# HyBRid adsorption-photocatalytic air filtEr for rEmoving pollutants and odours from aircraft cabin ZonE

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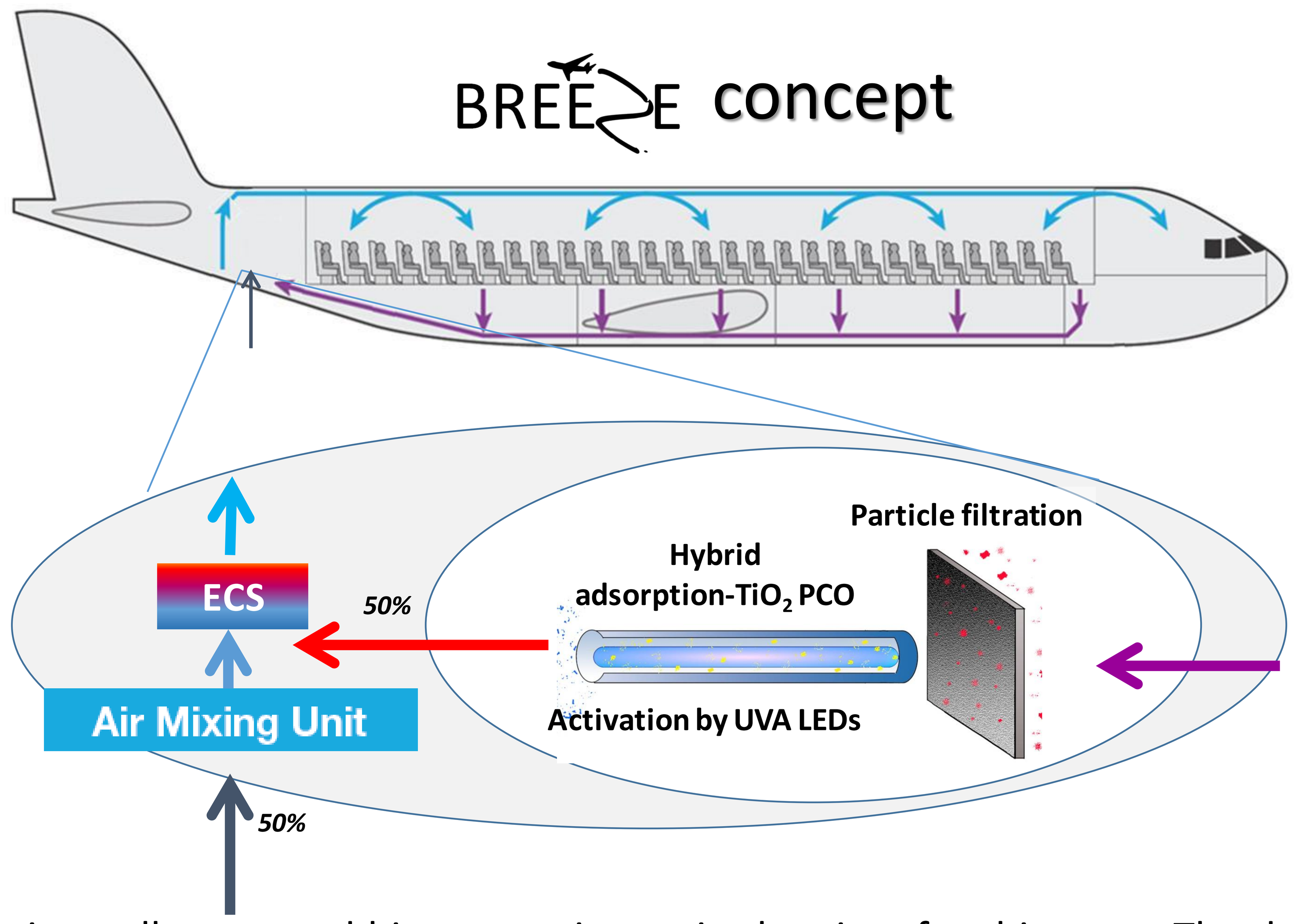
## INTRODUCTION

In the majority of aircraft approximately half of the cabin air is exhausted while the other half is recirculated, passing through a High Efficiency Particulate Air (HEPA) filter to extract contaminants (particles, bio-contaminants) [1], after which it is mixed with outside air to be returned to the cabin. The mixing ratio is controlled by the Environmental Control System (ECS) which provides air supply, thermal control and pressurization of the cabin.

This configuration, along with a high occupation density, leads to the dispersion of germs and viruses and the accumulation of pollutants:

- Ozone from outside air
- Volatile organic compounds (VOC)
  - Bioeffluents (acetone and ethanol)
  - VOC representative of indoor atmosphere
- Polybrominated diphenyl ethers (PBDEs) used as flame retardants
- Bio-contaminants (bacteria and viruses)

This poor quality of cabin air has been related with symptoms such as headaches, blurred vision, dizziness, nausea and other health problems.

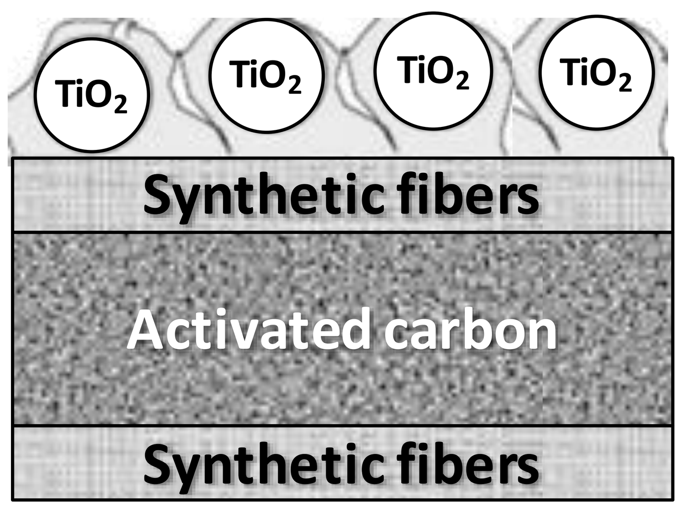



The objective of the Breeze project is the development of a novel air purifier capable of removing pollutants and bio-contaminants in the aircraft cabin zone. The device will be installed after the HEPA filtration stage of the recirculated air and will provide efficient and durable degradation of ozone, VOCs, PBDEs and bio-contaminants.

## MATERIALS

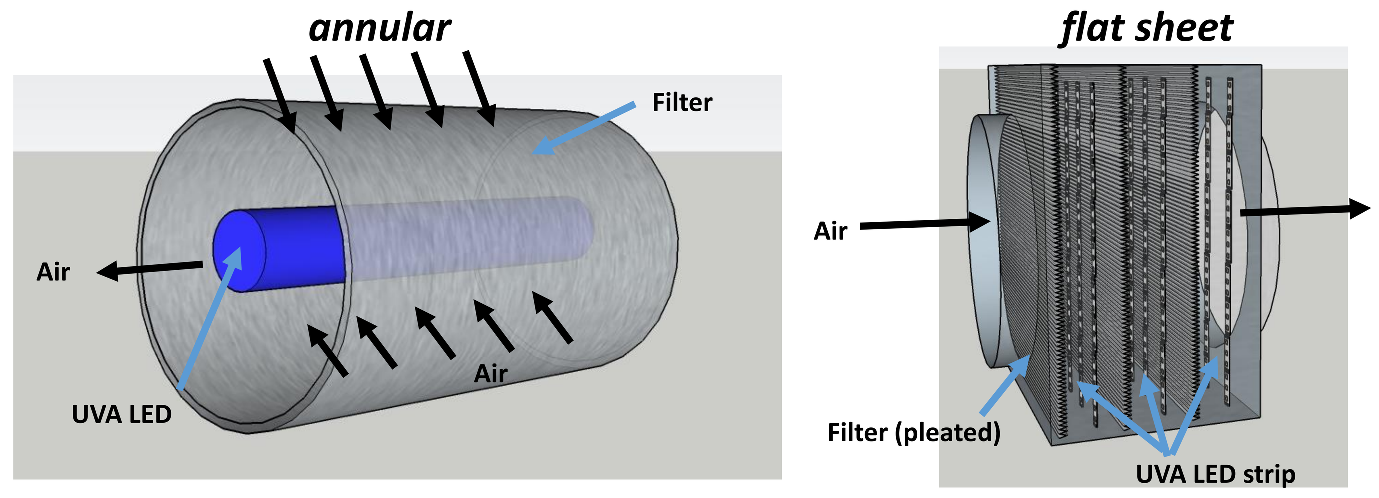
### Combination of adsorption and photocatalysis activated by UV-LED

The combination of adsorption and photocatalysis has shown promising results on the degradation of organic pollution. The adsorbent retains the pollutant close to the catalyst surface, enhancing their decomposition through the transfer of the adsorbed molecules onto the photoactive particles. This combined process should conduct to low generation of by-products and high durability of the filter (cleaned by photocatalysis).




### Configuration of the reactor

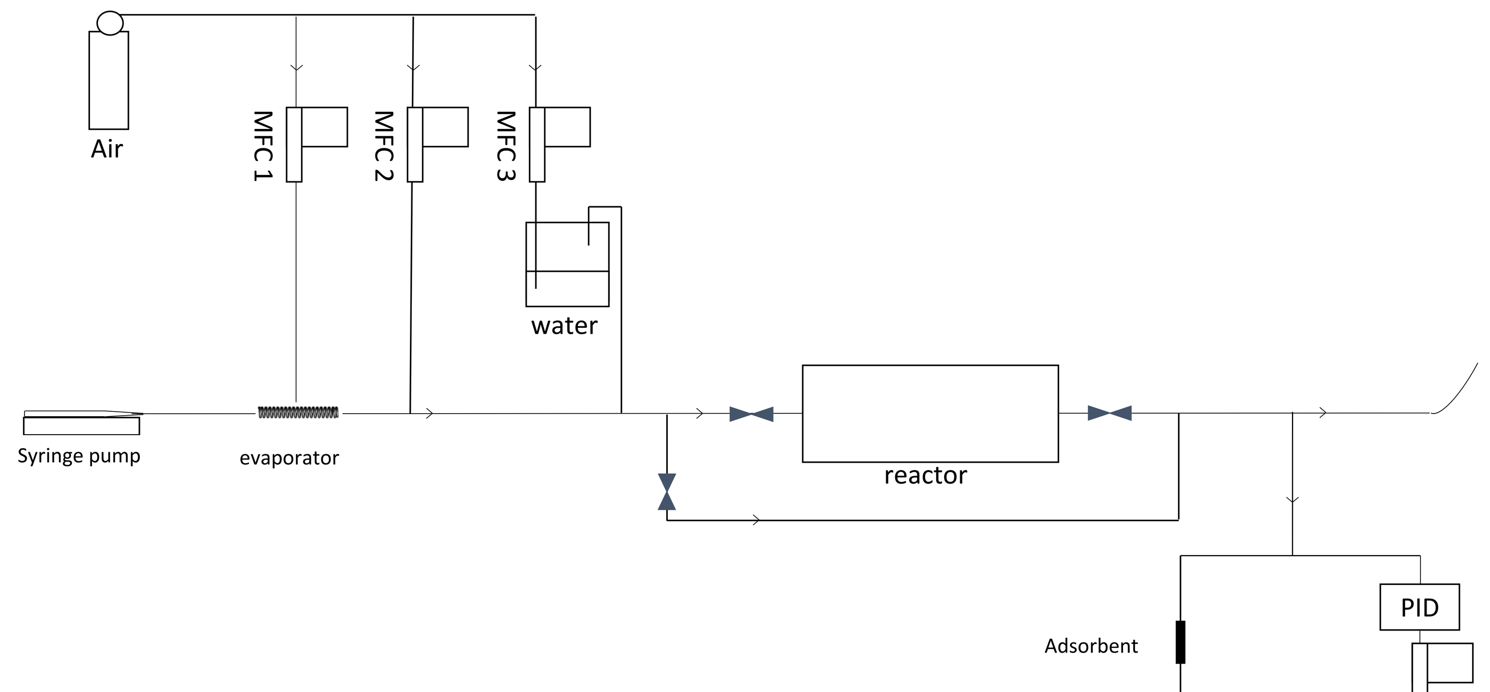
Number and configuration of UV-LEDs and filters will be optimised and two reactor's geometries will be tested:




## EXPERIMENTS AT LAB SCALE

### Continuous single pass setup (lab scale)

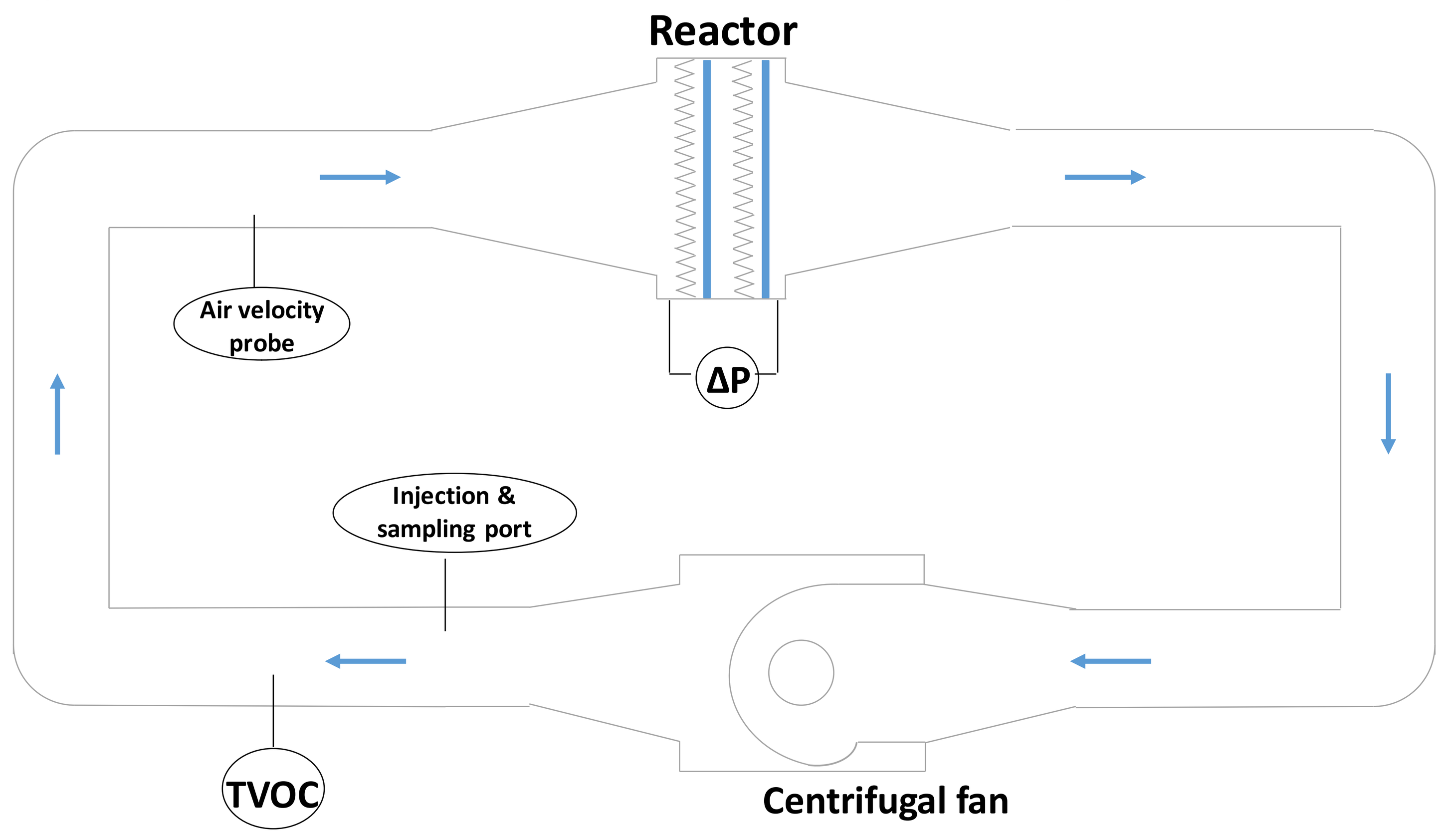
In this setup, the pollutant is continuously injected into the reactor, controlling pollutant concentration, air humidity and total flow rate.




*MFC: Mass flow controller*

### Recirculation loop (prototype testing)

Prototype will be tested with air recirculation in a closed-loop at high air flow rate (400L/s, real flow that will be treated in an aircraft)




## EXPERIMENTS IN ENVIRONMENT CONTROL SYSTEM (ECS) DEMONSTRATOR

The optimised BREEZE device will be integrated in an Environment Control System (ECS) demonstrator in Liebherr Aerospace's facilities for its final validation in an operational environment (TRL 6).

Results obtained at lab scale will be checked:

- VOC concentration (total -TVOC- and individual compounds)
- Ozone
- Bio-contaminants
- Pressure drop of the filter

**Constraints for air filter subassembly integration in the ECS**

| | |
|---|---|
| Weight (kg) | 9 kg clean |
| Length and width (mm) | 550 mm x 550 mm |
| Life span of filter (h) | >3,000 h |
| Treated air flow (L/s) | 300 L/s up to 6,000 ft<br>420 L/s up to 8,000 ft |
| Pressure drop (mbar) | 6 mbar clean to 10 mbar end of life |
| Relative humidity | 15% |
| Temperature | 23ºC |

**E-ECS demonstrator for large aircraft [2]**

## CONCLUDING REMARKS

Filter material, lighting system and reactor configuration will be optimised to achieve elimination of VOCs (>85% removal), PBDEs (up to 95% removal), ozone (up to 80% removal) and microbiological contamination (>95% inactivation) at lab and pilot scale. Possible generation of by-products in the gas phase will be taken into account. Filter durability will be assessed with an expected life time of 3000 hours under real humidity/pressure conditions.

## REFERENCES

[1] DR. Space, RA. Johnson, WL Rankin, NL Nagda, in *Air quality and comfort in airliner cabins*, NL. Nagda, (Ed), West Conshohocken, ASTM International, 2000, p. 189.
[2] CleanSky2 Joint Technical Programme. Brussels, 23 March 2015.

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