

# **Recommendation of WINDOW 6 & THERM 6 for Use in Determining the Solar Heat Gain Coefficients, Visible Transmittance, & U-Factors of Complex Glazing Systems**

*Presented to*  
**NFRC Research Subcommittee**

November 8, 2011

**NFRC 2011 Fall Membership Meeting**



# Background

- WINDOW 6 and THERM 6 have been developed with new capabilities
- Calculate the SHGC, VT and U-Factor of
  - Woven Shades,
  - Venetian Blinds, and
  - Fritted Glass
- Shading Systems Can Be Located
  - Indoor
  - Between Glazing
  - Outdoor

# Introduction

- Recent NFRC Research Project (07-101-RP) attempted to evaluate and validate these new features within WINDOW 6 and THERM 6
- Compared results from tests and simulations
- From these comparisons, NFRC Software Subcommittee developed the following **recommendations**

# Recommendations

- Obtain Approval of WINDOW 6 & THERM 6 for:

	U-factor		SHGC/MT	
	Vertical	Tilted	Vertical	Tilted
Fritted Glazing	Y	Y	Y	Y
Indoor Woven Shades	N	N	Y	Y
Indoor Venetian Blinds	N	N	Y	Y
Between Glass Venetian Blinds	Y	N	Y	Y
Outdoor Woven Shades	Y	Y	Y	Y

# Recommendations

- Simulation Manual Chapters Due 12/31/11
- Post Latest WINDOW 6 & THERM 6 on 01/15/12
  - Webinar Mandatory for Simulators and IA's
- Training & Exams by 02/15/12
  - Webinar Mandatory for Simulators and IA's
- Ballot Technical Documents NFRC Spring 2012 Meeting
- Allow Use for Complex Glazing After 04/01/12
  - Accreditation of two or more NFRC Simulation Laboratories
- Refer to Letter from Software Approval Task Group Dated 10/17/11 to NFRC Membership

# Criteria for Recommendation

- U-Factor (NFRC 100)
  - Within  $\pm 0.03$  if U-Factor is  $\leq 0.30$
  - Within 10% if U-Factor is  $> 0.30$
- SHGC (PMTG)
  - Within  $\pm 0.06$  if SHGC is  $\leq 0.40$
  - Within 15% if SHGC is  $> 0.40$

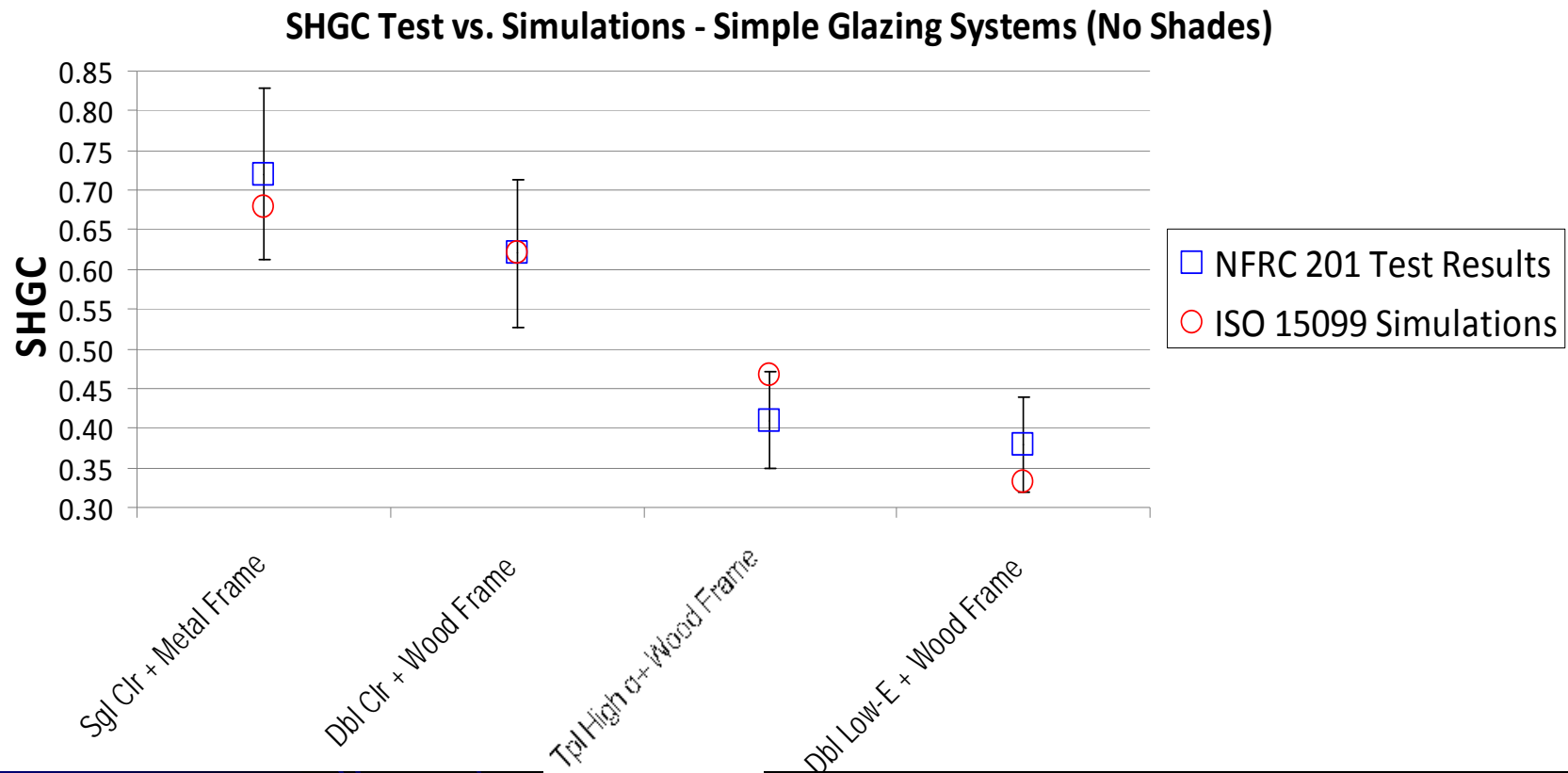
*Criteria Values are **Bold** in the Following Tables*

*The following Simple Glazing Systems were used to establish Criteria*

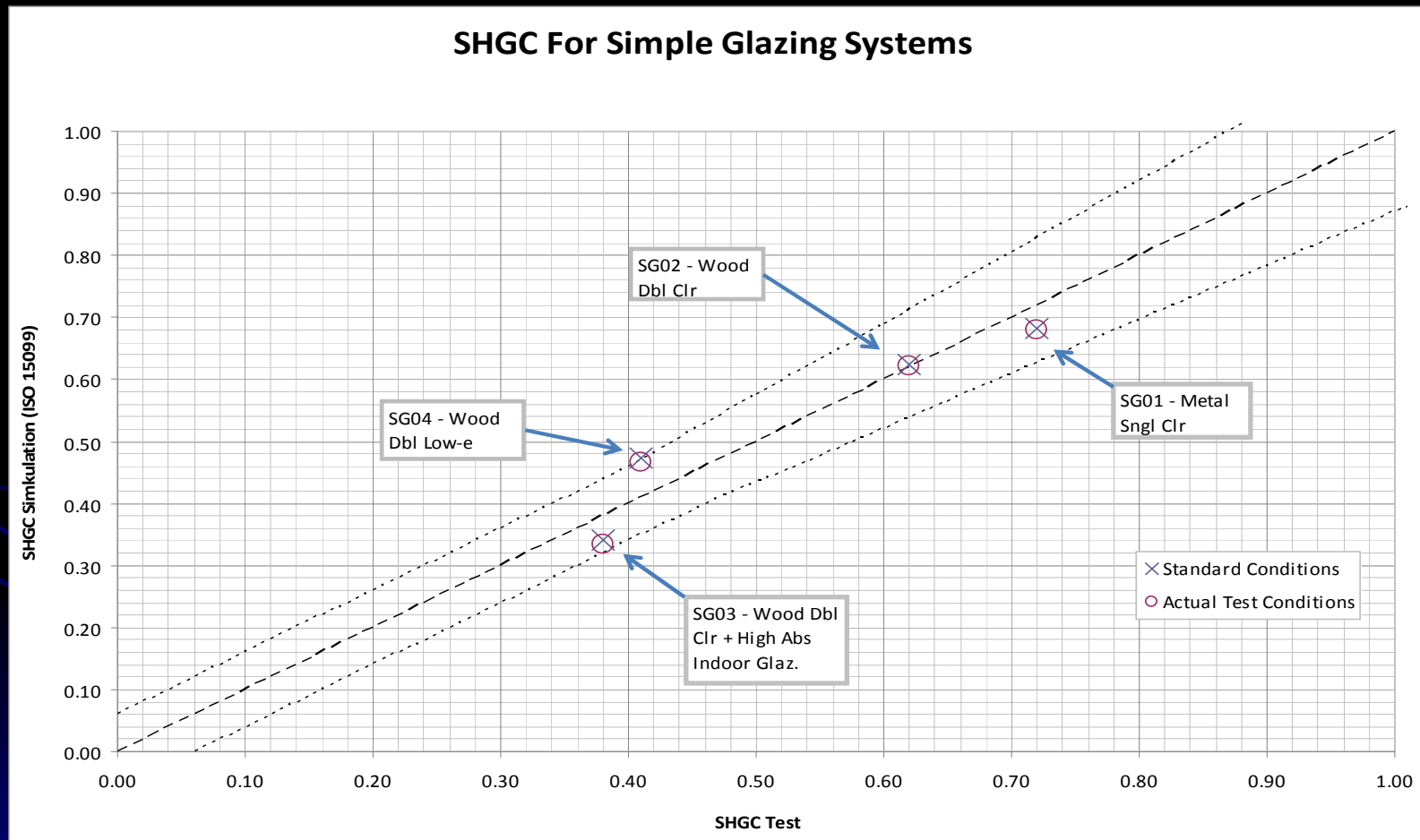
# Comparison of SHGC Simple Glazing Systems

Test Specimen	NFRC 201	ISO 15099	% Diff.	Diff.
	Test	Simulation		
Sgl Clr + Metal Frame	0.72	0.680	<b>-5.61%</b>	-0.040
Dbl Clr + Wood Frame	0.62	0.621	<b>0.21%</b>	0.001
Tpl High $\alpha$ + Wood Frame	0.41	0.467	<b>13.79%</b>	0.057
Dbl Low-E + Wood Frame	0.38	0.333	<b>-12.36%</b>	<b>-0.047</b>
Minimum	0.38	0.335	-12.36%	-0.047
Maximum	0.72	0.681	13.79%	0.057
Average	<b>0.53</b>	<b>0.525</b>	<b>-0.99%</b>	<b>-0.007</b>
Standard Deviation	0.164	0.1567	11.11%	0.0477

# Comparison of SHGC Simple Glazing Systems



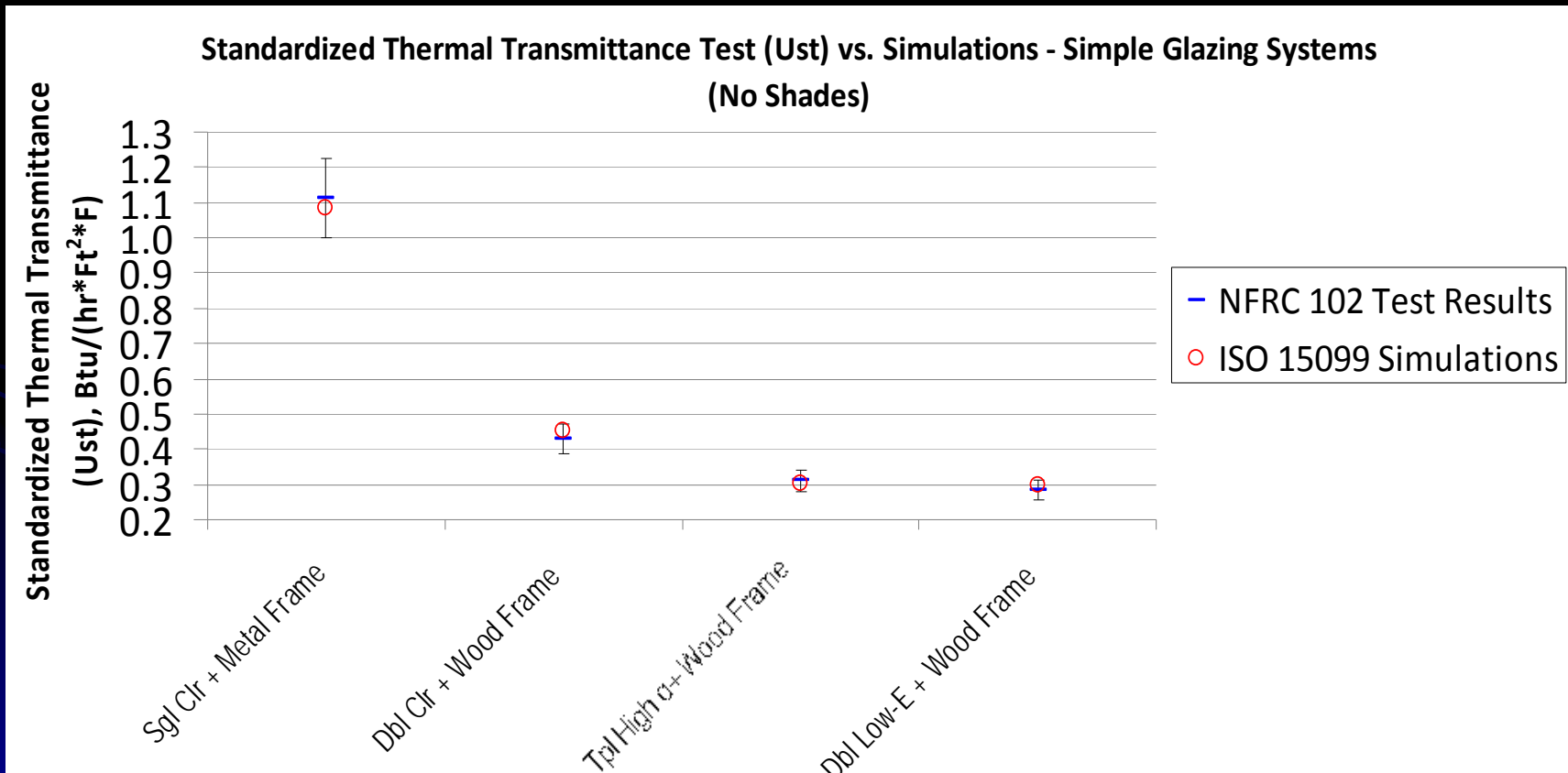
# Comparison of SHGC Simple Glazing Systems



# Comparison of U-Factor Simple Glazing Systems

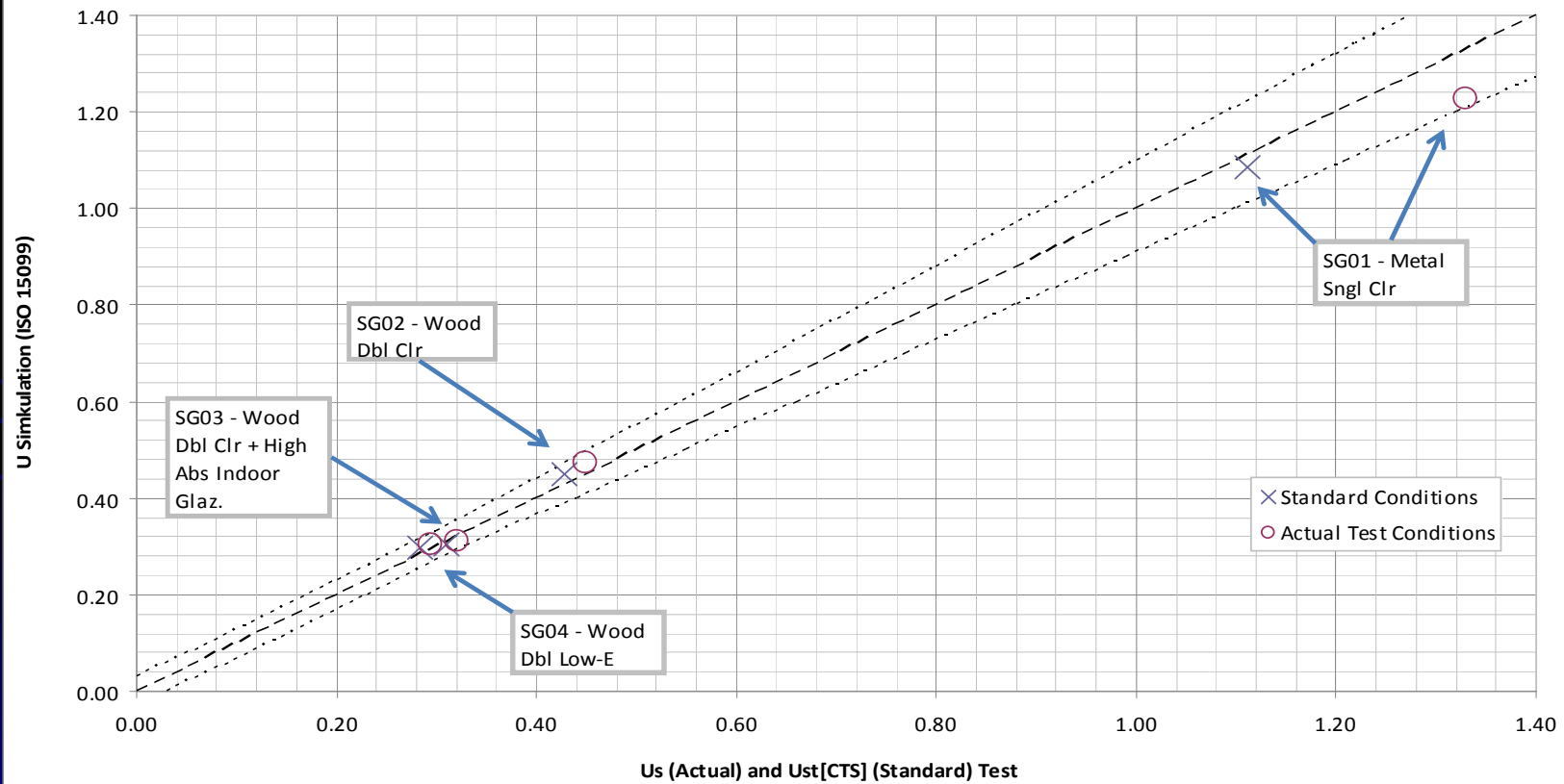
	NFRC 102	ISO 15099		
Test Specimen	Test	Simulation	% Diff.	Diff.
Sgl Clr + Metal Frame	1.11	1.085	<b>-2.38%</b>	-0.027
Dbl Clr + Wood Frame	0.43	0.451	<b>5.23%</b>	0.022
Tpl High $\alpha$ + Wood Frame	0.31	0.303	<b>-2.46%</b>	-0.008
Dbl Low-E + Wood Frame	0.28	0.296	4.15%	<b>0.012</b>
Minimum	0.28	0.296	-2.46%	-0.027
Maximum	1.11	1.085	5.23%	0.022
Average	<b>0.53</b>	<b>0.534</b>	<b>1.13%</b>	<b>0.000</b>
Standard Deviation	0.390	0.3745	4.13%	0.0216

# Comparison of U-Factor Simple Glazing Systems



# Comparison of U-Factor Simple Glazing Systems

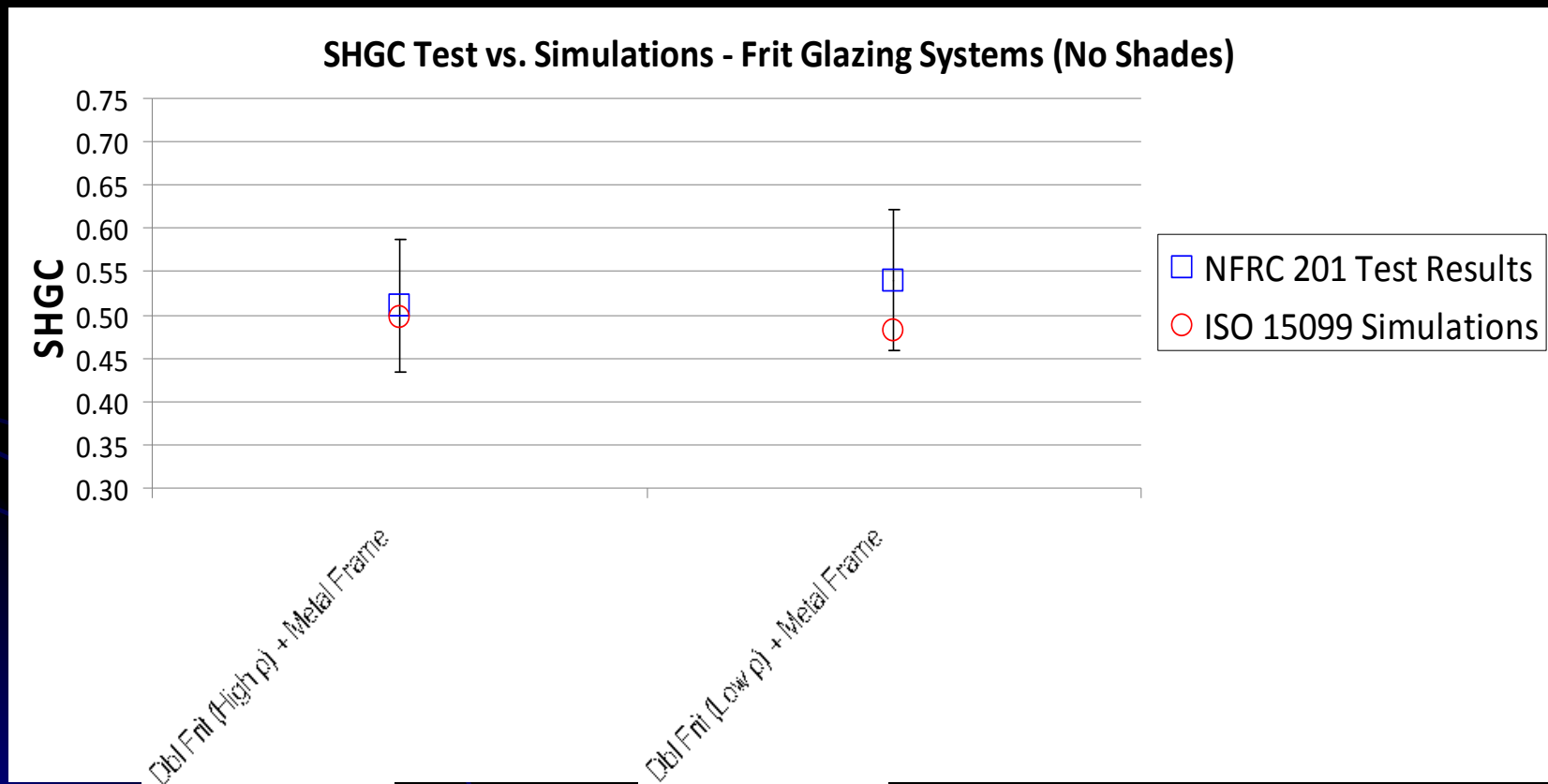
## Us vs. Actual & Ust vs. Standard For Simple Glazing Systems



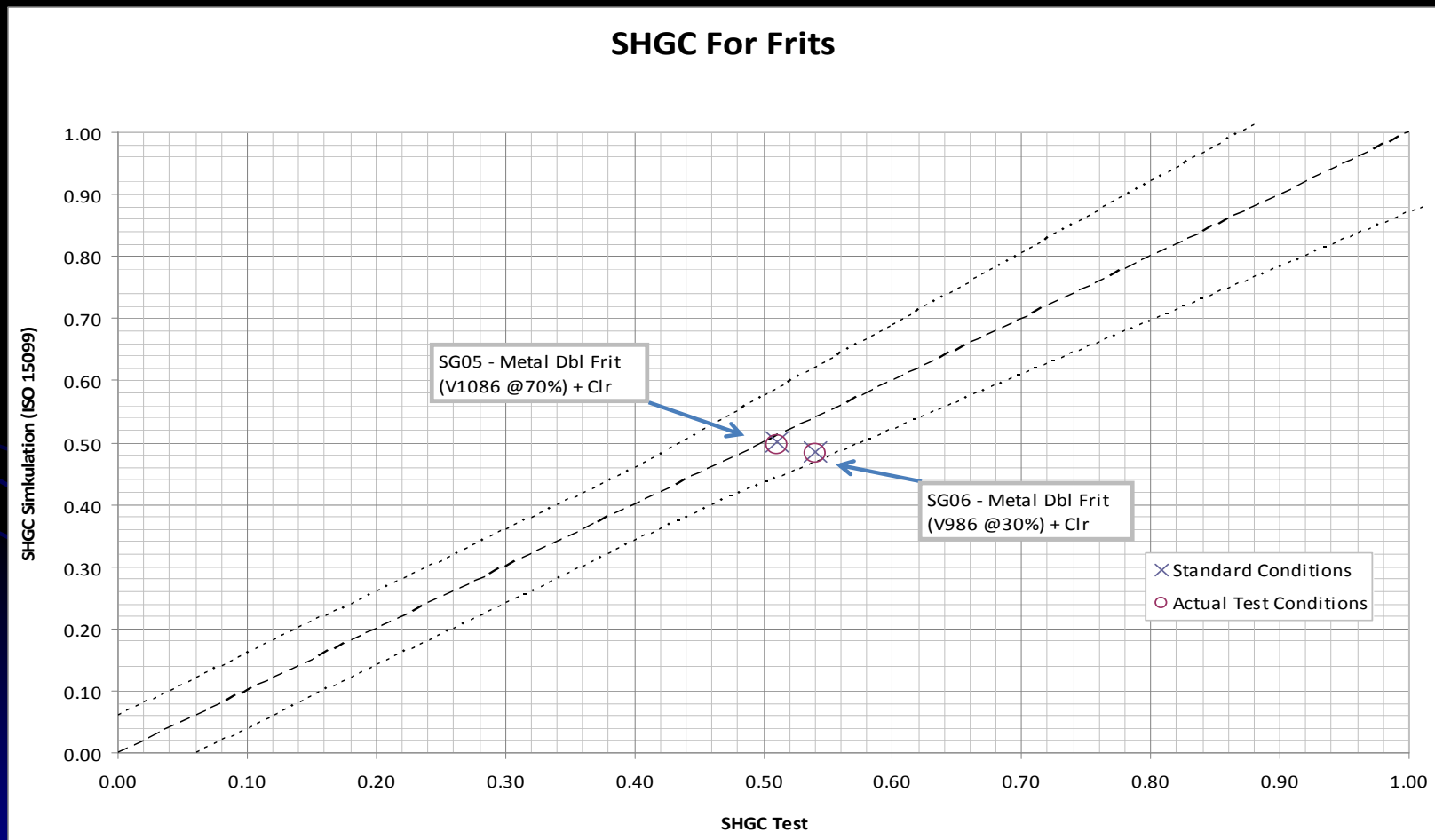
# Recommendation: SHGC Frit Glazing Systems

Test Specimen	NFRC 201 Test	ISO 15099 Simulation	% Diff.	Diff.
Dbl Frit (High $\rho$ ) + Metal Frame	0.51	0.497	<b>-2.55%</b>	-0.013
Dbl Frit (Low $\rho$ ) + Metal Frame	0.54	0.482	<b>-10.74%</b>	-0.058
Minimum	0.51	0.482	-10.74%	-0.058
Maximum	0.54	0.497	-2.55%	-0.013
Average	<b>0.53</b>	<b>0.490</b>	<b>-6.64%</b>	<b>-0.036</b>
Standard Deviation	0.021	0.0106	5.79%	0.0318

# Recommendation: SHGC Frit Glazing Systems



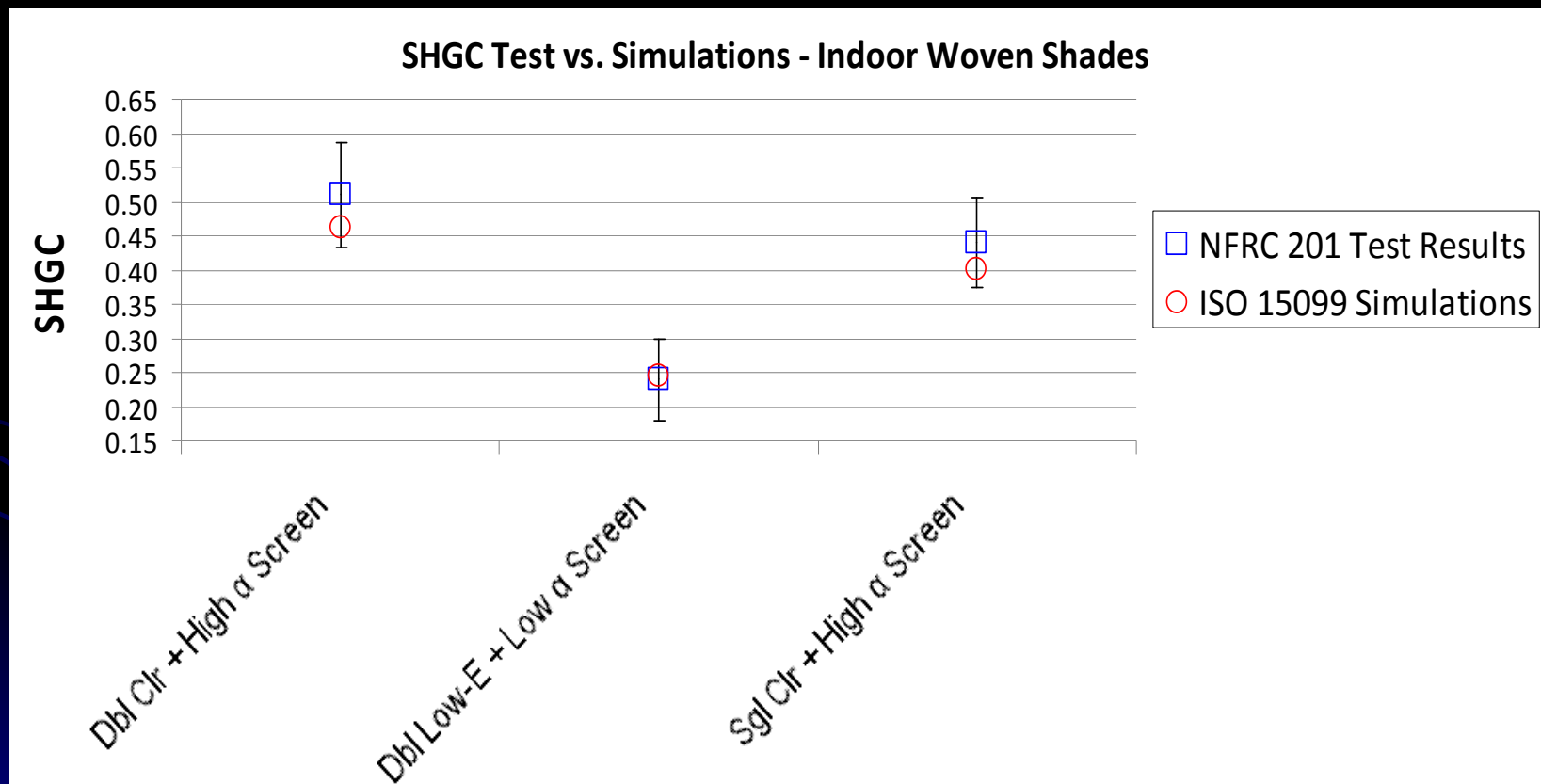
# Recommendation: SHGC Frit Glazing Systems



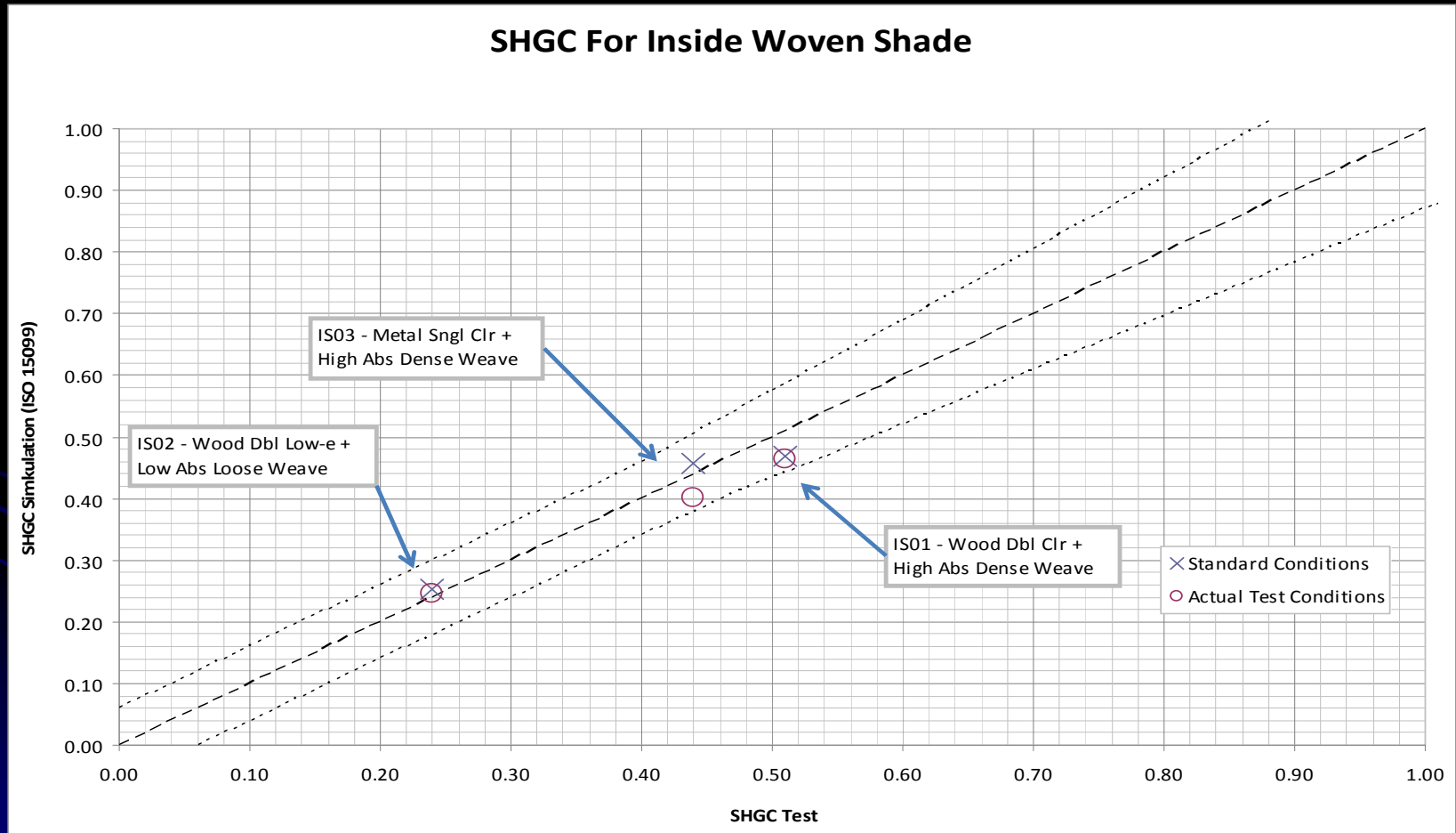
# Recommendation: SHGC Indoor Woven Shades

Test Specimen	NFRC 201	ISO 15099	% Diff.	Diff.
	Test	Simulation		
Dbl Clr + High $\alpha$ Screen	0.51	0.463	<b>-9.19%</b>	-0.047
Dbl Low-E + Low $\alpha$ Screen	0.24	0.246	2.32%	<b>0.006</b>
Sgl Clr + High $\alpha$ Screen	0.44	0.402	<b>-8.55%</b>	-0.038
Minimum	0.24	0.246	-9.19%	-0.047
Maximum	0.51	0.463	2.32%	0.006
Average	<b>0.40</b>	<b>0.370</b>	<b>-5.14%</b>	<b>-0.026</b>
Standard Deviation	0.140	0.1123	6.47%	0.0280

# Recommendation: SHGC Indoor Woven Shades



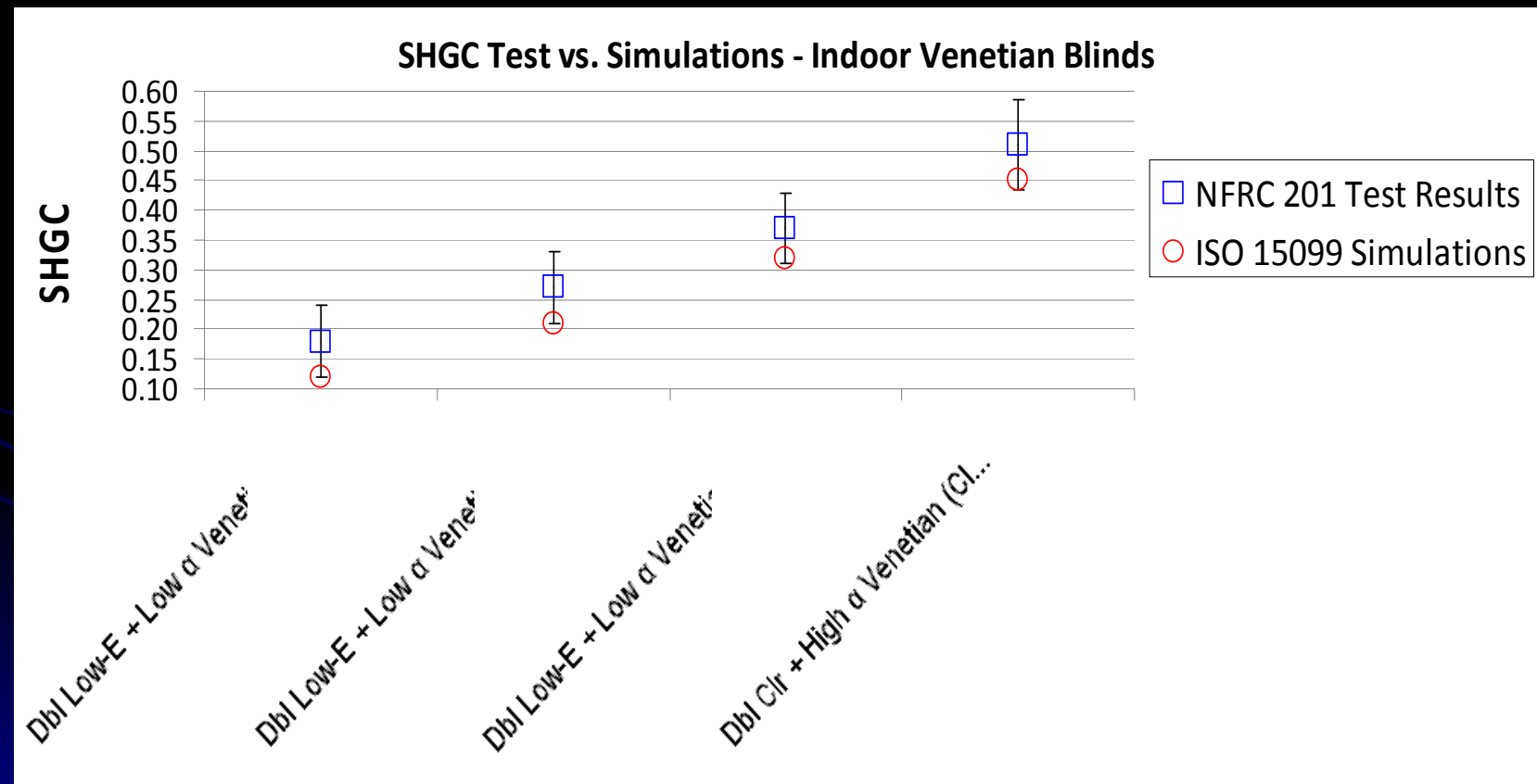
# Recommendation: SHGC Indoor Woven Shades



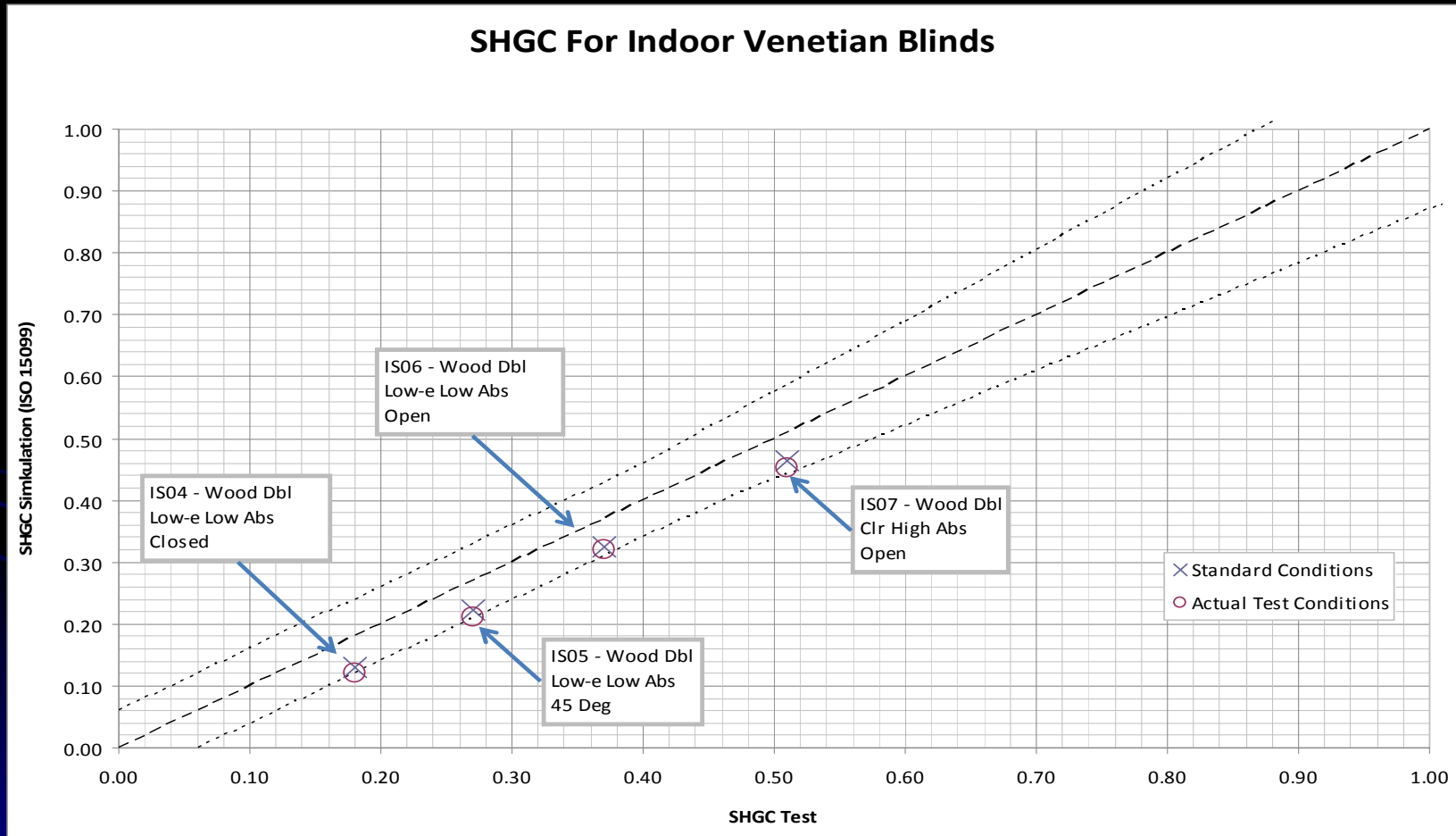
# Recommendation: SHGC Indoor Venetian Blinds

Test Specimen	NFRC 201	ISO 15099	% Diff.	Diff.
	Test	Simulation		
Dbl Low-E + Low $\alpha$ Venetian (Closed)	0.18	0.120	-33.17%	<b>-0.060</b>
Dbl Low-E + Low $\alpha$ Venetian (45°)	0.27	0.211	-21.95%	<b>-0.059</b>
Dbl Low-E + Low $\alpha$ Venetian (Open)	0.37	0.320	-13.63%	<b>-0.050</b>
Dbl Clr + High $\alpha$ Venetian (Closed)	0.51	0.452	<b>-11.47%</b>	-0.058
Minimum	0.18	0.120	-33.17%	-0.060
Maximum	0.51	0.452	-11.47%	-0.050
Average	<b>0.33</b>	<b>0.276</b>	<b>-20.05%</b>	<b>-0.057</b>
Standard Deviation	0.142	0.1428	9.84%	0.0044

# Recommendation: SHGC Indoor Venetian Blinds



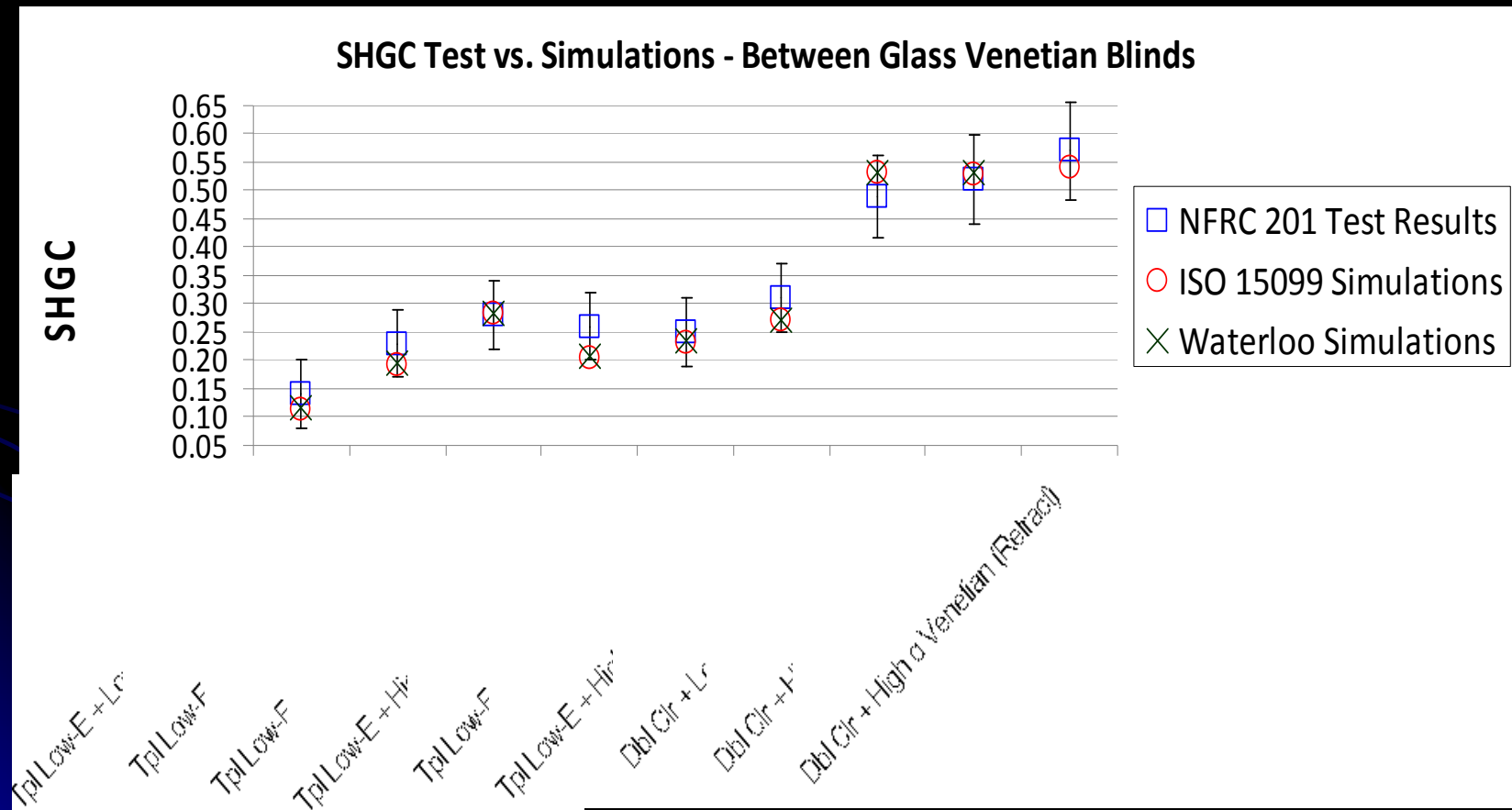
# Recommendation: SHGC Indoor Venetian Blinds



# Recommendation: SHGC Between Glazing Venetian Blinds

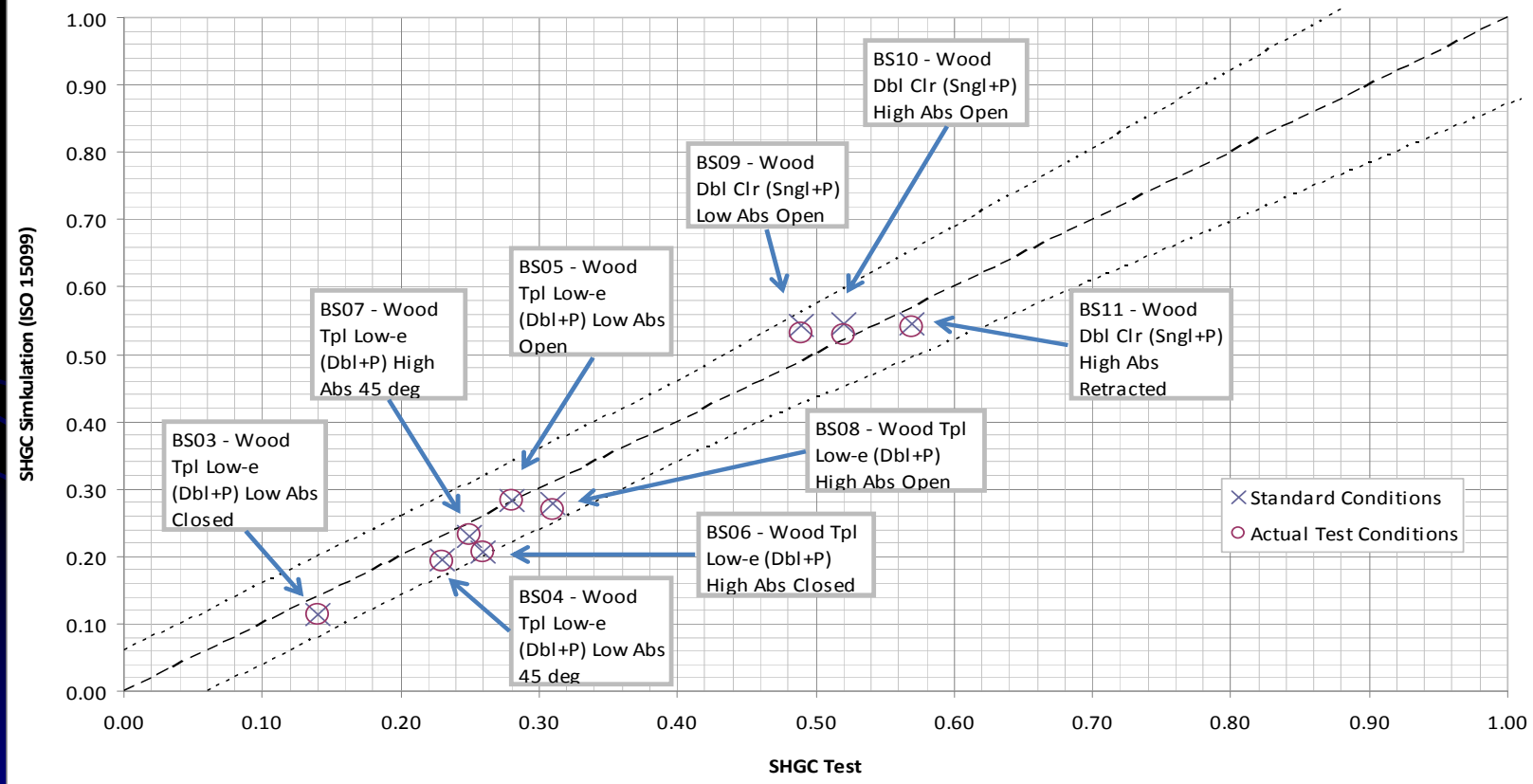
Test Specimen	NFRC 201	ISO 15099	% Diff.	Diff.
	Test	Simulation		
Tpl Low-E + Low $\alpha$ Venetian (Closed)	0.14	0.115	-18.01%	<b>-0.025</b>
Tpl Low-E + Low $\alpha$ Venetian (45°)	0.23	0.193	-16.03%	<b>-0.037</b>
Tpl Low-E + Low $\alpha$ Venetian (Open)	0.28	0.284	1.25%	<b>0.004</b>
Tpl Low-E + High $\alpha$ Venetian (Closed)	0.26	0.206	-20.92%	<b>-0.054</b>
Tpl Low-E + High $\alpha$ Venetian (45°)	0.25	0.232	-7.21%	<b>-0.018</b>
Tpl Low-E + High $\alpha$ Venetian (Open)	0.31	0.270	-12.83%	<b>-0.040</b>
Dbl Clr + Low $\alpha$ Venetian (Open)	0.49	0.530	<b>8.23%</b>	0.040
Dbl Clr + High $\alpha$ Venetian (Open)	0.52	0.530	<b>1.86%</b>	0.010
Dbl Clr + High $\alpha$ Venetian (Retract)	0.57	0.540	<b>-5.33%</b>	-0.030
Minimum	0.14	0.115	-20.92%	-0.054
Maximum	0.57	0.540	8.23%	0.040
Average	<b>0.34</b>	<b>0.322</b>	<b>-7.66%</b>	<b>-0.017</b>
Standard Deviation	0.150	0.1655	10.05%	0.0295

# Recommendation: SHGC Between Glazing Venetian Blinds



# Recommendation: SHGC Between Glazing Venetian Blinds

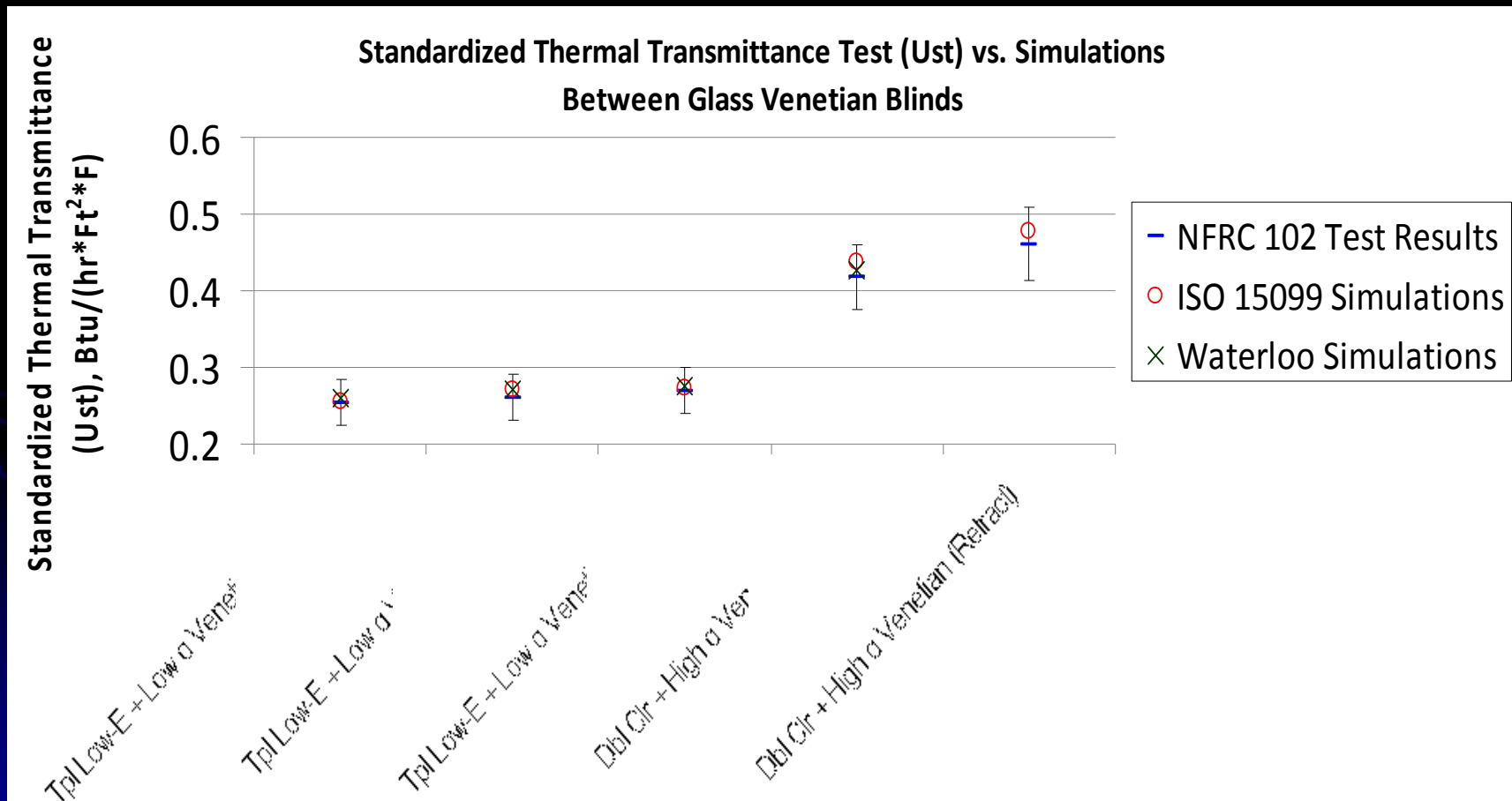
## SHGC For Between Glazing Venetian Blinds



# Recommendation: U-Factor Between Glazing Venetian Blinds

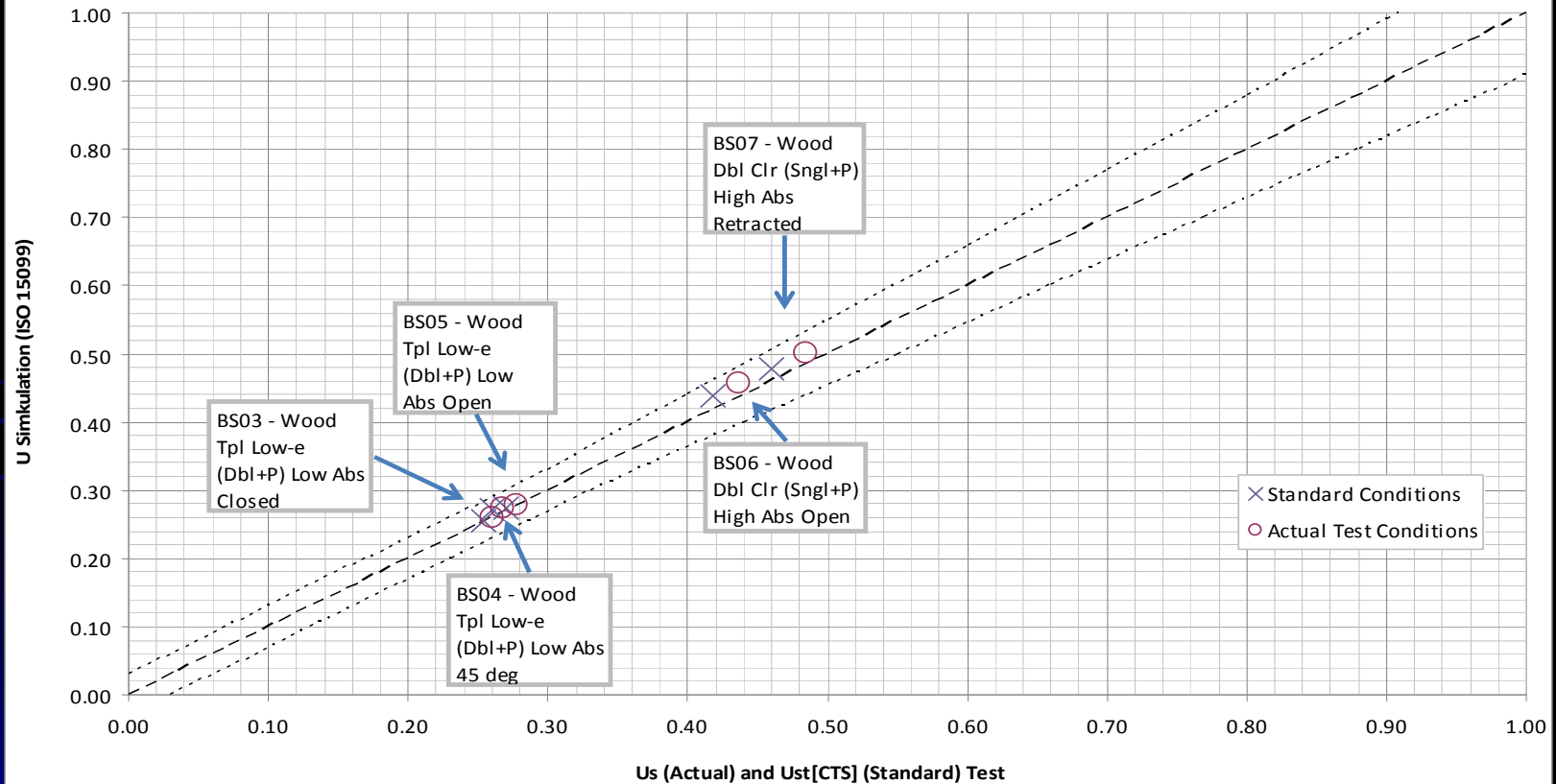
Test Specimen	NFRC 102	ISO 15099	% Diff.	Diff.
	Test	Simulation		
Tpl Low-E + Low $\alpha$ Venetian (Closed)	0.25	0.256	1.04%	<b>0.003</b>
Tpl Low-E + Low $\alpha$ Venetian (45°)	0.26	0.270	3.85%	<b>0.010</b>
Tpl Low-E + Low $\alpha$ Venetian (Open)	0.27	0.274	1.50%	<b>0.004</b>
Dbl Clr + High $\alpha$ Venetian (Open)	0.42	0.439	<b>5.11%</b>	0.021
Dbl Clr + High $\alpha$ Venetian (Retract)	0.46	0.479	<b>4.08%</b>	0.019
Minimum	0.25	0.256	1.04%	0.003
Maximum	0.46	0.479	5.11%	0.021
Average	<b>0.33</b>	<b>0.344</b>	<b>3.12%</b>	<b>0.011</b>
Standard Deviation	0.099	0.1063	1.76%	0.0084

# Recommendation: U-Factor Between Glazing Venetian Blinds



# Recommendation: U-Factor Between Glazing Venetian Blinds

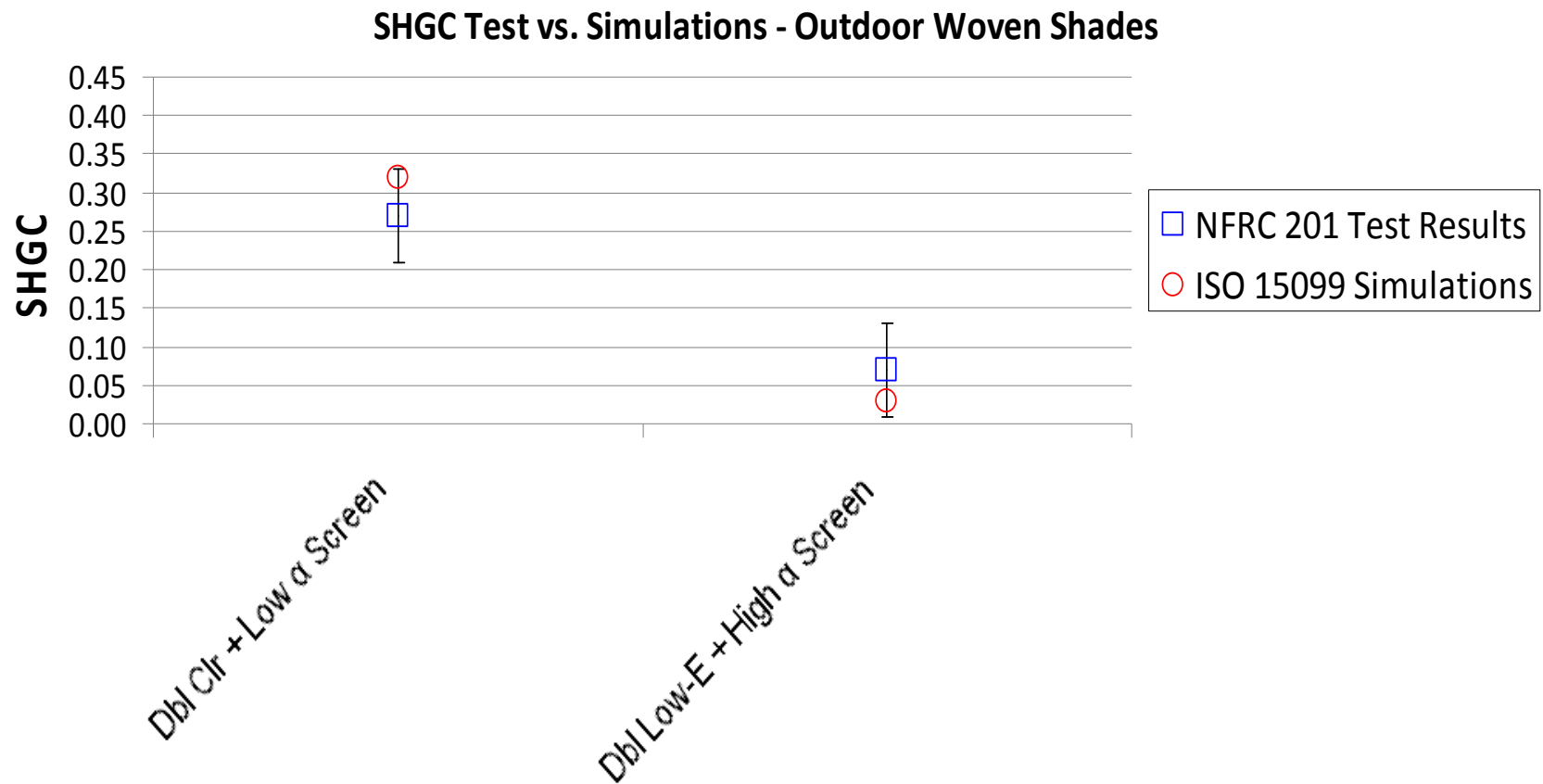
Us vs. Actual & Ust vs. Standard For Between Glazing Venetian Blinds



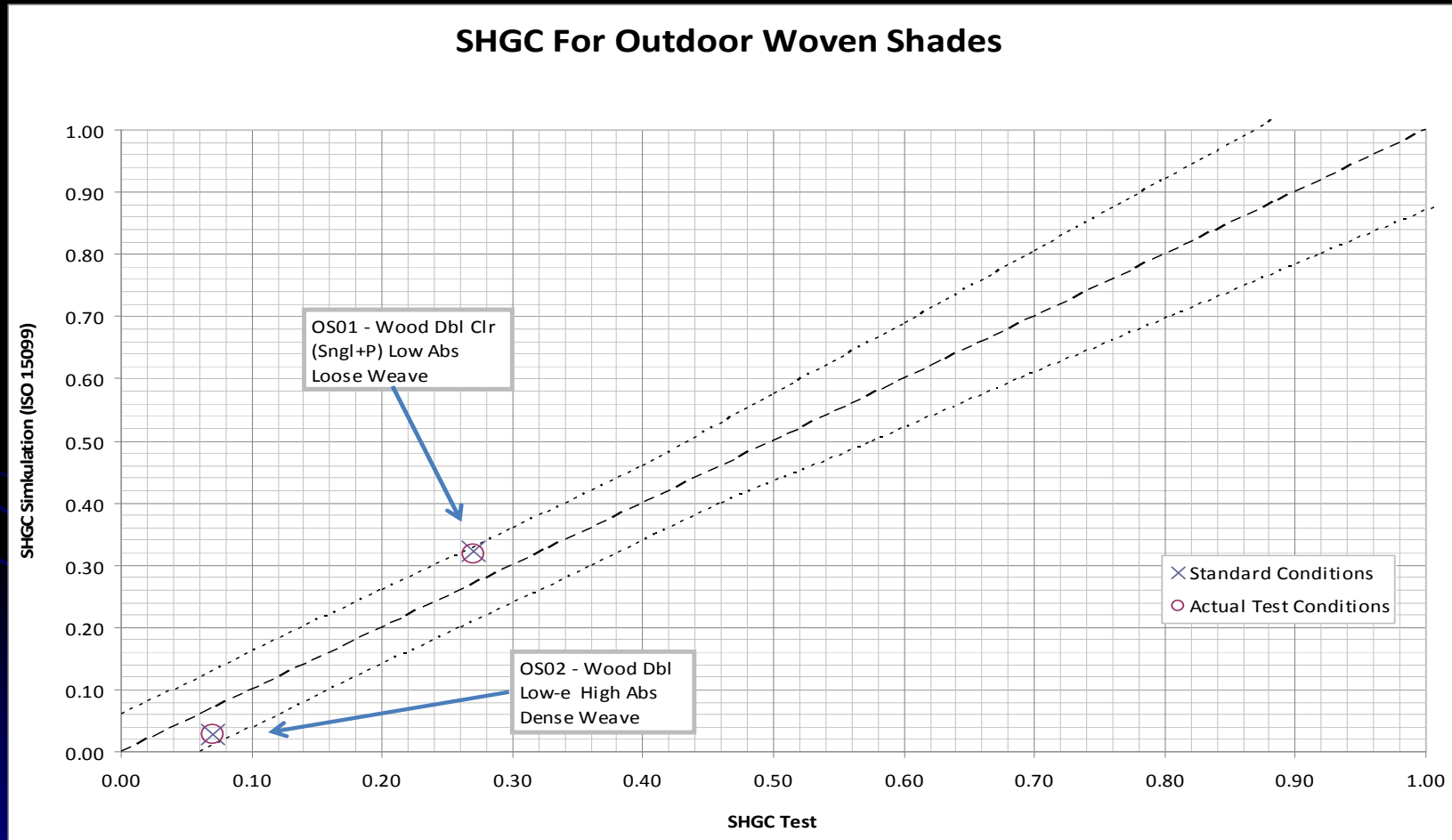
# Recommendation: SHGC Outdoor Woven Shades

Test Specimen	NFRC 201	ISO 15099	% Diff.	Diff.
	Test	Simulation		
Dbl Clr + Low $\alpha$ Screen	0.27	0.319	18.06%	<b>0.049</b>
Dbl Low-E + High $\alpha$ Screen	0.07	0.029	-59.10%	<b>-0.041</b>
Minimum	0.07	0.029	-59.10%	-0.041
Maximum	0.27	0.319	18.06%	0.049
Average	<b>0.17</b>	<b>0.174</b>	<b>-20.52%</b>	<b>0.004</b>
Standard Deviation	0.141	0.2051	54.56%	0.0637

# Recommendation: SHGC Outdoor Woven Shades



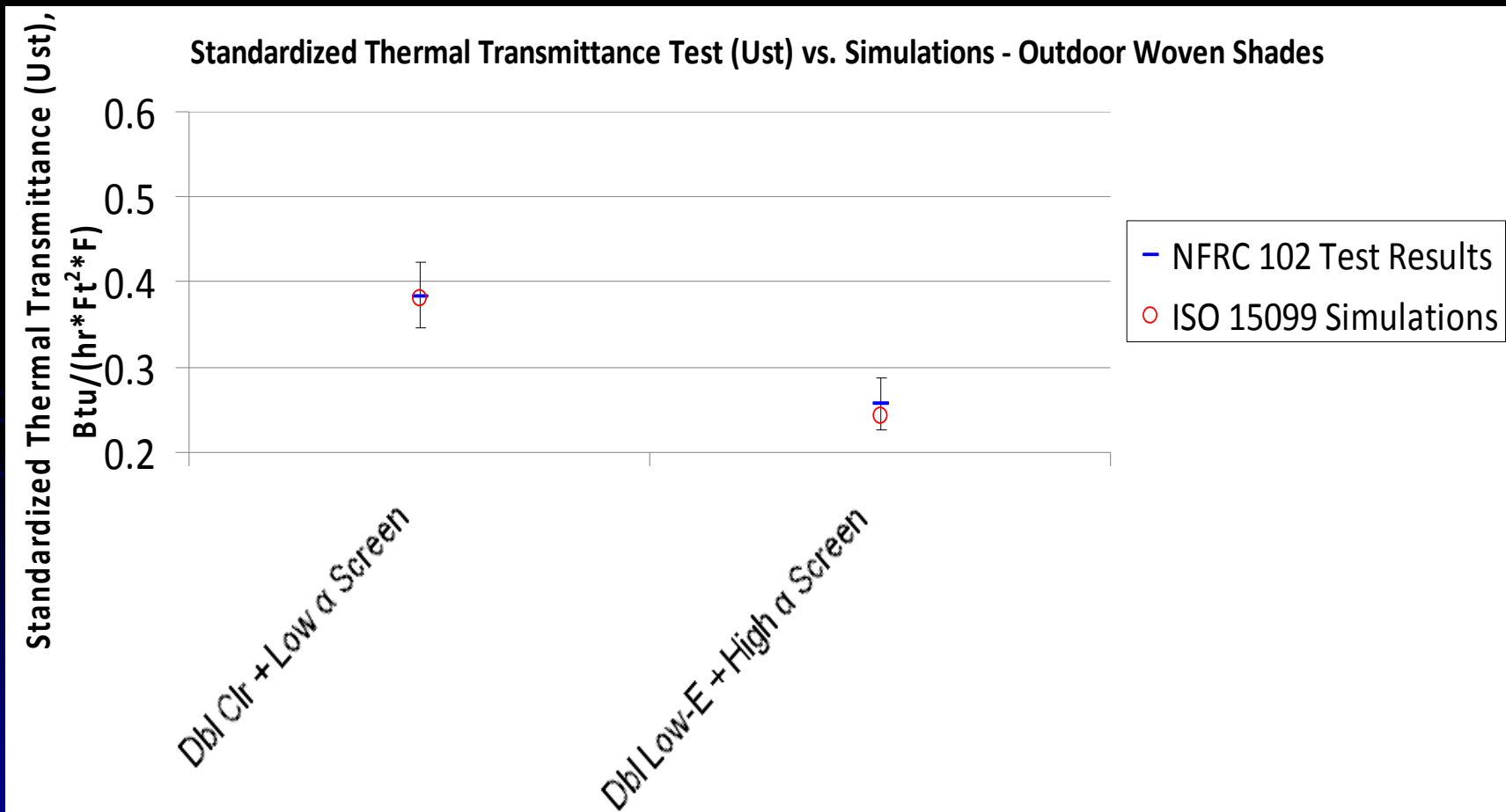
# Recommendation: SHGC Outdoor Woven Shades



# Recommendation: U-Factor Outdoor Woven Shades

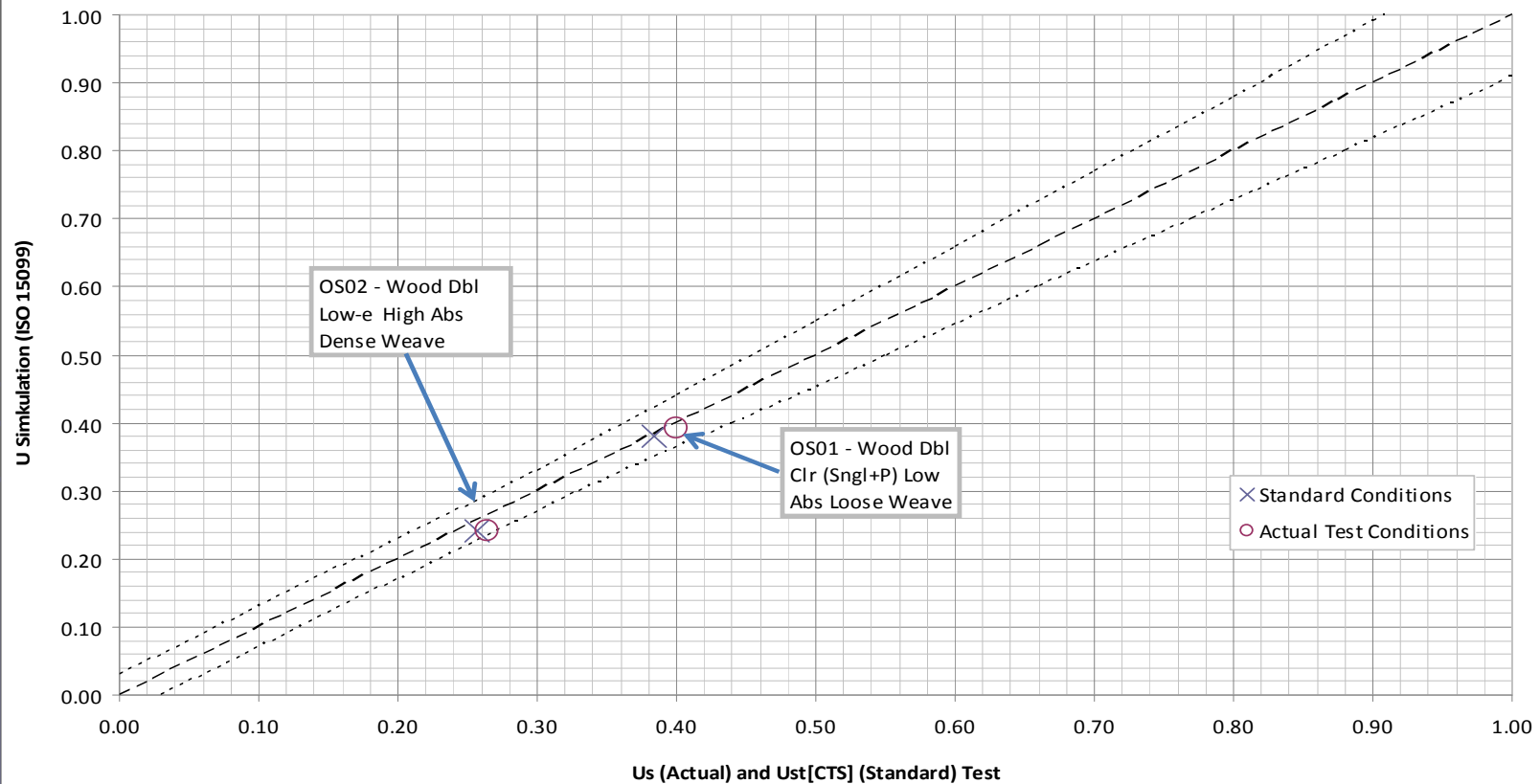
Test Specimen	NFRC 102	ISO 15099	% Diff.	Diff.
	Test	Simulation		
Dbl Clr + Low $\alpha$ Screen	0.38	0.380	<b>-0.82%</b>	-0.003
Dbl Low-E + High $\alpha$ Screen	0.26	0.242	<b>-6.08%</b>	<b>-0.016</b>
Minimum	0.26	0.242	-6.08%	-0.016
Maximum	0.38	0.380	-0.82%	-0.003
Average	<b>0.32</b>	<b>0.311</b>	<b>-3.45%</b>	<b>-0.009</b>
Standard Deviation	0.089	0.0982	3.72%	0.0088

# Recommendation: U-Factor Outdoor Woven Shades



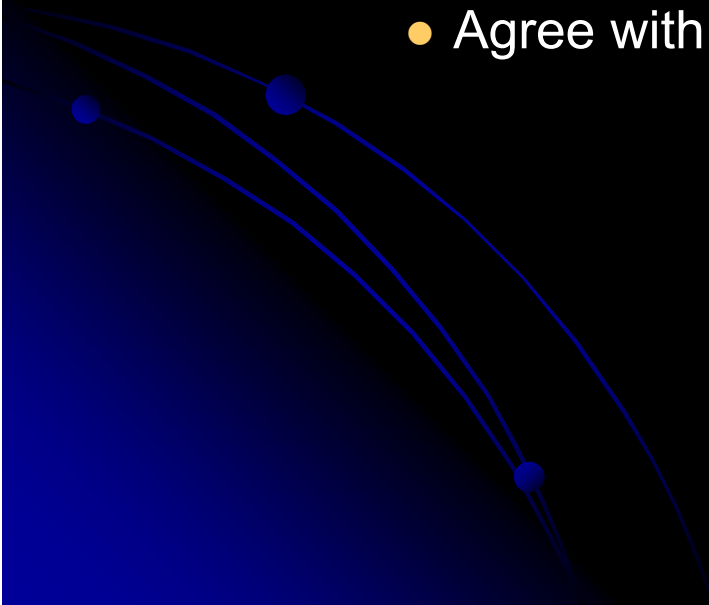
# Recommendation: U-Factor Outdoor Woven Shades

Us vs. Actual & Ust vs. Standard For Outside Woven Shade



# Research Project Recommendations

- Approve WINDOW 6 and THERM 6 for:
  - SHGC/VT Only
    - Indoor Screen
      - Agree with SHGC Test within 0.01 or 9.2%
    - Indoor Venetian Blind
      - Agree with SHGC Test equal to or within 0.06 or 11.5%



# Research Project Recommendations


- Approve WINDOW 6 and THERM 6 for:
  - SHGC/VT & U-Factor
    - Frit Glazing
      - Agree with SHGC Test within 10.8%
      - U-Factor not validated as Frit coating does not significantly affect the thermal properties of glass
    - Venetian Blinds Between Glass
      - Agree with SHGC Test within 0.06 or 8.3%
      - Agree with U-Factor Test equal to or within 0.01 or 5.2%
    - Outdoor Woven Shades
      - Agree with SHGC Test within 0.05
      - Agree with U-Factor Test within 0.02 or 1%

# Considerations

- Frit Glazing

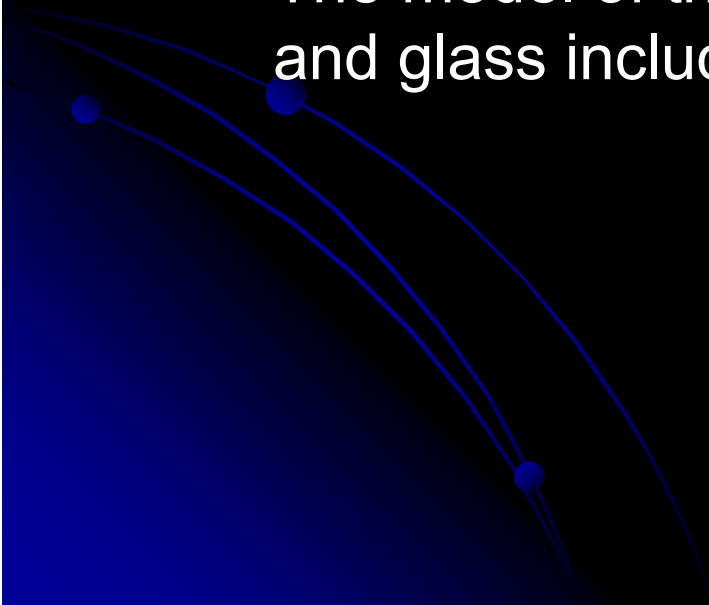
- As U-Factor was not validated, NFRC Staff needs to track and report any issues with the U-Factor validation (test and simulation results) of windows with Frit glazing
- The samples used to determine the optical properties of Frit glazing are not identical to the actual Frit coating on the rated product
  - These differences will be investigated in upcoming Optical Properties ILC

# Considerations

- Visible Transmittance
    - The Visible Spectrum is a subset of the Solar Spectrum so SHGC results are assumed to validate Visible Transmittance
    - NFRC Staff is urged to compile results from tests and simulations
      - Share Data with Appropriate Task Groups
- 

# Considerations

- U-Factor of Outside Woven Shades at a Tilt
  - Although this configuration was not tested, the outside surface heat transfer coefficients of a test specimen exposed to  $\approx 12$  mph of wind does not appreciably change with tilt
  - The model of the cavity between the planer shade and glass includes the effect of tilted products



# Considerations

- All **Recommended** Products
  - NFRC Staff is urged to compile results from tests and simulations
    - Share Data with Appropriate Task Groups
    - Validation Testing
    - Independent Verification Program
- Funding Permitted, continue research on non-recommended products

Questions or Comments?

