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## ESTIMATION OF DIRT ATTRACTION ON RUNNING SURFACES OF CROSS-COUNTRY SKIS



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# Dirt always exists on our skis running surfaces

- We have to answer just a one question: How much?



Stone grinded skis waxed with Swix CH8 after 5,3 km. Air temperature +7,7°C. 2005-04-03

To comprehend ski glide behaviour  
we have to notice contamination.

- A few tons of scientific and semi scientific papers attended the ski/snow glide problem, a few kilograms of such papers pointed out importance to take a dirt amount in account. However, our literature review discovered – nobody does.

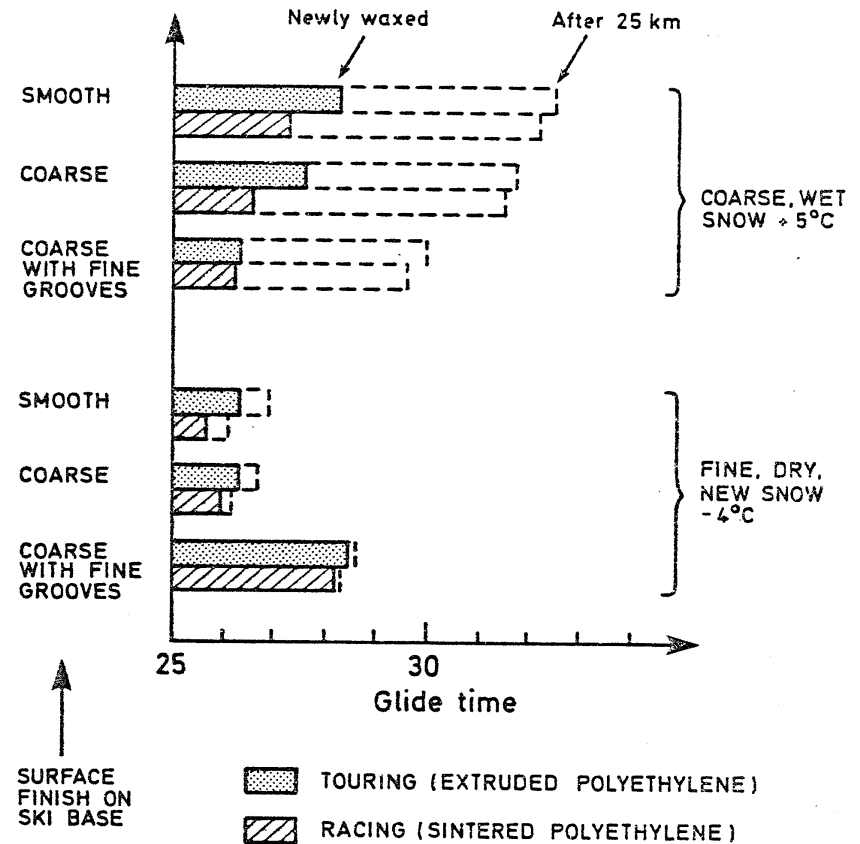
$\mu_{dirt}$

# Worn out or soiled?

- SLOTFELDT-ELLINGSEN, D. & TORGERSEN, L. (1982)  
Gliegenskaper til skisåler av polyetylen. Oslo, SINTEF:

Merk den store forskjellen på våtsnø mellom nysmurte ski og ski etter 25 kms bruk. Dette skyldes at voksen slittes vekk. =

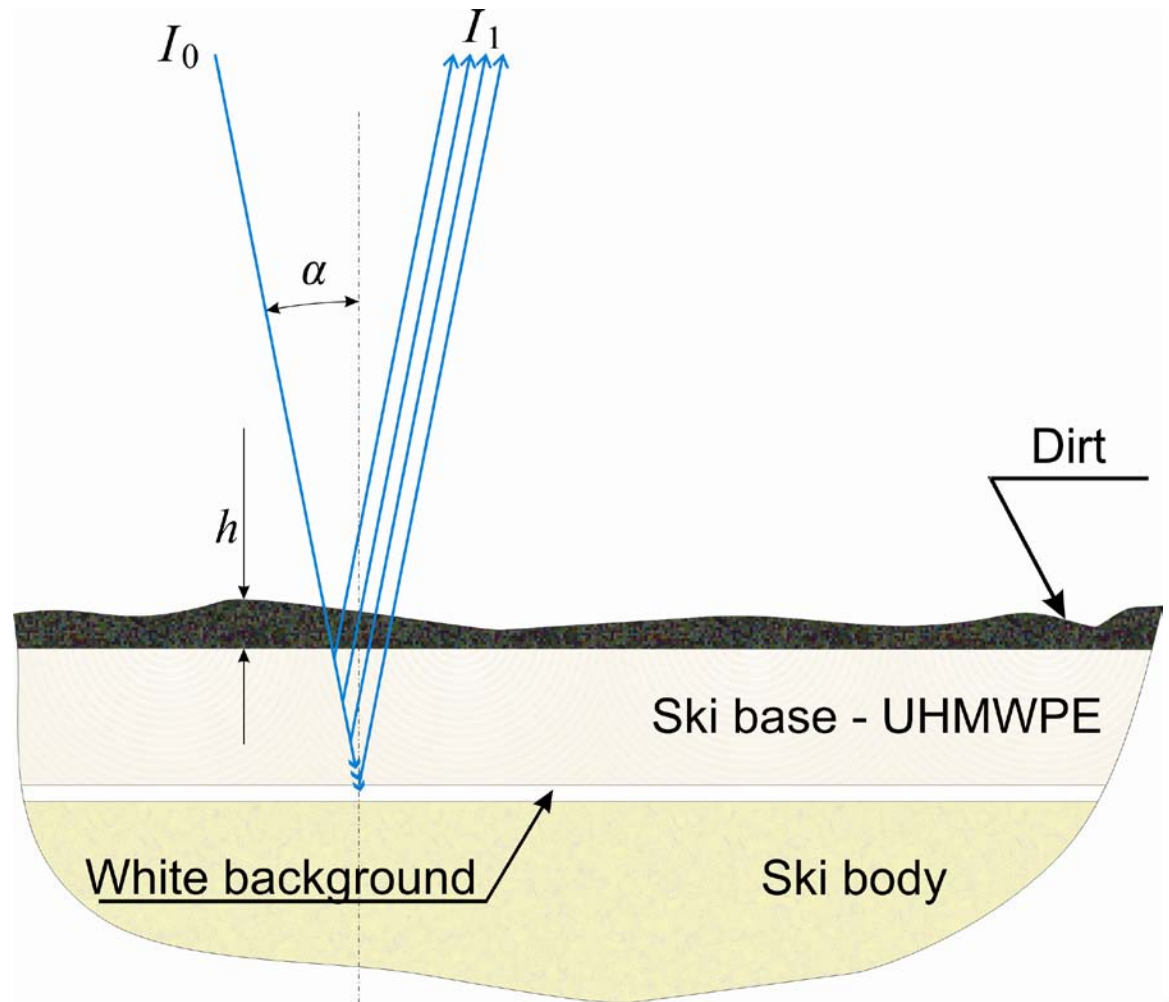
**Notice the big difference on the wet snow between fresh waxed skis and skis after 25 km. That is because the glide wax is worn out.**



Figur 24. Figuren viser hvordan glien avhenger av sålens overflatestruktur på forskjellige føretyper. Merk den store forskjellen på våtsnø mellom nysmurte ski og ski etter 25 kms bruk. Dette skyldes at voksen slittes vekk. På kaldføre er skiene nesten like gode etter 25 km som ved starten. (Figur 21-23 viser bilder av de 3 overflatestrukturer som ble benyttet i denne testen.)

# Beer-Lambert Law.

- The fraction of light absorbed by each layer of solution is the same.



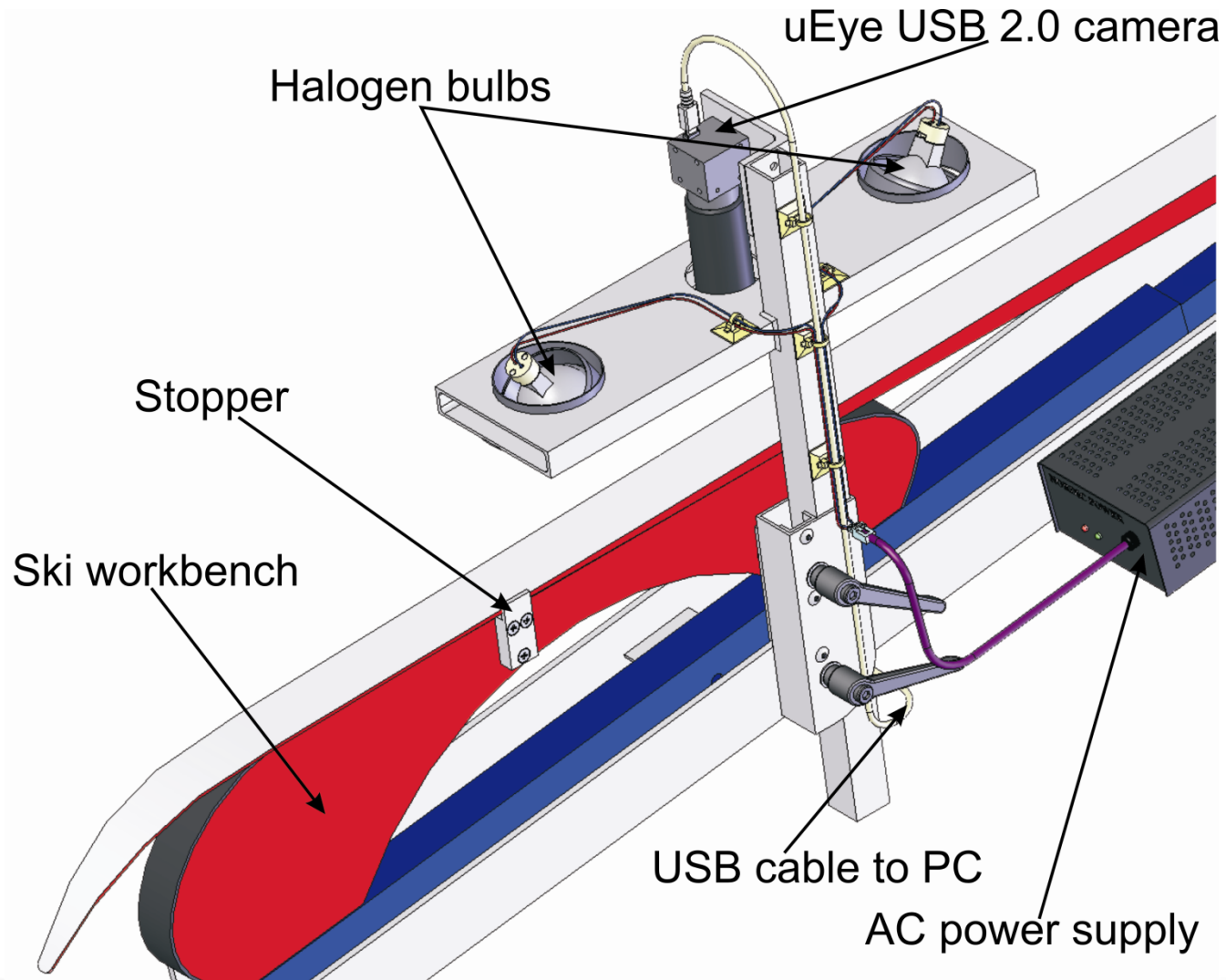


# Black on black is invisible.

- Madshus A/S kindly did help us and made a few pairs skis with transparent base (P-Tex® 2000) and white background.



# Ski under the camera.



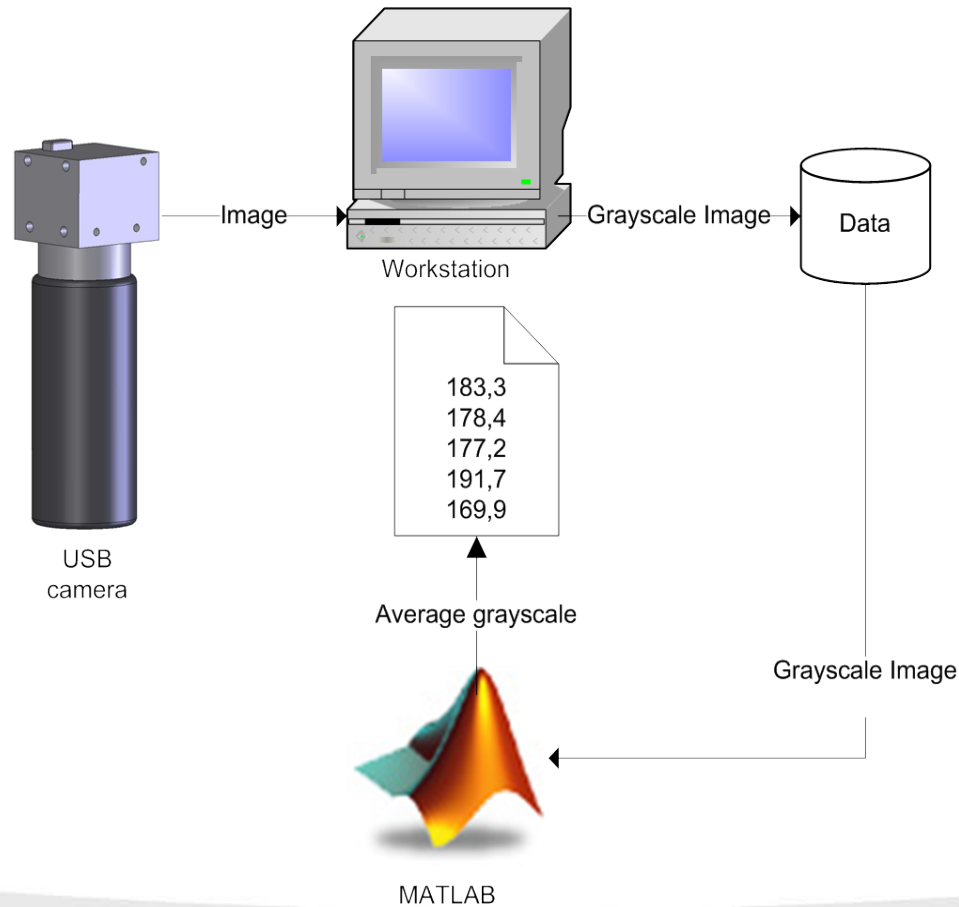
# The processed area of the ski running surface.

- The area is located just in front of the pressure peak.





# Whiteness recorded as an average of grayscale matrix (0-255).



# The method validation

- The results of 40 measurements of the same sample with a two-minute interval between measurements to avoid warming-up the sample. Distribution of the average grayscale fitted as a Gaussian Distribution presented by Minitab 15 Statistical Software.

## Anderson-Darling Normality Test

A-Squared	3,38
P-Value <	0,005

Mean	132,84
StDev	0,41
Variance	0,17
Skewness	2,37535
Kurtosis	6,61066
N	40

Minimum	132,46
1st Quartile	132,59
Median	132,71
3rd Quartile	132,89
Maximum	134,52

## 95% Confidence Interval for Mean

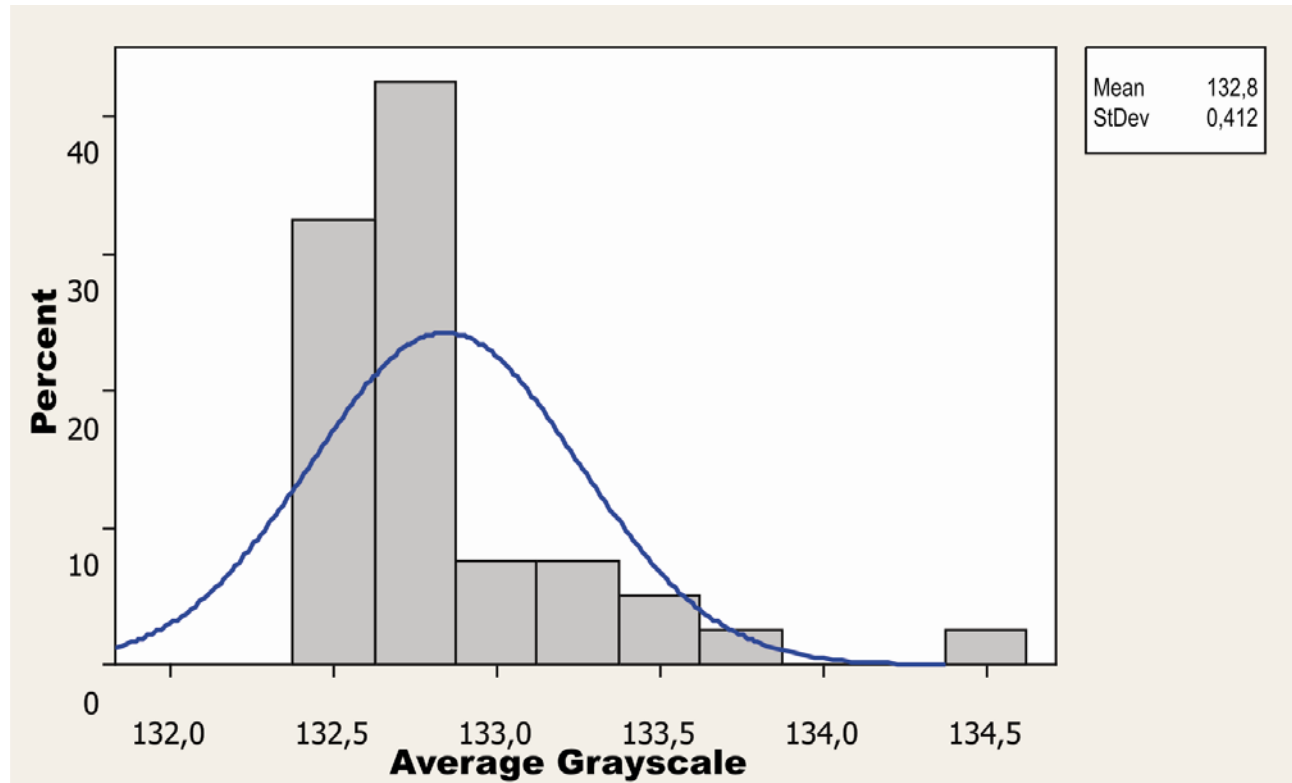
132,71	132,97
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## 95% Confidence Interval for Median

132,63	132,80
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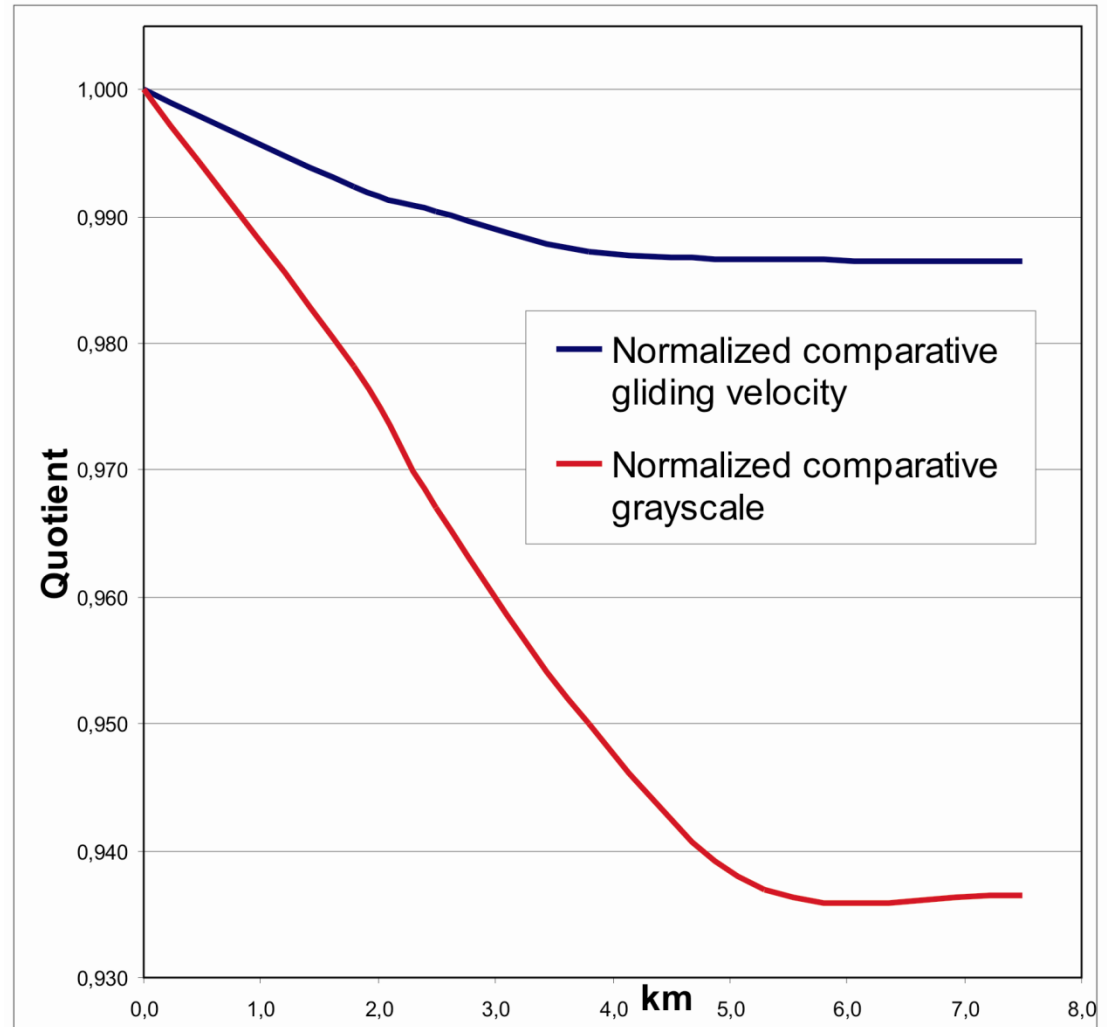
## 95% Confidence Interval for StDev

0,34	0,53
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# Whiteness vs. velocity

- Velocity and whiteness relative to distance on wet snow



# Discussion

- From our results we can draw the conclusion that the above-stated method to estimate the dirt attraction on the running surface of XC skis works precisely enough under wet snow conditions
- However, on cold, dry snow grime covers the ski gliding surface utterly insignificantly, and the grayscale measurement lies inside the margin of error in the test results.

# Future work

- To design some kind of ski running base scanner



# Acknowledgements

- The authors are grateful to Gunnar Bjertnæs and Svein Inge Holtesmo from Madshus AS for the sample skis with a transparent base and for the fruitful discussions we have had, to Sven-Gunnar Johansson - Backcountry Equipment AB for the comfortable ski boots, to Torbjørn Ragg - Rottefella AS for the high-tech ski bindings and to the staff at Östersund Ski Stadium for always preparing the ski track perfectly.



**Thank you!**



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