Failure Rates of Thin Film Modules during Qualification Testing

A Presentation
from
TUV Rheinland Group

Presented by
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Outline

- Introduction
- Results and Analysis (3 out of 7 Labs' data presented here)
  - Lab 1: Failure Rate and Failure Distribution
  - Lab 2: Failure Distribution
  - Lab 3: Failure Distribution
- Conclusions

Failure Rate vs. Failure Distribution

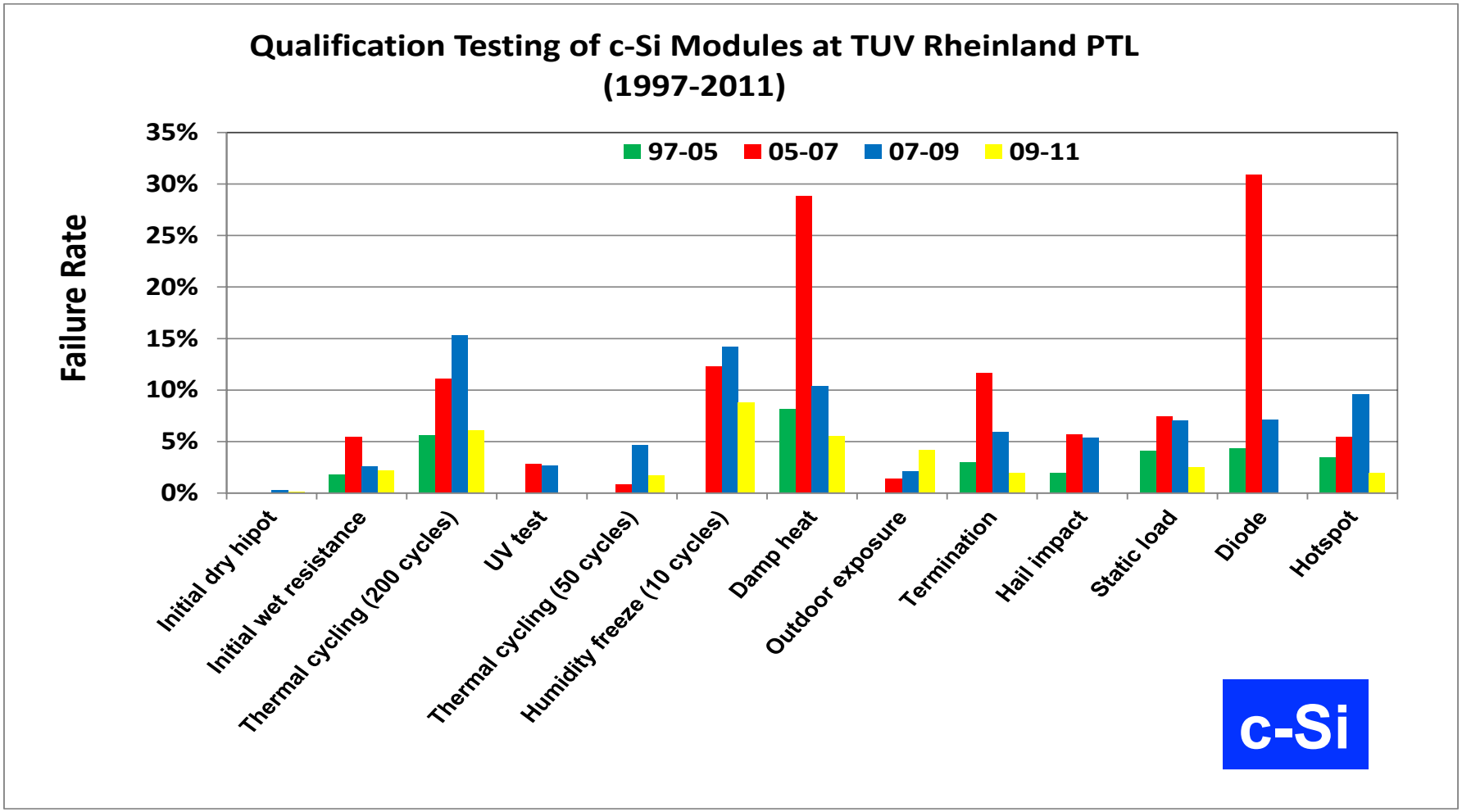
Failure Rate =

Number of Modules Failed in a Specific Test ÷ Total Number of Modules Tested in the Specific Test

Failure Distribution =

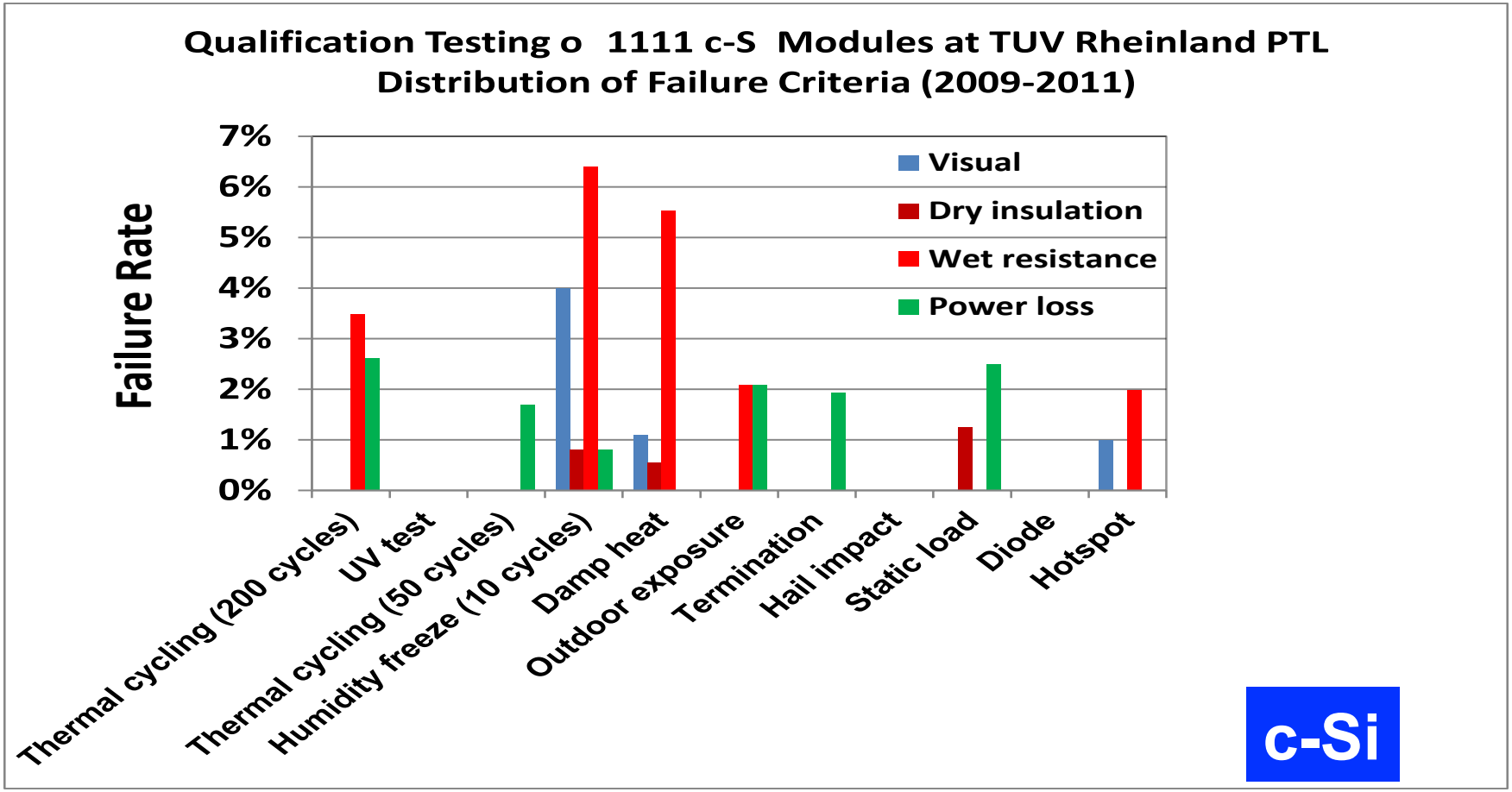
Number of Module Failures in a Specific Test ÷ Total Number of Module Failures in All the Tests

Lab 1: Failure Rates
(Total modules tested in 2009-2011 period = 1111)



Top 3 Failure Rate Tests (2009-2011):

Lab 1: Failure Criteria



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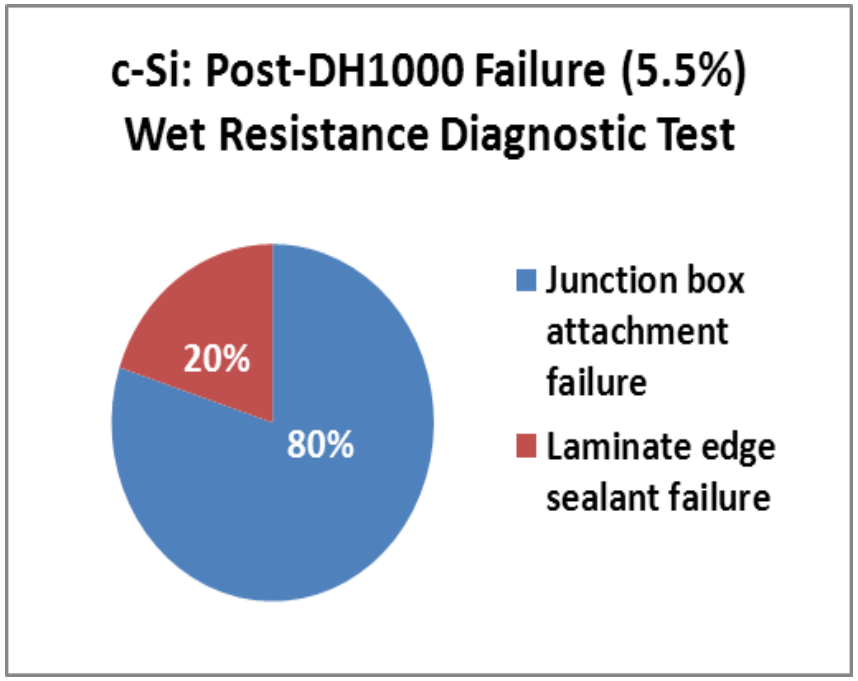
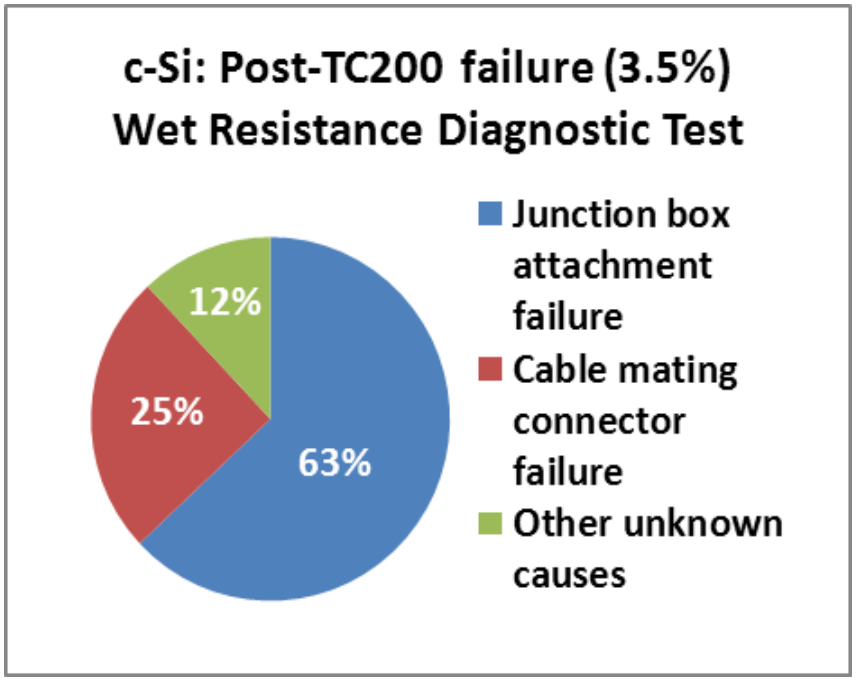
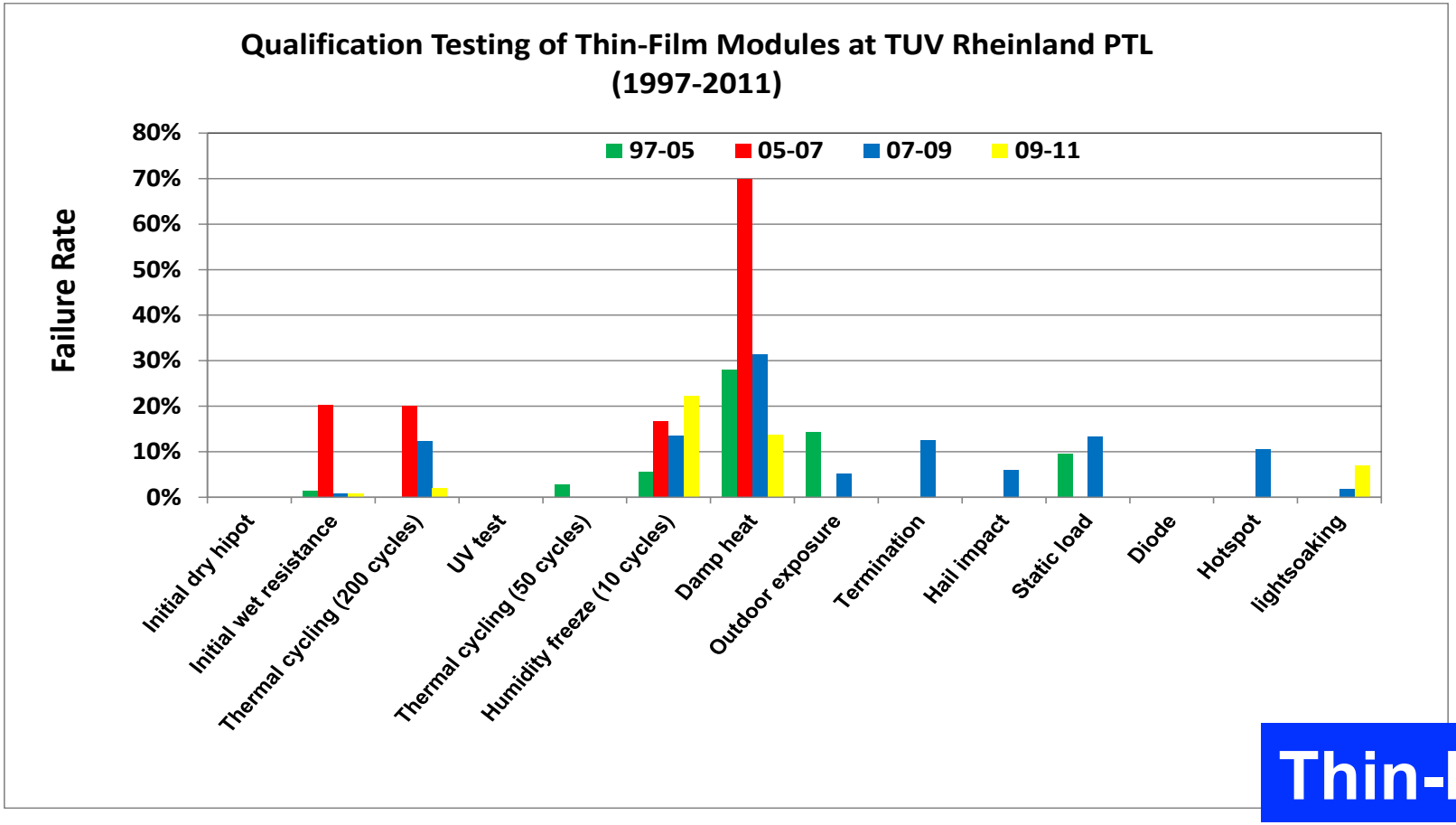
Cause for Wet Resistance Failure





c-Si

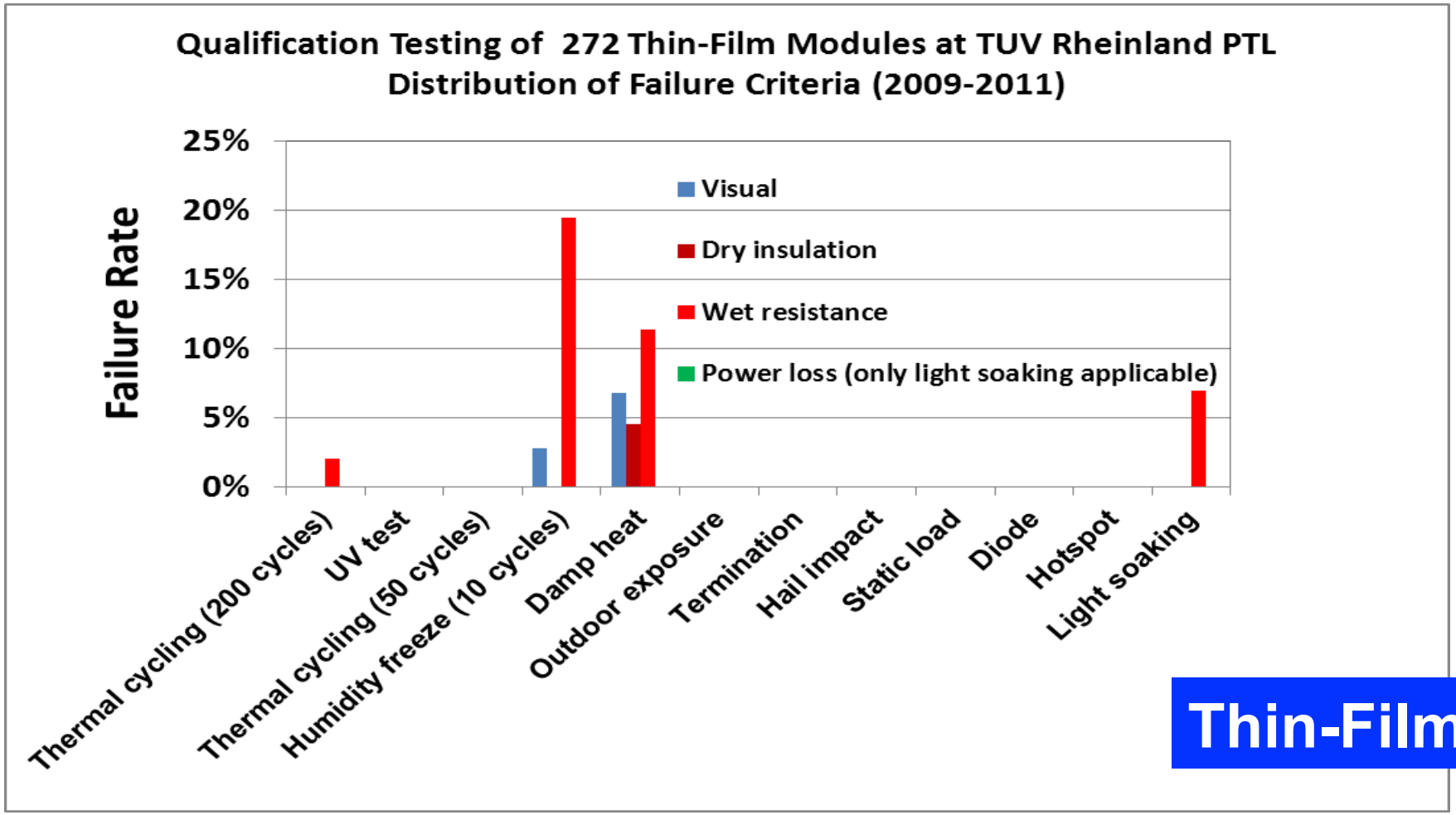
Lab 1: Failure Rates
(Total modules tested in 2009-2011 period = 272)



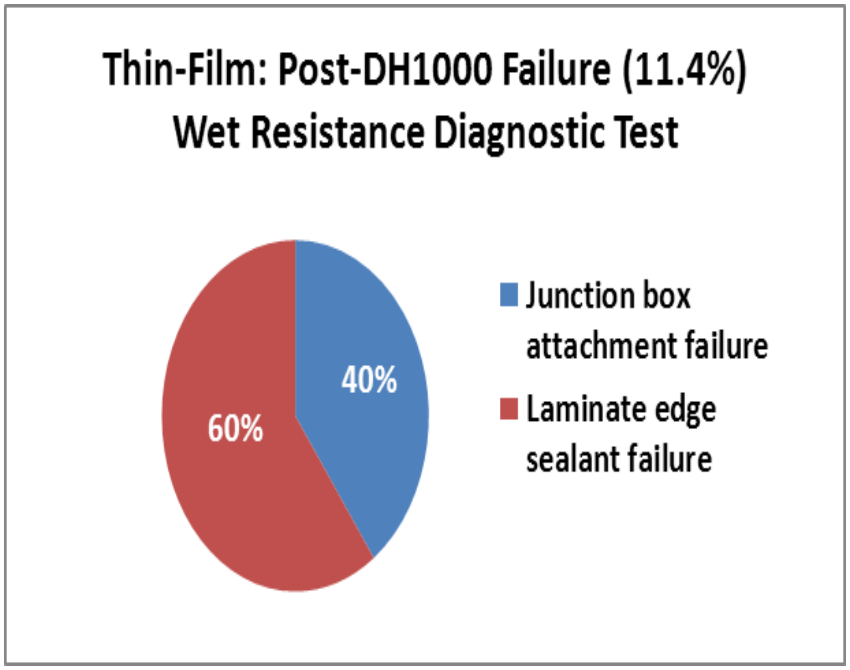
Thin-Film

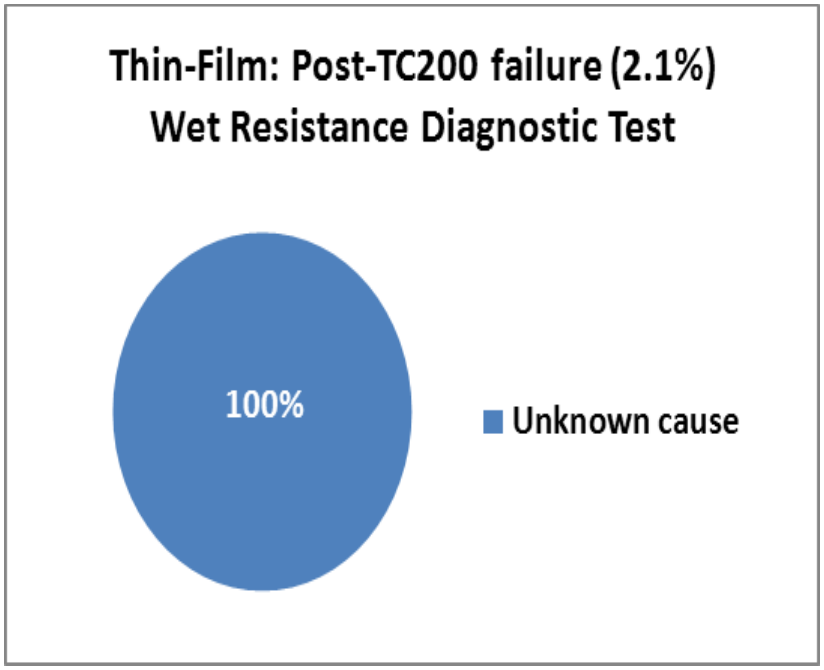
Top 3 Failure Rate Tests (2009-2011):

Lab 1: Failure Criteria



Cause for Wet Resistance Failure





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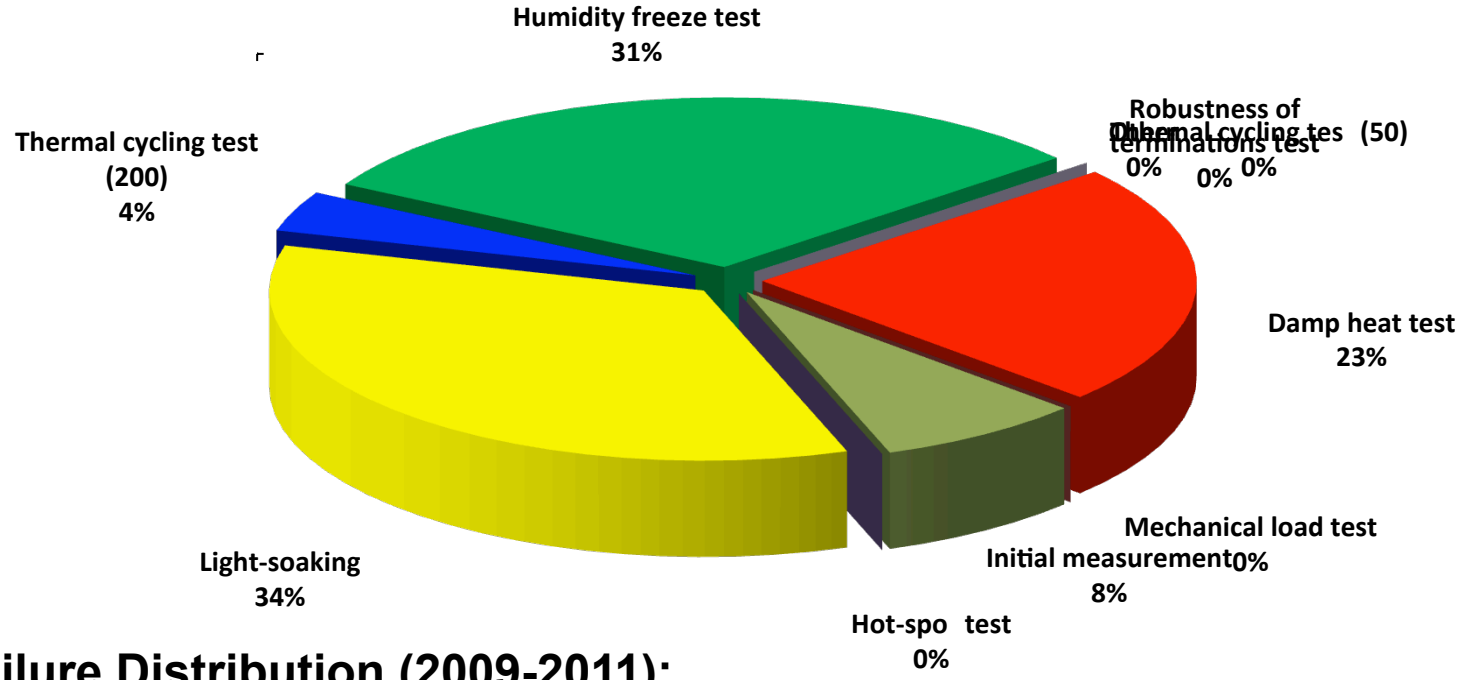
Lab 1: Failure Distribution (Total failures = 26)

LAB 1: Distribution of test failures for thin-film PV modules 2009-2011 (IEC 1646 only)



Top 3 Failure Distribution (2009-2011): Light soaking; Humidity freeze; Damp heat

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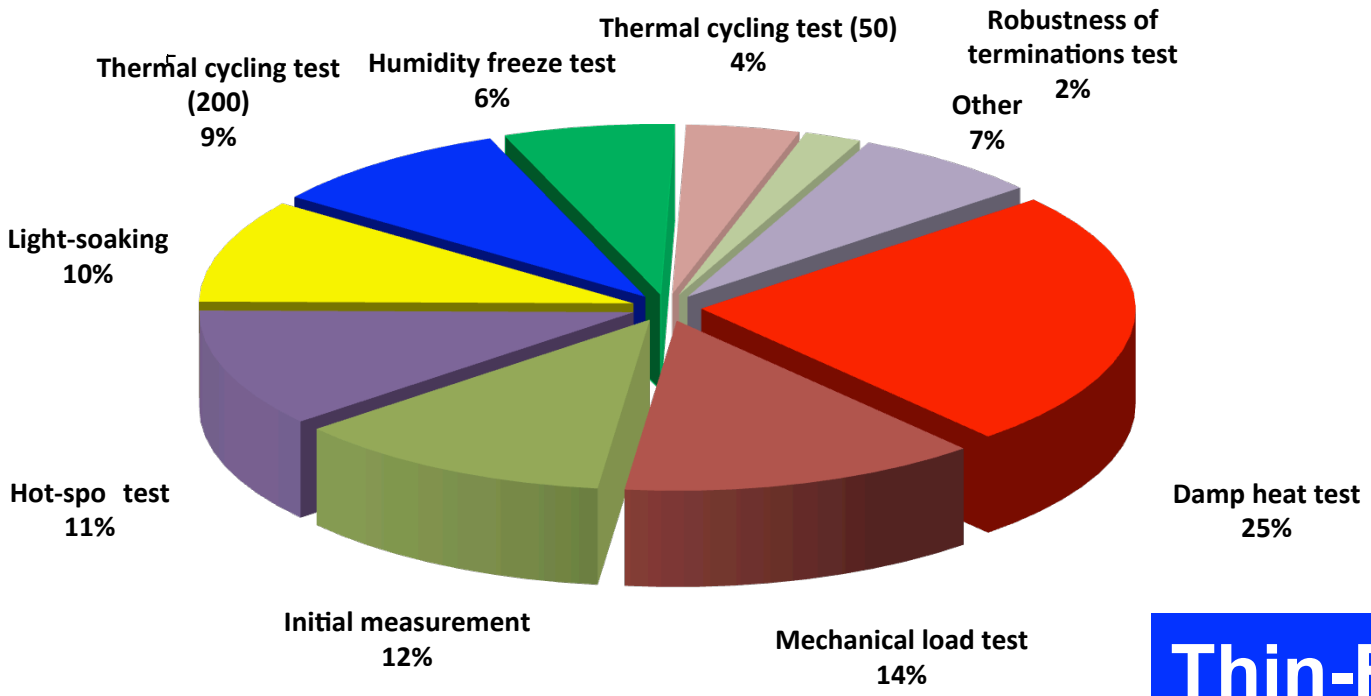
Lab 2: Failure Distribution (Total failures = 142)

Lab 2: Distribution of test failures for thin-film PV modules 2007-2011 (IEC 1646 only)



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Top 3 Failure Distribution (2007-2011): Damp heat; Mechanical load; Hotspot

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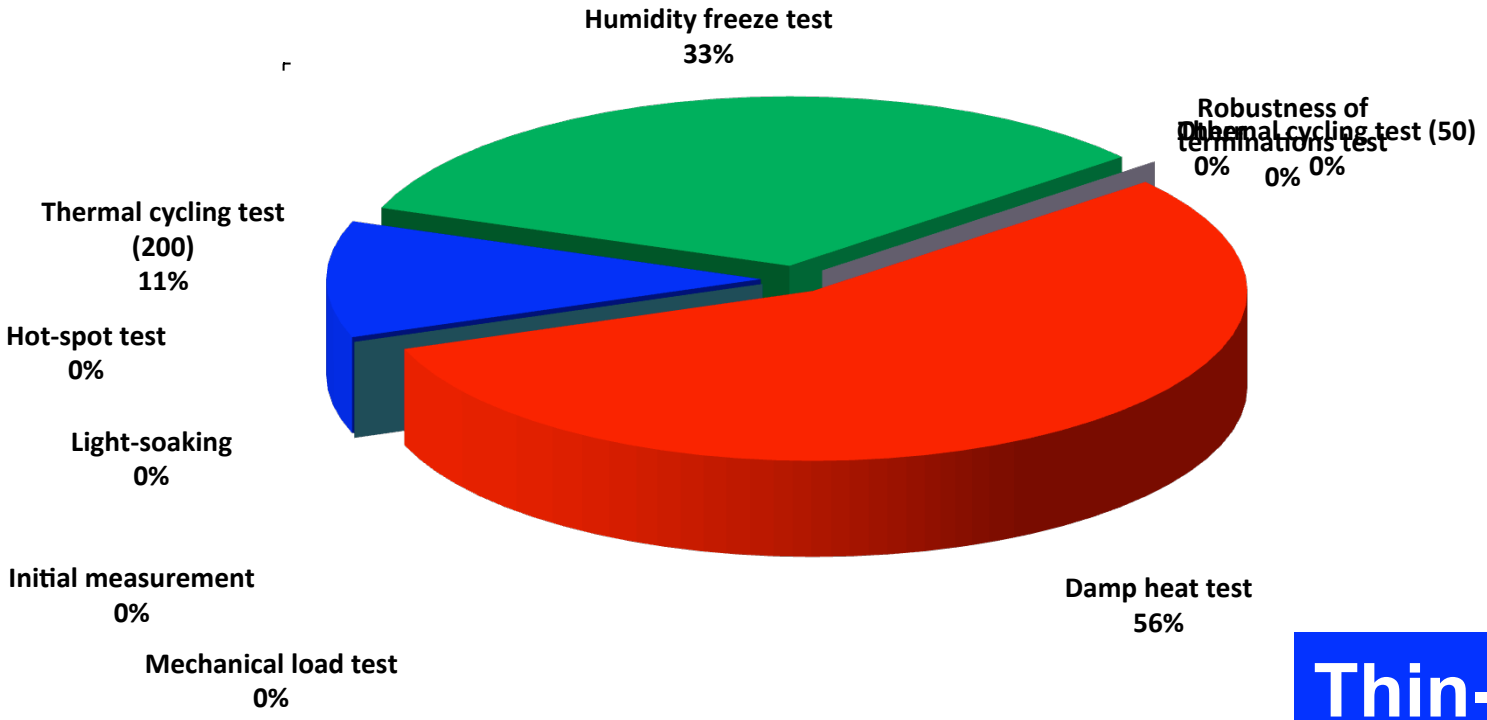
Lab 3: Failure Distribution (Total failures = 9)

Lab 3: Distribution of test failures for thin-film PV modules 2011-2012 (IEC 1646 only)



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Top 3 Failure Distribution (2011-2012): Damp heat; humidity freeze; thermal cycling

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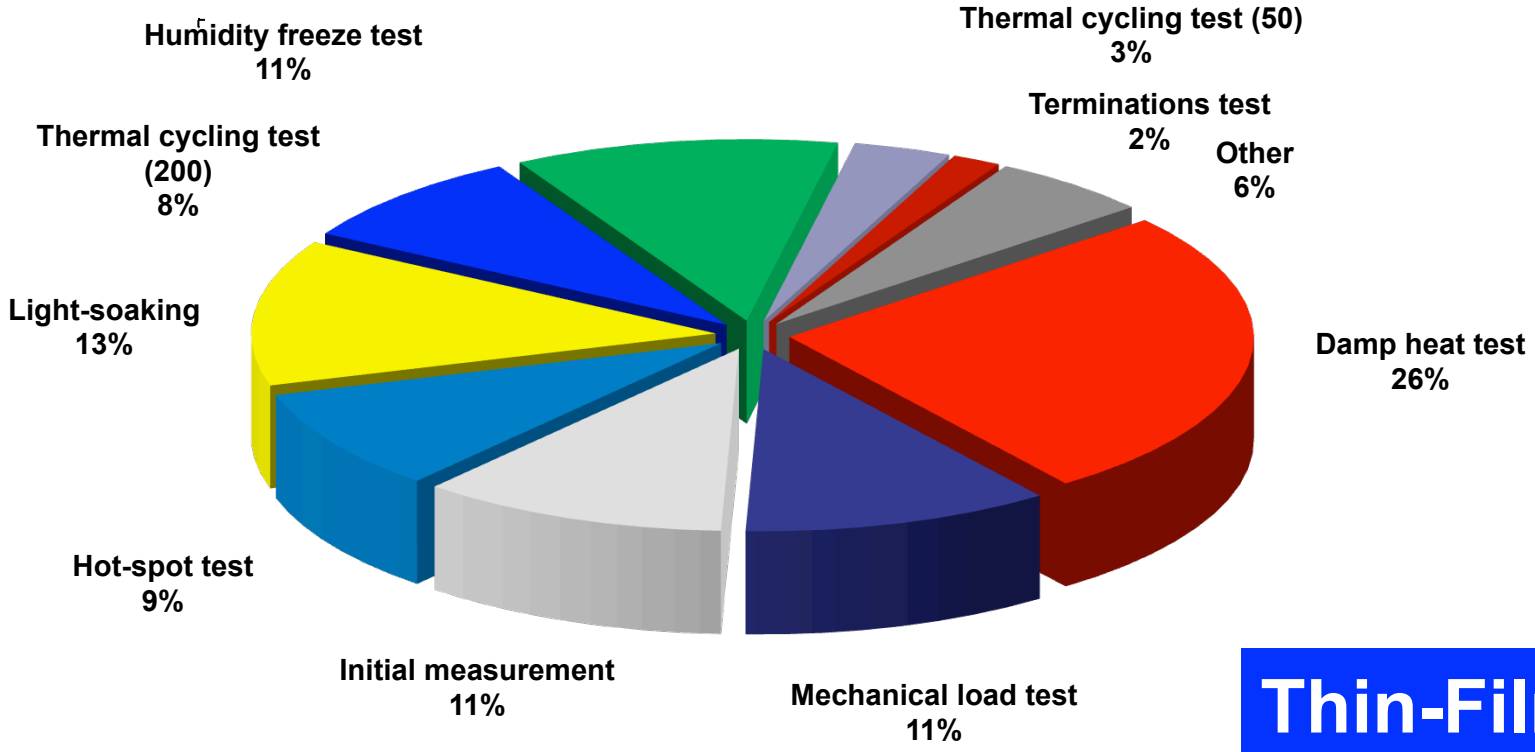
Global Labs: Failure Distribution (Total failures = 177)

Global Labs: Distribution of test failures for thin-film PV modules (IEC 1646 only)



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Top 3 Failure Distribution (Global):
Damp heat; light soaking; humidity freeze/mechanical load

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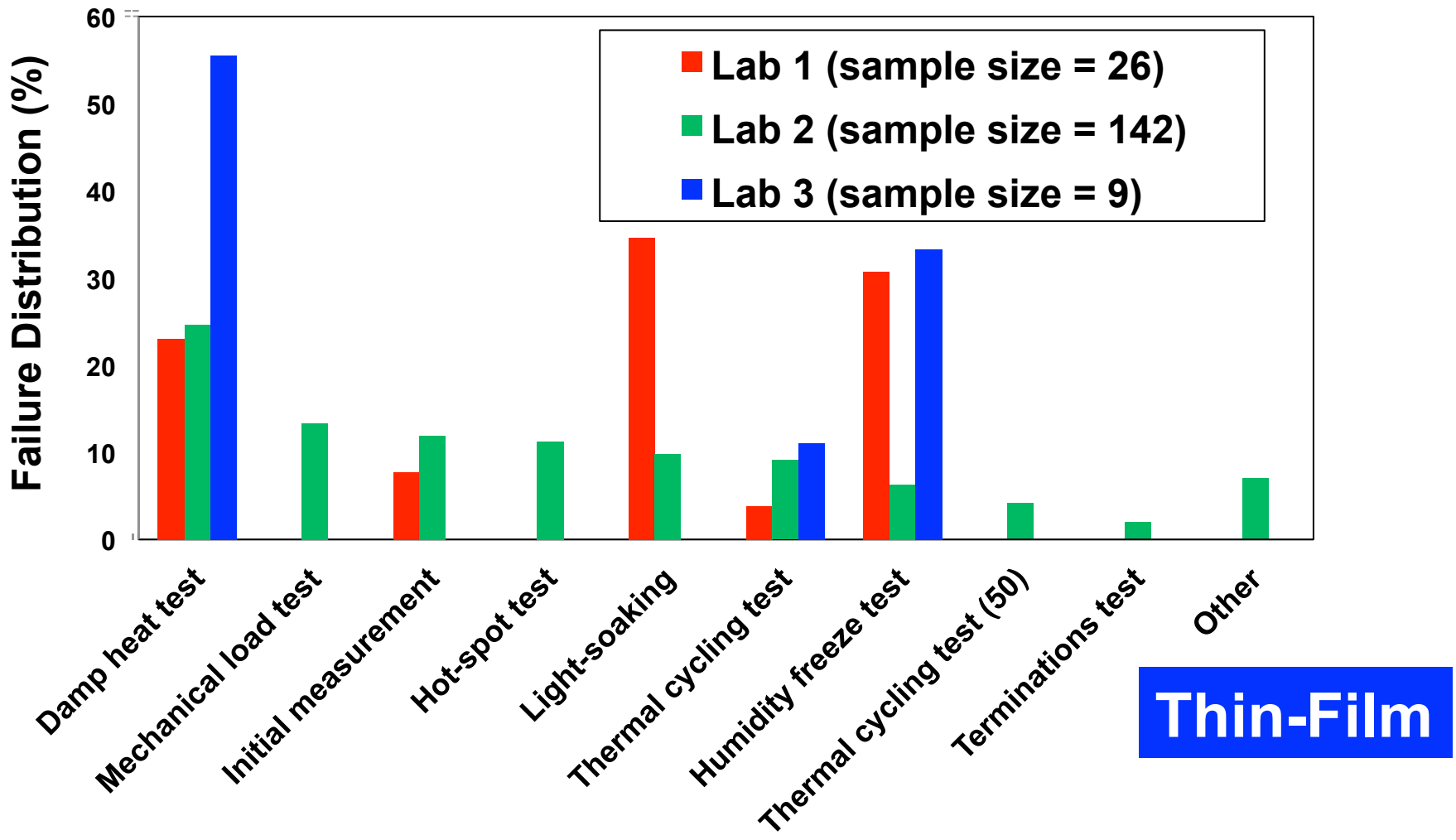
Higher Failure Distribution Variability Between Labs: Attributed to Large Design Variability and Limited Sample Size



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Conclusions: Thin-Film PV Modules

- Failure rates in the accelerated qualification tests have overall decreased in 2009-2011 period as compared to the previous periods of 1997-2005, 2005-2007 and 2007-2009.
- Failure rates (2009-2011) between the accelerated qualification tests range between 0% and 22% depending on the test type. This implies that the failure rate in the actual field conditions could be significantly influenced by the site climatic condition.
- Top three failure rate tests (2009-2011) are humidity freeze, damp heat and light soaking.
- Global results indicate that the top three failure distribution tests are damp heat, light soaking and humidity freeze/mechanical load tests.
- Higher failure distribution variability between labs is attributed to large design variability and limited sample size