12–18 Year-Old PV Power Plants in Arizona:

Potential Induced Degradation Analysis of 1900 Individual Modules

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Dedicated To

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Outline

PID

- **Evaluated Systems: An overview**
- **Question:** ***Is the PID mechanism responsible for PV module degradation in hot-dry climatic conditions?***

- **Fielded Systems Test Data**
  - ***1900 modules tested individually***
  - ***3-23 modules per string***
  - ***Six different models/manufacturers***
  - ***12-18 years old***

- **Accelerated Indoor Test Data**
  - ***Three different models/manufacturers***
  - ***+ Bias (fresh, TC200 and DH1000 stressed samples)***
  - ***- Bias (fresh, TC200 and DH1000 stressed samples)***
  - ***+ Regeneration Bias (fresh, TC200 and DH1000 samples)***
- **Conclusions**

Evaluated Systems

Fielded Systems: Location (Tempe, Arizona)

Hot-Dry Climate, + Biased Systems

Fielded Systems: Module Designation

Fielded Systems: Details

Model Designation and Module Count								
Array	Model A18	Model A13	Model B	Model C12	Model C4	Model D	Model E	Model F
Size	9 kW	11.6 kW	81.9 kW	51.3 kW	51.3 kW	12 kW	8.8 kW	14.4 kW
#Modules (1-axis)	168		1155	176	40	48	50	120
#Modules (33°Lat.Tilt)		216	-		-	-	-	-
#Modules (String)	3	21	21	8	8	8	12	23
String Voltage (Voc)	65	455	455	505	505	485	532	483
Years Fielded	18	13.3	13.3	11.7	3-4	11.7	11.7	11.7

Replaced Modules

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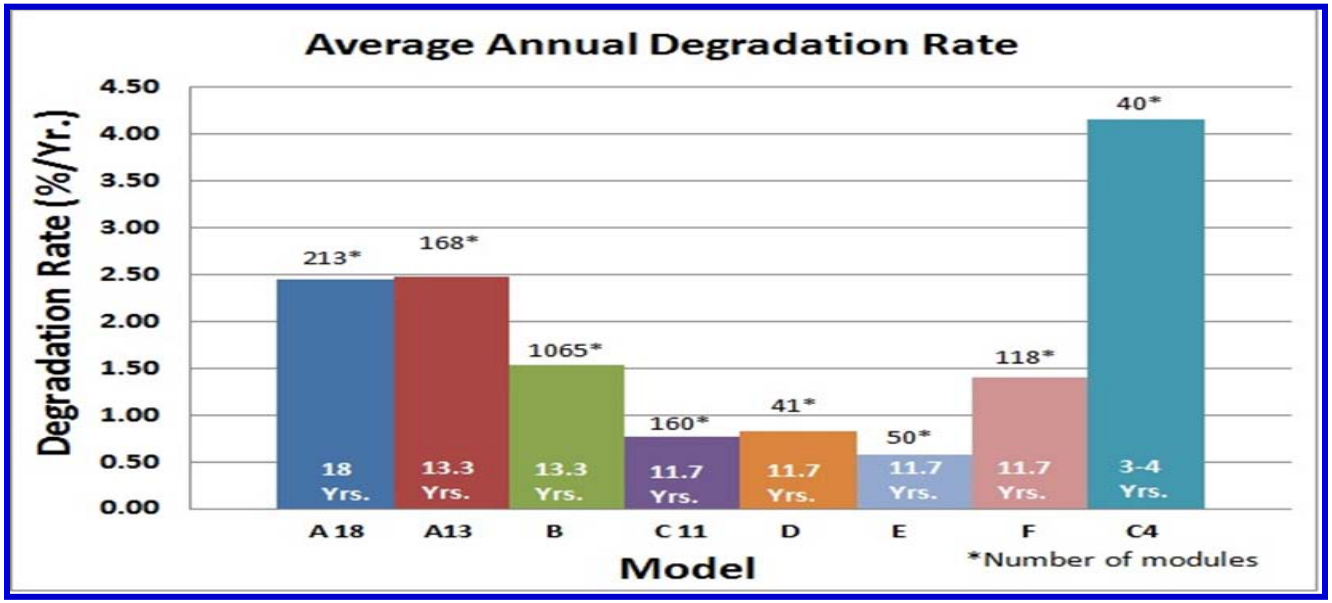
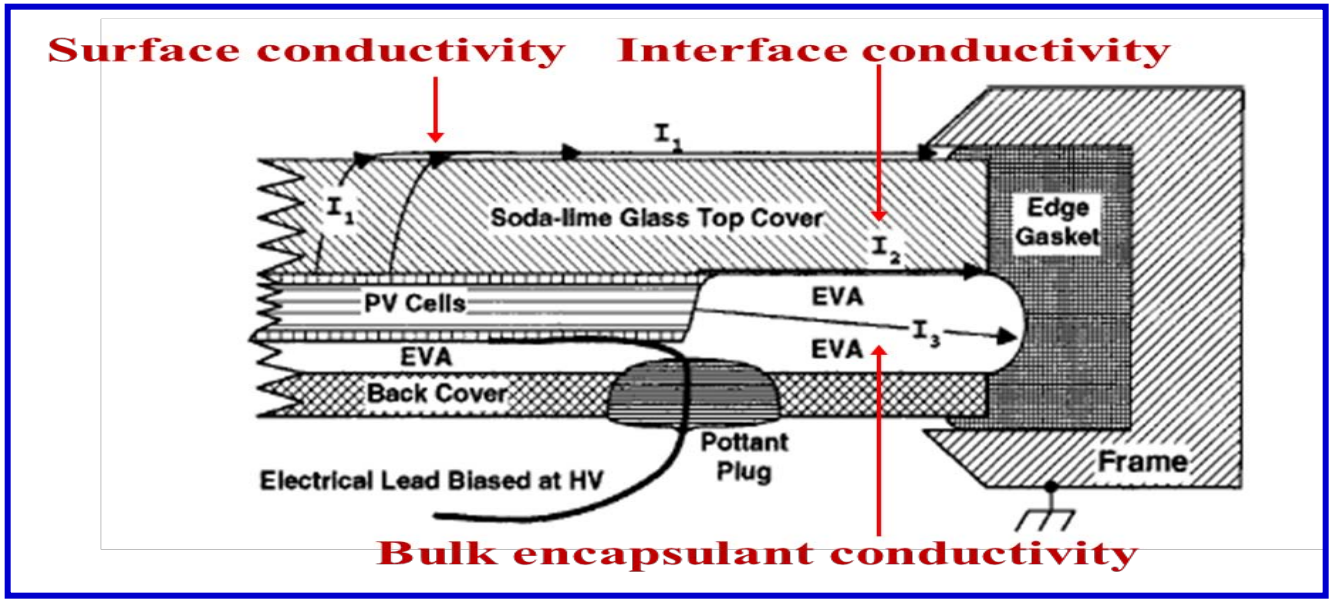
Question

Question



Hot-Dry Climate

Is PID mechanism responsible for the degradation in hot-dry climates?



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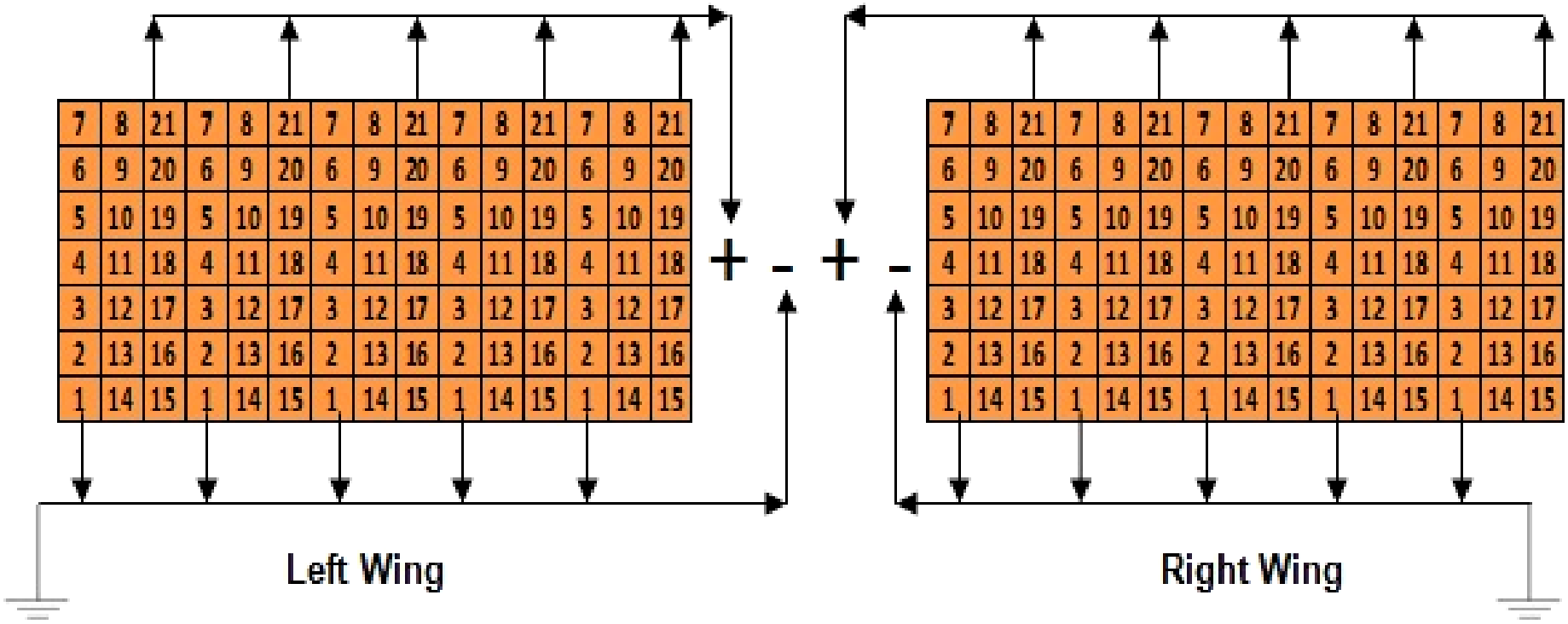
Fielded Systems Test Data

Model B

1-Axis Tracker



- 21 modules in a series string
- 55 strings total

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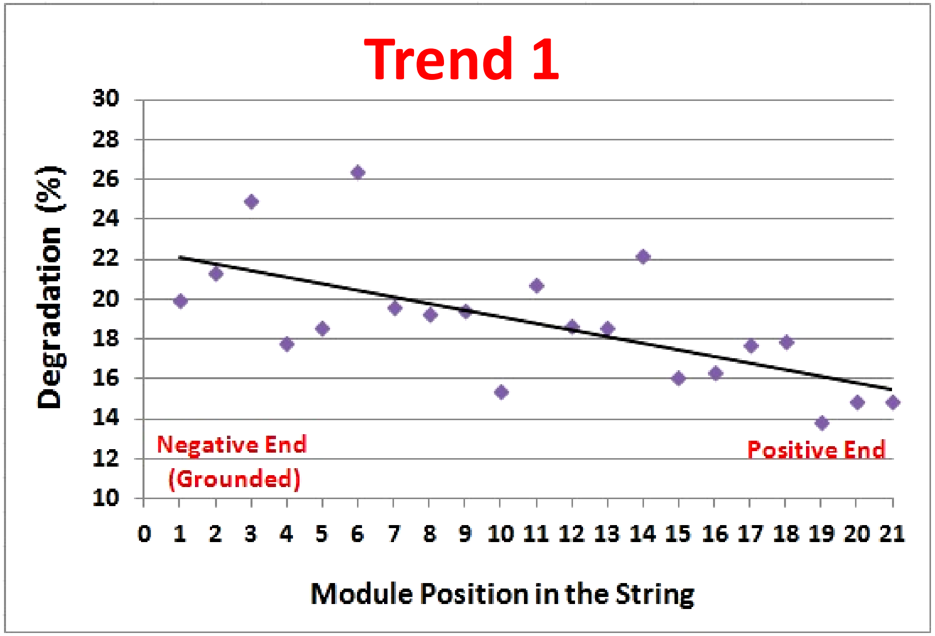
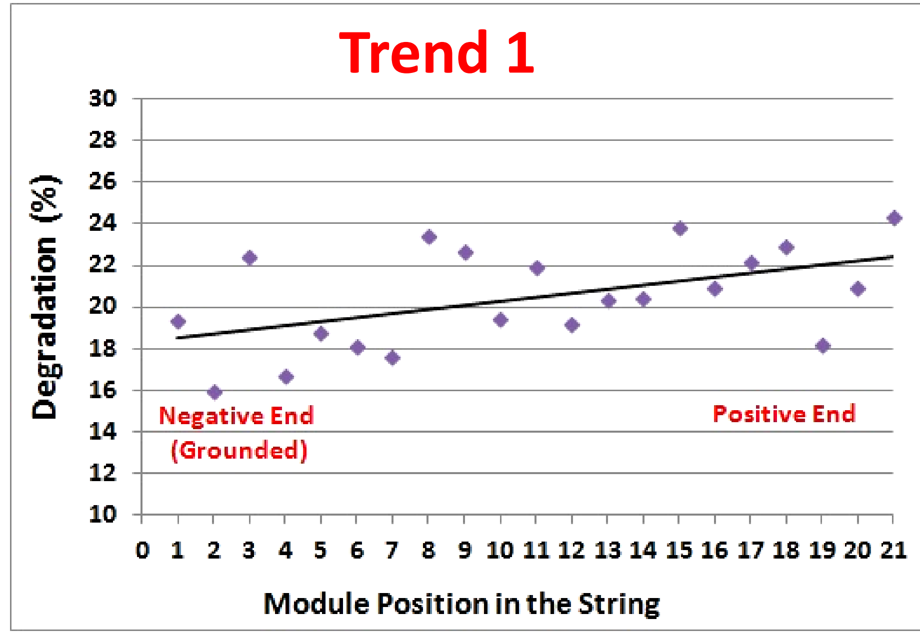
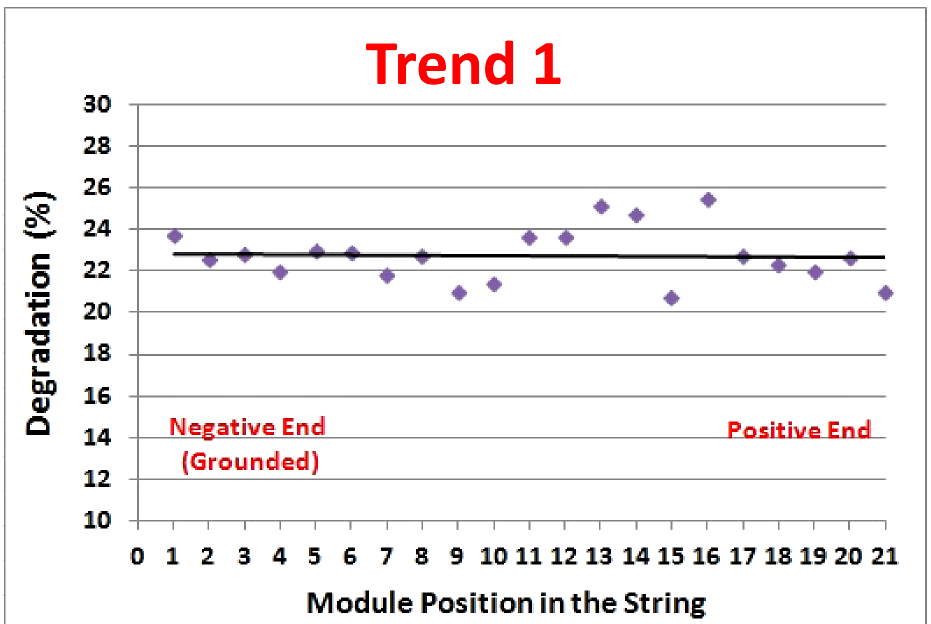
Model B







Overall: No Specific Trend

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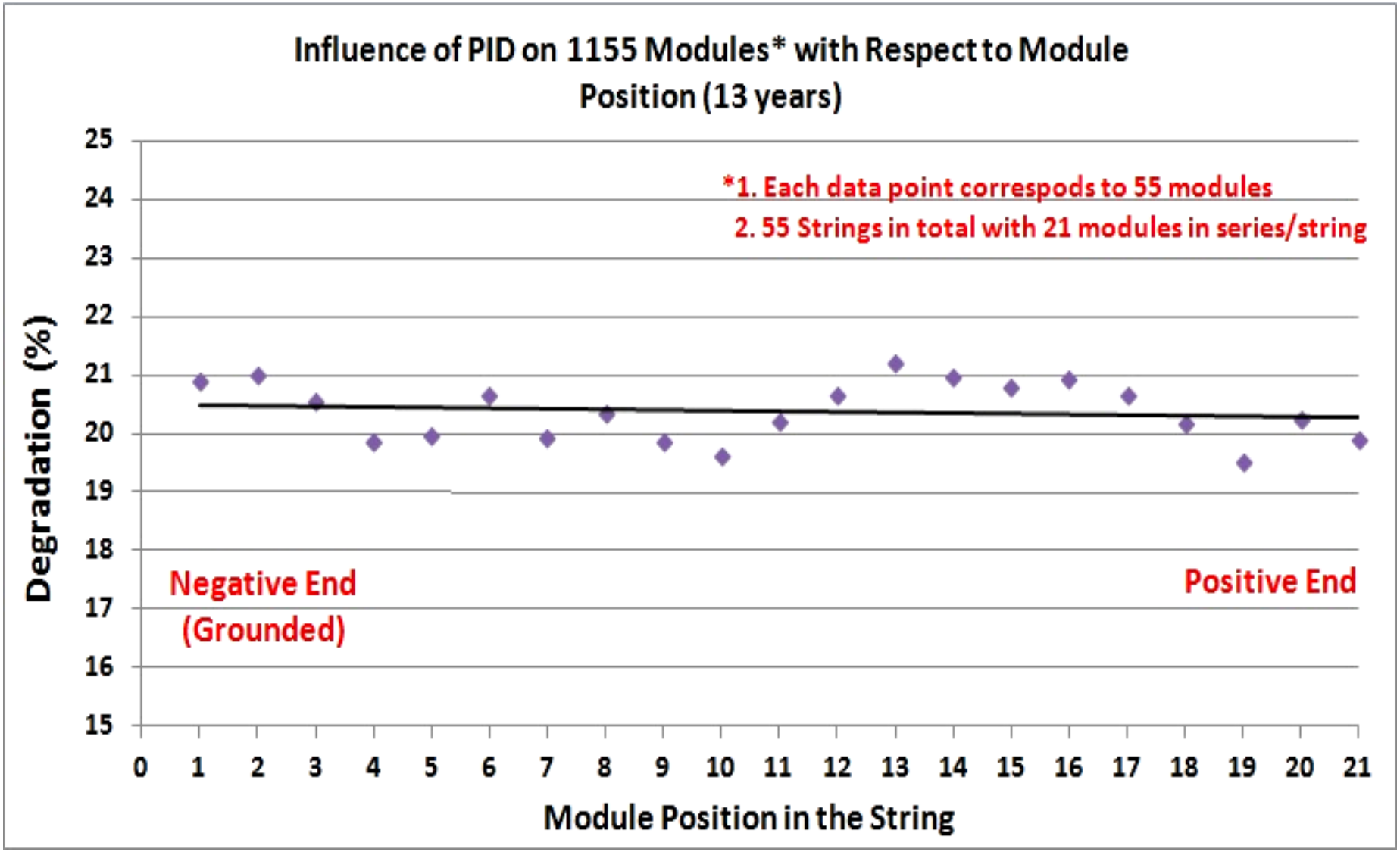
Model B

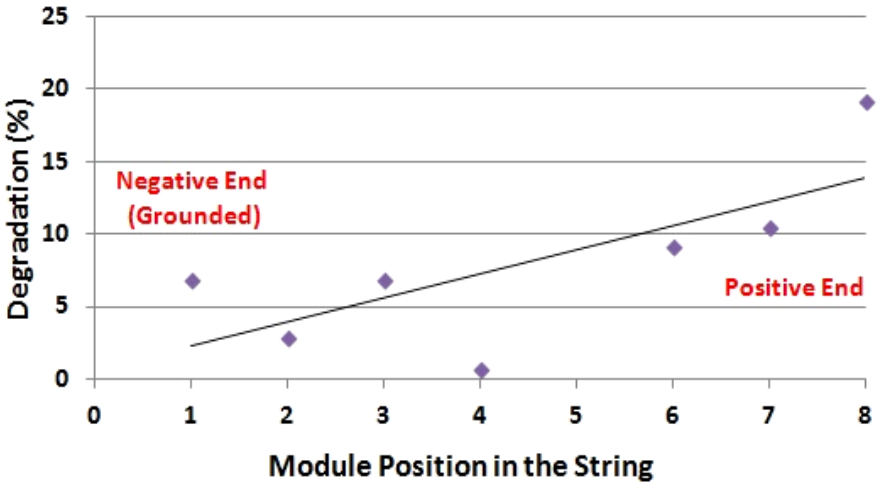
Overall: No Specific Trend

PID Mechanism Does not Seem to Be Responsible for Degradation

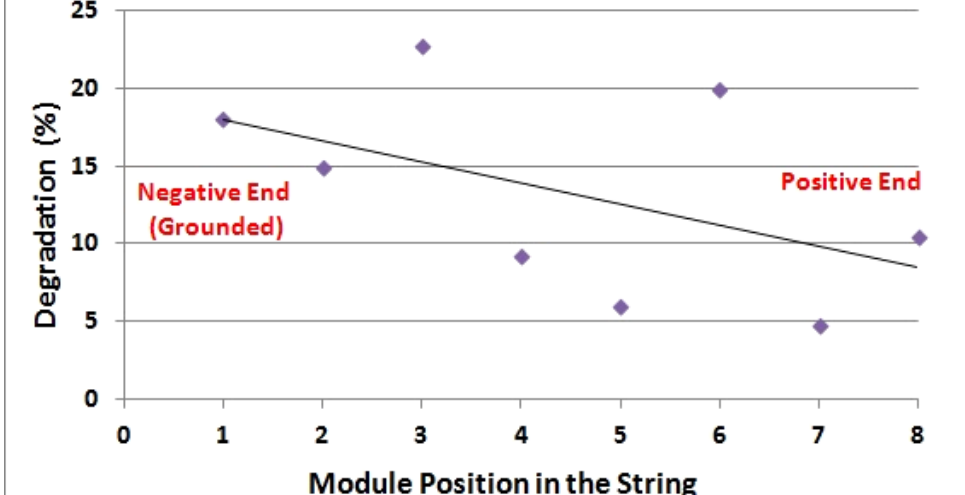


Model C

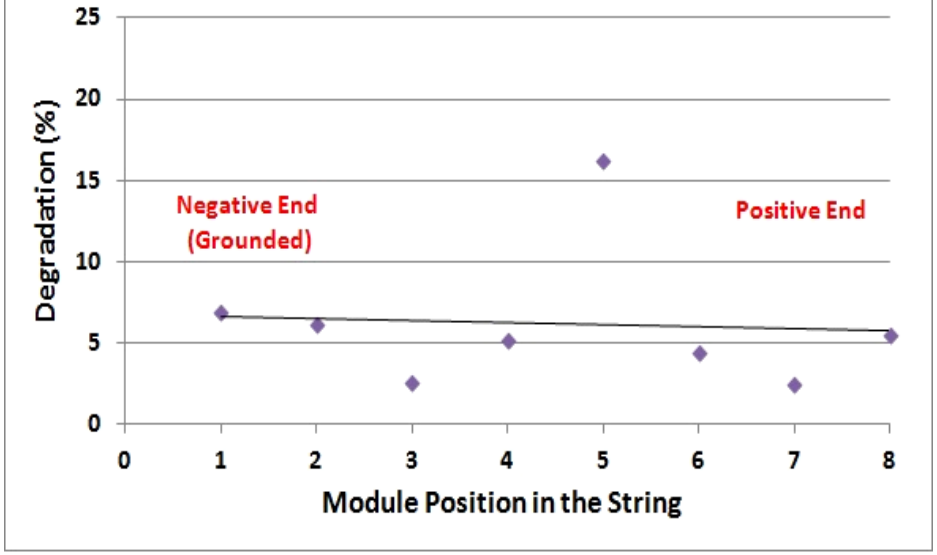
Trend 1



Trend 2



Trend 3

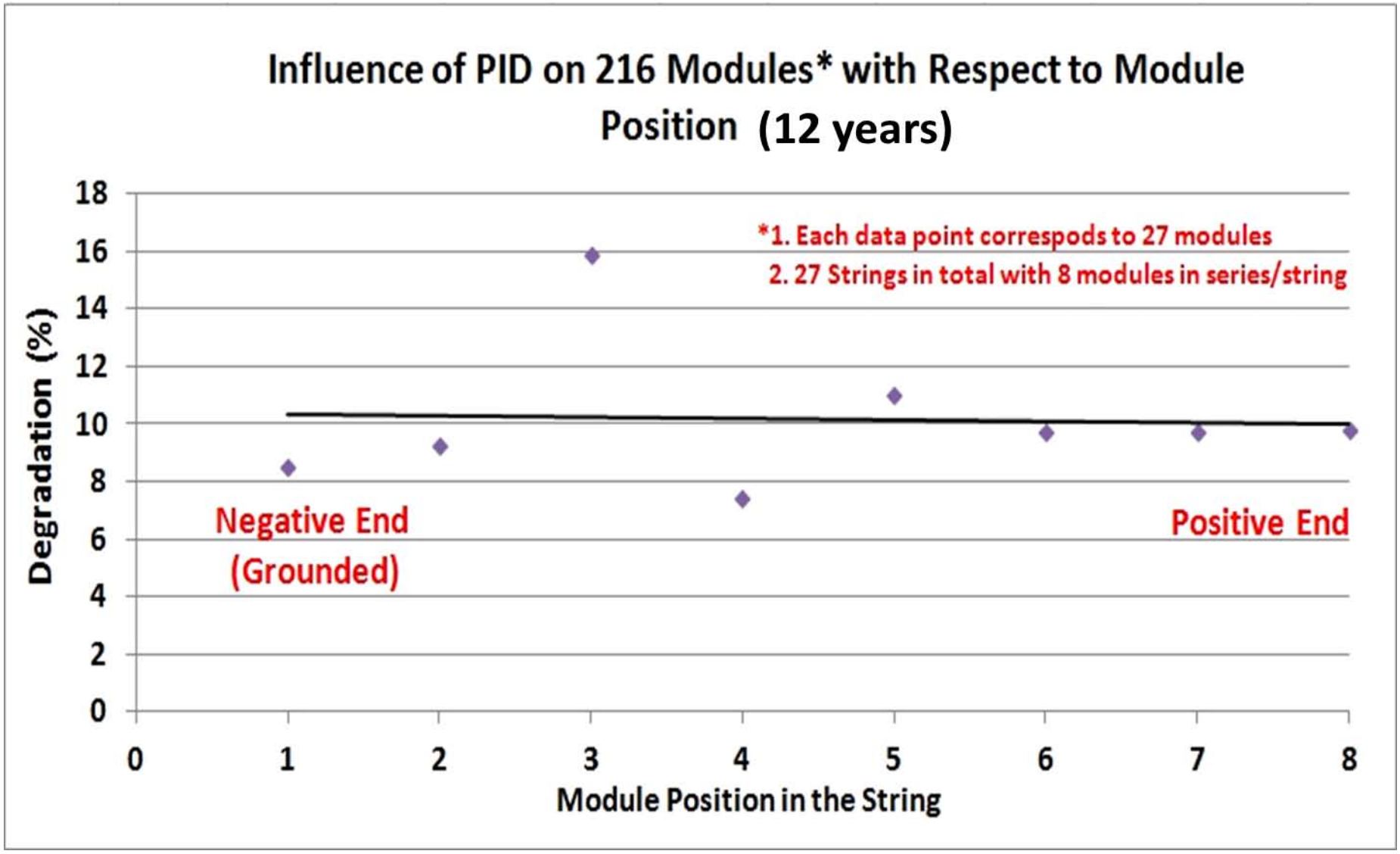


Overall: No Specific Trend

Model C

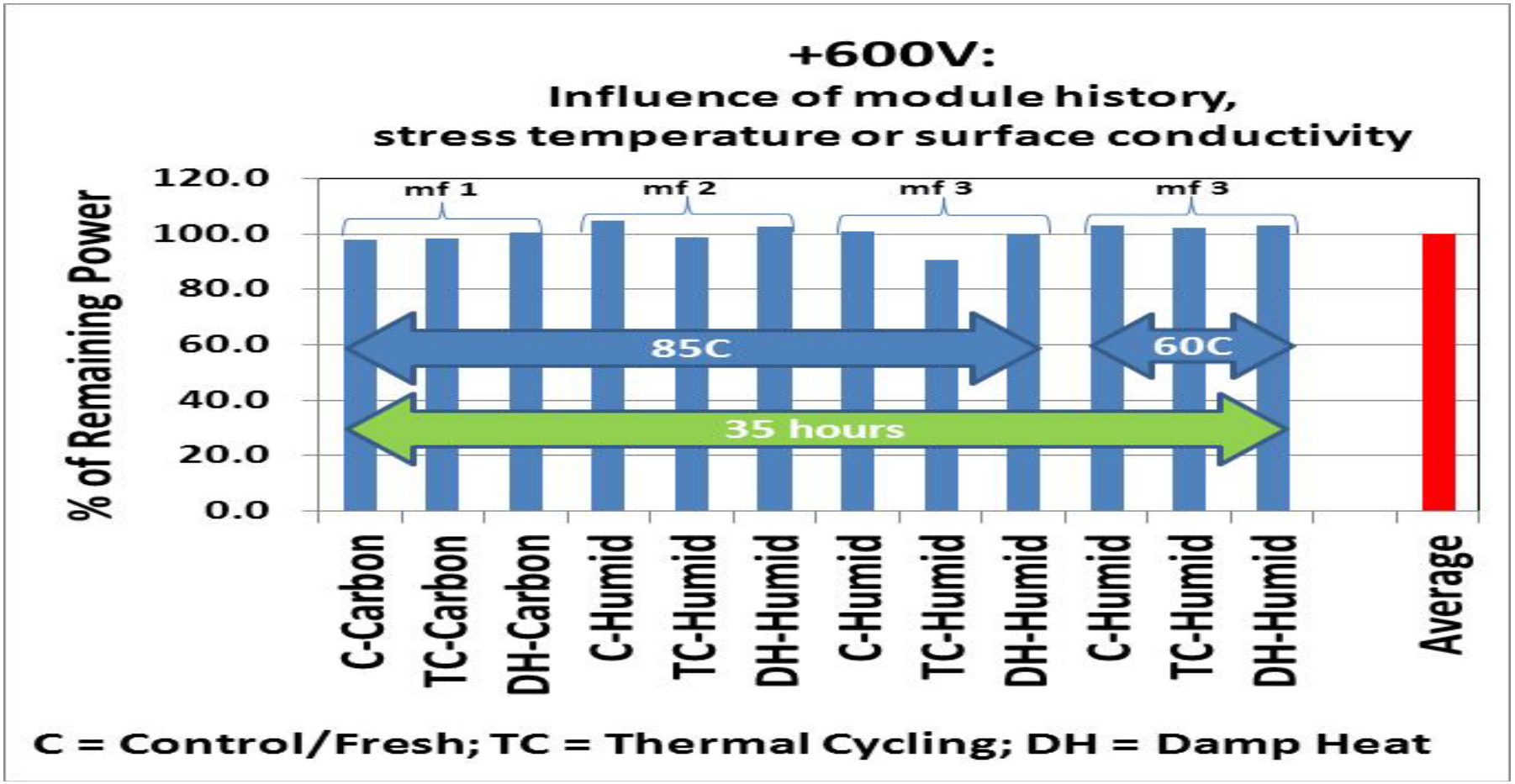
Overall: No Specific Trend

PID Mechanism Does not Seem to Be Responsible for Degradation



Accelerated Indoor Test Data

Bias: + 600V



+ Bias: Does not seem to affect the performance irrespective of pre-history (fresh, TC or DH) and surface conductivity (conductive carbon or humidity) of the modules. It is consistent with fielded systems test data.

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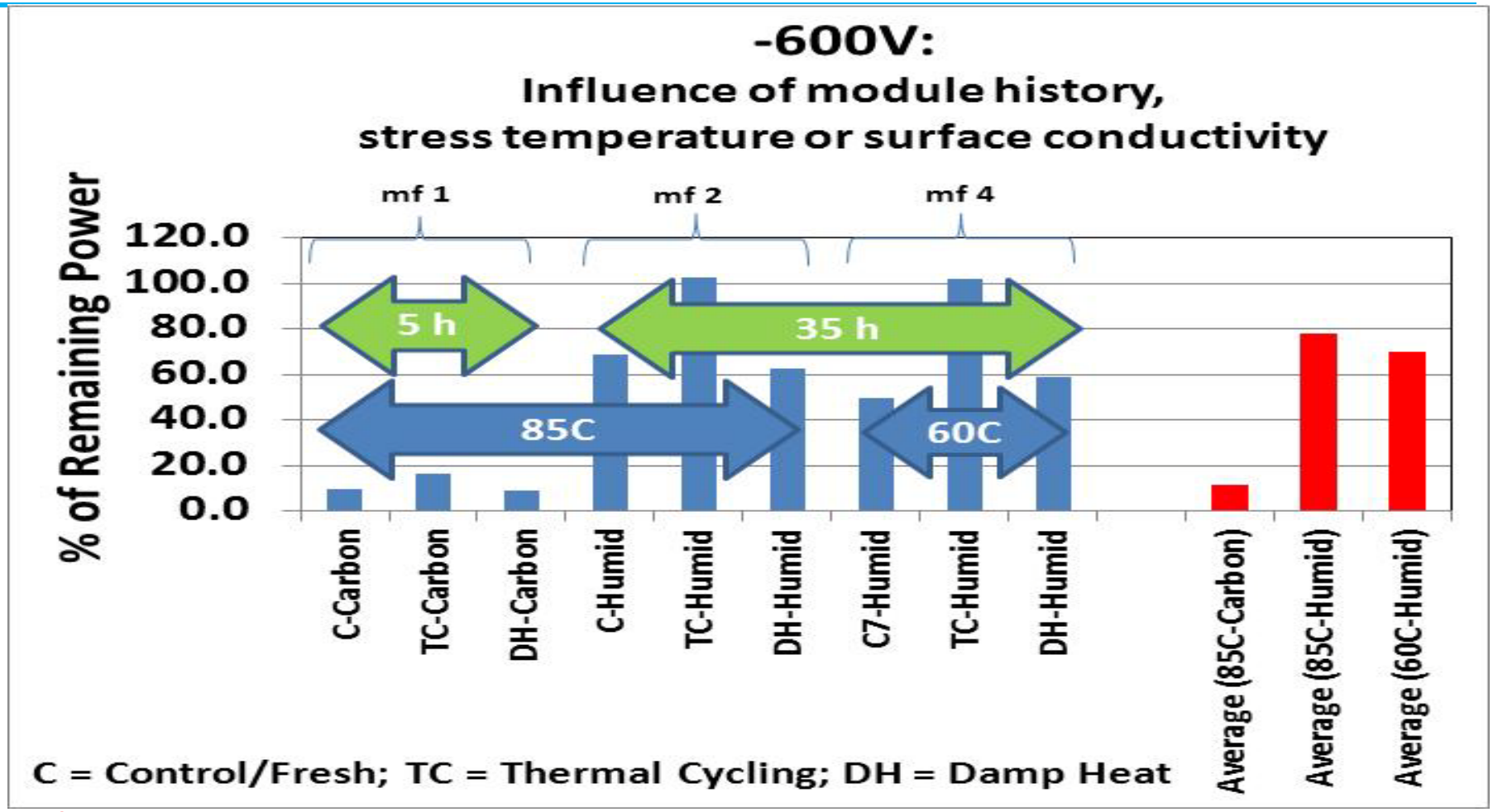
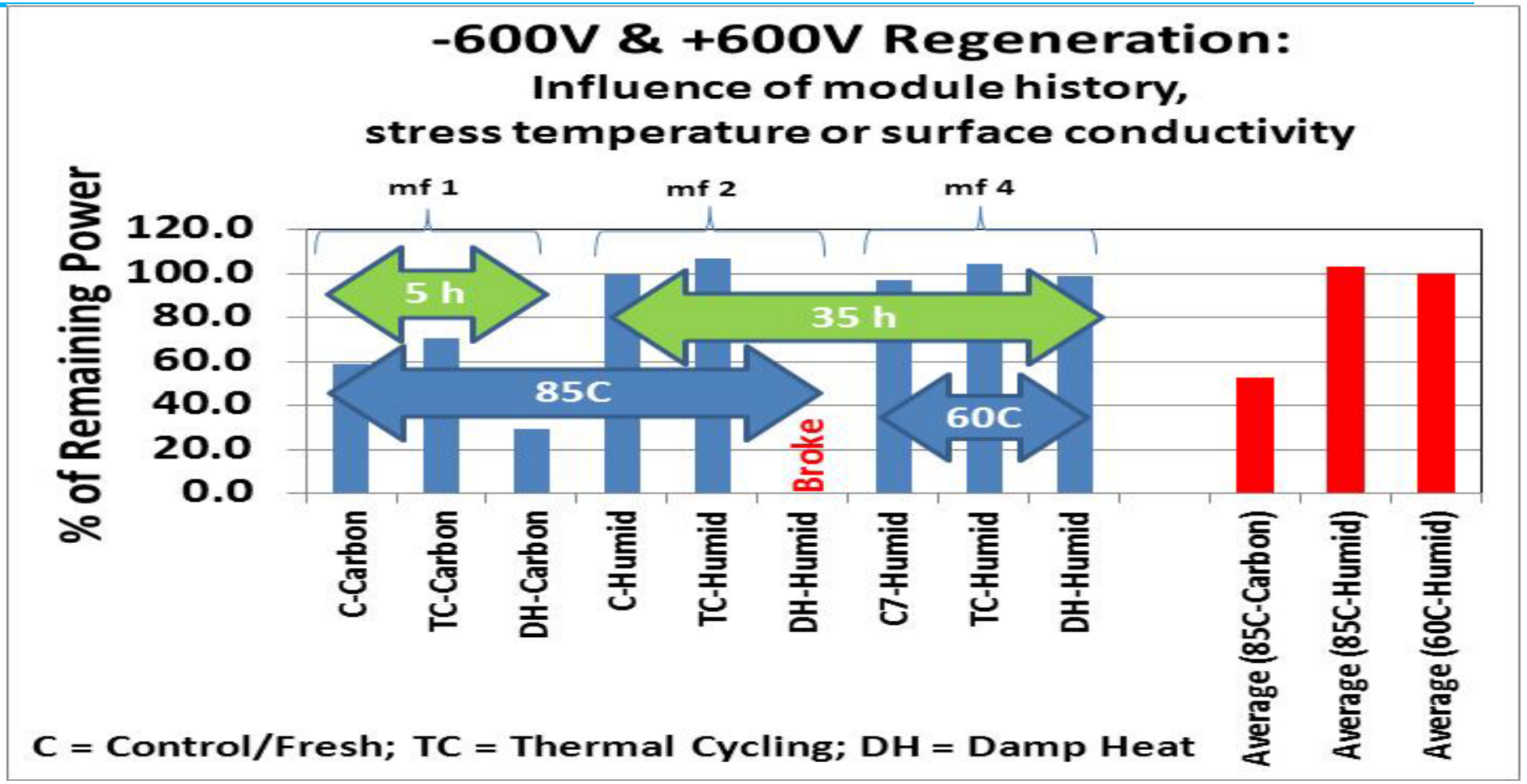
Bias: -600V



- Bias: Seems the performance degradation depends on the pre-history (fresh, TC or DH) and surface conductivity (conductive carbon or humidity) of the modules. The TC stressed module does not degrade under low surface conductivity (TC-Humid) as compared to fresh and DH stressed modules (similar to hot-dry climatic conditions of Phoenix, AZ?).

Bias: -600V & +600V Regeneration



+ Regeneration Bias: Original power is fully (if humidity) or partly (if conductive carbon) recovered depending the surface conductivity.

The DH stressed module with conductive carbon film recovered only very little as compared to fresh and TC stressed modules.

Conclusions

Conclusions

- **Fielded Systems Test Data**
  - **+ Bias:** Modules degrade at 0.6-2.5% per year but the PID does not seem to be responsible for the degradation of negative grounded systems in the hot-dry climatic condition of Phoenix, Arizona

- **Accelerated Indoor Test Data**
  - **+ Bias:** Does not seem to affect the performance irrespective of pre-history (fresh, TC or DH) and surface conductivity (conductive carbon or humidity) of the modules. It is consistent with fielded systems test data.
  - **- Bias:** Seems the performance degradation depends on the pre-history (fresh, TC or DH) and surface conductivity (conductive carbon or humidity) of the modules.
  - **+ Regeneration Bias:** Original power is fully (if humidity) or partly (if conductive carbon) recovered depending the surface conductivity.

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