

Initial Summary of Round Robin Tvis Measurements for Tubular Daylight Devices (TDD)

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Windows and Daylighting Research

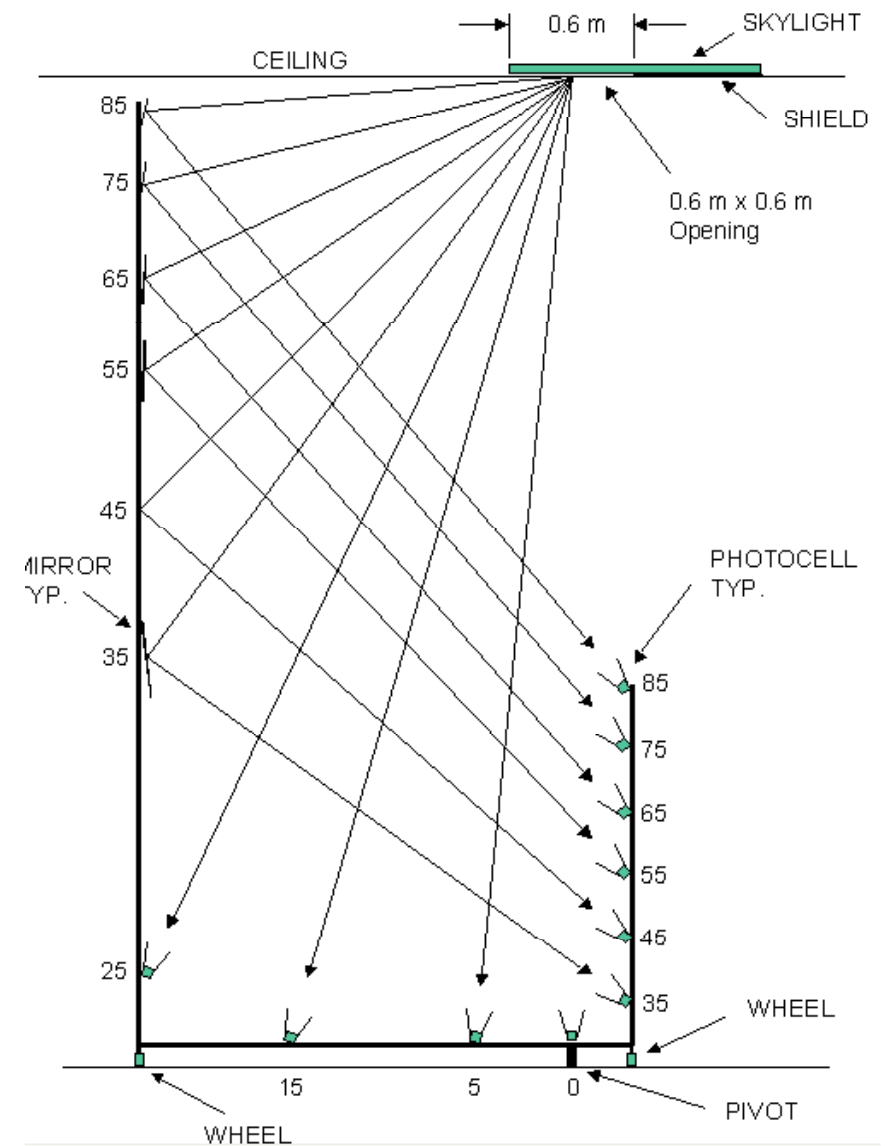
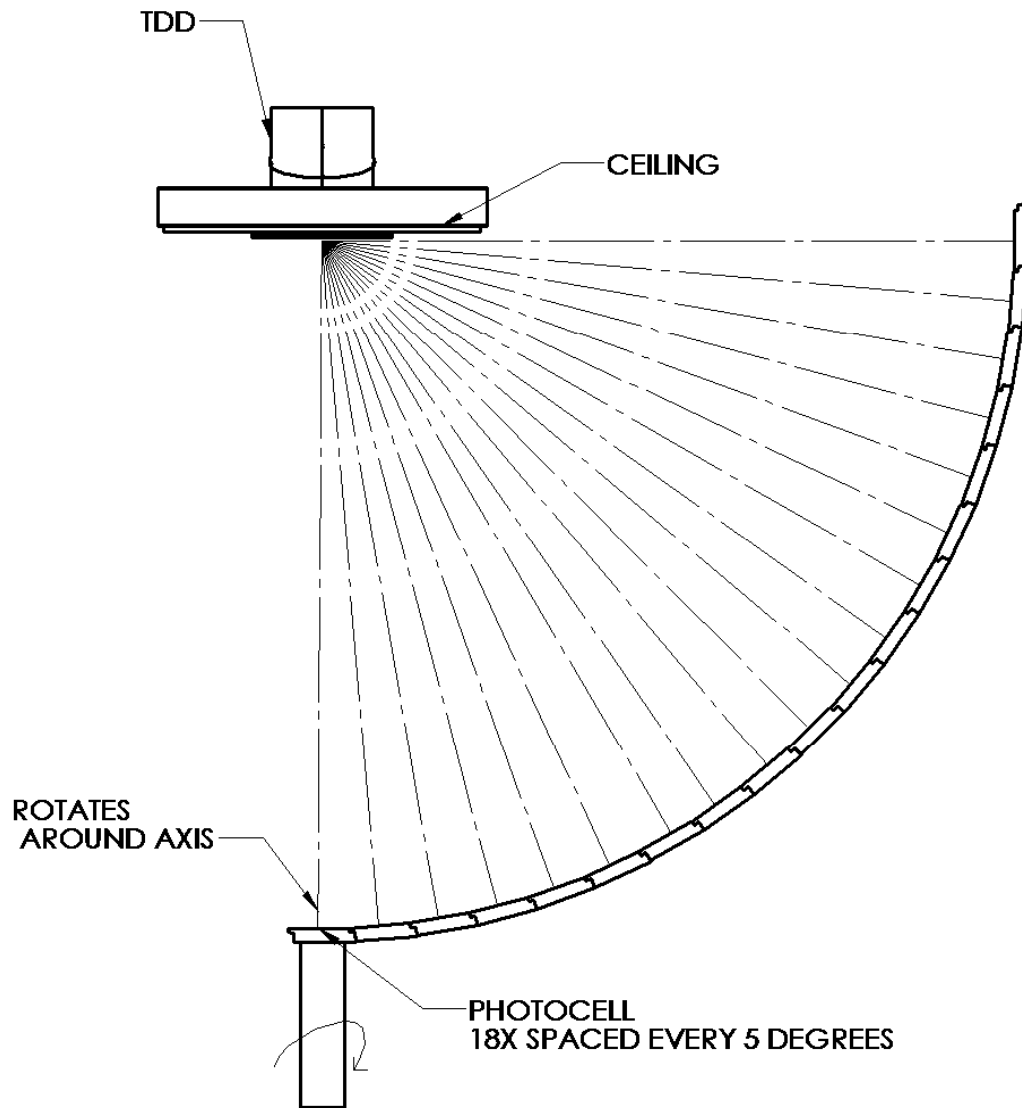
LBNL

Project Overview

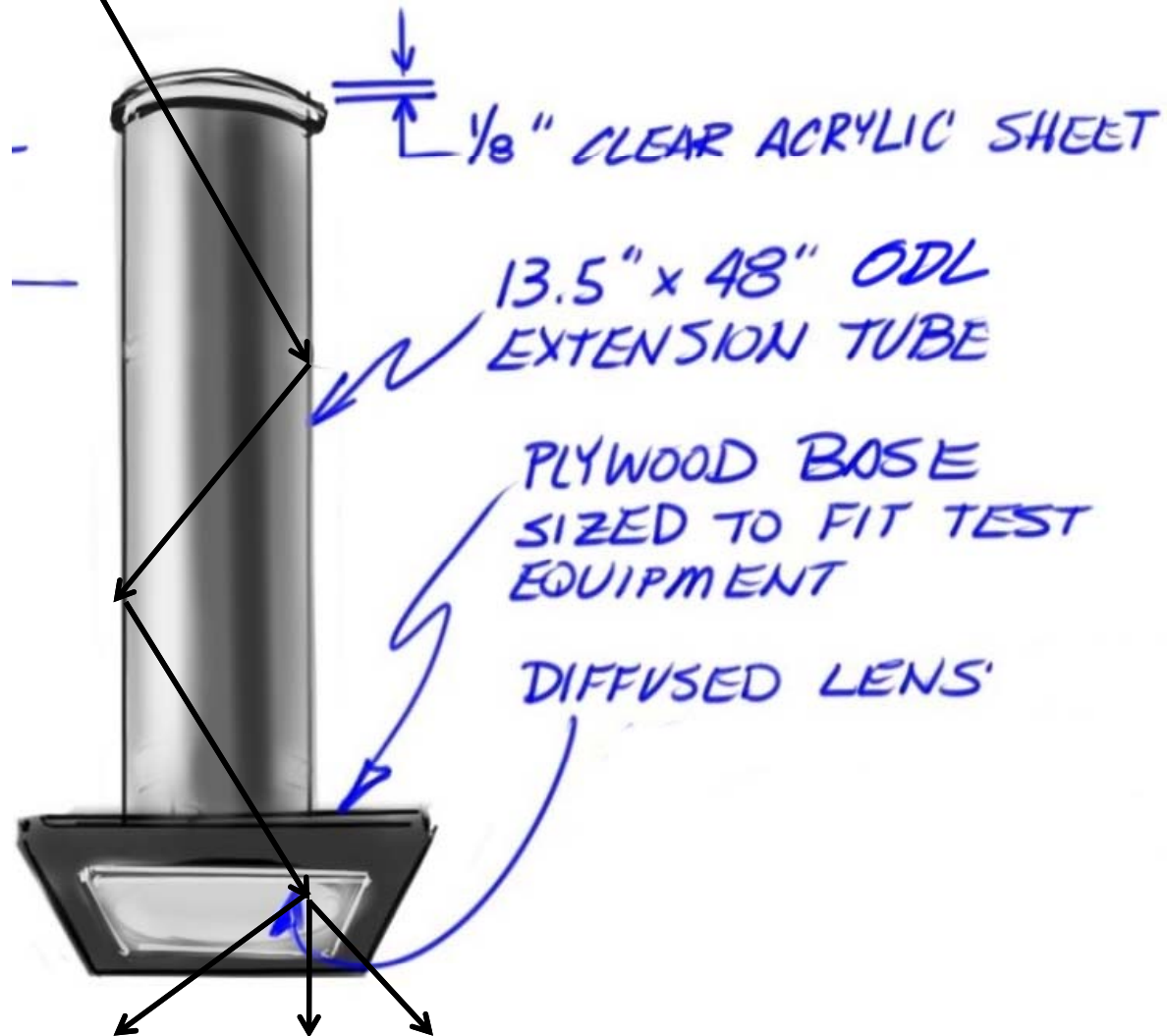
- Reference tube and 3 commercial tubes
- Measured at 3 labs:
 - LBNL integrating sphere
 - Lab X and Y using goniophotometers



Lab x and y goniophotometers



Reference Tube

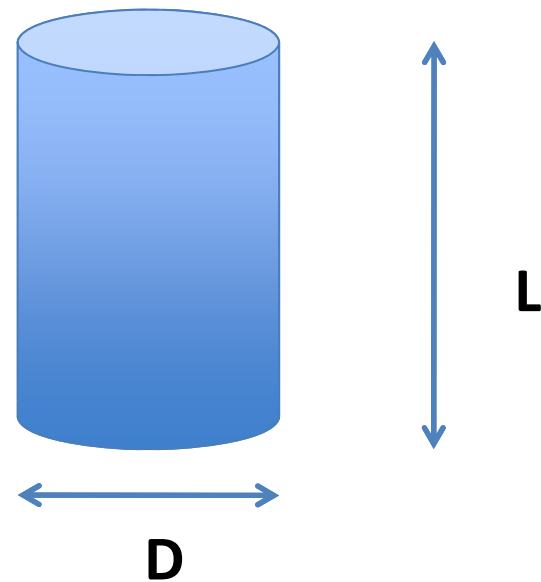


Commercial TDD

- Three TDD's (A, B, C) from manufacturers
- 14" diameter
- Each lab received a separate tube
 - (not a round robin with same samples)
- Assembled per manufacturers instructions

Length over Diameter Ratio

L/D ratio	LBL	Lab X	Lab Y
Reference Tube	3.55	3.55	3.55
Tube A	3.45	3.07	3.51
Tube B	3.37	3.33	3.31
Tube C	3.42	3.66	3.43

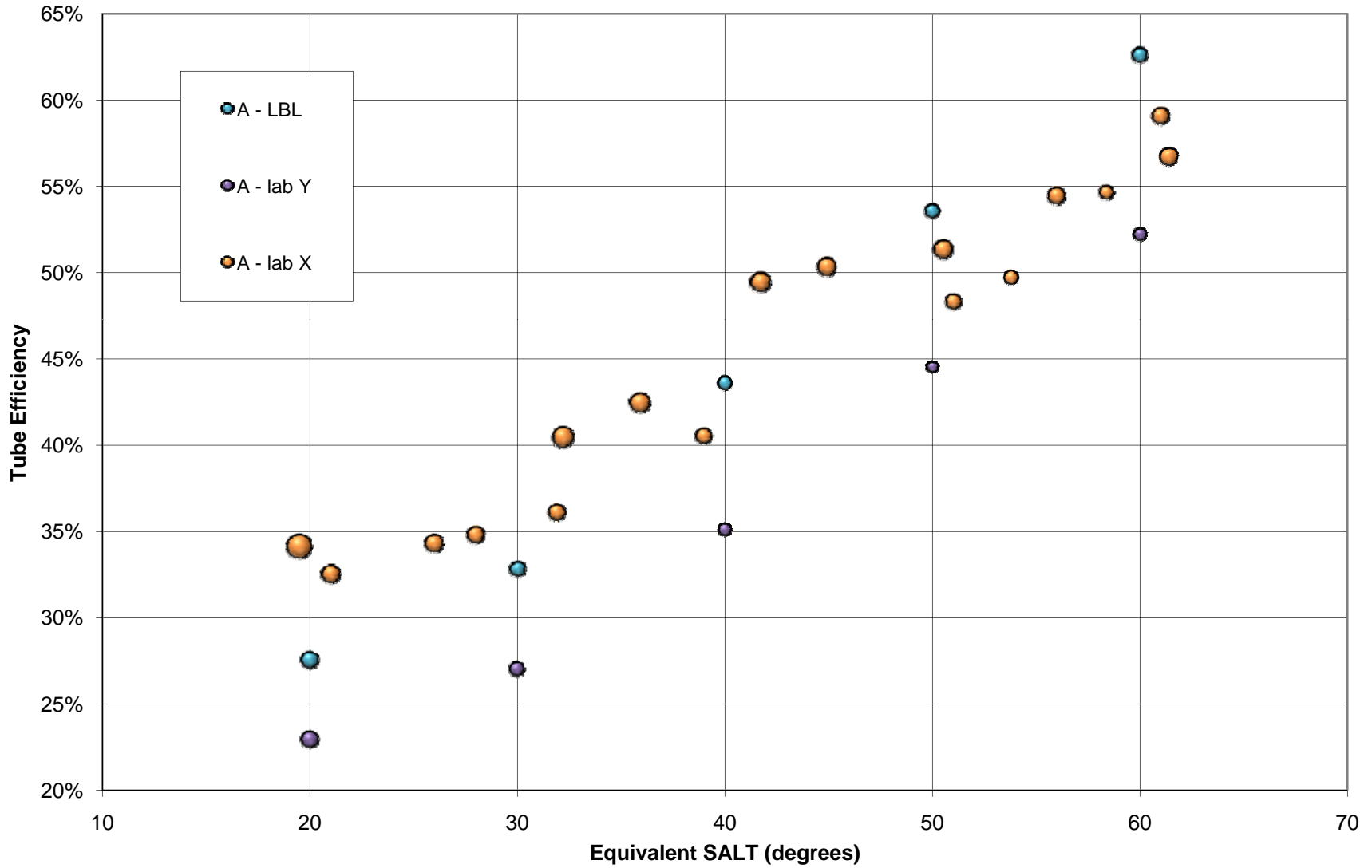


Sky Ratio

- T=Total Sky illuminance
- D=Diffuse Sky illuminance (sun blocked)
- Sky Ratio = D/T
- If Sky Ratio ≤ 0.3
 - Clear Sky according to IESNA = bright solar beam
 - “Valid” test condition

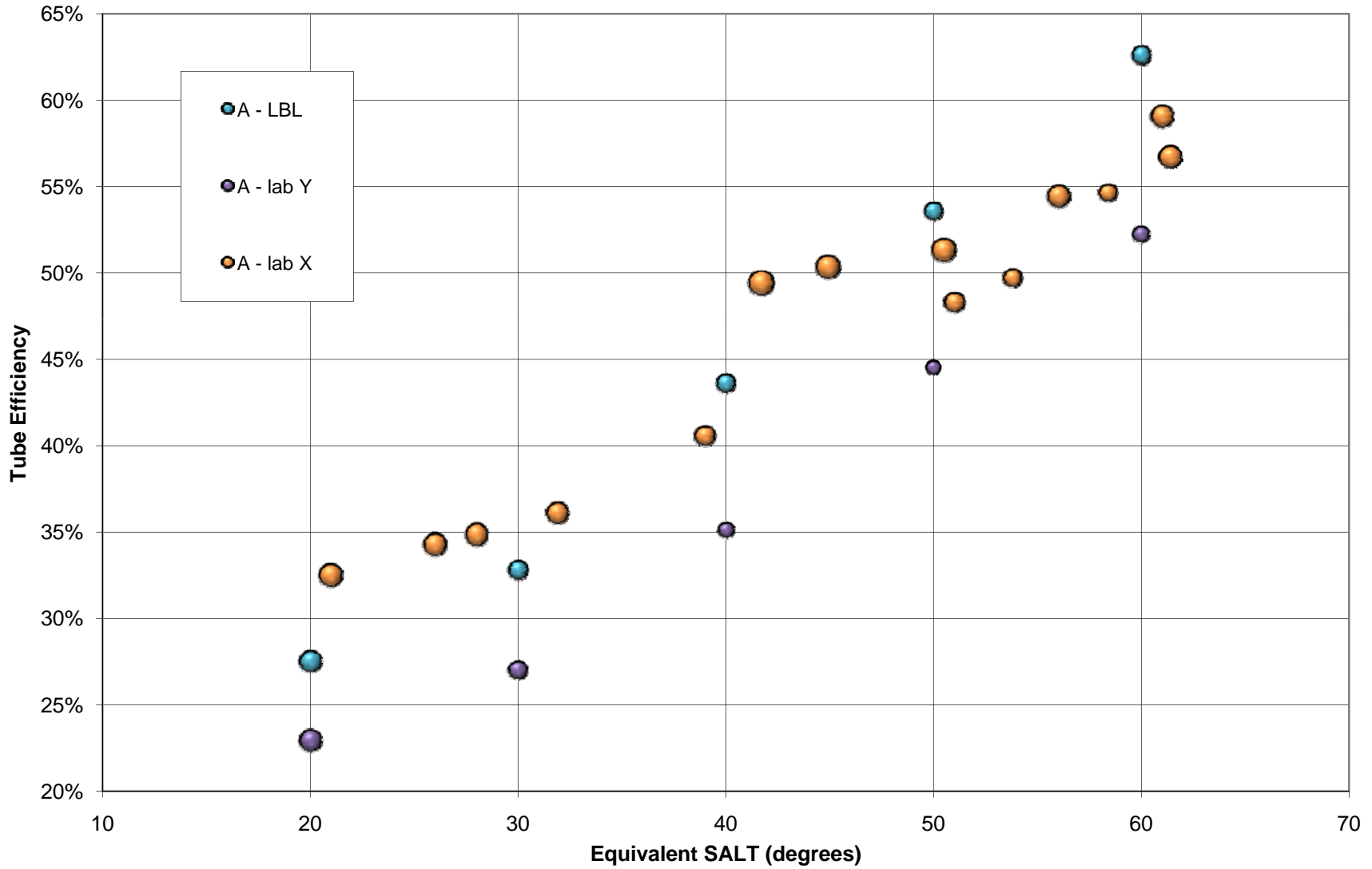
A

Product A Tube Efficiency
Bubble Size Proportional to Sky Ratio (range 0.11-0.47)



A

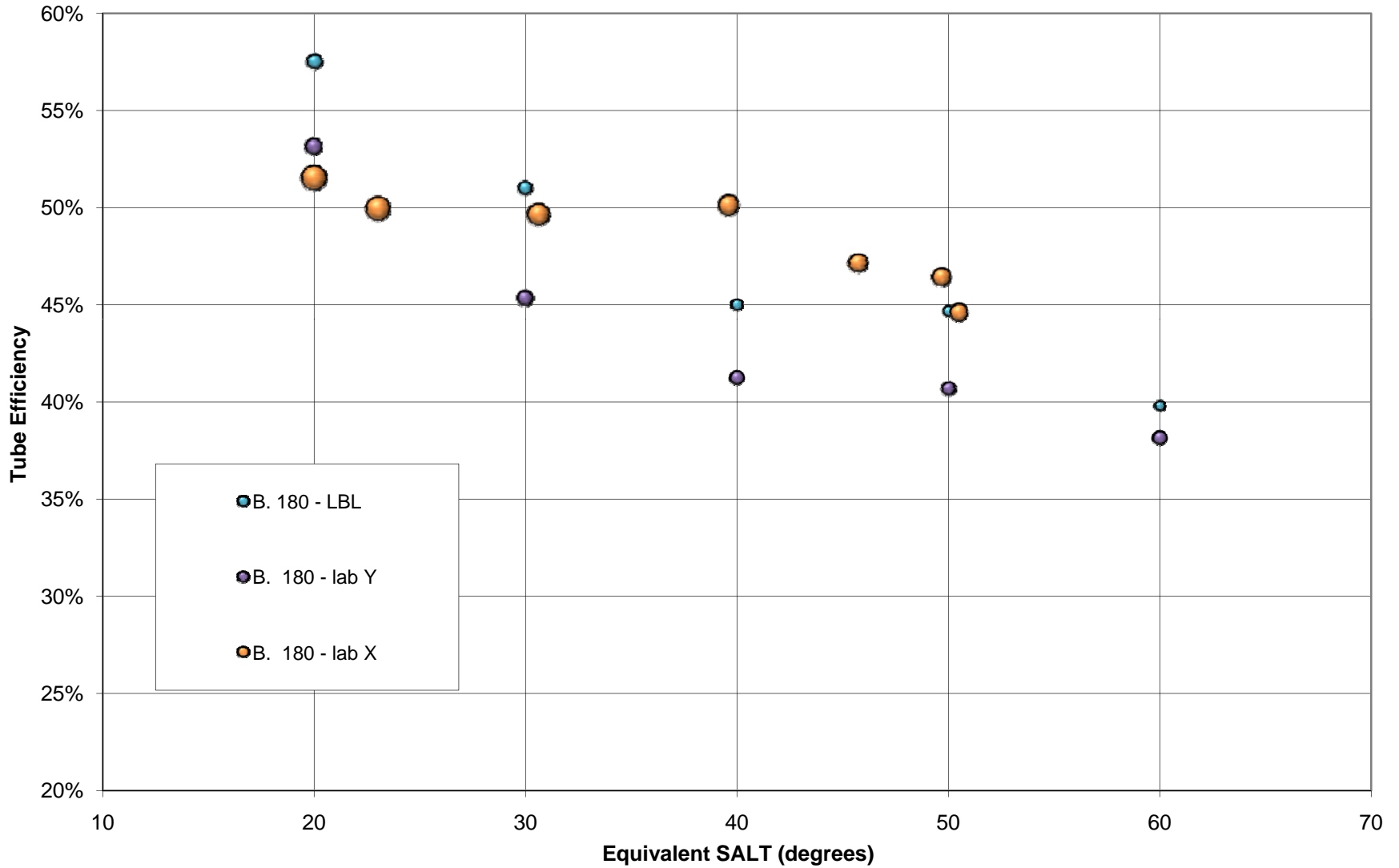
Product A Tube Efficiency
Bubble Size Proportional to Sky Ratio (range 0.11-0.30)



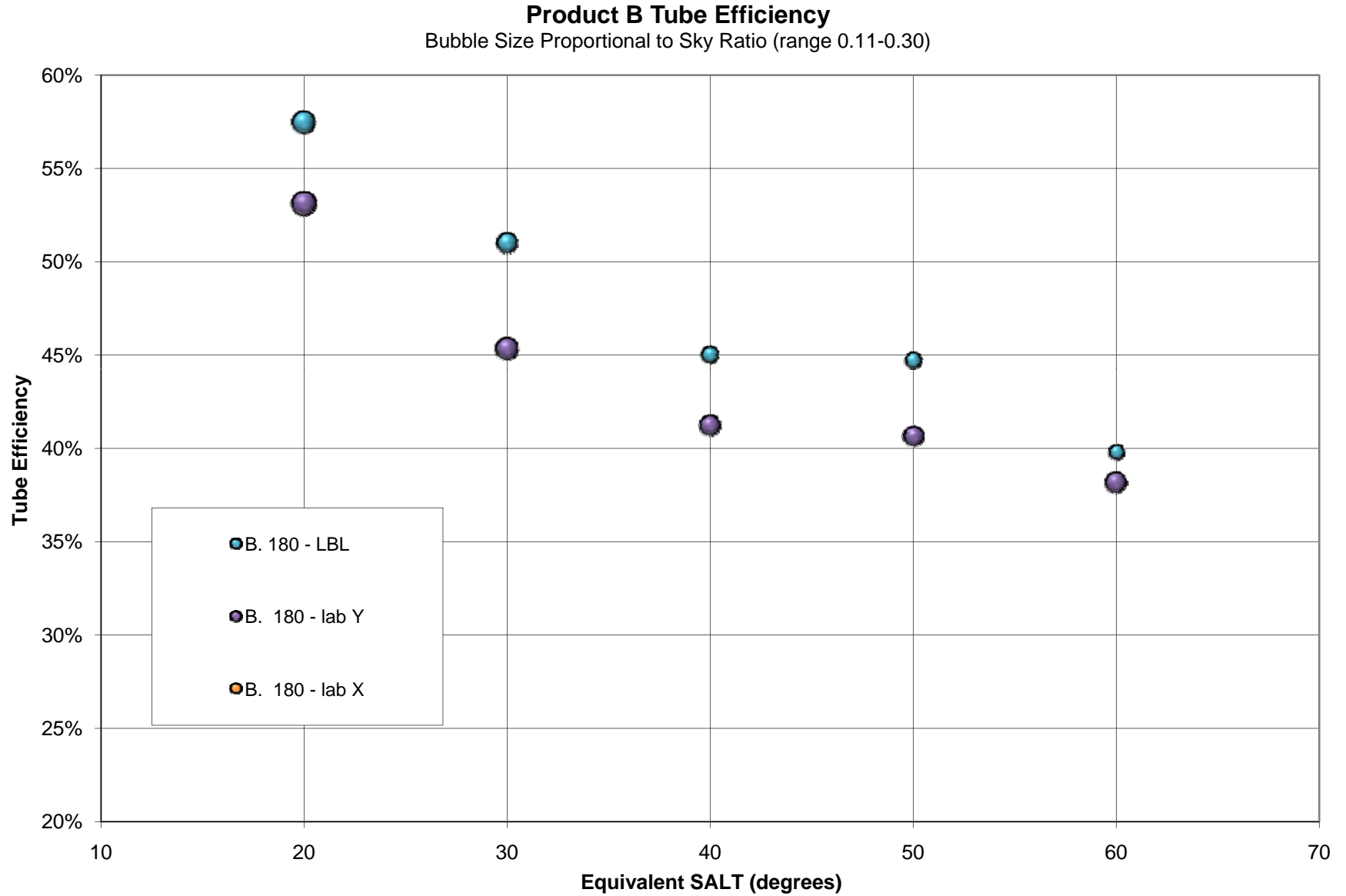
Measurements with sky ratio >0.30 removed

B

Product B Tube Efficiency
Bubble Size Proportional to Sky Ratio (range 0.11-0.56)



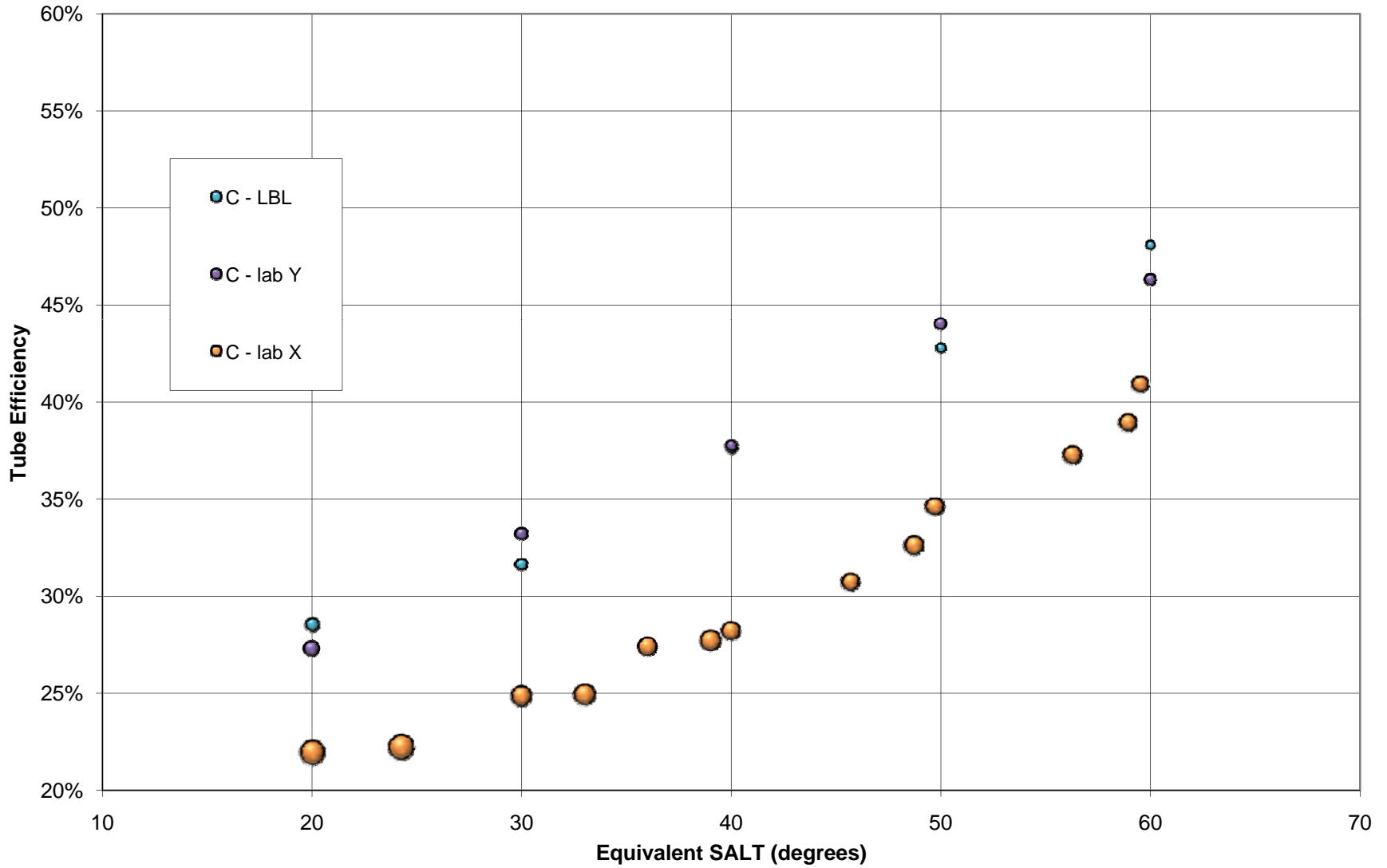
B



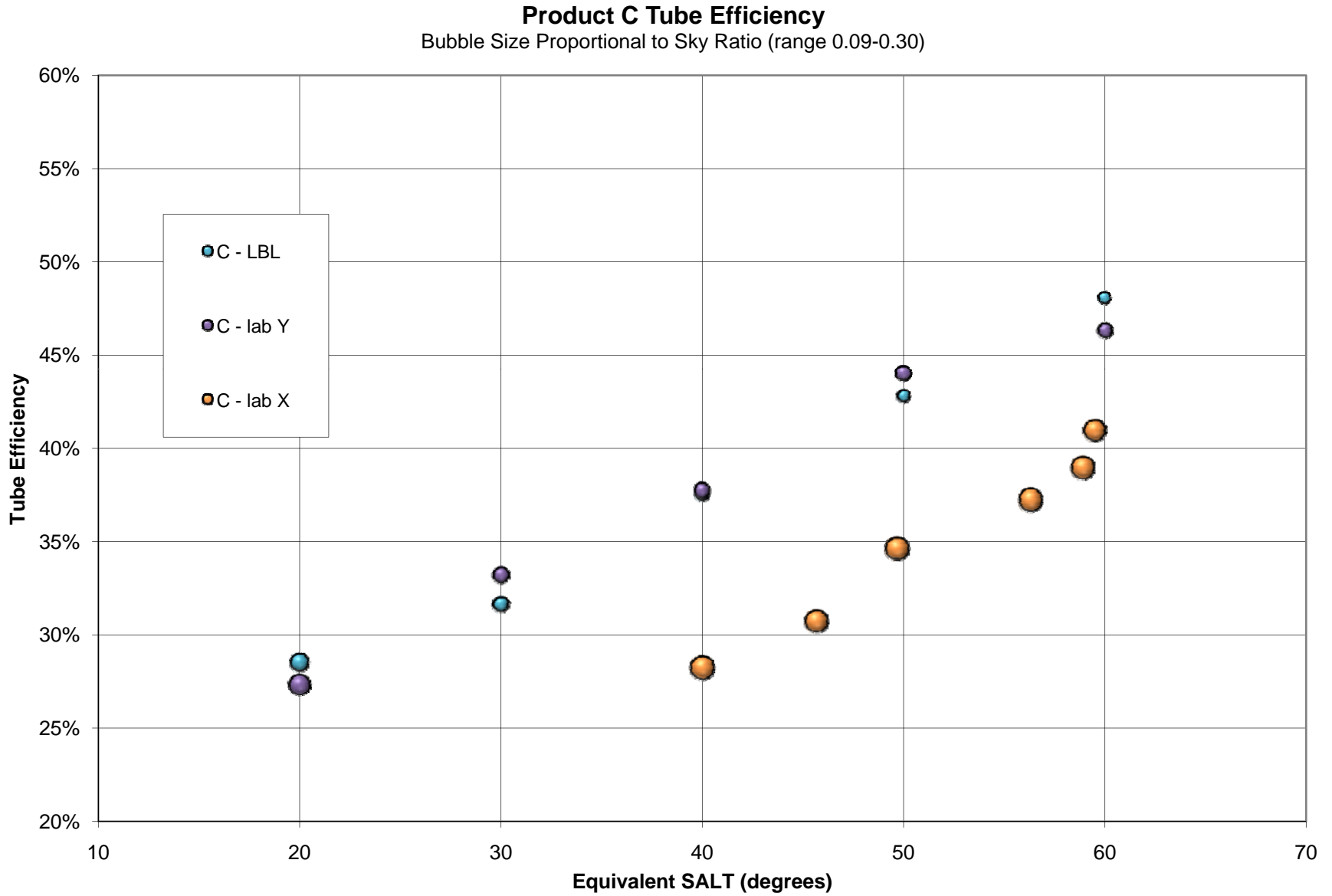
Measurements with sky ratio >0.30 removed

C

Product C Tube Efficiency
Bubble Size Proportional to Sky Ratio (range 0.09-0.54)



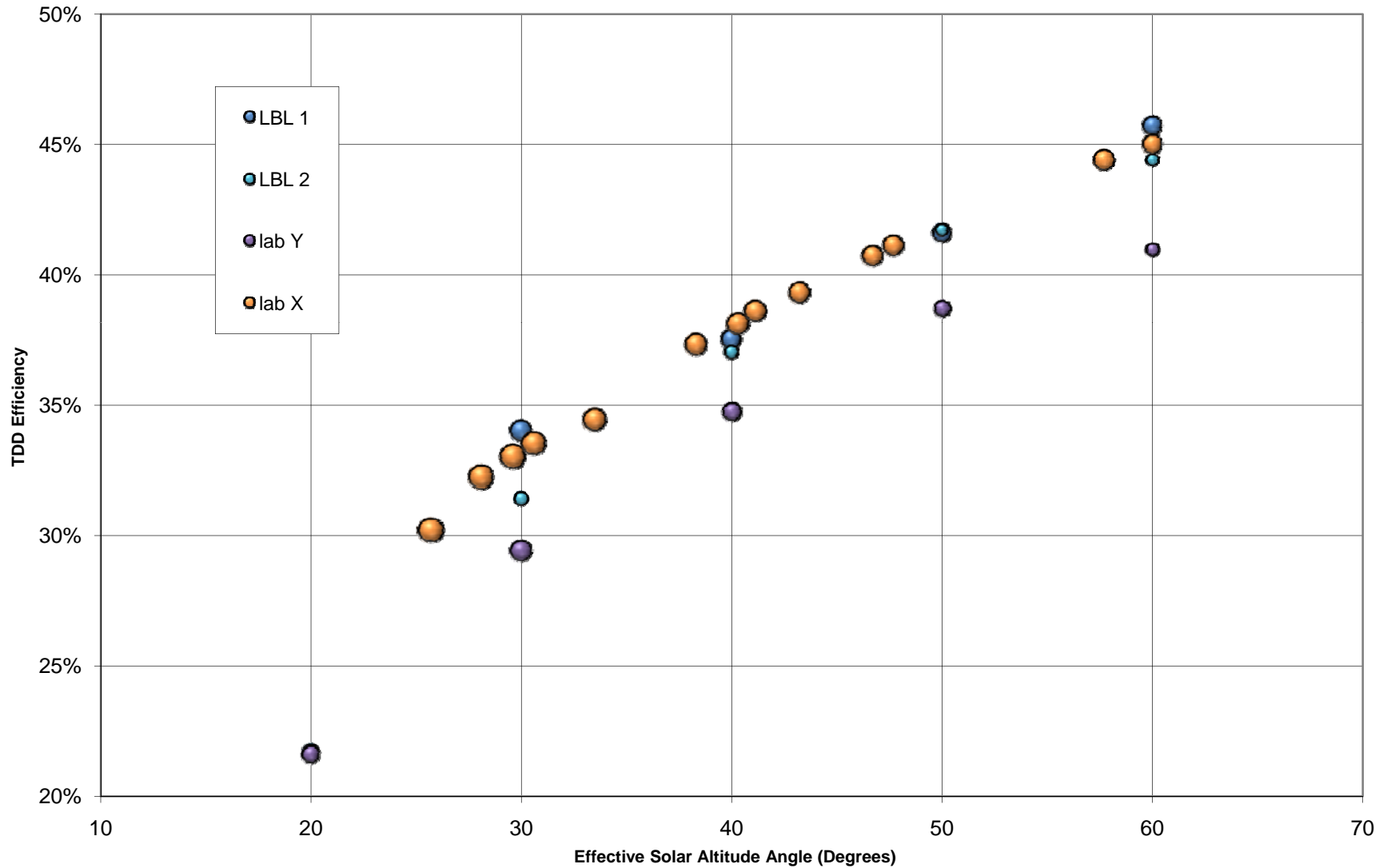
C



Measurements with sky ratio >0.30 removed

Ref

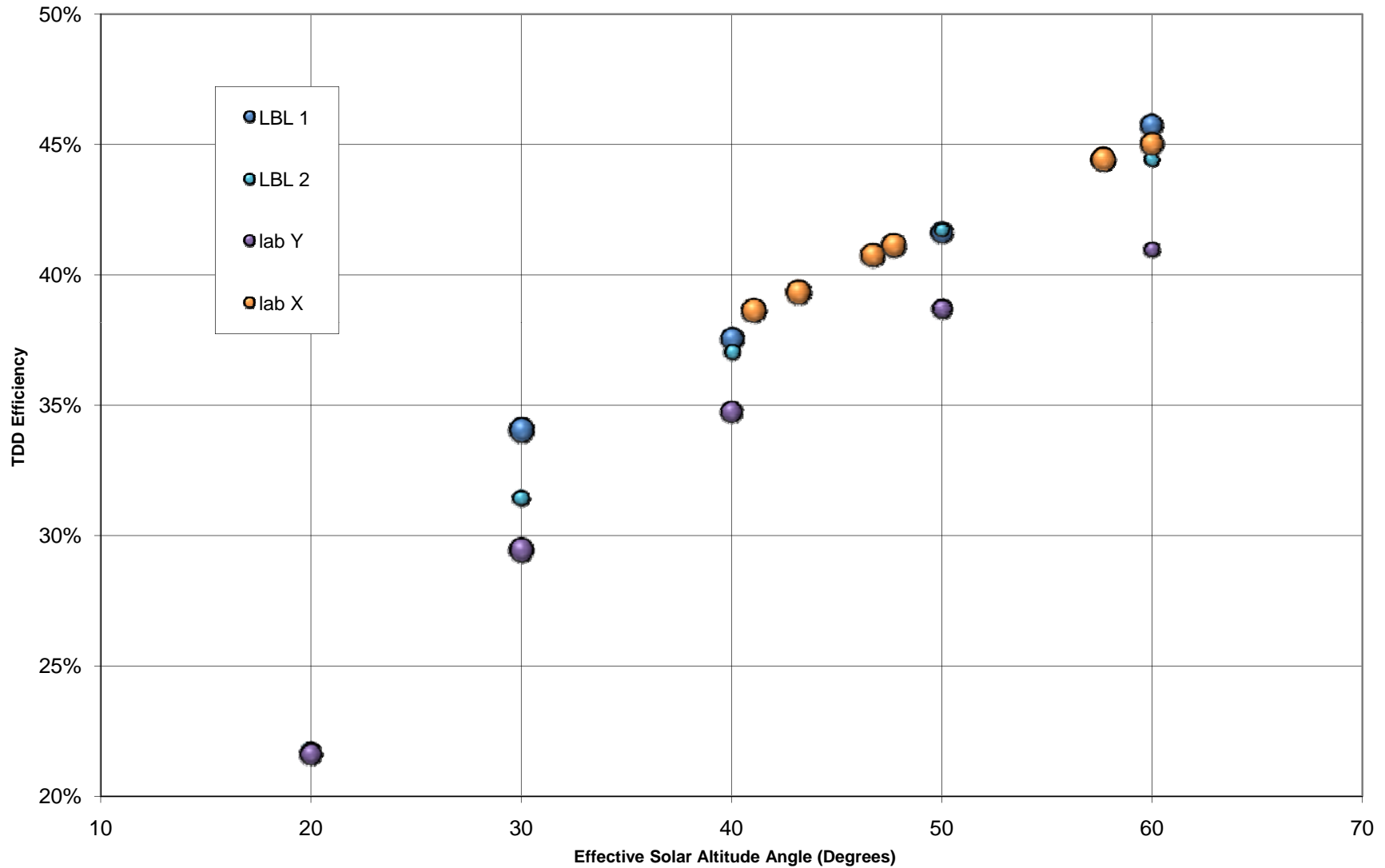
Reference Tube Efficiency 180 Azimuth - Three Labs
Bubble Size Proportional to Sky Ratio (range 0.10-0.38)



Ref

Reference Tube Efficiency 180 Azimuth - Three Labs

Bubble Size Proportional to Sky Ratio (range 0.10-0.30)



Measurements with sky ratio >0.30 removed

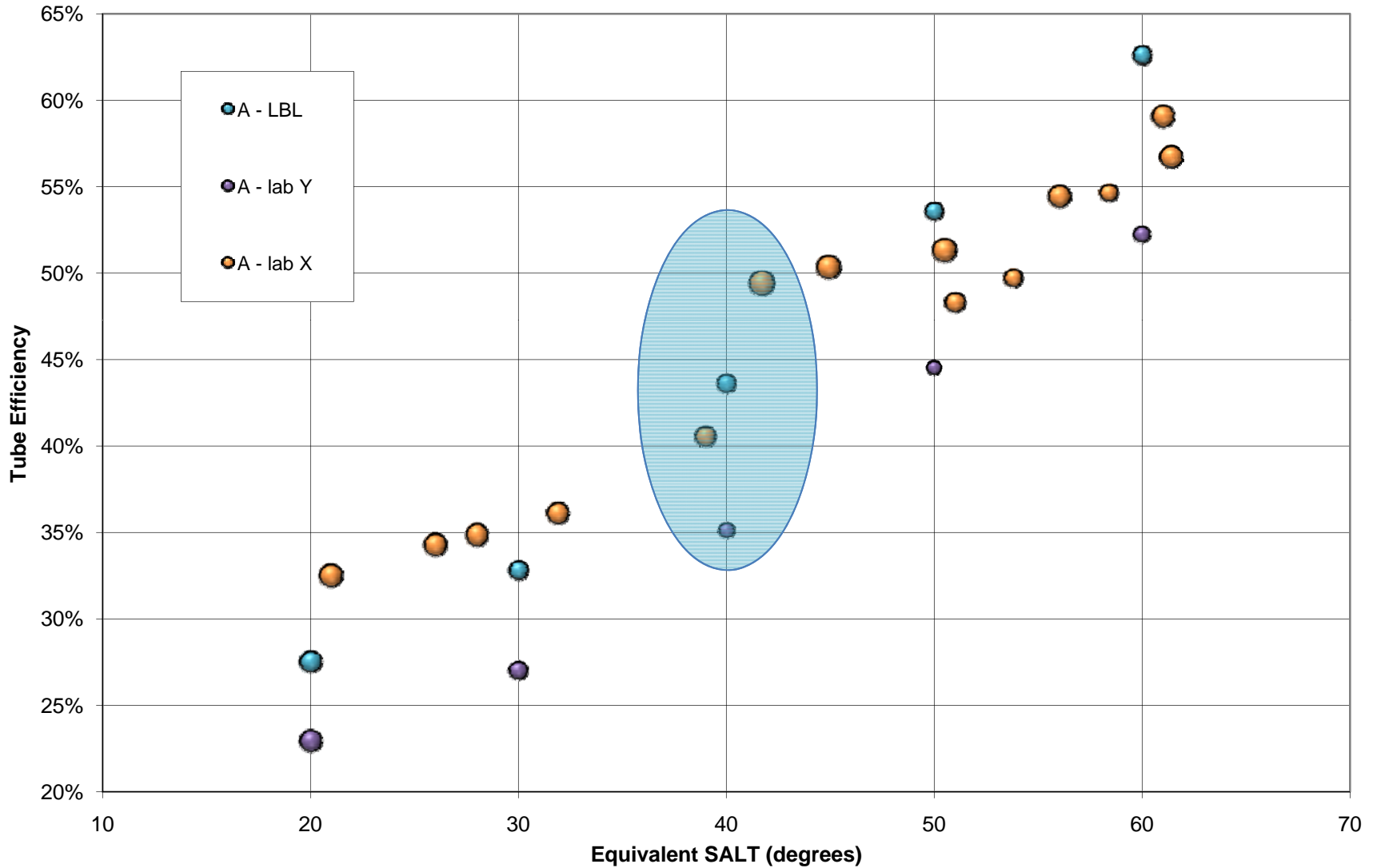
Results

Product	Angle	Lab X	Lab Y	Comment
Ref	60	+0.006 (1.4%)	-0.035 (-7.9%)	Lab Y low
A	40	-0.031 (-7.1%) or +0.058 (13.3%)	-0.085 (-19.5%)	See next slide
C	40	-0.094 (-25%)	+0.001 (0.27%)	Lab X low

Referenced to LBL measurements, absolute percentages

A

Product A Tube Efficiency
Bubble Size Proportional to Sky Ratio (range 0.11-0.30)



Lab X: 8.9% difference over 2.7 degrees

Lab X vs Lab Y 14.3% difference

Discussion

- Significant discrepancies between three methods
- No clear “trends” between three methods
- We believe that sphere measurements are reasonably “accurate” – based on past studies
- Results do not show that Goniophotometers can measure/calculate Visible Transmittance that agrees with Integrating Sphere measurements
- Potential Sky Condition impact
- Other Errors could be:
 - Operator error
 - Data processing error
 - Fundamental device design problem
- Not possible to infer error source based on work to date
- Shape of T_{vis} vs angle varies with design of device- so a standard angle for testing (or range for average) must be chosen with care; or full angle dependence reported

Next Steps??

- Three groups now share analysis and data processing methods to look for any obvious errors
- New Validation studies with reference sources, e.g. 14" fixed luminance, electric powered sample
- Model simple tubular systems with Ray Tracing and compare to measurements
- Study direct vs diffuse component impacts with LBNL sphere; can be used to set uncertainty bounds
- Time frame? Funding?
- LBNL User Testbed Facility