RECONVOLUTION ANALYSIS OF OCCLUSION RECOVERY FLUX CURVES

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Overview

Occlusion Studies give important information about the stratum corneum barrier & how it changes when normal transpiration is disrupted.

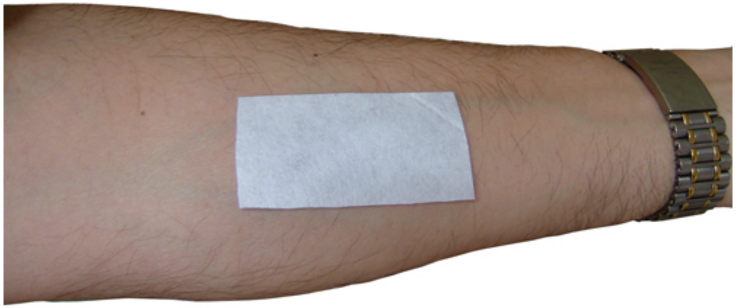
Our aim was to improve **Occlusion Recovery Data Analysis**.

Plan of Presentation

1. Protocol & Measurement Method
2. Data
3. Steady-state Analysis
4. Transient Analysis
5. Summary & Conclusions

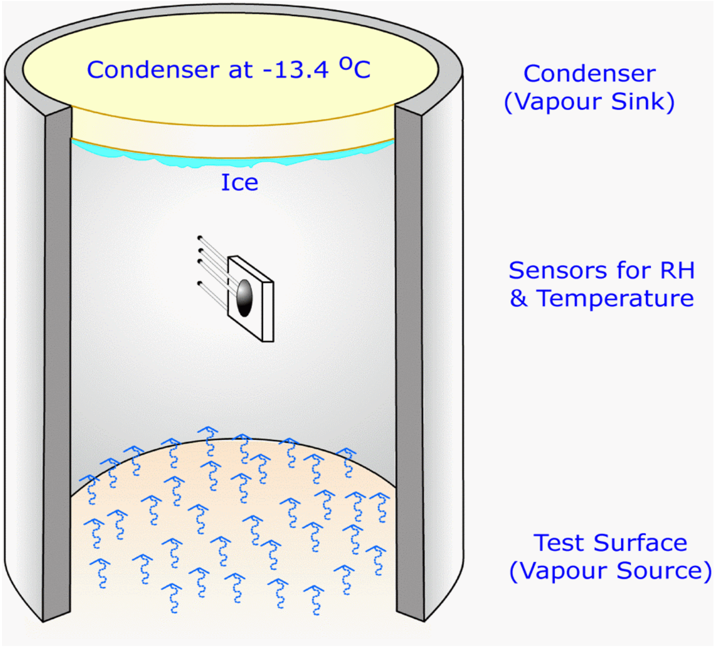
Protocol

1. Use the middle portion of the left volar forearm.
2. Acclimatise as recommended in the TEWL Guidelines.
3. Record a *baseline* flux density time-series curve (normal TEWL).
4. Apply a Silgel™ wound dressing (~8 * 3 cm) to the test site. It sticks.
5. Remove the dressing after a pre-determined interval (3, 6, 9, 12, 15 min).
6. Immediately (< 5 sec) start measuring an *occlusion recovery* curve.
7. Start the next experiment at **4** above.



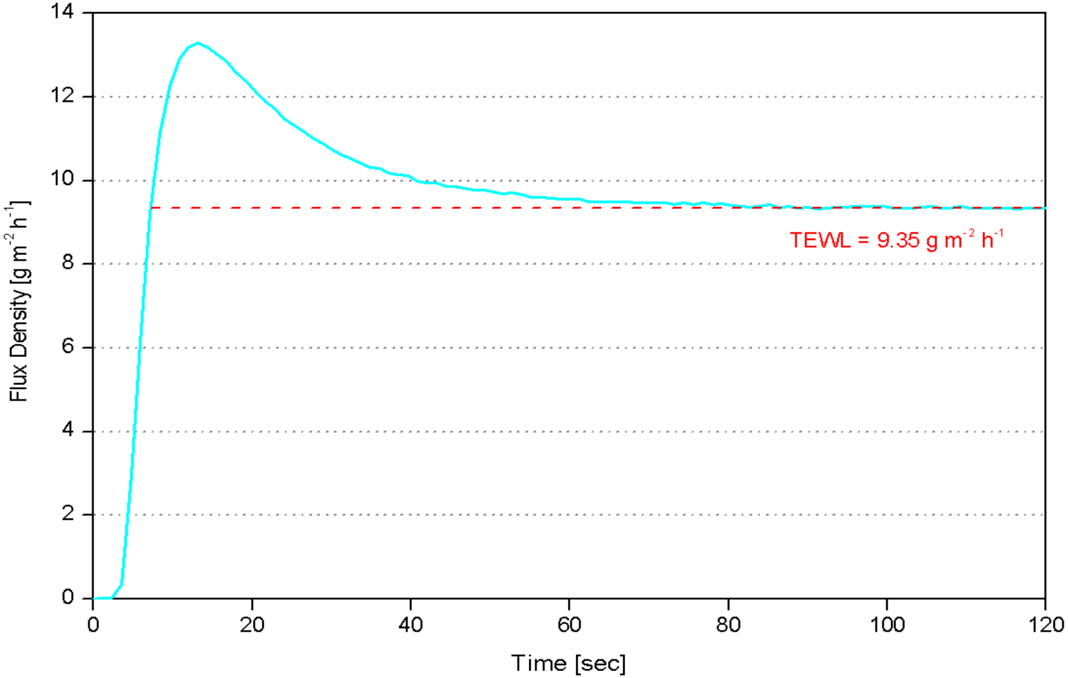
Measurement Method

The measurements used a condenser-chamber instrument (AquaFlux).



Closed measurement chamber with microclimate control.

Data 1: Baseline Flux Density (TEWL)



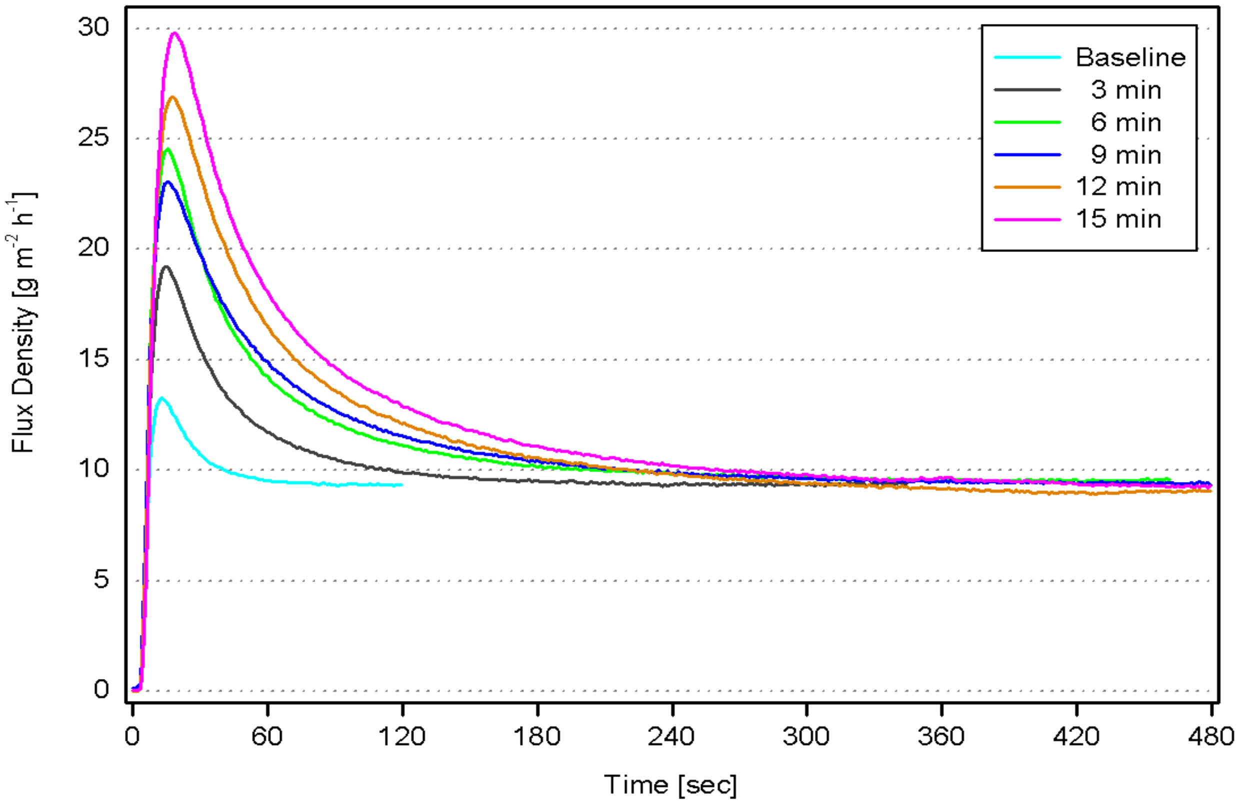
The initial bump is is due to:-

(i) Ambient humidity capture (while the measurement orifice is open).

(ii) SSWL, depending on skin & ambient conditions.

The enclosed area above the dashed red line is ~1µg of H_2O.

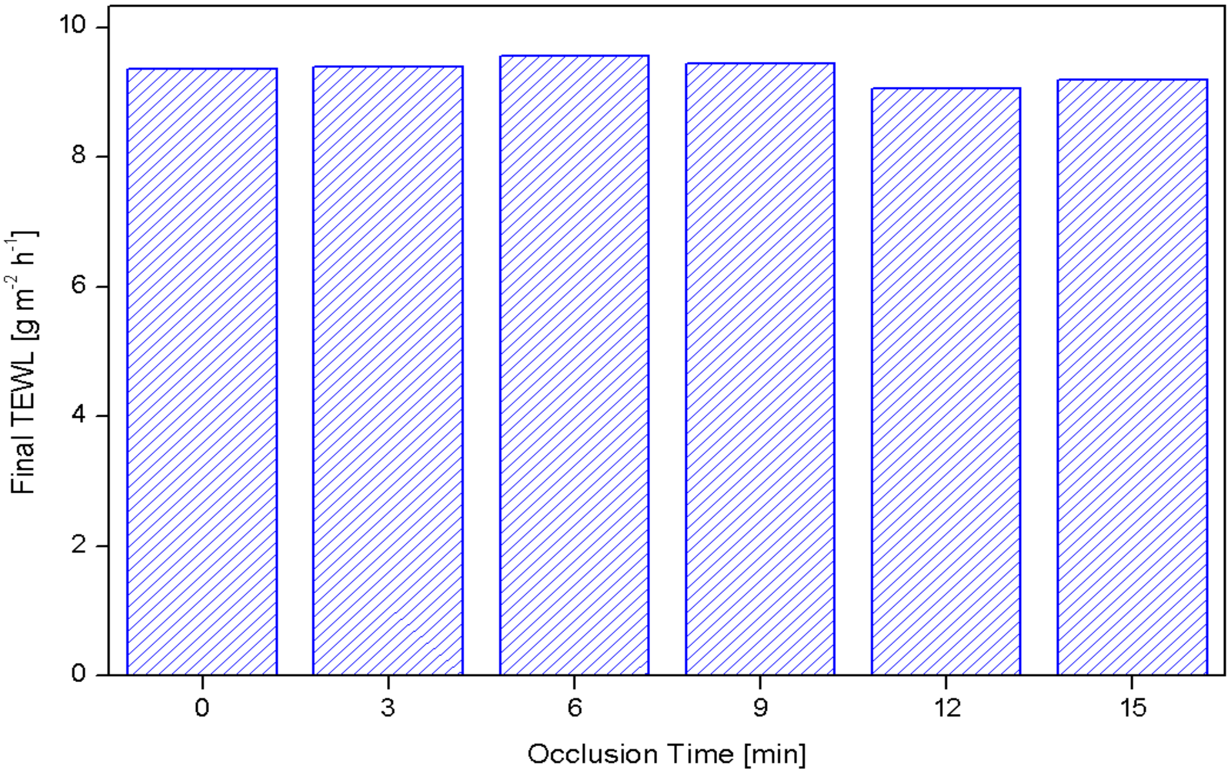
Data 2: Occlusion Recovery Curves



The SSWL bump increases with occlusion time.

The final TEWL values are close to baseline TEWL (ie full recovery).

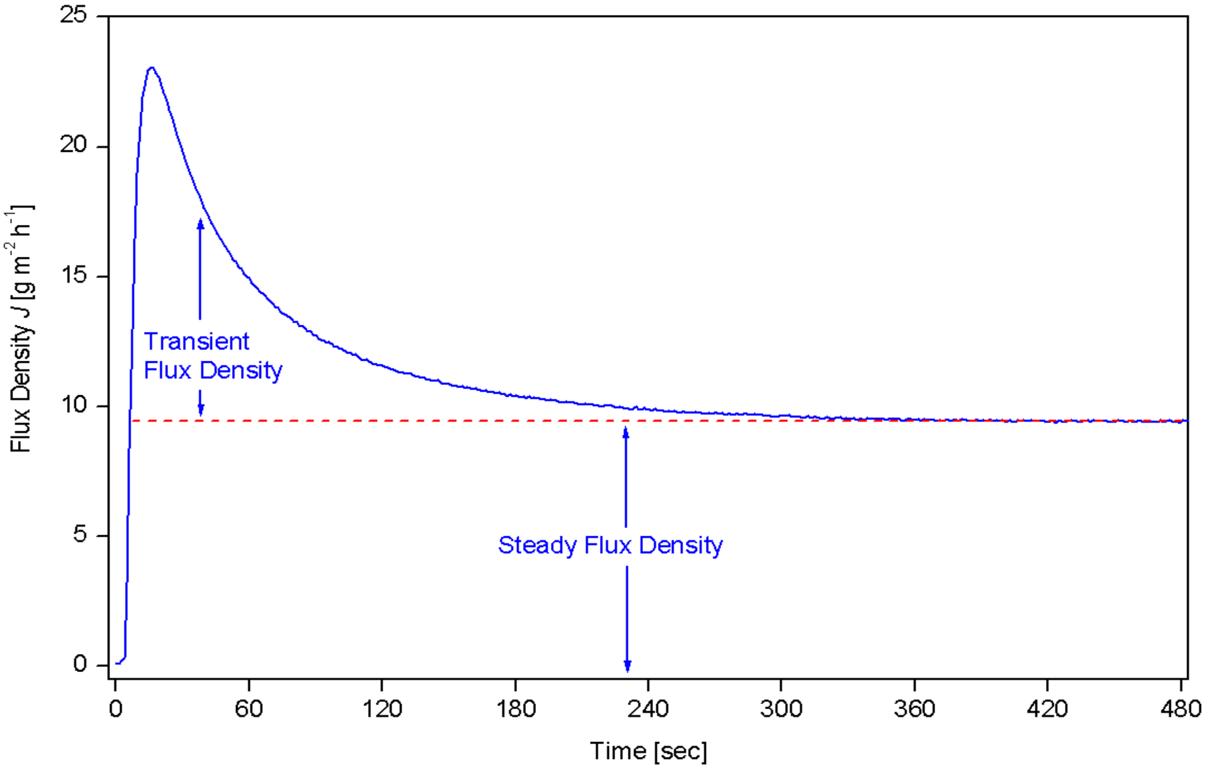
Steady-state Analysis 1: Final TEWL



Final TEWL calculated as average over final 20 points.

< Final TEWL > = (9.34 ± 0.18) g m^{-2} h^{-1},   CV = 1.9%

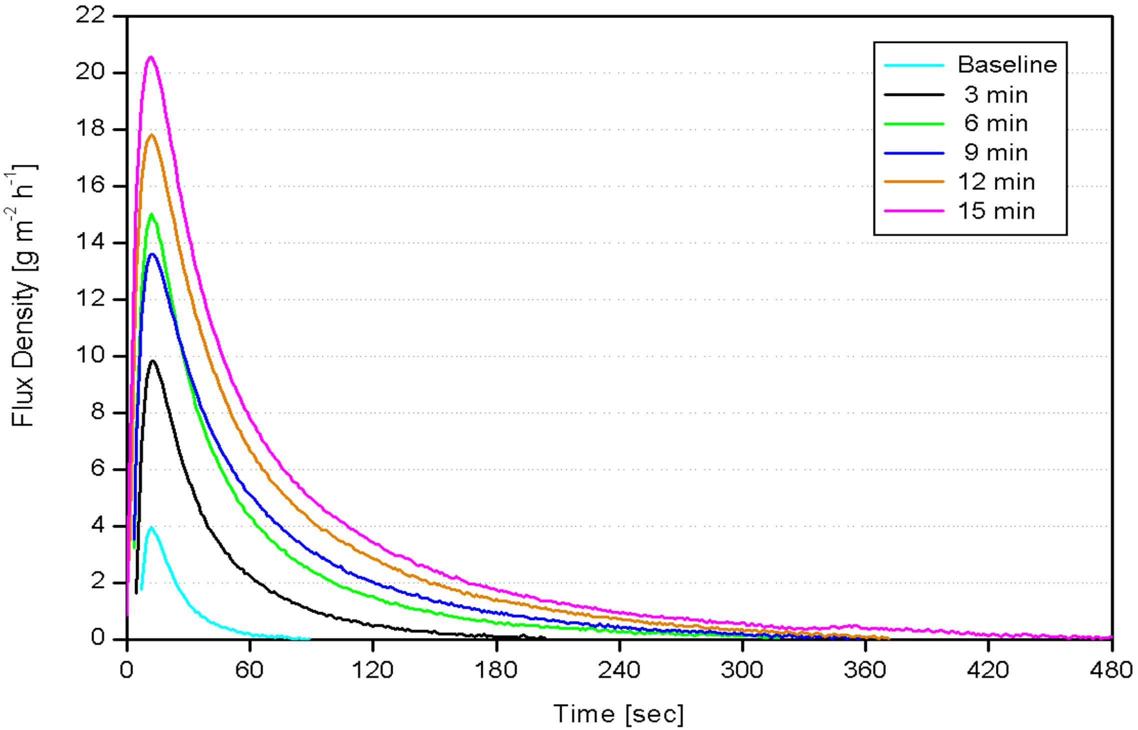
Separation of Steady & Transient Components



It is convenient to separate *steady* & *transient* components of flux density.

Subtract the *steady* component (= final TEWL) from all curves.

Transient Components



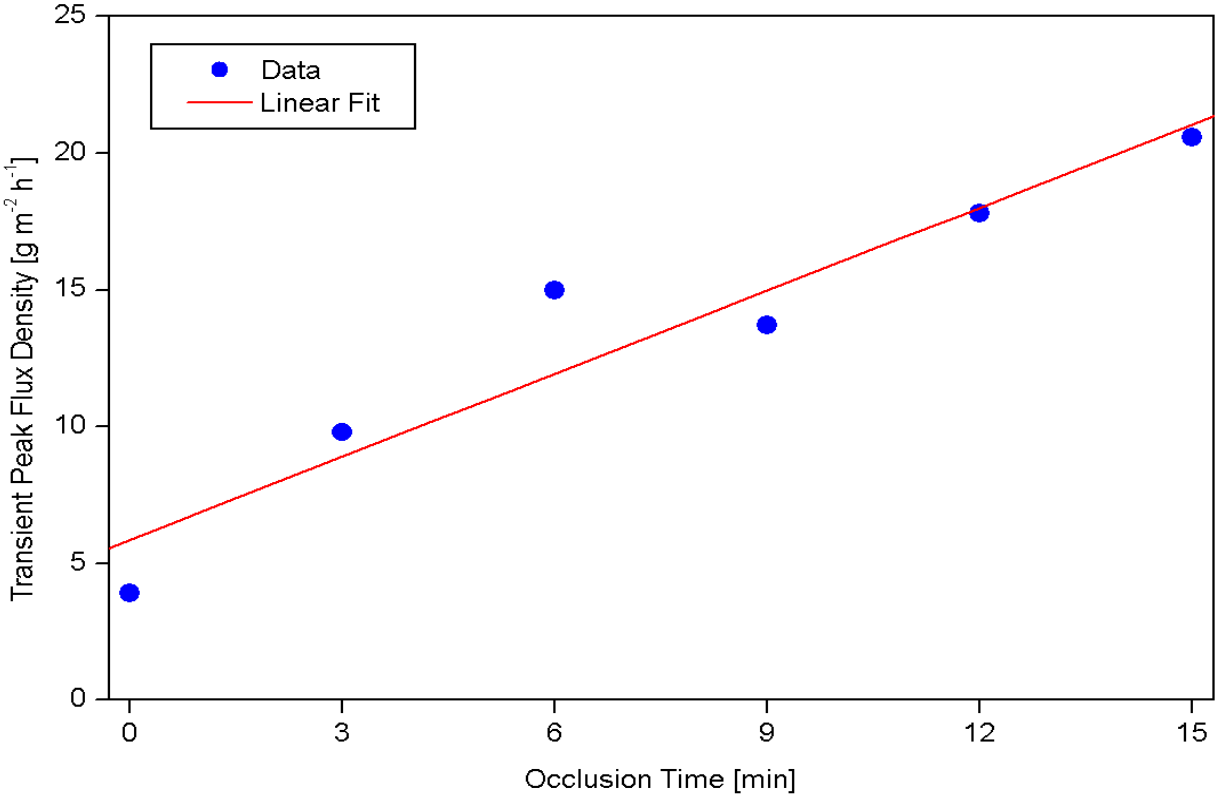
Now analyse the transient components of the flux curves:-

1. Peak flux density
2. Trapped water (SSWL)

From the areas, corrected for baseline SSWL.

3. Decay analysis

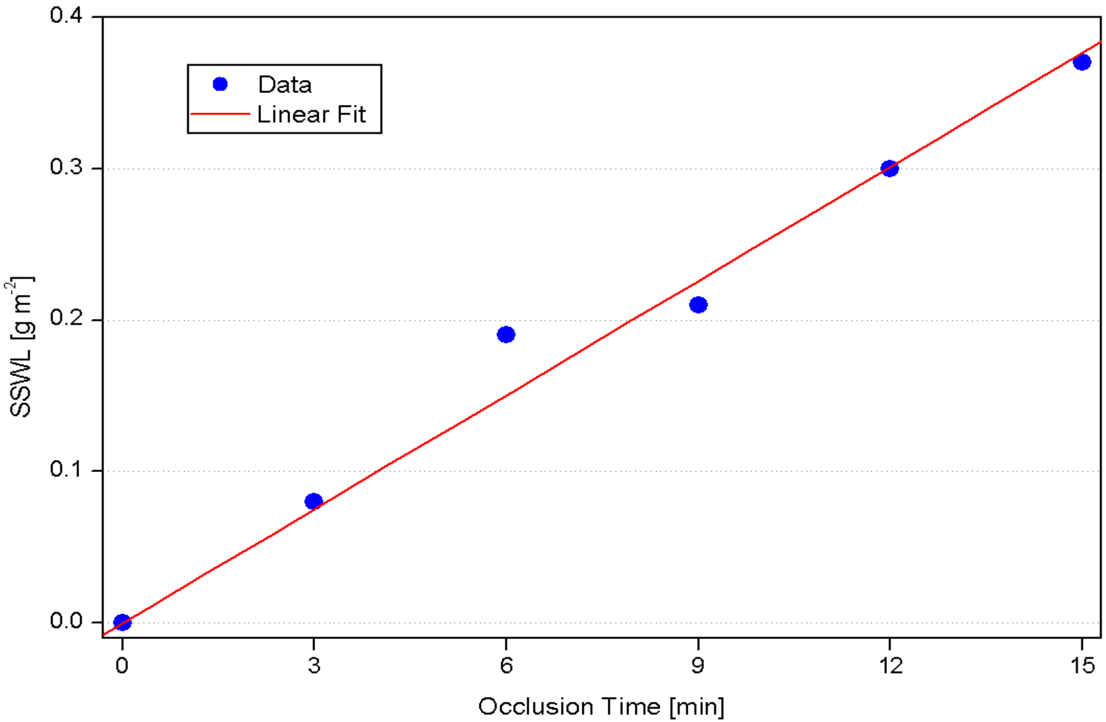
Transient Analysis 1: Transient Peak Flux Density



Linear fit gives a slope of (1.0 ± 0.2) g m^{-2} h^{-1} per minute of occlusion time.

Pearson Correlation Coefficient = 0.95.

Transient Analysis 2A: Trapped Water (SSWL)



Linear fit gives a slope of (0.025 ± 0.001) g m^{-2} per minute of occlusion time.

Pearson Correlation Coefficient = 0.99.

Transient Analysis 2B: Trapped Water (SSWL)

Water is trapped at a rate of ~1.5 g m^{-2} h^{-1} during occlusion.

This is ~17% of the unperturbed steady-state TEWL.

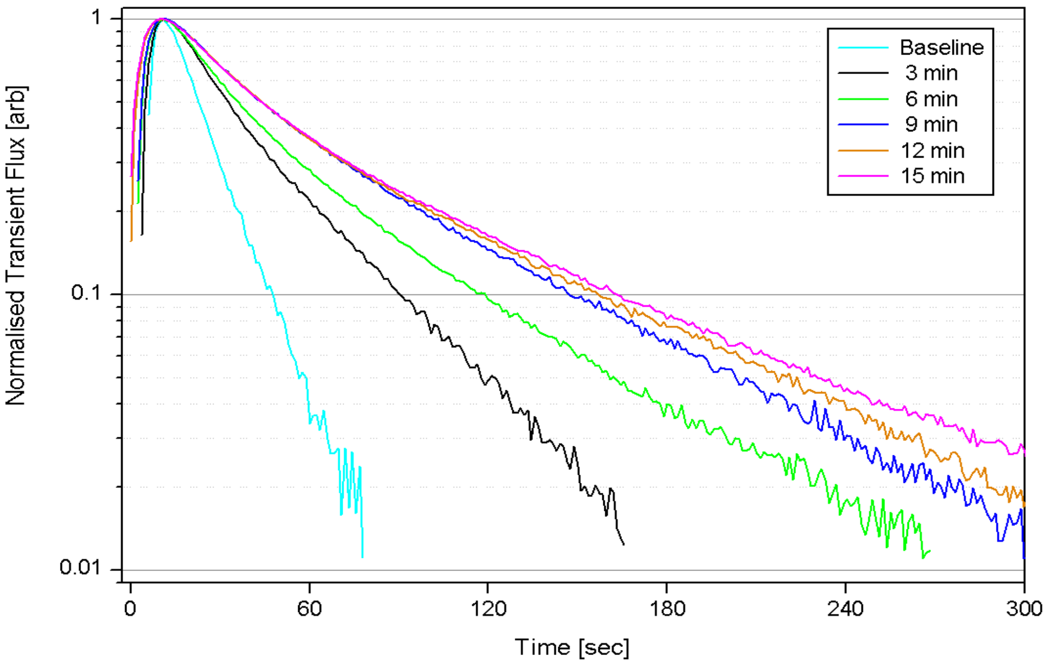
Silgel uptake accounts for <10% of the steady-state TEWL.

Why so little? Why so linear?

Transient Analysis 3A: Decay Analysis

There is no model (yet), so look for 1st order processes, ie exponential analysis.

A peak - normalised Log - Lin plot (below) is useful for visual inspection.



Normalised Log - Lin plot of **Slide 9** data.

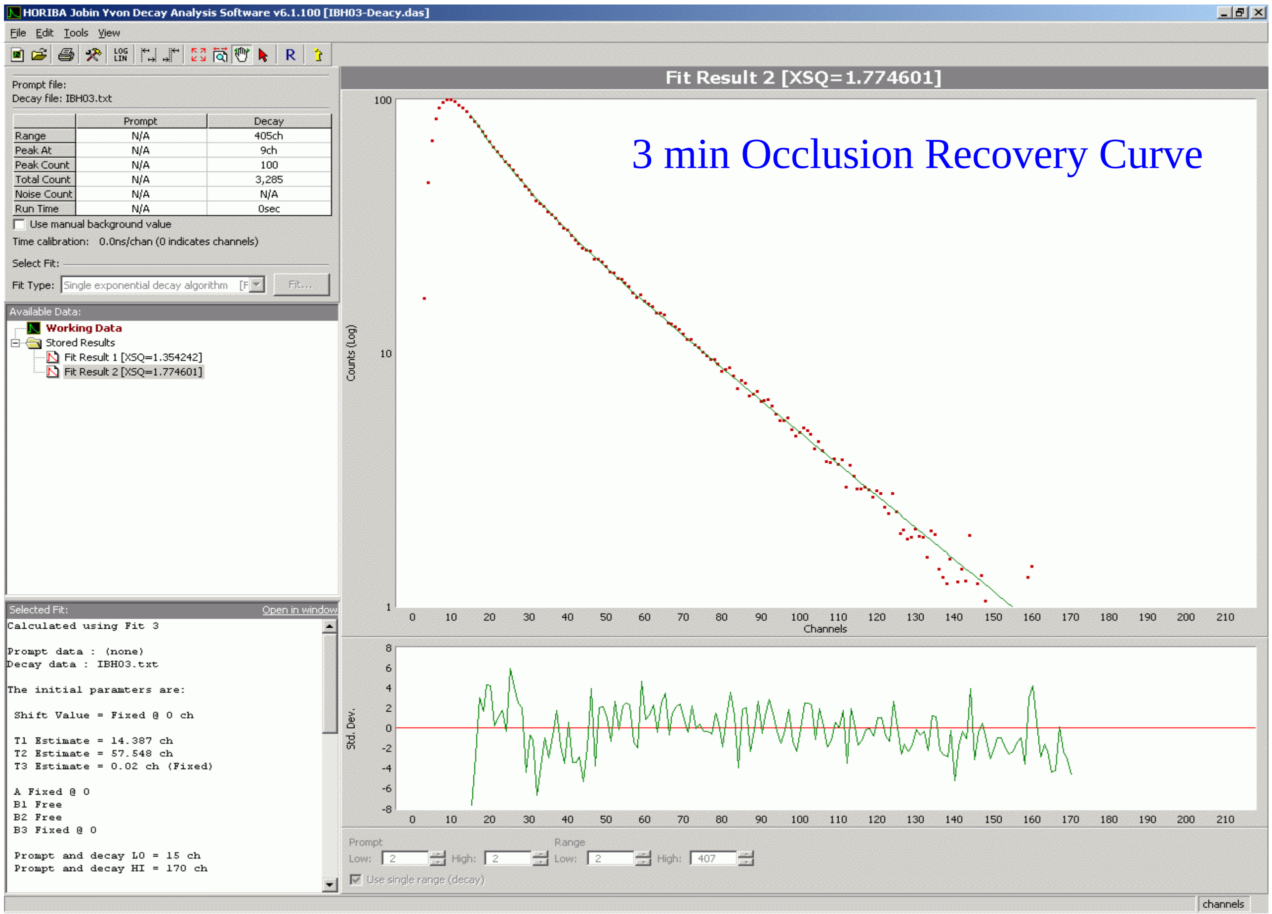
Baseline decay looks mono-exponential.

A 2^{nd} exponential component becomes increasingly apparent with occlusion time.

Data around the peak are distorted by the finite instrumental response speed.

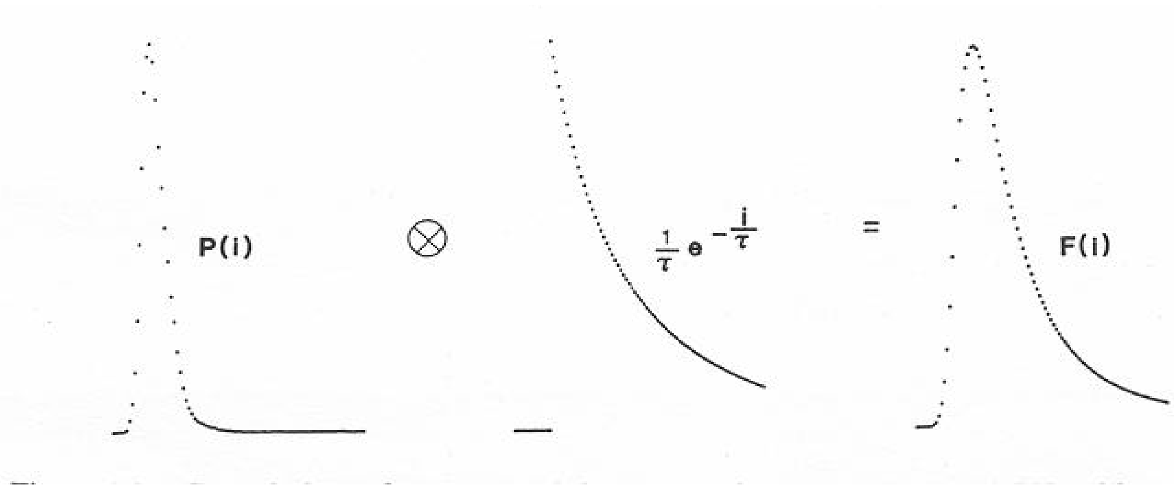
Transient Analysis 3B: Tail-fitting

Ignore the distorted data around the peak & fit the decaying tail only, eg:-



Reconvolution Analysis 1: The Method

Is it possible to fit around the peak by correcting for the distortion ?



P(i) is the instrumental **Impulse Response Function**.

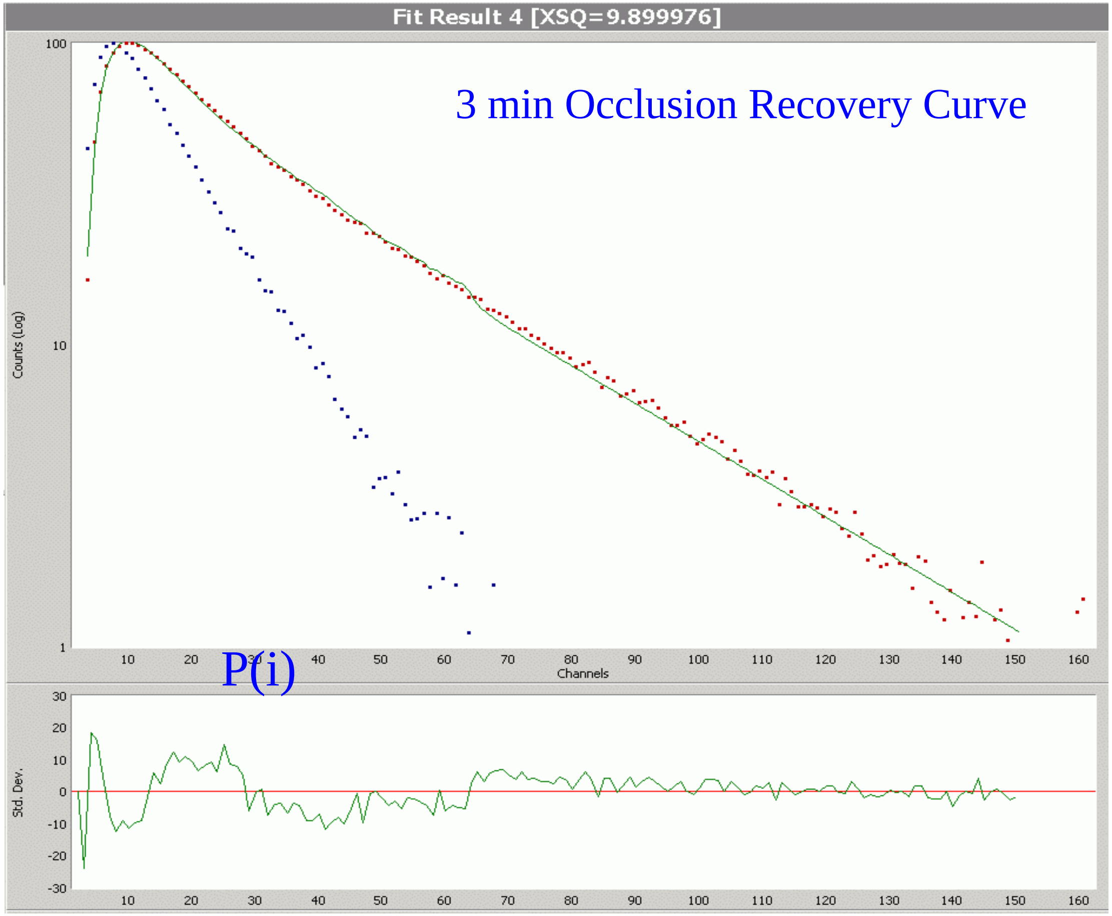
The model function in this case is a mono-exponential decay.

F(i) is the distorted model function that can be compared with the data.

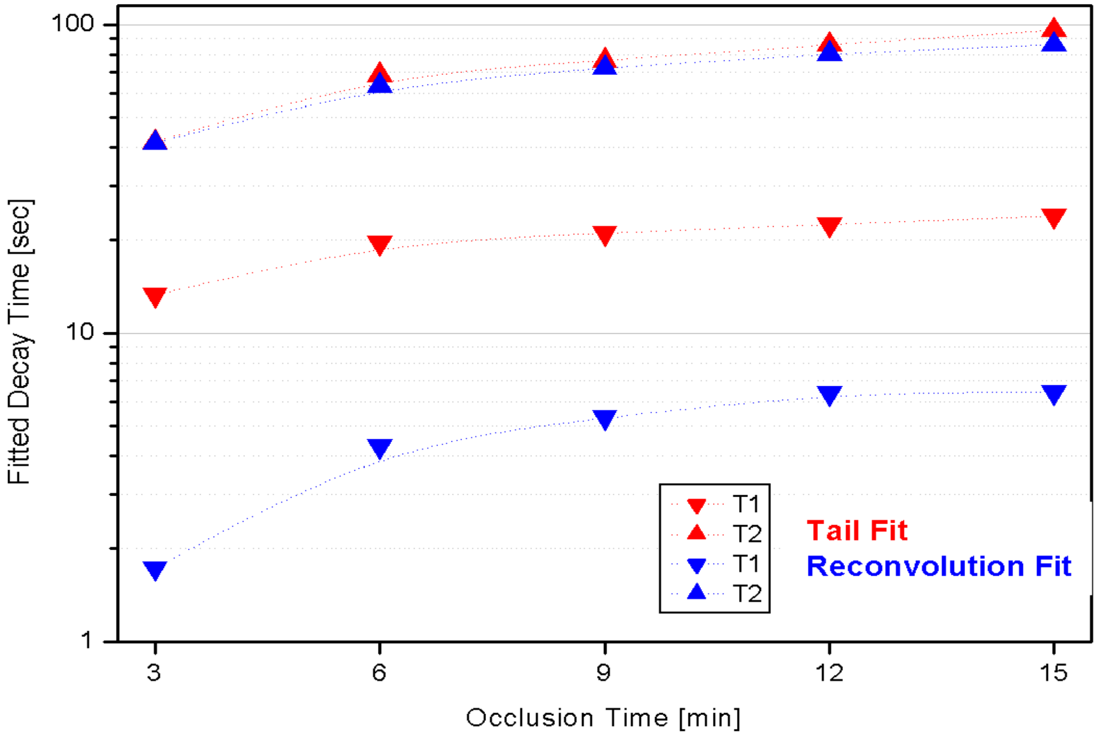
We used the transient component of the baseline flux curve for P(i).

Reconvolution Analysis 2: Example

The fit around the peak is "reasonable" but there are systematic deviations.



Reconvolution Analysis 3: Fitted Decay Times



The fitted parameters follow similar trends.

Reconvolution analysis gives faster decay times.

The effect is particularly pronounced with T1.

Summary & Conclusions

Reconvolution analysis gives faster decay times, as expected.

The effect is most pronounced for fast-decaying components.

However

The fitted decay-time trends are unaffected.

Therefore

The improved accuracy of the fitted decay times would be useful in the context of a meaningful occlusion model.

In the absence of such a model, it's not too exciting!

Acknowledgement

We thank IBH (a **Horiba Jobin-Yvon** company) for providing their reconvolution software on favourable terms (ie for free!).