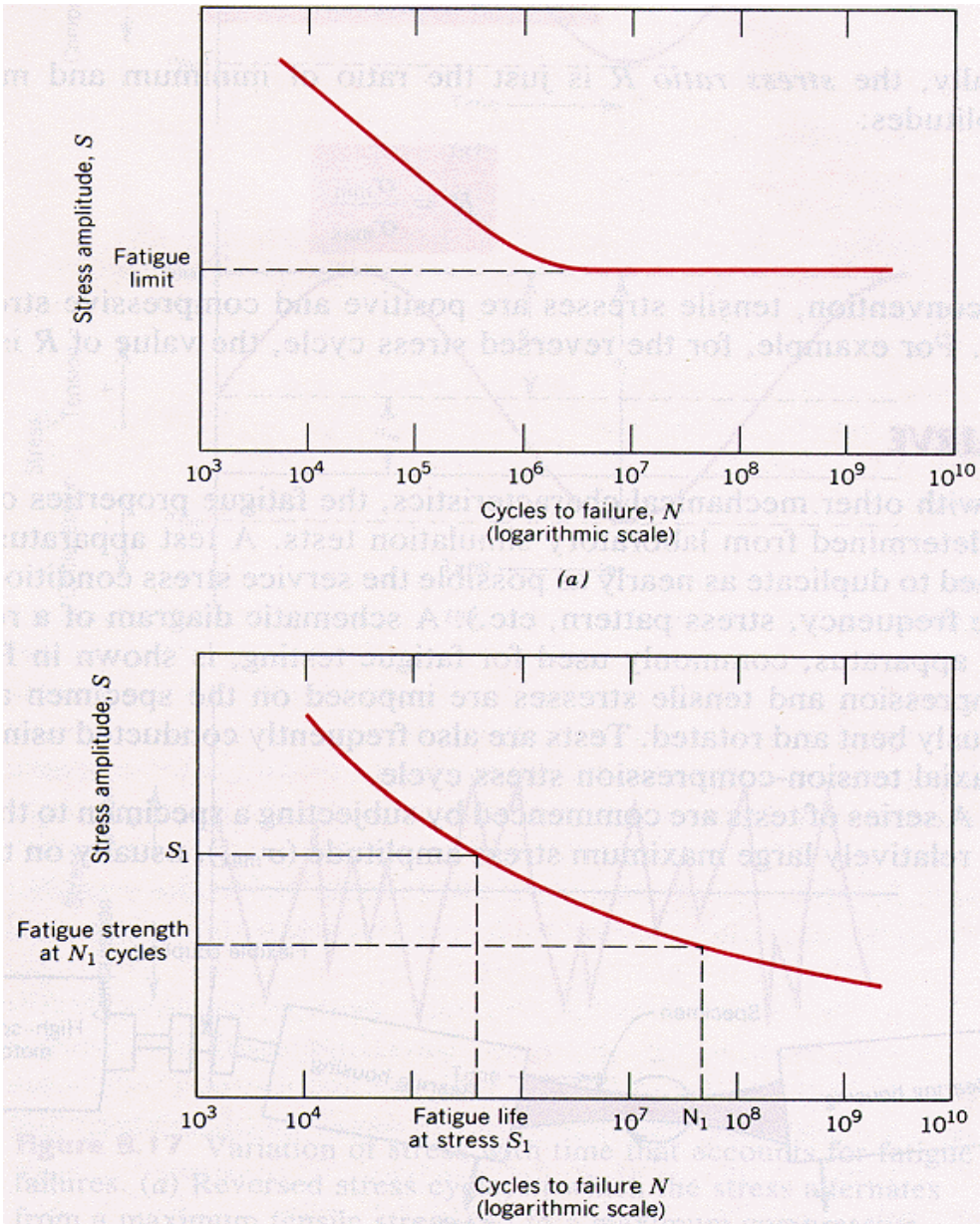
Laser-Induced Surface Fatigue of Cu and CuZr: Data Analysis

- Ultimate goal of the laser tests
- Analysis of the recent results
  - Image analysis
  - Roughness measurements
- Prediction possibilities
- Further studies

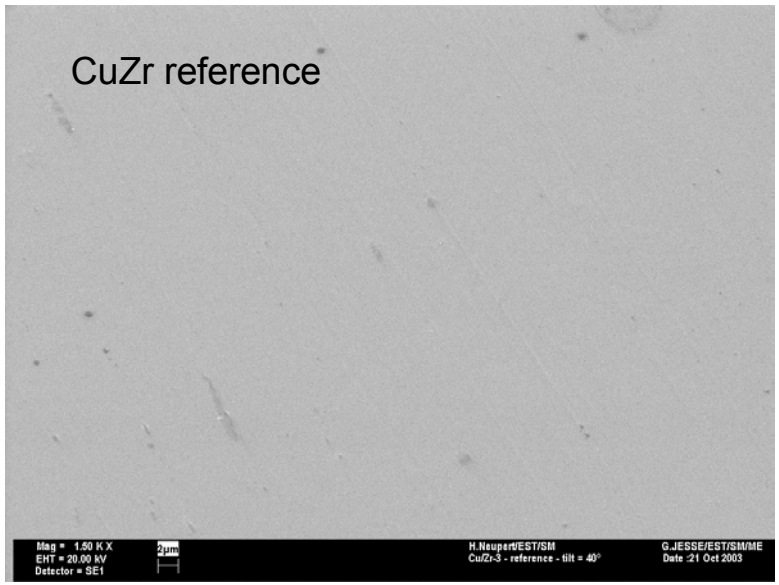


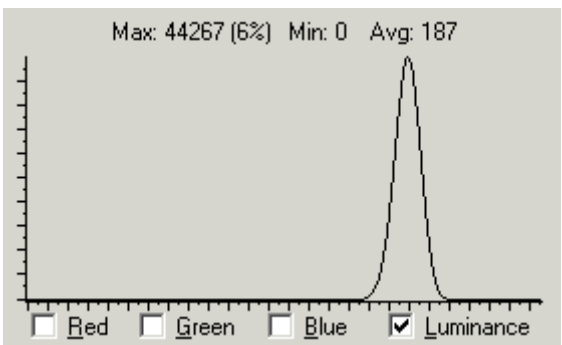
Fatigue: a bulk specimen fails when it breaks...

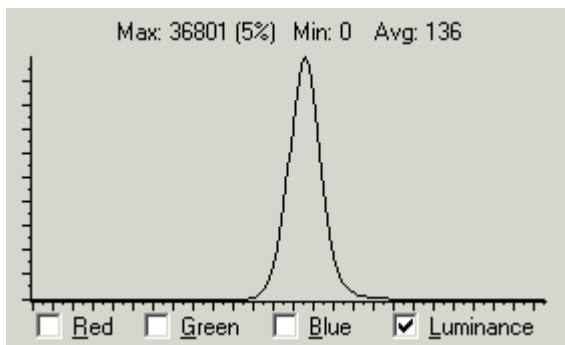
A surface fails when a parameter “p” (to be defined) reaches a given limit

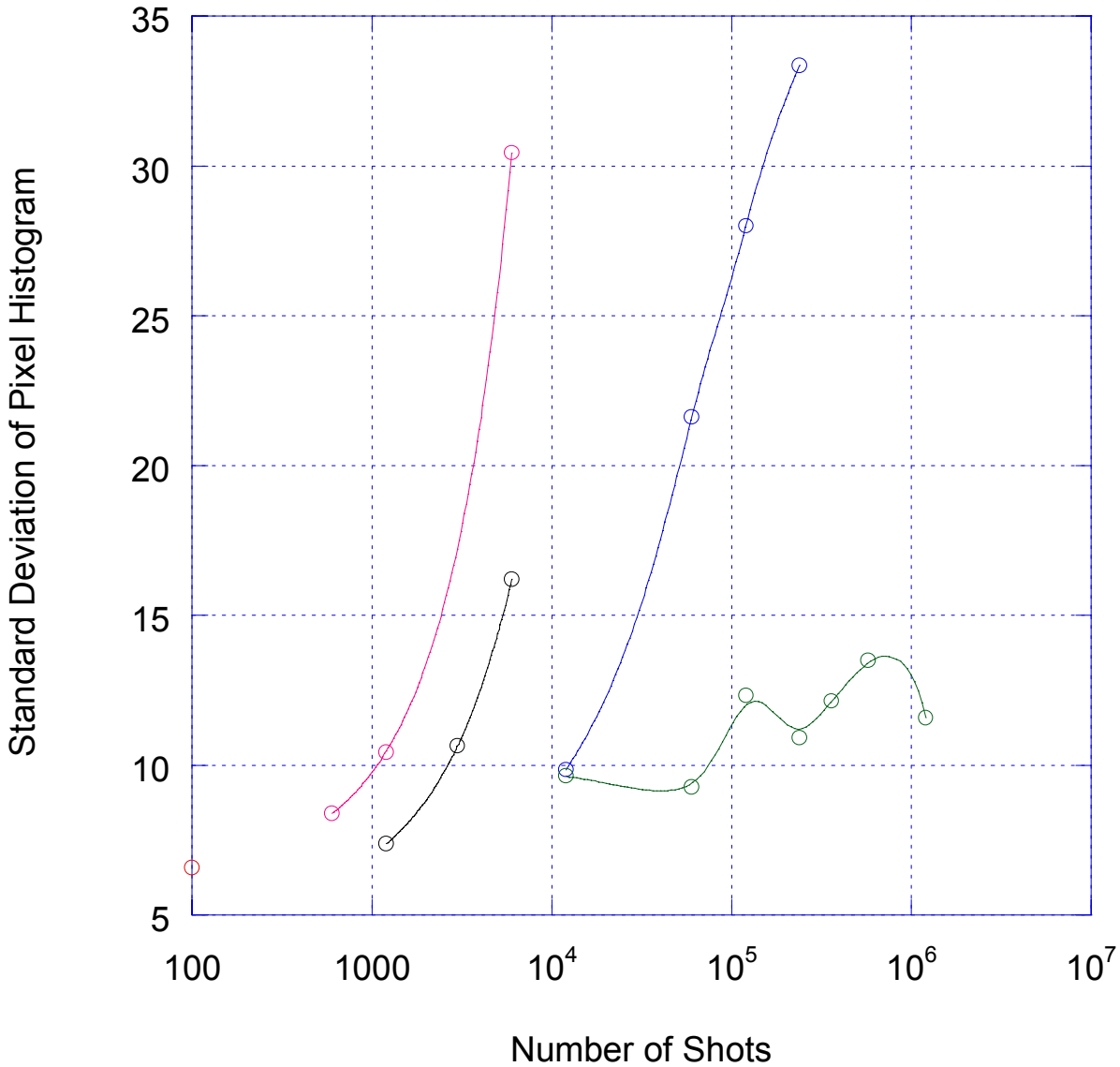
Plots from S. Heikkinen talk 26.6.2003

Image analysis: histogram of the number of pixels having the same intensity





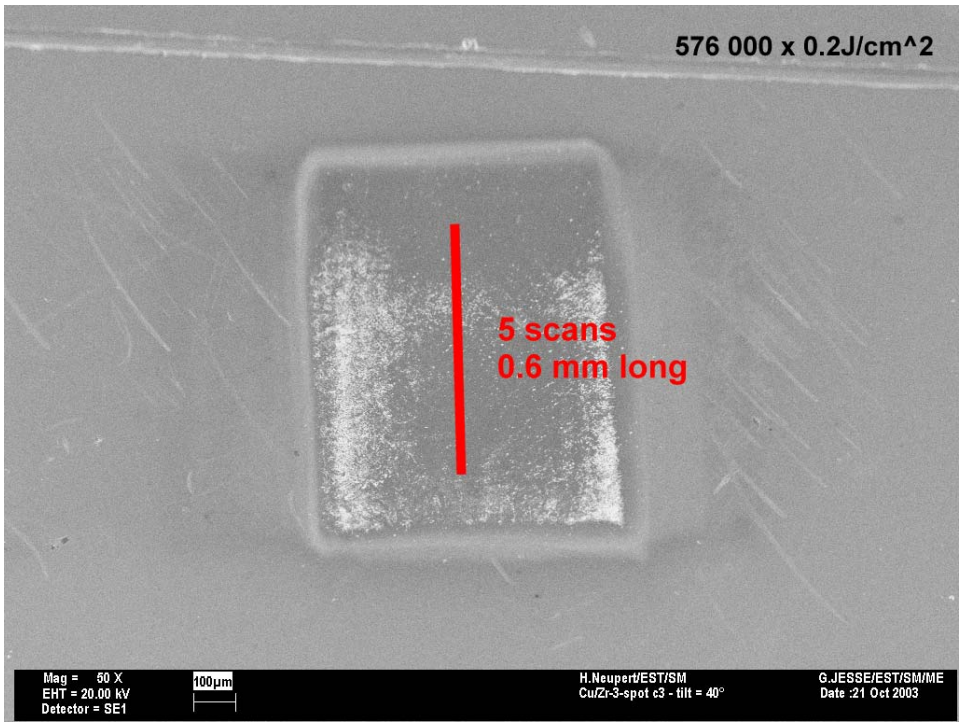




Problems:

- Difficult reproducibility
- Small zone analysed
- SEM pictures take a lot of time

Roughness measurements



Scans along the long axis, excluding border regions

Standard roughness measurement

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Range: 30µm
scan length: 0.6mm
speed: 20 mm/min
cutoff: 0.08µm
stylus: 53
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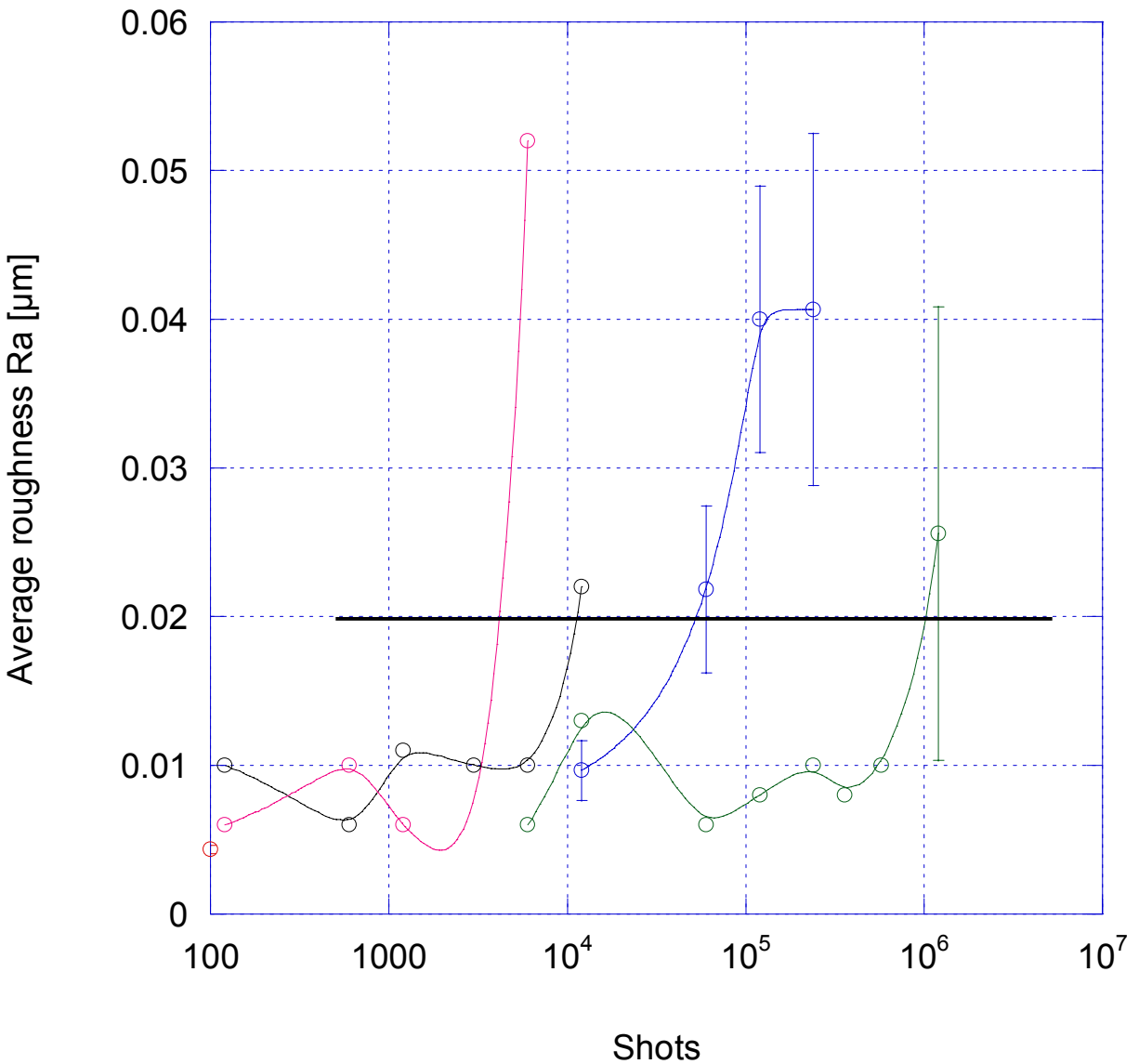
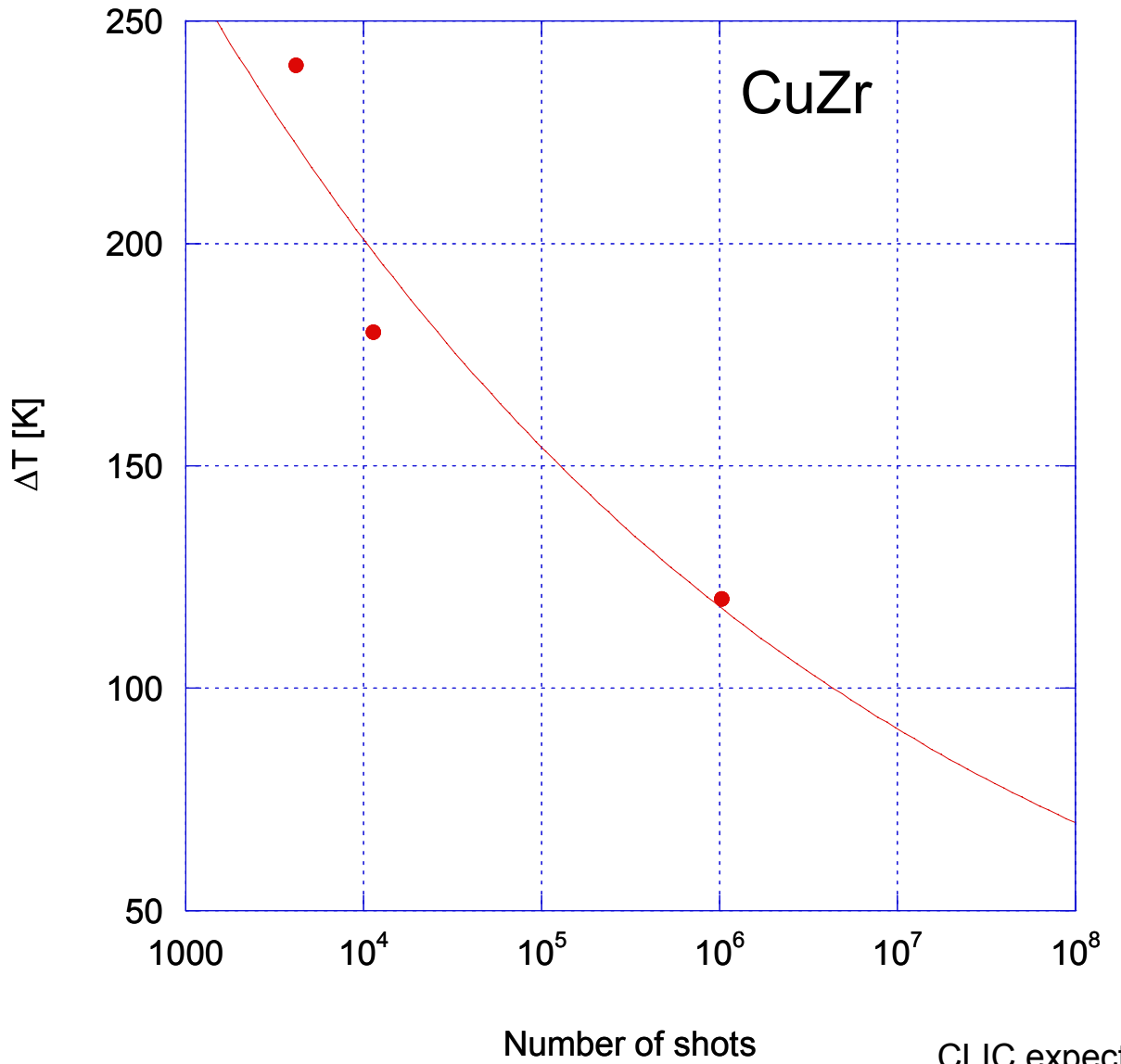
Used parameter: R_a



Roughness R_a
Error bars depend on the number of scans

"p" parameter:
for example
R_a=0.02 µm



0.2 J/cm^2→ΔT≅120K

0.3 J/cm^2→ΔT≅180K

0.4 J/cm^2→ΔT≅240K

CLIC expected lifetime:
3x10^{10} cycles

Open question:

- What is the acceptable value of R_a (if chosen as reference measurement)?

Suggestion (I. Syratchev):

- Laser-treat a copper cell and test in RF

Model [S.P.Morgan JAP 20 (1948) 353]:

- Surface resistance can double because of roughness (depending on ratio between r.m.s. roughness and penetration depth)

What about positive feedback due to increased surface resistance?

Further tests:

- Test at 0.1 J/cm^2 (equivalent to $\Delta T \cong 60$ K)

Suppose R_a = 0.02 μm is a good criteria and the previous prediction is correct, then we need more than 1000 hours with our XeCl laser (repetition rate = 20 Hz)

Discussion started with HARP experiment to borrow KrF laser (248 nm, 200 Hz repetition rate): 1000 CHF/month, needs new gas lines and some safety stuff (original price of the laser 70 kCHF)

- A coating that recrystallizes at very low temperature, for example gold, may bring a substantial benefit (curing of the damaged surface)