ICON: Cloud-Based Semantic Structures, Verified Models and Advanced Experimental Methods

WP 4 - Optical measurement and data-processing methods applying bi-directional data

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ICON Project Meeting
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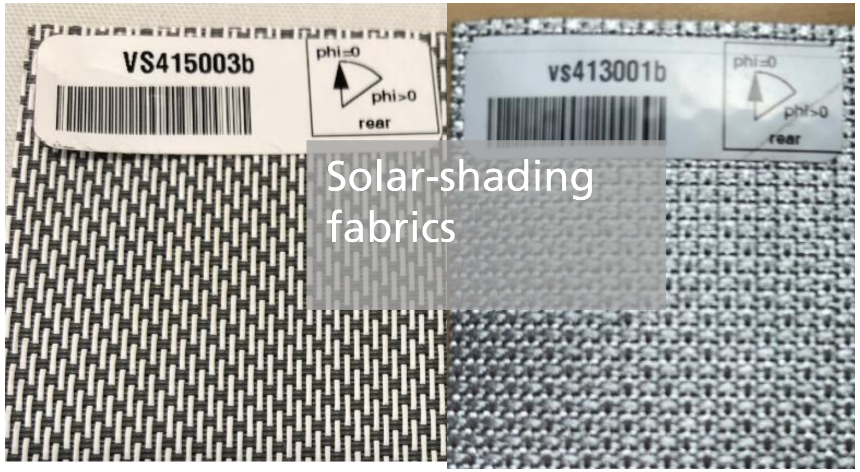
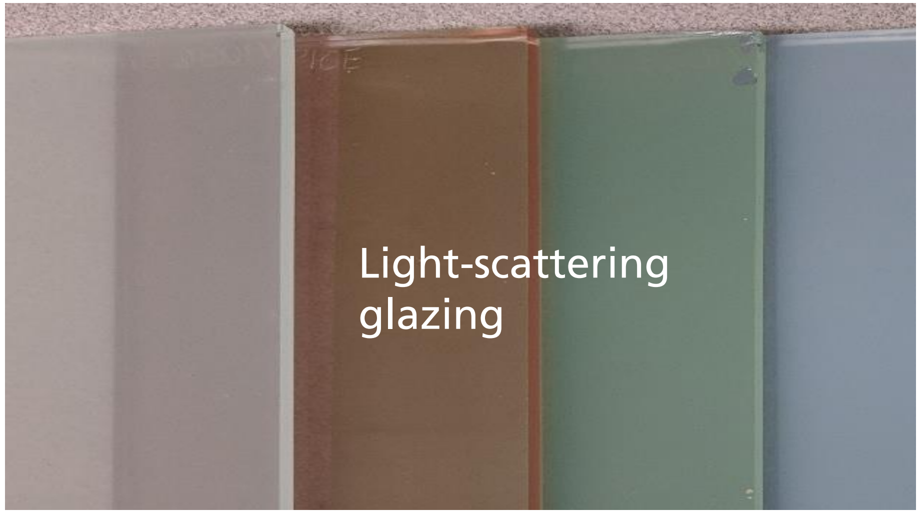
Two major outcomes from WP4

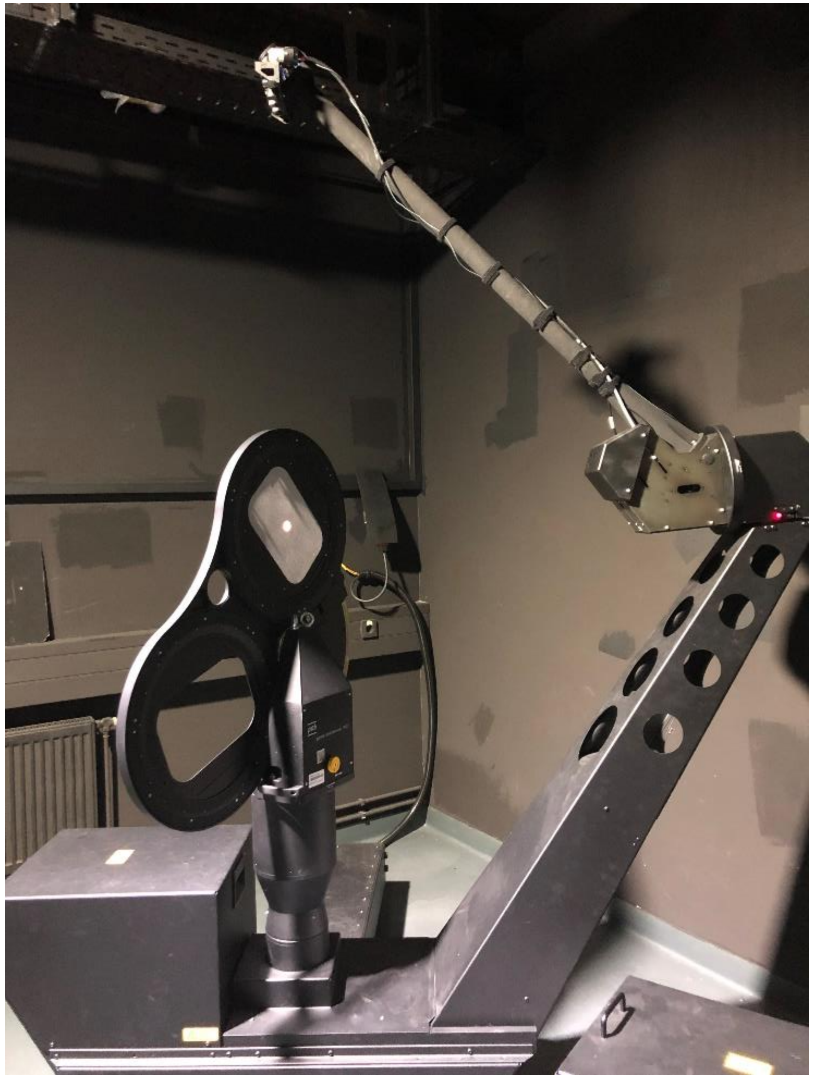
- Detailed angle-resolved bi-directional scattering data (BSDF)
  - Goniophotometer measurements at Fraunhofer ISE and LBNL
  - Measured data as input to Radiance
  - Documented in IEA SHC Task 61 on "Integrated Solutions for Daylighting and Electric Lighting" white paper
- Diffuse glazing model in WINDOW 7.8
  - NFRC standards for spectrally resolved scattering data
  - Based on normal-normal and normal-diffuse components
  - Measured with large-entrance-port integrating sphere





IEA SHC Task 61 measurement procedures

- Fraunhofer ISE and LBNL collaborated with other members of task 61 to decrease the variance in our measurement results using photogoniometers
  - Dark signal correction for samples with dominating specular components
  - Beam size, shape and focus
  - Standardized conversion to Klems basis using Radiance



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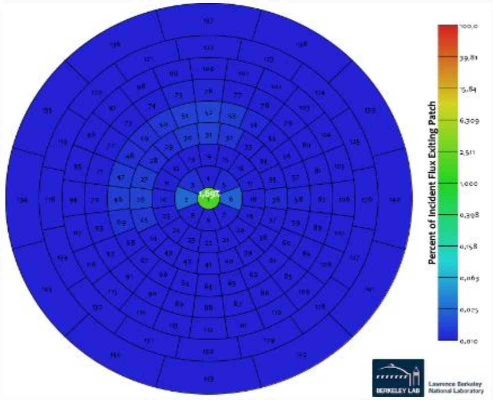
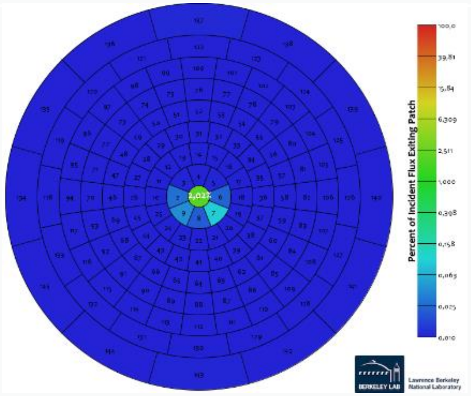
IEA SHC Task 61 measurement procedures

- Good agreement between direct-direct and direct-hemispherical values
- Slightly different distribution around the specular direction

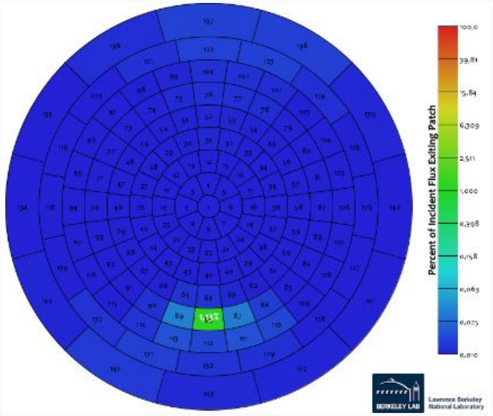
LBNL	Fraunhofer ISE

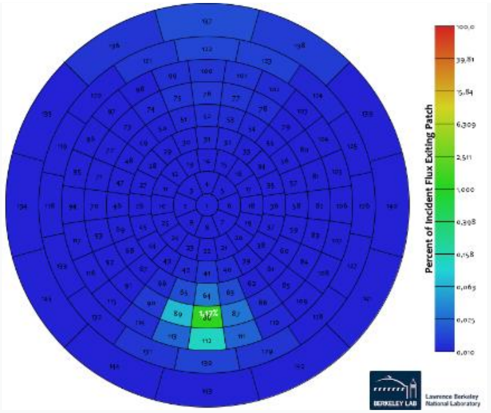




$\tau_{d\text{-}h}$ = 2.8%, $\tau_{d\text{-}d}$ = 1.69%

$\tau_{d\text{-}h}$ = 3.3%, $\tau_{d\text{-}d}$ = 2.02%





$\tau_{d\text{-}h}$ = 2.5%, $\tau_{d\text{-}d}$ = 1.13%

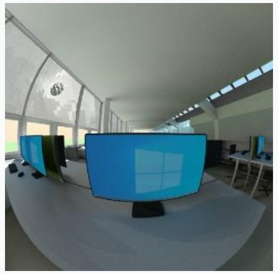
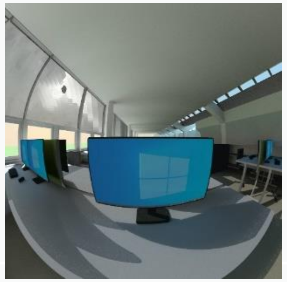
$\tau_{d\text{-}h}$ = 2.7%, $\tau_{d\text{-}d}$ = 1.17%

Figures by D. Moroder-Geisler, Bartenbach

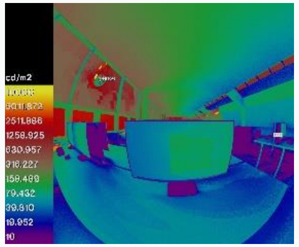
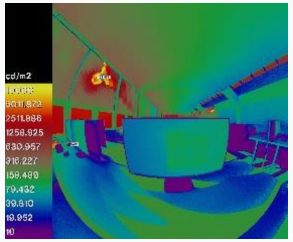
IEA SHC Task 61 daylight analysis

- Point-in-time rendering of images using LBNL and Fraunhofer ISE data for a shade screen
- The method is sensitive to variation between the data sets but qualitatively give the same result with respect to the glare area in the scene

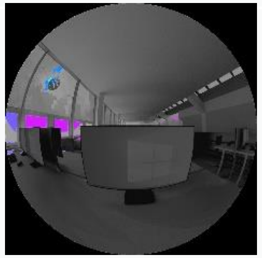
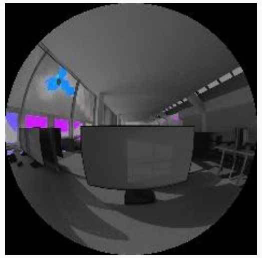
LBNL	Fraunhofer ISE

Point-in time rendering

Falsecolor luminance

Ev = 593 lx, DGP = 0.28

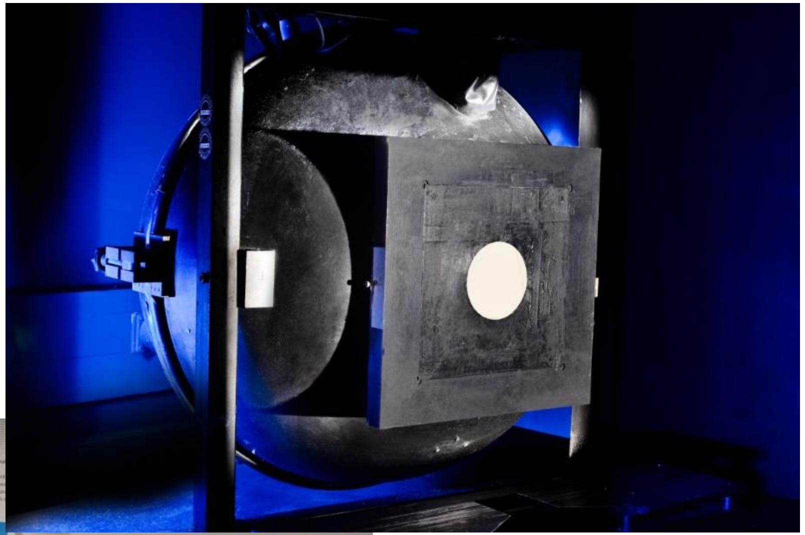
Ev = 1145 lx, DGP = 0.38

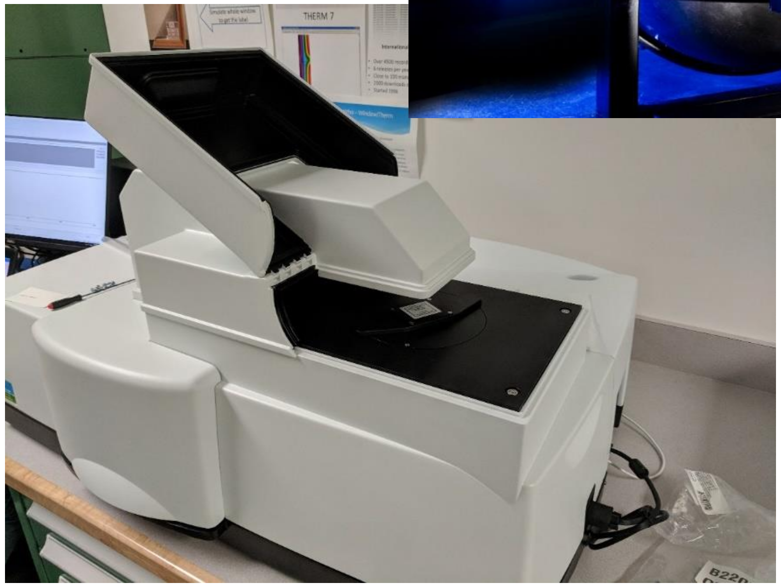
Glare evaluation

Figures by D. Moroder-Geisler, Bartenbach

NFRC 300 and NFRC 301 standards for integrating-sphere measurements of normal-normal and normal-diffuse components of light-scattering glazing products

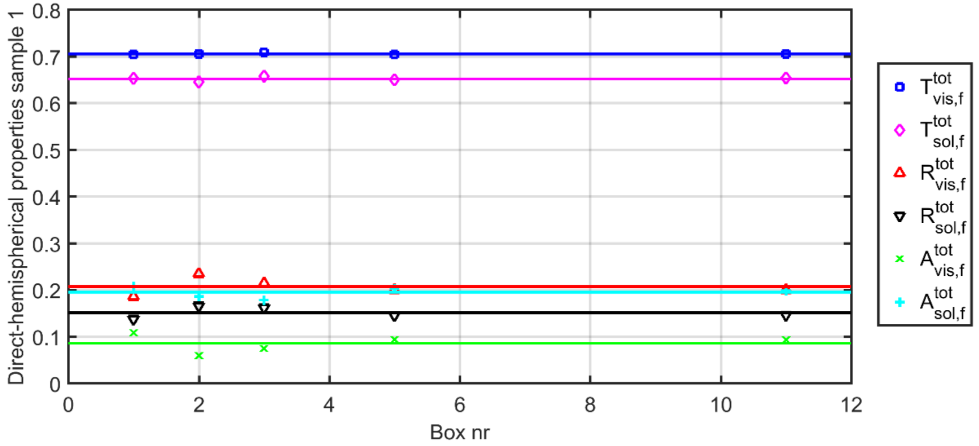
- Previous situation: Measured transmittance values for light-scattering glazing were up to 0.10 too low!
- A commercial instrument was needed for industry to accept a standard for measuring diffuse glazing
- An inter-laboratory comparison (ILC) with 12 labs, a mix of the commercial and research instruments
- Normal-hemispherical values within +- 0.02 which matches reflectance measurements of specular glazing
- The NFRC standards language is suitable for adoption in EN410 and ISO 9050

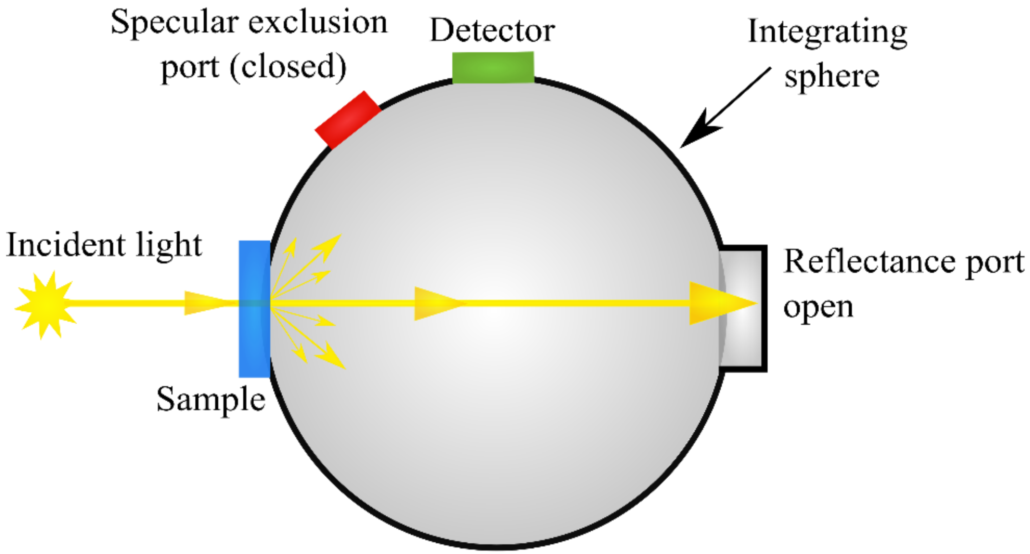




NFRC 300 and NFRC 301 standards for integrating-sphere measurements of normal-normal and normal-diffuse components of light-scattering glazing products

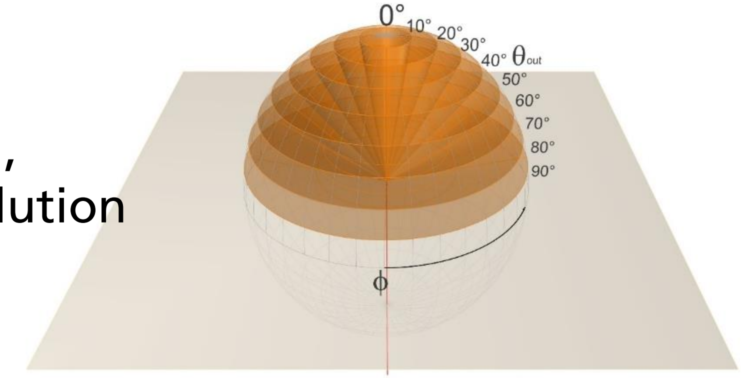
- Slightly worse agreement for the normal-normal component, within 0.03 for transmittance and 0.04 for reflectance
- Well-known that sphere geometry influences the measured value for the normal-diffuse measured value
- The control put in place was meant to normalize the impact of the geometry but did not completely compensate all effects

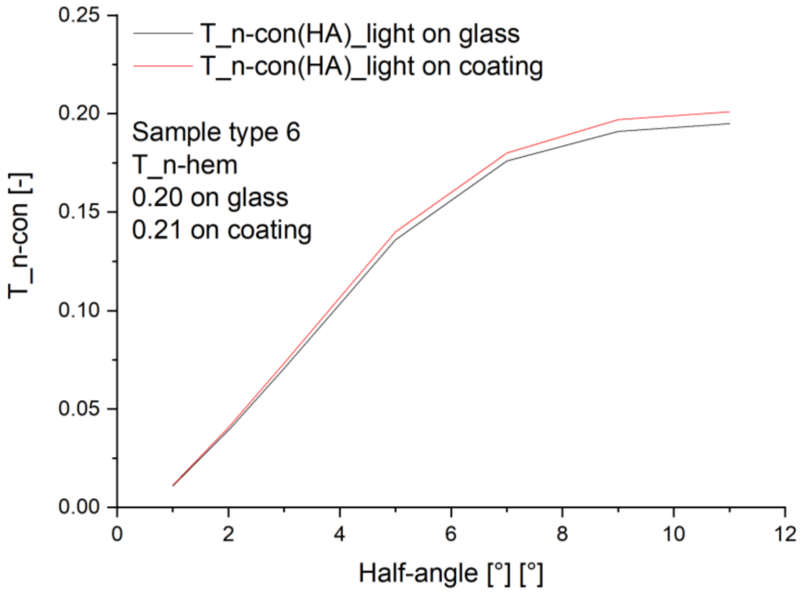




Understanding why there is larger disagreement in normal-normal measurements of glass samples

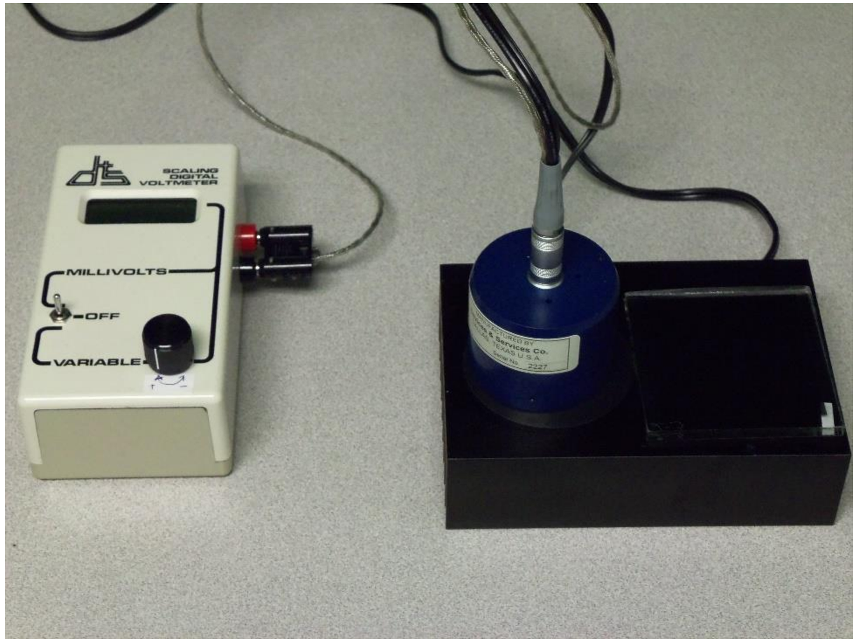
- Definition of new quantity, normal-conical, allowed for detailed study using high-resolution BSDF data to predict what would be expected for different geometries
- Comparing the measured data and expected value from the normal-conical value matching that measurement instrument's geometry, it was clear that there was a mismatch
- The beam gets larger for glass samples and even at 3mm thickness there is a significantly larger spot than the reference measurement case





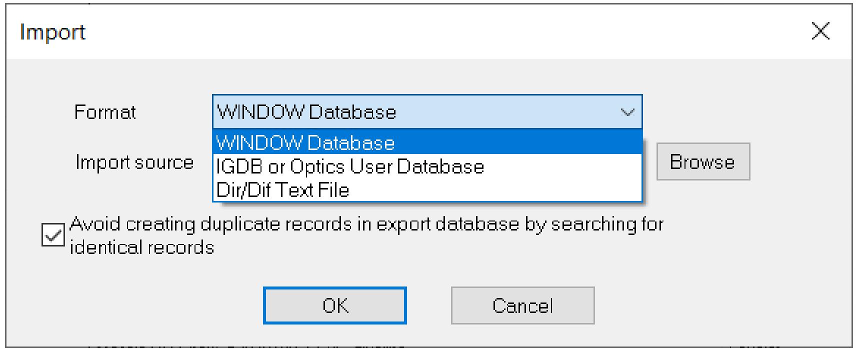
NFRC 301 covers emissivity of rough surfaces

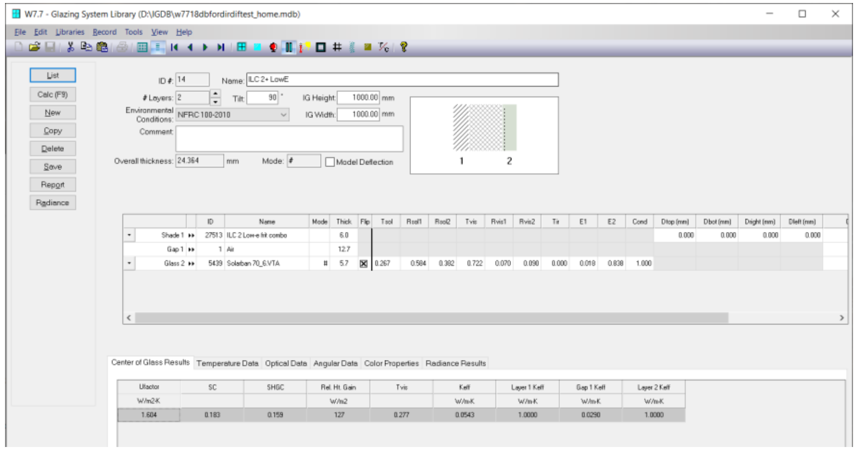
- FTIR instruments with an integrating sphere are not common among glass manufacturers since coated glass is specular and can be measured with near-normal reflectance accessory
- A broadband emissometer was compared to FTIR instruments fitted with integrating spheres to find a low-cost and easy-to-use alternative to an IR integrating sphere
- Good agreement was achieved between 3 integrating spheres and 5 emissometers



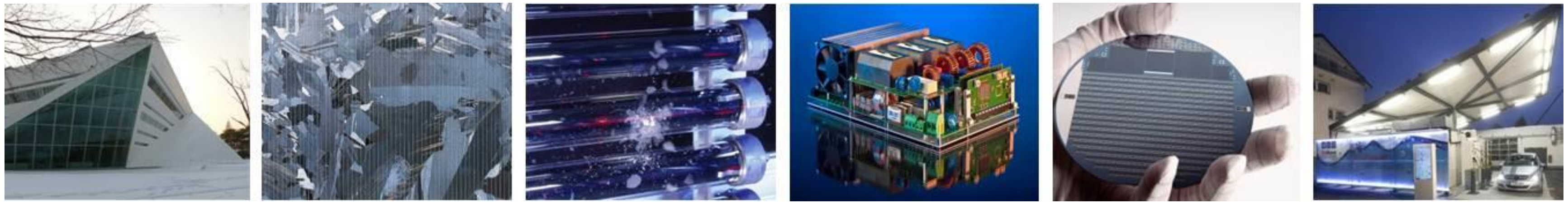
Modelling diffuse glazing in WINDOW 7.8

- Text files with data for normal-normal and normal-diffuse reflectance and transmittance can be imported
- Allows for U and SHCG (g-value) calculation of multi-pane window configurations where one or more of the panes is a diffuse glazing
- Public version soon to be released which will allow for NFRC to update its simulation manual and allow for more accurate NFRC rating of windows with diffuse glazing





Thank you for your attention!



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