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## Comparing Experimental Apples and Oranges with Quantile-Quantile Plots

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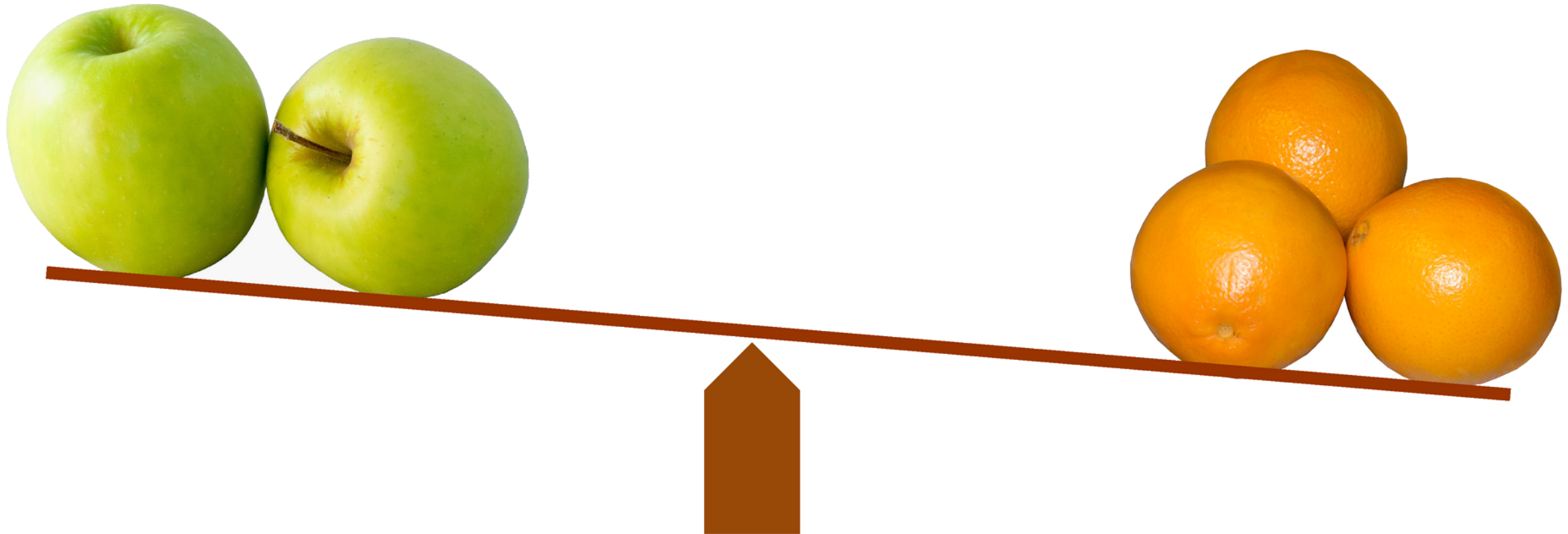
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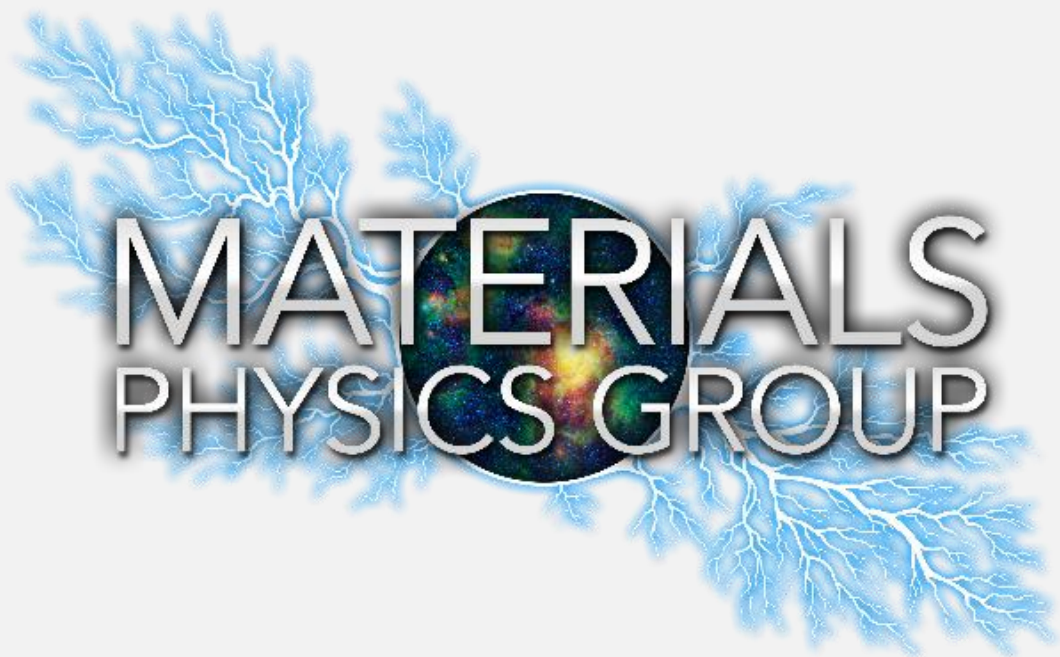


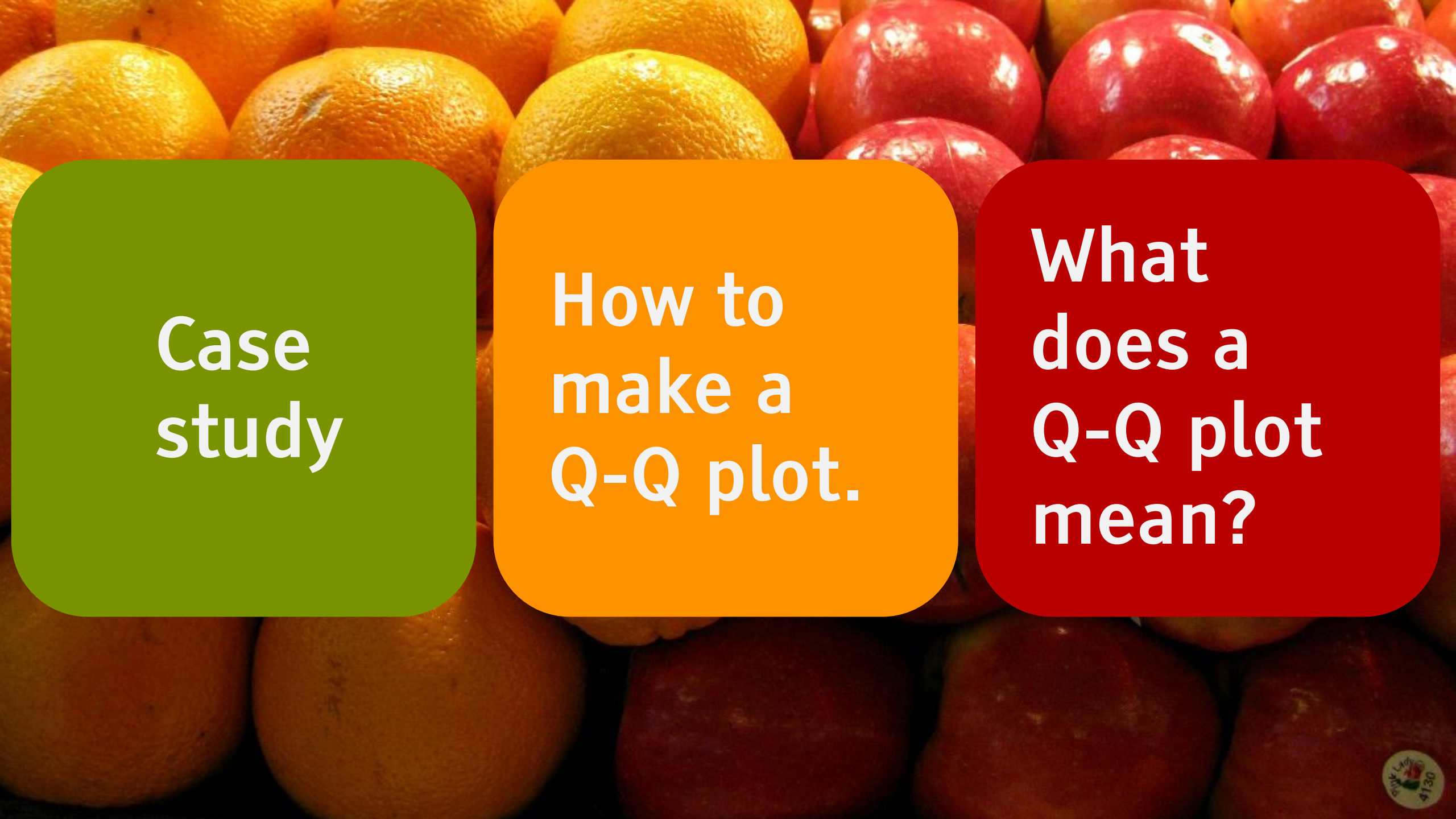
# Comparing Experimental Apples and Orange with Quantile-Quantile Plots





**UtahStateUniversity**  
DEPARTMENT OF PHYSICS



The background of the slide is a close-up photograph of a large quantity of fresh fruit, including bright orange oranges and vibrant red apples. The fruits are piled together, creating a textured and colorful backdrop. Three semi-transparent colored boxes (green, orange, and red) are overlaid on the image, each containing white text.

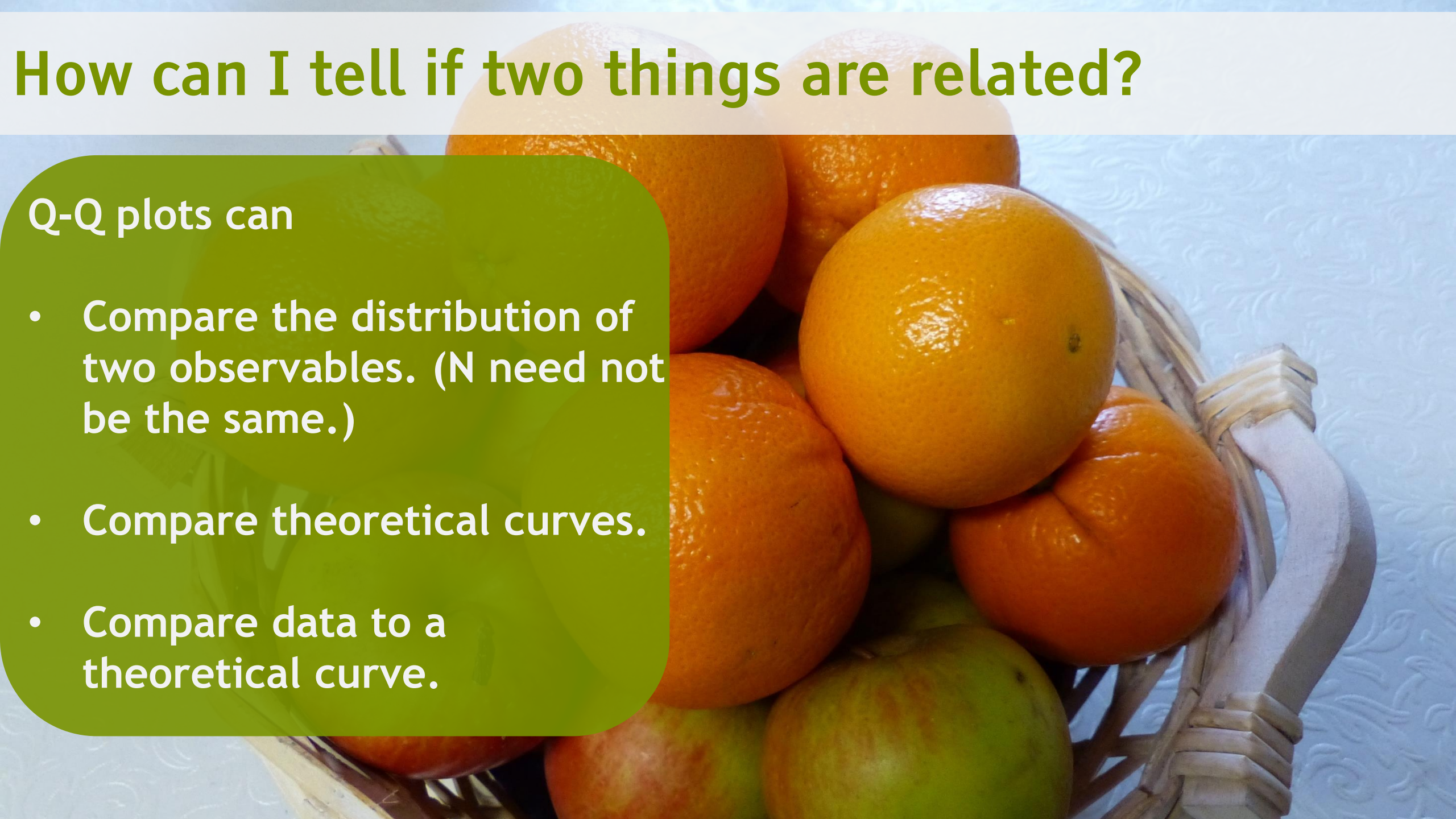
**Case  
study**

**How to  
make a  
Q-Q plot.**

**What  
does a  
Q-Q plot  
mean?**



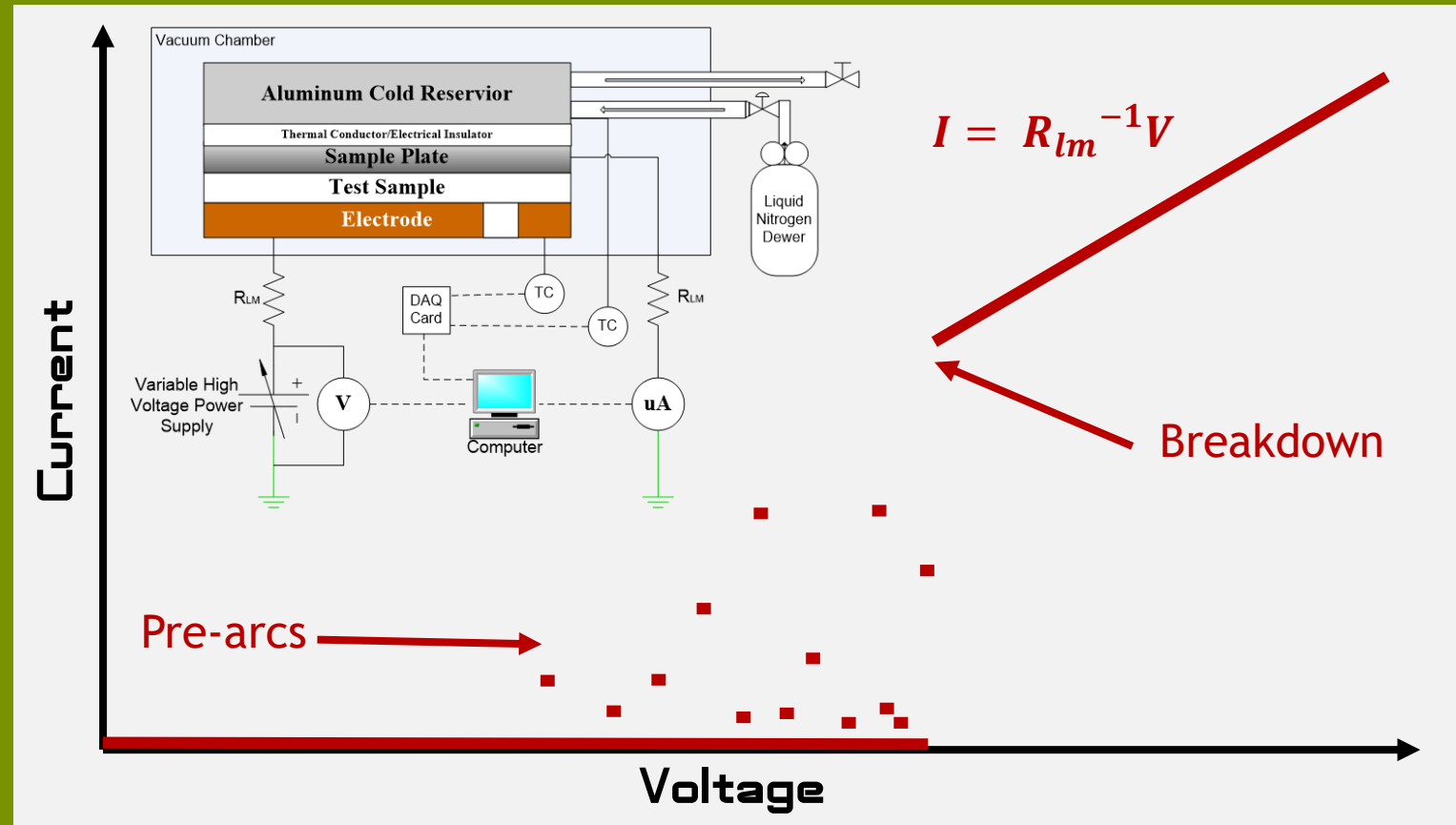
# How can I tell if two things are related?

A photograph of a woven basket filled with several oranges and a few green apples. The basket is set against a light blue background with a subtle, repeating floral or scrollwork pattern. The lighting is bright, highlighting the textures of the fruit and the basket.

Q-Q plots can

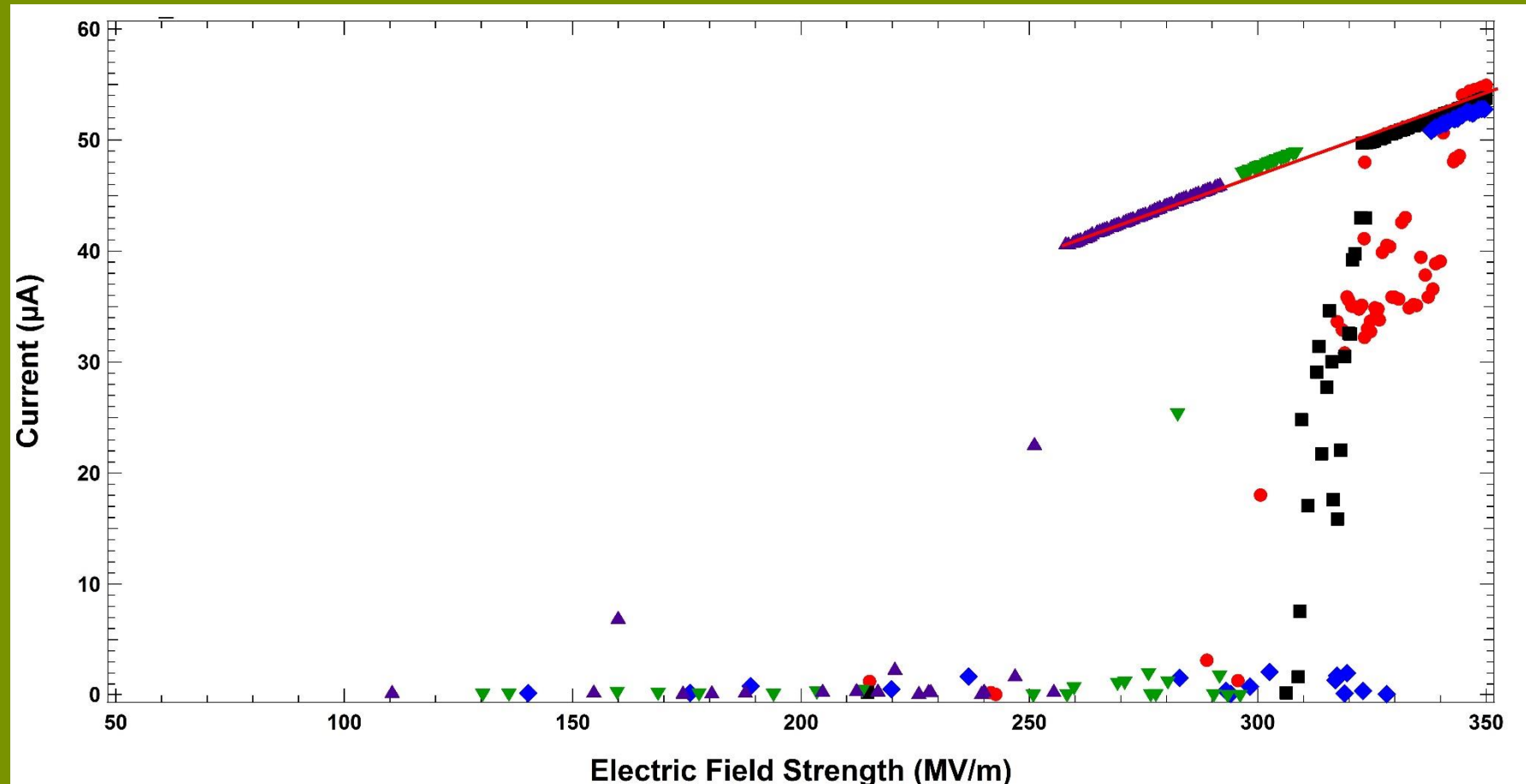
- Compare the distribution of two observables. (N need not be the same.)
- Compare theoretical curves.
- Compare data to a theoretical curve.

# Case Study: Dielectric Breakdown Testing



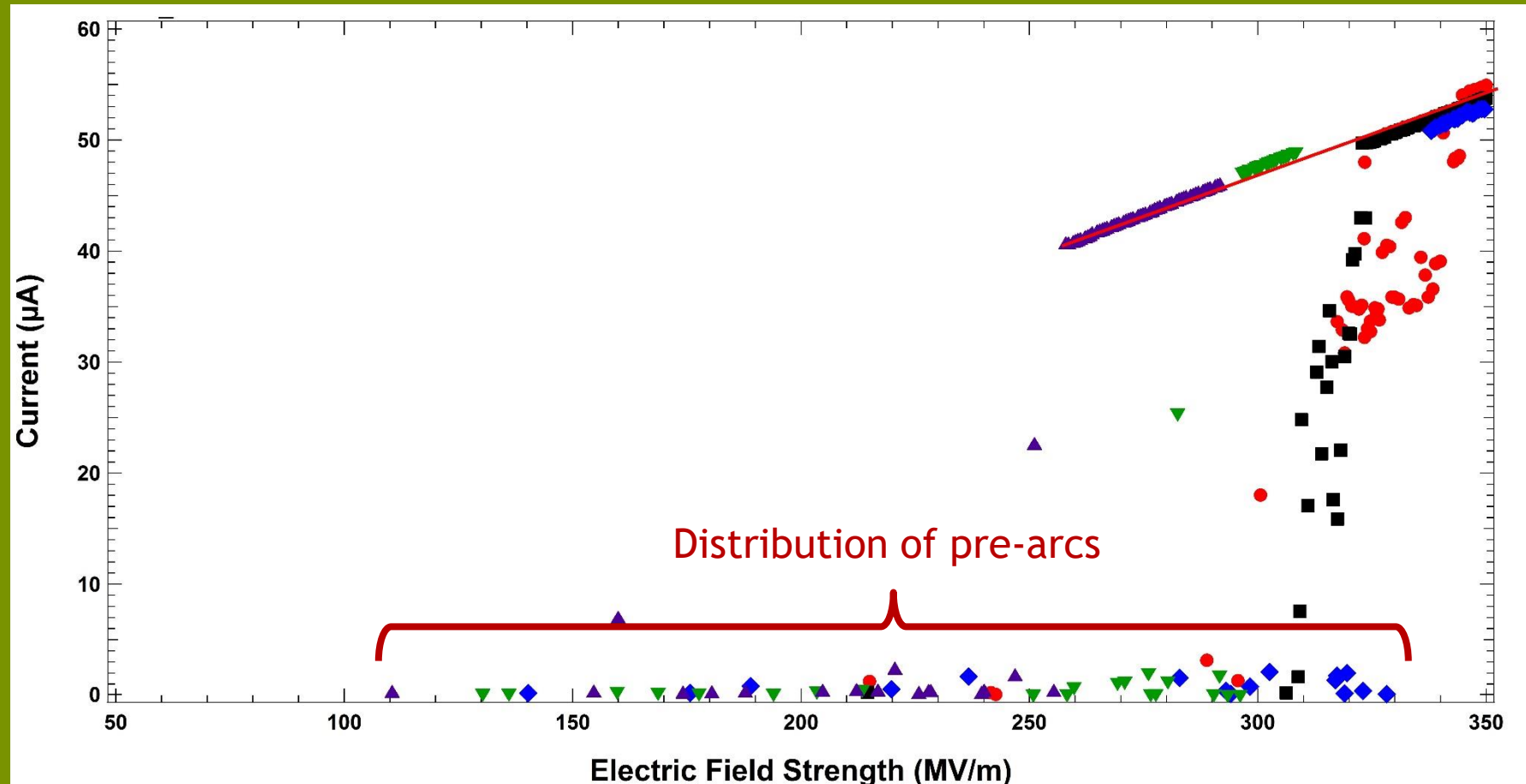
Voltage is increased across a dielectric sample in a parallel-plate capacitor and monitor the leakage current.

# Case Study: Dielectric Breakdown Testing



Plot of 5 voltage step-up to breakdown tests on LDPE.

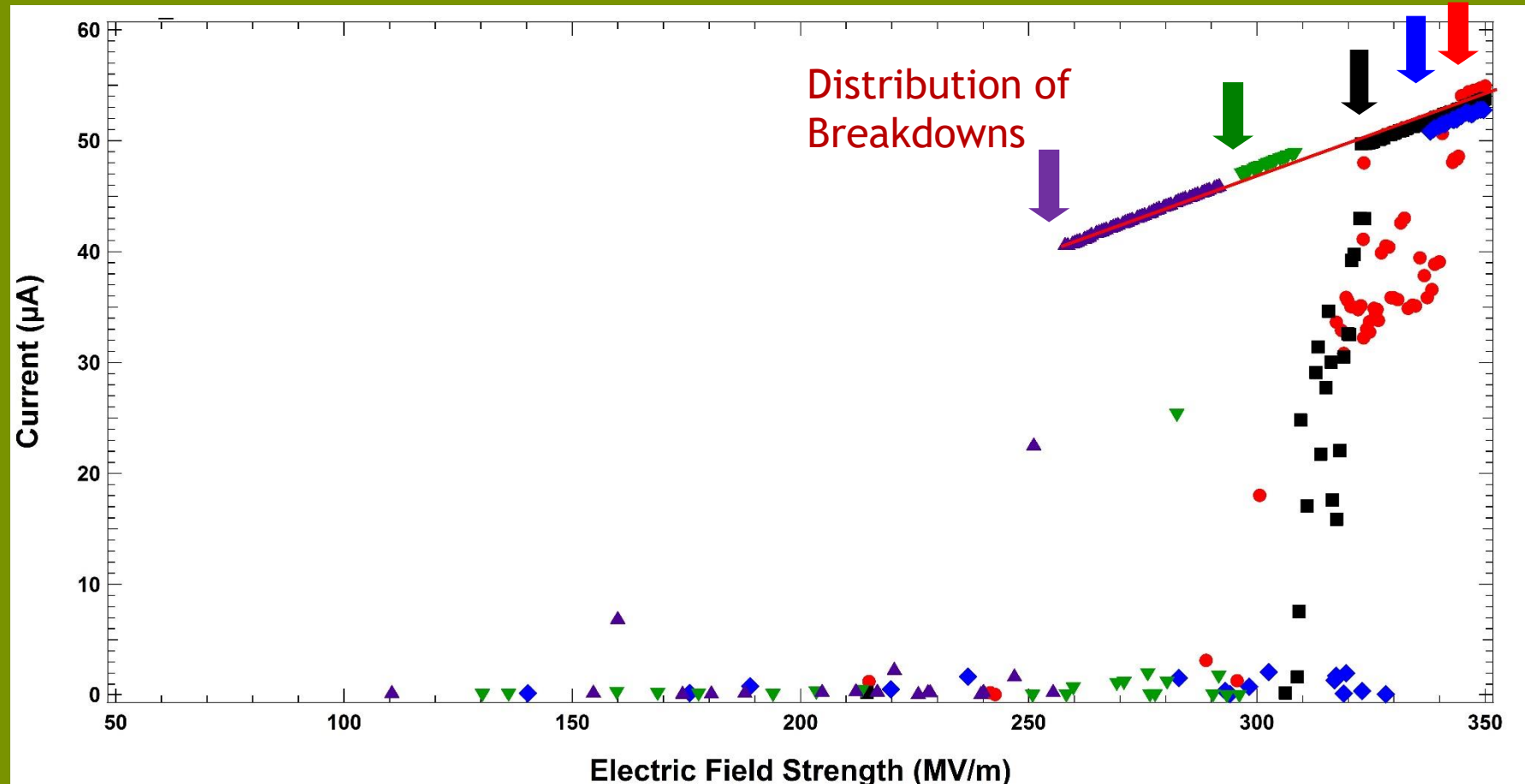
# Case Study: Dielectric Breakdown Testing



Plot of 5 voltage step-up to breakdown tests on LDPE.



# Case Study: Dielectric Breakdown Testing



Plot of 5 voltage step-up to breakdown tests on LDPE.

# Are pre-arcs related to the breakdowns?

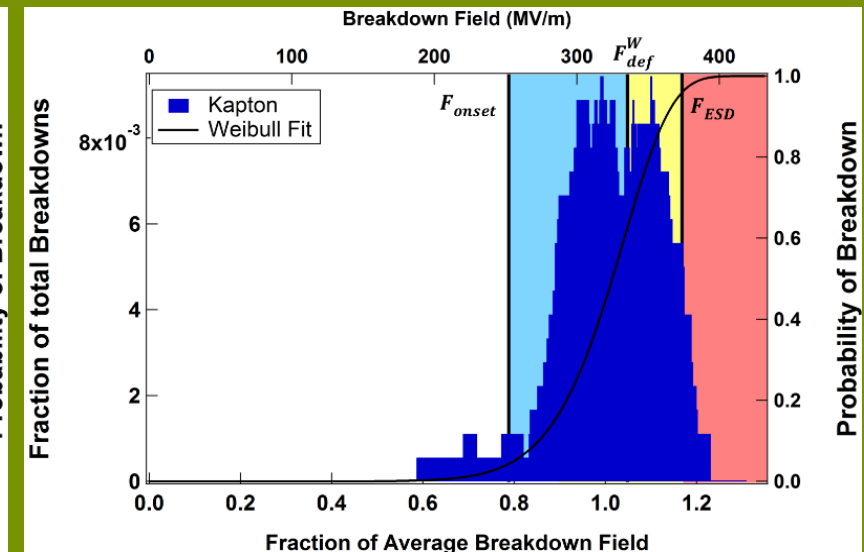
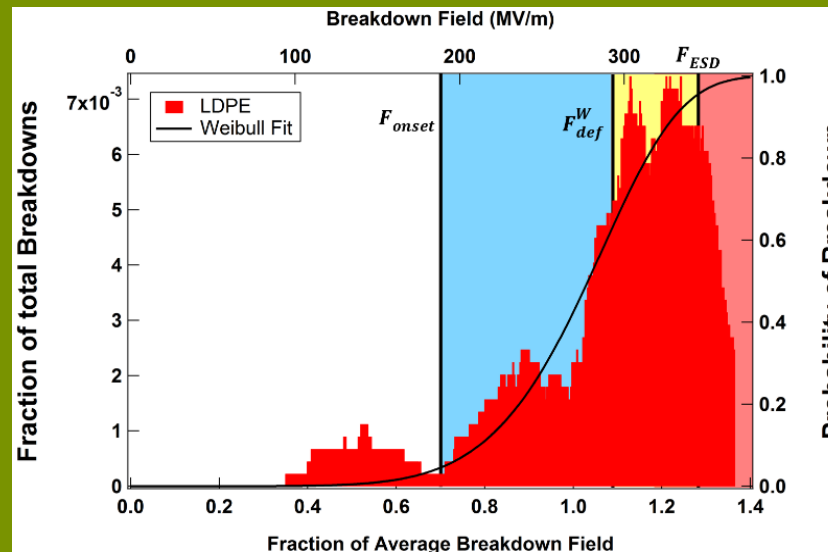
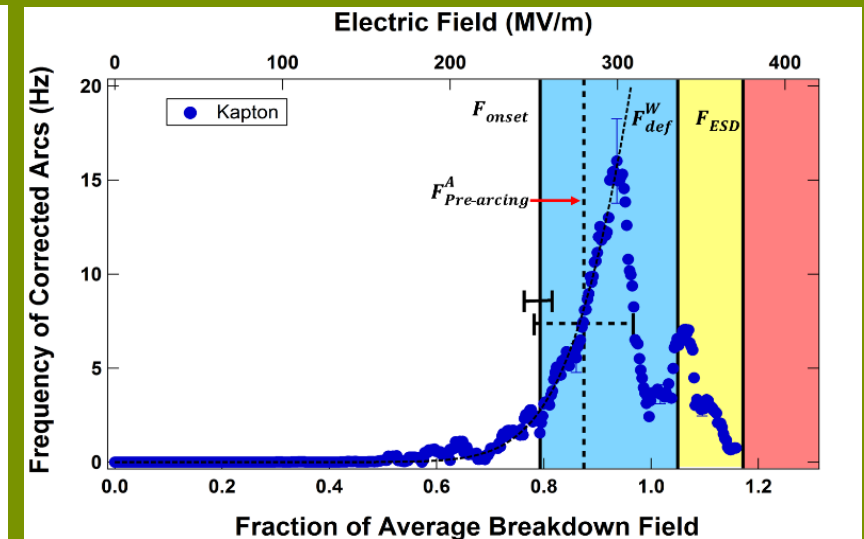
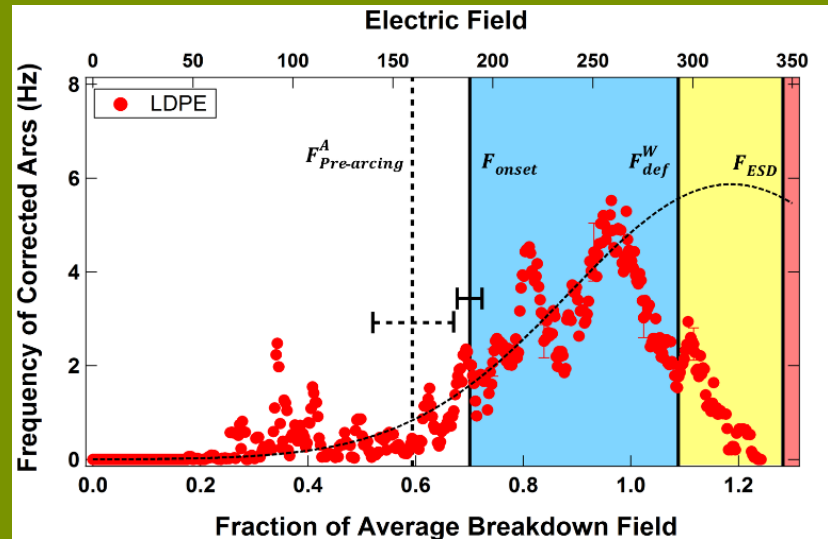
Pre-arcing distributions



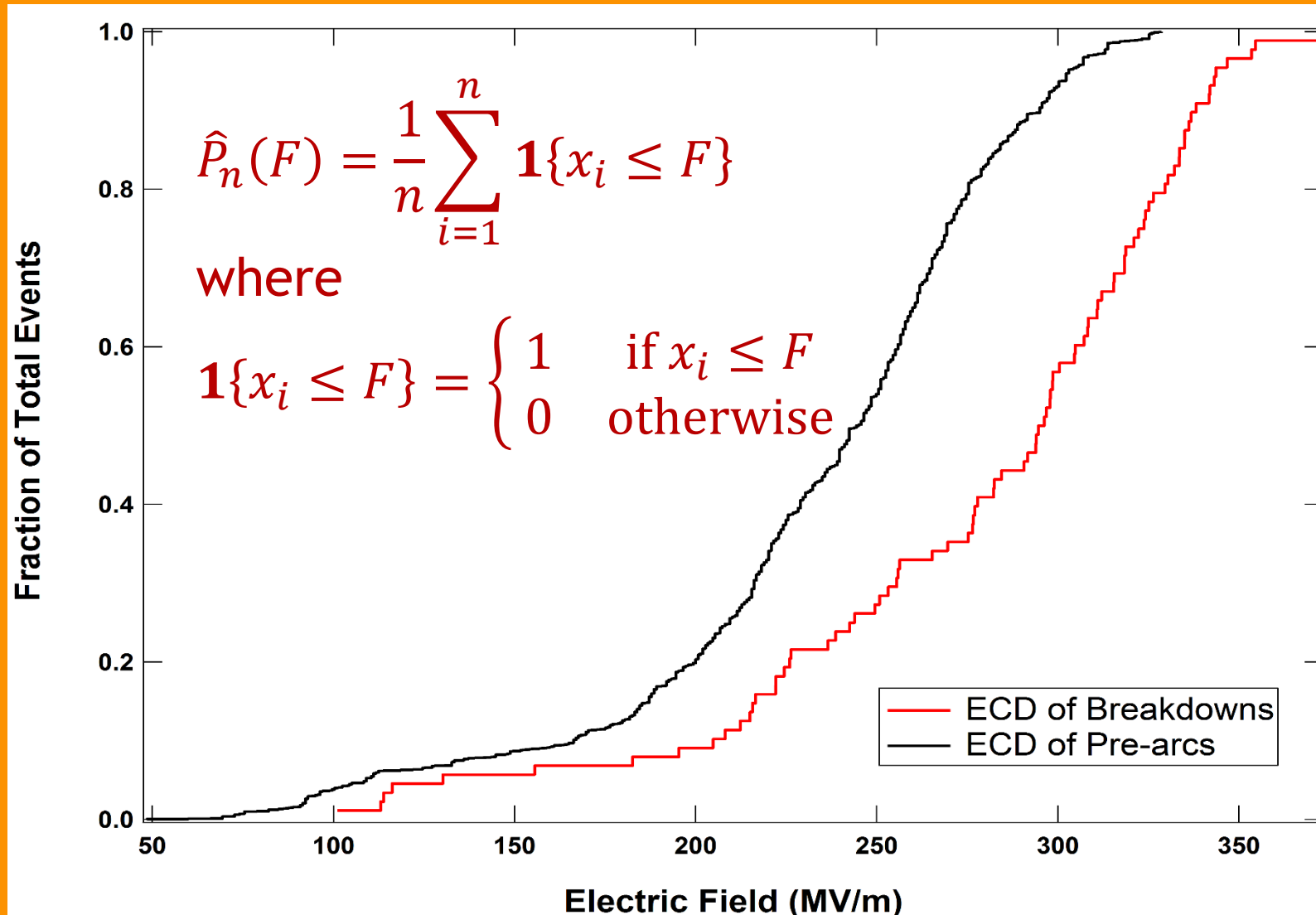
Breakdown distributions

The reviewer for our last paper was not convinced.

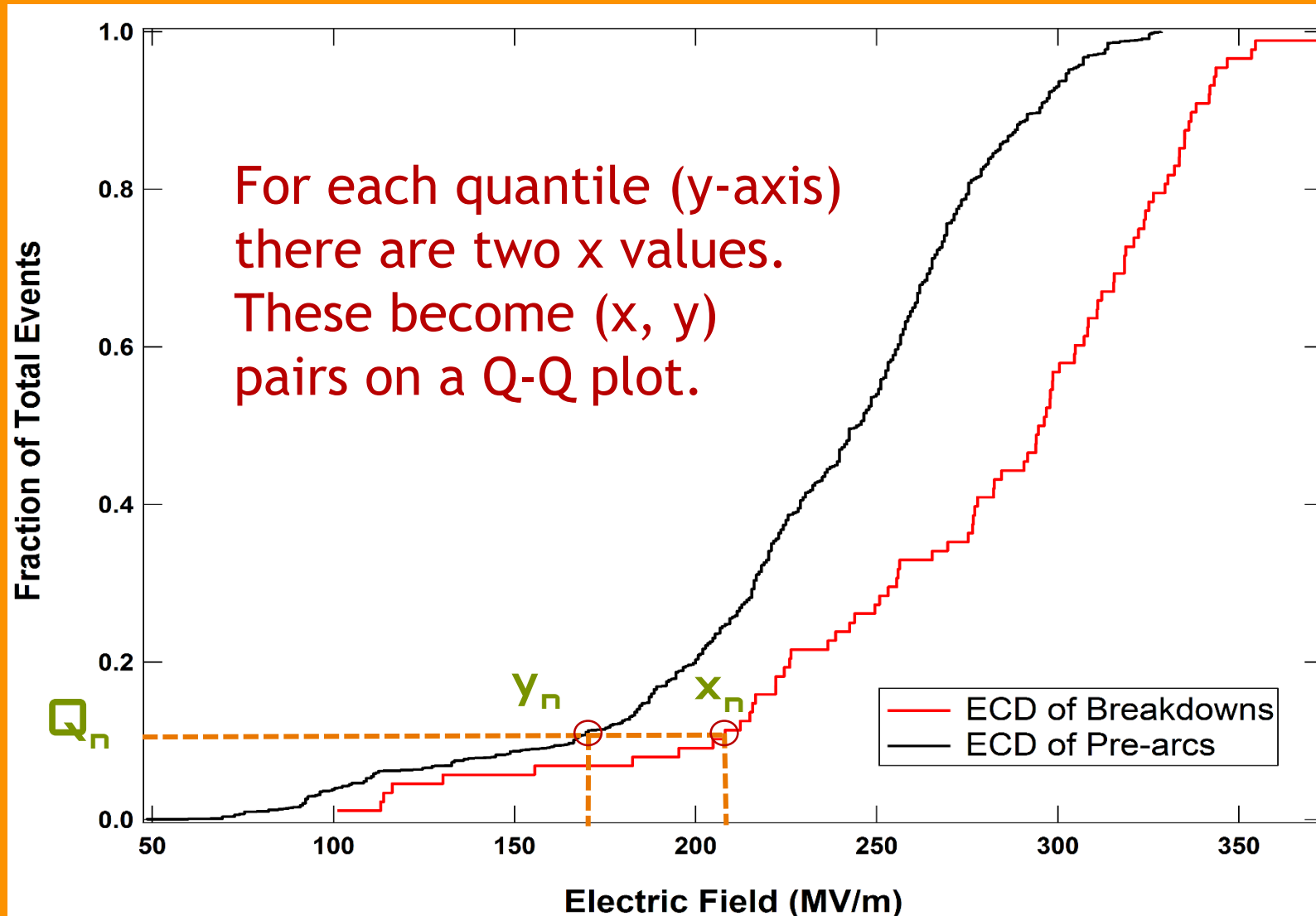
A better method was needed.



# Step 1: Empirical Cumulative Distributions

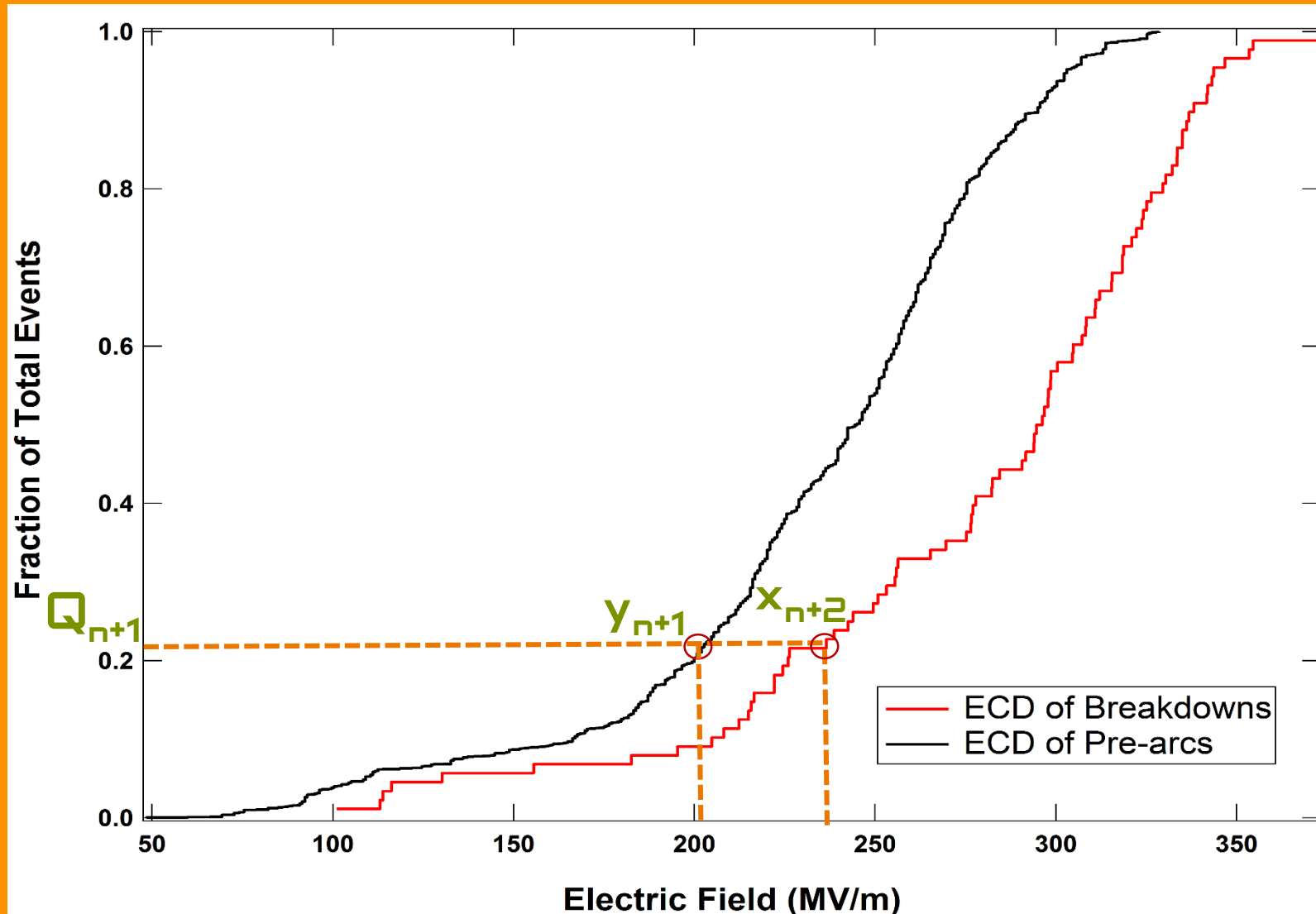


# Step 2: Match the quantiles.

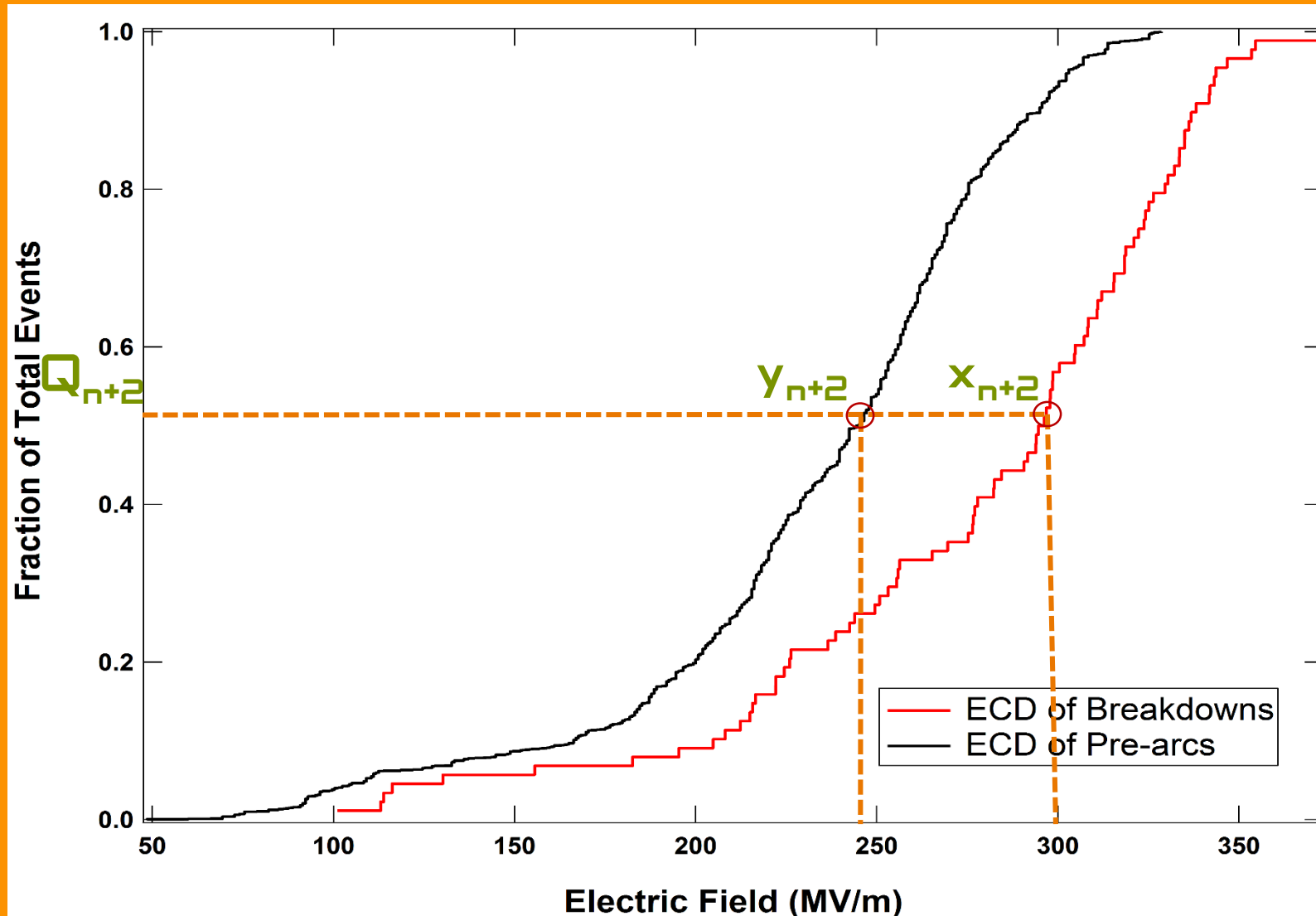




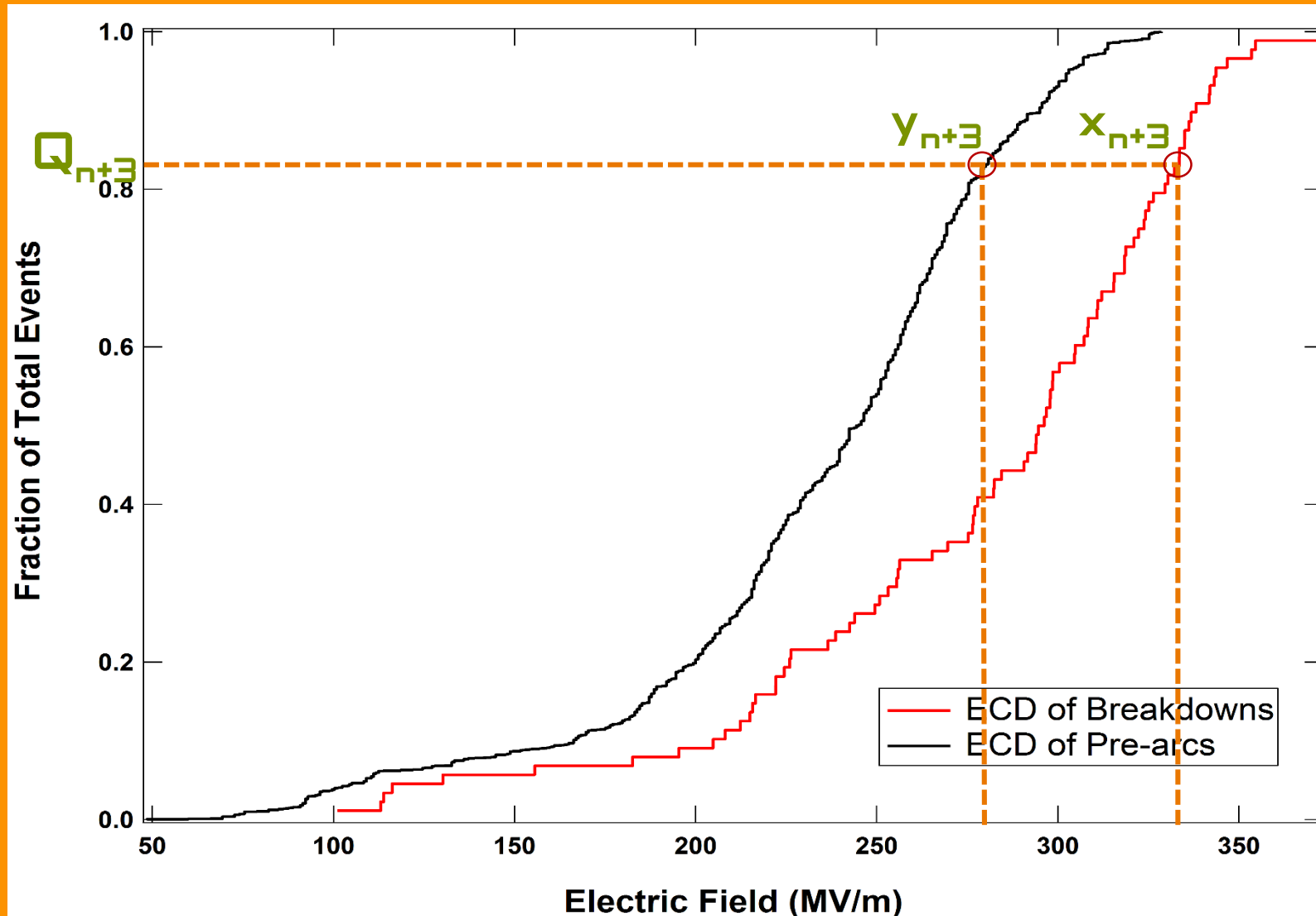
# Step 2: Match the quantiles.



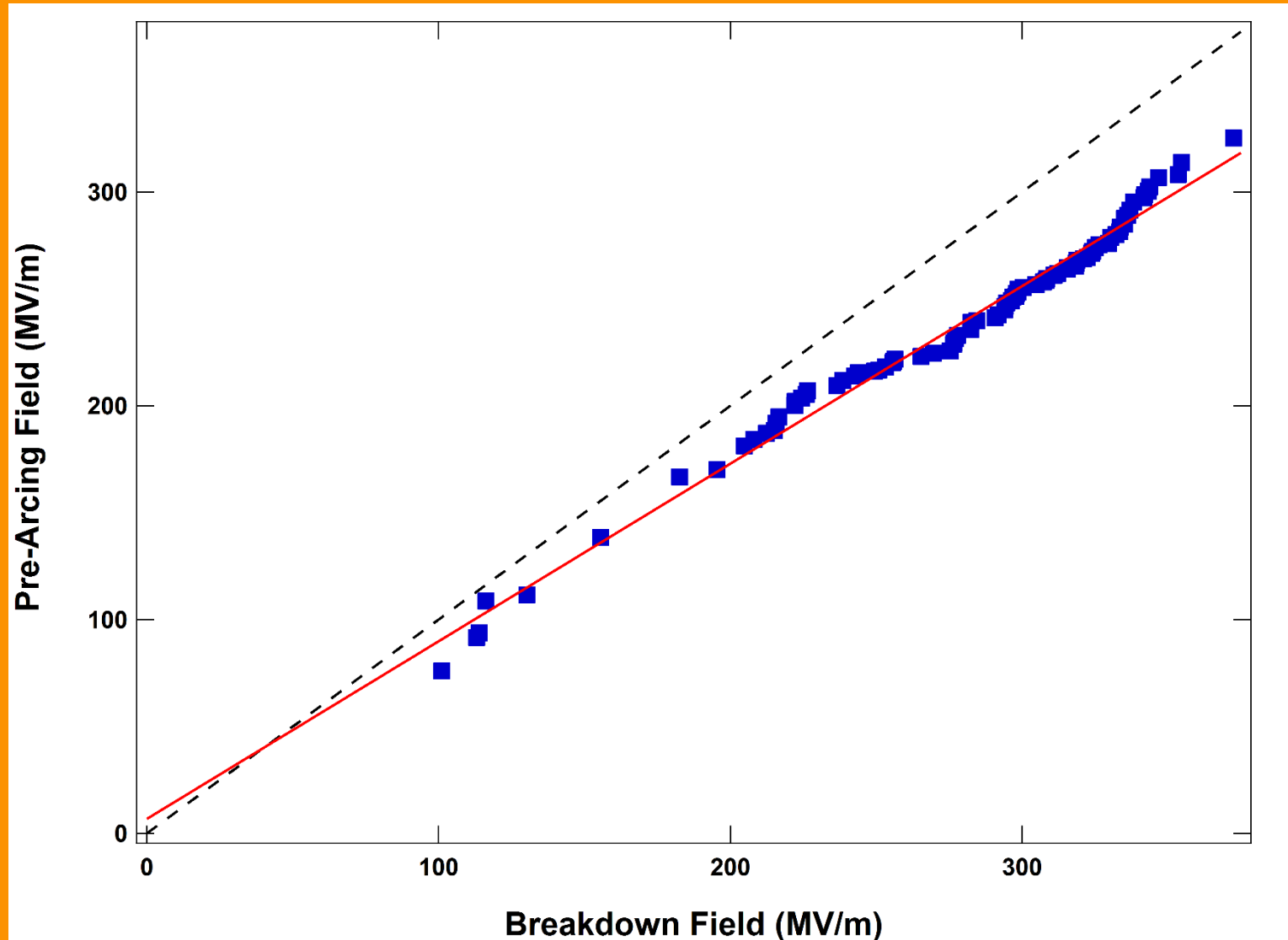
# Step 2: Match the quantiles.



# Step 2: Match the quantiles.



# Step 3: Plot pairs and fit to a line.



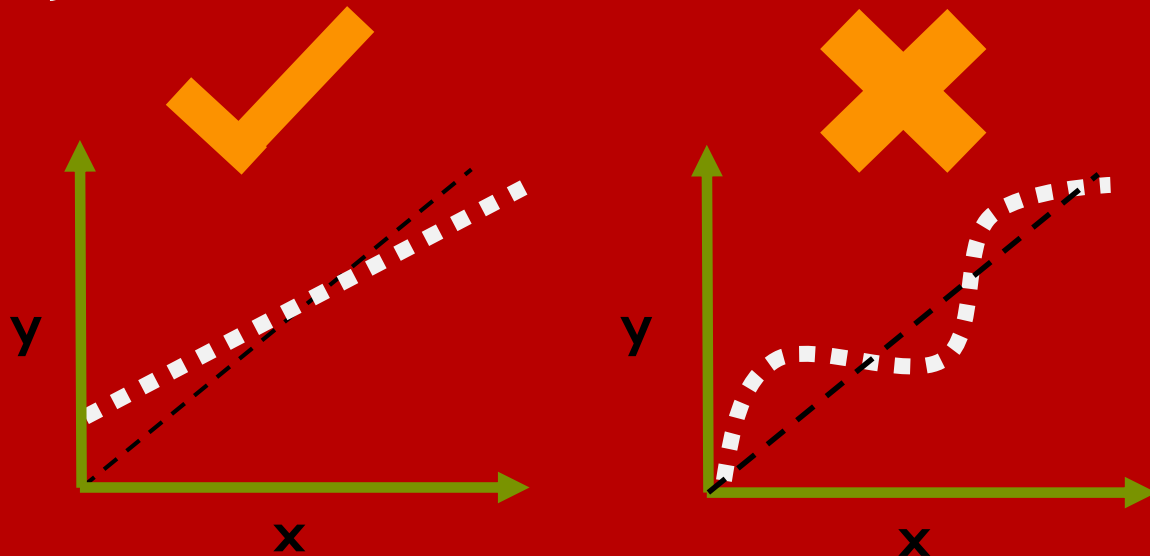


# What does it mean?

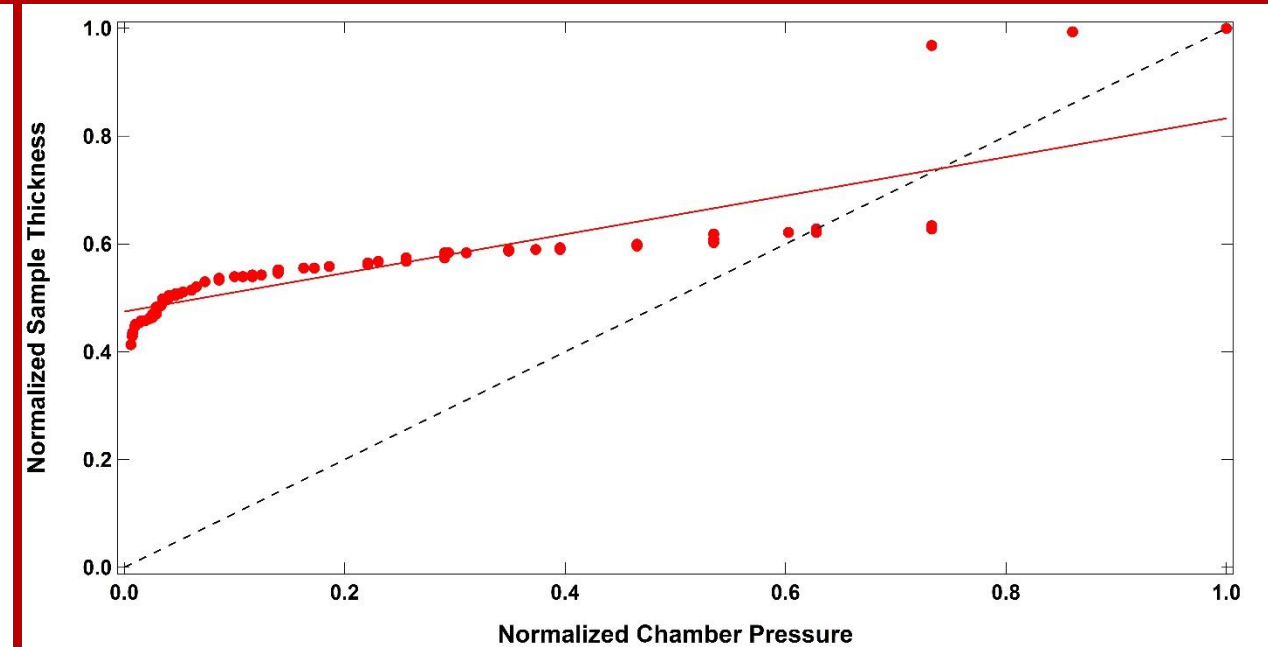
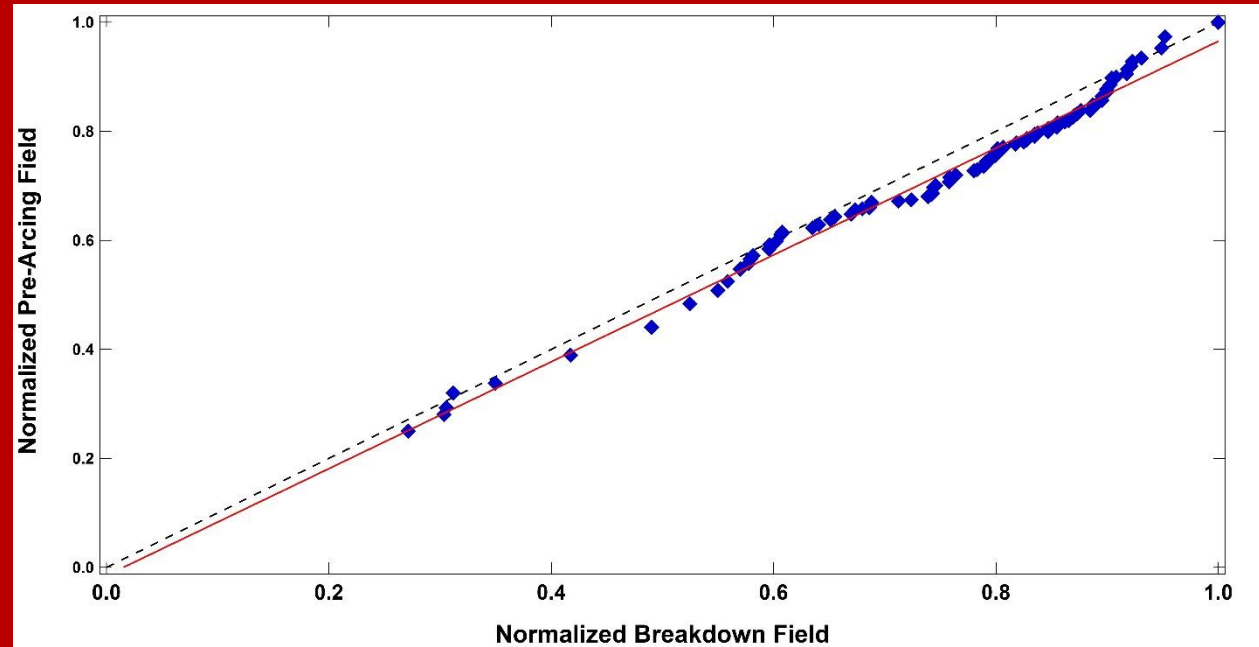
Quantile-Quantile plots compare the distributions of two observables.

If the distributions are related the plot is a linear.

If the fields at each quantile are identical, points will lie on  $y=x$ .



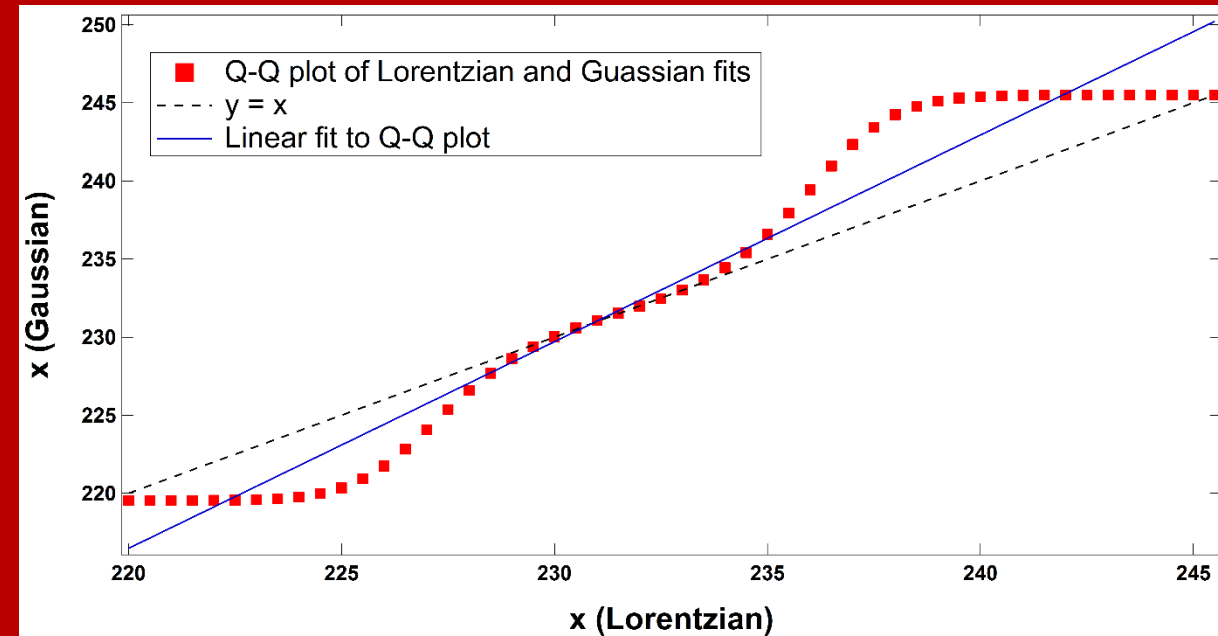
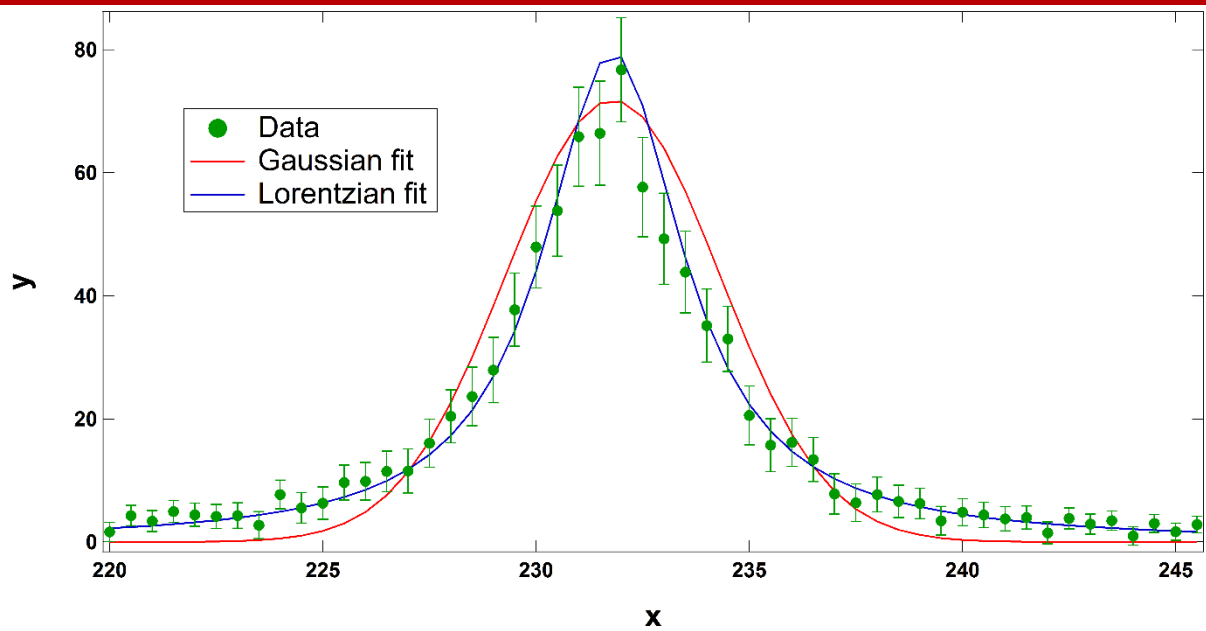
# Check the method.



We see that pre-arcing correlates very well to breakdowns.

Sample thickness and chamber pressure do not—no surprise.

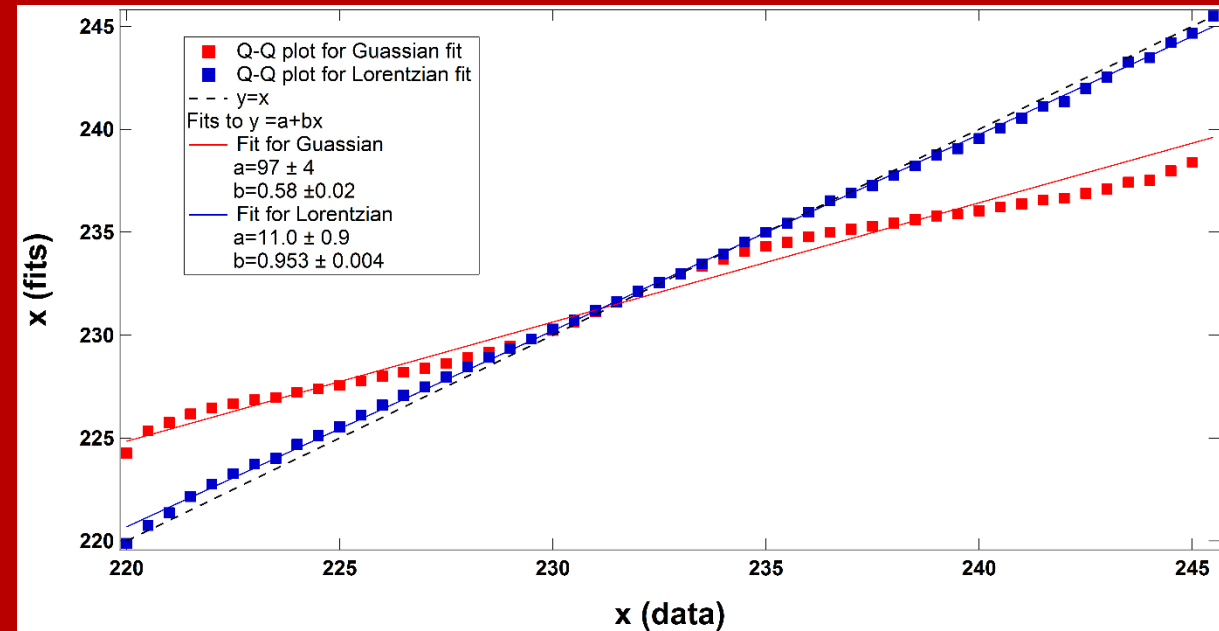
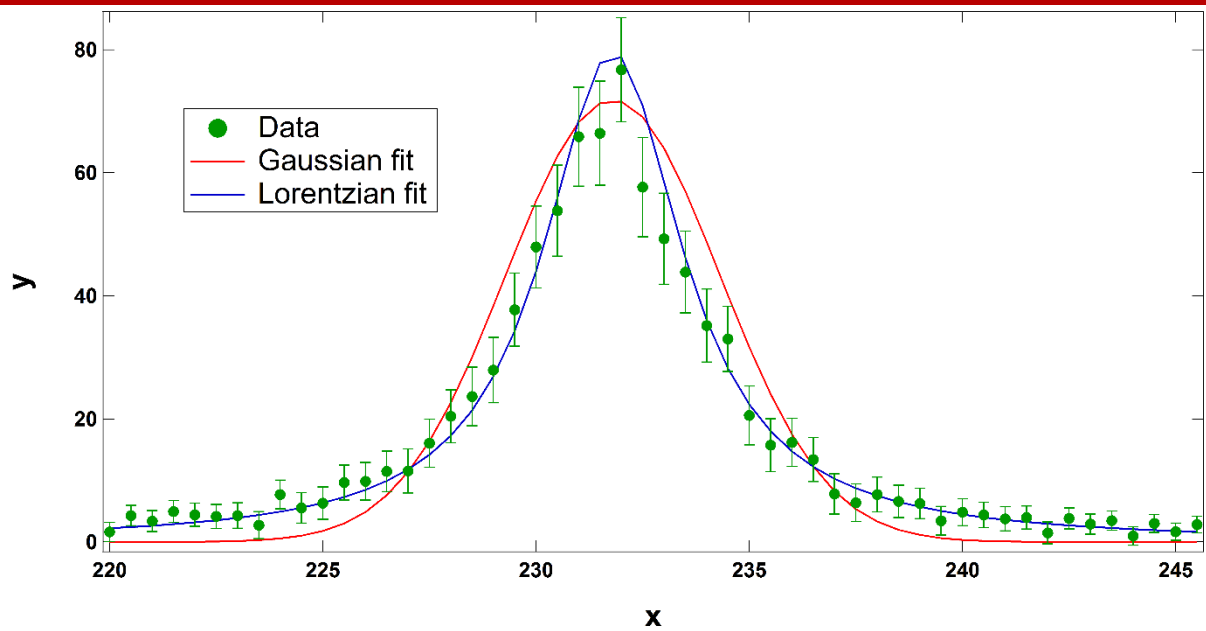
# Additional Applications of Q-Q plots.



A Q-Q plot of the two fits shows that the two fits are significantly different.

Q-Q plots can compare mathematical functions.

# Additional Applications of Q-Q plots.



Q-Q plots comparing the two fits to the data show that the Lorentzian fit is better in this case.

Q-Q plots can compare data to theoretical fits.



The background of the slide features a close-up photograph of several lemons and limes. The lemons are bright yellow and slightly out of focus, while the limes are a vibrant green and more in focus in the foreground. The overall lighting is bright and natural, highlighting the textures of the citrus fruits.

**Pre-arc  
correlates  
to  
breakdown.**

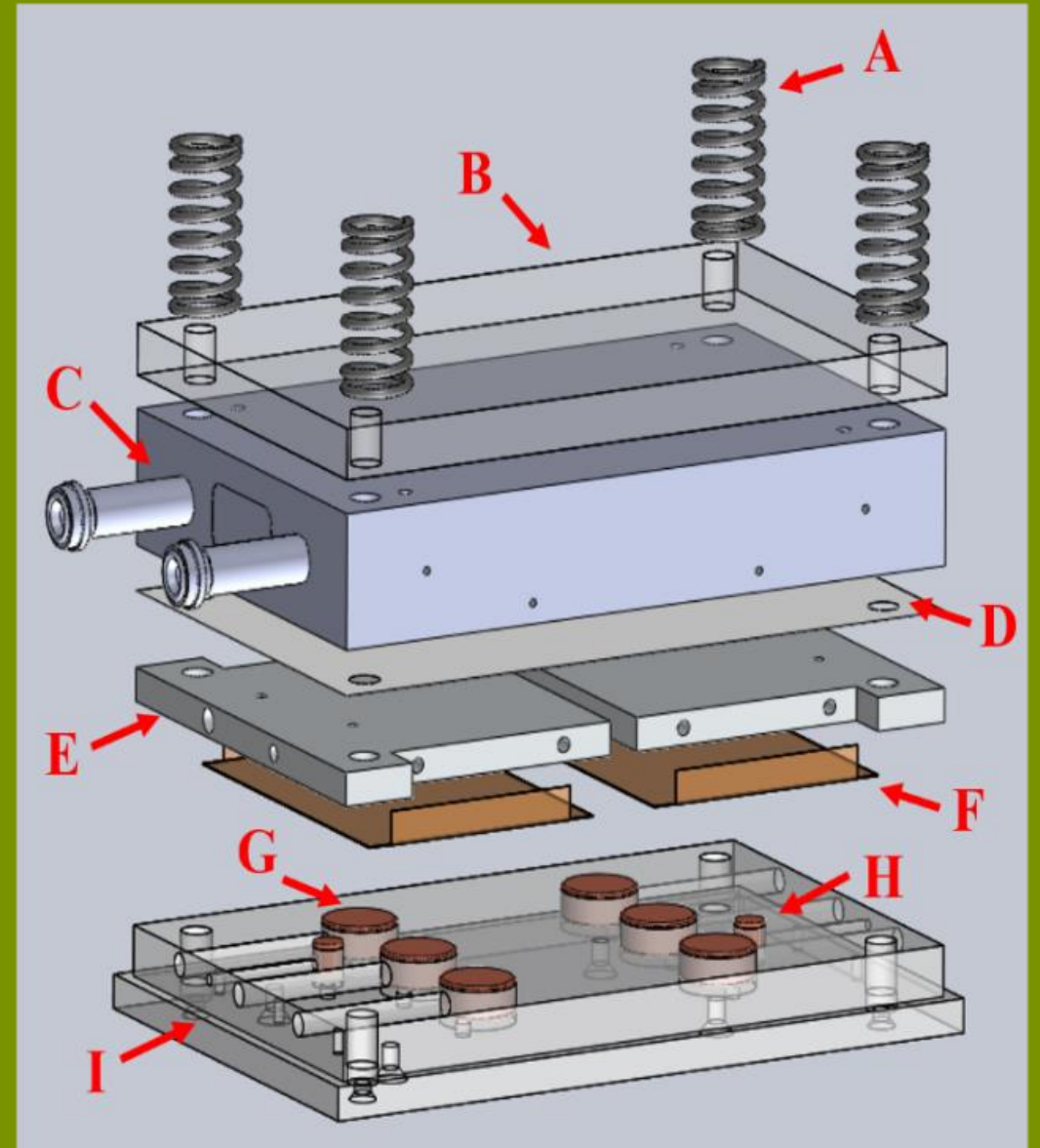
**Q-Q plots  
are  
versatile  
and easy to  
make.**

**A powerful  
empirical  
tool for  
physics  
research.**

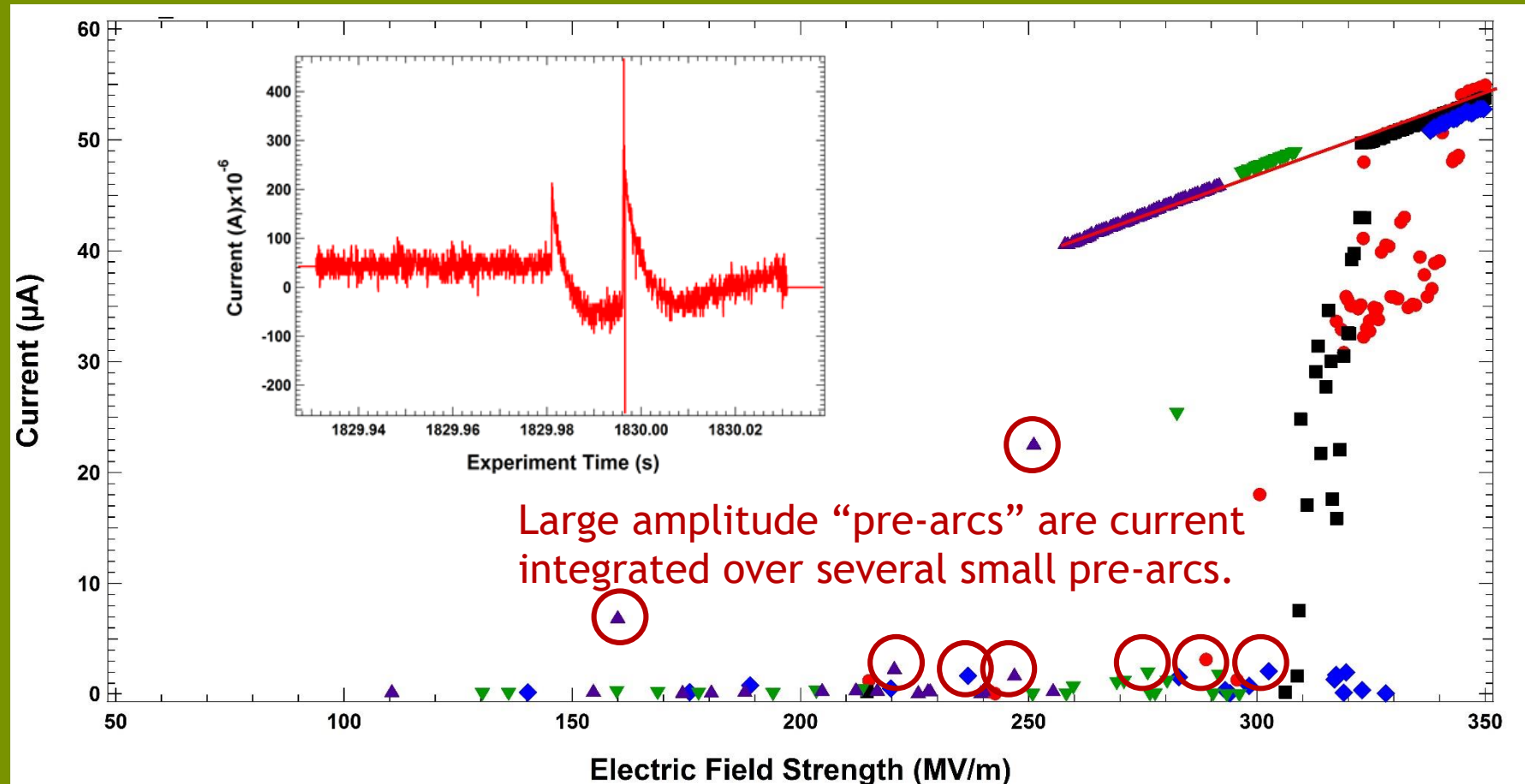
# Case Study: Dielectric Breakdown Testing

## ESD Test Assembly:

- (A) Adjustable pressure springs,
- (B) Insulating layer
- (C) Cryogen reservoir,
- (D) Thermally conductive, electrically isolating layer,
- (E) Sample and mounting plate,
- (F) Sample
- (G) HV Cu electrode
- (H) Cu thermocouple electrode,
- (I) Insulating base.

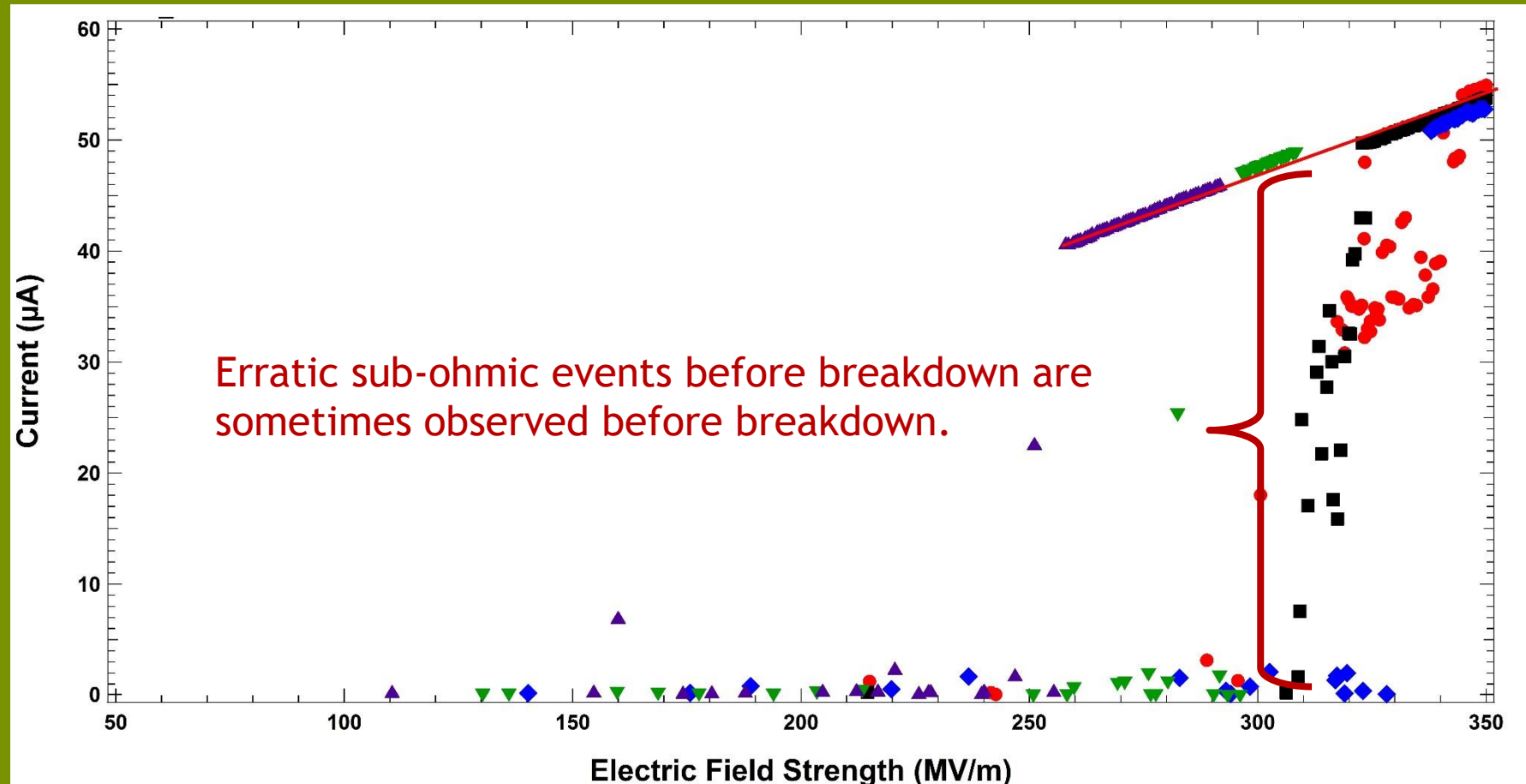


# Case Study: Dielectric Breakdown Testing



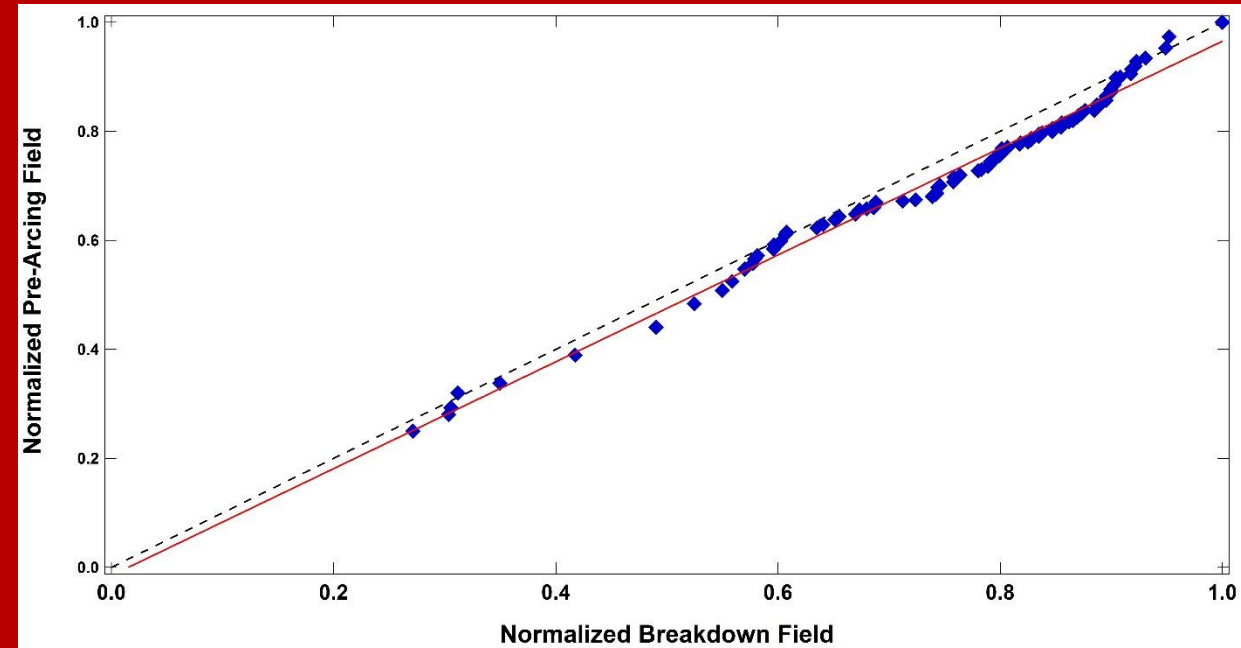
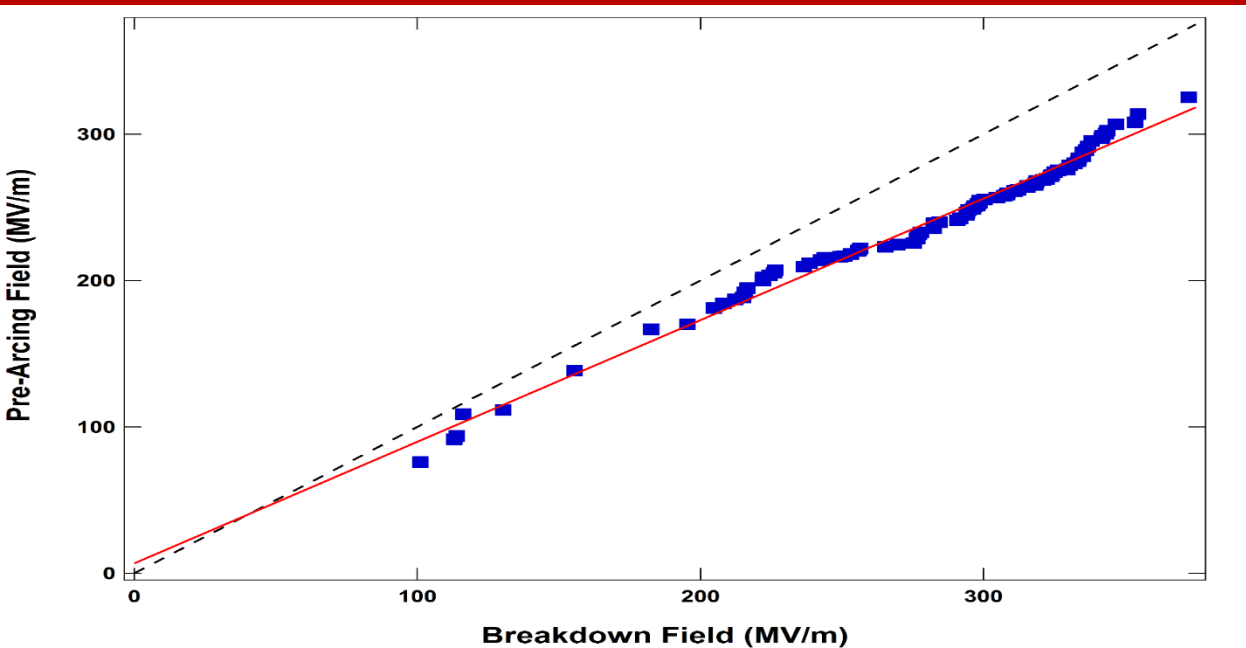
Plot of 5 voltage step-up to breakdown tests on LDPE.

# Case Study: Dielectric Breakdown Testing



Plot of 5 voltage step-up to breakdown tests on LDPE.

# Effect of scaling on Q-Q plots.



Re-scaling the fields the fields brings in the Q-Q plot closer to  $y=x$ .