



bas**I****C**Ccolor

Profiling Cameras with Raw Data

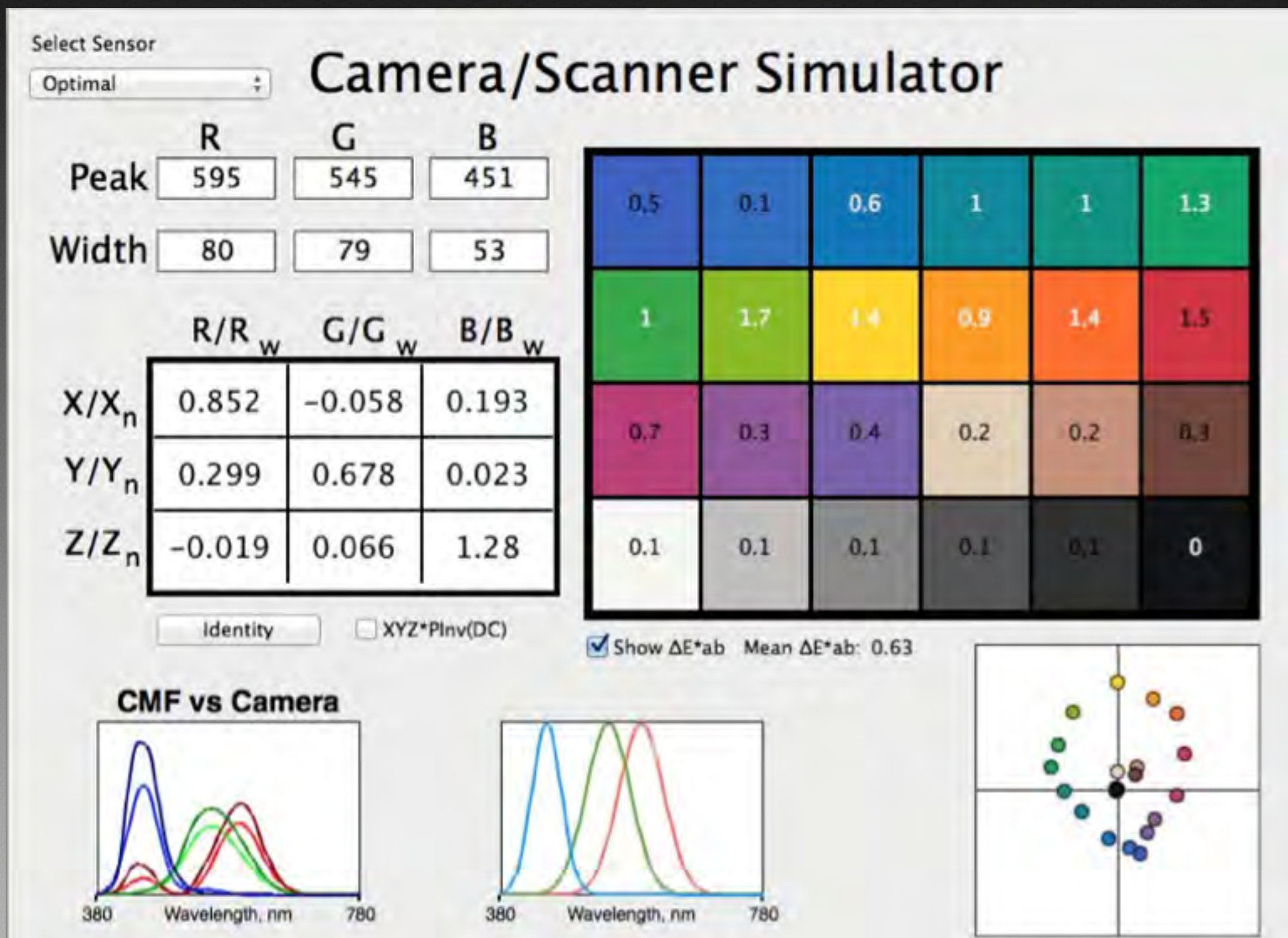
Franz Herbert
franz.herbert@chameleo.eu
baslCColor GmbH

Color characterization of digital cameras

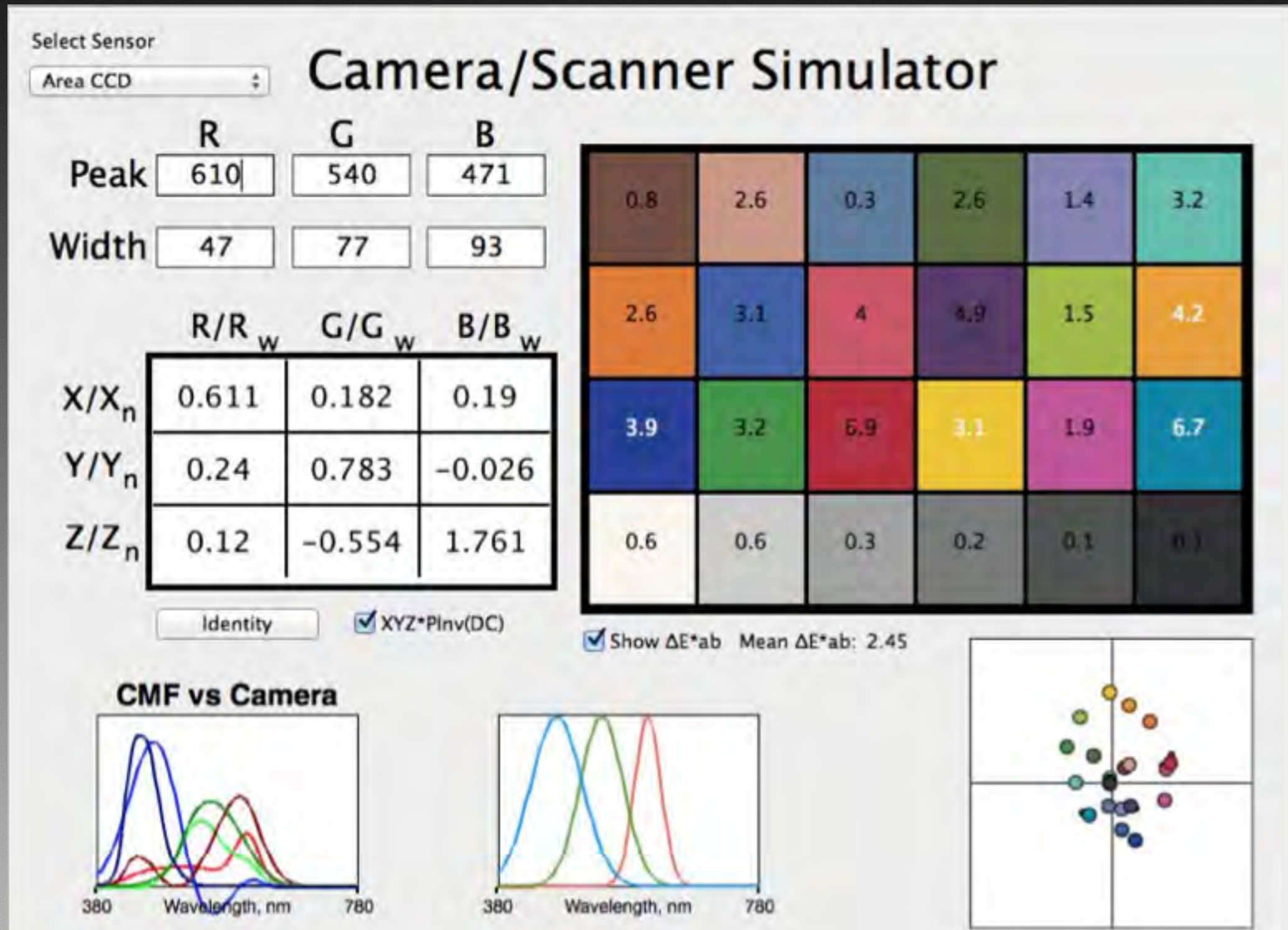
From RAW format to an RGB image



Colorimetric Camera



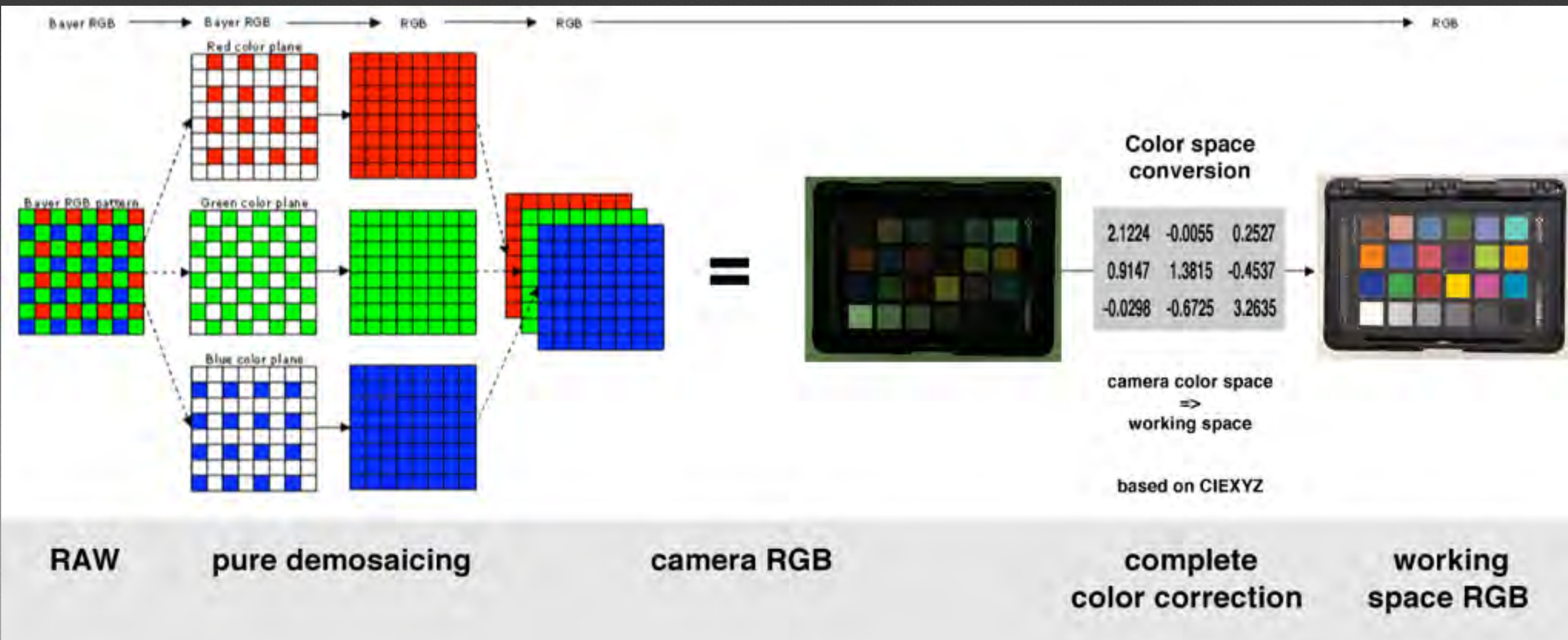
Commercial Camera



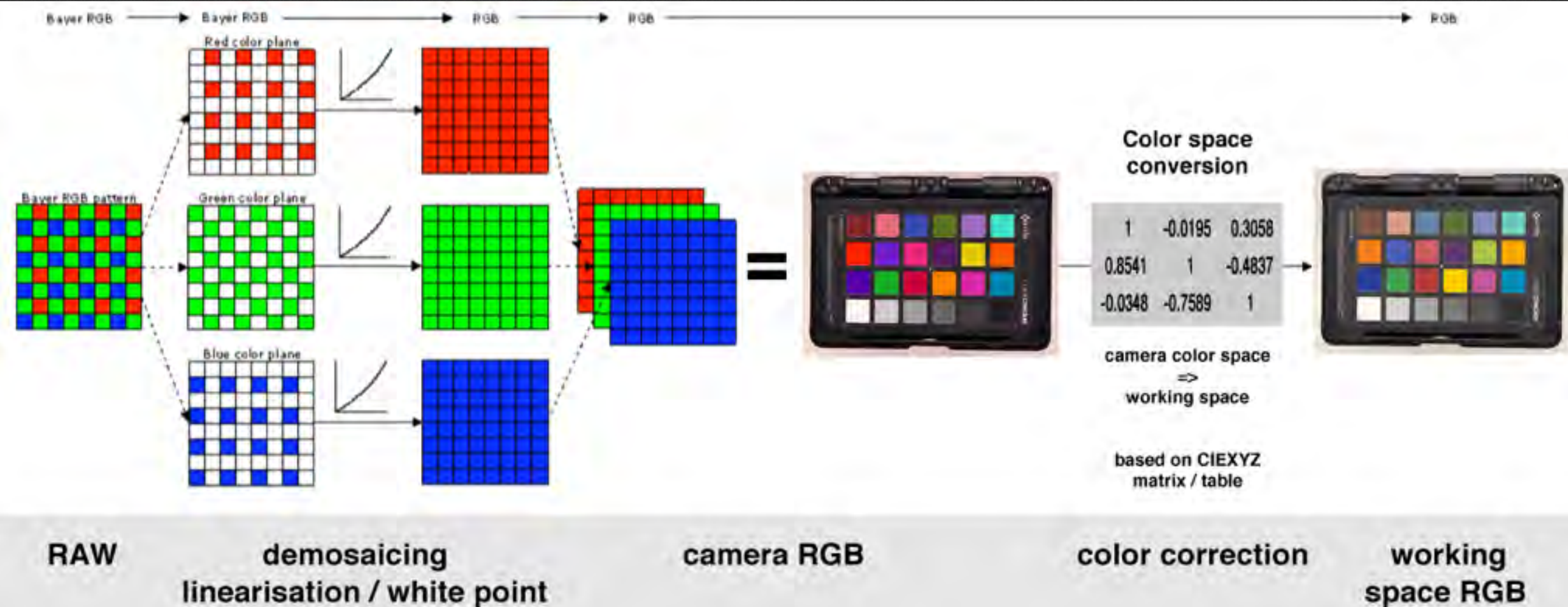
“Perfect” Camera

- Camera cannot be color accurate
- if the spectral sensitivity of the filters is not colorimetric
- such filters don't exist in reality

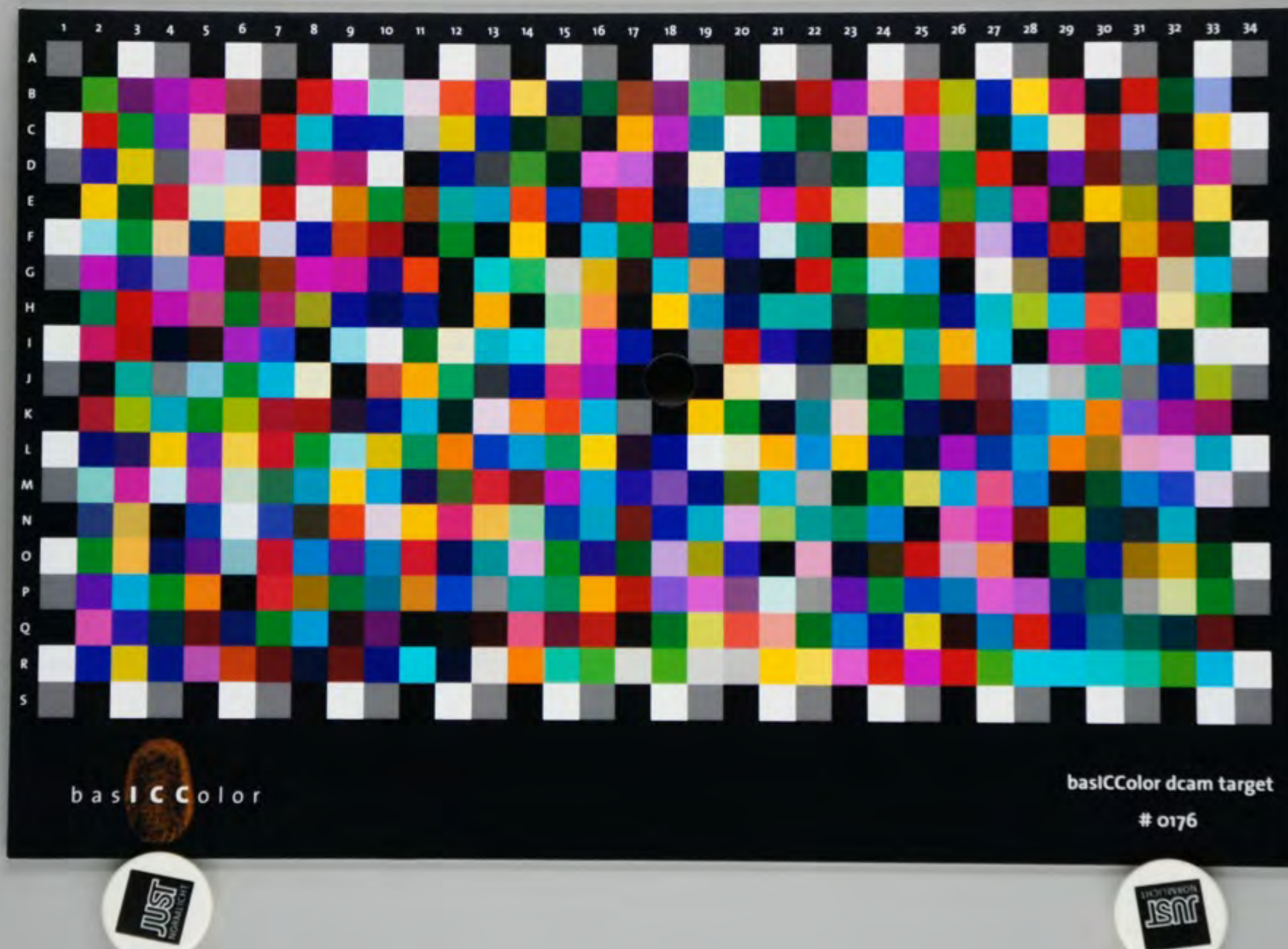
Digital Development



Digital Development



Profiling from any measurable target



Adding additional measurements
for precision in custom colors



Profiling RAW

All cameras that support RAW data must have default profile in software that “develops” images

Common RAW Converters

Adobe Camera Raw (Photoshop, Lightroom, etc.)

Capture One (Phase One)

Phocus (Hasselblad)

dcraw (Open Source)

Profiling RAW

Default Profiles work “pretty” well most of the time

They don’t handle difficult lighting conditions well

Most photographers rely on them

... and edit their images a lot

Our goal

Get robust transformation that will work well for given objects and lighting condition

From variety of standard profiling targets

Using spectral measurement of target

Using spectral measurement of illumination

RAW Profiles

Adobe Camera Raw (ACR)

DNG profile:

- 1 or 2 calibration illuminants

- for each a 3x3 matrix

- 1 curve

- 3D floating point table in HSV in ProPhoto space

RAW Profiles

ICC Profile version 4

3x4 matrix

3 input, 3 matrix, 3 output curves

3D lookup table in profile connection space

High precision when PCS is XYZ and matrix converts directly into it

Profiling RAW

input4: Job Selection

basIcColor input 4

basIcColor

Manufacturer : X-Rite
Model : ColorChecker Passport
Reference : ColorChecker 24 Passport.txt
Patches : 24
Columns : 6
Rows : 4
Lab/Spectral : Spectral
ColorChecker Passport Job

ColorChecker DC Job

ColorChecker SG Job

HutchColorTarget Job

Near Neutral Job

RoyBerns Job

SpyderCheckr Job

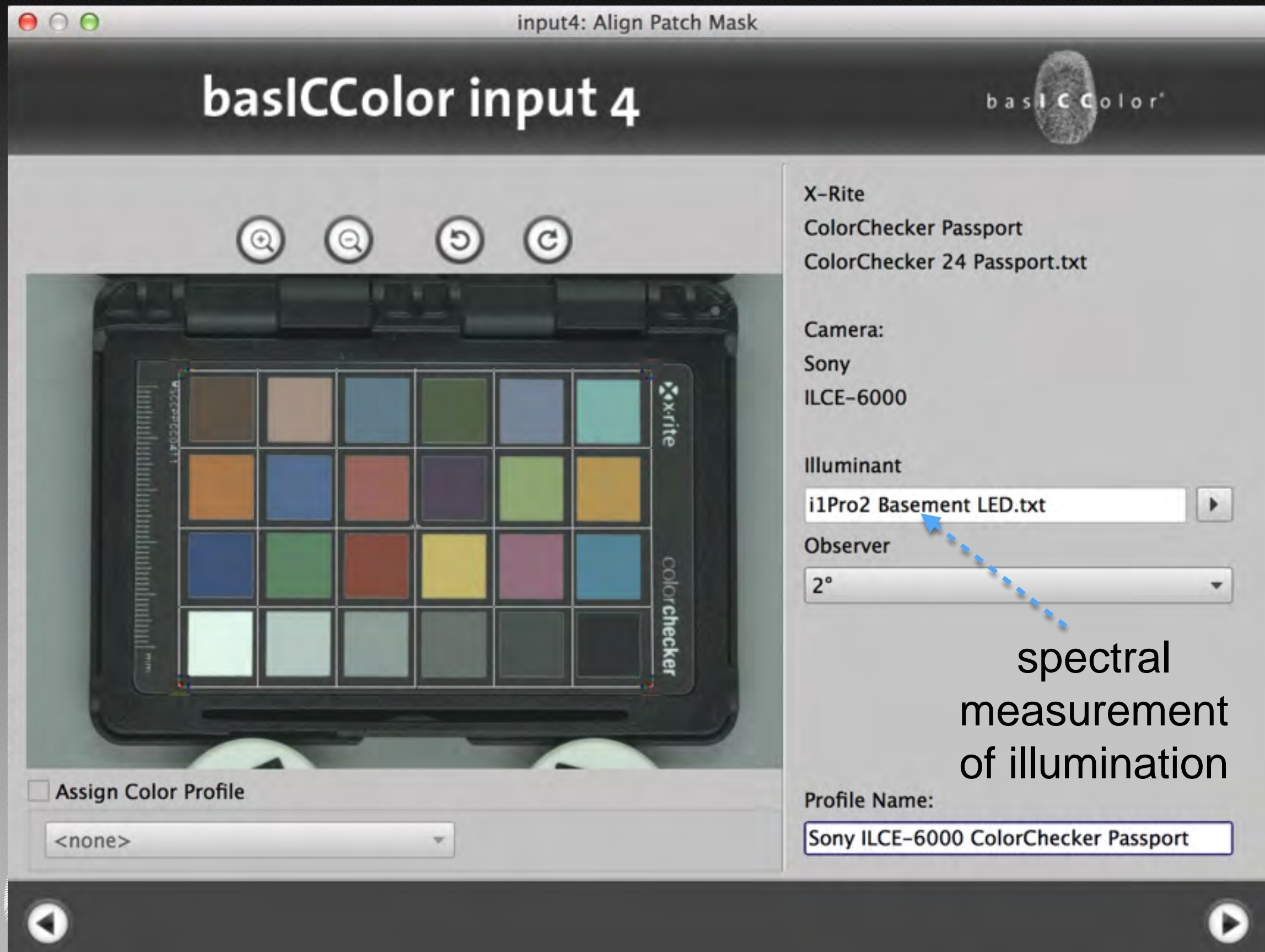
dcam with trap Job

dcam without trap Job

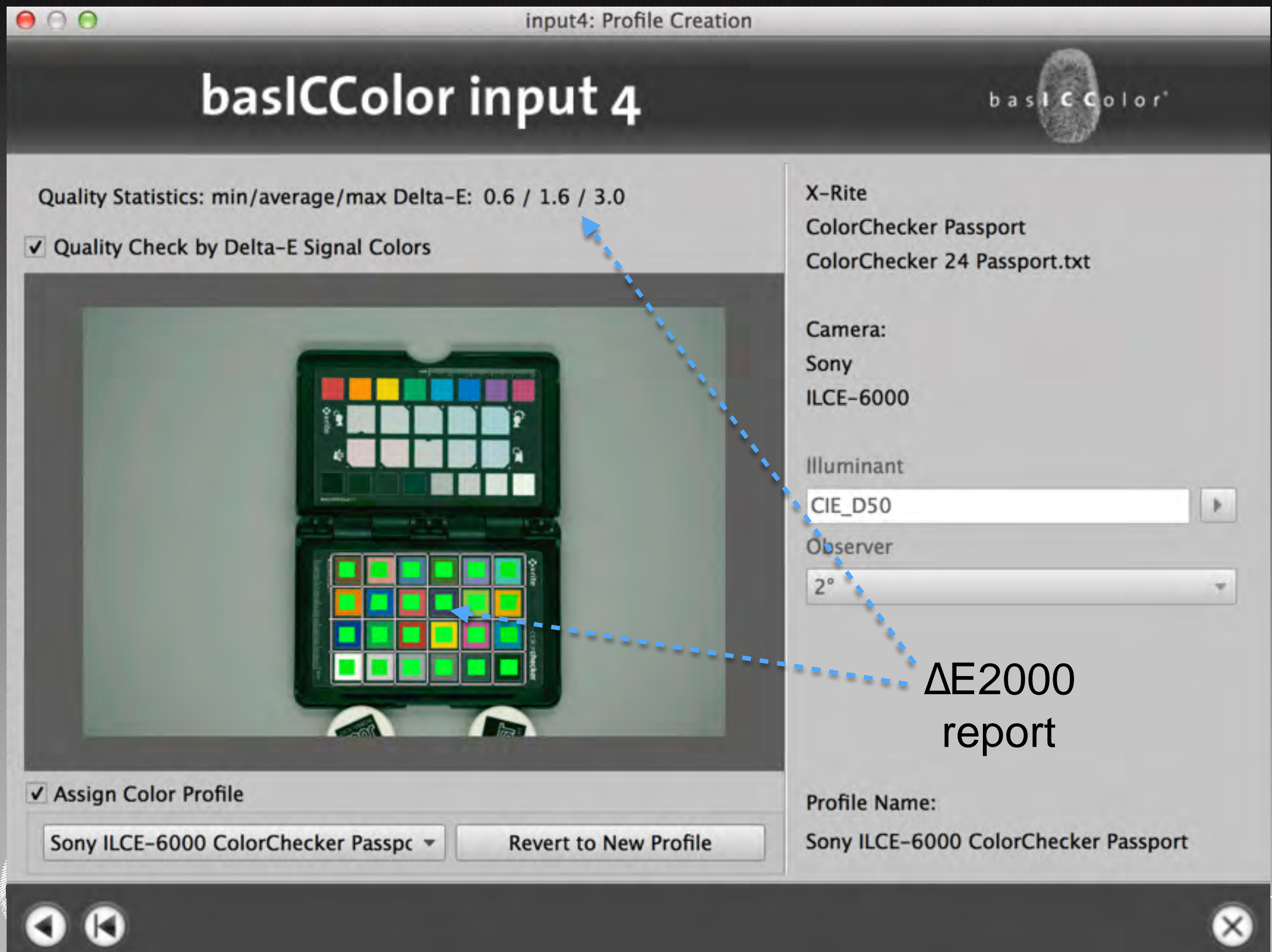
spectral measurement of target

basIcColor

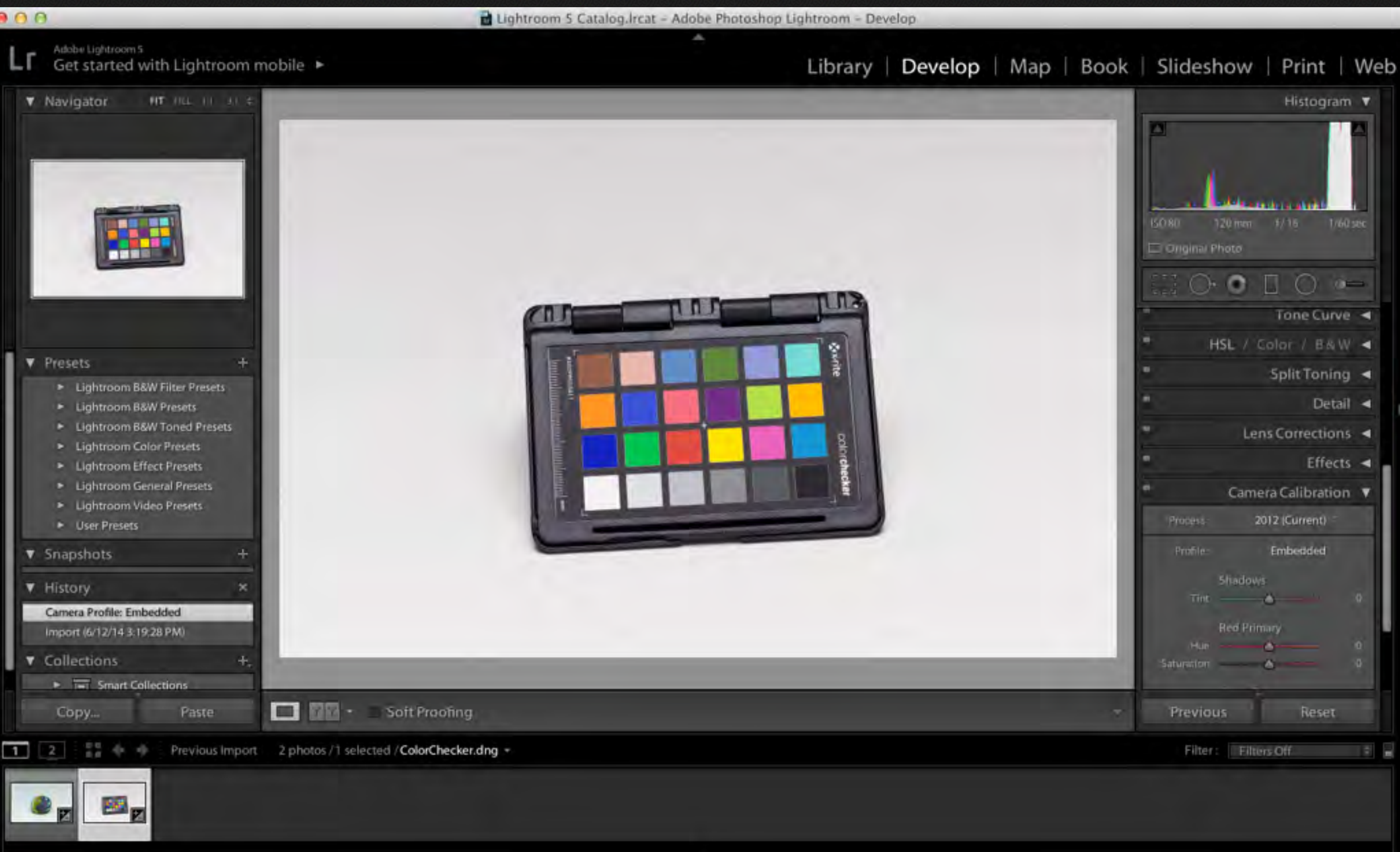
Profiling RAW



Profiling RAW



Using “RAW Profiles” in Lightroom



Using “RAW Profiles” in Lightroom

Lightroom 5 Catalog.lrcat - Adobe Photoshop Lightroom - Develop

Library | Develop | Map | Book | Slideshow | Print | Web

Adobe Lightroom 5
Get started with Lightroom mobile ▶

▼ Navigator Fit Full Web

▼ Presets +

- ▶ Lightroom B&W Filter Presets
- ▶ Lightroom B&W Presets
- ▶ Lightroom B&W Toned Presets
- ▶ Lightroom Color Presets
- ▶ Lightroom Effect Presets
- ▶ Lightroom General Presets
- ▶ Lightroom Video Presets
- ▶ User Presets

▼ Snapshots +

▼ History ×

- Camera Profile: LEaf Aptus II 10 Rein...
- Camera Profile: Embedded
- Import (6/12/14 3:19:28 PM)

▼ Collections +

Copy... Paste

Soft Proofing

▼ Histogram

ISO 80 120 mm 1/16 1/60 sec

☐ Original Photo

Tone Curve ◀

HSL / Color / B&W ◀

Split Toning ◀

Detail ◀

Lens Corrections ◀

Effects ◀

Camera Calibration ▼

Process: 2012 iCurent

Profile: ☒ Embedded
✓ LEaf Aptus II 10 Reinhardt Blitz

Shadows

Tint

Red Primary

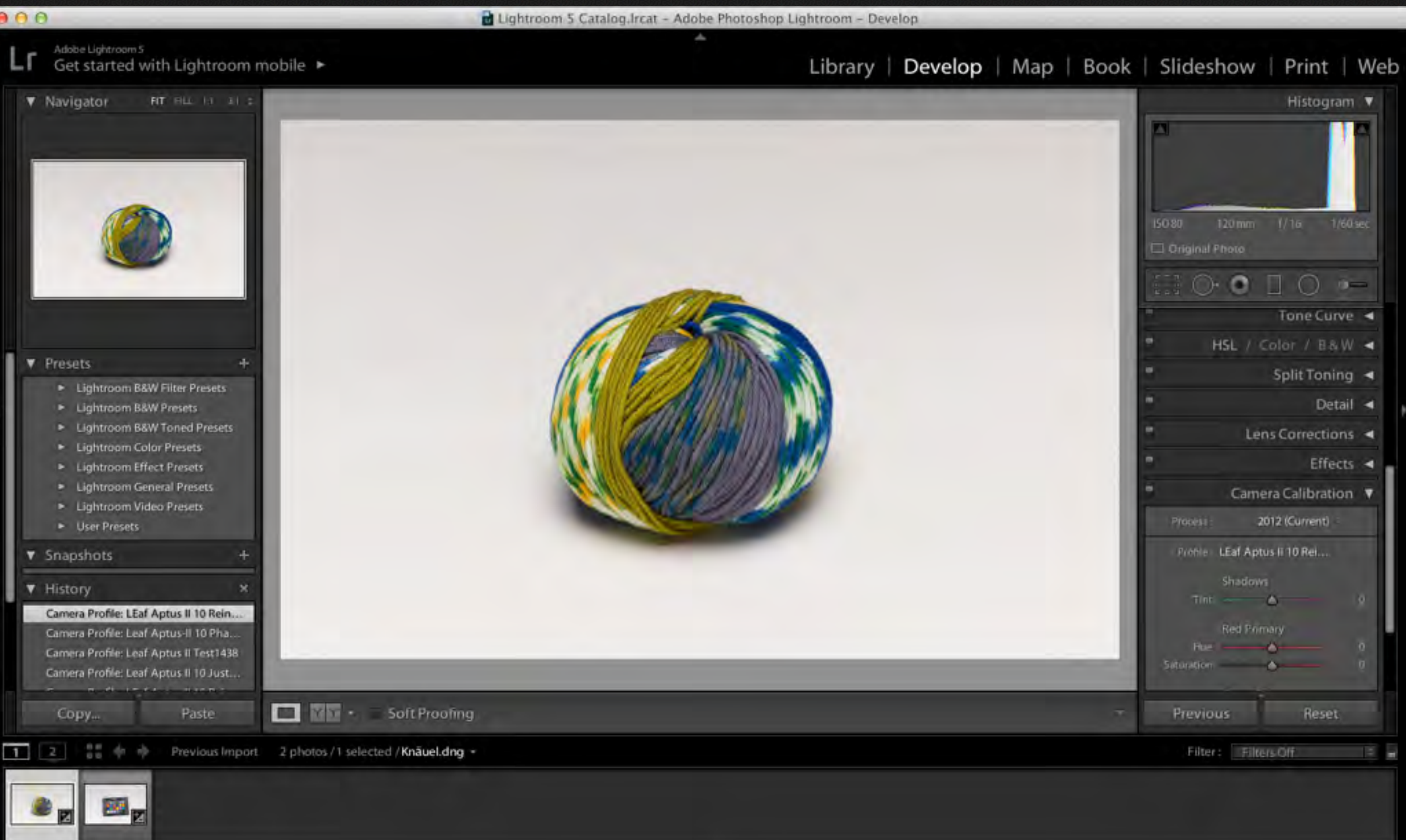
Hue

Saturation

Previous Reset

1 2 Previous Import 2 photos / 1 selected / ColorChecker.dng Filter: Filters Off

Using “RAW Profiles” in Lightroom



Using “RAW Profiles” in Lightroom



Studio Photography
zero corrections after profiling

Question

Is it good enough?



Multi-spectral Approach

- Remove infrared filter -> “long” red
- 1 RGB Image using yellow filter
- 1 RGB Image using blue-green filter
- = 6 color channels (RGB + RGB)
- Developed and patented by
 - Francisco Imai (Rochester Institute of Technology)
 - Roy Berns (Rochester Institute of Technology)

Methodology

compute linear transformation (6x3 matrix)

RGB + RGB = CIE XYZ

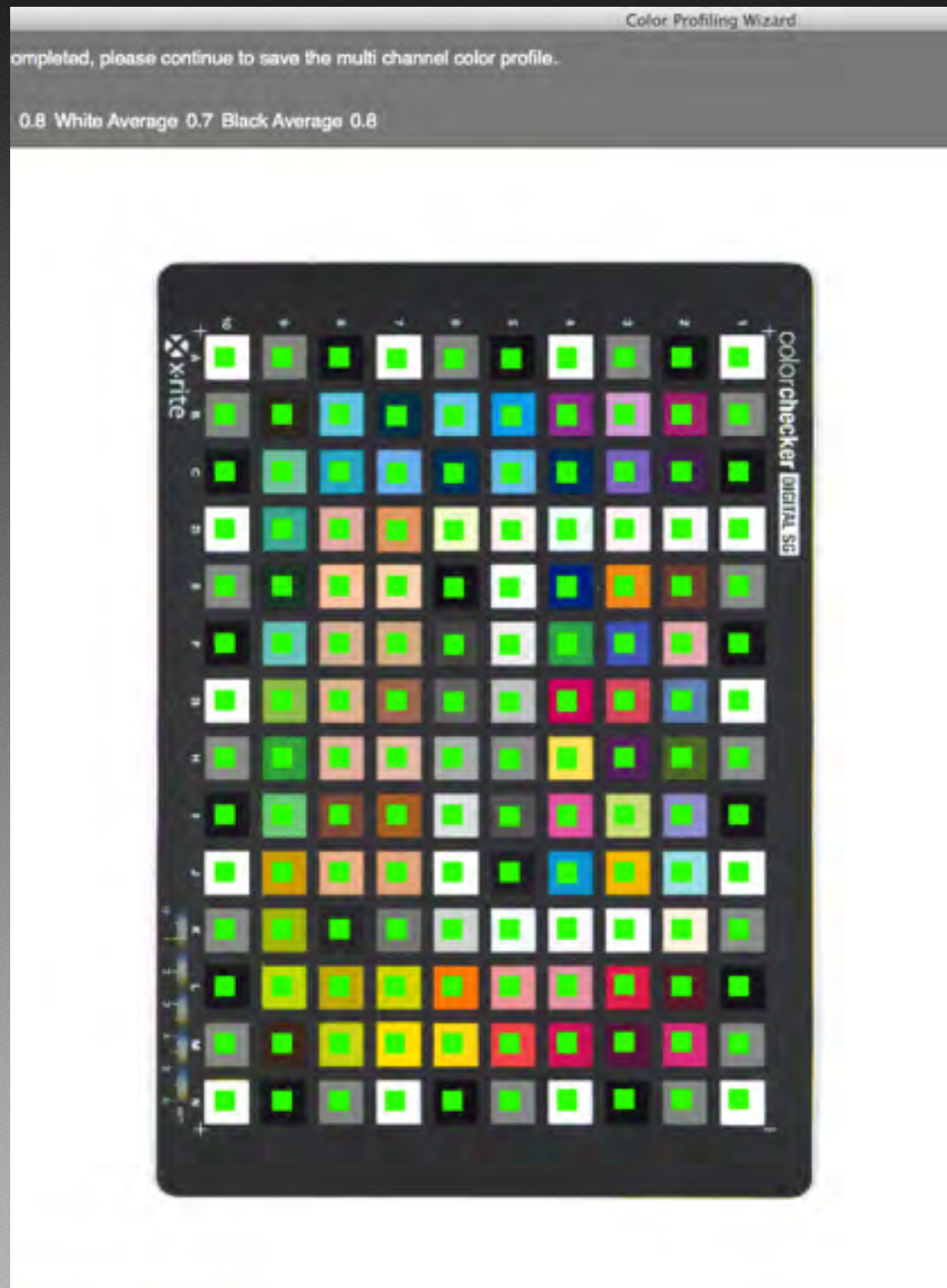
very high precision

Implementation



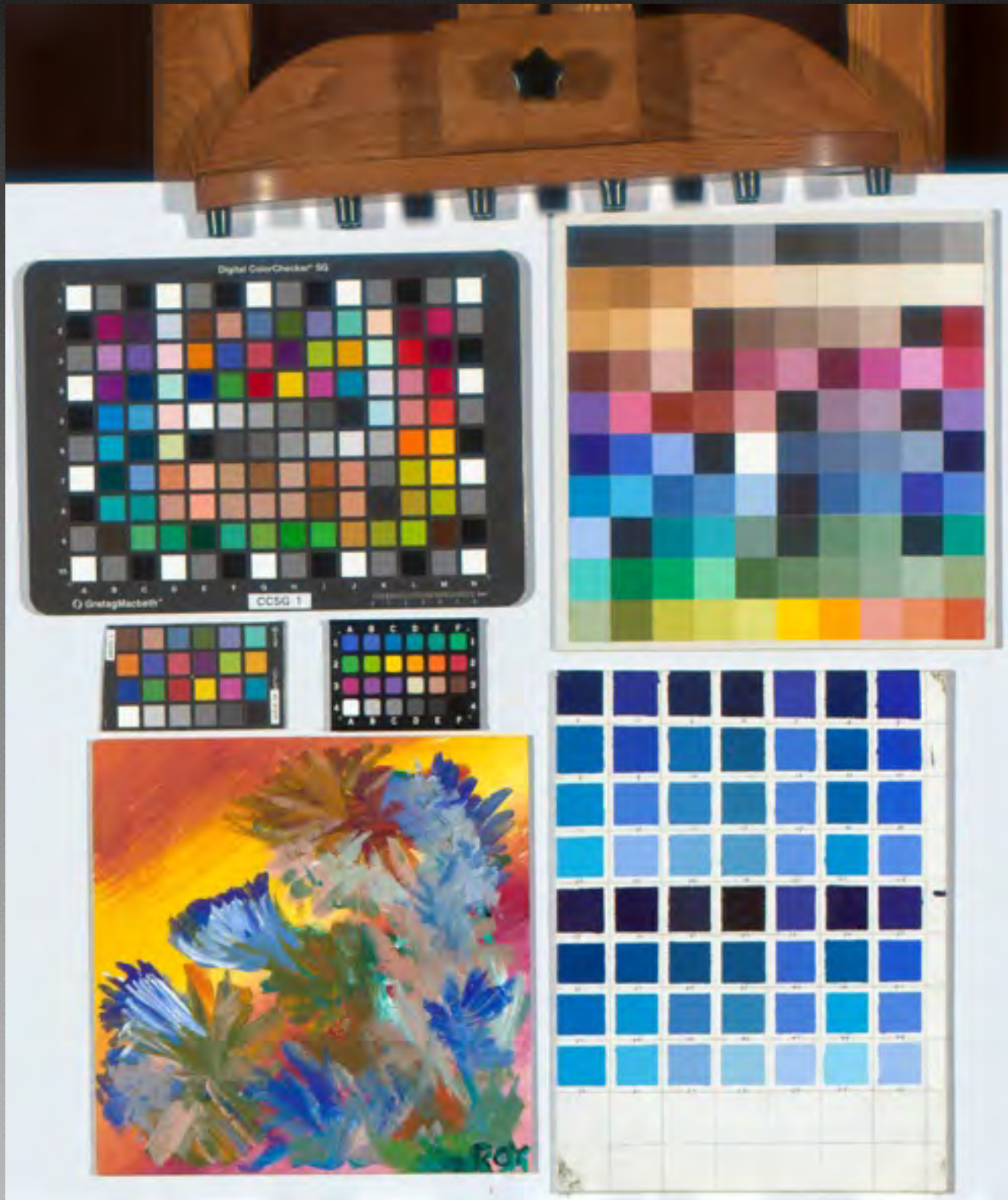
- Sinar CTM
- motorized filter exchange
- used mainly by museums for archiving artwork

Result



- ColorChecker SG
- deltaE2000
- Average: 0.82
- Maximum: 1.77
- White Ø: 0.7
- Black Ø: 0.8

Verification

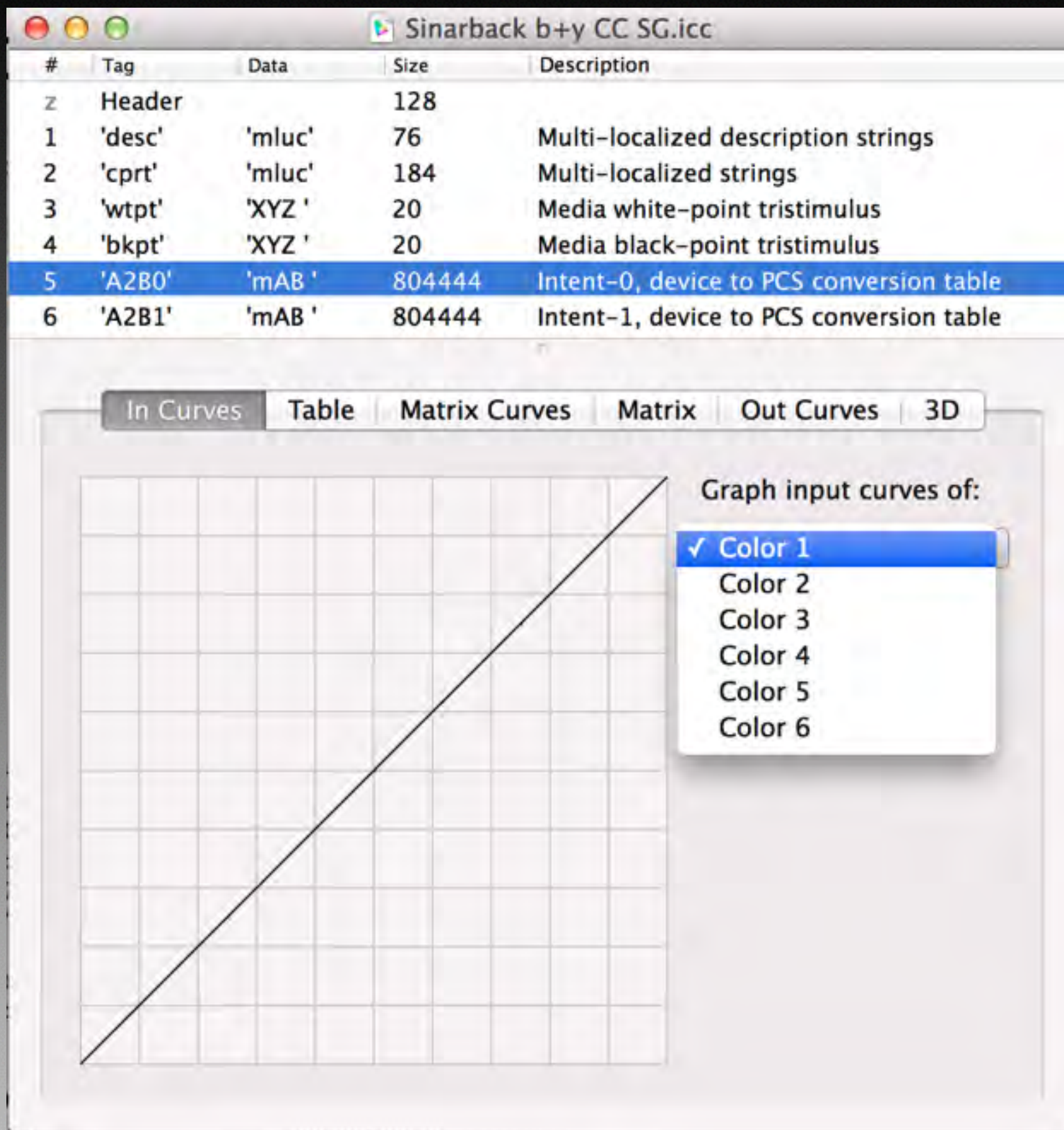


- 40+ pigments (Justin)
- dE00 $\bar{\sigma}$ 1.2, max 3.5
- 6 blue pigments
- dE00 $\bar{\sigma}$ 1.3, max 4.2



Encoding

- ICC Profile
 - only possible in 6-dimensional Lookup Table
 - high interpolation error
- DNG Profiles
 - allow for 6x3 matrix



ICC Profile 6-channel

Thank You !



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