



## LP-ENS Corporate meeting

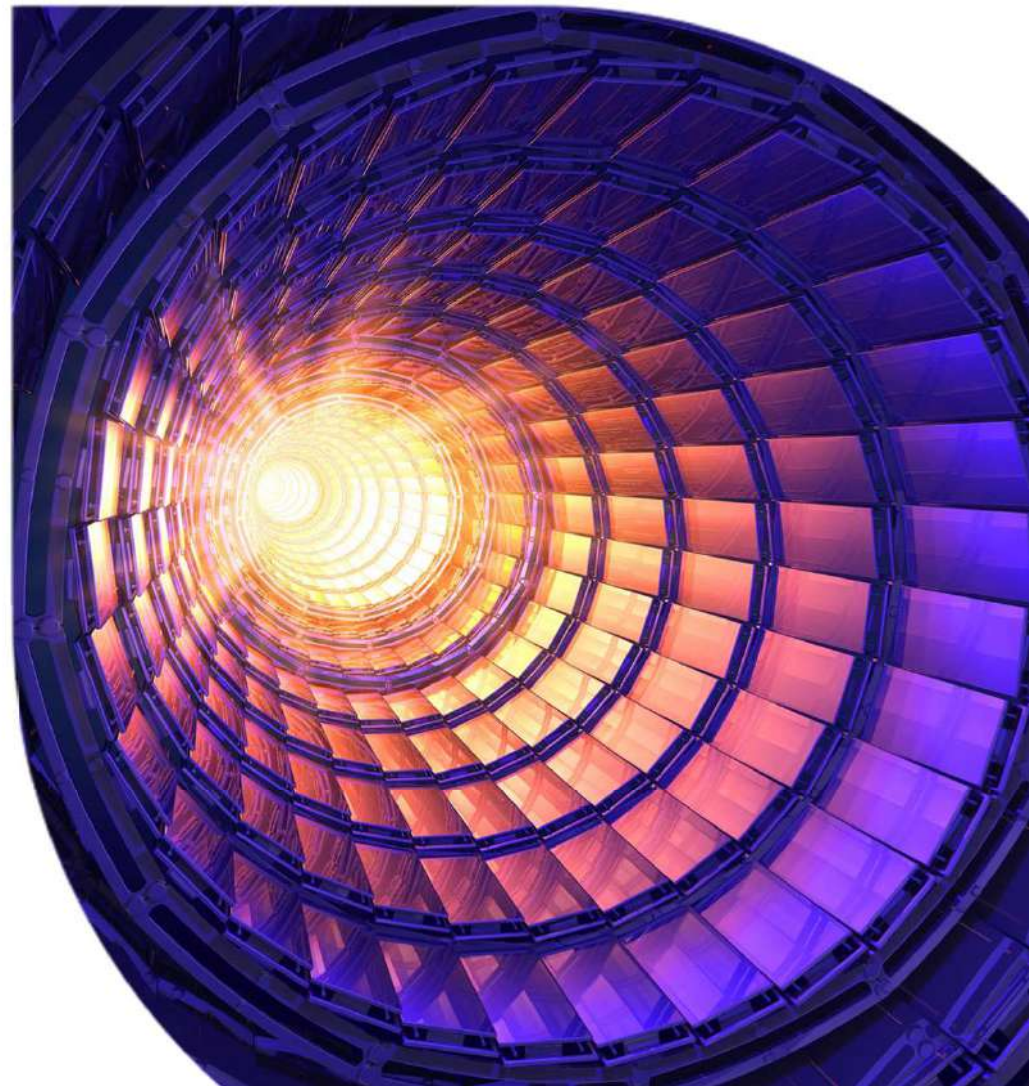


Département  
de Physique  
—  
École normale  
supérieure

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**PARIS 28 th November 2019**  
**LP ENS Corporate meeting**

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# Luc Gaffet

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 French Foreign Trade Advisor

- In charge of Air Liquide consortia for cryogenic and vacuum services and operation for CERN / LHC based in Geneva.
- GM of Air Liquide subsidiary in Gabon – based in Libreville
- Business and contract manager for ITER program .
- Currently Big Science Market Director





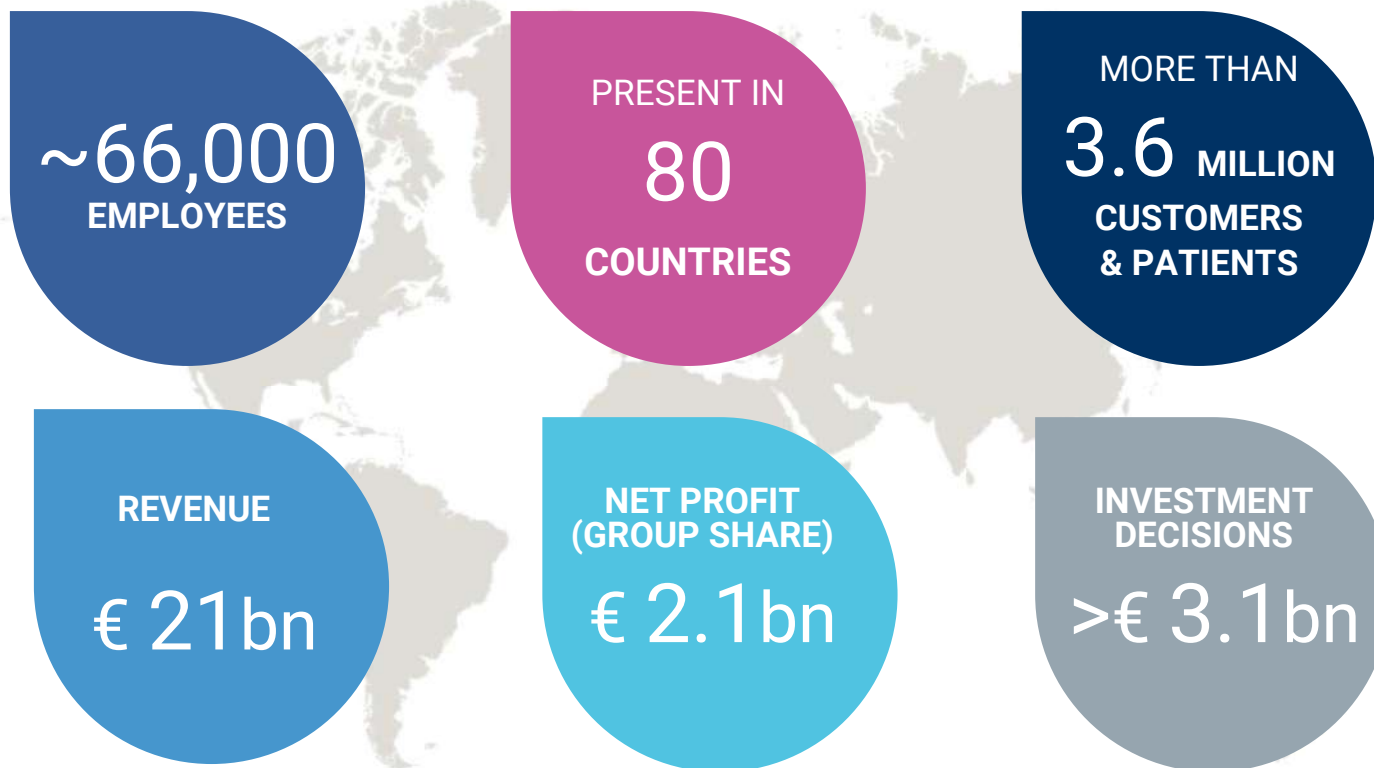
# Group presentation

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November 2019 LP ENS  
Air Liquide Group

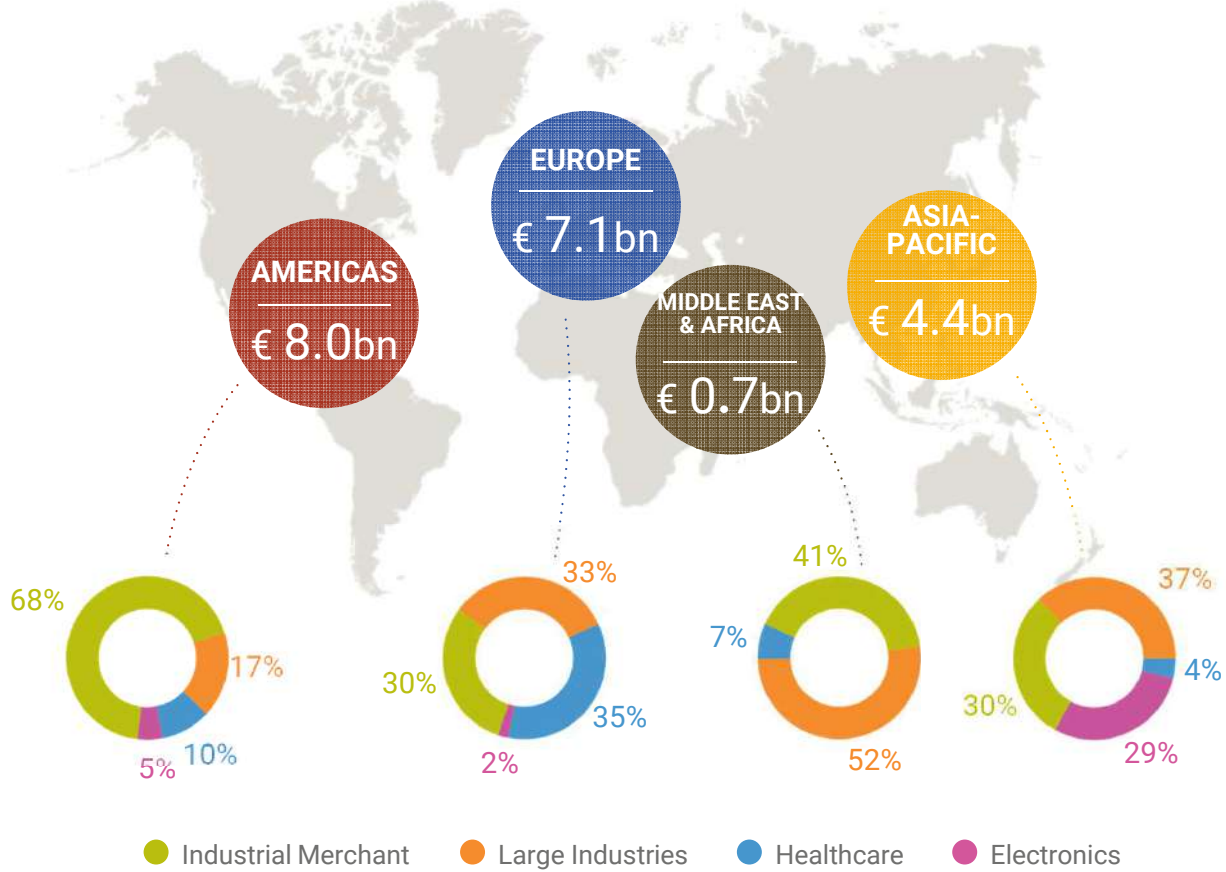
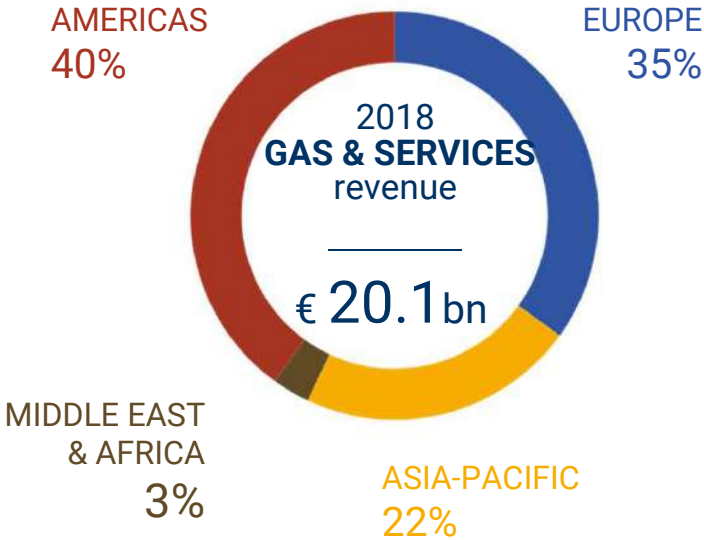


# 2018 Key Figures



2018 Figures

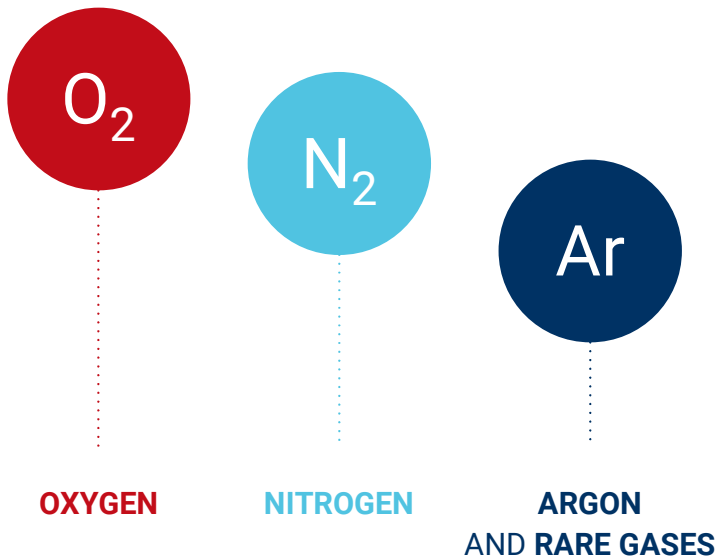
# Gas & Services Revenue Breakdown by Region



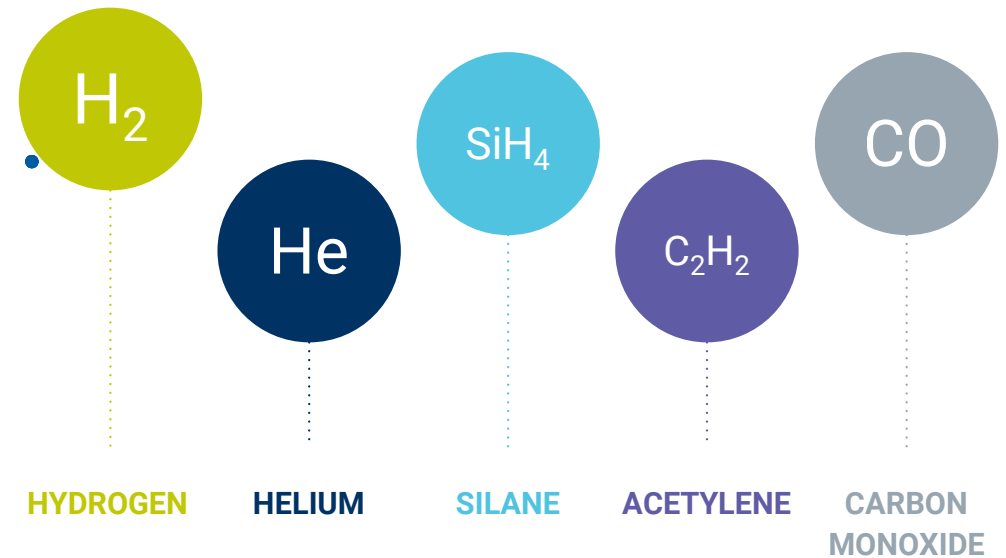
2018 Figures

# Unique expertise and skills

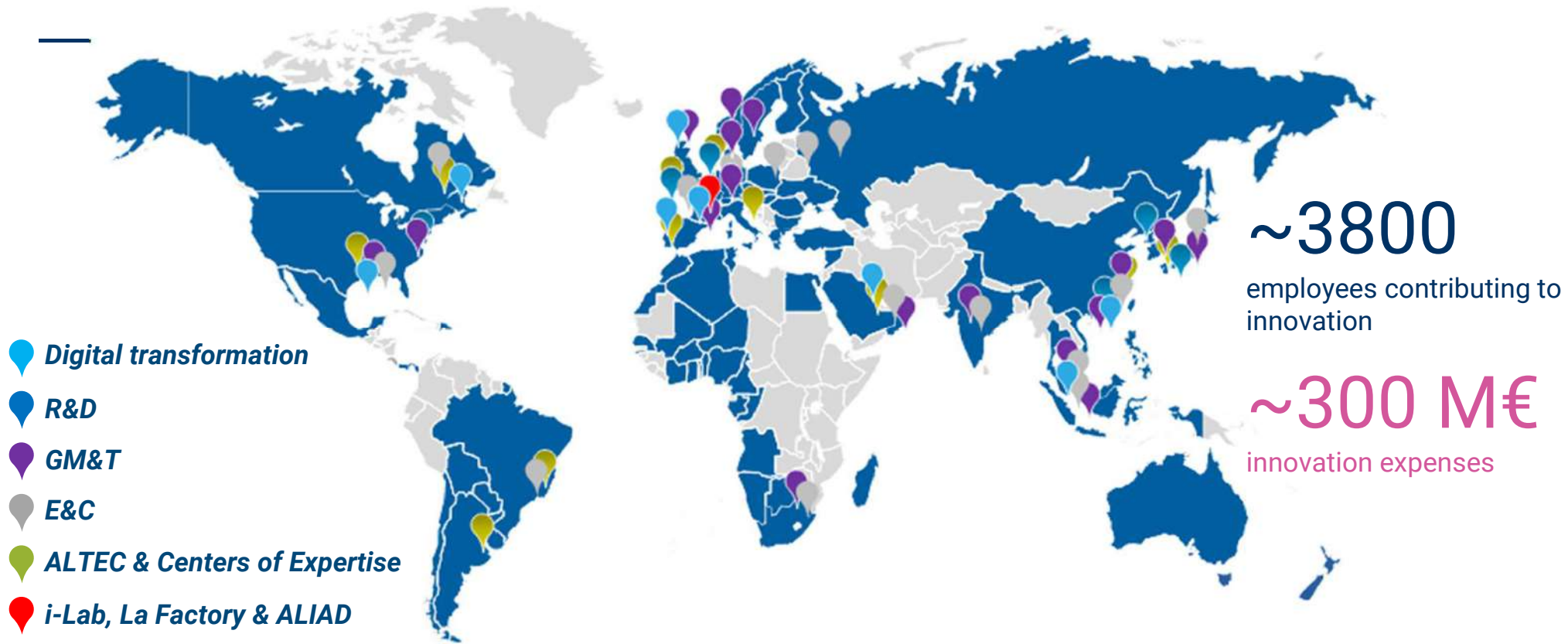
Separating the components of the **air** to take advantage of their properties



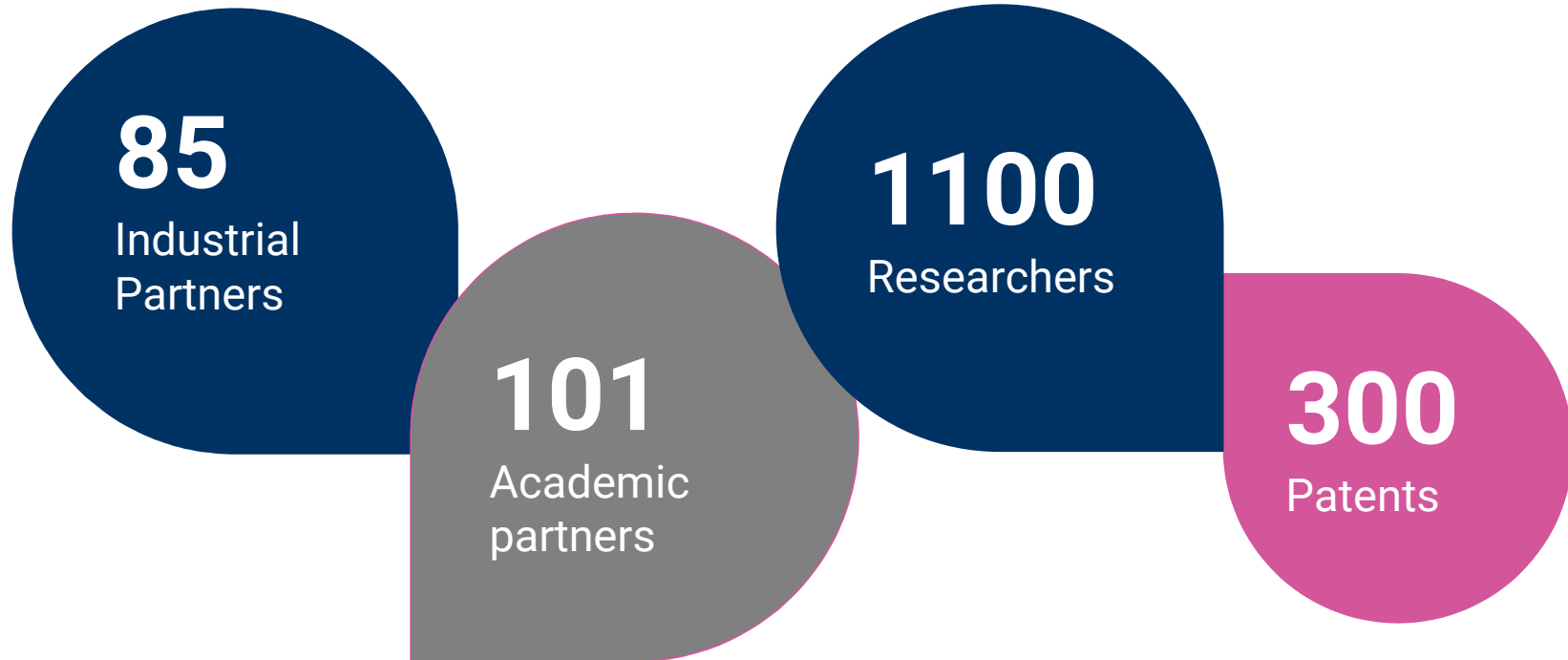
Producing molecules from **natural resources** of the Planet



# R&D in Air Liquide, a worldwide network



# 2018 R&D Key Figures







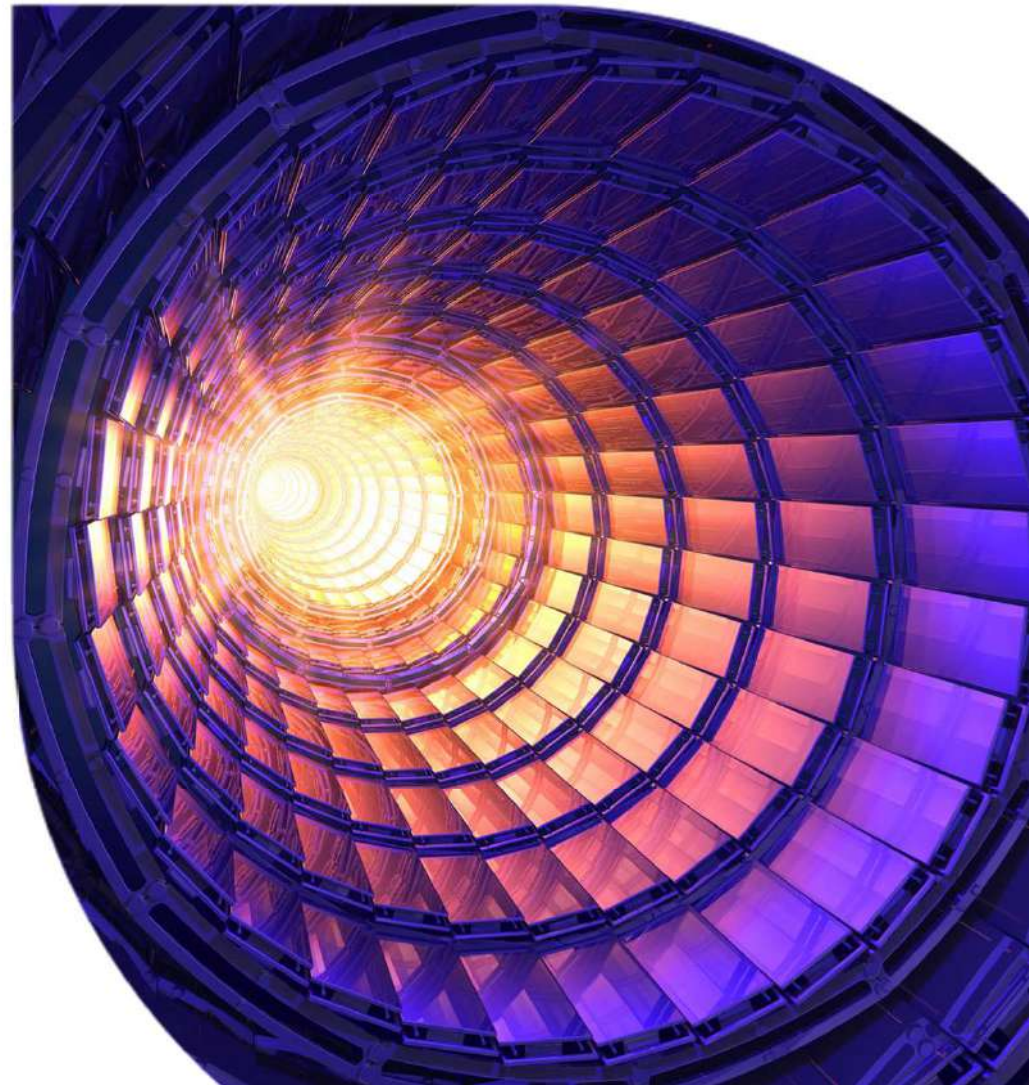
## 2 Air Liquide in big Science

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# Nuclear Fusion

## GENERAL PRESENTATION

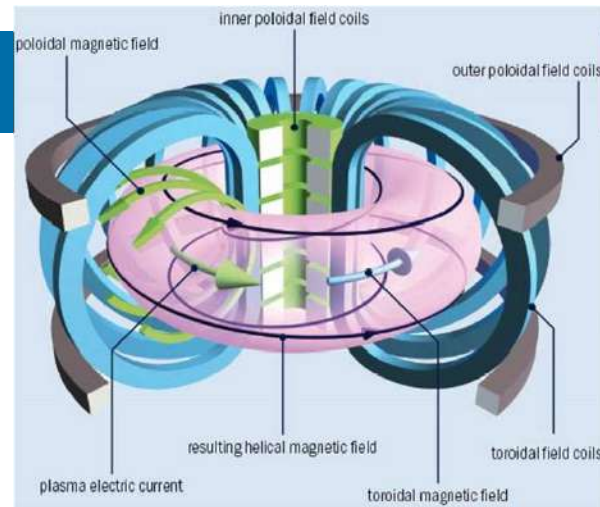
Fusion is a nuclear process aimed to produce energy by smashing together hydrogen isotopes - Deuterium and Tritium - inside a plasma. Magnetic confinement of the plasma (~150MK) by using large superconductor coils cooled at cryogenic temperature is the main approach to generate power. The device confining the torus shaped plasma is named 'Tokamak'.

## GLOBAL FIGURES

- There are around 40 Tokamaks in operation worldwide including 12 units using superconductor coils.
- Invested by state institutes and international organizations

## APPLICATIONS

Fusion plants are aimed to replace the current fission nuclear plants to produce energy with no long-lived nuclear waste and by using hydrogen isotopes (water) as fuel.



Air Liquide 4K Cold Box

## AIR LIQUIDE CONTRIBUTION

### Superconducting magnets and thermal shields

Air Liquide supply the cryoplants and the associated devices, as cold boxes and cryolines, to cool down the magnets, the thermal shields and some other devices at 4K, 20K and 80K

### Isotopes

Cryogenic units to distillate, separate and purify Deuterium, Tritium, Hydrogen and Helium

### Cryogenics

Large quantities of LHe and LN2

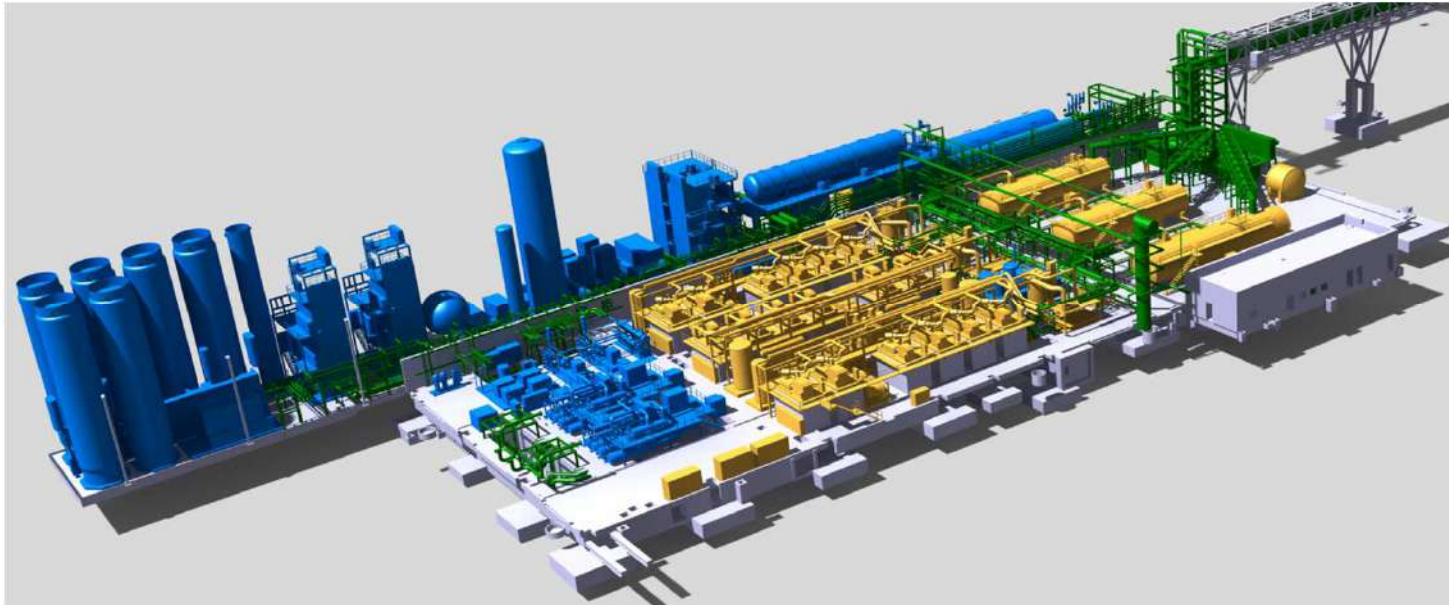
# ITER – The Project

- ITER is a worldwide organization which was created to demonstrate that nuclear fusion is an energy source of the future.
- A collaboration gathering China, the European Union, India, Japan, Korea, Russia and the United States
- ITER plant is currently under construction in Cadarache ( France).



***• Fusion is the process at the core of the sun. What we see as light and feel as warmth is a result of a fusion reaction: Hydrogen nuclei collide, fuse into heavier Helium atoms and release tremendous amounts of energy in the process. Fusion offers Important advantages: no carbon emission, no air pollution, and unlimited fuel, intrinsically safe.***

## Liquid Helium Plant (in yellow) Liquid Nitrogen Plant (in blue)



- *Helium plant is the largest helium plant in the world.*
- *Helium is liquefied at  $-269\text{ }^{\circ}\text{C}$  and is employed to cooling down the superconductors to produce de magnetic field to sustain the plasma*
- *Nitrogen is liquefied at  $-196\text{ }^{\circ}\text{C}$  and it is employed to cooling down the helium plant and the thermal shields inside the Tokamak*
- *The total power of the Air Liquide plants is 40Mw*



# Colliders

## GENERAL PRESENTATION

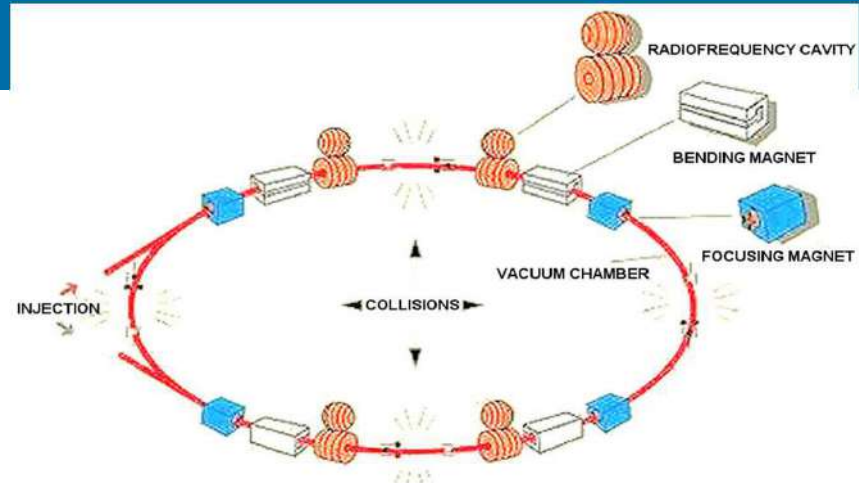
Colliders, also known as "atom smashers" are a type of particle accelerator involving directed beams of particles. Colliders can be either ring accelerators or linear accelerators, and can hit a single particle beam against a fixed target or two front beams (protons).

## GLOBAL FIGURES

- There are around 10 colliders in operation worldwide
  - Invested by institutes and international organizations
- SPS & LHC (FR:CH) SLAC (US) CEBAF (US) RHIC (US) BEPC (CN)  
VEPP-4M (RU) SuperKEKB (JP) DAFNE (IT) NICA (RU)

## APPLICATIONS

Colliders are mainly used for fundamental research.



## AIR LIQUIDE CONTRIBUTION

### Radio frequency cavities

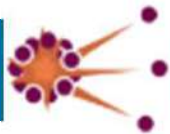
Refrigerators for Superconducting cavities operate at temperature of 4.5K, 2K or 1.8K.

### Superconducting Magnets

Refrigerators for electromagnets operate in a superconducting state, with magnets cooled down to 1.8K or 4.5K.

### Cryogenics

LIN and LAr required for cooling and process in large quantity.



# Neutron Sources

## GENERAL PRESENTATION

*Cold and Spallation neutron sources generate neutrons which are used for matter observation.*

## GLOBAL FIGURES

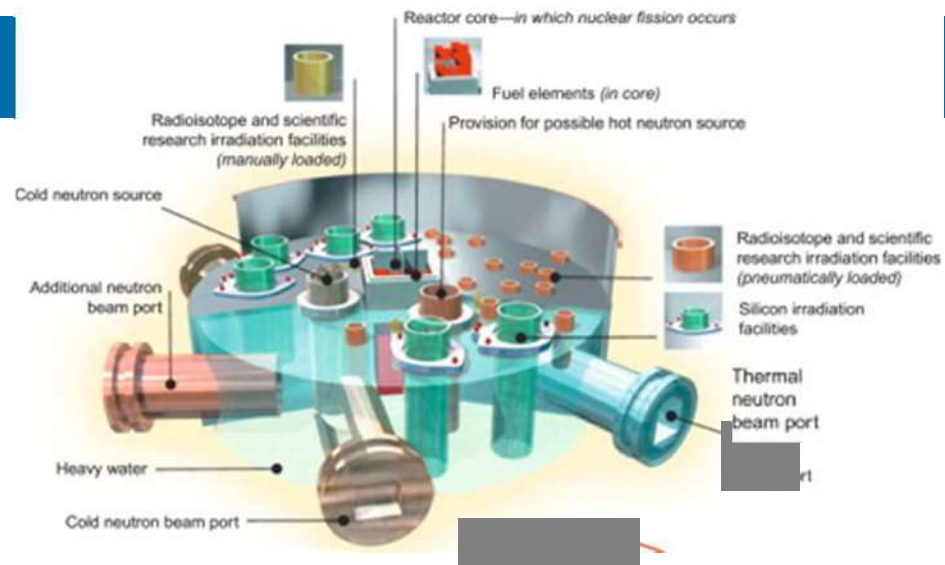
- There are around 15 CNS in operation and less than 10 SNS in operation worldwide

- Owned and operates by institutes and international organizations:

ESS(SE), SNC(US), LANSCE(US), CSNS(CN), JSNS(JP), ISIS(GB), SNS(US) ILL(FR), ISIS(GB), CNS(US), CCNS(PRC), PSI(CH), HZB(DE), FRM(DE), PIK(RU), KUANS-RANS(JP) ANSTO (AU)

## APPLICATIONS

*CNS are mainly used for experiments in medical, biological or metallurgical imaging, pharmacology, materials processing, catalysis, new materials and also CP fundamental physic violation*



## AIR LIQUIDE CONTRIBUTION

Supply **customized solutions** in mechanical cold production, liquefaction, storage and distribution of cryogenic fluids at 20K, 4K and 2K.

**Provide molecules**

He3 and He4 for cryostats and LN2 for cooling and enriched BF3



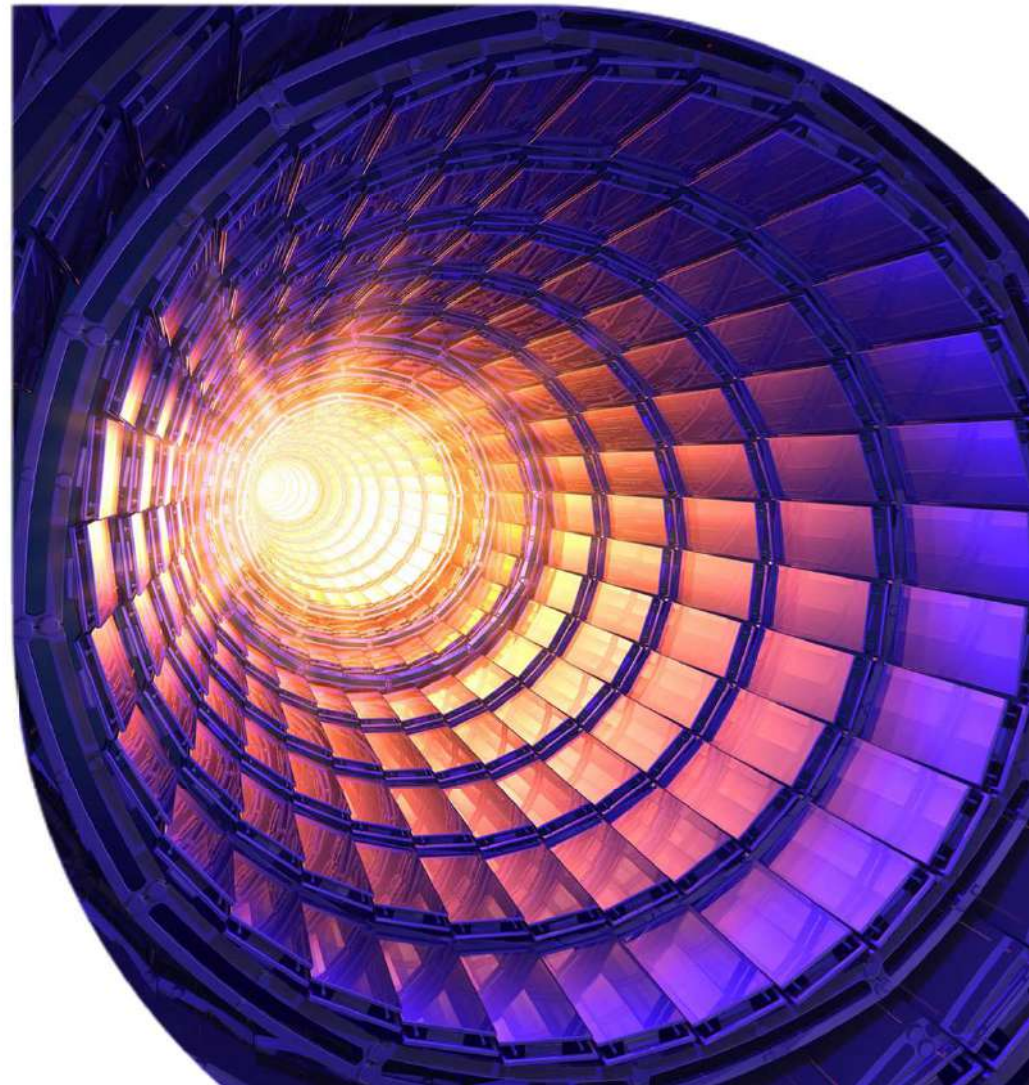
## 3 Career and professional areas for scientist in Air Liquide

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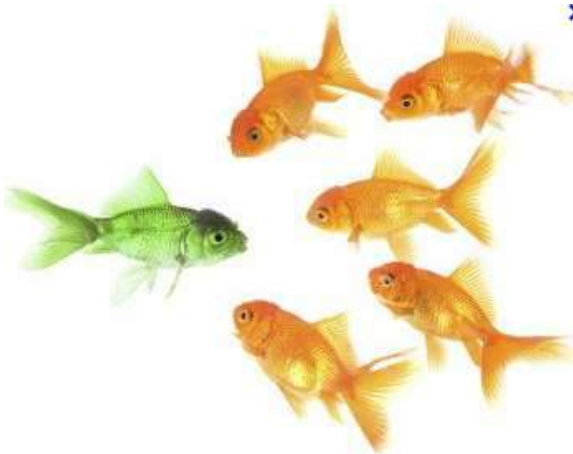
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## Why having a job in Air Liquide ?

- Air Liquide is a techno oriented company, most part of the management come from scientific's area (engineer or academics).
- Air Liquide strategy is based on a strong intellectual policy in order to have proprietary technology (entrance barrier etc...)
- To build IP and patent we wanted and we need to have total mastery of their depth of field



***Science and innovation is the horsepower for the Group !***



## Why having a job in Air Liquide ?



- When you start a career in Air Liquide group on a R&D activity, you benefit of status advantage in comparison of other activities (sector wage collective agreement: level 460 before 29 years).
- Technical Career ladder program offer a strong way to support technical career progression as a alternative to the management path (local expert, Senior Expert fellow ...)

# Scientist in Air Liquide Advanced Technologies (example)

- **ALAT : Based in Grenoble**
- **Total staff ~1000 FTE**
- **170 M€/y**
- **ALAT = Engineering activity and techno provider for the group and customer**
  - **Space activity (Ariane 5 and 6)**
  - **Big Science**
  - **Aeronautic**
  - **Hydrogen and energy transition**

Doctors and PhD in ALAT by activity

