Filmトラブルシューティング

（アールテック　宮沢）

R-TECH.INC

EBT(2,3)における
過去の事例からの参考資料

2013 *JASTRO*

Q：フィルムは操作室等の机の中で保存していたか？
（低湿度保存だと、脱水問題が発生するので、必ず、常温及び一般部屋内で保存）

Q：スキャナの左端にあるキャリブレーション位置に物（フィルム等）は無いか？

Q：Color48BITで取得したか（Grayscale等で収集していないか）？

Q：Colorで自動濃度補正はOFFになっているか？

Q：透過原稿（フィルム）で収集したか（まれに反射原稿で収集した施設有り）？

Q：透過原稿ユニットの面（蓋の部分）での汚れは無いか？

Q：使用した線量変換テーブルはフィルムと同じ方向で取得したか？

Q：単純照射野（例10x10等）では複数回の照射を行ったか？
（例　200MUの照射例では50MUx４回等、2重曝射の考慮）

Q：フィルム全体照射では太陽光を利用して、ファントムの問題、平坦度の問題を回避したか？

Q：スキャナの平坦度は基準チャートを用いて常時同様の取り込みで比較したか？

R-TECH.INC

Q:フィルムの保管は問題ないでしょうか？

操作室の机の中に保存して、乾燥室、冷蔵庫等には入れないで下さい。

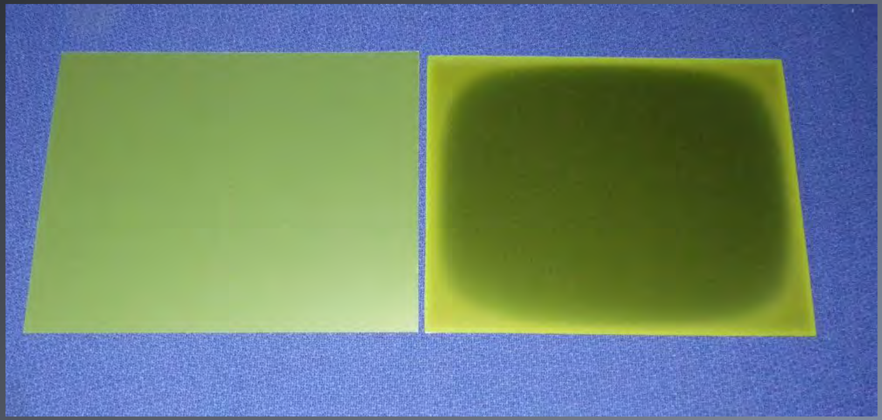
R-TECH社の保管例

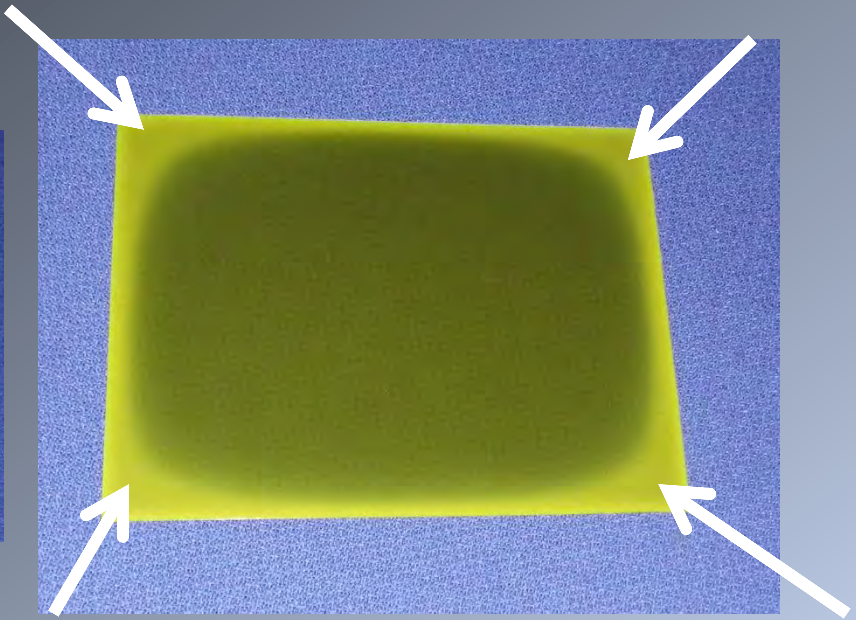
保管条件

Q:フィルムの保管は問題ないでしょうか？

2013 *JASTRO*

乾燥箱（低湿度）内で乳剤が変化した事例



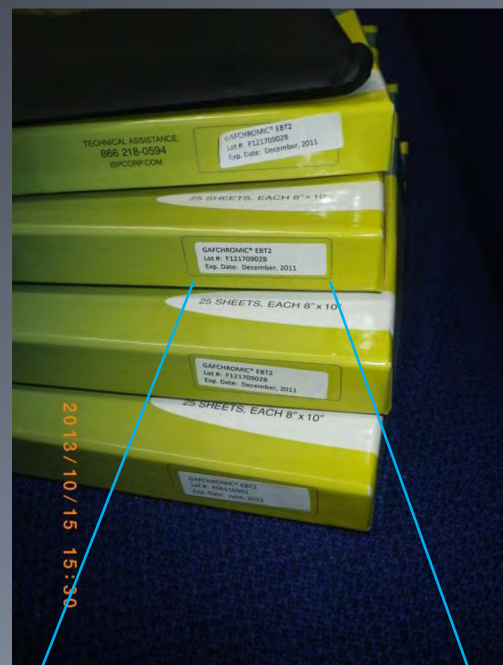


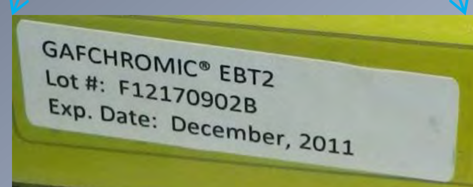
フィルムの周囲から脱水状態に変化している

R-TECH.INC

長期保存下での濃度変化に関して

R-TECH社内での長期間、自然環境下での濃度変化の追跡例





R-TECH.INC

Q:スキャナの感度等に変化はないですか？

2013 *JASTRO*

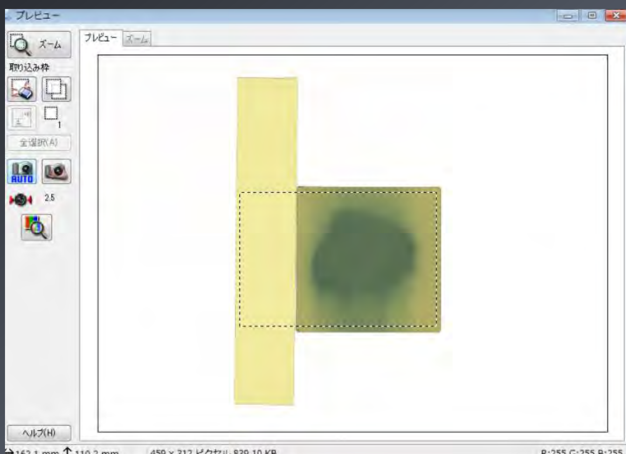
0.5mm程度の半透明色シートを用いてフィルムと同時に取り込み、ADC値の変化を見る

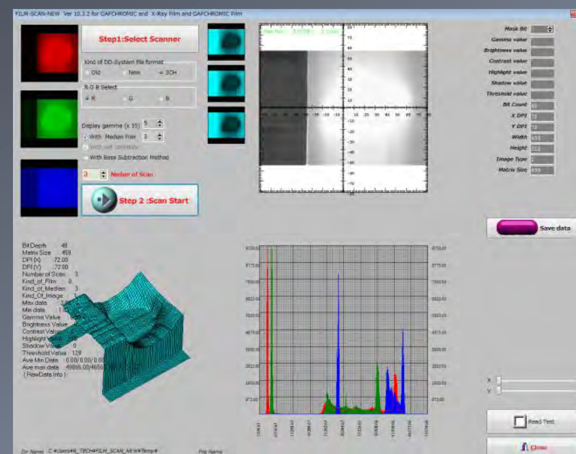
30cmx30cm以上の大きさなので、基礎特性の取得は容易
注意：塩ビシートの場合は表面が柔らかいので取扱注意

R-TECH.INC

Q:スキャナの感度等に変化はないですか？

2013 *JASTRO*





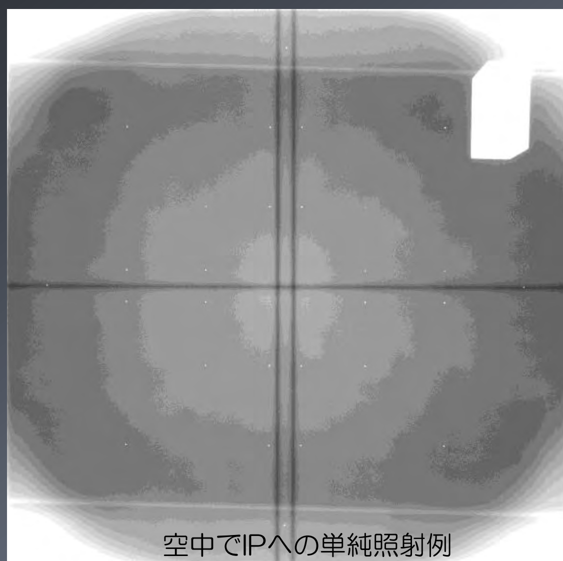
半透明ピースを用いた取り込みの例

この場所の読み込み値（ADC等）を監視してスキャナの変動を監視する

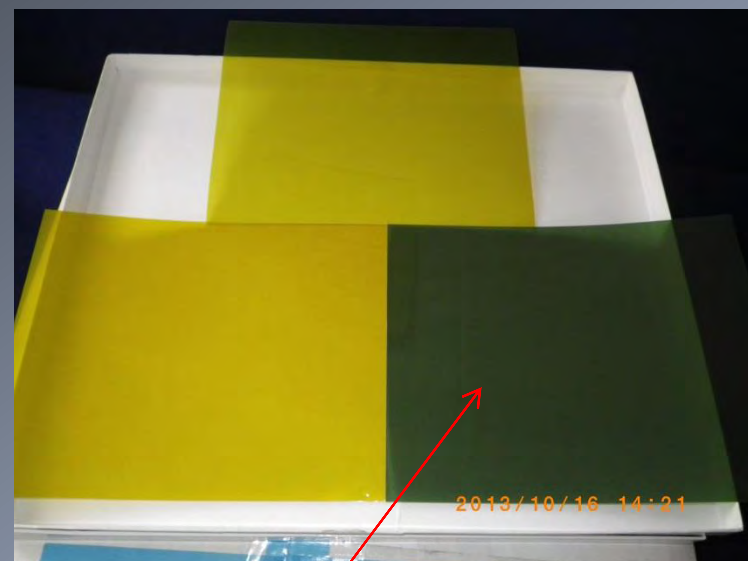
R-TECH.INC

Q:フィルム全体の濃度計測では直射日光を利用する

2013 *JASTRO*



空中でIPへの単純照射例



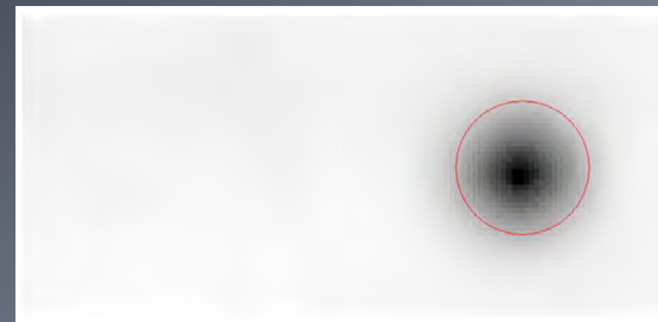
基準濃度の作成例

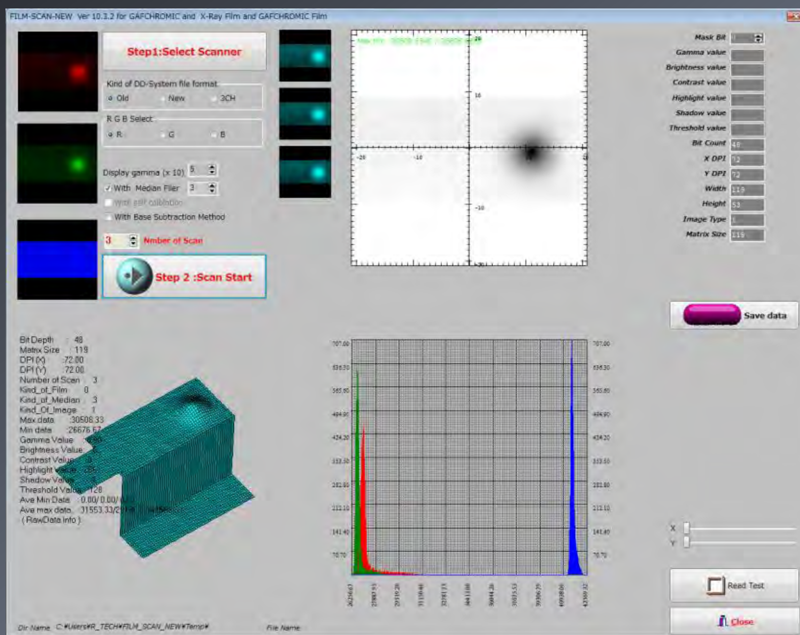
日影等にも反応するのでフィルム面に均一に日があたるように

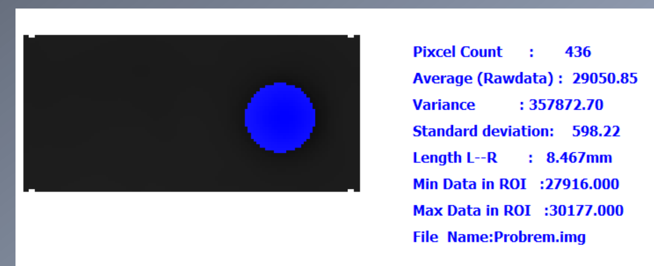
R-TECH.INC

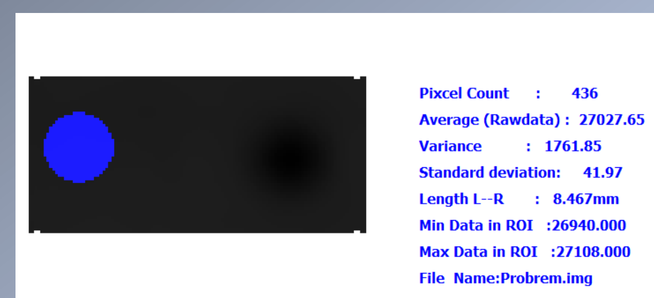
大きな障害陰影の出現（究明中）

2013 *JASTRO*









大きな障害陰影ではADC値200以上（暫定）の相違がある場合は問題となる

R-TECH.INC

Q:キャリブレーション位置にフィルムは置いてませんか？

2013 *JASTRO*

A. **Do not cover the Calibration Window** - 1.5 cm wide area where scanning starts;
B. Place film at the center of the scan window perpendicular to the scan direction;
C. Choose landscape (preferred), or portrait scanning orientation, but **be consistent;**

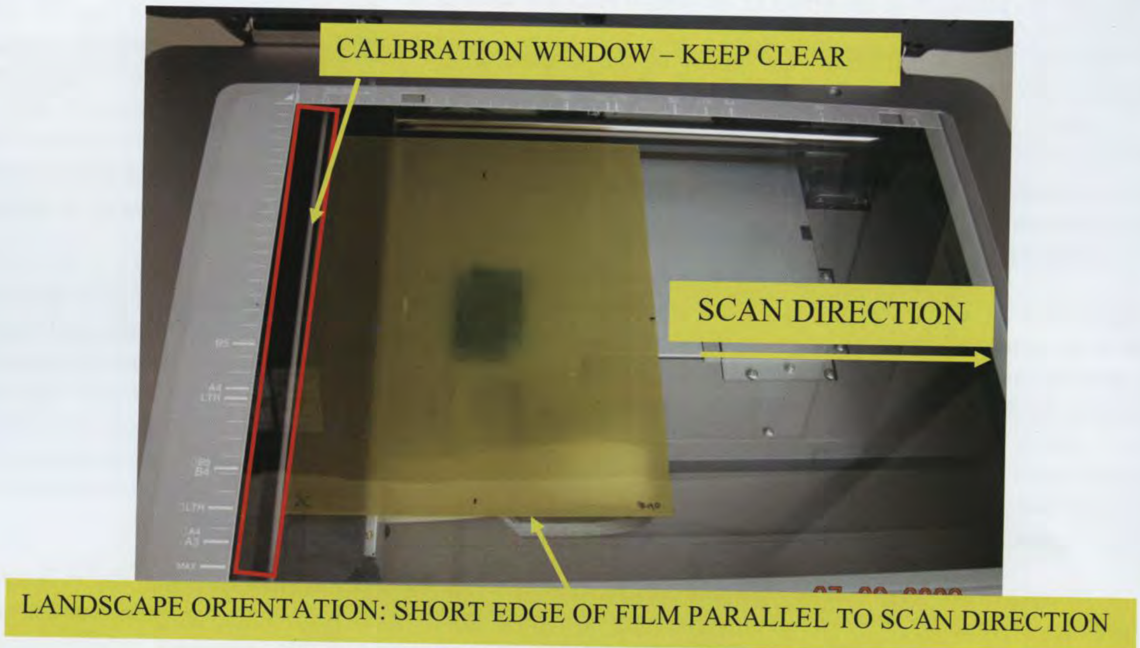


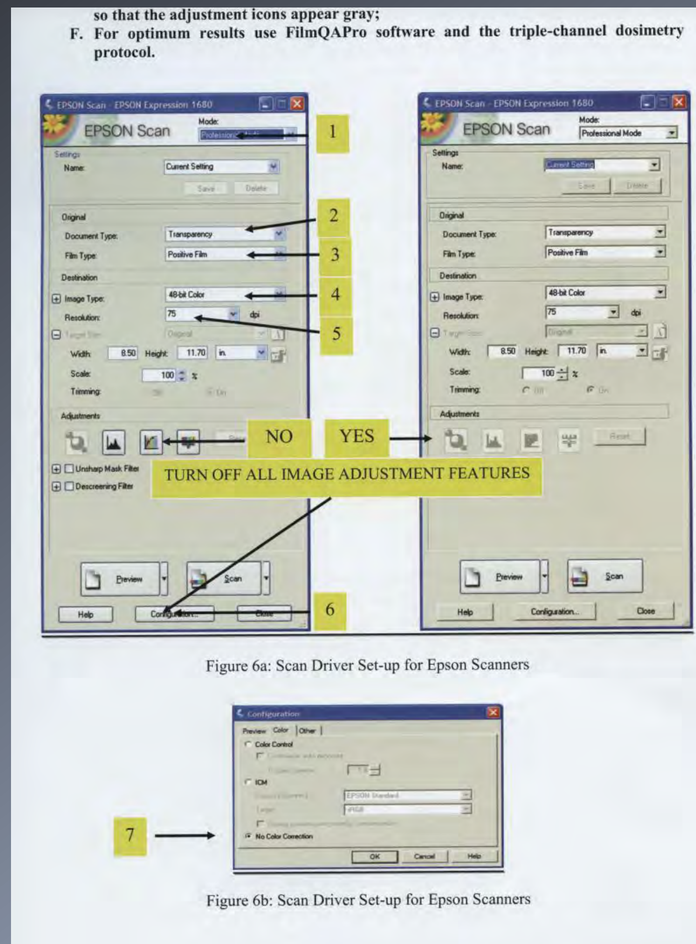
Figure 6: Film Placement for Flatbed Scanning

製造元からの注意事項を抜粋（EPSON ES1000G）

R-TECH.INC

Q:取り込み設定は間違いありませんか？

2013 *JASTRO*



so that the adjustment icons appear gray;

F. For optimum results use FilmQAPro software and the triple-channel dosimetry protocol.

Figure 6a: Scan Driver Set-up for Epson Scanners

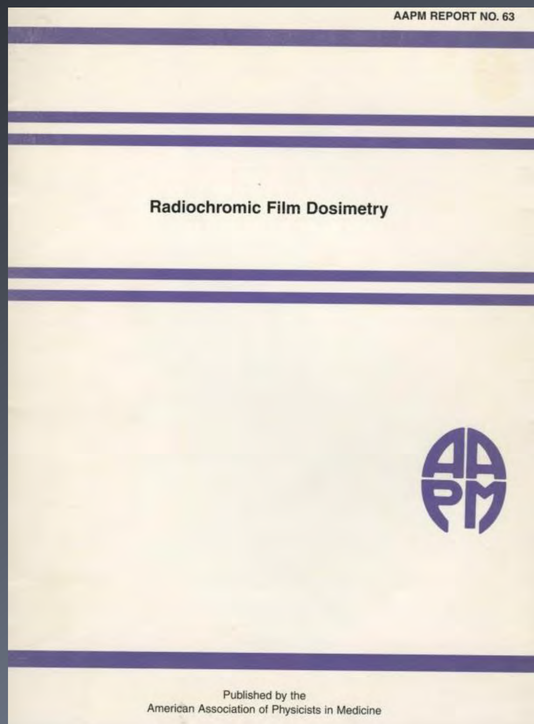
Figure 6b: Scan Driver Set-up for Epson Scanners

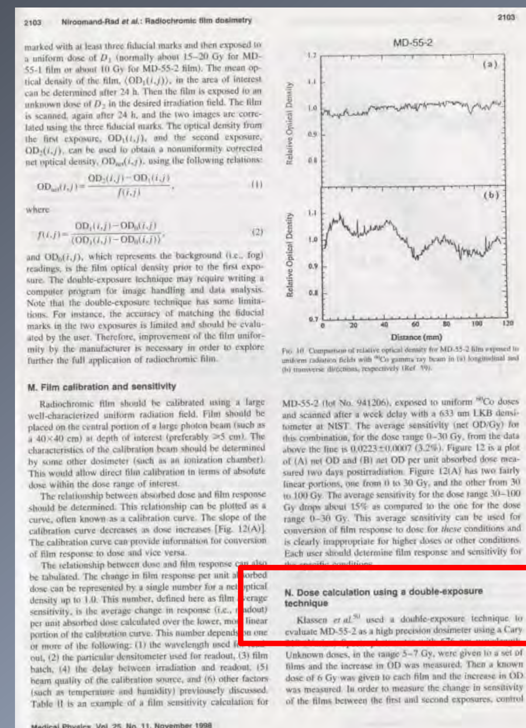
製造元からの取り込み条件の確認事項

R-TECH.INC

Q:多重曝射は考慮しましたか？

2013 *JASTRO*





2103 Niroomand-Rad *et al.*: Radiochromic film dosimetry 2103

marked with at least three fiducial marks and then exposed to a uniform dose of D_1 (normally about 15–20 Gy for MD-55-1 film or about 10 Gy for MD-55-2 film). The mean optical density of the film, $\langle OD_1(i,j)\rangle$, in the area of interest can be determined after 24 h. Then the film is exposed to an unknown dose of D_2 in the desired irradiation field. The film is scanned, again after 24 h, and the two images are correlated using the three fiducial marks. The optical density from the first exposure, $OD_1(i,j)$, and the second exposure, $OD_2(i,j)$, can be used to obtain a nonuniformity corrected net optical density, $OD_{net}(i,j)$, using the following relations:

$$OD_{net}(i,j)=\frac{OD_2(i,j)-OD_1(i,j)}{f(i,j)}, \quad (1)$$

where

$$f(i,j)=\frac{OD_1(i,j)-OD_0(i,j)}{\langle OD_1(i,j)-OD_0(i,j)\rangle}, \quad (2)$$

and $OD_0(i,j)$, which represents the background (i.e., fog) readings, is the film optical density prior to the first exposure. The double-exposure technique may require writing a computer program for image handling and data analysis. Note that the double-exposure technique has some limitations. For instance, the accuracy of matching the fiducial marks in the two exposures is limited and should be evaluated by the user. Therefore, improvement of the film uniformity by the manufacturer is necessary in order to explore further the full application of radiochromic film.

FIG. 10. Comparison of relative optical density for MD-55-2 film exposed to uniform radiation fields with ^{60}Co gamma ray beam in (a) longitudinal and (b) transverse directions, respectively (Ref. 59).

M. Film calibration and sensitivity

Radiochromic film should be calibrated using a large well-characterized uniform radiation field. Film should be placed on the central portion of a large photon beam (such as a 40×40 cm) at depth of interest (preferably ≥5 cm). The characteristics of the calibration beam should be determined by some other dosimeter (such as an ionization chamber). This would allow direct film calibration in terms of absolute dose within the dose range of interest.

The relationship between absorbed dose and film response should be determined. This relationship can be plotted as a curve, often known as a calibration curve. The slope of the calibration curve decreases as dose increases [Fig. 12(A)]. The calibration curve can provide information for conversion of film response to dose and vice versa.

The relationship between dose and film response can also be tabulated. The change in film response per unit absorbed dose can be represented by a single number for a net optical density up to 1.0. This number, defined here as film average sensitivity, is the average change in response (i.e., readout) per unit absorbed dose calculated over the lower, most linear portion of the calibration curve. This number depends on one or more of the following: (1) the wavelength used for readout, (2) the particular densitometer used for readout, (3) film batch, (4) the delay between irradiation and readout, (5) beam quality of the calibration source, and (6) other factors (such as temperature and humidity) previously discussed. Table II is an example of a film sensitivity calculation for MD-55-2 (lot No. 941206), exposed to uniform ^{60}Co doses and scanned after a week delay with a 633 nm LKB densitometer at NIST. The average sensitivity (net OD/Gy) for this combination, for the dose range 0–30 Gy, from the data above the line is 0.0223±0.0007 (3.2%). Figure 12 is a plot of (A) net OD and (B) net OD per unit absorbed dose measured two days postirradiation. Figure 12(A) has two fairly linear portions, one from 0 to 30 Gy, and the other from 30 to 100 Gy. The average sensitivity for the dose range 30–100 Gy drops about 15% as compared to the one for the dose range 0–30 Gy. This average sensitivity can be used for conversion of film response to dose for *these* conditions and is clearly inappropriate for higher doses or other conditions. Each user should determine film response and sensitivity for the specific conditions.

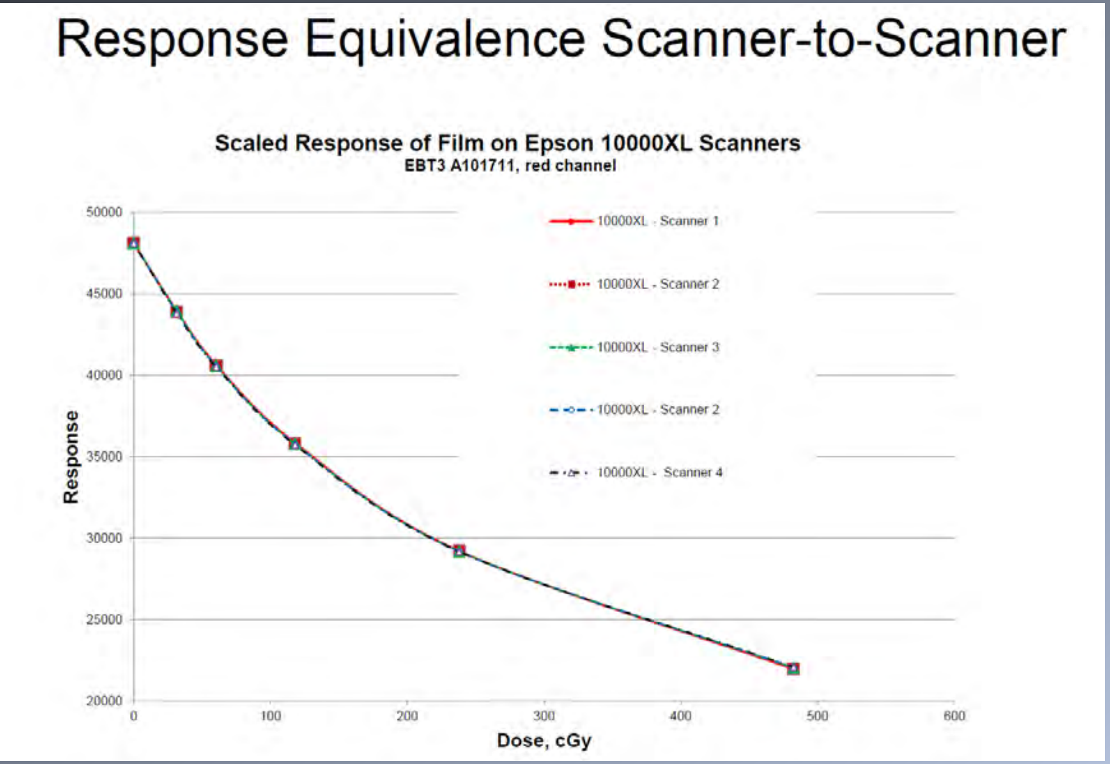
N. Dose calculation using a double-exposure technique

Klassen *et al.*[50] used a double-exposure technique to evaluate MD-55-2 as a high precision dosimeter using a Cary [illegible]
Unknown doses, in the range 5–7 Gy, were given to a set of films and the increase in OD was measured. Then a known dose of 6 Gy was given to each film and the increase in OD was measured. In order to measure the change in sensitivity of the films between the first and second exposures, control

R-TECH.INC

Q:スキャナはフラットベット型ですか？

市販スキャナの信頼性

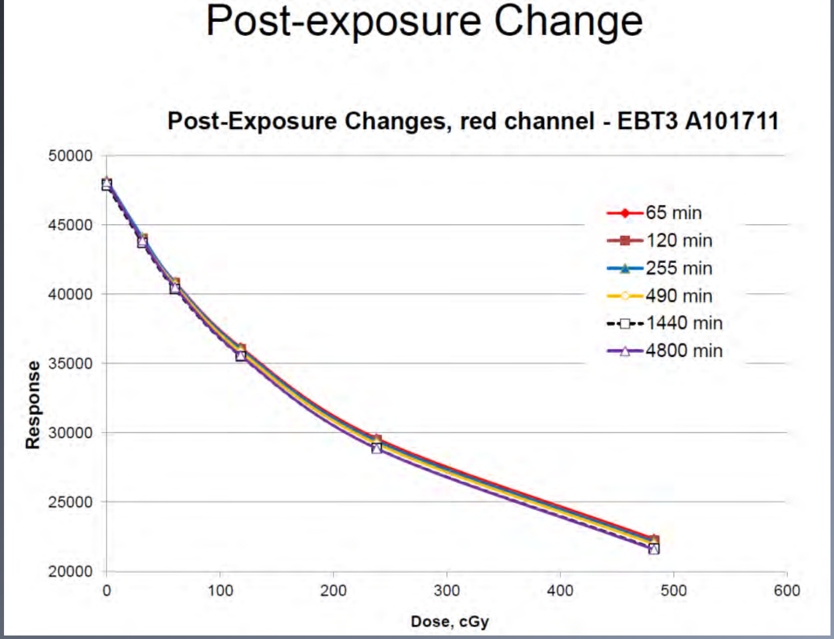


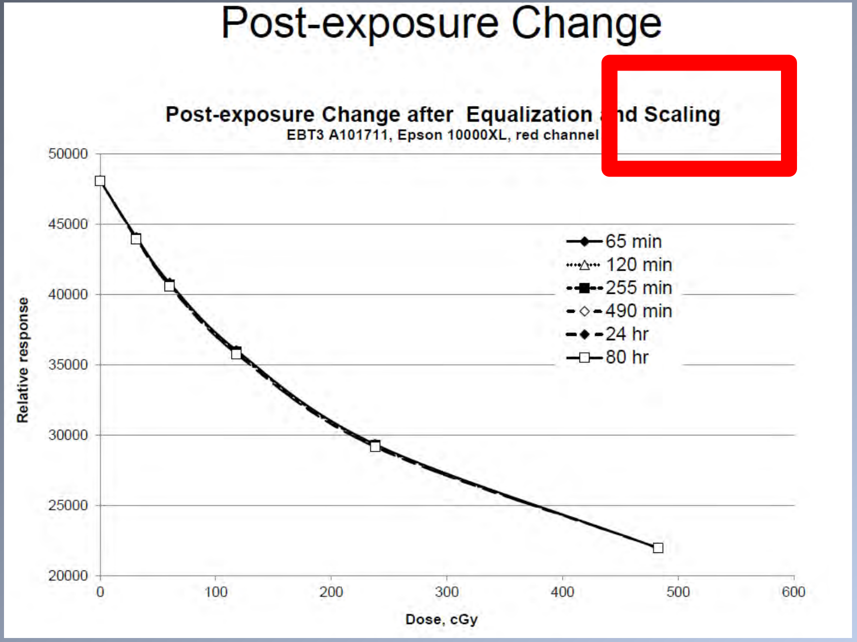
10000XL（米国）　ES10000G（日本）

Q:コントロール（テーブル）と実射は同じ時間ですか？

2013 *JASTRO*

照射後潜像時間は





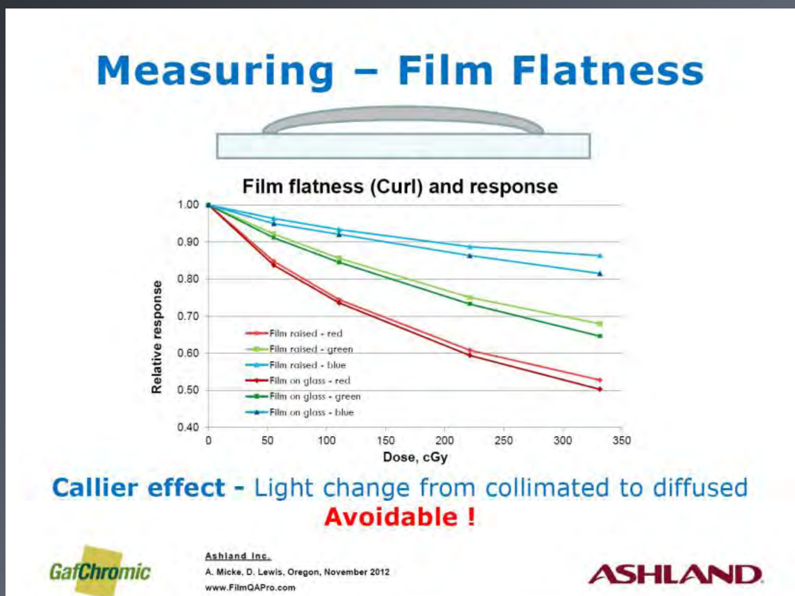
日本では時間毎のテーブルを参照する方式が一般的

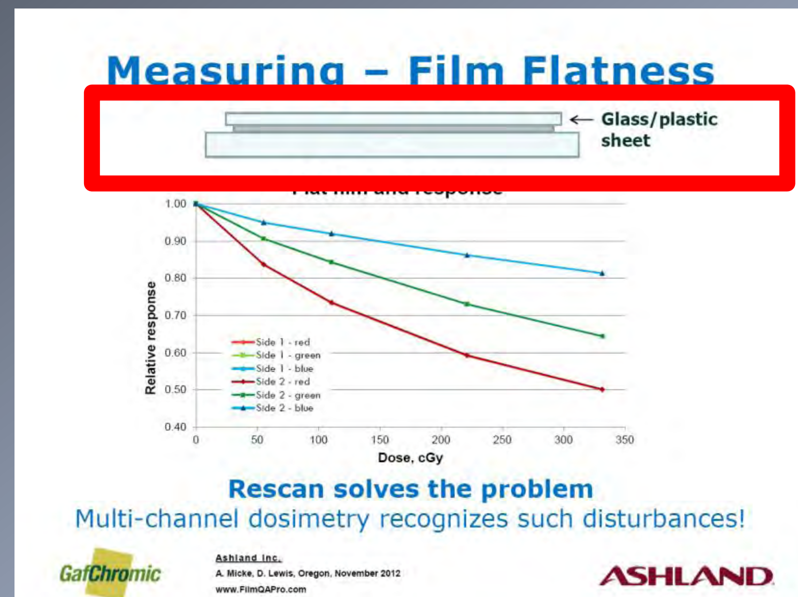
R-TECH.INC

Q:フィルムの‘反り’は確認しましたか？

2013 *JASTRO*

フィルムの反り対策は





フィルムの上にガラス等の透明度の高い重しを置く

R-TECH.INC

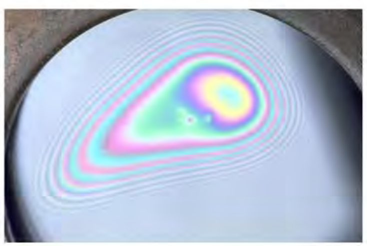
Q:モアレ軽減処理は施していますか？

2013 *JASTRO*

モアレ対策は

Newton's Rings Pattern

- Interference pattern formed by an air gap of varying thickness between two closely spaced surfaces
  - Constructive/destructive interference between reflected/refracted rays
  - Monochromatic light yields light and dark bands
  - White light yields colored bands
    - Constructive interference for λ_1, destructive interference for λ_2



Avoid Contact Between Film and Glass

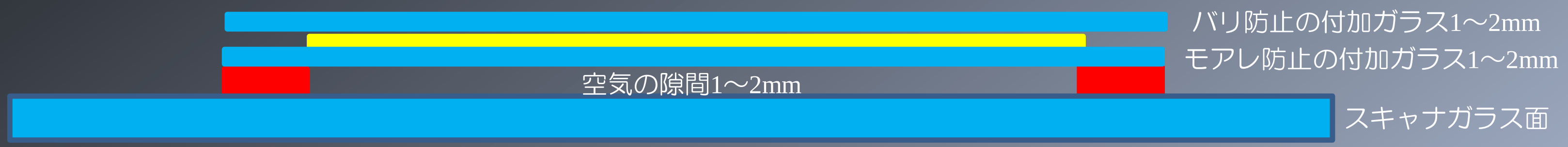
- Make a simple frame
  - Approximately 1-2 mm thick
  - Cardboard, plastic, rubber

拡大等が必要な場合は絶大な効果が有る

R-TECH.INC

フィルムの‘反り‘や’モアレ軽減’を考慮すると

2013 *JASTRO*



１：スキャナガラス面の上に隙間を持たせた、ガラス板を載せる。
（載せた、ガラス板との間に1円玉にて隙間を作る）
３：フィルムを載せて、‘反り’防止のガラスを更に載せる。

DPI=72～100、48BITColor,DD-System ではNewFormat&With Selfcalblation,3x3 Median filter

＊ガラス板又は無反射ガラスの厚みは１～２mm厚で、できるかぎり透明度の高い物を使用

R-TECH.INC

まとめ

EDR2に比べて特性等に多くの課題があるが、
水中使用、現像機が必要無し、照射後の結果参照が早い等の利点も多くある。

今後も現場の声が反映できるように努力したいと考えている