Fault detection in photovoltaic systems

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Overview

- Introduction

- The problem

- Background

- Results

- Conclusions

Introduction

- PV (photovoltaic) systems growing (~137 GWp)

- Installation of 16~24 panels

- Degradation and faults occur

- Interesting to perform analysis on datasets

The problem

- Can we detect a solar panel fault occurs?

- Can we measure the degradation over time?

- Can we differentiate shading from real faults?
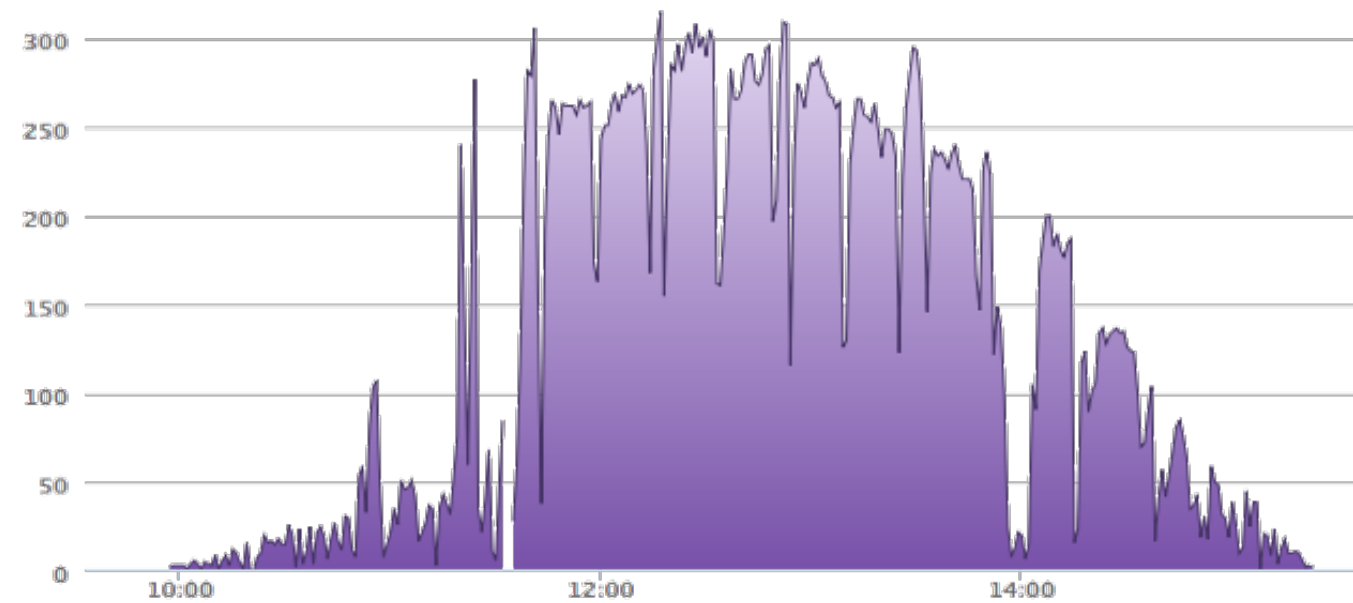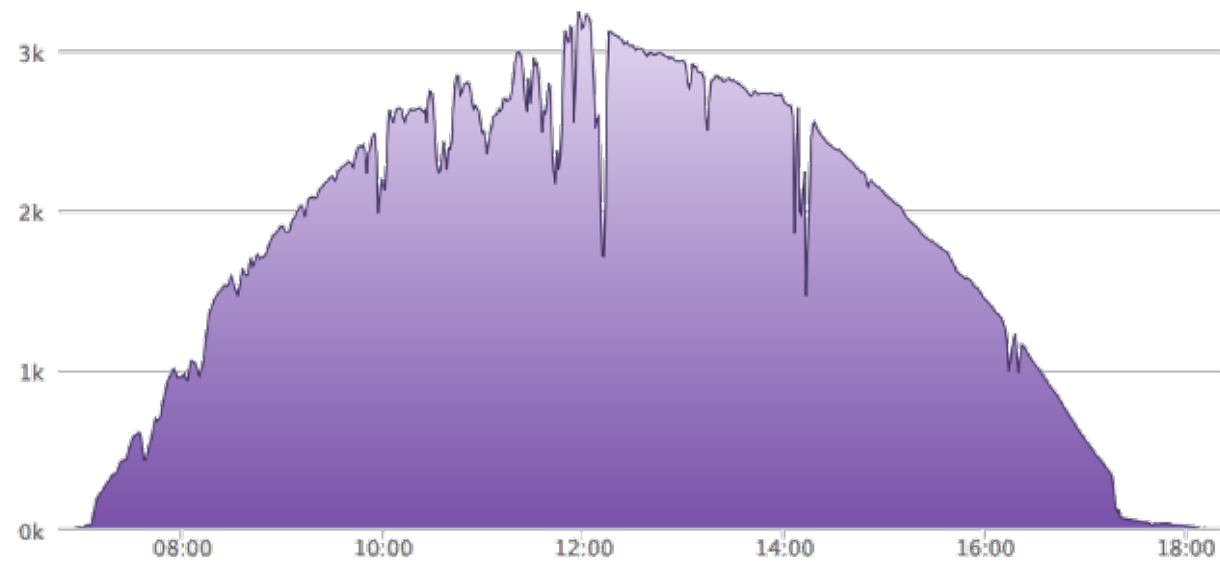
Methodology

- Implement algorithms

- Simulation framework providing data

- Evaluate implementations over different configurations and real-life data

Background

- Each panel is connected to a PV inverter

- Converts DC into AC efficiently

- Also transmits measurements regularly

- Current, Voltage, and inverter temperature available
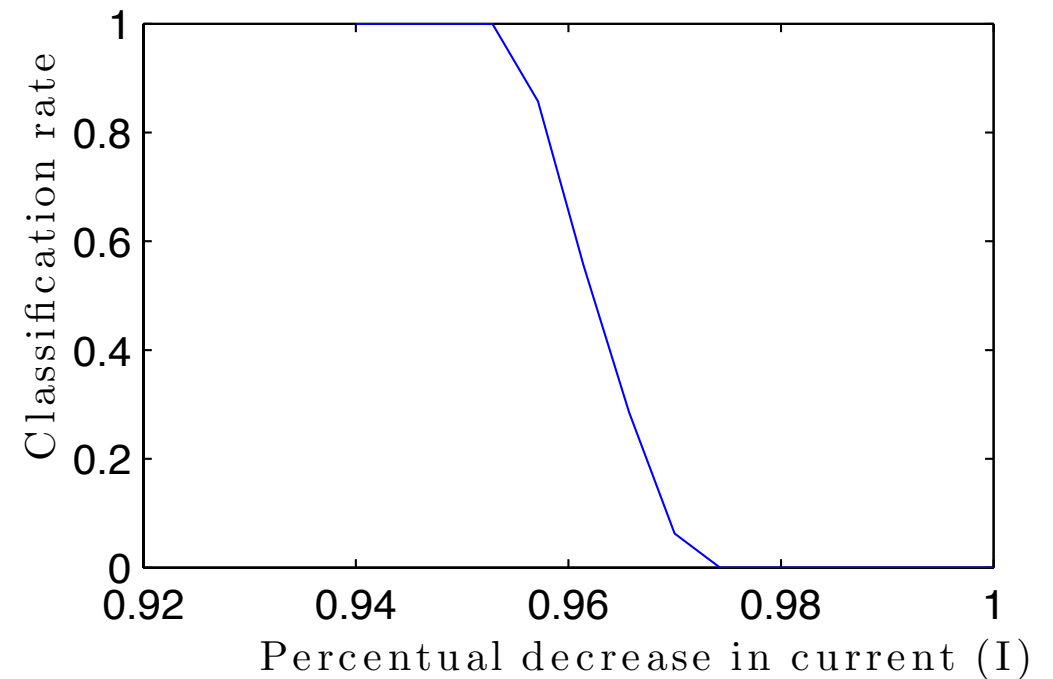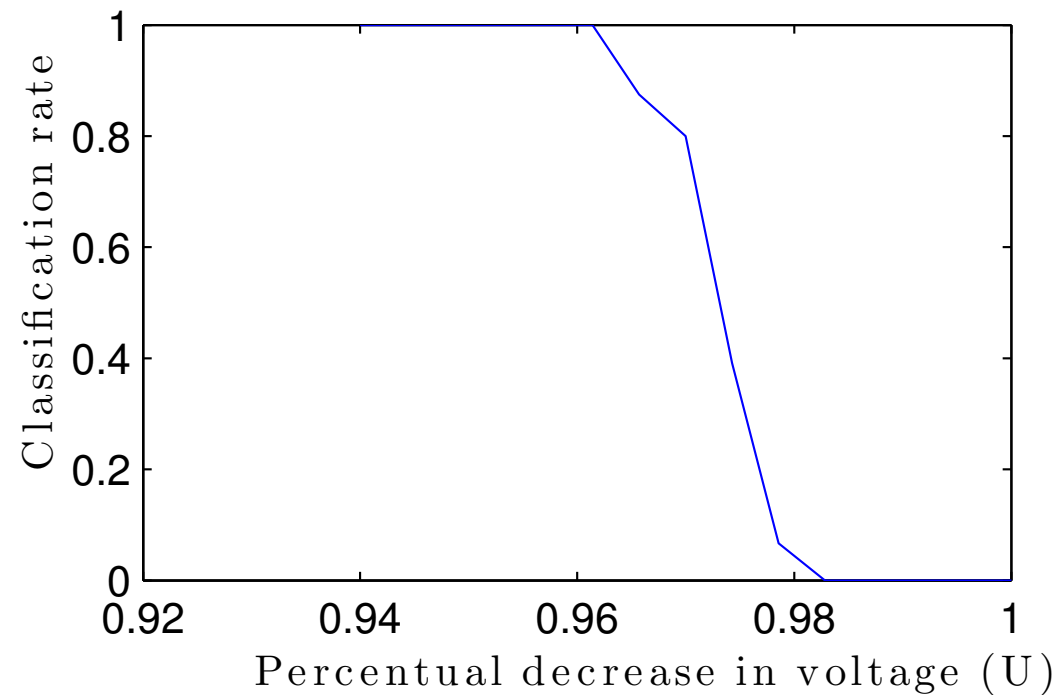
Background cont.

- Power output during two different days
- Large differences observable
- Location dependent
- Different configurations and solar panels

Immediate failures

- Assumption: faults isolated to few panels

- Analyze current and voltage in isolation

- Consider continuos segments

- Normalize and perform thresholding

Immediate results

- Classification rate as function of fault percentage

- Similar performance characteristics

Degradation

- Theoretical model: equivalent electrical circuit

- Fit observations on circuit parameters

- Solved using non-linear regression

- Unsuitable with only current and voltage

Degradation cont.

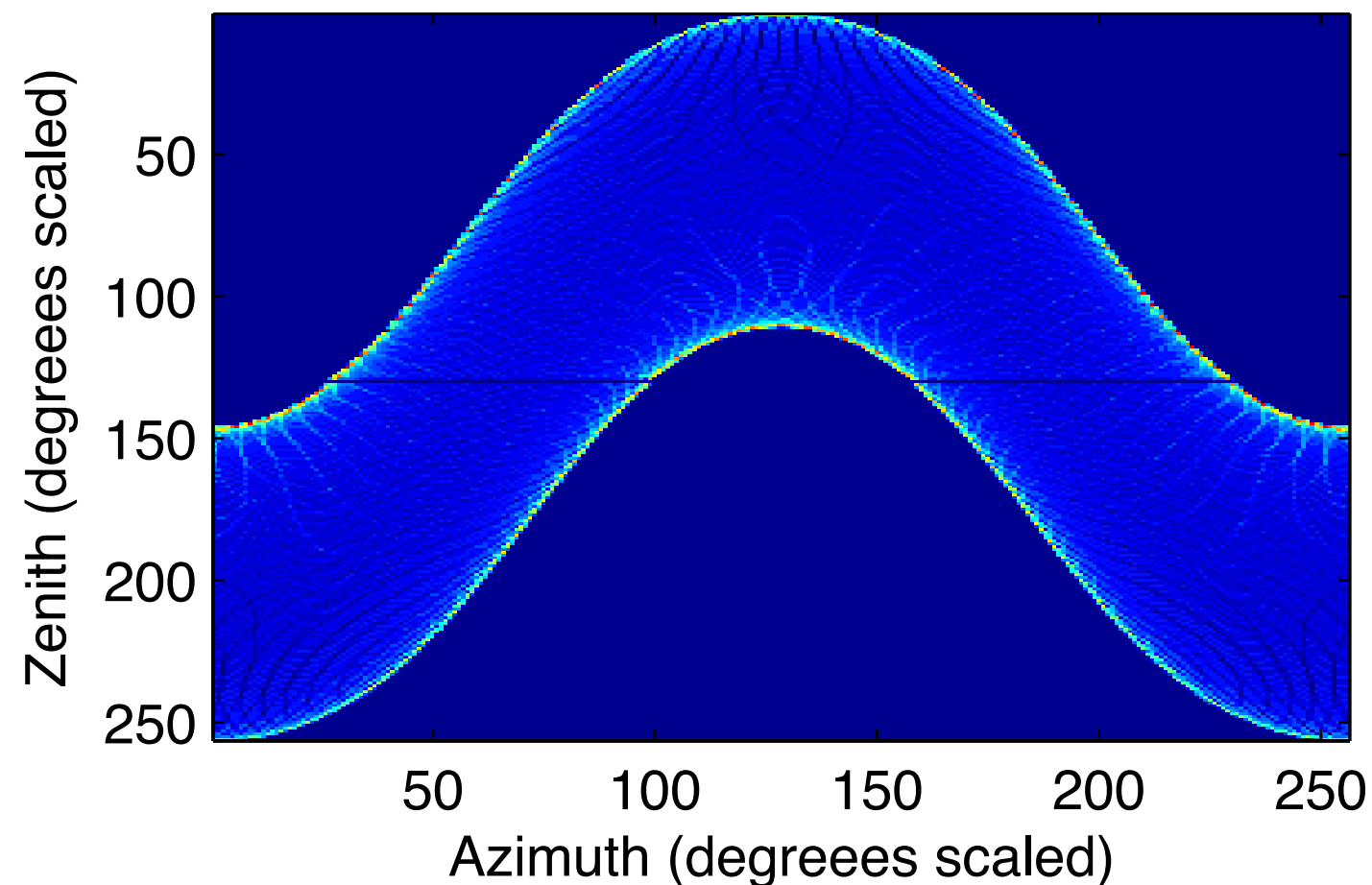- Alternative approach: measure similarity

- Assume repetitive environmental conditions

- Locate similar points in time

- Consider degradation ratio
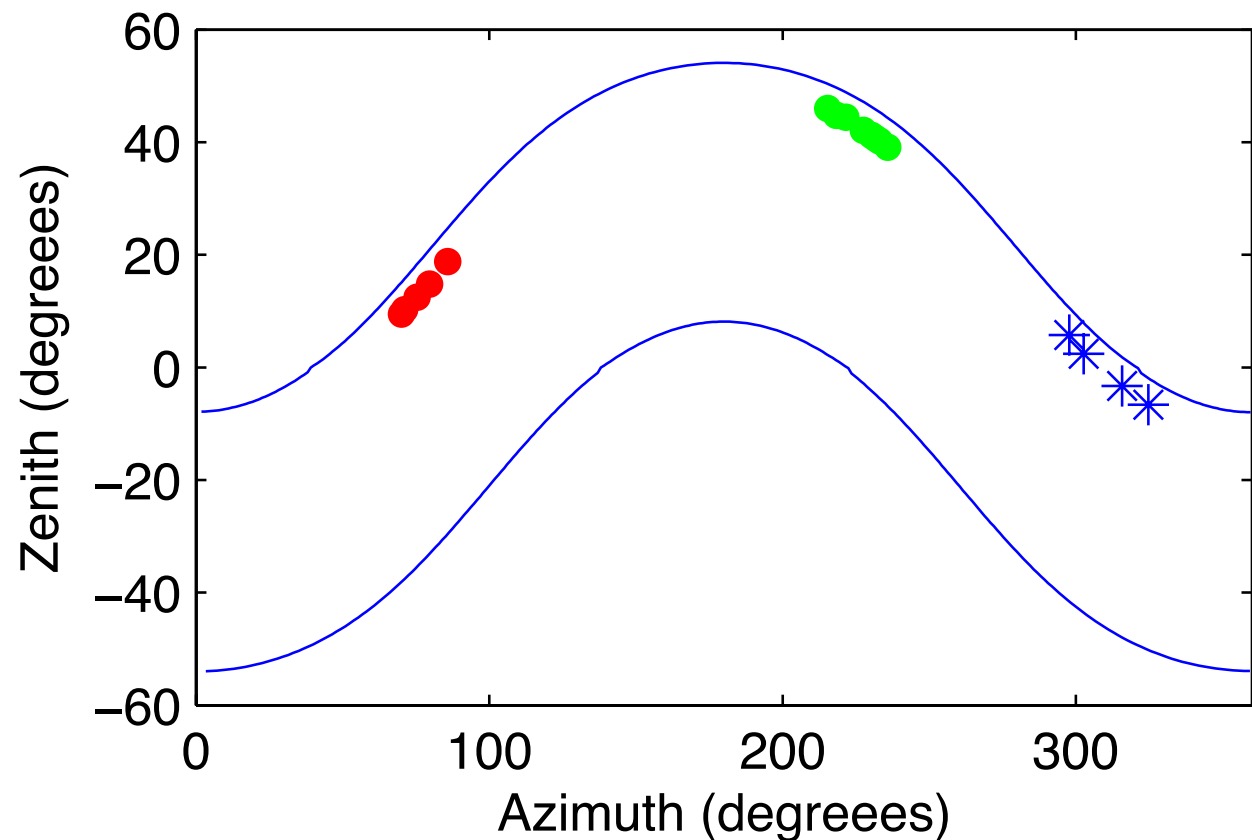
Degradation results
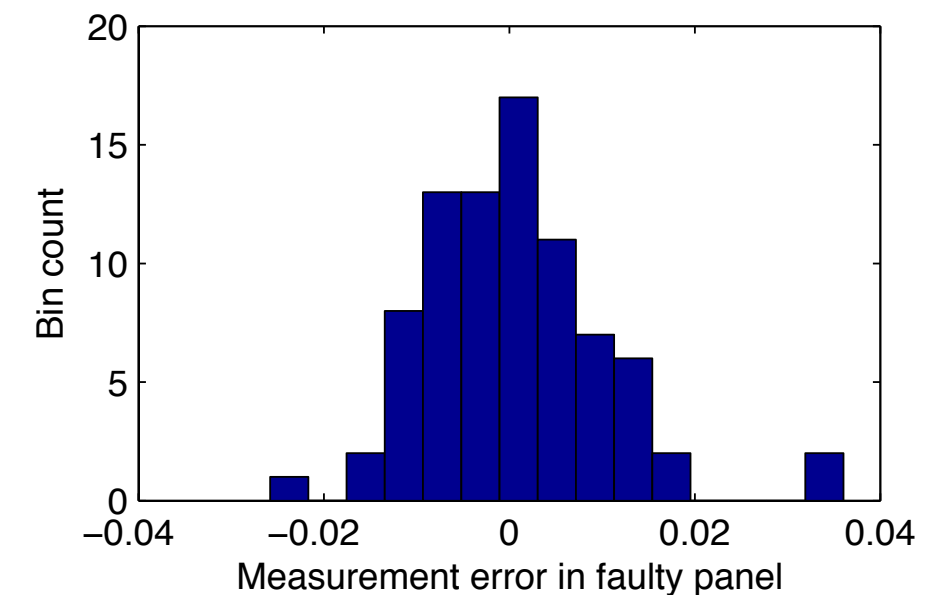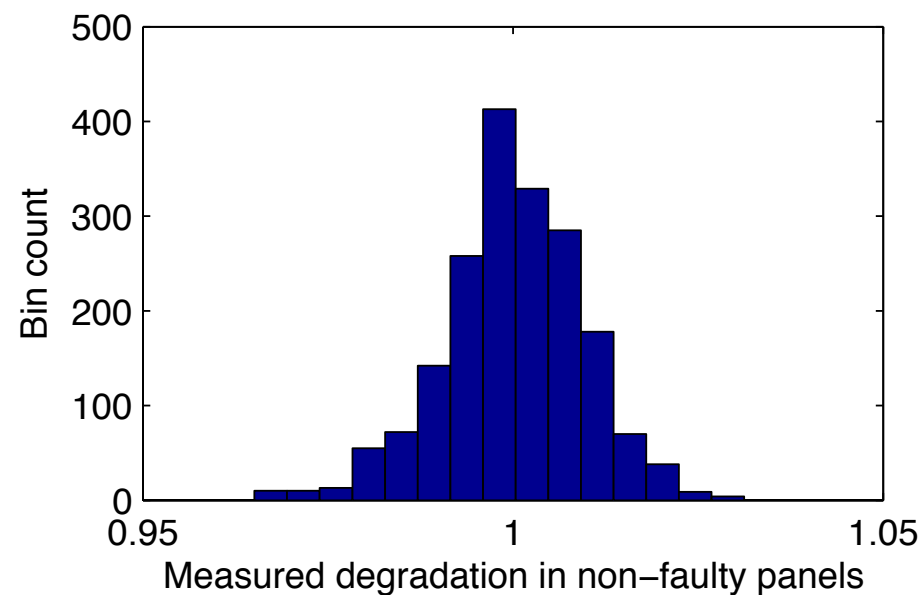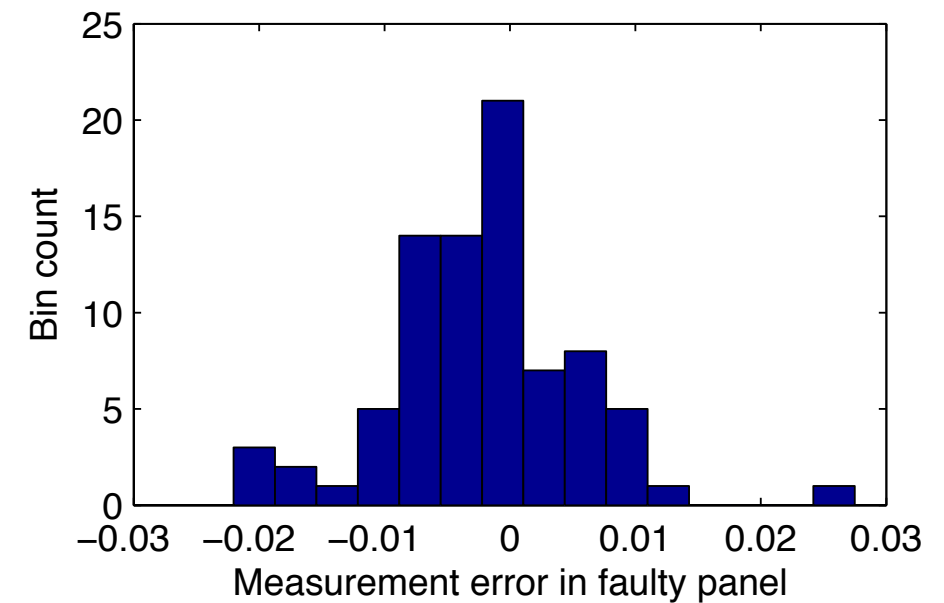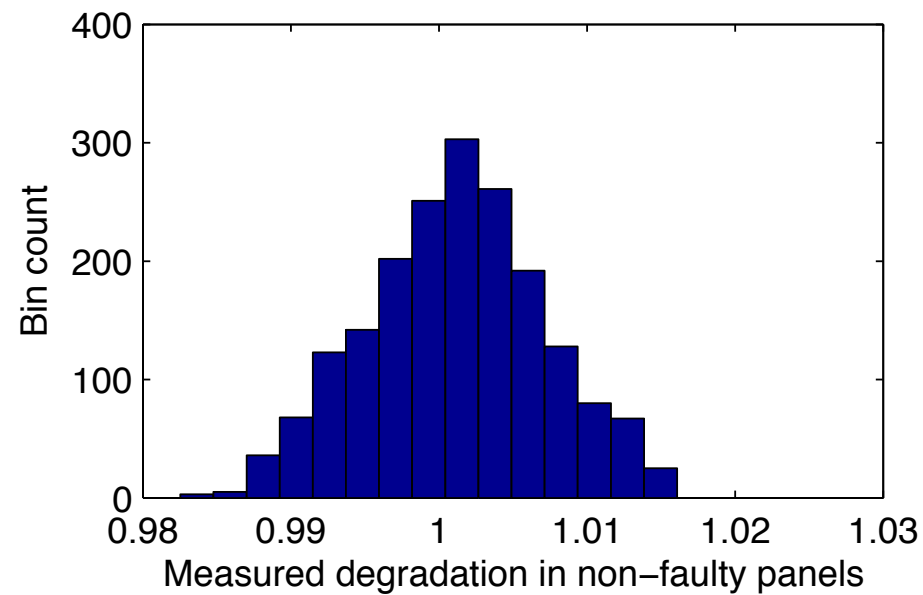
Partial shading

- Task: distinguish faults from shading

- Suitable to consider the solar plane

Partial shading cont.

- Inherent difficulties

- Clusters of indicators likely shading

- Motivates use of suitable clustering method

- DBSCAN suitable

- Results in labelling of dataset

Partial shading results

Experiment carried out at KTH

Piece of cardboard gradually swept over 40 minutes

Conclusions

- Fault detection is needed in practice

- Reliable detection of significant faults

- Degradation depends on environment

- Foundations of partial shading