

# CAMERA

October 5, 2010

---

annotate

*Deconvolute/Annotate LC/ESI-MS data*

---

## Description

Annotate isotope peaks, adducts and fragments for a (grouped) `xcmsSet` `xs`. Returns a `xsAnnotate` object.

## Usage

```
annotate(object, sigma = 6, perfwHM = 0.6, cor_eic_th = 0.75, maxcharge = 3, max
```

## Arguments

<code>object</code>	<code>xcmsSet</code> with peak group assignments
<code>sigma</code>	Isotopic peak relationship table
<code>perfwHM</code>	Adduct/Fragment peak relationship table
<code>cor_eic_th</code>	correlation threshold (0..1)
<code>maxcharge</code>	max charge of the ions
<code>maxiso</code>	max number of isotopes
<code>ppm</code>	ppm error
<code>mzabs</code>	absolut error
<code>multiplier</code>	max. number <code>n</code> of <code>[nM+x]</code> clusterions
<code>sample</code>	Index of which sample is used for the correlation, NA for auto-selection
<code>quick</code>	Use only <code>groupFWHM</code> and <code>findIsotopes</code>
<code>psg_list</code>	Calculation will only be done for the selected groups
<code>polarity</code>	Which polarity mode was used for measuring of the ms sample
<code>nSlaves</code>	Number of slaves for parallel calculation (Warning: Beta)
<code>max_peaks</code>	If run in parallel mode, value defines how much peaks will be calculated in every thread

**Details**

Batch script for a annotation for a (grouped) `xcmsSet` `xs`. Generate intern a `xsAnnotate` object and calls the member function for the annotation step. Function list: 1: `groupFWHM()`, 2: `findIsotopes()`, 3: `groupCorr()`, 4: `findAdducts()` Return the `xsAnnotate` object which all the annotations. For more information see the funtion manpages.

**Value**

`annotate` returns an `xsAnnotate` object. For more information about see [xsAnnotate-class](#)

**Author(s)**

Carsten Kuhl <ckuhl@ipb-halle.de>

**Examples**

```
library(CAMERA)
file <- system.file('mzdata/MM14.mzdata', package = "CAMERA")
xs <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
xsa <- annotate(xs)
```

---

`annotateDiffreport` *Deconvolute/Annotate LC/ESI-MS data*

---

**Description**

Wrapper function for the `xcms` `diffreport` and the `annotate` function. Returns a `diffreport` with the result from the annotation progress.

**Usage**

```
annotateDiffreport(object, sample=NA, sigma = 6, perfw hm = 0.6, cor_eic_th = 0.7,
  multiplier = 3, polarity = "positive", nSlaves = 1, psg_list =
  class1 = levels(sampclass(object))[1], class2 = levels(sampclass(object))[2],
  eicmax = 0, eicwidth = 200, sortpval = TRUE, classeic = c(class1, class2),
  metlin = FALSE, h = 480, w = 640, ...)
```

**Arguments**

<code>object</code>	<code>xcmsSet</code> with peak group assignments
<code>sample</code>	Index of which sample is used for the correlation, NA for auto-selection
<code>sigma</code>	Isotopic peak relationship table
<code>perfw hm</code>	Adduct/Fragment peak relationship table
<code>cor_eic_th</code>	correlation threshold (0..1)
<code>maxcharge</code>	max charge of the ions
<code>maxiso</code>	max number of isotopes
<code>ppm</code>	ppm error
<code>mzabs</code>	absolut error
<code>multiplier</code>	max. number n of [nM+x] clusterions

polarity	Which polarity mode was used for measuring of the ms sample
nSlaves	Number of slaves for parallel calculation (Warning: Beta)
psg_list	Index-list of pseudospectra. Only for those ones will the annotation be calculated. Useful as a speed-up
pval_th	pval threshold. Creates a new psg_list. A pseudospectra is selected if it contains peaks, with pval < pval_th
fc_th	Same as pval. Select those groups with contains peaks with fold-change > fc_th. Pval_th and fc_th can be combined
quick	If quick is TRUE, only groupFWHM and findIsotopes will be calculated. Useful for preselecting groups with psg_list
class1	character vector with the first set of sample classes to be compared
class2	character vector with the second set of sample classes to be compared
filebase	base file name to save report, .tsv file and _eic will be appended to this name for the tabular report and EIC directory, respectively. if blank nothing will be saved
eicmax	number of the most significantly different analytes to create EICs for
eicwidth	width (in seconds) of EICs produced
sortpval	logical indicating whether the reports should be sorted by p-value
classeic	character vector with the sample classes to include in the EICs
value	intensity values to be used for the diffreport. If value="into", integrated peak intensities are used. If value="maxo", maximum peak intensities are used. If value="intb", baseline corrected integrated peak intensities are used (only available if peak detection was done by <code>findPeaks.centWave</code> ).
metlin	mass uncertainty to use for generating link to Metlin metabolite database. the sign of the uncertainty indicates negative or positive mode data for M+H or M-H calculation. a value of FALSE or 0 removes the column
h	Numeric variable for the height of the eic and boxplots that are printed out.
w	Numeric variable for the width of the eic and boxplots print out made.
...	optional arguments to be passed to <code>mt.teststat</code>

## Details

Batch script wrapper for combining the annotation and the diffreport for a (grouped) `xcmsSet` `xs`. Function list: 1: `diffreport()`, 2: `groupFWHM()`, 3: `findIsotopes()`, 4: `groupCorr()`, 5: `findAdducts()` For a speedup calculation users can create a quick run, with `quick = TRUE` to preselect pseudospectra of interest. The indices of those pseudospectra are set with `psg_list` in a second run. On the other hand, a automatic selection with `pval_th` and/or `fc_th` can be performed. Returns the normal `xcms` diffreport table, with the additional CAMERA slots

## Value

`annotate` returns an `xsAnnotate` object. For more information about see [xsAnnotate-class](#)

## Author(s)

Carsten Kuhl <[ckuhl@ipb-halle.de](mailto:ckuhl@ipb-halle.de)>

**Examples**

```

#Multiple sample
library(CAMERA)
library(faahKO)
xs.grp      <- group(faahko)
xs.fill     <- fillPeaks(xs.grp)

#fast preselection
diffreport <- annotateDiffreport(xs.fill,quick=TRUE)
index <- c(1,18,35,45,56) #Make only for those grps a adduct annotation
diffreport2 <- annotateDiffreport(xs.fill,psg_list=index)

#automatic selection, all groups with peaks p-val < 0.05 and fold-change > 3
diffreport <- annotateDiffreport(xs.fill,pval_th=0.05,fc=3)

```

---

findAdducts-methods

*Calculate Adducts and Annotate LC/ESI-MS Spectra*

---

**Description**

Annotate adducts (and fragments) for a xsAnnotate object. Returns a xsAnnotate object with annotated pseudospectra.

**Usage**

```
findAdducts(object, ppm=5, mzabs=0.015, multiplier=3, polarity=NULL, rules=NULL)
```

**Arguments**

object	the xsAnnotate object
ppm	ppm error for the search
mzabs	allowed variance for the search
multiplier	highest number(n) of allowed clusterion [nM+ion]
polarity	Which polarity mode was used for measuring of the ms sample
rules	personal ruleset or with NULL standard ruleset will be calculated
max_peaks	If run in parralel mode, this number defines how much peaks will be calculated in every thread
psg_list	Vector of pseudospectra indices. The correlation analysis will be only done for those groups

**Details**

Adducts (and fragments) are annotated for a xsAnnotate object. For every pseudospectra group, generated bei groupFWHM and groupCorr, all possible Adducts are calculated and mapped to the peaks. If at least two adducts match, a possible molecule-mass for the group can be calculated. After the annotation every masshypothese is checked against the charge of the calculated isotopes. It is recommend to call findIsotopes() before the annotation step.

**Author(s)**

Carsten Kuhl <ckuhl@ipb-halle.de>

**Examples**

```
library(CAMERA)
file <- system.file('mzdata/MM14.mzdata', package = "CAMERA")
xs <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- findIsotopes(an) # optional but recommended.
an <- groupFWHM(an)
# an <- groupCorr(an) # optional but very recommended step
an <- findAdducts(an,polarity="positive")
peaklist <- getPeaklist(an) # get the annotated peak list
```

---

findIsotopes-methods

*Deconvolute/Annotate LC/ESI-MS data*

---

**Description**

Annotate isotope peaks for a `xsAnnotate` object. Returns a `xsAnnotate` object with annotated isotopes.

**Arguments**

<code>object</code>	the <code>xsAnnotate</code> object
<code>maxcharge</code>	max. number of the isotope charge
<code>maxiso</code>	max. number of the isotope peaks
<code>ppm</code>	ppm error for the search
<code>mzabs</code>	allowed variance for the search

**Details**

Isotope peaks are annotated for a `xsAnnotate` object according to given rules (`maxcharge`, `maxiso`). The algorithm benefits from a earlier grouping of the data, with `groupFWHM`. Generates a list of all possible isotopes, which is stored in `object@isotopes`. Those isotope information will be used in the `groupCorr` function.

**Methods**

```
object = "xsAnnotate" findIsotopes(object, maxcharge=3, maxiso=3, ppm=5,
mzabs=0.01)
```

**Author(s)**

Carsten Kuhl <ckuhl@ipb-halle.de>

## Examples

```
library(CAMERA)
file <- system.file('mzdata/MM14.mzdata', package = "CAMERA")
xs <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- groupFWHM(an)
an <- findIsotopes(an)
```

---

getPeaklist	<i>Retrieve the annotated peaklist</i>
-------------	--

---

## Description

Extract all groups from a xsAnnotate object. Returns a peaklist with annotated peaks.

## Usage

```
getPeaklist(object)
```

## Arguments

object            xsAnnotate object

## Details

xsAnnotate groups LC/MS Peaklist after there EIC correlation and FWHM. These function extract one of these so called "pseudo spectra groups" with include the peaklist with there annotations. For a grouped xcmsSet it returns the grouped peaktable.

## Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

## Examples

```
library(CAMERA)
file <- system.file('mzdata/MM14.mzdata', package = "CAMERA")
xs <- xcmsSet(c(file), method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- groupFWHM(an)
an <- findIsotopes(an)
an <- findAdducts(an,polarity="positive")
peaklist <- getPeaklist(an)
```

---

getpspectra      *Retrieve a spectra-group peaklist*

---

### Description

Extract one group from a xsAnnotate object. Returns a peaklist with annotated peaks.

### Usage

```
getpspectra(object, grp)
```

### Arguments

object	xsAnnotate object
grp	index of pseudo-spectra-group

### Details

xsAnnotate groups LC/MS Peaklist after there EIC correlation and FWHM. These function extract one of these so called "pseudo spectra groups" with include the peaklist with there annotations. The annotation depends on a before called findAdducts() ( and findIsotopes() ). Attention: The indices for the isotopes, are those from the whole peaklist. See getPeaklist() .

### Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

### Examples

```
library(CAMERA)
file <- system.file('mzdata/MM14.mzdata', package = "CAMERA")
xs <- xcmsSet(c(file), method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- groupFWHM(an)
peaklist <- getpspectra(an, 1)
```

---

groupCorr-methods      *EIC correlation grouping of LC/ESI-MS data*

---

### Description

Grouping the peaks after the correlation of the EICs into pseudospectragroups for a xsAnnotate object. Return a xsAnnotate object with group information.

### Usage

```
groupCorr(object, cor_eic_th=0.75, psg_list = NULL, polarity = NA)
```

**Arguments**

object	The xsAnnotate object
cor_eic_th	Correlation threshold for the EIC correlation
psg_list	Vector of pseudospectra indices. The correlation analysis will be only done for those groups
polarity	Optional feature, that ensure that [M+H] <sup>+</sup> , [M+Na] <sup>+</sup> , [M+K] <sup>+</sup> in pos. mode and [M-H] <sup>-</sup> [M+Cl] <sup>-</sup> ions in neg. mode will not be separated in different groups

**Details**

The algorithm correlates the EIC of a every peak with all others, to find the peaks that belong to one substance. LC/MS data should grouped with groupFWHM first. This step reduce the runtime a lot and increased the number of correct classifications. If you perform the findIsotope step first, annotated isotopes will always be in the same group.

**Author(s)**

Carsten Kuhl <ckuhl@ipb-halle.de>

**Examples**

```
library(CAMERA)
file      <- system.file('mzdata/MM14.mzdata', package = "CAMERA");
xs        <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5, 10));
an        <- xsAnnotate(xs);
an.group  <- groupFWHM(an);
an.iso    <- findIsotopes(an.group); #optional step
index     <- c(1,4); #Only group one and four will be calculate
an.grp.corr <- groupCorr(an.iso, psg_list=index, polarity="positive");

#For csv output
# write.csv(file="peaklist_with_isotopes.csv",getPeaklist(an))

#Multiple sample
library(faahKO)
xs.grp    <- group(faahko)

#With selected sample
xsa       <- xsAnnotate(xs.grp, sample=1)
xsa.group <- groupFWHM(xsa)
xsa.iso   <- findIsotopes(xsa.group) #optional step
index     <- c(1,4) #Only group one and four will be calculate
xsa.grp.corr <- groupCorr(xsa.iso, psg_list=index, polarity="positive")

#With automatic selection
xsa.auto  <- xsAnnotate(xs.grp)
xsa.grp   <- groupFWHM(xsa.auto)
xsa.iso   <- findIsotopes(xsa.grp) #optional step
index     <- c(1,4) #Only group one and four will be calculate
xsa.grp.corr <- groupCorr(xsa.iso, psg_list=index, polarity="positive")
#Note: Group 1 and 4 have no subgroups
```



---

groupFWHM-methods *FWHM-Grouping of LC/ESI-MS data*

---

## Description

Group peaks of one `xsAnnotate` object after the FWHM of their retention times into pseudospectra-groups. Returns a `xsAnnotate` object with group information.

## Usage

```
groupFWHM(object, sigma = 6 , perfwHM = 0.6)
```

## Arguments

<code>object</code>	the <code>xsAnnotate</code> object
<code>sigma</code>	the multiplier of the standard deviation
<code>perfwHM</code>	percentage of the width of the FWHM

## Details

Every peak who eluted at the same time as a selected peak, will be part of the group. Same time is defined about the `Rt_med +/- FWHM * perfwHM`. For single sample the selection of peaks starts at the most abundant and goes down the smaller ones. In a multiple sample set you can define a sample, that will be used for the process or use the automatic selection. This selects the most abundant peak as a representative for every peak group. Peak group means here those ones from the `xcms` grouping. The FWHM (full width at half maximum) of a peak is estimated as  $FWHM = SD * 2.35$ . The calculation of the SD, the peak is assumed as a normal distribution.

## Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

## Examples

```
library(CAMERA)
#Single sample
file <- system.file('mzdata/MM14.mzdata', package = "CAMERA")
xs <- xcmsSet(file, method="centWave", ppm=30, peakwidth=c(5,10))
an <- xsAnnotate(xs)
an <- groupFWHM(an)

#Multiple sample
library(faahKO)
xs <- group(faahko)
#With selected sample
xs.anno <- xsAnnotate(xs, sample=1)
xs.group <- groupFWHM(xs.anno)

#With automatic selection
xs.anno.auto <- xsAnnotate(xs)
xs.group.auto <- groupFWHM(xs.anno.auto)
```

---

`mm14`*Extract of marker mixture 14 LC/MS data*

---

## Description

`xcmsSet` object containing quantitated LC/MS peaks from a marker mixture. The data is a centroided subset from 117-650 *m/z* and 271-302 seconds with 134 peaks. Positive ionization mode data in `mzData` file format.

## Usage

```
data(mm14)
```

## Format

The format is:

```
Formal class 'xcmsSet' [package "xcms"] with 8 slots
  @ peaks      : num [1:83, 1:11] 117 117 118 119 136
  .. ..- attr(*, "dimnames")=List of 2
  .. .. ..$ : NULL
  .. .. ..$ : chr [1:11] "mz" "mzmin" "mzmax" "rt"
  ..@ groups   : logi[0 , 0 ]
  ..@ groupidx : list()
  ..@ phenoData:'data.frame': 1 obs. of  1 variable:
  .. ..$ class: Factor w/ 1 level "mzdata": 1
  ..@ rt       :List of 2
  .. ..$ raw   :List of 1
  .. .. ..$ : num [1:112] 270 271 271 271 272 ...
  .. ..$ corrected:List of 1
  .. .. ..$ : num [1:112] 270 271 271 271 272 ...
  ..@ filepaths: chr "mzdata/MM14.mzdata"
  ..@ profinfo :List of 2
  .. ..$ method: chr "bin"
  .. ..$ step   : num 0.1
  ..@ polarity : chr(0)
```

## Details

The corresponding raw `mzData` files are located in the `mzData` subdirectory of this package.

## Author(s)

Carsten Kuhl <ckuhl@ipb-halle.de>

## Source

<http://doi:10.1186/1471-2105-9-504>

## References

Data originally reported in "Highly sensitive feature detection for high resolution LC/MS" BMC Bioinformatics; 2008; 9:504.

---

plotEICs-methods    *Plot extracted ion chromatograms from (multiple) Pseudospectra*

---

## Description

Batch plot a list of extracted ion chromatograms to the current graphics device.

## Arguments

object	the xsAnnotate object
xraw	xcmsRaw object underlying the the xsAnnotate
maxlabel	How many m/z labels to print
sleep	seconds to pause between plotting EICs
...	other graphical parameters

## Value

None.

## Methods

```
object = "xsAnnotate" plotEICs(object, xraw, pspecIdx=1:length(object@pspectra),  
                                  maxlabel=0, sleep=0)
```

## Author(s)

Steffen Neumann, <sneumann@ipb-halle.de>

## See Also

[xsAnnotate-class](#), [png](#), [pdf](#), [postscript](#),

---

plotPsSpectrum-methods

*Plot a Pseudospectrum*

---

### Description

Plot a pseudospectrum, with the most intense peaks labelled, to the current graphics device.

### Arguments

object	the <code>xsAnnotate</code> object
pspec	ID of the pseudospectrum to print
log	Boolean, whether the $\log(\text{intensity})$ should be shown
value	Which of a peak's intensities should be used
maxlabel	How many m/z labels to print
title	Main title of the Plot
sleep	Time (in seconds) to wait between successive Spectra, if multiple <code>pspec</code> are requested.

### Value

None.

### Methods

```
object = "xsAnnotate" plotPsSpectrum(object, pspec=NULL, log=FALSE, value="maxo",
maxlabel=0, title=NULL, sleep=0)
```

### Author(s)

Steffen Neumann, <sneumann@ipb-halle.de>

### See Also

[xsAnnotate-class](#), [png](#), [pdf](#), [postscript](#),

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psDist-methods

*Distance methods for xsAnnotate*

---

### Description

The package `xcms` contains several methods for calculating a distance between two sets of peaks. the CAMERA method `psDist` is the generic wrapper to use these methods for processing two pseudospectra from two different `xsAnnotate` objects.

**Arguments**

object1	a xsAnnotate object with pseudospectra
object2	a xsAnnotate object with pseudospectra
PSpec1	index of pseudospectrum in object1
PSpec2	index of pseudospectrum in object2
method	method to use for distance calculation. See details.
...	mzabs, mzppm and parameters for the distance function.

**Details**

Different algorithms can be used by specifying them with the `method` argument. For example to use the "meanMZmatch" approach one would use: `specDist(object1, object2, pspectrum1, pspectrum2, method="meanMZmatch")`. This is also the default.

Further arguments given by `...` are passed through to the function implementing the method.

A character vector of *nicknames* for the algorithms available is returned by `getOption("BioC")$xcms$specDist`. If the nickname of a method is called "meanMZmatch", the help page for that specific method can be accessed with `?specDist.meanMZmatch`.

**Value**

mzabs	maximum absolute deviation for two matching peaks
mzppm	relative deviations in ppm for two matching peaks
symmetric	use symmetric pairwise m/z-matches only, or each match

**Methods**

**object1 = "xsAnnotate"** `specDist(object1, object2, pspectrum1, pspectrum2, method, ...)`

**Author(s)**

Joachim Kutzera, <jkutzer@ipb-halle.de>

---

xsAnnotate-class     *Class xsAnnotate, a class for annotate peak data*

---

**Description**

This class transforms a set of peaks from multiple LC/MS or GC/MS samples into a matrix of preprocessed data. It groups the peaks and does nonlinear retention time correction without internal standards. It fills in missing peak values from raw data. Lastly, it generates extracted ion chromatograms for ions of interest.

**Objects from the Class**

Objects can be created with the `xsAnnotate` constructor which gathers peaks from a set NetCDF files. Objects can also be created by calls of the form `new("xsAnnotate", ...)`.

## Slots

**annoGrp:** Assignment of mass hypotheses to correlation groups  
**annoID:** The assignemnt of peaks to the mass difference rule used  
**derivativeIons:** List with annotation result for every peak  
**formula:** Matrix containing putative sum formula (intended for future use)  
**isoID:** Matrix containing IDs and additional of all annotated isotope peaks  
**groupInfo:** (grouped) Peaktable with "into" values  
**isotopes:** List with annotated isotopid results for every peak  
**polarity:** A single string with the polarity mode of the peaks  
**pspectra:** List contains all pseudospectra with there peak IDs  
**psSamples:** List containing information with sample was sample was selecteted as representative (automatic selection)  
**ruleset:** A dataframe describing the mass difference rules used for the annotation  
**runParallel:** Flag if CAMERA runs in serial or parallel mode  
**sample:** Number of the used xcmsSet sample (beforehand sample selection)  
**xcmsSet:** The embedded xcmsSet

## Methods

**groupFWHM** signature(object = "xsAnnotate"): group the peak data after the FWHM of the retention time  
**groupCorr** signature(object = "xsAnnotate"): group the peak data after the correlation of the EICs  
**findIsotopes** signature(object = "xsAnnotate"): search for possible isotopes in the spectra  
**findAdducts** signature(object = "xsAnnotate"): search for possible adducts in the spectra  
**plotEICs** signature(object = "xsAnnotate"): plot EICs of pseudospectra

## Note

No notes yet.

## Author(s)

Carsten Kuhl, <ckuhl@ipb-halle.de>

## See Also

[xsAnnotate](#)

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xsAnnotate	<i>Constructor for a xsAnnotate object which one assigned xcmsSet object</i>
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---

### Description

This function handles the construction of xsAnnotate object. It is generate from a xcmsSet object adapt its peaktable.

### Usage

```
xsAnnotate(xs = NULL, sample=NA, nSlaves = 1)
```

### Arguments

xs	a xcmsSet object
sample	Index of the group xcmsSet sample, that is used for the EIC corelations step. For automatic selection don't set a value.
nSlaves	For parallel mode set nSlaves higher than 1, but not higher than the number of cpu cores.

### Value

A xsAnnotate object.

### Author(s)

Carsten Kuhl, <ckuhl@ipb-halle.de>

### See Also

[xsAnnotate-class](#)

### Examples

```
library(faahKO)
xs <- group(faahko)
xs.anno <- xsAnnotate(xs, sample=1)
#With automatic selection
xs.anno.autoselect <-xsAnnotate(xs)
```

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