basICColor

Profiling Cameras with Raw Data

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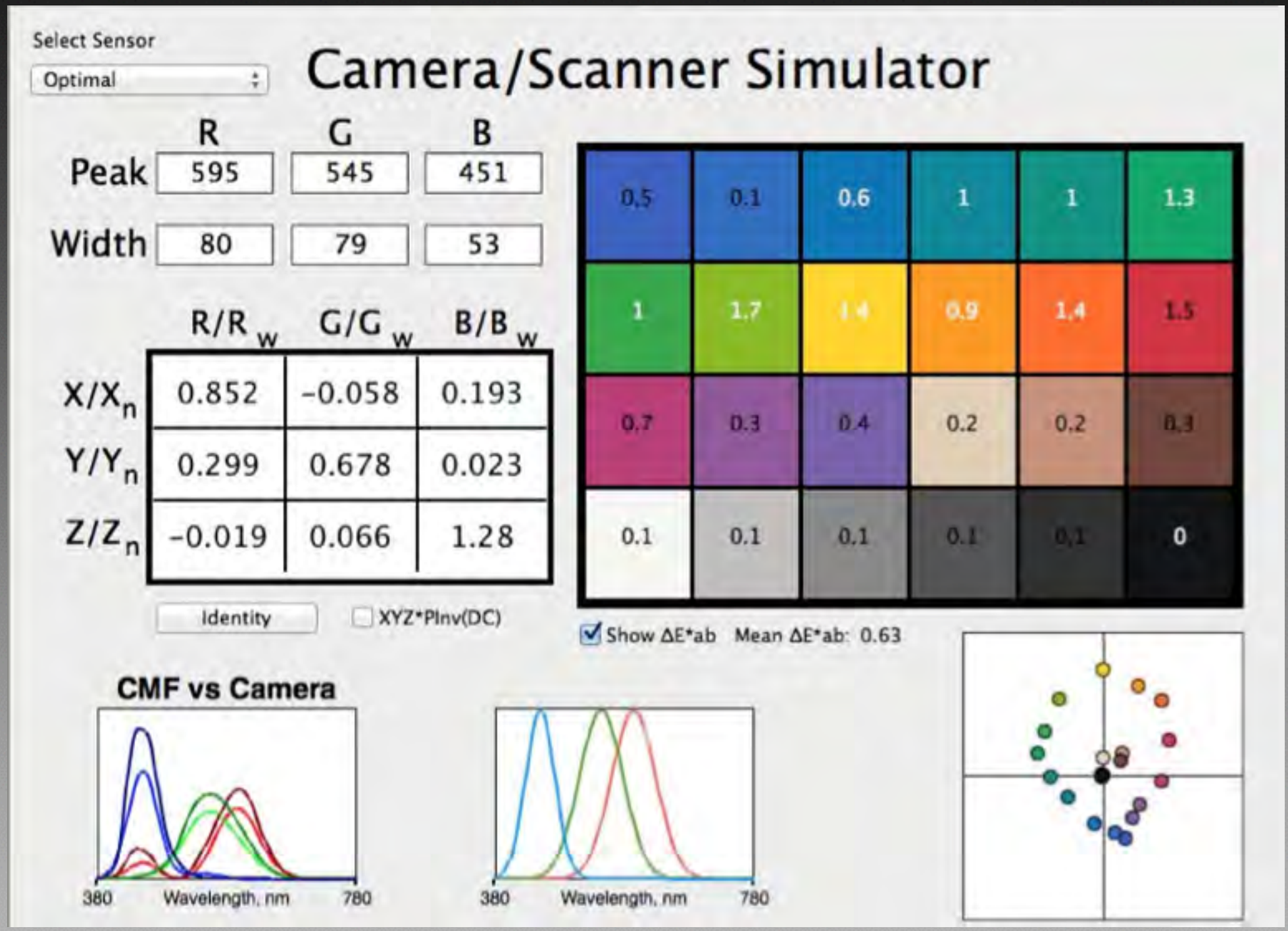
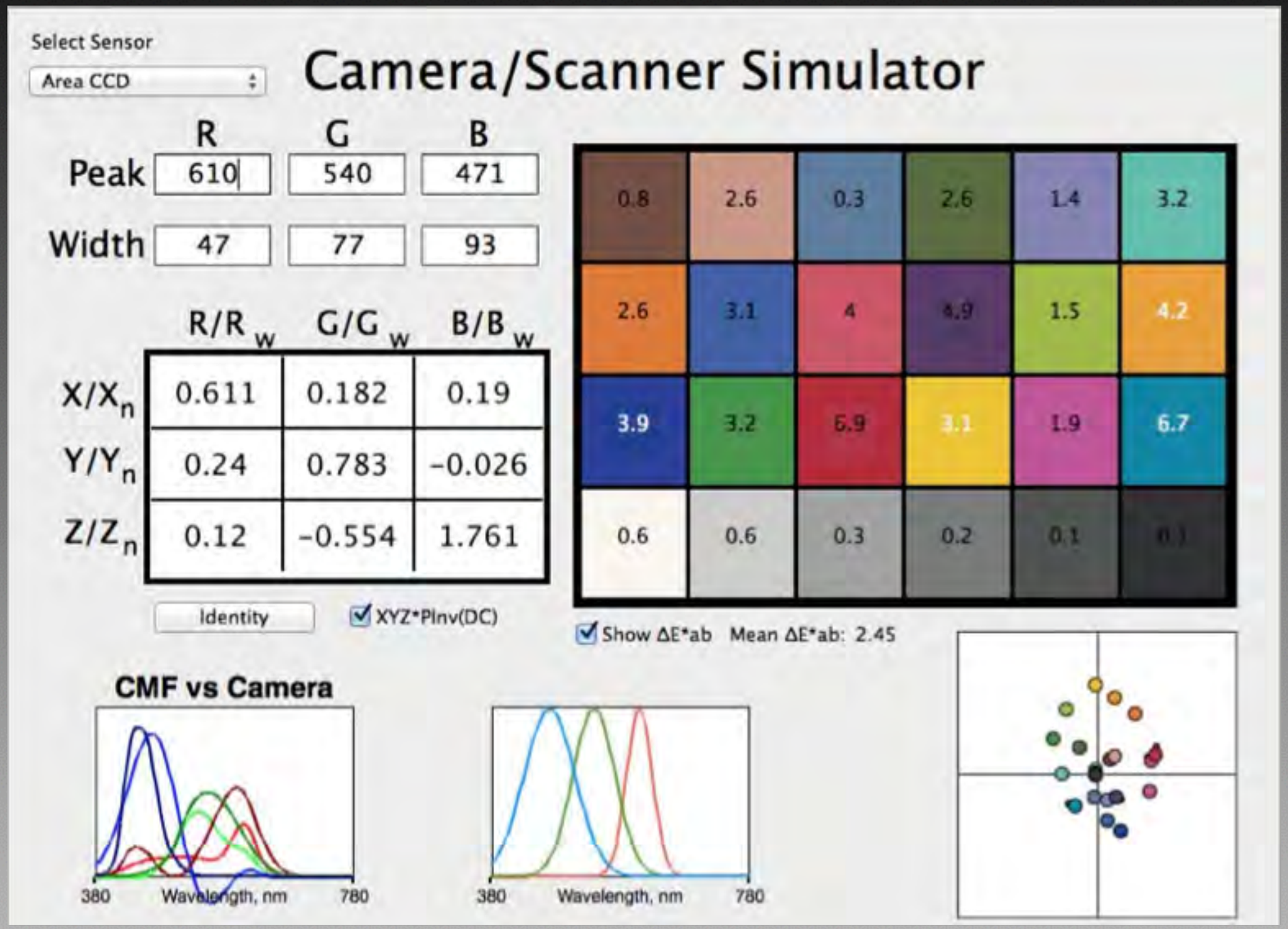
Color characterization of digital cameras

From RAW format to an RGB image

Colorimetric Camera



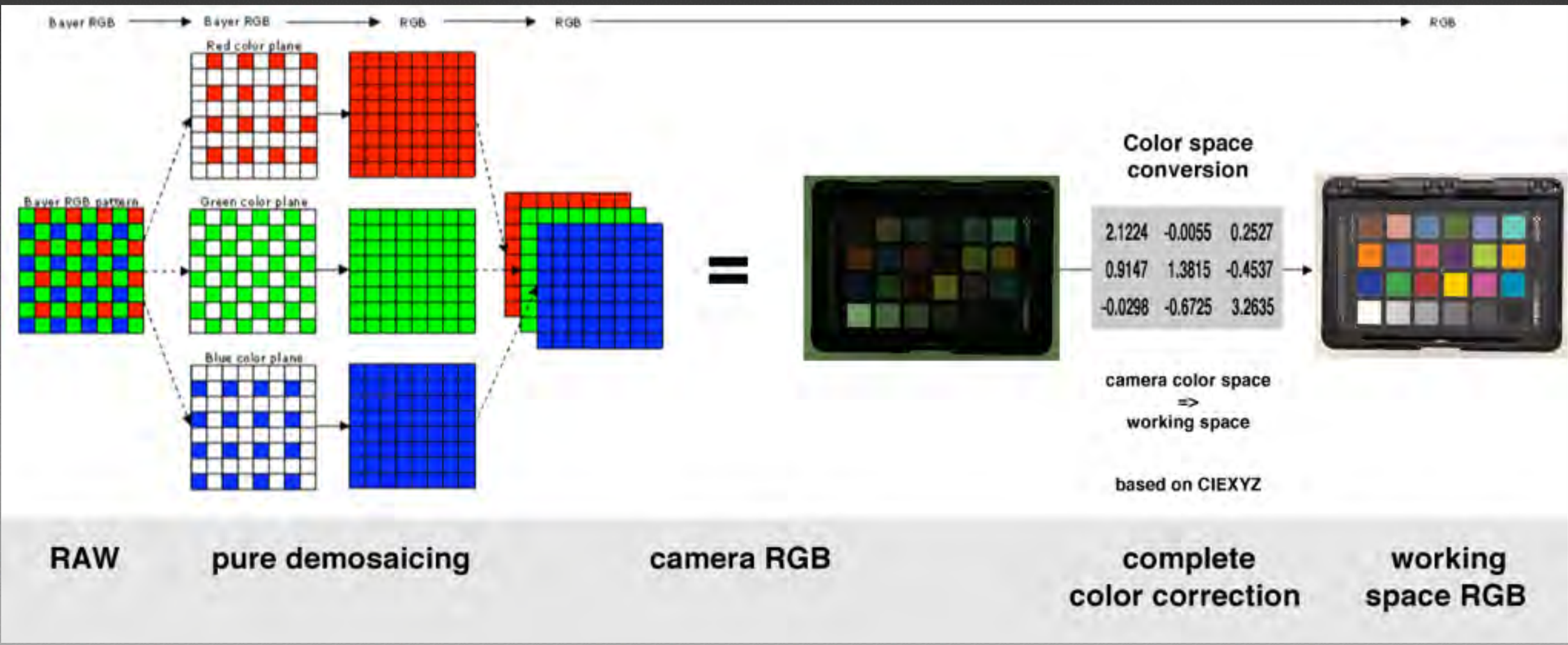
Commercial Camera



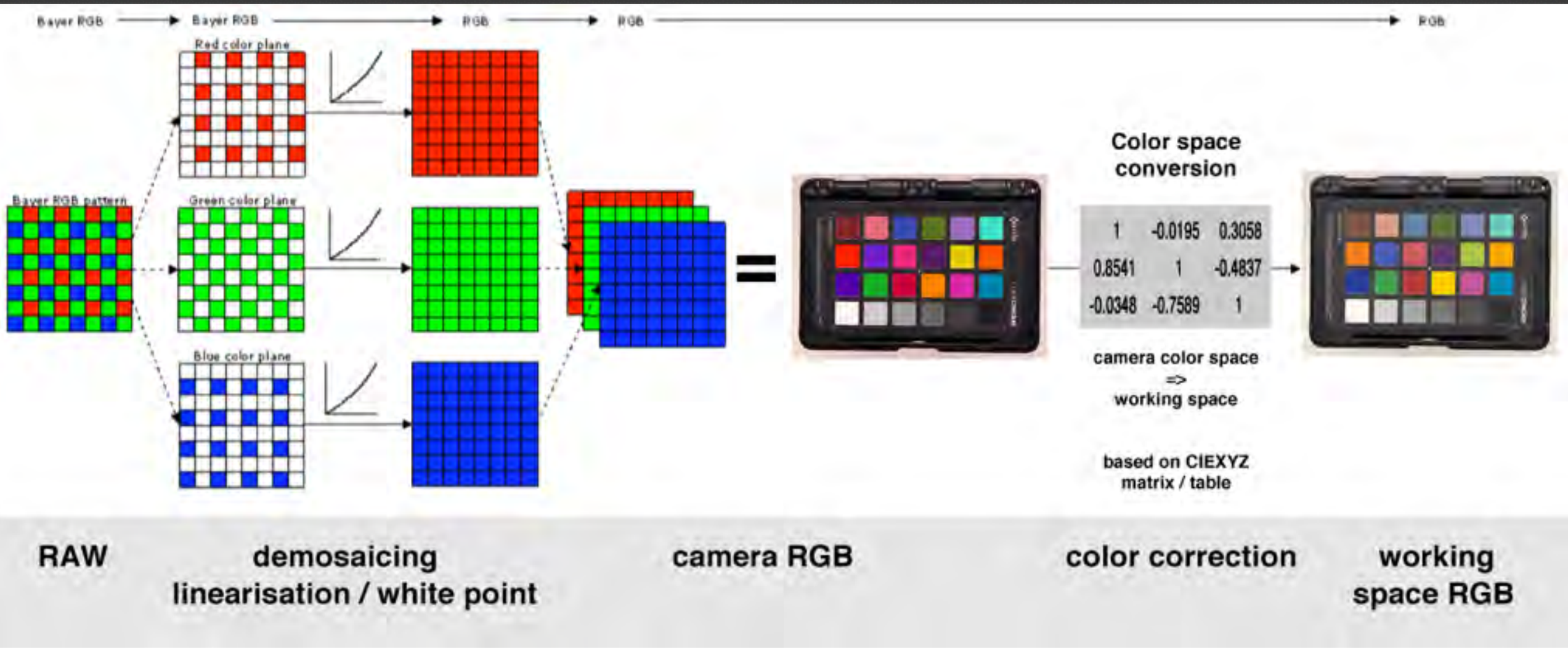
“Perfect” Camera

- 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

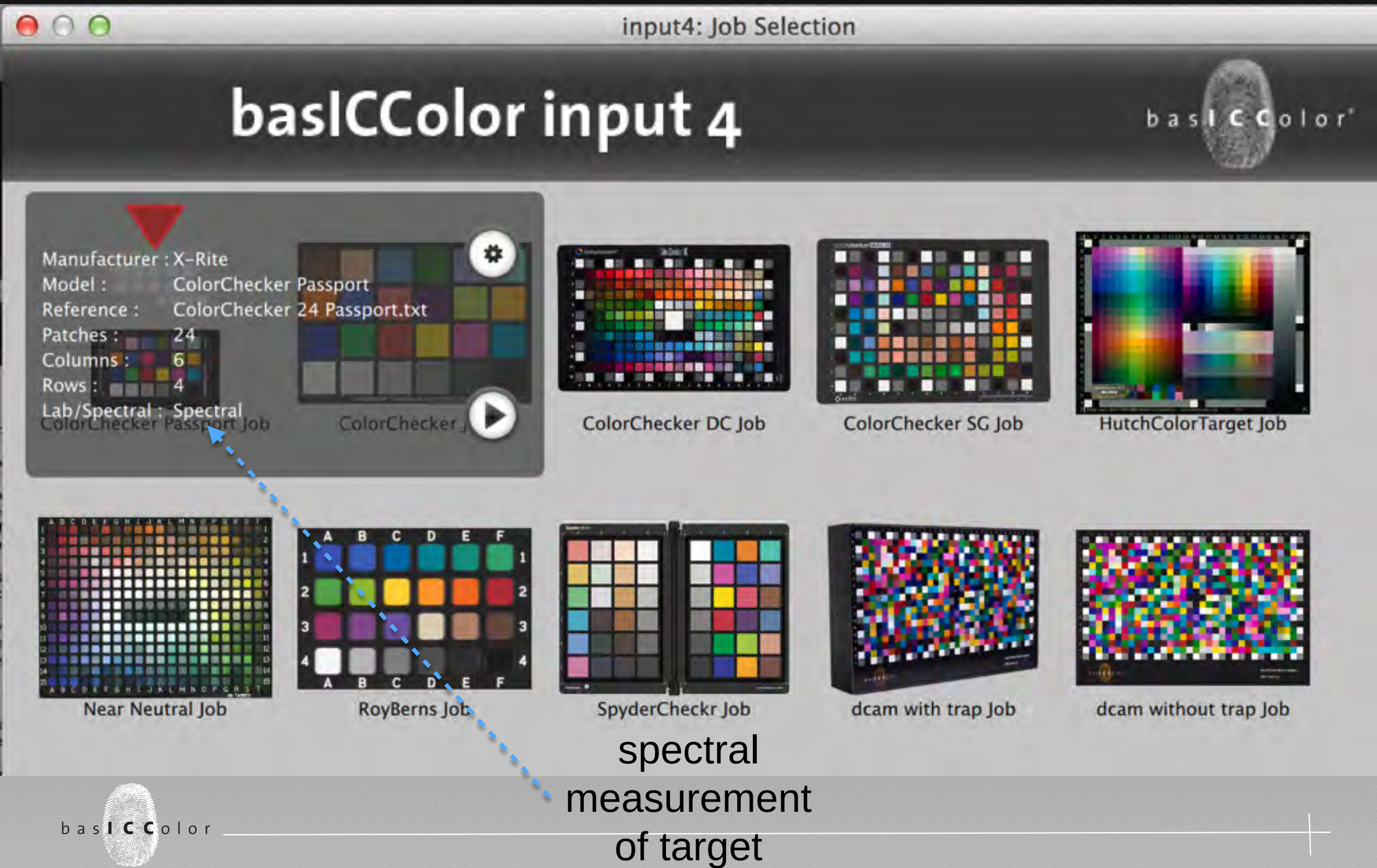
RAW Profiles

ICC Profile version 4

- 3x4 matrix
- 3 input, 3 matrix, 3 output curves
- 3D lookup table in profile connection space

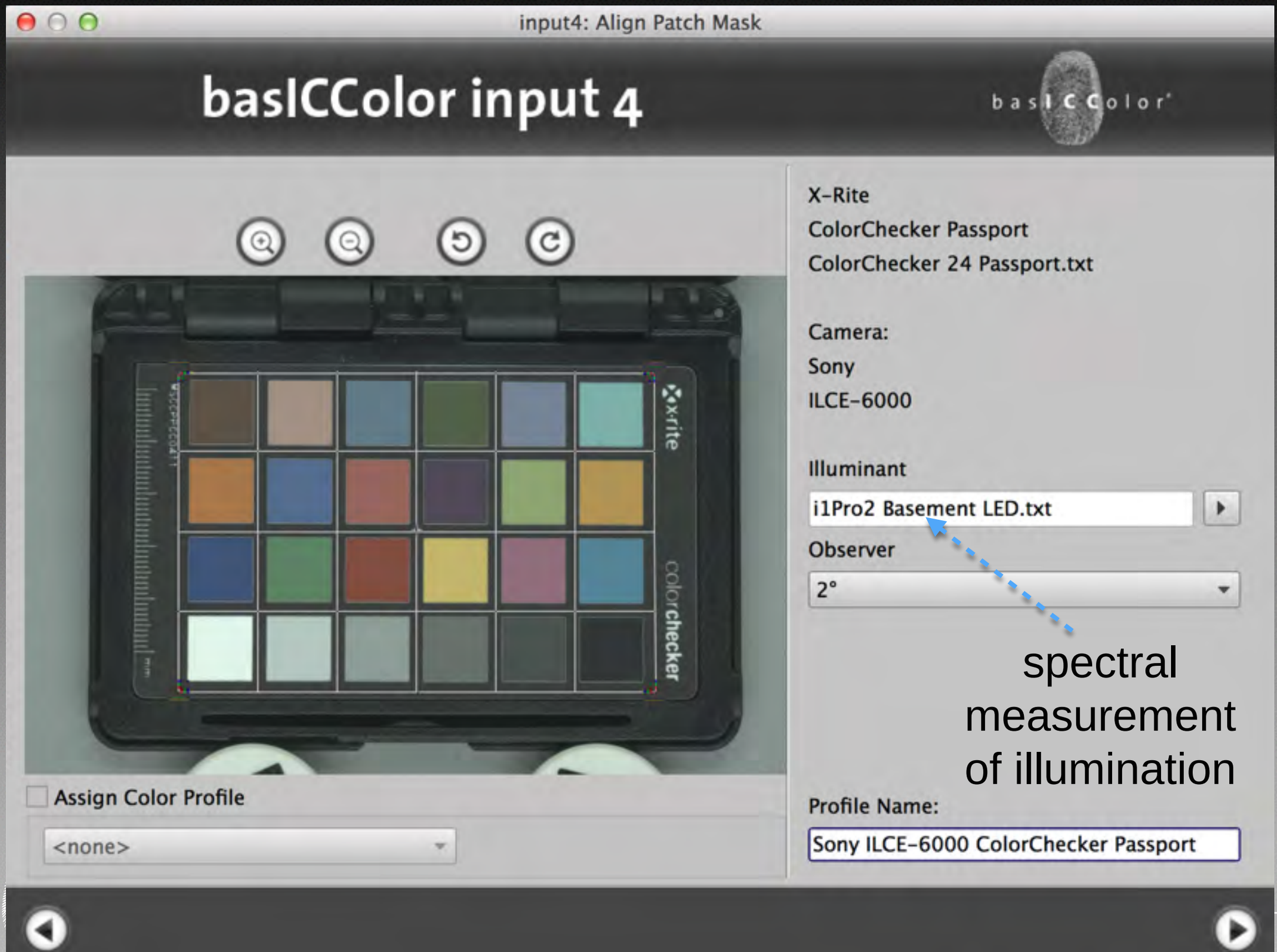
High precision when PCS is XYZ and matrix converts directly into it

Profiling RAW

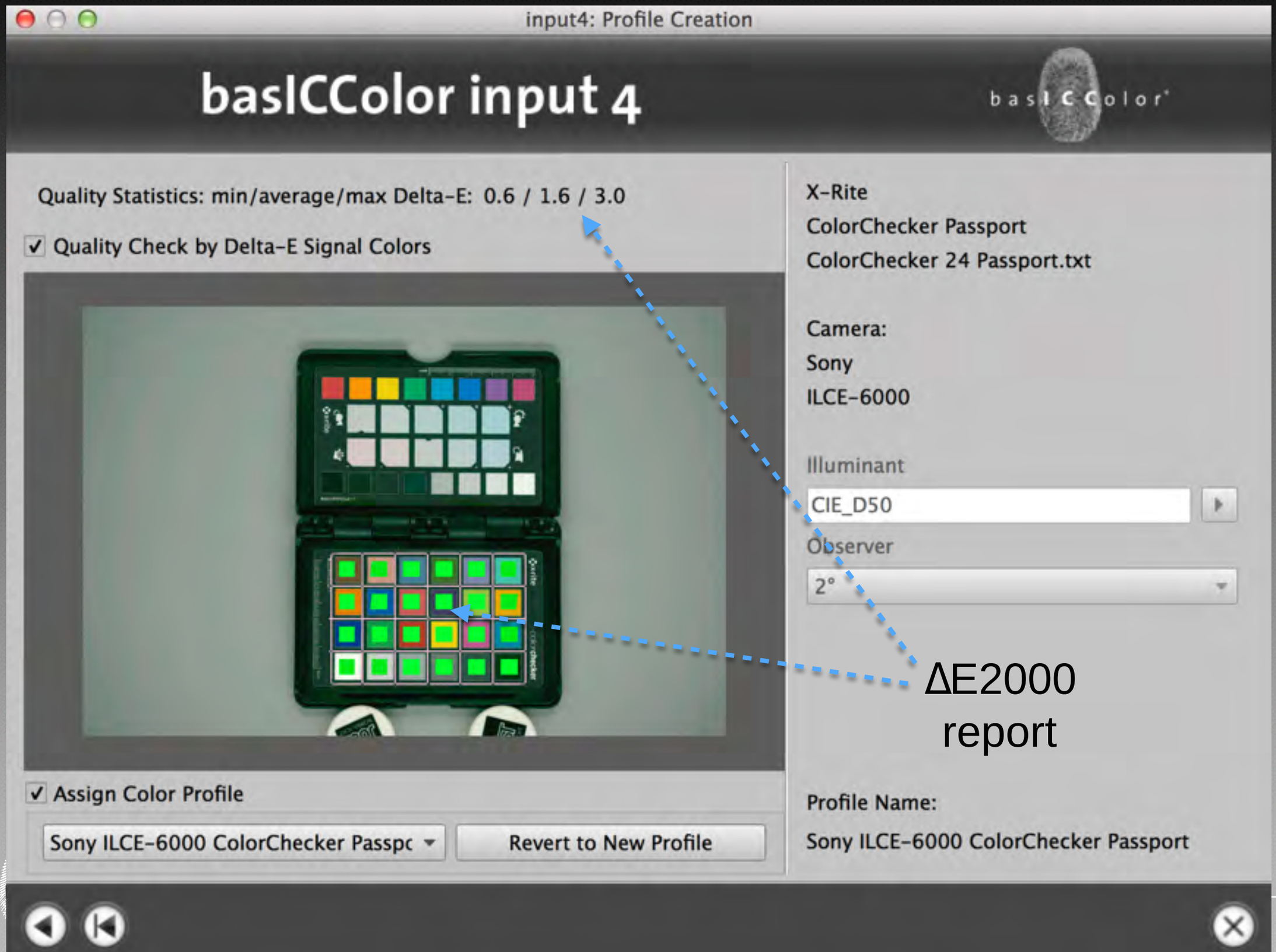


spectral measurement of target

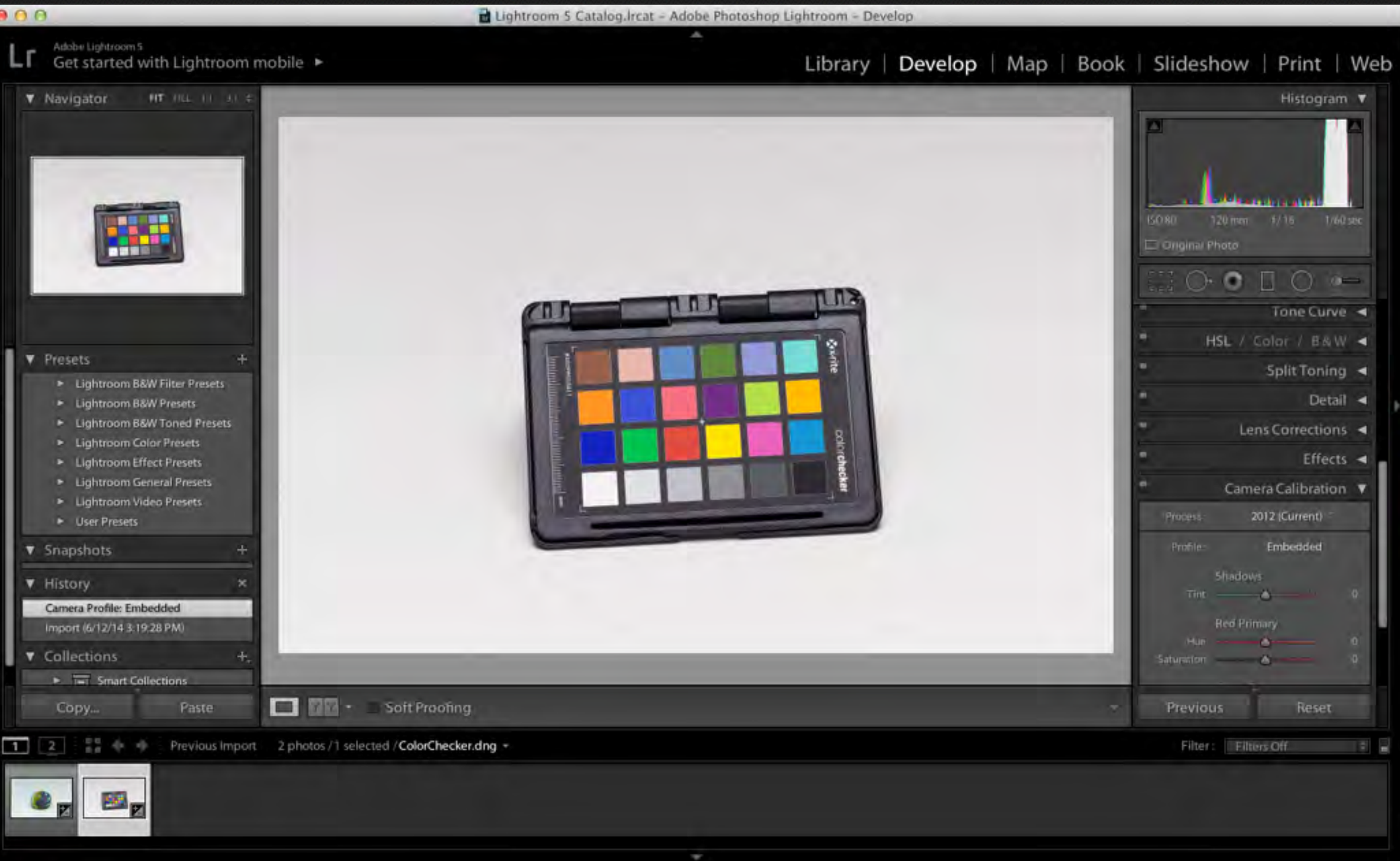
Profiling RAW



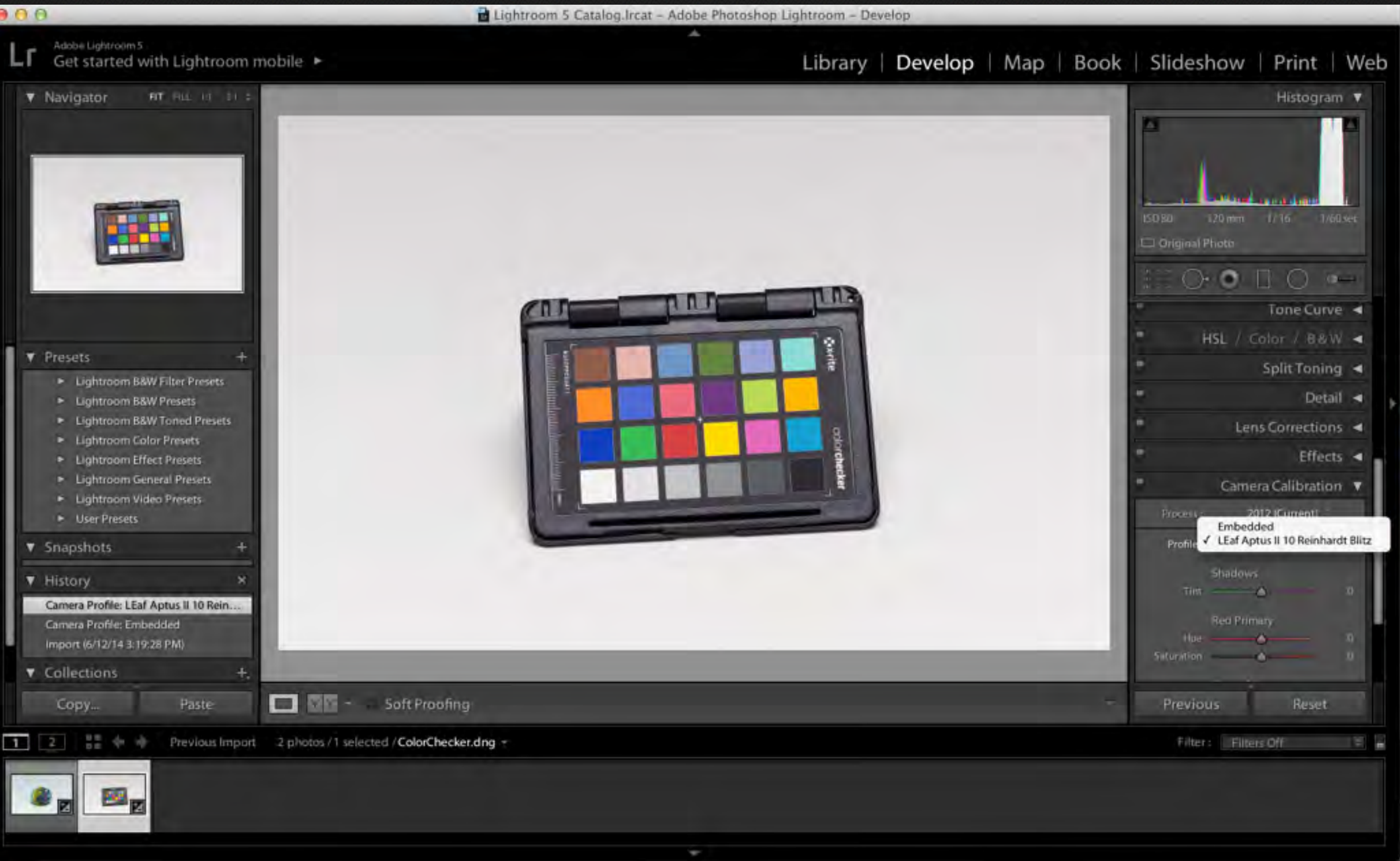
Profiling RAW



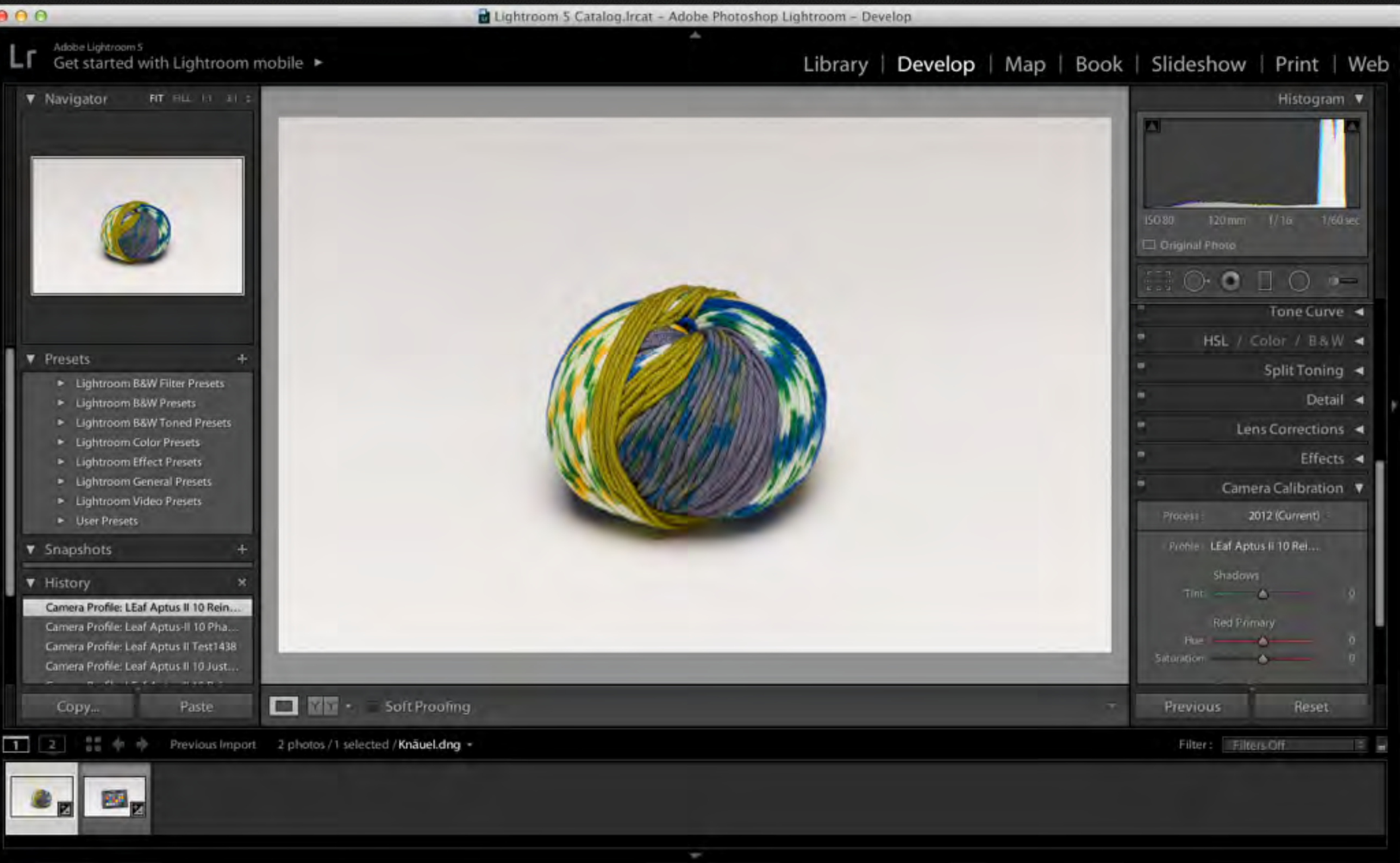
Using “RAW Profiles” in Lightroom



Using “RAW Profiles” in Lightroom



Using “RAW Profiles” in Lightroom



Using “RAW Profiles” in Lightroom

Studio Photography
zero corrections after profiling

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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)

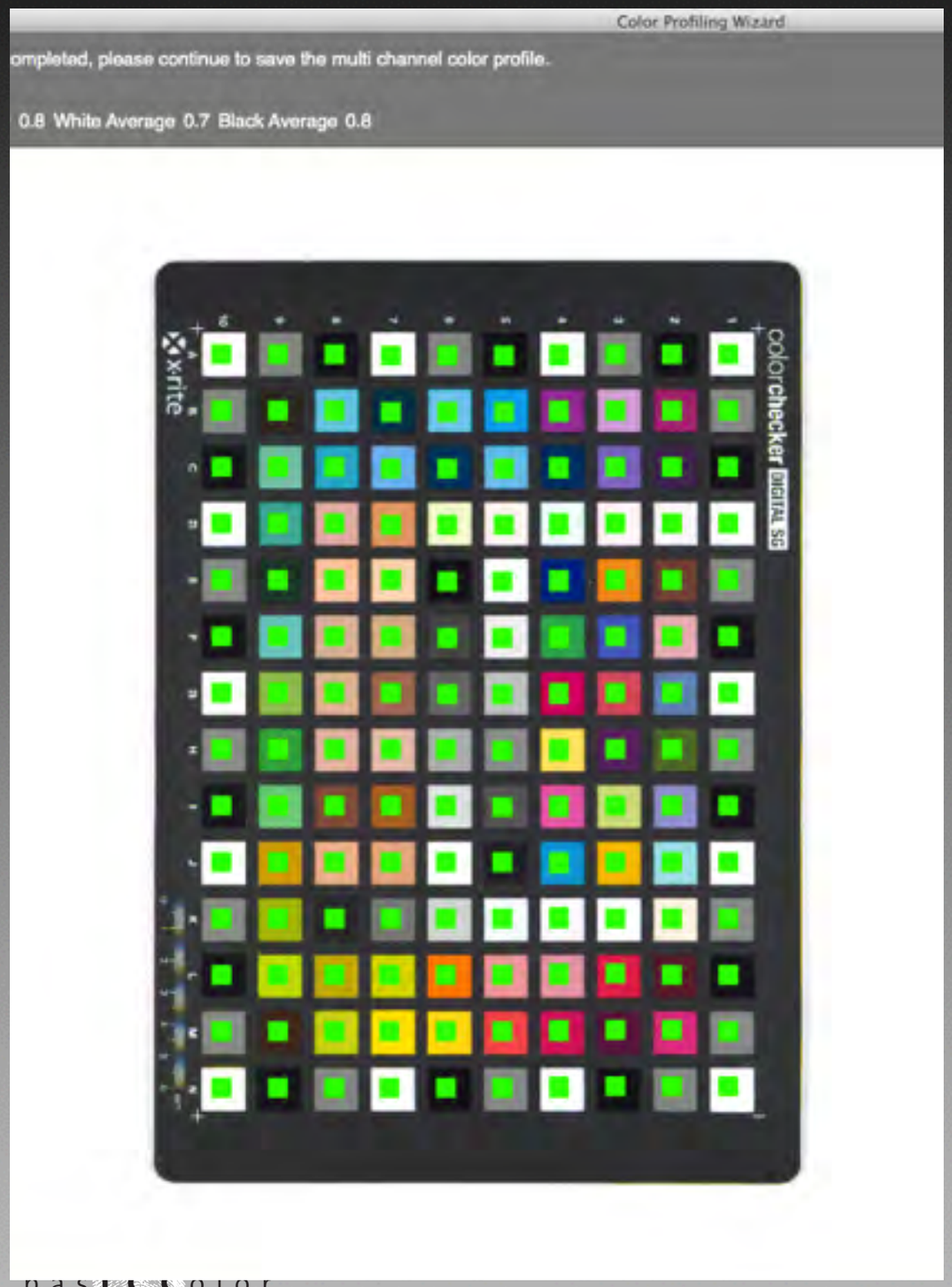
RGB + RGB = CIE XYZ

very high precision

Implementation

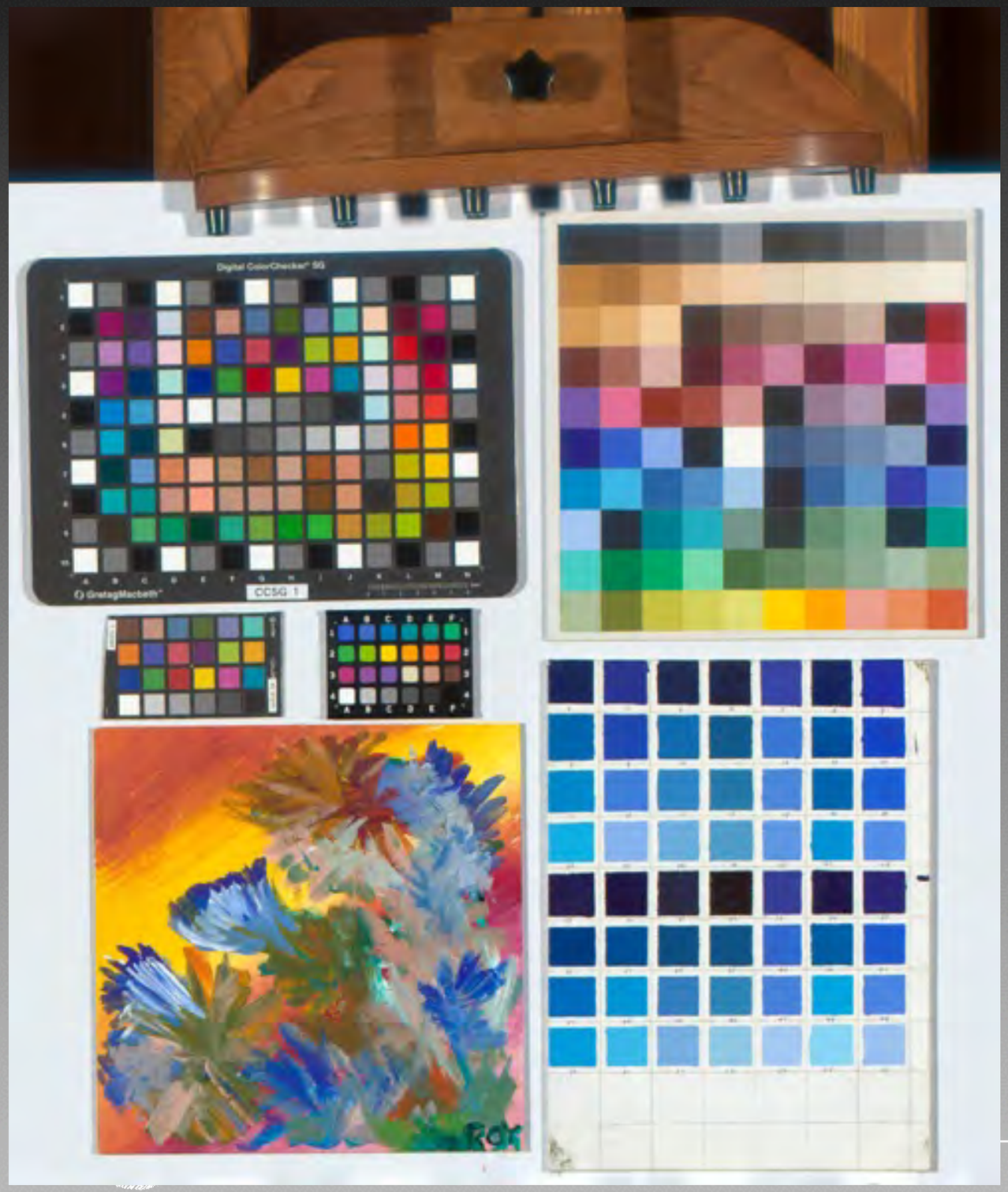
- Sinar CTM
- motorized filter exchange
- used mainly by museums for archiving artwork

Result



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

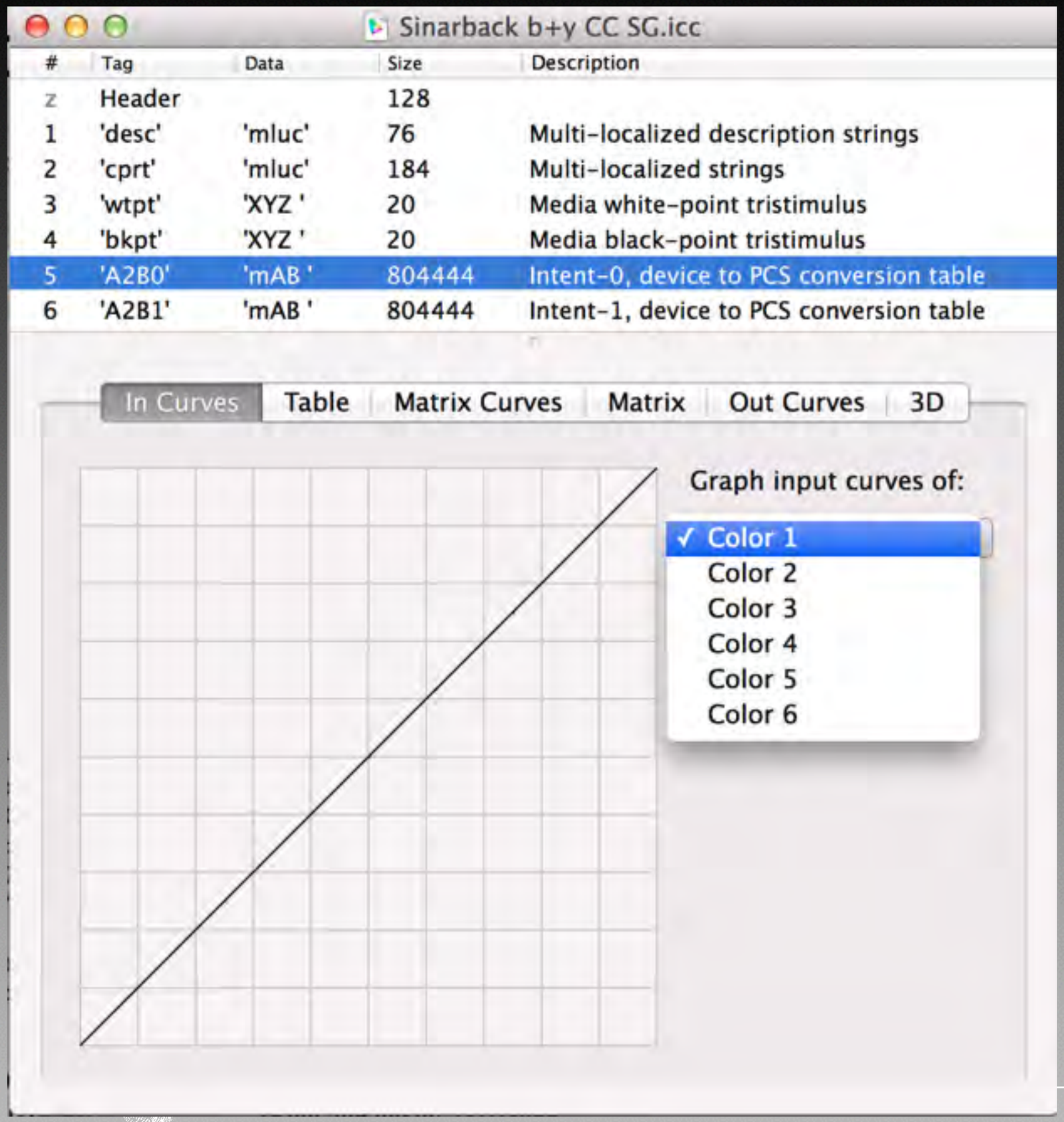
Verification



- 40+ pigments (Justin)
  - dE00 ø 1.2, max 3.5
- 6 blue pigments
  - dE00 ø 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 !

Questions?

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