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9th Renewable Energy Postgraduate Symposium (REPS)

Stellenbosch University

13 – 14th September, 2018

STERG
SOLAR THERMAL ENERGY RESEARCH GROUP

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Irradiance Feedback Control System for a 5-kW Xenon Arc Lamp Solar Simulator

Julian C. Nwodo

Supervisor: Prof. Edson L. Meyer
Co-Supervisor: Dr. Richmore Kaseke
Co-Supervisor: Dr. Raymond T. Taziwa

13th September, 2018

Outline

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- Introduction → Background → Aim → Objectives
- Materials and Methods → System Architecture → Hardware → Methodology
- Results → Lamp Startup → Irradiance and Temperature Test → Irradiance Non-Uniformity
- Conclusions
- References
- Acknowledgements

Introduction

- The combination of a number of equipment or components connected in a particular order to perform a specific task is often referred to as a system.

- When the system's input quantity is controlled by varying the input quantity then the system is called as a control system.

Introduction

The control system should regulate or direct or command.

Hence, a control system is an arrangement of distinct physical components connected in such a manner so as to:

Regulate or direct or to direct or to command itself or some other system.

Introduction

Types of Control Systems

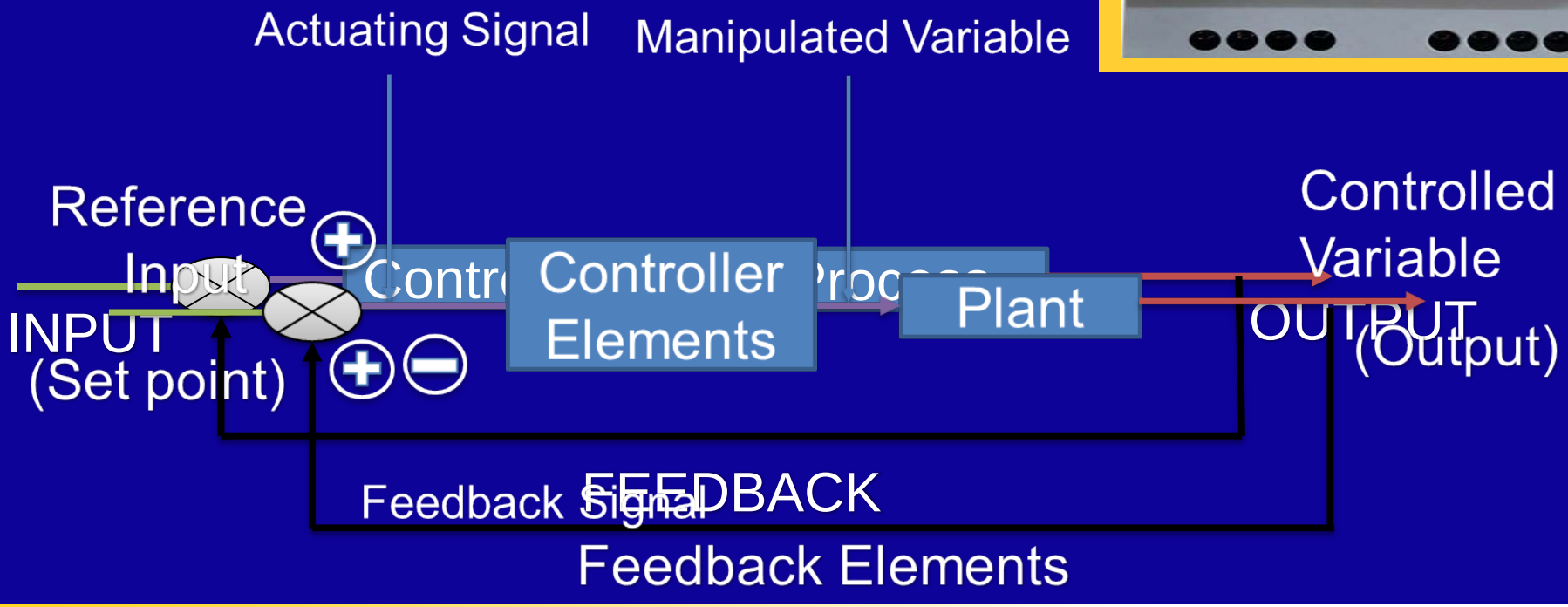
- **Open loop control systems**
- **Closed loop control system**

Open loop control systems

Introduction

Types of Control Systems

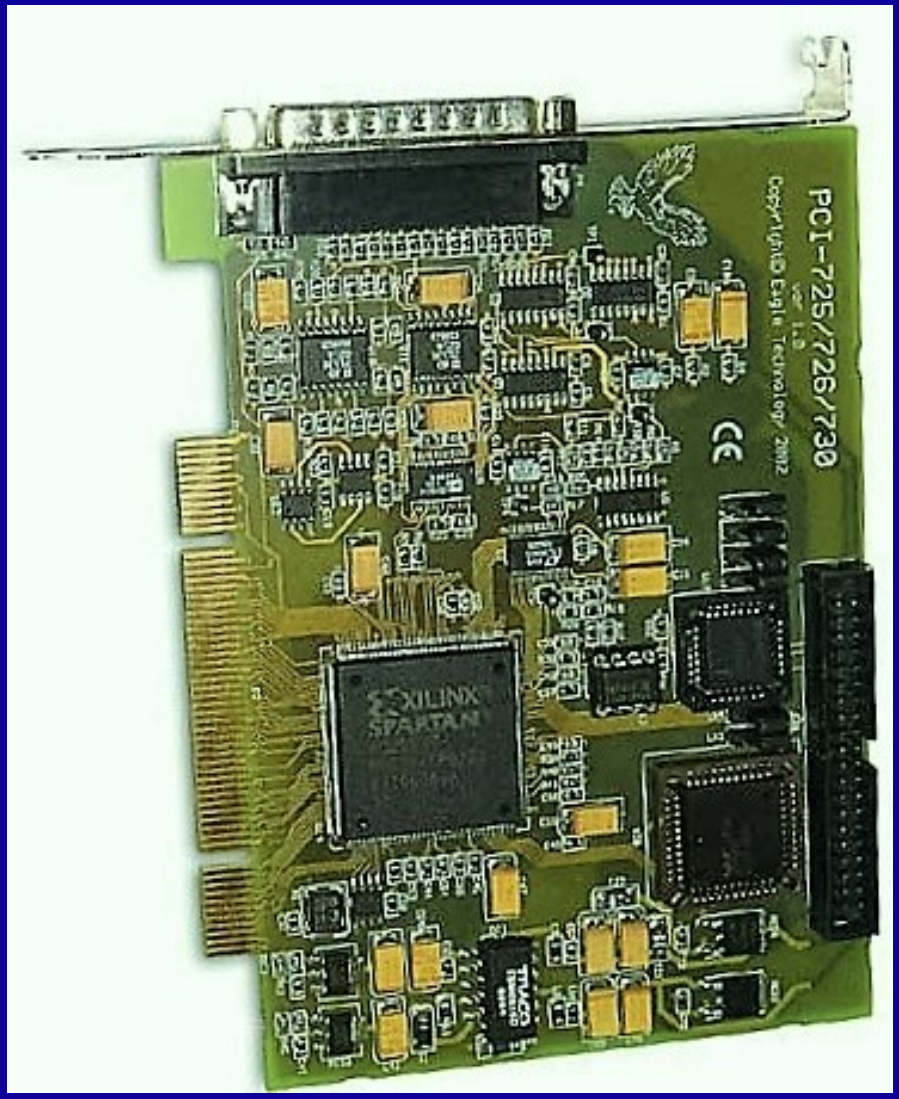
Closed loop control systems



Aim and Objectives

Aim:

- To design an irradiance feedback control system for a 5-kw xenon arc lamp solar simulator.



Aim and Objectives

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Objectives:

- Design of an irradiance feedback control system.
- Minimize human-machine interaction while carrying out indoor tests.
- To achieve solar simulator set point quicker thereby reducing temperature build up on the target area.

Materials and Methods

System Architecture

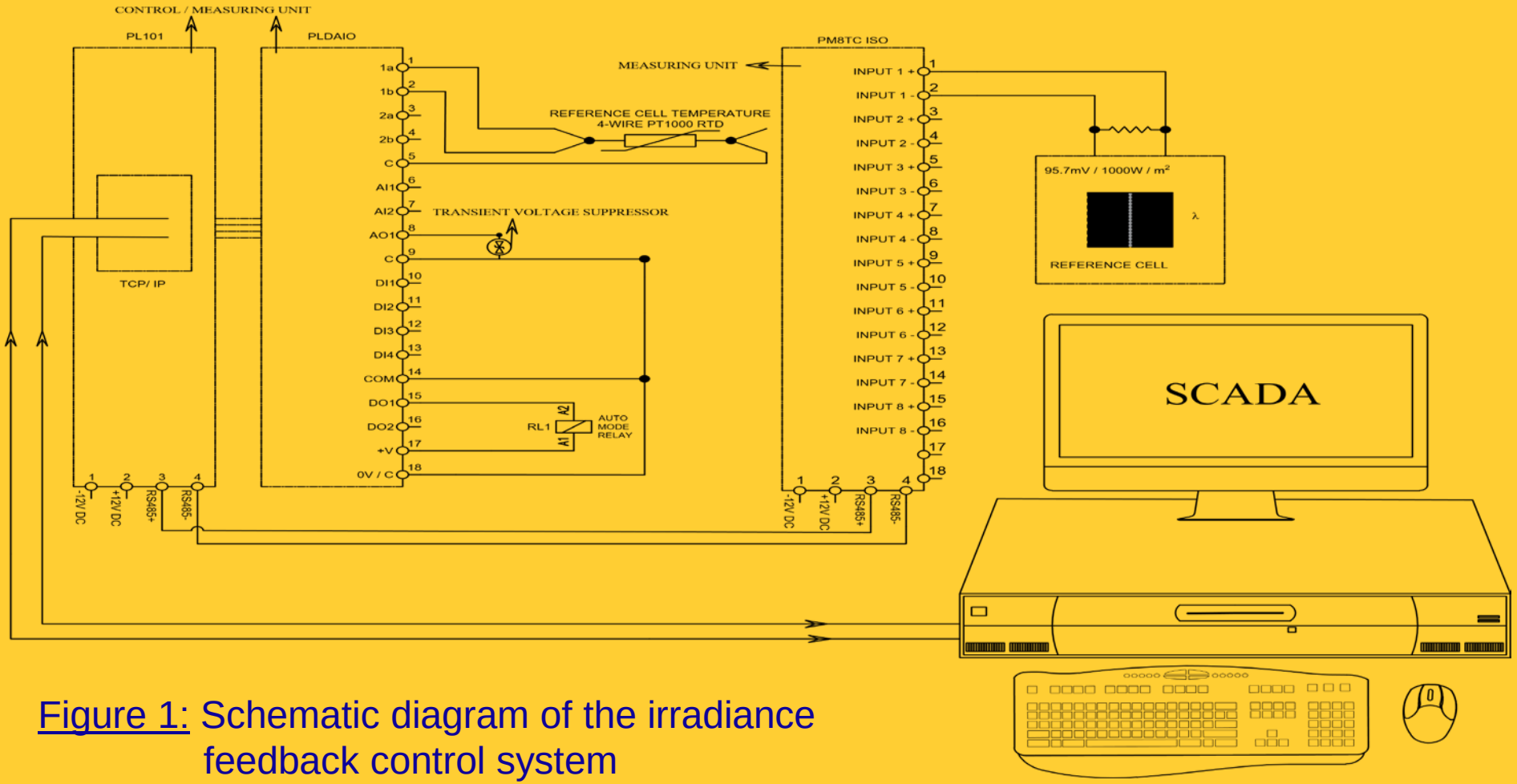

Figure 1: Schematic diagram of the irradiance feedback control system

Materials and Methods

Hardware Description

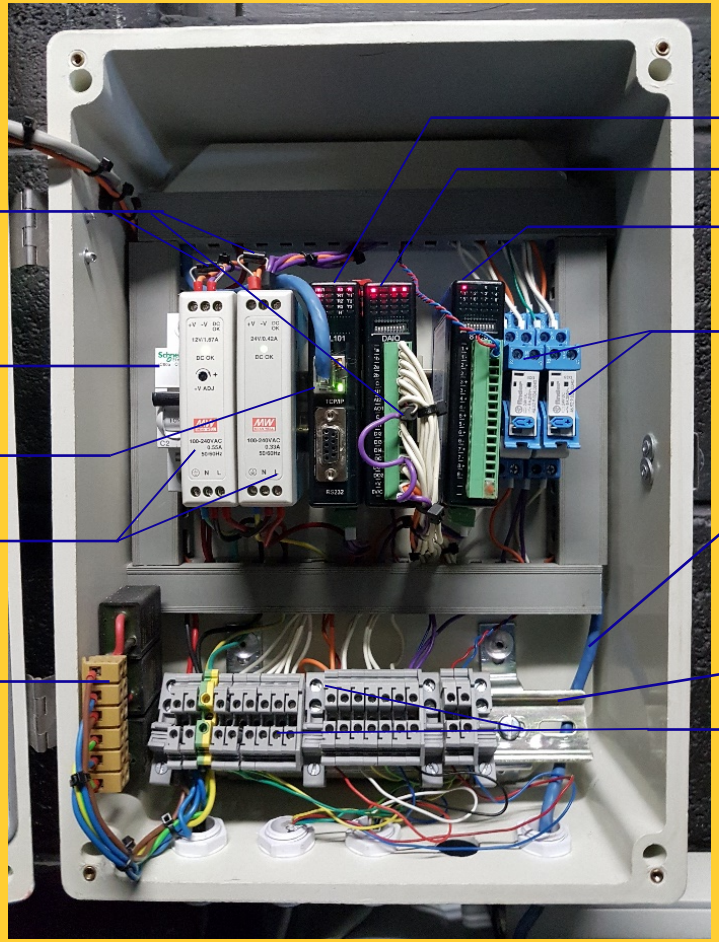

Figure 2: Schematic diagram of the irradiance feedback control system

Materials and Methods

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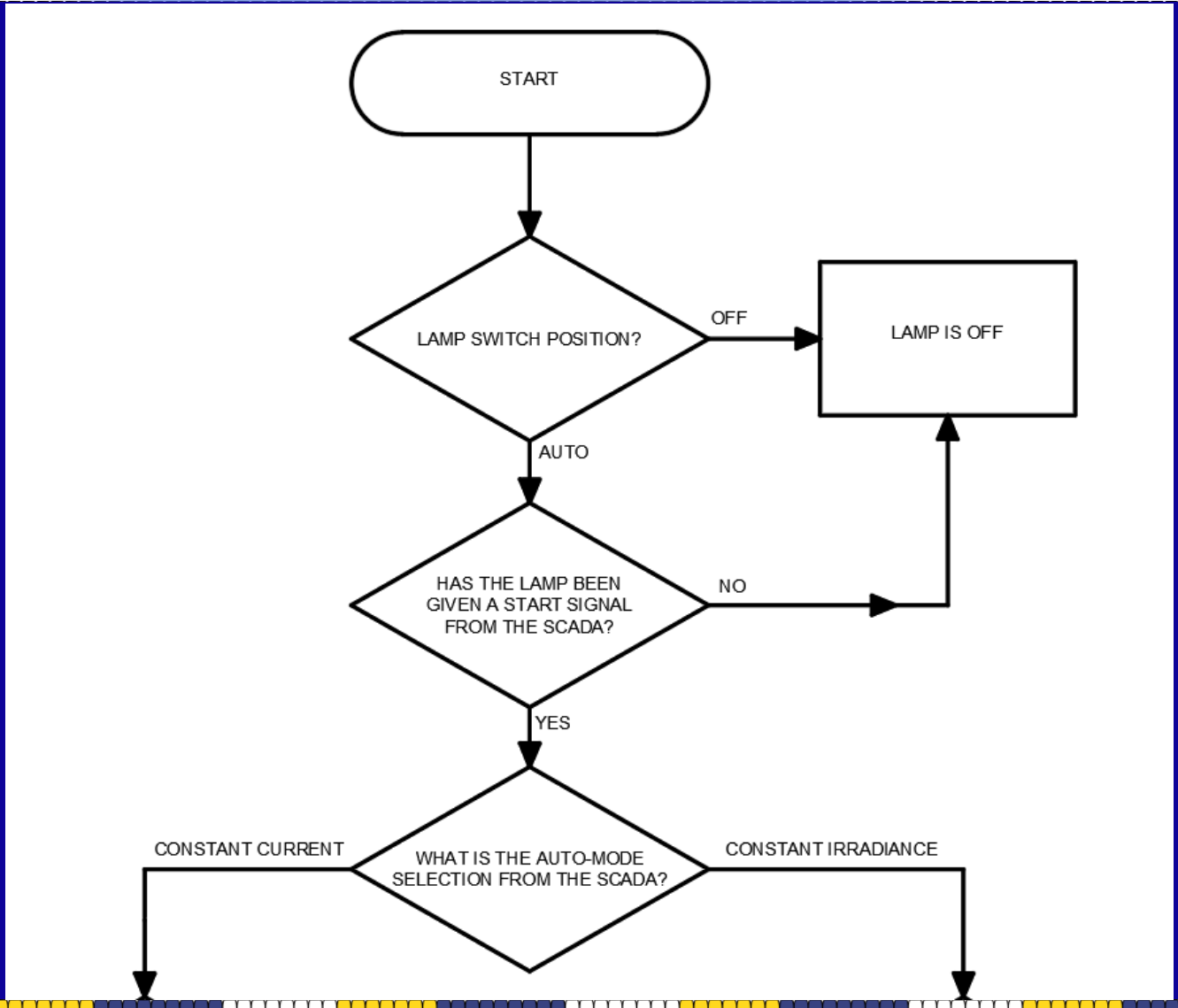
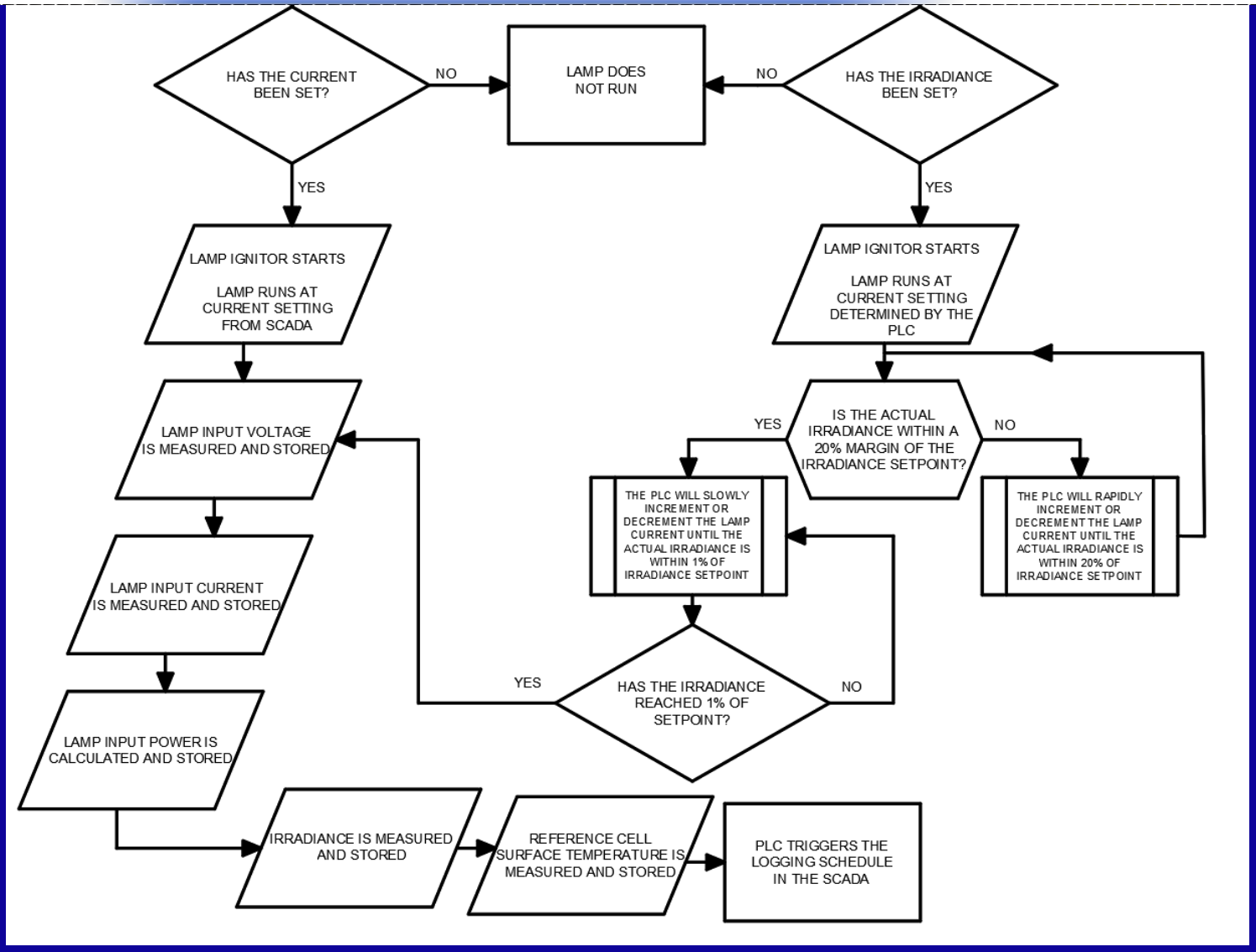
Methodology

Methodology



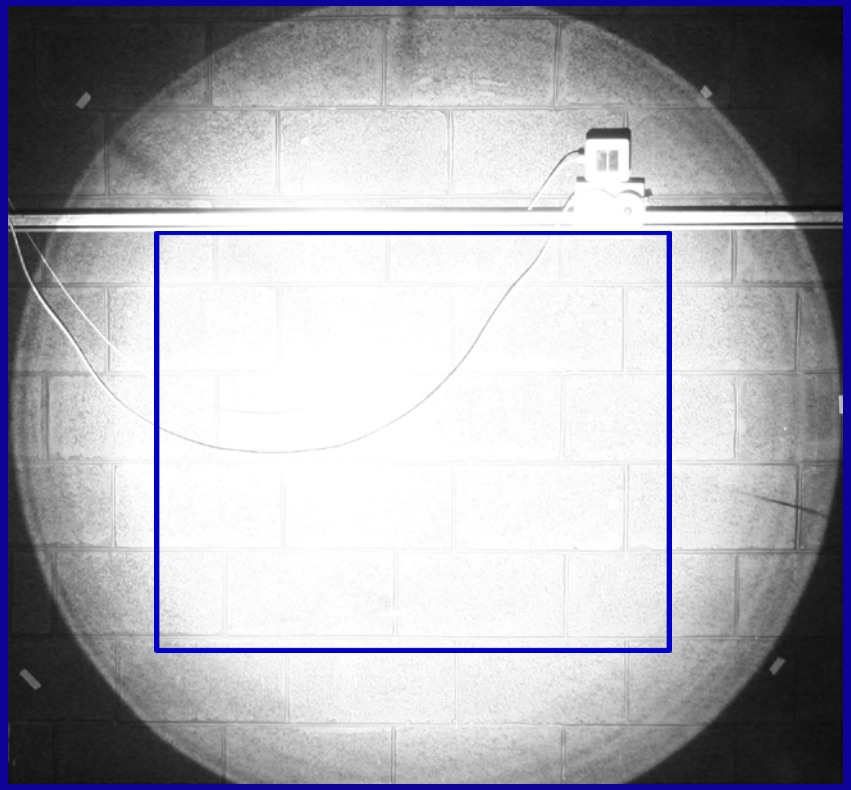
Methodology



Methodology

Irradiance, Temperature & Non-Uniformity Test

- Target area 2m x 2m



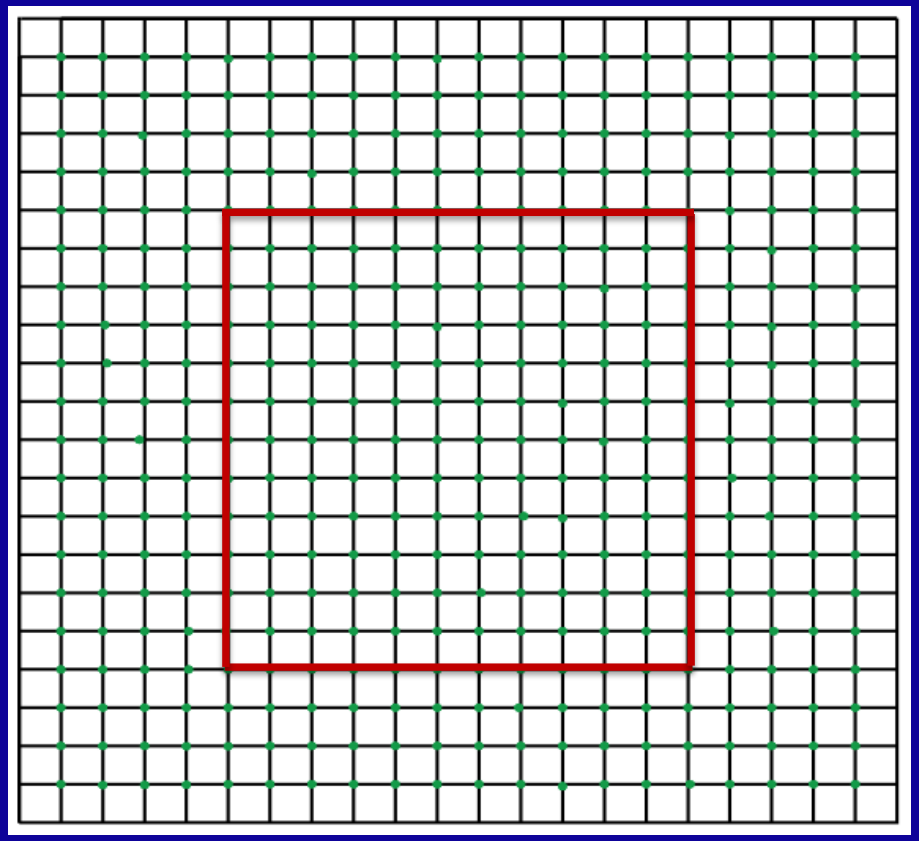


Figure 4: Target area

Device Under Test

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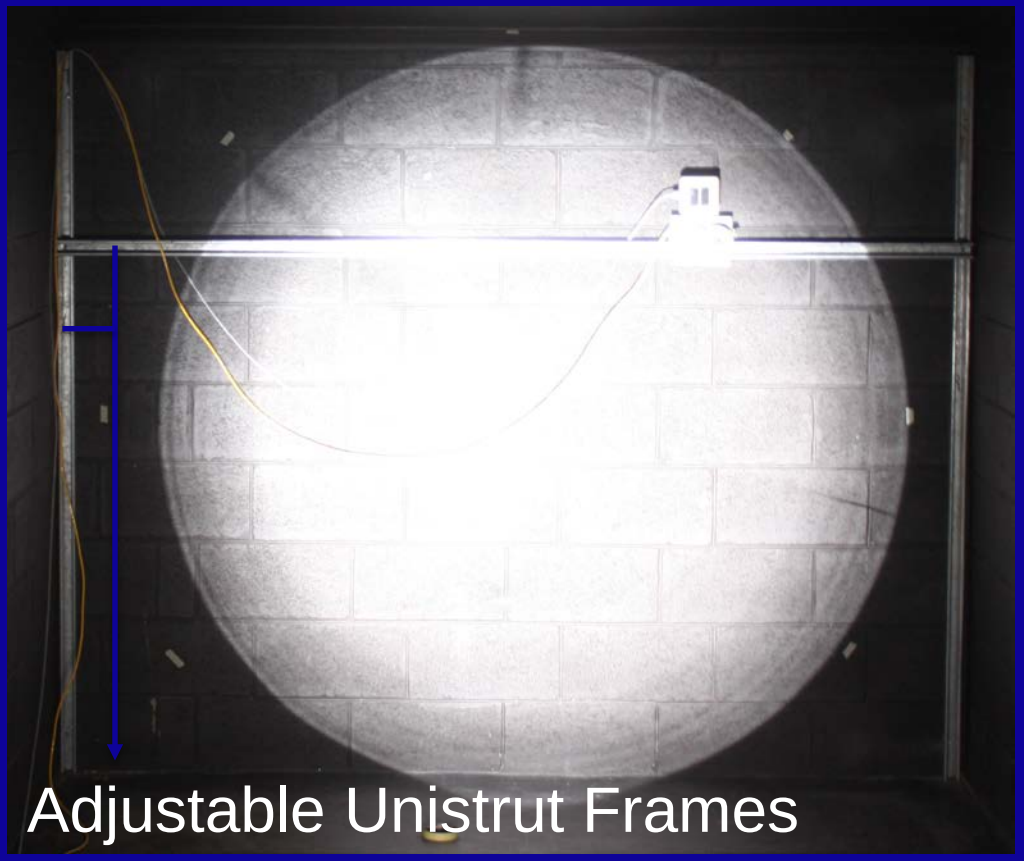


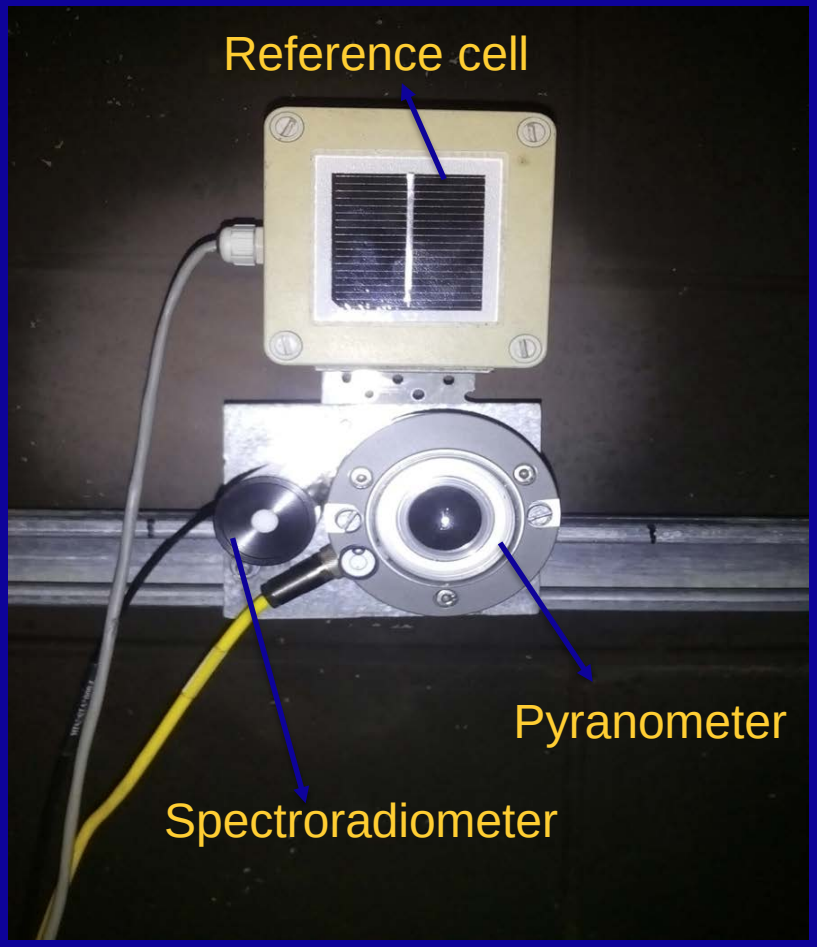


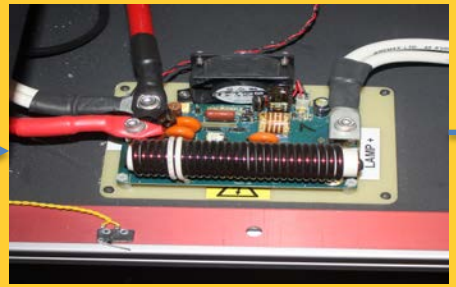
Figure 5: Target area showing device under test

METHODOLOGY

Characterisation

5 kW DC Power Supply

Igniter

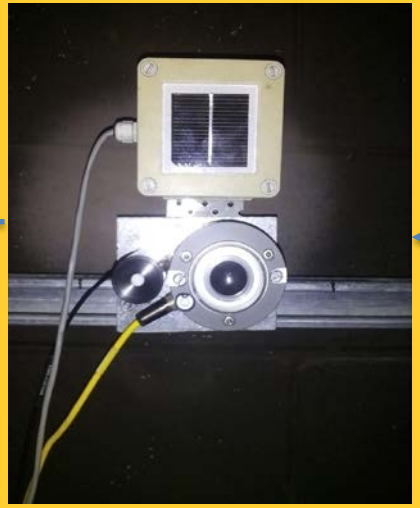


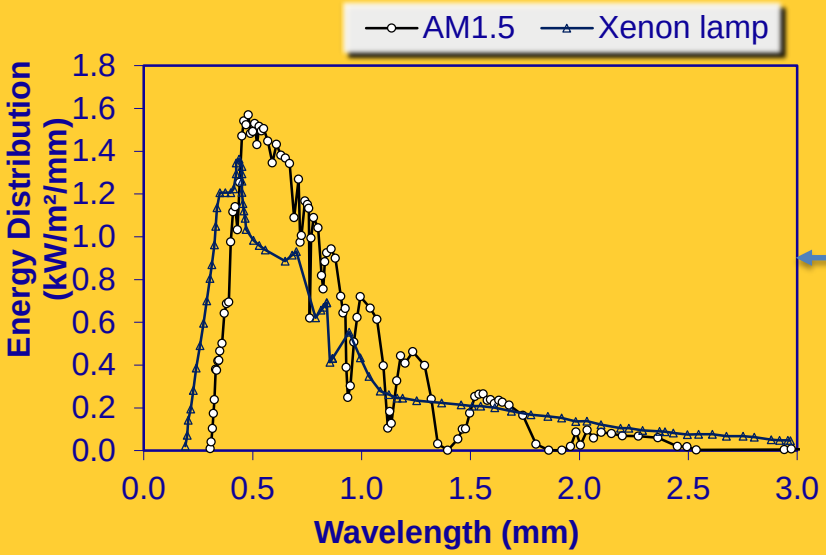
5 kW Xe Arc Lamp

Reflector with Xe-Arc Lamp

Auto/Manual Lamp Control

Target Area with Reference cell, Pyranometer and Spectroradiometer



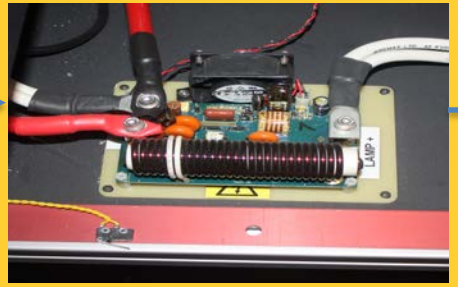


METHODOLOGY

Applying the Xenon-lamp solar simulator on various PV technologies

5 kW DC Power Supply

Igniter

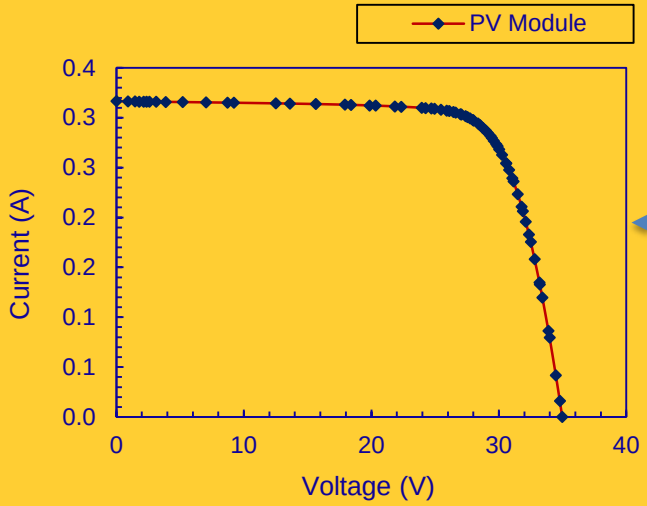


5 kW Xe Arc Lamp

Reflector with Xe-Arc Lamp

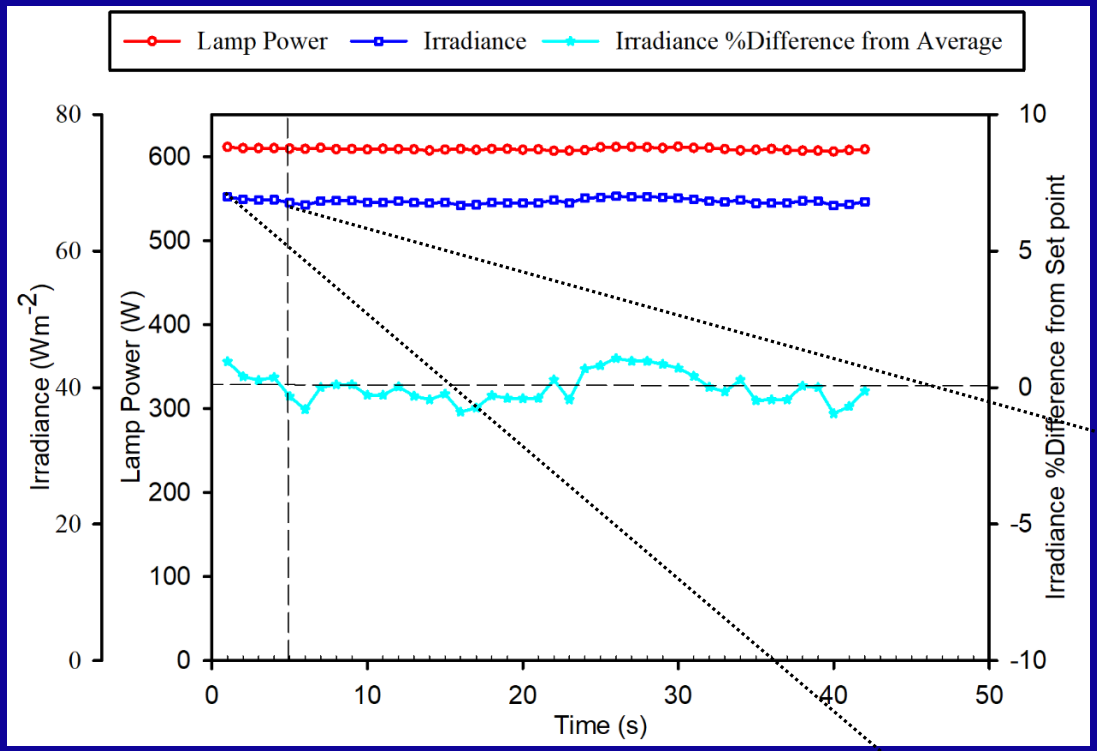
IFCS

Target Area with Reference cell and C-Si Module



Results

Lamp Startup



Irradiance 67 Wm^{-2}

Power 600 W

± 1% drift from set point

Lamp stability 5 sec

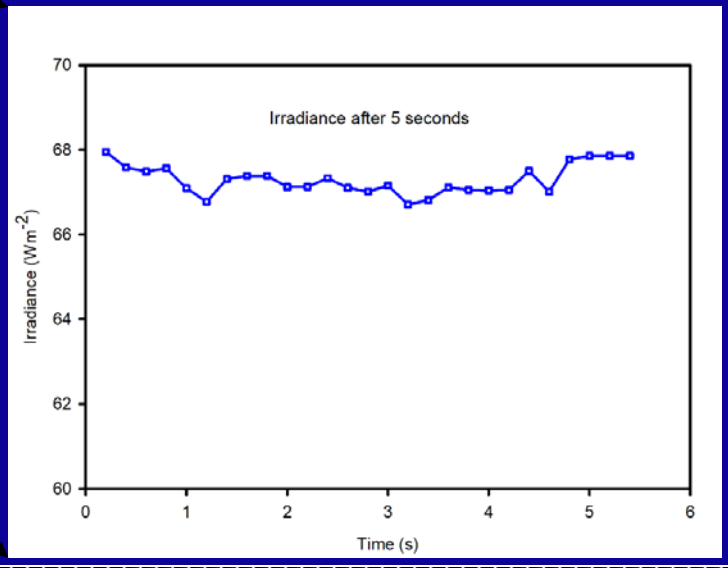
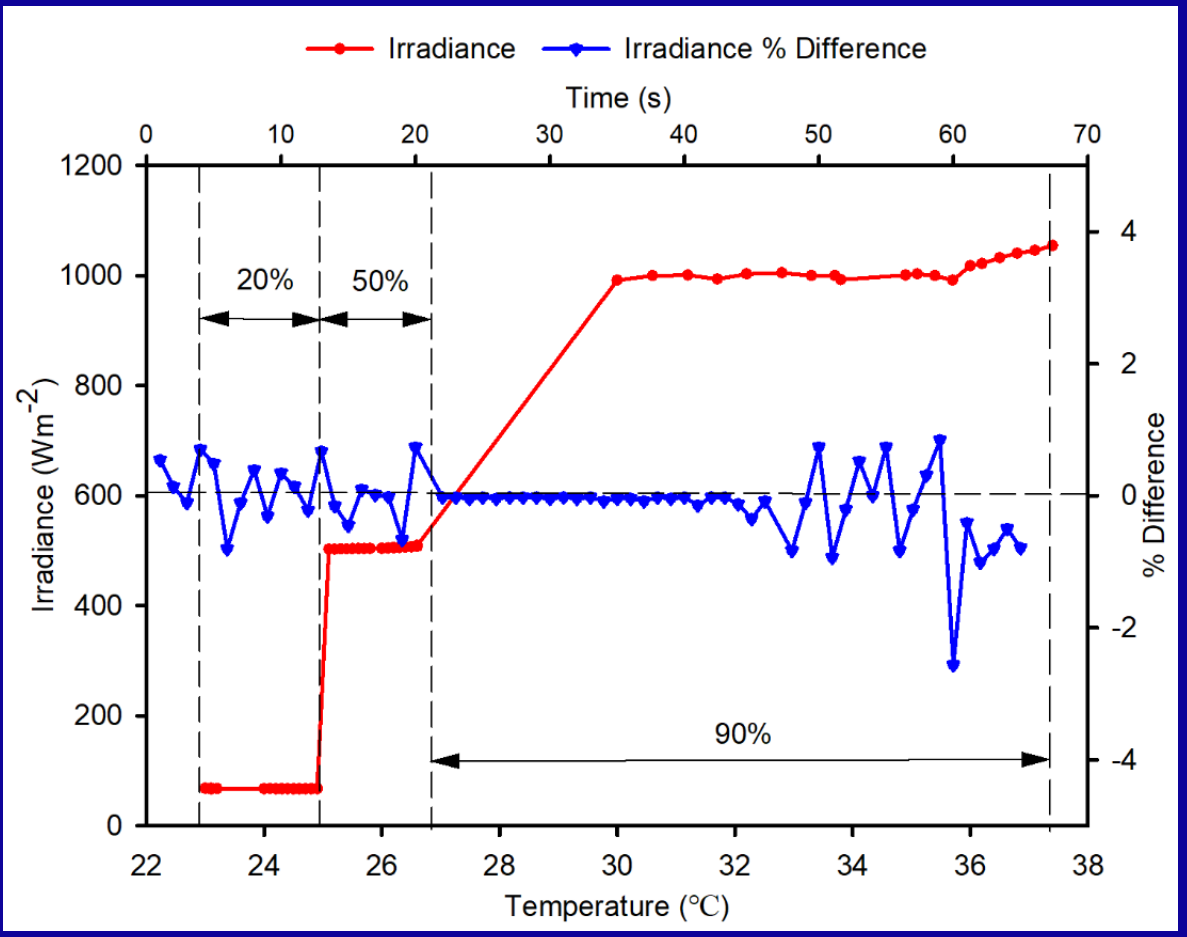


Figure 6: Xenon arc lamp power and irradiance distribution

Results

Varying Lamp Input Power and Temperature Test



1000 Wm^{-2} at 90% max current, 20 s, 35 °C

± 2.3% irradiance drift from set point

Figure 7: Solar simulator operated at varying set points of its rated current

Results

Non-Uniformity

Table 1: Non-Uniformity at varying irradiance set points

Power level	Current Drawn (A)	Cell surface Temperature (℃)	Non-Uniformity (%)
20 % of rated max	29	22.6	1.02
50 % of rated max	72.5	24.4	1.53
90 % of rated max	130.5	25.4	3.26

Conclusions

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IRRADIANCE 1000 Wm^{-2} ➔ 90% ➔ <10 s to stabilize…

Non-Uniformity 1000 Wm^{-2} ➔ 3.26% ➔ Class A

PERFOMANCE Achieves Set points faster,…

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Acknowledgements

- Prof. E. L. Meyer
- Dr. R. Kaseke
- Dr. R. T. Taziwa
- M. Adonis

THANK YOU FOR LISTENING