
# OME Files C++ status

Roger Leigh

May 2017

*Progress over the last year and upcoming features*

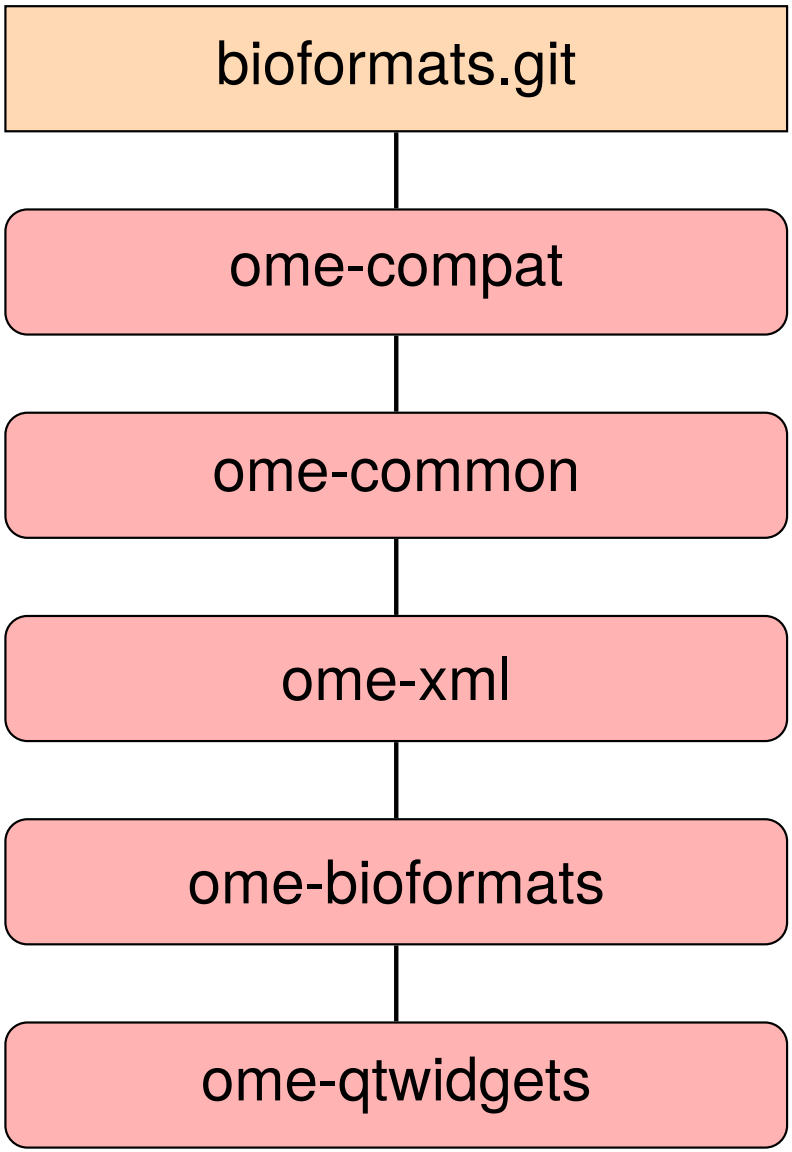
# Introduction


What *is* OME Files?

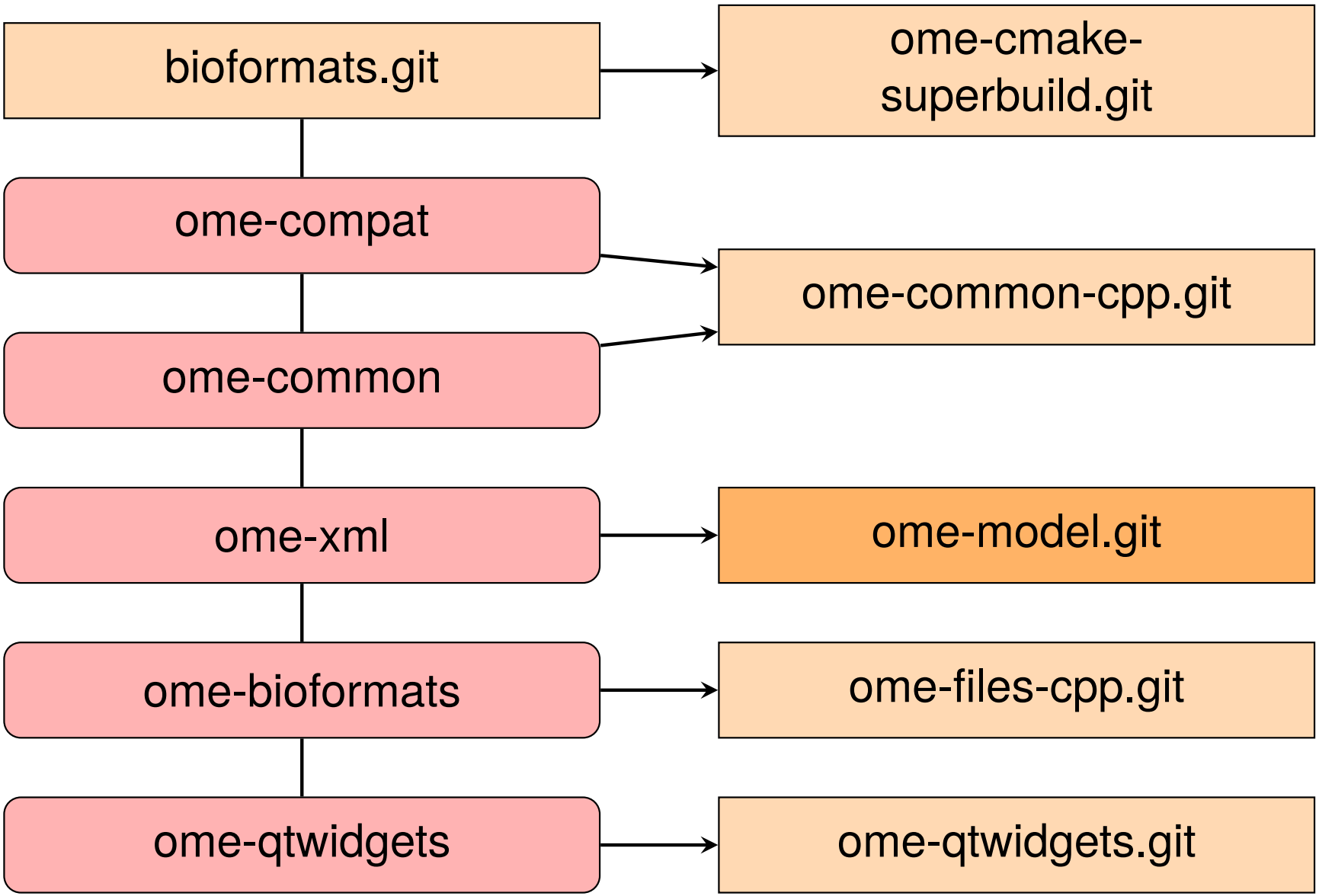
OME Files is a reference implementation of the OME Metadata Model and the OME-TIFF file format.

- Broad API compatibility with Bio-Formats Java
- Read and write support for OME-TIFF and TIFF
- OME Files: reader and writer API
- OME Model: model and metadata API

# Component splitting: completed



# Component splitting: completed

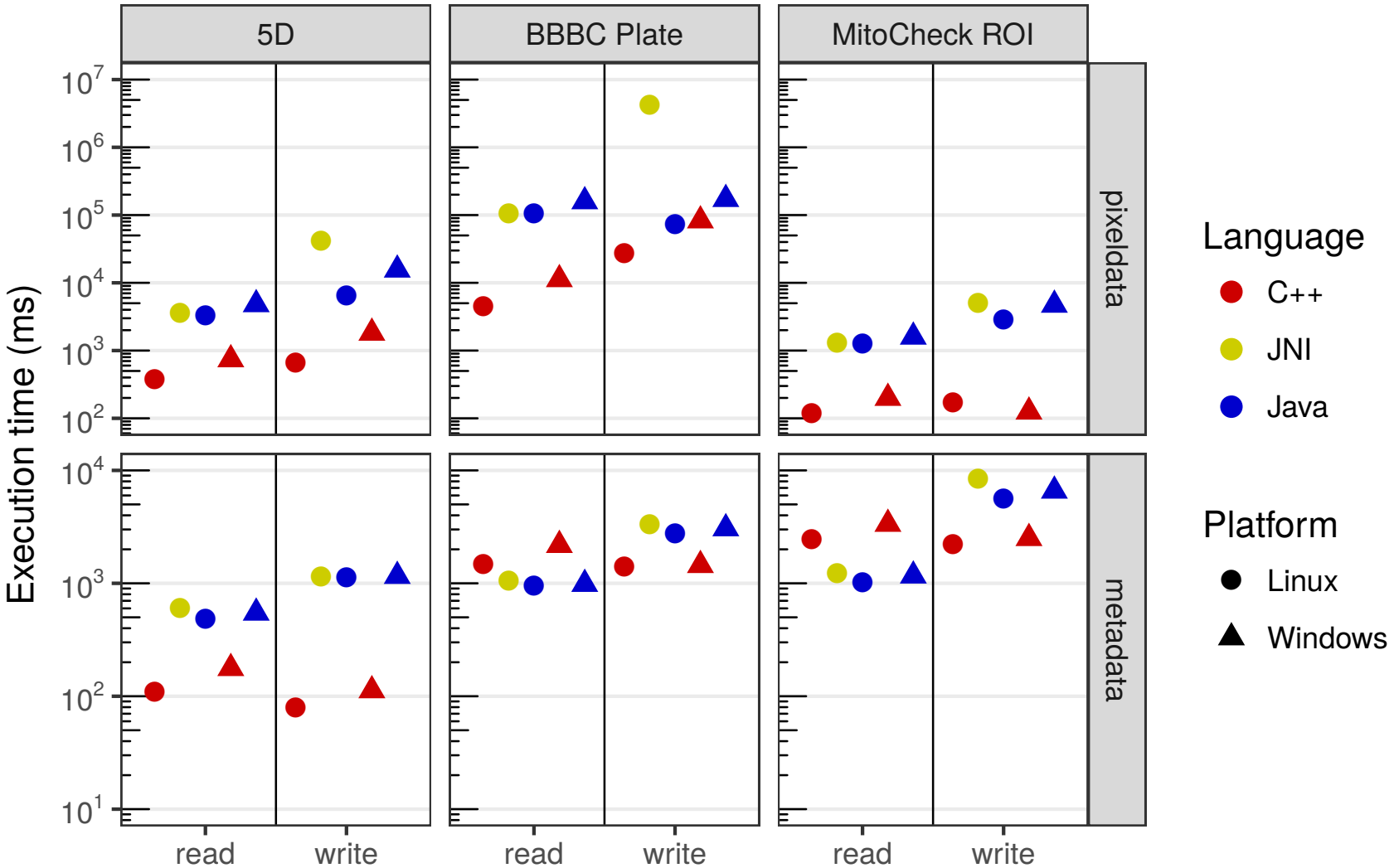


# Performance testing

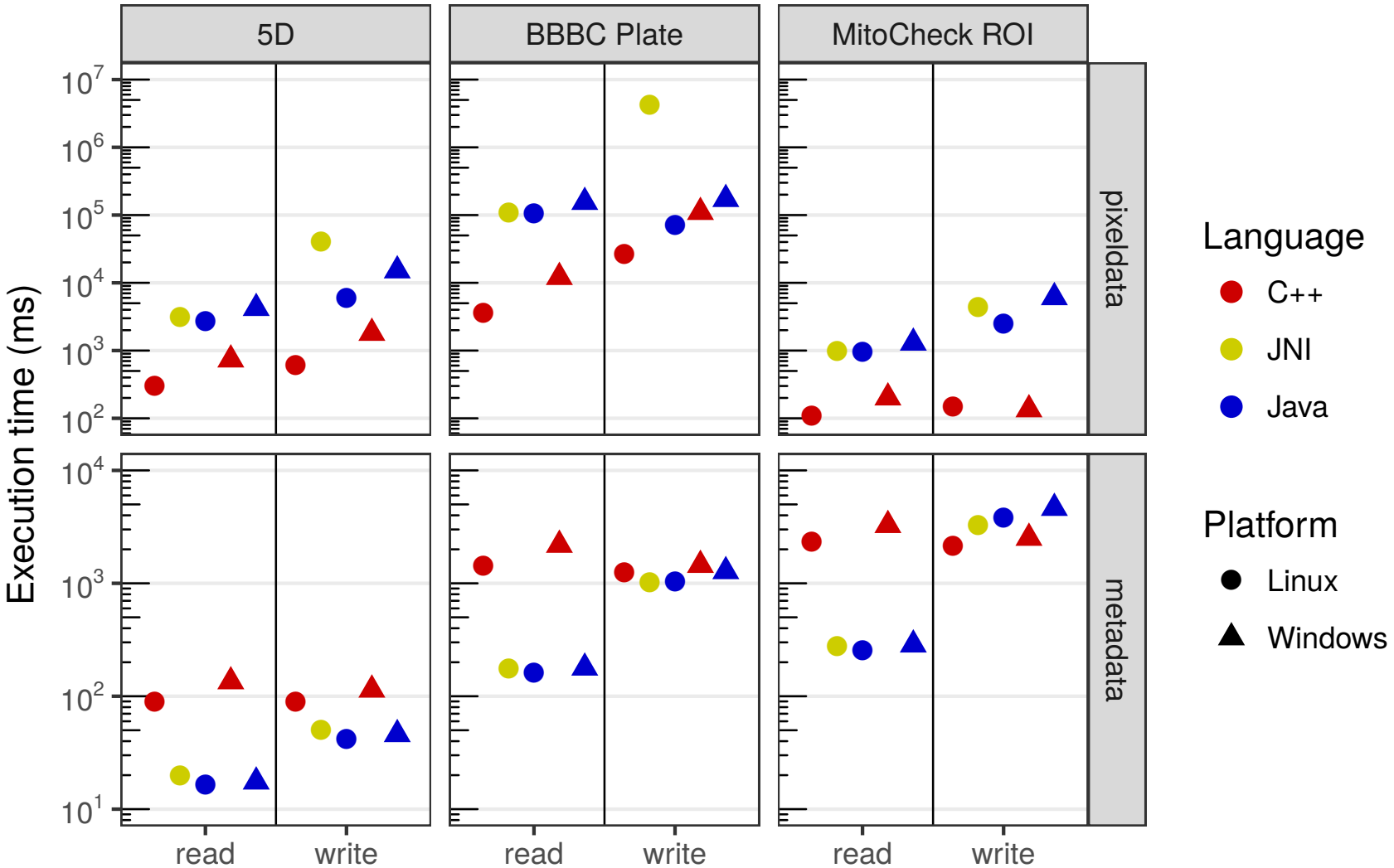
- Profiling of C++, Java and JNI (JACE)
- Real-world data-sets:
  - Simple 5D volume (small, limited metadata)
  - Plate (many images, large pixeldata size)
  - ROI (many ROIs, large metadata size)
- Detailed investigation with call and cache profiling (`valgrind` with `callgrind` and `cachegrind`)
- Ongoing work: tiling performance

Repository: `https://github.com/openmicroscopy/ome-files-performance/tree/0_1`
Preprint: `http://biorxiv.org/content/early/2017/03/09/088740`
Zenodo: `https://zenodo.org/record/559270`

# Performance testing results



# Performance testing results (repeated)



# Windows support

- Added support for VS2015
- Dropped support for VS2012
- Added command line tools
- Numerous fixes and enhancements

# Data model

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- Map annotations
- Model has feature and API parity in C++ and Java
- Native unit and quantity support
- C++ and Java model maintained together in a unified codebase

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- Units
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Minor features:

- BinData
- ROI transforms

# TIFF readers and writers

- added TIFF compression
- added default strip and tile size heuristic
- added IFD offset caching
- added OME-TIFF validity checks, metadata caching, file caching, plane element handling

```
writer.setCompression("lzw");
writer.setInterleaved(false);
writer.setTileSizeX(512U);
writer.setTileSizeY(512U);
```

# Additional changes

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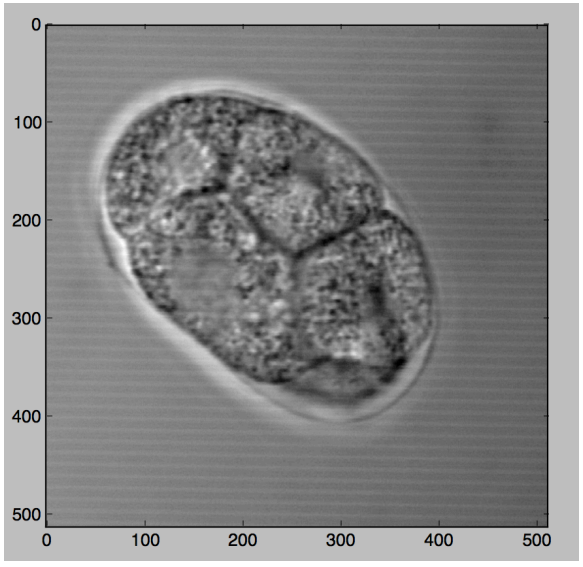
```
typedef model::primitives::Quantity
  <model::enums::UnitsLength,
   model::primitives::PositiveFloat> PositiveLength;
metadatastore.setPixelsPhysicalSizeX
  (PositiveLength(118.2,
      model::enums::UnitsLength::MICROMETER), 0);

// C++11
metadatastore.setPixelsPhysicalSizeX
  ({118.2, UnitsLength::MICROMETER}, 0);

//  Low level Boost.Units
micrometre_quantity len(118.2);
```

# Python API

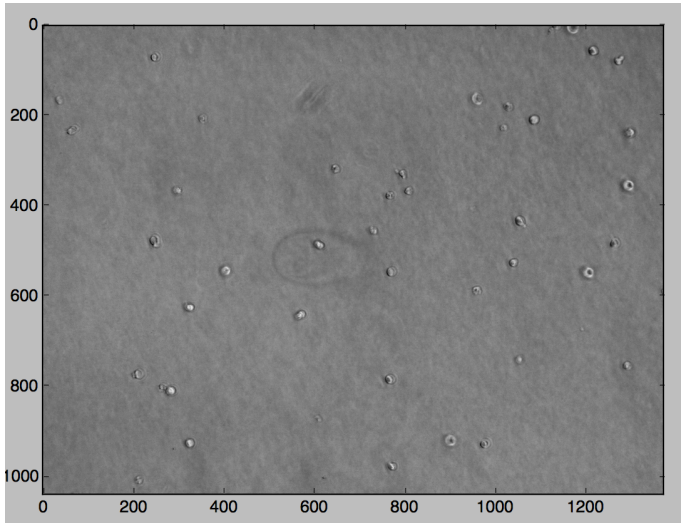
- `https://github.com/ome/ome-files-py`
- Core: Python extension module that wraps the C++ API
- Can open image planes as NumPy arrays
- Work in progress: exposes a subset of `OMETIFFReader`

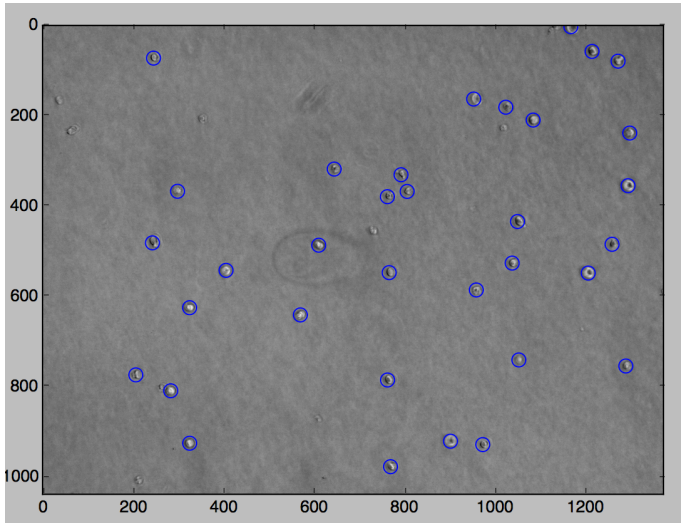
```
import ome_files
import matplotlib.pyplot as plt

reader = ome_files.OMETIFFReader()
reader.set_id("tubhiswt_C0.ome.tif")
pixels = reader.open_array(0)
reader.close()
plt.imshow(pixels, cmap="gray")
plt.show()
```



# Python API: external metadata

```
import matplotlib.pyplot as plt
import pandas as pd
import datapackage
import ome_files
import ome_files.metadata as ofmd

reader = ome_files.OMETIFFReader()
reader.set_id("9I5TT808_F00000010.companion.ome")
pixels = reader.open_array(0)
plt.imshow(pixels, cmap="gray")
plt.show()
meta = ofmd.OMEXMLMetadata(reader.get_ome_xml())
reader.close()
cmso_annotations = [
  _ for _ in meta.get_map_annotations()
  if _.Namespace == "CMSO/dpkg"
]
ann = cmso_annotations[0]
paths = ann.Value.get("FilePath")
dp = datapackage.DataPackage(paths[0])
res_map = dict((_.descriptor["name"],
      _.local_data_path) for _ in dp.resources)
df = pd.read_csv(res_map["objects_table"])
df = df[df["time index"] == 0]
x, y = df["cell col"].values, df["cell row"].values
plt.scatter(x=x, y=y, s=100, edgecolors='b',
      facecolors='none')
plt.imshow(pixels, cmap="gray")
plt.show()
```



# Future possibilities

- Flexible model annotations
  - `Modulo`
  - Direct serialisation of custom annotations

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  - `Modulo`
  - Direct serialisation of custom annotations
- Options API (YAML?)

# Feedback requested (and help required)

Feedback appreciated:

- Dropping support for VS2013 (deprecate then EOL?)
- Adding support for VS2017?
- Windows DLLs

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Help or advice needed:

- Supporting Windows DLLs

# Summary

OME Files C++ now supports:

- The latest OME-TIFF and OME Model versions
- Complete API parity with Bio-Formats (modulo `Modulo`)

Performance profiling shows:

- Pixel data performance exceeds Java performance
- Metadata writing exceeds Java performance
- Metadata reading mostly exceeds Java performance