Institut national de l'environnement industriel et des risques

Measurement of exposure to radiofrequency radiation from 5G-NR telephony in South Korea in public areas

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INERIS
maîtriser le risque
pour un développement durable

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Available data on 5G-NR technology in South Korea

- General data of the 5G-NR network in South Korea
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- Geographic variability of exposure according to different typologies of environment
- Geographic variability of exposure on transport networks
- Temporal variability of exposure at fixed point

Characterization of a 5G-NR base station

Questions?

Objectives

- The Ministry of Ecological and Inclusive Transition commissioned INERIS a study aimed at characterizing the exposure of people to non-ionizing radiation from the 5G-NR networks in a context where its commercial exploitation is already effective.
  - mid 2019, only 2 countries entered the commercial exploitation phase of these new networks: Australia (since July 2019) and South Korea (since April 2019). Note that in Europe, Switzerland already has the infrastructure to initiate the commercial deployment of this technology but without putting it into service.
  - On the basis of these elements, it was decided to characterize the exposure of people to 5G-NR in South Korea since it has the greatest maturity in terms: of users, of coverage, etc. It was decided to make this assessment in November 2019 (3 Millions 5G-NR subscribers)
  - an other measurement campaign was performed in July 2022 (24 Millions 5G-NR subscribers)

Available data on 5G-NR technology in South Korea

⁄ General data of the 5G-NR network in South Korea

- Operator bandwidth

Operator	Bandwidth used
LGU+	3420 -3500
KT	3500 -3600
SKT	3600 -3700

- Base station manufacturer

Manufacturer	LGU+ (Bandwidth 80) Central frequency (3459,99)	KT (Bandwidth 100) Central frequency (3549,99)	SKT (Bandwidth 100) Central frequency (3650,01)
HUAWEI	-180 kHz (3459,81)		
SAMSUNG	-31,15 (3428,84)	-41.22 (3508,77)	-41.22 (3608,79)
NOKIA	-630 kHz (3459,36)	90 kHz (3550,08)	-570 kHz (3649,44)
ERICSSON LG		-41.22 (3508,77)	-41.22 (3649,92)

Available data on 5G-NR technology in South Korea

/ 5G-NR network coverage evolution

- Geographic repartition of base station

Region	KT 5G base station number (2019)	KT 5G base station number (2022)
All over the country	38 999	161 965
Seoul	9 878	26 322
Seoul metropolitan area (Incheon)	11 716	44 769
Gangwon-do	1 107	9 078
Chungcheong-do	3 529	17 153
Jeolla	3 124	15 291
Gyeongsang-do	9 241	45 637
Ile de Jeju	404	3 715

- Manufacturer repartition of base station

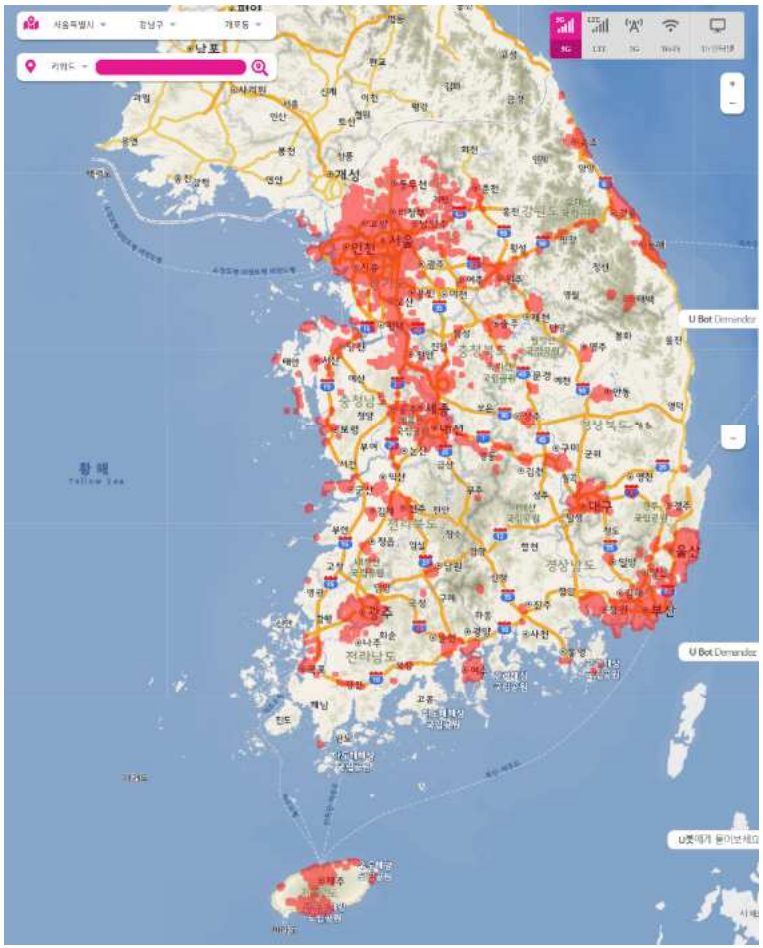
Manufacturer	KT 5G base station number (2019)	KT 5G base station number (2022)
SAMSUNG	31 464	111 218
ERICSSON LG	4 317	29 701
NOKIA	3 218	21 046

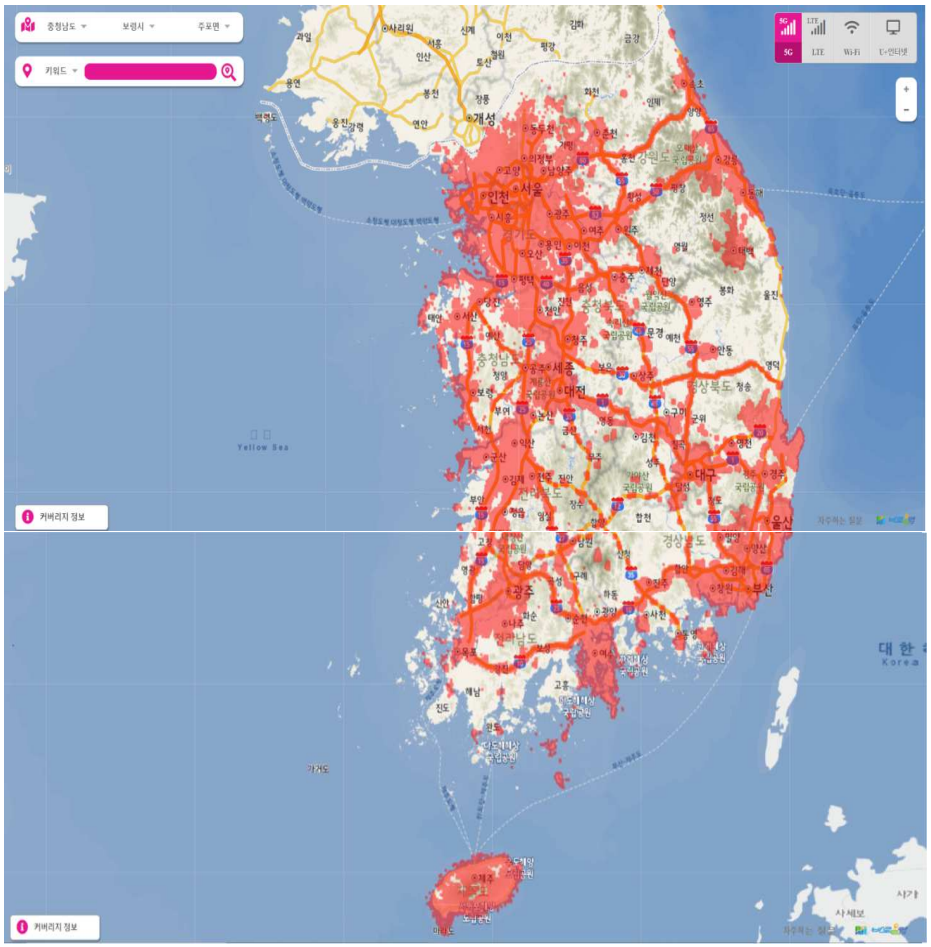
Available data

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Coverage of 5G-NR technology in South Korea

⁄ LGU+ coverage network in South Korea (in 2019 and in 2022)



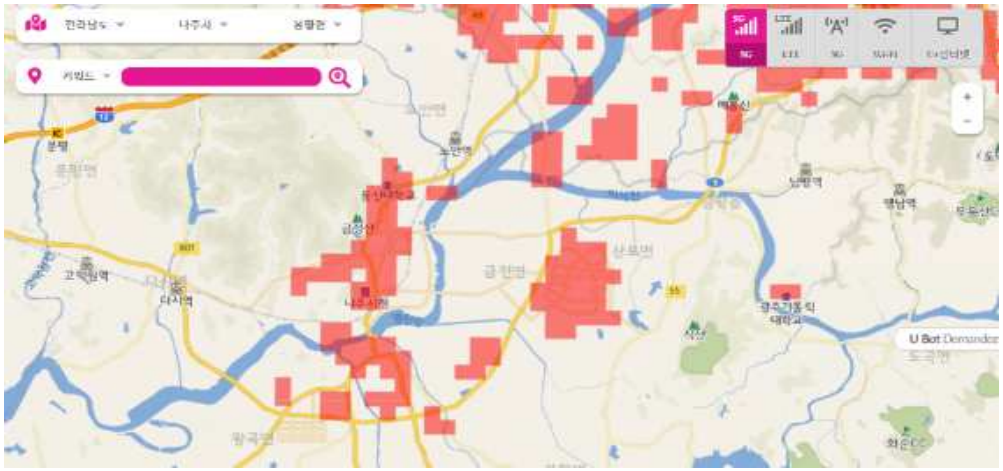


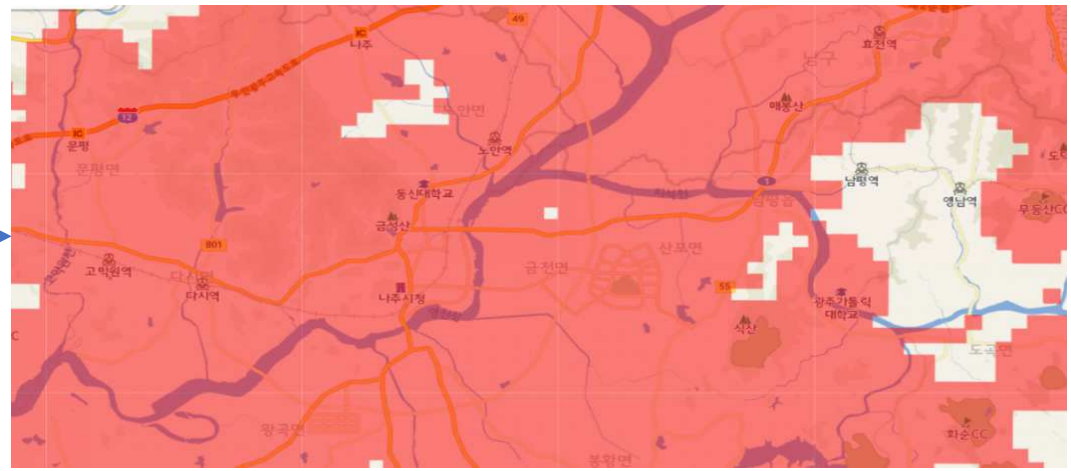
Available data

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Coverage of 5G-NR technology in South Korea

⁄ LGU+ coverage network in Seoul center and Naju (in 2019 and in 2022)



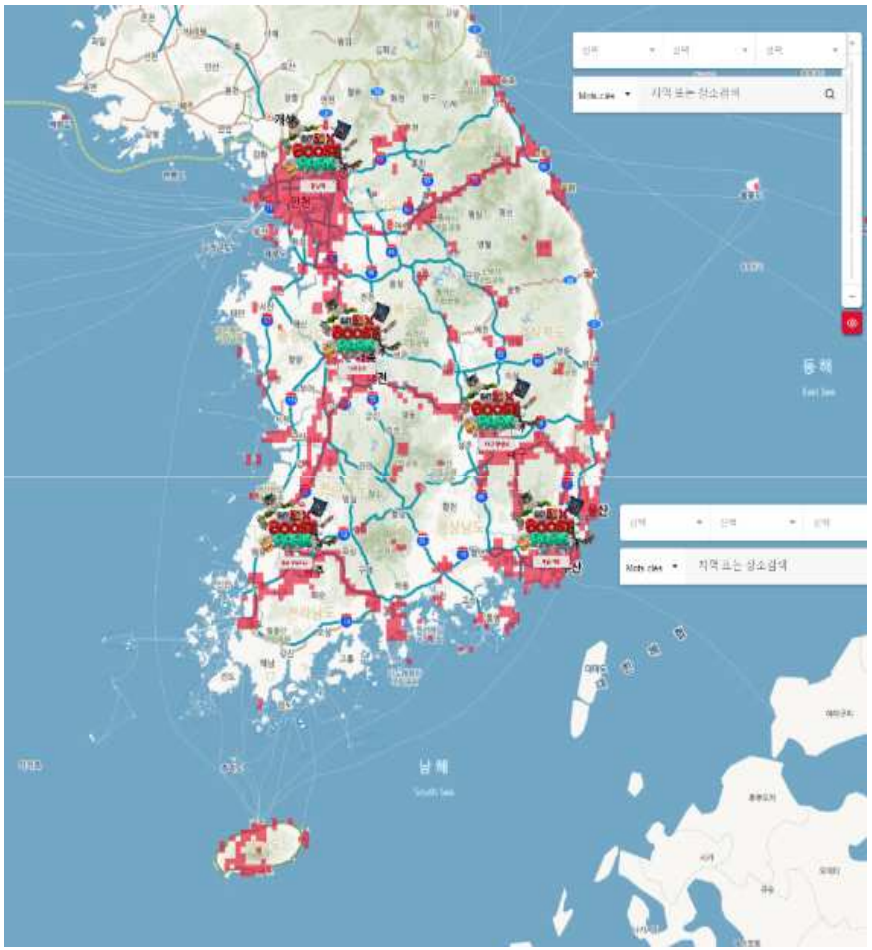


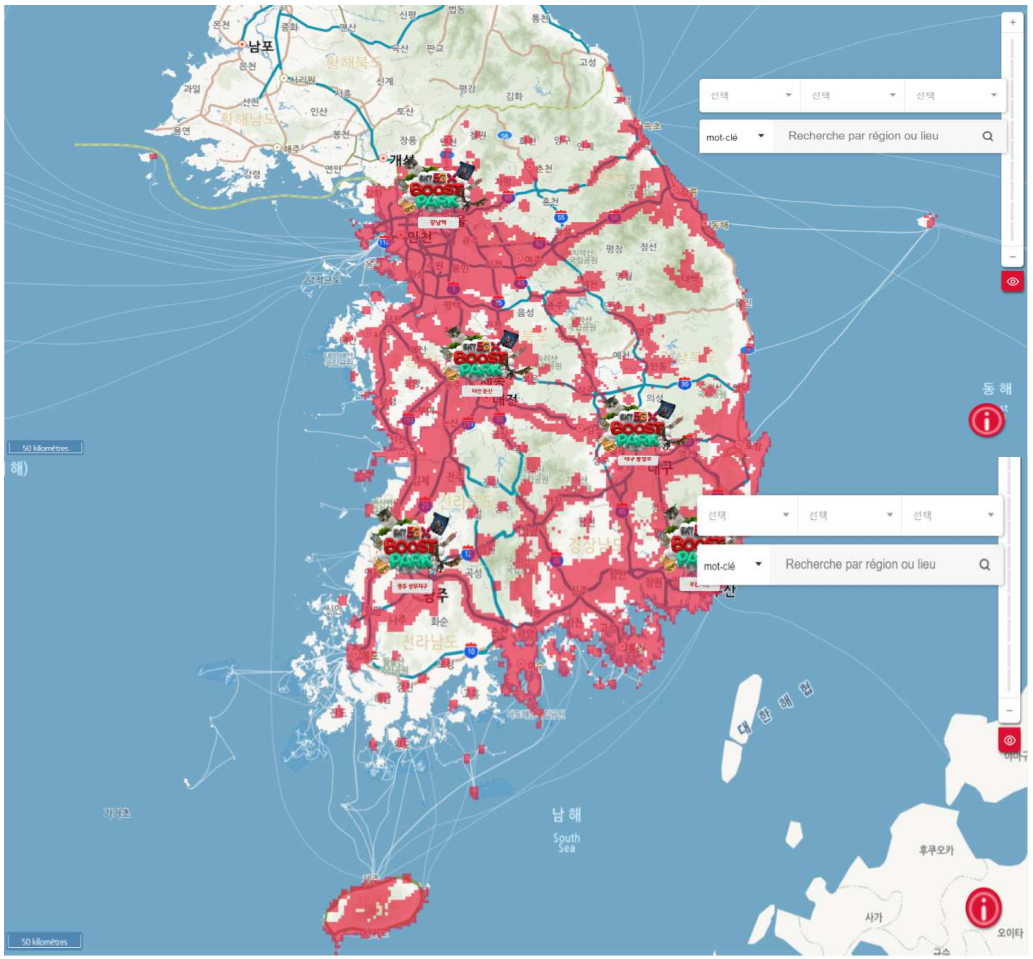
Available data

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Coverage of 5G-NR technology in South Korea

⁄ SKT coverage network in South Korea (in 2019 and in 2022)



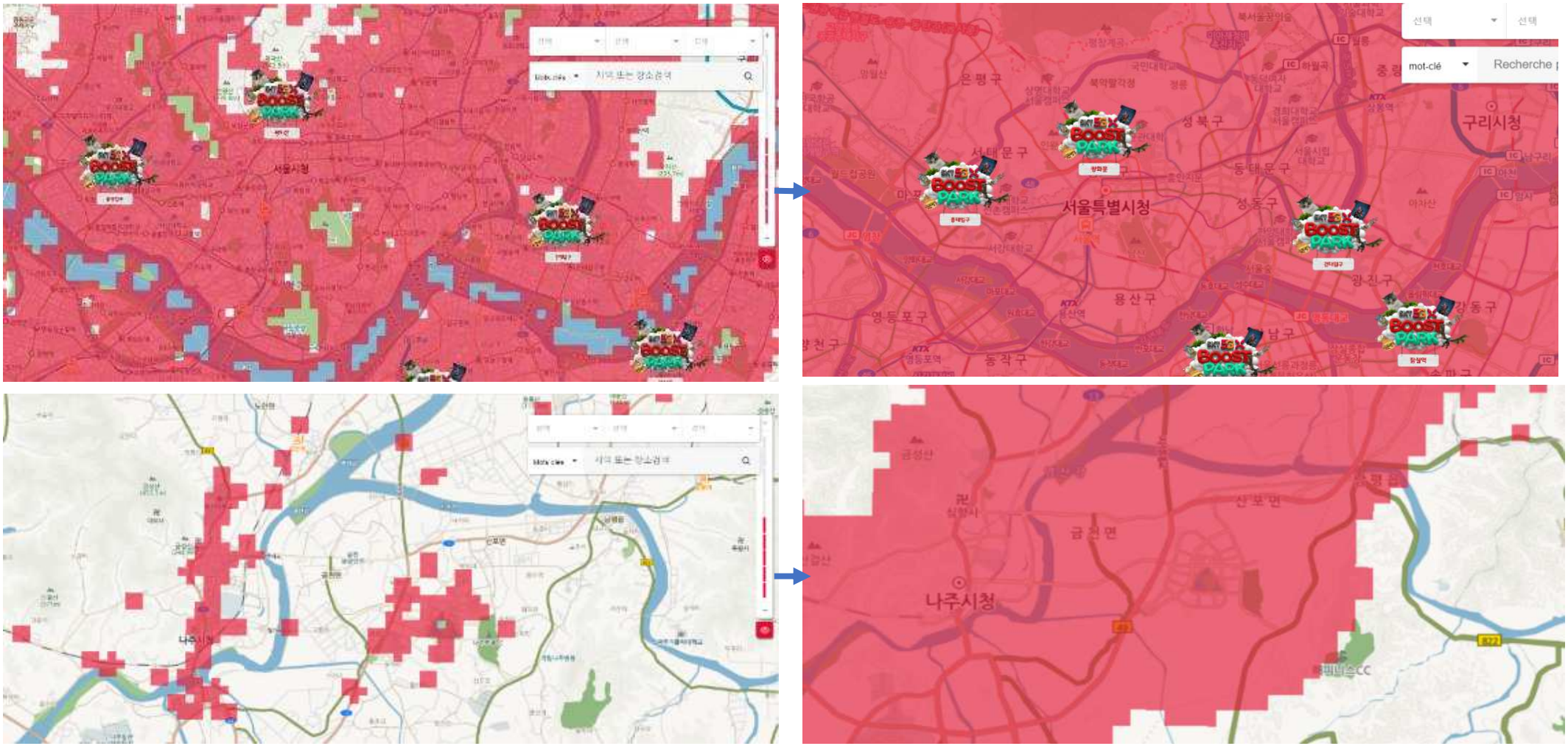


Available data

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Coverage of 5G-NR technology in South Korea

⁄ SKT coverage network in Seoul center and Naju (in 2019 and in 2022)

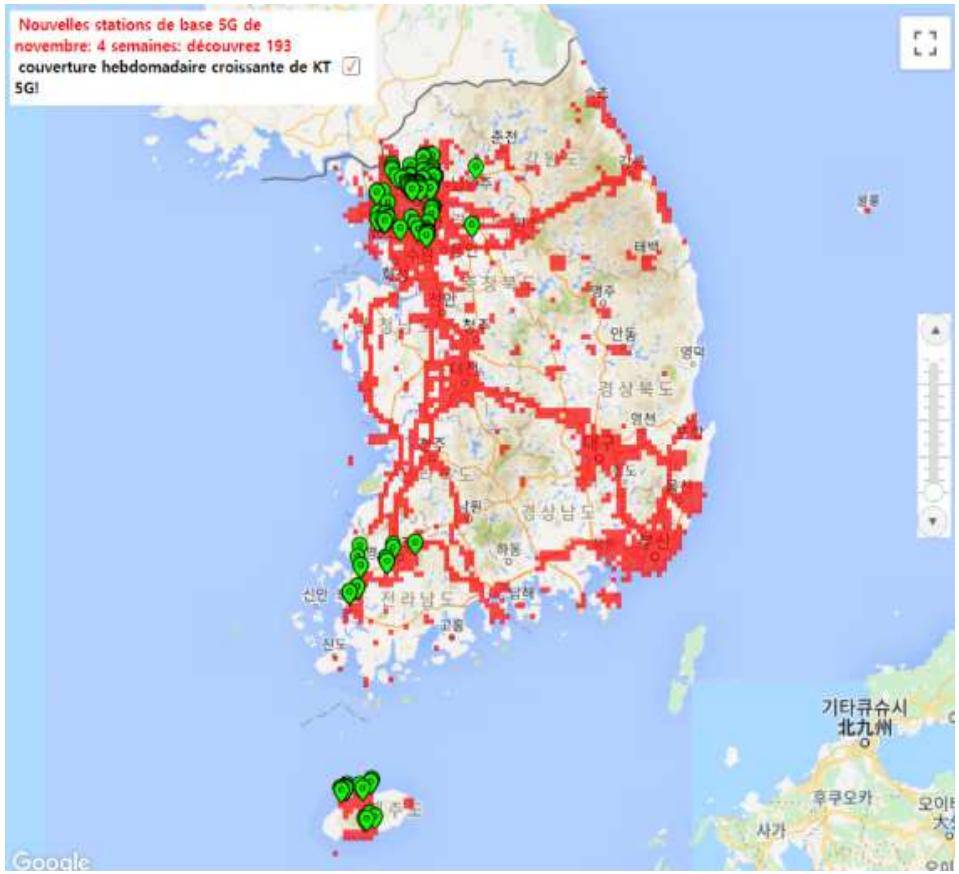


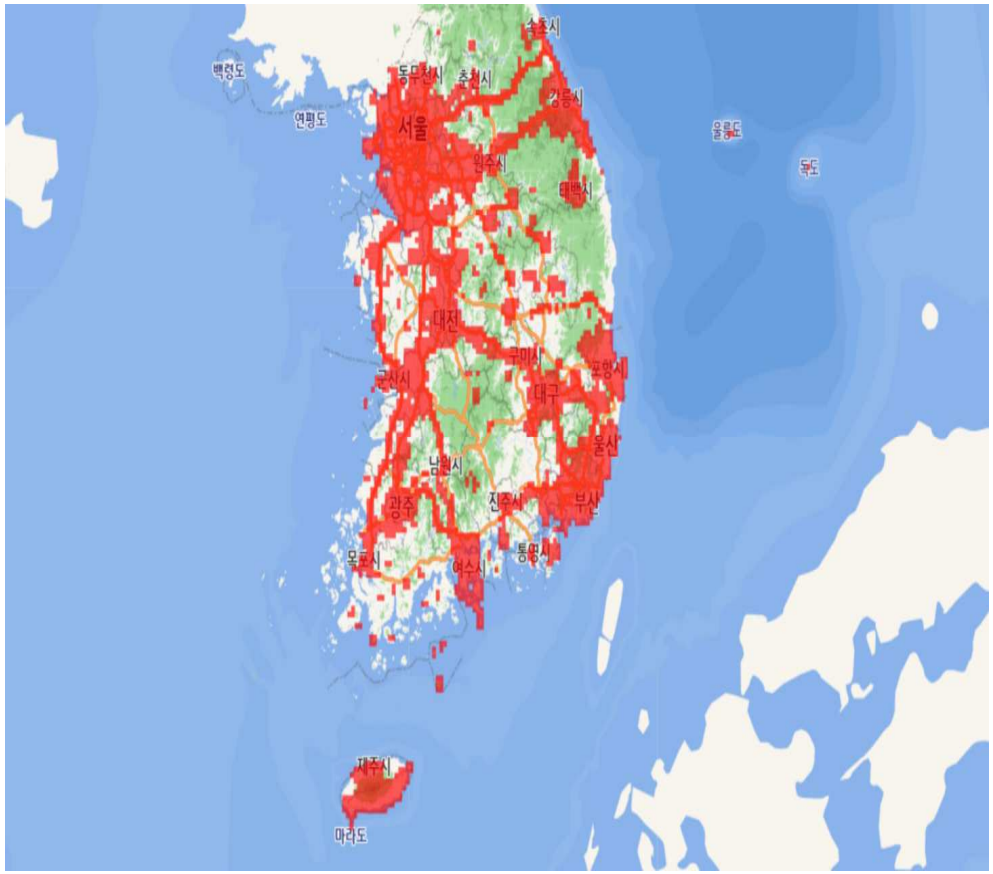
Available data

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Coverage of 5G-NR technology in South Korea

⁄ KT coverage network in South Korea (in 2019 and in 2022)



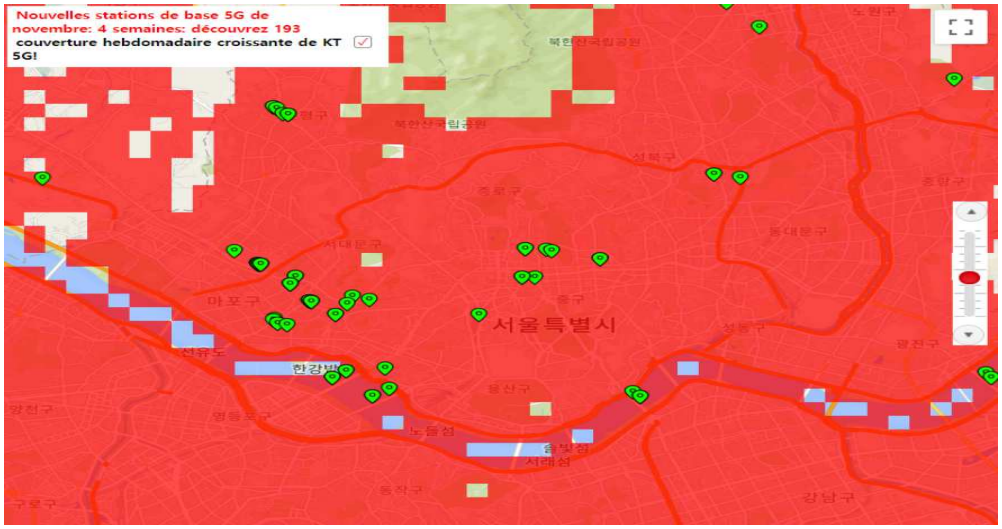


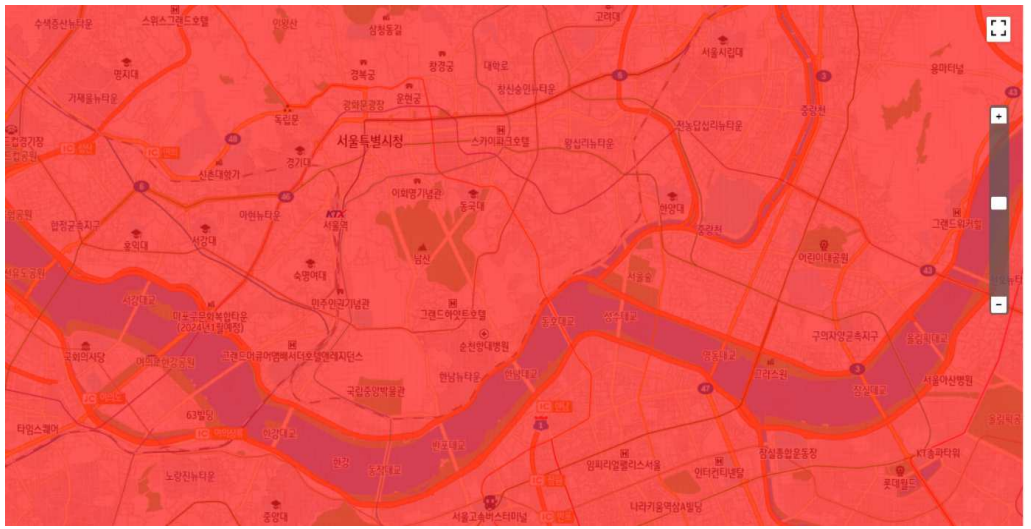
Available data

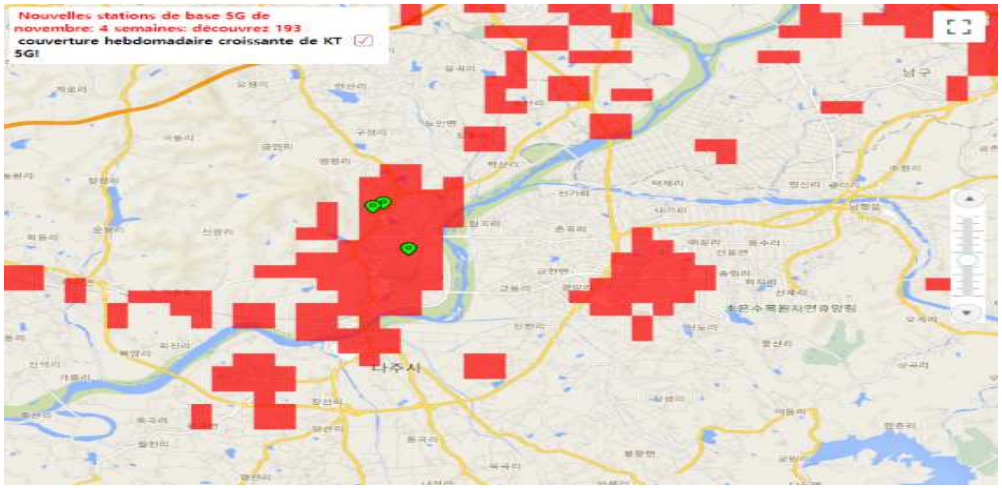
Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

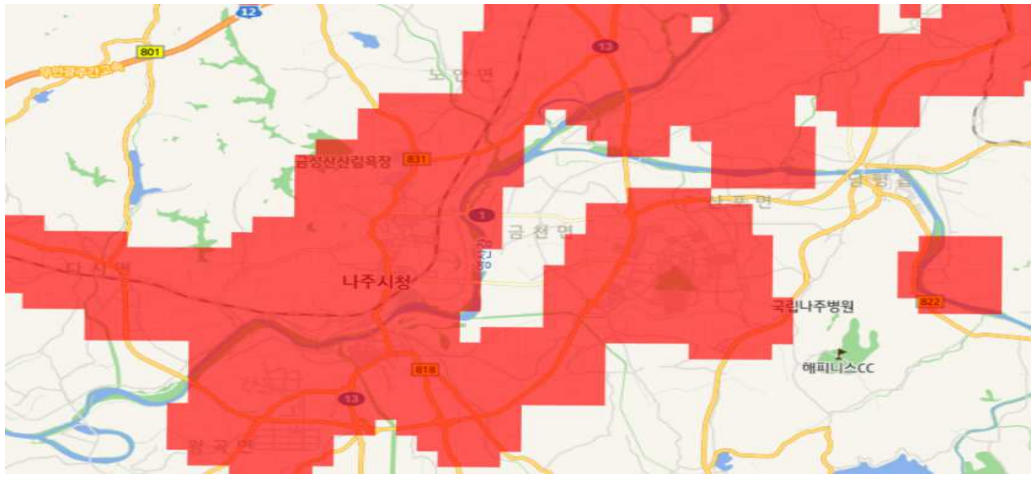
Coverage of 5G-NR technology in South Korea

⁄ KT coverage network in Seoul center and Naju (in 2019 and in 2022)









Equipement used, and measured services

Designation	Exposimeter 88 - 5875	
Manufacturer / Model	Fields at Work / ExpoM-RF (MHz)	
Setup for measured service	FM	87.5 - 108
	DVB-T	470 - 790
	LTE 800 U L	791 - 821
	LTE 800 D L	832 - 862
	GSM -R 900 U L	880 - 915
	GSM -R 900 D L	925 - 960
	GSM / LTE 1800 UL	1710 - 1785
	GSM / LTE 1800 DL	1805 - 1880
	DECT	1880 - 1900
	UMTS / LTE 2100 UL	1920 - 1980
	UMTS / LTE 2100 DL	2110 - 2170
	W2G	2400 - 2483
	LTE 2600 UL	2500 - 2570
	LTE 2600 DL	2620 - 2690
	5G TDD (Low Band)	3400 - 3600
	W5G	5150 - 5850

Exposure measurement

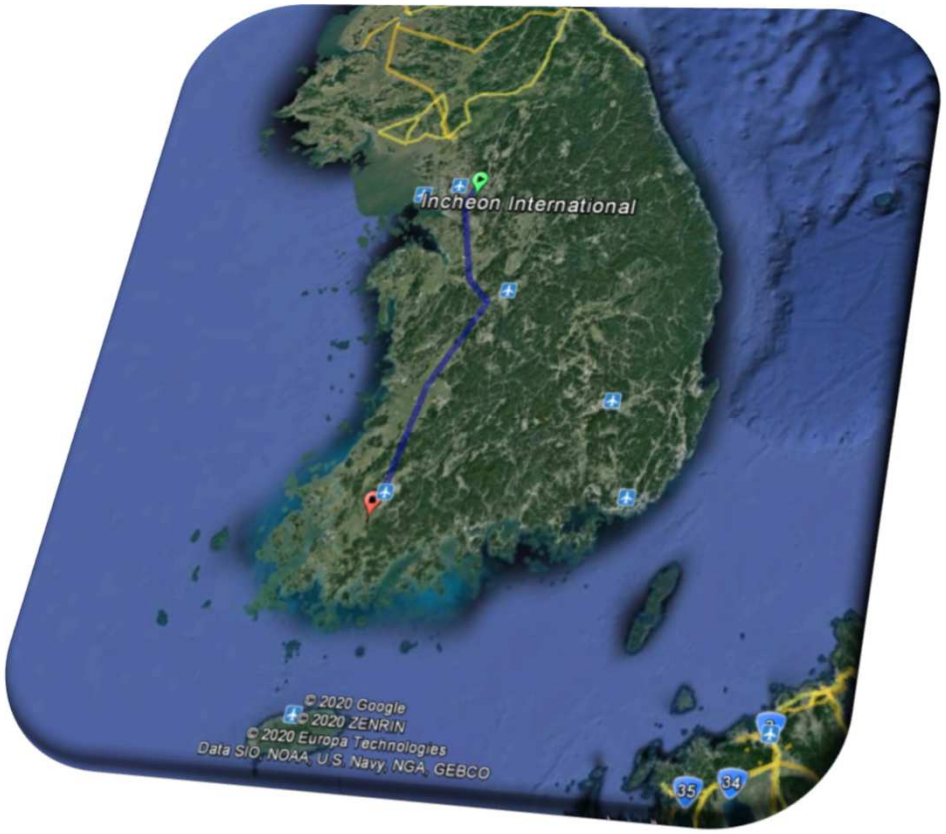
Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Different types of environnement measured

- Urban residential area - New city of Naju,
- Urban trade aera - New city of Naju,
- Urban entertainment area - New city of Naju,

- Dense urban residential area - Seoul,
- Dense urban trade area - Seoul,
- Dense urban entertainment area - Seoul.
- Dense urban business area - Seoul.

- Urban trip - Seoul,
- Extra urban trip - Seoul to Incheon,
- Railways trip – Seoul to Naju

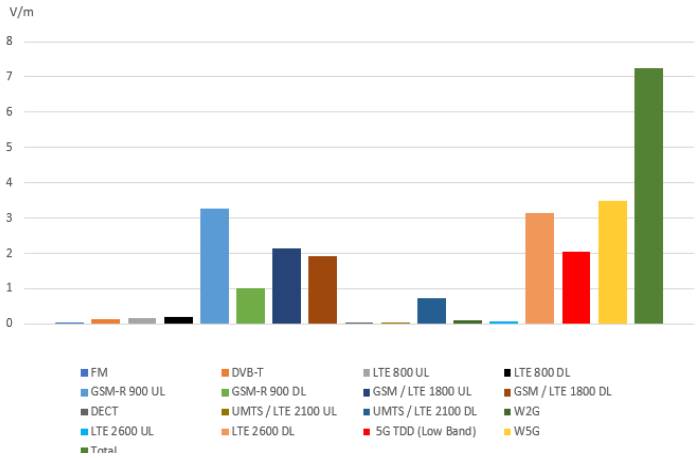


Measurement results : close to 5G-NR Base station

On the roof of building – Naju new city ,

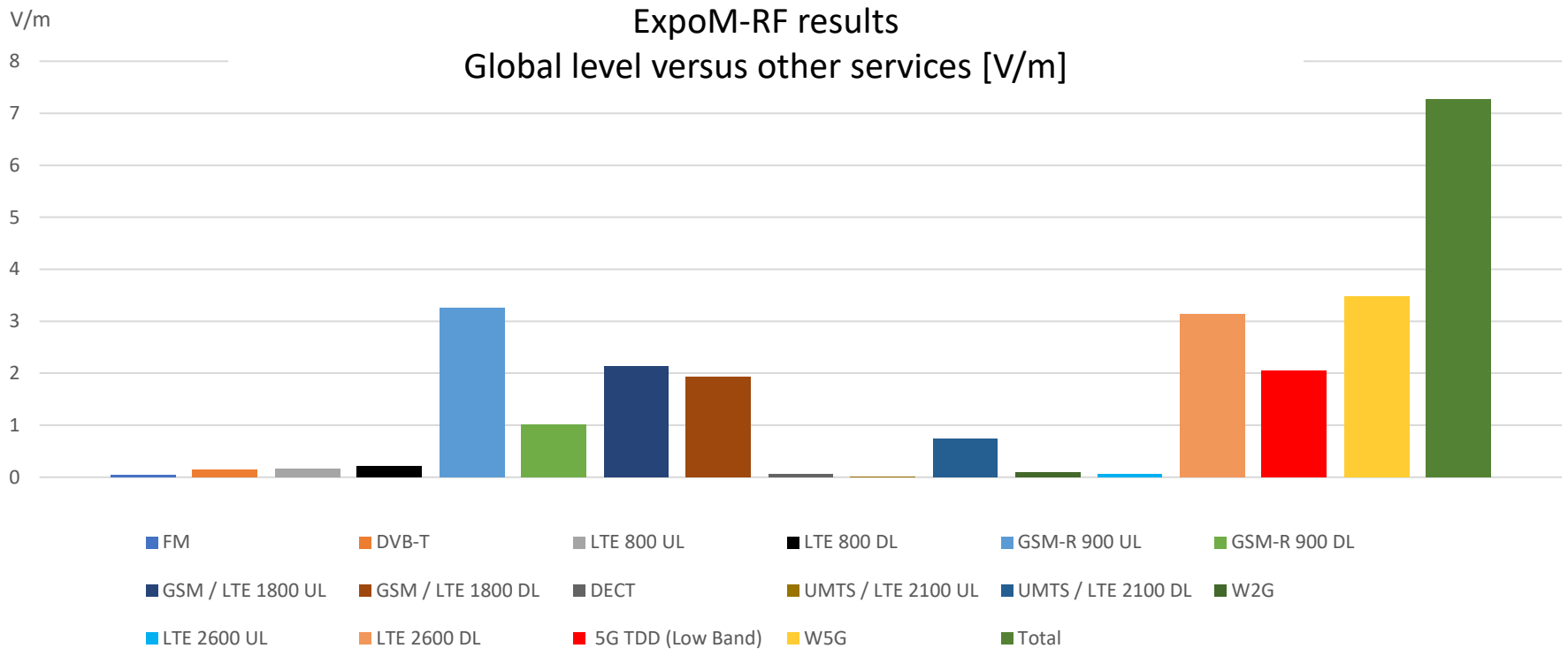
- In the main beam – Naju new city,
- In a nearby building (NRRA) – Naju new city.

ExpoM-RF results
Global level versus other services [V/m]



Exposure measurement

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022



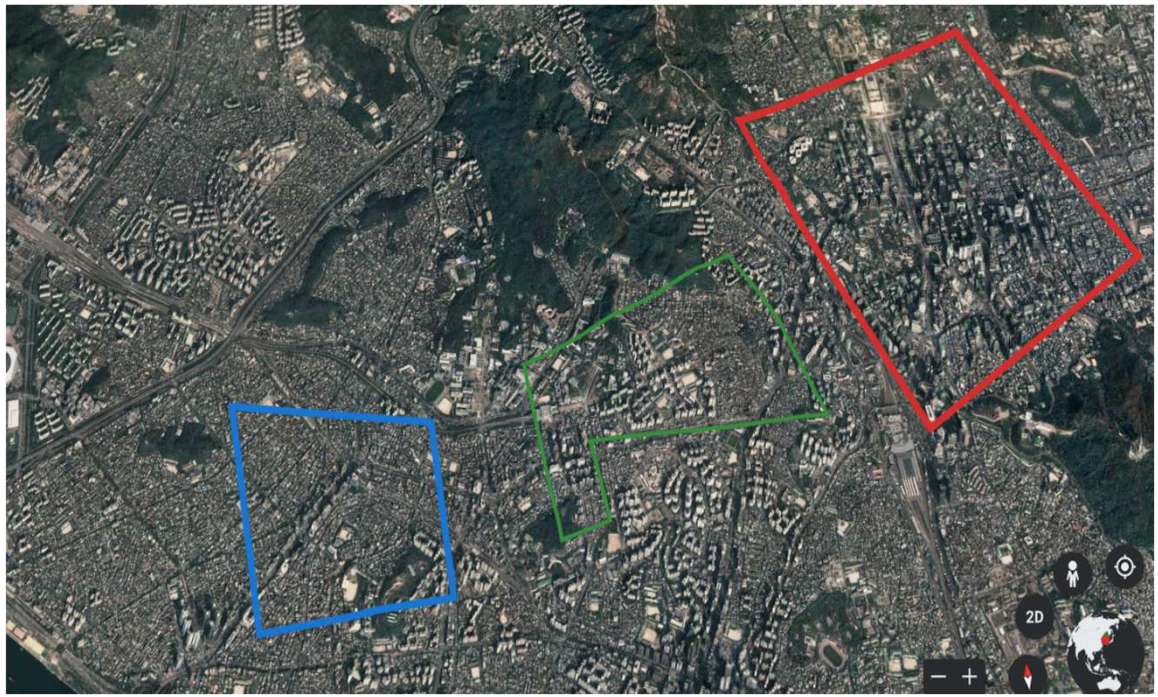
Year of meseaurement	Global level for all the services [mV/m]	5G TDD (Low Band) Average level [mV/m]	5G TDD (Low Band) Maximum level [mV/m]	5G TDD (Low Band) Stand dev [mV/m]
2019	1037,4	561,4	2576,2	669,7
2022	7265,1	2055,8	7688,4	3075,5

Exposure measurement

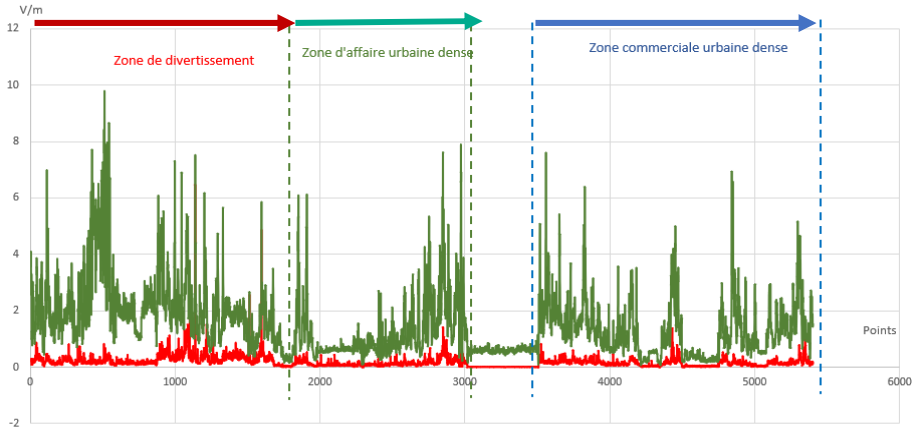
Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Measurement results : Seoul center

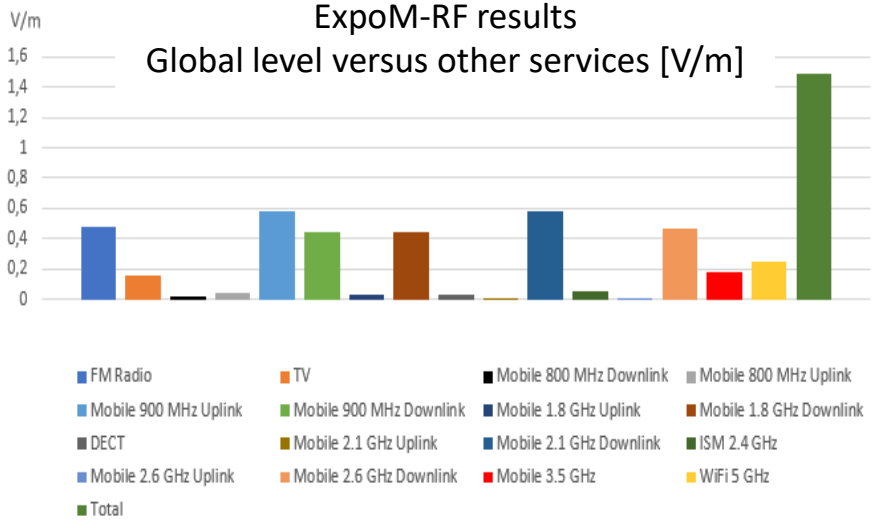
- Dense urban trade area - Seoul,
- Dense urban entertainment area - Seoul,
- Dense urban business area - Seoul.



ExpoM-RF results
Global level versus 5G TDD Low band [V/m]



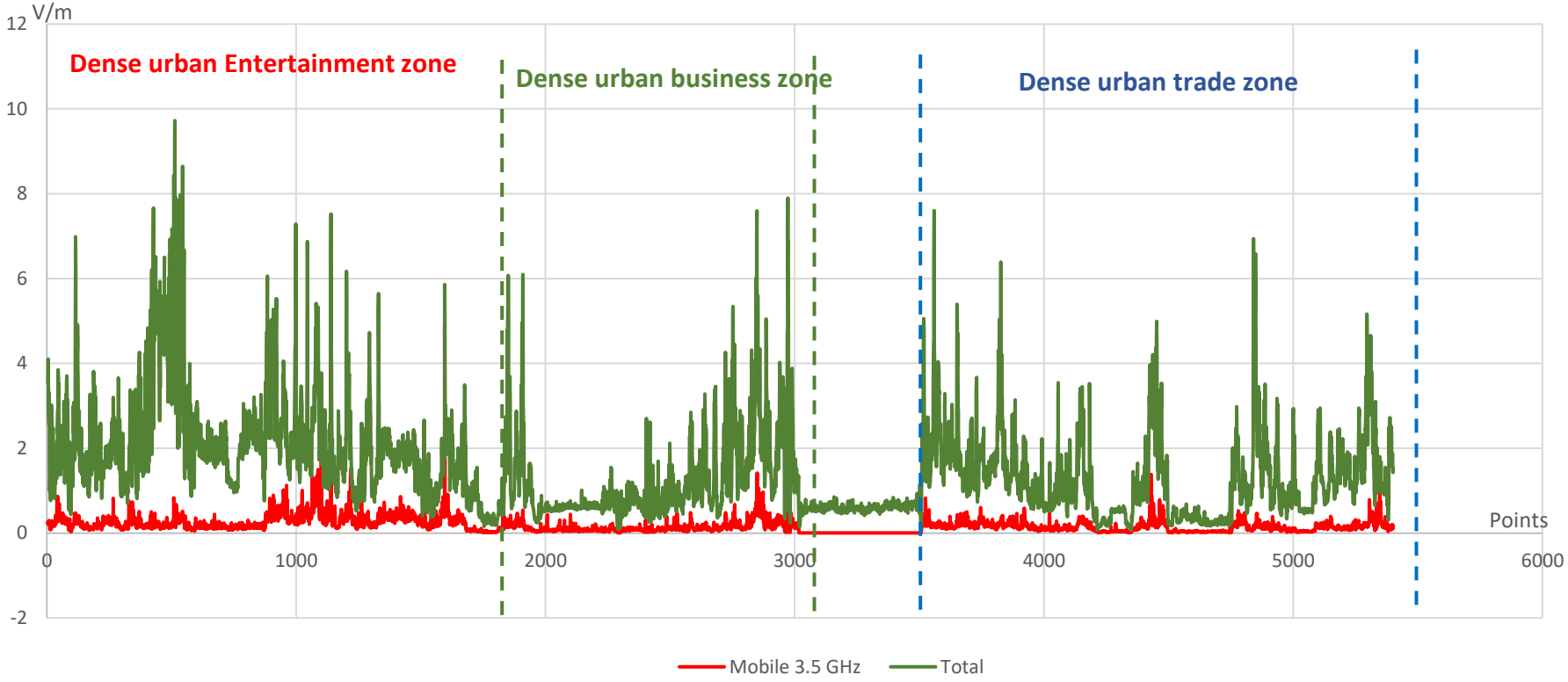
ExpoM-RF results
Global level versus other services [V/m]



Exposure measurement

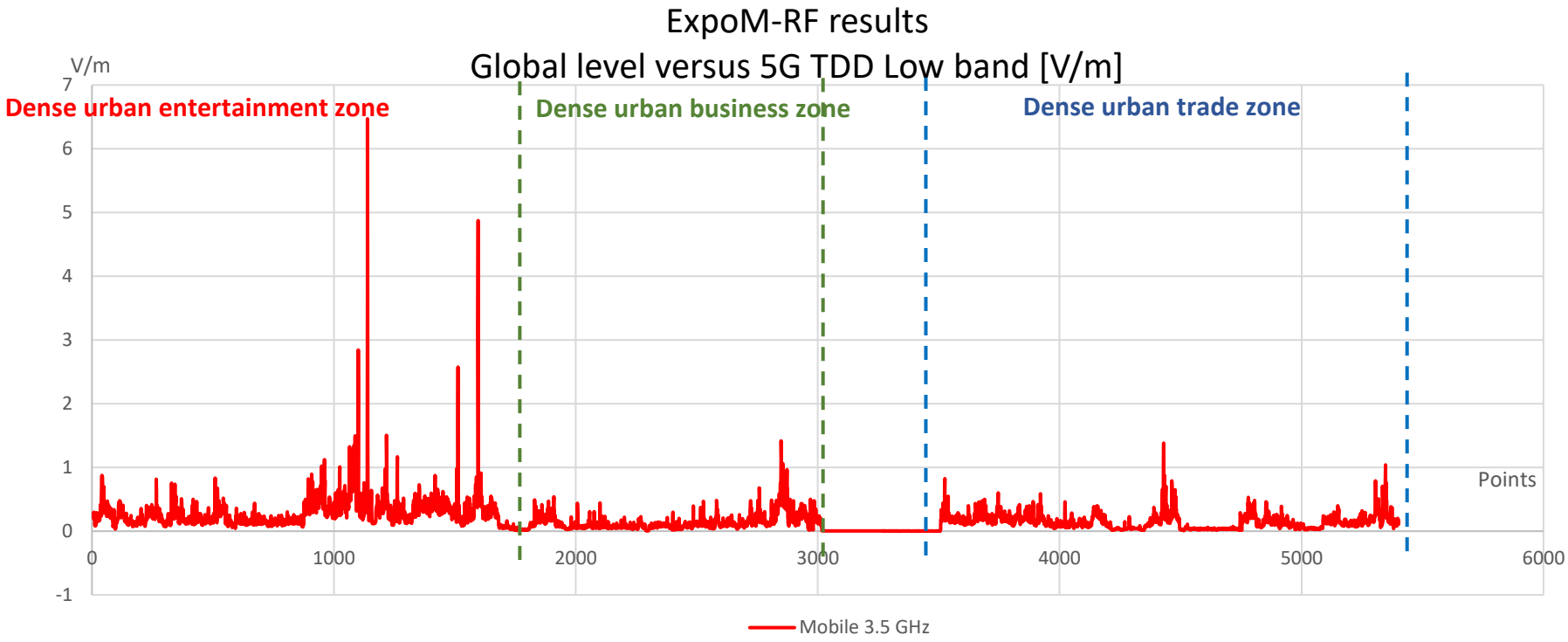
Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

ExpoM-RF results
Global level versus 5G TDD Low band [V/m]



Exposure measurement

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022



Year of measurements	Global level for all the services [mV/m]	5G TDD (Low Band) Average level [mV/m]	5G TDD (Low Band) Maximum level [mV/m]	5G TDD (Low Band) Stand dev [mV/m]
2019	1846,6	139,8	2135,6	157,8
2022	1490,6	176,9	6469,2	201,2

Exposure measurement

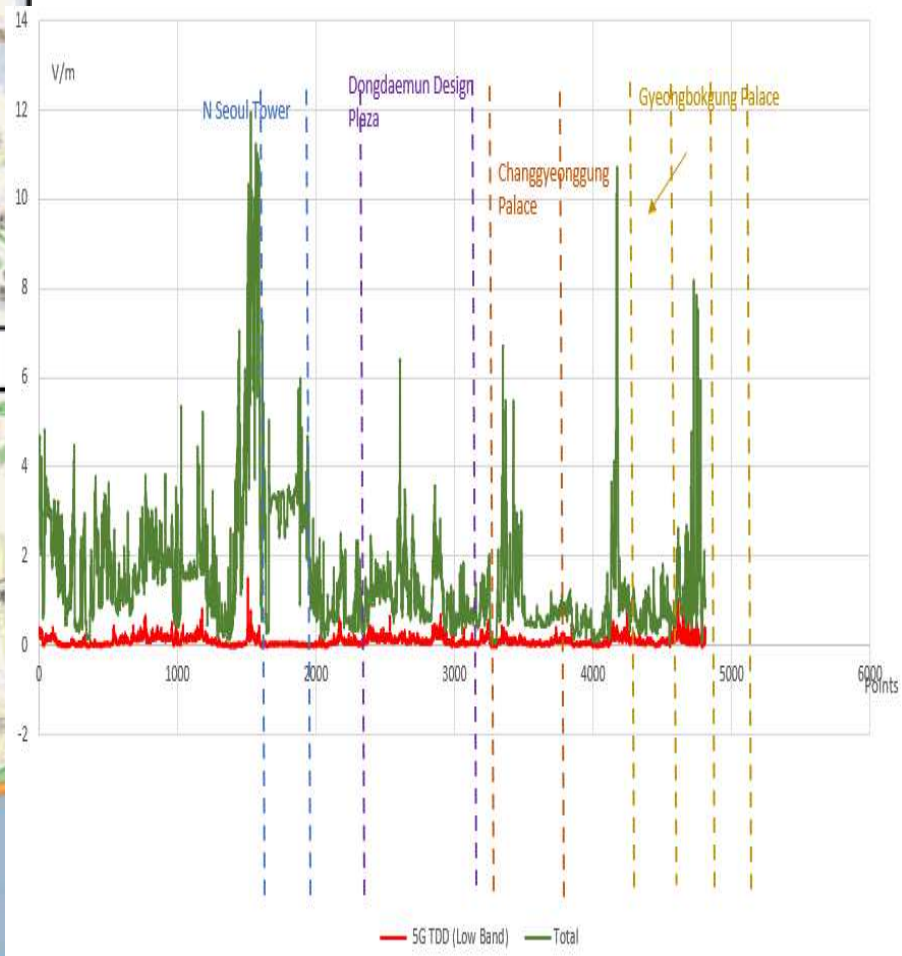
Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Measurement results : Exposure on transport network

1st : Seoul trip ➔ on the bus

1 : Gwanghwamun
2 : Myeong-dong
3 : Hanok Village
4 : Ambassador Hotel
5 : Jangchungdan Park
6 : N Seoul Tower
7 : Hyatt Hotel
8 : Dongdaemun Design Plaza
9 : Daehangno
10 : Changgyeonggung Palace
11 : Changdeokgung Palace
12 : Insa-dong
13 : Cheongwadae
14 : Gyeongbokgung Palace
15 : Sejong Center Performance Arts

ExpoM-RF results
Global level versus 5G TDD Low band [V/m]



Exposure measurement

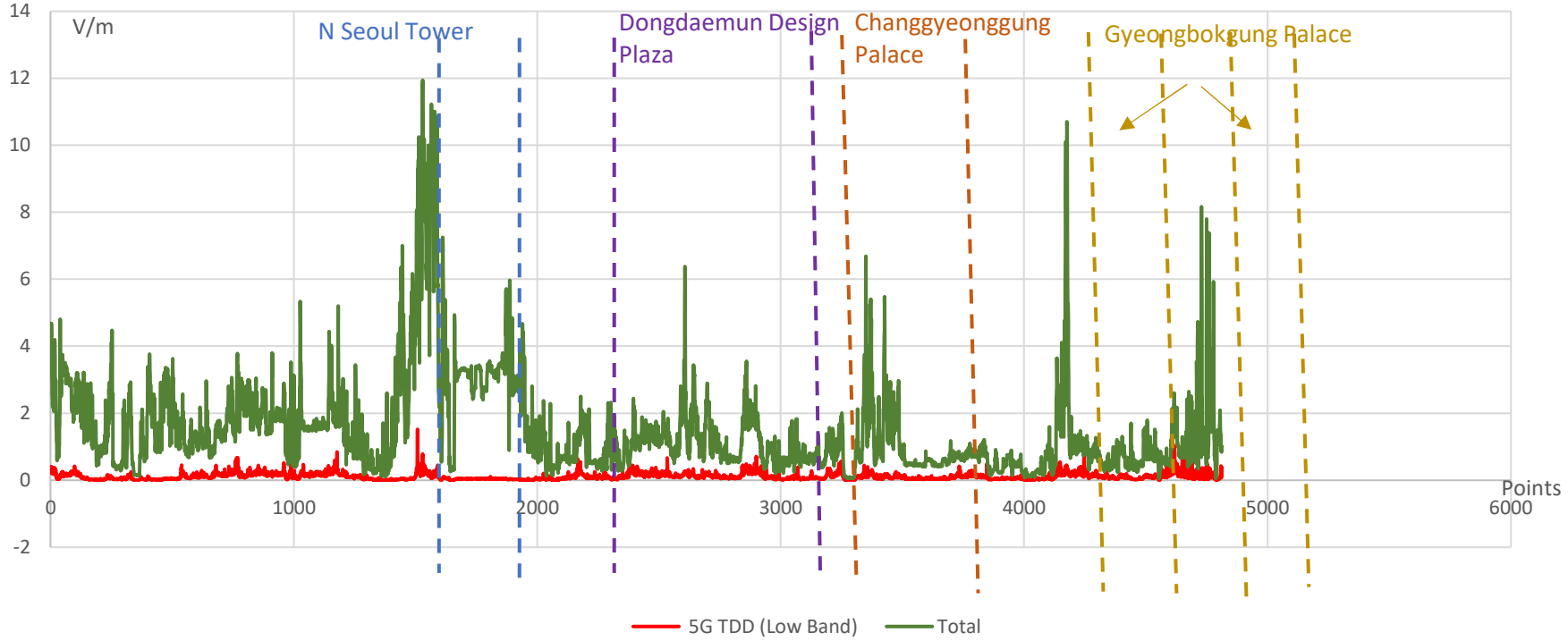
Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Measurement results : Exposure on transport network

1st : Seoul trip ➔ on the bus

ExpoM-RF results

Global level versus 5G TDD Low band [V/m]



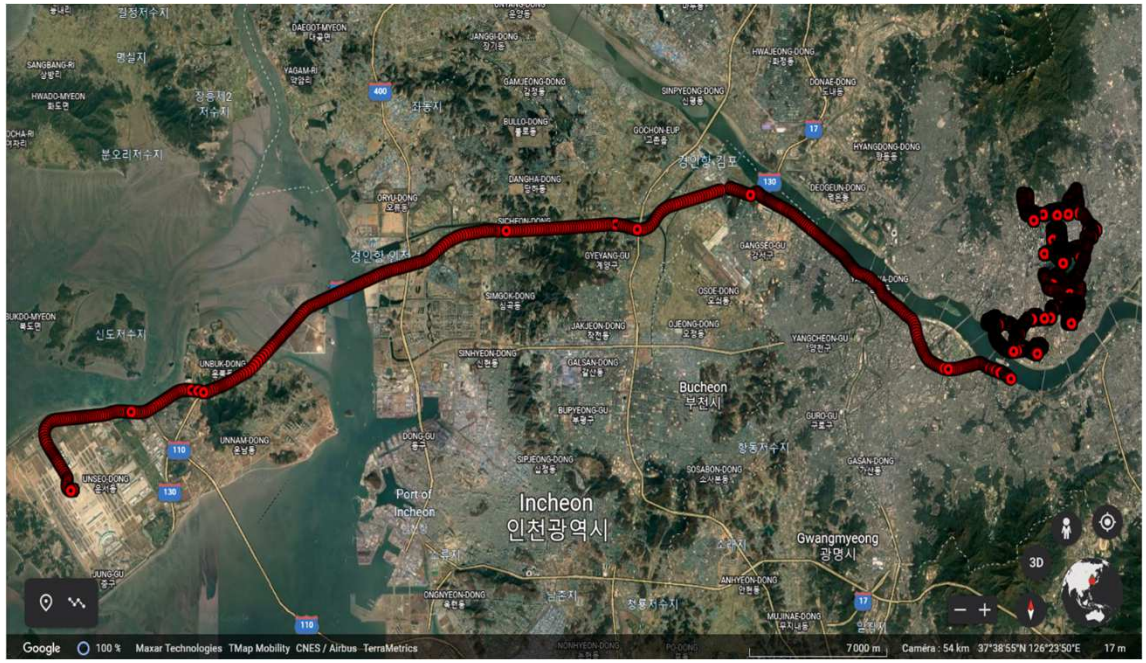
Year of measurements	Global level for all the services [mV/m]	5G TDD (Low Band) Average level [mV/m]	5G TDD (Low Band) Maximum level [mV/m]	5G TDD (Low Band) Stand dev [mV/m]
2019	805,4	47,6	1547,5	62,1
2022	1497,5	113,8	1516,2	102,7

Exposure measurement

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Measurement results : Exposure on transport network

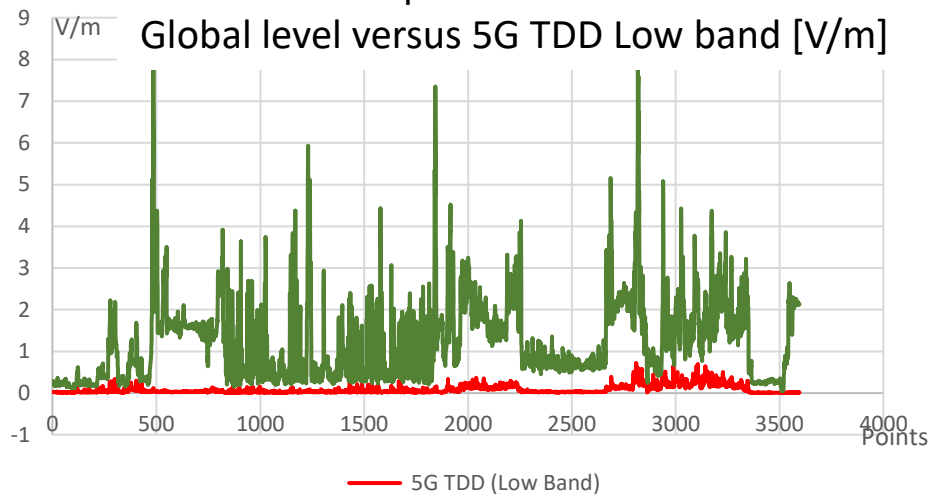
2nd : extra urban trip ➔ on the subway



Year of measurements	Global level for all the services [mV/m]	5G TDD (Low Band) Average level [mV/m]	5G TDD (Low Band) Maximum level [mV/m]	5G TDD (Low Band) Stand dev [mV/m]
2019	282,4	20,0	497,8	36,7
2022	1179,8	81,1	715,0	94,4

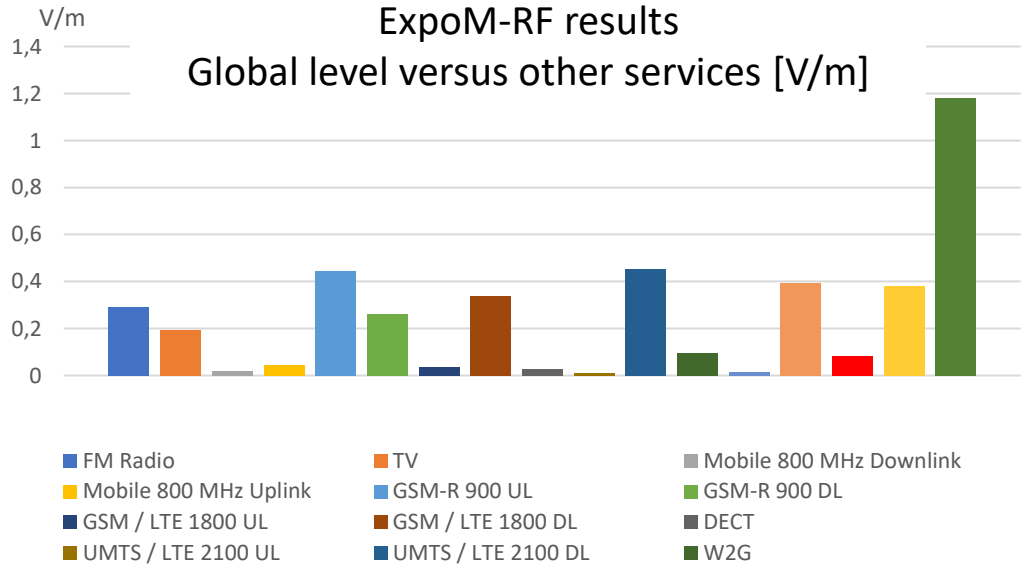
ExpoM-RF results

Global level versus 5G TDD Low band [V/m]



ExpoM-RF results

Global level versus other services [V/m]



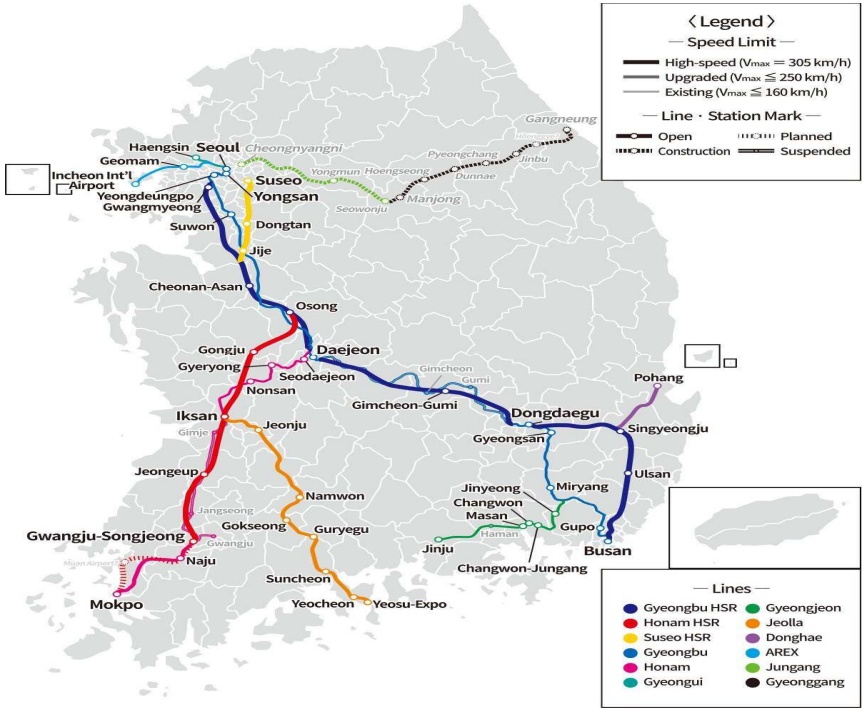
Exposure measurement

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Measurement results : Exposure on transport network

3d : railways trip ➔ on the train,

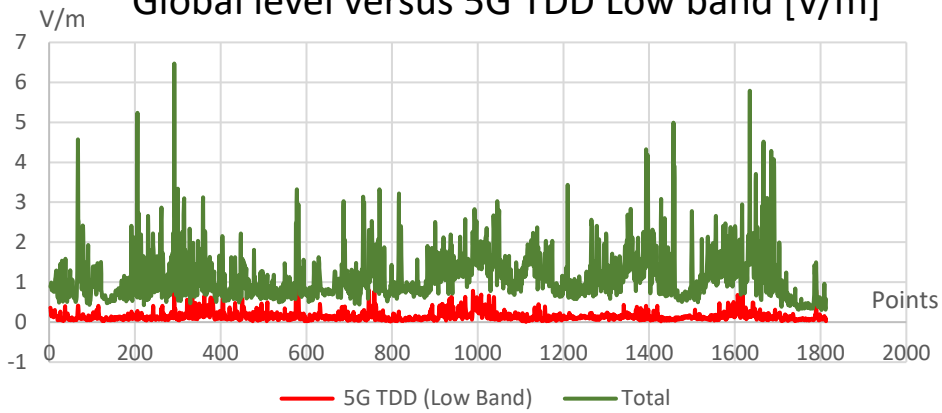
／ The outward trip : from Seoul to Naju



Year of measurements	Global level for all the services [mV/m]	5G TDD (Low Band) Average level [mV/m]	5G TDD (Low Band) Maximum level [mV/m]	5G TDD (Low Band) Stand dev [mV/m]
2019	415,33	22,90	396,34	-
2022	1126,2	147,1	1227,9	115,2

ExpoM-RF results

Global level versus 5G TDD Low band [V/m]



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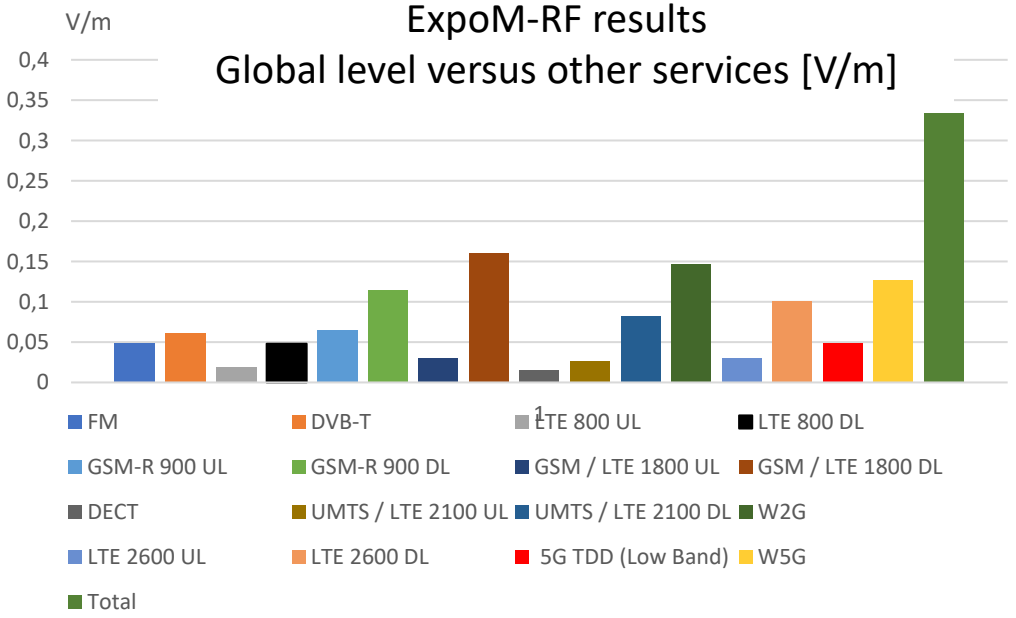
Global level versus other services [V/m]



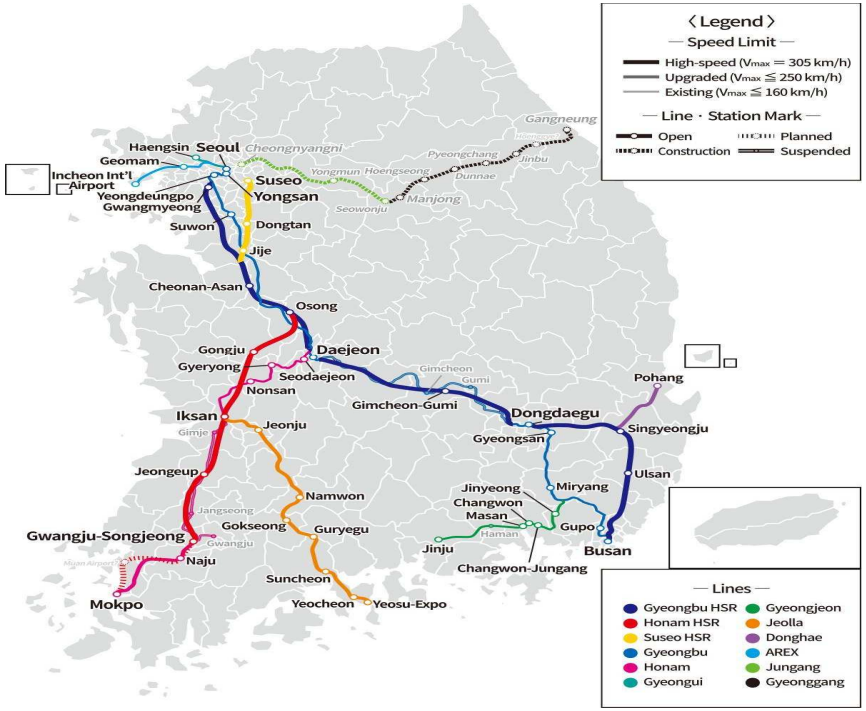
Exposure measurement

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Measurement results : Exposure on transport network

3d : railways trip ➔ on the train,

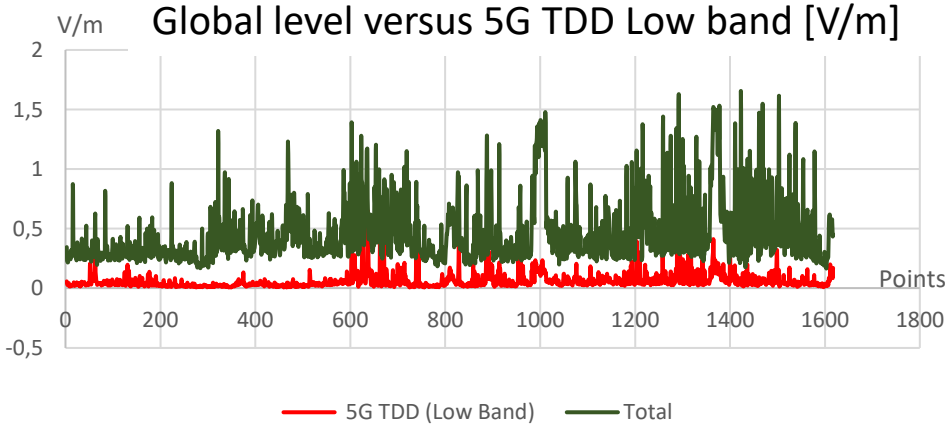
／ The return trip : from Naju to Seoul



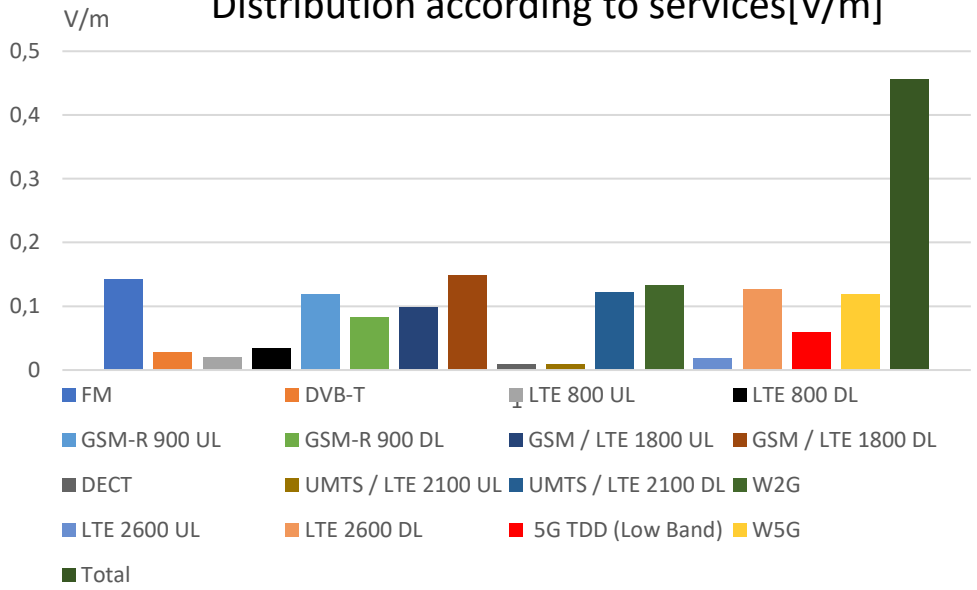
Year of measurements	Global level for all the services [mV/m]	5G TDD (Low Band) Average level [mV/m]	5G TDD (Low Band) Maximum level [mV/m]	5G TDD (Low Band) Stand dev [mV/m]
2019	373,0	16,1	732,3	33,5
2022	454,9	59,9	710,4	62,2

ExpoM-RF results

Global level versus 5G TDD Low band [V/m]



Distribution according to services[V/m]



Exposure measurement

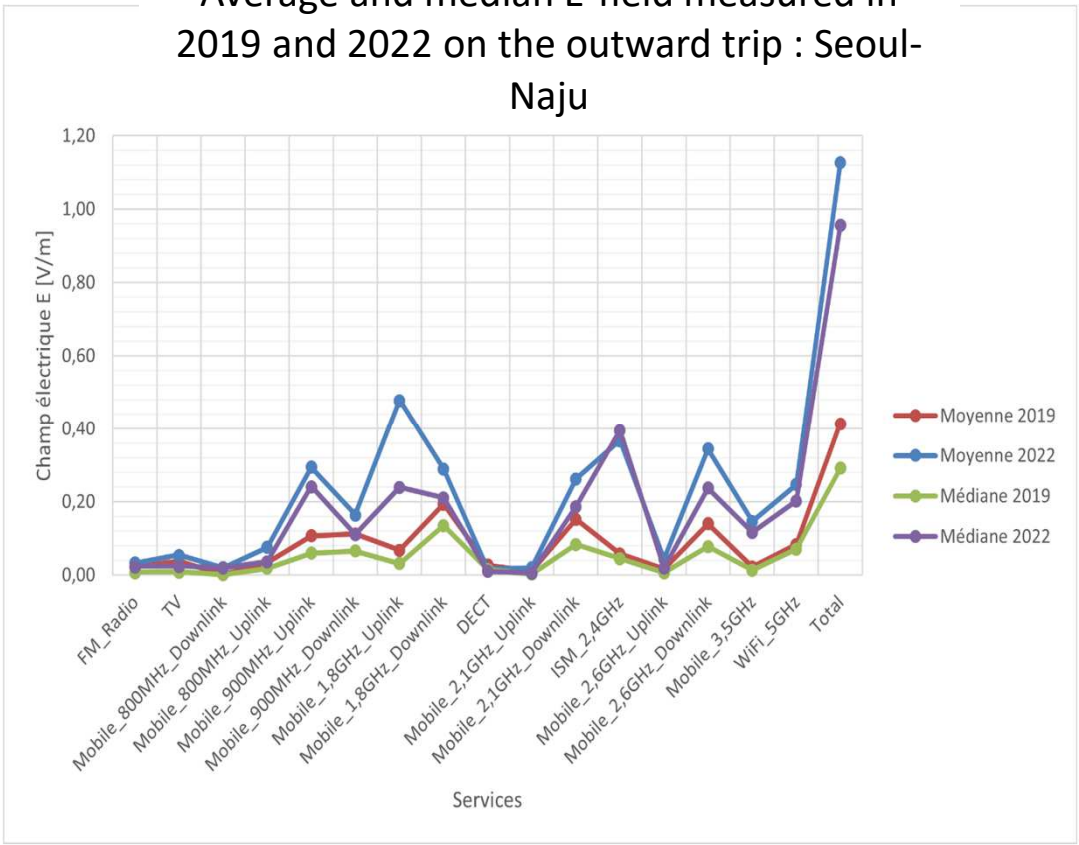
Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Measurement results : Exposure on transport network

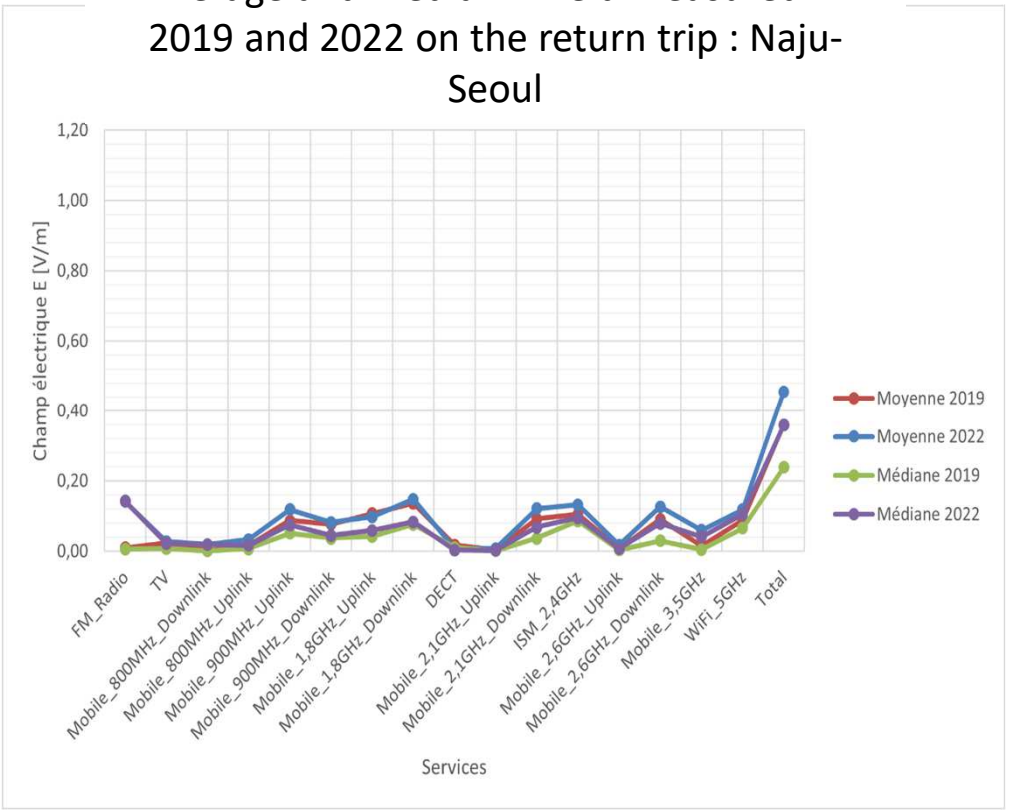
3d : railways trip ➔ on the train,

⁄ Measurement results comparison

Average and median E-field measured in 2019 and 2022 on the outward trip : Seoul-Naju



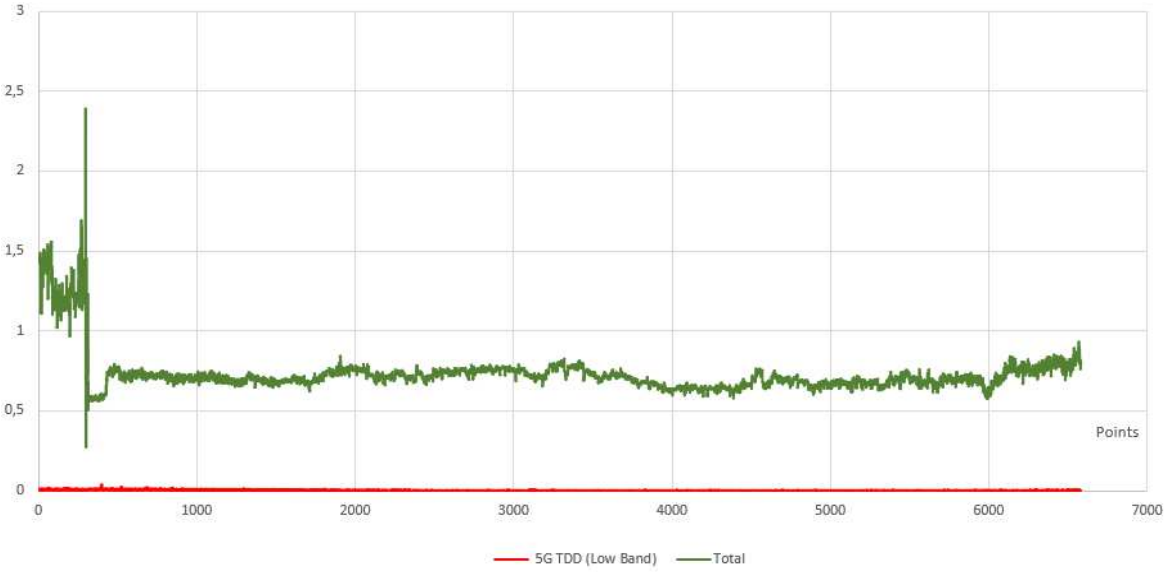
Average and median E-field measured in 2019 and 2022 on the return trip : Naju-Seoul

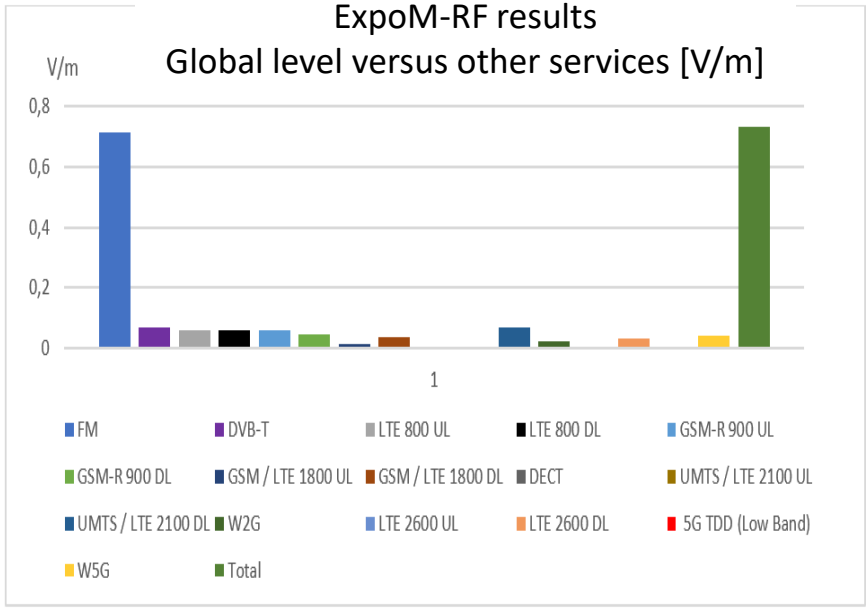


Exposure measurement

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Temporal variability at fixed point exposure during 24 h





/ For 5G TDD low band (2022 measurement results and 2019 measurement results)

Evaluation type	Global level for all the services [mV/m]	5G TDD (Low Band) Average level [mV/m]	5G TDD (Low Band) Maximum level [mV/m]	5G TDD (Low Band) Stand dev [mV/m]
At fixed point 2019	586,1	5,2	129,3	4,1
At fixed point 2022	733,0	2,6	90,2	7,7

Summary of geographic measurements

⁄ For 5G TDD low band (2022 measurements and 2019 measurements)

Evaluation type	Global level for all the services [mV/m]	5G TDD (Low Band) Average level [mV/m]	5G TDD (Low Band) Maximum level [mV/m]	5G TDD (Low Band) Stand dev [mV/m]
Dense urban zone	1846,6	139,8	2135,6	157,8
	1324,58	134,62	6469,29	
Rural zone	335,8	17,4	804,8	50,9
Urban zone	469,1	20,3	258,4	25,2
	398,55	39,61	266,54	34,98
Close to 5G-NR base station	1037,4	561,4	2576,2	669,7
	7265,19	2055,85	7688,48	3075,57
Railways line (Seoul – Naju)	373,0	16,1	732,3	33,5
	953,17	122,9	1487,39	145,36
Urban trip	805,4	47,6	1547,5	62,1
	1497,56	113,89	1516,22	102,74
Extra urbain trip	282,4	20,0	497,8	36,7
	1179,8	81,11	715,01	94,44
At fixed point	586,1	5,2	129,3	4,1
	733,04	2,64	90,20	7,75

Characterization of a 5G-NR base station

Measurement of exposure to radio frequency radiation from 5G-NR telephony in South Korea 07-2022

Wide band level with a 100 kHz – 6 GHz fieldmeter

- GPS coordinates: 35 ° 01’17.45”N / 126 ° 47’37.50 ” E

  At the corner of Hanbit road and Bitgaram road

  Level R + 6

  NAJU - SOUTH KOREA

	2019	
Measurement point	**Level [V/m] in the bandwidth 100 kHz – 6GHz**	**Comments**
1 (at 15 m from the antenna)	12,13	KT base station initial power
4 (at 20m from the antenna)	4,69	KT base station max power

	2022	
Measurement point	**Level [V/m] in the bandwidth 100 kHz – 6GHz**	**Comments**
1 (at 15m far from the antenna	15,38	KT base station max power
2 (in the main beam)	1,05	KT base station initial power
3 (in the main beam)	2,17	KT base station max power

Questions?