Analisi di guasti e previsioni di produzione in impianti di produzione dell’energia: misura e telecontrollo di impianti fotovoltaici.

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Why monitoring and predict solar plant performance?

Increasing the production efficiency of solar photovoltaic systems

Forecast the production in order to increase the economical turn over of the investement.

Predict failures and out of production

Maintaining plant in a efficient way

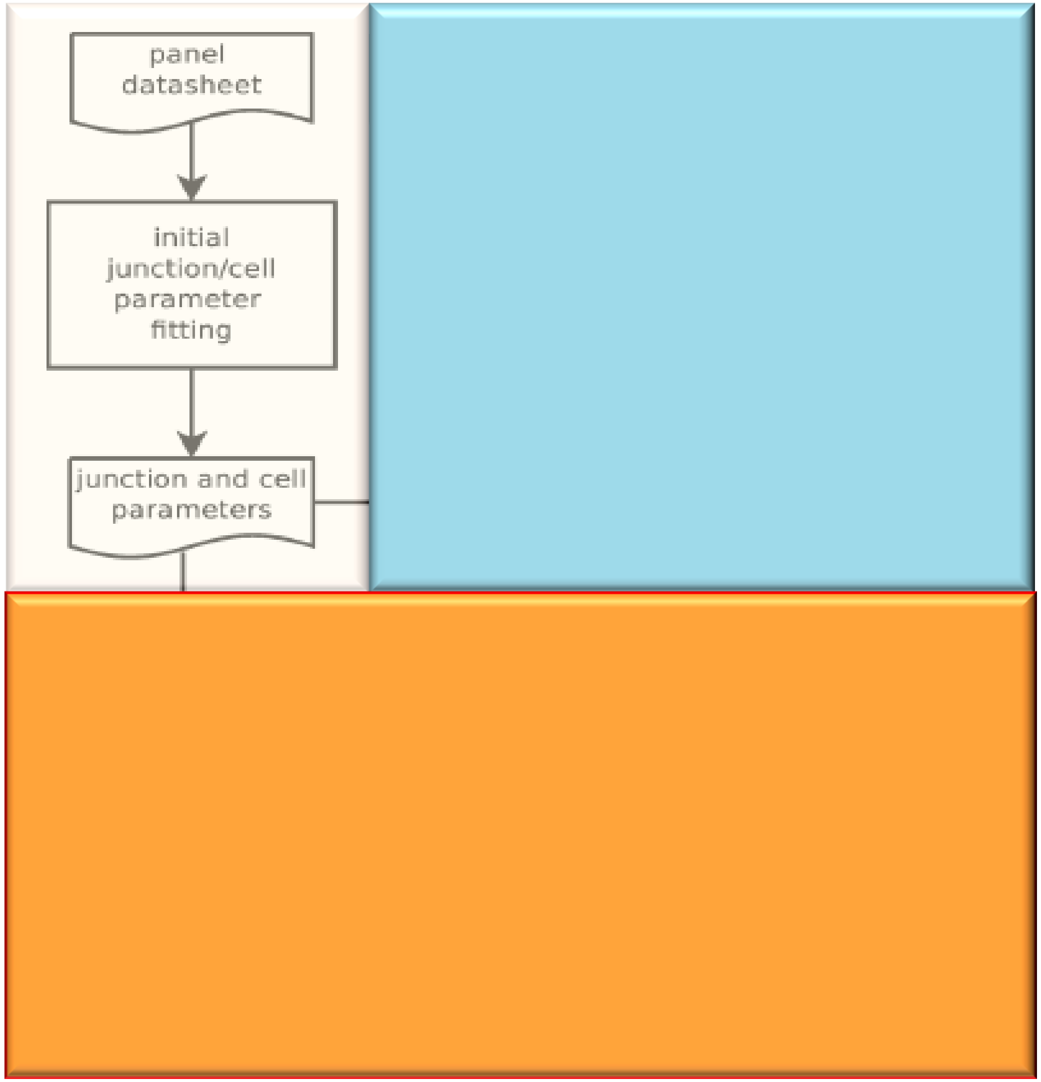
What are the key point of an efficient PV system?

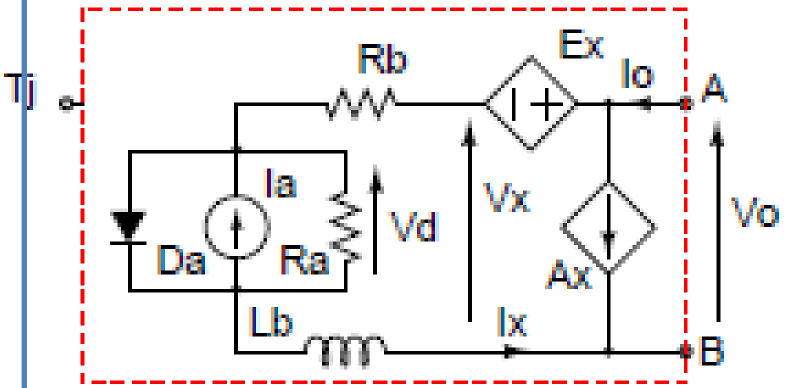
The plant must always work at its maximum designed efficiency even considering equipment degradation due to aging

Variability in energy production must be exclusively due to unavoidable irradiance, working temperature and wind speed fluctuations.

Point of force of the proposed method?

- detecting simple electrical failures
- evaluating progressive efficiency degradation, caused by dust on photovoltaic panels
- evaluating efficiency degradation due to, silicon aging
- predicting energy production according to weather forecast data

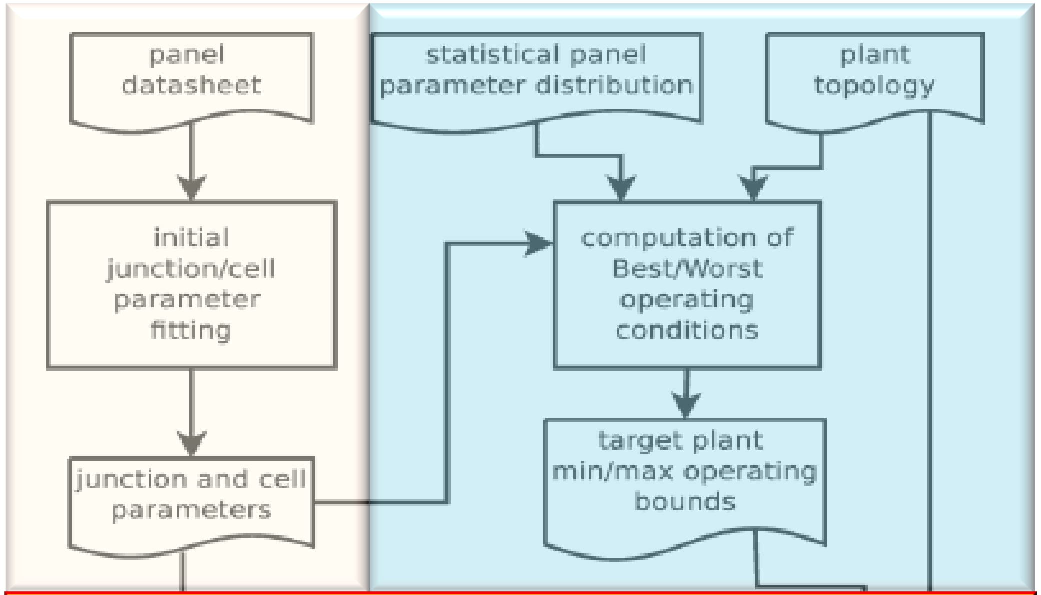

panel datasheet
initial junction/cell parameter fitting
junction and cell parameters



MacroModel of the cell

Temperature of the panel as a function of ambient temperature, irradiance and wind as follows

$$T_{PV} = T_{\text{amb}} + \frac{S\left(T_{\text{noct}} - T_o\right)}{S_o + h\left(\nu - \nu_o\right)\left(T_{\text{noct}} - T_o\right)}$$



panel datasheet

initial junction/cell parameter fitting

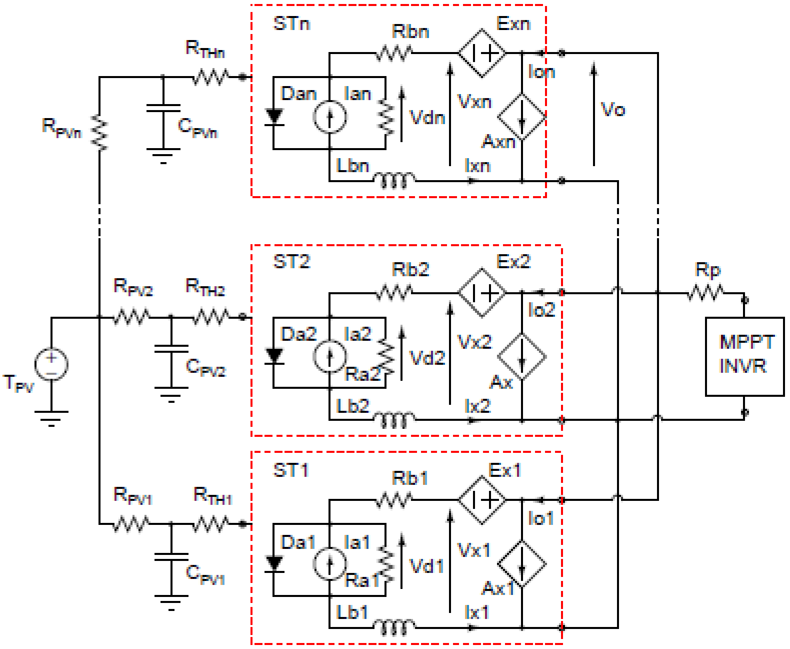
junction and cell parameters

statistical panel parameter distribution

plant topology

computation of Best/Worst operating conditions

target plant min/max operating bounds


STn
Rbn
Exn
R_{THn}
Ion
Dan
Ian
Vdn
Vxn
Vo
R_{PVn}
C_{PVn}
Axn
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ST2
Rb2
Ex2
Rp
R_{PV2}
R_{TH2}
Io2
Da2
Ia2
Vd2
Vx2
MPPT
INVR
T_{PV}
C_{PV2}
Ra2
Ax
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Ix2
ST1
Rb1
Ex1
R_{PV1}
R_{TH1}
Io1
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Vx1
C_{PV1}
Ra1
Ax1
Lb1
Ix1

Macro Model of the Plant

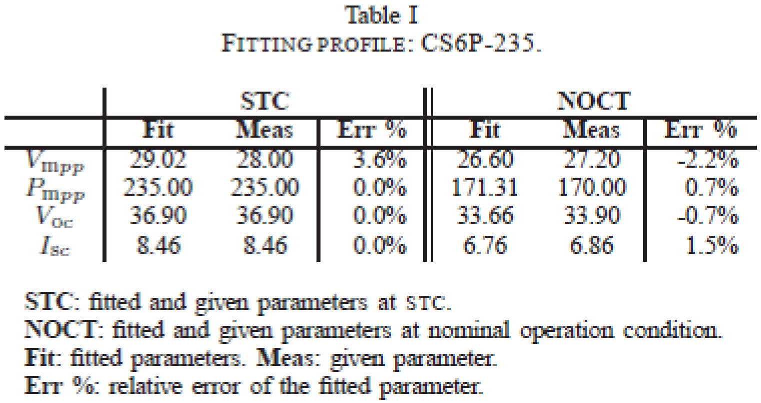


Table I
FITTING PROFILE: CS6P-235.

	STC			NOCT		
	Fit	**Meas**	**Err %**	**Fit**	**Meas**	**Err %**
V_{mpp}	29.02	28.00	3.6%	26.60	27.20	-2.2%
P_{mpp}	235.00	235.00	0.0%	171.31	170.00	0.7%
V_{oc}	36.90	36.90	0.0%	33.66	33.90	-0.7%
I_{sc}	8.46	8.46	0.0%	6.76	6.86	1.5%

STC: fitted and given parameters at STC.
NOCT: fitted and given parameters at nominal operation condition.
Fit: fitted parameters. **Meas**: given parameter.
Err %: relative error of the fitted parameter.

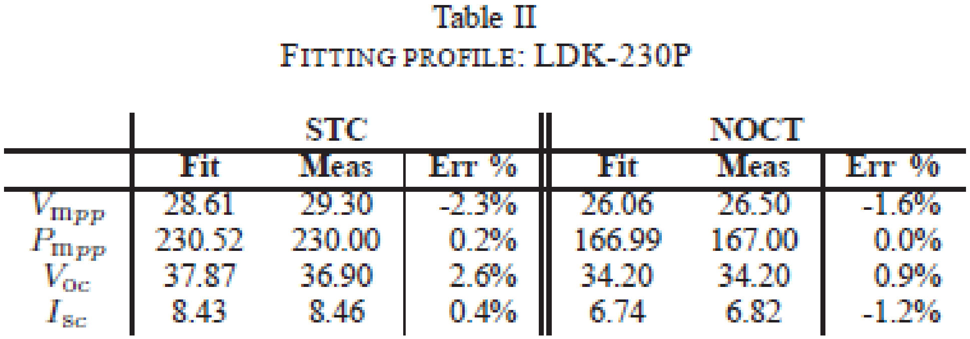
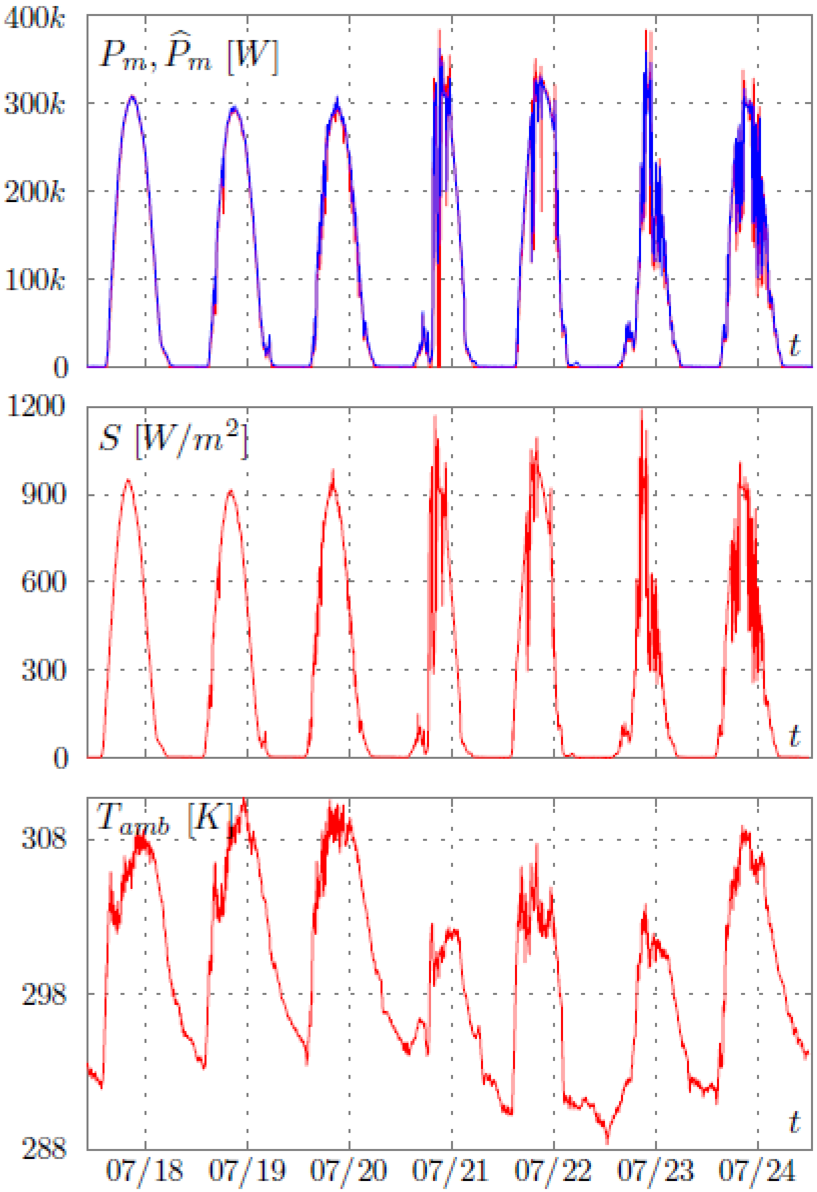
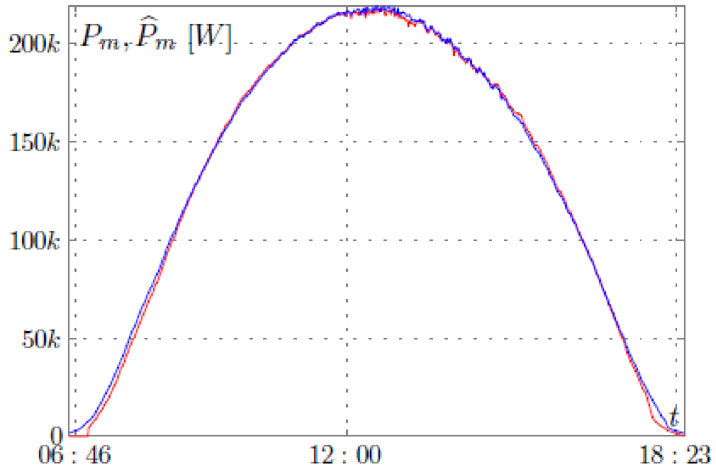


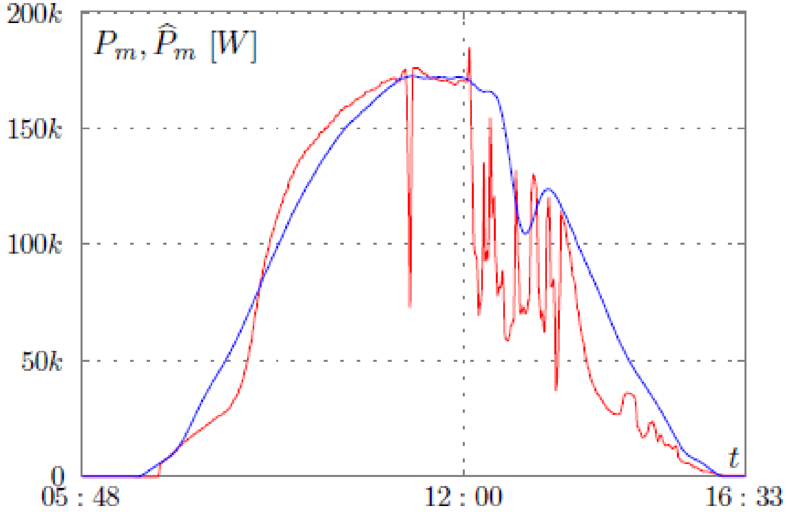
Table II
FITTING PROFILE: LDK-230P

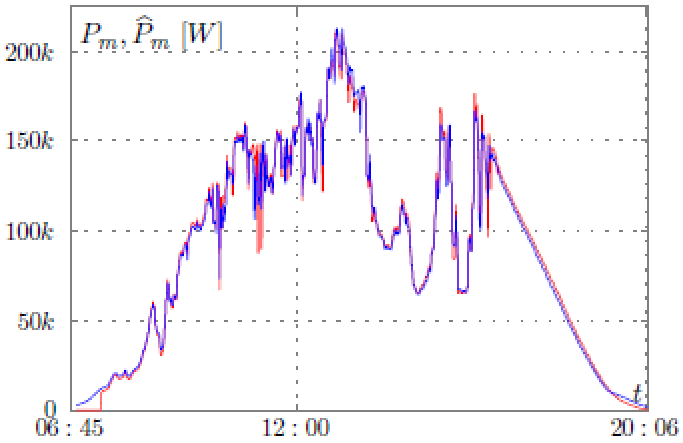
	STC			NOCT		
	Fit	**Meas**	**Err %**	**Fit**	**Meas**	**Err %**
V_{mpp}	28.61	29.30	-2.3%	26.06	26.50	-1.6%
P_{mpp}	230.52	230.00	0.2%	166.99	167.00	0.0%
V_{oc}	37.87	36.90	2.6%	34.20	34.20	0.9%
I_{sc}	8.43	8.46	0.4%	6.74	6.82	-1.2%

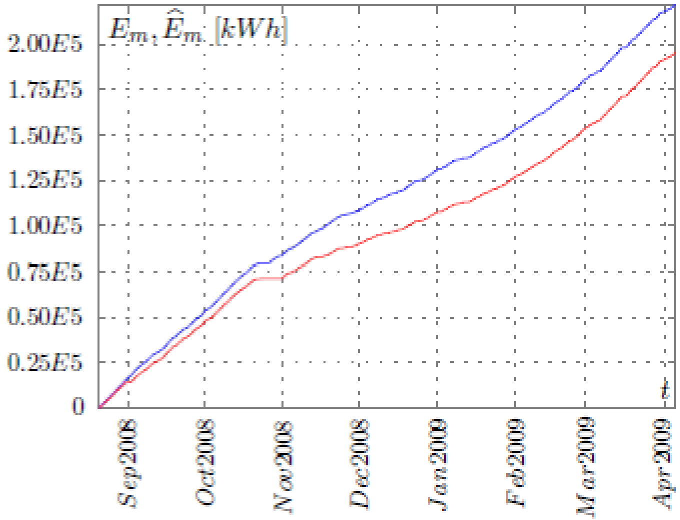
Comparison along one week of measured data versus simulation
results for a sub-plant of a 500kW nominal power solar plant.



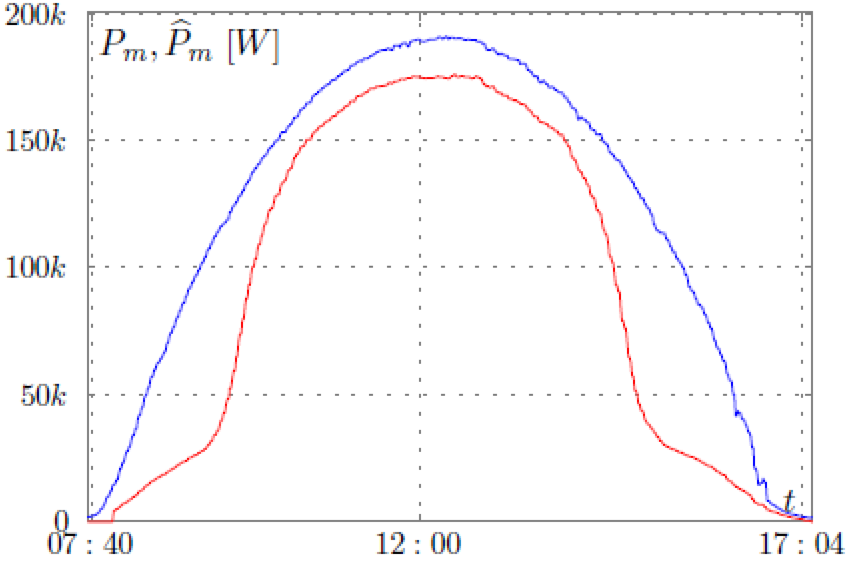








Measured (Pm, in red) and simulated (b Pm, in blue) power duringa cloudy day



Anomalous behaviour (in this case due to the MPPT).

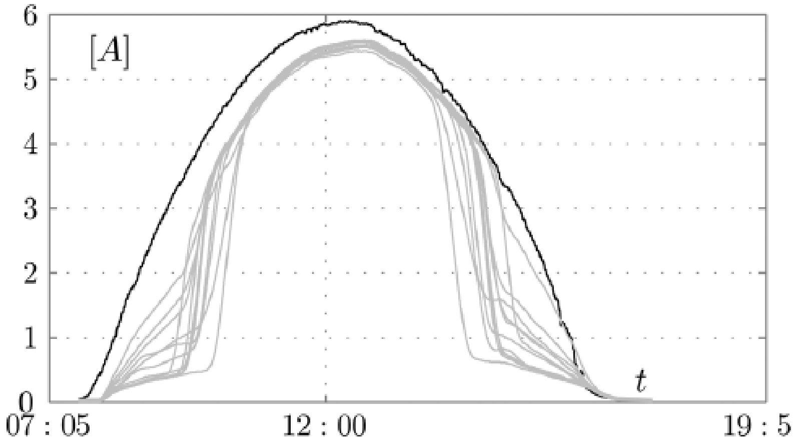
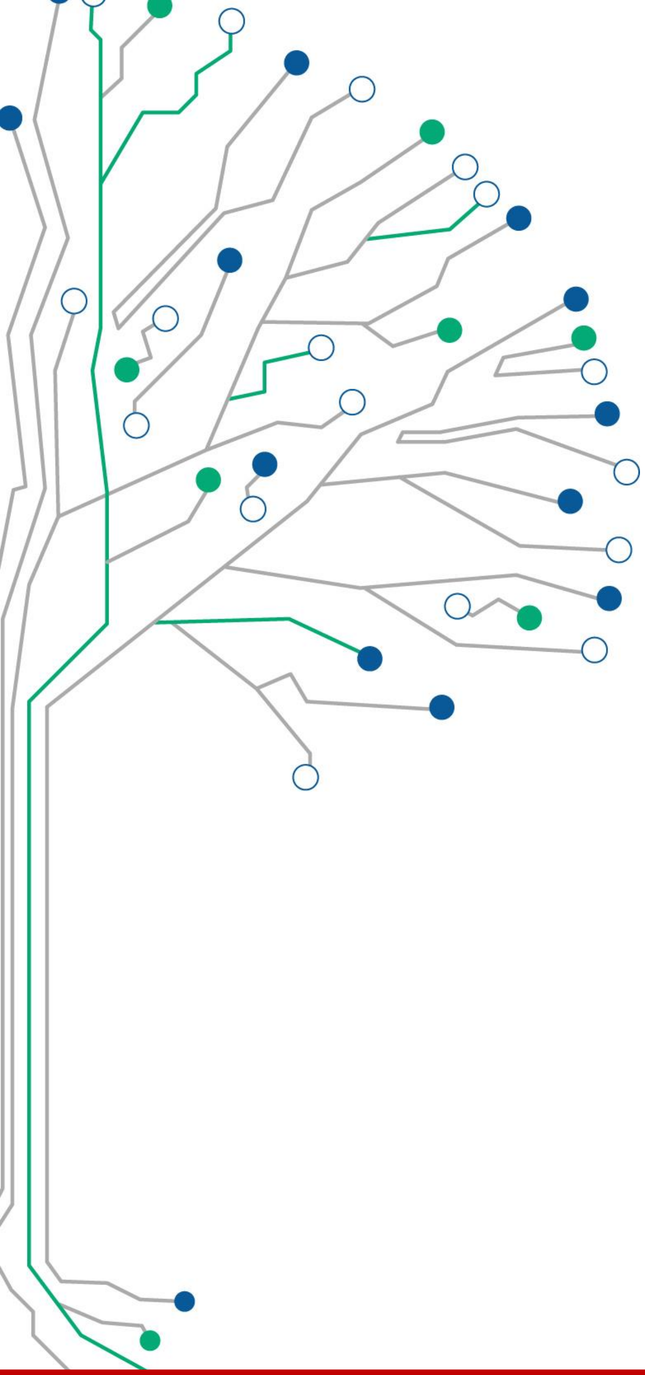


Fig. 10. Simulated, in black, and measured, in light gray, average currents flowing through the string-boxes during the same day of Fig. 9.



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Grazie per l’attenzione!