

Epidermis Preservation and Mid-Dermal Damage

Using the Nidek 810 nm Diode Laser

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3 mm spot size was used

Pattern generator creating the largest square area with 20% overlap

Cooling Methods Used:

1. Cooling with the Window at Room Temperature (25 C)
2. Cooling with the Window at 5 C and waiting for thermal recovery between patterns
3. Cooling with the Blower at setting 6 as close as possible to skin surface, ~45° angle of incidence

We have previously shared with you problems with the window not maintaining 5 C during the laser irradiation. This can cause epidermal damage at lower fluences.

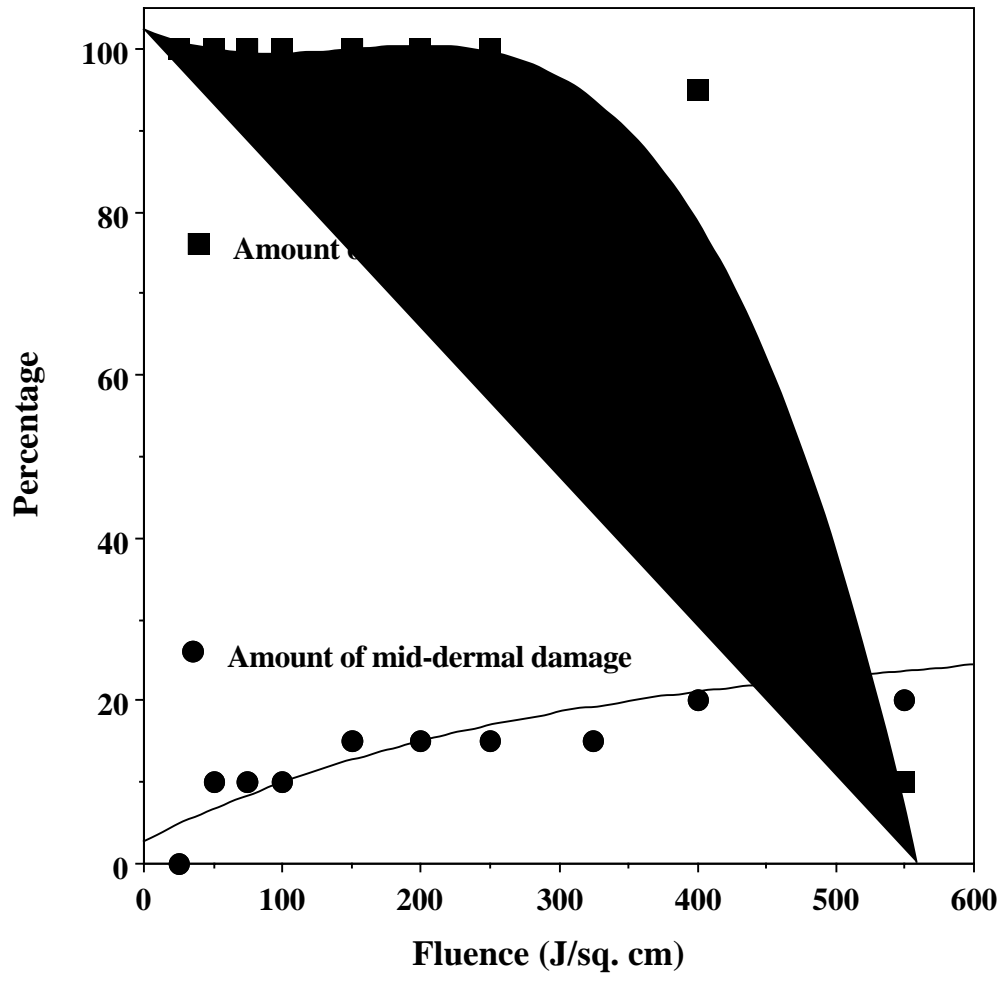
We have also previously shared with you the distortion of the skin by the blower. Also, on one day the blower was cold enough to create frost on the skin and caused hypothermic erytherma.

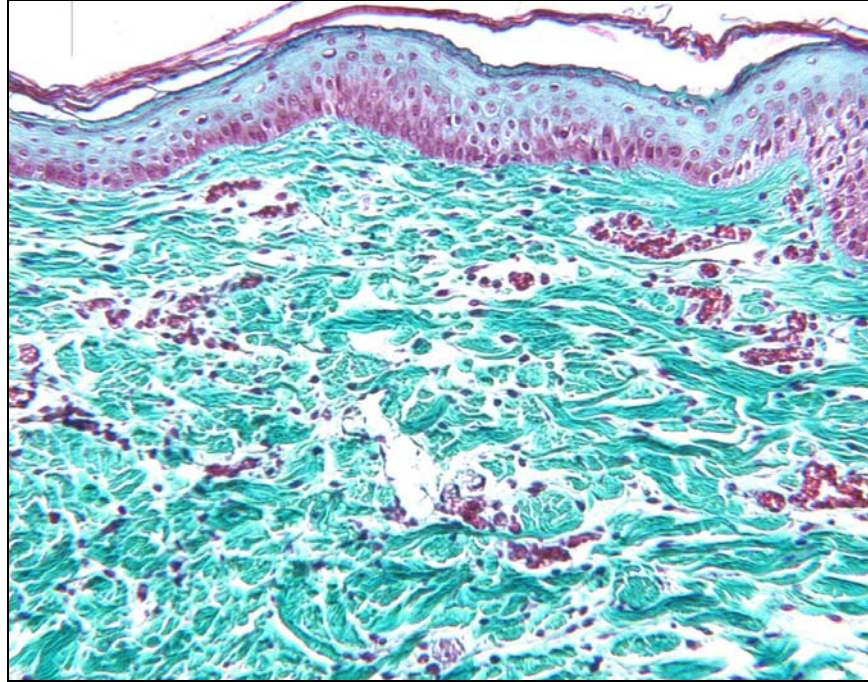
Threshold for Epidermal Damage

The thermal damage to the collagen in the mid-dermal region was quantified. This was plotted as a function of the fluence on the first set of figures. On the same figures, the amount of epidermal preservation was also plotted. These plots can be used to determine the optimal treatment fluence.

Protecting the skin with a Window at 25 C, the epidermis is fully preserved when the fluence is below 300 J/cm². A picture of an acute biopsy with a fluence of 250 J/cm² follows this plot. Note that the epidermis is fully preserved. There is a small amount of collagen damage in the mid-dermis. This occurs primarily to the collagen surrounding the hair follicles.

Window at Room Temperature (25 C)

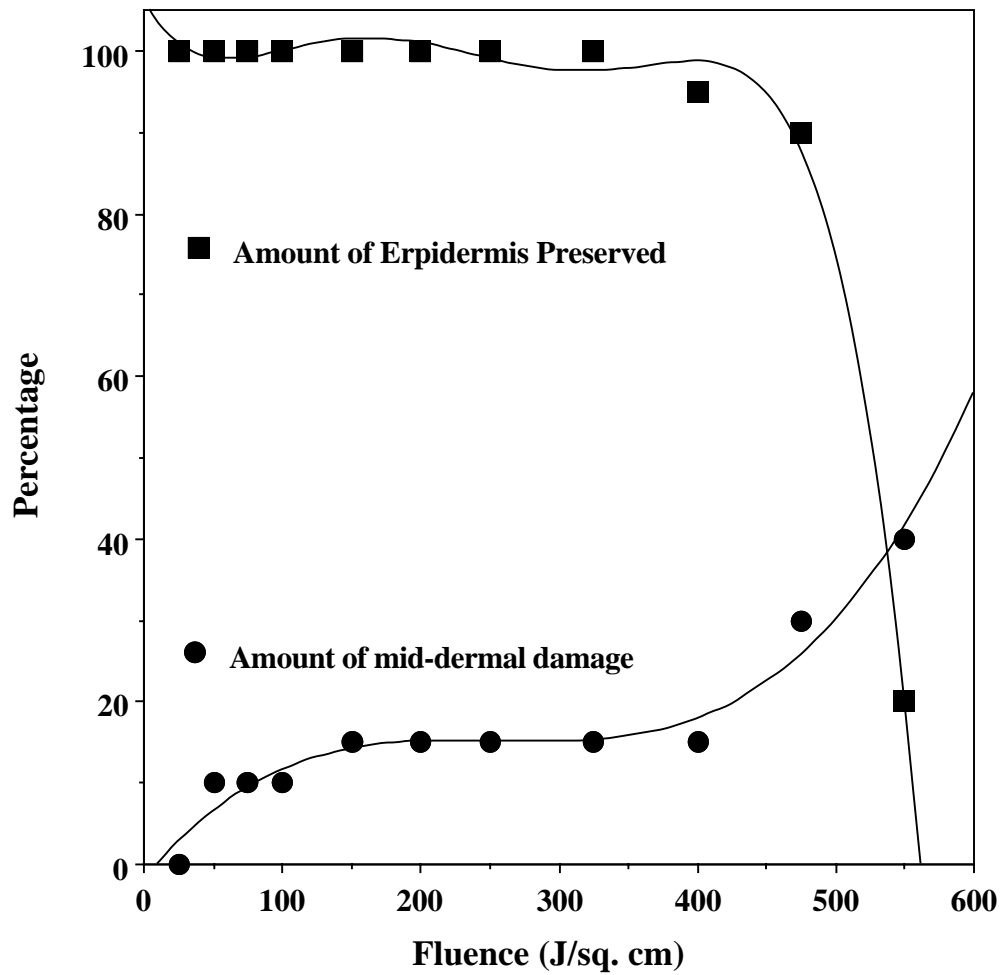




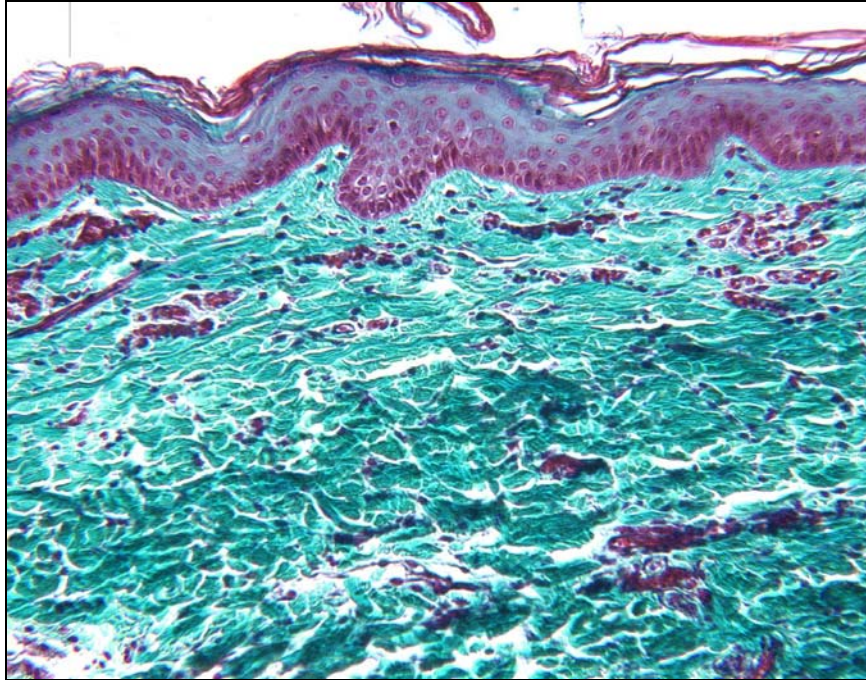
Acute biopsy of piglet skin, 250 J/cm² fluence, the surface was protected with a Window at 25 C. The epidermis was fully preserved

Protecting the skin with a Window at 5 C, the epidermis is fully preserved when the fluence is below 375 J/cm². A picture of an acute biopsy with a fluence of 350 J/cm² follows this plot. Note that the epidermis is fully preserved. There is a small amount of collagen damage in the mid-dermis. This occurs primarily to the collagen surrounding the hair follicles.

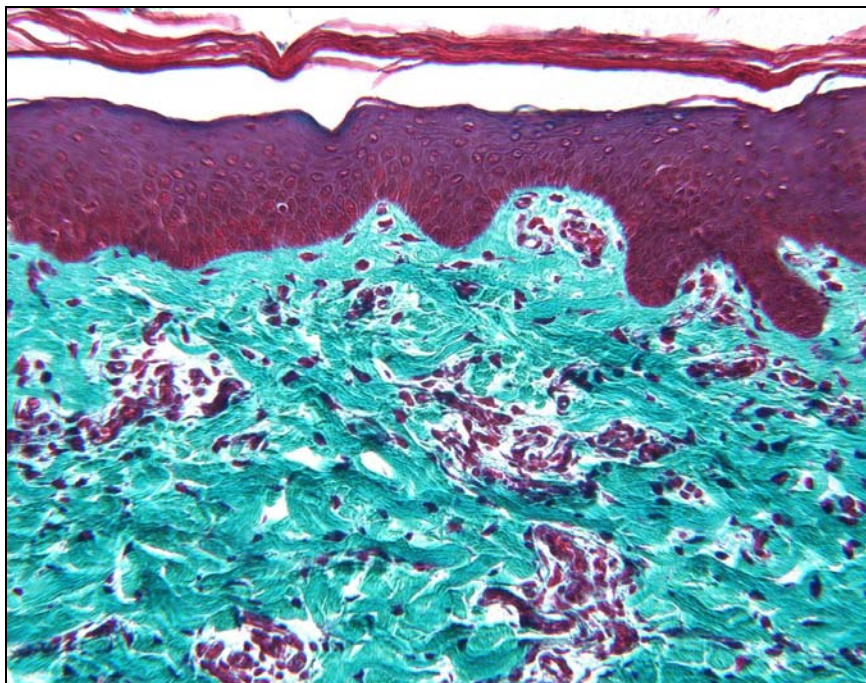
Window at 5 C



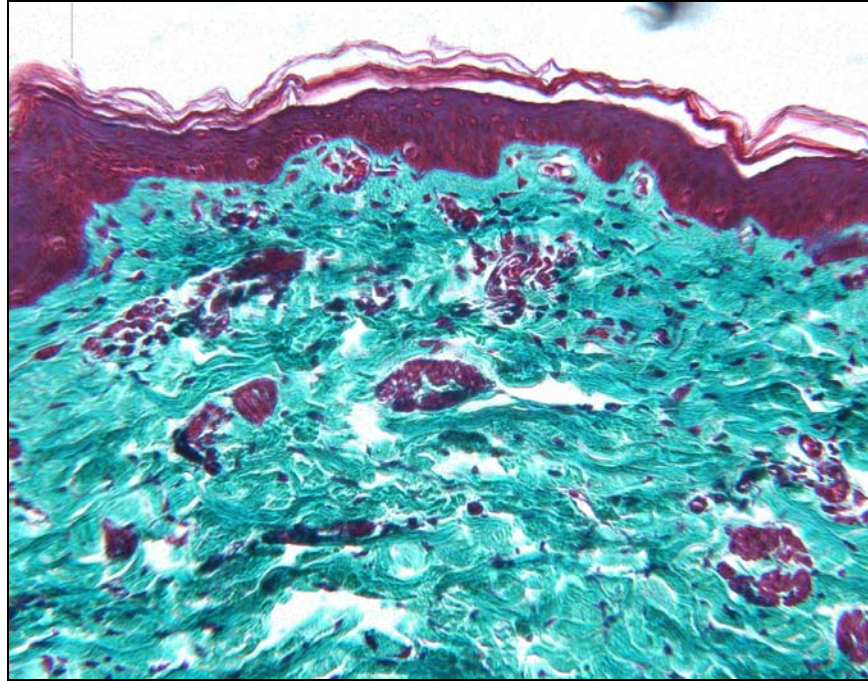
The piglet skin treated with 350 J/cm² and the surface protected with the Window at 5 C is also shown 7, 14 and 28 days after treatment. The epidermis does not slough during the healing process. By day 28, the skin looks normal.



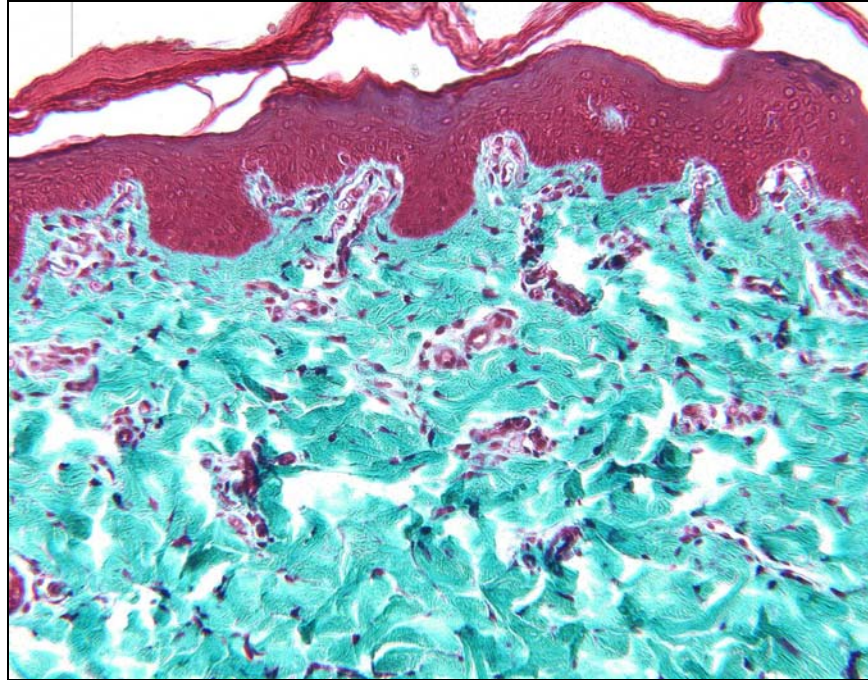
Acute biopsy of piglet skin, 350 J/cm² fluence, the surface was protected with a Window at 5 C. The epidermis was fully preserved



Day 7 after treatment, 350 J/cm² fluence, the surface was protected with a Window at 5 C. Collagen is regenerating, the epidermis remained intact.



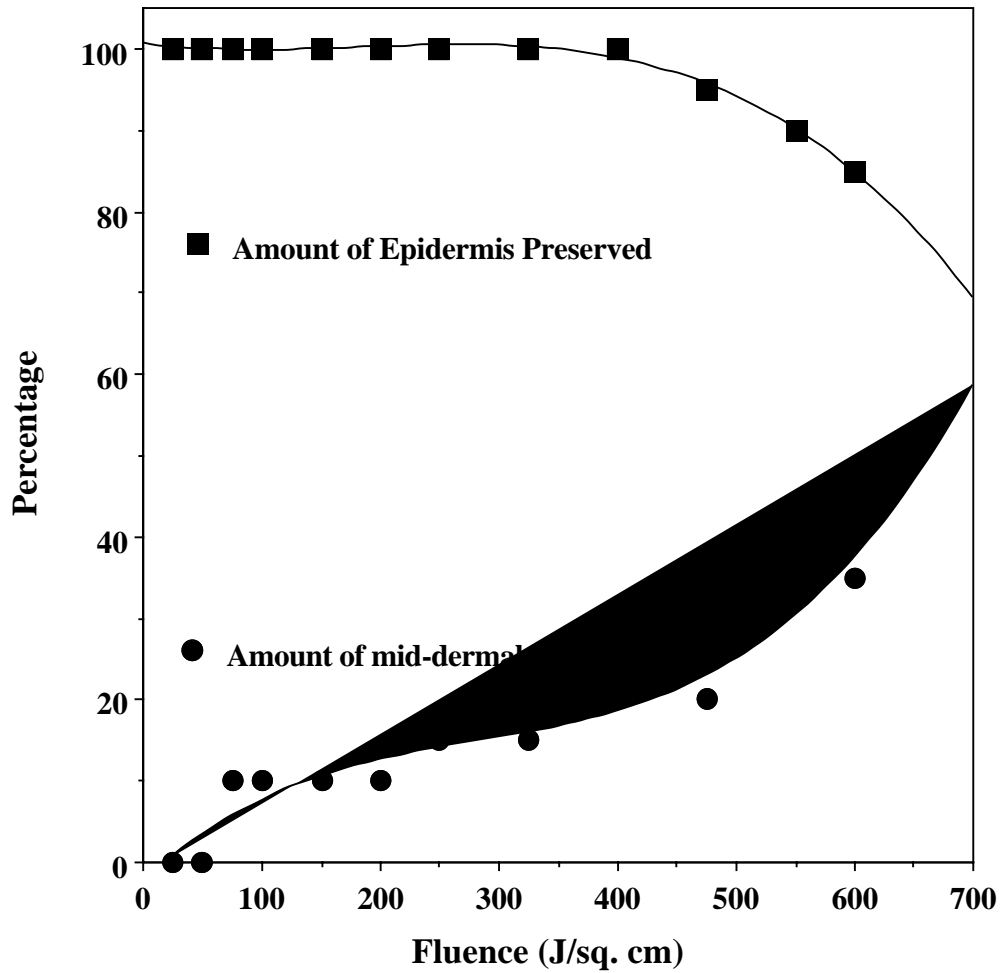
Day 14 after treatment, 350 J/cm² fluence, the surface was protected with a Window at 5 C. Collagen is replaced, the epidermis remains healthy.



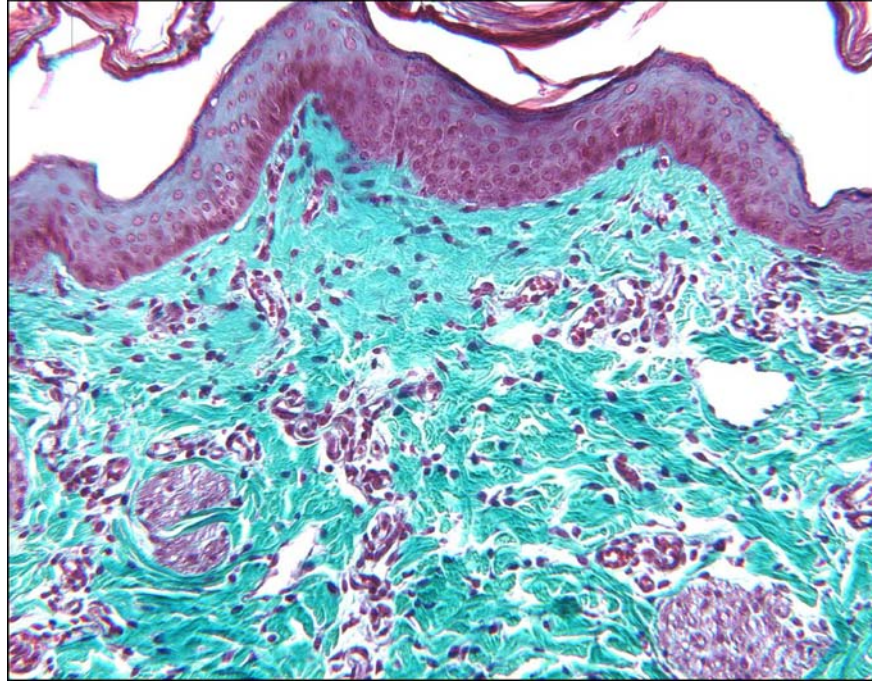
Day 28 after treatment, 350 J/cm² fluence, the surface was protected with a Window at 5 C. Skin appears normal.

Protecting the skin with a blower at a setting of 6, the epidermis is fully preserved when the fluence is below 450 J/cm². A picture of an acute biopsy with a fluence of 400 J/cm² follows this plot. Note that the epidermis is fully preserved. There is a moderate amount of collagen damage in the mid-dermis. This occurs primarily to the collagen surrounding the hair follicles.

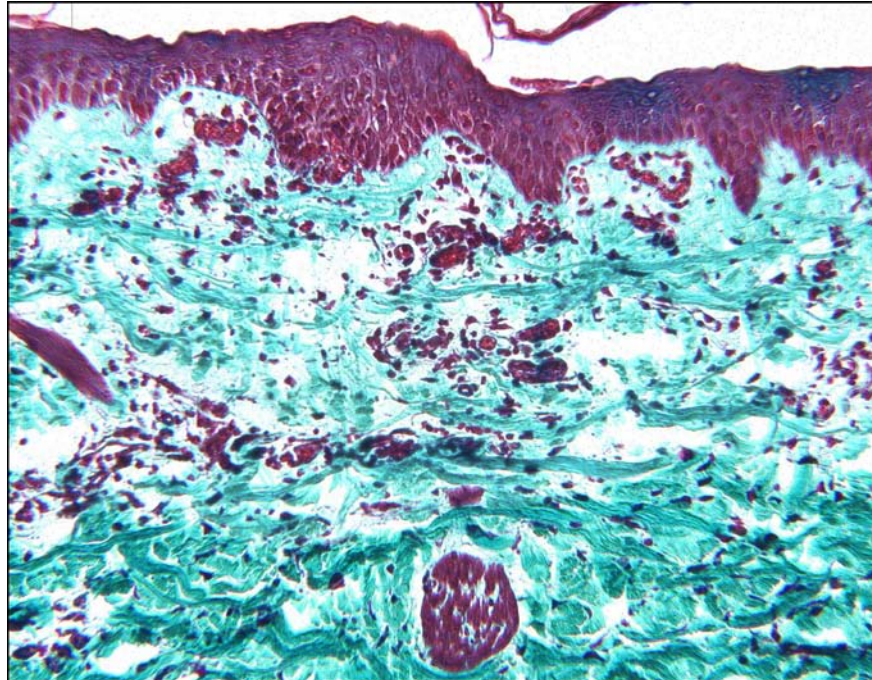
Surface Cooled with Blower



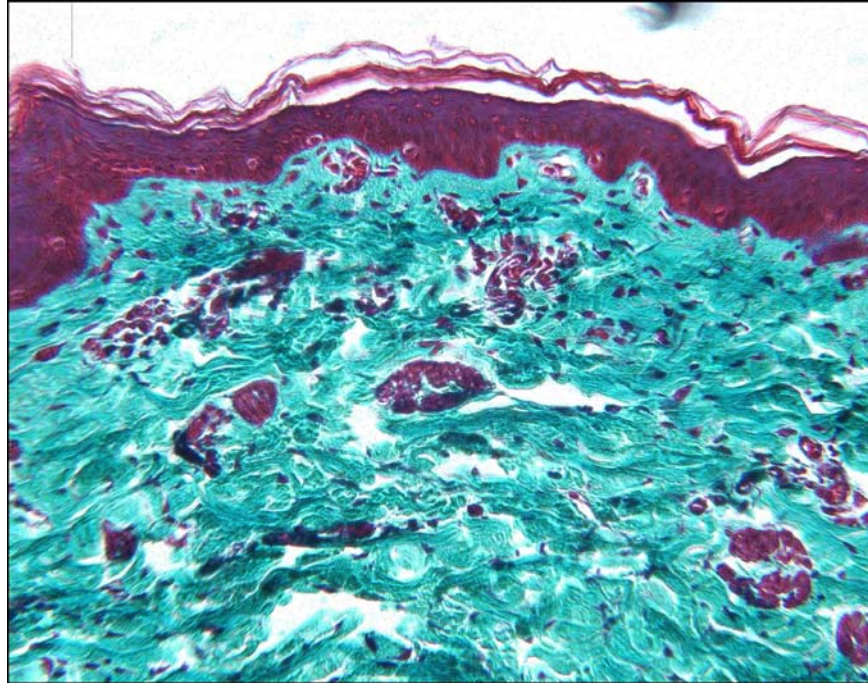
The piglet skin treated with 400 J/cm² and the surface protected with the blower is also shown 7, 14 days after treatment. The epidermis does not slough during the healing process. By day 28, the skin looks normal.



Acute biopsy of piglet skin, 400 J/cm² fluence, the surface was protected with the blower. The epidermis was fully preserved



Day 7 after treatment, 400 J/cm² fluence, the surface was protected with the blower. Additional blood vessels near surface. Collagen is regenerating, the epidermis remained intact.



Day 14 after treatment, 400 J/cm² fluence, the surface was protected with the blower. Collagen is replaced, the epidermis remains healthy.

Threshold for Epidermal Damage in Pigmented Skin

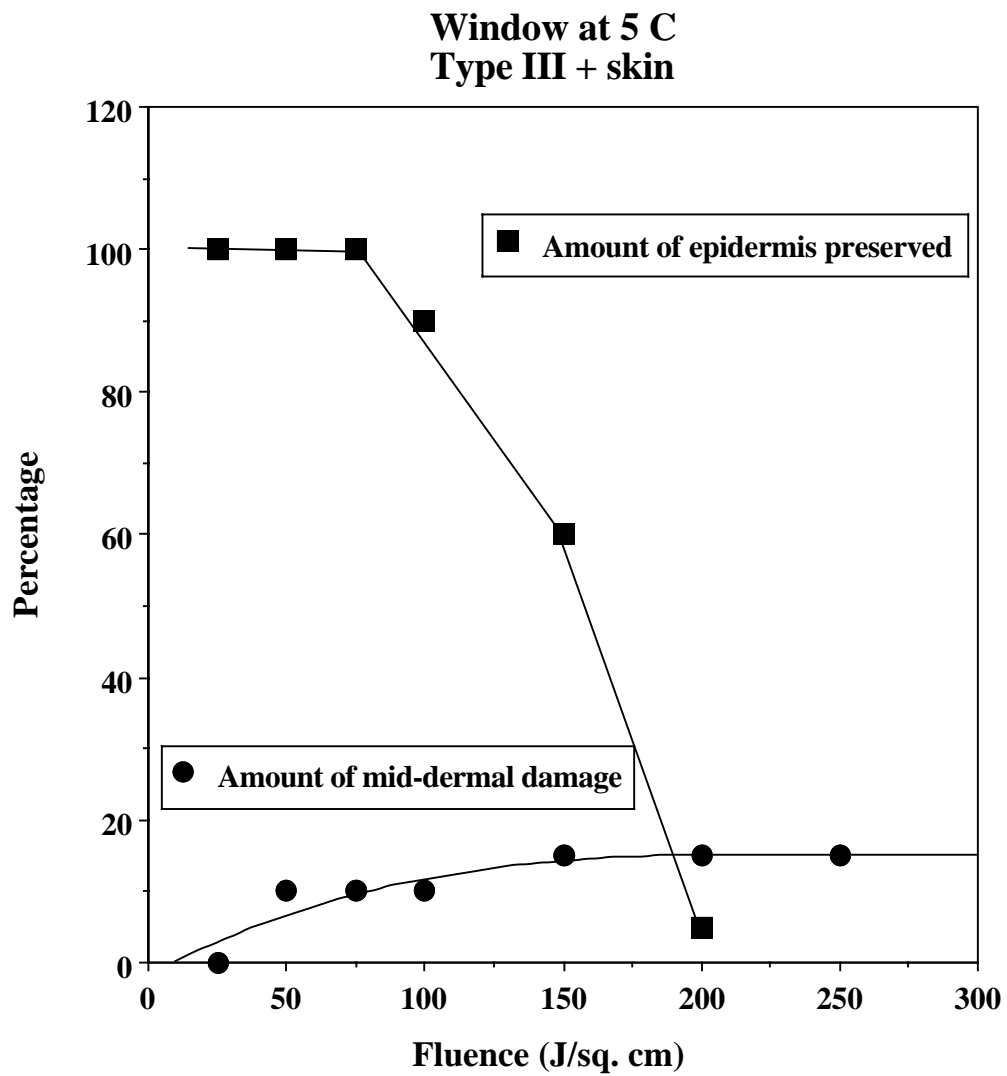
We also measured the threshold for epidermal damage in piglets with pigmented skin.

We show on the next two graphs the epidermal damage threshold for Type III + skin.

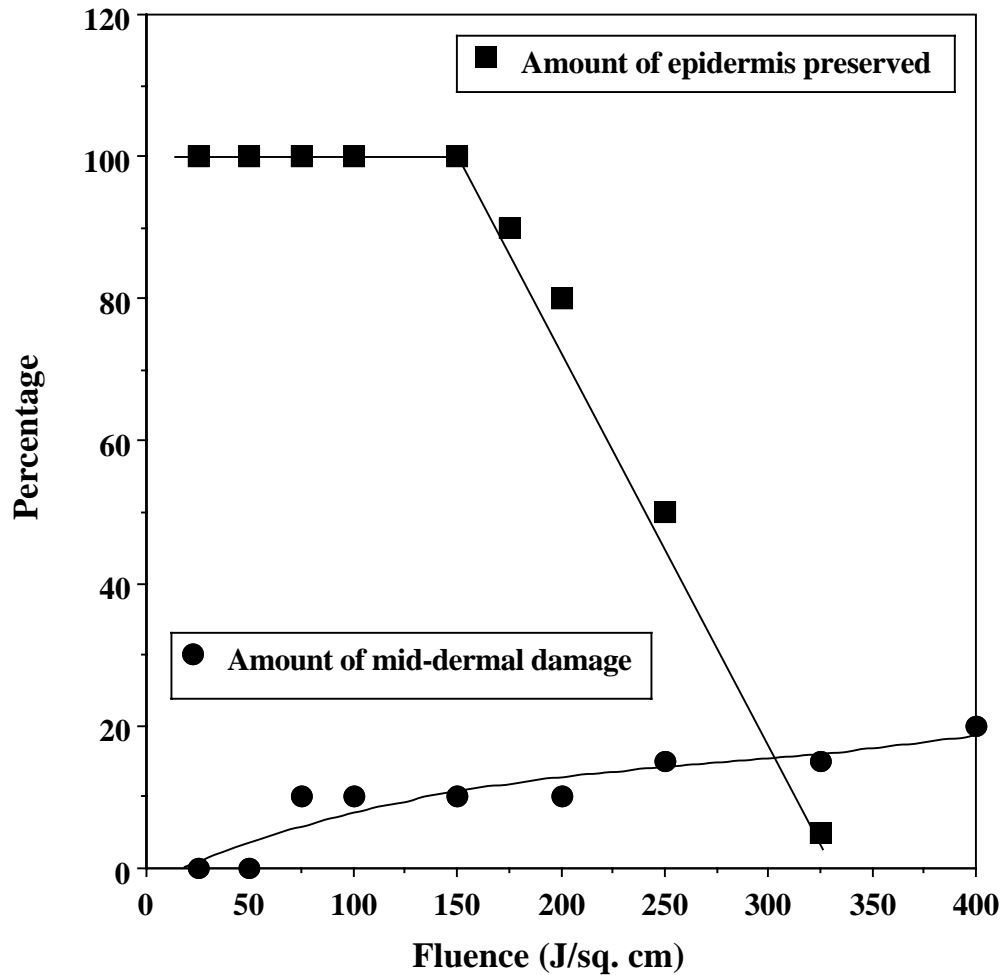
When the surface is protected with a Window at 5 C, the damage threshold drops to 75 J/cm². When the surface is protected with the blower, the damage threshold drops to 150 J/cm². These values are shown on the graphs and summarized in the Table below

Table I: Epidermal Damage Thresholds (in J/cm²)

	Window at 25 C	Window at 5 C	Blower
Type I skin	250	350	400
Type III+ skin		75	150



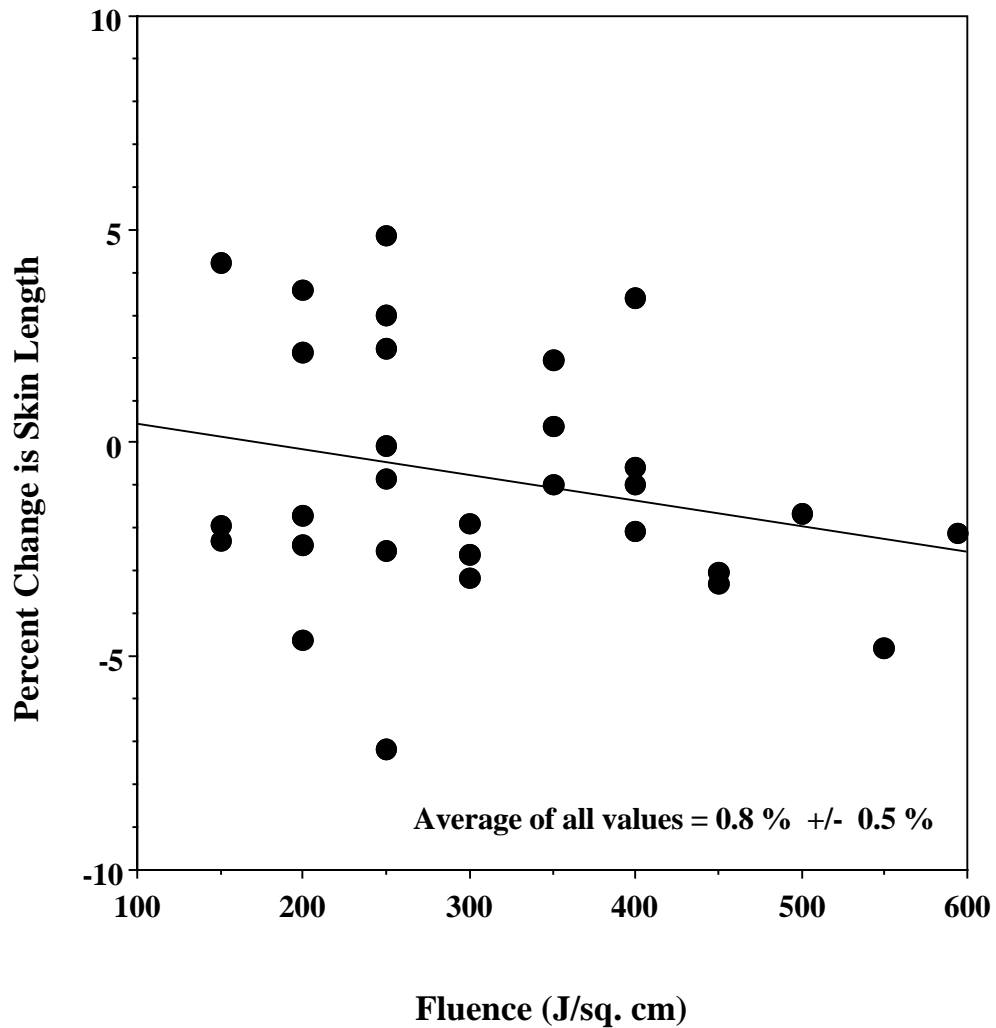
Surface cooled with blower Type III + skin



Evidence of Skin Remodeling

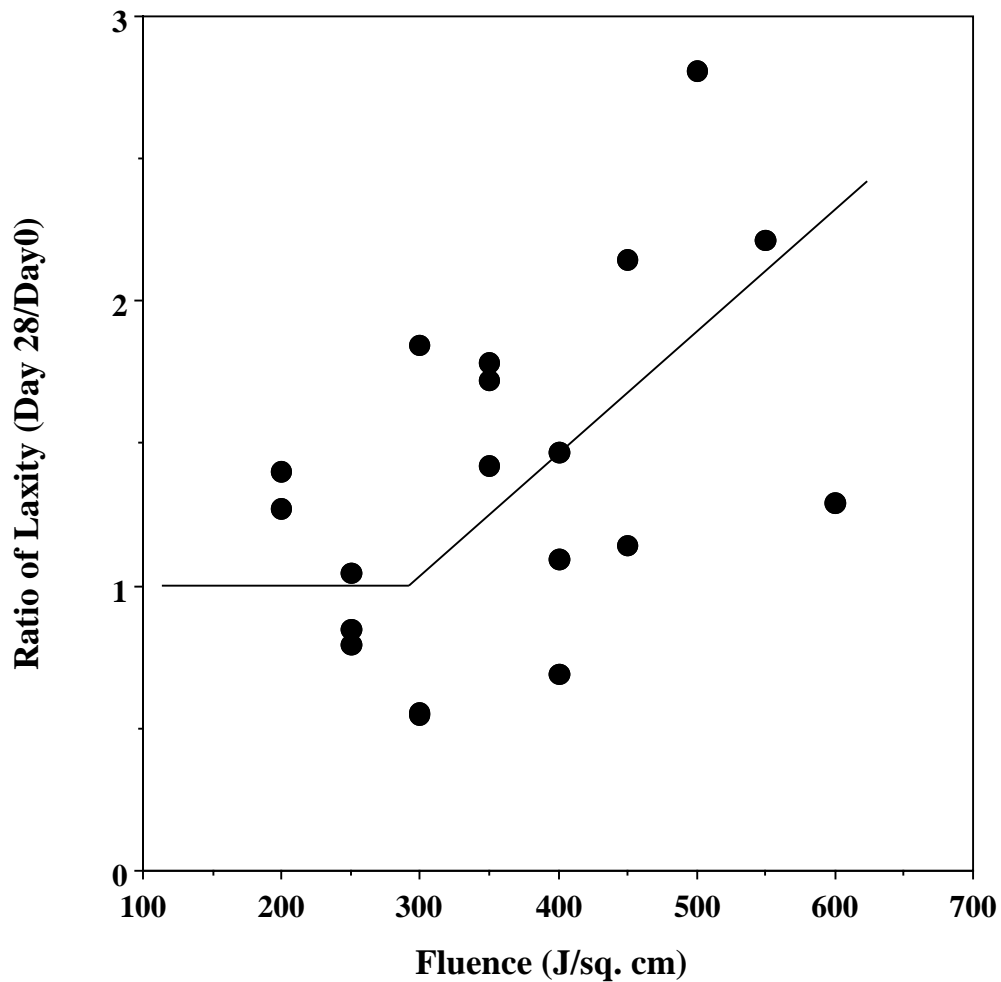
To gain evidence that these treatments could be used for non-ablative resurfacing, we measured the skin shrinkage. We marked the skin with a matrix of points and measured the distance between the points. We then treated the skin between the points and measured the distance again. We make ten measurements for each fluence and averaged these distances into a single percent change in length. The measurements were made for a range of fluences from 50 J/cm² to 600 J/cm². These values are shown on a plot of

Percent change in length versus the fluence. There is a trend for an expansion of the skin with higher fluence (not a contraction). This change is not statistically significant. The average of all points measured is a change in length of $0.8\% \pm 0.5\%$. This value is statistically not different from zero.



It is unknown, at this point why no contraction of the skin was measured.

We also measured the skin laxity or how much the skin stretches for small forces of pull. We measured the first time immediately after treating the skin with the laser and then after 28 days of healing. Measurements were made as a function of fluence and they are plotted on the final graph.



For the lowest fluences, the skin did not change. However, as the fluence increased the skin became more lax at 28 days. This means that the skin would stretch more with a given force of pull. This increase could be due to increased elastin generated by the

fibroblasts during the wound healing. It might also be due to a decrease in the amount of collagen in the skin, or that we have not waited long enough for the collagen to fully mature and cross-link. This change indicates that the laser does have an effect on the skin structure. More experiments are needed to determine the nature of this change.