Microbiology Imaging

Update

MIWG ICC Meeting November 5th 2016

PIONEERING DIAGNOSTICS

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BIOMÉRIEUX

Background : Virtual Reading versus Manual Reading

Virtual reading **shall be at least equivalent** to manual reading (i.e. : reference method)

?

⇔

Manual Reading = *physically* read an inoculated ppm plate

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

Objective : Provide a consistent diagnostic value to petri plate imaging systems

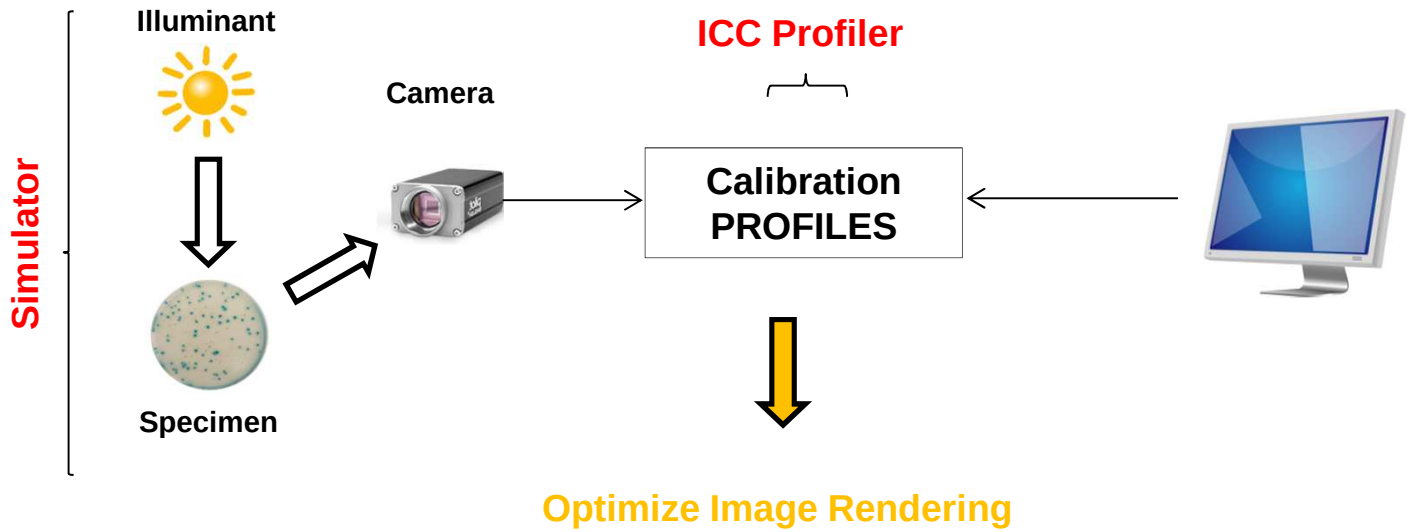
System A

≠

System B

Calibration = Provide consistent rendering

Color Simulator and Calibrator



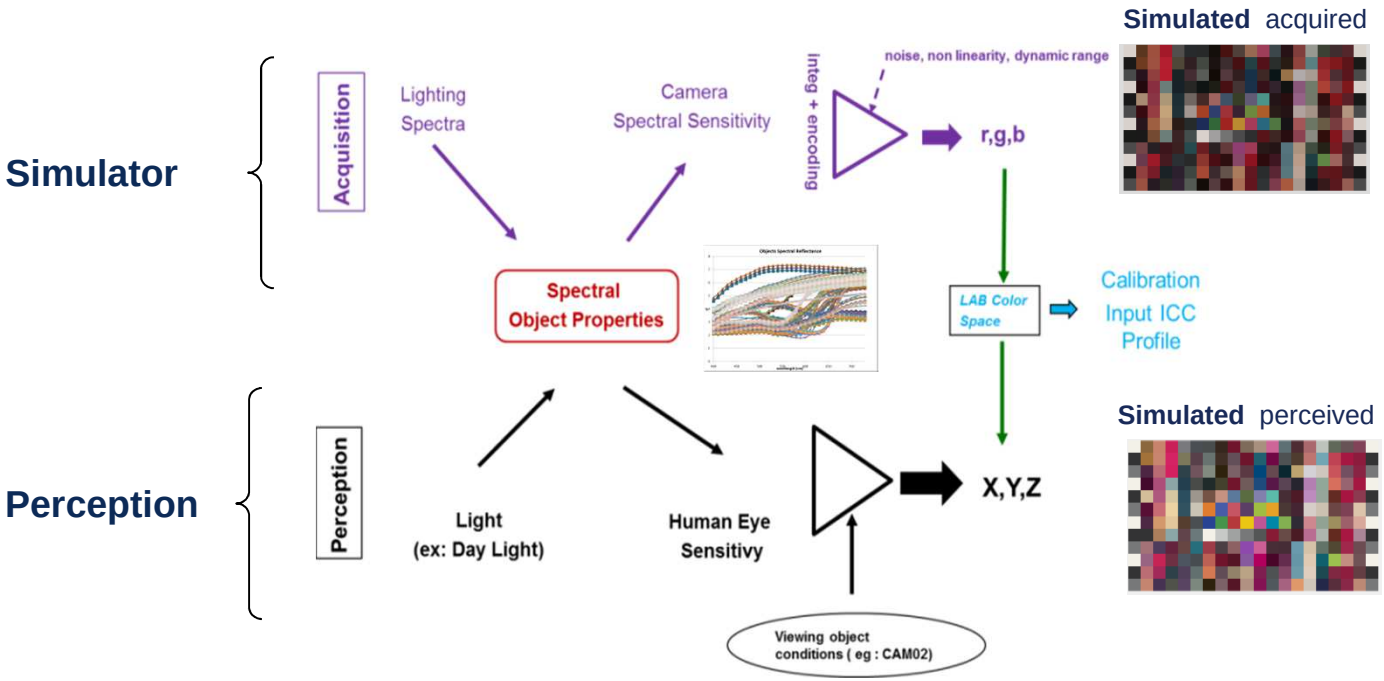
Objectives

Simulator - Develop an image acquisition simulator ➔ spectral reflectance factors to RGB camera conversion

Calibrator – Compute Calibration (i.e. : ICC) profiles from biological samples reflectance

Spectral-Based Color calibration

Based on the spectral knowledge of the biological media and samples



Steps

- RGB values are computed through an image acquisition simulator (spectral reflectance + lightings + camera sensitivity)
- XYZ values are computed through a perception model
- Imaging System Calibration (i.e. ICC) profile

Acquisition System Simulator

Objective: Describe an image acquisition simulator that predicts the digital values computed by a real camera

• Inputs

- Object spectral **reflectance** (spectral biological data)
- **Illuminant** spectral power (LEDs or standard illuminant)
- Spectral **sensitivity** of the camera sensor

• Output

- RGB image of the scene

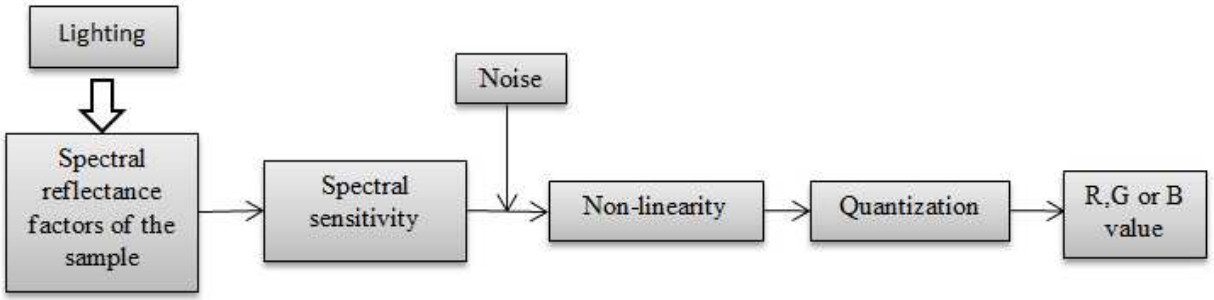
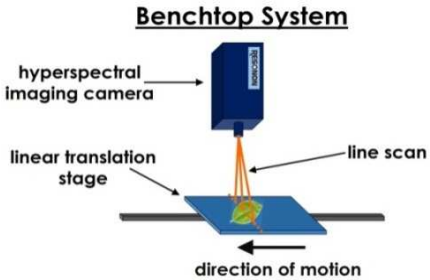
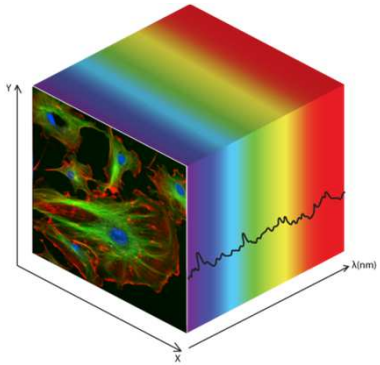
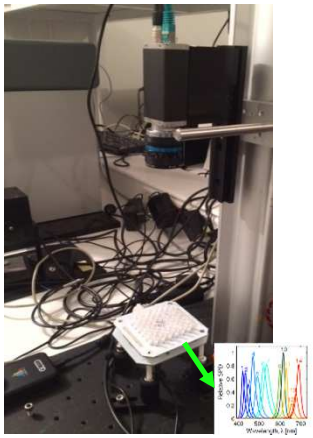
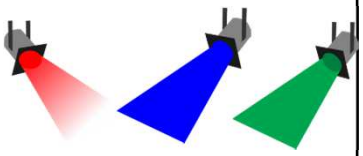


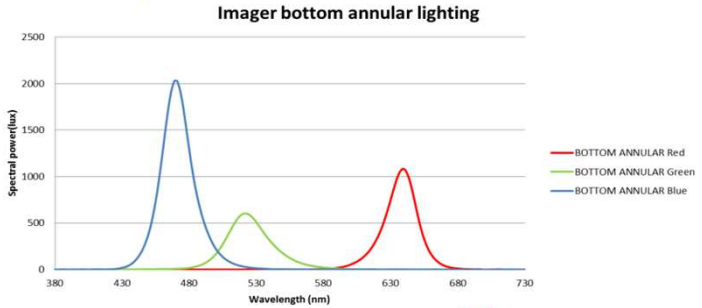
Image acquisition chain

➢ Develop a mathematical model

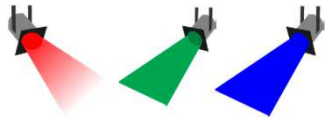
Simulator – Measurement devices

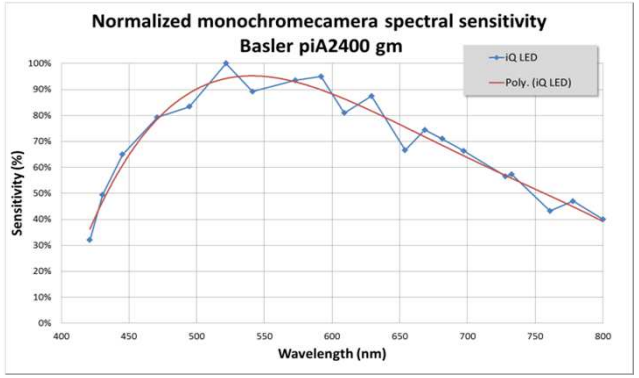
Spectral reflectance factors	Camera spectral sensitivities	Illuminant spectral power	Noise measurement
  Hyperspectral cube	 IQ Led (14 bands) Sampling ~ Monochromator sampling ~ 10 nm	 Spectrometer	 Black mask in front of the camera lens

Simulator – Measures



Spectral power distribution

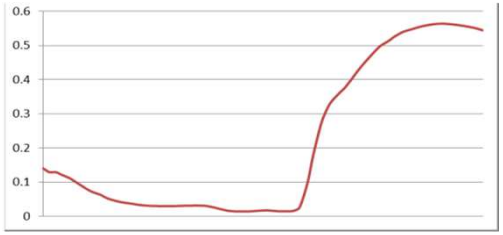




Sensitivity measures

- Measure the spectral power of **incident** lighting
- Compute the related sensitivity (sensor + lens)

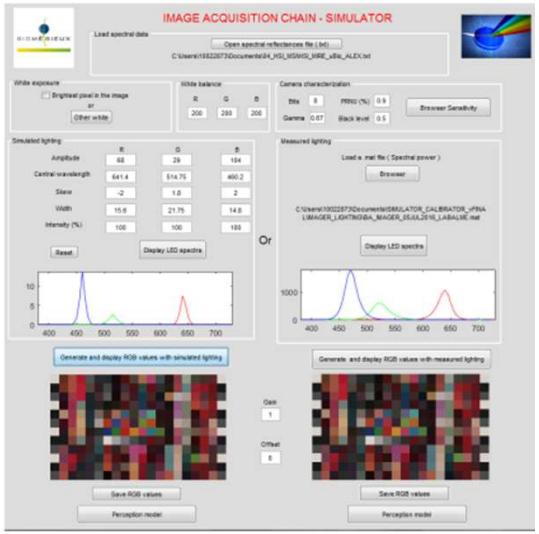
Spectral reflectance factors



Noise measures

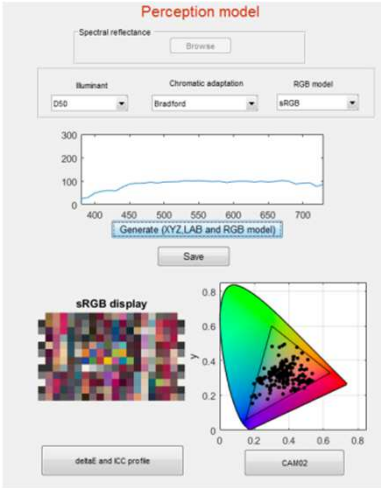
Color calibration matlab tool

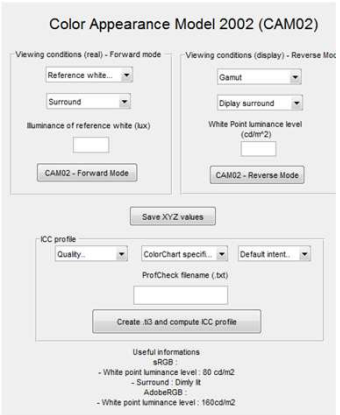
Simulator
RGB values



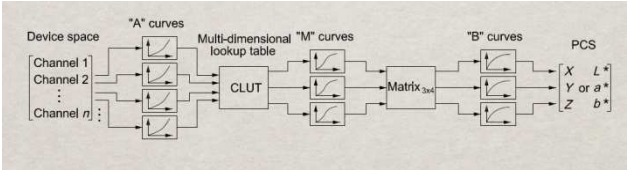
Transformation tables

Perception model
XYZ or LAB values

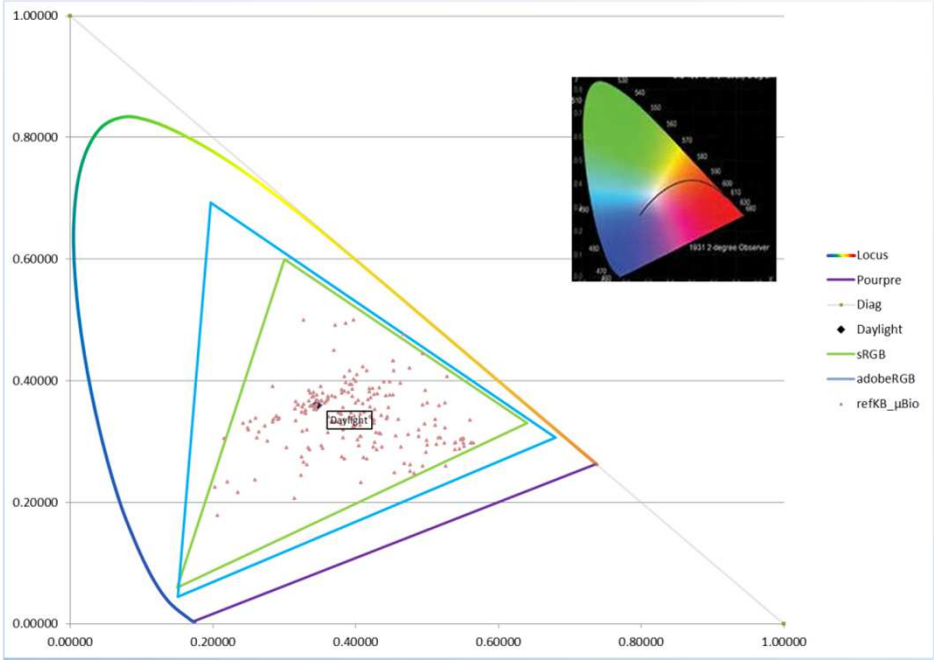




Input ICC profiles (using ArgyllCMS)

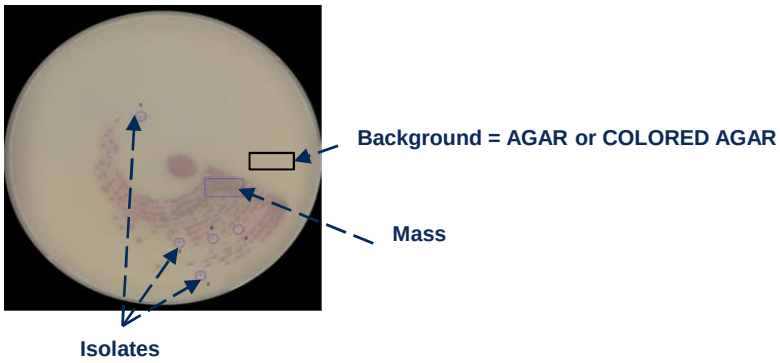


Reference KB µBIO - Content



4 Different Region Interest

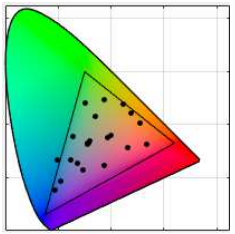
- AGAR
- COLORED AGAR
- MASS
- ISOLATES

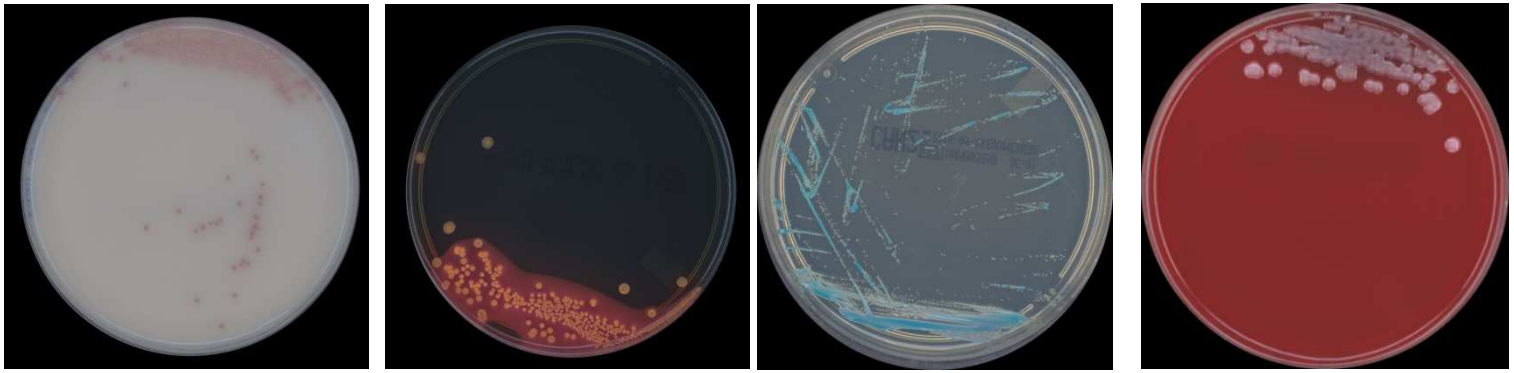


➔ 20 different bioMerieux culture media were used.

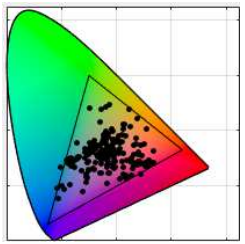
Color calibration - Results

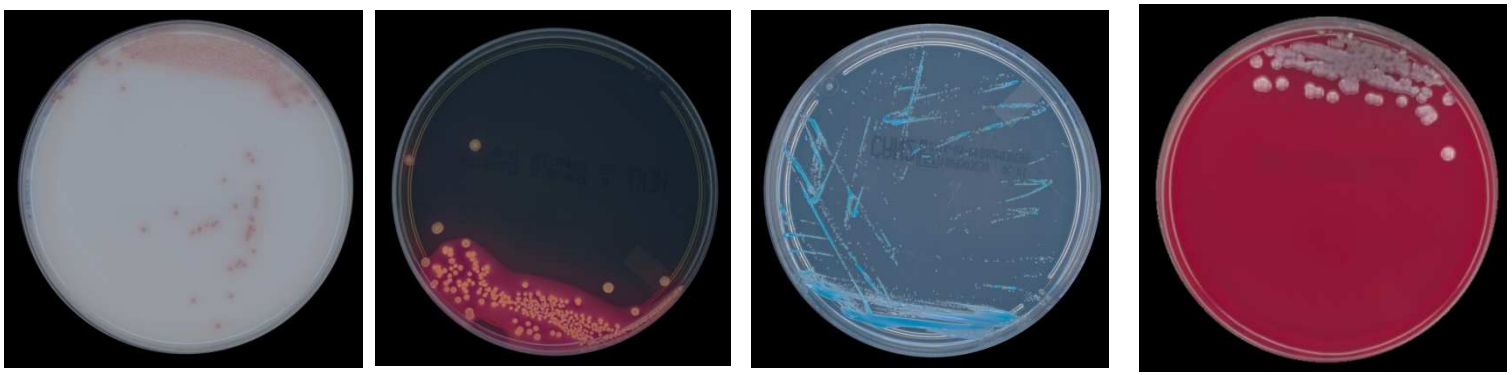
ColorChecker (24)





Microbiological knowledge (240)





2016 Achievements

We have developed numerous tools :

✓An image acquisition simulator (monochrome and color camera)
✓A tool which computes XYZ and LAB tri-stimulus values (and many other colorimetric functions)
✓A tool which computes ICC profiles without using any commercial tool
✓A tool which uses the Color Appearance Model 02 (CAM02)
✓Graphical user interfaces

Results

- The imaging simulator is **validated** for a **$\Delta E < 2$** compared to real images (for **non-transparent** objects)

- Hyperspectral imaging system provides **adequate** agar reflectance factor measurements

- The calibration (i.e. : ICC) profiles generated with the spectral-based method is **equivalent** to chart based method when a ColorChecker is used.

- The profile computed with a microbiological spectral knowledge base seems to give **better rendering results** especially for blood medium.

Next Steps

- **Decision to split the exiting document into 1 primer & 3 white papers**
- **1 x primer on microbiological imaging ➔ late**
- **3 white papers :**
  - WPA - Spectral Characterization - Acquisition – Analysis

    ➔ **Open Point** : for non transparent objects, special methods might ***need to be IP protected*** before publishing.

  - WPB - Spectral Knowledge Base

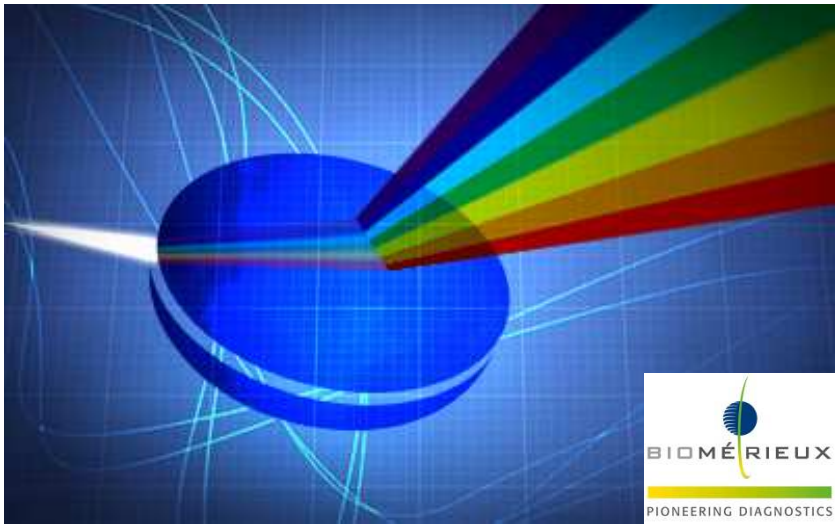
    ➔ **Open Point:** How to share the virtual target content with the MIWG ?

  - WPC - Spectral Calibration

    ➔ **Open Point** : investigate how the calibration matlab tool good be shared or not within the MIWG ?

➔ **The plan** is to have an **internal** clinical evaluation of the spectral based calibration.

Thank you



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