HIE-ISOLDE Workshop: The Technical Aspects

Target Area Infrastructure

Ventilation

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- Work Package ESR 13: Cooling and Ventilation Design Study;
- Reasons for the system upgrade;
- Technical solutions proposed:
  - MEDICIS Laboratory;
  - Tunnel Ventilation;
- Conclusions

WORK PACKAGE ESR13:
COOLING AND VENTILATION DESIGN STUDY

WORK PAC

ISOLDE Target Area and

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 μA:

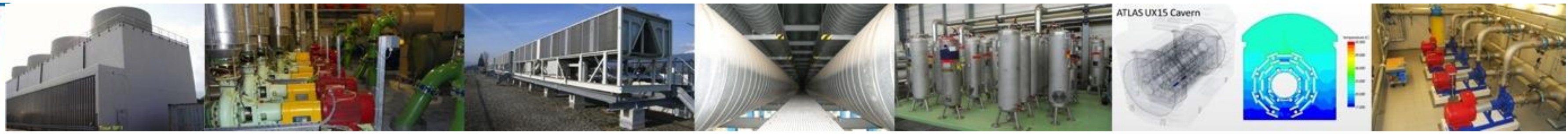
- Average activity released at the ISOLDE stack: 5×10^5 Bq/m^3;
- Total air flow through the ISOLDE stack (class A + Tunnel + HRS&GPS): 7500 m^3/h;

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

- **3 μSv/year** (overall CERN objective **10 μSv/year**);

The increase of beam intensity (from 2 μA to 6 μA) 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

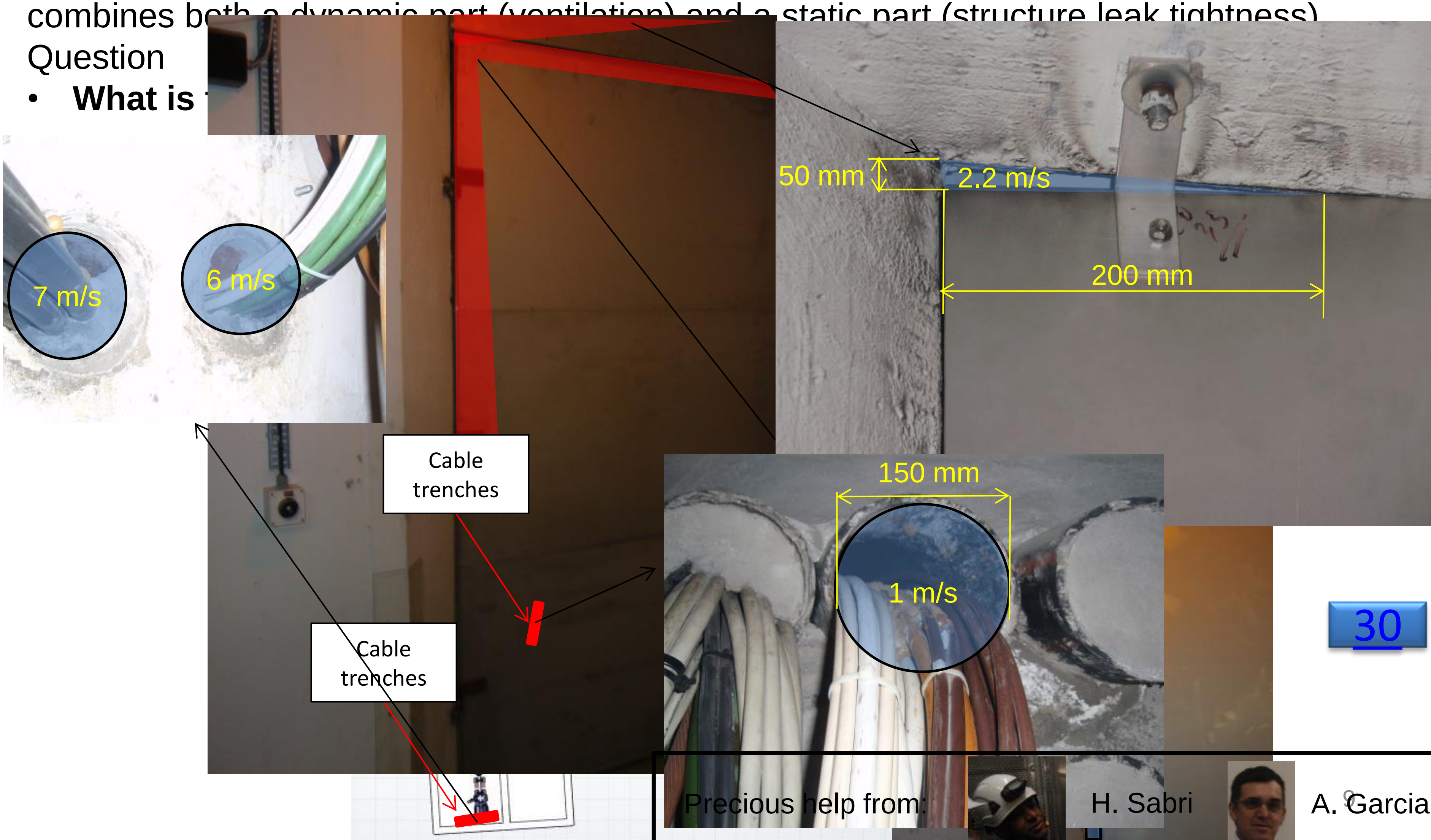


REASONS FOR THE SYSTEM UPGRADE: TUNNEL CONFINEMENT

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 t**



REASONS FOR SYSTEM UPGRADE: TUNNEL CONFINEMENT

- A ΔP= -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 m^3/h is required;
- Considering the tunnel volume of 1000 m^3, it works out a leak rate of 2 vol/h
- In nuclear installations, the average value for leak rates should range around **0.4 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

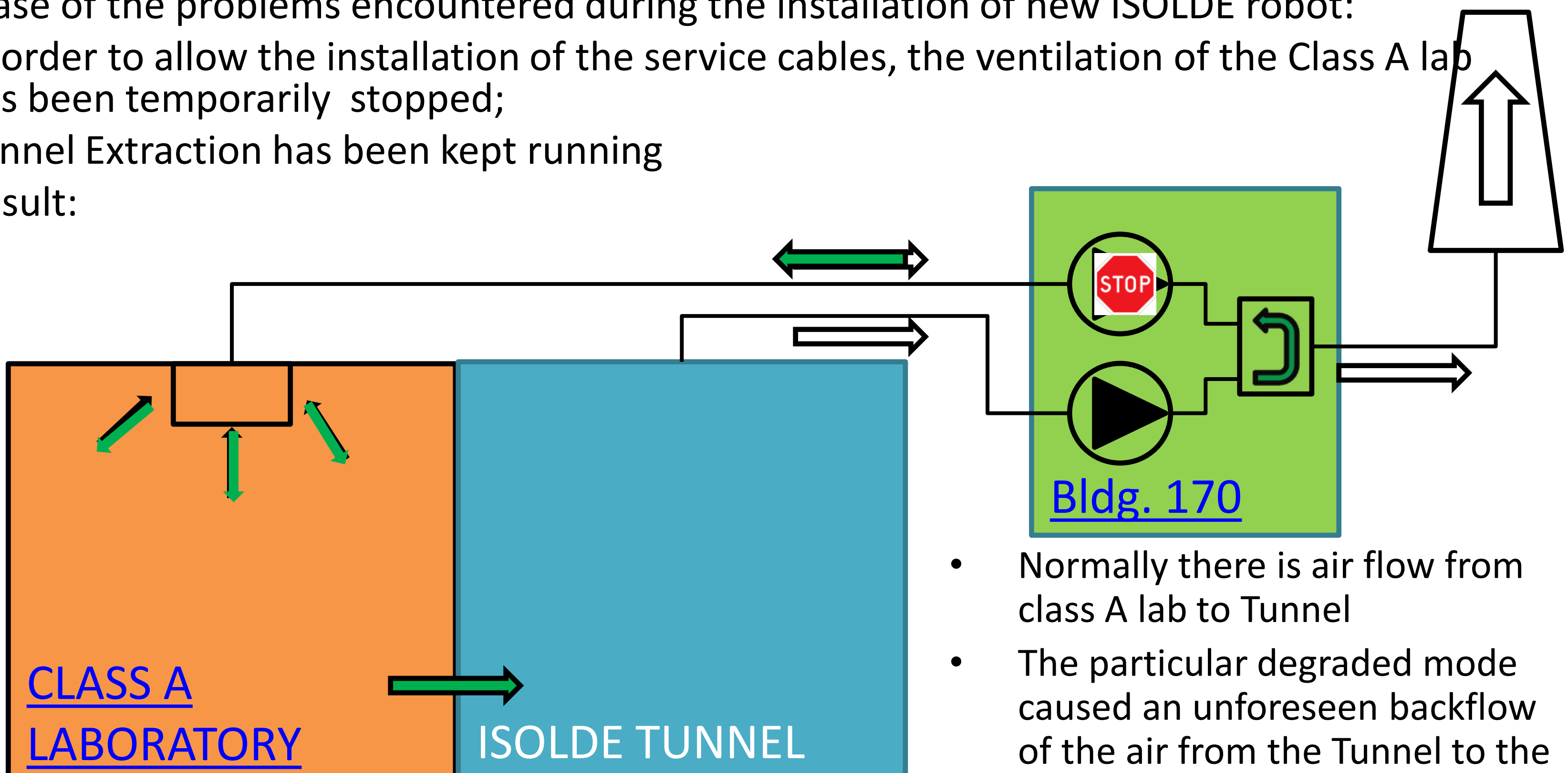
Class A Laboratory and ISOLDE Tunnel are supplied by two separated HVAC systems

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

TECHNICAL SOLUTIONS PROPOSED: MEDICIS LABORATORY

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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;

From:
Sent: 06 August 2013 14:15
To: Andrea Polato
Subject: RE: Besoin d'aide

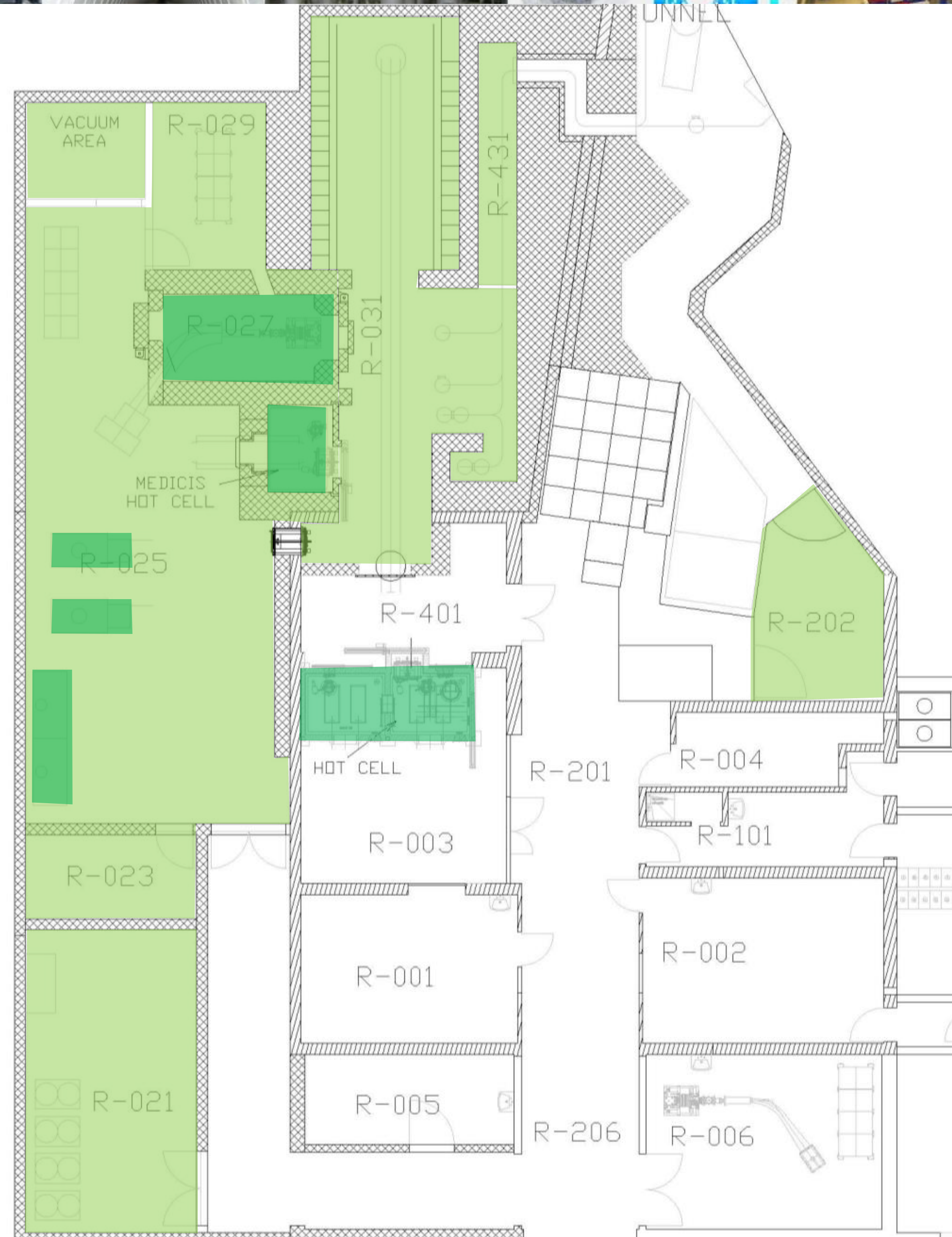
C'est sur, bravo pour la promo : Tu as aussi gagne un cocktail gratuit pour le ground breaking avec le DG du CERN si tu reviens…

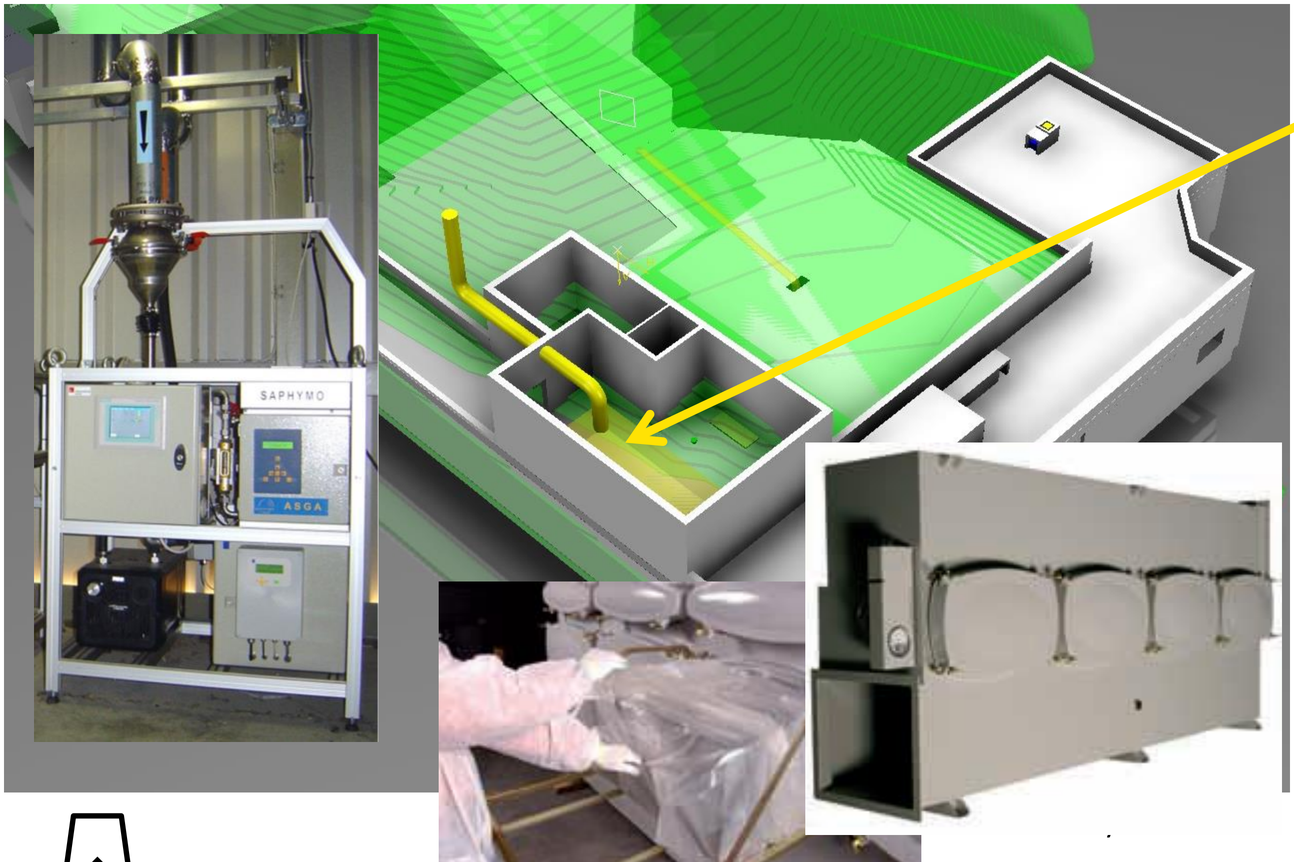
Je te prepare un petit dossier.

Medicis groundbreaking ceremony of the 4th of September 2013

Class A Laboratory Extension:

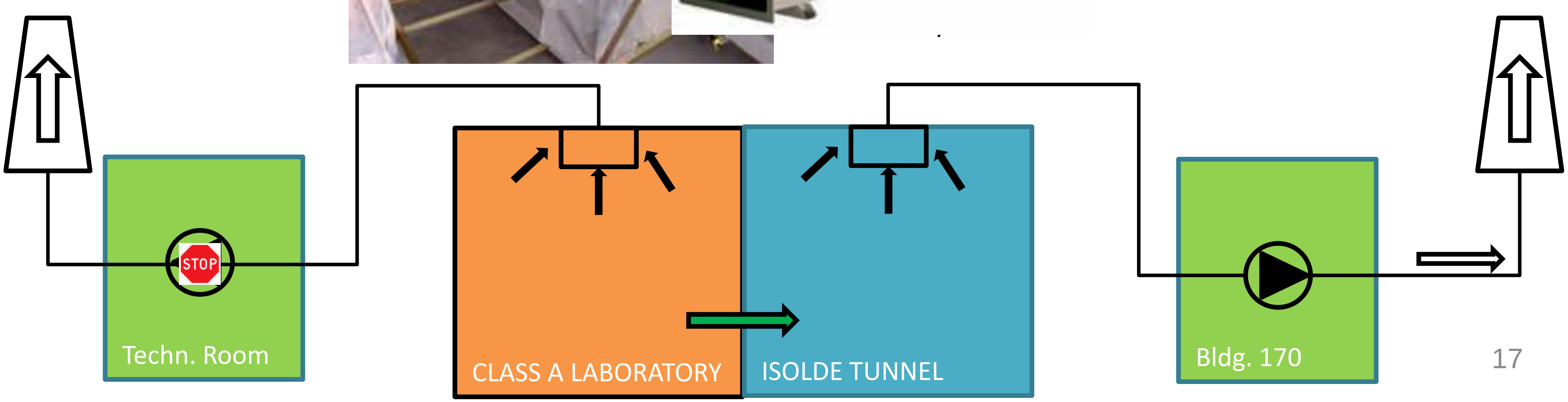
- 240 m² extension (from 265 m² to 505 m²);
- New rooms for:
  - Waste disposals (R021, Vacuum Area);
  - MEDICIS experiment (R025, R027, R029 and R023);
  - Target decay before dismantling (R031);
  - Airlocks (R202, R431);
  - Process Enclosures (Hot Cell and MEDICIS Hot Cell);
- New ventilation and 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**



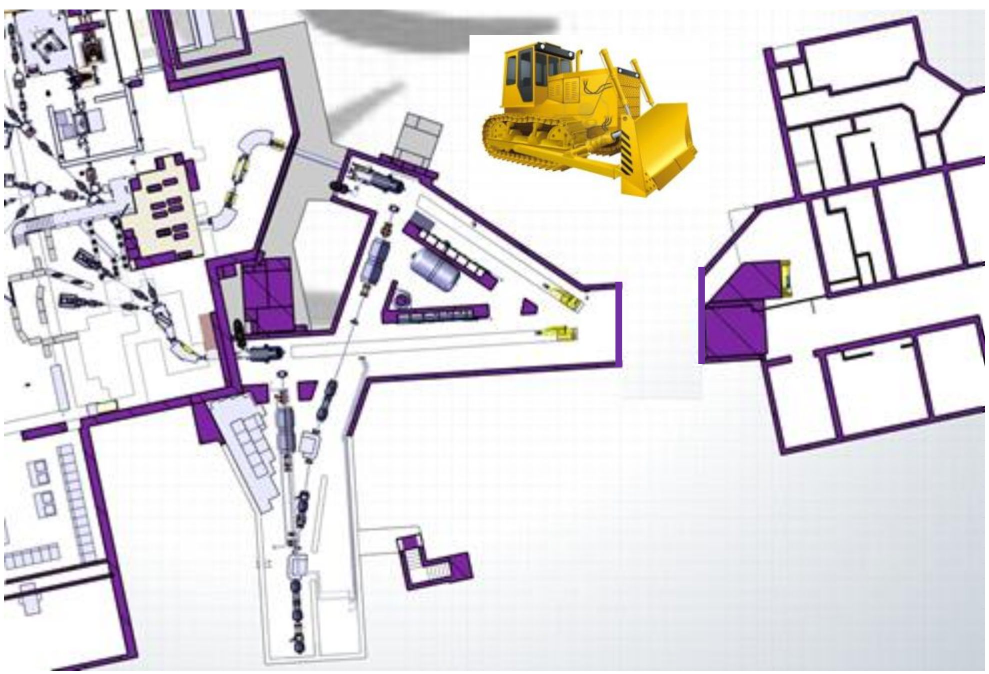
Airlock chambers

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?

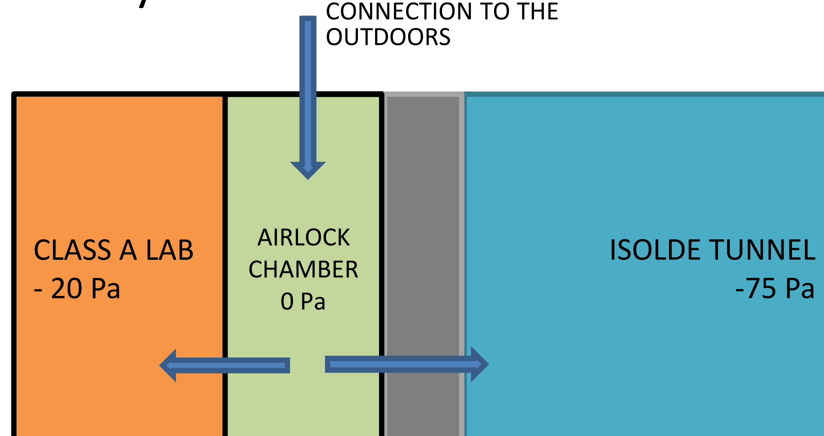
Conceptually, the solution is:



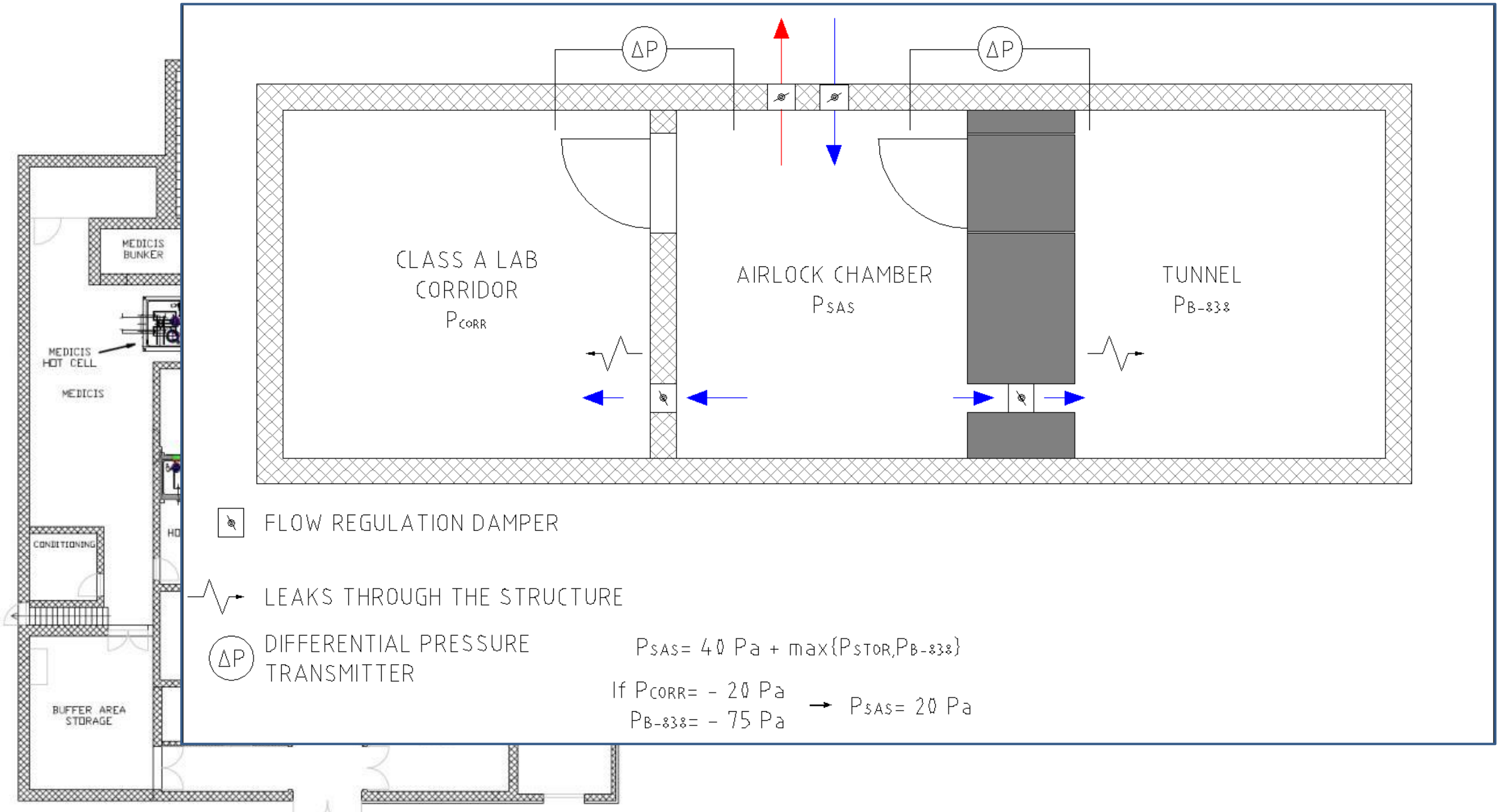
NOT FEASABLE

An alternative approach is needed

Ideally:



Airlock chambers



- Pressure inside the airlocks will be set in such a way to be over pressurized (ΔP= 40 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;

TECHNICAL SOLUTIONS PROPOSED: TUNNEL VENTILATION

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

- Reduction of the extraction flow rate.

Why?

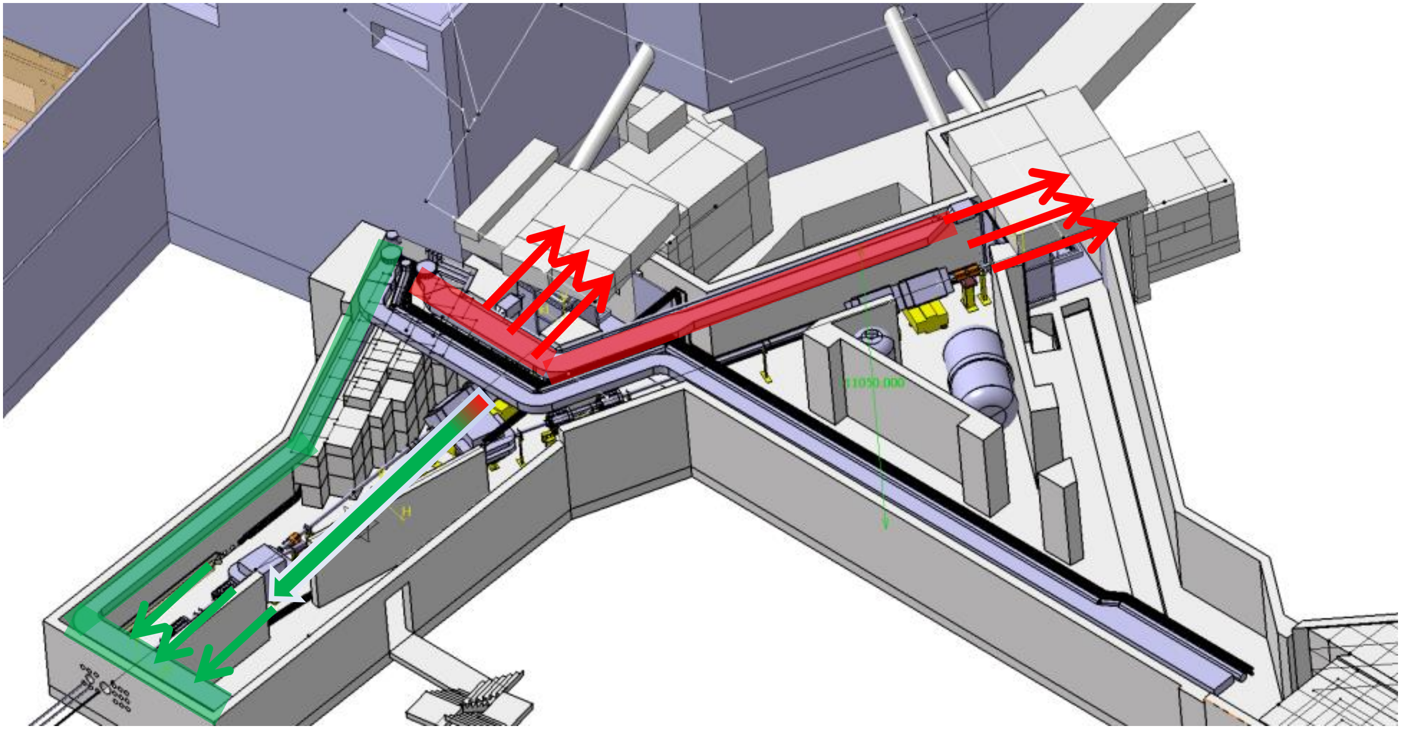
$$flow\left[\frac{m^3}{h}\right]\cdot activity\left[\frac{Bq}{m^3}\right]=\frac{Bq}{h}\rightarrow\frac{Bq}{year}\rightarrow\boldsymbol{\frac{Sv}{year}}\leq\mathbf{10}\,\boldsymbol{\frac{\mu Sv}{year}}\text{ (CERN objectives)}$$

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 m³/h; ????
2. Extraction air flow: **2900 m³/h;**

Apparently no reasons for having an air supply during beam mode

Proposed Beam Mode ventilation parameters:

1. Supply air flow: 0 m³/h;
2. **Extraction air flow: 1800 m³/h;**

REDUCTION OF THE TUNNEL ΔP

Considering that:

An extraction air flow:

$$1800\ m^3/h;$$

Is necessary to keep a differential pressure:

$$\Delta P = -75\ Pa$$

And considering that:

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

$$\Delta P \leq -50\ Pa$$

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

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

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

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

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

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

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

EN 12207 class	Leak rate @ ΔP= 100 Pa (m³/h x m²)	Leaks @ ΔP= 100 Pa (m³/h)	Leaks @ ΔP= 70 Pa (m³/h)
1	50 m³/h x m²	228 m³/h	**220 m³/h**
2	27 m³/h x m²	123 m³/h	**119 m³/h**
3	9 m³/h x m²	41 m³/h	**40 m³/h**
4	3 m³/h x m²	14 m³/h	**13 m³/h**

TECHNICAL SOLUTIONS PROPOSED: TUNNEL VENTILATION

Resuming:

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

This amount can partly compensate the increase of activity in Bq/m³:

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

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

CONCLUSIONS

MAIN CONSEQUENCES & CONCLUSIONS

- 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;

THANK YOU FOR YOUR ATTENTION

QUESTIONS?