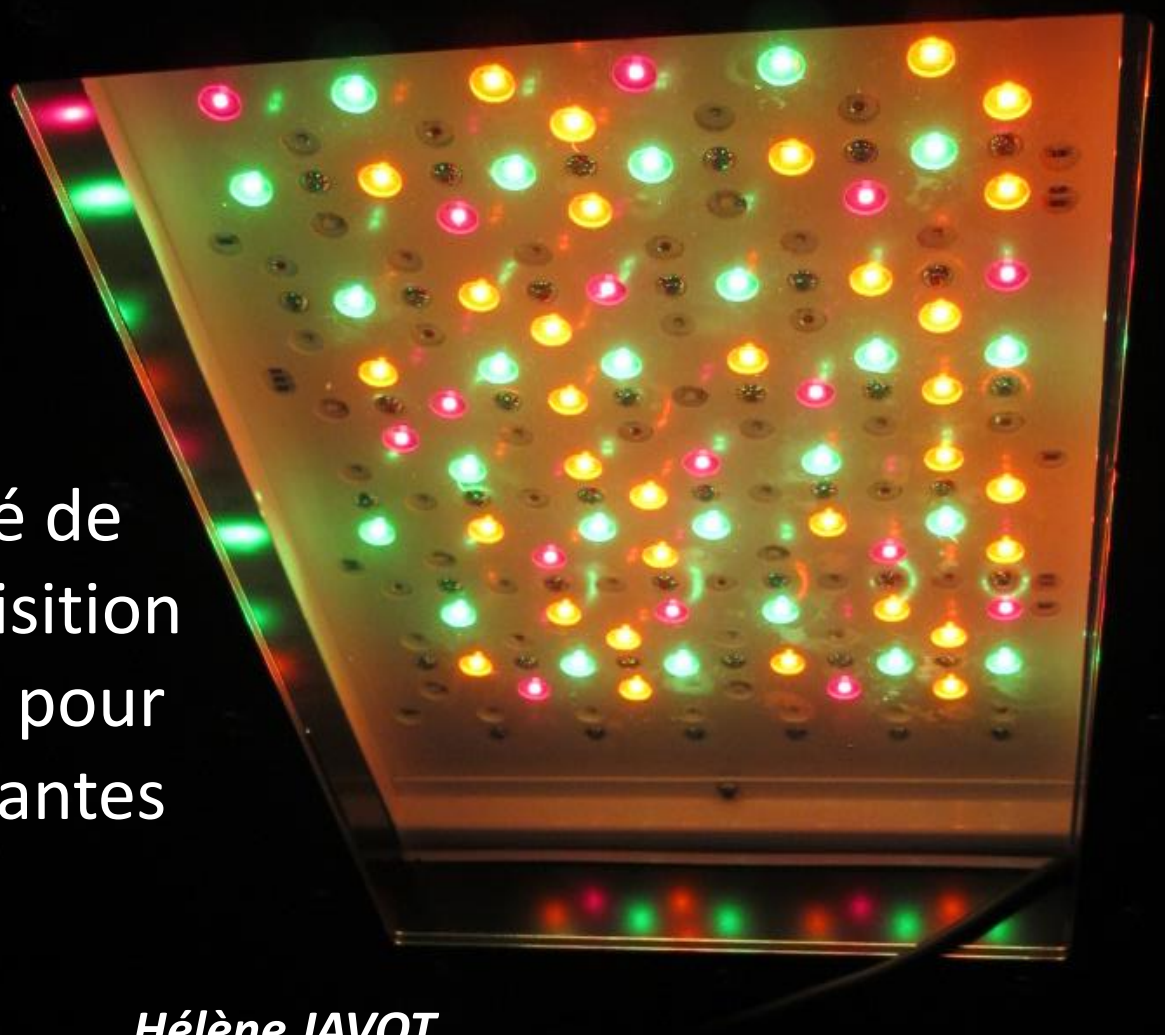
LUMALUM:

Pilotage concerté de systèmes d'acquisition et d'illumination pour l'imagerie des plantes en temps réel



Hélène JAVOT

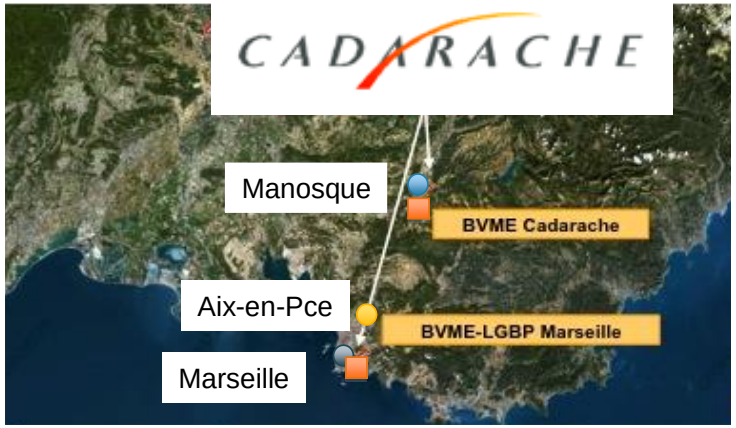
CONTEXTE DU PROJET LUMALUM

L. Nussaume

Laboratoire de Biologie du Développement des Plantes (LBDP)

Institut de Biologie Environnementale et Biotechnologies

CNRS – CEA – Université Aix Marseille



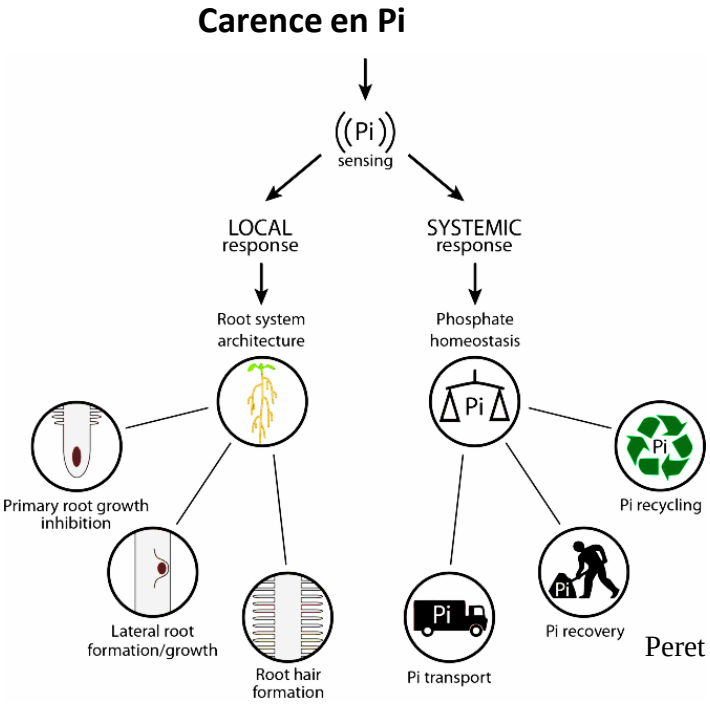
THEMATIQUE DE RECHERCHE AU LBDP

Etude des réponses des plantes à la **carence en phosphate (Pi)**

500µM Pi

15µM Pi

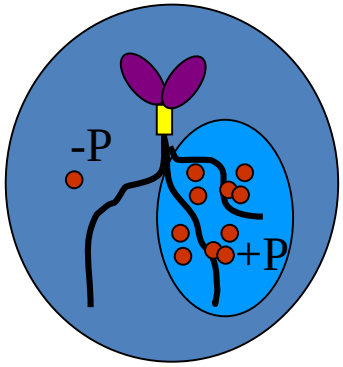
Modèle principal:
Arabidopsis thaliana



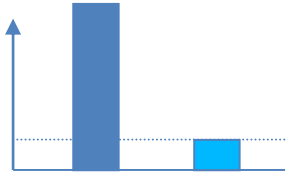
Peret *et al.* (2011)

Des réponses “Locales” et “Systémiques”

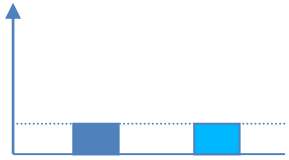
DES LIGNEES MARQUEURS
DES REPONSES LOCALES/SYSTEMIQUES



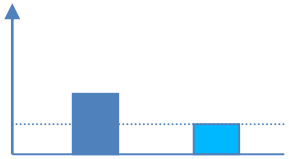
Locally regulated gene

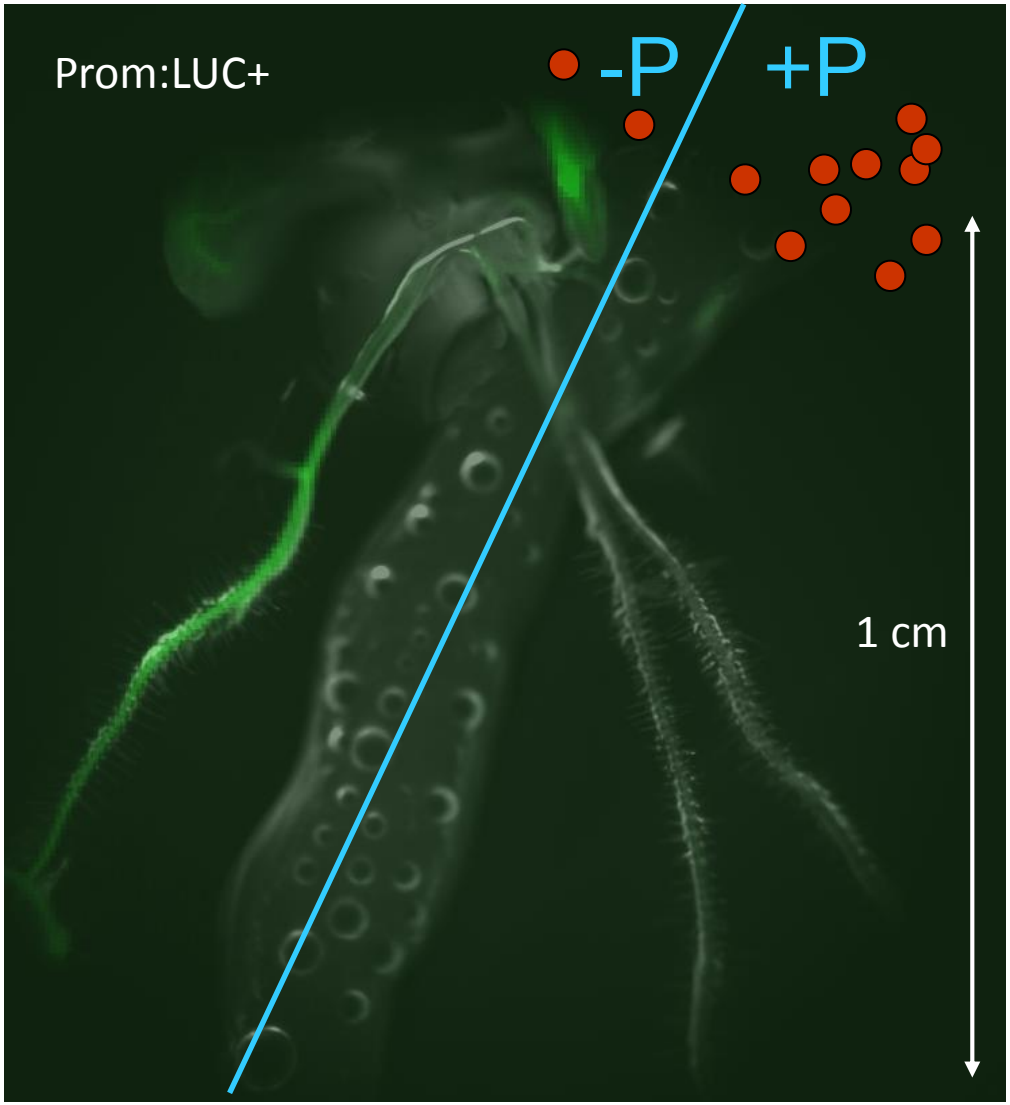


Systemically regulated gene



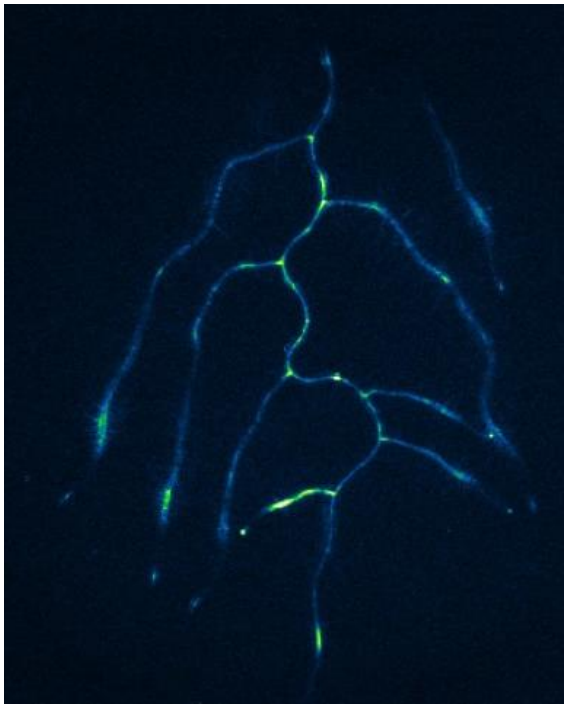
In between... example:

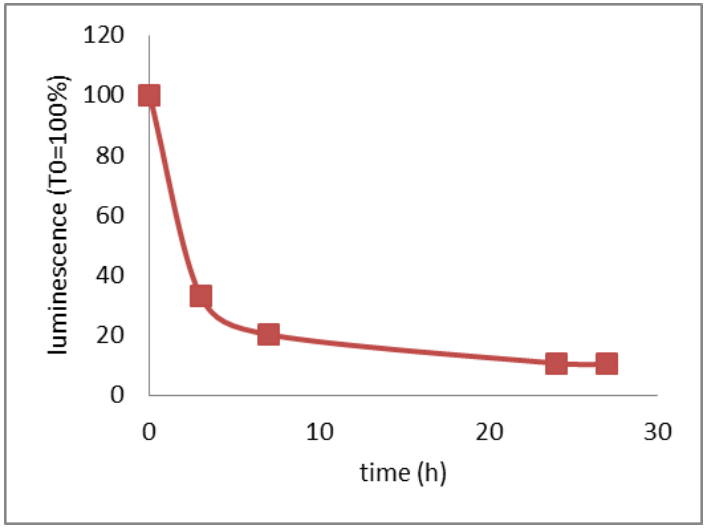




ELARGIR NOTRE VISION DES REPONSES A LA CARENCE

-Vision « Macroscopique » des réponses
-Améliorer la résolution temporelle
-Permettre des suivis sur 2 jours

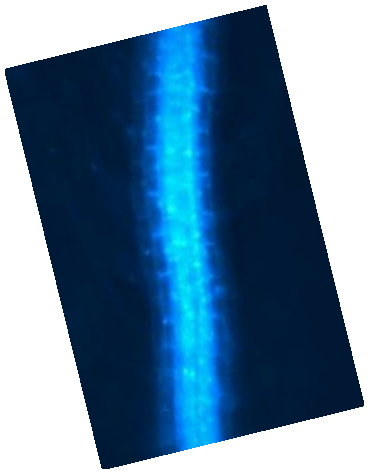


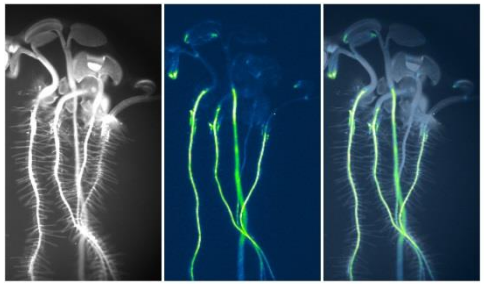


Choix de suivi en luminescence

DES OUTILS D'IMAGERIE NON ADAPTES AUX PLANTES EN CULTURE

Cabinet Opaque





Javot (2011) Mic.Mic.

LV200 Olympus

QUE VOULONS NOUS VRAIMENT?

-Un système peu coûteux

-Compatible avec notre caméra haute sensibilité déjà acquise

-Evolutif

non limité à N boîtes de petri
non limité à Arabidopsis
compatible avec des plantes en sol

-Large choix de longueurs d'ondes d'illumination

LUMALUM!!!

LUMALUM: un projet reposant sur des plateformes collaboratives

Objectif:

Développer notre système d'imagerie…

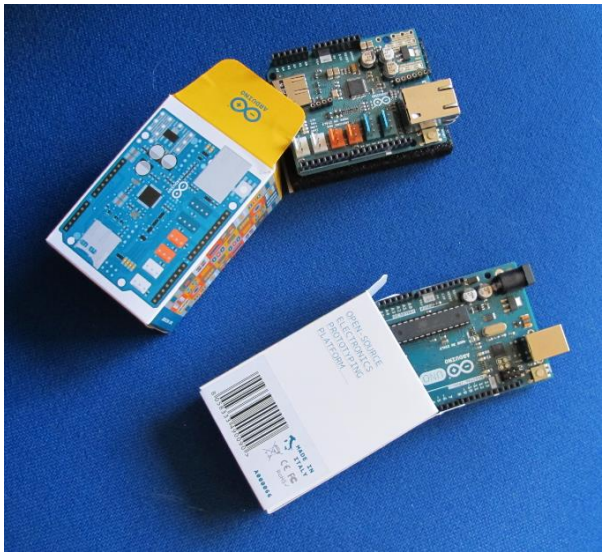
…mais anticiper sa modification pour VOS applications

TECHNOLOGIE ARDUINO

-Interface de programmation et pilotage électronique basée sur l'Open Source

-Une communauté

-Des formations



Interface ARDUINO

µ-Manager

µ-Manager Open Source Microscopy Software

-Dérivé d'Image J

-Pilote de nombreux périphériques:

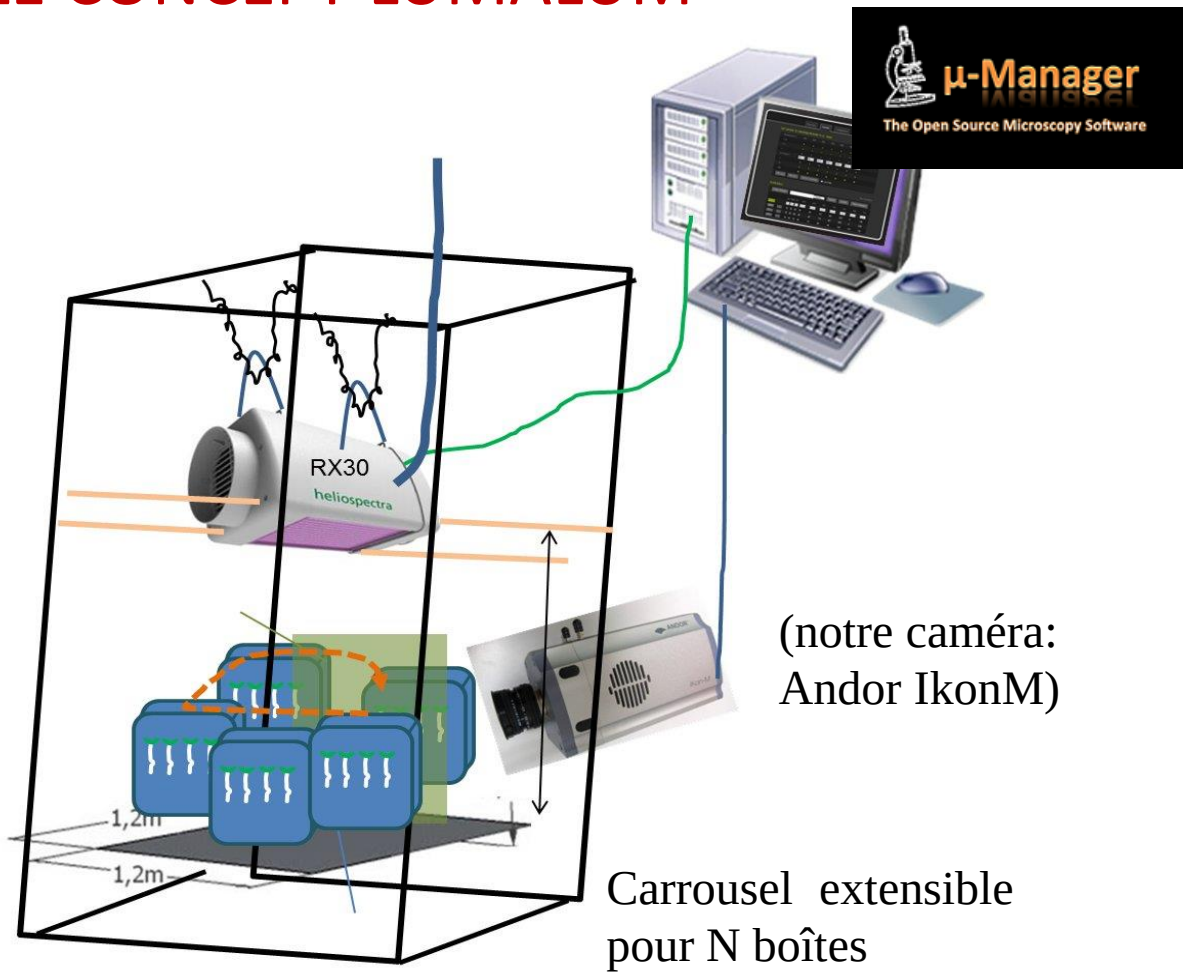
- Microscopes
- Shutter
- Filtres
- TTL communications (Arduino)
- Etc.

Cameras

- **ABSCamera** - Cameras from ABS Gesellschaft für Automatisierung, Bildverarbeitung, Software GmbH Jena
- **Andor** - Andor cameras
- **AndorSDK3** - New model Andor cameras
- **Apogee** - Apogee cameras
- **AxioCam** - Zeiss AxioCam medium resolution and high resolution models (Windows)
- **BaumerOptronic** - Leica DFC camera (through BaumerOptronic FXLib)
- **BiostepEagleIce** - biostep EagleIce camera
- **dc1394** - Firewire cameras that adhere to the iidc1394 specs (see also **IIDC**)
- **DECamera** - Direct Electron Cameras
- **DemoCamera** - Virtual, emulated equipment for testing
- **DSLRRemoteCamera** - Canon DSLR cameras (Windows)
- **FLICamera** - Finger Lakes Instrumentation Cameras
- **GigECamera** - GigE Vision- and GenICam-compliant cameras
- **GPhoto** - Canon and Nikon DSLR cameras (Mac, Linux)
- **Hamamatsu** - Legacy adapter for Hamamatsu cameras (via DCAM-API); now Mac only
- **HamamatsuHam** - Hamamatsu cameras (via DCAM-API)
- **IDS_uEye** - IDS uEye USB cameras (also Thorlabs DCUxxxx, Edmund EO-xxxxM) (Linux, Windows)
- **IIDC** - Firewire (and USB) cameras compatible with the IIDC specification (see also **dc1394**)
- **Leica Cameras** - These use the **BaumerOptronic** adapter
- **Micropix** - Cameras from Micropix
- **Mightex_C_Cam** - Mightex C-series USB cameras
- **MoticCamera** - Motic cameras
- **OpenCVgrabber** - Supports numerous USB cameras and frame grabbers (those using a DirectShow or WDM class driver). (Windows)
- **NKRemoteCamera** - Nikon Digital SLR (Windows)
- **Photometrics** - A.k.a. **PVCAM**
- **PICAM** - Princeton Instruments cameras using the PICam interface
- **PrincetonInstruments** - Princeton Instruments cameras
- **PVCAM** - Roper/Photometrics cameras (not for Princeton Instruments)
- **PCO_Camera** - Supports all PCO cameras (Sensicam, Pixelfly and others)
- **Piper** - Stanford Photonics cameras
- **ProgRes** - Jenoptik cameras (ProgRes series)
- **PSRemoteCamera** - Canon PowerShot camera (Windows)
- **QCam** - QImaging cameras
- **QSICamera** - QSI cameras (Windows)
- **RaptorEPIX** - EMCCD cameras
- **ScionCam** - Scion cameras
- **Sensicam** - PCO/Cooke Sensicam camera
- **SpotCamera** - Diagnostic Instruments Spot cameras
- **TetheredCam** - Canon and Nikon DSLR cameras (Windows)
- **ThorlabsUSBCamera** - Thorlabs cameras (Windows)
- **TIScam** - The Imaging Source cameras (tested on USB/CCD models) and video frame grabbers
- **TSI** - Thorlabs Scientific Imaging Cameras
- **TwainCamera** - Cameras fully implementing Twain Imaging Standard
- **Video4Linux** - Video4Linux compatible cameras
- **XIMEACamera** - XIMEA cameras (and some Olympus Soft Imaging cameras)
- a non-Open Source adapter for DVC cameras (Micro-Manager 1.0 only) is available from **DVC**

LE CONCEPT LUMALUM

Interface ARDUINO



(notre caméra: Andor IkonM)

Carrousel extensible pour N boîtes

DU CONCEPT A LA MISE EN OEUVRE

Collaborations

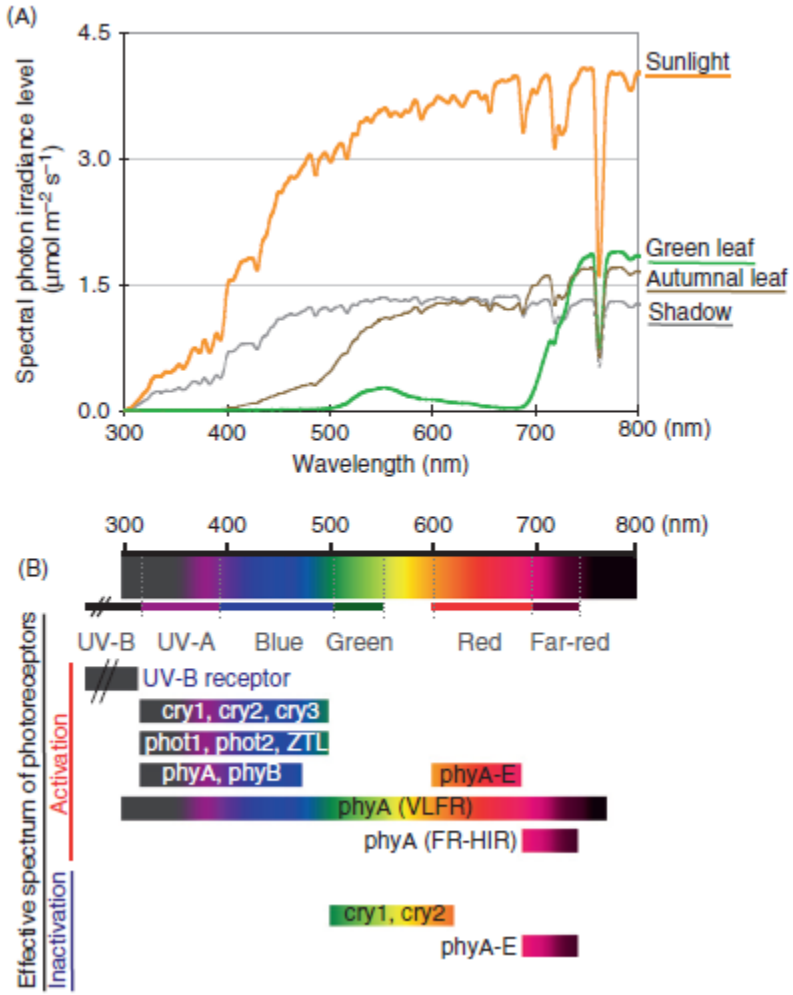
IBMP
Jérôme MUTTERER

Groupe de recherche appliquée en phytotechnologie (GRAP)
Michel PHILIBERT
Frédéric GIBIAT
Frédéric ESPANET

Financements

Programme Interdisciplinaire CNRS: « Instrumentations aux limites » 2014

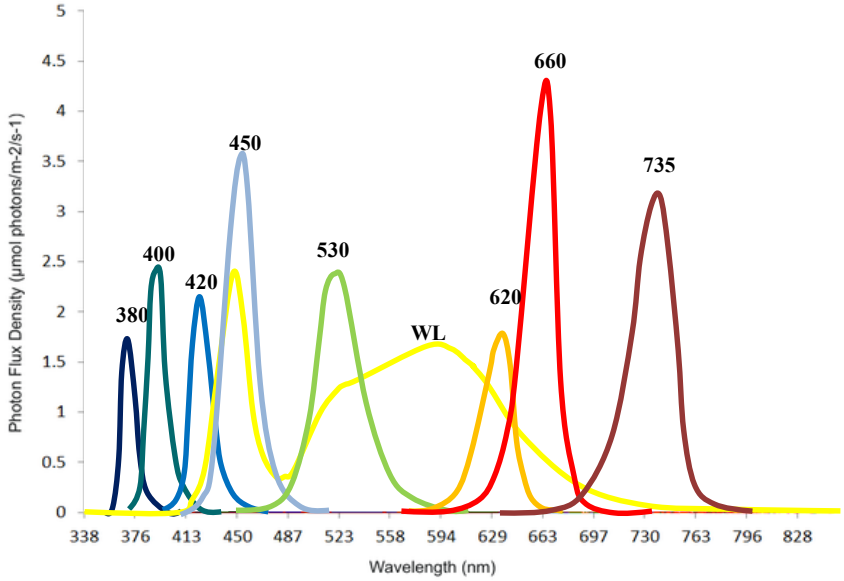
OPTIMISER LE SPECTRE DE LONGUEURS D'ONDES



Kami 2010 Cur.Top.Dev.Biol.

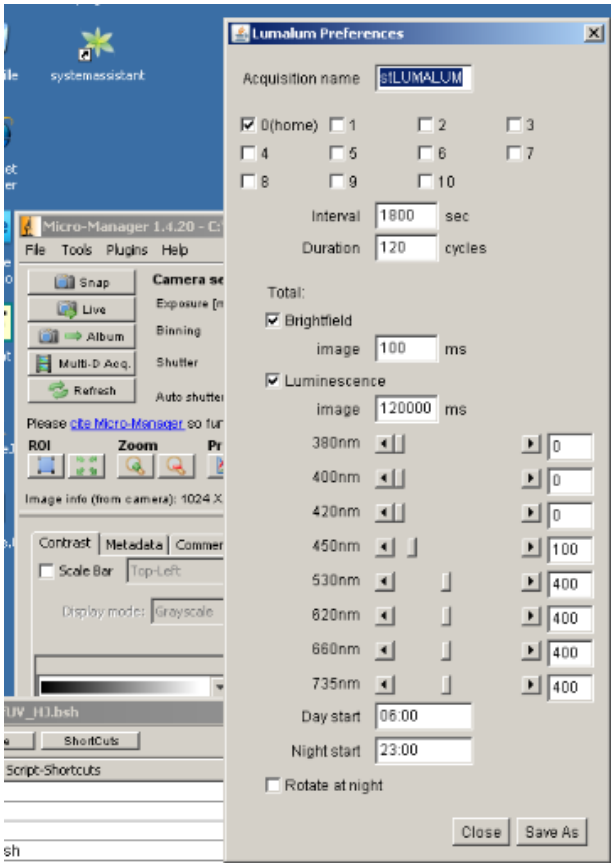
Heliospectra RX30

heliospectra



Pilotage par ordinateur

INTERFACE UTILISATEUR (GUI)



Deux versions des scripts associés:

-Accès aux scripts en **lecture** (utilisateur)

-Accès aux scripts en **lecture / écriture** (Manager du système)

SEQUENCE DES EVENEMENTS

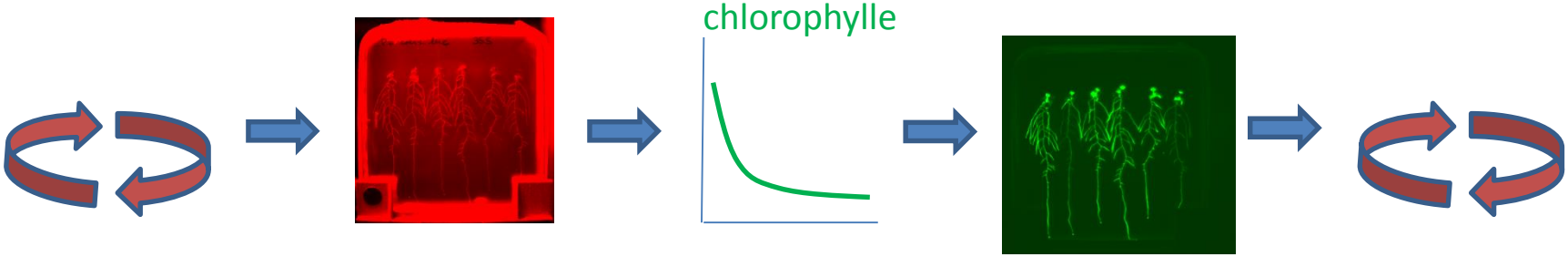
Choix de l'illumination

Lumière faible

obscurité

obscurité

De-excitation chlorophylle



Randomisation

Image champ clair

Attente 1-2mn

Image luminescence

Pour N boîtes

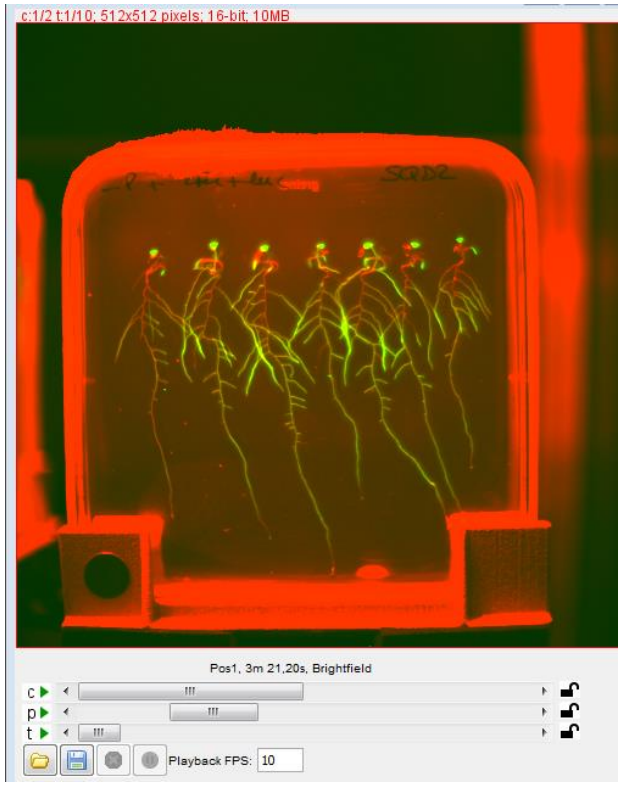
Entre les acquisitions

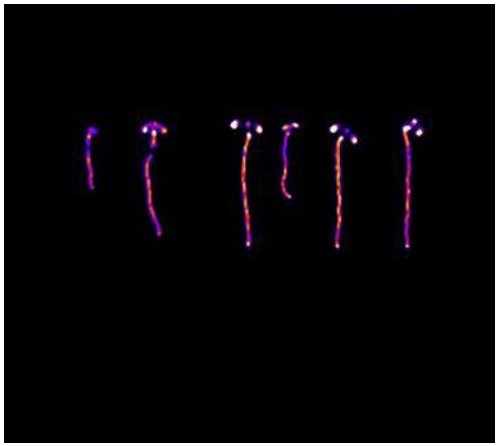
Acquisitions

Entre les acquisitions

QUELQUES EXEMPLES

Un fichier à 3 dimensions:
-Numéro de boîte de Petri
-Mode d'imagerie
(lumière blanche/ luminescence)
-Points de cinétique





Exemple de cinétique sur plusieurs jours
(sans carrousel)

REMERCIEMENTS

LBDP
Laurent NUSSAUME

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Michel PHILIBERT
Frédéric GIBIAT
Frédéric ESPANET

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Jérôme MUTTERER

Financeurs

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Réseau GDR2588