

# Package ‘adductomicsR’

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**Type** Package

**Title** Processing of adductomic mass spectral datasets

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## Description

Processes MS2 data to identify potentially adducted peptides from spectra that has been corrected for mass drift and retention time drift and quantifies MS1 level mass spectral peaks.

**Depends** R (>= 3.6), adductData, ExperimentHub, AnnotationHub

**Imports** parallel (>= 3.3.2), data.table (>= 1.10.4), OrgMassSpecR (>= 0.4.6), foreach (>= 1.4.3), mzR (>= 2.14.0), ade4 (>= 1.7.6), rvest (>= 0.3.2), pastecs (>= 1.3.18), reshape2 (>= 1.4.2), pracma (>= 2.0.4), DT (>= 0.2), fpc (>= 2.1.10), doSNOW (>= 1.0.14), fastcluster (>= 1.1.22), RcppEigen (>= 0.3.3.3.0), bootstrap (>= 2017.2), smoother (>= 1.1), dplyr (>= 0.7.5), zoo (>= 1.8), stats (>= 3.5.0), utils (>= 3.5.0), graphics (>= 3.5.0), grDevices (>= 3.5.0), methods (>= 3.5.0), datasets (>= 3.5.0)

**License** Artistic-2.0

**biocViews** MassSpectrometry, Metabolomics, Software, ThirdPartyClient, DataImport, GUI

**RoxygenNote** 6.1.0

**Suggests** knitr (>= 1.15.1), rmarkdown (>= 1.5), Rdisop (>= 1.34.0), testthat

**VignetteBuilder** knitr

**Collate** '00AdductSpec-class.R' '00AdductQuantif-class.R'  
'IsotopicDistributionMod.R' 'adductQuant.R' 'adductSpecGen.R'  
'digestMod.R' 'dotProdMatrix.R' 'dotProdSpectra.R'  
'dynamicNoiseFilter.R' 'filterAdductTable.R' 'findPeaks.R'  
'generateTargTable.R' 'loessWrapperMod.R' 'ms2Group.R'  
'nAdjPeaks.R' 'outputPeakTable.R' 'peakIdQuant\_newMethod.R'  
'peakIntegrate.R' 'peakListId.R' 'peakRangeSum.R' 'probPeaks.R'  
'retentionCorr.R' 'rtDevModelSave.R' 'rtDevModelling.R'  
'signalGrouping.R' 'specSimPepId.R' 'spectraCreate.R'  
'truePeakTrough.R'

**BugReports** <https://github.com/JosielHayes/adductomicsR/issues>

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adductQuant

*Adduct quantification for adductomicsR*

---

### Description

reads mzXML files from a directory, corrects RT according to RT correction model and quantifies peaks.

**Usage**

```
adductQuant(nCores = NULL, targTable = NULL,
intStdRtDrift = NULL, rtDevModels = NULL,
filePaths = NULL, quantObject = NULL, indivAdduct = NULL, maxPpm = 4,
minSimScore = 0.8, spikeScans = 2, minPeakHeight = 100, maxRtDrift = 20,
maxRtWindow = 120, isoWindow = 80,
hkPeptide = "LVNEVTEFAK", gaussAlpha = 16)
```

**Arguments**

nCores	number of cores to use for analysis. If NULL then 1 core will be used.
targTable	is the fullpath to the target table. See inst/extdata/examplePeptideTargetTable.csv for an example.
intStdRtDrift	the maximum drift for the internal standard in seconds. Default = NULL and therefore no RT correction is applied to the internal standard.
rtDevModels	is the full path to the rtDevModels.RData file from rtDevModels(). default is NULL and therefore has no RT correction.
filePaths	required list of mzXML files for analysis. If all files are in the same directory these can be accessed using list.files('J:\parentdirectory\directoryContainingfiles', pattern='.mzXML', all.files=FALSE, full.names=TRUE).
quantObject	character string for filepath to an AdductQuantif object to be integrated.
indivAdduct	numeric vector of AdductQuantif targets to re-integrate
maxPpm	numeric for the maximum parts per million to be used.
minSimScore	a numeric between 0
spikeScans	a numeric for the number of scans that a spike must be seen in for it to be integrated. Default is 2.
minPeakHeight	numeric to determine the minimum height for a peak to be integrated. Default is set low at 100.
maxRtDrift	numeric for the maximum retention time drift to be considered. Default is 20.
maxRtWindow	numeric in seconds for the retention time window (total window will be 2 times this value)
isoWindow	numeric for the pepide isotope window in seconds, default is 80
hkPeptide	is capitalized string for the housekeeping peptide. The default is 'LVNEVTE-FAK' from human serum albumin.
gaussAlpha	numeric for the gaussian smoothing parameter to smooth the peaks. Default is 16. Output is an adductQuantf object saved to the working directory

**Value**

adductQuant object

**Examples**

```
## Not run:
eh = ExperimentHub();
temp = query(eh, 'adductData');
adductQuant(nCores=2, targTable=paste0(system.file("extdata",
package = "adductomicsR"),'/exampletargTable2.csv'), intStdRtDrift=30,
```

```

rtDevModels=paste0(hubCache(temp),"/rtDevModels.RData"),
filePaths=list.files(hubCache(temp),pattern=".mzXML", all.files=FALSE,
full.names=TRUE)[1],quantObject=NULL,
indivAdduct=NULL,maxPpm=5,minSimScore=0.8,spikeScans=1,
minPeakHeight=100,maxRtDrift=20,maxRtWindow=240,isoWindow=80,
hkPeptide='LVNEVTEFAK', gaussAlpha=16)

## End(Not run)

```

---

AdductQuantif-class     *AdductQuantif class The AdductQuantif class contains a peak integral matrix, peak ranges and region of integration, the isotopic distribution identified for each integrated peak and the target table of peaks integrated.*

---

## Description

AdductQuantif class The AdductQuantif class contains a peak integral matrix, peak ranges and region of integration, the isotopic distribution identified for each integrated peak and the target table of peaks integrated.

## Usage

x

## Format

An object of class NULL of length 0.

## Value

peak integral matrix, peak ranges and region of integration, the isotopic distribution identified for each integrated peak and the target table of peaks integrated and their corresponding MS1 scan isotopic patterns

## Slots

peakQuantTable a matrix containing the peak integration results and consisting of a row for each peak identified in each sample (e.g 200 samples and 50 targets 200 \* 50 = 10,000 rows)

peakIdData list of peak IDs

predIsoDist list of predicted Iso distances

targTable dataframe target table

file.paths character path to file

Parameters dataframe of specified parameters

**Methods**

- c** signature(object = "AdductQuantif"): Concatenates the spectra information.
- file.paths** signature(object = "AdductQuantif"): Accesses the file paths.
- peakQuantTable** signature(object = "AdductQuantif"): Accesses the peak quantification data as a table.
- peakIdData** signature(object = "AdductQuantif"): Accesses the ID data for the peaks.
- predIsoDist** signature(object = "AdductQuantif"): Accesses the predicted isotopic distribution.
- targTable** signature(object = "AdductQuantif"): Accesses the user provided target table.

**Author(s)**

JL Hayes <jlhayes1982@gmail.com>

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AdductSpec-class	<i>AdductSpec class</i>
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**Description**

The AdductSpec class contains dynamic noise filtered composite MS/MS spectra and their corresponding MS1 scan isotopic patterns. Produced by adductSpecGen() from mzXML files.

**Usage**

x

**Format**

An object of class NULL of length 0.

**Value**

dynamic noise filtered composite MS/MS spectra and their corresponding MS1 scan isotopic patterns

**Slots**

adductMS2spec list of adduct MS2 spectras  
 groupMS2spec list of group MS2 spectras  
 metaData dataframe of metadata from mzXML  
 aaResSeqs matrix of amino acid sequences  
 specPepMatches list of spectra peptide matches  
 specPepCompSpec list of comp spectra peptide matches  
 sumAdductType dataframe of adduct types  
 Peptides dataframe of peptides under study  
 rtDevModels list of rtDevModels  
 targetTable dataframe target table  
 file.paths character of file path  
 Parameters dataframe of parameters

## Methods

- c** signature(object = "AdductSpec"): Concatenates the spectra information.
- Specfile.paths** signature(object = "AdductSpec"): Accesses the file paths.
- adductMS2spec** signature(object = "AdductSpec"): Accesses the adduct MS2 spectral information.
- metaData** signature(object = "AdductSpec"): Accesses the scan metadata.
- Parameters** signature(object = "AdductSpec"): Accesses the user parameters.
- groupMS2spec** signature(object = "AdductSpec"): Accesses the spectral information for the grouped MS2 spectra.
- rtDevModels** signature(object = "AdductSpec"): Accesses the retention time deviation models.
- sumAdductType** signature(object = "AdductSpec"): Accesses the total adduct types.
- Peptides** signature(object = "AdductSpec"): Accesses the peptide information.
- specPepMatches** signature(object = "AdductSpec"): Accesses the peptide matches in the spectra.

## Author(s)

JL Hayes <jlhayes1982@gmail.com>

---

adductSpecGen	<i>Constructor of AdductSpec object deconvolute spectra MS2 and MS1 levels</i>
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---

## Description

reads mzXML files from a directory extracts metadata info, groups ion signals with [signalGrouping](#), filters noise dynamically [dynamicNoiseFilter](#) and identifies precursor ion charge state, by isotopic pattern.

## Usage

```
adductSpecGen(mzXmlDir=NULL, runOrder=NULL, nCores=NULL,
intStdMass=834.77692,intStdPeakList=c(290.21, 403.30, 516.38,
587.42,849.40, 884.92, 958.46, 993.97,1050.52, 1107.06, 1209.73,
1337.79,1465.85),TICfilter=10000, DNF=2, minInt=300,
minPeaks=5,intStd_MaxMedRtDrift=360, intStd_MaxPpmDev=200,minSpecEx=40,
outputPlotDir=NULL)
```

## Arguments

- |          |  |
|----------|--|
| mzXmlDir | character a full path to a directory containing either .mzXML or .mzML data  |
| runOrder | character a full path to a csv file specifying the runorder for each of the files the first column must contain the precise file name and the second column an integer representing the precise run order. |
| nCores   | numeric the number of cores to use for parallel computation. The default is to 1 core  |

intStdMass	numeric vector of the mass of the internal standard. Default is the mass of
intStdPeakList	numeric vector of masses for the internal standard peaks
TICfilter	numeric minimum total ion current of an MS/MS scan. Any MS/MS scan below this value will be filtered out (default=0).
DNF	dynamic noise filter minimum signal to noise threshold (default = 2), calculated as the ratio between the linear model predicted intensity value and the actual intensity.
minInt	numeric minimum intensity value
minPeaks	minimum number of signal peaks following dynamic noise filtration (default = 5).
intStd_MaxMedRtDrift	numeric the maximum retention time drift window (in seconds) to identify internal standard MS/MS spectrum scans (default = 600).
intStd_MaxPpmDev	numeric the maximum mass accuracy window (in ppm). to identify internal standard MS/MS spectrum scans (default = 200 ppm).
minSpecEx	numeric the minimum percentage of the total ion current explained by the internal standard fragments (default = 40). Sometime spectra are not identified due to this cutoff being set too high. If unexpected datapoints have been interpolated then reduce this value.
outputPlotDir	character string for the output directory for plots, default is working directory.

**Value**

AdductSpec object

---

digestMod *modified Digest function (from OrgMassSpecR package)*

---

**Description**

allows maxCharge to be set to calculate precursor m/z

**Usage**

```
digestMod(sequence, enzyme = "trypsin", missed = 0,
maxCharge = 8, IAA = TRUE, N15 = FALSE, custom = list())
```

**Arguments**

sequence	a character string representing the amino acid sequence.
enzyme	is the enzyme to perform in silico digestion with
missed	the maximum number of missed cleavages. Must be an integer of 0 (default) or greater. An error will result if the specified number of missed cleavages is greater than the maximum possible number of missed cleavages.
maxCharge	numeric max charge charge for predicted precursor m/z

IAA	logical. TRUE specifies iodoacetylated cysteine and FALSE specifies unmodified cysteine. Used only in determining the elemental formula, not the three letter codes.
N15	logical indicating if the nitrogen-15 isotope should be used in place of the default nitrogen-14 isotope. calculation
custom	list of custom masses

### Details

see [Digest](#) for details of further function arguments.

### Value

dataframe

### Examples

```
digestMod('MKWVTFISLLFLFSSAYSRGVFRDDAHKSEVAHRFKDLGEENFKALVLIA',
enzyme = "trypsin", missed = 0, maxCharge = 8, IAA = TRUE, N15 = FALSE,
custom = list())
```

---

dotProdMatrix      *dot product matrix calculation*

---

### Description

dot product matrix calculation

### Usage

```
dotProdMatrix(allSpectra = NULL, spectraNames = NULL, binSizeMS2 =
NULL)
```

### Arguments

allSpectra	a numeric matrix consisting of two columns 1. mass and 2. intensity
spectraNames	character names of individual spectra to compare must equal number of rows of allSpectra
binSizeMS2	numeric the MS2 bin size to bin MS2 data prior to dot product calculation (default = 0.1 Da).

### Value

a matrix of equal dimension corresponding to the number of unique spectrum names



---

dotProdSpectra      *dot product calculation*

---

### Description

hierarchical clustering (complete method see [hclust](#)). Dissimilarity metric based on 1-dot product spectral similarity. Retention time and mass groups are therefore further subdivided based on spectral similarity. If outlying mass spectra have been erroneously grouped then these will be re-classified.

### Usage

```
dotProdSpectra(adductSpectra = NULL, nCores = NULL,
minDotProdSpec = 0.8, maxGroups = 10)
```

### Arguments

adductSpectra    AdductSpec object

nCores            numeric the number of cores to use for parallel computation. The default is to use 1 core.

minDotProdSpec   numeric minimum dot product score

maxGroups        numeric maximum number of groups to include from the dendrogram.

### Value

adductSpectra AdductSpec object

---

dynamicNoiseFilter      *Dynamic Noise filtration*

---

### Description

Dynamic Noise filtration

### Usage

```
dynamicNoiseFilter(spectrum.df = NULL, DNF = 2, minPeaks = 5,
minInt = 100)
```

### Arguments

spectrum.df      a dataframe or matrix with two columns: 1. Mass/ Mass-to-charge ratio 2. Intensity

DNF                dynamic noise filter minimum signal to noise threshold (default = 2), calculated as the ratio between the linear model predicted intensity value and the actual intensity.

minPeaks         minimum number of signal peaks following dynamic noise filtration (default = 5).

minInt            integer minimum dynamic noise filter

## Details

Dynamic noise filter adapted from the method described in Xu H. and Frietas M. 'A Dynamic Noise Level Algorithm for Spectral Screening of Peptide MS/MS Spectra' 2010 BMC Bioinformatics. The function iteratively calculates linear models starting from the median value of the lower half of all intensities in the spectrum.df. The linear model is used to predict the next peak intensity and ratio is calculated between the predicted and actual intensity value. Assuming that all preceding intensities included in the linear model are noise, the signal to noise ratio between the predicted and actual values should exceed the minimum signal to noise ratio (default DNF = 2). The function continues until either the DNF value minimum has been exceeded and is also below the maxPeaks or maximum number of peaks value. As the function must necessarily calculate potentially hundreds of linear models the RcppEigen package is used to increase the speed of computation.

## Value

a list containing 3 objects: 1. Above.noise The dynamic noise filtered matrix/ dataframe 2. meta-Data a dataframe with the following column names: 1. Noise.level the noise level determined by the dynamic noise filter function. 2. IntCompSpec Total intensity composite spectrum. 3. Total-IntSNR Sparse ion signal to noise ratio (mean intensity/ stdev intensity) 4. nPeaks number of peaks in composite spectrum 3. aboveMinPeaks Logical are the number of signals above the minimum level

---

filterAdductTable	<i>filter samples with low QC and features with large missing values Removes adducts that have not been integrated with many missing values and provides QC on samples</i>
-------------------	--

---

## Description

filter samples with low QC and features with large missing values Removes adducts that have not been integrated with many missing values and provides QC on samples

## Usage

```
filterAdductTable(adductTable = NULL, percMissing = 51, HKPmass =
"575.3", quantPeptideMass = "811.7", remHKPzero = FALSE, remQuantPepzero
=FALSE, remHKPlow = FALSE, outputDir = NULL)
```

## Arguments

adductTable	character a full path to the peaktable with number of rows equal to the number of adducts from outputPeakTable() which starts with adductQuantif_peakList_
percMissing	numeric percentage threshold to remove adducts with missing values. Default is 51. It is recommended to use just over the number of samples in the smallest group of your study. 51 is used as default for a 50:50 case control study
HKPmass	numeric mass for the housekeeping peptide. Must be the same as that in the adduct table. max 2 decimal places. default= 575.3 for the LVNEVTEFAK peptide
quantPeptideMass	numeric mass for the peptide for which adducts are being quantified, Default is 811.7 for the ALVLIAFAQYLQQCPFEDHVK peptide

remHKPzero	logical if TRUE removes all samples where the housekeeping peptide is 0. default= FALSE
remQuantPepzero	logical if TRUE removes all samples where the peptide under quantification is 0. default= FALSE
remHKPlow	logical if TRUE removes all samples where the housekeeping peptide has an area less than 100000. default= TRUE. This is recommended because this peak should be large. If the HKP has been mis-identified quantification of all adducts will be affected.
outputDir	character path to results directory output is a csv file with only adducts and samples that passed filter. Remaining adducts can be quantified manually however it is recommended to rescale the quantification results and include the quantification method as a covariate in downstream analysis.

**Value**

csv file

**Examples**

```
filterAdductTable(adductTable=paste0(system.file("extdata",
package="adductomicsR"),'/example_adductQuantif_peakList.csv'), percMissing
=51,HKPMass = "575.3", quantPeptideMass = "811.7",
remHKPzero=FALSE,remQuantPepzero = FALSE, remHKPlow = FALSE, outputDir =
NULL)
```

---

findPeaks	<i>identify peaks</i>
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---

**Description**

identifies peaks in a vector of intensities.

**Usage**

```
findPeaks(x, m = 3)
```

**Arguments**

x	numeric vector of intensities.
m	number of peaks to identify

**Value**

string of peaks

**Examples**

```
findPeaks(c(200, 300,200, 200, 200 , 300, 200), m = 3)
```

---

generateTargTable	<i>Make a target table for adductomicsR quantification using specSimPep results</i>
-------------------	---

---

**Description**

Make a target table for adductomicsR quantification using specSimPep results

**Usage**

```
generateTargTable(allresultsFile = NULL, csvDir = NULL)
```

**Arguments**

`allresultsFile` character a full path to the allResults file generated by specSimPepId  
`csvDir` character a full path to a directory to save the csv file to output is a csv file called targTable.csv which can be used in the adductQuant function

**Value**

csv file

**Examples**

```
generateTargTable(paste0(system.file("extdata", package="adductomicsR"),
'/allResults_ALVLIIFAQYLQQPFEDHVK_example.csv'), csvDir=getwd())
```

---

IsotopicDistributionMod

*modified function from package OrgMassSpecR*

---

**Description**

modified function from package OrgMassSpecR

**Usage**

```
IsotopicDistributionMod(formula = list(), charge = 1)
```

**Arguments**

`formula` list of character strings representing elemental formula  
`charge` numeric for charge of the element

**Value**

dataframe of a spectrum

**Examples**

```
IsotopicDistributionMod(formula=list("CH3CH2OH", "H2O"), charge = 1)
```

---

loessWrapperMod	<i>wrapper script for loess modeling</i>
-----------------	--

---

**Description**

adapted from bisoreg package

**Usage**

```
loessWrapperMod(x, y, span.vals = seq(0.25, 1, by = 0.05),  
folds = 5)
```

**Arguments**

x	predictor values
y	response values
span.vals	values of the tuning parameter to evaluate using cross validation
folds	number of 'folds' for the cross-validation procedure

**Value**

LOESS model

**Examples**

```
loessWrapperMod (rnorm(200), rnorm(200), span.vals =  
seq(0.25, 1, by = 0.05), folds = 5)
```

---

ms2Group	<i>group MS/MS precursor masses</i>
----------	-------------------------------------

---

**Description**

hierarchically cluster ms/ms precursor scans within and across samples, according to a m/z and retention time error.

**Usage**

```
ms2Group(adductSpectra = NULL, nCores = NULL,  
maxRtDrift = NULL,  
ms1mzError = 0.1, ms2mzError = 1, dotProdClust = TRUE, minDotProd = 0.8,  
fclustMethod = "median", disMetric = "euclidean", compSpecGen = TRUE,  
adjPrecursorMZ = TRUE)
```

**Arguments**

adductSpectra	AdductSpec object
nCores	numeric the number of cores to use for parallel computation. The default is to use 1 core.
maxRtDrift	numeric for the maximum retention time drift to be considered. Default is 20.
ms1mzError	numeric maximum MS1 mass:charge error
ms2mzError	numeric maximum MS2 mass:charge error
dotProdClust	logical remove previous dot prod clustering results
minDotProd	numeric. Minimum mean dot product spectral similarity score to keep a spectrum within an MS/MS group (default = 0.8).
fclustMethod	method to use for the fclust function
disMetric	metric to use for distance in clustering
compSpecGen	logical for whether composite spectra generation is necessary
adjPrecursorMZ	logical for precursor mass:charge adjustment

**Value**

a list identical to adductSpectra containing an additional list element:

---

nAdjPeaks	<i>remove lower intensity adjacent peaks</i>
-----------	--

---

**Description**

remove lower intensity adjacent peaks

**Usage**

```
nAdjPeaks(peaksTmp = NULL, troughsTmp = NULL, peakRangeTmp = NULL)
```

**Arguments**

peaksTmp	character vector with indices of detected peaks from findPeaks
troughsTmp	character vector with indices of detected troughs from findPeaks
peakRangeTmp	matrix of the peak range data with at least 3 columns (1. mass-to-charge, 2. intensity, 3. retention time)

**Value**

peaksTmp but with lower intensity adjacent peaks between the same troughs removed

---

outputPeakTable	<i>output peak table from AdductQuantif object</i>
-----------------	--

---

**Description**

output peak table from AdductQuantif object

**Usage**

```
outputPeakTable(object = NULL, outputDir = NULL)
```

**Arguments**

object	a 'AdductQuantif' class object
outputDir	character full path to a directory to output the peak to default is the current working directory

**Value**

a peaktable with number of rows equal to the number of adducts quantified and 14 peak group information columns plus a number of columns equal to the number of samples quantified. The peak table is saved as a csv file in the output directory named: `adductQuantif_peakList_`today's date`.csv`. The peak table is also returned to the R session and can be assigned to an object.

**Examples**

```
eh = ExperimentHub();
Temp = query(eh, c("adductData", "adductQuant", "Rda"))[[1]];
outputPeakTable(object=Temp)
```

---

peakIdQuant_newMethod	<i>Adduct Peak quant</i>
-----------------------	--------------------------

---

**Description**

peak must be at least 50 percent resolved from overlapping peaks. i.e. the peaks trough must be at least 50 percent of the peak apex intensity for the peak to be considered sufficiently resolved.

**Usage**

```
peakIdQuant_newMethod(mzTmp = NULL, rtTmp = NULL,
  peakRangeRtSub = NULL, rtDevModel = NULL, isoPat = NULL,
  isoPatPred = NULL, minSimScore = 0.96, maxPpm = 4,
  gaussAlpha = 16, spikeScans = 2, minPeakHeight = 5000,
  maxRtDrift = 20, showPlots = FALSE,
  isoWindow = 10, maxGapMs1Scan = 5, intMaxPeak = FALSE)
```

**Arguments**

mzTmp	expected mass to charge of target
rtTmp	expected retention time (in minutes) of target
peakRangeRtSub	matrix MS1 scans covering entire chromatographic range within which to identify peaks of interest. Contains the following three columns column 1 = mass, column 2 = intensity, column 3 = retention time, column 4 = scan number.
rtDevModel	loess retention time deviation model for the file.
isoPat	named numeric containing the expected mass differences between isotopes for the peptide of interest.
isoPatPred	matrix output from the <a href="#">IsotopicDistribution</a> function with additional 'id' column.
minSimScore	numeric minimum dot product score for consideration (must be between 0-1, default = 0.96).
maxPpm	numeric ppm value for EIC extraction and integration.
gaussAlpha	numeric alpha value for <a href="#">smth.gaussian</a> of smoother package. If supplied gaussian smoothing will be performed (suggested value = 16).
spikeScans	numeric number of scans that constitute a spike.
minPeakHeight	numeric minimum peak height, default 5000
maxRtDrift	numeric maximum retention time drift, default 20 secs
showPlots	boolean for whether plots should be produced
isoWindow	numeric isowindow size, default 10
maxGapMs1Scan	maximum MS1 scan gap, default 5
intMaxPeak	boolean integrate maximum peak

**Value**

list

---

peakIntegrate	<i>integrate a peak from a peak table with peak start and peak end retention times</i>
---------------	--

---

**Description**

integrate a peak from a peak table with peak start and peak end retention times

**Usage**

```
peakIntegrate(peakTable = NULL, peakStart = NULL,
              peakEnd = NULL, expMass = NULL,
              expRt = NULL)
```



**Arguments**

peakTable	a table of at least 5 columns: <ol style="list-style-type: none"> <li>1. mass-to-charge.</li> <li>2. intensity</li> <li>3. adjusted retention time</li> <li>4. raw retention time</li> <li>5. scan numbers</li> </ol>
peakStart	retention time for peak start (in seconds).
peakEnd	retention time for peak end (in seconds).
expMass	expected mass-to-charge of target.
expRt	expected retention time of target (in seconds).

**Value**

list with peak and peak table

---

peakListId	<i>peak list Identification</i>
------------	---------------------------------

---

**Description**

peak list Identification

**Usage**

```
peakListId(adductSpectra = NULL, peakList = c(290.21, 403.3,
516.38, 587.42, 849.4, 884.92, 958.46, 993.97, 1050.52, 1107.06,
1209.73, 1337.79,
1465.85), exPeakMass = 834.7769, frag.delta = 1, minPeaksId = 7,
minSpecEx = 50, maxRtDrift = 360, maxPpmDev = 200, allScans = TRUE,
closestMassByFile = TRUE, outputPlotDir = NULL)
```

**Arguments**

adductSpectra	AdductSpec object param peakList numeric vector of peak masses param ex-PeakMass numeric internal standard peak mass
peakList	numeric vector of peak masses
exPeakMass	numeric mass of explained peak
frag.delta	integer delta mass accuracy difference.
minPeaksId	numeric minimum number of peaks IDed
minSpecEx	numeric the minimum percentage of the total ion current explained by the internal standard fragments (default = 40). Sometime spectra are not identified due to this cutoff being set too high. If unexpected datapoints have been interpolated then reduce this value.

maxRtDrift	numeric the maximum retention time drift (in seconds) to identify MS/MS spectrum scans (default = 360). param outputPlotDir character string of output directory (e.g. internal standard IAA-T3 peak list = peakList= c(290.21, 403.30, 516.38, 587.42, 849.40, 884.92, 958.46, 993.97, 1050.52, 1107.06, 1209.73, 1337.79, 1465.85))
maxPpmDev	numeric ppm deviation
allScans	boolean include all scans
closestMassByFile	boolean closest mass in files
outputPlotDir	character string for output plot directory

**Value**

dataframe peak list

---

peakRangeSum	<i>raw eic signal intensity and mass summation and spike removal.</i>
--------------	---

---

**Description**

raw eic signal intensity and mass summation and spike removal.

**Usage**

```
peakRangeSum(peakRange = NULL, spikeScans = 2, rtDevModel = NULL,
gaussAlpha = NULL,
maxEmptyRt = 7)
```

**Arguments**

peakRange	matrix consisting of 5 columns: <ol style="list-style-type: none"> <li>1. mass-to-charge values</li> <li>2. intensity</li> <li>3. retention time (in seconds)</li> <li>4. scan number</li> </ol>
spikeScans	numeric number of scans <= a spike. Any peaks <= this value will be removed (default = 2).= FALSE
rtDevModel	loess model to correct retention times.
gaussAlpha	numeric alpha value for <a href="#">smth.gaussian</a> of smoother package. If supplied gaussian smoothing will be performed (suggested value = 16).
maxEmptyRt	numeric maximum size of empty retention time beyond which missing values will be zero-filled

**Value**

matrix with masses and intensities summed by retention time and retention time correction based on the loess model supplied, the matrix has spikes removed (consecutive non-zero intensity values  $\leq$  spikeScans in length), empty time segments are zero filled ( $> 3$  seconds), optionally gaussian smoothed using the `linksmth.gaussian` function of the `smoother` package and is also subset based on the minimum and maximum retention time windows supplied (`rtWin`). The returned matrix consists of 5 columns:

1. average mass-to-charge values by unique retention time in supplied `peakRange` table
2. maximum intensity values by unique retention time in supplied `peakRange` table
3. loess model corrected retention times
4. original retention time values
5. scan number by unique retention time in supplied `peakRange` table

---

probPeaks

*potentially problematic peak identification*

---

**Description**

potentially problematic peak identification

**Usage**

```
probPeaks(object = NULL, nTimesMad = 3,
  metrics = c("nMadDotProdDistN",
    "nMadSkewness", "nMadKurtosis", "nMadRtGroupDev",
    "nMadPeakArea", "duplicates"))
```

**Arguments**

<code>object</code>	an 'AdductQuantif' class object
<code>nTimesMad</code>	numeric number of median absolute deviations to identify potential problem peaks.
<code>metrics</code>	character string column names of metrics with which to identify potential problem peaks or a list with individual <code>nTimesMad</code> arguments and with list element names corresponding to column names of metrics.
<code>...</code>	further arguments to <code>mad</code>

**Value**

'AdductQuantif' class object

---

retentionCorr	<i>loess-based retention time deviation correction</i>
---------------	--

---

### Description

loess-based retention time deviation correction

### Usage

```
retentionCorr(adductSpectra = NULL,
              smoothingSpan = NULL, nMissing = 1,
              nExtra = 1, folds = 7, outputFileDir = NULL)
```

### Arguments

adductSpectra	AdductSpec object
smoothingSpan	numeric. fixed smoothing span, argument to loess. If argument is not supplied then optimal smoothing span is calculated for each file separately.
nMissing	numeric. maximum number of missing files for a MS/MS scan group to be utilized in the loess retention time deviation model. Roughly 15 percent missing values is a good starting point (e.g. nMissing=10 for 68 samples).
nExtra	numeric maximum number of extra scans above the total number of files for a MS/MS scan group to be utilized in the loess retention time deviation model. If a MS/MS scan group consists of many scans far in excess of the number of files then potentially MS/MS scans from large tailing peaks or isobars may be erroneously grouped together and used to adjust retention time incorrectly.
folds	numeric. number of cross validation steps to perform in identifying optimal smoothing span parameter (see: bisoreg package for more details)
outputFileDir	character full path to a directory to save the output images

### Value

LOESS RT models as adductSpectra AdductSpec object

---

rtDevModelling	<i>MS/MS spectrum grouping and retention time deviation modelling for adductomicsR</i>
----------------	--

---

### Description

MS/MS spectrum grouping and retention time deviation modelling for adductomicsR

**Usage**

```
rtDevModelling(MS2Dir = NULL, runOrder = NULL,
nCores = NULL, TICfilter = 0,
intStdPeakList=c(290.21, 403.30, 516.38, 587.42,849.40, 884.92, 958.46,
993.97,1050.52, 1107.06, 1209.73, 1337.79,1465.85),
intStdMass = 834.77692, intStd_MaxMedRtDrift = 600, intStd_MaxPpmDev = 200,
minSpecEx = 40,
minDotProd = 0.8, percMissing = 15, percExtra = 100, smoothingSpan = 0.8,
saveRtDev = 1, outputPlotDir = NULL)
```

**Arguments**

MS2Dir	character a full path to a directory containing either .mzXML or .mzML data
runOrder	character a full path to a csv file specifying the runorder for each of the files the first column must contain the precise file name and the second column an integer representing the precise run order.
nCores	numeric the number of cores to use for parallel computation. The default is to 1 core.
TICfilter	numeric minimum total ion current of an MS/MS scan. Any MS/MS scan below this value will be filtered out (default=0).
intStdPeakList	character a comma separated list of expected fragment ions for the internal standard spectrum (no white space).
intStdMass	numeric expected mass-to-charge ratio of internal standard precursor (default = 834.77692).
intStd_MaxMedRtDrift	numeric the maximum retention time drift window (in seconds) to identify internal standard MS/MS spectrum scans (default = 600).
intStd_MaxPpmDev	numeric the maximum mass accuracy window (in ppm) to identify internal standard MS/MS spectrum scans (default = 200 ppm).
minSpecEx	numeric the minimum percentage of the total ion current explained by the internal standard fragments (default = 40). Sometimes spectra are not identified due to this cutoff being set too high. If unexpected datapoints have been interpolated then reduce this value.
minDotProd	numeric. Minimum mean dot product spectral similarity score to keep a spectrum within an MS/MS group (default = 0.8).
percMissing	numeric. percentage of missing files for a MS/MS scan group to be utilized in the loess retention time deviation model. Roughly 15 percent missing values (default = 15%) is a good starting point (e.g. nMissing=10 for 68 samples).
percExtra	numeric percentage of extra scans above the total number of files for a MS/MS scan group to be utilized in the loess retention time deviation model. If a MS/MS scan group consists of many scans far in excess of the number of files then potentially MS/MS scans from large tailing peaks or isobars may be erroneously grouped together and used to adjust retention time incorrectly (default = 100% i.e. the peak group can only have one scan per file, this value can be increased if two or more consecutive scans for example can be considered).
smoothingSpan	numeric. fixed smoothing span, argument to <a href="#">loess</a> . If argument is not supplied then optimal smoothing span is calculated for each file seperately using 7-fold CV.

saveRtDev integer (default = 1) should just the retention time deviation model be saved (TRUE = 1) or the AdductSpec class object (FALSE = 0) as .RData workspace files.

outputPlotDir character (default = NULL) output directory for plots.

### Value

LOESS RT models as adductSpectra AdductSpec object

### Examples

```
eh = ExperimentHub();
temp = query(eh, 'adductData');
temp[['EH2061']]; #first mzXML file
file.rename(cache(temp["EH2061"]), file.path(hubCache(temp),
'data42_21221_2.mzXML'));
rtDevModelling(MS2Dir=hubCache(temp),nCores=2,runOrder=paste0(
system.file("extdata",package="adductomicsR"),
'/runOrder2.csv'), intStdPeakList=c(290.21, 403.30, 516.38,
587.42,849.40, 884.92, 958.46, 993.97,1050.52, 1107.06,1209.73,
1337.79,1465.85))
```

---

rtDevModelSave	<i>extract and save retention time deviation models from adductSpec class object</i>
----------------	--

---

### Description

extract and save retention time deviation models from adductSpec class object

### Usage

```
rtDevModelSave(object = NULL, outputDir = NULL)
```

### Arguments

object an 'adductSpec' class object or full path to a .RData file of the 'adductSpec' object

outputDir character full path to a directory to save the .RData file (defaults to the current working directory if unsupplied).

### Value

save a .RData file containing the rt deviation models and returns to the workspace.

---

signalGrouping	<i>Signal grouping</i>
----------------	------------------------

---

**Description**

Euclidean distances between m/z signals are hierarchically clustering using the average method and the composite spectrum groups determined by an absolute error cutoff

**Usage**

```
signalGrouping(spectrum.df = NULL, mzError = 0.8, minPeaks = 5)
```

**Arguments**

spectrum.df	a dataframe or matrix with two or more columns: 1. Mass/ Mass-to-charge ratio 2. Intensity
mzError	interpeak absolute m/z error for signal grouping (Default = 0.001)
minPeaks	numeric minimum number of peaks to integrate

**Value**

dataframe of m/z grouped signals, the m/z values of the input dataframe/ matrix peak groups are averaged and the signal intensities summed.

---

specSimPepId	<i>spectral similarity based adducted peptide identification for adductomicsR</i>
--------------	---

---

**Description**

spectral similarity based adducted peptide identification for adductomicsR

**Usage**

```
specSimPepId(MS2Dir=NULL, nCores=NULL,
rtDevModels=NULL, topIons=100, topIntIt=5, minDotProd=0.8, precCh=3,
minSNR=3, minRt=20, maxRt=35, minIdScore=0.4, minFixed=3, minMz=750,
maxMz=1000, modelSpec=c('ALVLIIFAQYLQQPFEDHVK', 'RHPYFYAPELLFFAK'),
groupMzabs=0.005, groupRtDev=0.5, possFormMzabs=0.01,
minMeanSpecSim=0.7, idPossForm=0, outputPlotDir= NULL)
```

**Arguments**

MS2Dir	character a full path to a directory containing either .mzXML or .mzML data
nCores	numeric the number of cores to use for parallel computation. The default is to use 1 core.
rtDevModels	a list object or a full path to an RData file containing the retention time deviation models for the dataset.

topIons	numeric the number of most intense ions to consider for the basepeak to fragment mass difference calculation (default = 100). Larger values will slightly increase computation time, however when the modified/variable ions happen to be low abundance this value should be set high to ensure these fragment ions are considered.
topIntIt	numeric the number of most intense peaks to calculate the peak to peak mass differences from (default = 5 i.e. the base peak and the next 4 most intense ions greater than 10 daltons in mass from one another will be considered the multiple iterations increase computation time but in the case that the peptide spectrum is contaminated/chimeric or the variable ions are of lower intensity this parameter should be increased).
minDotProd	numeric minimum dot product similarity score (cosine) between the model spectra's variable ions and the corresponding intensities of the basepeak to fragment ion mass differences identified in the experimental spectrum scans (default = 0.8). Low values will greatly increase the potential for false positive peptide annotations.
precCh	integer charge state of precursors (default = 3).
minSNR	numeric the minimum signal to noise ratio for a fragment ion to be considered. The noise level for each fixed or variable ion is calculated by taking the median of the bottom half of ion intensities within the locality of the fragment ion. The locality is defined as within +/- 100 Daltons of the fragment ion.
minRt	numeric the minimum retention time (in minutes) within which to identify peptide spectra (default=20).
maxRt	numeric the maximum retention time (in minutes) within which to identify peptide spectra (default=45).
minIdScore	numeric the minimum identification score this is an average score of all of the 7 scoring metrics (default=0.4).
minFixed	numeric the minimum number of fixed fragment ions that must have been identified in a spectrum for it to be considered.
minMz	numeric the minimum mass-to-charge ratio of a precursor ion.
maxMz	numeric the maximum mass-to-charge ration of a precursor ion.
modelSpec	<p>character full path to a model spectrum file (.csv). Alternatively built in model tables (in the extdata directory) can be used by just supplying the one letter amino acid code for the peptide (currently available are: "ALVLIIFAQYLQQCPFED-HVK" and "RHPYFYAPELLFFAK"). If supplying a custom table it must consist of the following mandatory columns ("mass", "intensity", "ionType" and "fixed or variable").</p> <ol style="list-style-type: none"> <li>1. mass - m/z of fragment ions.</li> <li>2. intensity - intensity of fragment ions can be either relative or absolute intensity</li> <li>3. ionType - the identity of the B and Y fragments can optionally added here (e.g. [b6]2+, [y2]1+) or if not known such as for mixed disulfates this column can also contain empty fields.</li> <li>4. fixed or variable - this column contains whether a fragment ion should be considered either 'fixed', 'variable' (i.e. modified) or if it is an empty field it will not be considered.</li> </ol>

As default the following model spectra are included in the external data directory of the adductomics package:



	<ol style="list-style-type: none"> <li>1. 'modelSpectrum_ALVLIAFAQYLQQCPFEDHVK.csv'</li> <li>2. 'modelSpectrum_RHPYFYAPELLFFAK.csv'</li> </ol>
groupMzabs	numeric after hierarchical clustering of the spectra the dendrogram will be cut at this height (in Da) generating the mass groups.
groupRtDev	numeric after hierarchical clustering of the spectra the dendrogram will be cut at this height (in minutes) generating the retention time groups.
possFormMzabs	numeric the maximum absolute mass difference for matching adduct mass to possible formulae.
minMeanSpecSim	numeric minimum mean dot product similarity score (cosine) between the spectra of a group identified by hierarchical clustering. This parameter is set to prevent erroneous clustering of dissimilar spectra (default = 0.7).
idPossForm	integer if = 1 then the average adduct masses of each spectrum group will be matched against an internal database of possible formula to generate hypotheses. The default 0 mean this will not take place as the computation is potentially time consuming.
outputPlotDir	character (default = NULL) output directory for plots.

**Value**

dataframe of putative adducts

**Examples**

```
## Not run:
eh = ExperimentHub();
temp = query(eh, 'adductData');
specSimPepId(MS2Dir=hubCache(temp), nCores=2,
rtDevModels=paste0(hubCache(temp), '/rtDevModels.RData'))

## End(Not run)
```

---

spectraCreate

*Deconvolute both MS2 and MS1 levels scans adductomics*

---

**Description**

Deconvolute both MS2 and MS1 levels scans adductomics

**Usage**

```
spectraCreate(MS2file = NULL, TICfilter = 10000, DNF = 2, minInt =
100, minPeaks = 5)
```

**Arguments**

MS2file	character vector of mzXML file locations
TICfilter	numeric minimum total ion current of an MS/MS scan. Any MS/MS scan below this value will be filtered out (default=0).

DNF	dynamic noise filter minimum signal to noise threshold (default = 2), calculated as the ratio between the linear model predicted intensity value and the actual intensity.
minInt	numeric minimum intensity value
minPeaks	minimum number of signal peaks following dynamic noise filtration (default = 5).

**Value**

list of MS2 spectra

---

truePeakTrough	<i>true peak and trough detection</i>
----------------	---------------------------------------

---

**Description**

true peak and trough detection

**Usage**

```
truePeakTrough(peaksTmp = NULL, troughsTmp = NULL, peakRangeTmp =
NULL, minRes = 50, lrRes = FALSE)
```

**Arguments**

peaksTmp	character vector with indices of detected peaks from findPeaks
troughsTmp	character vector with indices of detected troughs from findPeaks
peakRangeTmp	matrix of the peak range data with at least 3 columns (1. mass-to-charge, 2. intensity, 3. retention time)
minRes	numeric minimum percentage left/right resolution
lrRes	logical if true both the left and right troughs must be above the minRes else the peak will be discounted. (default = FALSE i.e. if only the left or right trough is less than minRes then the peak will be retained)

**Value**

a named numeric of both the peaks and troughs fitting the criteria.

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