quantumpower.cmi.cz

Quantum Power

Open source Quantum traceability for AC power standards

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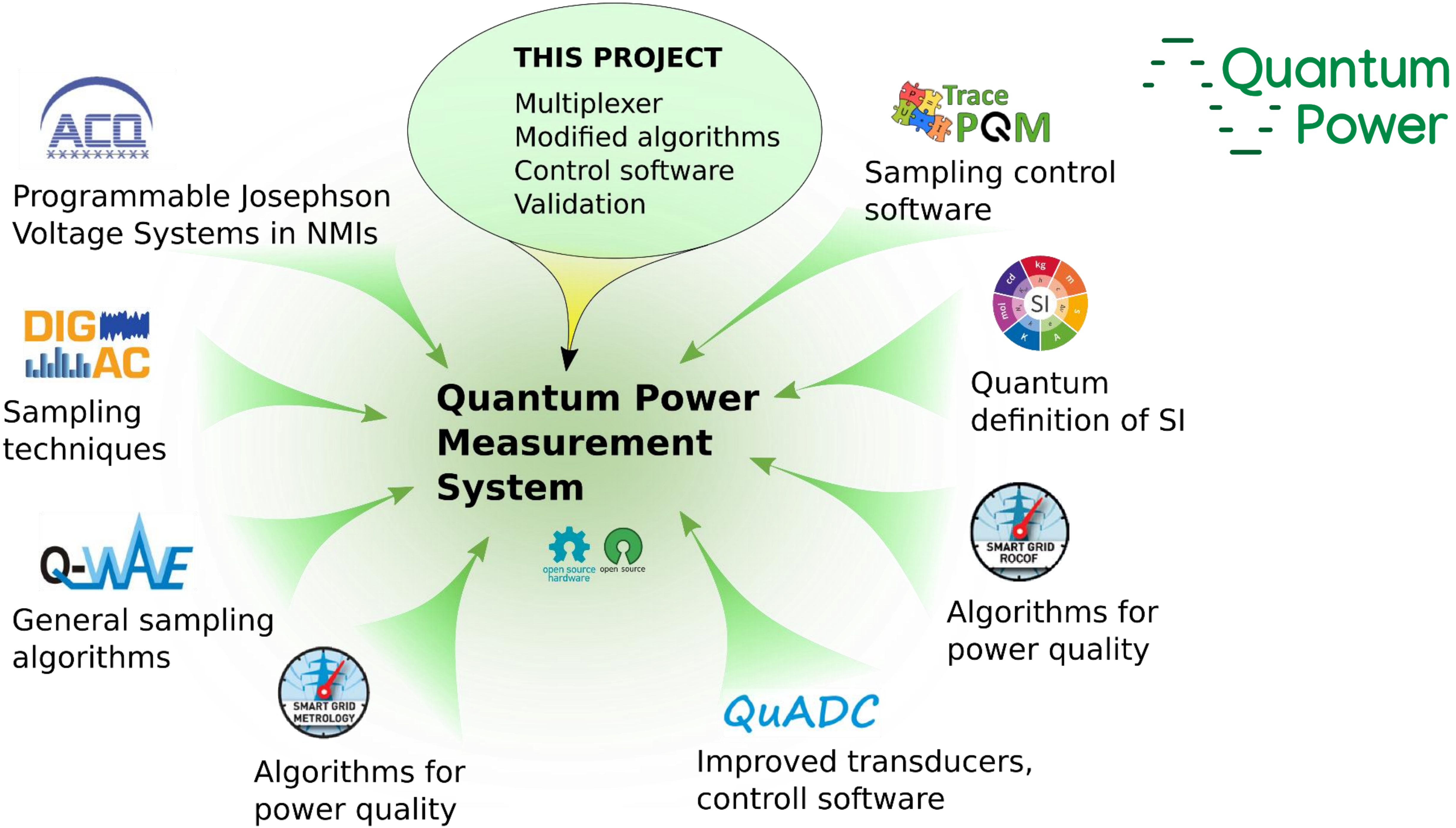
EURAMET TC-EM SC DC and Quantum Metrology meeting

02.06.2021


Quantum Power
THIS PROJECT
Multiplexer
Modified algorithms
Control software
Validation
ACQ
Programmable Josephson
Voltage Systems in NMIs
Trace PQM
Sampling control
software
DIG AC
Sampling
techniques
Quantum Power
Measurement
System
SI
Quantum
definition of SI
open source hardware
open source
Q-WAVE
General sampling
algorithms
SMART GRID ROCOF
Algorithms for
power quality
SMART GRID METROLOGY
Algorithms for
power quality
QuADC
Improved transducers,
controll software

Objectives

1. **To design and realise a practical quantum sampling electrical power standard based on programmable Josephson voltage standards**, traceable digitizers and transducers. The quantum sampling standard should be able to measure electrical power, power quality (PQ) parameters and phasor. The target uncertainties are better than 20 µW/VA for power measurements and less than **2 µW/VA for the contribution of the digitizers.**
2. **To develop software for the operation of the quantum sampling electrical power standard developed in Objective 1.** The software should enable measurement control, data processing and uncertainty estimation. Additionally, it should be **open source** and easily modifiable to control different AC quantum systems.
3. **To develop new methods** and algorithms for the measurement of electrical power using quantum systems, **validate these methods** and algorithms using a transfer standard and develop a protocol for future comparison of QPSs.
4. **For each participant, to develop an individual strategy** for the long-term operation of the capacity developed, including regulatory support, research collaborations, quality schemes and accreditation. Additionally, to develop a strategy for offering calibration services from the established facilities to their own country and neighboring countries. The individual strategies should be discussed within the consortium and with other EURAMET NMIs/DIs including members of relevant EMNs, JRPs and EURAMET TCs, to ensure that a coordinated and optimised approach to the development of traceability in this field is developed for Europe as a whole.

WP1

Review of methods

Multiplexer

Algorithms

WP2

Software

Quantum Power Meas. System

Comparison and validation

WP3

Strategies

Promotion

WP4

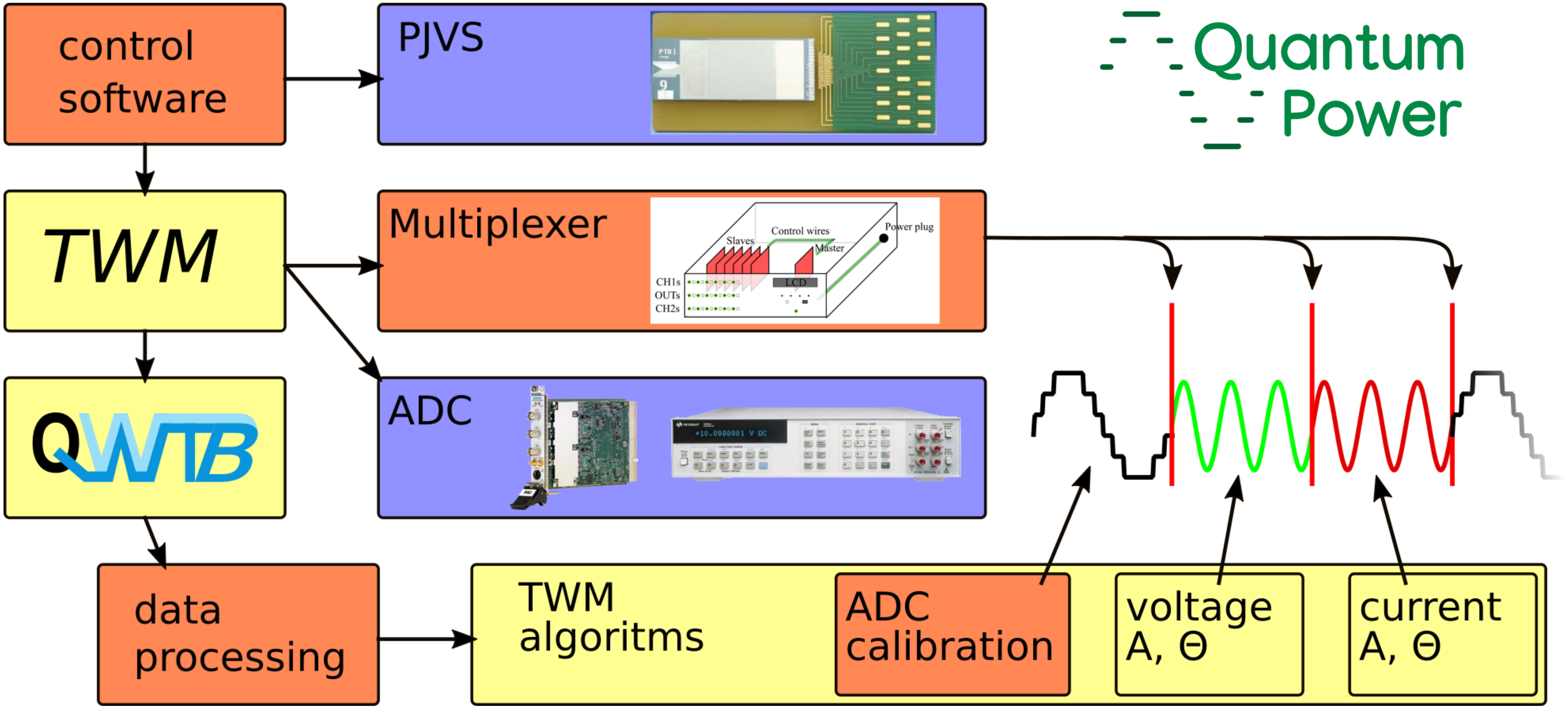
Impact

Knowledge transfer

WP5

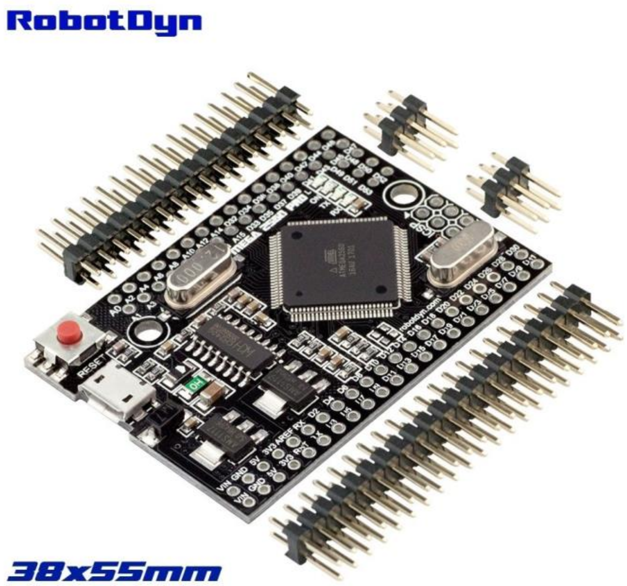
Management

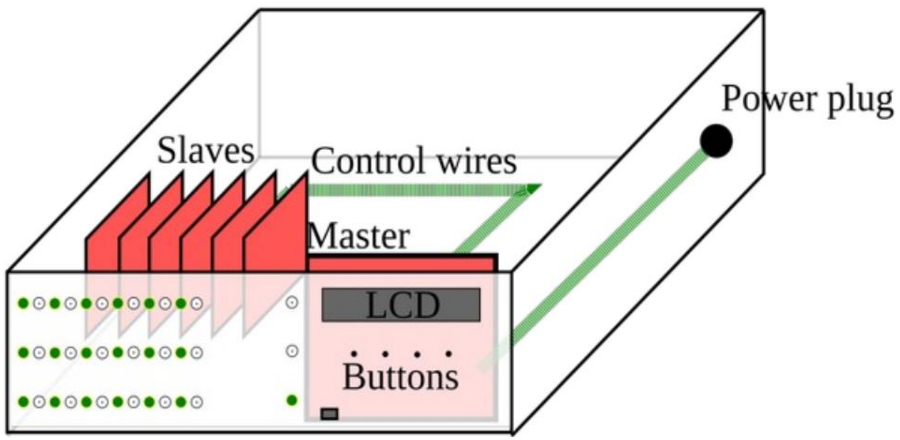
Open source Quantum power standard

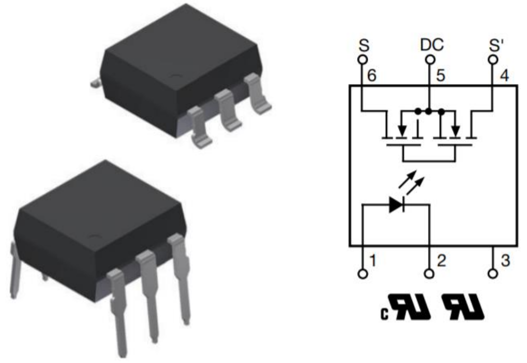


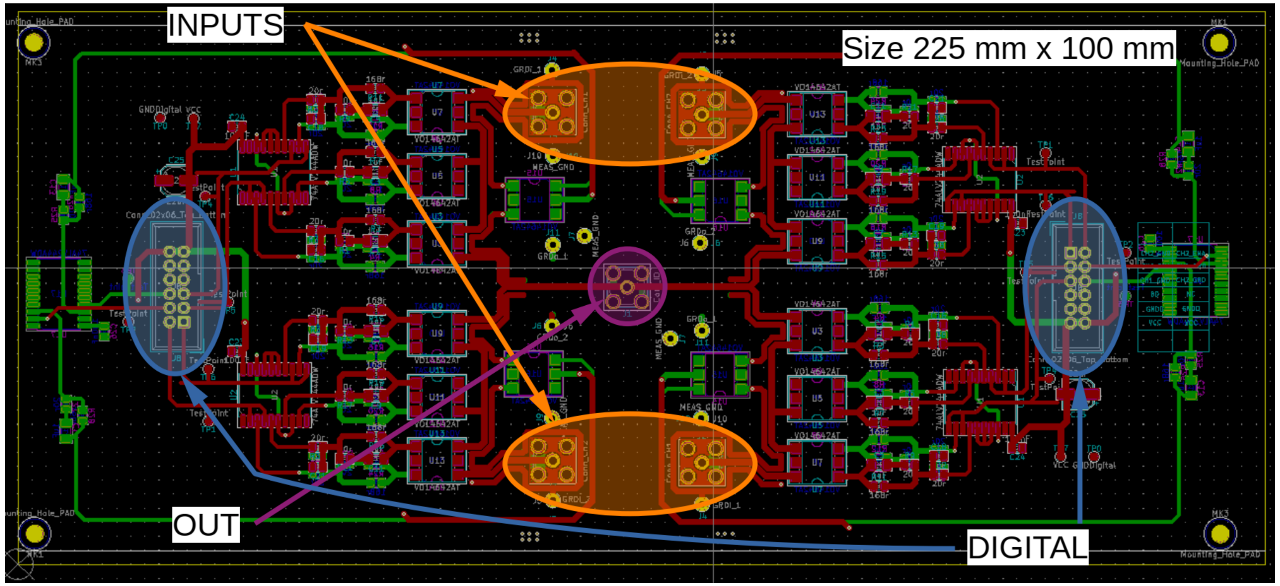
github.com/KaeroDot/QPsw

Modular multiplexer



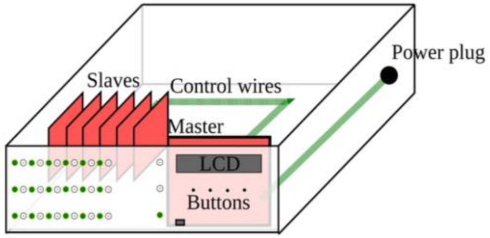




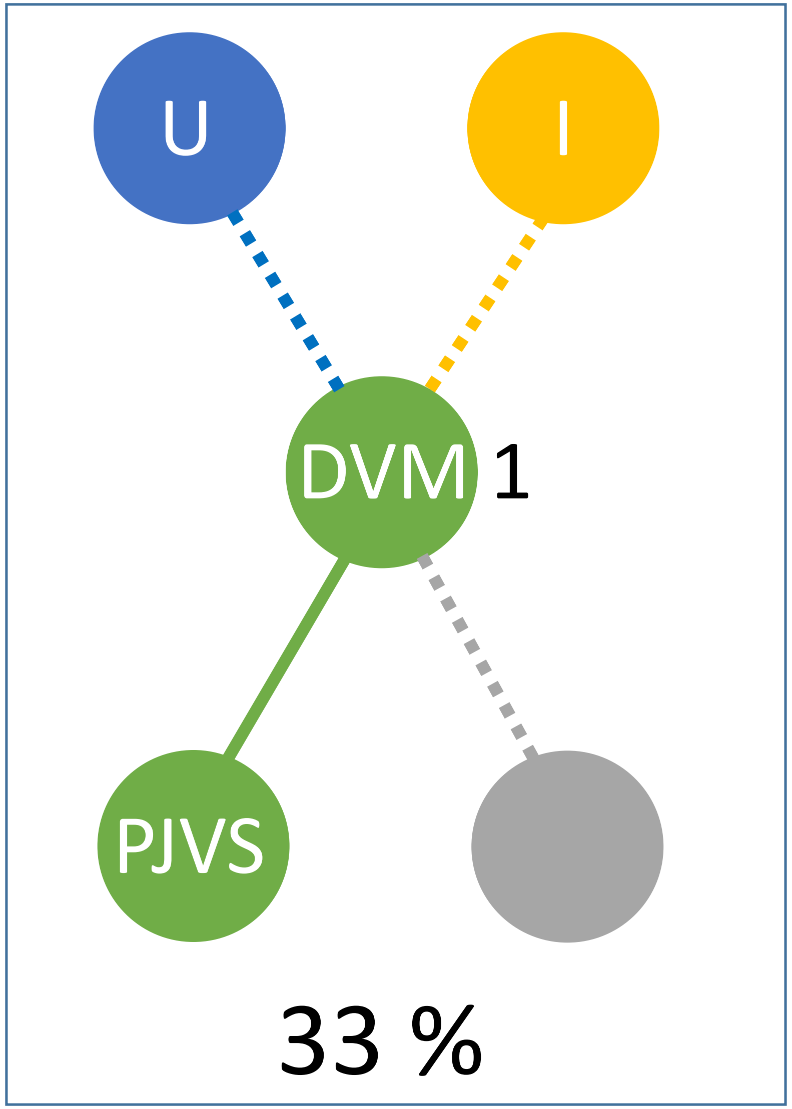


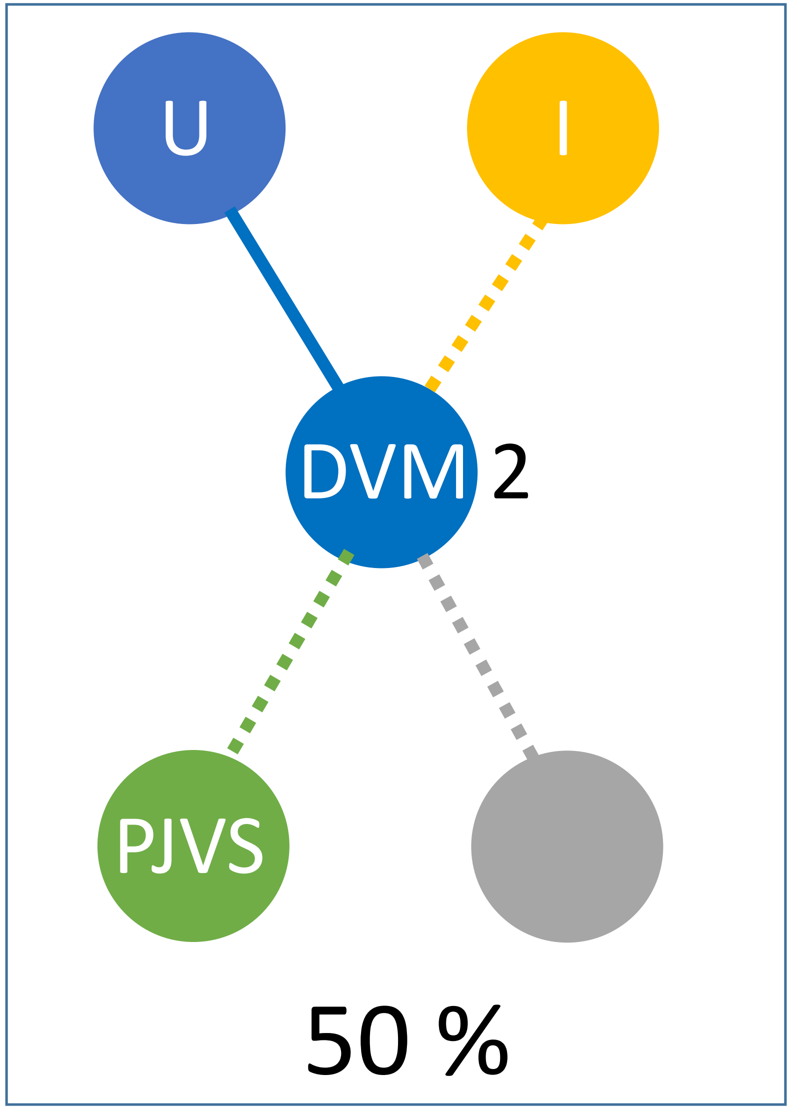
- Masterboard control
- Slaveboards for channels (2-4)
- Photovoltaic relays (changeable)
  - Direct sampling
  - Slow switching
  - 450/800 µS (ON/OFF)
  - 0.4 Ω on-state resistance
- Phase and amplitude stability?

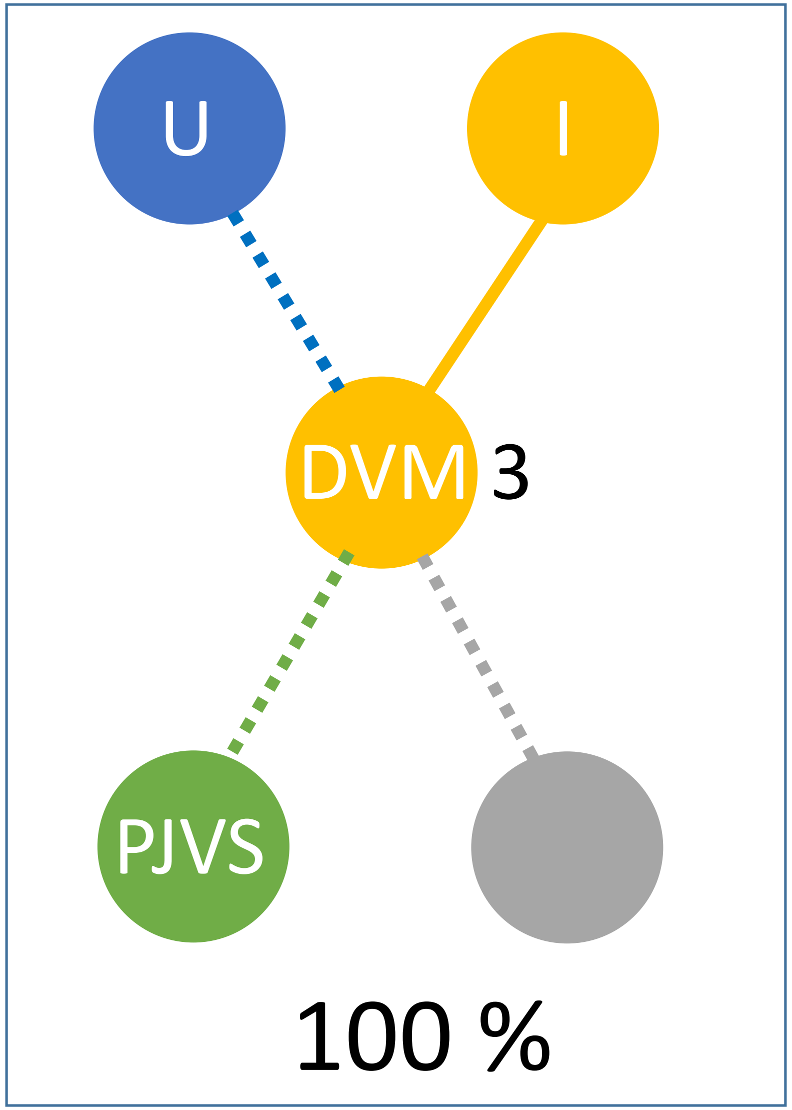
Suma valor
a un país de ideas



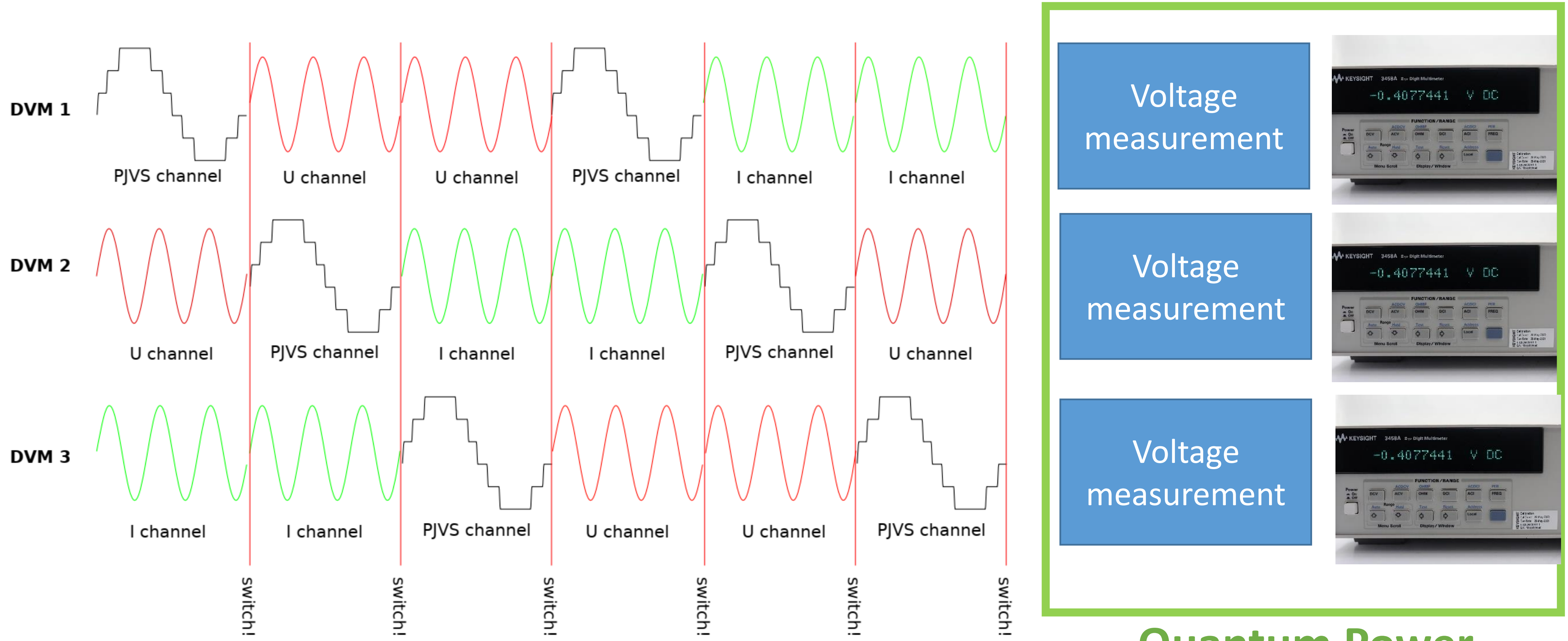
3 slave boards for full waveform







Traceability for the sampling system



Quantum Power Measurement system

Deliverables

D1 – Multiplexer (M10)
D2 – Software (M20)
D3 – Guidance and advantages of QPS (M25)
D4 – Comparison protocol (M36)
D5 – Validation of system (M32)
D6 – Individual strategies (M26)

Relevant objective (Activity delivering the deliverable)	Deliverable number	Deliverable description	Deliverable type	Partners (Lead in bold)	Delivery date
1 (A1.3.4)	D1	Summary report on the development of an open hardware multiplexer based on a single Josephson chip. The multiplexer must be sufficiently wideband to cover the required frequency range (20 Hz to 1 kHz).	Summary report	**INTI**, CMI, JV, VTT	Jun 2021 (M10)
2, 3 (A2.1.5)	D2	Report describing the open-source software with implementation of new methods for quantum sampling and power measurement, including non-RMS power and phasors	Report	**CMI**, UMA, VTT	Apr 2022 (M20)
1 (A3.2.2)	D3	Report providing guidance on i) the development of a quantum power standard based on PJVS and ii) the advantages, requirements and needs for adaptation of existing PJVS to QPS	Report	**PTB**, CEM, CMI, INRIM, JV, VTT, INTI, UMA	Sep 2022 (M25)
3 (A3.3.3)	D4	Protocol for a future comparison of quantum sampling electrical power measurements	Documented protocol	**INRIM**, CEM, CMI, JV, PTB, VTT, INTI, UMA	Aug 2023 (M36)
1, 3 (A2.3.5)	D5	Report on the validation of the new QPSs, including results of a comparison between at least two QPSs. Target uncertainties are 20 µW/VA for power measurements and 2 µW/VA contribution from the digitizer.	Report	**CEM**, CMI, INRIM, JV, PTB, VTT	Apr 2023 (M32)
4 (A3.1.10)	D6	Report on the agreed individual strategies and coordinated strategic plan for the long-term operation of the capacity for AC power standards developed at INRIM, CEM, CMI, JV, PTB, VTT and INTI.	Report	**INRIM**, CEM, CMI, JV, PTB, VTT, INTI, UMA	Oct 2022 (M26)

Open to the whole community

- All system components are open source, published on GitHub
- Power, phasors, AC voltage/current directly traceable to the SI
- Modular design – Flexible for many purposes
- Adaptable to new samplers/PJVS systems/algoritms
- Everyone is welcome as Stakeholder or Collaborator

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