



# CATHI final review meeting

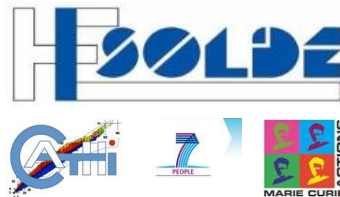
## Target Area Infrastructure

# Cooling and Ventilation

Andrea Polato\* - CERN EN-CV-PJ

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# Contents

- [Work Package ESR 13: Cooling and Ventilation Design Study;](#)
- [Ventilation](#)
- [Cooling](#)
- [Conclusions](#)

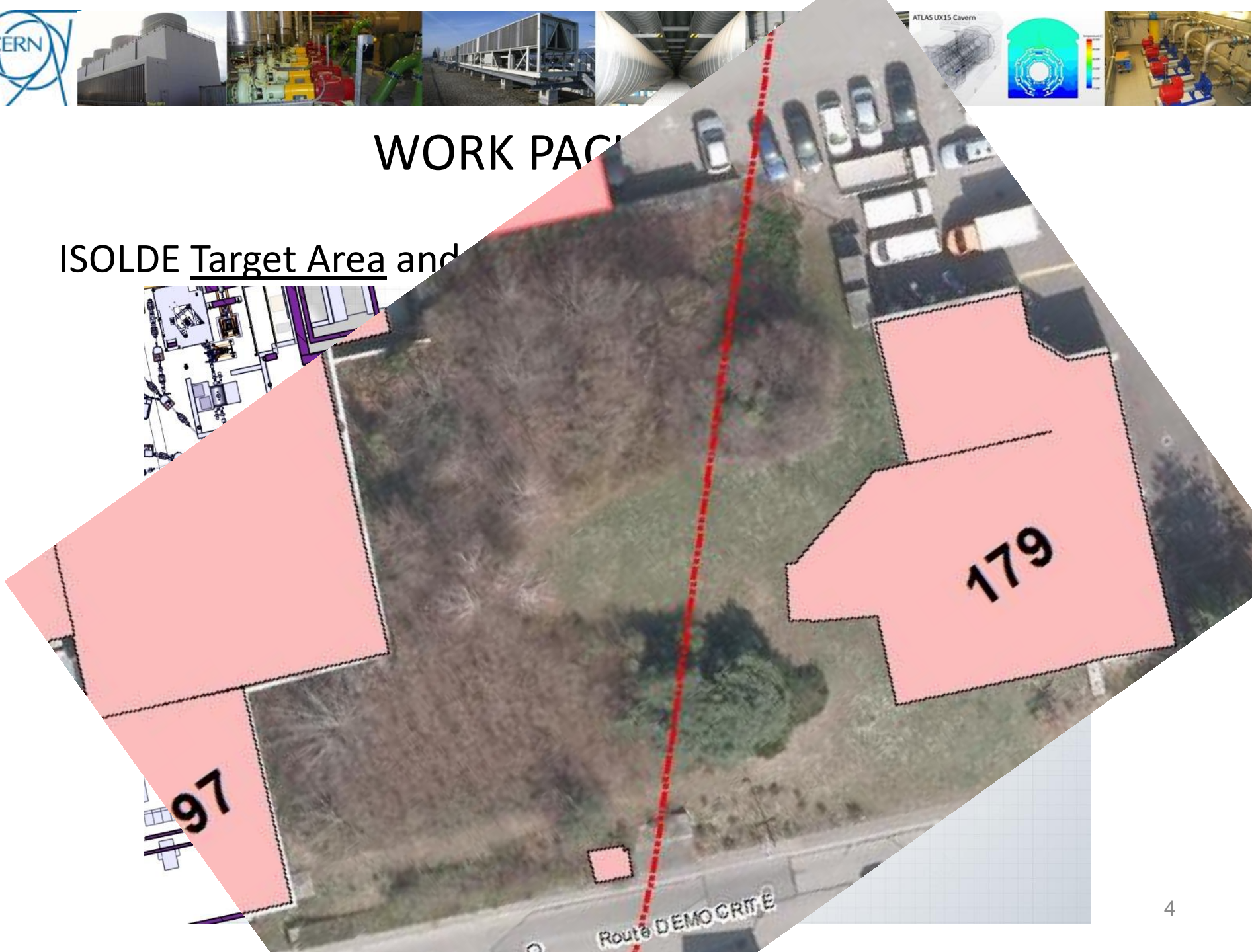


# WORK PACKAGE ESR13: COOLING AND VENTILATION DESIGN STUDY



# WORK PACKAGE

## ISOLDE Target Area and







# VENTILATION



# VENTILATION SYSTEM: REASONS FOR THE SYSTEM UPGRADE



# REASONS FOR THE SYSTEM UPGRADE

1. Proton beam intensity upgrade;
2. Improvement of the tunnel confinement; 
3. Independency among Tunnel and Class A Laboratory; 



## REASONS FOR THE SYSTEM UPGRADE: INTENSITY UPGRADE

Today the activity releases in atmosphere are in line with the CERN objectives

Question:

- **What will happen after the intensity upgrade?**

Currently with a beam intensity of 2  $\mu\text{A}$ :

- Average activity released at the ISOLDE stack:  $5 \times 10^5 \text{ Bq/m}^3$ ;
- Total air flow through the ISOLDE stack (class A + Tunnel + HRS&GPS):  $7500 \text{ m}^3/\text{h}$ ;

Standing at the historical parameters, the average contribution in terms of effective dose of ISOLDE on the reference population

- **3  $\mu\text{Sv}/\text{year}$**  (overall CERN objective **10  $\mu\text{Sv}/\text{year}$** );

The increase of [beam intensity](#) (from 2  $\mu\text{A}$  to 6  $\mu\text{A}$ ) and energy (from 1.4 GeV to 2 GeV) will have an effect on the releases and, as a consequence:

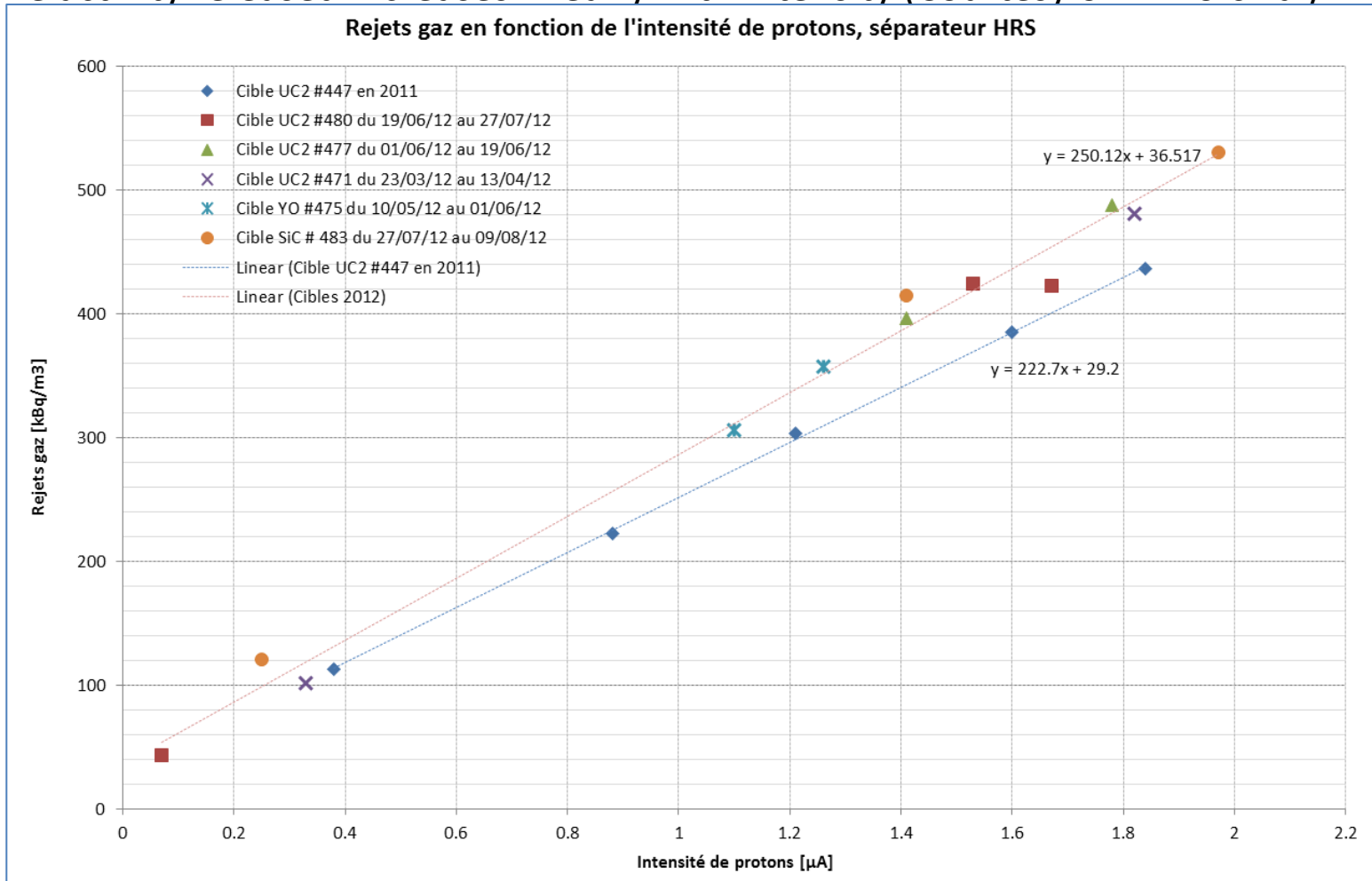
- An intervention on the ventilation system would result in lower emissions





# REASONS FOR THE SYSTEM UPGRADE: INTENSITY UPGRADE

- The activity released increases linearly with intensity (Courtesy of A. Dorsival):



\* The effect of the increase in the beam energy from 1.4 GeV to 2 GeV on the releases is still under evaluation



# REASONS FOR THE SYSTEM UPGRADE: TUNNEL CONFINEMENT

The concept of confinement (i.e. keeping contaminated air inside a defined volume) combines both a dynamic part (ventilation) and a static part (structure leak tightness)

Question  
 • What is

7 m/s

6 m/s

50 mm

2.2 m/s

200 mm

Cable trenches

Cable trenches

150 mm

1 m/s

30

Precious help from: H. Sabri

A. Garcia



# REASONS FOR SYSTEM UPGRADE: TUNNEL CONFINEMENT

- A  $\Delta P = -75$  Pa is generated inside the Tunnel with respect to the outdoors;
- In order to get to this value an extraction flow of nearly  $3000 \text{ m}^3/\text{h}$  is required;
- Considering the tunnel volume of  $1000 \text{ m}^3$ , it works out a leak rate of  $2 \text{ vol/h}$
- In nuclear installations, the average value for leak rates should range around  **$0.4 \text{ vol/h}$** ;
- This difference is due to the poor static confinement of the Tunnel;

## Consequences:

- Size of the confinement equipment (fan, ducts, filters, regulation dampers);
- Expenditures in terms of electrical energy to handle the confinement;
- Amount of activity released in atmosphere;



# REASONS FOR THE SYSTEM UPGRADE: TUNNEL VS. CLASS A LABORATORY INDEPENDENCY

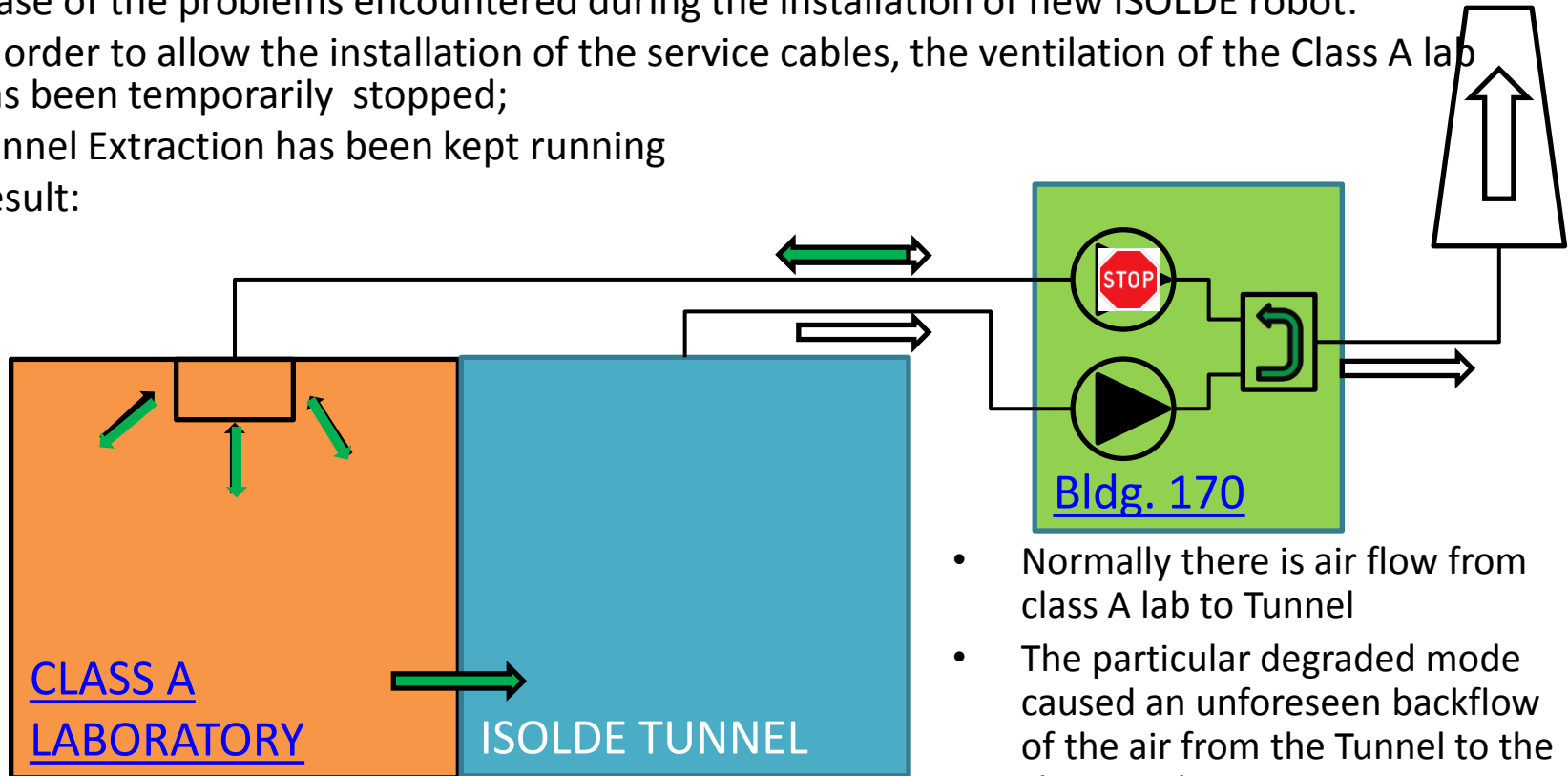
Class A Laboratory and ISOLDE Tunnel are supplied by two separated HVAC systems

Question

- **Are the two ventilation systems independent?**

Real case of the problems encountered during the installation of new ISOLDE robot:

- In order to allow the installation of the service cables, the ventilation of the Class A lab has been temporarily stopped;
- Tunnel Extraction has been kept running
- Result:

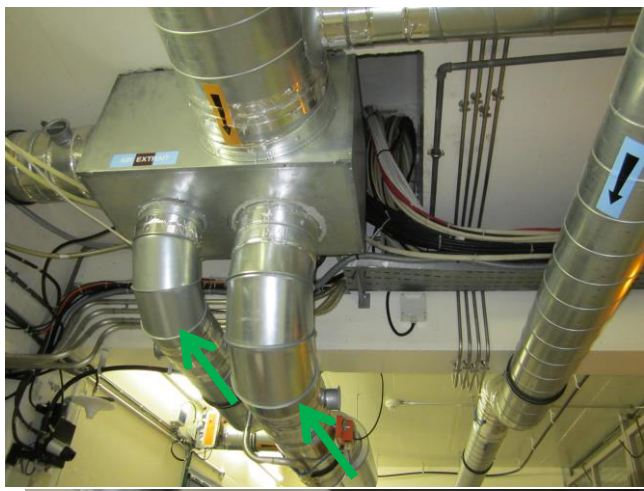


- Normally there is air flow from class A lab to Tunnel
- The particular degraded mode caused an unforeseen backflow of the air from the Tunnel to the class A Laboratory



# REASONS FOR THE SYSTEM UPGRADE

Real case of the problems encountered during the installation of new ISOLDE robot





# VENTILATION SYSTEM: TECHNICAL SOLUTIONS PROPOSED: MEDICIS LABORATORY



# TECHNICAL SOLUTIONS PROPOSED: MEDICIS LABORATORY

The project for the extension of the Class A Laboratory in order to host the MEDICIS Laboratory

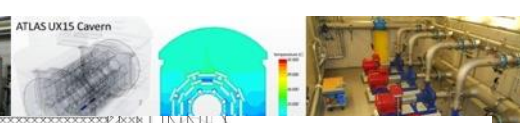


Constituted an occasion to propose some technical solutions to improve:

- The separation between ISOLDE Tunnel and class A Laboratory;
- The leaktightness of the tunnel;

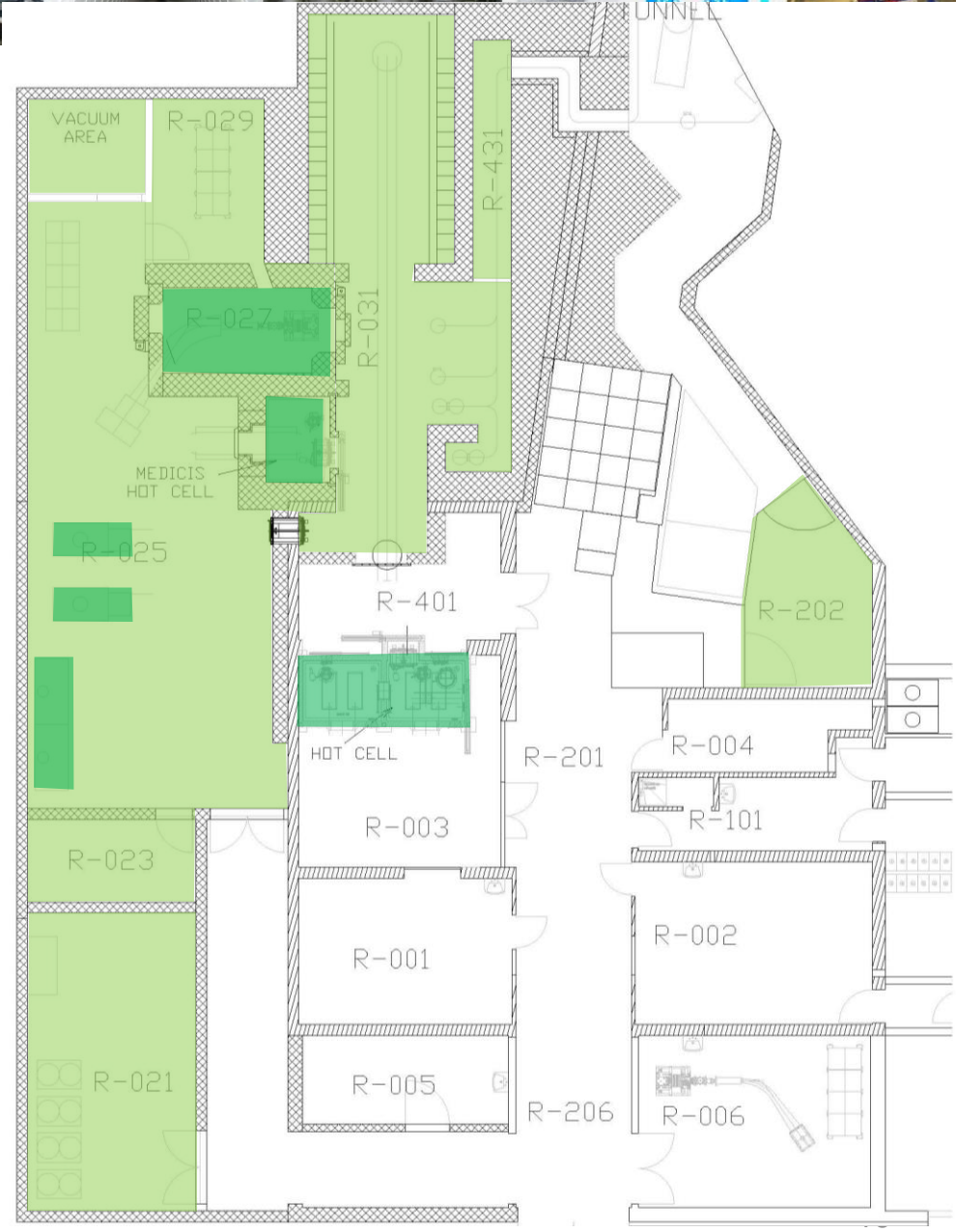


Medicis groundbreaking ceremony of the 4<sup>th</sup> of September 2013

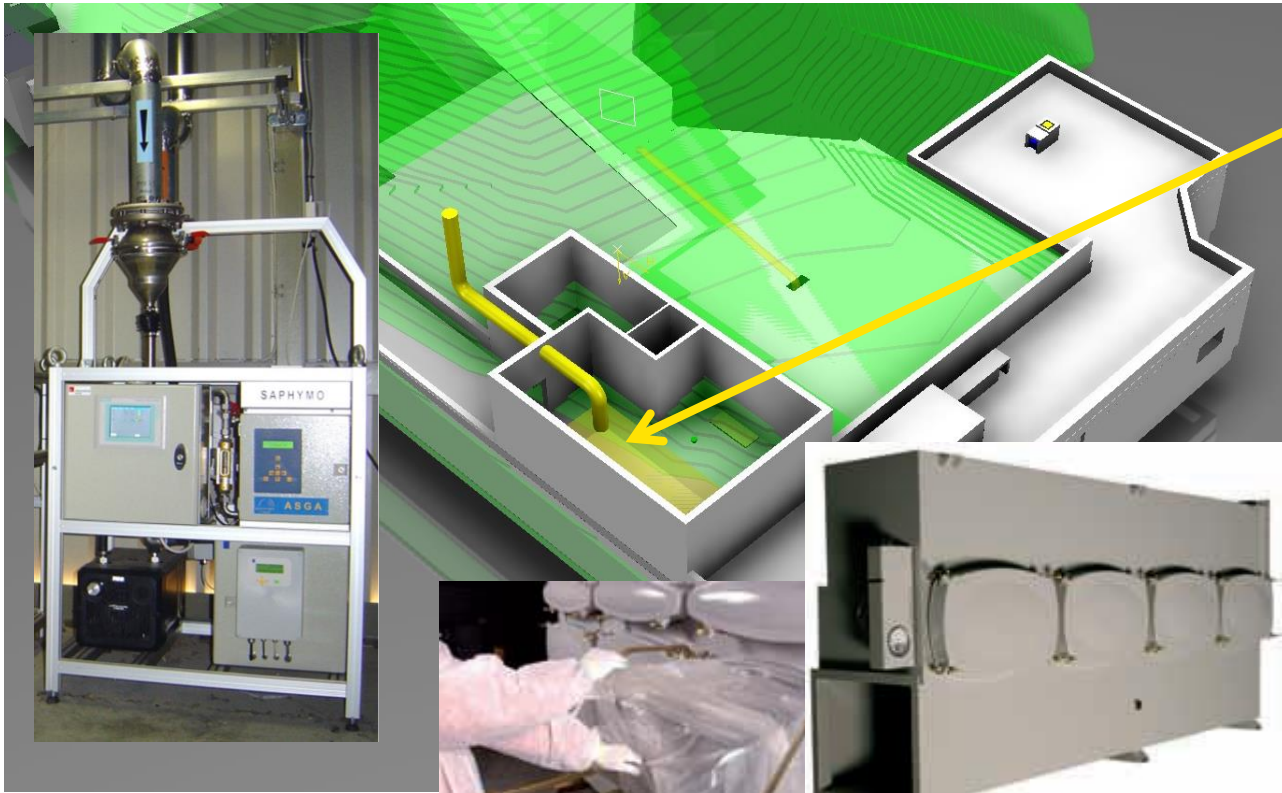


### Class A Laboratory Extension:

- 240 m<sup>2</sup> extension (from 265 m<sup>2</sup> to 505 m<sup>2</sup>);
- New rooms for:
  - Waste disposals (R021, Vacuum Area);
  - MEDICIS experiment (R025, R027, R029 and R023);
  - Target decay before dismantling (R031);
  - Airlocks (R202, R431);
  - Process Enclosures (Hot Cell and MEDICIS Hot Cell);
- New ventilation and confinement system for the whole building:
  - New Ventilation technical room;
  - [Redundant equipment to increase availability of the system](#)
  - [Differentiated extractions for laboratory and process \(hot cells + glove boxes\);](#)
  - [Integration of the existing ventilation network into the new one;](#)
  - [Updated definition of the pressure hierarchy;](#)
  - New airlock chambers for the separation from the Tunnel;

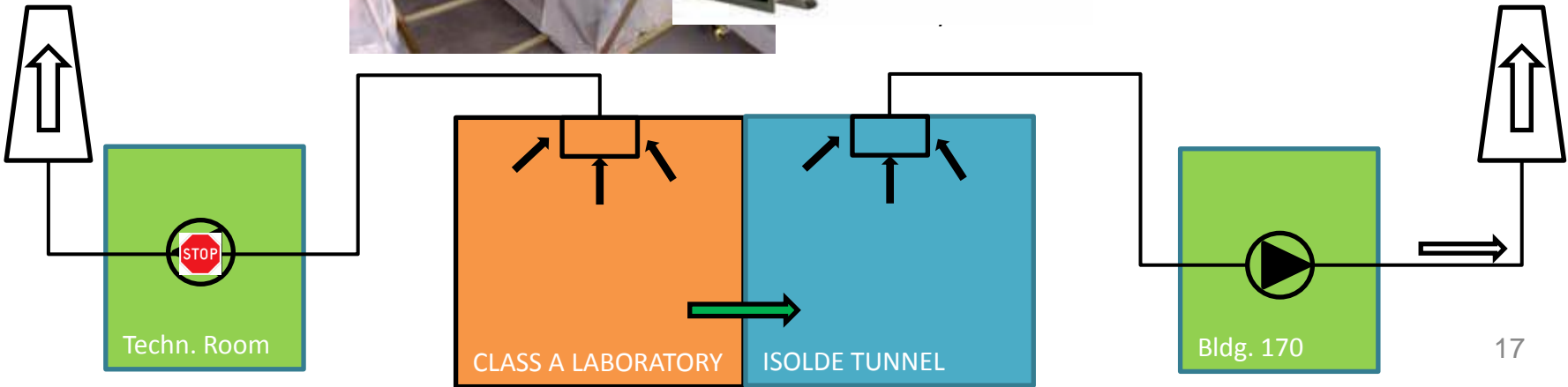






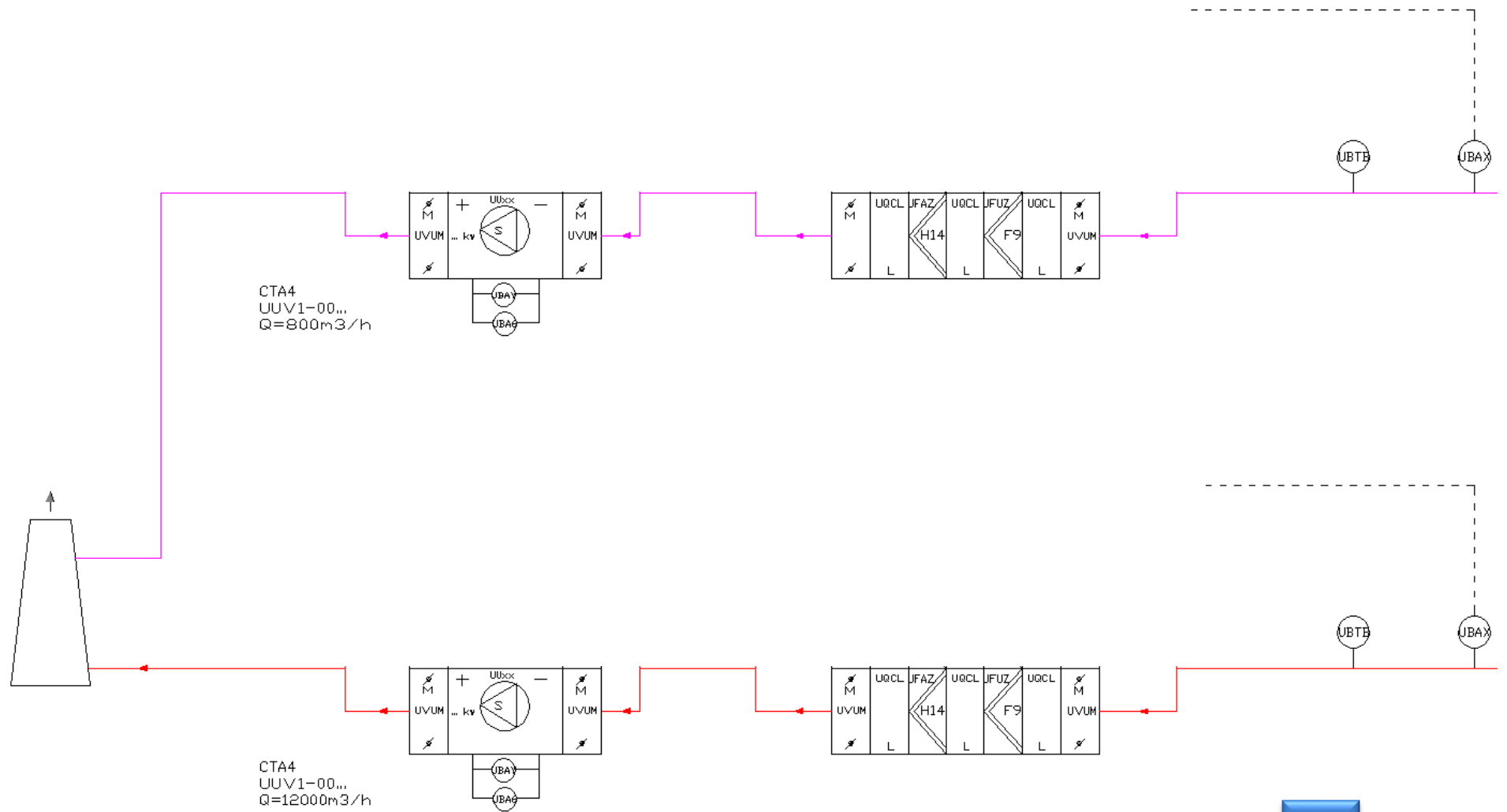
### Ventilation Technical Room

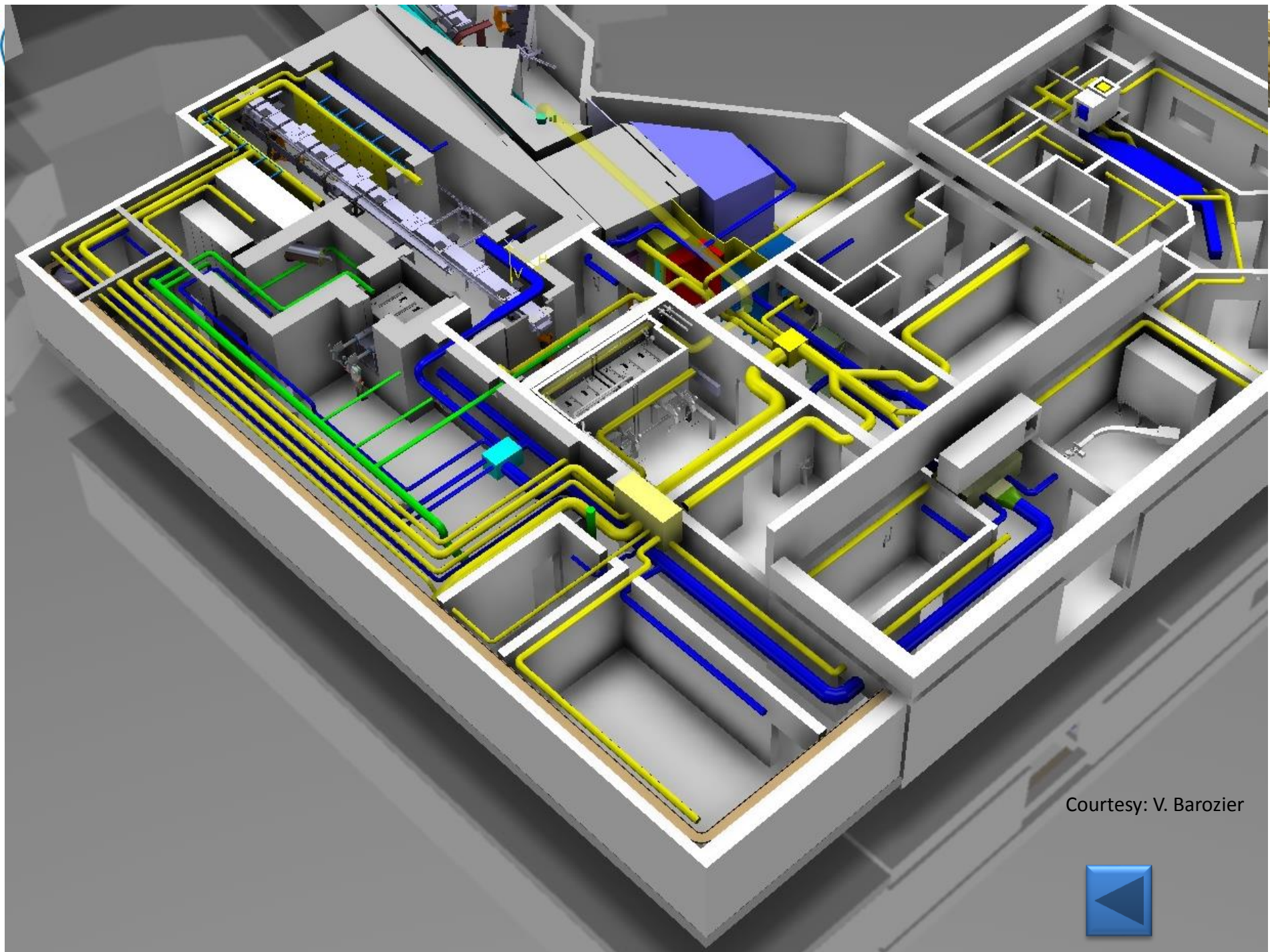
- Dedicated stack for the release of the extraction into environment;
- Dedicated station to monitor the activity releases;
- No interferences with the tunnel extraction;
- No risk of unpredicted backflows in case of ventilation stops;
- **Interface between Class A lab and Tunnel still present**





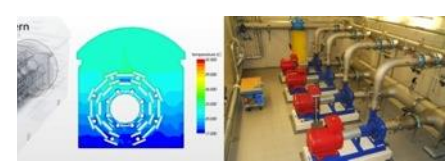
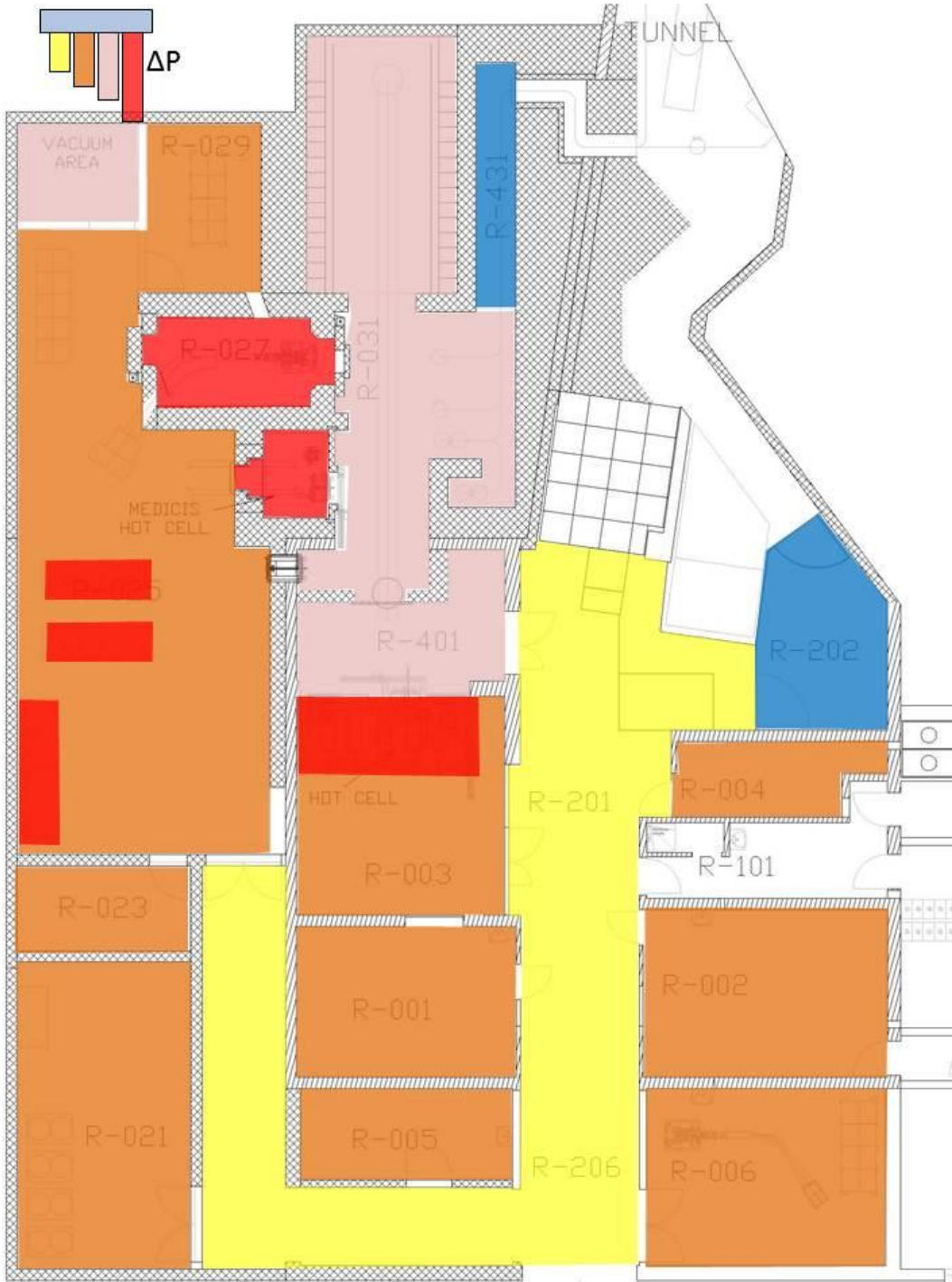
# Redundant equipment





Courtesy: V. Barozier







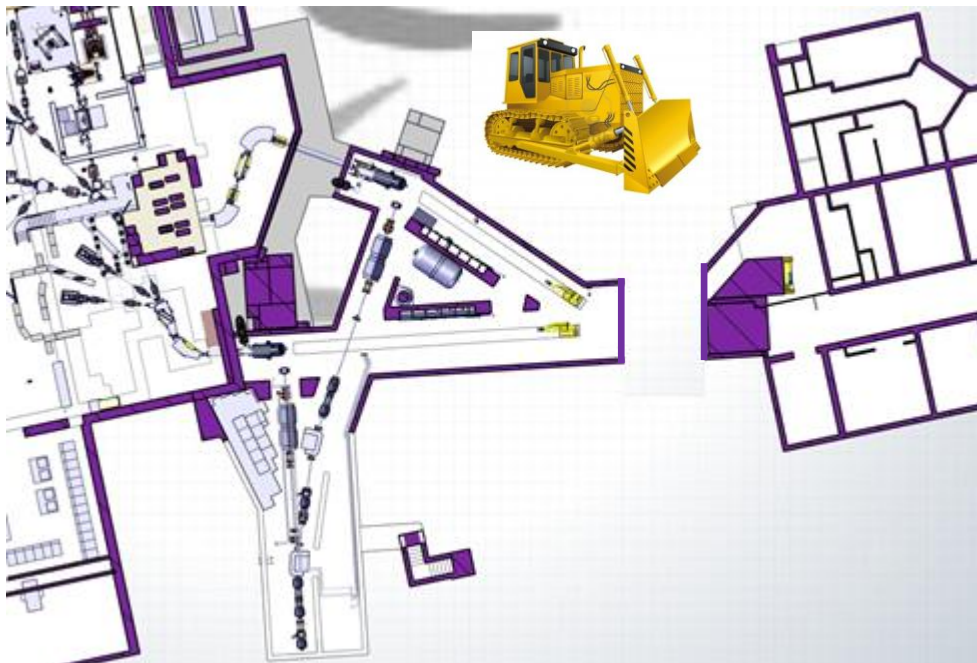
# Airlock chambers

Purpose of the airlocks:

- Create a volume between Tunnel and Class A Laboratory in such a way to:
  - Avoid activated air backflows from the Tunnel to the Class A Laboratory;
  - Prevent the Class A Laboratory evacuation in case of Tunnel ventilation stop (and vice versa);
  - Enhance a more flexible pressure regulation in the two buildings;
- Increase the leaktightness of the structure;

How to do it?

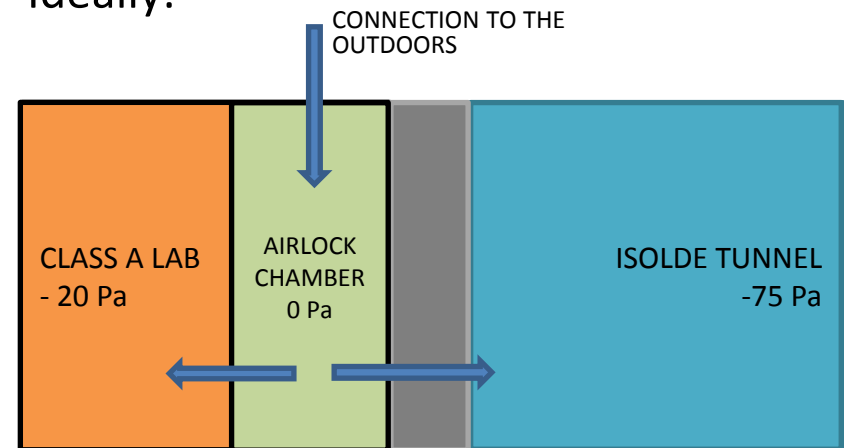
Conceptually, the solution is:



NOT FEASIBLE

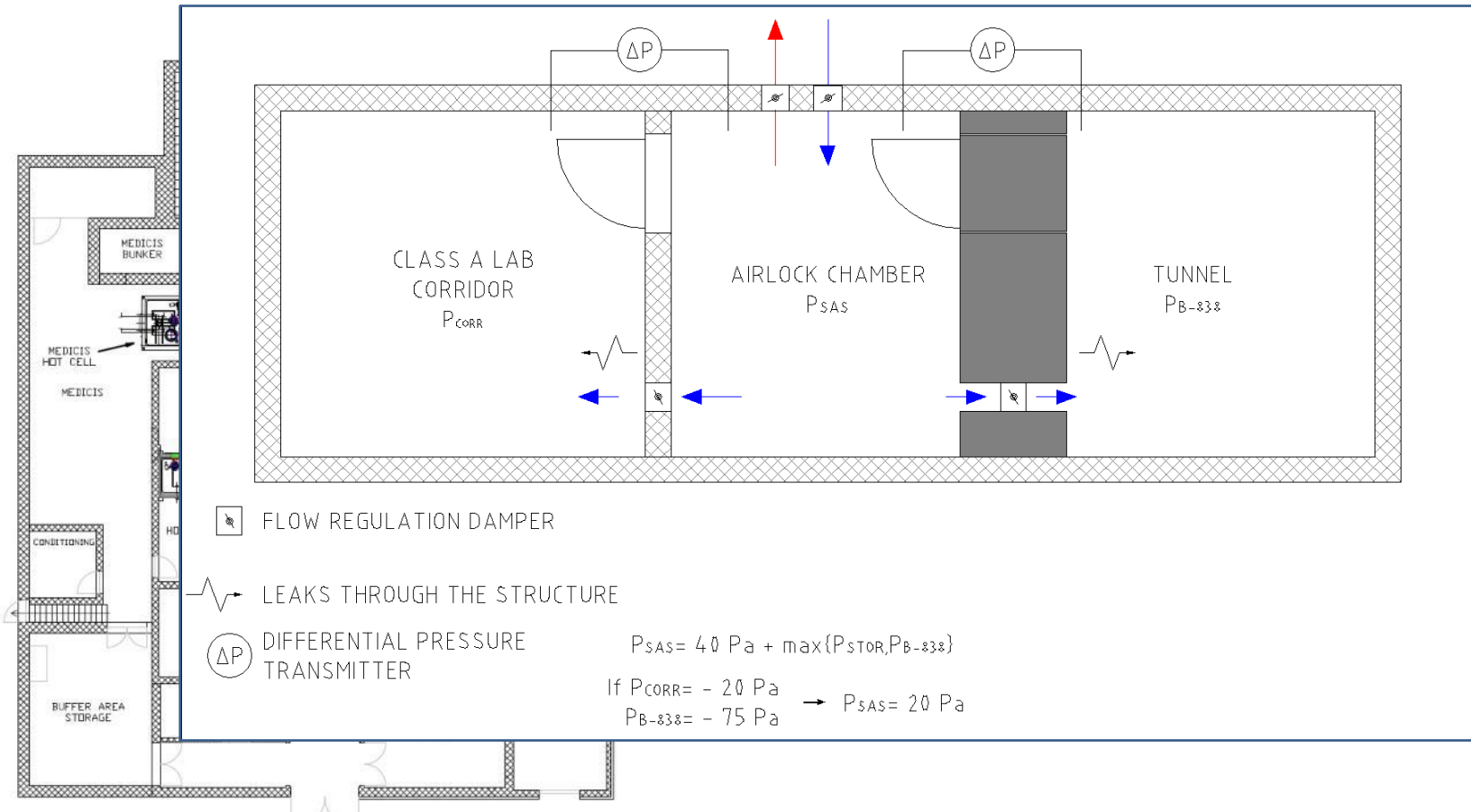
An alternative approach is needed

Ideally:





# Airlock chambers



- Pressure inside the airlocks will be set in such a way to be over pressurized ( $\Delta P = 40 \text{ Pa}$ ) with respect to the higher among the pressures of the interfacing volumes;
- Class A Laboratory will not “see” what’s happening inside the Tunnel and vice-versa;
- [The adoption of the airlock will imply a better sealing of the areas, thus improving the leaktightness of the tunnel;](#)



# VENTILATION SYSTEM: TECHNICAL SOLUTIONS PROPOSED: TUNNEL VENTILATION



# TECHNICAL SOLUTIONS PROPOSED: TUNNEL VENTILATION

The main goal of the intervention on the ventilation system of the ISOLDE Tunnel:

- Reduction of the extraction flow rate.

## Why?

$$flow \left[ \frac{m^3}{h} \right] \cdot activity \left[ \frac{Bq}{m^3} \right] = \frac{Bq}{h} \rightarrow \frac{Bq}{year} \rightarrow \frac{Sv}{year} \leq 10 \frac{\mu Sv}{year} \text{ (CERN objectives)}$$

An increase of the activity due to the intensity upgrade can be – partly – compensated by a reduction in the extraction flow rate.

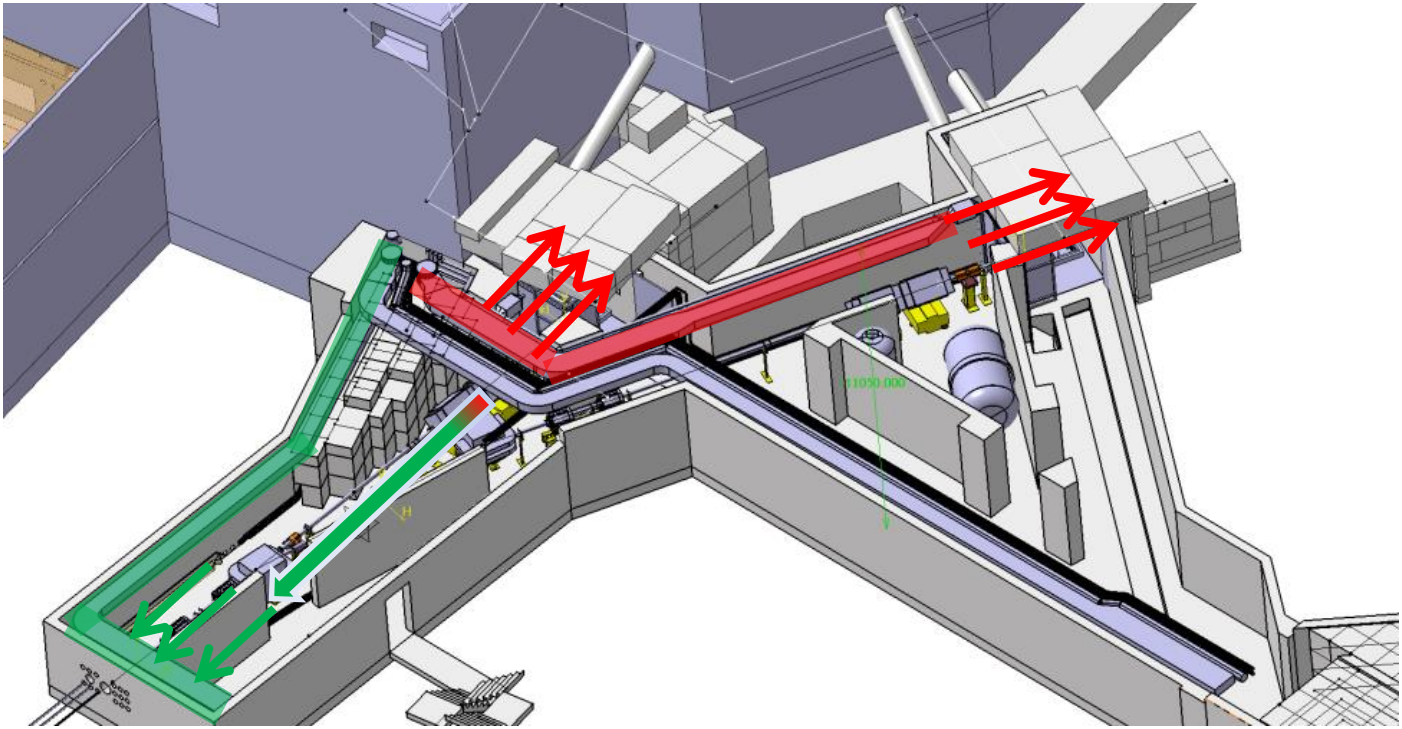
## How?

1. Stop of air supply during beam mode;
2. Reduction of the Tunnel differential pressure;
3. New airlock for the tunnel access;





# STOP OF THE AIR SUPPLY DURING BEAM MODE



Current Beam Mode ventilation parameters:

- 1. Supply air flow: **1100 m<sup>3</sup>/h**; **????**
- 2. Extraction air flow: **2900 m<sup>3</sup>/h**;

Apparently no reasons for having an air supply during beam mode

Proposed Beam Mode ventilation parameters:

- 1. Supply air flow: **0 m<sup>3</sup>/h**;
- 2. **Extraction air flow:** **1800 m<sup>3</sup>/h**;



## REDUCTION OF THE TUNNEL $\Delta P$

Considering that:

An extraction air flow:

$$1800 \text{ m}^3/\text{h};$$

Is necessary to keep a differential pressure:

$$\Delta P = -75 \text{ Pa}$$

And considering that:

According to the Swiss Ordinance ORaP 814.554 the differential pressure shall be, for the Class A sectors:

$$\Delta P \leq -50 \text{ Pa}$$

What would be the flow necessary to ensure the minimum differential pressure?

$$Q_2 = Q_1 \times \left( \frac{\Delta P_2}{\Delta P_1} \right)^{0.5}$$

$$Q_{@50Pa} = 1800 \times \left( \frac{50}{75} \right)^{0.5} = \mathbf{1470 \text{ m}^3/\text{h}}$$



# Airlock chambers

Estimated flow trough the existing door between Class A Laboratory and ISOLDE Tunnel:

- Dimensions: 1.5 m x 3.25 m;
- Gap door/wall: 10 mm÷30 mm;
- Air speed trough the gap: 0.4 m/s÷2.5 m/s

$$flow \left[ \frac{m^3}{h} \right] = gap \ surface [m^2] \times air \ speed [m/s] = 380 [m^3/h]$$

Using the standard NF EN 12207-2000 for the doors leak tightness classification:

- Dimensions: 1.4 m x 3.25 m;
- $\Delta P_{AIRLOCK-TUNNEL}$ : 70 Pa;

EN 12207 class	Leak rate @ $\Delta P= 100$ Pa ( $m^3/h \times m^2$ )	Leaks @ $\Delta P= 100$ Pa ( $m^3/h$ )	Leaks @ $\Delta P= 70$ Pa ( $m^3/h$ )
1	50 $m^3/h \times m^2$	228 $m^3/h$	220 $m^3/h$
2	27 $m^3/h \times m^2$	123 $m^3/h$	119 $m^3/h$
3	9 $m^3/h \times m^2$	41 $m^3/h$	40 $m^3/h$
4	3 $m^3/h \times m^2$	14 $m^3/h$	13 $m^3/h$





# TECHNICAL SOLUTIONS PROPOSED: TUNNEL VENTILATION

## Resuming:

- Initial value of extraction flow:  $Q_{ext} = 2900 \text{ m}^3/h;$
- After the stop of the supply:  $Q_{ext} = 1800 \text{ m}^3/h;$
- After the  $\Delta P$  reduction from 75 Pa to 50 Pa:  $Q_{ext} = 1470 \text{ m}^3/h;$
- After NF EN 12207-2000 category 4 door in place:  $Q_{ext} = 1100 \text{ m}^3/h (-60%);$

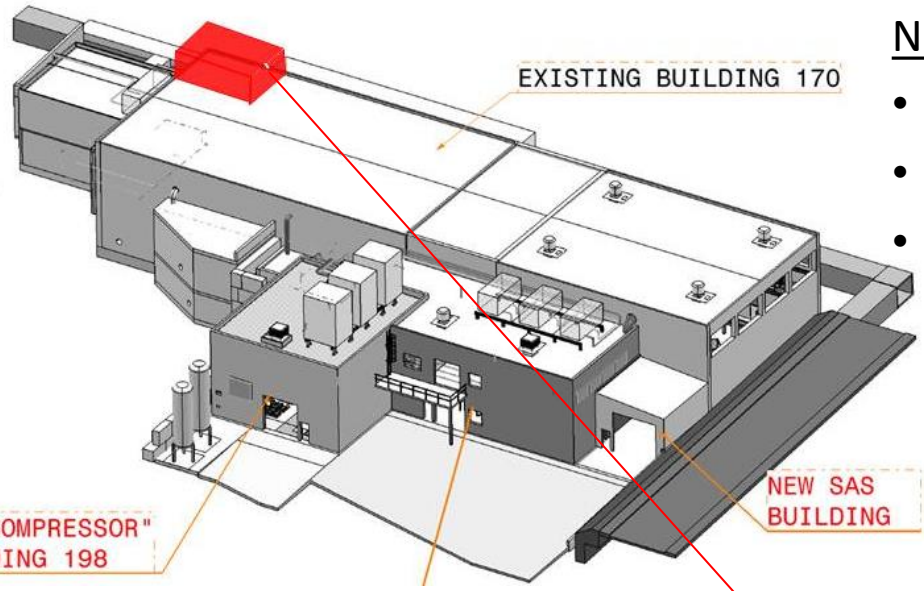
This amount can partly compensate the increase of activity in  $\text{Bq}/\text{m}^3$ :

$$\text{flow} \left[ \frac{\text{m}^3}{\text{h}} \right] \cdot \text{activity} \left[ \frac{\text{Bq}}{\text{m}^3} \right]$$

## What else can be done?

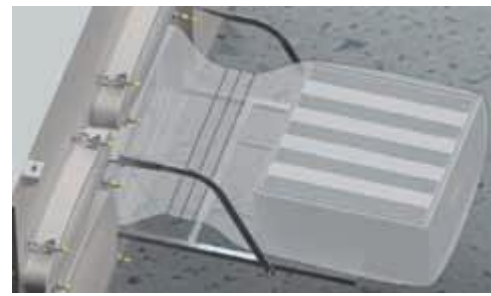
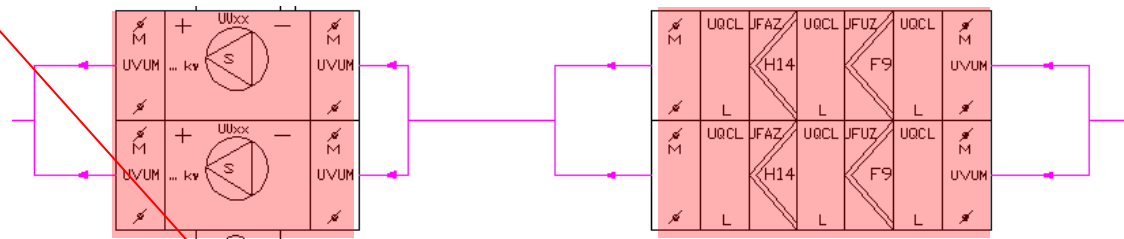
- An intervention on the structure of the tunnel can improve the leaktightness by far;
- If these interventions don't reach the prefixed effective dose limits, it is necessary to intervene on the beam operation in such a way to cope with the limits

Other interventions have been foreseen. These are not closely related to the improvement of the confinement system, but move in the direction of the operational safety



### New Tunnel extraction AHU

- Redundant fans;
- Redundant double stage filters;
- Bag-in/bag-out filters casing for safe maintenance operations.



### Technical Room:

- New technical room for the nuclear extraction from the tunnel;





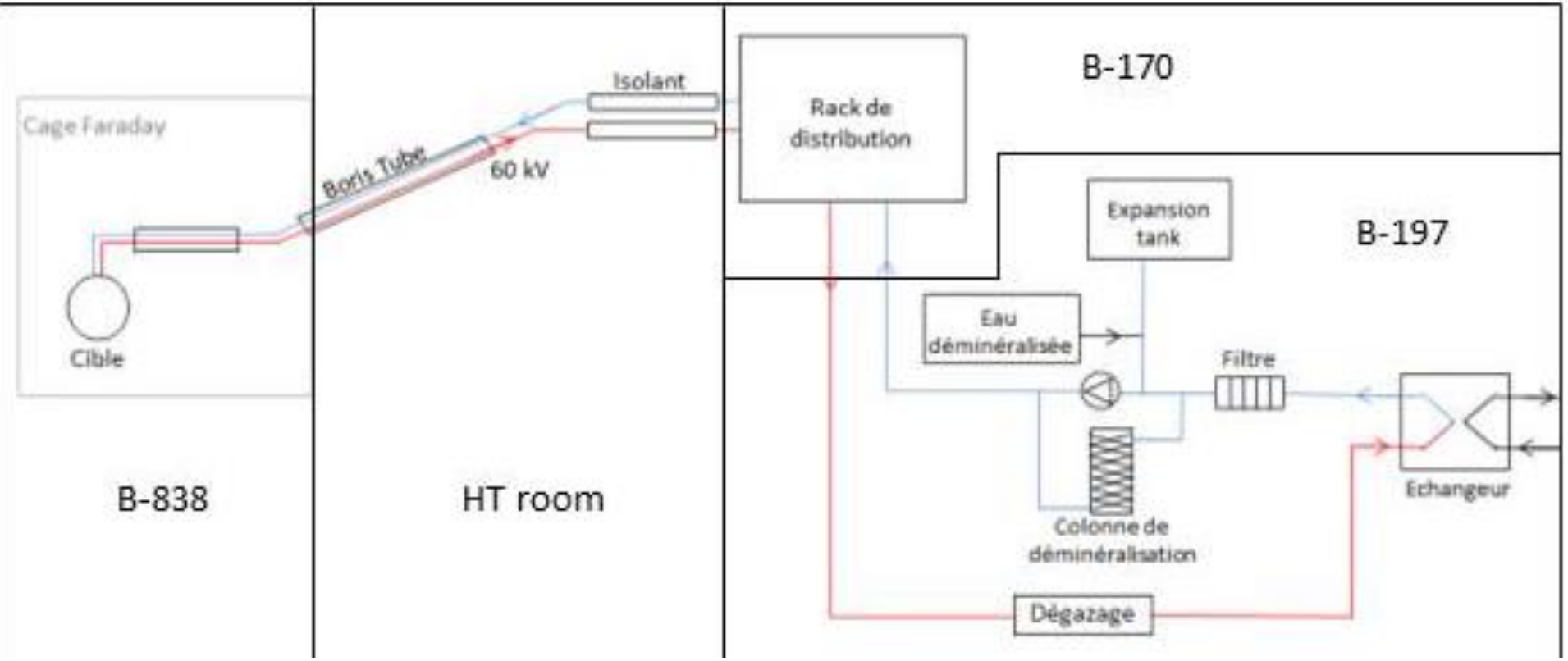
# COOLING



# COOLING SYSTEM: CURRENT COOLING SYSTEM



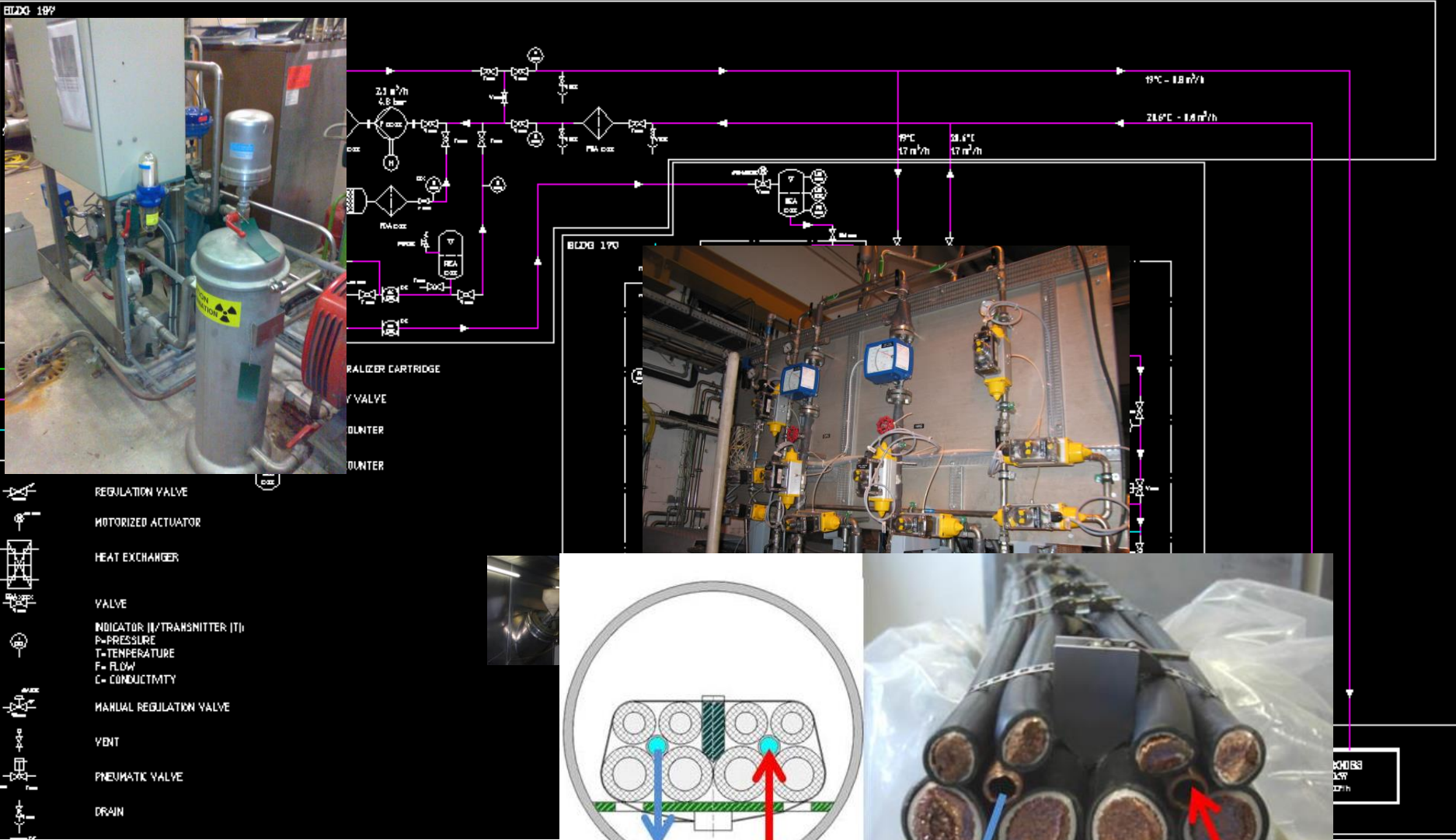
# CURRENT COOLING SYSTEM







# CURRENT COOLING SYSTEM



04083  
1.47  
1.27/h

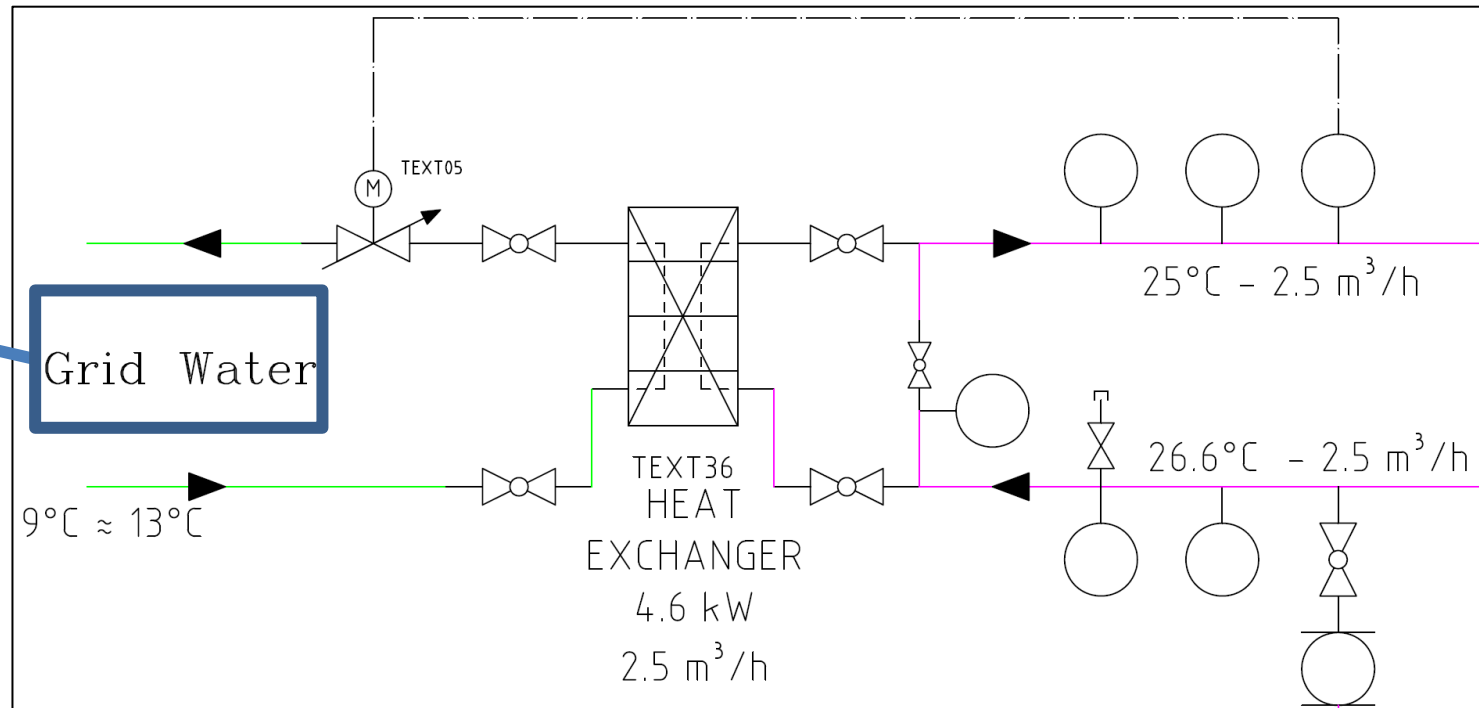


# COOLING SYSTEM: REASONS FOR THE SYSTEM UPGRADE



# REASONS FOR THE SYSTEM UPGRADE

The use of an open circuit as a primary cooling loop, should be avoided, because of its high consumption of fresh water

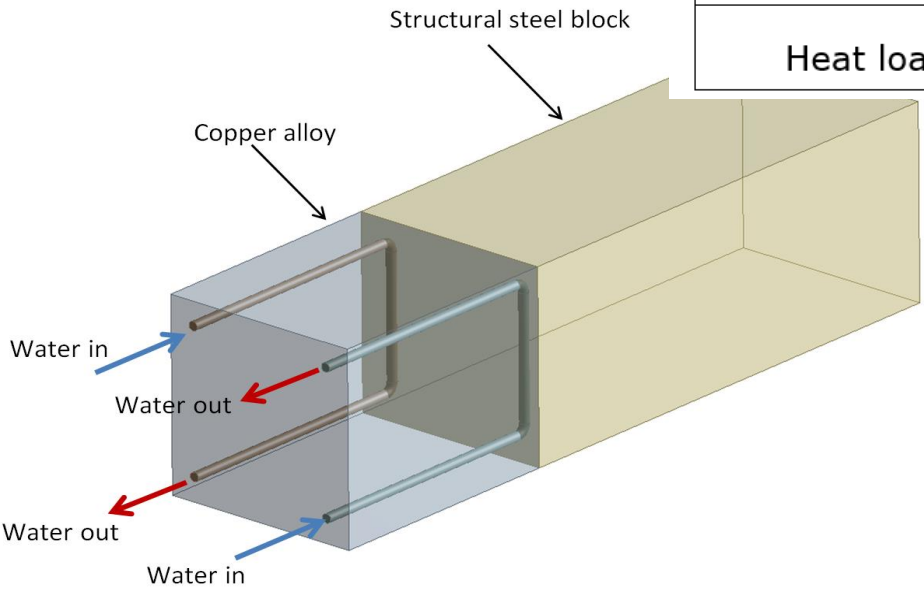




# REASONS FOR THE SYSTEM UPGRADE

- New Beam Dumps for HRS and GPS, shall be actively cooled

<b>HRS beam dump</b>	Demineralized water
Supply temperature	27°C
Heat load	6.5 kW
<b>GPS beam dump</b>	Demineralized water
Supply temperature	27°C
Heat load	6.5 kW





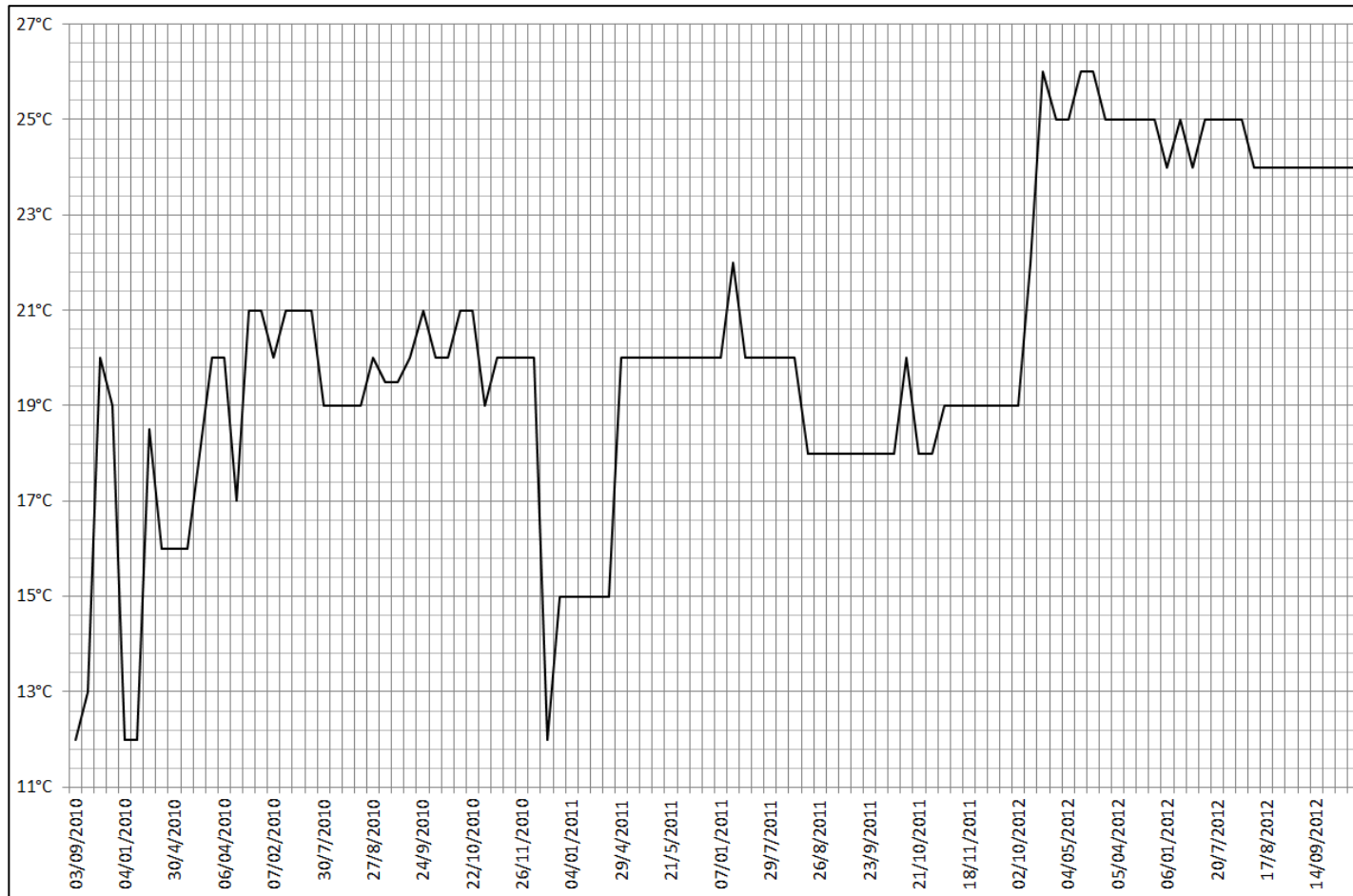
# COOLING SYSTEM: TECHNICAL SOLUTIONS PROPOSED



# TECHNICAL SOLUTIONS PROPOSED

Looking at the temperatures of the secondary loop in 2010, 2011 and 2012 it was noticed that

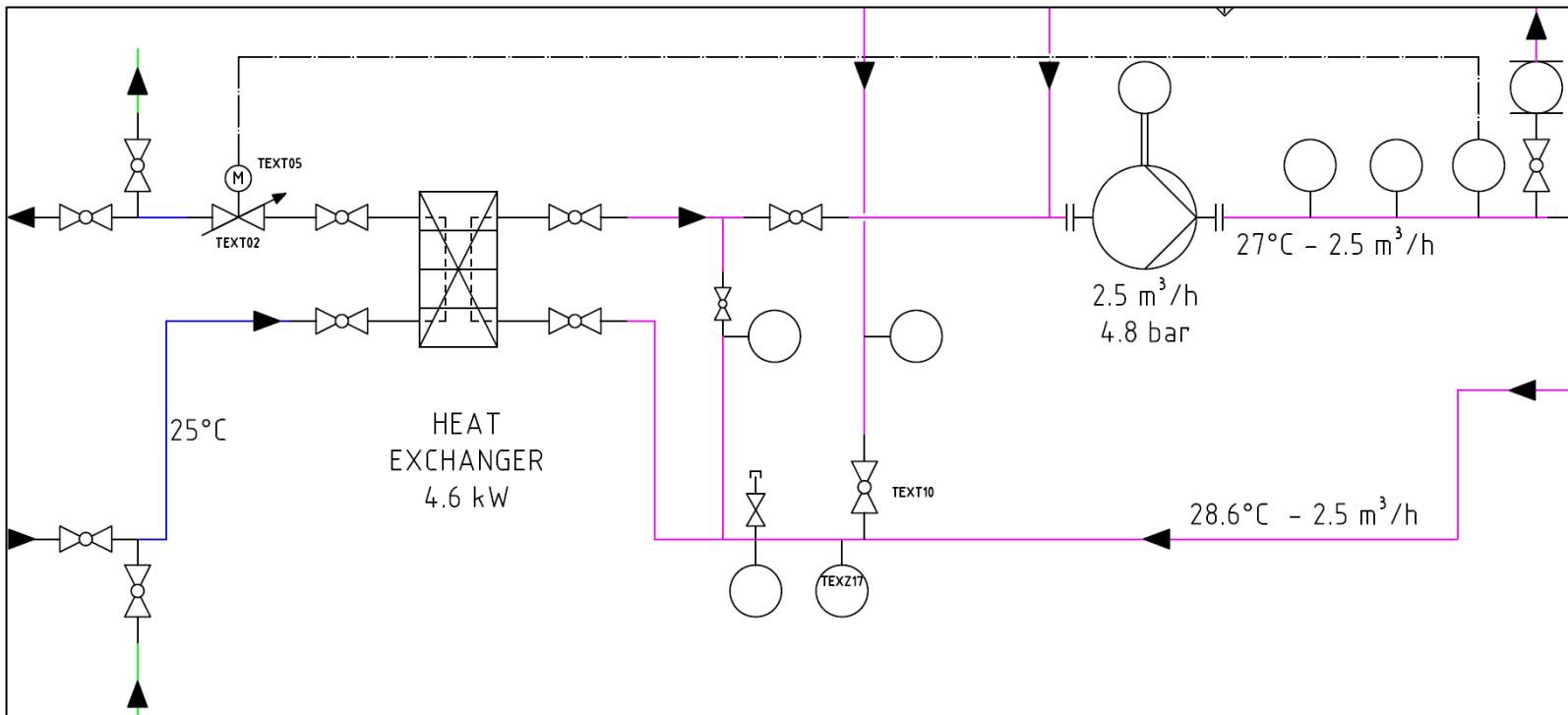
- targets can work without problems also at temperatures of more than 25°C.





# TECHNICAL SOLUTIONS PROPOSED

- new cooling towers for the ISOLDE facility
- Targets cooling system can be integrated into the cooling tower loop
- Water from the towers will be supplied at 25°C
- Connections on the cooling towers pipes have been already foreseen for the implementation of the upgrade.

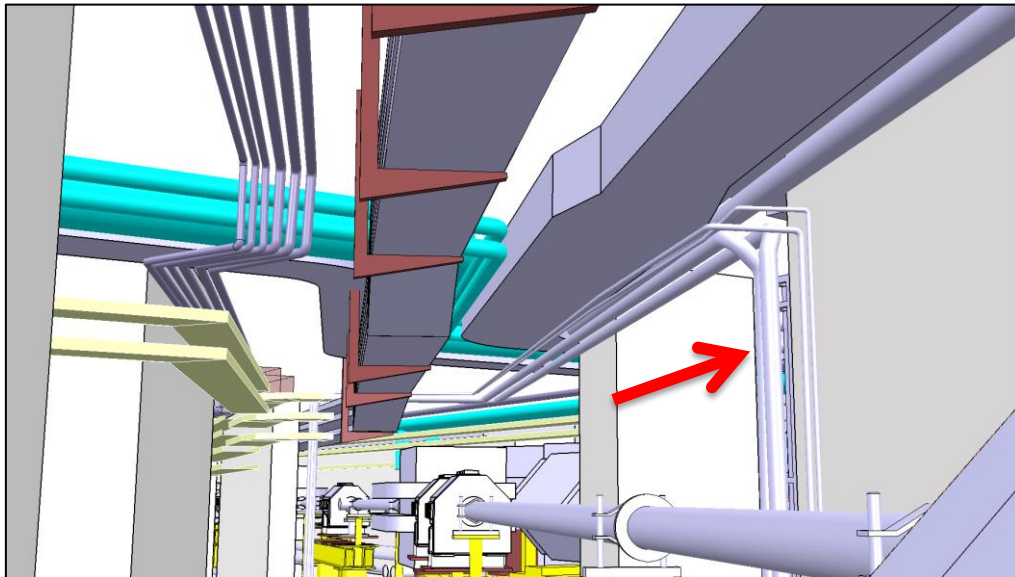




# TECHNICAL SOLUTIONS PROPOSED

Concerning the Beam Dumps cooling

- A demineralized water loop present in the tunnel.
- The loop is sized to remove a total of 230 kW (demineralized supply temperature 27°C) from the magnets installed in the ISOLDE tunnel.
- It is possible to integrate the beam dumps cooling system in the magnets cooling loop in consideration also of the beam dumps heat load of small entity with respect to the magnets' loop capacity

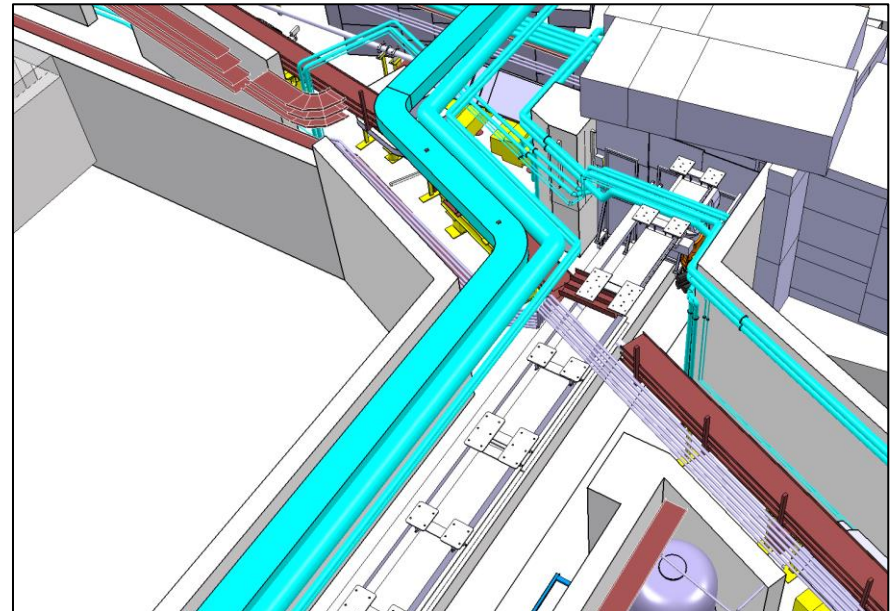
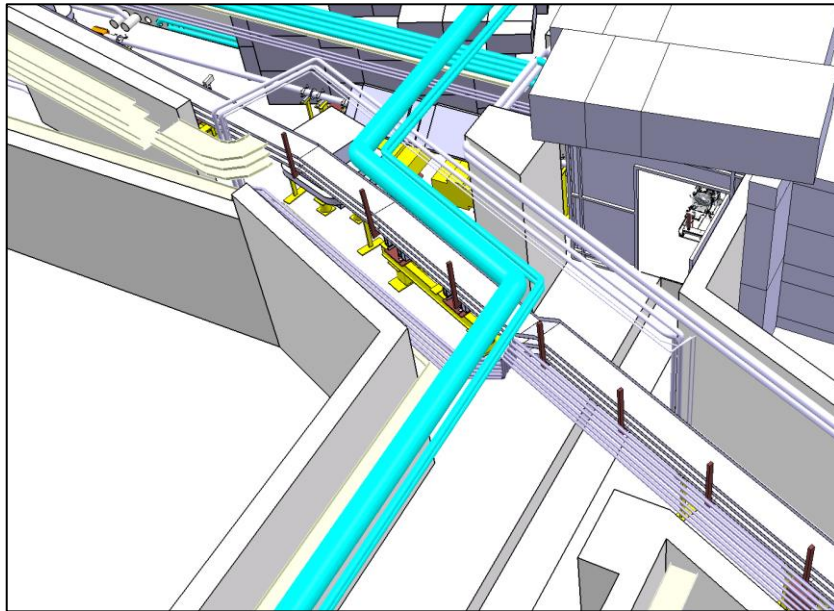






# TECHNICAL SOLUTIONS PROPOSED

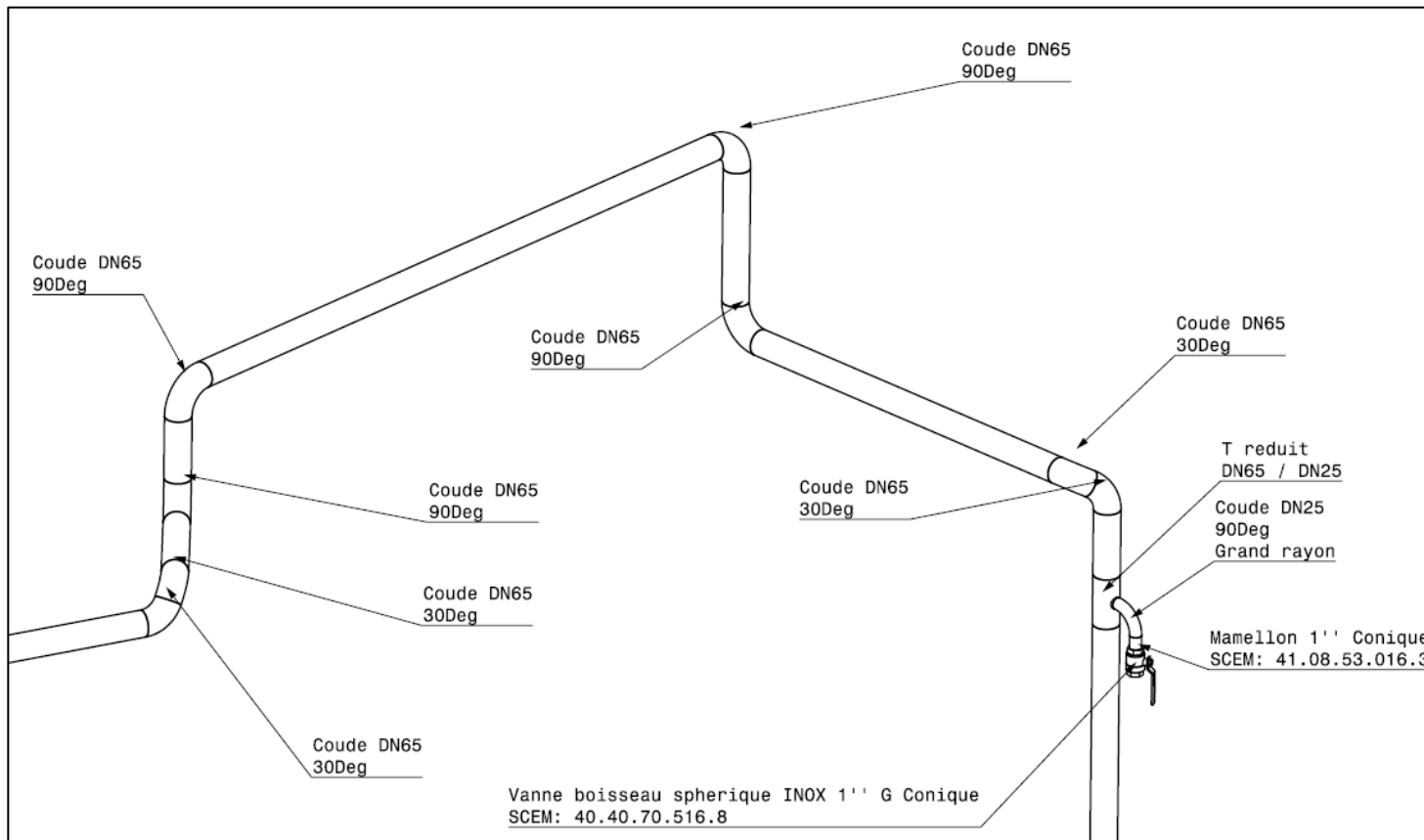
The works for the installation of the new robot in the ISOLDE tunnel imposed a change of the routing of the cooling water pipes.





# TECHNICAL SOLUTIONS PROPOSED

These works gave to opportunity to install on the pipes two connections, where in the future connect the beam dumps





# CONCLUSIONS



# CONCLUSIONS

- VENTILATION SYSTEM

- New MEDICIS Project constitutes a great occasion to develop some solutions in line with the *ESR13: Cooling and Ventilation Design Study*, in particular:
  - Separation of the ISOLDE Tunnel and the Class A Laboratory (new MEDICIS ventilation + airlocks);
  - The improvement of the Leaktightness of the tunnel (airlocks);
- The solutions proposed for the tunnel ventilation moves in the sense of the reduction of the activity releases. Nevertheless this is not a simple ventilation task, but should involve also:
  - Civil engineers, to improve the leaktightness of the area;
  - ISOLDE irradiation planning, in order to define in detail the irradiation campaigns in order to cope with the effective dose objectives;

- COOLING SYSTEM

- New solutions for the upgrade of the targets cooling system were described and studied;
- The presence of the beam dumps to be active cooled was also taken into consideration



THANK YOU FOR YOUR ATTENTION  
QUESTIONS?