# Package 'lcmsPlot'

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**Type** Package

**Title** Comprehensive Liquid Chromatography-Mass Spectrometry (LC-MS) data visualisation package

**Version** 1.0.0

**Description** lcmsPlot is an R package designed for visualising Liquid Chromatography-Mass Spectrometry (LC-MS) data with publication-ready high-quality plots.
The package enables users to generate and customise chromatograms, mass traces, spectra, and more with fine-tuned aesthetics and annotation options.

**License** GPL-3

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`lcmsPlot-package` *lcmsPlot: Comprehensive Liquid Chromatography-Mass Spectrometry (LC-MS) data visualisation package*

---

## Description

lcmsPlot offers flexible and powerful visualisation of raw and processed LC-MS data. It supports chromatograms, mass spectra, and other plot types, combining high performance with broad customisation. Designed for large datasets, it facilitates assessment of signal quality, feature comparison across samples, and generation of publication-ready figures.

## Details

### Main features

- Unified, intuitive, and ggplot2-like interface.
- Plot from different types of sources, such as raw files (e.g. mzML), XCMS objects (e.g., `XCMSnExp`), or Compound Discoverer results.
- Plot chromatograms, mass traces, spectra, and more.

- Combine different types of LC-MS data plots (e.g. chromatograms with spectra).
- Arrange plots in different ways according to metadata factors.
- Large-scale plotting through iterative batching.

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## See Also

Useful links:

- https://github.com/computational-metabolomics/lcmsPlot
- Report bugs at https://github.com/computational-metabolomics/lcmsPlot/issues

---

# +,lcmsPlotClass,function-method

*Apply a function to an* `lcmsPlotClass` *object using the infix* `+` *operator*

---

## Description

This provides a convenient infix style for applying transformations to `lcmsPlotClass` objects.

## Usage

```
## S4 method for signature 'lcmsPlotClass,function'
e1 + e2
```

## Arguments

| | |
|---|---|
| `e1` | An instance of class `lcmsPlotClass`. |
| `e2` | A function that takes an `lcmsPlotClass` object and returns another. |

## Value

An instance of class `lcmsPlotClass`.

## Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

p <- lcmsPlot(raw_files) +
  lp_chromatogram(aggregation_fun = "max") +
  lp_arrange(group_by = "sample_id") +
  lp_legend(position = "bottom") +
  lp_labels(legend = "Sample")
```

---

# convert_rt_to_seconds *Convert retention times to seconds*

---

## Description

Convert retention time columns from minutes to seconds.

## Usage

```
convert_rt_to_seconds(peaks)
```

## Arguments

| | |
|---|---|
| peaks | A tibble containing rt, rtmin, and rtmax columns in minutes. |

## Value

peaks with retention time columns converted to seconds.

---

# create_bpc_tic *Create a base peak or total ion current chromatogram*

---

## Description

Create a base peak or total ion current chromatogram

## Usage

```
create_bpc_tic(raw_data, aggregation_fun, rt_adjusted = NULL)
```

### Arguments

| | |
|---|---|
| raw_data | An instance of class MsRawReader. |
| aggregation_fun | A function indicating the aggregation method. One of "sum" or "max". |
| rt_adjusted | A numeric vector representing the adjusted RT values. If NULL it will use the raw RT values. |

### Value

A list with one tibble containing the chromatograms with columns rt and intensity.

---

## create_chromatogram *Create an extracted ion chromatogram*

---

### Description

Create an extracted ion chromatogram

### Usage

```
create_chromatogram(
  raw_data,
  mz_range,
  rt_range,
  ms_level = 1,
  fill_gaps = FALSE,
  adjusted_rt = NULL
)
```

### Arguments

| | |
|---|---|
| raw_data | An instance of class MsRawReader. |
| mz_range | A numeric vector indicating the m/z range. |
| rt_range | A numeric vector indicating the RT range. |
| ms_level | A numeric value indicating the MS level of the scans to consider. |
| fill_gaps | A logical indicating whether to fill gaps between scans with zeros. |
| adjusted_rt | A tibble containing the raw and adjusted RTs. |

### Value

A list with two data frames (chromatograms and mass_traces) containing the chromatograms with columns rt and intensity and mass traces with columns rt and mz.

`create_chromatograms` *Create chromatogram data from a data object*

## Description

Dispatches to the appropriate implementation based on the type of `data_obj` and `features`. Returns a named list with slots to be assigned onto `lcmsPlotDataContainer`.

## Usage

```
create_chromatograms(data_obj, metadata, options, features)

## S4 method for signature 'DBIConnection,data.frame,list,NULL'
create_chromatograms(data_obj, metadata, options, features)

## S4 method for signature 'XcmsRawList,data.frame,list,NULL'
create_chromatograms(data_obj, metadata, options, features)

## S4 method for signature 'XcmsRawList,data.frame,list,ANY'
create_chromatograms(data_obj, metadata, options, features)

## S4 method for signature 'MChromatograms,data.frame,list,NULL'
create_chromatograms(data_obj, metadata, options, features)

## S4 method for signature 'XChromatogram,data.frame,list,NULL'
create_chromatograms(data_obj, metadata, options, features)

## S4 method for signature 'XChromatograms,data.frame,list,NULL'
create_chromatograms(data_obj, metadata, options, features)

## S4 method for signature 'ANY,data.frame,list,NULL'
create_chromatograms(data_obj, metadata, options, features)

## S4 method for signature 'ANY,data.frame,list,character'
create_chromatograms(data_obj, metadata, options, features)

## S4 method for signature 'ANY,data.frame,list,ANY'
create_chromatograms(data_obj, metadata, options, features)
```

## Arguments

| | |
|---|---|
| `data_obj` | The data object (e.g. `XCMSnExp`, `DBIConnection`, `character`). |
| `metadata` | A `tibble` of sample metadata. |
| `options` | A `list` of plot options. |
| `features` | `NULL`, a `character` vector of feature IDs, or a `matrix`/`tibble` of feature ranges. |

### Value

A named list with elements chromatograms, mass_traces, feature_metadata, and detected_peaks.

---

create_data_container_from_obj *Create an instance of class* lcmsPlotDataContainer *from a data object*

---

### Description

The create_data_container_from_obj function creates an instance of class lcmsPlotDataContainer given a data object. See lcmsPlotDataContainer for more information about the supported data objects.

### Usage

```
create_data_container_from_obj(data_obj, sample_id_column, metadata)
```

### Arguments

| | |
|---|---|
| data_obj | The data object (see lcmsPlotDataContainer). |
| sample_id_column | A character value indicating the sample ID column. |
| metadata | A data.frame containing the samples metadata in case it is not provided in the dataset object. |

### Value

An instance of class lcmsPlotDataContainer. The object contains the input data and the standardised metadata.

### Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

data_container <- create_data_container_from_obj(
  data_obj = raw_files,
  sample_id_column = NULL,
  metadata = NULL
)
```

## create_intensity_map *Create an instance of class* lcmsPlotDataContainer *from an intensity map*

### Description

This function creates an lcmsPlotDataContainer object from an intensity map which is a point-cloud of m/z and RT points.

### Usage

```
create_intensity_map(obj, options)

## S4 method for signature 'lcmsPlotDataContainer,list'
create_intensity_map(obj, options)
```

### Arguments

| | |
|---|---|
| obj | An instance of class lcmsPlotDataContainer. |
| options | A list representing the plot object's options. |

### Value

An instance of class lcmsPlotDataContainer with the created intensity map, a tibble with columns mz and rt.

## create_peak_density *Create an instance of class* lcmsPlotDataContainer *from a peak density dataset.*

### Description

This function creates an lcmsPlotDataContainer object from a dataset that contains peak density data for each feature (i.e., the kernel density of peak apex RTs across samples for each m/z bin), mirroring the algorithm used by xcms::plotChromPeakDensity().

### Usage

```
create_peak_density(obj, options)

## S4 method for signature 'lcmsPlotDataContainer,list'
create_peak_density(obj, options)
```

### Arguments

| | |
|---|---|
| obj | An instance of class lcmsPlotDataContainer. |
| options | A list representing the plot object's options. |

### Value

An instance of class lcmsPlotDataContainer with the created peak density dataset. The peak_density slot is a tibble with columns rt, density, rtmin, rtmax, data_type ("density" or "rect"), mzmin, mzmax, metadata_index, and feature_metadata_id.

---

## create_rt_diff *Create an instance of class* lcmsPlotDataContainer *from an RT adjustment dataset*

---

### Description

This function creates an lcmsPlotDataContainer object from a dataset that contains the data to generate RT raw vs adjusted plots.

### Usage

```
create_rt_diff(obj, options)

## S4 method for signature 'lcmsPlotDataContainer,list'
create_rt_diff(obj, options)
```

### Arguments

| | |
|---|---|
| obj | An instance of class lcmsPlotDataContainer. |
| options | A list representing the plot object's options. |

### Value

An instance of class lcmsPlotDataContainer with the created RT adjustment dataset, a tibble with columns rt_raw, rt_adj, and diff.

## create_spectra *Create an instance of class* lcmsPlotDataContainer *from spectra*

### Description

Create an instance of class lcmsPlotDataContainer from spectra

### Usage

```
create_spectra(obj, options)

## S4 method for signature 'lcmsPlotDataContainer,list'
create_spectra(obj, options)
```

### Arguments

| | |
|---|---|
| obj | An instance of class lcmsPlotDataContainer. |
| options | A list representing the plot object's options. |

### Value

An lcmsPlotDataContainer object with the created spectra.

## create_spectra_for_sample *Create spectra for a single sample*

### Description

Create spectra for a single sample

### Usage

```
create_spectra_for_sample(
  raw_obj,
  detected_peaks,
  sample_metadata,
  options,
  rt_range = NULL
)
```

### Arguments

| | |
|---|---|
| raw_obj | An instance of class mzR. |
| detected_peaks | A tibble containing the detected peaks to consider. Only applicable for modes "closest_apex" and "across_peak". |
| sample_metadata | A tibble containing the sample's metadata. |
| options | A list representing the plot object's options. |
| rt_range | A numeric value indicating the RT range to apply to the detected peaks. |

### Value

A tibble representing spectra with columns mz, intensity, and rt.

---

## create_spectrum_from_closest_scan_to_rt

*Create a spectrum of the closest scan to the specified RT*

---

### Description

Create a spectrum of the closest scan to the specified RT

### Usage

```
create_spectrum_from_closest_scan_to_rt(raw_data, rt, ms_level)
```

### Arguments

| | |
|---|---|
| raw_data | An instance of class MsRawReader. |
| rt | A numeric value indicating the RT to consider. |
| ms_level | A numeric value indicating the MS level of the scans. |

### Value

A tibble representing a spectrum with columns mz, intensity, and rt.

---

`create_spectrum_from_scan_index`
*Create a spectrum of the specified scan*

---

## Description

Create a spectrum of the specified scan

## Usage

```
create_spectrum_from_scan_index(raw_data, sample_metadata, scan_index)
```

## Arguments

| | |
|---|---|
| `raw_data` | An instance of class `MsRawReader`. |
| `sample_metadata` | A `tibble` indicating the sample metadata. |
| `scan_index` | A `numeric` value indicating the scan index. |

## Value

A `tibble` representing a spectrum with columns `mz`, `intensity`, and `rt`.

---

`create_total_ion_current`
*Create an instance of class* `lcmsPlotDataContainer` *from total ion current (TIC) dataset*

---

## Description

This function creates an `lcmsPlotDataContainer` object from a dataset that contains TIC values for each sample.

## Usage

```
create_total_ion_current(obj, options)

## S4 method for signature 'lcmsPlotDataContainer,list'
create_total_ion_current(obj, options)
```

## Arguments

| | |
|---|---|
| `obj` | An instance of class `lcmsPlotDataContainer`. |
| `options` | A `list` representing the plot object's options. |

### Value

An instance of class `lcmsPlotDataContainer` with the created RT adjustment dataset, a `tibble` with columns `sample_id` and `intensity`.

---

`create_xcms_raw_list` *Create an* `XcmsRawList` *from raw LC-MS files*

---

### Description

Reads one or more raw MS files using `xcms::xcmsRaw()` and wraps the results in an `XcmsRawList`. Optionally runs the reads in parallel via `BiocParallel`.

### Usage

```
create_xcms_raw_list(
  paths,
  profstep = 1,
  mslevel = NULL,
  scanrange = NULL,
  BPPARAM = NULL
)
```

### Arguments

| | |
|---|---|
| `paths` | A `character` vector of file paths to raw MS files (e.g. `.mzML`, `.mzXML`, `.CDF`). |
| `profstep` | A `numeric` value passed to `xcms::xcmsRaw()` controlling the mass bin size used to build the profile matrix. Defaults to `0`, which skips profile matrix generation. Only set this to a positive value if you need the profile matrix for peak detection. |
| `mslevel` | A `numeric` value passed to `xcms::xcmsRaw()` indicating which MS level to load. `NULL` loads all levels. Defaults to `NULL`. |
| `scanrange` | A length-2 `integer` vector passed to `xcms::xcmsRaw()` restricting the range of scans to read. `NULL` reads all scans. Defaults to `NULL`. |
| `BPPARAM` | A `BiocParallelParam` object controlling parallel execution. When `NULL` (default) files are read sequentially. |

### Value

An `XcmsRawList` object with one `xcmsRaw` element per file.

### Examples

```
paths <- dir(
    system.file("cdf", package = "faahKO"),
    full.names = TRUE,
    recursive = TRUE
)[1:3]
xl <- create_xcms_raw_list(paths)
```

## default_options *Get the default options*

### Description

`default_options()` returns a list of default settings used throughout the package. These options control aspects such as sample metadata handling, plotting, chromatogram and spectra display, and general visualization parameters.

### Usage

```
default_options()
```

### Value

A named `list` containing all default options.

## detect_separator *Detect field separator from file extension*

### Description

Determines the column separator to use when reading a delimited text file based on its file extension. Files ending in `.tsv` (case-insensitive) are assumed to be tab-delimited; all others default to comma-delimited.

### Usage

```
detect_separator(path)
```

### Arguments

| | |
|---|---|
| `path` | A `character` value indicating the path to the file whose separator should be detected. |

### Value

A `character` value indicating the field separator: `"\t"` for TSV files, otherwise `","`.

## ExternalDataSource-class *External data source wrapper*

### Description

An S4 class representing an external data source such as MZmine. This class acts as an adapter for external data sources by converting data to a common format (XCMS).

### Slots

`name` A `character` value indicating the name of the data source.

`metadata` A `data.frame` representing the sample metadata.

`peaks` A `data.frame` representing the exported peaks.

## field *Construct a field specification for data frame validation*

### Description

Construct a field specification for data frame validation

### Usage

```
field(name, type = NULL, required = TRUE)
```

### Arguments

| | |
|---|---|
| `name` | A `character` value giving the column name. |
| `type` | A function used to check the column's type (e.g. `is.numeric`). If `NULL`, no type check is performed. |
| `required` | A `logical` value indicating whether the column must be present. Defaults to `TRUE`. |

### Value

A named `list` with elements `name`, `type`, and `required`.

## get_adjusted_rts *Retrieve raw and adjusted retention times from an xcms object*

### Description

Extracts raw and adjusted retention times from an xcms-processed object when retention time correction has been performed.

### Usage

```
get_adjusted_rts(obj)
```

### Arguments

| | |
|---|---|
| obj | An object potentially containing xcms-processed LC-MS data. |

### Details

If the object is not an xcms processed data object, or if retention time adjustment has not been applied, the function returns NULL.

### Value

A tibble with one row per scan, containing:

**file_index** Index of the originating raw data file.

**raw_rt** Original (unadjusted) retention time.

**adj_rt** Adjusted retention time after RT correction.

If no adjusted retention times are available, NULL is returned.

## get_detected_peaks *Get the detected peaks from the data object (e.g. XCMSnExp)*

### Description

get_detected_peaks() is an internal helper that standardises extraction of detected chromatographic peaks across different object types commonly used in LC-MS workflows.

## Usage

```
get_detected_peaks(obj)

## S3 method for class 'character'
get_detected_peaks(obj)

## S3 method for class 'XCMSnExp'
get_detected_peaks(obj)

## S3 method for class 'MsExperiment'
get_detected_peaks(obj)

## S3 method for class 'MChromatograms'
get_detected_peaks(obj)

## S3 method for class 'XChromatograms'
get_detected_peaks(obj)

## S3 method for class 'XChromatogram'
get_detected_peaks(obj)

## S3 method for class 'XcmsRawList'
get_detected_peaks(obj)

## S3 method for class 'ExternalDataSource'
get_detected_peaks(obj)
```

## Arguments

| | |
|---|---|
| obj | A data object containing or representing samples. |

## Details

Supported inputs behave as follows:

- character – Assumed to represent sample paths; no peak detection information is available. Always returns NULL.
- XCMSnExp and MsExperiment – If the object is processed and contains chromatographic peaks, extracts xcms::chromPeaks(obj) and returns it as a data frame. The column sample is renamed to sample_index.

When peaks are not found or the object is not processed, NULL is returned.

## Value

A tibble of detected peaks (one row per peak), or NULL if no peaks are available.

## get_features *Get the feature data (m/z and RT ranges) for a set of features*

### Description

Get the feature data (m/z and RT ranges) for a set of features

### Usage

```
get_features(
  options,
  sample_metadata,
  grouped_peaks = NULL,
  full_rt_range = NULL
)
```

### Arguments

| | |
|---|---|
| options | The plot object's options. This contains the input features. |
| sample_metadata | The sample's metadata. |
| grouped_peaks | The grouped peaks to use as input features. |
| full_rt_range | The full RT range if an RT range is not given. |

### Value

A list of feature data (see get_feature_data).

## get_feature_data *Get a feature's m/z and RT ranges given different feature specifications*

### Description

Get a feature's m/z and RT ranges given different feature specifications

### Usage

```
get_feature_data(feature, options, full_rt_range)
```

### Arguments

| | |
|---|---|
| feature | The input feature which can be a vector or a data frame row. The accepted columns combinations are:<br>• mz, rt (optional)<br>• mzmin, mzmax, rtmin (optional), rtmax (optional) |
| options | The plot object's options. |
| full_rt_range | The full RT range if an RT range is not given. |

## Value

A named list defining a feature with names: feature_id, mzr, rtr.

---

`get_grouped_peaks` *Get the grouped peaks across samples (features) from the data object*

---

## Description

`get_grouped_peaks()` is an internal helper that retrieves feature-level grouped peaks, i.e., chromatographic peaks aligned across samples.

## Usage

```
get_grouped_peaks(obj)

## Default S3 method:
get_grouped_peaks(obj)

## S3 method for class 'XCMSnExp'
get_grouped_peaks(obj)

## S3 method for class 'XcmsExperiment'
get_grouped_peaks(obj)

## S3 method for class 'MsExperiment'
get_grouped_peaks(obj)
```

## Arguments

| | |
|---|---|
| `obj` | A data object containing or representing samples. |

## Value

A `tibble` of grouped (feature-level) peaks, or `NULL` if not available.

---

`get_grouping_variables`
*Get the grouping variables for a plot*

---

## Description

`get_grouping_variables()` extracts the variables used to group data in a plot based on the provided plot options. It first checks for facet specifications, and if absent, falls back to grid row/column settings.

### Usage

```
get_grouping_variables(opts)
```

### Arguments

| | |
|---|---|
| opts | A list of plot options. |

### Value

A character vector containing the names of the grouping variables used for faceting or grid layout. May contain NULL values if no grouping is specified.

---

## get_metadata *Get the metadata associated with the input object*

---

### Description

get_metadata() is a generic helper used internally to standardise metadata extraction across different classes of input objects.

### Usage

```
get_metadata(obj, sample_id_column, metadata)

## S3 method for class 'character'
get_metadata(obj, sample_id_column, metadata)

## S3 method for class 'XCMSnExp'
get_metadata(obj, sample_id_column, metadata)

## S3 method for class 'MsExperiment'
get_metadata(obj, sample_id_column, metadata)

## S3 method for class 'MChromatograms'
get_metadata(obj, sample_id_column, metadata)

## S3 method for class 'XChromatograms'
get_metadata(obj, sample_id_column, metadata)

## S3 method for class 'XChromatogram'
get_metadata(obj, sample_id_column, metadata)

## S3 method for class 'XcmsRawList'
get_metadata(obj, sample_id_column, metadata)

## S3 method for class 'ExternalDataSource'
get_metadata(obj, sample_id_column, metadata)
```

```
## S3 method for class 'DBIConnection'
get_metadata(obj, sample_id_column, metadata)
```

## Arguments

| | |
|---|---|
| obj | A data object containing or representing samples. |
| sample_id_column | A character value indicating the column that should be used as the sample ID. |
| metadata | Optional metadata tibble used to replace or augment sample metadata when not already embedded in the object. |

## Details

Depending on the class of obj, metadata may be:

- **constructed** (e.g., from character vectors of file paths), or
- **extracted and optionally replaced** (e.g., from XCMSnExp or MsExperiment objects).

Across all methods, the returned metadata is enriched with:

- sample_index - a sequential index of samples
- sample_id - an identifier column selected via sample_id_column
- sample_path - a file path associated with each sample (if applicable)

## Value

A tibble containing standardised metadata with at least sample_index, sample_id, and sample_path.

## Character vector input (character)

A character vector is treated as a list of sample file paths (e.g., .mzML, .mzXML, .cdf).

**If metadata is NULL:** Metadata is *constructed automatically*:

- sample_path: full paths given in obj
- sample_index: row number
- sample_id: basename of each file without extension

**If metadata is provided:** The supplied metadata is used and the following columns are added:

- sample_index: row number
- sample_id: extracted from the sample_id_column
- sample_path: the input paths from obj

### `XCMSnExp` input

Metadata is taken from `xcms::phenoData(obj)`.

**If `metadata` is provided:** It replaces the existing `phenoData`.

The returned metadata always includes:

- `sample_index`: row number
- `sample_id`: extracted using `sample_id_column`
- `sample_path`: values from `xcms::fileNames(obj)`

### `MsExperiment` input

Metadata is taken from `MsExperiment::sampleData(obj)`.

**If `metadata` is provided:** It replaces existing `sampleData`.

The returned metadata includes:

- `sample_index`: row number
- `sample_id`: extracted using `sample_id_column`
- `sample_path`: values from `xcms::fileNames(obj)`

### `MChromatograms` and `XChromatograms` input

Metadata is taken from `MSnbase::phenoData(obj)`.

`sample_id` is resolved in the following order:

1. `sample_id_column` (if provided and present in `phenoData`)
2. Basename without extension of the `spectraOrigin` column
3. `"sample1"`, `"sample2"`, ... (fallback)

`sample_path` is set to `spectraOrigin` if present, otherwise `NA`.

**If `metadata` is provided:** It is column-bound onto the extracted `phenoData`.

The returned metadata always includes:

- `sample_index`: row number
- `sample_id`: resolved as above
- `sample_path`: from `spectraOrigin` or `NA`

### `XChromatogram` input

Represents a single chromatogram (one sample). `sample_path` is always `NA`.

**If `metadata` is NULL:** Returns a single-row tibble with `sample_index = 1`, `sample_id = "sample1"`, and `sample_path = NA`.

**If `metadata` is provided:** Must have exactly one row. The supplied metadata is used with:

- `sample_index`: `1`
- `sample_id`: from `sample_id_column` if present, otherwise `"sample1"`
- `sample_path`: `NA`

`XcmsRawList` **input**

Each element of the list is an `xcmsRaw` object. `sample_path` is extracted from the `@filepath` slot of each `xcmsRaw`.

**If** `metadata` **is NULL:** Metadata is *constructed automatically*:

- `sample_index`: sequential index
- `sample_id`: basename without extension of `sample_path`
- `sample_path`: from `xcmsRaw@filepath`

**If** `metadata` **is provided:** Must have one row per `xcmsRaw` object. The supplied metadata is used with:

- `sample_index`: row number
- `sample_id`: from `sample_id_column` if present, otherwise basename of path
- `sample_path`: from `xcmsRaw@filepath`

`ExternalDataSource` **input**

Metadata is taken from the `@metadata` slot of the `ExternalDataSource` object. The `metadata` parameter is ignored.

The returned metadata always includes:

- `sample_index`: row number
- `sample_id`: extracted using `sample_id_column`

`DBIConnection` **input**

Metadata is queried from a Compound Discoverer SQLite database via `get_workflow_input_files()`.

**If** `metadata` **is NULL:** Returns the query result with:

- `sample_index`: row number
- `sample_id`: from `StudyFileID`
- `sample_path`: from `PhysicalFileName`

**If** `metadata` **is provided:** It is joined onto the query result using `sample_id_column`.

## get_mz_range *Compute an m/z range given a ppm tolerance*

### Description

Compute an m/z range given a ppm tolerance

### Usage

```
get_mz_range(mz, ppm = 5)
```

### Arguments

| | |
|---|---|
| mz | A numeric value indicating the m/z value to calculate the range for. |
| ppm | A numeric value indicating the tolerance in parts per million (ppm). Default is 5. |

### Value

A numeric vector with two values indicating the m/z range.

## get_workflow_input_files *Retrieve workflow input files from a Compound Discoverer database*

### Description

Extracts the contents of the WorkflowInputFiles table from a Compound Discoverer results database.

### Usage

```
get_workflow_input_files(conn)
```

### Arguments

| | |
|---|---|
| conn | A DBIConnection to a Compound Discoverer results database. |

### Value

A tibble containing information about the workflow input files.

## get_XCMSnExp_object_example

*Get an* XCMSnExp *example object from the* faahKO *dataset*

### Description

Get an XCMSnExp example object from the faahKO dataset

### Usage

```
get_XCMSnExp_object_example(indices = c(1, 2, 3), should_group_peaks = FALSE)
```

### Arguments

| | |
|---|---|
| indices | A numeric vector of sample indices to select from the faahKO CDF files. Defaults to the first three samples. |
| should_group_peaks | A logical value indicating whether to group the detected peaks. |

### Value

An XCMSnExp object containing raw data, detected chromatographic peaks, and, if requested, grouped features.

### Examples

```
get_XCMSnExp_object_example(indices = 1:5)
```

## get_xic_traces_from_compounds

*Extract XIC traces associated with selected compounds*

### Description

Queries a Compound Discoverer results database to retrieve extracted ion chromatogram (XIC) traces associated with consolidated compounds matching a user-supplied filter expression.

### Usage

```
get_xic_traces_from_compounds(conn, compounds_query_str)
```

### Arguments

| | |
|---|---|
| conn | A DBIConnection to a Compound Discoverer results database. |
| compounds_query_str | A character value giving a filtering expression evaluated on the resulting compound table (e.g. using compound name, formula, retention time, or m/z). |

### Details

The query joins multiple internal Compound Discoverer tables to link consolidated compounds to reference ions, chromatogram peaks, and XIC trace data.

### Value

A `tibble` containing XIC trace metadata and binary trace data for the selected compounds.

---

## `io_close_raw_data` *Close open* `MsRawReader` *connections*

---

### Description

Close open `MsRawReader` connections

### Usage

```
io_close_raw_data(raw_data)
```

### Arguments

| | |
|---|---|
| `raw_data` | A list of `MsRawReader` objects (as returned by `io_get_raw_data()`). |

### Value

`NULL`

---

## `io_get_raw_data` *Get* `MsRawReader` *objects for a set of sample paths*

---

### Description

Get `MsRawReader` objects for a set of sample paths

### Usage

```
io_get_raw_data(sample_paths)
```

### Arguments

| | |
|---|---|
| `sample_paths` | A `character` vector of file paths to the raw MS data files (e.g., `.mzML`, `.mzXML`, `.CDF`, `.raw`). |

### Value

A named list of `MsRawReader` objects, where each element corresponds to a file in `sample_paths`.

## is_cd_result — *Check whether an object is a Compound Discoverer database connection*

### Description

The object must inherit from `DBIConnection`, and its `dbname` slot must reference a path ending in `.cdResult`.

### Usage

```
is_cd_result(obj)
```

### Arguments

| | |
|---|---|
| `obj` | An object to test. |

### Value

A `logical` value indicating whether the object is a Compound Discoverer database connection.

## is_cd_results_path — *Check whether a path corresponds to a Compound Discoverer results file*

### Description

Check whether a path corresponds to a Compound Discoverer results file

### Usage

```
is_cd_results_path(path)
```

### Arguments

| | |
|---|---|
| `path` | A `character` value giving a file system path. |

### Value

A `logical` value indicating whether the path corresponds to a Compound Discoverer results directory.

## is_xcms_data *Check whether an object is from XCMS*

### Description

Check whether an object is from XCMS

### Usage

```
is_xcms_data(obj)
```

### Arguments

| | |
|---|---|
| obj | The input object to check. |

### Value

A logical value indicating whether the object is an XCMS one, i.e. XCMSnExp or MsExperiment.

## is_xcms_processed_data *Check whether an object is an XCMS data container*

### Description

Check whether an object is an XCMS data container

### Usage

```
is_xcms_processed_data(obj)
```

### Arguments

| | |
|---|---|
| obj | The input object to check. |

### Value

A logical value indicating whether obj is an XCMS experiment object.

`iterate_plot_batches` *Iterate on the batches of plots*

## Description

`iterate_plot_batches` iterates over batches of plots defined by the `batch_size` parameter passed to the `lcmsPlot` constructor function.

## Usage

```
iterate_plot_batches(object, iter_fn)

## S4 method for signature 'lcmsPlotClass,function'
iterate_plot_batches(object, iter_fn)
```

## Arguments

| | |
|---|---|
| `object` | An instance of class `lcmsPlotClass`. |
| `iter_fn` | The function to apply to each item being iterated on. |

## Value

`NULL` (called for its side effect).

## Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

p <- lcmsPlot(raw_files, batch_size = 2) +
  lp_chromatogram(features = rbind(c(
    mzmin = 334.9,
    mzmax = 335.1,
    rtmin = 2700,
    rtmax = 2900))) +
  lp_arrange(group_by = "sample_id") +
  lp_legend(position = "bottom") +
  lp_labels(legend = "Sample")

pdf(tempfile(fileext = ".pdf"))
iterate_plot_batches(p, function(plot_obj) {
  print(plot_obj)
})
dev.off()
```

lcmsPlot *Create an* lcmsPlotClass *object*

## Description

The lcmsPlotClass class allows a unified approach for the management of LC-MS data for the purpose of visualisation. It includes the options for customising the plot, the LC-MS data, and the underlying plot object. The lcmsPlot function is the main entry point and the preferred approach to creating lcmsPlotClass objects.

## Usage

```
lcmsPlot(
  dataset,
  sample_id_column = "sample_id",
  metadata = NULL,
  batch_size = NULL,
  BPPARAM = NULL
)
```

## Arguments

| | |
|---|---|
| dataset | An object of type XCMSnExp, MsExperiment, MZmineSource, or character. If a character vector is supplied, it will be interpreted as a list of mzML paths. |
| sample_id_column | A character value indicating which column should be used as the sample ID. By default it is "sample_id". |
| metadata | A data.frame containing the samples metadata in case it is not provided in the dataset object. |
| batch_size | A numeric value indicating the number of samples per batch. This parameter is necessary when plotting multiple batches using the iterate_plot_batches or next_plot functions. |
| BPPARAM | A BiocParallelParam object for enabling parallelism. See BiocParallelParam for more information. |

## Value

An instance of lcmsPlotClass. It will create the necessary internal structures related to the data (data slot) and options (options slot).

## Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

p <- lcmsPlot(raw_files)
```

## lcmsPlotClass-class *Managing LC-MS data for visualisation*

### Description

The `lcmsPlotClass` class allows a unified approach for the management of LC-MS data for the purpose of visualisation. It includes the options for customising the plot, the LC-MS data, and the underlying plot object.

### Slots

`options` A `list` to store the plot options.

`data` An instance of class `lcmsPlotDataContainer`.

`history` A `list` to store the applied layers to generate a plot; for internal use.

`plot` A `patchwork` object representing the underlying plot object.

### General information

The `lcmsPlotClass` class has been designed to be the entry point for all data and outputs related to the `lcmsPlot` package. The class abstracts away the data handling, making it easier to use `lcmsPlot` with existing data wrappers like `MsExperiment` or `XCMSnExp`.

### Preferred usage

The `lcmsPlotClass` class can be used directly to instantiate an object, however the preferred approach is to use the `lcmsPlot` function.

## lcmsPlotDataContainer-class *A unified storing mechanism for LC-MS data*

### Description

The `lcmsPlotDataContainer` class allows the storage of different types of LC-MS data. This class can be used independently from the plotting utilities, however the preferred approach is to use it with the `lcmsPlotClass` class.

### Slots

`data_obj` The data object. One of: `XCMSnExp`, `MsExperiment`, `MChromatograms`, `XChromatograms`, `XChromatogram`, `XcmsRawList`, or `character` representing mzML paths.

`metadata` A `data.frame` containing the sample metadata.

`chromatograms` A `data.frame` containing the chromatograms.

`mass_traces` A `data.frame` containing the mass traces.

spectra A data.frame containing the spectra.

peak_density A data.frame containing peak density curve data and optional feature-group rectangles, as produced by lp_peak_density().

total_ion_current A data.frame containing the total ion current.

intensity_maps A data.frame containing the 2D intensity maps representing the distribution of detected peaks across m/z and RT.

rt_diff A data.frame containing the raw and adjusted RT values.

feature_metadata A data.frame containing feature/compound annotations attached to datasets through a column called feature_metadata_id.

detected_peaks A data.frame containing the detected peaks from an XCMSnExp or MsExperiment object.

---

lp_arrange *Define the arrangement of chromatograms*

---

## Description

The lp_arrange function specifies how chromatograms should be arranged when visualised. It determines the grouping metadata factor through the group_by parameter.

## Usage

```
lp_arrange(group_by)
```

## Arguments

| | |
|---|---|
| group_by | A character value determining the column to group by in the samples metadata. |

## Value

A function that takes an lcmsPlot object and returns a modified version with the specified arrangement options stored in options$arrangement. It is intended for use with the + operator, which incrementally layers new data or visual components onto the lcmsPlot object.

## Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

## Plots chromatograms overlayed without specifying a grouping factor
p <- lcmsPlot(raw_files) +
  lp_chromatogram(aggregation_fun = "max")
p
```

```
## Plots chromatograms overlayed specifying a grouping factor
## (e.g., sample_id)
p <- p + lp_arrange(group_by = "sample_id")
p
```

---

`lp_chromatogram` *Define the chromatograms to plot*

---

## Description

The `lp_chromatogram` function allows the generation of different types of chromatograms.

## Usage

```
lp_chromatogram(
  features = NULL,
  sample_ids = NULL,
  ppm = 10,
  rt_tol = 10,
  line_type = "solid",
  highlight_peaks = FALSE,
  highlight_peaks_color = NULL,
  highlight_peaks_mode = "polygon",
  highlight_peaks_factor = "sample_id",
  aggregation_fun = "max",
  rt_type = "uncorrected",
  rt_unit = "second",
  intensity_unit = "absolute",
  fill_gaps = FALSE,
  na.rm = FALSE,
  highlight_apices = list(column = NULL, top_n = NULL)
)
```

## Arguments

| | |
|---|---|
| `features` | Specifies which features to generates the chromatogram for. This can be either: a `matrix` with columns `mz` and `rt` (optional); a `matrix` with columns `mzmin`, `mzmax`, `rtmin` (optional), `rtmax` (optional); a `data.frame` with columns `sample_id`, `mz` and `rt` (optional); a `data.frame` with columns `sample_id`, `mzmin`, `mzmax`, `rtmin` (optional), `rtmax` (optional); a `character` vector representing the grouped peaks (feature) names as returned by `xcms::groupnames` - requires the data to be an `XCMSnExp` or `MsExperiment` object with grouped peaks. |
| `sample_ids` | A `character` vector specifying the sample IDs to include in the plot. If `NULL`, the function uses the sample IDs specified in the `lcmsPlot` object. |
| `ppm` | A `numeric` value specifying the mass accuracy (in ppm) used when generating chromatograms. Ignored when the `features` parameter specifies both `mzmin` and `mzmax`. |

rt_tol A numeric value specifying the RT tolerance used when generating chromatograms. Ignored when the features parameter specifies both rtmin and rtmax.

line_type A character value specifying the line type (from ggplot2). One of: "solid", "dashed", "dotted", "dotdash", "longdash", "twodash".

highlight_peaks
A logical value indicating whether to highlight the detected peaks; the input data must be an XCMSnExp or MsExperiment object.

highlight_peaks_color
A character value indicating the color of the highlighted peaks.

highlight_peaks_mode
A character value indicating how the peaks should be highlighted. One of "polygon" (fills the area under the curve), "rectangle" (draws a bounding box from rtmin to rtmax up to the peak apex), or "point" (marks the peak apex with a point). Defaults to "polygon".

highlight_peaks_factor
A character value indicating the factor from the metadata that determines the color. By default it colors by sample_id.

aggregation_fun
A character value indicating which aggregation function to use for the spectra intensities; one of max or sum. Only applicable to summary chromatograms.

rt_type A chracter value indicating what type of RT to use for the chromatograms. One of uncorrected (default), corrected, or both; the input data must be an XCMSnExp or MsExperiment object. If both is chosen, this will give access to a metadata column called rt_adjusted that can be used to differentiate the two RT types (e.g., through faceting).

rt_unit A character value indicating the unit to use for the RT axis; one of "minute" or "second".

intensity_unit A character value indicating the unit to use for the intensity axis; one of "absolute" or "relative".

fill_gaps A logical value indicating whether to fill gaps in RT with 0 intensity.

na.rm A logical value. When TRUE, data points whose intensity is NA are removed before plotting. Defaults to FALSE.

highlight_apices
A logical value indicating whether to highlight apices with the corresponding RT values in a chromatogram.

## Value

This function returns another function that takes an lcmsPlot object and produces a modified version containing the generated chromatograms in its data slot. It is designed to be used with the + operator, which serves as a layering mechanism. Each use of + incrementally enriches the lcmsPlot object by adding new data or visual components.

### Summary chromatograms

In this type of chromatogram, the intensities of the spectra from each scan in an LC–MS dataset are either summed to produce the total ion current (TIC) chromatogram or the most intense peak is selected to produce the base peak chromatogram (BPC). To create such chromatograms do not specify the `features` parameter as that will create the chromatograms for the selected features. In this context, the main parameter if `aggregation_fun` which can take either `sum` (TIC) or `max` (BPC).

### Feature chromatograms

A feature is a combination of retention time (RT) and m/z. Feature chromatograms can be created by specifiying the `features` parameter.

### Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

p <- lcmsPlot(raw_files) +
  lp_chromatogram(aggregation_fun = "max") +
  lp_arrange(group_by = "sample_id")

p
```

---

## lp_compound_discoverer

*Define the options to use when plotting LC-MS data coming from Compound Discoverer results.*

---

### Description

Define the options to use when plotting LC-MS data coming from Compound Discoverer results.

### Usage

```
lp_compound_discoverer(compounds_query = NULL, rt_extend = 10)
```

### Arguments

`compounds_query`

A `character` value indicating the expression used to filter compounds from the Compound Discoverer results. The expression is evaluated on the compound table and can reference the following columns:

**name** Compound name.

**formula** Chemical formula of the compound.

**adduct** Ion adduct (e.g. `[M+H]+`, `[M-H]-`).

**rt** Retention time of the compound (in seconds).

**rtmin** Minimum retention time of the compound peak.

**rtmax** Maximum retention time of the compound peak.

**mz** Mass-to-charge ratio (m/z) of the detected ion.

**maxo** Maximum observed peak intensity.

**into** Integrated peak area reported by Compound Discoverer.

`rt_extend` A `numeric` value indicating how much (in seconds) the retention time window should be extended on each side of the compound peak when extracting and plotting chromatograms.

## Value

A function that takes an `lcmsPlot` object and returns a modified version with the specified Compound Discoverer options stored in `options$compound_discoverer`. It is intended for use with the `+` operator, which incrementally layers new data or visual components onto the `lcmsPlot` object.

## Examples

```
## Not run:
lcmsPlot("cd_example.cdResult") +
  lp_compound_discoverer(
    compounds_query = 'name %in% c("Proline", "Betaine")',
    rt_extend = 5
  ) +
  lp_chromatogram(highlight_peaks = TRUE) +
  lp_grid(rows = "sample_id", cols = "name", free_x = TRUE) +
  lp_labels(title = "Compound Discoverer example", legend = "Sample") +
  lp_legend(position = "bottom")

## End(Not run)
```

---

# `lp_facets` *Define the plot's faceting*

---

## Description

The `lp_facets` function arranges plots into a grid based on a metadata factor, creating a series of smaller plots (facets).

## Usage

```
lp_facets(facets, ncol = NULL, nrow = NULL, free_x = FALSE, free_y = FALSE)
```

### Arguments

| | |
|---|---|
| facets | A character vector of factors from the sample metadata to use for faceting. |
| ncol | A numeric value indicating the number of columns in the layout. |
| nrow | A numeric value indicating the number of rows in the layout. |
| free_x | A logical value indicating whether the x-axis scales are allowed to vary across panels. |
| free_y | A logical value indicating whether the y-axis scales are allowed to vary across panels. |

### Value

A function that takes an lcmsPlot object and returns a modified version with the specified faceting options stored in options$facets. It is intended for use with the + operator, which incrementally layers new data or visual components onto the lcmsPlot object.

### Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

## Plots chromatograms overlayed
p <- lcmsPlot(raw_files) +
  lp_chromatogram(aggregation_fun = "max")
p

## Using lp_facets we create facets for each sample_id
p <- p + lp_facets(facets = "sample_id")
p
```

---

## lp_get_plot *Get the underlying plot object.*

---

### Description

Get the underlying plot object.

### Usage

```
lp_get_plot()
```

### Value

A function that takes an lcmsPlot object and returns a modified version with the rendered plot stored in the plot slot. It is intended for use with the + operator, which incrementally layers new data or visual components onto the lcmsPlot object.

## Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:4]

## Create faceted chromatogram plots with a reference RT line
p <- lcmsPlot(raw_files) +
  lp_chromatogram(features = rbind(c(
    mzmin = 334.9,
    mzmax = 335.1,
    rtmin = 2700,
    rtmax = 2900))) +
  lp_facets(facets = 'sample_id', ncol = 4) +
  lp_rt_line(intercept = 2800, line_type = 'solid', color = 'red')
p

## Extract the ggplot object and apply a theme
p <- p +
  lp_get_plot() +
  ggplot2::theme_bw()
p
```

---

# lp_grid *Define a gridded plot*

---

## Description

The `lp_grid` function arranges plots into a matrix of panels defined by row and column faceting metadata factors.

## Usage

```
lp_grid(rows, cols, free_x = FALSE, free_y = FALSE)
```

## Arguments

| | |
|---|---|
| `rows` | A `character` value indicating the factors that represent rows. |
| `cols` | A `character` value indicating the factors that represent columns. |
| `free_x` | A `logical` value indicating whether the x-axis scales are allowed to vary across panels. |
| `free_y` | A `logical` value indicating whether the y-axis scales are allowed to vary across panels. |

## Value

A function that takes an `lcmsPlot` object and returns a modified version with the specified grid options stored in `options$grid`. It is intended for use with the `+` operator, which incrementally layers new data or visual components onto the `lcmsPlot` object.

## Examples

```
raw_files <- dir(
  system.file("cdf", package = "faahKO"),
  full.names = TRUE,
  recursive = TRUE
)[1:4]

## Create metadata for the samples
metadata <- data.frame(
  sample_id = sub("\\.CDF", "", basename(raw_files)),
  factor1 = c("S", "S", "C", "C"),
  factor2 = c("T", "U", "T", "U")
)

## Create feature chromatograms for the specified samples
p <- lcmsPlot(raw_files, metadata = metadata) +
  lp_chromatogram(features = rbind(c(
    mzmin = 334.9,
    mzmax = 335.1,
    rtmin = 2700,
    rtmax = 2900)))
p

## Arrange chromatograms in a grid split by experimental factors
## Rows correspond to `factor1` and columns correspond to `factor2`
p <- p + lp_grid(rows = "factor1", cols = "factor2")
p
```

---

`lp_intensity_map` *Define a 2D intensity map*

---

## Description

The `lp_intensity_map` function produces an intensity map in which signal intensity is represented at each m/z / RT coordinate.

## Usage

```
lp_intensity_map(
  mz_range,
  rt_range,
  sample_ids = NULL,
  density = FALSE,
  x_dim = "rt",
  y_dim = "mz",
  fill_scale = NULL
)
```

### Arguments

| | |
|---|---|
| mz_range | A numeric value indicating the m/z range of the map. |
| rt_range | A numeric value indicating the RT range of the map. |
| sample_ids | A character vector specifying the sample IDs to include in the plot. If NULL, the function uses the sample IDs specified in the lcmsPlot object. |
| density | A logical value indicating whether to show a density plot. |
| x_dim | A character value indicating which dimension to place on the x-axis. One of "rt" (default) or "mz". |
| y_dim | A character value indicating which dimension to place on the y-axis. One of "mz" (default) or "rt". |
| fill_scale | A ggplot2 scale object to use for the fill aesthetic (e.g. scale_fill_gradient(low = "white", high = "red")). When NULL (default), uses scale_fill_viridis_c for intensity and scale_fill_viridis_d for density plots. |

### Value

This function returns another function that takes an lcmsPlot object and produces a modified version containing the generated 2D intensity map in its data slot. It is designed to be used with the + operator, which serves as a layering mechanism. Each use of + incrementally enriches the lcmsPlot object by adding new data or visual components.

### Examples

```
raw_files <- dir(
  system.file("cdf", package = "faahKO"),
  full.names = TRUE,
  recursive = TRUE)[1]

p <- lcmsPlot(raw_files) +
  lp_intensity_map(
    mz_range = c(200, 600),
    rt_range = c(4200, 4500),
    density = TRUE)
p
```

---

## lp_labels *Define the labels of the plot*

---

### Description

The lp_labels function allows the specification of the plot title and the legend title.

### Usage

```
lp_labels(title = NULL, legend = NULL)
```

### Arguments

| | |
|---|---|
| title | A character value indicating the plot title. |
| legend | A character value indicating the legend's title. |

### Value

A function that takes an lcmsPlot object and returns a modified version with the specified label options stored in options$labels. It is intended for use with the + operator, which incrementally layers new data or visual components onto the lcmsPlot object.

### Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

## Create a chromatogram plot by grouping samples into batches
## By default, the legend is derived from the grouping variable
p <- lcmsPlot(raw_files, batch_size = 2) +
  lp_chromatogram(features = rbind(c(
    mzmin = 334.9,
    mzmax = 335.1,
    rtmin = 2700,
    rtmax = 2900))) +
  lp_arrange(group_by = "sample_id")
p

## Customise the legend label
p <- p + lp_labels(legend = "Sample")
p
```

---

## lp_layout *Define the plot layout*

---

### Description

Define the plot layout

### Usage

```
lp_layout(design = NULL)
```

### Arguments

| | |
|---|---|
| design | Specification of the location of areas in the layout See https://patchwork.data-imaginist.com/reference/wrap_plots.html |

## Value

A function that takes an `lcmsPlot` object and returns a modified version with the specified layout options stored in `options$layout`. It is intended for use with the `+` operator, which incrementally layers new data or visual components onto the `lcmsPlot` object.

## Examples

```
data_obj <- get_XCMSnExp_object_example(indices = 1)

## Plot chromatograms and spectra for selected samples and features
p <- lcmsPlot(data_obj, sample_id_column = 'sample_name') +
  lp_chromatogram(
    features = rbind(
      c(mzmin = 334.9, mzmax = 335.1, rtmin = 2700, rtmax = 2900),
      c(mzmin = 278.99721, mzmax = 279.00279, rtmin = 2740, rtmax = 2840)
    ),
    sample_ids = 'ko15',
    highlight_peaks = TRUE
  ) +
  lp_spectra(mode = "closest_apex", ms_level = 1) +
  lp_facets(facets = "feature_id", ncol = 2)

## Customise panel layout to place chromatogram above spectra
p <- p + lp_layout(design = "C\nS\nS")
```

---

# lp_legend *Define the legend layout*

---

## Description

Define the legend layout

## Usage

```
lp_legend(position = NULL)
```

## Arguments

| | |
|---|---|
| `position` | A `character` value indicating the legend's position. One of `"top"`, `"right"`, `"bottom"`, `"left"`, or `"inside"`. |

## Value

A function that takes an `lcmsPlot` object and returns a modified version with the specified legend options stored in `options$legend`. It is intended for use with the `+` operator, which incrementally layers new data or visual components onto the `lcmsPlot` object.

## Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

## Create a chromatogram plot grouped by sample with a custom legend label
p <- lcmsPlot(raw_files, batch_size = 2) +
  lp_chromatogram(features = rbind(c(
    mzmin = 334.9,
    mzmax = 335.1,
    rtmin = 2700,
    rtmax = 2900))) +
  lp_arrange(group_by = "sample_id") +
  lp_labels(legend = "Sample")
p

## Move the legend below the plot
p <- p + lp_legend(position = "bottom")
p
```

---

# lp_mass_trace *Define the mass trace to plot*

---

## Description

The `lp_mass_trace` function enables the generation of mass traces, which are graphical representations commonly used in mass spectrometry data analysis. A mass trace plots individual data points defined by their retention time and corresponding mass-to-charge ratio (m/z), making it easier to visualise how specific ions behave over the course of a chromatographic run.

## Usage

```
lp_mass_trace()
```

## Value

This function returns another function that takes an `lcmsPlot` object and produces a modified version containing the generated mass traces in its `data` slot. It is designed to be used with the `+` operator, which serves as a layering mechanism. Each use of `+` incrementally enriches the `lcmsPlot` object by adding new data or visual components.

## Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]
```

```
## Create chromatograms of a specific feature
p <- lcmsPlot(raw_files) +
  lp_chromatogram(features = rbind(c(
    mzmin = 334.9,
    mzmax = 335.1,
    rtmin = 2700,
    rtmax = 2900))) +
  lp_arrange(group_by = "sample_id")

## Add mass traces
p <- p + lp_mass_trace()

p
```

---

`lp_peak_density` *Plot the peak density for one or more m/z features*

---

## Description

The `lp_peak_density` function produces a peak density plot. For each supplied feature (m/z bin):

- The x axis shows retention time.
- The y axis shows sample indices (1 to n), positioned within the density range.
- Detected peaks are plotted as coloured points at each sample's position.
- The kernel density estimate of peak apex RTs is drawn as a line.
- When `min_fraction` is supplied, the density-descent grouping algorithm is simulated and feature groups that pass the threshold are highlighted with semi-transparent rectangles.

## Usage

```
lp_peak_density(
  features = NULL,
  bw = 30,
  min_fraction = NULL,
  min_samples = 1L,
  sample_groups = NULL,
  max_features = 50L,
  rt_unit = "second"
)
```

## Arguments

| | |
|---|---|
| `features` | A `matrix` or `data.frame` with columns `mzmin` and `mzmax` (required) and `rtmin`, `rtmax` (optional). Each row defines one m/z bin. When omitted, the features are taken from `lp_chromatogram` if it has already been called on the same object. |
| `bw` | A `numeric` value specifying the kernel density bandwidth in seconds. Passed to `stats::density()`. Defaults to `30`. |

| | |
|---|---|
| min_fraction | A numeric value in [0, 1]. When supplied, simulates the PeakDensityParam grouping algorithm and draws semi-transparent rectangles for feature groups where at least this fraction of samples (per group) contain a peak. Defaults to NULL (no simulation). |
| min_samples | An integer specifying the minimum absolute number of samples per group required to define a feature group. Only used when min_fraction is set. Defaults to 1L. |
| sample_groups | A vector of length equal to the number of samples assigning each sample to a group (as in PeakDensityParam). Defaults to NULL, which treats all samples as a single group. |
| max_features | An integer specifying the maximum number of feature group rectangles to draw per m/z bin. Defaults to 50L. |
| rt_unit | A character value indicating the unit for the RT axis; one of "second" (default) or "minute". |

## Value

This function returns another function that takes an lcmsPlot object and produces a modified version containing the generated peak density data in its data slot. It is designed to be used with the + operator, which serves as a layering mechanism.

## Examples

```
data_obj <- get_XCMSnExp_object_example(
  indices = 1:3,
  should_group_peaks = TRUE)
p <- lcmsPlot(data_obj, sample_id_column = "sample_name") +
  lp_peak_density(
    features = rbind(c(mzmin = 334.9, mzmax = 335.1,
                       rtmin = 2700,  rtmax = 2900)),
    bw = 30,
    min_fraction = 0.5)
p
```

---

# lp_rt_diff_plot *Generate the retention time difference plot between raw and adjusted datasets*

---

## Description

The lp_rt_diff_plot function generates the data necessary to plot the difference between the raw and retention time adjusted datasets. Only applicable to XCMSnExp and MsExperiment objects.

## Usage

```
lp_rt_diff_plot()
```

## Value

This function returns another function that takes an `lcmsPlot` object and produces a modified version containing the generated retention time differences, between raw and adjusted, in its `data` slot. It is designed to be used with the + operator, which serves as a layering mechanism. Each use of + incrementally enriches the `lcmsPlot` object by adding new data or visual components.

## Examples

```
data_obj <- get_XCMSnExp_object_example(
  indices = 1:3,
  should_group_peaks = TRUE)
p <- lcmsPlot(data_obj, sample_id_column = "sample_name") +
  lp_rt_diff_plot()
p
```

---

# lp_rt_line *Define a vertical line on a retention time value*

---

## Description

Define a vertical line on a retention time value

## Usage

```
lp_rt_line(intercept, line_type = "dashed", color = "black")
```

## Arguments

| | |
|---|---|
| `intercept` | A `numeric` value indicating the retention time axis (x-axis) intercept. |
| `line_type` | A `character` value indicating the line type. One of `"solid"`, `"dashed"`, `"dotted"`, `"dotdash"`, `"longdash"`, `"twodash"`. |
| `color` | A `character` value indicating the line color. |

## Value

A function that takes an `lcmsPlot` object and returns a modified version with the specified RT line options stored in `options$rt_lines`. It is intended for use with the + operator, which incrementally layers new data or visual components onto the `lcmsPlot` object.

## Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:4]

## Create chromatogram plots faceted by sample
p <- lcmsPlot(raw_files) +
```

```
  lp_chromatogram(features = rbind(c(
    mzmin = 334.9,
    mzmax = 335.1,
    rtmin = 2700,
    rtmax = 2900))) +
  lp_facets(facets = 'sample_id', ncol = 4)
p

## Add a vertical retention time reference line
p <- p + lp_rt_line(intercept = 2800, line_type = 'solid', color = 'red')
p
```

---

`lp_spectra` *Define the spectra to plot*

---

## Description

The `lp_spectra` function enables the generation of spectra, which are graphical representations of ions detected at each mass-to-charge ratio (m/z) with their corresponding absolute or relative intensities.

## Usage

```
lp_spectra(
  sample_ids = NULL,
  mode = "closest_apex",
  ms_level = 1,
  rt = NULL,
  scan_index = NULL,
  interval = 3,
  spectral_match_db = NULL,
  match_target_index = NULL,
  peak_label_size = 3,
  intensity_breaks_by = 20,
  auto_facet = TRUE
)
```

## Arguments

| | |
|---|---|
| `sample_ids` | A `character` vector specifying the sample IDs to include in the plot. If `NULL`, the function uses the sample IDs specified in the `lcmsPlot` object or the `lp_chromatogram` function. |
| `mode` | The method to choose the scan from which to extract the spectra. One of: `closest`, the closest scan to the specified RT - `rt` parameter); `closest_apex`, the closest scan to a detected peak; `across_peak`, selects scans across a detected peak at a certain interval specified in the `interval` parameter. `mode` is not applicable to standalone spectra. |

ms_level The MS level to consider for the scan.

rt When mode = "closest", the RT to consider.

scan_index The exact scan index to consider for extracting a spectrum. scan_index and mode are mutually exclusive.

interval When mode = "across_peak." The RT interval to consider.

spectral_match_db
The database containing reference spectra used for matching and comparison with the input spectra.

match_target_index
The index, ranked by descending match score, identifying which reference spectrum to display in the mirror plot.

peak_label_size
A numeric value controlling the font size of m/z labels annotated on spectral peaks. Defaults to 3.

intensity_breaks_by
A numeric value specifying the step size (in percent) between y-axis intensity breaks. Defaults to 20.

auto_facet A logical value. When TRUE (default), a facet is automatically added to separate spectra from different samples or scans. Set to FALSE to suppress automatic faceting.

## Value

This function returns another function that takes an lcmsPlot object and produces a modified version containing the generated spectra in its data slot. It is designed to be used with the + operator, which serves as a layering mechanism. Each use of + incrementally enriches the lcmsPlot object by adding new data or visual components.

## Spectra associated with chromatograms

A spectrum is obtained from a scan at a specific retention time (RT). Therefore, when plotting a chromatogram together with its associated spectra, it is common to mark the RT with a vertical line on the chromatogram to indicate where the spectra were acquired. See the example below on how to generate these types of spectra.

## Standalone spectra

Standalone spectra can also be generated, provided no chromatograms are present (i.e., lp_chromatogram has not been used).

## Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1]

p <- lcmsPlot(raw_files) +
```

```
  lp_chromatogram(features = rbind(c(
    mzmin = 334.9,
    mzmax = 335.1,
    rtmin = 2700,
    rtmax = 2900))) +
  lp_spectra(mode = "closest", rt = 2785)
p
```

---

`lp_total_ion_current` *Define the total ion current (TIC)*

---

## Description

The `lp_total_ion_current` generates summary data for the total ion current (TIC) of the selected samples.

## Usage

```
lp_total_ion_current(sample_ids = NULL, type = "boxplot")
```

## Arguments

| | |
|---|---|
| `sample_ids` | A `character` vector specifying the sample IDs to include in the plot. If `NULL`, the function uses the sample IDs specified in the `lcmsPlot` object. |
| `type` | A `character` value indicating the type of plot; one of `"boxplot"`, `"violin"`, `"jitter"`. |

## Value

This function returns another function that takes an `lcmsPlot` object and produces a modified version containing the generated total ion current (TIC) in its `data` slot. It is designed to be used with the `+` operator, which serves as a layering mechanism. Each use of `+` incrementally enriches the `lcmsPlot` object by adding new data or visual components.

## Examples

```
data_obj <- get_XCMSnExp_object_example()

p <- lcmsPlot(data_obj, sample_id_column = "sample_name") +
  lp_total_ion_current(type = "violin") +
  lp_arrange(group_by = "sample_id")
p
```

## merge_by_index *Merge two data frames using a row-index match*

### Description

Merge two data frames using a row-index match

### Usage

```
merge_by_index(a, b, index_col)
```

### Arguments

| | |
|---|---|
| a | The left data frame. |
| b | The right data frame whose row order defines the index. |
| index_col | The name of the column in a that contains row indices referring to b. |

### Value

A tibble resulting from a left join of a and the indexed b.

## MsDialPeaksSource *Create an MS-DIAL data source from peak lists*

### Description

This function reads MS-DIAL peak list files and sample metadata and converts them into a format compatible with xcms-style peak tables.

### Usage

```
MsDialPeaksSource(peaks_paths, sample_paths, metadata_path = NULL)
```

### Arguments

| | |
|---|---|
| peaks_paths | A character vector of paths to MS-DIAL peak list files (CSV or TSV). The ordering should match the one in the metadata (i.e., the samples). |
| sample_paths | A character vector of paths to raw sample files (e.g., mzML). |
| metadata_path | A character value (optional) indicating the path to a metadata file (CSV or TSV). If NULL, a metadata data.frame is created from sample_paths. |

### Value

An object of class ExternalDataSource.

## Examples

```
## Create temporary example files
tmp_dir <- tempdir()

## Fake raw sample paths
sample_paths <- file.path(
  tmp_dir,
  c("sample1.mzML", "sample2.mzML")
)

## Create minimal MS-DIAL peak list files (one per sample)
peak_list_paths <- file.path(
  tmp_dir,
  c("sample1_peaks.csv", "sample2_peaks.csv")
)

msdial_peaks_1 <- tibble::tibble(
  "Precursor m/z" = c(100.1, 200.2),
  "RT (min)" = c(5.0, 10.0),
  "Area" = c(10000, 20000),
  "Height" = c(500, 800),
  "RT left(min)" = c(4.8, 9.8),
  "RT right (min)" = c(5.2, 10.2)
)

msdial_peaks_2 <- tibble::tibble(
  "Precursor m/z" = c(150.3, 250.4),
  "RT (min)" = c(6.0, 12.0),
  "Area" = c(15000, 25000),
  "Height" = c(600, 900),
  "RT left(min)" = c(5.8, 11.8),
  "RT right (min)" = c(6.2, 12.2)
)

utils::write.csv(msdial_peaks_1, peak_list_paths[1], row.names = FALSE)
utils::write.csv(msdial_peaks_2, peak_list_paths[2], row.names = FALSE)

## Create the data source
ds <- MsDialPeaksSource(
  peaks_paths = peak_list_paths,
  sample_paths = sample_paths
)
```

---

`MsRawReader-class` *Virtual base class for raw MS file readers*

---

## Description

`MsRawReader` is an abstract S4 class that defines the interface for reading raw mass spectrometry data files. Concrete subclasses implement the interface for specific backends (e.g., `mzR`, `rawrr`).

## ms_chromatogram *Extract an extracted ion chromatogram (XIC) using the native backend*

### Description

ms_chromatogram() uses the backend's own XIC extraction mechanism rather than reconstructing chromatograms scan-by-scan from ms_peaks(). Currently only implemented for RawrrReader (ThermoFisher .raw files), which delegates to rawrr::readChromatogram().

### Usage

```
ms_chromatogram(reader, mz, ppm, rt_range)

## S4 method for signature 'MzrReader'
ms_chromatogram(reader, mz, ppm, rt_range)

## S4 method for signature 'RawrrReader'
ms_chromatogram(reader, mz, ppm, rt_range)

## S4 method for signature 'XcmsRawReader'
ms_chromatogram(reader, mz, ppm, rt_range)
```

### Arguments

| | |
|---|---|
| reader | An instance of MsRawReader. |
| mz | A numeric scalar — the target m/z. |
| ppm | A numeric scalar — the mass tolerance in ppm. |
| rt_range | A length-2 numeric vector — the RT window in seconds. |

### Value

A list with two tibbles: chromatograms (columns rt and intensity) and mass_traces (empty for backends that do not expose per-scan m/z data via this interface).

## ms_close *Close a raw MS file reader connection*

### Description

Close a raw MS file reader connection

## Usage

```
ms_close(reader)

## S4 method for signature 'MzrReader'
ms_close(reader)

## S4 method for signature 'RawrrReader'
ms_close(reader)

## S4 method for signature 'XcmsRawReader'
ms_close(reader)
```

## Arguments

| | |
|---|---|
| reader | An instance of MsRawReader. |

## Value

```
invisible(NULL)
```

---

ms_header *Get scan header information from a raw MS file reader*

---

## Description

Get scan header information from a raw MS file reader

## Usage

```
ms_header(reader)

## S4 method for signature 'MzrReader'
ms_header(reader)

## S4 method for signature 'RawrrReader'
ms_header(reader)

## S4 method for signature 'XcmsRawReader'
ms_header(reader)
```

## Arguments

| | |
|---|---|
| reader | An instance of MsRawReader. |

## Value

A tibble with at least the columns seqNum, retentionTime, msLevel, basePeakIntensity, and totIonCurrent.

## ms_peaks *Get peak matrices for selected scans from a raw MS file reader*

### Description

Get peak matrices for selected scans from a raw MS file reader

### Usage

```
ms_peaks(reader, scans)

## S4 method for signature 'MzrReader'
ms_peaks(reader, scans)

## S4 method for signature 'RawrrReader'
ms_peaks(reader, scans)

## S4 method for signature 'XcmsRawReader'
ms_peaks(reader, scans)
```

### Arguments

| | |
|---|---|
| reader | An instance of MsRawReader. |
| scans | An integer vector of scan sequence numbers to retrieve. |

### Value

A list of two-column matrices with columns mz and intensity, one element per scan (always a list, even for a single scan).

## MZmineFeatureListsSource *Create an MZmine data source from feature lists*

### Description

This function reads MZmine feature list files (supports version 2 and above) and sample metadata and converts them into a format compatible with xcms-style peak tables.

### Usage

```
MZmineFeatureListsSource(
  feature_lists_paths,
  sample_paths,
  metadata_path = NULL
)
```

## Arguments

| | |
|---|---|
| feature_lists_paths | A character vector of paths to MZmine feature list files (CSV or TSV). |
| sample_paths | A character vector of paths to raw sample files (e.g., mzML). |
| metadata_path | A character value (optional) indicating the path to a metadata file (CSV or TSV). If NULL, a metadata data.frame is created from sample_paths. |

## Value

An object of class ExternalDataSource.

## Examples

```
## Create temporary example files
tmp_dir <- tempdir()

## Fake sample paths
sample_paths <- file.path(
  tmp_dir,
  c("sample1.mzML", "sample2.mzML")
)

## Create a minimal MZmine 2 feature list CSV
feature_list_path <- file.path(tmp_dir, "mzmine_features.csv")

mzmine_features <- tibble::tibble(
  "row m/z" = c(100.1, 200.2),
  "sample1.mzML Feature status" = c("DETECTED", "DETECTED"),
  "sample1.mzML Feature m/z" = c(100.1, 200.2),
  "sample1.mzML Feature RT" = c(300, 600),
  "sample1.mzML Peak area" = c(10000, 20000),
  "sample1.mzML Peak height" = c(500, 800),
  "sample1.mzML Feature m/z min" = c(99.9, 199.9),
  "sample1.mzML Feature m/z max" = c(100.3, 200.4),
  "sample1.mzML Feature RT start" = c(290, 590),
  "sample1.mzML Feature RT end" = c(310, 610),
  check.names = FALSE
)

utils::write.csv(mzmine_features, feature_list_path, row.names = FALSE)

## Create the data source
ds <- MZmineFeatureListsSource(
  feature_lists_paths = feature_list_path,
  sample_paths = sample_paths
)
```

## MzrReader-class *An* mzR*-backed raw MS file reader*

### Description

Wraps an open mzR connection (as returned by mzR::openMSfile()).

### Slots

connection An mzR connection object.

## next_plot *Move to the next plot object (batch-mode)*

### Description

next_plot progresses an lcmsPlotClass object to the next plot in a batch-processing sequence. This is typically used when multiple plots are generated and inspected iteratively, such as when navigating large LC–MS datasets in a batched workflow. The batch size is defined in the lcmsPlot function's argument batch_size.

### Usage

```
next_plot(object)

## S4 method for signature 'lcmsPlotClass'
next_plot(object)
```

### Arguments

| | |
|---|---|
| object | An instance of class lcmsPlotClass. |

### Value

An instance of class lcmsPlotClass.

### Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

p <- lcmsPlot(raw_files, batch_size = 2) +
  lp_chromatogram(features = rbind(c(
    mzmin = 334.9,
```

```
    mzmax = 335.1,
    rtmin = 2700,
    rtmax = 2900))) +
  lp_arrange(group_by = "sample_id") +
  lp_legend(position = "bottom") +
  lp_labels(legend = "Sample")

p <- next_plot(p)
p
```

---

`open_cd_result_connection` *Open a connection to a Compound Discoverer results database*

---

## Description

Establishes a read-only SQLite database connection to a Compound Discoverer results directory.

## Usage

```
open_cd_result_connection(cd_result_path)
```

## Arguments

`cd_result_path` A `character` value giving the path to a Compound Discoverer results file.

## Value

A `DBIConnection` object connected to the Compound Discoverer SQLite database.

---

`open_raw_reader` *Open a raw MS file as an* `MsRawReader`

---

## Description

Dispatches to `MzrReader` for standard open formats (`.mzML`, `.mzXML`, `.CDF`) or `RawrrReader` for ThermoFisher `.raw` files.

## Usage

```
open_raw_reader(path)
```

## Arguments

`path` A `character` value giving the file path.

## Value

An instance of `MsRawReader` (either `MzrReader` or `RawrrReader`).

## parse_trace *Parse a binary XIC trace from Compound Discoverer*

### Description

Decodes a binary XIC trace blob stored in a Compound Discoverer results database and converts it into a retention time-intensity data frame.

### Usage

```
parse_trace(data)
```

### Arguments

| | |
|---|---|
| data | A raw vector or binary object containing the encoded XIC trace. |

### Value

A tibble with columns:

**rt** Retention time in seconds.

**intensity** Signal intensity.

If the trace cannot be parsed, NULL is returned.

## plot_chromatogram *Plot chromatograms from one or more datasets*

### Description

plot_chromatogram() generates a ggplot2 chromatogram plot from processed datasets. It can handle multiple datasets, optionally highlight detected peaks or apices, and apply faceting or grid layouts based on plot options.

### Usage

```
plot_chromatogram(datasets, supporting_datasets, options, single = FALSE)
```

### Arguments

| | |
|---|---|
| datasets | A named list of data frames containing the primary datasets to plot. Typically includes chromatograms and optionally spectra. |
| supporting_datasets | A list of supporting data frames, such as detected peaks, used for highlighting features. |
| options | A list of plot options, controlling units, faceting, highlighting, and other visual parameters. |
| single | A logical value that indicates whether it should treat the plot as a single dataset variant, which can affect faceting and layout behavior. Default is FALSE. |

### Value

A ggplot object representing the chromatogram plot.

---

## plot_data *Plot the specified LC-MS data*

---

### Description

Plot the specified LC-MS data

### Usage

```
plot_data(datasets, obj)
```

### Arguments

| | |
|---|---|
| datasets | A list of data frames, each representing a dataset to be visualised. |
| obj | The lcmsPlot object. |

### Value

A patchwork plot object representing the final plot.

## plot_intensity_map *Plot an LC-MS intensity map*

### Description

plot_intensity_map() generates a ggplot2 from an intensity map which is a point-cloud of m/z and RT points.

### Usage

```
plot_intensity_map(datasets, supporting_datasets, options, single = FALSE)
```

### Arguments

| | |
|---|---|
| datasets | A named list of data frames containing the primary datasets to plot. For a 2D intensity map the used key is intensity_maps. |
| supporting_datasets | A list of supporting data frames, such as detected peaks, used for highlighting features. |
| options | A list of plot options, controlling units, faceting, highlighting, and other visual parameters. |
| single | A logical value that indicates whether it should treat the plot as a single dataset variant, which can affect faceting and layout behavior. Default is FALSE. |

### Value

A ggplot object representing the 2D intensity map plot.

## plot_mass_trace *Plot a mass trace*

### Description

plot_mass_trace() generates a ggplot2 from a mass trace

### Usage

```
plot_mass_trace(datasets, supporting_datasets, options, single = FALSE)
```

### Arguments

| | |
|---|---|
| datasets | A named list of data frames containing the primary datasets to plot. For a mass trace plot the used key is mass_traces. |
| supporting_datasets | A list of supporting data frames, such as detected peaks, used for highlighting features. |
| options | A list of plot options, controlling units, faceting, highlighting, and other visual parameters. |
| single | A logical value that indicates whether it should treat the plot as a single dataset variant, which can affect faceting and layout behavior. Default is FALSE. |

### Value

A ggplot object representing the mass trace plot.

---

## plot_multiple_datasets

*Plot multiple dataset types*

---

### Description

plot_multiple_datasets() iterates over the provided datasets, dispatches each one to its corresponding plotting function as defined in plot_config, and combines the resulting plots into a single patchwork object.

### Usage

```
plot_multiple_datasets(datasets, obj, plot_config)
```

### Arguments

| | |
|---|---|
| datasets | A named list of data frames, where each element represents a dataset to be plotted. The names must match the supported dataset types defined in plot_config. |
| obj | An instance of class lcmsPlotClass. |
| plot_config | A named list defining the plotting functions to use for each dataset type. List names correspond to dataset types, and values are functions that return ggplot objects. |

### Value

A patchwork object combining all generated plots.

## plot_multiple_faceted_datasets *Plot multiple faceted dataset types*

### Description

`plot_multiple_faceted_datasets()` generates plots for multiple dataset types and arranges them into a faceted grid. Datasets are split according to the faceting variables defined in `obj@options$facets`, with each facet panel containing a vertically stacked set of dataset-specific plots.

### Usage

```
plot_multiple_faceted_datasets(datasets, obj, plot_config)
```

### Arguments

| | |
|---|---|
| `datasets` | A named `list` of data frames, where each element represents a dataset to be plotted. The names must match the supported dataset types defined in `plot_config`. |
| `obj` | An instance of class `lcmsPlotClass`. |
| `plot_config` | A named `list` defining the plotting functions to use for each dataset type. List names correspond to dataset types, and values are functions that return ggplot objects. |

### Value

A `patchwork` object combining all generated plots.

## plot_peak_density *Plot a peak density plot*

### Description

`plot_peak_density()` generates a ggplot2 peak density plot that mirrors `xcms::plotChromPeakDensity()`. For each m/z feature:

- The x axis shows retention time.
- The y axis shows sample indices (1 to n), positioned within the density range so that sample rows are evenly spaced from 0 to `max(density)`.
- Detected peaks are plotted as coloured points at each sample's y position.
- The kernel density estimate of peak apex RTs is drawn as a line.
- When feature group simulation is enabled, semi-transparent rectangles mark feature groups that pass the `min_fraction` / `min_samples` threshold.

### Usage

```
plot_peak_density(datasets, supporting_datasets, options, single = FALSE)
```

### Arguments

| | |
|---|---|
| datasets | A named list of data frames. The used key is peak_density. |
| supporting_datasets | A list of supporting data frames. The used key is detected_peaks, which provides per-sample peak positions. |
| options | A list of plot options. |
| single | A logical value indicating whether to treat the plot as a single dataset variant. Default is FALSE. |

### Value

A ggplot object representing the peak density plot.

---

## plot_rt_diff *Plot an RT alignment difference plot*

---

### Description

plot_rt_diff() generates a ggplot2 from a dataset containing the differences between raw and adjusted retention times.

### Usage

```
plot_rt_diff(datasets, supporting_datasets, options, single = FALSE)
```

### Arguments

| | |
|---|---|
| datasets | A named list of data frames containing the primary datasets to plot. For an RT difference plot the used key is rt_diff. |
| supporting_datasets | A list of supporting data frames, such as detected peaks, used for highlighting features. |
| options | A list of plot options, controlling units, faceting, highlighting, and other visual parameters. |
| single | A logical value that indicates whether it should treat the plot as a single dataset variant, which can affect faceting and layout behavior. Default is FALSE. |

### Value

A ggplot object representing the RT difference plot.

## plot_single_dataset *Plot a single dataset type*

### Description

plot_single_dataset() allows the plotting of a single dataset type (e.g., only chromatograms).

### Usage

```
plot_single_dataset(datasets, obj, plot_config)
```

### Arguments

| | |
|---|---|
| datasets | A named list of data frames, where each element represents a dataset to be plotted. The names must match the supported dataset types defined in plot_config. |
| obj | An instance of class lcmsPlotClass. |
| plot_config | A list that defines the plot configuration. This list should use the supported dataset types as keys (e.g., chromatograms), with each value providing the corresponding function used to plot that dataset type. |

### Value

A patchwork object combining all generated plots. In this case the patchwork object contains a single ggplot2 object.

## plot_spectrum *Plot spectra from one or more datasets*

### Description

plot_spectrum() generates a ggplot2 MS spectra plot.

### Usage

```
plot_spectrum(datasets, supporting_datasets, options, single = FALSE)
```

### Arguments

| | |
|---|---|
| datasets | A named list of data frames containing the primary datasets to plot. For a spectra plot the used key is spectra. |
| supporting_datasets | A list of supporting data frames, such as detected peaks, used for highlighting features. |
| options | A list of plot options, controlling units, faceting, highlighting, and other visual parameters. |
| single | A logical value that indicates whether it should treat the plot as a single dataset variant, which can affect faceting and layout behavior. Default is FALSE. |

### Value

A ggplot object representing the RT difference plot.

---

`plot_total_ion_current` *Plot total ion current for one or more samples*

---

### Description

`plot_total_ion_current()` generates a ggplot2 of the total ion current of the samples within the dataset.

### Usage

```
plot_total_ion_current(datasets, supporting_datasets, options, single = FALSE)
```

### Arguments

| | |
|---|---|
| `datasets` | A named `list` of data frames containing the primary datasets to plot. For a TIC plot the used key is `total_ion_current`. |
| `supporting_datasets` | A `list` of supporting data frames, such as detected peaks, used for highlighting features. |
| `options` | A list of plot options, controlling units, faceting, highlighting, and other visual parameters. |
| `single` | A `logical` value that indicates whether it should treat the plot as a single dataset variant, which can affect faceting and layout behavior. Default is `FALSE`. |

### Value

A ggplot object representing the RT difference plot.

---

`process_metadata` *Process sample metadata*

---

### Description

Construct a metadata data frame aligned with a set of sample paths. If a metadata file is provided, it is read from disk and combined with the sample paths. Otherwise, a minimal metadata table is created.

### Usage

```
process_metadata(sample_paths, metadata_path = NULL)
```

### Arguments

| | |
|---|---|
| sample_paths | A character vector of sample file paths. |
| metadata_path | A character value indicating the path to a delimited metadata file with a header. |

### Value

A tibble containing a sample_path column and any additional metadata.

---

## RawrrReader-class *A* rawrr*-backed raw MS file reader*

---

### Description

Stores the path to a ThermoFisher .raw file. rawrr does not maintain persistent connections, so the path is re-used for each read operation.

### Slots

path A character value giving the path to the .raw file.

---

## remove_null_elements *Remove* NULL *elements from a list*

---

### Description

Remove NULL elements from a list

### Usage

```
remove_null_elements(lst)
```

### Arguments

| | |
|---|---|
| lst | A list from which NULL entries should be removed. |

### Value

A list containing only the non-NULL elements of lst.

## run_matching_plot_variant

*Selects and executes the appropriate plot variant*

### Description

Determines which plotting variant is applicable for the given datasets and plotting options, then executes the first matching variant. Plot variants are evaluated in order, and the first whose condition evaluates to `TRUE` is used to generate the plot.

### Usage

```
run_matching_plot_variant(datasets, obj)
```

### Arguments

| | |
|---|---|
| `datasets` | A `list` of data frames, each representing a dataset to be visualised. |
| `obj` | An instance of class `lcmsPlotClass`. |

### Value

A `patchwork` plot object generated by the selected plot variant.

## show,ExternalDataSource-method

*Show a summary of an instance of class* `ExternalDataSource`

### Description

Show a summary of an instance of class `ExternalDataSource`

### Usage

```
## S4 method for signature 'ExternalDataSource'
show(object)
```

### Arguments

| | |
|---|---|
| `object` | An instance of class `ExternalDataSource`. |

### Value

Invisible `NULL`

## Examples

```
## Create dummy metadata
metadata <- data.frame(
  sample_id = c("S1", "S2"),
  sample_path = c("sample1.mzML", "sample2.mzML")
)

## Create dummy peaks
peaks <- data.frame(
  mz = c(100.1, 150.2),
  rt = c(300, 450),
  rtmin = c(290, 440),
  rtmax = c(310, 460),
  into = c(10000, 15000),
  maxo = c(2000, 2500),
  sample_index = c(1, 2)
)

## Create ExternalDataSource object
eds <- new(
  "ExternalDataSource",
  name = "Example data source",
  metadata = metadata,
  peaks = peaks
)

## Show summary
eds
```

---

# show,lcmsPlotClass-method

*Plot the* `lcmsPlotClass` *object*

---

## Description

Display an instance of `lcmsPlotClass` class to the selected device.

## Usage

```
## S4 method for signature 'lcmsPlotClass'
show(object)
```

## Arguments

| | |
|---|---|
| `object` | An instance of class `lcmsPlotClass`. |

## Value

Invisible `NULL`

## Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

## Shows summary information as the plot has not been built yet
p <- lcmsPlot(raw_files)
p

## Shows the actual plot
p <- lcmsPlot(raw_files) +
  lp_chromatogram(aggregation_fun = "max") +
  lp_arrange(group_by = "sample_id") +
  lp_legend(position = "bottom") +
  lp_labels(legend = "Sample")

p
```

---

# show,lcmsPlotDataContainer-method

*Show a summary of an instance of class* `lcmsPlotDataContainer`

---

## Description

Show a summary of an instance of class `lcmsPlotDataContainer`

## Usage

```
## S4 method for signature 'lcmsPlotDataContainer'
show(object)
```

## Arguments

| | |
|---|---|
| `object` | An instance of class `lcmsPlotDataContainer`. |

## Value

Invisible `NULL`

## Examples

```
raw_files <- dir(
   system.file("cdf", package = "faahKO"),
   full.names = TRUE,
   recursive = TRUE)[1:5]

data_obj <- new("lcmsPlotDataContainer",
    data_obj = raw_files,
```

```
    metadata = tibble::tibble(),
    chromatograms = tibble::tibble(),
    mass_traces = tibble::tibble(),
    spectra = tibble::tibble(),
    peak_density = tibble::tibble(),
    total_ion_current = tibble::tibble(),
    intensity_maps = tibble::tibble(),
    rt_diff = tibble::tibble(),
    feature_metadata = tibble::tibble(),
    detected_peaks = tibble::tibble())
data_obj
```

---

`show,XcmsRawList-method` *Show a summary of an* `XcmsRawList` *object*

---

## Description

Show a summary of an `XcmsRawList` object

## Usage

```
## S4 method for signature 'XcmsRawList'
show(object)
```

## Arguments

| | |
|---|---|
| `object` | An instance of `XcmsRawList`. |

## Value

Invisible `NULL`.

---

`validate_data_frame` *Validate a data frame against a list of field specifications*

---

## Description

Returns `TRUE` on success or a `character` string describing the first failure. `NULL` and empty data frames always pass.

## Usage

```
validate_data_frame(df, fields, exact = FALSE)
```

### Arguments

| | |
|---|---|
| df | A data.frame or tibble to validate. |
| fields | A list of field specifications created with field(). |
| exact | A logical value. If TRUE, the column names of df must be identical to the names in fields (same set, same order). Defaults to FALSE. |

### Value

TRUE if validation passes, or a character string describing the first failure.

---

## validate_object *Validate the data frame slots of an S4 object*

---

### Description

Iterates over a named list of validator functions, applying each to the corresponding slot of object.

### Usage

```
validate_object(object, validators)
```

### Arguments

| | |
|---|---|
| object | An S4 object whose slots are to be validated. |
| validators | A named list of functions, where each name matches a slot of object and each function accepts a data.frame/tibble and returns TRUE or a character error string (as produced by validate_data_frame()). |

### Value

TRUE if all validators pass, or a character string describing the first failure in the form "@slot_name: <message>".

---

## XcmsRawList *Create an* XcmsRawList *object*

---

### Description

Wraps one or more xcmsRaw objects into an XcmsRawList container for use as the dataset argument of lcmsPlot.

### Usage

```
XcmsRawList(...)
```

### Arguments

| | |
|---|---|
| ... | One or more xcmsRaw objects, or a single list of xcmsRaw objects. |

### Value

An instance of XcmsRawList.

### Examples

```
paths <- dir(
    system.file("cdf", package = "faahKO"),
    full.names = TRUE,
    recursive = TRUE
)[c(1, 2)]
raw1 <- xcms::xcmsRaw(paths[1])
raw2 <- xcms::xcmsRaw(paths[2])
xl <- XcmsRawList(raw1, raw2)
```

---

## XcmsRawList-class *A list of* xcmsRaw *objects representing multiple samples*

---

### Description

XcmsRawList is a container for one or more xcmsRaw objects, where each element corresponds to a single sample. It is the recommended way to pass in-memory raw LC-MS data to lcmsPlot.

### Slots

data A list of xcmsRaw objects, one per sample.

---

## XcmsRawReader-class *An* xcmsRaw*-backed raw MS file reader*

---

### Description

Wraps an in-memory xcmsRaw object. No file connection is opened or closed.

### Slots

obj An xcmsRaw object.

xcmsraw_to_readers *Convert an* XcmsRawList *to a named list of* XcmsRawReader*s*

## Description

Each element is keyed by the file path stored in `@filepath` of the corresponding `xcmsRaw` object.

## Usage

```
xcmsraw_to_readers(xcmsraw_list)
```

## Arguments

| | |
|---|---|
| `xcmsraw_list` | An `XcmsRawList` object. |

## Value

A named `list` of `XcmsRawReader` objects.

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