

ERGtools2 - Case of use

Moritz Lindner

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Contents

Libraries	1
A Standard Workflow	2
Importing data	2
Configuring the data object for analysis	2
Visualizing and subsetting the data	2
Placing Markers for Measurement	5
Summarizing and analysing a set of exams	7
Special use cases	14
Automatic rejection of outlier recordings	14
Extracting and analysing oscillatory potentials	18
Session info	22
<i>FilePath: “/media/moritz/DATADISK/02_Manuskripte/ERGtools2”</i>	

Libraries

```
library(ERGtools2)

## Lade nötiges Paket: EPhysData

## Lade nötiges Paket: units

## udunits database from /usr/share/xml/udunits/udunits2.xml

## Registered S3 method overwritten by 'quantmod':
##   method      from
##   as.zoo.data.frame zoo
```

```
##
## Attache Paket: 'ERGtools2'

## Das folgende Objekt ist maskiert 'package:base':
##
##      Position

library(EPhysMethods) # containing filter functions, etc
library(cowplot)
library(ggplot2)
```

A Standard Workflow

Importing data

```
Example_Exam <-
  ImportEspion(
    filename = paste0(getwd(), "/Data/ExampleSet/CR1377_22020812_MoLv1_DALAlong.TXT"),
    Import = c("Raw",
               "Measurements"),
    where = list(Channel = "ERG", Type= "Flash", Eye= "LE") # only import channels containing Flash ERG
  )

## Importing /media/moritz/DATADISK/02_Manuskripte/ERGtools2/Data/ExampleSet/CR1377_22020812_MoLv1_DALA

## Warning: Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
## the recording.
## Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
## the recording.
```

Configuring the data object for analysis

```
Example_Exam<-ClearMeasurements(Example_Exam) # to remove the Marker placement done in the manufacturer

Example_Exam<-SetStandardFunctions(Example_Exam) # set the standard functions for filtering, averaging
```

Visualizing and subsetting the data

```
FigStdWorkflow_A<-ggERGExam(Example_Exam)
```

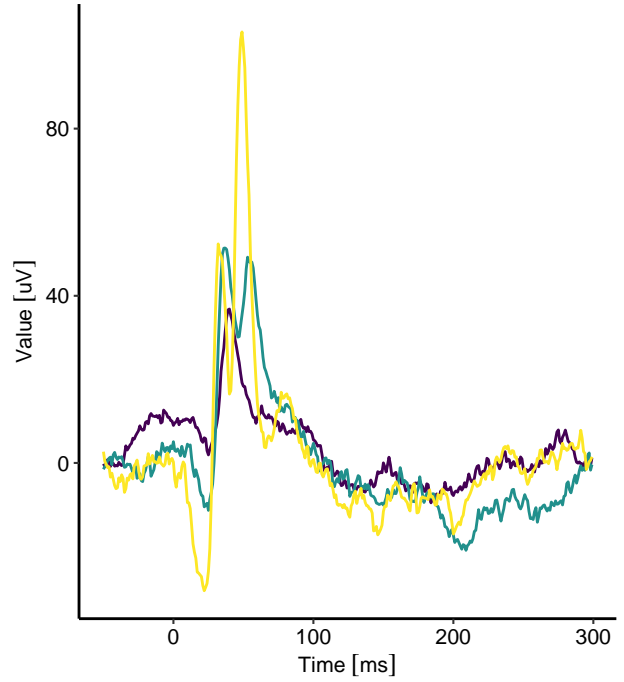
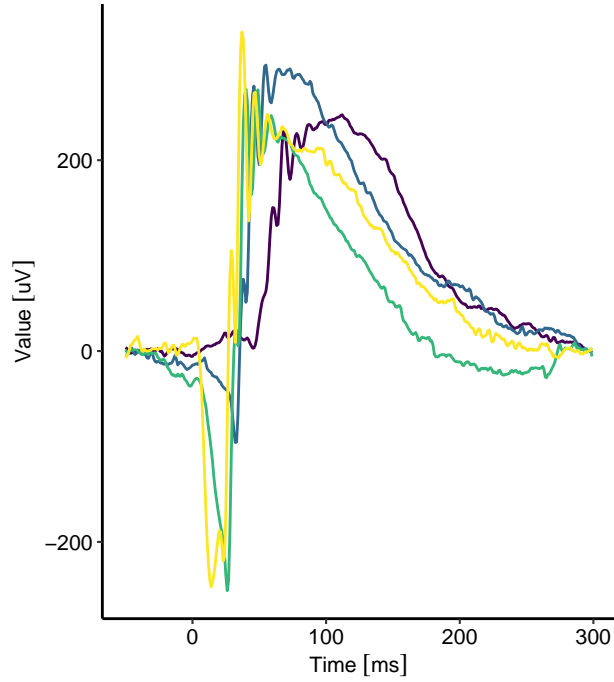
CRI1377

DA-Flash

LA-Flash

StimulusEnergy — 0.001 — 0.01 — 0.1 — 1

StimulusEnergy — 1 — 3 — 10



```
ggsave2("FigStdWorkflow_A.pdf", FigStdWorkflow_A, width = 7.5, height=6, units = "cm")
plot(FigStdWorkflow_A)
```

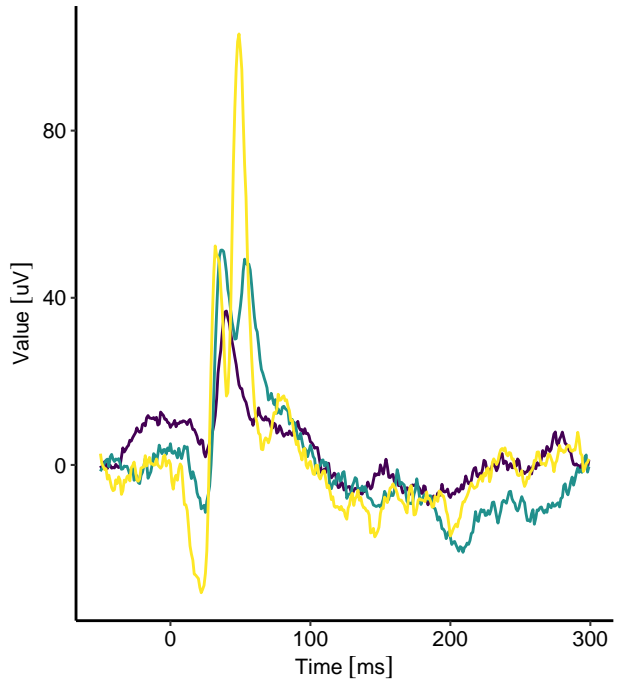
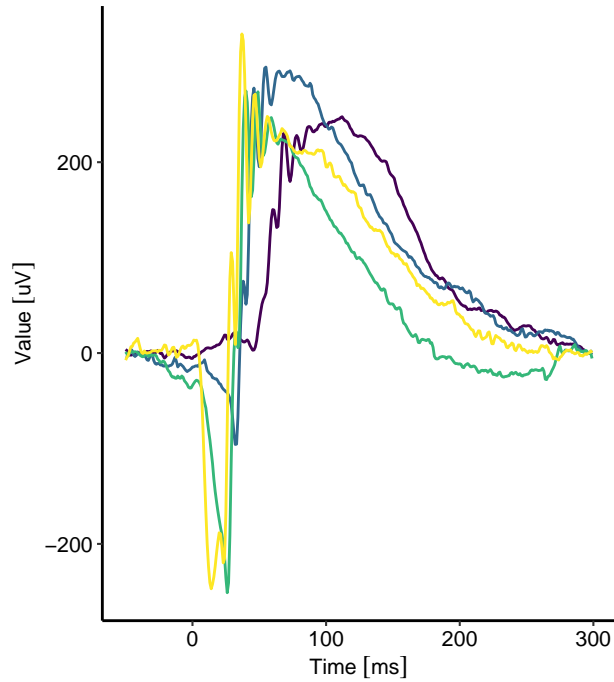
CRI1377

DA-Flash

LA-Flash

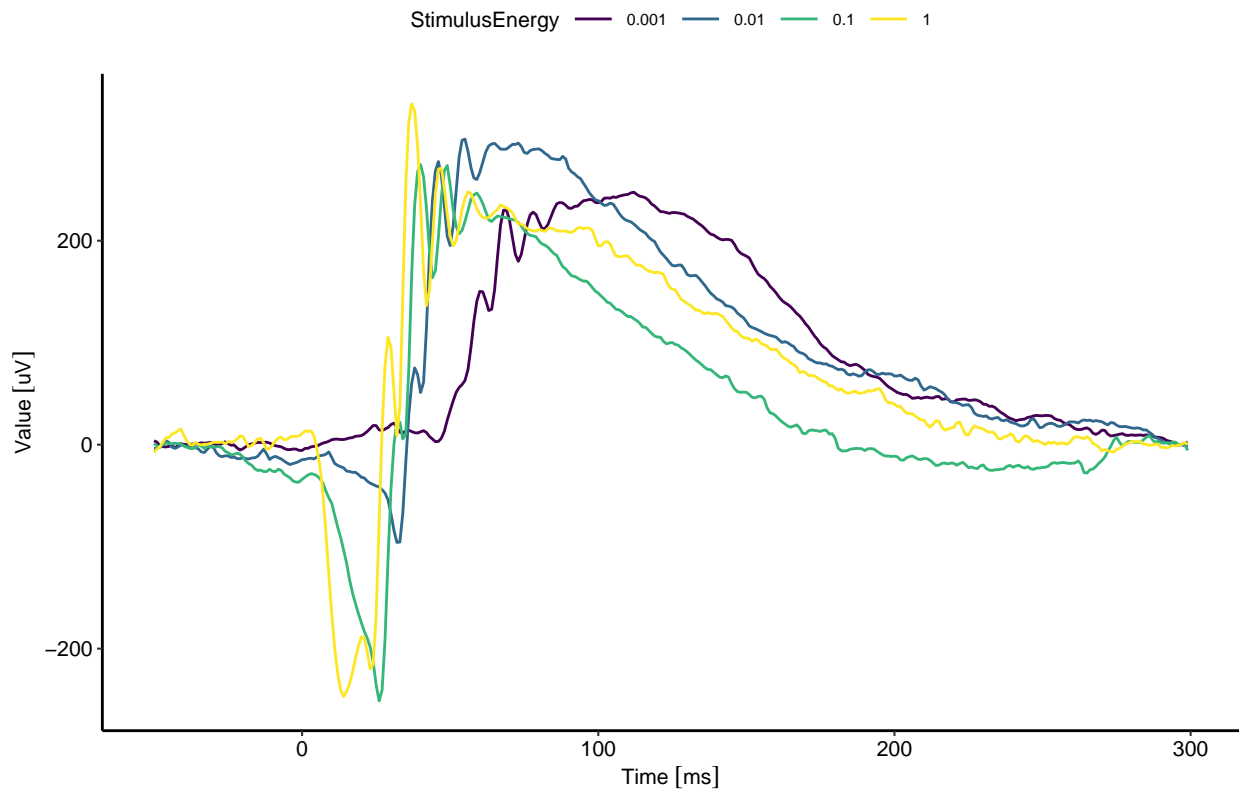
StimulusEnergy — 0.001 — 0.01 — 0.1 — 1

StimulusEnergy — 1 — 3 — 10



```
Example_Exam_Subset<-DropRecordings(Example_Exam, where=list(Background="LA")) # drop all recordings ac
ggERGExam(Example_Exam_Subset)
```

DA-Flash



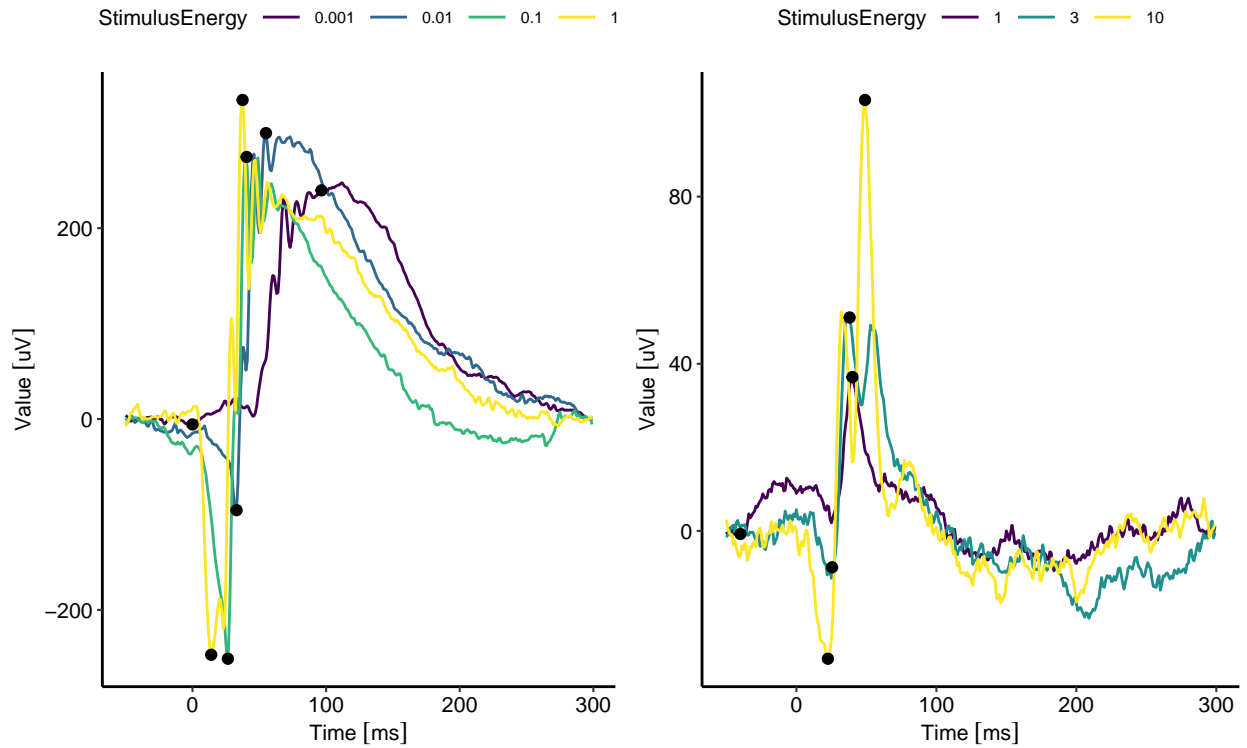
Placing Markers for Measurement

```
# Uncomment next line when running code manually  
#Example_Exam<-exploreERGExam(Example_Exam)  
  
Example_Exam<-AutoPlaceMarkers(Example_Exam)  
ggERGExam(Example_Exam)
```

CRI1377

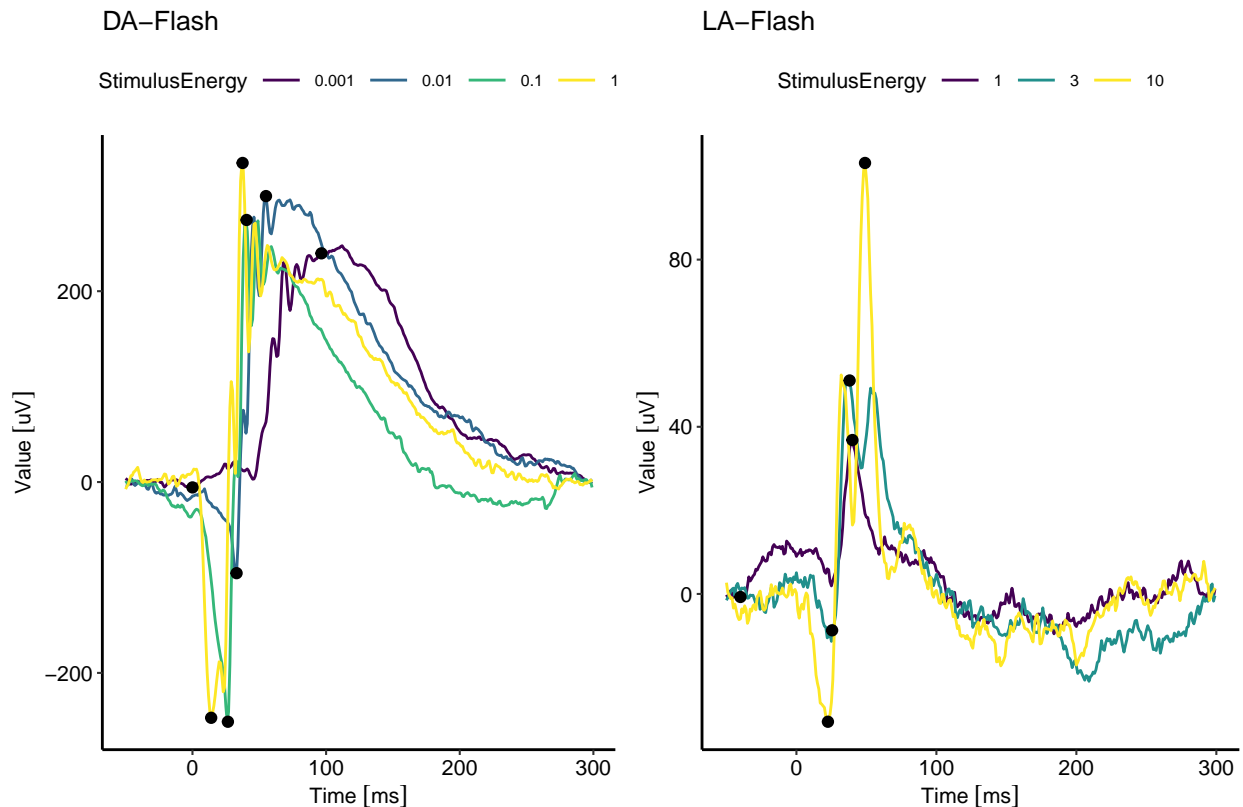
DA-Flash

LA-Flash



```
# Uncomment next line when running code manually
# Example_Exam<-interactiveMeasurements(Subset(Example_Exam,where=list(Background="LA")))
ggERGExam(Example_Exam)
```

CRI1377



Summarizing and analysing a set of exams

```
dir<-paste0(getwd(),"/Data/ExampleSet/") # make a list of all files in a folder
recordings<-list.files(dir)
Exams<-list()
for (r in recordings){ # now loop through this list to import each file, the warnings we get can be ignored
  Exam <-
    ImportEspion(
      filename = paste0(dir,r),
      Import = c("Raw",
                  "Measurements"),
      where = list(Channel = "ERG", Type= "Flash", Eye= "LE") # only import channels containing Flash E
    )
  Exam<-ClearMeasurements(Exam)
  Exam<-SetStandardFunctions(Exam)
  Exam<-AutoPlaceMarkers(Exam)
  Exams[[Subject(Exam)]]<-Exam
}
```

```
## Importing /media/moritz/DATADISK/02_Manuskripte/ERGtools2/Data/ExampleSet/CR1376_20220818_MoLv1_DALA
```

```
## Warning: Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
```

```

## the recording.
## Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
## the recording.

## Importing /media/moritz/DATADISK/02_Manuskripte/ERGtools2/Data/ExampleSet/CR1377_22020812_MoLv1_DALA

## Warning: Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
## the recording.
## Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
## the recording.

## Importing /media/moritz/DATADISK/02_Manuskripte/ERGtools2/Data/ExampleSet/CR1379_20220818_MoLv1_DALA

## Warning: Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
## the recording.
## Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
## the recording.

## Importing /media/moritz/DATADISK/02_Manuskripte/ERGtools2/Data/ExampleSet/CR1429_22020726_MoLv1_DALA

## Warning: Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
## the recording.
## Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
## the recording.

## Warning in doTryCatch(return(expr), name, parentenv, handler): While importing
## TrialTrace for Step '1', Channel '2', Repeat '': It seems like Trials/Repeats
## have been rejected in the Espion software and were therefore not included into
## the export file. It is recommended to export all Trials and reject unwanted
## Trials inside ERGtools2.

## Warning in doTryCatch(return(expr), name, parentenv, handler): While importing
## TrialTrace for Step '2', Channel '2', Repeat '': It seems like Trials/Repeats
## have been rejected in the Espion software and were therefore not included into
## the export file. It is recommended to export all Trials and reject unwanted
## Trials inside ERGtools2.

## Importing /media/moritz/DATADISK/02_Manuskripte/ERGtools2/Data/ExampleSet/CR1459_22020926_MoLv1_DALA

## Warning: Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
## the recording.

## Warning: Provision of the protocol is recommended and may be essential if the marker
## table is not provided or does not include markers for each step and channel of
## the recording.

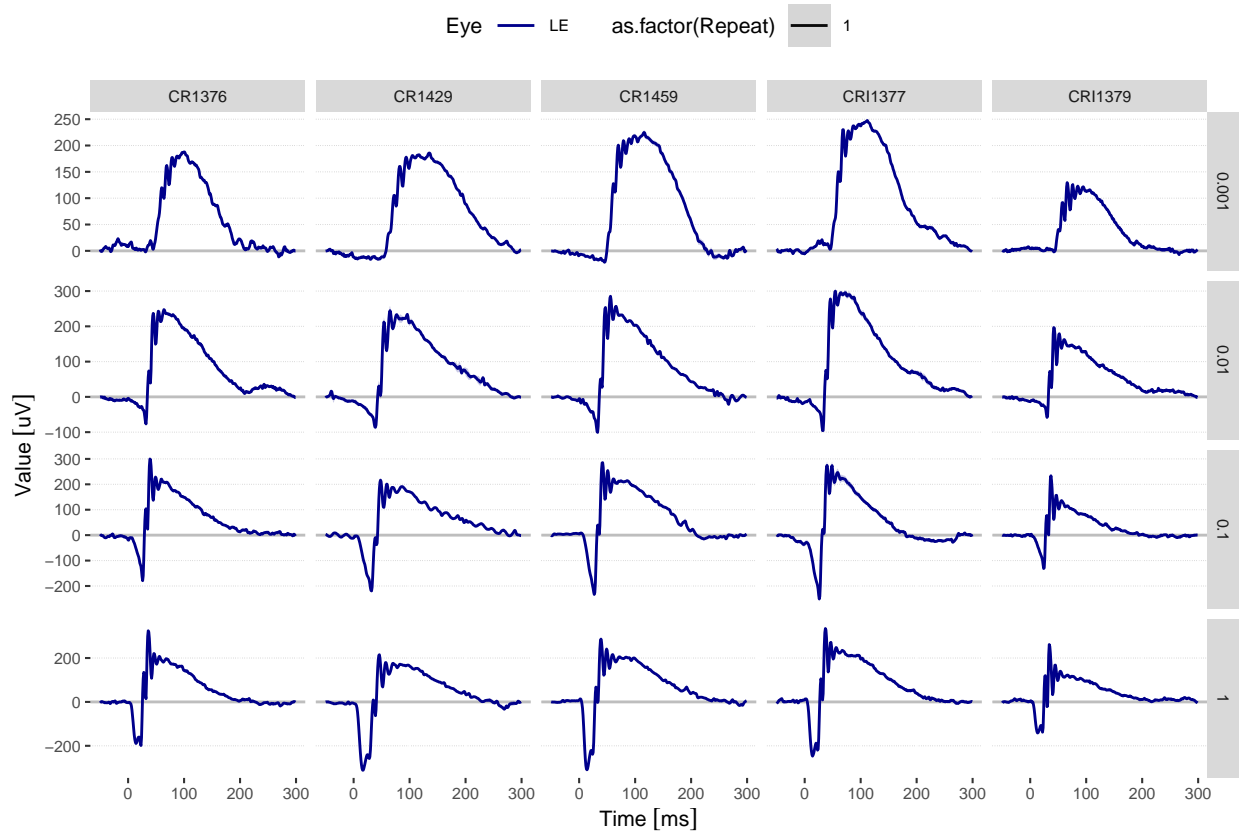
```



```
## Warning in doTryCatch(return(expr), name, parentenv, handler): While importing
## TrialTrace for Step '6', Channel '2', Repeat '': It seems like Trials/Repeats
## have been rejected in the Espion software and were therefore not included into
## the export file. It is recommended to export all Trials and reject unwanted
## Trials inside ERGtools2.
```

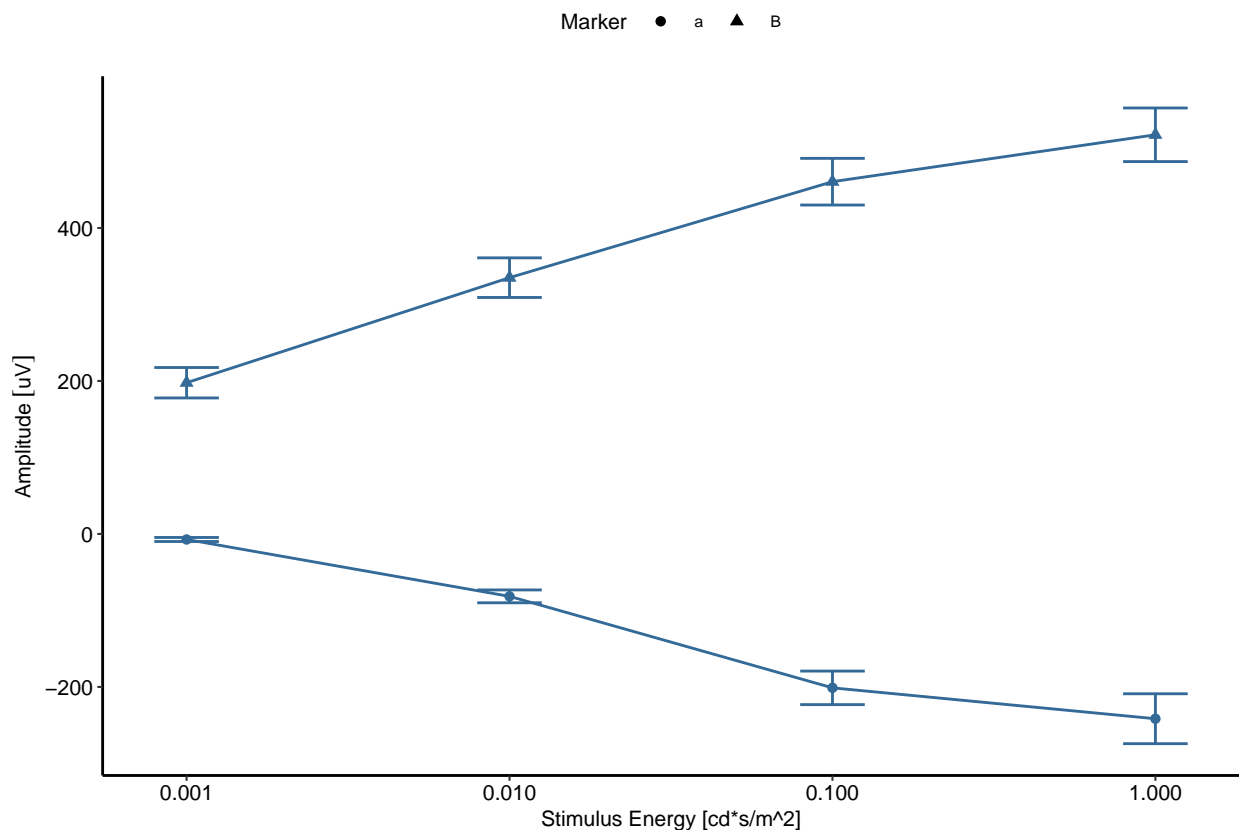
```
ggPlotRecordings(Exams,
  where = list(Background = "DA", Type = "Flash"))
```

```
## Running 'ggPlotRecordings()'. This may take a while for long ERGExam lists.
```



```
ggsave2("FigStdWorkflow_2A.pdf", width = 9, height=9, units = "cm")
```

```
ggIntensitySequence(Exams,
  where = list(Background = "DA", Type = "Flash"),
  point.size = 1.5)
```



```
ggsave2("FigStdWorkflow_2B.pdf", width = 7, height=6, units = "cm")
```

```
CollectMeasurements(Exams)
```

##	Step	Description	Recording	Channel	Repeat	Eye	Name	Relative
## 1	1	DA 0 001 cd s m	1	ERG	1	LE	a	<NA>
## 2	1	DA 0 001 cd s m	1	ERG	1	LE	B	a
## 3	2	DA 0 01 cd s m	2	ERG	1	LE	a	<NA>
## 4	2	DA 0 01 cd s m	2	ERG	1	LE	B	a
## 5	3	DA 0 1 cd s m	3	ERG	1	LE	a	<NA>
## 6	3	DA 0 1 cd s m	3	ERG	1	LE	B	a
## 7	4	DA 1 cd s m	4	ERG	1	LE	a	<NA>
## 8	4	DA 1 cd s m	4	ERG	1	LE	B	a
## 9	5	LA Single 1 0 Flash	5	ERG	1	LE	a	<NA>
## 10	5	LA Single 1 0 Flash	5	ERG	1	LE	B	a
## 11	6	LA Single 3 0 Flash	6	ERG	1	LE	a	<NA>
## 12	6	LA Single 3 0 Flash	6	ERG	1	LE	B	a
## 13	7	LA Single 10 0 Flash	7	ERG	1	LE	a	<NA>
## 14	7	LA Single 10 0 Flash	7	ERG	1	LE	B	a
## 15	1	DA 0 001 cd s m	1	ERG	1	LE	a	<NA>
## 16	1	DA 0 001 cd s m	1	ERG	1	LE	B	a
## 17	2	DA 0 01 cd s m	2	ERG	1	LE	a	<NA>
## 18	2	DA 0 01 cd s m	2	ERG	1	LE	B	a
## 19	3	DA 0 1 cd s m	3	ERG	1	LE	a	<NA>
## 20	3	DA 0 1 cd s m	3	ERG	1	LE	B	a
## 21	4	DA 1 cd s m	4	ERG	1	LE	a	<NA>

## 22	4	DA 1 cd s m	4	ERG	1	LE	B	a
## 23	5	LA Single 1 0 Flash	5	ERG	1	LE	a	<NA>
## 24	5	LA Single 1 0 Flash	5	ERG	1	LE	B	a
## 25	6	LA Single 3 0 Flash	6	ERG	1	LE	a	<NA>
## 26	6	LA Single 3 0 Flash	6	ERG	1	LE	B	a
## 27	7	LA Single 10 0 Flash	7	ERG	1	LE	a	<NA>
## 28	7	LA Single 10 0 Flash	7	ERG	1	LE	B	a
## 29	1	DA 0 001 cd s m	1	ERG	1	LE	a	<NA>
## 30	1	DA 0 001 cd s m	1	ERG	1	LE	B	a
## 31	2	DA 0 01 cd s m	2	ERG	1	LE	a	<NA>
## 32	2	DA 0 01 cd s m	2	ERG	1	LE	B	a
## 33	3	DA 0 1 cd s m	3	ERG	1	LE	a	<NA>
## 34	3	DA 0 1 cd s m	3	ERG	1	LE	B	a
## 35	4	DA 1 cd s m	4	ERG	1	LE	a	<NA>
## 36	4	DA 1 cd s m	4	ERG	1	LE	B	a
## 37	5	LA Single 1 0 Flash	5	ERG	1	LE	a	<NA>
## 38	5	LA Single 1 0 Flash	5	ERG	1	LE	B	a
## 39	6	LA Single 3 0 Flash	6	ERG	1	LE	a	<NA>
## 40	6	LA Single 3 0 Flash	6	ERG	1	LE	B	a
## 41	7	LA Single 10 0 Flash	7	ERG	1	LE	a	<NA>
## 42	7	LA Single 10 0 Flash	7	ERG	1	LE	B	a
## 43	1	DA 0 001 cd s m	1	ERG	1	LE	a	<NA>
## 44	1	DA 0 001 cd s m	1	ERG	1	LE	B	a
## 45	2	DA 0 01 cd s m	2	ERG	1	LE	a	<NA>
## 46	2	DA 0 01 cd s m	2	ERG	1	LE	B	a
## 47	3	DA 0 1 cd s m	3	ERG	1	LE	a	<NA>
## 48	3	DA 0 1 cd s m	3	ERG	1	LE	B	a
## 49	4	DA 1 cd s m	4	ERG	1	LE	a	<NA>
## 50	4	DA 1 cd s m	4	ERG	1	LE	B	a
## 51	5	LA Single 1 0 Flash	5	ERG	1	LE	a	<NA>
## 52	5	LA Single 1 0 Flash	5	ERG	1	LE	B	a
## 53	6	LA Single 3 0 Flash	6	ERG	1	LE	a	<NA>
## 54	6	LA Single 3 0 Flash	6	ERG	1	LE	B	a
## 55	7	LA Single 10 0 Flash	7	ERG	1	LE	a	<NA>
## 56	7	LA Single 10 0 Flash	7	ERG	1	LE	B	a
## 57	1	DA 0 001 cd s m	1	ERG	1	LE	a	<NA>
## 58	1	DA 0 001 cd s m	1	ERG	1	LE	B	a
## 59	2	DA 0 01 cd s m	2	ERG	1	LE	a	<NA>
## 60	2	DA 0 01 cd s m	2	ERG	1	LE	B	a
## 61	3	DA 0 1 cd s m	3	ERG	1	LE	a	<NA>
## 62	3	DA 0 1 cd s m	3	ERG	1	LE	B	a
## 63	4	DA 1 cd s m	4	ERG	1	LE	a	<NA>
## 64	4	DA 1 cd s m	4	ERG	1	LE	B	a
## 65	5	LA Single 1 0 Flash	5	ERG	1	LE	a	<NA>
## 66	5	LA Single 1 0 Flash	5	ERG	1	LE	B	a
## 67	6	LA Single 3 0 Flash	6	ERG	1	LE	a	<NA>
## 68	6	LA Single 3 0 Flash	6	ERG	1	LE	B	a
## 69	7	LA Single 10 0 Flash	7	ERG	1	LE	a	<NA>
## 70	7	LA Single 10 0 Flash	7	ERG	1	LE	B	a
##	Time	Voltage	Subject	Group	ExamDate			
## 1	0.0310 [s]	-2.0383069 [uV]	CR1376	0	2022-08-16 10:53:41			
## 2	0.0955 [s]	186.4152317 [uV]	CR1376	0	2022-08-16 10:53:41			
## 3	0.0325 [s]	-70.7528330 [uV]	CR1376	0	2022-08-16 10:53:41			
## 4	0.0645 [s]	318.0240514 [uV]	CR1376	0	2022-08-16 10:53:41			

## 5	0.0265	[s]	-175.4332551	[uV]	CR1376	0	2022-08-16	10:53:41
## 6	0.0400	[s]	472.5466852	[uV]	CR1376	0	2022-08-16	10:53:41
## 7	0.0230	[s]	-198.6900201	[uV]	CR1376	0	2022-08-16	10:53:41
## 8	0.0370	[s]	516.8584293	[uV]	CR1376	0	2022-08-16	10:53:41
## 9	0.0295	[s]	-17.8737140	[uV]	CR1376	0	2022-08-16	10:53:41
## 10	0.0400	[s]	33.6568481	[uV]	CR1376	0	2022-08-16	10:53:41
## 11	0.0255	[s]	-5.5195789	[uV]	CR1376	0	2022-08-16	10:53:41
## 12	0.0530	[s]	58.5163887	[uV]	CR1376	0	2022-08-16	10:53:41
## 13	0.0235	[s]	-20.0560929	[uV]	CR1376	0	2022-08-16	10:53:41
## 14	0.0485	[s]	116.2060109	[uV]	CR1376	0	2022-08-16	10:53:41
## 15	0.0000	[s]	-5.6327413	[uV]	CRI1377	0	2022-08-12	11:54:57
## 16	0.0965	[s]	245.5506086	[uV]	CRI1377	0	2022-08-12	11:54:57
## 17	0.0330	[s]	-95.4677544	[uV]	CRI1377	0	2022-08-12	11:54:57
## 18	0.0550	[s]	395.1253381	[uV]	CRI1377	0	2022-08-12	11:54:57
## 19	0.0265	[s]	-250.0754019	[uV]	CRI1377	0	2022-08-12	11:54:57
## 20	0.0405	[s]	521.0791908	[uV]	CRI1377	0	2022-08-12	11:54:57
## 21	0.0140	[s]	-247.0355817	[uV]	CRI1377	0	2022-08-12	11:54:57
## 22	0.0375	[s]	580.3660621	[uV]	CRI1377	0	2022-08-12	11:54:57
## 23	-0.0400	[s]	-0.7195593	[uV]	CRI1377	0	2022-08-12	11:54:57
## 24	0.0400	[s]	37.5468171	[uV]	CRI1377	0	2022-08-12	11:54:57
## 25	0.0255	[s]	-10.4145864	[uV]	CRI1377	0	2022-08-12	11:54:57
## 26	0.0380	[s]	61.4911811	[uV]	CRI1377	0	2022-08-12	11:54:57
## 27	0.0225	[s]	-30.0617504	[uV]	CRI1377	0	2022-08-12	11:54:57
## 28	0.0490	[s]	133.1896458	[uV]	CRI1377	0	2022-08-12	11:54:57
## 29	0.0430	[s]	-1.6935731	[uV]	CRI1379	0	2022-08-16	12:04:31
## 30	0.0665	[s]	130.9577513	[uV]	CRI1379	0	2022-08-16	12:04:31
## 31	0.0310	[s]	-54.8687636	[uV]	CRI1379	0	2022-08-16	12:04:31
## 32	0.0430	[s]	250.0899613	[uV]	CRI1379	0	2022-08-16	12:04:31
## 33	0.0250	[s]	-128.7135035	[uV]	CRI1379	0	2022-08-16	12:04:31
## 34	0.0375	[s]	356.0739975	[uV]	CRI1379	0	2022-08-16	12:04:31
## 35	0.0135	[s]	-141.6833086	[uV]	CRI1379	0	2022-08-16	12:04:31
## 36	0.0350	[s]	394.4244023	[uV]	CRI1379	0	2022-08-16	12:04:31
## 37	0.0270	[s]	-9.4809895	[uV]	CRI1379	0	2022-08-16	12:04:31
## 38	0.0390	[s]	15.9727114	[uV]	CRI1379	0	2022-08-16	12:04:31
## 39	0.0195	[s]	-4.6232949	[uV]	CRI1379	0	2022-08-16	12:04:31
## 40	0.0365	[s]	33.6790807	[uV]	CRI1379	0	2022-08-16	12:04:31
## 41	0.0180	[s]	-11.3302291	[uV]	CRI1379	0	2022-08-16	12:04:31
## 42	0.0495	[s]	68.7465564	[uV]	CRI1379	0	2022-08-16	12:04:31
## 43	0.0025	[s]	-14.4315070	[uV]	CR1429	0	2022-09-14	11:01:00
## 44	0.1055	[s]	195.5306039	[uV]	CR1429	0	2022-09-14	11:01:00
## 45	0.0390	[s]	-86.2645861	[uV]	CR1429	0	2022-09-14	11:01:00
## 46	0.0655	[s]	329.6008365	[uV]	CR1429	0	2022-09-14	11:01:00
## 47	0.0320	[s]	-219.5709215	[uV]	CR1429	0	2022-09-14	11:01:00
## 48	0.0485	[s]	435.4916330	[uV]	CR1429	0	2022-09-14	11:01:00
## 49	0.0170	[s]	-311.2914575	[uV]	CR1429	0	2022-09-14	11:01:00
## 50	0.0460	[s]	526.3570672	[uV]	CR1429	0	2022-09-14	11:01:00
## 51	0.0320	[s]	-15.7517460	[uV]	CR1429	0	2022-09-14	11:01:00
## 52	0.0580	[s]	53.1868419	[uV]	CR1429	0	2022-09-14	11:01:00
## 53	0.0315	[s]	-20.1612616	[uV]	CR1429	0	2022-09-14	11:01:00
## 54	0.0555	[s]	78.3343671	[uV]	CR1429	0	2022-09-14	11:01:00
## 55	0.0265	[s]	-29.7262137	[uV]	CR1429	0	2022-09-14	11:01:00
## 56	0.0650	[s]	154.0166277	[uV]	CR1429	0	2022-09-14	11:01:00
## 57	0.0195	[s]	-12.4397352	[uV]	CR1459	0	2022-08-26	13:01:15
## 58	0.0970	[s]	230.1339388	[uV]	CR1459	0	2022-08-26	13:01:15

## 59	0.0330	[s]	-100.7445542	[uV]	CR1459	0	2022-08-26	13:01:15
## 60	0.0565	[s]	382.6203862	[uV]	CR1459	0	2022-08-26	13:01:15
## 61	0.0275	[s]	-232.3591804	[uV]	CR1459	0	2022-08-26	13:01:15
## 62	0.0420	[s]	517.6675889	[uV]	CR1459	0	2022-08-26	13:01:15
## 63	0.0140	[s]	-309.3362752	[uV]	CR1459	0	2022-08-26	13:01:15
## 64	0.0395	[s]	591.4785377	[uV]	CR1459	0	2022-08-26	13:01:15
## 65	0.0280	[s]	-12.0952291	[uV]	CR1459	0	2022-08-26	13:01:15
## 66	0.0465	[s]	40.1823050	[uV]	CR1459	0	2022-08-26	13:01:15
## 67	0.0265	[s]	-17.6110215	[uV]	CR1459	0	2022-08-26	13:01:15
## 68	0.0410	[s]	66.2415868	[uV]	CR1459	0	2022-08-26	13:01:15
## 69	0.0215	[s]	-25.8541336	[uV]	CR1459	0	2022-08-26	13:01:15
## 70	0.0560	[s]	148.5445519	[uV]	CR1459	0	2022-08-26	13:01:15
##	StimulusEnergy	Background	Type					
## 1	1e-03		DA Flash					
## 2	1e-03		DA Flash					
## 3	1e-02		DA Flash					
## 4	1e-02		DA Flash					
## 5	1e-01		DA Flash					
## 6	1e-01		DA Flash					
## 7	1e+00		DA Flash					
## 8	1e+00		DA Flash					
## 9	1e+00		LA Flash					
## 10	1e+00		LA Flash					
## 11	3e+00		LA Flash					
## 12	3e+00		LA Flash					
## 13	1e+01		LA Flash					
## 14	1e+01		LA Flash					
## 15	1e-03		DA Flash					
## 16	1e-03		DA Flash					
## 17	1e-02		DA Flash					
## 18	1e-02		DA Flash					
## 19	1e-01		DA Flash					
## 20	1e-01		DA Flash					
## 21	1e+00		DA Flash					
## 22	1e+00		DA Flash					
## 23	1e+00		LA Flash					
## 24	1e+00		LA Flash					
## 25	3e+00		LA Flash					
## 26	3e+00		LA Flash					
## 27	1e+01		LA Flash					
## 28	1e+01		LA Flash					
## 29	1e-03		DA Flash					
## 30	1e-03		DA Flash					
## 31	1e-02		DA Flash					
## 32	1e-02		DA Flash					
## 33	1e-01		DA Flash					
## 34	1e-01		DA Flash					
## 35	1e+00		DA Flash					
## 36	1e+00		DA Flash					
## 37	1e+00		LA Flash					
## 38	1e+00		LA Flash					
## 39	3e+00		LA Flash					
## 40	3e+00		LA Flash					
## 41	1e+01		LA Flash					

```
## 42      1e+01      LA Flash
## 43      1e-03      DA Flash
## 44      1e-03      DA Flash
## 45      1e-02      DA Flash
## 46      1e-02      DA Flash
## 47      1e-01      DA Flash
## 48      1e-01      DA Flash
## 49      1e+00      DA Flash
## 50      1e+00      DA Flash
## 51      1e+00      LA Flash
## 52      1e+00      LA Flash
## 53      3e+00      LA Flash
## 54      3e+00      LA Flash
## 55      1e+01      LA Flash
## 56      1e+01      LA Flash
## 57      1e-03      DA Flash
## 58      1e-03      DA Flash
## 59      1e-02      DA Flash
## 60      1e-02      DA Flash
## 61      1e-01      DA Flash
## 62      1e-01      DA Flash
## 63      1e+00      DA Flash
## 64      1e+00      DA Flash
## 65      1e+00      LA Flash
## 66      1e+00      LA Flash
## 67      3e+00      LA Flash
## 68      3e+00      LA Flash
## 69      1e+01      LA Flash
## 70      1e+01      LA Flash
```

Special use cases

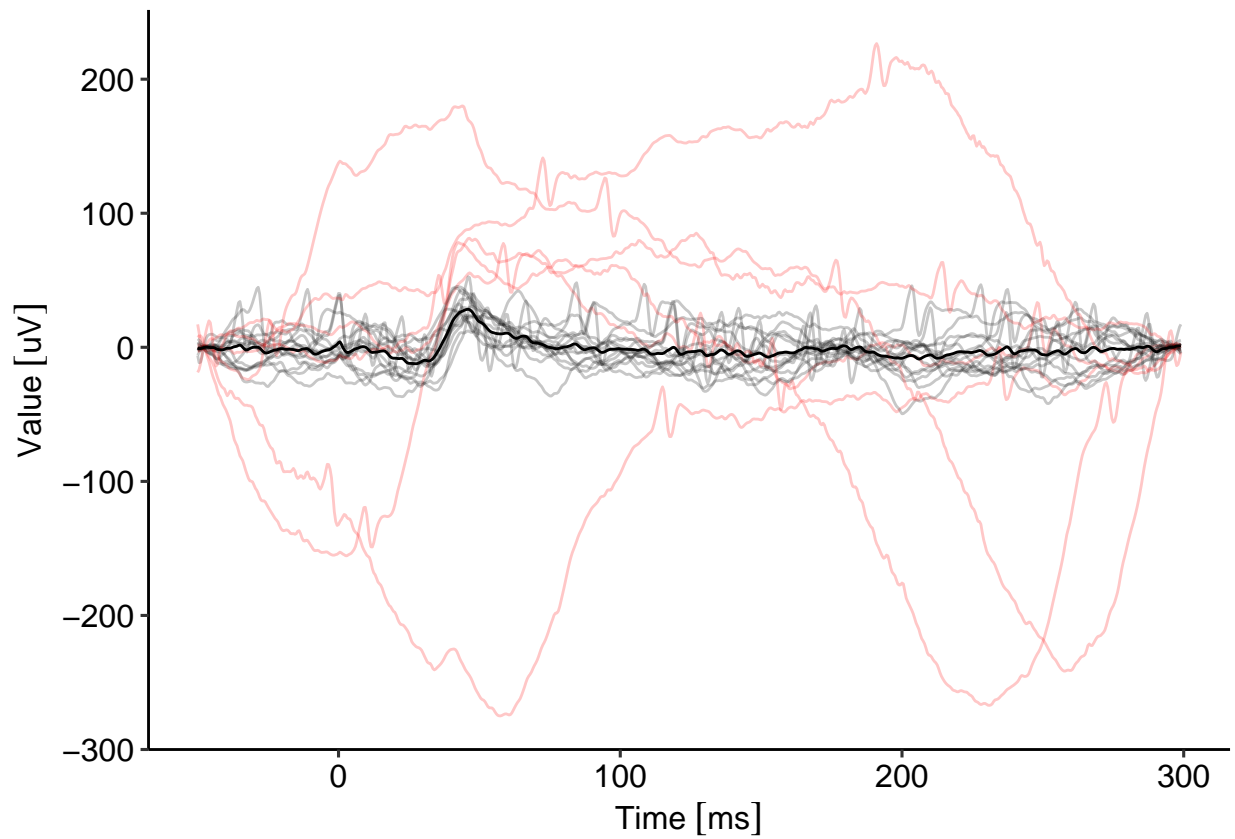
Automatic rejection of outlier recordings

```
Noisy_Exam<-Subset(Exams[[5]],where=list(StimulusEnergy=1,Background="LA"))
Noisy_Exam<-ClearMeasurements(Noisy_Exam)
```

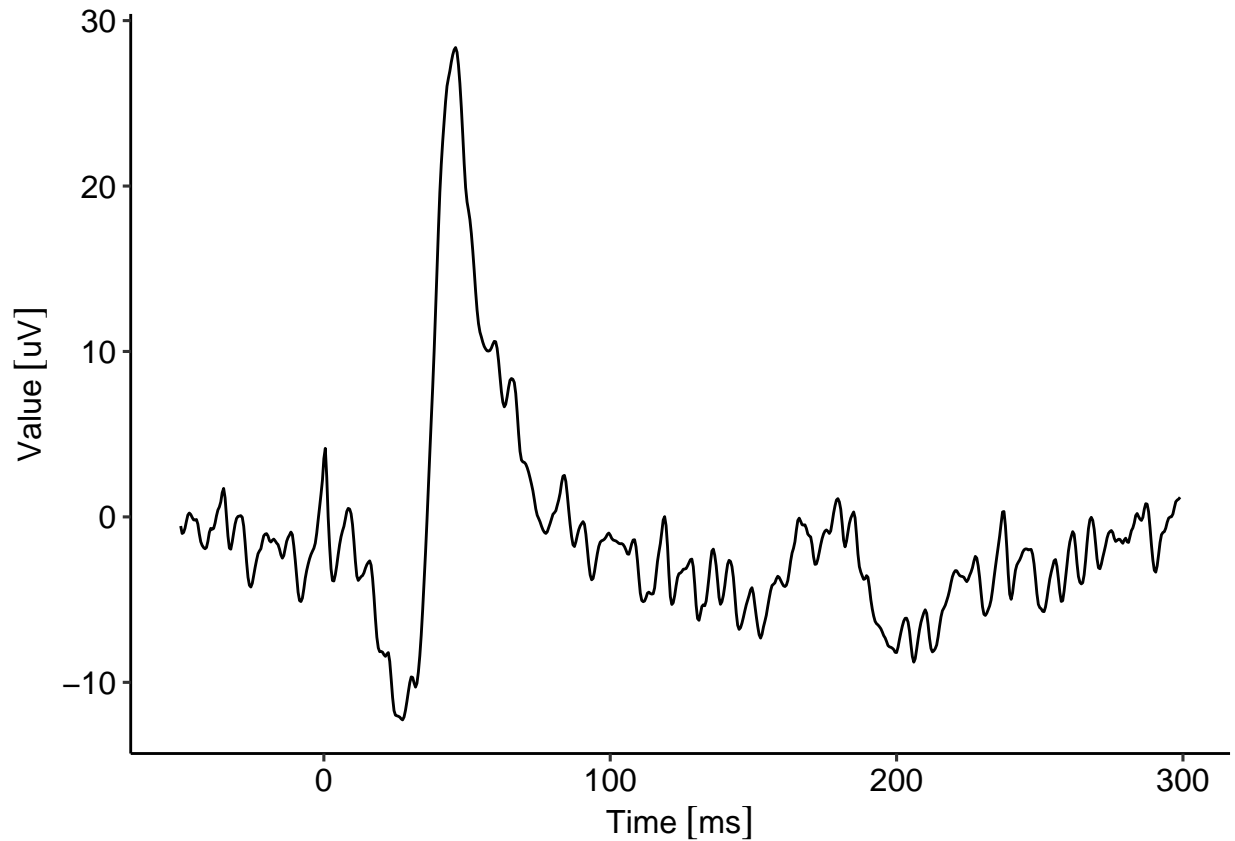
```
# now replace the Rejection function for each Step/Recording in the object (in this case, there is only
Rejected(Noisy_Exam, where=list(Step=5))<-autoreject.by.distance
table(Rejected(Noisy_Exam[[1]]))
```

```
##
## FALSE  TRUE
##    14    6
```

```
Noise_dist_left <-
  ggERGTrace(Noisy_Exam, where = list(StimulusEnergy = 1, Background = "LA")) + theme(legend.position =
Noise_dist_left # Print all trials with the rejected highlighted
```



```
Noise_dist_right <-
  ggERGTrace(Noisy_Exam,
    where = list(StimulusEnergy = 1, Background = "LA"),
    Raw = F) + theme(legend.position = "none")
Noise_dist_right # Print averaged recording with the rejected highlighted
```

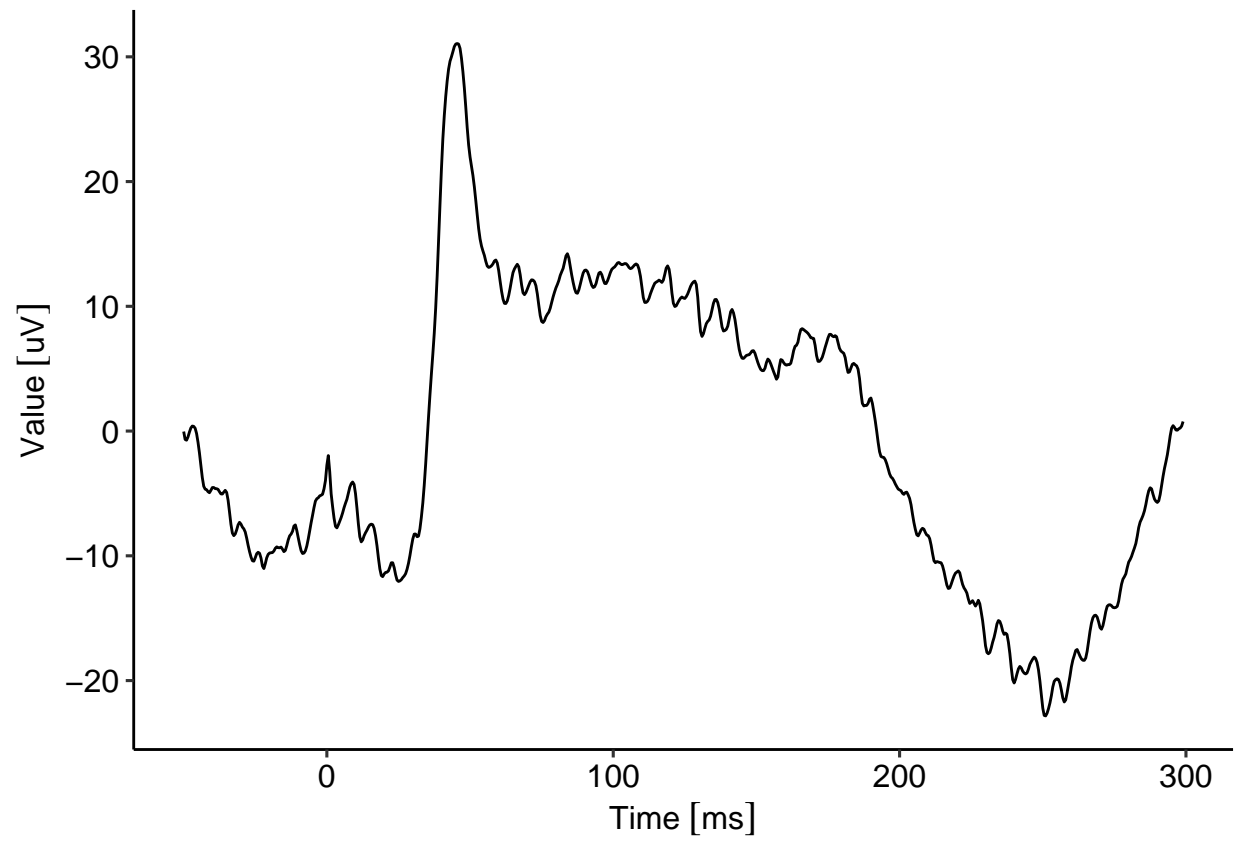


```
Rejected(Noisy_Exam, where = list(Step = 5)) <- function(x) {
  logical(dim(x)[2])
} # set all traces to be included, i.e. the function for rejection returns false for all trials.

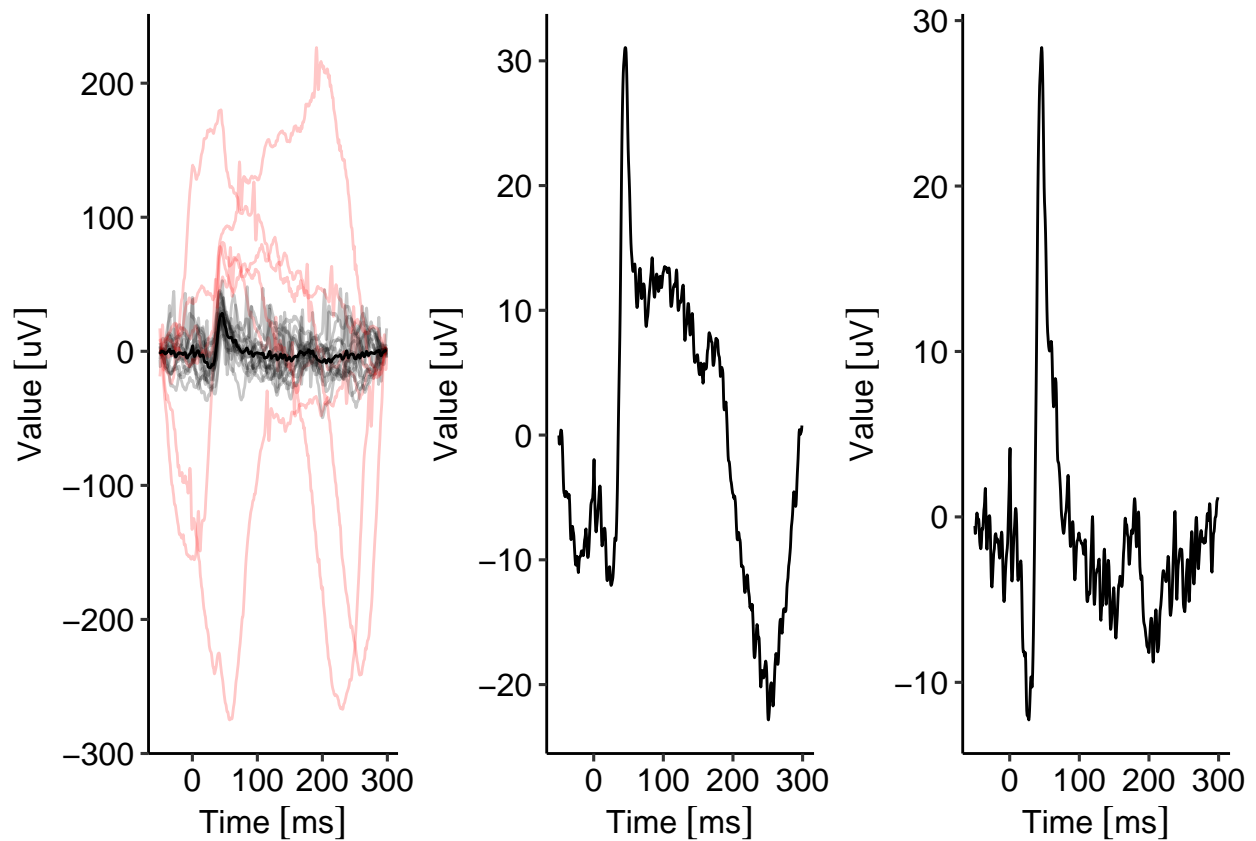
table(Rejected(Noisy_Exam[[1]]))
```

```
##
## FALSE
##      20
```

```
Noise_thresh_middle <-
  ggERGTrace(Noisy_Exam,
    where = list(StimulusEnergy = 1, Background = "LA"),
    Raw = F) + theme(legend.position = "none")
Noise_thresh_middle
```

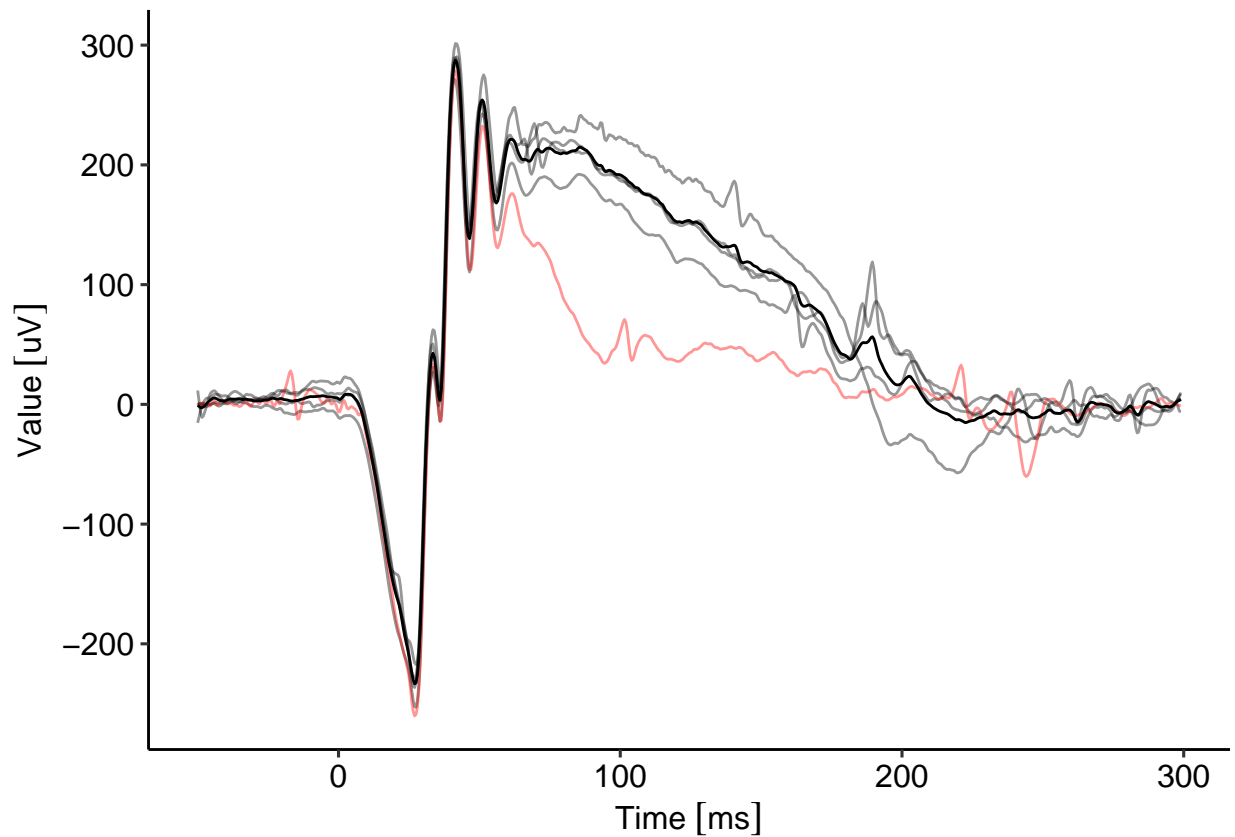
```
plot_grid(Noise_dist_left,Noise_thresh_middle,Noise_dist_right,nrow = 1)
```



```
ggsave2("FigNOISE.PDF", width = 16, height=5, units = "cm")
```

Extracting and analysing oscillatory potentials

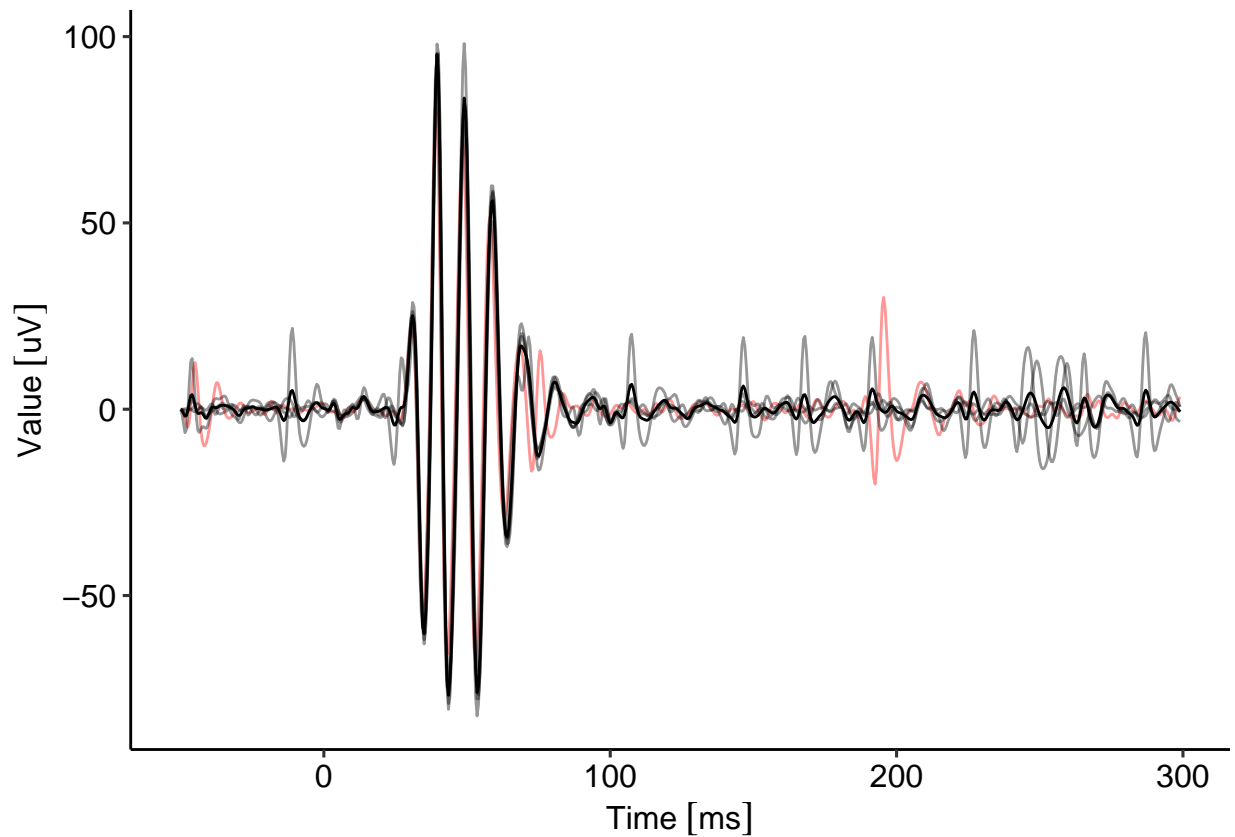
```
Exam_forOPs<-Subset(Exam,where=list(StimulusEnergy=0.1,Background="DA"))
Exam_forOPs<-ClearMeasurements(Exam_forOPs)
FigOP_A <-
  ggERGTrace(Exam_forOPs, where = list(StimulusEnergy = 0.1, Background = "DA")) + theme(legend.position="bottom")
FigOP_A
```



```
# filter and plot OPs
cutoff <-
  freq.to.w(c(75, 300), samp.freq = 2000) # convert to digital angular frequencies, we need to know the

FilterFunction(Exam_forOPs, where = list(Step = 3)) <-
  function(x) {
    # we set the new filter
    eval(substitute(
      filter.bandpass(x, low, high),
      list(low = cutoff[1], high = cutoff[2])
    ))
  }

FigOP_B <-
  ggERGTrace(Exam_forOPs, where = list(StimulusEnergy = 0.1, Background = "DA")) + theme(legend.position = "bottom")
FigOP_B
```



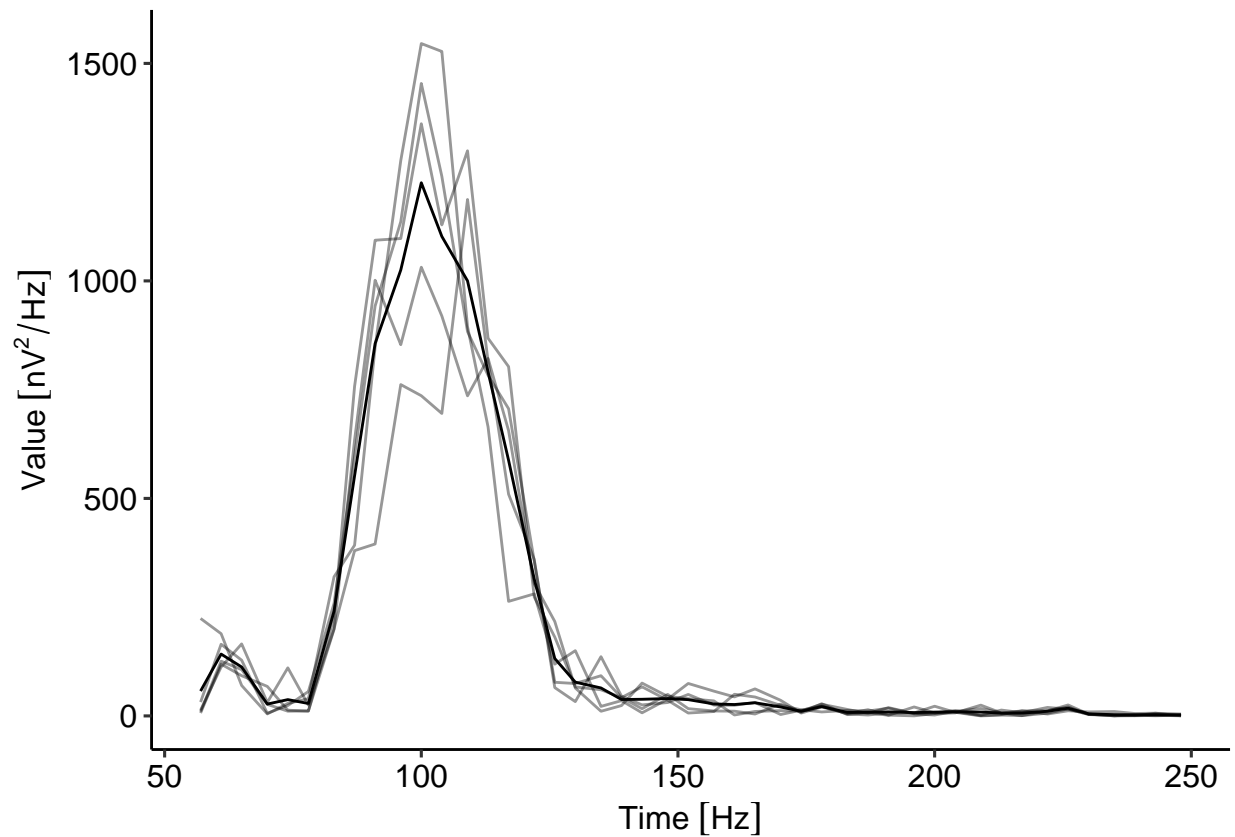
```
# calculate spectral power
```

```
cutoff <-  
  freq.to.w(c(0.5, 300), samp.freq = 2000) # convert to digital angular frequencies, we need to know th  
  
FilterFunction(Exam_forOPs, where = list(Step = 3)) <- function(x) { # we set the new filter  
  filter.bandpass(x, cutoff[1], cutoff[2])  
}  
PSD <- lapply(Exam_forOPs, function(x) {  
  psd<-PSD(Subset(x,Time = as_units(c(0,230),"ms")))  
  psd<-Subset(psd,Time = as_units(c(55,250),"Hz"))  
})
```

```
## Data is subsetting by time, thus resetting filter function.  
## Data is subsetting by time, thus resetting filter function.
```

the PSD object now contains data of the unit nV²/Hz. The ggERGTrace method will expect a unit convertible to V, which is not preset here. So we have to use the lower-level function ggEPhysData.

```
FigOP_C <- ggEPhysData(PSD[[1]]) + theme(legend.position = "none")  
FigOP_C
```



```
# extract the values to perform further analyses
```

```
out <- lapply(PSD, function(y) {  
  df_LA<-as.data.frame(y, Raw=F) # get averaged data  
  df_LA  
}, ReturnEPhysSet = F)
```

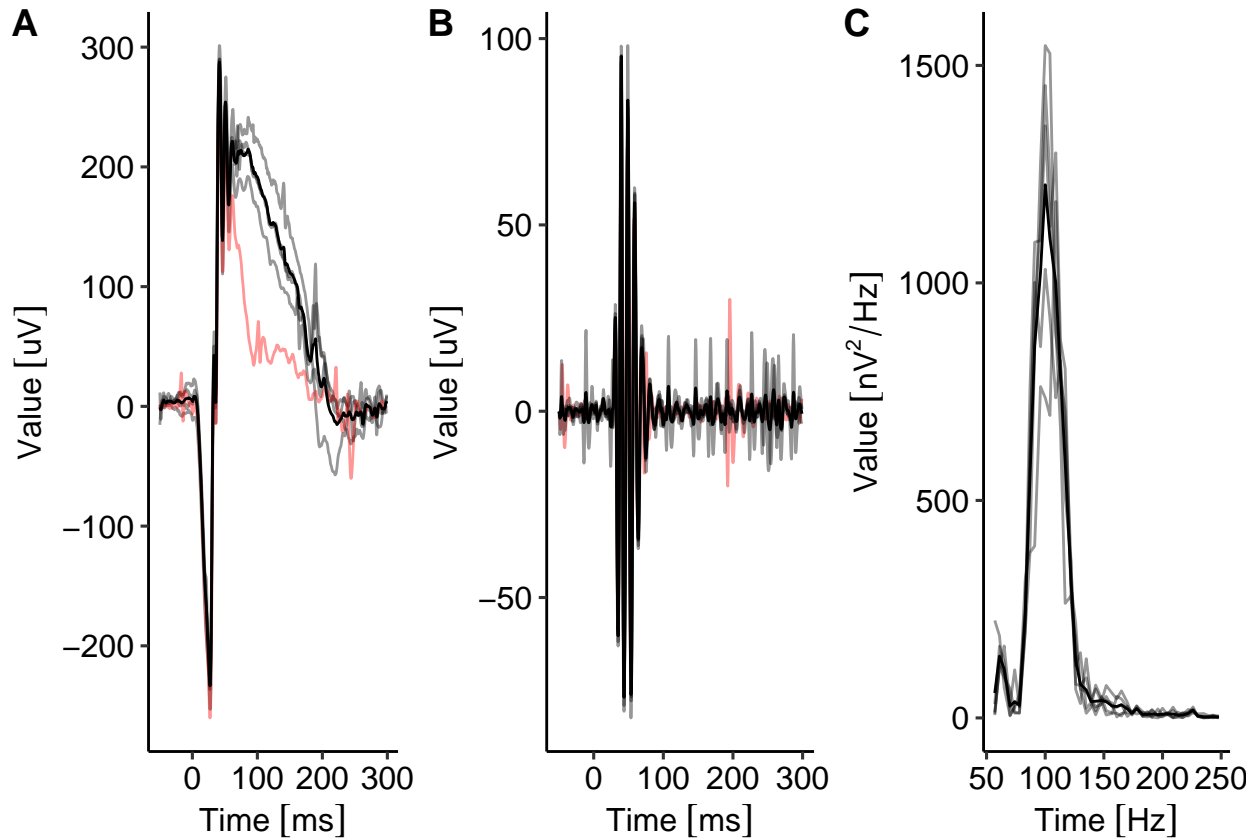
```
out<-out[[1]] # get the first (and in this case only) recording in the data set
```

```
# find the peak frequency  
out$Time[which.max(out$Value)]
```

```
## 100 [Hz]
```

```
# make composite figure
```

```
plot_grid(FigOP_A,FigOP_B,FigOP_C,labels=c("A","B","C"),nrow=1)
```



```
ggsave2("FigOP.PDF", width = 16, height=5, units = "cm")
```

Session info

```
sessionInfo()
```

```
## R version 4.1.2 (2021-11-01)
## Platform: x86_64-pc-linux-gnu (64-bit)
## Running under: Ubuntu 22.04.5 LTS
##
## Matrix products: default
## BLAS:   /usr/lib/x86_64-linux-gnu/blas/libblas.so.3.10.0
## LAPACK: /usr/lib/x86_64-linux-gnu/lapack/liblapack.so.3.10.0
##
## locale:
##  [1] LC_CTYPE=de_DE.UTF-8      LC_NUMERIC=C
##  [3] LC_TIME=de_DE.UTF-8      LC_COLLATE=de_DE.UTF-8
##  [5] LC_MONETARY=de_DE.UTF-8  LC_MESSAGES=de_DE.UTF-8
##  [7] LC_PAPER=de_DE.UTF-8     LC_NAME=C
##  [9] LC_ADDRESS=C             LC_TELEPHONE=C
## [11] LC_MEASUREMENT=de_DE.UTF-8 LC_IDENTIFICATION=C
##
```

```

## attached base packages:
## [1] stats      graphics  grDevices utils      datasets  methods   base
##
## other attached packages:
## [1] ggplot2_3.5.1      cowplot_1.1.3      EPhysMethods_0.3.1 ERGtools2_0.8.5
## [5] EPhysData_0.9.7    units_0.8-0
##
## loaded via a namespace (and not attached):
## [1] httr_1.4.7          tidyr_1.3.1         bit64_4.5.2          jsonlite_1.8.9
## [5] viridisLite_0.4.2  hdf5r_1.3.11        carData_3.0-5        Formula_1.2-5
## [9] shiny_1.9.1         TTR_0.24.4          highr_0.11           yaml_2.3.10
## [13] pillar_1.9.0        backports_1.5.0     lattice_0.20-45      glue_1.8.0
## [17] digest_0.6.37       promises_1.3.0      ggsignif_0.6.4       colorspace_2.1-1
## [21] htmltools_0.5.8.1  httpuv_1.6.15       pkgconfig_2.0.3      broom_1.0.7
## [25] purrr_1.0.2         xtable_1.8-4        scales_1.3.0         later_1.3.2
## [29] pracma_2.4.4        tibble_3.2.1        farver_2.1.2         generics_0.1.3
## [33] car_3.1-3           ggpubr_0.6.0        DT_0.33              withr_3.0.1
## [37] shinyjs_2.1.0       lazyeval_0.2.2      cli_3.6.3            quantmod_0.4.26
## [41] magrittr_2.0.3      mime_0.12            evaluate_1.0.1       fansi_1.0.6
## [45] MASS_7.3-55         rstatix_0.7.2       xts_0.14.1           textshaping_0.3.6
## [49] tools_4.1.2         data.table_1.16.2   lifecycle_1.0.4     stringr_1.5.1
## [53] plotly_4.10.4.9000 munsell_0.5.1       compiler_4.1.2       signal_1.8-1
## [57] systemfonts_1.0.4   rlang_1.1.4         grid_4.1.2           rstudioapi_0.13
## [61] htmlwidgets_1.6.4   labeling_0.4.3      rmarkdown_2.28       gtable_0.3.5
## [65] abind_1.4-8         curl_5.2.3          R6_2.5.1             gridExtra_2.3
## [69] zoo_1.8-12          knitr_1.48          dplyr_1.1.4          fastmap_1.2.0
## [73] bit_4.5.0           utf8_1.2.4          ragg_1.2.1           stringi_1.8.4
## [77] Rcpp_1.0.13         vctrs_0.6.5         tidyselect_1.2.1     xfun_0.48

```