University of Glasgow

Investigating steam penetration into dental handpieces

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Industrial scholarship in partnership with W&H

The role of the handpiece

Handpiece types:

Dental turbine:
e.g. used to drill tooth


NSK

Dental slow speed motor:
e.g. used to polish teeth

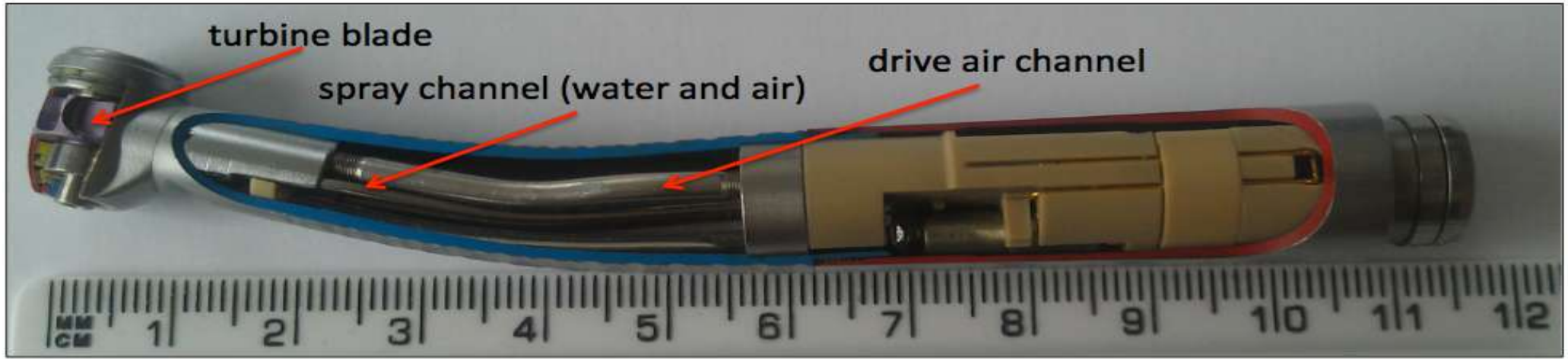

Dr. Peter Derham

Straight handpiece:
e.g. used for oral surgery


W&H

Background I

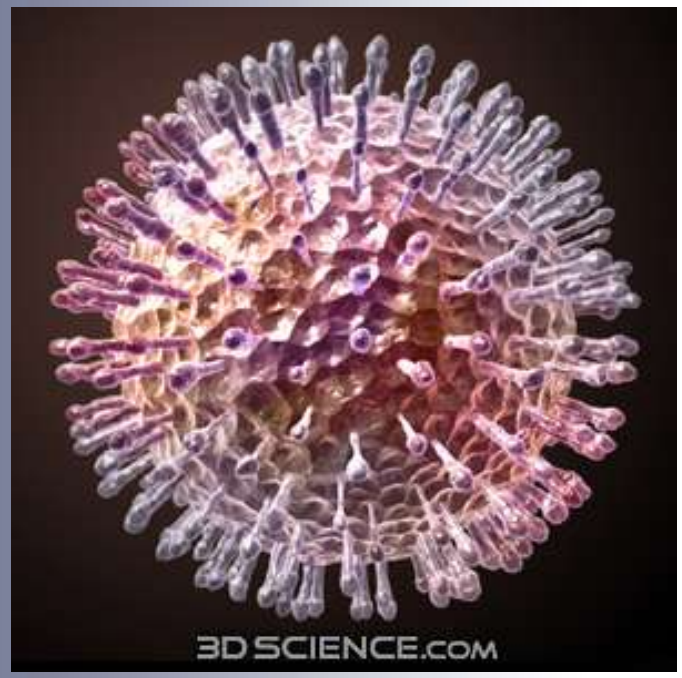
- Handpieces weak link in the dental infection prevention chain
- Handpiece cleaning and sterilization challenging = access to internal components and lumens e.g., stainless steel, D=0.9 mm & L=83 mm, in air driven turbines
- Weight: 42 – 100g



Background II

- Critical to remove air to achieve sterilization parameters (Perkins et al. 1956, Bowie et al. 1963)
- Controversies exist on the role of air removal during handpiece sterilization for patient safety (Larsen et al 1997, Andersen et al 1999, Smith et al 2007; Smith 2013)

Background III



- The risk of cross contamination has been raised = biofouling inside handpieces
  - HIV (Lewis et al 1992 and 1995)
  - Herpes simplex (Epstein et al 1993, 1995, Hu et al 2007)
  - Vegetative bacteria (Kellett et al 1980, Herd et al 2007, Chin et al 2006)

Aims

- Investigate steam penetration into dental handpieces
- Investigate steam penetration into process challenge devices (PCD’s)
- Using N type and B type bench-top steam sterilization process.

Outline

- Thermometric study
  - Investigation steam penetration/air removal in dental handpieces by measuring temperature/time changes
- Chemical indicator study
- Biological indicator study

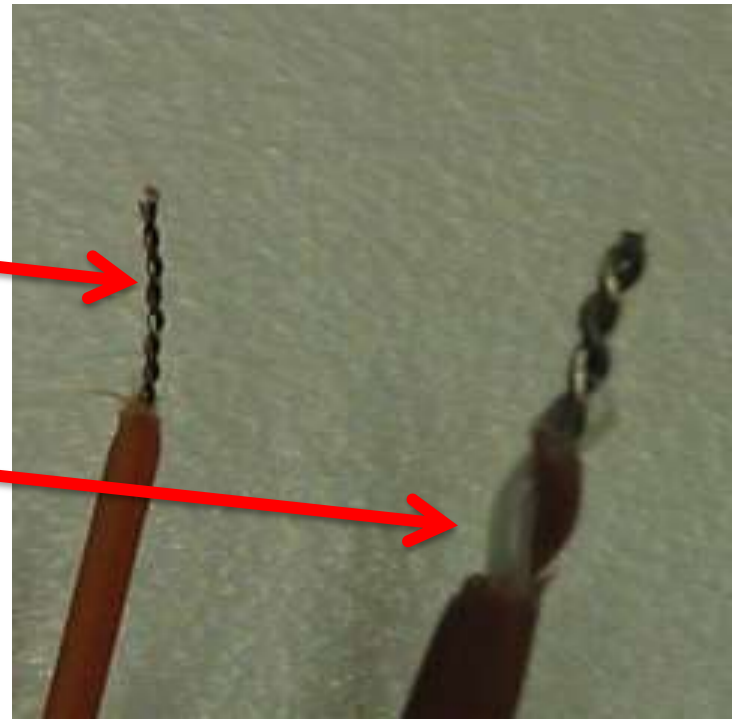
Thermometric Study

- **Method:**
- Type N machines (N=1)
- Handpiece types/makes:
  - Turbines (N=3)
  - Slow speed motors (N=2)
- Loads
  - Small
  - Full (as per sterilizer manufacturer's instructions)
- Orientation of handpieces: horizontal in center of chamber

- Control BDT

Thermometric study

- **Thermocouple investigations**
  - Thermocouple = T type (2 mm x 1 mm, standard error less than 1°C)
    - Air channel d=2.3 mm, L=80 mm
  - Thermocouple = T type (D = 0.8 mm, standard error less than 1°C)
    - Spray channels d=0.9 mm, L=83 mm



Thermometric study

- **Data logger investigations**
  - Temperature sensors (Teflon, d=2 mm, approx. L=30 cm, accuracy ± 0.05°C)
  - Air channel d=2.3 mm, L=80 mm
  - Pressure sensors (accuracy 0.25%)

Thermometric Study

Calibration thermocouples:

Calibration equipment used

- Pressure calibrator (DRUCK)
- Hot block (AMETEK)
- Data logger (ANVILLE 825)

Calibration procedure:

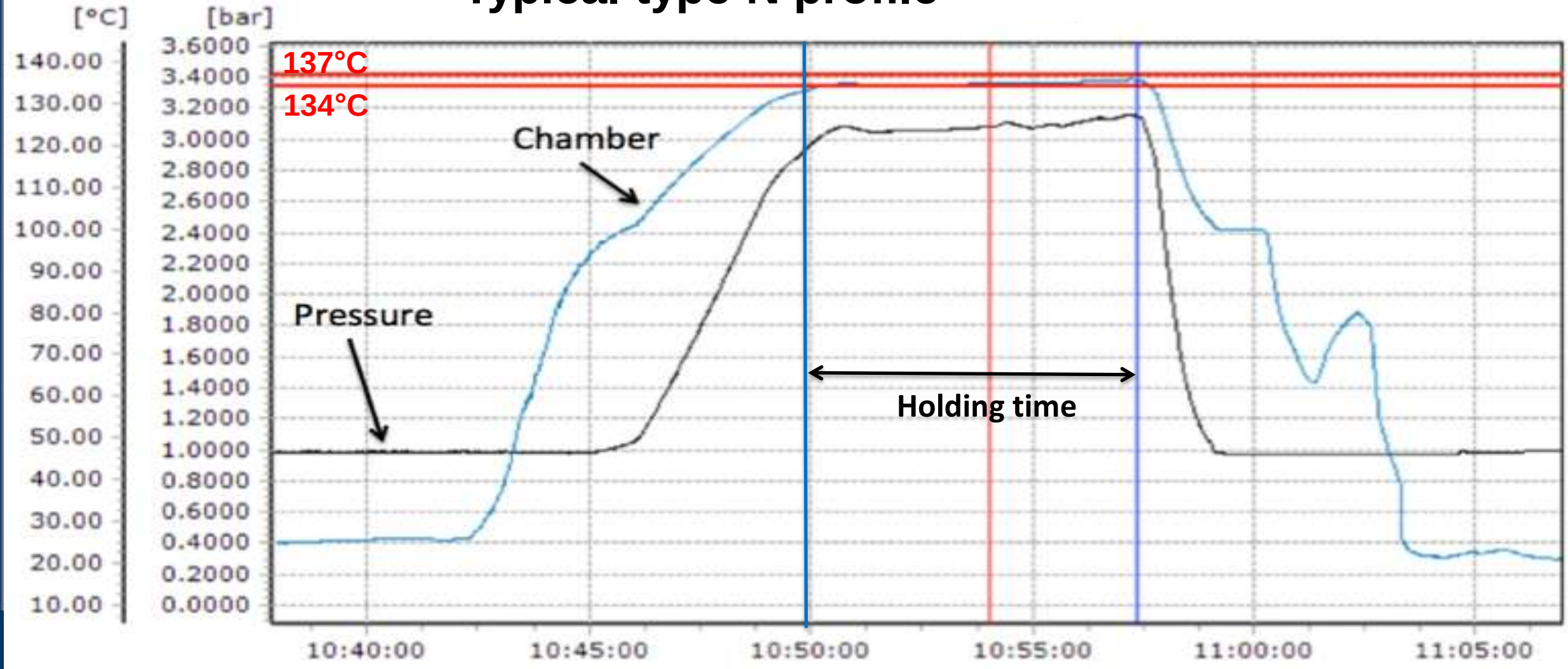
- Thermocouples calibrated every 10 cycles

Calibration data loggers:

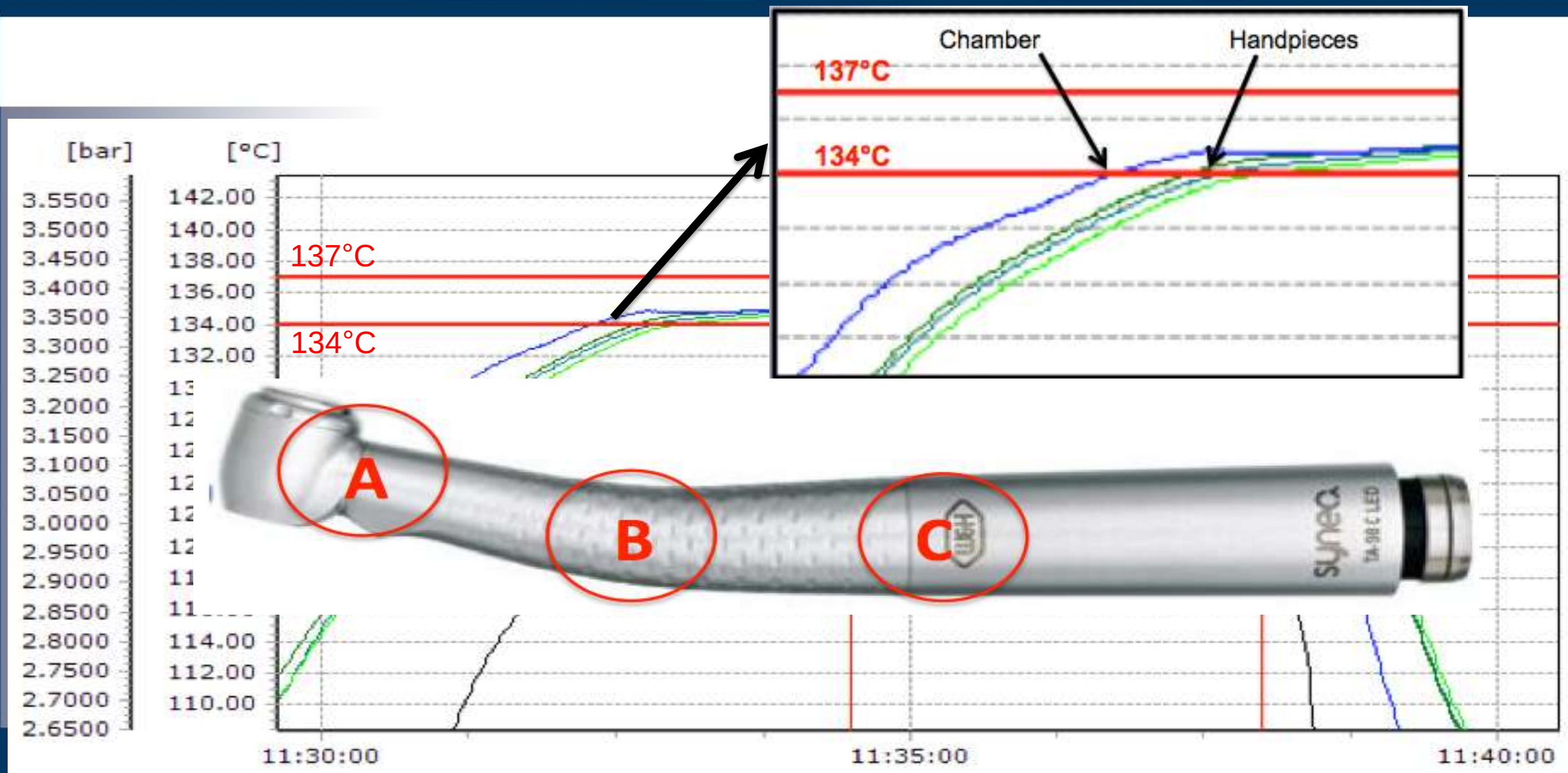
- Denmark

Thermometric Study

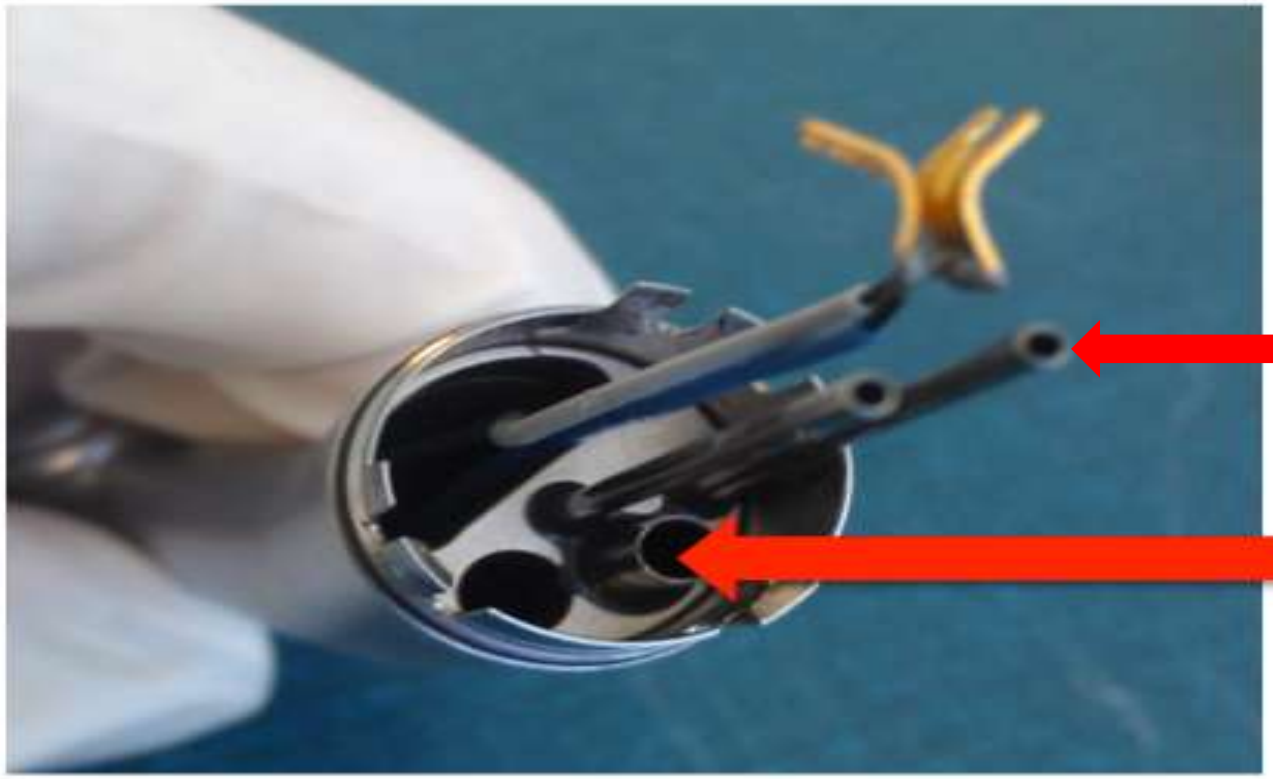
Typical type N profile



Thermometric Study



Thermometric Study



Spray channel
D=0.9 mm,
L=83 mm,
V=0.045 ml

→Thin thermocouples

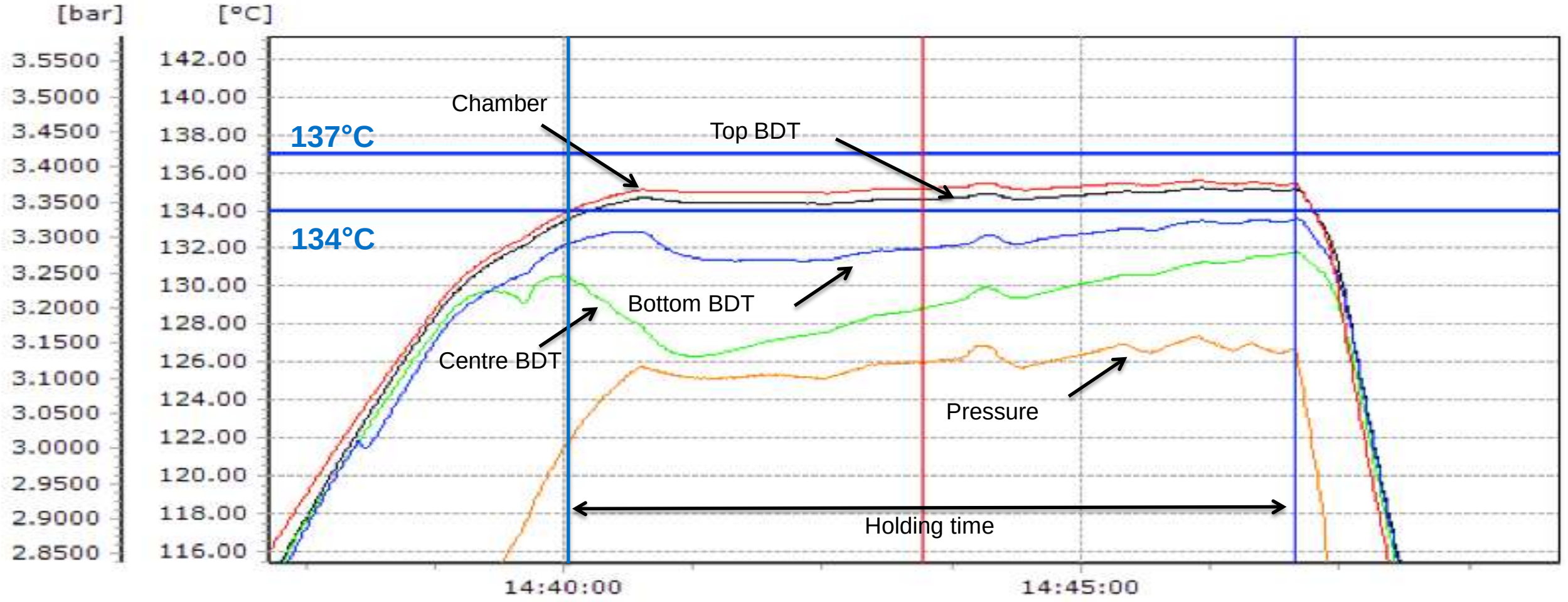
Drive air channel
D=2.3 mm,
L=80 mm,
V=332 ml

→Regular thermocouples

→ellab data loggers

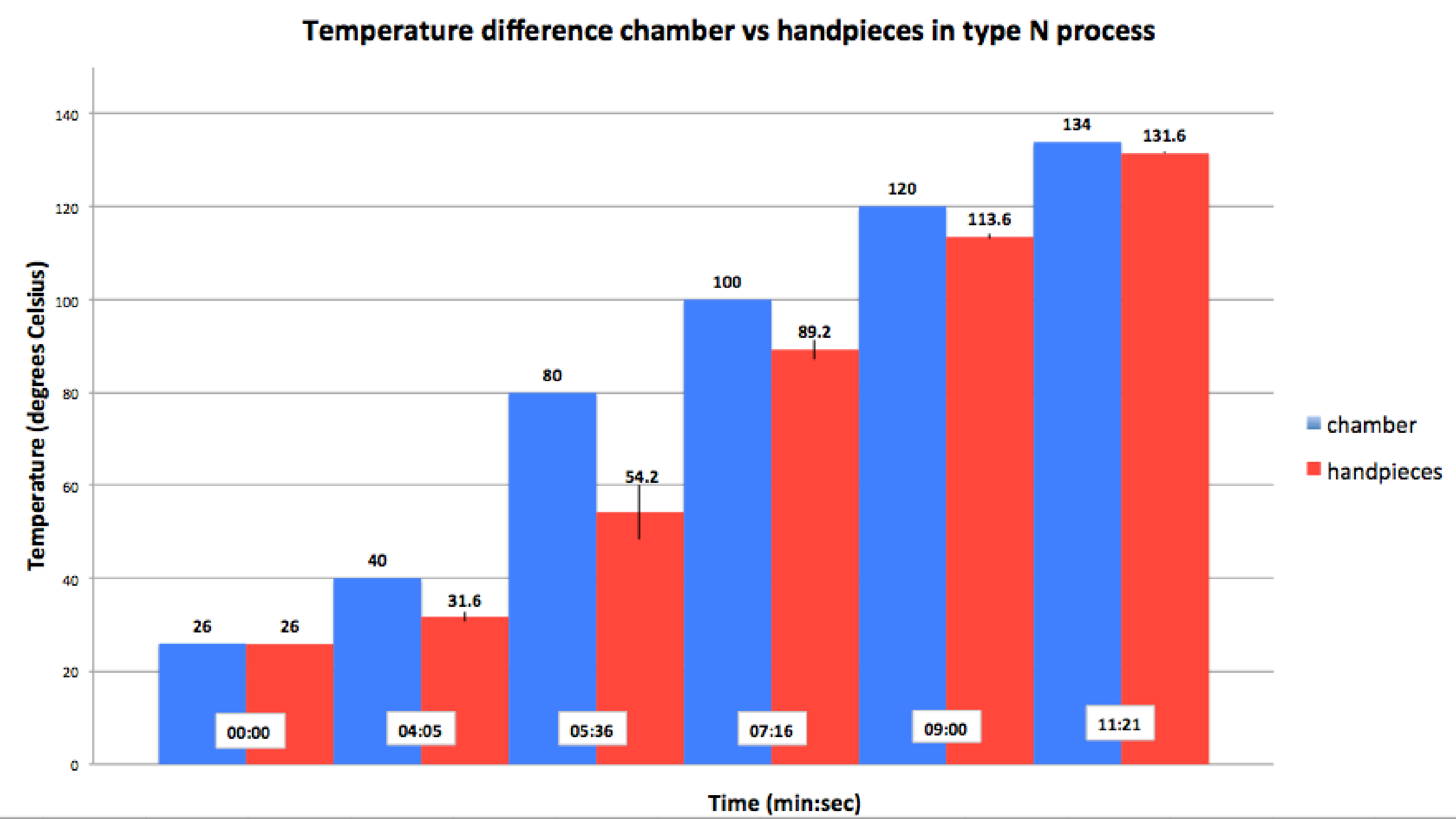
Thermometric study - Control

Type N BDT



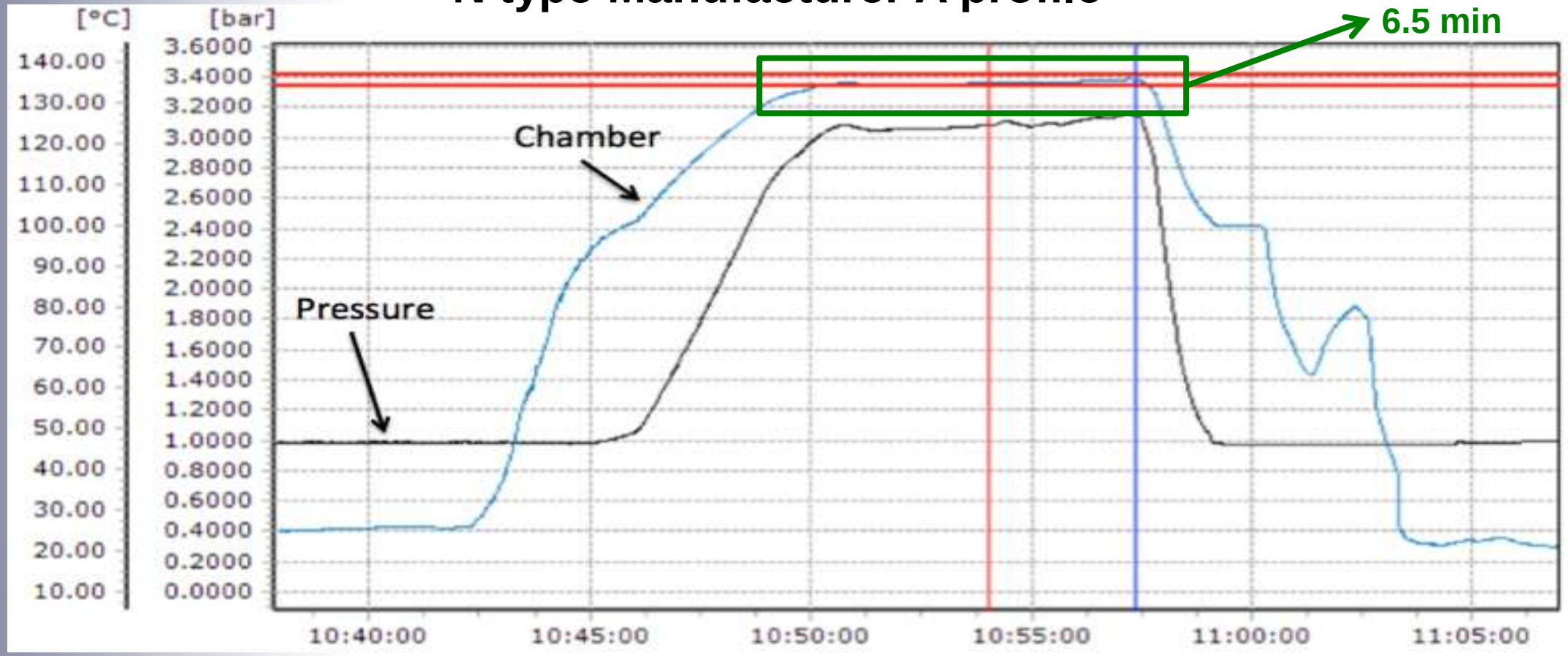
Thermometric study - Results

N type Manufacturer A (holding time 6.5 min)	Handpiece Manufacturer A (turbine) N = 192	Handpiece Manufacturer B (turbine) N = 9	Handpiece Manufacturer C (turbine) N = 9	Handpiece Manufacturer D (motor) N = 9	Handpiece Manufacturer A (motor) N = 9
Temperature lag of handpiece to chamber at 134°C	15 – 100 sec	23 – 80 sec	18 – 147 sec	13 – 38 sec	-1 – 8 sec


Temperature difference chamber vs handpieces in type N process
Temperature (degrees Celsius)
0
20
40
60
80
100
120
140
26
26
40
31.6
80
54.2
100
89.2
120
113.6
134
131.6
00:00
04:05
05:36
07:16
09:00
11:21
Time (min:sec)
chamber
handpieces

Thermometric Study - Results

N type Manufacturer A profile



Outline

- Thermometric study

- Chemical indicator study

  investigate if chemical indicator strips (used in the Browne helix pcd, class 2) perform a pass at different locations inside the handpiece using a type N sterilization process

- Biological indicator study

  determining whether a non-vacuum sterilization process effectively inactivates spores of *Geobacillus stearothermophilus*

CI and BI Study

- **Method:**
- Type N machines (N=4)
- Type B machines (N=1)
- Handpiece types/makes:
  - Turbines (N=1)
  - Slow speed motors (N=1)
  - Surgical handpiece (N=1)
- Loads
  - Small
  - Full (as per sterilizer manufacturer's instructions)
- Orientation of handpieces: horizontal in center of chamber
- Control Browne's helix pcd, BDT

CI and BI Study

- **Method:**
- ellab data loggers (teflon, D = 2 mm)
- Browne's Helix chemical indicators (class 2)
- *Geobacillus stearothermophilus* spores on paper strips (Excelsior, population 2.5 x 10^6 spores per strip, D_{121}= 2.3 min)

CI and BI Study

- **Method:**
- Chemical indicators:
  - Visual assessment
- Spore recovery method:
  - TSB at 56°C
  - Checked for growth every 24 h over 8 days
  - Plated onto Tryptone Soy Agar → Gram Stain

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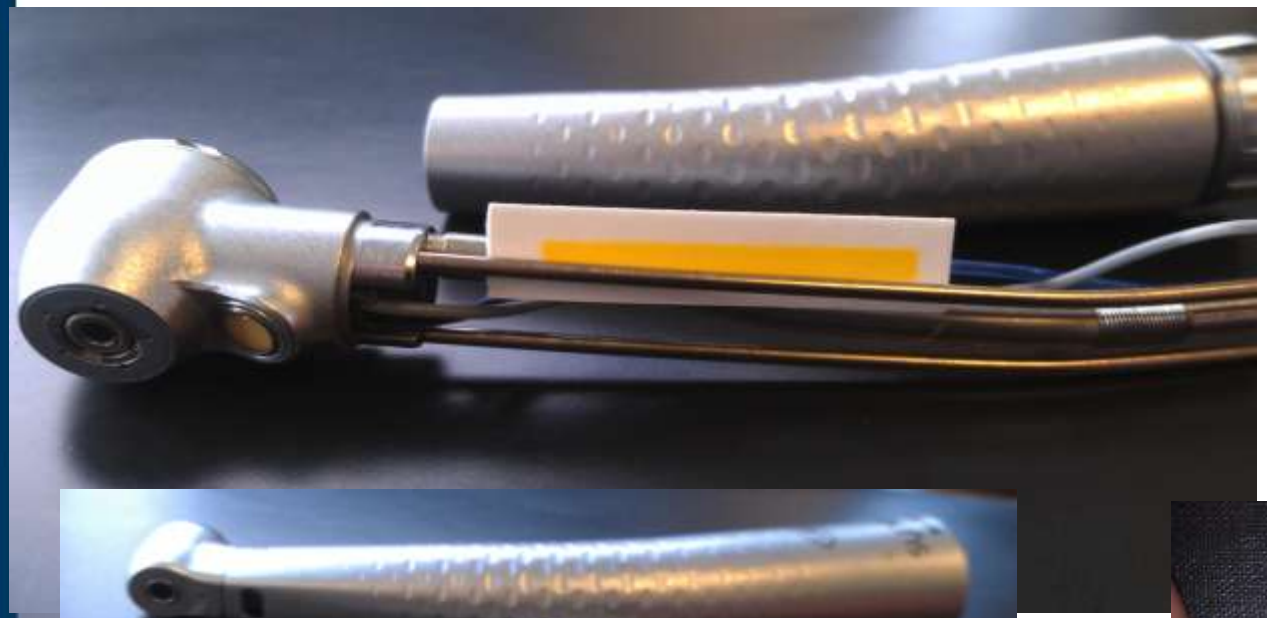
CI and BI Study



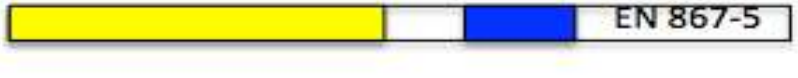
CI and BI Study

Air turbine

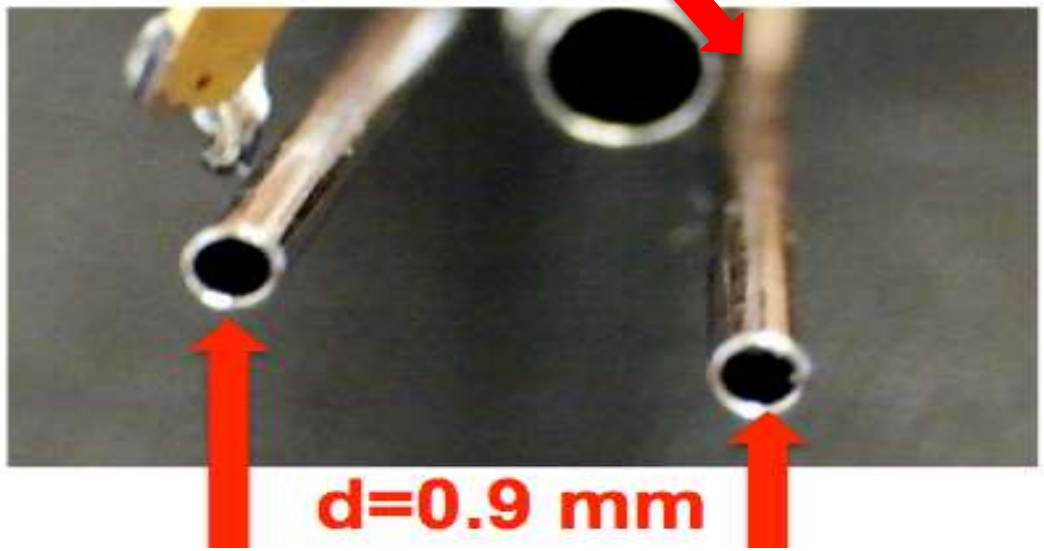
Drive air channel
50 mm x 2 mm

Spray channel
50 mm x 0.8 mm

Turbine head
5 mm x 1.5 mm



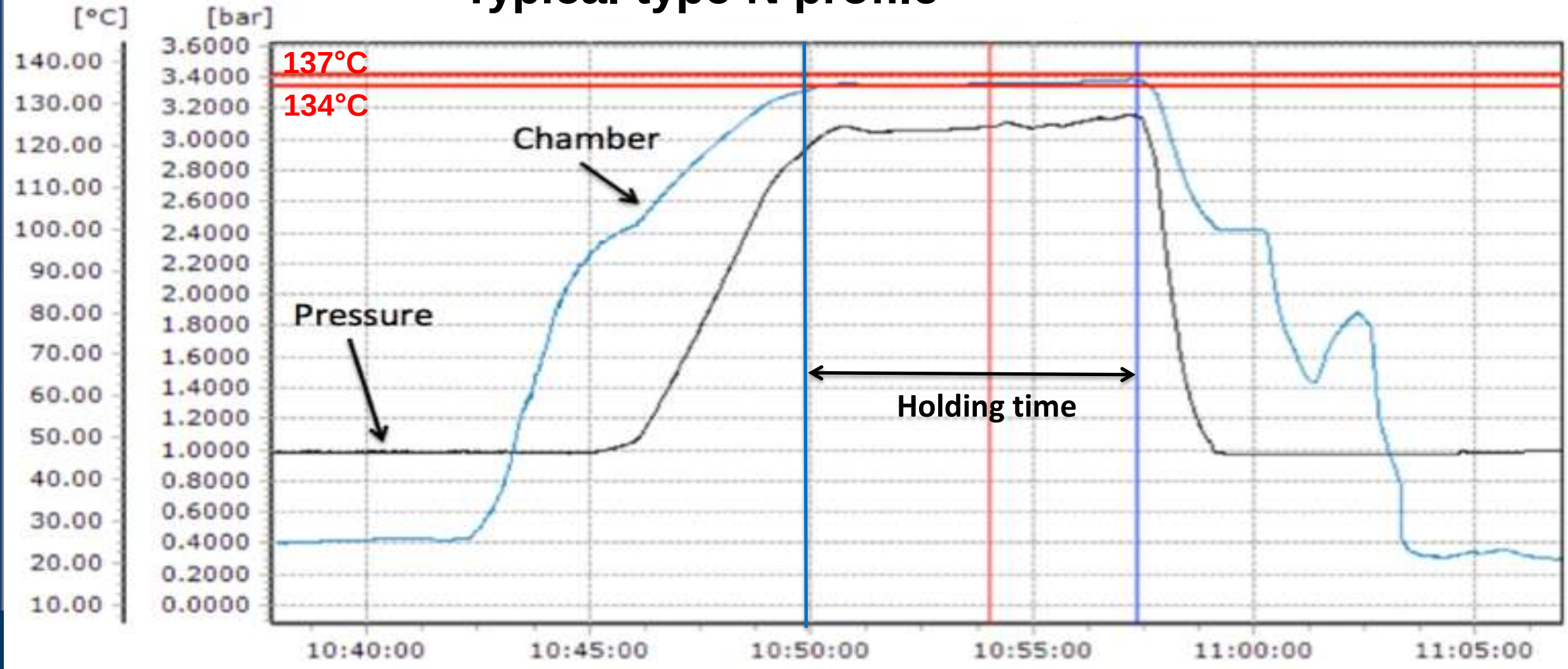
d=2.3 mm, l=80 mm,
v=0.332 ml



d=0.9 mm
l=85 mm,
v=0.054 ml

CI and BI Study

Typical type N profile



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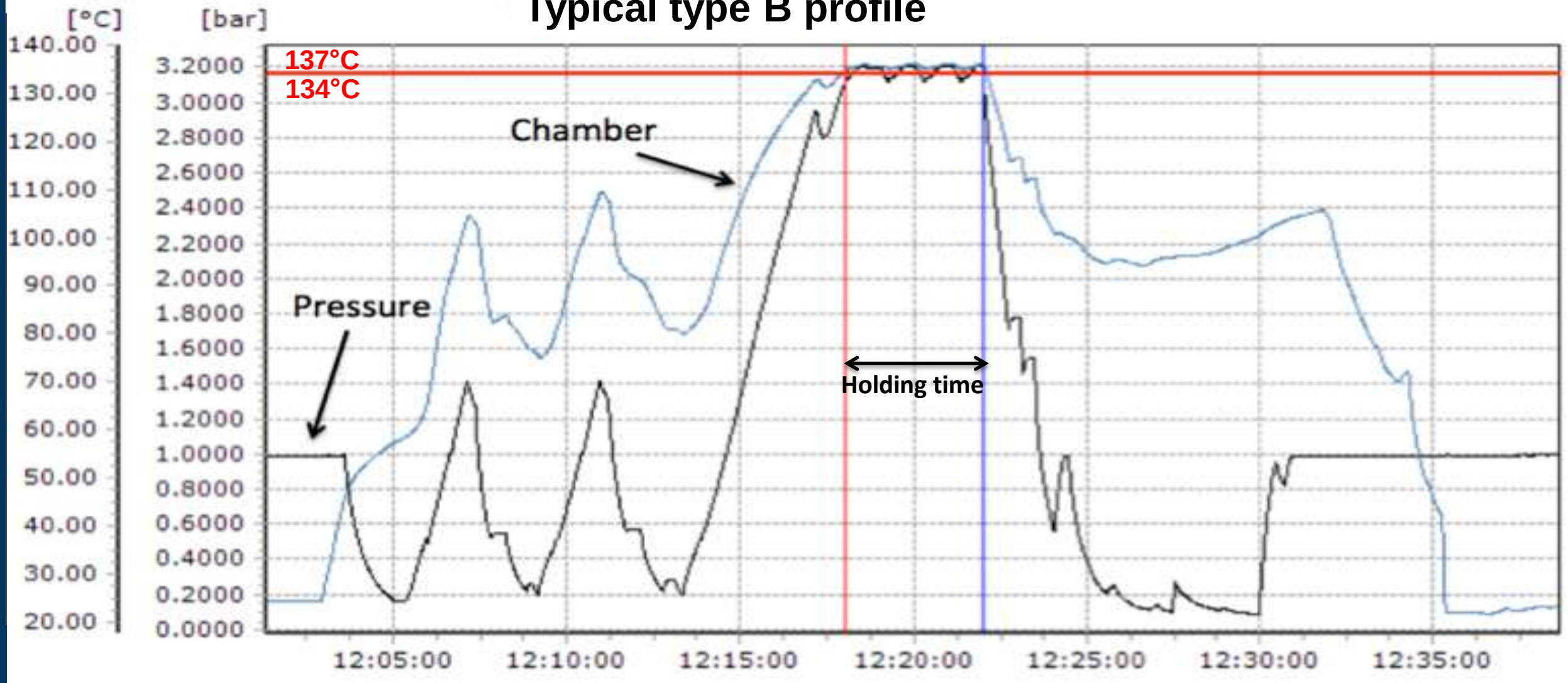
CI and BI Study

Typical type B profile



CI and BI Study - control

CI and BI Study - Results

1 + 1 (safety) min at 134°C (Perkins, 1956)
→ 2 + 1 (safety) min at 134°C (1st MRC repo

3 sets of 3 different handpieces per cycle	Type N Manufacturer A	Type N Manufac B	urer
Holding time at 134°C	6 min 30 sec	6 min 30	sec
Temperature lag of handpiece to chamber at 134°C	15 – 100 sec	25 – 39 s	
BI fail	0/108	1/108	
CI fail	0/108	0/108	

* straight surgical handpiece back

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Conclusions

- Steam penetration into dental handpiece lumens is impaired using type N process.
- More difficult to ensure sterility in surgical handpieces.
- It can not be assumed that all type N machines and all handpiece types are compatible.

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