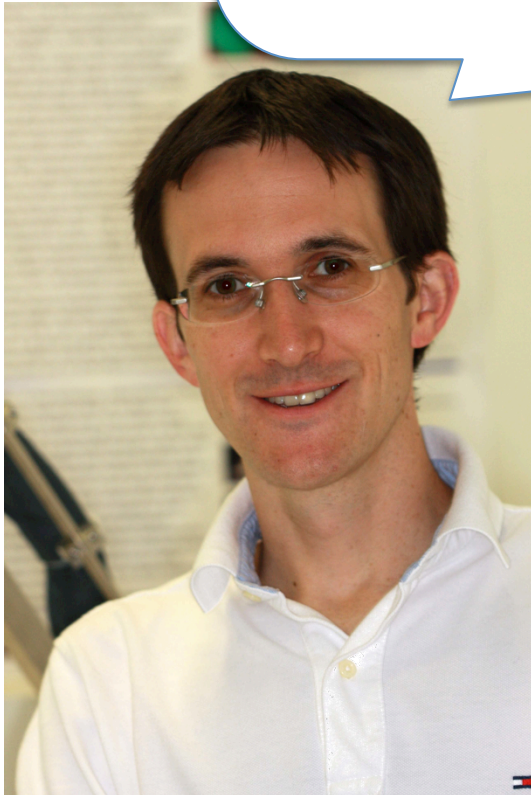




## **Cold atmospheric argon plasma significantly decreases bacterial load of chronic infected wounds in patients**

G. Isbary, W. Stolz, H.-U. Schmidt, T. Shimizu, B. Steffes, J. Zimmermann, W. Bunk, R. Monetti, S. Karrer, J. Heinlin, M. Landthaler, G. Morfill

**Repetitio est mater studiorum**  
"Repetition is the mother of  
study"



# Phase II study: MicroPlaSter

(ADTEC Plasma Technology Co. Ltd., Hiroshima/London)  
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# Chronic wounds in dermatology



Venous diseases



Arterial diseases



Infections



Diabetes mellitus



Carcinoma



Pyoderma gangraenosum

# Chronic Wounds

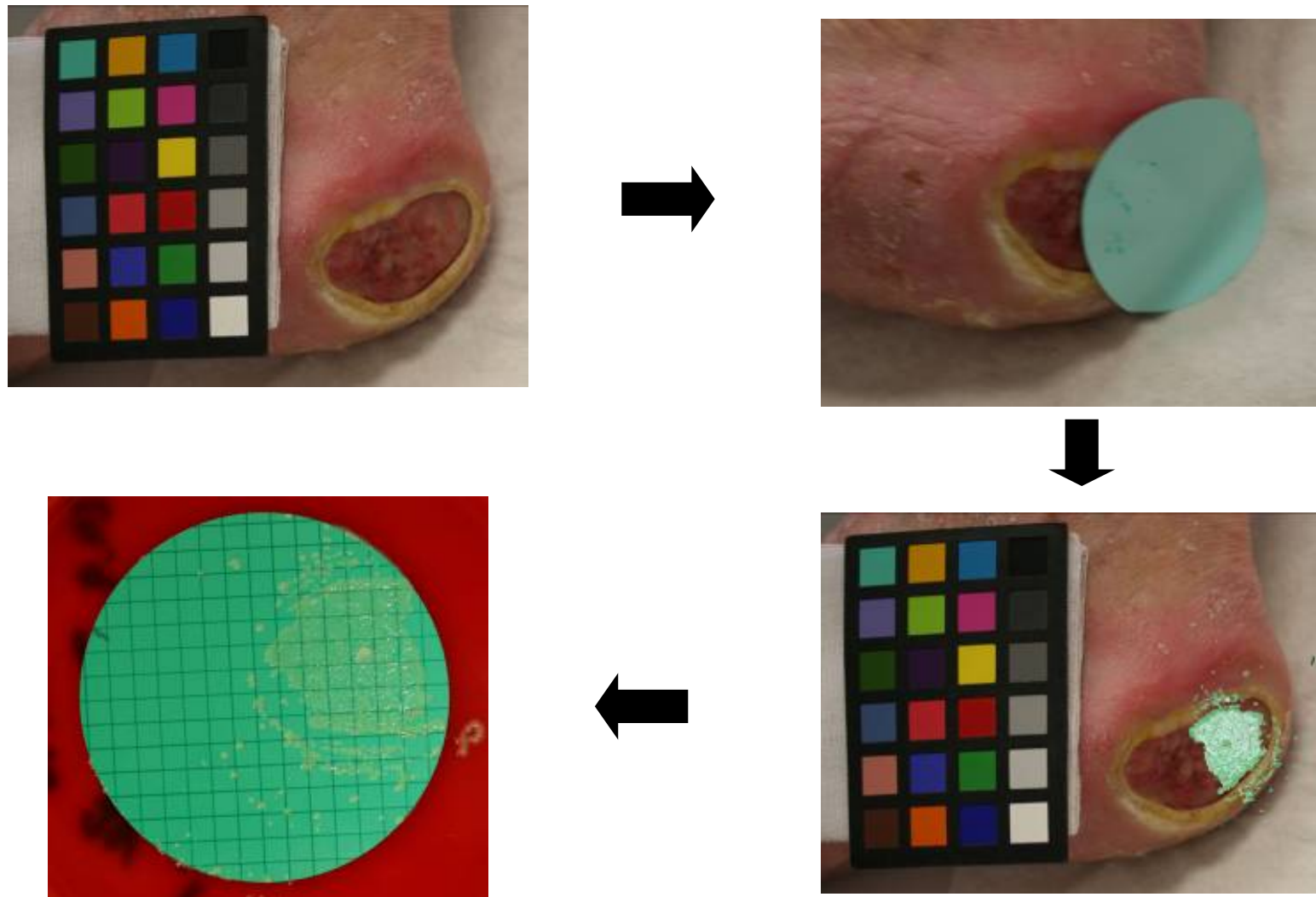
- Socioeconomic problem (high costs, high prevalence)
- Long and difficult treatment
- Problem: secondary infections
- Bacterial resistance, side effects
- Lack of new antibiotic agents

# Cold atmospheric plasmas are ideal antibiotics

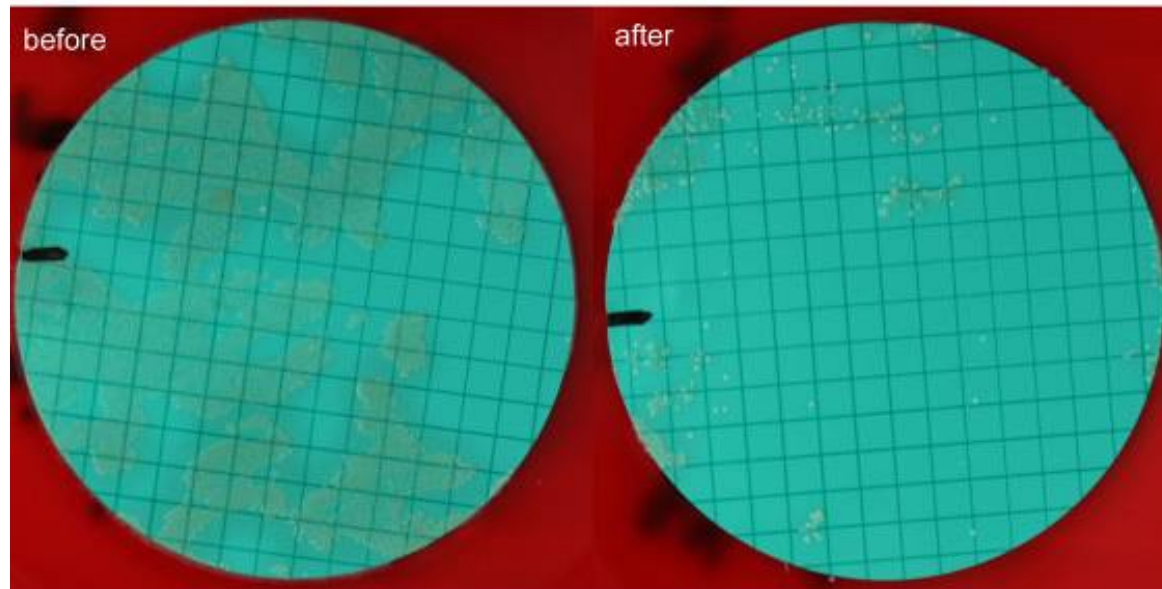
## **Low temperature argon plasma:**

- Allows in-vivo application, without damaging tissue
- Medical cocktail – can be tuned for different purposes
- Waste-free (only electricity required) and economical (running cost, maintainanance)
- Contact free application, reaches “rough” surfaces down to micrometer scale
- Bactericidal (fungicidal and virucidal)
- Physical-therapy → Resistance and allergic reactions are less feasible
- Enhanced wound healing

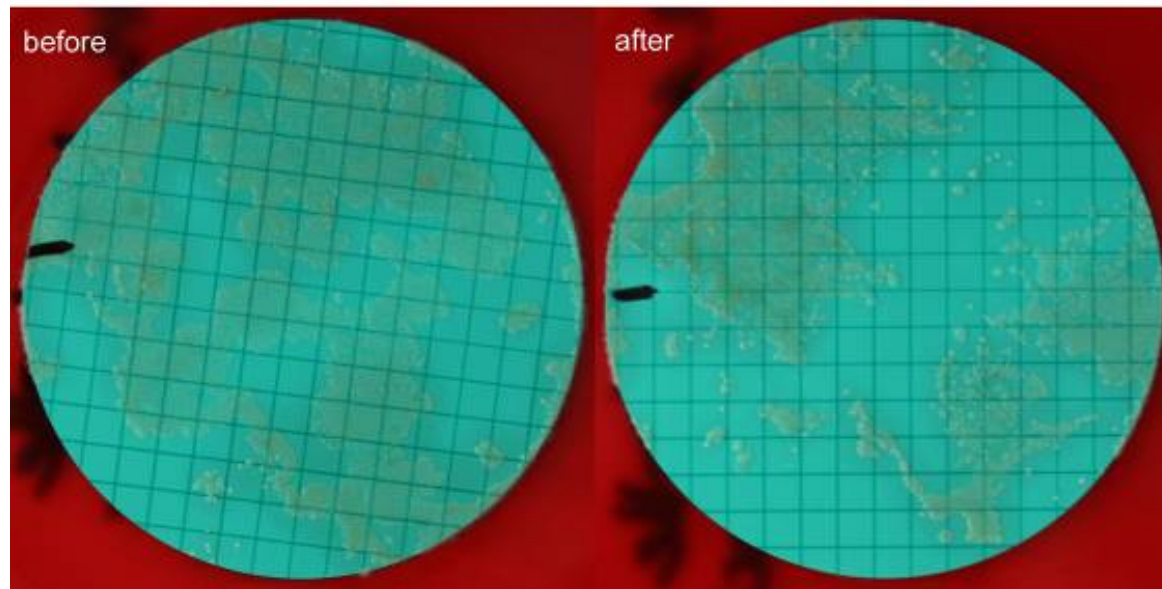
# Nitrocellulosis filters revealed a higher accuracy and reproducibility



### MRSA before and after plasma treatment



### MRSA before and after control

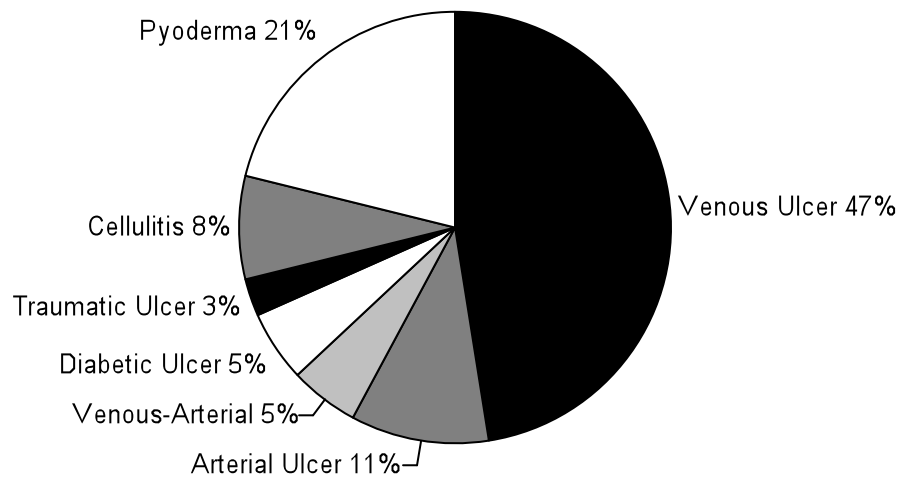




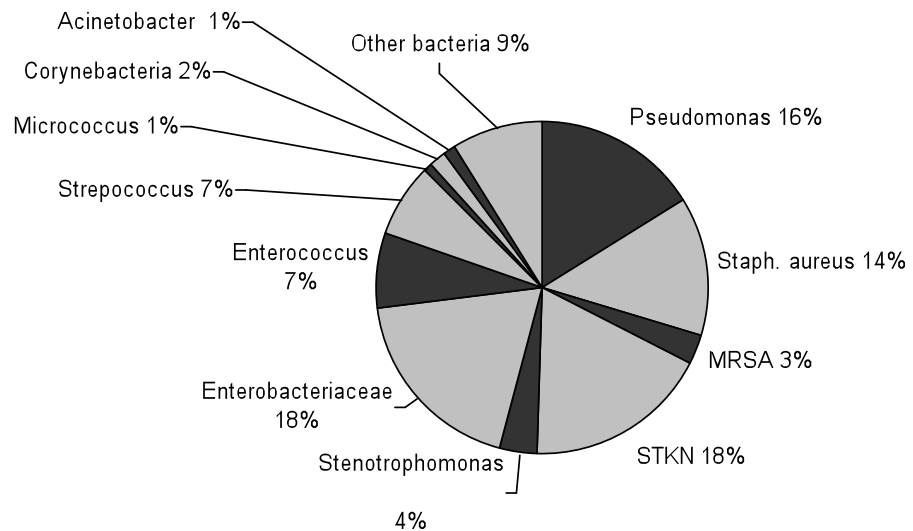
# Interim analysis (efficacy of plasma treatment)

- 36 patients
- 291 treatments
- 5 min treatment time
- Primary aetiology of wounds: venous ulcers (47%)
- Filter taken before and after treatment

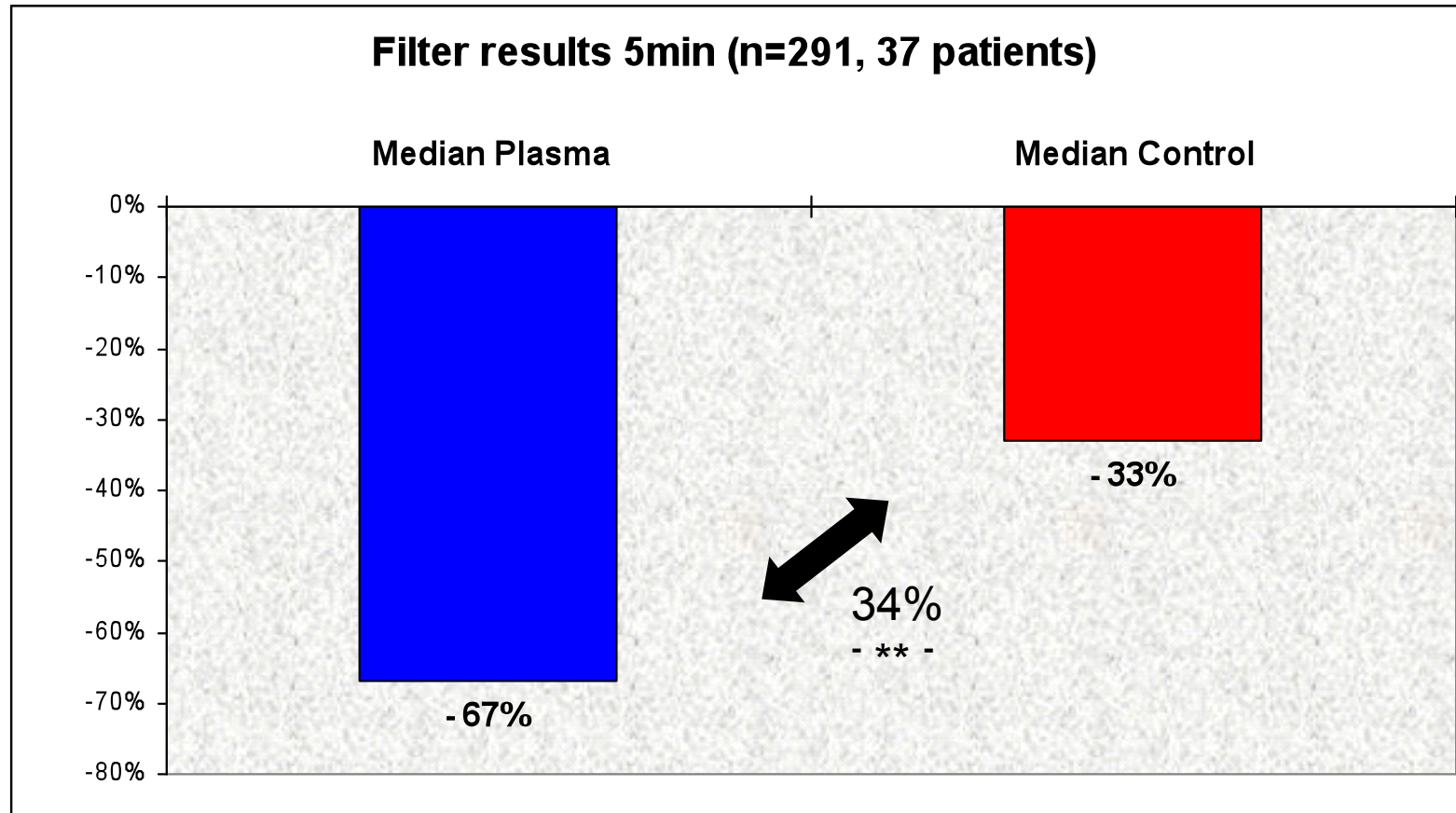
### primary aetiology of ulcers



### Germs located on wound



# Results: 5 min treatment time



Highly significant ( $p < 10^{-6}$ ) higher germ reduction (34%) in plasma treated area

# Interim analysis (efficacy of plasma treatment)

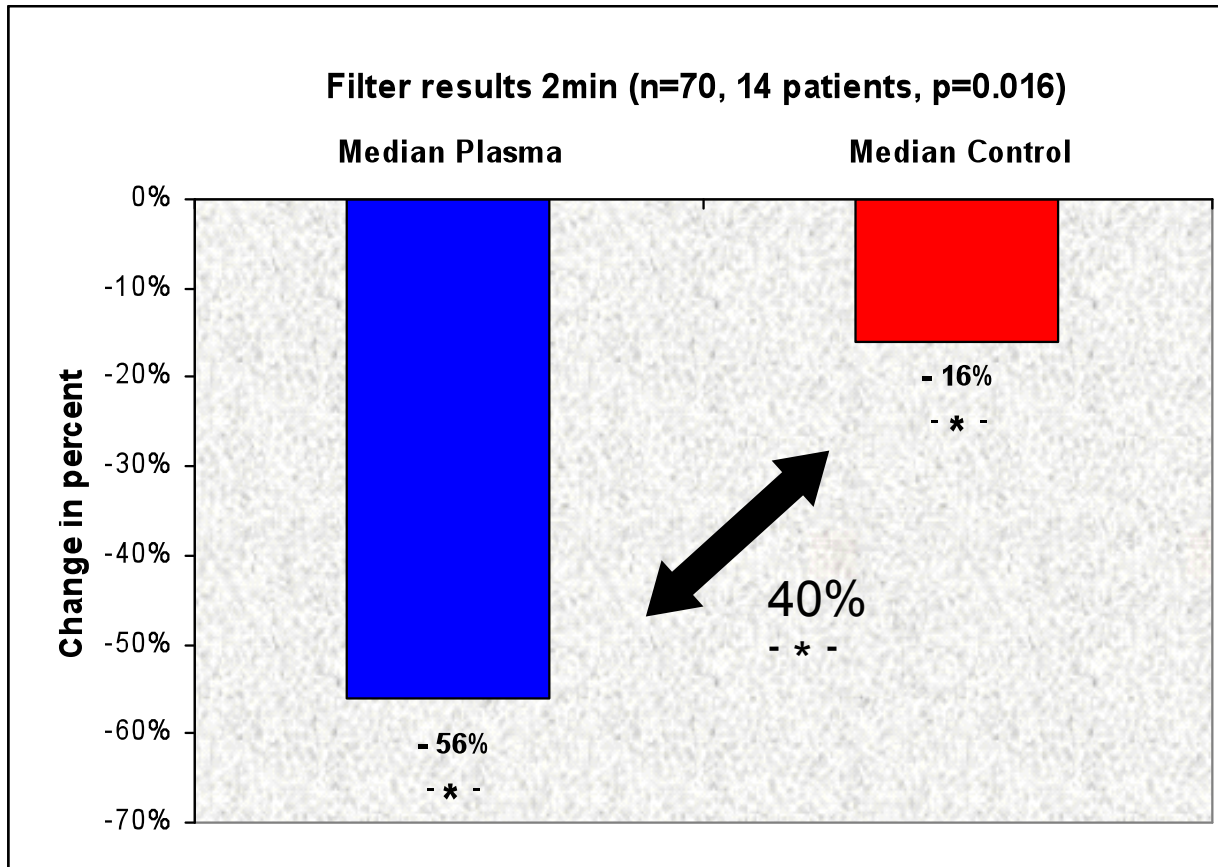
- 14 patients
- 70 treatments
- 2 min treatment time
- Filter taken before and after treatment

# Background of treatment time reduction: UV-measurements of argon plasma

- There are no regulations and studies about long-term effects of plasma treatment
- We do produce UV, and to some parts UVC as well, which is known to be carcinogenic

To have a „safe“ distance to the WHO limits and european recommendations we decided to reduce treatment time to 2 min

# Results: 2 min treatment time



Significant ( $p < 0.016$ ) higher germ reduction (40%) in plasma treated area

# Faster wound healing due to plasma therapy?

Very difficult part to measure/evaluate the wound size and changes

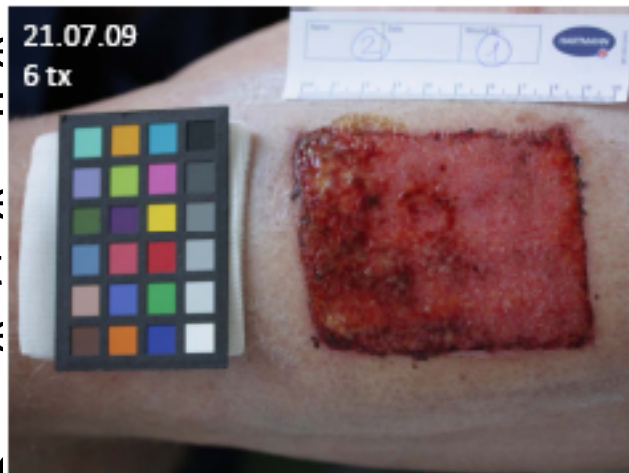
Data in progress, BUT:

Possible faster wound healing due to first „impressions“ of an interim analysis with mesh grafts

Keratinocytes: induce VEGF

Fibroblasts: induce inhibit induce

reduced IL-6, IL-8, IL-10, IL-15



FGF, GM-CSF, 4

(treatment time)

(treatment time)

x, IFN $\gamma$ , MMP1,

)

# Results

- A highly significant (34%,  $p < 10^{-6}$ ) higher germ reduction in 5 min plasma treated area vs. control area
- A significant (40%,  $p = 0.016$ ) higher germ reduction in 2 min plasma treated area vs. control area
- No side effects occurred until now, and the treatment is well tolerated
- The use of nitrocellulosis filters revealed a higher accuracy and reproducibility than common swab techniques



# Hailey-Hailey Disease

- syn: familial benign chronic pemphigus
- autosomal dominant inherited skin disorder
- mutation in the *ATP2C1* gene on chromosome 3q21.1
- characterized by suprabasal acantholysis and leads to recurrent erosive and oozing skin lesions in intertriginous areas especially in summer periods and during sudatory work
- problem: frequent secondary infections
- Topical treatment: disinfectants, corticoids, antibiotics, antifungals, immunosuppressive

03.05.2010

axilla before

14.05.2010

axilla after 8 plasma treatments

03.05.2010

ledge before

07.05.2010

ledge without treatment

10.06.2010



10.06.2010



14.06.2010



axilla after 4 plasma treatments

25.06.2010



axilla after 11 plasma treatments

14.06.2010



ledge after 4 plasma treatments

25.06.2010



ledge after 11 plasma treatments





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