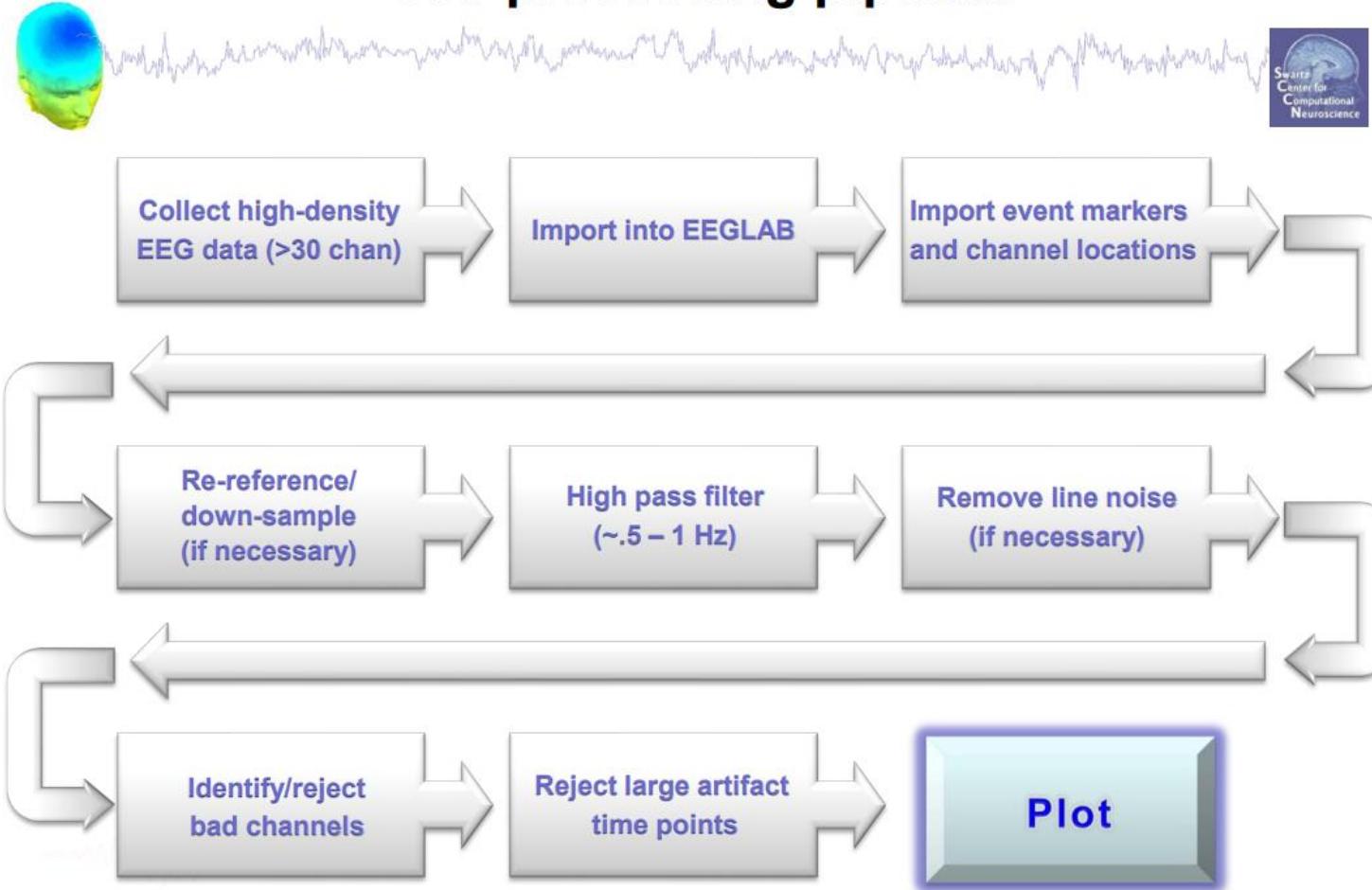


EEGLAB and ERPLAB

Interdisciplinary Schools
Signal Processing Department
Parisa Khoorahe

EEGLAB

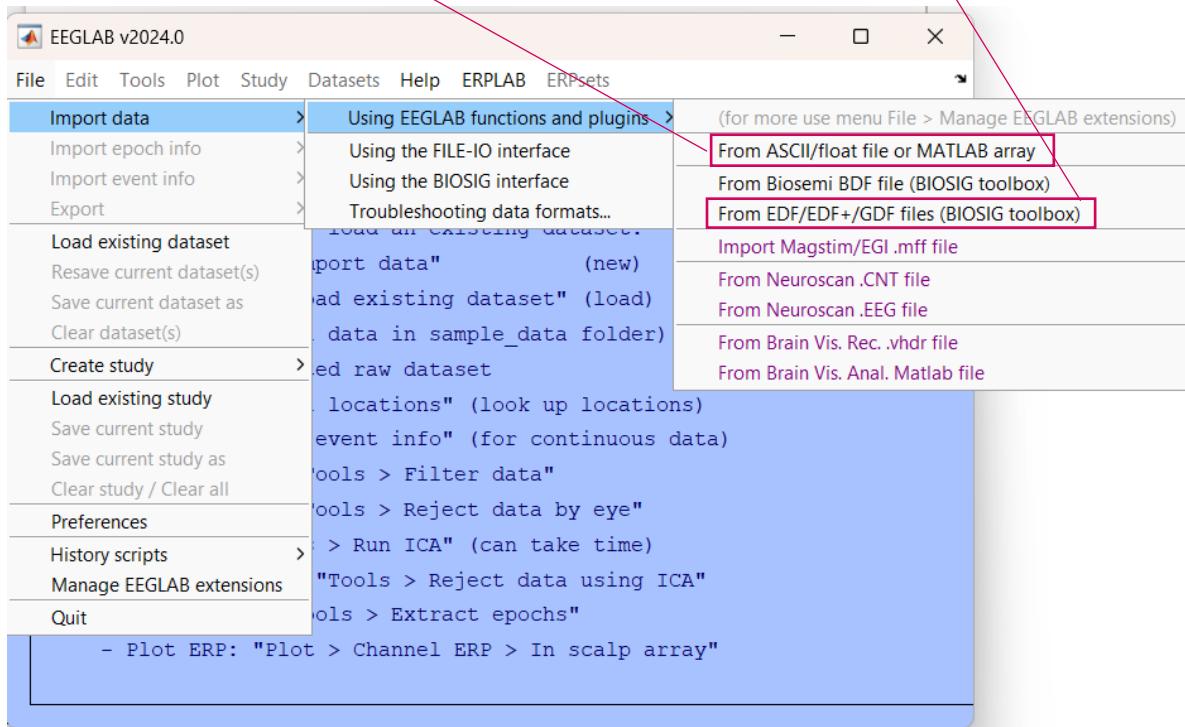
Pre-processing pipeline



EEGLAB

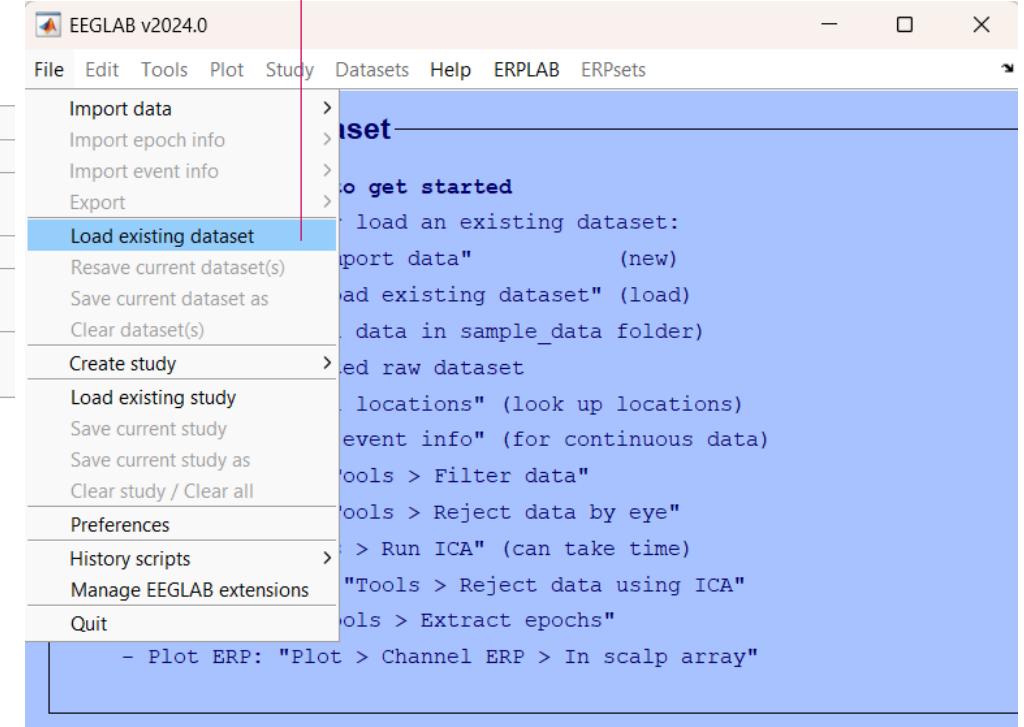
Import/Load files

For .mat files



For .edf/edf+ files

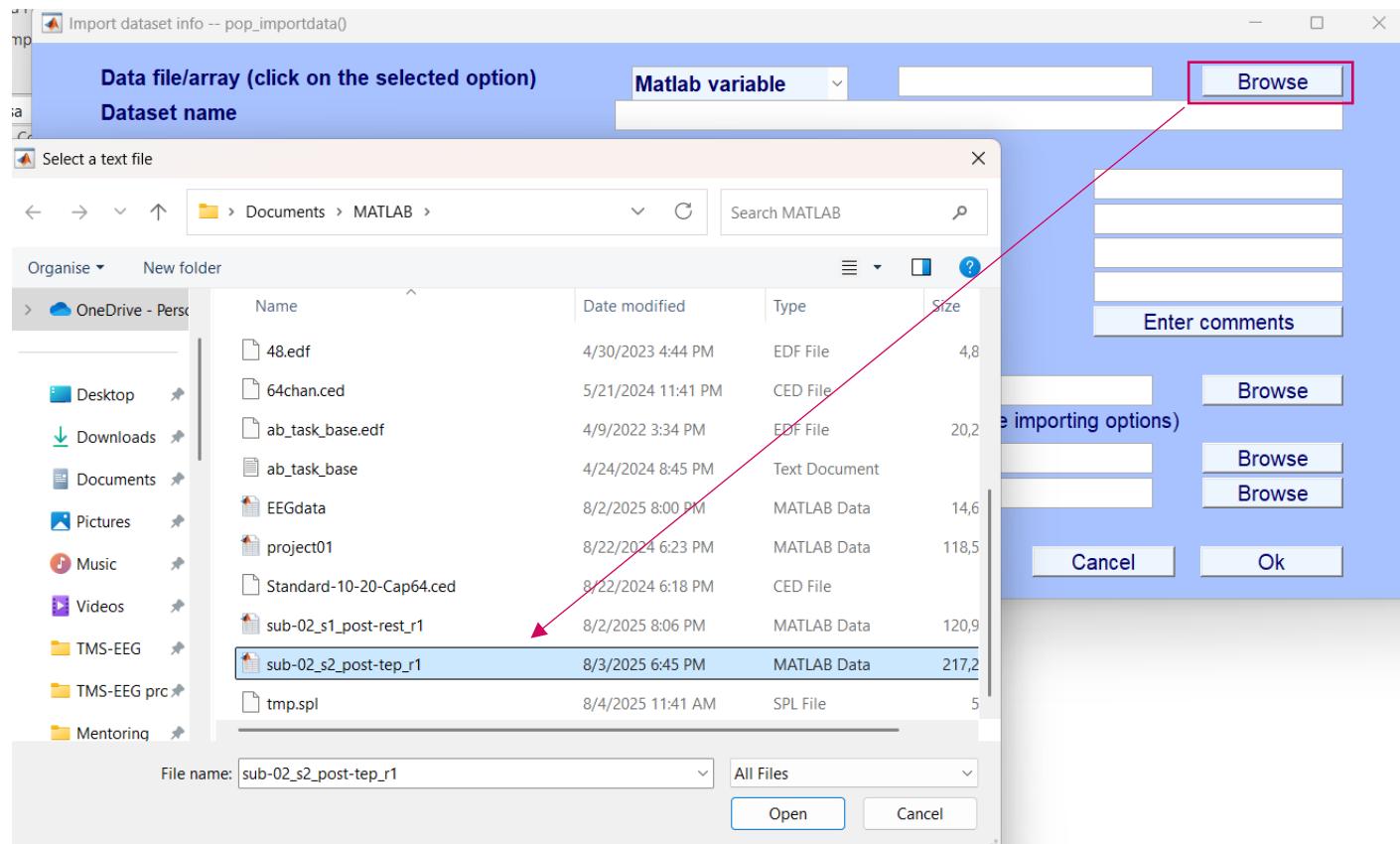
For .set files



EEGLAB

Import/Load files

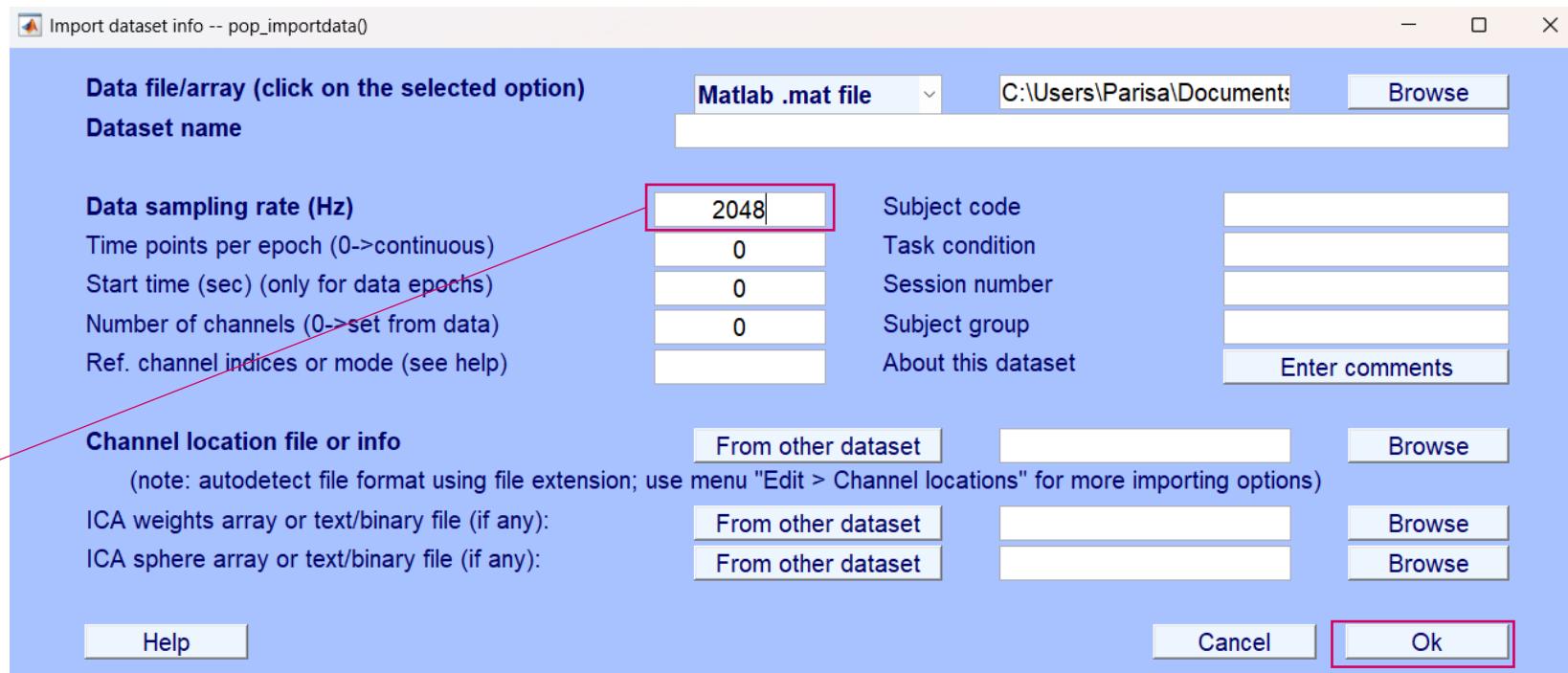
For .mat files



EEGLAB

Import/Load files

For .mat files

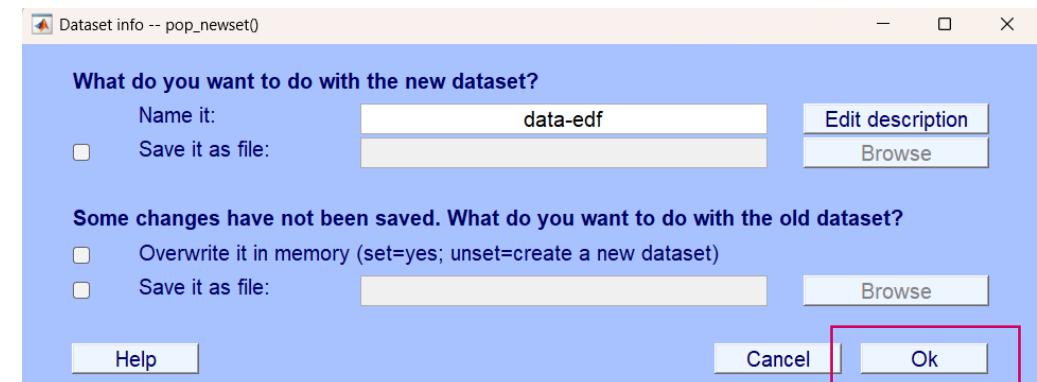
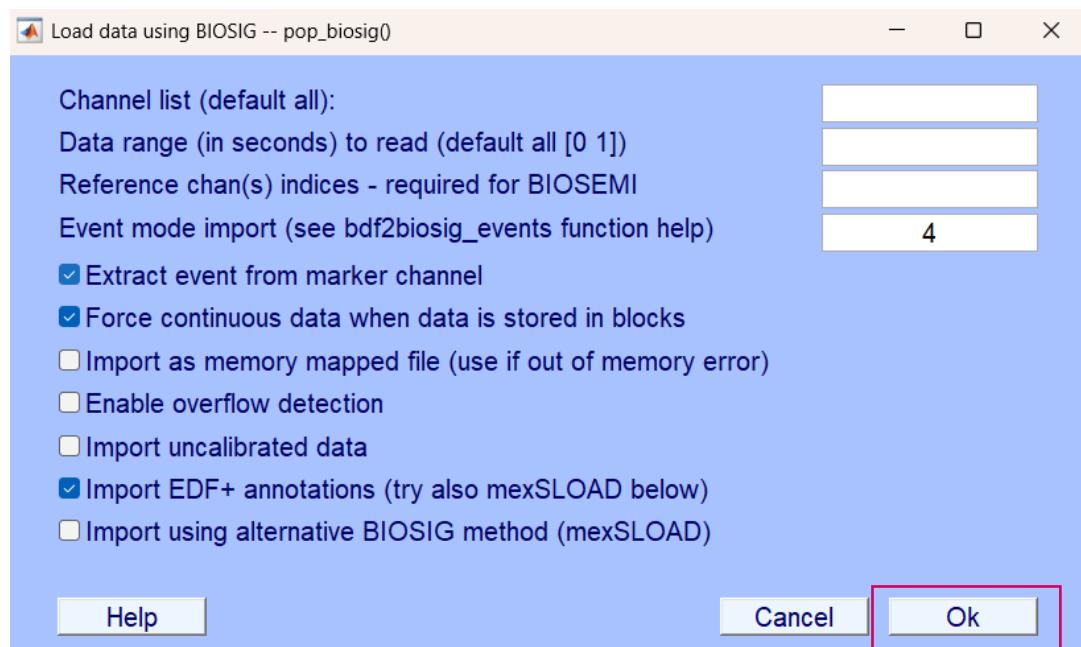


Based on the data sampling rate

EEGLAB

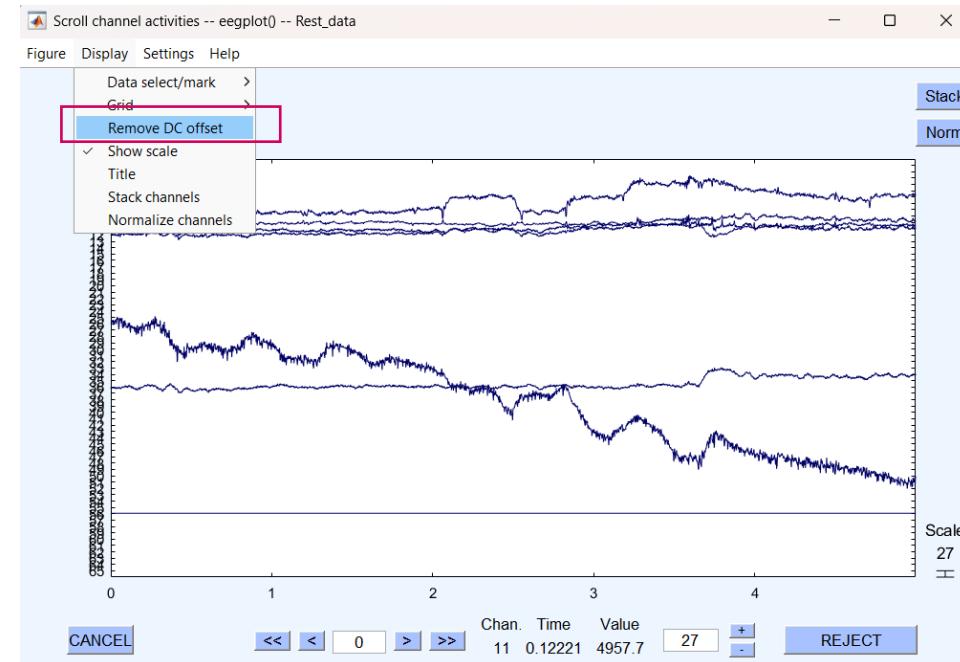
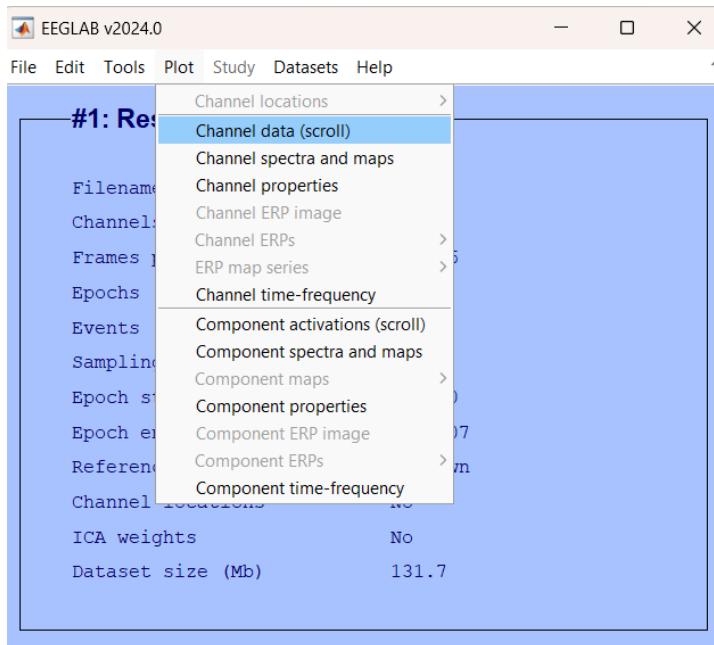
Import/Load files

For .edf/edf+ files



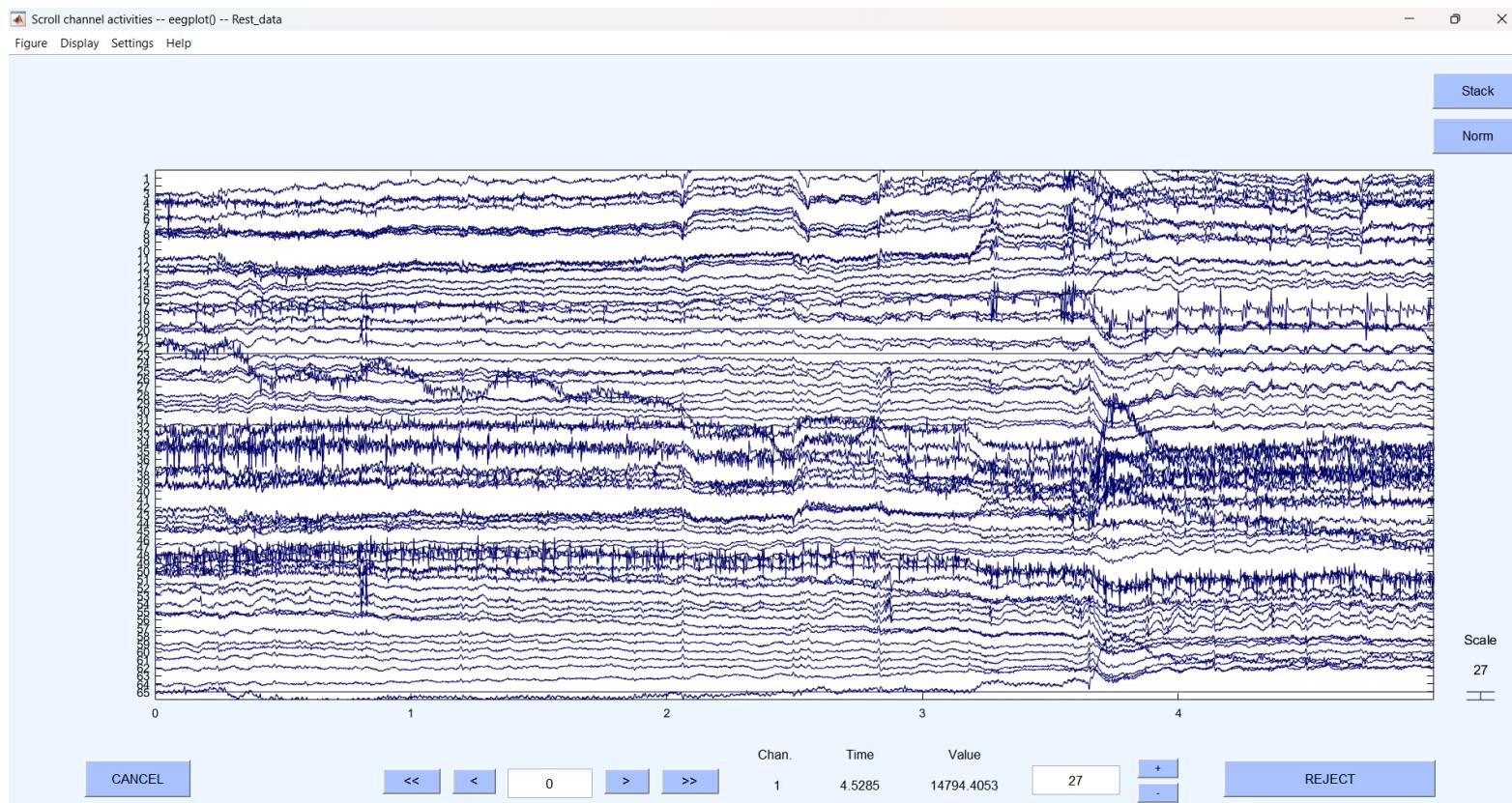
EEGLAB

Plot channel data



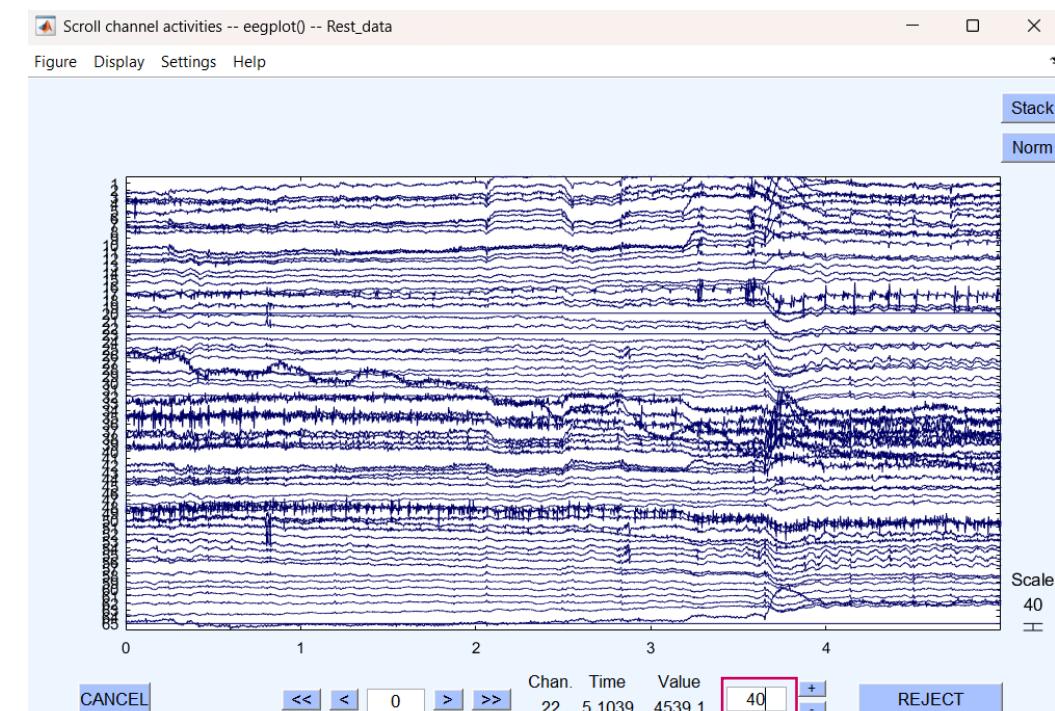
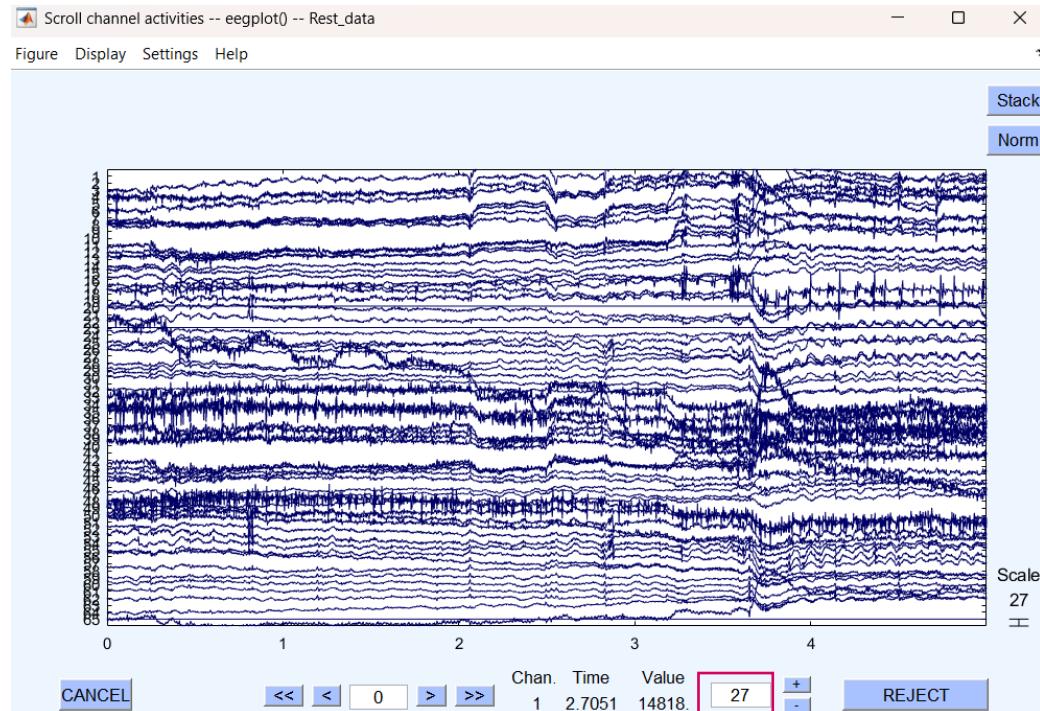
EEGLAB

Plot channel data



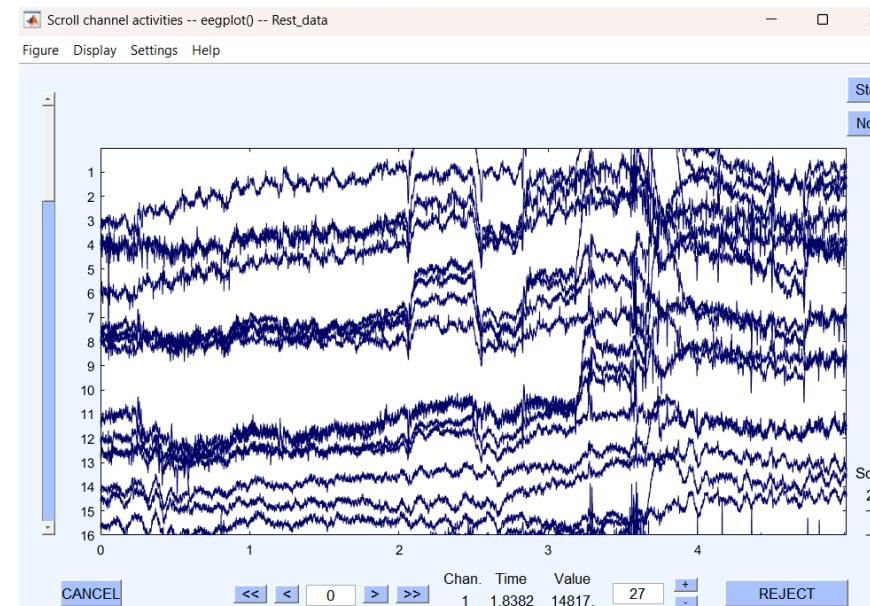
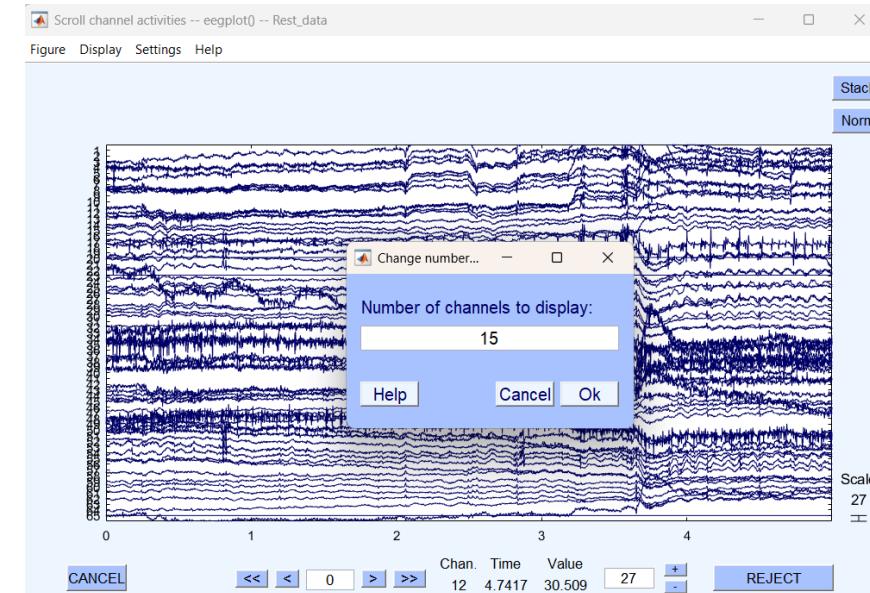
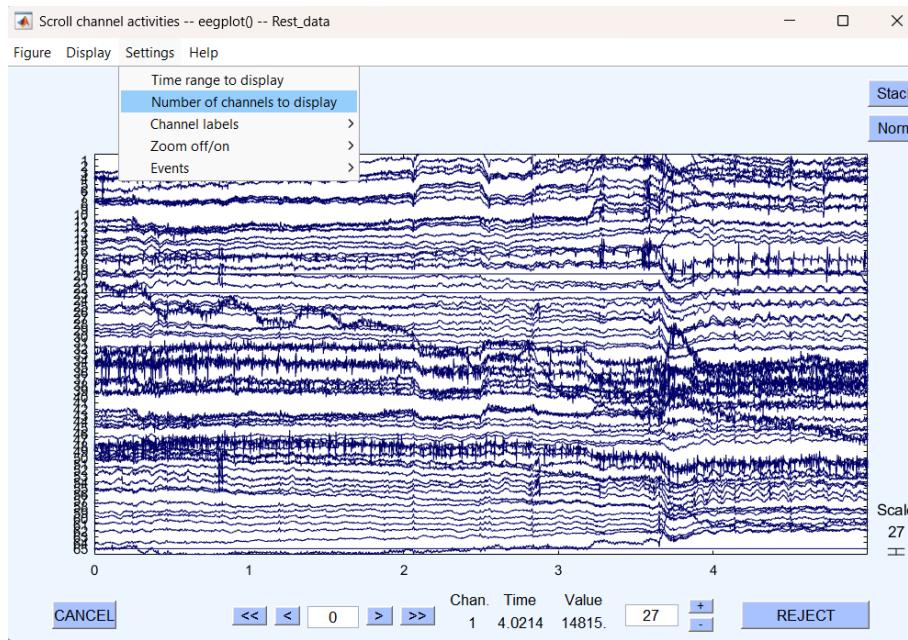
EEGLAB

Plot channel data



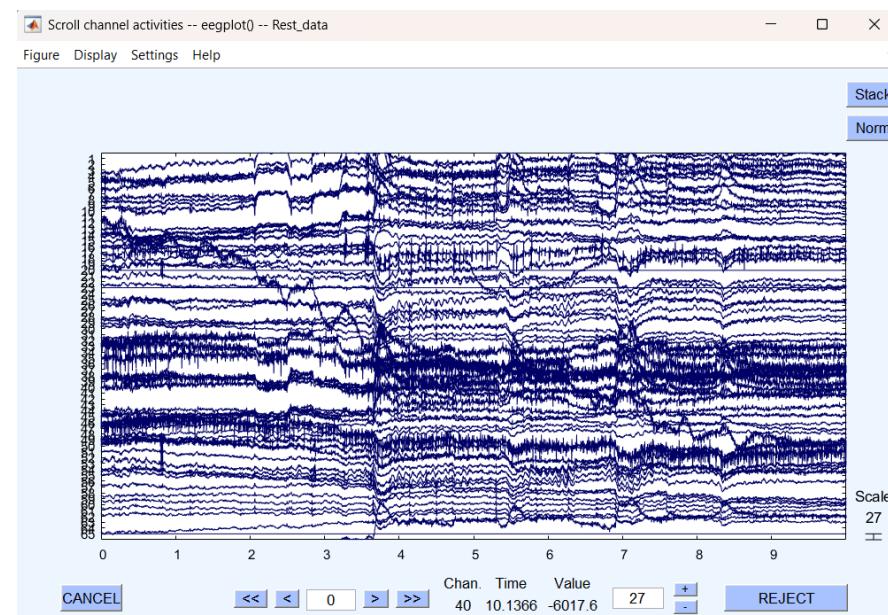
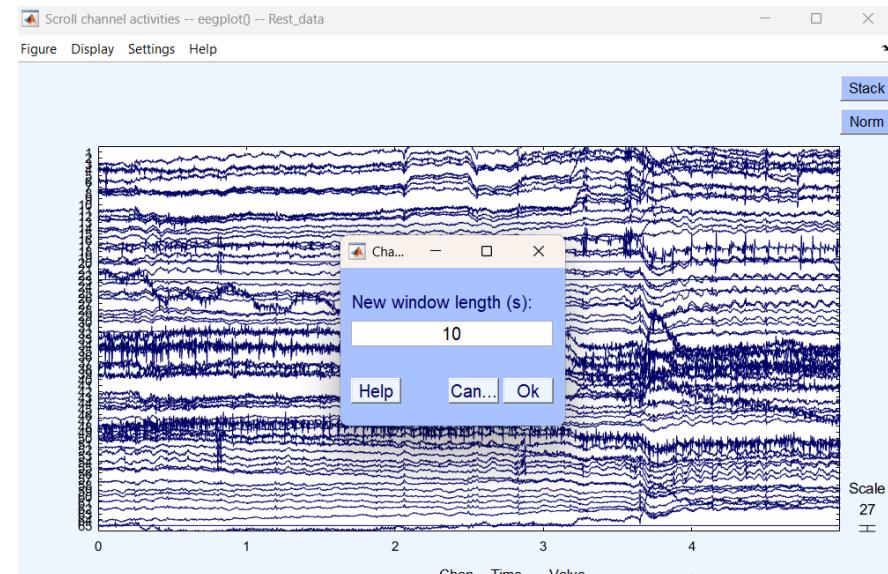
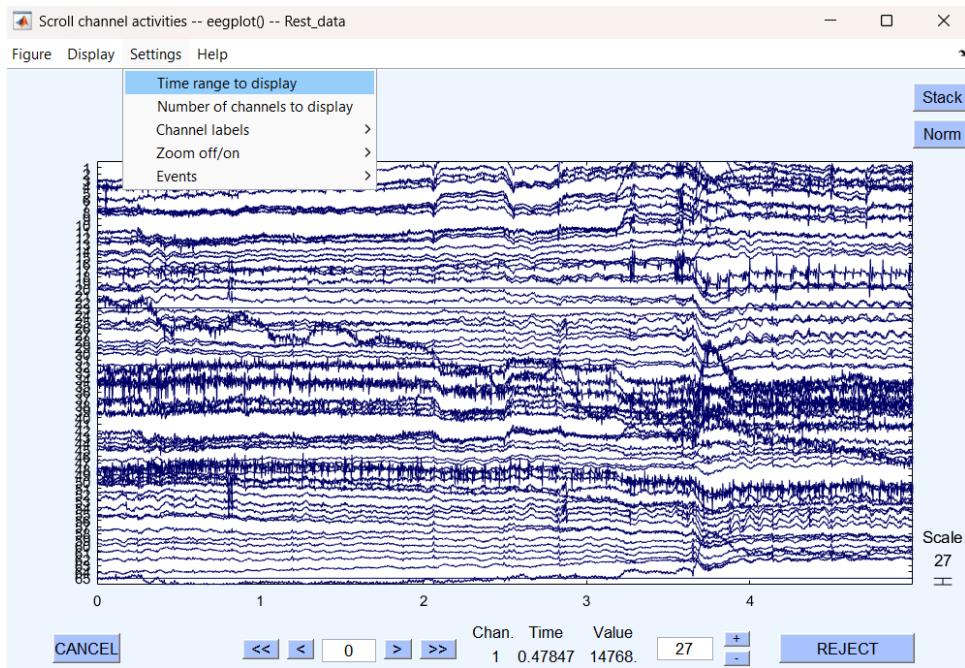
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Plot channel data



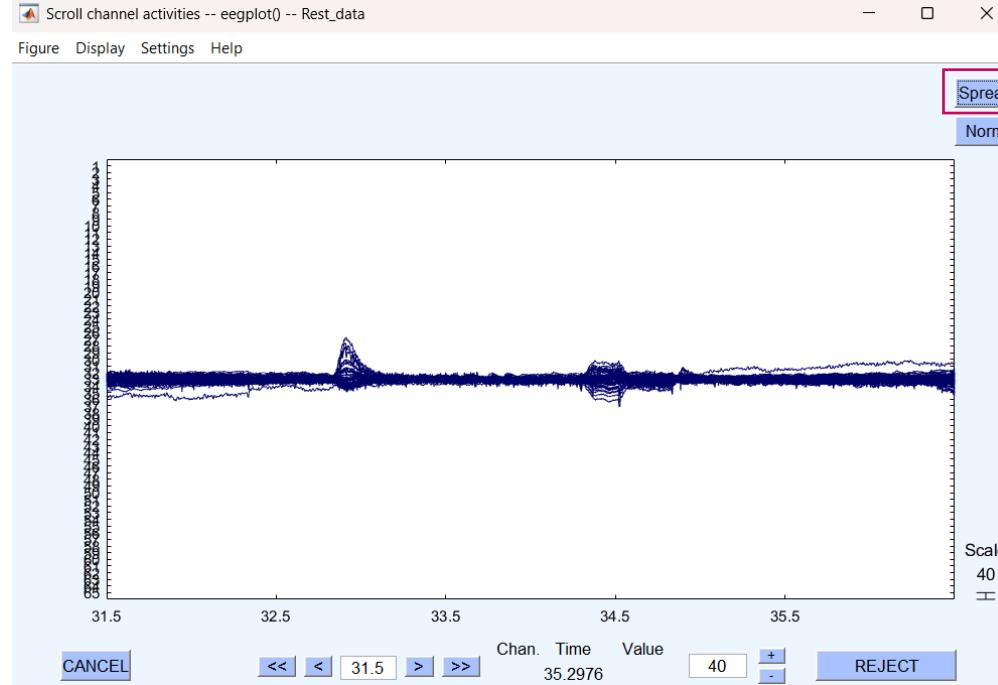
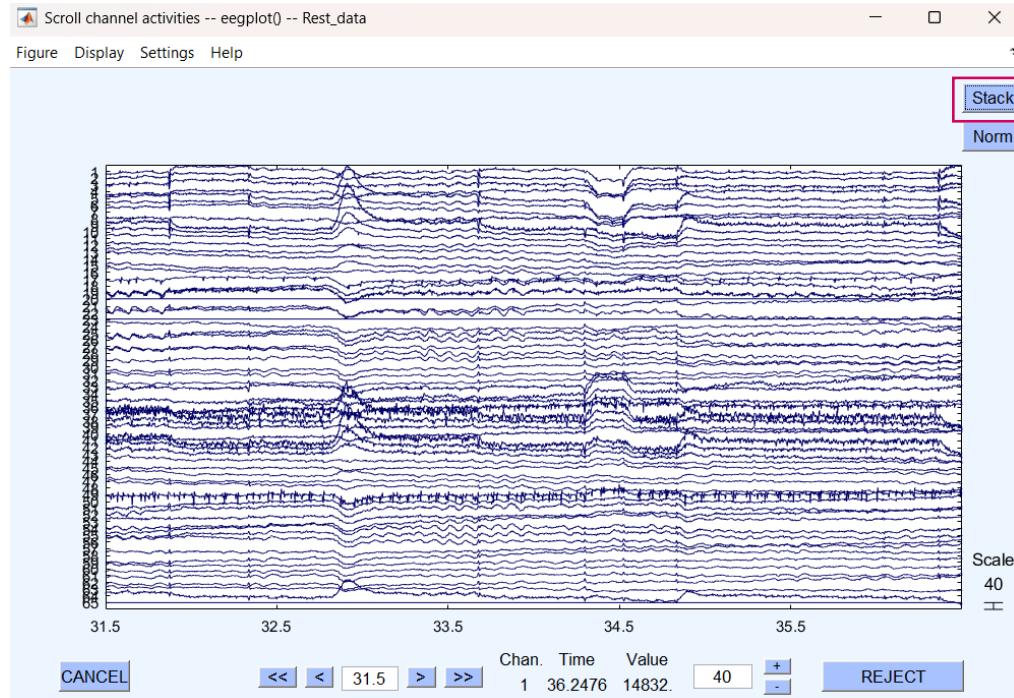
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Plot channel data



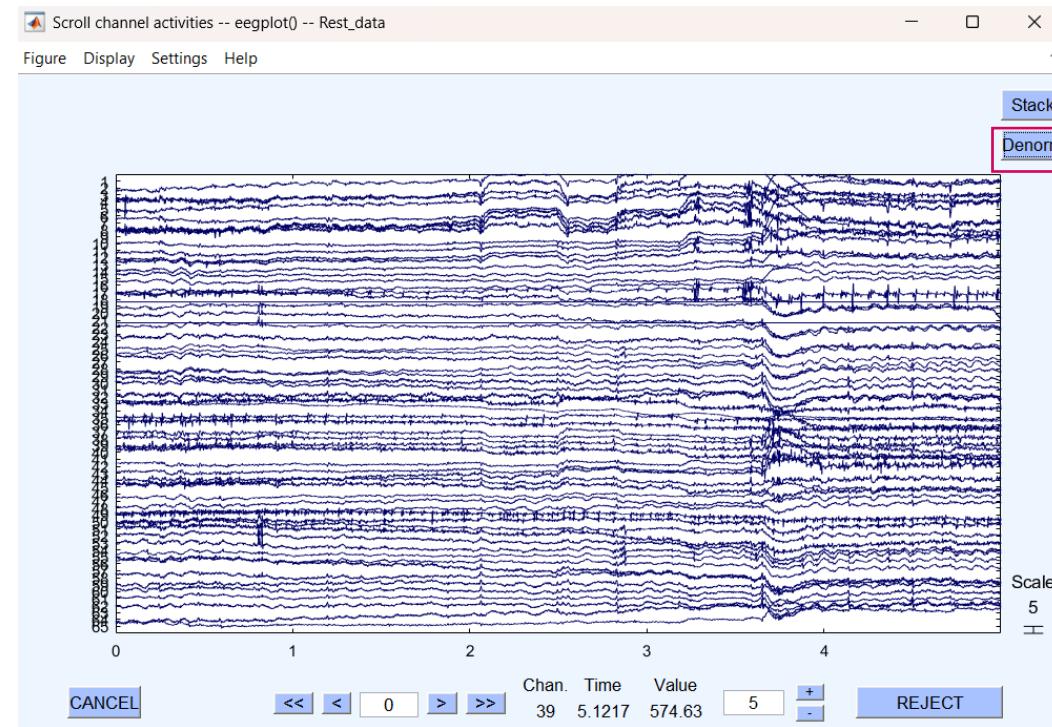
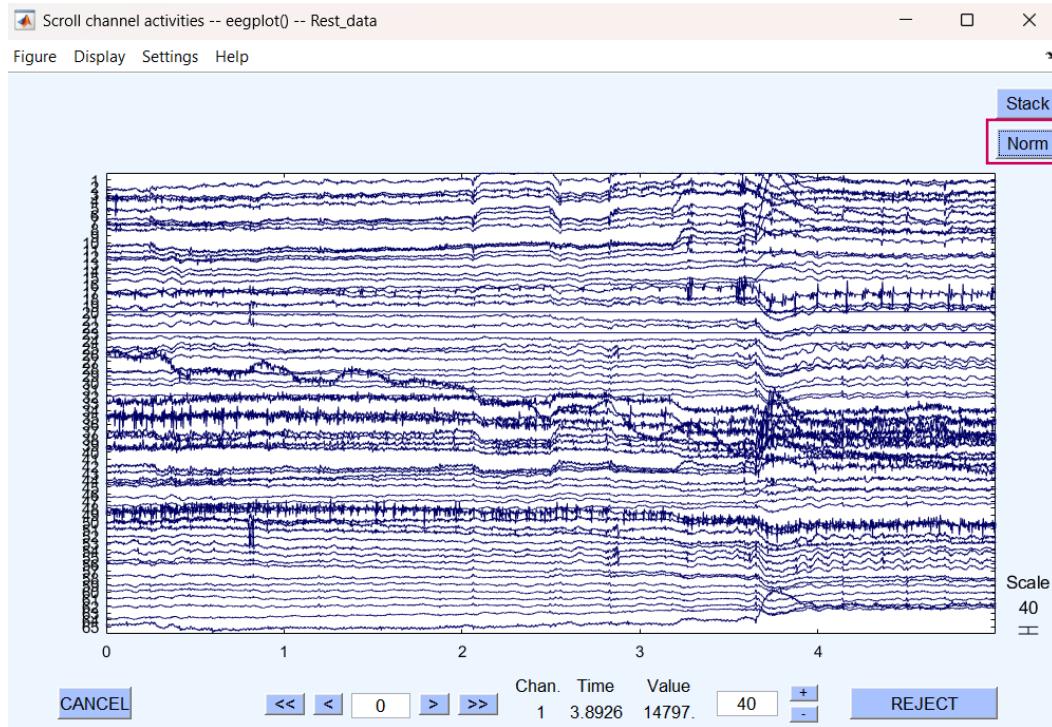
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Plot channel data



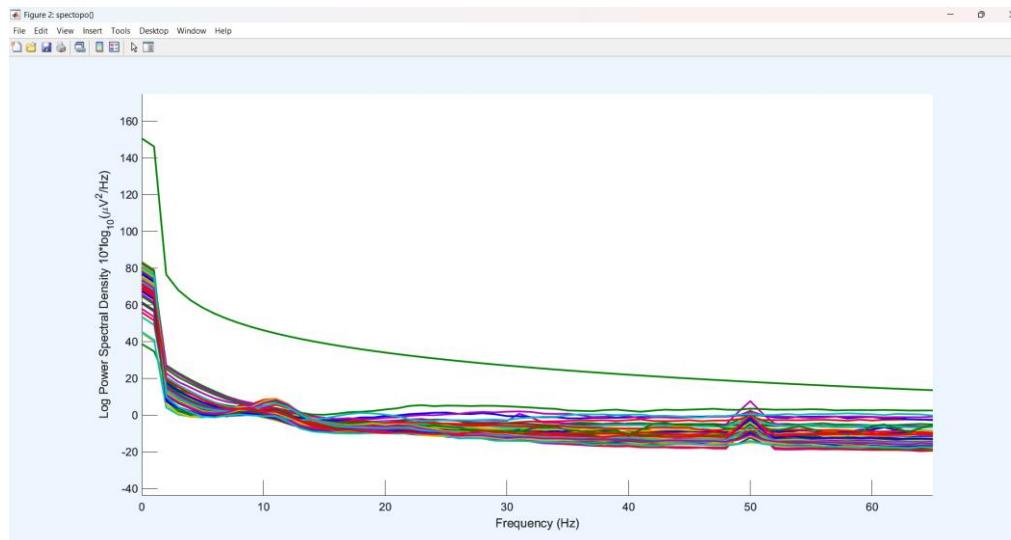
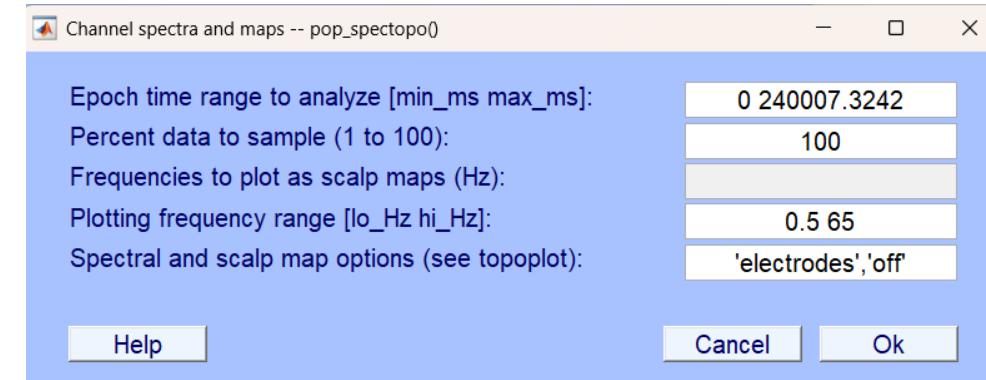
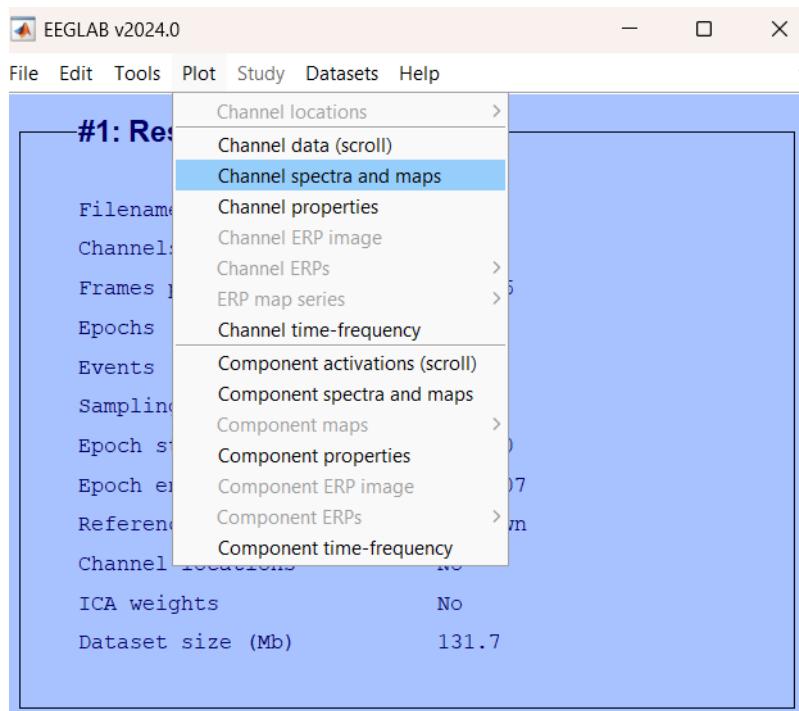
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Plot channel data



EEGLAB

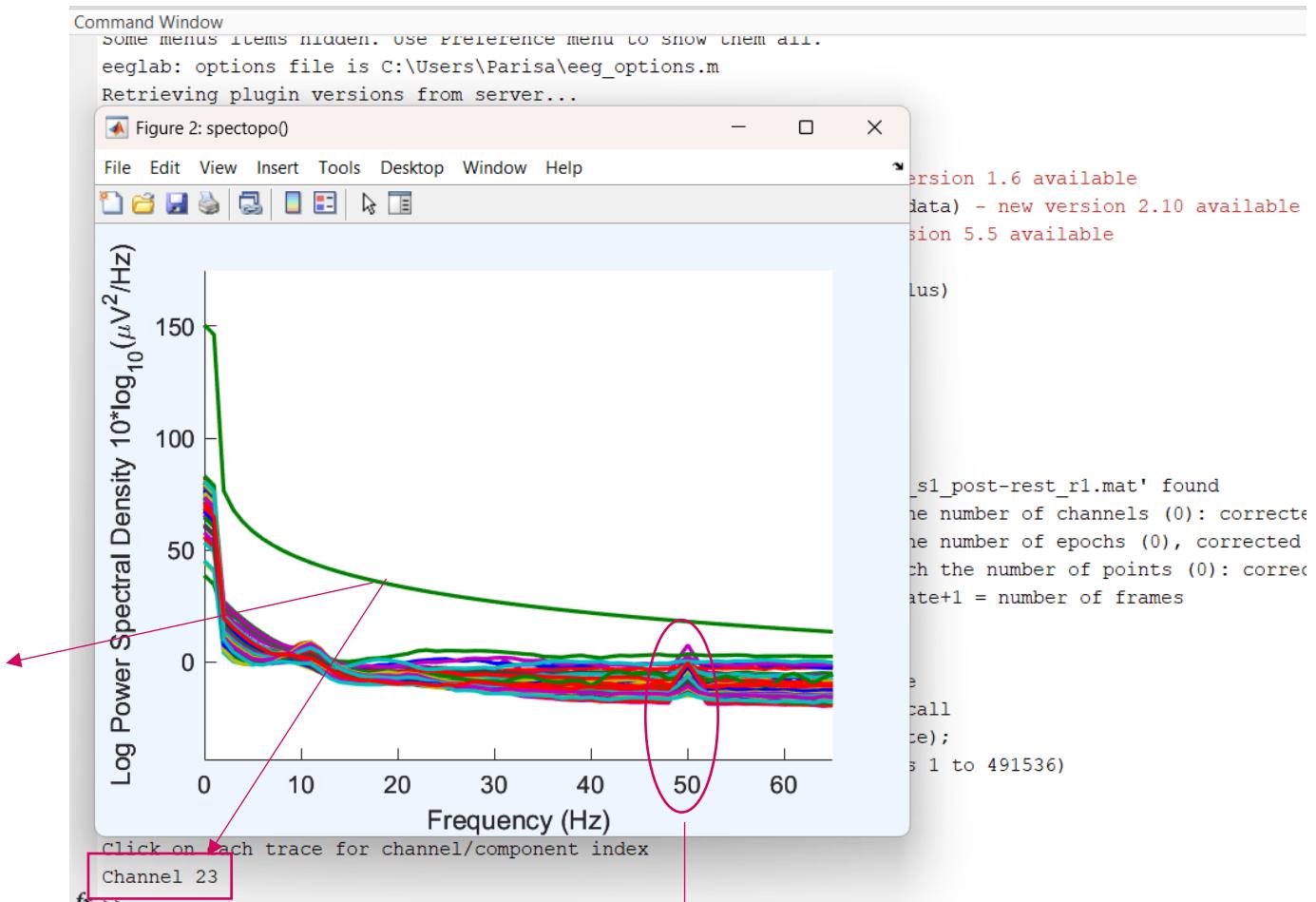
Plot channel spectra and maps



EEGLAB

Plot channel spectra
and maps

Bad channel

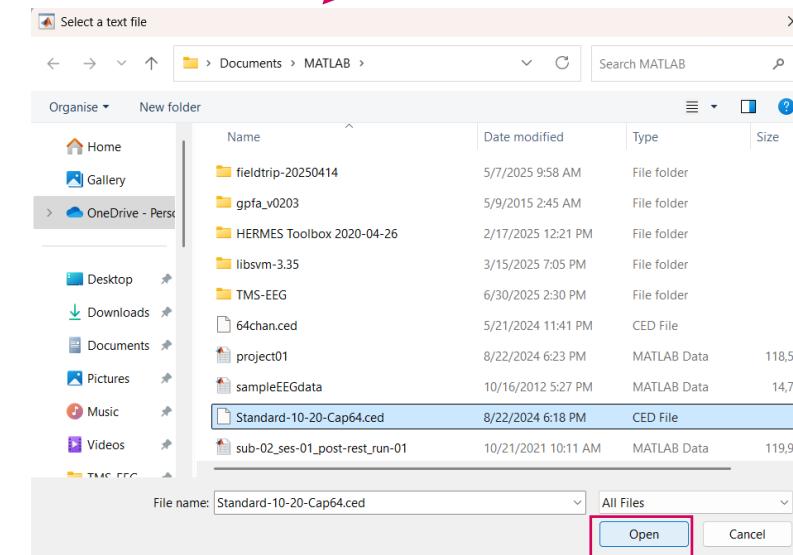
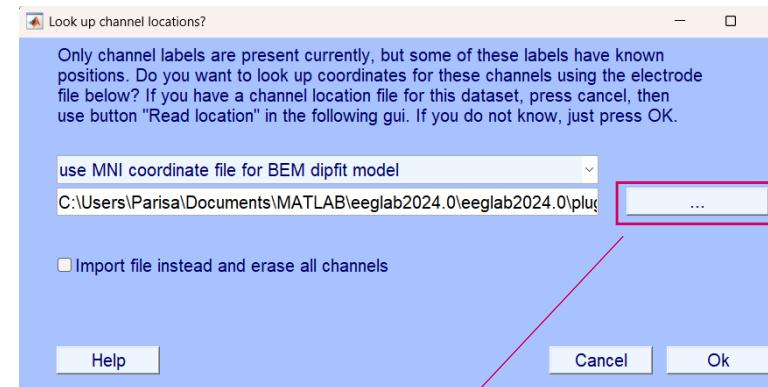
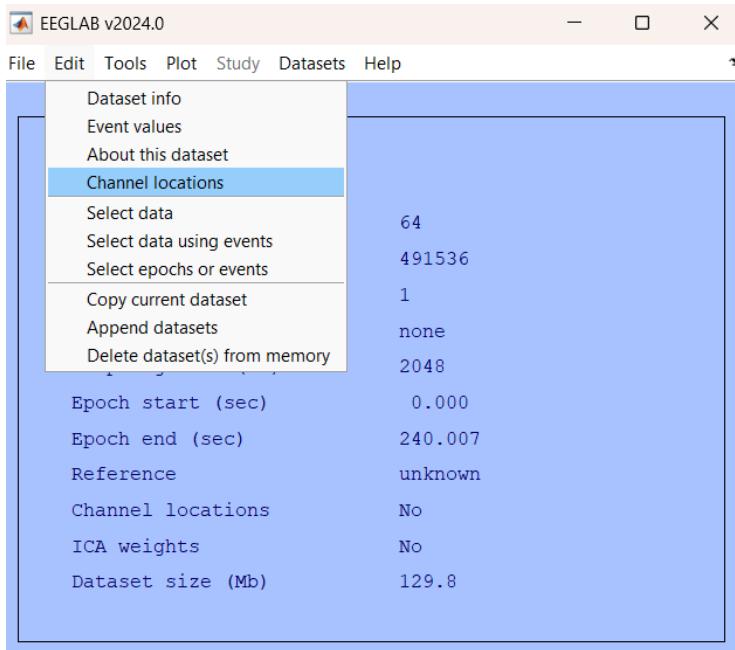


To see the number of a
specific channel, left-click on it

Line noise

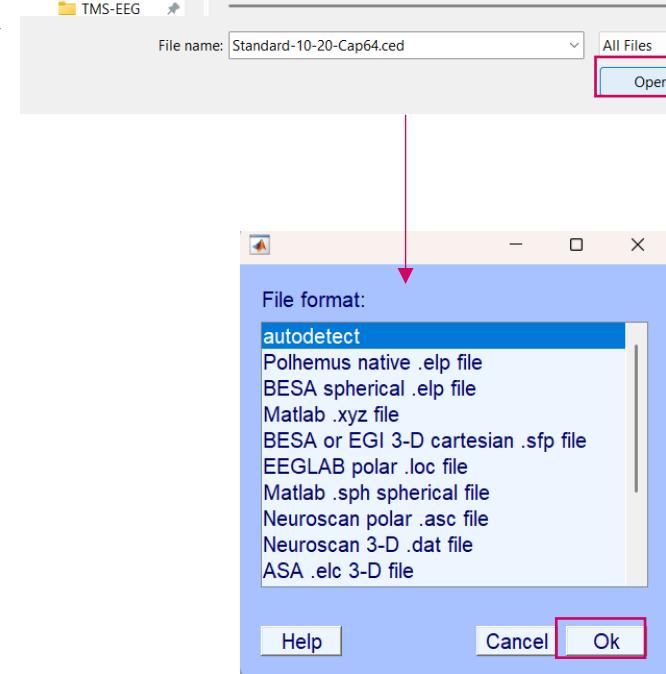
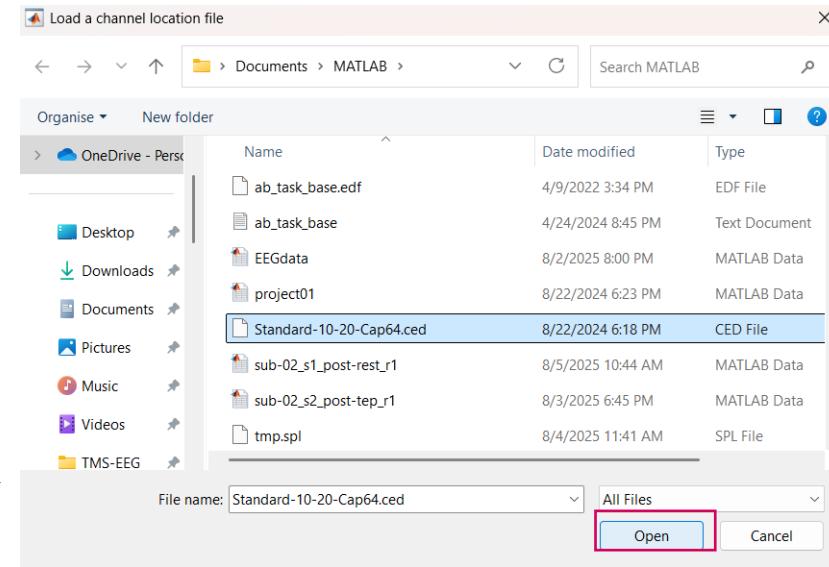
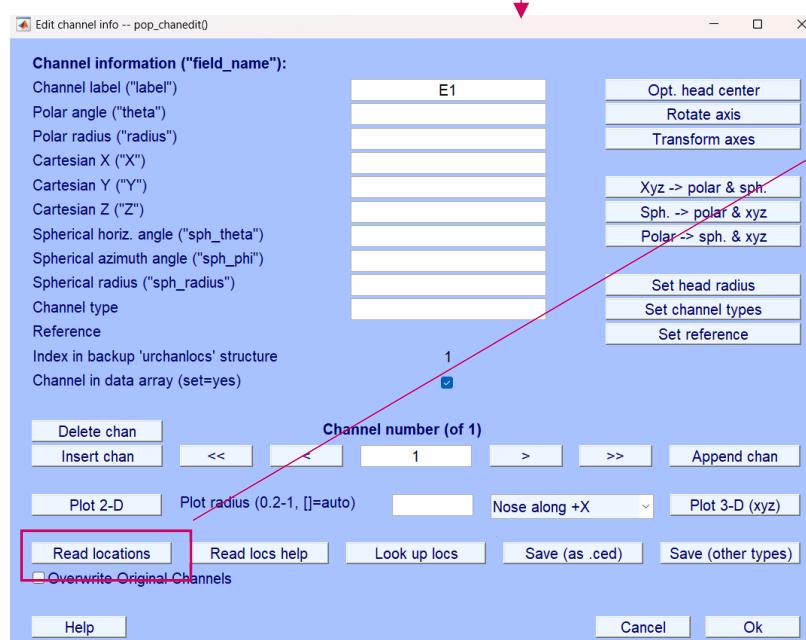
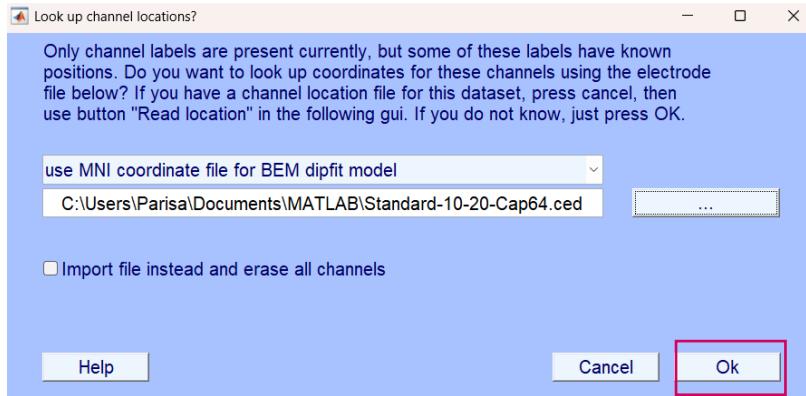
EEGLAB

Channel locations



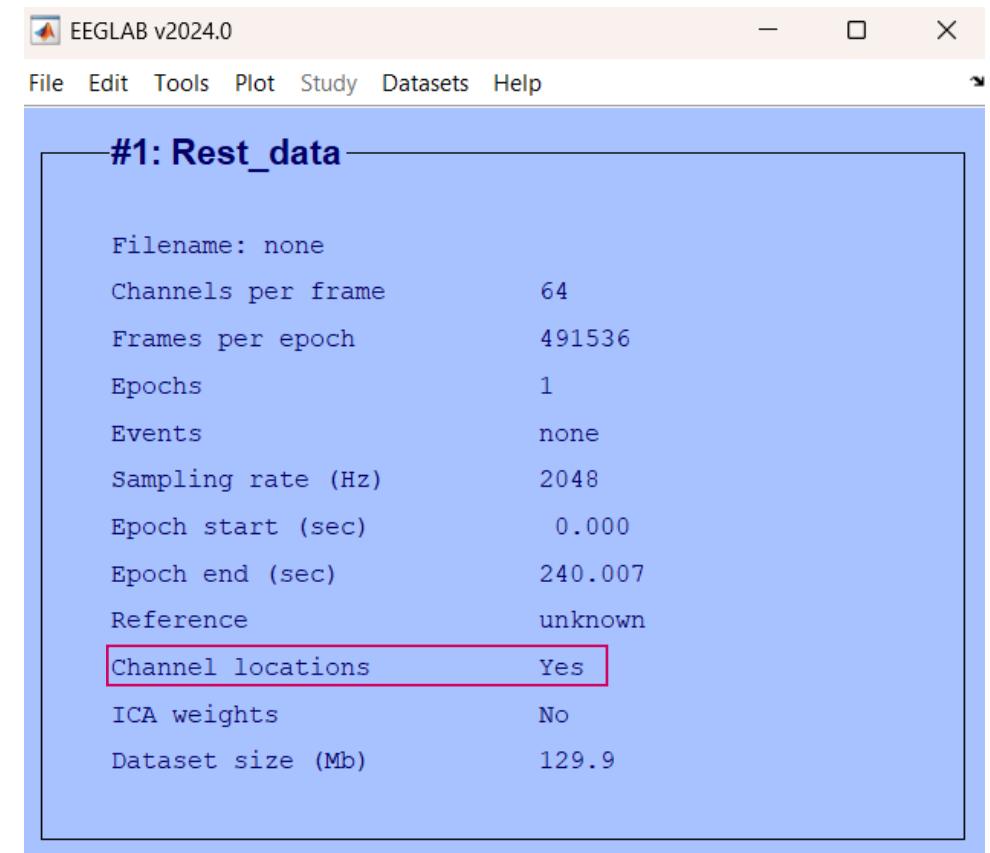
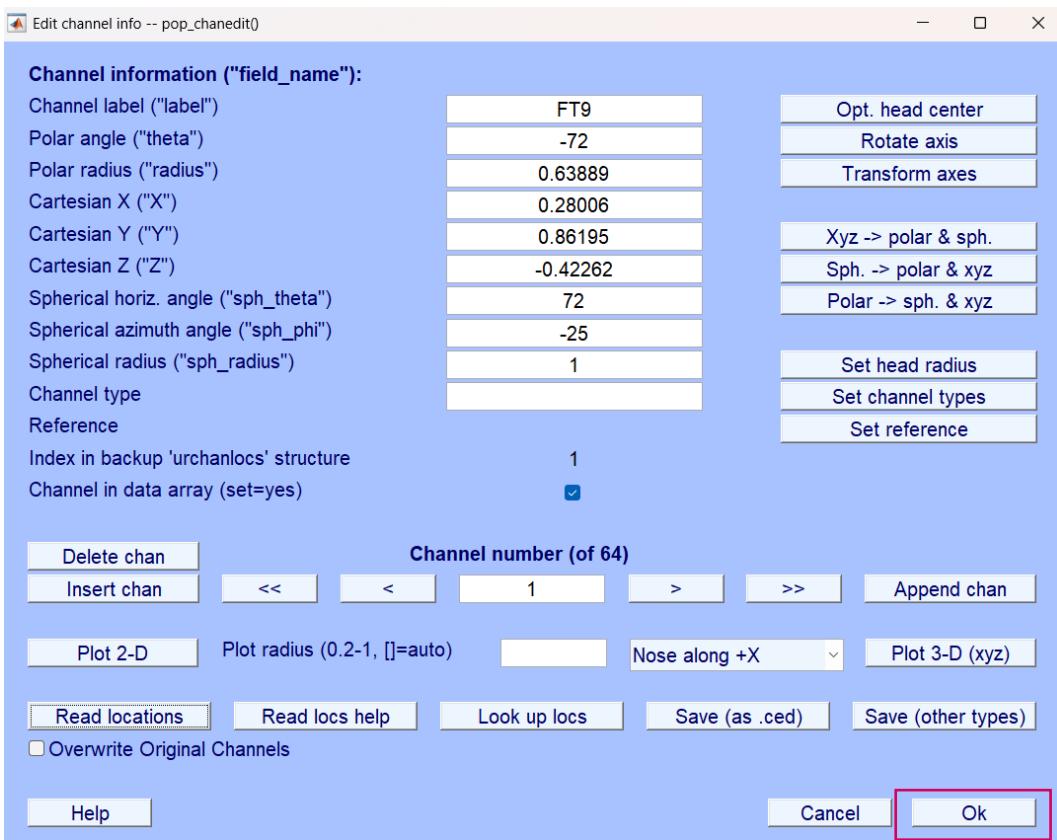
EEGLAB

Channel locations



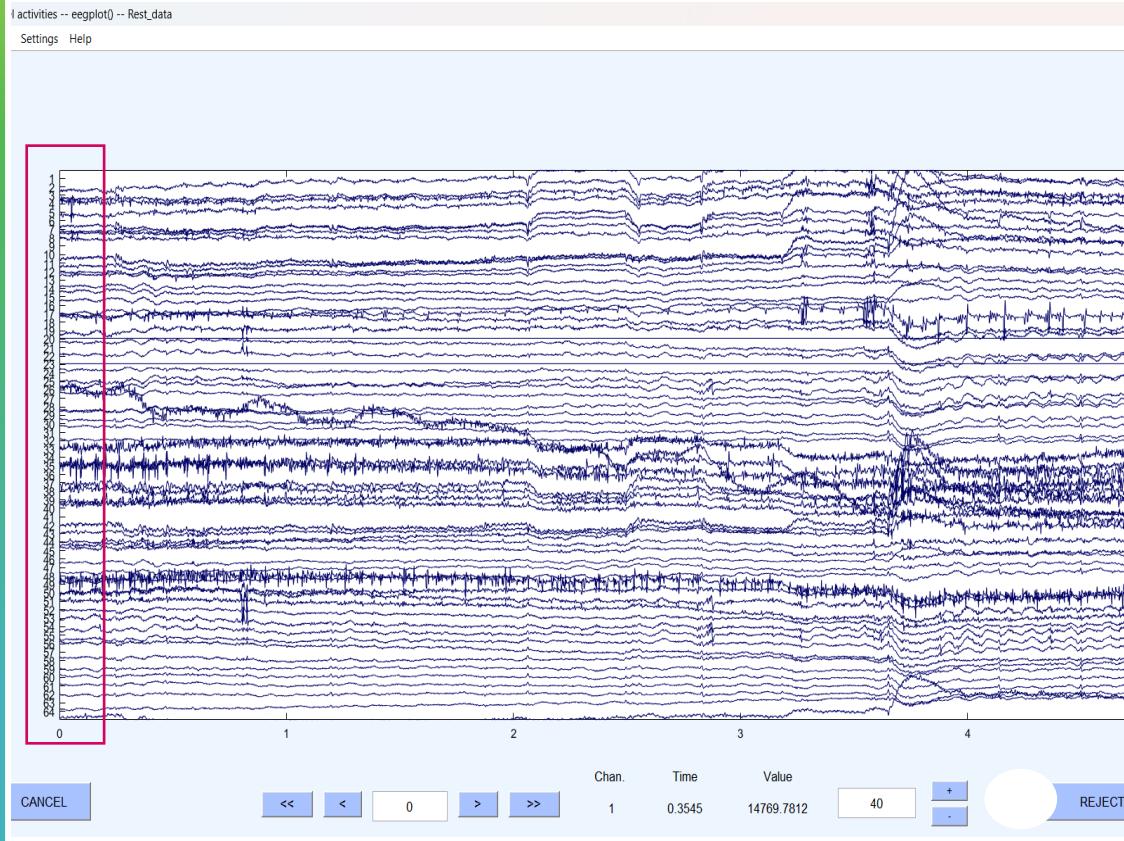
EEGLAB

Channel locations

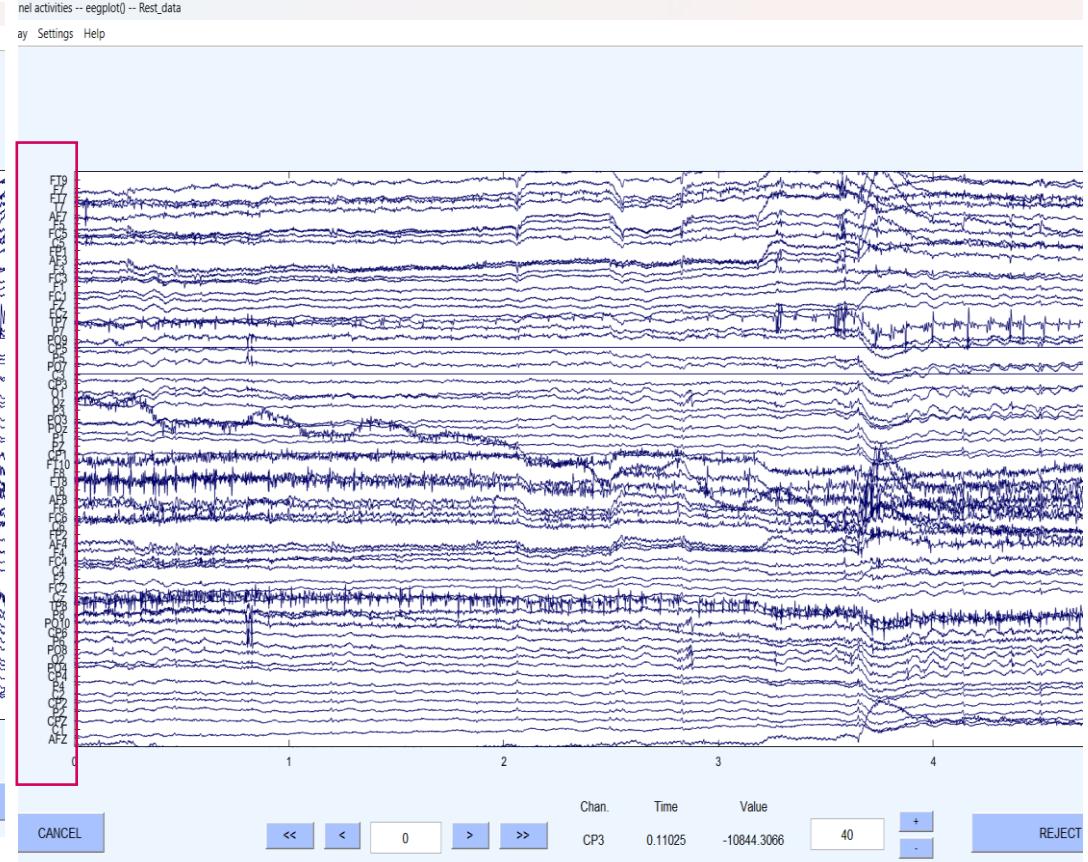


EEGLAB

Channel locations



Before importing channel locations



After importing channel locations

EEGLAB

Channel locations

Number	labels	theta	radius	X	Y	Z	sph_theta	sph_phi	sph_radius	type
1	Fp1	-109	0.525	-29.4	83.9	-6.99	109	-4.49	89.2	
2	Fpz	-89.9	0.506	0.112	88.2	-1.71	89.9	-1.11	88.3	
3	Fp2	-70.6	0.525	29.9	84.9	-7.08	70.6	-4.5	90.3	
4	AF7	-129	0.538	-54.8	68.6	-10.6	129	-6.88	88.4	
5	AF3	-114	0.421	-33.7	76.8	21.2	114	14.2	86.5	
6	AFz	-89.8	0.368	0.231	80.8	35.4	89.8	23.7	88.2	
7	AF4	-65.3	0.42	35.7	77.7	22	65.3	14.4	88.3	
8	AF8	-51.3	0.538	55.7	69.7	-10.8	51.3	-6.87	89.9	
9	F7	-149	0.544	-70.3	42.5	-11.4	149	-7.92	82.9	
10	F5	-143	0.434	-64.5	48	16.9	143	11.9	82.2	
11	F3	-133	0.333	-50.2	53.1	42.2	133	30	84.4	
12	F1	-116	0.257	-27.5	56.9	60.3	116	43.7	87.4	
13	Fz	-89.7	0.23	0.312	58.5	66.5	89.7	48.6	88.5	
14	F2	-62.9	0.263	29.5	57.6	59.5	62.9	42.6	87.9	
15	F4	-46.3	0.341	51.8	54.3	40.8	46.3	28.5	85.5	
16	F6	-36.3	0.439	67.9	49.8	16.4	36.3	11	85.8	
17	F8	-31.3	0.544	73	44.4	-12	31.3	-7.99	86.3	
18	FT7	-170	0.543	-80.8	14.1	-11.1	170	-7.73	82.8	
19	FC5	-166	0.405	-77.2	18.6	24.5	166	17.1	83.1	
20	FC3	-159	0.273	-60.2	22.7	55.5	159	40.8	85	
21	FC1	-143	0.157	-34.1	26	80	143	61.8	90.7	
22	FCz	-89.2	0.0954	0.376	27.4	88.7	89.2	72.8	92.8	
23	FC2	-37.2	0.161	34.8	26.4	78.8	37.2	61	90.1	
24	FC4	-20.8	0.279	62.3	23.7	55.6	20.8	39.8	86.8	
25	FC6	-14.1	0.408	79.5	19.9	24.4	14.1	16.6	85.6	
26	FT8	-10.7	0.543	81.8	15.4	-11.3	10.7	-7.75	84	
27	FT10	-9.69	0.67	84.1	14.4	-50.5	9.69	-30.6	99.2	
28	T7	169	0.535	-84.2	-16	-9.35	-169	-6.23	86.2	
29	C5	170	0.391	-80.3	-13.8	29.2	-170	19.7	86.5	
30	C3	170	0.255	-65.4	-11.6	64.4	-170	44.1	92.5	
31	C1	165	0.126	-36.2	-9.98	89.8	-165	67.3	97.3	
32	Cz	87.5	0.0291	0.401	-9.17	100	-87.5	84.8	101	
33	C2	14.3	0.132	37.7	-9.62	88.4	-14.3	66.3	96.6	
34	C4	9.22	0.261	67.1	-10.9	63.6	-9.22	43.1	93.1	
35	C6	8.7	0.394	83.5	-12.8	29.2	-8.7	19.1	89.3	
36	T8	10	0.535	85.1	-15	-9.49	-10	-6.27	86.9	
37	TP9	151	0.64	-85.6	-46.5	-45.7	-151	-25.1	108	
38	TP7	152	0.523	-84.8	-46	-7.06	-152	-4.18	96.8	
39	CP5	150	0.397	-79.6	-46.6	30.9	-150	18.6	97.3	
40	CP3	144	0.279	-63.6	-47	65.6	-144	39.7	103	
41	CP1	127	0.183	-35.5	-47.3	91.3	-127	57.1	109	
42	CP2	89.5	0.141	0.386	-47.3	99.4	-89.5	64.6	110	
43	CP2	50.8	0.188	38.4	-47.1	90.7	-50.8	56.2	109	
44	CP4	35	0.284	66.6	-46.6	65.6	-35	38.9	104	
45	CP6	29	0.399	83.3	-46.1	31.2	-29	18.1	100	
46	TP8	28	0.523	85.5	-45.5	-7.13	-28	-4.21	97.2	
47	TP10	28.6	0.639	86.2	-47	-45.9	-28.6	-25	108	
48	P7	135	0.508	-72.4	-73.5	-2.49	-135	-1.38	103	
49	P5	131	0.413	-67.3	-76.3	28.4	-131	15.6	106	
50	P3	124	0.331	-53	-78.8	55.9	-124	30.5	110	
51	P1	110	0.27	-28.6	-80.5	75.4	-110	41.4	114	
52	Pz	89.8	0.247	0.325	-81.1	82.6	-89.8	45.5	116	
53	P2	68.4	0.269	31.9	-80.5	76.7	-68.4	41.5	116	
54	P4	54.7	0.331	55.7	-78.6	56.6	-54.7	30.4	112	
55	P6	48.2	0.414	67.9	-75.9	28.1	-48.2	15.4	106	
56	P8	45	0.508	73.1	-73.1	-2.54	-45	-1.41	103	
57	P07	119	0.492	-54.8	-97.5	2.79	-119	1.43	112	
58	P03	110	0.394	-36.5	-101	37.2	-110	19.1	114	
59	P0z	89.9	0.354	0.216	-102	50.6	-89.9	26.3	114	
60	P04	70	0.396	36.8	-101	36.4	-70	18.7	113	
61	P08	60.3	0.492	55.7	-97.6	2.73	-60.3	1.39	112	
62	O1	105	0.476	-29.4	-112	8.84	-105	4.35	117	
63	Oz	89.9	0.46	0.108	-115	14.7	-89.9	7.27	116	
64	O2	75.1	0.476	29.8	-112	8.8	-75.1	4.34	116	

Ln 1, Col 1 | 3,265 characters

Plain text

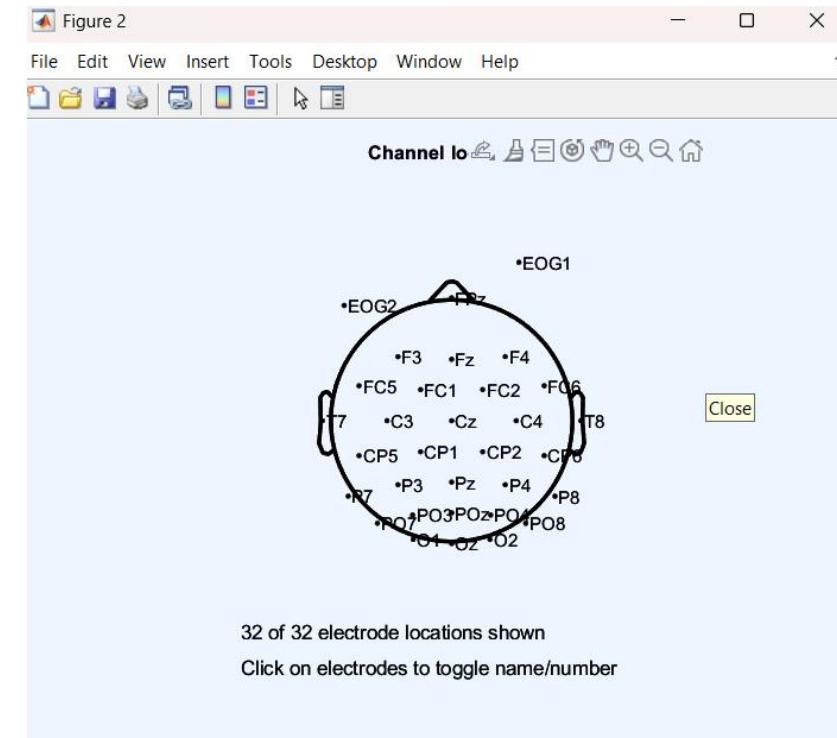
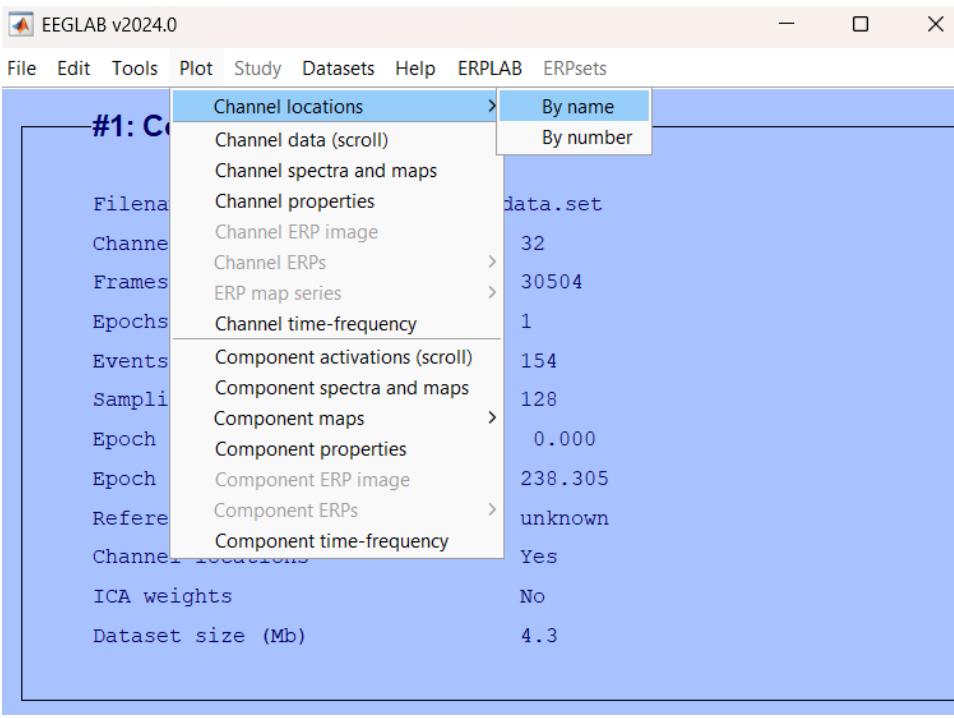
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25	FC6	-14.1	0.408	79.5	19.9	24.4	14.1	16.6	85.6				
26	FT8	-10.7	0.543	81.8	15.4	-11.3	10.7	-7.75	84				
27	FT10	-9.69	0.67	84.1	14.4	-50.5	9.69	-30.6	99.2				
28	T7	169	0.535	-84.2	-16	-9.35	-169	-6.23	86.2				
29	C5	170	0.391	-80.3	-13.8	29.2	-170	19.7	86.5				
30	C3	170	0.255	-65.4	-11.6	64.4	-170	44.1	92.5				
31	C1	165	0.126	-36.2	-9.98	89.8	-165	67.3	97.3				
32	Cz	87.5	0.0291	0.401	-9.17	100	-87.5	84.8	101				
33	C2	14.3	0.132	37.7	-9.62	88.4	-14.3	66.3	96.6				
34	C4	9.22	0.261	67.1	-10.9	63.6	-9.22	43.1	93.1				
35	C6	8.7	0.394	83.5	-12.8	29.2	-8.7	19.1	89.3				
36	T8	10	0.535	85.1	-15	-9.49	-10	-6.27	86.9				
37	TP9	151	0.64	-85.6	-46.5	-45.7	-151	-25.1	108				
38	TP7	152	0.523	-84.8	-46	-7.06	-152	-4.18	96.8				
39	CP5	150	0.397	-79.6	-46.6	30.9	-150	18.6	97.3				
40	CP3	144	0.279	-63.6	-47	65.6	-144	39.7	103				
41	CP1	127	0.183	-35.5	-47.3	91.3	-127	57.1	109				
42	CP2	89.5	0.141	0.386	-47.3	99.4	-89.5	64.6	110				
43	CP2	50.8	0.188	38.4	-47.1	90.7	-50.8	56.2	109				
44	CP4	35	0.284	66.6	-46.6	65.6	-35	38.9	104				
45	CP6	29	0.399	83.3	-46.1	31.2	-29	18.1	100				
46	TP8	28	0.523	85.5	-45.5	-7.13	-28	-4.21	97.2				
47	TP10	28.6	0.639	86.2	-47	-45.9	-28.6	-25	108				
48	P7	135	0.508	-72.4	-73.5	-2.49	-135	-1.38	103				
49	P5	131	0.413	-67.3	-76.3	28.4	-131	15.6	106				
50	P3	124	0.331	-53	-78.8	55.9	-124	30.5	110				
51	P1	110	0.27	-28.6	-80.5	75.4	-110	41.4	114				
52	Pz	89.8	0.247	0.325	-81.1	82.6	-89.8	45.5	116				
53	P2	68.4	0.269	31.9	-80.5	76.7	-68.4	41.5	116				
54	P4	54.7	0.331	55.7	-78.6	56.6	-54.7	30.4	112				
55	P6	48.2	0.414	67.9	-75.9	28.1	-48.2	15.4	106				
56	P8	45	0.508	73.1	-73.1	-2.54	-45	-1.41	103				
57	P07	119	0.492	-54.8	-97.5	2.79	-119	1.43	112				
58	P03	110	0.394	-36.5	-101	37.2	-110	19.1	114				
59	P0z	89.9	0.354	0.216	-102	50.6	-89.9	26.3	114				
60	P04	70	0.396	36.8	-101	36.4	-70	18.7	113				
61	P08	60.3	0.492	55.7	-97.6	2.73	-60.3	1.39	112				
62	O1	105	0.476	-29.4	-112	8.84	-105	4.35	117				
63	Oz	89.9	0.46	0.108	-115	14.7	-89.9	7.27	116				
64	O2	75.1	0.476	29.8	-112	8.8	-75.1	4.34	116				

Ln 1, Col 1 | 3,265 characters

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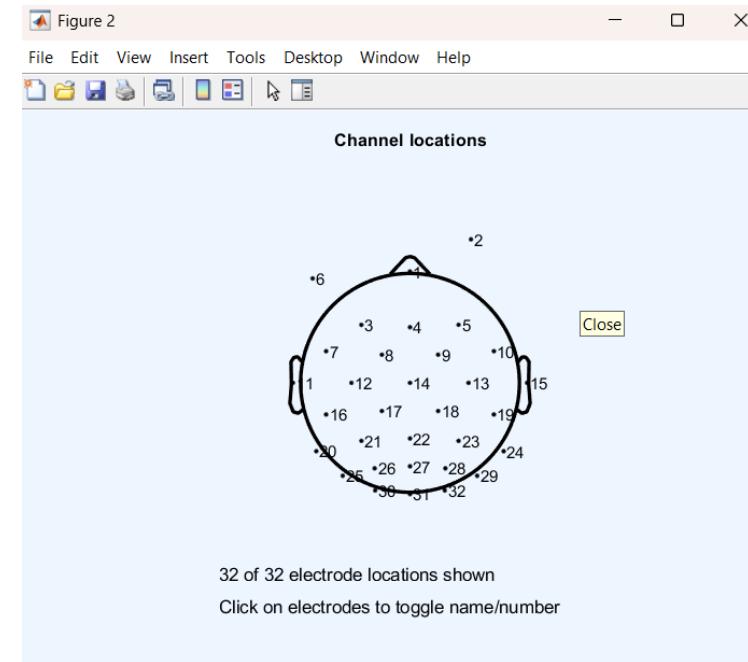
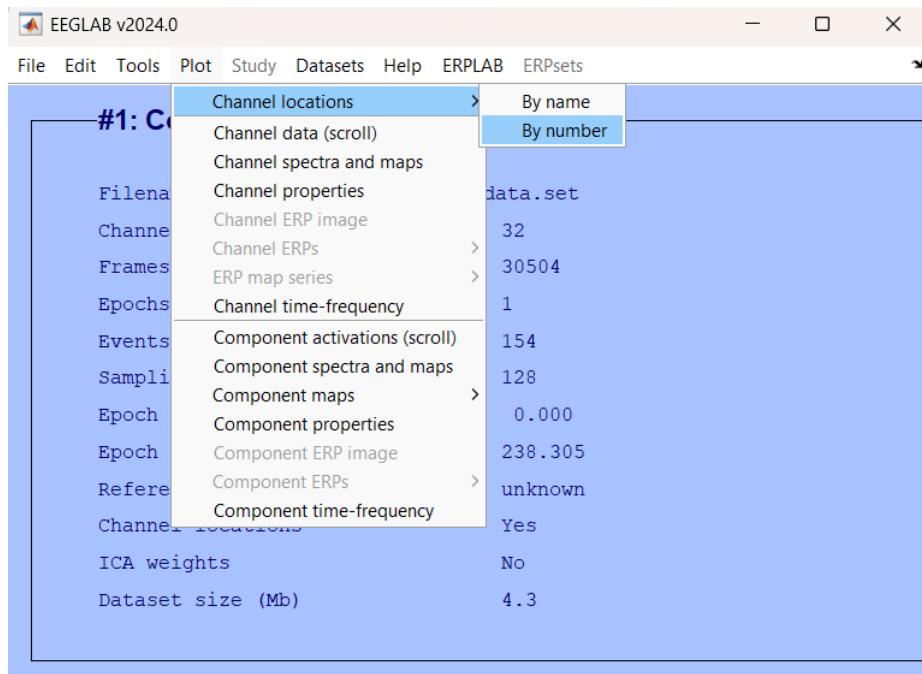
EEGLAB

Plot channel locations



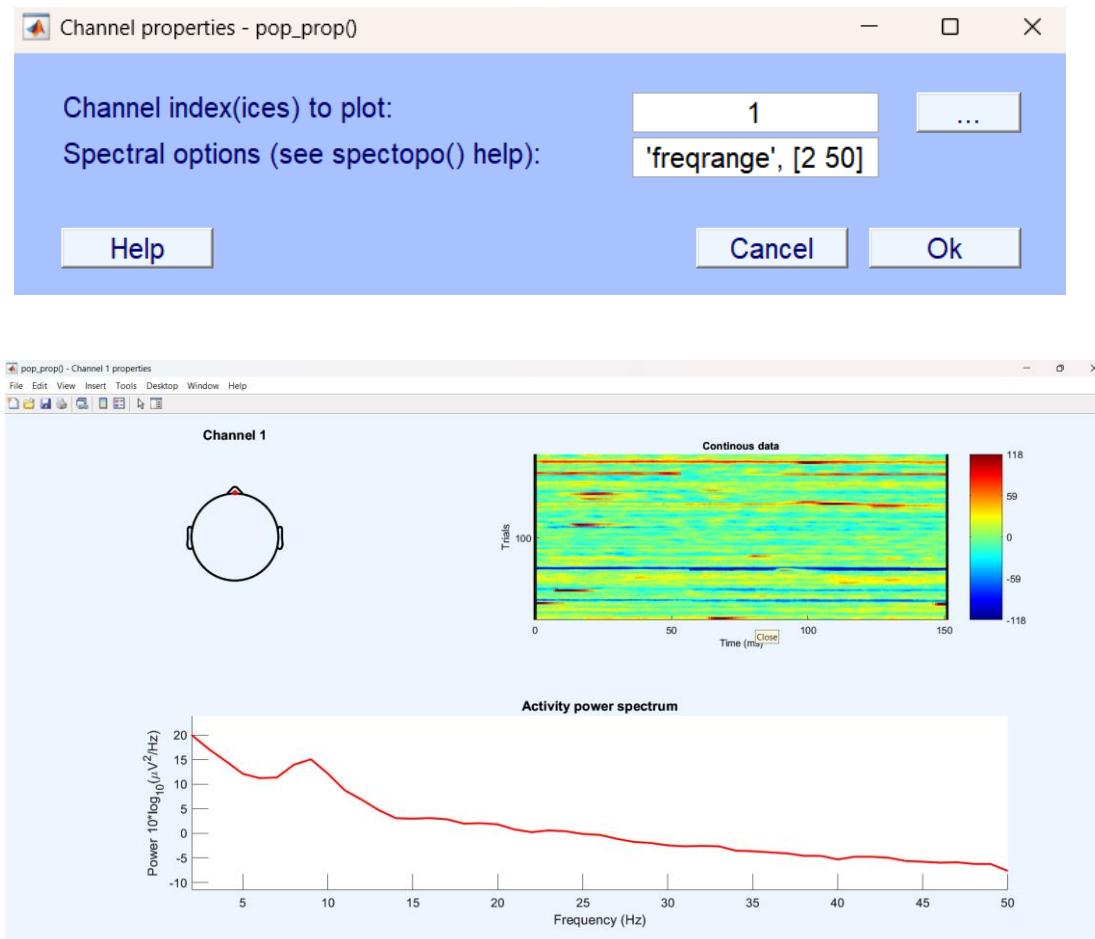
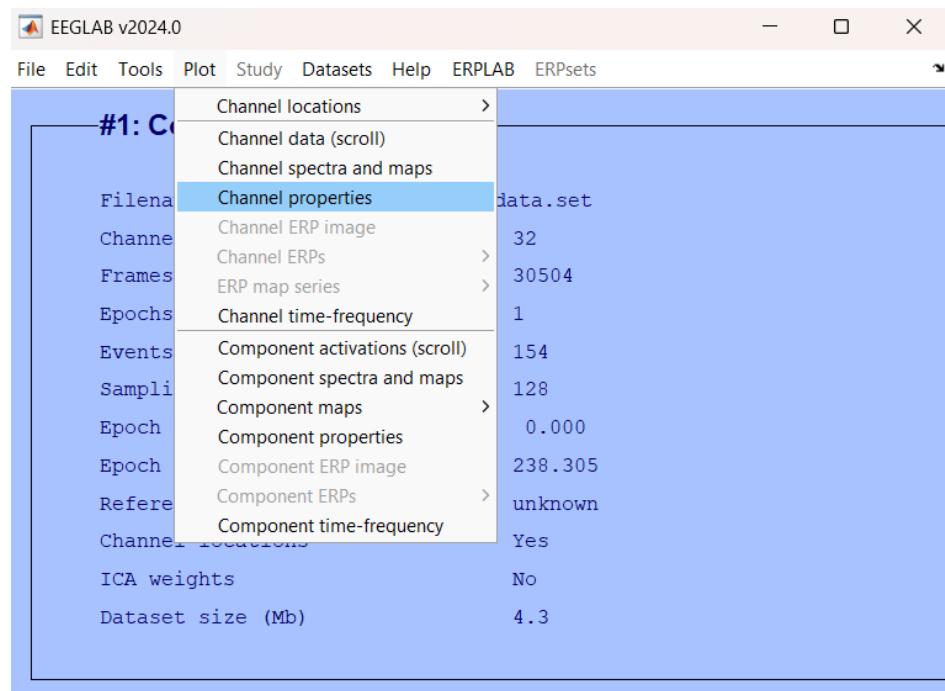
EEGLAB

Plot channel locations



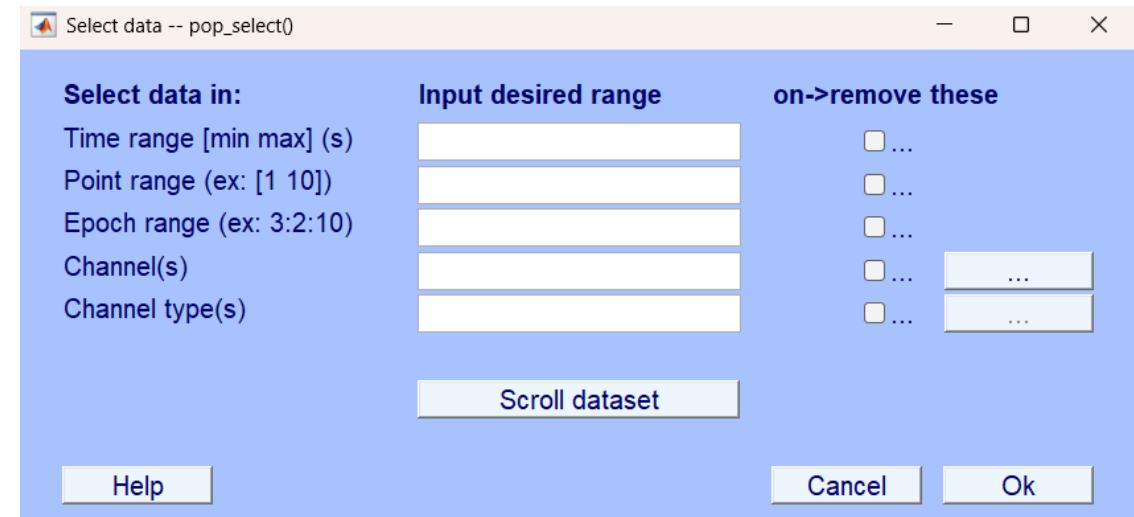
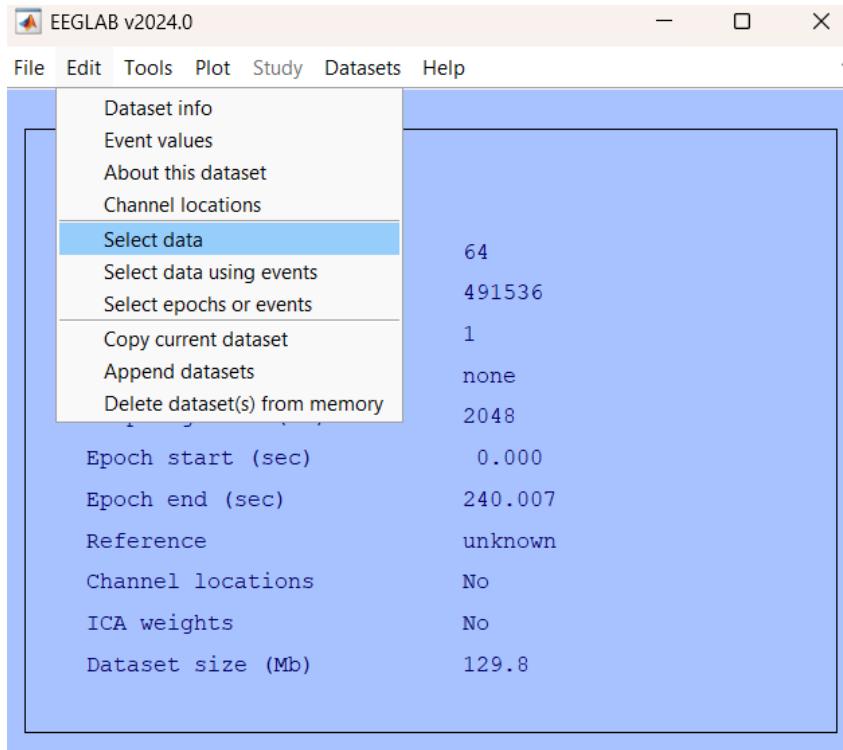
EEGLAB

Channel properties



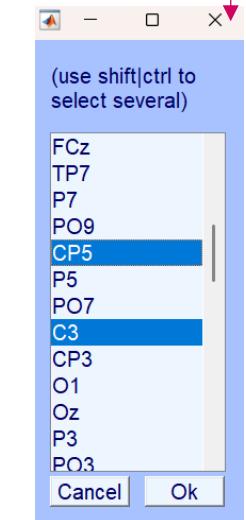
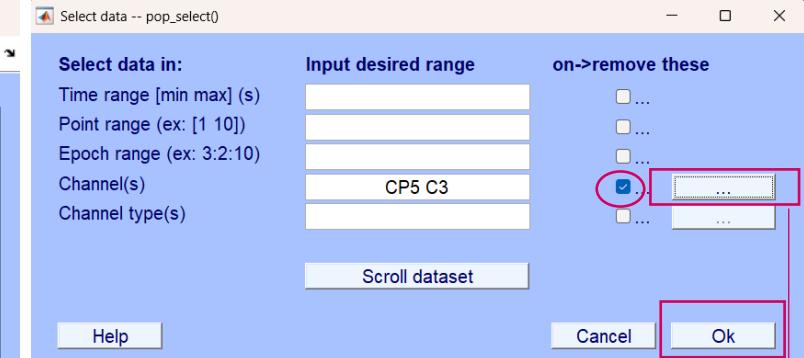
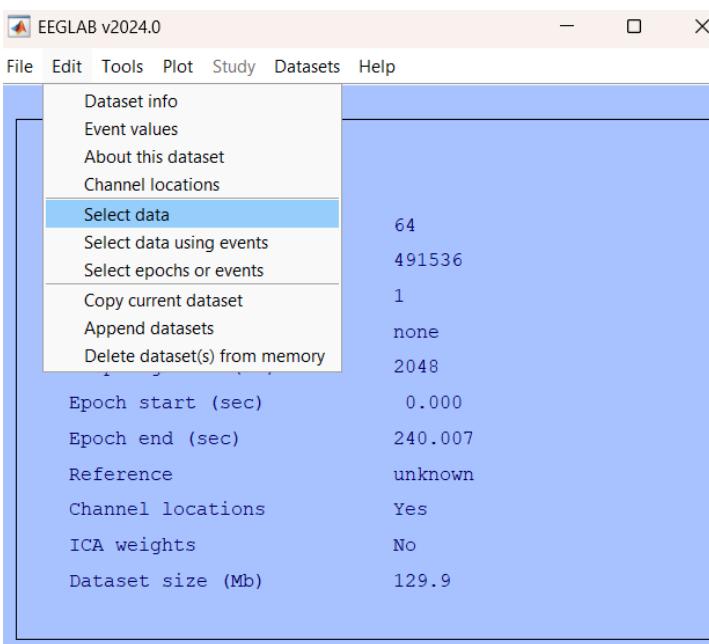
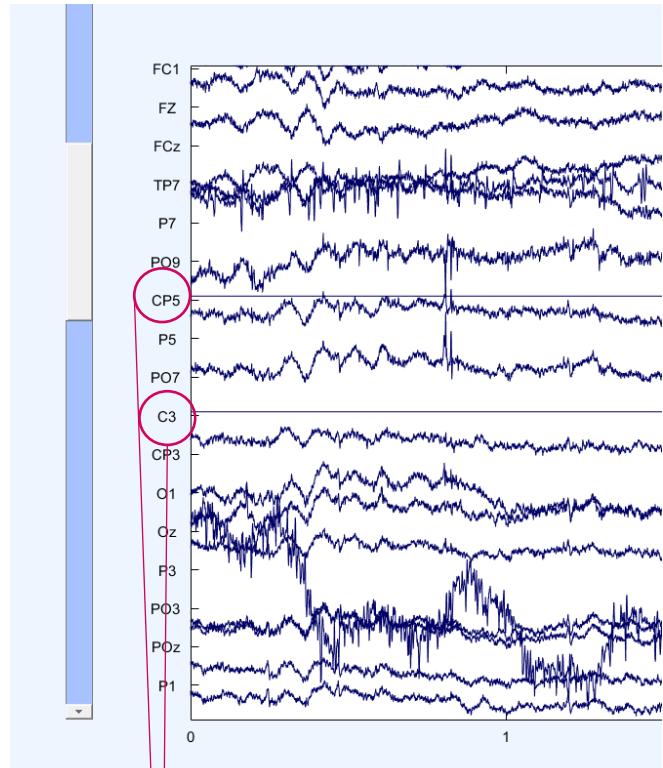
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Select Data (keep or remove data)



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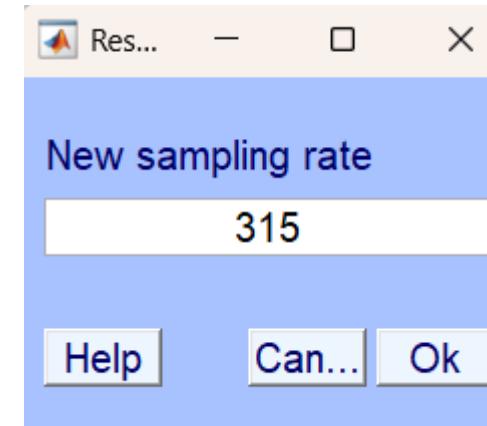
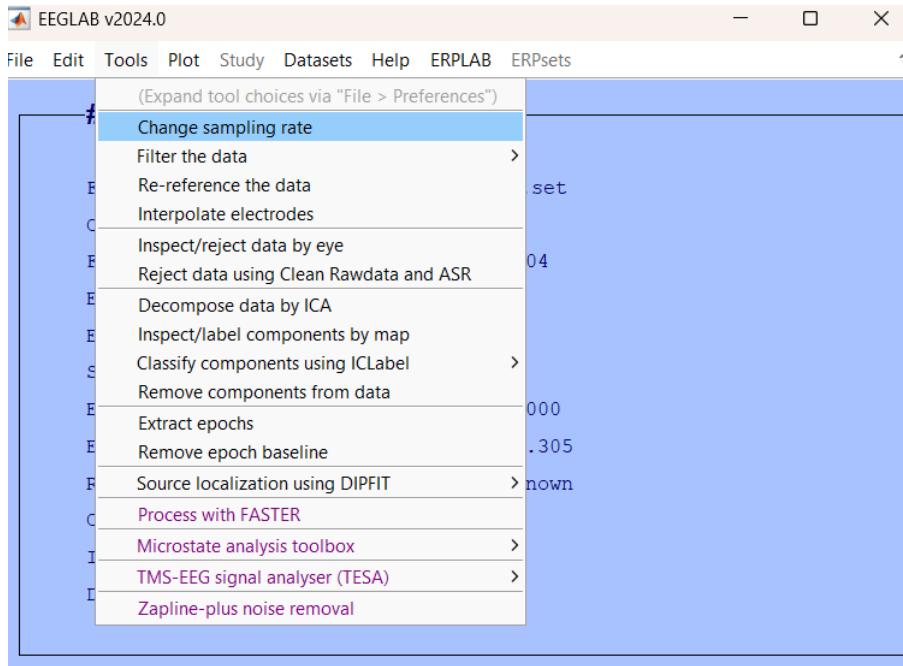
Select data- remove a bad channel



Bad channels (flat)

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Change sampling rate



EEGLAB

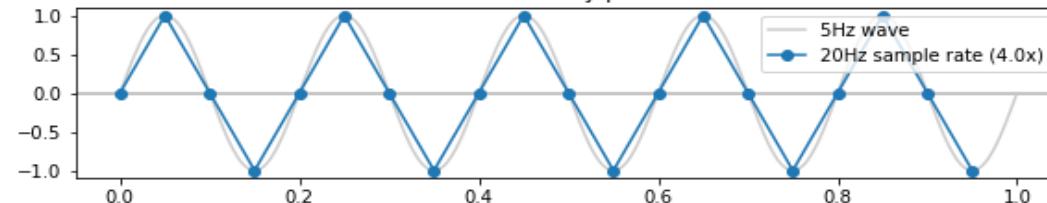
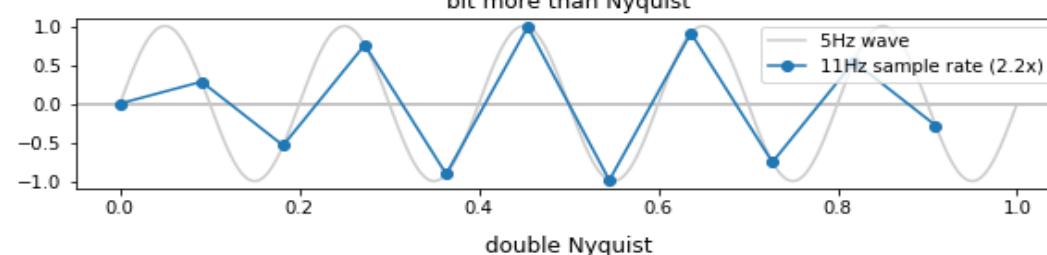
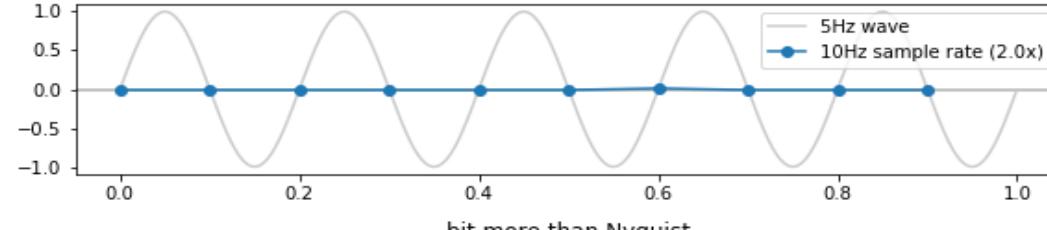
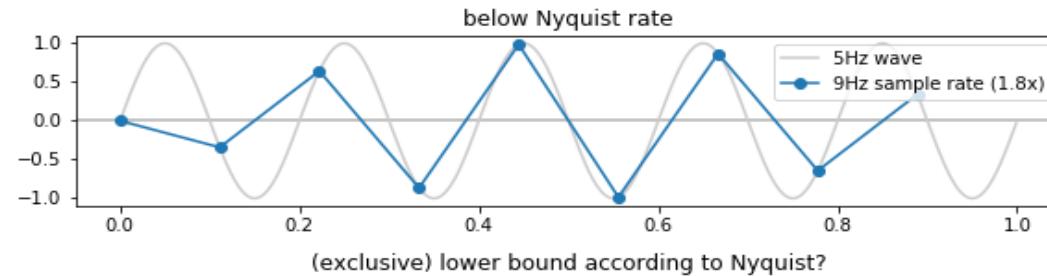
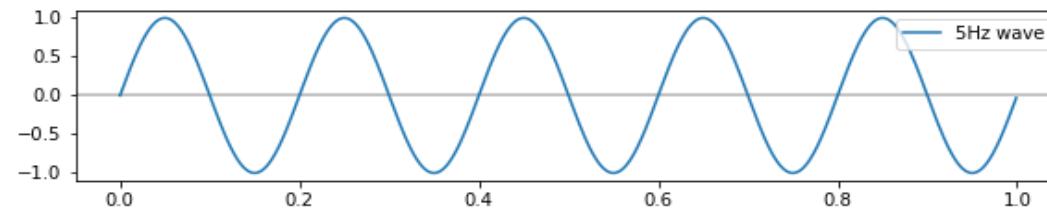
Change sampling rate

Nyquist Theorem

$$f_s \geq 2f_m$$

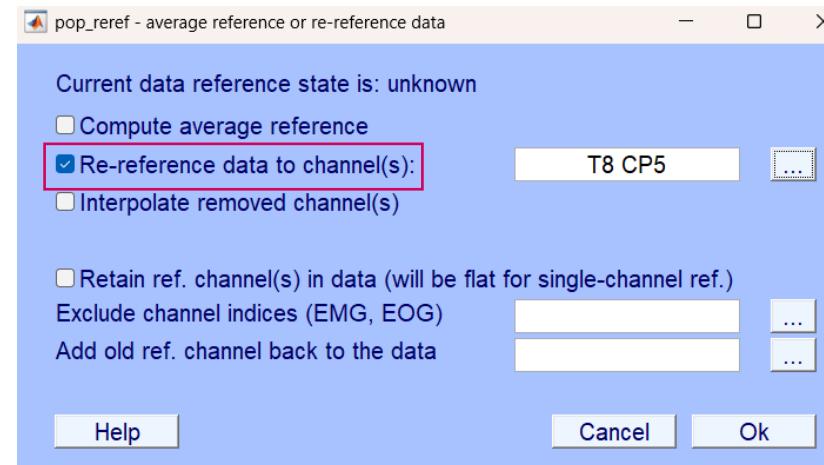
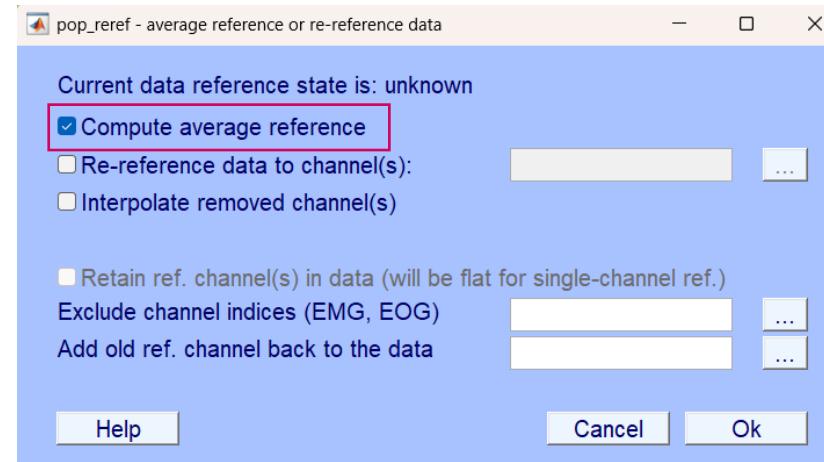
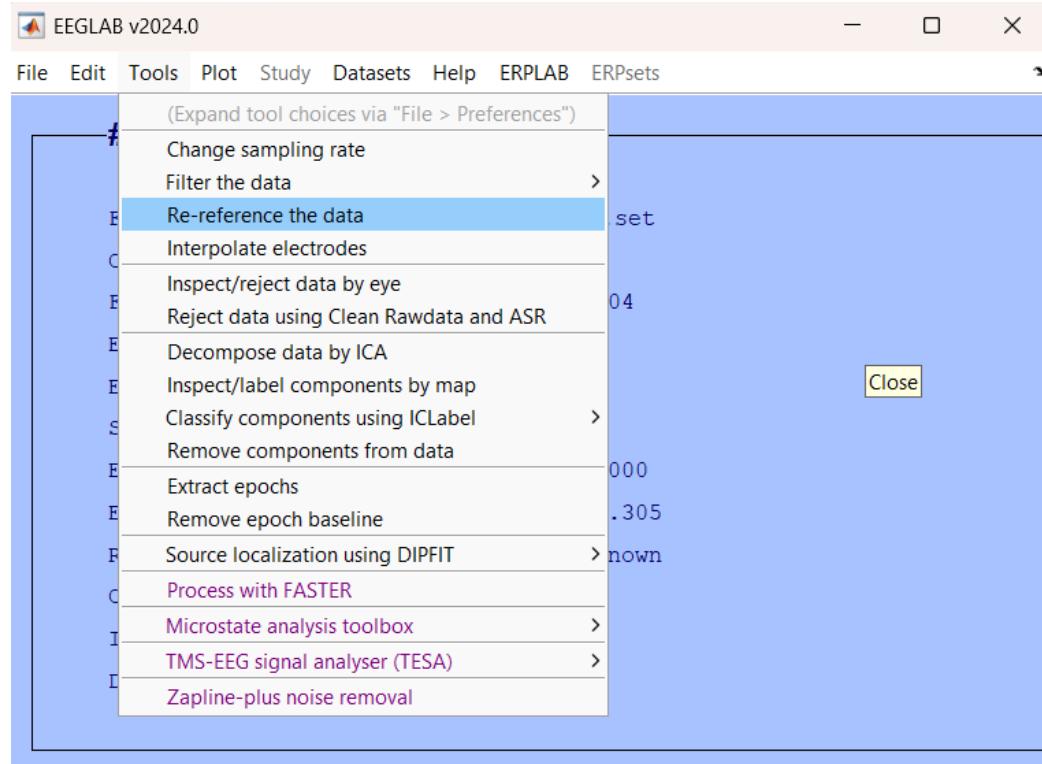
fs: sampling rate of signal

fm: maximum frequency in signal



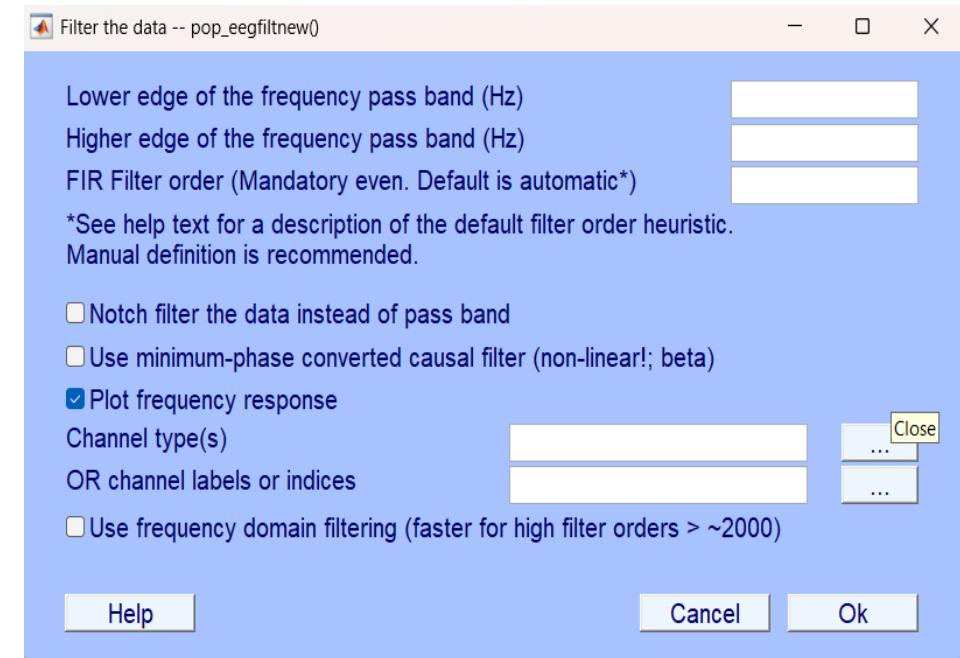
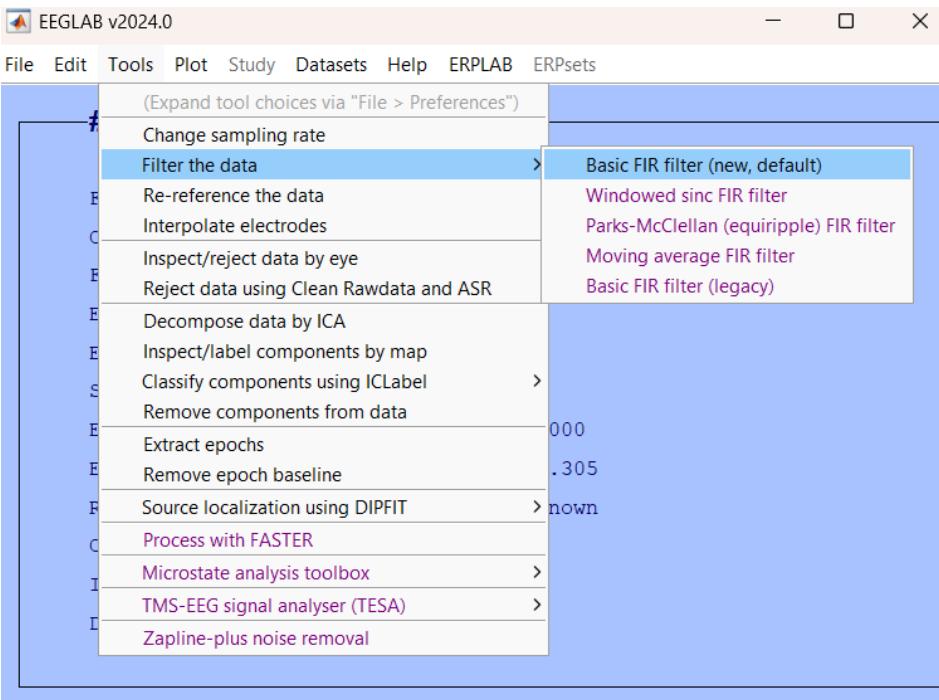
EEGLAB

Re-reference the data



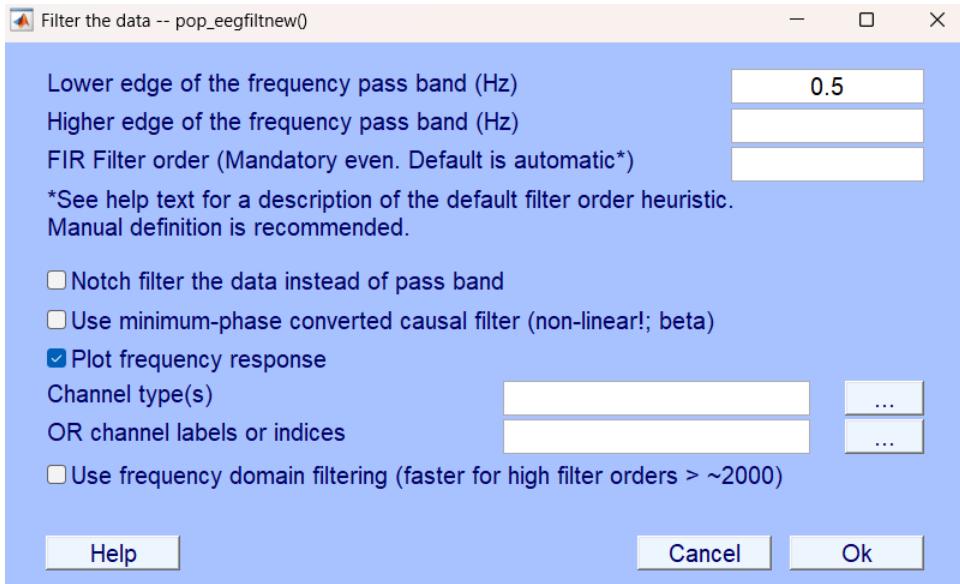
EEGLAB

Filter the data

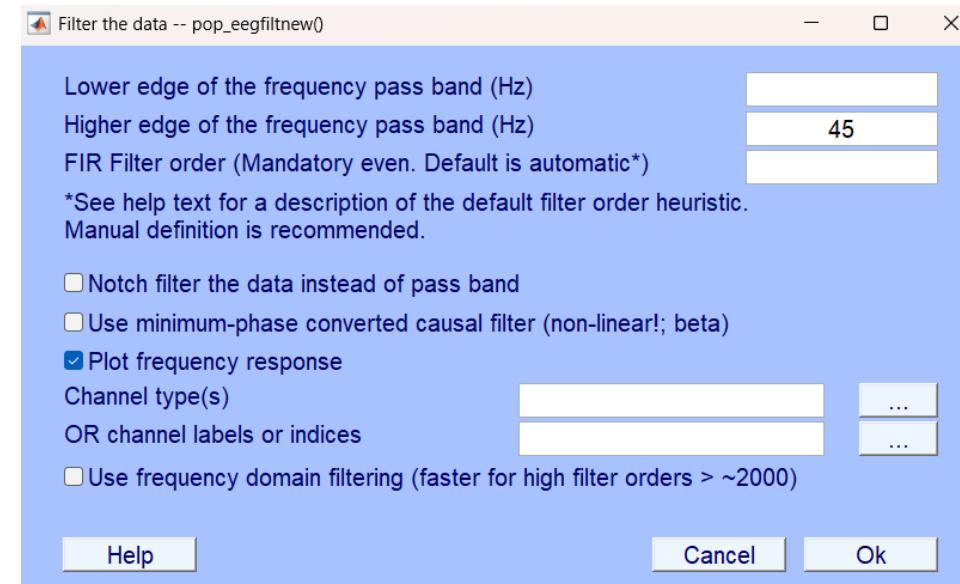


EEGLAB

Filter the data



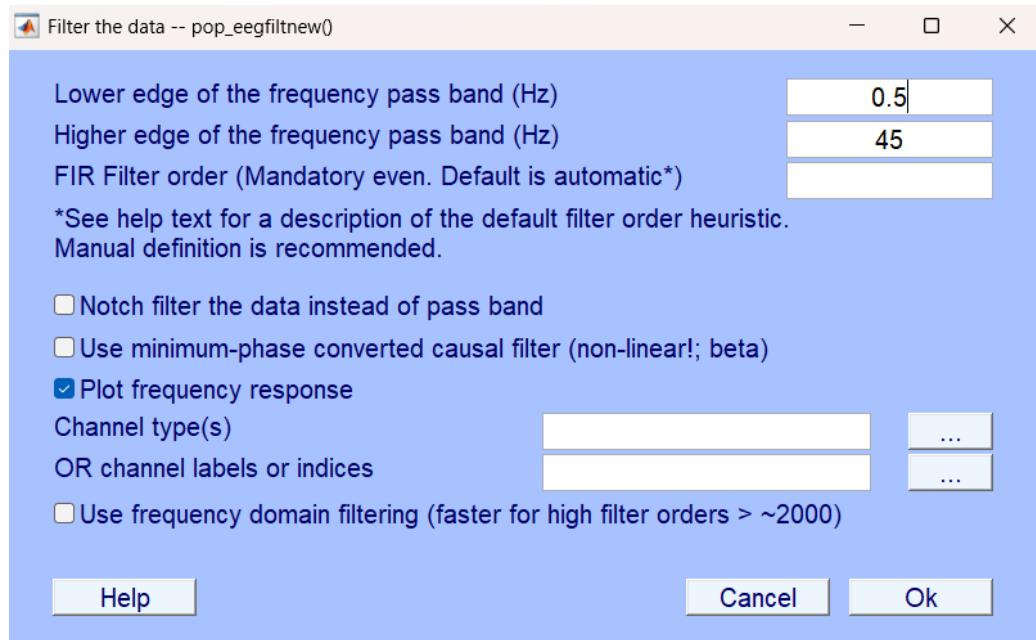
High-pass filter



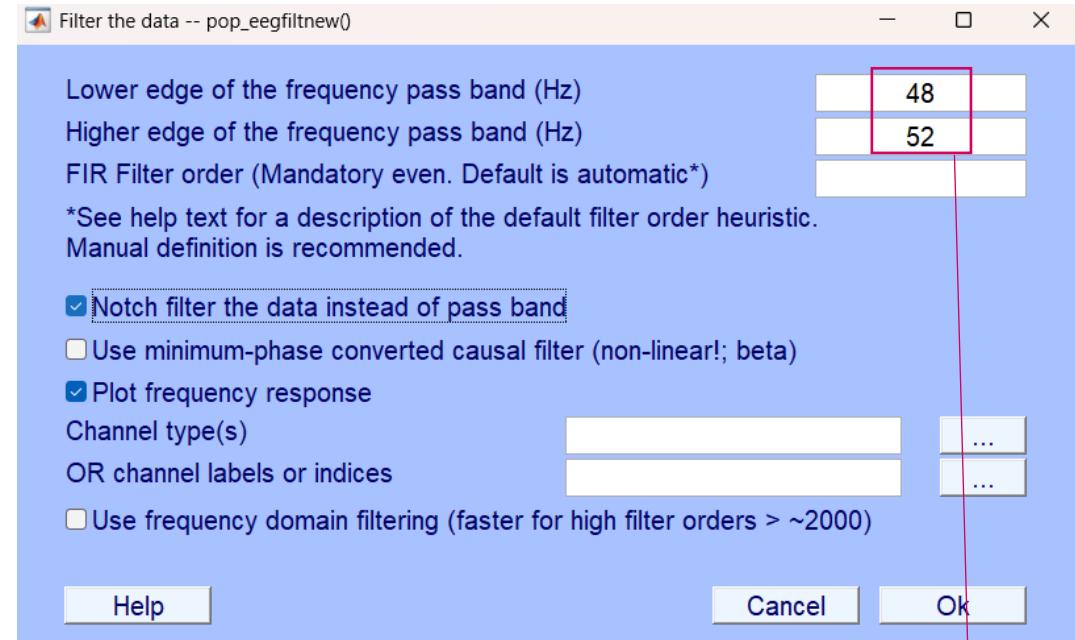
Low-pass filter

EEGLAB

Filter the data



band-pass filter

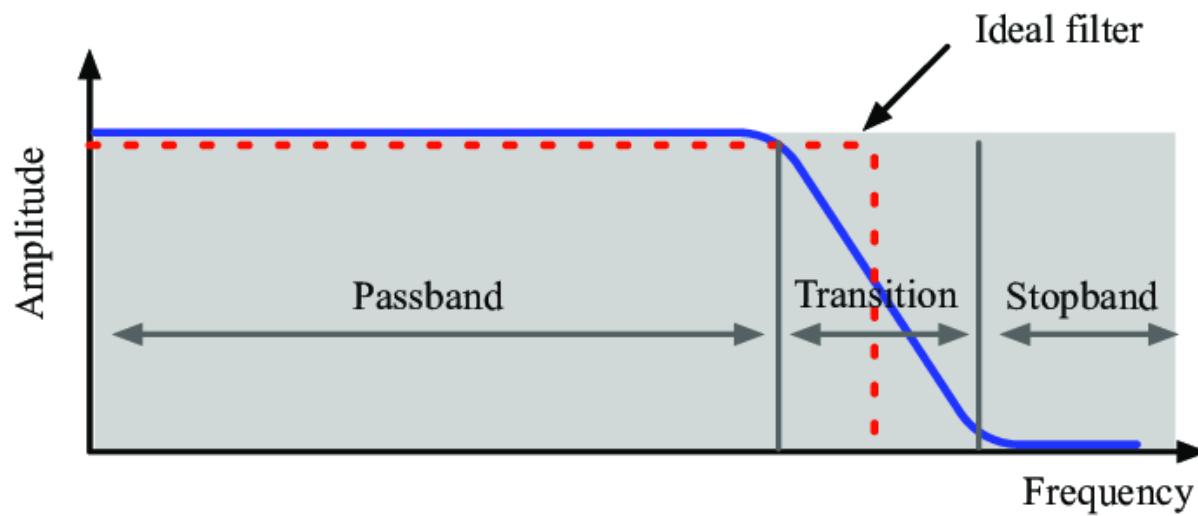
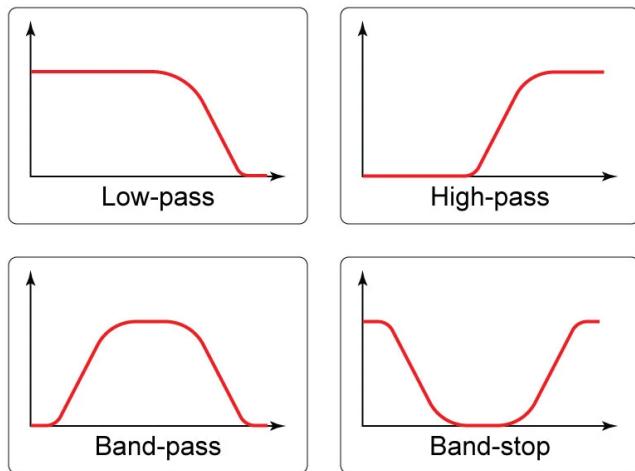


band-stop filter

Line noise

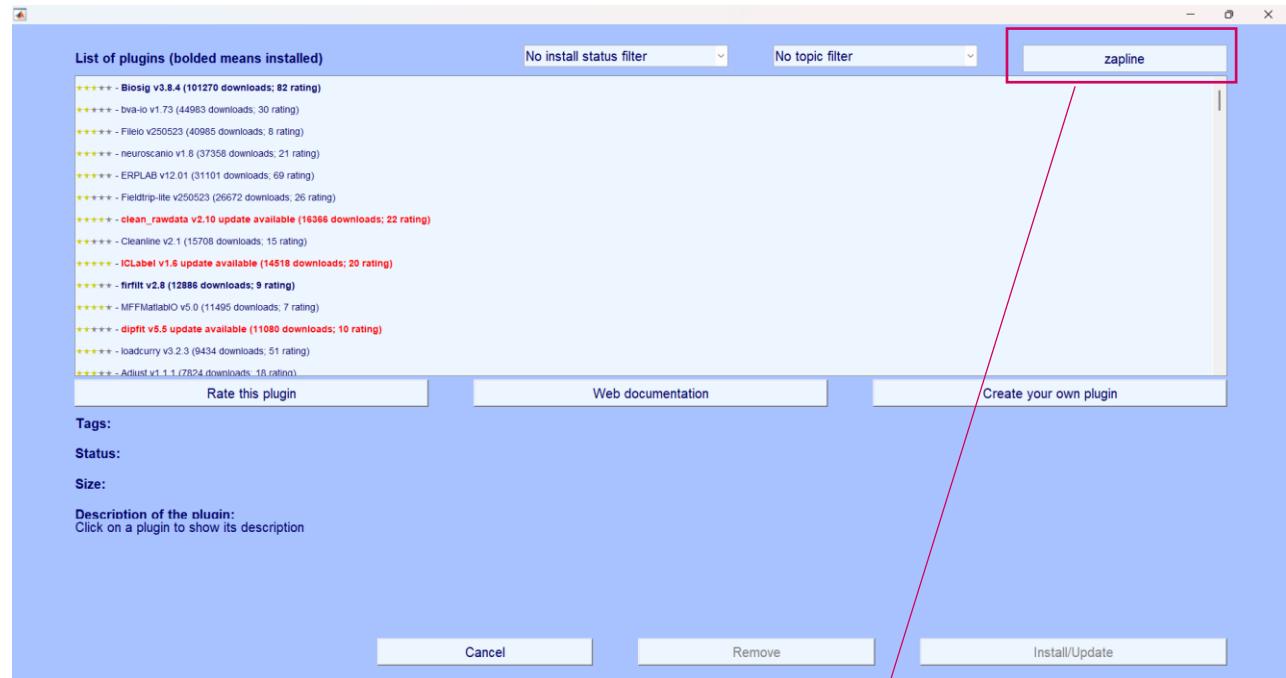
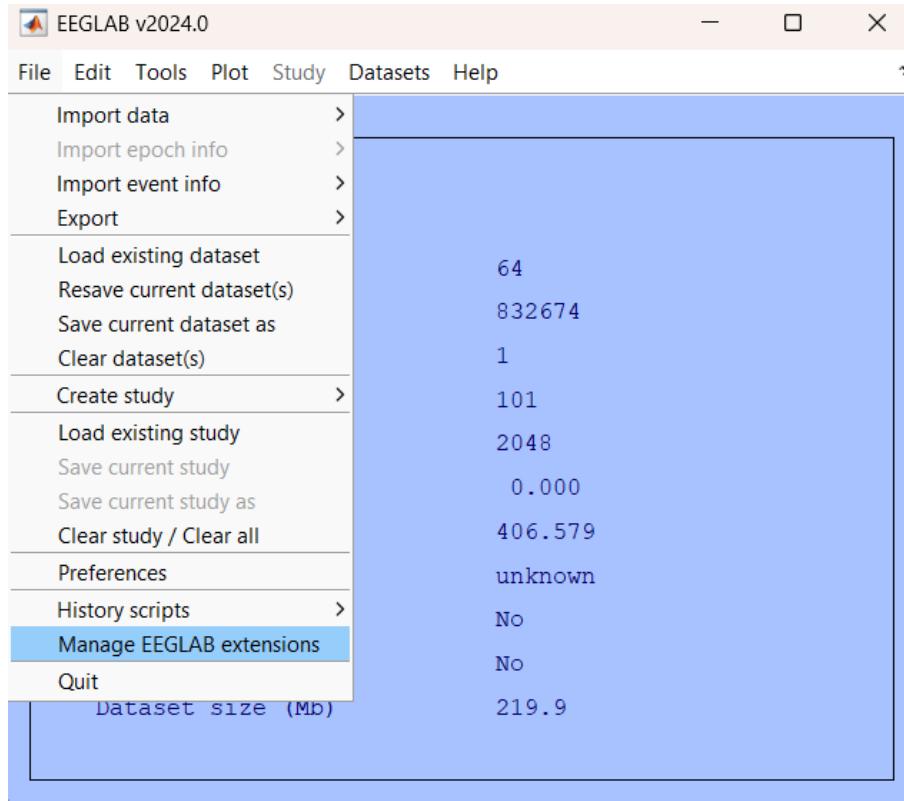
EEGLAB

Filter the data



EEGLAB

Installing plugins



Type the name of the plugin
and press Enter

EEGLAB

Installing plugins

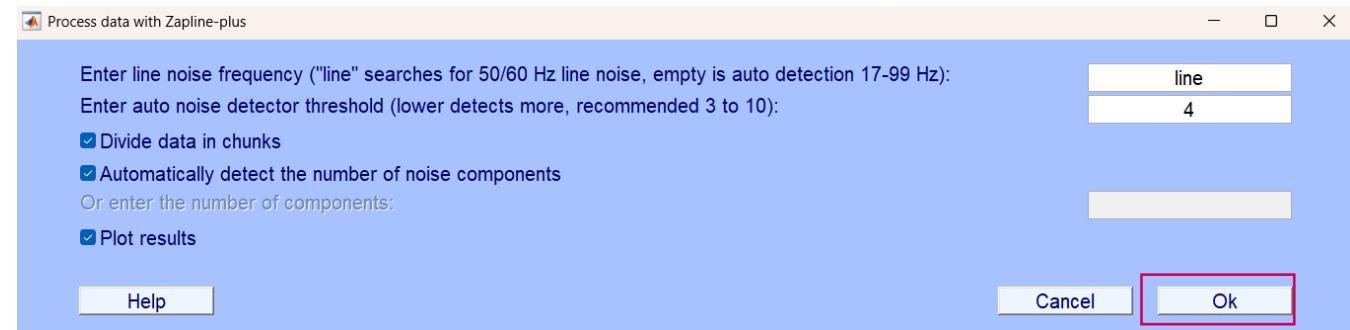
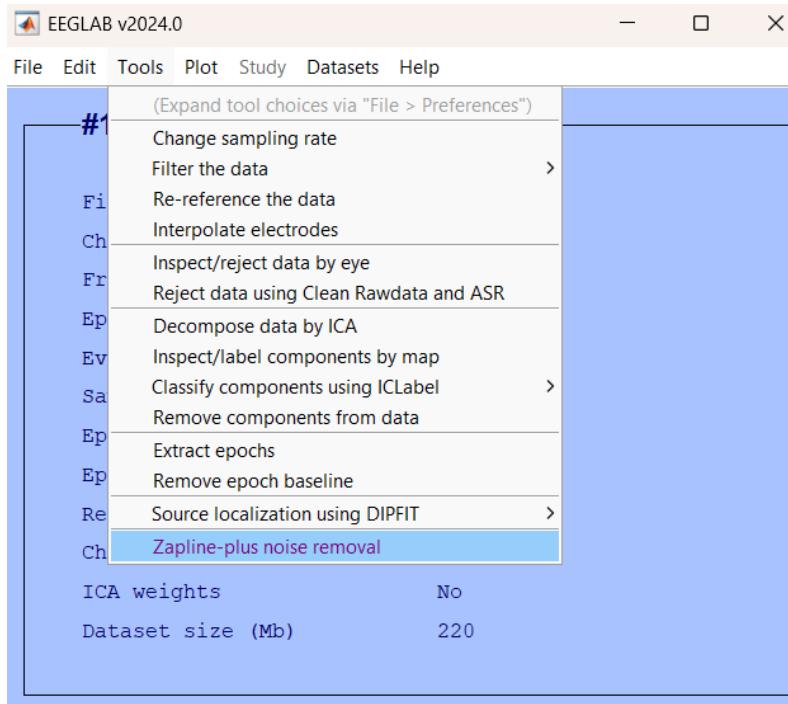


Click on it

install

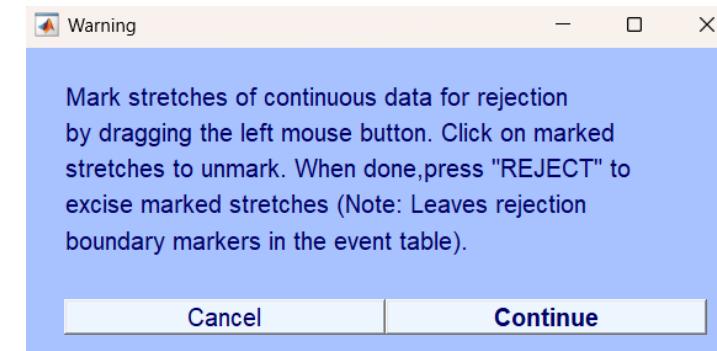
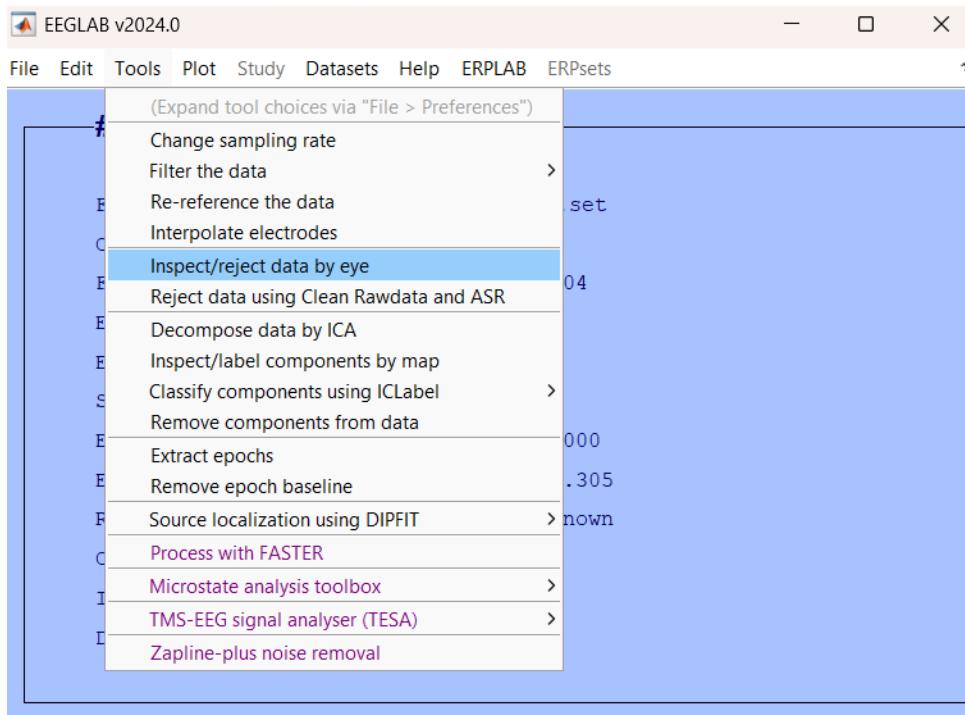
EEGLAB

Zipline plugin



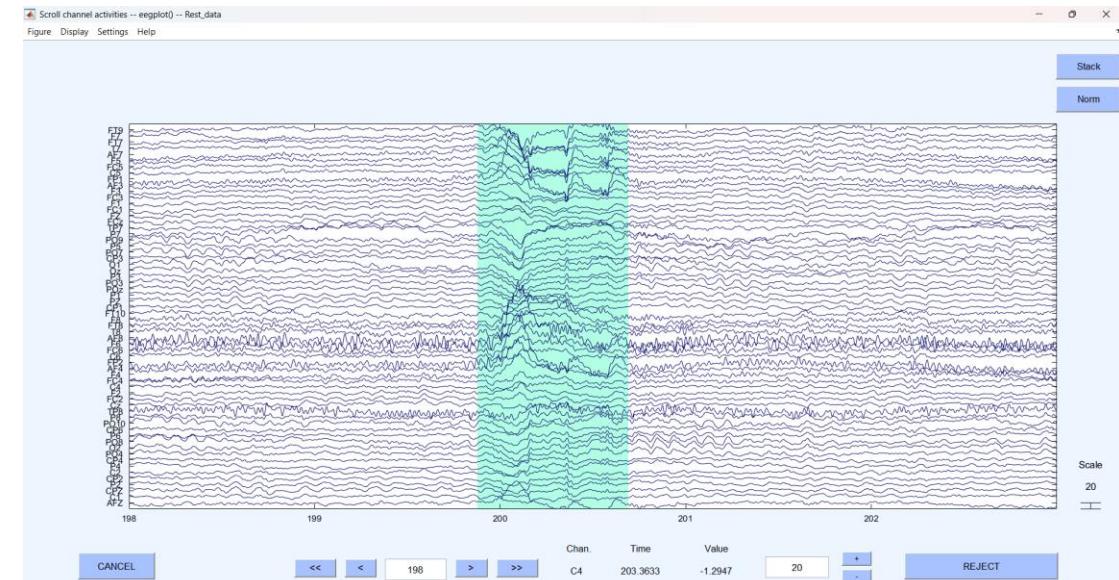
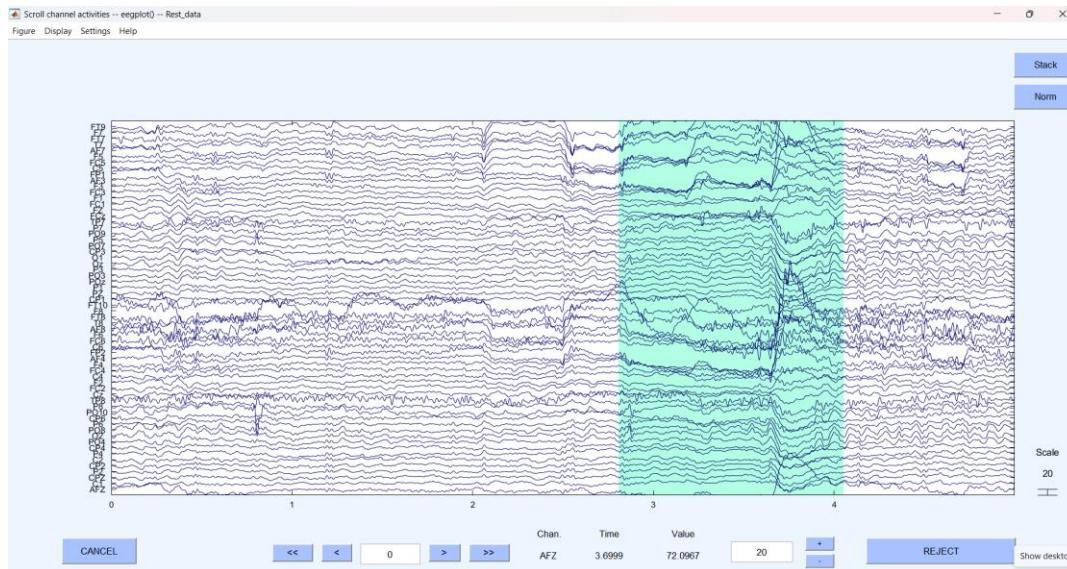
EEGLAB

Inspect/reject data by eye (**Before ICA**)



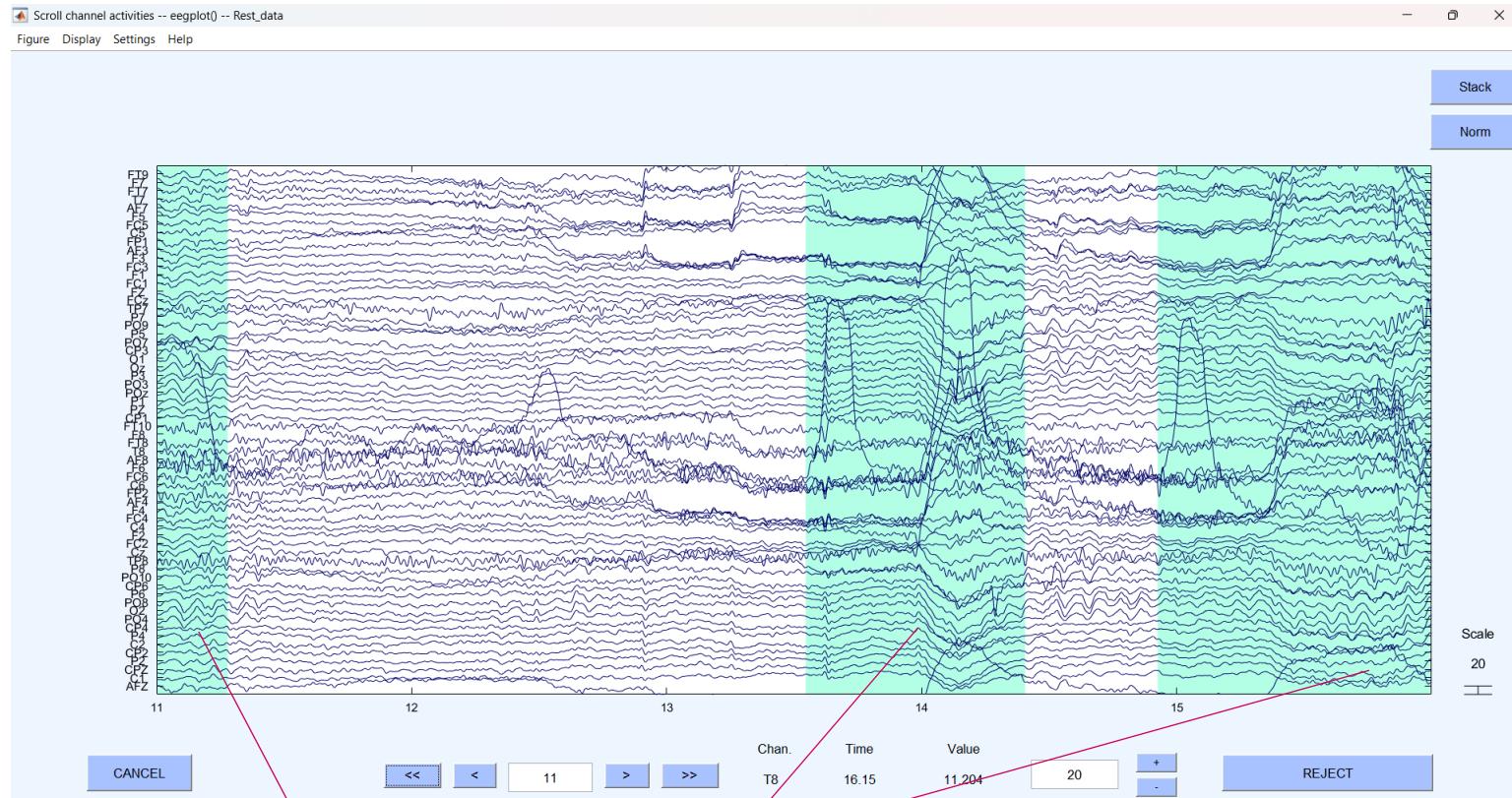
EEGLAB

Inspect/reject data by eye (**Before ICA**)



EEGLAB

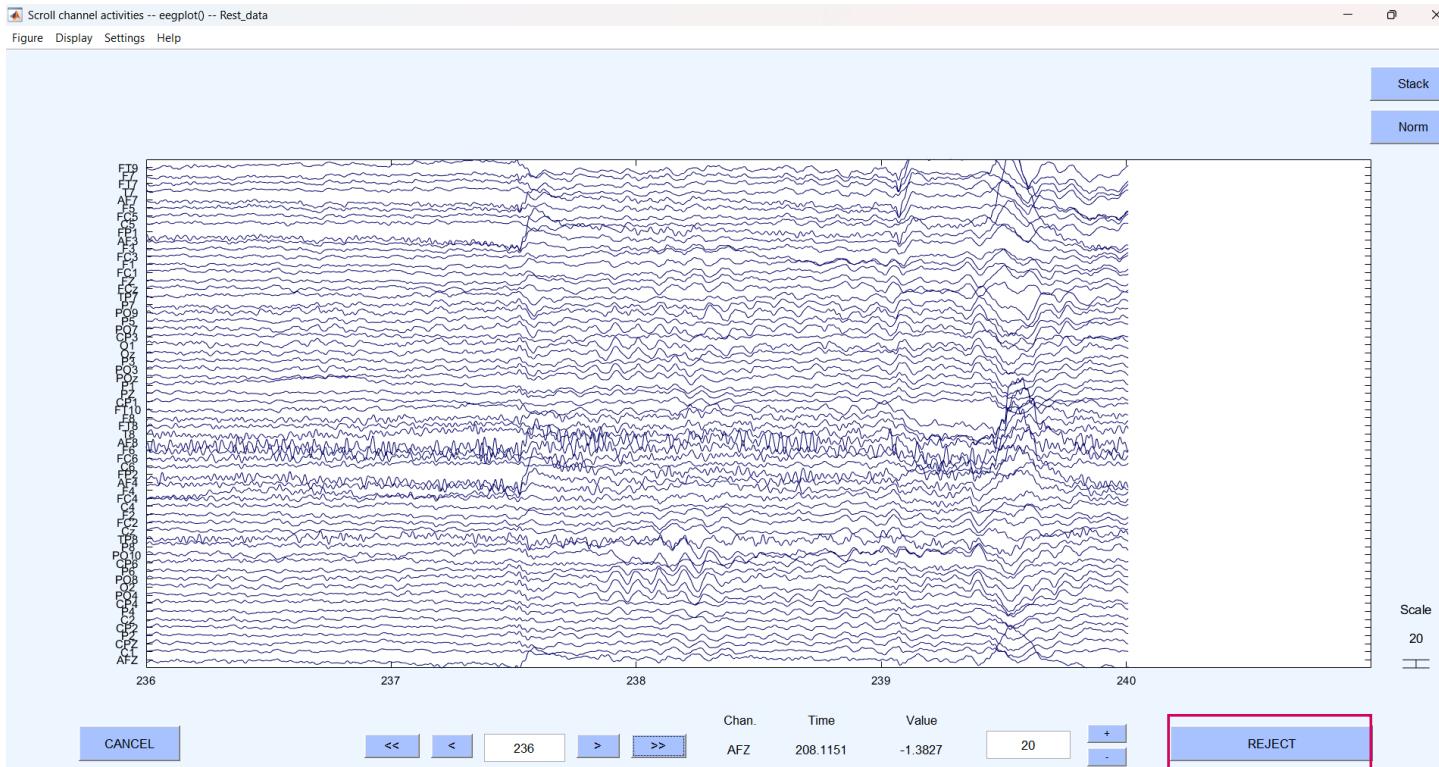
Inspect/reject data by eye (**Before ICA**)



Select artifacts with left click

EEGLAB

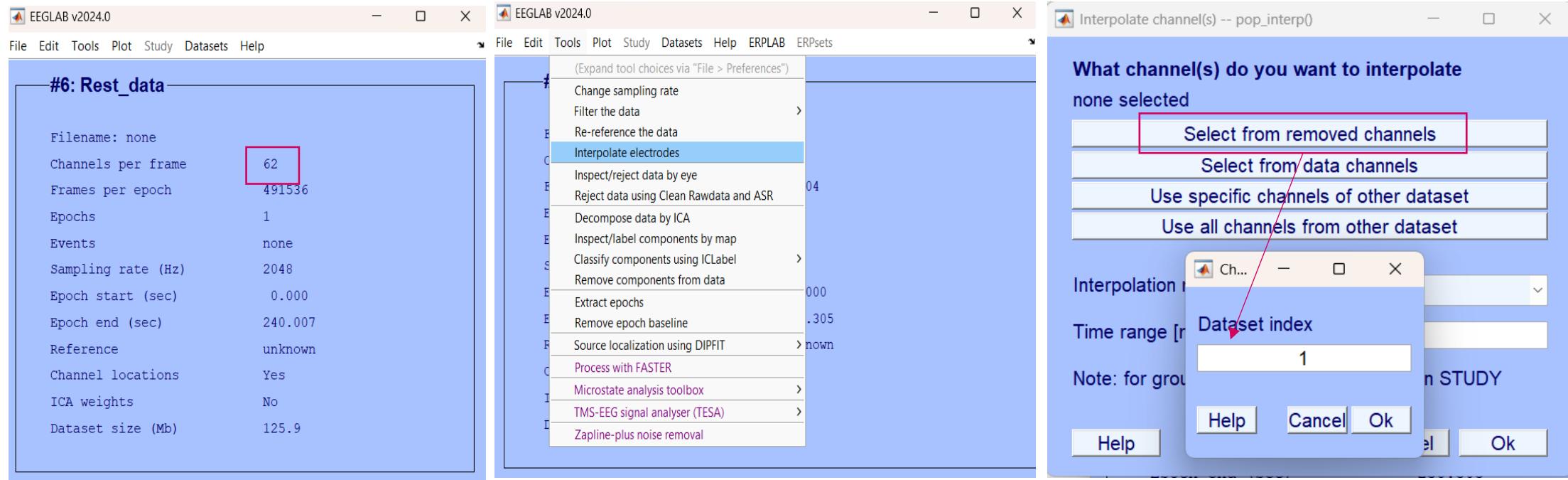
Inspect/reject data by eye (**Before ICA**)



Remove artifacts with the reject button

EEGLAB

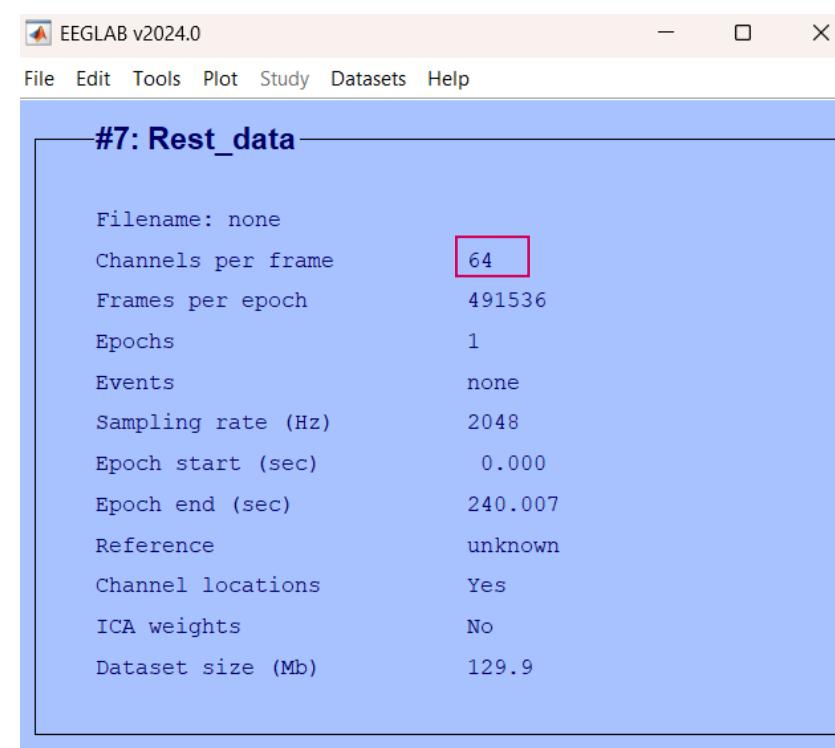
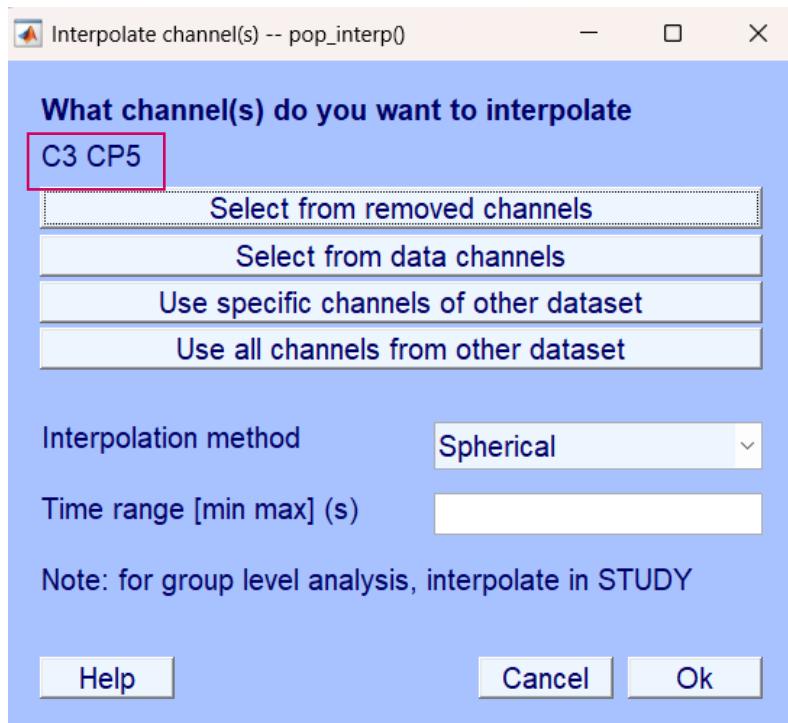
Interpolate electrodes (**After ICA & components rejection**)



After removing channel(s)

EEGLAB

Interpolate electrodes (**After ICA & components rejection**)



EEGLAB

Save the dataset

