MIC 2021 – NEW TECHNOLOGIES

WHY ADOPTING RF WIDEBAND VECTOR ARRAY TECHNOLOGY FOR YOUR 5G CHALLENGES?

STEPHANE PANNETRAT
CEO – ART-Fi
Wednesday, March 17, 2021

SUMMARY

5G Technology: why adopting an evolutive technology is essential to align with the wireless innovation?

5G measurement: focus on multiple emissions - how to accurately measure the most complex network standard?

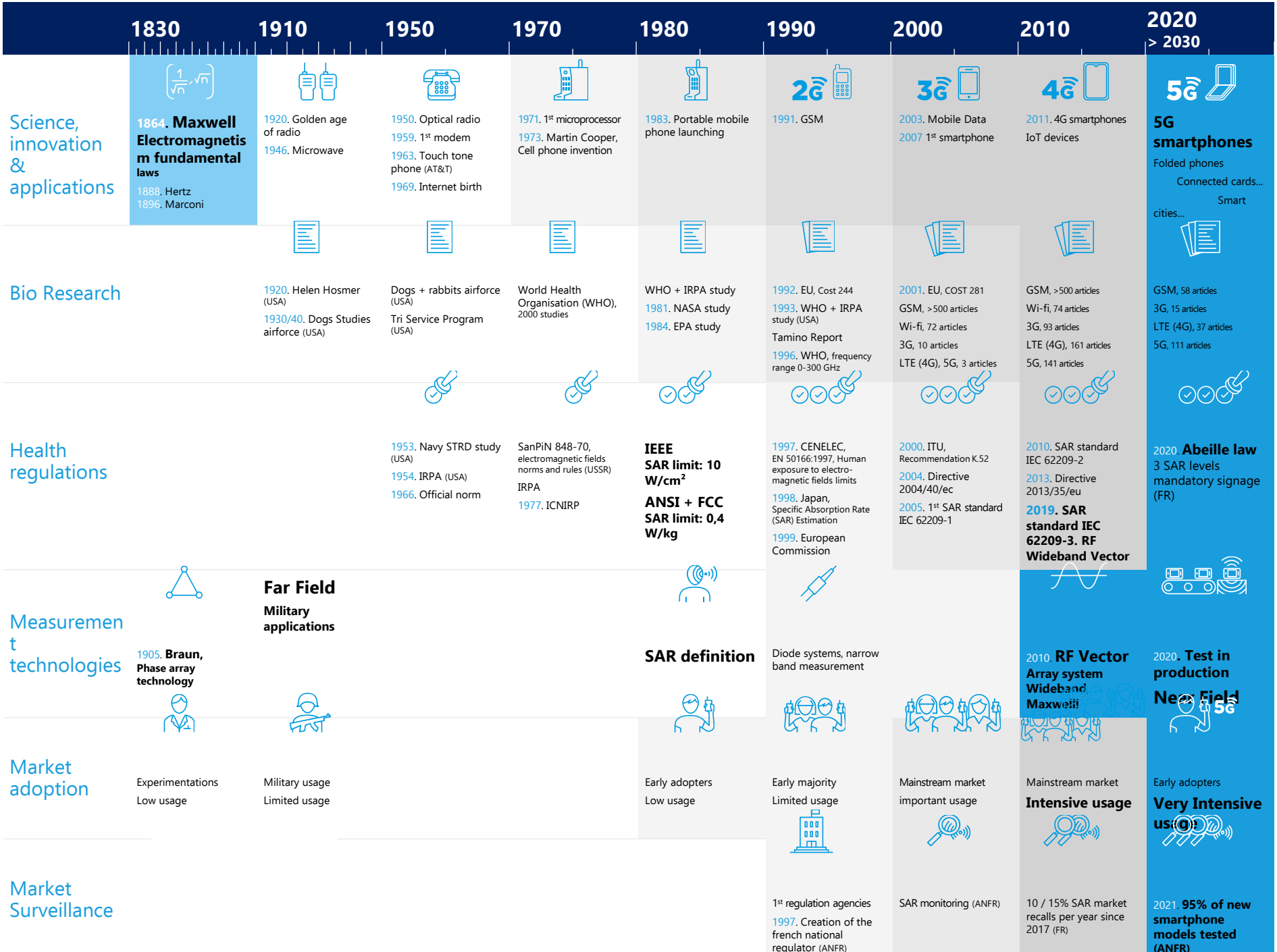
5G Regulation: why complying with latest standard is an opportunity for the whole wireless industry?

5G Business and future: how to meet your customers needs to improve your market shares now and be ready for the future ?

ART-Fi

5G TECHNOLOGY

WHY ADOPTING VECTOR ARRAY TECHNOLOGY IS ESSENTIAL TO ALIGN WITH THE WIRELESS INNOVATION?


1830
1910
1950
1970
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1990
2000
2010
2020
> 2030
Science, innovation & applications
1864. Maxwell Electromagnetism fundamental laws
1888. Hertz
1896. Marconi
1920. Golden age of radio
1946. Microwave
1950. Optical radio
1959. 1st modem
1963. Touch tone phone (AT&T)
1969. Internet birth
1971. 1st microprocessor
1973. Martin Cooper, Cell phone invention
1983. Portable mobile phone launching
1991. GSM
2003. Mobile Data
2007 1st smartphone
2011. 4G smartphones
IoT devices
5G smartphones
Folded phones
Connected cards...
Smart cities...
Bio Research
1920. Helen Hosmer (USA)
1930/40. Dogs Studies airforce (USA)
Dogs + rabbits airforce (USA)
Tri Service Program (USA)
World Health Organisation (WHO), 2000 studies
WHO + IRPA study
1981. NASA study
1984. EPA study
1992. EU, Cost 244
1993. WHO + IRPA study (USA)
Tamino Report
1996. WHO, frequency range 0-300 GHz
2001. EU, COST 281
GSM, >500 articles
Wi-fi, 72 articles
3G, 10 articles
LTE (4G), 5G, 3 articles
GSM, >500 articles
Wi-fi, 74 articles
3G, 93 articles
LTE (4G), 161 articles
5G, 141 articles
GSM, 58 articles
3G, 15 articles
LTE (4G), 37 articles
5G, 111 articles
Health regulations
1953. Navy STRD study (USA)
1954. IRPA (USA)
1966. Official norm
SanPiN 848-70, electromagnetic fields norms and rules (USSR)
IRPA
1977. ICNIRP
IEEE
SAR limit: 10 W/cm²
ANSI + FCC
SAR limit: 0,4 W/kg
1997. CENELEC, EN 50166:1997, Human exposure to electro-magnetic fields limits
1998. Japan, Specific Absorption Rate (SAR) Estimation
1999. European Commission
2000. ITU, Recommendation K.52
2004. Directive 2004/40/ec
2005. 1st SAR standard IEC 62209-1
2010. SAR standard IEC 62209-2
2013. Directive 2013/35/eu
2019. SAR standard IEC 62209-3. RF Wideband Vector
2020. Abeille law
3 SAR levels mandatory signage (FR)
Measurement technologies
1905. Braun, Phase array technology
Far Field
Military applications
SAR definition
Diode systems, narrow band measurement
2010. RF Vector Array system Wideband Maxwell
2020. Test in production
Near Field
Market adoption
Experimentations
Low usage
Military usage
Limited usage
Early adopters
Low usage
Early majority
Limited usage
Mainstream market
important usage
Mainstream market
Intensive usage
Early adopters
Very Intensive usage
Market Surveillance
1st regulation agencies
1997. Creation of the french national regulator (ANFR)
SAR monitoring (ANFR)
10 / 15% SAR market recalls per year since 2017 (FR)
2021. 95% of new smartphone models tested (ANFR)

WIRELESS INNOVATION & NON-IONIZING RF EXPOSURE MILESTONES 1/3

	1830	1910	1950	1970	1980	1990	2000	2010	2020 > 2030
Science, innovation & applications	**1864. Maxwell Electromagnetism fundamental laws** 1888. Hertz 1896. Marconi	1920. Golden age of radio 1946. Microwave	1950. Optical radio 1959. 1st modem 1963. Touch tone phone (AT&T) 1969. Internet birth	1971. 1st microprocessor 1973. Martin Cooper, Cell phone invention	1983. Portable mobile phone launching	1991. GSM	2003. Mobile Data 2007 1st smartphone	2011. 4G smartphones IoT devices	**5G smartphones** Folded phones Connected cards... Smart cities...
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Health regulations			1953. Navy STRD study (USA) 1954. IRPA (USA) 1966. Official norm	SanPiN 848-70, electromagnetic fields norms and rules (USSR) IRPA 1977. ICNIRP	**IEEE SAR limit: 10 W/cm²** **ANSI + FCC SAR limit: 0,4 W/kg**	1997. CENELEC, EN 50166:1997, Human exposure to electro-magnetic fields limits 1998. Japan, Specific Absorption Rate (SAR) Estimation 1999. European Commission	2000. ITU, Recommendation K.52 2004. Directive 2004/40/ec 2005. 1st SAR standard IEC 62209-1	2010. SAR standard IEC 62209-2 2013. Directive 2013/35/eu **2019. SAR standard IEC 62209-3. RF Wideband Vector**	2020. **Abeille law** 3 SAR levels mandatory signage (FR)

WIRELESS INNOVATIONS are NUMEROUS and are going VERY FAST
STANDARDS & REGULATIONS has to anticipate to AVOID TO BE LATE
MOBILE PHONES' 12th generation and 5G are embedding THE MOST COMPLEX technology ever produced

WE ARE OBSERVING ACCELERATIONS OF NON-IONIZING RESEARCH PROGRAMS AND OF STANDARD AND REGULATION FOR HUMAN RF EXPOSURE

WIRELESS INNOVATION & NON-IONIZING RF EXPOSURE MILESTONES 2/3

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Measurement technologies	1905. **Braun, Phase array technology**	**Far Field** **Military applications**			**SAR definition**	Diode systems, narrow band measurement		2010. **RF Vector Array system Wideband, Maxwe!!!**	2020. **Test in production** **Near Field**
Market adoption	Experimentations Low usage	Military usage Limited usage			Early adopters Low usage	Early majority Limited usage	Mainstream market important usage	Mainstream market **Intensive usage**	Early adopters **Very Intensive usage**
Market Surveillance						1st regulation agencies 1997. Creation of the french national regulator (ANFR)	SAR monitoring (ANFR)	10 / 15% SAR market recalls per year since 2017 (FR)	2021. **95% of new smartphone models tested (ANFR)**

A GLOBAL CHAIN : SCIENCE, INNOVATION, APPLICATIONS, IMPACT RESEARCH, STANDARDIZATION, REGULATION, MARKET SURVEILLANCE ...

HUMAN RF EXPOSURE MEASUREMENT : Almost two centuries after the maxwell law of physics, ART-Fi has succeeded into developing the first and the only one **RF WIDEBAND VECTOR PROBE ARRAY SAR** measurement system

How to address the LEGAL DEMAND of 100% Mobile phones compliance ? And what about refurbishing industry?

ART-Fi : first ever solution enabling up to 100% mobile phones testing in production-line

RF Wideband Vector Technology offers multiples features to improve both : production yield, antenna performances, and SAR control

=> This generates satisfaction from the industry, to the regulators and consumers : DISRUPTION

WIRELESS INNOVATION & NON-IONIZING RF EXPOSURE MILESTONES 3/3

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From the 1990's, **MARKET SURVEILLANCE HAS STARTED** to develop over the world

France is a small country but an old scientific country with a VERY STRONG EXPERTISE ON RF & ELECTROMAGNETISM

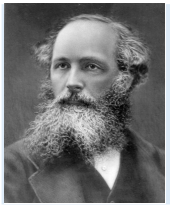
FRANCE IS THE MOST RIGOROUS COUNTRY FOR SAR LEGISLATION (Market surveillance, SAR values displaying, SAR testing configurations, ...)

ART-Fi is TEAMING WITH ANFR (FRANCE) TO STRENGHT SAR MARKET SURVEILLANCE PROCESSES (2020) : this is a golden contribution to the regulation world for anticipating Human RF Exposure risks assessments

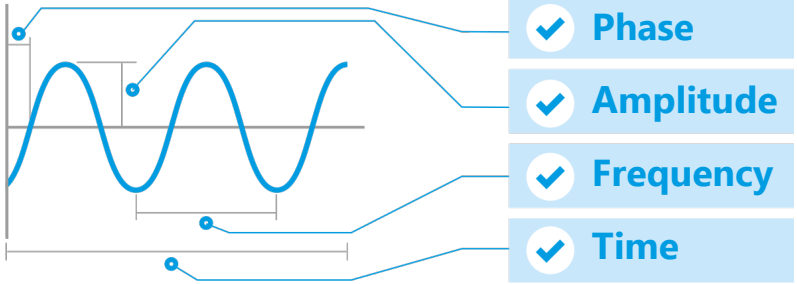
5G MULTIPLE & SIMULTAEOUS EMISSIONS

HOW TO ACCURATELY MEASURE THE MOST COMPLEX NETWORK STANDARD?

5G: MULTI-EMISSION SOLUTION & MAIN BENEFITS

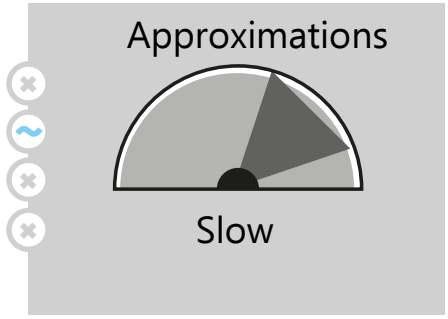


Science : Héritage Maxwell



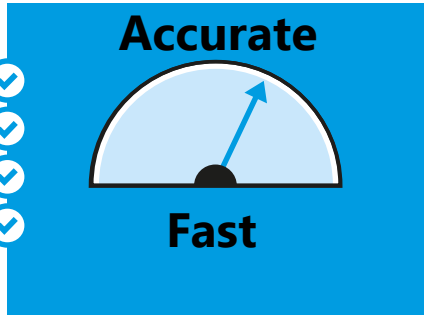
IEC historical standards and « non RF » approaches

- ✖ Phase
- ~ Amplitude
- ✖ Frequency
- ✖ Time



RF Wideband Vector Probe Array

- ✔ Phase
- ✔ Amplitude
- ✔ Frequency
- ✔ Time



THE TECHNOLOGICAL BARRIER HAS EVER BEEN THE PHASE DIRECT MEASUREMENT
DIRECT PHASE MEASUREMENT IMPLIES :
- RF HETERODYNE RECEIVER for SAR acquisition
- Exact 2D-3D calculation thanks to Maxwell and Huygens equations and principle .
DIRECT PHASE COMBINES maximum ACCURACY and SPEED
DIRECT PHASE MEASUREMENT WITH RF RECEIVER is included in RF Wideband Vector Probe Array

D-PHASE
100% Wideband Vector Probes

*"The technology developed by ART-Fi exploits the principles of **multi-spectral holography** and by using **the direct measurement of the phase**, it allows to reach an unbeatable speed and precision compared to other techniques. **It is without context a technological breakthrough.**" Matthias Fink - Physician, Academie of Science*

5G: MULTI-EMISSION SOLUTION & MAIN BENEFITS

Construction

- ✓ RF receiver : Super heterodyne
- ✓ Spectral analysis of I/Q demodulated time-domain RF signals
- ✓ Phase-Coherent acquisition of Time-Domain signals

Real emission modes testing conditions, No DUT test mode required

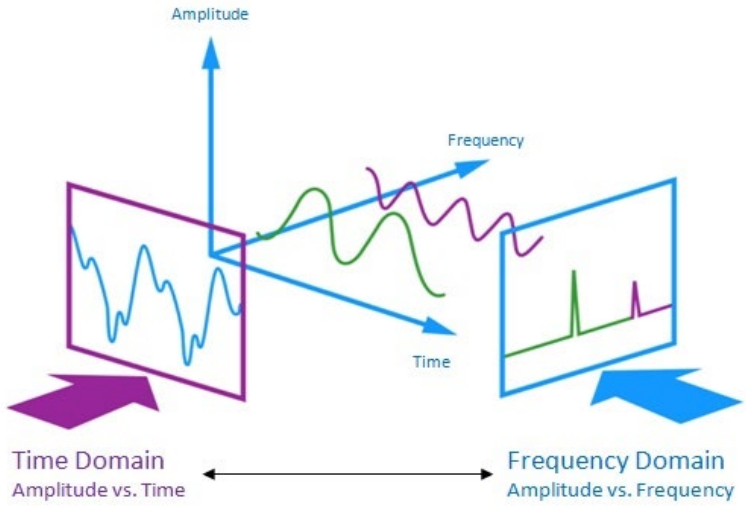
- ✓ RF receiver super heterodyne acquisition
- ✓ It uses the same dataflow for both SAR measurements and real DUT status checkings
- ✓ Eliminate any measurement mis-synchronisation and bad measurement due to DUT behaviour and status during the test
- ✓ **Only technology for enabling such 5G measurements in the intended use real operation** mode for multiple frequency emissions (carrier agreggation, …)

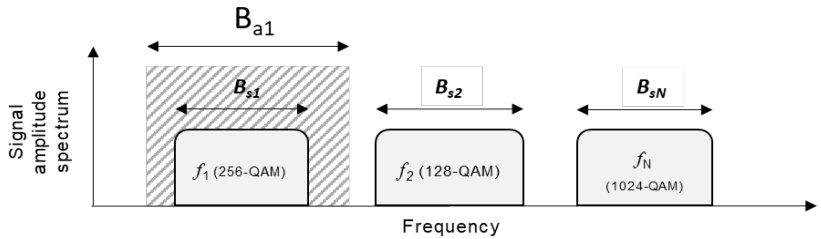
Frequency & Time Domain measurements allows to ensure compliances also for

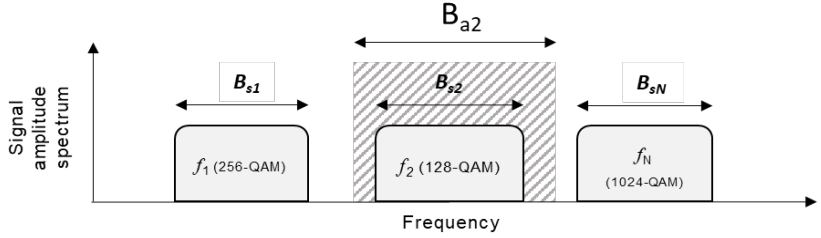
- ✓ Duty cycle
- ✓ Frequencies
- ✓ Spectrum modulation

Easy-to-use

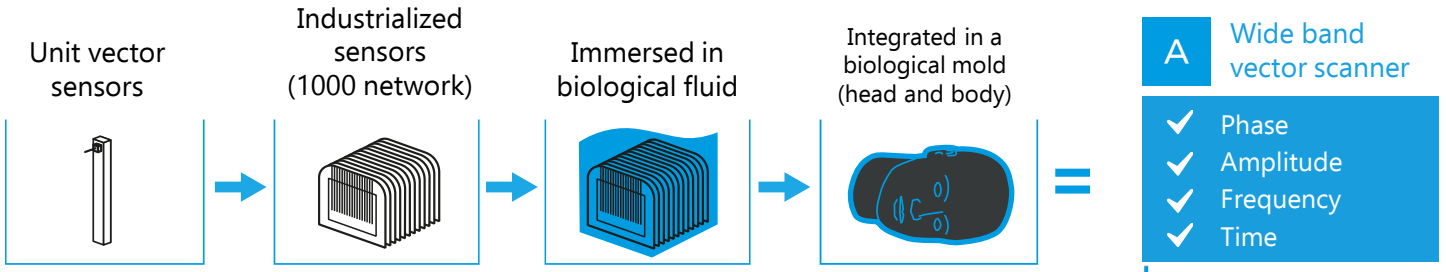
- ✓ Native Modulation measurement readiness
- ✓ No need to stop antenna/frequency 1 to measure antenna/frequency 2 and vice versa and etc …







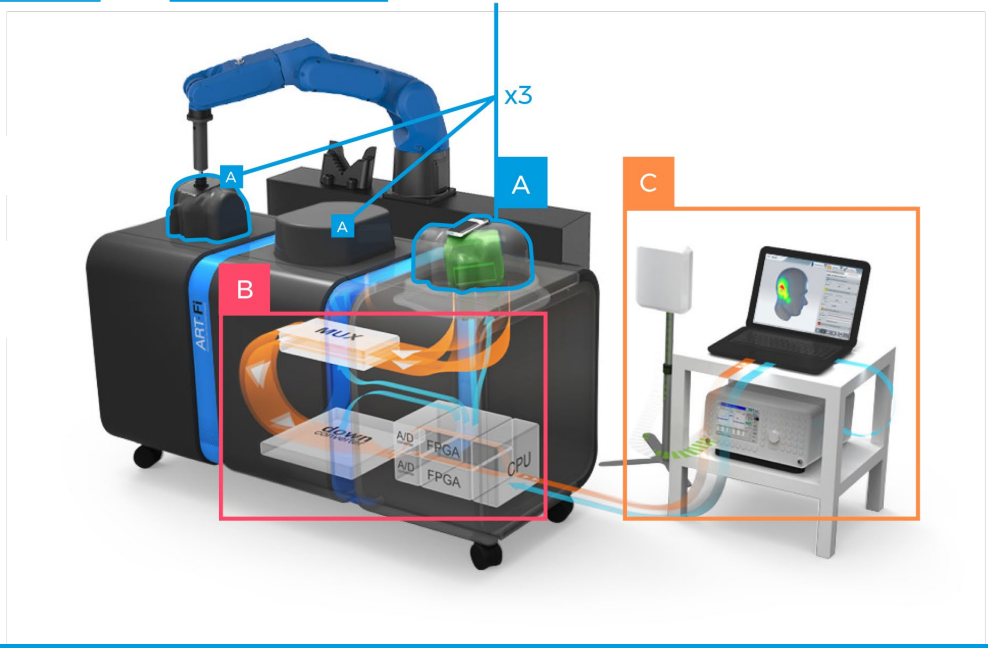
D-PHASE CORE TECHNOLOGY



A Wide band vector scanner

B Signal acquisition and processing

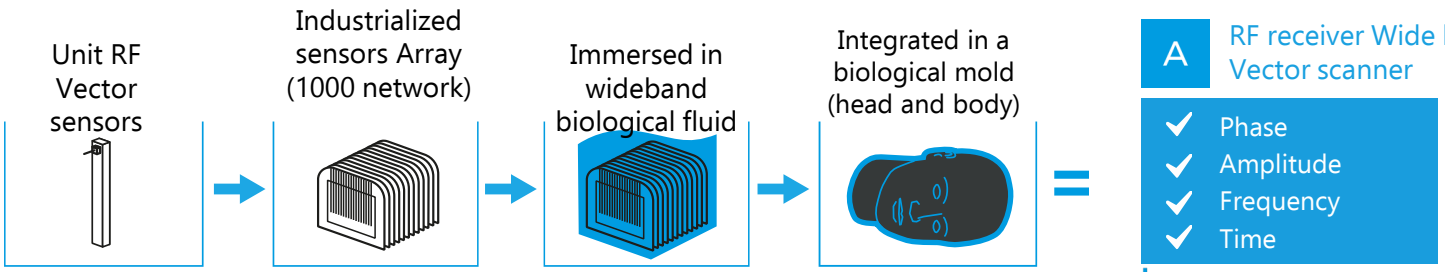
C Automation, quality & 3D analysis



BASED ON D-PHASE TECHNOLOGY, ART-MAN IS THE ONLY 5G HIGH PRECISION SYSTEM WORLWIDE MEASURING HUMAN EXPOSURE TO ELECTOMAGNETIC WAVES IN REAL TIME

ART-MAN IS THE ONLY SYSTEM ABLE TO ACCURATEY MEASURE 5G MULTIPLE EMISSIONS IN A REAL ENVIRONMENT

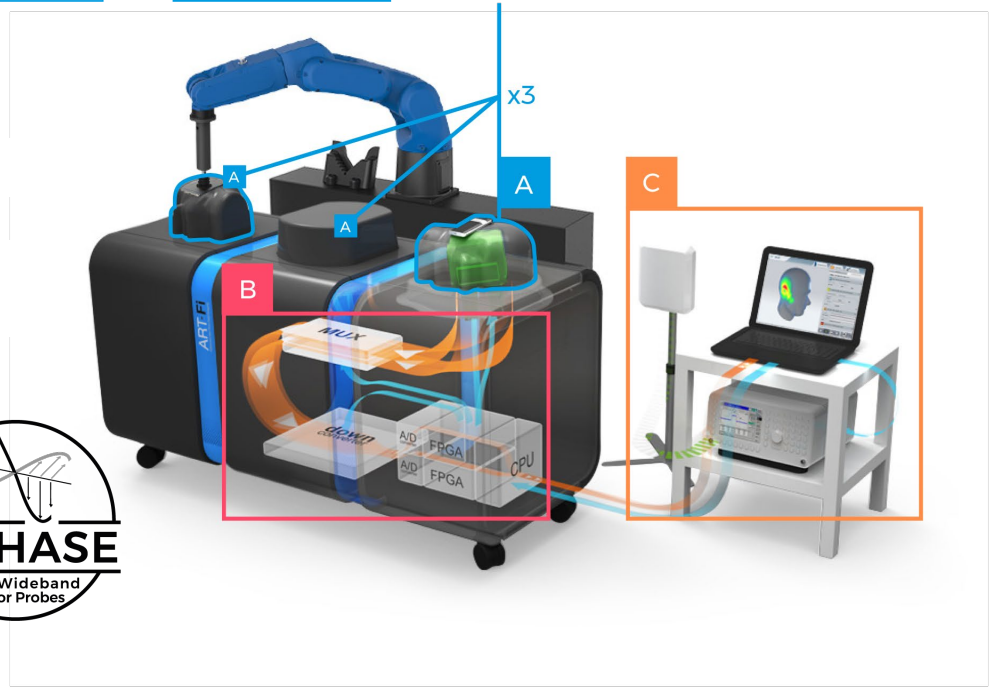
D-PHASE : RF receiver - RF Wideband Vector Probe Array



A — RF Wideband Vector scanner

B — Super heterodyne, Phase coherent Signal acquisition and processing

C — 3D, automation, Quality & Analysis



Maxwell and Huygens' Heritage

An evolutive technology able to adress a lot of challenges on SAR and for EMF

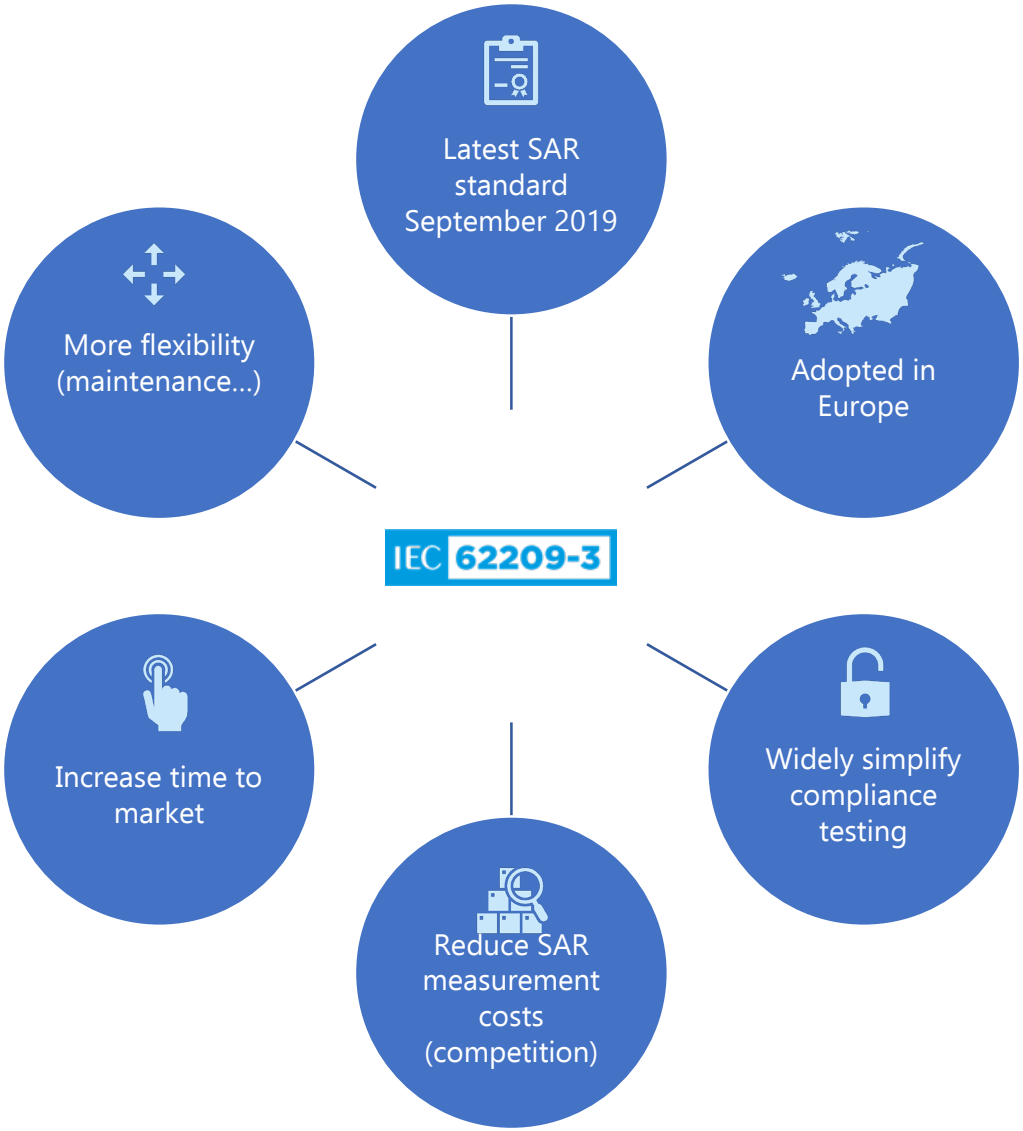
Near-Field can adress Far-Field if and only if RF Wideband Vector approaches are used

D-Phase : the technology is fully public

5G REGULATION

WHY ADOPTING IEC 62209-3 STANDARD IS AN OPPORTUNITY FOR THE SAR INDUSTRY?

5G CHALLENGES: WHY ADOPTING NEW IEC 62209-3 STANDARD?



5G BUSINESS

HOW TO MEET YOUR CUSTOMERS NEEDS & IMPROVE YOUR MARKET SHARES?

5G: CERTIFICATION LABORATORIES MAIN NEEDS

ART-Fi MAIN BENEFITS FOR 5G CHALLENGES

1. Efficiency

2. - Maximum measurement accuracy
- Real-time measurement

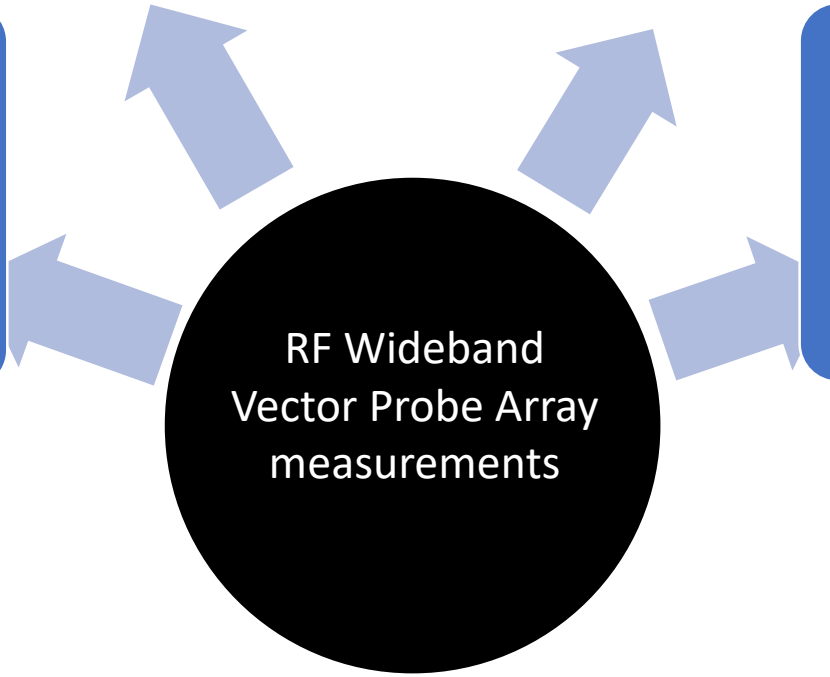
3. - No more difficulties with fluids management and mobile positioning

1. Standard & regulation experts

2. - International standards leaders
- Recognized by worldwide regulators

1. Innovation leader

2. - RF Vector wide band array system inventor new testing abilities
- Evolutive platform, future proof technology



Lab quality improvement

- Unique closed loop measurement process with autocheck mobile status during measurements

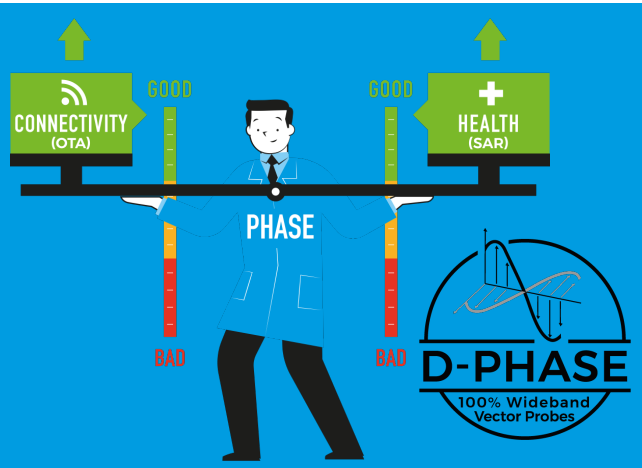
5G WIRELESS DEVICES LIFE CYCLE : A TESTING NEED EVERYWHERE

	Design	Certification	Production	Distributor	End users	Repair & Refurb.	End users
Today	✓	✓	X	X	X	X	X
D-PHASE TECHNOLOGY	✓	✓	✓	✓	✓	✓	✓

TO ANSWER THE GREAT COMPLEXITY OF THE 5G STANDARD, D-PHASE TECHNOLOGY ACCELERATES THE SAR BUSINESS TRANSFORMATION

RF WIDEBAND VECTOR TECHNOLOGY BENEFITS TO ALL AREAS OF THE WIRELESS BUSINESS BUT ALSO TO CUSTOMERS

AS CONSUMERS WE WILL BENEFIT FROM SAFER & MORE EFFICIENT 5G WIRELESS DEVICES EVEN AFTER MARKET ACCESS AND OVER TIME



5G Multiple emissions is just a step,

Measurement techniques has to be used to leverage technologies deployement efficiently

Let's the Radio science enter in the game of Human RF Exposure truely and surely

THANK YOU FOR ATTENDING

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