Triple Channel Technique
Film Dosimetry

Micke A., Lewis D., Yu X.
International Specialty Products
ISP proprietary technology, patents pending
Single Channel Film Dosimetry

Calibration Curve $X=R$

$R_{ave} = R_{ave}(D) \leftrightarrow D=D(R_{ave})$

- $X_{ave}$ average film response

Any $X$ value delivers dose $D(X)$

- $X + \Delta X \rightarrow D(X) + \Delta D \ (X=RGB)$
- Any color disturbance $\Delta R$ leads to deviation $\Delta D$ in Dose $D$
  e.g. Scanner non-linearity, Film thickness variation

$D=D_X$
RGB Calibration Curves
- Dose induced color $C$:
  $$C(D) = \{R(D), G(D), B(D)\}$$
- Dose exposure generates only ‘certain’ colors $C$
  - Not all $C$ deliver dose value
- Observed color $C_{scan}$ is superposed with disturbance $\Delta C$
  $$C_{scan} = C(D) + \Delta C$$
- Solution: Optimize dose $D$ value, i.e. minimize $\Delta C$
  $$|C_{scan} - C(D)| \rightarrow \text{min}$$
Triple Channel Film Dosimetry

Definition:
Color channels in terms of ‘optical density’ $d_X$
- $d_X = -\log(X)$ for $X = R, G, B$ (generally wave length)

Model:
Scanned density $d_{X,\text{scan}}$ is (simple) product
- $d_{X,\text{scan}}(D) = d_{X,D}(D) \cdot \Delta d$
- $d_{X,D}$ is calibration function
- ! disturbance $\Delta d$ independent of dose + $X$ (wave length)!
  but $\Delta d = \Delta d$( thickness, scanner, noise )

Solution:
- $\Delta d_X = d_{X,\text{scan}}(D) / d_{X,D}(D)$ for all $X = R,G,B$
- Optimized dose $D$:
  $\left( \Delta d_R - \Delta d_B \right)^2 + \left( \Delta d_B - \Delta d_G \right)^2 + \left( \Delta d_G - \Delta d_R \right)^2 \rightarrow \text{min}$
Triple Channel Film Dosimetry Example

Dose map and disturbance (uniformity) $\Delta d$ map and Horizontal profile
Triple Channel Correction
What happen to the Marker Dye?

.Marker Dye needed at ‘lower’ dosage:
  \[ \Delta d \approx \frac{d_{B,\text{scan}}(0)}{d_{B,D}(0)} \]
  otherwise ‘scanner noise’ dominates \( \Delta d \)

.At ‘higher’ dosage Red channel is saturating and has function like Marker Dye
Triple Channel Film Dosimetry Features and Advantages

- Separate Dose and Dose-independent effects
  - Allows compensation for film thickness variation
  - Allows ‘smart’ noise reduction (not yet implemented)

- Enable the use of full film dose sensitivity of all channels RGB without “transition error”

- Significant improvement of dose map accuracy

- Allows to ‘sense’ calibration errors