

DEVELOPMENT OF A STANDARD FOR PETRI DISH IMAGING

PIONEERING DIAGNOSTICS

MIWG ICC meeting, March 4th 2015

Jeremie Pescatore, Imaging System Core Asset Architect

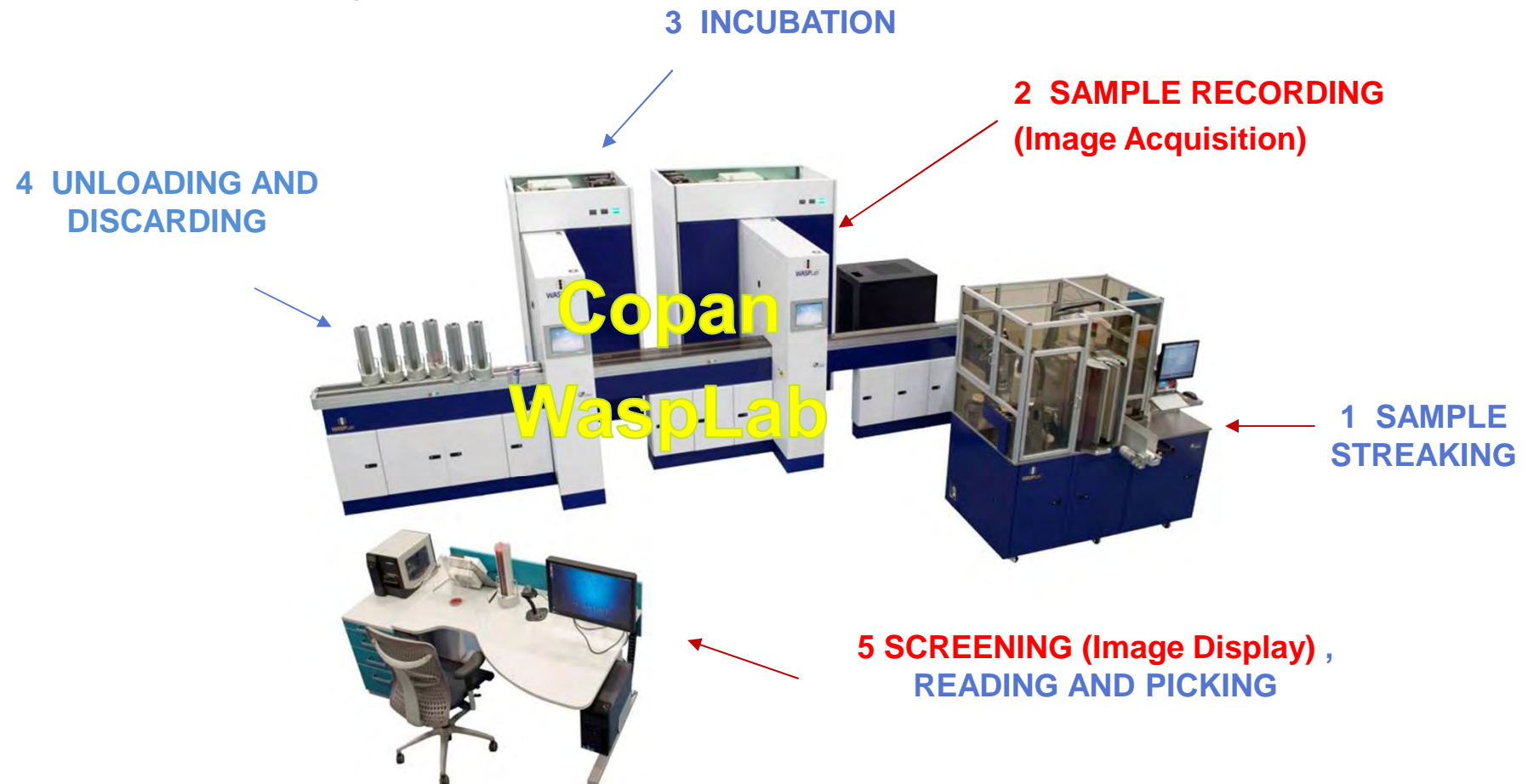
Revision 2 – uncontrolled copy



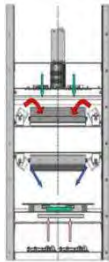
Business Update

In January 2015, bioMérieux announced a strategic **agreement w. COPAN** around 2 pillars :

- Distribution agreement
- Co-development agreement



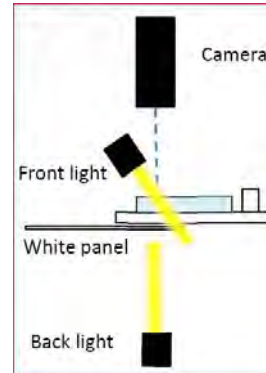
Need For Standards ?



+



« former » FMLA
bioMérieux



+



COPAN

COMPETITOR

Image information shall

➔ Give an **equivalent medical value** at any moment in the microbiological workflow

User Needs

Image Quality Requirement → The virtual reading shall allow to :

1. Detect growing colonies of a minimum size
2. Reliably distinguish different type of colonies on the same plate
3. Distinguish colonies by **their color** on chromogenic media
4. Detect **hemolysis** (alpha & beta) at the surrounding of the colonies
5. Detect **swarming** at the surrounding of the colonies



Image Quality Verification → Virtual reading **shall be at least equivalent** to manual reading (ie : reference method) **for the different criterias.**



Manual Reading = *physically* read an inoculated ppm plate

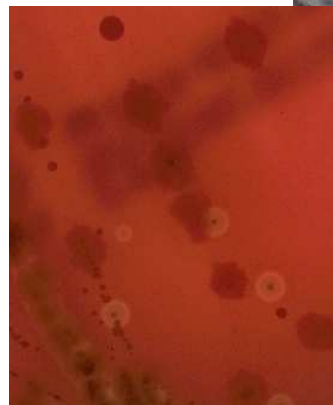
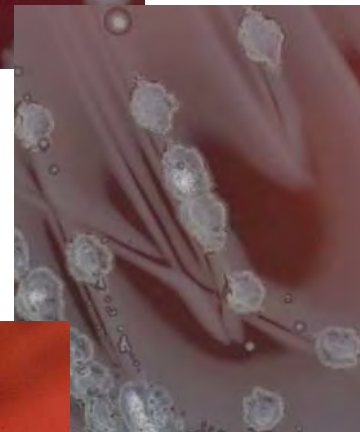
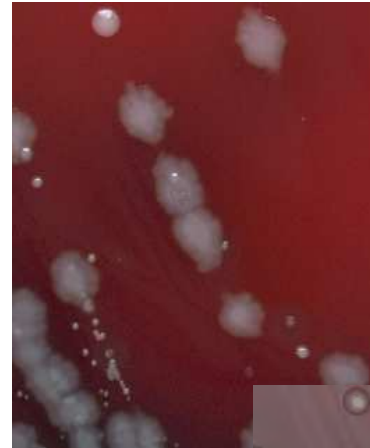
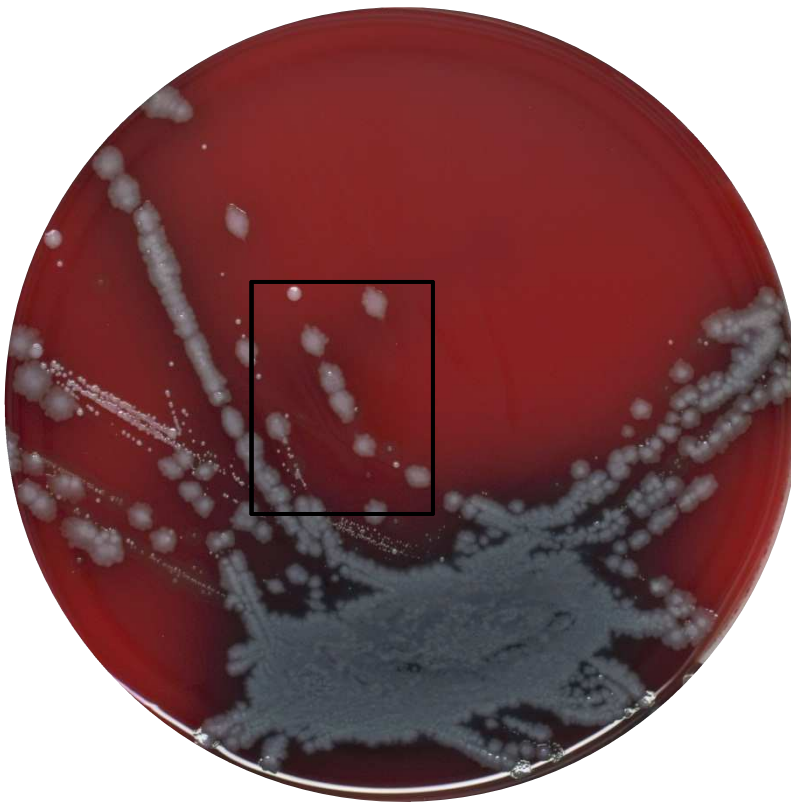
Virtual Reading = reading an inoculated ppm plate on a *display*

Reliably distinguish different species of colonies on the same plate

Specimen: Broncho Alveolar Liquid

Medium : Columbia blood Agar

Incubation : 24h under CO₂



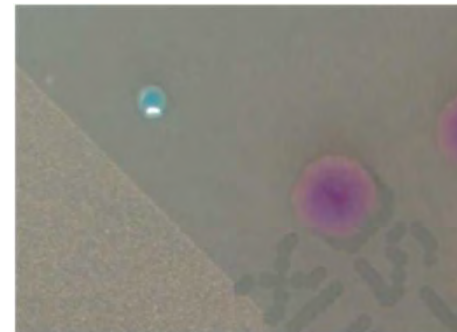
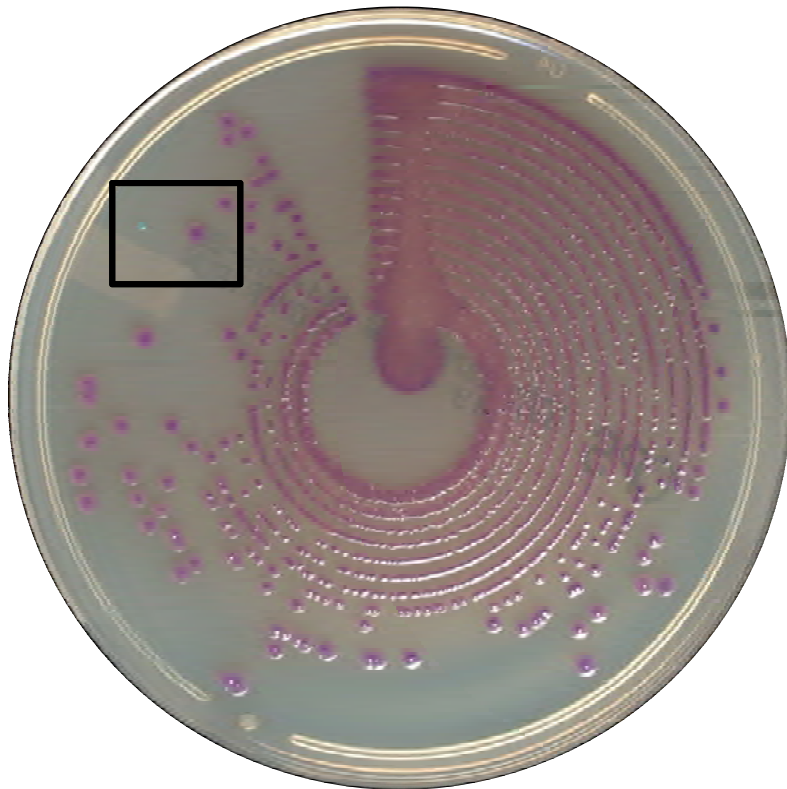
Distinguish colonies by their color on Chromogenic Media

Specimen: Urines

Medium : CPS

Incubation : 24h under O₂

Direct Identification of *E.coli* w *Enterococcus* (contaminant)



Detect hemolysis (alpha and beta) growing artefacts at the surrounding of the colonies

Specimen: Pure strain of *S.pneumoniae*

Medium : Columbia blood agar

Incubation : 24h under CO₂

Hémolyse: alpha



Specimen: Pure strain of *S.agalactiae*

Medium : Columbia blood agar

Incubation : 24h under O₂

Hémolyse: beta

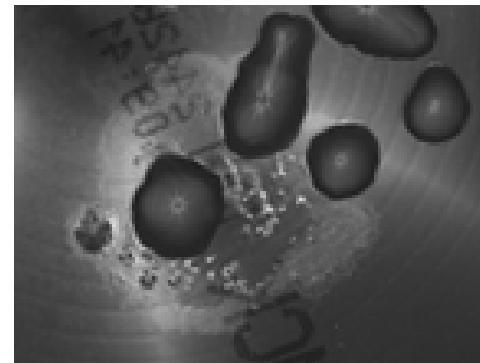
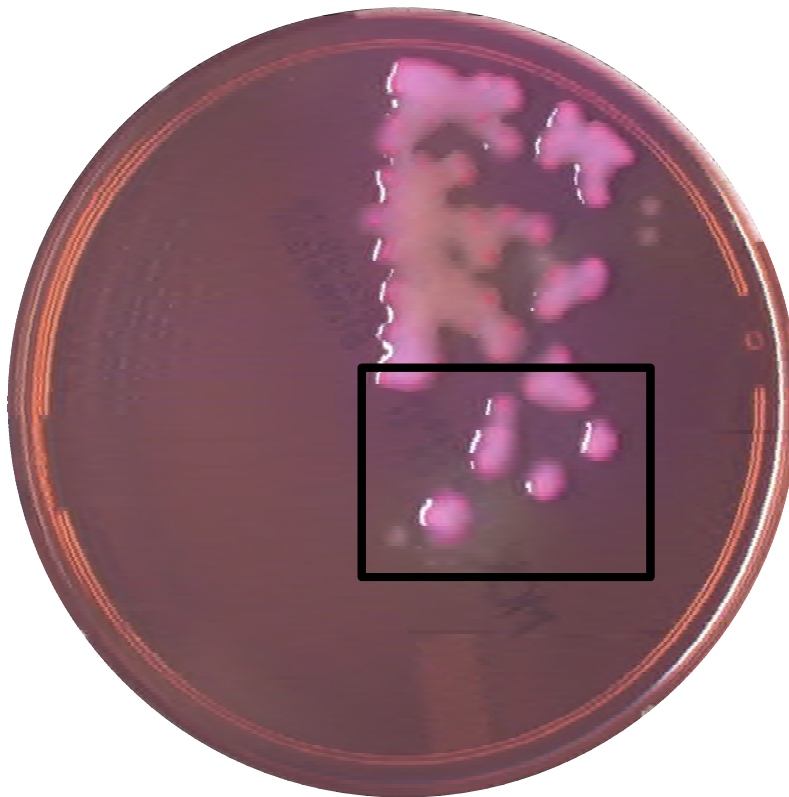


Detect swarming growing artefact at the surrounding of the colonies

Specimen: Mixed culture of *P.mirabilis* and *K.pneumoniae*

Medium : MCK

Incubation : 24h under O₂



IMAGING SYSTEM

Core Asset Architecture

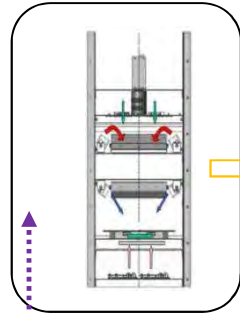
PIONEERING DIAGNOSTICS



System Requirements



Image Acquisition



T_{exposure}

Image Processing

Lighting
Correction

Color
Correction

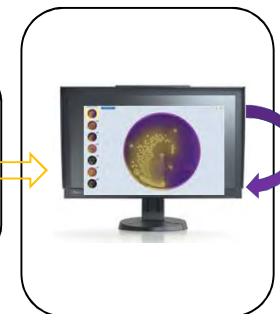
Plate
Shuttering

Image
Resizing (opt)

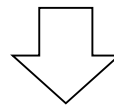
Calibration Data

Calibration Data

Image Display



Monitor
Calibration
Data



Contrast

Color Resolution

Spatial Resolution



Metric

Measurement Method

ΔE_{2000}



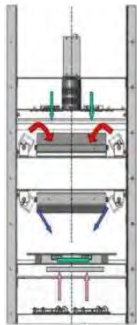
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System Product Break Down Structure

Imaging System :

- SR 1 : image contrast
- SR 2 : spatial resolution
- SR 3 : color resolution



allocate



allocate



Acquisition System w. components

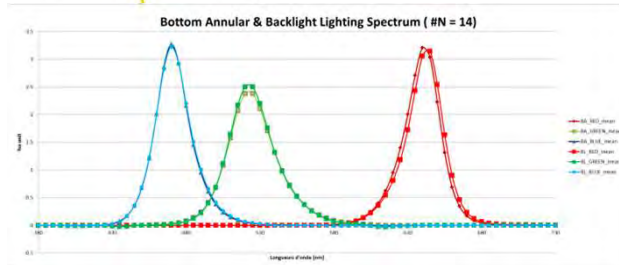
Lightings
Camera (incl optics)
Robotic arm
Climatic Environment
Calibration & Control Tools

ppm
component

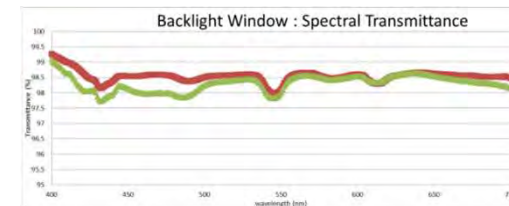
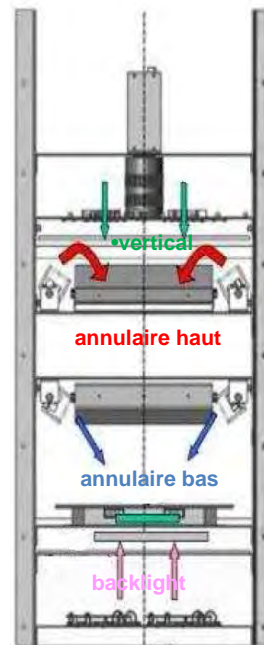
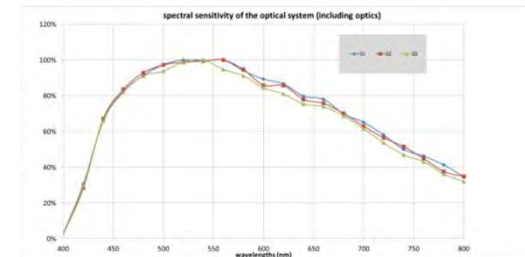
Display System w. components

User Interfaces
Monitor
Image processing
Climatic environnement

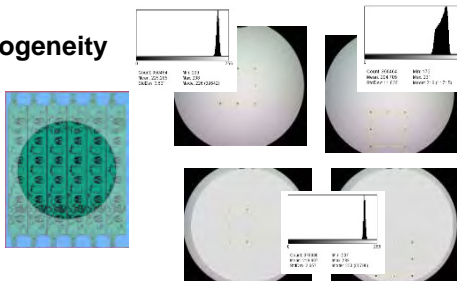
Acquisition Critical Component Specifications



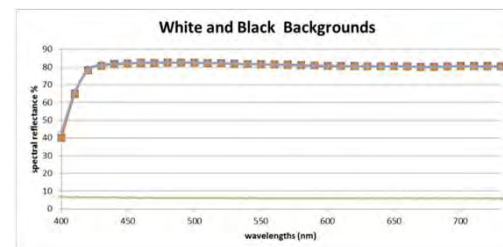
camera
 size = 1800 x 1800 (ie : 3 Mpixels)
 resolution = 50 μ m
 FOV = 9 cm
 Large Field Depth = +/- 6 mm



Homogeneity



Backgrounds



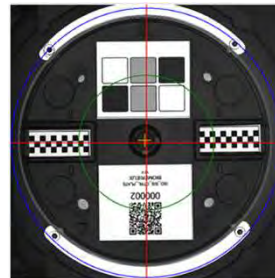
➔ **Repeatable & Reproducible Acquisition System**

Acquisition System : Calibration & Control

Calibration

plate centering
focus adjustment
pixel resolution

Tool



Control

LED flux (weekly)

inhomogeneity correction
white balance



icc input profiles per
lighting



color (semesterly) → delta E2000

Display User Interface Specifications

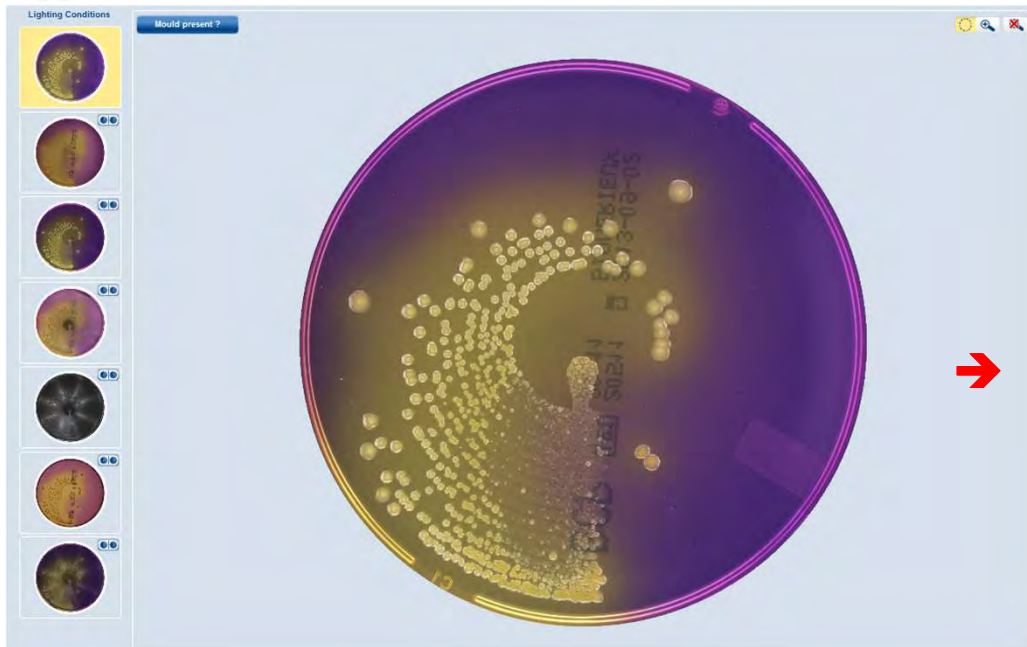


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- 27 inches monitor
- Ultra Full HD Resolution (2560x1440)
- sRGB gamut
- Protection against ambient luminosity
- Monthly calibration

[Home](#) > [Culture Reading List](#) > [Culture Reading Overview](#) > [Culture Reading](#)



- Display w. blue Grey background with no chromatic adaptation
- Image Display 1000x1000 w . bi-linear interpolation
- Zoom up to native resolution

IMAGING SYSTEM

« Standards » Perspectives

PIONEERING DIAGNOSTICS

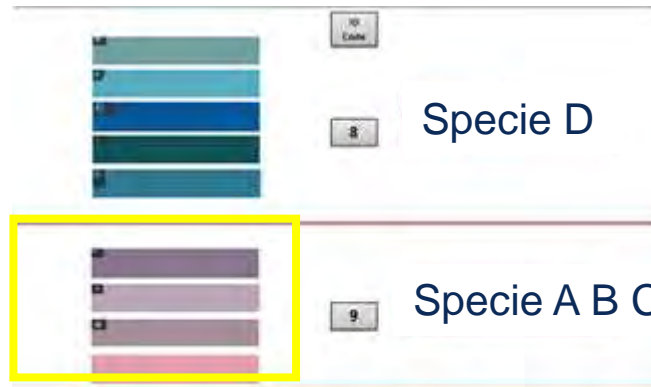


Jeremie Pescatore, Imaging System Core Asset Architect

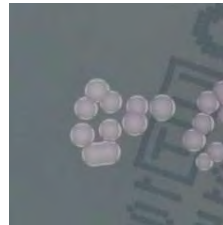
Color Resolution Problematic

Example

chromogenic scale



Specie A



Specie B

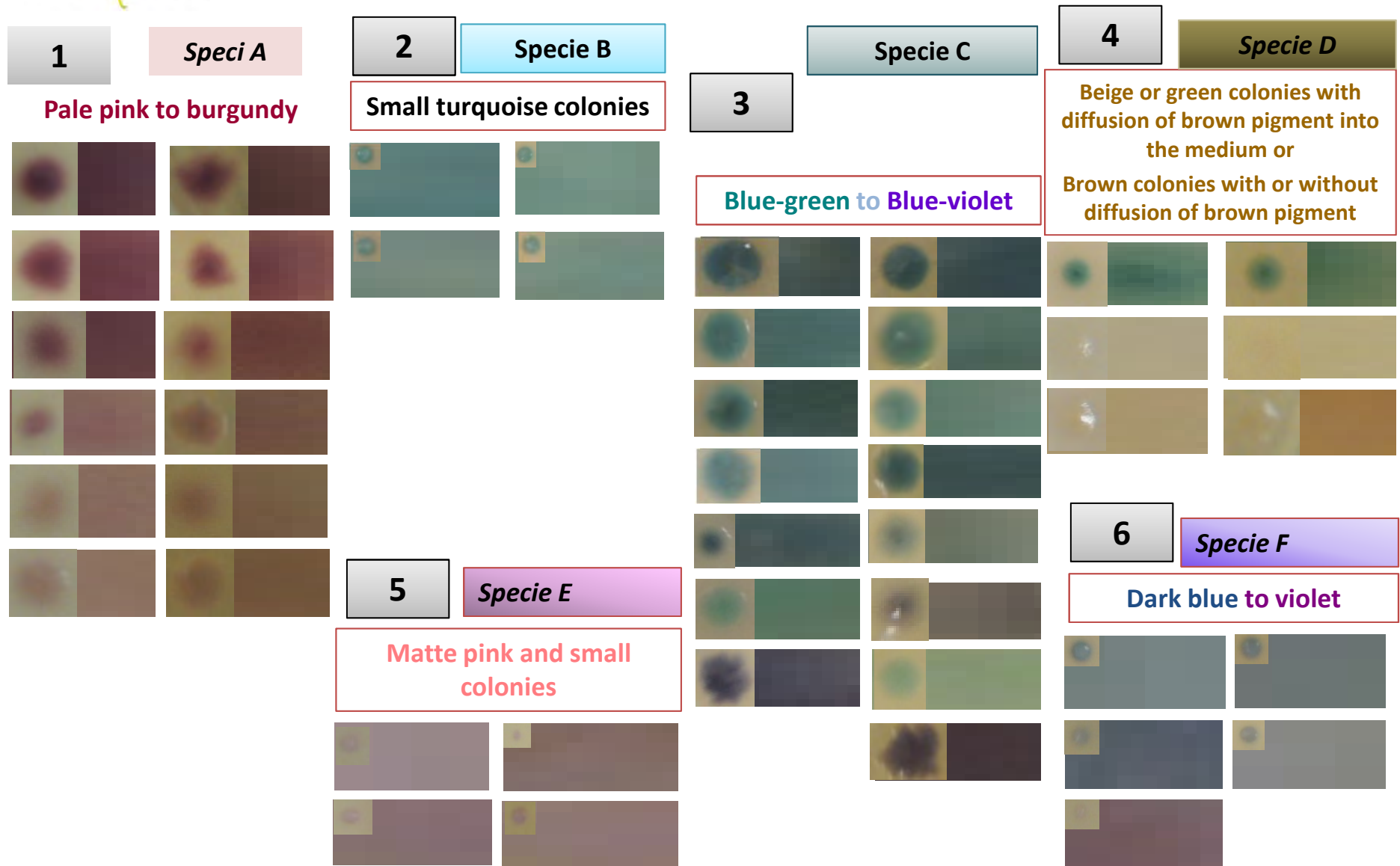


Specie C

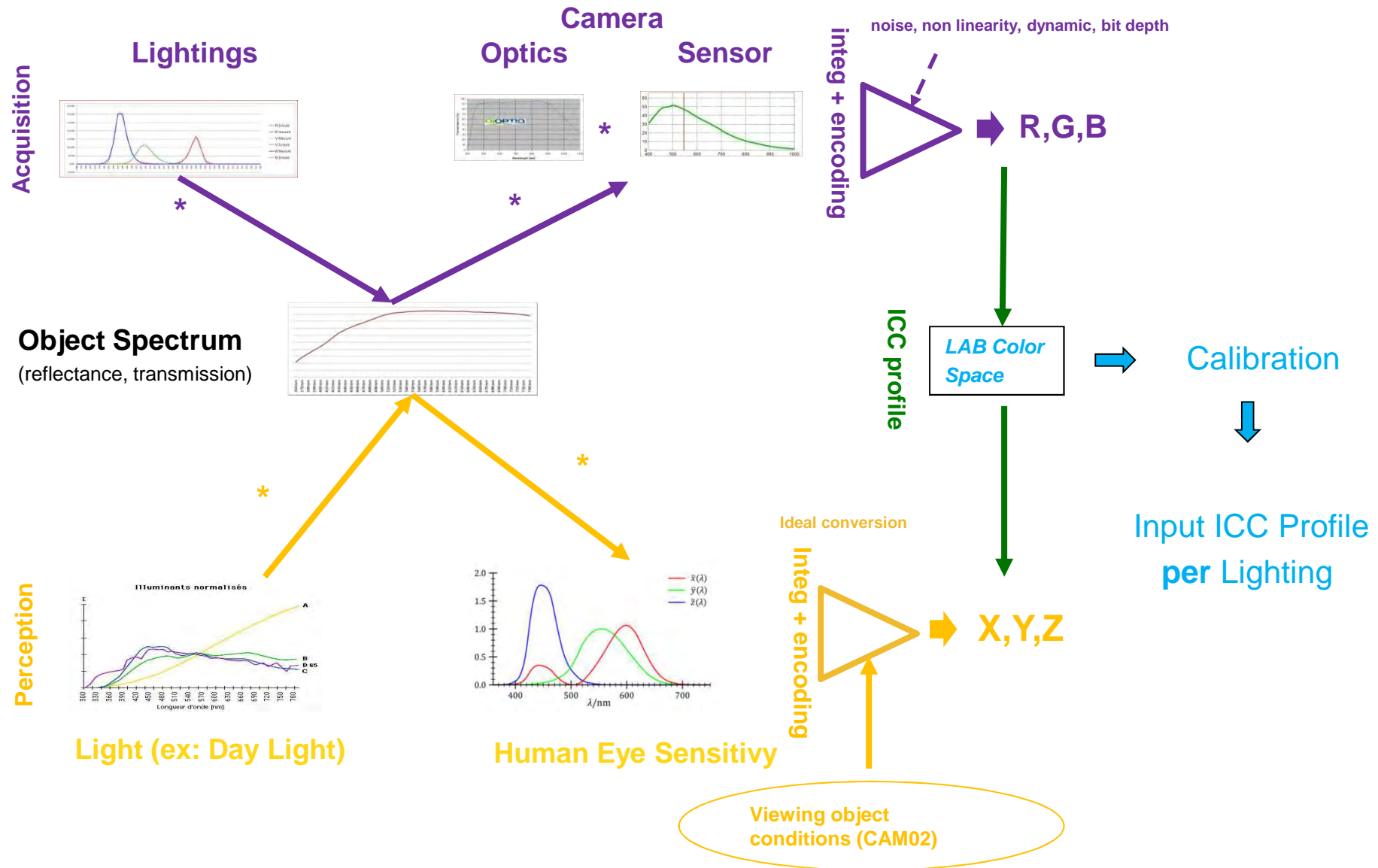


→ Optimize & Control Color through Spectral Modelisation

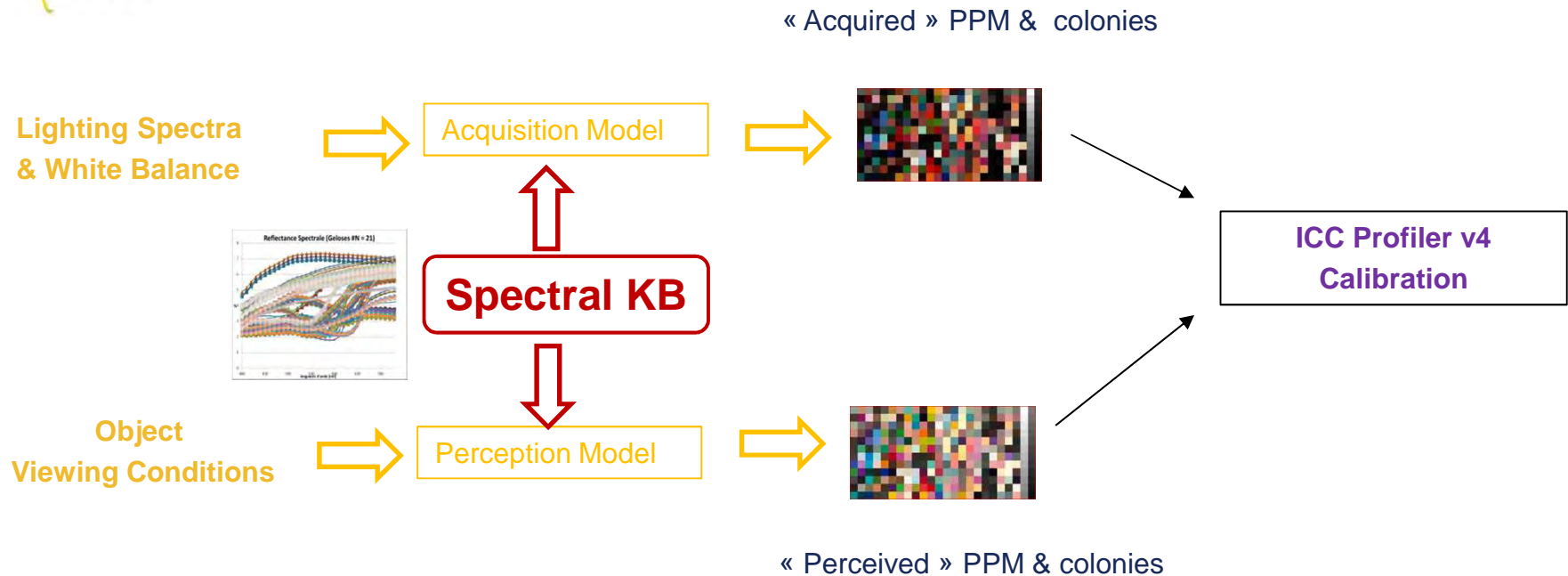
Colors Reading Scale Complexity



Perceived Spectral Model : Optimize ICC profile



Knowledge Based Spectral Calibration



GOALS :

- 1) Build a **Knowledge Base** of spectral reflectance & transmittance
- 2) **Standardize** spectral reflectance & transmittance measurement & **control** method

Spectral Knowledge Base : Constraints

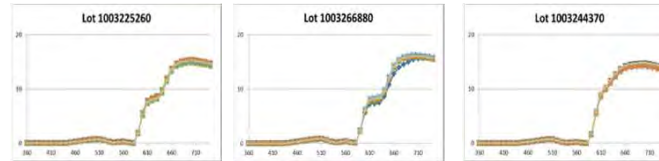
Spectrophotometer :
(\varnothing): 8 ou 3 mm
Range : 360 nm à 740 nm
Resolution : 10 nm



Inoculated
plate

Background
plate

Non Inoculated Plate



- Product Batch Variability
- Incubation Time & Environnement (O₂, CO₂, other)

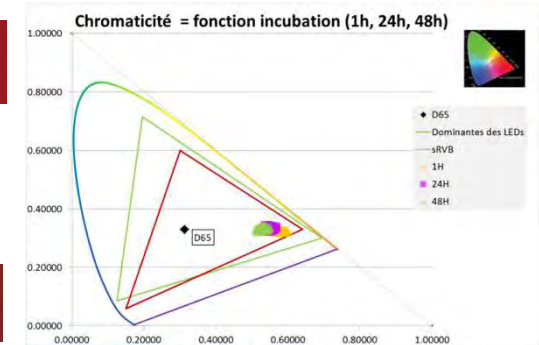
T0+1h



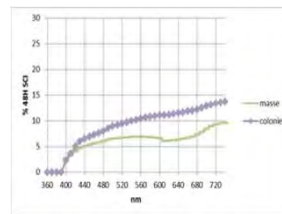
T0+24h



T0+48h

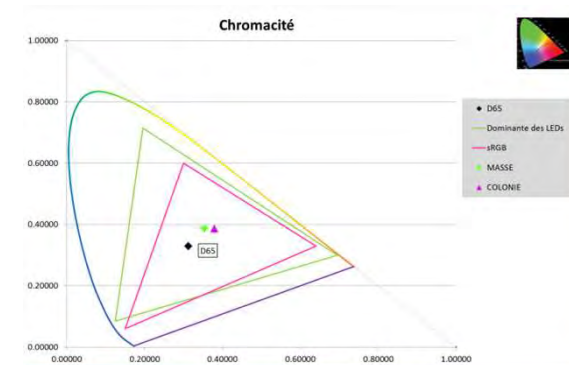
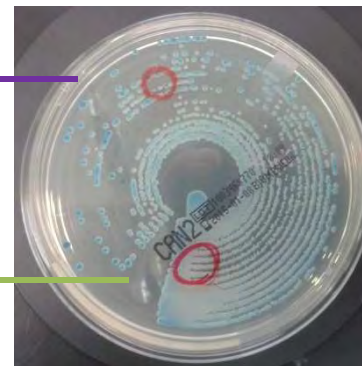


Inoculated Plate



Colony

Mass

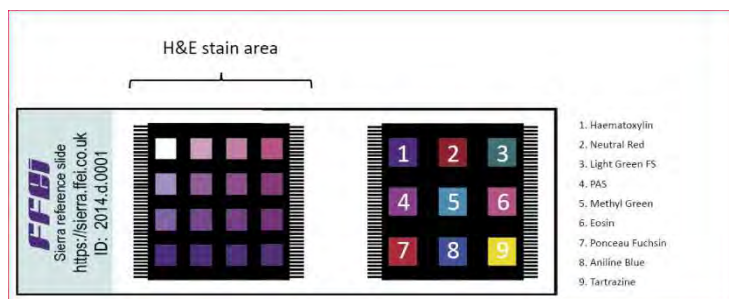


- ➔ Needs to handle an HSI system to build the spectral knowledge base (work in progress)
- ➔ Needs to Define a μ Biological protocol (strains, incubation protocols)

ICC (*Work in Progress*): WSI spectral control slide



- **bioMérieux interest** : assessment of Petri **backlight** imaging control **for the control purpose**



bioMérieux imager acquisition

PPM Plates : Reading Environments

Culture Reading = Reading of petri plates to define « isolates »

Clean Environnement where **clinical diagnostic** is performed.

→ ambient room conditions may (to some extent) be controlled

ID / AST Reading = Reading of petri plates to pick « isolates »

Dirty Environnement : where **clinical diagnostic** is not necessarily performed

→ ambient room conditions is difficult to control

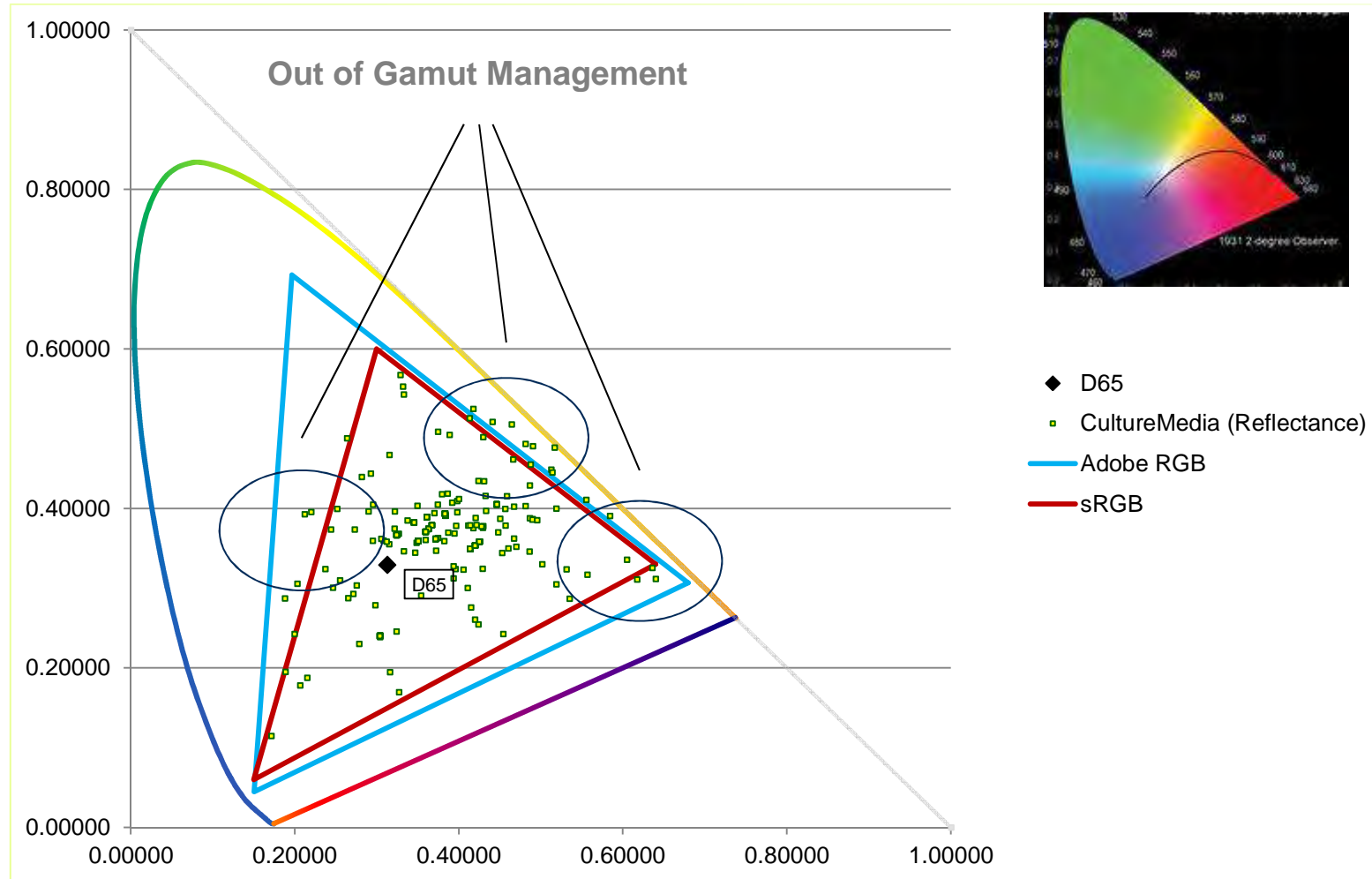
Mobile Culture Reading = Reading of petri plates out of the Laboratory

Environnement : where **clinical diagnostic may be** performed

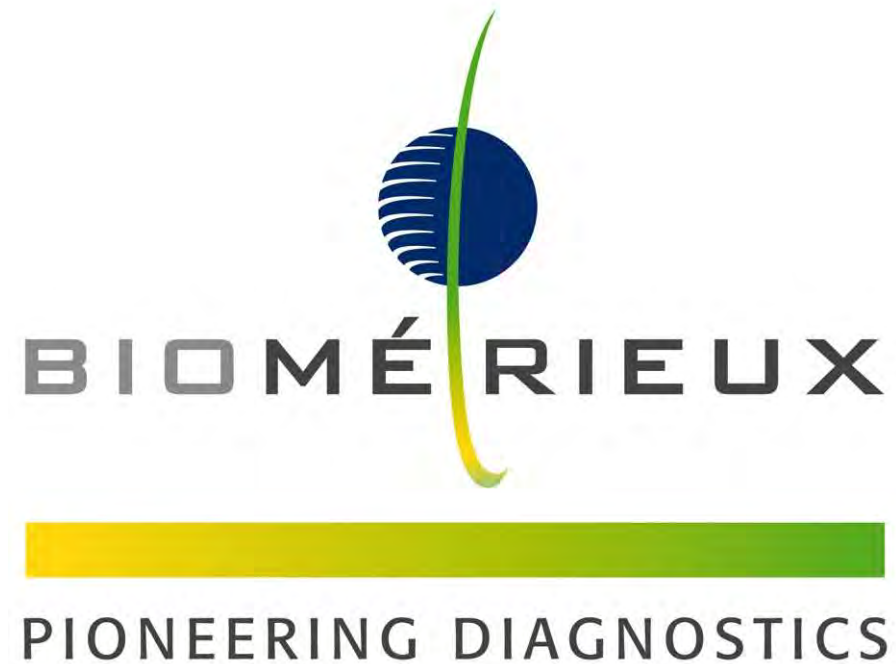
→ ambient room conditions is difficult to control

Can be build standardized common viewing conditions = Display ICC Output profile ?

ICC (Work in Progress): Medical ICC Output Profile



→ define a **standardized** gamut management for display review & connectivity



Medical RGB color space – mRGB (wip)



- **Problem Statement** : There is no suitable colour display calibration objective for medical imaging displays designed to display colour images
- **Proposal** : Define a set of colour spaces and ICC profiles for medical displays using the GSDF as the greyscale “Medical RGB Color – mRGB”
- **Participants** : AAPM WGMD, ICC

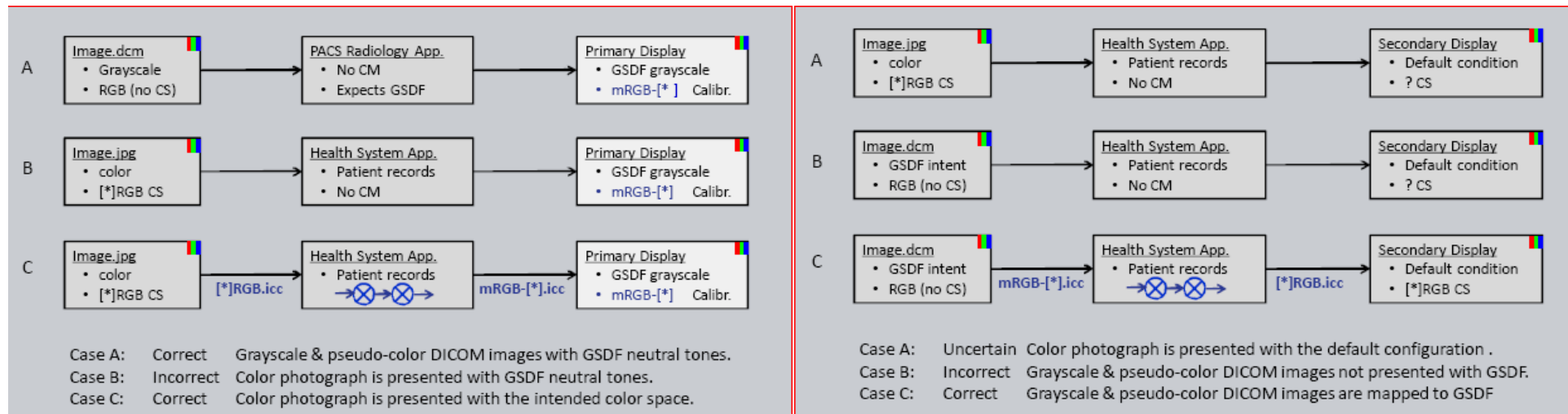
Specification (1)	sRGB	aRGB	ACR	mRGB
Luminance Response	~2.2 power function	2.199 power function	DICOM GSDF	DICOM GSDF
Color Gamut	HDTV based ITU-R BT.709-5	‘Wide’ (extended G)	-nd-	[*] (referenced)
L_{max} , cd/m ²	80	160 (125-200)	350/420/250	350 (250-450)
L_{min} , cd/m ²	-nd-	0.56	L_{max} / LR	L_{max} / LR
Luminance Ratio (LR)	-nd-	287.9 (230-400)	350 (> 250)	350 (300-400)
White Point	D65	D65	D65	D65
Gray tracking	-nd-	-nd-	-nd-	IEC MT51
Surround	20% refl. lx	Gray (D65, 2°) 20% L_{max}	-nd-	Gray (D65, >2°) 20% L_{max}
Ambient Illumination, lx	64 (D50)	32 (D65) (16-64)	20-40	-nd-
Veiling Glare	1.0%	accounted	-nd-	-nd-
L_{amb} , cd/m ²	-nd-	-nd-	$L_{amb} < \frac{1}{4} L_{min}$	$L_{amb} < [\frac{1}{4}, \frac{2}{3}] L_{min}$

In/Out gamut management within bMX product

Medical RGB color space – mRGB (wip)



- Primary Display a.k.a diagnostic
- Secondary a.k.a review, enterprise, other



Problem statement : because of the builtin DICOM GSDF calibration, the color behavior of medical color displays is altered/distorted.