GTE Industrieelektronik GmbH

Theory

Biofidel measuring system

Data acquisition & Evaluation

HRC proven safety

GTE Industrieelektronik

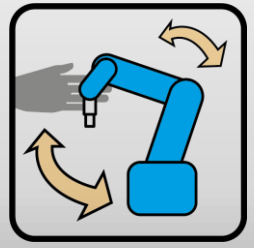
GTE Industrieelektronik GmbH

measurement technology and methods for the validation of a HRC application

Dr. Daniel Meixner

GTE Industrieelektronik GmbH

HRC



Theory

GTE Industrieelektronik GmbH

Power and force limiting

Literature

- DIN EN ISO 10218
- ISO / TS 15066
- RIA TR R15.806-2018

- DGUV Information
  FB-HM 080

Literature

- DIN EN ISO 10218
- **ISO / TS 15066**
- **RIA TR R15.806-2018**

→ thresholds

- DGUV Information
  FB-HM 080

Literature

- DIN EN ISO 10218
- **ISO / TS 15066**
- **RIA TR R15.806-2018**

thresholds

- DGUV Information FB-HM 080

Literature

- DIN EN ISO 10218
- **ISO / TS 15066**
- **RIA TR R15.806-2018**

thresholds

- DGUV Information FB-HM 080

Thresholds

onset of pain

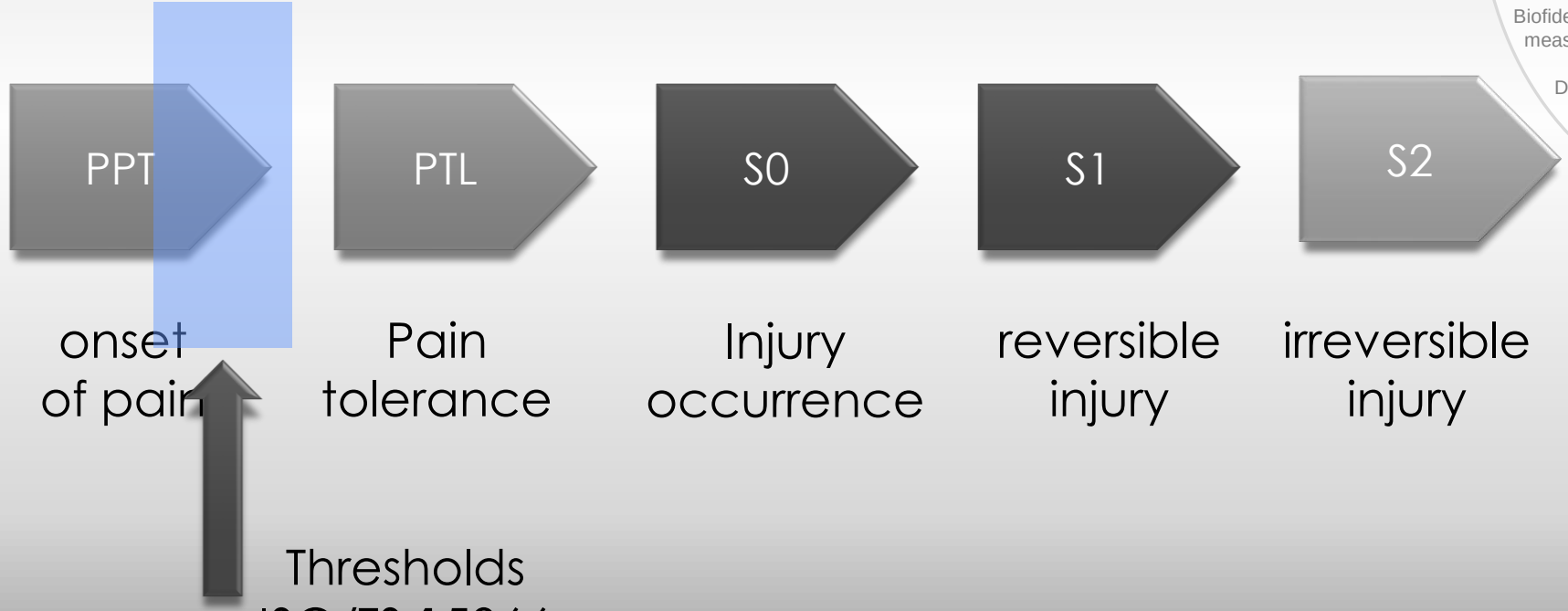
Pain tolerance

Injury occurrence

reversible injury

irreversible injury

Thresholds


PPT
PTL
S0
S1
S2
onset of pain
Pain tolerance
Injury occurrence
reversible injury
irreversible injury
Thresholds ISO/TS 15066

Thresholds

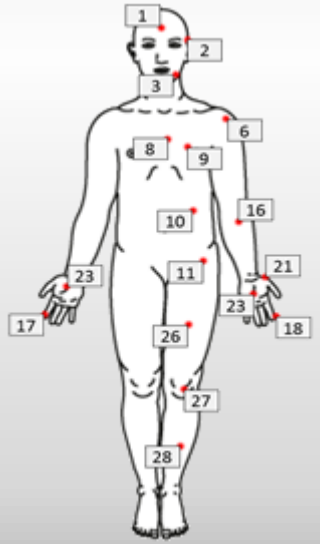
IFA-Entwicklung
Versuchseinrichtung Druckalgometer
(100 Probanden, ca. 9500 Messungen

Schläfenknochen

Dornfortsatz
7. Halswirbel

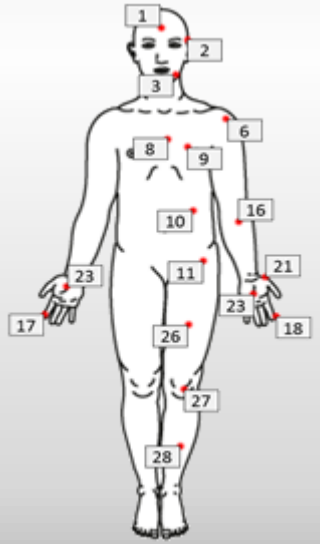
Speichenknochen

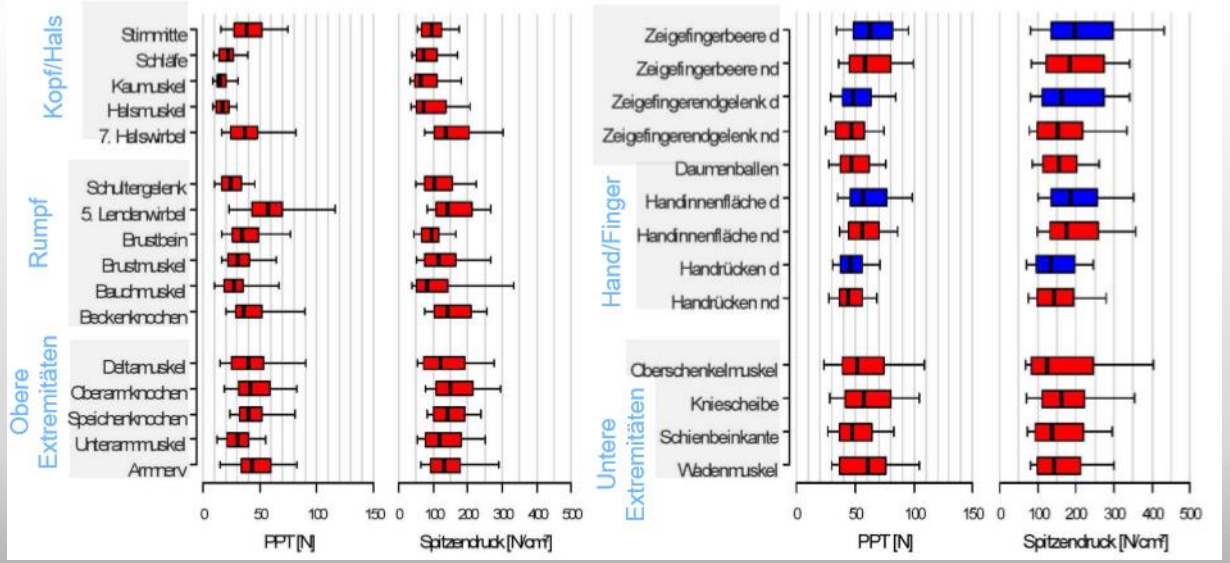
Thresholds



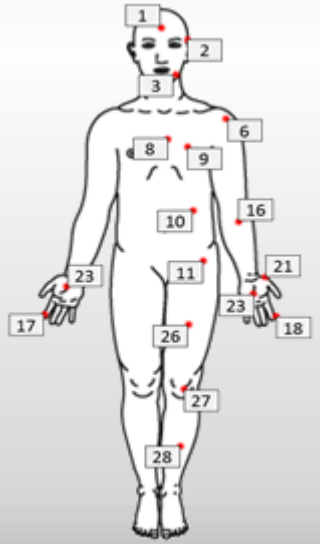
- Blind
- Increasing force 2 N/s or 5 N/s
- Pain Trigger and release by switch

Thresholds


1
2
3
6
8
9
10
16
11
21
23
23
17
18
26
27
28


Kopf/Hals
Stirnmitte
Schläfe
Kaumuskel
Halsmuskel
7. Halswirbel
Rumpf
Schultergelenk
5. Lendenwirbel
Brustbein
Brustmuskel
Bauchmuskel
Beckenknochen
Obere Extremitäten
Deltamuskel
Oberarmknochen
Speichenknochen
Unterarmmuskel
Armnerv
0 50 100 150
PPT [N]
0 100 200 300 400 500
Spitzendruck [N/cm²]
Hand/Finger
Zeigefingerbeere d
Zeigefingerbeere nd
Zeigefingerendgelenk d
Zeigefingerendgelenk nd
Daumenballen
Handinnenfläche d
Handinnenfläche nd
Handrücken d
Handrücken nd
Untere Extremitäten
Oberschenkelmuskel
Kniescheibe
Schienbeinkante
Wadenmuskel
0 50 100 150
PPT [N]
0 100 200 300 400 500
Spitzendruck [N/cm²]

Thresholds


1
2
3
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10
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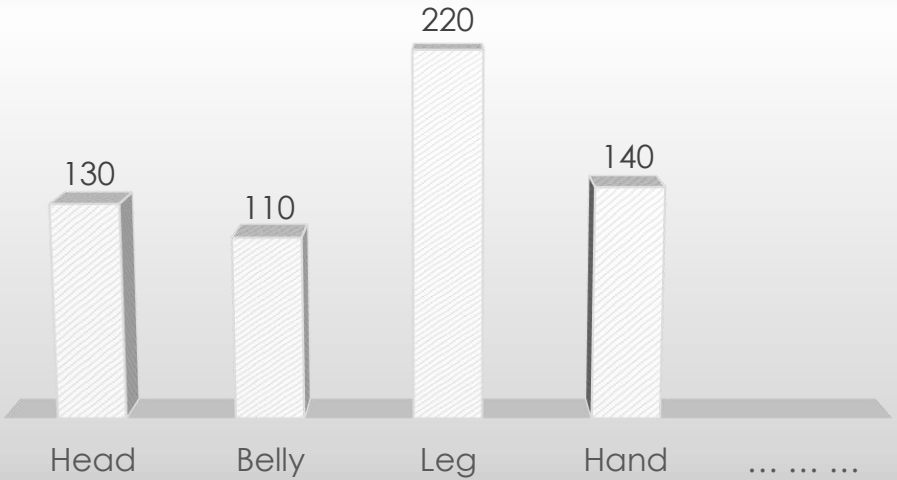
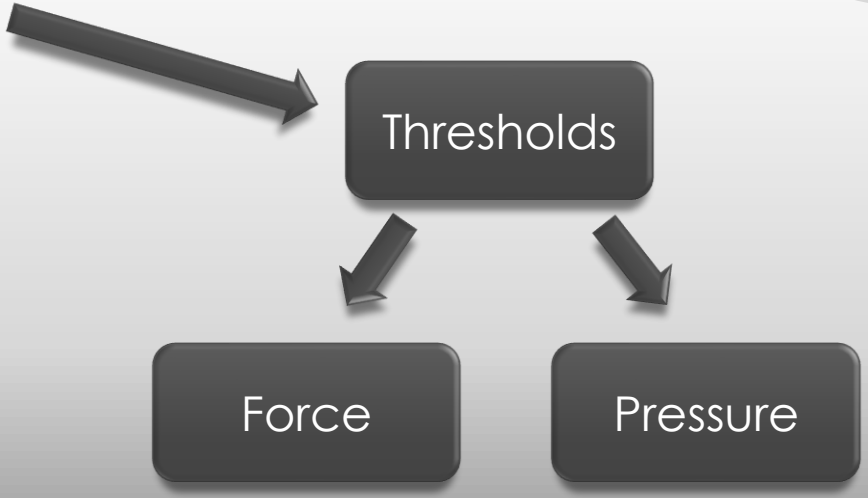
18
27
28


130
110
220
140
Head
Belly
Leg
Hand
... ...

Literature

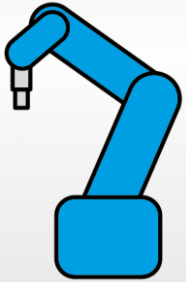
- DIN EN ISO 10218
- **ISO / TS 15066**
- **RIA TR R15.806-2018**

- DGUV Information FB-HM 080

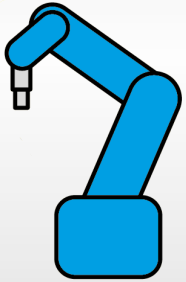


Force & pressure

Force

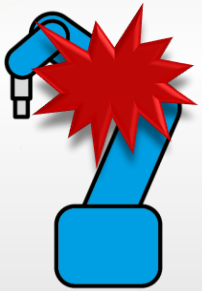


Pressure

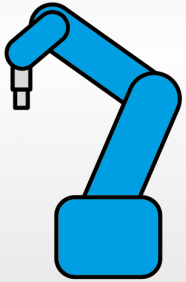


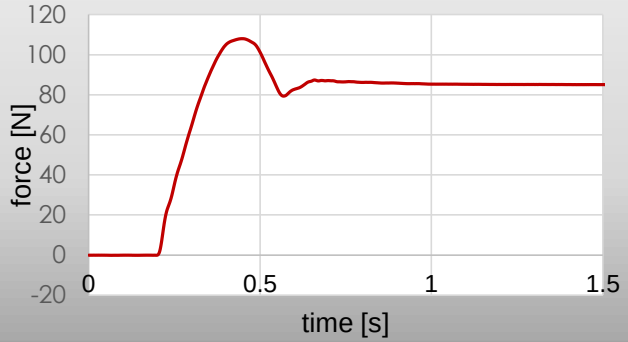
Force & pressure

Force



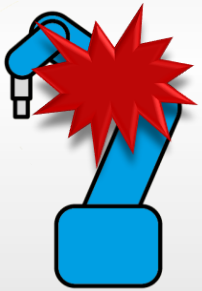
Pressure

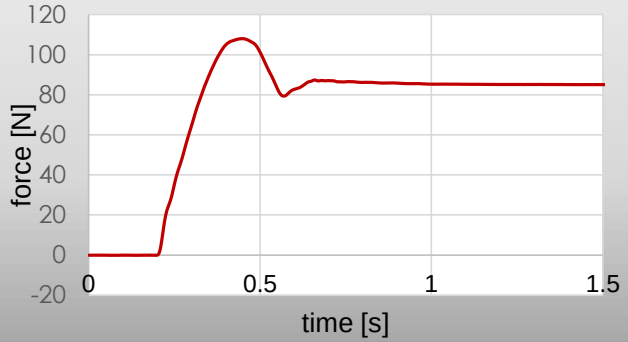




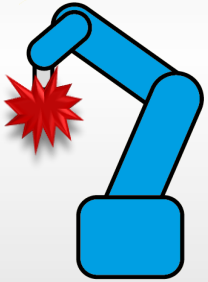
Force & pressure

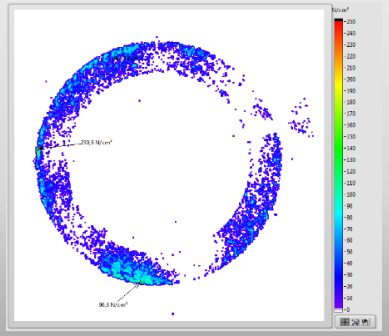
Force





Pressure

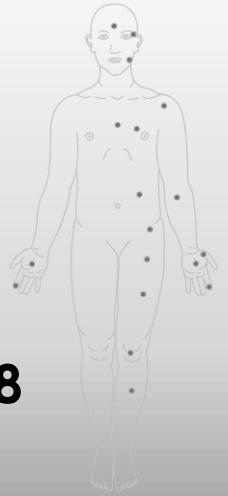




Biofidel measuring system

GTE Industrieelektronik GmbH

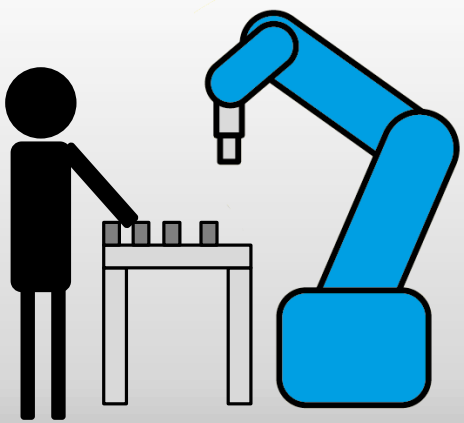
Measurement of collision forces and pressures



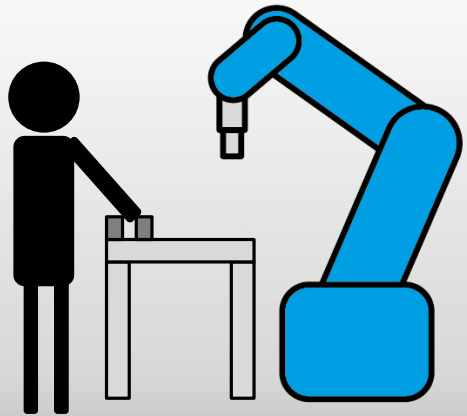
According to **FB HM 080 & RIA TR R15.806-2018**

Substitution

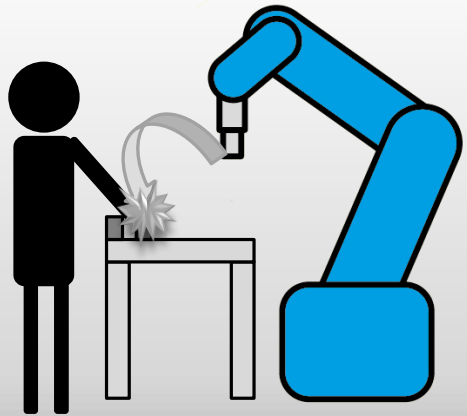
GTE Industrieelektronik GmbH



Substitution

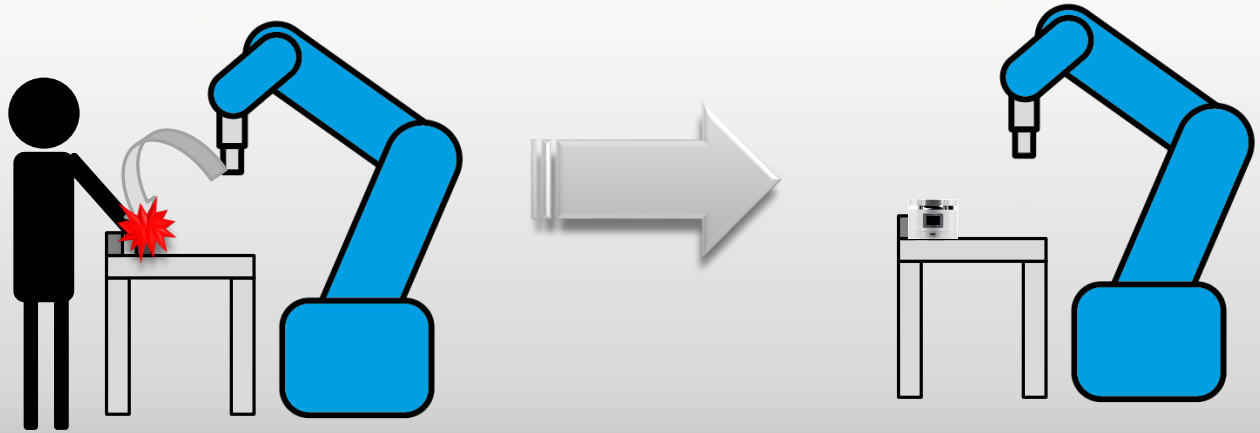


Substitution



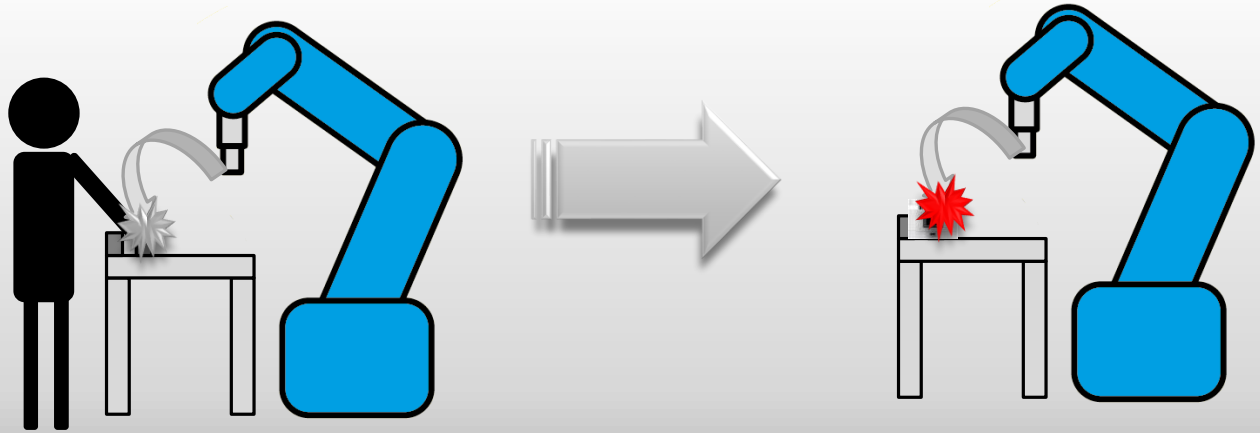
Substitution

GTE Industrieelektronik GmbH



Substitution

GTE Industrieelektronik GmbH



Measuring system

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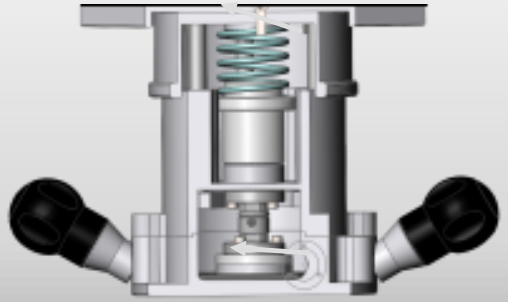
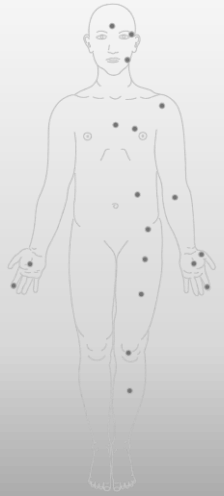
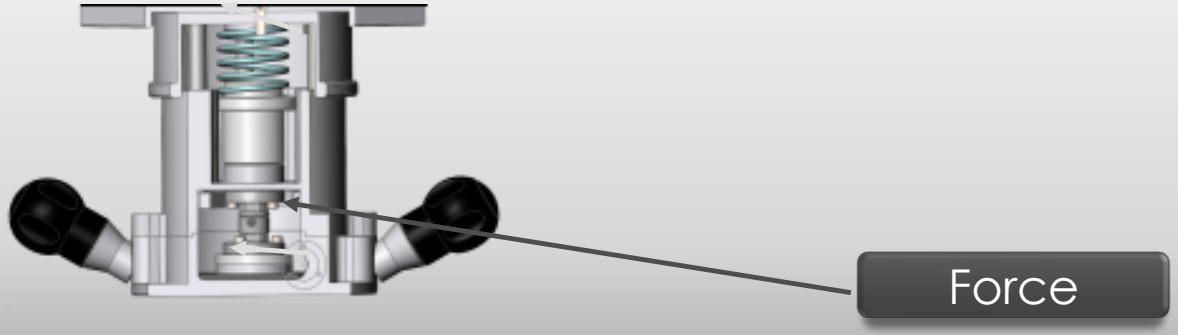


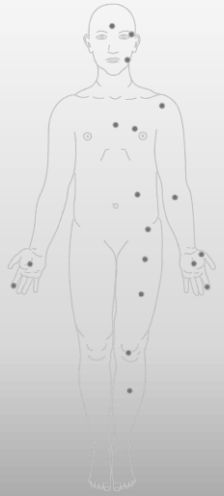


Measuring system

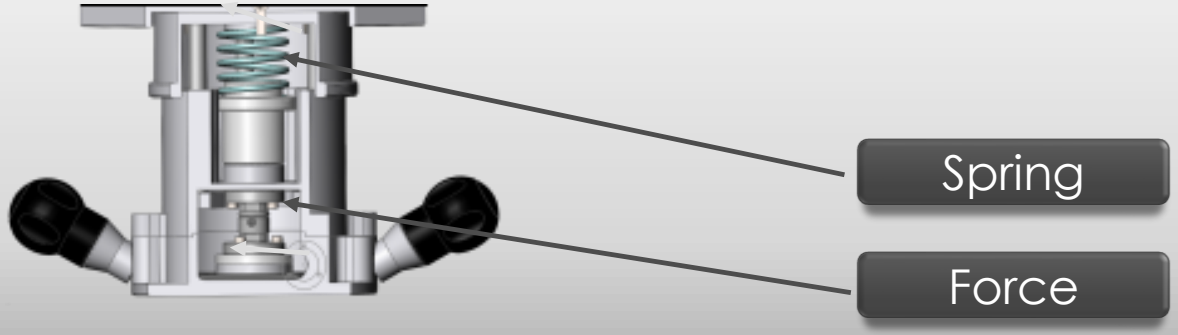
Measuring system

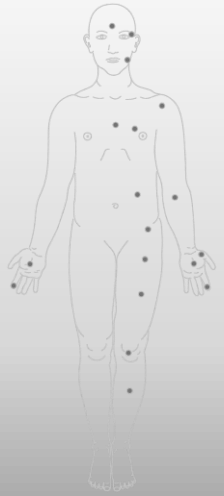
GTE Industrieelektronik GmbH



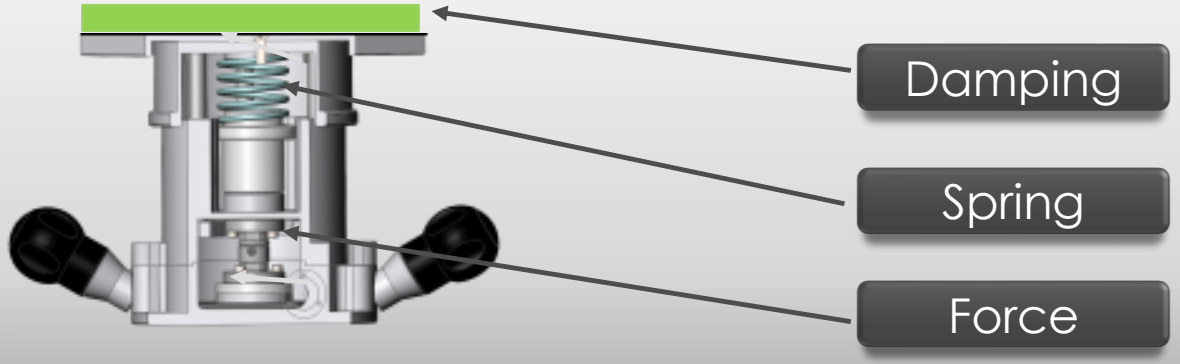


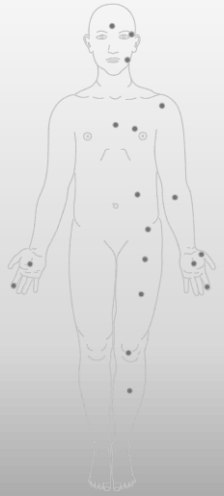
Measuring system





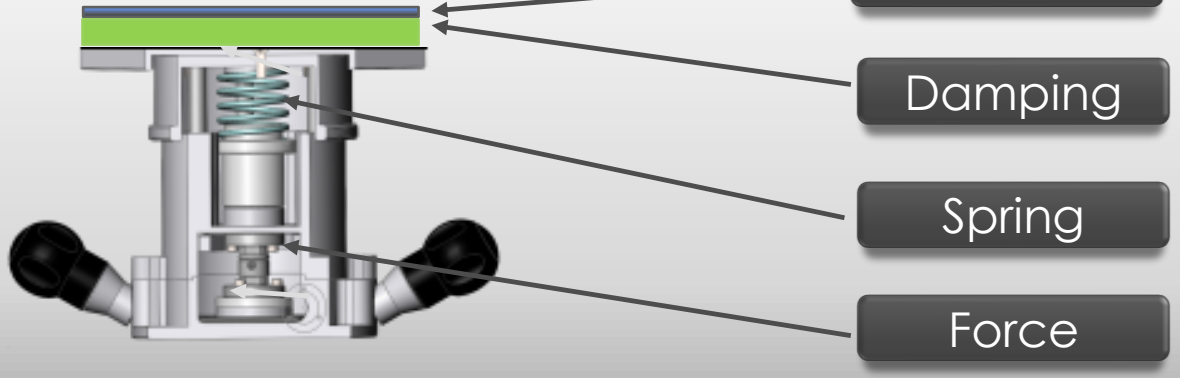
Measuring system

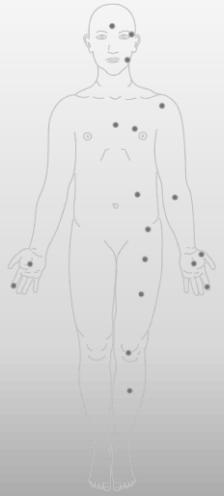




Measuring system

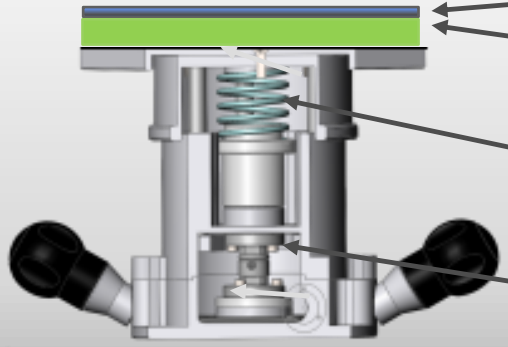
GTE Industrieelektronik GmbH





Measuring system

GTE Industrieelektronik GmbH

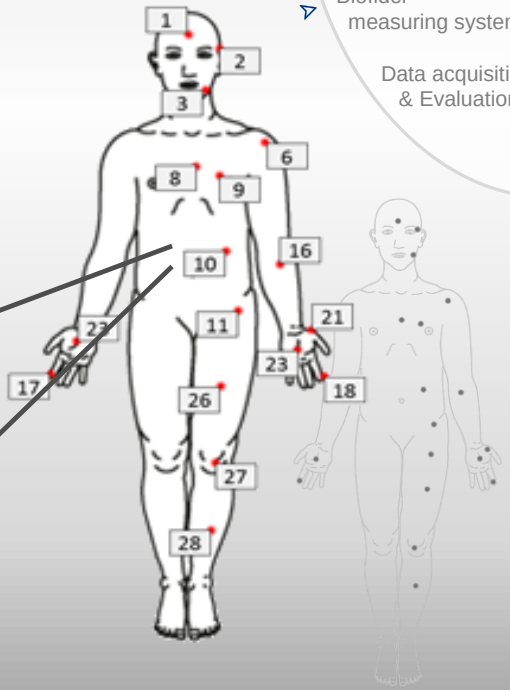


Pressure

Damping

Spring

Force



Measuring set up according FB-HM 080 & RIA TR R.15.806-2018

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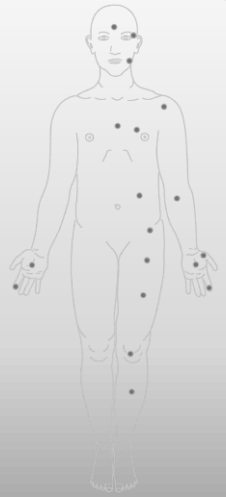
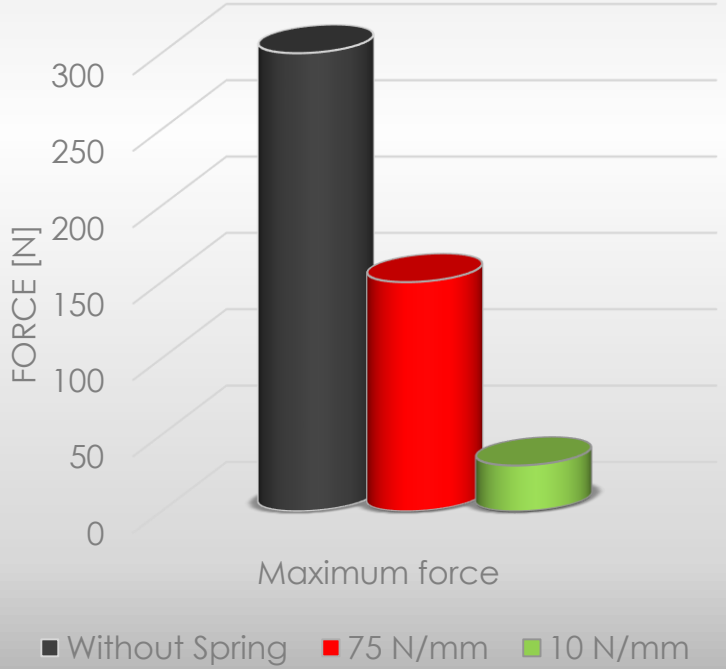
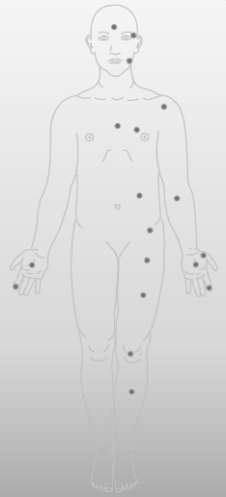
Body region	Damping material K1 [Shore A]	Thick-ness [mm]	Spring K2 [N/mm]
Skull and forehead	critical zone		150
Face			75
Hand and finger	70	7	75
Neck			50
Lower arm and wrist			40
Chest			25
Pelvis			25
Lower leg	30	14	60
Thigh and knee			50
Back and shoulders			35
Upper arm and ellbow			30
Abdomen	10	21	10



Spring

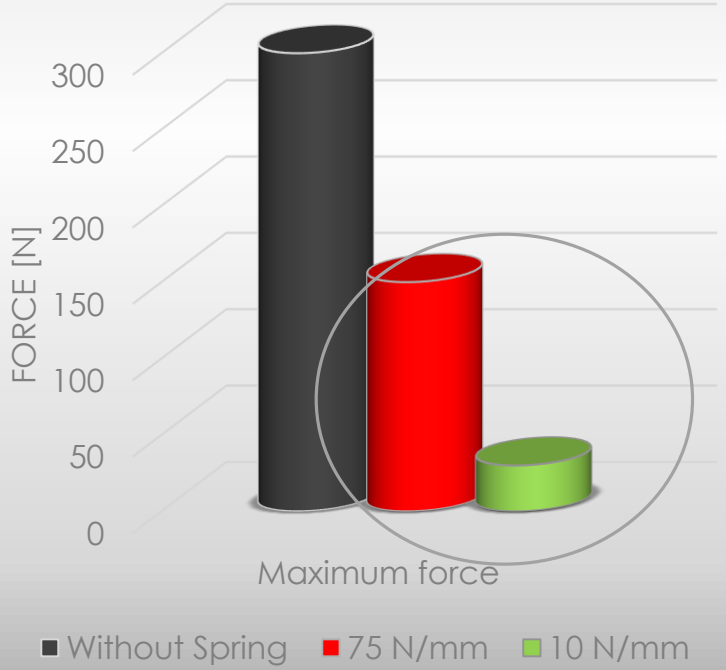


GTE Industrieelektronik GmbH

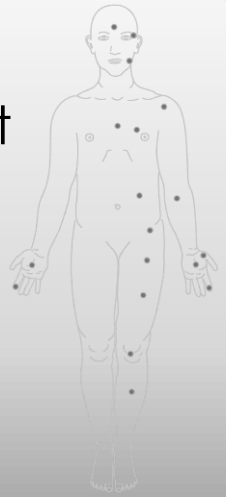


Measuring system

Spring

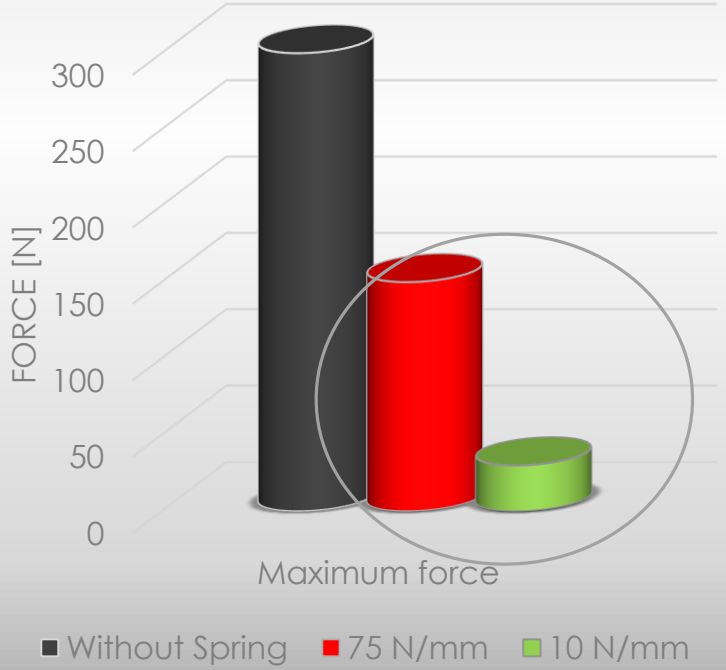


difference depends on the robot type and its movement



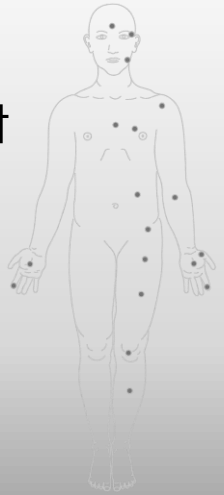
Measuring system

Spring



difference depends on the robot type and its movement

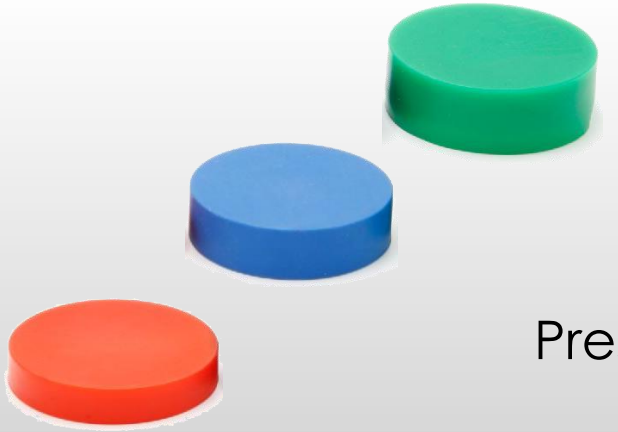
According to **FB HM 080** possible to use **harder** spring



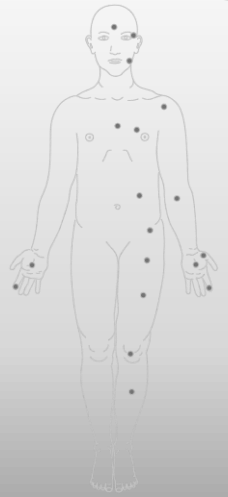
Measuring system

Damping element

GTE Industrieelektronik GmbH



Pressure distribution

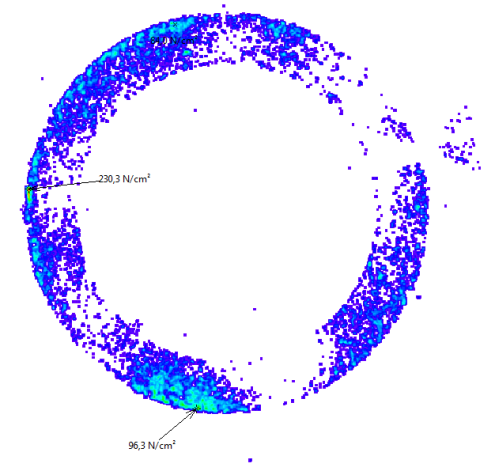


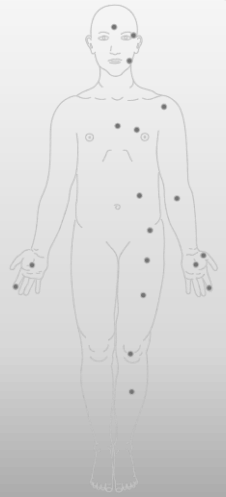
Damping element

GTE Industrieelektronik GmbH

Pressure distribution

without



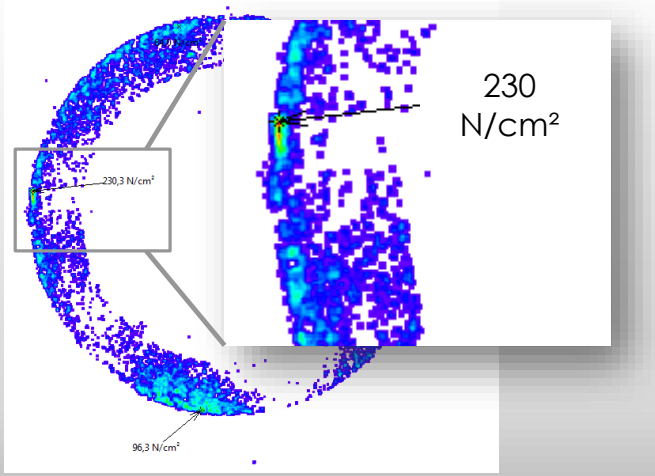


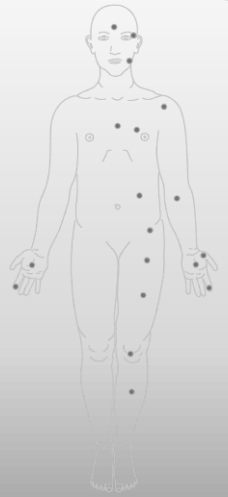
Damping element

GTE Industrieelektronik GmbH

Pressure distribution

without



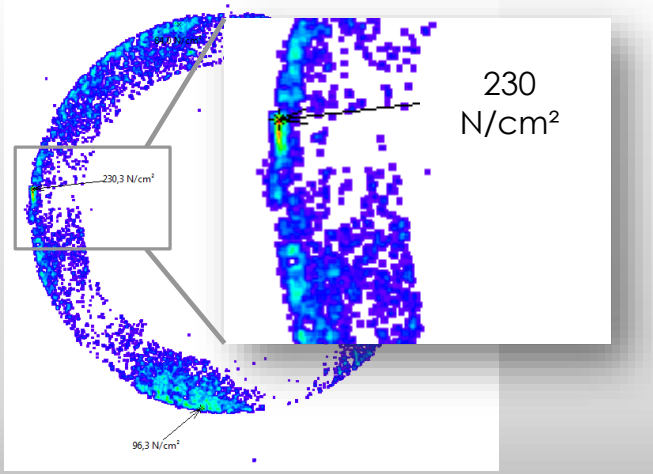


Damping element

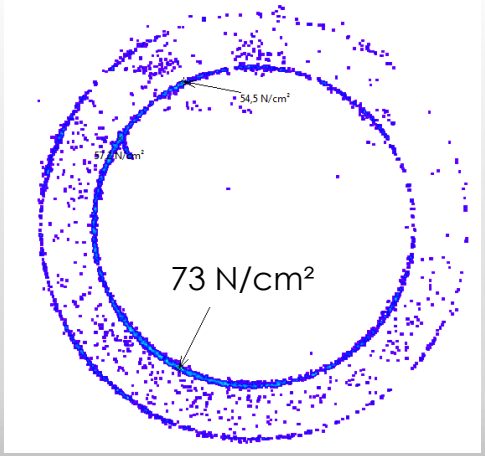
GTE Industrieelektronik GmbH

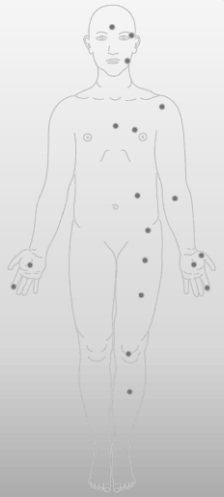
Pressure distribution

without



with



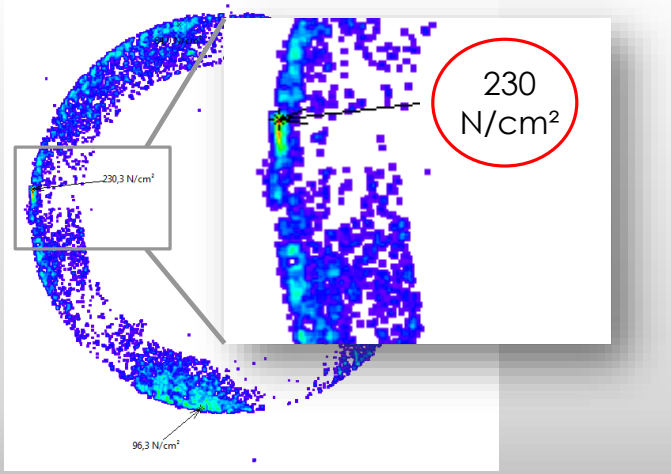


Damping element

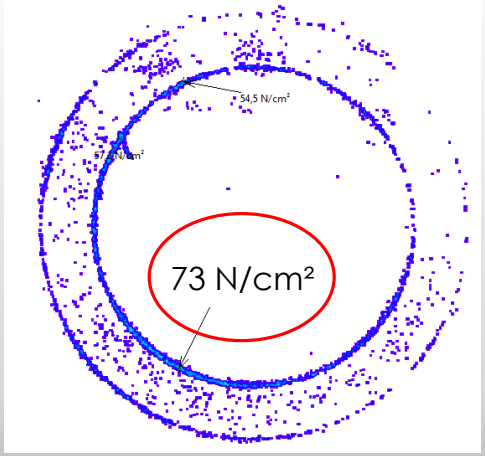
GTE Industrieelektronik GmbH

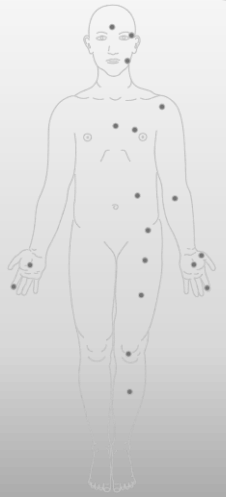
Pressure distribution

without

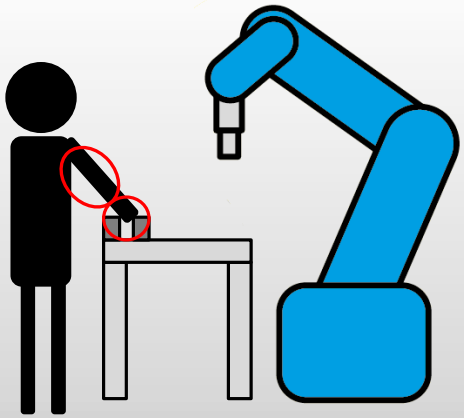


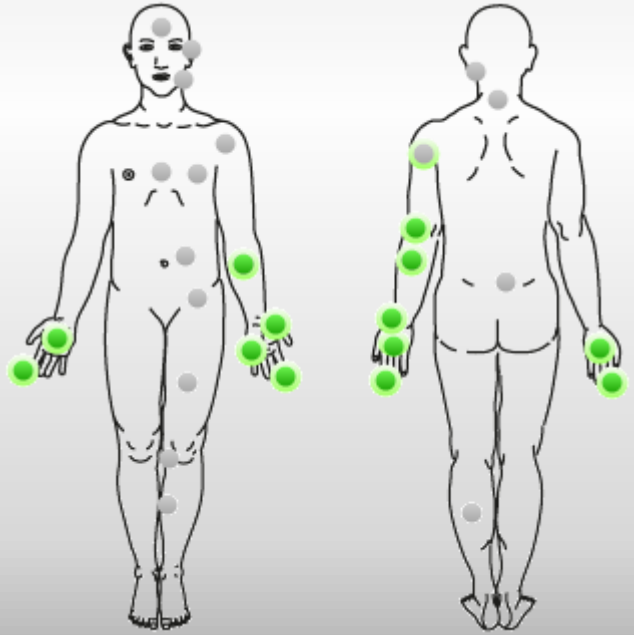
with

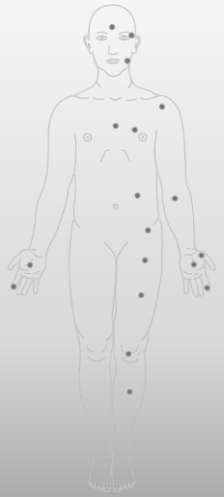




Substitution

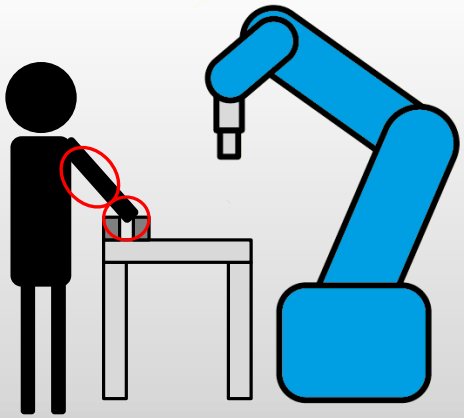


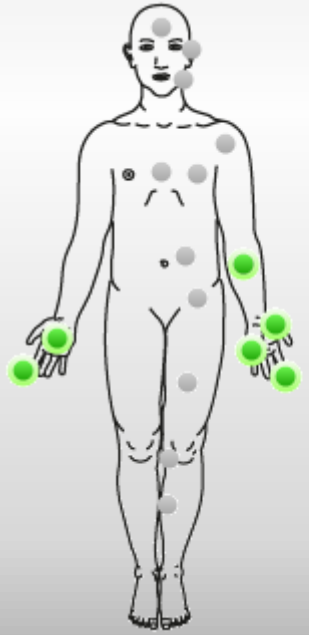


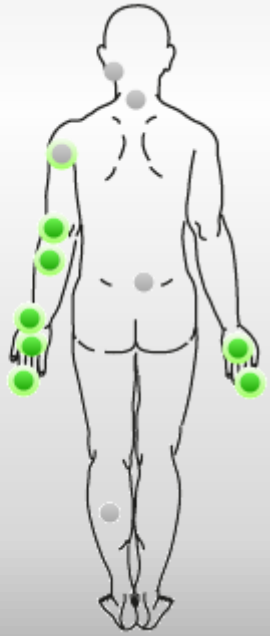


Measuring system

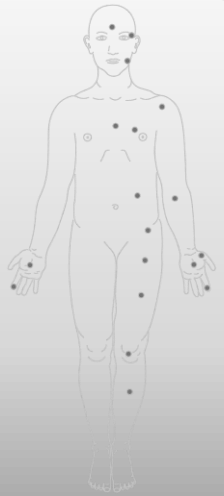
Substitution







13 Points



Substitution

GTE Industrieelektronik GmbH

10 N/mm

30 N/mm

10 N/mm 70°

30 N/mm 70°

10 N/mm 30°

30 N/mm 30°

10 N/mm 10°

30 N/mm 10°

40 N/mm

75 N/mm

40 N/mm 70°

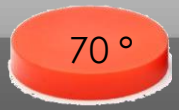
75 N/mm 70°

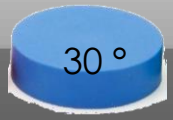
40 N/mm 30°

75 N/mm 30°

40 N/mm 10°

75 N/mm 10°





Substitution

GTE Industrieelektronik GmbH

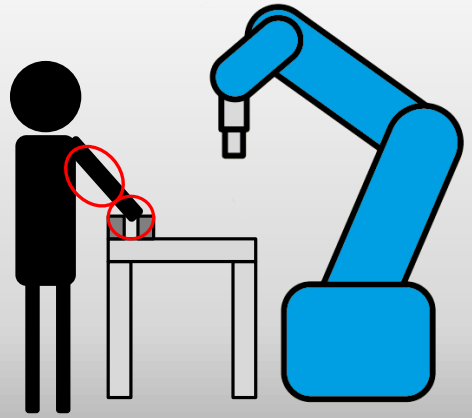
10 N/mm

30 N/mm

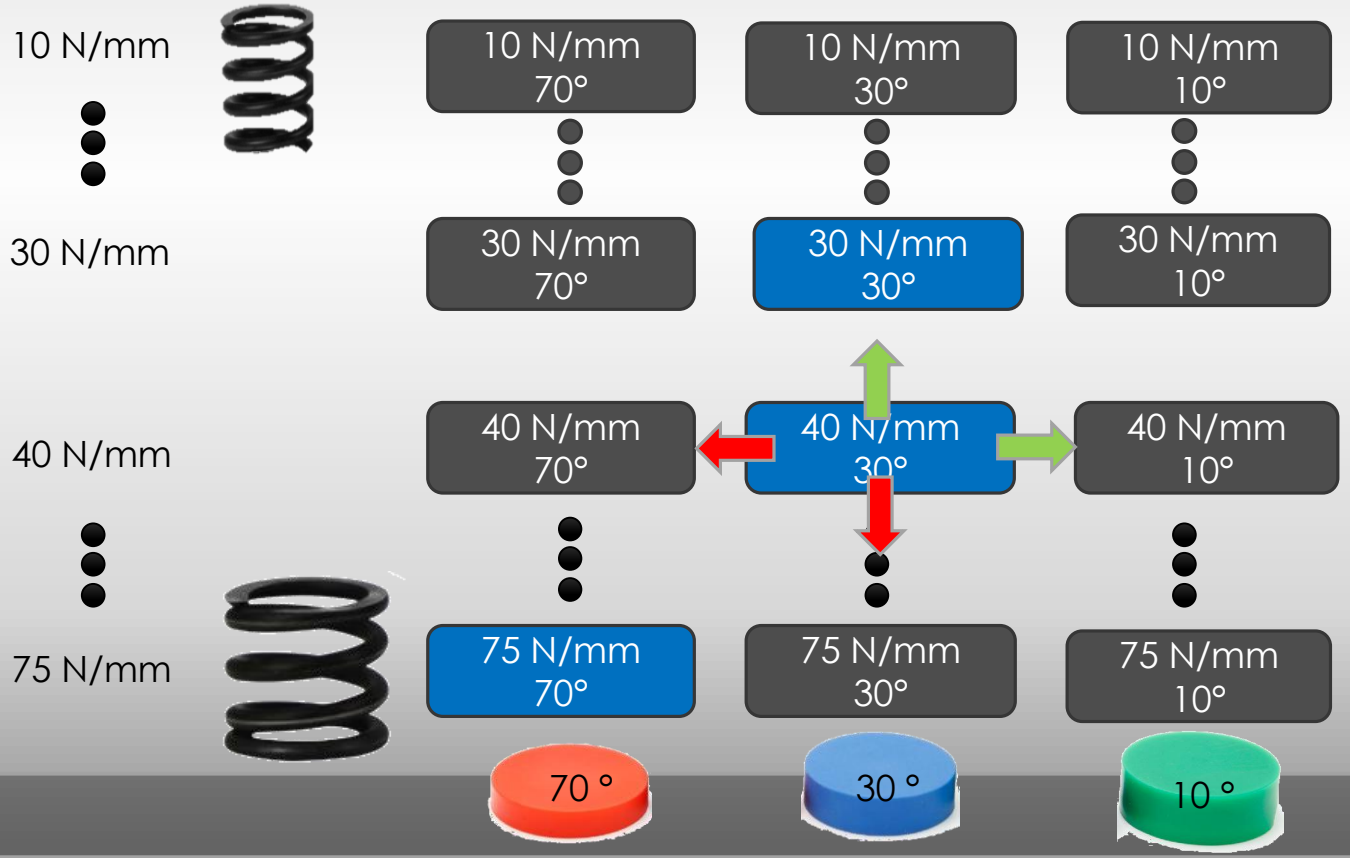
40 N/mm

75 N/mm

10 N/mm 70°	10 N/mm 30°	10 N/mm 10°
30 N/mm 70°	30 N/mm 30°	30 N/mm 10°
40 N/mm 70°	40 N/mm 30°	40 N/mm 10°
75 N/mm 70°	75 N/mm 30°	75 N/mm 10°
70 °	30 °	10 °



Substitution



Substitution

GTE Industrieelektronik GmbH

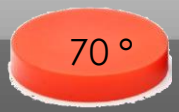
10 N/mm

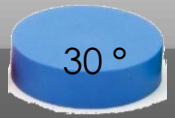
30 N/mm

40 N/mm

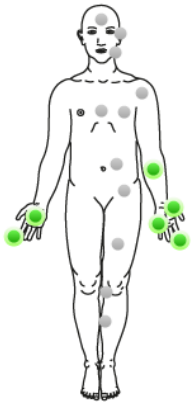
75 N/mm

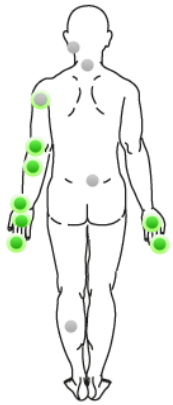
10 N/mm 70°	10 N/mm 30°	10 N/mm 10°
30 N/mm 70°	30 N/mm 30°	30 N/mm 10°
40 N/mm 70°	40 N/mm 30°	40 N/mm 10°
75 N/mm 70°	75 N/mm 30°	75 N/mm 10°





Substitution





- ☐ Skull and forehead
- ☐ Face
- ☐ Nape
- ☐ Back and shoulders
- ☐ Chest
- ☐ Belly
- ☐ Pelvis
- ☐ Upper arm and elbow
- ☑ Underarm and wrist
- ☑ Hand and finger
- ☐ Thigh and knee

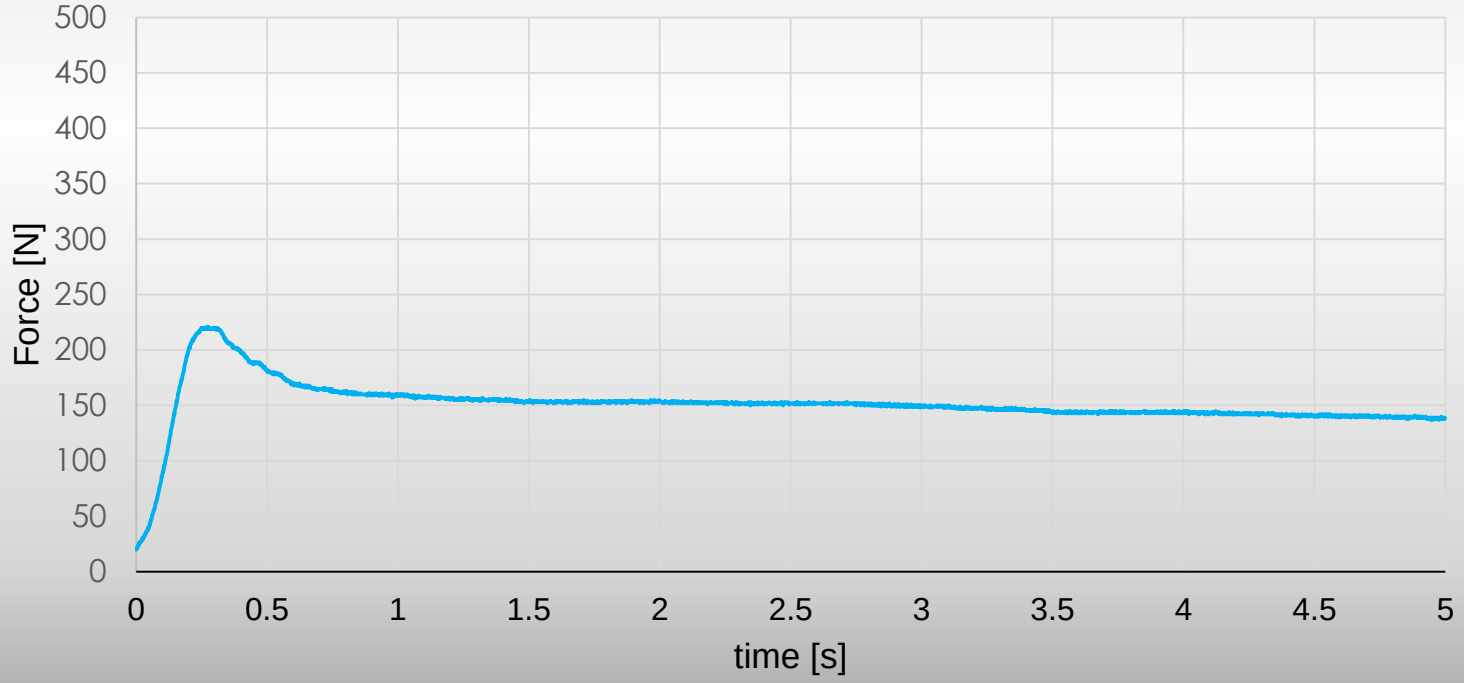
Spring	30 N/mm
Shore hardness:	30 ° Shore A
Material thickness:	14 mm

	Force	Pressure
Static:	150 N	190 N/cm²
Transient:	300 N	380 N/cm²

measurements

Measurement	Force [N] Transient	Force [N] Static	Pressure [N/cm²] Transient	Pressure [N/cm²] Static
30 N/mm 30 °ShoreA (blue)	300	150	440	220
40 N/mm 70 °ShoreA (red)	320	160	360	180
75 N/mm 70 °ShoreA (red)	280	140	380	190

Evaluation



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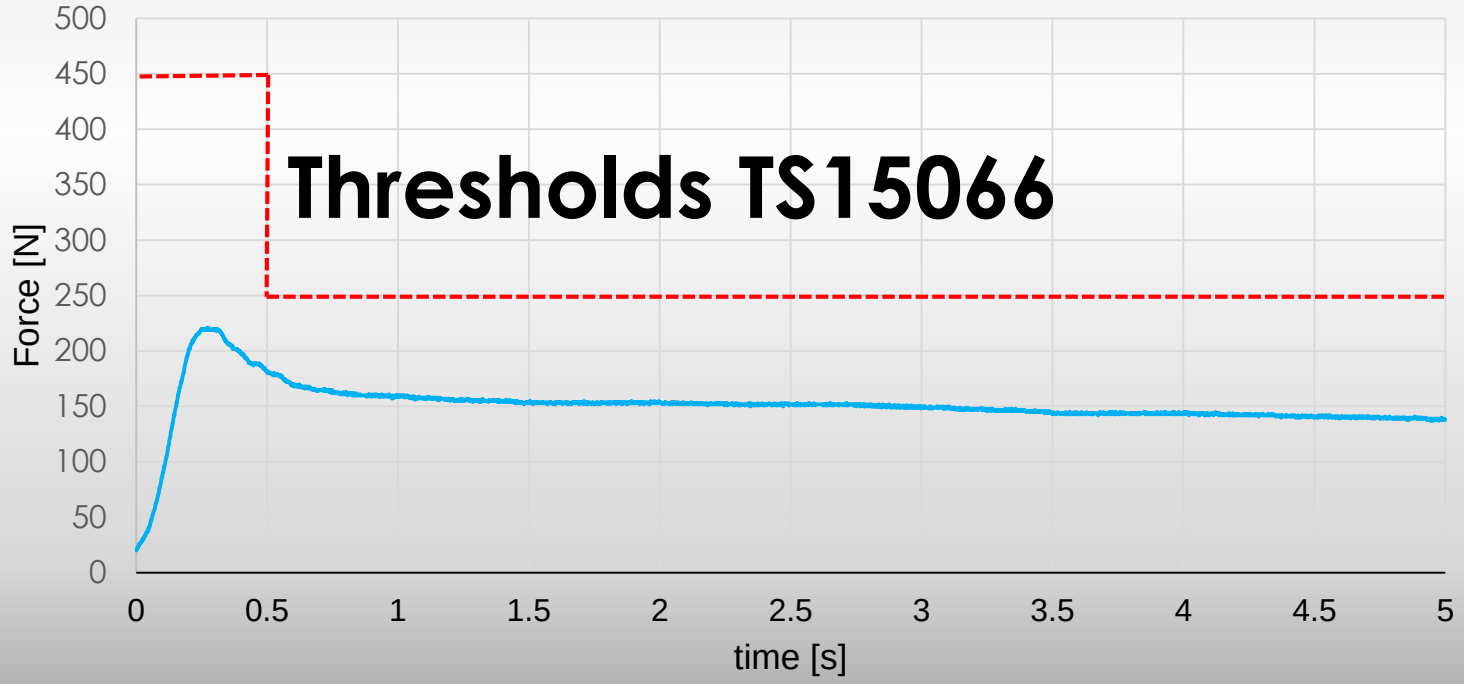
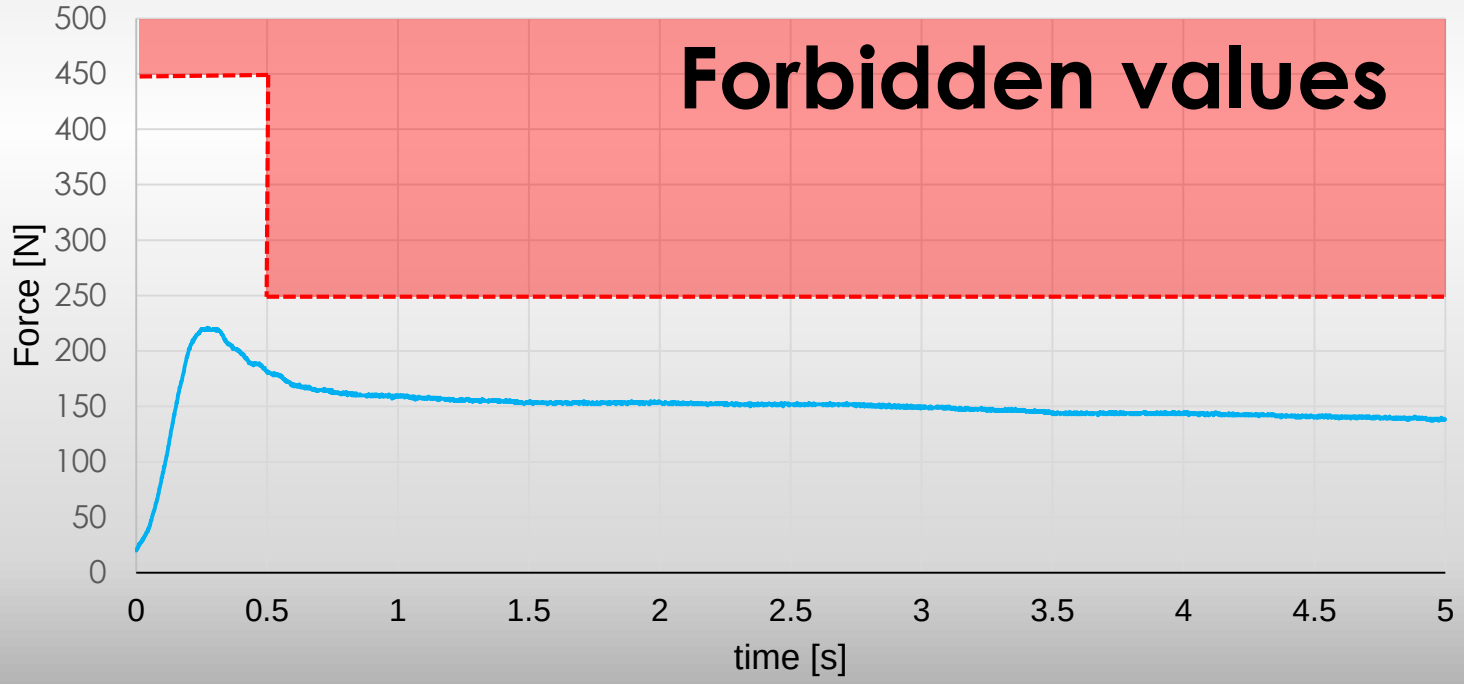
Data acquisition

Evaluation



Data acquisition

Evaluation



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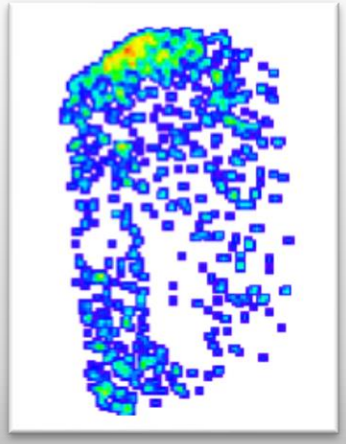
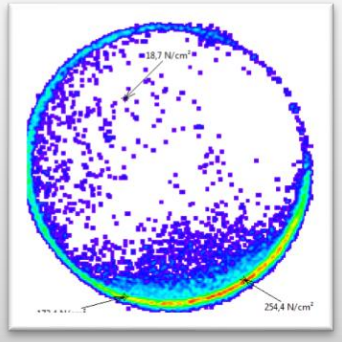
Data acquisition

Evaluation – pressure

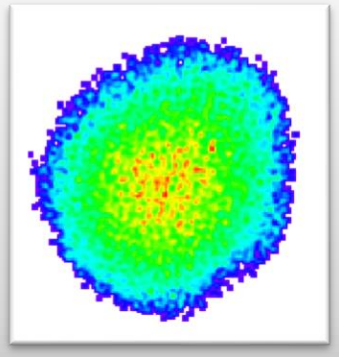
gripper



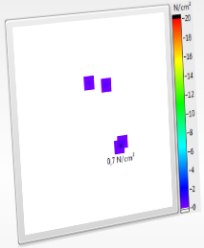
cylinder

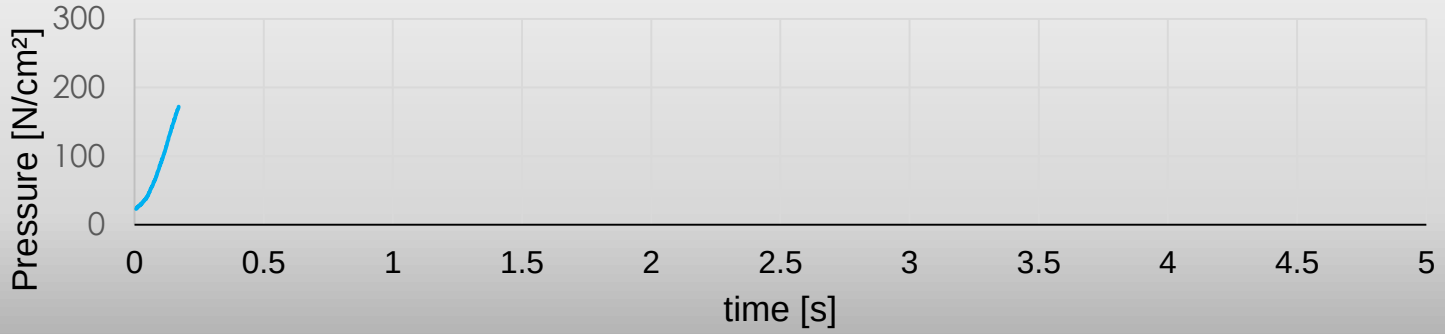


sphere



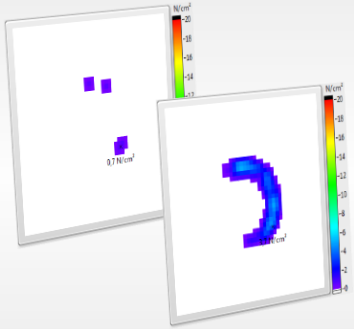
Evaluation – pressure

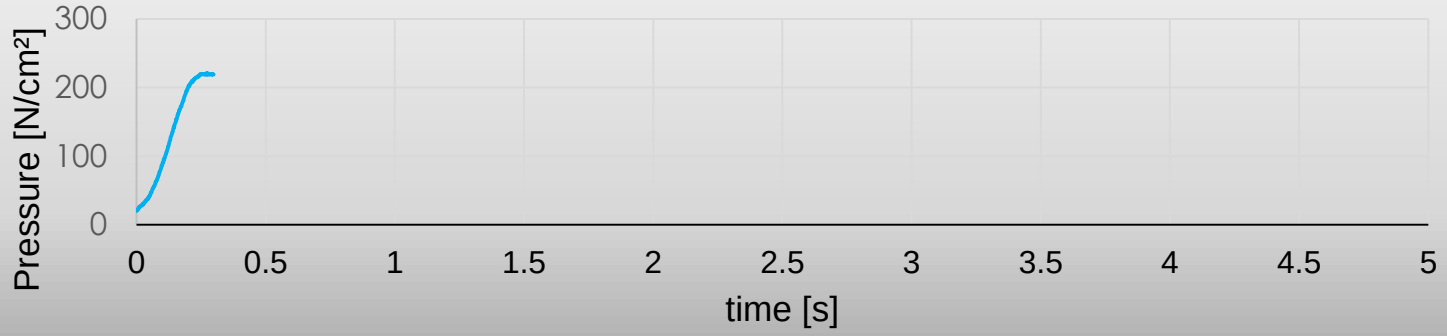




Data acquisition

Evaluation – pressure

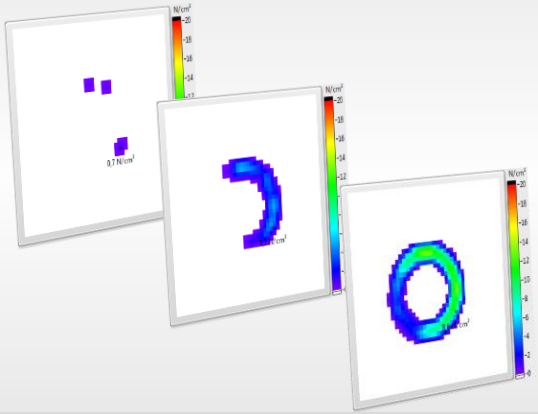


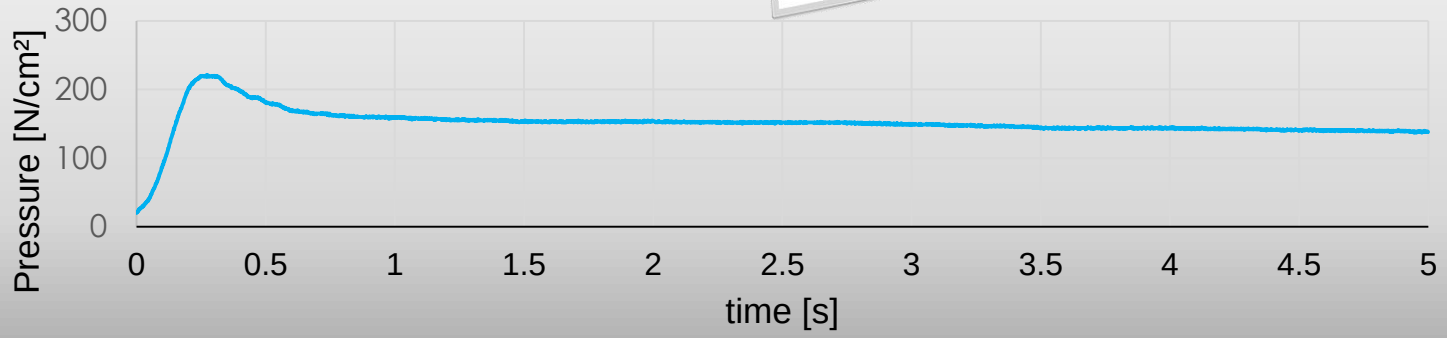


Data acquisition

Evaluation – pressure

GTE Industrieelektronik GmbH





Data acquisition

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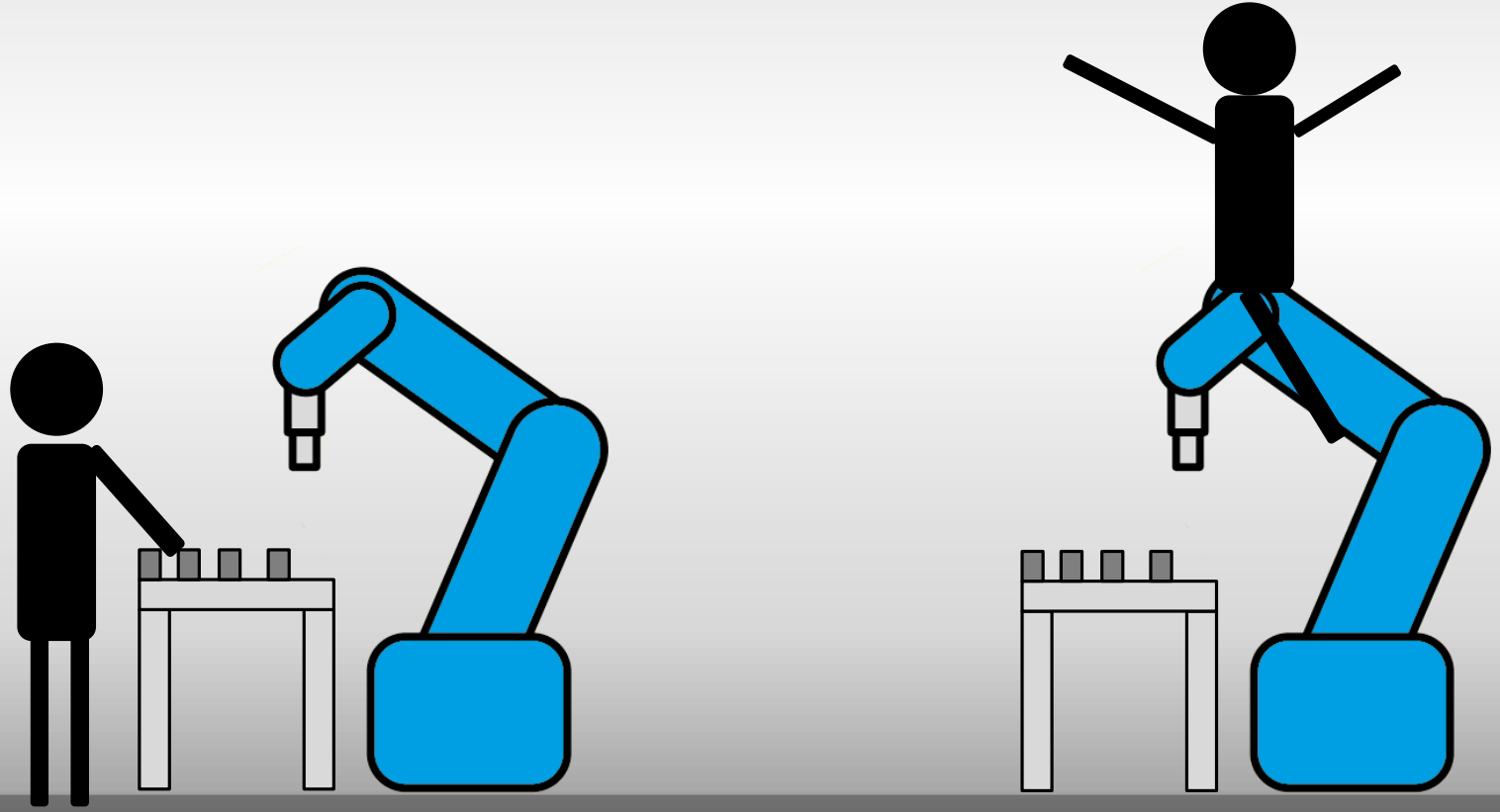
Which collision points within an HRC application needs to be measured?

Realistic collision points!

Collision points



Collision points

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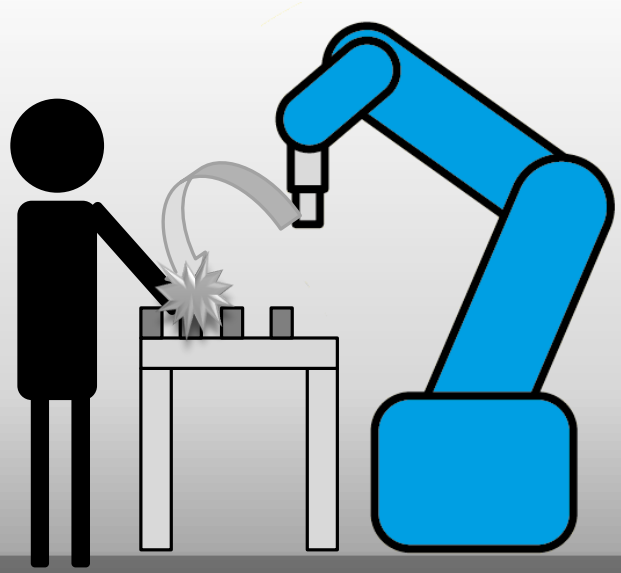
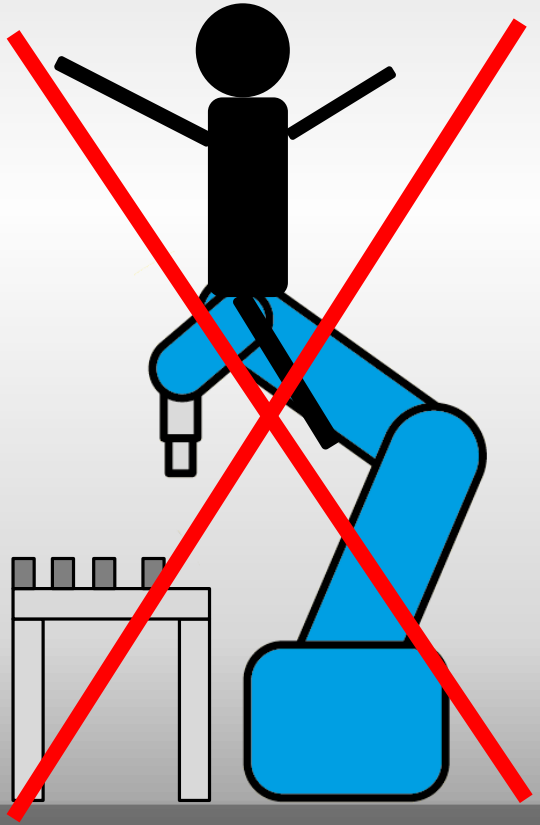
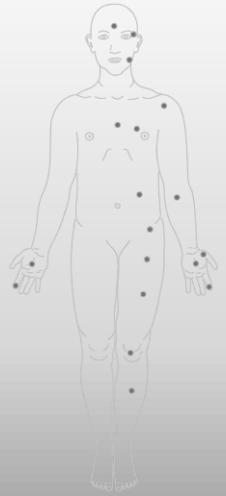




System



GTE Industrieelektronik GmbH

Theory

Biofidel measuring system

Data acquisition & Evaluation

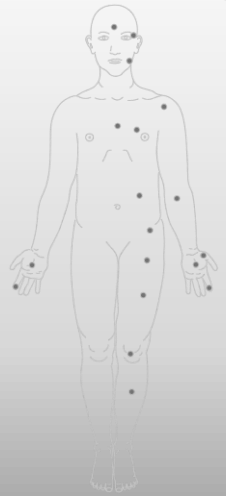
Measuring system

System

GTE Industrieelektronik GmbH

2016

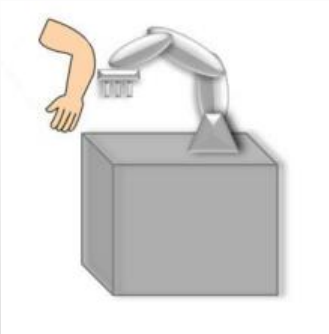
2019



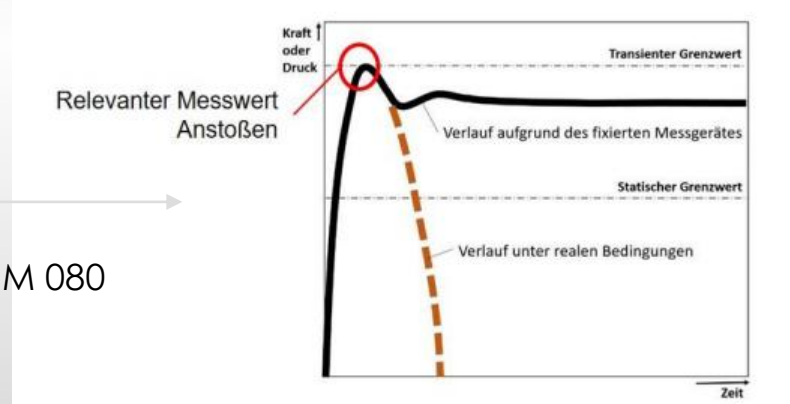
Measuring system

Thank you for your attention

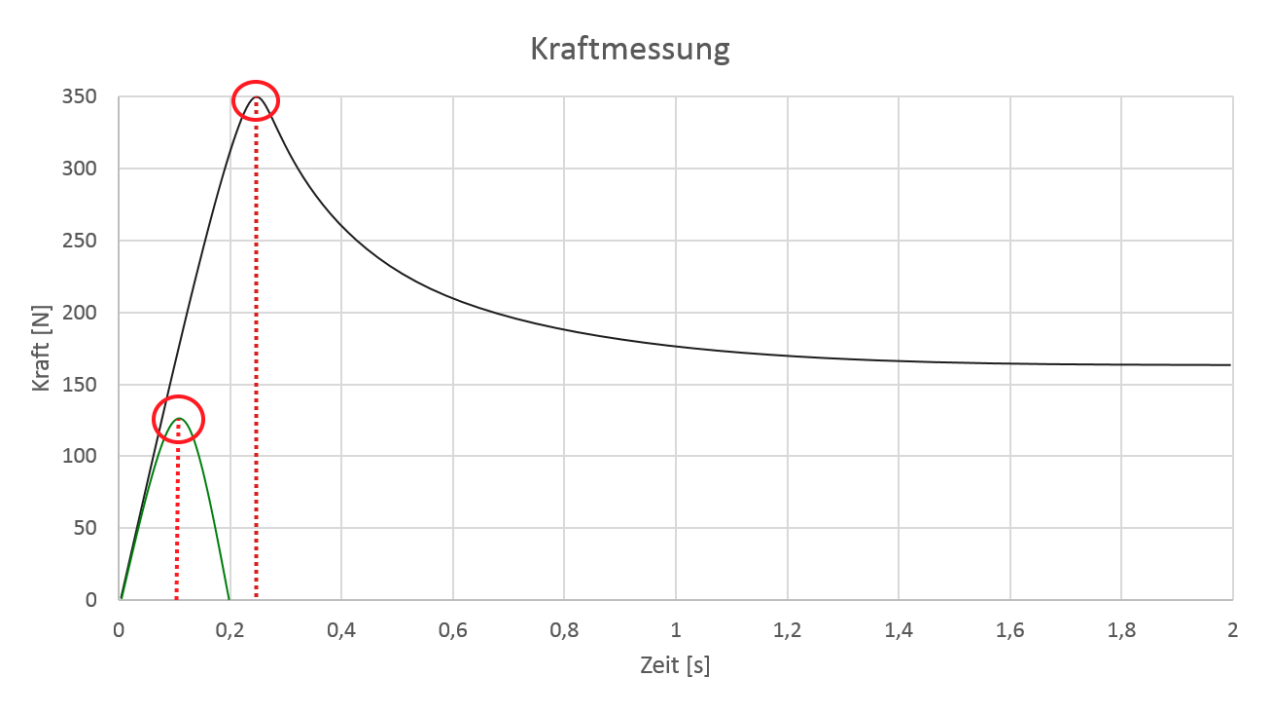
Messung



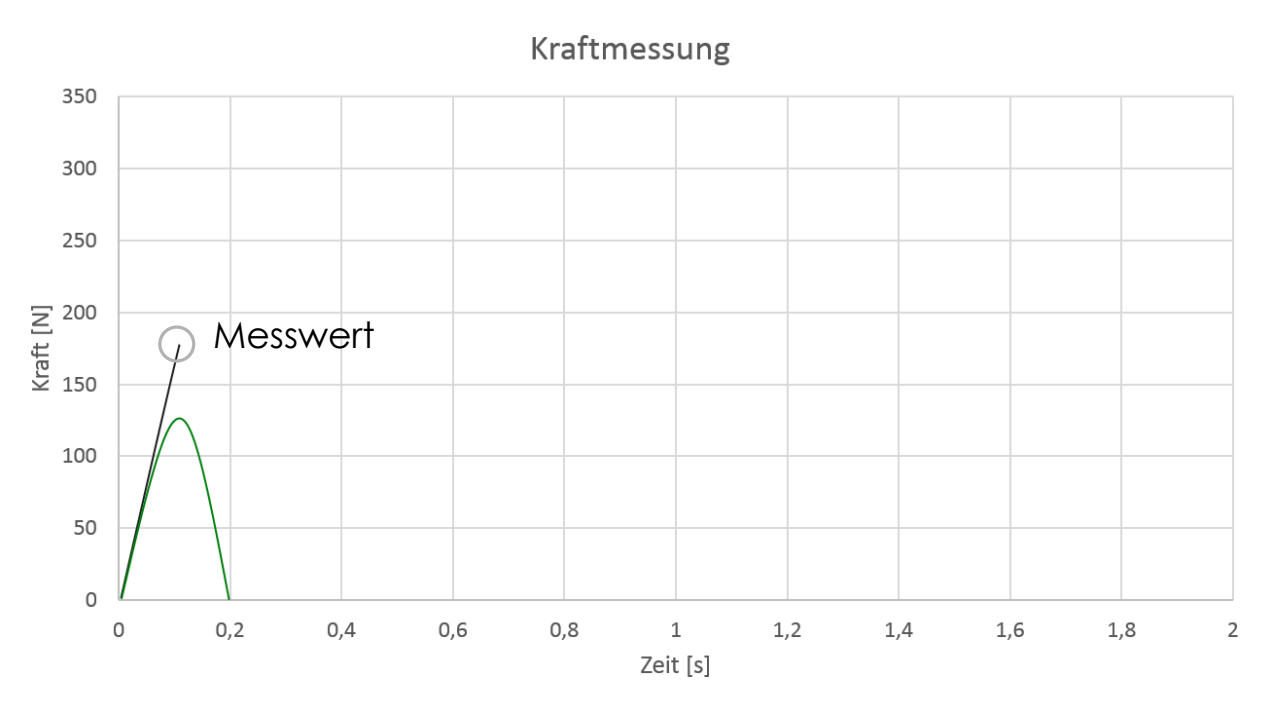
FB HM 080



Freier Stoß


Kraftmessung
Kraft [N]
350
300
250
200
150
100
50
0
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
1,8
2
Zeit [s]

Freier Stoß


Kraftmessung
Kraft [N]
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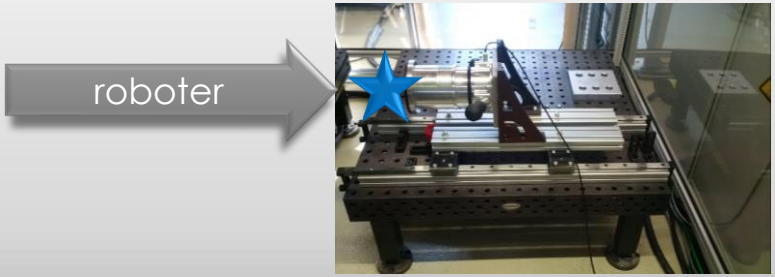
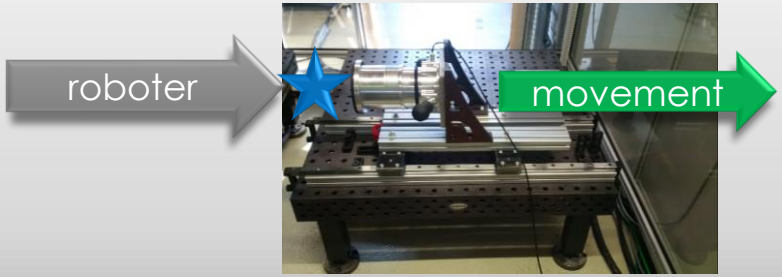
300
250
200
150
100
50
0
Messwert
0
0,2
0,4
0,6
0,8
1
1,2
1,4
1,6
1,8
2
Zeit [s]

Messungen

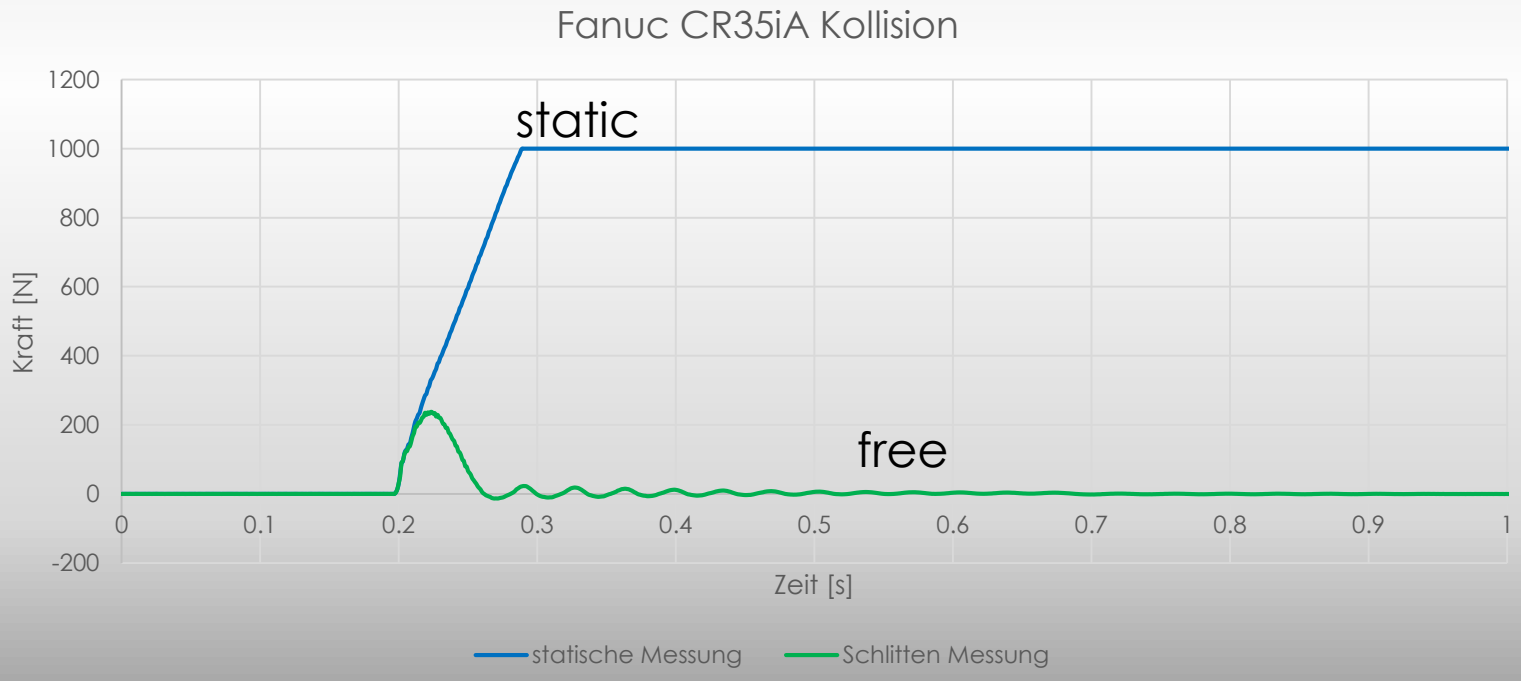
- Static measurement



- Free measurement



Messungen


Fanuc CR35iA Kollision
static
free
Kraft [N]
1200
1000
800
600
400
200
0
-200
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
Zeit [s]
statische Messung
Schlitten Messung

Messungen

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