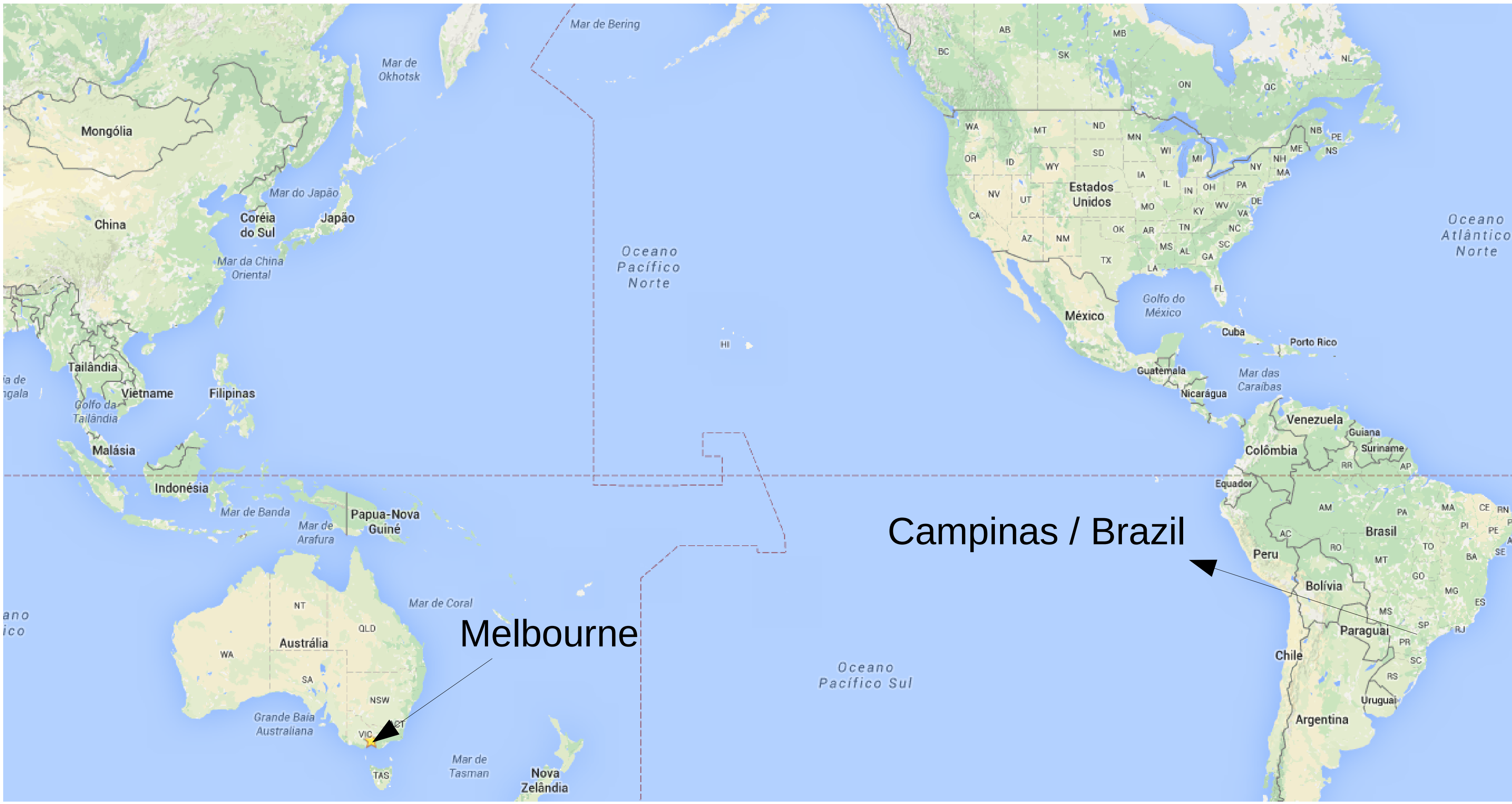
Py4Syn - a Python library for beamline control under EPICS

LNLS

Laboratório Nacional de Luz Síncrotron – the name in Portuguese to National Synchrotron Light Laboratory



LNLS

Sirius building site – July 2015

General View

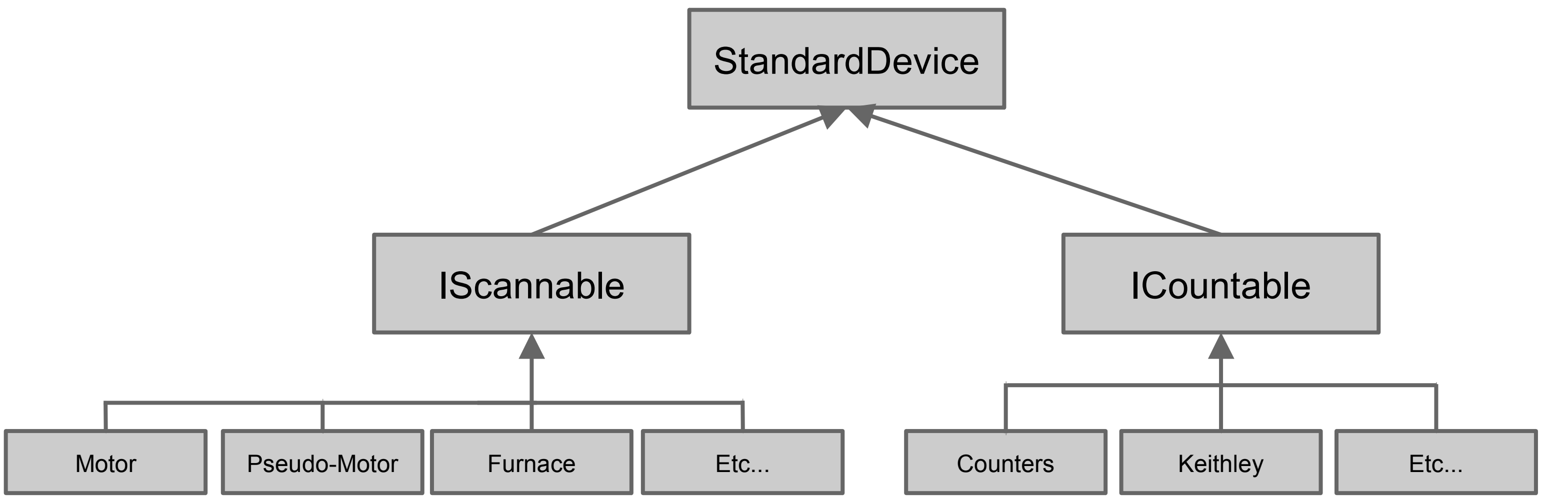
What is Py4Syn?

Py4Syn *(Python For Synchrotron)* is:

- A Python package
- Used as a high level tier
- A Device manipulation tool
- Used for scans
- Used to see charts in real-time
- Simple

Devices

Devices classification



Complete list: http://py4syn.readthedocs.org/en/latest/epics.html

Motor Movement

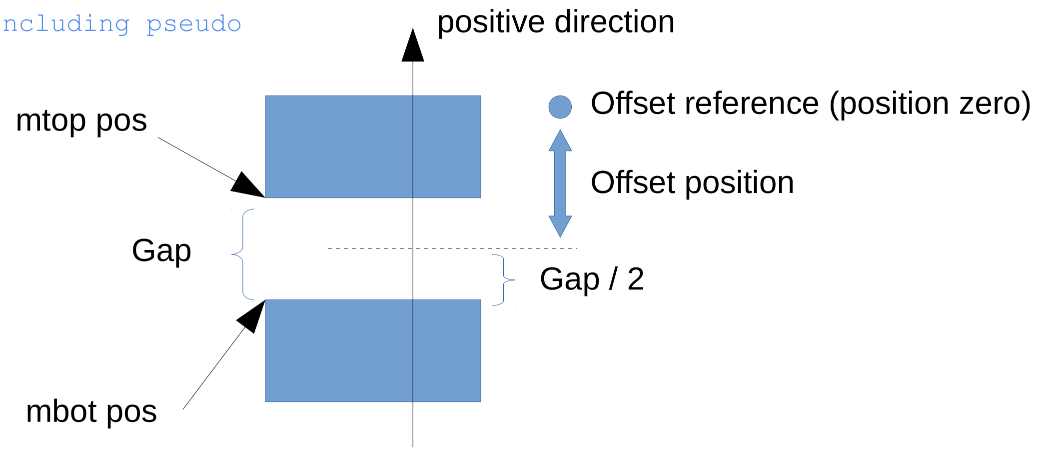
```
from py4syn.utils.motor import *

createMotor('mtop','SOL:DMC1:m3') # Create a motor named mtop

umv('mtop', 10)  # Move mtop to absolute position 10
                 # Wait for arrival
                 # Show position while moving

wa() # Show the position of all motors created

currentPosition = wmr('mtop') # Read the current position

mv('mtop', 20, wait=False) # Move mtop to absolute position 20
                           # Do not wait for arrival
                           # Do not show position while moving

# Here code can run while motor is moving
```

Complete list in:
http://py4syn.readthedocs.org/en/latest/utils/utils_motor.html

Pseudo-Motors

Example: create a pseudo-motor to control gap size and offset of a slit

```
from py4syn.utils.motor import *

createMotor('mtop','SOL:DMC1:m3') # Create motor mtop
createMotor('mbot','SOL:DMC1:m4') # Create motor mbot

gapRBV = 'A[mtop]-A[mbot]' # Equation to describe gap size
gapTopTarget = 'A[offset]+T[gap]/2.0' # Equation to define mtop target
gapBotTarget = 'A[offset]-T[gap]/2.0' # Equation to define mbot target

offsetRBV = 'A[mtop]-A[gap]/2.0' # Equation to describe offset position
offsetTopTarget = 'T[offset]+A[gap]/2.0' # Equation to define mtop target
offsetBotTarget = 'T[offset]-A[gap]/2.0' # Equation to define mbot target

createPseudoMotor('offset', 'off slit 1', offsetRBV, {mtop: offsetTopTarget, mbot: offsetBotTarget})
createPseudoMotor('gap', 'gap slit 1', gapRBV, {mtop:gapTopTarget, mbot: gapBotTarget})

wa() # Show motor position for all motors, including pseudo
umv('gap', 5) # Move gap to 5 and wait
wa() # Show motor position for all motors, including pseudo
```



Counters

```
from py4syn.epics.ScalerClass import *
from py4syn.utils.counter import *

scaler = Scaler('SOL:SCALER', 10, 'scaler1') # Create a scaler

createCounter('det',scaler, 3, factor=1) # Create a counter named det
createCounter('mon',scaler, 10, monitor=True) # Create a counter named mon

ct(1, use_monitor=False)# Run a 1 preset time count in all counters
                        # Show results at the end

counting = ctr(1000, use_monitor=True)# Run a counting and return data

disableCounter('det') # Disable det counter
```

Complete list: http://py4syn.readthedocs.org/en/latest/utils/utils_counter.html

Charts

There is a need to show data in real-time and the need that data rendering would not generate lateness in running scans.

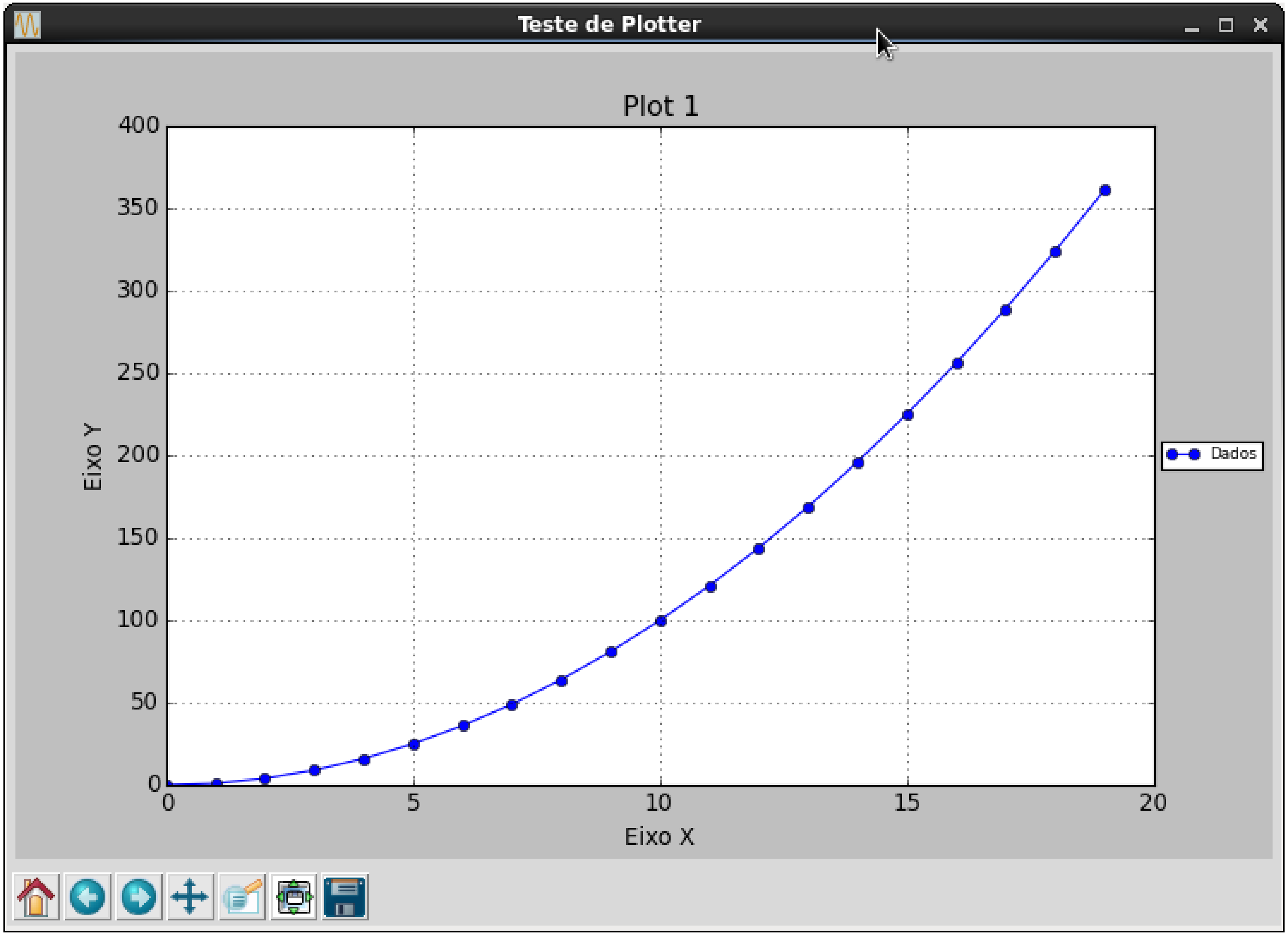
- Real-time rendering.
- Many charts in the same windows.
- Data overlap in the same chart.

Example 1: Simple chart

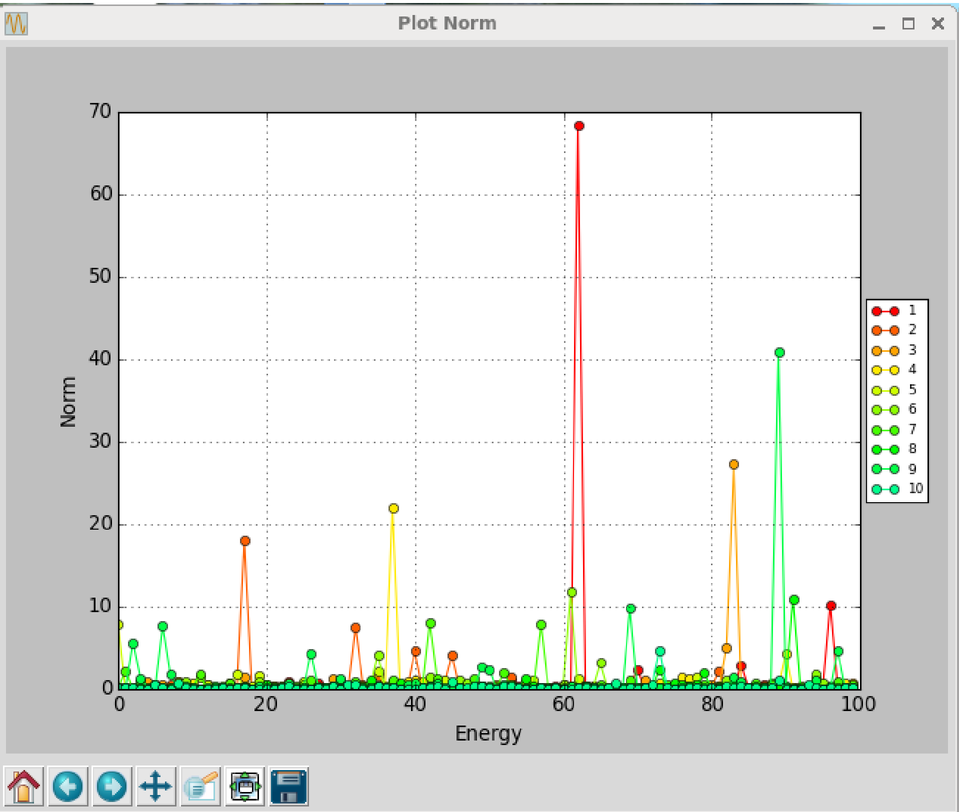
```
import time
from py4syn.utils.plotter import *

pl = Plotter("Teste de Plotter", daemon=False) # Create a Plotter (Window)
pl.createAxis("Plot 1", xlabel="Eixo X", ylabel="Eixo Y", grid=True,
line_style="-", line_marker="o", line_color="blue", label="Dados")  # Create a
new axis

for i in range(0, 20):
    pl.plot(i, i*i, axis=1) # Put a new point in chart
    time.sleep(0.1)
```

Complete list: http://py4syn.readthedocs.org/en/latest/utils/utils_plotter.html

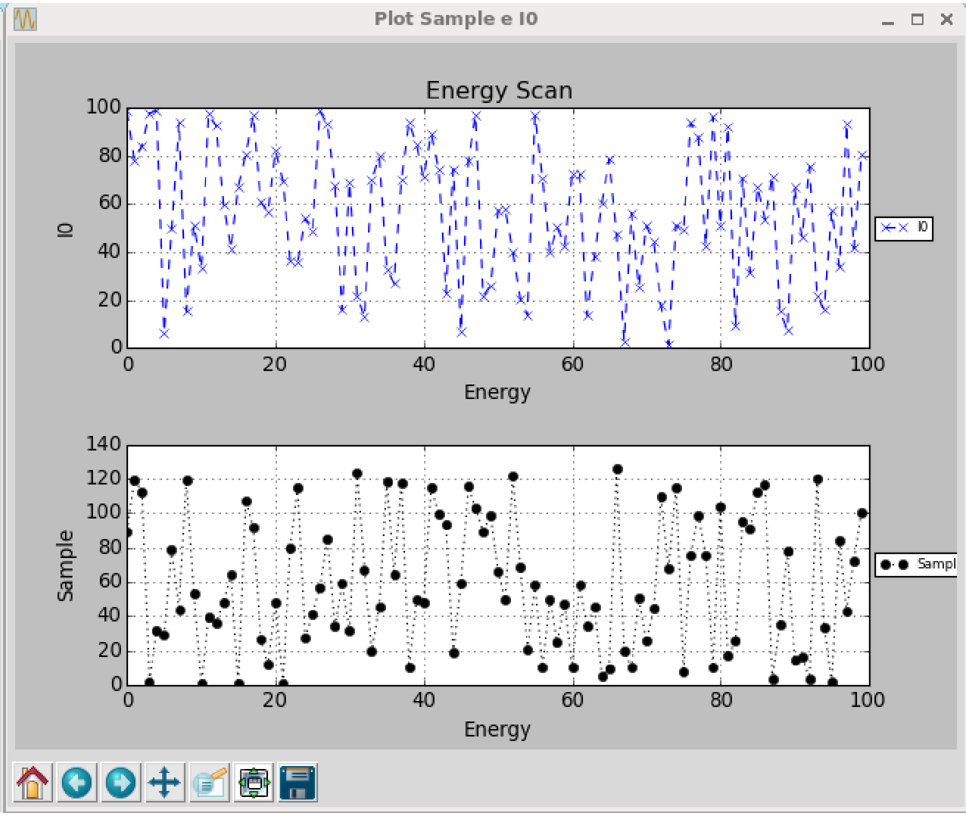
Charts


Teste de Plotter
Plot 1
400
350
300
250
200
150
100
50
0
Eixo Y
0
5
10
15
20
Eixo X
Dados

Charts



Plot Norm
Norm
Energy
1
2
3
4
5
6
7
8
9
10



Plot Sample e I0
Energy Scan
I0
Energy
Sample
Energy
Sampl

Scans

In Py4Syn library, devices are divided into two groups:

IScannable

The IScannable interface defines some standard operations that all devices intended to be used during a scan must implement. For example:

- **setValue** - Define the target value
- **getValue** - Read the current value
- **wait** - Wait until the target is hit
- **getLowLimit -** Read low limit
- **getHighLimit** - Read high limit

ICountable

The ICountable interface defines some standard operations that all devices intended to be used as counters must implement:

- **getValue** – Read the current value
- **setCountTime** - Define integration time
- **setPresetValue** - Define preset value
- **startCount –** Start a counting
- **stopCount**- Stop a counting
- **canMonitor** – Define if it can be used as a monitor
- **canStopCount** - Define if counting can be interrupted
- **isCounting –** Verify if counting is being done
- **wait –** Wait until counting ends

These special interfaces allow a generalization of devices for scanning functions independently of its type: a motor, a furnace, a MCA, a CCD, etc.

Scans

There are 3 scanning types available:

- **Scan**
  - In a Scan, the number of points is the same for all used devices.
  - Devices will search for its targets at the same time.
  - There are no restrictions to the number of devices or points used.
  - There are no restrictions to devices types being used as long as the Iscannable interface is implemented.

- **Mesh**
  - In a mesh the number of points is independent for each used device.
  - For each point of a device, the next device will do a complete scan before the former device goes to the next point.
  - There are no restrictions to the number of devices or points used.
  - There are no restrictions to devices types being used as long as the IScannable interface is implemented.

- **Timescan**
  - In a timescan no devices but counters are used. This scan runs in time defined intervals.
  - It is possible to define a delay time between measurements.

scan function

Example:

- scan('m1', 0, 2, 'm2', 2, 6, 2, 0.1)

Where:

- m1 will go from 0 to 2 with steps of value 1 ((2-0)/2)
- m2 will go from 2 to 6 with steps of value 2 ((6-2)/2)
- 3 points in total (2 points + 1 final point)
- 0.1 seconds of integration time

Results in:

Point	m1	m2
0	0.0	2.0
1	1.0	4.0
2	2.0	6.0

mesh function

Example:

- mesh('m1', 0, 2, 2, 'm2', 2, 6, 2, 0.1)

Where:

- m1 will go from 0 to 2 with steps of value 1 ((2-0)/2)
- m2 will go from 2 to 6 with steps of value 2 ((6-2)/2)
- 9 points in total (2 points + 1 final point) to m1 and m2, and for mesh, total = pm1*pm2 = 3*3
- 0.1 seconds of integration time

Results in:

Point	m1	m2
0	0.0	2.0
1	0.0	4.0
2	0.0	6.0
3	1.0	2.0
4	1.0	4.0
5	1.0	6.0
6	2.0	2.0
7	2.0	4.0
8	2.0	6.0

timescan function

Standard format of timescan function:

timescan(time, delay, repeat)

Where:

time is the integration time to be configured in used counters. Default value is 1 second.

delay is the time to wait until the next counting. Default value is 1 second.

repeat is the number of counting to be done. Default value is infinite.

Callbacks

Independently of the scan type, many customizations are possible to the actions by means of user defined functions (*Callbacks*).

There are 7 available callbacks for all scan types:

- **Pre Scan Callback**
  - Called before the start of a scan.
- **Pre Point Callback**
  - Called before any device is commanded to its target.
- **Pre Operation Callback**
  - Called after all devices arrive in the target and before the start of the counters.
- **Operation Callback**
  - Called while the counters are counting.
- **Post Operation Callback**
  - Called after the counting and before the chart updates.
- **Post Point Callback**
  - Called after all operations and before the start of a new point.
- **Post Scan Callback**
  - Called after the end of the scan.

Callbacks

Example: Defining a callback to be called during the counting

```
from py4syn.utils.scan import *

def myCallback(**kwargs): # Function that will be called during the operation.
   scanObject = kwargs['scan'] # Reference to scan object.
   indexArray = kwargs['idx'] # Reference to the point index.
   positionArray = kwargs['pos'] # Reference to the devices position.
   print('Callback message')

setPreScanCallback(defaultPreScanCallback)  # Configuring PreScanCallback to default.

setOperationCallback(mycallback)  # Configuring OperationCallback to our function.

scan('m1', 0, 180, 10, 1) # Running the scan with the configuration.
```

Data

Focusing in better performance and the lowest possible dead-time, data is kept in memory during data registration. Only at the end of a scanning (by error or success) data is transferred to disk. To change this default behavior, one must use the function setPartialWrite(True). Doing so, data is saved at each iteration.

The standard file format is the same used by SPEC and PyMCA because beamlines in LNLS are historically used to it. This format is supported by many analysis programs, too.

Example:

```
#E 1413896783
#D Tue Oct 21 11:06:23 2014
#C py4syn User = user.name
#C This is a comment, ignore it
#S 1 scan(gap, 10, 11, 10, 0.01)
#D Tue Oct 21 11:06:15 2014
#T 0.01  (Seconds)
#N 7
#L points  gap  seconds  I0  cyber  testeField  timestamp
0 10.0 7.495 0.50 0.733 N/A 2014-10-21 11:06:17.423802
1 10.1 5.973 0.40 0.496 N/A 2014-10-21 11:06:17.988520
…
…
```

Laboratório Nacional de Luz Síncrotron

Data

Saving data using a different format:

- Create a class that implements FileWriter interface
- Methods to be implemented:
  - writeHeader(self) – Write the header to a file
  - writeData(self, partial=False, idx=-1) – Write data to file
  - close(self) – Close the file
- Pass the new class to scan object: scan.setFileWriter(writer)

writeData must use data information provided by SCAN_DATA dictionary. Its structure is described in http://py4syn.readthedocs.org/en/latest/utils/utils_scan.html#handling-the-data

Py4Syn

Py4Syn is open-source. Code can be get at https://github.com/hhslepicka/py4syn

Complete documentation: http://py4syn.lnls.br

Published paper: http://scripts.iucr.org/cgi-bin/paper?S1600577515013715