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LightField Experiment XML Specification

Teledyne Princeton Instruments

Experiment XML

Specification

Revision History

Issue	Date	List of Changes
5	March 18, 2019	Issue 5 of this document incorporates the following changes: <ul style="list-style-type: none">• Updated the copyright year;• Rebranded as Teledyne Princeton Instruments.
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Chapter 1

Introduction to Experiment XML

The purpose of this manual is to provide information about the experiment information (devices and setup) stored as an XML document: it can be seen in an SPE file taken from LightField. All of the elements in the Experiment XML belong to the experiment namespace:

<http://www.princetoninstruments.com/experiment/2009>. While custom elements can be added, they must not be in this namespace. Custom attributes, however, can be added to an element in the experiment namespace, but they must be in a namespace (which must not be the experiment namespace).

```
<?xml version="1.0" encoding="utf-8" ?>
<SpeFormat version="3.0"
  xmlns="http://www.princetoninstruments.com/spe/2009">
  <DataFormat>
  <MetaFormat>
  <Calibrations>
  <DataHistories>
    <DataHistory id="1">
      <Origin creator="jjones" created="2012-04-25T14:31:31.6636112-04:00"
        software="LightField" softwareVersion="4.2.1.0"
        softwareCompany="Princeton Instruments">
        <Experiment xmlns="http://www.princetoninstruments.com/
          experiment/2009" version="3"
            xmlns:r="http://www.princetoninstruments.com/ex
              periment/restore/2009" r:version="1">

          <System>
          <Devices>
          <Environment>
        </Origin>
      </DataHistory>
    </DataHistories>
    <GeneralInformation>
  </SpeFormat>
```

Figure 1. Location of the Experiment Namespace in the XML Footer

Notes:

1. Note any other Teledyne Princeton Instruments namespace is not documented and for internal use.
2. All data are expressed in a culture-invariant locale (effectively en-us).
3. Unless otherwise noted, any experiment element or attribute within the same parent element can be in any order.

The root element of the XML document is **Experiment**. The version of the experiment information is kept in the **version** attribute. As can be seen in Figure 1, experiment information is broken down into three sections via the following child elements:

- **System:** describes which devices make up the experiment
- **Devices:** lists settings for each device
- **Environment:** lists settings that apply to the experiment as a whole

Any SPE data file acquired with LightField contains this experiment information. In LightField, the information can be exported by opening the file in Data View, showing file information, and saving that information to file. Once the XML file has been saved, the user can open it (for example, with Internet Explorer) and navigate to `SpeFormat/DataHistories/DataHistory/Origin` to see the experiment XML.

Experiment Devices

System

The **System** element describes all devices used in the experiment. It details devices with optional/configurable components. It also indicates how the devices interconnect. For each type of device in the system, there is a corresponding child element to contain a group of that type. All of the child elements listed below contain a count attribute representing the number of devices of that type. The following child elements are supported:

- **Cameras:** one or more cameras are in the experiment.
- **Spectrometers:** one or more spectrometers are in the experiment.
- **FilterWheels:** one or more externally-controlled filter wheels are in the experiment; note this type of filter wheel is one that is controlled via its own control box, as opposed to a spectrometer.
- **LightSources:** one or more generic light source; a generic light source is a symbol used to show the direction of light and is not any real instrument.
- **DeviceLinks:** one or more pairs of devices interconnect.

All devices within a group above contain a unique **deviceID** attribute. This is used to reference that particular device when describing settings in the Devices section.

```
<System>
  <Cameras count="1">
  <Spectrometers count="1">
  <FilterWheel count="1">
  <LightSources count="1">
  <DeviceLinks count="4">
</System>
```

Figure 2. System Components

Camera

The **Camera** element identifies a particular camera. The following attributes apply:

- **model:** the camera model.
- **serialNumber:** the unique camera serial number.
- **computerInterface:** how the camera connects to the computer.
- **demo (optional):** set to True if this is a software-simulated camera and not a real instrument; if this attribute is not present it is assumed the camera is a real instrument.

```
<Cameras count="1">
  <Camera deviceID="1"
    model="PI-MAX4: 1024i"
    serialNumber="2203120007"
    computerInterface="Gigabit Ethernet"
    demo="False" />
</Cameras>
```

Figure 3. Camera Attributes

Spectrometer

The **Spectrometer** element identifies a particular spectrometer. The following attributes apply:

- **model:** the spectrometer model.
- **serialNumber:** the unique spectrometer serial number.
- **computerInterface:** how the spectrometer connects to the computer.

The **Spectrometer** element describes optional/configurable components with child elements. These elements contain a count attribute representing the number of components for each type. The following child elements are supported:

- **Turrets (model dependent):** for spectrometers that support them, lists each turret with a **Turret** child element.
- **Gratings:** lists each grating with a **Grating** child element; for spectrometers that support turrets, this will be a child of each **Turret** element instead of the **Spectrometer** element.
- **OpticalPorts:** lists each entrance and exit port.
- **DeviceAccessories:** lists accessories controlled by this spectrometer such as filter wheels.

The following describe all component elements:

- **Grating:** the value of this element describes the grating with a simple string (as indicated by the **type** attribute value of **String**); this description typically starts with the blazing wavelength (in either nm or μm units) followed by the groove density (in grooves per millimeter).
- **Entrance/Exit (optical ports):** describes the location of the ports with either or both **Front/Side** elements; each of these elements will then contain a **Type** element whose value describes the type of port (with an **OpticalPortType** as specified by its **type** attribute)
- **FilterWheel (as a device accessory):** contains a **deviceID** . in the format “*parent deviceID.accessory ID*”.

```

<Spectrometers count="1">
  <Spectrometer deviceID="2"
    model="SP-2-300i"
    serialNumber="25589976"
    computerInterface="USB">
    <Turrets count="2">
      <Turret id="1">
        <Gratings count="3">
          <Grating id="1"
            type="String">150nm,1200</Grating>
          <Grating id="2"
            type="String">300nm,1200</Grating>
          <Grating id="3"
            type="String">750nm,600</Grating>
        </Gratings>
      </Turret>
      <Turret id="2">
        <Gratings count="3">
          <Grating id="1"
            type="String">h-vis,2400</Grating>
          <Grating id="2" type="String">1.2um,600</Grating>
          <Grating id="3" type="String">Mirror,1200</Grating>
        </Gratings>
      </Turret>
    </Turrets>
    <OpticalPorts count="4">
      <Entrance>
        <Front>
          <Type id="1" type="OpticalPortType">ManualSlit</Type>
        </Front>
        <Side>
          <Type id="2" type="OpticalPortType">ManualSlit</Type>
        </Side>
      </Entrance>
      <Exit>
        <Front>
          <Type id="3" type="OpticalPortType">FocalPlane</Type>
        </Front>
        <Side>
          <Type id="4" type="OpticalPortType">FocalPlane</Type>
        </Side>
      </Exit>
    </OpticalPorts>
    <DeviceAccessories count="1">
      <FilterWheel deviceID="1.1" />
    </DeviceAccessories>
  </Spectrometer>
</Spectrometers>

```

Figure 4. Spectrometer Elements and Attributes

FilterWheel

The **FilterWheel** element identifies a particular externally-controlled filter wheel. The following attributes apply:

- **model:** the filter wheel (control box) model.

- **serialNumber:** the unique filter wheel (control box) serial number.
- **computerInterface:** how the filter wheel (control box) connects to the computer.

LightSource

The **LightSource** element identifies a particular generic (symbolic) light source. The following attributes apply:

- **model:** the type of generic light source.

```
<LightSources count="1">
  <LightSource deviceID="4" model="LightSource" />
</LightSources>
```

Figure 5. LightSource Element

DeviceLink

The **DeviceLink** element identifies a connection between two other devices (or accessories). The following attributes apply:

- **firstDeviceID:** the first device.
- **firstDeviceLinkNode:** the direction light through the first device and/or location of the link.
- **secondDeviceID:** the second device.
- **secondDeviceLinkNode:** the direction light through the second device and/or location of the link.

```
<DeviceLinks count="3">
  <DeviceLink firstDeviceID="2"
    firstDeviceLinkNode="Input"
    secondDeviceID="1"
    secondDeviceLinkNode="FrontOutput" />
  <DeviceLink firstDeviceID="1"
    firstDeviceLinkNode="SideInput"
    secondDeviceID="1.1"
    secondDeviceLinkNode="Output" />
  <DeviceLink firstDeviceID="1.1"
    firstDeviceLinkNode="Input"
    secondDeviceID="3"
    secondDeviceLinkNode="Output" />
</DeviceLinks>
```

Figure 6. Device Link Element

Experiment Settings

Devices

The **Devices** element describes all settings of each device used in the experiment in a hierarchical representation. Settings are grouped by device and then broken down into more and more subgroups until the setting value is finally represented. The devices are grouped similarly to those in **System** as indicated below:

- **Cameras:** groups settings belonging to one or more camera.
- **Spectrometers:** groups settings belonging to one or more spectrometers.
- **FilterWheels:** groups settings belonging to one or more externally-controlled filter wheels.

```
<Devices>
  <Cameras count="1">
    <Spectrometers count="1">
      <FilterWheels count="1">
        </Devices>
```

Figure 7. Devices Elements and Attributes

```
<Devices>
  <Cameras count="1">
    <Camera deviceID="2">
      <Sensor>
        <ShutterTiming>
          <ExposureTime type="Double">100</ExposureTime>
          <DelayResolution r:readOnly="True"
            type="Double">1000</DelayResolution>
          <Mode type="ShutterTimingMode">Normal</Mode>
          <ClosingDelay type="Double">8</ClosingDelay>
        </ShutterTiming>
        <ReadoutControl>
        <HardwareIO>
        <Intensifier>
        <Adc>
        <Acquisition>
        <Experiment>
      </Camera>
    </Cameras>
    <Spectrometers count="1">
  </Devices>
```

Figure 8. ShutterTiming Element and Attributes

Each device with one or more settings is represented by the appropriate child element whose **deviceID** attribute refers back to that device defined in **System**. Child elements are then used to group settings until an element with the **type** attribute is found. This indicates the setting can no longer be grouped

(divided into smaller groups) and it is this element that represents the experiment setting. This experiment setting element has the following attributes:

- **type:** describes the type of the setting's value.
- **relevance (optional):** if set to False, the setting has no effect in this experiment but has been recorded for completeness; if this attribute does not exist it is assumed the setting is relevant and has an effect.

For detailed information about setting names, units ..., refer to the **LightField Experiment Settings.chm** help file located in the Program Files\Princeton Instruments\LightField directory (the same directory containing the PrincetonInstruments.LightField.exe file). The following two examples describe how to locate a setting in the **chm** file.

Example 1: The **chm** file contains the full names of settings. If for example, you want to find out what the units are for **Exposure Time**, first search for the **ExposureTime** element in the XML (refer to Figure 8). This element is a child element of **ShutterTiming** (a child element of **Camera**). Using **ShutterTiming** as the base word, append **ExposureTime** to it. The resulting term **ShutterTimingExposureTime** is then searchable in the LightField Experiment Settings.chm file. After opening the **Search** navigation pane (see Figure 9), enter the term to find the topic in which it occurs. As can be seen in Figure 9, one of the choices is "ShutterTimingExposureTime field". Double-click on that title to open the field description. The description says "the duration of the time the sensor is exposed to light in milliseconds".

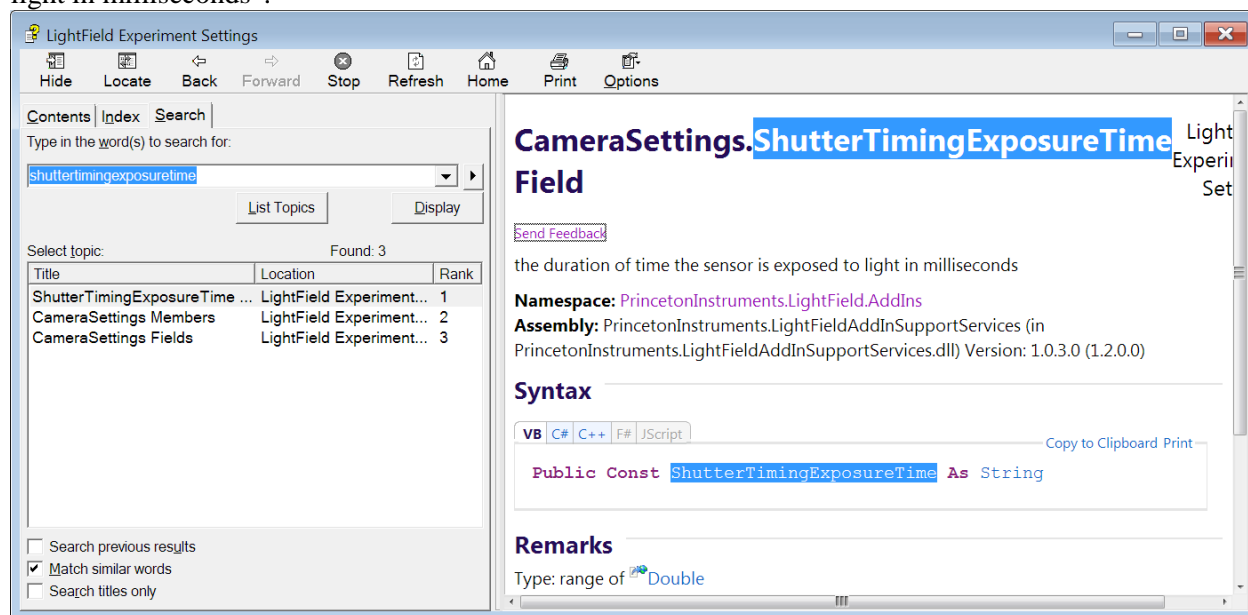


Figure 9. CameraSettings.ShutterTimingExposureTime

Example 2: To find information about the left margin of a camera sensor's active area, again look under the **Camera** element (refer to Figure 10). Concatenate **Sensor**, **Layout**, **ActiveArea**, and **LeftMargin** to create the term **SensorLayoutActiveAreaLeftMargin**. After opening the **Search** navigation pane in the **chm** file (see Figure 11), enter the term to find the topic in which it occurs. As can be seen in Figure 11, one of the choices is "SensorLayoutActiveAreaLeftMargin field". Double-click on that title to open the field description. The description says it is "the number of inactive columns to the left of the active area".

```
<Devices>
  <Cameras count="1">
    <Camera deviceID="2">
      <Sensor>
        <Layout>
          <ActiveArea>
            <Width r:priority="1" type="Int32">1024</Width>
            <Height r:priority="1" type="Int32">1024</Height>
            <TopMargin type="Int32">0</TopMargin>
            <LeftMargin type="Int32">24</LeftMargin>
            <BottomMargin type="Int32">8</BottomMargin>
            <RightMargin type="Int32">24</RightMargin>
          </ActiveArea>
        </Layout>
        <ShutterTiming>
        <ReadoutControl>
        <HardwareIO>
        <Intensifier>
        <Adc>
        <Acquisition>
        <Experiment>
      </Camera>
    </Cameras>
    <Spectrometers count="1">
  </Devices>
```

Figure 10. Sensor Element and Attributes

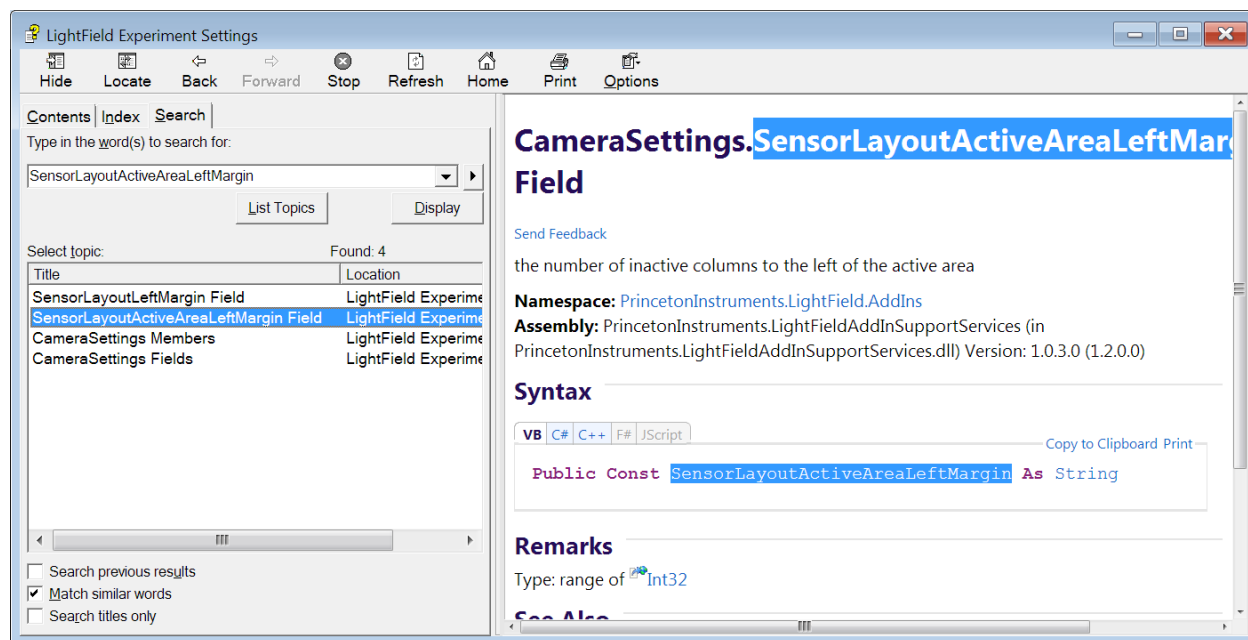


Figure 11. CameraSettings.SensorLayoutActiveAreaLeftMargin

Environment

Children elements describe settings that apply to the experiment as a whole and contain a **type** attribute used to describe how the value of the element should be interpreted.

```
<Environment>
  <WorkingDirectory type="String">C:\Users\jjones\Documents\LightField
</WorkingDirectory>
  <ScratchDirectory type="String">C:\Users\jjones\AppData\Local\Temp
</ScratchDirectory>
</Environment>
```


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