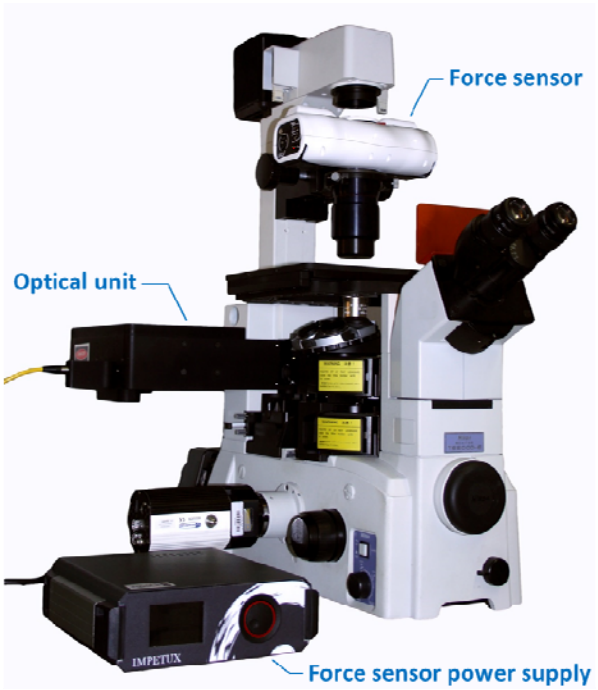
IMPETUX

The Force of Light

Optical manipulation systems for quantitative cell and tissue mechanics

多光阱、免校准细胞组织力学测试分析光镊

IMPETUX开发的光学操纵平台包括一套光镊单元（**Cygnium G-422**）和一套力学传感器单元（**Lunam T-40i**）。



直接测量细胞和组织内部的力

不需校准即可测量

主动的微-流变信息

简洁的“on-microscope”光-力学设计

兼容各种显微镜 (epi-FL, DIC, TIRFF,...)

用户友好型操作软件

多目标捕获能力，用于复杂操纵实验 (>10 光阱)

Cygnium G-422光镊系统是为进行活细胞和活组织实验而特别设计的。它基于专利技术，克服了当前常见光镊系统的局限性，在复杂介质中的力学测量方面具有很大的优势。

Cygnium G-422光镊可以安装在倒置显微镜上进行工作。系统采用声光偏转技术可同时形成**多个同步(分时)光阱**(>100)，**自动测量**每个光阱产生的力，**并同时采集荧光图像。**

Cygnium G-422可检测工作介质的流变学性质。IMPETUX技术通过主动或被动的方法来**测量细胞质之类具有高度粘弹性的复杂介质中的微-流变振幅**。

光镊单元主要特点和技术参数如下：

- **通过声光偏转仪来快速控制光束，产生多个光阱 (>100 独立光阱)**

- 2D 快速捕获控制 (100 kHz)。**可以在100 kHz对多达10个独立光阱进行力测量**
- 精确定位各个光阱
- 超稳定低噪声红外激光，生物兼容性好
- 工作场 (60x物镜下通常为 80 µm x 80 µm) 内所有光阱激光功率具有**高度均一性(<1 %)**

- **样本激光功率可 >0.5 W**
- **最大捕获力为100-500 pN**
- **同步荧光成像**
- **兼容各种显微镜 (DIC, TIRFF…)**
- 配有用用户友好型的控制和采集软件
- 光单元带有高质量铝合金外壳，使系统具有高度的力学稳定性

- 光单元尺寸 (L x H x W): 360 x 250 x 90 mm.

激光单元和 Cygnium G-422 电子驱动器挂载于高质量外壳中，可放在支架或桌面上。

力传感器模块**Lunam T-40i**可同时测量多个光阱产生的力。本公司采用**独特的专利技术**测量激光束传播方向的次级振幅而非样品位置来得到力，**测量更加直接**。系统出厂时已进行过精确校准，样品造成的光束偏转与被捕获颗粒受到的力可以直接对应。

这使我们的系统具有了独特的优势。它以反焦平面干涉技术为基础，对待操纵的样品没有限制，也不须用户进行校准，**在测量活细胞时特别有用。**

Lunam T-40i力传感器与其它同类竞争产品相比具有以下核心优势：

- **直接进行力学测量，**可在**样品定位检测**模式工作

- 系统出厂时已进行了永久校准：在更改样品或开始测量前**不需校准**

- **可以可靠的对厚样品 (最厚0.5 mm) 进行力学测量**
- **可对不同大小和形状的样品进行精确力学测量** (含非球形样品)

- **精确确定作用于样品的激光功率**
- **可对线性范围以外的光阱进行测量**：在同样的条件下，Lunam T-40i 能测量更高的力，比同类竞争产品高2-3倍。这**显著降低了**为达到某些力而需要的**照射样品的激光功率**

Lunam T-40i 力传感器主要性能和技术参数如下：

- **力分辨率 <50 fN**
- **位置分辨率 <1 nm**
- **兼容商业迷你孵箱和激光共聚焦成像腔**(如Warner Instruments RC-30WA模型)

- 高数值孔径 (NA=1.4) 浸入式光学
- 整个带宽中力传感器总噪声 <0.1 pN
- 温度-补偿，duo-lateral位置灵敏检测器(最大采样频率100 kHz)

- 高达100 kHz，18位模拟-数字信号转换
- 提供高度可控的低噪声线性功率(可用100/120/220/240 VAC- 50/60 Hz)

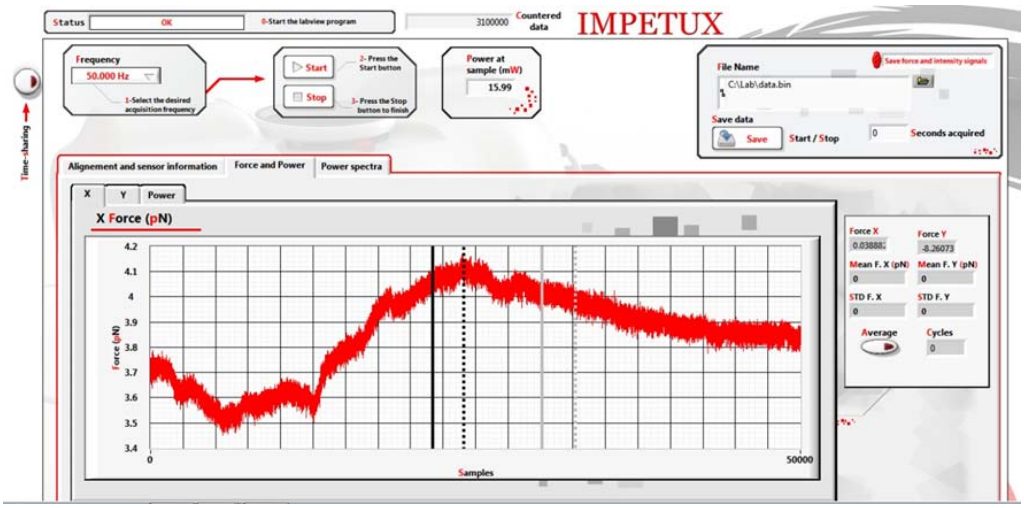
- 对称和健壮的光-力设计
- 传感器头单元尺寸：22 cm x 18 cm x 11 cm
- 通过高速USB 2.0端口与电脑连接
- 带有用户友好的采集软件和LabVIEW库
- 安装调试过程直观，确保了测量的正确性和重复性

此外，Lunam T-40i 力传感器还可以与以下附加选项补充使用：

-力夹紧模块对样品施加恒定力

-Z轴力测量模块进行 **3D 力测量**

Impetux提供的控制和采集软件是一个**Labview应用程序**，可**控制一些显微镜摄像机**(如SCMOS Hamamatsu ORCA Flash 4.0 V3)，也可控制光阱的产生和同步力学测量信息采集。工作场内**光阱的产生**及其位置和位移可通过在屏幕界面上简单的**单击和拖拽鼠标进行控制**。也可**通过预定义文件来产生光阱**，以精细地控制光阱位移。每个光阱的直接力学测量会产生有用的实时数据 (可达100 kHz采样频率) ，这些数据可以不同格式进行存储以进行进一步的分析。此软件也可以**自动执行程序来对样品进行主动微-流变学研究**。
LabVIEW是科学仪器领域广泛使用的软件开发工具。它具有很多优点，可由用户、Impetux公司或第三方开发人员根据需要很方便地进行简单的修改。为达到此目的，**IMPETUX 发布了开放源码的.vi 模块**。



LabVIEW的另外一个优势是可以很方便地将以后安装到系统上的设备(如新摄像头和自动平台)的控制方法整合进软件，因为大多数仪器制造商都会为它们的设备提供LabVIEW环境的驱动控制。

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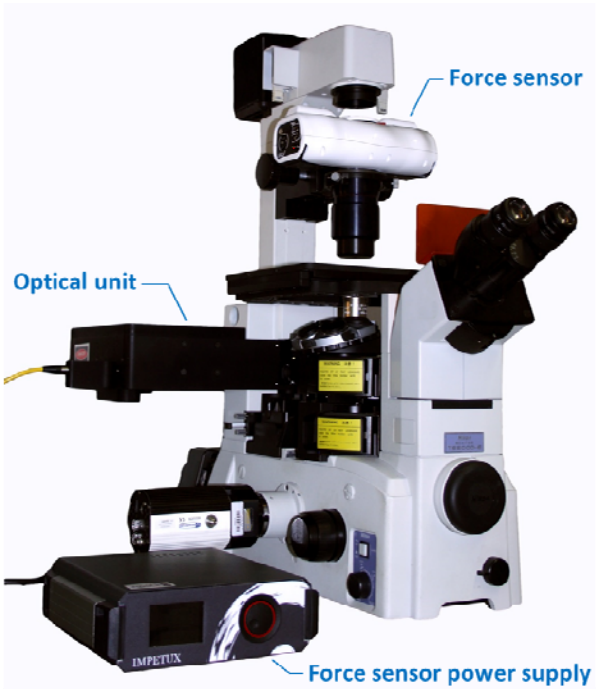
The Force of Light

The optical manipulation platform developed by IMPETUX consists of an optical trapping unit (**Cygnium G-422**) combined with a force sensor unit (**Lunam T-40i**).



Direct measurement of **forces inside cells and tissues**.

Calibration-free force measurements.

Active micro-**rheological information**.

Compact "on-microscope" opto-mechanical design.

Compatible with different microscopies (epi-FL, DIC, TIRFF,...)

User-friendly software.

Multiple trapping capabilities for complex manipulation experiments (>10 traps).

The **optical trapping** system **Cygnium G-422** has been specifically designed to work with living cells and tissues. It is based on a patented technology that overcomes the main limitations of current systems, bringing key advantages for the measurement of forces in complex media.

The optical tweezers Cygnium G-422 is conceived to work as a satellite component of an inverted microscope. The system offers the possibility to **work with multiple traps** (>100) simultaneously synchronized (**time sharing**) by means of acousto-optic deflection technology, **automatically measuring the force** exerted by each trap **and allowing the acquisition of fluorescence images at the same time.**

Cygnium G-422 allows the possibility to determine the rheological properties of the working medium. By mean of active/passive techniques, IMPETUX technology offers the possibility of **measuring micro-rheological magnitudes inside complex mediums like cells cytoplasm** with great viscosity and abundant of elastic properties.

The main performances and technical specifications of the optical trapping unit are:

- **Ultra-fast beam steering through acousto-optic deflectors for the generation of multiple traps (>100 independent traps)**.
- 2D fast trap steering (100 kHz). **Force measurements at 100 kHz can be simultaneously performed for up to 10 independent traps**.
- Accurate positioning of the individual traps.
- Ultra-stable low noise Infrared laser for biological compatibility.
- **Optimized laser power homogeneity (<1 %)** of all traps generated in the working field (typically 80 µm x 80 µm for a 60X objective magnification).
- **Laser power at sample as high as >0.5 W**.
- **Maximum typical trapping forces of 100-500 pN**.
- **Simultaneous Fluorescence imaging**.
- **Compatible with different microscopies (DIC, TIRFF…)**
- User-friendly control and acquisition software included.
- Robust high-quality aluminum enclosure of the optical unit specially designed for the maximum mechanical stability of the system.
- Dimensions of the Optical unit (L x H x W): 360 x 250 x 90 mm.

The laser unit (included in the system) and Cygnium G-422 electronic drivers are mounted into a high quality enclosure (either rack or table top enclosure).

The **force sensor** module **Lunam T-40i** is specially conceived to simultaneously measure the forces exerted by several optical traps generated by the optical trapping module. **Our patented and distinctive technology** measures the force as a derived magnitude of the direction of propagation of the laser beam, instead of the sample position, which **provides a direct route to the force**. After an accurate calibration at factory, the deflection of the beam produced by the sample directly corresponds to the optical force exerted on the trapped particle.

This gives our technology a key advantage over the competence systems, usually based on back focal plane interferometry, as no restrictions on the sample are imposed and no previous calibration form the user side is required. **This is especially advantageous when working with living cells**.

Among the most relevant advantages of the Lunam T-40i force sensor compared to other competitors, we highlight:

- Ability to perform **direct force measurements** and work in **sample position detection** mode.
- Permanent calibration of the system made at factory: **No need of any previous calibration to start measuring** or when sample is changed.
- **Reliable force measurements inside thick samples (up to 0.5 mm)**.
- **Exact force measurement independently of sample size and shape** (including non-spherical samples).
- **Precise determination of the laser power at sample.**
- **Possibility of measuring beyond the linear region of the trap**: under the same conditions, Lunam T-40i is capable of measuring higher forces (a 2-3 fold factor) than its competitors. This **significantly reduces the laser power irradiation of the sample** necessary to measure a certain force.

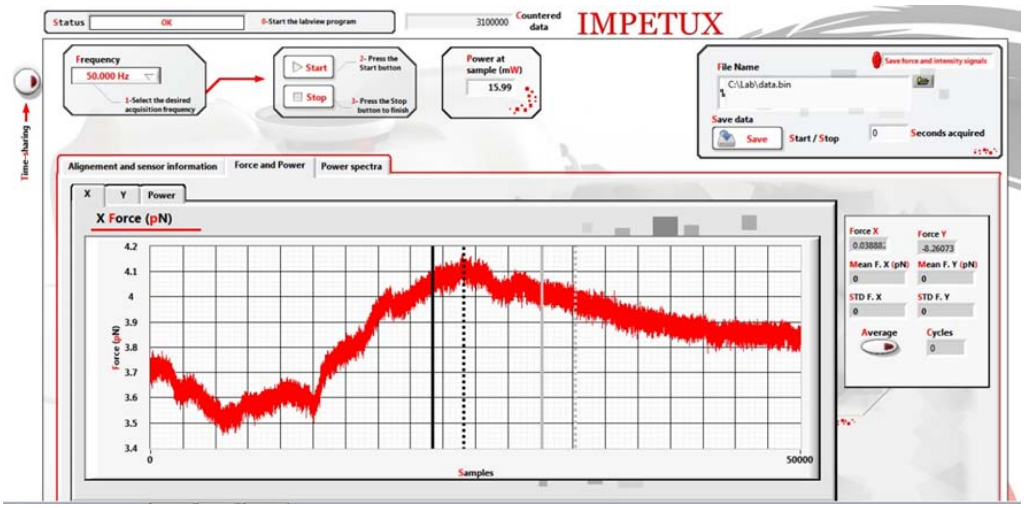
The main performances and technical specifications of the Lunam T-40i force sensor unit are:

- **Force resolution <50 fN.**
- **Position resolution <1nm.**
- **Compatible with commercial micro-incubation chambers and confocal imaging chambers** (like for instance the RC-30WA model from Warner Instruments).
- High Numerical-Aperture (NA=1.4) immersion optics.
- Integrated sensor noise over the whole bandwidth <0.1 pN (typ.).
- Temperature-compensated, duo-lateral position sensitive detector (PSD) (max. sampling frequency 100 kHz).
- Up to 100 kHz, 18-bit, analog-to-digital conversion.
- Highly-regulated, low-noise linear power supply (models with 100/120/220/240 VAC- 50/60 Hz available).
- Symmetric and robust opto-mechanical design.
- Sensor head unit dimensions: 22 cm x 18 cm x 11 cm.
- Direct PC communication through Hi-speed USB 2.0 port.
- User-friendly acquisition software and LabVIEW libraries included.
- Straightforward installation and tuning routines ensure correct measurements and reproducibility.

Additionally, the Lunam T-40i force sensor can also be complemented with additional options like:

- **Force clamping** modulus to apply constant force levels on samples
- **Z axis force measurement** modulus for **3D force measures**.

The control and acquisition software supplied by Impetux consists of a **Labview application** with moduli for the **control of several microscope cameras** (like for instance SCMOS Hamamatsu ORCA Flash 4.0 V3), the generation of optical traps and the acquisition of synchronized force measurements. The **generation of the traps** as well as their positioning and displacement over the working field can be **controlled by simply clicking and dragging the mouse** over the camera screen interface. The **traps can also be generated though predefined files** in order to execute finely controlled trap displacements. The direct force measurements of each tarp generate useful data (up to 100 kHz sampling frequency) in real time which can be stored in several format files for their ulterior analysis. **Automated routines are also implemented in the software in order to perform active micro-rheological studies of the samples**.
LabVIEW is the preferred software development tool used in scientific instrumentation environments and has the advantage that it allows implementing simple modifications by the user, Impetux technicians or third-party developers in case of need. For this purpose, **IMPETUX distributes .vi modules with open source code**.



An additional advantage of LabVIEW is the ease of implementation into the software of control routines for any new equipment that is added later to the system (such as new cameras or motorized platforms) since most of the instrumentation manufacturers facilitate the control drivers of their equipment in this environment.