

TrainPURE - 3D Active Filter

ISOePM1 80% Class F9 (EN 16890:2017)

- importance of air filtration
- real environment testing
- comparison of sanitization technologies
- TrainPURE “basic” filter characteristics
- TrainPure “ultra” filter characteristics

Analysis of aerosol propagation in a real environment on an operating train with passengers on board and the risk of contagion within its carriages

DLG
81-2008

- Clearly states the obligation to maintain safe and healthy work environments
- Indoor air quality is directly related to the health and well-being of workers
 - Dirty or contaminated air systems can cause respiratory problems and other illnesses

PME: Particle Matter Emission (EN16510-1:2018)

BFE: Bacterial Filtration Efficiency (EN2859-1:2007)

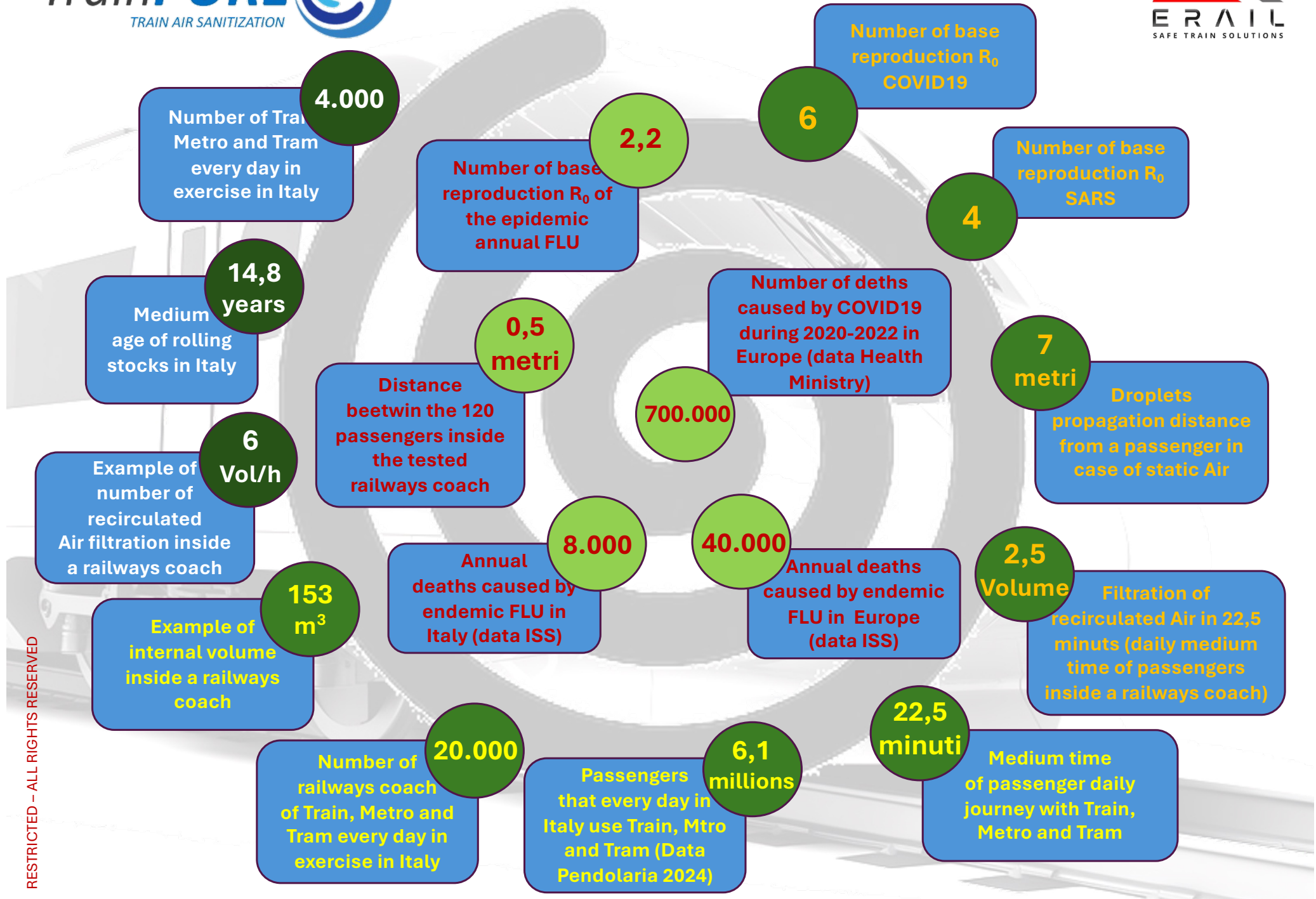
VFE: Viral Filtration Efficiency (EN14683:2019)

FCA: Filter Classification Efficiency (EN16890-1:2017)



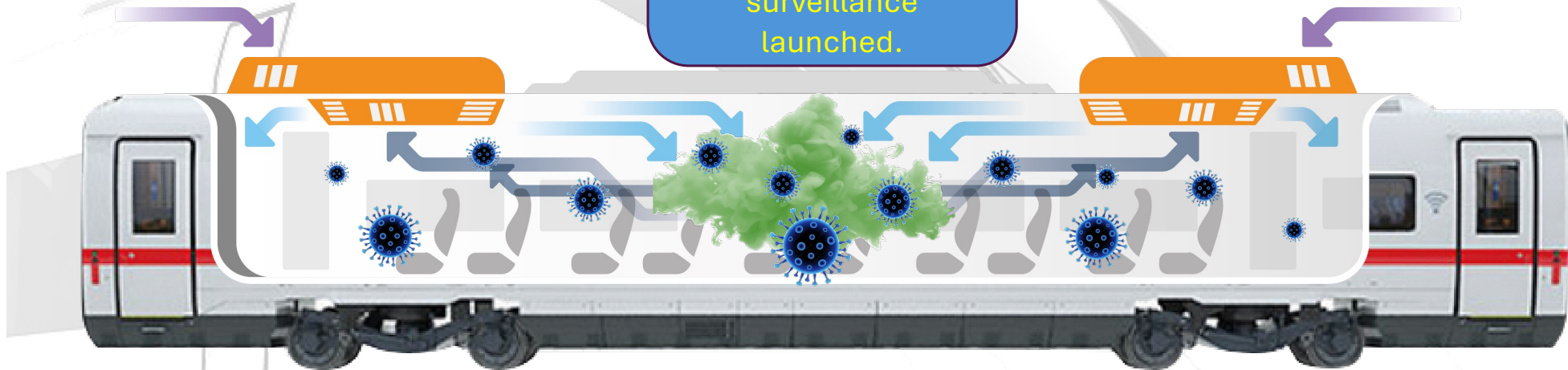
DLG
81-2008

- Proper maintenance of aeraulic systems prevents respiratory problems and other illnesses by reducing the risk of spreading contaminants
- Failure to comply with the provisions of Legislative Decree 81/08 can result in significant legal penalties and fines as well as criminal liability of directors



24
October
2024

SUPERIOR
INSTITUTE OF HEALTH
RespiVirNet:
respiratory virus
surveillance
launched.



Time spent inside
train carriages
during a journey

90%

Concentration of
PM1 particles
compared to
other particulate
matter

90%

Number of million
particles inhaled
per breath

350

Average length of
a train, subway, or
tram coaches

22
metri

Aerosol
pollution in closed
environments
compared to
outdoor levels

x5

Volume of
air inhaled
per minute

8 litri

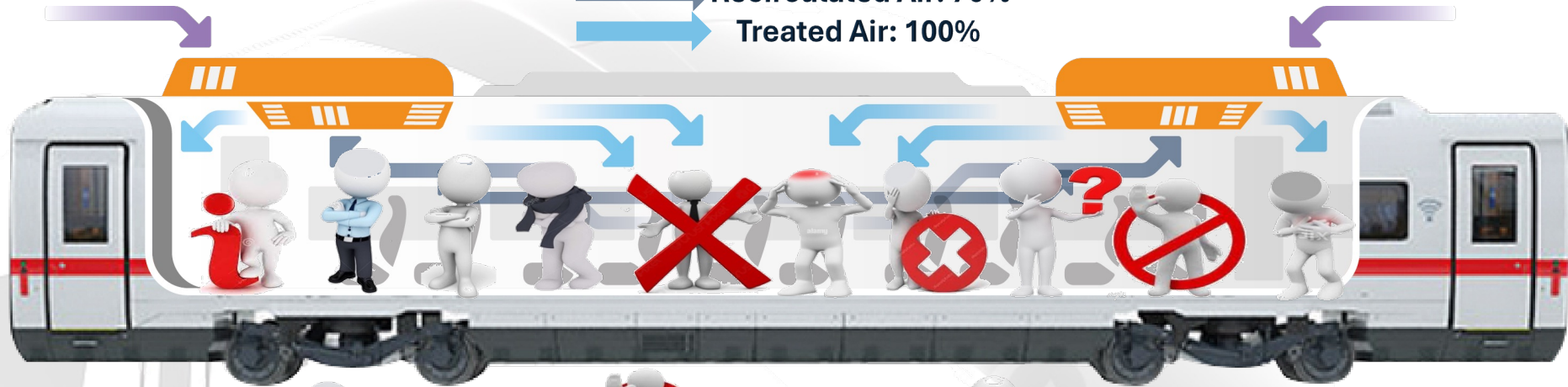
Number of
million
particles
ingested per
minute

25

mileage
average
per day of each
individual traveler

26,7
Km

External Air: 30%
Recirculated Air: 70%
Treated Air: 100%



Crew: 1



Vaccinated
Passengers: 10



Passengers not yet
infected: 87

120

number of passengers
inside three coaches train
model MINUETTO used
for the on-board test



Immune
Passengers: 5



Asintomatic
Passengers: 2



Just Infected
Passengers: 5



Incubating
Passengers: 5



Infected
Passengers: 5

88

Hypothetical breakdown
of passengers at risk of
infection aboard the
train on which the tests
were performed

2.100
m³/h

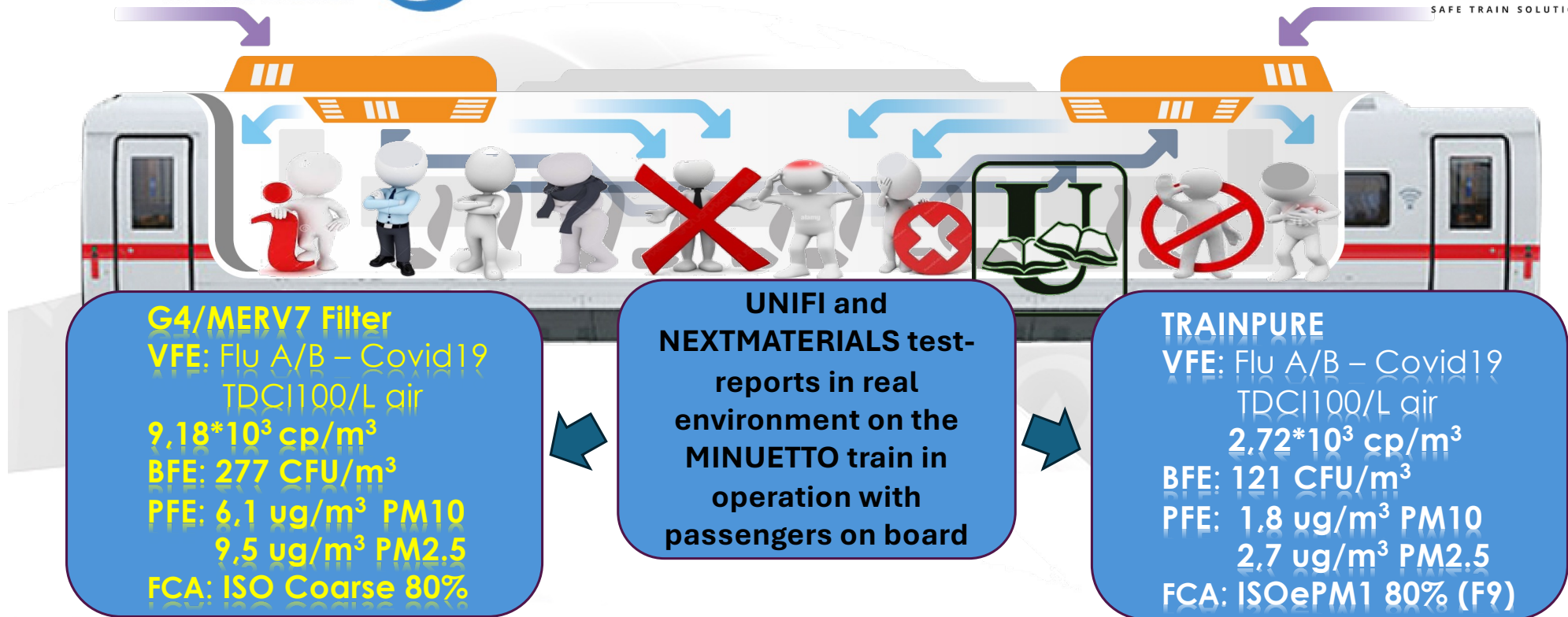
example flow rate of
air treated by an
AHU/HVAC on board
the train

0,8
m/sec

Example of air speed
at the diffuser exit
inside a railways

738
m³

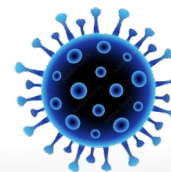
example amount of air
treated in 1 hour with a
recirculation of 6 vol/h



**? Passengers at risk of infection
 without TrainPURE: 88**

64%

**Abbattimento
 Certificato BFE**



**? Passengers at risk of infection
 using TrainPURE: 32**

The flu virus alone with its variants each year affects about 15 Mln Italians and costs the state more than 10 Bn Euros in lost GDP and health care costs, both direct and indirect.

In fact, 1/4 of the Italian population each year is affected by the influenza virus, which means that 2 Mln rail-transit passengers contract and spread this virus.

Reducing even 50% of the infection aboard the transport railroad means reducing by about 7% the cost incurred by Italians for the flu virus; with a saving of about 700 Mln per year for the Italian State.

Filters Comparison

G4 MERV7

- LOW COST.
- PARTICULATE INTERCEPTION (PM10)
- NO ELECTRICAL ABSORPTION
- ACCEPTABLE FLOW LOSS (60-80 Pa)
 - BACTERIAL AND VIRUS VIABILITY ON FILTER SURFACE
 - LOW DURABILITY
- COST OF WASTE DISPOSAL

ELECTROSTATIC + FILTER

- ACCEPTABLE COST
- PARTICULATE INTERCEPTION (PM1)
- ACCEPTABLE FLOW RATE LOSS (60-80 Pa)
 - DISCRETE ELECTRICAL ABSORPTION
- LOW INTERCEPTION OF NANOPARTICLES SUCH AS VIRUSES AND BACTERIA
 - LARGE FOOTPRINT
 - LOW DURABILITY
 - MAINTENANCE COSTS
- COST OF WASTE DISPOSAL

3D COATED FOAM

- LOW COST
- PARTICULATE INTERCEPTION (PM1)
- NO ELECTRICAL ABSORPTION
- BACTERIA AND VIRUSES FILTRATION
- VIABILITY BACTERIA AND VIRUSES ON FILTER SURFACE
- IMPORTANT FLOW LOSS (80-100 Pa)
 - MODERATE DURABILITY
 - SPECIAL WASTE DISPOSAL

UV-C LAMP + FILTER

- DISCRETE COST.
- PARTICULATE INTERCEPTION (PM2.5)
- ACCEPTABLE FLOW LOSS (80-120 Pa)
 - DISCRETE ELECTRICAL ABSORPTION
 - CONSIDERABLE FOOTPRINT
 - MODERATE DURABILITY
 - MAINTENANCE COSTS
- GENERATION OF HARMFUL BY-PRODUCTS
- HAZARDOUS WASTE DISPOSAL

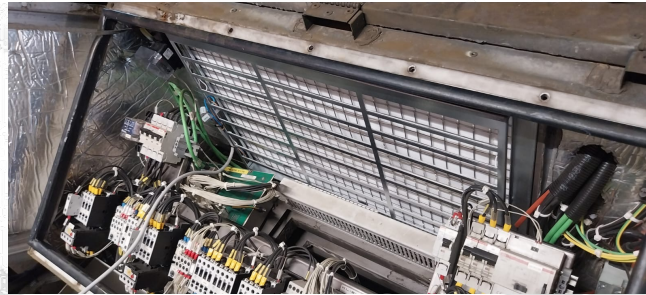
HEPA

- LOW COST
- PARTICULATE INTERCEPTION (PM0.5)
- NO ELECTRICAL ABSORPTION
- BACTERIA AND VIRUSES FILTRATION
- VIABILITY BACTERIA AND VIRUSES ON FILTER SURFACE
- CONSIDERABLE FLOW LOSS (150-200 Pa)
 - MODERATE DURABILITY
 - SPECIAL WASTE DISPOSAL

ELECTROSTATIC + UV-C + FILTER

- PARTICULATE INTERCEPTION (PM0.5)
- ACCEPTABLE NONPARTICLE FILTRATION SUCH AS BACTERIA AND VIRUSES
 - IMPORTANT COST
- IMPORTANT ELECTRICAL ABSORPTION
 - CONSIDERABLE FLOW RATE LOSS (150-200 Pa)
 - CONSIDERABLE FOOTPRINT
 - SHORT SERVICE LIFE
 - MAINTENANCE COSTS
- GENERATION OF HARMFUL BY-PRODUCTS
- HAZARDOUS WASTE DISPOSAL

Active Filter 3D (base) – 2D Meshed



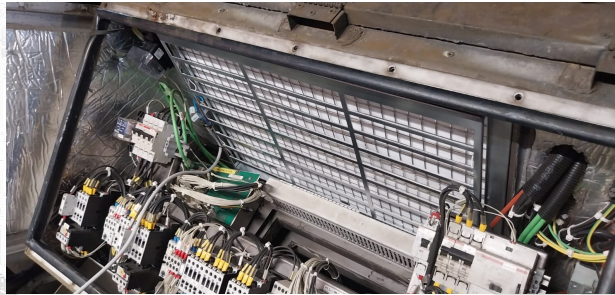
**50% abatement of Virus
and Bacteria in 60
minutes at 6 Vol/h of
recirculation air**

THE BASIC VERSION OF THE TRAINPURE FILTER, SUCH AS THE ONE USED FOR TESTING THE MINUET TRAIN, HAS THE CHARACTERISTIC OF REDUCING THE CIRCULATION OF VIRUSES AND BACTERIA INSIDE THE RAILROAD CAR BY 64%. IN PRINCIPLE, THIS PERCENTAGE OF PATHOGENIC NANO-PARTICLE ABATEMENT CAN HAVE A SIGNIFICANT IMPACT ON THE POSSIBLE CONTAGION FOUND ON BOARD. ACCORDING TO KNOWN STATISTICS, THE 6 MILLION PEOPLE WHO TRAVEL BY TRAIN, METRO, AND STREETCAR IN ITALY EACH DAY TAKE AN AVERAGE TRAVEL TIME OF JUST OVER 22 MINUTES. THAT FIGURE IS DERIVED FROM THE ESTIMATE THAT 3 MILLION PASSENGERS SPEND 8 MINUTES ON THE MEDIUM AND THE OTHER 3 MILLION SPEND 36 MINUTES. WITH A TRANSMISSION RATIO $R_0=2.2/2.5$ TYPICAL OF THE ANNUAL INFLUENZA VIRUS, ONE INFECTED PASSENGER POTENTIALLY CAN INFECTION TWO OTHERS. WITH TRAINPURE, THE TRANSMISSION RATIO WITHIN THE CARRIAGE OF A TRAIN, SUBWAY, OR STREETCAR IS HALVED, RESULTING IN ONE INFECTED PASSENGER POTENTIALLY INFECTING ONLY ONE OTHER.

Absorption:	60W
Durability:	5 years (like n.10 G4/MERV7 or n. 30 HEPA)
Recyclable:	90%
Initial Cost:	30 times more than HEPA filter
5 Years Cost:	45% less respect HEPA Filter
Flow Rate Loss:	40% less respect HEPA Filter
Maintenance:	4 months VS 2 months of HEPA Filter



Active Filter 3D (**ultra**) – 3D Meshed



50% abatement of Virus and Bacteria in 10 minutes at 6 Vol/h of recirculating air

THE ULTRA VERSION OF THE TRAINPURE FILTER, BORN FROM THE UPGRADE OF THE BASIC VERSION USED FOR TESTING ON THE MINUET TRAIN, HAS THE CHARACTERISTIC OF REDUCING TO 50% THE CIRCULATION OF VIRUSES AND BACTERIA INSIDE THE RAILROAD CAR AT THE FIRST PASSAGE OF AIR THROUGH THE HVAC SYSTEM. IN PRINCIPLE, SUCH A PERCENTAGE OF PATHOGENIC NANOPARTICLE ABATEMENT CAN HAVE A HUGE IMPACT ON POSSIBLE CONTAGION. THIS WOULD MEAN, ACCORDING TO THE CONSIDERATIONS MADE IN THE ABOVE DESCRIPTION OF THE BASIC VERSION, IN THE LIGHT OF A CONSERVATIVE WEIGHTED AVERAGE, BEING ABLE TO REDUCE THIS RISK BY 75%. ROUGHLY EQUIVALENT TO A 14% REDUCTION IN THE ANNUAL COST, BETWEEN GDP LOSS AND BOTH DIRECT (BORNE BY THE STATE) AND INDIRECT (BORNE BY THE CITIZEN) HEALTH CARE COSTS. THE ULTRA VERSION OF THE TRAINPURE FILTER MAKES IT POSSIBLE TO HAVE MAINTENANCE THAT IS NO LONGER SCHEDULED SEMI-ANNUALLY, BUT WHEN ACTUALLY-NEEDED, PROVIDING CONSIDERABLE TIME SAVINGS FOR THE TRAIN SERVICE EMPLOYEES IN QUESTION.

Absorption:	360W
Durability:	5 years (like n.10 G4/MERV7 or n. 30 HEPA)
Recyclable:	95%
Initial Cost:	50 times more than HEPA filter
5 Years Cost:	20% less like an HEPA Filter
Flow Rate Loss:	60% less respect HEPA Filter
Maintenance:	actually needed VS 2 months of HEPA Filter



Active Filter 3D (ultra)

TAQA (Train Air Quality Analysis)



50% abatement of Virus and Bacteria in 10 minutes at 6 Vol/h of recirculating air

1. Differential Magnetothermic
2. DC-DC Converter Device
3. Surge Protector
4. Absorption Measurement
5. Efficiency Probe LEDs UV-C
6. Probe Temperature
7. Differential Probe Air-Pressure
8. Data Elaboration File LOG
9. Wireless Transmission
10. Wireless Palmtop
11. Software Elab. File LOG (Palmtop/Remote PC)



RaDA
(Rail Download Area)

LOG

TST
(Train Storage and Transmit)

LOG

TIMo
(Train Information Monitoring)

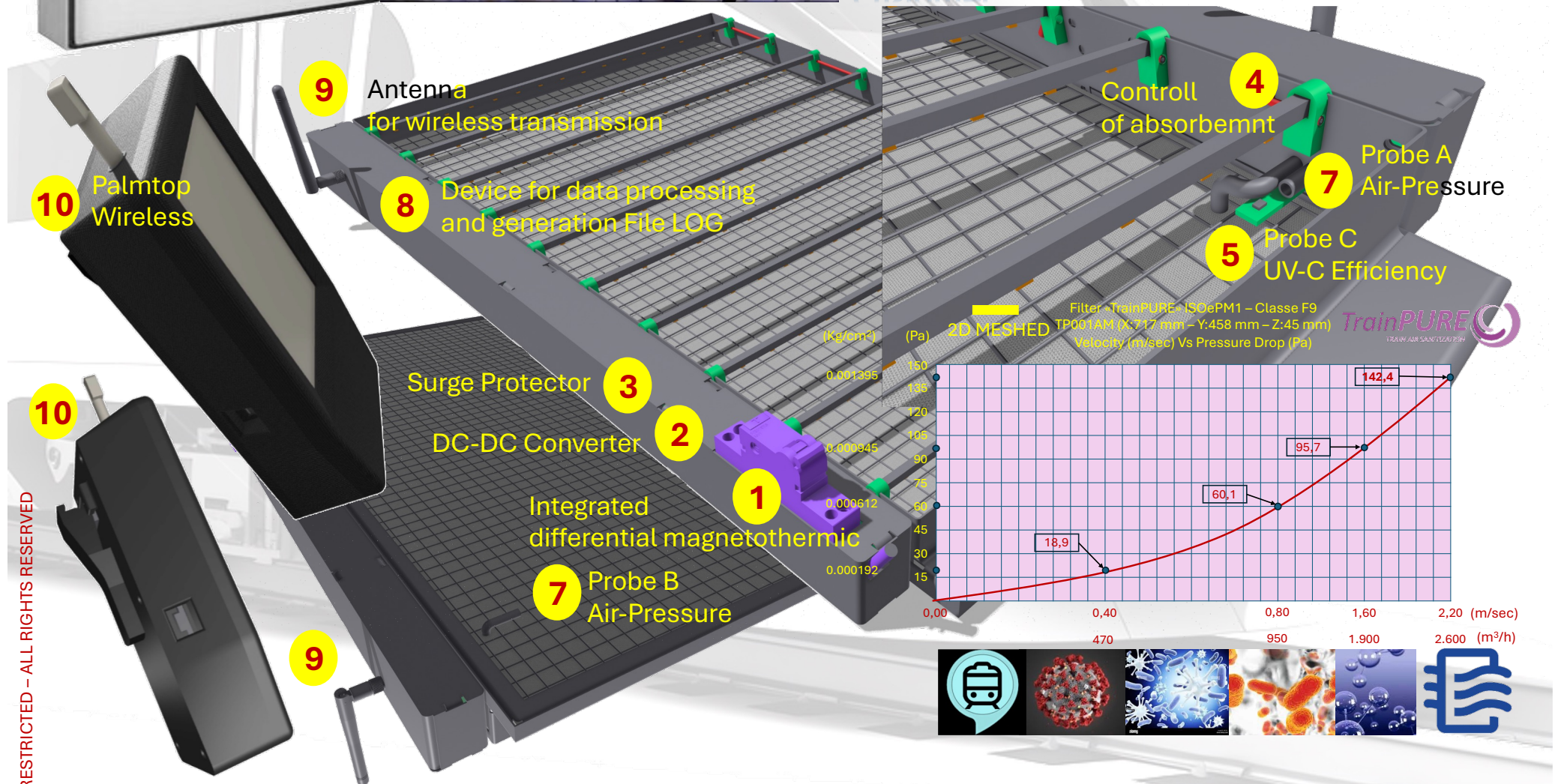


THE TRAINPURE FILTER IN THE ULTRA VERSION IS EQUIPPED WITH A SERIES OF ELECTRONIC MONITORING AND DIAGNOSTIC COMPONENTS CAPABLE OF GENERATING A LOG FILE CONTAINING PARAMETERS ON THE EFFICIENCY CONTROL OF THE LEDs, (OPERATION AND INTENSITY) AND DEGRADE OF THE 3D FILTER MEASURING THE ACTUAL FLOW AT THE VALLEY OF THE APPARATUS. THIS ALLOWS A TRAIN CONTROL OPERATOR, BEFORE AND AFTER TRANSPORT OPERATION, TO RECEIVE THIS DATA ON A DEDICATED PDA WITH PROPRIETARY SOFTWARE THAT CAN IN TURN BE FORWARDED TO MAINTENANCE CONTROL AND PLANNING FOR APPROPRIATE EVALUATION. THE ENTIRE SYSTEM PROVIDES THAT WHEN DEGRADATION IS REACHED, DUE TO CLOGGING OF THE 3D FILTER BY MEASURING ITS PRESSURE DROP, ONLY THE CARTRIDGE IS REPLACED, TO BE SENT FOR RESTORATION, WITH THE SPARE INTERCHANGE KIT WITH WHICH THE APPARATUS IS EQUIPPED.

Active Filter 3D (ultra)



custom-made inside the exact dimensions of G4/MERV7 or HEPA filters whose replacement is required based on the available spaces on the target AHU/HVAC and the specifications received from the customer



71%

**AVERAGE
CERTIFIED BFE
ABATEMENT WITH
«BASE» FILTER AT
THE INLETS OF THE
TRAIN**

- PARTICULATE INTERCEPTION (PM1)
- EXCELLENT NONPARTICLE FILTRATION SUCH AS BACTERIA AND VIRUSES
 - ACCEPTABLE COST
 - LOW ELECTRICAL ABSORPTION
 - CUSTOMIZABLE FOOTPRINT
 - LONG LIFE
- LOW MAINTENANCE COST
- DOES NOT USE CHEMICALS OR GENERATE HARMFUL BY-PRODUCTS
- 90% RECYCLABLE DOES NOT CONSTITUTE SPECIAL OR HAZARDOUS WASTE DISPOSAL

64%

**AVERAGE
CERTIFIED BFE
ABATEMENT WITH
«BASE» FILTER OF
THE ALL TREATED
AIR INSIDE THE
TRAIN**

Adopting TrainPURE means guaranteeing rail traffic managers and rolling stock manufacturers the choice of one of the best, if not the best available and certified technology that the market can offer, particularly advantageous when upgrading on-board aeratic systems already in operation, to solve air sanitization from viruses and bacteria; also protecting against future, albeit undesirable, situations such as the one experienced during the Covid19 pandemic.

92%

**ESTIMED AVERAGE
BFE ABATEMENT «ULTRA»
FILTER AT THE INLETS TO
THE TREATED AIR TRAIN**



ERAIL SR.L. Capitale Sociale € 200.000,00 i.v.
P.IVA 02469260463 - R.E.A. FE-223448 - SDI M5UXCR1
Via S. Margherita n.12 - Migliaro - 44027 Fiscaglia (FE)
Uffici: Via della Villa Lorenzi n.8 - 50123 Firenze
+39 055 4223854 - info@erail.it - erail@pec.it

EN ISO 9001-2015 - Organismo di certificazione: 1-421-001-015
Certificato N°: IT01 / B7320111Q

85%

**ESTIMED AVERAGE
BFE ABATEMENT «ULTRA»
FILTER OF THE ALL TREATED
AIR INSIDE THE TRAIN**

