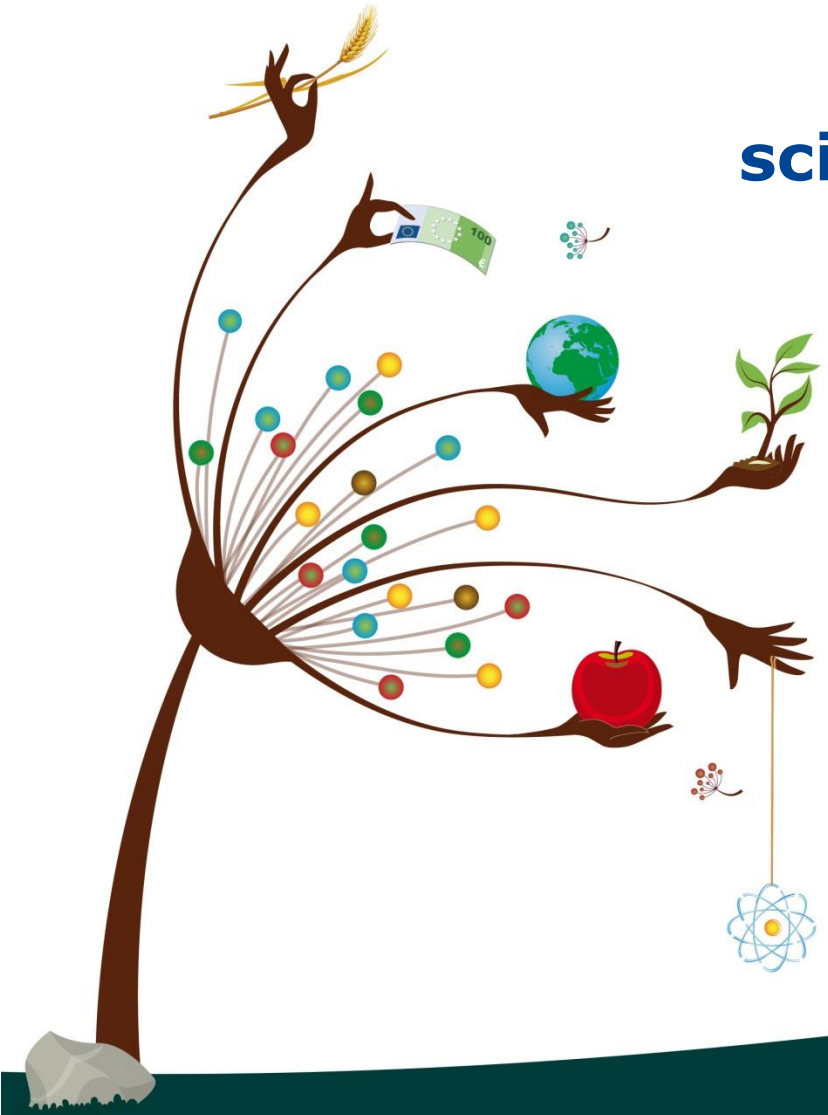


The European Commission's science and knowledge service

Joint Research Centre

Interoperability and Cybersecurity in Electromobility

Dr.-Ing. Harald W. Scholz, JRC C.4

Transatlantic Collaboration

European Commission

JOINT RESEARCH CENTRE
The European Commission's in-house science service

Argonne NATIONAL LABORATORY





- Underpinning global standards with applied research
- address interoperability issues between electric vehicles, smart grids and recharging systems
- focus on common goals with complementary capacities

JOINT RESEARCH CENTRE

Institute for Energy and Transport (IET)

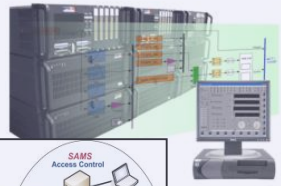
Argonne NATIONAL LABORATORY

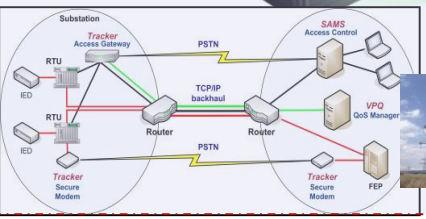
EU/US common approach for global standardization of EVs and EVSEs

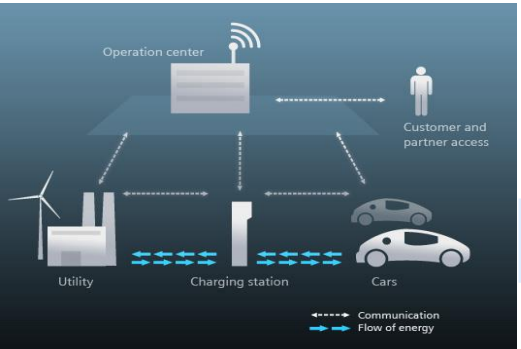
Petten, The Netherlands

Battery Research

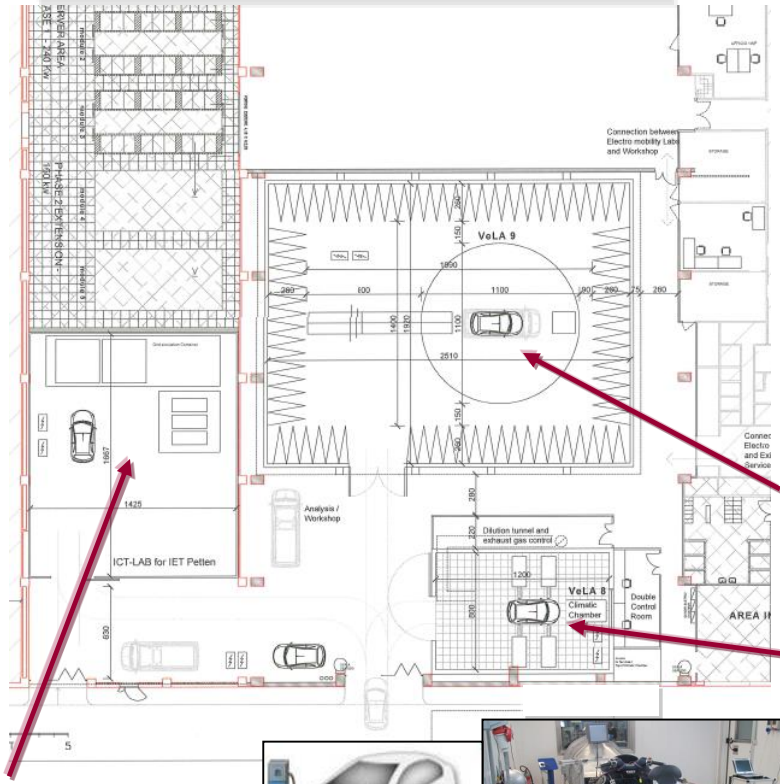
Smart Grid Research



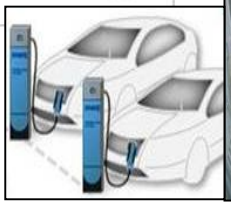




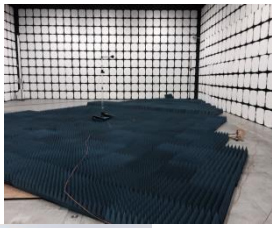
2015: Inauguration of New Interoperability Laboratory in JRC Ispra

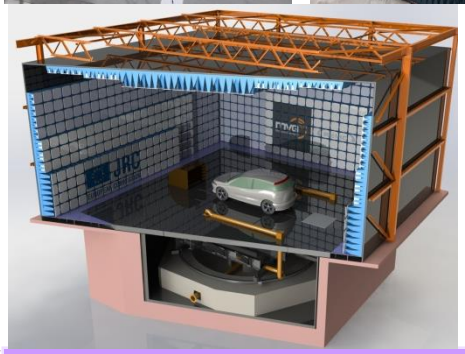


Vehicle-to-Grid Interoperability



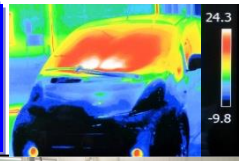
Ispra, Italy





EMC testing under load

Vehicle charging and -performance under varied temperatures



Key targets for technical harmonization:

- EV-EVSE interoperability;
- interoperability and monitoring of multi-brand, multi charging-points in fair billing schemes; load-management; EVSEs and EVs in the internet of things

- Vehicle test procedures,
- gaining quantitative knowledge base on (H)EV efficiency, consumption, range, their HVAC influence on these latter, their pollution, etc.

- Battery test procedures.

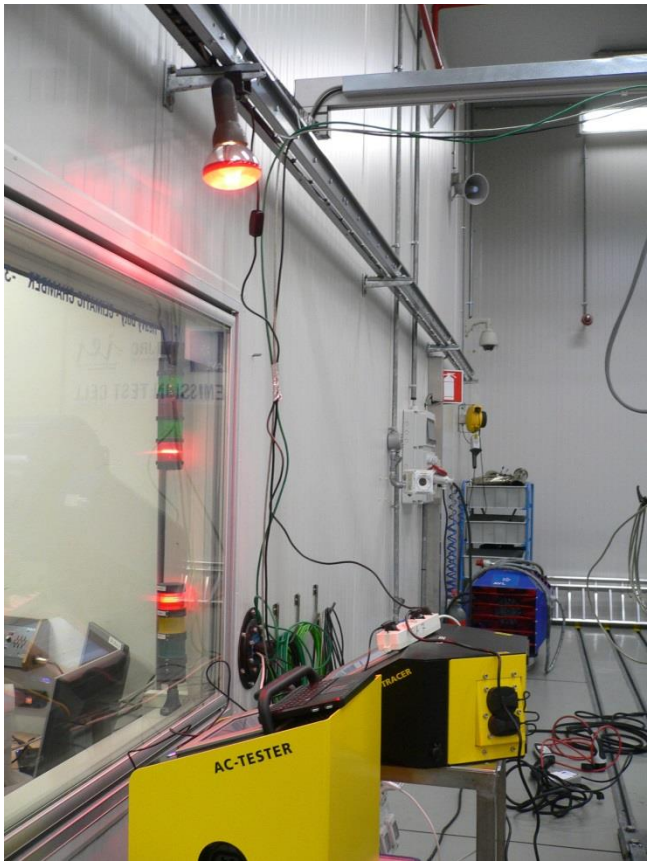
What is Interoperability ?

= ability to charge conveniently, safely and securely - anywhere, anytime – getting billed comfortably and fairly and enabling smooth integration of functions offered by energy service providers (market of additional services)

European Commission

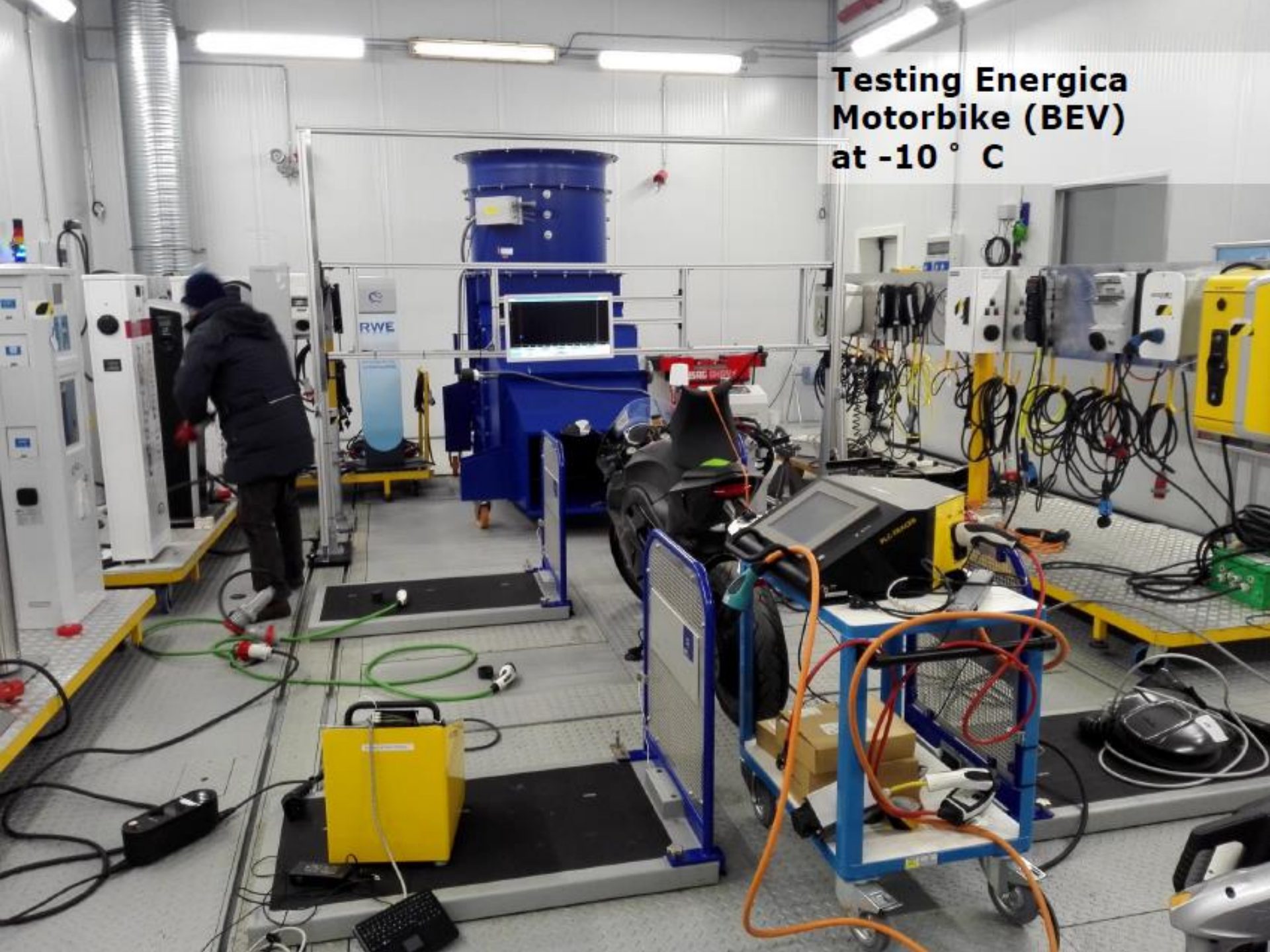
We started in VELA 7…

Testing Interoperability from -30°C to +40°C



and continued in VeLA 8…

Testing Interoperability from -30°C to +40°C


Testing Energica
Motorbike (BEV)
at -10 ° C
RWE

Interoperability tests between electric vehicles & recharging devices at JRC:

- Since January 2014, **30** different EVs and PHEVs were tested against **76** AC-charging devices (25 AC-Type-1, 23 AC-Type-2 and 28 AC-outlets in multi-type public columns). DC fast charge testing ongoing

- Tests featured unique temperature coverage from -30°C to +40°C

- The project saw measurement devices, EVs and rechargers improving **due to** and **during the** campaign

Audi BMW DAIMLER Ford

Joint Research Centre

GM OPEL PORSCHE VW

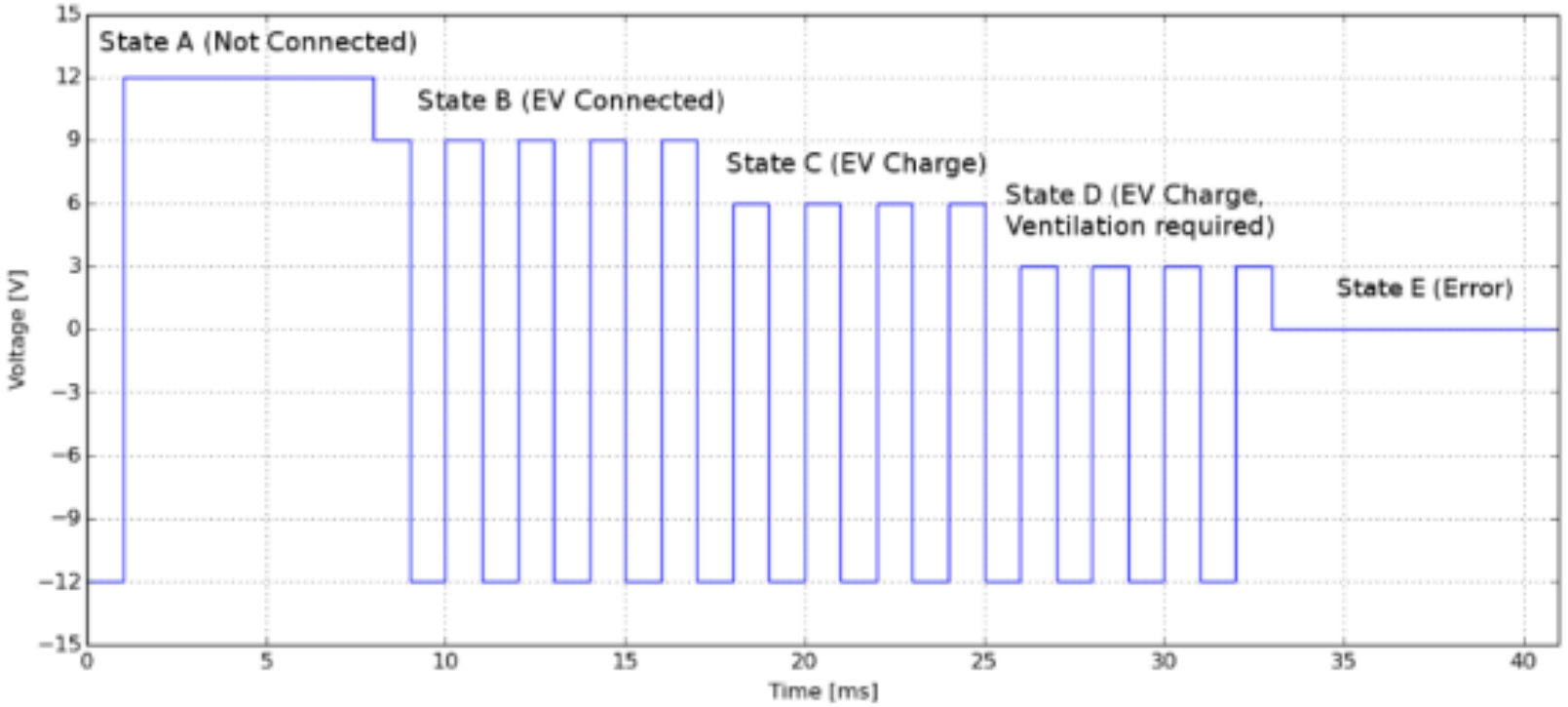
Joint Research Centre

European Commission

Result example:

A-, B- and C-state voltages of AC-EVSEs,
as measured under "ideal" car-simulation conditions

IEC 61851 requires:

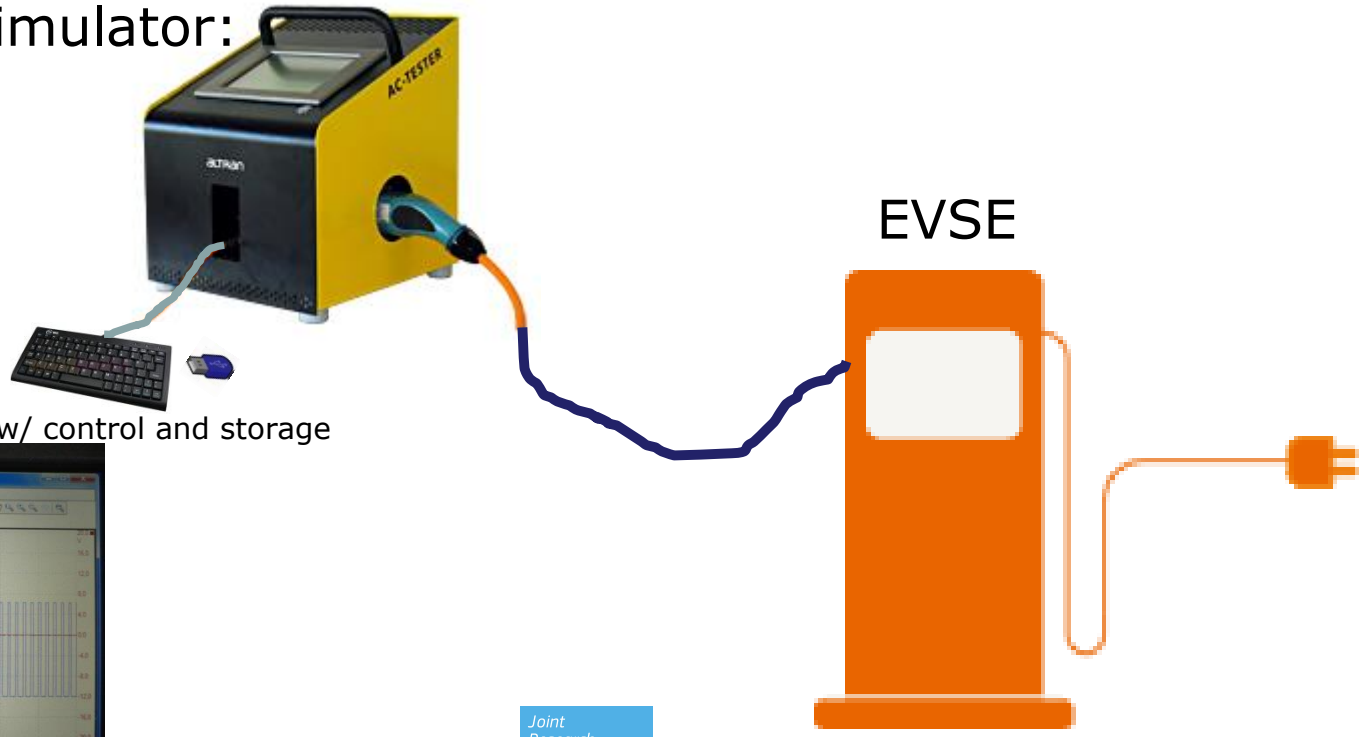


Setup of Measurement:

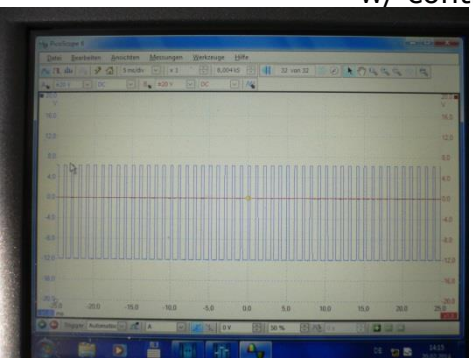
R-Variable, Nominal values

State	Rcp [Ohm]	Ucp [V]	Fcp [Hz]	Ti:Tp [%]	UL1 [V]	UL2 [V]	UL3 [V]
A	open	12.1	0	100	0	0	0
B	2700	9	999	53.1	1	1	1
C	877	5.9	999	52.9	229	232	232
B	2700	9	999	53.1	1	1	1

EV-simulator:



w/ control and storage



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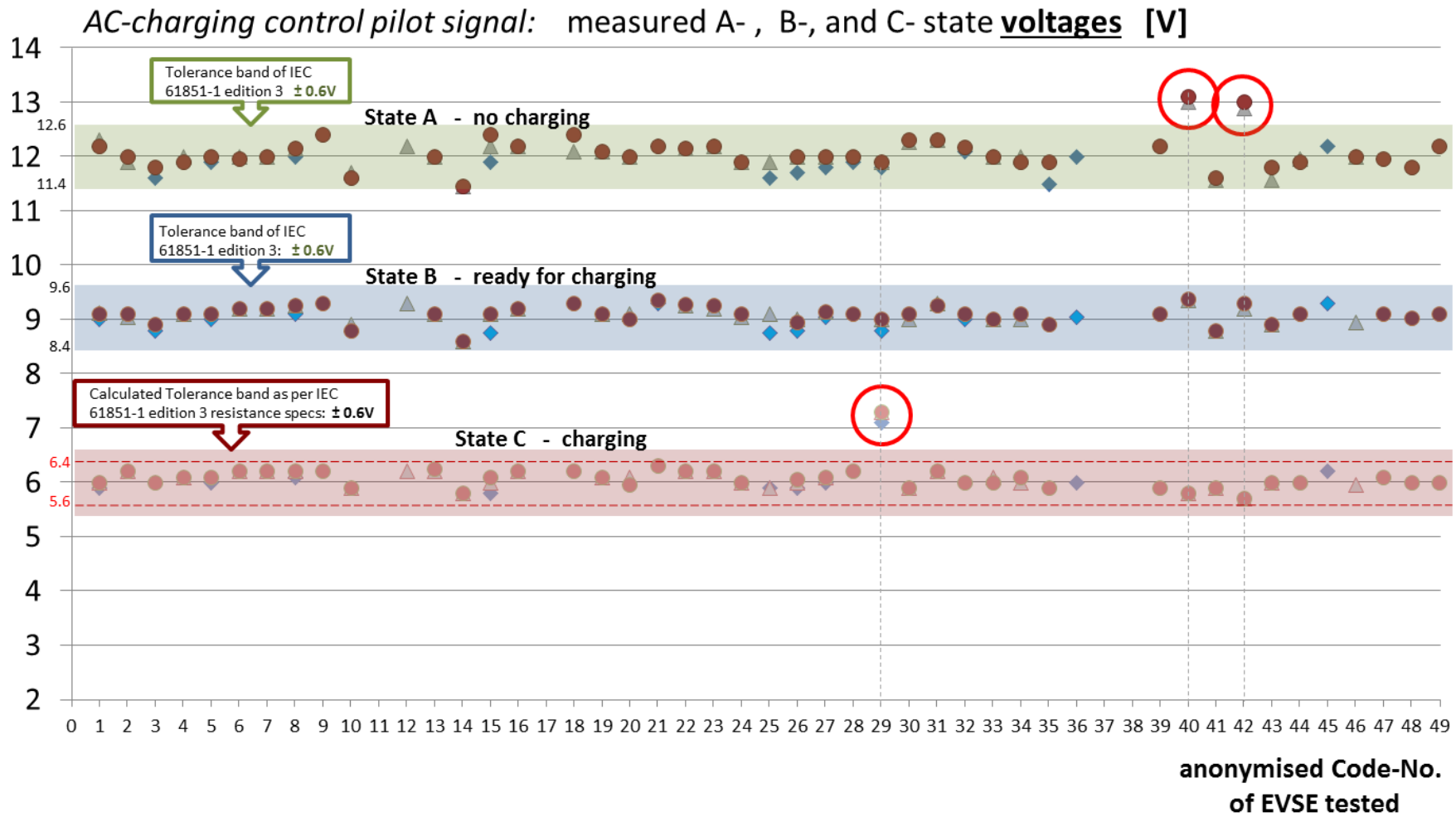
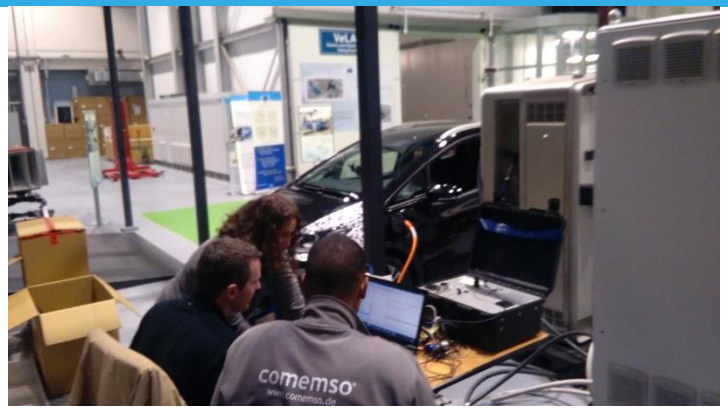


Conclusions with direct influence for standardisation:

1.) Need to check for all states: "surprise aberrants" may remain undiscovered if one looks only after A-state and B-state alone. ⇨Important for Global Test Device Specification (of ANL, JRC & industry coalition)

2.) thermal influence on A-, B- and C-state voltages remain small

3.) few A-state aberrations were observed, but w/o consequence for interoperability during B- and C-state.



Issues found with **CCS-Fast Charging** columns, when tested against *real* EVs:

- **Voltage windows offered by columns ("EVSE") were adapted to single models, and not interoperable for all CCS-EVs**
- **Power-line communication with too strong sending power, which cause cross-talk in charging parks between distinct EV-EVSE couples. ISO 15118 had been formulated so complicatedly, that producers have not understood it, or did not implement it.**

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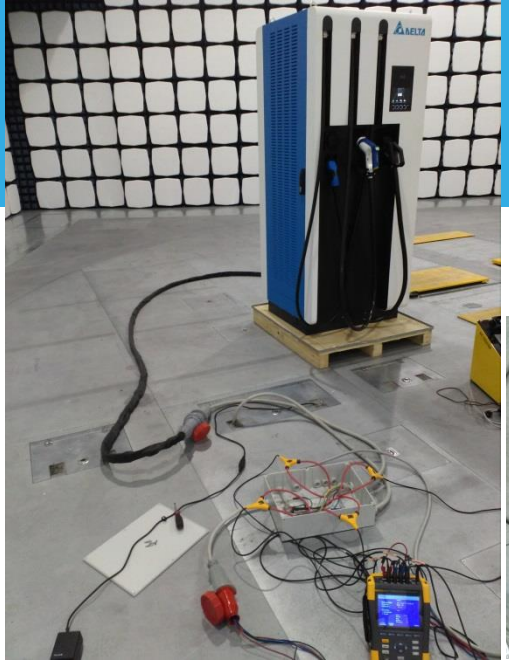
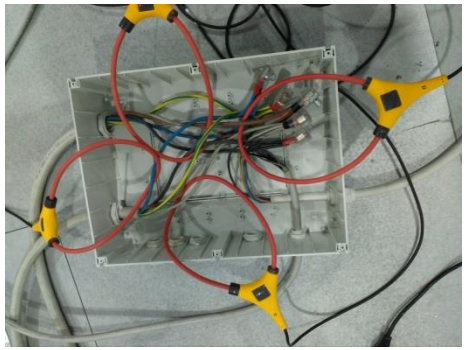
***Measurement device* that simulates:**

- a perfectly ISO15118-conform EV to a real EVSE,

and

- a perfectly ISO 15118-conform EVSE to a real EV



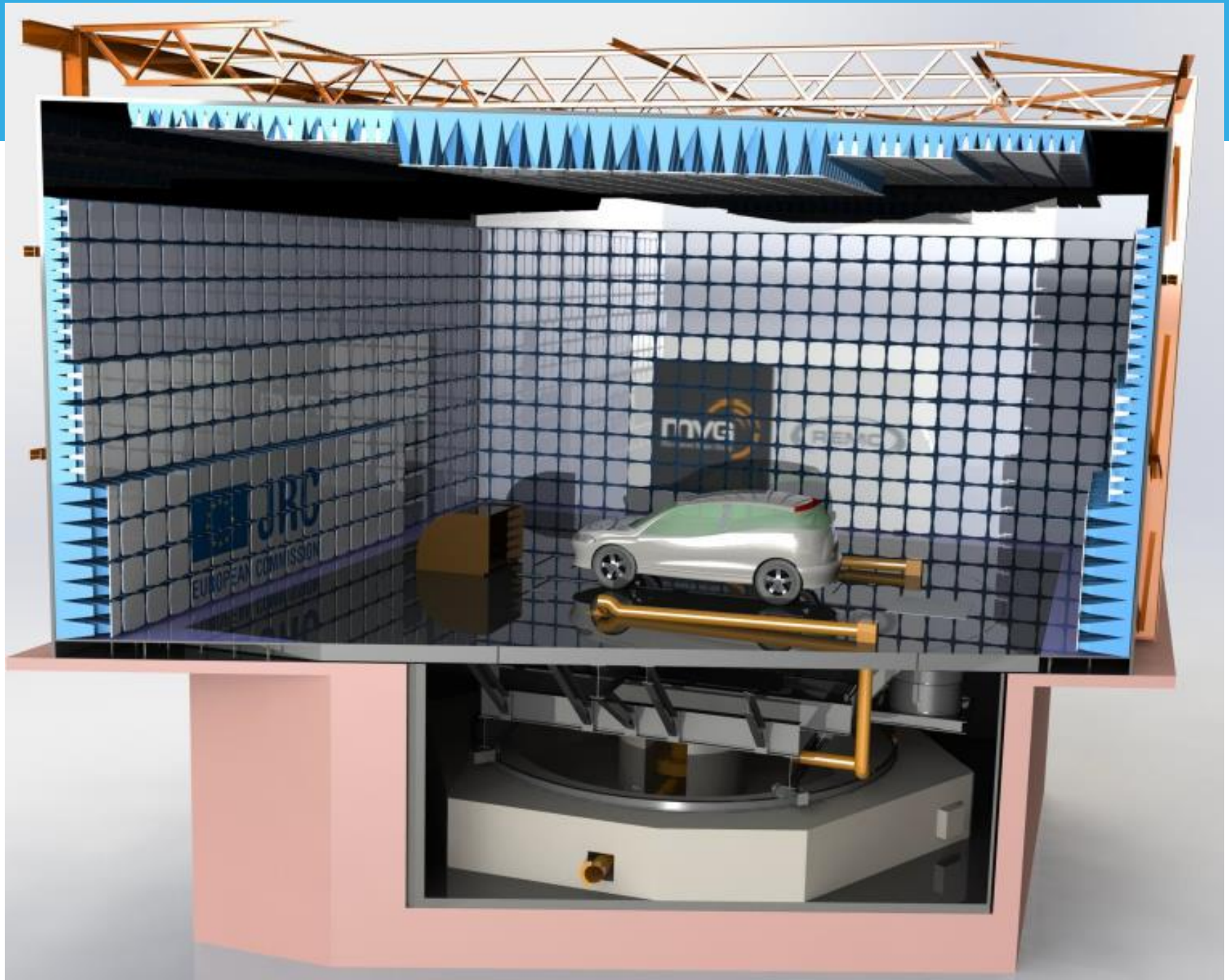


Need to test conducted total harmonic distortions from **CCS- and ChaDeMo Fast Charging** columns back into the grid:

- **Activity together with the JRC Unit C.3 (A. Lucas), partly critical results**
- **We compare C.3's FLUKE measurement equipment with our Yokogawa equipment for underpinning the results.**

BOSCH CANbus diagnosis tool

Hioki and Yokogawa multi-channel power analyzers with Hioki clamps up to 500 A and able to be used from -30° C to 50° C.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EUROPEAN COMMISSION

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Semi-anechoic chamber for electromagnetic compatibility [EMC] testing (emission and immunity) of electric / hybrid / fuel cell vehicles; validated acc. to relevant CISPR and IEC standards:

- functions at **23 °C ± 2K** and controlled humidity
- Two-axes chassis dynamometer in a **11m-turntable** positioning system, axle load of **2500kg each axis**, floor payload accordingly
- 138kW per axle cont., **165kW per axle** (peak power for > 1 minute)
- Up to **210 km/h** test speed; capable of **10m/s² acceleration and recuperative deceleration** on the roller bench
- AC- and DC-fast- recharging possibility for electric vehicles mounted on the turntable: **filtered input today 400V 63A 3p; 500V 350kVA by September 2017**
- Inert gas fire extinction system; **36000m³/h air rinse** for gas emergency. SCADA control system stops roller-bench. Video control. Full ATEX for H2 etc.

VeLA 9

Fully CISPR 16-1-4 conform for 3m-, 5m- and 10m-distance tests, etc.

Chamber quality for Immunity tests:

- 200V/m continuous field strength
- 600V/m transient field strength

...over 9 kHz to 18 GHz

Shielding >>100dB acc. to EN 50147-1

Conformities:

Conform to SAE J551, CISPR 25.

Also conform to ANSI 63.4, FCC parts 15 & 18, EN 50147-2, CISPR 11, 16,22; VCCIV-3 2001.4 up to 6 GHz

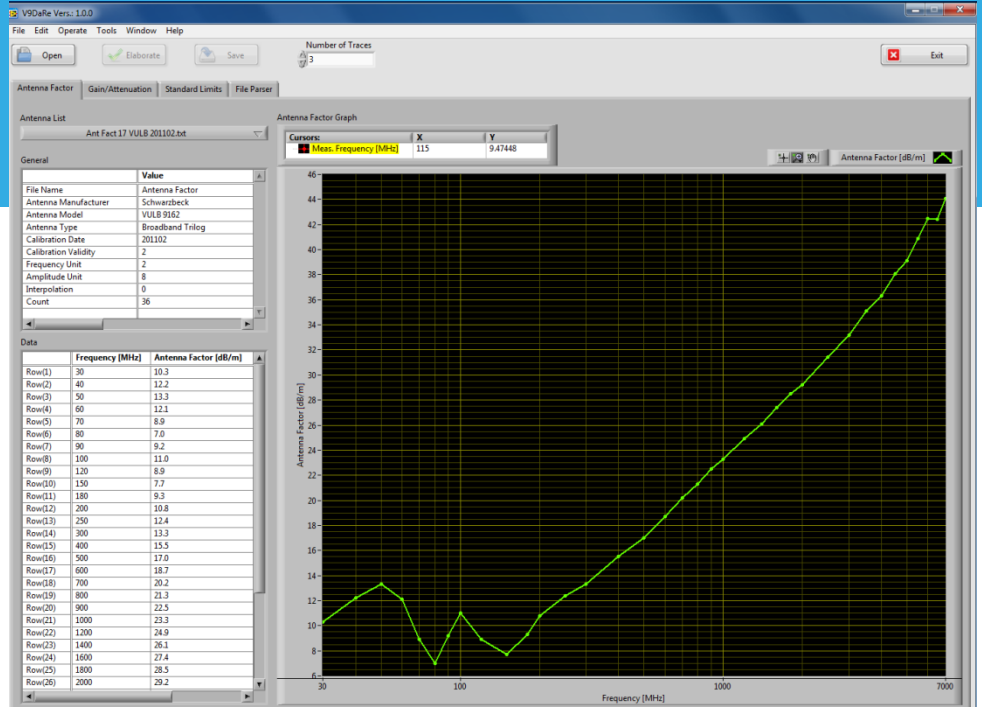
VeLA 9

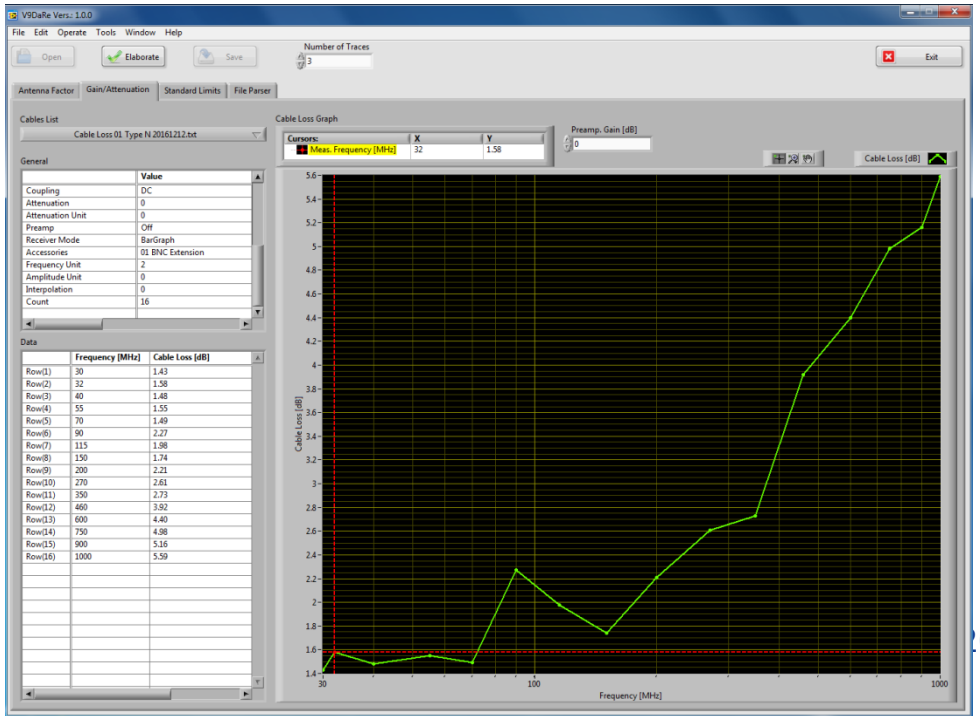
Full measurement chain for EMC emission testing of EV-charging:

Elaboration:

- **In order to calculate correct data of e.g., field strength over time-of-charging-process, our LAB-VIEW software automatically compensates for the frequency dependent antenna-factors (see upper left)**

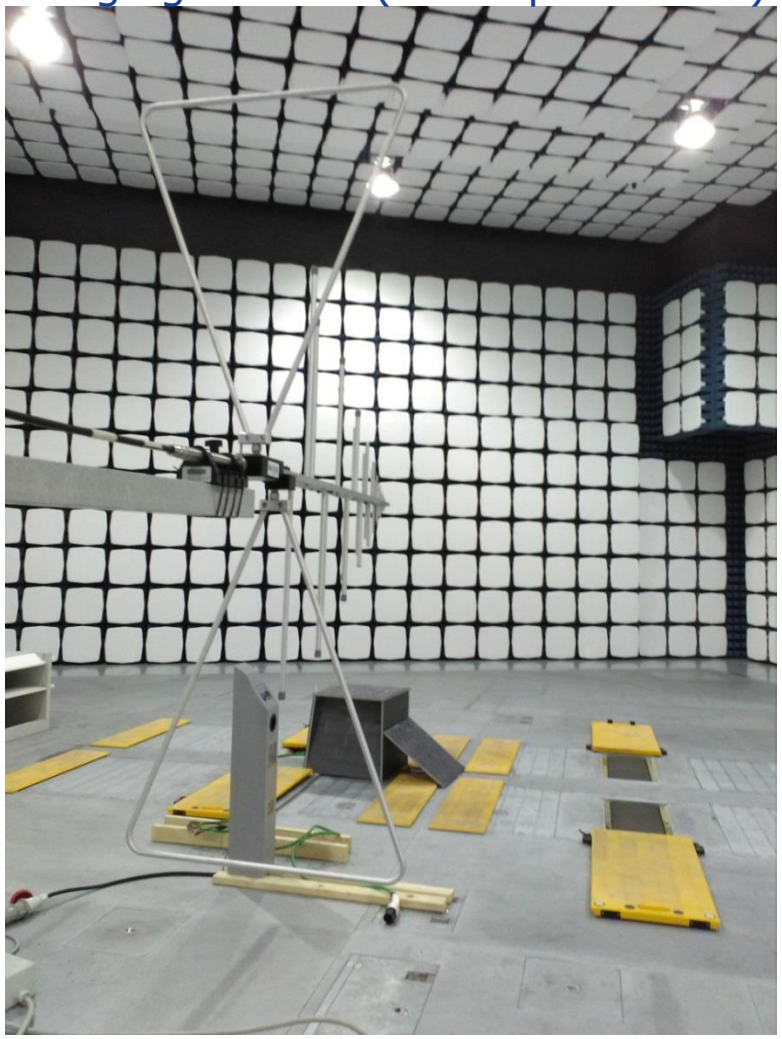
- **as well as the losses in the antenna cabling and connections to the receiver (see lower left)**



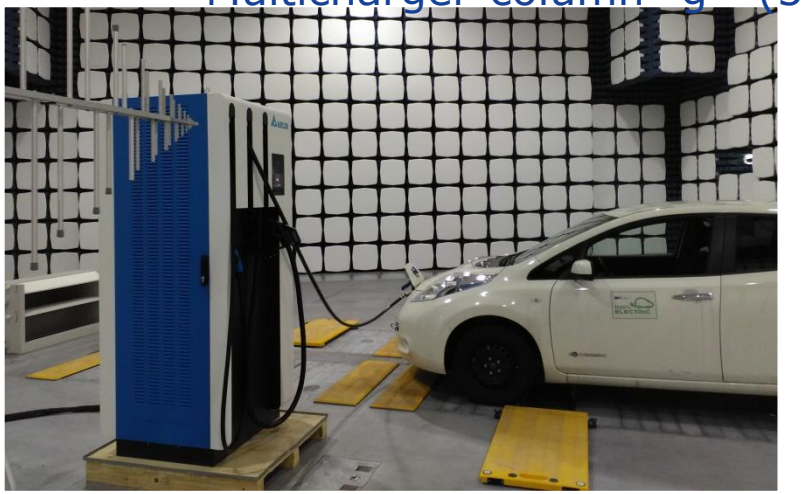


EMC tests of AC-charging processes

AC-charging simulator (ALTRAN) shielded vs. a PLC-capable AC-charging column ("79" up to 22kW)



CHaDeMo EV (Nissan Leaf) vs. a Multicharger-column "g" (50kW)

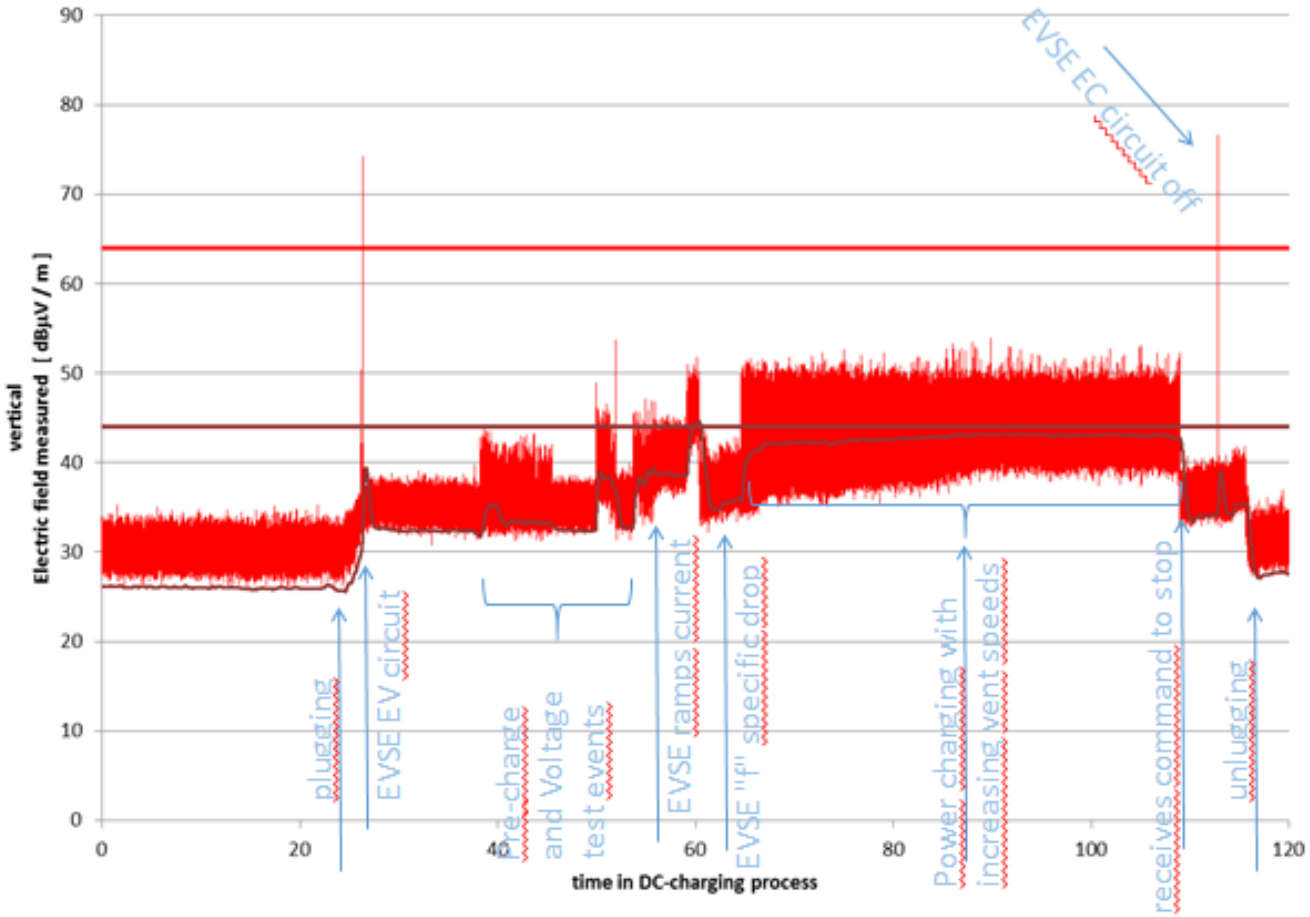


CCS EV (BMW i3 extended battery vers.) vs. CCS-column "f" (50kW)

Long range CCS EV (Ampera-e) vs. CCS-column "s" (44kW)

CCS EV (Ford Focus e) vs. CCS-column "f" (50kW), horizontal polarization

50kW DC-chargeable EV (no. 3) on charger "f" (CCS)



Result example, we follow the whole charging process for two minutes;
e.g., 40MHz was critical with one of the DC-Multi-chargers

IEC 61851-21-1 and -21-1 subcommittee (in IEC TC 69) is not considering these spikes, as they do not yet see the EV-EVSE ***couple***.

• consequence: JRC is now invited to take part at Dr. Baerenfaenger's committee.

5 Statements on the Future of Mobility

(from: WIRED Editorial 27.11.2015)

 # 1: Who wants a networked future, must be willing to give data.

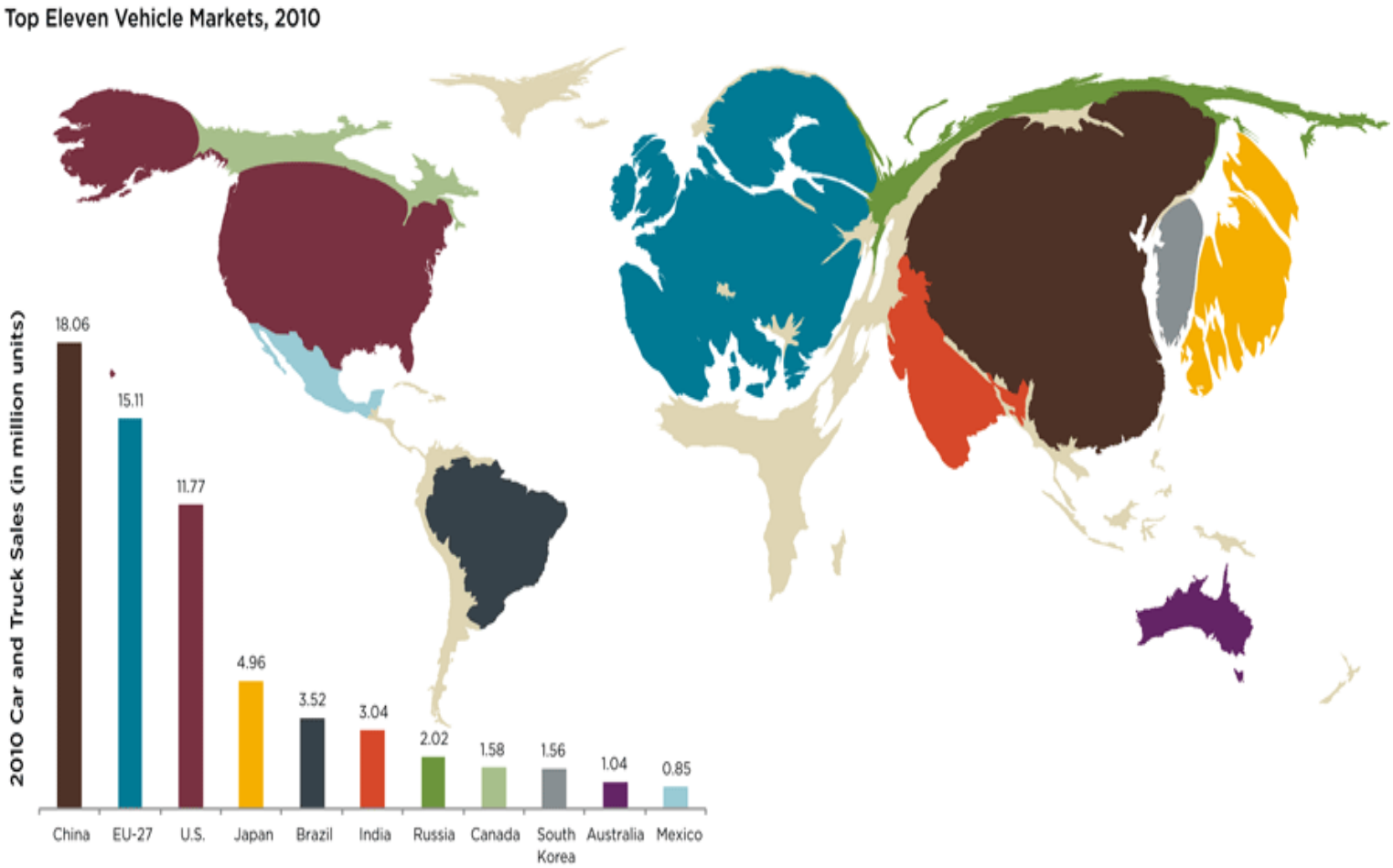
 # 2: Sharing-Providers must be willing to share the markets.

 # 3: Vehicle OEMs must think their products as Software.

 # 4: Smart Cities need Smart Citizens.

 # 5: We (EU, USA) are not necessarily the early adopters anymore.

World vehicle markets *have already* totally changed…



Bosch: success stories with:
Networked parking
Networked vehicle fleets
Networked cargo /containers / freight wagons (railway)

Continental explained as safety and security relevant:
Firmware Over The Air (FOTA) *notably also for charging columns !*

How do charging providers argue ?

BOSCH (pars pro totum for those serving EV OEM), but there are others, like HUBJECT, etc.:

Charging Apps seek and find publicly accessible, internet-connected charging-columns / -stations. Charging is paid via the app.

- Promised: easier and fairer payment (no lump sums, no higher prices through roaming)

Europe-wide network of accessible charging stations

- networks growing, e.g.: Bosch: 20k charging spots of 20 networks in 10 countries covered

Secure, cloud-based software solutions

- Reliable Partner of high competence in SW & automotive technol. Promise to adapt to future *car integration*

Charging at competitive prices

- Charging Apps allows tailor-made price-models. Continuous exchange with charging station operators allows competitive prices for all players. No base fee, billing is according to use

Charging with assured quality

- App shows, whether a station is functional or defective. Offers hotline service in case of dysfunction

Legal certainty in an environment of regionally different regulations

- As market for operating charging stations is regionally fragmented, but nevertheless regulated, providers establishes contracts with market participants and takes over business- and liability risks for customers.

Integration of charging-cybersecurity into vehicle, respectively, *cloud-embedded* vehicle

Today: communication between user and EVSE

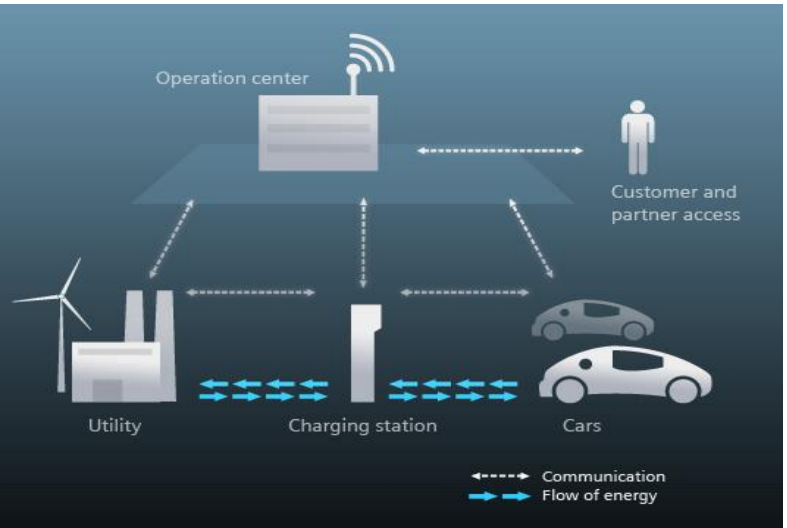
Tomorrow: communication *via cloud* and provider, provider clears EVSE

Day after tomorrow: *Vehicle* embedding of communication between user and provider („My OEM cares for my charging experience...“)

Why necessary ? Vehicle must act according to smart-grid needs:

V1G

V2G



What does the charging provider know of me, what does the charging station know of me ?

- Account / credit card info (?)
- **where** I am
- the fact, **that** I am not at home ...
- the fact, **that** I am currently charging and *cannot* come home *before xyz hrs* ...
- the history, of how often and regularly I am at that column, and when, so I become plannable for others ...

Risk...

Fraunhofer SIT: Project DELTA

Prof. Dr. Christoph Krauß
Tel.: +49 6151 869-116

European Commission

German Project DELTA (Data security and -integrity in electro-mobility during charging and legally calibrated billing)

- They define use cases and reference architectures
- Based on this, the Fraunhofer SIT experts develop a **security profile** and **technical guidelines**

The security profile is **implemented into a prototypical charging column**.

Joint Research Centre

Fraunhofer SIT: Project DELTA

Prof. Dr. Christoph Krauß
Tel.: +49 6151 869-116

European Commission

DELTA's **key questions** are::

- Securing the communication between the EVSE and the EV by further development of the int. standard ISO/IEC15118
- Securing the EVSE and the Charge-Controller in the EV against illegal or improper access or manipulation
- Definition and embedding of a security module into the EV's Charge-Controller and the EVSE
- Securing the Communication with backend -systems, with public-key-infrastructures, assuring security of the backend -systems themselves

Contributing to new Standards for OEMs: In order to safeguard products against data-theft and manipulation.

Project Lifetime

2 years of project life-time, part of the German government's funding program „ELEKTRO POWER II“, (BMWi)

Project Partners: VDE German Electro-/Electronic Industry Association), Stuttgart Research Centre for motorised Transport (FKFS), the German Physico-technological calibration authority (PTB), utility RWE , Technical University of Dortmund, company Webolution GmbH.

Thanks for your attention, any questions ?