

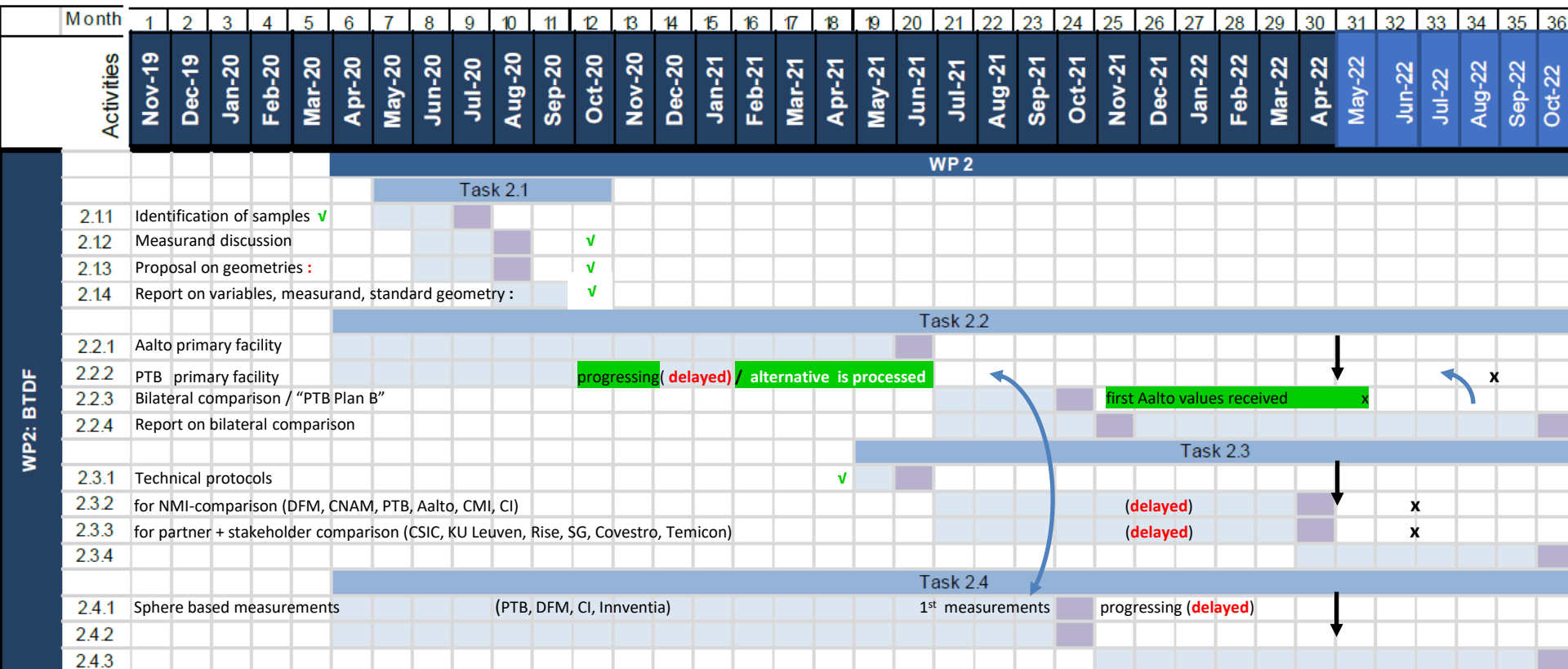
## WP2: Traceable BTDF Measurements

WP2 aims to provide a European measurement landscape capable of offering traceable BTDF calibrations and measurements for versatile standards and at different measurement configurations.

**4<sup>th</sup> Progress meeting  
CSIC, April 27<sup>th</sup> 2022**

**Build  
&  
compare**

New schedule (+6 months) “Covid prolongation” / contradiction: reporting according to old schedule



## ■ C2.a → Task 2.1: Determination of the measurand

The aim of this task is to determine the measurand of BTDF, which is dependent on the specific design and construction of the sample. Depending on the survey of samples and reference probes in Task 5.1, for the most frequent applications e.g. diffusers for luminaires or beam-forming, the important structural variables will be identified, the case-dependent measurand will be determined and the appropriate standard geometry will be defined.

date	Activity number	Activity description	Partners (Lead in bold)	Completion
Jul 20	A2.1.1 M9	Using the results from <b>A5.1.2</b> and commercially available samples, the important structural variables for at least 4 different diffuser types will be identified by PTB and CMI e.g. 1) quasi-Lambertian homogenous thick diffuser, 2) quasi-homogenous diffuser based on stochastic surface roughness with vanishing azimuthal dependence, 3) diffuser with imprinted functional dependence, and 4) diffuser with functional dependence resulting in a dedicated angle dependence and scattering widths, e.g. for beam-forming applications. This will provide input to A2.1.2 and A2.1.3.	PTB, CMI	✓
Aug 20	A2.1.2 M10	Based on the results of A2.1.1, the measurand will be defined by PTB, Aalto and CMI for the 4 different diffuser types studied. It is envisaged that the measurand may vary in complexity for the different types or require type-specific settings.	PTB, Aalto, CMI	✓
Aug 20	A2.1.3 M10	With input from A2.1.1 and A2.1.2, a common or a type-dependent standard set of geometries will be defined by PTB, Aalto and CMI for the diffusers under study. In order to reduce the measurement effort for sample characterisation, it is highly desirable to minimise the geometrical requirements whenever possible. In cases where residual contributions of disregarded geometrical contributions may exist because of the specific sample outline, a procedure to estimate a possible uncertainty contribution will be given.	PTB, Aalto, CMI	✓
Oct 20	A2.1.4 M12	Aalto, with the support of PTB and CMI, will write a report on the results of A2.1.1 to A2.1.3 (structural variables, measurand, and standard geometry). This report will be used in A2.2.3 and A2.3.1.	Aalto, PTB, CMI	✓

## ■ C2.b → Task 2.2: Development of BTDF primary facilities

The aim of this task is to strengthen the consortium's measurement infrastructure by developing primary facilities for BTDF measurement at Aalto and PTB. These facilities will be complementary with respect to sample treatment and will enable the characterisation of different sample classes e.g. rigid, powder-like or liquid samples. The effort of both partners will be supported by consulting other partners in the consortium.

date	Activity numbers	Activity description	Partners (Lead in bold)
Jun 21	A2.2.1 M20	Aalto, in consultation with CNAM and CSIC will develop a BTDF primary facility for the measurement of samples mainly in perpendicular orientation (horizontal samples). This opens the possibility to characterise the BTDF properties of samples with high weight or non-rigid samples like liquids.	✓
Jun 21	A2.2.2 M20	PTB, in consultation with CNAM and CSIC will develop a BTDF primary facility for the measurement of samples mainly in horizontal orientation (vertical samples). This will enable the measurement of rigid samples of moderate weight, which may be characterised in different inclinations and orientations with respect to the measurement beam. A detection-based BTDF set-up is envisaged, capable of determining the diffuse transmittance properties for sample sizes from about 100 mm to only a few millimetres in diameter. The wavelength range in the first development stage realised within the project will be the visible.	✓

**Two presentations yesterday  
PTB & Aalto**

Technical work in progress

Acquisition process finished / measurements expected before end of project



## Samples for A.2.3.2

$$\lambda = 633 \text{ \& } 445 \text{ nm}$$

### 4. Samples

Id.	Name	Type	Scattering description	Dimensions (mm x mm x mm)
A	Thorlabs ED1-S20	Injected molded Zeonor on N-BK7	Rectangular, FWHM ~ 20°/20°	∅ 25.4 x 1.5
B	Thorlabs DG20-220	NBK7, active surface sandblasted	Gaussian, FWHM 16°	∅ 50.8 x 2
C	Heraeus HOD-500	Fused synthetic SiO <sub>2</sub> with uniform bubbles	Lambertian	∅ 50 x .2
D	Temicon PAN001008	Holographic on standard-glass	Gaussian elliptical, FWHM 24° x 12°	50 x 50 x 2
E	Sphere Optics	Zenith polymer; PTFE foil, on 90 mm x 110 mm plate, stretched by ring fixture	Lambertian	∅ 45 x (0,25 + 3(plate))

## Samples for A.2.3.3

$$\lambda = 633 \text{ nm}$$

### 4. Samples

Id.	Name	Type	Scattering description	Dimensions (mm x mm x mm)
B	Thorlabs DG20-220	N-BK7	Gaussian-like FWHM ~ 16°	∅ 50.8 x 2
C	Heraeus HOD-500	Fused synthetic SiO <sub>2</sub> with uniform bubbles	Lambertian	∅ 50 x 2
E	Sphere Optics Zenith	Zenith polymer; PTFE	Lambertian	∅ 45 x 0.25
Co1	Covestro DQ5142 – thin	Polycarbonate-based	Gaussian narrow, FWHM < 35°	50 x 50 x 1
Co3	Covestro DQ5142 – thick	Polycarbonate-based	Gaussian wide > 35°	50 x 50 x 3

Excellent support by Rafael Oser (Covestro), provided specifically-tailored samples ✓

## A.2.3.2 3. Schedule

		Date	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22
		Participant											
1	DFM (pilot 1)										waiting		
	PTB (pilot 2)										waiting		
2	CNAM									in progress			
	Aalto									in progress			
	CMI									in progress			
	CI									in progress			

## A.2.3.3 3. Schedule

		Date	Jul-21	Aug-21	Sep-21	Oct-21	Nov-21	Dec-21	Jan-22	Feb-22	Mar-22	Apr-22	May-22
		Participant											
1	Covestro (pilot 1)										in progress		
	CSIC (pilot 2)										in progress		
2	KU-Leuven										✓		
	RISE										✓		
	Saint-Gobain										✓		
	Temicon										✓		



## ■ C2.d → Task 2.4: Novel traceability routes for sphere-based measurements

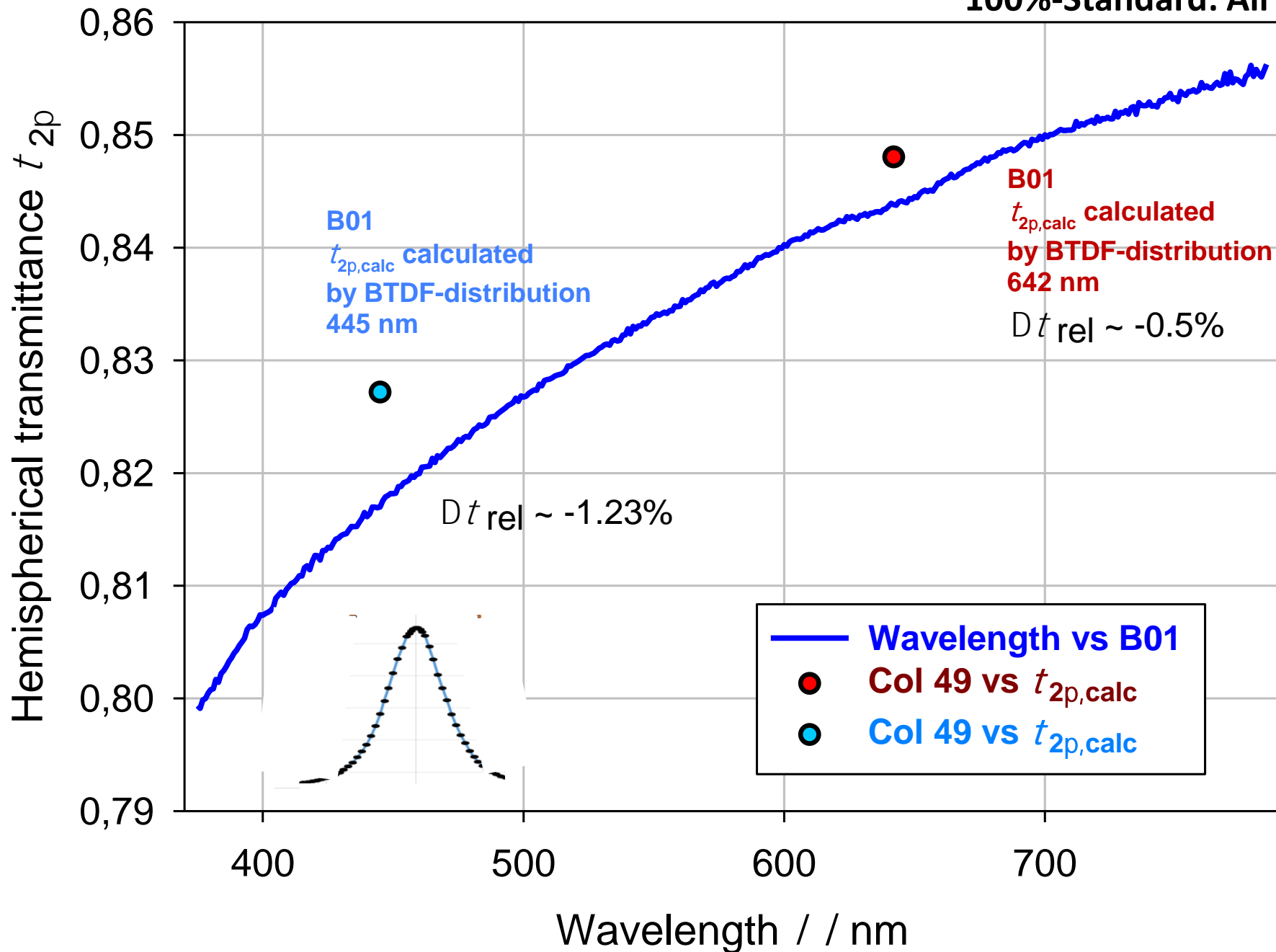
The aim of this task is to explore goniometric measurements of BTDF as possible traceability routes for sphere-based measurements of diffuse transmittance. In most cases, standards for sphere-based calibrations are supposed to be Lambertian or close to it. Therefore, considerable errors occur when calibrating samples with explicit non-Lambertian characteristics. In this task, it will be investigated if traceability to goniometric measurements leads to improved results.

■ Activity number	Activity description	Partners (Lead in bold)
A2.4.1 Apr. 22	The performance of 2 measurement scenarios, i) <u>goniospectrophotometric</u> measurements for the complete hemisphere, supported by results gained with appropriate models, and ii) measurement in sphere geometry ( $0^\circ/d$ or $d/0^\circ$ ) will be compared by PTB, DFM, CI and <u>Innventia</u> . For this purpose, measurements will be performed on 2 classes of samples from A5.2.4, one being quasi-Lambertian and a second exhibiting a far-off Lambertian angle dependence. From measurements of the former (coming from A2.3.1) the level of possible congruence for both measurement schemes with available Lambertian references can be deduced. For the latter, possible deviations will be revealed, and it can be tested whether deviations in sphere measurements can be reduced by using <u>goniospectrophotometrically</u> calibrated samples as references. The outcomes of this activity will be used in A2.4.3 and A4.3.2.	<b>PTB</b> , DFM, CI, <u>Innventia</u>

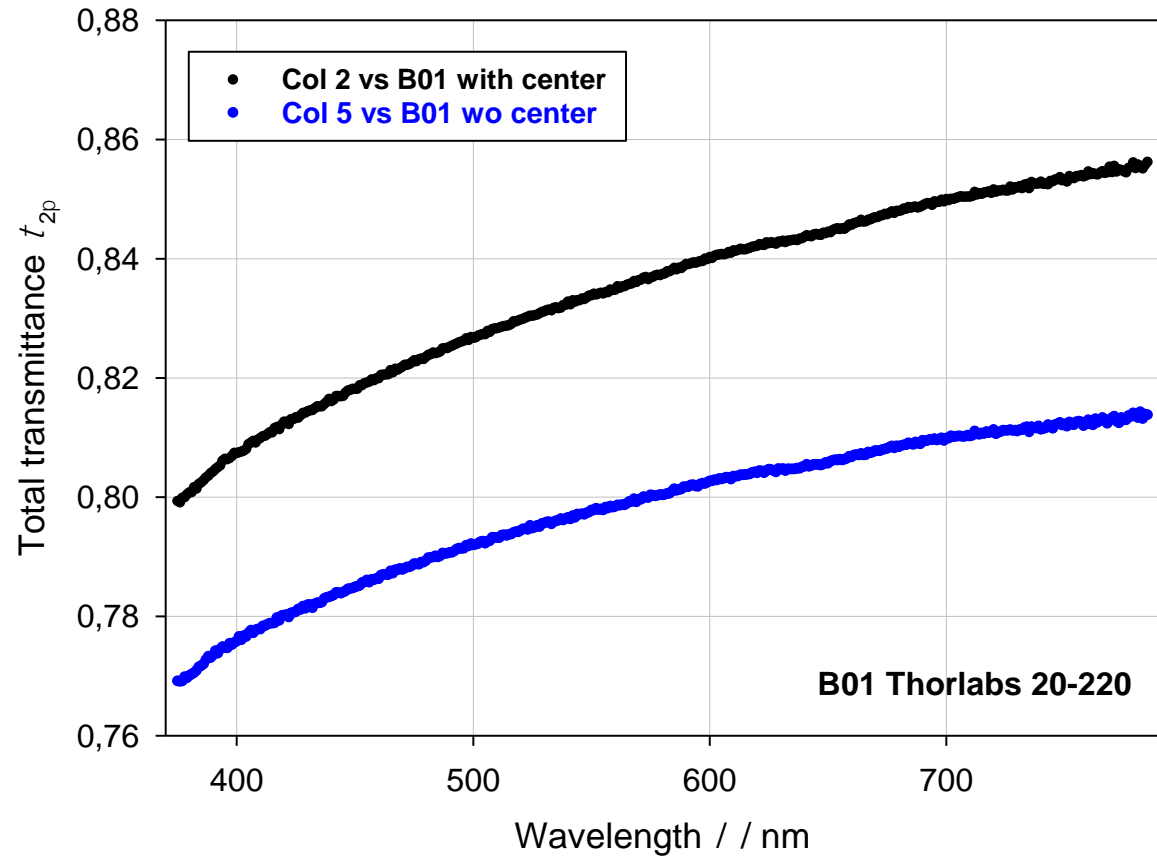
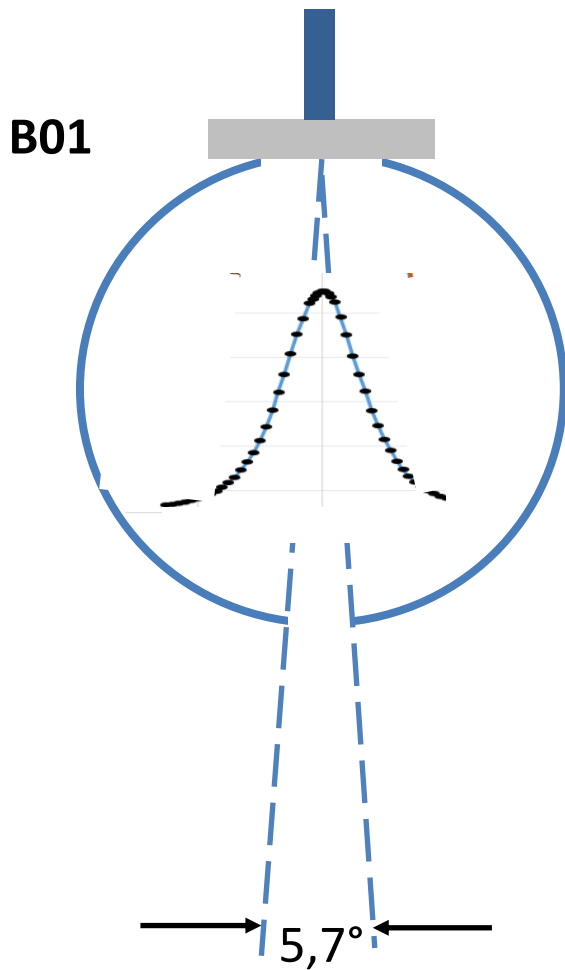
Various measurements performed

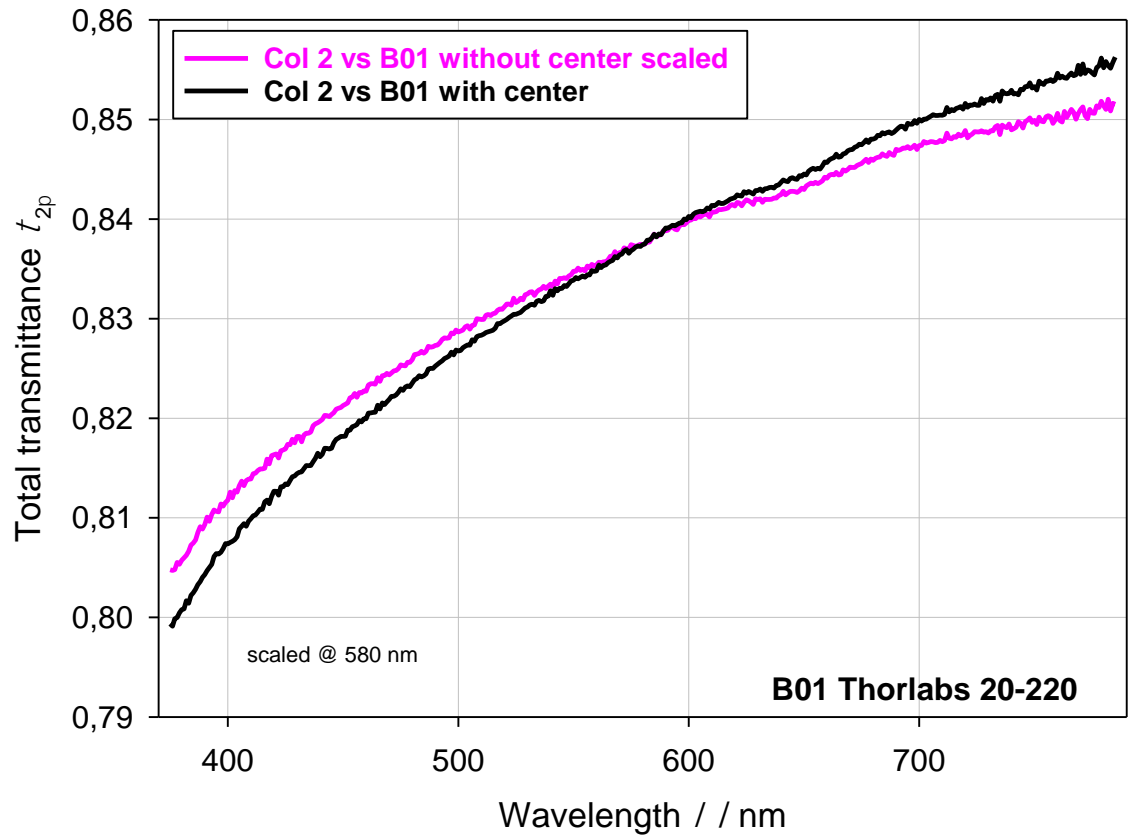
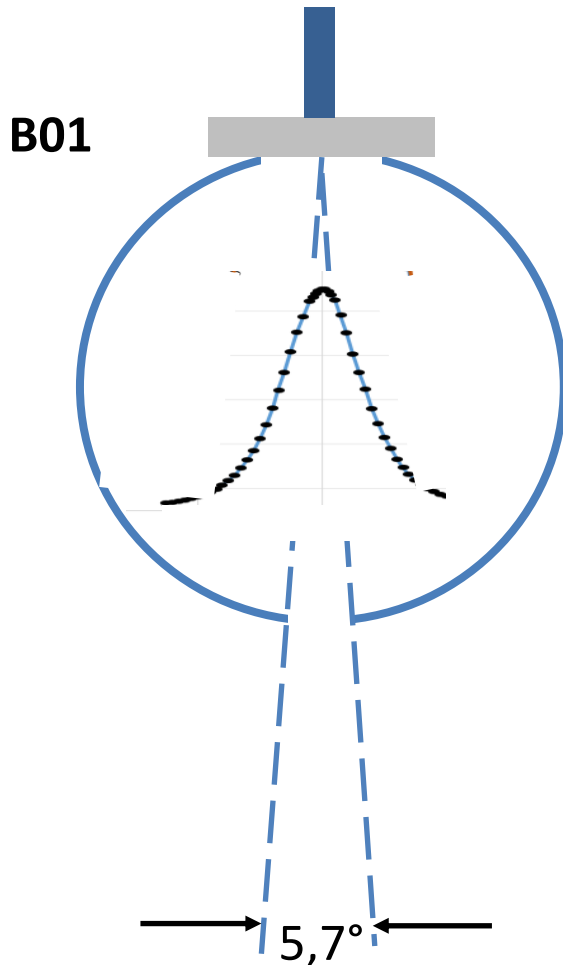
Observed deviations under evaluation ( - ) / side result

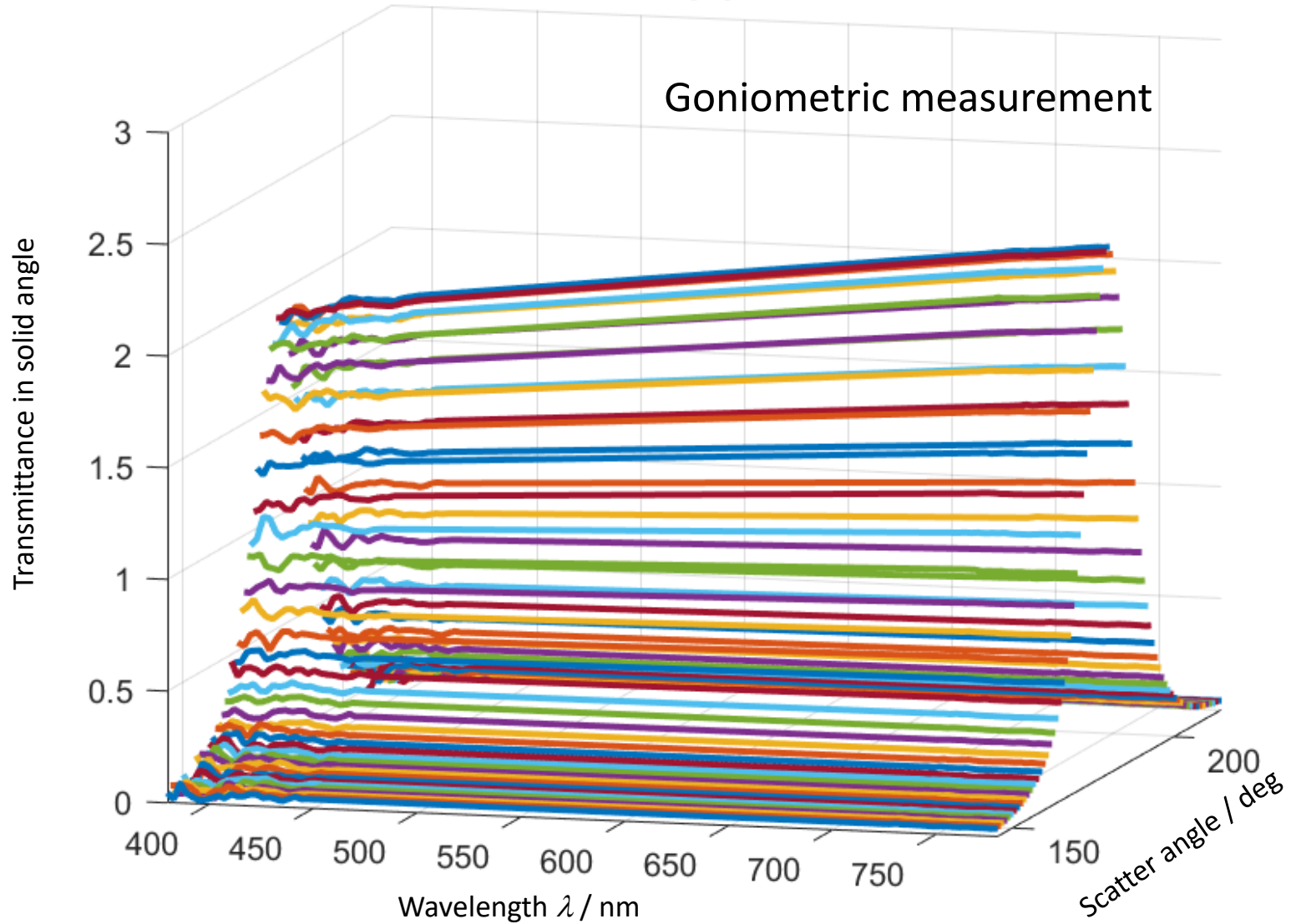
100%-Standard: Air







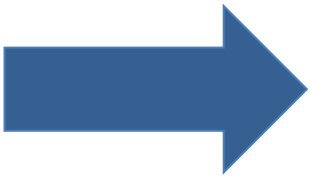




## ■ C2.d → Task 2.4: Novel traceability routes for sphere-based measurements

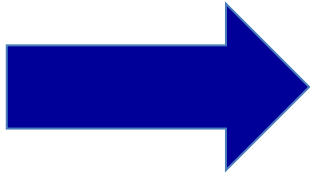
A2.4.2¶ M24□	The performance of the two measurement scenarios, <u>goniospectrophotometric measurements for the entire hemisphere vs measurement in predefined geometry as reported in ISO 14782</u> will be compared by CI, CNAM and <u>Innventia</u> . For this purpose, measurements will be performed by CI, CNAM and <u>Innventia</u> on 2 classes of films (from A5.2.5), one being quasi-Lambertian and a second exhibiting a strong angular dependence within an angle of 5 degrees from specular, which is the approximate angle subtended by the exit port on a <u>hazemeter</u> . The outcomes of this activity will be used in A2.4.3 and A4.3.2.□	<u>CI, CNAM, Innventia</u> □
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Report given at workshop yesterday

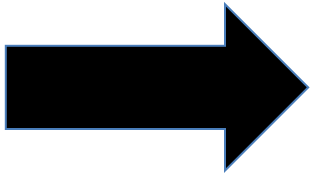


Partner measurements to be completed asap

Start / complete Pilot BTDF re-measurements



Evaluate Sphere activity measurements



Write reports / papers pinched for time, but already a lot of knowledge gained



Physikalisch-Technische Bundesanstalt  
Braunschweig und Berlin

Bundesallee 100  
38116 Braunschweig

A. Schirmacher  
AG Reflexion und Transmission



Telefon: 0531 592-4510  
E-Mail: [alfred.schirmacher@ptb.de](mailto:alfred.schirmacher@ptb.de)

[www.ptb.de](http://www.ptb.de)



good spirit of discussion  
within BxDiff