ISOLDE Consolidation and Improvements programme until LS3 and beyond

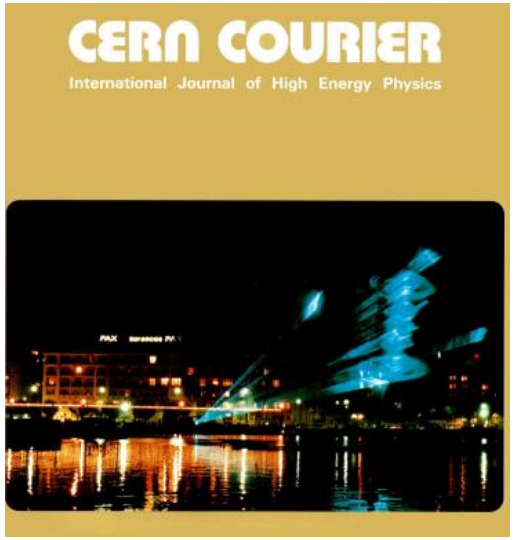
ISOLDE Workshop and Users meeting 2023 – 29/11/2023 to 01/12/2023

Joachim Vollaire on behalf of many teams supporting ISOLDE operation, consolidation and improvements

Outline

- Context and introduction
- Fire safety consolidation and ventilation upgrade
- BTY line upgrade for 1.4 GeV and 2.0 GeV operation
- Replacement of the ISOLDE Beam Dumps
- Beam Switching project
- What about REX HIE-ISOLDE Linac ?
- Conclusions and perspectives

Context: ISOLDE using PS Booster beam since more than 30 years



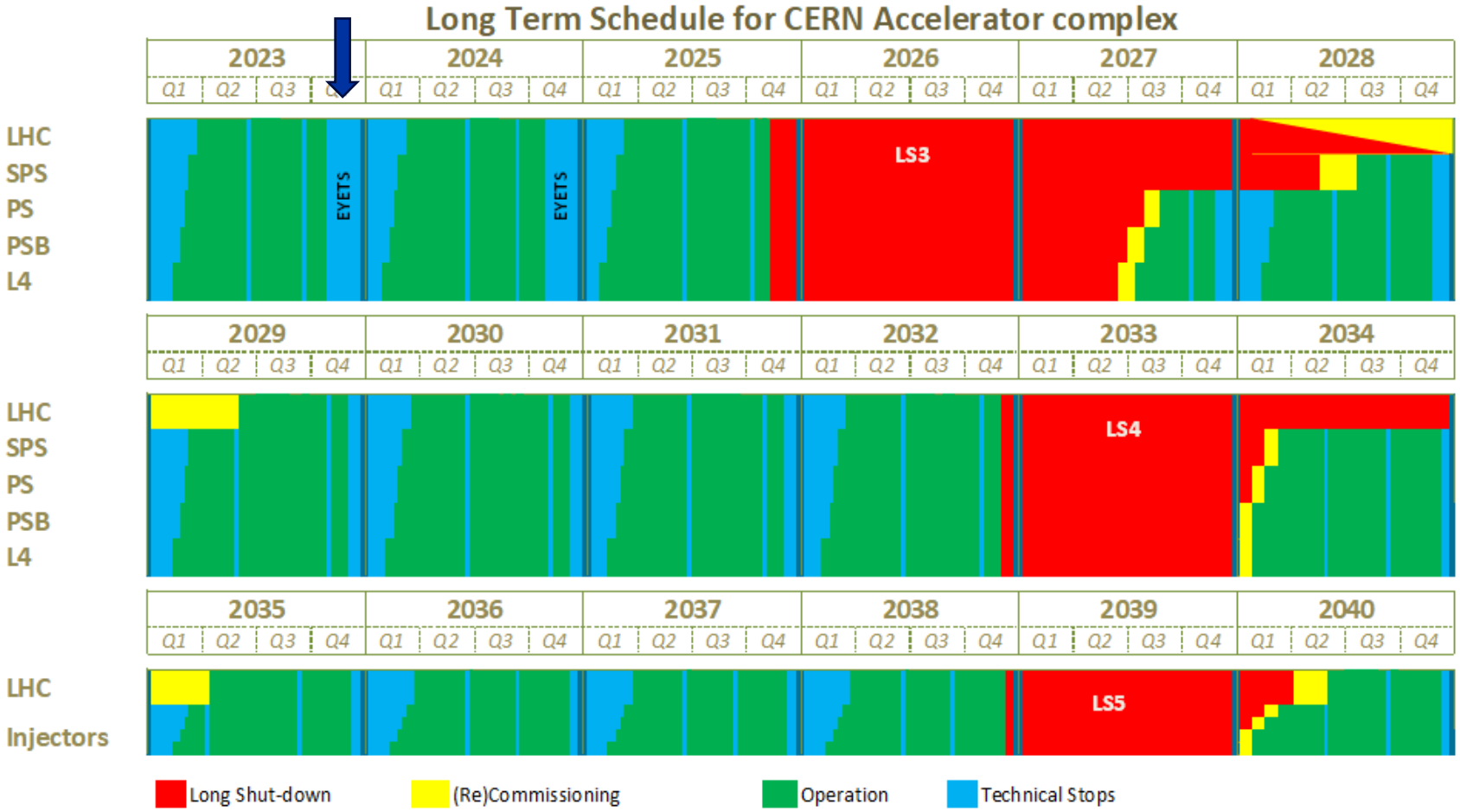
CERN Courier July/August 1992

https://cds.cern.ch/record/1732048/files/vol32-issue6.pdf

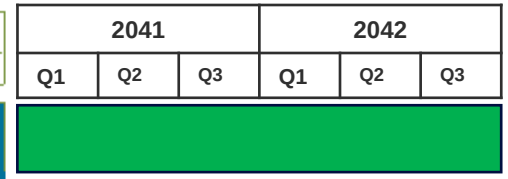
26 May was a double celebration at CERN - the formal opening of the ISOLDE on-line isotope separator at its new home at the 1 GeV Booster accelerator, and the twentieth anniversary of the first acceleration of Booster beam to 800 MeV, the machine's nominal energy before its upgrade to 1 GeV in 1988.

Many systems and equipment were installed 30 years ago (and some are even older) and face obsolescence issues.
Continuous consolidation program is an opportunity to enhance performances (not only one to one replacement)

Context: Long term accelerators planning



50 years of ISOLDE at the PS Booster ?



2 more years of operation before LS3. LS3 ~1.5 years stop is a unique opportunity to perform consolidations and major changes to the facility. Activities to be carefully planned (budget and workforce) due to competition with other activities CERN wide.

https://edms.cern.ch/document/2311633/2.1

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Fire safety consolidation and ventilation upgrade

Motivation: study initiated by CERN HSE unit (**F**ire-**I**nduced **R**adiological **I**ntegrated **A**ssessment) with ISOLDE target area as one study case. Memorandum issued with list of recommendations.

Date

To

Cc

LOERTSCHER (HSE/OHS), Fabrice MALACRIDA (HSE/RP), Saverio LA

From

Subject

In the context of the FIRIA project (Fire-Induced Radiological Integrated Assessment), the HSE unit assessed the radiological impact induced by fire accidents in the ISOLDE target area (b. 838) as well as by accidents involving the loss of integrity of actinide targets.

The conclusions of the FIRIA study along with experience from ISOLDE operation have led to recommendations presented to you in the HSE Technical Management Board on the 25 February 2021. They are summarised in the following and address both accidental situations and normal operation:

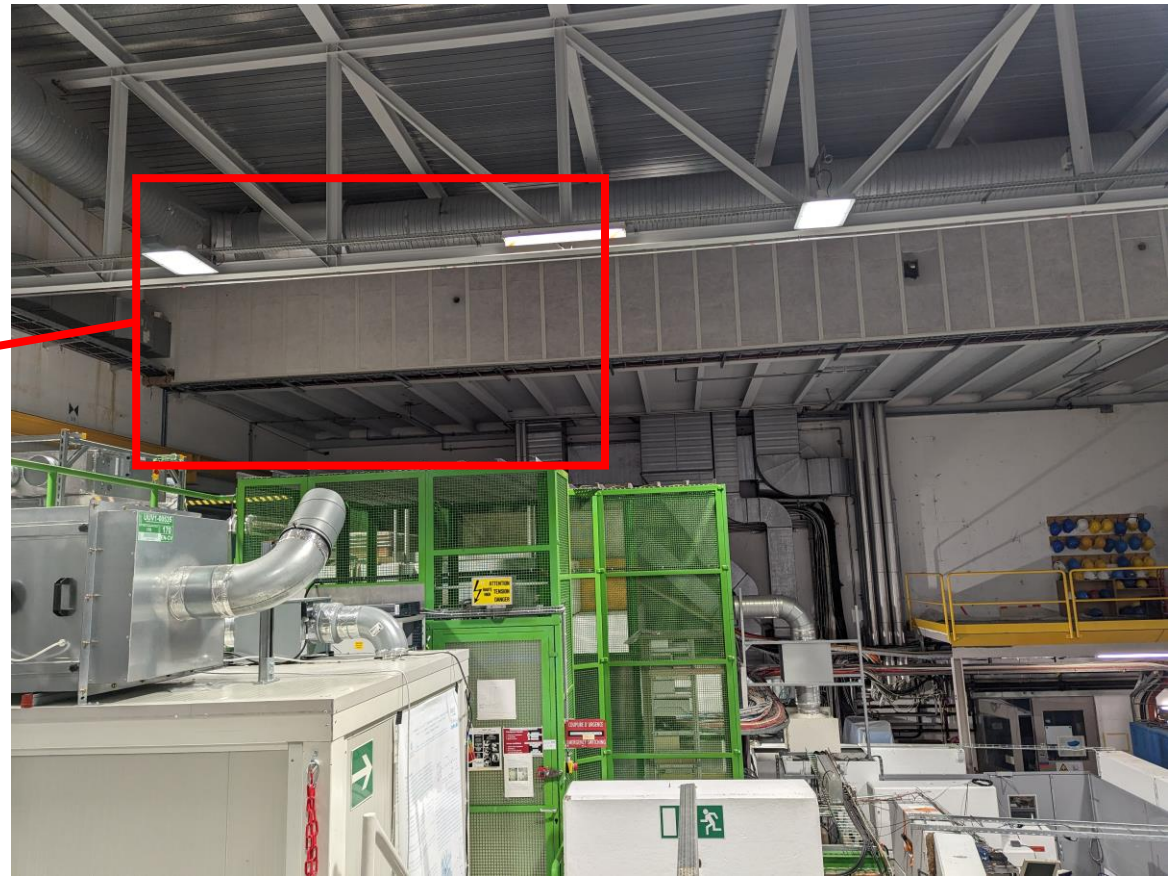
The HSE unit recommends the study and implementation of consolidation and mitigation measures that improve fire safety, such as installation of smoke and fire dampers, implementation of fire-rated sealing of the facility leaks, installation of a dry firefighting network and the replacement of the pumps with dry ones. If the pumps cannot be replaced for technical reasons, they should be separated with fire-resistant barriers or they should be relocated to a room outside of the target area that ensures containment of the radioactivity.

The HSE unit recommends a review of radiation safety of the ventilation system and, in particular, the implementation of filters for volatile forms of iodine. Iodine filtration systems are standard in the nuclear industry.

Target and separator areas ventilation today

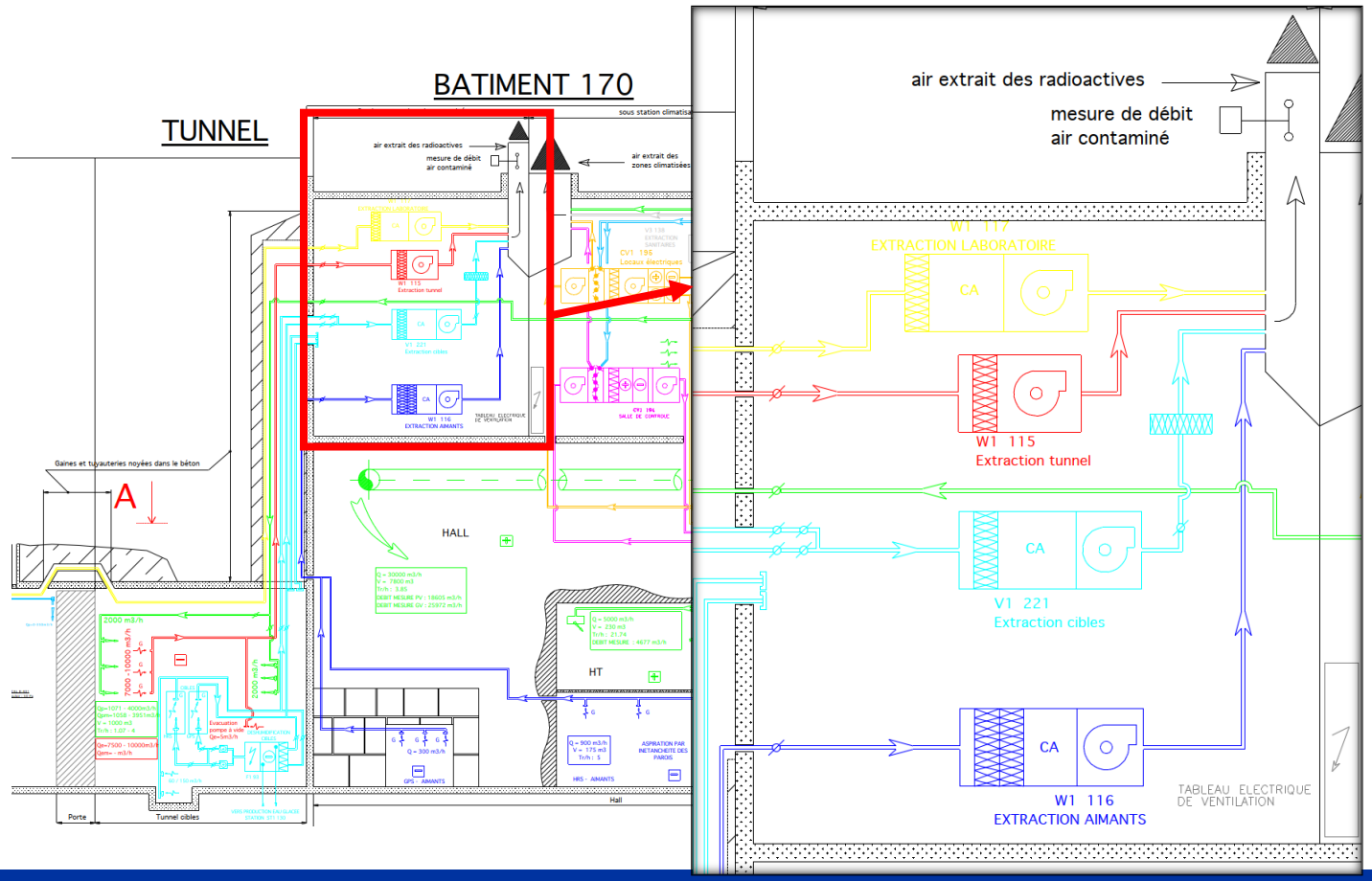
Existing ventilation system:

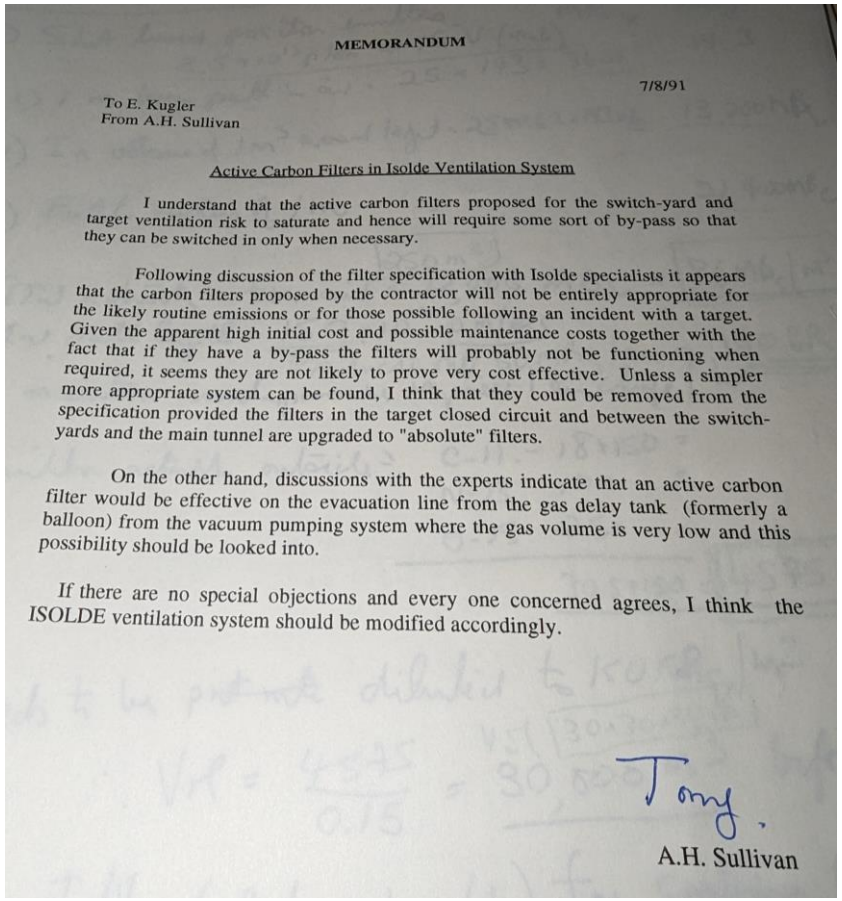
- Design based on standards used in early 90s (fire safety awareness limited – no fire dampers)
- Ventilation hardware within the experimental hall (smoke would leak into the experimental hall in case of incident). No space in the existing CV technical room.



Case of Charcoal filters

- Charcoal filters to trap volatiles radioactive species (as iodine) foreseen in the original design but not installed (casing with space reservation).
- Space for charcoal filters was later used for additional extractors installation (redundancy)





MEMORANDUM

7/8/91

To E. Kugler
From A.H. Sullivan

Active Carbon Filters in Isolde Ventilation System

I understand that the active carbon filters proposed for the switch-yard and target ventilation risk to saturate and hence will require some sort of by-pass so that they can be switched in only when necessary.

Following discussion of the filter specification with Isolde specialists it appears that the carbon filters proposed by the contractor will not be entirely appropriate for the likely routine emissions or for those possible following an incident with a target. Given the apparent high initial cost and possible maintenance costs together with the fact that if they have a by-pass the filters will probably not be functioning when required, it seems they are not likely to prove very cost effective. Unless a simpler more appropriate system can be found, I think that they could be removed from the specification provided the filters in the target closed circuit and between the switch-yards and the main tunnel are upgraded to "absolute" filters.

On the other hand, discussions with the experts indicate that an active carbon filter would be effective on the evacuation line from the gas delay tank (formerly a balloon) from the vacuum pumping system where the gas volume is very low and this possibility should be looked into.

If there are no special objections and every one concerned agrees, I think the ISOLDE ventilation system should be modified accordingly.

Tony.

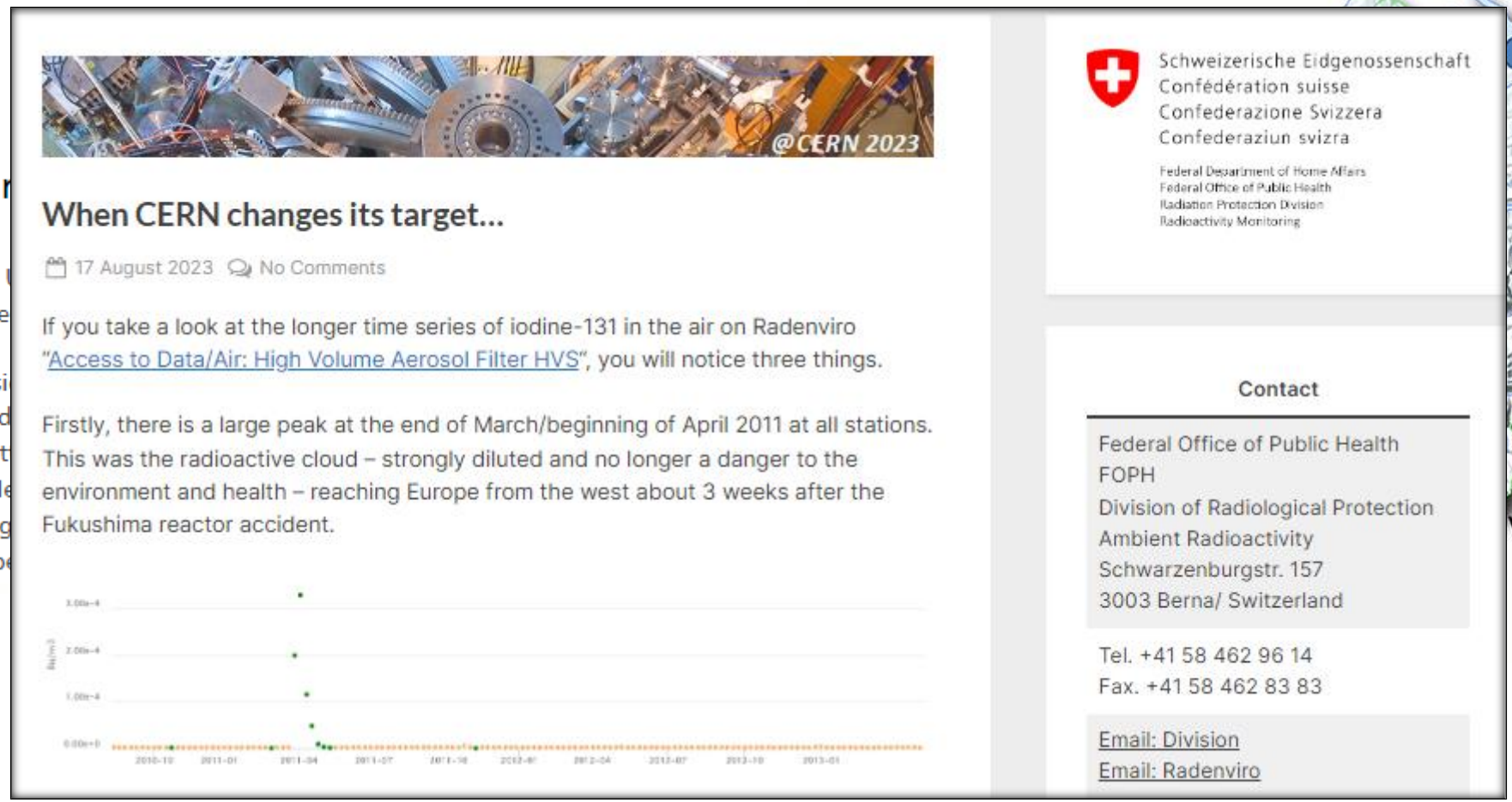
A.H. Sullivan

Iodine releases (target changes / targets storage)

High-volur

Since 1993, the
collectors. Curre

- HV-POS: Posi
- HV-CAD: Cad
- HV-GUT: Güt
- HV-CERN: Me
- HV-KLI: Kling
- HV-LBF: Liebe

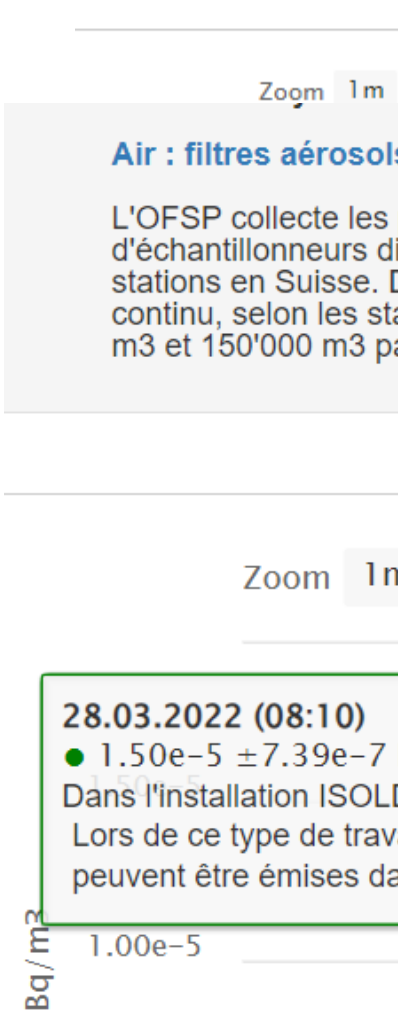


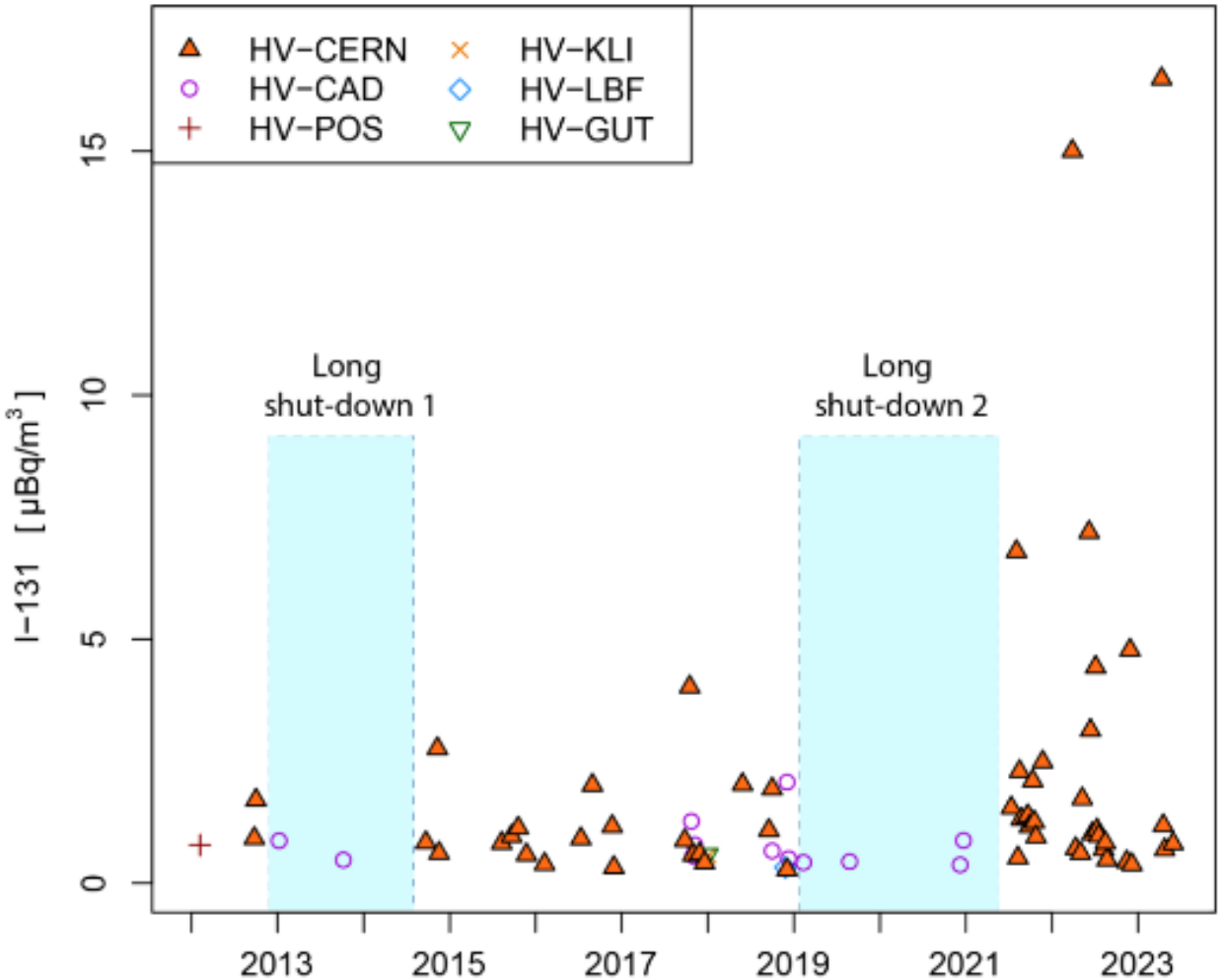
https://www.radenviro.ch/when-cern-changes-its-target/?lang=en

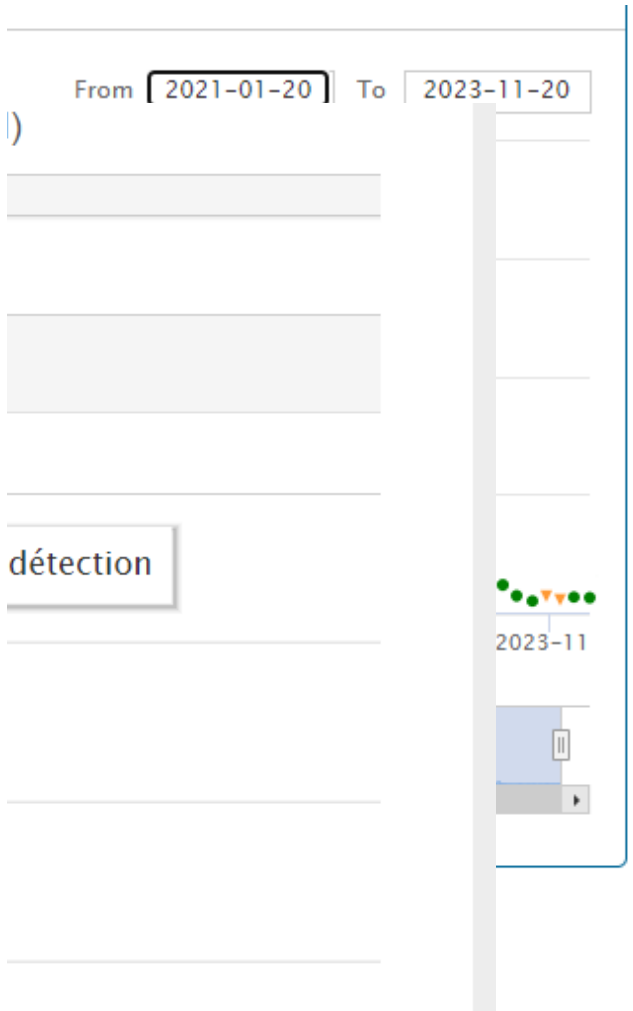
Environmental Radioactivity Section - Federal Office of Public Health FOPH

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Iodine releases (target changes / targets storage)

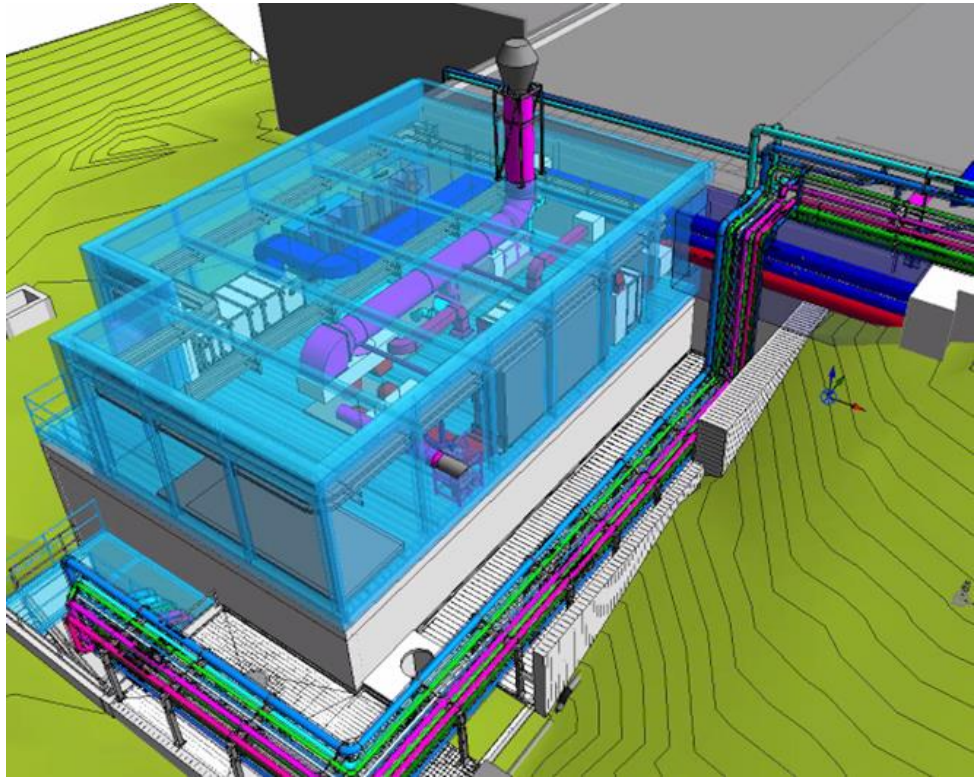


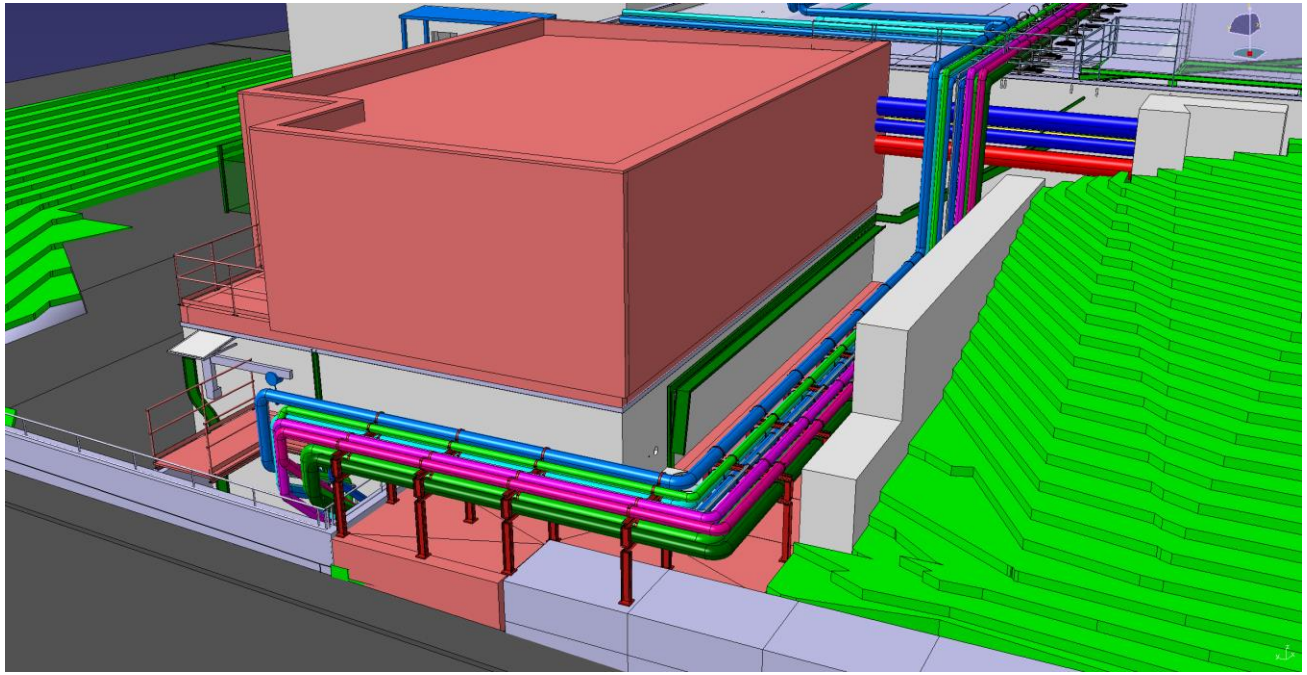




Proposed solution

- New floor on top of Build. 197 (building adjacent to the exp. hall and CV room)
- Relocation of hall CV hardware related to primary areas ventilation and addition of fire dampers as well as charcoal filters.



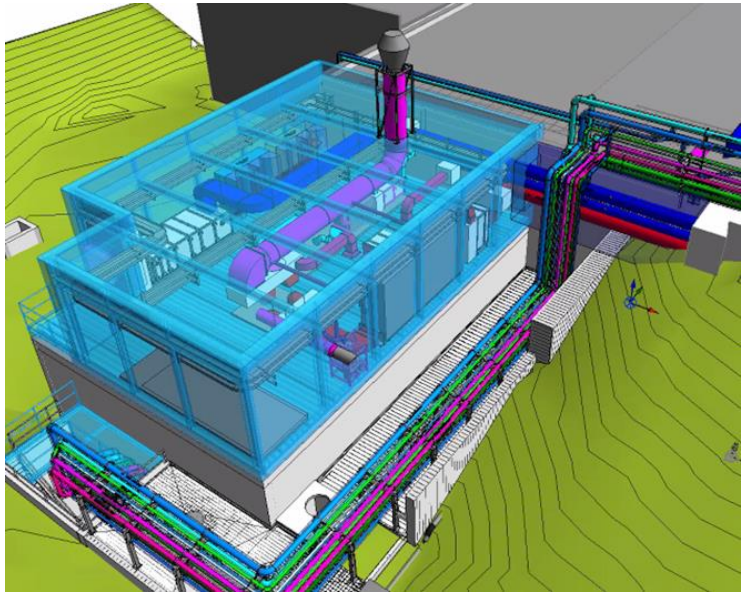


P. L. Melania Averna (many contributing groups)

Proposed solution : implementation

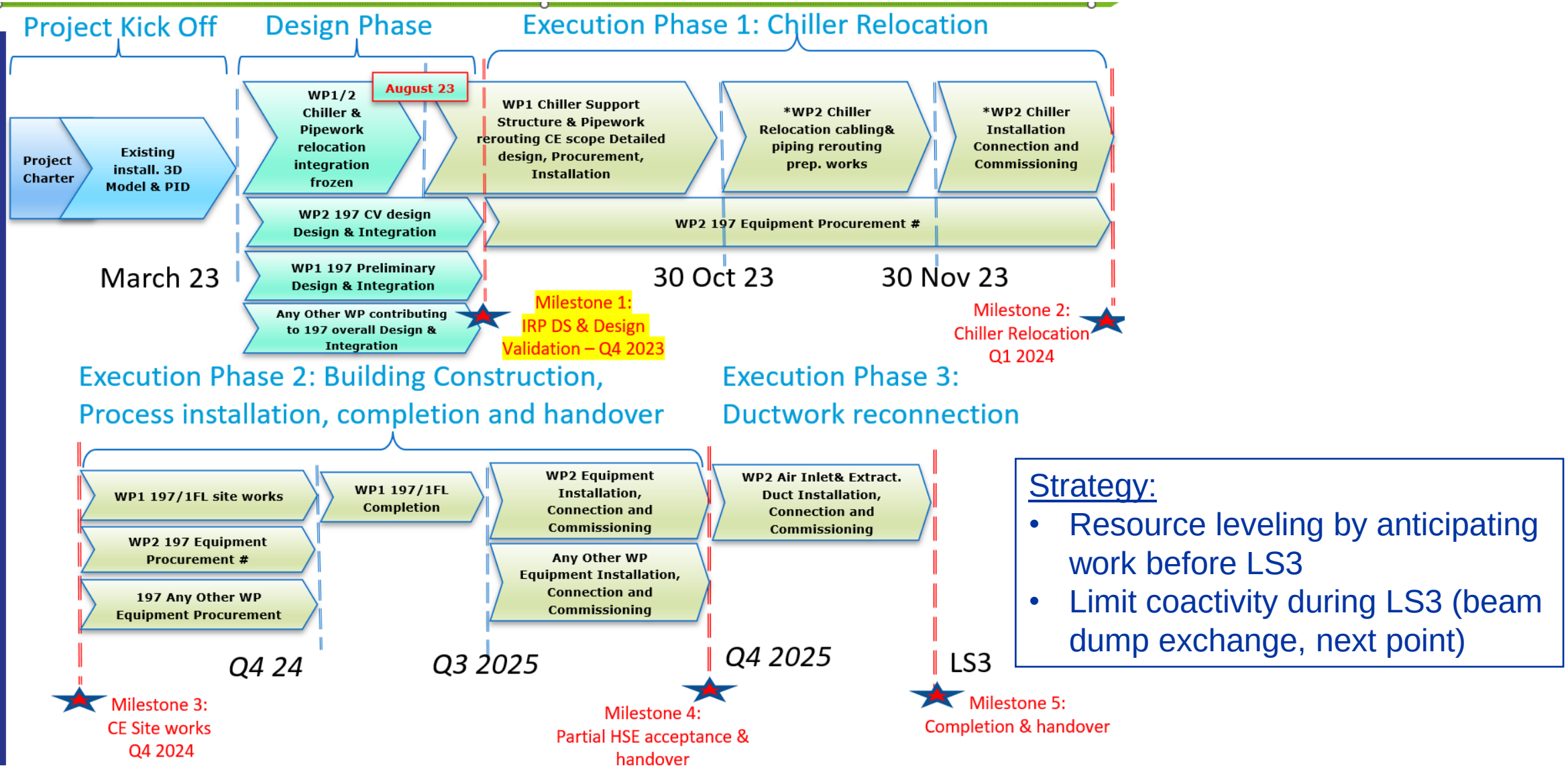
- Top of Build. 197 occupied by water chiller and many services running along the building. Rerouting of services needed before construction (impact on operation)
- Relocation of services and displacement of chiller during the winter shutdown
- Construction of the building and installation of equipment in parallel to operation
- Target and separator areas ventilation transfer to the new system early LS3

Worksite as of 29/11/2023



ISOLDE PRIMARY AREAS: Fire Safety & Ventilation Upgrade - Planning

Timeline V2



Strategy:

- Resource leveling by anticipating work before LS3
- Limit coactivity during LS3 (beam dump exchange, next point)

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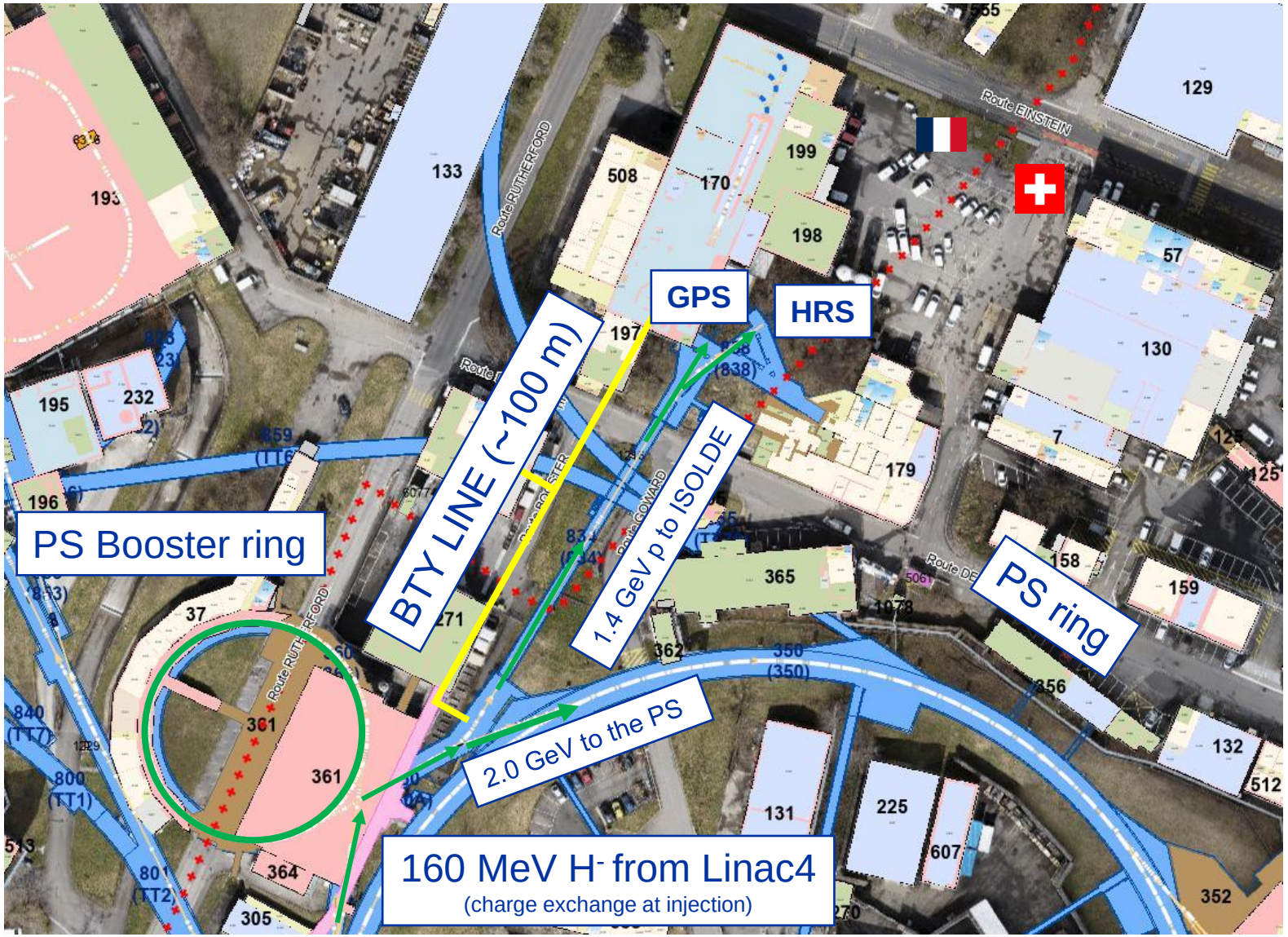
BTY line

LIU upgrades – LS2:

- Linac4 : H^- (higher intensity, reduced loss at PSB injection: charge exchange)
- PS Booster energy increase

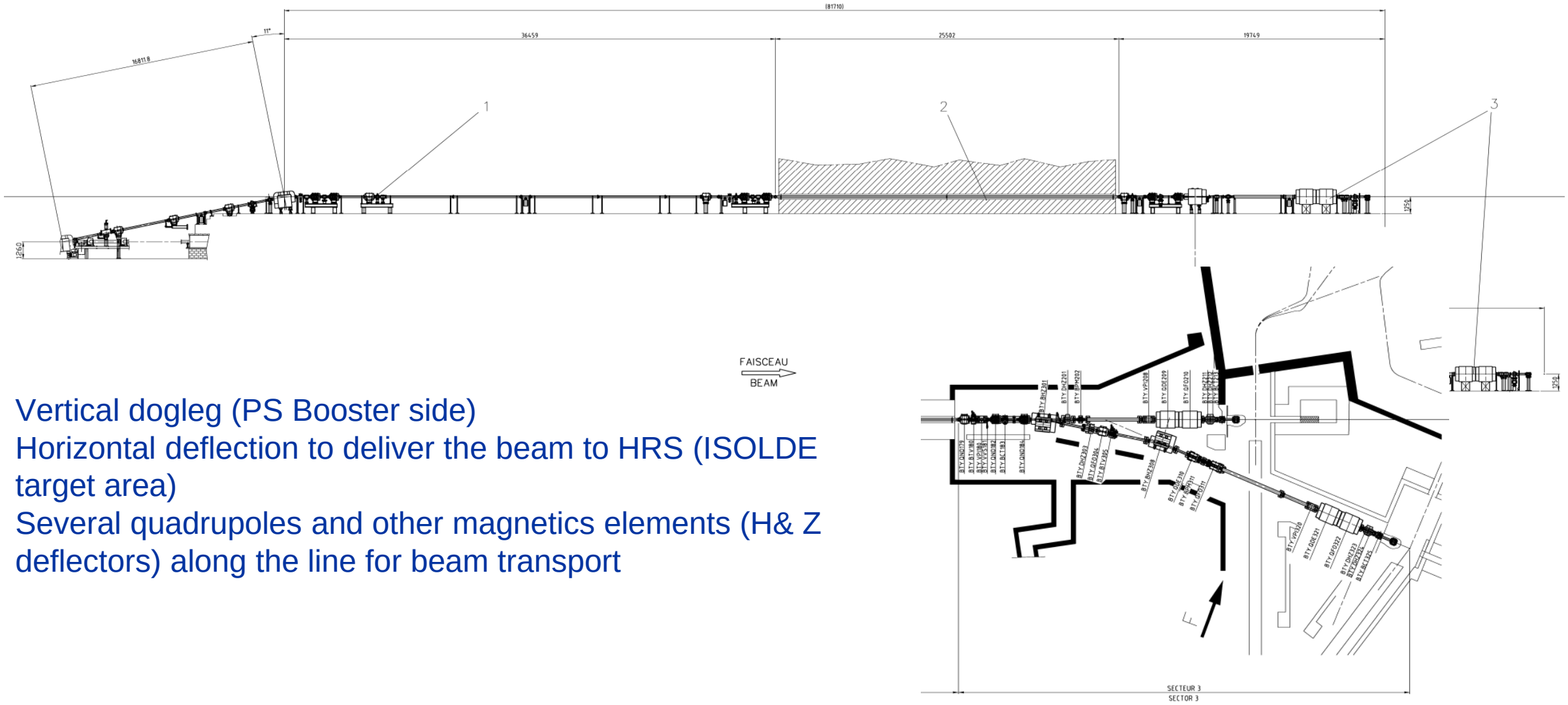
However, BTY line not upgraded, currently limited to 1.4 GeV (1.7 GeV max for GPS)

Study group established one year ago. Contribution from many groups



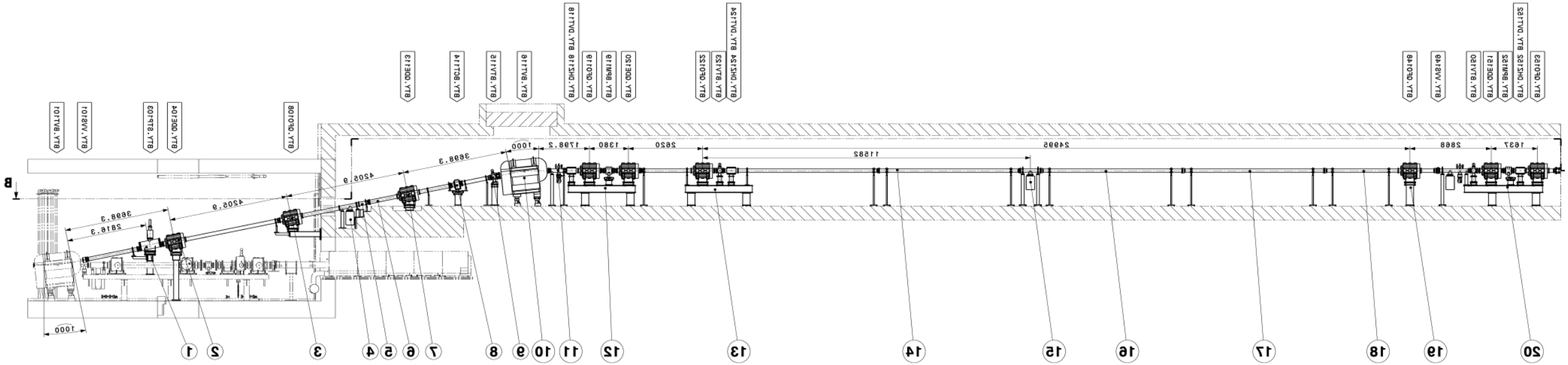
Intensity limitation (2 mA averaged) due to RP considerations and beam dumps mechanical integrity

BTY line: how to bring 2 GeV protons to GPS&HRS



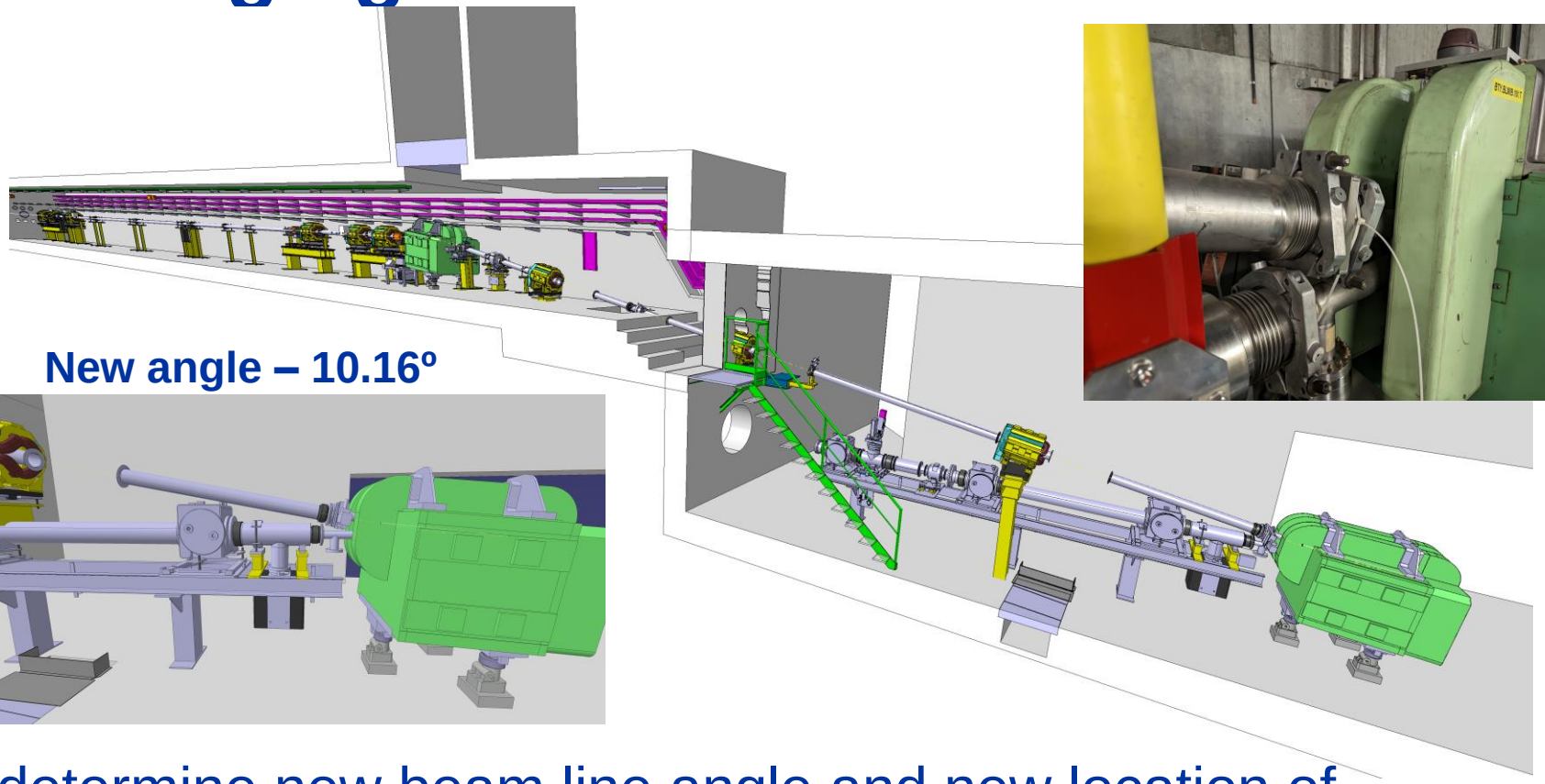
- Vertical dogleg (PS Booster side)
- Horizontal deflection to deliver the beam to HRS (ISOLDE target area)
- Several quadrupoles and other magnetics elements (H& Z deflectors) along the line for beam transport

BTY line: vertical dogleg



- Two options:
  - change dipole/power supply for higher integrated field needed for higher energy
  - **Change the beam line angle – modify the beam line configuration (optics) keeping the same magnets**

BTY line: vertical dogleg modification



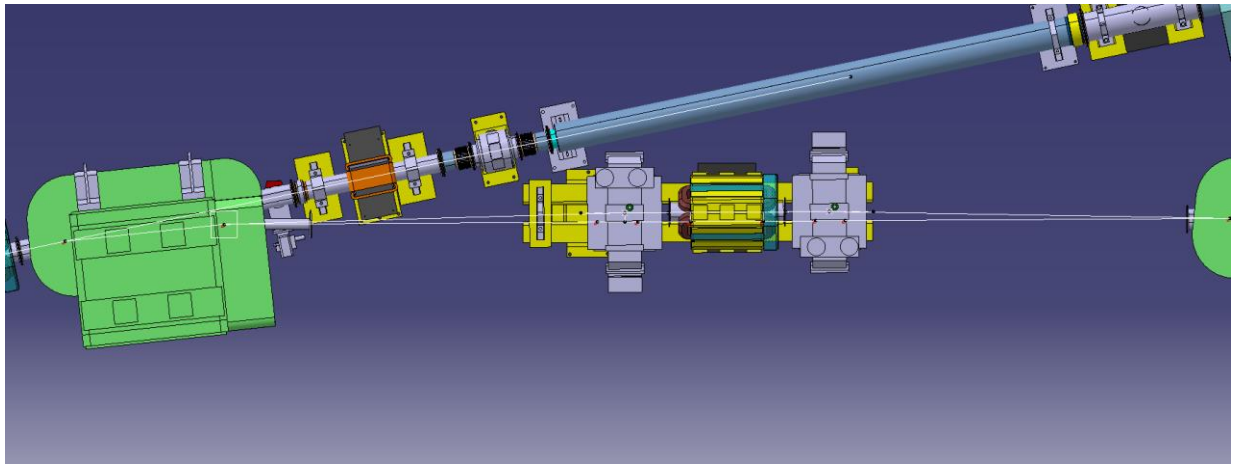
New angle – 10.16º

- Detailed optics study to determine new beam line angle and new location of magnets.
- Integration study ongoing to determine interferences (civil engineering) and modifications required (supports, vacuum pipe…)

BTY line: ISOLDE side – HRS switch

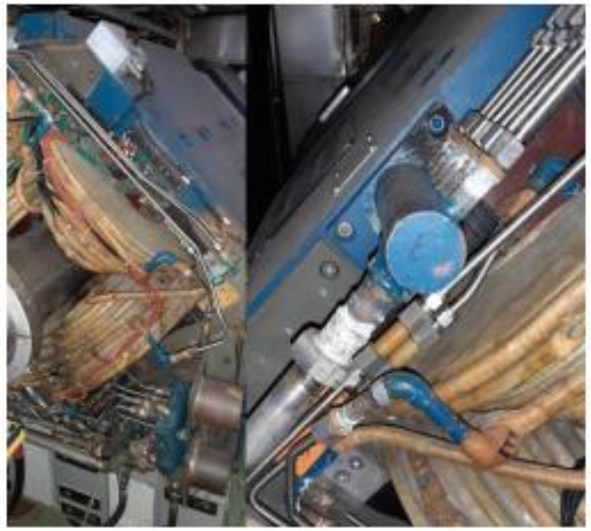
- One vertical bend (PS Booster side) – PS Booster at lower altitude as regards to ISOLDE

Addition of two small dipoles



study integrating 2x PXMCXCEHWP: BTV and DHZ/DVT to be reintegrated downstream of new magnets

Consolidation of final focusing quadrupoles (QDE209, QFO210, QDE321,QFO322)



Aging issue – different options (aperture) and beam spot size on target
Laminated yoke considered (pulsed mode – energy consideration)

BTY line: Power convertors

- Consolidation request due to obsolescence of equipment. 2.0 GeV BTY line upgrade included in the specification (extra budget made available)
- Order placed: Compatible with 2 GeV option and pulsed operation (replacement of the final focusing quadrupole) will be beneficial for energy saving

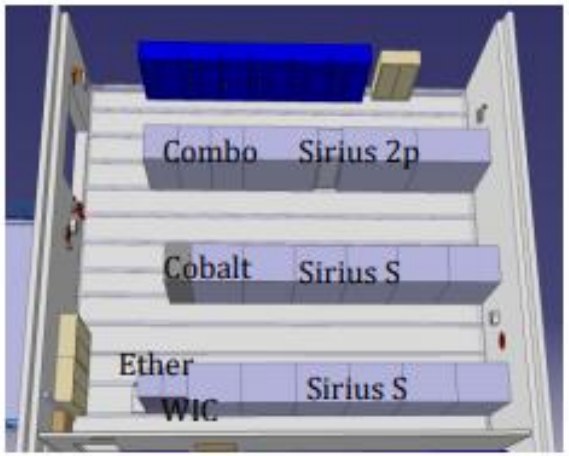


Figure 7 — Building 197/1-401: possible integration of SIRIUS converters.

CERN | SY Accelerator Systems

REFERENCE
PSB-RP-ES-0002

Date: 2023-07-05

FUNCTIONAL SPECIFICATION

Sirius S and 2P Power Converters for Magnets of the PSB-BTY Transfer Line in the Framework of the Accelerator Consolidation Project

ABSTRACT:

This document covers the functional specifications of SIRIUS converters for the replacement of old power supplies in the framework of the accelerator consolidation program for the PSB-BTY Transfer line.

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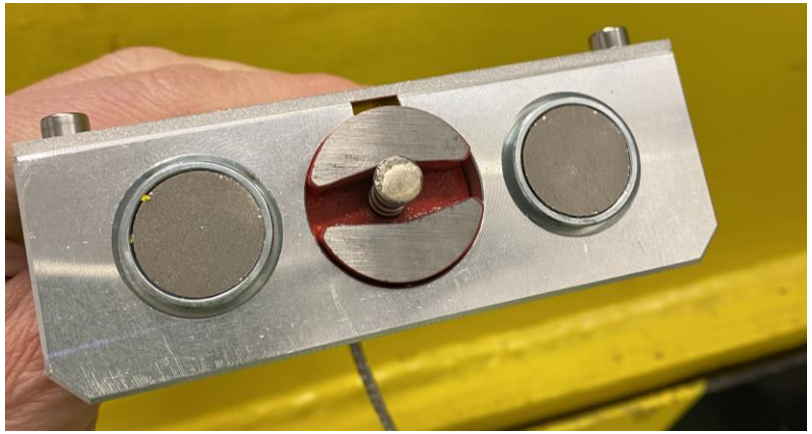
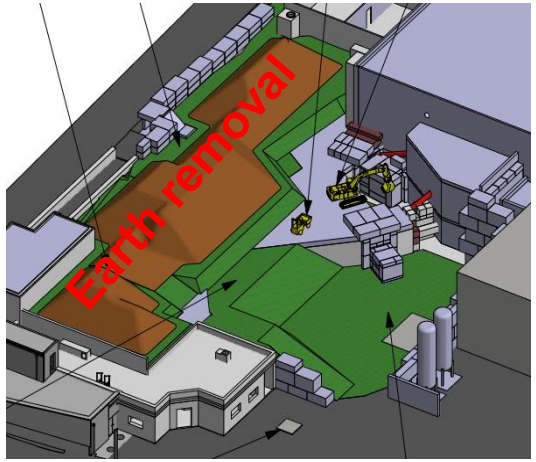
Beam Dumps Replacement Study

- Motivation: the beam dumps are iron blocks (not active shielding) surrounded by shielding blocks that are covered with soil
- Unknown condition (only front face is visible during YETS)
- Absence of monitoring and cooling limits operation with available power
- Thermo-Couple installed on accessible face of dumps during the YETS last year (cross check with simulations)



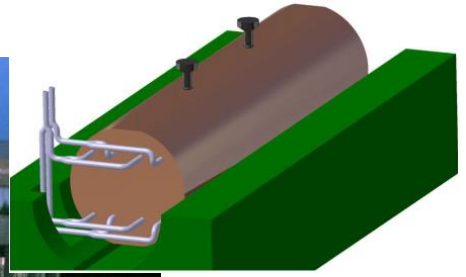
Ana-Paula Bernardes Project Leader

Solution: Beam Dumps Replacement Study



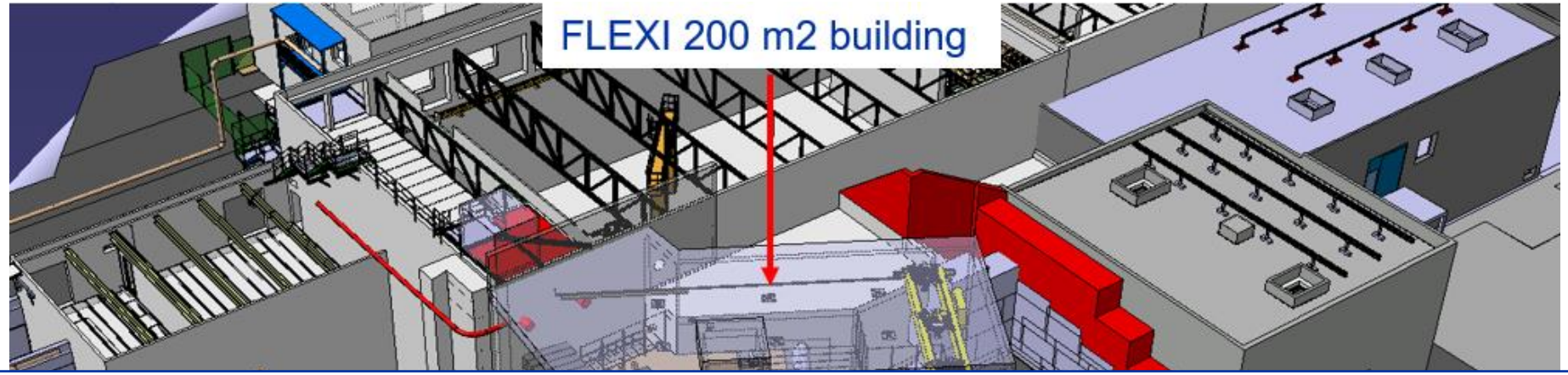
- Detailed study ongoing for beam dumps removal (optimization of costs)
- Doing the reverse process as the one done for the construction
- Activity only considered during a LS
- Major worksite (reason to anticipate B. 197 work)
- New beam dumps and shielding able to cope safely with increased beam power

Water cooled dumps



Ana-Paula Bernardes Project Leader

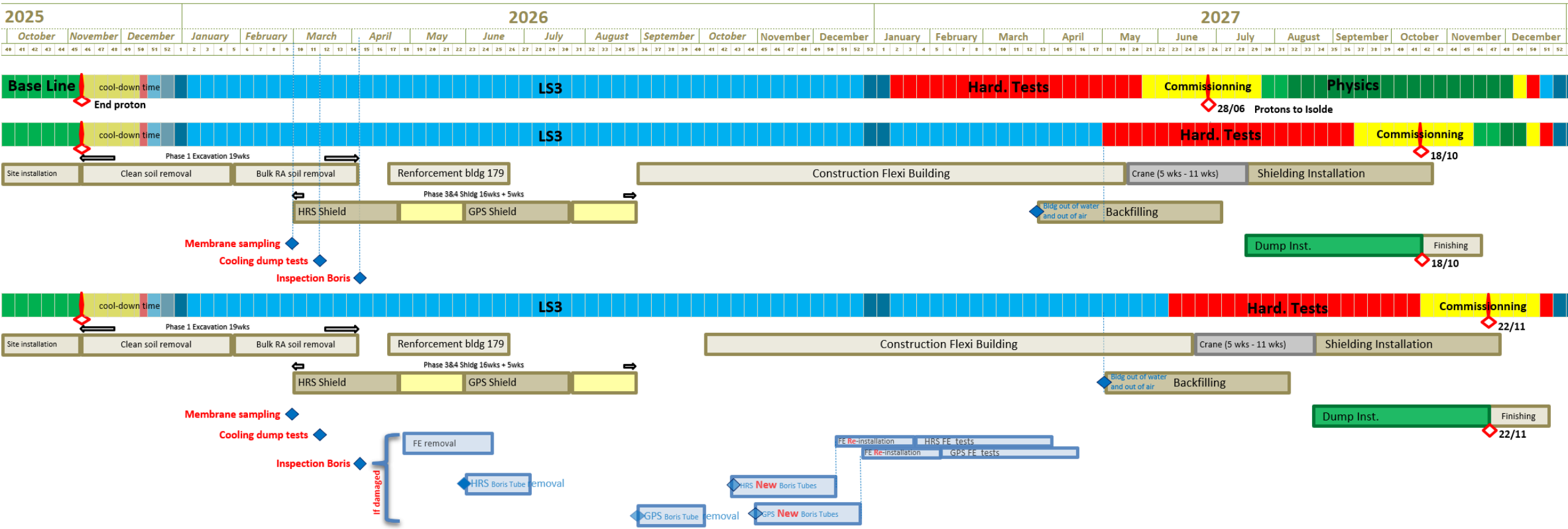
What to rebuild? FLEXI Building on top of target area



- New technical building allowing for handling of shielding and dumps (anticipate dismantling).
- Re-enforced shielding to cope safely with higher beam power. Major effort ongoing to identify existing shielding blocks around CERN to re-use (cost reduction)
- Not accessible during operation (equivalent of HT room or separator areas).
- New access possibility to HRS separator area. New access to target area.
- Space and reservation for Frontends (target stations) evolution (see next slides)

What to rebuild? FLEXI Building on top of target area

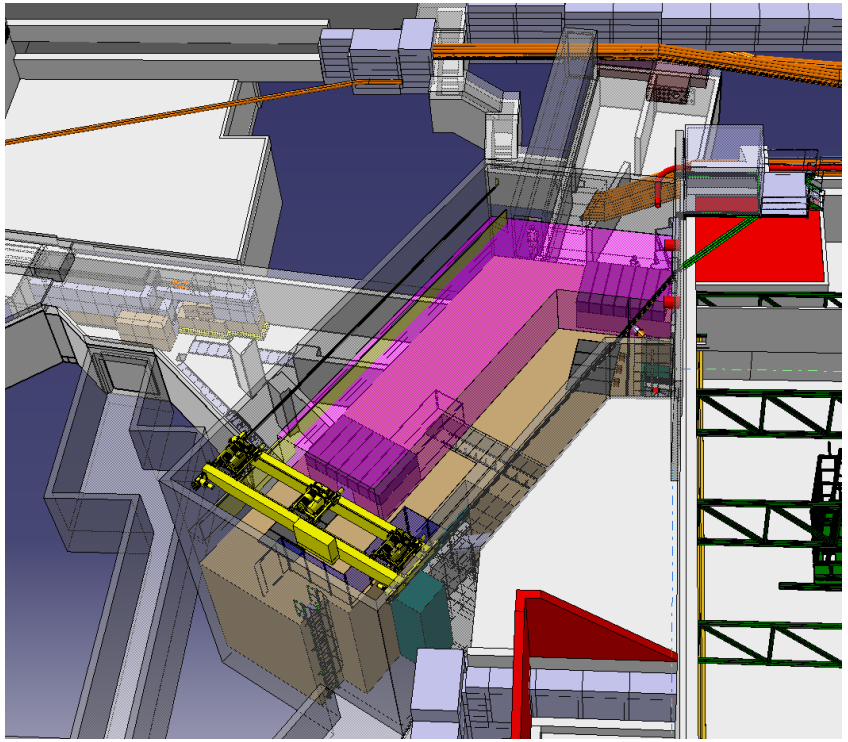
Detailed planning studies ongoing (different scenarios to account for unexpected situations)
Activity (if approved) will be the major worksite around ISOLDE during LS3 (LS window not to be missed)

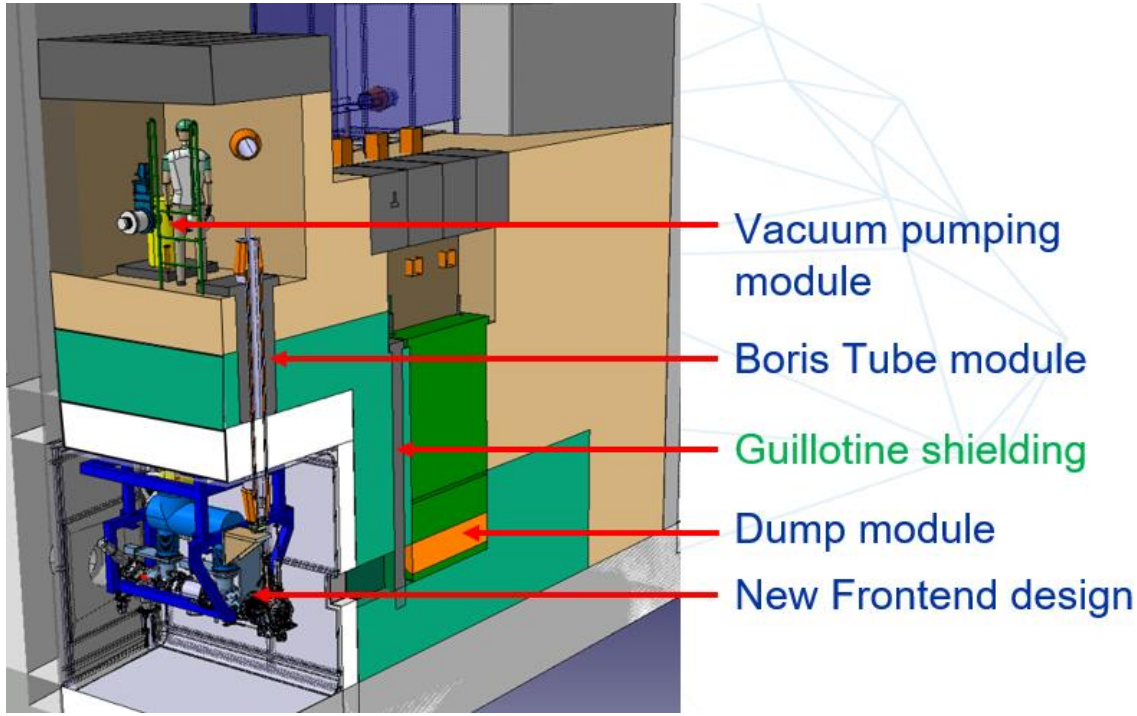


Planning study in work – S. Mataguez

Possibilities offered by the FLEXI building (beyond LS3)

- Frontend (target station) upgrade currently limited by infrastructure (passage of services via the Boris tube for the target). Space limited in Faraday cages, not remote-handling compatible.
- Crane and vertical handling offers new possibility. Relocation of Turbo Pumps (sensitive to radiations)
- More simplified Frontend and possibility for remote handling
- Sub-are in FLEXI building for target systems (cooling skid, primary oil pumps…)
- Interface with Building 197 extension (fire safety) carefully considered





Concept from Stefano Marzari

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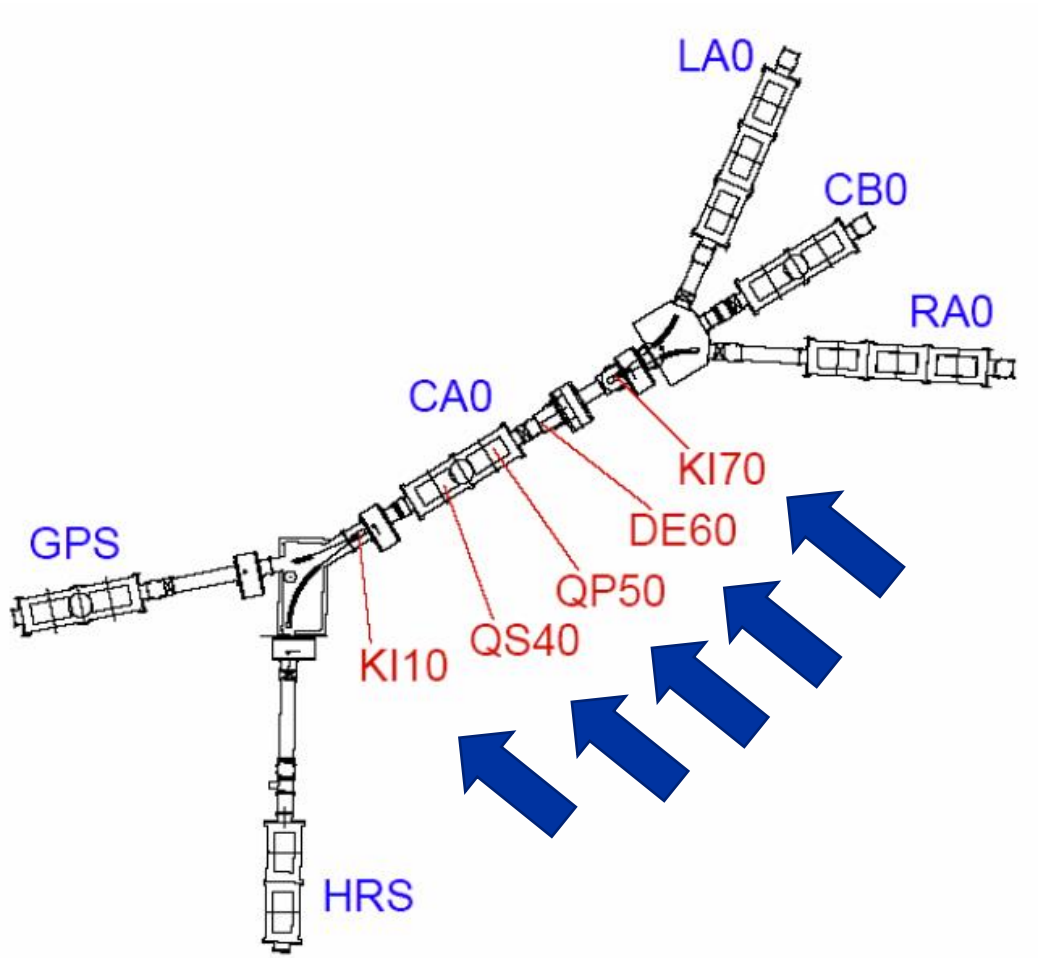
Beam Switching of the central beam line



Both FE deliver beam to multiple beamlines

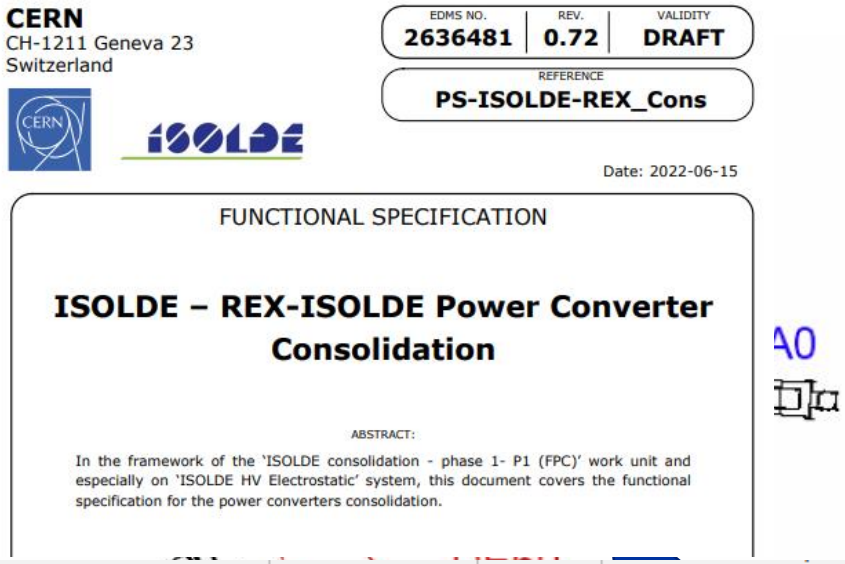
Constraints:

Beam parameters are different for HRS, GPS

1. Trained person entering at ISOLDE
2. Swap High Voltage cables
3. Load voltage set data

Yago Gracia, Line Le, Max Schütt, Mia Au, Sebastian Rothe

Beam Switching of the central beam line



CERN
CH-1211 Geneva 23
Switzerland

EDMS NO.	REV.	VALIDITY
2636481	0.72	DRAFT

REFERENCE
PS-ISOLDE-REX_Cons

Date: 2022-06-15

FUNCTIONAL SPECIFICATION

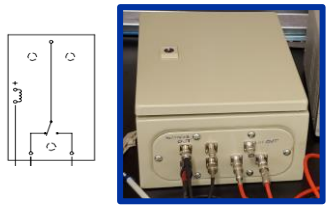
ISOLDE – REX-ISOLDE Power Converter Consolidation

ABSTRACT:

In the framework of the 'ISOLDE consolidation - phase 1- P1 (FPC)' work unit and especially on 'ISOLDE HV Electrostatic' system, this document covers the functional specification for the power converters consolidation.

YCA0.QP50-POS	FUG - HCN 7EM-6500	+6500	1m	on electrode) - |6kV| instead of |6500| okay
YCA0.KIK60-NEG	FUG - HCN 7EM-6500	-6500	1m	Alternated mode requested (2x PC switched on electrode - bipolarity managed by the switch) - Deflector instead of kicker => DE instead KI - |6kV| instead of |6500| okay
YCA0.KIK60-POS	FUG - HCN 7EM-6500	+6500	1m	Alternated mode requested (2x PC switched on electrode - bipolarity managed by the switch) - Deflector instead of kicker => DE instead KI - |6kV| instead of |6500| okay
YCA0.KIK70	CERN - DC24-D3500	+3500 and -3500	500u	Alternated and shared mode requested (2x PC switched on electrode and switching @ 10kHz)
YLA0.KIK70-NEG	FUG - HCN 7EM-6500	-6500	1m	|6kV| instead of |6500| ok
YLA0.KIK70-POS	FUG - HCN 7EM-6500	+6500	1m	|6kV| instead of |6500| ok
YLA1.QS60-B	FUG - HCN 7EM-6500	-6500	1m	|6kV| instead of |6500| ok
YLA1.QS60-L	FUG - HCN 7EM-6500	+6500	1m	|6kV| instead of |6500| ok
YLA1.QS60-R	FUG - HCN 7EM-6500	+6500	1m	|6kV| instead of |6500| ok
YLA1.QS60-T	FUG - HCN 7EM-6500	-6500	1m	|6kV| instead of |6500| ok
YCB0.KIK70	CERN - DC24-D3500	+3500 and -3500	500u	Change for bipolar 3.5kV is requested
YLC0.BEH10	CERN - DC24-D3500	+3500 and -3500	500u	to be removed

Tests at Offline 2



Electromechanical Relay

Solid State Switch

	Time (ms) to transmit 95% of beam	
Quadrupole	Switch Box	Solid State
QP30	10.12	**1.88**
QP40	30.8	**5.56**
QP50	3.16	**1.84**

elected **Solid State** solution for prototype
witching tested up to 100Hz (10ms)
K for most extreme values in CA0 (931V to 2200V)
-> **All CA0 cases covered**
o do: test with new ISEG supplies at Offline 2
o do: Functional spec. for logic and TTL generator

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- Replacement of the ISOLDE Beam Dumps
- Beam Switching project
- **What about REX HIE-ISOLDE Linac ?**
- Conclusions and perspectives

What about the REX-HIE ISOLDE Linac ?

- Concerns regarding the availability of the REXEBIS and REXTRAP in case of failure of the solenoid magnets
- Aging of the NC section of the Linac (cavities and amplifier tubes)
- Mechanical stress to HIE ISOLDE Cryo Modules induced by annual thermal cycles (warm-up during winter-stop)
- Degradation of machine performances over time
- Availability of the Linac for HE physics with physics typically starting mid-July (important backlog of experiment)

What about the REX-HIE ISOLDE Linac ?

- MD ongoing to assess the possibility to use the RFQ cooler-buncher as an accumulation, cooling and bunching stage instead of REXTRAP (solenoid failure). Consolidation and improvements of REXEBIS considered until LS3
- Analysis ongoing and tests just performed with cold GHe at 85K in the cryo-module shields during the HIE ISOLDE Linac warm-up during the last days. **Context:** benefit of keeping the shield and cavities(?) at LN temperature during the winter stop.

Status of old requests - SY/RF

- The REX 101MHz now includes LLRF and HLRF to take advantage of the successful consolidation of Linac3 amplifiers and controls, it is now presented for approval.
- We request approval to start the activity for the HIE ISOLDE cryomodule, short of manpower until LS3 due to HL-LHC; however, critical orders can be sent out in the meantime. Also to be discussed in the context of FCC developments.

Accelerator Consolidation day – SY-RF presentation(Oct. 2023)

Outline

- Context and introduction
- Fire safety consolidation and ventilation upgrade
- BTY line upgrade for 1.4 GeV and 2.0 GeV operation
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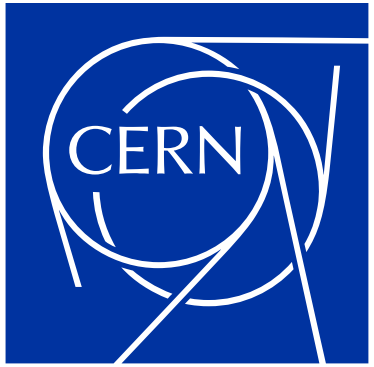
- What about REX HIE-ISOLDE Linac ?
- **Conclusions and perspectives**

Conclusions and perspectives

- Projects, studies and activities are ongoing in view of LS3 to enhance ISOLDE performances (benefit from injector upgrade…)
- Consolidations requests put forward by the technical teams have been approved and are prepared. Possibility to anticipate upgrades identified and positively supported (BTY@2 GeV, beam switching…)
- Special MTP allocation in 2023 (3.5 MCHF) to cover urgent items and studies (construction of Build. 197 extension)
- Scope, Cost and Schedule review of the programme scheduled on the 12th of December (important input for the MTP2024 preparation)
- Decision on approval of all requests (including the dumps) mid-2024
- Some activities to continue after LS3 (new Frontends, robots exchange…)



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