



HAL
open science

CABLE SOLAR Project : CAptive Balloons for aLtitudE SOLAR farms

Yoan Bourlier, Géraud Delpont, Tiphaine Mathieu-Pennober, Jean-François Guillemoles, Johan Parra, Anne Migan-Dubois, Vincent Bourdin, Jordi Badosa, Jean-Charles Dupont, Vincent Boitier, et al.

► **To cite this version:**

Yoan Bourlier, Géraud Delpont, Tiphaine Mathieu-Pennober, Jean-François Guillemoles, Johan Parra, et al.. CABLE SOLAR Project : CAptive Balloons for aLtitudE SOLAR farms. 13ème Journées Nationales du Photovoltaïque (JNPV 2023), Dec 2023, Dourdan, France. . hal-04730943

HAL Id: hal-04730943

<https://hal.science/hal-04730943v1>

Submitted on 11 Oct 2024

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.

CNRS-IPVF Yoan Bourlier, Géraud Delpont, Tiphaine Mathieu-Pennober, Jean-François Guillemoles, TANKERS SAS Mickaël Frodin, Julien Prudent
 IPVF SAS Karim Medjoubi, Corentin Domeneghetti, Thomas Guillemot, Nicolas Vandamme, SOYPV SAS, Alexandre Crossay, Damien Gamet, Daniel Lincot, SOLAR CLOTH SAS, Alain Janet
 IPSL-SIRTAs Johan Parra, Anne Migan-Dubois, Vincent Bourdin, Jordi Badosa, Jean-Charles Dupont, LAAS-CNRS Vincent Boitier, Corinne Alonso

CABLE SOLAR Project : Captive Balloons for altitude SOLAR farms

Main goal

Development of a long-duration flying platform using photovoltaic energy and thin film solar cells architecture to produce electricity

Main Objectives

- Durable Captive balloon autonomous in energy
- Developing an airborne platform for solar cells characterizations

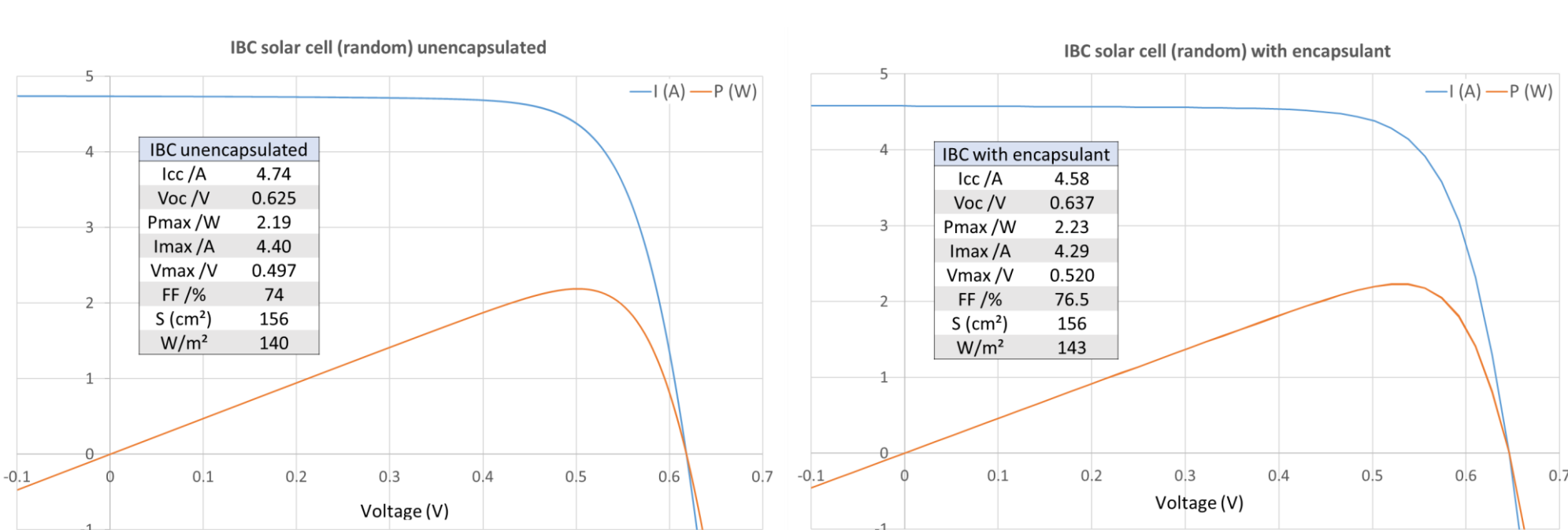
Main achievements

- Electrical contacts, Encapsulation and I/V characterization were performed on isolated solar cells
- The first two "on scale PV-ring" using Si and CIGS solar cell technologies have been designed and realized
- Installation of the winching station and first flights realized with Tankers SAS

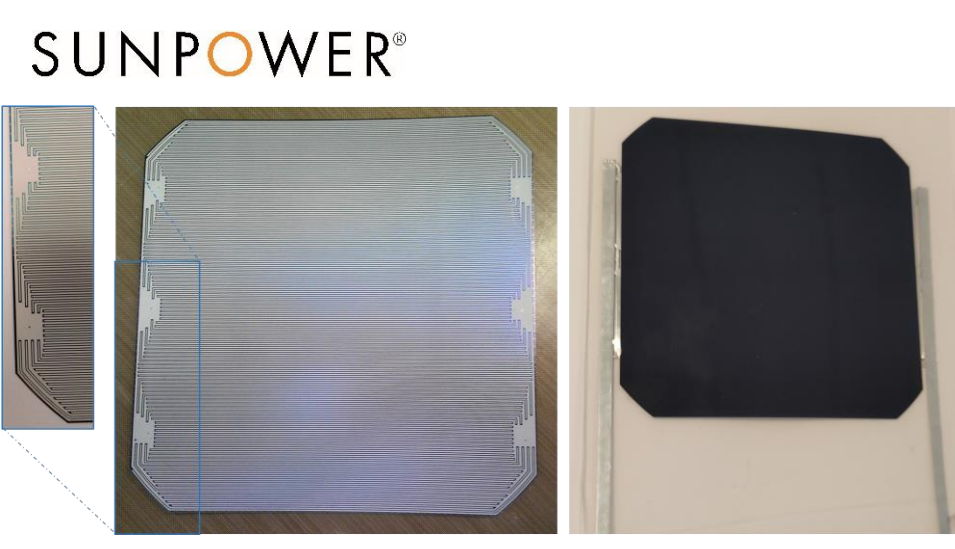


Solar cells electrical characterization & On-scale module design

Si solar cells encapsulated at IPVF with indoor I/V characterization

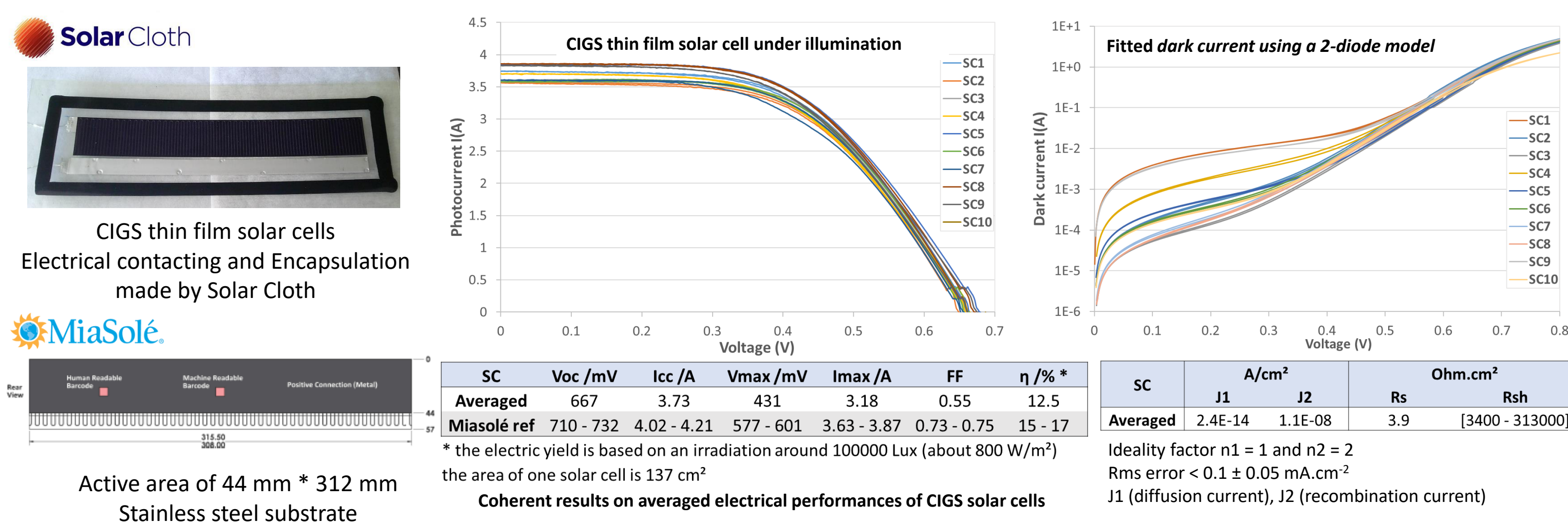


No significant electrical performance loss observed with encapsulant

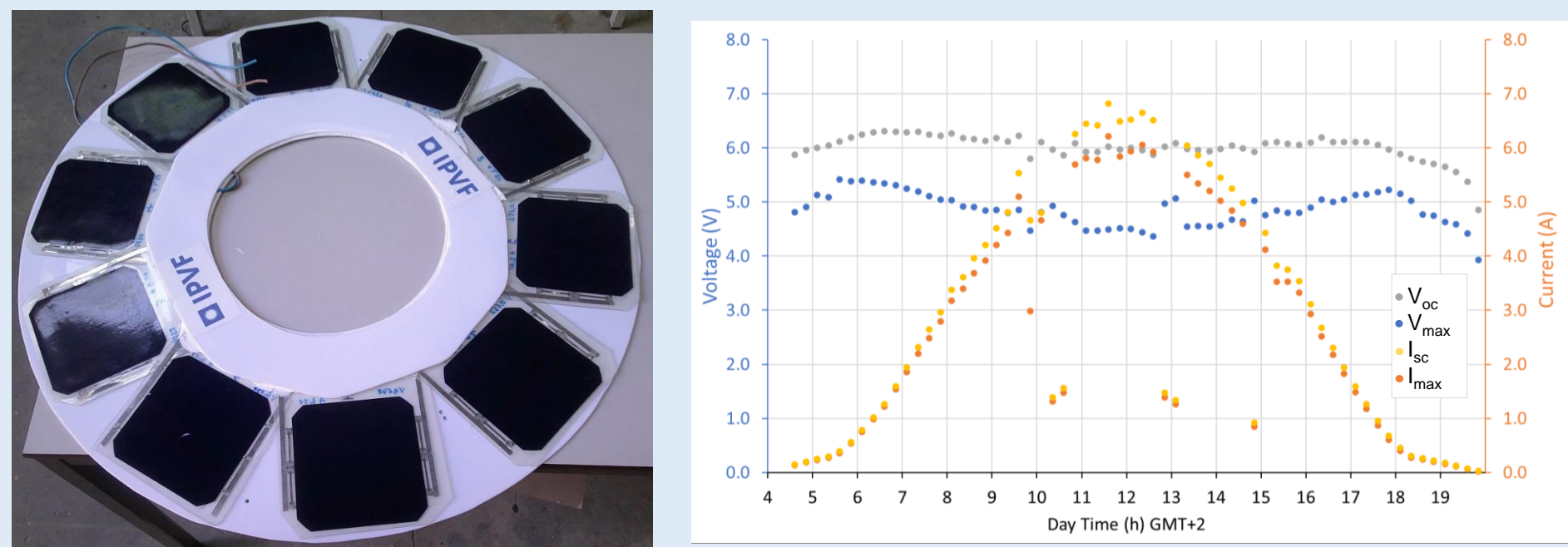


Monocrystalline Silicon solar cells
 Interdigitated back contact (IBC) architecture
 12.5 cm x 12.5 cm
 Electrical contact and encapsulation at IPVF

CIGS thin film technology with outdoor I/V characterization at SOYPV

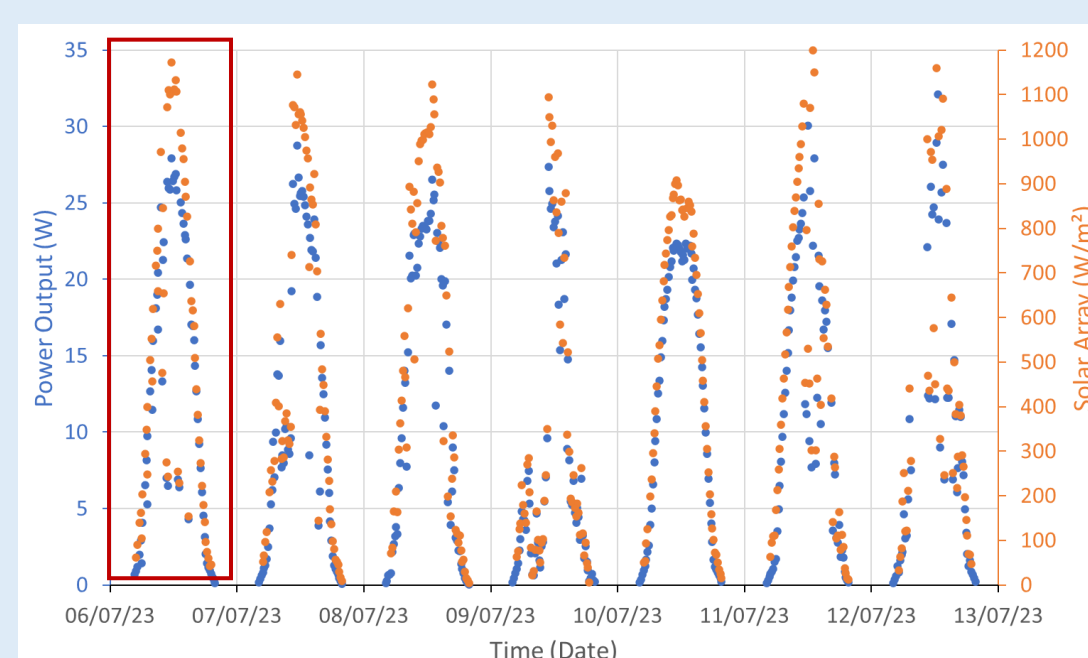


Outdoor electrical measurements at SIRTAs

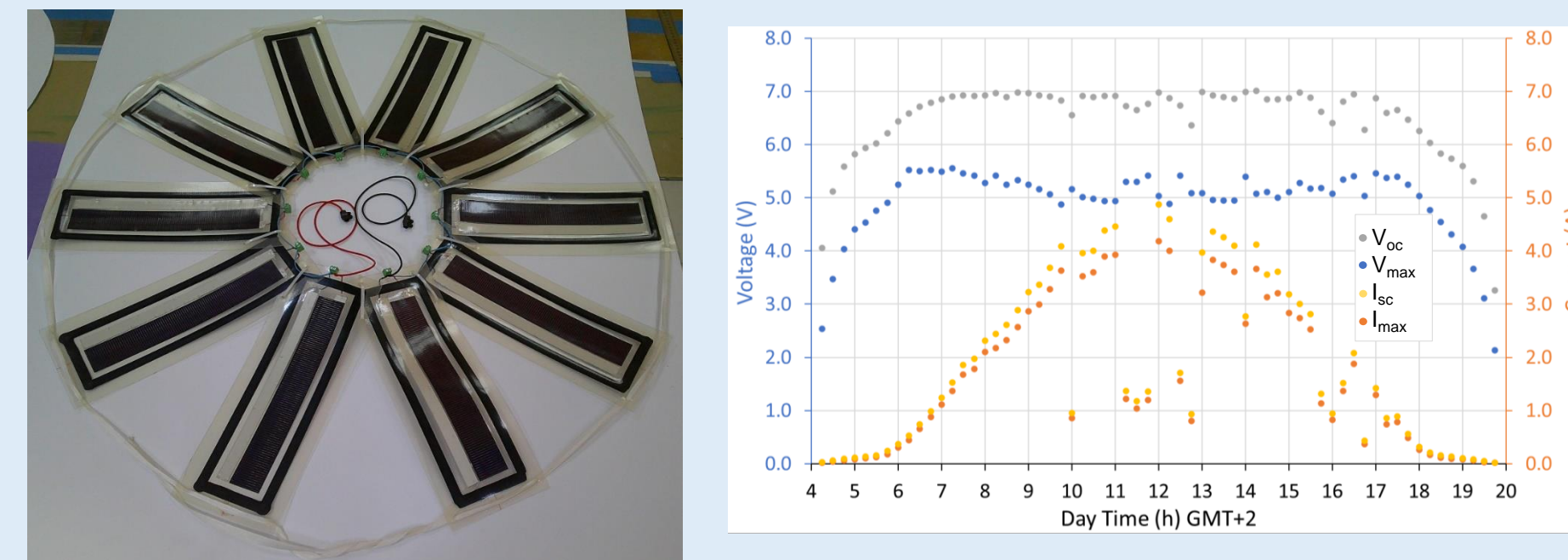


Module design
 10 IBC solar cells connected in series
 IBC unit cell weight : 8g, 12.5*12.5 cm
 with encapsulant : 45g, 16*15 cm
 Total weight of the ring : 1.5 kg

Power output = 25-30 W
 V_{max} ~ 5V
 I_{max} ~ 6A
 15% < η < 17%

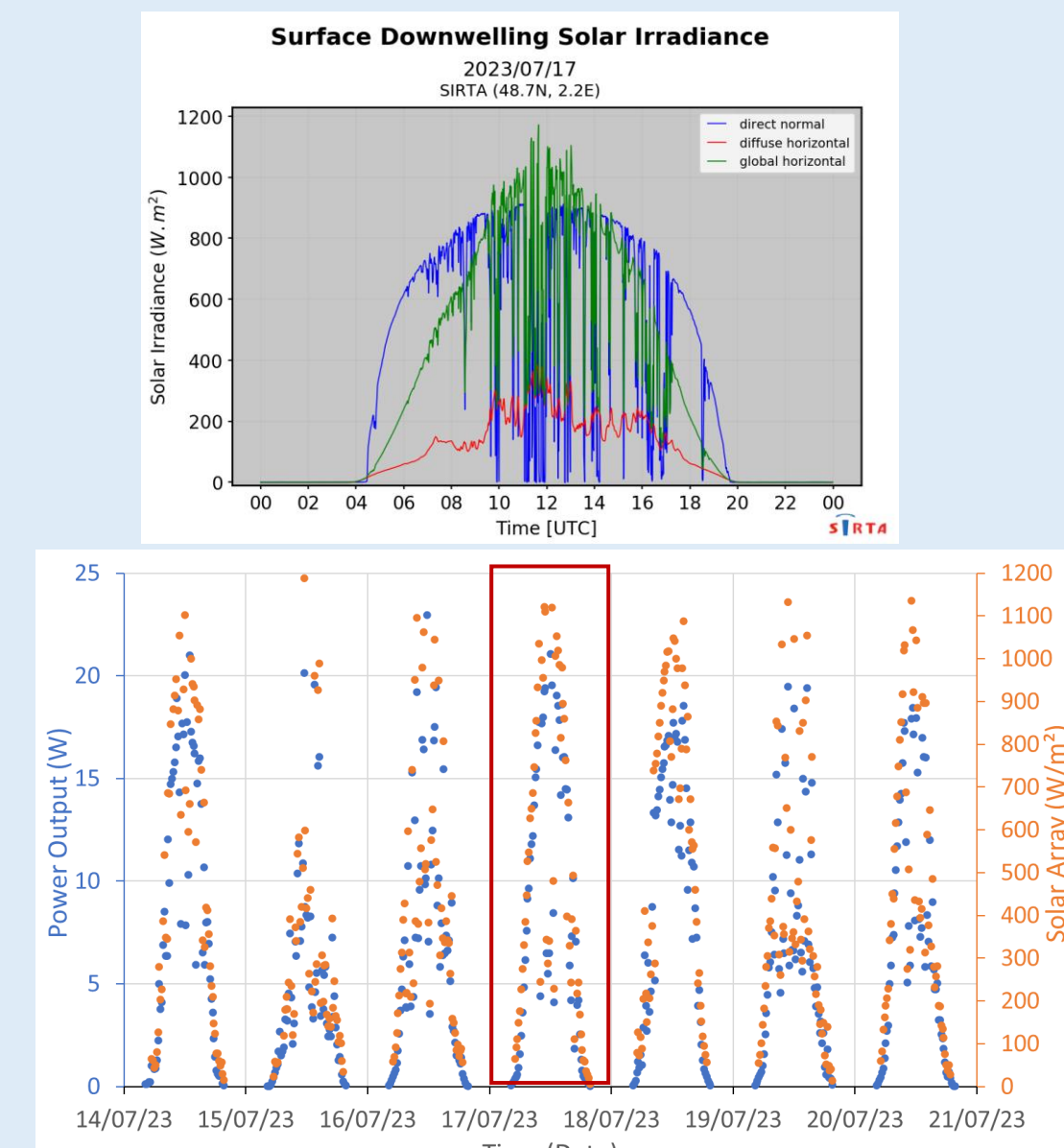


Outdoor electrical measurements at SIRTAs



Module design
 10 CIGS solar cells connected in series
 CIGS unit cell weight : 8.7g, 5.7*31 cm
 with encapsulant : 70g, 15*40 cm
 Total weight of the ring : 0.800 kg

Power output = 15-20 W
 V_{max} ~ 5V
 I_{max} ~ 3.5A
 12% < η < 14%



PV integration and first flight



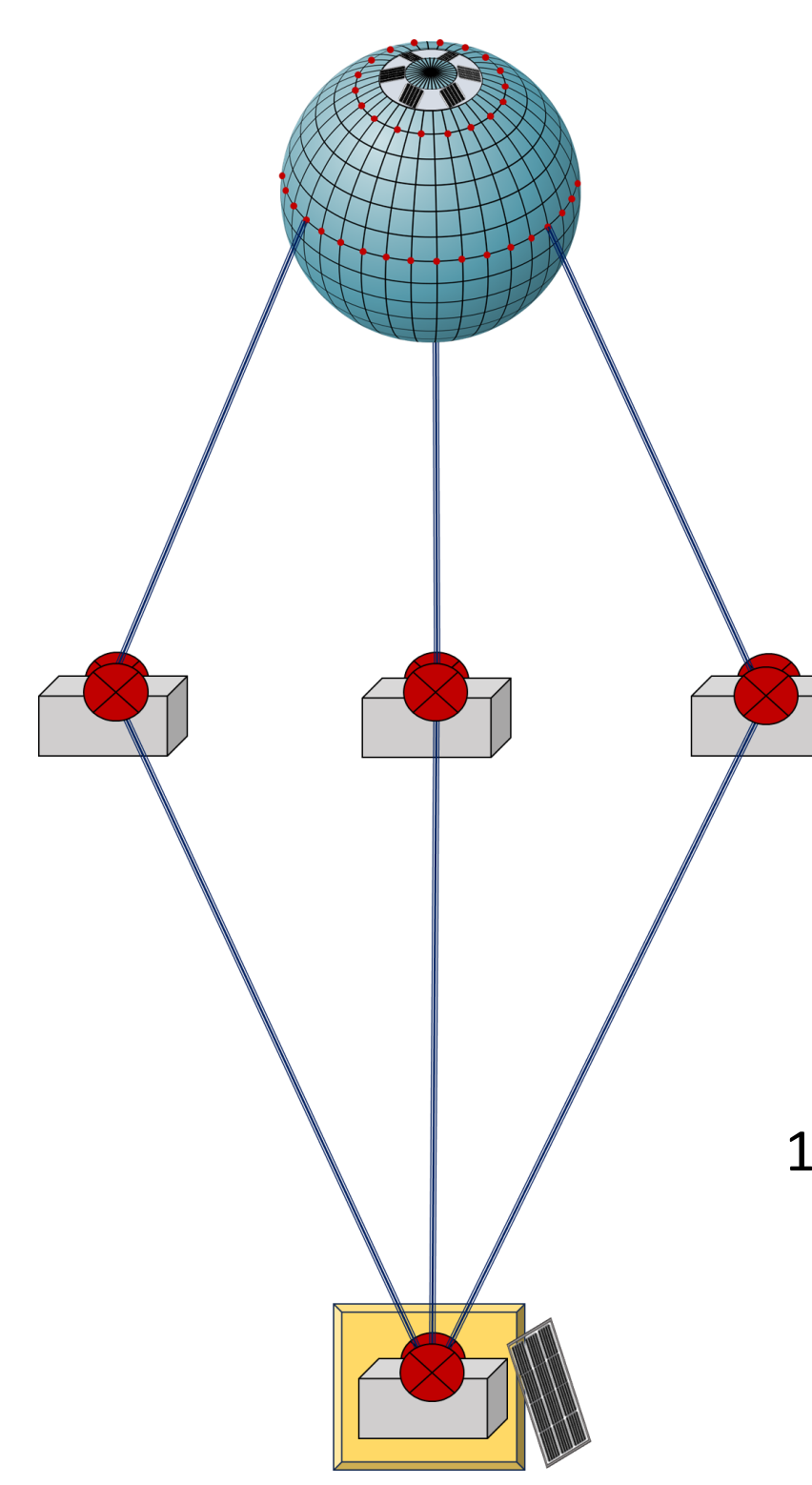
Indoor tests at Tankers building



Platform of flight and PV installation



First flights in June 2023



Description of the platform

- Captive balloon**
 - 4 m diameter Sphere
 - 30 m³ of Helium
 - 4G communication
 - Environmental sensors
 - 50 meters of altitude
 - PV ring for battery loading
- Stabilization**
 - 1 overall net
 - 3 deported cable pulley sealed on ground
- Ground station**
 - 1 electric winch sealed on ground
 - Connected anemometer
 - Wind alert communication
 - Manual and remote control
 - 12V battery monitoring with a 120W PV panel

Under progress... and Forecast

- Embedded system for airborne measurement of the PV production
- Sensor network under development → distribution of the solar array on the balloon vs daytime
- Array simulation in LAAS laboratory → optimization of the PV architecture
- Next flight campaign at SIRTAs-IPSL meteorological measurements platform in preparation
- Bibliographic study and technico-economic assessment in progress



SIRTAs platform PV panels in real conditions with environmental measurement facilities

Acknowledgment

- We want to thank **M. Alain Janet (Solar Cloth)** for the supply of the CIGS thin film solar cells
- We are very grateful to **Mrs. Christine Dillmann (INRAE)** for giving us the opportunity to fly on their land
- We specially thank **M. Rolland Sarda (LSCE)** for providing us the Helium

Funding

- This work is supported by the EDF Chair of "Energies durables" of the Polytechnic Institute of Paris

