TIGRES

Plasma for perfect adhesion

Plasma for perfect folder gluing

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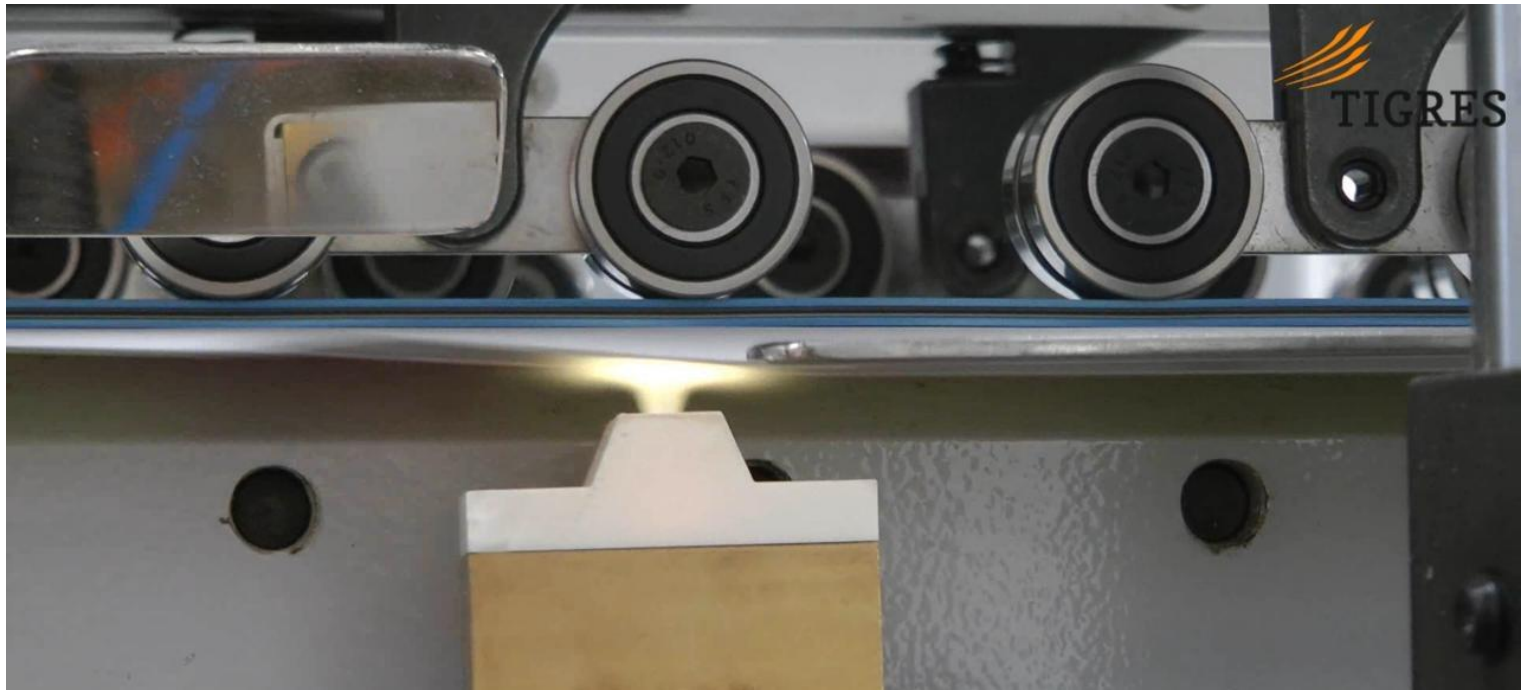

Introduction

Berrin Küzün

Dipl. Phys.-Ing.

Head of process engineering, project management, working with plasma and plasma coating since 2009.

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TIGRES

Plasma for perfect adhesion

Introduction

Peter van Steenacker

Electronics engineer

Sales Manager since 1998 for plasma systems. Extensive experience with plasma nozzles (APPJ), DBD-Plasma and vacu

Extensive experience in lecturing regarding plasma treatment, with presentations, seminars, webinars and training.

Head of PlasmaXperience, the platform from TIGRES for plasma know-how

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TIGRES
Plasma for perfect adhesion

About TIGRES GmbH

TIGRES GmbH has been established in 1993 as an independend, family owned technology based company

Targets:

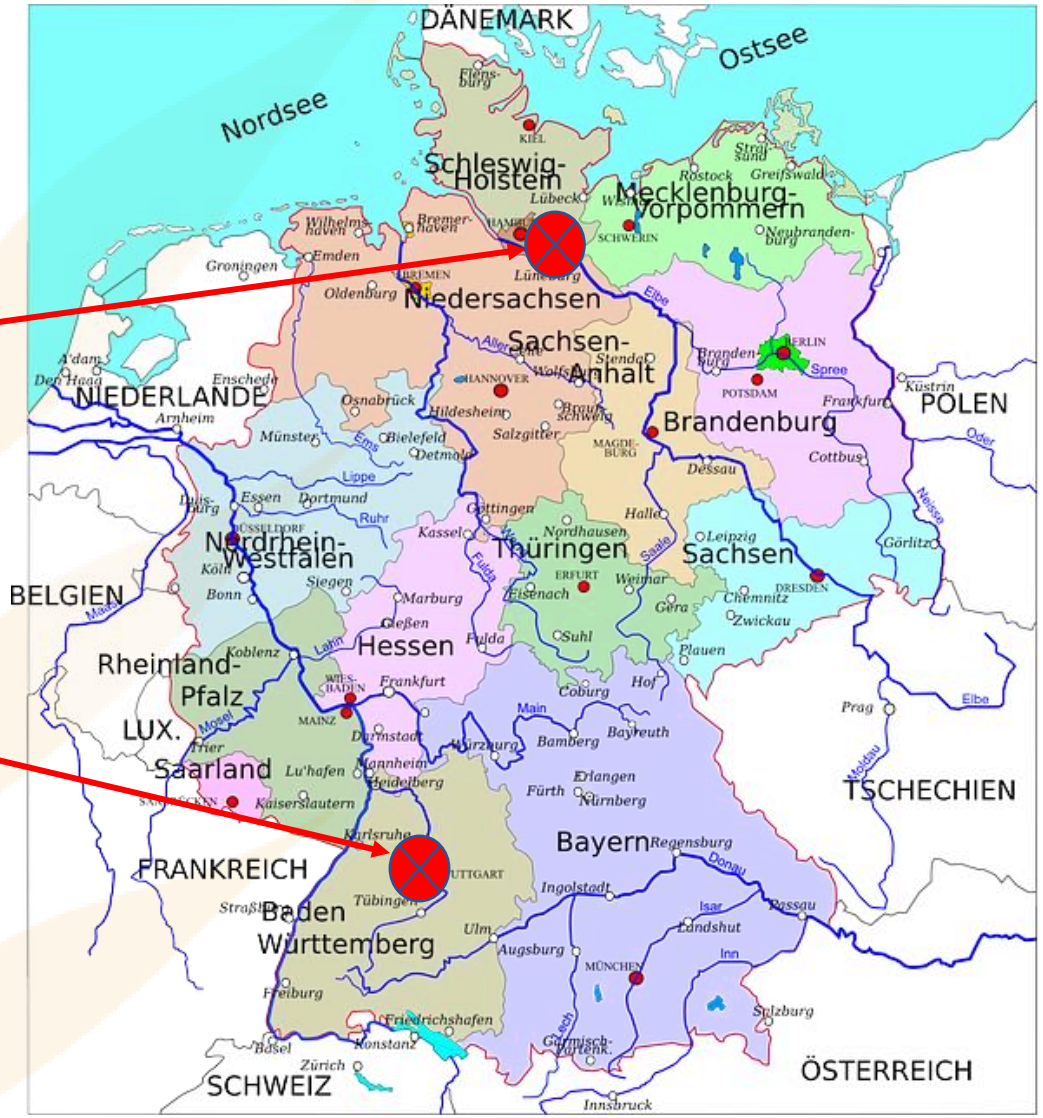
- ✓ Development
- ✓ Production
- ✓ Sales

of atmospheric plasma (AP) units

- ➢ AP Plasma devices for narrow and wide plasma application
- ➢ AP Plasma in different power categories
- ➢ AP Plasma with different temperatures
- ➢ Generators

TIGRES GmbH Germany

- Appr. 25 Empolyees
- Main office and production in Marschacht (near Hamburg)
- Sales office near Stuttgart
- Appr. 14 sales agents world wide



Picture from OpenClipart-Vectors auf Pixabay

Applikation folding boxes: Purpose of treatment

High end folded boxes for high price products with difficult to bond surface like painted or lamined are treatet with plasma to enable or improve adhesion of glue.

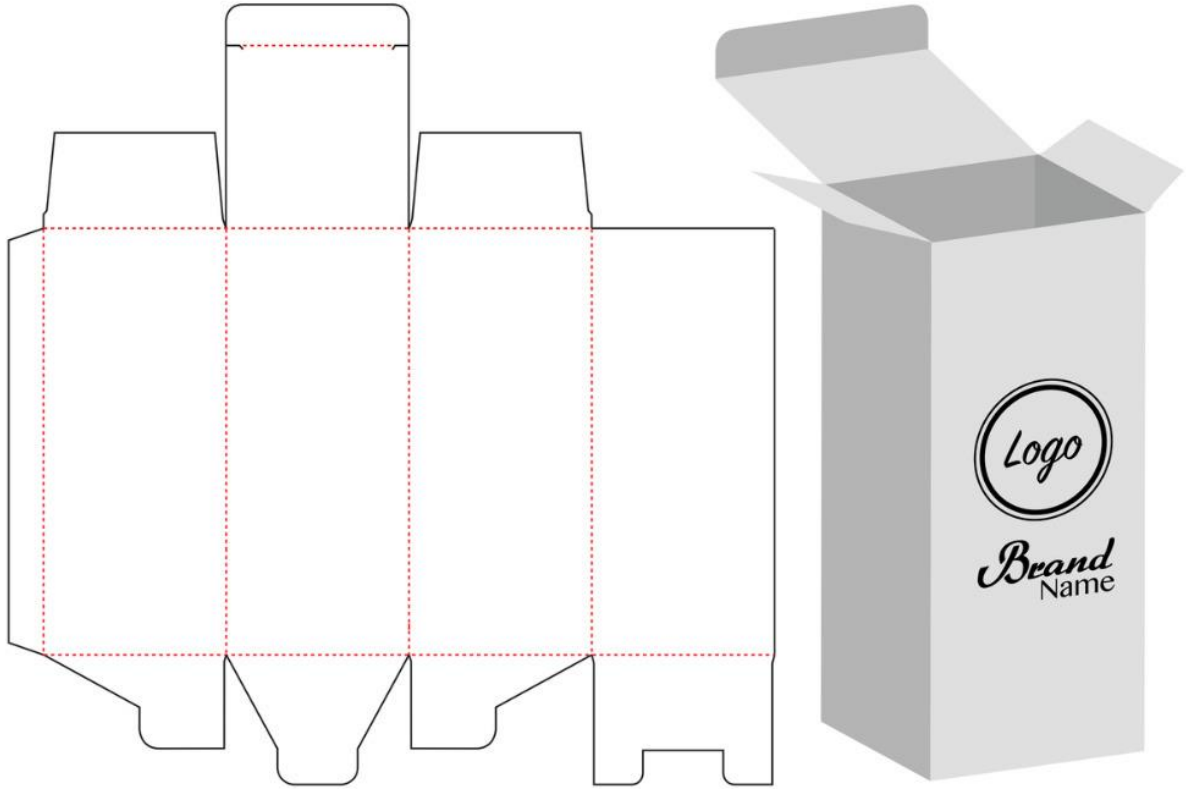
Application Folder Gluer: Goal of customer

Goal of customer:

Gluing of folding boxes made of cardboard on painted or laminated surface with low surface energy, using standard glue.

Typical specification:

- 1-4 glue application nozzles, mostly 3-4
- Speed up to 600 m/min
- Treatment width <15 mm per nozzle



Application folder gluer: Glue types and material

Glue types:

Water based glue, PVA glue (Weißleim)

PU-Hotmelt

Cardboard material: Cardboard/paper

Cardboard Coatings:

PE: Easy to treat, mostly very good adhesion, also for water based glue. Sometimes can be burned of when operating at slow speed.

PET-Film

Varnish

UV-Coating

Application Folder Gluer: Typical folder gluer

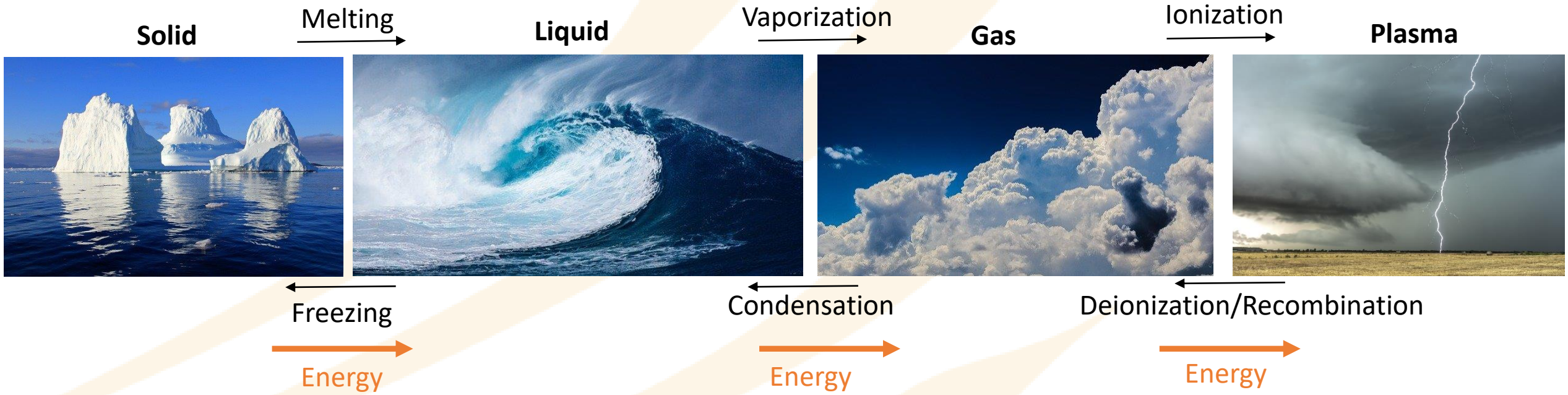
Folder gluer: Modular system, fitted to customers needs. Customers prepares system for specific folding box.
Example: MK, former Heidelberg

Application: Folder gluer manufactorers

Manufacturers (OEM):

Heidelberg (MK) (Germany)
Bobst (Switzerland)
Kama (Germany)
Kohmann.de (Germany)
Bahmüller (Germany)
Koenig & Bauer Duran (Turkey)
Vega (Italy)
Western Slope (USA)
Heasn (China)
Etc.

What is Plasma?



Plasma is an ionised gas.
More than 99 % of all visible mater in the universe are in the plasma state (Wikipedia).

The surface

Dust, dirt, oil etc. >1µm

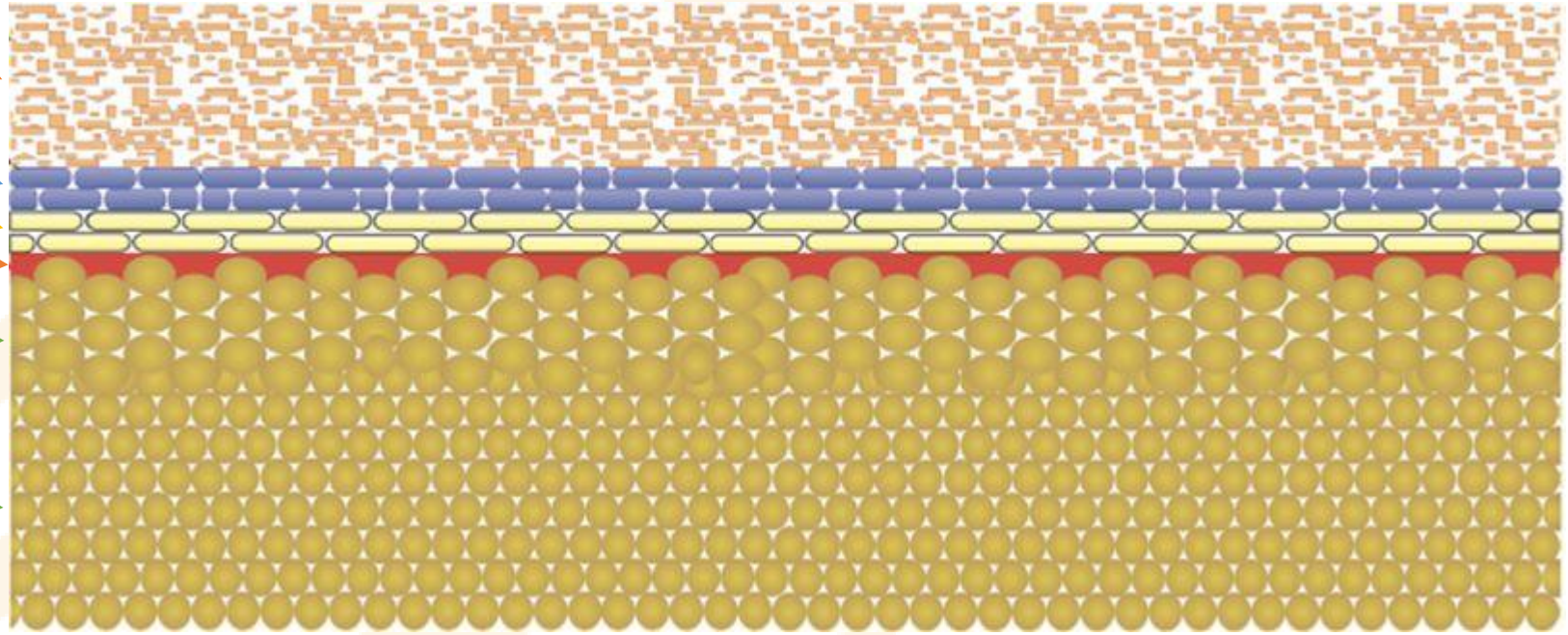
Gases, water 5-10 nm

Oxides, additives 5-10 nm

Boundary surface

High density layer >1 µm

Undisturbed region



Picture: Dipl. Ing. (FH) Simone Fischer

The perfect surface

Dust free

Fat free

Dry

Adhesion theory

Effects multiply each other

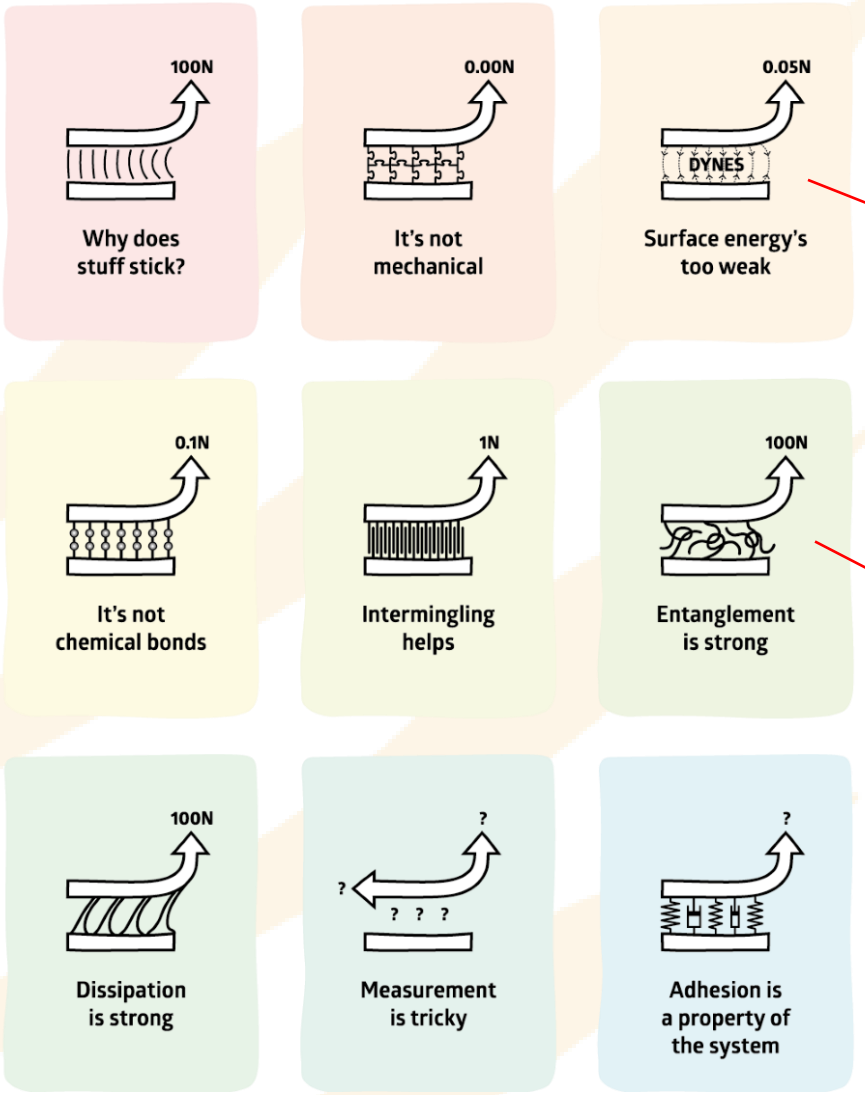
1. Primary valency bonds
2. Secondary valency bonds
   1. Van der Waals interactions
   2. Dipol interactions
   3. Induction forces
   4. Dispersion forces
   5. Hydrogen bonds
3. Mechanical clamping
   1. Change of surface from semi-crystalline to amorph, (enables Polymer-Polymer-Interdiffusion)
   2. Electron/ion bombardment
4. Diffusion
   1. PVC with diffusion adhesives
   2. PS with Cyanacrylat
   3. PMMA with UV adhesives
5. Electrostatic forces

https://de.wikipedia.org/wiki/Van-der-Waals-Kr%C3%A4fte

https://pubmed.ncbi.nlm.nih.gov/25008078/

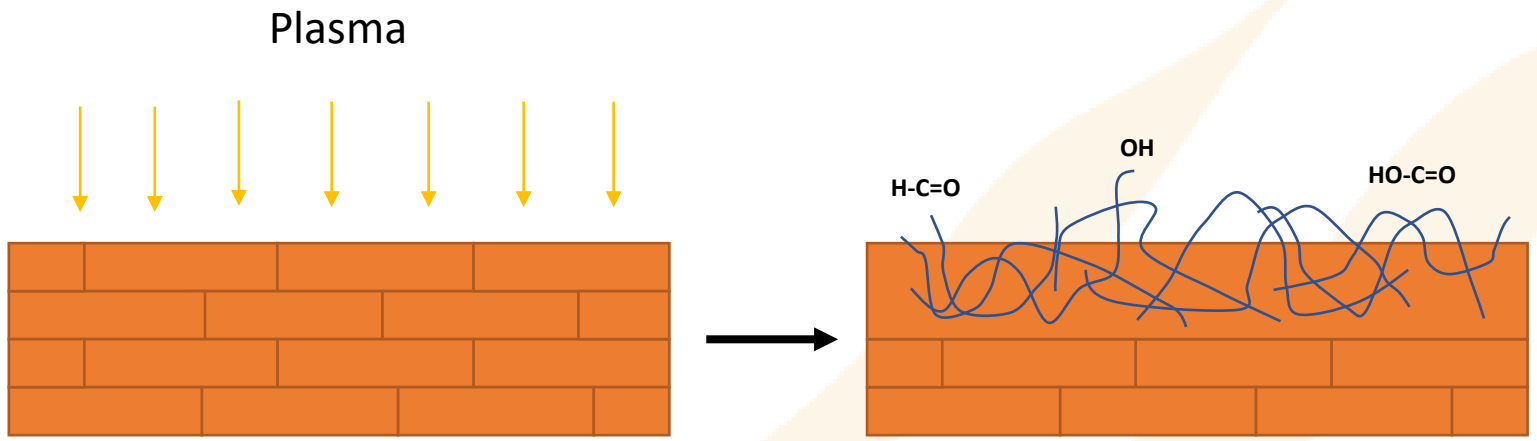
Adhesion: Why does stuff stick?

Prof. Steven Abbott
PhD in Chemistry
https://www.stevenabbott.co.uk/about-prof-steven-abbott.php



https://www.stevenabbott.co.uk/practical-adhesion/

Influence of plasma on crystallinity



Crystallin/partly crystallin surface

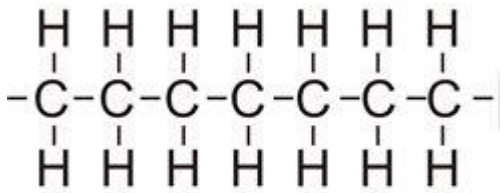
Amorphous surface

Effect of plasma treatment:
Surface gets more arorphous
Enables intermingling/Entanglement

Source: https://www.stevenabbott.co.uk/practical-adhesion/entanglement.php

Reactions on the surface

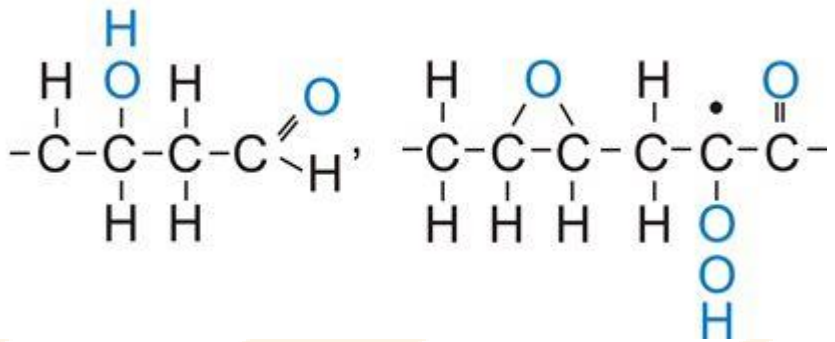
Polymer chain (PE)



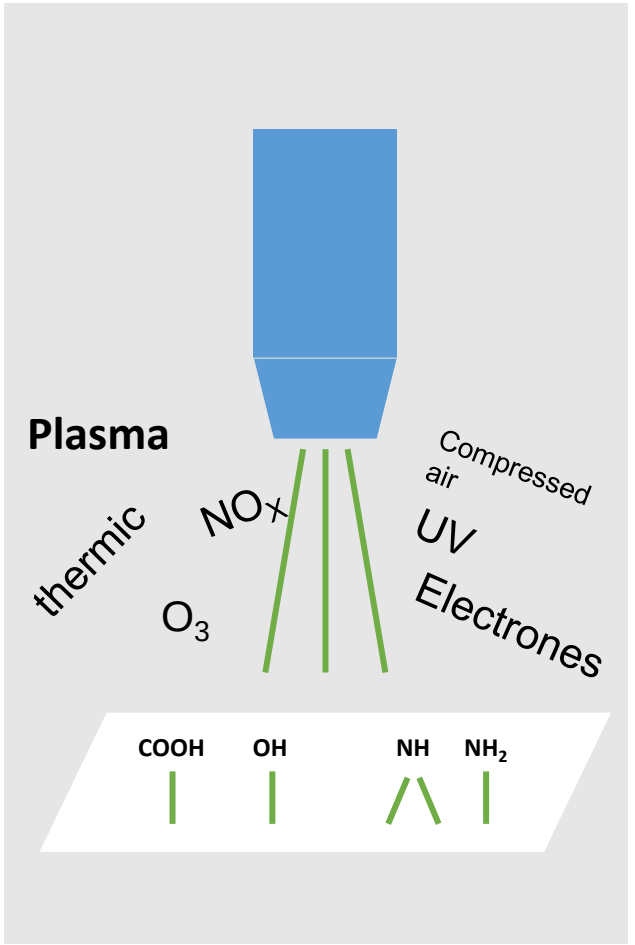
reactive species

•OH, •OOH, •O etc.

Pre treatment



Picture: Dipl. Ing. (FH) Simone Fischer



- Radicals and photons, created by the plasma, break the polymer chains
- Oxygen and nitrogene is bounded to the polymer chain

⇨ Increase of surface energy of the Polymer

Effect of surface treatment on wettabilty

Influence of surface treatment on the wettablity of polymers

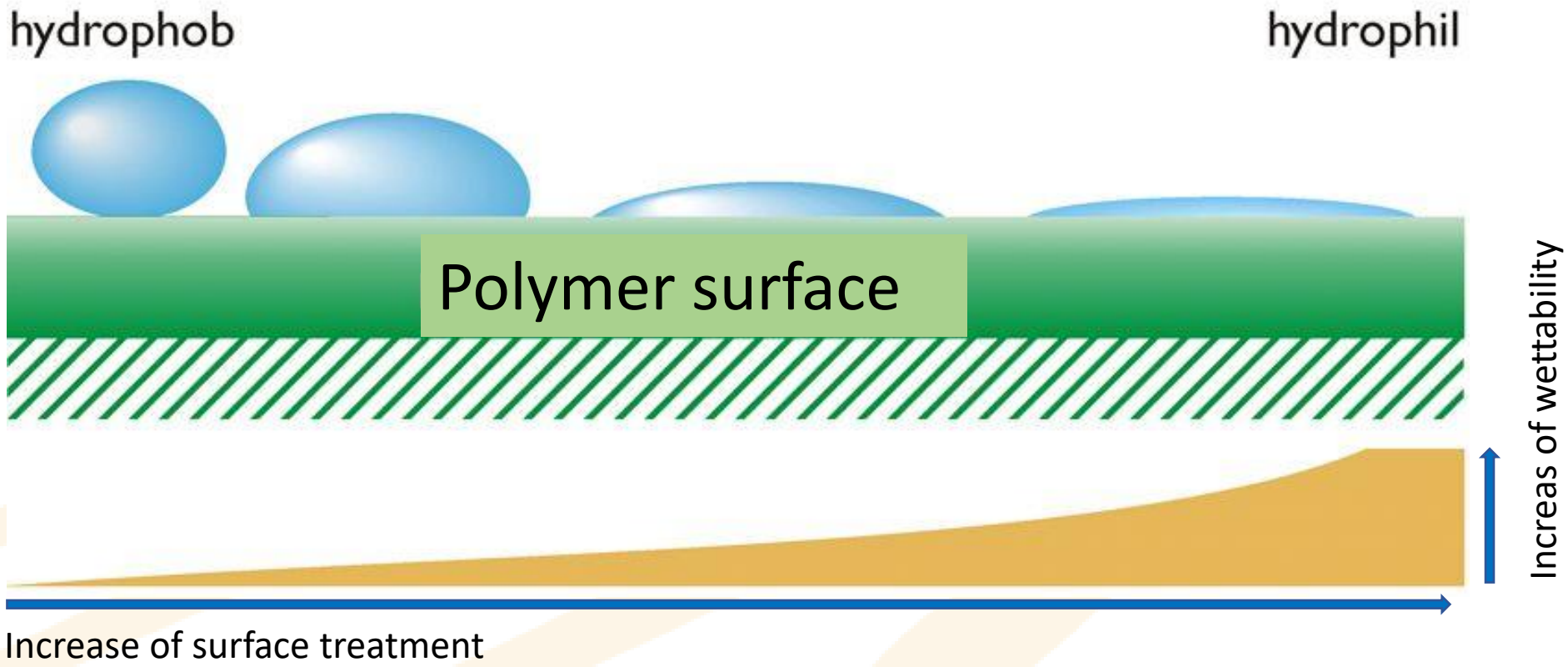


Bild: Dipl. Ing. (FH) Simone Fischer

Surface energy and material

Typical surface energy of polymers:		Typical specified surface energy for:	
PTFE	< 18-19 mN/m	UV-Ink	Appr. 48 – 56 mN/m
Silicone	< 20 mN/m	Water based ink	Appr. 50 – 56 mN/m
PP	Appr. 29-31 mN/m	Coatings	Appr. 46 – 52 mN/m
PE	Appr. 30-32 mN/m	UV-glue	Appr. 44 – 50 mN/m
PS	Appr. 34-38 mN/m	Water based glue	Appr. 48 – 56 mN/m
PC	Appr. 35-44 mN/m	Solvent based glue	Appr. 38 mN/m
PUR	Appr. 43-47 mN/m		

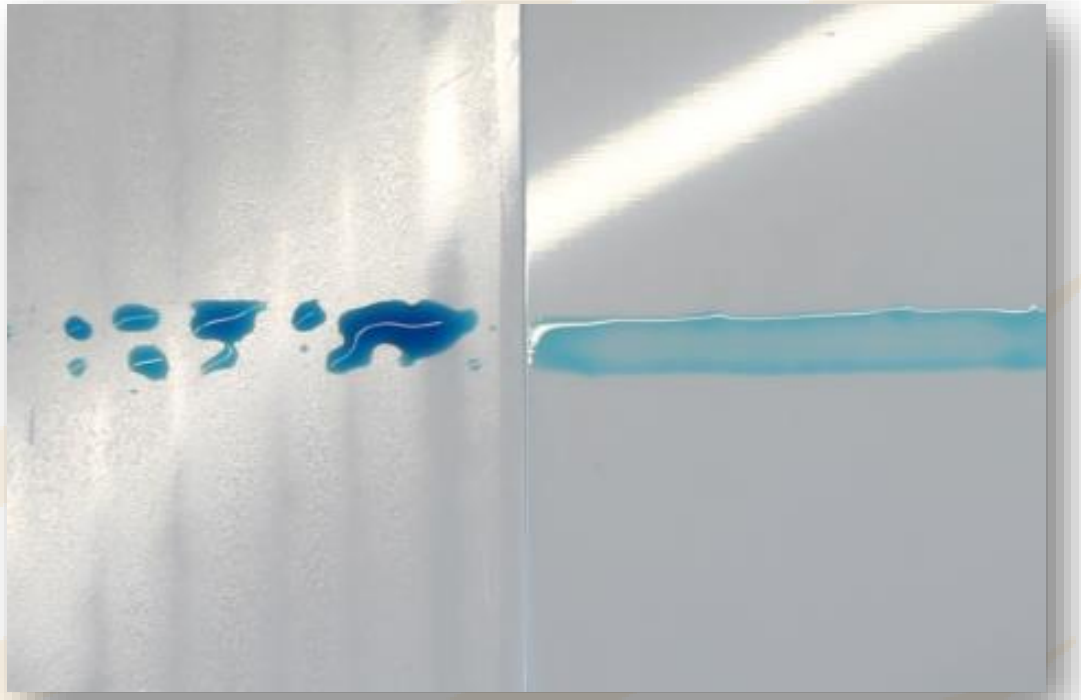
Test inks for measurement of surface energy

Definition:

- Measurement is done in mN/m. In the past it was also refered to as „Dyne“
- ISO 8296: The film of the test ink has to have a sharp edge for 2-3 sek. or more
- ISO 8296 is defined for PE film
- Lifetime is 3 months according to the ISO 8296. More details in separat test ink slides.
- Test ink shop

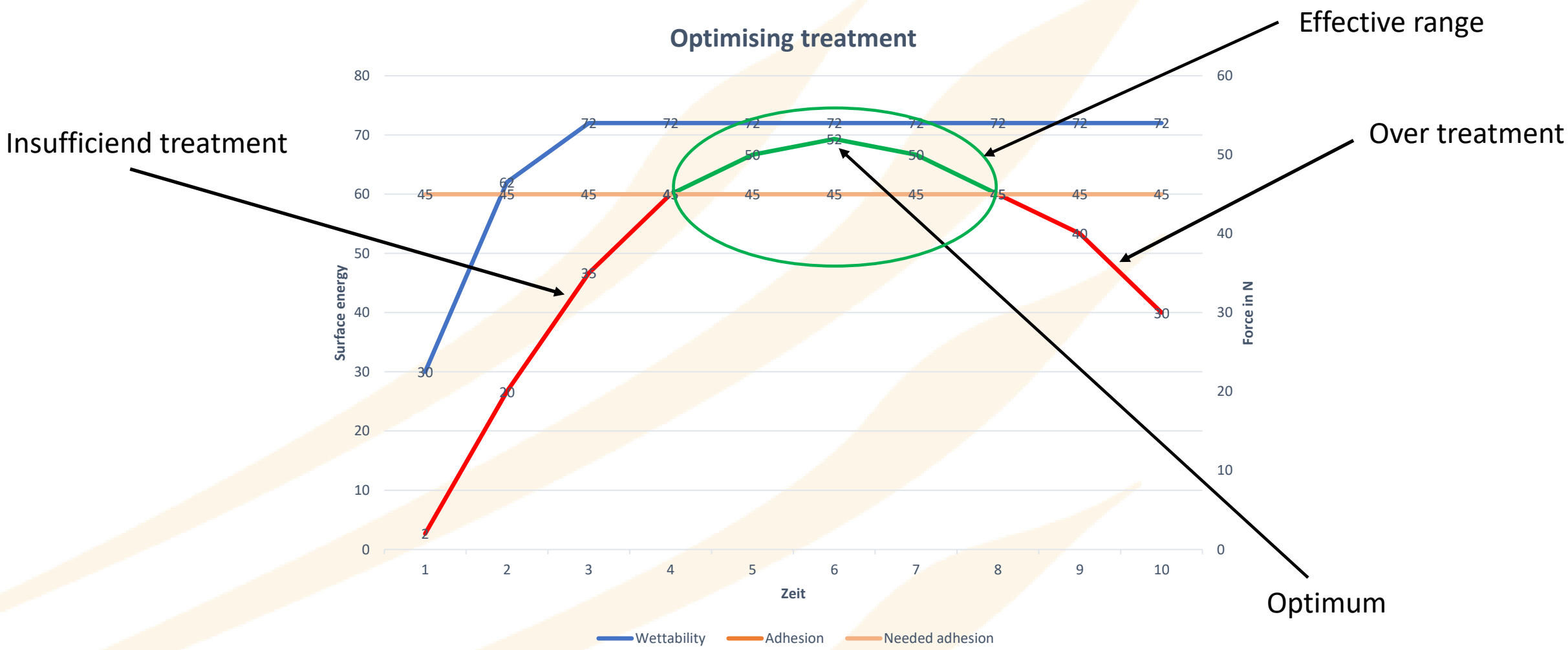
Wettability of surface

Low surface energy
Test ink stay for less than 2-3 sek.

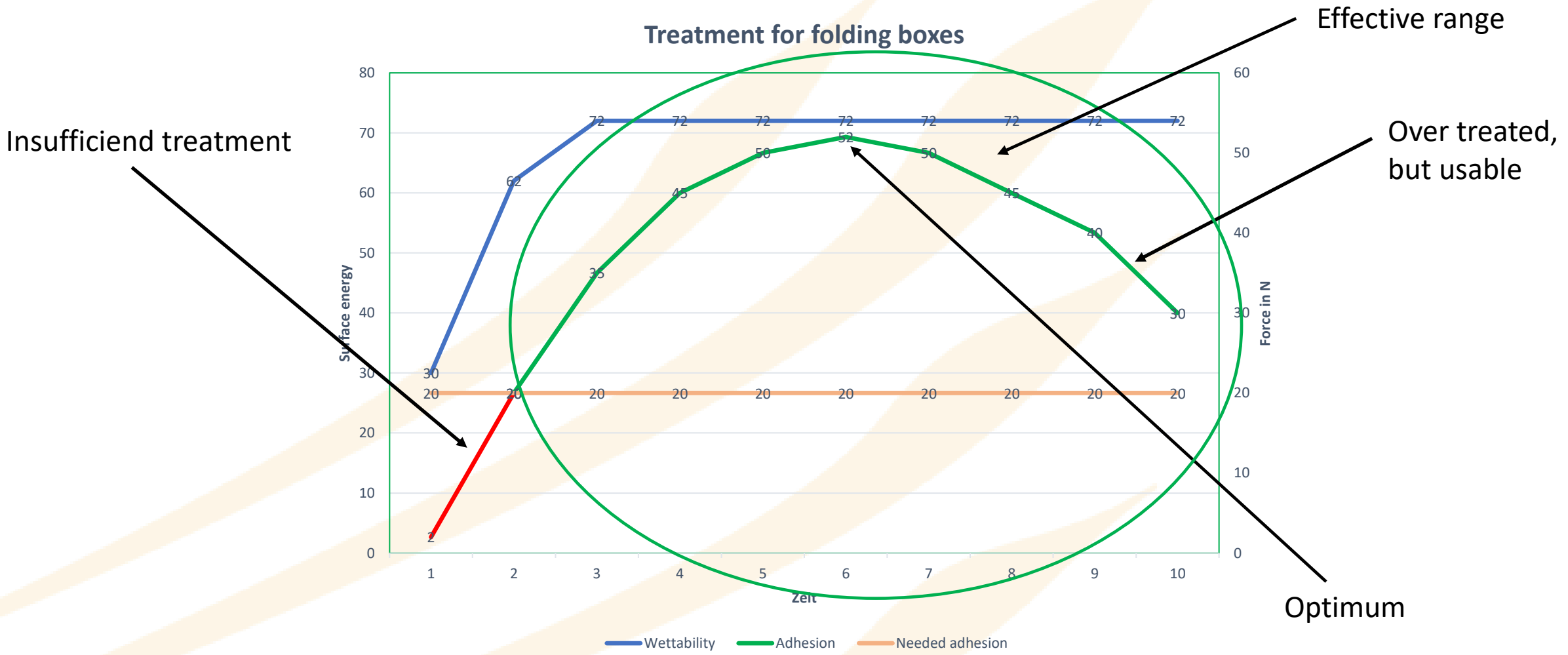


High surface energy
Test ink stay for 2-3 sek. or longer

Using plasma for folding boxes: Finding the perfect plasma dose



Optimising plasma for folding boxes



Application Folder gluer: TIGRES solution

TIGRES Solution:

- M4 Generator with up to 4 CAT1000 nozzles, typical 3-4
- Trolley (mobile solution often demanded) for several production lines
- Mounting brackets for nozzles
- Optional exhaustion

Application Folder gluer: TIGRES solution

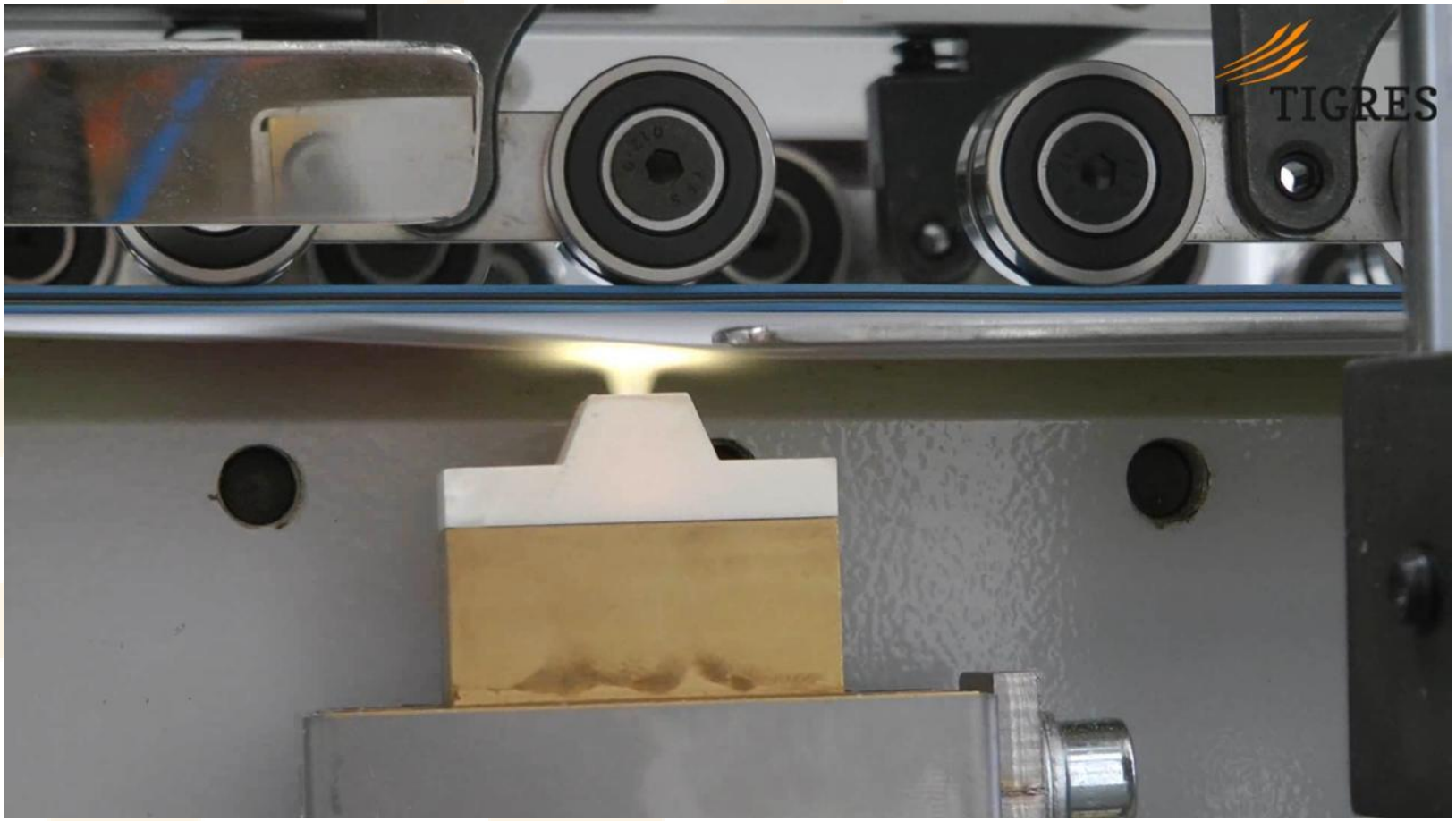
Application Folder gluer: Using plasma

Typical adjustment CAT1000

Distance nozzle to surface:

5 - 15 mm

The closer the nozzle is to the surface, the hotter it the surface gets

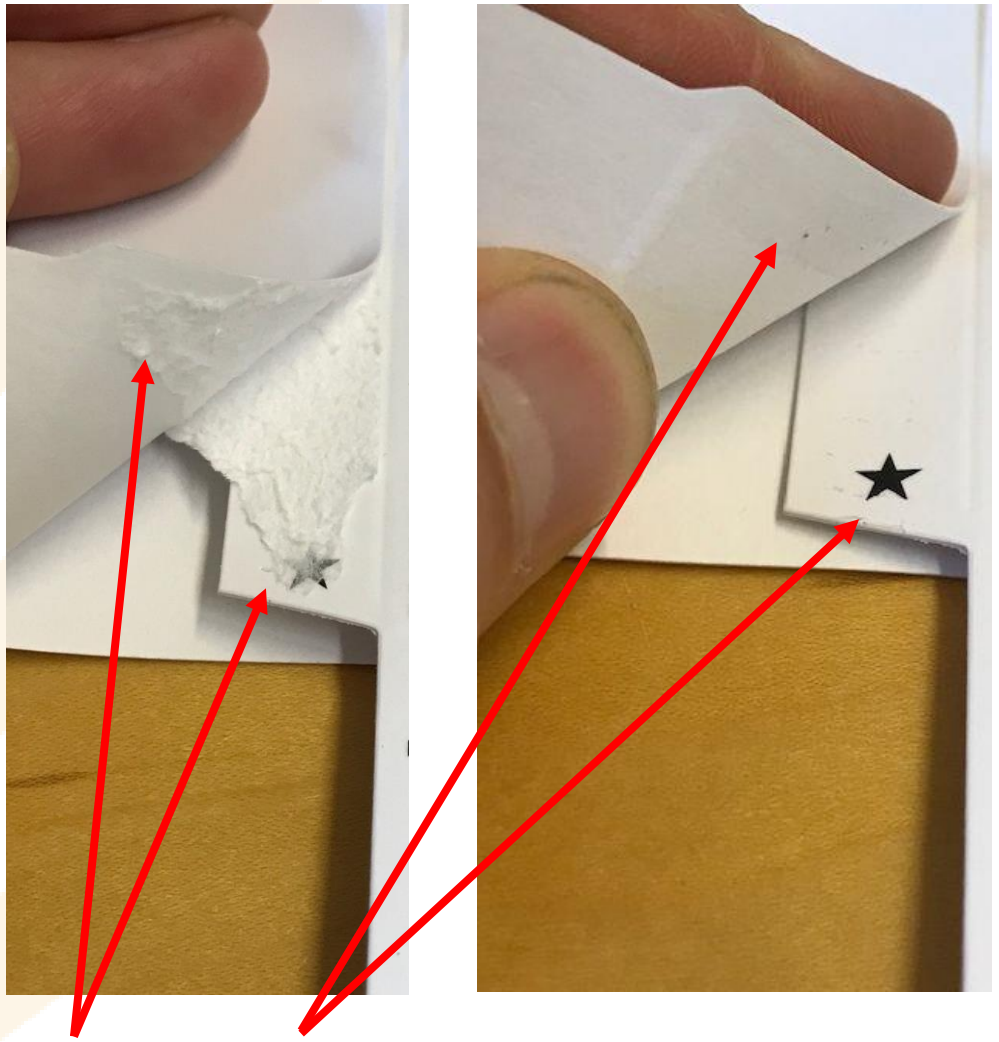


Application Folder Gluer: How to test treatability with plasma

How to:

- Distance Nozzle to cardboard 5 - 15 mm (Focus nozzle)
- Cardboard with paint or plastic film
  - Activate for hotmelt
  - Burning/activating plastic layer of for water-based glue

  - Glue can take up to 24 h to dry!



With and without plasma treatment after 24 h

Benefit of plasma for folded boxes

Benefits

Increase in productivity

- ✓ Less glue types in stock (no more need for special glues)
- ✓ Lowering of production costs, standard glues usable

Improved quality

- ✓ Perfect, homogeneous and consistent gluing of coated, laminated and synthetic surfaces

Optimised ergonomics

- ✓ Each nozzle customized control and adjustable
- ✓ Optional trolley for flexible use
- ✓ Adjustable mounting per nozzle for easy handling in the machine

Reduction of environmental impact

- ✓ No VOC (volatile organic compounds)
- ✓ No solvents

Complies CE regulations

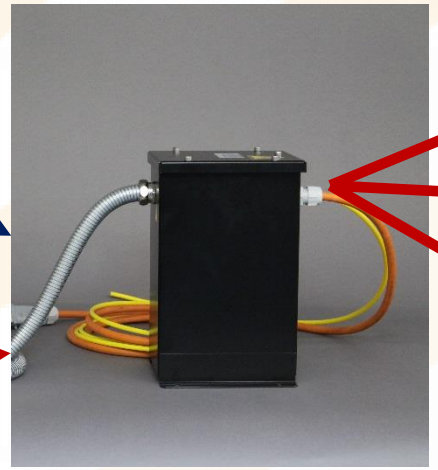
General structure of standard devices

Power supply

+

Tool

Generator + Transformer external



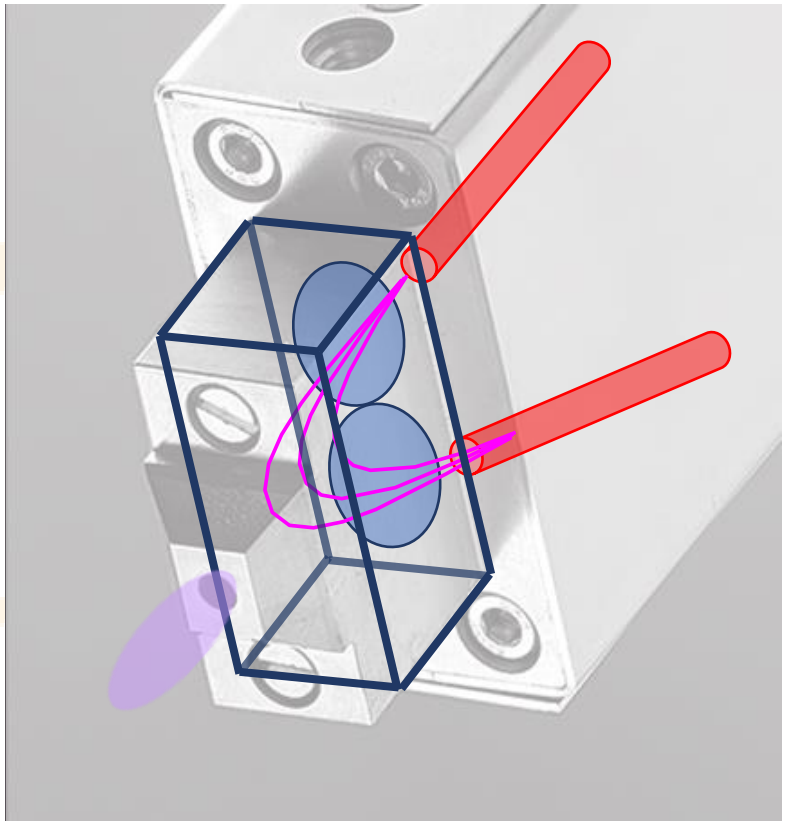
T-SPOT

CAT

MEF

Tool CAT

Plasma is generated by two arcs, whereby the counter arc also acts as the counter electrode = minimizing the effects of wear on plasma generation. CAT= Curved Arc Technology



1000 [W] / Nozzle

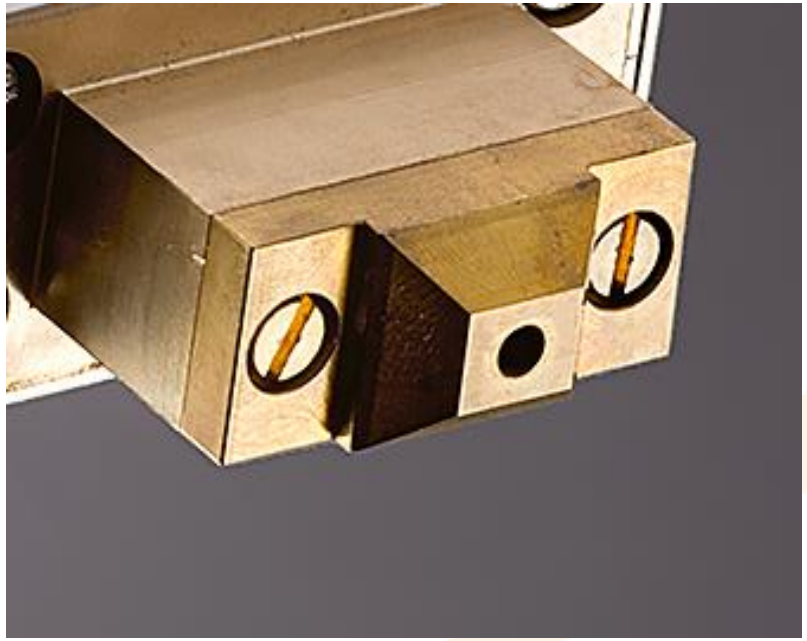
50 [l/min] / Nozzle

(CAT 1000)

Patented

The ramp up time of the plasma is app. 20 ms.
Lifetime of electrodes is up to 10.000 h

Tool CAT: Focus and Slot Nozzle



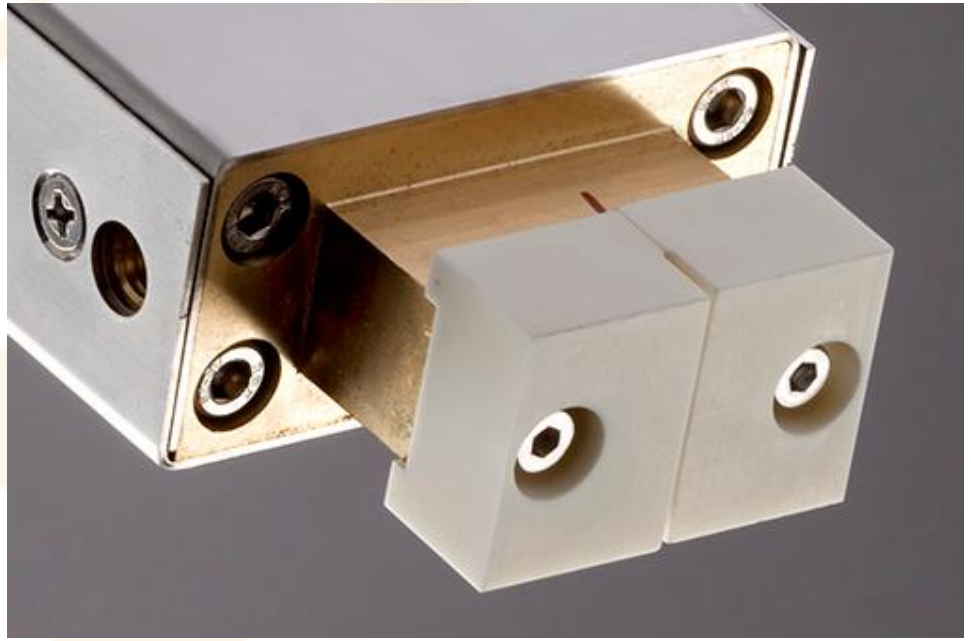
Focus Nozzle

<u>Treatment width:</u>

CAT1000: app. 14-18 mm

<u>Treatment depth:</u>

CAT1000: app. 18-25 mm



Slot Nozzle

<u>Treatment width:</u>

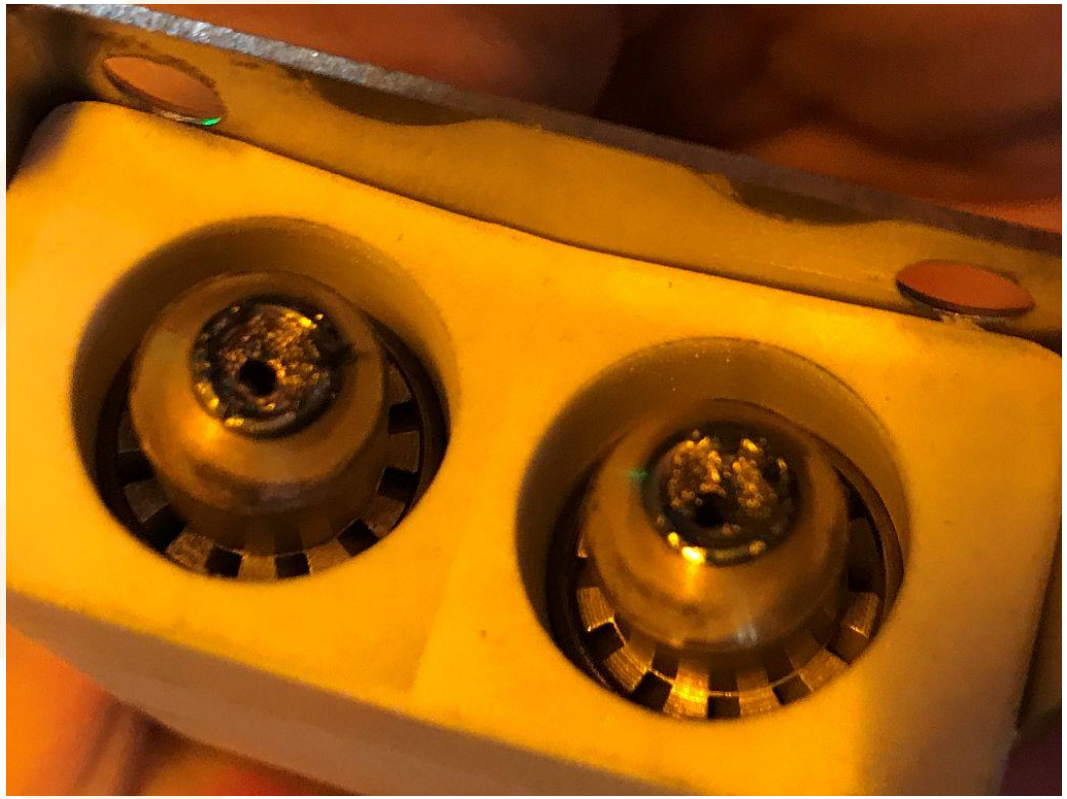
CAT1000: app. 25-32 mm

<u>Treatment depth:</u>

CAT1000: app. 4-8 mm

CAT: Changing Electrodes

CAT electrodes, 4.000 h, still ok



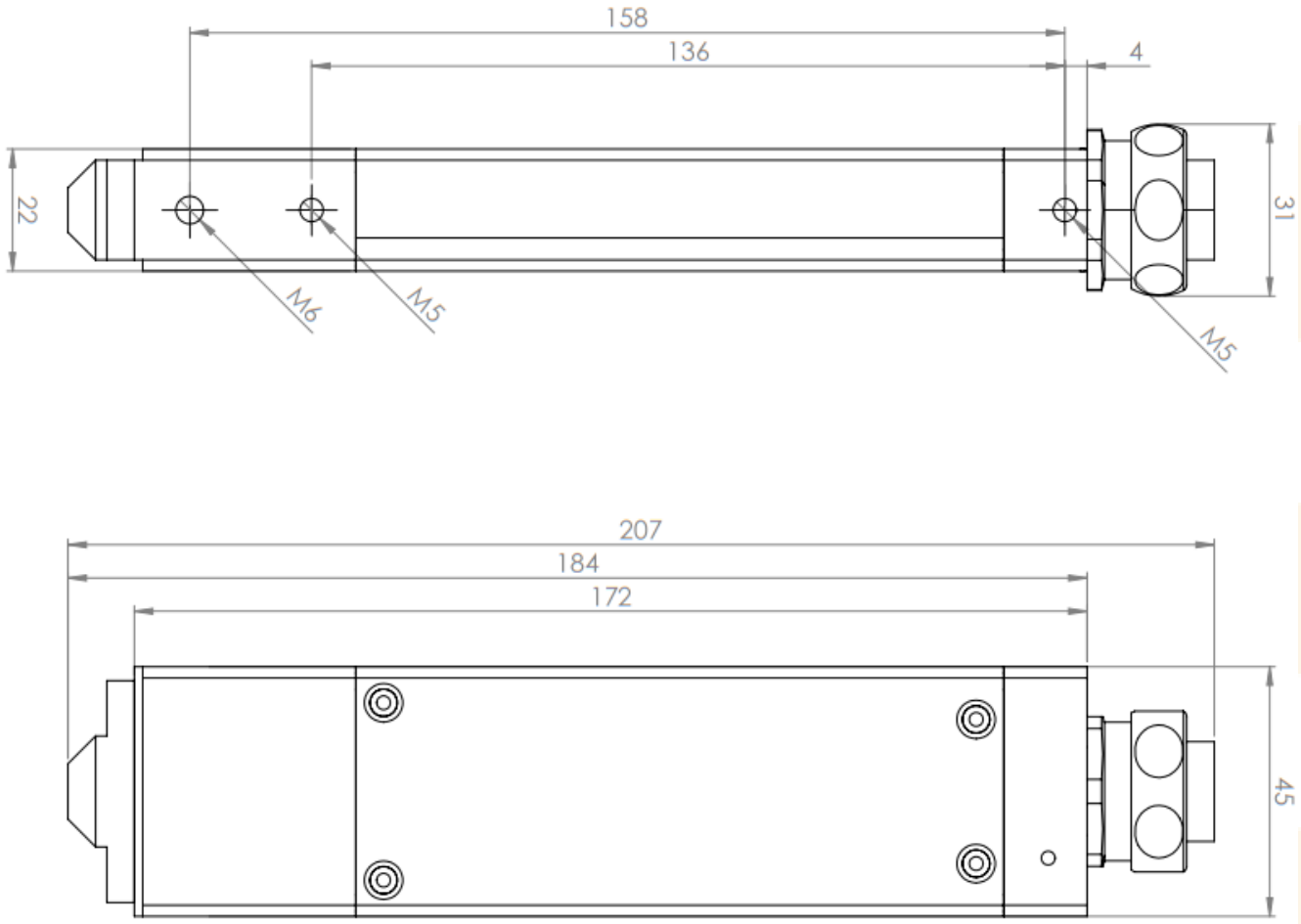
CAT electrodes, 8.000 h, still ok

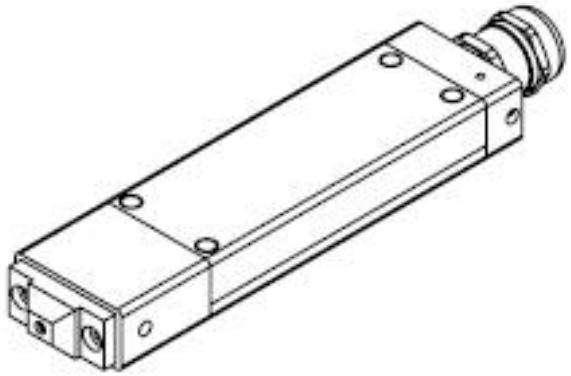
CAT electrodes, estimated lifetime in good production environment app. 10.000 h. Clean air and continous use helps.

CAT: Changing Electrodes

CAT1000: Drawings

CAT1000





Drawings and step-files available

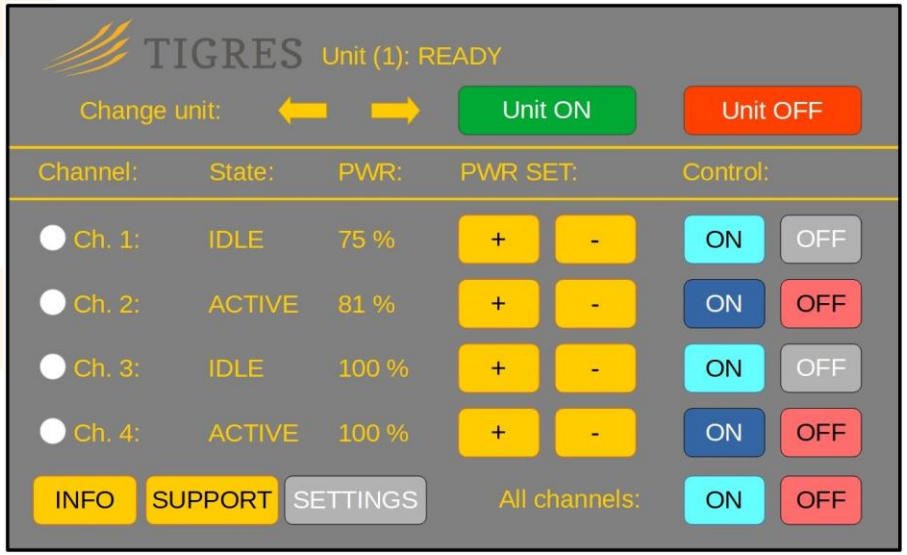
CAT1000: Technical Data

Plasma head	CAT1000 1K	CAT1000 2K	CAT1000 3K	CAT1000 4K
Treatment width[1)] per nozzle, focus and slot	Up to app. 18 mm (Focus) per plasma head Up to app. 30 mm (Slot) per plasma head			
Working distance[2)]	Focus : 3 – 20 mm, Slot : 2 – 5 mm			
Dimensions (h/w/d) app. in mm	182/45/22	(2x) 182/45/22	(3x) 182/45/22	(4x) 182/45/22
Weight app.	850 g	(2x) 850 g	(3x) 850 g	(4x) 850 g
Generator	M1	M2	M4	M4
Power	1000 W	2 x 1000 W	3 x 1000 W	4 x 1000 W
Power supply	400 V 3~; 10 A 50/60 Hz	400 V 3~; 10 A 50/60 Hz	400 V 3~; 10 A 50/60 Hz	400 V 3~; 16 A 50/60 Hz
Dimesions (h/w/d)app. in mm min. mounting depth	250/381/436 630 / 63 TE	250/381/436 630 / 63 TE	250/436/524 630	250/436/524 630
Weight app.	18 kg	20 kg	22 kg	22 kg
Supply cable	3 m, up to 10 m optional	3 m, up to 10 m optional	3 m, up to 10 m optional	3 m, up to 10 m optional
HV-Cable	2 m	2 m	2 m	2 m
Primary cable	3 m, min. 6 m possible	3 m, min. 6 m possible	3 m, min. 6 m possible	3 m, min. 6 m possible
Display	Yes	Yes	Yes	Yes
Remote control	Yes	Yes	Yes	Yes
Compressed air, 6 bar	55 l/min	55 l/min per tool	55 l/min per tool	55 l/min per tool
Transformer	External	(2x) external	(3x) external	(4x) external
Dimesions (h/w/d) app. in mm	270/145/160	270/145/160	270/145/160	270/145/160
Weight ca.	7 kg	7 kg	7 kg	7 kg
Options				

Depending on the application:[1) 2)]material, [1) 2)]treatment speed, [1)]working distance

M-Generator

- ✓ Modular, compact design
- ✓ Intuitive usable touch panel, external panel available
- ✓ Up to four nozzles per generator (M4)
- ✓ Each nozzle separatly controlled and adjustable
- ✓ High prozess reliability by monitoring of relevant system values for each single nozzle
- ✓ SQI (System quality index): Monitoring index of closed loop controller to ensure homogenius plasma power
- ✓ Efficient trouble shooting by detailled error log with functionality analyses and full text diplay
- ✓ Real time remote monitoring and maintenance with RSU
  - ➢ Full industry 4.0 functionality



Process reliability: Real power control

Key Feature #1: Real Power Control for each plasma head

The M-Generator controls each plasma head individually with a closed loop controller.

The controller not only measures the plasma power, but controls the power of the plasma within a specified window.

The controller turns off the plasma when the specified setpoint cannot be maintained.

What is controlled?

✓ Current

How: The frequency controls the current

Monitored:

✓ Line voltage Measurement

Process reliability: Real power monitoring with SQI

Key Feature #2: Real time monitoring with System Quality Index (SQI)

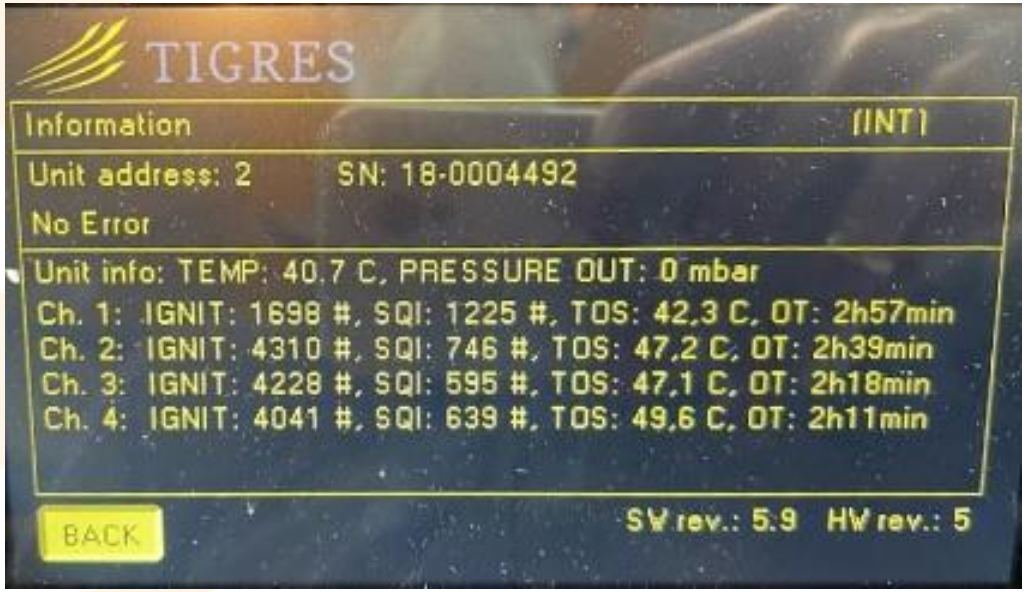
The M-Generator **controls the plasma** discharge and **calculates** an **SQI factor**.

1. DC-Current feedback output stage
2. Working frequency (controls the DC-current)
3. Setpoint control values: Input display/interface (f.e. 500 W)

4. Primary current

Out of the values 1 and 3 the SQI factor is calculated

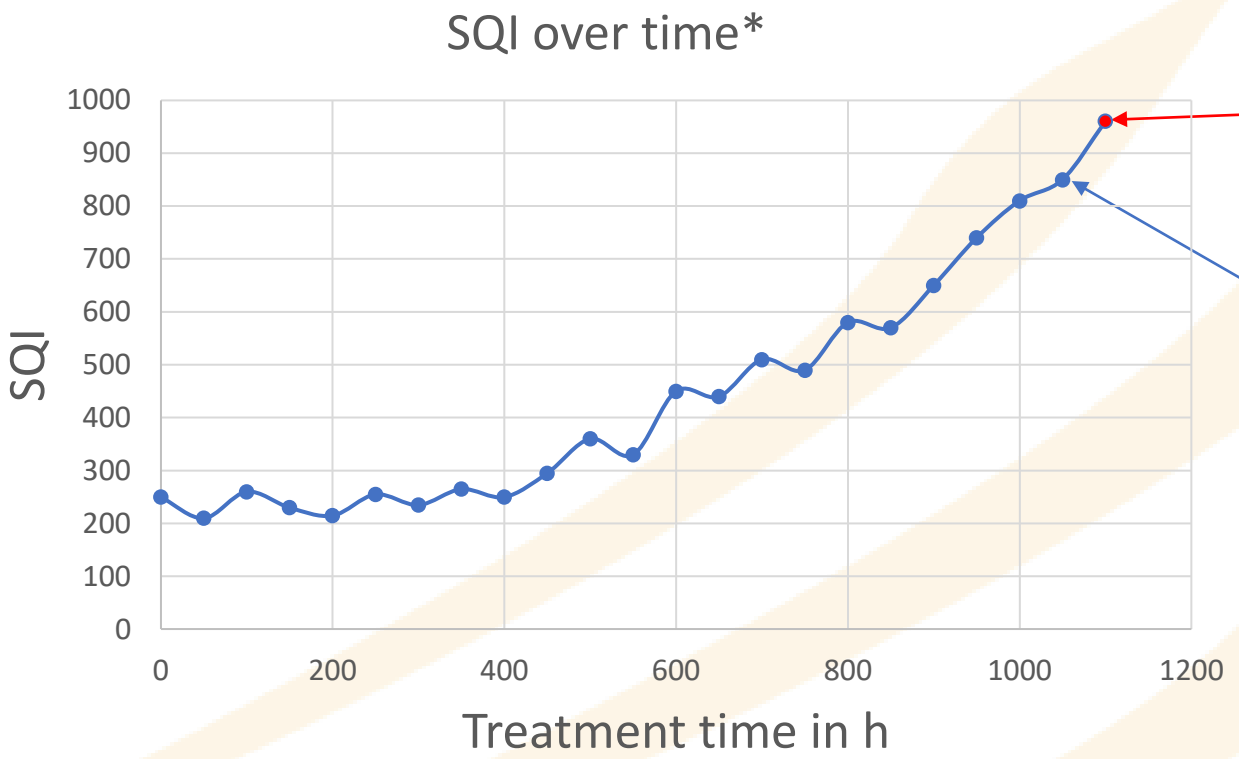
The limit of the SQI can be adjusted in the display/BUS to the need of the application.
(Very low for very sensitive processes, very high for very insensitive processes)



Example: Worn down elektrodes start to flicker. SQI increases about factor 3-4.

Process reliablity: Example worn out electrodes

Example SQI over time



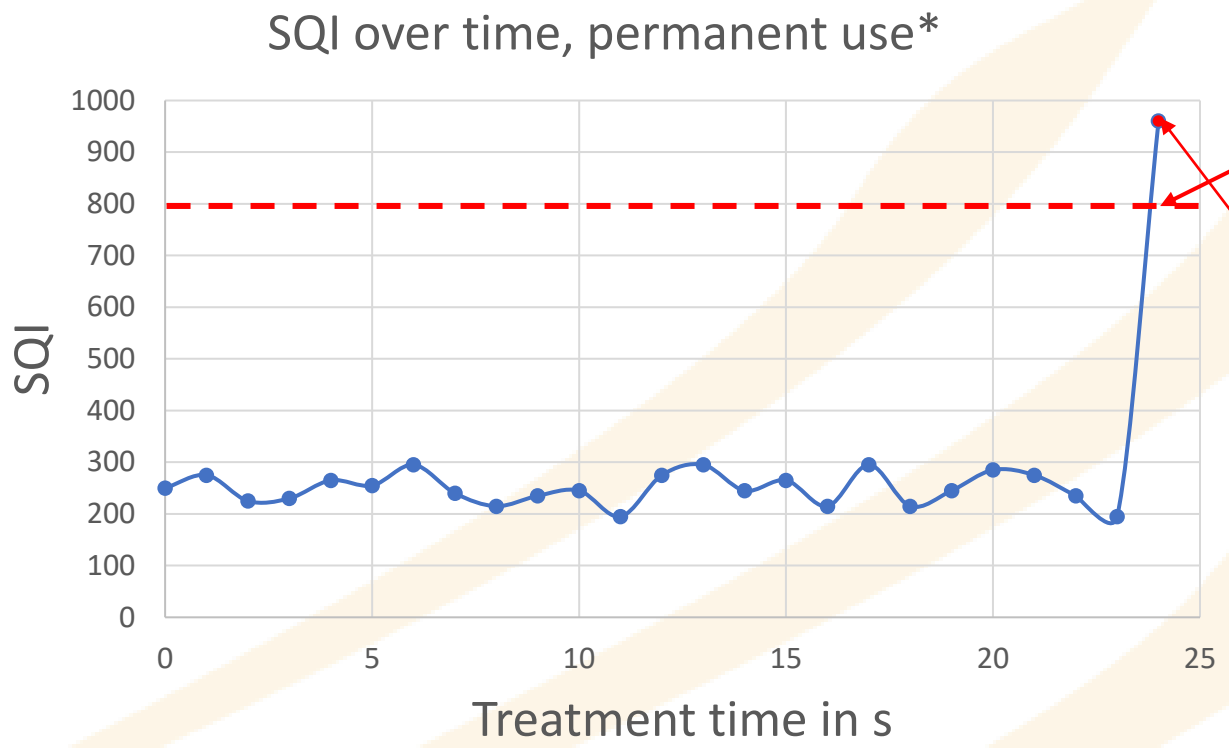
f. e. treatment results insufficient

f.e. treatment sufficient

Implement inspection of electrode after 850 h and possibly change of electrodes

*Example, SQI values are not memorised. Values have to be noted or evaluated via optional BUS connection.

Example SQI limit



In the example an SQI limit of 800 is set

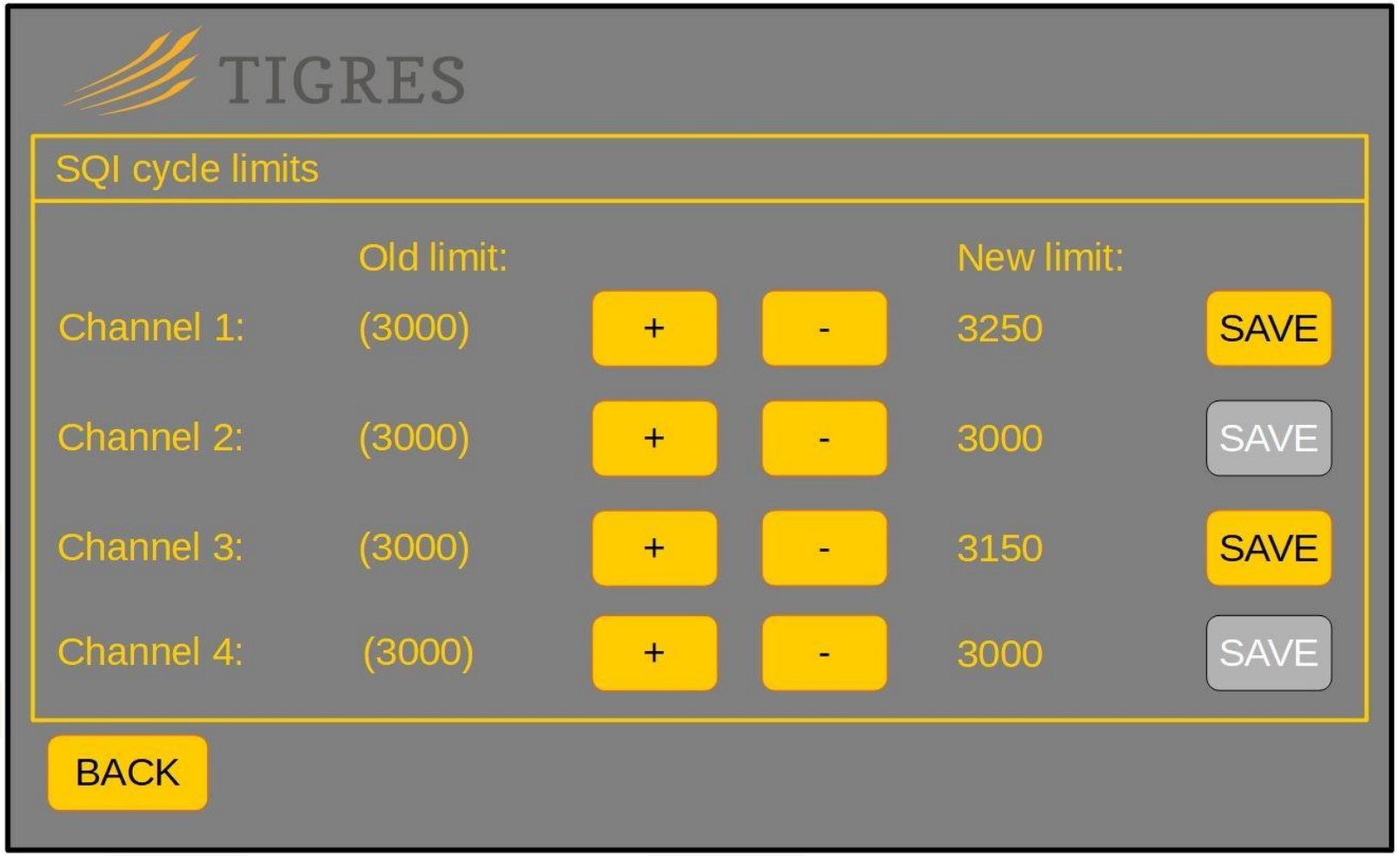
Plasma not ideal (f.e. air hose blocked), SQI-Wert > 800

Immidiatly after exceedind of SQI the system stops and shows an error

*Example, SQI values are not memorised. Values have to be noted or evaluated via optional BUS connection.

Process reliability: Real power monitoring with SQI

Key Feature #2: Real time monitoring with System Quality Index (SQI)

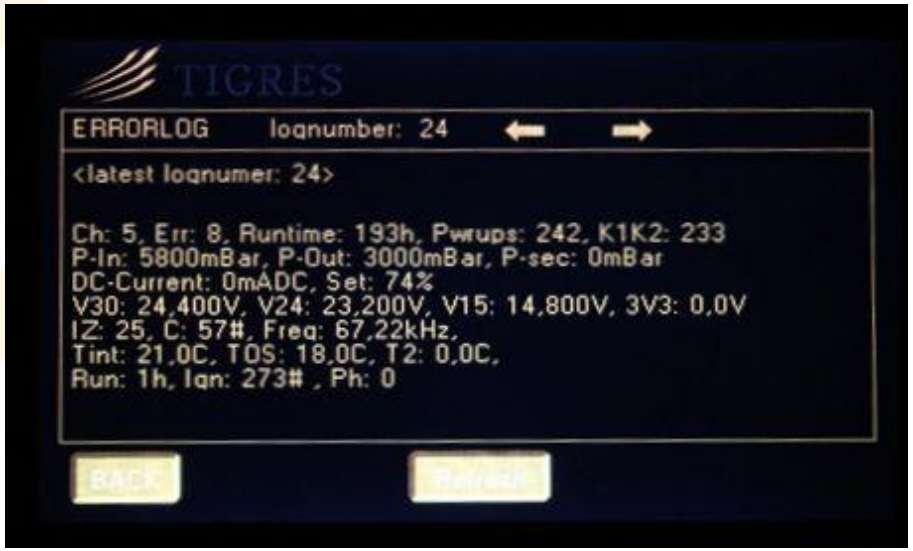


Process reliability: Error log

Key Feature #3: Error log with analysis functionality

In case of an error, the error Log saves a data set consisting of:

- Detailed error code (> 85 internal specified)
- Each error log contains of error code + a set of parameters at the time of occurrence
- 50 errors logged in display (EEPROM)
- All internal errors are stored on an SD-card
- Software tool for full data log enables a systematic trouble shooting



TIGRES Remote Service Unit RSU

RSU - *Remote Service Unit*

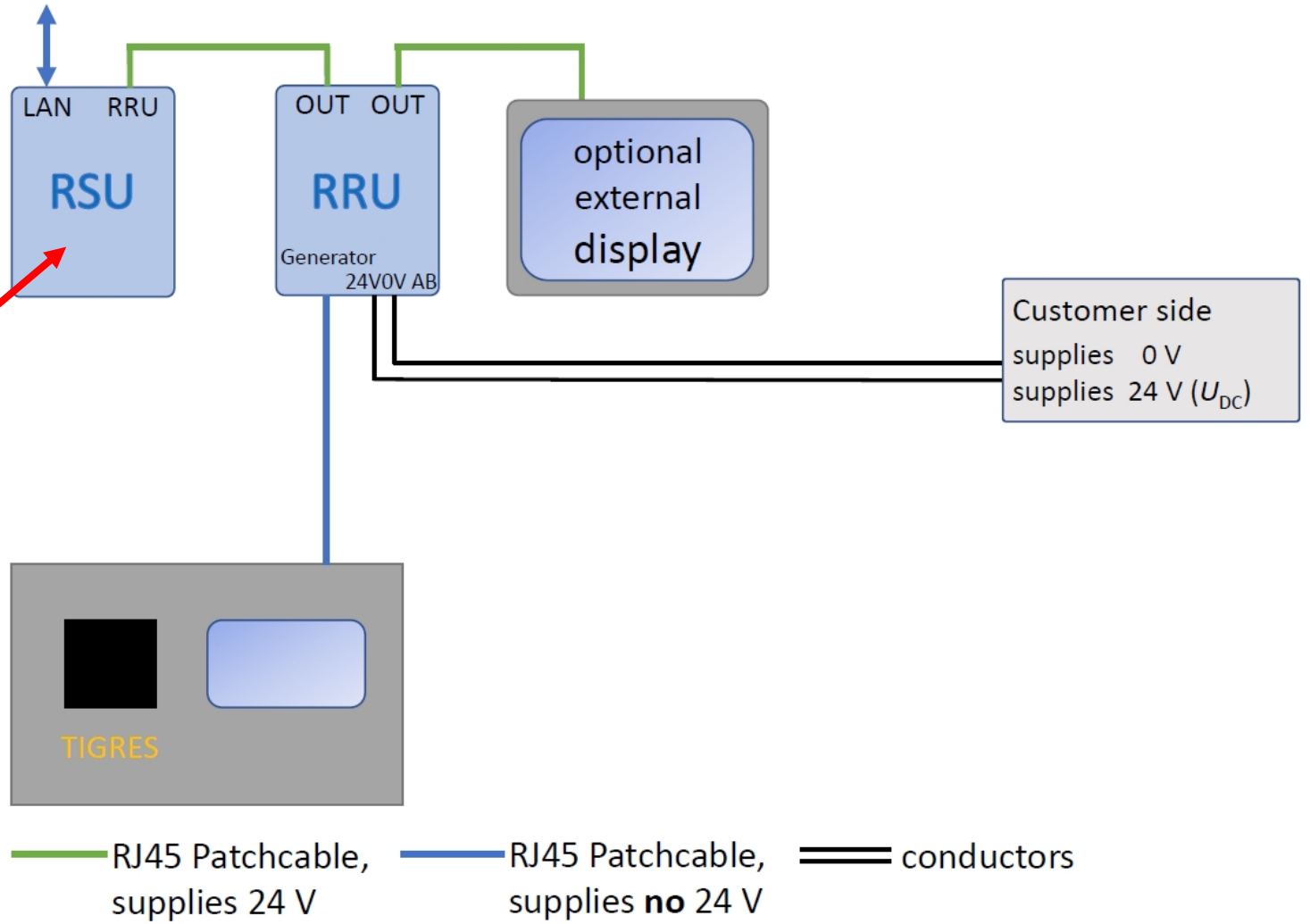
- RSU enables:
  - ✓ Real time remote maintenance
  - ✓ Remote change of configuration
  - ✓ Data logging
    - ➢ Data base enables better trouble shooting, optimization/individualization of the configuration
- Secure communication RSU ←→ TIGRES Server

→ Enables minimal downtime of trouble shooting cases due to instant access

TIGRES Remote Service Unit RSU in real time

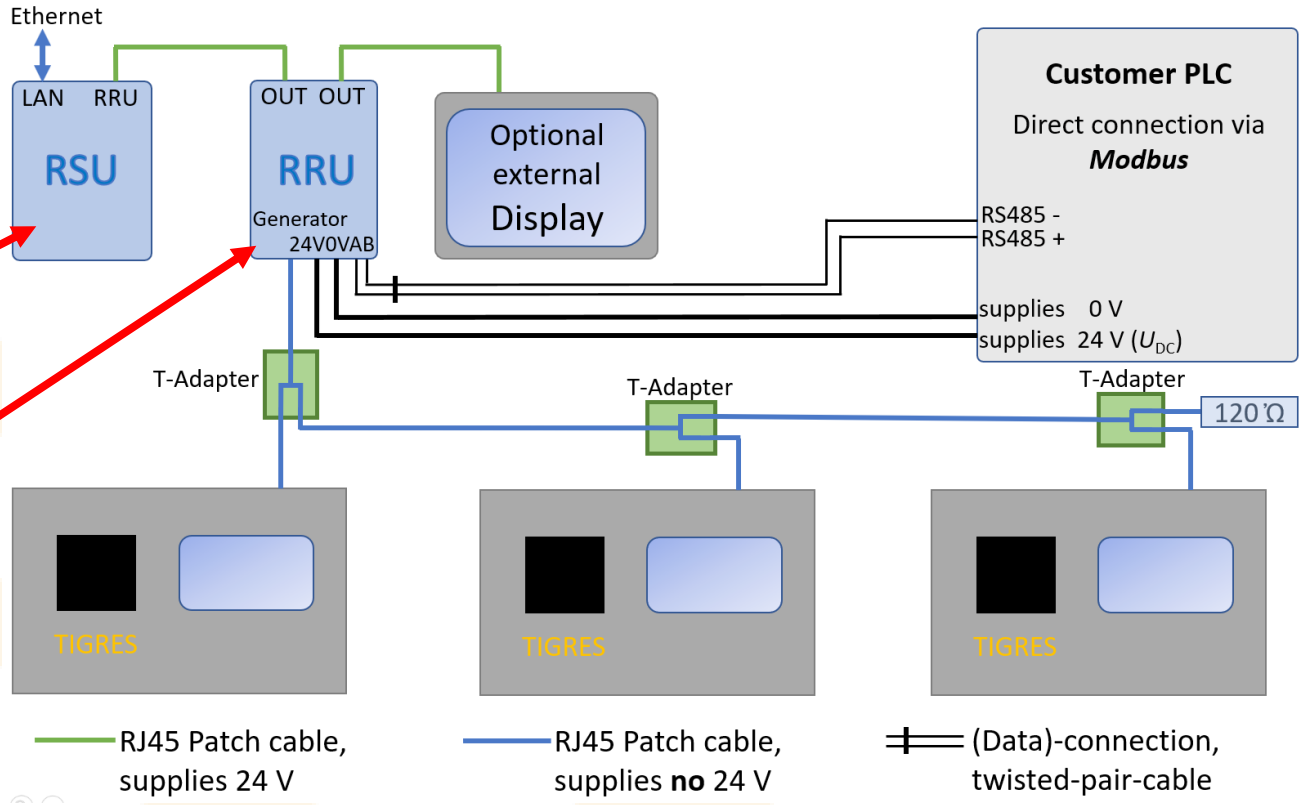
TIGRES RSU (Remote Service Unit)
Enables online process monitoring
For:

- ✓ Start up
- ✓ Diagnoses
- ✓ Remote service
- ✓ Service support
- ✓ Parameter setting



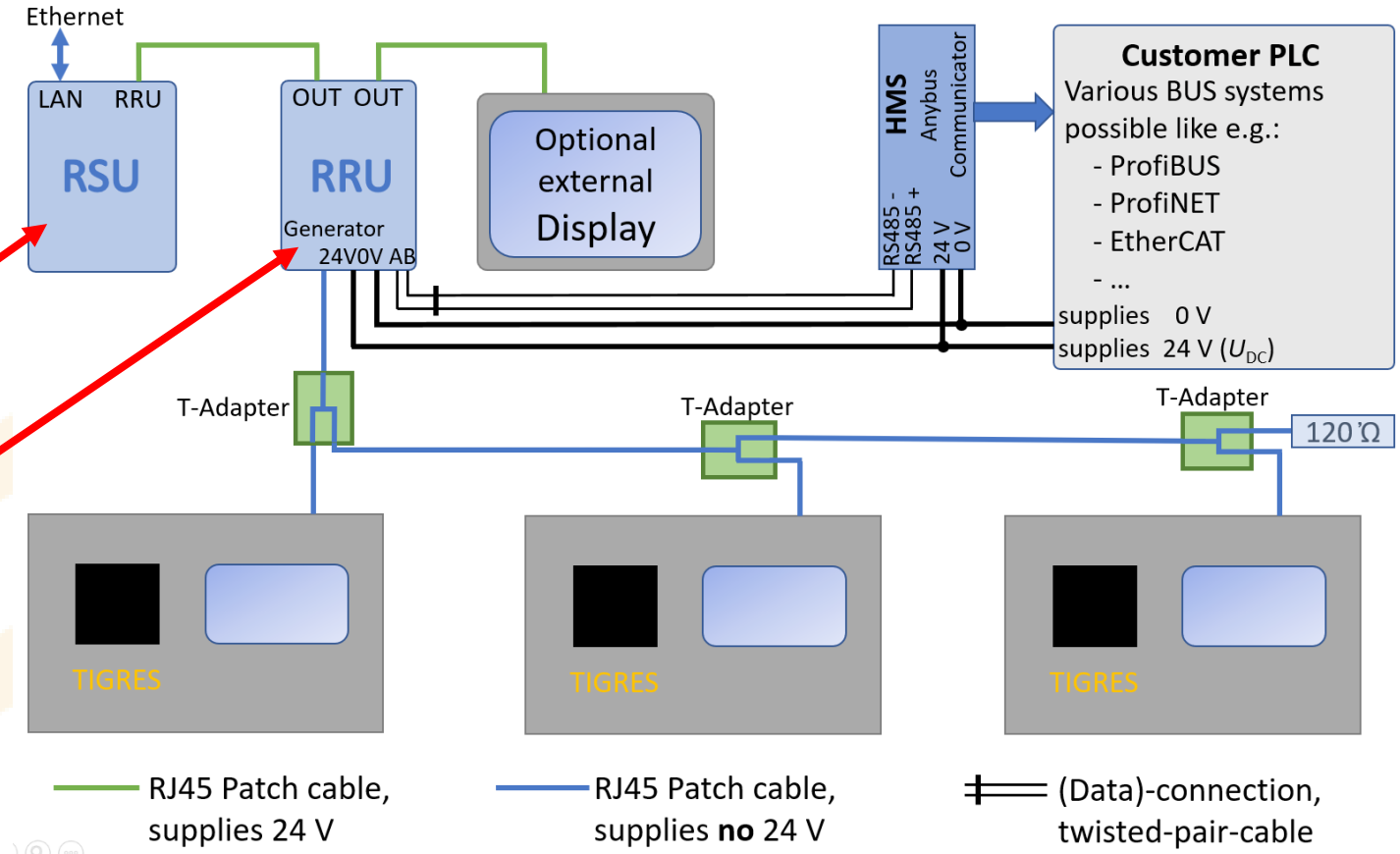
RSU and Modbus: Overview

Connecting via Modbus

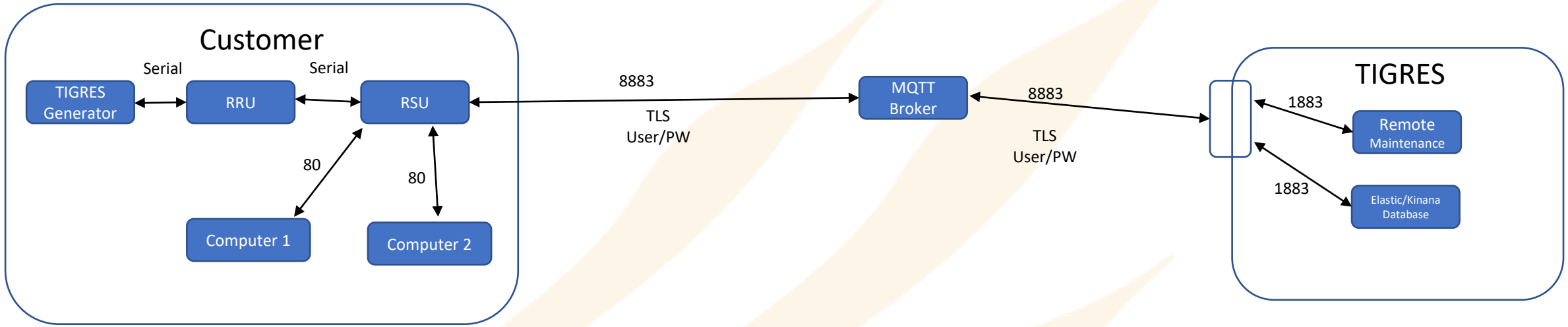


RSU and bus systems via HMS: Overview

Connecting via Anybus



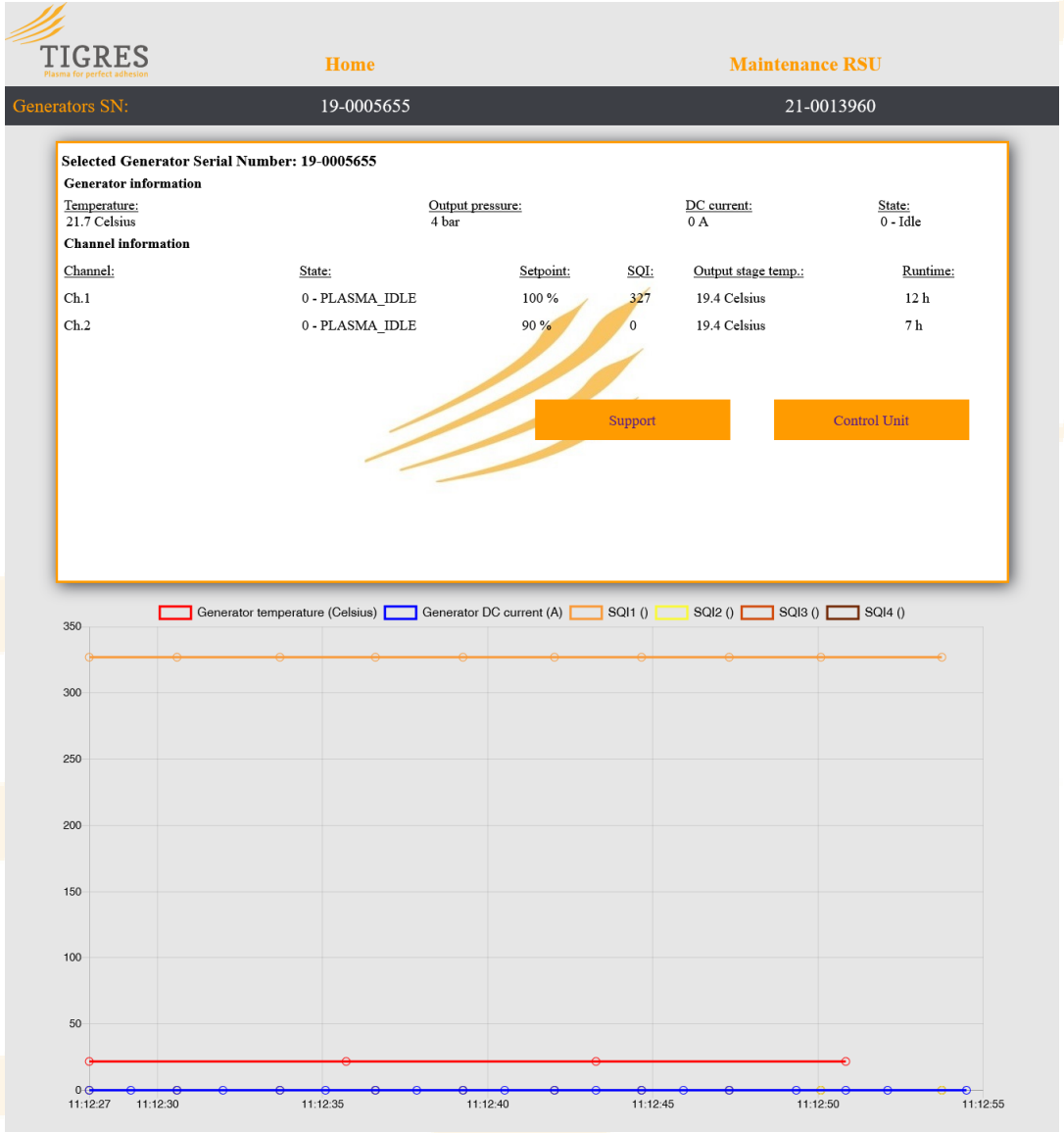
TIGRES Remote maintenance via RSU



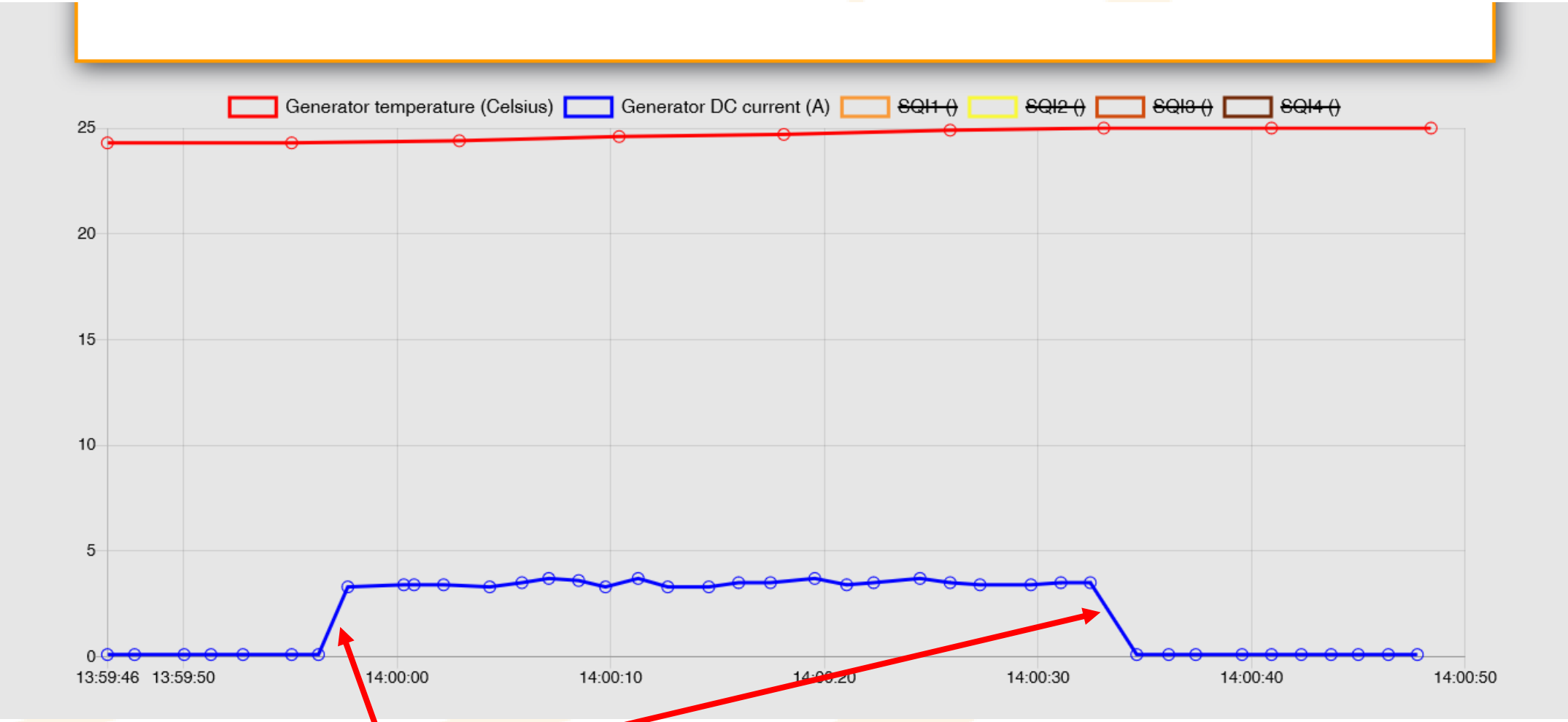
- RSU delivers data to TIGRES only about status of generator
- Data only available for TIGRES only after approval from customer

RSU = Remote Service Unit, GateKeeper
RRU = Round Robin Unit, Switch box

TIGRES Remote maintenance

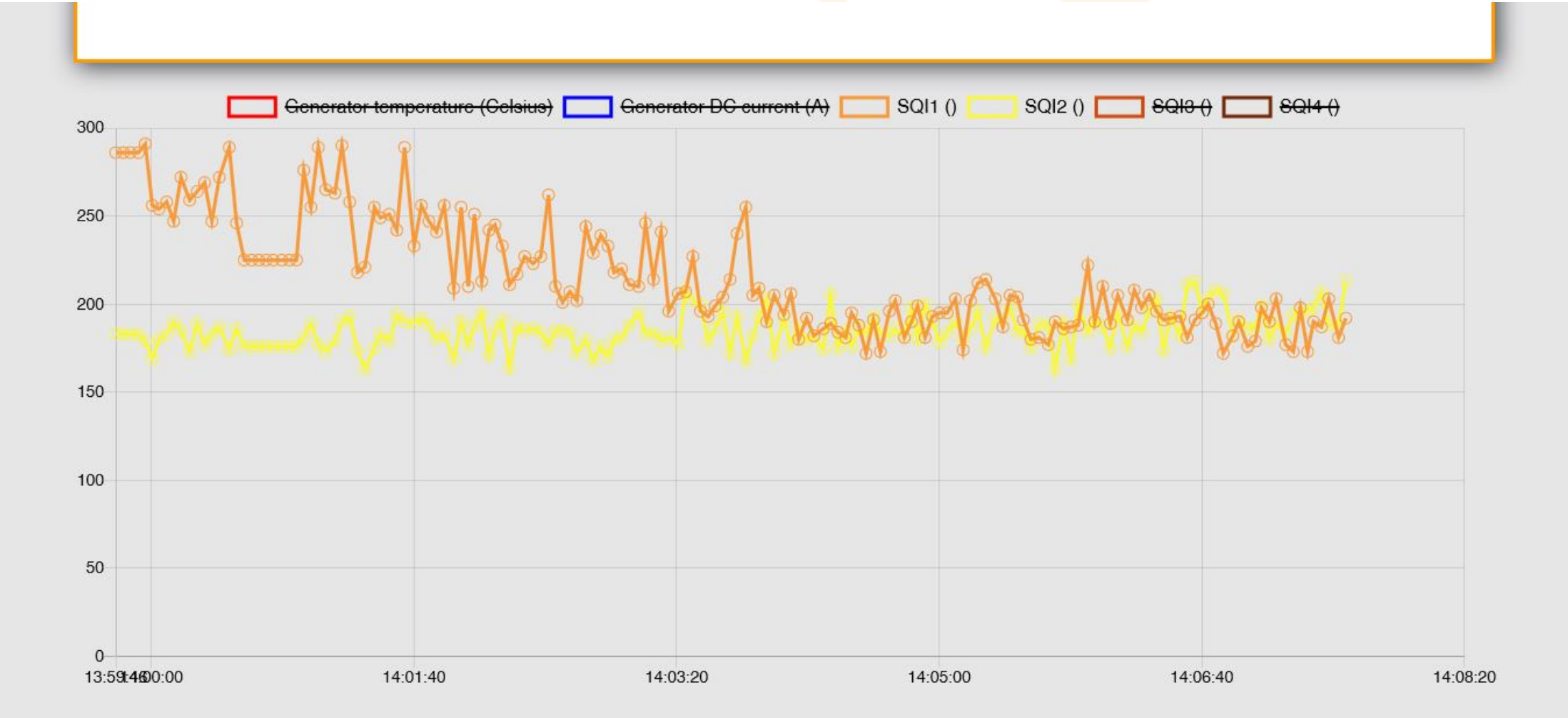


TIGRES Remote maintenance

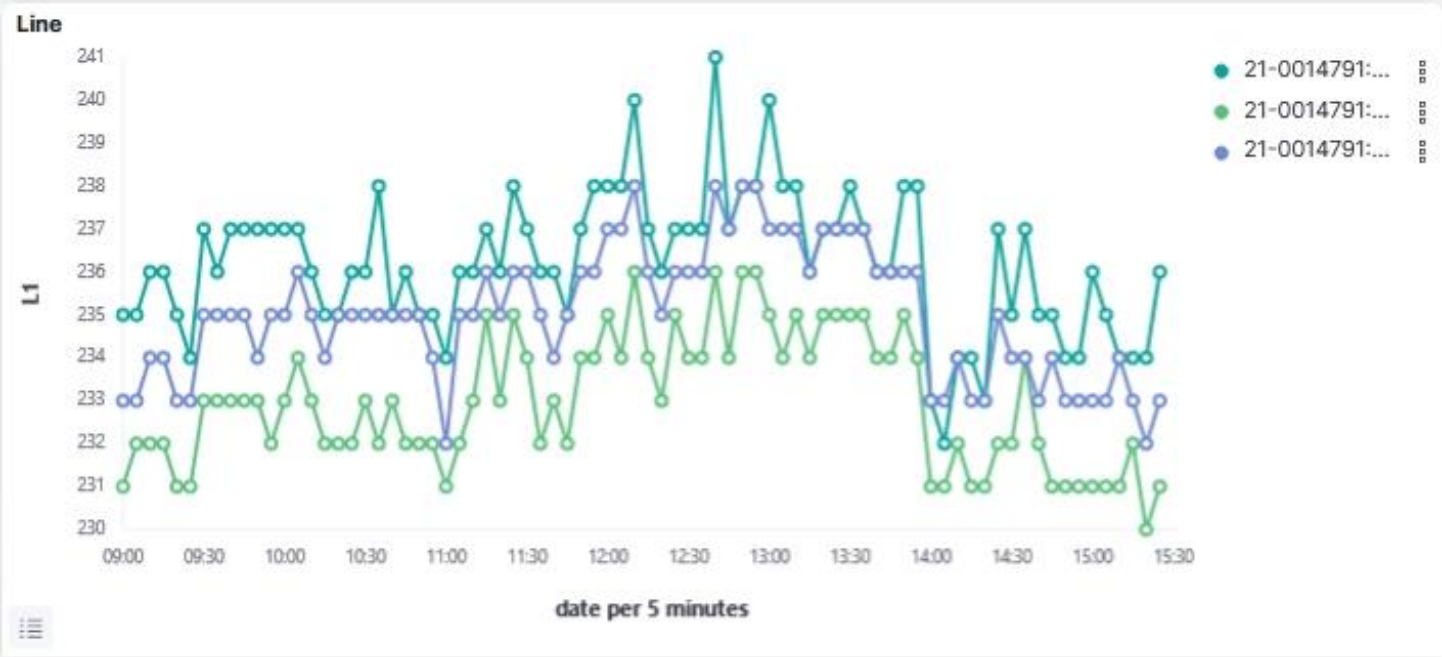


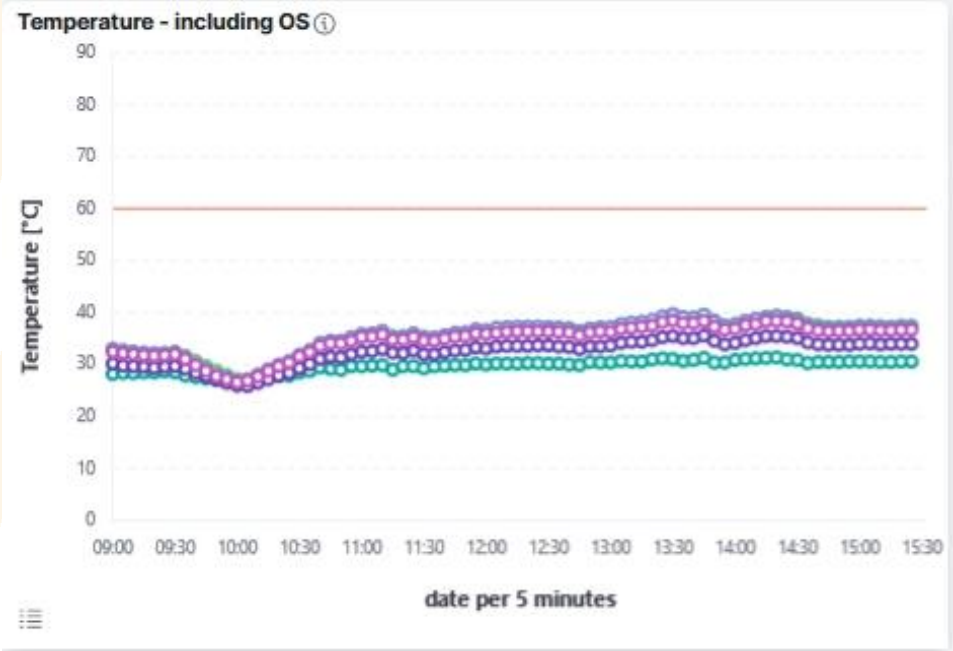
Data visible online, f. e. start and stop of discharge

TIGRES Remote maintenance: What the customer sees



TIGRES Remote maintenance: What TIGRES sees



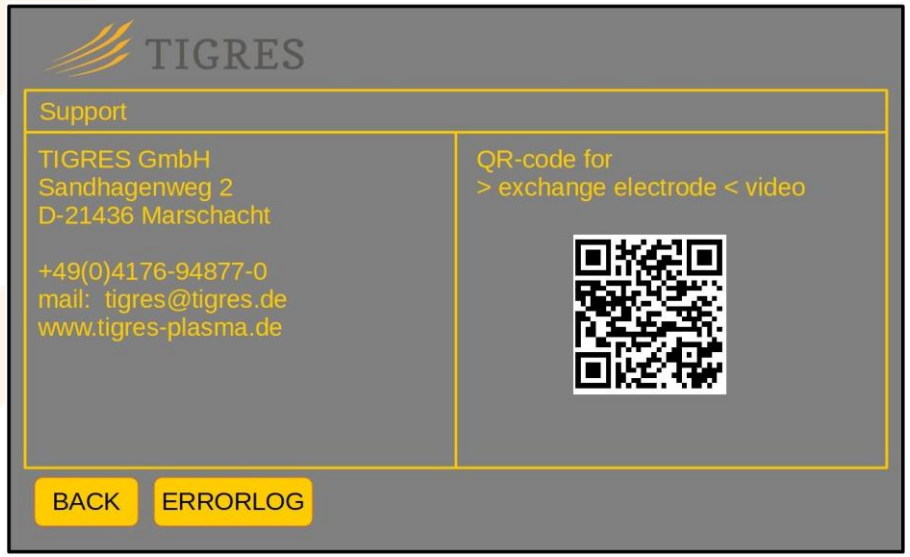


Maintenance

Maintenance

- Build for 100ED (24/7)
- Wearing parts: Electrodes
- Lifetime of electrodes:
  - CAT: Lifetime: Up to app. 10.000 h
- Electrodes can be changed by maintenance personnel. Video instruction available.

Easy change of electrodes:
Voiceless online video available via QR-Code and smartphone
https://www.tigres-cloud.de/public



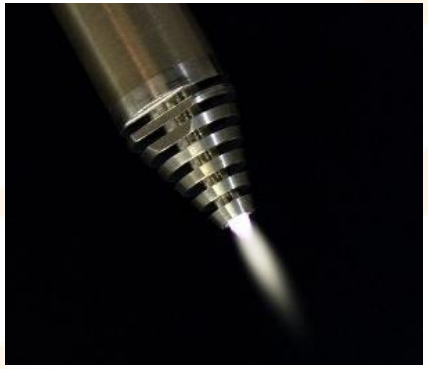
TIGRES Process consulting, testing equipment etc.

Rental systems:

More than 20 rental systems are available for testing

Testing at your production facility:
We support you with process consulting and in the testing with plasma systems at your production facility.

T-SPOT

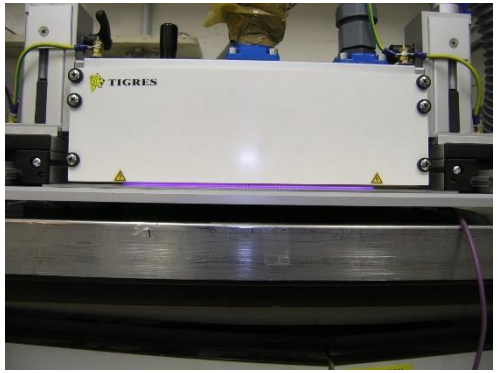


CAT

MEF

T-JET

DBD



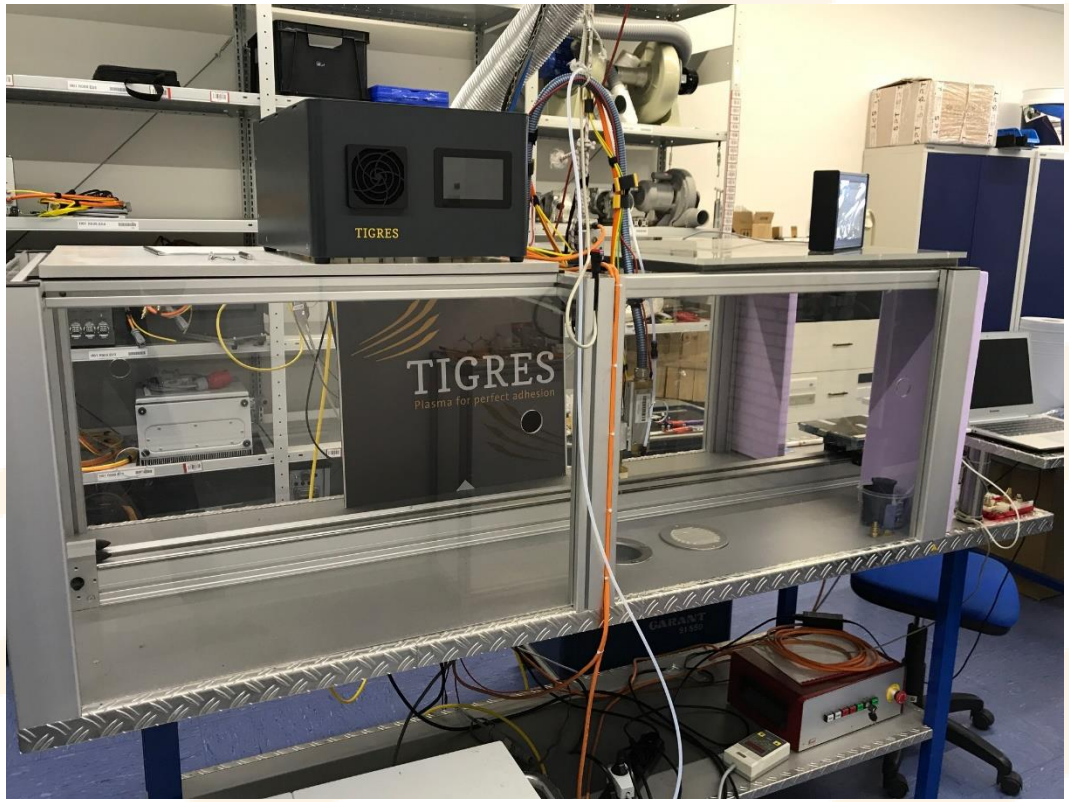
TIGRES Lab: Sampling

Processing of your samples:

Processing and analysing of samples for or with you, with verification and documentation of the results.

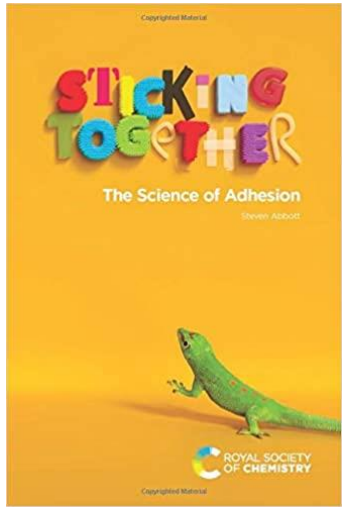
Practical training how to use plasma equipment for:

Activation, Cleaning, Deburring and plasma coating



TIGRES: Literature

For beginners: „Sticking together, the science of adhesion“, in englisch by Prof. Steven Abbot, PhD in Chemistry:



https://amzn.to/3ppgWRE

All the books in englisch by Steven Abbot:

https://www.stevenabbott.co.uk/books.php/

TIGRES: Archive webinars

All webinars can be watched again:

https://www.tigres-plasma.de/en/webinars/182-webinar-archiv

TIGRES: Upcoming shows

15 – 17 March 2022 | Munich Trade Fair Centre, Germany

5th International Exhibition of Print Technology for Industrial Manufacturing

Messegelände München

Am Messeturm

81829 München

Free tickets available:

https://www.tigres-plasma.de/de/unternehmen/messen-events

CCE INTERNATIONAL
Corrugated & Carton Exhibition

https://www.cce-international.com/2021/english/

TIGRES: Linkedin

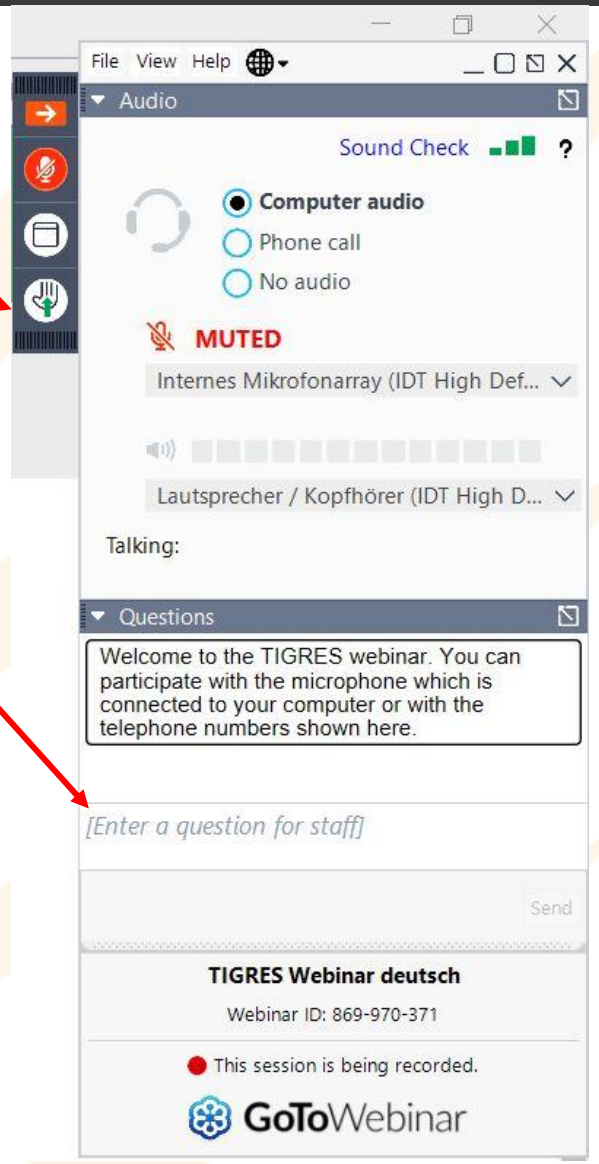
Please connect with TIGRES to stay in contact and get information about webinars, seminars, shows and plasma related content:

TIGRES GmbH

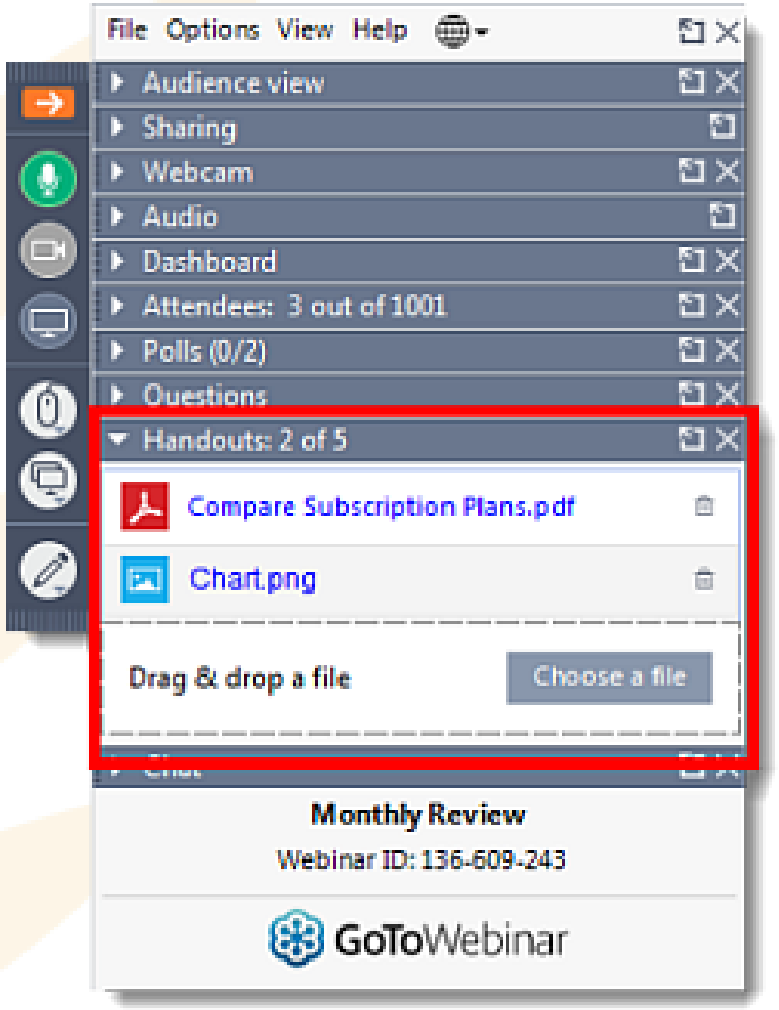
https://www.linkedin.com/company/tigresgmbh

More questions?

If you have more questions



PDF of the presentation



After the webinar: Survey

SURVEY

Evaluation of the webinar

103 characters left

QUESTIONS

7 of 25

- General expectations were met
- Presentation of Peter van Steenacker
- Technical functioning of the webinar
- Comments to technical functioning (Video quality, sound etc.)
- Would you recommend TIGRES as a provider of webinars?
- May we use your name for a testimonial for our webinars? Please type your name and if you want a short comment
- Any other comments?

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