MIPSS

The air sterilization of the XXI century

analisi r&s tecnologie ambientali

SERECO BIOTEST

an environmental high tech shuttle structure

SISTEMA QUALITA' ISO 9001 REG. N. 3957

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Set-up: 1976
Activity: ENVIRONMENT&PUBLIC HEALTH

Core business: R&D – Design of industrial&civil wastewater treatment – Biomass upgrading – Industrial Ecology - Industrial odour control- Environmental accounting - EMAS scheme certification –Ecoaudit - Recovery and treatment of polluted sites LCA and Mass Flow Analysis

Support activity: Laboratory specialized in ecotoxicological and environmental analysis
Number of employees: 7
Patents : 1 under PCT procedure
Main R&D projects in the last 5 years: NOVOCAT (Tar Decomposition By Novel Catalytic Gas Cleaning Methods) (UE funding)

TRANSFORMITY (Transfer of New Technological Competences to the enterprises for waste management) (UE funding)

MIPSS (Microbial Indoor Pollution Solution System) Fondo Inn. Tecnologica –MICA – art 14 L. 46/82

SERMAPP (Sereco Magnesium Ammonium Phosfate Process) Fondo Inn. Tecnologica –MICA – art 14 L. 46/82

References: University of Perugia; ARPA Umbria; INDESIT Company; ENEL Spa; SADAM; ANSALDO ; SANGEMINI Mineral Waters; NESTLE'– Perugina; PFITZER Italia; Public Boards: PROVINCE of Perugia, Municipalities of, Marsciano, Bettona, Todi , Assisi, Castiglion Fiorentino, Fabriano; Comunità Montana Alta Valle del Tevere

Details may be found in:
www.serecobiotest.it
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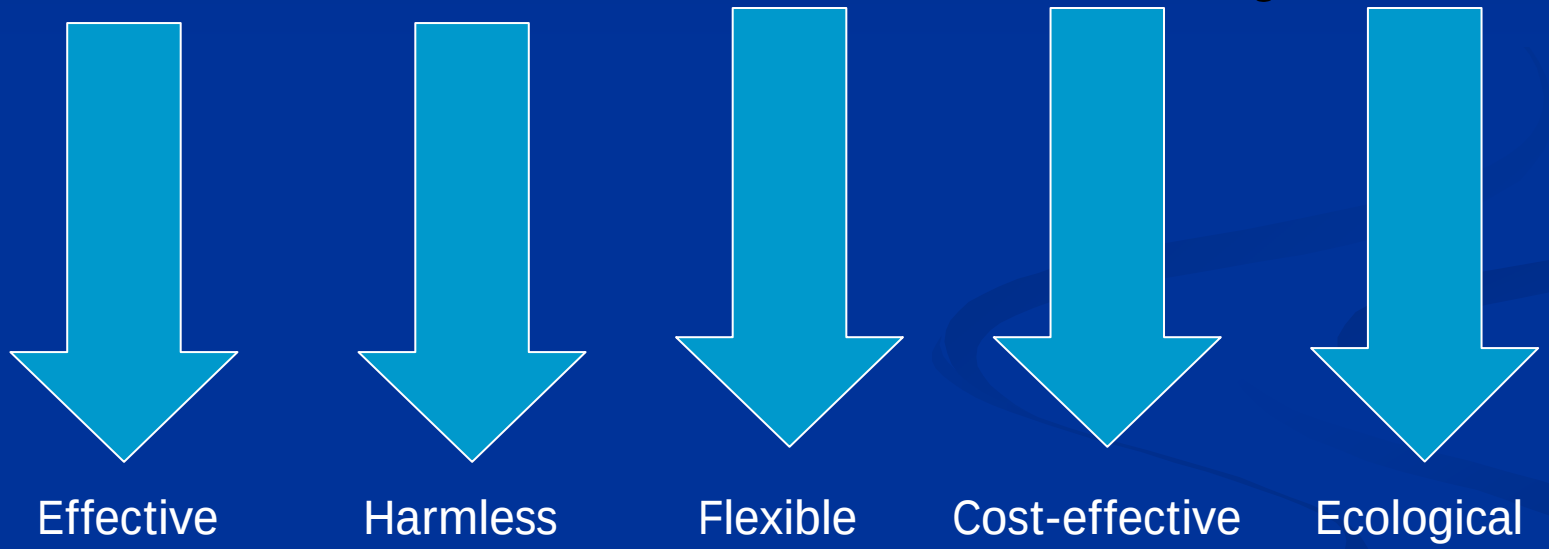
MIPSS
Microbial Indoor Pollution Solution System



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The problem to tackle

AIRBORNE ENVIRONMENTAL INFECTIONS

WHERE CAN THEY OCCUR?

OUTDOOR

Zootechnical stables

Landfills

Composting facilities

Manure spreading

Terroristic attacks

INDOOR

Air conditioning (Legionella)

Domestic exposure

Car filters

Refrigerators

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The problem to tackle

FOODBORNE DISEASES (FBD)

According to the WHO in industrialized countries the percentage of people suffering from FBD each year has been reported to be up to **30%**

In USA around **76 milion** cases of foodborne diseases, resulting in **325.000** hospitalizations and **5000** deaths occur each year

The costs of FBD is an enormous burden to communities and the health system: **35$ bilion** annually in medical costs and lost productivity

Besides muscle-food the greatest blame is to be put on eggs, sweats and pastry.

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FOODBORNE DISEASES (FBD)

CHALLENGES ANS DEVELOPMENTS

- Trying to unravel as much as possible the lumping etiologies of the diseases
- Tackle whatever potential hidden cause of contamination

Refrigeration cells and **domestic refrigerators** can build-up a substantial amount of pathogen microrganisms connected to the outbeak of FBD.

Contaminated air circulation, due to the presence of biodegradable organic material represents a risk of food cross-contamination, particularly when the temperature setting is subjected to driftings (e.g for electrical black-outs elettrici, break down of thermostats, etc...).

Epidemiologies have put particular emphasis on microrganisms such as:

- Psycrophylic (Campylobacter, Lysteria)
- Enterohaemorrhagic E.coli (E.coli strain O157)

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What is it?

The system is based on the use of natural zeolites combined with specific inorganic anti-bacterial/anti-fungal principles harmless to humans and free of unwanted side-effects

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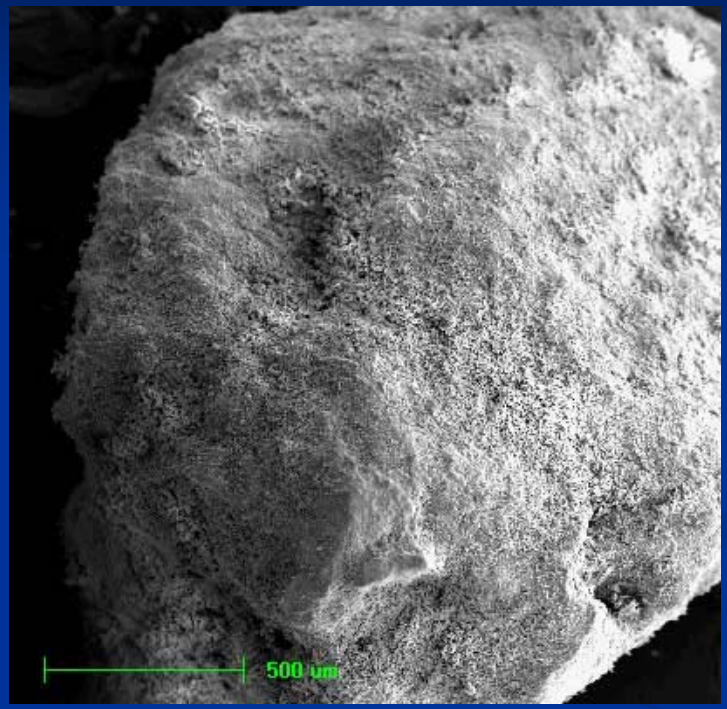
How does it work?



Zeolites are hydrated aluminosilicates of alkali or alkaline-earth metals (Na, K, Mg, Ca, Sr, Ba)

Zeolites feature a tethraedrical nanocrystalline base-structure with large pores and regularly arranged channels (average dimension ranges between 2.5 and 7 angstrom) in which the cations are weakly linked and can thus easily exchange with other cations found in the surrounding environment e.g. in a water solution

CRYSTALCHEMICAL FEATURES OF NATURAL ZEOLITE

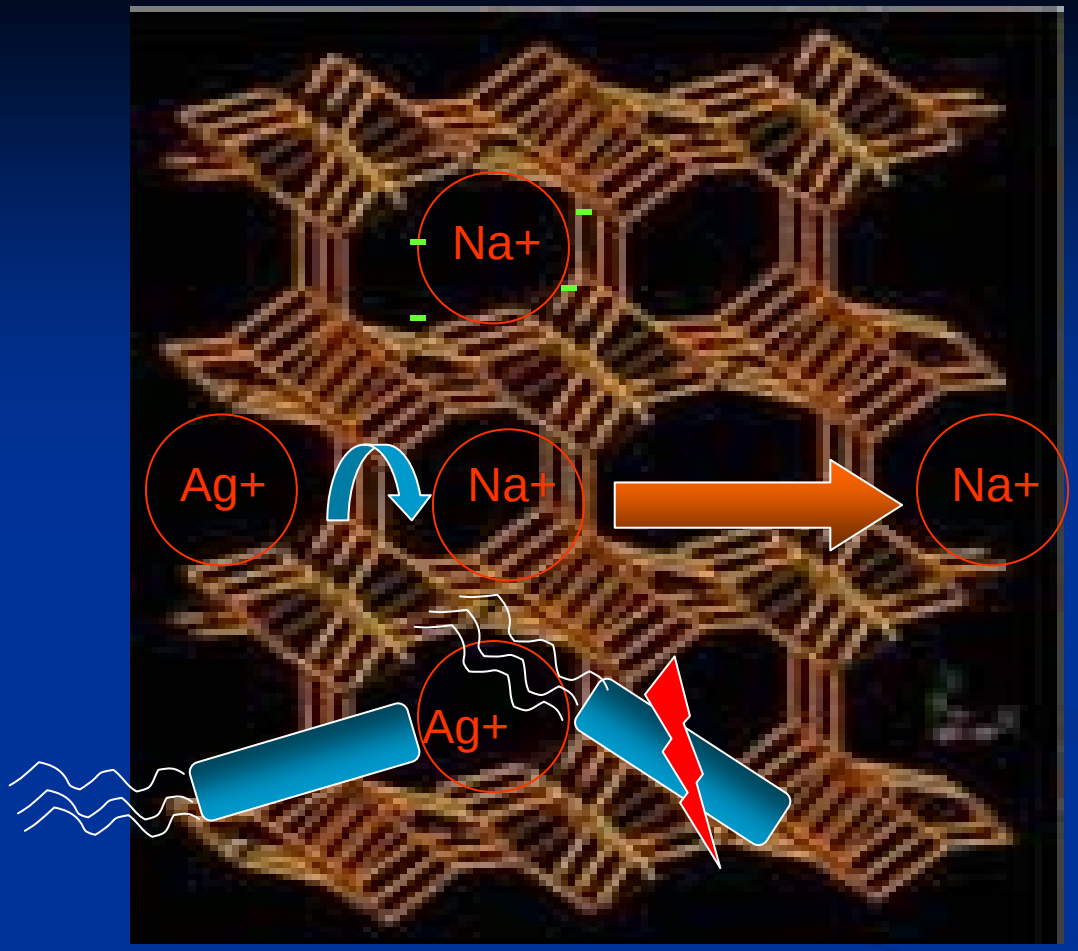
1. High and selective CEC (Cationic Exchange Capacity) up to 3-4 meq/g
   - selection based on molecule dimensions and polarity
   - cations with low solvation energy are favoured (NH_4, metals)
2. High structural cryptoporosity (ranges between 20% and 50% crystal volume)
3. Broad specific surface (up to 200-300 m^2/g). 20 g zeolites have the surface of a football pitch
4. Reversible dehydration at T<300°C without modification of the tetrahedrical structure
5. Molecular sieve-behaviour -→selective permeability for molecules

MIPSS – Useful roles

Zeolites can be useful for various applications such as remotions of odours or radioactive ions (e.g. iodine)

No bactericidal activity

The metallizations of zeolite, e.g. with silver, copper, zinc, impart antimicrobial properties



Ag strongly binded into the crystalline building of the zeolite can exert a powerful bactericidal effect by complexing the sulphydrylic groups of the bacterial membrane proteins causing the denaturization and irreversible destruction of the microbial cell membrane

Advantages over exsisting technologies for air sterilization

- HEPA FILTERS
  - No regeneration
  - Relevant disposal costs (thermal destruction)
  - Recontamination due to bacterial cell REPAIR-→ Bacteria in the filter remain viable
  - Efficiency based on dust retention (EN 1822) not on the effect upon microrganisms
- UV- OXIDZING AGENTS (O_3, Chlorine, Formaldehyde)
  - Bacteria can repair the damage (as in the case of UV rays)
  - Undesired products (ozone, radicals, etc…) can affect human health or foodstuff quality
- GRANULAR ACTIVATED CARBON (GAC)
  - Traps bacteria but without killing effect → AC constitutes a tremendous proliferation site for bacteria
  - Regeneration from bacteria can only be done at T> 150-180°C -→ volatilization of AC -→ loss of activity -→ cost effectiveness

THE PROTOTYPE

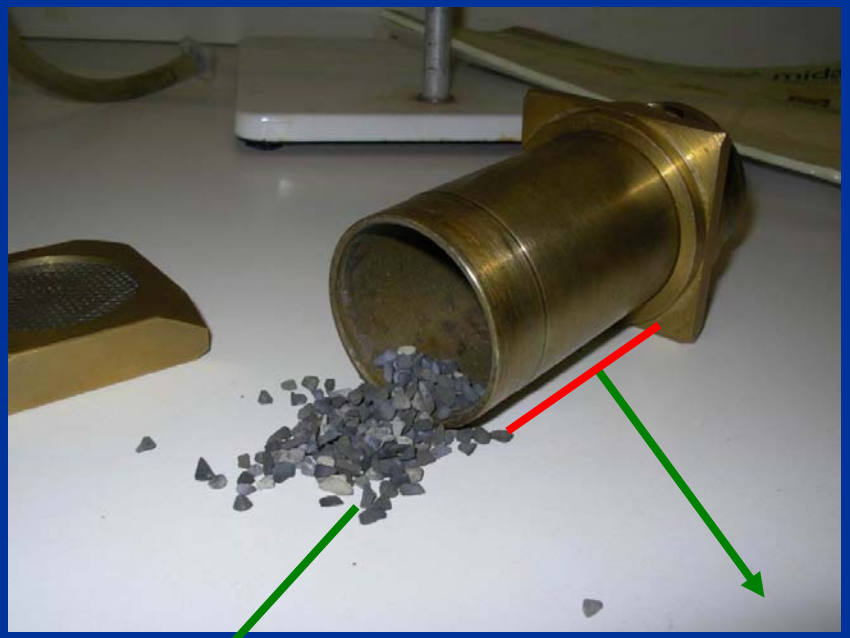
We developed a test prototype for the evaluation of the sterilization efficiency of the system

The system is modular and provided with a 12 V suction module that forces the air thorughout the filter bed

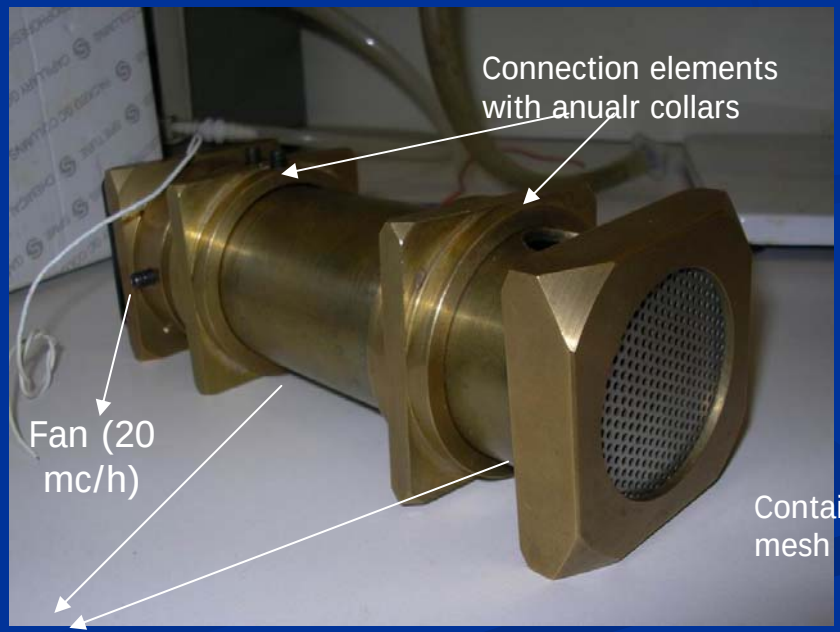
The fan can also work on compression

Basic module has an overall length of 8,5 cm

Made of brass



Zeolite 2<mm<3.33



FILTER MODULAR SECTIONS

Square-shaped end block

FLUIDODINAMYCAL AND GEOMETRIC PARAMETERS AND CONTACT TIMES

Tubolar filter (final prototype)

Air path (filter length) = 8,5 cm

Average airflow velocity[1] = 1,42 m/s

Contact time [2]: 0,085 m/ 1,42 m/s = 0,060 s

diameter = 4,5 cm

Contact surface perpendicular to airflow = 15,90 cm^2

Contact volume = 135,12 cm^3

Zeolite apparent density = 0,89 g/cm^3

Airflow volume = 0,0016 × 1,42 × 3600 = 13 m^3/h

Ventilator nominal airflow volume = 20 m^3/h

Average pressure drop = 40% (max 70%)

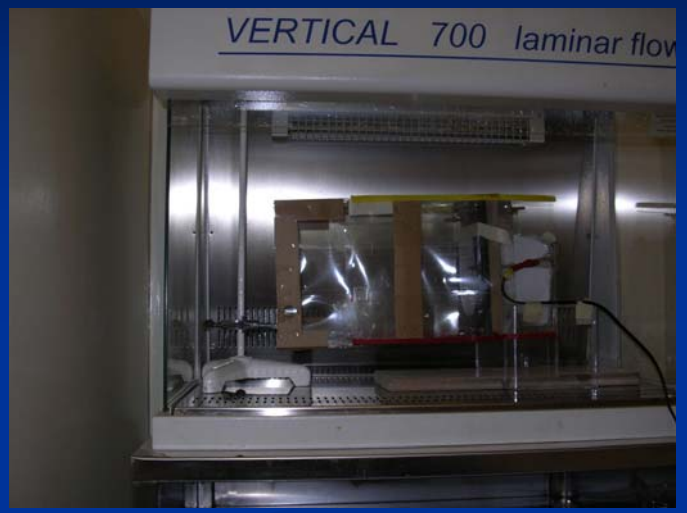
Hourly air volume changes guaranteed for a 200 l refrigerator = 25-50

[1] Under pressure drop conditions (measured after the filter)

[2] To be considered as “time of flight”

BIOLOGICAL TESTS ON THE EFFECTIVENESS OF ABATEMENT OF AIRBORNE MICROBES

- Type of micro-organisms used:
  - Mesophylic bacteria
  - Escherichia coli
  - Pseudomonas aeruginosa
  - Candida albicans



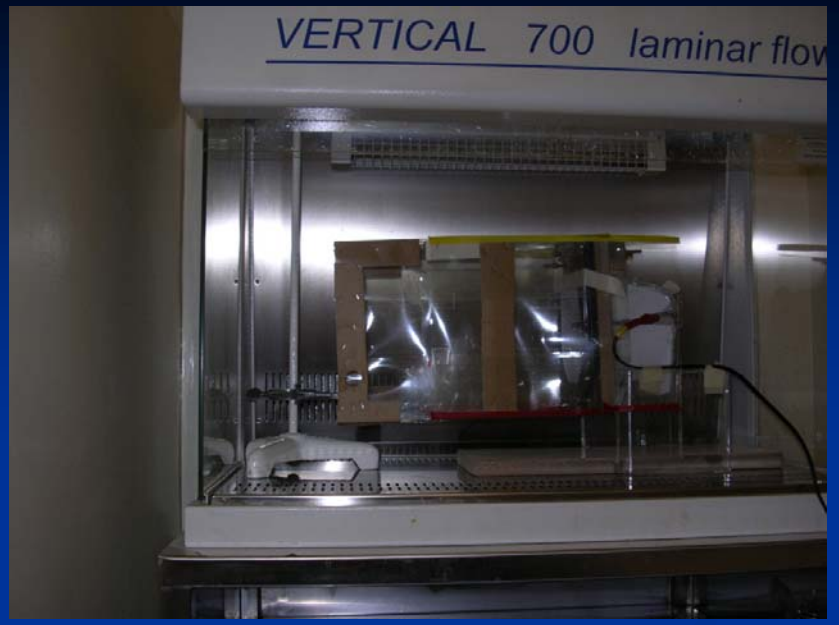
Aerosol used derived from suspensions having a micro-organism title ranging from 10^5 to 10^8 CFU/ml

The bacterial aerosol was inputted intermittently (10'' + 10'' pause) into the system

Each test lasted 5 minutes

Tests carried out with empty tube, tube fitted with M+-Z, with Z and with AC

RESULTS



Lab trials with both generic mesophylic micro-organisms and specific germ strains showed the effectiveness of the filtering treatment with relative bacterial abatement efficiency up to **99.97%,** starting from 1500 CFU/dish bacterial concentrations

Both zeolite without silver and AC can reduce airborne microbes but these materials do not permanently deactivate bacteria, which can then regenerate when in contact with a suitable growth medium

Tests on refrigerators

Tests on refrigerators: hard test

- Verifica della capacità massima filtrante del dispositivo filtro mantiene inalterata la sua capacità filtrante dopo trattamento con aerosol batterico concentrato (10^7UFC/ml) fino ad un massimo di 20' -→ esposizione batterica massima al filtro di 2×10^7UFC (velocità di consumo di aerosol è pari a ca. 0,1ml/min)
- No fenomeni di rilascio massivo di batteri dal filtro.
- Tale livello di esposizione notevolmente più alto di quello che è presumibile trovare all'interno di un frigorifero. in prossimità di impianti di depurazione a fanghi attivi le concentrazioni di carica batterica mesofila presentano valori massimi che vanno da. 500 UFC/m^3 = 5×10^{-4} UFC/ml fino a 1000 UFC/m^3 = 1×10^{-3} UFC/ml. Quindi le concentrazioni di microrganismi utilizzate nell'esperimento sono decine di miliardi di volte superiori rispetto a quelle riscontrabili in ambienti estremi
- Ipotizzando che la contaminazione all'interno del frigo sia paragonabile a quella di un impianto di depurazione (500 UFC/m^3) e considerando che il volume del frigo è di 250 litri, si ha che la carica presente nel frigo, sotto questa ipotesi, è di 125 UFC
- Negli esperimenti effettuati, si aveva un'esposizione di aerosol contenenti 10^7 ufc per 2 ore circa (120'). Un'analoga esposizione da parte dei batteri presenti nel frigo (125 UFC), si sarebbe avuta in 960.000 minuti, circa 666 giorni, circa **2 anni**

Il calcolo si ottiene applicando la seguente formula :
Ove
E = esposizione batterica al filtro (UFC) = $1,2\ 10^7$
C1 = concentrazione batterica nella sospensione da aerosolizzare (UFC/ml) = 10^7
R1 = rate di aersolizzazione batterica (UFC/min) = 0,1
t1 = tempo di esposizione (min) = 120'
C2 = concentrazione batterica nella sospensione da aerosolizzare (UFC/ml) = 125
R2 = rate di aersolizzazione batterica (UFC/min) = 1
t2 = tempo di esposizione (min) = **X**
sotto l'ipotesi che in un solo minuto tutti i batteri contenuti nella sospensione liquida si portino in fase aeriforme con concentrazione di 125 UFC/m3.

Collaboration/agreement sought

- Direct transfer of trading/manufacturing licence for the patent based on a selling contract or a royalty agreement
- Possibility of receiving exclusivity, total or restricted to specific market segments
- Sign-up research contracts aimed at supporting research activities for implementation and engineering of the process to specific industrial applications
- Direct financing from industry also by recurring to public grants (e.g. through the EC VII FP)