# Pixelator Instrument Control and Data Acquisition System for Scanning Spectro-Microscopy

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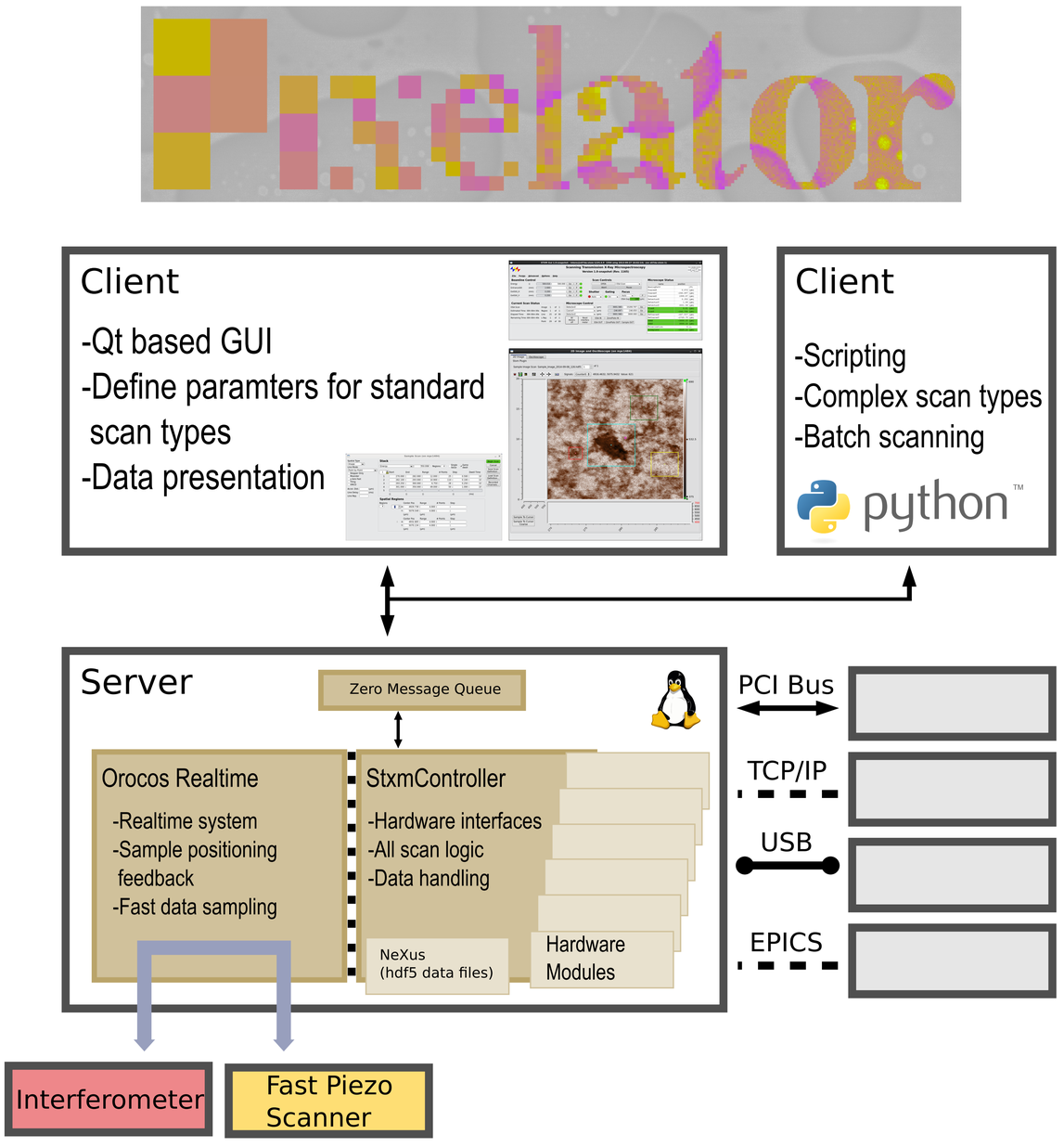
## Introduction

Scanning transmission X-ray spectro-microscopy (STXM) is a synchrotron-based materials analysis technique that provides high resolution imaging with strong, natural contrast based on various X-ray spectroscopic effects. Basic STXM experiments involve focusing a monochromatic X-ray beam onto a thin sample and measuring the amount of transmitted radiation - this provides a single pixel of an image that is built up by raster-scanning the sample and measuring pixel values one-by-one. Typical data sets involve a set of images at different photon energies (a data-cube of two spatial dimensions and one spectroscopic dimension). While slower than full-field imaging, the simple set-up allows easier access to spectroscopy, other detector types for sensitivity to the sample surface (electron detection) or the presence of trace elements (fluorescence), and special sample environments. Precision and reproducibility of the scanning system can be provided by interferometric measurement of the sample position (in any number of dimensions), with feedback to the scanning stages.

## Software

Software to control STXM instruments require a great deal of flexibility in order to deal with the myriad hardware types and allow novel scan types. At the same time, overhead must be minimised in order to keep the scan speed reasonably fast. Pixelator is a collaboration between the Paul Scherrer Institute, the Max-Planck-Institut für Intelligente Systeme and Semafor Informatik & Energie AG. Pixelator has been in standard use at the PolLux/SLS STXM since late 2012 and has also been installed at the HERMES/Soleil, the MAXYMUS/BESSY, MYSTIIC/BESSY STXMs as well as the SOPHIE pychography+STXM instrument currently running at SoftiMAX. Many hardware interface modules are implemented for common beamline control systems (EPICS and TANGO), motor controllers (Newport, PI, Smaract) and I/O cards (Agilent, NI). New additions include support for PandABox and modernising the realtime system with Orocos.
Scans can be conducted point-wise or on the fly with any number of scan axes. Scan arrays don't need to be rectangular, and Fermat spiral scans are often used for ptychography scans. Scripted experiment control is implemented by a Python library that produces the same high-level commands as the client GUI sends to the server.




## Hardware

STXM experiments require the integration of many diverse components, each with their own communications systems. The fastest scanning axis in a STXM experiment tends to be the sample x-axis, as the sample is raster-scanned to form an image. High speed scanning of the sample is achieved with a fast piezo scanner and positioning precision is measured via an interferometer, with feedback to the piezo scanner.
STXM experiments tend to involve novel sample environments and so Pixelator allows easy configuration of arbitrary extra input/output channels in order to integrate user-systems for hardware control and sample environment sensors.