Damage avoidance due to the use of high voltage hrc fuses and temperature monitoring

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motivation

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destroyed medium voltage switchgear as a result of a blown-up hv hrc fuse with the occurrence of arcing

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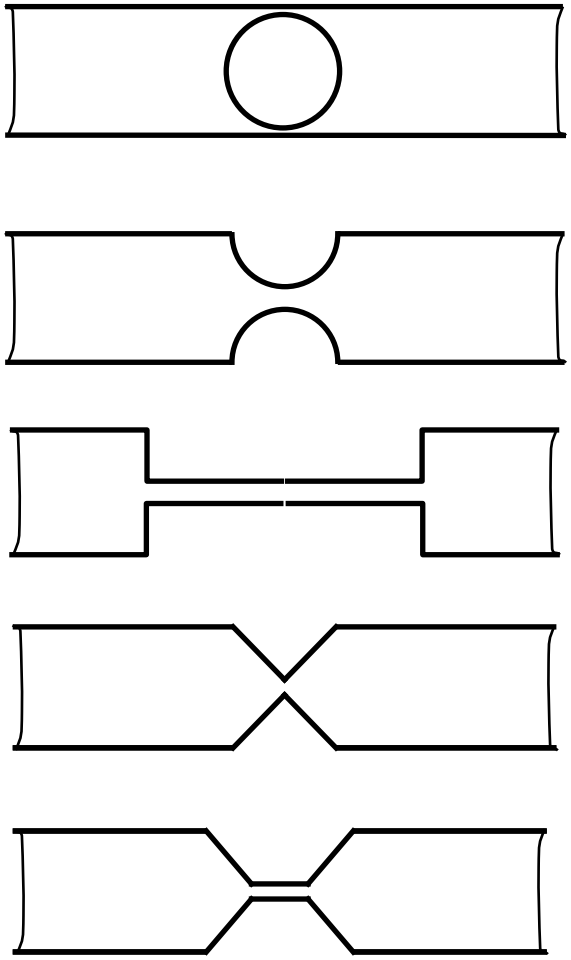
different shapes for fuse elements



Shapes of fuse elements

Shape of the restrictions

influences

- the chronology of the melting of the fuse element restrictions
- the maximum value of the transient current till melting of the fuse elements
- the heat transfer to the surrounding sand
- together with the number of the restrictions the arcing voltage

possible causes for degradation of fuses

- short circuit in transformer coil with long term failure current /1/,
- transformer operation above rated power /1/,
- lower mapping of the fuse to transformer rating than necessary /1/,
- unacceptable temperature around the fuse, imperfect heat dissipation /1/,
- inadequate contacting /1/,
- partial melting of fuse-elements as a result of thunderstorm /1/,
- variations in production quality,
- wrong engineered switchgear,
- mechanically induced vibrations,
- *strongly pulsate currents.*

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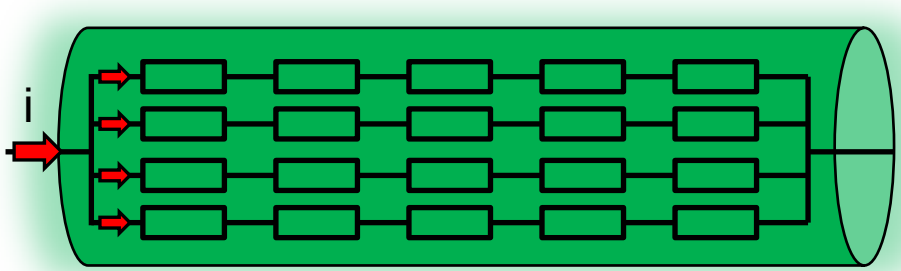
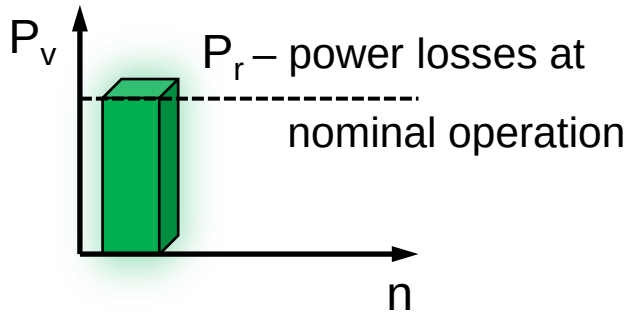
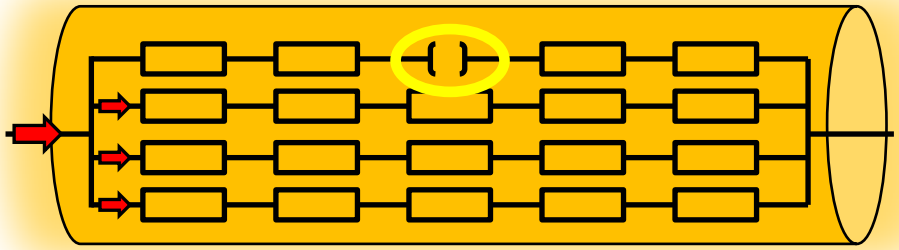
thermal power losses P_v

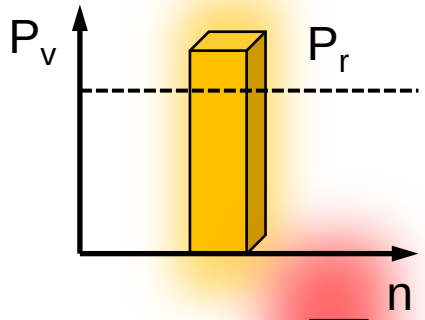




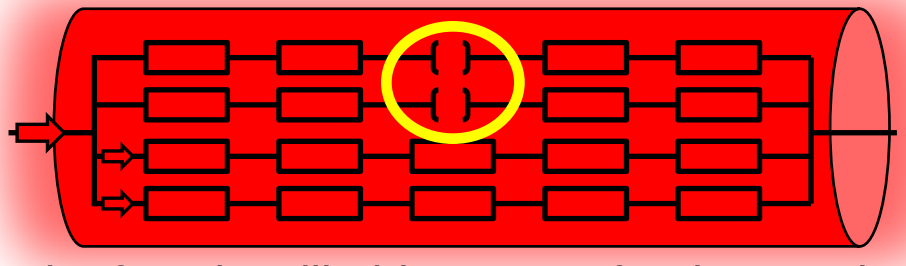
n – number of broken fuse elements

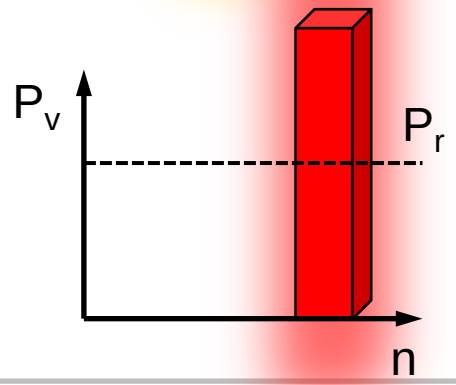
single broken fuse elements





two broken fuse elements

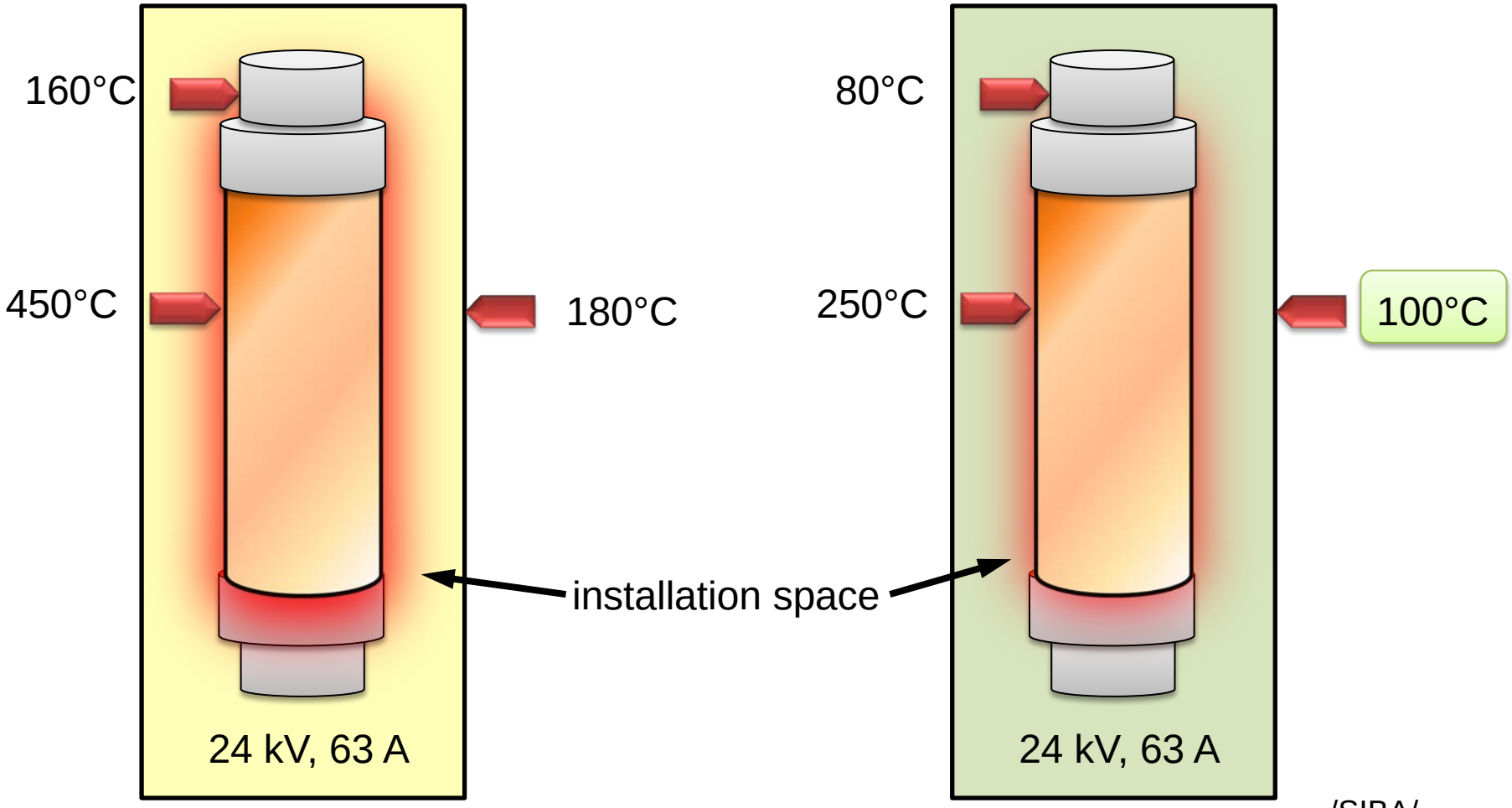




The fuse is still able to transfer the rated current!

temperatures at a standard hrc fuse

highest temperatures at hrc fuses with thermal release device



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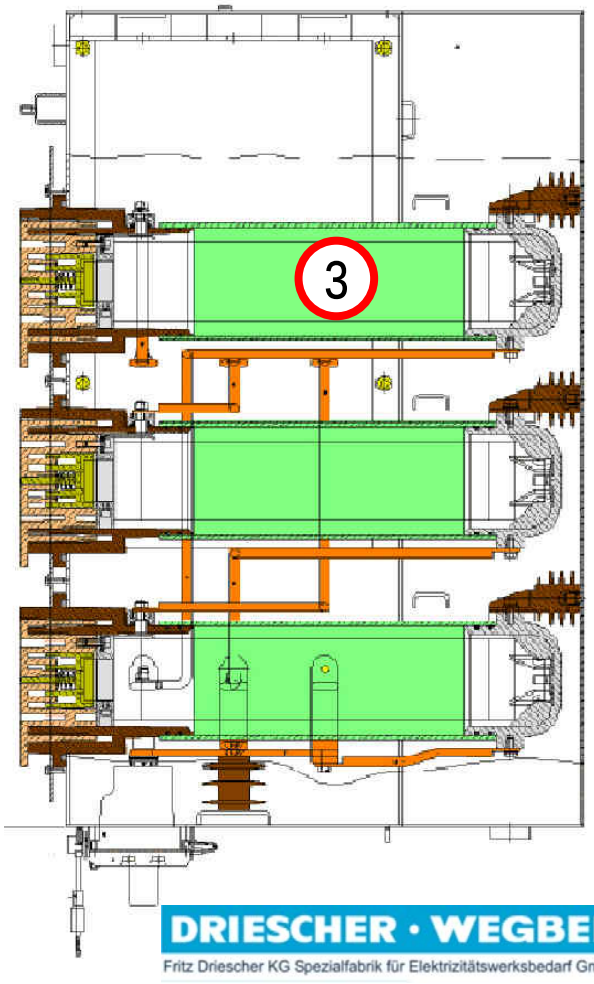
SF_6 insulated switchgear

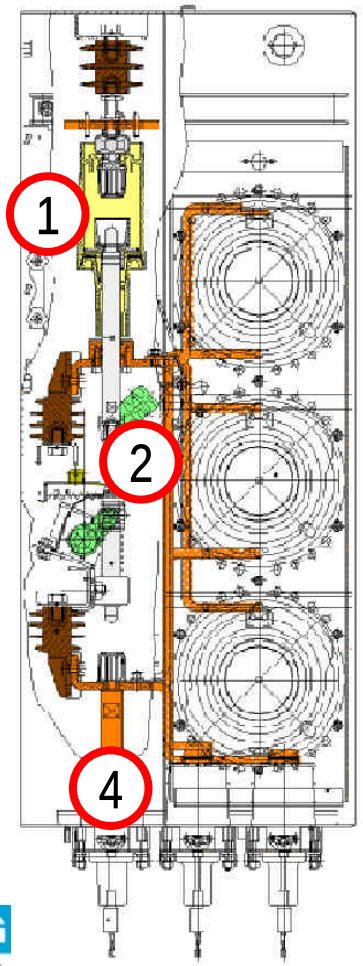
transformer field

1. SF_6-arcing chamber
2. earthing switch with auxillary ground switch
3. fuse tube
4. bushing

lateral view



front view

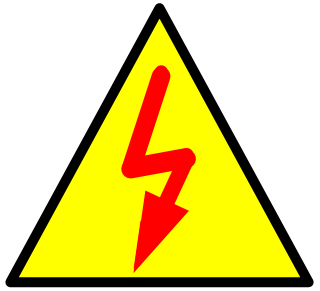


SF_6-switchgear
Typ MINEX® / G·I·S·E·L·A®

contactless temperature measurement

Goal

- Maximum effectivness of already existing equipment
- Failure detection on early phase
- Measuring of the temperature at vulnerable points of interest
- e.g. inside switch gear – busbar,
  fuse



Problem

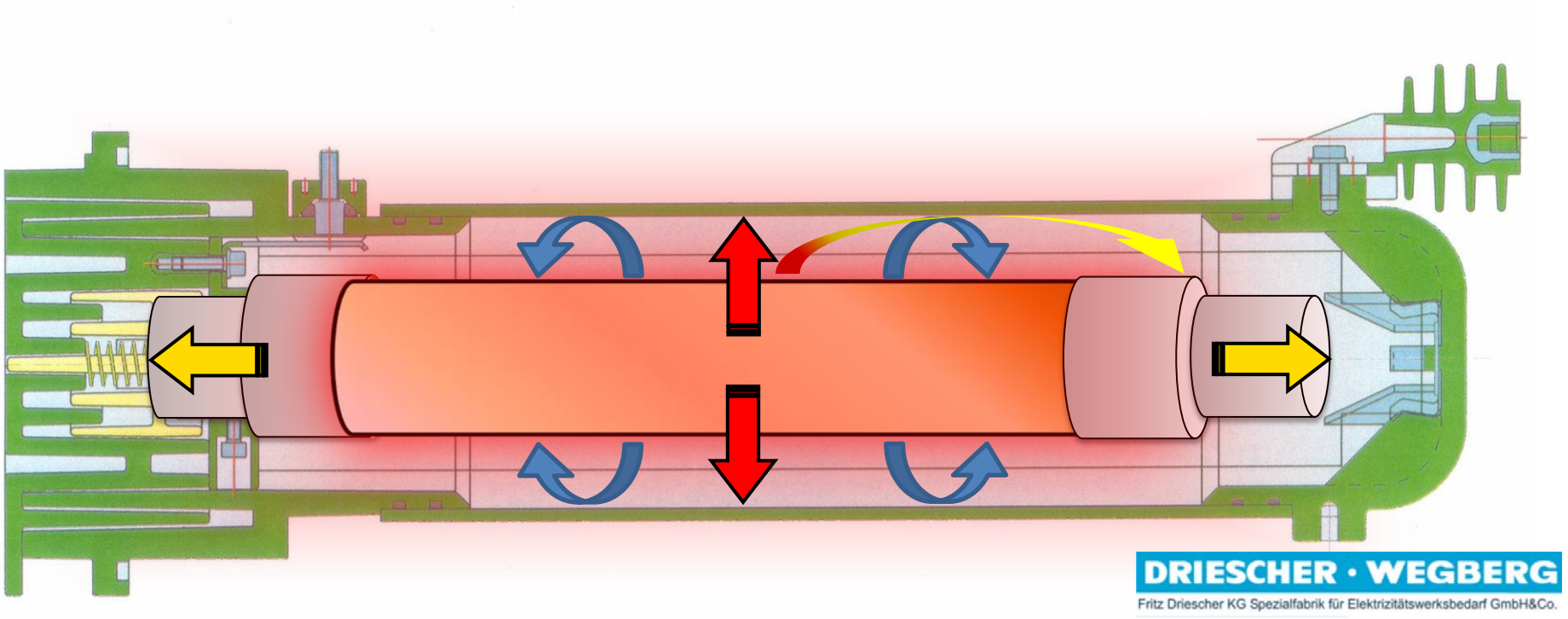
High Voltage – availability of measuring point not given!

HV hrc fuse boxed within switchgear

research laboratory HTW Berlin

- thermal power losses heats up fuse and switchgear and vice versa

structure of the fuse tube



Reduced heat transmisson insude fuse tube and switch gear - consequences:

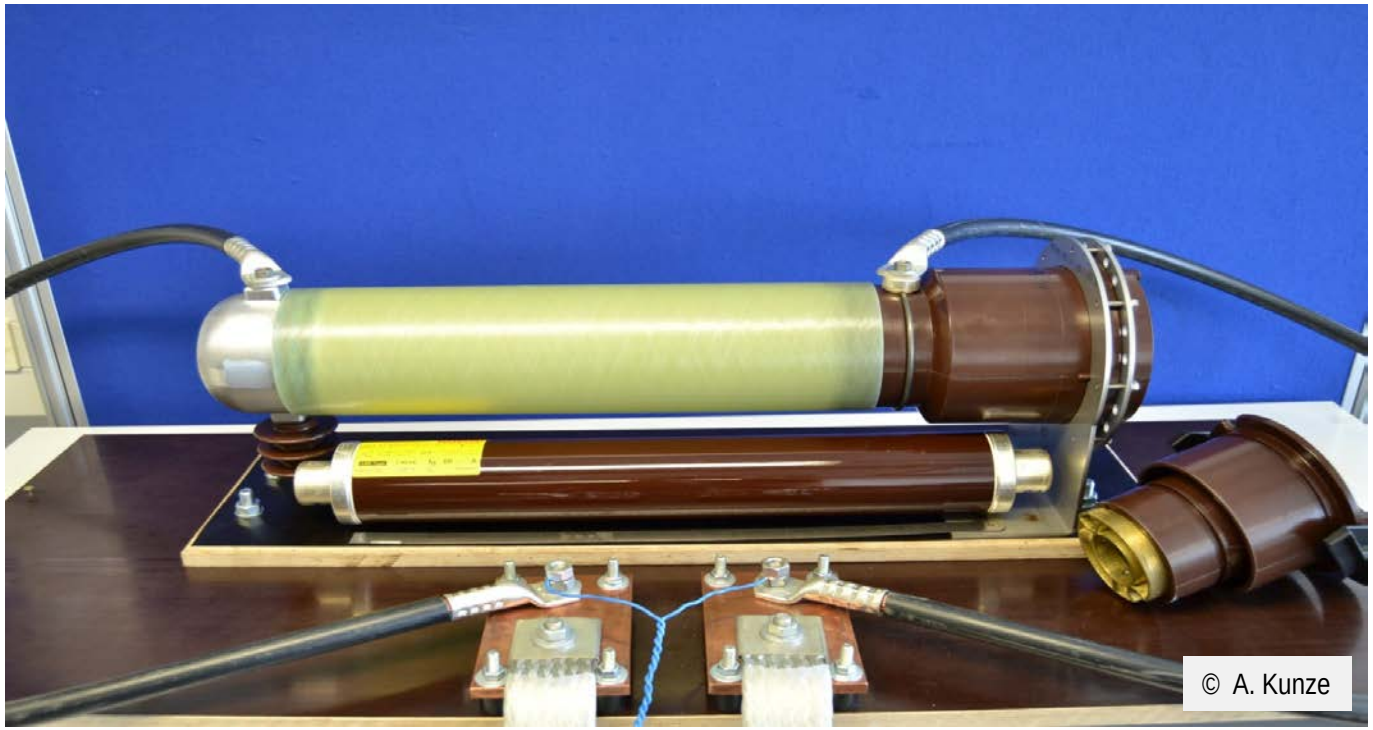
thermal conductivity

operational currents are reduced below rating of fuses

convective flow of heat

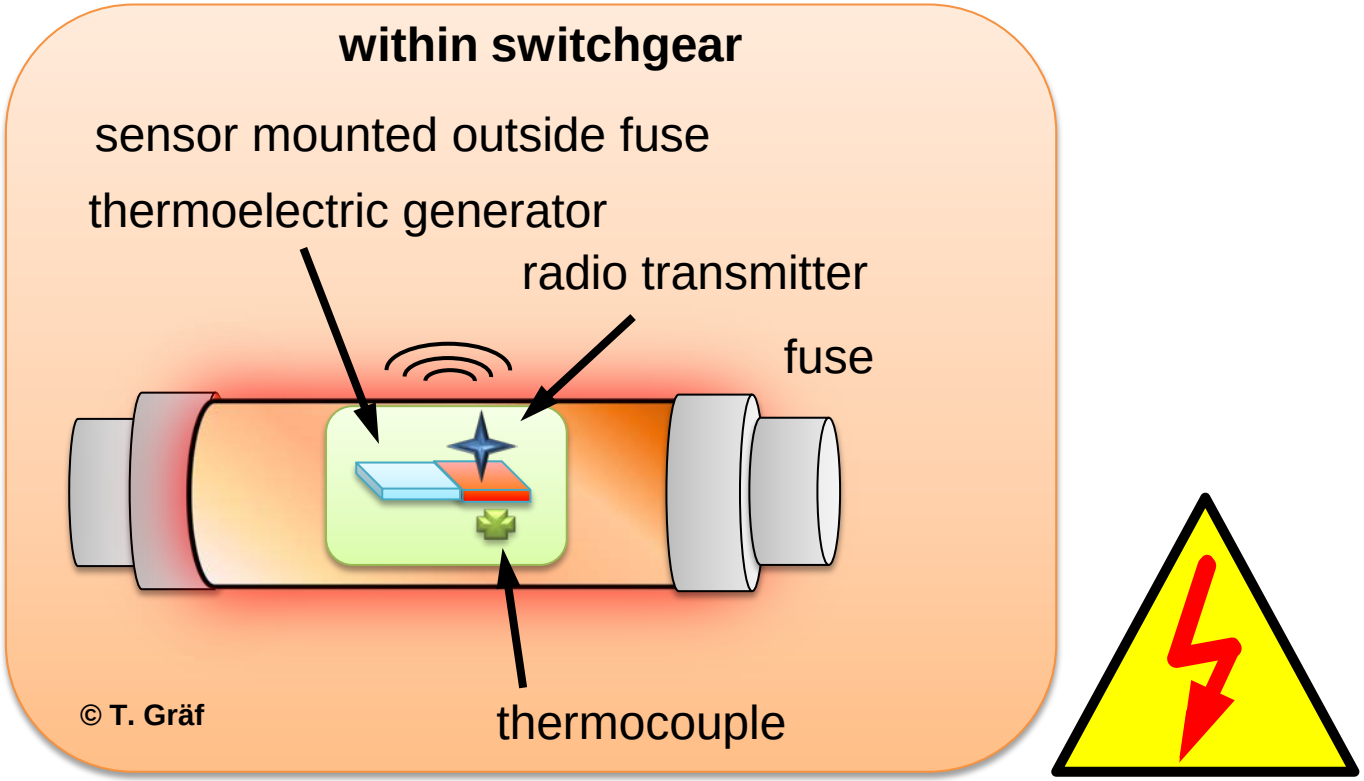
test set-up

for the investigation of the thermal situation
inside and around the fuse tube



test set-up according standard DIN EN 20282-1
VDE 0670-4 Hochspannungssicherungen – Teil 1
hv hrc fuse: 20/36 kV, „e“ = 537 mm

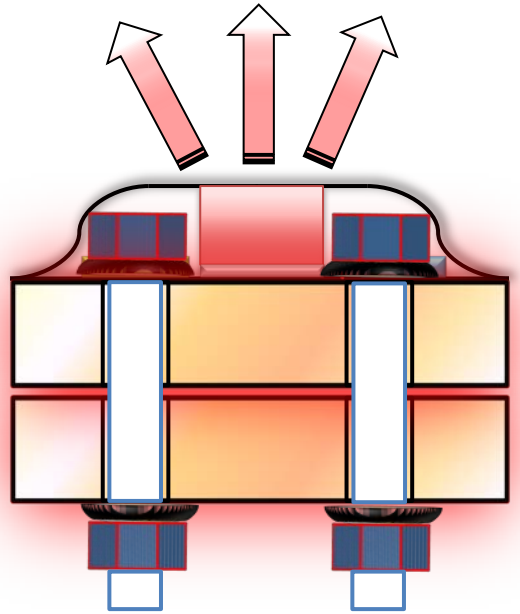
the idea

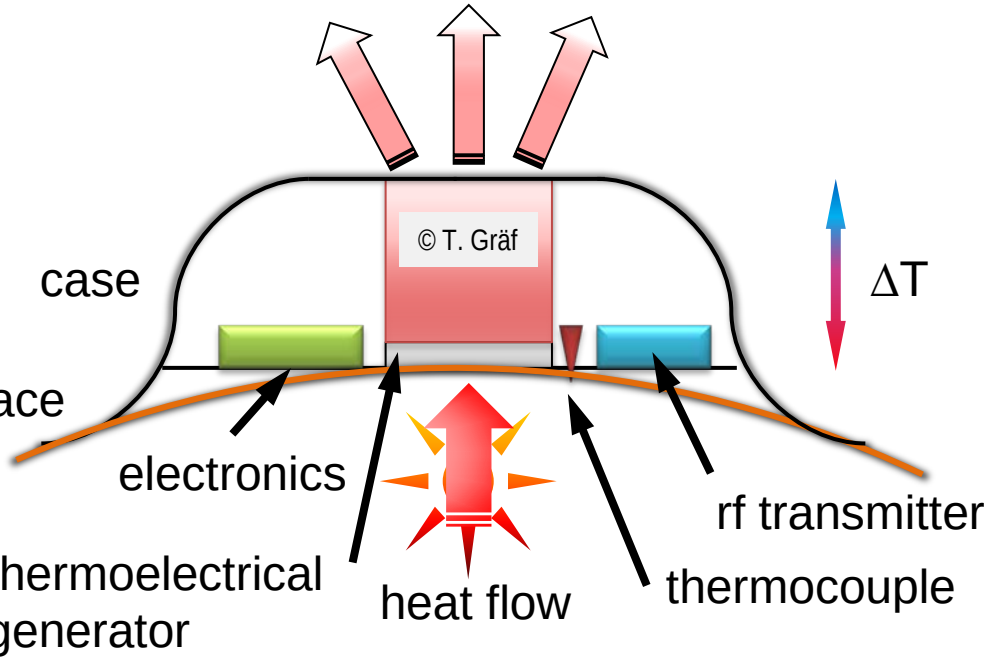


principal design

sensor design

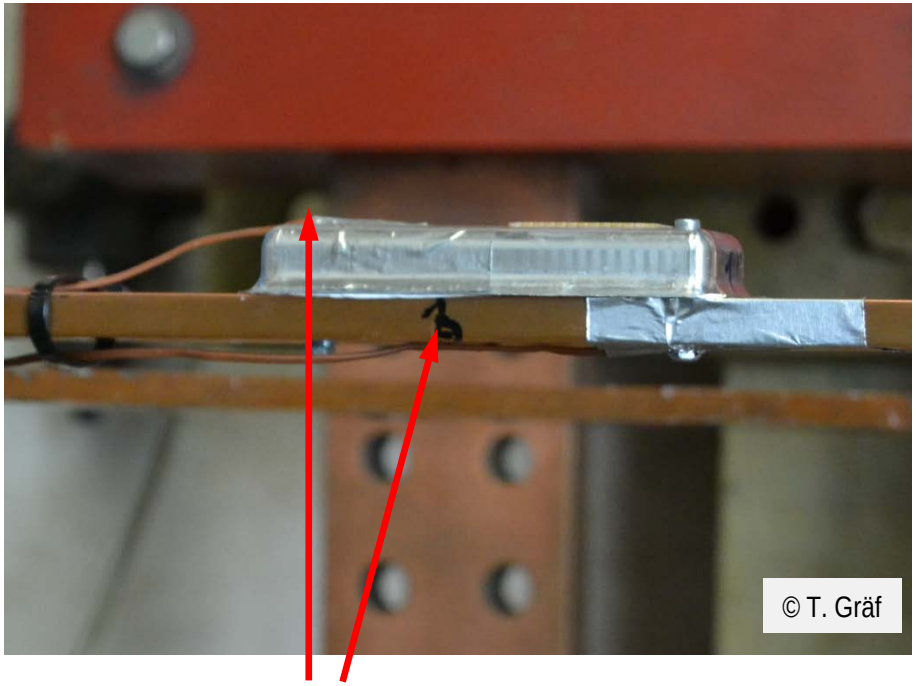
use of heat transfer from screw or contact for energy harvesting, in parallel measurement of the temperature





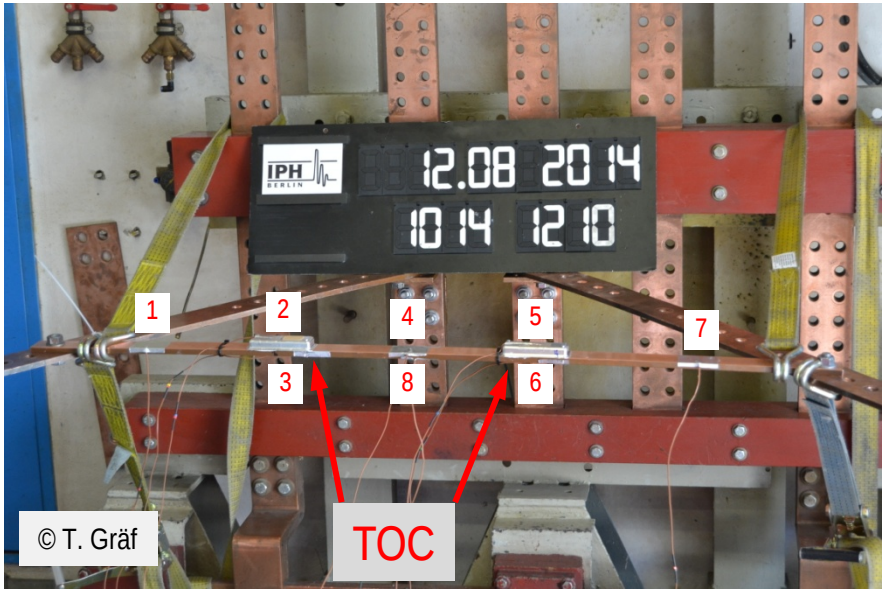
functional sensor design - testing

measurement of the temperature while performing short circuit current test



thermocouple für reference measurement

proof of immunity to interference – short circuit testing



proof of immunity

16 kA - 63 kA, 1s – 3s; no defects, no failure to sensors

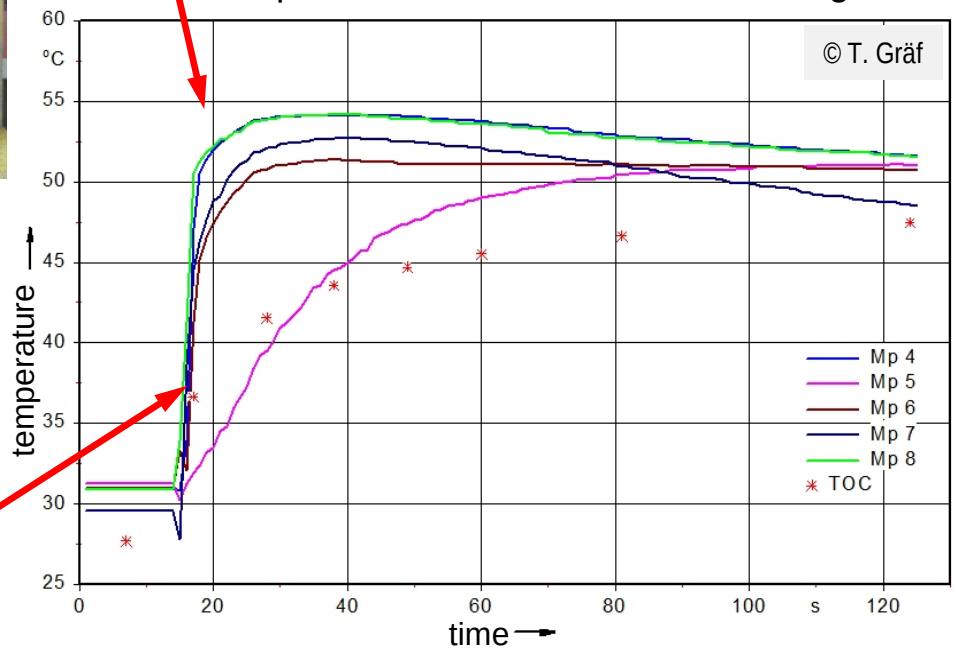
no interence to the electronics

Mp 1 – Mp 8 – thermocouple for reference measurement

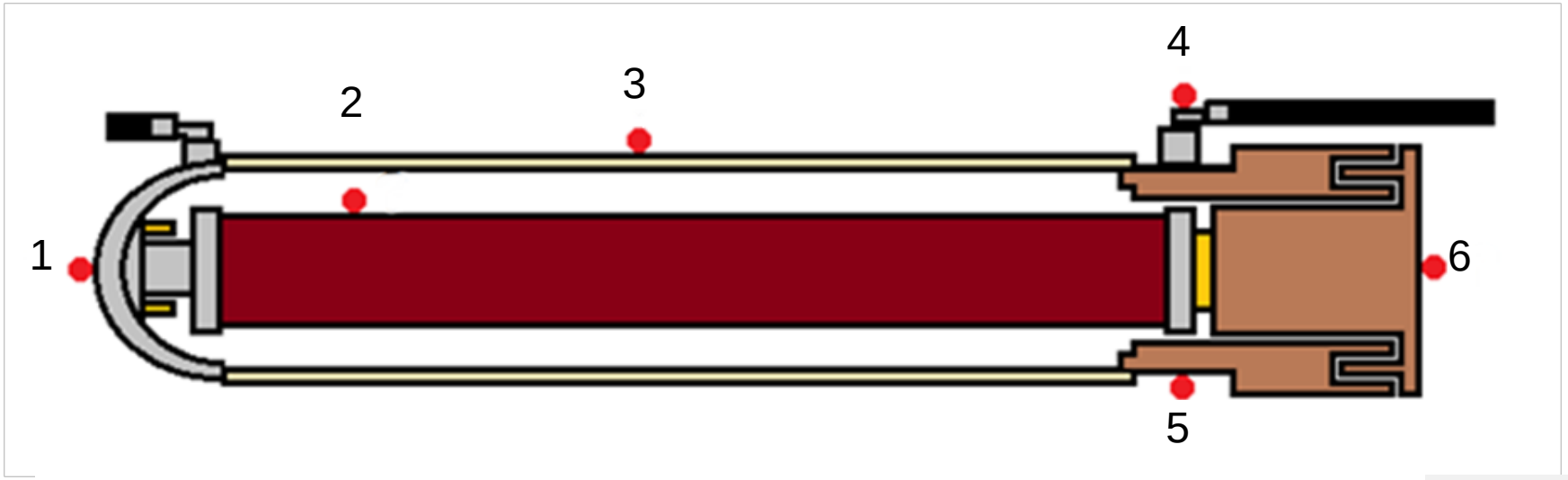
measurement of the temperature while short circuit testing!

Thermal Observation Contactless Sensor

temperatures while short circuit testing



Where should the sensor be placed?



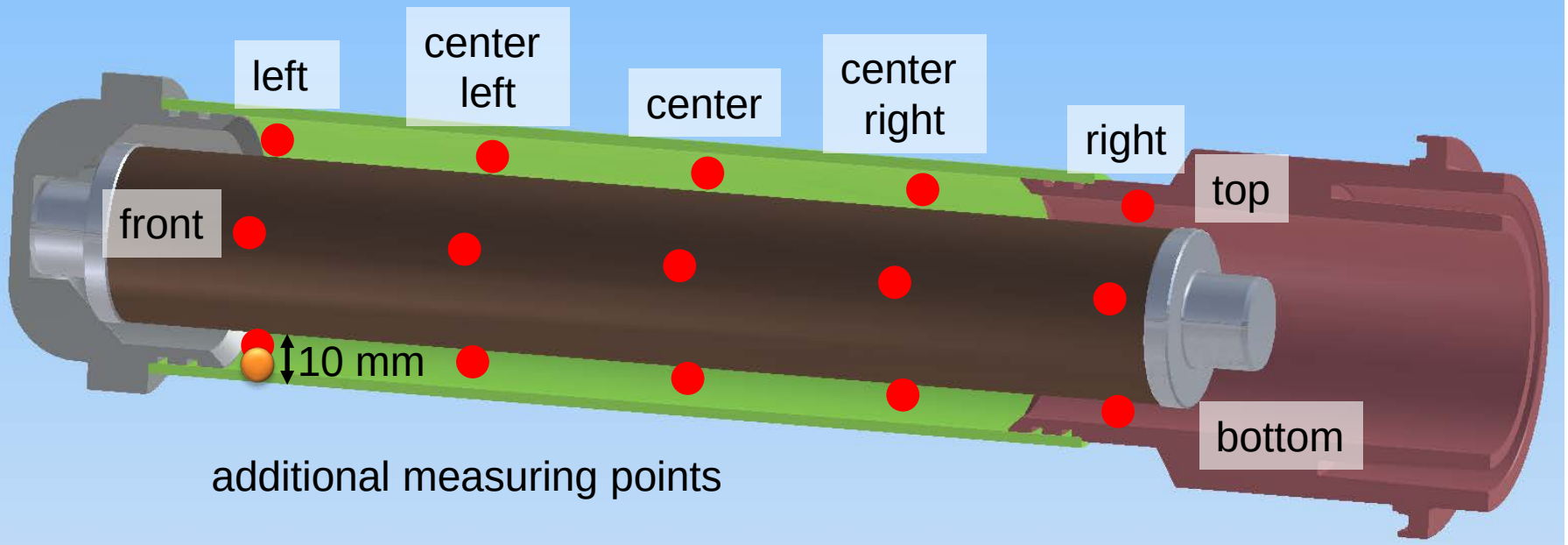
1 – alumninium case
2 – hv hrc fuse
3 – fuse tube
4 – right contact
5 – fuse tubular
6 – fuse cover

Disadvantage: points 1, 3, 4 & 5 inside sf_6 compartment!

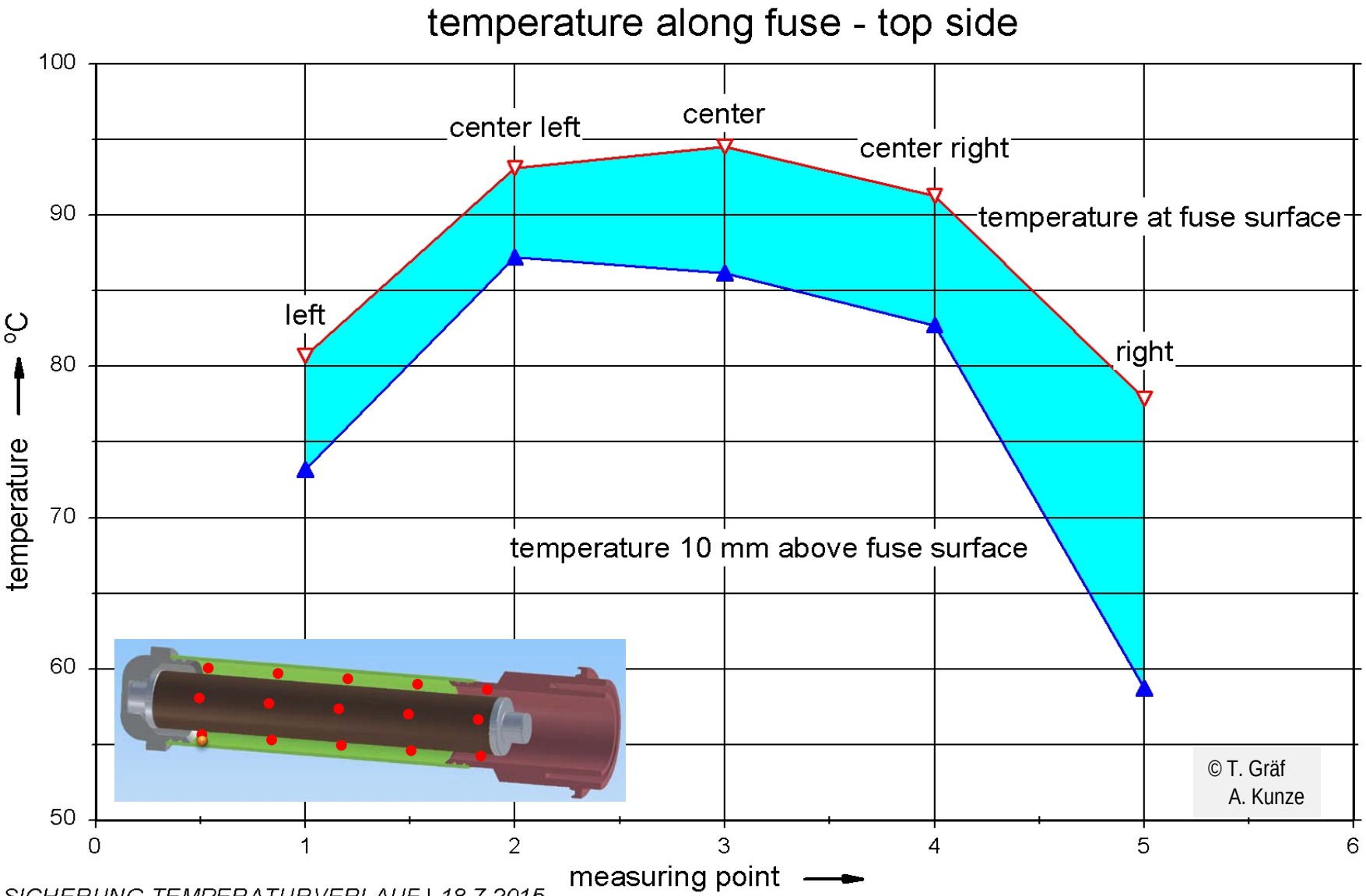
Disadvantage: point 6 far away from heat source – long time delay

Point 2: The selected measuring point!

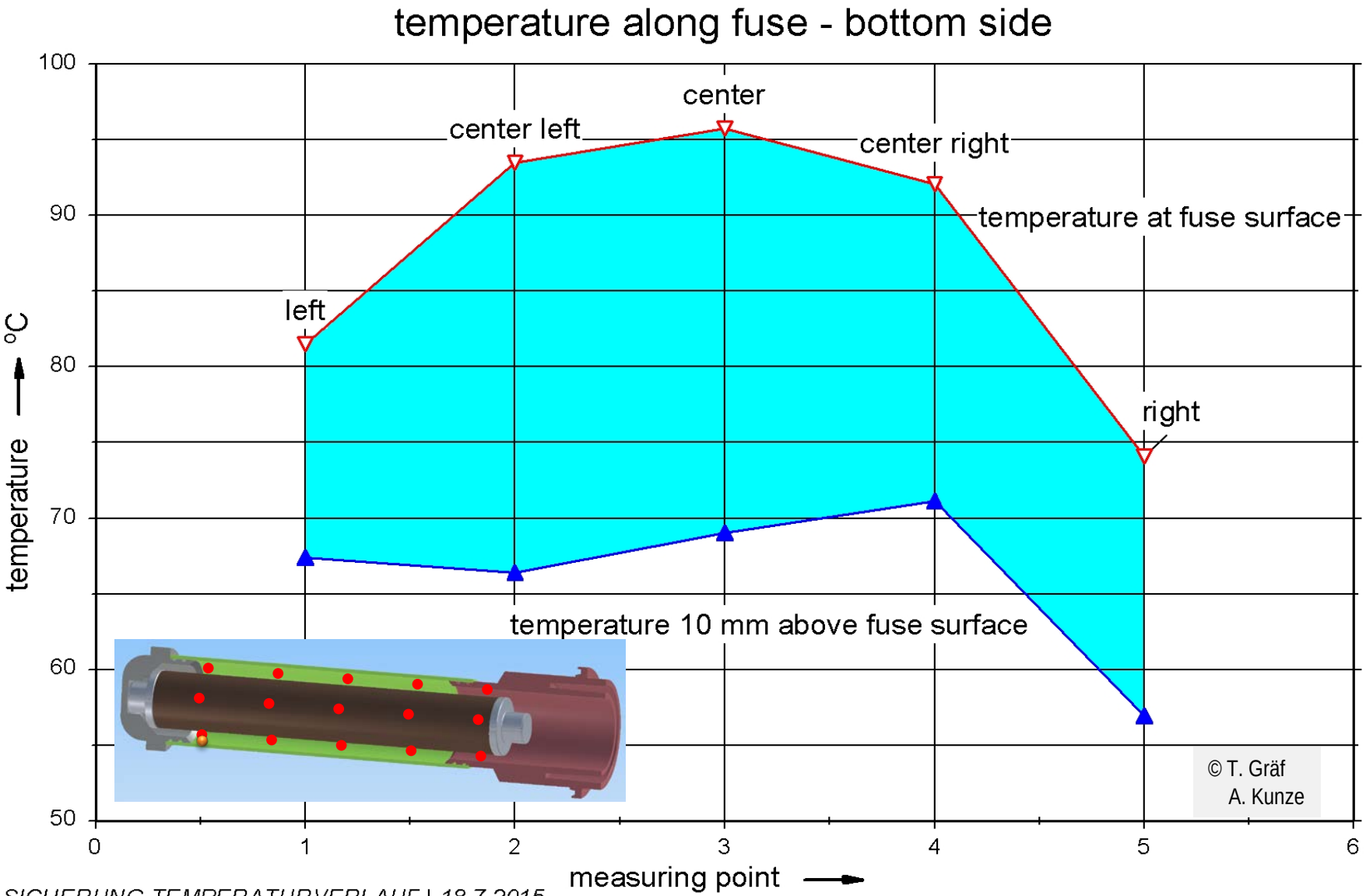
definition of measuring points around hv hrc fuse



Is it possible to generate sufficient electrical energy to power the electronics?



HH SICHERUNG TEMPERATURVERLAUF | 18.7.2015



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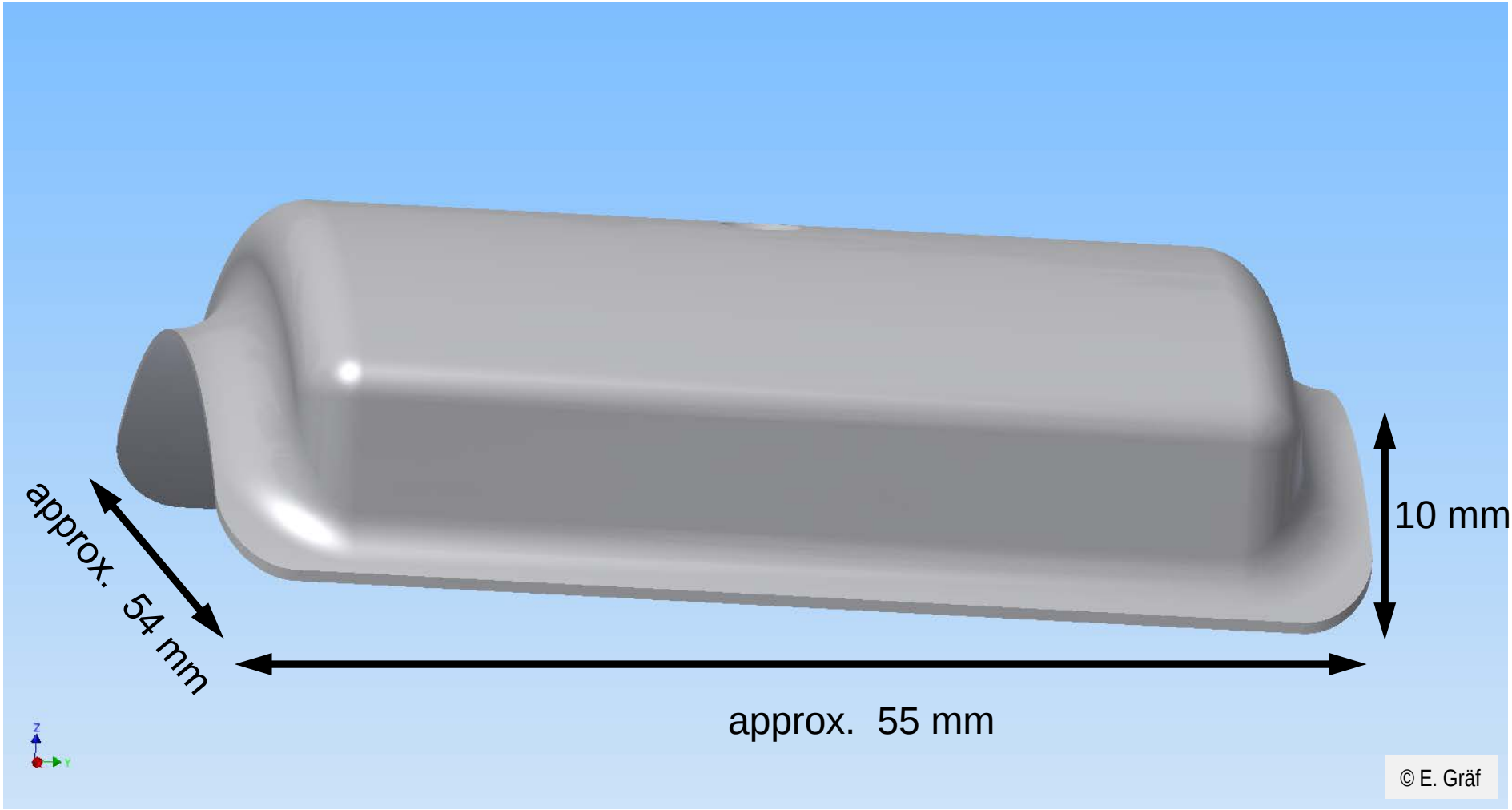
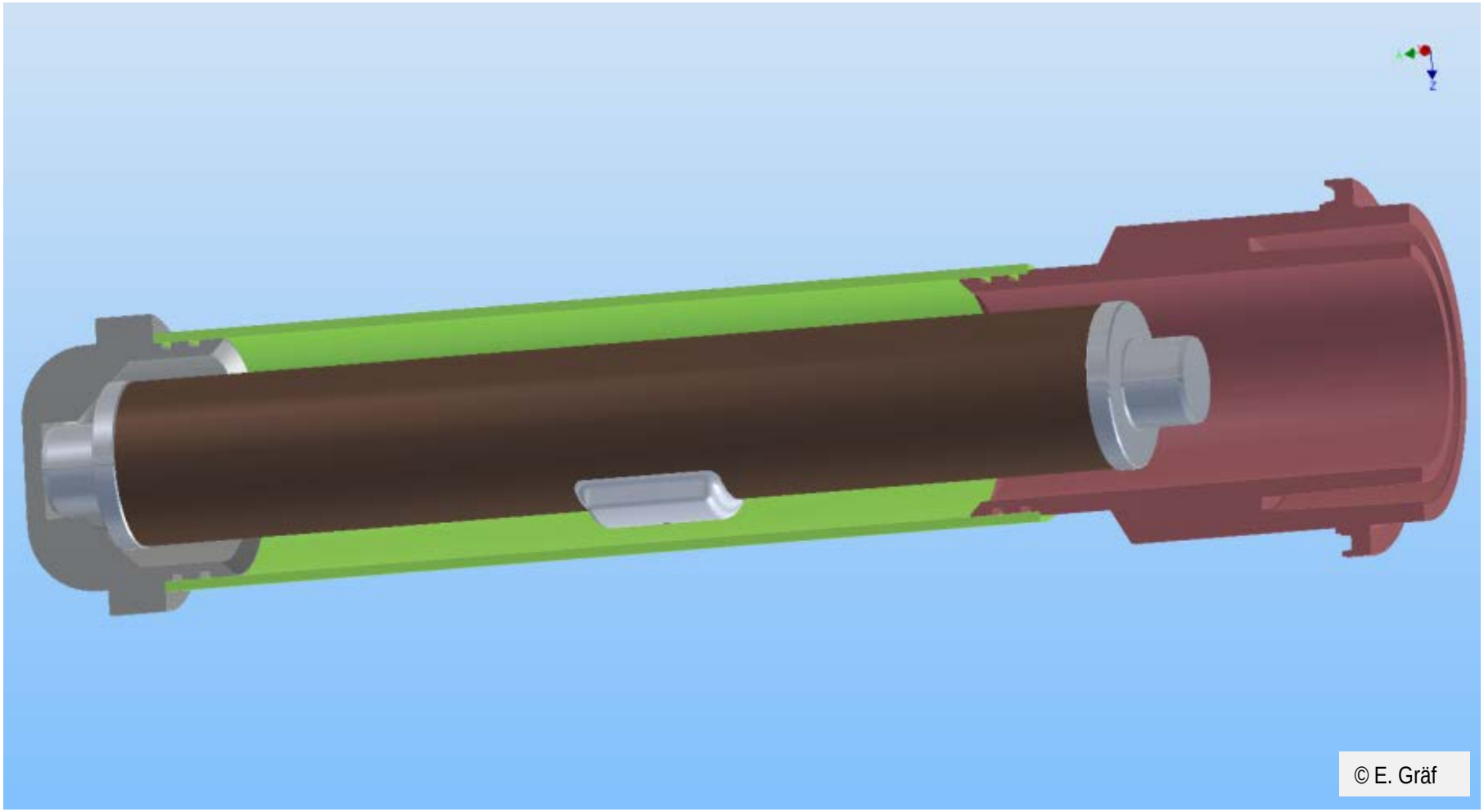
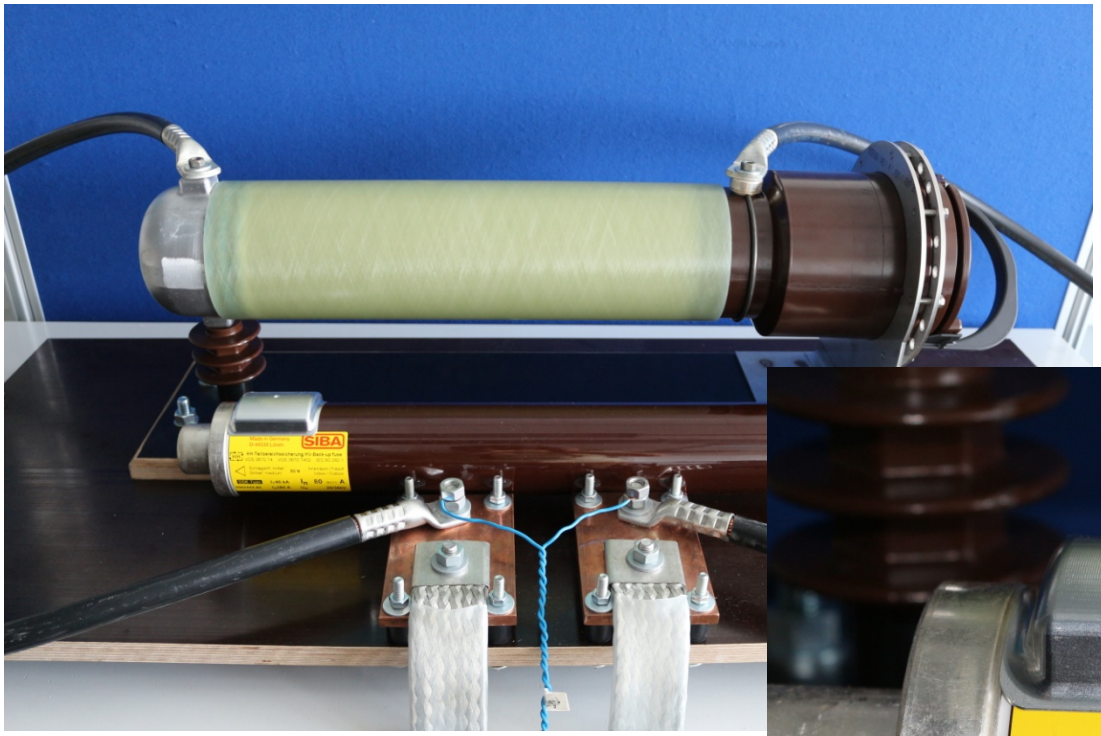
actual sensor design



sensor location for further investigations



actual sensor for further investigations



current state of the investigations – conclusion

Next investigations

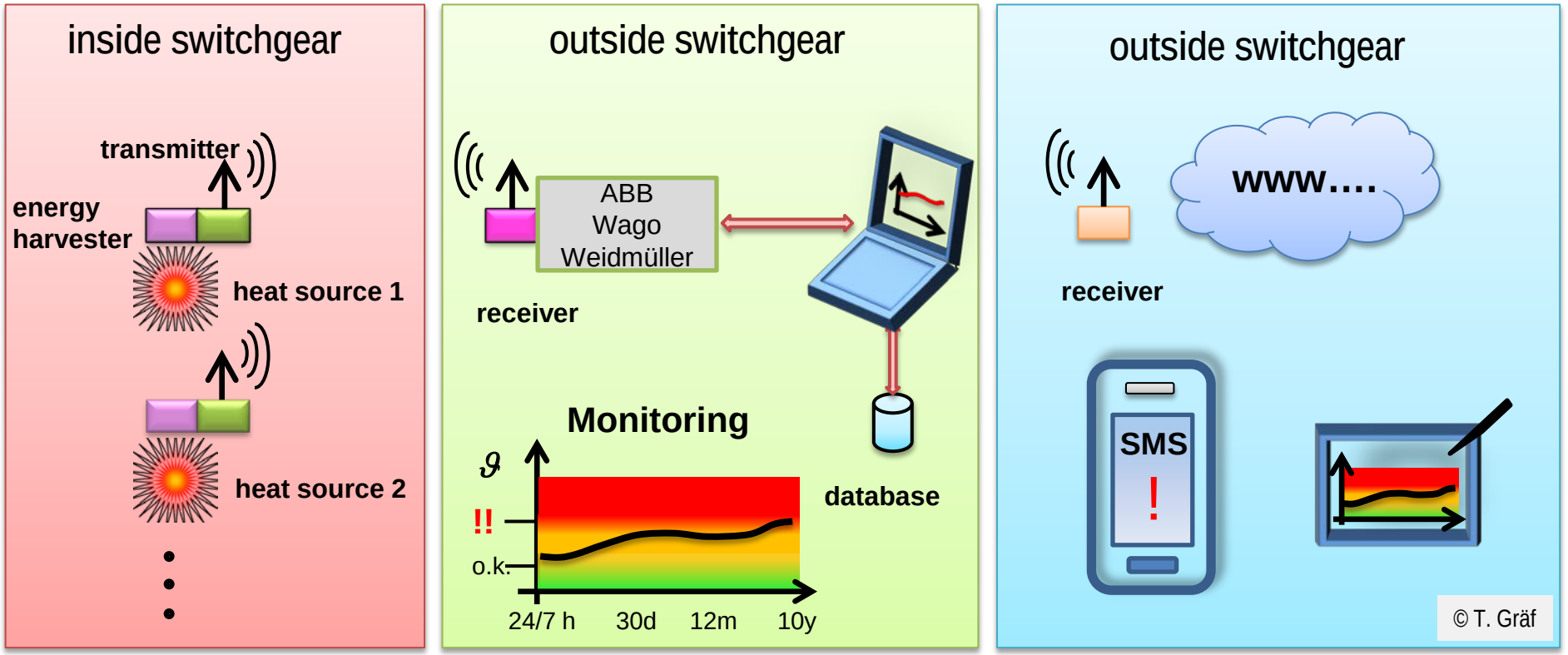
Investigations on insulation coordination and dielectric condition

- Measurement of the impulse withstand voltage with and without thermal sensor to estimate the influence
- Mesurement of the inception and exception voltage for partial discharges
- test of the radio frequency transmission between fuse sensor and receiver while the sensor is operating inside switchgear und current flow

temperature measurement inside switchgear

1. solution

2. solution



world premiere 2015

Energy HANNOVER MESSE

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damage avoidance

Hochschule für Technik und Wirtschaft Berlin
University of Applied Sciences

Use cases - advantages

Use Cases

- Measurement at screws, joints, fuses
- Measurement at circuit breakers, busbars, current transformers, voltage transformers at high voltage level as well as low voltage level

Advantages

- Optimized utilization – considering the ambient temperature – short term overload recognition
- Monitoring of the temperature while short circuit current
- Prevention before failure – maintenance support

- Measurement at unreachable measuring spots
- Connectivity to any communication standard
- No maintenance necessary
- Transfer of measurement data, warning via sms, email or internet by passing limits

Acknowledgment

NH/HH-Recycling

IPH BERLIN

DRIESCHER · WEGBERG
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Thank you for your attention!