

# Introduction to Automating LightField 6 with Python™



4411-0163  
Issue 5  
January 7, 2020

[www.princetoninstruments.com](http://www.princetoninstruments.com)

## Revision History

Issue	Date	List of Changes
Issue 5	January 7, 2020	Issue 5 of this document incorporates the following changes: <ul style="list-style-type: none"><li>• Updated the copyright year.</li></ul>
Issue 4	July 24, 2019	Issue 4 of this document incorporates the following changes: <ul style="list-style-type: none"><li>• Global removal of Fax number.</li></ul>
Issue 3	March 18, 2019	Issue 3 of this document incorporates the following changes: <ul style="list-style-type: none"><li>• Added new sample application:<ul style="list-style-type: none"><li>— Section 5.2.14, <code>synchronous_acquisition.py</code>, on page 23.</li></ul></li><li>• Rebranded as Teledyne Princeton Instruments.</li></ul>
Issue 2	January 2, 2018	Issue 2 of this document incorporates the following changes: <ul style="list-style-type: none"><li>• Updated the copyright date.</li></ul>
Issue 1	November 27, 2017	This is the initial release of this document.

©Copyright 2017-2020    Teledyne Princeton Instruments  
All Rights Reserved    3660 Quakerbridge Rd  
                                 Trenton, NJ 08619  
                                 TEL: 800-874-9789 / 609-587-9797

All rights reserved. No part of this publication may be reproduced by any means without the written permission of Teledyne Princeton Instruments.

Printed in the United States of America.

Pentium is a registered trademark of Intel Corporation.

Python" is a registered trademark of the Python Software Foundation ("PSF"). The Python logos (in several variants) are use trademarks of the PSF as well.

PVCAM is a registered trademark of Teledyne Princeton Instruments

Scientific Imaging ToolKit and SITK are trademarks of R Cubed Software Consultants, LLC.

IntelliCal, PICam, SuperSYNCHRO, and SyncMASTER are trademarks and IsoPlane, LightField, and PI-MAX are registered trademarks of Teledyne Princeton Instruments.

Windows and Windows Vista are registered trademarks of Microsoft Corporation in the United States and/or other countries.

The information in this publication is believed to be accurate as of the publication release date. However, Teledyne Princeton Instruments does not assume any responsibility for any consequences including any damages resulting from the use thereof. The information contained herein is subject to change without notice. Revision of this publication may be issued to incorporate such change.

# Table of Contents

---

<b>Chapter 1:</b>	<b>Introduction to Automation.....</b>	<b>5</b>
1.1	Prerequisites .....	6
<b>Chapter 2:</b>	<b>Prepare LightField.....</b>	<b>7</b>
2.1	Verify SDK Installation .....	7
2.2	Create Default Experiment .....	9
<b>Chapter 3:</b>	<b>Build a Simple Automation Application.....</b>	<b>11</b>
3.1	Development Tools .....	11
3.2	Sample Application Development.....	12
<b>Chapter 4:</b>	<b>Using LightField Experiment Settings Help File.....</b>	<b>15</b>
4.1	Identify Device Parameters and Valid Enumeration Values .....	15
<b>Chapter 5:</b>	<b>Sample Applications.....</b>	<b>19</b>
5.1	Common Program Elements .....	19
5.1.1	Required DLLs .....	20
5.1.2	Required Imports.....	20
5.2	Application-Specific Information .....	20
5.2.1	acquisition_filename.py .....	20
5.2.2	add_remove-device.py .....	21
5.2.3	emccd.py.....	21
5.2.4	event_handling.py.....	21
5.2.5	exposure_acquire.py .....	21
5.2.6	multiple_lightfields.py .....	21
5.2.7	multiple_roi.py.....	22
5.2.8	repetitive_gating.py .....	22
5.2.9	saving_loading_experiments.py.....	22
5.2.10	sequential_gating.py.....	22
5.2.11	settings.py.....	23
5.2.12	spe_file_access.py .....	23
5.2.13	spectrometer.py .....	23
5.2.14	synchronous_acquisition.py .....	23
5.2.15	temperature.py .....	24
<b>Appendix A:</b>	<b>Install Python™ .....</b>	<b>25</b>
A.1	Install Python™ .....	25
A.2	Install Python for .Net .....	28

## List of Figures

Figure 2-1:	Typical Control Panel Window . . . . .	7
Figure 2-2:	Typical <i>Programs and Features</i> Dialog: Change . . . . .	8
Figure 2-3:	Typical InstallShield Wizard Dialog . . . . .	8
Figure 3-1:	Typical New Python™ Shell Window . . . . .	12
Figure 3-2:	Typical New Python™ Editor Window . . . . .	12
Figure 3-3:	Typical Python™ Code Snippet: Required Imports . . . . .	13
Figure 4-1:	Typical <i>LightField Experiment Settings.chm</i> Help File . . . . .	15
Figure 4-2:	Typical Classes Table . . . . .	16
Figure 4-3:	CameraSettings Class Information . . . . .	16
Figure 4-4:	Partial View: CameraSettings Members Table . . . . .	17
Figure 4-5:	CameraSettings Members: AdcQuality Entry . . . . .	17
Figure 4-6:	AdcQuality Camera Setting Information . . . . .	18
Figure 4-7:	AdcQuality Camera Setting Information . . . . .	18
Figure A-1:	List of Available Python™ Versions. . . . .	25
Figure A-2:	Open File - Security Warning . . . . .	26
Figure A-3:	Typical Python™ Setup Dialog . . . . .	26
Figure A-4:	Typical Installation Progress Bar . . . . .	27
Figure A-5:	Typical Setup Success Dialog . . . . .	27
Figure A-6:	List of Available Python for .Net Download Packages . . . . .	28
Figure A-7:	Python™ Installation Directory with Python for .Net File . . . . .	29
Figure A-8:	Typical Command Prompt Window . . . . .	29
Figure A-9:	Typical Command Prompt Window: Python™ Installation Directory . . . . .	30
Figure A-10:	Command to Launch PIP Package Manager . . . . .	30
Figure A-11:	Typical Python for .Net Installation Successful Message. . . . .	31

## List of Tables

	Revision History . . . . .	2
Table 5-1:	Sample Teledyne Princeton Instruments Python™ Applications . . . . .	19

# Chapter 1: Introduction to Automation

---

LightField 6 is able to interface with several third-party applications in order to automate the configuration and performance of experiments within LightField.

Automation is the ability to use a programming environment (e.g., Python™,) to control LightField externally to perform tasks such as:

- Modifying experiment configuration parameters such as:
  - Exposure Time;
  - Frames to Save;
- Connecting/disconnecting hardware;
- Displaying live data as it is being acquired;
- Importing previously acquired data that have been saved.

Automation differs from a standard LightField Add-in in that LightField is actually being controlled by an external program as opposed to running what is, effectively, a LightField subroutine.

This document provides an introduction to developing automation routines using Python™ programming environment.



## **NOTE:**

---

This document is not intended to be a tutorial about using Python™. It is written with the assumption that the reader possesses a basic knowledge of the Python™ programming language.

---

This document provides information necessary to automate LightField 6 with Python™, including:

- Installing all required software;
- Configuring LightField 6 for automation by Python™;
- How to build an automation application;
- Experiment settings;
- Sample Python™ automation applications.

## 1.1 Prerequisites

In order to automate LightField 6 using Python™, the following requirements must be satisfied:

- LightField 6 must be installed on the host computer, including the **Add-Ins and Automation SDK** option.

**NOTE:**

For complete information, refer to the installation instructions included with LightField 6.

- **64-bit compatible** Python™ version 3.6.3 (or later) must be installed on the host computer.

The most recent **64-bit** version of Python™ is available for download from the following website:

<https://www.python.org/downloads/windows/>

**NOTE:**

If Python™ is not already installed, refer to [Section A.1, Install Python™](#), on page 25 for complete information.

- **64-bit compatible Python for .Net** version 3.6.0 (or later), must be installed on the host computer.

Python for .Net is required to integrate Python™ applications with .NET 4.0+ Common Language Runtime (CLR) on Windows. This is required to run sample automation scripts created by Teledyne Princeton Instruments.

Additional information about Python for .Net is available here:

<https://pythonnet.github.io/>

**NOTE:**

If **Python for .Net** is not already installed on the host computer, refer to [Section A.2, Install Python for .Net](#), on page 28 for complete information.

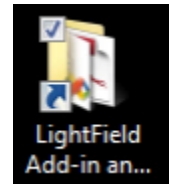
# Chapter 2: Prepare LightField

This chapter describes the steps necessary to prepare LightField for automation using Python™.

## 2.1 Verify SDK Installation

Before developing any automation routines, verify the **Add-Ins and Automation SDK** has been included as part of the LightField installation.

When the SDK has been included, LightField places a shortcut on the host computer desktop. This shortcut points to a directory in which information required by the automation application developer is stored. This information includes:

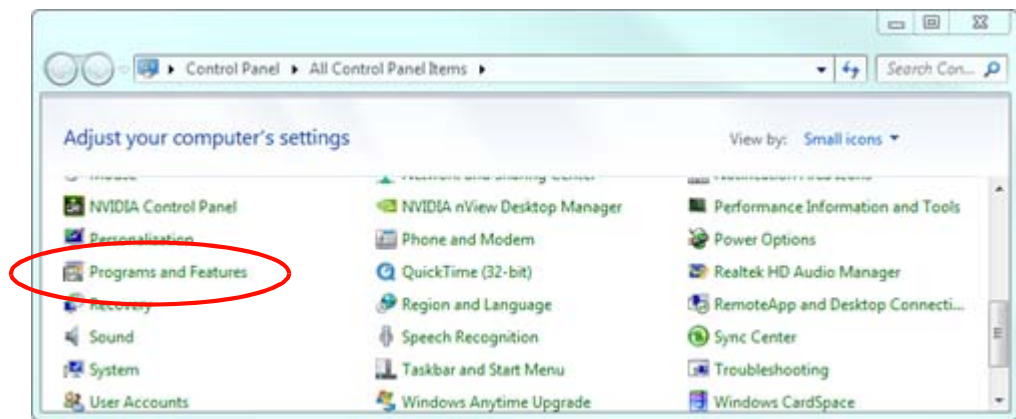


- **LightField Add-ins and Automation Programming Manual.pdf;**  
Provides detailed programming information about the API and .NET function required to develop an automation application.
- **Experiment XML Specification.pdf;**  
This is the specification that defines how a LightField experiment file is structured.
- **SPE 3.0 File Format Specification.pdf;**  
This is the specification that defines how LightField saves acquired data. In order to access data after it has been saved, how it is stored/save must first be understood which is detailed in this document.
- **LightField Experiment Settings.chm.**  
This Windows Help File provides information about all settings used when interacting with LightField. The information included in this help file is required when developing automation applications.

If the shortcut is not located on the host computer's desktop, it is a good indication that the SDK has not been included in the current LightField installation. Perform the following procedure to modify the LightField installation on the host computer:

1. Open the **Windows Control Panel** and select **Programs and Features**. See [Figure 2-1](#).

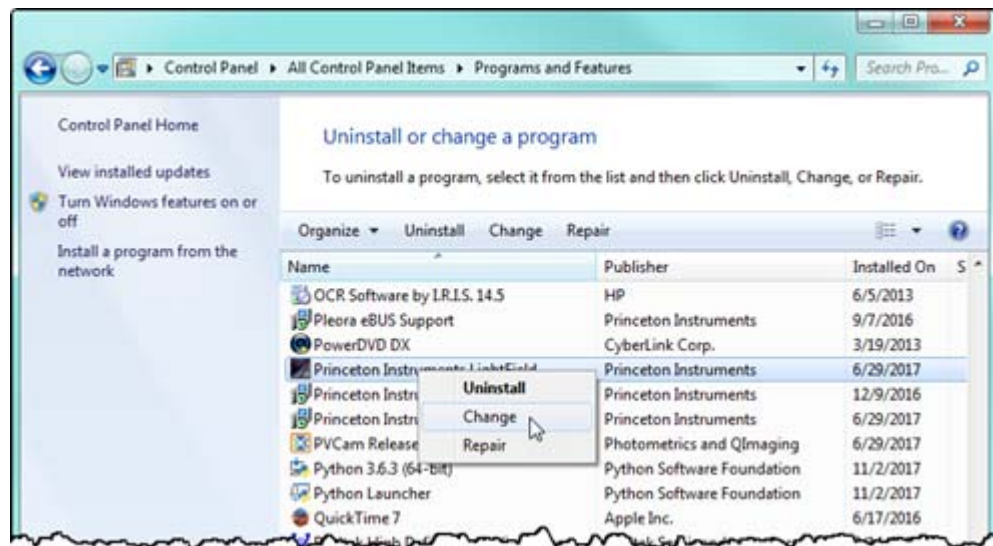
Figure 2-1: Typical Control Panel Window



4411-0163\_015

2. From the list of installed programs, scroll to locate **Princeton Instruments LightField**, right-click on it, and select **Change** from the pull-down menu. See [Figure 2-2](#).

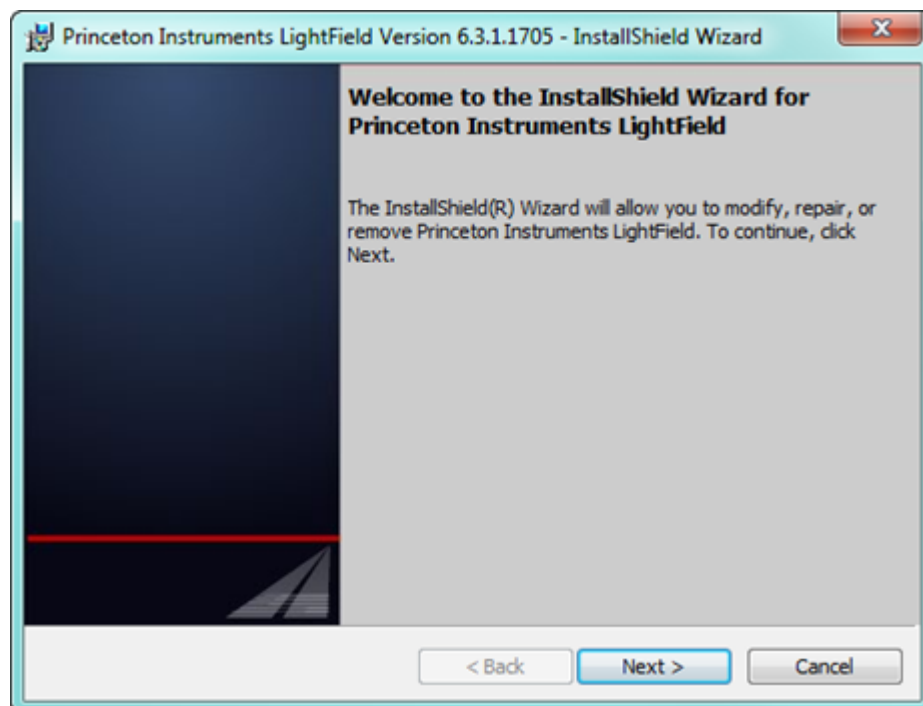
Figure 2-2: Typical *Programs and Features* Dialog: Change



4411-0163\_016

3. The **InstallShield Wizard** will launch. Follow on-screen prompts to modify the LightField Installation to include **LightField Add-in** and **Automation SDK**. See [Figure 2-3](#).

Figure 2-3: Typical InstallShield Wizard Dialog



4411-0163\_017



## 2.2 Create Default Experiment

It is recommended that a baseline, default LightField experiment be created and saved prior to beginning any automation application development. Doing so will reduce the number of preliminary and initial configuration steps required by the automation application.

Perform the following procedure to create a default experiment that will serve as the basic experiment for automation routines:

1. Launch LightField.
2. Once LightField has finished initializing, verify that all devices are properly installed and have been placed on the Device Grid within the Experiment Workspace.
3. Configure a baseline set of experiment parameters.  
These should be appropriate for the specific experiment and application for which an automation application is to be developed.
4. Once the baseline configuration is set, save the experiment with a descriptive name that will be easily recognizable for future use. The name of this file will be required as an input when developing the Python™ automation application.

*This page is intentionally blank.*

# Chapter 3: Build a Simple Automation Application

---

Once a preliminary LightField project template has been created and saved as described in [Chapter 2, Prepare LightField](#), on page 7, development of an automation application can begin.



## **NOTE:**

This document is not intended to be a tutorial about using or programming in Python™. It is written with the assumption that the reader possesses a basic knowledge of the Python™ programming language.

## 3.1 Development Tools

The recommended way to build Python™ applications is using the Python™ Integrated Development and Learning Environment (IDLE). IDLE provides two primary window types/functions:

- Editor;  
The Editor provides the workspace in which application coding is performed.
- Shell.  
The Shell window is used to execute Python™ applications.



## **NOTE:**

For proper application execution, LightField must be running and a supported device must be connected to the Host Computer.

Key features of IDLE include:

- Supports having multiple Editor windows open simultaneously;
- Depressing the F5 key from within the Editor window will launch and run the current code/sample.

Complete information about IDLE is available at the following website:

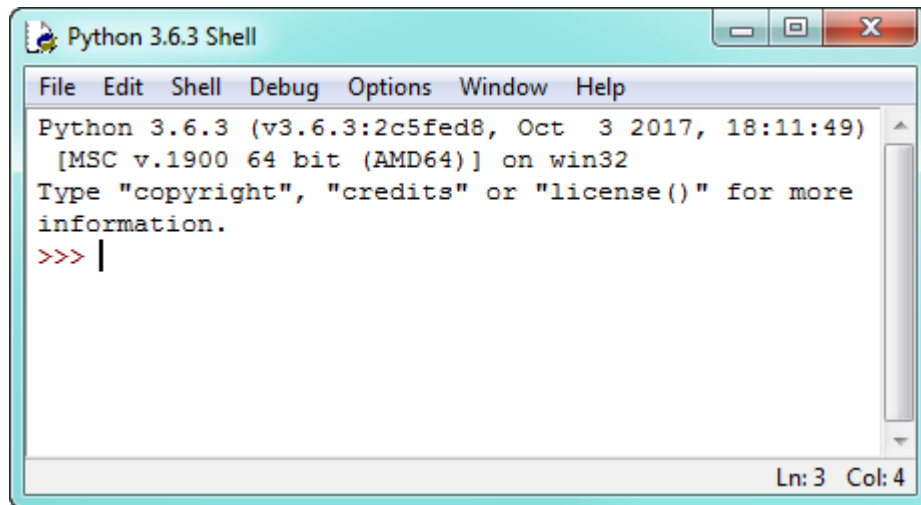
<https://docs.python.org/2/library/idle.html>

## 3.2 Sample Application Development

Perform the following procedure to develop a simple automation application that will:

- Launch LightField;
  - Modify the experiment exposure time;
  - Acquire an image;
  - Close LightField.
1. From the host computer's desktop, launch IDLE. A new Python™ Shell Window is opened. See [Figure 3-1](#).

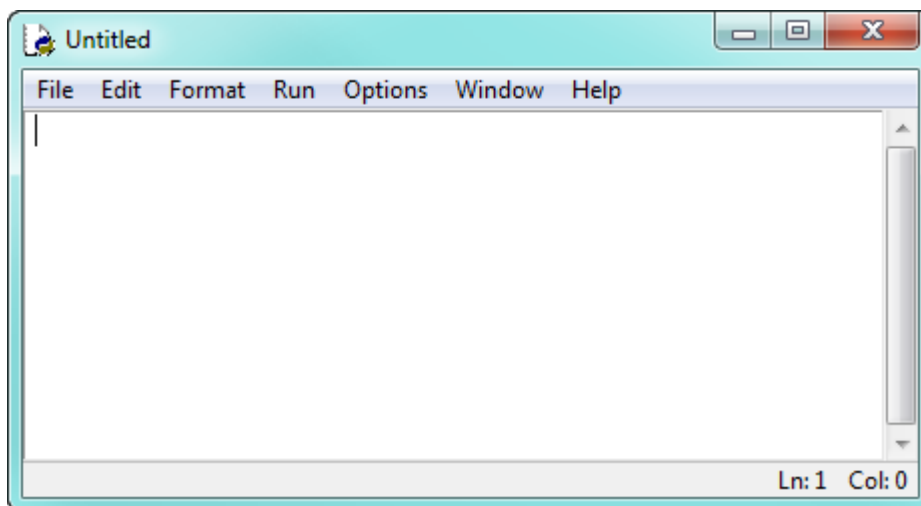
Figure 3-1: Typical New Python™ Shell Window



4411-0163\_001

2. From the menu bar, select **File ► New File**, or type  + . A new Python™ Editor window is opened. See [Figure 3-2](#).

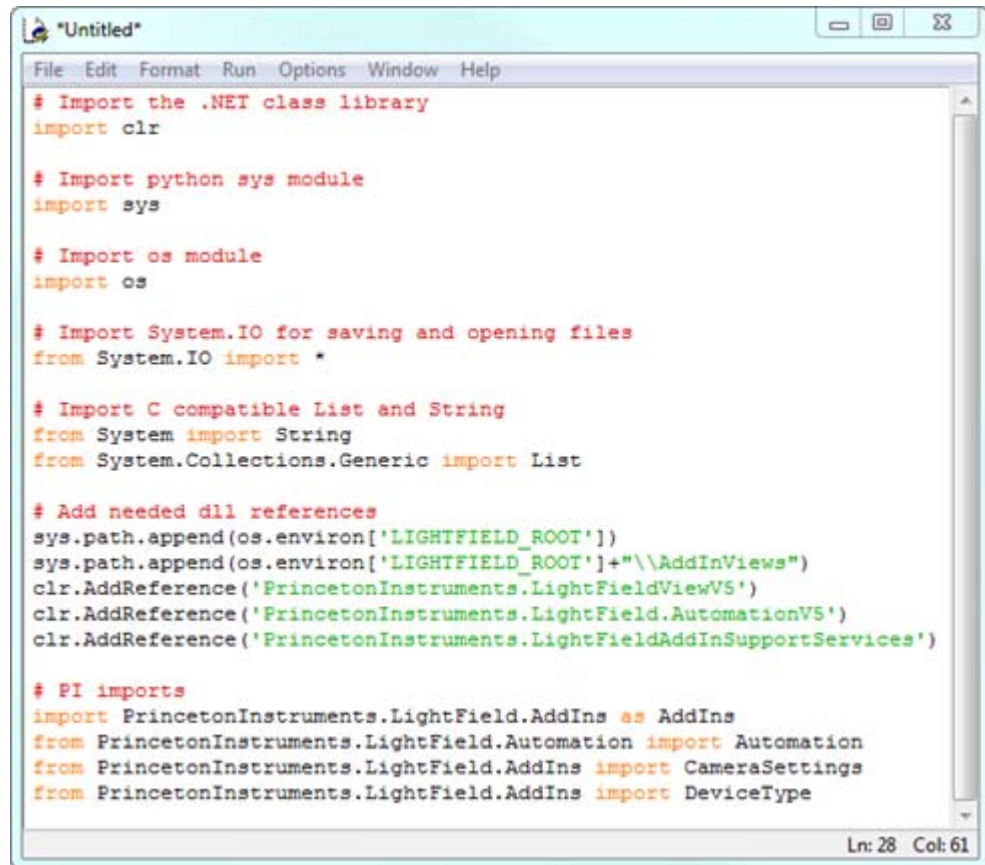
Figure 3-2: Typical New Python™ Editor Window



4411-0163\_002

3. Within the **Editor** window, add the required **Imports** and **DLL References**. See [Figure 3-3](#).

**Figure 3-3: Typical Python™ Code Snippet: Required Imports**



```

*Untitled*
File Edit Format Run Options Window Help

# Import the .NET class library
import clr

# Import python sys module
import sys

# Import os module
import os

# Import System.IO for saving and opening files
from System.IO import *

# Import C compatible List and String
from System import String
from System.Collections.Generic import List

# Add needed dll references
sys.path.append(os.environ['LIGHTFIELD_ROOT'])
sys.path.append(os.environ['LIGHTFIELD_ROOT']+"\\AddInViews")
clr.AddReference('PrincetonInstruments.LightFieldViewV5')
clr.AddReference('PrincetonInstruments.LightField.AutomationV5')
clr.AddReference('PrincetonInstruments.LightFieldAddInSupportServices')

# PI imports
import PrincetonInstruments.LightField.AddIns as AddIns
from PrincetonInstruments.LightField.Automation import Automation
from PrincetonInstruments.LightField.AddIns import CameraSettings
from PrincetonInstruments.LightField.AddIns import DeviceType

Ln: 28 Col: 61

```

4411-0163\_003

4. Next, add the following code to verify a camera setting, such as **Analog Gain**:

```

def set_value(setting, value):
    # Check for existence before setting
    # gain, adc rate, or adc quality
    if experiment.Exists(setting):
        experiment.SetValue(setting, value)

```

If the specified camera setting does not exist, the `experiment.SetValue` function will not be executed.

5. Next, add the following code to locate a connected device:

```

def device_found():
    # Find connected device
    for device in experiment.ExperimentDevices:
        if (device.Type == DeviceType.Camera):
            return True

    # If connected device is not a camera inform the user
    print("Camera not found. Please add a camera and try again.")
    return False

```

6. Add the following code to create an instance of LightField that loads with no experiment:

```
# Create the LightField Application (true for visible)
# The 2nd parameter forces LF to load with no experiment
auto = Automation(True, List[String]())
```

7. Next, add the following code to get an experiment object:

```
# Get experiment object
experiment = auto.LightFieldApplication.Experiment
```

8. Finally, add the following code to set the exposure time and acquire an image:

```
if (device_found() == True):
    #Set exposure time
    set_value(CameraSettings.ShutterTimingExposureTime, 20.0)

    # Acquire image
    experiment.Acquire()
```

# Chapter 4: Using LightField Experiment Settings Help File

Information required to modify LightField settings using Python™ code is in the **LightField Experiment Settings.chm** help file found in the **Add-in and Automation SDK** folder.

The help file includes the following Classes available for configuration updates via Python™:

- CameraSettings
- ExperimentSettings
- SpectrometerSettings

This chapter describes how to identify this information when creating a Python™ automation application.

## 4.1 Identify Device Parameters and Valid Enumeration Values

Perform the following procedure to identify required parameters and associated valid enumeration values required in order to develop Python™ automation applications.

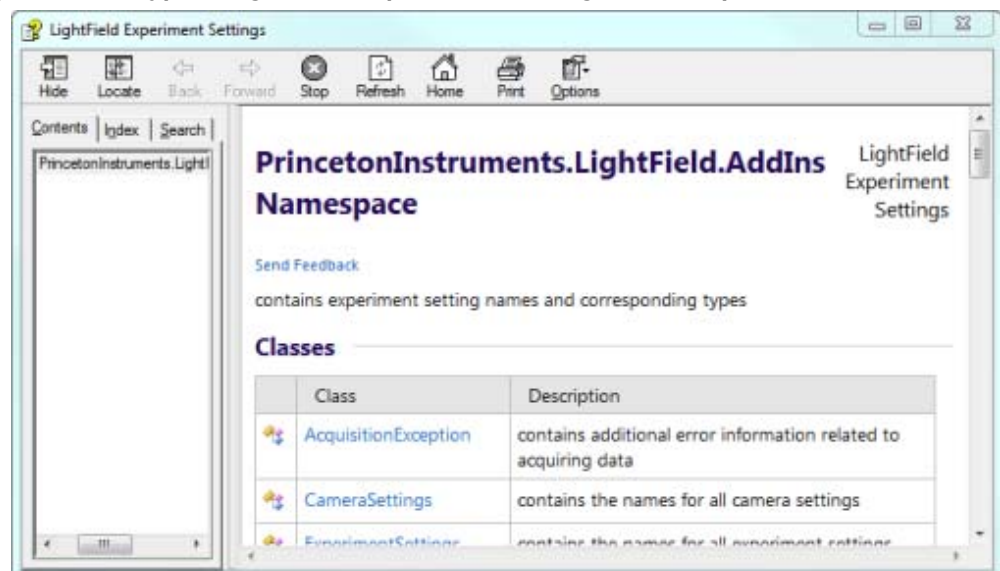


### NOTE:

In this example, the parameter **Analog to Digital Conversion Quality** will be spotlighted.

1. Open the **Add-in and Automation SDK** folder using the shortcut on the host computer's desktop.
2. Locate the file named **LightField Experiment Settings.chm** and double-click on it to open the Help file. See [Figure 4-1](#).

Figure 4-1: Typical *LightField Experiment Settings.chm* Help File









4411-0163\_006

3. The ADC Quality setting is a **Camera** setting. Within the **Classes** table, click on **CameraSettings**. See [Figure 4-2](#).

Figure 4-2: Typical Classes Table

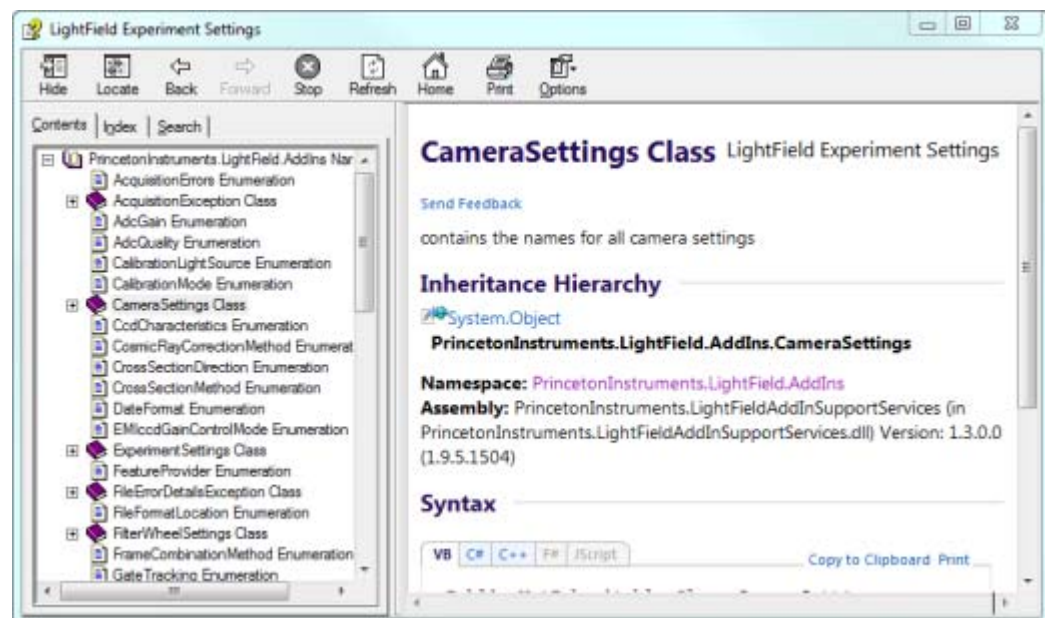
## Classes

	Class	Description
	<a href="#">AcquisitionException</a>	contains additional error information related to acquiring data
	<a href="#">CameraSettings</a>	contains the names for all camera settings
	<a href="#">ExperimentSettings</a>	contains the names for all experiment settings
	<a href="#">FileErrorDetailsException</a>	contains additional error information located in a file
	<a href="#">FilterWheelSettings</a>	contains the names for all filter wheel settings
	<a href="#">SpectrometerSettings</a>	contains the names for all spectrometer settings

4411-0163\_007

Information about the `CameraSettings` class is displayed in the Help window primary frame, and the Contents tab expands. See [Figure 4-3](#).

Figure 4-3: CameraSettings Class Information

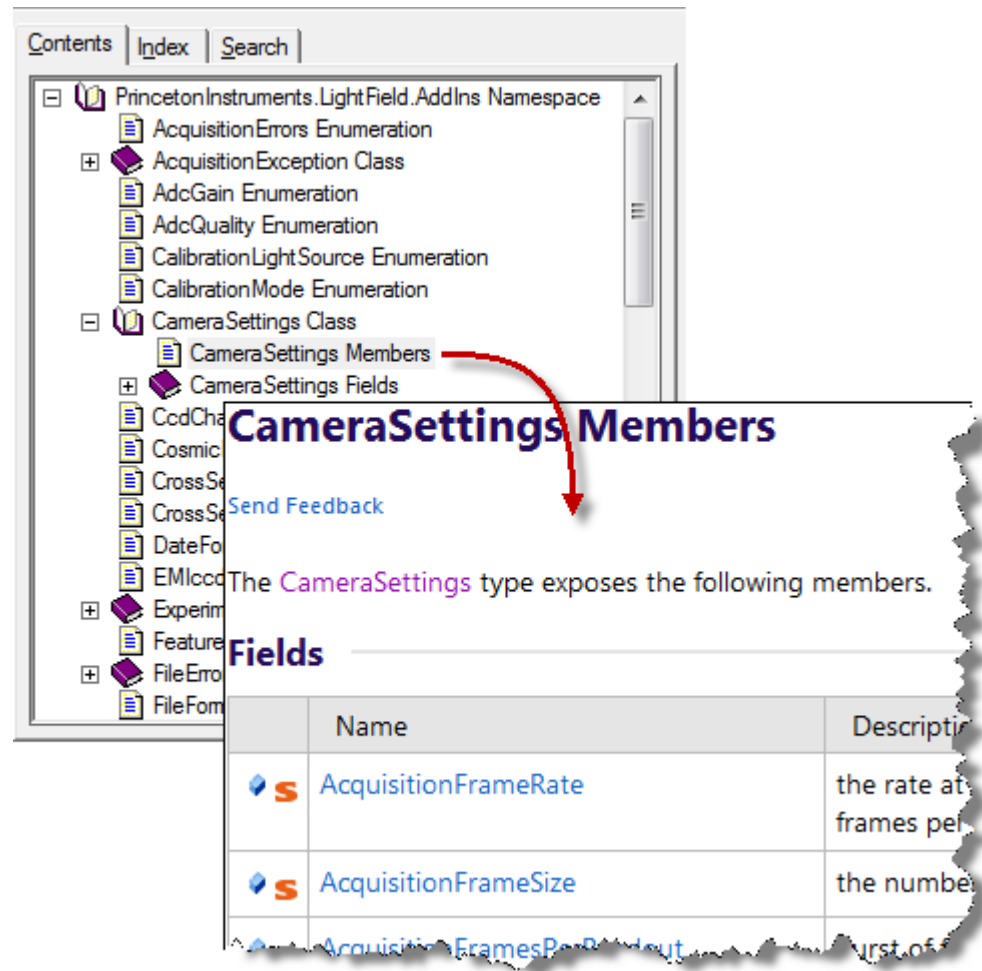


4411-0163\_008



4. Within the **Contents** tab, expand the `CameraSettings` Class book and click on the `CameraSettings Members` entry to view the members within the primary help panel. [Figure 4-4](#) illustrates a partial view of the `CameraSettings Members` table.

Figure 4-4: Partial View: `CameraSettings Members` Table



**CameraSettings Members**

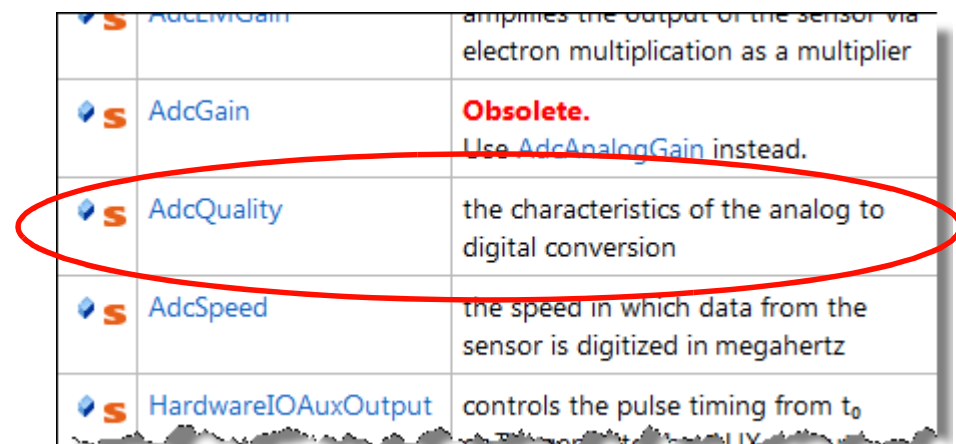
[Send Feedback](#)

The `CameraSettings` type exposes the following members.

Name	Description
<code>AcquisitionFrameRate</code>	the rate at which frames are acquired
<code>AcquisitionFrameSize</code>	the number of frames acquired
<code>AcquisitionFramesPerBuffer</code>	the number of frames in the buffer

5. Scroll the `CameraSettings Members` table until `AdcQuality` is visible. See [Figure 4-5](#).

Figure 4-5: `CameraSettings Members`: `AdcQuality` Entry



<code>AdcAnalogGain</code>	amplifies the output of the sensor via electron multiplication as a multiplier
<code>AdcGain</code>	<b>Obsolete.</b> Use <code>AdcAnalogGain</code> instead.
<code>AdcQuality</code>	the characteristics of the analog to digital conversion
<code>AdcSpeed</code>	the speed in which data from the sensor is digitized in megahertz
<code>HardwareIOAuxOutput</code>	controls the pulse timing from $t_0$

6. Click on `AdcQuality` to view information about this camera setting in the primary help panel. See [Figure 4-6](#).

Figure 4-6: `AdcQuality` Camera Setting Information

LightField  
Experiment  
Settings

## CameraSettings.AdcQuality Field

[Send Feedback](#)

the characteristics of the analog to digital conversion

**Namespace:** `PrincetonInstruments.LightField.AddIns`  
**Assembly:** `PrincetonInstruments.LightFieldAddInSupportServices`  
 (in `PrincetonInstruments.LightFieldAddInSupportServices.dll`)  
 Version: 1.3.0.0 (1.9.5.1504)

### Syntax

[VB](#)
[C#](#)
[C++](#)
[F#](#)
[JScript](#)

[Copy to Clipboard](#)
[Print](#)

```
Public Const AdcQuality As String
```

### Remarks

Type: collection of [AdcQuality](#)

4411-0163\_011

7. Within the **Remarks** section, click on the [AdcQuality](#) link to view the set of valid Enumeration values/members. See [Figure 4-7](#).

Figure 4-7: `AdcQuality` Camera Setting Information

```
Public Const AdcQuality As String
```

### Remarks

Type: collection of [AdcQuality](#)

### Syntax

[VB](#)
[C#](#)
[C++](#)
[F#](#)
[JScript](#)

[Copy to Clipboard](#)
[Print](#)

```
Public Enumeration AdcQuality
```

### Members

	Member name	Value	Description
	<b>LowNoise</b>	1	gives the lowest noise
	<b>HighCapacity</b>	2	can store more light
	<b>HighSpeed</b>	4	digitizes at faster speeds
	<b>ElectronMultiplied</b>	3	performs electron multiplication to boost signal

4411-0163\_012

All information required to modify `AdcQuality` using Python™ is now known.

# Chapter 5: Sample Applications

---

Teledyne Princeton Instruments includes a library of sample Python™ applications. This chapter provides information about each of these sample applications.

Refer to [Table 5-1](#) for a list of pre-written applications that are available and where additional information can be found.

**Table 5-1: Sample Teledyne Princeton Instruments Python™ Applications**

File/Application Name	For Complete Information, refer to...
<code>acquisition_filename.py</code>	<a href="#">Section 5.2.1, <code>acquisition_filename.py</code></a> , on page 20
<code>add_remove-device.py</code>	<a href="#">Section 5.2.2, <code>add_remove-device.py</code></a> , on page 21
<code>emccd.py</code>	<a href="#">Section 5.2.3, <code>emccd.py</code></a> , on page 21
<code>event_handling.py</code>	<a href="#">Section 5.2.4, <code>event_handling.py</code></a> , on page 21
<code>exposure_acquire.py</code>	<a href="#">Section 5.2.5, <code>exposure_acquire.py</code></a> , on page 21
<code>multiple_lightfields.py</code>	<a href="#">Section 5.2.6, <code>multiple_lightfields.py</code></a> , on page 21
<code>multiple_roi.py</code>	<a href="#">Section 5.2.7, <code>multiple_roi.py</code></a> , on page 22
<code>repetitive_gating.py</code>	<a href="#">Section 5.2.8, <code>repetitive_gating.py</code></a> , on page 22
<code>saving_loading_experiments.py</code>	<a href="#">Section 5.2.9, <code>saving_loading_experiments.py</code></a> , on page 22
<code>sequential_gating.py</code>	<a href="#">Section 5.2.10, <code>sequential_gating.py</code></a> , on page 22
<code>settings.py</code>	<a href="#">Section 5.2.11, <code>settings.py</code></a> , on page 23
<code>spe_file_access.py</code>	<a href="#">Section 5.2.12, <code>spe_file_access.py</code></a> , on page 23
<code>spectrometer.py</code>	<a href="#">Section 5.2.13, <code>spectrometer.py</code></a> , on page 23
<code>synchronous_acquisition.py</code>	<a href="#">Section 5.2.14, <code>synchronous_acquisition.py</code></a> , on page 23
<code>temperature.py</code>	<a href="#">Section 5.2.15, <code>temperature.py</code></a> , on page 24

## 5.1 Common Program Elements

This section provides information about program elements that are required by all Python™ applications designed to automate LightField:

Refer to the following sections for complete information:

- [Section 5.1.1, Required DLLs](#), on page 20;
- [Section 5.1.2, Required Imports](#), on page 20.

### 5.1.1 Required DLLs

The set of required DLLs is declared in the following block of code near the beginning of each Python™ file:

```
# Add needed dll references
sys.path.append(os.environ['LIGHTFIELD_ROOT'])
sys.path.append(os.environ['LIGHTFIELD_ROOT']+"\\AddInViews")
clr.AddReference('PrincetonInstruments.LightFieldViewV5')
clr.AddReference('PrincetonInstruments.LightField.AutomationV5')
clr.AddReference('PrincetonInstruments.LightFieldAddInSupport
Services')
```

### 5.1.2 Required Imports

The following required elements are imported by all Python™ applications:

- Addins;
- Automation.

The set of required imports is declared near the beginning of each Python™ file in a block of code resembling the following:

```
# PI imports
from PrincetonInstruments.LightField.Automation import Automation
from PrincetonInstruments.LightField.AddIns import [Name_of_import]

[additional_import_statements]
```

where [Name\_of\_import] can be a/an:

- class;
- enumeration;
- variable;
- etc.

Application-specific import requirements are provided in the following section.

## 5.2 Application-Specific Information

This section provides information specific to each sample application supplied by Teledyne Princeton Instruments.

### 5.2.1 `acquisition_filename.py`

#### Description

When called, `acquisition_filename.py` saves an acquired image in the default LightField directory.

#### Required Imports

The following additional imports are required by `acquisition_filename.py`:

- ExperimentSettings
- DeviceType

### 5.2.2 `add_remove-device.py`

#### Description

When called, `add_remove-device.py` instructs LightField to add the first available device. Once the current device is no longer required, LightField then removes it.

#### Required Imports

There are no additional imports required by `add_remove-device.py`.

### 5.2.3 `emccd.py`

#### Description

When called, `emccd.py` configures **EM ADC Quality** and the first **ADC Rate** available. It also sets the **EM Gain** to 10, and acquires an image.

#### Required Imports

The following additional imports are required by `emccd.py`:

- `CameraSettings`
- `AdcQuality`
- `DeviceType`

### 5.2.4 `event_handling.py`

#### Description

When called, `event_handling.py` informs the user when LightField is ready to run.

#### Required Imports

The following additional imports are required by `event_handling.py`:

- `DeviceType`

### 5.2.5 `exposure_acquire.py`

#### Description

When called, `exposure_acquire.py` configures LightField and acquires an exposure.

#### Required Imports

The following additional imports are required by `exposure_acquire.py`:

- `CameraSettings`
- `DeviceType`

### 5.2.6 `multiple_lightfields.py`

#### Description

When called, `multiple_lightfields.py` enables the acquisition of image data from two discreet instances of LightField.

#### Required Imports

The following additional imports are required by `multiple_lightfields.py`:

- `IDevice`
- `DeviceType`
- `ExperimentSettings`

### 5.2.7 `multiple_roi.py`

#### Description

When called, `multiple_roi.py` defines two regions of interest within LightField. The dimensions of each ROI are printed. These ROIs are then used to acquire an image.

#### Required Imports

The following additional imports are required by `multiple_roi.py`:

- `RegionOfInterest`
- `DeviceType`

### 5.2.8 `repetitive_gating.py`

#### Description

When called, `repetitive_gating.py`:

- Sets and gets a value for on-chip accumulations;
- Configures Repetitive Gate Pulse Width and Delay;
- Acquires an image.

#### Required Imports

The following additional imports are required by `repetitive_gating.py`:

- `CameraSettings`
- `GatingMode`
- `Pulse`
- `DeviceType`

### 5.2.9 `saving_loading_experiments.py`

#### Description

When called, `saving_loading_experiments.py` saves an experiment and prints saved experiments.

#### Required Class Imports

There are no additional imports are required by `saving_loading_experiments.py`.

### 5.2.10 `sequential_gating.py`

#### Description

When called, `sequential_gating.py`:

- Sets and gets a value for on-chip accumulations;
- Configures starting and ending sequential pulse width and delay;
- Configures the number of frames;
- Acquires an image.

#### Required Imports

The following additional imports are required by `sequential_gating.py`:

- `CameraSettings`
- `ExperimentSettings`
- `GatingMode`
- `Pulse`
- `DeviceType`

### 5.2.11 settings.py

#### Description

When called, `settings.py` displays a device's capabilities.

#### Required Imports

The following additional imports are required by `settings.py`:

- `CameraSettings`
- `DeviceType`

### 5.2.12 spe\_file\_access.py

#### Description

When called, `spe_file_access.py`:

- Acquires an image;
- Opens the corresponding \*.spe file;
- Returns the image dimensions, in pixels (e.g., 1024 x 1024);
- Reports the intensity of the first 10 pixels.

#### Required Imports

The following additional imports are required by `spe_file_access.py`:

- `ExperimentSettings`
- `DeviceType`

### 5.2.13 spectrometer.py

#### Description

When called, `spectrometer.py` configures an attached spectrometer device.

#### Required Imports

The following additional imports are required by `spectrometer.py`:

- `SpectrometerSettings`
- `DeviceType`

### 5.2.14 synchronous\_acquisition.py

#### Description

When called, `synchronous_acquisition.py`:

- Synchronously Acquires 3 images using LightField's Capture function;
- Processes data using the Numpy extension module.

Perform the following procedure to install Numpy:

1. Open a Command Prompt.
2. Change the working directory to be the Python™ directory.

For example:

```
cd C:\Users\[user_name]\AppData\Local\Programs\Python\Python36
```

3. Enter the following command:

```
python -m pip install numpy [enter]
```

4. Wait for **Successfully Installed** to be displayed.

#### Required Imports

The following additional imports are required by `synchronous_acquisition.py`:

- `Numpy`;
- `ExperimentSettings`;
- `DeviceType`.

**NOTES:**

If Numpy is not installed, open the sample code, locate the following lines, and comment them out:

---

```
# numpy import
import numpy as np
```

---



---

```
def print_statistics(image_data, image_frame):

    # Create a new 1-dimensional array from an iterable object of
    # type float.

    # Image data can be returned as uint[], ushort[], float[]

    # Use float for best results with/without background subtraction
    array = np.fromiter(image_data, float)

    # Calculated mean
    print("\nMean: %s" % str(round(np.mean(array))))

    # Calculated median
    print("\nMedian: %s" % str(round(np.median(array))))

    # Calculated max
    print("\nMax Value: %s" % str(round(np.max(array))))

    # Calculated min
    print("\nMin Value: %s" % str(np.min(array)))
```

---



---

```
print_statistics(image_data, image_frame)
```

---

### 5.2.15 temperature.py

#### Description

When called, [temperature.py](#):

- Changes the temperature set point to  $-10^{\circ}\text{C}$ ;
- Reports the current temperature;
- Reports the current status (i.e., locked/unlocked.)

#### Required Imports

The following additional imports are required by [temperature.py](#):

- CameraSettings
- SensorTemperatureStatus
- DeviceType



# Appendix A: Install Python™

This appendix provides the information necessary to install Python™ and Python.Net on a host computer in order to automate LightField 6.

## A.1 Install Python™

Perform the following procedure to install Python™ on the host computer:

1. Download the most recent **64-bit** version of Python™ from here:

<https://www.python.org/downloads/windows/>



### NOTE:

As of the date of this document, the most recent **64-bit** version is **Python™ 3.6.3**.

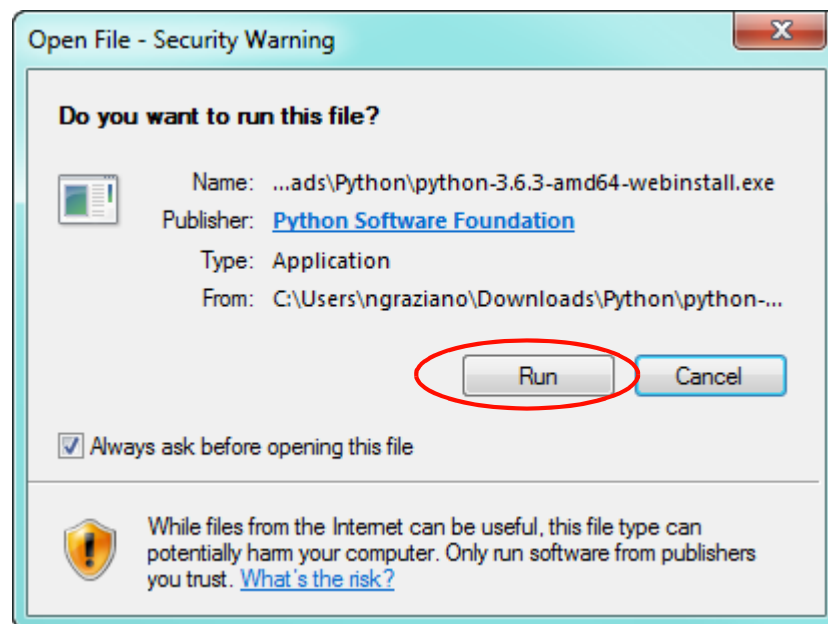
Figure A-1: List of Available Python™ Versions



4411-0163\_020

2. When the **Security Warning** dialog is displayed, click **Run**. See [Figure A-2](#).

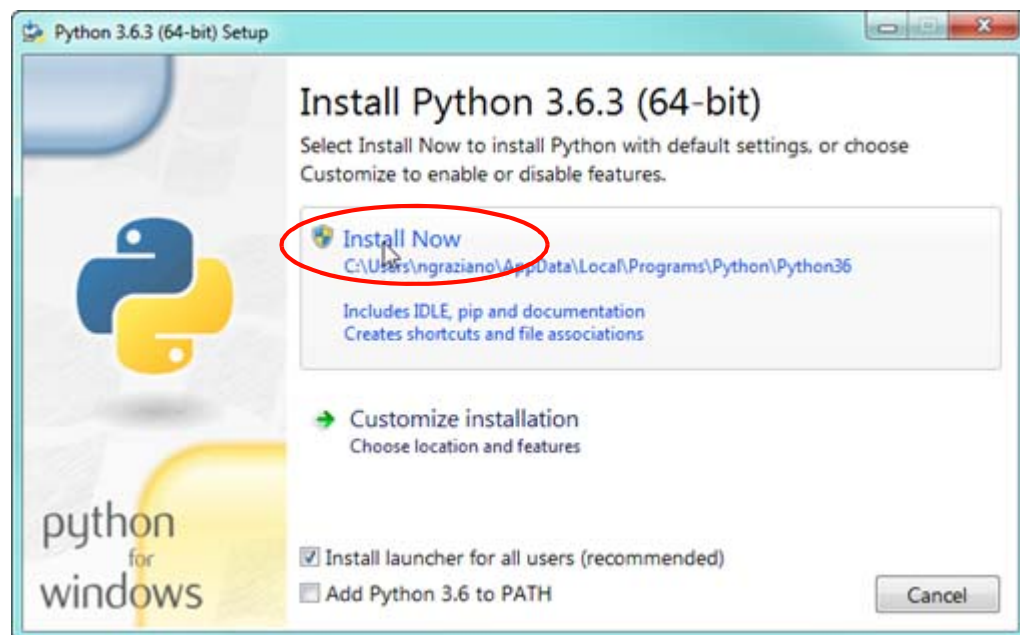
Figure A-2: Open File - Security Warning



4411-0163\_021

3. When prompted, click **Install Now**. See [Figure A-3](#).

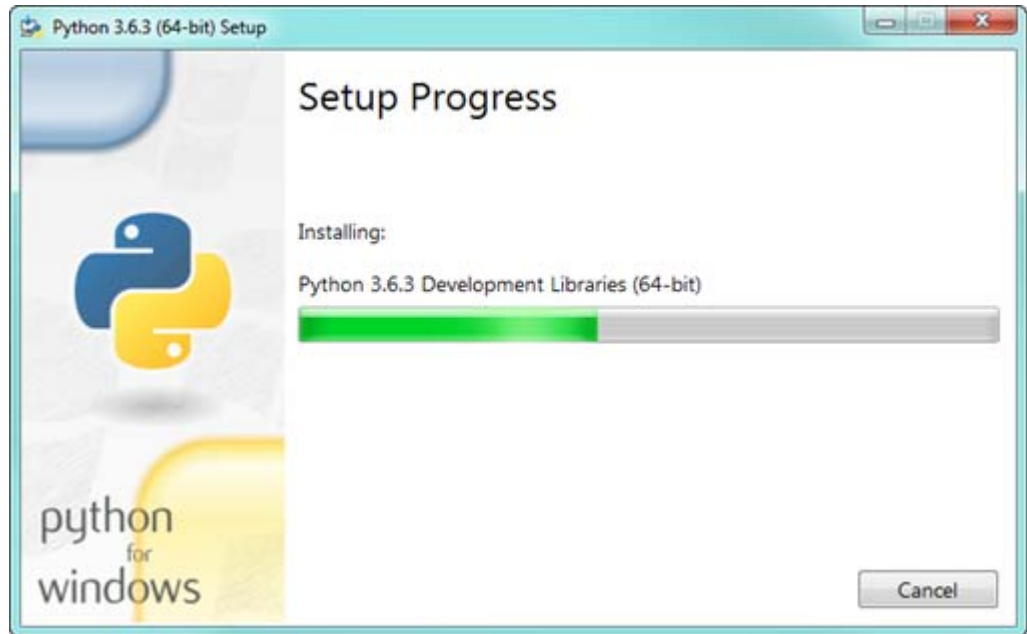
Figure A-3: Typical Python™ Setup Dialog



4411-0163\_023

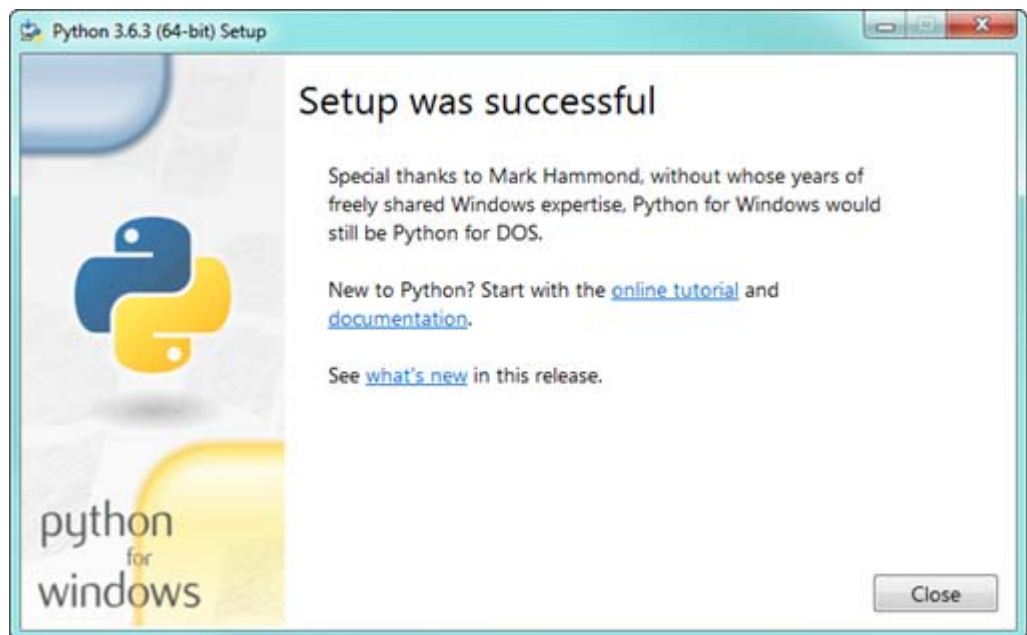
4. The installation will begin, and the progress is indicated with a standard Windows progress bar. See [Figure A-4](#).

Figure A-4: Typical Installation Progress Bar



5. When installation is complete, click **Close**. See [Figure A-5](#).

Figure A-5: Typical Setup Success Dialog



## A.2 Install Python for .Net

Perform the following procedure to install PythonNet:

1. Download the most recent **64-bit** version **Python for .Net** which is available here:

<https://pypi.python.org/pypi/pythonnet/2.3.0>



### NOTE:

As of the date of this document, the most recent **64-bit** version is:

`pythonnet-2.3.0-cp36-cp36m-win_amd64.whl`

See [Figure A-6](#).

Figure A-6: List of Available Python for .Net Download Packages

The screenshot shows the PyPI package page for `pythonnet 2.3.0`. The page includes a sidebar with navigation links, a main content area with package details, and a table of available download packages. The package `pythonnet-2.3.0-cp36-cp36m-win_amd64.whl` is highlighted with a red circle.

File	Type	Py Version	Uploaded on	Size
<code>pythonnet-2.3.0-cp27-cp27m-win32.whl (md5)</code>	Python Wheel	cp27	2017-03-11	57KB
<code>pythonnet-2.3.0-cp27-cp27m-win_amd64.whl (md5)</code>	Python Wheel	cp27	2017-03-11	57KB
<code>pythonnet-2.3.0-cp33-cp33m-win32.whl (md5)</code>	Python Wheel	cp33	2017-03-11	57KB
<code>pythonnet-2.3.0-cp33-cp33m-win_amd64.whl (md5)</code>	Python Wheel	cp33	2017-03-11	57KB
<code>pythonnet-2.3.0-cp34-cp34m-win32.whl (md5)</code>	Python Wheel	cp34	2017-03-11	57KB
<code>pythonnet-2.3.0-cp34-cp34m-win_amd64.whl (md5)</code>	Python Wheel	cp34	2017-03-11	57KB
<code>pythonnet-2.3.0-cp35-cp35m-win32.whl (md5)</code>	Python Wheel	cp35	2017-03-11	58KB
<code>pythonnet-2.3.0-cp35-cp35m-win_amd64.whl (md5)</code>	Python Wheel	cp35	2017-03-11	57KB
<code>pythonnet-2.3.0-cp36-cp36m-win32.whl (md5)</code>	Python Wheel	cp36	2017-03-11	58KB
<code>pythonnet-2.3.0-cp36-cp36m-win_amd64.whl (md5)</code>	Python Wheel	cp36	2017-03-11	57KB
<code>pythonnet-2.3.0.tar.gz (md5)</code>	Source		2017-03-11	1MB

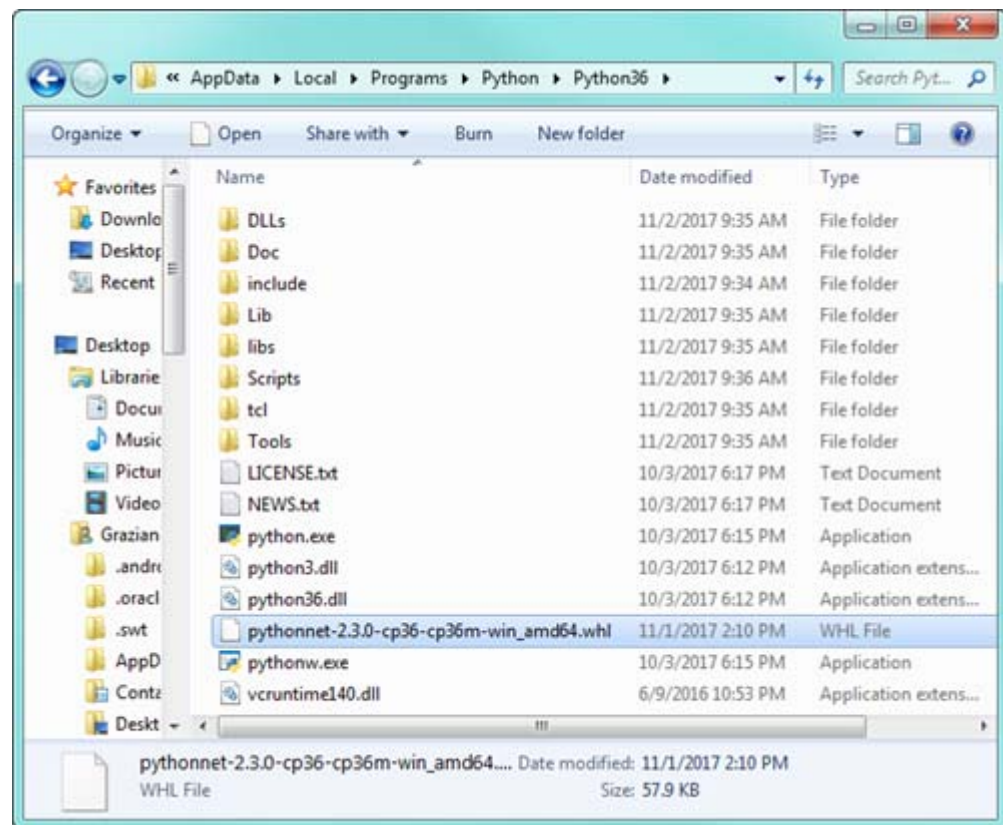
Author: The Python for .Net developers  
 Home Page: <https://pythonnet.github.io/>  
 License: MIT

2. Open a Windows Explorer window and navigate to the directory in which the **Python for .Net** file was saved.
3. Open a second Explorer window and navigate to the Python™ installation directory on the host computer. This is typically:

`C:\Users\[user_name]\AppData\Local\Programs\Python\Python36`

4. Move or place a copy of the **Python for .Net** file into the Python™ installation directory. See [Figure A-7](#).

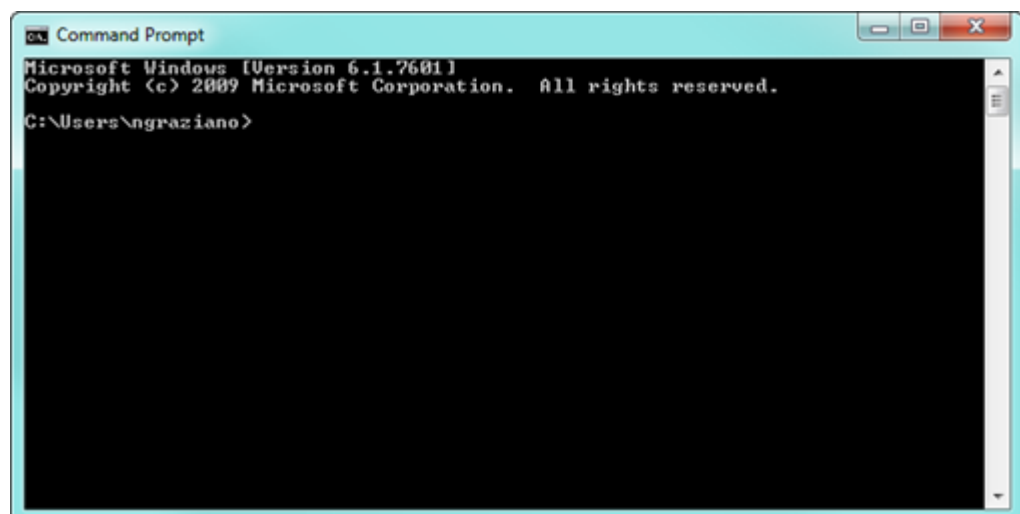
Figure A-7: Python™ Installation Directory with Python for .Net File



4411-0163\_027

5. Open a **Command Prompt** window.

Figure A-8: Typical Command Prompt Window



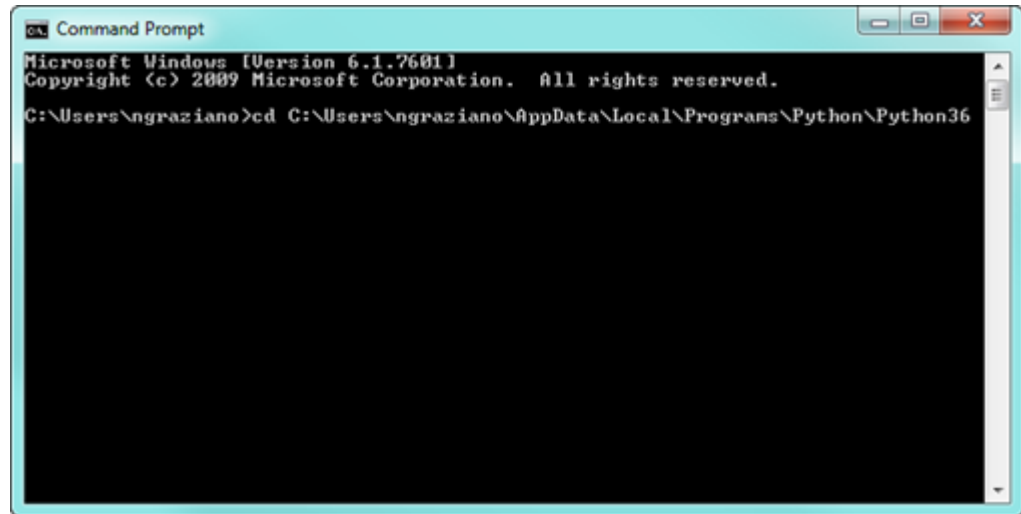
4411-0163\_028

6. Issue the following command to change to the installation directory for Python™.

```
CD
C:\Users\[user_name]\AppData\Local\Programs\Python\Python36
```

See [Figure A-9](#).

Figure A-9: Typical Command Prompt Window: Python™ Installation Directory

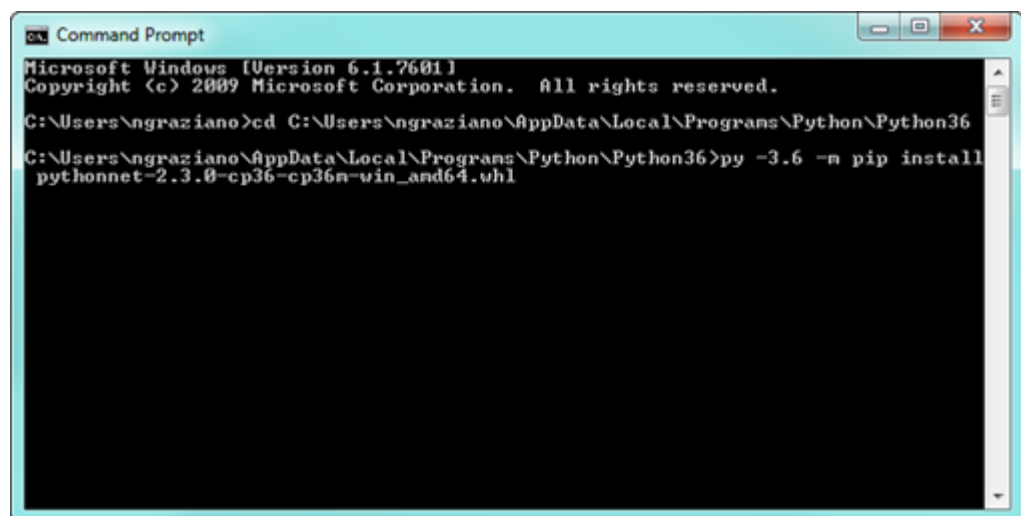


7. Issue the command to instruct the **pip package manager**<sup>a</sup> to install the **Python for .Net \*.whl** file:

```
py -3.6 -m pip install pythonnet-2.3.0-cp36-cp36m-
win_amd64.whl
```

See [Figure A-10](#).

Figure A-10: Command to Launch PIP Package Manager



---

a. **pip** is a package management system used to install and manage software packages written in Python™.

8. Once installed, the system will return a **Successfully Installed pythonnet-x.y.z** message indicating that Python™ scripts may now be executed. See [Figure A-11](#).

**NOTE:**

**x.y.z** corresponds to the specific version of PythonNet that has been installed.

Figure A-11: Typical Python for .Net Installation Successful Message

```
Command Prompt
Microsoft Windows [Version 6.1.7601]
Copyright (c) 2009 Microsoft Corporation. All rights reserved.

C:\Users\ngraziano>cd C:\Users\ngraziano\AppData\Local\Programs\Python\Python36

C:\Users\ngraziano\AppData\Local\Programs\Python\Python36>py -3.6 -m pip install
pythonnet-2.3.0-cp36-cp36m-win_and64.whl
Processing c:\users\ngraziano\appdata\local\programs\python\python36\pythonnet-2
.3.0-cp36-cp36m-win_and64.whl
Installing collected packages: pythonnet
Successfully installed pythonnet-2.3.0

C:\Users\ngraziano\AppData\Local\Programs\Python\Python36>
```

4411-0163\_031

*This page is intentionally blank.*



*This page is intentionally blank.*



[www.princetoninstruments.com](http://www.princetoninstruments.com)



**TELEDYNE PRINCETON INSTRUMENTS**  
Everywhereyoulook™

Part of the Teledyne Imaging Group

[info@princetoninstruments.com](mailto:info@princetoninstruments.com)

**USA** +1 877-474-2286 | **France** +33 (1) 60 86 03 65 | **Germany** +49 (0) 89 660 7793 | **UK & Ireland** +44 (0) 1628 472 346  
**Singapore** +65 6408 6240 | **China** +86 10 659 16460 | **Japan** +81 (3) 5639 2741