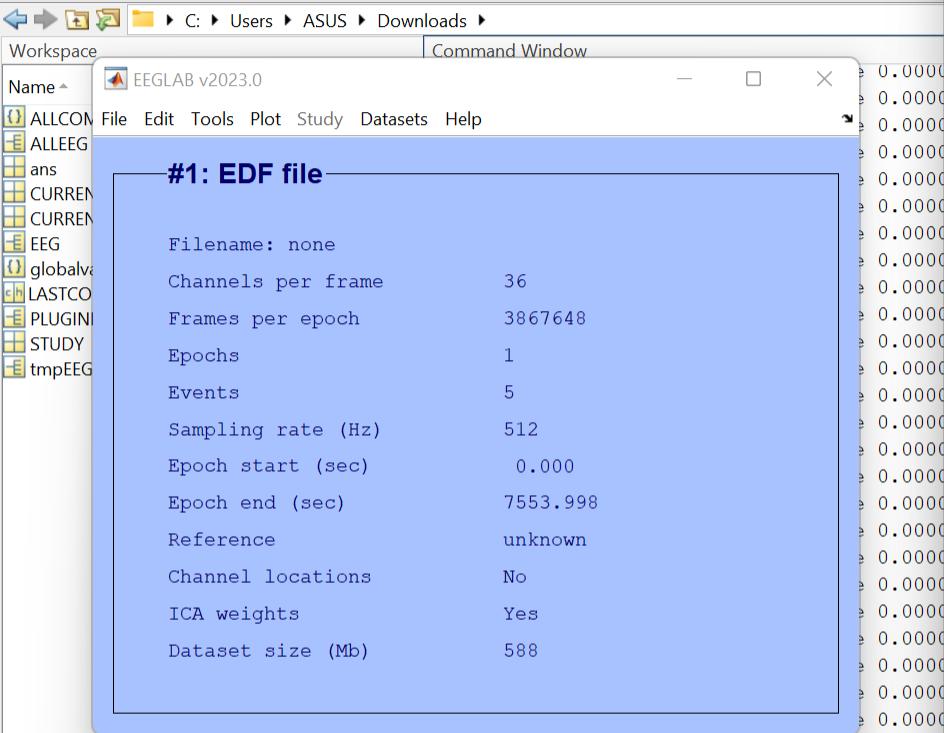
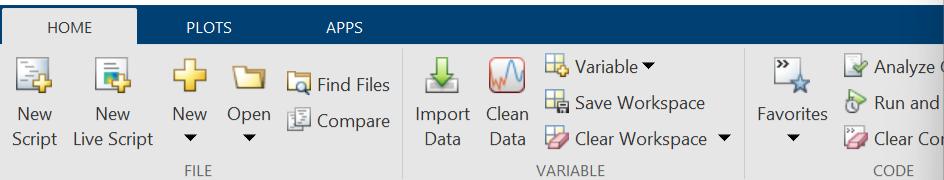


```

Warning: channel labels should not be empty, creating unique labels
Warning: the size of the channel location structure does not match with
          number of channels. Channel information have been removed.
eeg_checkset warning: number of channels different in data and channel file/struct: channel file/struct removed
Warning: channel labels should not be empty, creating unique labels
Warning: the size of the channel location structure does not match with
          number of channels. Channel information have been removed.
Done.
fx >>

```



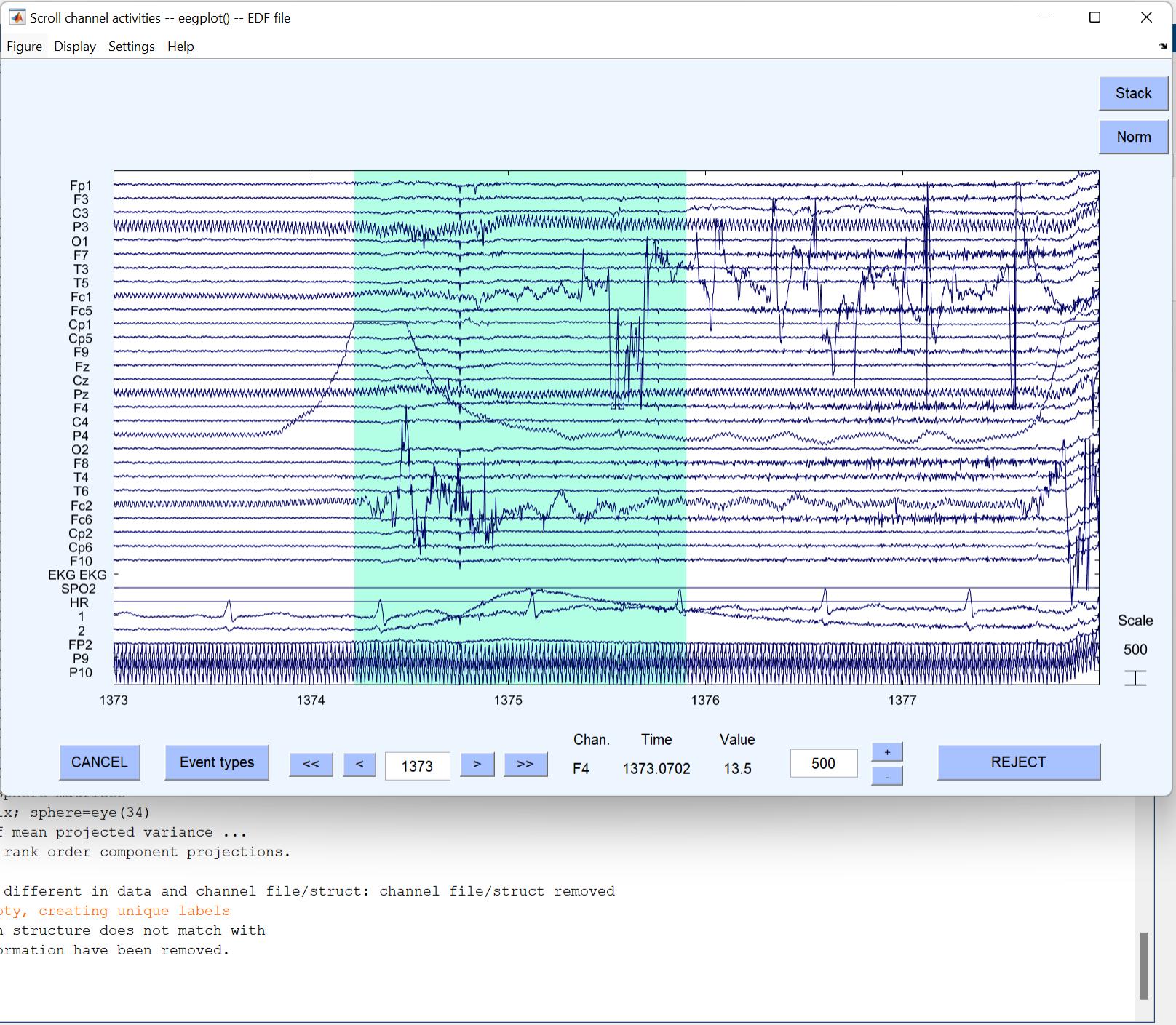


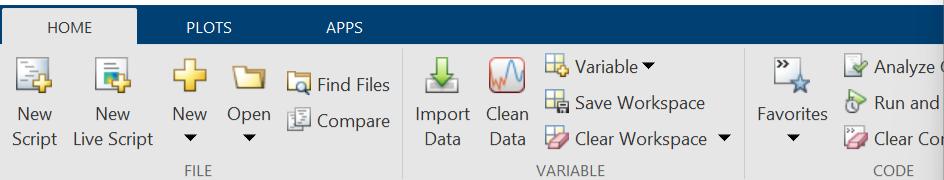
```

step 352 - lrate 0.000000, wchange 0.000000
step 353 - lrate 0.000000, wchange 0.000000
step 354 - lrate 0.000000, wchange 0.000000
step 355 - lrate 0.000000, wchange 0.000000
step 356 - lrate 0.000000, wchange 0.000000
Composing the eigenvector, weights, and s...
    into a single rectangular weights matrix; sphere=eye(34)
Sorting components in descending order of mean projected variance ...
Using pseudo-inverse of weight matrix to rank order component projections.
Scaling components to RMS microvolt
eeg_checkset warning: number of channels different in data and channel file/struct: channel file/struct removed
Warning: channel labels should not be empty, creating unique labels
Warning: the size of the channel location structure does not match with
    number of channels. Channel information have been removed.
Scaling components to RMS microvolt
Scaling components to RMS microvolt

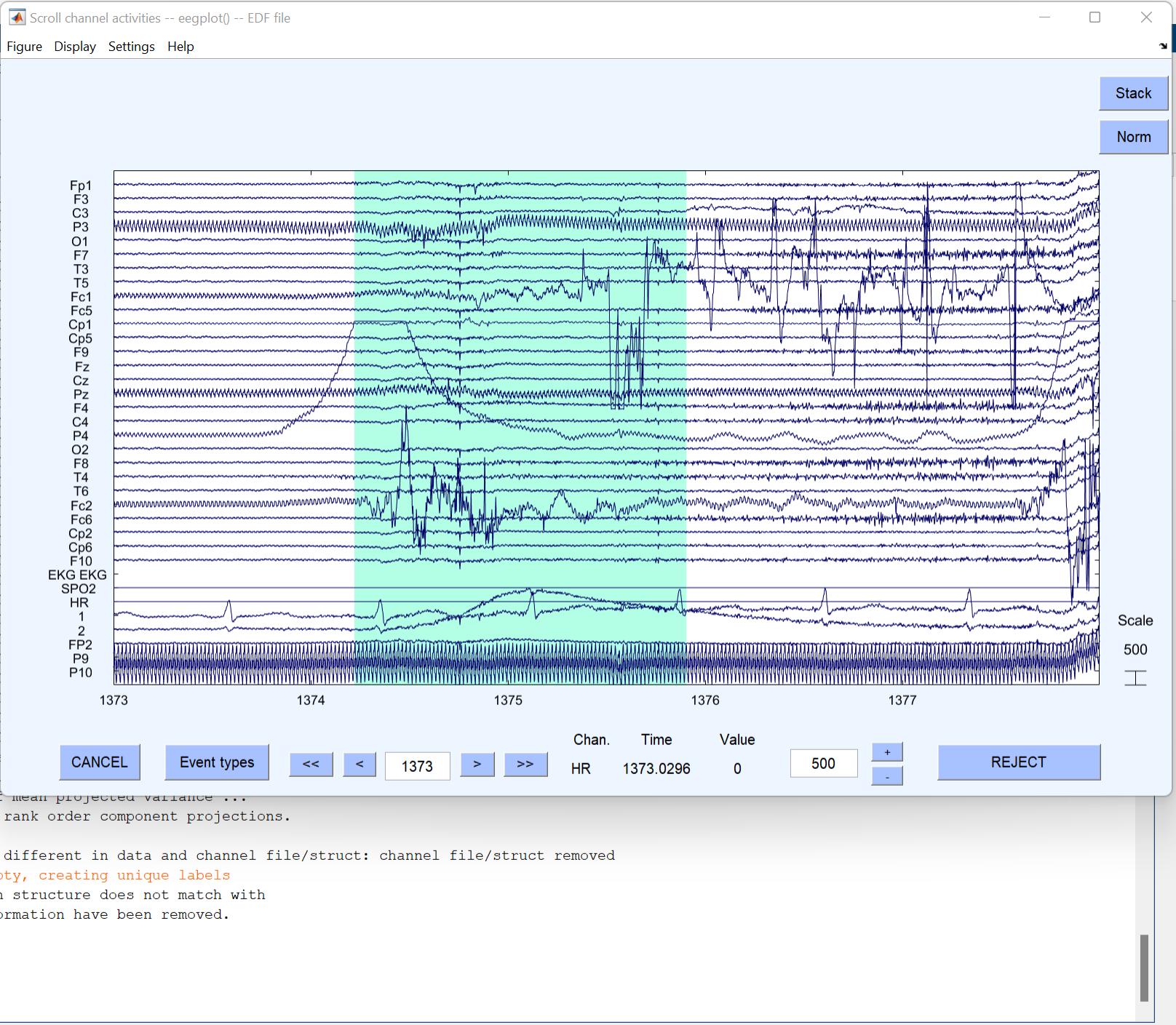
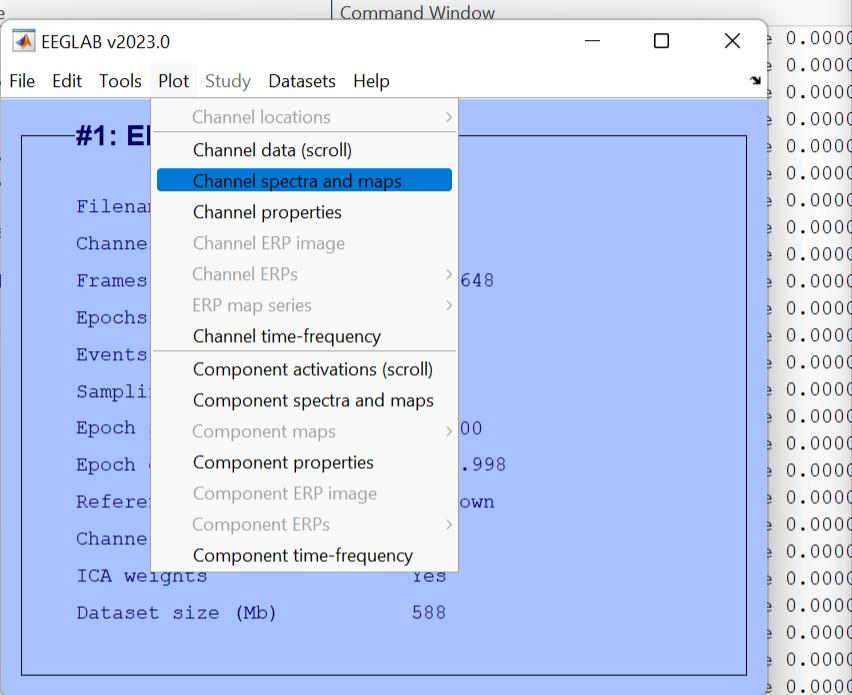
```

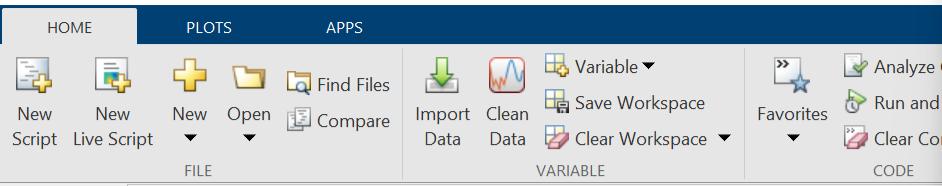
fx Done.





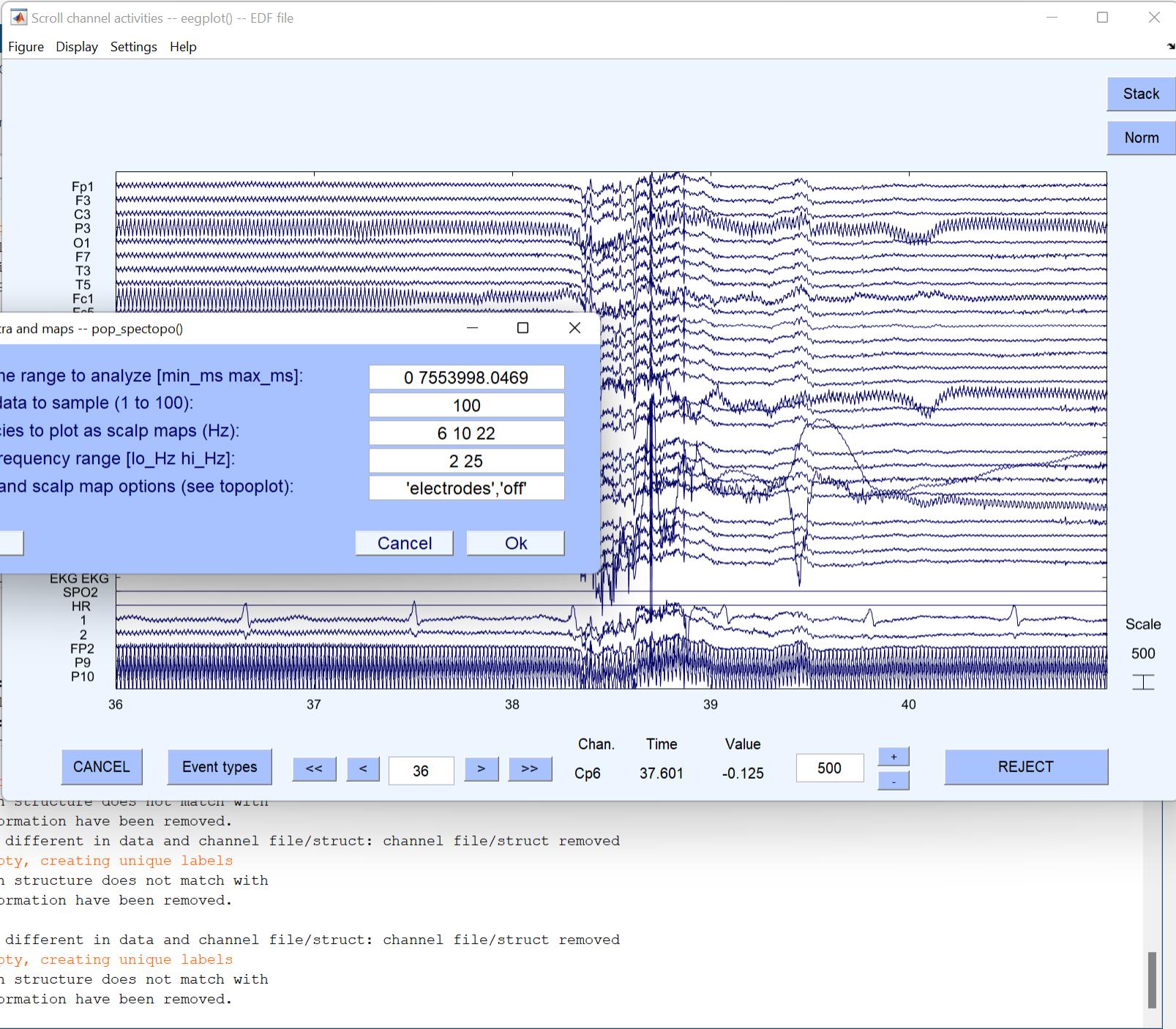
C: > Users > ASUS > Downloads >





C: > Users > ASUS > Downloads >

Workspace		Command Window
Name	Value	
ALLCOM	1x21 cell	to convert between channel location
ALLEEG	1x1 struct	Warning: channel labels should not be empty
ans		readlocs(): 'loc' format assumed from file
EEGLAB v2023.0		and in E1, LPA, RE



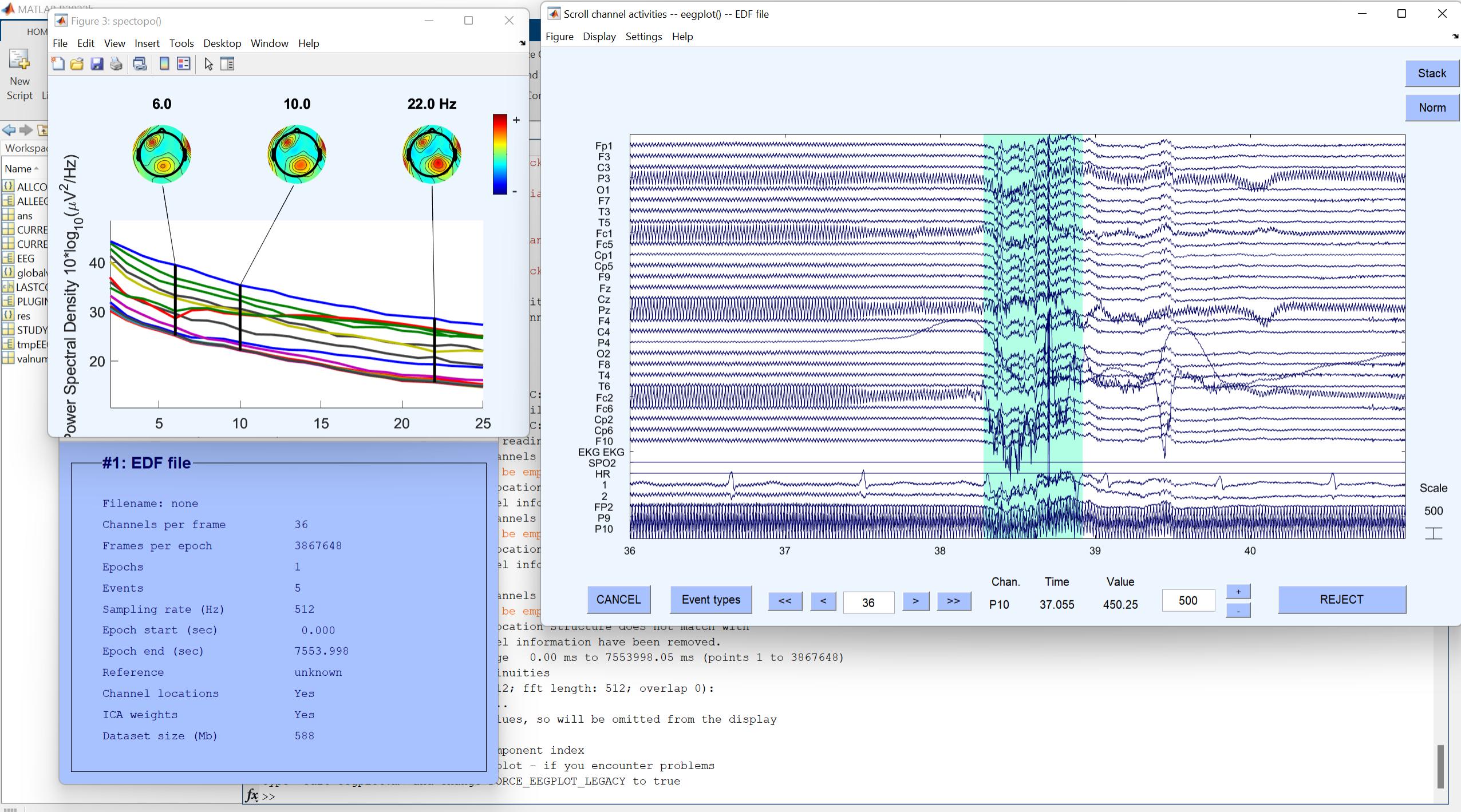
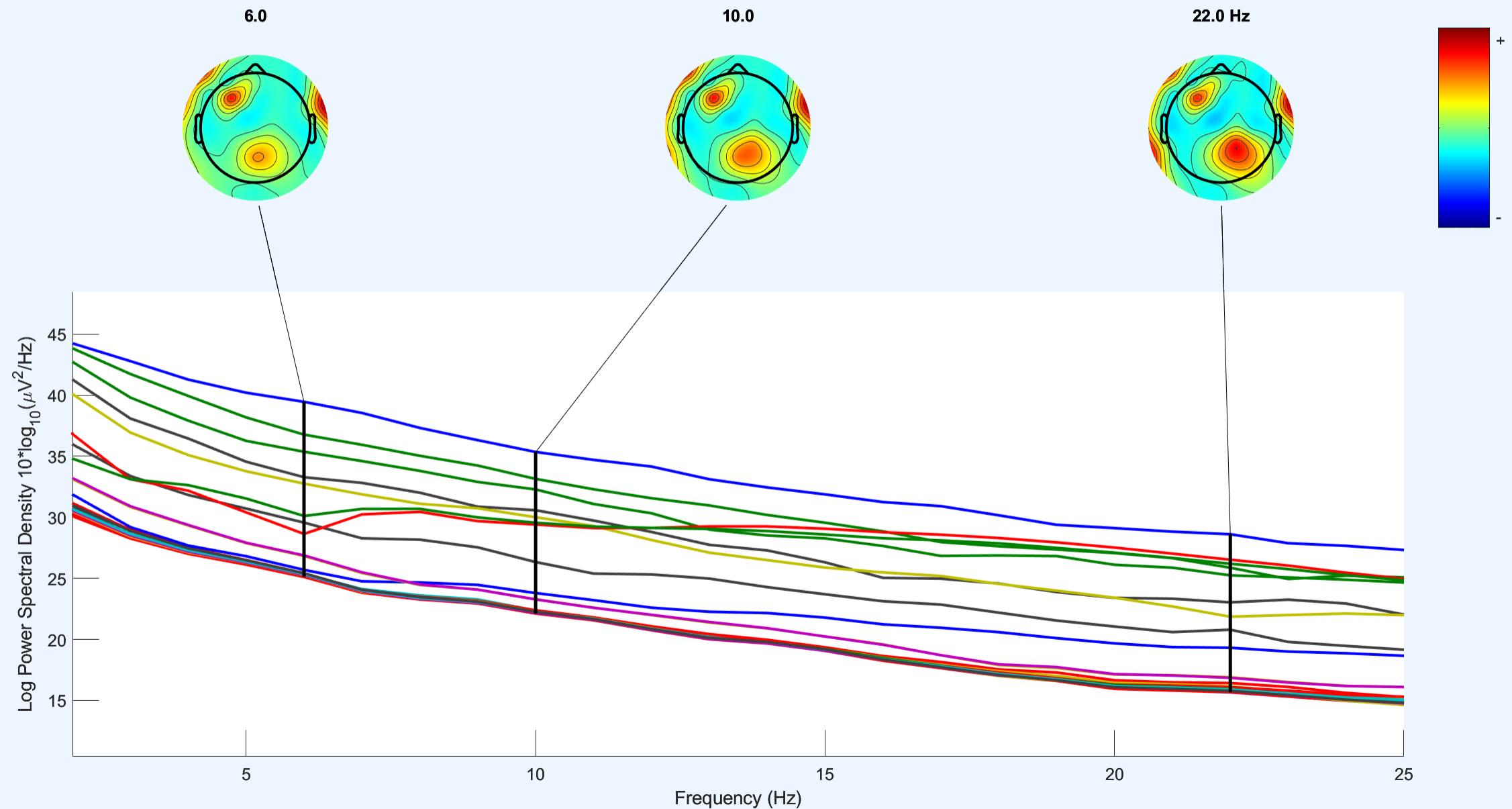


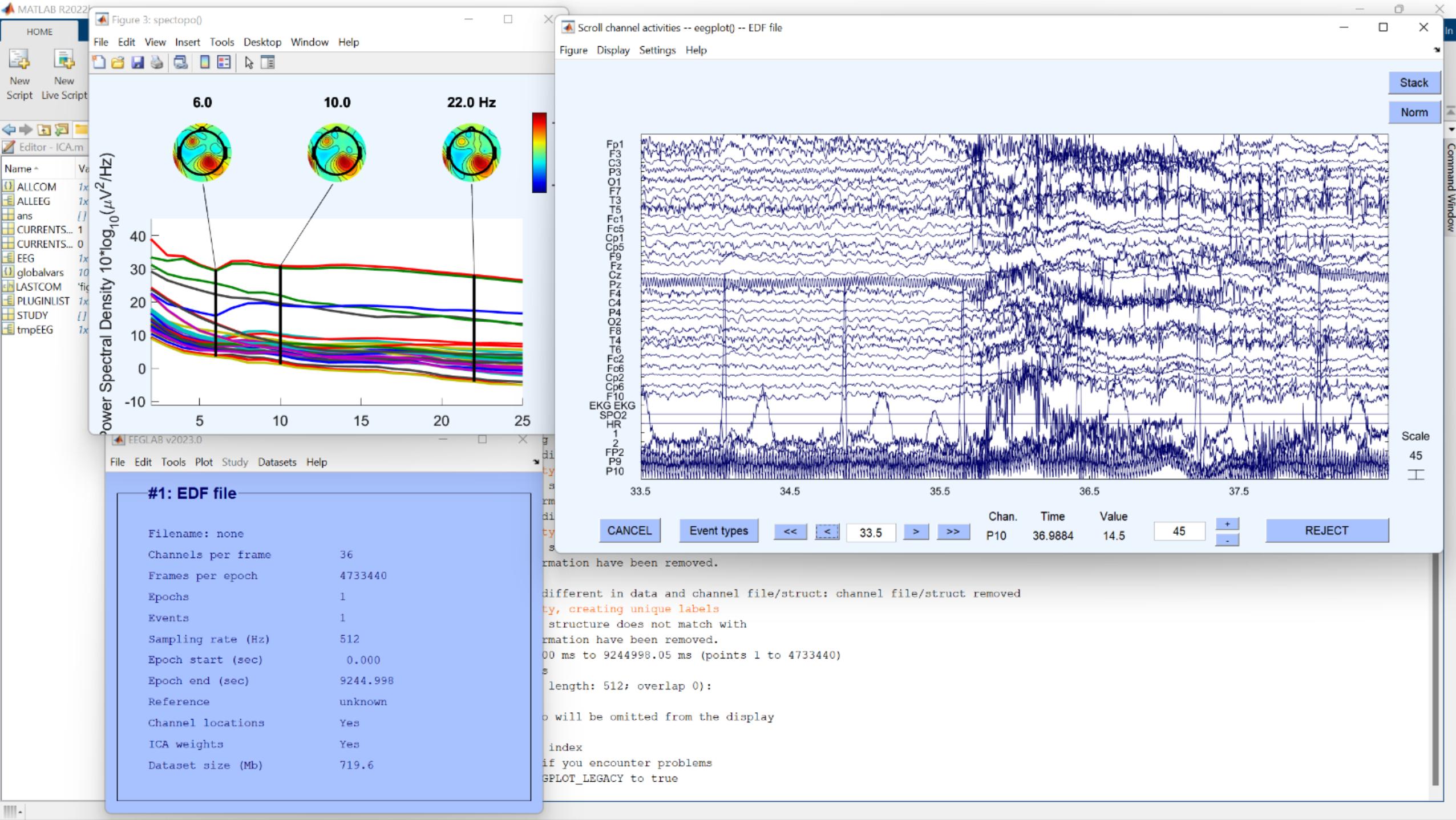
Figure 3: spectopo()

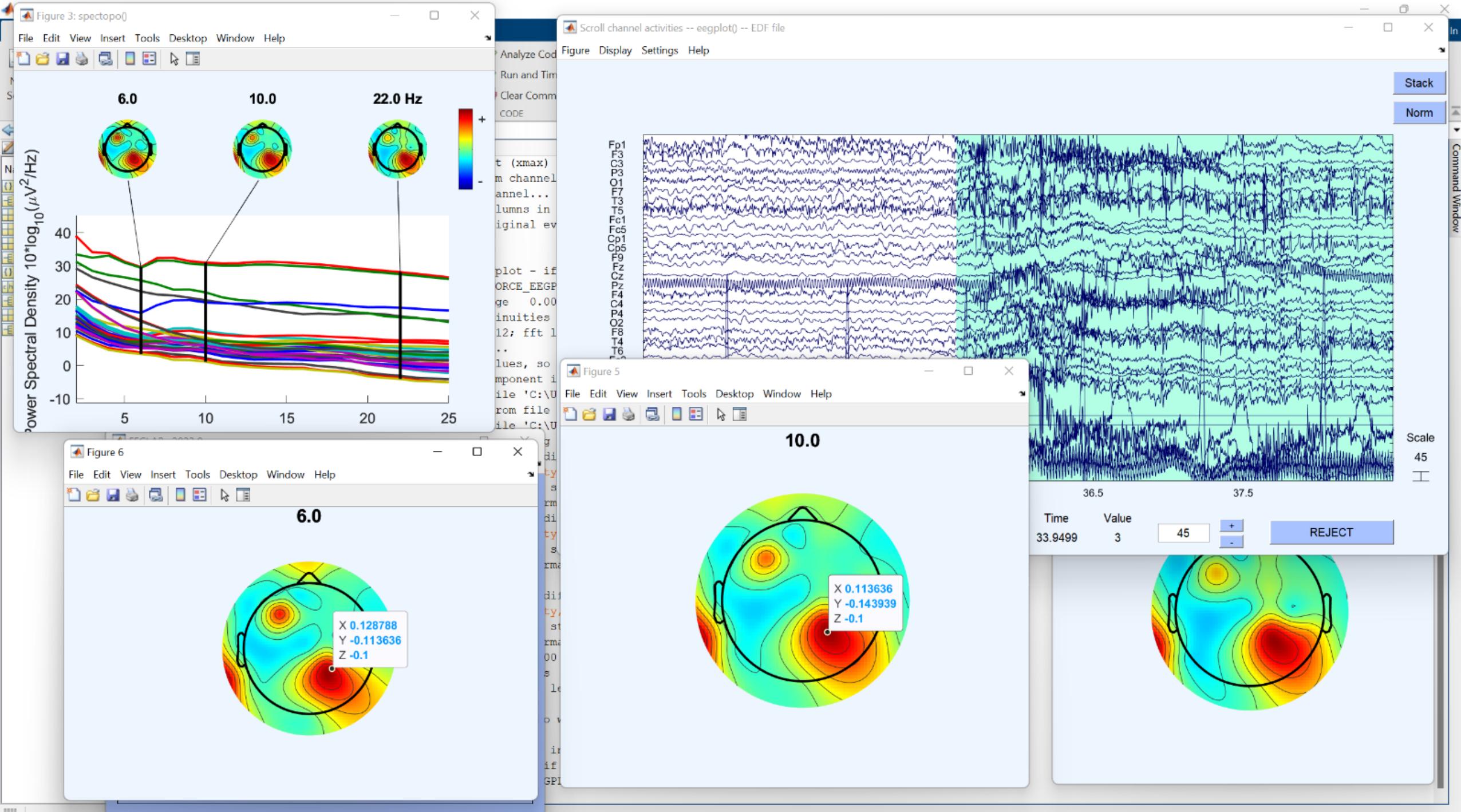
File Edit View Insert Tools Desktop Window Help

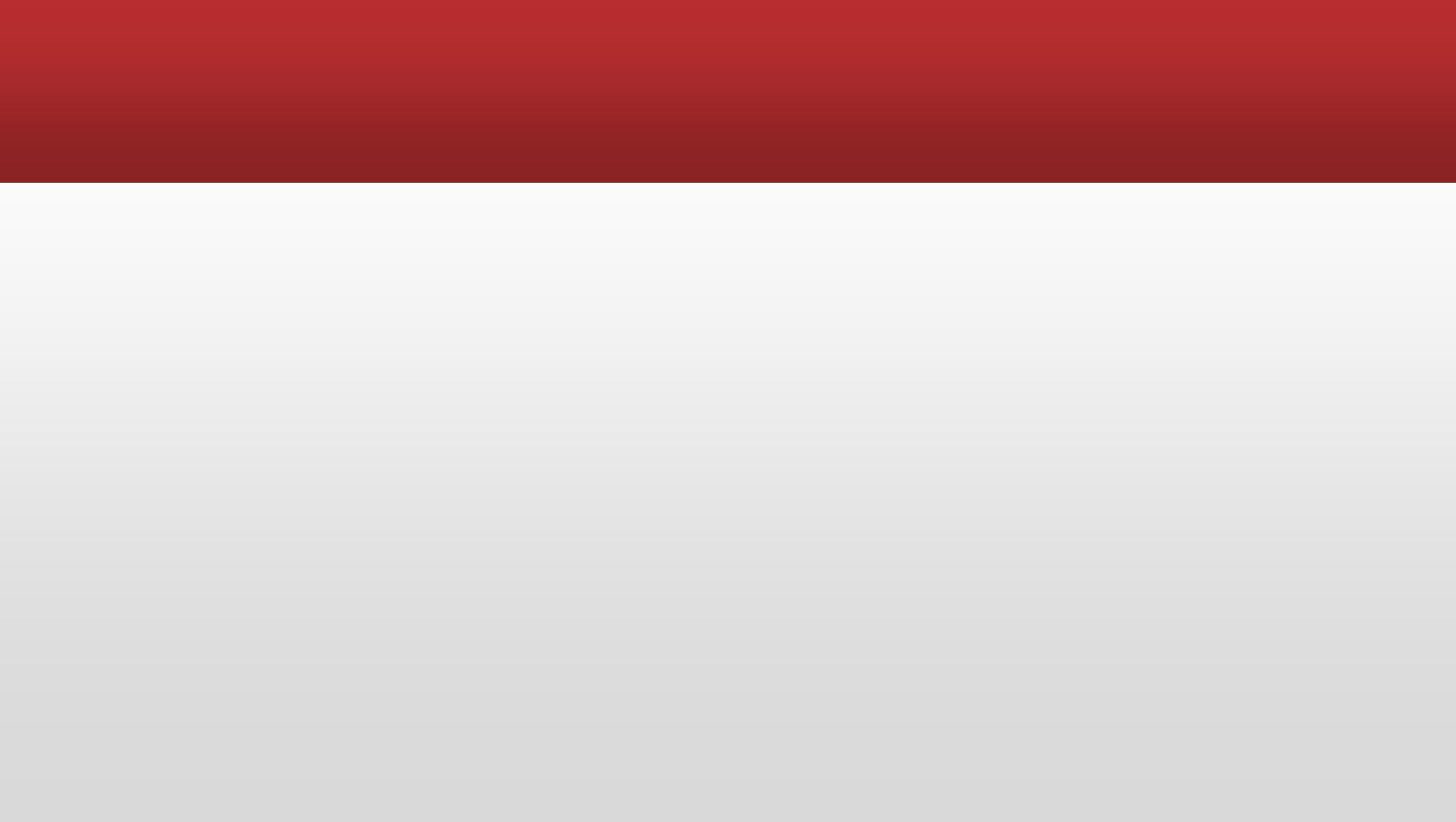


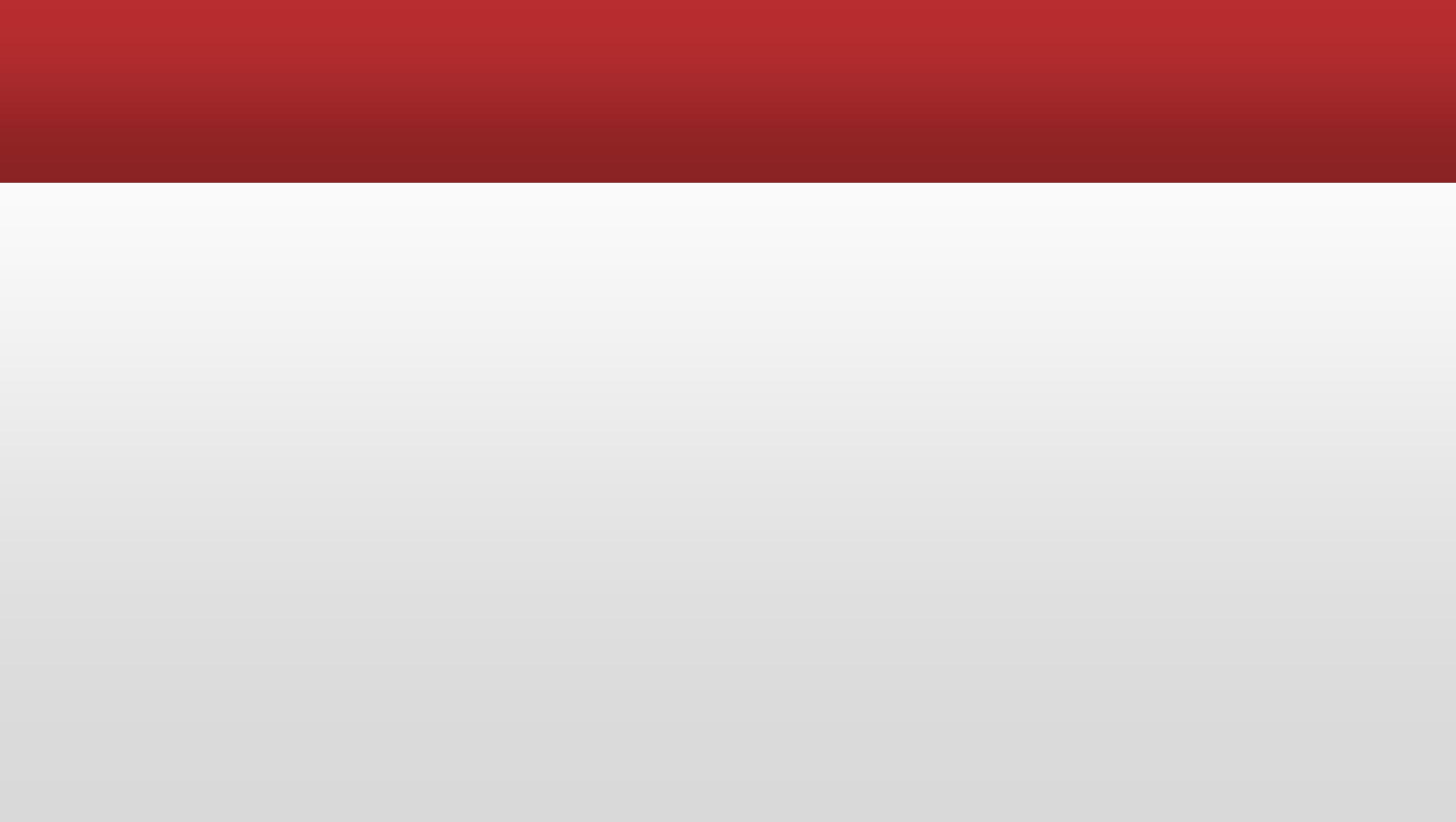
- □ X

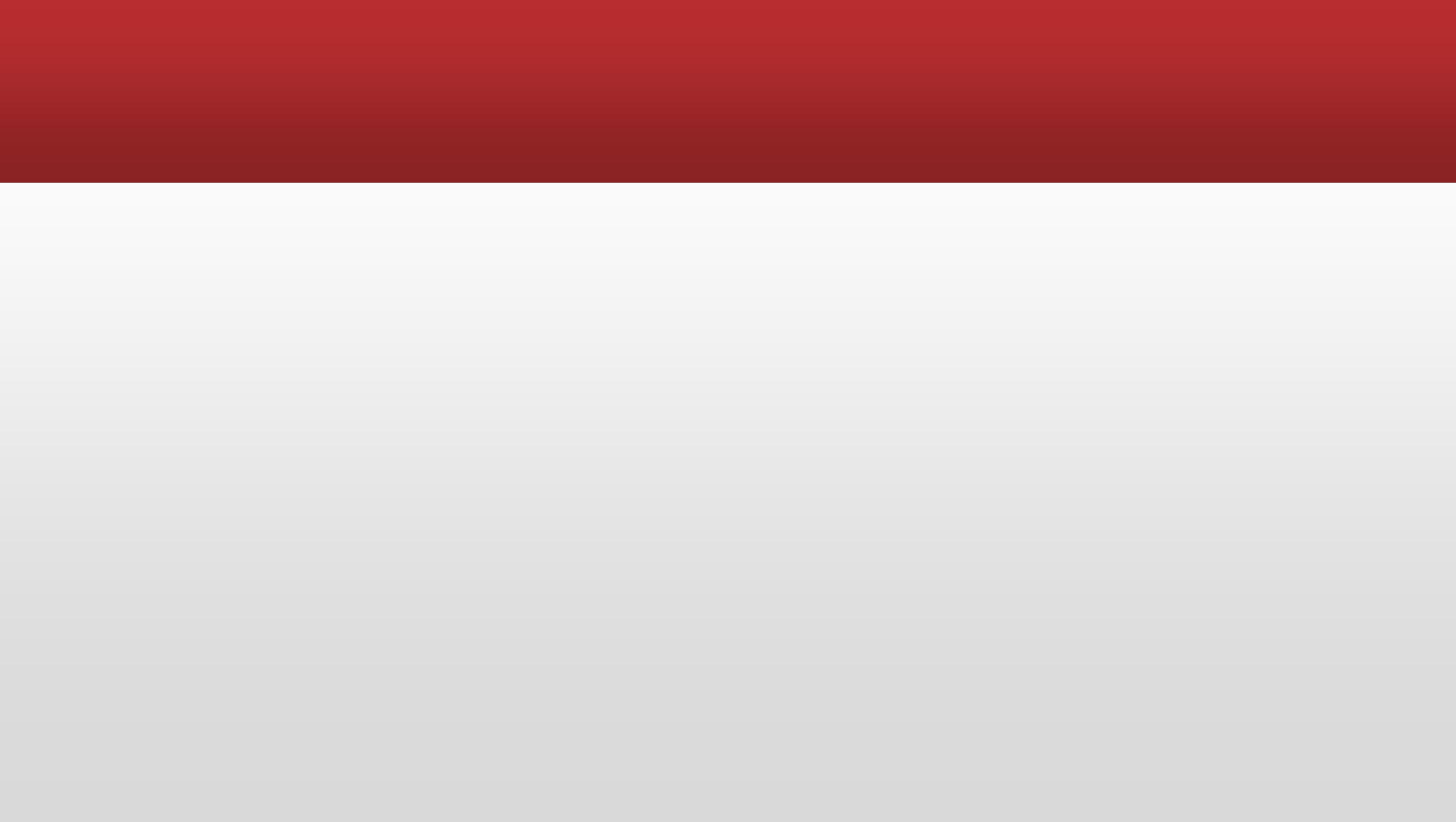


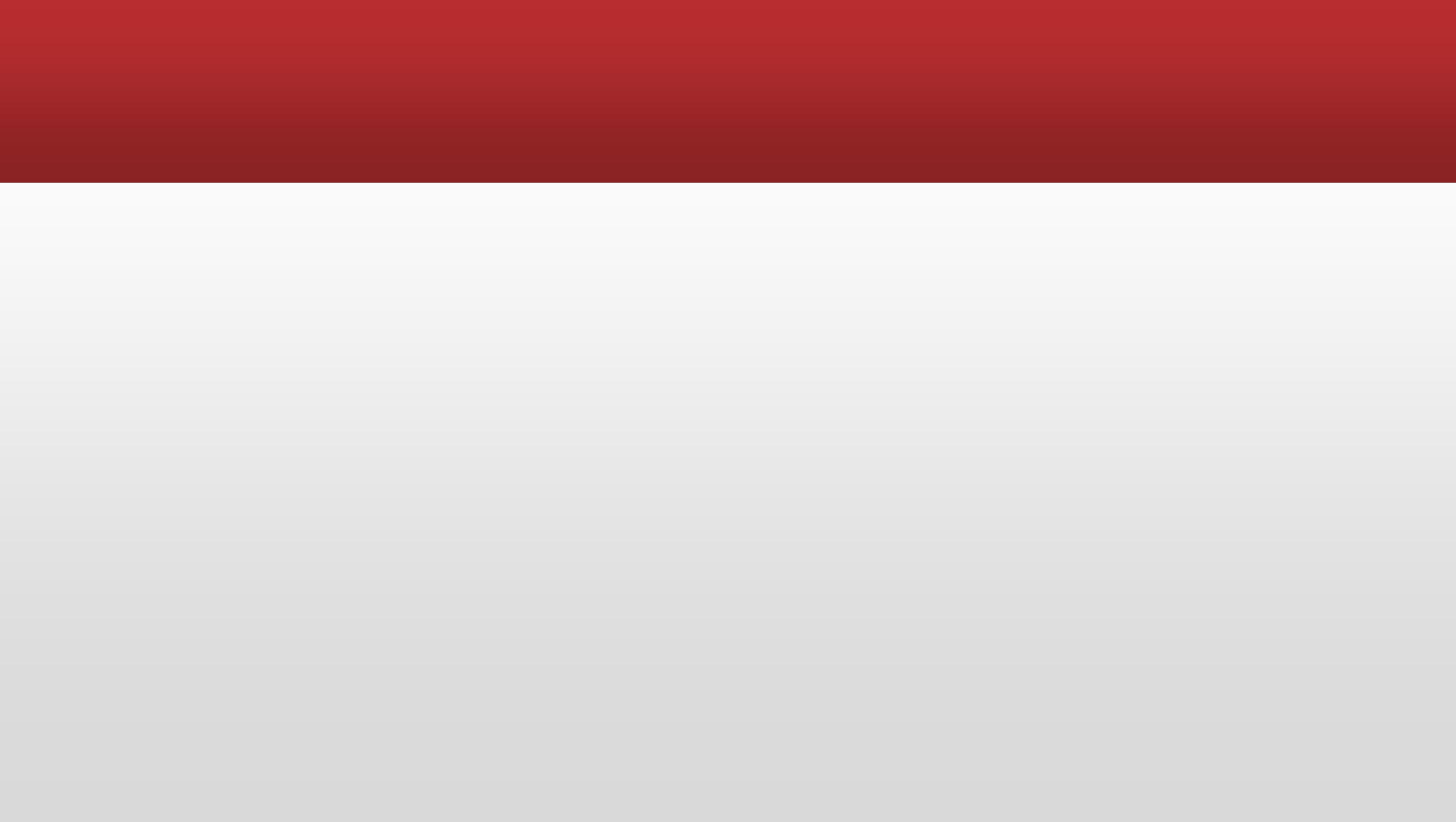


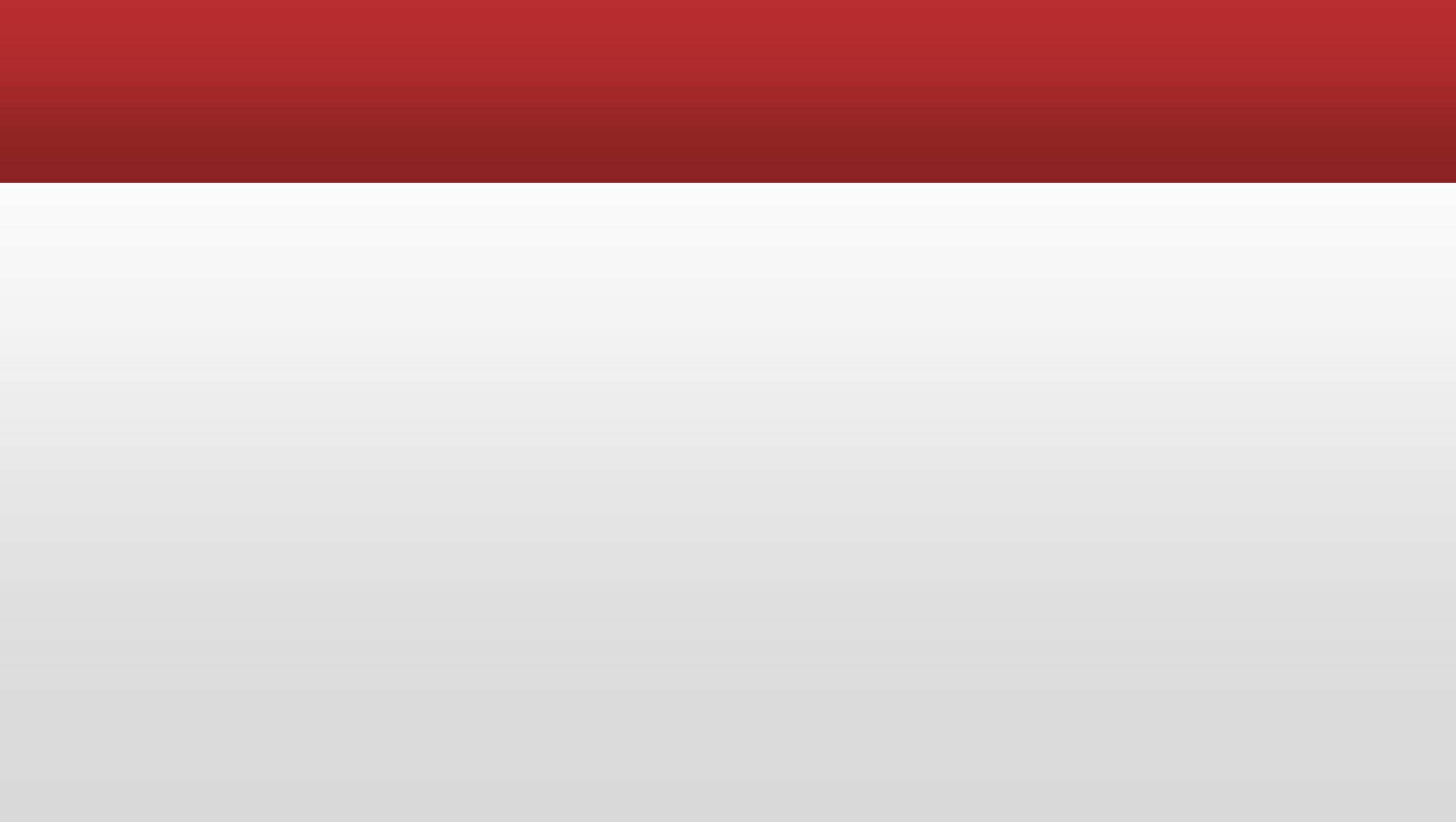


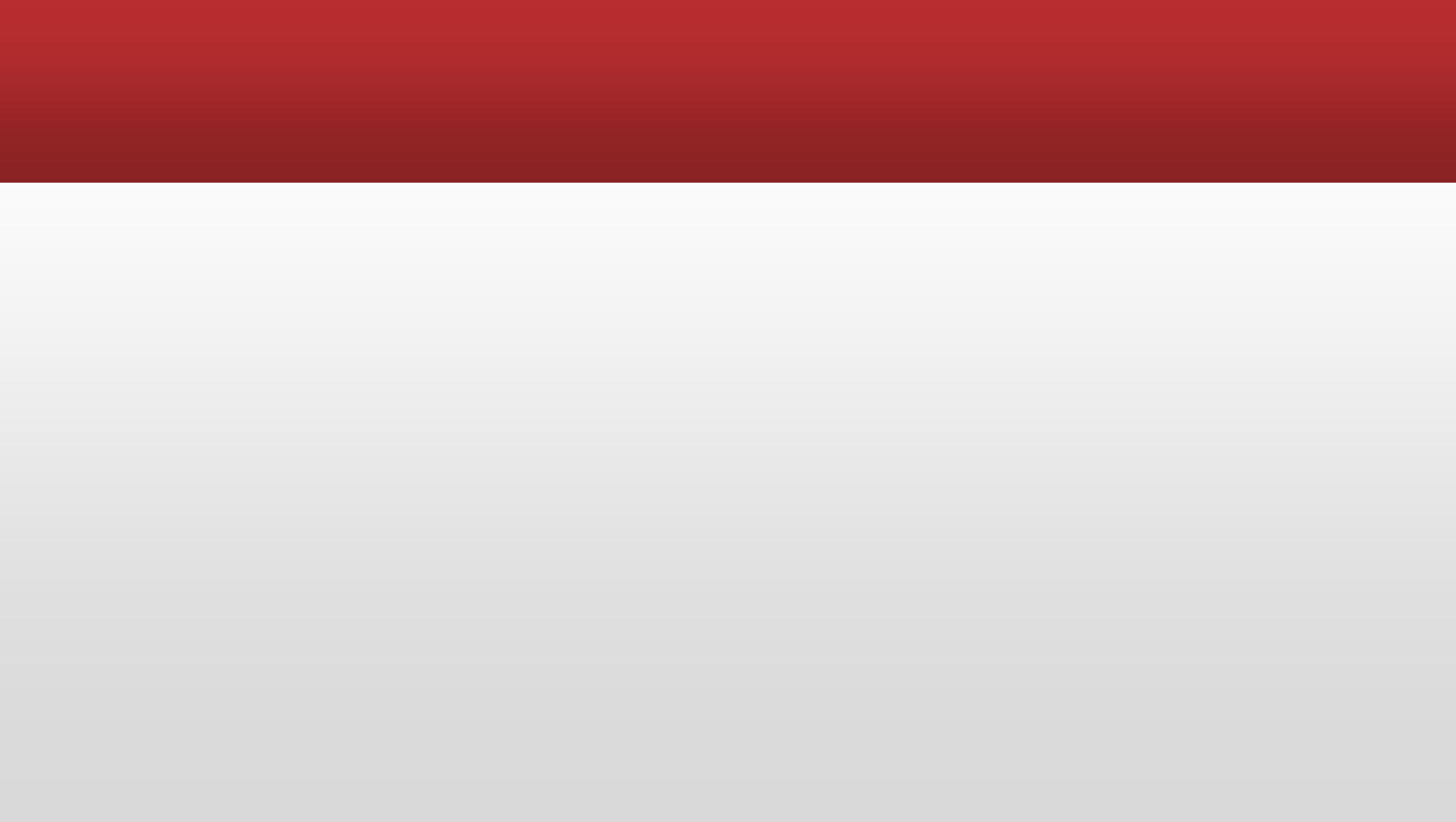


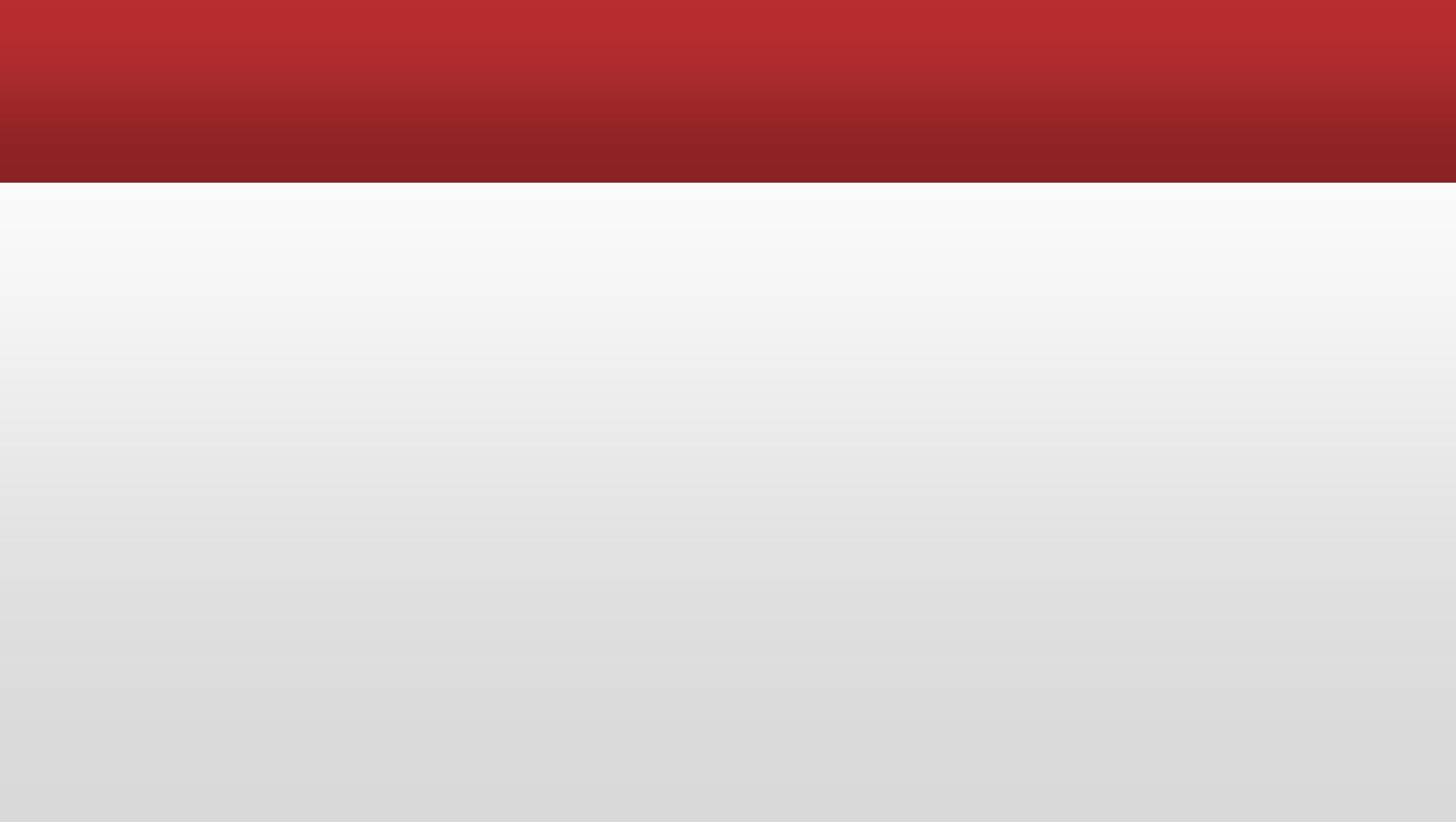


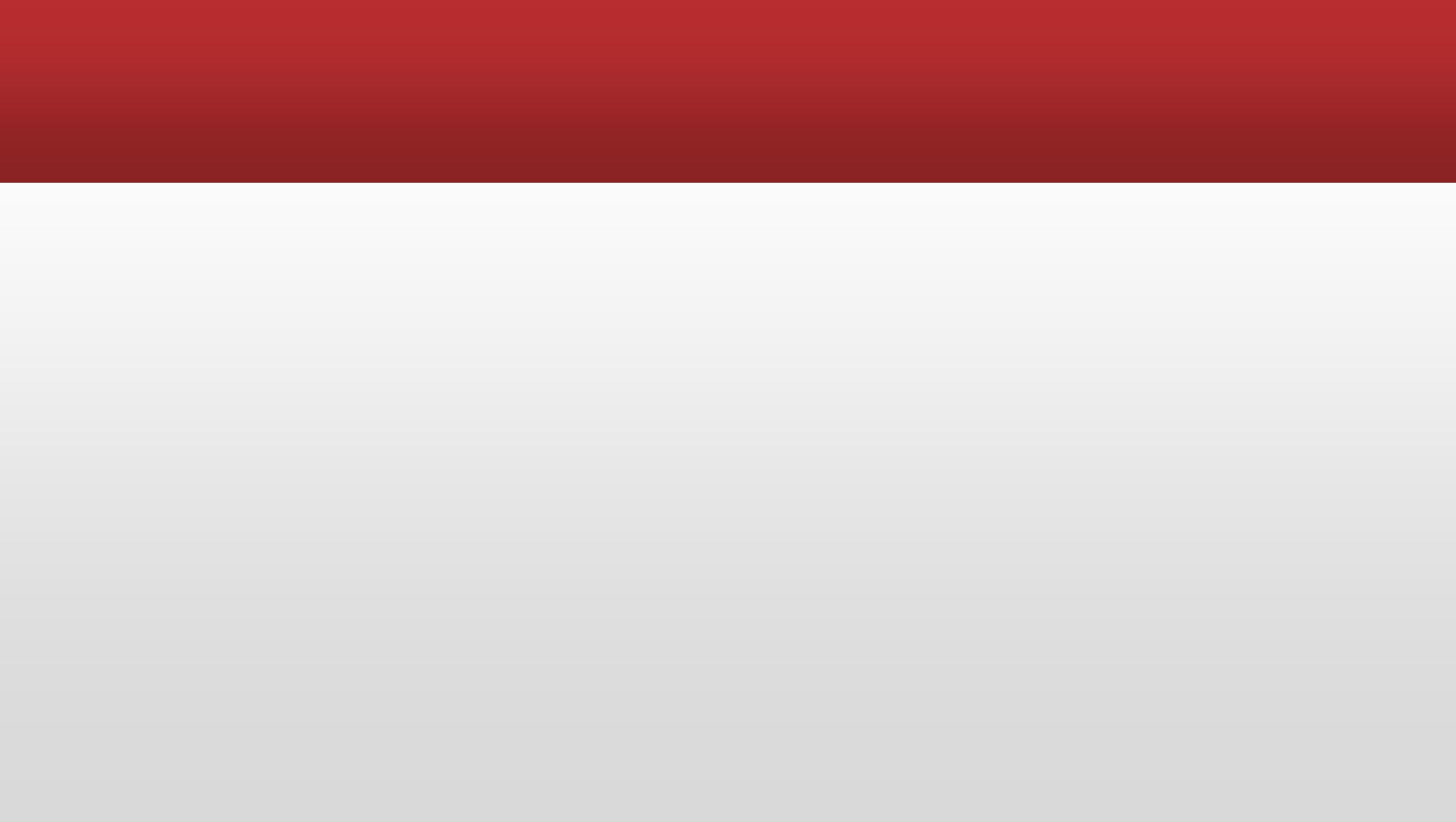


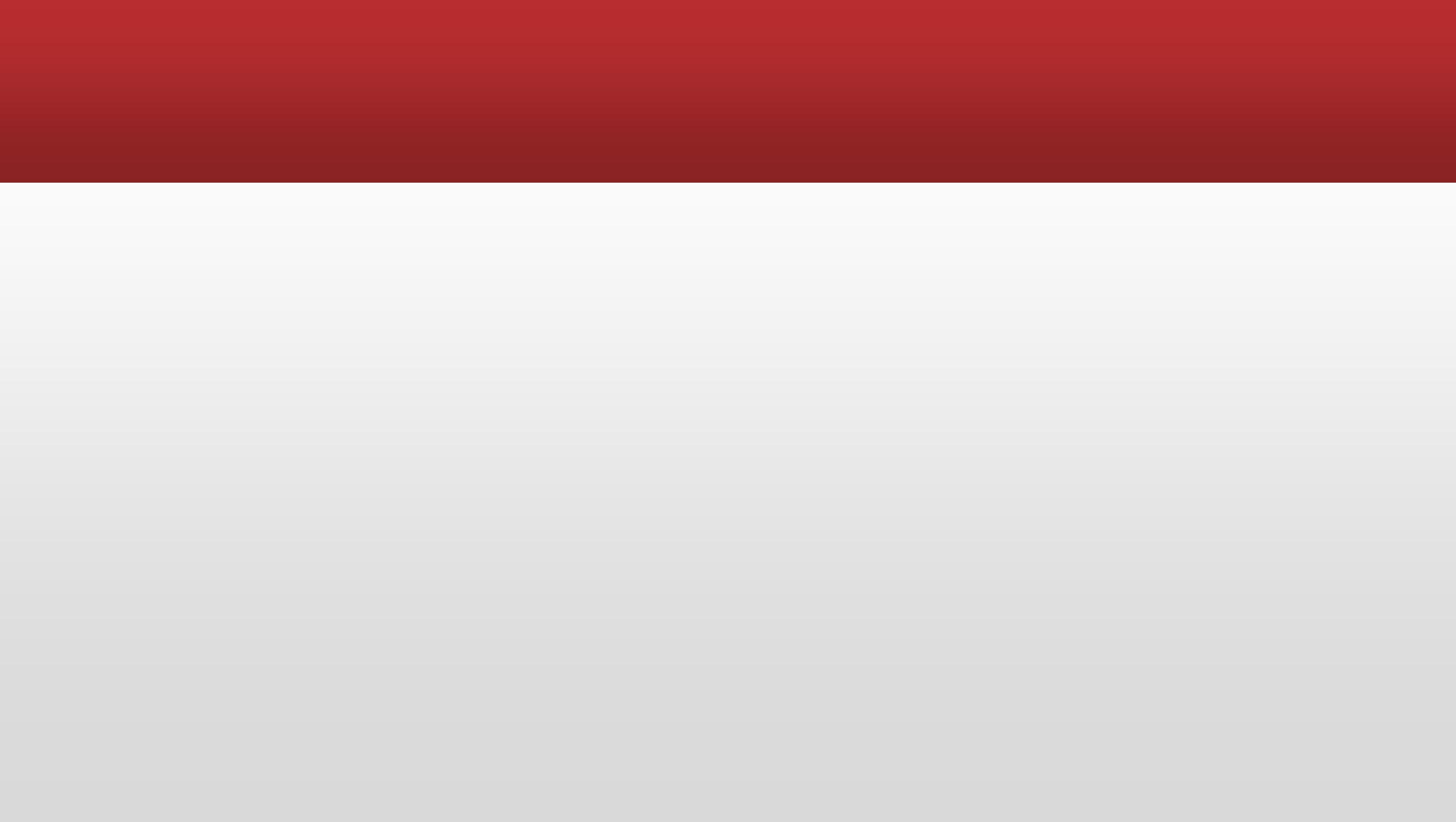


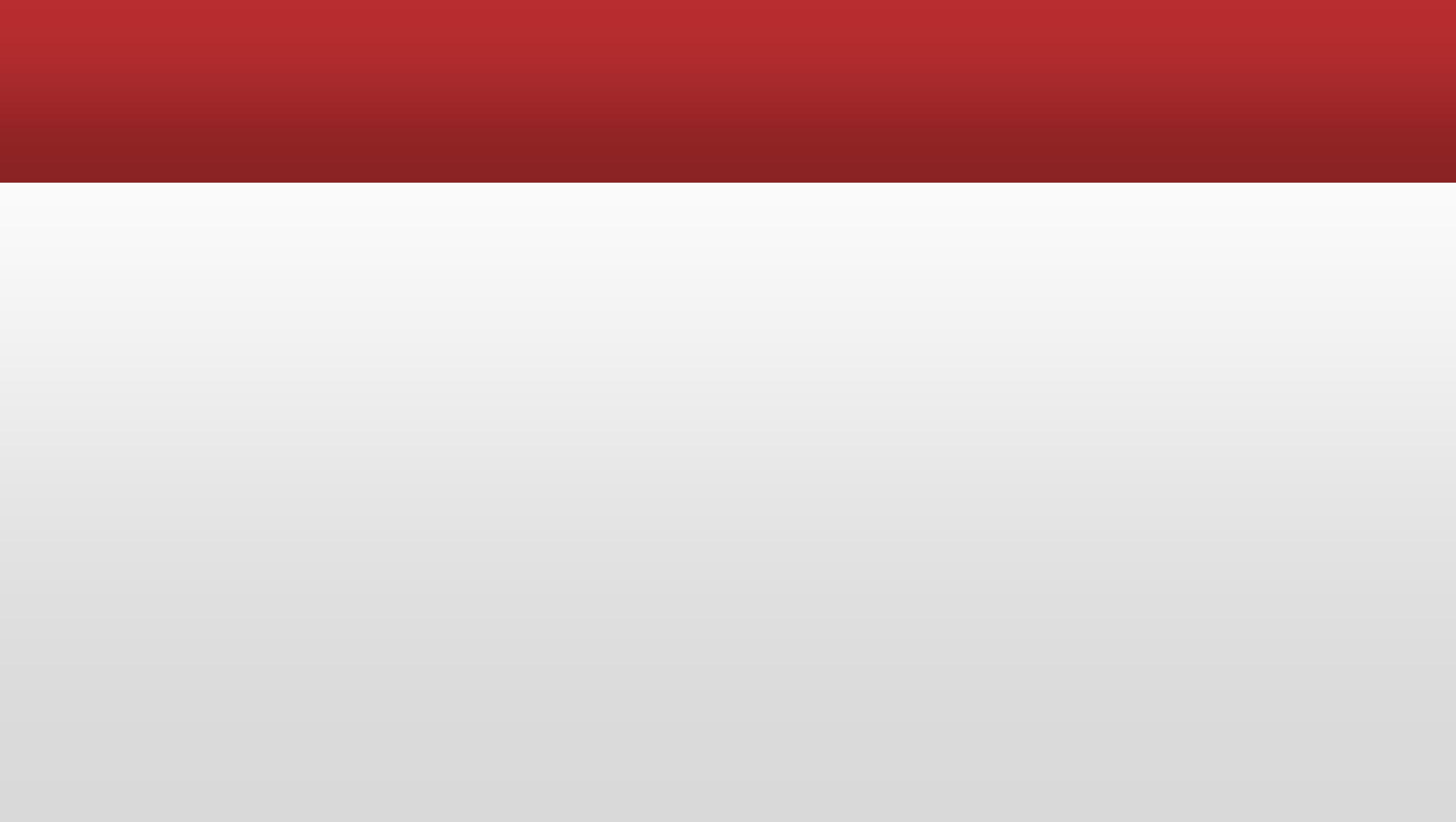


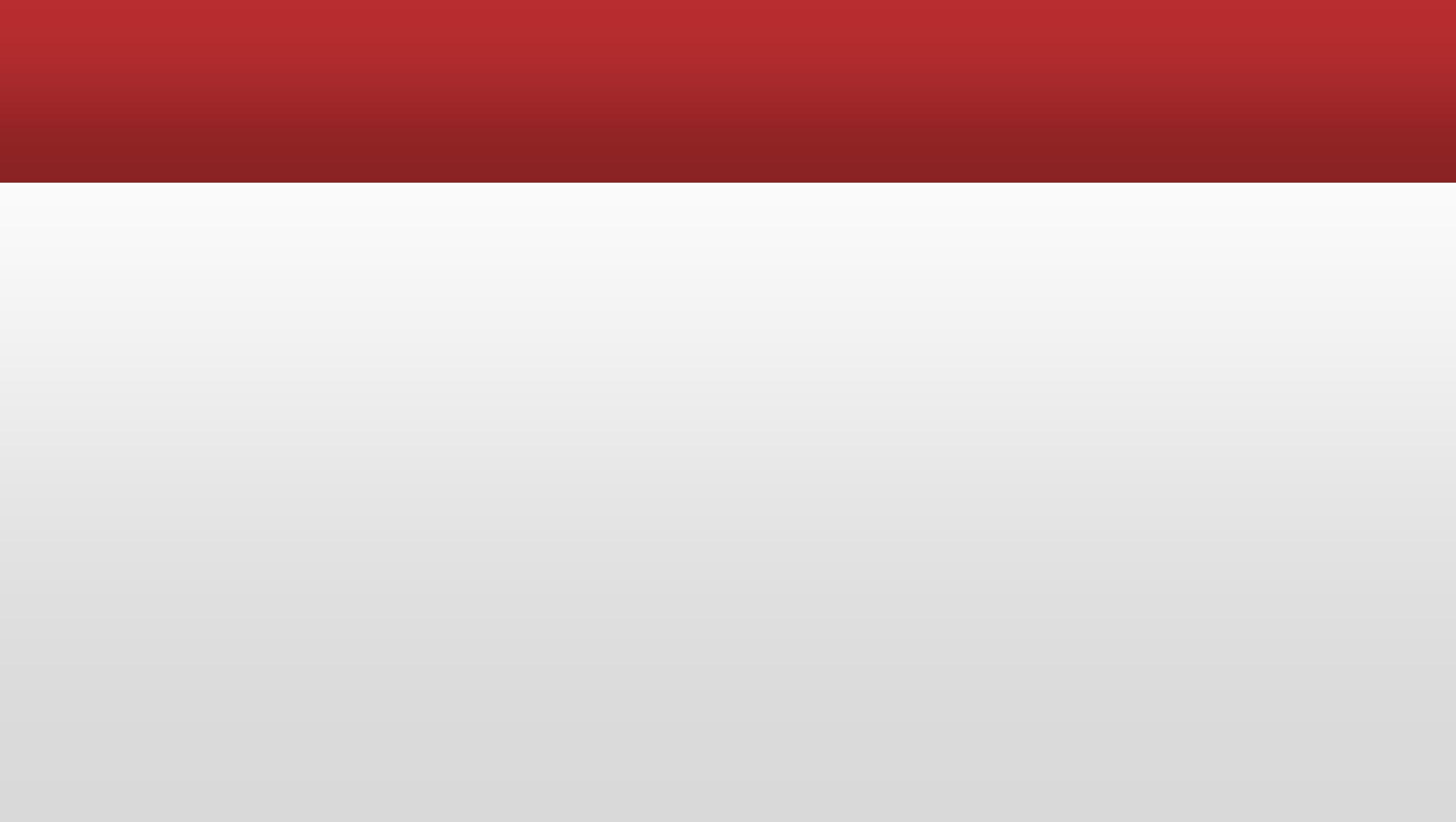


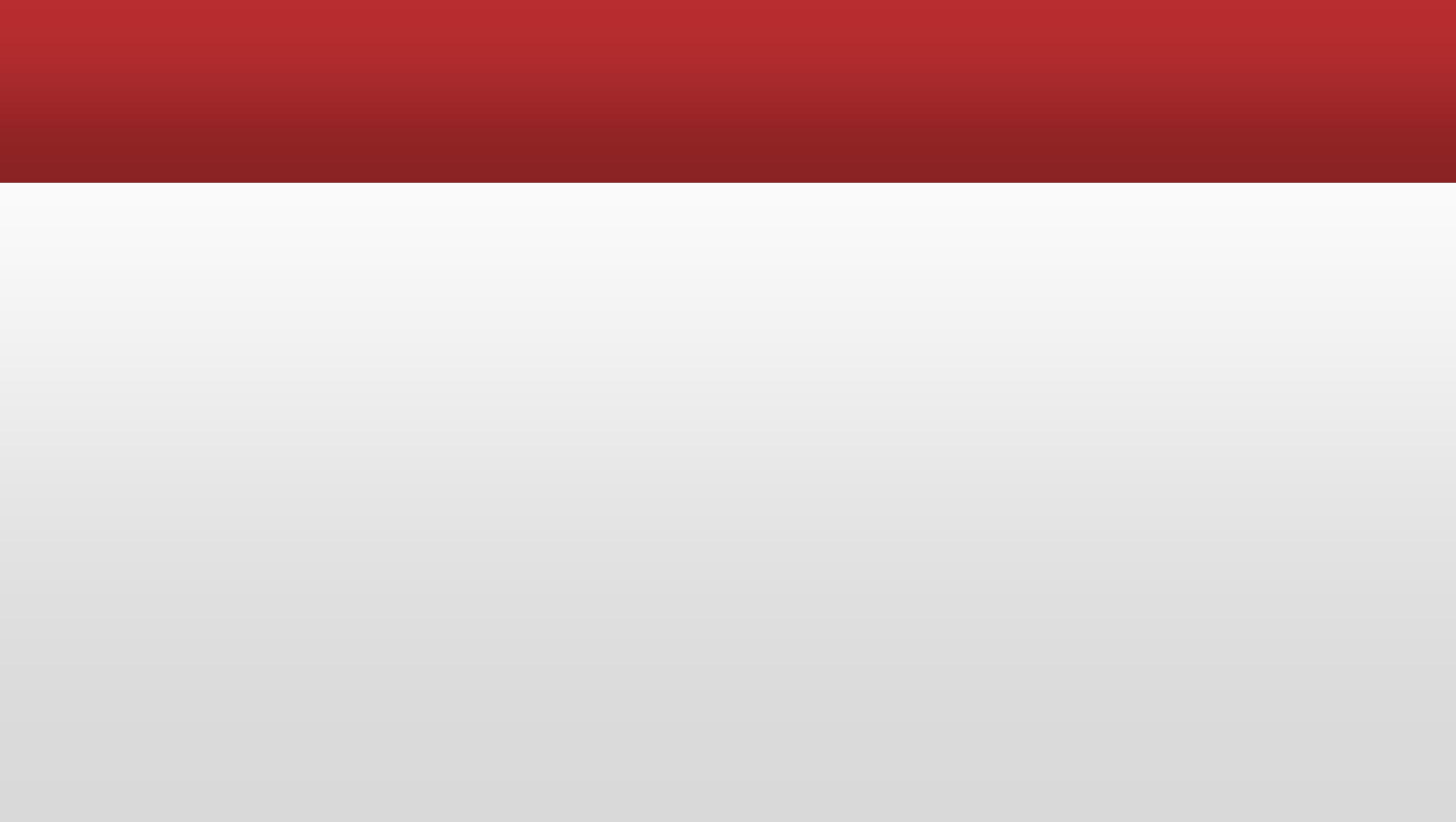


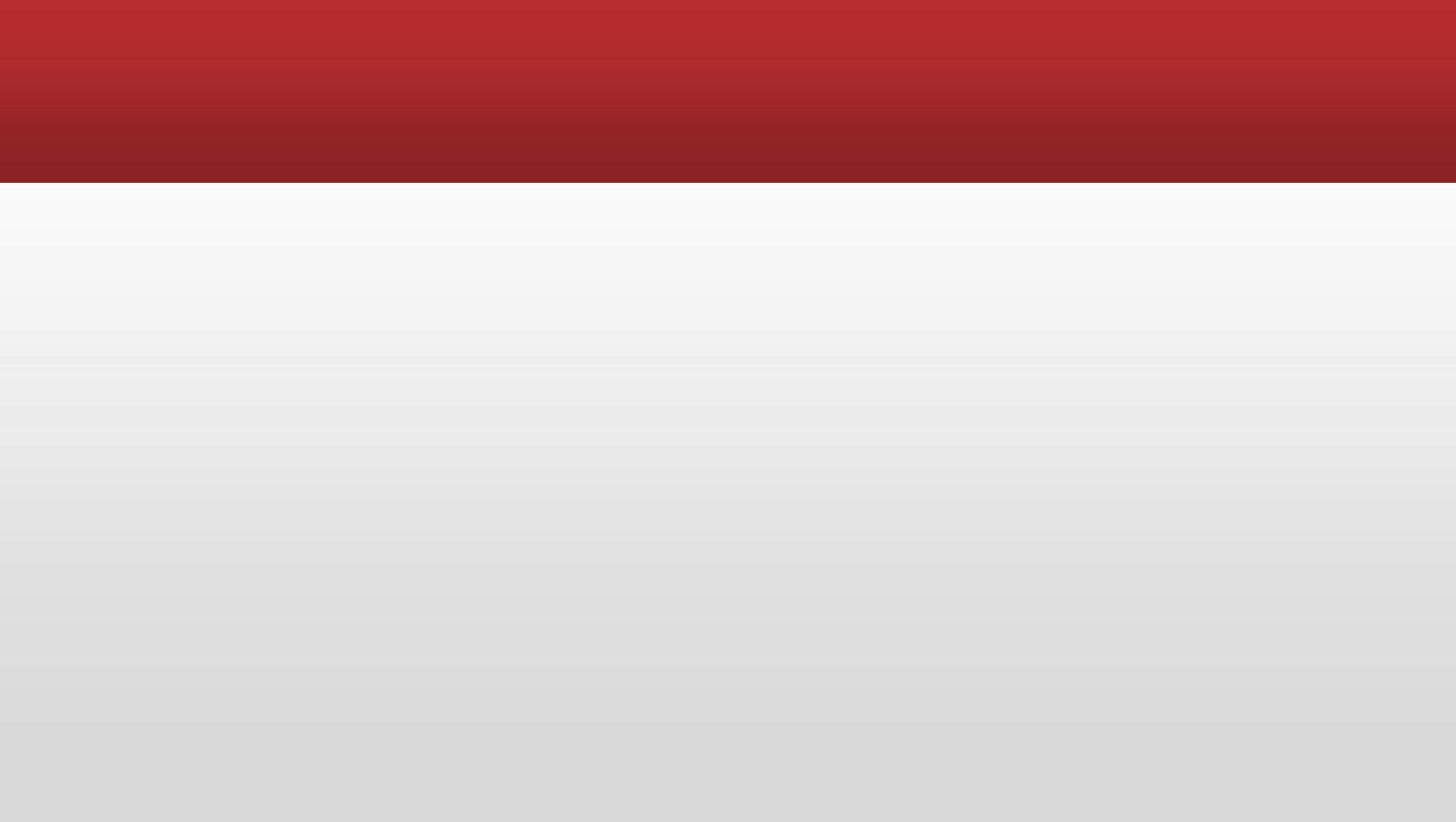


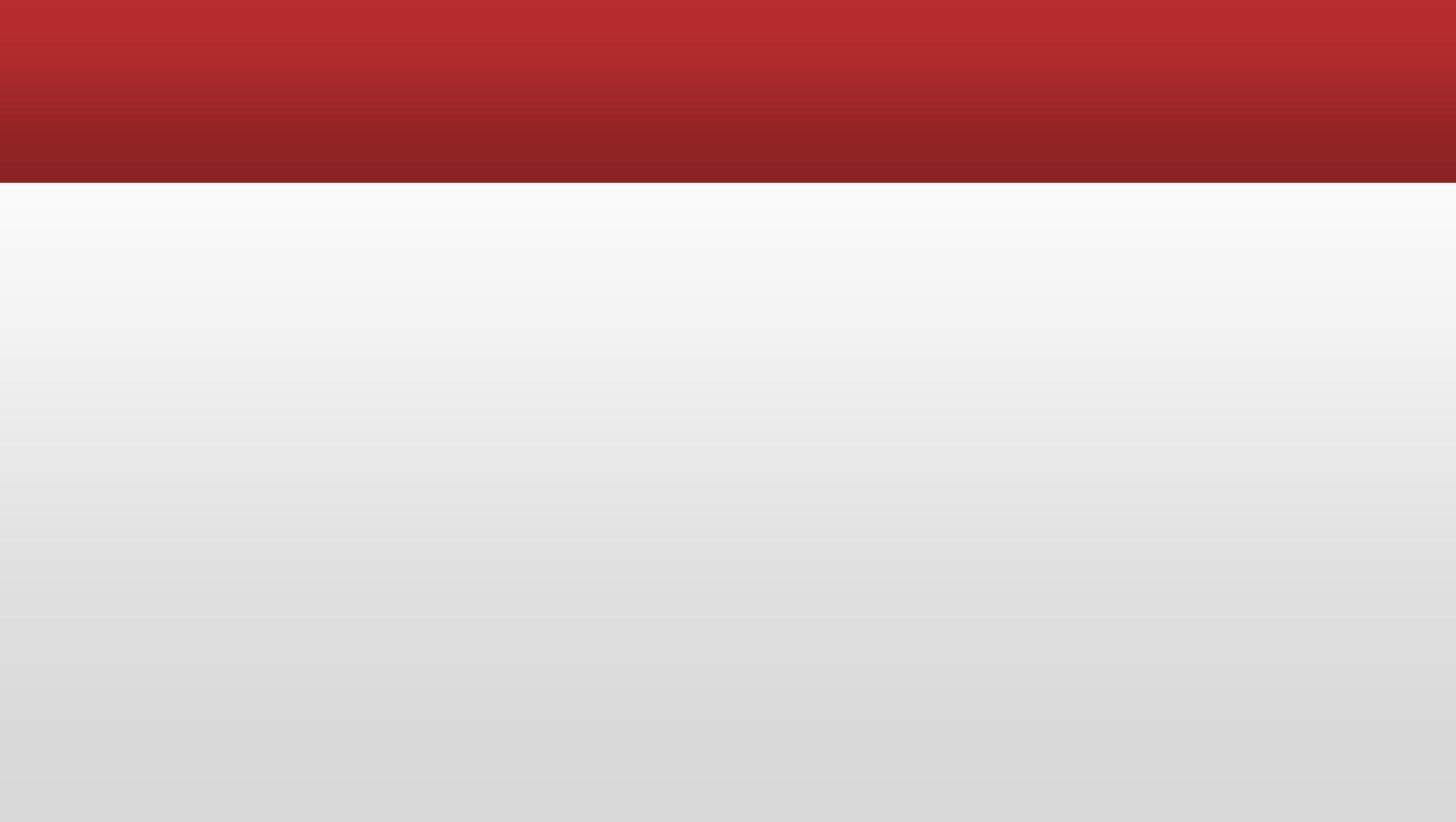


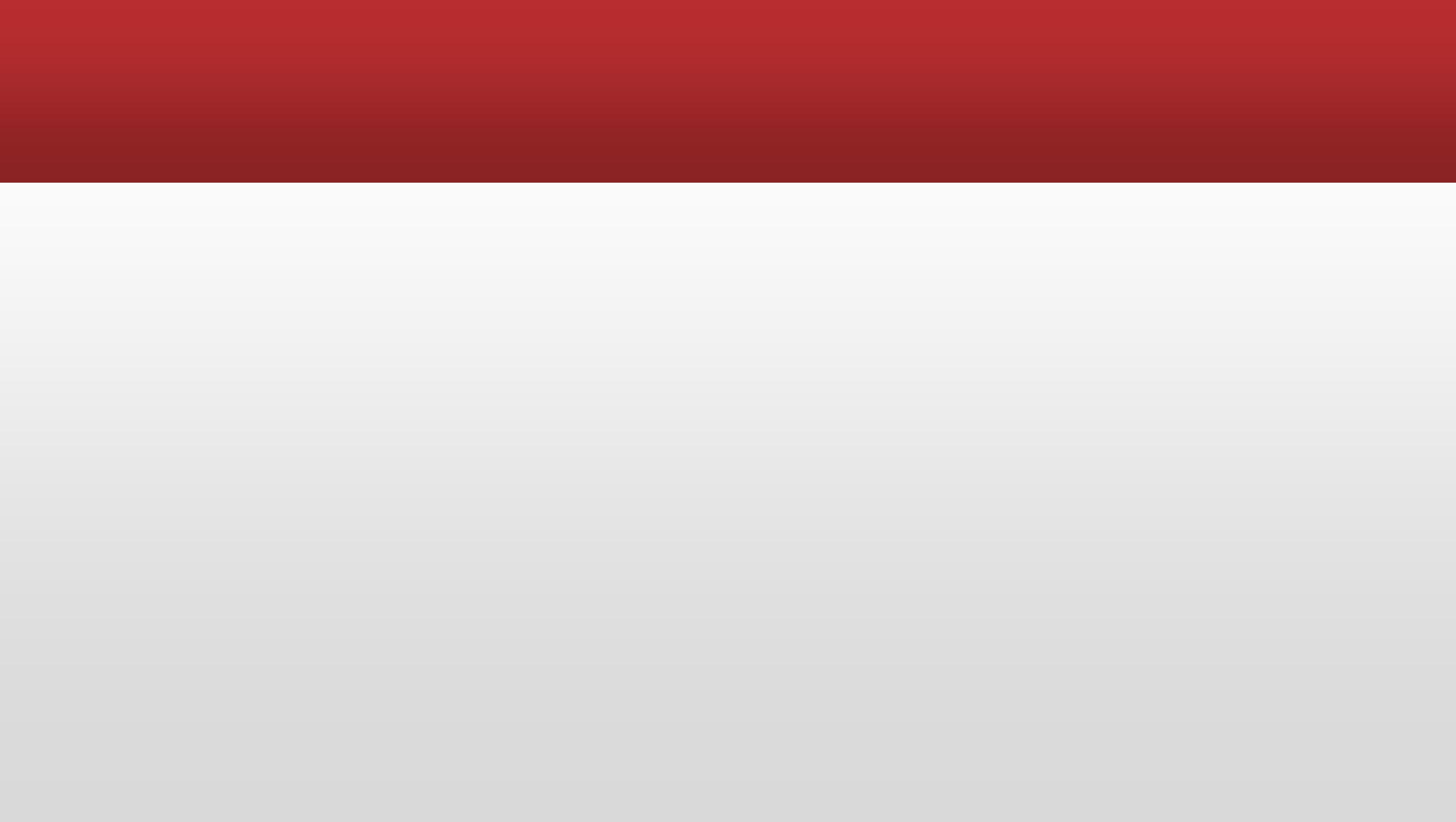


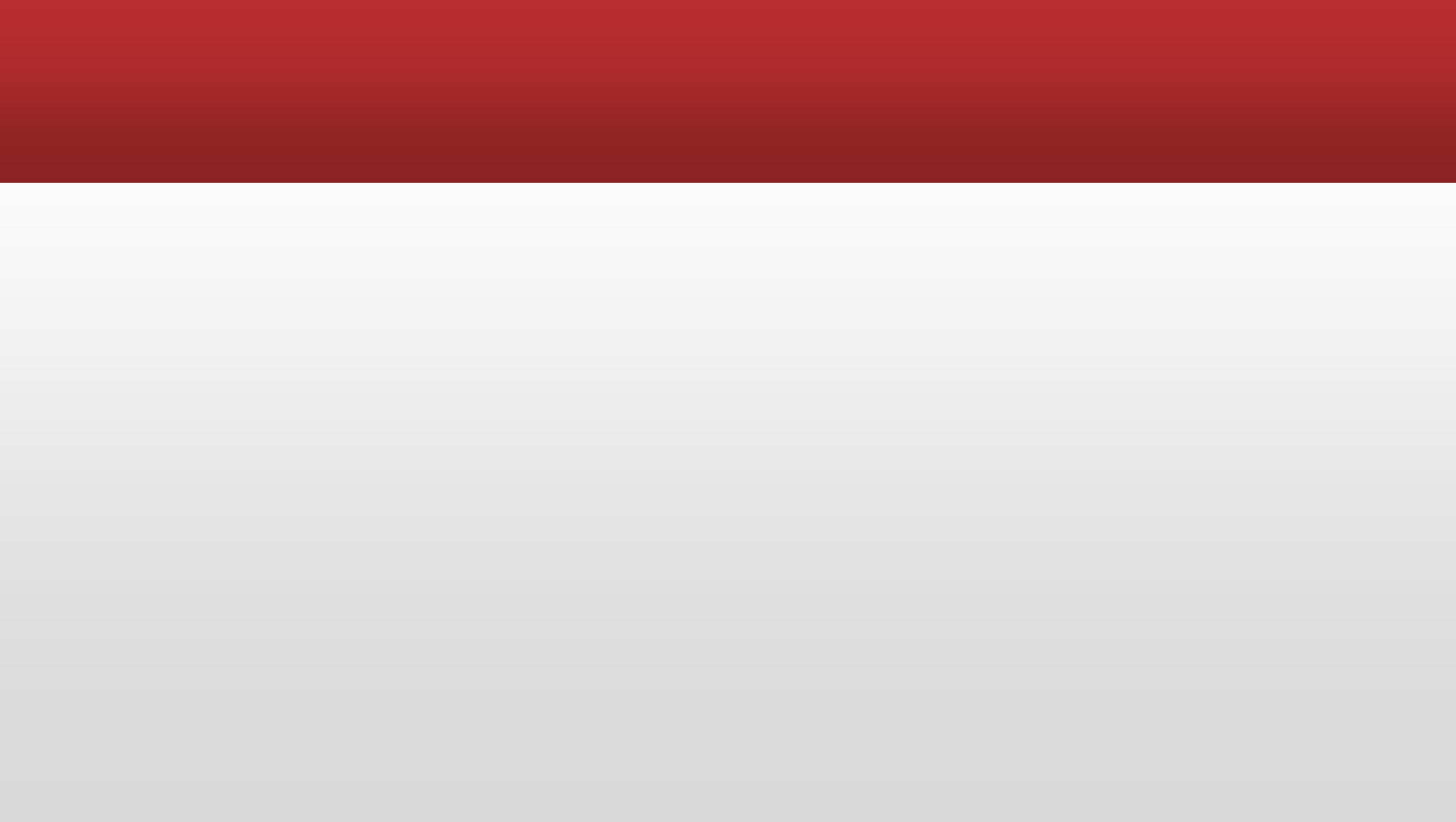


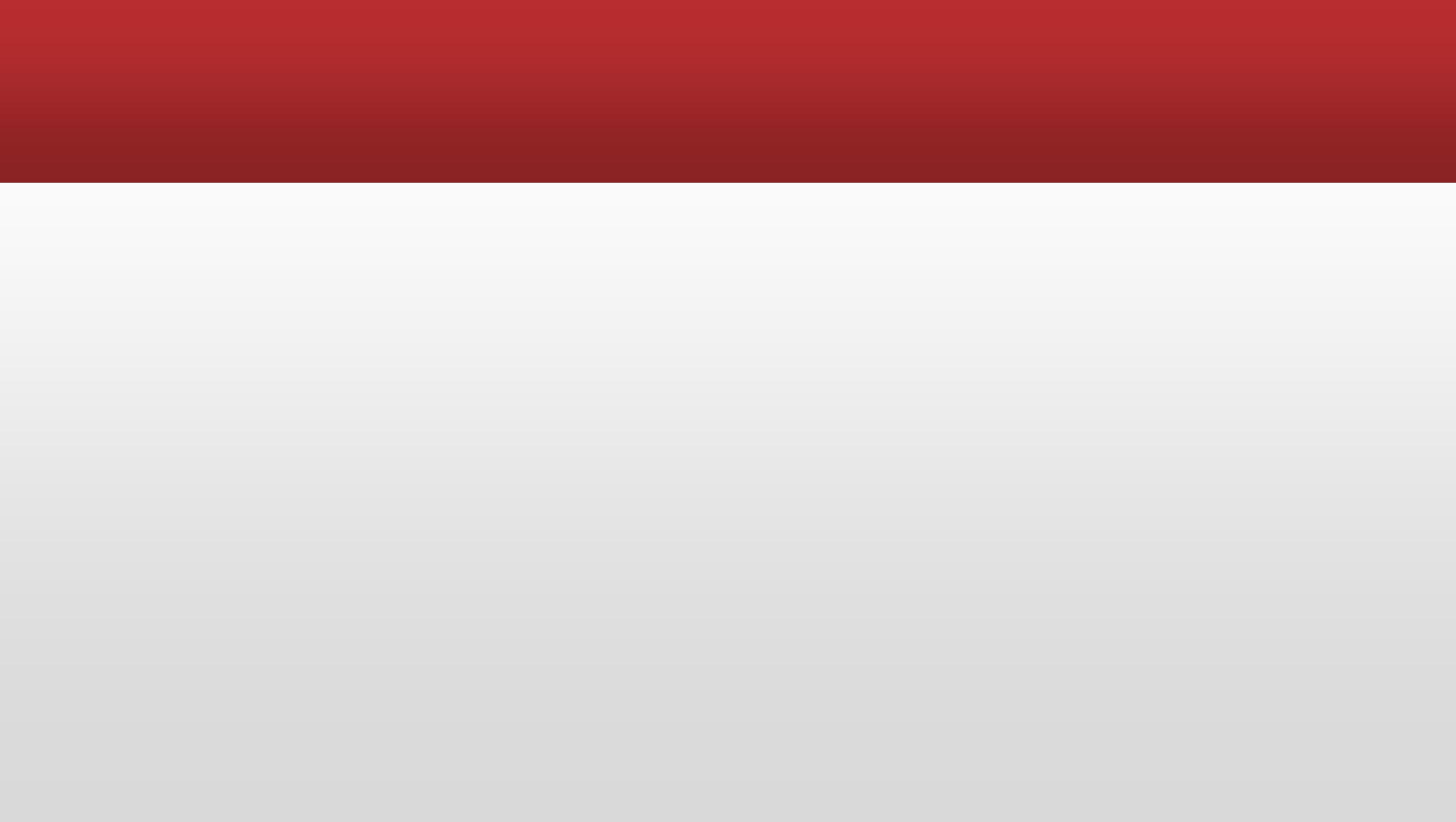


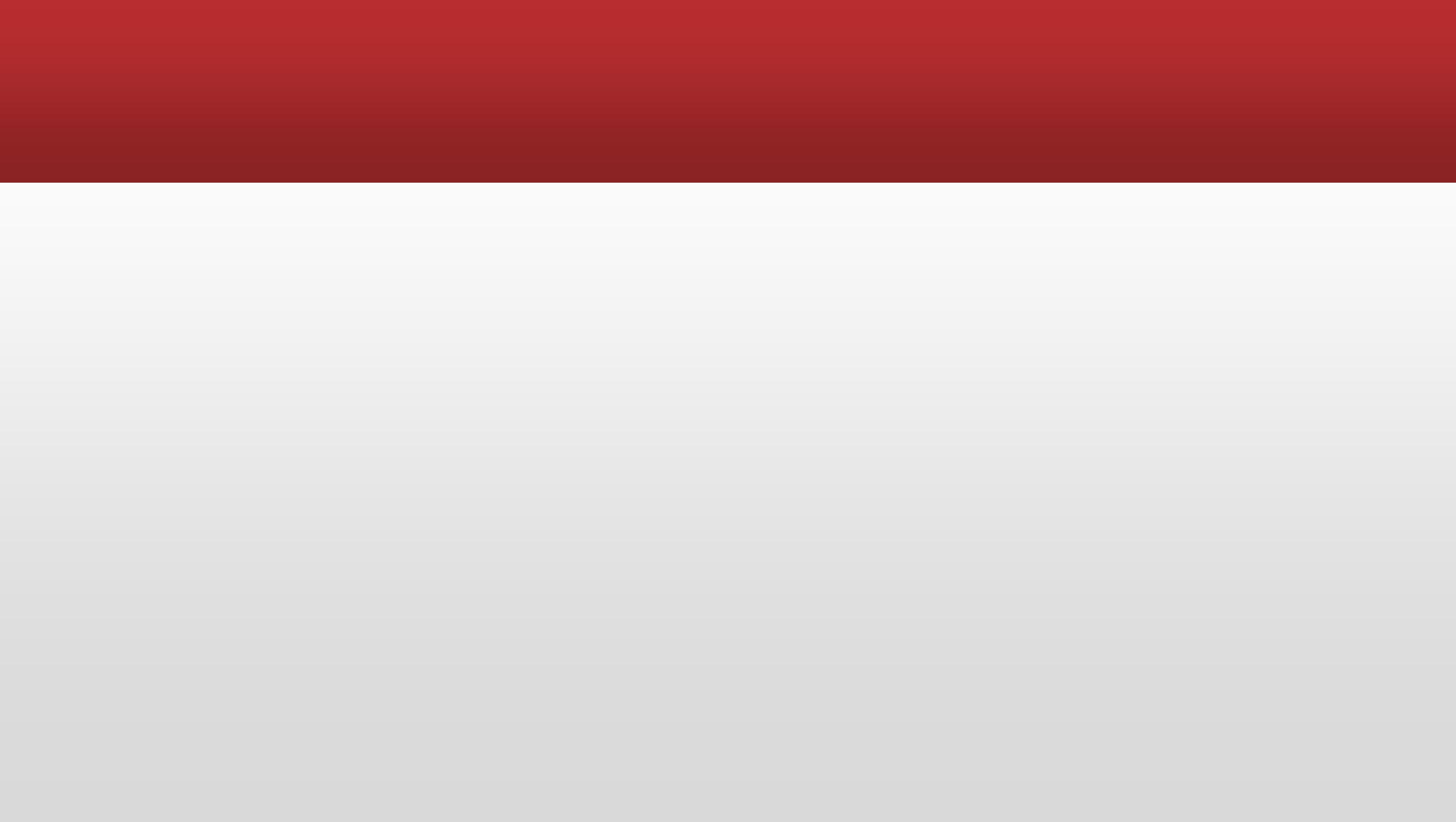


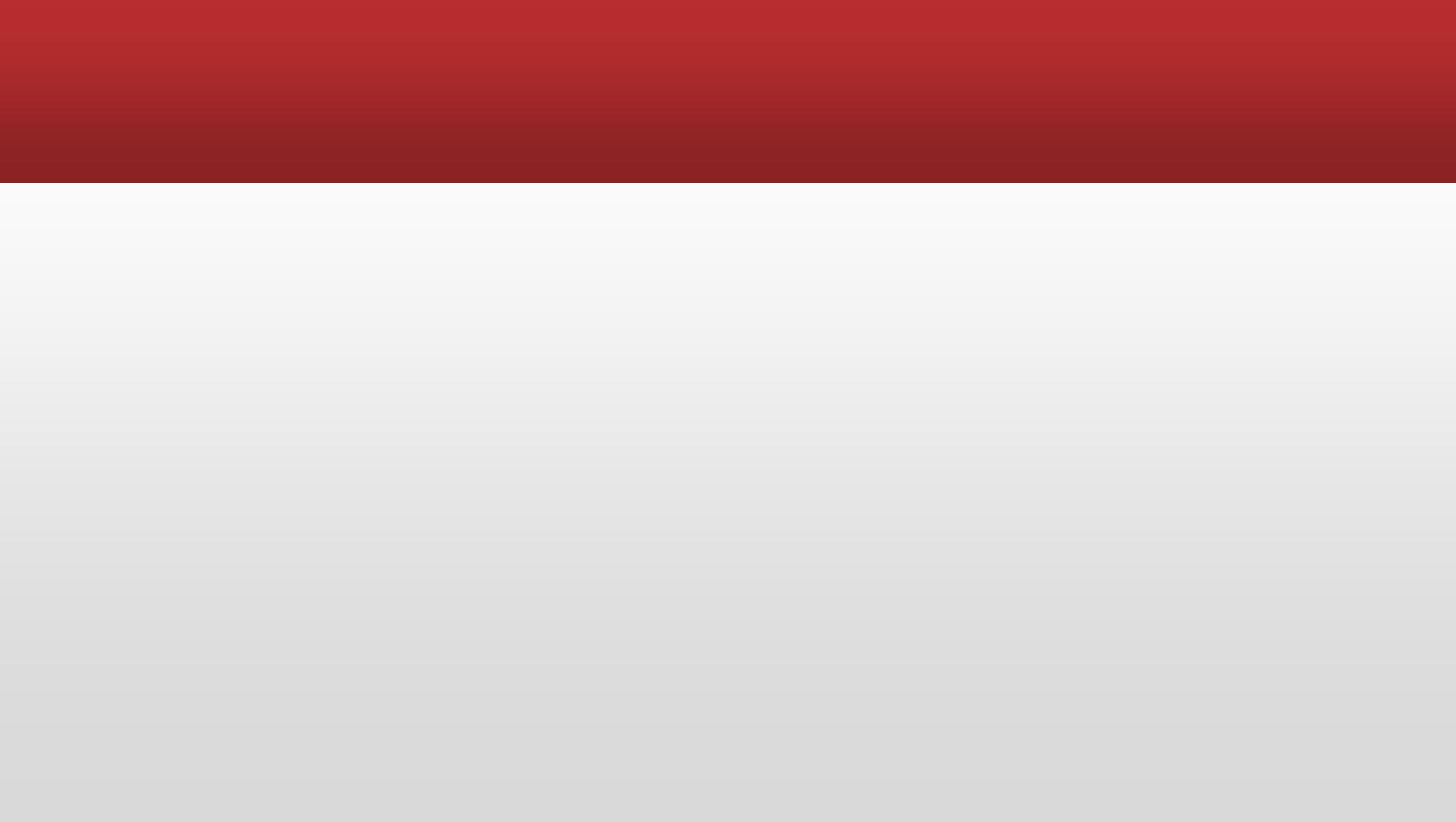


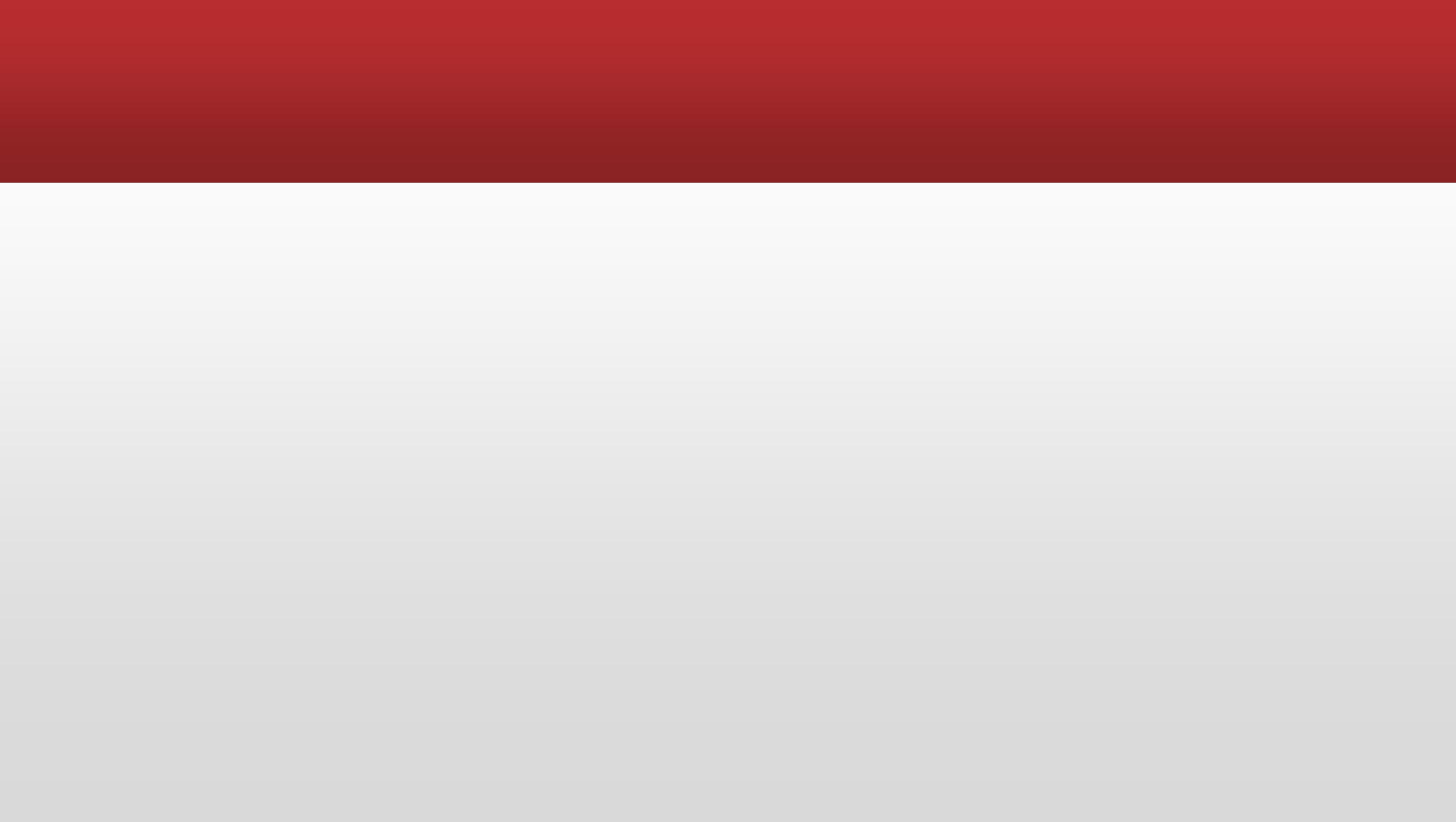


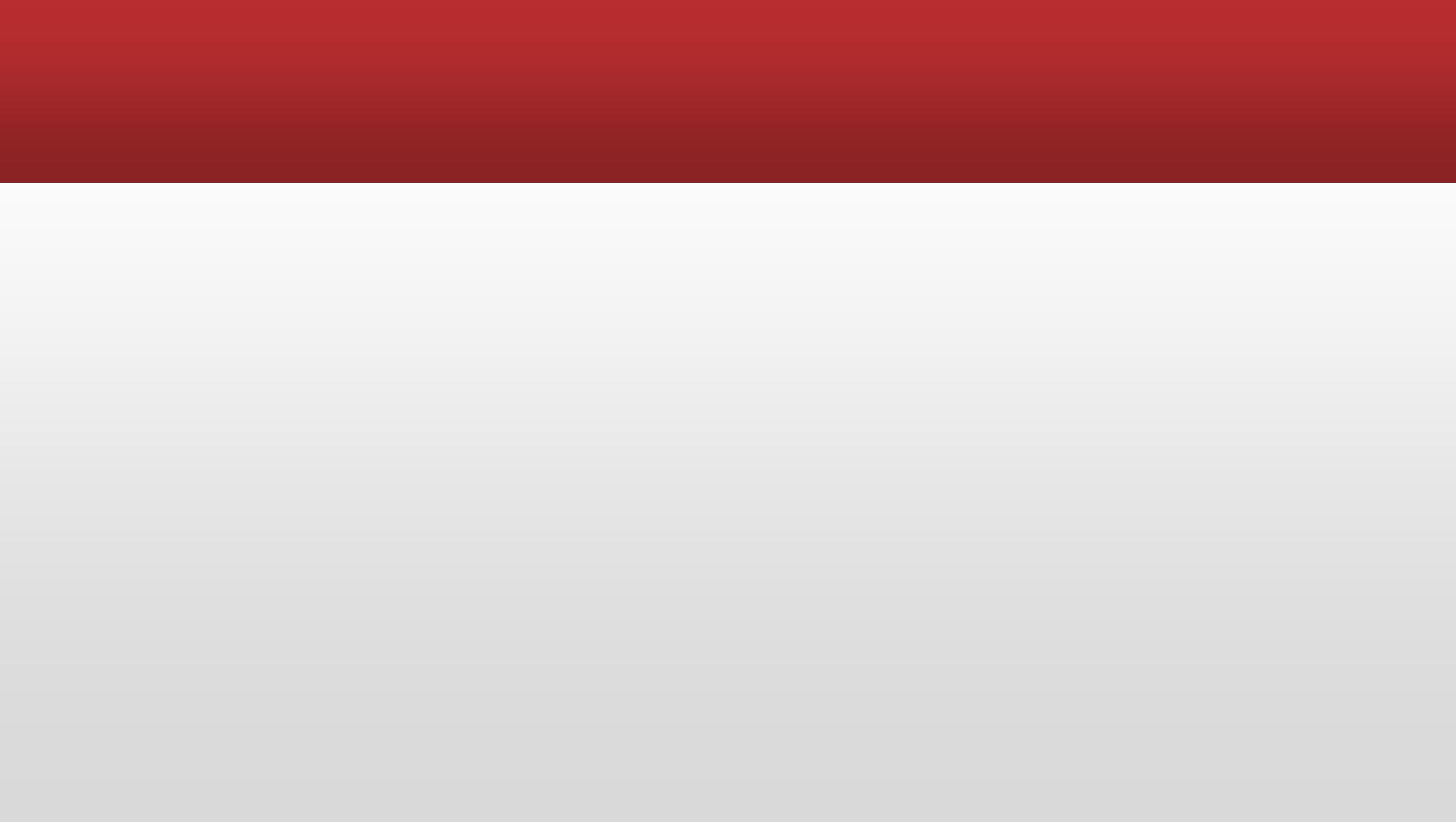


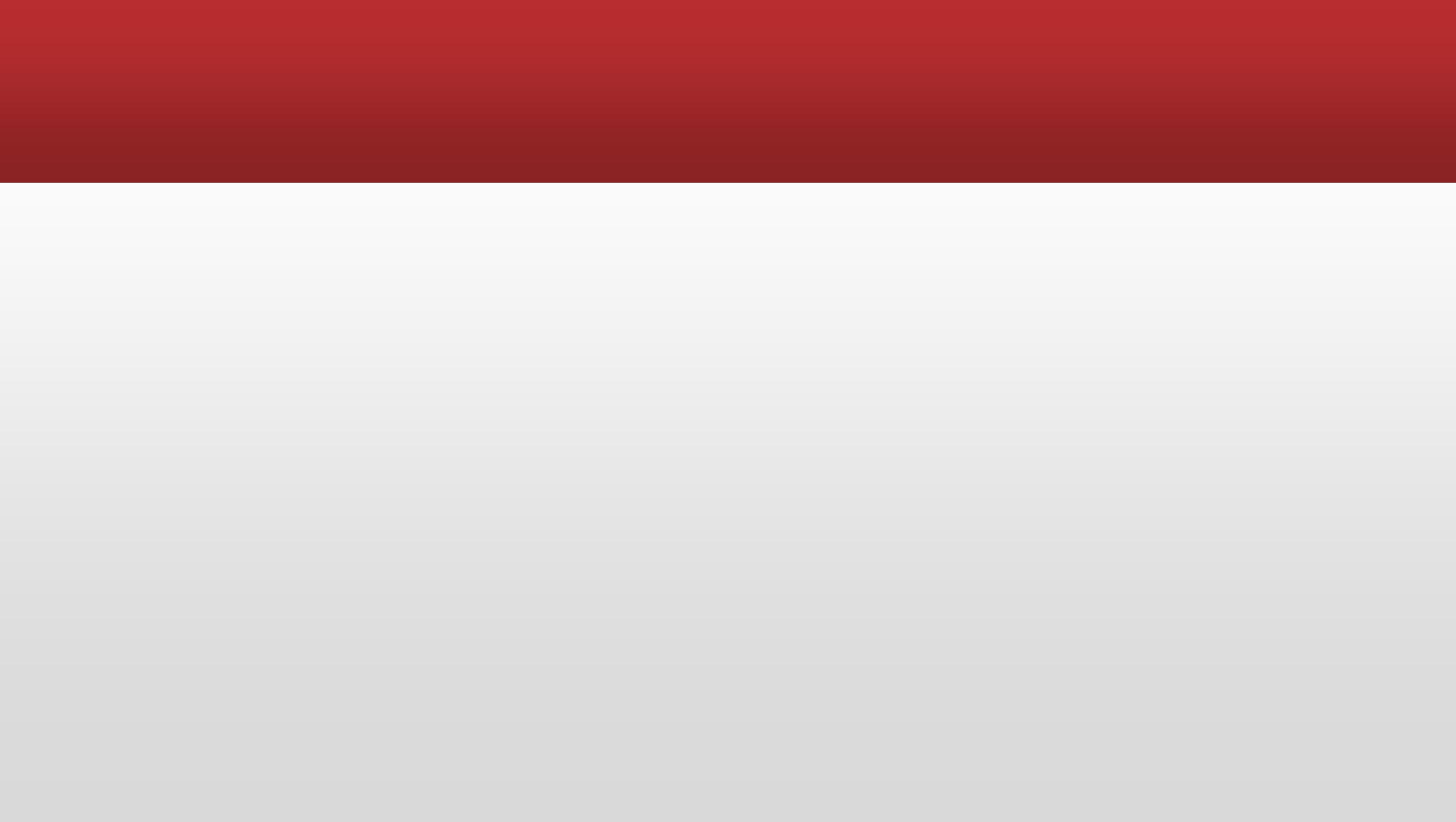


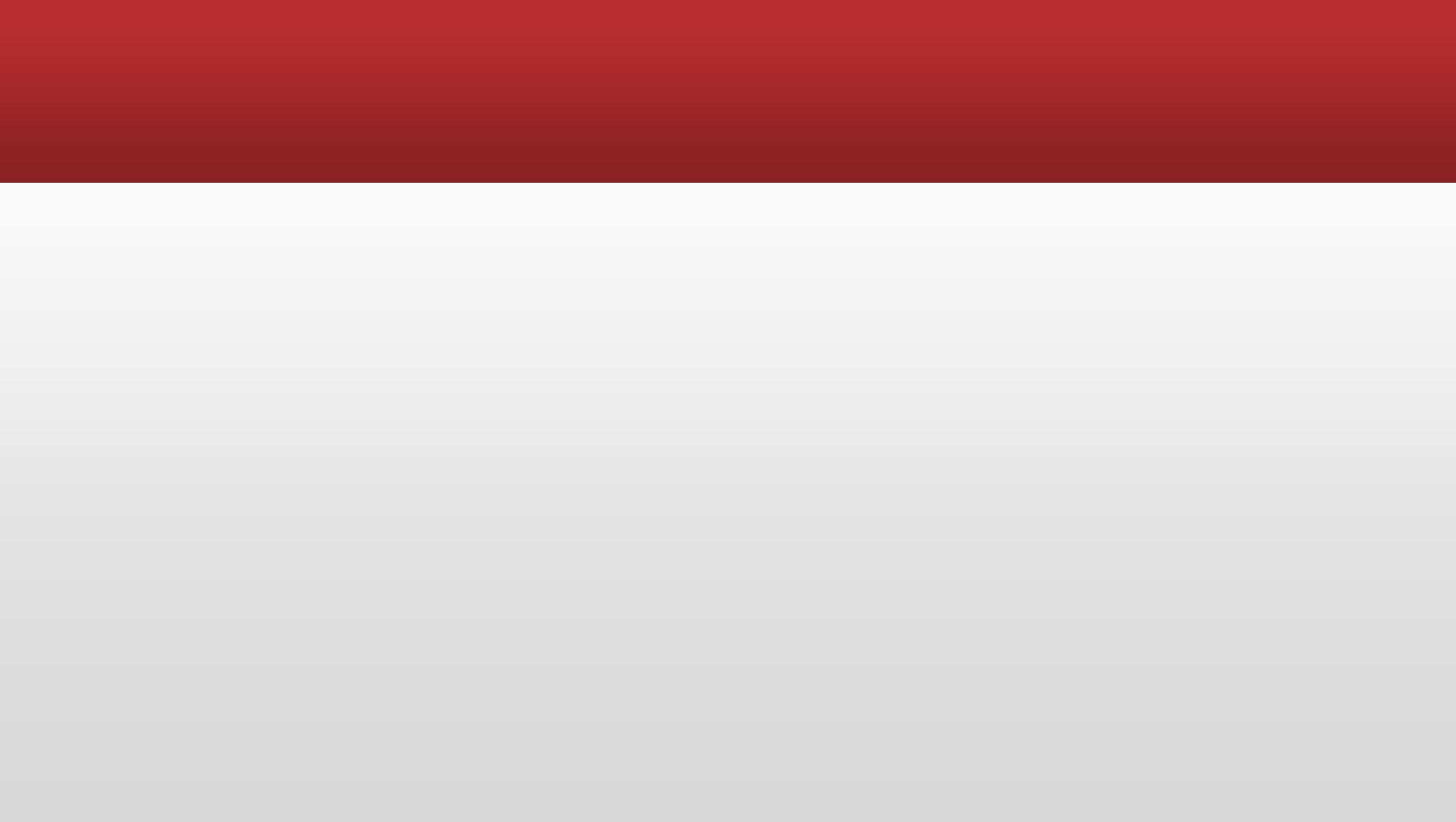


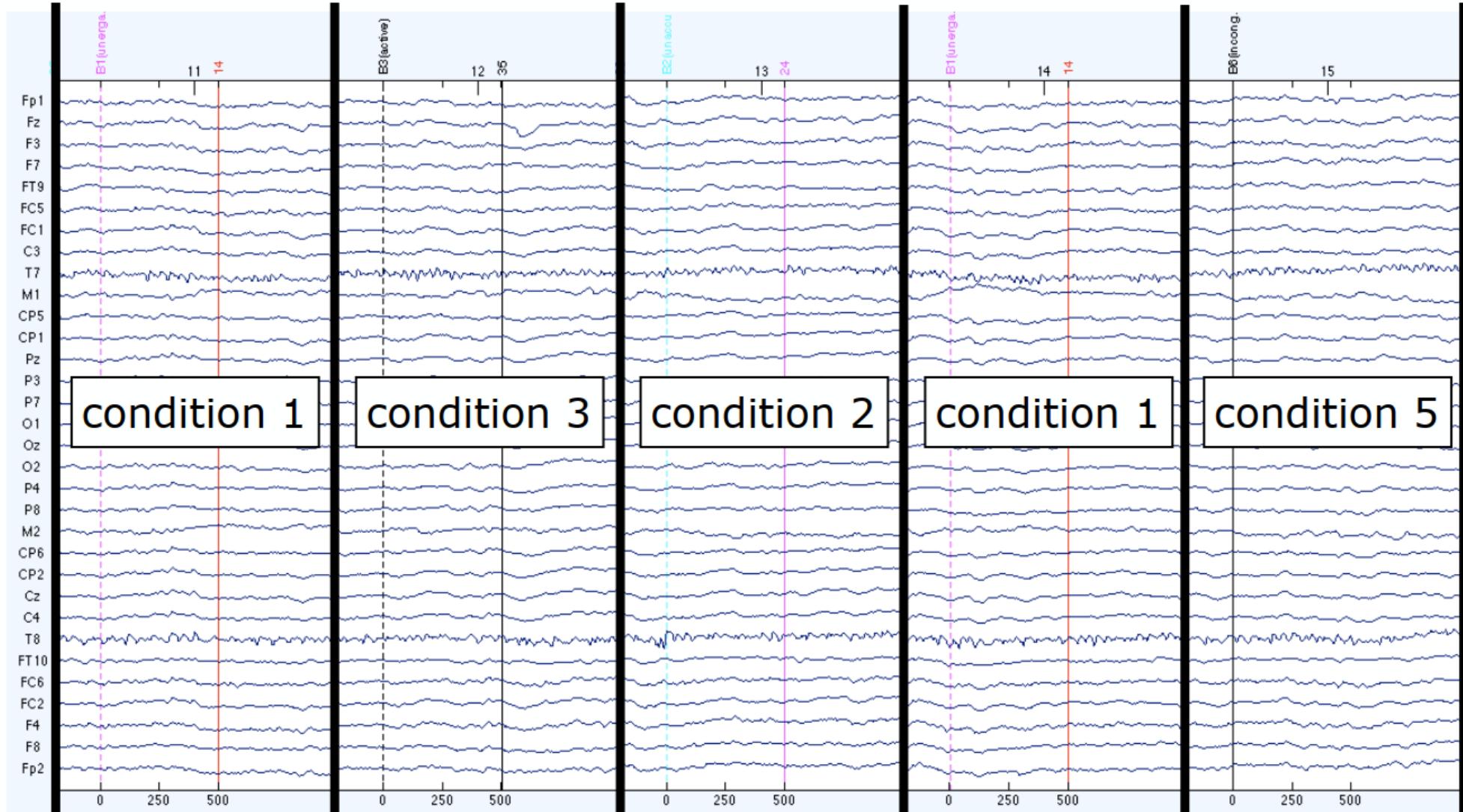


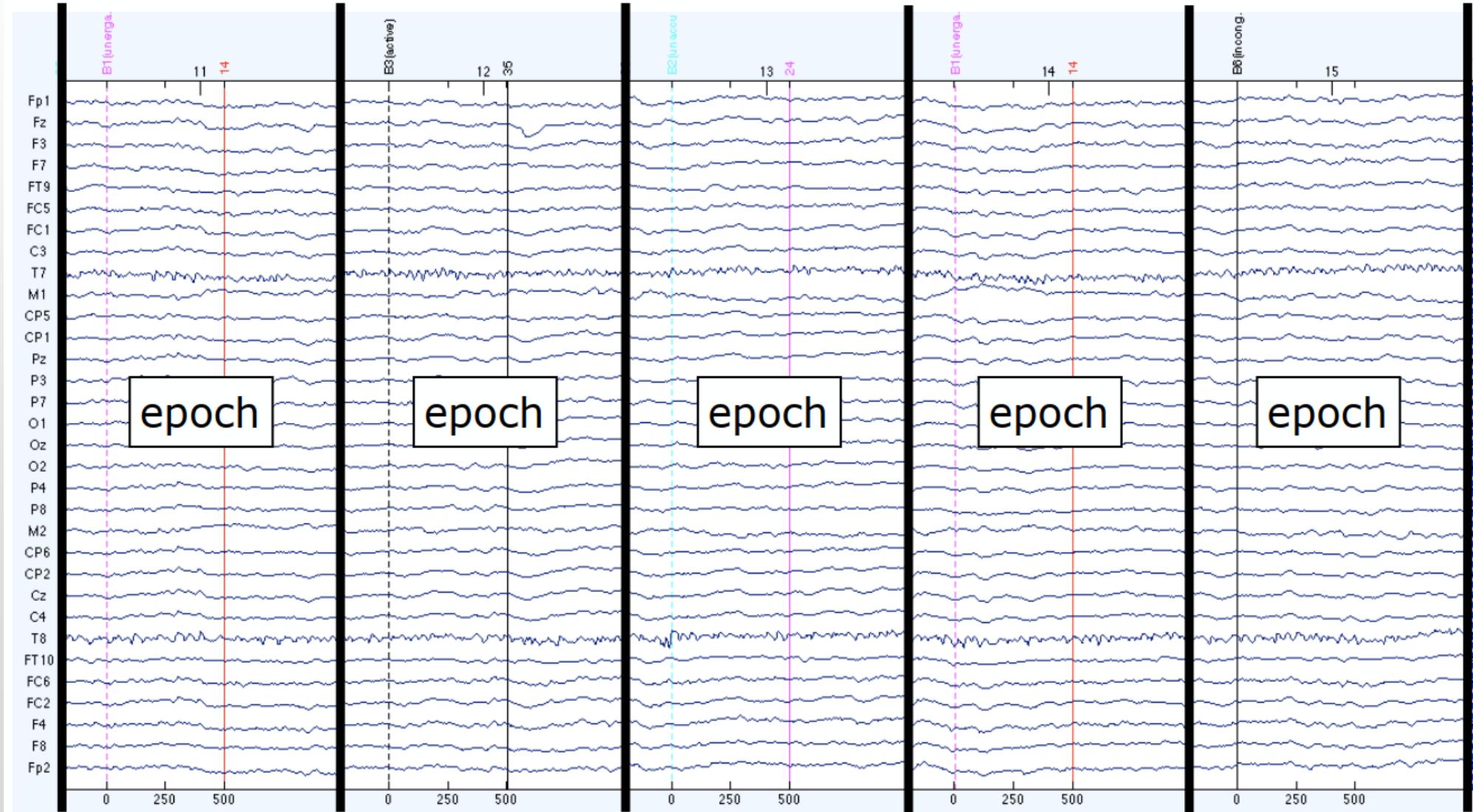


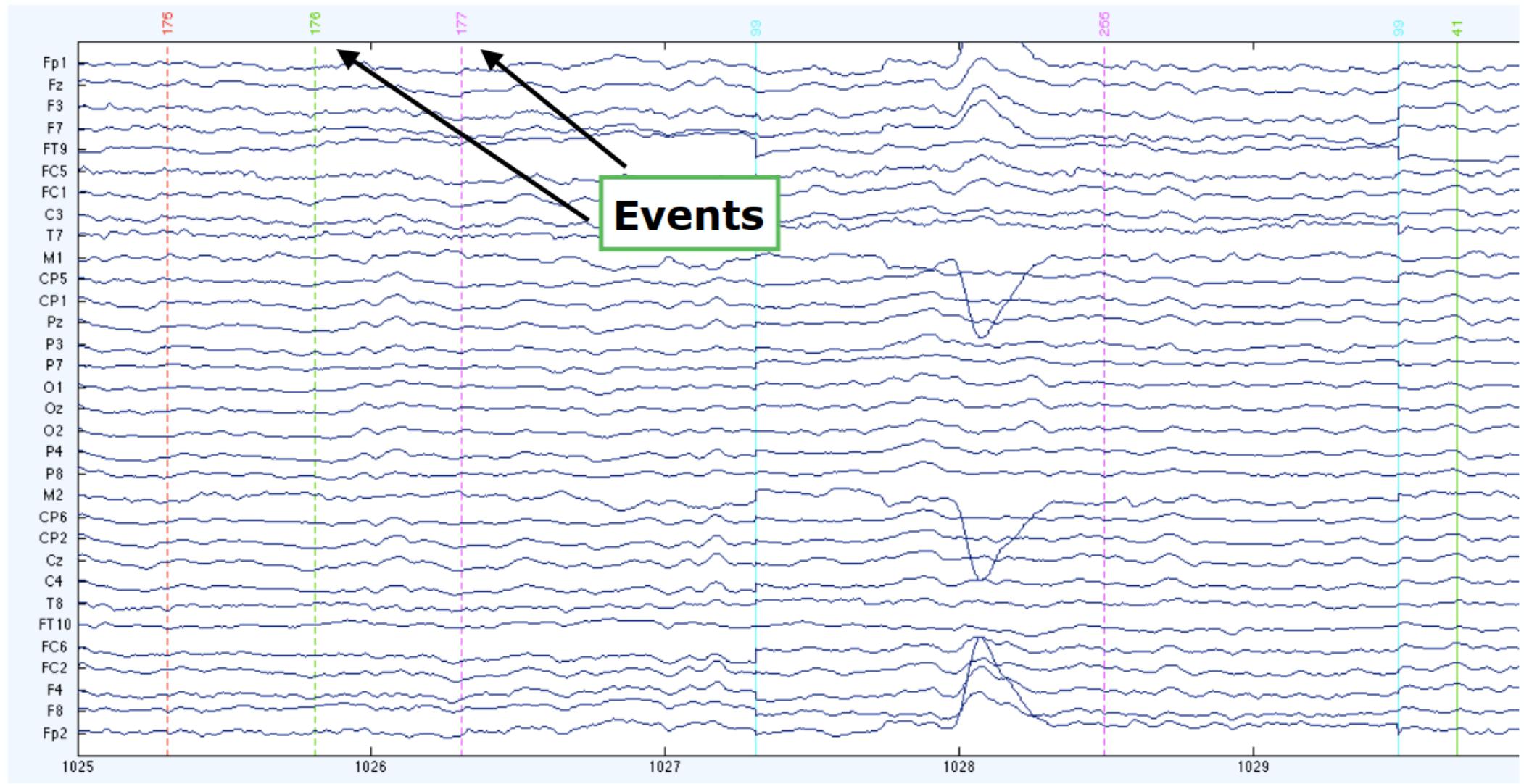


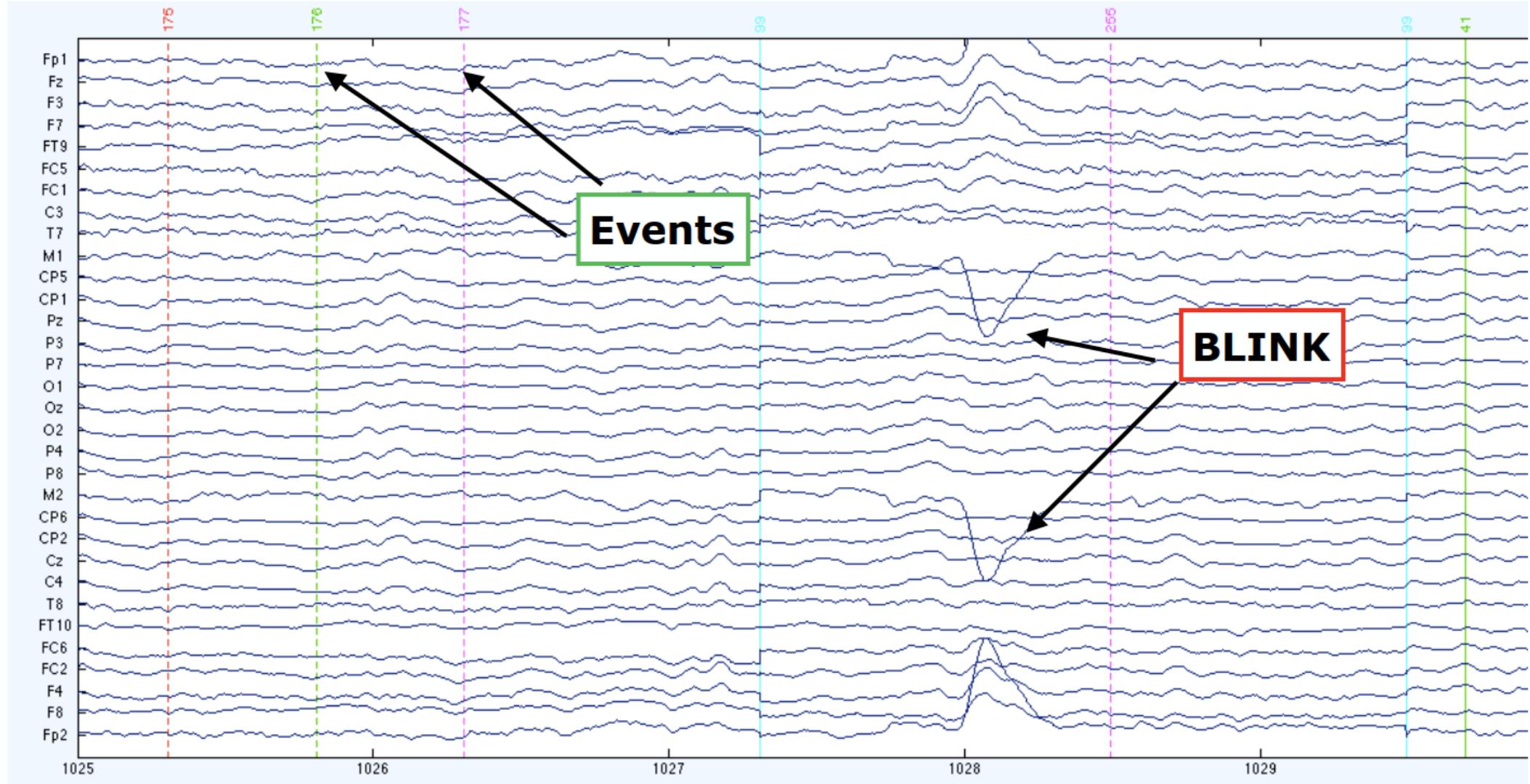


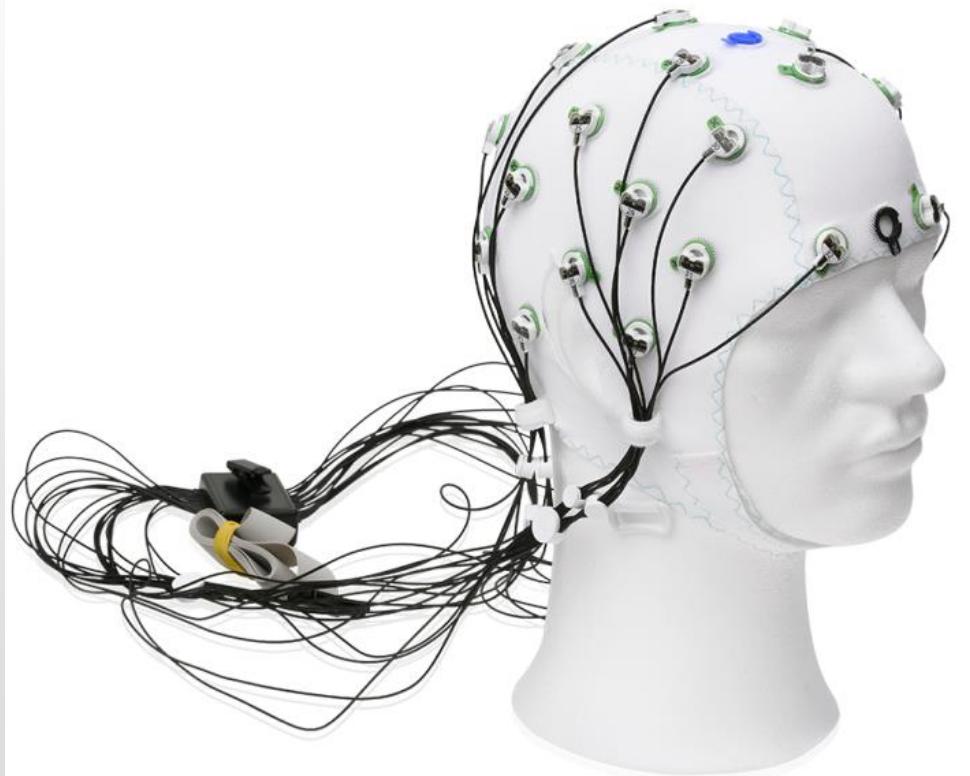




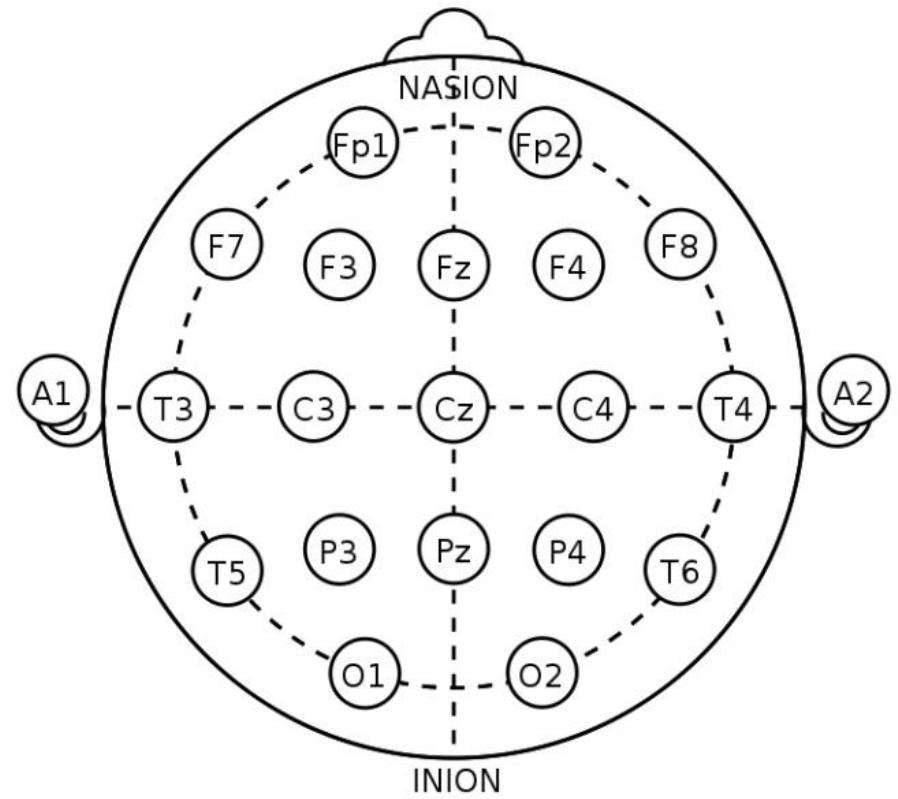








Brain Products Caps



THE END