3DRC SOP FOR DIGITAL FABRIC PHYSICS TESTING V.2 UPDATED JUNE 2024

3DRC

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3D·RC
3D Retail Coalition

Standard Operating Procedure
For Digital Fabric Physics Interoperability

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1. Foreword

This Standard Operating Procedure (SOP) document was created by the 3D Retail Coalition (3DRC). The 3DRC is a group of brands, retailers and academics who have come together in a pre-competitive way to solve common issues, challenges and industry problems in the apparel industry. This SOP is intended for brands, retailers & fabric suppliers with in-house testing labs and independent testing labs. This work started in 2020 and since, we have made great progress in making fabric physics data more universal and usable by brands, retailers, vendors and 3D software providers. Thank you to all of the fabric suppliers and labs who participated in the initial PILOT of this SOP.

The purpose of this document is to share how to test fabric physics once on classical testing equipment and use in multiple 3D software. A universal 3D fabric physics test set would dramatically change the way we work today by eliminating the need to test a single fabric multiple times to support the data needs of each 3D software provider. Rather, the universal 3D fabric physics test set includes all relevant data needed by all 3D software providers through measurement and/or mathematical conversion. This universal nature of the test set will result in a reduction of time and cost for all parties involved in this work. The following pages explain the SOP of the universal 3D fabric physics test we are suggesting, based on our previous work.

We ask anyone who is using this document to provide feedback for clarity, formulas, process, and efficiency especially as 3D software continue to improve and evolve. We are grateful for your feedback and look forward to collaborating.

2. Scope

This document is valid from November 2021, and covers SOP for testing fabric physics properties needed for 3D software solutions published by Assyst/Vidya, Browzwear, CLO3D, Gerber, Optitex and Style 3D.

3. Responsibility

For questions and feedback regarding the content, please contact: Innovation.lead@3drc.pi.tv
Link Online tool website: https://d-fip.ieee-saopen.org/
Link 3DRC website: http://3drc.pi.tv/

4. Mass per Unit Area (Weight, gsm)

4.1. Scope

This method describes the determination of mass per unit area using small samples. Existing EN, ISO, and ASTM standards are sufficient to follow for generating data in any of the 3D tools studied. Some software solutions call for slight differences in units or measures, which are outlined below.

4.2. Standard

4.2.1. Option 1: EN 12127: 1997: Textile-Fabrics – Determination of mass per unit area using small samples.

4.2.2. Option 2: ISO 3801: 1977: Textiles: Woven fabrics: Determination of mass per unit length and mass per unit area.

4.2.3. Option 3: ASTM D3776: Option C: Small swatch of fabric.

4.3. Testing Conditions

4.3.1 Preparations for Test Specimen

Option 1: Condition fabric according to ASTM D1776.

Option 2: Condition fabric according to ISO 139.

4.3.2 Procedure: Follow the selected standard procedure.

4.3.3. Equipment, Supplies and Reagents: Only those described in the preparation standard above.

4.4. Software Specifications

4.4.1 Assyst/Vidya, Browzwear, Gerber, Optitex, Style 3D, CLO Version 4.42 & above: Give the mass per unit area in g/m2.

4.4.2. If using CLO 4.41 or previous use this method:

Give the mass in g per 198 cm2 s. Software specific unit referred to as “area CLO” g/m2 *0.0198 = g/area CLO

5. Thickness

5.1. Scope

This method describes the determination of the thickness of textiles under a specified pressure. It is not valid for coated fabrics or non-woven fabrics (EN ISO 5084). All software providers manage this data in the same way, with only one calling for a different unit of measure.

5.2. Standard

5.2.1. Option 1: EN ISO 5084: 1996: Determination of thickness of textile and textile products alternative.

5.2.2. Option 2: ASTM D1777: 1996 (2019): Standard test method for thickness of textile material.

5.3. Testing Conditions

5.3.1. Preparation for Test Specimen:

Option 1: Condition fabric according to ASTM D1776.

Option 2: Condition fabric according to ISO 139.

5.3.2. Procedure: Follow the selected standard’s procedure.

5.3.3. Equipment, Supplies and Reagents: Only those described in the preparation standard above.

5.4. Software Specifications

5.4.1. Assyst/Vidya, Browzwear, CLO3D, Gerber and Style 3D:

Give Thickness in mm.

5.4.2. Optitex

Give Thickness in cm.

6. Bending

6.1. Scope

This method describes the determination of the fabric’s stiffness. Multiple standards use the same Cantilever method needed for the majority of the software providers. One software provider does not follow the standard, however, data collected via the standard method may be used.

6.2 Standard

6.2.1. Option 1: DIN 53362: 2003 (German Standard)

6.2.2. Option 2: BS 3356: 1990 (British Standard)

6.2.3. Option 3: AS2001.2.9 (Australian Standard)

6.2.4. Option 4: ASTM D1388: 2018 (USA Standard)

6.3 Testing Conditions

6.3.1 Preparations for Test Specimen:

Option 1: Condition fabric according to ASTM D1776.

Option 2: Condition fabric according to ISO 139.

6.3.2. Procedure:

The angle of inclination is 41.5° ± 0.5° on your testing equipment.

(*) software in chart below have additional documentation in section 6.4.

6.4 Software Specifications: Equipment, Supplies and Reagents: See chart below for software-specific needs.

Bending Needs by Software

	Browzwear (*)	Assyst/Vidya	Gerber	Optitex	CLO 3D	Style 3D
Testing principle	See Browzwear Manual Fold Bend Test (*) Link in appendix	Cantilever	Cantilever	Cantilever	Cantilever Modification See 6.4.1	Cantilever
Number and size of Specimen	3 per direction; Determine medium value per direction; 2.5cm (W) x 25cm (L): fraying not necessary.				3 per direction, determine medium value per direction, 3cm(W)×22cm(L): fraying not necessary.	
Testing Direction	See Browzwear Manual Fold Bend Test (*) Link in appendix	Warp, Weft, Bias	Warp, Weft, Bias	Warp, Weft, Bias	Warp, Weft, Bias	Warp, Weft, Bias
Input Variables for Results Calculation	See Browzwear Manual Fold Bend Test (*) Link in appendix	Overhang length per direction. Fabric weight	Overhang length per direction. Fabric weight	Overhang length per direction. Fabric weight	Contact length Moving distance	Overhang length per direction. Fabric weight
Output/Unit	Flexural rigidity [dyn*cm]	Bending stiffness [µNcm]	Bending rigidity [g*cm]	Flexural rigidity [dyn*cm]	No calculation necessary before input into software [mm]	Flexural rigidity [dyn*cm]
Calculation	BW recommends using the FAB analyzer for Bending however, if that is not available, See Browzwear Manual Fold Bend Test (*) Link in appendix	$G = m\left(\frac{l}{2}\right)^3 \cdot 10^{-3} \cdot g$ G = Flexural Rigidity (µNcm) l = overhang length (cm) m = mass per unit area (g/m^2) g = 980 [1 dyn*cm = 10 µNcm]	$G = m\left(\frac{l}{2}\right)^3 \cdot 10^{-3} \cdot g$ G = Flexural Rigidity (µNcm) l = overhang length (cm) m = mass per unit area (g/m^2) g = 980 [1 dyn*cm = 10 µNcm]	$G = m\left(\frac{l}{2}\right)^3 \cdot 10^{-3} \cdot g$ G = Flexural Rigidity (µNcm) l = overhang length (cm) m = mass per unit area (g/m^2) g = 980 [1 dyn*cm = 10 µNcm]	Raw Data entered directly into software	$G = m\left(\frac{l}{2}\right)^3 \cdot 10^{-4} \cdot g$ G = Flexural Rigidity (dyn*cm) l = overhang length (cm) m = mass per unit area (g/m^2) g = 980

6.5 Additional Documentation

6.5.1. CLO 3D:

6.5.1.1. Take the classical instrument and additionally fix a ruler with mm increments in the instrument parallel to the top platform with a distance of 25mm and the 0-point starting at the beginning of the slope.

6.5.1.2. Use the settings for testing with the additionally fixed ruler. In this case, two medium values are needed per direction (warp, weft, and bias directions).

6.5.1.3. All values in mm.

6.5.1.4. Images for reference

Fig. A.1 Schematic of modified cantilever device with ruler attached.

Fig. A.2 Photograph of standard cantilever with ruler attached to a box (25mm from Upper Ruler)

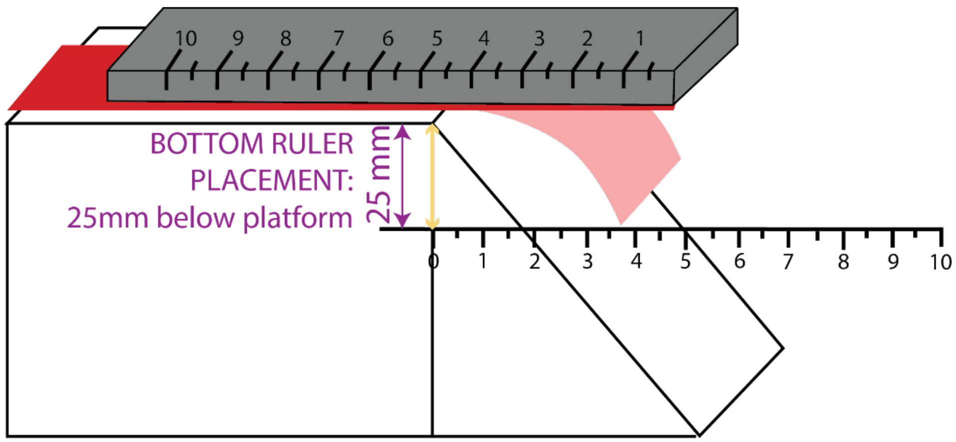

Fig. A.1

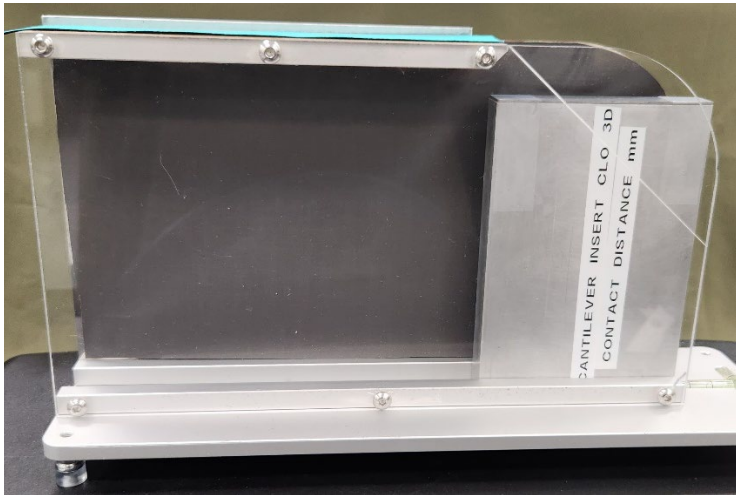

Fig. A.2

6.5.1.5. Fabric specimen is placed on the top platform of the device with the weighted ruler placed on top and the "0mm" aligned to the edge of the specimen. Specimen is moved forward with the slider until it makes contact with the edge of the LOWER RULER.

(a) = Contact Distance (mm) (LOWER RULER).

Fig. A.4 Schematic drawing of modified Cantilever device

Fig. A.5 Measurement reading example

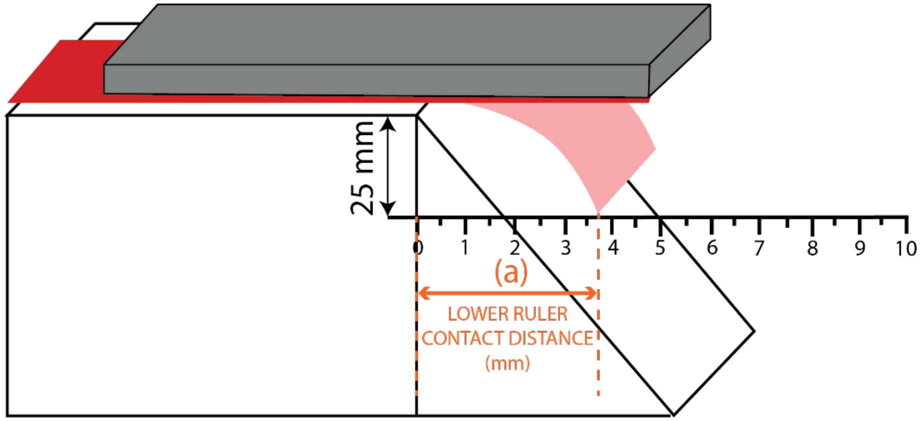

Fig. A.4

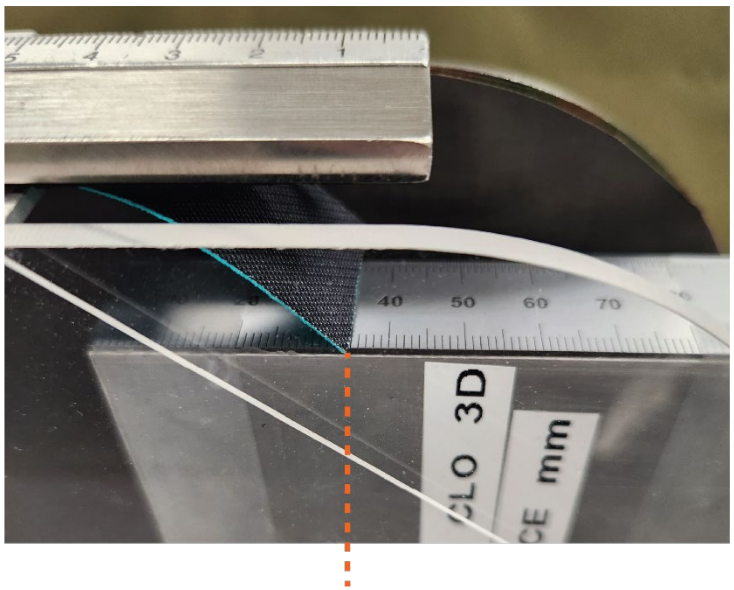

Fig. A.5 The Contact Distance (a) on the Lower Ruler is measured where the fabric specimen makes contact with the edge of the ruler. In this example, the measurement is 35mm.

6.5.1.6. Keep the specimen in place and take the measurement on the UPPER RULER at the edge where the fabric starts to drop.

(b) = Moving Distance / Length (mm) (UPPER RULER).

Fig. A.7 Schematic of modified Cantilever device.

Fig. A.8 Measurement reading example

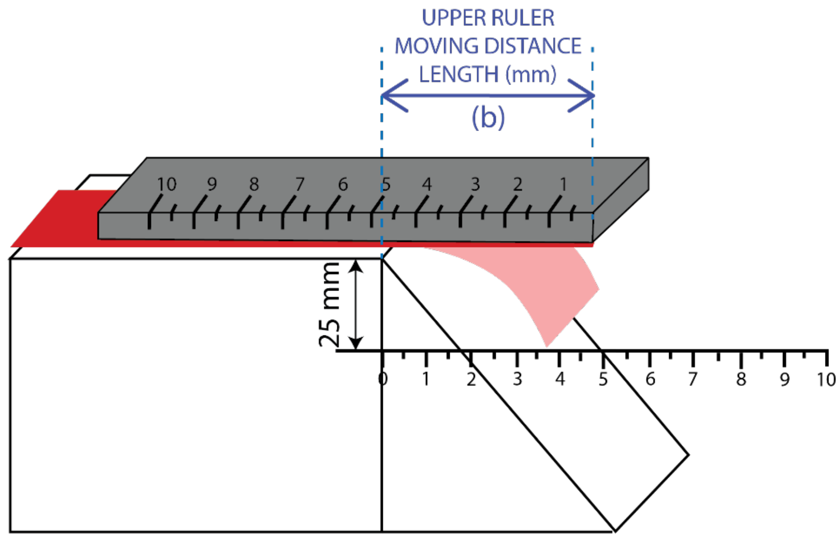

Fig. A.7 The Moving Distance / Length (B) on the Upper Ruler is measured from the edge of the fabric drop. In this example, the measurement is 48mm.

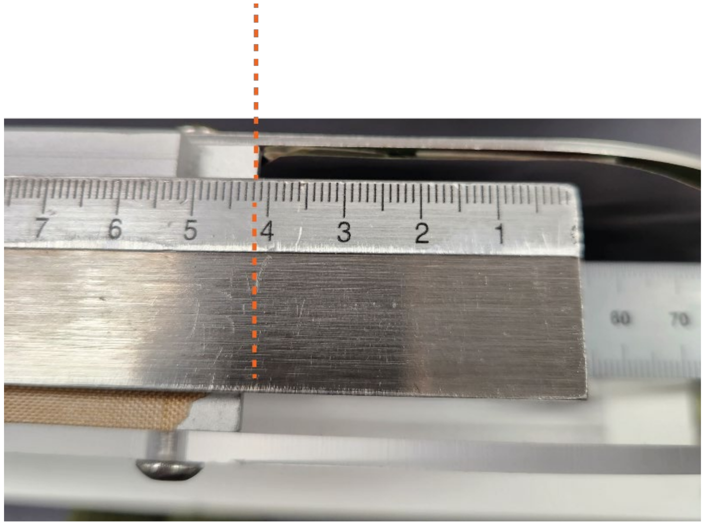

Fig. A.8 The Moving Distance / Length (B) on the Upper Ruler is measured from the edge of the fabric drop. In this example, the measurement is 42mm.

6.5.1.7. Additional Information for CLO data input

Remark: Just test the fabric face side, no need to test the fabric back side.

Fig. A.9 Example of .csv file for CLO Raw Data:

i. Note: For bending, the excel doc indicates Contact Distance and Moving Distance (Length).
ii. Note: the value for Stretch Length Warp, Weft and Bias distance must be a minimum value of 0.5mm. Each subsequent value must be a 0.5mm increment to avoid an error message when importing into CLO.

Fig. A.10 Screenshot of bend values in CLO software

i. Note: Moving Distance is labeled as “Length (mm)”

Fig. A.11 Example of an excel documentation of Bend Values for CLO

Fig. A.12 Vizoo Modified Cantilever

i. This device can measure both traditional cantilever and CLO modified method. This hardware is custom built by Vizoo and follows ASTM D1388. Right side is the traditional Cantilever, left side is the CLO modified.

Version	0.1				
Fabric Name	Test Fabric				
Type	Knit				
Size(mm)	200				
Thickness(mm)	0.45				
Mass(g)	2.25				
Contact Distance Weft(mm)	4.56				
Moving Distance Weft(mm)	22				
Contact Distance Warp(mm)	5				
Moving Distance Warp(mm)	24				
Contact Distance Bias(mm)	5.5				
Moving Distance Bias(mm)	25.5				
Stretch Length Weft(mm)	8	41	72	105.85	145
Stretch Force Weft(Kgf)	0.01	0.03	0.05	0.077	0.111
Stretch Length Warp(mm)	12	38	64.5	91.25	120.6
Stretch Force Warp(Kgf)	0.01	0.03	0.054	0.093	0.141
Stretch Length Bias(mm)	31	62.5	97.6	135	164.5
Stretch Force Bias(Kgf)	0.011	0.031	0.062	0.11	0.193

Fig. A.9

Bending Test

	Weft	Warp	Bias
Contact Distance (mm)			
Length (mm)			

Fig. A.10

Tip: Moving distance is always higher than the Contact distance						
		Moving Distance (mm)		Moving Distance (mm)		Moving Distance (mm)
	Bottom Ruler	Top Ruler	Bottom Ruler	Top Ruler	Bottom Ruler	Top Ruler
Laminate Name	Contact Distance (lengt	Contact Length (length	Contact Distance (widt	Contact Length (width	Contact Distance (bias	Contact Length (bias)

Fig. A.11

Fig. A.12

7. Force as a function of elongation (stretch, shear/bias, elastine)

7.1. Scope

This method describes the determination of the force elongation values needed for 3D virtualization. The 3D software providers do not follow international standards precisely; however all derive their measurements from standards. Procedural differences are described in this section. Using tensile testing in 45 degree of the fabric direction (bias), as well shear behavior can be determined.

7.2. Standard

7.2.1. Option 1: EN ISO 139340 1: 2013

7.2.2. Option 2: ASTM D5034

7.3. Testing Conditions

7.3.1. Preparations for Test Specimen

Option 1: Condition fabric according to ASTM D1776.

Option 2: Condition fabric according to ISO 139.

7.3.2. Procedure:

(*) software in chart below have additional documentation in section 7.4.

Equipment, Supplies and Reagents: See chart below for software-specific needs.

Elongation Needs by Software						
	Style 3D	**Browzwear (*)**	**Assyst/Vidya**	**Gerber**	**Optitex**	**CLO 3D**
Number and Size of Specimen	3 per direction; Determine medium value per direction. 25cm x 5cm. Precise cutting recommended, use rotary cutter, Fraying not necessary.					While CLO specimen size is CLO 220mm x 30mm, it is OK to use standard specimen size 25cm x 5cm for classical testing equipment.
Machine Settings	Gauge length: 200mm Testing rate: 10mm/s Clamps: metal clamps with 32mm minimum width Maximum applied load: 18N Number of cycles: one	Gauge length: 200 mm Testing rate: 100 mm/min a CRE testing machine Pretention: none Clamps: rubber clamps with 50 mm minimum width Load cells: smallest possible e.g. 120N (for Instron machines, load cell can be 500N when accuracy is 0.5%) Maximum applied load: 25 N for non-stretch wovens, 12 N for knit or stretch woven fabrics. Can be up to 250N for composites or non-elastic materials, such as leather. Number of cycles:				Load cells: smallest possible e.g. 120 N (for Instron machines, load cell can be 500N when accuracy is 0.5%)
Output/Unit	$K = \frac{F \cdot l_o}{\Delta l \cdot w} =$ K[N/m] F = force [N] w = specimen width (5 cm) l0 = initial length/clamp distance 8cm) Δl = extension[cm] corresponding to Force F [N]	Elongation [%] at 1 N/5 cm = 20 N/m 2 N/5 cm = 40 N/m		Stretch (cm/g) = $\frac{\Delta L\ (cm)}{500gf} * \frac{L_o\ (cm)}{Sample\ width(cm)}$ L = length [cm] corresponding to Force 500gf Gerber requires a 3" width (7.62cm) x 7" length (17.78cm) sample. If we test using the recommended 5cm width x 20cm length sample, the "Stretch" value is the elongation (cm) at the force of 328gf. (500gf/7.62cm * 5cm = 328gf) Stretch (cm/g) = $\frac{\Delta L\ (cm)}{328gf} * \frac{20\ (cm)}{5\ (cm)}$	Young's modulus = $Slope = \frac{Rise}{Run}$ Young's modulus (E), can be calculated by dividing the stress (σ) by extensional strain (ε): $E = \frac{\sigma}{\varepsilon} = \frac{F/W}{\Delta L/L_o} = \frac{F \cdot L_o}{W \cdot \Delta L} = \frac{F \cdot L_o}{W(L - L_o)}$ F = force [1N = 101.97grf = 0.101kgf] W = specimen width (5 cm) L_o = clamp distance at the start of the test = **20cm** L = length [cm] corresponding to Force F [N] Attention: force must not reach area where plastic deformation of fabric starts Both Stretch and Shear properties are measured using grf/cm units. Properties are defined within the range of 10-100,000 grf/cm. The lower value represents almost ideal stretchable fabric; the upper limit represents completely non-stretchable, rigid material.	(**) CLO NOTE: Read the kgf/5 cm for non-stretch woven fabrics at: 2mm, 4mm, 6mm, 8mm, 10mm Or for knits or stretch woven fabrics at: 10mm, 20mm, 30mm, 40mm, 50mm (*) for composites or materials with very low elasticity: Max applied load may need to increase. Take force measurements at: 2mm, 3mm, 4mm, 5mm, 6mm (optional)
Testing Direction	Warp, Weft, Bias					
Final Output/Calculation	Not necessary Note: (*) see Appendix	Not necessary				Recalculate on a strip width 3cm → kgf/3cm

(**) CLO Note: if the fabric has a very low elasticity, it might not be possible to measure the elongation at 10 mm. In this case the data at 2, 4, 6 and 8 mm is sufficient.

8. Additional Documentation

8.1 Appendix

8.1.1 Bend - Browzwear Manual Fold Bend https://support.browzwear.com/Fabric%20Analyzer/using-data2.htm

8.1.2 Elongation – Browzwear - Start the elongation test and apply 4 times approx. 5 N to the specimen. Have all specimens tested in this way.

8.1.3 Guidance from Optitex on stretch calculations: Stretch Property Concept (optitex.com)

- Formulas and testing methods by Browzwear capture multiple data points for each test required for digitizing fabrics (ex. Stretch test, bend test etc.) derived from the use of the Browzwear Fabric Analyzer (FAB). Calculations in this SOP capture data for different tests, using classical testing methods. However, to enter the data created by the SOP into Browzwear applications, a single value is used at this time. *Browzwear has stated that "while this method will provide simulation results in 3D, True to Life/ Digital twin is not guaranteed but instead multiple points from the FAB are preferred for accurate true to life simulation."*

- We recommend that SOP users save the full data set from their classical equipment, in the form of a graph and a raw text file. Saving this more detailed data will preserve compatibility with any future developments from Browzwear and other 3D platforms. The 3DRC will continue to work with Browzwear and *other 3D software* on the best way to register multiple data points from classical equipment into their software as much as possible.

- For further reading - https://github.com/vizoogmbh/u3m